Supporting Information for

Copper-Catalyzed Enantioconvergent Radical C(sp^3)–N Cross-Coupling of Activated Racemic Alkyl Halides with (Hetero)aromatic Amines under Ambient Conditions

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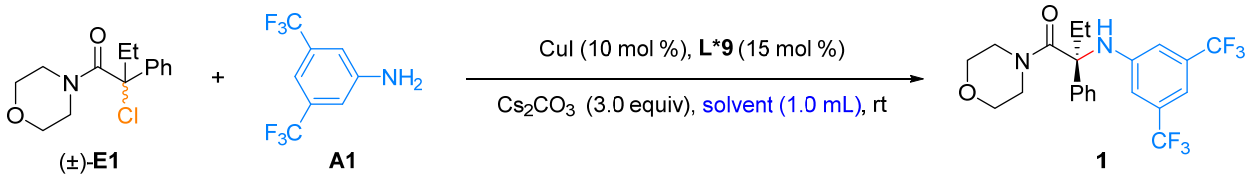
1. Tables for experiments

Table S1. Reaction condition optimization with tertiary α-chloroamide **E1** and (hetero)aromatic amine **A1**: screening of different solvents[a]

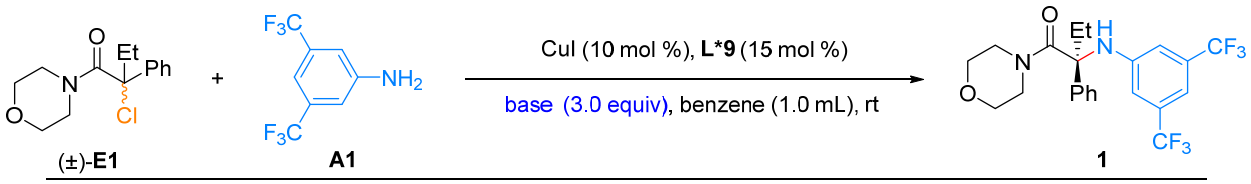


(±)-**E1** **A1** **1**

Entry	Solvent	Yield (%)	ee (%)
1	1,4-dioxane	92	94
2	DMF	12	87
3	DMA	15	88
4	DMSO	trace	–
5	MTBE	90	93
6	$^{i}Pr_2O$	8	93
7	THF	90	92
8	DME	93	92
9	benzene	91	95
10	PhMe	92	94
11	$PhCF_3$	92	92
12	PhF	91	93
13	DCM	93	91
14	DCE	92	92
15	CH_3CN	93	84
16	EtOAc	92	90
17	cyclohexane	9	89
18	*n*-hexane	trace	–

[a]Reaction conditions: (±)-**E1** (0.05 mmol), **A1** (0.06 mmol), CuI (10 mol %), **L*9** (15 mol %), and Cs_2CO_3 (3.0 equiv) in solvent (1.0 mL) at rt for 72 h under argon; yield was based on ^{1}H NMR analysis of the crude product using 1,3,5-trimethoxybenzene as an internal standard; the ee value was based on HPLC analysis.

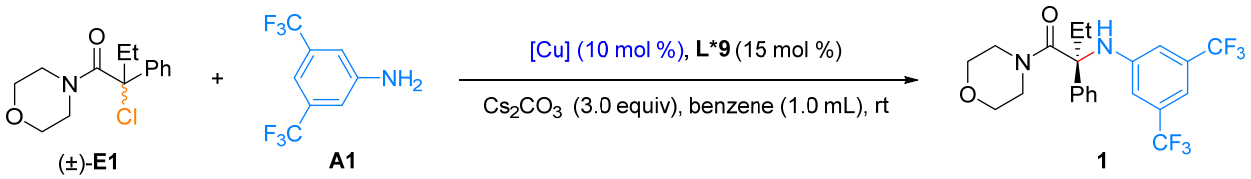
Table S2. Reaction condition optimization with tertiary α-chloroamide **E1** and (hetero)aromatic amine **A1**: screening of different bases[a]



Entry	Base	Yield (%)	ee (%)
1	Cs_2CO_3	91	95
2	Rb_2CO_3	90	95
3	K_3PO_4	90	95
4	Na_3PO_4	54	95
5	CsF	7	94
6	LiOH	0	–
7	LiOMe	0	–
8	LiO^tBu	trace	94
9	Na_2CO_3	23	94
10	NaOMe	74	94
11	NaO^tBu	0	–
12	NaOH	7	95
13	K_2CO_3	90	95
14	KOMe	6	11
15	KO^tBu	6	0
16	KOH	0	–

[a]Reaction conditions: (±)-**E1** (0.05 mmol), **A1** (0.06 mmol), CuI (10 mol %), **L*9** (15 mol %), and base (3.0 equiv) in benzene (1.0 mL) at rt for 72 h under argon; yield was based on ^{1}H NMR analysis of the crude product using 1,3,5-trimethoxybenzene as an internal standard; the ee value was based on HPLC analysis.

Table S3. Reaction condition optimization with tertiary α-chloroamide **E1** and (hetero)aromatic amine **A1**: screening of different copper salts[a]

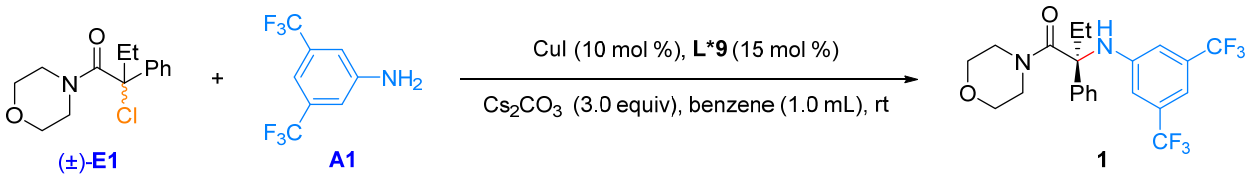


(±)-**E1** **A1** **1**

Entry	[Cu]	Yield (%)	ee (%)
1	CuI	91	95
2	CuCN	6	95
3	CuSCN	90	95
4	CuTc	90	95
5	$CuBH_4(PPh_3)_2$	27	95
6	$CuBr{\cdot}SMe_2$	91	95
7	CuOAc	trace	95
8	$Cu(PPh_3)_3Br$	18	95
9	$Cu(CH_3CN)_4PF_6$	91	94
10	$Cu(acac)_2$	14	95
11	$Cu(OTf)_2$	87	94
12	$Cu(OAc)_2$	0	–
13	$CuCl_2$	35	94
14	CuF_2	0	–
15	IMesCuCl	0	–
16	$CuBr_2$	91	95
17	$Cu_3(PO_4)_2$	0	–

[a]Reaction conditions: (±)-**E1** (0.05 mmol), **A1** (0.06 mmol), [Cu] (10 mol %), **L*9** (15 mol %), and Cs_2CO_3 (3.0 equiv) in benzene (1.0 mL) at rt for 72 h under argon; yield was based on ^1H NMR analysis of the crude product using 1,3,5-trimethoxybenzene as an internal standard; the ee value was based on HPLC analysis.

Table S4. Reaction condition optimization with tertiary α-chloroamide **E1** and (hetero)aromatic amine **A1**: screening of starting materials loading[a]

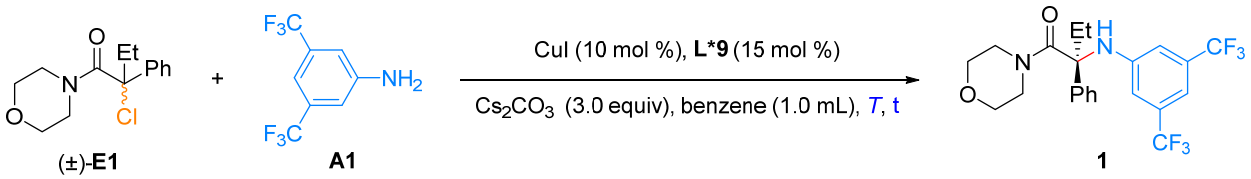


(±)-**E1** **A1** **1**

Entry	(±)-**E1** (equiv)	**A1** (equiv)	Yield (%)	ee (%)
1	1.0	1.2	91	95
2	1.0	1.1	91	95
3	1.0	1.0	91	95
4	1.1	1.0	96	95
5	1.2	1.0	>99	95

[a]Reaction conditions: (±)-**E1**, **A1**, CuI (10 mol %), **L*9** (15 mol %), and Cs_2CO_3 (3.0 equiv) in benzene (1.0 mL) at rt for 72 h under argon; yield was based on ^{1}H NMR analysis of the crude product using 1,3,5-trimethoxybenzene as an internal standard; the ee value was based on HPLC analysis.

Table S5. Reaction condition optimization with tertiary α-chloroamide **E1** and (hetero)aromatic amine **A1**: screening of temperature and time[a]

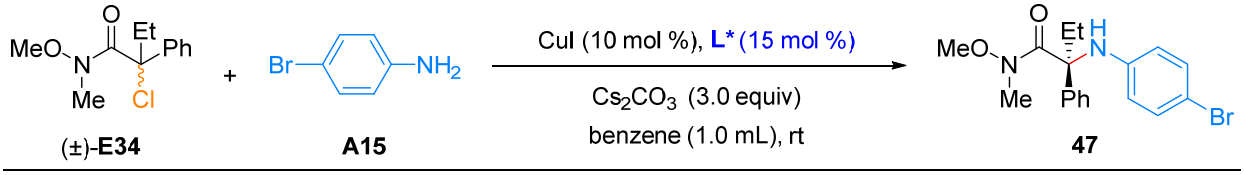


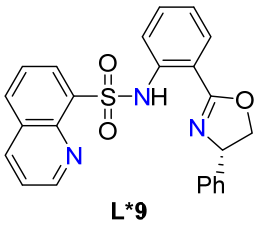
(±)-**E1** **A1** **1**

Entry	*T* (°C)	t (h)	Yield (%)	Ee (%)
1	40	8	>99	92
2	35	8	>99	93
3	30	8	>99	94
4	25	48	>99	95
5	25	24	>99	95
6	25	16	65	95
7	25	8	22	95
8	20	48	>99	95
9	20	24	82	95
10	10	48	12	95
11[b]	0	48	19	95

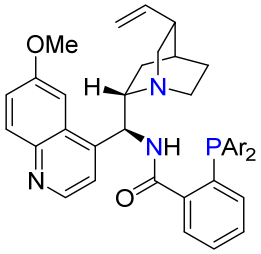
[a]Reaction conditions: (±)-**E1** (0.06 mmol), **A1** (0.05 mmol), CuI (10 mol %), **L*9** (15 mol %), and Cs_2CO_3 (3.0 equiv) in benzene (1.0 mL) at *T* for t under argon; yield was based on ^{1}H NMR analysis of the crude product using 1,3,5-trimethoxybenzene as an internal standard; the ee value was based on HPLC analysis. [b]THF was used.

Table S6. Reaction condition optimization with tertiary α-chloroamide **E34** and (hetero)aromatic amine **A15**: screening of different ligands[a]





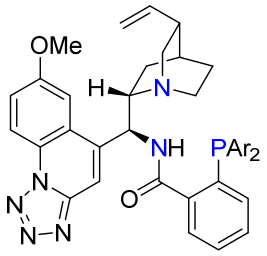
L*9



L*3: Ar = 3,5-^{t}Bu$_2$C$_6$H$_3$

L*15: Ar = 4-OMeC$_6$H$_4$

L*16: Ar = 4-OPhC$_6$H$_4$

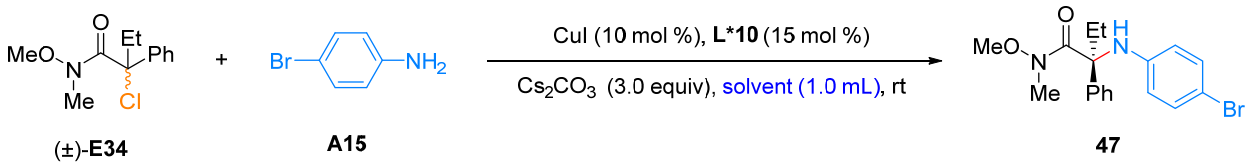


L*10: Ar = 4-OPhC$_6$H$_4$

Entry	L*	Yield (%)	ee (%)
1	**L*9**	90	14
2	**L*3**	68	64
3	**L*15**	31	69
4	**L*16**	60	74
5	**L*10**	68	76

[a]Reaction conditions: (±)-**E34** (0.05 mmol), **A15** (0.05 mmol), CuI (10 mol %), **L*** (15 mol %), and Cs_2CO_3 (3.0 equiv) in benzene (1.0 mL) at rt for 72 h under argon; yield was based on ^{1}H NMR analysis of the crude product using 1,3,5-trimethoxybenzene as an internal standard; the ee value was based on HPLC analysis.

Table S7. Reaction condition optimization with tertiary α-chloroamide **E34** and (hetero)aromatic amine **A15**: screening of different solvents[a]

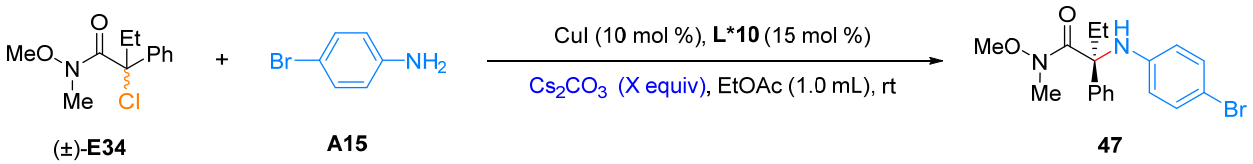


(±)-**E34** **A15** **47**

Entry	Solvent	Yield (%)	ee (%)
1	benzene	68	76
2	DMF	0	–
3	THF	44	75
4	1,4-dioxane	47	76
5	DCM	87	68
6	CH_3CN	8	73
7	EtOAc	66	78
8	*n*-hexane	28	65

[a]Reaction conditions: (±)-**E34** (0.05 mmol), **A15** (0.05 mmol), CuI (10 mol %), **L*10** (15 mol %), and Cs_2CO_3 (3.0 equiv) in solvent (1.0 mL) at rt for 72 h under argon; yield was based on ^{1}H NMR analysis of the crude product using 1,3,5-trimethoxybenzene as an internal standard; the ee value was based on HPLC analysis.

Table S8. Reaction condition optimization with tertiary α-chloroamide **E34** and (hetero)aromatic amine **A15**: screening of Cs_2CO_3 loading[a]

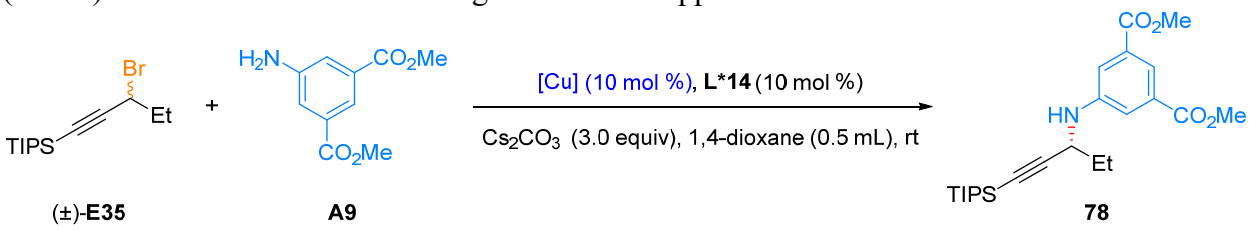


(±)-**E34** **A15** **47**

Entry	Cs_2CO_3 (X equiv)	Yield (%)	ee (%)
1	2	38	74
2	3	66	78
3	4	70	79
4	5	75	80
5	6	79	80
6	7	81	80
7	8	82	81
8[b]	8	94	81
9[c]	8	99	81

[a]Reaction conditions: (±)-**E34** (0.05 mmol), **A15** (0.05 mmol), CuI (10 mol %), **L*10** (15 mol %), and Cs_2CO_3 (X equiv) in EtOAc (1.0 mL) at rt for 72 h under argon; yield was based on ^{1}H NMR analysis of the crude product using 1,3,5-trimethoxybenzene as an internal standard; the ee value was based on HPLC analysis. [b](±)-**E34** (0.055 mmol). [c](±)-**E34** (0.06 mmol).

Table S9. Reaction condition optimization with secondary propargyl bromide **E35** and (hetero)aromatic amine **A9**: screening of different copper salts[a]

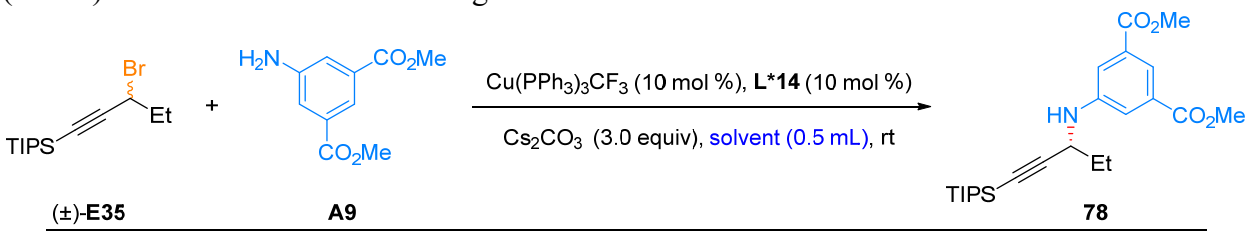


(±)-**E35** **A9** **78**

Entry	[Cu]	Yield (%)	ee (%)
1	CuI	33	86
2	CuBr	27	85
3	$CuBr_2$	41	84
4	CuCN	0	–
5	CuTc	23	81
6	$CuBr{\cdot}SMe_2$	34	84
7	$Cu(CH_3CN)_4PF_6$	31	82
8	$Cu(PPh_3)_3Br$	27	88
9	$Cu(PPh_3)_3CF_3$	32	90
10	–	0	–
11[b]	$Cu(PPh_3)_3CF_3$	0	–

[a]Reaction conditions: (±)-**E35** (0.05 mmol), **A9** (0.075 mmol), [Cu] (10 mol %), **L*14** (10 mol %), and Cs_2CO_3 (3.0 equiv) in 1,4-dioxane (0.5 mL) at rt for 48 h under argon; yield was based on ^{1}H NMR analysis of the crude product using 1,3,5-trimethoxybenzene as an internal standard; the ee value was based on HPLC analysis. [b]Without **L*14**.

Table S10. Reaction condition optimization with secondary propargyl bromide **E35** and (hetero)aromatic amine **A9**: screening of different solvents[a]

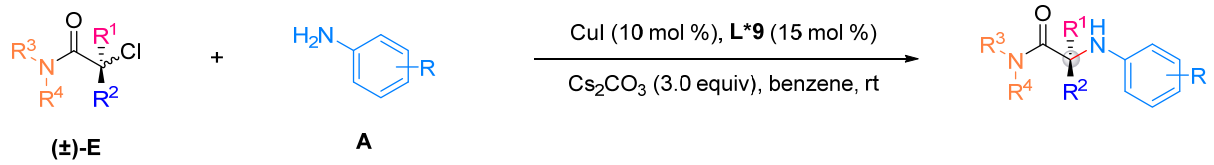


(±)-**E35** **A9** **78**

Entry	Solvent	Yield (%)	ee (%)
1	1,4-dioxane	32	90
2	THF	33	86
3	CH_3CN	0	–
4	MTBE	27	85
5	DME	21	86
6	benzene	26	86
7	$PhCF_3$	0	–
8	DCM	13	84
9	DMF	0	–
10	EtOAc	26	85
11[b]	1,4-dioxane	51	90
12[c]	1,4-dioxane	62	90
13[d]	1,4-dioxane	63	90

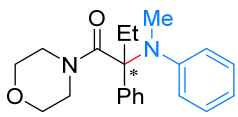
[a]Reaction conditions: (±)-**E35** (0.05 mmol), **A9** (0.075 mmol), $Cu(PPh_3)_3CF_3$ (10 mol %), **L*14** (10 mol %), and Cs_2CO_3 (3.0 equiv) in solvent (0.5 mL) at rt for 48 h under argon; yield was based on ^1H NMR analysis of the crude product using 1,3,5-trimethoxybenzene as an internal standard; the ee value was based on HPLC analysis. [b]For 96 h. [c]For 120 h. [d]For 144 h.

2. Figures for experiments

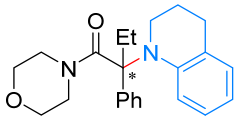


(±)-E　　A

Unsuccessful arylamines:



trace[a]



trace[a]

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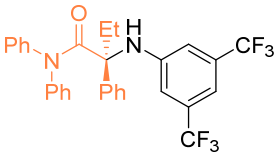
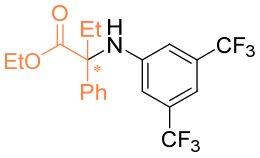
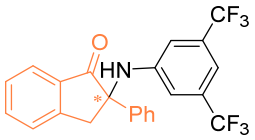


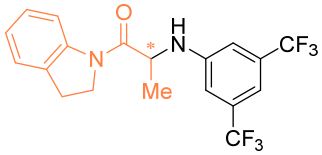
trace[b]



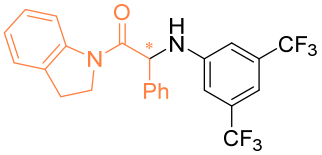
99%, 25% ee



99%, 13% ee

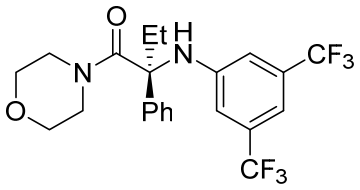


99%, 46% ee[c]



99%, 47% ee

Figure S1. Unsuccessful examples. Standard reaction conditions: (±)-**E** (1.2 equiv), **A1** (0.20 mmol), CuI (10 mol %), **L*9** (15 mol %), and Cs_2CO_3 (3.0 equiv) in benzene (4.0 mL) at rt for 72 h under argon; yields were isolated ones; ee values were determined by HPLC analysis. [a]Most of **E1** was recovered. [b]3-Ethyl-1,3-diphenylindolin-2-one was obtained in 90% yield. [c]Alkyl bromide was used.



1

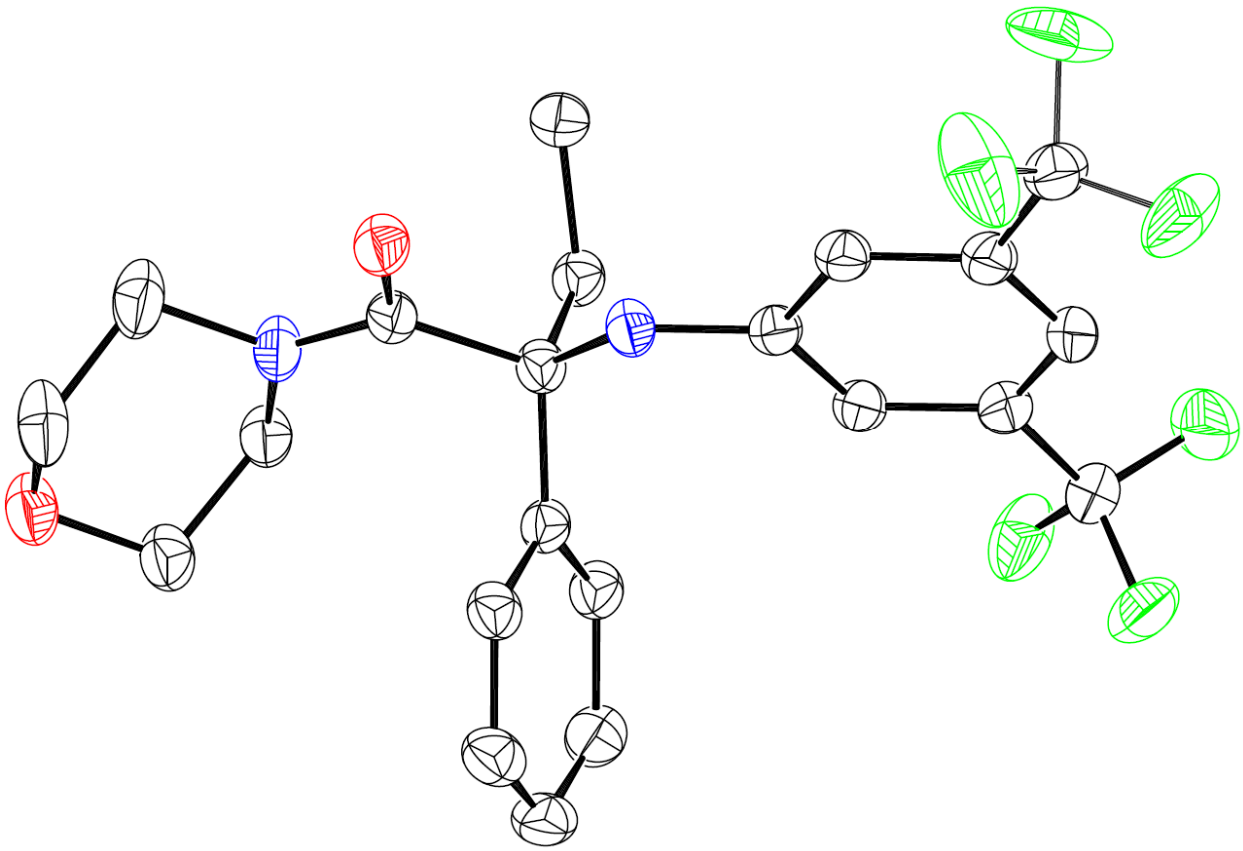
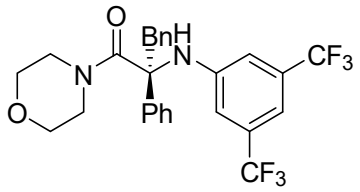


Figure S2. The X-ray structure of **1**.



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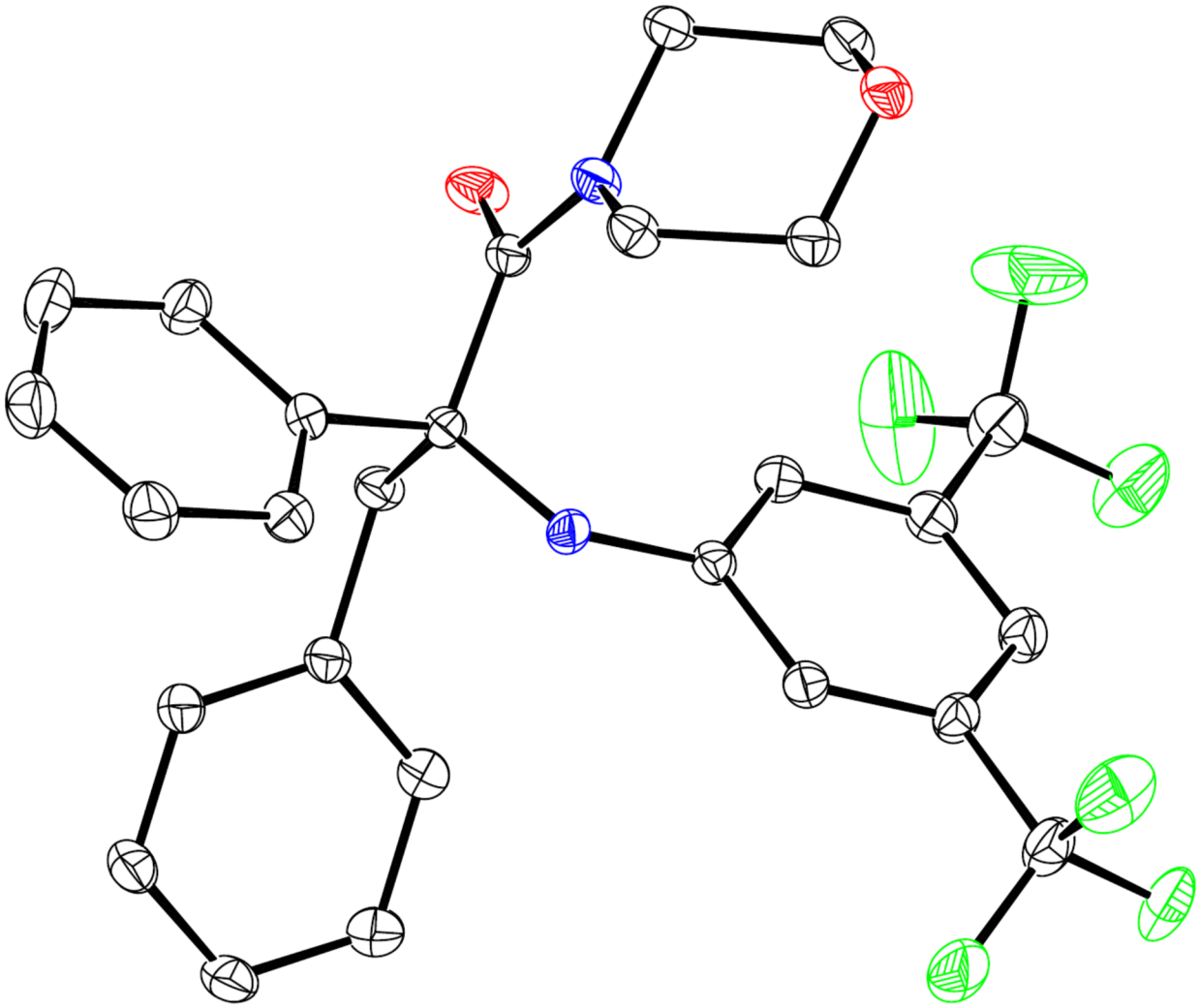
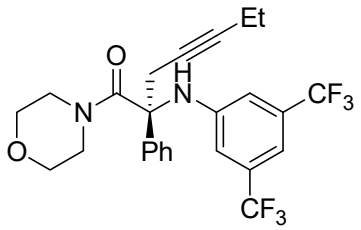


Figure S3. The X-ray structure of **5**.



13

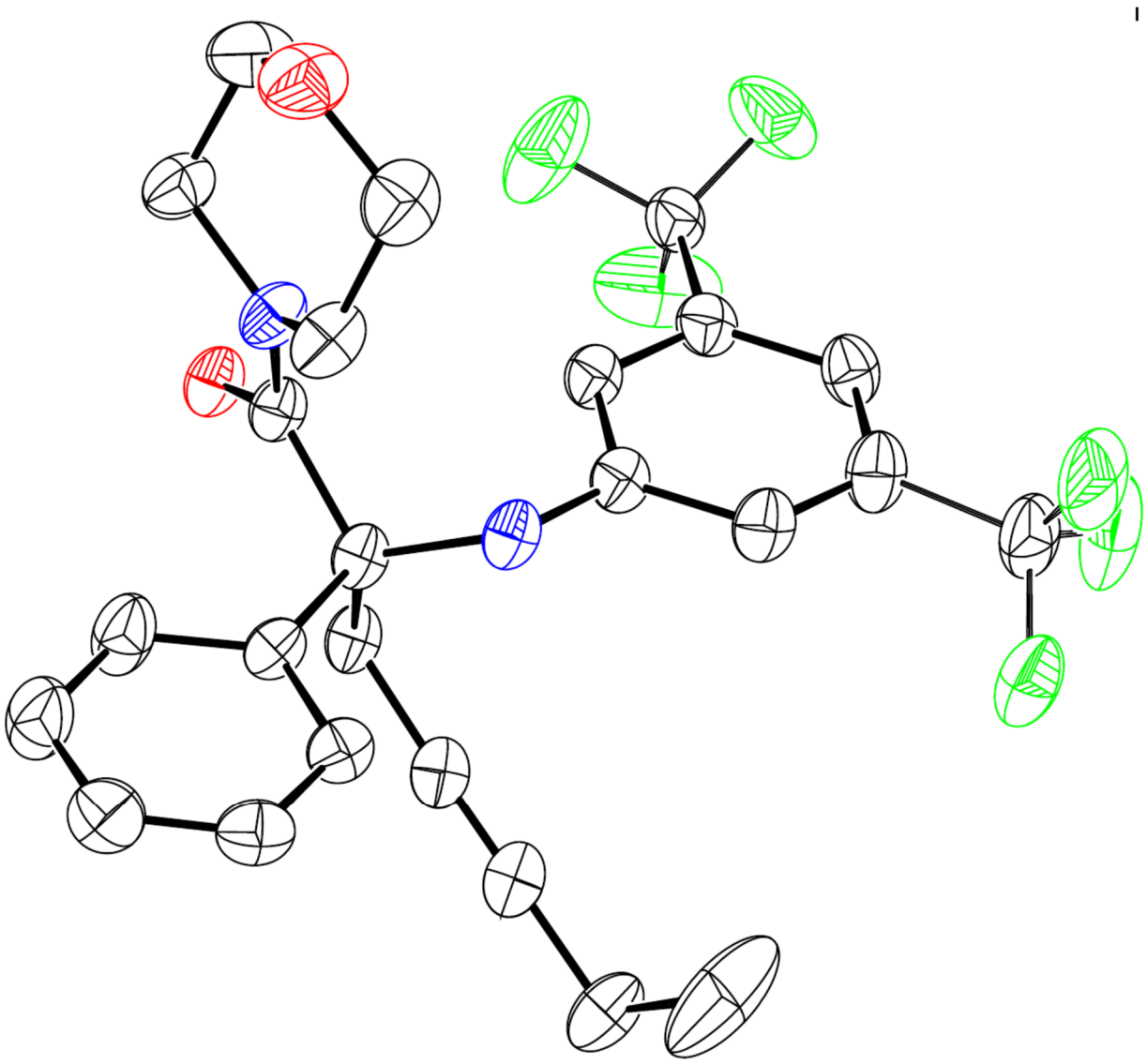
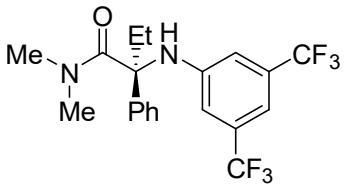


Figure S4. The X-ray structure of **13**.



31

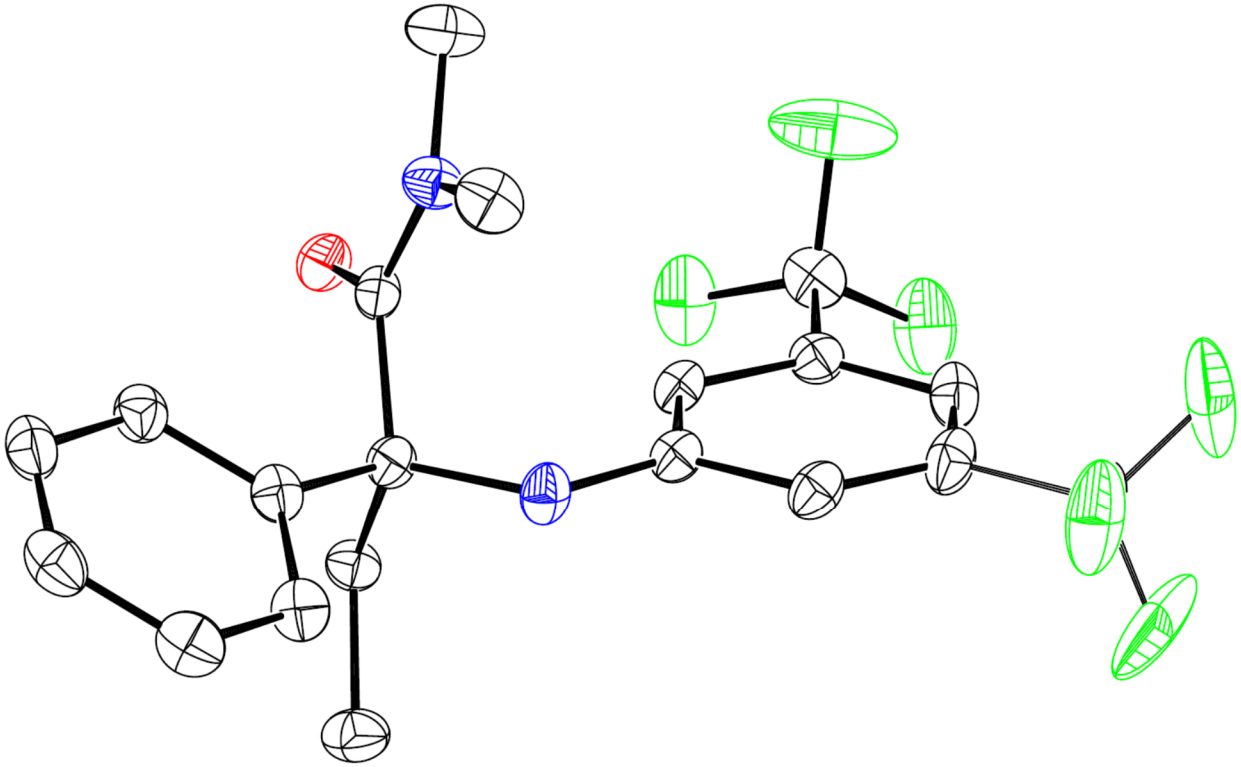
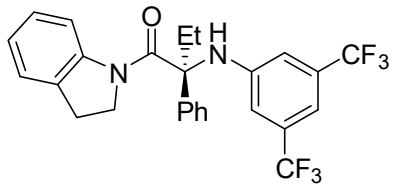


Figure S5. The X-ray structure of **31**.



32

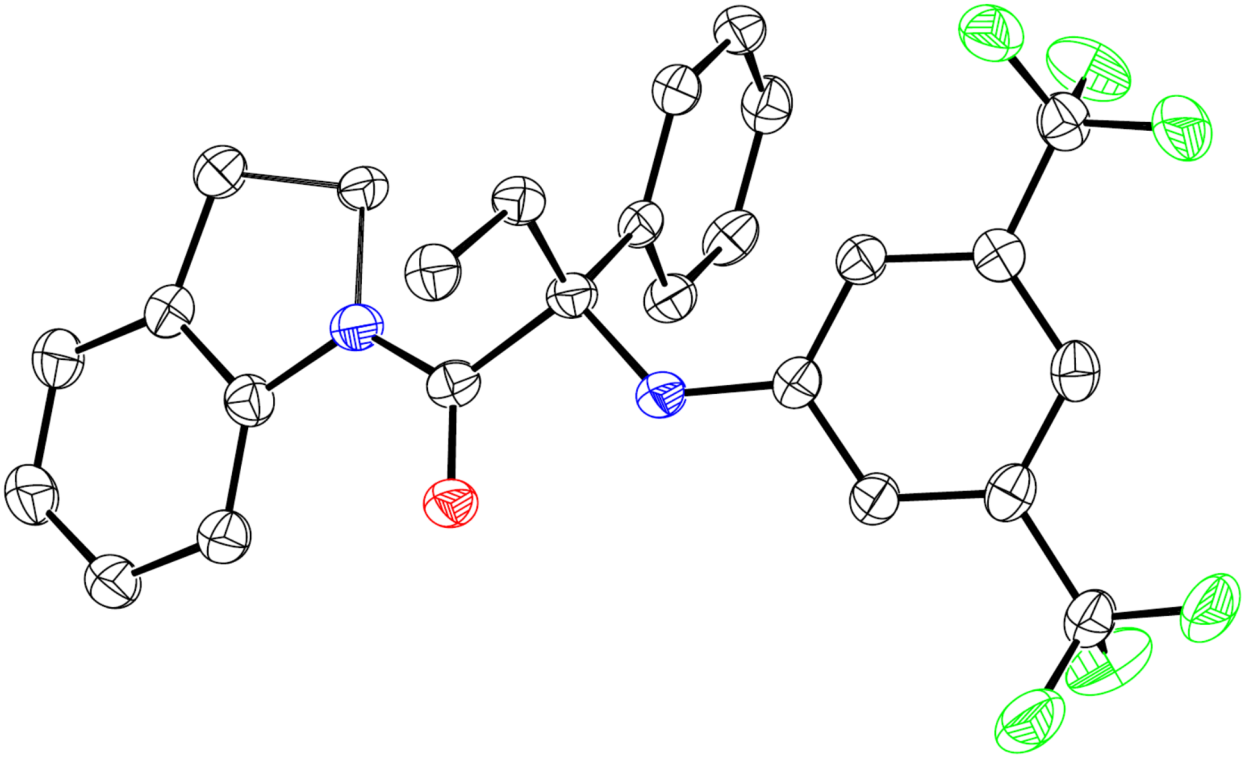
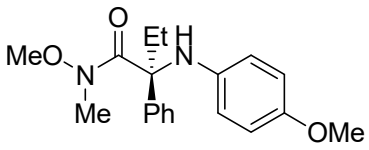


Figure S6. The X-ray structure of **32**.



53

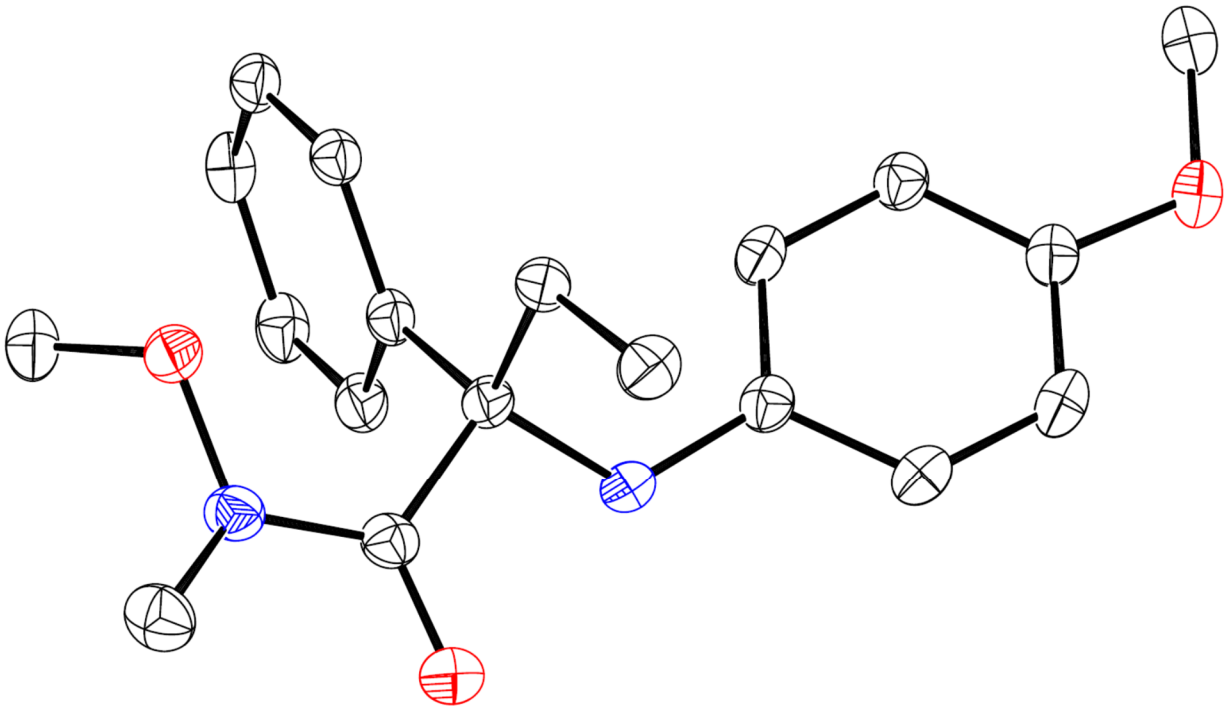
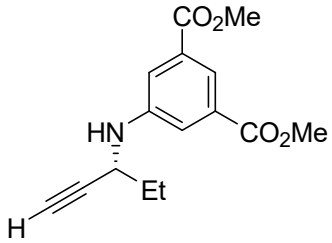


Figure S7. The X-ray structure of **53**.



96

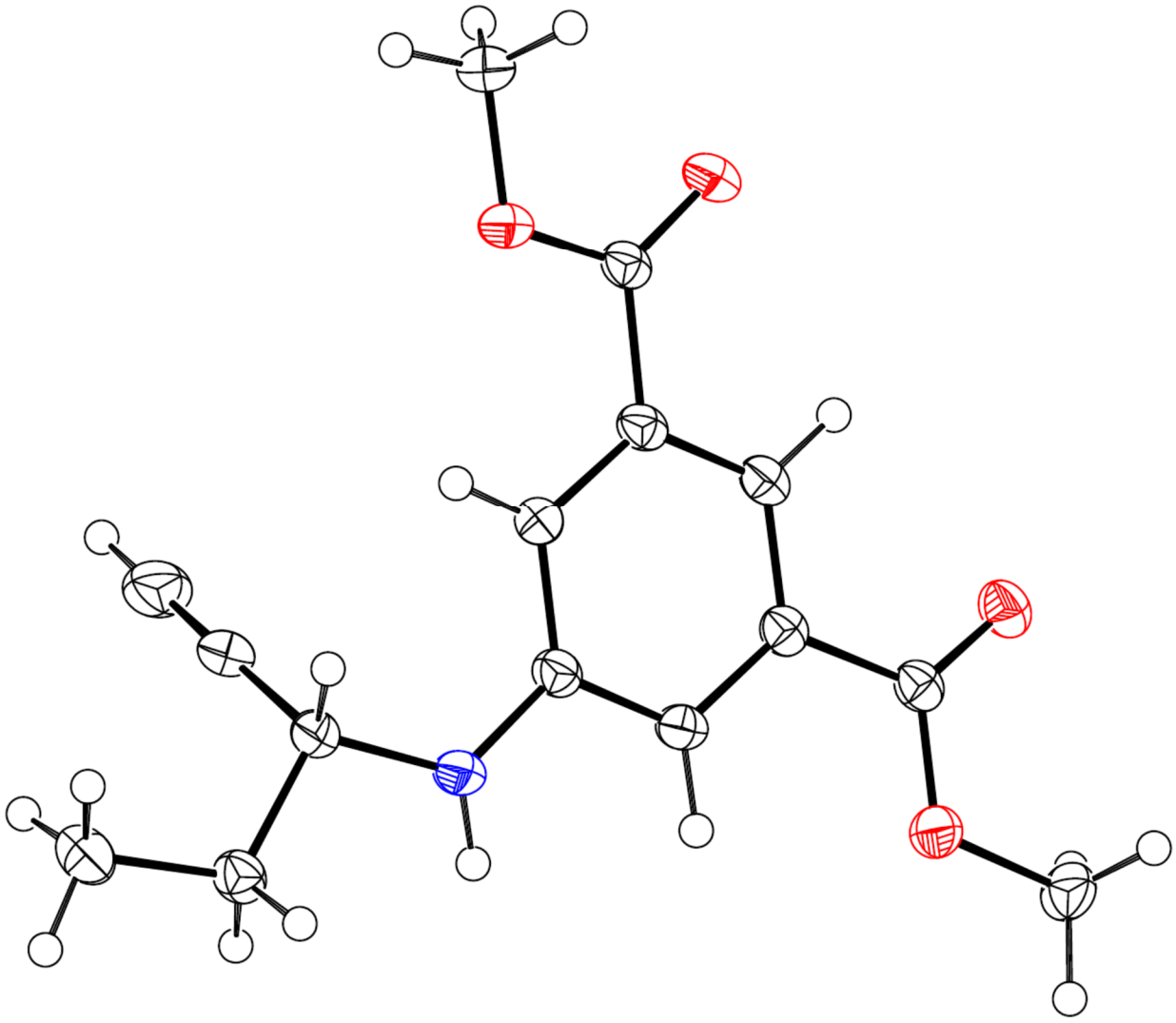


Figure S8. The X-ray structure of **96**.

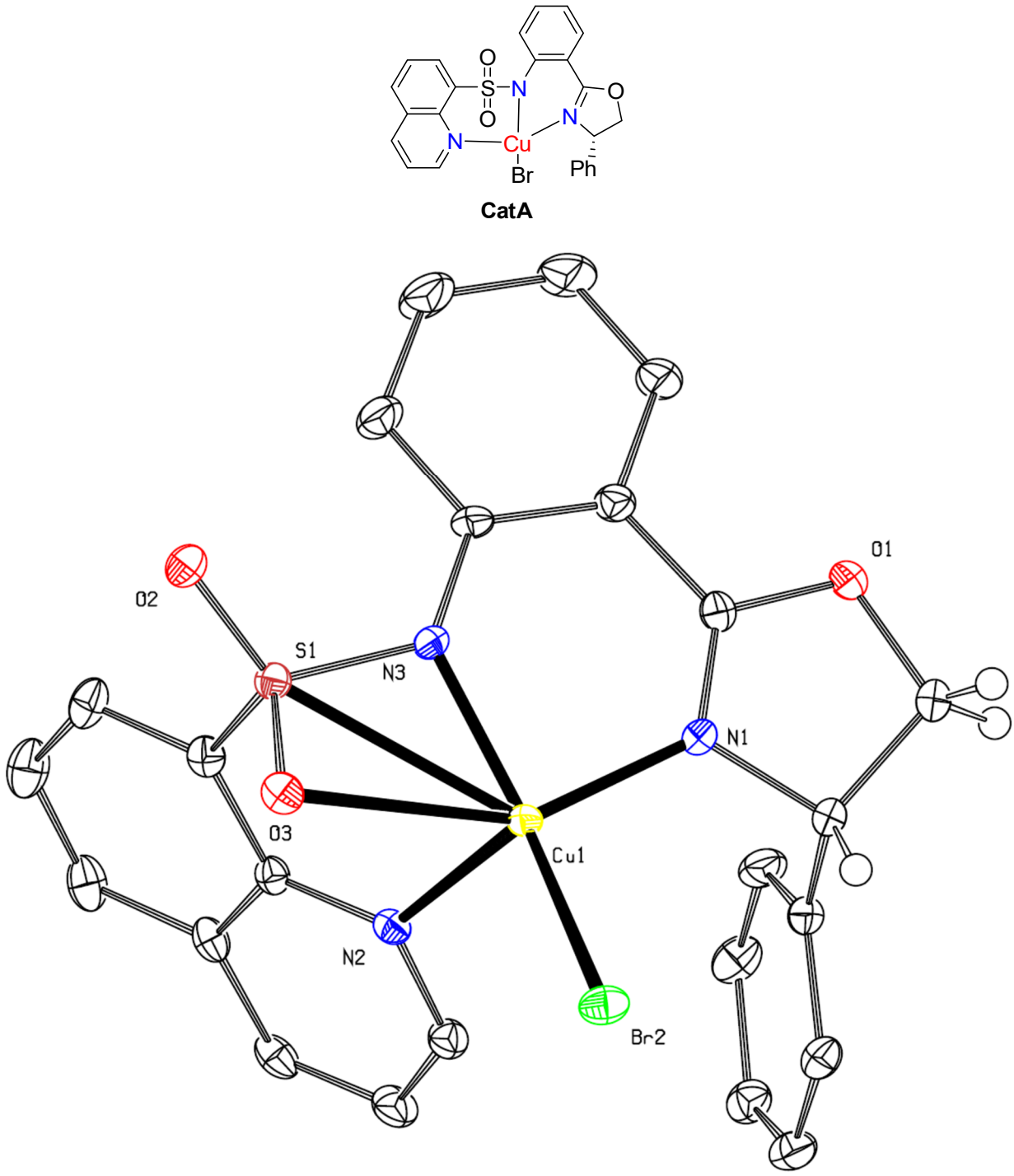


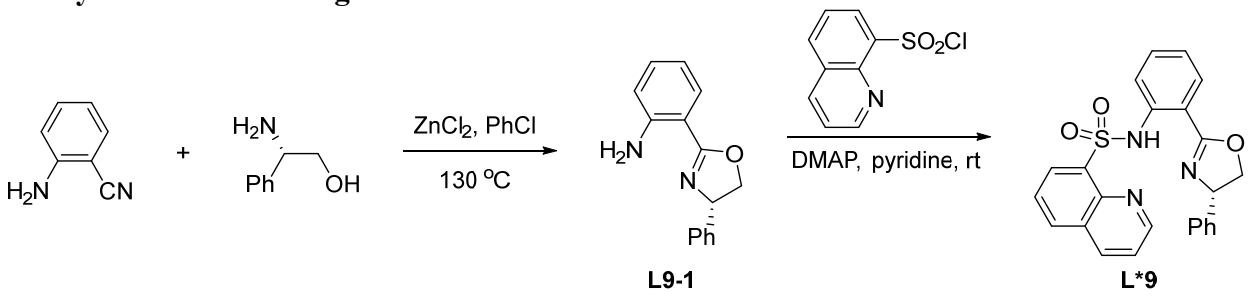
Figure S9. The X-ray structure of **CatA**.

3. General information

Most of reactions were carried out under argon atmosphere using Schlenk techniques. Reagents were purchased at the highest commercial quality and used without further purification, unless otherwise stated. CH_2Cl_2, THF, and DMF were purified and dried using a solvent-purification system that contained activated alumina under argon. CuI was purchased from Sigma-Aldrich. Cs_2CO_3 was purchased from Bide Pharmatech Ltd. and treated by hot gun (approximate 300 to 400 °C) for 2 minutes in vacuum. Anhydrous 1.4-dioxane, EtOAc, and benzene was purchased from J&K Scientific. Analytical thin layer chromatography (TLC) was performed on precoated silica gel 60 GF254 plates. Flash column chromatography was performed using Tsingdao silica gel (60, particle size 0.040–0.063 mm). As the eluent, the petroleum ether (PE), EtOAc, CH_2Cl_2 and CH_3OH were purchased from Shanghai Titan Scientific Co. Ltd without further purification. Visualization on TLC was achieved by use of UV light (254 nm), iodine on silica gel or basic $KMnO_4$ indicator. NMR spectra were recorded on Bruker DRX-400 and DPX-600 spectrometers at 400 or 600 MHz for ^{1}H NMR, 100 or 150 MHz for ^{13}C NMR, 376 MHz for ^{19}F NMR and 162 MHz for ^{31}P NMR respectively, in $CDCl_3$, CD_3OD or DMSO-d_6 with tetramethylsilane (TMS) as internal standard. The chemical shifts are expressed in ppm and coupling constants are given in Hz. Data for ^{1}H NMR are recorded as follows: chemical shift (ppm), multiplicity (s, singlet; d, doublet; t, triplet; q, quarter; p, pentet, m, multiplet), coupling constant (Hz), integration. Data for ^{13}C NMR are reported in terms of chemical shift (δ, ppm). Mass spectrometric data were obtained using Bruker Apex IV RTMS. Enantiomeric excess (ee) was determined using Agilent high-performance liquid chromatography (HPLC) with a Hatachi detector (at appropriate wavelength) or SHIMADZU LC-20AD with SPD-20AV detector. Column conditions are reported in the experimental section below. X-ray diffraction was measured on a 'Bruker APEX-II CCD' diffractometer with Cu–Kα radiation.

4. The synthesis of ligands and alkyl halides

The synthesis of chiral ligand L*9 and L*14



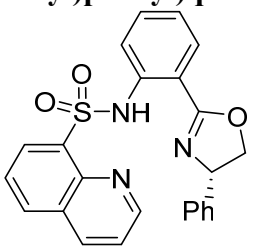
L9-1 L*9

General procedure for preparation of L*9:

According to the literature reported procedure.[1] Under an argon atmosphere, to a solution of 2-aminobenzonitrile (1.18 g, 10.0 mmol, 1.0 equiv) and (*S*)-2-amino-2-phenylethan-1-ol (2.06 g, 15.0 mmol, 1.5 equiv) in chlorobenzene (30 mL) was added dry $ZnCl_2$ (4.02 g, 30.0 mmol, 3.0 equiv) at once at rt. Then, the reaction mixture was reflux for 24 h. After completion (monitored by TLC), the reaction mixture was dissolved in water, EtOAc, and 2 mL ethylenediamine. Next, the reaction was extracted with EtOAc three times. The combined organic phase was washed with brine, dried over Na_2SO_4, filtrated and concentrated to afford the crude product, which was purified by flash column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to afford the product **L9-1** as a white solid (2.17 g, 91% yield).

According to the literature reported procedure.[2] Under an argon atmosphere, to a solution of (*S*)-2-(4-phenyl-4,5-dihydrooxazol-2-yl)aniline **L9-1** (1.43 g, 6.0 mmol, 1.0 equiv) and quinoline-8-sulfonyl chloride (2.04 g, 9.0 mmol, 1.5 equiv) in pyridine (30 mL, 0.2 M) was added DMAP (146.5 mg, 1.2 mmol, 0.2 equiv) at 0 °C. Then the reaction mixture was warmed up to room temperature and stirred overnight. After completion (monitored by TLC), the reaction was quenched by water and extracted with EtOAc three times. The combined organic phase was washed with brine, dried over Na_2SO_4, filtrated and concentrated to afford the crude product, which was purified by flash column chromatography on silica gel (CH_2Cl_2/CH_3OH = 50/1 to 20/1) to afford the product **L*9** as a white solid (2.54 g, 99% yield).

(*S*)-*N*-(2-(4-Phenyl-4,5-dihydrooxazol-2-yl)phenyl)quinoline-8-sulfonamide (L*9)

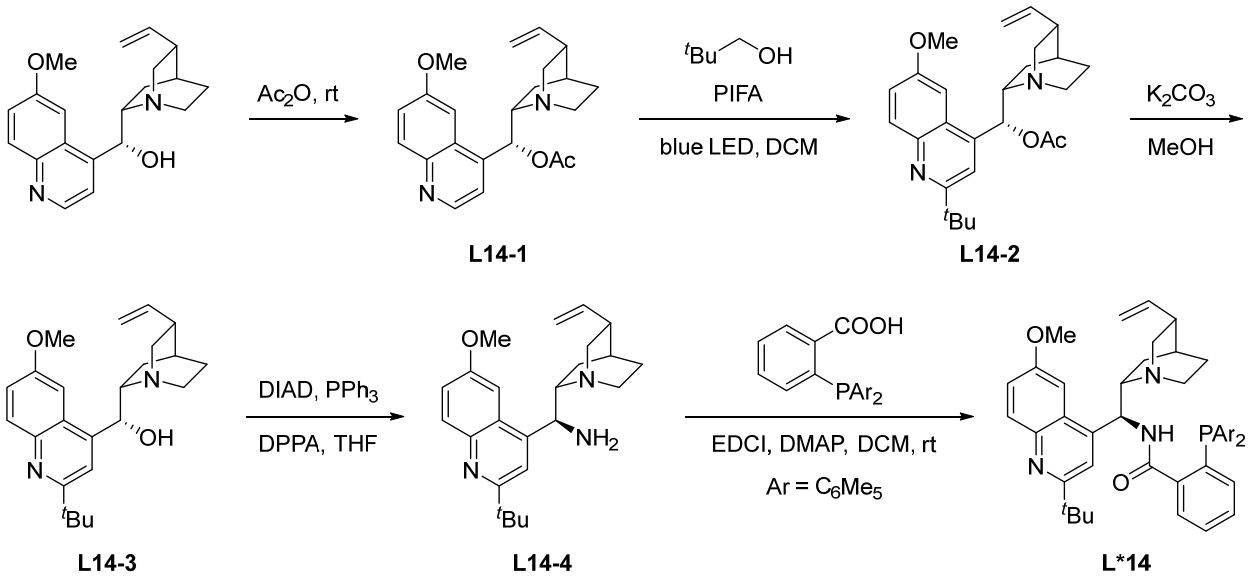


L*9

^{1}H NMR (400 MHz, $CDCl_3$) δ 12.73 (s, 1H), 8.58 – 8.56 (m, 1H), 8.36 – 8.34 (m, 1H), 8.09 – 8.07 (m, 1H), 7.97 – 7.95 (m, 1H), 7.81 – 7.75 (m, 2H), 7.60 – 7.56 (m, 1H), 7.40 – 7.25 (m, 7H), 6.94 – 6.90 (m, 1H), 5.56 (dd, *J* = 10.1, 7.9 Hz, 1H), 4.71 (dd, *J* = 10.1, 8.4 Hz, 1H), 4.20 (t, *J* = 8.2 Hz, 1H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 163.9, 151.3, 143.6, 142.0, 139.5, 136.3, 135.9, 133.7, 132.4, 132.0, 129.5, 128.8, 128.6, 127.7, 126.8, 125.0, 121.9, 121.4, 116.4, 112.8, 73.4, 70.0.

HRMS (ESI) m/z calcd. for $C_{24}H_{20}N_3O_3S$ $[M + H]^+$ 430.1220, found 430.1218.



General procedure for preparation of L*14:

According to the literature reported procedure.[3] Quinine (3.24 g, 10.0 mmol) was dissolved in acetic anhydride (20.0 mL) and stirred at room temperature for 2 h. After that, the reaction solution became clear and then was poured into ice-water, basified with aqueous ammonium hydroxide solution, and extracted with CH_2Cl_2 (30 mL × 3). The combined organic phase was washed with brine, dried over Na_2SO_4, filtrated, and concentrated to afford the crude acetylated quinine **L14-1**, which was used directly in the next step without further purification.

According to the literature reported procedure.[4] To a solution of **L14-1** (1.83 g, 5.0 mmol, 1.0 equiv) in dry CH_2Cl_2 (25 mL) was added 2,2-dimethylpropan-1-ol (2.20 g, 25.0 mmol, 5.0 equiv) at room temperature. PIFA (4.30 g, 10.0 mmol, 2.0 equiv) was then added. The reaction was irradiated with 24 W blue LEDs and kept at room temperature under fan cooling for 12 h. After completion (monitored by TLC), the reaction was quenched by addition of saturated $NaHCO_3$ until pH>8 and then extracted with CH_2Cl_2 (20 mL × 3). The combined organic phase was washed with brine, dried over Na_2SO_4, filtrated, and concentrated to afford the crude product, which was purified by flash column chromatography on silica gel to afford **L14-2** (0.74 g, 35% yield).

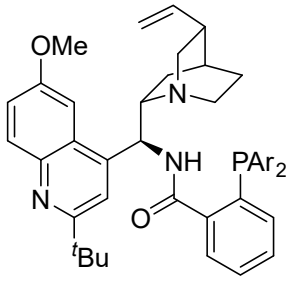
According to the literature reported procedure.[5] To a solution of **L14-2** (422.3 mg, 1.0 mmol) in MeOH (10 mL) was slowly added K_2CO_3 (689.6 mg, 5.0 mmol, 5.0 equiv) at 0 °C. Then the mixture was slowly warmed to room temperature and stirred for 2 h. After completion (monitored by TLC), the reaction was quenched with H_2O (10 mL) and extracted with CH_2Cl_2 (10 mL × 3). The combined organic phase was washed with brine, dried over Na_2SO_4, filtrated, and concentrated to afford the crude product, which was purified by flash column chromatography on silica gel (EtOAc/MeOH = 10:1) to afford **L14-3** as a white solid (362.7 mg, 95% yield).

According to the literature reported procedure[6] with slightly modification. Under an argon atmosphere, to a solution of **L14-3** (304.2 mg, 0.8 mmol, 1.0 equiv) and triphenylphosphine (PPh_3) (272.6 mg, 1.04 mmol, 1.3 equiv) in THF (5 mL) was added diisopropyl azodicarboxylate (DIAD) (210.2 mg, 1.04 mmol, 1.3 equiv) at once and stirred for 15 min at 0 °C. Then the reaction mixture was added diphenyl phosphoryl azide (DPPA) (286.0 mg, 1.04 mmol, 1.3 equiv) dropwise over 15 min at 0 °C. The reaction was allowed to warm to room temperature and stirred for 20 h. Next the reaction was heated to 50 °C for 4 h. Another portion of PPh_3 (293.5 mg, 1.12

mmol, 1.4 equiv) was then added and the reaction stirred at 50 °C for an additional 4 h. After cooling the solution to room temperature, H_2O (1 mL) was added and the solution stirred overnight at room temperature. The mixture was concentrated under reduced pressure, dissolved in CH_2Cl_2 (5 mL) and diluted with HCl aqueous solution (3.0 M, 5 mL) The aqueous layer was washed with CH_2Cl_2 (5 mL × 3), alkalinized with ammonium hydroxide and washed with CH_2Cl_2 (5 mL × 3). The combined organic phase was washed with brine, dried over Na_2SO_4, filtrated and concentrated to afford the crude product, which was purified by flash column chromatography on silica gel (CH_2Cl_2/CH_3OH = 100/1 to 10/1) to afford **L14-4** as a yellowish oil (189.6 mg, 62% yield).

According to the literature reported procedure.[7] Under an argon atmosphere, to a solution of **L14-4** (189.6 g, 0.5 mmol, 1.0 equiv), 2-(bis(2,3,4,5,6-pentamethylphenyl)phosphaneyl)benzoic acid (234.3 mg, 0.525 mmol, 1.05 equiv), and DMAP (6.1 mg, 0.05 mmol, 0.1 equiv) in CH_2Cl_2 (5 mL) was added EDCI (115 mg, 0.6 mmol, 1.2 equiv) at 0 °C. Then the reaction mixture was warmed up to room temperature and stirred overnight. After completion (monitored by TLC), the reaction was quenched by water and extracted with CH_2Cl_2 (5 mL × 3) three times. The combined organic phase was washed with brine, dried over Na_2SO_4, filtrated and concentrated to afford the crude product, which was purified by flash column chromatography on silica gel (CH_2Cl_2/CH_3OH = 100/1 to 10/1) to afford the product **L*14** as a yellowish solid (325.3 mg, 81% yield).

2-(Bis(2,3,4,5,6-pentamethylphenyl)phosphaneyl)-*N*-((*S*)-(2-(*tert*-butyl)-6-methoxyquinolin-4-yl)((1*S*,2*S*,4*S*,5*R*)-5-vinylquinuclidin-2-yl)methyl)benzamide (L*14)



L*14 (Ar = C_6Me_5)

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (d, *J* = 9.1 Hz, 1H), 7.75 – 7.71 (m, 2H), 7.57 – 7.56 (m, 1H), 7.39 (s, 1H), 7.30 – 7.26 (m, 1H), 7.22 – 7.13 (m, 3H), 5.85 – 5.67 (m, 2H), 5.03 – 4.99 (m, 2H), 3.81 (s, 3H), 3.44 – 3.34 (m, 1H), 3.26 – 3.14 (m, 2H), 2.69 – 2.63 (m, 2H), 2.31 – 2.21 (m, 1H), 2.18 (s, 3H), 2.13 (s, 3H), 2.06 (s, 6H), 1.98 (s, 12H), 1.79 (s, 6H), 1.63 – 1.60 (m, 1H), 1.55 – 1.49 (m, 2H), 1.42 (s, 9H), 0.89 – 0.83 (m, 1H), 0.77 – 0.67 (m, 1H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 168.7, 165.6, 157.1, 143.8, 143.6, 141.6, 140.9, 140.6, 138.2, 137.3, 135.4, 135.0, 133.4, 132.7, 132.6, 132.42, 132.39, 131.0, 129.6, 129.4, 127.7, 126.6, 121.0, 114.2, 101.6, 59.3, 56.0, 55.7, 55.5, 41.3, 39.5, 37.7, 30.2, 27.7, 27.5, 27.1, 19.9, 19.8, 19.7, 19.6, 17.12, 17.0, 16.4.

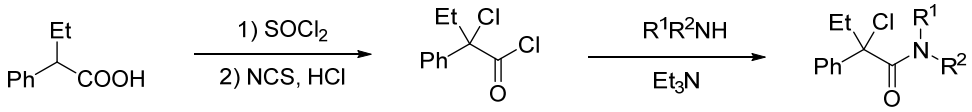
^{31}P NMR (162 MHz, $CDCl_3$) δ -24.26.

HRMS (ESI) m/z calcd. for $C_{53}H_{67}N_3O_2P$ $[M + H]^+$ 808.4965, found 808.4953.

The synthesis of propargyl bromides substrates

All the propargyl bromides were synthesized following the literatures.[7,8]

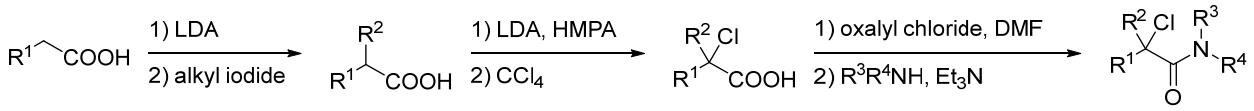
The synthesis of α-halide amide substrates



General procedure 1:

According to the literature reported procedure.[9] The carboxylic acid (25 mmol) was dissolved in $SOCl_2$ (7.25 mL, 100 mmol), and the resulting solution was heated at reflux for 30 min. The mixture was allowed to cool to room temperature, and then *N*-chlorosuccinimide (8.34 g, 63 mmol), $SOCl_2$ (5 mL), and HCl (concentrated, 4 drops) were added. The resulting mixture was heated at 90 °C for 2.5 h. The mixture was then allowed to cool to room temperature, the precipitate was filtered off and washed by CCl_4, and the solvent was removed by evaporation. The resulting liquid residue was used in the next step without further purification.

To a solution of amine (25.0 mmol, 1.0 equiv) and Et_3N (3.03 g, 30.0 mmol, 1.2 equiv) in CH_2Cl_2 (50 mL) was added the above α-chloro acid chloride at 0 °C. Then the reaction mixture was warmed up to room temperature and stirred overnight. After completion (monitored by TLC), the reaction was quenched with HCl aqueous solution (1.0 M, 50 mL) and extracted with CH_2Cl_2 three times. The combined organic phase was washed with brine, dried over Na_2SO_4, filtrated and concentrated to afford the crude product, which was purified by flash column chromatography on silica gel to afford the desired product.



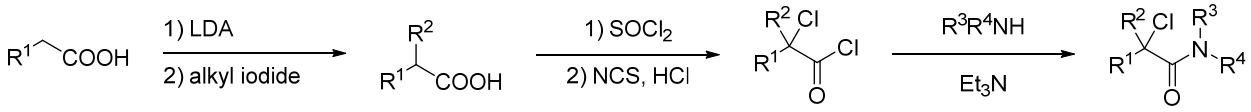
General procedure 2:

According to the literature reported procedure[10] with slightly modification. To a solution of carboxylic acid (20.0 mmol, 1.0 equiv) in anhydrous THF (40 mL) was added lithium diisopropylamide (LDA) (44.0 mmol, 2.2 equiv, 1.0 M in THF) via syringe at −78 °C under argon. After being stirred at −78 °C for 30 min, the reaction mixture was warmed up to 0 °C and stirred for another 1 h. The solution was then cooled to −78°C again and alkyl iodide (21.0 mmol, 1.05 equiv) was added in one portion. The reaction was warmed up to room temperature over 1 h and stirred overnight. The resulting solution was quenched with brine, acidified with 1.0 M aqueous HCl solution, and extracted with EtOAc three times. The combined organic phase was washed with brine, dried over Na_2SO_4, filtered and concentrated to afford the crude acid, which was used directly in the next step without further purification.

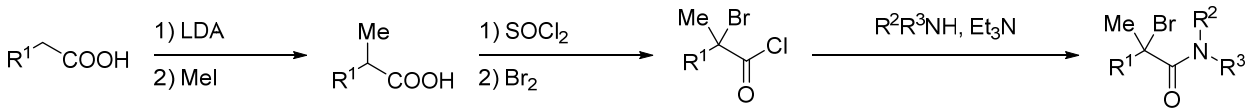
To a solution of the above acid in THF (40 mL) was added hexamethylphosphoramide (HMPA, 6 mL) and lithium diisopropylamide (LDA) (44.0 mmol, 2.2 equiv, 1.0 M in THF) via syringe at −78°C under argon. The reaction was slowly warmed up to 0 °C and stirred for another 1 h. Then the reaction mixture was cooled down to −78 °C again and treated with a solution of CCl_4 (80.0 mmol, 4.0 equiv) in THF (3 mL). After being stirred at −78 °C for 2 h, the reaction mixture was warmed up to room temperature over 1 h and stirred overnight. Then, the reaction was quenched with brine, acidified with 1.0 M aqueous HCl solution, and extracted with EtOAc three times. The combined organic phase was washed with brine, dried over Na_2SO_4, filtered and concentrated to afford the crude α-chloro acid, which was used directly in the next step without further purification.

To a solution of the above α-chloro acid in CH_2Cl_2 (50 mL) was added oxalyl chloride (24.0 mmol, 1.2 equiv) and a drop of DMF at 0 °C. The reaction mixture was stirred 40 °C for 3 h. Then, the solvent was removed under reduced pressure to afford the α-chloro acid chloride,

which was used directly in the next step without further purification.
To a solution of amine (20.0 mmol, 1.0 equiv) and Et_3N (2.43 g, 24.0 mmol, 1.2 equiv) in CH_2Cl_2 (50 mL) was added the above α-chloro acid chloride at 0 °C. Then the reaction mixture was warmed up to room temperature and stirred overnight. After completion (monitored by TLC), the reaction was quenched with HCl aqueous solution (1.0 M, 50 mL) and extracted with CH_2Cl_2 three times. The combined organic phase was washed with brine, dried over Na_2SO_4, filtrated and concentrated to afford the crude product, which was purified by flash column chromatography on silica gel to afford the desired product.



General procedure 3:
According to the literature reported procedure.[9,10] To a solution of carboxylic acid (20.0 mmol, 1.0 equiv) in anhydrous THF (40 mL) was added lithium diisopropylamide (LDA) (44.0 mmol, 2.2 equiv, 1.0 M in THF) via syringe at −78 °C under argon. After being stirred at −78 °C for 30 min, the reaction mixture was warmed up to 0 °C and stirred for another 1 h. The solution was then cooled to −78°C again and alkyl iodide (21.0 mmol, 1.05 equiv) was added in one portion. The reaction was warmed up to room temperature over 1 h and stirred overnight. The resulting solution was quenched with brine, acidified with 1.0 M aqueous HCl solution, and extracted with EtOAc three times. The combined organic phase was washed with brine, dried over Na_2SO_4, filtered and concentrated to afford the crude acid, which was used directly in the next step without further purification.
The above acid was dissolved in $SOCl_2$ (5.8 mL, 80 mmol), and the resulting solution was heated at reflux for 30 min. The mixture was allowed to cool to room temperature, and then *N*-chlorosuccinimide (6.65 g, 50 mmol), $SOCl_2$ (4.0 mL), and HCl (concentrated, 4 drops) were added. The resulting mixture was heated at 90 °C for 2.5 h. The mixture was then allowed to cool to room temperature, the precipitate was filtered off and washed by CCl_4, and the solvent was removed by evaporation. The resulting liquid residue was used in the next step without further purification.
To a solution of amine (20.0 mmol, 1.0 equiv) and Et_3N (2.43 g, 24.0 mmol, 1.2 equiv) in CH_2Cl_2 (50 mL) was added the above α-chloro acid chloride at 0 °C. Then the reaction mixture was warmed up to room temperature and stirred overnight. After completion (monitored by TLC), the reaction was quenched with HCl aqueous solution (1.0 M, 50 mL) and extracted with CH_2Cl_2 three times. The combined organic phase was washed with brine, dried over Na_2SO_4, filtrated and concentrated to afford the crude product, which was purified by flash column chromatography on silica gel to afford the desired product.

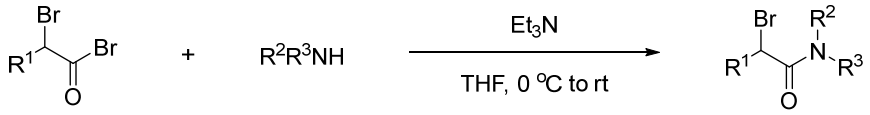


General procedure 4:
According to the literature reported procedure.[10] To a solution of carboxylic acid (10.0 mmol, 1.0 equiv) in anhydrous THF (20 mL) was added lithium diisopropylamide (LDA) (25.0 mmol, 2.5 equiv, 1.0 M in THF) via syringe at −78 °C under argon. After being stirred at −78 °C for 30 min, the reaction mixture was warmed up to 0 °C and stirred for another 1 h. The solution was then

cooled to −78°C again and iodomethane (22.0 mmol, 2.2 equiv) was added dropwise into the reaction mixture. The reaction was warmed up to room temperature over 1 h and stirred overnight. The resulting solution was quenched with brine, acidified with 1.0 M aqueous HCl solution, and extracted with EtOAc three times. The combined organic phase was dried over Na_2SO_4, filtered and concentrated to afford the crude acid, which was used directly in the next step without further purification.

The above acid was dissolved in $SOCl_2$ (3.0 mL), and the resulting solution was heated at reflux for 30 min. The mixture was allowed to cool to room temperature, and then Br_2 (3.16 g, 20.0 mmol, 2.0 equiv) and $SOCl_2$ (2.0 mL) were added. The resulting mixture was heated at 50 °C for 24 h. Then the solvent was removed under reduced pressure to afford the α-bromo acid chloride, which was used directly in the next step without further purification.

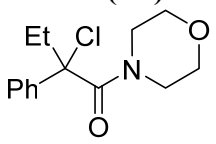
To a solution of amine (10.0 mmol, 1.0 equiv) and Et_3N (1.21 g, 12.0 mmol, 1.2 equiv) in CH_2Cl_2 (20 mL) was added the above α-bromo acid chloride at 0 °C. Then the reaction mixture was warmed up to room temperature and stirred overnight. After completion (monitored by TLC), the reaction was quenched with HCl aqueous solution (1.0 M, 20 mL) and extracted with CH_2Cl_2 three times. The combined organic phase was washed with brine, dried over Na_2SO_4, filtrated and concentrated to afford the crude product, which was purified by flash column chromatography on silica gel to afford the desired product.



General procedure 5:

According to the literature reported procedure.[11] To a solution of Et_3N (3.64 g, 36.0 mmol, 1.2 equiv) and amine (30.0 mmol, 1.0 equiv) in THF (50 mL) was added α-bromo acid bromide (36.0 mmol, 1.2 equiv) dropwise at 0 °C. Then the reaction mixture was warmed up to room temperature and stirred overnight. After completion (monitored by TLC), the reaction was quenched with HCl aqueous solution (1.0 M, 50 mL) and extracted with CH_2Cl_2 three times. The combined organic phase was washed with brine, dried over Na_2SO_4, filtrated and concentrated to afford the crude product, which was purified by flash column chromatography on silica gel to afford the desired product.

2-Chloro-1-morpholino-2-phenylbutan-1-one (E1)



E1

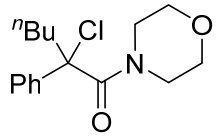
According to **General procedure 1** with 2-phenylbutanoic acid (8.20 g, 50.0 mmol, 1.0 equiv) and morpholine (4.35 g, 50.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E1** as a yellowish oil (11.06 g, 83% overall yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.28 (m, 5H), 3.75 – 3.68 (s, 4H), 3.42 – 3.37 (m, 2H), 3.11 – 3.00 (m, 2H), 2.39 (dq, *J* = 14.5, 7.3 Hz, 1H), 2.20 (dq, *J* = 14.4, 7.2 Hz, 1H), 0.80 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 168.7, 139.5, 128.5, 127.9, 125.4, 74.6, 66.6, 65.6, 47.6, 43.5,

38.0, 8.6.
HRMS (ESI) m/z calcd. for $C_{14}H_{19}ClNO_2$ $[M + H]^+$ 268.1099, found 268.1097.

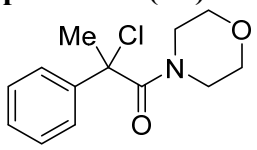
2-Chloro-1-morpholino-2-phenylhexan-1-one (E2)



E2

According to **General procedure 2** with 2-phenylacetic acid (1.36 g, 10.0 mmol, 1.0 equiv), 1-iodobutane (1.93 g, 10.5 mmol, 1.05 equiv), and morpholine (0.87 g, 10.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 20/1) to yield the product **E2** as a yellowish oil (1.05 g, 36% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.34 (m, 4H), 7.33 – 7.29 (m, 1H), 3.84 – 3.51 (m, 4H), 3.48 – 3.25 (m, 2H), 3.15 – 2.84 (m, 2H), 2.36 – 2.29 (m, 1H), 2.22 – 2.14 (m, 1H), 1.44 – 1.32 (m, 1H), 1.31 – 1.16 (m, 2H), 1.03 – 0.92 (m, 1H), 0.81 (t, J = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.6, 139.9, 128.5, 127.8, 125.2, 74.1, 66.6, 65.5, 47.6, 44.7, 43.5, 26.3, 22.5, 13.8.
HRMS (ESI) m/z calcd. for $C_{16}H_{23}ClNO_2$ $[M + H]^+$ 296.1412, found 296.1414.

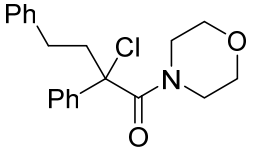
2-Chloro-1-morpholino-2-phenylpropan-1-one (E3)



E3

According to **General procedure 1** with 2-phenylpropanoic acid (1.50 g, 10.0 mmol, 1.0 equiv), and morpholine (0.87 g, 10.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E3** as a yellow oil (1.96 g, 77% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.43 (m, 2H), 7.41 – 7.36 (m, 2H), 7.34 – 7.29 (m, 1H), 3.74 – 3.68 (m, 4H), 3.51 – 3.40 (m, 2H), 3.23 – 3.13 (m, 1H), 2.99 – 2.90 (m, 1H), 1.95 (s, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.5, 141.8, 128.8, 128.0, 124.4, 70.2, 66.6, 65.6, 47.8, 43.5, 35.3.
HRMS (ESI) m/z calcd. for $C_{13}H_{17}ClNO_2$ $[M + H]^+$ 254.0942, found 254.0940.

2-Chloro-1-morpholino-2,4-diphenylbutan-1-one (E4)

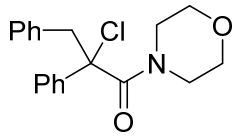


E4

According to **General procedure 2** with 2-phenylacetic acid (0.68 g, 5.0 mmol, 1.0 equiv), (2-iodoethyl)benzene (1.22 g, 5.25 mmol, 1.05 equiv), and morpholine (0.44 g, 5.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum

ether/EtOAc = 20/1) to yield the product **E4** as a yellowish oil (0.34 g, 20% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 – 7.45 (m, 2H), 7.42 – 7.38 (m, 2H), 7.36 – 7.31 (m, 1H), 7.23 – 7.19 (m, 2H), 7.15 – 7.08 (m, 3H), 3.70 – 3.63 (m, 4H), 3.46 – 3.40 (m, 2H), 3.06 – 3.00 (m, 2H), 2.80 – 2.72 (m, 1H), 2.67 – 2.58 (m, 1H), 2.49 – 2.35 (m, 2H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.3, 141.5, 139.7, 128.8, 128.4, 128.2, 128.1, 125.8, 125.3, 73.7, 66.6, 65.6, 47.7, 47.1, 43.6, 31.0.
HRMS (ESI) m/z calcd. for $C_{20}H_{23}ClNO_2$ $[M + H]^+$ 344.1412, found 344.1412.

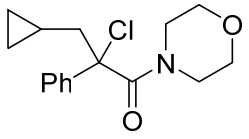
2-Chloro-1-morpholino-2,3-diphenylpropan-1-one (E5)



E5

According to **General procedure 2** with 2-phenylacetic acid (1.36 g, 10.0 mmol, 1.0 equiv), (bromomethyl)benzene (1.78 g, 10.5 mmol, 1.05 equiv), and morpholine (0.87 g, 10.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 50/1) to yield the product **E5** as a white solid (2.29 g, 70% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 – 7.23 (m, 3H), 7.15 – 7.09 (m, 3H), 7.07 – 7.03 (m, 2H), 6.66 – 6.64 (m, 2H), 3.74 – 3.51 (m, 6H), 3.40 – 3.30 (m, 2H), 3.07 – 2.95 (m, 2H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.7, 138.7, 134.8, 131.6, 128.2, 128.0, 127.0, 126.5, 125.8, 73.1, 66.6, 65.5, 50.1, 47.6, 43.6.
HRMS (ESI) m/z calcd. for $C_{19}H_{21}ClNO_2$ $[M + H]^+$ 330.1255, found 330.1251.

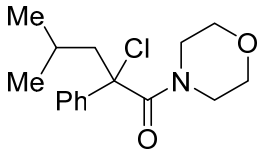
2-Chloro-3-cyclopropyl-1-morpholino-2-phenylpropan-1-one (E6)



E6

According to **General procedure 3** with 2-phenylacetic acid (2.72 g, 20.0 mmol, 1.0 equiv), (bromomethyl)cyclopropane (2.81 g, 21.0 mmol, 1.05 equiv), and morpholine (1.74 g, 20.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E6** as a yellowish oil (2.79 g, 48% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 – 7.42 (m, 2H), 7.39 – 7.29 (m, 3H), 3.75 – 3.63 (m, 4H), 3.38 – 3.32 (m, 2H), 3.11 – 2.97 (m, 2H), 2.32 (dd, J = 14.7, 6.2 Hz, 1H), 2.10 (dd, J = 14.6, 7.0 Hz, 1H), 0.75 – 0.65 (m, 1H), 0.35 – 0.28 (m, 1H), 0.17 – 0.10 (m, 1H), -0.04 – -0.10 (m, 1H), -0.39 – -0.46 (m, 1H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.8, 139.9, 128.4, 127.9, 125.6, 74.1, 66.6, 65.6, 49.6, 47.6, 43.5, 6.2, 4.5, 4.3.
HRMS (ESI) m/z calcd. for $C_{16}H_{21}ClNO_2$ $[M + H]^+$ 294.1255, found 294.1253.

2-Chloro-4-methyl-1-morpholino-2-phenylpentan-1-one (E7)



E7

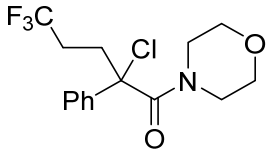
According to **General procedure 3** with 2-phenylacetic acid (2.72 g, 20.0 mmol, 1.0 equiv), 1-iodo-2-methylpropane (3.86 g, 21.0 mmol, 1.05 equiv), and morpholine (1.74 g, 20.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E7** as a yellowish oil (3.48 g, 59% overall yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 – 7.42 (m, 2H), 7.40 – 7.36 (m, 2H), 7.34 – 7.29 (m, 1H), 3.72 – 3.53 (m, 4H), 3.37 – 3.27 (m, 2H), 3.15 – 2.91 (m, 2H), 2.28 – 2.18 (m, 2H), 1.76 – 1.61 (m, 1H), 0.81 (d, J = 6.8 Hz, 3H), 0.52 (d, J = 6.7 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 168.8, 139.8, 128.6, 128.0, 125.5, 74.1, 66.6, 65.6, 53.2, 47.7, 43.6, 24.6, 24.4, 24.2.

HRMS (ESI) m/z calcd. for $C_{16}H_{23}ClNO_2$ $[M + H]^+$ 296.1412, found 296.1409.

2-Chloro-5,5,5-trifluoro-1-morpholino-2-phenylpentan-1-one (E8)



E8

According to **General procedure 2** with 2-phenylacetic acid (2.72 g, 20.0 mmol, 1.0 equiv), 1-1,1,1-trifluoro-3-iodopropane (4.70 g, 21.0 mmol, 1.05 equiv), and morpholine (1.74 g, 20.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **E8** as a yellowish oil (5.17 g, 77% overall yield).

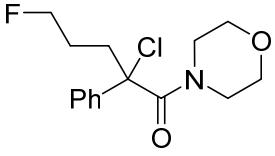
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 – 7.34 (m, 5H), 3.79 – 3.55 (m, 4H), 3.40 – 3.32 (m, 2H), 3.16 – 2.93 (m, 2H), 2.66 – 2.54 (m, 1H), 2.45 – 2.29 (m, 2H), 2.06 – 1.89 (m, 1H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 167.6, 138.8, 129.1, 128.7, 127.0 (q, J = 274.5 Hz), 125.0, 72.3, 66.6, 65.5, 47.6, 43.6, 38.0 (q, J = 3.1 Hz), 30.0 (q, J = 28.7 Hz).

^{19}F NMR (376 MHz, $CDCl_3$) δ -66.10.

HRMS (ESI) m/z calcd. for $C_{15}H_{18}ClF_3NO_2$ $[M + H]^+$ 336.0973, found 336.0971.

2-Chloro-5-fluoro-1-morpholino-2-phenylpentan-1-one (E9)

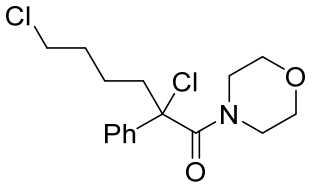


E9

According to **General procedure 2** with 2-phenylacetic acid (2.72 g, 20.0 mmol, 1.0 equiv), 1-fluoro-3-iodopropane (3.95 g, 21.0 mmol, 1.05 equiv), and morpholine (1.74 g, 20.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **E9** as a yellowish oil (4.20 g, 70% overall yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 – 7.31 (m, 5H), 4.46 – 4.38 (m, 1H), 4.34 – 4.26 (m, 1H), 3.76 – 3.55 (m, 4H), 3.46 – 3.27 (m, 2H), 3.12 – 2.88 (m, 2H), 2.48 – 2.40 (m, 1H), 2.32 – 2.25 (m, 1H), 1.94 – 1.77 (m, 1H), 1.57 – 1.41 (m, 1H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.2, 139.4, 128.8, 128.2, 125.2, 83.6 (d, J = 164.5 Hz), 73.4, 66.6, 65.5, 47.6, 43.5, 41.1 (d, J = 5.4 Hz), 25.8 (d, J = 19.9 Hz).
^{19}F NMR (376 MHz, $CDCl_3$) δ -218.22.
HRMS (ESI) m/z calcd. for $C_{15}H_{20}ClFNO_2$ $[M + H]^+$ 300.1161, found 300.1159.

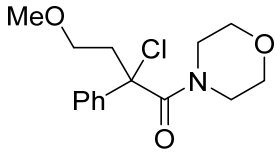
2,6-Dichloro-1-morpholino-2-phenylhexan-1-one (E10)



E10

According to **General procedure 3** with 2-phenylacetic acid (1.36 g, 10.0 mmol, 1.0 equiv), 1-chloro-4-iodobutane (2.29 g, 10.5 mmol, 1.05 equiv), and morpholine (0.87 g, 10.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **E10** as a yellowish oil (1.00 g, 30% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.30 (m, 5H), 3.80 – 3.58 (m, 4H), 3.50 – 3.23 (m, 4H), 3.05 – 2.98 (m, 2H), 2.38 – 2.31 (m, 1H), 2.22 – 2.15 (m, 1H), 1.78 – 1.52 (m, 3H), 1.22 – 1.11 (m, 1H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.3, 139.5, 128.6, 128.0, 125.2, 73.6, 66.5, 65.5, 47.5, 44.5, 44.2, 43.5, 32.3, 21.8.
HRMS (ESI) m/z calcd. for $C_{16}H_{22}Cl_2NO_2$ $[M + H]^+$ 330.1022, found 330.1021.

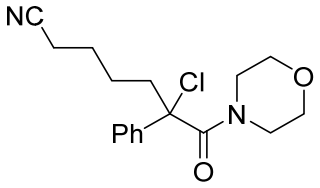
2-Chloro-4-methoxy-1-morpholino-2-phenylbutan-1-one (E11)



E11

According to **General procedure 2** with 2-phenylacetic acid (0.68 g, 5.0 mmol, 1.0 equiv), 1-iodo-2-methoxyethane (0.98 g, 5.25 mmol, 1.05 equiv), and morpholine (0.44 g, 5.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E11** as a yellowish oil (0.43 g, 29% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 – 7.36 (m, 4H), 7.35 – 7.31 (m, 1H), 3.67 – 3.26 (m, 8H), 3.20 (s, 3H), 3.07 – 2.97 (m, 2H), 2.69 – 2.62 (m, 1H), 2.50 – 2.43 (m, 1H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.1, 139.6, 128.8, 128.2, 125.0, 72.2, 69.1, 66.6, 65.5, 58.4, 47.7, 44.5, 43.6.
HRMS (ESI) m/z calcd. for $C_{15}H_{21}ClNO_3$ $[M + H]^+$ 298.1204, found 298.1205.

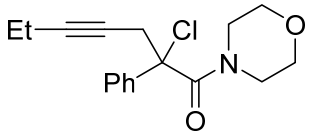
6-Chloro-7-morpholino-7-oxo-6-phenylheptanenitrile (E12)



E12

According to **General procedure 2** with 2-phenylacetic acid (1.36 g, 10.0 mmol, 1.0 equiv), 5-bromopentanenitrile (1.69 g, 10.5 mmol, 1.05 equiv), and morpholine (0.87 g, 10.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E12** as a yellowish oil (0.71 g, 22% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.31 (m, 5H), 3.75 – 3.62 (m, 4H), 3.47 – 3.31 (m, 2H), 3.08 – 2.92 (m, 2H), 2.38 – 2.14 (m, 4H), 1.68 – 1.50 (m, 3H), 1.28 – 1.15 (m, 1H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.3, 139.3, 128.8, 128.2, 125.1, 119.4, 73.4, 66.6, 65.5, 47.6, 44.2, 43.5, 25.2, 23.6, 16.9.
HRMS (ESI) m/z calcd. for $C_{17}H_{22}ClN_2O_2$ $[M + H]^+$ 321.1364, found 321.1362.

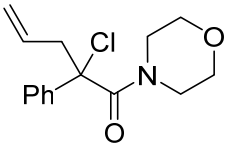
2-Chloro-1-morpholino-2-phenylhept-4-yn-1-one (E13)



E13

According to **General procedure 2** with 2-phenylacetic acid (1.36 g, 10.0 mmol, 1.0 equiv), 1-bromopent-2-yne (1.53 g, 10.5 mmol, 1.05 equiv), and morpholine (0.87 g, 10.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **E13** as a yellowish solid (1.38 g, 45% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 – 7.45 (m, 2H), 7.41 – 7.32 (m, 3H), 3.78 – 3.69 (m, 4H), 3.46 – 3.29 (m, 2H), 3.24 – 3.19 (m, 1H), 3.12 – 3.05 (m, 2H), 2.98 – 2.91 (m, 1H), 2.11 – 2.04 (m, 2H), 1.01 (t, J = 7.5 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 167.7, 138.6, 128.33, 128.28, 125.7, 85.6, 74.2, 71.4, 66.6, 65.6, 47.7, 43.5, 36.8, 13.8, 12.4.
HRMS (ESI) m/z calcd. for $C_{17}H_{21}ClNO_2$ $[M + H]^+$ 306.1255, found 306.1252.

2-Chloro-1-morpholino-2-phenylpent-4-en-1-one (E14)

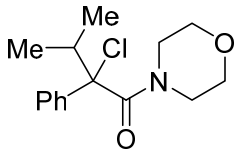


E14

According to **General procedure 2** with 2-phenylacetic acid (2.72 g, 20.0 mmol, 1.0 equiv), 3-iodoprop-1-ene (3.53 g, 21.0 mmol, 1.05 equiv), and morpholine (1.74 g, 20.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E14** as a yellowish oil (2.30 g, 41% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 – 7.34 (m, 4H), 7.33 – 7.28 (m, 1H), 5.70 – 5.59 (m, 1H), 5.00 – 4.86 (m, 2H), 3.68 – 3.52 (m, 4H), 3.40 – 3.33 (m, 2H), 3.13 – 2.89 (m, 4H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 168.0, 139.2, 132.4, 128.4, 127.9, 125.2, 119.0, 72.5, 66.4, 65.4, 49.4, 47.4, 43.4.
HRMS (ESI) m/z calcd. for $C_{15}H_{19}ClNO_2$ $[M + H]^+$ 280.1099, found 280.1101.

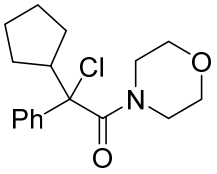
2-Chloro-3-methyl-1-morpholino-2-phenylbutan-1-one (E15)



E15

According to **General procedure 2** with 2-phenylacetic acid (1l36 g, 10.0 mmol, 1.0 equiv), 2-iodopropane (1.78 g, 10.5 mmol, 1.05 equiv), and morpholine (0.87 g, 10.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E15** as a yellowish solid (0.73 g, 26% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 – 7.29 (m, 5H), 3.81 – 3.58 (m, 4H), 3.47 – 3.27 (m, 2H), 3.18 – 2.83 (m, 2H), 2.80 – 2.71 (m, 1H), 1.15 (d, J = 6.4 Hz, 3H), 0.65 (d, J = 6.8 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.3, 138.7, 128.2, 127.8, 125.9, 79.1, 66.6, 65.5, 47.9, 43.6, 39.2, 19.8, 17.9.
HRMS (ESI) m/z calcd. for $C_{15}H_{21}ClNO_2$ $[M + H]^+$ 282.1255, found 282.1253.

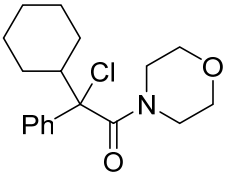
2-Chloro-2-cyclopentyl-1-morpholino-2-phenylethan-1-one (E16)



E16

According to **General procedure 1** with 2-cyclopentyl-2-phenylacetic acid (0.82 g, 4.0 mmol, 1.0 equiv), and morpholine (0.35 g, 4.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E16** as a colorless oil (0.77 g, 63% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.42 (m, 2H), 7.38 – 7.34 (m, 2H), 7.31 – 7.27 (m, 1H), 3.77 – 3.60 (m, 4H), 3.48 – 3.25 (m, 2H), 3.09 – 2.85 (m, 3H), 2.11 – 2.03 (m, 1H), 1.75 – 1.66 (m, 1H), 1.63 – 1.55 (m, 1H), 1.54 – 1.44 (m, 2H), 1.36 – 1.24 (m, 2H), 1.15 – 1.06 (m, 1H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.7, 139.7, 128.4, 127.7, 125.4, 78.7, 66.6, 65.5, 51.6, 47.7, 43.5, 29.8, 28.4, 25.9, 25.5.
HRMS (ESI) m/z calcd. for $C_{17}H_{23}ClNO_2$ $[M + H]^+$ 308.1412, found 308.1408.

2-Chloro-2-cyclohexyl-1-morpholino-2-phenylethan-1-one (E17)

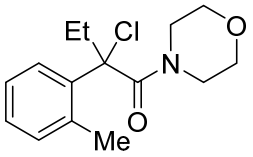


E17

According to **General procedure 2** with 2-phenylacetic acid (1.36 g, 10.0 mmol, 1.0 equiv),

iodocyclohexane (2.20 g, 10.5 mmol, 1.05 equiv), and morpholine (0.87 g, 10.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E17** as a colorless oil (2.72 g, 85% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.28 (m, 5H), 3.69 – 3.36 (m, 6H), 3.16 – 2.80 (m, 2H), 2,42 – 2.32 (m, 1H), 2,26 – 2.14 (m, 1H), 1.78 – 1.71 (m, 1H), 1.66 – 1.57 (m, 2H), 1.42 – 1.24 (m, 2H), 1.22 – 0.97 (m, 3H), 0.89 – 0.76 (m, 1H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.2, 138.4, 128.1, 127.8, 126.1, 78.4, 66.5, 65.5, 49.0, 47.9, 43.6, 29.5, 28.2, 26.44, 26.37, 26.35.
HRMS (ESI) m/z calcd. for $C_{18}H_{25}ClNO_2$ $[M + H]^+$ 322.1568, found 322.1565.

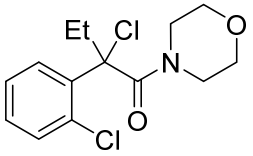
2-Chloro-1-morpholino-2-(*o*-tolyl)butan-1-one (E18)



E18

According to **General procedure 2** with 2-(o-tolyl)acetic acid (4.50 g, 30.0 mmol, 1.0 equiv), iodoethane (4.91 g, 31.5 mmol, 1.05 equiv), and morpholine (2.61 g, 30.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 20/1) to yield the product **E18** as a yellow oil (0.48 g, 6% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.79 – 7.77 (m, 1H), 7.25 – 7.20 (m, 2H), 7.15 – 7.13 (m, 1H), 3.80 – 3.58 (m, 4H), 3.41 – 3.36 (m, 1H), 3.31 – 3.25 (m, 1H), 3.14 – 3.09 (m, 1H), 2.97 – 2.91 (m, 1H), 2.51 (dq, J = 14.7, 7.4 Hz, 1H), 2.31 – 2.22 (m, 4H), 0.78 (t, J = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.1, 136.8, 133.6, 132.3, 128.0, 127.8, 126.2, 75.8, 66.7, 65.7, 47.3, 43.3, 33.7, 20.1, 8.3.
HRMS (ESI) m/z calcd. for $C_{15}H_{21}ClNO_2$ $[M + H]^+$ 282.1255, found 282.1252.

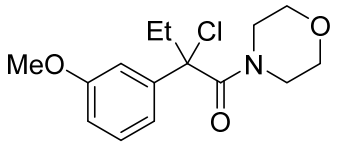
2-Chloro-2-(2-chlorophenyl)-1-morpholinobutan-1-one (E19)



E19

According to **General procedure 2** with 2-(2-chlorophenyl)acetic acid (5.10 g, 30.0 mmol, 1.0 equiv), iodoethane (4.91 g, 31.5 mmol, 1.05 equiv), and morpholine (2.61 g, 30.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 30/1) to yield the product **E19** as a yellow oil (5.08 g, 56% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 – 7.89 (m, 1H), 7.39 – 7.27 (m, 3H), 3.73 – 3.65 (m, 4H), 3.38 – 3.33 (m, 1H), 3.24 – 3.11 (m, 2H), 2.98 – 2.93 (m, 1H), 2.62 – 2.45 (m, 2H) 0.74 (t, J = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 167.7, 136.6, 131.3, 130.6, 129.8, 129.5, 127.1, 74.4, 66.6, 65.6, 47.1, 43.5, 32.7, 8.1.
HRMS (ESI) m/z calcd. for $C_{14}H_{18}Cl_2NO_2$ $[M + H]^+$ 302.0709, found 302.0707.

2-Chloro-2-(3-methoxyphenyl)-1-morpholinobutan-1-one (E20)



E20

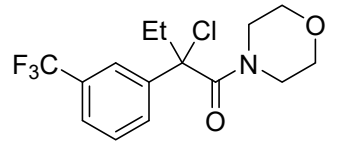
According to **General procedure 2** with 2-(3-methoxyphenyl)acetic acid (1.66 g, 10.0 mmol, 1.0 equiv), iodoethane (1.64 g, 10.5 mmol, 1.05 equiv), and morpholine (0.87 g, 10.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E20** as a yellow oil (0.62 g, 21% overall yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.22 – 7.18 (m, 1H), 6.90 – 6.84 (m, 2H), 6.76 (dd, *J* = 8.3, 2.5 Hz, 1H), 3.73 (s, 3H), 3.58 – 3.52 (m, 4H), 3.37 – 3.26 (m, 2H), 3.01 – 2.91 (m, 2H), 2.33 – 2.19 (m, 1H), 2.16 – 2.05 (m, 1H), 0.73 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 168.3, 159.5, 140.9, 129.4, 117.5, 112.7, 111.5, 74.3, 66.4, 65.4, 55.0, 47.4, 43.3, 37.6, 8.5.

HRMS (ESI) m/z calcd. for $C_{15}H_{21}ClNO_3$ $[M + H]^+$ 298.1204, found 298.1206.

2-Chloro-1-morpholino-2-(3-(trifluoromethyl)phenyl)butan-1-one (E21)



E21

According to **General procedure 2** with 2-(3-(trifluoromethyl)phenyl)acetic acid (2.04 g, 10.0 mmol, 1.0 equiv), iodoethane (1.64 g, 10.5 mmol, 1.05 equiv), and morpholine (0.87 g, 10.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E21** as a yellow oil (0.90 g, 27% overall yield).

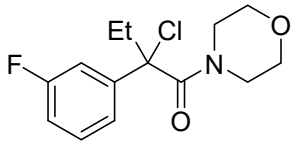
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 – 7.69 (m, 1H), 7.63 – 7.60 (m, 2H), 7.56 – 7.52 (m, 1H), 3.70 – 3.53 (m, 4H), 3.42 – 3.31 (m, 2H), 3.06 – 2.91 (m, 2H), 2.42 (dq, *J* = 14.5, 7.3 Hz, 1H), 2.21 (dq, *J* = 14.5, 7.2 Hz, 1H), 0.82 (t, J = 7.3 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 167.9, 140.9, 131.1 (q, *J* = 32.3 Hz), 129.2, 128.8, 124.9 (q, *J* = 3.7 Hz), 123.6 (q, *J* = 271.0 Hz), 122.3 (q, *J* = 4.0 Hz), 73.8, 66.6, 65.5, 47.6, 43.6, 38.0, 8.6.

^{19}F NMR (376 MHz, $CDCl_3$) δ -62.68.

HRMS (ESI) m/z calcd. for $C_{15}H_{18}ClF_3NO_2$ $[M + H]^+$ 336.0973, found 336.0972.

2-Chloro-2-(3-fluorophenyl)-1-morpholinobutan-1-one (E22)

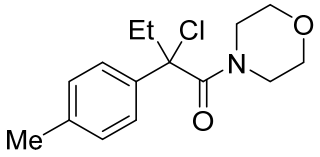


E22

According to **General procedure 2** with 2-(3-fluorophenyl)acetic acid (1.54 g, 10.0 mmol, 1.0 equiv), iodoethane (1.64 g, 10.5 mmol, 1.05 equiv), and morpholine (0.87 g, 10.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E22** as a yellow oil (1.72 g, 60% overall yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 – 7.33 (m, 1H), 7.21 – 7.17 (m, 1H), 7.15 – 7.12 (m, 1H), 7.06 – 7.01 (m, 1H), 3.83 – 3.66 (m, 4H), 3.52 – 3.36 (m, 2H), 3.23 – 3.06 (m, 1H), 2.99 – 2.87 (m, 1H), 2.39 (dq, *J* = 14.5, 7.3 Hz, 1H), 2.19 (dq, *J* = 14.5, 7.2 Hz, 1H), 0.81 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.1, 162.6 (d, *J* = 246.1 Hz), 142.2 (d, *J* = 7.1 Hz), 130.2 (d, *J* = 8.1 Hz), 121.0 (d, *J* = 3.0 Hz), 114.9 (d, *J* = 21.1 Hz), 113.0 (d, *J* = 23.7 Hz), 73.7 (d, *J* = 1.7 Hz), 66.6, 65.6, 47.5, 43.5, 37.8, 8.8.
^{19}F NMR (376 MHz, $CDCl_3$) δ -111.31.
HRMS (ESI) m/z calcd. for $C_{14}H_{18}ClFNO_2$ $[M + H]^+$ 286.1005, found 286.1003.

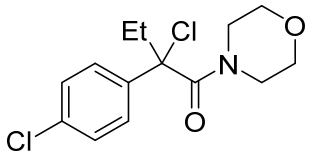
2-Chloro-1-morpholino-2-(*p*-tolyl)butan-1-one (E23)



E23

According to **General procedure 1** with 2-(*p*-tolyl)acetic acid (3.00 g, 20.0 mmol, 1.0 equiv), iodoethane (3.27 g, 21.0 mmol, 1.05 equiv), and morpholine (1.74 g, 20.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E23** as a yellowish oil (2.88 g, 51% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28 – 7.26 (m, 2H), 7.19 – 7.17 (m, 2H), 3.87 – 3.53 (m, 4H), 3.49 – 3.30 (m, 2H), 3.19 – 2.89 (m, 2H), 2.42 – 2.33 (m, 4H), 2.24 – 2.15 (m, 1H), 0.81 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.8, 137.7, 136.5, 129.1, 125.3, 74.6, 66.6, 65.6, 47.6, 43.5, 38.0, 20.9, 8.7.
HRMS (ESI) m/z calcd. for $C_{15}H_{21}ClNO_2$ $[M + H]^+$ 282.1255, found 282.1254.

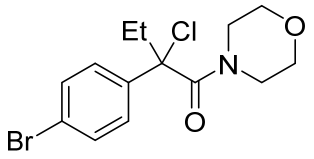
2-Chloro-2-(4-chlorophenyl)-1-morpholinobutan-1-one (E24)



E24

According to **General procedure 2** with 2-(4-chlorophenyl)acetic acid (3.40 g, 20.0 mmol, 1.0 equiv), iodoethane (3.27 g, 21.0 mmol, 1.05 equiv), and morpholine (1.74 g, 20.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E24** as a yellowish solid (3.52 g, 58% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.29 (m, 4H), 3.83 – 3.51 (m, 4H), 3.43 – 3.33 (m, 2H), 3.14 – 3.06 (m, 1H), 3.04 – 2.95 (m, 1H), 2.36 (dq, *J* = 14.5, 7.2 Hz, 1H), 2.16 (dq, *J* = 14.5, 7.2 Hz, 1H), 0.79 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.2, 138.1, 133.8, 128.7, 126.8, 73.9, 66.6, 65.6, 47.5, 43.5, 37.9, 8.6.
HRMS (ESI) m/z calcd. for $C_{14}H_{18}Cl_2NO_2$ $[M + H]^+$ 302.0709, found 302.0706.

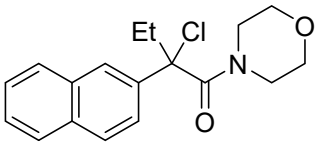
2-(4-Bromophenyl)-2-chloro-1-morpholinobutan-1-one (E25)



E25

According to **General procedure 2** with 2-(4-bromophenyl)acetic acid (4.28 g, 20.0 mmol, 1.0 equiv), iodoethane (3.27 g, 21.0 mmol, 1.05 equiv), and morpholine (1.74 g, 20.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **E25** as a yellowish solid (2.35 g, 34% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 – 7.50 (m, 2H), 7.29 – 7.26 (m, 2H), 3.74 – 3.64 (m, 4H), 3.44 – 3.37 (m, 2H), 3.22 – 3.06 (m, 1H), 3.03 – 2.96 (m, 1H), 2.37 (dq, *J* = 14.6, 7.3 Hz, 1H), 2.17 (dq, *J* = 14.5, 7.3 Hz, 1H), 0.80 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.1, 138.7, 131.7, 127.1, 122.0, 73.9, 66.6, 65.6, 47.6, 43.5, 37.8, 8.6.
HRMS (ESI) m/z calcd. for $C_{14}H_{18}BrClNO_2$ $[M + H]^+$ 346.0204, found 346.0201.

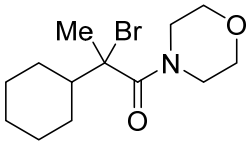
2-Chloro-1-morpholino-2-(naphthalen-2-yl)butan-1-one (E26)



E26

According to **General procedure 2** with 2-(naphthalen-2-yl)acetic acid (1.86 g, 10.0 mmol, 1.0 equiv), iodoethane (1.64 g, 10.5 mmol, 1.05 equiv), and morpholine (0.87 g, 10.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 20/1) to yield the product **E26** as a yellowish oil (1.06 g, 33% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 2.0 Hz, 1H), 7.87 – 7.84 (m, 3H), 7.56 – 7.50 (m, 2H), 7.45 – 7.42 (m, 1H), 3.76 – 3.67 (m, 4H), 3.45 – 3.38 (m, 2H), 3.01 – 2.99 (m, 2H), 2.47 (dq, *J* = 14.5, 7.3 Hz, 1H), 2.30 (dq, *J* = 14.5, 7.2 Hz, 1H), 0.82 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.7, 136.8, 132.8, 132.6, 128.5, 128.1, 127.6, 126.8, 126.6, 124.6, 123.0, 74.8, 66.7, 65.7, 47.6, 43.6, 37.8, 8.7.
HRMS (ESI) m/z calcd. for $C_{18}H_{21}ClNO_2$ $[M + H]^+$ 318.1255, found 318.1256.

2-Bromo-2-cyclohexyl-1-morpholinopropan-1-one (E27)

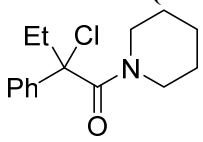


E27

According to **General procedure 4** with 2-cyclohexylacetic acid (1.42 g, 10.0 mmol, 1.0 equiv), iodomethane (3.12 g, 22.0 mmol, 2.2 equiv), and morpholine (0.87 g, 10.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **E27** as a white solid (1.20 g, 40% overall yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 3.82 – 3.64 (m, 8H), 2.20 – 2.16 (m, 1H), 2.03 – 1.96 (m, 1H), 1.90 – 1.86 (m, 1H), 1.83 (s, 3H), 1.82 – 1.79 (m, 1H), 1.71 – 1.67 (m, 1H), 1.53 – 1.48 (m, 1H), 1.32 – 1.08 (m, 5H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.7, 68.1, 66.6, 46.6, 28.6, 28.0, 26.6, 26.5, 26.0.
HRMS (ESI) m/z calcd. for $C_{13}H_{23}BrNO_2$ $[M + H]^+$ 304.0907, found 304.0907.

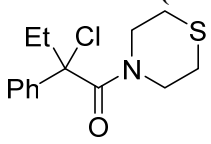
2-Chloro-2-phenyl-1-(piperidin-1-yl)butan-1-one (E28)



E28

According to **General procedure 1** with 2-phenylbutanoic acid (3.28 g, 20.0 mmol, 1.0 equiv) and piperidine (1.70 g, 20.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E28** as a yellowish oil (3.19 g, 60% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 – 7.33 (m, 4H), 7.31 – 7.27 (m, 1H), 3.72 – 3.47 (m, 2H), 3.30 – 3.12 (m, 1H), 3.08 – 2.92 (m, 1H), 2.39 (dq, J = 14.6, 7.3 Hz, 1H), 2.20 (dq, J = 14.4, 7.2 Hz, 1H), 1.63 – 1.44 (m, 4H), 1.31 – 1.26 (m, 1H), 0.95 – 0.86 (m, 1H), 0.79 (t, J = 7.2 Hz, 1H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.3, 140.0, 128.3, 127.5, 125.4, 74.9, 47.8, 44.3, 38.1, 25.5, 24.7, 24.2, 8.7.
HRMS (ESI) m/z calcd. for $C_{15}H_{21}ClNO$ $[M + H]^+$ 266.1306, found 266.1303.

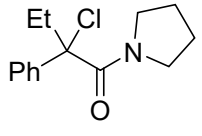
2-Chloro-2-phenyl-1-thiomorpholinobutan-1-one (E29)



E29

According to **General procedure 1** with 2-phenylbutanoic acid (3.28 g, 20.0 mmol, 1.0 equiv) and thiomorpholine (2.06 g, 20.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E29** as a yellowish oil (3.94 g, 70% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.36 (m, 4H), 7.33 – 7.30 (m, 1H), 4.07 – 3.77 (m, 2H), 3.49 – 3.30 (m, 2H), 2.62 – 2.55 (m, 2H), 2.43 – 2.31 (m, 2H), 2.20 (dq, J = 14.5, 7.2 Hz, 1H), 1.88 – 1.75 (m, 1H), 0.78 (t, J = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.5, 139.3, 128.4, 127.8, 125.2, 74.7, 49.1, 45.7, 38.0, 27.1, 26.0, 8.5.
HRMS (ESI) m/z calcd. for $C_{14}H_{19}ClNOS$ $[M + H]^+$ 284.0870, found 284.0869.

2-Chloro-2-phenyl-1-(pyrrolidin-1-yl)butan-1-one (E30)

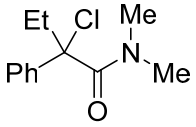


E30

According to **General procedure 1** with 2-phenylbutanoic acid (3.28 g, 20.0 mmol, 1.0 equiv)

and pyrrolidine (1.42 g, 20.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E30** as a yellowish oil (3.18 g, 63% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.39 (m, 2H), 7.37 – 7.33 (m, 2H), 7.31 – 7.27 (m, 1H), 3.58 – 3.51 (m, 2H), 3.50 – 3.43 (m, 1H), 2.49 – 2.40 (m, 2H), 2.21 (dq, *J* = 14.5, 7.2 Hz, 1H), 1.80 – 1.63 (m, 3H), 1.56 – 1.46 (m, 1H), 0.80 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.1, 139.1, 128.1, 127.4, 125.5, 75.5, 47.4, 47.0, 37.1, 26.1, 23.0, 8.4.
HRMS (ESI) m/z calcd. for $C_{14}H_{19}ClNO$ $[M + H]^+$ 252.1150, found 252.1148.

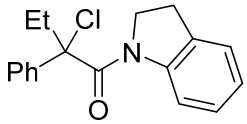
2-Chloro-*N*,*N*-dimethyl-2-phenylbutanamide (E31)



E31

According to **General procedure 1** with 2-phenylbutanoic acid (8.20 g, 50.0 mmol, 1.0 equiv), dimethylamine hydrochloride (4.05 g, 50.0 mmol, 1.0 equiv), and Et_3N (11.12 g, 110.0 mmol, 2.2 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E31** as a colorless oil (6.19 g, 55% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.28 (m, 5H), 2.99 (s, 3H), 2.63 (s, 3H), 2.40 (dq, *J* = 14.5, 7.3 Hz, 1H), 2.20 (dq, *J* = 14.5, 7.2 Hz, 1H), 0.80 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.7, 139.7, 128.4, 127.6, 125.3, 74.8, 38.5, 38.0, 37.4, 8.7.
HRMS (ESI) m/z calcd. for $C_{12}H_{17}ClNO$ $[M + H]^+$ 226.0993, found 226.0991.

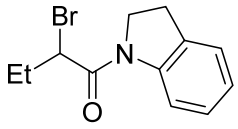
2-Chloro-1-(indolin-1-yl)-2-phenylbutan-1-one (E32)



E32

According to **General procedure 1** with 2-phenylbutanoic acid (3.28 g, 20.0 mmol, 1.0 equiv) and indoline (2.38 g, 20.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 50/1) to yield the product **E32** as a yellowish oil (4.14 g, 69% overall yield).
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.32 (d, *J* = 8.2 Hz, 1H), 7.47 – 7.44 (m, 2H), 7.38 – 7.29 (m, 3H), 7.25 – 7.20 (m, 1H), 7.13 – 7.10 (m, 1H), 7.05 – 7.01 (m, 1H), 4.19 – 4.12 (m, 1H), 3.08 – 3.01 (m, 1H), 2.95 – 2.87 (m, 1H), 2.75 – 2.67 (m, 1H), 2.52 (dq, *J* = 14.5, 7.2 Hz, 1H), 2.29 (dq, *J* = 14.5, 7.3 Hz, 1H), 0.85 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 167.9, 143.8, 138.8, 131.5, 128.5, 127.9, 127.3, 125.7, 124.4, 124.3, 118.1, 76.3, 49.0, 37.6, 28.6, 8.6.
HRMS (ESI) m/z calcd. for $C_{18}H_{19}ClNO$ $[M + H]^+$ 300.1150, found 300.1149.

2-Bromo-1-(indolin-1-yl)butan-1-one (E33)



E33

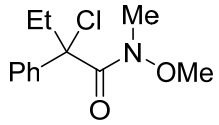
According to **General procedure 5** with 2-bromobutanoyl bromide (8.20 g, 36.0 mmol, 1.2 equiv) and indoline (3.57 g, 30.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E33** as a brown solid (7.47 g, 93% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.26 (d, *J* = 7.9 Hz, 1H), 7.23 – 7.19 (m, 2H), 7.07 – 7.03 (m, 1H), 4.36 – 4.30 (m, 2H), 4.10 – 4.03 (m, 1H), 3.29 – 3.16 (m, 2H), 2.33 – 2.21 (m, 1H), 2.19 – 2.06 (m, 1H), 1.06 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 166.5, 142.7, 131.4, 127.6, 124.6, 124.3, 117.5, 48.2, 47.8, 28.0, 27.9, 12.2.

HRMS (ESI) m/z calcd. for $C_{12}H_{15}BrNO$ $[M + H]^+$ 268.0332, found 268.0328.

2-Chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide (E34)



E34

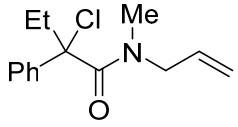
According to **General procedure 1** with 2-phenylbutanoic acid (8.20 g, 50.0 mmol, 1.0 equiv), *N*,*O*-dimethylhydroxylamine hydrochloride (4.85 g, 50.0 mmol, 1.0 equiv), and Et_3N (11.12 g, 110.0 mmol, 2.2 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **E34** as a yellowish oil (6.55 g, 54% overall yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.34 (m, 4H), 7.39 – 7.26 (m, 1H), 3.13 (s, 3H), 3.00 (s, 3H), 2.50 (dq, *J* = 14.5, 7.3 Hz, 1H), 2.24 (dq, *J* = 14.5, 7.2 Hz, 1H), 0.82 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 170.3, 139.8, 128.1, 127.4, 125.4, 74.7, 59.3, 35.8, 34.1, 8.2.

HRMS (ESI) m/z calcd. for $C_{12}H_{17}ClNO_2$ $[M + H]^+$ 242.0942, found 242.0939.

***N*-Allyl-2-chloro-*N*-methyl-2-phenylbutanamide (E44)**



E44

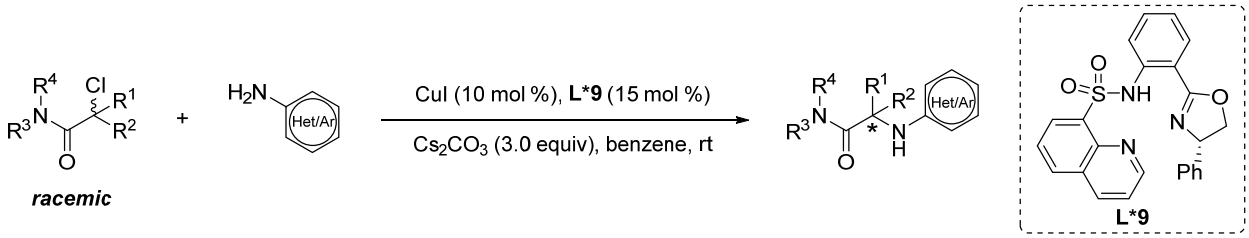
According to **General procedure 1** with 2-phenylbutanoic acid (4.10 g, 25.0 mmol, 1.0 equiv) and *N*-methylprop-2-en-1-amine (1.78 g, 25.0 mmol, 1.0 equiv), the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 30/1) to yield the product **E44** as a yellowish oil (4.96 g, 79% overall yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 – 7.35 (m, 4H), 7.32 – 7.28 (m, 1H), 5.83 – 4.92 (m, 3H), 4.00 – 3.54 (m, 2H), 2.88 – 2.58 (m, 3H), 2.42 (dq, *J* = 14.5, 7.2 Hz, 1H), 2.21 (dq, *J* = 14.5, 7.2 Hz, 1H), 0.80 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 169.9, 169.6, 139.8, 139.6, 132.7, 132.2, 128.4, 127.7, 127.6, 125.4, 118.3, 117.0, 75.0, 53.1, 51.9, 38.1, 38.0, 36.1, 33.9, 8.6.

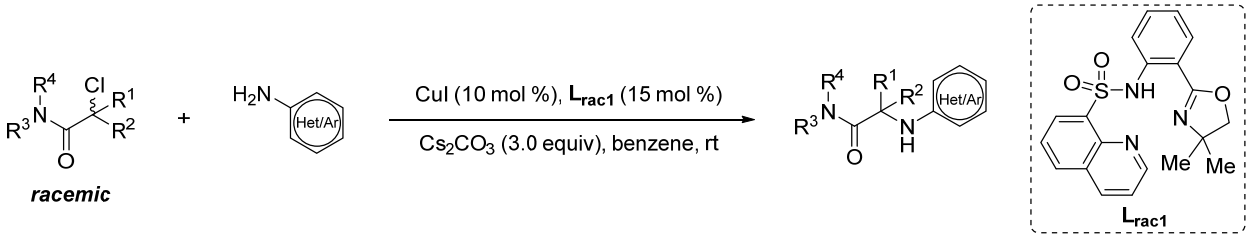
HRMS (ESI) m/z calcd. for $C_{14}H_{19}ClNO$ $[M + H]^+$ 252.1150, found 252.1150.

5. Cross-coupling of activated racemic alkyl halides with (hetero)aromatic amines



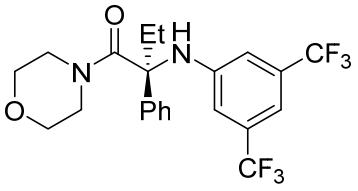
General procedure A:

Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with CuI (3.8 mg, 0.02 mmol, 10 mol %), **L*9** (12.9 mg, 0.03 mmol, 15 mol %), Cs_2CO_3 (195.5 mg, 0.60 mmol, 3.0 equiv), racemic tertiary alkyl chloride (0.24 mmol, 1.2 equiv), (hetero)aromatic amine (0.20 mmol, 1.0 equiv), and anhydrous benzene (4.0 mL) were sequentially added into the mixture and the reaction mixture was stirred at room temperature for 72 h. Upon completion (monitored by TLC), the precipitate was filtered off and washed by EtOAc. The filtrate was evaporated and the residue was purified by column chromatography on silica gel to afford the desired product.



The racemates of products were prepared following the procedure: Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with CuI (3.8 mg, 0.02 mmol, 10 mol %), $\mathbf{L_{rac1}}$ (11.4 mg, 0.03 mmol, 15 mol %), Cs_2CO_3 (195.5 mg, 0.60 mmol, 3.0 equiv), racemic tertiary alkyl chloride (0.24 mmol, 1.2 equiv), (hetero)aromatic amine (0.20 mmol, 1.0 equiv), and anhydrous benzene (4.0 mL) were sequentially added into the mixture and the reaction mixture was stirred at room temperature for 72 h. Upon completion (monitored by TLC), the precipitate was filtered off and washed by EtOAc. The filtrate was evaporated and the residue was purified by column chromatography on silica gel to afford the desired product.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-1-morpholino-2-phenylbutan-1-one (1)

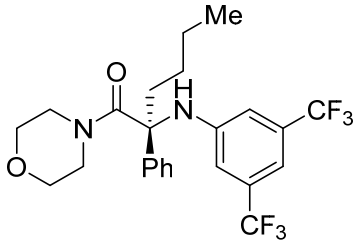


1

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 7.5/1) to yield the product **1** as a white solid (90.6 mg, 98% yield, 95%

ee).
[α]$_D^{27}$ = +21 (*c* 2.2, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 9.30 min, t_R (minor) = 11.23 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 – 7.48 (m, 2H), 7.41 – 7.38 (m, 2H), 7.32 – 7.28 (m, 1H), 7.00 (s, 1H), 6.86 (s, 2H), 6.76 (s, 1H), 3.70 – 3.01 (m, 8H), 2.68 (dq, *J* = 14.6, 7.4 Hz, 1H), 2.32 (dq, *J* = 14.2, 7.2 Hz, 1H), 0.89 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.1, 145.1, 140.6, 131.9 (q, *J* = 32.4 Hz), 129.2, 128.2, 126.8, 123.4 (q, *J* = 271.0 Hz), 113.43 – 113.39 (m), 109.8 – 109.7 (m), 66.1, 66.0, 45.7, 23.8, 8.1.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.34.
HRMS (ESI) m/z calcd. for $C_{22}H_{23}F_6N_2O_2$ $[M + H]^+$ 461.1658, found 461.1653.

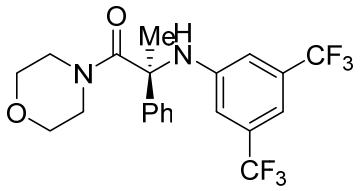
(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-1-morpholino-2-phenylhexan-1-one (2)



2

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylhexan-1-one **E2** (70.8 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **2** as a colorless oil (87.9 mg, 90% yield, 96% ee).
[α]$_D^{27}$ = +16 (*c* 2.2, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 7.25 min, t_R (minor) = 8.90 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 – 7.47 (m, 2H), 7.41 – 7.37 (m, 2H), 7.32 – 7.27 (m, 1H), 6.99 (s, 1H), 6.84 (s, 2H), 6.78 (s, 1H), 3.71 – 3.08 (m, 8H), 2.65 – 2.58 (m, 1H), 2.29 – 2.22 (m, 1H), 1.40 – 1.28 (m, 3H), 1.16 – 1.07 (m, 1H), 0.85 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.4, 145.1, 140.7, 131.9 (q, *J* = 32.4 Hz), 129.1, 128.2, 126.8, 123.4 (q, *J* = 271.0 Hz), 113.40 – 113.36 (m), 109.7 – 109.6 (m), 66.1, 65.5, 45.8, 30.7, 25.9, 22.7, 13.9.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.34.
HRMS (ESI) m/z calcd. for $C_{24}H_{27}F_6N_2O_2$ $[M + H]$+ 489.1971, found 489.1975.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-1-morpholino-2-phenylpropan-1-one (3)



3

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylpropan-1-one **E3**

(60.7 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **3** as a yellowish oil (88.5 mg, 99% yield, 66% ee).

[α]$_D^{27}$ = +21 (*c* 0.5, $CHCl_3$).

HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 12.40 min, t_R (major) = 13.38 min.

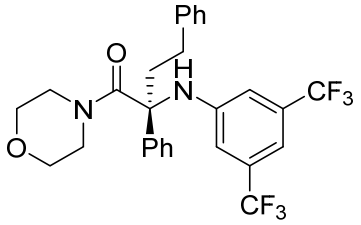
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 – 7.46 (m, 2H), 7.43 – 7.39 (m, 2H), 7.34 – 7.29 (m, 1H), 7.04 (s, 1H), 6.88 (d, *J* = 1.5 Hz, 2H), 6.61 (s, 1H), 3.72 – 3.36 (m, 8H), 1.95 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 171.4, 145.2, 140.9, 131.9 (q, *J* = 32.3 Hz), 129.2, 128.3, 126.4, 123.4 (q, *J* = 271.0 Hz), 113.53 – 113.49 (m), 110.0 – 119.9 (m), 66.0, 62.5, 45.7, 21.2.

^{19}F NMR (376 MHz, $CDCl_3$) δ -63.33 (s, 6F).

HRMS (ESI) m/z calcd. For $C_{21}H_{21}F_6N_2O_2$ $[M + H]^+$ 447.1502, found 447.1497.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-1-morpholino-2,4-diphenylbutan-1-one (4)



4

According to **General Procedure A** with 2-chloro-1-morpholino-2,4-diphenylbutan-1-one **E4** (82.4 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **4** as a colorless oil (102.3 mg, 95% yield, 96% ee).

[α]$_D^{27}$ = +18 (*c* 0.5, $CHCl_3$).

HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 12.76 min, t_R (minor) = 17.12 min.

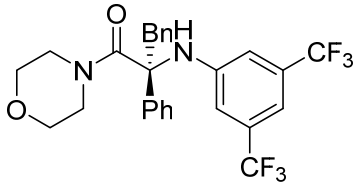
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 – 7.47 (m, 2H), 7.41 – 7.37 (m, 2H), 7.32 – 7.28 (m, 1H), 7.26 – 7.23 (m, 2H), 7.19 – 7.15 (m, 1H), 7.06 – 7.03 (m, 3H), 6.86 – 6.82 (m, 3H), 3.72 –3.11 (m, 8H), 3.03 – 2.95 (m, 1H), 2.76 – 2.69 (m, 1H), 2.60 – 2.53 (m, 1H), 2.49 – 2.42 (m, 1H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 170.1, 145.0, 140.9, 140.3, 131.9 (q, *J* = 32.4 Hz), 129.2, 128.6, 128.4, 128.3, 126.7, 126.3, 123.4 (q, *J* = 270.9 Hz), 113.51 – 113.47 (m), 110.0 – 109.9 (m), 66.1, 65.4, 45.6, 33.3, 30.4.

^{19}F NMR (376 MHz, $CDCl_3$) δ -63.29.

HRMS (ESI) *m/z* calcd. for $C_{28}H_{27}F_6N_2O_2$ $[M + H]^+$ 537.1971, found 537.1982.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-1-morpholino-2,3-diphenylpropan-1-one (5)



5

According to **General Procedure A** with 2-chloro-1-morpholino-2,3-diphenylpropan-1-one **E5** (79.0 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **5** as a colorless oil (103.0 mg, 99% yield, 94% ee).

[α]$_D^{27}$ = +16 (*c* 0.6, $CHCl_3$).

HPLC analysis: Chiralcel ODH (*n*-hexane/*i*-PrOH = 99.5/0.5, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 18.48 min, t_R (minor) = 23.17 min.

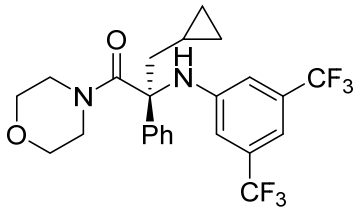
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 – 7.31 (m, 5H), 7.19 – 7.10 (m, 4H), 7.02 (s, 2H), 6.63 (s, 2H), 5.80 (s, 1H), 3.77 – 3.19 (m, 9H), 3.04 – 2.63 (m, 1H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 169.8, 145.4, 139.6, 135.0, 132.4 (q, *J* = 32.5 Hz), 130.3, 129.0, 128.3, 127.9, 127.0, 125.8, 123.4 (q, *J* = 271.1 Hz), 113.72 – 113.70 (m), 110.8 – 110.6 (m), 66.3, 66.0, 65.5, 47.0, 44.0, 39.1.

^{19}F NMR (376 MHz, $CDCl_3$) δ -63.18.

HRMS (ESI) *m/z* calcd. for $C_{27}H_{25}F_6N_2O_2$ $[M + H]^+$ 523.1815, found 523.1816.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-3-cyclopropyl-1-morpholino-2-phenylpropan-1-one (6)



6

According to **General Procedure A** with 2-chloro-3-cyclopropyl-1-morpholino-2-phenylpropan-1-one **E6** (70.3 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **6** as a colorless oil (94.9 mg, 98% yield, 94% ee).

[α]$_D^{27}$ = +24 (*c* 2.4, $CHCl_3$).

HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 10.22 min, t_R (minor) = 13.92 min.

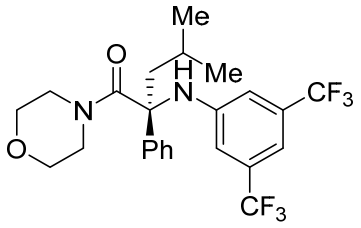
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 – 7.45 (m, 2H), 7.41 – 7.38 (m, 2H), 7.33 – 7.28 (m, 1H), 7.02 (s, 1H), 6.87 (s, 2H), 6.78 (s, 1H), 4.08 – 2.92 (m, 8H), 2.76 (dd, *J* = 14.2, 5.5 Hz, 1H), 2.05 (dd, *J* = 14.2, 7.6 Hz, 1H), 0.71 – 0.61 (m, 1H), 0.48 – 0.39 (m, 2H), -0.01 – -0.08 (m, 2H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 170.5, 145.4, 140.8, 132.0 (q, *J* = 32.4 Hz), 129.1, 128.2, 126.5, 123.4 (q, *J* = 271.1 Hz), 113.4 – 113.3 (m), 109.9 – 109.8 (m), 66.0, 65.9, 45.5, 36.0, 5.8, 4.2, 3.8.

^{19}F NMR (376 MHz, $CDCl_3$) δ -63.31.

HRMS (ESI) *m/z* calcd. for $C_{24}H_{25}F_6N_2O_2$ $[M + H]^+$ 487.1815, found 487.1813.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-4-methyl-1-morpholino-2-phenylpentan-1-one (7)



7

According to **General Procedure A** with 2-chloro-4-methyl-1-morpholino-2-phenylpentan-1-one **E7** (70.8 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **7** as a colorless oil (95.9 mg, 98% yield, 91% ee).

[α]$_D^{27}$ = +24 (*c* 2.3, $CHCl_3$).

HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 6.51 min, t_R (minor) = 8.55 min.

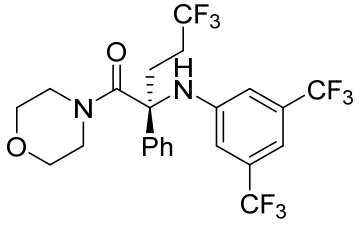
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 (s, 2H), 7.39 – 7.35 (m, 2H), 7.30 – 7.26 (m, 1H), 7.00 – 6.97 (m, 2H), 6.81 (s, 2H), 4.32 – 2.85 (m, 8H), 2.68 (dd, *J* = 14.3, 5.2 Hz, 1H), 2.19 (dd, *J* = 14.3, 6.0 Hz, 1H), 1.82 – 1.72 (m, 1H), 0.93 (d, *J* = 6.7 Hz, 3H), 0.86 (d, *J* = 6.7 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 170.8, 145.1, 141.0, 131.8 (q, *J* = 32.3 Hz), 129.1, 128.2, 126.8, 123.5 (q, *J* = 271.0 Hz), 113.13 – 113.09 (m), 109.45 – 109.36 (m), 65.9, 65.8, 64.9, 46.5, 44.9, 38.9, 24.5, 24.3, 23.7.

^{19}F NMR (376 MHz, $CDCl_3$) δ -63.34.

HRMS (ESI) *m/z* calcd. for $C_{24}H_{26}F_6N_2NaO_2$ $[M + Na]^+$ 511.1791, found 511.1788.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-5,5,5-trifluoro-1-morpholino-2-phenylpentan-1-one (8)



8

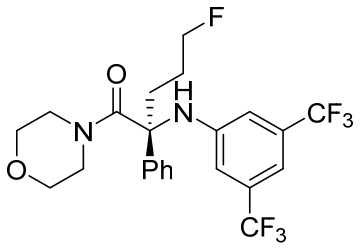
According to **General Procedure A** with 2-chloro-5,5,5-trifluoro-1-morpholino-2-phenylpentan-1-one **E8** (80.4 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **8** as a white solid (90.9 mg, 93% yield, 94% ee).

[α]$_D^{27}$ = +23 (*c* 2.6, $CHCl_3$).

HPLC analysis: Chiralcel ODH (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 10.10 min, t_R (minor) = 11.91 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.41 (m, 4H), 7.36 – 7.32 (m, 1H), 7.08 (s, 1H), 6.89 (s, 2H), 6.57 (s, 1H), 3.84 – 3.09 (m, 8H), 2.97 – 2.89 (m, 1H), 2.53 – 2.46 (m, 1H), 2.31 – 2.15 (m, 1H), 2.01 – 1.85 (m, 1H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.4, 144.5, 139.0, 132.2 (q, J = 32.6 Hz), 129.5, 128.8, 126.9 (q, J = 274.4 Hz), 126.2, 123.3 (q, J = 270.0 Hz), 113.6 – 113.5 (m), 110.8 – 110.6 (m), 66.0, 64.7, 45.6, 29.2 (q, J = 29.1 Hz), 25.2 – 25.1 (m).
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.39, -66.15.
HRMS (ESI) *m/z* calcd. for $C_{23}H_{22}F_9N_2O_2$ $[M + H]^+$ 529.1532, found 529.1531.

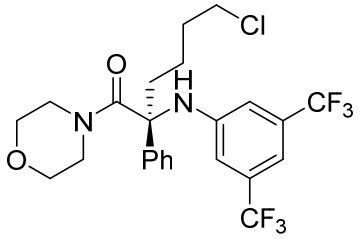
(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-5-fluoro-1-morpholino-2-phenylpentan-1-one (9)



9

According to **General Procedure A** with 2-chloro-5-fluoro-1-morpholino-2-phenylpentan-1-one **E9** (71.8 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 3/1) to yield the product **9** as a white solid (98.2 mg, 99% yield, 96% ee).
$[\alpha]_D^{27}$ = +38 (*c* 2.4, $CHCl_3$).
HPLC analysis: Chiralcel IF (*n*-hexane/*i*-PrOH = 99/1, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 13.61 min, t_R (minor) = 16.78 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 – 7.48 (m, 2H), 7.42 – 7.39 (m, 2H), 7.33 – 7.29 (m, 1H), 7.01 (s, 1H), 6.86 (s, 2H), 6.80 (s, 1H), 4.60 – 4.30 (m, 2H), 3.86 – 2.94 (m, 8H), 2.77 – 2.70 (m, 1H), 2.55 – 2.48 (m, 1H), 1.84 – 1.53 (m, 2H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.0, 144.8, 140.0, 131.9 (q, J = 32.4 Hz), 129.2, 128.4, 126.6, 123.4 (q, J = 271.0 Hz), 113.34 – 113.30 (m), 110.0 – 109.9 (m), 83.5 (d, J = 164.4 Hz), 66.0, 65.1, 45.7, 27.3, 25.3 (d, J = 19.8 Hz).
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.34, -218.51.
HRMS (ESI) *m/z* calcd. for $C_{23}H_{24}F_7N_2O_2$ $[M + H]^+$ 493.1721, found 493.1719.

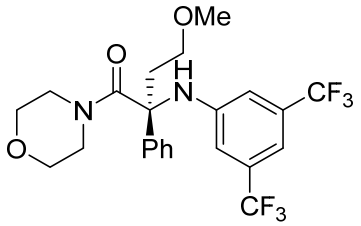
(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-6-chloro-1-morpholino-2-phenylhexan-1-one (10)



10

According to **General Procedure A** with 2,6-dichloro-1-morpholino-2-phenylhexan-1-one **E10** (79.0 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **10** as a colorless oil (101.7 mg, 97% yield, 96% ee).
[α]$_D^{27}$ = +22 (*c* 2.5, $CHCl_3$).
HPLC analysis: Chiralcel IF (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 10.47 min, t_R (minor) = 12.16 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 – 7.46 (m, 2H), 7.42 – 7.38 (m, 2H), 7.33 – 7.29 (m, 1H), 7.02 (s, 1H), 6.87 (s, 2H), 6.71 (s, 1H), 3.75 – 3.38 (m, 10H), 2.64 – 2.57 (m, 1H), 2.36 – 2.28 (m, 1H), 1.87 – 1.70 (m, 2H), 1.56 – 1.45 (m, 1H), 1.43 – 1.31 (m, 1H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.1, 144.9, 140.2, 131.9 (q, *J* = 32.3 Hz), 129.2, 128.3, 126.5, 123.4 (q, *J* = 271.0 Hz), 113.45 – 113.42 (m), 110.0 – 109.9 (m), 66.1, 65.4, 45.7, 44.3, 32.1, 30.5, 21.0.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.32.
HRMS (ESI) m/z calcd. for $C_{24}H_{26}ClF_6N_2O_2$ $[M + H]^+$ 523.1582, found 523.1582.

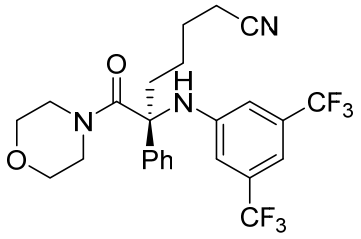
(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-4-methoxy-1-morpholino-2-phenylbutan-1-one (11)



11

According to **General Procedure A** with 2-chloro-4-methoxy-1-morpholino-2-phenylbutan-1-one **E11** (71.3 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **11** as a colorless oil (97.0 mg, 99% yield, 95% ee).
[α]$_D^{27}$ = +18 (*c* 2.4, $CHCl_3$).
HPLC analysis: Chiralcel IF (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 10.12 min, t_R (minor) = 16.09 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 – 7.45 (m, 2H), 7.41 – 7.38 (m, 2H), 7.32 – 7.29 (m, 1H), 7.03 (s, 1H), 6.86 (s, 2H), 6.77 (s, 1H), 3.68 –3.23 (m, 13H), 2.86 – 2.80 (m, 1H), 2.66 – 2.59 (m, 1H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.4, 145.2, 140.0, 132.0 (q, *J* = 32.4 Hz), 129.1, 128.2, 126.6, 123.4 (q, *J* = 271.0 Hz), 113.8 – 113.7 (m), 110.2 – 110.1 (m), 68.2, 65.9, 64.3, 58.9, 45.5, 31.8.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.33.
HRMS (ESI) *m/z* calcd. for $C_{23}H_{25}F_6N_2O_3$ $[M + H]^+$ 491.1764, found 491.1770.

(*S*)-6-((3,5-Bis(trifluoromethyl)phenyl)amino)-7-morpholino-7-oxo-6-phenylheptanenitrile (12)



12

According to **General Procedure A** with 6-chloro-7-morpholino-7-oxo-6-phenylheptanenitrile **E12** (76.8 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 2/1) to yield the product **12** as a colorless oil (89.2 mg, 87% yield, 96% ee).

[α]$_D^{27}$ = +15 (*c* 2.2, $CHCl_3$).

HPLC analysis: Chiralcel IC (*n*-hexane/*i*-PrOH = 95/5, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 21.74 min, t_R (major) = 29.36 min.

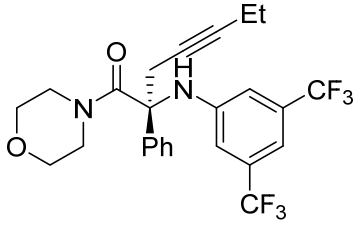
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.39 (m, 4H), 7.34 – 7.30 (m, 1H), 7.04 (s, 1H), 6.89 (s, 2H), 6.60 (s, 1H), 3.91 – 2.89 (m, 8H), 2.64 – 2.56 (m, 1H), 2.38 – 2.20 (m, 3H), 1.71 – 1.61 (m, 2H), 1.54 – 1.42 (m, 1H), 1.38 – 1.30 (m, 1H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 169.9, 144.8, 139.9, 132.0 (q, *J* = 32.5 Hz), 129.3, 128.4, 126.3, 123.3 (q, *J* = 271.0 Hz), 119.2, 113.4 – 113.3 (m), 110.2 – 110.1 (m), 66.0, 65.3, 45.9, 31.2, 25.2, 23.0, 17.0.

^{19}F NMR (376 MHz, $CDCl_3$) δ -63.29.

HRMS (ESI) *m/z* calcd. for $C_{25}H_{26}F_6N_3O_2$ $[M + H]^+$ 514.1924, found 514.1926.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-1-morpholino-2-phenylhept-4-yn-1-one (13)



13

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylhept-4-yn-1-one **E13** (73.2 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **13** as a white solid (98.9 mg, 99% yield, 89% ee).

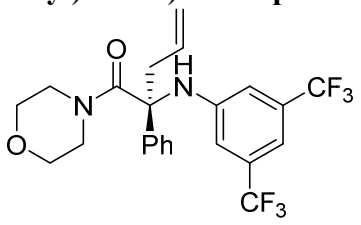
[α]$_D^{27}$ = +36 (*c* 0.6, $CHCl_3$).

HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 12.26 min, t_R (major) = 16.53 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 – 7.40 (m, 4H), 7.39 – 7.34 (m, 1H), 7.23 (s, 1H), 7.09 (s, 2H), 5.89 (s, 1H), 3.55 – 3.46 (m, 4H), 3.34 – 3.16 (m, 6H), 2.09 – 2.03 (m, 2H), 1.02 (t, *J* = 7.5 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 169.5, 145.6, 139.1, 132.2 (q, *J* = 32.6 Hz), 129.0, 128.3, 125.3, 123.3 (q, *J* = 271.0 Hz), 115.31 – 115.28 (m), 112.0 – 111.9 (m), 86.0, 73.5, 66.1, 65.5, 45.3, 27.2, 14.0, 12.2.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.24.
HRMS (ESI) *m/z* calcd. for $C_{25}H_{25}F_6N_2O_2$ $[M + H]^+$ 499.1815, found 499.1810.

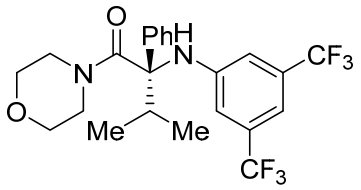
(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-1-morpholino-2-phenylpent-4-en-1-one (14)



14

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylpent-4-en-1-one **E14** (67.0 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **14** as a colorless oil (80.3 mg, 85% yield, 93% ee).
$[\alpha]_D^{27}$ = +22 (*c* 2.0, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 9.60 min, t_R (minor) = 12.77 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 – 7.42 (m, 4H), 7.35 – 7.30 (m, 1H), 7.07 (s, 1H), 6.92 (s, 2H), 6.47 (s, 1H), 5.65 – 5.55 (m, 1H), 5.10 (d, *J* = 10.0 Hz, 1H), 4.97 (d, *J* = 17.0 Hz, 1H), 3.77 – 2.96 (m, 10H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.8, 145.2, 140.0, 132.0 (q, *J* = 32.5 Hz), 131.6, 129.2, 128.4, 126.3, 123.4 (q, *J* = 271.0 Hz), 119.7, 113.93 – 113.90 (m), 110.5 – 110.3 (m), 66.1, 65.4, 45.6, 36.6.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.31.
HRMS (ESI) m/z calcd. for $C_{23}H_{23}F_6N_2O_2$ $[M + H]^+$ 473.1658, found 473.1662.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-3-methyl-1-morpholino-2-phenylbutan-1-one (15)

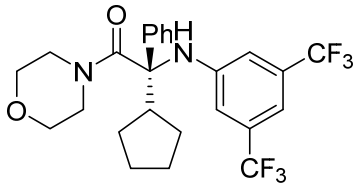


15

According to **General Procedure A** with 2-chloro-3-methyl-1-morpholino-2-phenylbutan-1-one **E15** (67.5 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **15** as a white solid (86.3 mg, 91% yield, 94% ee).
$[\alpha]_D^{27}$ = −26 (*c* 2.3, $CHCl_3$).
HPLC analysis: Chiralcel ODH (*n*-hexane/*i*-PrOH = 99.5/0.5, flow rate 1.0 mL/min, λ = 254

nm), t_R (minor) = 16.72 min, t_R (major) = 18.74 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 – 7.33 (m, 5H), 7.08 (s, 1H), 6.89 (s, 2H), 5.90 (s, 1H), 3.66 – 3.04 (m, 9H), 0.97 – 0.90 (m, 6H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.7, 146.6, 137.4, 131.9 (q, J = 33.0 Hz), 128.9, 128.2, 126.6, 123.4 (q, J = 271.0 Hz), 113.8, 110.3 – 110.1 (m), 69.6, 66.0, 45.9, 32.6, 19.8, 17.8.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.25.
HRMS (ESI) m/z calcd. for $C_{23}H_{24}F_6N_2NaO_2$ $[M + Na]^+$ 497.1634, found 497.1633.

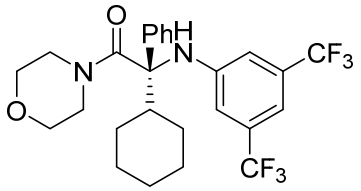
(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-2-cyclopentyl-1-morpholino-2-phenylethan-1-one (16)



16

According to **General Procedure A** with 2-chloro-2-cyclopentyl-1-morpholino-2-phenylethan-1-one **E16** (73.7 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **16** as a white solid (98.1 mg, 98% yield, 96% ee).
$[\alpha]_D^{27}$ = −55 (*c* 2.4, $CHCl_3$).
HPLC analysis: Chiralcel IH (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 8.90 min, t_R (major) = 11.20 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 – 7.28 (m, 5H), 6.99 (s, 1H), 6.74 (s, 2H), 6.57 (s, 1H), 3.83 – 2.77 (m, 9H), 2.11 – 2.02 (m, 1H), 1.65 – 1.48 (m, 6H), 1.39 – 1.28 (m, 1H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 171.1, 146.9, 138.5, 131.4 (q, J = 32.3 Hz), 129.0, 128.2, 127.4, 123.4 (q, J = 271.1 Hz), 114.33 – 114.28 (m), 109.8 – 109.7 (m), 68.5, 66.2, 65.6, 47.1, 45.5, 44.4, 29.3, 28.1, 25.2, 23.6.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.26.
HRMS (ESI) m/z calcd. for $C_{25}H_{26}F_6N_2NaO_2$ $[M + Na]^+$ 523.1791, found 523.1789.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-2-cyclohexyl-1-morpholino-2-phenylethan-1-one (17)

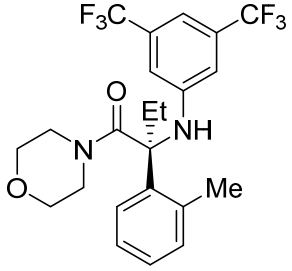


17

According to **General Procedure A** with 2-chloro-2-cyclohexyl-1-morpholino-2-phenylethan-1-one **E17** (77.1 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **17** as a white solid (96.1 mg, 93% yield, 97% ee).

[α]$_D^{27}$ = −36 (*c* 0.5, $CHCl_3$).
HPLC analysis: Chiralcel ODH (*n*-hexane/*i*-PrOH = 99.5/0.5, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 12.50 min, t_R (major) = 14.34 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 – 7.21 (m, 6H), 7.05 (s, 1H), 6.81 (s, 2H), 3.65 – 2.94 (m, 8H), 2.68 – 2.63 (m, 1H), 2.11 – 2.04 (m, 1H), 1.81 – 1.62 (m, 4H), 1.42 – 0.98 (m, 5H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.6, 146.6, 137.7, 131.8 (q, *J* = 30.5 Hz), 128.9, 128.1, 126.9, 123.4 (q, *J* = 271.0 Hz), 113.8, 110.0 – 109.8 (m), 69.8, 66.0, 46.1, 43.4, 30.2, 27.8, 26.8, 26.4, 26.1.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.25.
HRMS (ESI) m/z calcd. for $C_{26}H_{28}F_6N_2NaO_2$ $[M + Na]^+$ 537.1947, found 537.1946.

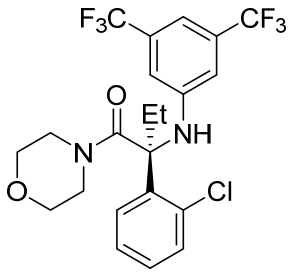
(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-1-morpholino-2-(o-tolyl)butan-1-one (18)



18

According to **General Procedure A** with 2-chloro-1-morpholino-2-(o-tolyl)butan-1-one **E18** (67.5 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **18** as a white solid (94.2 mg, 99% yield, 94% ee).
[α]$_D^{27}$ = +10 (*c* 1.9, $CHCl_3$).
HPLC analysis: Chiralcel ADH (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 5.06 min, t_R (major) = 5.58 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.77 – 7.75 (m, 1H), 7.34 – 7.30 (m, 1H), 7.25 – 7.21 (m, 1H), 7.14 – 7.11 (m, 1H), 6.96 (s, 1H), 6.81 – 6.79 (m, 3H), 3.93 – 3.23 (m, 7H), 2.88 – 2.74 (m, 2H), 2.26 – 2.17 (m, 4H), 0.93 (t, *J* = 7.2 Hz, 3H)
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.7, 145.1, 138.1, 137.9, 133.3, 131.8 (q, *J* = 32.3 Hz), 128.5, 127.0, 126.4, 123.5 (q, *J* = 271.0 Hz), 113.41 – 113.38 (m), 109.5 – 109.4 (m), 66.9, 65.9, 65.3, 47.1, 44.3, 25.0, 20.2, 8.1.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.36.
HRMS (ESI) m/z calcd. for $C_{23}H_{25}F_6N_2O_2$ $[M + H]^+$ 475.1815, found 475.1811.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-2-(2-chlorophenyl)-1-morpholinobutan-1-one (19)



19

According to **General Procedure A** with 2-chloro-2-(2-chlorophenyl)-1-morpholinobutan-1-one **E19** (72.3 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **19** as a white solid (98.5 mg, 99% yield, 94% ee).

[α]$_D^{27}$ = +50 (*c* 2.4, $CHCl_3$).

HPLC analysis: Chiralcel ADH (*n*-hexane/*i*-PrOH = 95/5, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 6.10 min, t_R (major) = 7.16 min.

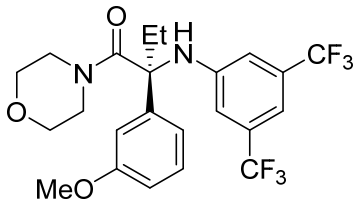
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 – 7.84 (m, 1H), 7.42 – 7.38 (m, 1H), 7.35 – 7.32 (m, 1H), 7.29 – 7.25 (m, 1H), 6.97 (s, 1H), 6.91 (s, 1H), 6.82 (s, 2H), 3.95 – 2.96 (m, 8H), 2.80 (dq, *J* = 14.4, 7.3 Hz, 1H), 2.18 (dq, *J* = 14.2, 7.2 Hz, 1H), 0.97 (t, *J* = 7.2 Hz, 3H)

^{13}C NMR (100 MHz, $CDCl_3$) δ 168.4, 145.0, 137.8, 134.1, 132.3, 131.7 (q, *J* = 32.3 Hz), 129.8, 128.8, 127.0, 123.4 (q, *J* = 2721.0 Hz), 113.53 – 113.50 (m), 109.7 – 109.5 (m), 66.4, 65.8, 65.0, 46.9, 44.8, 25.4, 8.1.

^{19}F NMR (376 MHz, $CDCl_3$) δ -63.34.

HRMS (ESI) m/z calcd. for $C_{22}H_{22}ClF_6N_2O_2$ $[M + H]^+$ 495.1269, found 495.1265.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-2-(3-methoxyphenyl)-1-morpholinobutan-1-one (20)



20

According to **General Procedure A** with 2-chloro-2-(3-methoxyphenyl)-1-morpholinobutan-1-one **E20** (71.3 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 3/1) to yield the product **20** as a white solid (77.1 mg, 79% yield, 96% ee).

[α]$_D^{27}$ = +30 (*c* 1.9, $CHCl_3$).

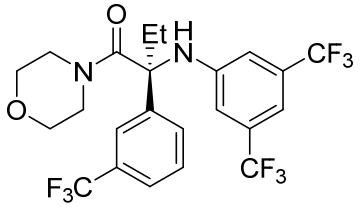
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 11.81 min, t_R (minor) = 16.22 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (t, *J* = 8.0 Hz, 1H), 7.08 (d, *J* = 7.7 Hz, 1H), 7.01 – 6.98 (m, 2H), 6.88 (s, 2H), 6.85 – 6.82 (m, 1H), 6.71 (s, 1H), 3.79 (s, 3H), 3.65 – 3.01 (m, 8H), 2.65 (dq, *J* = 14.6, 7.4 Hz, 1H), 2.27 (dq, *J* = 14.3, 7.2 Hz, 1H), 0.88 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 170.0, 160.3, 145.1, 142.3, 131.9 (q, *J* = 32.3 Hz), 130.1, 123.5

(q, J = 271.0 Hz), 118.9, 113.50 – 113.47 (m), 113.3, 113.2, 109.8 – 109.7 (m), 66.2, 65.9, 55.4, 45.7, 23.9, 8.1.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.31.
HRMS (ESI) m/z calcd. for $C_{23}H_{25}F_6N_2O_3$ $[M + H]^+$ 491.1764, found 491.1764.

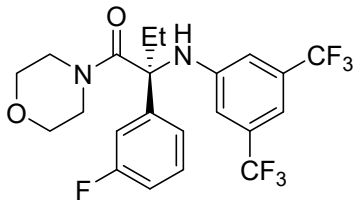
(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-1-morpholino-2-(3-(trifluoromethyl)phenyl)butan-1-one (21)



21

According to **General Procedure A** with 2-chloro-1-morpholino-2-(3-(trifluoromethyl)phenyl)butan-1-one **E21** (80.4 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 4/1) to yield the product **21** as a colorless oil (83.8 mg, 79% yield, 95% ee).
[α]$_D^{27}$ = +16 (c 2.2, $CHCl_3$).
HPLC analysis: Chiralcel IG (n-hexane/i-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 6.78 min, t_R (minor) = 7.85 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.77 (s, 1H), 7.68 – 7.66 (m, 1H), 7.62 – 7.60 (m, 1H), 7.57 – 7.53 (m, 1H), 7.04 (s, 1H), 6.83 (s, 2H), 6.76 (s, 1H), 3.71 – 3.15 (m, 8H), 2.73 (dq, J = 14.6, 7.4 Hz, 1H), 2.34 (dq, J = 14.2, 7.1 Hz, 1H), 0.91 (t, J = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.4, 144.7, 142.2, 132.1 (q, J = 32.5 Hz), 131.6 (q, J = 31.7 Hz), 130.3, 129.9, 125.1 (q, J = 3.7 Hz), 123.62 (q, J = 271.0 Hz), 123.56, 123.3 (q, J = 271.1 Hz), 113.52 – 113.48 (m), 110.4 – 110.3 (m), 66.1, 65.8, 45.8, 23.7, 8.1.
^{19}F NMR (376 MHz, $CDCl_3$) δ -62.84, -63.44.
HRMS (ESI) m/z calcd. for $C_{23}H_{22}F_9N_2O_2$ $[M + H]^+$ 529.1532, found 529.1537.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-2-(3-fluorophenyl)-1-morpholinobutan-1-one (22)

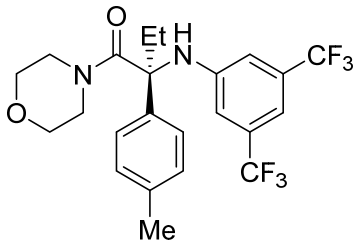


22

According to **General Procedure A** with 2-chloro-2-(3-fluorophenyl)-1-morpholinobutan-1-one **E22** (68.4 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **22** as a colorless oil (90.2 mg, 94% yield, 95% ee).
[α]$_D^{27}$ = +36 (c 2.3, $CHCl_3$).
HPLC analysis: Chiralcel ODH (n-hexane/i-PrOH = 99.5/0.5, flow rate 1.0 mL/min, λ = 254

nm), t_R (major) = 16.67 min, t_R (minor) = 19.92 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 – 7.37 (m, 1H), 7.33 – 7.31 (m, 1H), 7.21 – 7.18 (m, 1H), 7.05 – 7.00 (m, 2H), 6.86 (s, 2H), 6.74 (s, 1H), 3.56 – 3.41 (m, 8H), 2.66 (dq, *J* = 14.6, 7.3 Hz, 1H), 2.30 (dq, *J* = 14.2, 7.1 Hz, 1H), 0.89 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.5, 163.2 (d, *J* = 247.3 Hz), 144.8, 143.5 (q, *J* = 6.3 Hz), 132.0 (q, *J* = 32.4 Hz), 130.7 (d, *J* = 8.3 Hz), 123.4 (q, *J* = 271.0 Hz), 122.3, 115.4 (d, *J* = 20.9 Hz), 114.2 (d, *J* = 22.0 Hz), 113.5 – 113.4 (m), 110.2 – 110.0 (m), 66.1, 65.7 (d, *J* = 1.7 Hz), 45.7, 23.9, 8.0.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.36, -110.57.
HRMS (ESI) m/z calcd. for $C_{22}H_{22}F_7N_2O_2$ $[M + H]^+$ 479.1564, found 479.1564.

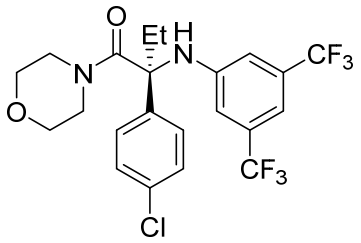
(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-1-morpholino-2-(*p*-tolyl)butan-1-one (23)



23

According to **General Procedure A** with 2-chloro-1-morpholino-2-(*p*-tolyl)butan-1-one **E23** (67.5 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **23** as a white solid (93.0 mg, 98% yield, 94% ee).
$[\alpha]_D^{27}$ = +46 (*c* 2.3, $CHCl_3$).
HPLC analysis: Chiralcel ODH (*n*-hexane/*i*-PrOH = 99.5/0.5, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 10.13 min, t_R (minor) = 11.50 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.34 (m, 2H), 7.20 – 7.18 (m, 2H), 7.00 (s, 1H), 6.87 (s, 2H), 6.73 (s, 1H), 3.90 – 2.97 (m, 8H), 2.65 (dq, *J* = 14.6, 7.3 Hz, 1H), 2.33 – 2.25 (m, 4H), 0.87 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.3, 145.2, 138.1, 137.4, 131.8 (q, *J* = 32.3 Hz), 129.8, 126.6, 123.5 (q, *J* = 270.9 Hz), 113.41 – 113.37 (m), 109.64 – 109.57 (m), 66.1, 65.7, 45.7, 23.8, 20.9, 8.1.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.31.
HRMS (ESI) m/z calcd. for $C_{23}H_{24}F_6N_2NaO_2$ $[M + Na]^+$ 497.1634, found 497.1634.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-2-(4-chlorophenyl)-1-morpholinobutan-1-one (24)



24

According to **General Procedure A** with 2-chloro-2-(4-chlorophenyl)-1-morpholinobutan-1-one **E24** (72.3 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **24** as a colorless oil (98.1 mg, 99% yield, 94% ee).

[α]$_D^{27}$ = +45 (*c* 2.4, $CHCl_3$).

HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 99/1, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 13.29 min, t_R (major) = 15.75 min.

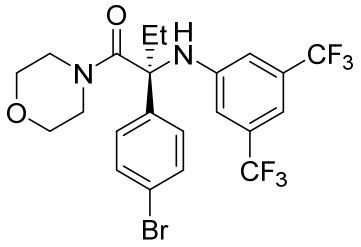
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 – 7.38 (m, 4H), 7.04 (s, 1H), 6.85 (s, 2H), 6.74 (s, 1H), 3.81 – 3.00 (m, 8H), 2.66 (dq, *J* = 14.6, 7.3 Hz, 1H), 2.29 (dq, *J* = 14.3, 7.2 Hz, 1H), 0.88 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 169.7, 144.8, 139.3, 134.2, 132.0 (q, *J* = 32.4 Hz), 129.3, 128.1, 123.4 (q, *J* = 271.0 Hz), 113.43 – 113.39 (m), 110.1 – 110.0 (m), 66.1, 65.6, 45.7, 23.8, 8.0.

^{19}F NMR (376 MHz, $CDCl_3$) δ -63.32.

HRMS (ESI) m/z calcd. for $C_{22}H_{22}ClF_6N_2O_2$ $[M + H]^+$ 495.1269, found 495.1268.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-2-(4-bromophenyl)-1-morpholinobutan-1-one (25)



25

According to **General Procedure A** with 2-(4-bromophenyl)-2-chloro-1-morpholinobutan-1-one **E25** (82.8 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **25** as a white solid (95.3 mg, 89% yield, 94% ee).

[α]$_D^{27}$ = +47 (*c* 0.5, $CHCl_3$).

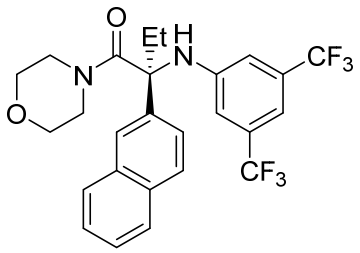
HPLC analysis: Chiralcel ODH (*n*-hexane/*i*-PrOH = 99/1, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 16.80 min, t_R (minor) = 19.19 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 – 7.53 (m, 2H), 7.37 – 7.35 (m, 2H), 7.04 (s, 1H), 6.84 – 6.71 (m, 3H), 3.60 – 3.24 (m, 8H), 2.65 (dq, *J* = 14.5, 7.3 Hz, 1H), 2.28 (dq, *J* = 14.3, 7.2 Hz, 1H), 0.88 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 169.6, 144.8, 139.8, 132.3, 132.0 (q, *J* = 32.5 Hz), 128.4, 123.4

(q, J = 271.1 Hz), 122.3, 113.44 – 113.41 (m), 110.2 – 110.1 (m), 66.1, 65.7, 45.7, 23.8, 8.1.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.31.
HRMS (ESI) m/z calcd. for $C_{22}H_{21}BrF_6N_2NaO_2$ $[M + Na]^+$ 561.0583, found 561.0581.

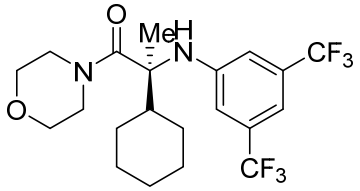
(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-1-morpholino-2-(naphthalen-2-yl)butan-1-one (26)



26

According to **General Procedure A** with 2-chloro-1-morpholino-2-(naphthalen-2-yl)butan-1-one **E26** (76.1 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 7.5/1) to yield the product **26** as a colorless oil (86.0 mg, 84% yield, 93% ee).
$[\alpha]_D^{27}$ = −10 (*c* 1.1, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 11.21 min, t_R (major) = 12.37 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (s, 1H), 7.87 – 7.80 (m, 3H), 7.55 – 7.48 (m, 3H), 6.98 (s, 1H), 6.94 (s, 2H), 6.78 (s, 1H), 3.83 – 3.03 (m, 8H), 2.83 (dq, J = 14.7, 7.4 Hz, 1H), 2.43 (dq, J = 14.2, 7.1 Hz, 1H), 0.92 (t, J = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.1, 145.1, 137.8, 132.9, 132.6, 131.9 (q, J = 32.4 Hz), 129.4, 127.9, 127.7, 127.0, 126.9, 125.5, 124.3, 123.4 (q, J =270.9 Hz), 113.51 – 113.48 (m), 110.0 – 109.9 (m), 66.2, 66.1, 45.7, 24.0, 8.2.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.34.
HRMS (ESI) m/z calcd. for $C_{26}H_{25}F_6N_2O_2$ $[M + H]^+$ 511.1815, found 511.1819.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-2-cyclohexyl-1-morpholinopropan-1-one (27)

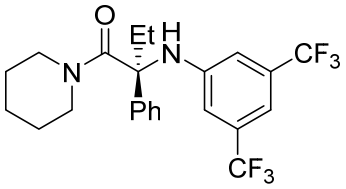


27

According to **General Procedure A** with 2-bromo-2-cyclohexyl-1-morpholinopropan-1-one **E27** (72.7 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **27** as a white solid (88.7 mg, 98% yield, 77% ee).
$[\alpha]_D^{27}$ = −41 (*c* 2.2, $CHCl_3$).
HPLC analysis: Chiralcel OD3 (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 11.17 min, t_R (major) = 18.59 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.19 (s, 1H), 6.97 (s, 2H), 4.48 (s, 1H), 4.00 – 3.17 (m, 8H), 1.94 – 1.73 (m, 5H), 1.62 – 1.59 (m, 1H), 1.44 (s, 3H), 1.31 – 1.19 (m, 5H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 171.0, 146.0, 132.5 (q, J = 32.6 Hz), 123.3 (q, J = 271.1 Hz), 113.4 – 113.3 (m), 111.0 – 110.9 (m), 66.7, 64.8, 45.2, 43.7, 28.3, 26.8, 26.6, 26.5, 26.1, 18.3.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.25.
HRMS (ESI) *m/z* calcd. for $C_{21}H_{27}F_6N_2O_2$ $[M + H]^+$ 453.1971, found 453.1979.

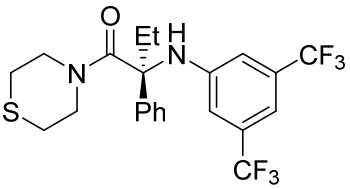
(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-2-phenyl-1-(piperidin-1-yl)butan-1-one (28)



28

According to **General Procedure A** with 2-chloro-2-phenyl-1-(piperidin-1-yl)butan-1-one **E28** (63.6 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 7.5/1) to yield the product **28** as a white solid (91.2 mg, 99% yield, 95% ee).
$[\alpha]_D^{27}$ = +39 (*c* 2.2, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 6.41 min, t_R (minor) = 8.88 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 – 7.48 (m, 2H), 7.39 – 7.35 (m, 2H), 7.28 – 7.25 (m, 1H), 7.00 (s, 1H), 6.95 (s, 1H), 6.83 (s, 2H), 3.83 – 3.09 (m, 4H), 2.67 (dq, J = 14.6, 7.4 Hz, 1H), 2.36 (dq, J = 14.2, 7.1 Hz, 1H), 1.49 – 1.03 (m, 6H), 0.89 (t, J = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.4, 145.2, 141.1, 131.9 (q, J = 32.4 Hz), 128.9, 127.9, 126.9, 123.4 (q, J = 271.0 Hz), 113.24 – 113.20 (m), 109.3 – 109.2 (m), 65.9, 46.3, 25.3, 24.1, 23.4, 8.2.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.35.
HRMS (ESI) m/z calcd. for $C_{23}H_{25}F_6N_2O$ $[M + H]^+$ 459.1866, found 459.1862.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-2-phenyl-1-thiomorpholinobutan-1-one (29)

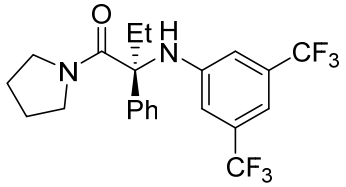


29

According to **General Procedure A** with 2-chloro-2-phenyl-1-thiomorpholinobutan-1-one **E29** (67.9 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 7.5/1) to yield the product **29** as a white solid (94.1 mg, 99% yield, 94% ee).
$[\alpha]_D^{27}$ = +45 (*c* 2.3, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 7.94 min, t_R (minor) = 10.77 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 – 7.48 (m, 2H), 7.43 – 7.39 (m, 2H), 7.33 – 7.28 (m, 1H), 7.00 (s, 1H), 6.83 – 6.80 (m, 3H), 4.16 – 3.36 (m, 4H), 2.65 (dq, *J* = 14.6, 7.3 Hz, 1H), 2.51 – 1.77 (m, 5H), 0.87 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.0, 145.0, 140.6, 131.8 (q, *J* = 32.4 Hz), 129.2, 128.2, 126.8, 123.4 (q, *J* = 271.1 Hz), 113.4 – 113.3 (m), 109.7 – 109.6 (m), 66.0, 48.0, 26.6, 23.7, 8.1.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.32.
HRMS (ESI) m/z calcd. for $C_{22}H_{23}F_6N_2OS$ $[M + H]^+$ 477.1430, found 477.1426.

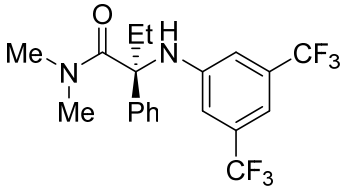
(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-2-phenyl-1-(pyrrolidin-1-yl)butan-1-one (30)



30

According to **General Procedure A** with 2-chloro-2-phenyl-1-(pyrrolidin-1-yl)butan-1-one **E30** (60.3 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 7.5/1) to yield the product **30** as a white solid (87.3 mg, 98% yield, 94% ee).
[α]$_D^{27}$ = +34 (*c* 2.1, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 8.65 min, t_R (minor) = 14.94 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 – 7.50 (m, 2H), 7.39 – 7.35 (m, 2H), 7.30 – 7.26 (m, 1H), 6.96 (s, 1H), 6.90 (s, 1H), 6.80 (s, 2H), 3.58 – 3.54 (m, 2H), 3.18 – 3.12 (m, 1H), 2.65 – 2.51 (m, 2H), 2.43 (dq, *J* = 14.3, 7.2 Hz, 1H), 1.75 – 1.55 (m, 4H), 0.88 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.8, 145.2, 140.1, 131.7 (q, *J* = 32.3 Hz), 128.9, 128.0, 127.3, 123.5 (q, *J* = 271.0 Hz), 113.18 – 113.15 (m), 109.3 – 109.1 (m), 65.9, 48.5, 46.8, 26.7, 22.9, 22.0, 8.1.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.36.
HRMS (ESI) m/z calcd. for $C_{22}H_{23}F_6N_2O$ $[M + H]^+$ 445.1709, found 445.1705.

(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-*N*,*N*-dimethyl-2-phenylbutanamide (31)

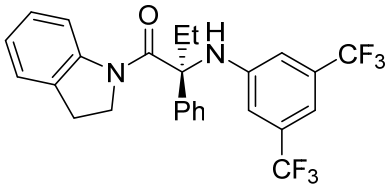


31

According to **General Procedure A** with 2-chloro-*N*,*N*-dimethyl-2-phenylbutanamide **E31** (54.0 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **31** as a white solid (82.5 mg, 99% yield, 95% ee).
[α]$_D^{27}$ = +12 (*c* 1.2, $CHCl_3$).

HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 5.88 min, t_R (minor) = 8.47 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 – 7.48 (m, 2H), 7.40 – 7.36 (m, 2H), 7.30 – 7.26 (m, 1H), 6.97 (s, 1H), 6.89 (s, 1H), 6.83 (s, 2H), 2.95 – 2.59 (m, 7H), 2.45 (dq, *J* = 14.1, 7.2 Hz, 1H), 0.87 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 171.3, 145.2, 140.6, 131.8 (q, *J* = 32.2 Hz), 129.0, 128.0, 126.9, 123.5 (q, *J* = 270.9 Hz), 113.3 – 113.2 (m), 109.5 – 109.3 (m), 66.0, 38.1, 23.1, 8.2.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.36.
HRMS (ESI) m/z calcd. for $C_{20}H_{21}F_6N_2O$ $[M + H]^+$ 419.1553, found 419.1550.

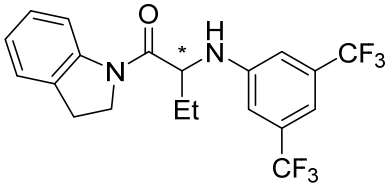
(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-1-(indolin-1-yl)-2-phenylbutan-1-one (32)



32

According to **General Procedure A** with 2-chloro-1-(indolin-1-yl)-2-phenylbutan-1-one **E32** (71.8 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 20/1) to yield the product **32** as a white solid (97.1 mg, 99% yield, 93% ee).
$[\alpha]_D^{27}$ = +62 (*c* 2.4, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 99/1, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 7.04 min, t_R (minor) = 10.33 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.34 (d, *J* = 8.2 Hz, 1H), 7.56 – 7.54 (m, 2H), 7.41 – 7.38 (m, 2H), 7.33 – 7.29 (m, 1H), 7.27 – 7.23 (m, 1H), 7.13 – 7.11 (m, 1H), 7.07 – 7.03 (m, 1H), 7.01 (s, 1H), 6.90 (s, 2H), 6.77 (s, 1H), 3.81 – 3.75 (m, 1H), 3.26 – 3.20 (m, 1H), 2.96 – 2.88 (m, 1H), 2.81 – 2.52 (m, 3H), 0.91 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.0, 145.1, 143.8, 139.7, 132.0 (q, *J* = 32.4 Hz), 131.0, 129.2, 128.4, 127.5, 127.2, 123.5 (q, *J* = 271.0 Hz), 124.7, 124.5, 118.4, 113.45 – 113.41 (m), 109.85 – 109.75 (m), 67.0, 48.6, 28.8, 23.0, 8.0.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.29.
HRMS (ESI) m/z calcd. for $C_{26}H_{23}F_6N_2O$ $[M + H]^+$ 493.1709, found 493.1709.

2-((3,5-Bis(trifluoromethyl)phenyl)amino)-1-(indolin-1-yl)butan-1-one (33)

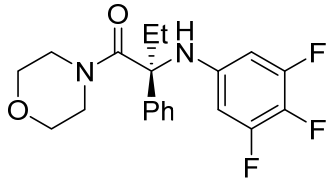


33

According to **General Procedure A** with 2-bromo-1-(indolin-1-yl)butan-1-one **E33** (64.1 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum

ether/EtOAc = 7.5/1) to yield the product **33** as a white solid (82.4 mg, 99% yield, 54% ee).
HPLC analysis: Chiralcel IA (*n*-hexane/*i*-PrOH = 95/5, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 7.35 min, t_R (major) = 9.74 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.24 – 8.22 (m, 1H), 7.30 – 7.19 (m, 2H), 7.14 – 7.13 (m, 1H), 7.08 – 7.05 (m, 1H), 7.01 – 6.86 (m, 2H), 5.44 – 7.39 (m, 1H), 4.73 – 4.30 (m, 1H), 4.28 – 4.05 (m, 2H), 3.28 – 73.07 (m, 2H), 2.06 – 1.95 (m, 1H), 1.89 – 1.78 (m, 1H), 1.12 – 1.04 (m, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.2, 147.8, 142.4, 132.5 (q, *J* = 32.5 Hz), 131.2, 127.6, 124.7, 124.5, 123.5 (q, *J* = 270.9 Hz), 117.4, 112.39 – 112.36 (m), 110.6 – 110.5 (m), 56.3, 47.9, 28.1, 25.18, 25.15, 9.65, 9.62.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.20, -63.21.
HRMS (ESI) m/z calcd. For $C_{20}H_{19}F_6N_2O$ $[M + H]^+$ 417.1396, found 417.1390.

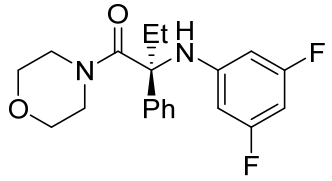
(*S*)-1-Morpholino-2-phenyl-2-((3,4,5-trifluorophenyl)amino)butan-1-one (34)



34

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv), 3,4,5-trifluoroaniline **A2** (29.4 mg, 0.20 mmol, 1.0equiv), and anhydrous THF (4.0 mL) at 10 °C for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 4/1) to yield the product **34** as a white solid (71.9 mg, 95% yield, 90% ee).
$[\alpha]_D^{27}$ = +37 (*c* 1.7, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 95/5, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 15.03 min, t_R (minor) = 16.34 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 – 7.38 (m, 4H), 7.33 – 7.29 (m, 1H), 6.12 – 6.06 (m, 3H), 3.74 – 2.95 (m, 8H), 2.60 (dq, *J* = 14.6, 7.3 Hz, 1H), 2.28 (dq, *J* = 14.3, 7.2 Hz, 1H), 0.81 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.4, 152.8 – 150.2 (m), 141.2, 140.5 – 140.2 (m), 133.6 – 130.9 (m), 129.1, 128.1, 126.5, 98.4 – 98.1 (m), 66.14, 66.06, 45.7, 24.2, 7.9.
^{19}F NMR (376 MHz, $CDCl_3$) δ -35.28, -35.34, -76.12.
HRMS (ESI) *m/z* calcd. for $C_{20}H_{22}F_3N_2O_2$ $[M + H]^+$ 379.1628, found 379.1633.

(*S*)-2-((3,5-Difluorophenyl)amino)-1-morpholino-2-phenylbutan-1-one (35)

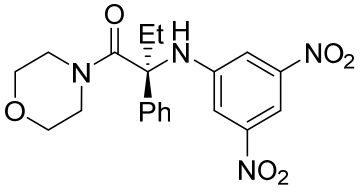


35

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv), 3, 5-difluoroaniline **A3** (25.8 mg, 0.20 mmol, 1.0equiv), and anhydrous THF (4.0 mL) at 10 °C for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 4/1) to yield the product **35** as a white

solid (71.4 mg, 99% yield, 87% ee).
[α]$_D^{27}$ = +30 (*c* 1.7, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 95/5, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 15.97 min, t_R (minor) = 18.22 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.44 (m, 2H), 7.41 – 7.38 (m, 2H), 7.32 – 7.28 (m, 1H), 6.26 (s, 1H), 6.06 – 5.99 (m, 3H), 3.75 – 3.02 (m, 8H), 2.65 (dq, *J* = 14.7, 7.4 Hz, 1H), 2.30 (dq, *J* = 14.3, 7.2 Hz, 1H), 0.81 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.4, 163.7 (dd, *J* = 242.0, 16.0 Hz), 146.6 (t, *J* = 13.5 Hz), 141.1, 129.0, 128.0, 126.4, 97.3 – 97.0 (m), 92.3 (t, *J* = 26.0 Hz), 66.1, 66.0, 45.7, 24.3, 7.9.
^{19}F NMR (376 MHz, $CDCl_3$) δ -110.60.
HRMS (ESI) *m/z* calcd. for $C_{20}H_{23}F_2N_2O_2$ $[M + H]^+$ 361.1722, found 361.1726.

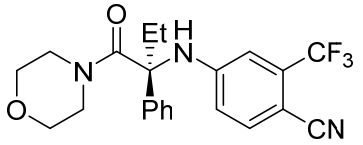
(*S*)-2-((3,5-Dinitrophenyl)amino)-1-morpholino-2-phenylbutan-1-one (36)



36

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and 3,5-dinitroaniline **A4** (36.6 mg, 0.20 mmol, 1.0equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 3/1) to yield the product **36** as a yellowish solid (81.2 mg, 98% yield, 94% ee).
[α]$_D^{27}$ = +70 (*c* 2.0, $CHCl_3$).
HPLC analysis: Chiralcel IF (*n*-hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 11.72 min, t_R (minor) = 15.89 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.10 (t, *J* = 2.0 Hz, 1H), 7.59 – 7.54 (m, 4H), 7.46 – 7.41 (m, 3H), 7.35 – 7.31 (m, 1H), 3.90 – 3.01 (m, 8H), 2.78 (dq, *J* = 14.6, 7.3 Hz, 1H), 2.37 (dq, *J* = 14.3, 7.1 Hz, 1H), 0.96 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.5, 148.9, 145.7, 139.6, 129.4, 128.6, 127.0, 112.8, 105.5, 66.2, 66.0, 45.6, 22.9, 8.2.
HRMS (ESI) *m/z* calcd. for $C_{20}H_{22}NaN_4O_6$ $[M + Na]^+$ 437.1432, found 437.1433.

(*S*)-4-((1-Morpholino-1-oxo-2-phenylbutan-2-yl)amino)-2-(trifluoromethyl)benzonitrile (37)

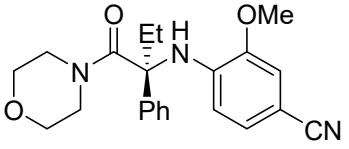


37

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and 4-amino-2-(trifluoromethyl)benzonitrile **A5** (37.2 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 2/1) to yield the product **37** as a yellowish solid (81.1 mg, 97% yield, 91% ee).
[α]$_D^{27}$ = +80 (*c* 1.8, $CHCl_3$).

HPLC analysis: Chiralcel OD3 (*n*-hexane/*i*-PrOH = 90/10, flow rate 0.8 mL/min, λ = 254 nm), t_R (major) = 14.33 min, t_R (minor) = 16.13 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 – 7.47 (m, 2H), 7.42 – 7.38 (m, 2H), 7.34 – 7.29 (m, 3H), 6.83 (s, 1H), 6.57 (dd, *J* = 8.7, 2.5 Hz, 1H), 3.77 – 3.01 (m, 8H), 2.68 (dq, *J* = 14.5, 7.3 Hz, 1H), 2.35 (dq, *J* = 14.2, 7.1 Hz, 1H), 0.89 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.6, 147.5, 139.9, 135.6, 133.5 (q, *J* = 31.6 Hz), 129.2, 128.4, 126.7, 122.4 (q, *J* = 272.3 Hz), 117.0, 114.9, 111.8 (q, *J* = 4.8 Hz), 94.8, 66.0, 65.9, 45.6, 23.5, 8.1.
^{19}F NMR (376 MHz, $CDCl_3$) δ -62.61.
HRMS (ESI) m/z calcd. for $C_{22}H_{23}F_3N_3O_2$ $[M + H]^+$ 418.1737, found 418.1737.

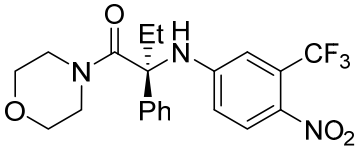
(*S*)-3-Methoxy-4-((1-morpholino-1-oxo-2-phenylbutan-2-yl)amino)benzonitrile (38)



38

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv), and 4-amino-3-methoxybenzonitrile **A6** (29.6 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 2/1) to yield the product **38** as a white solid (73.9 mg, 97% yield, 88% ee).
$[\alpha]_D^{27}$ = +49 (*c* 1.8, $CHCl_3$).
HPLC analysis: Chiralcel ADH (*n*-hexane/*i*-PrOH = 90/10, flow rate 1.0 mL/min, λ = 300 nm), t_R (minor) = 18.47 min, t_R (major) = 23.82 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.40 (m, 4H), 7.34 – 7.30 (m, 1H), 6.99 – 6.96 (m, 1H), 6.93 – 6.92 (m, 1H), 6.84 (s, 1H), 6.43 (d, *J* = 8.4 Hz, 1H), 3.94 (s, 3H), 3.56 – 3.29 (m, 8H), 2.54 – 2.47 (m, 1H), 2.40 (dq, *J* = 14.3, 7.2 Hz, 1H), 0.70 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.6, 146.7, 140.4, 138.2, 129.0, 127.9, 126.6, 125.8, 120.4, 111.6, 110.0, 97.8, 66.1, 65.8, 55.9, 45.4, 25.6, 7.6.
HRMS (ESI) m/z calcd. for $C_{22}H_{26}N_3O_3$ $[M + H]^+$ 380.1969, found 380.1963.

(*S*)-1-Morpholino-2-((4-nitro-3-(trifluoromethyl)phenyl)amino)-2-phenylbutan-1-one (39)

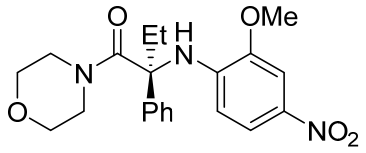


39

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and 4-nitro-3-(trifluoromethyl)aniline **A7** (41.2 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 2/1) to yield the product **39** as a yellowish solid (86.4 mg, 99% yield, 87% ee).
$[\alpha]_D^{27}$ = +103 (*c* 2.1, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 80/20, flow rate 0.8 mL/min, λ = 254 nm), t_R (major) = 14.49 min, t_R (minor) = 17.42 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.79 (d, *J* = 9.1 Hz, 1H), 7.57 – 7.40 (m, 5H), 7.35 – 7.31 (m, 1H), 6.85 (d, *J* = 2.7 Hz, 1H), 6.51 (dd, *J* = 9.1, 2.7 Hz, 1H), 4.15 – 2.95 (m, 8H), 2.72 (dq, *J* = 14.6, 7.3 Hz, 1H), 2.35 (dq, *J* = 14.2, 7.2 Hz, 1H), 0.92 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.5, 148.3, 139.9, 136.1, 129.4, 128.7, 128.6, 126.9, 126.2 (q, *J* = 33.0 Hz), 122.2 (q, *J* = 271.7 Hz), 113.8, 112.8 (q, *J* = 6.7 Hz), 66.1, 66.0, 45.8, 23.4, 8.3.
^{19}F NMR (376 MHz, $CDCl_3$) δ -60.38.
HRMS (ESI) *m/z* calcd. for $C_{21}H_{23}F_3N_3O_4$ $[M + H]^+$ 438.1635, found 438.1632.

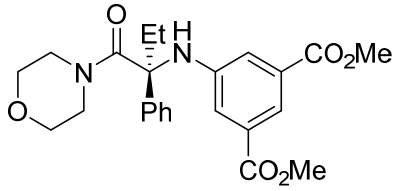
(*S*)-2-((2-Methoxy-4-nitrophenyl)amino)-1-morpholino-2-phenylbutan-1-one (40)



40

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv), and 2-methoxy-4-nitroaniline **A8** (33.6 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 2/1) to yield the product **40** as a yellowish oil (75.3 mg, 94% yield, 87% ee).
$[\alpha]_D^{27}$ = +78 (*c* 2.3, $CHCl_3$).
HPLC analysis: Chiralcel IC (*n*-hexane/*i*-PrOH = 60/40, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 20.10 min, t_R (minor) = 27.30 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 – 7.60 (m, 2H), 7.48 – 7.28 (m, 6H), 6.34 (d, *J* = 8.9 Hz, 1H), 4.00 (s, 3H), 3.56 – 3.12 (m, 8H), 2.62 (dq, *J* = 15.1, 7.6 Hz, 1H), 2.40 (dq, *J* = 14.4, 7.2 Hz, 1H), 0.77 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.2, 146.1, 140.4, 140.2, 137.0, 129.1, 128.1, 126.1, 119.0, 107.8, 104.5, 66.0, 65.9, 56.1, 45.6, 24.8, 7.8.
HRMS (ESI) m/z calcd. for $C_{21}H_{26}N_3O_5$ $[M + H]^+$ 400.1867, found 400.1860.

Dimethyl (*S*)-5-((1-morpholino-1-oxo-2-phenylbutan-2-yl)amino)isophthalate (41)

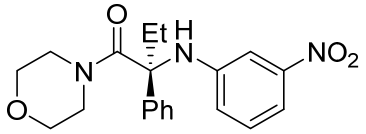


41

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and dimethyl 5-aminoisophthalate **A9** (41.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 3/1) to yield the product **41** as a white solid (87.2 mg, 99% yield, 82% ee).
$[\alpha]_D^{27}$ = +54 (*c* 2.1, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 60/40, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 16.02 min, t_R (minor) = 20.75 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 (s, 1H), 7.53 – 7.51 (m, 2H), 7.43 – 7.38 (m, 4H), 7.31 – 7.27 (m, 1H), 6.38 (s, 1H), 3.86 (s, 6H), 3.67 – 3.00 (m, 8H), 2.70 (dq, *J* = 14.5, 7.3 Hz, 1H), 2.33 (dq, *J* = 14.4, 7.1 Hz, 1H), 0.81 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 170.5, 166.5, 144.6, 141.0, 130.9, 128.8, 127.8, 126.5, 119.4, 119.1, 66.1, 66.0, 52.1, 45.5, 24.2, 7.8.
HRMS (ESI) *m/z* calcd. for $C_{24}H_{29}N_2O_6$ $[M + H]^+$ 441.2020, found 441.2018.

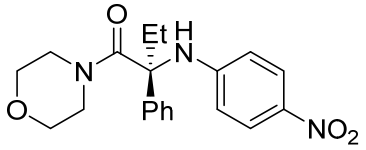
(*S*)-1-Morpholino-2-((3-nitrophenyl)amino)-2-phenylbutan-1-one (42)



42

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv), 3-nitroaniline **A10** (27.6 mg, 0.20 mmol, 1.0equiv), and anhydrous THF (4.0 mL) at 10 °C for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **42** as a yellowish solid (67.0 mg, 91% yield, 94% ee).
$[\alpha]_D^{27}$ = +76 (*c* 1.3, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 75/25, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 12.31 min, t_R (minor) = 13.95 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 – 7.50 (m, 2H), 7.42 – 7.39 (m, 3H), 7.33 – 7.28 (m, 2H), 7.14 – 7.10 (m, 1H), 6.86 – 6.83 (m, 1H), 6.52 (s, 1H), 3.69 – 3.13 (m, 8H), 2.70 (dq, *J* = 14.6, 7.4 Hz, 1H), 2.34 (dq, *J* = 14.3, 7.1 Hz, 1H), 0.84 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.4, 148.9, 145.2, 140.8, 129.4, 129.0, 128.0, 126.6, 120.6, 111.6, 107.9, 66.1, 66.0, 45.6, 24.0, 7.9.
HRMS (ESI) *m/z* calcd. for $C_{20}H_{24}N_3O_4$ $[M + H]^+$ 370.1761, found 370.1768.

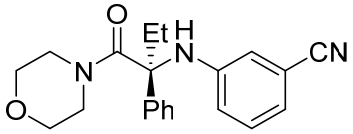
(*S*)-1-Morpholino-2-((4-nitrophenyl)amino)-2-phenylbutan-1-one (43)



43

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and 4-nitroaniline **A11** (27.6 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 3/1) to yield the product **43** as a yellowish solid (72.3 mg, 98% yield, 88% ee).
$[\alpha]_D^{27}$ = +96 (*c* 1.8, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 60/40, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 9.30 min, t_R (minor) = 17.35 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 – 7.88 (m, 2H), 7.49 – 7.48 (m, 2H), 7.42 – 7.38 (m, 2H), 7.33 –7.27 (m, 2H), 6.47 –6.45 (m, 2H), 3.78 – 3.09 (m, 8H), 2.73 (dq, *J* = 14.6, 7.4 Hz, 1H), 2.35 (dq, *J* = 14.3, 7.1 Hz, 1H), 0.88 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.9, 149.8, 140.4, 137.7, 129.2, 128.3, 126.7, 125.9, 112.6, 66.1, 66.0, 45.8, 23.9, 8.1.
HRMS (ESI) *m/z* calcd. for $C_{20}H_{24}N_3O_4$ $[M + H]^+$ 370.1761, found 370.1760.

(*S*)-3-((1-Morpholino-1-oxo-2-phenylbutan-2-yl)amino)benzonitrile (44)



44

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv), 3-aminobenzonitrile **A12** (23.6 mg, 0.20 mmol, 1.0 equiv), and anhydrous THF (4.0 mL) at 10 °C for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 4/1) to yield the product **44** as a yellowish solid (69.0 mg, 99% yield, 88% ee).

[α]D^{27} = +62 (*c* 1.7, $CHCl_3$).

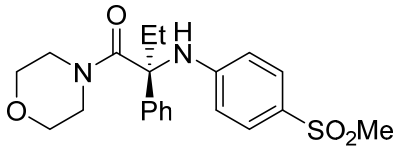
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 75/25, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 14.36 min, t_R (minor) = 16.23 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 – 7.46 (m, 2H), 7.41 – 7.38 (m, 2H), 7.32 – 7.28 (m, 1H), 7.09 – 7.05 (m, 1H), 6.86 – 6.84 (m, 1H), 6.78 – 6.75 (m, 1H), 6.71 (s, 1H), 6.31 (s, 1H), 3.65 – 3.33 (m, 8H), 2.62 (dq, *J* = 14.7, 7.3 Hz, 1H), 2.33 (dq, *J* = 14.3, 7.2 Hz, 1H), 0.81 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 170.4, 144.8, 140.9, 129.6, 129.0, 128.0, 126.4, 120.6, 119.3, 119.1, 116.5, 112.4, 66.1, 65.9, 45.6, 24.2, 7.8.

HRMS (ESI) m/z calcd. for $C_{21}H_{24}N_3O_2$ $[M + H]^+$ 350.1863, found 350.1862.

(*S*)-2-((4-(Methylsulfonyl)phenyl)amino)-1-morpholino-2-phenylbutan-1-one (45)



45

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv), 4-(methylsulfonyl)aniline **A13** (34.2 mg, 0.20 mmol, 1.0 equiv), and anhydrous THF (4.0 mL) at 10 °C for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 1/1) to yield the product **45** as a white solid (76.9 mg, 96% yield, 88% ee).

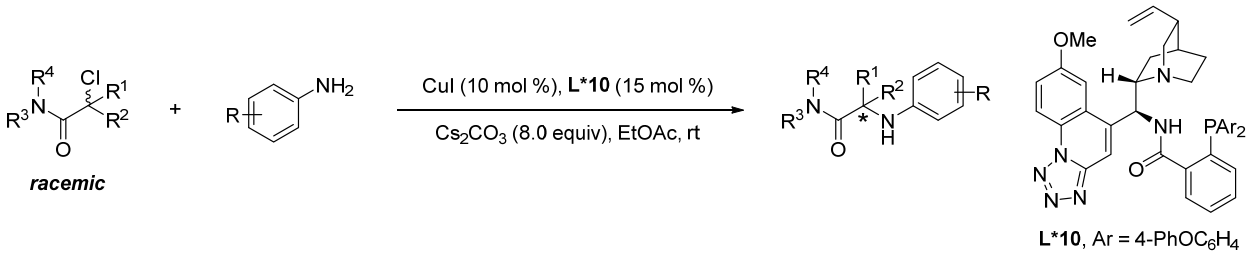
[α]D^{27} = +66 (*c* 1.9, $CHCl_3$).

HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 50/50, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 15.12 min, t_R (minor) = 22.60 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 – 7.48 (m, 4H), 7.41 – 7.37 (m, 2H), 7.32 – 7.28 (m, 1H), 6.83 (s, 1H), 6.59 – 6.57 (m, 2H), 3.54 – 3.10 (m, 8H), 2.93 (s, 3H), 2.68 (dq, *J* = 13.9, 7.0 Hz, 1H), 2.35 (dq, *J* = 14.3, 7.2 Hz, 1H), 0.83 (t, *J* = 7.2 Hz, 3H).

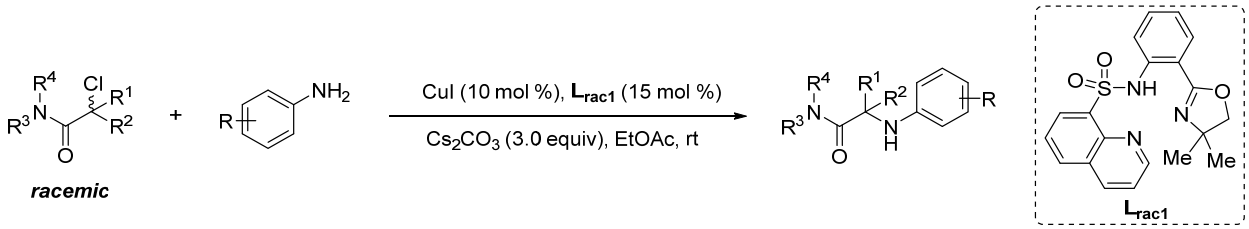
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.1, 148.7, 140.6, 129.0, 128.8, 128.0, 126.9, 126.5, 113.3, 66.0, 65.8, 45.6, 44.8, 24.0, 8.0.

HRMS (ESI) m/z calcd. for $C_{21}H_{26}NaN_2O_4S$ $[M + Na]^+$ 425.1505, found 425.1503.



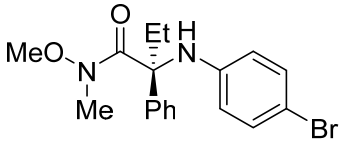
General procedure B:

Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with CuI (3.8 mg, 0.02 mmol, 10 mol %), **L*10** (25.1 mg, 0.03 mmol, 15 mol %), Cs_2CO_3 (521.3 mg, 1.60 mmol, 8.0 equiv), racemic tertiary alkyl chloride (0.24 mmol, 1.2 equiv), aromatic amine (0.20 mmol, 1.0 equiv), and anhydrous EtOAc (4.0 mL) were sequentially added into the mixture and the reaction mixture was stirred at room temperature for 72 h. Upon completion (monitored by TLC), the precipitate was filtered off and washed by EtOAc. The filtrate was evaporated and the residue was purified by column chromatography on silica gel to afford the desired product.



The racemates of products were prepared following the procedure: Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with CuI (3.8 mg, 0.02 mmol, 10 mol %), $\mathbf{L_{rac1}}$ (11.4 mg, 0.03 mmol, 15 mol %), Cs_2CO_3 (195.5 mg, 0.60 mmol, 3.0 equiv), racemic tertiary alkyl chloride (0.24 mmol, 1.2 equiv), aromatic amine (0.20 mmol, 1.0 equiv), and anhydrous EtOAc (4.0 mL) were sequentially added into the mixture and the reaction mixture was stirred at room temperature for 72 h. Upon completion (monitored by TLC), the precipitate was filtered off and washed by EtOAc. The filtrate was evaporated and the residue was purified by column chromatography on silica gel to afford the desired product.

(*S*)-2-((4-Bromophenyl)amino)-*N*-methoxy-*N*-methyl-2-phenylbutanamide (47)



47

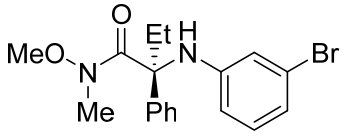
According to **General Procedure B** with 2-chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide **E34** (57.9 mg, 0.24 mmol, 1.2 equiv) and 4-bromoaniline **A15** (34.2 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **47** as a colorless oil (74.8 mg, 99% yield, 81% ee).

$\mathbf{[\alpha]_D^{27}}$ = +81 (*c* 1.8, $CHCl_3$).

HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 8.39 min, t_R (minor) = 14.76 min.

According to **General Procedure A** with 2-chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide **E34** (57.9 mg, 0.24 mmol, 1.2 equiv) and 4-bromoaniline **A15** (34.2 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **47** as a colorless oil (72.0 mg, 96% yield, 16% ee).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 – 7.52 (m, 2H), 7.37 – 7.35 (m, 2H), 7.25 – 7.22 (m, 1H), 7.04 – 7.00 (m, 2H), 6.30 – 6.26 (m, 2H), 6.07 (s, 1H), 3.16 (s, 3H), 2.72 (dq, *J* = 14.4, 7.3 Hz, 1H), 2.58 (s, 3H), 2.50 (dq, *J* = 14.5, 7.5 Hz, 1H), 0.78 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 172.8, 143.5, 142.2, 131.4, 128.4, 127.4, 127.2, 116.3, 108.5, 66.0, 59.3, 33.6, 21.7, 8.1.
HRMS (ESI) m/z calcd. for $C_{18}H_{22}BrN_2O_2$ $[M + H]^+$ 377.0859, found 377.0857.

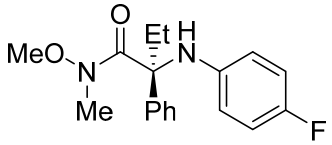
(*S*)-2-((3-Bromophenyl)amino)-*N*-methoxy-*N*-methyl-2-phenylbutanamide (48)



48

According to **General Procedure B** with 2-chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide **E34** (57.9 mg, 0.24 mmol, 1.2 equiv) and 3-bromoaniline **A16** (34.2 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **48** as a yellowish oil (69.6 mg, 93% yield, 85% ee).
$[\alpha]_D^{27}$ = +82 (*c* 1.7, $CHCl_3$).
HPLC analysis: Chiralcel IA (*n*-hexane/*i*-PrOH = 95/5, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 6.42 min, t_R (minor) = 10.03 min.
According to **General Procedure A** with 2-chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide **E34** (57.9 mg, 0.24 mmol, 1.2 equiv) and 3-bromoaniline **A16** (34.2 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **48** as a yellowish oil (73.8 mg, 98% yield, 8% ee).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 – 7.51 (m, 2H), 7.37 – 7.33 (m, 2H), 7.26 – 7.22 (m, 1H), 6.79 – 6.75 (m, 1H), 6.65 – 6.63 (m, 1H), 6.57 – 6.56 (m, 1H), 6.31 – 6.28 (m, 1H), 6.14 (s, 1H), 3.15 (s, 3H), 2.73 (dq, *J* = 14.4, 7.2 Hz, 1H), 2.60 – 2.49 (m, 4H), 0.80 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 172.7, 145.8, 142.0, 129.9, 128.4, 127.4, 127.2, 122.6, 119.5, 117.4, 113.1, 66.0, 59.3, 33.6, 21.7, 8.1.
HRMS (ESI) m/z calcd. for $C_{18}H_{22}BrN_2O_2$ $[M + H]^+$ 377.0859, found 377.0854.

(*S*)-2-((4-Fluorophenyl)amino)-*N*-methoxy-*N*-methyl-2-phenylbutanamide (49)

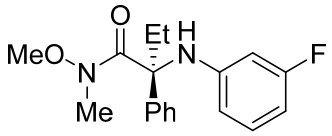


49

According to **General Procedure B** with 2-chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide **E34** (57.9 mg, 0.24 mmol, 1.2 equiv) and 4-fluoroaniline **A17** (22.2 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **49** as a yellowish oil (50.7 mg, 80% yield, 78% ee).
$[\alpha]_D^{27}$ = +64 (*c* 1.2, $CHCl_3$).

HPLC analysis: Chiralcel IA (*n*-hexane/*i*-PrOH = 95/5, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 7.16 min, t_R (minor) = 13.69 min.
According to **General Procedure A** with 2-chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide **E34** (57.9 mg, 0.24 mmol, 1.2 equiv) and 4-fluoroaniline **A17** (22.2 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **49** as a yellowish oil (57.9 mg, 92% yield, 27% ee).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 – 7.53 (m, 2H), 7.37 – 7.34 (m, 2H), 7.26 – 7.22 (m, 1H), 6.71 – 6.64 (m, 2H), 6.38 – 6.34 (m, 2H), 5.81 (s, 1H), 3.15 (s, 3H), 2.69 (dq, *J* = 14.4, 7.2 Hz, 1H), 2.59 (s, 3H), 2.44 (dq, *J* = 14.5, 7.5 Hz, 1H), 0.78 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 173.3, 155.8 (d, *J* = 233.9 Hz), 142.9, 140.9 (d, *J* = 1.8 Hz), 128.4, 127.3, 127.1, 116.4 (d, *J* = 7.2 Hz), 115.1 (d, *J* = 21.8 Hz), 66.4, 59.2, 33.6, 22.3, 8.0.
^{19}F NMR (376 MHz, $CDCl_3$) δ -127.85.
HRMS (ESI) m/z calcd. For $C_{18}H_{22}FN_2O_2$ $[M + H]^+$ 317.1660, found 317.1656.

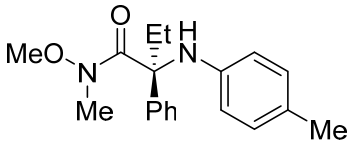
(*S*)-2-((3-Fluorophenyl)amino)-*N*-methoxy-*N*-methyl-2-phenylbutanamide (50)



50

According to **General Procedure B** with 2-chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide **E34** (57.9 mg, 0.24 mmol, 1.2 equiv) and 3-fluoroaniline **A18** (22.2 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **50** as a yellowish oil (51.3 mg, 81% yield, 84% ee).
$[\alpha]_D^{27}$ = +92 (*c* 1.2, $CHCl_3$).
HPLC analysis: Chiralcel IA (*n*-hexane/*i*-PrOH = 95/5, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 6.49 min, t_R (minor) = 10.53 min.
According to **General Procedure A** with 2-chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide **E34** (57.9 mg, 0.24 mmol, 1.2 equiv) and 3-fluoroaniline **A18** (22.2 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **50** as a yellowish oil (60.5 mg, 96% yield, 12% ee).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 – 7.52 (m, 2H), 7.37 – 7.33 (m, 2H), 7.26 – 7.22 (m, 1H), 6.91 – 6.85 (m, 1H), 6.24 – 6.18 (m, 3H), 6.06 – 6.02 (m, 1H), 3.16 (s, 3H), 2.73 (dq, *J* = 14.4, 7.3 Hz, 1H), 2.60 – 2.51 (m, 4H), 0.80 (t, *J* = 7.4 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 172.8, 163.5 (d, *J* = 240.2 Hz), 146.2 (d, *J* = 11.0 Hz), 142.2, 129.6 (d, *J* = 10.2 Hz), 128.4, 127.4, 127.2, 110.8 (d, *J* = 2.2 Hz), 103.2 (d, *J* = 21.5 Hz), 101.1 (d, *J* = 25.4 Hz), 66.1, 59.3, 33.6, 21.8, 8.1.
^{19}F NMR (376 MHz, $CDCl_3$) δ -113.23.
HRMS (ESI) m/z calcd. for $C_{18}H_{22}FN_2O_2$ $[M + H]^+$ 317.1660, found 317.1656.

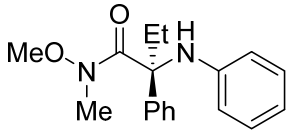
(*S*)-*N*-Methoxy-*N*-methyl-2-phenyl-2-(*p*-tolylamino)butanamide (51)



51

According to **General Procedure B** with 2-chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide **E34** (57.9 mg, 0.24 mmol, 1.2 equiv) and *p*-toluidine **A19** (21.4 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **51** as a colorless oil (58.1 mg, 93% yield, 74% ee).
[α]$_D^{27}$ = +73 (*c* 1.4, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 9.40 min, t_R (minor) = 16.17 min.
According to **General Procedure A** with 2-chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide **E34** (57.9 mg, 0.24 mmol, 1.2 equiv) and *p*-toluidine **A19** (21.4 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **51** as a colorless oil (50.2 mg, 80% yield, 39% ee).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 – 7.53 (m, 2H), 7.36 – 7.32 (m, 2H), 7.25 – 7.20 (m, 1H), 6.80 – 6.77 (m, 2H), 6.37 – 6.34 (m, 2H), 5.75 (s, 1H), 3.14 (s, 3H), 2.69 (dq, *J* = 14.5, 7.3 Hz, 1H), 2.60 (s, 3H), 2.49 (dq, *J* = 14.8, 7.4 Hz, 1H), 2.13 (s, 3H), 0.78 (t, *J* = 7.4 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 173.5, 143.0, 142.2, 129.2, 128.3, 127.3, 126.9, 126.3, 115.4, 66.2, 59.2, 33.6, 22.3, 20.3, 8.0.
HRMS (ESI) m/z calcd. for $C_{19}H_{25}N_2O_2$ $[M + H]^+$ 313.1911, found 313.1908.

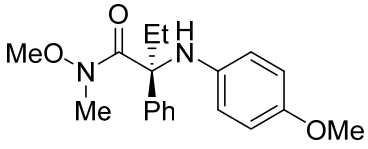
(*S*)-*N*-Methoxy-*N*-methyl-2-phenyl-2-(phenylamino)butanamide (52)



52

According to **General Procedure B** with 2-chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide **E34** (57.9 mg, 0.24 mmol, 1.2 equiv) and aniline **A20** (18.6 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **52** as a colorless oil (54.7 mg, 92% yield, 76% ee).
[α]$_D^{27}$ = +64 (*c* 1.3, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 7.51 min, t_R (minor) = 10.40 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 – 7.54 (m, 2H), 7.37 – 7.33 (m, 2H), 7.25 – 7.21 (m, 1H), 6.98 – 6.93 (m, 2H), 6.58 – 6.54 (m, 1H), 6.44 – 6.41 (m, 2H), 5.96 (s, 1H), 3.15 (s, 3H), 2.72 (dq, *J* = 14.5, 7.3 Hz, 1H), 2.59 – 2.50 (m, 4H), 0.79 (t, *J* = 7.4 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 173.3, 144.6, 142.8, 128.7, 128.3, 127.4, 127.0, 117.0, 115.0, 66.1, 59.3, 33.6, 22.0, 8.1.
HRMS (ESI) m/z calcd. for $C_{18}H_{23}N_2O_2$ $[M + H]^+$ 299.1754, found 299.1751.

(*S*)-*N*-Methoxy-2-((4-methoxyphenyl)amino)-*N*-methyl-2-phenylbutanamide (53)

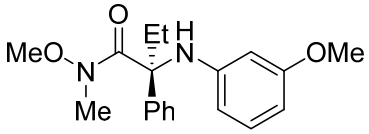


53

According to **General Procedure B** with 2-chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide

E34 (57.9 mg, 0.24 mmol, 1.2 equiv) and 4-methoxyaniline **A21** (24.6 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **53** as a colorless oil (57.8 mg, 88% yield, 69% ee).
[α]$_D^{27}$ = +49 (*c* 1.4, $CHCl_3$).
HPLC analysis: Chiralcel IA (*n*-hexane/*i*-PrOH = 90/10, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 7.43 min, t_R (minor) = 14.23 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 – 7.53 (m, 2H), 7.37 – 7.34 (m, 2H), 7.26 – 7.22 (m, 1H), 6.61 – 6.57 (m, 2H), 6.44 – 6.41 (m, 2H), 5.50 (s, 1H), 3.66 (s, 3H), 3.14 (s, 3H), 2.69 – 2.60 (m, 4H), 2.38 (dq, *J* = 14.5, 7.3 Hz, 1H), 0.76 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 173.8, 152.3, 143.4, 138.5, 128.2, 127.2, 126.9, 117.7, 114.3, 66.8, 59.2, 55.4, 33.5, 23.0, 7.9.
HRMS (ESI) m/z calcd. for $C_{19}H_{25}N_2O_3$ $[M + H]^+$ 329.1860, found 329.1857.

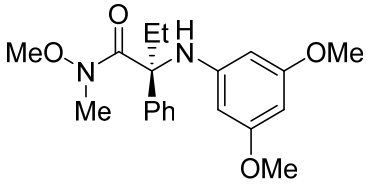
(*S*)-*N*-Methoxy-2-((3-methoxyphenyl)amino)-*N*-methyl-2-phenylbutanamide (54)



54

According to **General Procedure B** with 2-chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide **E34** (57.9 mg, 0.24 mmol, 1.2 equiv) and 3-methoxyaniline **A22** (24.6 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **54** as a colorless oil (42.1 mg, 64% yield, 81% ee).
[α]$_D^{27}$ = +78 (*c* 1.0, $CHCl_3$).
HPLC analysis: Chiralcel IA (*n*-hexane/*i*-PrOH = 90/10, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 6.29 min, t_R (minor) = 9.62 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 – 7.55 (m, 2H), 7.37 – 7.33 (m, 2H), 7.25 – 7.21 (m, 1H), 6.89 – 6.85 (m, 1H), 6.14 – 6.12 (m, 1H), 6.09 – 6.06 (m, 1H), 6.01 (s, 1H), 5.94 – 5.93 (m, 1H), 3.58 (s, 3H), 3.16 (s, 3H), 2.72 (dq, *J* = 14.4, 7.4 Hz, 1H), 2.63 – 2.54 (m, 4H), 0.80 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 173.1, 160.1, 145.8, 142.8, 129.4, 128.4, 127.4, 127.0, 108.1, 102.5, 100.3, 66.1, 59.2, 54.8, 33.6, 21.9, 8.2.
HRMS (ESI) m/z calcd. for $C_{19}H_{25}N_2O_3$ $[M + H]^+$ 329.1860, found 329.1856.

(*S*)-2-((3,5-Dimethoxyphenyl)amino)-*N*-methoxy-*N*-methyl-2-phenylbutanamide (55)

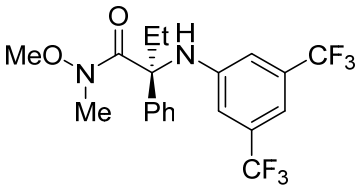


55

According to **General Procedure B** with 2-chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide **E34** (57.9 mg, 0.24 mmol, 1.2 equiv) and 3,5-dimethoxyaniline **A23** (30.6 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **55** as a colorless oil (53.1 mg, 74% yield, 80% ee).

[α]$_D^{27}$ = +67 (*c* 0.7, $CHCl_3$).
HPLC analysis: Chiralcel IA (*n*-hexane/*i*-PrOH = 90/10, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 7.43 min, t_R (minor) = 14.87 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 – 7.55 (m, 2H), 7.37 – 7.33 (m, 2H), 7.25 – 7.21 (m, 1H), 6.04 (s, 1H), 5.74 (t, *J* = 2.2 Hz, 1H), 5.61 (d, *J* = 2.2 Hz, 2H), 3.57 (s, 6H), 3.16 (s, 3H), 2.75 – 2.61 (m, 2H), 2.58 (s, 3H), 0.81 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 173.0, 161.0, 146.2, 142.8, 128.4, 127.4, 127.1, 93.4, 89.8, 66.1, 59.2, 54.8, 33.6, 21.9, 8.2.
HRMS (ESI) m/z calcd. for $C_{20}H_{27}N_2O_4$ $[M + H]^+$ 359.1965, found 359.1963.

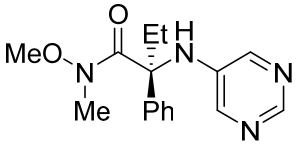
(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-*N*-methoxy-*N*-methyl-2-phenylbutanamide (56)



56

According to **General Procedure B** with 2-chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide **E34** (57.9 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **56** as a colorless oil (55.0 mg, 63% yield, 68% ee).
[α]$_D^{27}$ = +45 (*c* 1.3, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 99/1, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 5.09 min, t_R (minor) = 8.73 min.
According to **General Procedure A** with 2-chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide **E34** (57.9 mg, 0.24 mmol, 1.2 equiv) and 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **56** as a colorless oil (86.3 mg, 99% yield, 68% ee).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 – 7.52 (m, 2H), 7.39 – 7.35 (m, 2H), 7.28 – 7.24 (m, 1H), 6.96 (s, 1H), 6.76 (s, 2H), 6.67 (s, 1H), 3.20 (s, 3H), 2.82 (dq, *J* = 14.7, 7.4 Hz, 1H), 2.59 (s, 3H), 2.51 (dq, *J* = 14.6, 7.4 Hz, 1H), 0.85 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 172.1, 145.0, 140.9, 131.7 (q, *J* = 32.3 Hz), 128.7, 127.7, 127.4, 123.5 (q, *J* = 270.9 Hz), 113.4 – 113.3 (m), 109.4 – 109.2 (m), 66.1, 59.3, 33.6, 21.6, 8.2.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.39.
HRMS (ESI) m/z calcd. for $C_{20}H_{21}F_6N_2O_2$ $[M + H]^+$ 435.1502, found 435.1497.

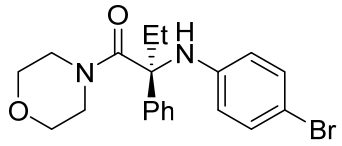
(*S*)-*N*-Methoxy-*N*-methyl-2-phenyl-2-(pyrimidin-5-ylamino)butanamide (57)



57

According to **General Procedure B** with 2-chloro-*N*-methoxy-*N*-methyl-2-phenylbutanamide **E34** (57.9 mg, 0.24 mmol, 1.2 equiv) and pyrimidin-5-amine **A24** (19.0 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 1/1) to yield the product **57** as a yellowish oil (57.8 mg, 96% yield, 83% ee).
[α]$_D^{27}$ = +62 (*c* 1.4, $CHCl_3$).
HPLC analysis: Chiralcel OD3 (*n*-hexane/*i*-PrOH = 90/10, flow rate 0.8 mL/min, λ = 254 nm), t_R (minor) = 11.13 min, t_R (major) = 13.96 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.41 (s, 1H), 7.90 (s, 2H), 7.54 – 7.52 (m, 2H), 7.39 – 7.35 (m, 2H), 7.29 – 7.25 (m, 1H), 6.32 (s, 1H), 3.20 (s, 3H), 2.82 (dq, *J* = 14.4, 7.3 Hz, 1H), 2.59 (s, 3H), 2.47 (dq, *J* = 14.6, 7.4 Hz, 2H), 0.84 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 171.9, 147.5, 141.8, 140.5, 138.6, 128.7, 127.8, 127.3, 65.6, 59.3, 33.6, 21.4, 8.0.
HRMS (ESI) m/z calcd. for $C_{16}H_{21}N_4O_2$ $[M + H]^+$ 301.1659, found 301.1656.

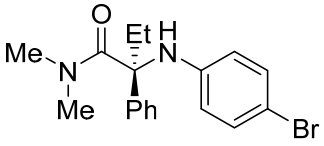
(*S*)-2-((4-Bromophenyl)amino)-1-morpholino-2-phenylbutan-1-one (58)



58

According to **General Procedure B** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and 4-bromoaniline **A15** (34.2 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **58** as a white solid (71.4 mg, 89% yield, 84% ee).
[α]$_D^{27}$ = +63 (*c* 1.7, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 14.22 min, t_R (minor) = 20.22 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.36 (m, 4H), 7.30 – 7.26 (m, 1H), 7.14 – 7.12 (m, 2H), 6.48 – 6.46 (m, 2H), 5.66 (s, 1H), 3.64 – 3.09 (m, 8H), 2.51 (dq, *J* = 14.7, 7.4 Hz, 1H), 2.35 (dq, *J* = 14.3, 7.2 Hz, 1H), 0.71 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 171.0, 143.5, 141.2, 131.7, 128.8, 127.7, 126.0, 116.4, 109.4, 66.14, 66.09, 45.5, 25.4, 7.6.
HRMS (ESI) m/z calcd. for $C_{20}H_{24}BrN_2O_2$ $[M + H]^+$ 403.1016, found 403.1010.

(*S*)-2-((4-Bromophenyl)amino)-*N*,*N*-dimethyl-2-phenylbutanamide (59)

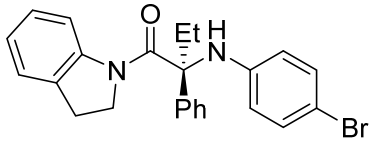


59

According to **General Procedure B** with 2-chloro-*N*,*N*-dimethyl-2-phenylbutanamide **E31** (54.0 mg, 0.24 mmol, 1.2 equiv) and 4-bromoaniline **A15** (34.2 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 7.5/1) to yield the product **59** as a white solid (63.4 mg, 88% yield, 83% ee).
[α]$_D^{27}$ = +63 (*c* 1.5, $CHCl_3$).

HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 85/15, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 10.26 min, t_R (minor) = 17.16 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.44 (m, 2H), 7.38 – 7.44 (m, 2H), 7.29 – 7.25 (m, 1H), 7.10 – 7.08 (m, 2H), 6.43 – 6.41 (m, 2H), 5.87 (s, 1H), 2.79 (s, 6H), 2.56 – 2.37 (m, 2H), 0.72 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 172.2, 143.7, 141.4, 131.6, 128.7, 127.5, 126.3, 116.2, 108.9, 66.0, 37.9, 24.6, 7.8.
HRMS (ESI) m/z calcd. for $C_{18}H_{22}BrN_2O$ $[M + H]^+$ 361.0910, found 361.0904.

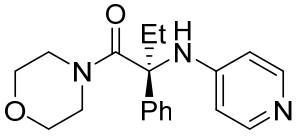
(*S*)-2-((4-Bromophenyl)amino)-1-(indolin-1-yl)-2-phenylbutan-1-one (60)



60

According to **General Procedure B** with 2-chloro-1-(indolin-1-yl)-2-phenylbutan-1-one **E32** (71.8 mg, 0.24 mmol, 1.2 equiv) and 4-bromoaniline **A15** (34.2 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **60** as a yellowish oil (84.5 mg, 97% yield, 80% ee).
$[\alpha]_D^{27}$ = +36 (*c* 2.1, $CHCl_3$).
HPLC analysis: Chiralcel OD3 (*n*-hexane/*i*-PrOH = 99.5/0.5, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 20.66 min, t_R (major) = 22.95 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.36 – 8.34 (m, 1H), 7.52 – 7.49 (m, 2H), 7.40 – 7.36 (m, 2H), 7.31 – 7.27 (m, 1H), 7.24 – 7.20 (m, 1H), 7.14 – 7.08 (m, 3H), 7.03 – 6.99 (m, 1H), 6.54 – 6.50 (m, 2H), 5.60 (s, 1H), 3.69 – 3.63 (m, 1H), 3.57 – 3.50 (m, 1H), 2.88 – 2.72 (m, 2H), 2.61 – 2.46 (m, 2H), 0.72 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 171.1, 143.9, 143.5, 140.2, 131.8, 131.0, 128.8, 127.8, 127.3, 126.3, 124.4, 124.2, 118.1, 116.4, 109.5, 67.2, 48.3, 28.8, 25.2, 7.5.
HRMS (ESI) m/z calcd. for $C_{24}H_{24}BrN_2O$ $[M + H]^+$ 435.1067, found 435.1060.

(*S*)-1-Morpholino-2-phenyl-2-(pyridin-4-ylamino)butan-1-one (61)

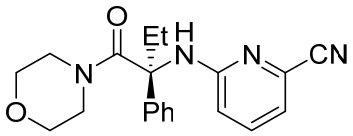


61

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and pyridin-4-amine **A25** (18.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (CH_2Cl_2/CH_3OH = 20/1) to yield the product **61** as a colorless oil (41.7 mg, 64% yield, 87% ee).
$[\alpha]_D^{27}$ = +36 (*c* 1.0, $CHCl_3$).
HPLC analysis: Chiralcel OD3 (*n*-hexane/*i*-PrOH = 80/20, flow rate 0.8 mL/min, λ = 254 nm), t_R (major) = 7.69 min, t_R (minor) = 10.73 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, *J* = 6.3 Hz, 2H), 7.71 (s, 1H), 7.51 – 7.49 (m, 1H), 7.43 – 7.39 (m, 2H), 7.35 – 7.31 (m, 1H), 6.55 (s, 2H), 5.88 (s, 1H), 3.65 – 3.36 (m, 8H), 2.63 (dq, *J* = 14.1, 7.2 Hz, 1H), 2.37 (dq, *J* = 14.3, 7.2 Hz, 1H), 0.85 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 169.4, 152.3, 145.2, 139.1, 129.2, 128.5, 126.6, 109.1, 66.1, 66.0, 45.7, 24.2, 8.0.
HRMS (ESI) m/z calcd. for $C_{19}H_{24}N_3O_2$ $[M + H]^+$ 326.1863, found 326.1860.

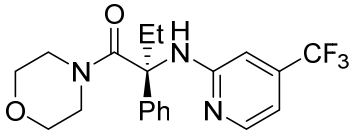
(*S*)-6-((1-Morpholino-1-oxo-2-phenylbutan-2-yl)amino)picolinonitrile (62)



62

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and 6-aminopicolinonitrile **A26** (23.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 2/1) to yield the product **62** as a yellowish oil (68.9 mg, 98% yield, 92% ee).
$[\alpha]_D^{27}$ = +194 (*c* 1.7, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 60/40, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 9.26 min, t_R (minor) = 13.51 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 – 7.48 (m, 2H), 7.35 – 7.31 (m, 2H), 7.30 – 7.21 (m, 2H), 7.15 (s, 1H), 6.79 (d, *J* = 7.2 Hz, 1H), 6.59 (d, *J* = 8.6 Hz, 1H), 3.84 – 2.96 (m, 9H), 2.15 (dq, *J* = 14.3, 7.2 Hz, 1H), 0.86 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.7, 155.6, 140.3, 136.7, 130.6, 128.1, 127.5, 127.0, 117.8, 117.4, 113.8, 66.1, 66.0, 45.9, 23.4, 8.2.
HRMS (ESI) m/z calcd. for $C_{20}H_{23}N_4O_2$ $[M + H]^+$ 351.1816, found 351.1814.

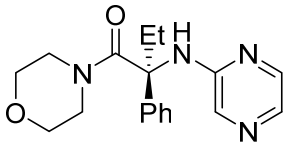
(*S*)-1-Morpholino-2-phenyl-2-((4-(trifluoromethyl)pyridin-2-yl)amino)butan-1-one (63)



63

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and 4-(trifluoromethyl)pyridin-2-amine **A27** (32.4 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 3/1) to yield the product **63** as a white solid (62.4 mg, 79% yield, 93% ee).
$[\alpha]_D^{27}$ = +52 (*c* 1.6, $CHCl_3$).
HPLC analysis: Chiralcel ODH (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 8.49 min, t_R (major) = 10.36 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.05 (d, *J* = 5.2 Hz, 1H), 7.49 – 7.47 (m, 2H), 7.36 – 7.33 (m, 2H), 7.27 – 7.23 (m, 1H), 6.87 (s, 1H), 6.63 (d, *J* = 5.3 Hz, 1H), 6.59 (s, 1H), 3.67 – 3.04 (m, 9H), 2.29 (dq, *J* = 14.5, 7.3 Hz, 1H), 0.81 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.7, 156.1, 149.0, 140.6, 139.0 (q, *J* = 32.9 Hz), 128.4, 127.6, 126.4, 123.0 (q, *J* = 271.4 Hz), 107.9, 104.5 (q, *J* = 4.1 Hz), 66.1, 66.0, 45.5, 25.2, 8.0.
^{19}F NMR (376 MHz, $CDCl_3$) δ -65.29.
HRMS (ESI) m/z calcd. for $C_{20}H_{23}F_3N_3O_2$ $[M + H]^+$ 394.1737, found 394.1736.

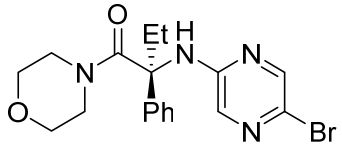
(*S*)-1-Morpholino-2-phenyl-2-(pyrazin-2-ylamino)butan-1-one (64)



64

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and pyrazin-2-amine **A28** (19.0 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 1/1) to yield the product **64** as a white solid (55.7 mg, 85% yield, 92% ee).
[α]$_D^{27}$ = +133 (*c* 0.5, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 23.16 min, t_R (minor) = 27.72 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (s, 1H), 7.78 – 7.77 (m, 1H), 7.65 (d, *J* = 2.8 Hz, 1H), 7.49 – 7.47 (m, 2H), 7.35 – 7.31 (m, 2H), 7.26 – 7.22 (m, 1H), 7.00 (s, 1H), 3.65 – 3.17 (m, 9H), 2.23 (dq, *J* = 14.3, 7.2 Hz, 1H), 0.86 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.6, 152.2, 141.4, 140.6, 133.4, 132.4, 128.4, 127.6, 126.8, 66.1, 65.8, 45.7, 24.1, 8.2.
HRMS (ESI) m/z calcd. for $C_{18}H_{23}N_4O_2$ $[M + H]^+$ 327.1816, found 327.1813.

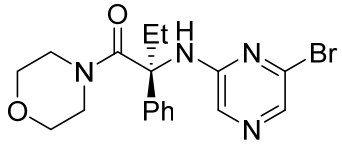
(*S*)-2-((5-Bromopyrazin-2-yl)amino)-1-morpholino-2-phenylbutan-1-one (65)



65

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and 5-bromopyrazin-2-amine **A29** (34.6 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 2/1) to yield the product **65** as a white solid (77.5 mg, 96% yield, 91% ee).
[α]$_D^{27}$ = +107 (*c* 1.9, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 21.73 min, t_R (minor) = 27.07 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 (d, *J* = 1.4 Hz, 1H), 7.63 (d, *J* = 1.4 Hz, 1H), 7.47 – 7.45 (m, 2H), 7.34 – 7.30 (m, 2H), 7.26 – 7.22 (m, 2H), 3.78 – 3.01 (m, 9H), 2.18 (dq, *J* = 14.3, 7.1 Hz, 1H), 0.87 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.3, 150.9, 143.2, 140.2, 132.7, 128.3, 127.7, 127.0, 125.3, 66.1, 65.8, 45.5, 23.2, 8.2.
HRMS (ESI) m/z calcd. for $C_{18}H_{22}BrN_4O_2$ $[M + H]^+$ 405.0921, found 405.0920.

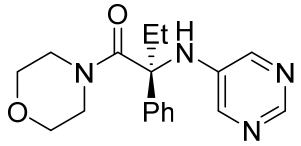
(*S*)-2-((6-Bromopyrazin-2-yl)amino)-1-morpholino-2-phenylbutan-1-one (66)



66

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and 6-bromopyrazin-2-amine **A30** (34.6 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 2/1) to yield the product **66** as a white solid (80.4 mg, 99% yield, 95% ee).
[α]$_D^{27}$ = +232 (*c* 2.0, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 20.07 min, t_R (minor) = 24.42 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74 (s, 2H), 7.48 – 7.47 (m, 2H), 7.39 (s, 1H), 7.35 – 7.31 (m, 2H), 7.27 – 7.22 (m, 1H), 3.86 – 2.95 (m, 9H), 2.14 (dq, *J* = 14.3, 7.2 Hz, 1H), 0.90 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.2, 151.4, 139.6, 137.5, 132.7, 130.7, 128.2, 127.8, 127.2, 66.2, 66.0, 46.0, 22.9, 8.3.
HRMS (ESI) m/z calcd. for $C_{18}H_{22}BrN_4O_2$ $[M + H]^+$ 405.0921, found 405.0920.

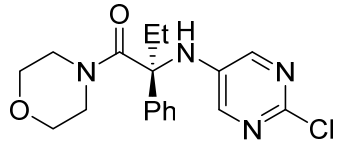
(*S*)-1-Morpholino-2-phenyl-2-(pyrimidin-5-ylamino)butan-1-one (67)



67

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and pyrimidin-5-amine **A24** (19.0 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (EtOAc) to yield the product **67** as a white solid (64.3 mg, 99% yield, 94% ee).
[α]$_D^{27}$ = +28 (*c* 1.6, $CHCl_3$).
HPLC analysis: Chiralcel OD3 (*n*-hexane/*i*-PrOH = 90/10, flow rate 0.8 mL/min, λ = 254 nm), t_R (minor) = 15.19 min, t_R (major) = 17.64 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.44 (s, 1H), 7.98 (s, 2H), 7.49 – 7.47 (m, 2H), 7.41 – 7.37 (m, 2H), 7.32 – 7.28 (m, 1H), 6.49 (s, 1H), 3.80 – 3.37 (m, 8H), 2.66 (dq, *J* = 14.7, 7.4 Hz, 1H), 2.33 (dq, *J* = 14.2, 7.2 Hz, 1H), 0.89 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.9, 148.0, 142.0, 140.4, 138.6, 129.2, 128.2, 126.8, 66.0, 65.5, 45.7, 23.4, 8.0.
HRMS (ESI) m/z calcd. for $C_{18}H_{23}N_4O_2$ $[M + H]^+$ 327.1816, found 327.1814.

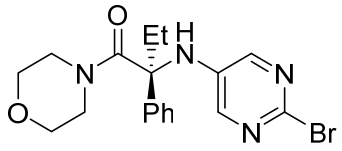
(*S*)-2-((2-Chloropyrimidin-5-yl)amino)-1-morpholino-2-phenylbutan-1-one (68)



68

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and 2-chloropyrimidin-5-amine **A31** (25.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 2/1) to yield the product **68** as a white solid (65.8 mg, 91% yield, 94% ee).
[α]$_D^{27}$ = +42 (*c* 1.7, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 60/40, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 13.53 min, t_R (minor) = 17.76 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 (s, 2H), 7.46 – 7.45 (m, 2H), 7.41 – 7.37 (m, 2H), 7.33 – 7.29 (m, 1H), 6.65 (s, 1H), 3.66 – 3.08 (m, 8H), 2.61 (dq, *J* = 14.6, 7.4 Hz, 1H), 2.30 (dq, *J* = 14.2, 7.1 Hz, 1H), 0.91 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.8, 148.4, 144.2, 140.0, 137.5, 129.4, 128.6, 127.0, 66.1, 65.6, 45.6, 23.3, 8.1.
HRMS (ESI) m/z calcd. for $C_{18}H_{22}ClN_4O_2$ $[M + H]^+$ 361.1426, found 361.1423.

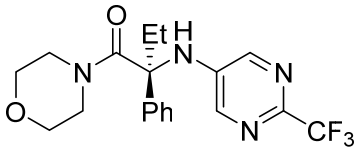
(*S*)-2-((2-Bromopyrimidin-5-yl)amino)-1-morpholino-2-phenylbutan-1-one (69)



69

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and 2-bromopyrimidin-5-amine **A32** (34.6 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 2/1) to yield the product **69** as a white solid (74.8 mg, 93% yield, 94% ee).
[α]$_D^{27}$ = +51 (*c* 2.0, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 60/40, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 15.14 min, t_R (minor) = 22.36 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 (s, 2H), 7.47 – 7.45 (m, 2H), 7.40 – 7.37 (m, 2H), 7.33 – 7.29 (m, 1H), 6.69 (s, 1H), 3.82 – 3.04 (m, 8H), 2.61 (dq, *J* = 14.6, 7.3 Hz, 1H), 2.32 (dq, *J* = 14.2, 7.1 Hz, 1H), 0.91 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.7, 144.2, 139.9, 138.3, 137.9, 129.4, 128.6, 126.9, 66.1, 65.5, 46.0, 23.1, 8.1.
HRMS (ESI) m/z calcd. for $C_{18}H_{22}BrN_4O_2$ $[M + H]^+$ 405.0921, found 405.0918.

(*S*)-1-Morpholino-2-phenyl-2-((2-(trifluoromethyl)pyrimidin-5-yl)amino)butan-1-one (70)

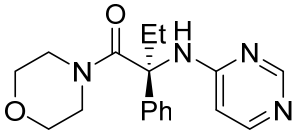


70

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and 2-(trifluoromethyl)pyrimidin-5-amine **A33** (32.6 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 2/1) to yield the product **70** as a white solid (77.9 mg, 99% yield, 92% ee).

[α]$_D^{27}$ = +30 (*c* 1.9, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 15.07 min, t_R (minor) = 19.17 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 (s, 2H), 7.51 – 7.49 (m, 2H), 7.42 – 7.39 (m, 2H), 7.35 – 7.31 (m, 1H), 7.17 (s, 1H), 3.90 – 2.92 (m, 8H), 2.69 (dq, *J* = 14.6, 7.3 Hz, 1H), 2.35 (dq, *J* = 14.2, 7.1 Hz, 1H), 0.94 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.4, 144.6 (q, *J* = 36.6 Hz), 141.0, 139.5, 129.4, 128.7, 126.9, 120.0 (q, *J* = 271.6 Hz), 66.0, 65.4, 45.8, 22.8, 8.1.
^{19}F NMR (376 MHz, $CDCl_3$) δ -69.00.
HRMS (ESI) m/z calcd. for $C_{19}H_{22}F_3N_4O_2$ $[M + H]^+$ 395.1689, found 395.1687.

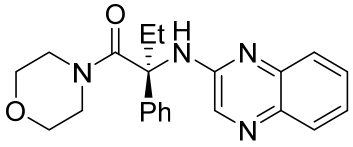
(*S*)-1-Morpholino-2-phenyl-2-(pyrimidin-4-ylamino)butan-1-one (71)



71

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and pyrimidin-4-amine **A34** (19.0 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (EtOAc /CH_3OH = 30/1) to yield the product **71** as a white solid (29.6 mg, 45% yield, 89% ee).
[α]$_D^{27}$ = +69 (*c* 0.7, $CHCl_3$).
HPLC analysis: Chiralcel OD3 (*n*-hexane/*i*-PrOH = 80/20, flow rate 0.8 mL/min, λ = 254 nm), t_R (major) = 8.07 min, t_R (minor) = 12.22 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.39 (s, 1H), 8.01 (s, 1H), 7.52 (s, 1H), 7.47 – 7.45 (m, 2H), 7.36 – 7.33 (m, 2H), 7.29 – 7.25 (m, 1H), 6.32 (d, *J* = 5.9 Hz, 1H), 3.54 – 3.15 (m, 8H), 2.27 – 2.20 (m, 1H), 0.86 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.0, 159.4, 157.8, 153.5, 139.0, 128.5, 127.9, 126.8, 106.1, 66.1, 66.0, 45.6, 24.0, 8.2.
HRMS (ESI) m/z calcd. for $C_{18}H_{23}N_4O_2$ $[M + H]^+$ 327.1816, found 327.1814.

(*S*)-1-Morpholino-2-phenyl-2-(quinoxalin-2-ylamino)butan-1-one (72)

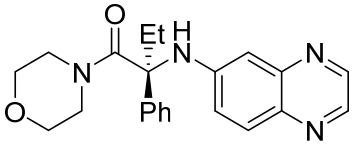


72

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and quinoxalin-2-amine A**35** (29.0 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 2/1) to yield the product **72** as a white solid (61.1 mg, 81% yield, 91% ee).
[α]$_D^{27}$ = +289 (*c* 1.5, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 80/20, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 35.89 min, t_R (minor) = 41.78 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.21 (s, 1H), 7.76 – 7.74 (m, 1H), 7.61 – 7.59 (m, 2H), 7.49 – 7.42 (m, 3H), 7.33 – 7.24 (m, 3H), 7.21 – 7.17 (m, 1H), 3.95 – 2.91 (m, 9H), 2.18 (dq, *J* = 14.3,

7.2 Hz, 1H), 0.90 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.7, 148.8, 141.3, 140.4, 139.5, 136.5, 129.4, 128.5, 128.0, 127.6, 127.4, 126.4, 123.9, 66.1, 66.0, 46.6, 22.7, 8.4.
HRMS (ESI) m/z calcd. for $C_{22}H_{25}N_4O_2$ $[M + H]^+$ 377.1972, found 377.1968.

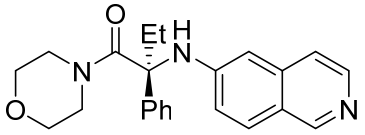
(*S*)-1-Morpholino-2-phenyl-2-(quinoxalin-6-ylamino)butan-1-one (73)



73

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv), quinoxalin-6-amine **A36** (29.0 mg, 0.20 mmol, 1.0 equiv), and anhydrous THF (4.0 mL) at 10 °C for 72 h, the reaction mixture was purified by column chromatography on silica gel (EtOAc /CH_2Cl_2 = 1/1) to yield the product **73** as a white solid (74.6 mg, 99% yield, 89% ee).
$[\alpha]_D^{27}$ = +207 (*c* 1.8, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 60/40, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 12.62 min, t_R (minor) = 16.44 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52 (d, *J* = 1.9 Hz, 1H), 8.41 (d, *J* = 1.9 Hz, 1H), 7.76 (d, *J* = 9.1 Hz, 1H), 7.60 (d, *J* = 7.5 Hz, 2H), 7.41 (t, *J* = 7.6 Hz, 2H), 7.30 – 7.27 (m, 1H), 7.22 (dd, *J* = 9.1, 2.6 Hz, 1H), 6.90 (s, 1H), 6.75 (d, *J* = 2.5 Hz, 1H), 3.72 – 3.25 (m, 8H), 3.00 (dq, *J* = 14.2, 7.3 Hz, 1H), 2.35 (dq, *J* = 14.1, 7.1 Hz, 1H), 0.89 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.3, 145.0, 144.9, 144.5, 140.6, 139.9, 137.5, 129.8, 129.0, 128.0, 126.8, 124.2, 104.5, 66.0, 65.9, 45.6, 22.7, 8.1.
HRMS (ESI) m/z calcd. for $C_{22}H_{25}N_4O_2$ $[M + H]^+$ 377.1972, found 377.1970.

(*S*)-2-(Isoquinolin-6-ylamino)-1-morpholino-2-phenylbutan-1-one (74)

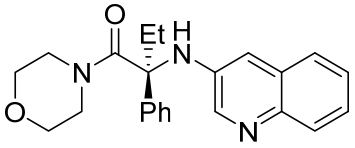


74

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and isoquinolin-6-amine **A37** (28.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (EtOAc /CH_3OH = 30/1) to yield the product **74** as a white solid (66.3 mg, 88% yield, 82% ee).
$[\alpha]_D^{27}$ = +146 (*c* 1.6, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 60/40, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 13.86 min, t_R (minor) = 19.35 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.88 (s, 1H), 8.20 (d, *J* = 6.0 Hz, 1H), 7.62 (d, *J* = 8.9 Hz, 1H), 7.55 – 7.53 (m, 2H), 7.42 – 7.38 (m, 2H), 7.31 – 7.27 (m, 1H), 7.20 (d, *J* = 6.0 Hz, 1H), 7.03 (dd, *J* = 8.9, 2.3 Hz, 1H), 6.74 (s, 1H), 6.51 (s, 1H), 3.65 – 3.23 (m, 8H), 2.77 (dq, *J* = 15.1, 7.6 Hz, 1H), 2.41 (dq, *J* = 14.3, 7.2 Hz, 1H), 0.82 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.3, 150.6, 146.1, 141.8, 140.5, 138.1, 129.0, 128.9, 128.0, 126.4, 122.3, 121.0, 119.3, 102.7, 66.1, 66.0, 45.4, 24.0, 7.9.

HRMS (ESI) m/z calcd. for $C_{23}H_{26}N_3O_2$ $[M + H]^+$ 376.2020, found 376.2016.

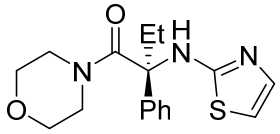
(*S*)-1-Morpholino-2-phenyl-2-(quinolin-3-ylamino)butan-1-one (75)



75

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and quinolin-3-amine **A38** (28.8 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 1/1) to yield the product **75** as a white solid (71.8 mg, 96% yield, 74% ee).
$[\alpha]_D^{27}$ = +92 (*c* 1.8, $CHCl_3$).
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 50/50, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 14.72 min, t_R (minor) = 20.78 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.49 (d, *J* = 2.9 Hz, 1H), 7.88 – 7.86 (m, 1H), 7.54 – 7.52 (m, 2H), 7.43 – 7.36 (m, 3H), 7.35 – 7.27 (m, 3H), 6.88 (d, *J* = 2.9 Hz, 1H), 6.28 (s, 1H), 3.54 – 3.32 (m, 8H), 2.69 (dq, *J* = 14.6, 7.4 Hz, 1H), 2.39 (dq, *J* = 14.4, 7.3 Hz, 1H), 0.81 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 170.5, 144.6, 141.7, 140.8, 137.6, 129.0, 128.9, 128.7, 128.0, 126.6, 126.4, 126.0, 124.9, 111.9, 66.1, 66.0, 45.6, 24.1, 7.8.
HRMS (ESI) m/z calcd. for $C_{23}H_{26}N_3O_2$ $[M + H]^+$ 376.2020, found 376.2016.

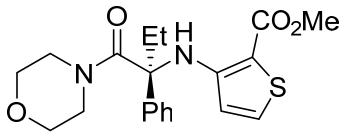
(*S*)-1-Morpholino-2-phenyl-2-(thiazol-2-ylamino)butan-1-one (76)



76

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and thiazol-2-amine **A39** (20.0 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 2/1) to yield the product **76** as a colorless oil (46.6 mg, 70% yield, 83% ee).
$[\alpha]_D^{27}$ = +16 (*c* 1.1, $CHCl_3$).
HPLC analysis: Chiralcel OD3 (*n*-hexane/*i*-PrOH = 90/10, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 9.74 min, t_R (major) = 12.78 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 – 7.46 (m, 2H), 7.43 – 7.34 (m, 3H), 7.31 – 7.27 (m, 1H), 7.01 (d, *J* = 3.6 Hz, 1H), 6.34 (d, *J* = 3.7 Hz, 1H), 3.82 – 3.36 (m, 8H), 2.98 (dq, *J* = 14.3, 7.2 Hz, 1H), 2.26 (dq, *J* = 14.2, 7.1 Hz, 1H), 0.89 (t, *J* = 7.3 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 169.9, 165.1, 139.9, 138.5, 128.6, 128.0, 127.0, 106.9, 67.1, 66.1, 45.3, 24.8, 8.0.
HRMS (ESI) m/z calcd. for $C_{17}H_{22}N_3O_2S$ $[M + H]^+$ 332.1427, found 332.1425.

Methyl (*S*)-3-((1-morpholino-1-oxo-2-phenylbutan-2-yl)amino)thiophene-2-carboxylate (77)



77

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (64.1 mg, 0.24 mmol, 1.2 equiv) and methyl 3-aminothiophene-2-carboxylate **A40** (31.4 mg, 0.20 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 3/1) to yield the product **77** as a colorless oil (70.9 mg, 91% yield, 80% ee).

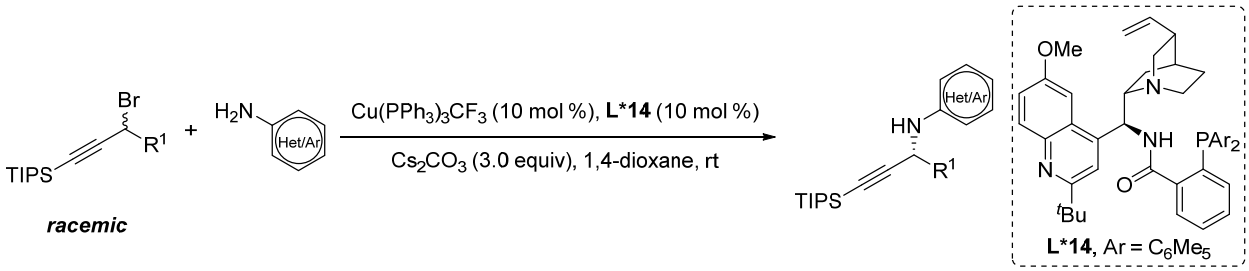
[α]D^{27} = +89 (*c* 1.7, $CHCl_3$).

HPLC analysis: Chiralcel OD3 (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 9.65 min, t_R (major) = 10.86 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.44 (s, 1H), 7.48 – 7.42 (m, 4H), 7.36 – 7.30 (m, 2H), 6.75 (d, *J* = 5.5 Hz, 1H), 3.89 (s, 3H), 3.71 – 2.82 (m, 8H), 2.45 (dq, *J* = 14.6, 7.3 Hz, 1H), 2.18 (dq, *J* = 14.7, 7.3 Hz, 1H), 0.54 (t, *J* = 7.4 Hz, 3H).

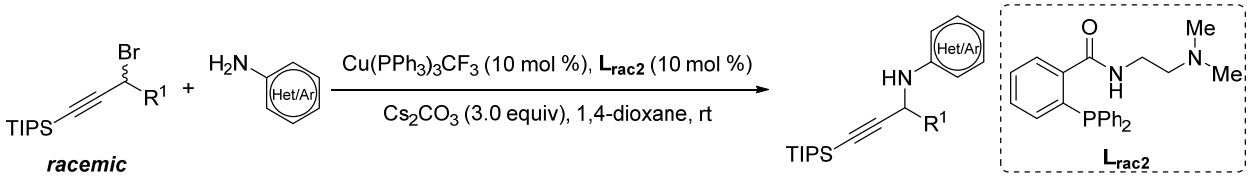
^{13}C NMR (100 MHz, $CDCl_3$) δ 171.6, 165.8, 153.0, 139.8, 132.3, 128.9, 127.5, 124.6, 117.4, 101.5, 67.5, 66.2, 51.3, 46.5, 30.9, 7.0.

HRMS (ESI) m/z calcd. for $C_{20}H_{25}N_2O_4S$ $[M + H]^+$ 389.1530, found 389.1528.



General procedure C:

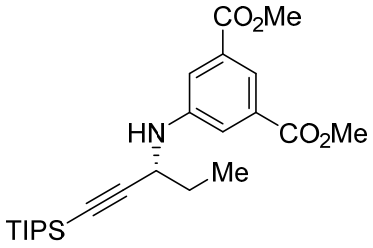
Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with $Cu(PPh_3)_3CF_3$ (9.2 mg, 0.01 mmol, 10 mol %), **L*14** (8.1 mg, 0.01 mmol, 10 mol %), Cs_2CO_3 (97.7 mg, 0.30 mmol, 3.0 equiv), and anhydrous 1,4-dioxane (0.5 mL). Then, the mixture was stirred at room temperature for 0.5 h. After that, racemic propargyl bromide (0.10 mmol, 1.0 equiv), (hetero)aromatic amine (0.15 mmol, 1.5 equiv), and anhydrous 1,4-dioxane (0.5 mL) were sequentially added into the mixture and the reaction mixture was stirred at room temperature for 120 h. Upon completion (monitored by TLC), the precipitate was filtered off and washed by EtOAc. The filtrate was evaporated and the residue was purified by column chromatography on silica gel to afford the desired product.



The racemates of products were prepared following the procedure: Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with

$Cu(PPh_3)_3CF_3$ (9.2 mg, 0.01 mmol, 10 mol %), $\mathbf{L_{rac2}}$ (3.8 mg, 0.01 mmol, 10 mol %), Cs_2CO_3 (195.5 mg, 0.60 mmol, 3.0 equiv), racemic propargyl bromide (0.10 mmol, 1.0 equiv), (hetero)aromatic amine (0.15 mmol, 1.5 equiv), and 1,4-dioxane (1.0 mL) were sequentially added into the mixture and the reaction mixture was stirred at room temperature for 120 h. Upon completion (monitored by TLC), the precipitate was filtered off and washed by EtOAc. The filtrate was evaporated and the residue was purified by column chromatography on silica gel to afford the desired product.

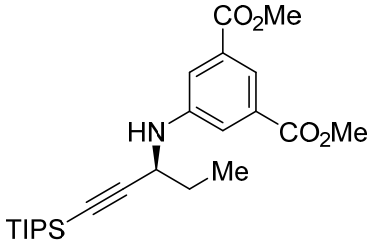
Dimethyl (*R*)-5-((1-(triisopropylsilyl)pent-1-yn-3-yl)amino)isophthalate (78)



78

According to **General Procedure C** with (3-bromopent-1-yn-1-yl)triisopropylsilane **E35** (30.2 mg, 0.10 mmol, 1.0 equiv) and dimethyl 5-aminoisophthalate **A9** (31.4 mg, 0.15 mmol, 1.5 equiv) for 120 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **78** as a colorless oil (26.7 mg, 62% yield, 90% ee).
[α]$_D^{27}$ = +78 (*c* 0.7, $CHCl_3$).
HPLC analysis: Chiralcel IF (*n*-hexane/*i*-PrOH = 98/2, flow rate 0.8 mL/min, λ = 280 nm), t_R (minor) = 15.76 min, t_R (major) = 17.84 min.
According to **General Procedure C** with (3-chloropent-1-yn-1-yl)triisopropylsilane **E35'** (25.8 mg, 0.10 mmol, 1.0 equiv) and dimethyl 5-aminoisophthalate **A9** (31.4 mg, 0.15 mmol, 1.5 equiv) for 120 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **78** as a colorless oil (16.8 mg, 39% yield, 84% ee).
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.06 (t, *J* = 1.4 Hz, 1H), 7.56 (d, *J* = 1.4 Hz, 2H), 4.16 (s, 1H), 3.99 (s, 1H), 3.91 (s, 6H), 1.93 – 1.75 (m, 2H), 1.14 (t, *J* = 7.4 Hz, 3H), 0.99 – 0.96 (m, 21H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 166.6, 147.0, 131.1, 120.4, 119.1, 107.1, 84.2, 52.2, 47.9, 28.7, 18.4, 11.0, 10.3.
HRMS (ESI) m/z calcd. for $C_{24}H_{38}NO_4Si$ $[M + H]^+$ 432.2565, found 432.2560.

Dimethyl (*S*)-5-((1-(triisopropylsilyl)pent-1-yn-3-yl)amino)isophthalate ((*S*)-78)

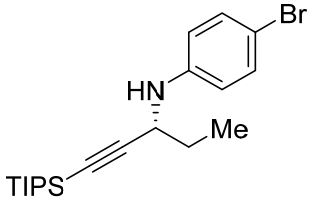


(*S*)-**78**

According to **General Procedure C** with (3-bromopent-1-yn-1-yl)triisopropylsilane **E35** (30.2 mg, 0.10 mmol, 1.0 equiv), dimethyl 5-aminoisophthalate **A9** (31.4 mg, 0.15 mmol, 1.5 equiv), and **L*14'** for 120 h, the reaction mixture was purified by column chromatography on silica gel

(petroleum ether/EtOAc = 10/1) to yield the product (*S*)-**78** as a colorless oil (23.7 mg, 55% yield, 90% ee).
[α]$_D^{27}$ = −131 (*c* 0.6, $CHCl_3$).
HPLC analysis: Chiralcel IF (*n*-hexane/*i*-PrOH = 98/2, flow rate 0.8 mL/min, λ = 280 nm), t_R (major) = 14.07 min, t_R (minor) = 15.90 min.

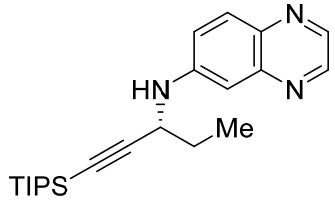
(*R*)-4-Bromo-*N*-(1-(triisopropylsilyl)pent-1-yn-3-yl)aniline (79)



79

According to **General Procedure C** with (3-bromopent-1-yn-1-yl)triisopropylsilane **E35** (30.2 mg, 0.10 mmol, 1.0 equiv) and 4-bromoaniline **A15** (25.6 mg, 0.15 mmol, 1.5 equiv) for 120 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 20/1) to yield the product **79** as a colorless oil (21.3 mg, 54% yield, 85% ee).
[α]$_D^{27}$ = +96 (*c* 0.5, $CHCl_3$).
HPLC analysis: Chiralcel AD (*n*-hexane/*i*-PrOH = 99.5/0.5, flow rate 0.5 mL/min, λ = 280 nm), t_R (major) = 9.90 min, t_R (minor) = 11.19 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27 – 7.23 (m, 2H), 6.61 – 6.57 (m, 2H), 4.01 (dd, *J* = 7.6, 5.7 Hz, 1H), 3.70 (s, 1H), 1.89 – 1.69 (m, 2H), 1.11 (t, *J* = 7.4 Hz, 3H), 1.04 – 0.97 (m, 21H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 145.9, 131.7, 115.9, 110.0, 107.8, 83.8, 48.2, 28.8, 18.5, 11.1, 10.3.
HRMS (ESI) m/z calcd. for $C_{20}H_{33}BrNSi$ $[M + H]^+$ 394.1560, found 394.1557.

(*R*)-*N*-(1-(Triisopropylsilyl)pent-1-yn-3-yl)quinoxalin-6-amine (80)

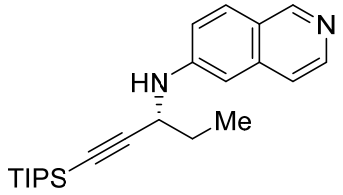


80

According to **General Procedure C** with (3-bromopent-1-yn-1-yl)triisopropylsilane **E35** (30.2 mg, 0.10 mmol, 1.0 equiv) and quinoxalin-6-amine **A36** (21.8 mg, 0.15 mmol, 1.5 equiv) for 120 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **80** as a colorless oil (25.3 mg, 69% yield, 89% ee).
[α]$_D^{27}$ = +92 (*c* 0.6, $CHCl_3$).
HPLC analysis: Chiralcel ODH (*n*-hexane/*i*-PrOH = 96/4, flow rate 0.8 mL/min, λ = 270 nm), t_R (major) = 13.39 min, t_R (minor) = 17.36 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.66 (d, *J* = 2.0 Hz, 1H), 8.53 (d, *J* = 1.9 Hz, 1H), 7.86 (d, *J* = 9.0 Hz, 1H), 7.19 (dd, *J* = 9.0, 2.4 Hz, 1H), 7.13 (d, *J* = 2.3 Hz, 1H), 4.33 – 4.25 (m, 2H), 1.98 – 1.82 (m, 2H), 1.16 (t, *J* = 7.4 Hz, 3H), 1.02 – 0.96 (m, 21H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 147.7, 145.1, 144.9, 140.7, 138.1, 129.9, 122.3, 106.9, 106.0, 84.3, 47.8, 28.5, 18.5, 11.1, 10.2.

HRMS (ESI) m/z calcd. for $C_{22}H_{34}N_3Si$ $[M + H]^+$ 368.2517, found 368.2508.

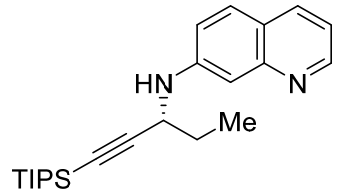
(*R*)-*N*-(1-(Triisopropylsilyl)pent-1-yn-3-yl)isoquinolin-6-amine (81)



81

According to **General Procedure C** with (3-bromopent-1-yn-1-yl)triisopropylsilane **E35** (30.2 mg, 0.10 mmol, 1.0 equiv) and isoquinolin-6-amine **A41** (21.6 mg, 0.15 mmol, 1.5 equiv) for 120 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 3/1) to yield the product **81** as a colorless oil (25.0 mg, 68% yield, 91% ee).
[α]$_D^{27}$ = +180 (*c* 0.6, $CHCl_3$).
HPLC analysis: Chiralcel ODH (*n*-hexane/*i*-PrOH = 96/4, flow rate 0.8 mL/min, λ = 254 nm), t_R (major) = 12.10 min, t_R (minor) = 14.87 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.98 (s, 1H), 8.32 (d, *J* = 5.8 Hz, 1H), 7.72 (d, *J* = 8.8 Hz, 1H), 7.39 (d, *J* = 5.8 Hz, 1H), 6.97 (dd, *J* = 8.8, 2.3 Hz, 1H), 6.88 (d, *J* = 2.3 Hz, 1H), 4.31 (d, *J* = 7.5 Hz, 1H), 4.21 (q, *J* = 6.9 Hz, 1H), 1.98 – 1.80 (m, 2H), 1.17 (t, *J* = 7.4 Hz, 3H), 1.00 – 0.98 (m, 21H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 151.3, 147.9, 143.1, 138.0, 128.8, 123.2, 119.4, 119.1, 107.0, 103.7, 84.3, 47.6, 28.6, 18.5, 11.1, 10.3.
HRMS (ESI) m/z calcd. for $C_{23}H_{35}N_2Si$ $[M + H]^+$ 367.2564, found 367.2555.

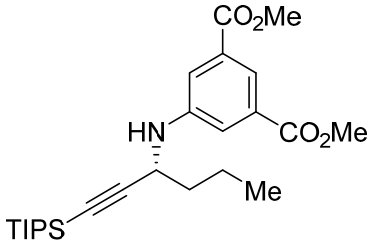
(*R*)-*N*-(1-(Triisopropylsilyl)pent-1-yn-3-yl)quinolin-7-amine (82)



82

According to **General Procedure C** with (3-bromopent-1-yn-1-yl)triisopropylsilane **E35** (30.2 mg, 0.10 mmol, 1.0 equiv) and quinolin-7-amine **A42** (21.6 mg, 0.15 mmol, 1.5 equiv) for 120 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 3/1) to yield the product **82** as a colorless oil (20.5 mg, 56% yield, 90% ee).
[α]$_D^{27}$ = +68 (*c* 0.5, $CHCl_3$).
HPLC analysis: Chiralcel ADH (*n*-hexane/*i*-PrOH = 96/4, flow rate 0.8 mL/min, λ = 254 nm), t_R (major) = 9.14 min, t_R (minor) = 16.28 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.74 (dd, *J* = 4.3, 1.6 Hz, 1H), 7.96 (dd, *J* = 8.1, 1.2 Hz, 1H), 7.59 (d, *J* = 8.8 Hz, 1H), 7.17 (d, *J* = 2.1 Hz, 1H), 7.12 (dd, *J* = 8.1, 4.3 Hz, 1H), 6.98 (dd, *J* = 8.8, 2.3 Hz, 1H), 4.31 – 4.25 (m, 1H), 4.16 (d, *J* = 7.6 Hz, 1H), 1.98 – 1.89 (m, 1H), 1.88 – 1.79 (m, 1H), 1.15 (t, *J* = 7.4 Hz, 3H), 1.02 – 0.98 (m, 21H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 150.4, 150.1, 147.5, 135.5, 128.4, 122.1, 118.7, 117.5, 107.5, 107.2, 83.9, 47.8, 28.5, 18.5, 11.1, 10.2.
HRMS (ESI) m/z calcd. for $C_{23}H_{35}N_2Si$ $[M + H]^+$ 367.2564, found 367.2555.

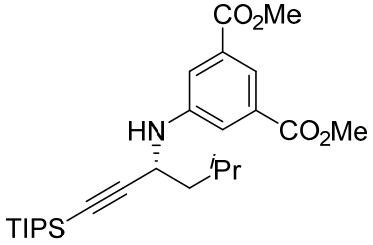
Dimethyl (*R*)-5-((1-(triisopropylsilyl)hex-1-yn-3-yl)amino)isophthalate (83)



83

According to **General Procedure C** with (3-bromohex-1-yn-1-yl)triisopropylsilane **E36** (31.6 mg, 0.10 mmol, 1.0 equiv) and dimethyl 5-aminoisophthalate **A9** (31.4 mg, 0.15 mmol, 1.5 equiv) for 120 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **83** as a colorless oil (24.5 mg, 55% yield, 87% ee).
[α]$_D^{27}$ = +99 (*c* 0.6, $CHCl_3$).
HPLC analysis: Chiralcel IC (*n*-hexane/*i*-PrOH = 97/3, flow rate 1.0 mL/min, λ = 280 nm), t_R (major) = 22.25 min, t_R (minor) = 28.44 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.06 (t, *J* = 1.5 Hz, 1H), 7.56 (d, *J* = 1.5 Hz, 2H), 4.21 (q, *J* = 6.7 Hz, 1H), 3.97 (d, *J* = 7.6 Hz, 1H), 3.91 (s, 6H), 1.86 – 1.73 (m, 2H), 1.64 – 1.56 (m, 2H), 1.00 (t, *J* = 7.3 Hz, 3H), 0.98 – 0.95 (m, 21H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 166.6, 147.0, 131.1, 120.3, 119.1, 107.3, 84.0, 52.2, 46.3, 37.6, 19.2, 18.4, 13.7, 11.0.
HRMS (ESI) m/z calcd. for $C_{25}H_{40}NO_4Si$ $[M + H]^+$ 446.2721, found 446.2713.

Dimethyl (*R*)-5-((5-methyl-1-(triisopropylsilyl)hex-1-yn-3-yl)amino)isophthalate (84)

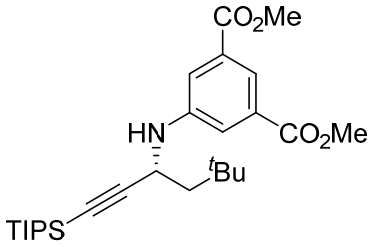


84

According to **General Procedure C** with (3-bromo-5-methylhex-1-yn-1-yl) triisopropylsilane **E37** (33.0 mg, 0.10 mmol, 1.0 equiv) and dimethyl 5-aminoisophthalate **A9** (31.4 mg, 0.15 mmol, 1.5 equiv) for 120 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **84** as a colorless oil (23.4 mg, 51% yield, 86% ee).
[α]$_D^{27}$ = +79 (*c* 0.5, $CHCl_3$).
HPLC analysis: Chiralcel IE (*n*-hexane/*i*-PrOH = 99/1, flow rate 0.4 mL/min, λ = 280 nm), t_R (major) = 15.34 min, t_R (minor) = 21.09 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.06 (t, *J* = 1.5 Hz, 1H), 7.56 (d, *J* = 1.5 Hz, 2H), 4.22 (q, *J* = 7.5 Hz, 1H), 3.94 – 3.91 (m, 7H), 2.05 – 1.95 (m, 1H), 1.73 – 1.66 (m, 2H), 1.00 (t, *J* = 7.1 Hz, 6H), 0.97 – 0.96 (m, 21H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 166.6, 147.0, 131.1, 120.4, 119.2, 107.4, 84.0, 52.2, 45.0, 44.7, 25.3, 22.8, 22.1, 18.4, 11.0.

HRMS (ESI) m/z calcd. for $C_{26}H_{42}NO_4Si$ $[M + H]^+$ 460.2878, found 460.2873.

Dimethyl (*R*)-5-((5,5-dimethyl-1-(triisopropylsilyl)hex-1-yn-3-yl)amino) isophthalate (85)



85

According to **General Procedure C** with (3-bromo-5,5-dimethylhex-1-yn-1-yl) triisopropylsilane **E38** (34.4 mg, 0.10 mmol, 1.0 equiv) and dimethyl 5-aminoisophthalate **A9** (31.4 mg, 0.15 mmol, 1.5 equiv) for 120 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **85** as a colorless oil (20.3 mg, 43% yield, 85% ee).

$[\alpha]_D^{27}$ = +64 (*c* 0.5, $CHCl_3$).

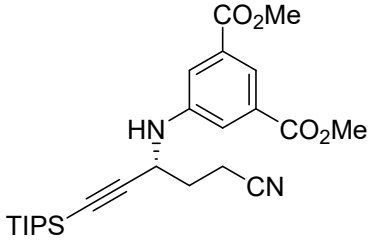
HPLC analysis: Chiralcel IE (*n*-hexane/*i*-PrOH = 99/1, flow rate 0.5 mL/min, λ = 280 nm), t_R (major) = 13.43 min, t_R (minor) = 20.55 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.06 (t, *J* = 1.4 Hz, 1H), 7.55 (d, *J* = 1.4 Hz, 2H), 4.22 (q, *J* = 6.9 Hz, 1H), 3.93 – 3.89 (m, 7H), 1.86 (dd, *J* = 13.7, 7.6 Hz, 1H), 1.71 (dd, *J* = 13.7, 5.3 Hz, 1H), 1.07 (s, 9H), 0.95 – 0.94 (m, 21H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 166.6, 146.7, 131.1, 120.4, 119.3, 108.6, 84.1, 52.2, 49.7, 43.7, 30.6, 30.0, 18.4, 11.1.

HRMS (ESI) m/z calcd. for $C_{27}H_{44}NO_4Si$ $[M + H]^+$ 474.3034, found 474.3024.

Dimethyl (*R*)-5-((5-cyano-1-(triisopropylsilyl)pent-1-yn-3-yl)amino)isophthalate (86)



86

According to **General Procedure C** with 4-bromo-6-(triisopropylsilyl)hex-5-ynenitrile **E39** (32.7 mg, 0.10 mmol, 1.0 equiv) and dimethyl 5-aminoisophthalate **A9** (31.4 mg, 0.15 mmol, 1.5 equiv) for 120 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 4/1) to yield the product **86** as a colorless oil (30.3 mg, 66% yield, 87% ee).

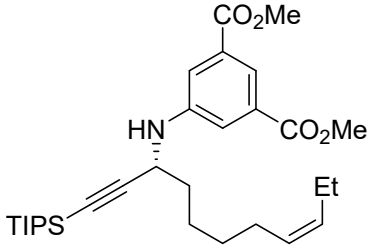
$[\alpha]_D^{27}$ = +84 (*c* 0.7, $CHCl_3$).

HPLC analysis: Chiralcel IF (*n*-hexane/*i*-PrOH = 90/10, flow rate 1.0 mL/min, λ = 230 nm), t_R (minor) = 9.08 min, t_R (major) = 10.80 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.12 (t, *J* = 1.4 Hz, 1H), 7.58 (d, *J* = 1.5 Hz, 2H), 4.39 (q, *J* = 7.2 Hz, 1H), 4.07 (d, *J* = 8.7 Hz, 1H), 3.92 (s, 6H), 2.73 – 2.60 (m, 2H), 2.27 – 2.11 (m, 2H), 0.99 – 0.97 (m, 21H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 166.4, 146.2, 131.4, 121.2, 119.3, 118.8, 104.6, 86.7, 52.2, 45.7, 31.0, 18.4, 14.1, 10.9.
HRMS (ESI) m/z calcd. for $C_{25}H_{37}N_2O_4Si$ $[M + H]^+$ 457.2517, found 457.2511.

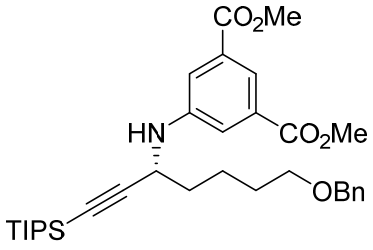
Dimethyl (*R*,*Z*)-5-((1-(triisopropylsilyl)undec-8-en-1-yn-3-yl)amino)isophthalate (87)



87

According to **General Procedure C** with (*Z*)-(3-bromoundec-8-en-1-yn-1-yl)triisopropylsilane **E40** (38.4 mg, 0.10 mmol, 1.0 equiv) and dimethyl 5-aminoisophthalate **A9** (31.4 mg, 0.15 mmol, 1.5 equiv) for 120 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **87** as a colorless oil (21.7 mg, 42% yield, 87% ee).
$[\alpha]_D^{27}$ = +82 (*c* 0.5, $CHCl_3$).
HPLC analysis: Chiralcel IC (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 230 nm), t_R (major) = 19.23 min, t_R (minor) = 23.30 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.06 (t, *J* = 1.5 Hz, 1H), 7.55 (d, *J* = 1.5 Hz, 2H), 5.42 – 5.29 (m, 2H), 4.20 (q, *J* = 6.4 Hz, 1H), 4.03 – 3.94 (m, 1H), 3.91 (s, 6H), 2.10 – 2.01 (m, 4H), 1.88 – 1.74 (m, 2H), 1.64 – 1.57 (m, 2H), 1.50 – 1.38 (m, 2H), 0.99 – 0.95 (m, 24H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 166.6, 147.0, 132.0, 131.1, 128.7, 120.4, 119.1, 107.2, 84.2, 52.2, 46.5, 35.4, 29.3, 26.9, 25.5, 20.5, 18.4, 14.4, 11.0.
HRMS (ESI) m/z calcd. for $C_{30}H_{48}NO_4Si$ $[M + H]^+$ 514.3347, found 514.3343.

Dimethyl (*R*)-5-((7-(benzyloxy)-1-(triisopropylsilyl)hept-1-yn-3-yl)amino) isophthalate (88)

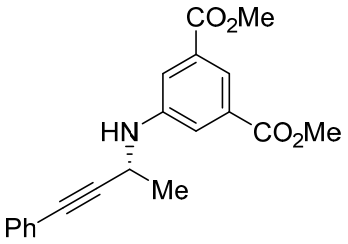


88

According to **General Procedure C** with (7-(benzyloxy)-3-bromohept-1-yn-1-yl) triisopropylsilane **E41** (43.6 mg, 0.10 mmol, 1.0 equiv) and dimethyl 5-aminoisophthalate **A9** (31.4 mg, 0.15 mmol, 1.5 equiv) for 120 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the product **88** as a colorless oil (29.5 mg, 52% yield, 85% ee).
$[\alpha]_D^{27}$ = +48 (*c* 0.7, $CHCl_3$).
HPLC analysis: Chiralcel IF (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 280 nm), t_R (minor) = 16.02 min, t_R (major) = 18.20 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.07 (t, *J* = 1.6 Hz, 1H), 7.55 (d, *J* = 1.5 Hz, 2H), 7.34 – 7.33 (m, 4H), 7.31 – 7.27 (m, 1H), 4.51 (s, 2H), 4.20 (s, 1H), 4.00 (s, 1H), 3.90 (s, 6H), 3.52 – 3.47 (m, 2H), 1.88 – 1.80 (m, 2H), 1.74 – 1.64 (m, 4H), 0.98 – 0.96 (m, 21H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 166.6, 146.9, 138.5, 131.1, 128.3, 127.6, 127.5, 120.4, 119.1, 107.2, 84.2, 72.9, 70.1, 52.2, 46.4, 35.3, 29.3, 22.8, 18.4, 11.0.
HRMS (ESI) m/z calcd. for $C_{33}H_{48}NO_5Si$ $[M + H]^+$ 566.3296, found 566.3293.

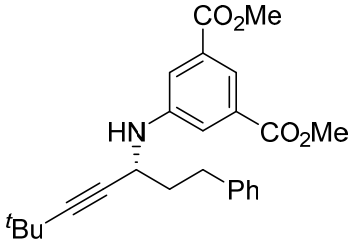
Dimethyl (*R*)-5-((4-phenylbut-3-yn-2-yl)amino)isophthalate (89)



89

According to **General Procedure C** with (3-bromobut-1-yn-1-yl)benzene **E42** (20.8 mg, 0.10 mmol, 1.0 equiv) and dimethyl 5-aminoisophthalate **A9** (31.4 mg, 0.15 mmol, 1.5 equiv) for 120 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 4/1) to yield the product **89** as a yellowish solid (25.6 mg, 76% yield, 78% ee).
$[\alpha]_D^{27}$ = +129 (*c* 0.5, $CHCl_3$).
HPLC analysis: Chiralcel IC (*n*-hexane/*i*-PrOH = 96/4, flow rate 1.0 mL/min, λ = 230 nm), t_R (major) = 24.56 min, t_R (minor) = 26.58 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.08 (d, *J* = 1.5 Hz, 1H), 7.61 (d, *J* = 1.2 Hz, 2H), 7.37 – 7.33 (m, 2H), 7.28 – 7.24 (m, 3H), 4.54 – 4.53 (m, 1H), 4.10 (s, 1H), 3.92 (s, 6H), 1.64 (d, *J* = 6.7 Hz, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 166.6, 146.8, 131.7, 131.3, 128.20, 128.19, 122.6, 120.4, 118.9, 89.8, 82.7, 52.2, 41.5, 22.2.
HRMS (ESI) m/z calcd. for $C_{20}H_{20}NO_4$ $[M + H]^+$ 338.1387, found 338.1382.

Dimethyl (*R*)-5-((6,6-dimethyl-1-phenylhept-4-yn-3-yl)amino)isophthalate (90)



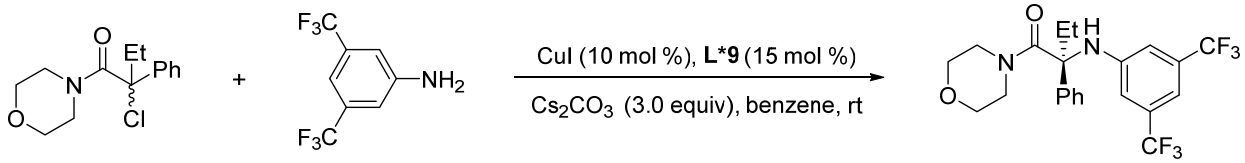
90

According to **General Procedure C** with (3-bromo-6,6-dimethylhept-4-yn-1-yl)benzene **E43** (27.8 mg, 0.10 mmol, 1.0 equiv) and dimethyl 5-aminoisophthalate **A9** (31.4 mg, 0.15 mmol, 1.5 equiv) for 120 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the product **90** as a colorless oil (14.3 mg, 35% yield, 74% ee).
$[\alpha]_D^{27}$ = +42 (*c* 0.5, $CHCl_3$).
HPLC analysis: Chiralcel IF (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 280 nm), t_R

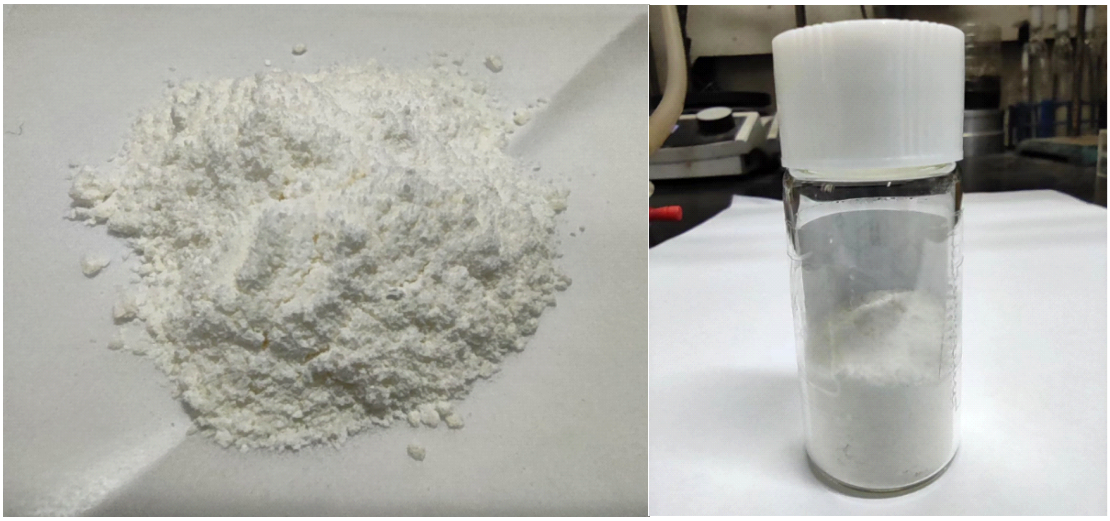
(minor) = 21.52 min, t_R (major) = 28.34 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.04 (t, *J* = 1.4 Hz, 1H), 7.50 (d, *J* = 1.4 Hz, 2H), 7.33 – 7.28 (m, 2H), 7.24 – 7.19 (m, 3H), 4.16 – 4.13 (m, 1H), 3.97 (s, 1H), 3.91 (s, 6H), 2.92 – 2.80 (m, 2H), 2.14 – 1.99 (m, 2H), 1.18 (s, 9H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 166.6, 147.0, 141.2, 131.1, 128.51, 128.46, 126.1, 120.1, 118.9, 93.4, 77.6, 52.2, 45.4, 37.3, 32.1, 31.0, 27.3.
HRMS (ESI) m/z calcd. for $C_{25}H_{30}NO_4$ $[M + H]^+$ 408.2169, found 408.2161.

6. Procedure for synthetic applications

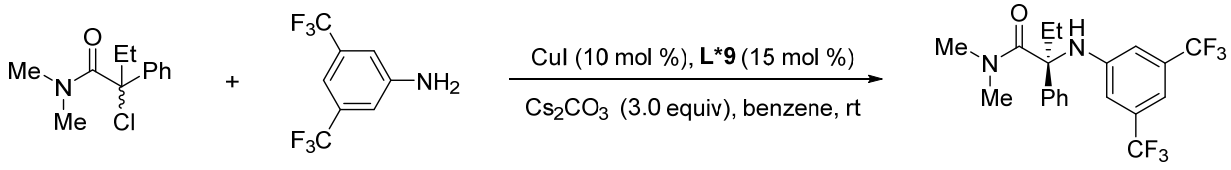
Gram-scale reaction



(±)-**E1** (1.2 equiv) **A1**, 5 mmol **1**, 2.29 g, 99%, 95% ee



Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with CuI (94.9 mg, 0.50 mmol, 10 mol %), **L*9** (321.8 mg, 0.75 mmol, 15 mol %), Cs_2CO_3 (4.89 g, 15.0 mmol, 3.0 equiv), 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (1.60 g, 6.0 mmol, 1.2 equiv), 3,5-bis(trifluoromethyl)aniline **A1** (1.15 g, 5.0 mmol, 1.0 equiv), and anhydrous benzene (100 mL) were sequentially added into the mixture and the reaction mixture was stirred at room temperature for 72 h. Upon completion (monitored by TLC), the precipitate was filtered off and washed by EtOAc. The filtrate was evaporated and the residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 7.5/1) to yield the product **1** as a white solid (2.29 g, 99% yield, 95% ee).

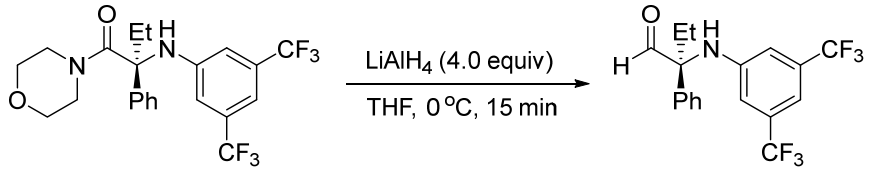


(±)-**E31** (1.2 equiv.) **A1**, 5 mmol **31**, 0.83 g, 99%, 95% ee

Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with CuI (38.0 mg, 0.20 mmol, 10 mol %), **L*9** (128.7 mg, 0.30 mmol, 15 mol %), Cs_2CO_3 (1954.8 mg, 6.0 mmol, 3.0 equiv), 2-chloro-*N*,*N*-dimethyl-2-phenylbutanamide **E28** (540.2 mg, 2.4 mmol, 1.2 equiv), 3,5-bis(trifluoromethyl)aniline **A1** (458.1 mg, 2.0 mmol, 1.0 equiv), and anhydrous benzene (40 mL) were sequentially added into the mixture and the reaction mixture was stirred at room temperature for 72 h. Upon completion (monitored by TLC), the precipitate was filtered off and washed by EtOAc. The filtrate was evaporated and the residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 7.5/1) to yield

the product **28** as a white solid (826.7 mg, 99% yield, 95% ee).

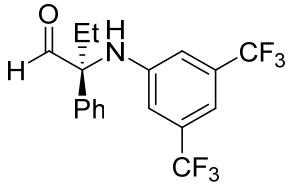
The synthesis of chiral amino aldehyde 91



1, 95% ee **91**, 91%, 95% ee

To a solution of **1** (89.0 mg, 0.20 mmol, 1.0 equiv) in THF (2 mL) was slowly added $LiAlH_4$ (30.4 mg, 0.80 mmol, 4.0 equiv) at 0 °C under argon. The reaction mixture was stirred for 15 min at 0 °C. Upon completion (monitored by TLC), the reaction was quenched with saturated $NaHCO_3$ solution (3 mL) and extracted with EtOAc (10 mL × 3), dried with Na_2SO_4, filtered and concentrated to afford the crude product, which was purified by flash column chromatography on silica gel (petroleum ether/EtOAc = 15/1) to yield the desired product **91** as a colorless oil (68.3 mg, 91% yield, 95% ee).

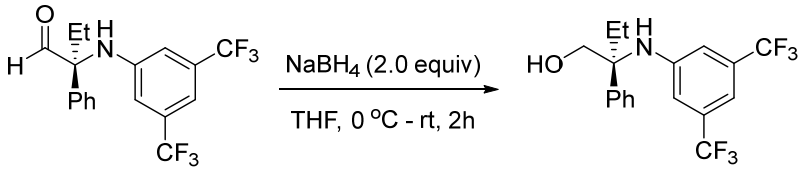
(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-2-phenylbutanal (91)



91

$[\alpha]_D^{27}$ = +103 (*c* 1.7, $CHCl_3$).
HPLC analysis: AD (*n*-hexane/*i*-PrOH = 100/0, flow rate 0.3 mL/min, λ = 254 nm), t_R (major) = 35.63 min, t_R (minor) = 54.25 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.13 (s, 1H), 7.44 – 7.40 (m, 4H), 7.39 – 7.34 (m, 1H), 7.09 (s, 1H), 6.77 (s, 2H), 5.80 (s, 1H), 2.60 – 2.46 (m, 2H), 0.83 (t, *J* = 7.4 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 195.0, 145.0, 135.3, 132.1 (q, *J* = 32.6 Hz), 129.7, 128.9, 127.1, 123.3 (q, *J* = 271.0 Hz), 113.63 – 113.60 (m), 110.6 – 110.4 (m), 69.8, 22.3, 7.6.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.37.
HRMS (ESI) m/z calcd. for $C_{18}H_{16}F_6NO$ $[M + H]^+$ 376.1131, found 376.1122.

The synthesis of chiral amino alcohol 92

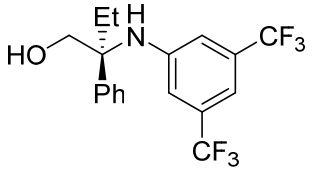


91, 95% ee **92**, 87%, 95% ee

To a solution of **91** (56.3 mg, 0.15 mmol, 1.0 equiv) in THF (2 mL) was slowly added $NaBH_4$ (11.4 mg, 0.30 mmol, 2.0 equiv) at 0 °C under argon. Then the reaction mixture was slowly warmed up to room temperature and stirred for 2 h. Upon completion (monitored by TLC), the reaction mixture was quenched with saturated aqueous NH_4Cl solution and extracted with EtOAc

(10 mL × 3). The combined organic layer was washed with brine, dried over anhydrous Na_2SO_4, filtered and concentrated to afford the crude product, which was purified by column chromatography on silica gel (petroleum ether/EtOAc = 5/1) to yield the desired product **92** as a colorless oil (49.0 mg, 87% yield, 95% ee).

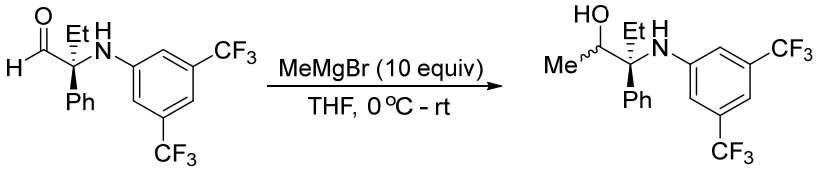
(*S*)-2-((3,5-Bis(trifluoromethyl)phenyl)amino)-2-phenylbutan-1-ol (92)



92

[α]$_D^{27}$ = +5.2 (*c* 1.0, $CHCl_3$).
HPLC analysis: AD (*n*-hexane/*i*-PrOH = 95/5, flow rate 0.8 mL/min, λ = 254 nm), t_R (minor) = 6.78 min, t_R (major) = 8.63 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.27 (m, 5H), 7.07 (s, 1H), 6.71 (s, 2H), 4.78 (s, 1H), 3.95 (d, *J* = 11.1 Hz, 1H), 3.87 (d, *J* = 11.0 Hz, 1H), 2.21 (dq, *J* = 14.9, 7.5 Hz, 1H), 2.05 (dq, *J* = 14.5, 7.4 Hz, 1H), 1.64 (s, 1H), 0.85 (t, *J* = 7.4 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 146.5, 141.0, 131.9 (q, *J* = 32.5 Hz), 129.0, 127.6, 126.2, 123.4 (q, *J* = 271.0 Hz), 114.1 – 114.0 (m), 110.4 – 110.2 (m), 66.1, 62.5, 29.0, 8.1.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.39.
HRMS (ESI) m/z calcd. for $C_{18}H_{18}F_6NO$ $[M + H]^+$ 378.1287, found 378.1285.

The synthesis of chiral amino alcohol 93

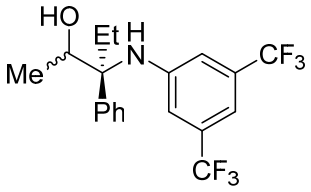


91, 95% ee

93, 75%, 5:1 dr, 95%/95% ee

To a solution of **91** (37.5 mg, 0.10 mmol, 1.0 equiv) in THF (4 mL) was slowly added MeMgBr (1 mL, 1.0 M in THF) at 0 °C under argon. Then the reaction mixture was slowly warmed up to room temperature and stirred for 1 h. Upon completion (monitored by TLC), the reaction mixture was quenched with saturated aqueous NH_4Cl solution and extracted with EtOAc (10 mL × 3). The combined organic layer was washed with brine, dried over anhydrous Na_2SO_4, filtered and concentrated to afford the crude product, which was purified by column chromatography on silica gel (petroleum ether/EtOAc = 10/1) to yield the desired product **93** as a colorless oil (29.4 mg, 75% yield, 5:1 dr, 95%/95% ee).

(3*S*)-3-((3,5-Bis(trifluoromethyl)phenyl)amino)-3-phenylpentan-2-ol (93)



93

[α]$_D^{27}$ = −19 (*c* 0.7, $CHCl_3$).

HPLC analysis: ODH (*n*-hexane/*i*-PrOH = 99/1, flow rate 1.0 mL/min, λ = 254 nm), t_R (minor) = 36.12 min, t_R (major) = 47.88 min, 95% ee; t_R (minor) = 52.55 min, t_R (major) = 55.90 min, 95% ee.

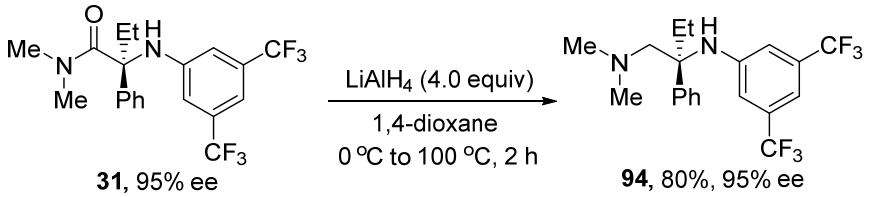
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 – 7.30 (m, 5H), 7.05 (s, 1H), 6.69 (s, 2H), 5.34 (s, 0.84H), 5.34 (s, 0.16H), 4.10 – 3.96 (m, 1H), 2.51 – 2.36 (m, 1H), 2.34 – 2.24 (m, 1H), 1.55 – 1.53 (m, 0.16H), 1.31 – 1.27 (m, 0.84H), 1.16 (d, *J* = 6.4 Hz, 0.48H), 1.04 (d, *J* = 6.4 Hz, 2.52H), 1.01 – 0.95 (m, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 146.8, 146.6, 141.3, 138.6, 131.8 (q, *J* = 32.4 Hz), 131.7 (q, *J* = 32.3 Hz), 128.8, 128.7 127.7, 127.6, 127.5, 127.2, 123.4 (q, *J* = 271.0 Hz), 114.2 – 114.1 (m), 113.83 – 113.78 (m), 109.9 – 109.7 (m), 109.6 – 109.5 (m), 74.7, 71.4, 64.8, 64.4, 24.7, 23.6, 18.4, 17.8, 8.9, 7.9.

^{19}F NMR (376 MHz, $CDCl_3$) δ -63.36, -63.39.

HRMS (ESI) m/z calcd. for $C_{19}H_{20}F_6NO$ $[M + H]^+$ 392.1444, found 392.1434.

The synthesis of chiral 1,2-diamine 94

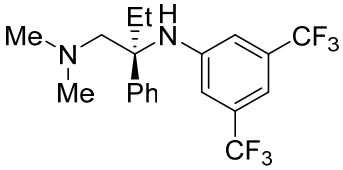


31, 95% ee

94, 80%, 95% ee

To a solution of $LiAlH_4$ (30.4 mg, 0.80 mmol, 4.0 equiv) in 1,4-dioxane (2 mL) was slowly added the solution of **31** (83.6 mg in 2 mL 1,4-dioxane, 0.2 mmol. 1.0 equiv) at 0 °C under argon. Then the reaction mixture was slowly warmed up to room temperature and stirred at 100 °C for 2 h. Upon completion (monitored by TLC), the reaction mixture was quenched with water (1 mL), NaOH aqueous solution (1 mL, 0.1 M) and water (1 mL) respectively at 0 °C. Then the reaction mixture was extracted with EtOAc (10 mL × 3). The combined organic layer was washed with brine, dried over anhydrous Na_2SO_4, filtered and concentrated to afford the crude product, which was purified by column chromatography on silica gel (petroleum ether/EtOAc = 8/1) to yield the desired product **94** as a white solid (64.5 mg, 80% yield, 95% ee).

(*S*)-*N*^{2}-(3,5-Bis(trifluoromethyl)phenyl)-*N*^{1}, *N*^{1}-dimethyl-2-phenylbutane-1,2-diamine (94)

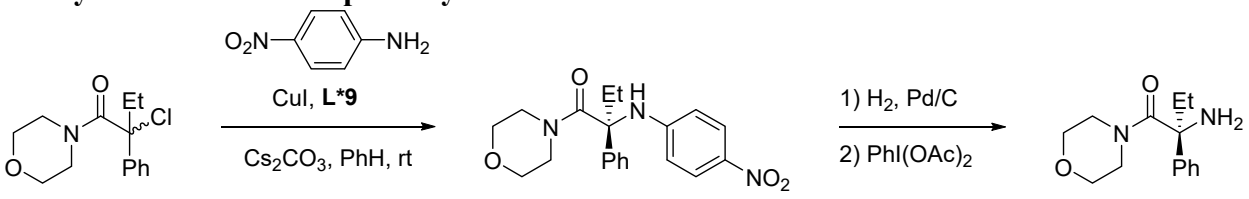


94

[α]$_D^{27}$ = +12 (*c* 1.6, $CHCl_3$).

HPLC analysis: ODH (*n*-hexane/*i*-PrOH = 100/0, flow rate 0.4 mL/min, λ = 254 nm), t_R (minor) = 34.60 min, t_R (major) = 36.36 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 – 7.27 (m, 4H), 7.24 – 7.20 (m, 1H), 7.03 (s, 1H), 6.76 (s, 2H), 5.54 (s, 1H), 2.83 (d, *J* = 13.2 Hz, 1H), 2.59 (d, *J* = 13.3 Hz, 1H), 2.23 (dq, *J* = 14.8, 7.4 Hz, 1H), 2.10 – 2.01 (m, 7H), 0.82 (t, *J* = 7.4 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 147.4, 143.9, 131.8 (q, *J* = 32.3 Hz), 128.5, 126.8, 126.3, 123.5 (q, *J* = 270.9 Hz), 113.72 – 113.68 (m), 109.4 – 109.2 (m), 67.6, 60.9, 47.7, 30.0, 8.2.
^{19}F NMR (376 MHz, $CDCl_3$) δ -63.27.
HRMS (ESI) m/z calcd. for $C_{20}H_{23}F_6N_2$ $[M + H]^+$ 405.1760, found 405.1749.

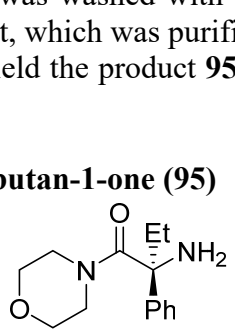
The synthesis of α-chiral primary amine 95



43, 99%, 88% ee — **95**, 87%, 88% ee

According to **General Procedure A** with 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (641.0 mg, 2.4 mmol, 1.2 equiv) and 4-nitroaniline **A11** (276.1 mg, 2.0 mmol, 1.0 equiv) for 72 h, the reaction mixture was purified by column chromatography on silica gel (petroleum ether/EtOAc = 3/1) to yield the product **43** as a yellowish solid (731.9 mg, 99% yield, 88% ee).
To a solution of **43** (73.8 mg, 0.20 mmol, 1.0 equiv) in anhydrous EtOAc (4 mL) was added Pd/C (30 mg, 10 wt%) in one portion. Then the reaction flask was evacuated and refilled with H_2 through a balloon, and the mixture was stirred under a H_2 atmosphere at room temperature for 4 h. After completion (monitored by TLC), the reaction was filtered through a short pad of celite and rinsed with EtOAc (5 mL × 3). The filtrate was concentrated under reduced pressure to afford the crude product, which was used in the next step without further purification.
To a solution of the above crude product was dissolved in CH_3CN (4 mL) and cooled to 0°C. $PhI(OAc)_2$ (128.8 mg, 0.40 mmol, 2.0 equiv) was added as a solid, and the homogeneous mixture was kept at 0 °C for 30 min before addition of H_2SO_4 (5 mL, 1.0 M). The aqueous layer was washed with CH_2Cl_2 and then was basified (pH=10) by dropwise addition of NaOH (10 mmol, 1.0 M in water) and saturated solution of Na_2CO_3, and was subsequently washed with CH_2Cl_2. The combined organic phase was washed with brine, dried over Na_2SO_4, filtrated and concentrated to afford the crude product, which was purified by flash column chromatography on silica gel (EtOAc/CH_3OH = 20/1) to yield the product **95** as a slight brown solid (43.3 mg, 87% yield, 88% ee).

(*S*)-2-Amino-1-morpholino-2-phenylbutan-1-one (95)

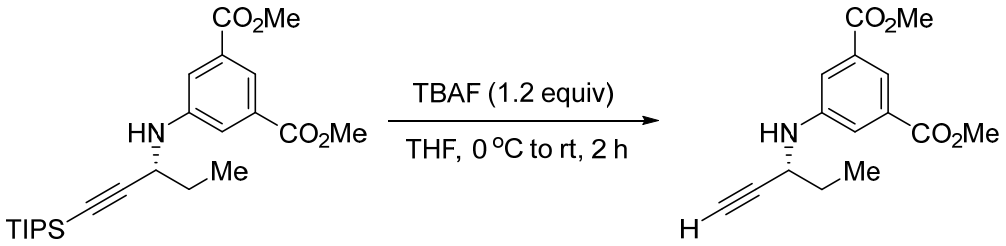


95

$[\alpha]_D^{27}$ = −13 (*c* 0.5, $CHCl_3$).
HPLC analysis: Chiralcel OJ (*n*-hexane/*i*-PrOH = 90/10, flow rate 1.0 mL/min, λ = 210 nm), t_R (major) = 11.83 min, t_R (minor) = 18.68 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.31 (m, 4H), 7.29 – 7.25 (m, 1H), 3.74 – 3.05 (m, 8H), 2.43 (s, 2H), 2.18 (dq, *J* = 14.8, 7.5 Hz, 1H), 2.07 (dq, *J* = 14.4, 7.3 Hz, 1H), 0.86 (t, *J* = 7.4 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 173.0, 143.3, 128.8, 127.3, 125.0, 66.3, 63.9, 46.9, 43.7, 33.0, 8.0.
HRMS (ESI) *m/z* calcd. for $C_{14}H_{21}N_2O_2$ $[M + H]^+$ 249.1598, found 249.1593.

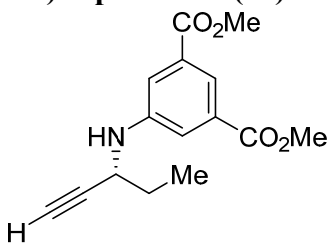
The synthesis of terminal alkyne derivative 96



78, 90% ee **96**, 87%, 90% ee

To a solution of **78** (43.1 mg, 0.1 mmol, 1.0 equiv) in THF (5 mL) was slowly added TBAF (0.12 mmol, 1.2 equiv, 1M in THF) at 0 °C. Then the mixture was slowly warmed to room temperature and stirred for 2 h before being quenched with H_2O (2 mL). The residue was extracted with EtOAc (10 mL × 3). The combined organic layer was washed with brine, dried over anhydrous Na_2SO_4, filtered and concentrated to afford the crude product, which was purified by column chromatography on silica gel (petroleum ether/EtOAc = 8:1) to afford the product **96** as a yellowish solid (23.9 mg, 87% yield, 90% ee).

Dimethyl (*R*)-5-(pent-1-yn-3-ylamino)isophthalate (96)

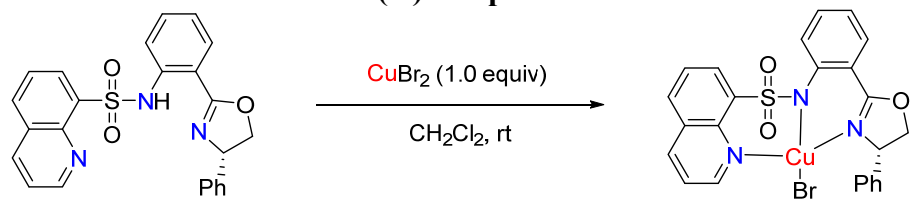


96

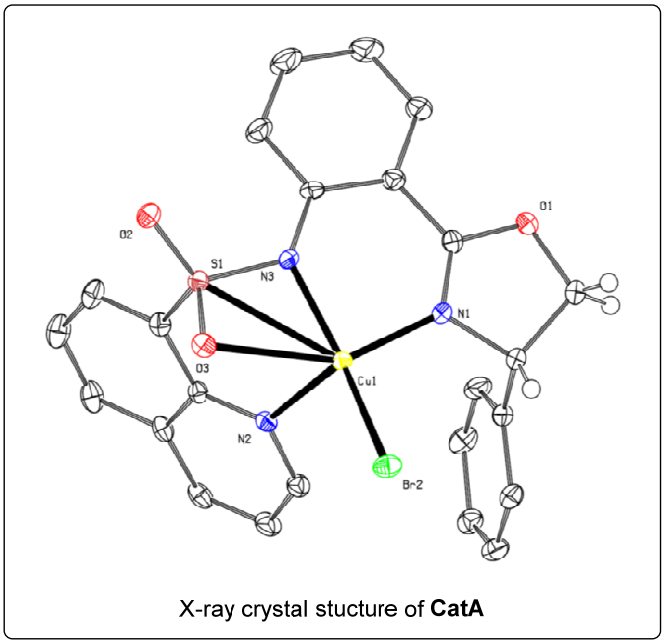
$[\alpha]_D^{27}$ = +12 (*c* 0.6, $CHCl_3$).
HPLC analysis: Chiralcel IF (*n*-hexane/*i*-PrOH = 90/10, flow rate 0.8 mL/min, λ = 254 nm), t_R (minor) = 14.88 min, t_R (major) = 17.37 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.07 (t, *J* = 1.4 Hz, 1H), 7.55 (d, *J* = 1.3 Hz, 2H), 4.15 – 4.10 (m, 1H), 4.04 (s, 1H), 3.92 (s, 6H), 2.25 (d, *J* = 1.6 Hz, 1H), 1.93 – 1.77 (m, 2H), 1.13 (t, *J* = 7.4 Hz, 3H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 166.6, 146.8, 131.3, 120.4, 118.7, 83.5, 71.4, 52.3, 46.8, 28.7, 10.2.
HRMS (ESI) m/z calcd. for $C_{15}H_{18}NO_4$ $[M + H]^+$ 276.1230, found 276.1224.

7. Mechanistic studies

Preparation and characterization of Cu(II) complex CatA



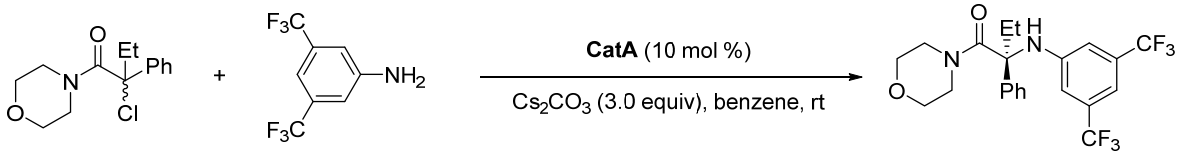
L*9 (1.0 equiv.) **CatA**, 98%



X-ray crystal stucture of **CatA**

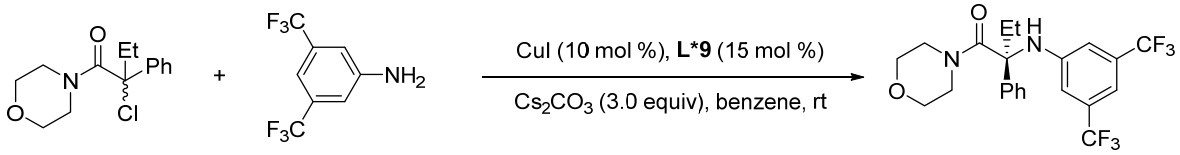
To a solution of $CuBr_2$ (22.1 mg, 0.20 mmol) in CH_2Cl_2 (2 mL) was added **L*9** (42.9 mg, 0.10 mmol) at room temperature and stirred overnight. Then the solution was dissolved in CH_2Cl_2 (10 mL) and filtered. Next, the solution was concentrated in vacuo and obtained product **CatA** (55.7 mg, 98% yield).

Reaction of Cu(II) complex CatA



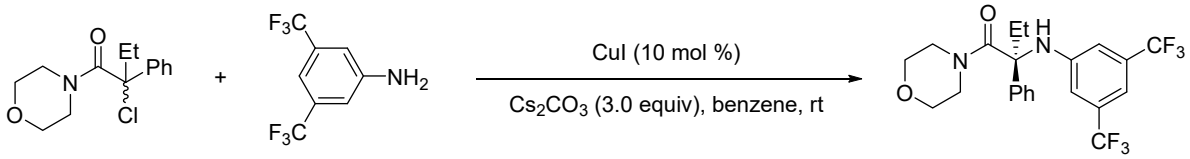
(±)-**E1** **A1** **1**, >99%, 95% ee

Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with **CatA** (2.8 mg, 0.005 mmol, 10 mol %), Cs_2CO_3 (48.9 mg, 0.15 mmol, 3.0 equiv), 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (16.0 mg, 0.06 mmol, 1.2 equiv), 3,5-bis(trifluoromethyl)aniline **A1** (11.5 mg, 0.05 mmol, 1.0 equiv), and anhydrous benzene (1.0 mL) were sequentially added into the mixture and the reaction mixture was stirred at rt for 72 h. Upon completion (monitored by TLC), the precipitate was filtered off and washed by EtOAc. The filtrate was evaporated and afforded the desired product **1** (yield of **1** was based on ^1H NMR analysis of the crude product using 1,3,5-trimethoxybenzene as an internal standard, >99%, 95% ee).



(±)-**E1** **A1** **1**, >99%, 95% ee

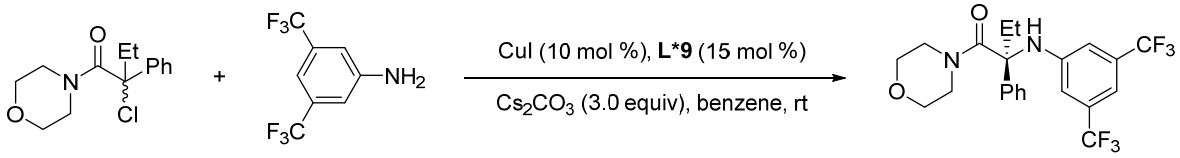
Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with CuI (0.9 mg, 0.005 mmol, 10 mol %), **L*9** (3.2 mg, 0.0075 mmol, 15 mol %), Cs_2CO_3 (48.9 mg, 0.15 mmol, 3.0 equiv), 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (16.0 mg, 0.06 mmol, 1.2 equiv), 3,5-bis(trifluoromethyl)aniline **A1** (11.5 mg, 0.05 mmol, 1.0 equiv), and anhydrous benzene (1.0 mL) were sequentially added into the mixture and the reaction mixture was stirred at rt for 72 h. Upon completion (monitored by TLC), the precipitate was filtered off and washed by EtOAc. The filtrate was evaporated and afforded the desired product **1** (yield of **1** was based on ^{1}H NMR analysis of the crude product using 1,3,5-trimethoxybenzene as an internal standard, >99%, 95% ee).



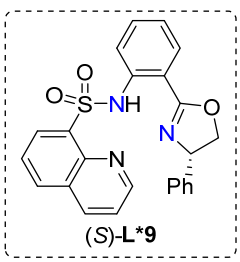
(±)-**E1** **A1** **1**, 0%, and no conversion of **E1**

Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with CuI (0.9 mg, 0.005 mmol, 10 mol %), Cs_2CO_3 (48.9 mg, 0.15 mmol, 3.0 equiv), 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (16.0 mg, 0.06 mmol, 1.2 equiv), 3,5-bis(trifluoromethyl)aniline **A1** (11.5 mg, 0.05 mmol, 1.0 equiv), and anhydrous benzene (1.0 mL) were sequentially added into the mixture and the reaction mixture was stirred at rt for 72 h. Upon completion, the precipitate was filtered off and washed by EtOAc. The filtrate was concentrated to afford the crude product and determined by ^{1}H NMR spectra (recovery of **E1** was based on ^{1}H NMR analysis of the crude product using 1,3,5-trimethoxybenzene as an internal standard, recovered **E1** >119%). Control experiments confirmed that no reaction takes place in the absence of the chiral ligand.

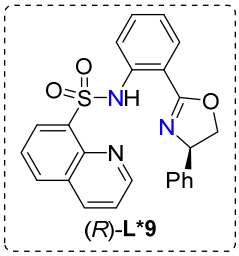
Linear relationship experiment



(±)-**E1** **A1** **1**



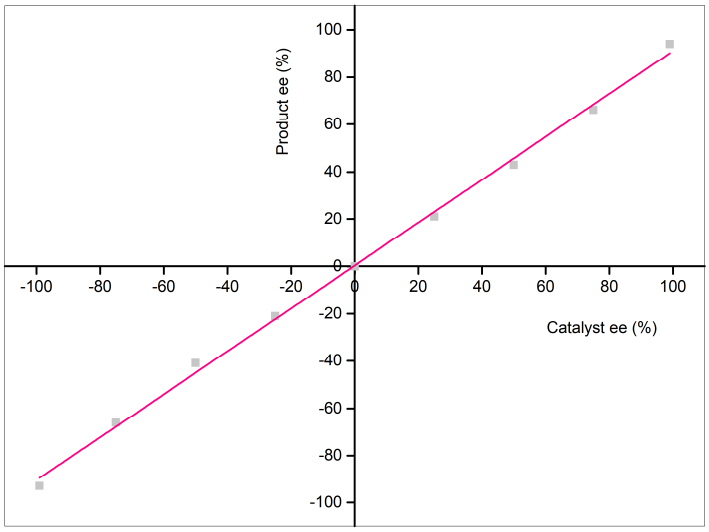
(*S*)-**L*9**



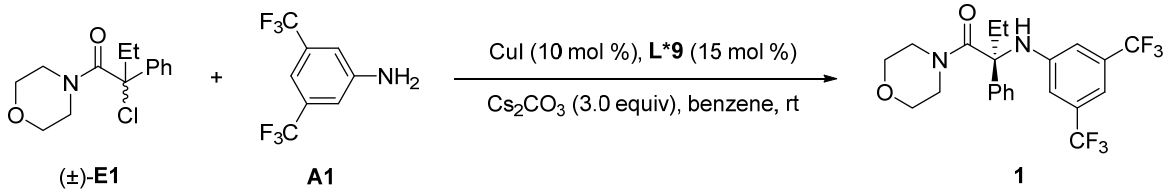
(*R*)-**L*9**

Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with CuI (0.9 mg, 0.005 mmol, 10 mol %), **L*9** (3.2 mg, 0.0075 mmol, 15 mol %), Cs_2CO_3 (48.9 mg, 0.15 mmol, 3.0 equiv), 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (16.0 mg, 0.06 mmol, 1.2 equiv), 3,5-bis(trifluoromethyl)aniline **A1** (11.5 mg, 0.05 mmol, 1.0 equiv), and anhydrous benzene (1.0 mL) were sequentially added into the mixture and the reaction mixture was stirred at rt for 72 h. Upon completion (monitored by TLC), the product was separated by preparative TLC. The ee values of products was then determined by HPLC, which indicated a linear relationship between ee values of products and corresponding catalysts. The catalyst **L*9** with different ee values were prepared by mixing (*S*)-**L*9** (99% ee) and *(R)*-**L*9** (99% ee) in appropriate ratios.

Entry	Catalyst ee (%)	Product ee (%)
1	99	94
2	75	66
3	50	43
4	25	21
5	0	0
6	-25	-21
7	-50	-41
8	-75	-66
9	-99	-93



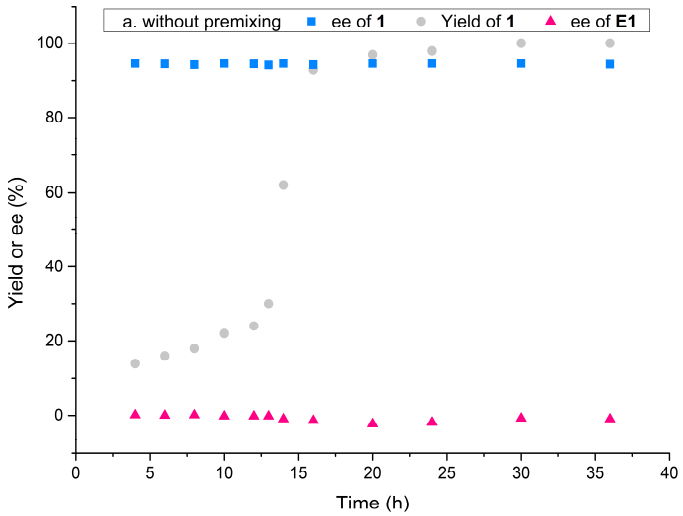
Time-course experiment with CuI/L*9



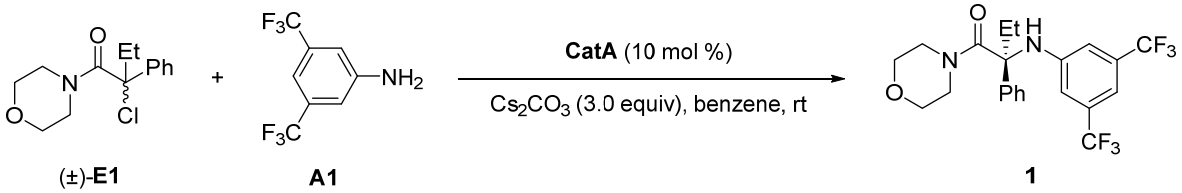
(±)-**E1** **A1** **1**

Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with CuI (0.9 mg, 0.005 mmol, 10 mol %), **L*9** (3.2 mg, 0.0075 mmol, 15

mol %), Cs_2CO_3 (48.9 mg, 0.15 mmol, 3.0 equiv), 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (16.0 mg, 0.06 mmol, 1.2 equiv), 3,5-bis(trifluoromethyl)aniline **A1** (11.5 mg, 0.05 mmol, 1.0 equiv), and anhydrous benzene (1.0 mL) were sequentially added into the mixture and the reaction mixture was stirred at rt for appropriate time. Upon completion, the precipitate was filtered off and washed by EtOAc. The filtrate was evaporated and the residue was analyzed by ^{1}H NMR spectroscopy using 1,3,5-trimethoxybenzene as an internal standard. The product was then separated by preparative TLC. The ee values of **1** and recovered **E1** were determined by HPLC analysis.

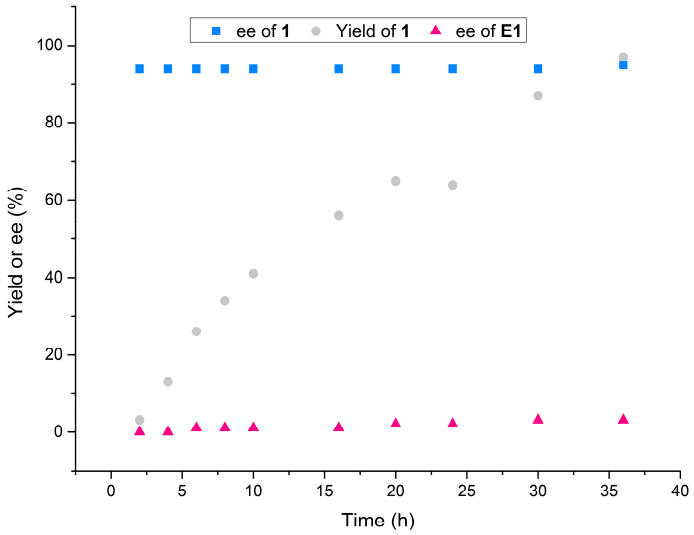


Time-course experiment with CatA

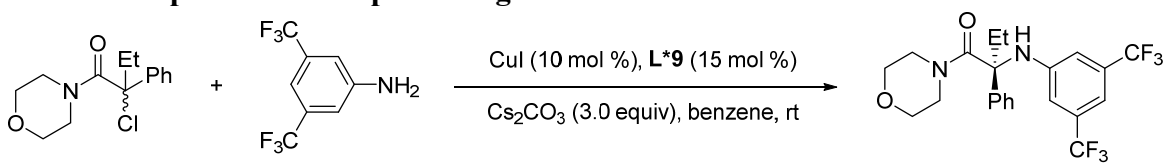


(±)-**E1** **A1** **1**

Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with **CatA** (2.8 mg, 0.005 mmol, 10 mol %), Cs_2CO_3 (48.9 mg, 0.15 mmol, 3.0 equiv), 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (16.0 mg, 0.06 mmol, 1.2 equiv), 3,5-bis(trifluoromethyl)aniline **A1** (11.5 mg, 0.05 mmol, 1.0 equiv), and anhydrous benzene (1.0 mL) were sequentially added into the mixture and the reaction mixture was stirred at rt for appropriate time. Upon completion, the precipitate was filtered off and washed by EtOAc. The filtrate was evaporated and the residue was analyzed by ^{1}H NMR spectroscopy using 1,3,5-trimethoxybenzene as an internal standard. The product was then separated by preparative TLC. The ee values of **1** and recovered **E1** were determined by HPLC analysis.

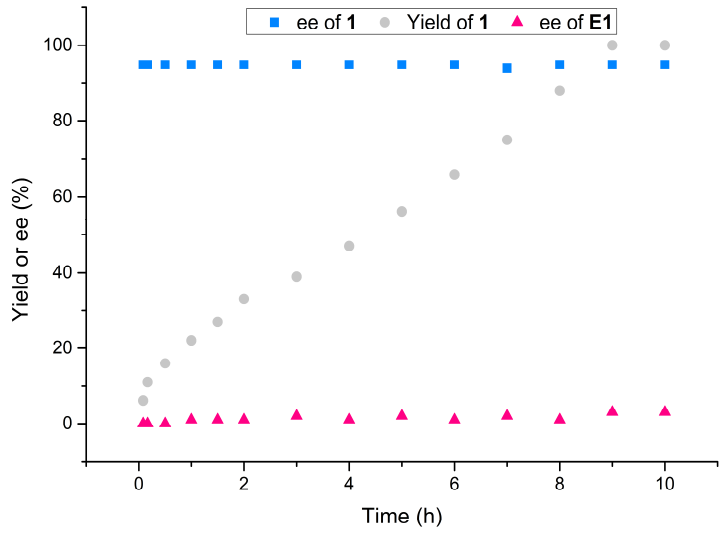


Time-course experiment with premixing

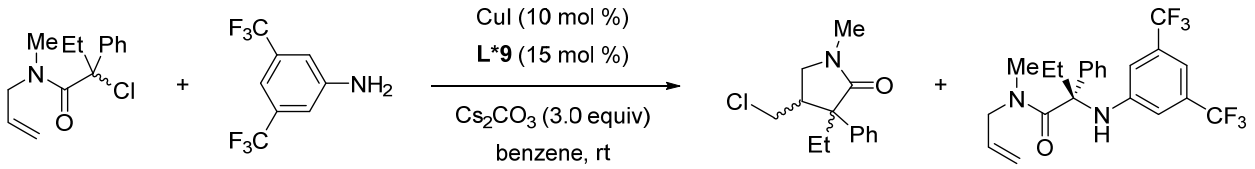


(±)-**E1** **A1** **1**

Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with CuI (0.9 mg, 0.005 mmol, 10 mol %), **L*9** (3.2 mg, 0.0075 mmol, 15 mol %), Cs_2CO_3 (48.9 mg, 0.15 mmol, 3.0 equiv), 3,5-bis(trifluoromethyl)aniline **A1** (11.5 mg, 0.05 mmol, 1.0 equiv), and anhydrous benzene (1.0 mL). Then, the mixture was stirred at 50 ℃ for 1 h. Next, the mixture was stirred at room temperature for 10 min. After that, 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (16.0 mg, 0.06 mmol, 1.2 equiv) was added into the mixture and the reaction mixture was stirred at room temperature for appropriate time. Upon completion, the precipitate was filtered off and washed by EtOAc. The filtrate was evaporated and the residue was analyzed by ^{1}H NMR spectroscopy using 1,3,5-trimethoxybenzene as an internal standard. The product was then separated by preparative TLC. The ee values of **1** and recovered **E1** were determined by HPLC analysis.



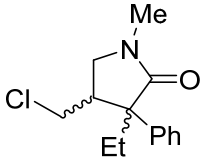
Radical clock experiments



(±)-**E44** **A1** **97**, 51%, 3:1 dr **98**, 49%, 95% ee

Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with CuI (3.8 mg, 0.02 mmol, 10 mol %), **L*9** (12.9 mg, 0.03 mmol, 15 mol %), Cs_2CO_3 (195.5 mg, 0.60 mmol, 3.0 equiv), *N*-allyl-2-chloro-*N*-methyl-2-phenylbutanamide **E44** (60.3 mg, 0.24 mmol, 1.2 equiv), 3,5-bis(trifluoromethyl)aniline **A1** (45.8 mg, 0.20 mmol, 1.0 equiv), and anhydrous benzene (4.0 mL) were sequentially added into the mixture and the reaction mixture was stirred at rt for 72 h. Upon completion (monitored by TLC), the precipitate was filtered off and washed by EtOAc. The filtrate was evaporated and the residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 15/1 to 3/1) to yield the product **97** as a colorless oil (25.7 mg, 51% yield, 3:1 dr) and **98** as a colorless oil (43.4 mg, 49% yield, 95% ee).

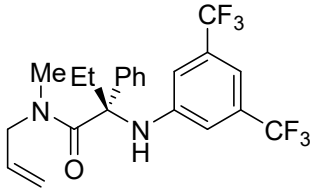
4-(Chloromethyl)-3-ethyl-1-methyl-3-phenylpyrrolidin-2-one (97)



97

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.11 (m, 5H), 3.77 – 3.48 (m, 2H), 3.28 – 2.71 (m, 6H), 2.18 – 1.88 (m, 2H), 1.00 (t, *J* = 7.3 Hz, 0.75H), 0.87 (t, *J* = 7.3 Hz, 2.24H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 175.9, 175.5, 140.9, 138.2, 128.6, 128.5, 127.2, 127.1, 127.0, 126.9, 55.9, 55.4, 50.9, 50.5, 47.0, 45.1, 43.3, 43.0, 30.0, 29.7, 28.3, 24.2, 9.1, 9.0.
HRMS (ESI) m/z calcd. for $C_{14}H_{19}ClNO$ $[M + H]^+$ 252.1150, found 252.1149.

(*S*)-*N*-Allyl-2-((3,5-bis(trifluoromethyl)phenyl)amino)-*N*-methyl-2-phenylbutanamide (98)



98

[α]$_D^{27}$ = +30 (*c* 1.0, $CHCl_3$).

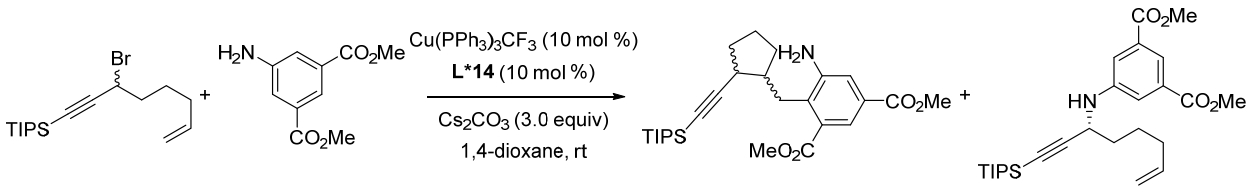
HPLC analysis: Chiralcel IG (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 254 nm), t_R (major) = 5.65 min, t_R (minor) = 7.11 min.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 – 7.48 (m, 2H), 7.39 (t, *J* = 7.6 Hz, 2H), 7.31 – 7.27 (m, 1H), 6.97 (s, 1H), 6.87 (s, 1H), 6.82 (s, 2H), 5.69 – 5.00 (m, 3H), 3.91 – 3.65 (m, 2H), 2.70 – 2.34 (m, 5H), 0.88 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 171.2, 145.2, 140.6, 131.84, 131.82 (q, *J* = 32.3 Hz), 129.1, 128.1, 127.0, 123.5 (q, *J* = 271.0 Hz), 117.8, 113.31 – 113.26 (m), 109.5 – 109.4 (m), 66.0, 52.8, 35.4, 23.3, 8.2.

^{19}F NMR (376 MHz, $CDCl_3$) δ -63.35.

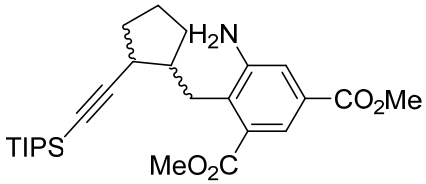
HRMS (ESI) m/z calcd. for $C_{22}H_{23}F_6N_2O$ $[M + H]^+$ 445.1709, found 445.1709.



(±)-**E45** **A9** **99**, 7%, 2:1 dr **100**, 25%, 86% ee

Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with $Cu(PPh_3)_3CF_3$ (18.4 mg, 0.02 mmol, 10 mol %), **L*14** (16.2 mg, 0.02 mmol, 10 mol %), Cs_2CO_3 (195.5 mg, 0.60 mmol, 3.0 equiv), and anhydrous 1,4-dioxane (1.0 mL). Then, the mixture was stirred at room temperature for 0.5 h. After that, (3-bromooct-7-en-1-yn-1-yl)triisopropylsilane **E45** (68.4 mg, 0.20 mmol, 1.0 equiv), dimethyl 5-aminoisophthalate **A9** (62.7 mg, 0.30 mmol, 1.5 equiv), and anhydrous 1,4-dioxane (1.0 mL) were sequentially added into the mixture and the reaction mixture was stirred at room temperature for 120 h. Upon completion (monitored by TLC), the precipitate was filtered off and washed by EtOAc. The filtrate was evaporated and the residue was purified by column chromatography on silica gel (petroleum ether/EtOAc = 15/1 to 5/1) to yield the product **99** as a colorless oil (6.3 mg, 7% yield, 2:1 dr) and **100** as a colorless oil (23.2 mg, 25% yield, 86% ee).

Dimethyl 5-amino-4-((2-((triisopropylsilyl)ethynyl)cyclopentyl)methyl)isophthalate (99)

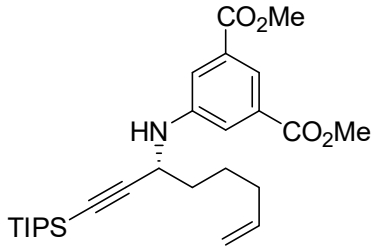


99

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 1.7 Hz, 0.34H), 7.80 (d, *J* = 1.7 Hz, 0.66H), 7.44 –

7.43 (m, 1H), 4.32 (s, 0.68H), 4.09 (s, 1.32H), 3.91 – 3.88 (m, 6H), 3.33 – 3.24 (m, 1H), 3.06 – 3.02 (m, 0.66H), 2.92 – 2.87 (m, 0.34H), 2.42 – 2.20 (m, 1H), 2.12 – 1.97 (m, 2H), 1.90 – 1.60 (m, 5H), 1.11 – 1.05 (m, 21H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 168.6, 168.3, 166.6, 146.0, 145.6, 131.9, 131.85, 131.77, 130.4, 128.34, 128.26, 121.3, 121.0, 118.8, 118.7, 112.4, 111.1, 84.3, 80.7, 52.19, 52.15, 52.14, 52.10, 47.0, 45.7, 38.0, 36.3, 33.0, 32.8, 31.3, 30.4, 29.9, 28.6, 23.2, 21.6, 18.7, 18.6, 11.34, 11.28.
HRMS (ESI) m/z calcd. for $C_{27}H_{42}NO_4Si$ $[M + H]^+$ 472.2878, found 472.2876.

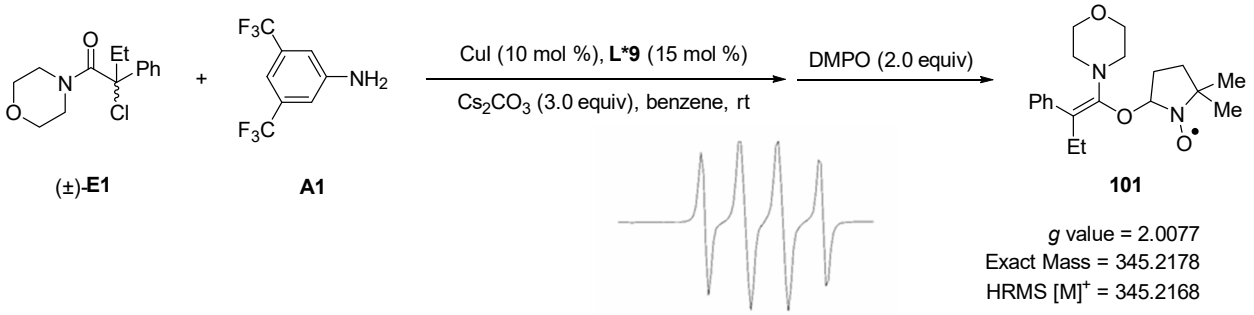
Dimethyl (*R*)-5-((1-(triisopropylsilyl)oct-7-en-1-yn-3-yl)amino)isophthalate (100)



100

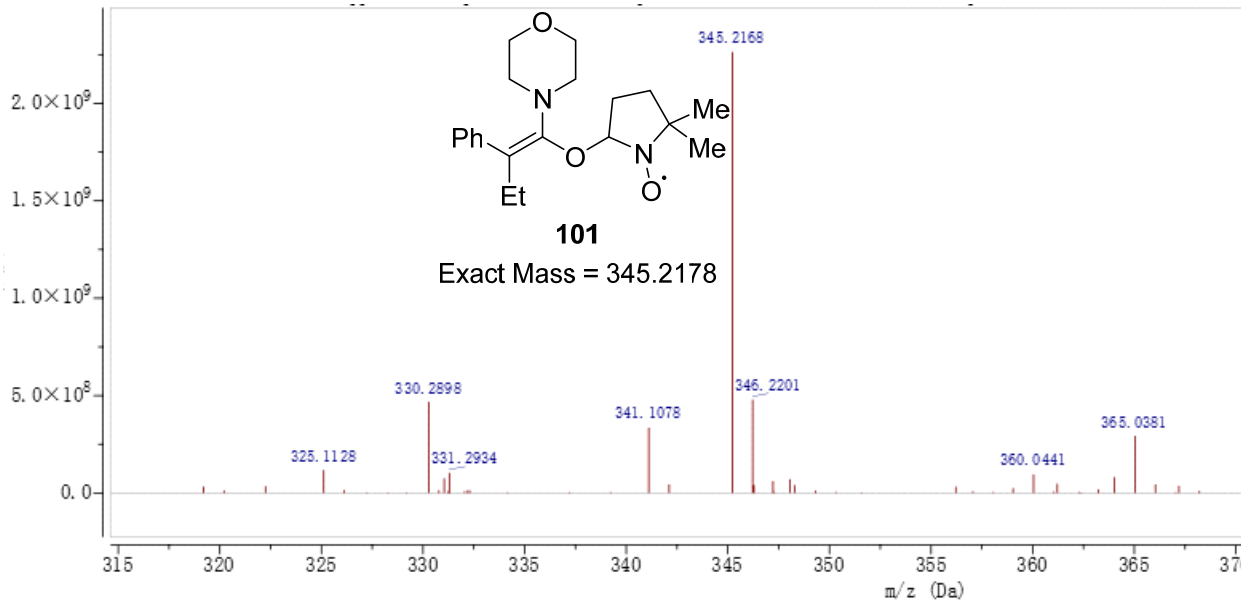
$[\alpha]_D^{27}$ = +71 (*c* 0.5, $CHCl_3$).
HPLC analysis: Chiralcel IC (*n*-hexane/*i*-PrOH = 98/2, flow rate 1.0 mL/min, λ = 230 nm), t_R (major) = 21.71 min, t_R (minor) = 26.14 min.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.07 (t, *J* = 1.5 Hz, 1H), 7.55 (d, *J* = 1.5 Hz, 2H), 5.87 – 5.77 (m, 1H), 5.08 – 4.98 (m, 2H), 4.21 (q, *J* = 7.0 Hz, 1H), 3.96 (d, *J* = 8.3 Hz, 1H), 3.91 (s, 6H), 2.19 – 2.12 (m, 2H), 1.90 – 1.76 (m, 2H), 1.75 – 1.66 (m, 2H), 0.98 – 0.96 (m, 21H).
^{13}C NMR (100 MHz, $CDCl_3$) δ 166.6, 146.9, 138.1, 131.2, 120.4, 119.1, 115.0, 107.1, 84.3, 52.2, 46.4, 34.9, 33.2, 25.1, 18.4, 11.0.
HRMS (ESI) m/z calcd. for $C_{27}H_{42}NO_4Si$ $[M + H]^+$ 472.2878, found 472.2874.

EPR Experiments for the detection of intermediate during the reaction



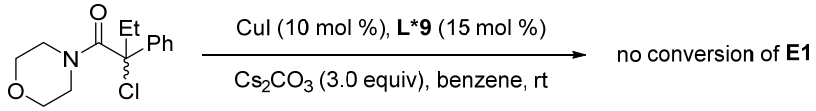
(±)-**E1** **A1** **101**

g value = 2.0077
Exact Mass = 345.2178
HRMS $[M]^+$ = 345.2168



Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with CuI (0.9 mg, 0.005 mmol, 10 mol %), **L*9** (2.5 mg, 0.0075 mmol, 15 mol %), Cs_2CO_3 (48.9 mg, 0.15 mmol, 3.0 equiv), 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (16.0 mg, 0.06 mmol, 1.2 equiv), 3,5-bis(trifluoromethyl)aniline **A1** (11.5 mg, 0.05 mmol, 1.0 equiv), and anhydrous benzene (1.0 mL) were sequentially added into the mixture and the reaction mixture was stirred at rt for 6 h. Next, 5,5-dimethyl-1-pyrroline *N*-oxide DMPO (11.3 mg, 0.10 mmol, 2.0 equiv) was added and the reaction mixture was stirred at rt for another 1 h. The resulting reaction mixture was analyzed by EPR. The tertiary carbon-centered radicals generated in the process of atom transfer would be affected by steric hindrance and then isomerized to oxygen-centered radicals. A distant signal of the persistent nitroxyl radical **101** was formed. Meanwhile, the proposed radical adducts **101** were consistent with the results of ESI-HRMS.

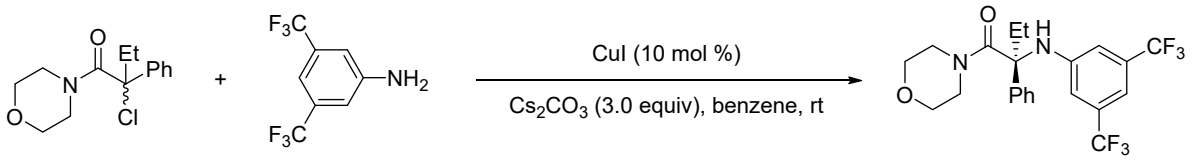
Effect of nucleophile and ligand on reaction initiation



(±)-**E1**

Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with CuI (0.9 mg, 0.005 mmol, 10 mol %), **L*9** (3.2 mg, 0.0075 mmol, 15 mol %), Cs_2CO_3 (48.9 mg, 0.15 mmol, 3.0 equiv), 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (13.4 mg, 0.05 mmol, 1.0 equiv), and anhydrous benzene (1.0 mL) were sequentially added into the mixture and the reaction mixture was stirred at rt for 72 h. Upon completion, the precipitate was filtered off and washed by EtOAc. The filtrate was concentrated to afford the crude product and determined by 1H NMR spectra (recovery of **E1** was based on ^{1}H NMR analysis of the crude product using 1,3,5-trimethoxybenzene as an internal standard, remaining **E1** >119%). Although we failed to synthesize the chiral ligand-chelated Cu(I)-amido complex, a control experiment without **A1** showed that no conversion of **E1** was observed. Thus, it is the transmetalation of Cu^I with the (hetero)aromatic amine that possibly occurs firstly rather than the

single electron-transfer between Cu^{I} and **E1**.



(±)-**E1** **A1** **1**, 0%, and no conversion of **E1**

Under argon atmosphere, an oven-dried resealable Schlenk tube equipped with a magnetic stir bar was charged with CuI (0.9 mg, 0.005 mmol, 10 mol %), Cs_2CO_3 (48.9 mg, 0.15 mmol, 3.0 equiv), 2-chloro-1-morpholino-2-phenylbutan-1-one **E1** (16.0 mg, 0.06 mmol, 1.2 equiv), 3,5-bis(trifluoromethyl)aniline **A1** (11.5 mg, 0.05 mmol, 1.0 equiv), and anhydrous benzene (1.0 mL) were sequentially added into the mixture and the reaction mixture was stirred at rt for 72 h. Upon completion, the precipitate was filtered off and washed by EtOAc. The filtrate was concentrated to afford the crude product and determined by 1H NMR spectra (recovery of **E1** was based on ^{1}H NMR analysis of the crude product using 1,3,5-trimethoxybenzene as an internal standard, remaining **E1** >119%). Control experiments confirmed that no reaction takes place in the absence of the chiral ligand.

8. References

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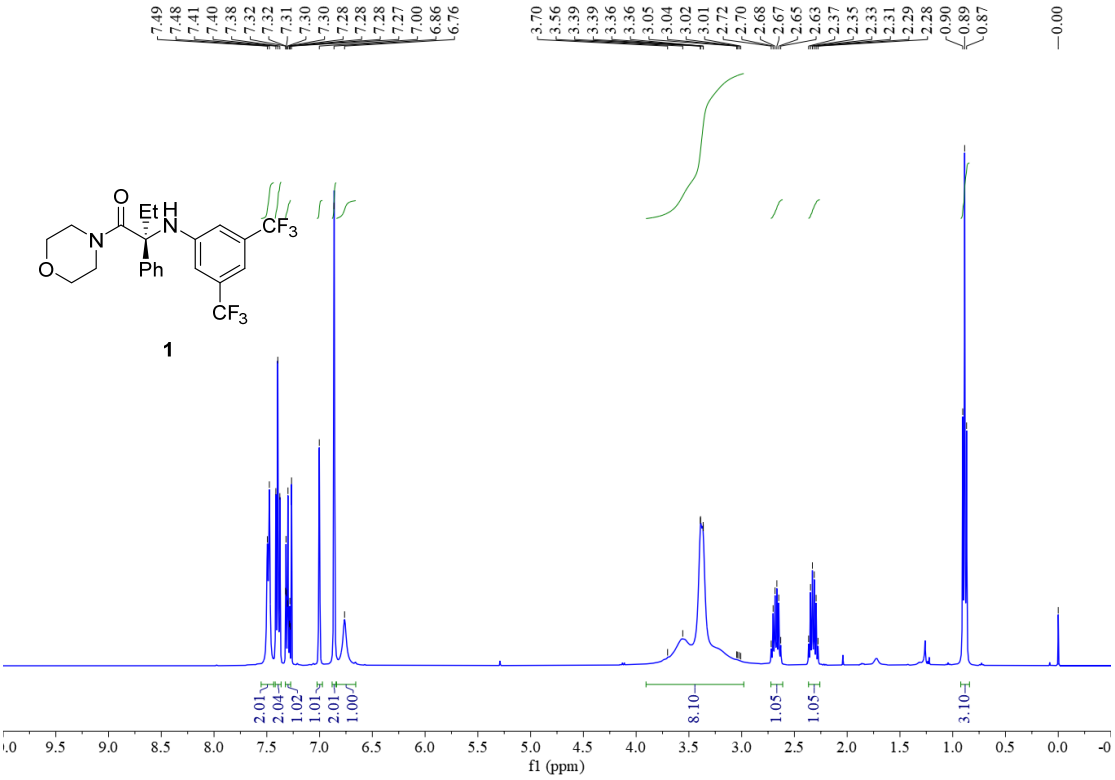
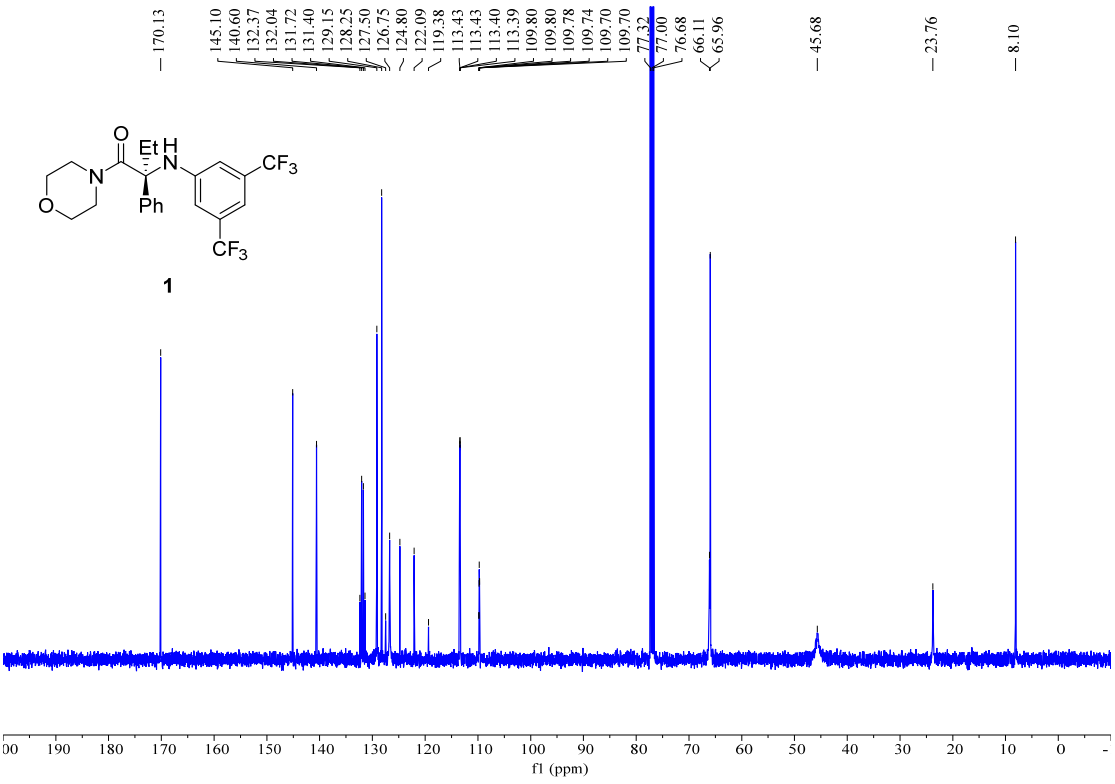
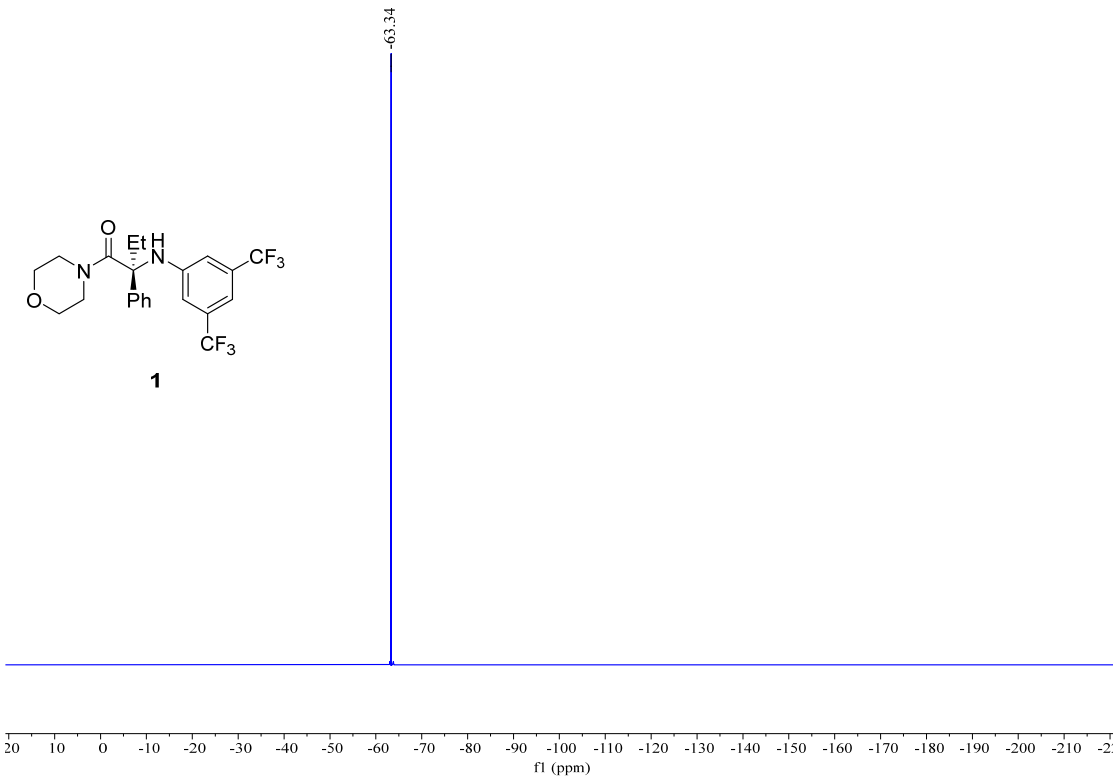
9. NMR spectra



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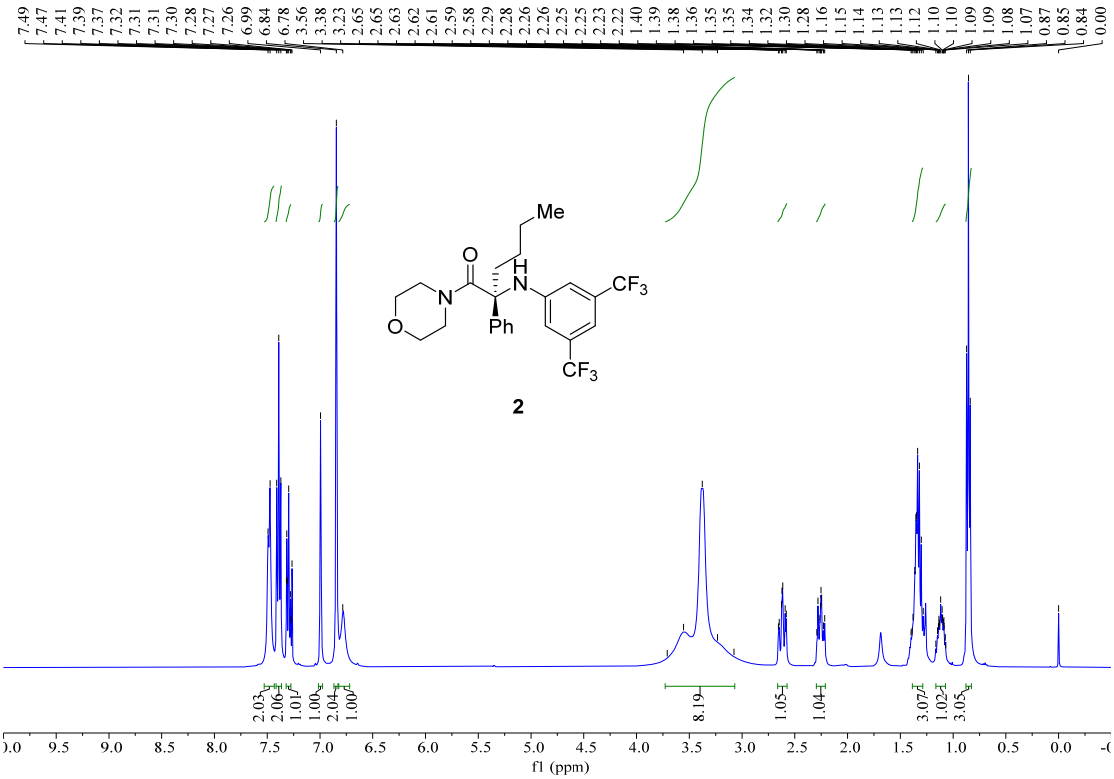
O
Et
H
N
N
O
Ph
CF3
CF3
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

1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Me
O
H
N
N
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CF3
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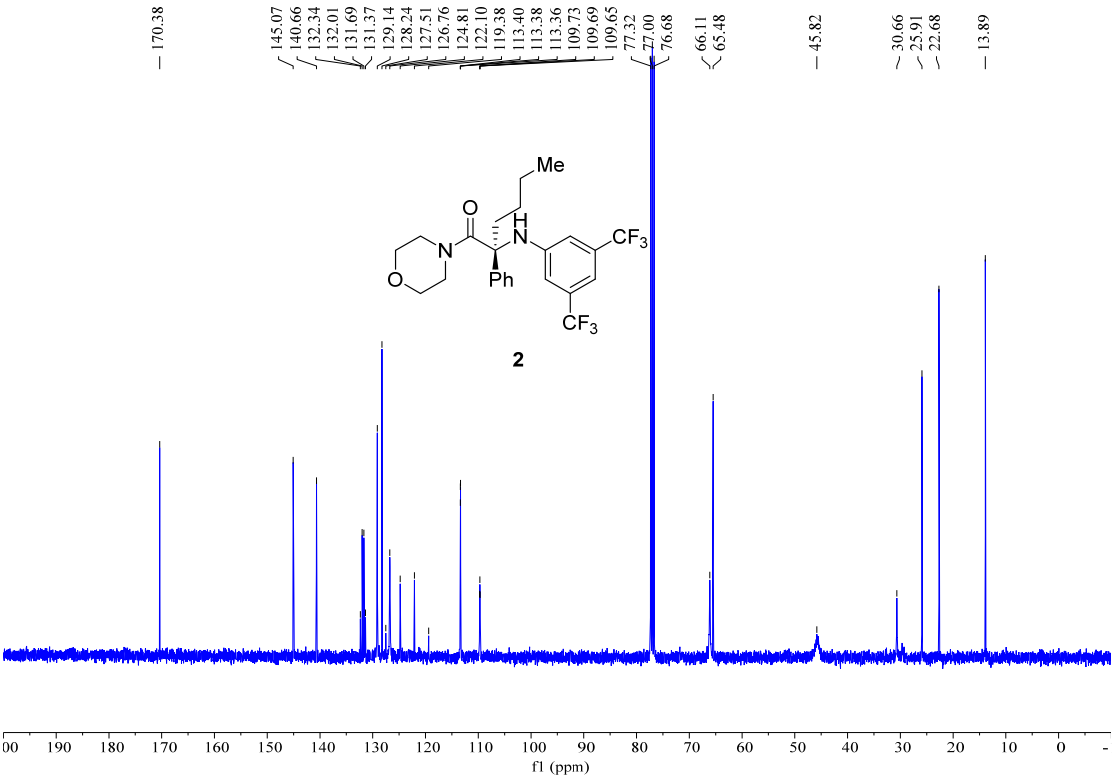
f1 (ppm)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145.07 140.66 132.34 132.01 131.69 131.37 129.14 128.24 127.51 126.76 124.81 122.10 119.38 113.40 113.38 113.36 109.73 109.69 109.65 77.32 77.00 76.68 66.11 65.48 45.82 30.66 25.91 22.68 13.89
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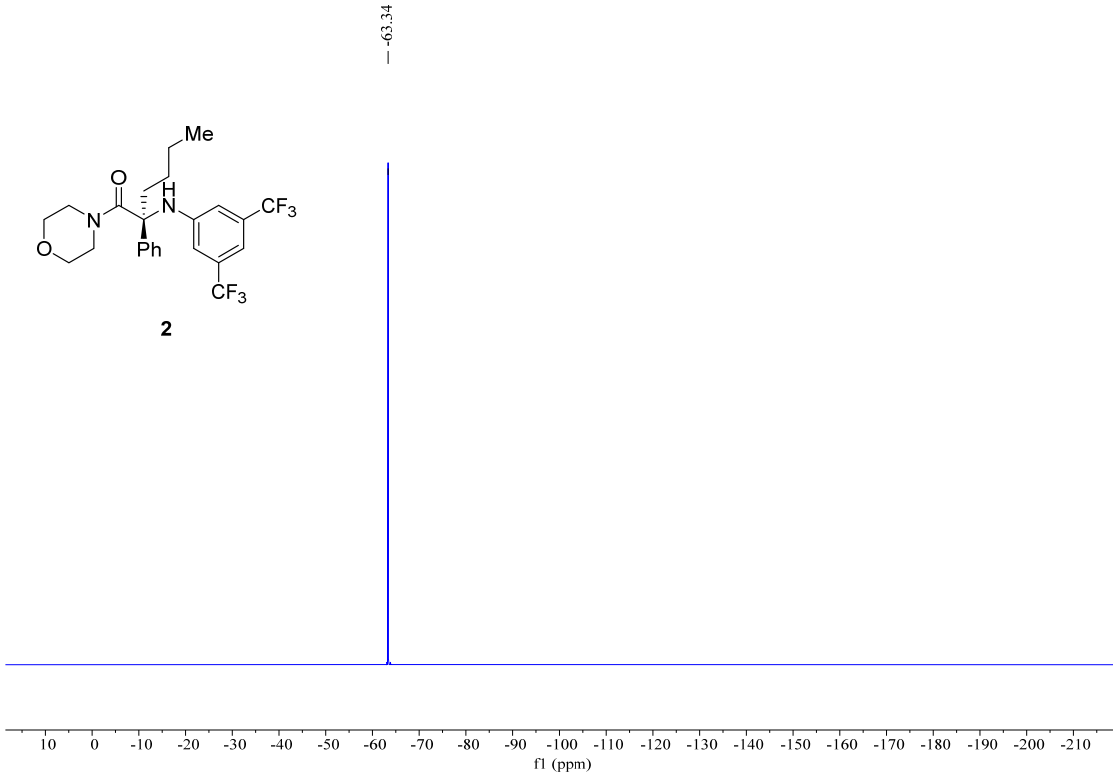
Ph
CF3
CF3
2
f1 (ppm)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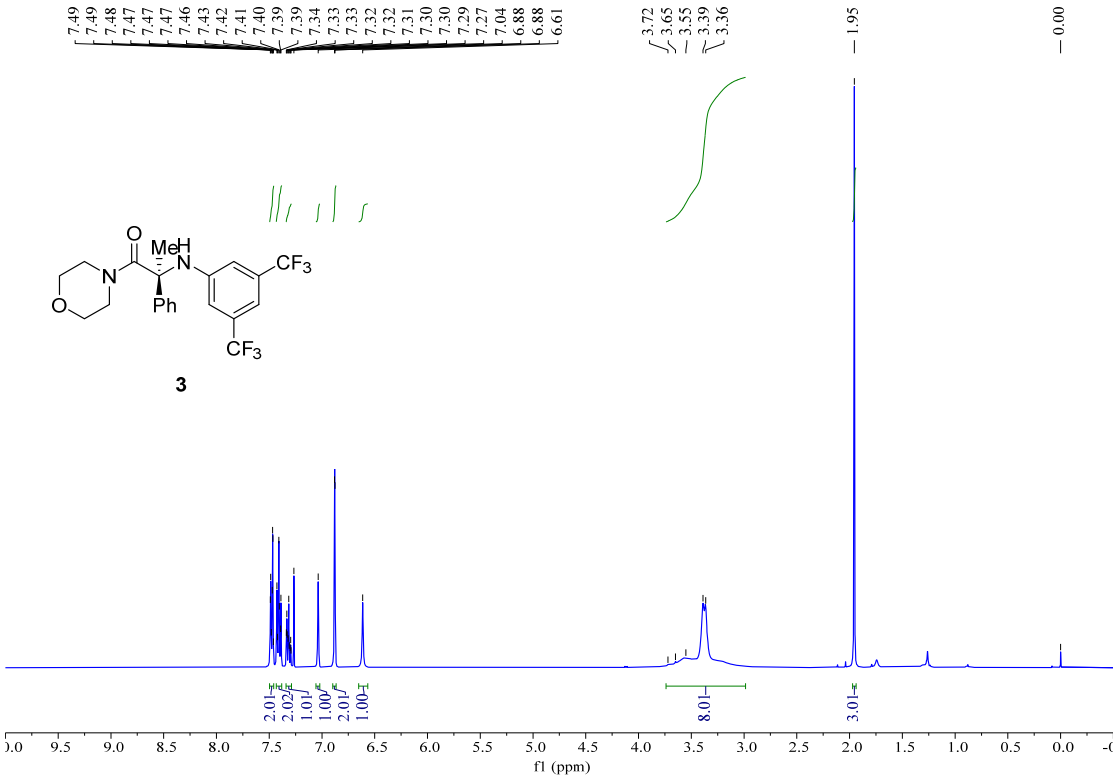
f1 (ppm)

2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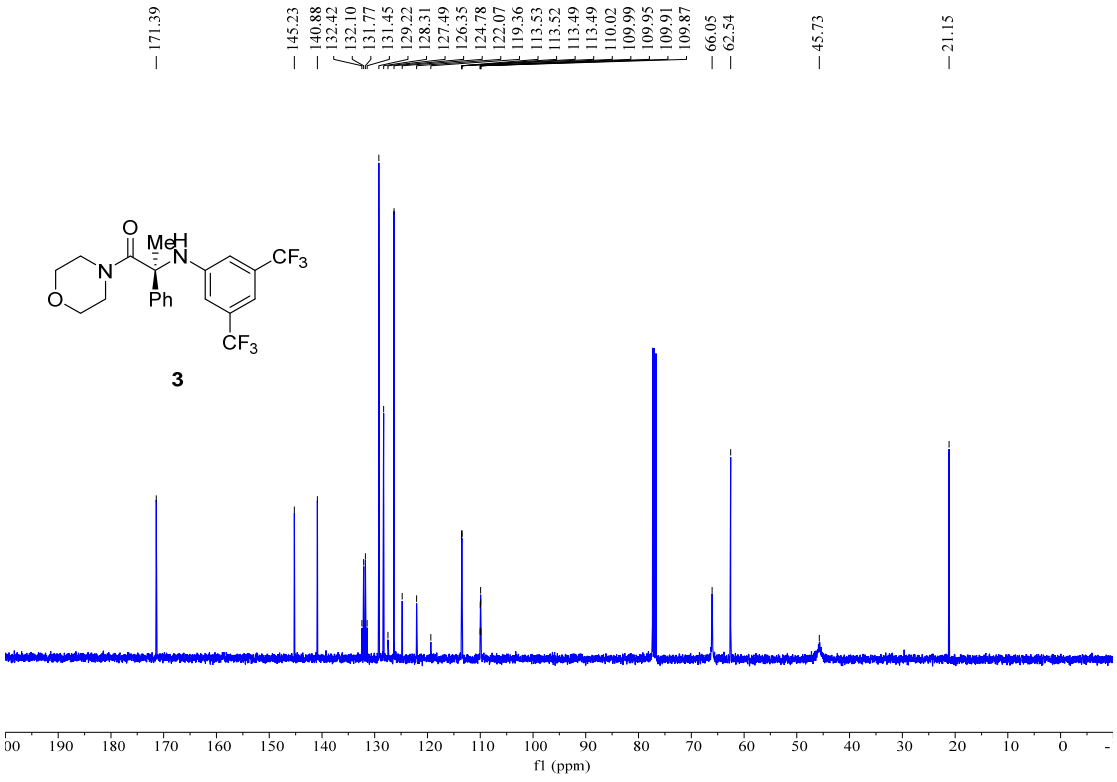
f1 (ppm)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Ph
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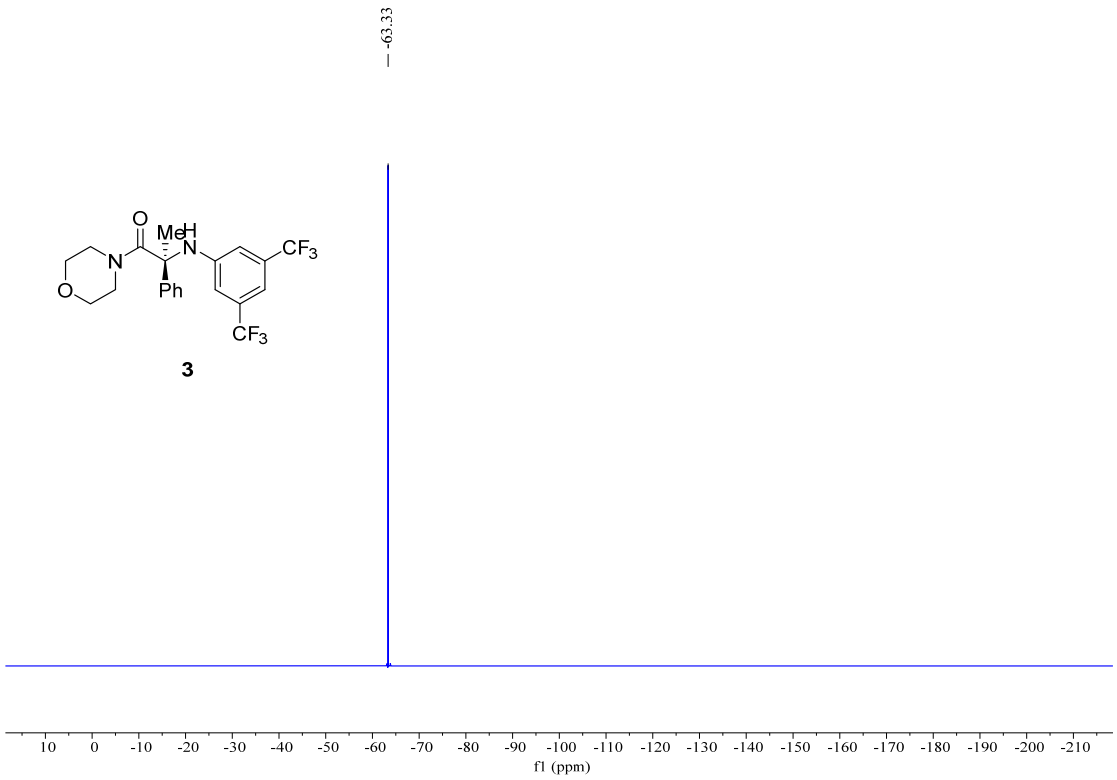
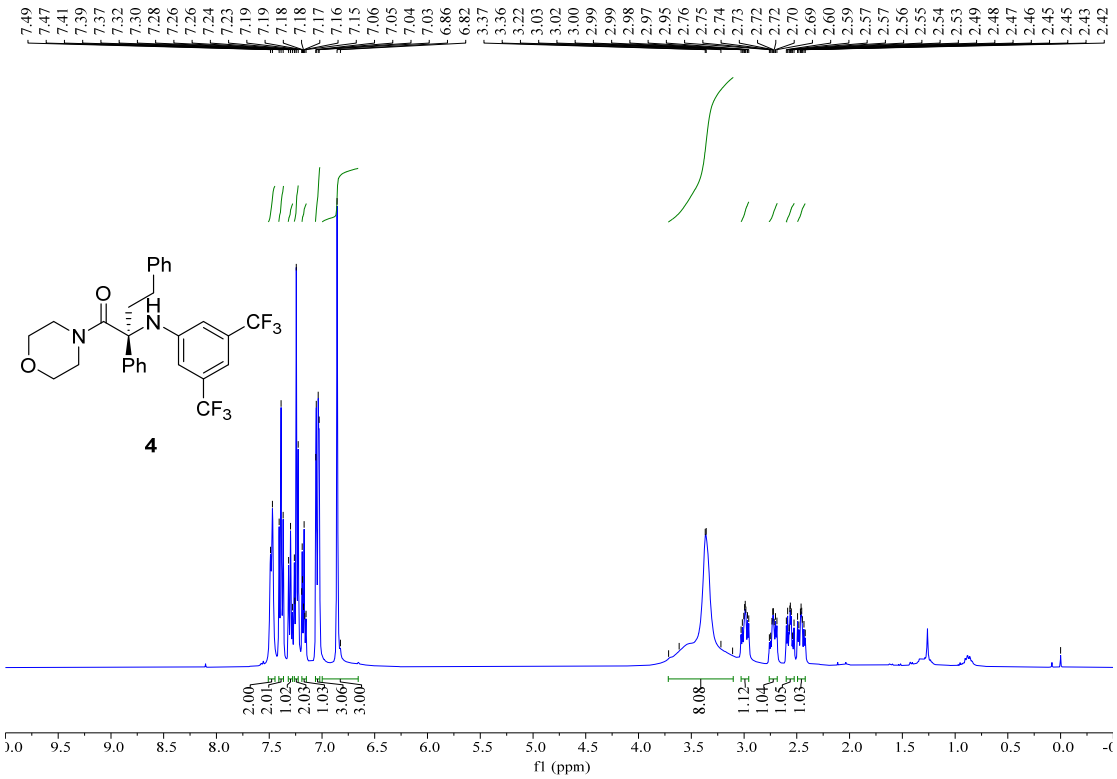
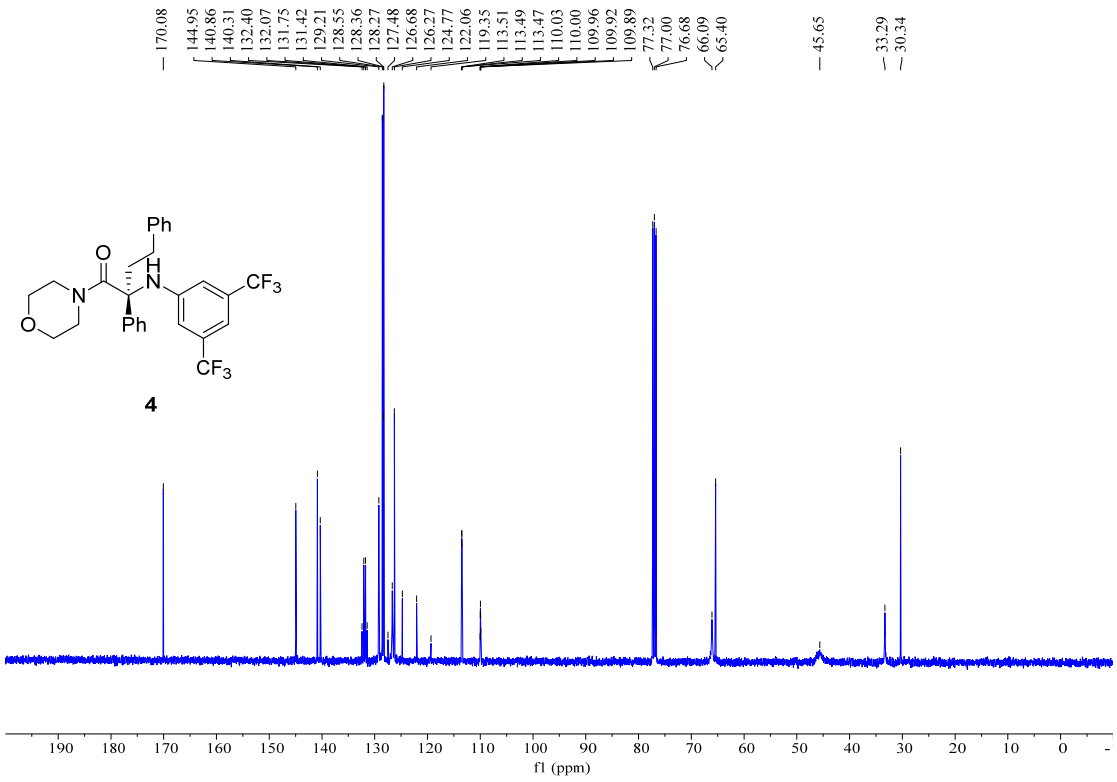
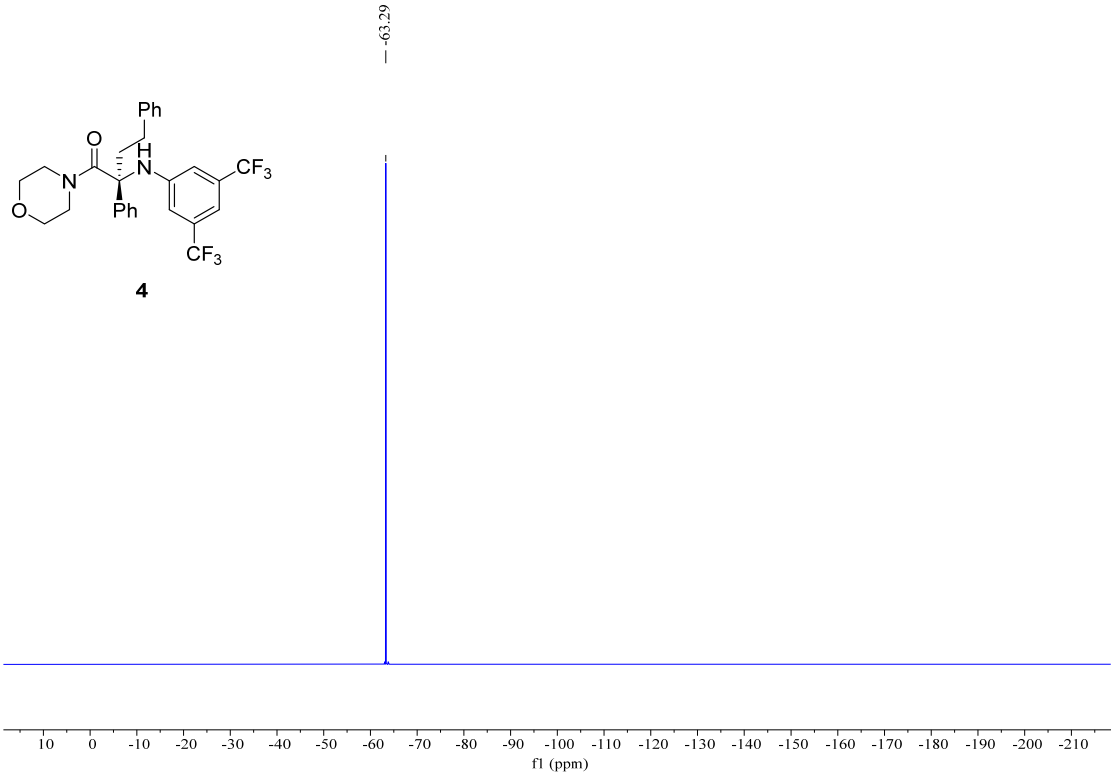
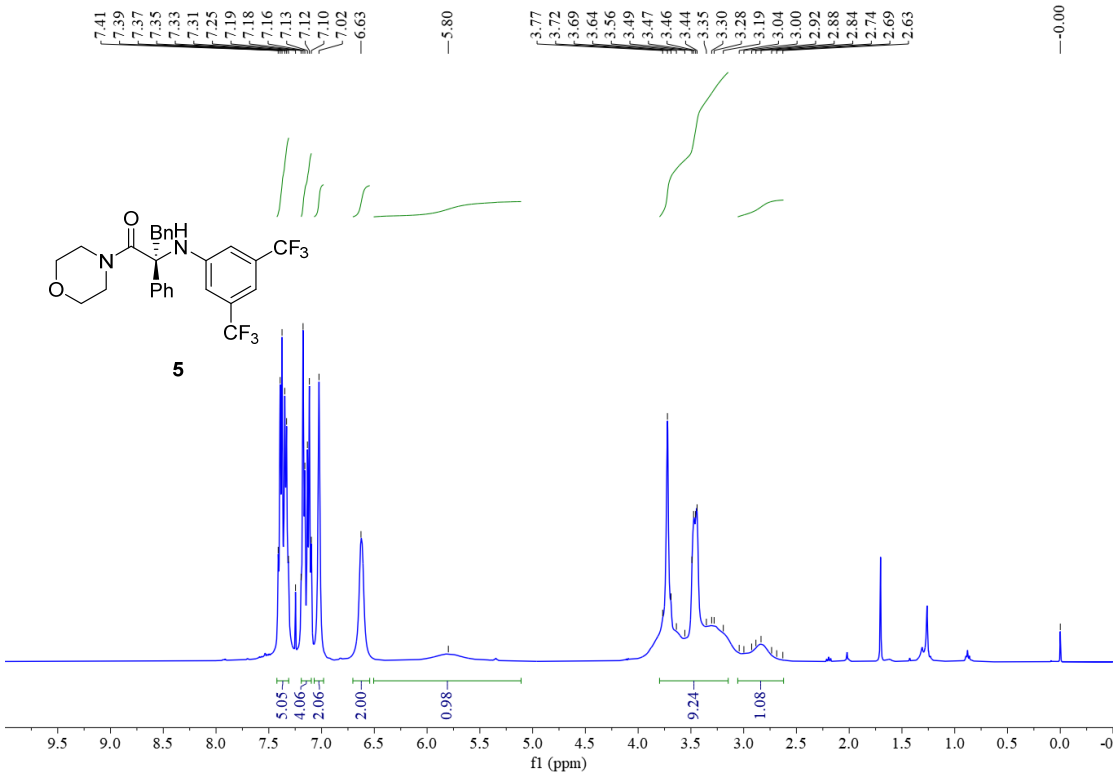
CF3
3
f1 (ppm)

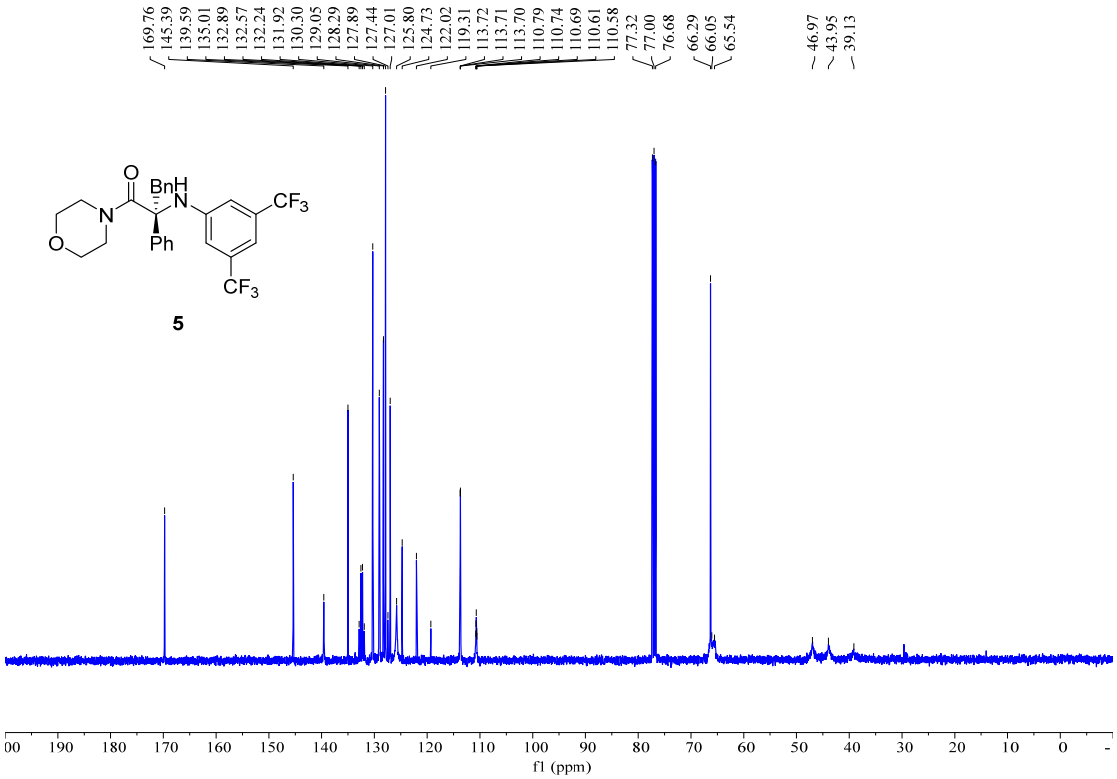

-63.33
O
Me
H
N
N
CF3
O
Ph
CF3
3
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

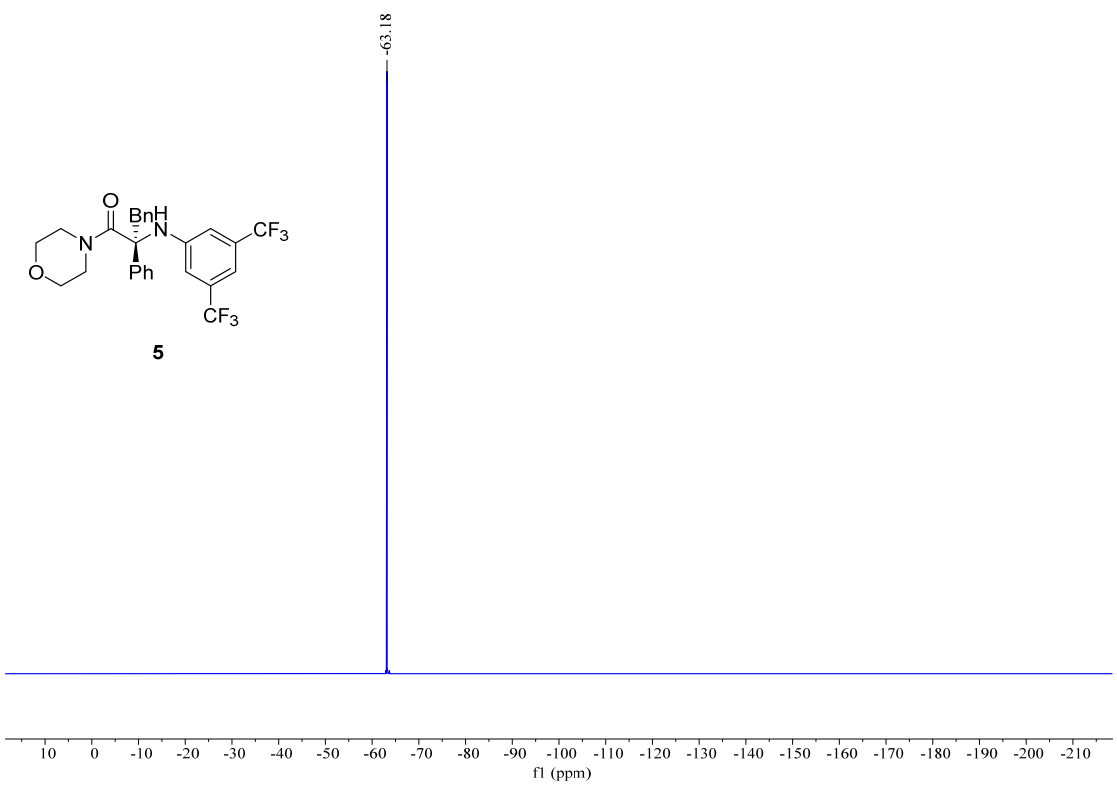

7.49 7.47 7.41 7.39 7.37 7.32 7.30 7.28 7.26 7.26 7.24 7.23 7.19 7.19 7.18 7.18 7.17 7.16 7.15 7.06 7.05 7.04 7.03 6.86 6.82
3.37 3.36 3.22 3.03 3.02 3.00 2.99 2.99 2.98 2.97 2.95 2.76 2.75 2.74 2.73 2.72 2.72 2.70 2.69 2.60 2.59 2.57 2.57 2.56 2.55 2.54 2.53 2.49 2.48 2.47 2.46 2.45 2.45 2.43 2.42
Ph
O
H
N
N
CF3
O
Ph
CF3
4
2.00 2.01 1.02 2.03 1.03 3.06 3.00
8.08 1.12 1.04 1.05 1.03
f1 (ppm)


170.08
144.95 140.86 140.31 132.40 132.07 131.75 131.42 129.21 128.55 128.36 128.27 127.48 126.68 126.27 124.77 122.06 119.35 113.51 113.49 113.47 110.03 110.00 109.96 109.92 109.89
77.32 77.00 76.68 66.09 65.40
45.65
33.29 30.34
Ph
O
H
N
N
CF3
O
Ph
CF3
4
f1 (ppm)

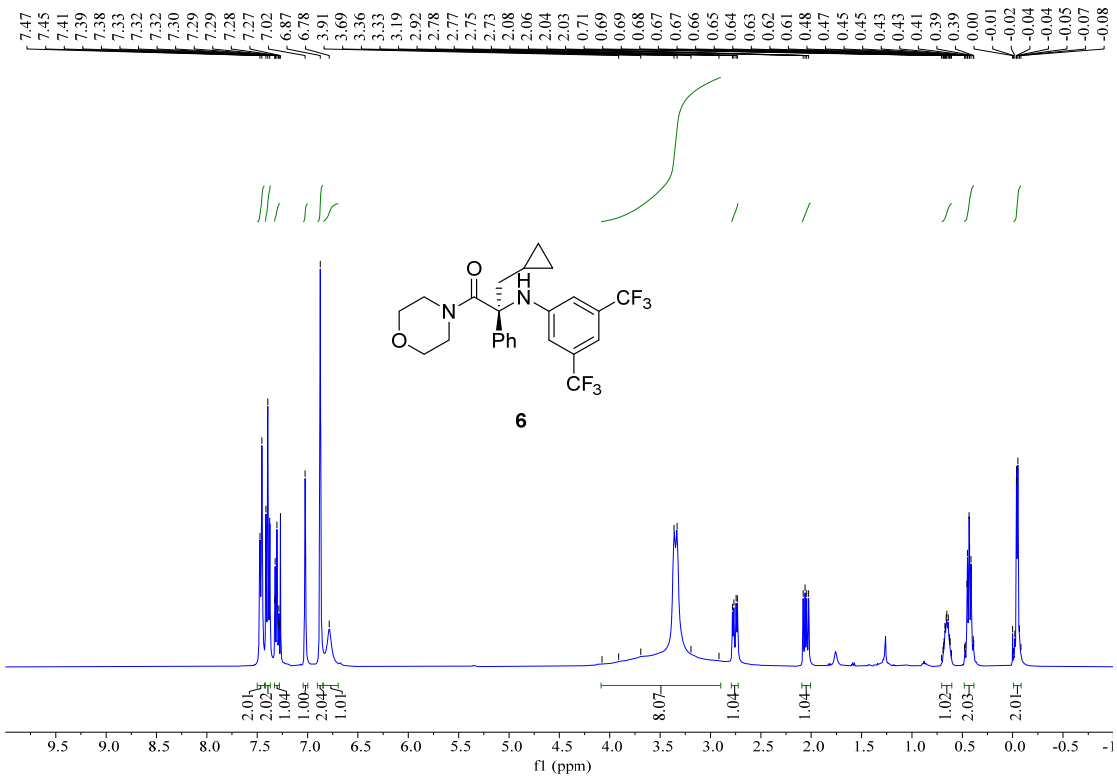

-63.29
Ph
O
H
N
CF3
N
O
Ph
CF3
4
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

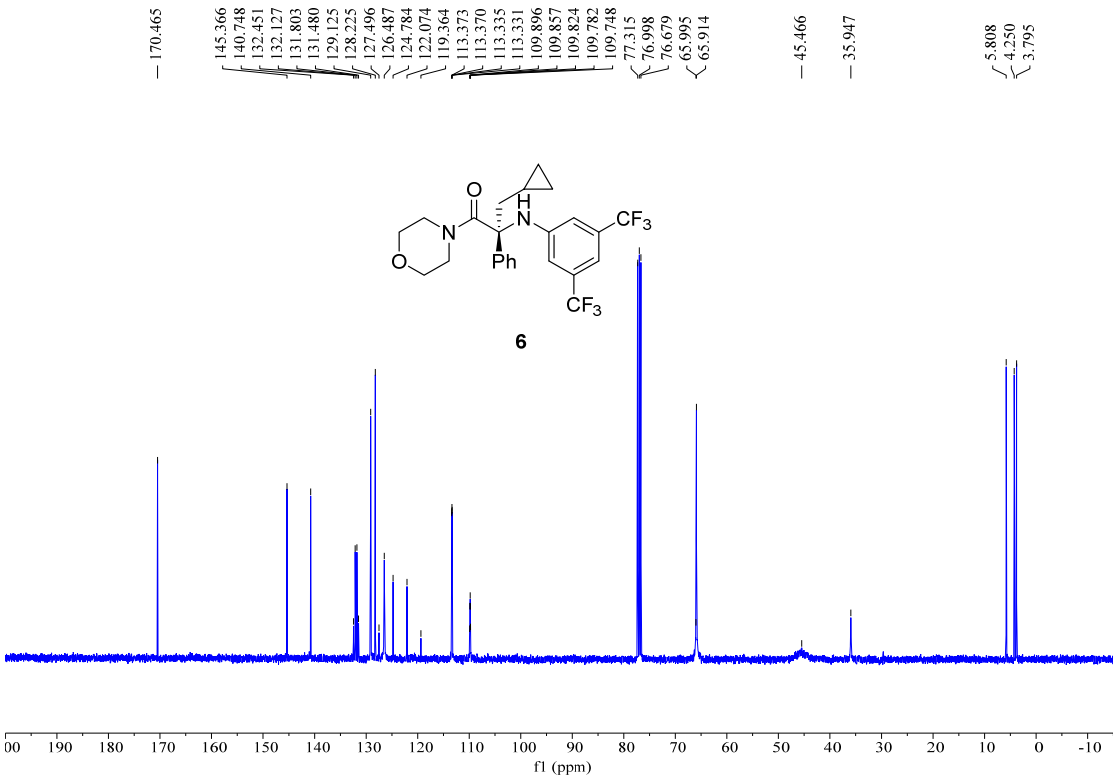

7.41
7.39
7.37
7.35
7.33
7.31
7.25
7.19
7.18
7.16
7.13
7.12
7.10
7.02
6.63
5.80
3.77
3.72
3.69
3.64
3.56
3.49
3.47
3.46
3.44
3.35
3.30
3.28
3.19
3.04
3.00
2.92
2.88
2.84
2.74
2.69
2.63
0.00
O
BnH
N
N
O
Ph
CF3
CF3
5
5.05
4.06
2.06
2.00
0.98
9.24
1.08
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0
f1 (ppm)

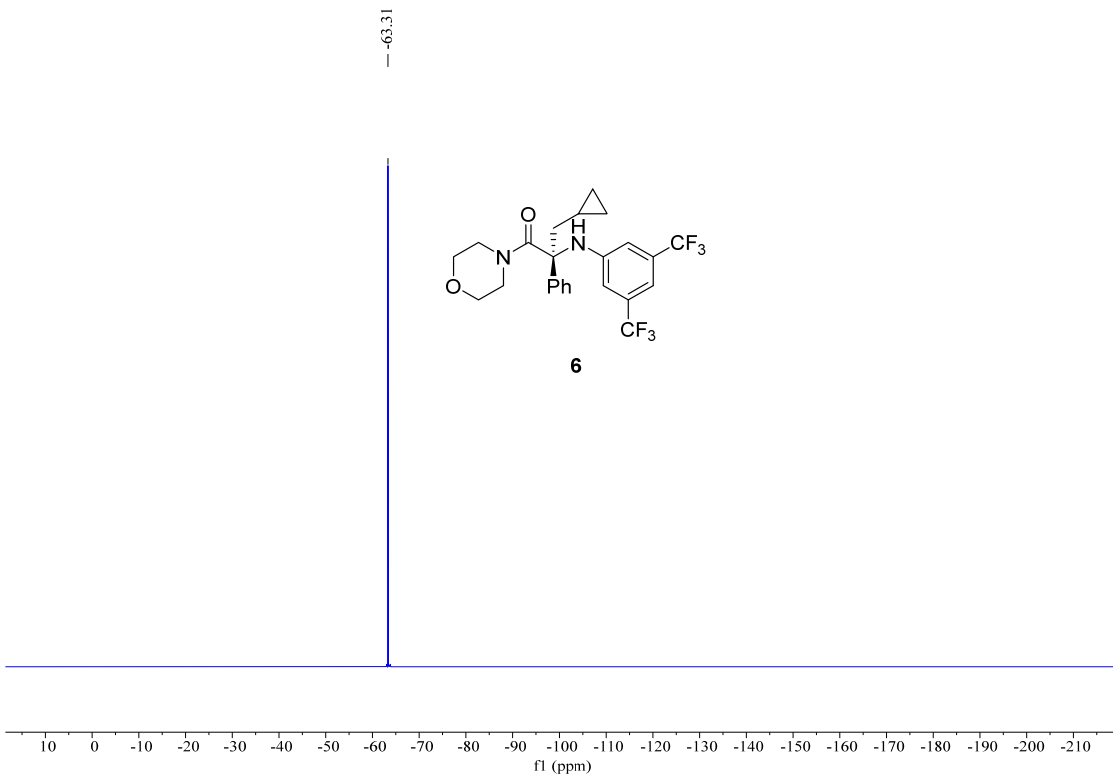

169.76
145.39
139.59
135.01
132.89
132.57
132.24
131.92
130.30
129.05
128.29
127.89
127.44
127.01
125.80
124.73
122.02
119.31
113.72
113.71
113.70
110.79
110.74
110.69
110.61
110.58
77.32
77.00
76.68
66.29
66.05
65.54
46.97
43.95
39.13
O
BnH
N
N
O
Ph
CF3
CF3
5
00 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -
f1 (ppm)


-63.18
O
BnH
N
N
O
Ph
CF3
CF3
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

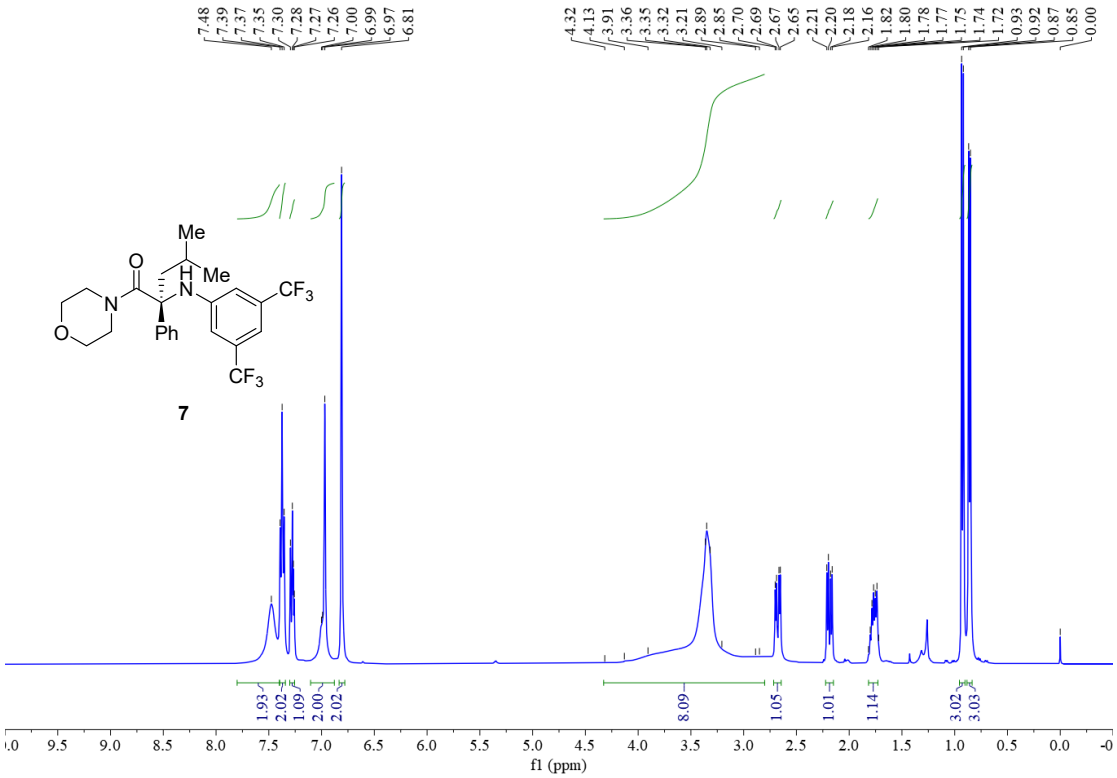
5

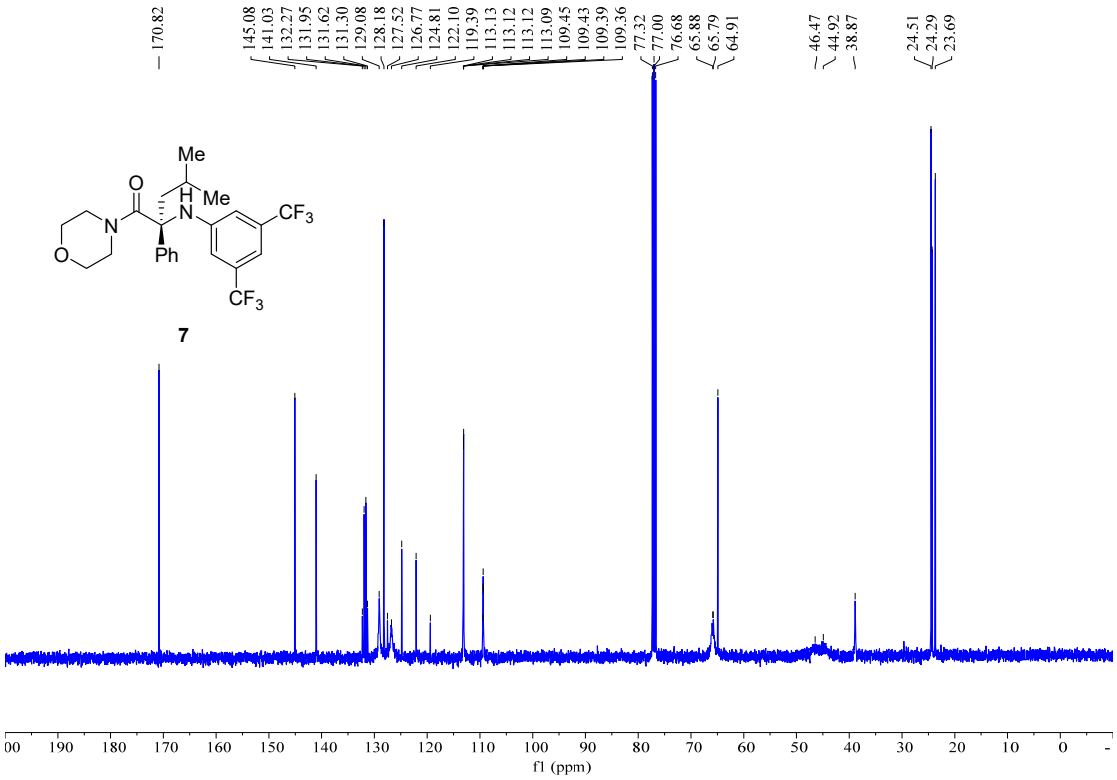

7.47 7.45 7.41 7.39 7.38 7.33 7.32 7.32 7.30 7.29 7.29 7.28 7.27 7.02 6.87 6.78 3.91 3.69 3.36 3.33 3.19 2.92 2.78 2.77 2.75 2.73 2.08 2.06 2.04 2.03 0.71 0.69 0.69 0.68 0.67 0.67 0.66 0.65 0.64 0.63 0.62 0.61 0.48 0.47 0.45 0.45 0.43 0.43 0.41 0.39 0.39 0.00 -0.01 -0.02 -0.04 -0.04 -0.05 -0.07 -0.08
O
N
O
H
N
Ph
CF3
CF3
6
2.01 2.02 1.04 1.00 2.04 1.01 8.07 1.04 1.04 1.02 2.03 2.01
f1 (ppm)

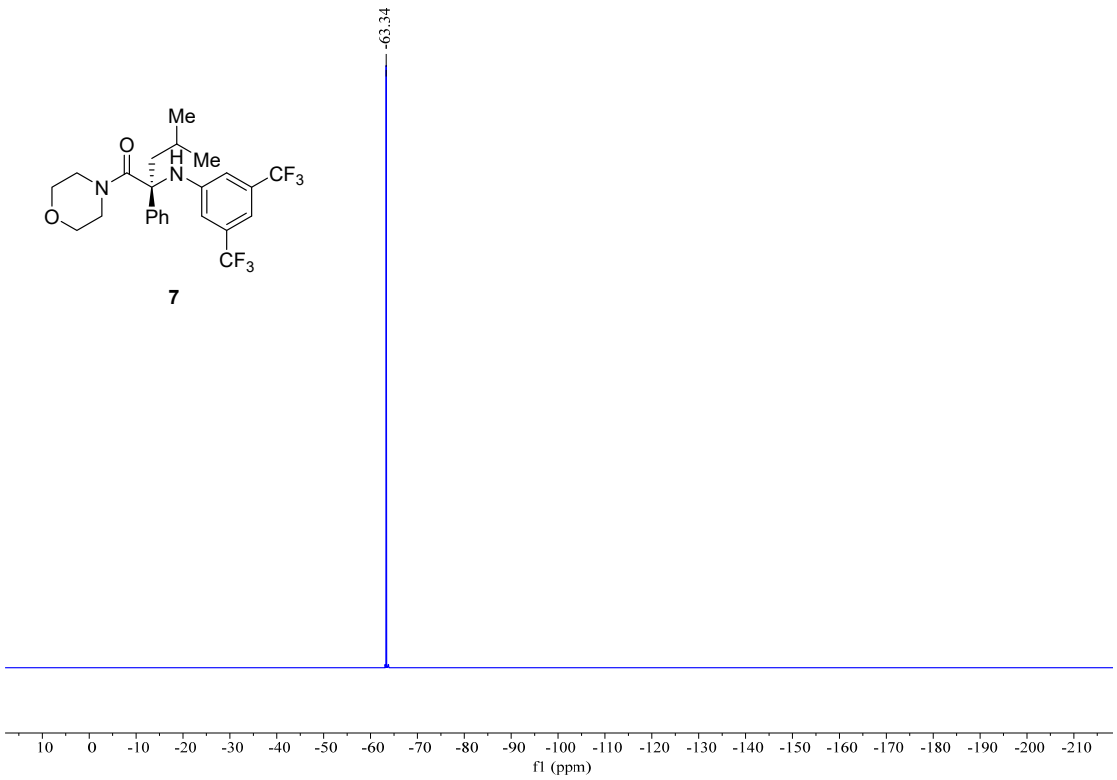

170.465
145.366 140.748 132.451 132.127 131.803 131.480 129.125 128.225 127.496 126.487 124.784 122.074 119.364 113.373 113.370 113.335 113.331 109.896 109.857 109.824 109.782 109.748 77.315 76.998 76.679 65.995 65.914
45.466
35.947
5.808 4.250 3.795
O
N
O
H
N
Ph
CF3
CF3
6
f1 (ppm)


-63.31
O
N
O
H
N
Ph
CF3
CF3
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

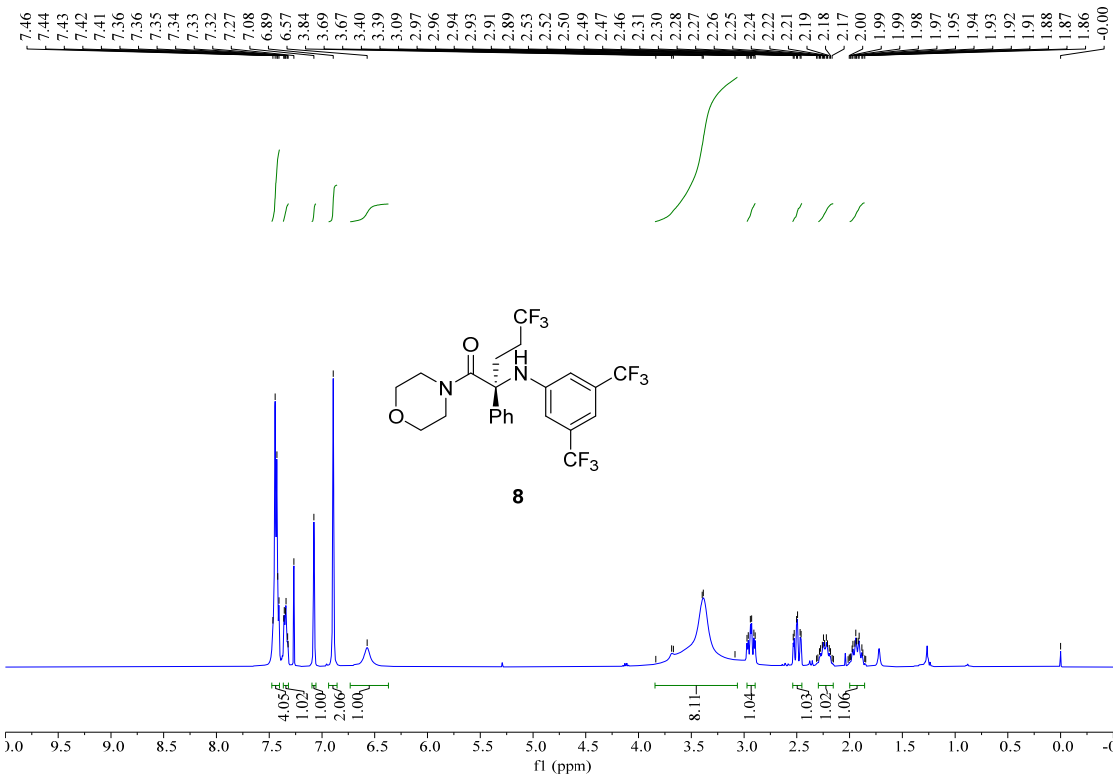
6

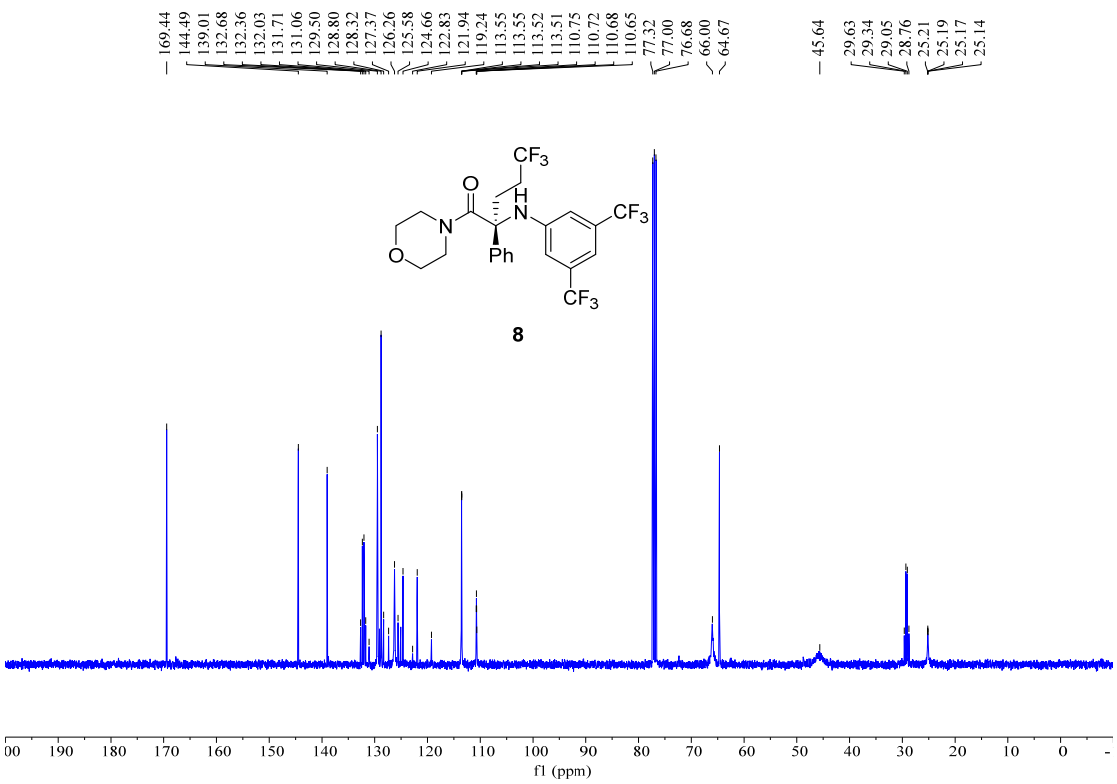

7.48
7.39
7.37
7.35
7.30
7.28
7.27
7.26
7.00
6.99
6.97
6.81
4.32
4.13
3.91
3.36
3.35
3.32
3.21
2.89
2.85
2.70
2.69
2.67
2.65
2.21
2.20
2.18
2.16
1.82
1.80
1.78
1.77
1.75
1.74
1.72
0.93
0.92
0.87
0.85
0.00
Me
O
H
Me
N
CF3
N
O
Ph
CF3
7
1.93
2.02
1.09
2.00
2.02
8.09
1.05
1.01
1.14
3.02
3.03
f1 (ppm)

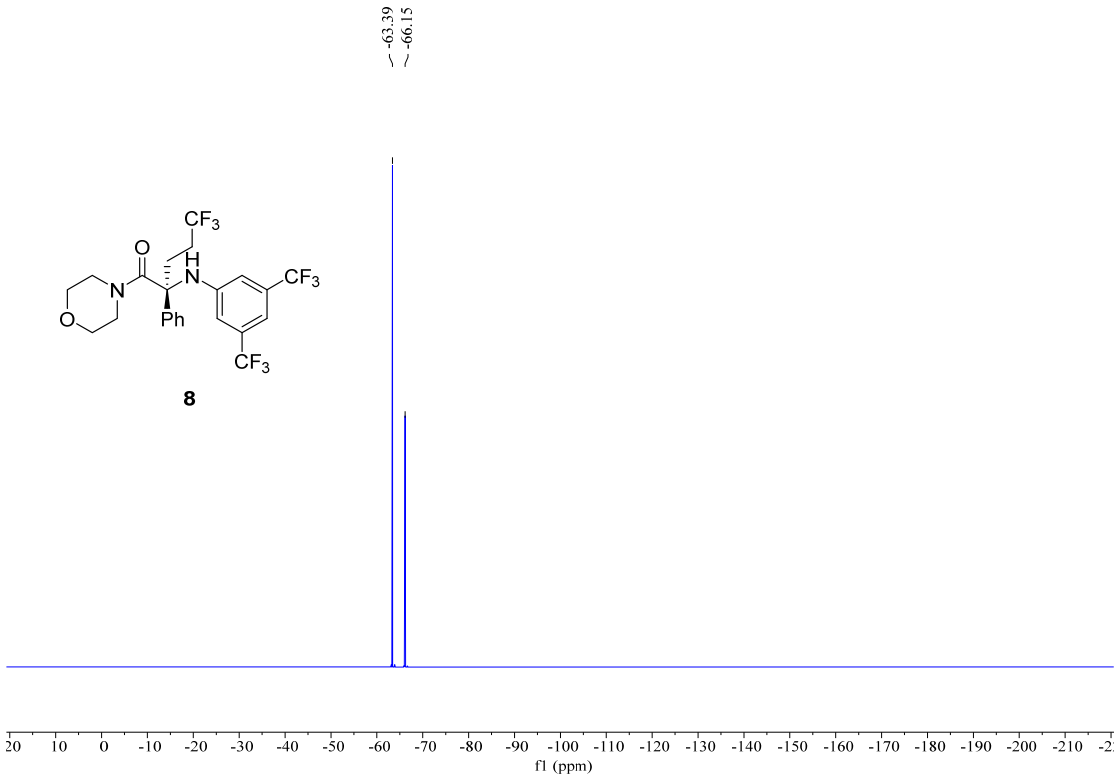

170.82
145.08
141.03
132.27
131.95
131.62
131.30
129.08
128.18
127.52
126.77
124.81
122.10
119.39
113.13
113.12
113.12
113.09
109.45
109.43
109.39
109.36
77.32
77.00
76.68
65.88
65.79
64.91
46.47
44.92
38.87
24.51
24.29
23.69
Me
O
H
Me
N
CF3
N
O
Ph
CF3
7
f1 (ppm)

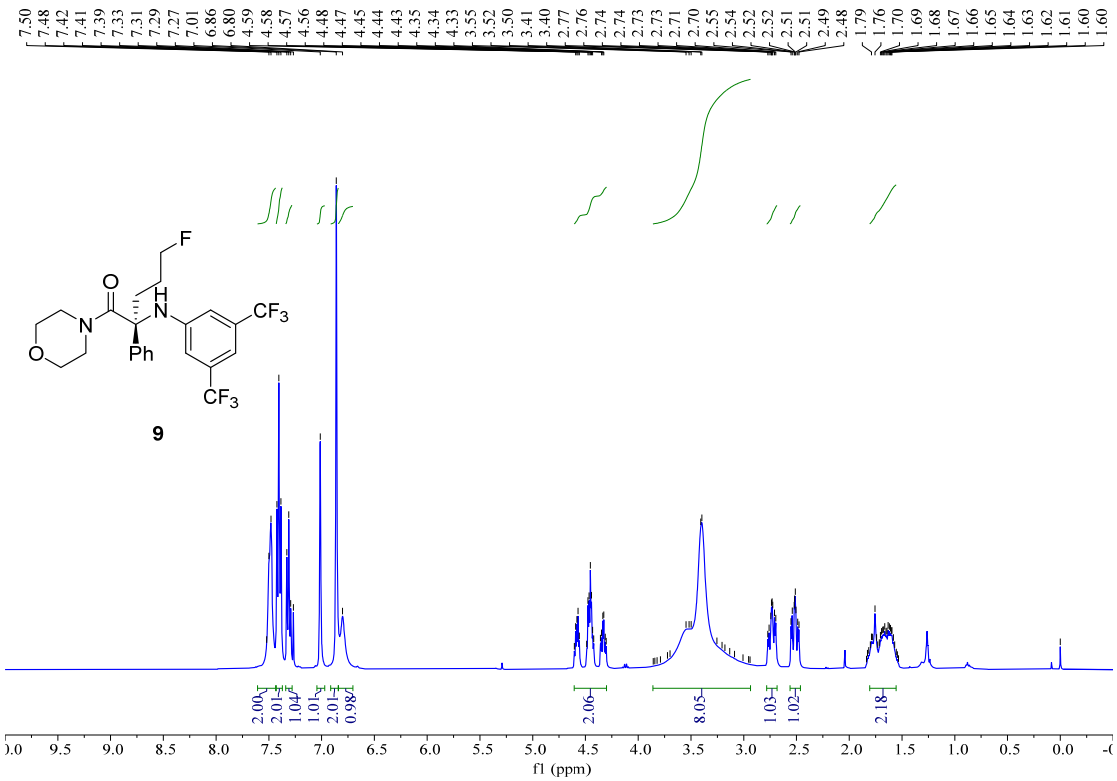

-63.34
Me
O
H
N
Me
CF3
N
O
Ph
CF3
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

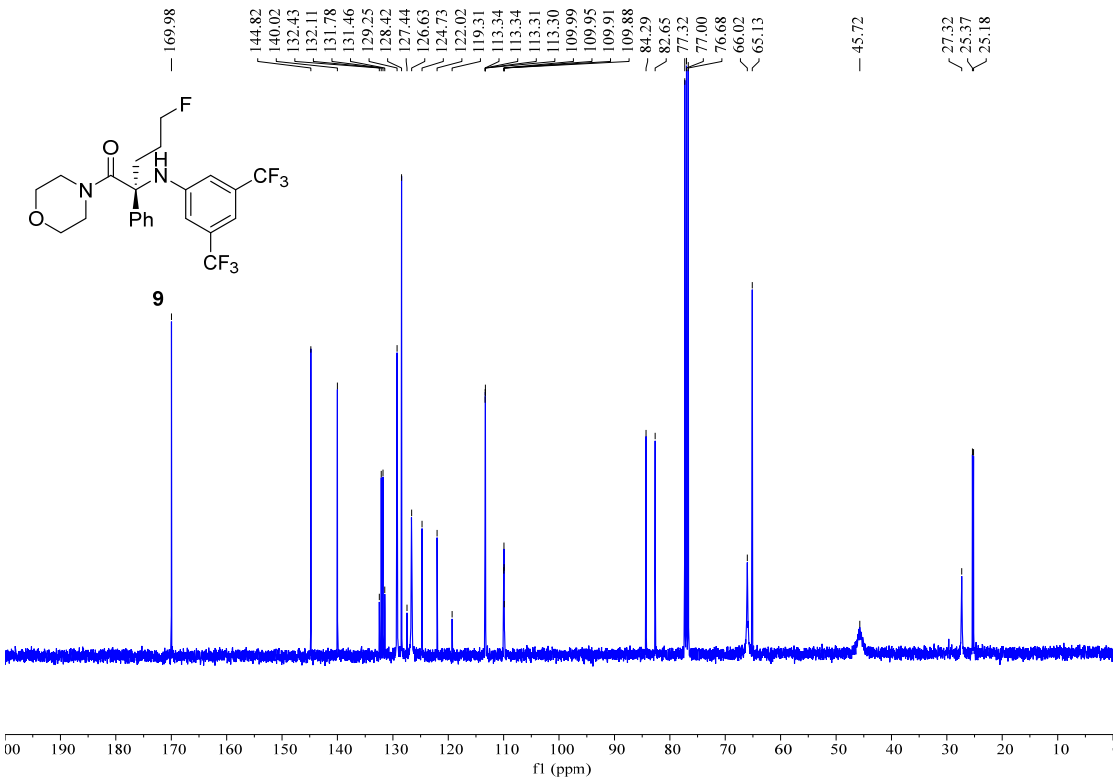
7

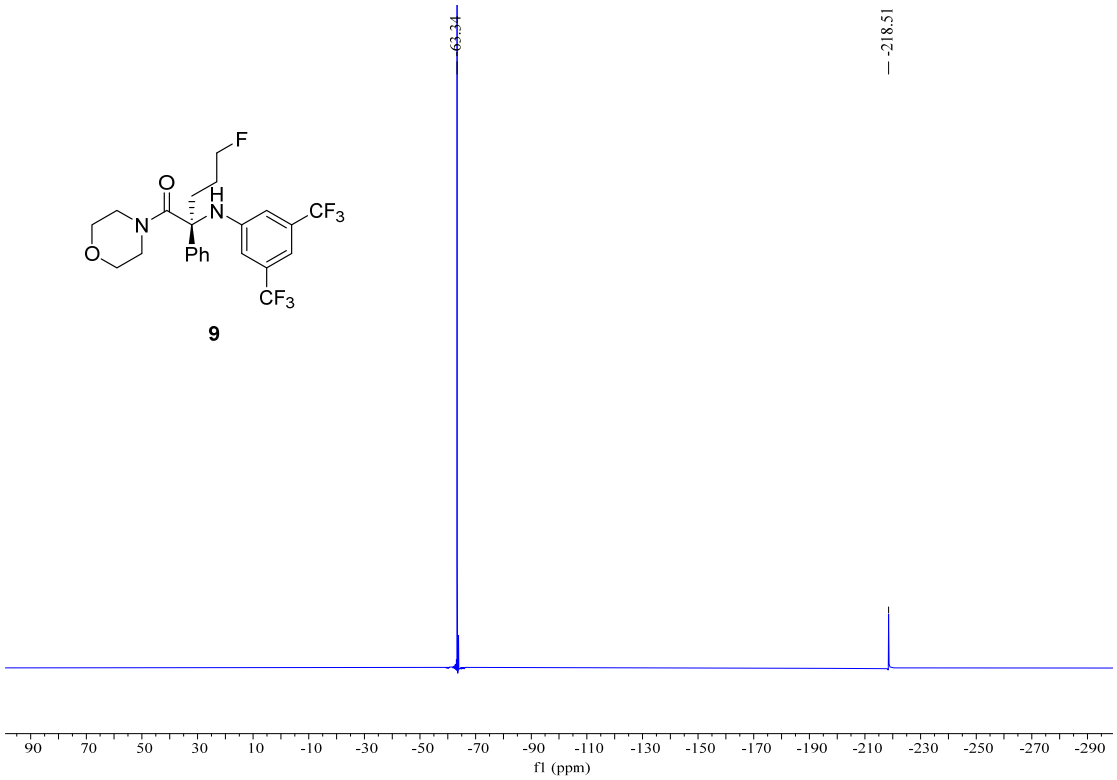

7.46 7.44 7.43 7.42 7.41 7.36 7.36 7.35 7.34 7.33 7.32 7.27 7.08 6.89 6.57 3.84 3.69 3.67 3.40 3.39 3.09 2.97 2.96 2.94 2.93 2.91 2.89 2.53 2.52 2.50 2.49 2.47 2.46 2.31 2.30 2.28 2.27 2.26 2.25 2.24 2.22 2.21 2.19 2.18 2.17 2.00 1.99 1.99 1.98 1.97 1.95 1.94 1.93 1.92 1.91 1.88 1.87 1.86 -0.00
CF3
O
H
N
CF3
N
O
Ph
CF3
8
4.05 1.02 1.00 2.06 1.00 8.11 1.04 1.03 1.02 1.06
f1 (ppm)


169.44 144.49 139.01 132.68 132.36 132.03 131.71 131.06 129.50 128.80 128.32 127.37 126.26 125.58 124.66 122.83 121.94 119.24 113.55 113.55 113.52 113.51 110.75 110.72 110.68 110.65 77.32 77.00 76.68 66.00 64.67 45.64 29.63 29.34 29.05 28.76 25.21 25.19 25.17 25.14
CF3
O
H
N
CF3
N
O
Ph
CF3
8
f1 (ppm)

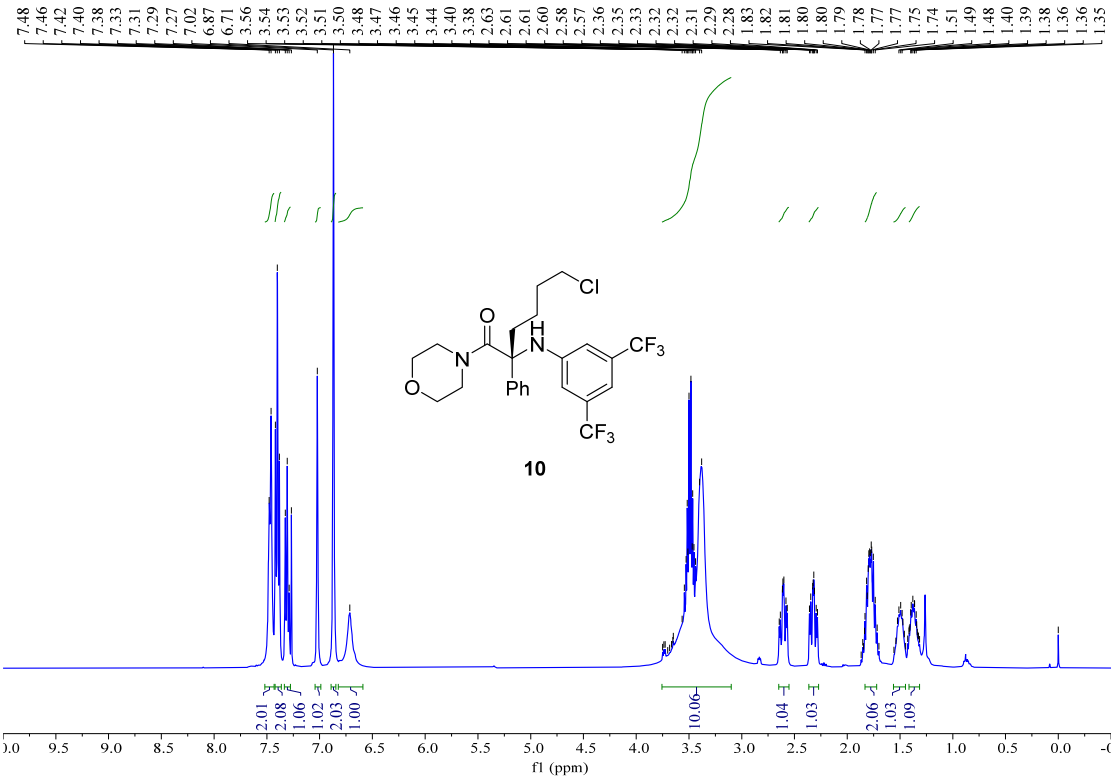

-63.39
-66.15
CF3
O
H
N
CF3
N
O
Ph
CF3
8
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

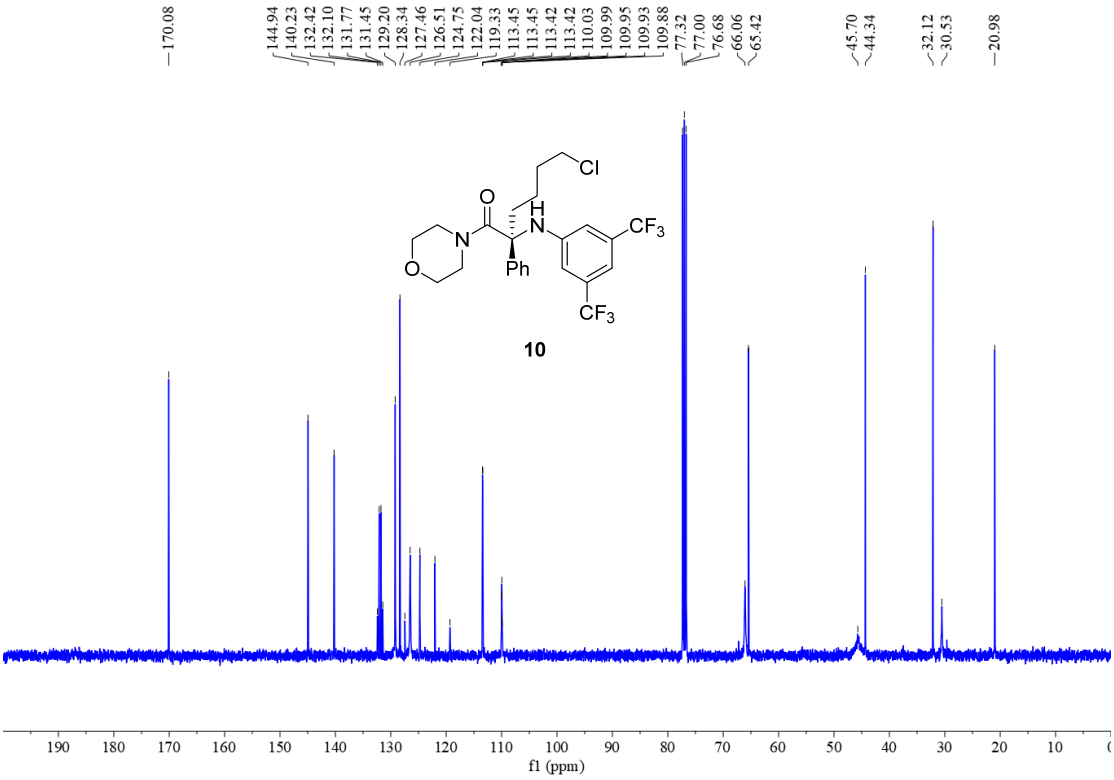

7.50 7.48 7.42 7.41 7.39 7.33 7.31 7.29 7.27 7.01 6.86 6.80 4.59 4.58 4.57 4.56 4.48 4.47 4.45 4.44 4.43 4.35 4.34 4.33 3.55 3.52 3.50 3.41 3.40 2.77 2.76 2.74 2.74 2.73 2.73 2.71 2.70 2.55 2.54 2.52 2.52 2.51 2.51 2.49 2.48 1.79 1.76 1.70 1.69 1.68 1.67 1.66 1.65 1.64 1.63 1.62 1.61 1.60 1.60
F
O
N
H
N
Ph
CF3
CF3
9
2.00 2.01 1.04 1.01 2.01 0.98 2.06 8.05 1.03 1.02 2.18
f1 (ppm)

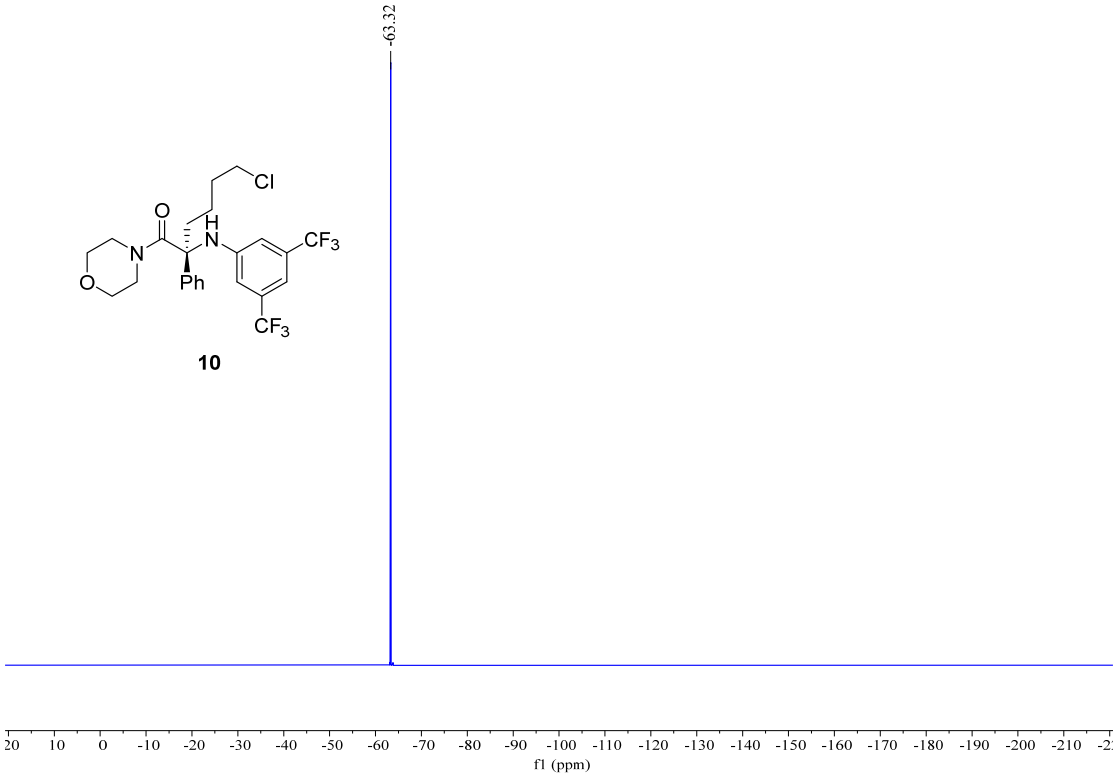

169.98
144.82 140.02 132.43 132.11 131.78 131.46 129.25 128.42 127.44 126.63 124.73 122.02 119.31 113.34 113.34 113.31 113.30 109.99 109.95 109.91 109.88
84.29 82.65 77.32 77.00 76.68 66.02 65.13
45.72
27.32 25.37 25.18
F
O
N
H
N
Ph
CF3
CF3
9
f1 (ppm)

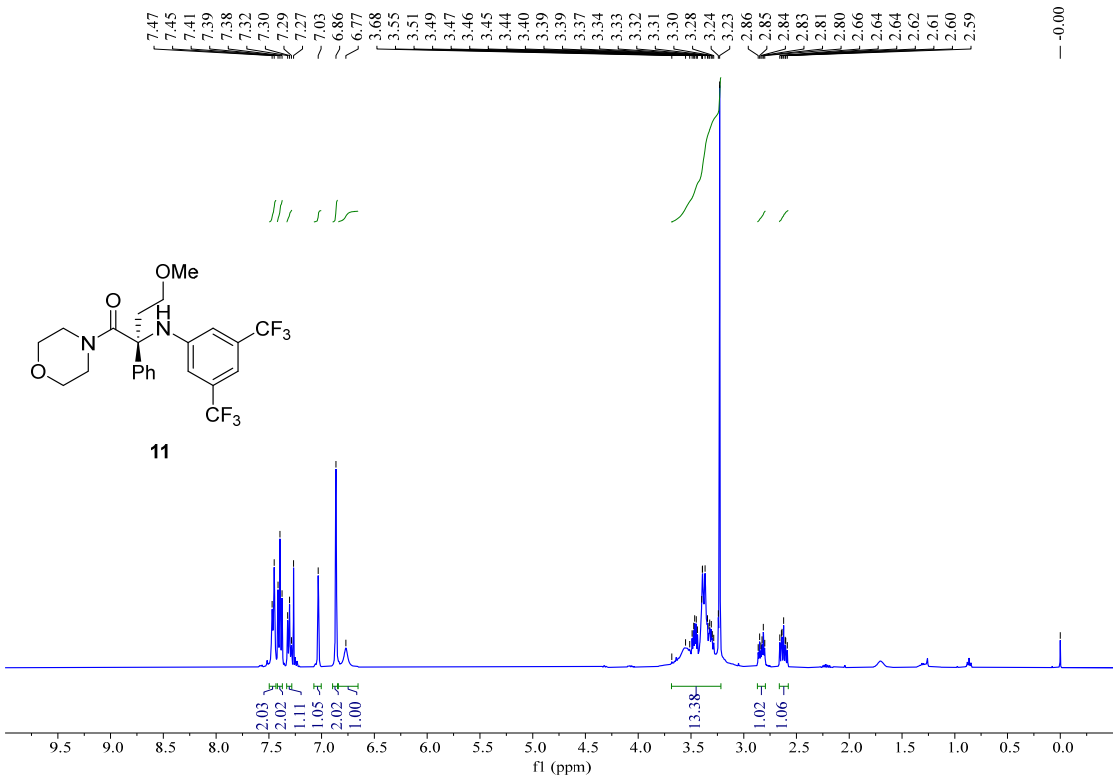

63.34
-218.51
F
O
H
N
CF3
N
O
Ph
CF3
90 70 50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230 -250 -270 -290
f1 (ppm)

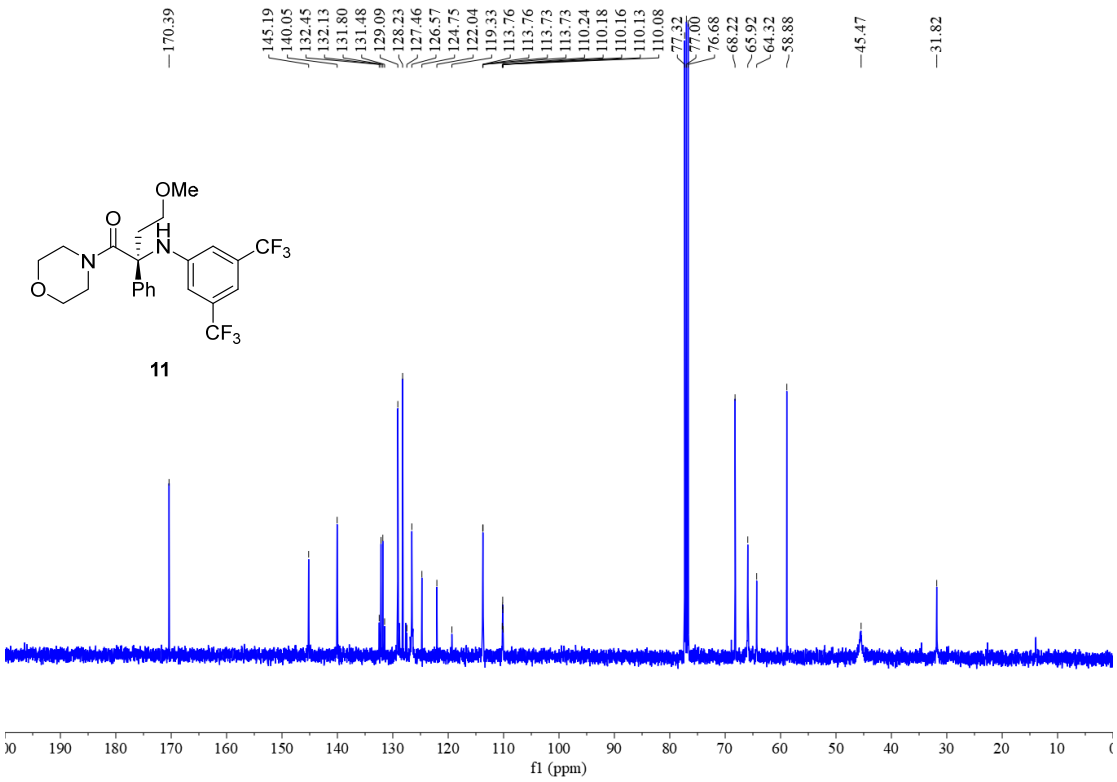
9

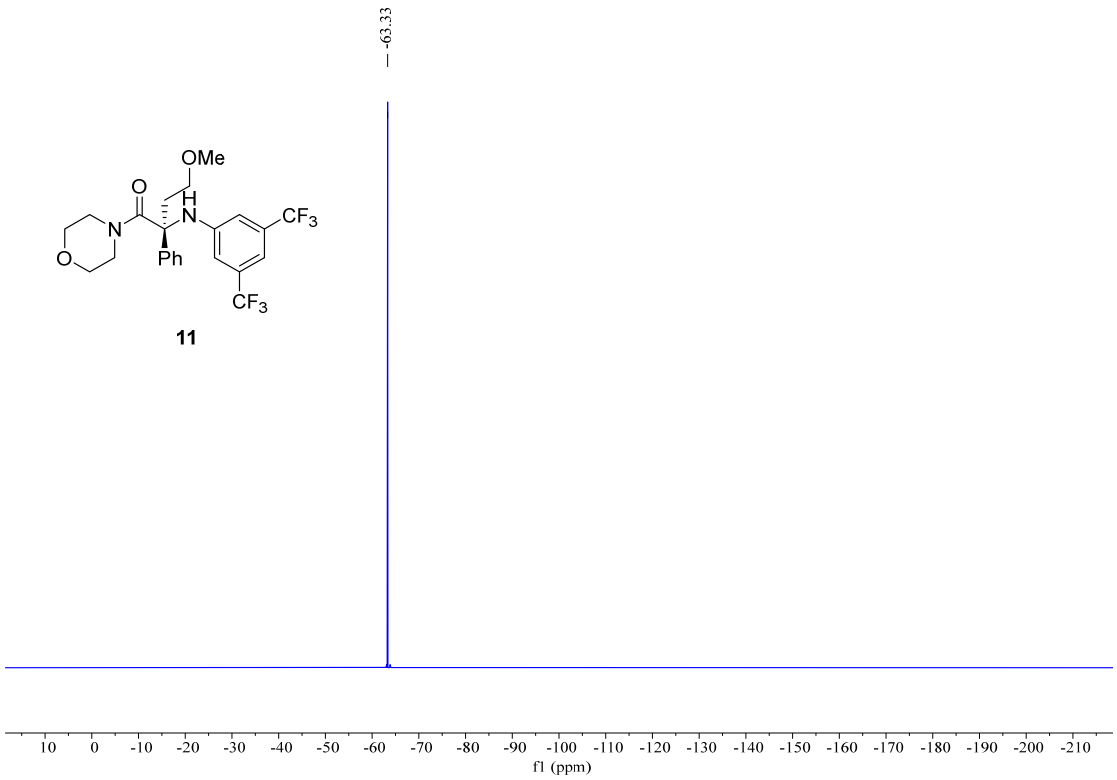

7.48 7.46 7.42 7.40 7.38 7.33 7.31 7.29 7.27 7.02 6.87 6.71 3.56 3.54 3.53 3.52 3.51 3.50 3.48 3.47 3.46 3.45 3.44 3.40 3.38 2.63 2.61 2.61 2.60 2.58 2.57 2.36 2.35 2.33 2.32 2.32 2.31 2.29 2.28 1.83 1.82 1.81 1.80 1.80 1.79 1.78 1.77 1.77 1.75 1.74 1.51 1.49 1.48 1.40 1.39 1.38 1.36 1.36 1.35
Cl
O
H
N
N
O
Ph
CF3
CF3
10
2.01 2.08 1.06 1.02 2.03 1.00 10.06 1.04 1.03 2.06 1.03 1.09
f1 (ppm)

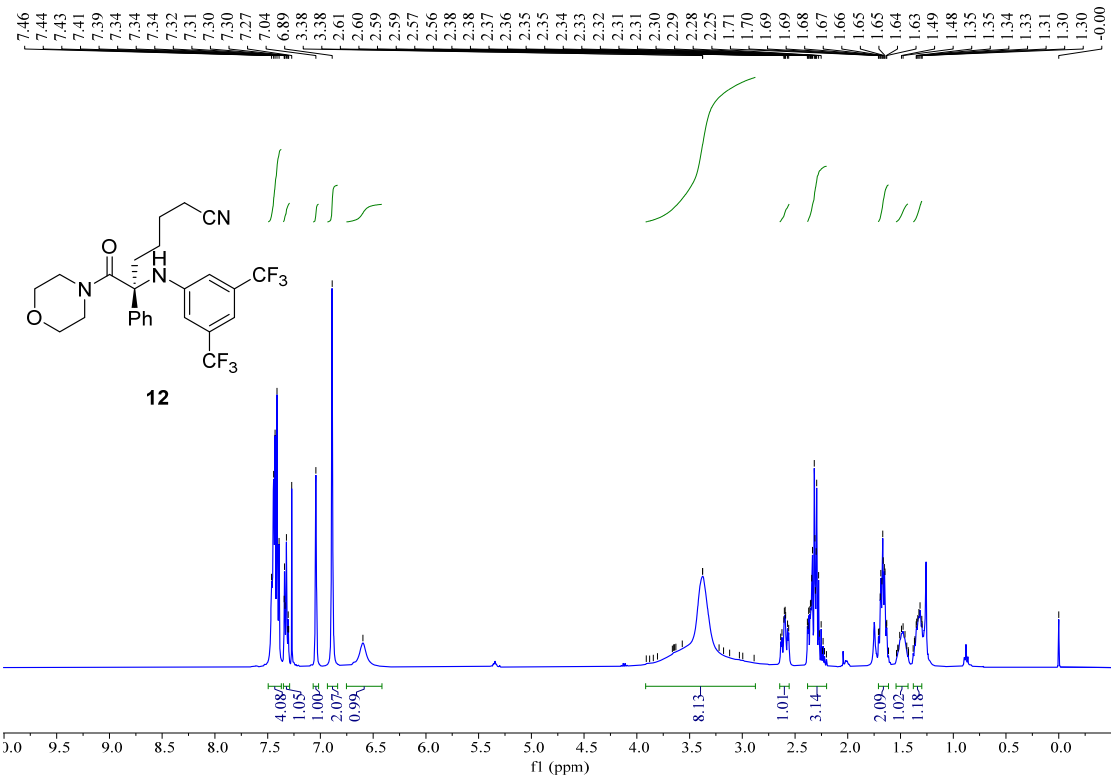

170.08
144.94 140.23 132.42 132.10 131.77 131.45 129.20 128.34 127.46 126.51 124.75 122.04 119.33 113.45 113.45 113.42 113.42 110.03 109.99 109.95 109.93 109.88 77.32 77.00 76.68 66.06 65.42
45.70 44.34
32.12 30.53
20.98
Cl
O
H
N
N
O
Ph
CF3
CF3
10
f1 (ppm)

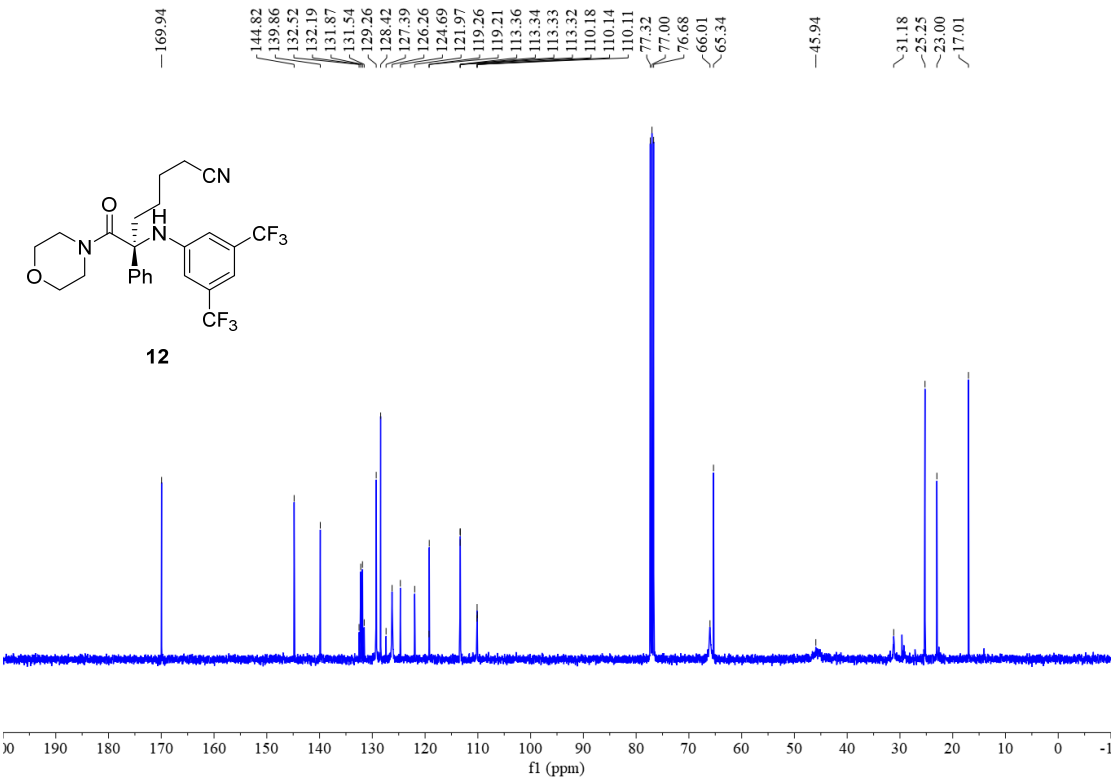

-63.32
Cl
O
H
N
N
CF3
O
Ph
CF3
10
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

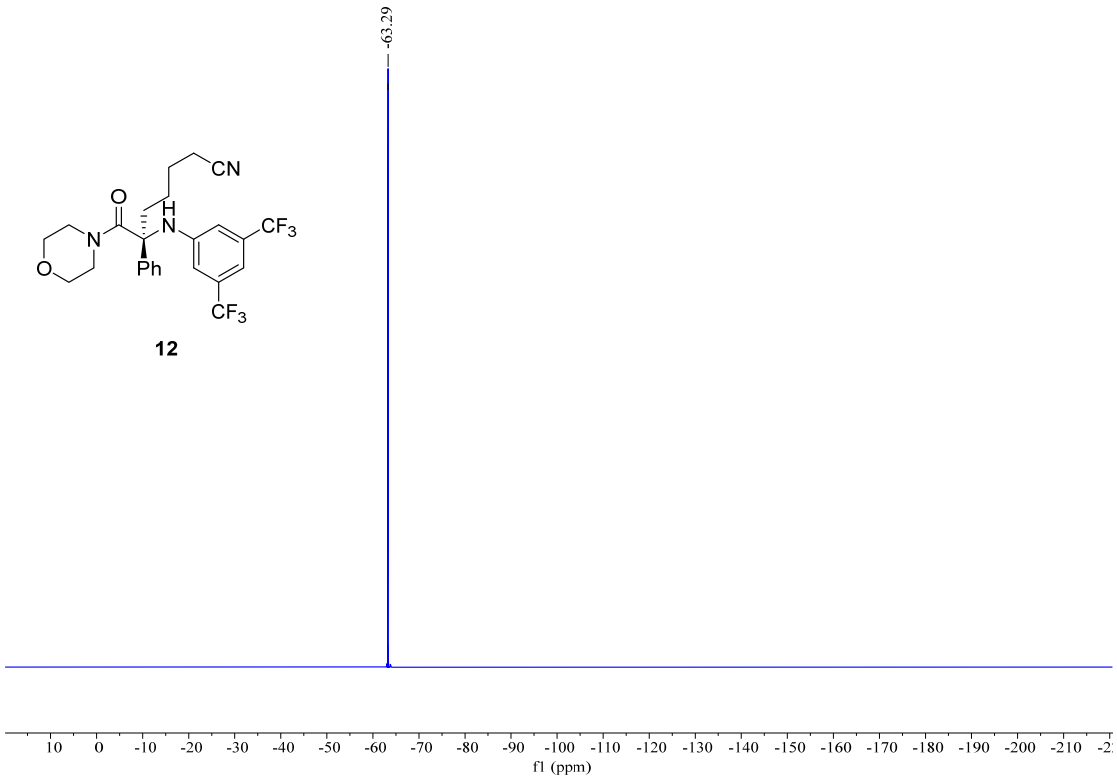

7.47
7.45
7.41
7.39
7.38
7.32
7.30
7.29
7.27
7.03
6.86
6.77
3.68
3.55
3.51
3.49
3.47
3.46
3.45
3.44
3.40
3.39
3.39
3.37
3.34
3.33
3.32
3.31
3.30
3.28
3.24
3.23
2.86
2.85
2.84
2.83
2.81
2.80
2.66
2.64
2.64
2.62
2.61
2.60
2.59
-0.00
OMe
O
H
N
N
O
Ph
CF3
CF3
11
2.03
2.02
1.11
1.05
2.02
1.00
13.38
1.02
1.06
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


170.39
145.19
140.05
132.45
132.13
131.80
131.48
129.09
128.23
127.46
126.57
124.75
122.04
119.33
113.76
113.76
113.73
113.73
110.24
110.18
110.16
110.13
110.08
77.32
77.00
76.68
68.22
65.92
64.32
58.88
45.47
31.82
OMe
O
H
N
N
O
Ph
CF3
CF3
11
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

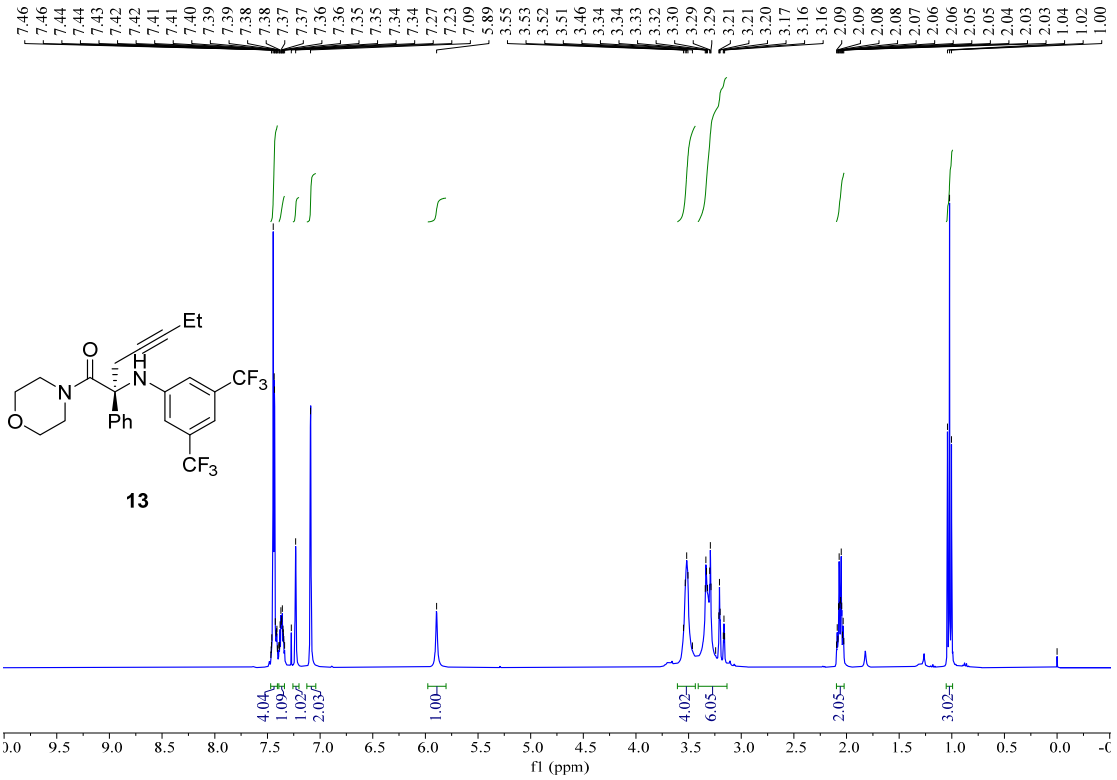

-63.33
OMe
O
H
N
CF3
N
O
Ph
CF3
11
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

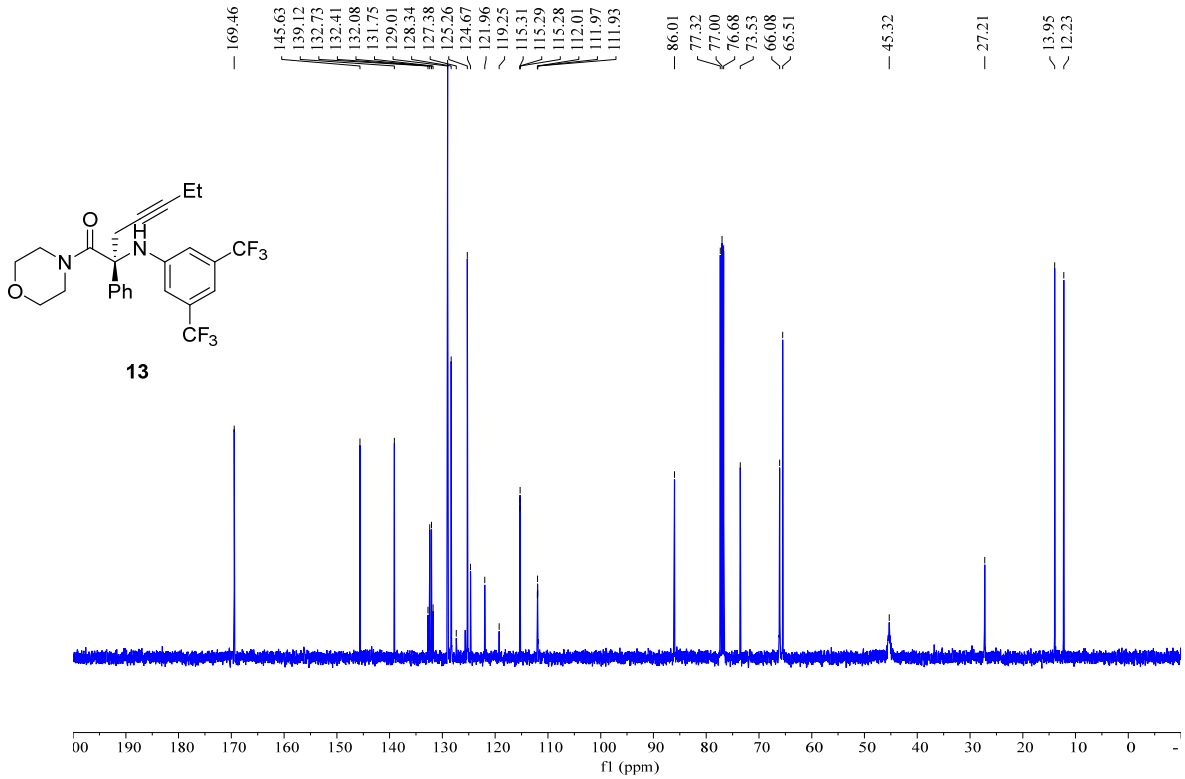

7.46 7.44 7.43 7.41 7.39 7.34 7.34 7.34 7.32 7.31 7.30 7.30 7.27 7.04 6.89 3.38 3.38 2.61 2.60 2.59 2.59 2.57 2.56 2.38 2.38 2.37 2.36 2.35 2.35 2.34 2.33 2.32 2.31 2.31 2.30 2.29 2.28 2.25 1.71 1.70 1.69 1.69 1.68 1.67 1.66 1.65 1.65 1.64 1.63 1.49 1.48 1.35 1.35 1.34 1.33 1.31 1.30 1.30 -0.00
CN
O
H
N
N
O
Ph
CF3
CF3
12
4.08
1.05
1.00
2.07
0.99
8.13
1.01
3.14
2.09
1.02
1.18
f1 (ppm)

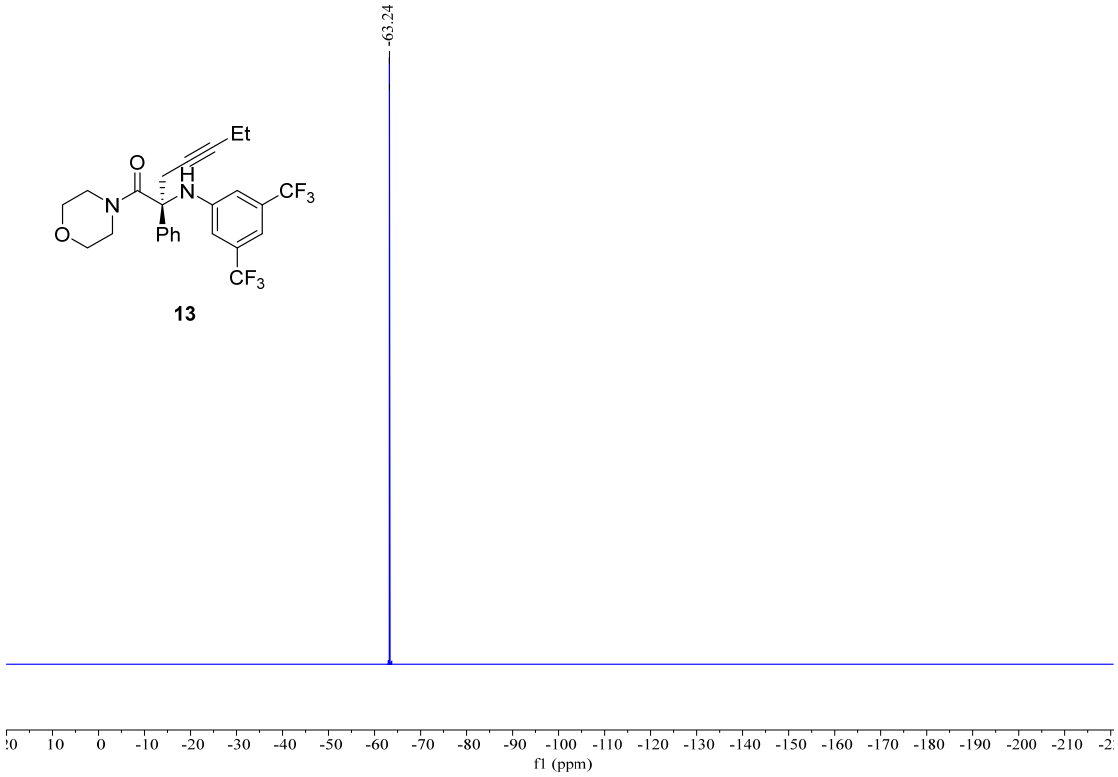

169.94
144.82 139.86 132.52 132.19 131.87 131.54 129.26 128.42 127.39 126.26 124.69 121.97 119.26 119.21 113.36 113.34 113.33 113.32 110.18 110.14 110.11 77.32 77.00 76.68 66.01 65.34
45.94
31.18 25.25 23.00 17.01
CN
O
H
N
N
O
Ph
CF3
CF3
12
f1 (ppm)

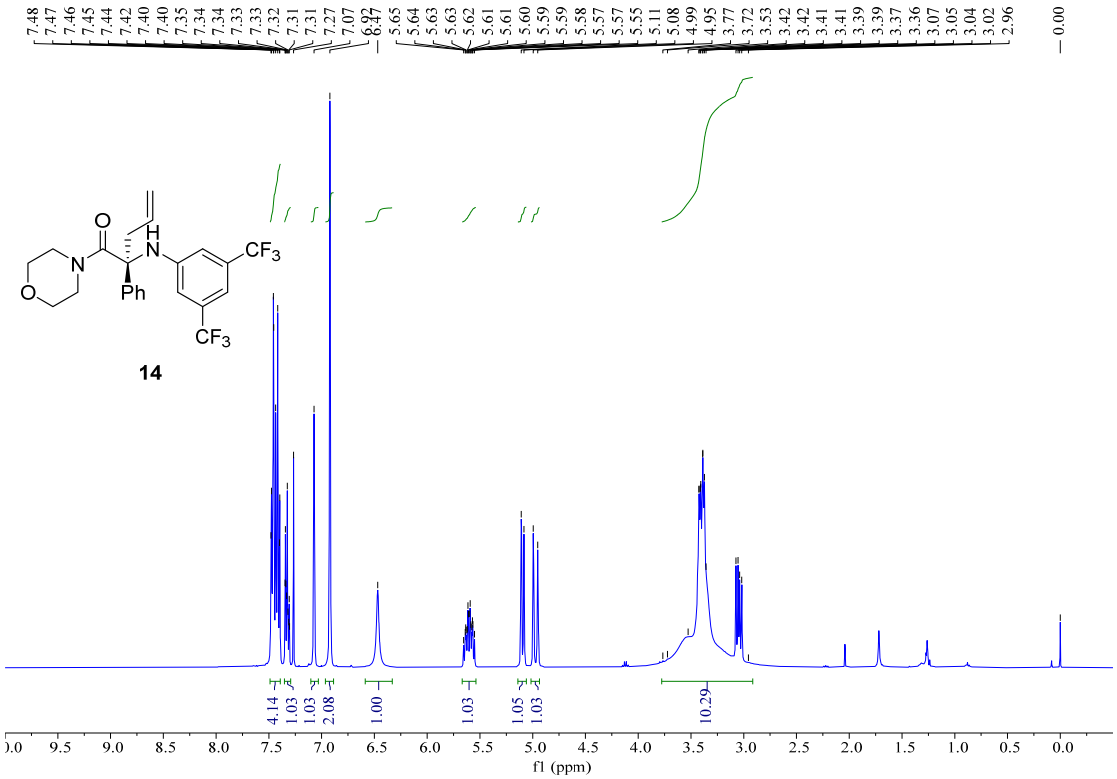

-63.29
CN
O
H
N
CF3
N
O
Ph
CF3
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

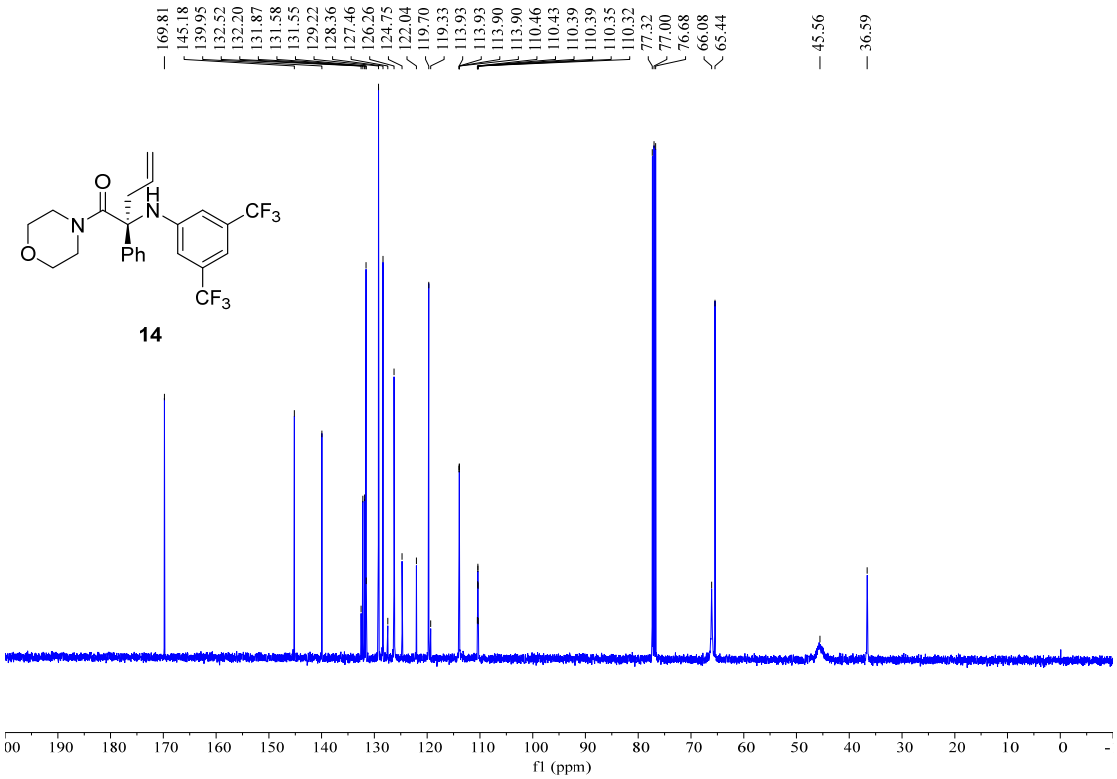
12

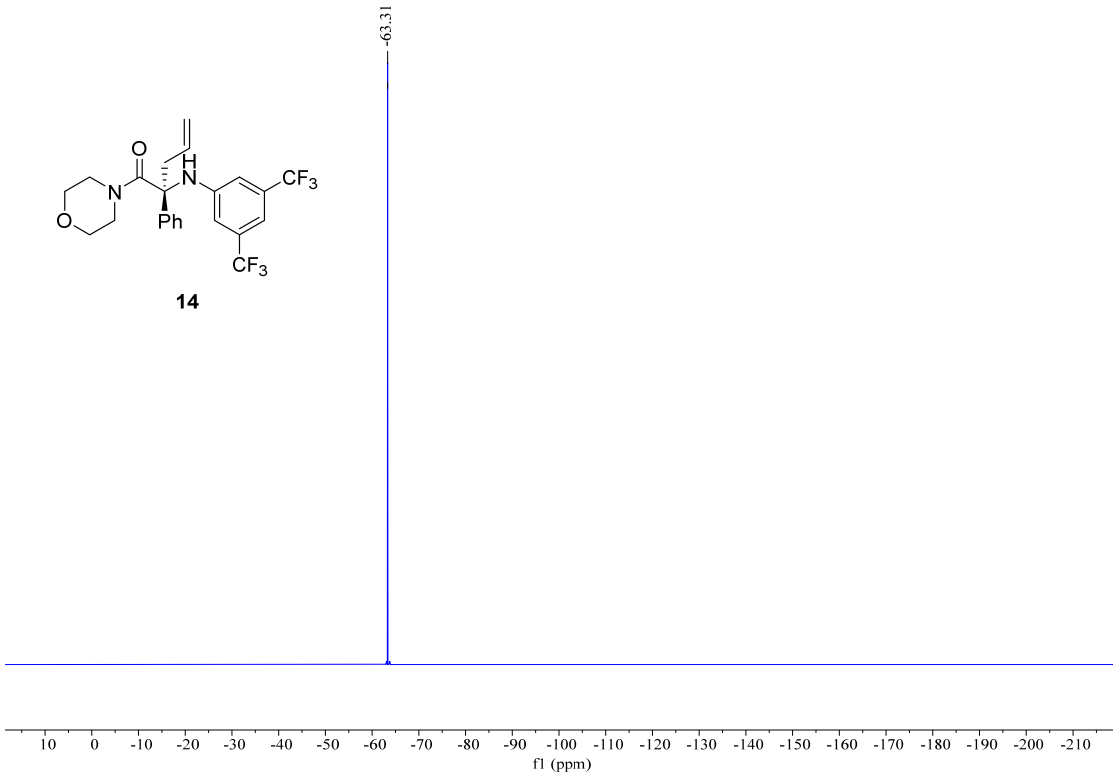

Et
O
H
N
N
O
Ph
CF3
CF3
13
f1 (ppm)


Et
O
H
N
N
O
Ph
CF3
CF3
13
f1 (ppm)

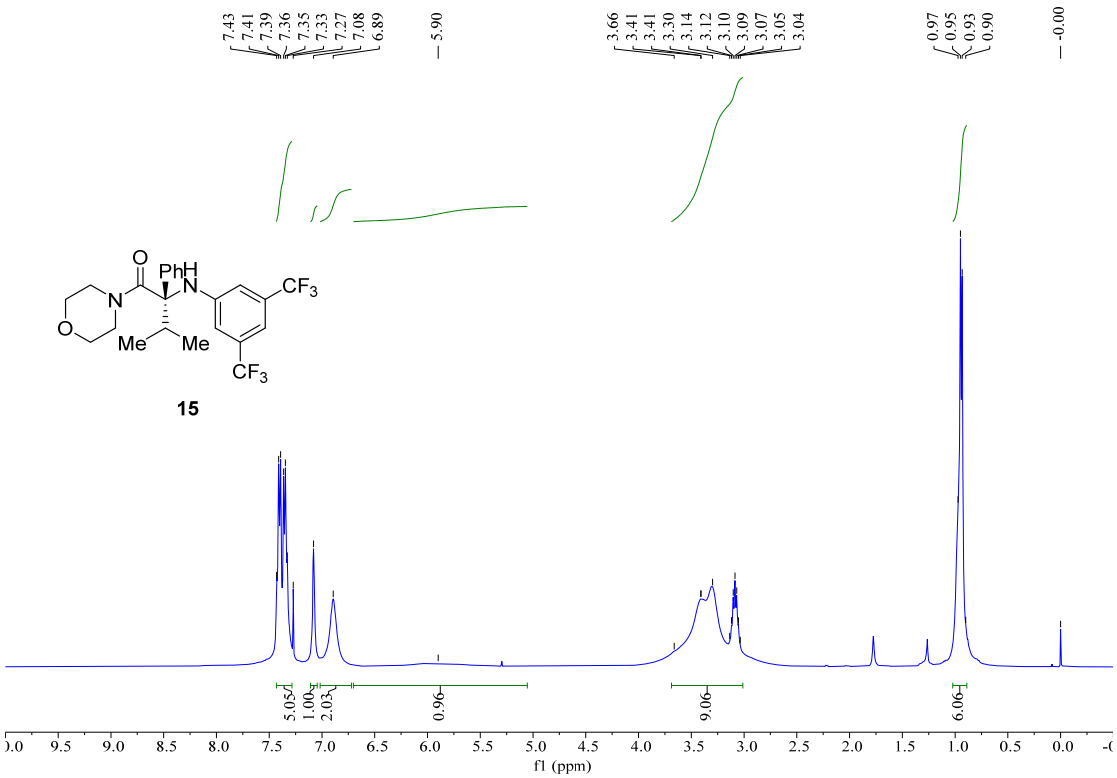

-63.24
Et
O
H
N
N
O
Ph
CF3
CF3
13
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

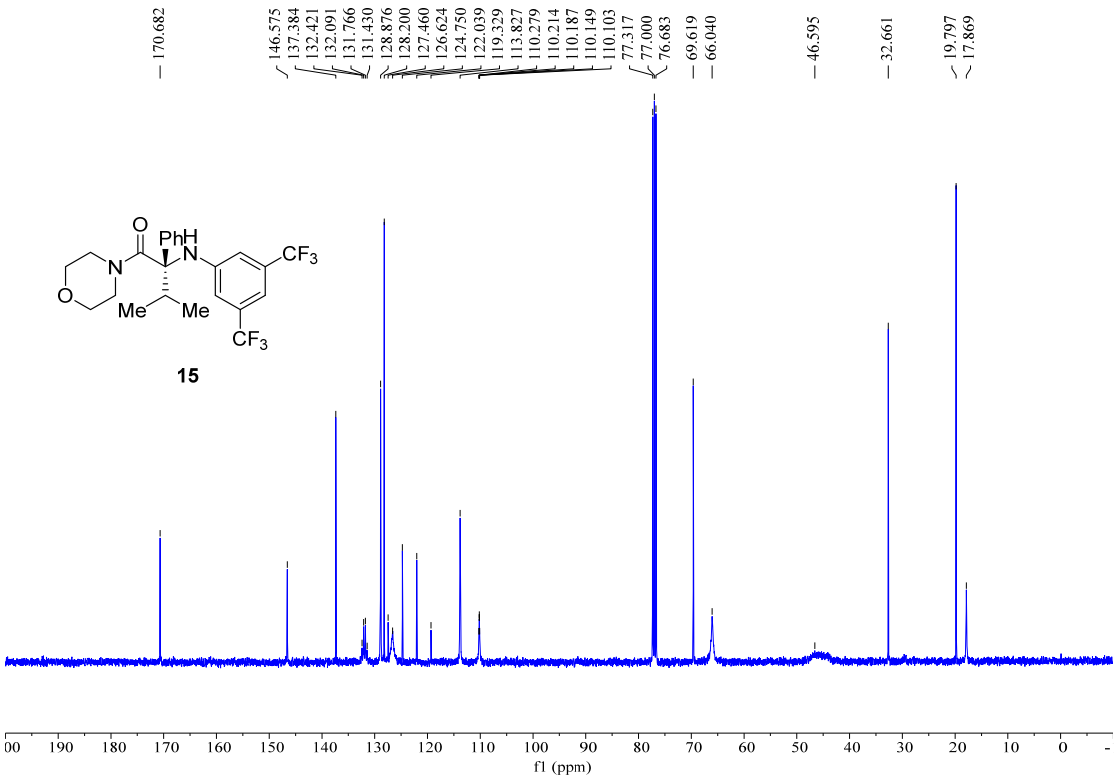

14
4.14
1.03
1.03
2.08
1.00
1.03
1.05
1.03
10.29
f1 (ppm)

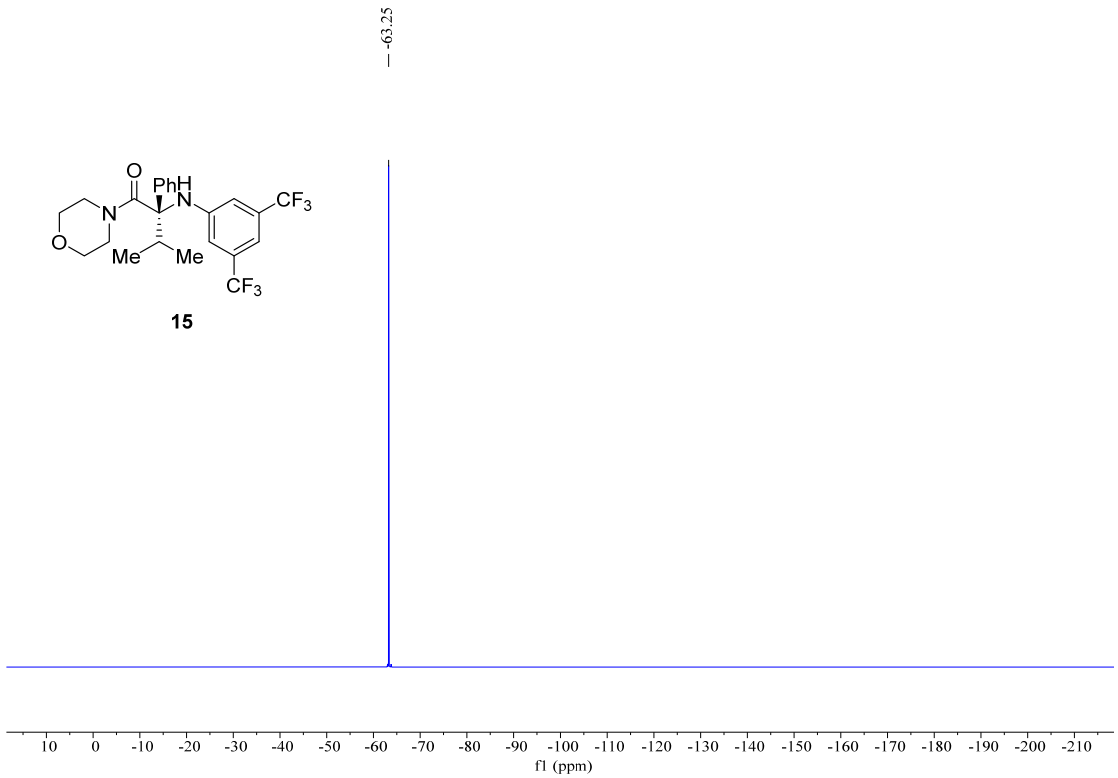

14
f1 (ppm)

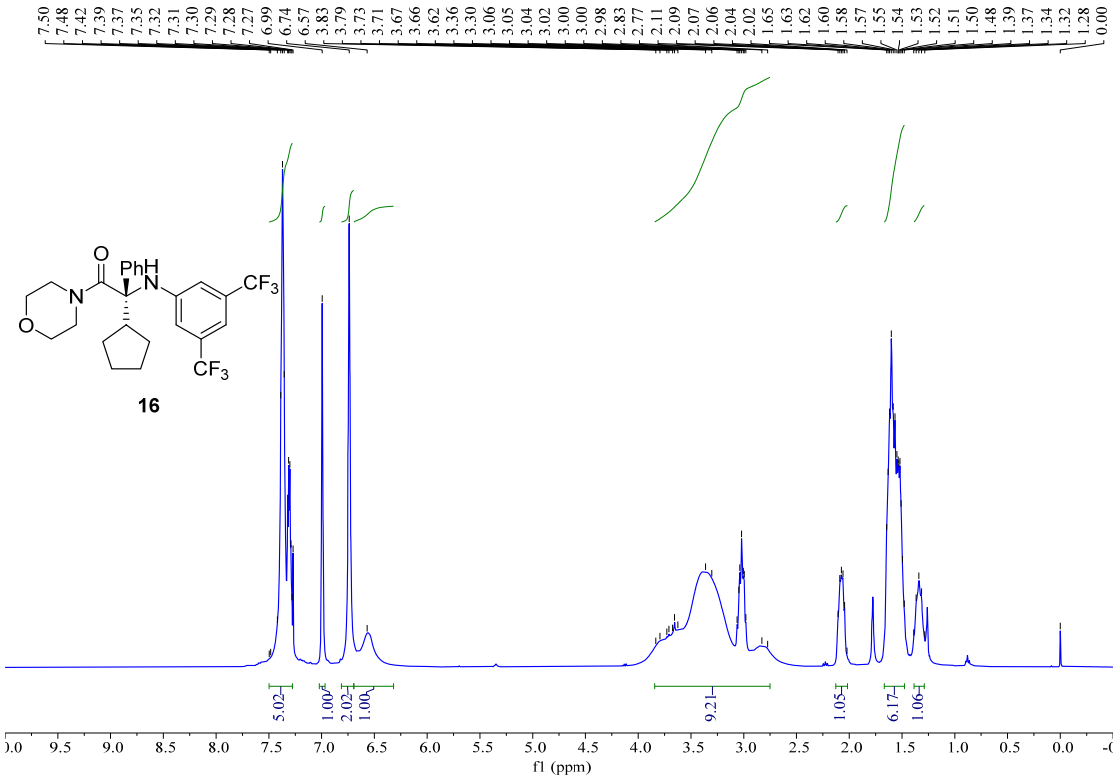

-63.31
O
N
O
Ph
H
N
CF3
CF3
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

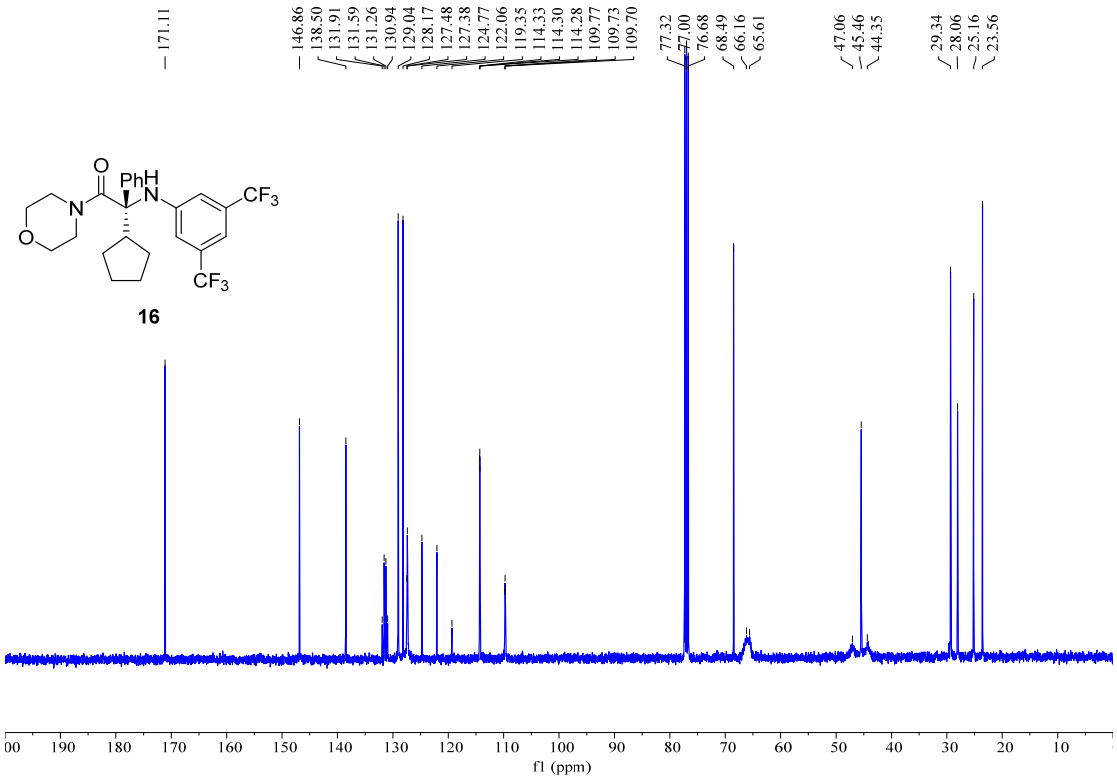
14

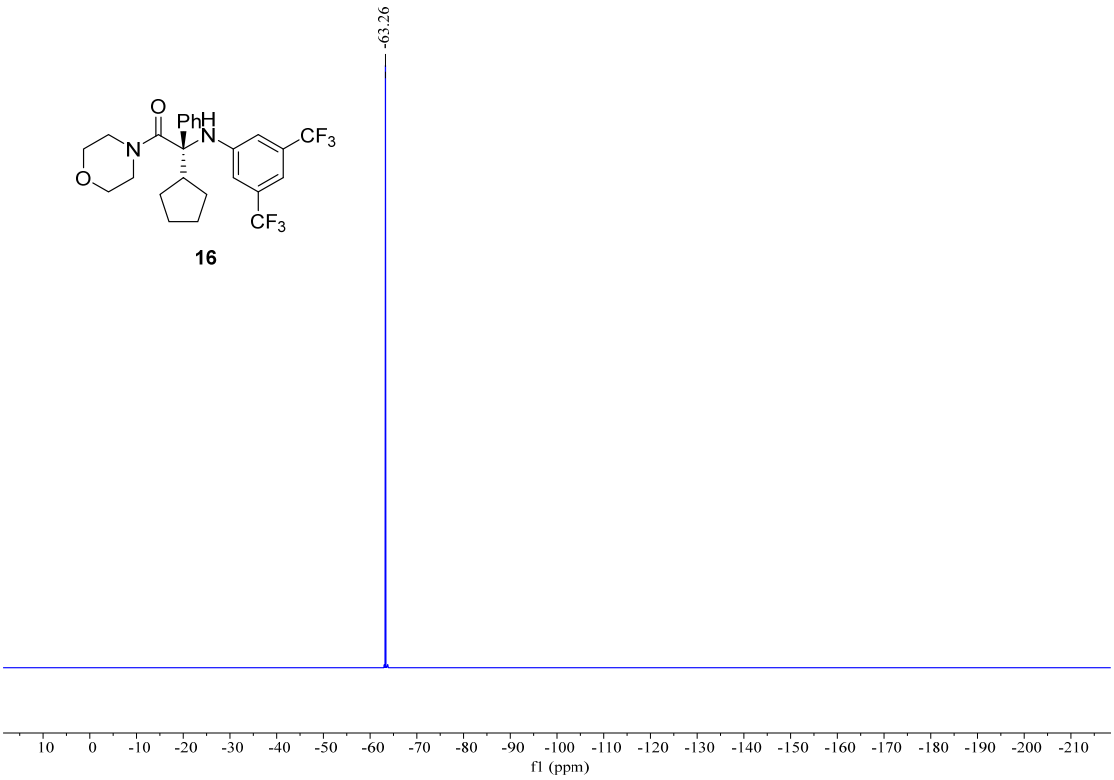

7.43
7.41
7.39
7.36
7.35
7.33
7.27
7.08
6.89
5.90
3.66
3.41
3.41
3.30
3.14
3.12
3.10
3.09
3.07
3.05
3.04
0.97
0.95
0.93
0.90
-0.00
O
PhH
N
N
O
Me
Me
CF3
CF3
15
5.05
1.00
2.03
0.96
9.06
6.06
f1 (ppm)

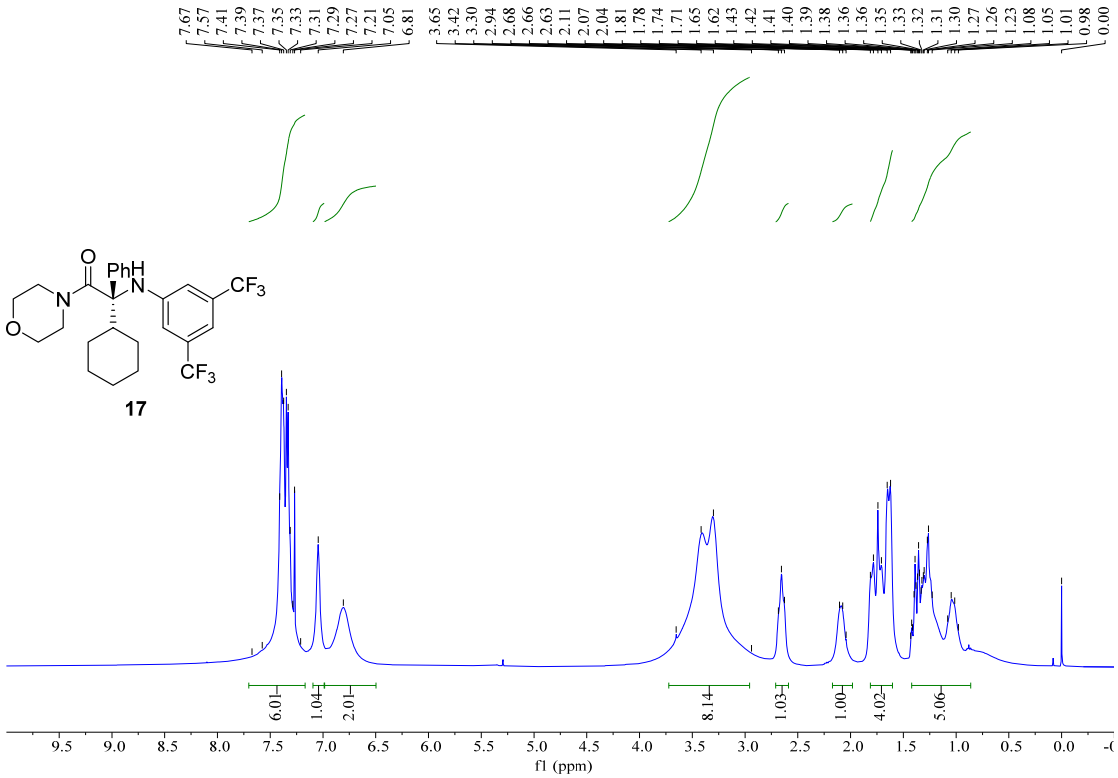

170.682
146.575
137.384
132.421
132.091
131.766
131.430
128.876
128.200
127.460
126.624
124.750
122.039
119.329
113.827
110.279
110.214
110.187
110.149
110.103
77.317
77.000
76.683
69.619
66.040
46.595
32.661
19.797
17.869
O
PhH
N
N
O
Me
Me
CF3
CF3
15
f1 (ppm)

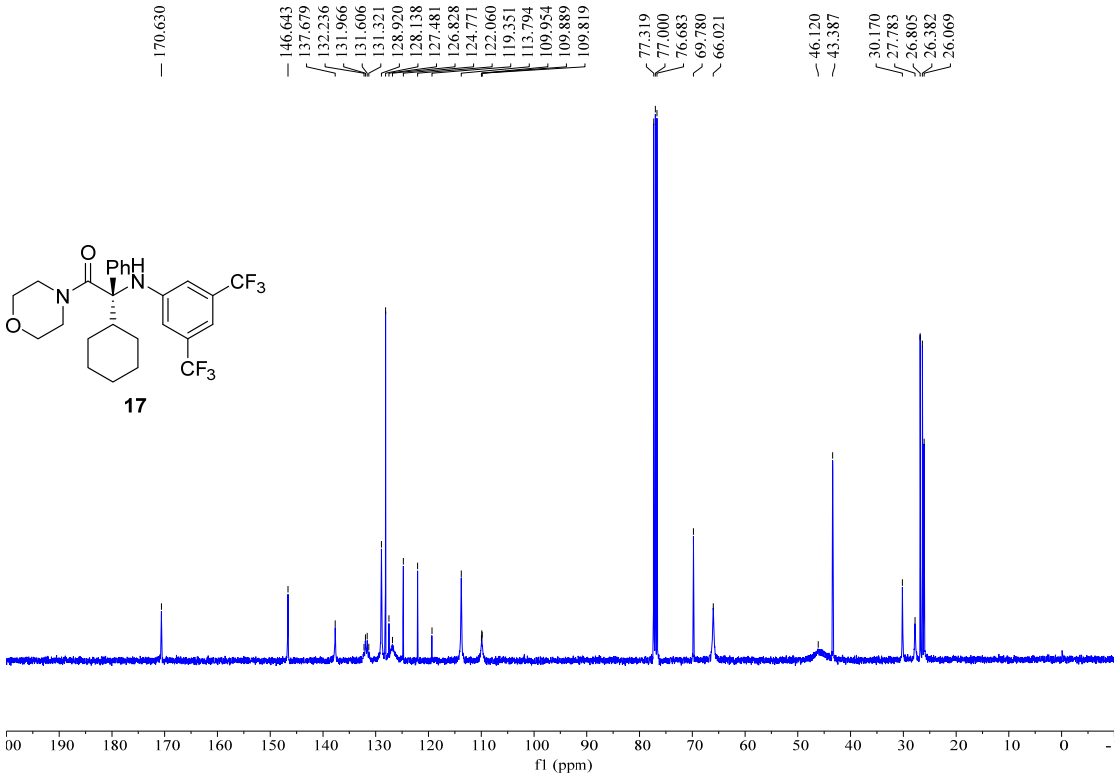

-63.25
O
PhH
N
N
O
Me
Me
CF3
CF3
15
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

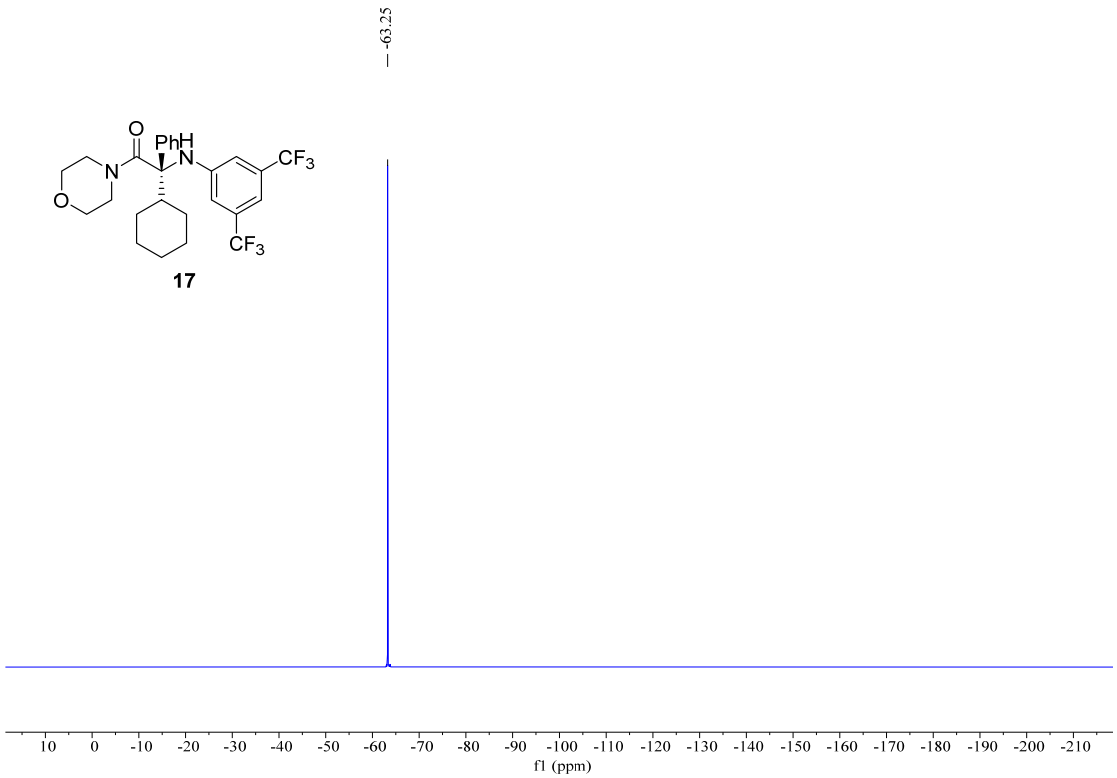

7.50 7.48 7.42 7.39 7.37 7.35 7.32 7.31 7.30 7.29 7.28 7.27 6.99 6.74 6.57 3.83 3.79 3.73 3.71 3.67 3.66 3.62 3.36 3.30 3.06 3.05 3.04 3.02 3.00 3.00 2.98 2.83 2.77 2.11 2.09 2.07 2.06 2.04 2.02 1.65 1.63 1.62 1.60 1.58 1.57 1.55 1.54 1.53 1.52 1.51 1.50 1.48 1.39 1.37 1.34 1.32 1.28 0.00
O
PhH
N
N
O
CF3
CF3
16
5.02
1.00
2.02
1.00
9.21
1.05
6.17
1.06
f1 (ppm)

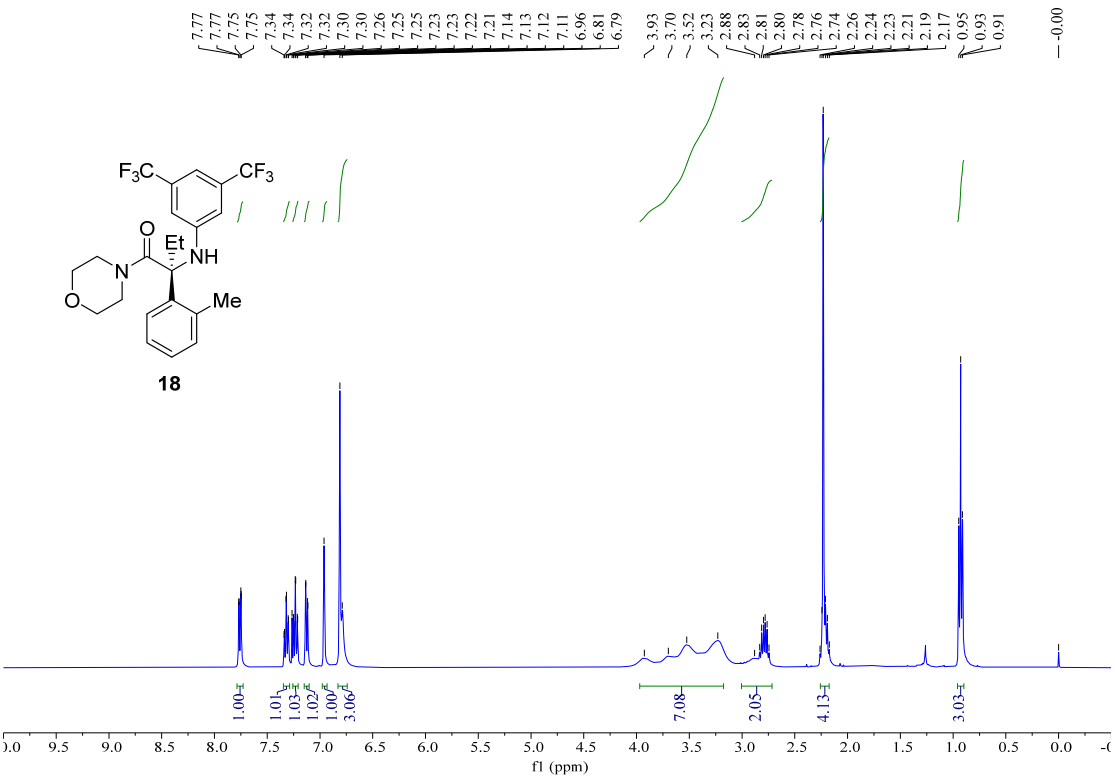

171.11
146.86 138.50 131.91 131.59 131.26 130.94 129.04 128.17 127.48 127.38 124.77 122.06 119.35 114.33 114.30 114.28 109.77 109.73 109.70
77.32 77.00 76.68 68.49 66.16 65.61
47.06 45.46 44.35
29.34 28.06 25.16 23.56
O
PhH
N
N
O
CF3
CF3
16
f1 (ppm)

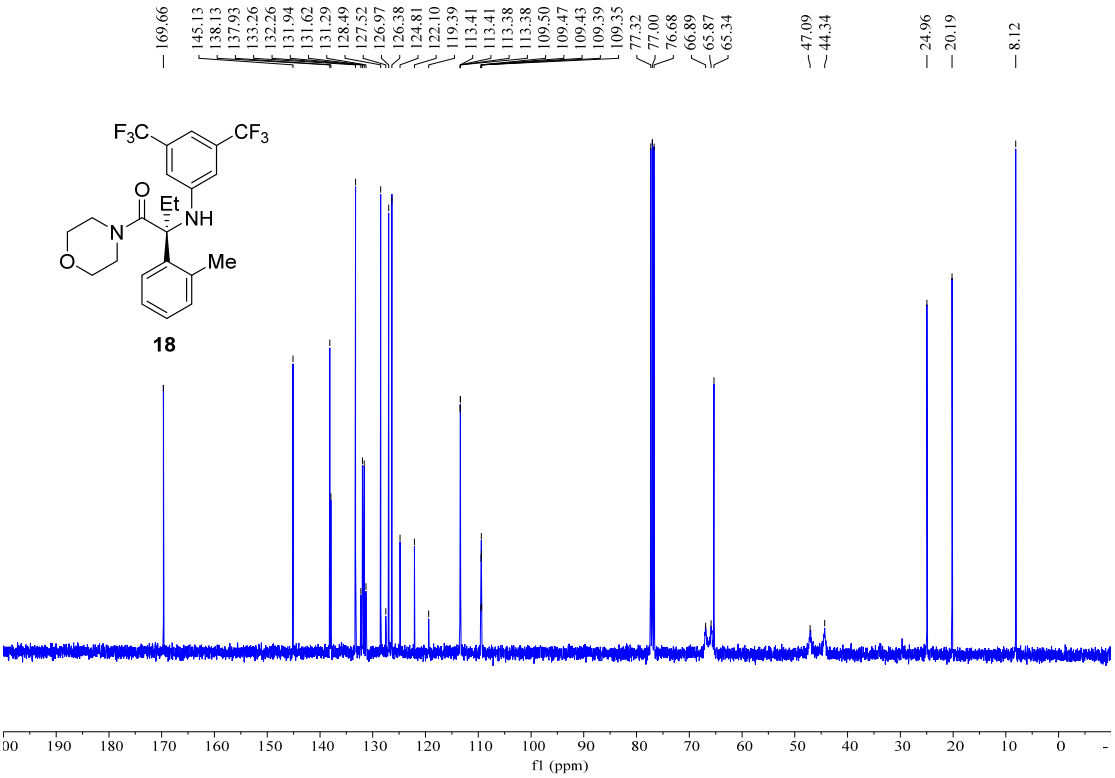

-63.26
O
PhH
N
N
O
CF3
CF3
16
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

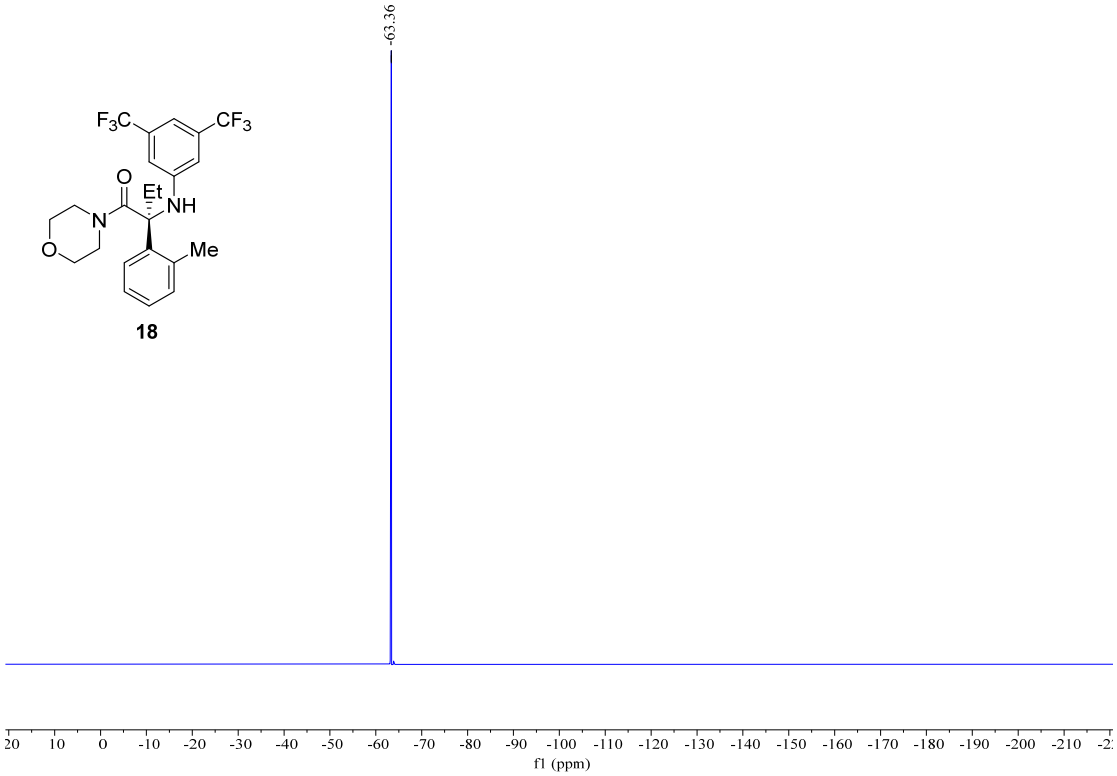

7.67
7.57
7.41
7.39
7.37
7.35
7.33
7.31
7.29
7.27
7.21
7.05
6.81
3.65
3.42
3.30
2.94
2.68
2.66
2.63
2.11
2.07
2.04
1.81
1.78
1.74
1.71
1.65
1.62
1.43
1.42
1.41
1.40
1.39
1.38
1.36
1.36
1.35
1.33
1.32
1.31
1.30
1.27
1.26
1.23
1.08
1.05
1.01
0.98
0.00
O
PhH
N
N
O
CF3
CF3
17
6.01
1.04
2.01
8.14
1.03
1.00
4.02
5.06
f1 (ppm)

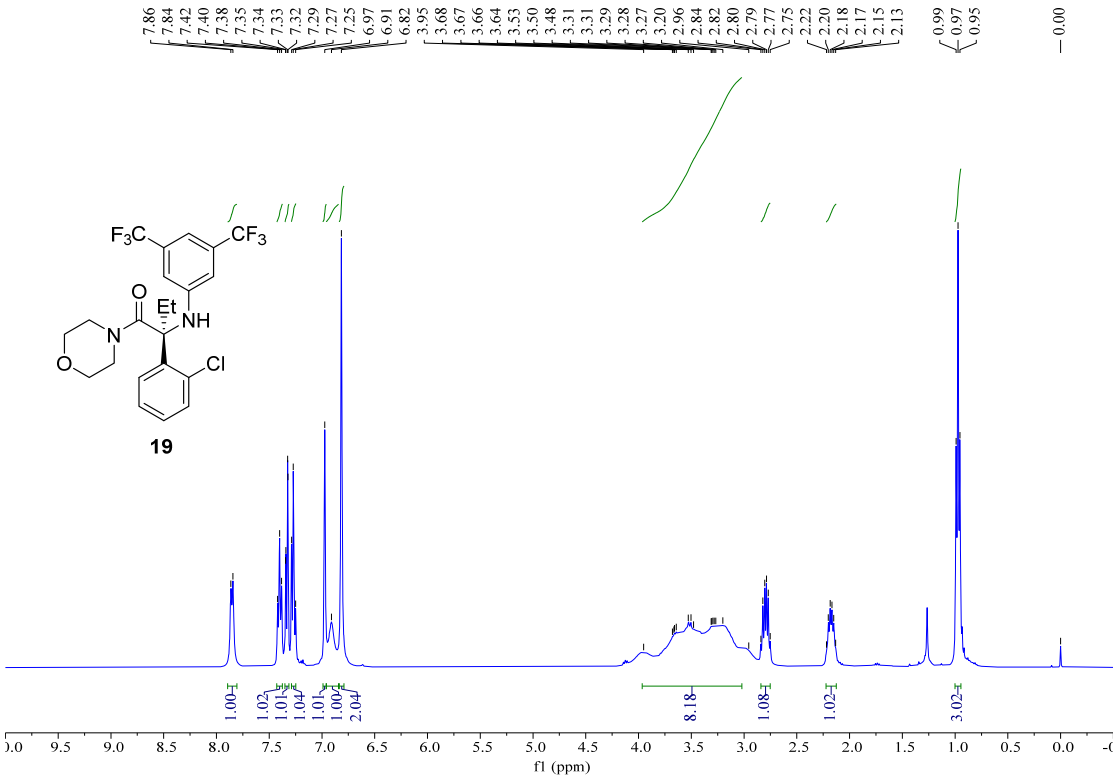

170.630
146.643
137.679
132.236
131.966
131.606
131.321
128.920
128.138
127.481
126.828
124.771
122.060
119.351
113.794
109.954
109.889
109.819
77.319
77.000
76.683
69.780
66.021
46.120
43.387
30.170
27.783
26.805
26.382
26.069
O
PhH
N
N
O
CF3
CF3
17
f1 (ppm)

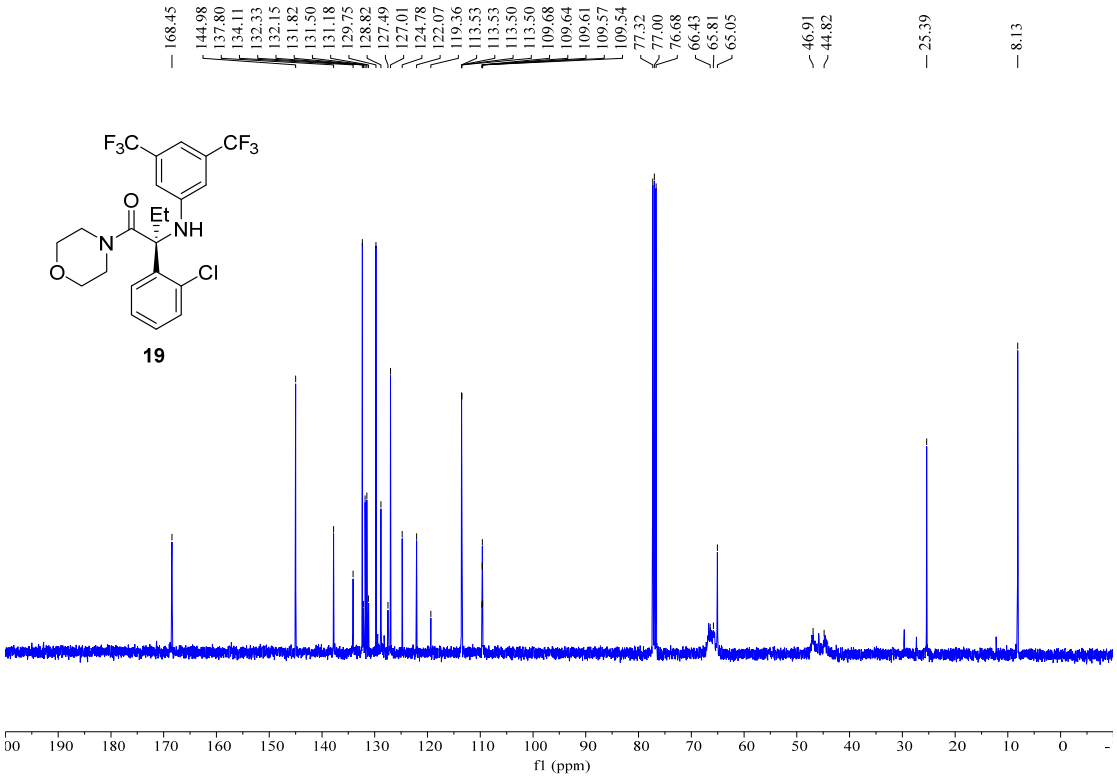

-63.25
O
PhH
N
N
O
CF3
CF3
17
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

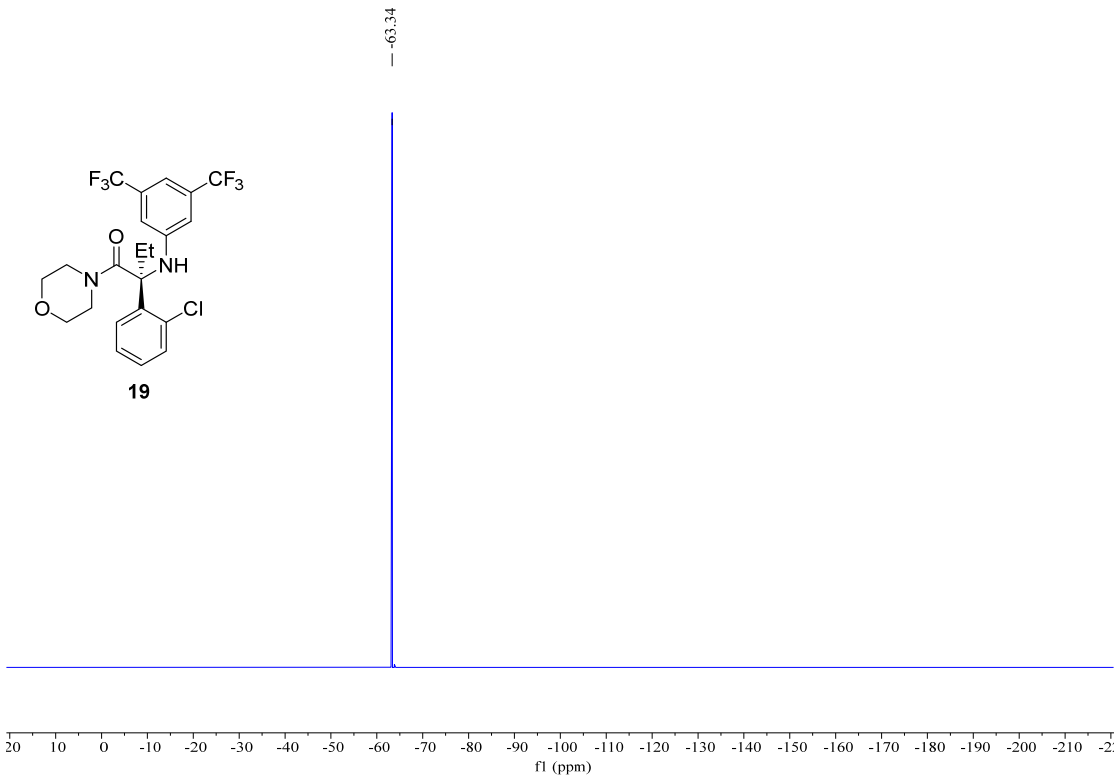

7.77
7.77
7.75
7.75
7.34
7.34
7.32
7.32
7.30
7.30
7.26
7.25
7.25
7.23
7.23
7.22
7.21
7.14
7.13
7.12
7.11
6.96
6.81
6.79
3.93
3.70
3.52
3.23
2.88
2.83
2.81
2.80
2.78
2.76
2.74
2.26
2.24
2.23
2.21
2.19
2.17
0.95
0.93
0.91
-0.00
F3C
CF3
O
Et
NH
N
O
Me
18
1.00
1.01
1.03
1.02
1.00
3.06
7.08
2.05
4.13
3.03
f1 (ppm)

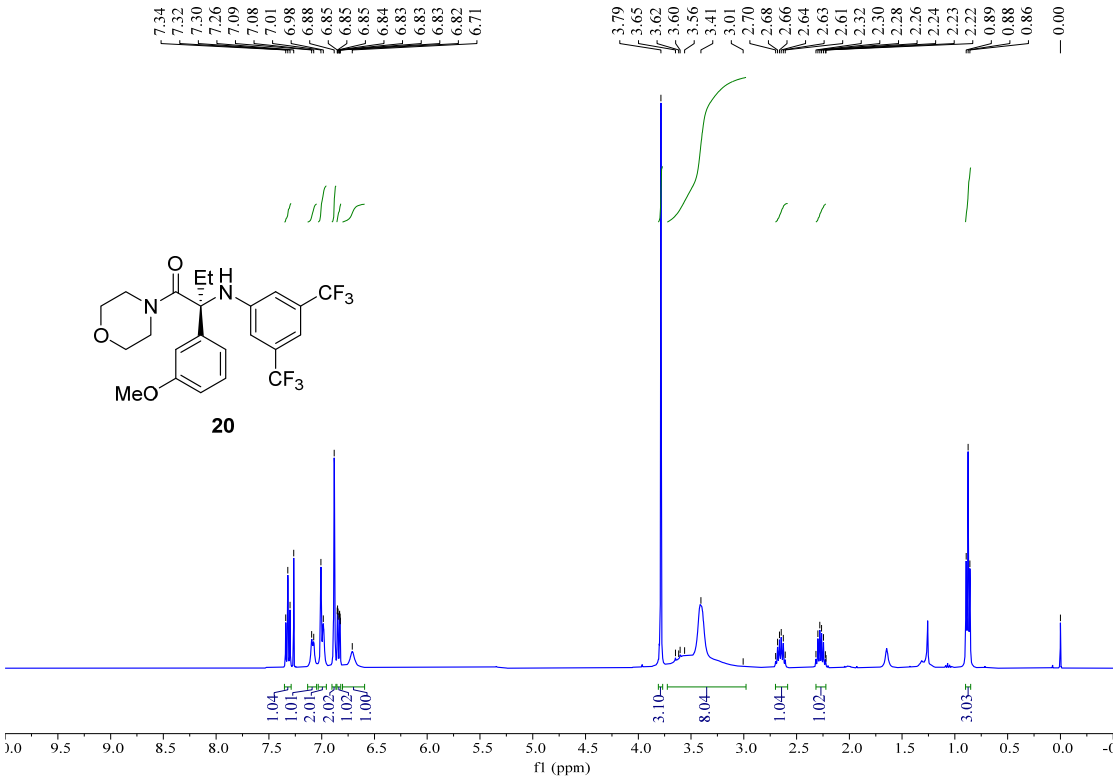

169.66
145.13
138.13
137.93
133.26
132.26
131.94
131.62
131.29
128.49
127.52
126.97
126.38
124.81
122.10
119.39
113.41
113.41
113.38
113.38
109.50
109.47
109.43
109.39
109.35
77.32
77.00
76.68
66.89
65.87
65.34
47.09
44.34
24.96
20.19
8.12
F3C
CF3
O
Et
NH
N
O
Me
18
f1 (ppm)

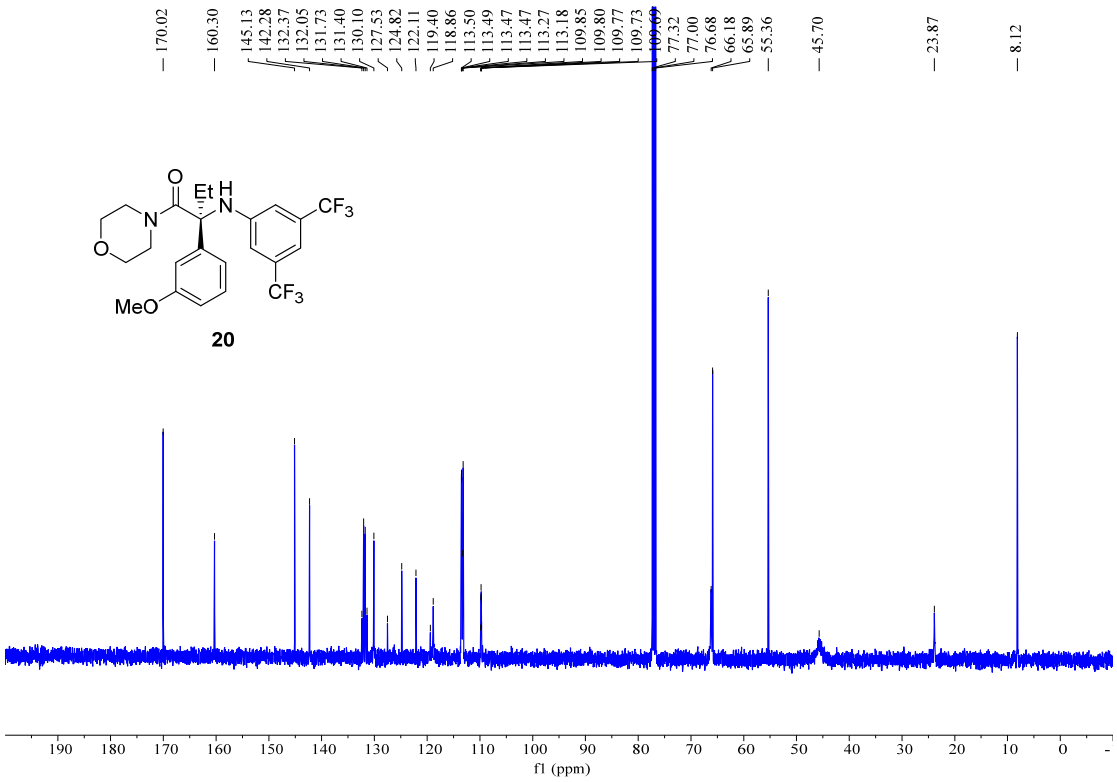

-63.36
F3C
CF3
O
Et
NH
N
O
Me
18
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

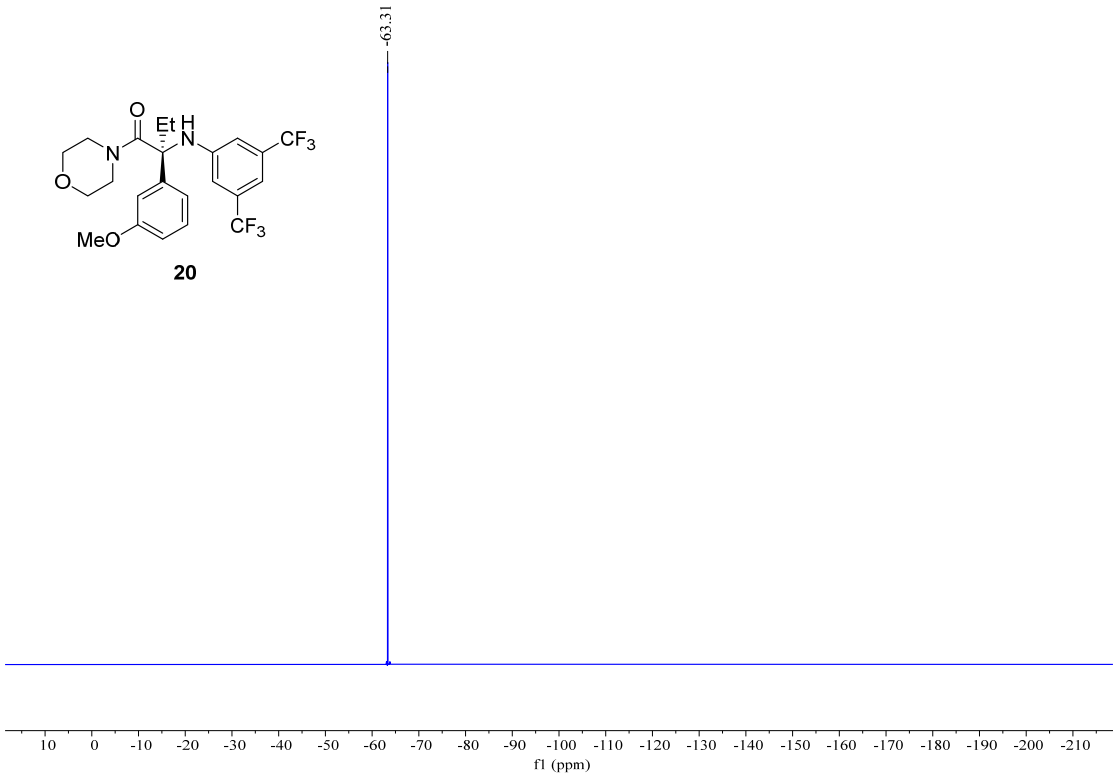

7.86
7.84
7.42
7.40
7.38
7.35
7.34
7.33
7.32
7.29
7.27
7.25
6.97
6.91
6.82
3.95
3.68
3.67
3.66
3.64
3.53
3.50
3.48
3.31
3.31
3.29
3.28
3.27
3.20
2.96
2.84
2.82
2.80
2.79
2.77
2.75
2.22
2.20
2.18
2.17
2.15
2.13
0.99
0.97
0.95
0.00
F3C
CF3
O
Et
NH
N
O
Cl
19
1.00
1.02
1.01
1.04
1.01
1.00
2.04
8.18
1.08
1.02
3.02
f1 (ppm)


168.45
144.98
137.80
134.11
132.33
132.15
131.82
131.50
131.18
129.75
128.82
127.49
127.01
124.78
122.07
119.36
113.53
113.53
113.50
113.50
109.68
109.64
109.61
109.57
109.54
77.32
77.00
76.68
66.43
65.81
65.05
46.91
44.82
25.39
8.13
F3C
CF3
O
Et
NH
N
O
Cl
19
f1 (ppm)

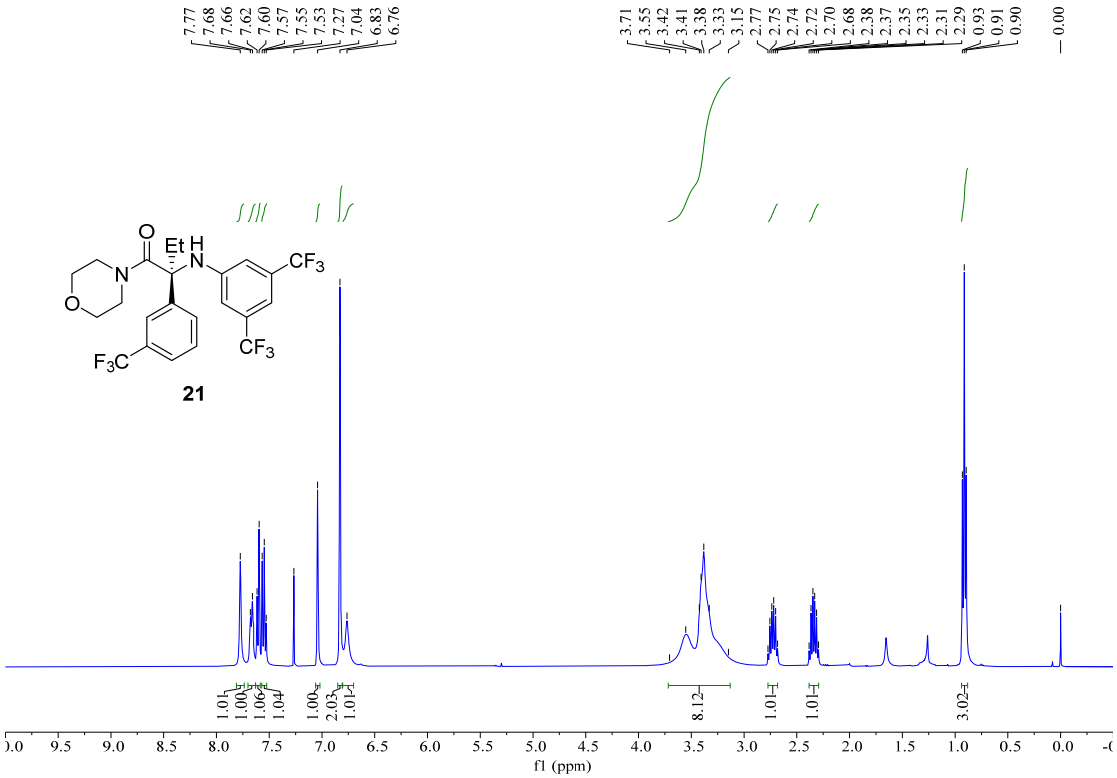

-63.34
F3C
CF3
O
Et
NH
N
O
Cl
19
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

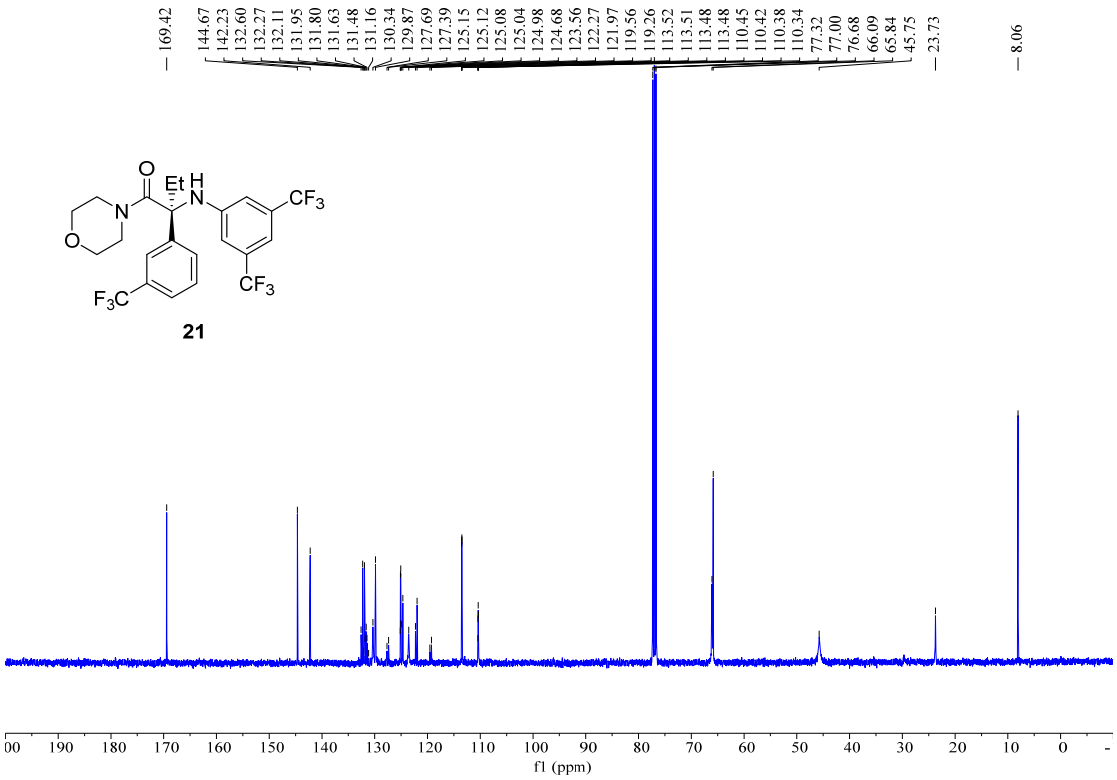

7.34
7.32
7.30
7.26
7.09
7.08
7.01
6.98
6.88
6.85
6.85
6.85
6.84
6.83
6.83
6.83
6.82
6.71
3.79
3.65
3.62
3.60
3.56
3.41
3.01
2.70
2.68
2.66
2.64
2.63
2.61
2.32
2.30
2.28
2.26
2.24
2.23
2.22
0.89
0.88
0.86
0.00
Et
H
N
O
N
O
CF3
CF3
MeO
20
1.04
1.01
2.01
2.02
1.02
1.00
3.10
8.04
1.04
1.02
3.03
f1 (ppm)


170.02
160.30
145.13
142.28
132.37
132.05
131.73
131.40
130.10
127.53
124.82
122.11
119.40
118.86
113.50
113.49
113.47
113.47
113.27
113.18
109.85
109.80
109.77
109.73
77.32
77.00
76.68
66.18
65.89
55.36
45.70
23.87
8.12
Et
H
N
O
N
O
CF3
CF3
MeO
20
f1 (ppm)


-63.31
O
Et H
N
N
O
CF3
CF3
MeO
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

20


7.77
7.68
7.66
7.62
7.60
7.57
7.55
7.53
7.27
7.04
6.83
6.76
3.71
3.55
3.42
3.41
3.38
3.33
3.15
2.77
2.75
2.74
2.72
2.70
2.68
2.38
2.37
2.35
2.33
2.31
2.29
0.93
0.91
0.90
0.00
Et
H
N
O
N
O
CF3
CF3
F3C
21
1.01
1.00
1.06
1.04
1.00
2.03
1.01
8.12
1.01
1.01
3.02
f1 (ppm)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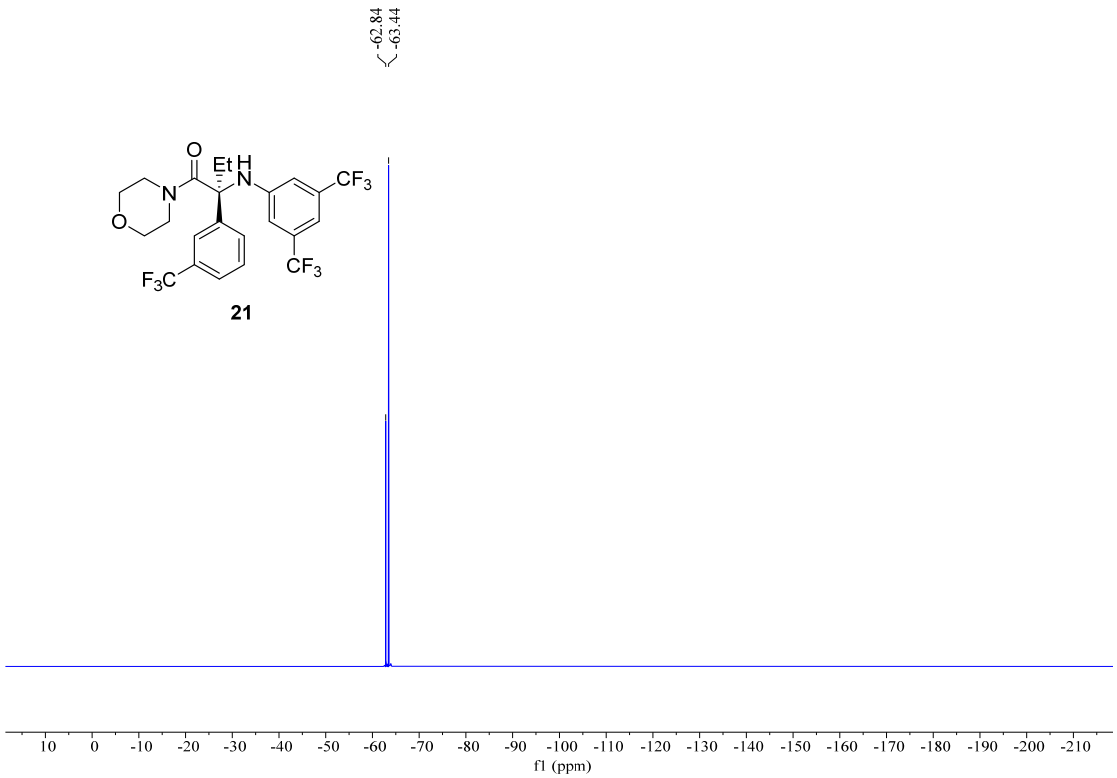
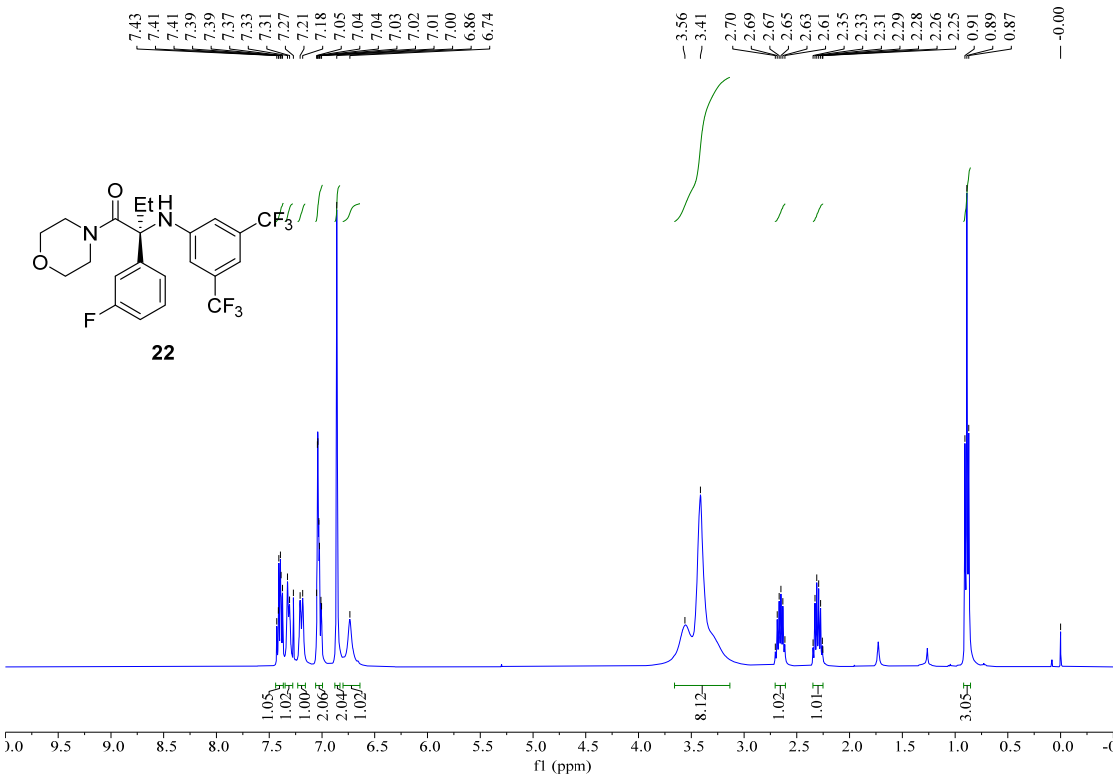
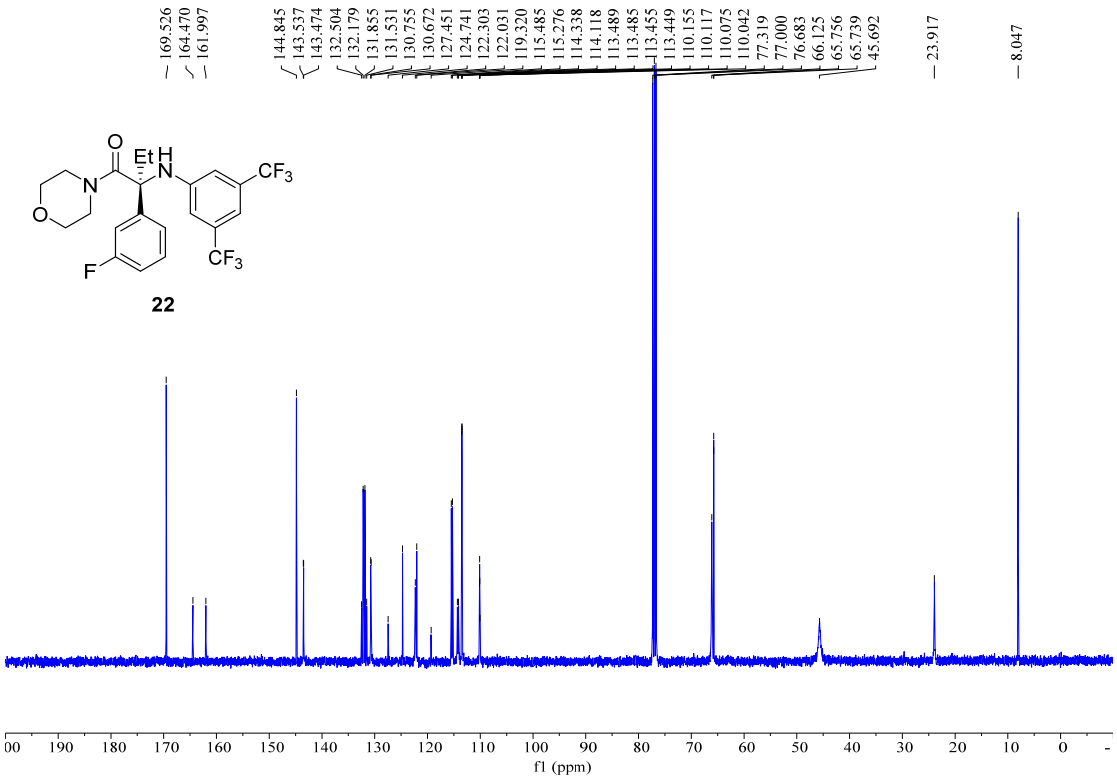
144.67
142.23
132.60
132.27
132.11
131.95
131.80
131.63
131.48
131.16
130.34
129.87
127.69
127.39
125.15
125.12
125.08
125.04
124.98
124.68
123.56
122.27
121.97
119.56
119.26
113.52
113.51
113.48
113.48
110.45
110.42
110.38
110.34
77.32
77.00
76.68
66.09
65.84
45.75
23.73
8.06
Et
H
N
O
N
O
CF3
CF3
F3C
21
f1 (ppm)


-62.84
-63.44
O
Et
H
N
N
O
CF3
CF3
F3C
21
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


7.43
7.41
7.41
7.39
7.39
7.37
7.33
7.31
7.27
7.21
7.18
7.05
7.04
7.04
7.03
7.02
7.01
7.00
6.86
6.74
3.56
3.41
2.70
2.69
2.67
2.65
2.63
2.61
2.35
2.33
2.31
2.29
2.28
2.26
2.25
0.91
0.89
0.87
-0.00
O
Et
H
N
N
O
CF3
CF3
F
22
1.05
1.02
1.00
2.06
2.04
1.02
8.12
1.02
1.01
3.05
f1 (ppm)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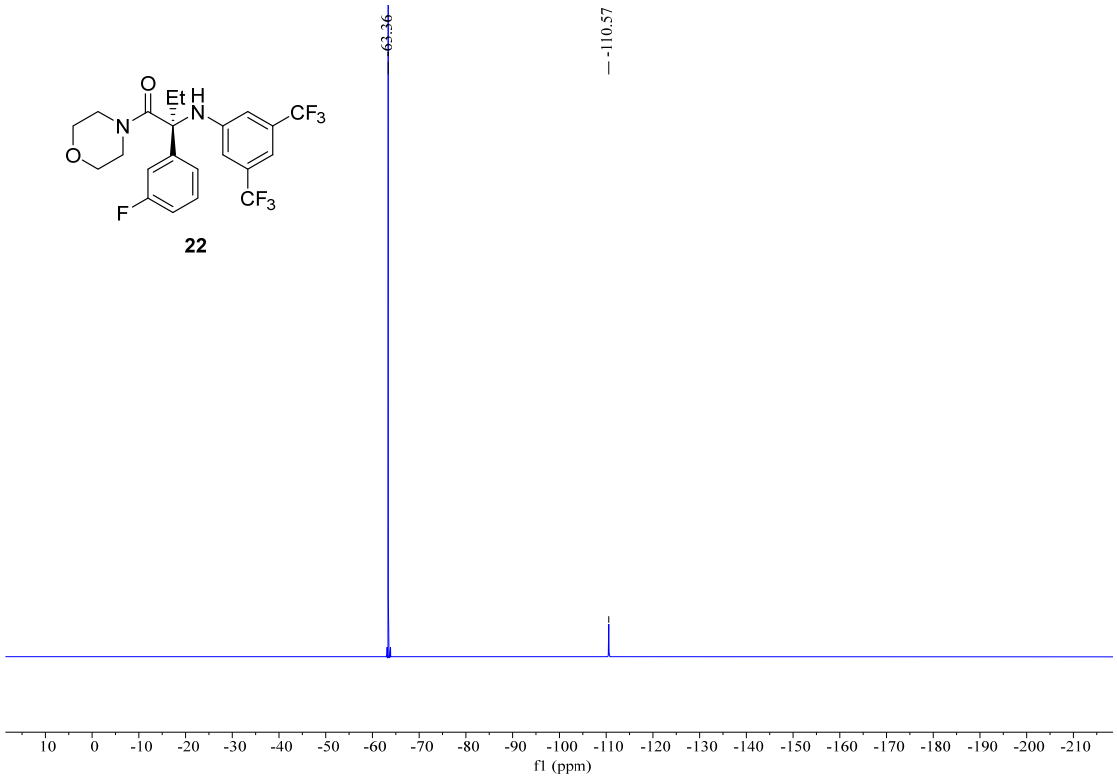
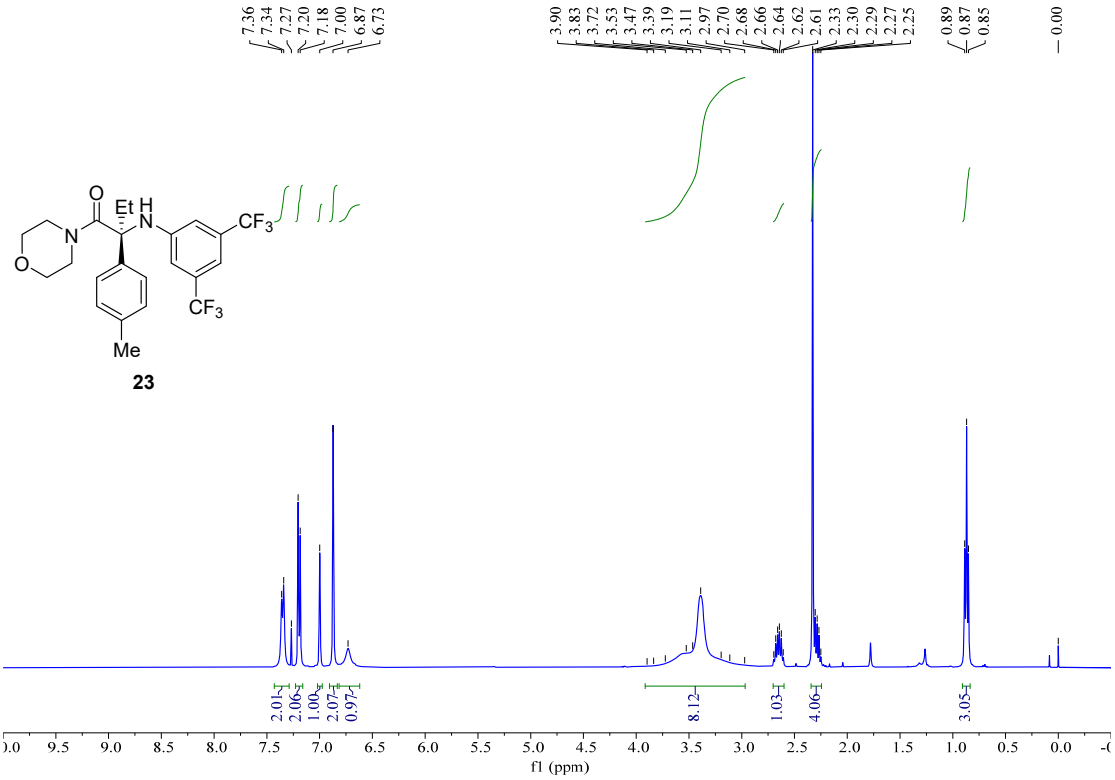
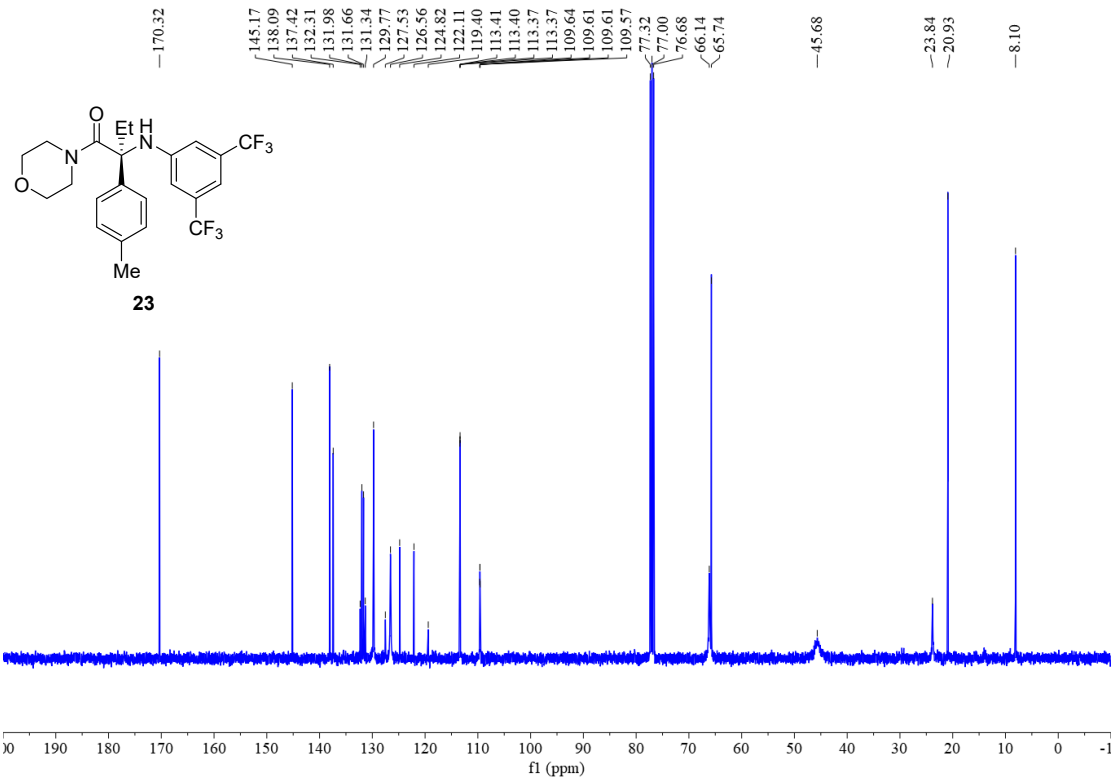
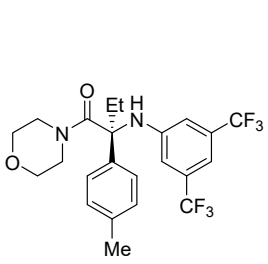
164.470
161.997
144.845
143.537
143.474
132.504
132.179
131.855
131.531
130.755
130.672
127.451
124.741
122.303
122.031
119.320
115.485
115.276
114.338
114.118
113.489
113.485
113.455
113.449
110.155
110.117
110.075
110.042
77.319
77.000
76.683
66.125
65.756
65.739
45.692
23.917
8.047
O
Et
H
N
N
O
CF3
CF3
F
22
f1 (ppm)


-63.36
-110.57
O
Et H
N
N
O
CF3
CF3
F
22
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

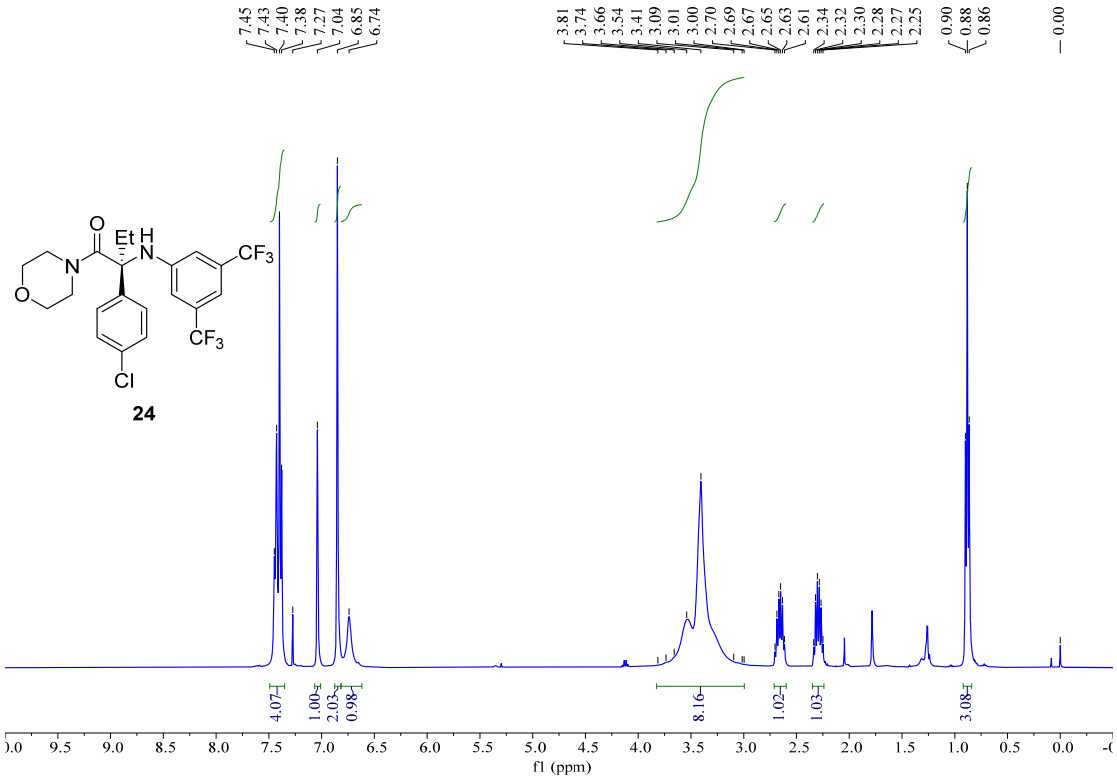

7.36
7.34
7.27
7.20
7.18
7.00
6.87
6.73
3.90
3.83
3.72
3.53
3.47
3.39
3.19
3.11
2.97
2.70
2.68
2.66
2.64
2.62
2.61
2.33
2.30
2.29
2.27
2.25
0.89
0.87
0.85
0.00
Et
H
N
O
N
O
CF3
CF3
Me
23
2.01
2.06
1.00
2.07
0.97
8.12
1.03
4.06
3.05
f1 (ppm)

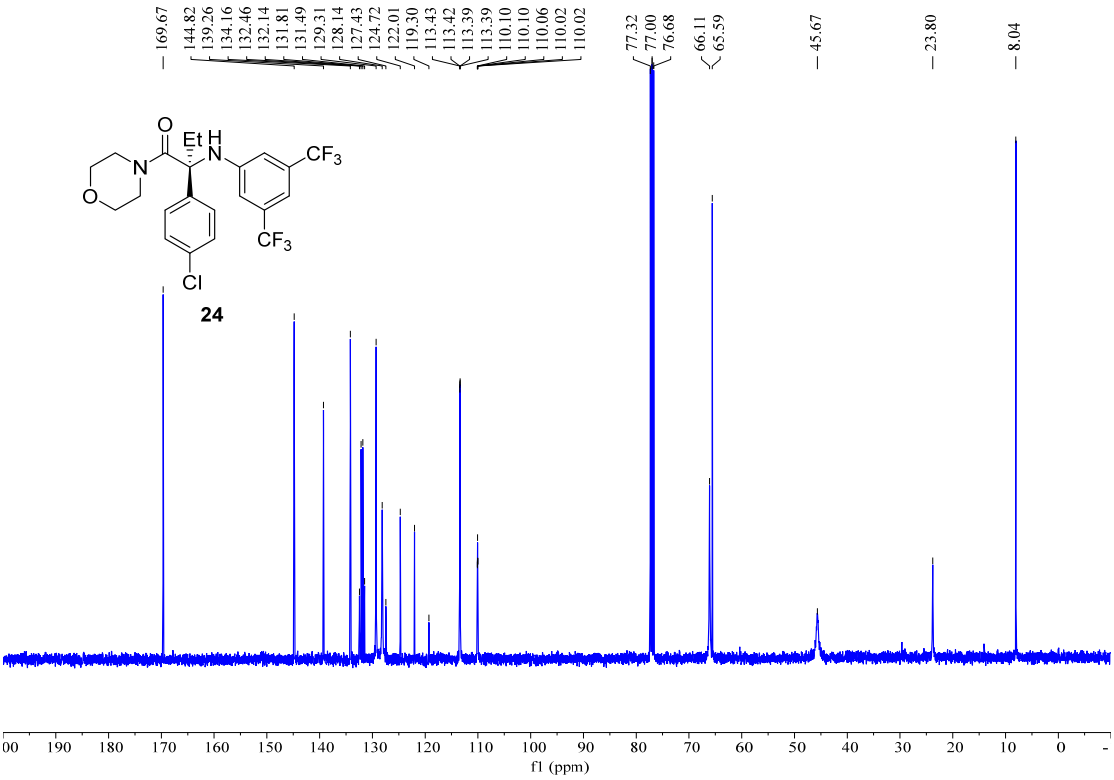

170.32
145.17
138.09
137.42
132.31
131.98
131.66
131.34
129.77
127.53
126.56
124.82
122.11
119.40
113.41
113.40
113.37
113.37
109.64
109.61
109.61
109.57
77.32
77.00
76.68
66.14
65.74
45.68
23.84
20.93
8.10
Et
H
N
O
N
O
CF3
CF3
Me
23
f1 (ppm)

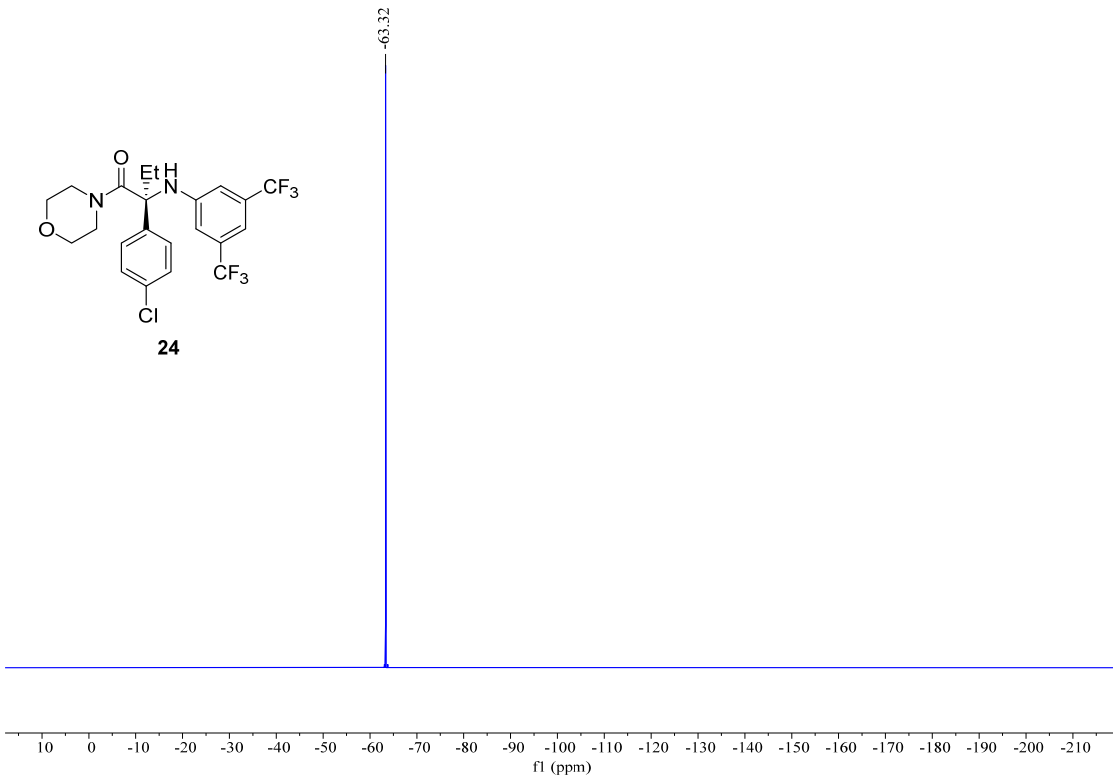

O
Et H
N
N
O
CF3
CF3
Me

23

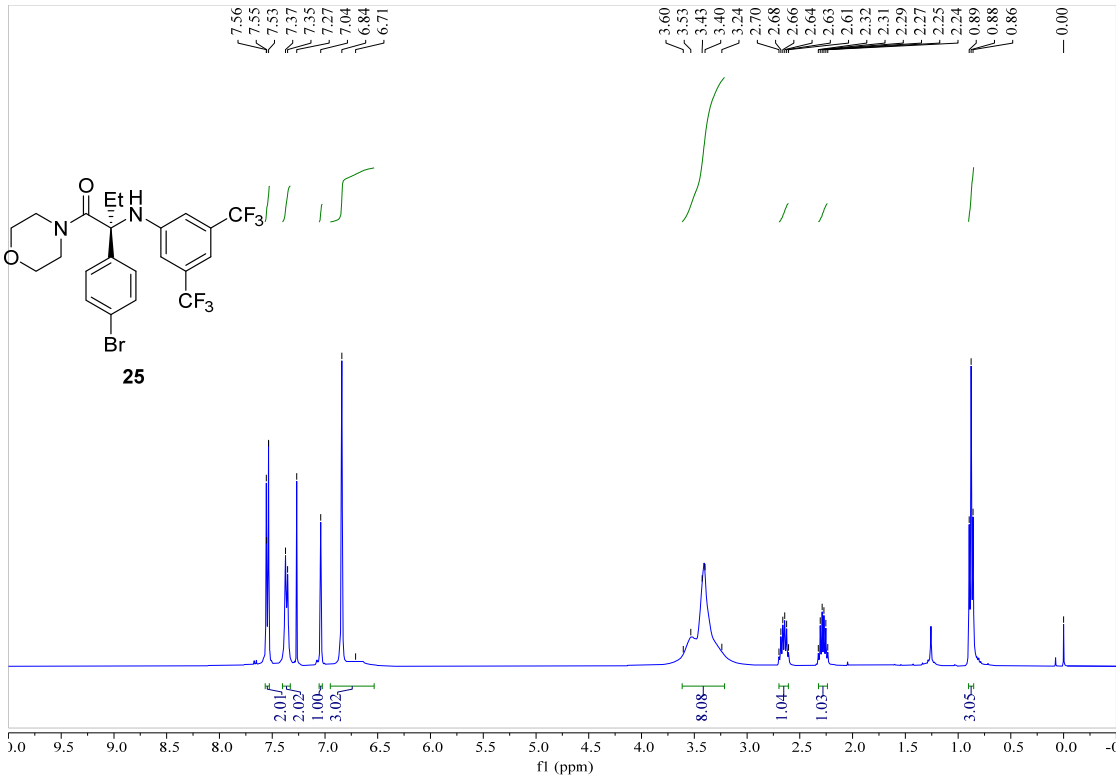
-63.31
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

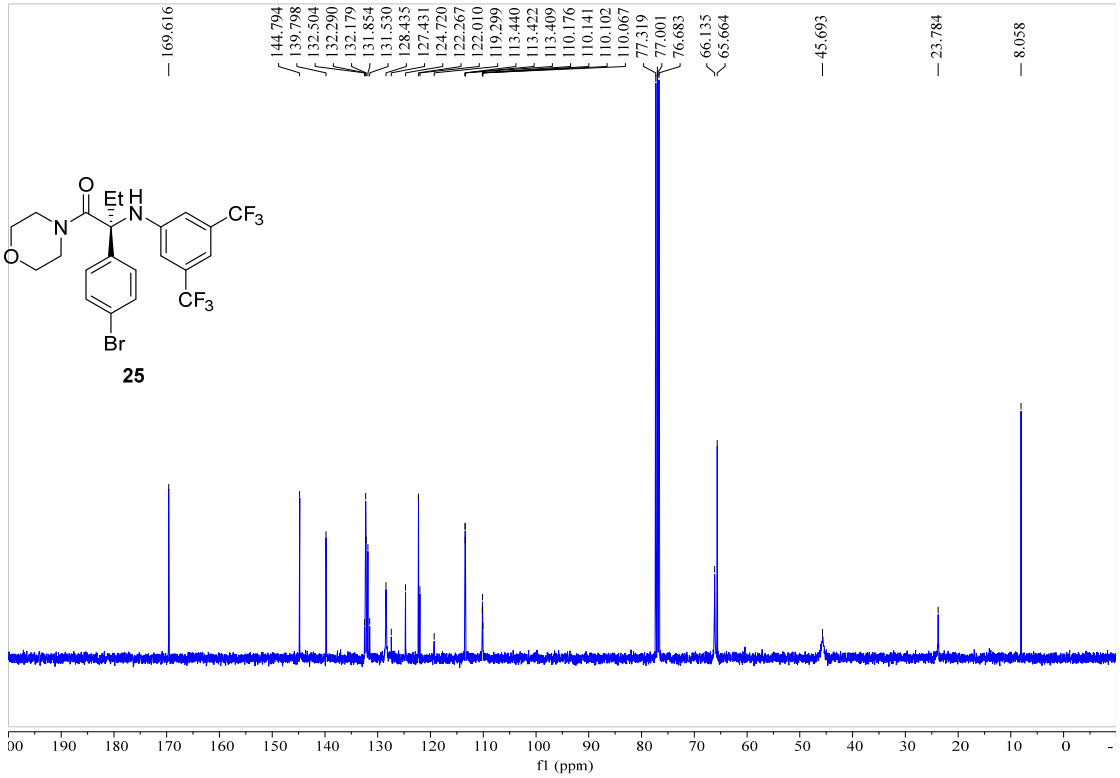

7.45
7.43
7.40
7.38
7.27
7.04
6.85
6.74
3.81
3.74
3.66
3.54
3.41
3.09
3.01
3.00
2.70
2.69
2.67
2.65
2.63
2.61
2.34
2.32
2.30
2.28
2.27
2.25
0.90
0.88
0.86
0.00
4.07
1.00
2.03
0.98
8.16
1.02
1.03
3.08
f1 (ppm)


169.67
144.82
139.26
134.16
132.46
132.14
131.81
131.49
129.31
128.14
127.43
124.72
122.01
119.30
113.43
113.42
113.39
113.39
110.10
110.10
110.06
110.02
110.02
77.32
77.00
76.68
66.11
65.59
45.67
23.80
8.04
f1 (ppm)


-63.32
O
Et
H
N
N
O
CF3
CF3
Cl
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

24


7.56
7.55
7.53
7.37
7.35
7.27
7.04
6.84
6.71
3.60
3.53
3.43
3.40
3.24
2.70
2.68
2.66
2.64
2.63
2.61
2.32
2.31
2.29
2.27
2.25
2.24
0.89
0.88
0.86
0.00
O
Et H
N
N
O
CF3
CF3
Br
25
2.01
2.02
1.00
3.02
8.08
1.04
1.03
3.05
f1 (ppm)


169.616
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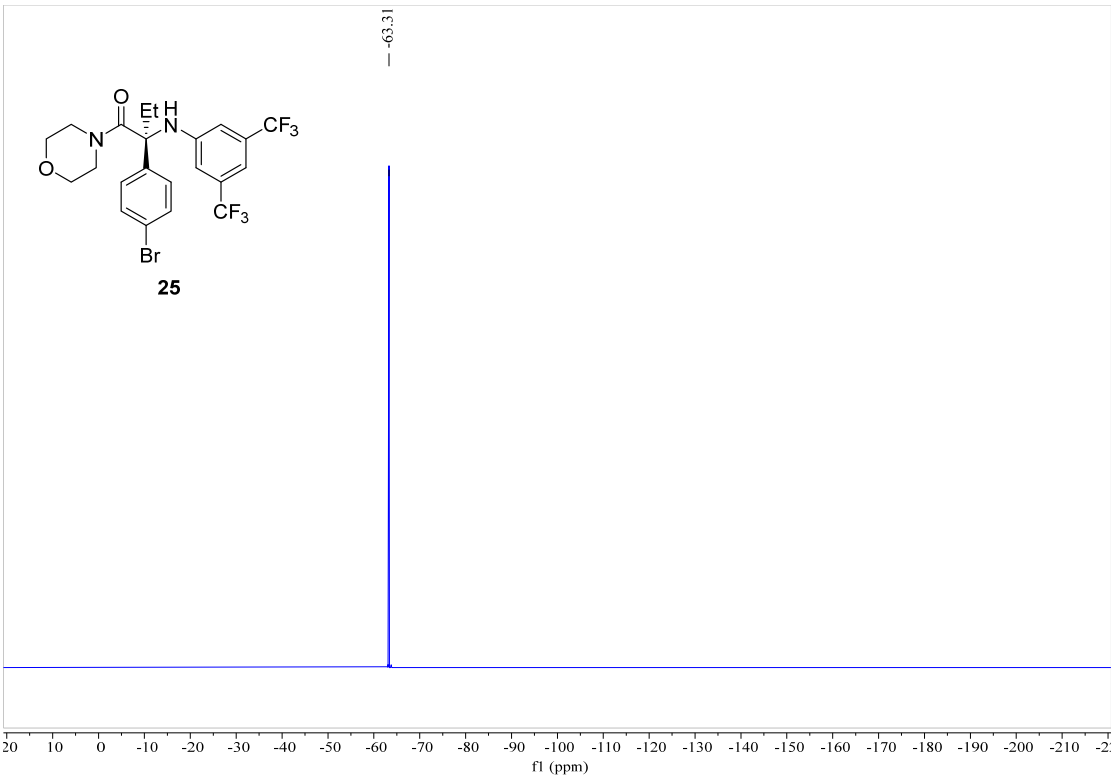
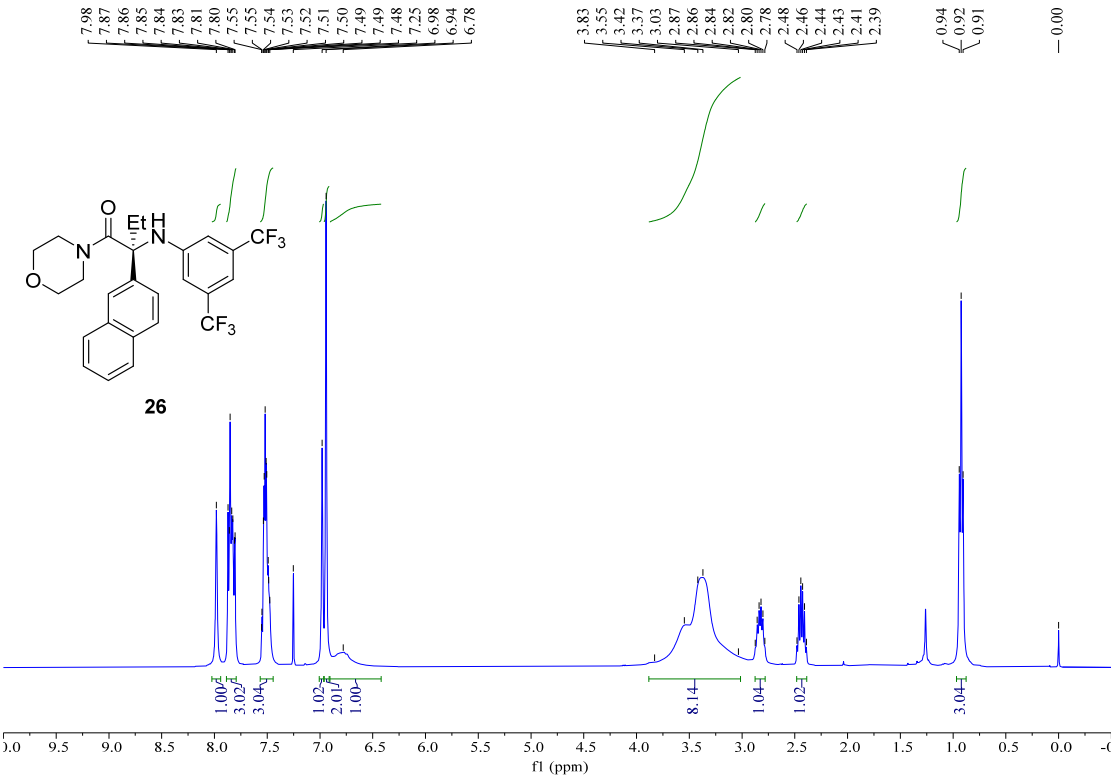
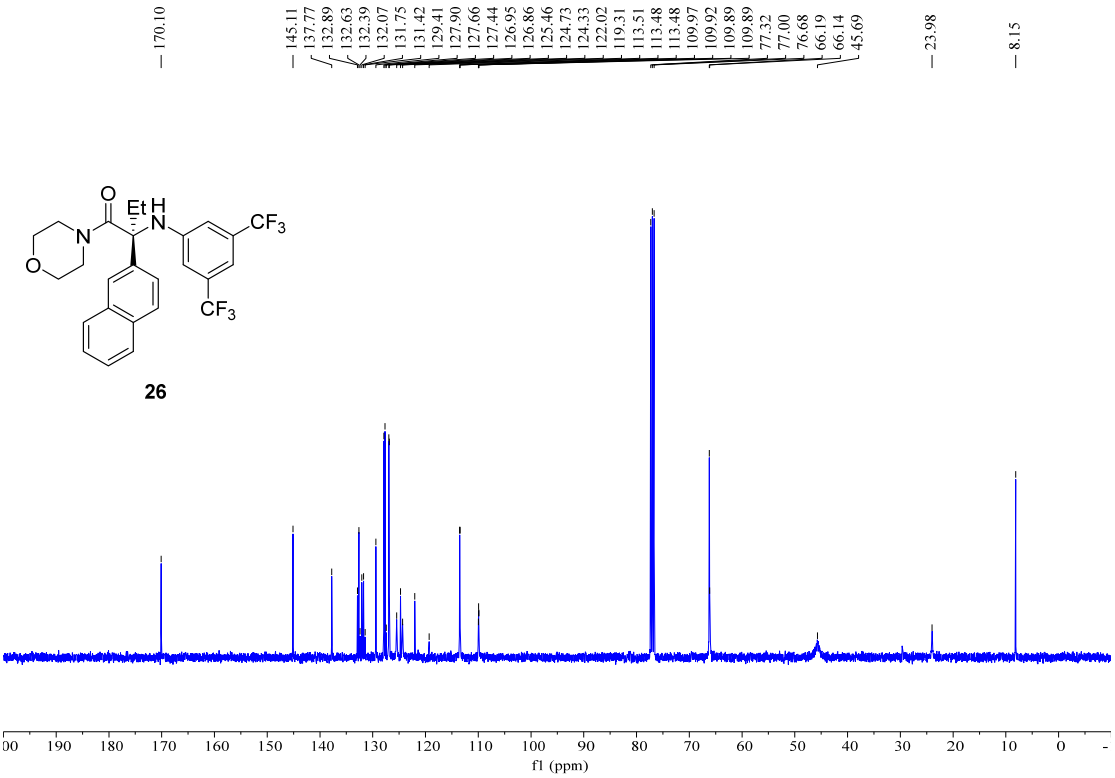
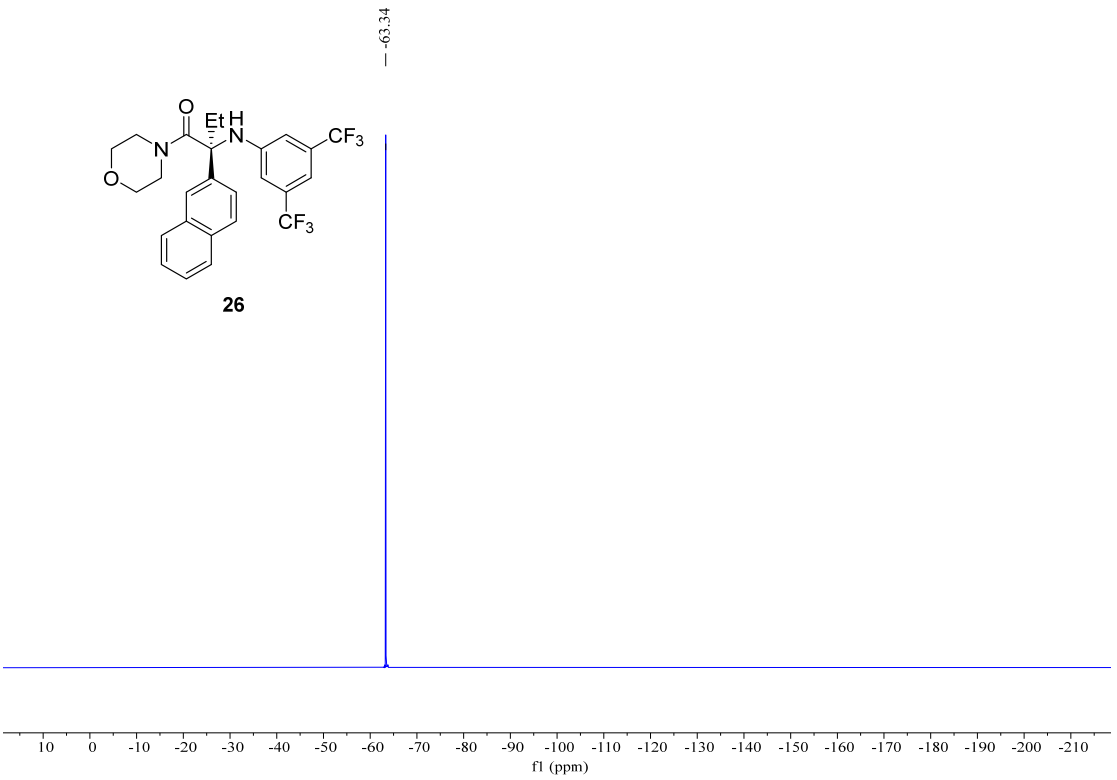
139.798
132.504
132.290
132.179
131.854
131.530
128.435
127.431
124.720
122.267
122.010
119.299
113.440
113.422
113.409
110.176
110.141
110.102
110.067
77.319
77.001
76.683
66.135
65.664
45.693
23.784
8.058
O
Et H
N
N
O
CF3
CF3
Br
25
f1 (ppm)

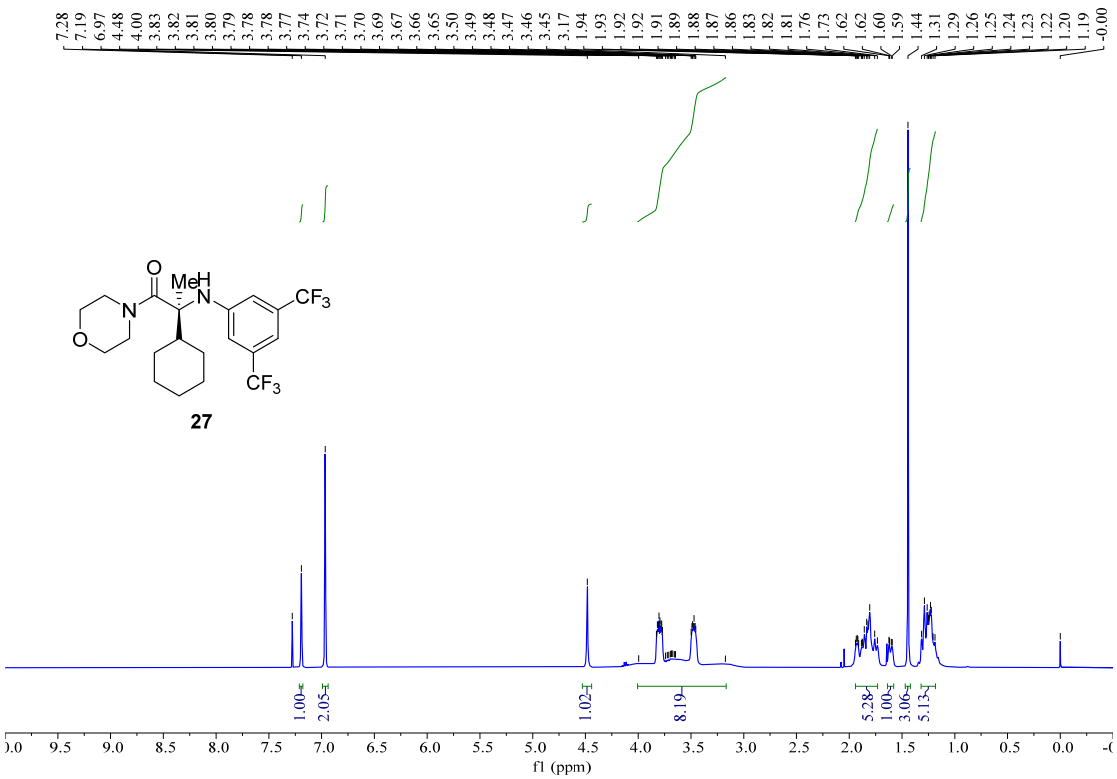

-63.31
O
Et
H
N
N
O
CF3
CF3
Br
25
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

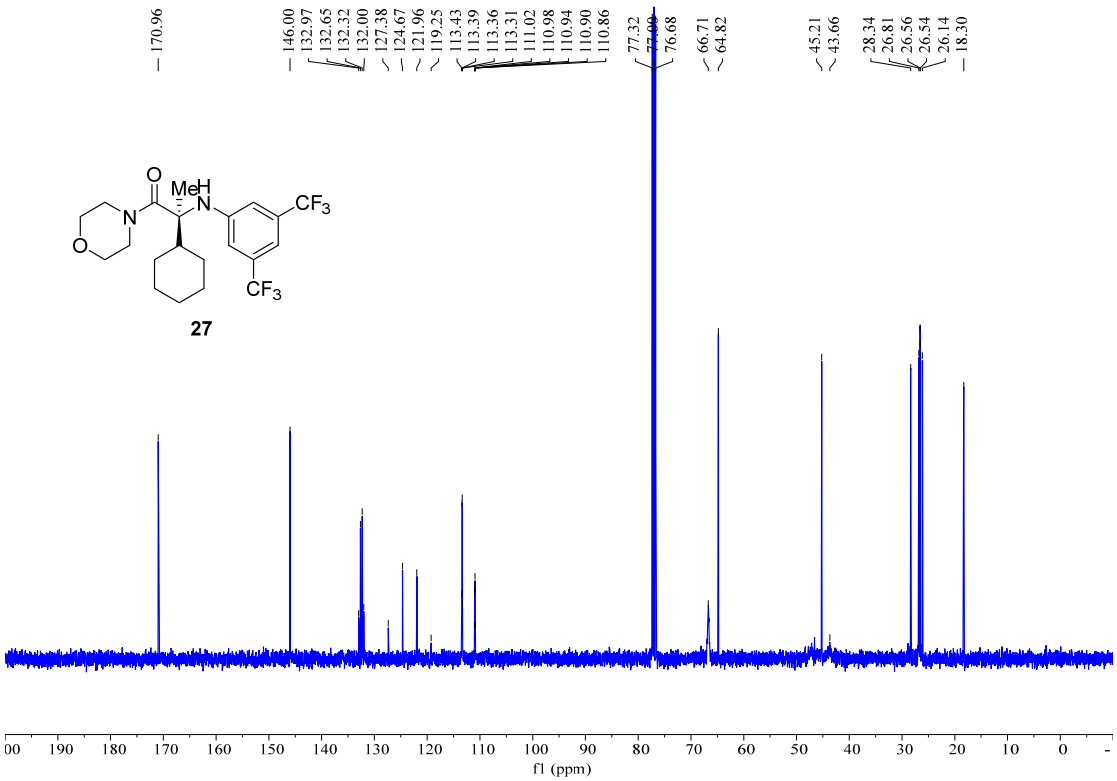

7.98
7.87
7.86
7.85
7.84
7.83
7.81
7.80
7.55
7.54
7.53
7.52
7.51
7.50
7.49
7.49
7.48
7.25
6.98
6.94
6.78
3.83
3.55
3.42
3.37
3.03
2.87
2.86
2.84
2.82
2.80
2.78
2.48
2.46
2.44
2.43
2.41
2.39
0.94
0.92
0.91
0.00
O
Et
H
N
N
O
CF3
CF3
26
1.00
3.02
3.04
1.02
2.01
1.00
8.14
1.04
1.02
3.04
f1 (ppm)

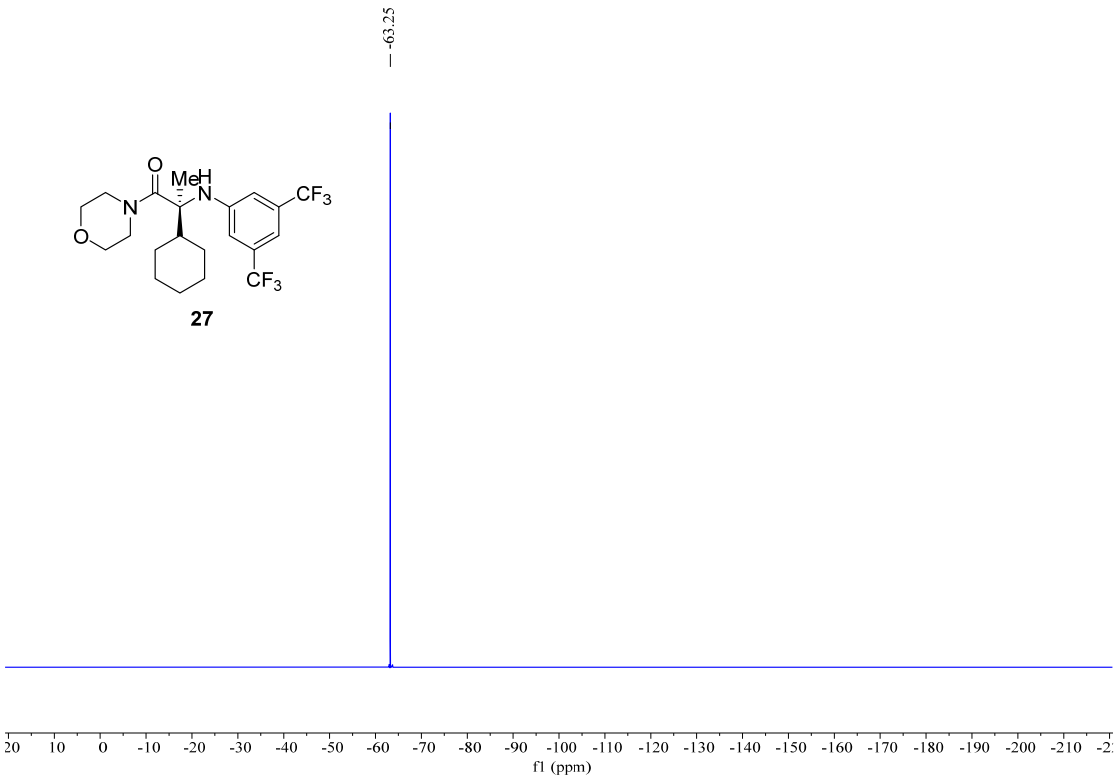

170.10
145.11
137.77
132.89
132.63
132.39
132.07
131.75
131.42
129.41
127.90
127.66
127.44
126.95
126.86
125.46
124.73
124.33
122.02
119.31
113.51
113.48
113.48
109.97
109.92
109.89
109.89
77.32
77.00
76.68
66.19
66.14
45.69
23.98
8.15
O
Et
H
N
N
O
CF3
CF3
26
f1 (ppm)


-63.34
O
Et
H
N
N
O
CF3
CF3
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

26


7.28 7.19 6.97 4.48 4.00 3.83 3.82 3.81 3.80 3.79 3.78 3.78 3.77 3.74 3.72 3.71 3.70 3.69 3.67 3.66 3.65 3.50 3.49 3.48 3.47 3.46 3.45 3.17 1.94 1.93 1.92 1.92 1.91 1.89 1.88 1.87 1.86 1.83 1.82 1.81 1.76 1.73 1.62 1.62 1.60 1.59 1.44 1.31 1.29 1.26 1.25 1.24 1.23 1.22 1.20 1.19 -0.00
O
Me
H
N
N
O
CF3
CF3
27
1.00 2.05 1.02 8.19 5.28 1.00 3.06 5.13
f1 (ppm)


170.96
146.00 132.97 132.65 132.32 132.00 127.38 124.67 121.96 119.25 113.43 113.39 113.36 113.31 111.02 110.98 110.94 110.90 110.86
77.32 77.00 76.68
66.71 64.82
45.21 43.66
28.34 26.81 26.56 26.54 26.14 18.30
O
Me
H
N
N
O
CF3
CF3
27
f1 (ppm)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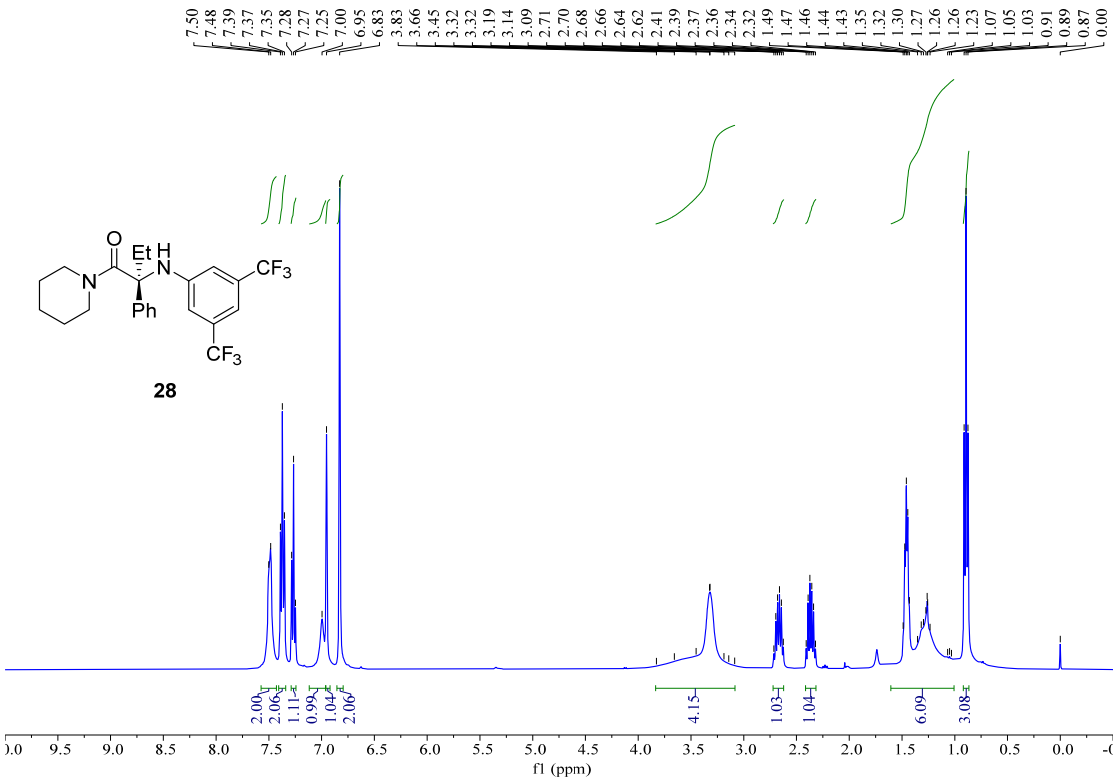
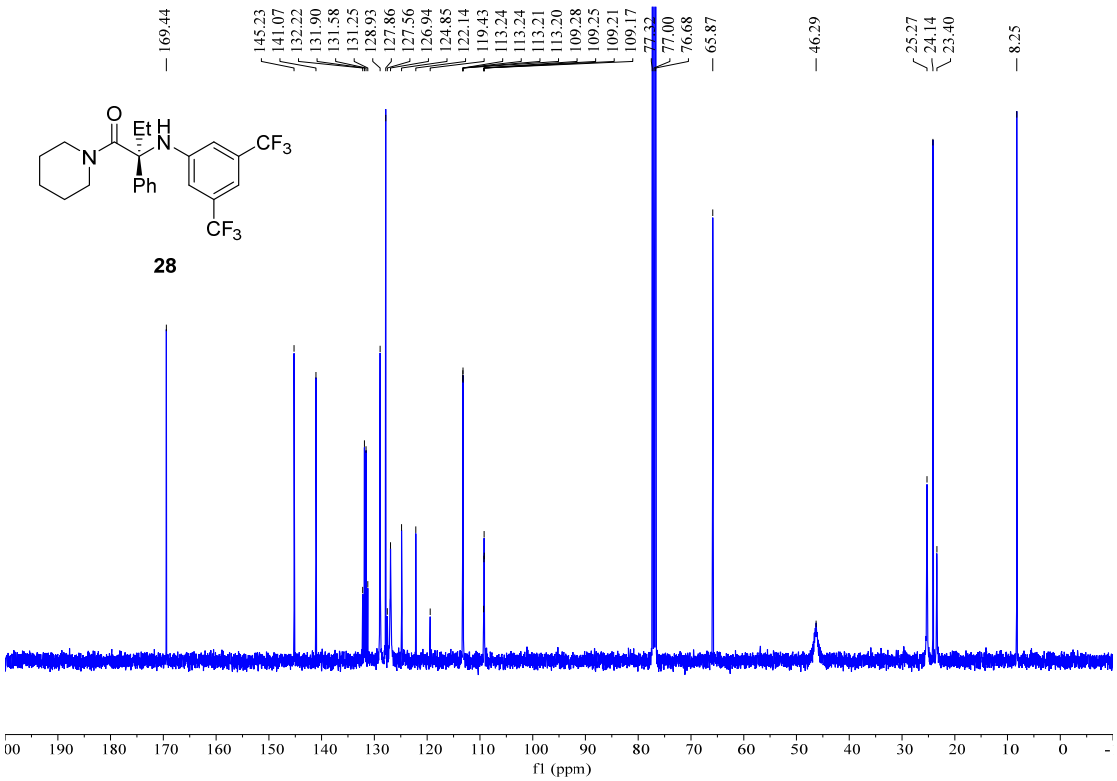
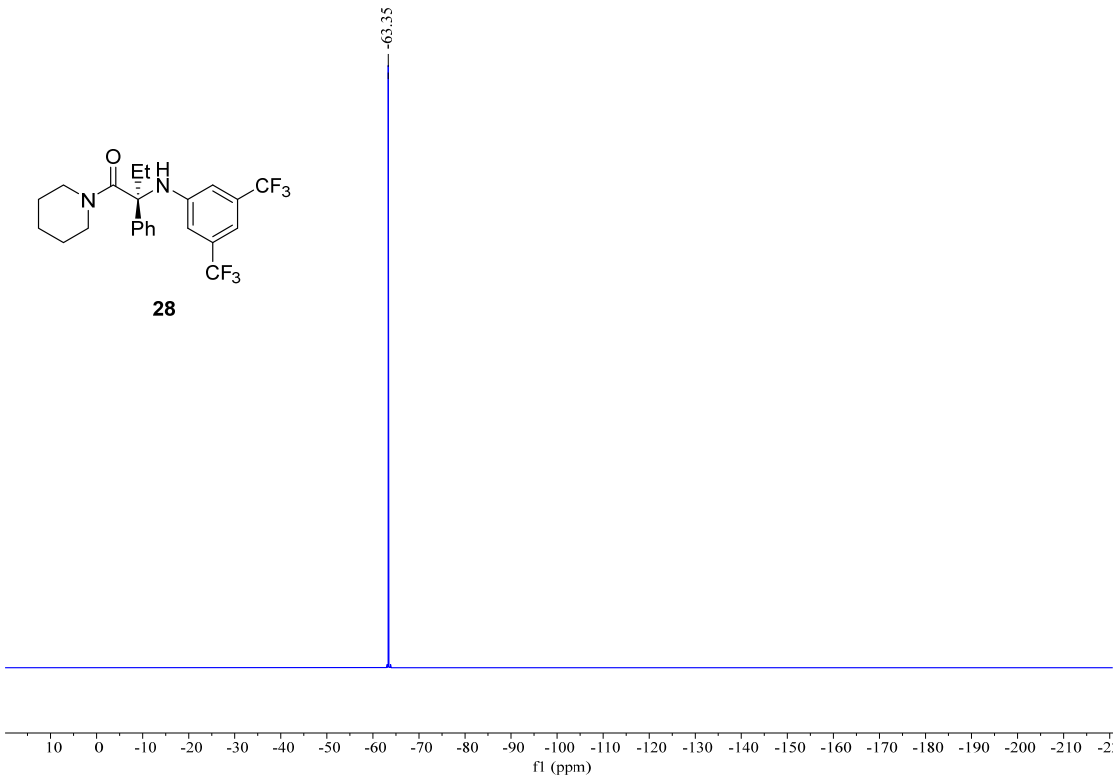
O
Me
H
N
N
O
CF3
CF3
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

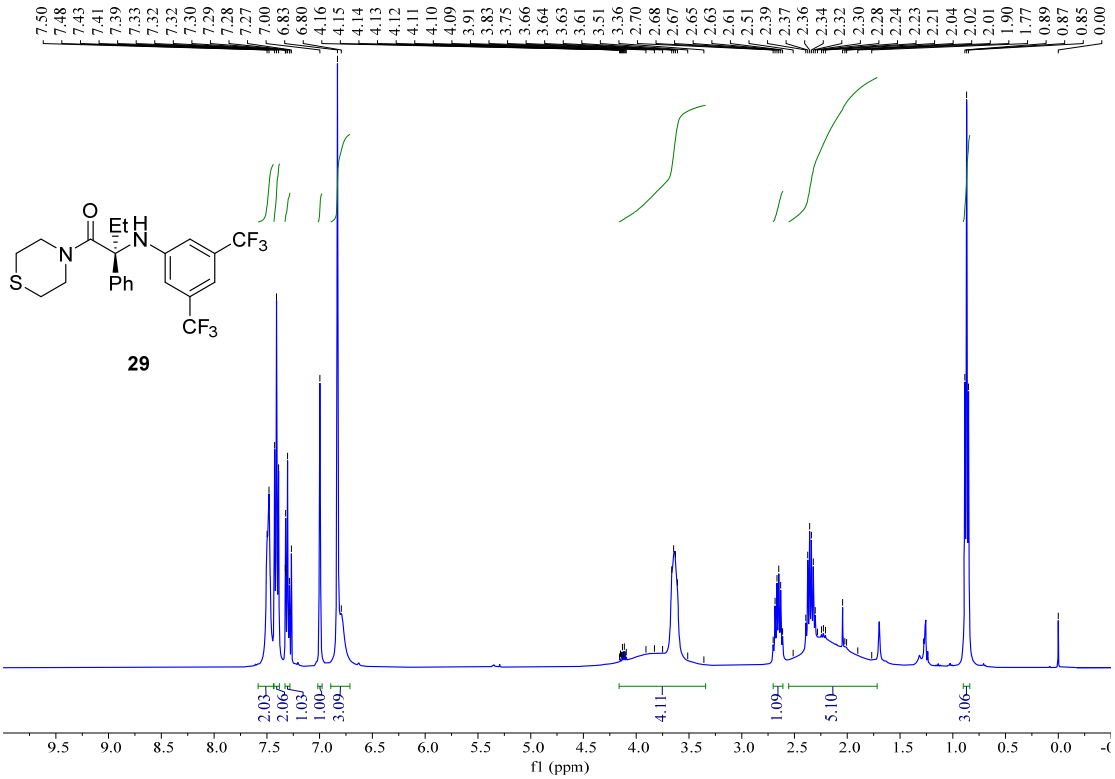
27

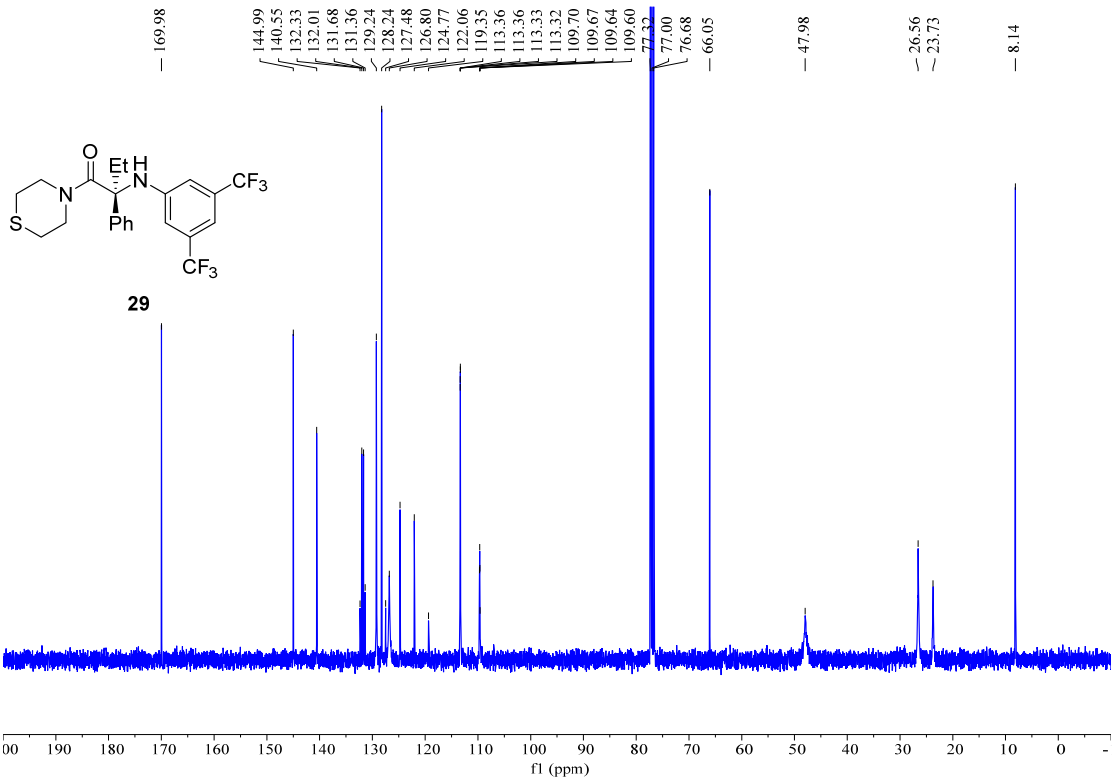

28
f1 (ppm)

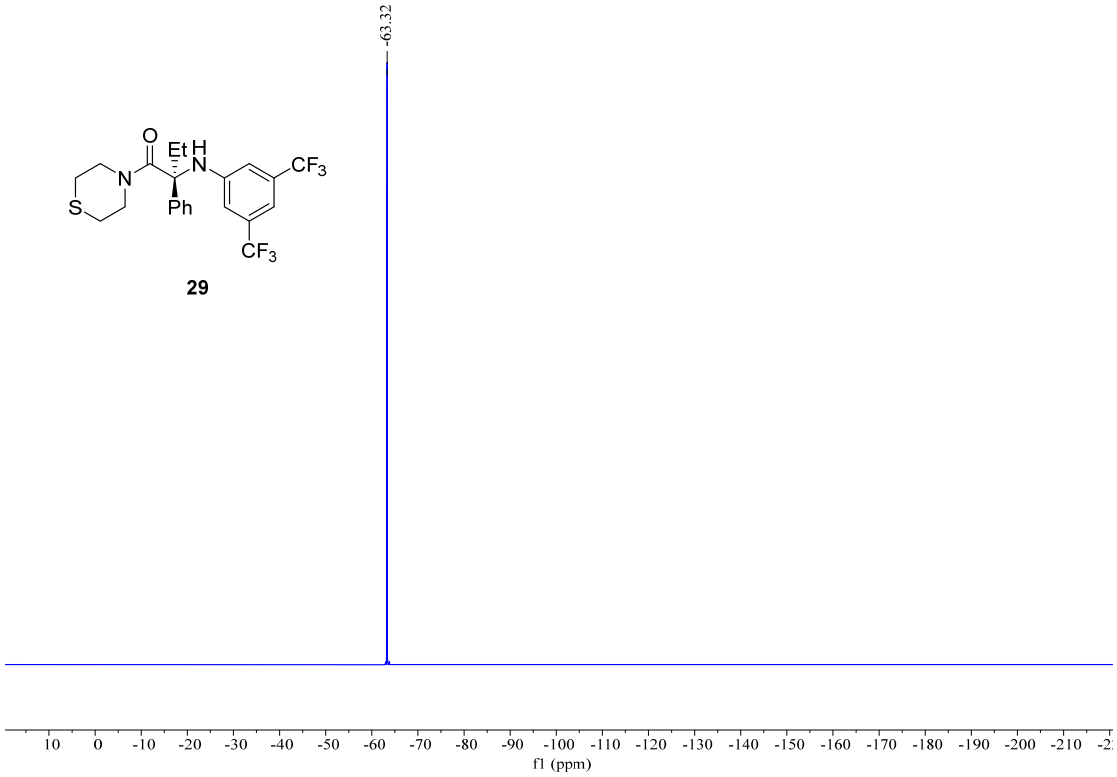

28
f1 (ppm)


-63.35
O
Et
H
N
N
Ph
CF3
CF3
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

28


7.50 7.48 7.43 7.41 7.39 7.33 7.32 7.32 7.30 7.29 7.28 7.27 7.00 6.83 6.80 4.16 4.15 4.14 4.13 4.12 4.11 4.10 4.09 3.91 3.83 3.75 3.66 3.64 3.63 3.61 3.51 3.36 2.70 2.68 2.67 2.65 2.63 2.61 2.51 2.39 2.37 2.36 2.34 2.32 2.30 2.28 2.24 2.23 2.21 2.04 2.02 2.01 1.90 1.77 0.89 0.87 0.85 0.00
O
Et H
N
N
S
Ph
CF3
CF3
29
2.03 2.06 1.03 1.00 3.09 4.11 1.09 5.10 3.06
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


169.98
144.99 140.55 132.33 132.01 131.68 131.36 129.24 128.24 127.48 126.80 124.77 122.06 119.35 113.36 113.36 113.33 113.32 109.70 109.67 109.64 109.60
77.32 77.00 76.68
66.05
47.98
26.56 23.73
8.14
O
Et H
N
N
S
Ph
CF3
CF3
29
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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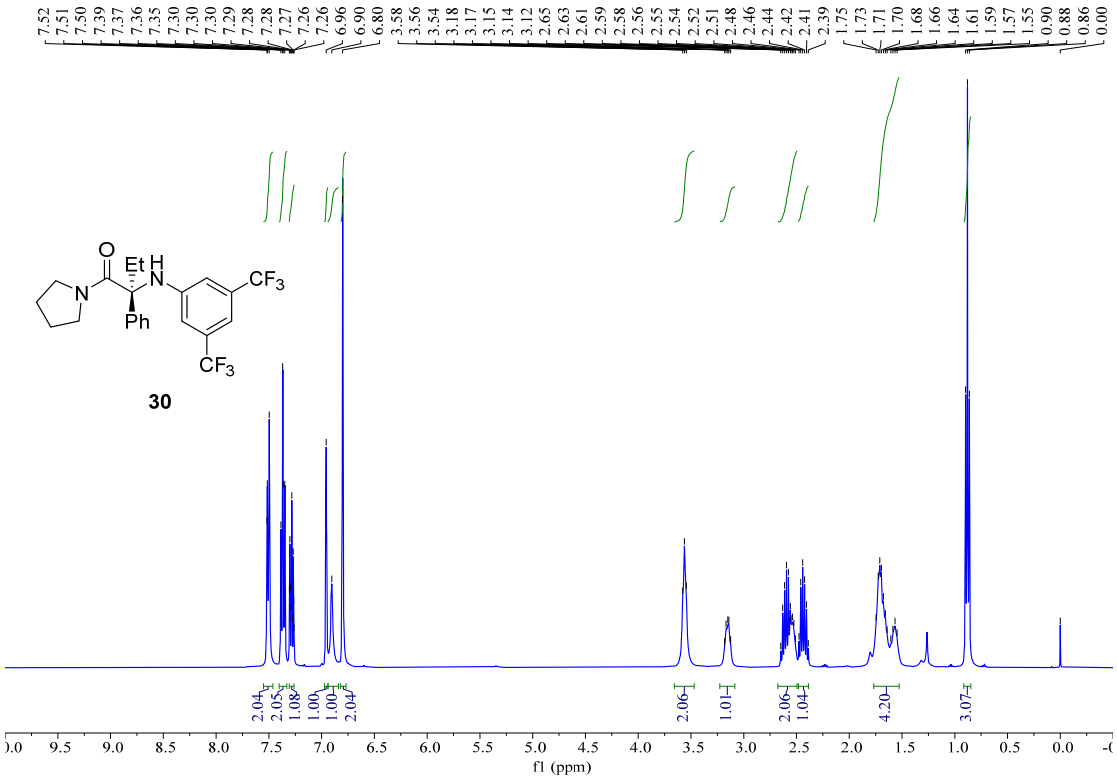
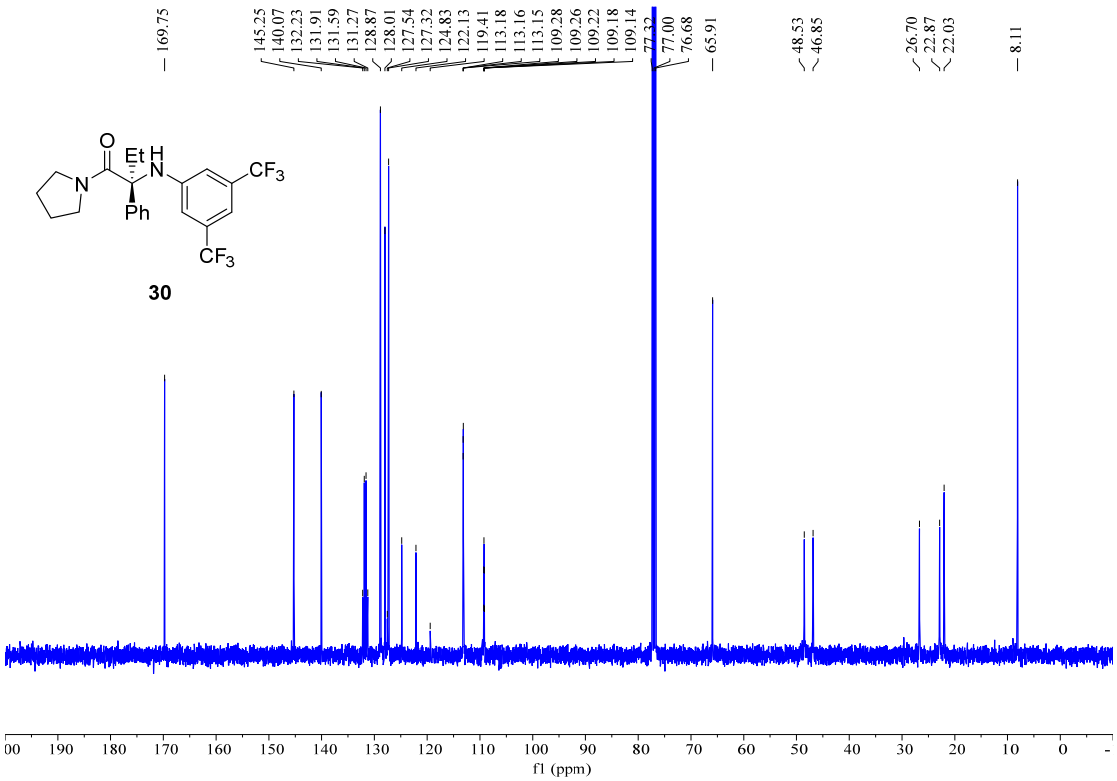
O
Et
H
N
N
S
Ph
CF3
CF3
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

29


7.52 7.51 7.50 7.39 7.37 7.36 7.35 7.30 7.30 7.30 7.29 7.28 7.28 7.27 7.26 7.26 6.96 6.90 6.80
3.58 3.56 3.54 3.18 3.17 3.15 3.14 3.12 2.65 2.63 2.61 2.59 2.58 2.56 2.55 2.54 2.52 2.51 2.48 2.46 2.44 2.42 2.41 2.39
1.75 1.73 1.71 1.70 1.68 1.66 1.64 1.61 1.59 1.57 1.55 0.90 0.88 0.86 0.00
O
Et H
N
N
Ph
CF3
CF3
30
2.04 2.05 1.08 1.00 1.00 2.04
2.06 1.01 2.06 1.04 4.20 3.07
f1 (ppm)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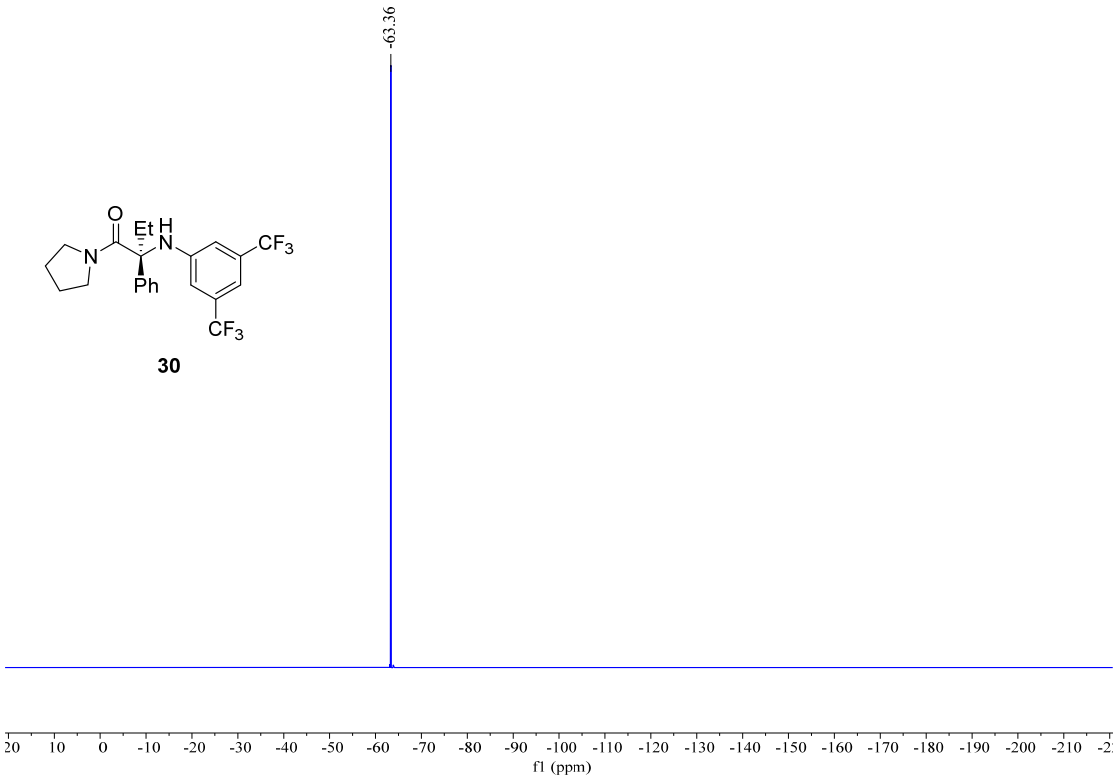
145.25 140.07 132.23 131.91 131.59 131.27 128.87 128.01 127.54 127.32 124.83 122.13 119.41 113.18 113.16 113.15 109.28 109.26 109.22 109.18 109.14
77.32 77.00 76.68
65.91
48.53 46.85
26.70 22.87 22.03
8.11
O
Et H
N
N
Ph
CF3
CF3
30
f1 (ppm)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O
Et
H
N
N
Ph
CF3
CF3
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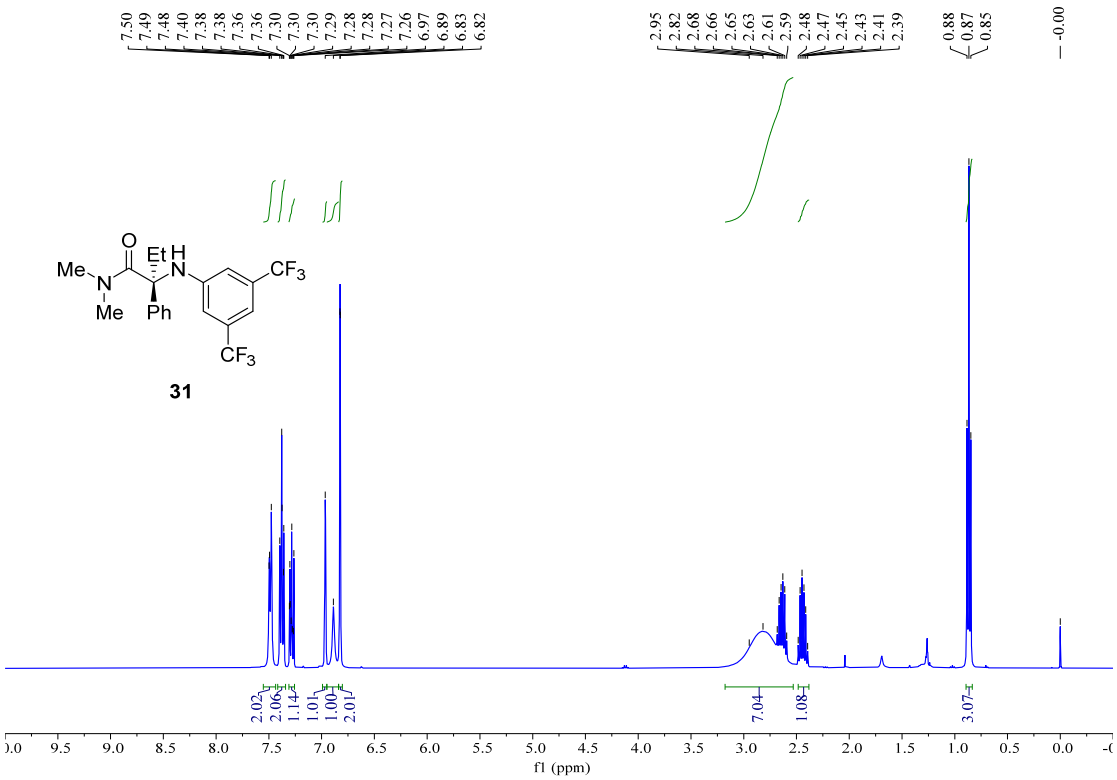
f1 (ppm)

30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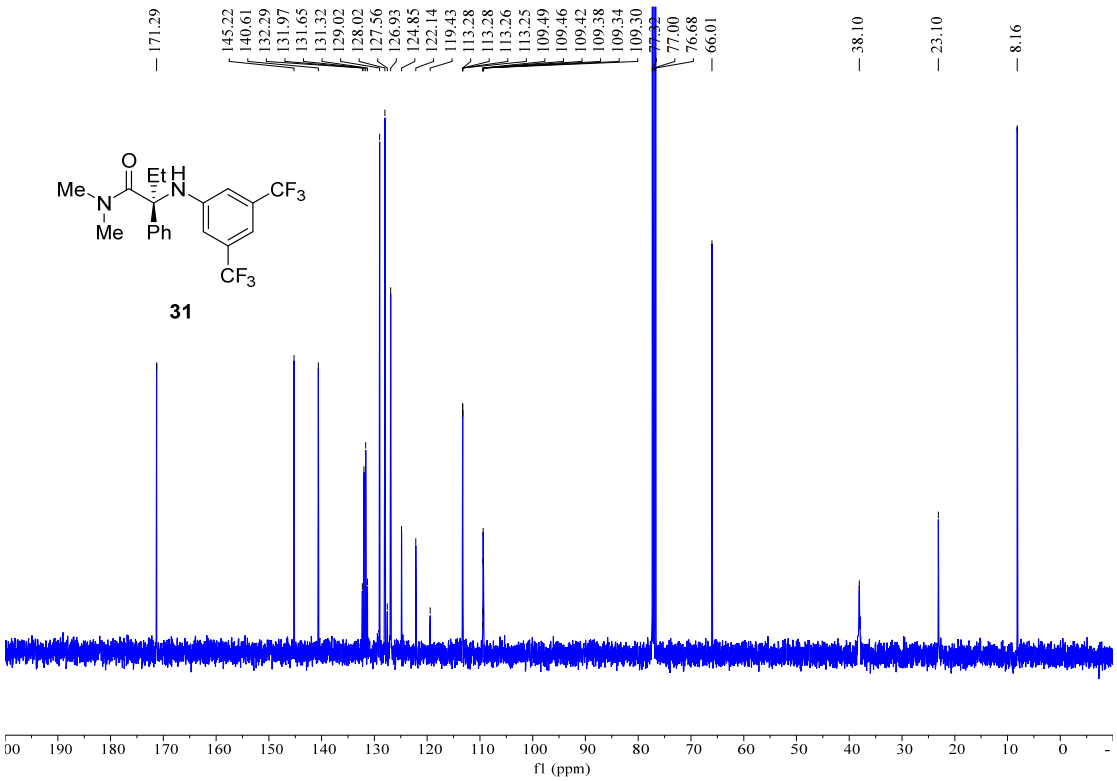
7.49
7.48
7.40
7.38
7.38
7.36
7.36
7.30
7.30
7.30
7.29
7.28
7.28
7.27
7.26
6.97
6.89
6.83
6.82
2.95
2.82
2.68
2.66
2.65
2.63
2.61
2.59
2.48
2.47
2.45
2.43
2.41
2.39
0.88
0.87
0.85
-0.00
Me
N
Me
O
Et
H
N
Ph
CF3
CF3
31
2.02
2.06
1.14
1.01
1.00
2.01
7.04
1.08
3.07
f1 (ppm)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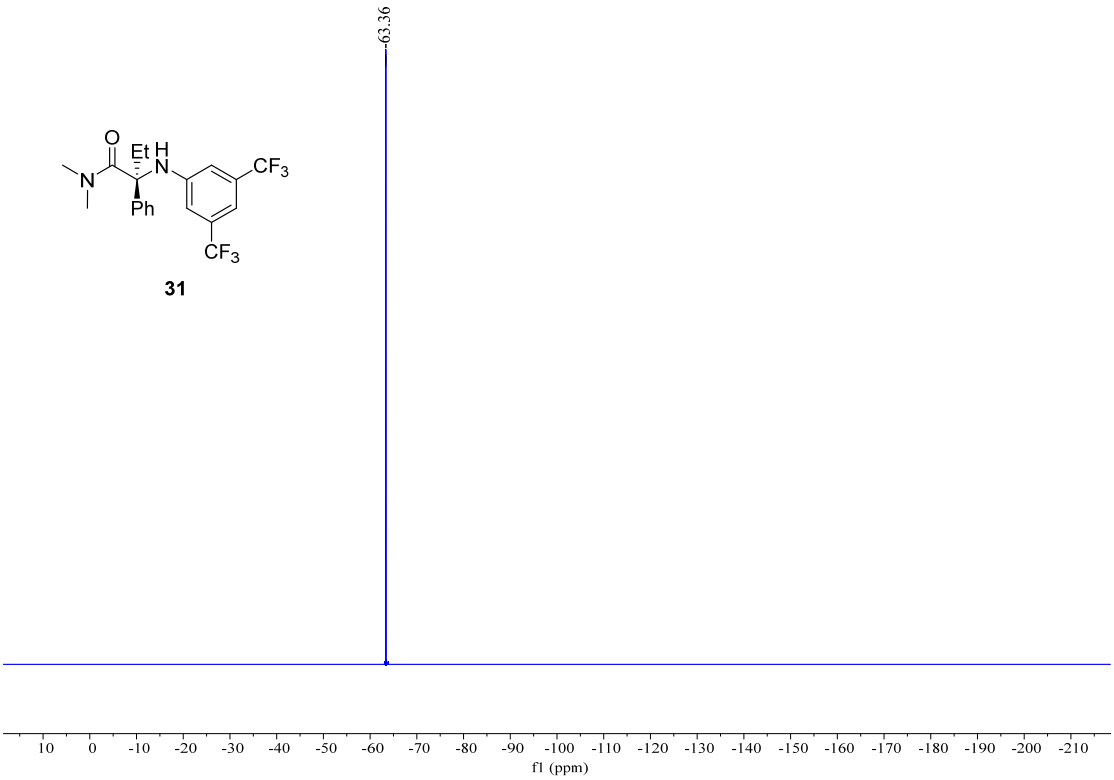
145.22
140.61
132.29
131.97
131.65
131.32
129.02
128.02
127.56
126.93
124.85
122.14
119.43
113.28
113.28
113.26
113.25
109.49
109.46
109.42
109.38
109.34
109.30
77.32
77.00
76.68
66.01
38.10
23.10
8.16
Me
N
Me
O
Et
H
N
Ph
CF3
CF3
31
f1 (ppm)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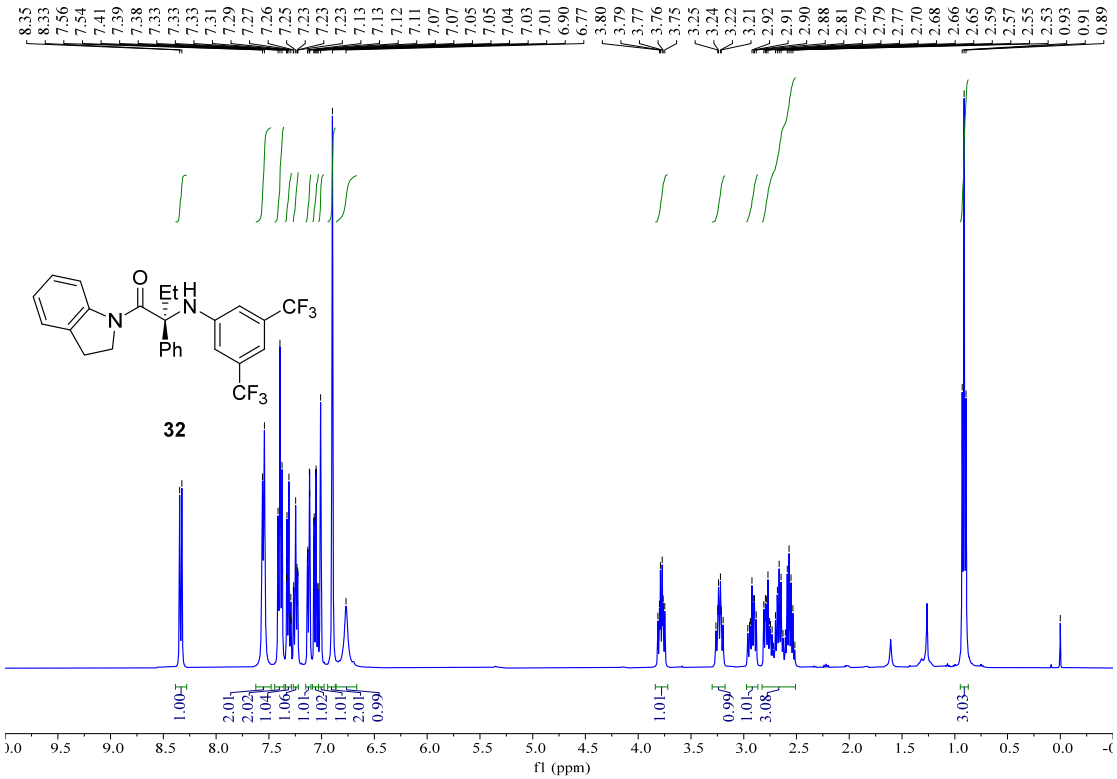
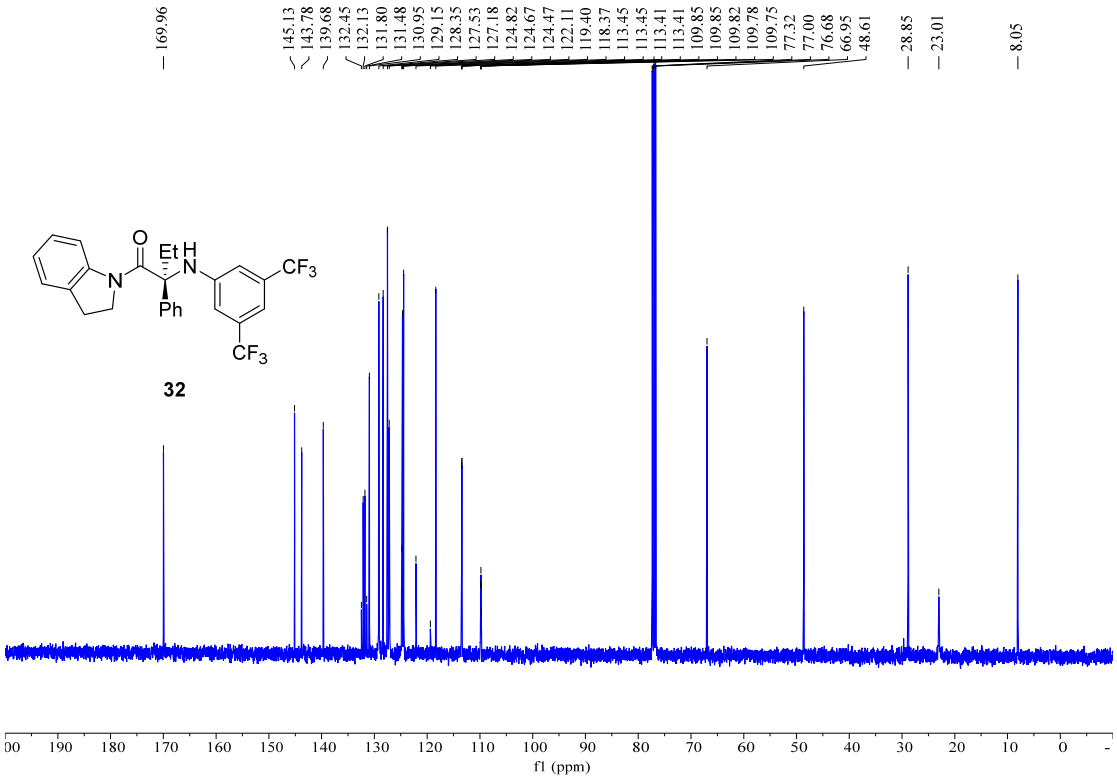
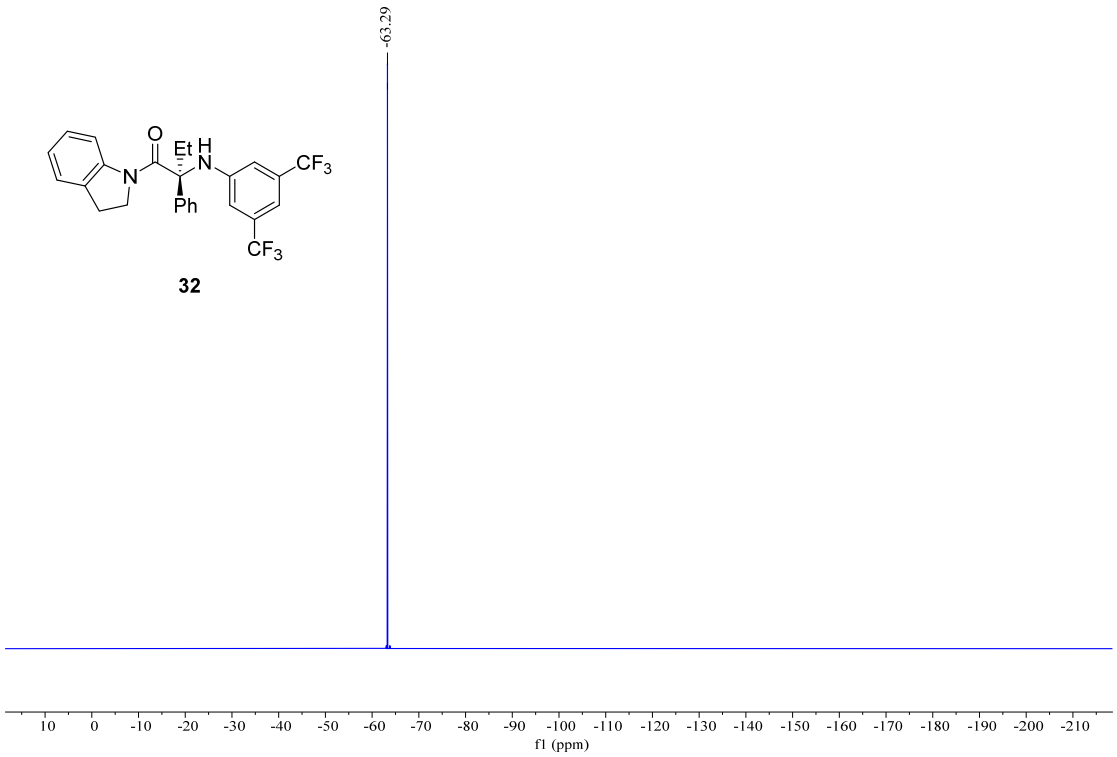
O
Et
H
N
N
Ph
CF3
CF3
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

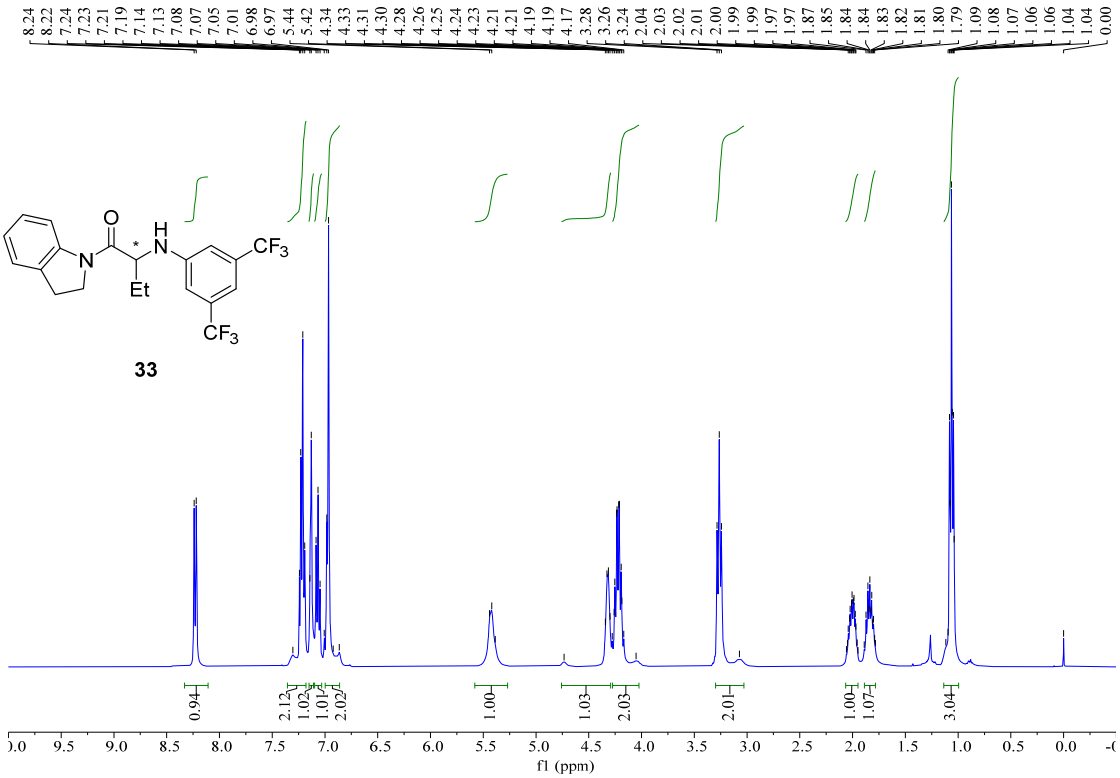
31

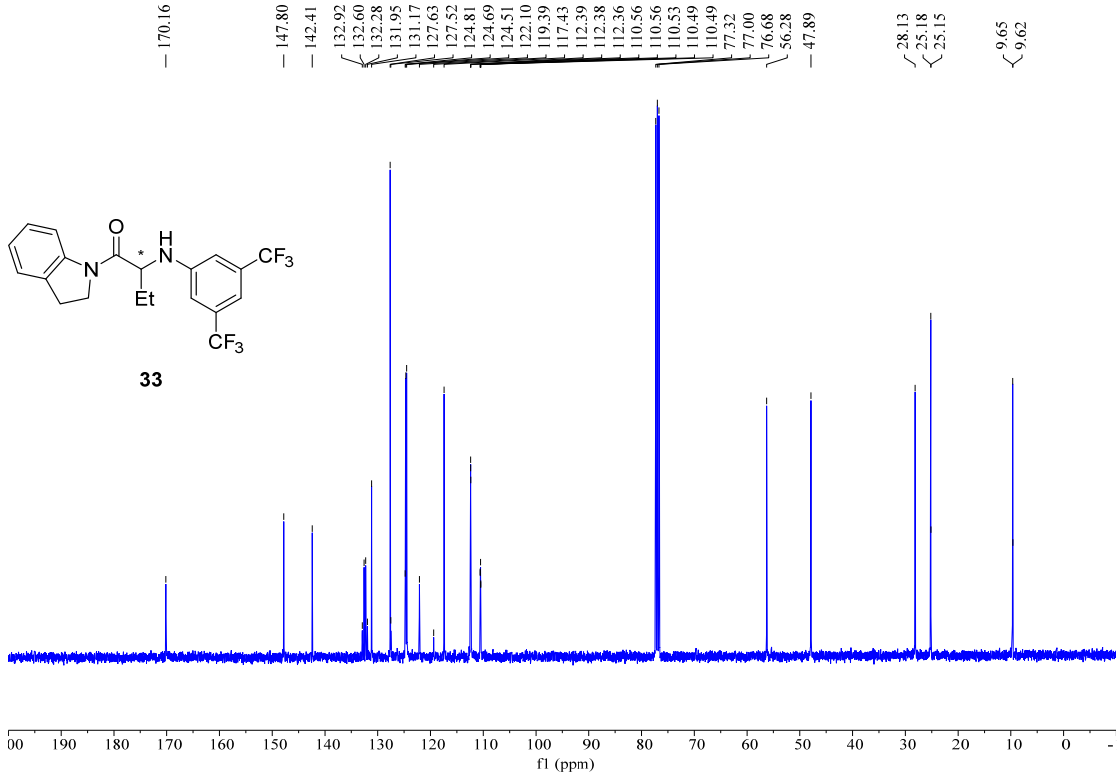

8.35 8.33 7.56 7.54 7.41 7.39 7.38 7.33 7.33 7.33 7.31 7.29 7.27 7.26 7.25 7.23 7.23 7.23 7.13 7.13 7.12 7.11 7.07 7.07 7.05 7.05 7.04 7.03 7.01 6.90 6.77
3.80 3.79 3.77 3.76 3.75 3.25 3.24 3.22 3.21 2.92 2.91 2.90 2.88 2.81 2.79 2.79 2.77 2.70 2.68 2.66 2.65 2.59 2.57 2.55 2.53 0.93 0.91 0.89
O
Et
H
N
N
Ph
CF3
CF3
32
1.00 2.01 2.02 1.04 1.06 1.01 1.02 1.01 2.01 0.99 1.01 0.99 1.01 3.08 3.03
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


169.96
145.13 143.78 139.68 132.45 132.13 131.80 131.48 130.95 129.15 128.35 127.53 127.18 124.82 124.67 124.47 122.11 119.40 118.37 113.45 113.41 113.41 109.85 109.85 109.82 109.78 109.75 77.32 77.00 76.68 66.95 48.61
28.85 23.01 8.05
O
Et
H
N
N
Ph
CF3
CF3
32
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


-63.29
O
Et
H
N
N
Ph
CF3
CF3
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

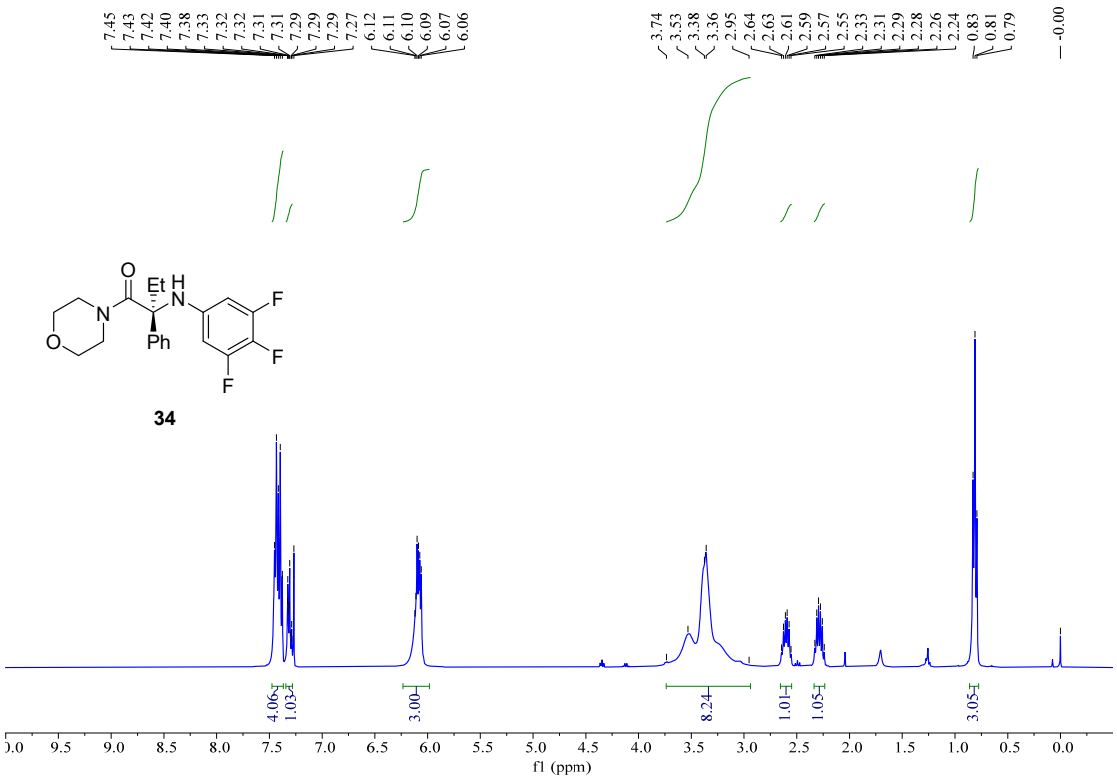
32


33
f1 (ppm)


33
f1 (ppm)


-63.20
-63.21
O
H
N
N
*
Et
CF3
CF3
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

33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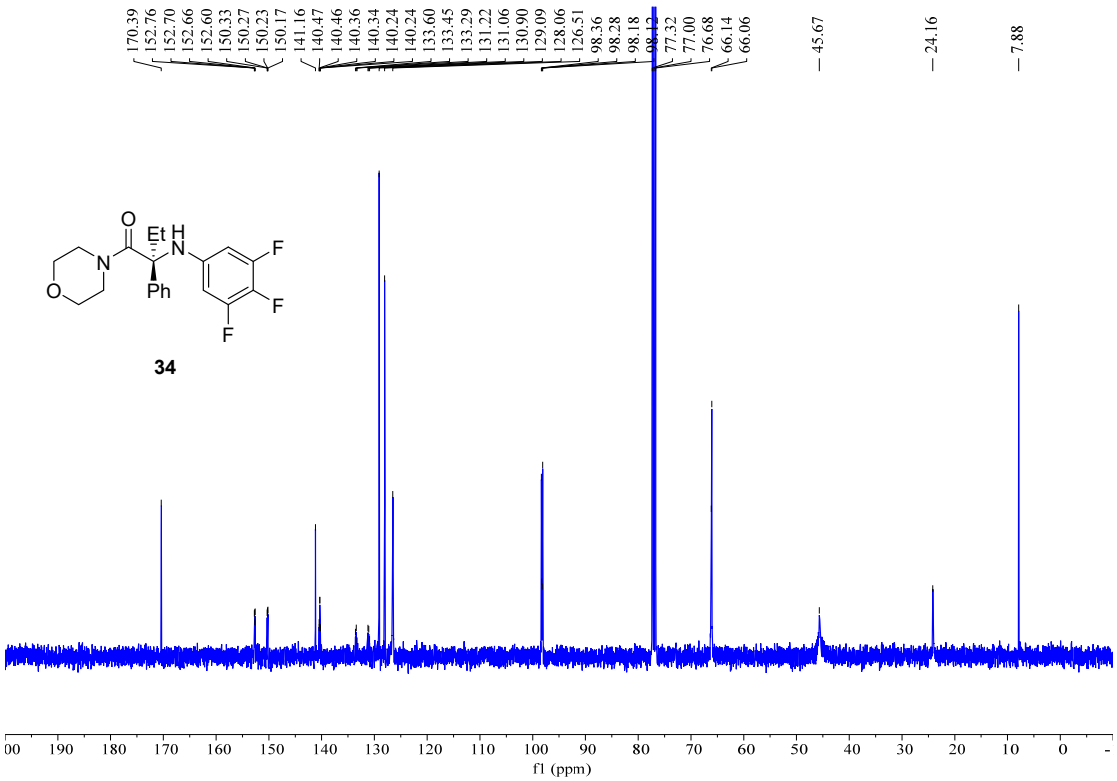
7.42
7.40
7.38
7.33
7.32
7.32
7.31
7.31
7.29
7.29
7.29
7.27
6.12
6.11
6.10
6.09
6.07
6.06
3.74
3.53
3.38
3.36
2.95
2.64
2.63
2.61
2.59
2.57
2.55
2.33
2.31
2.29
2.28
2.26
2.24
0.83
0.81
0.79
-0.00
O
Et
H
N
N
O
Ph
F
F
F
34
4.06
1.03
3.00
8.24
1.01
1.05
3.05
f1 (ppm)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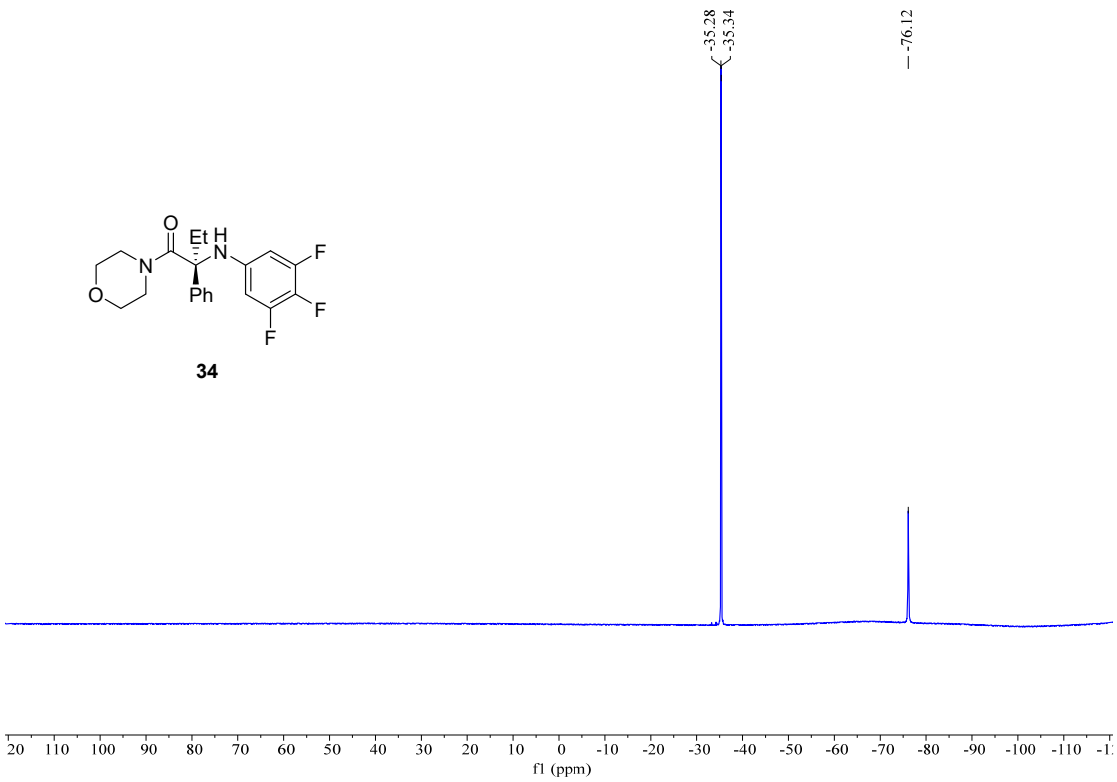
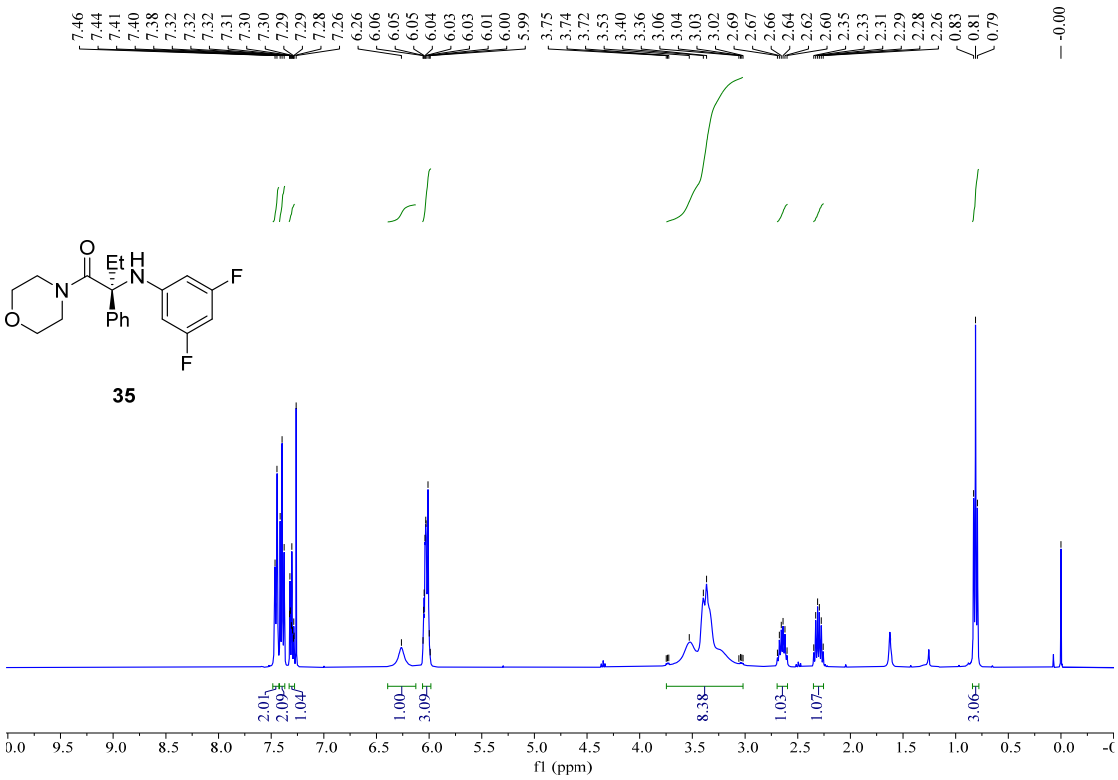
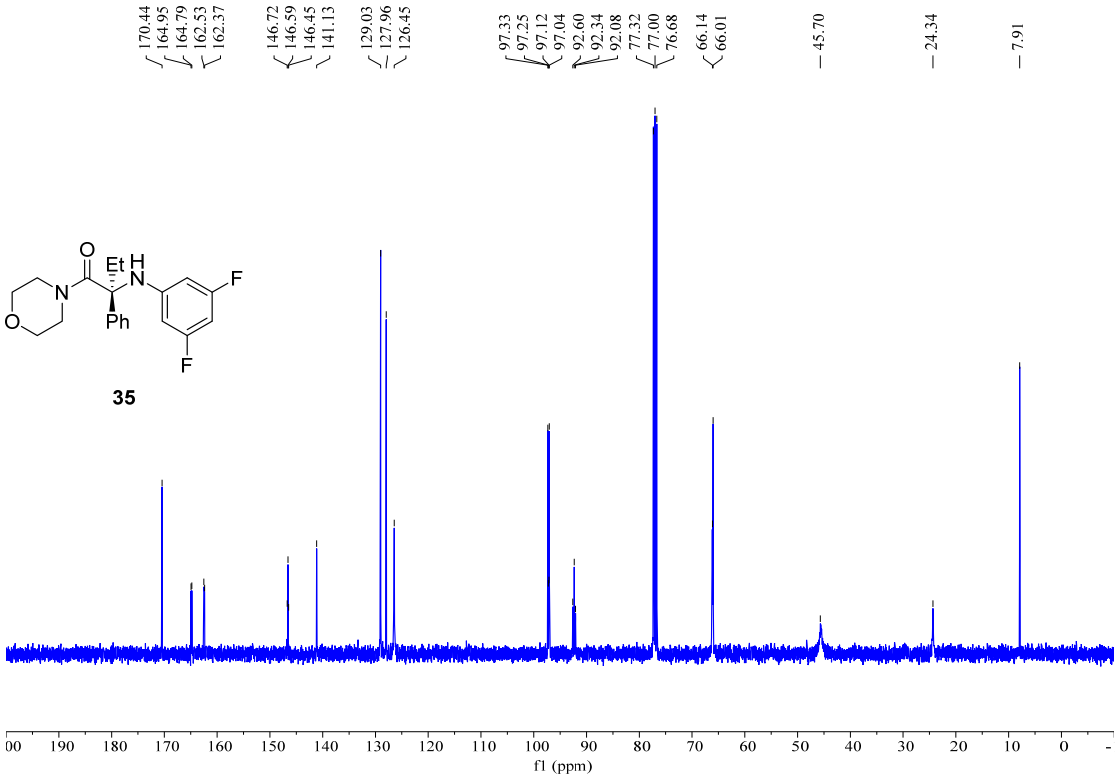
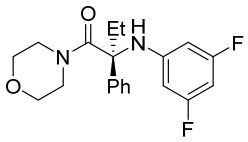
152.60
150.33
150.27
150.23
150.17
141.16
140.47
140.46
140.36
140.34
140.24
140.24
133.60
133.45
133.29
131.22
131.06
130.90
129.09
128.06
126.51
98.36
98.28
98.18
98.12
77.32
77.00
76.68
66.14
66.06
45.67
24.16
7.88
O
Et
H
N
N
O
Ph
F
F
F
34
f1 (ppm)


-35.28
-35.34
-76.12
O
Et
H
N
N
O
Ph
F
F
F
34
20 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110
f1 (ppm)

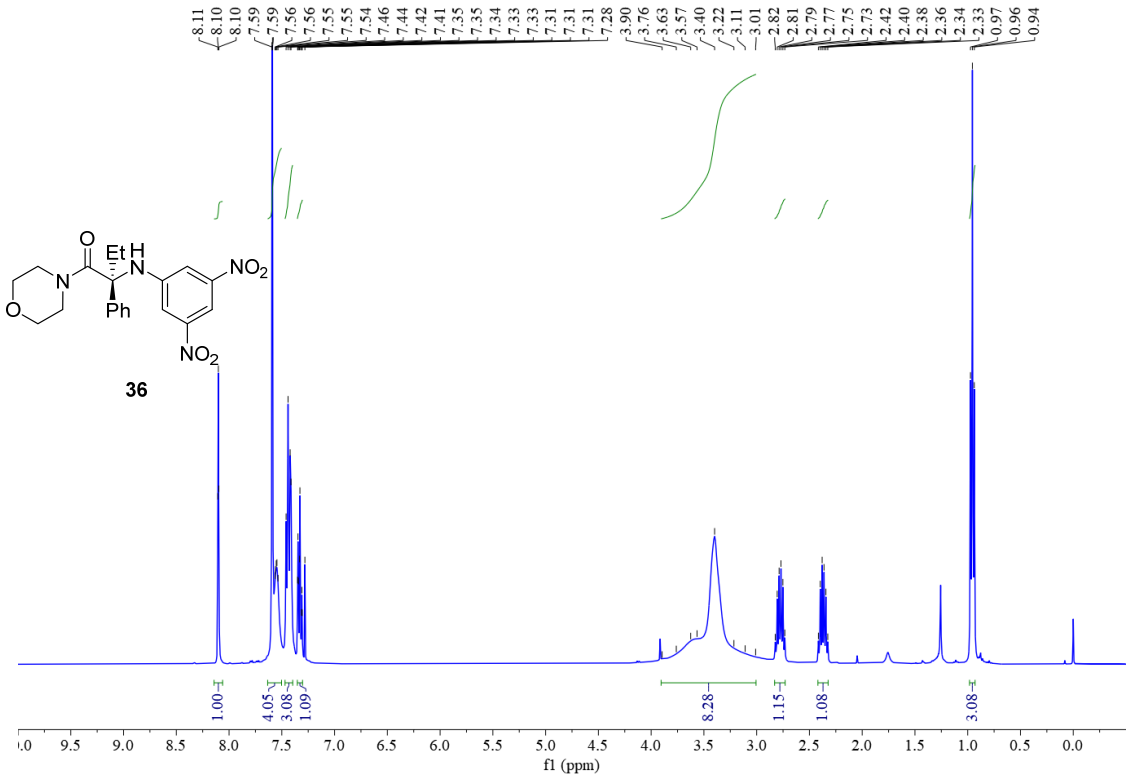

35
fl (ppm)


35
fl (ppm)


O
Et
H
N
N
O
Ph
F
F

35

-110.60
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)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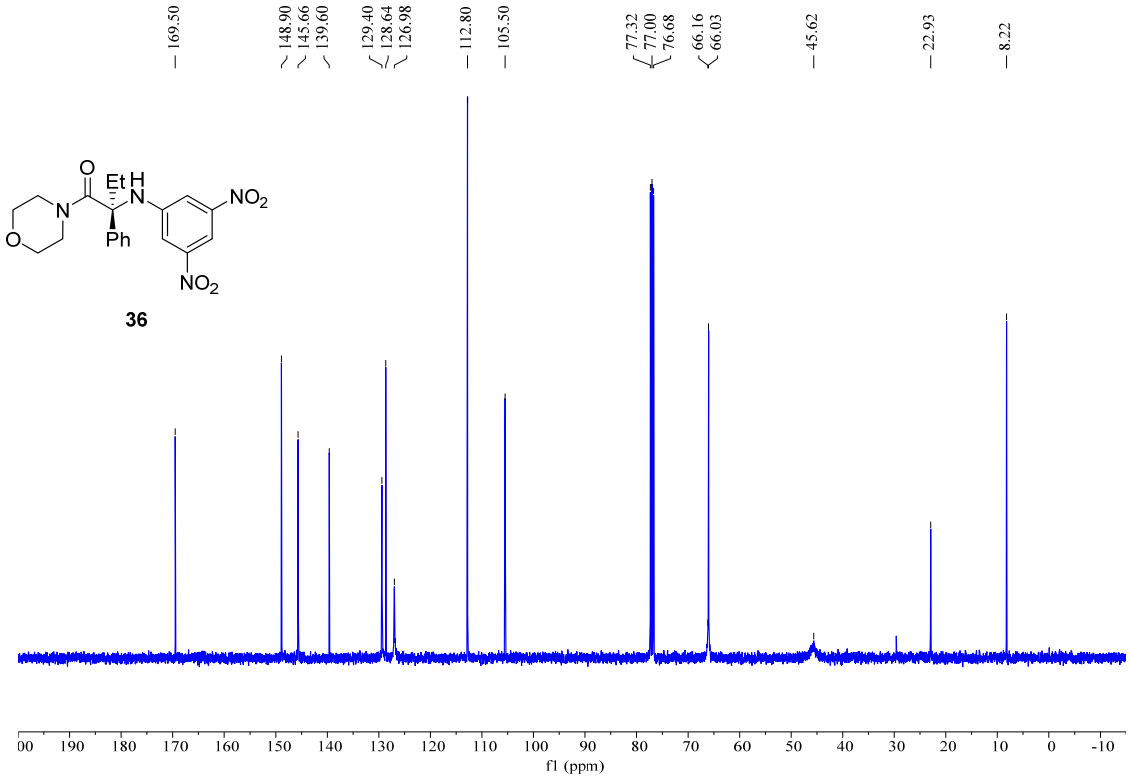
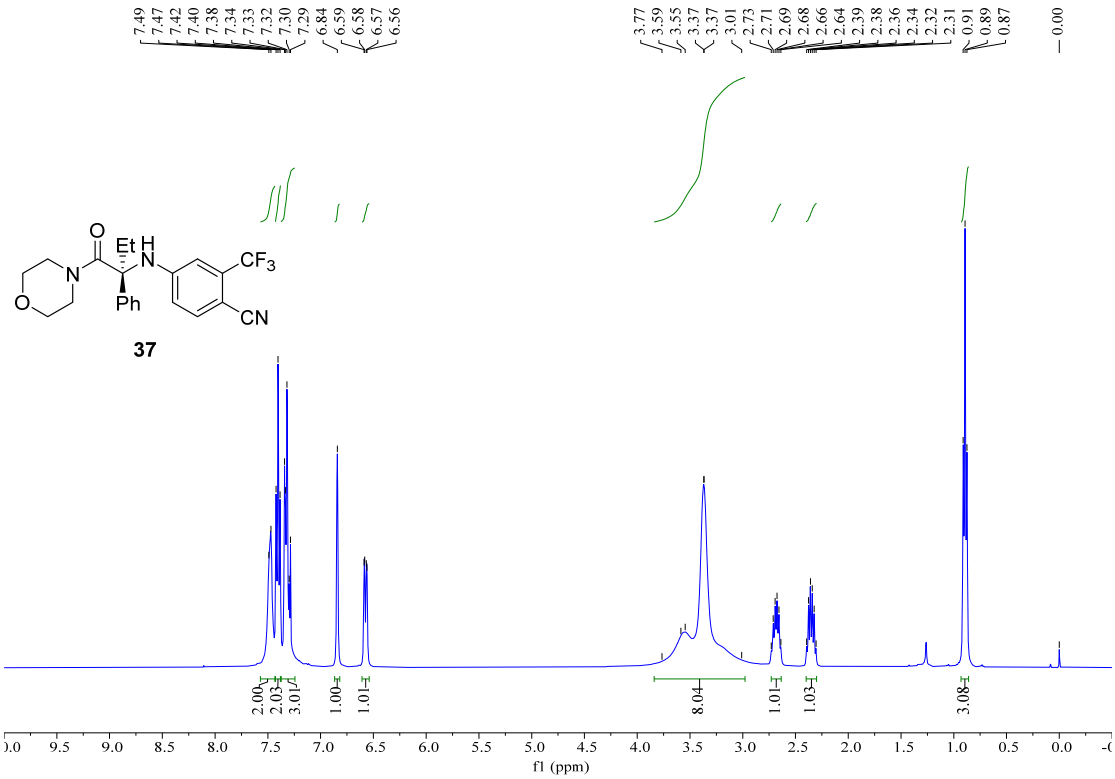
f1 (ppm)


36
f1 (ppm)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7.42
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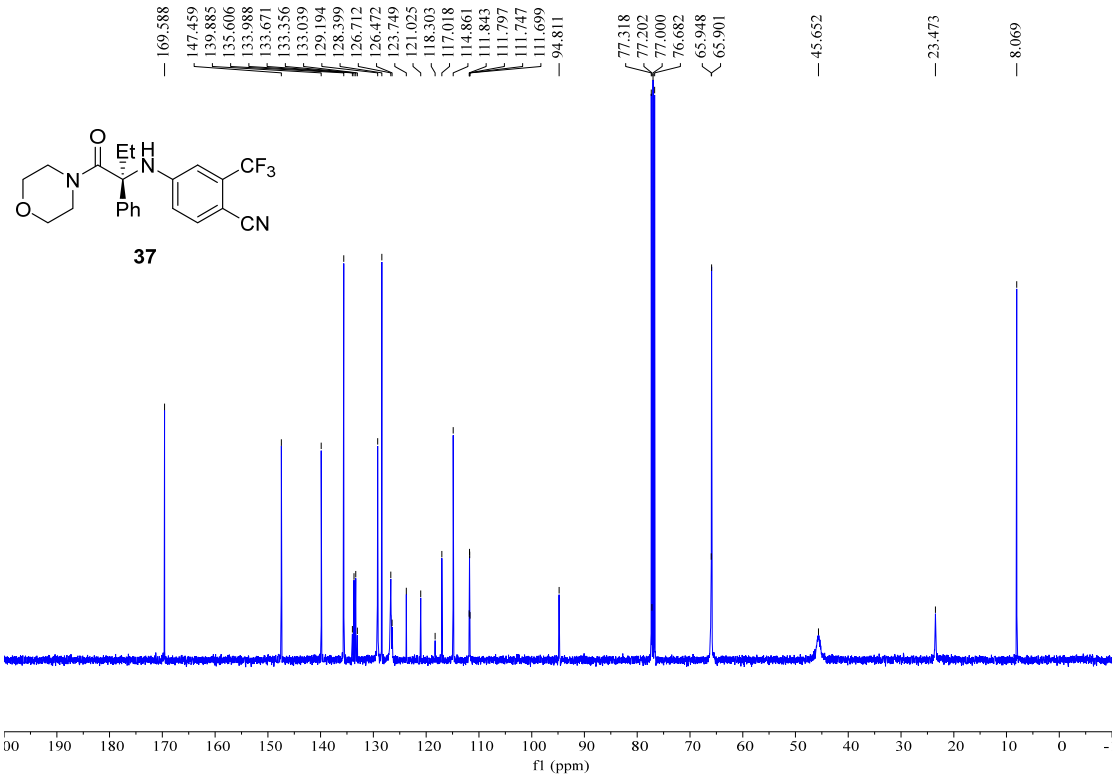
7.38
7.34
7.33
7.32
7.30
7.29
6.84
6.59
6.58
6.57
6.56
3.77
3.59
3.55
3.37
3.37
3.01
2.73
2.71
2.69
2.68
2.66
2.64
2.39
2.38
2.36
2.34
2.32
2.31
0.91
0.89
0.87
0.00
O
Et H
N
N
O
Ph
CF3
CN
37
2.00
2.03
3.01
1.00
1.01
8.04
1.01
1.03
3.08
f1 (ppm)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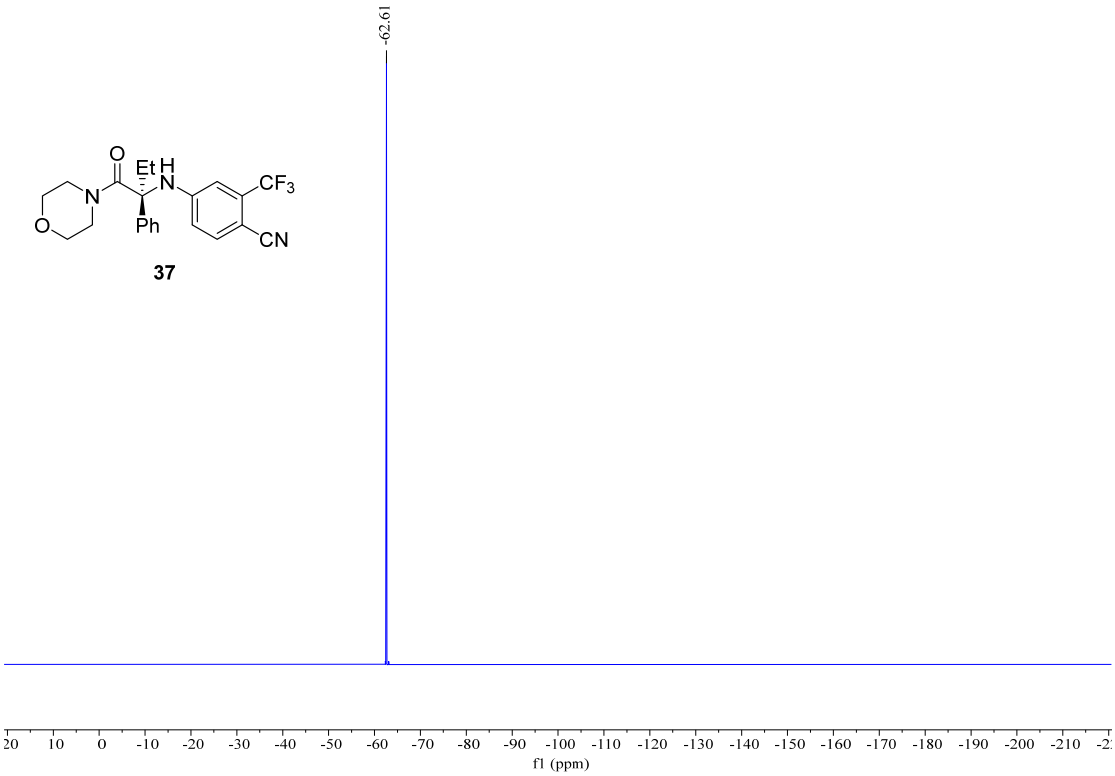
139.885
135.606
133.988
133.671
133.356
133.039
129.194
128.399
126.712
126.472
123.749
121.025
118.303
117.018
114.861
111.843
111.797
111.747
111.699
94.811
77.318
77.202
77.000
76.682
65.948
65.901
45.652
23.473
8.069
O
Et H
N
N
O
Ph
CF3
CN
37
f1 (ppm)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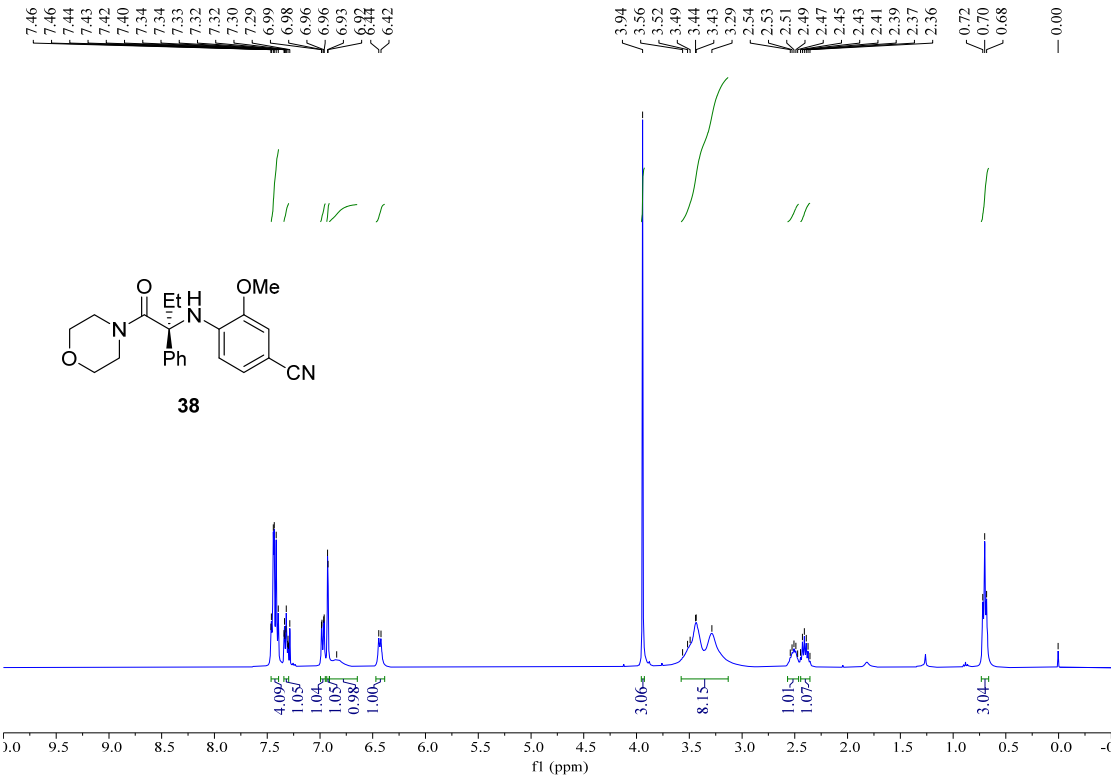
O
Et
H
N
N
O
Ph
CF3
CN
37
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)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7.43
7.42
7.40
7.34
7.34
7.33
7.32
7.32
7.30
7.29
6.99
6.98
6.96
6.96
6.93
6.92
6.44
6.42
3.94
3.56
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2.54
2.53
2.51
2.49
2.47
2.45
2.43
2.41
2.39
2.37
2.36
0.72
0.70
0.68
0.00
O
Et
H
N
OMe
N
O
Ph
CN
38
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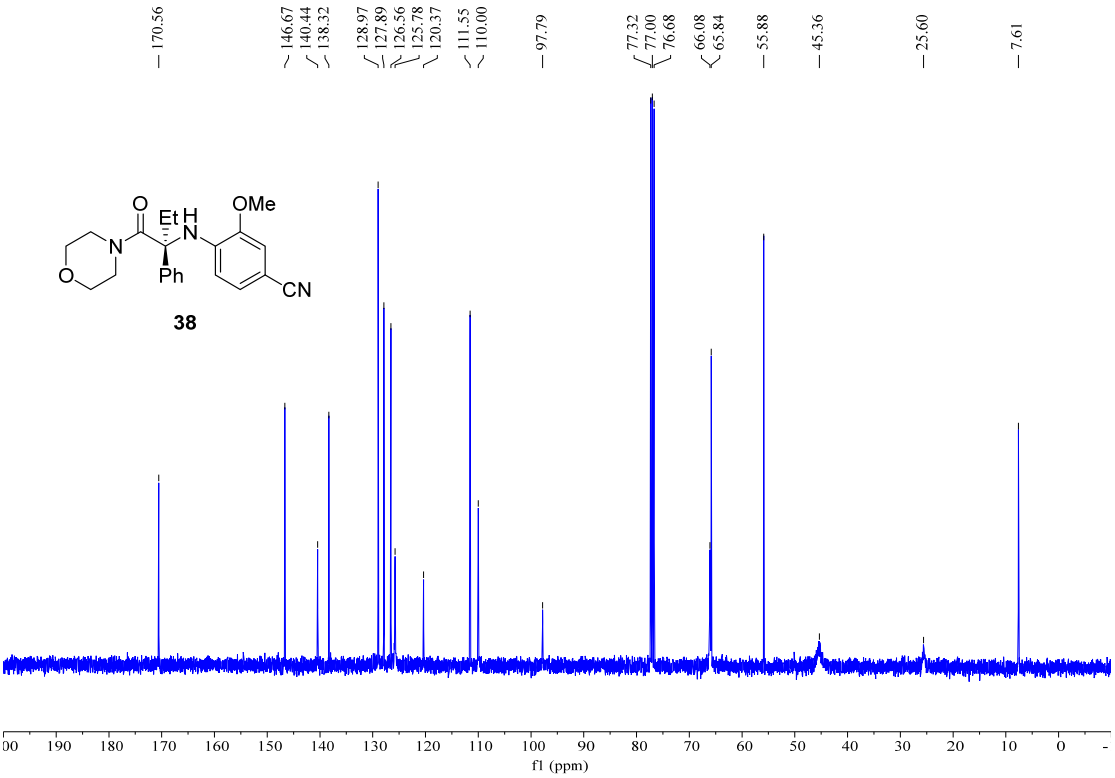
1.04
1.05
0.98
1.00
3.06
8.15
1.01
1.07
3.04
fl (ppm)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140.44
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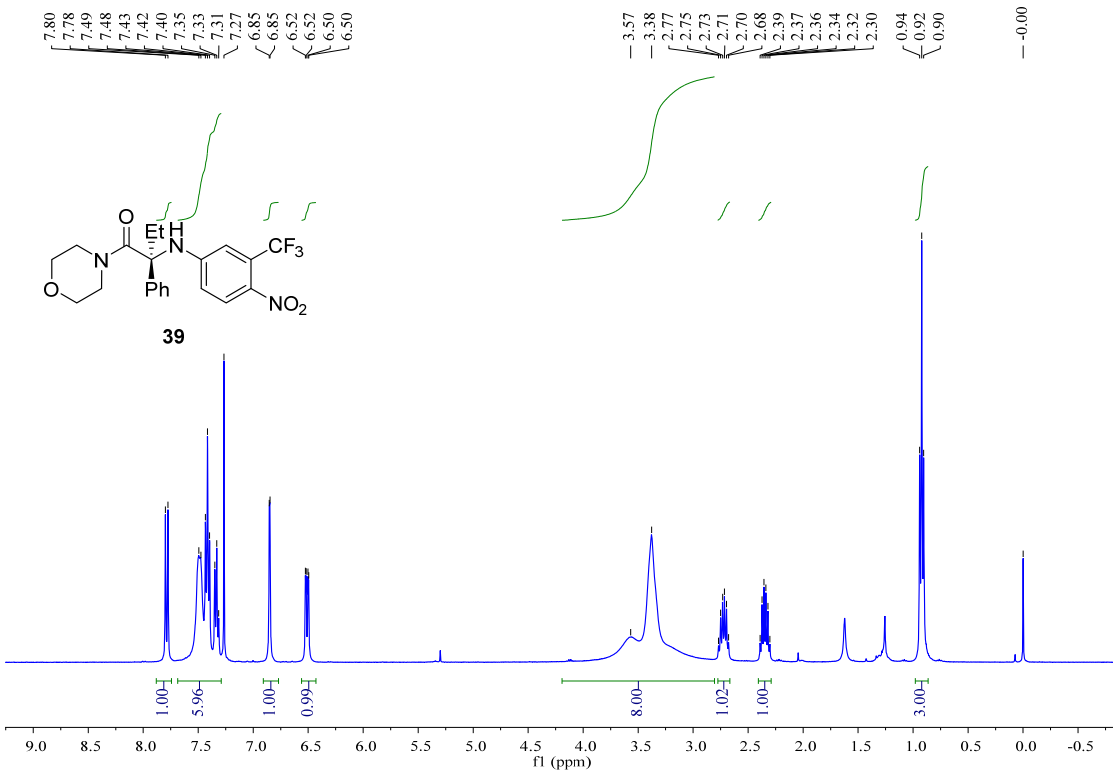
127.89
126.56
125.78
120.37
111.55
110.00
97.79
77.32
77.00
76.68
66.08
65.84
55.88
45.36
25.60
7.61
O
Et
H
N
OMe
N
O
Ph
CN
38
fl (ppm)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7.78
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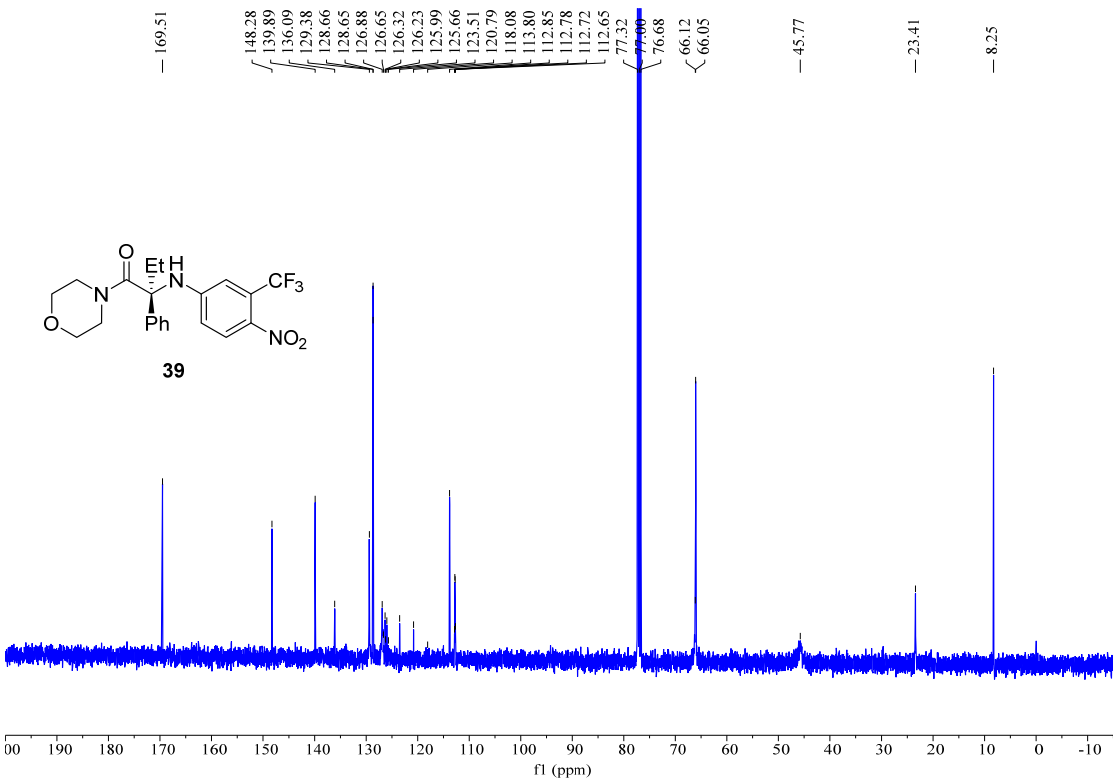
7.35
7.33
7.31
7.27
6.85
6.85
6.52
6.52
6.50
6.50
3.57
3.38
2.77
2.75
2.73
2.71
2.70
2.68
2.39
2.37
2.36
2.34
2.32
2.30
0.94
0.92
0.90
-0.00
O
Et
H
N
N
O
Ph
CF3
NO2
39
1.00
5.96
1.00
0.99
8.00
1.02
1.00
3.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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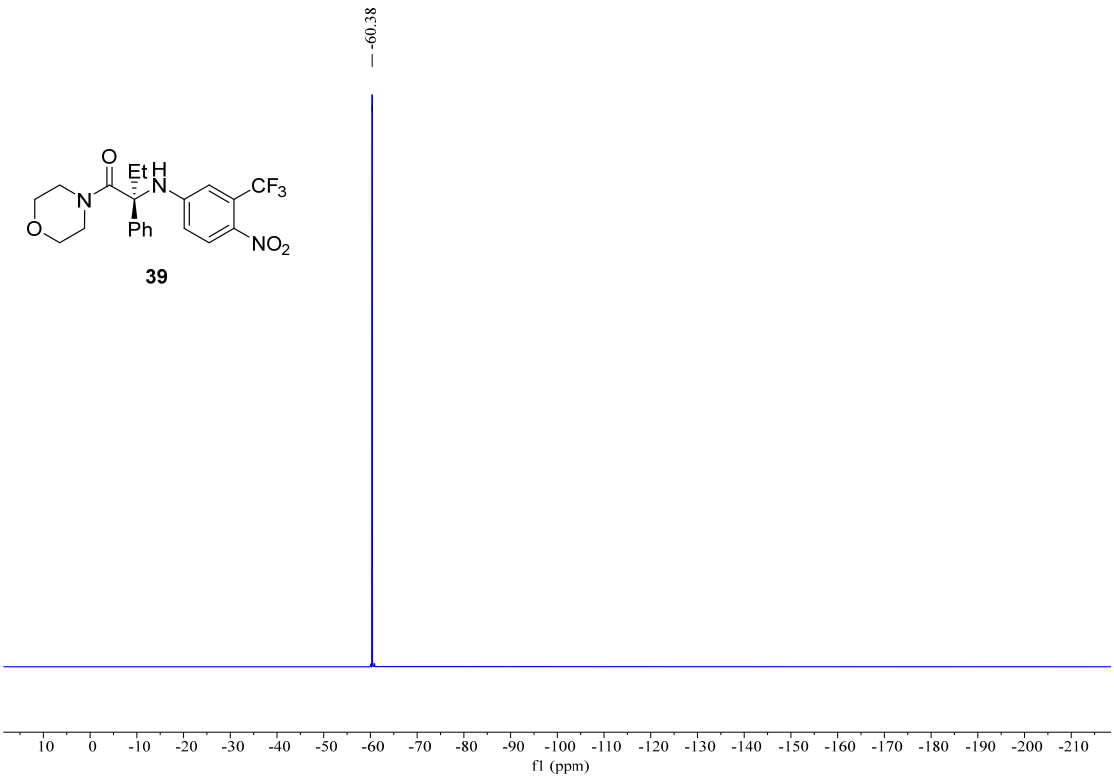
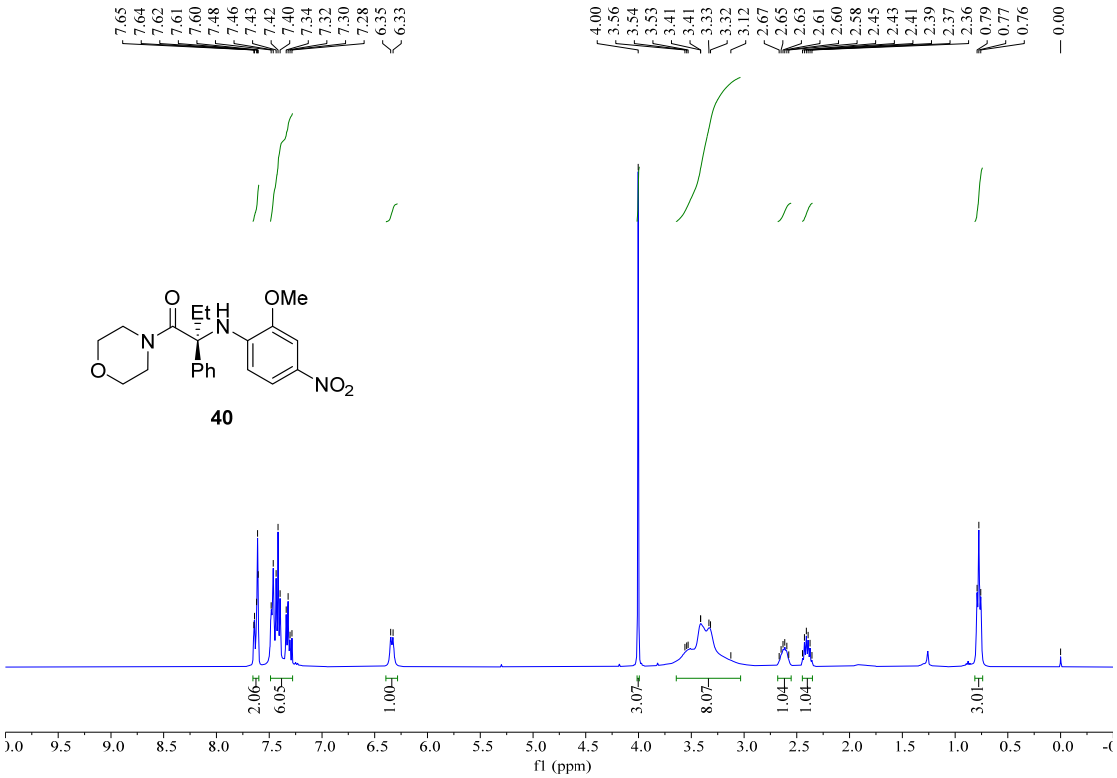
128.65
126.88
126.65
126.32
126.23
125.99
125.66
123.51
120.79
118.08
113.80
112.85
112.78
112.72
112.65
77.32
77.00
76.68
66.12
66.05
45.77
23.41
8.25
O
Et
H
N
N
O
Ph
CF3
NO2
39
00 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


-60.38
O
Et
H
N
CF3
N
O
Ph
NO2
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

39


7.65
7.64
7.62
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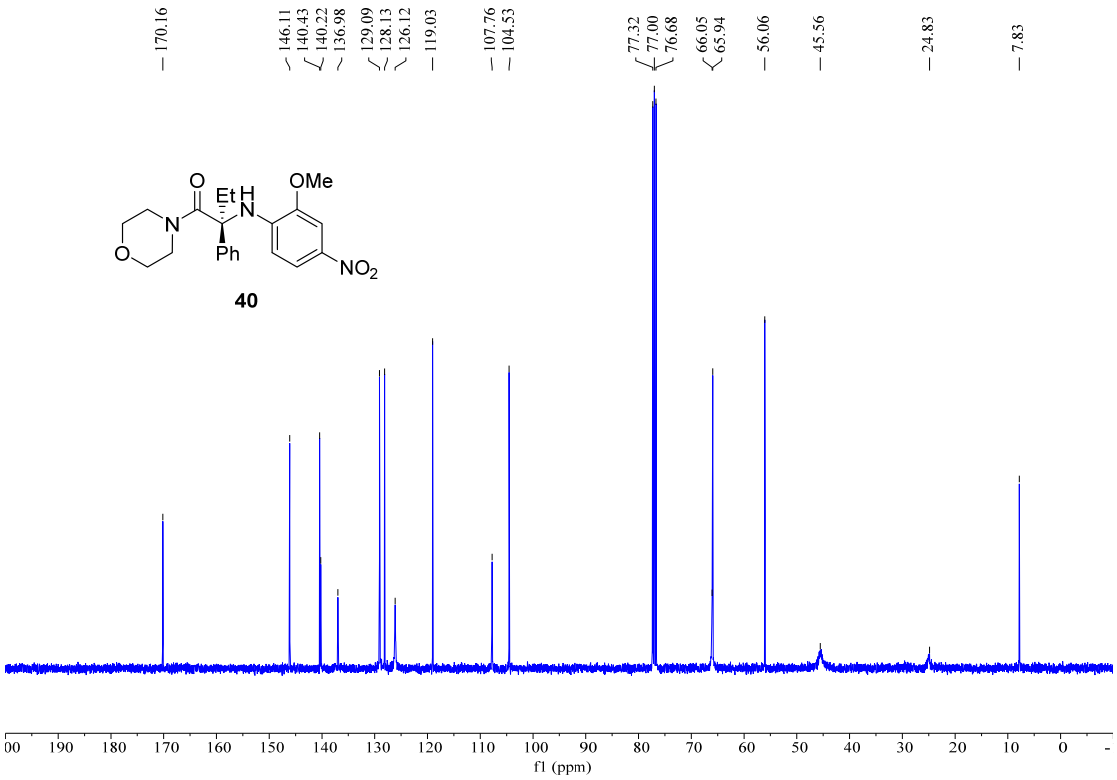
7.60
7.48
7.46
7.43
7.42
7.40
7.34
7.32
7.30
7.28
6.35
6.33
4.00
3.56
3.54
3.53
3.41
3.41
3.33
3.32
3.12
2.67
2.65
2.63
2.61
2.60
2.58
2.45
2.43
2.41
2.39
2.37
2.36
0.79
0.77
0.76
0.00
O
Et
H
N
OMe
N
O
Ph
NO2
40
2.06
6.05
1.00
3.07
8.07
1.04
1.04
3.01
f1 (ppm)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146.11
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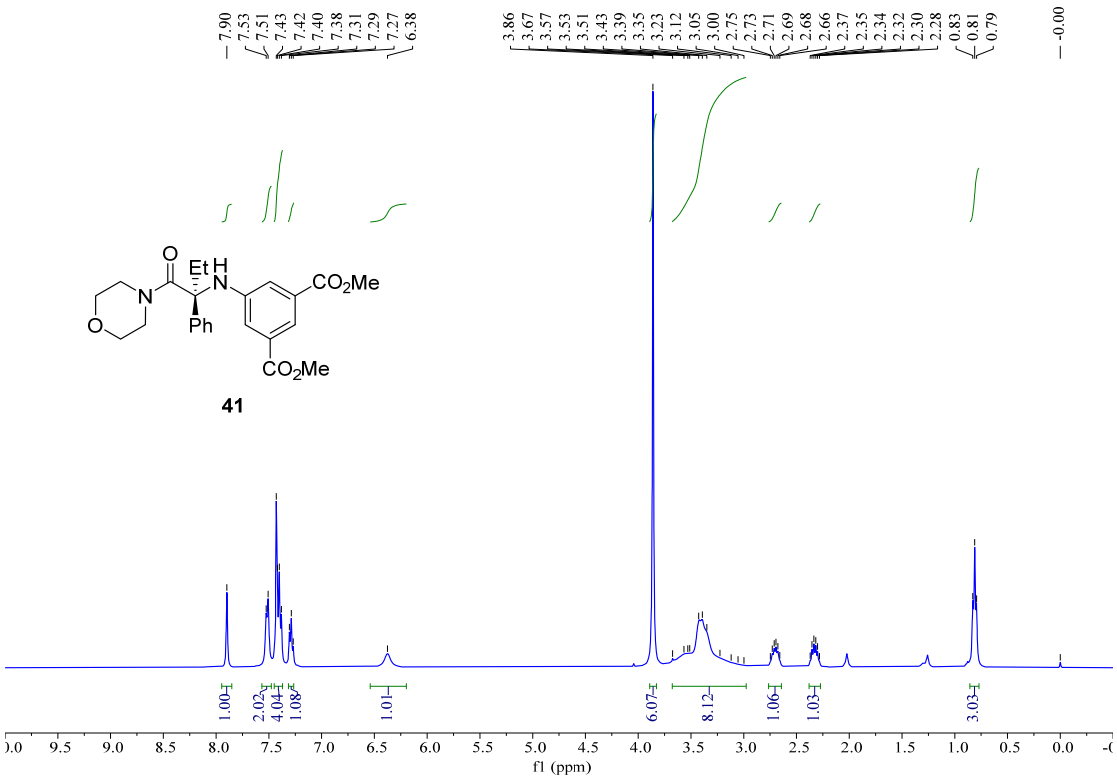
140.22
136.98
129.09
128.13
126.12
119.03
107.76
104.53
77.32
77.00
76.68
66.05
65.94
56.06
45.56
24.83
7.83
O
Et
H
N
OMe
N
O
Ph
NO2
40
f1 (ppm)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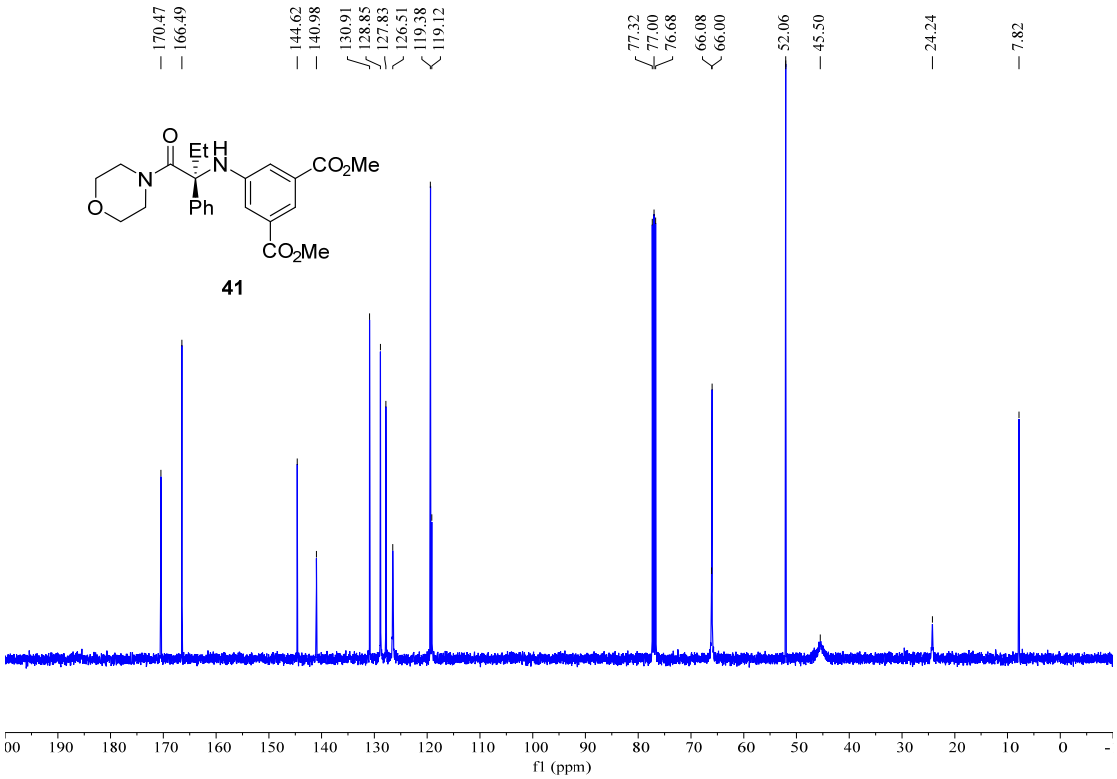
7.53
7.51
7.43
7.42
7.40
7.38
7.31
7.29
7.27
6.38
3.86
3.67
3.57
3.53
3.51
3.43
3.39
3.35
3.23
3.12
3.05
3.00
2.75
2.73
2.71
2.69
2.68
2.66
2.37
2.35
2.34
2.32
2.30
2.28
0.83
0.81
0.79
-0.00
O
Et
H
N
N
O
Ph
CO2Me
CO2Me
41
1.00
2.02
4.04
1.08
1.01
6.07
8.12
1.06
1.03
3.03
f1 (ppm)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166.49
144.62
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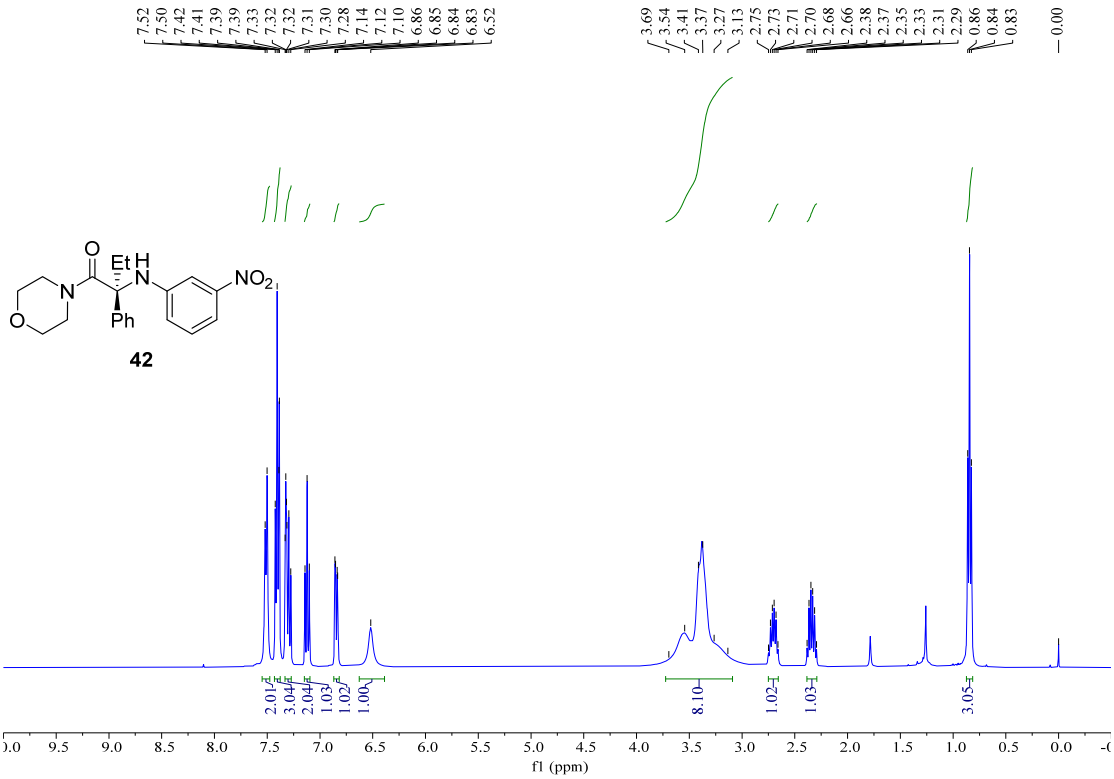
130.91
128.85
127.83
126.51
119.38
119.12
77.32
77.00
76.68
66.08
66.00
52.06
45.50
24.24
7.82
O
Et
H
N
N
O
Ph
CO2Me
CO2Me
41
f1 (ppm)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7.41
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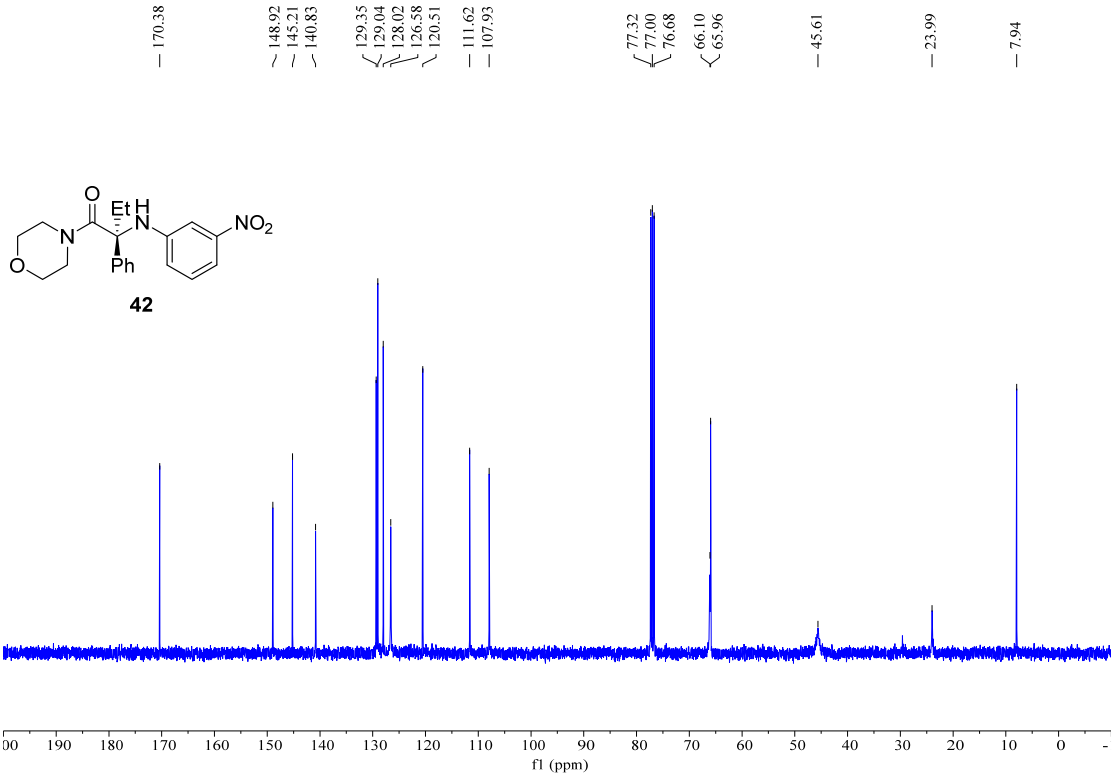
7.39
7.33
7.32
7.32
7.31
7.30
7.28
7.14
7.12
7.10
6.86
6.85
6.84
6.83
6.52
3.69
3.54
3.41
3.37
3.27
3.13
2.75
2.73
2.71
2.70
2.68
2.66
2.38
2.37
2.35
2.33
2.31
2.29
0.86
0.84
0.83
0.00
O
Et
H
N
N
NO2
O
Ph
42
2.01
3.04
2.04
1.03
1.02
1.00
8.10
1.02
1.03
3.05
f1 (ppm)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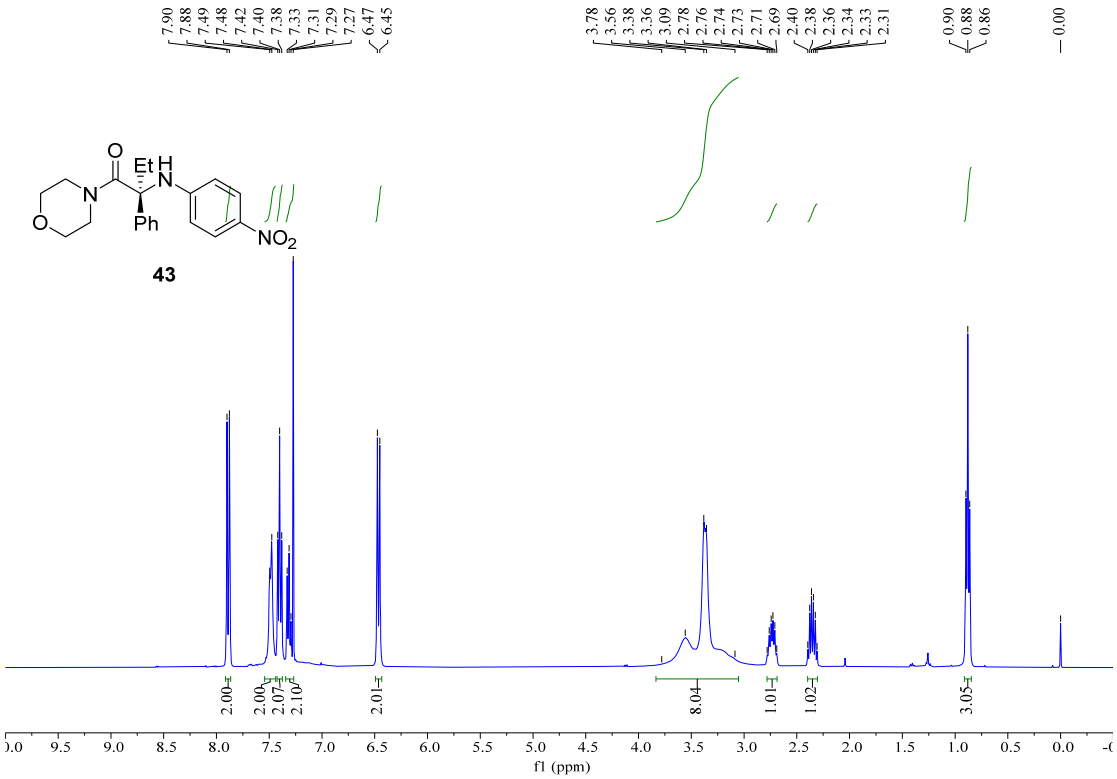
145.21
140.83
129.35
129.04
128.02
126.58
120.51
111.62
107.93
77.32
77.00
76.68
66.10
65.96
45.61
23.99
7.94
O
Et
H
N
N
NO2
O
Ph
42
f1 (ppm)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7.88
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7.48
7.42
7.40
7.38
7.33
7.31
7.29
7.27
6.47
6.45
3.78
3.56
3.38
3.36
3.09
2.78
2.76
2.74
2.73
2.71
2.69
2.40
2.38
2.36
2.34
2.33
2.31
0.90
0.88
0.86
0.00
O
Et
H
N
N
O
Ph
NO2
43
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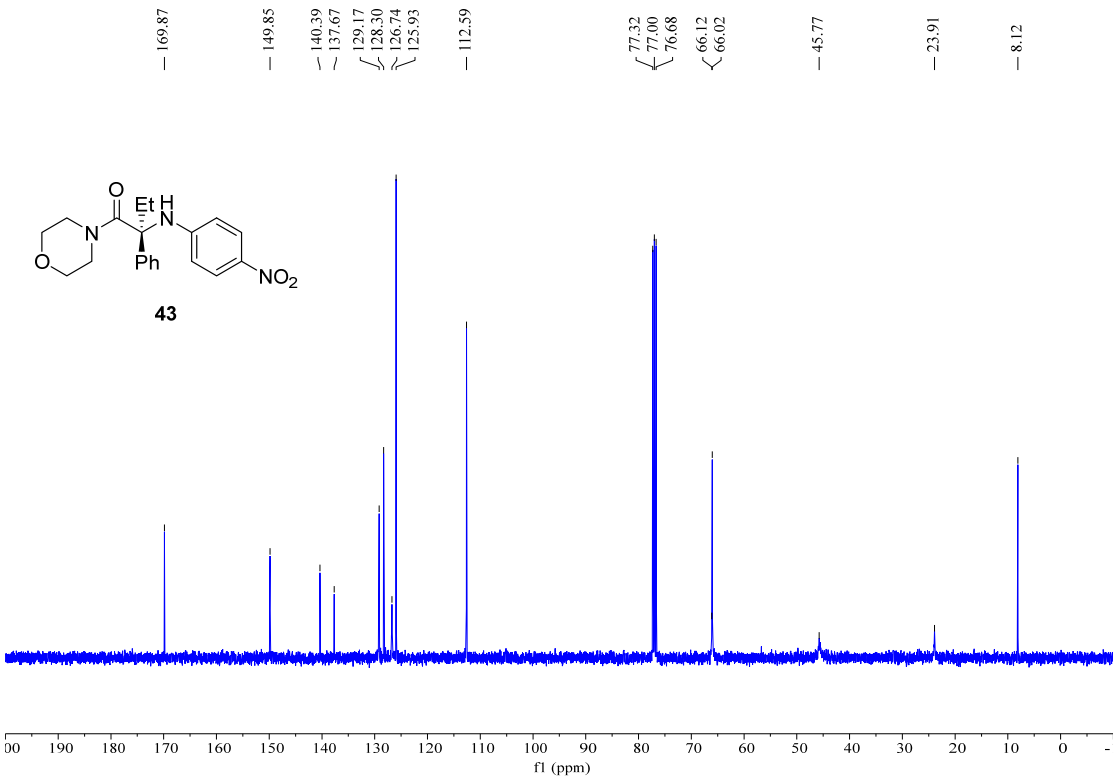
2.00
2.07
2.10
2.01
8.04
1.01
1.02
3.05
f1 (ppm)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126.74
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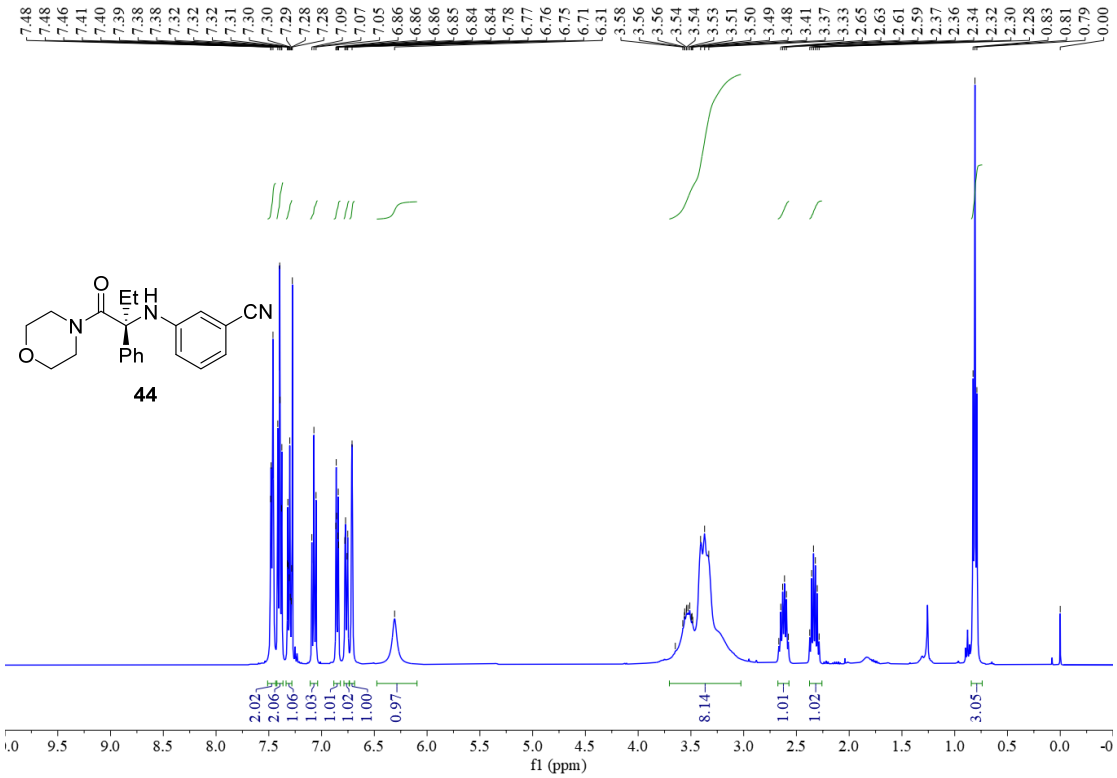
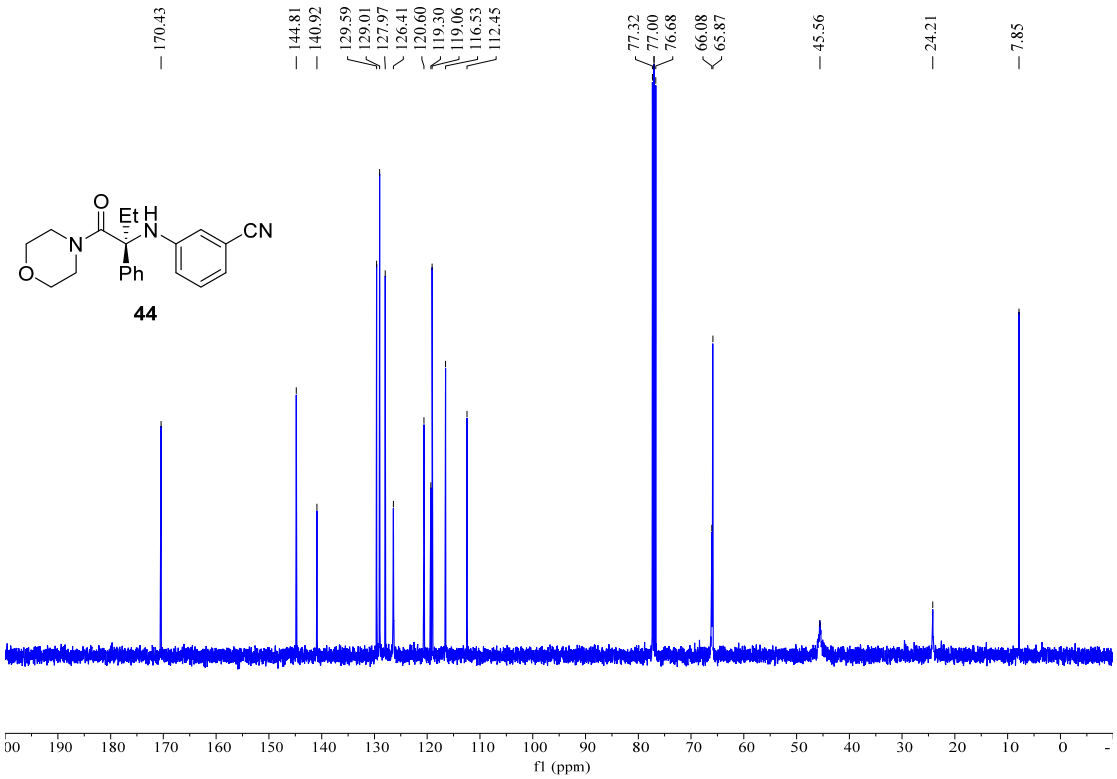
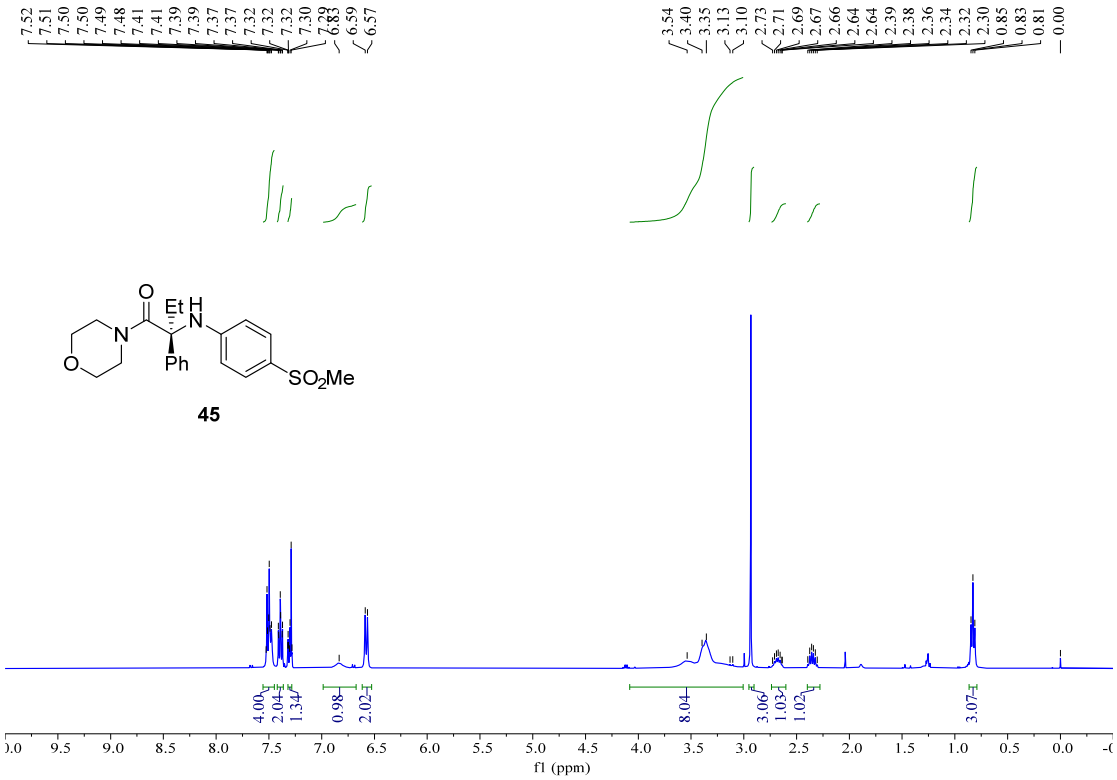
112.59
77.32
77.00
76.68
66.12
66.02
45.77
23.91
8.12
O
Et
H
N
N
O
Ph
NO2
43
f1 (ppm)


44
fl (ppm)


44
fl (ppm)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7.48
7.41
7.41
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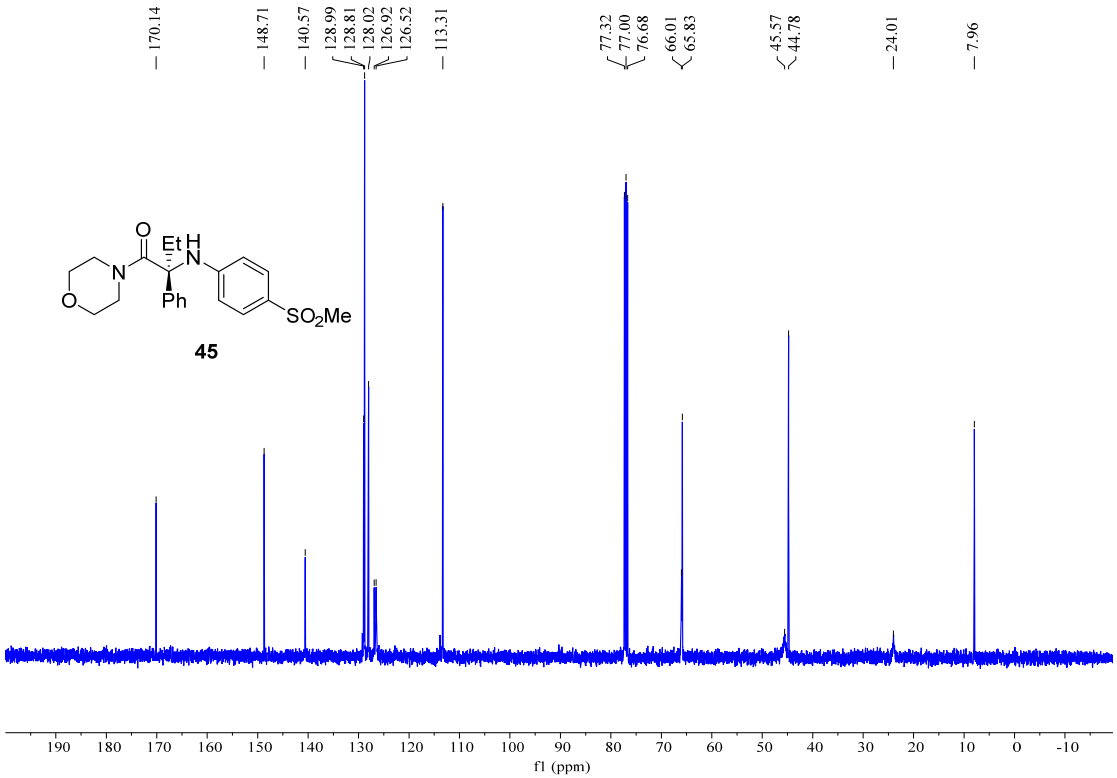
7.39
7.37
7.37
7.32
7.32
7.32
7.30
6.59
6.57
3.54
3.40
3.35
3.13
3.10
2.73
2.71
2.69
2.67
2.66
2.64
2.64
2.39
2.38
2.36
2.34
2.32
2.30
0.85
0.83
0.81
0.00
O
Et
H
N
N
O
Ph
SO2Me
45
4.00
2.04
1.34
0.98
2.02
8.04
3.06
1.03
1.02
3.07
f1 (ppm)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126.92
126.52
113.31
77.32
77.00
76.68
66.01
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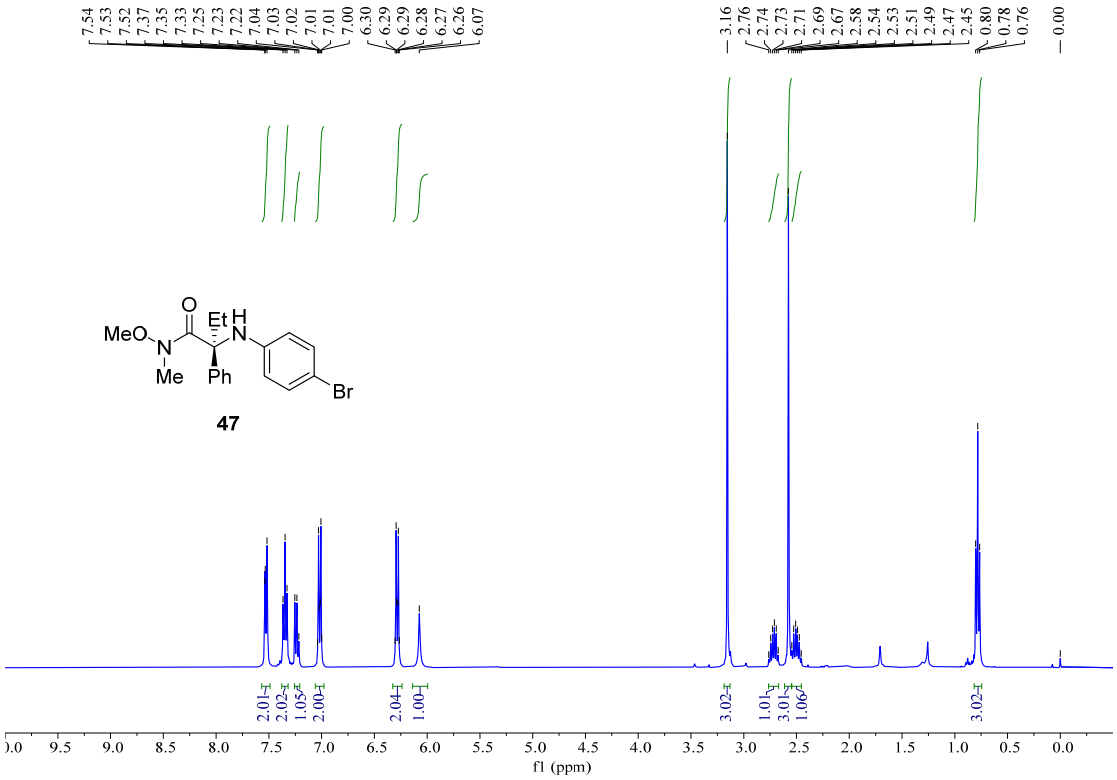
45.57
44.78
24.01
7.96
O
Et
H
N
N
O
Ph
SO2Me
45
f1 (ppm)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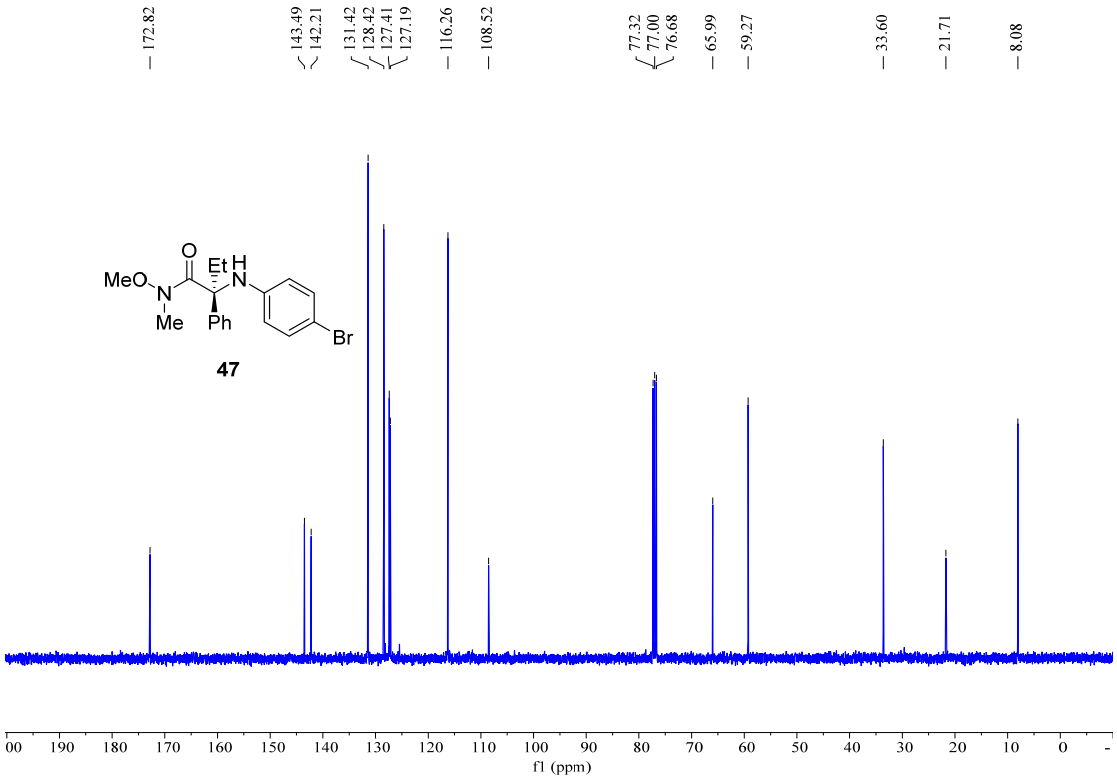
7.25
7.23
7.22
7.04
7.03
7.02
7.01
7.01
7.00
6.30
6.29
6.29
6.28
6.27
6.26
6.07
3.16
2.76
2.74
2.73
2.71
2.69
2.67
2.58
2.54
2.53
2.51
2.49
2.47
2.45
0.80
0.78
0.76
0.00
MeO
N
Me
O
Et
H
N
Ph
Br
47
2.01
2.02
1.05
2.00
2.04
1.00
3.02
1.01
3.01
1.06
3.02
f1 (ppm)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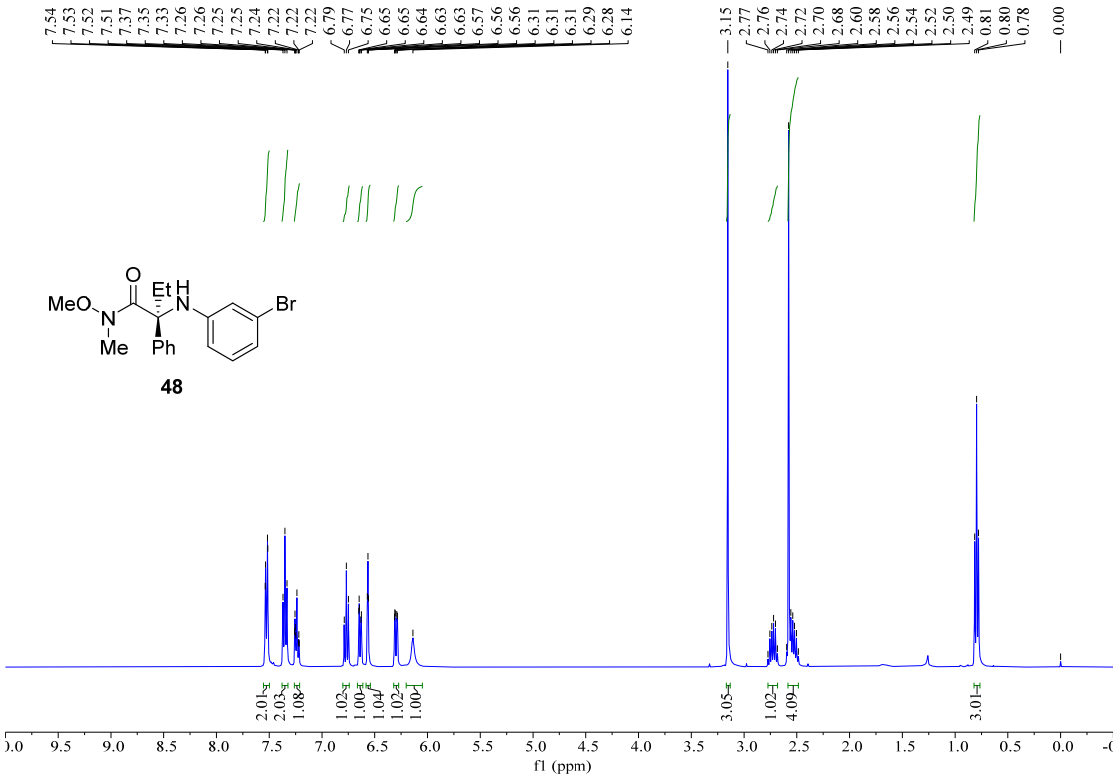
143.49
142.21
131.42
128.42
127.41
127.19
116.26
108.52
77.32
77.00
76.68
65.99
59.27
33.60
21.71
8.08
MeO
N
Me
O
Et
H
N
Ph
Br
47
f1 (ppm)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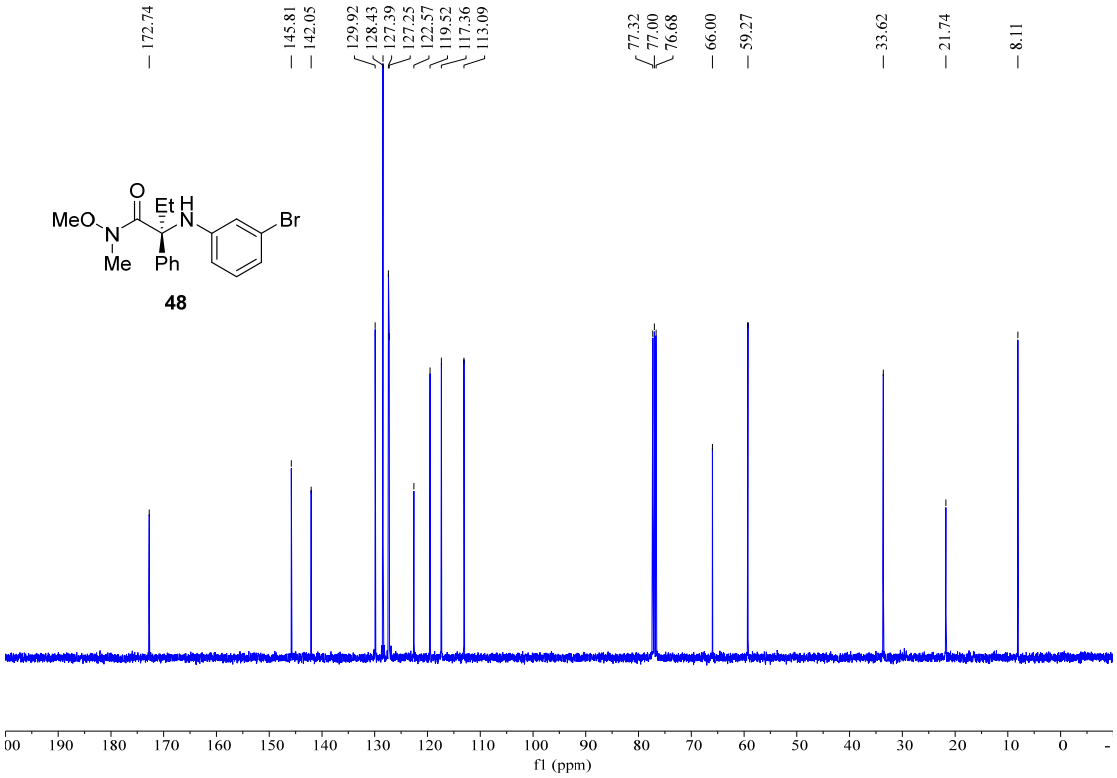
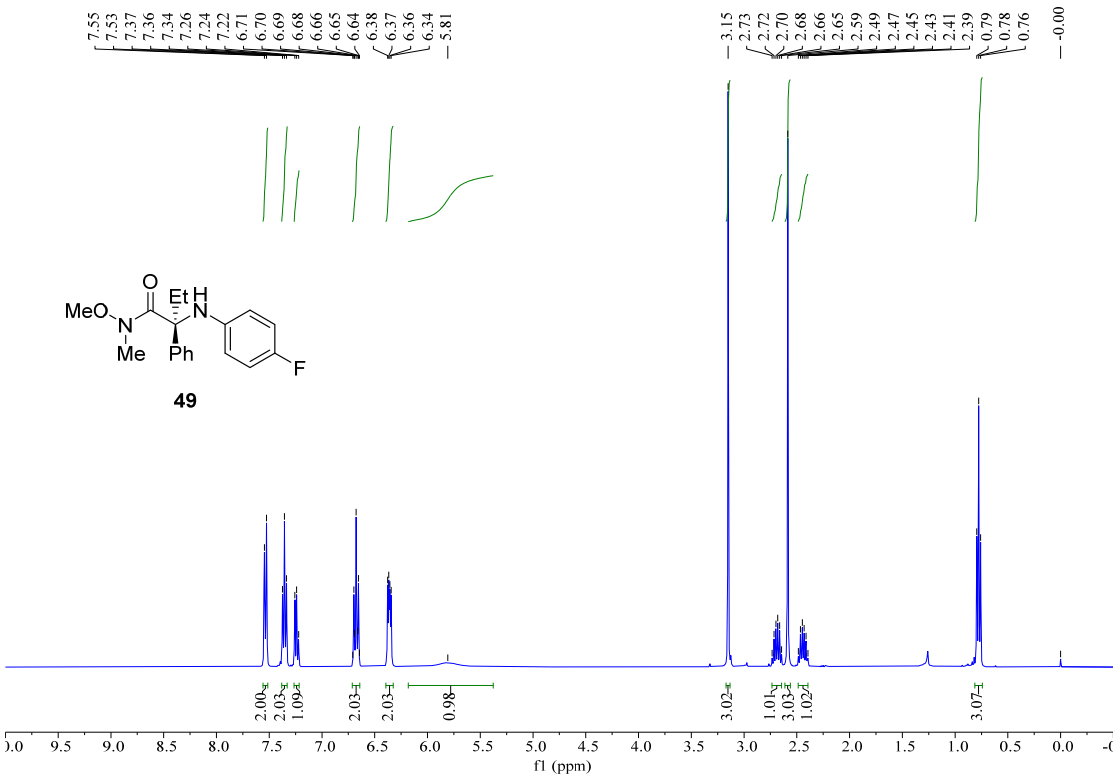
Me
O
Et
H
N
Ph
Br
48
f1 (ppm)


MeO
N
Me
O
Et
H
N
Ph
Br
48
f1 (ppm)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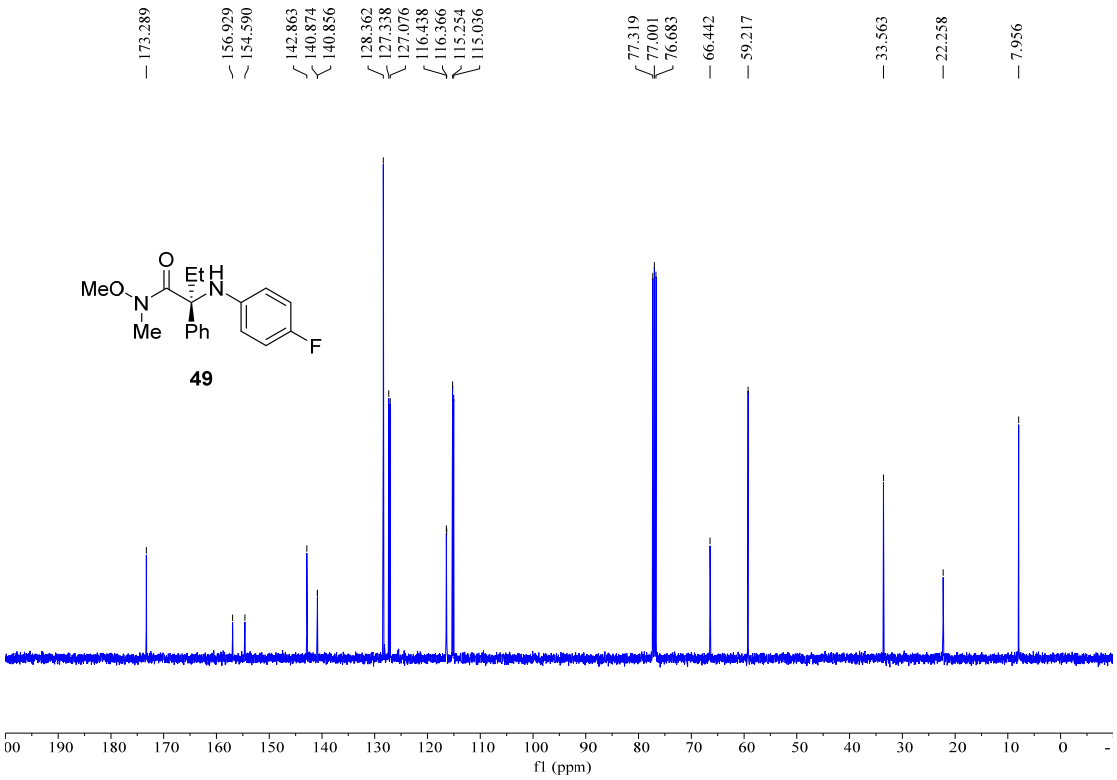
7.36
7.34
7.26
7.24
7.22
6.71
6.70
6.69
6.68
6.66
6.65
6.64
6.38
6.37
6.36
6.34
5.81
3.15
2.73
2.72
2.70
2.68
2.66
2.65
2.59
2.49
2.47
2.45
2.43
2.41
2.39
0.79
0.78
0.76
-0.00
MeO
N
Me
O
Et
H
N
Ph
F
49
2.00
2.03
1.09
2.03
2.03
0.98
3.02
1.01
3.03
1.02
3.07
f1 (ppm)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127.338
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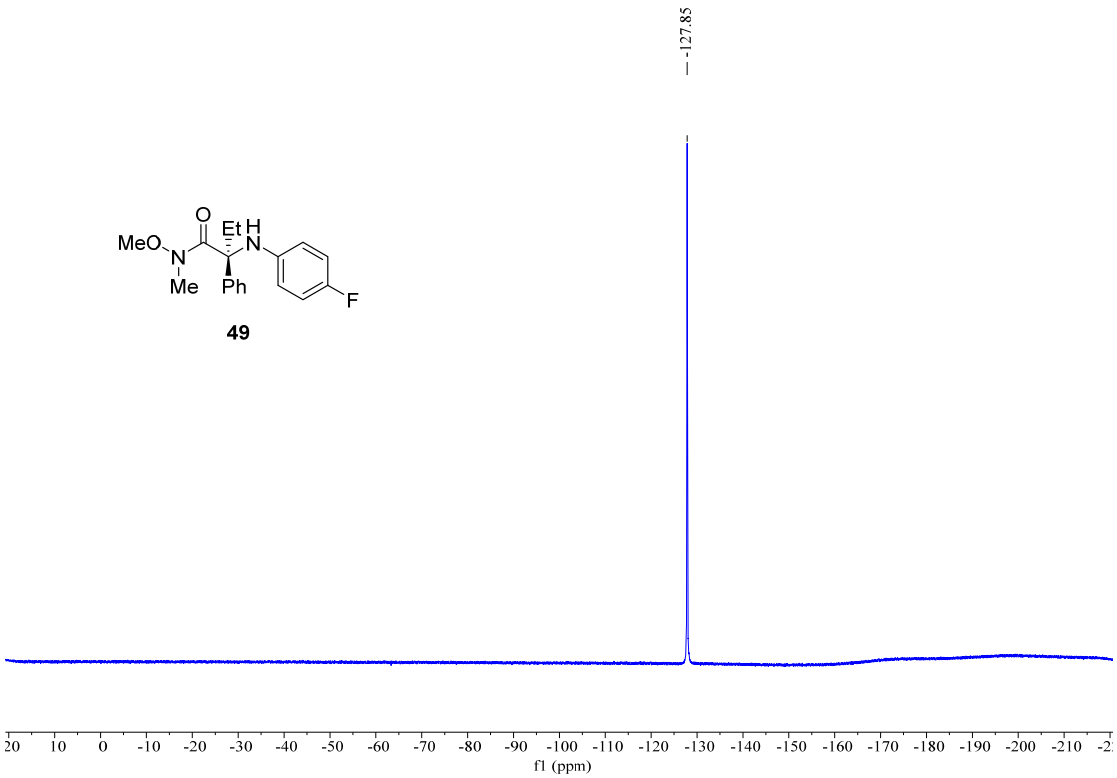
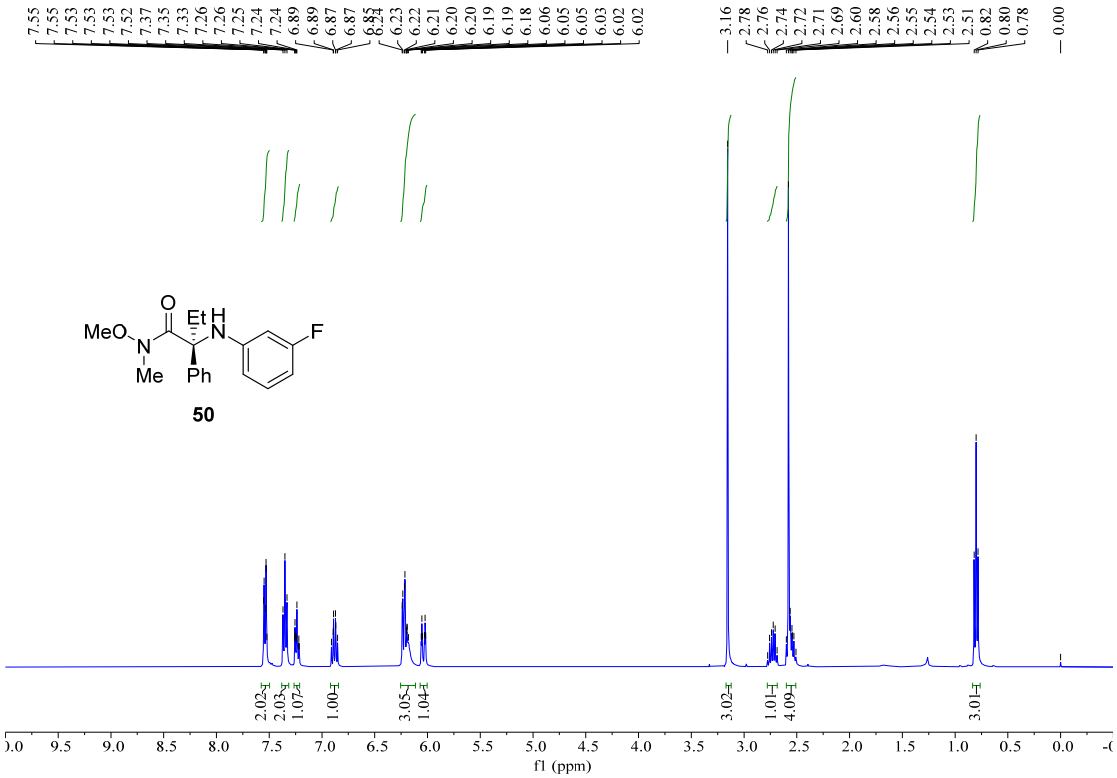
116.366
115.254
115.036
77.319
77.001
76.683
66.442
59.217
33.563
22.258
7.956
MeO
N
Me
O
Et
H
N
Ph
F
49
f1 (ppm)


-127.85
MeO
N
Me
O
Et
H
N
Ph
F
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

49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7.35
7.33
7.26
7.26
7.25
7.24
7.24
6.89
6.89
6.87
6.87
6.85
6.24
6.23
6.22
6.21
6.20
6.20
6.19
6.19
6.18
6.06
6.05
6.05
6.03
6.02
6.02
3.16
2.78
2.76
2.74
2.72
2.71
2.69
2.60
2.58
2.56
2.55
2.54
2.53
2.51
0.82
0.80
0.78
0.00
MeO
N
Me
O
Et
H
N
Ph
F
50
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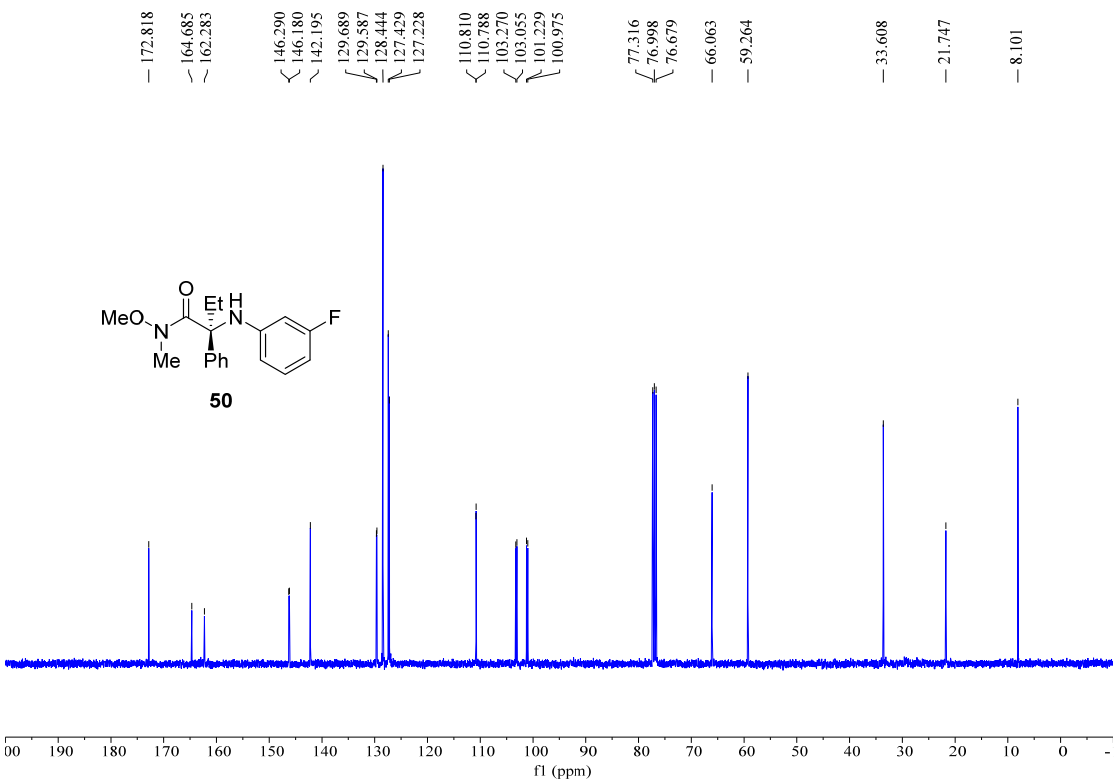
2.03
1.07
1.00
3.05
1.04
3.02
1.01
4.09
3.01
f1 (ppm)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129.689
129.587
128.444
127.429
127.228
110.810
110.788
103.270
103.055
101.229
100.975
77.316
76.998
76.679
66.063
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21.747
8.101
MeO
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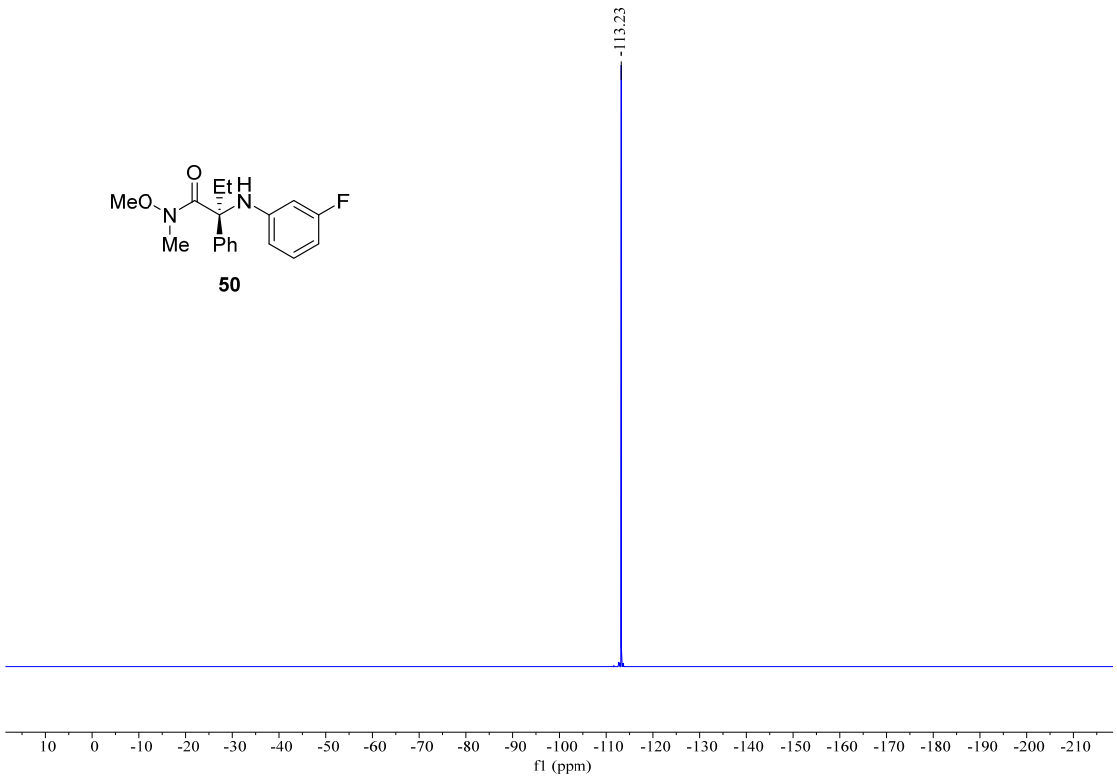
Me
O
Et
H
N
Ph
F
50
f1 (ppm)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Me
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Et
H
N
Ph
F
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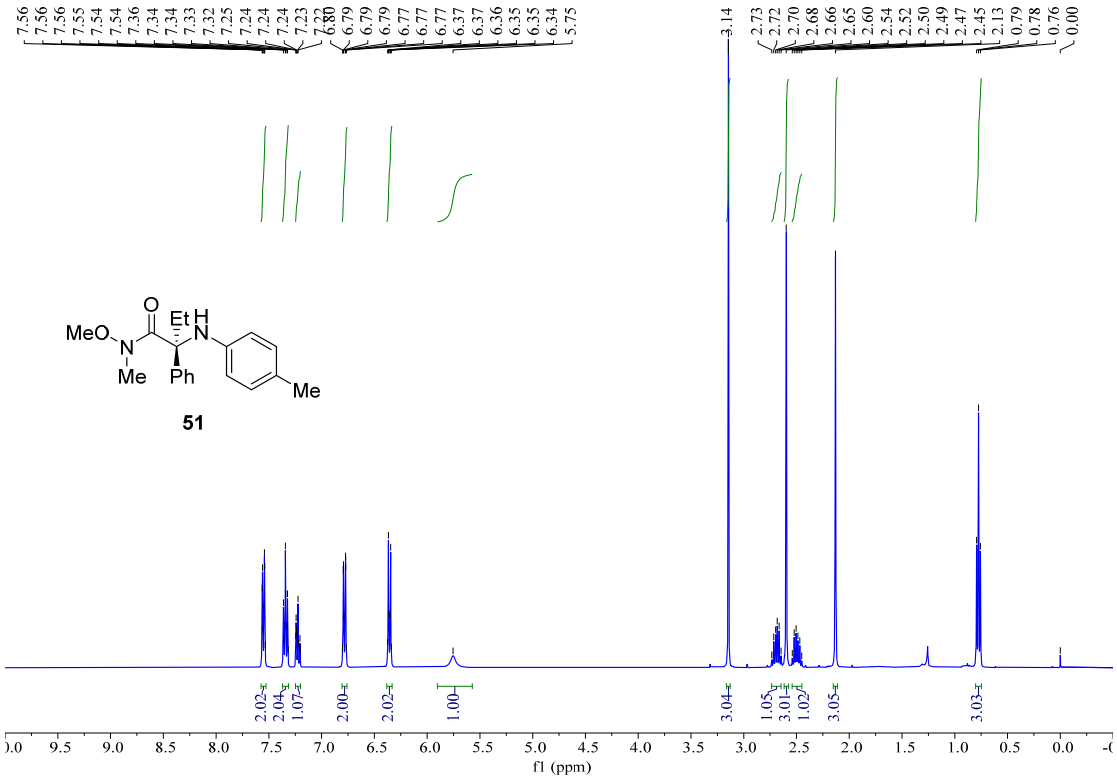
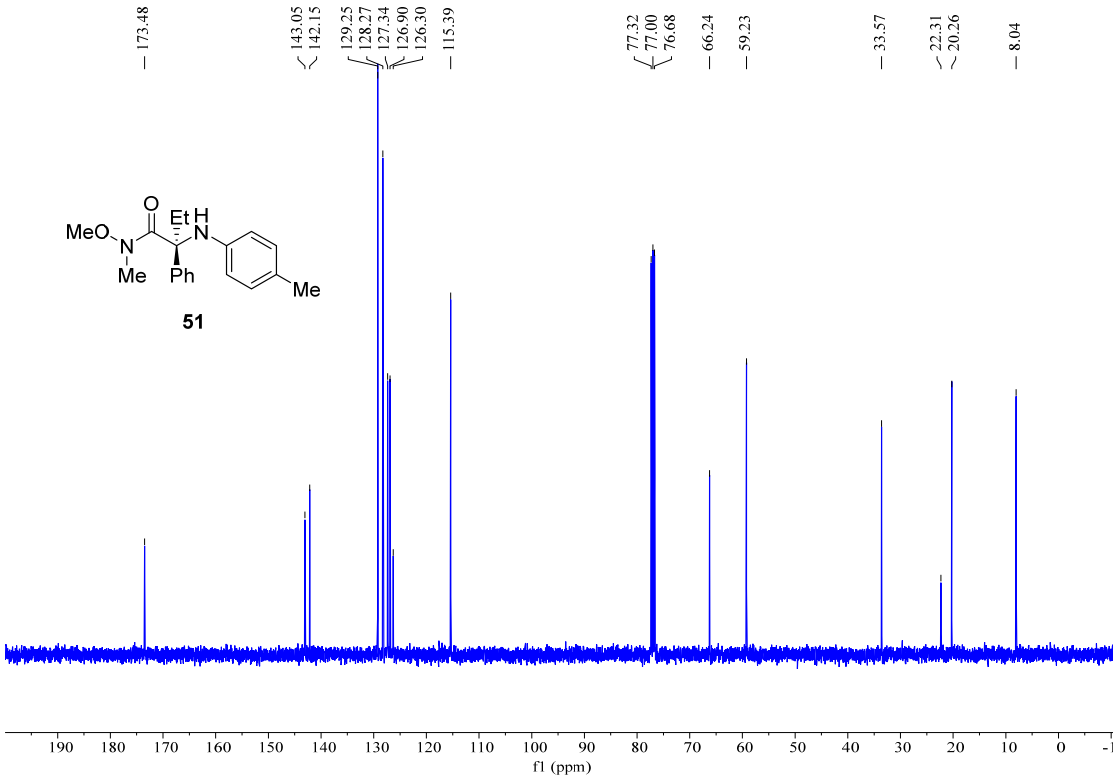
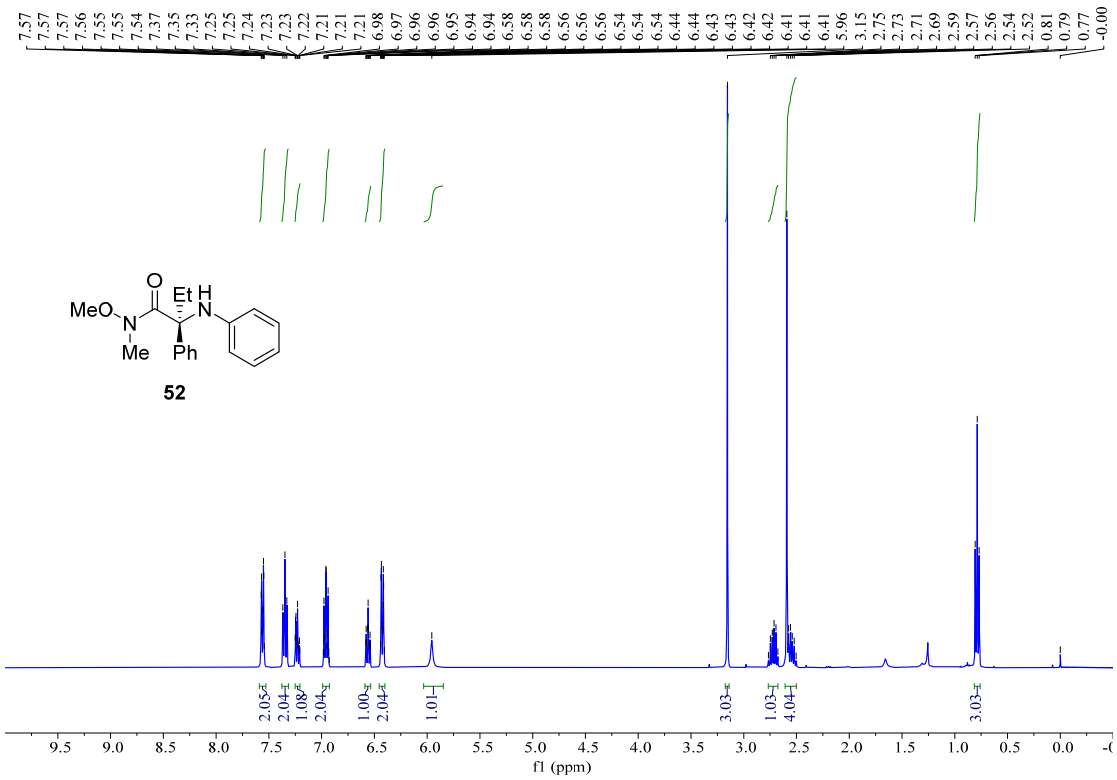
f1 (ppm)

50


7.56 7.56 7.56 7.55 7.54 7.54 7.36 7.34 7.34 7.33 7.32 7.25 7.24 7.24 7.24 7.23 6.80 6.79 6.79 6.79 6.77 6.77 6.77 6.37 6.36 6.35 6.34 5.75
3.14 2.73 2.72 2.70 2.68 2.66 2.65 2.60 2.54 2.52 2.50 2.49 2.47 2.45 2.13 0.79 0.78 0.76 0.00
MeO N Me O Et H N Ph Me
51
2.02 2.04 1.07 2.00 2.02 1.00 3.04 1.05 3.01 1.02 3.05 3.03
f1 (ppm)


173.48 143.05 142.15 129.25 128.27 127.34 126.90 126.30 115.39 77.32 77.00 76.68 66.24 59.23 33.57 22.31 20.26 8.04
MeO N Me O Et H N Ph Me
51
f1 (ppm)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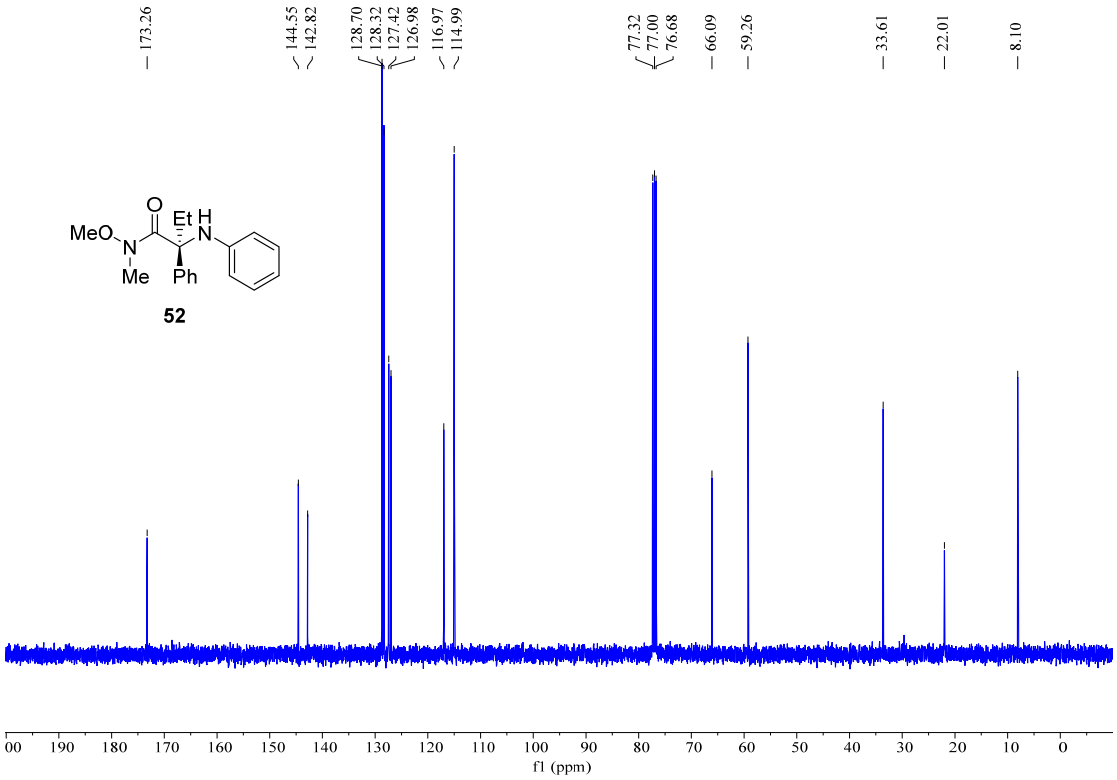
N
Me
O
Et
H
N
Ph
52
f1 (ppm)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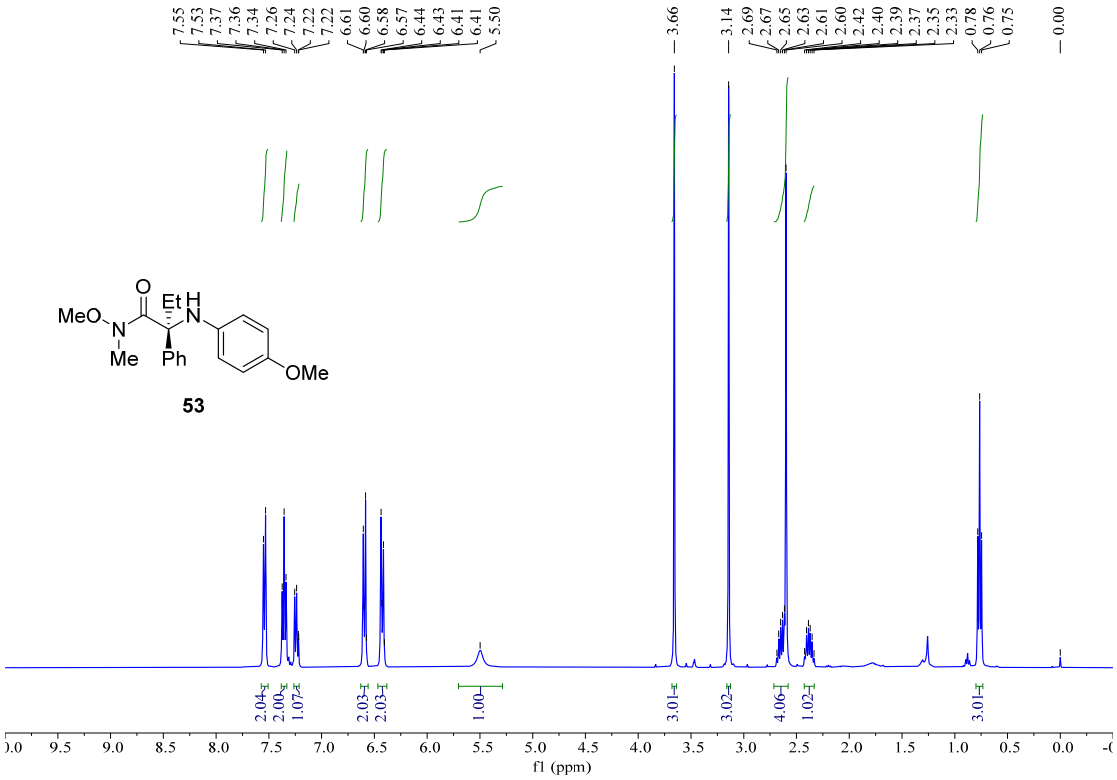
N
Me
O
Et
H
N
Ph
52
f1 (ppm)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7.53
7.37
7.36
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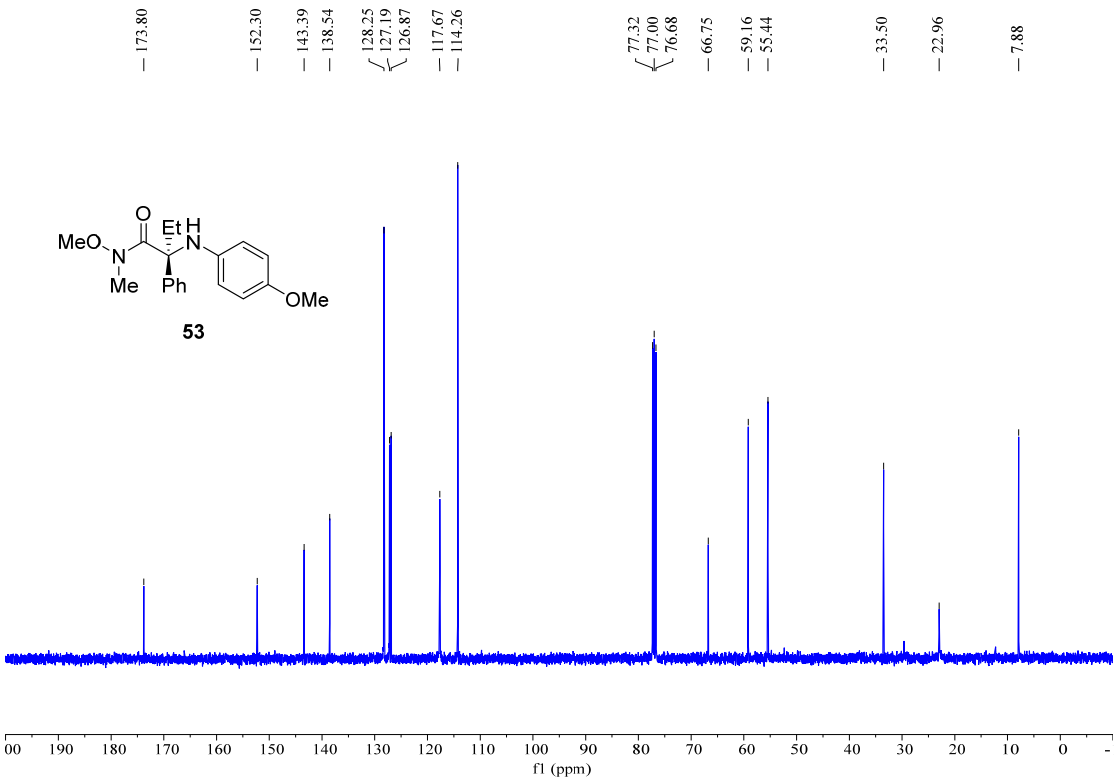
7.26
7.24
7.22
7.22
6.61
6.60
6.58
6.57
6.44
6.43
6.41
6.41
5.50
3.66
3.14
2.69
2.67
2.65
2.63
2.61
2.60
2.42
2.40
2.39
2.37
2.35
2.33
0.78
0.76
0.75
0.00
MeO
N
Me
O
Et
H
N
Ph
OMe
53
2.04
2.00
1.07
2.03
2.03
1.00
3.01
3.02
4.06
1.02
3.01
f1 (ppm)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152.30
143.39
138.54
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126.87
117.67
114.26
77.32
77.00
76.68
66.75
59.16
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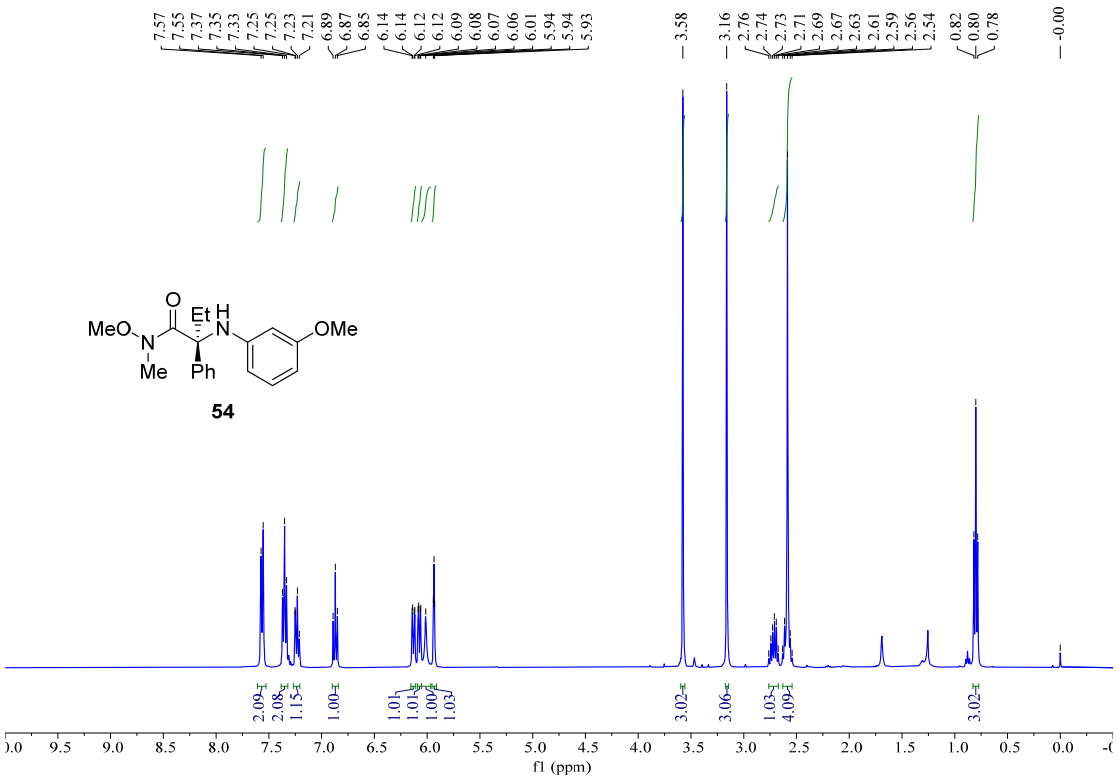
22.96
7.88
MeO
N
Me
O
Et
H
N
Ph
OMe
53
f1 (ppm)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7.55
7.37
7.35
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7.25
7.25
7.23
7.21
6.89
6.87
6.85
6.14
6.14
6.12
6.12
6.09
6.08
6.07
6.06
6.01
5.94
5.94
5.93
3.58
3.16
2.76
2.74
2.73
2.71
2.69
2.67
2.63
2.61
2.59
2.56
2.54
0.82
0.80
0.78
-0.00
MeO
N
Me
O
Et
H
N
Ph
OMe
54
2.09
2.08
1.15
1.00
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1.01
1.00
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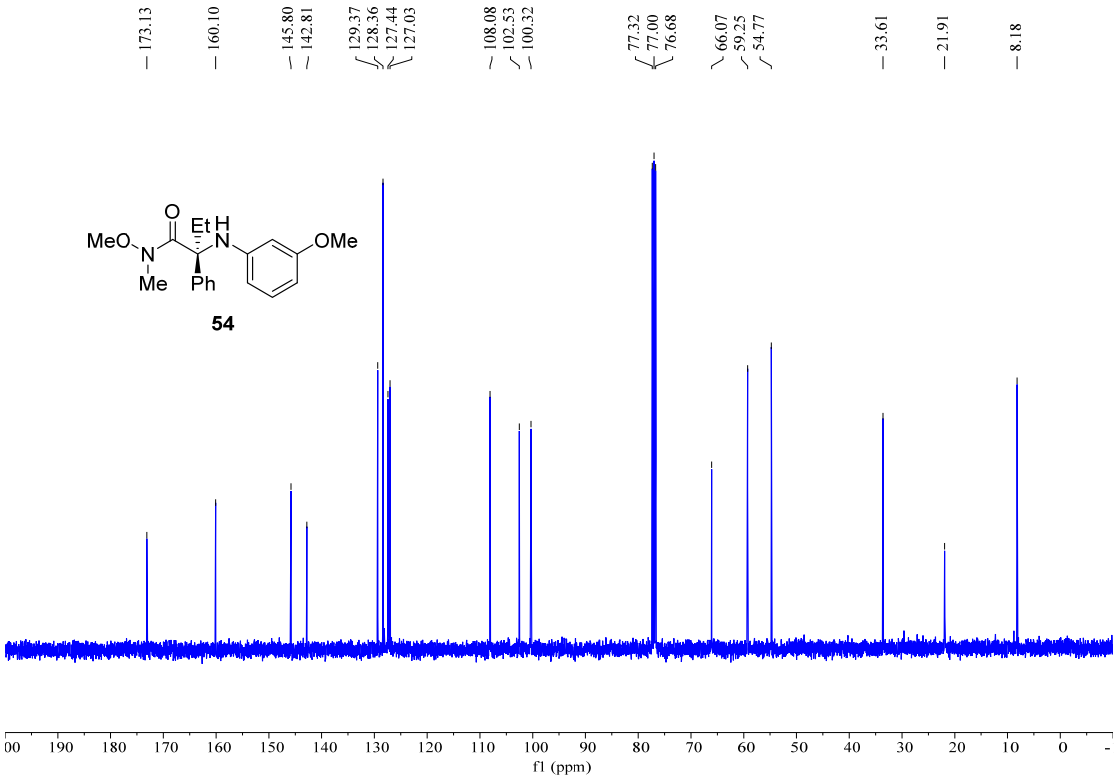
3.06
1.03
4.09
3.02
f1 (ppm)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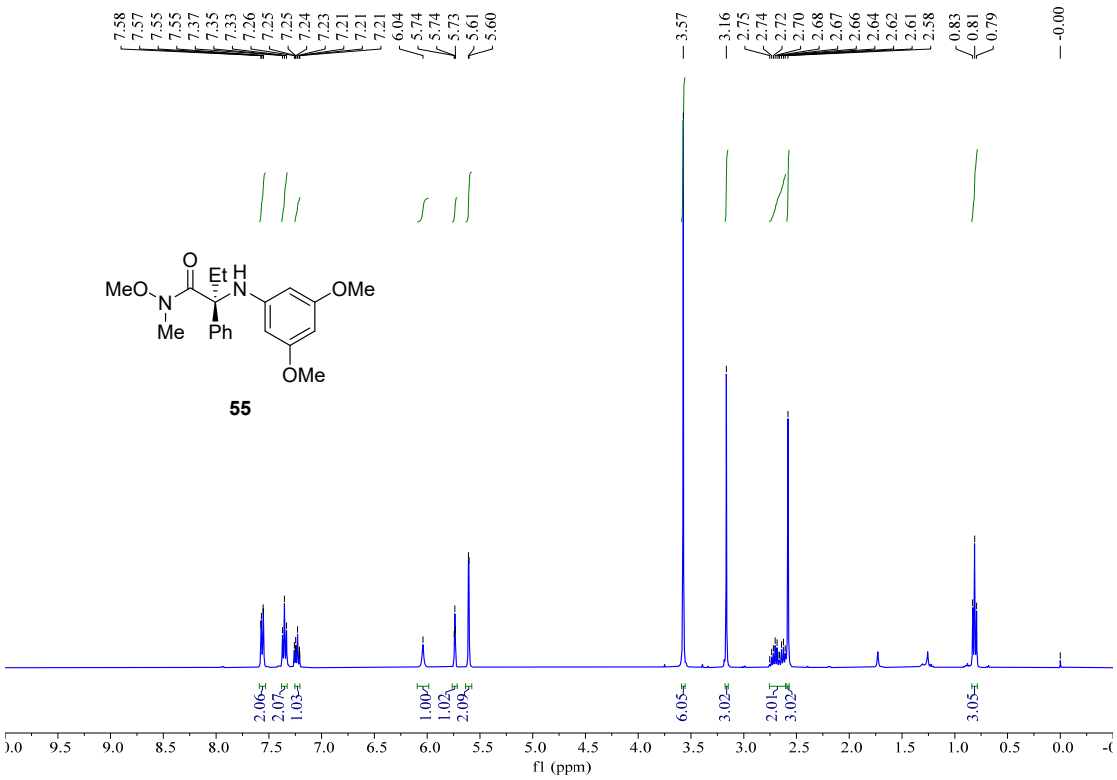
160.10
145.80
142.81
129.37
128.36
127.44
127.03
108.08
102.53
100.32
77.32
77.00
76.68
66.07
59.25
54.77
33.61
21.91
8.18
MeO
N
Me
O
Et
H
N
Ph
OMe
54
f1 (ppm)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7.57
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7.55
7.37
7.35
7.33
7.26
7.25
7.25
7.24
7.23
7.21
7.21
7.21
6.04
5.74
5.74
5.73
5.61
5.60
3.57
3.16
2.75
2.74
2.72
2.70
2.68
2.67
2.66
2.64
2.62
2.61
2.58
0.83
0.81
0.79
-0.00
MeO
N
Me
O
Et
H
N
Ph
OMe
OMe
55
2.06
2.07
1.03
1.00
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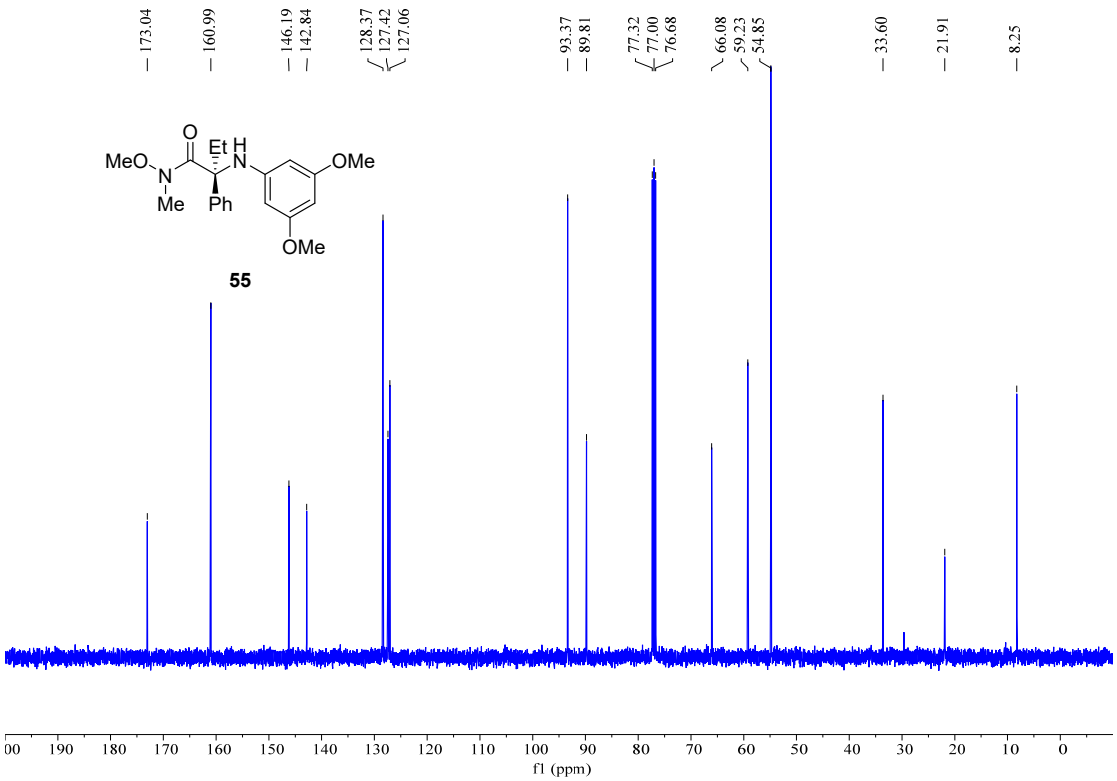
3.02
2.01
3.02
3.05
f1 (ppm)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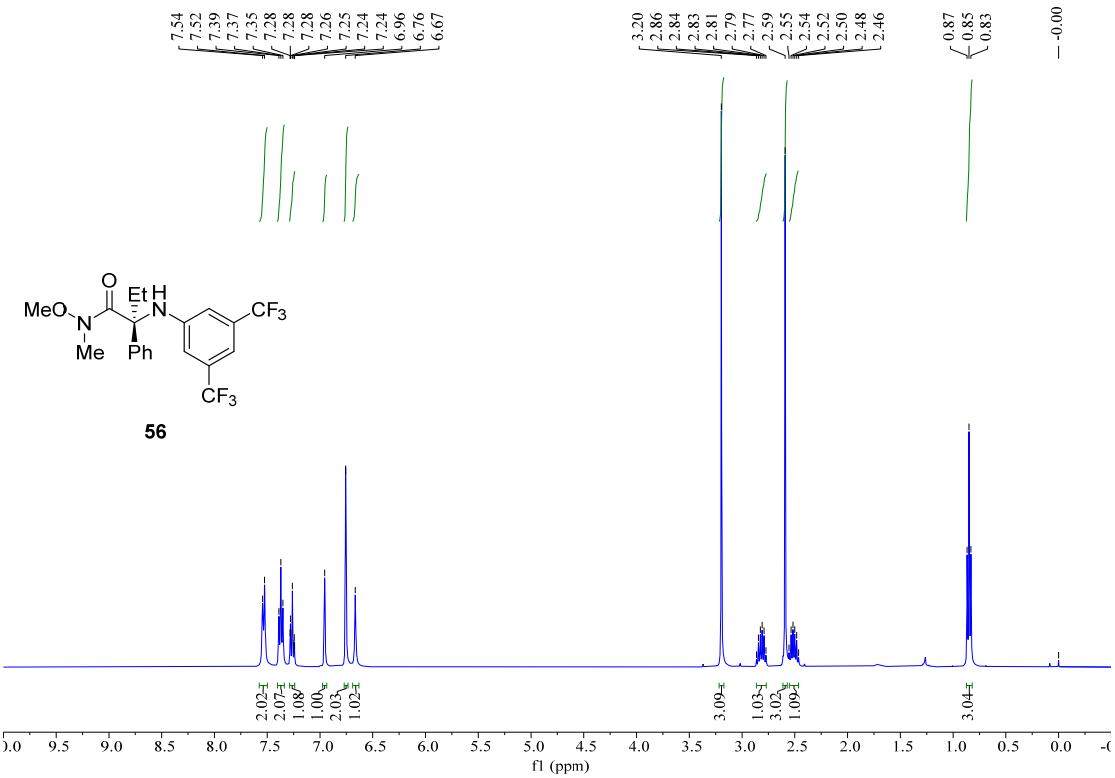
127.42
127.06
93.37
89.81
77.32
77.00
76.68
66.08
59.23
54.85
33.60
21.91
8.25
MeO
N
Me
O
Et
H
N
Ph
OMe
OMe
55
f1 (ppm)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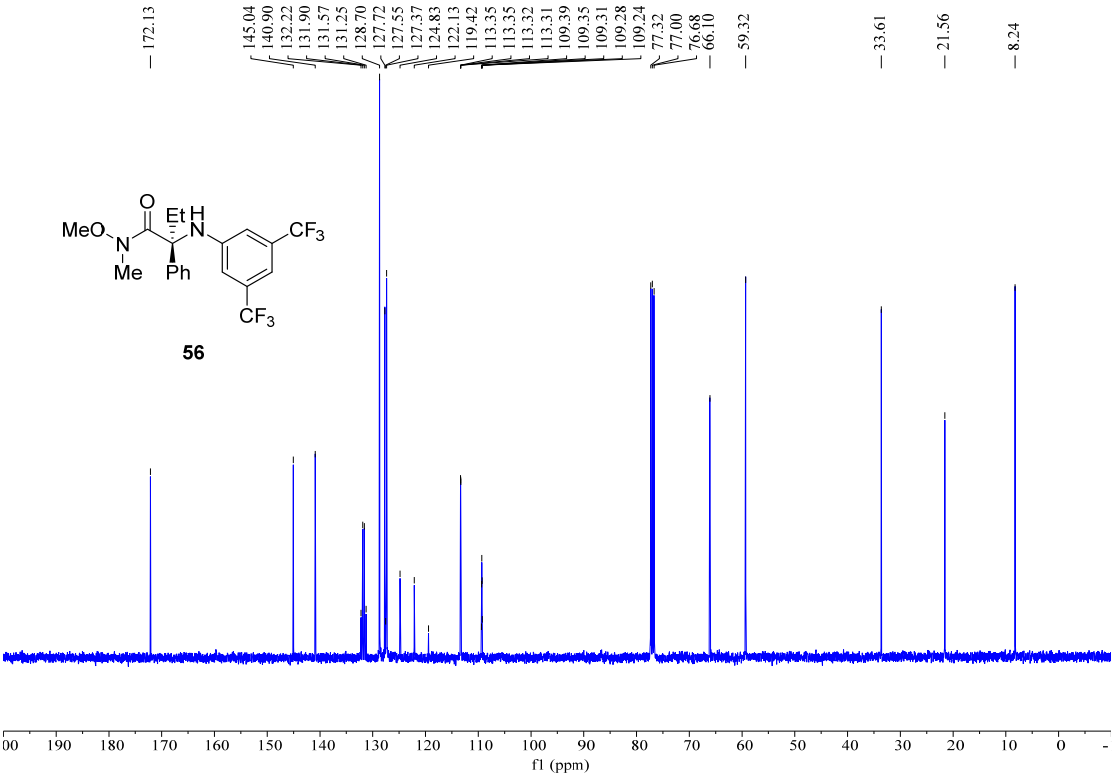
7.52
7.39
7.37
7.35
7.28
7.28
7.28
7.26
7.25
7.24
7.24
6.96
6.76
6.67
3.20
2.86
2.84
2.83
2.81
2.79
2.77
2.59
2.55
2.54
2.52
2.50
2.48
2.46
0.87
0.85
0.83
-0.00
MeO
N
Me
O
Et
H
N
Ph
CF3
CF3
56
2.02
2.07
1.08
1.00
2.03
1.02
3.09
1.03
3.02
1.09
3.04
f1 (ppm)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145.04
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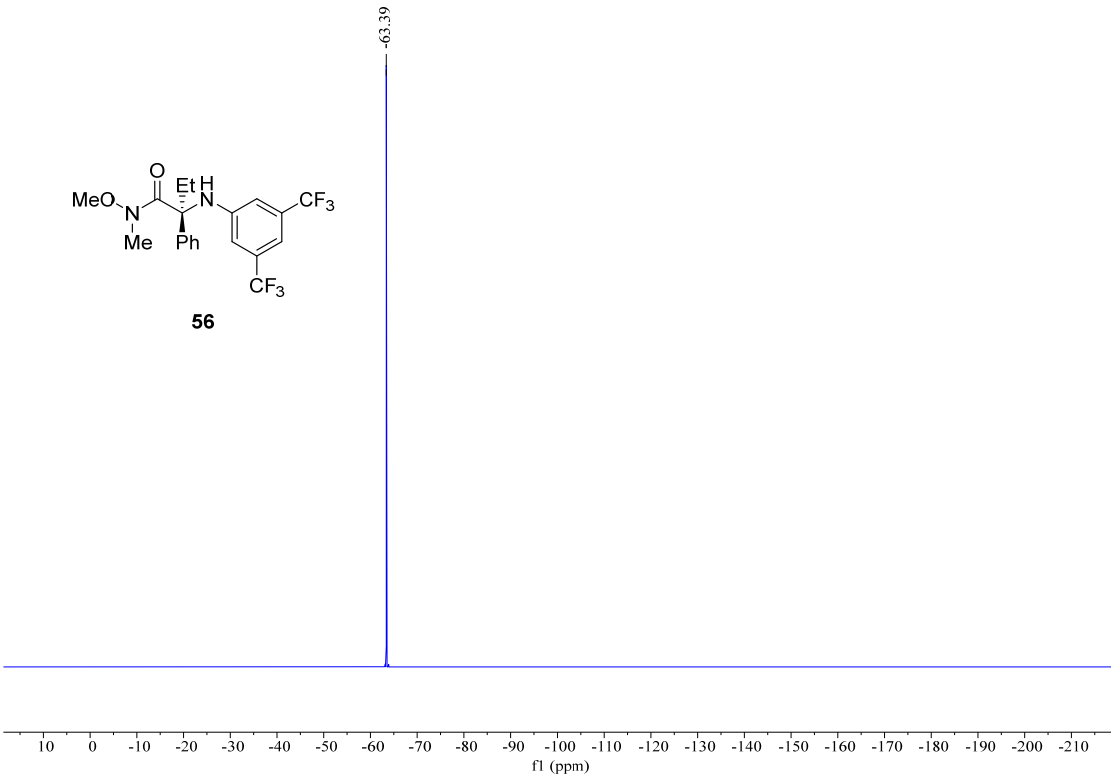
132.22
131.90
131.57
131.25
128.70
127.72
127.55
127.37
124.83
122.13
119.42
113.35
113.35
113.32
113.31
109.39
109.35
109.31
109.28
109.24
77.32
77.00
76.68
66.10
59.32
33.61
21.56
8.24
MeO
N
Me
O
Et
H
N
Ph
CF3
CF3
56
f1 (ppm)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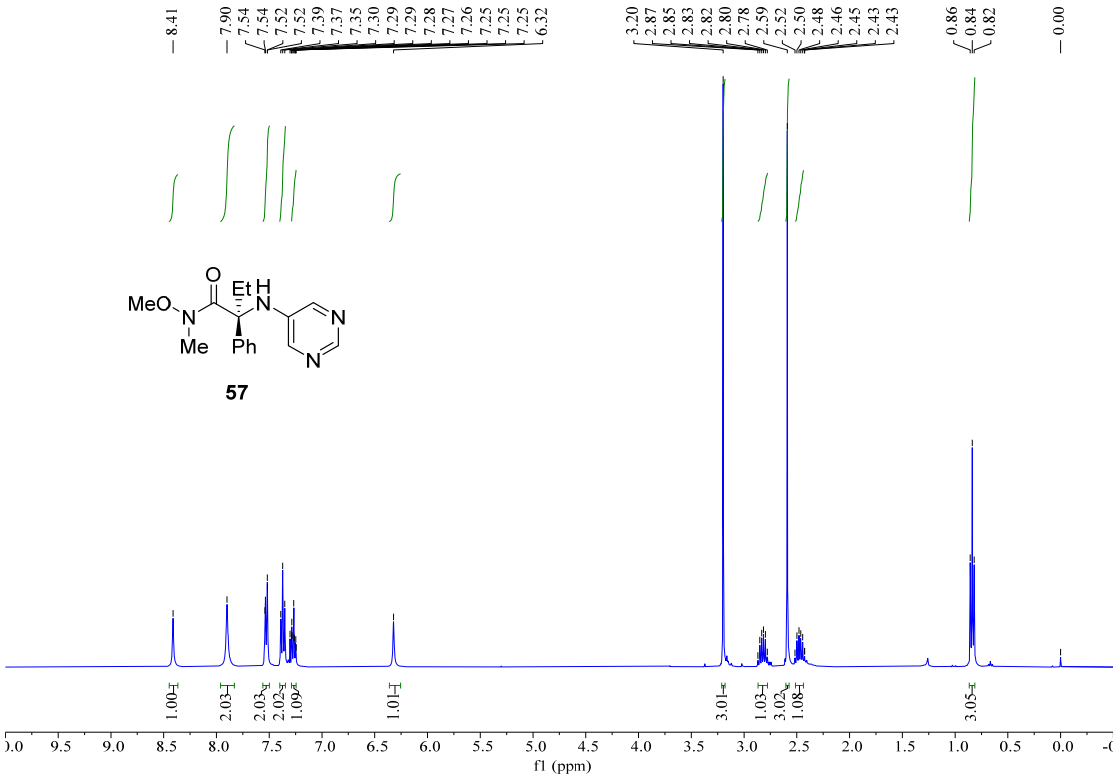
MeO
N
Me
O
Et
H
N
Ph
CF3
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

56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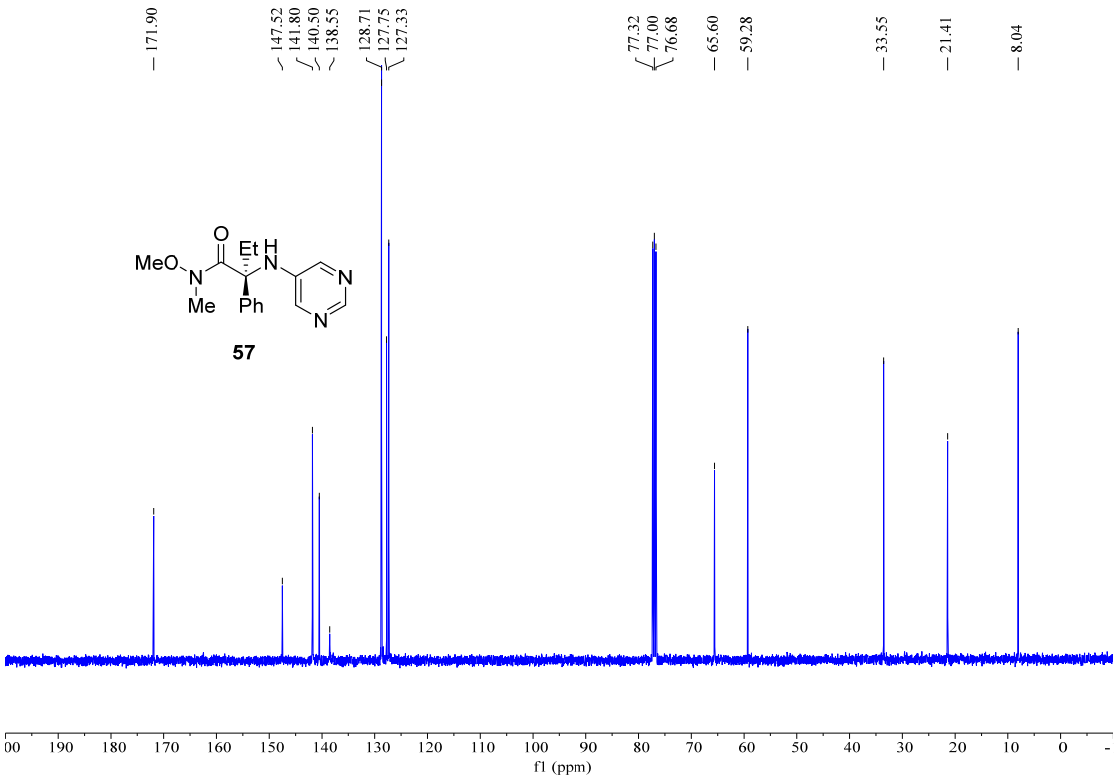
7.54
7.52
7.52
7.39
7.37
7.35
7.30
7.29
7.29
7.28
7.27
7.26
7.25
7.25
7.25
6.32
3.20
2.87
2.85
2.83
2.82
2.80
2.78
2.59
2.52
2.50
2.48
2.46
2.45
2.43
2.43
0.86
0.84
0.82
0.00
MeO
N
Me
O
Et
H
N
Ph
N
N
57
1.00
2.03
2.03
2.02
1.09
1.01
3.01
1.03
3.02
1.08
3.05
f1 (ppm)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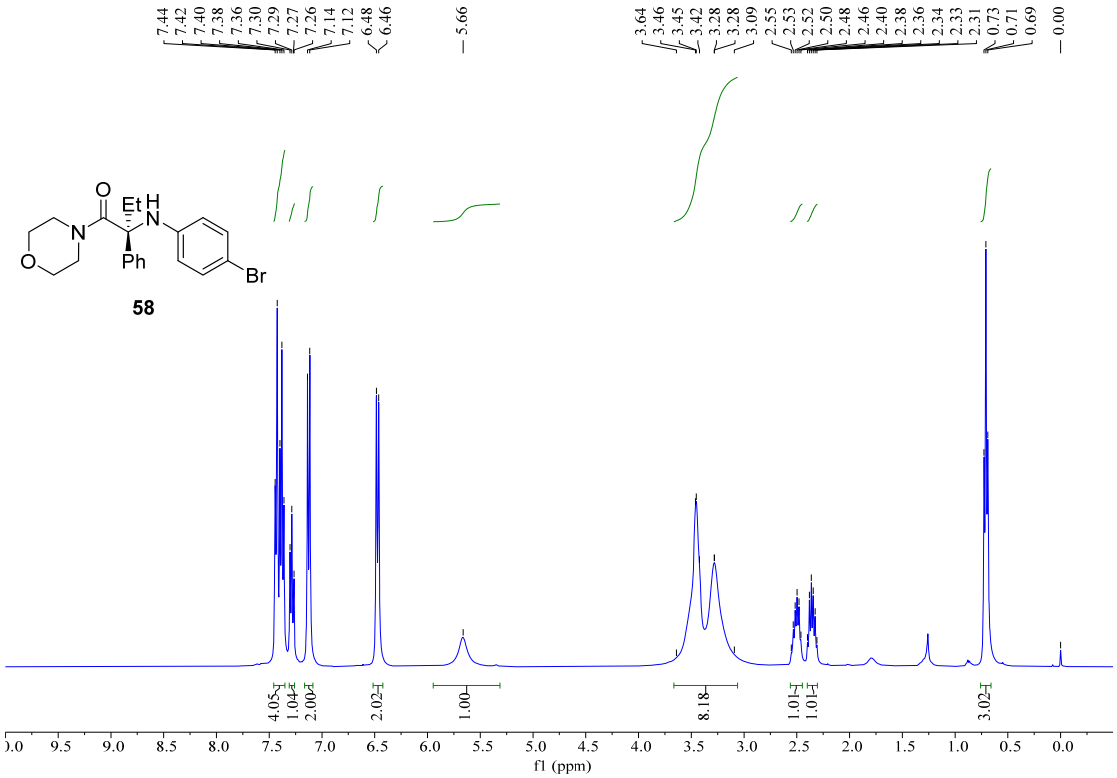
127.33
77.32
77.00
76.68
65.60
59.28
33.55
21.41
8.04
MeO
N
Me
O
Et
H
N
Ph
N
N
57
f1 (ppm)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7.14
7.12
6.48
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5.66
3.64
3.46
3.45
3.42
3.28
3.28
3.09
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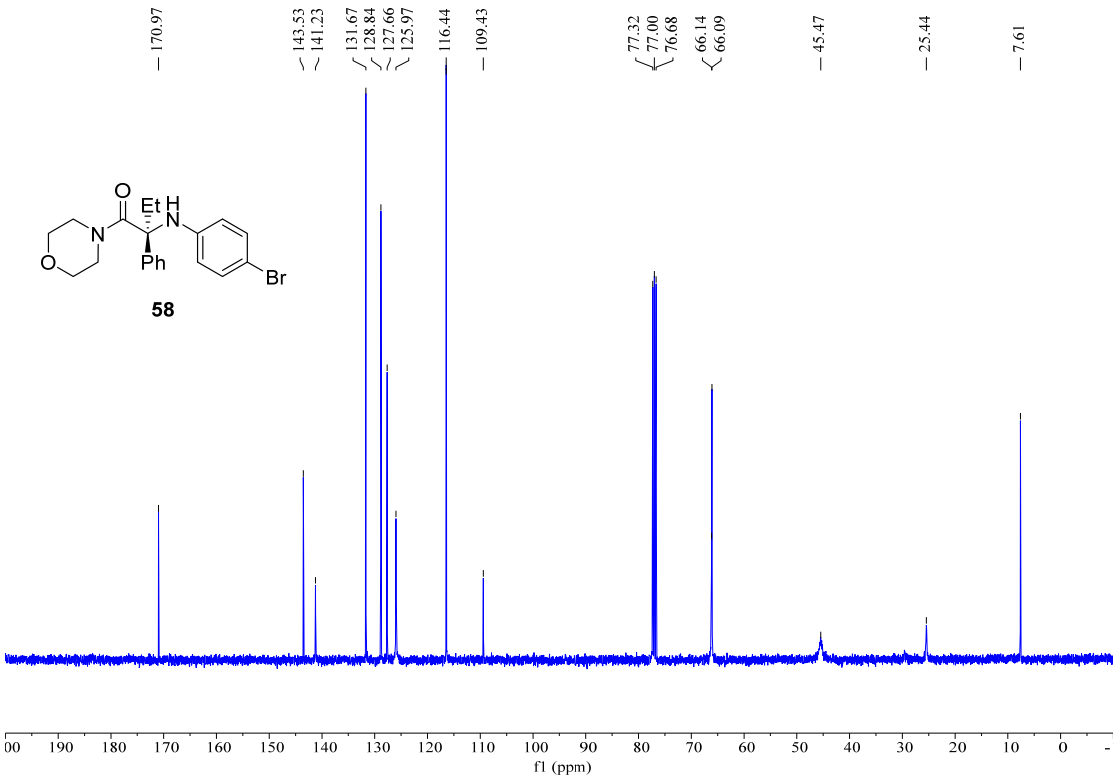
2.53
2.52
2.50
2.48
2.46
2.40
2.38
2.36
2.34
2.33
2.31
0.73
0.71
0.69
0.00
O
Et
H
N
N
O
Ph
Br
58
4.05
1.04
2.00
2.02
1.00
8.18
1.01
1.01
3.02
f1 (ppm)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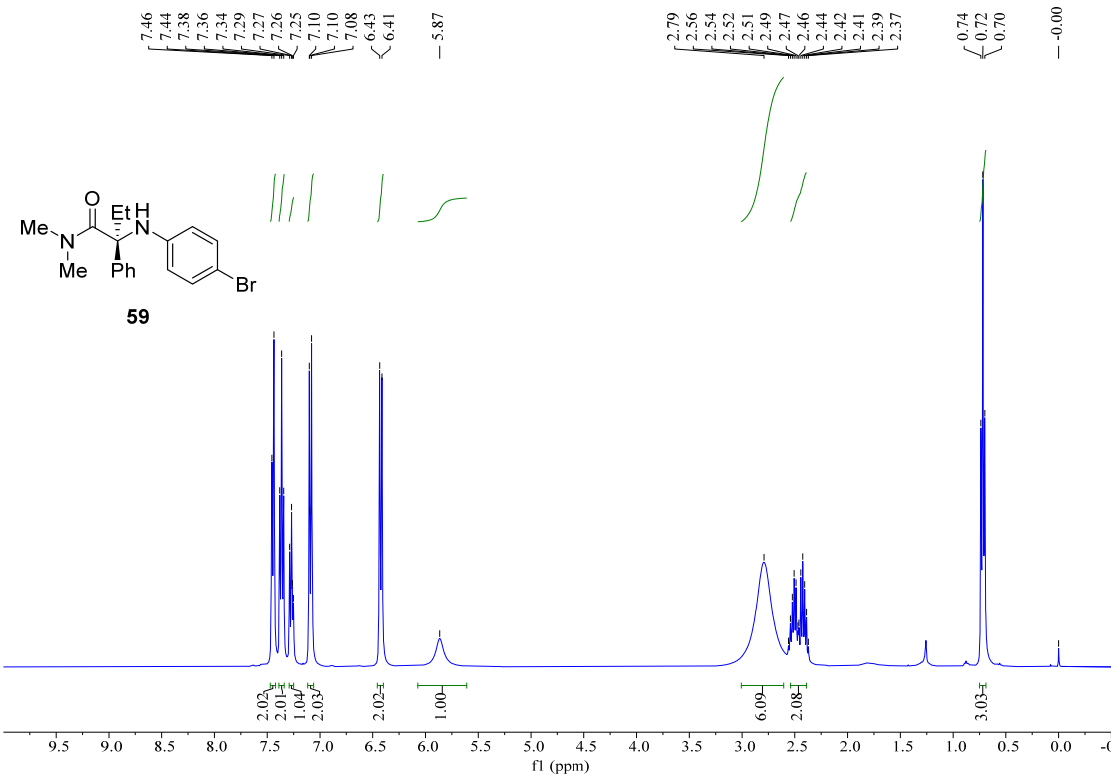
127.66
125.97
116.44
109.43
77.32
77.00
76.68
66.14
66.09
45.47
25.44
7.61
O
Et
H
N
N
O
Ph
Br
58
f1 (ppm)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7.38
7.36
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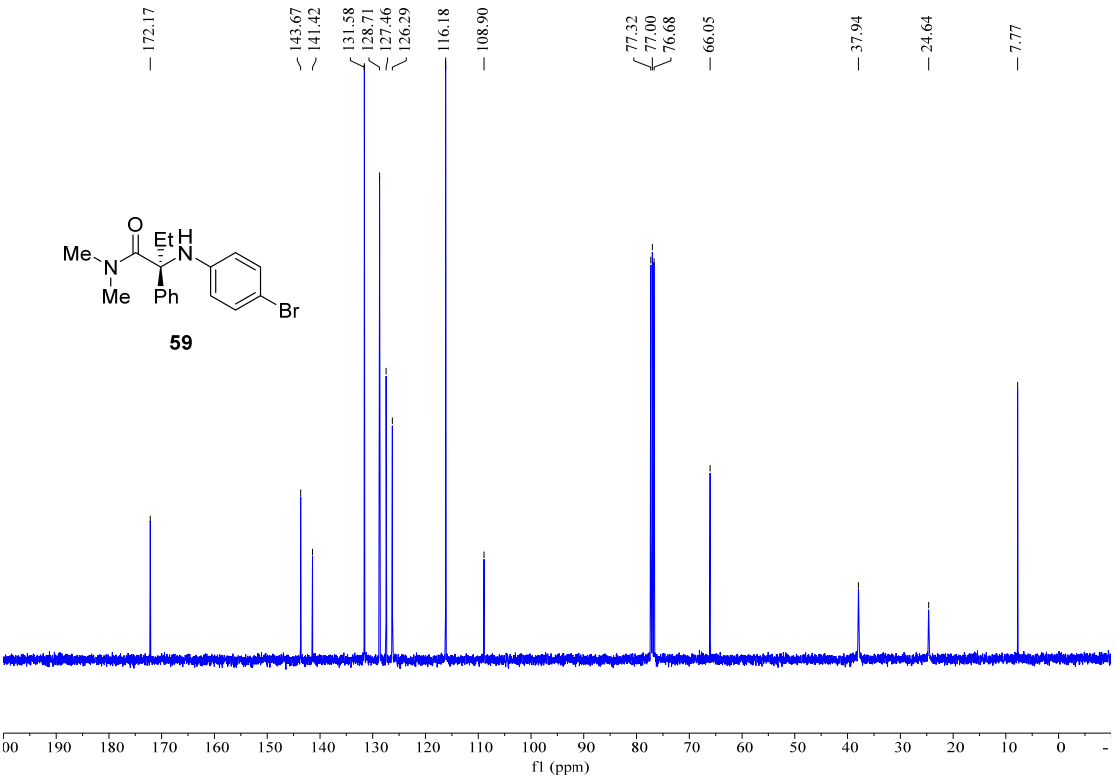
7.29
7.27
7.26
7.25
7.10
7.10
7.08
6.43
6.41
5.87
2.79
2.56
2.54
2.52
2.51
2.49
2.47
2.46
2.44
2.42
2.41
2.39
2.37
0.74
0.72
0.70
-0.00
Me
N
Me
O
Et
H
N
Ph
Br
59
2.02
2.01
1.04
2.03
2.02
1.00
6.09
2.08
3.03
f1 (ppm)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127.46
126.29
116.18
108.90
77.32
77.00
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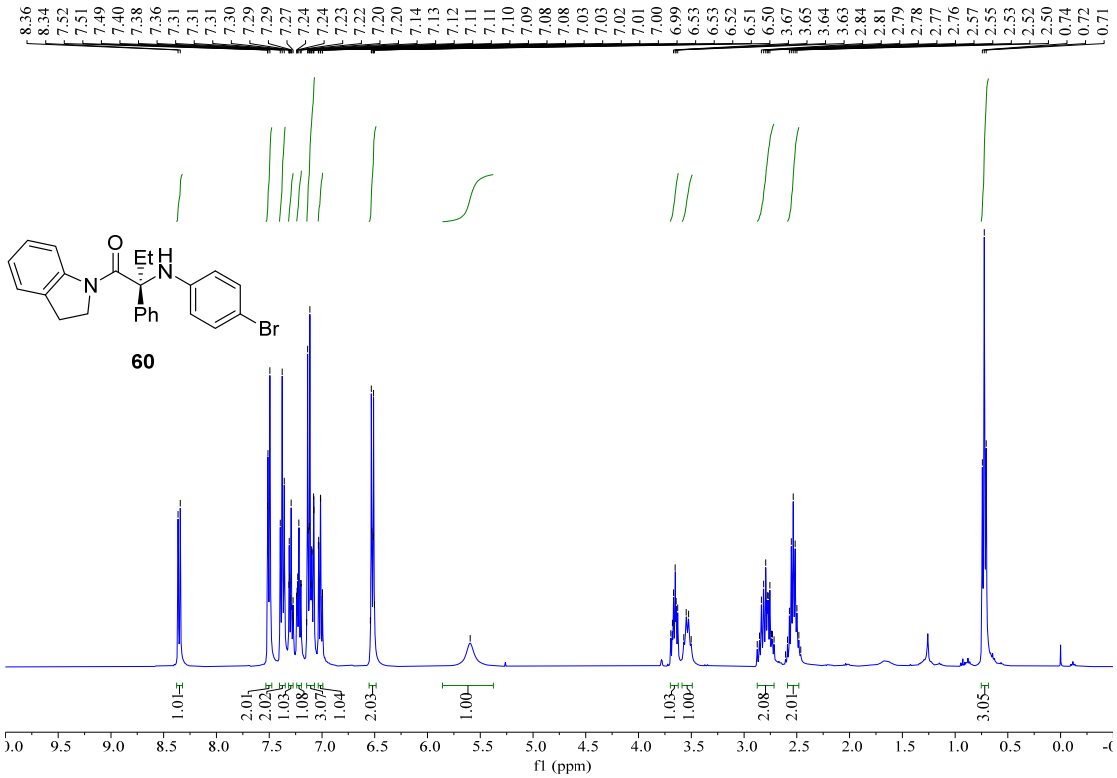
O
Et
H
N
Ph
Br
59
f1 (ppm)


8.36 8.34 7.52 7.51 7.49 7.40 7.38 7.36 7.31 7.31 7.31 7.30 7.29 7.29 7.27 7.24 7.24 7.23 7.22 7.20 7.20 7.14 7.13 7.12 7.11 7.11 7.10 7.09 7.08 7.08 7.03 7.03 7.02 7.01 7.00 6.99 6.53 6.53 6.52 6.51 6.50 3.67 3.65 3.64 3.63 2.84 2.81 2.79 2.78 2.77 2.76 2.57 2.55 2.53 2.52 2.50 0.74 0.72 0.71
O
Et H
N
N
Ph
Br
60
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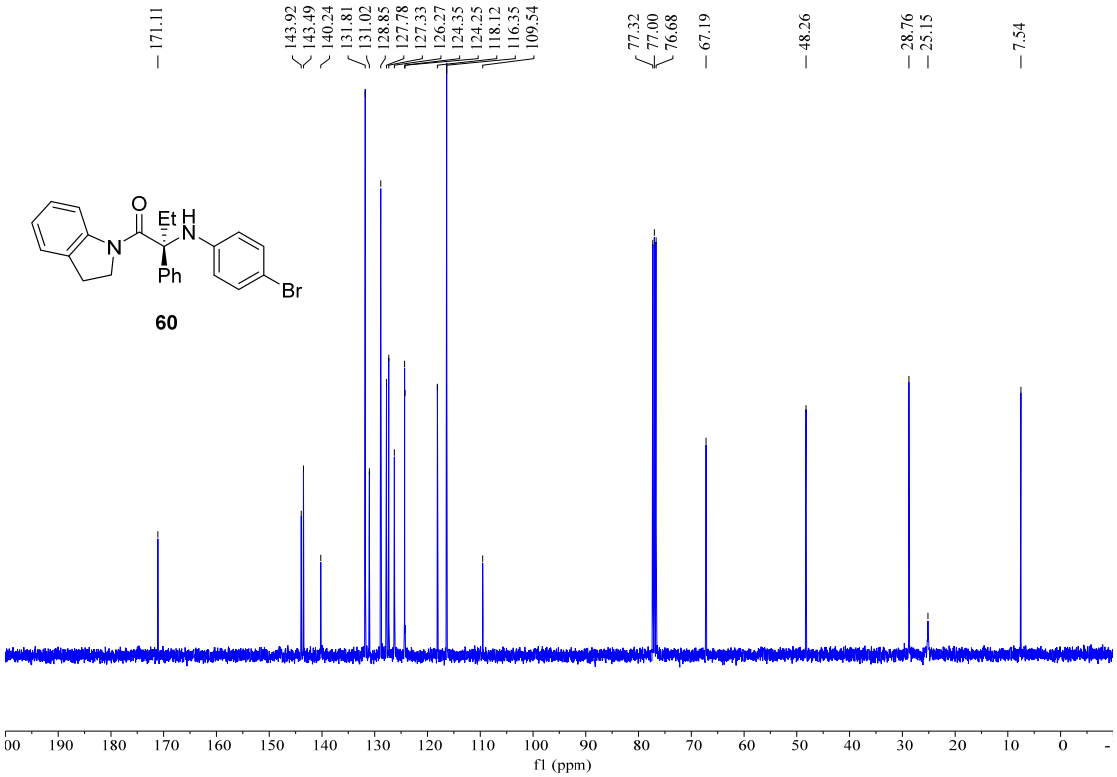
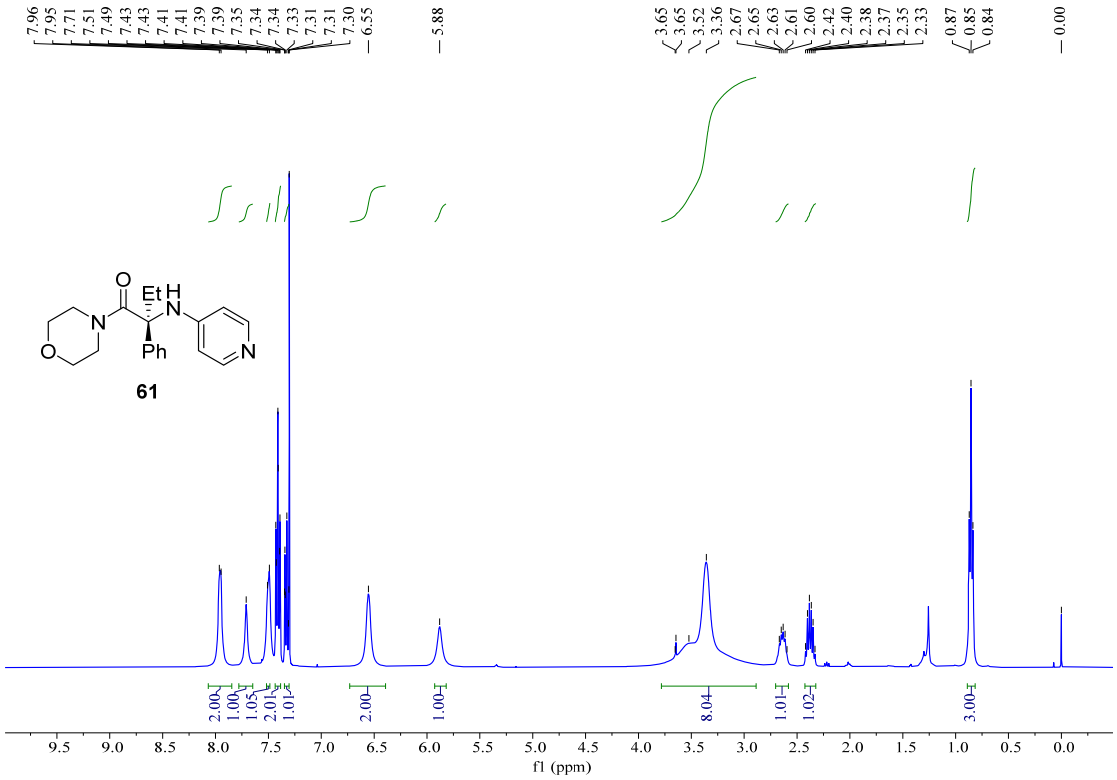
f1 (ppm)


171.11
143.92 143.49 140.24 131.81 131.02 128.85 127.78 127.33 126.27 124.35 124.25 118.12 116.35 109.54
77.32 77.00 76.68
67.19
48.26
28.76 25.15
7.54
O
Et H
N
N
Ph
Br
60
f1 (ppm)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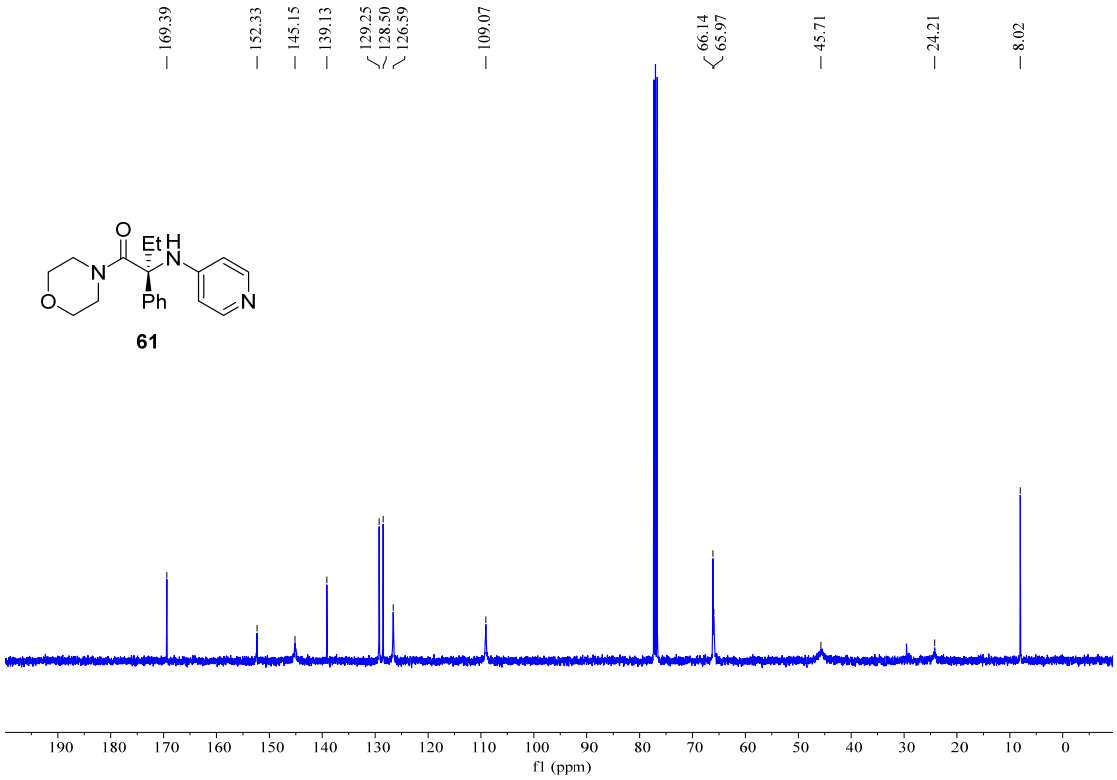
7.35
7.34
7.34
7.33
7.31
7.31
7.30
6.55
5.88
3.65
3.65
3.52
3.36
2.67
2.65
2.63
2.61
2.60
2.42
2.40
2.38
2.37
2.35
2.33
0.87
0.85
0.84
0.00
Et
H
N
O
N
O
Ph
N
61
2.00
1.00
1.05
2.01
1.01
2.00
1.00
8.04
1.01
1.02
3.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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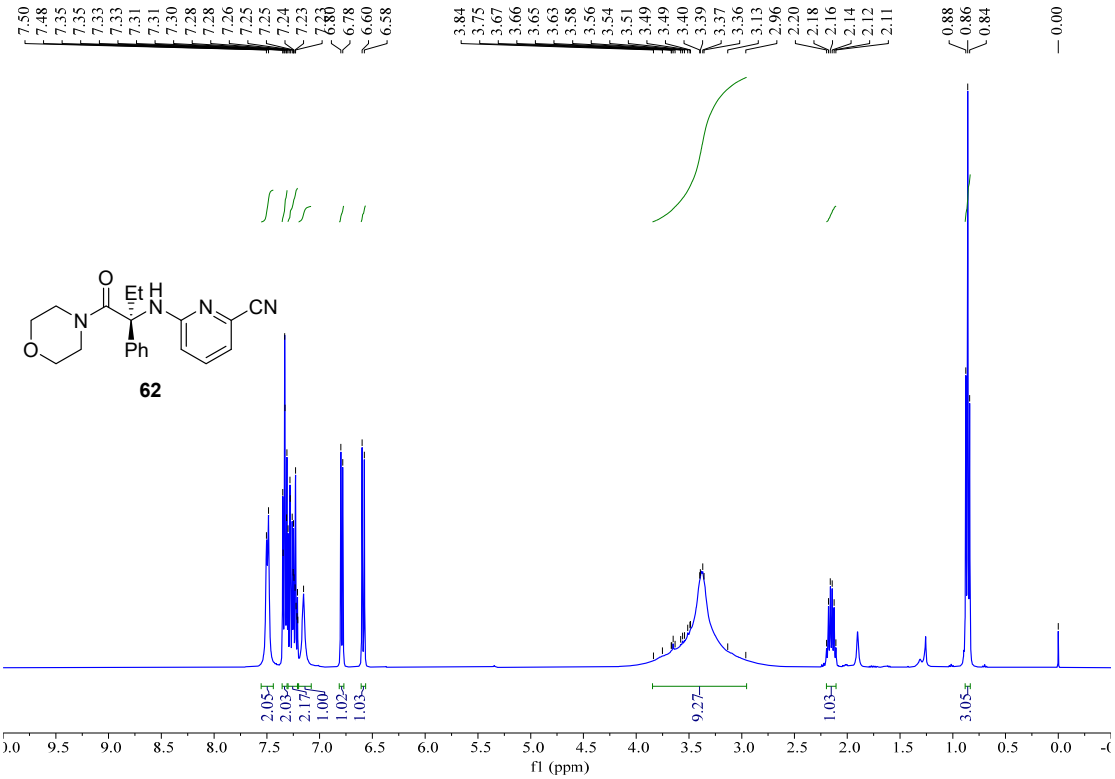
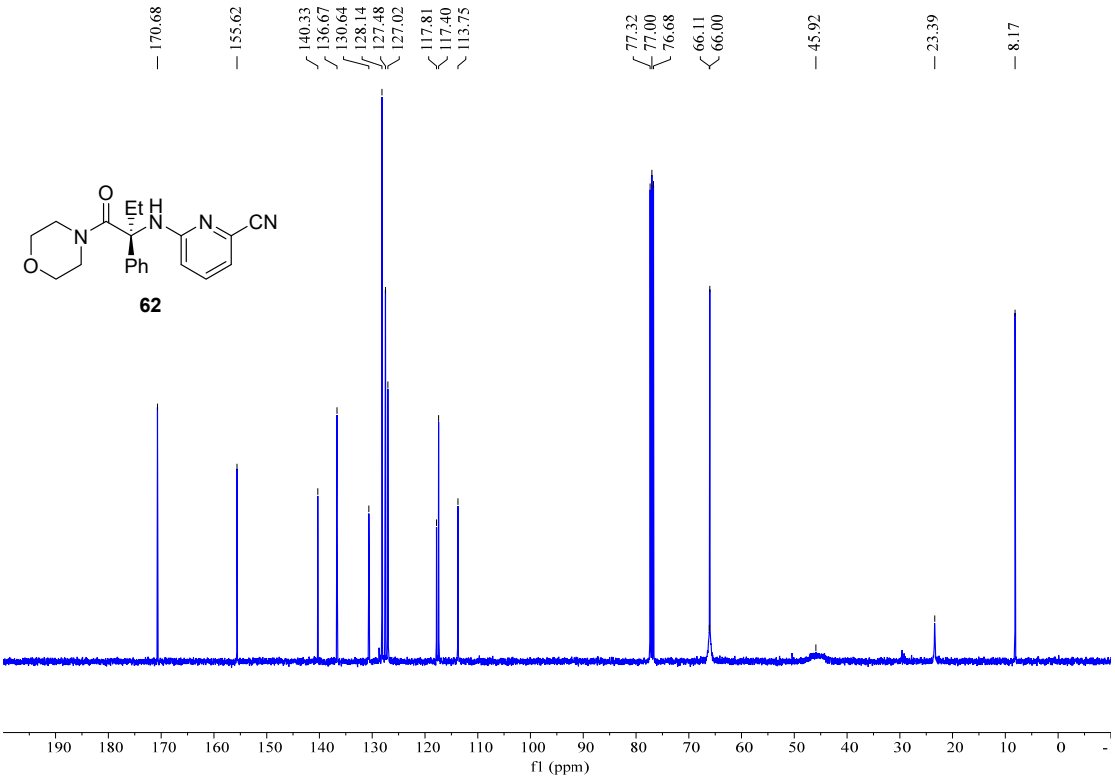
139.13
129.25
128.50
126.59
109.07
66.14
65.97
45.71
24.21
8.02
Et
H
N
O
N
O
Ph
N
61
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.50 7.48 7.35 7.35 7.33 7.33 7.31 7.31 7.30 7.28 7.28 7.26 7.25 7.25 7.24 7.23 6.78 6.60 6.58
3.84 3.75 3.67 3.66 3.65 3.63 3.58 3.56 3.54 3.51 3.49 3.49 3.40 3.39 3.37 3.36 3.13 2.96 2.20 2.18 2.16 2.14 2.12 2.11
0.88 0.86 0.84 0.00
O
Et H
N
N
CN
N
O
Ph
62
2.05 2.03 2.17 1.00 1.02 1.03 9.27 1.03 3.05
f1 (ppm)


170.68 155.62 140.33 136.67 130.64 128.14 127.48 127.02 117.81 117.40 113.75 77.32 77.00 76.68 66.11 66.00 45.92 23.39 8.17
O
Et H
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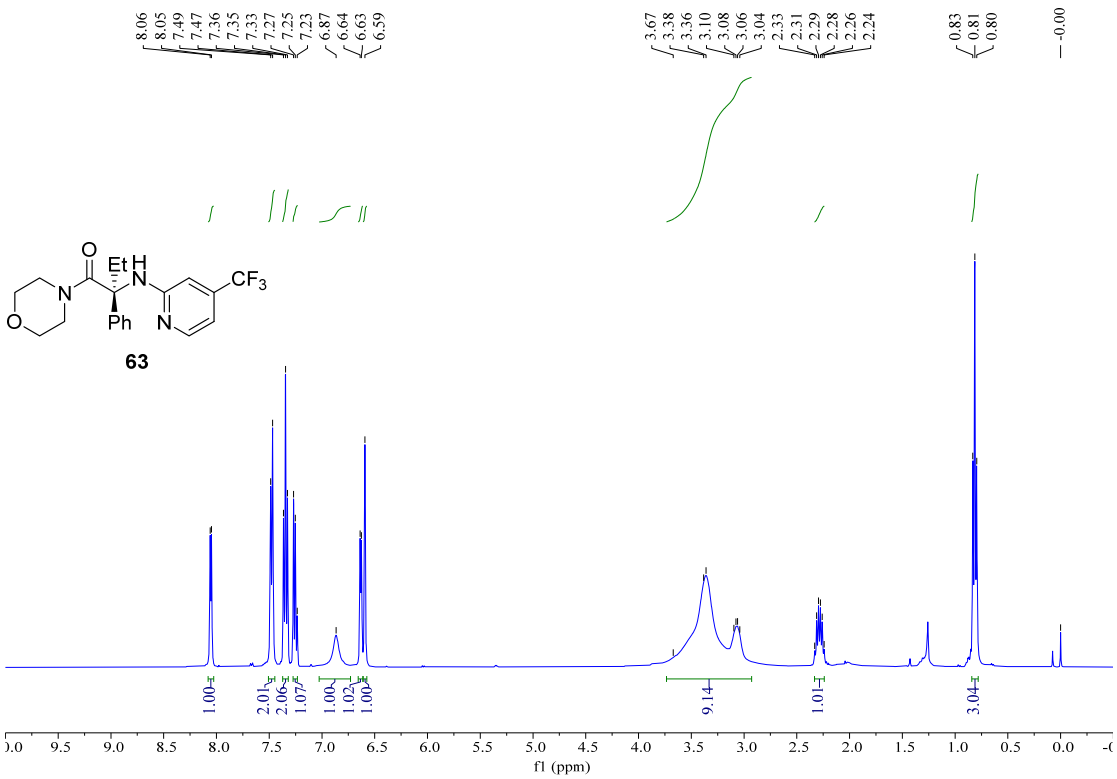
N
CN
N
O
Ph
62
f1 (ppm)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8.05
7.49
7.47
7.36
7.35
7.33
7.27
7.25
7.23
6.87
6.64
6.63
6.59
3.67
3.38
3.36
3.10
3.08
3.06
3.04
2.33
2.31
2.29
2.28
2.26
2.24
0.83
0.81
0.80
-0.00
O
Et
H
N
N
CF3
O
Ph
N
63
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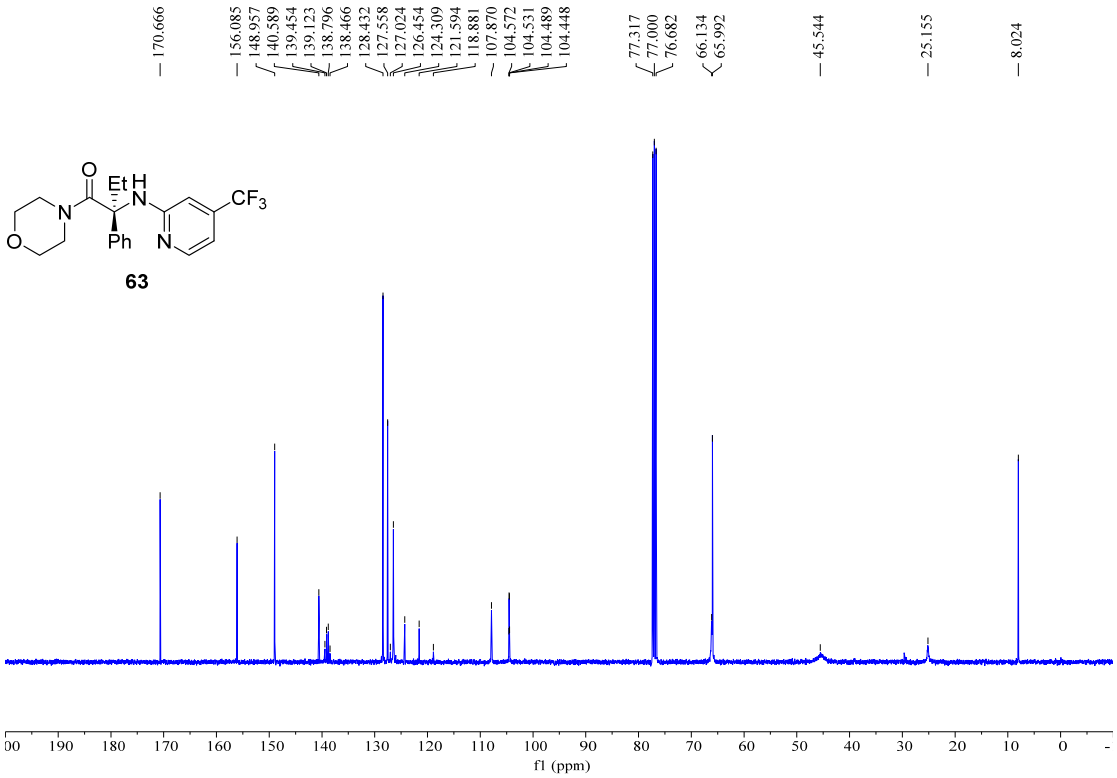
2.01
2.06
1.07
1.00
1.02
1.00
9.14
1.01
3.04
f1 (ppm)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148.957
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139.454
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138.796
138.466
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127.558
127.024
126.454
124.309
121.594
118.881
107.870
104.572
104.531
104.489
104.448
77.317
77.000
76.682
66.134
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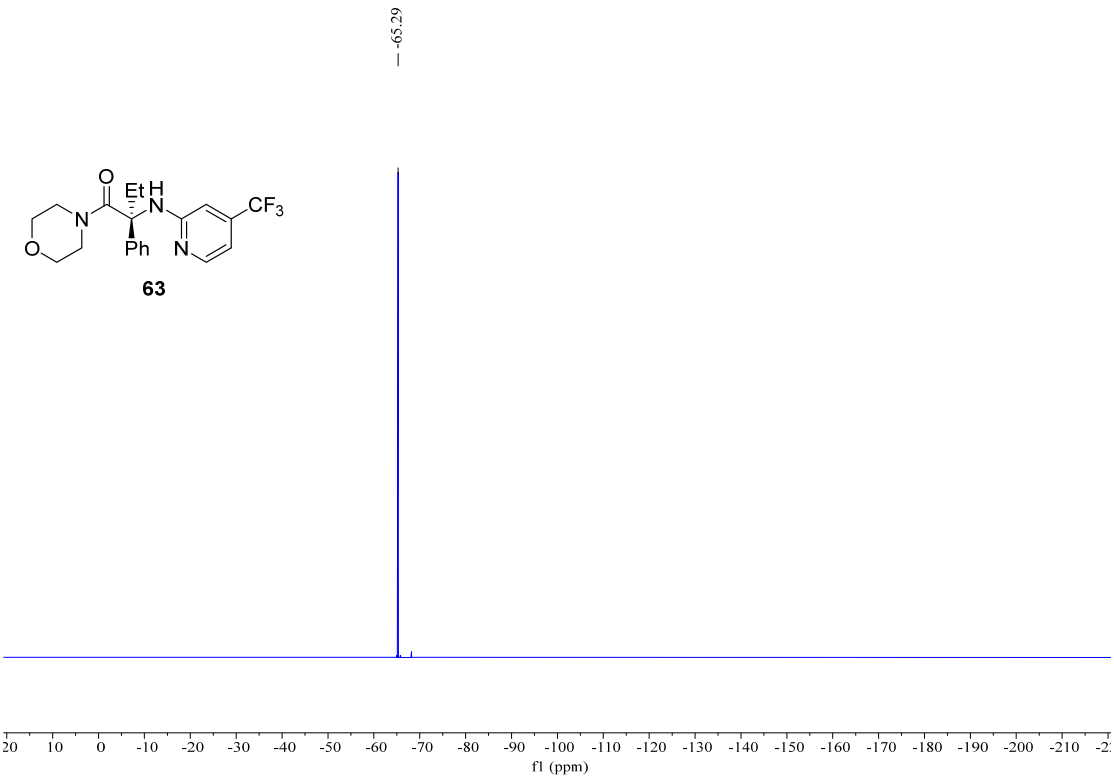
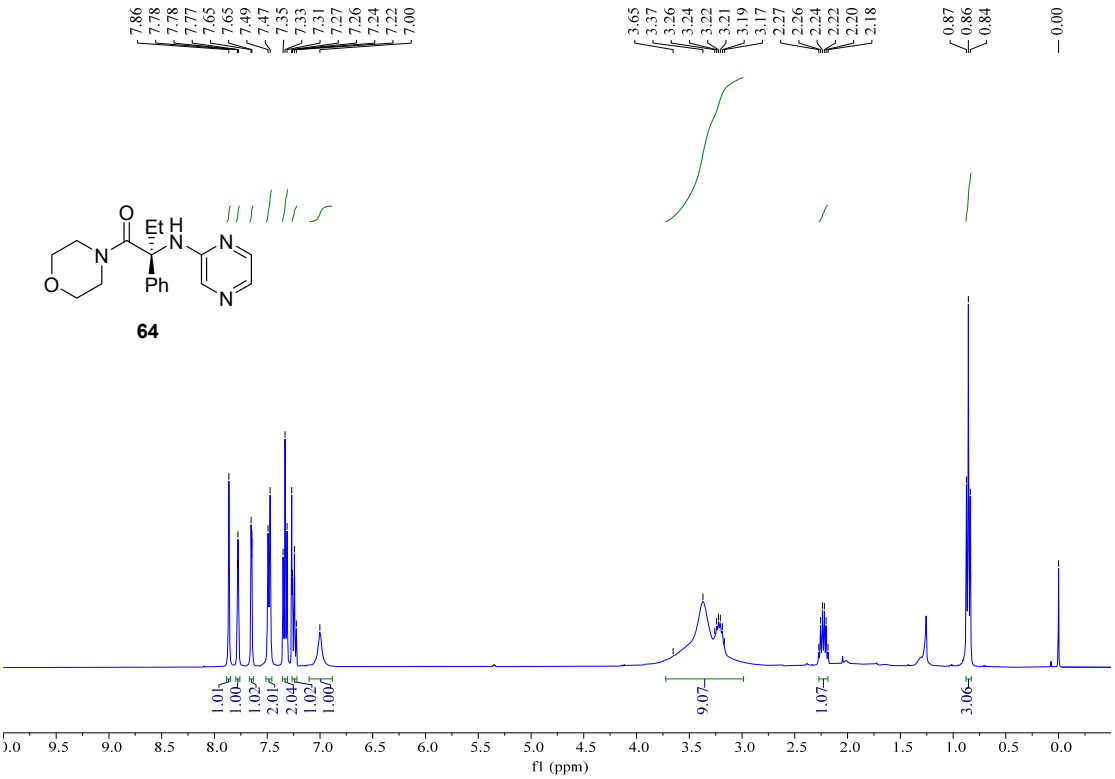
25.155
8.024
O
Et
H
N
N
CF3
O
Ph
N
63
f1 (ppm)


-65.29
O
Et
H
N
CF3
N
O
Ph
N
63
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)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7.78
7.78
7.77
7.65
7.65
7.49
7.47
7.35
7.33
7.31
7.27
7.26
7.24
7.22
7.00
3.65
3.37
3.26
3.24
3.22
3.21
3.19
3.17
2.27
2.26
2.24
2.22
2.20
2.18
0.87
0.86
0.84
0.00
O
Et H
N
N
N
O
Ph
64
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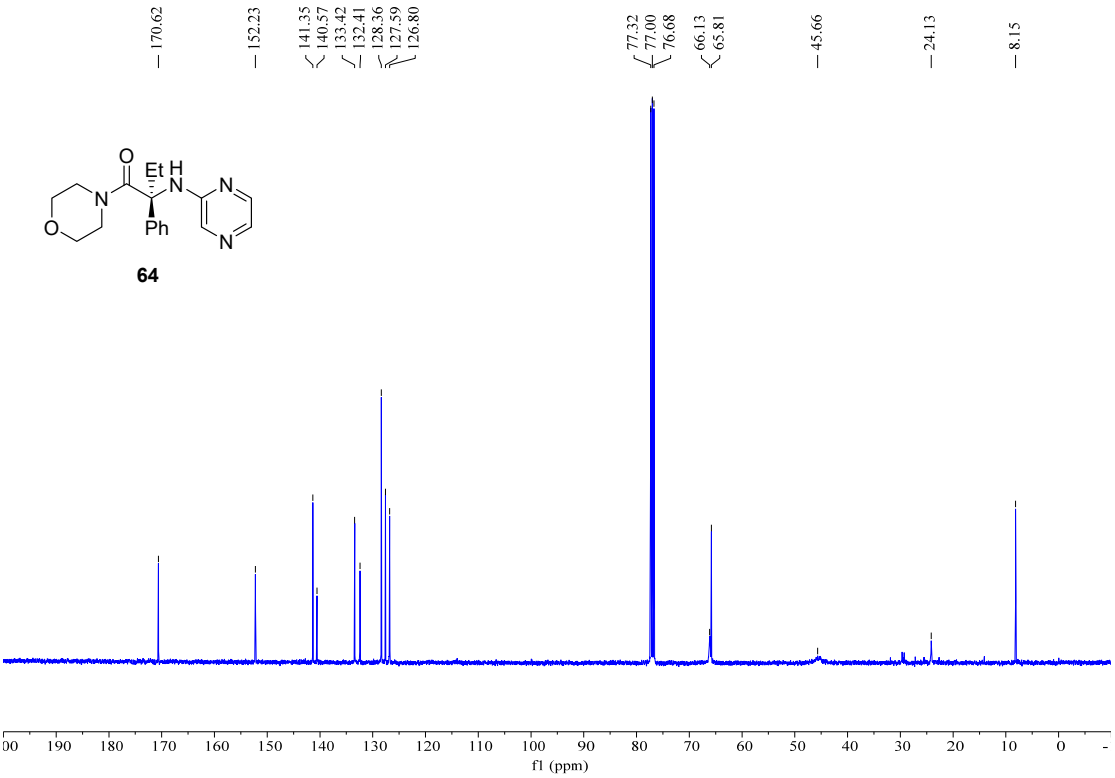
1.00
1.02
2.01
2.04
1.02
1.00
9.07
1.07
3.06
f1 (ppm)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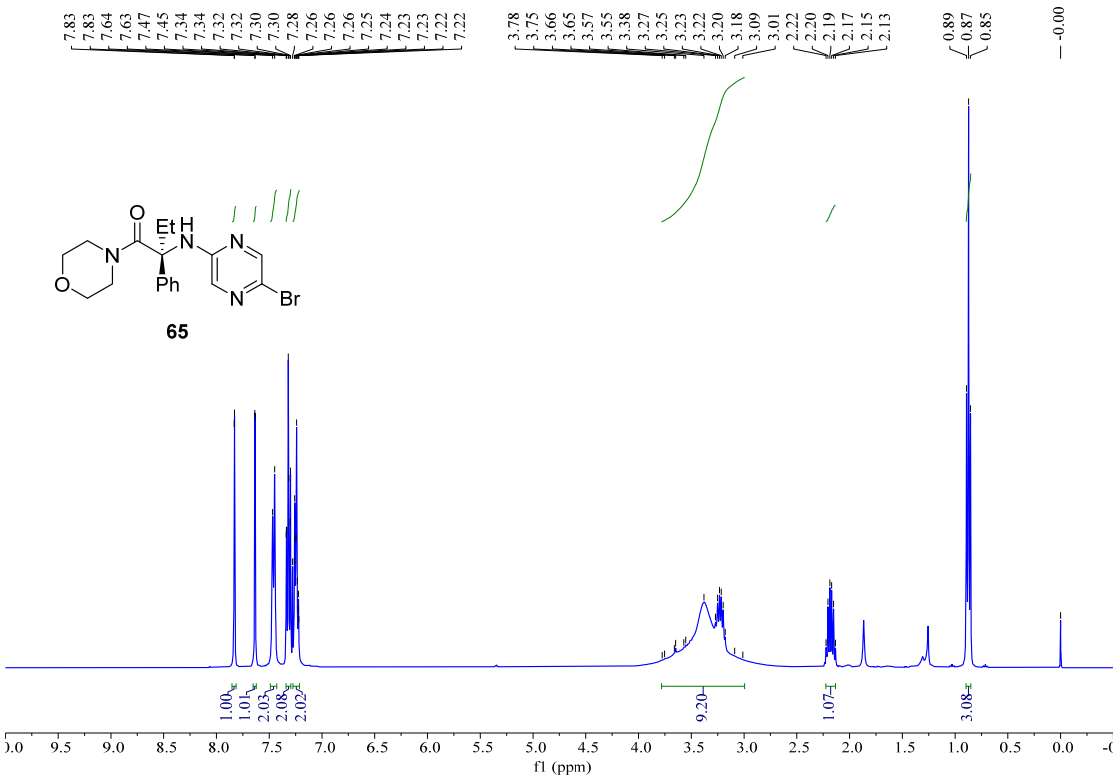
152.23
141.35
140.57
133.42
132.41
128.36
127.59
126.80
77.32
77.00
76.68
66.13
65.81
45.66
24.13
8.15
O
Et H
N
N
N
O
Ph
64
f1 (ppm)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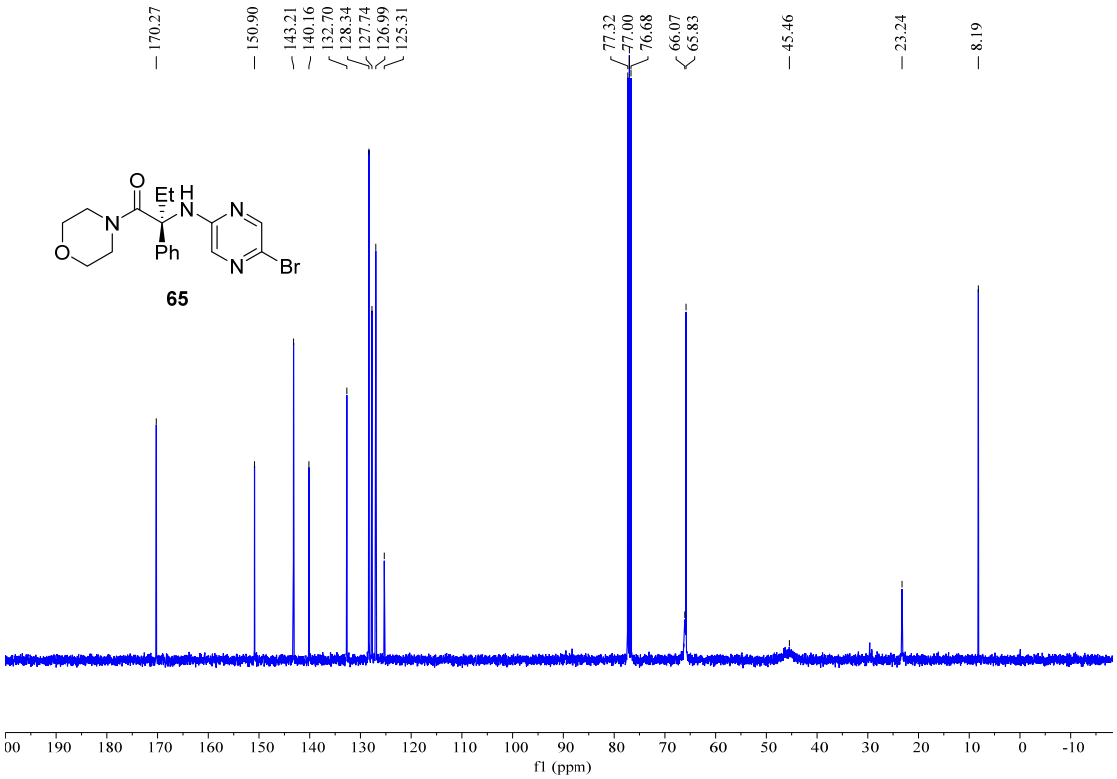
7.83
7.64
7.63
7.47
7.45
7.34
7.34
7.32
7.32
7.30
7.30
7.28
7.26
7.26
7.25
7.24
7.23
7.23
7.22
7.22
3.78
3.75
3.66
3.65
3.57
3.55
3.38
3.27
3.25
3.23
3.22
3.20
3.18
3.09
3.01
2.22
2.20
2.19
2.17
2.15
2.13
0.89
0.87
0.85
-0.00
Et
H
N
O
N
O
Ph
N
N
Br
65
1.00
1.01
2.03
2.08
2.02
9.20
1.07
3.08
f1 (ppm)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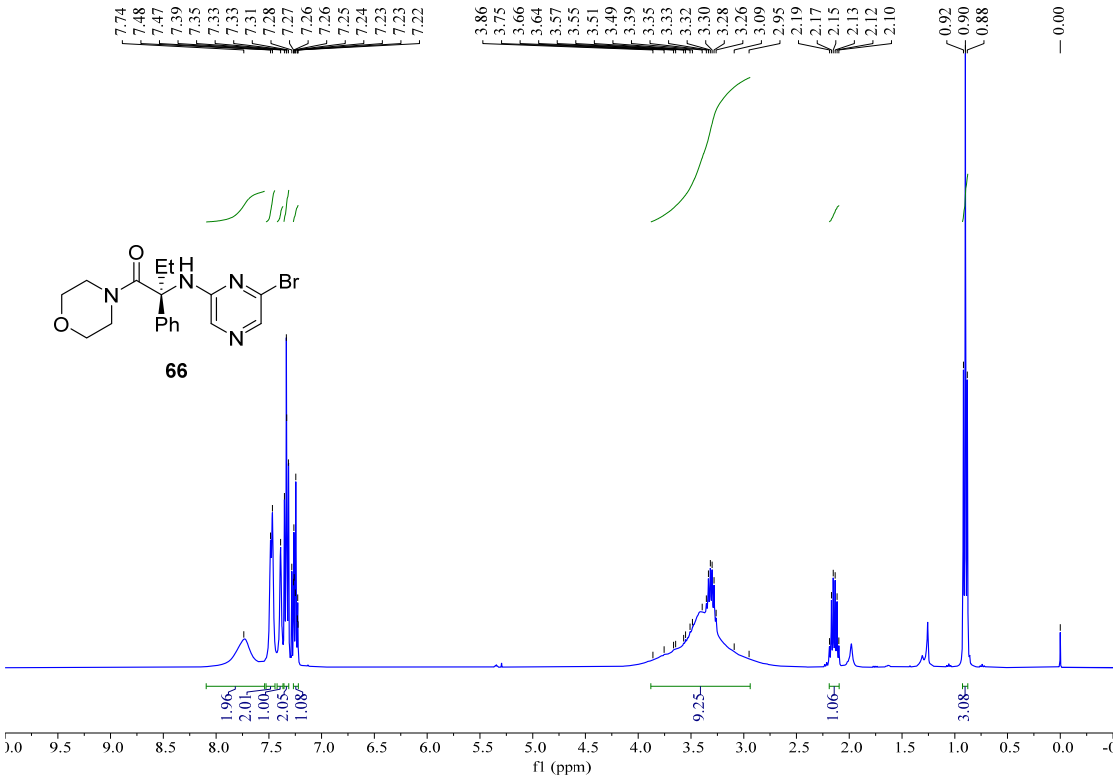
143.21
140.16
132.70
128.34
127.74
126.99
125.31
77.32
77.00
76.68
66.07
65.83
45.46
23.24
8.19
Et
H
N
O
N
O
Ph
N
N
Br
65
f1 (ppm)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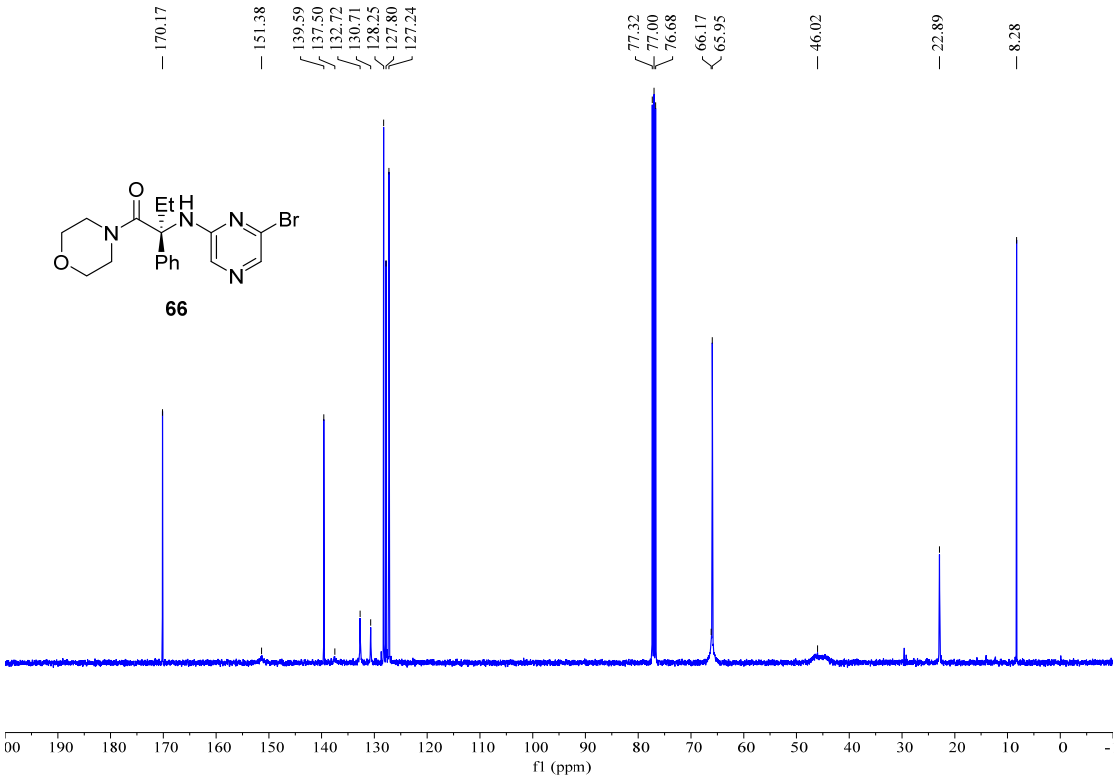
7.48
7.47
7.39
7.35
7.33
7.33
7.31
7.28
7.27
7.26
7.26
7.25
7.24
7.23
7.23
7.22
3.86
3.75
3.66
3.64
3.57
3.55
3.51
3.49
3.39
3.35
3.33
3.32
3.30
3.28
3.26
3.09
2.95
2.19
2.17
2.15
2.13
2.12
2.10
0.92
0.90
0.88
0.00
O
Et
H
N
N
N
Br
N
O
Ph
66
1.96
2.01
1.00
2.05
1.08
9.25
1.06
3.08
f1 (ppm)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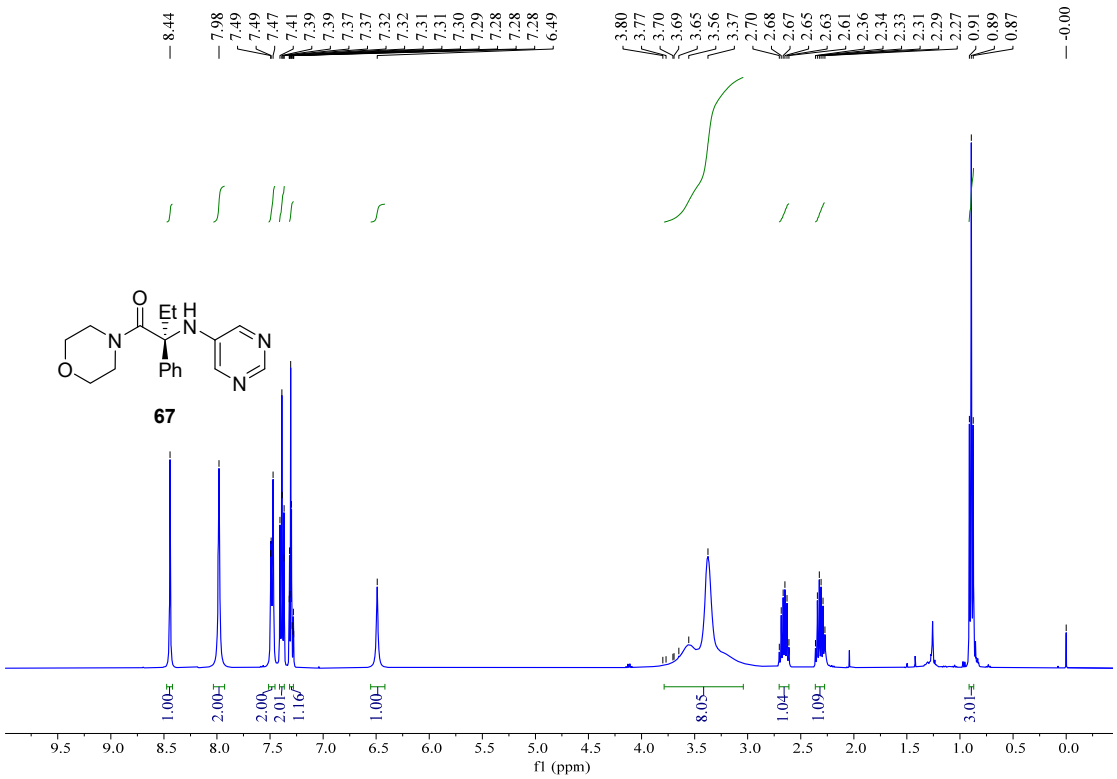
151.38
139.59
137.50
132.72
130.71
128.25
127.80
127.24
77.32
77.00
76.68
66.17
65.95
46.02
22.89
8.28
O
Et
H
N
N
N
Br
N
O
Ph
66
f1 (ppm)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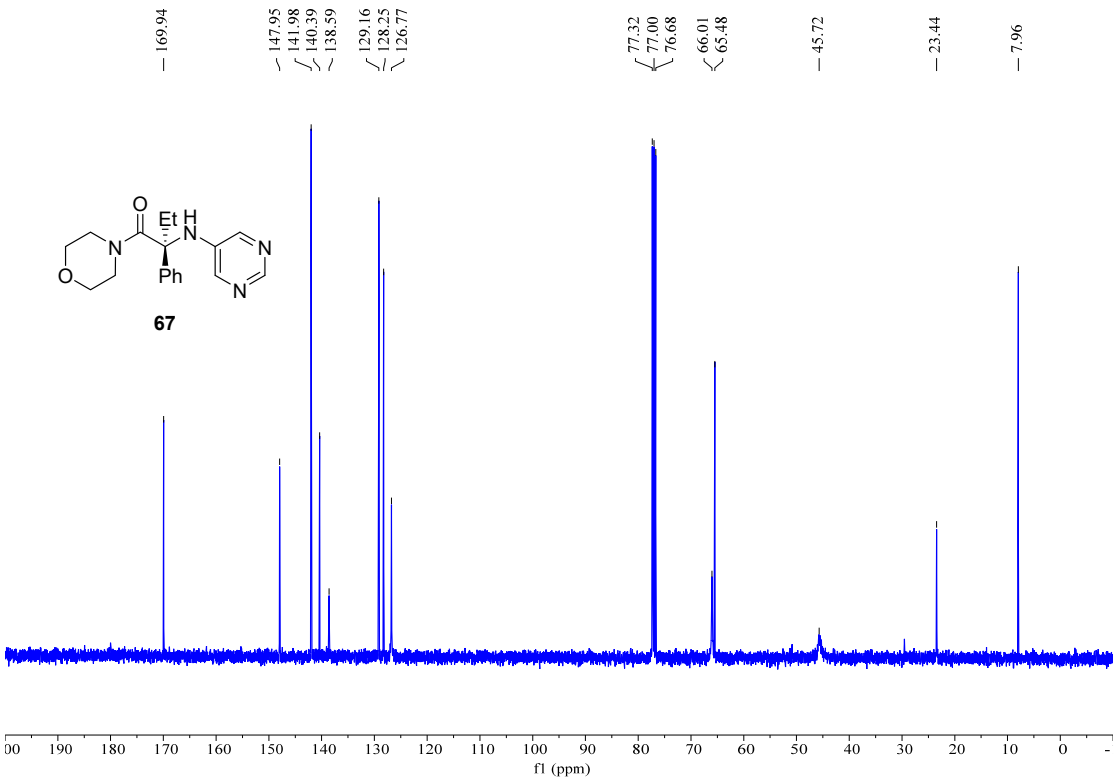
7.98
7.49
7.49
7.47
7.41
7.39
7.39
7.37
7.37
7.32
7.32
7.31
7.31
7.30
7.29
7.28
7.28
7.28
6.49
3.80
3.77
3.70
3.69
3.65
3.56
3.37
2.70
2.68
2.67
2.65
2.63
2.61
2.36
2.34
2.33
2.31
2.29
2.27
0.91
0.89
0.87
-0.00
1.00
2.00
2.00
2.01
1.16
1.00
8.05
1.04
1.09
3.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)
O
Et
H
N
N
O
N
Ph
N

67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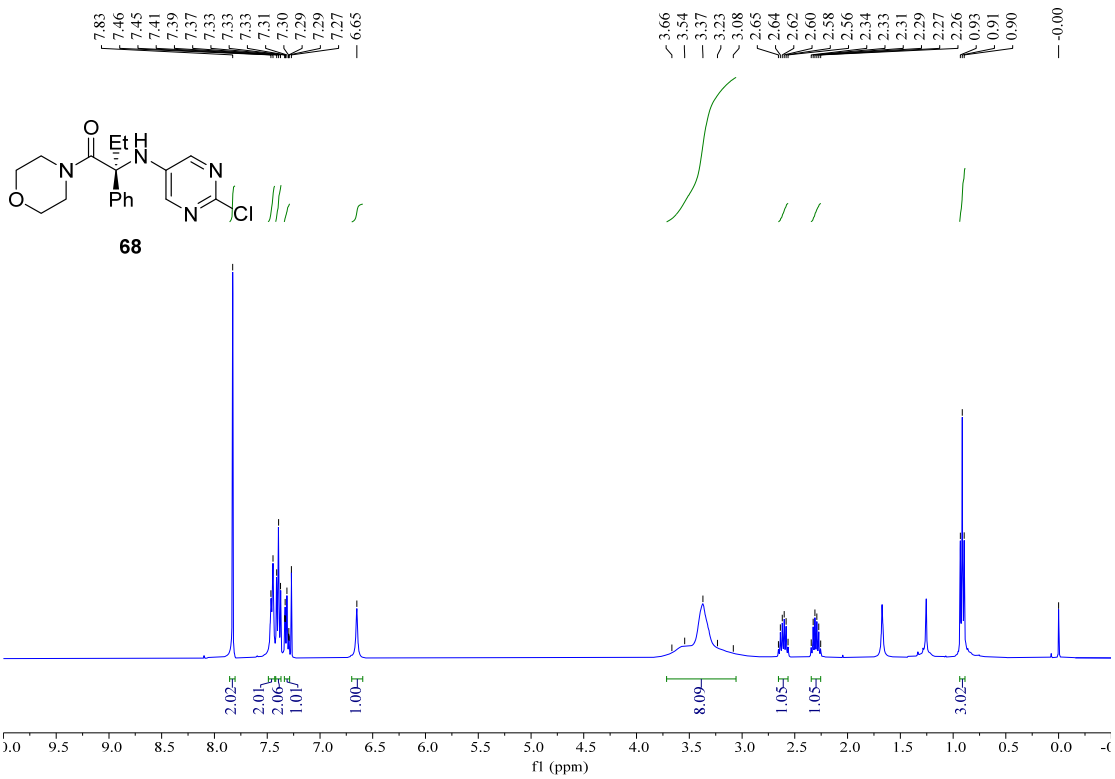
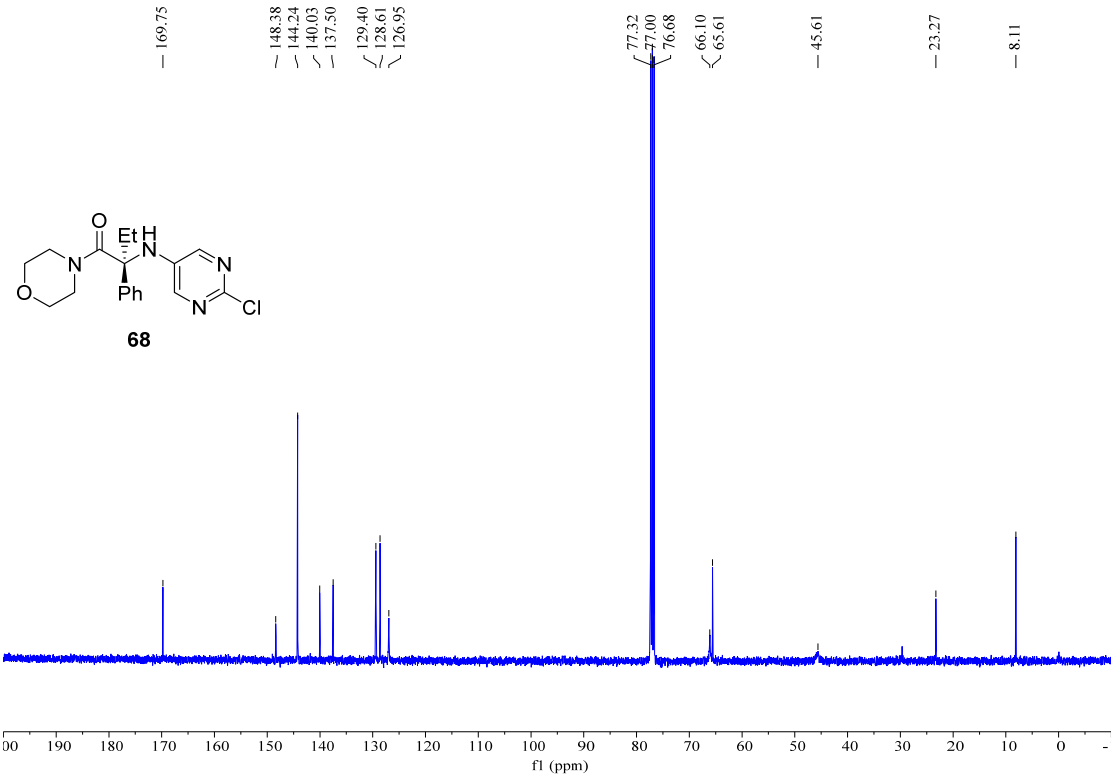
141.98
140.39
138.59
129.16
128.25
126.77
77.32
77.00
76.68
66.01
65.48
45.72
23.44
7.96
00 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -
f1 (ppm)
O
Et
H
N
N
O
N
Ph
N

67


7.83
7.46
7.45
7.41
7.39
7.37
7.33
7.33
7.33
7.31
7.30
7.29
7.29
7.27
6.65
3.66
3.54
3.37
3.23
3.08
2.65
2.64
2.62
2.60
2.58
2.56
2.34
2.33
2.31
2.29
2.27
2.26
0.93
0.91
0.90
-0.00
O
Et
H
N
N
O
N
Ph
N
Cl
68
2.02
2.01
2.06
1.01
1.00
8.09
1.05
1.05
3.02
f1 (ppm)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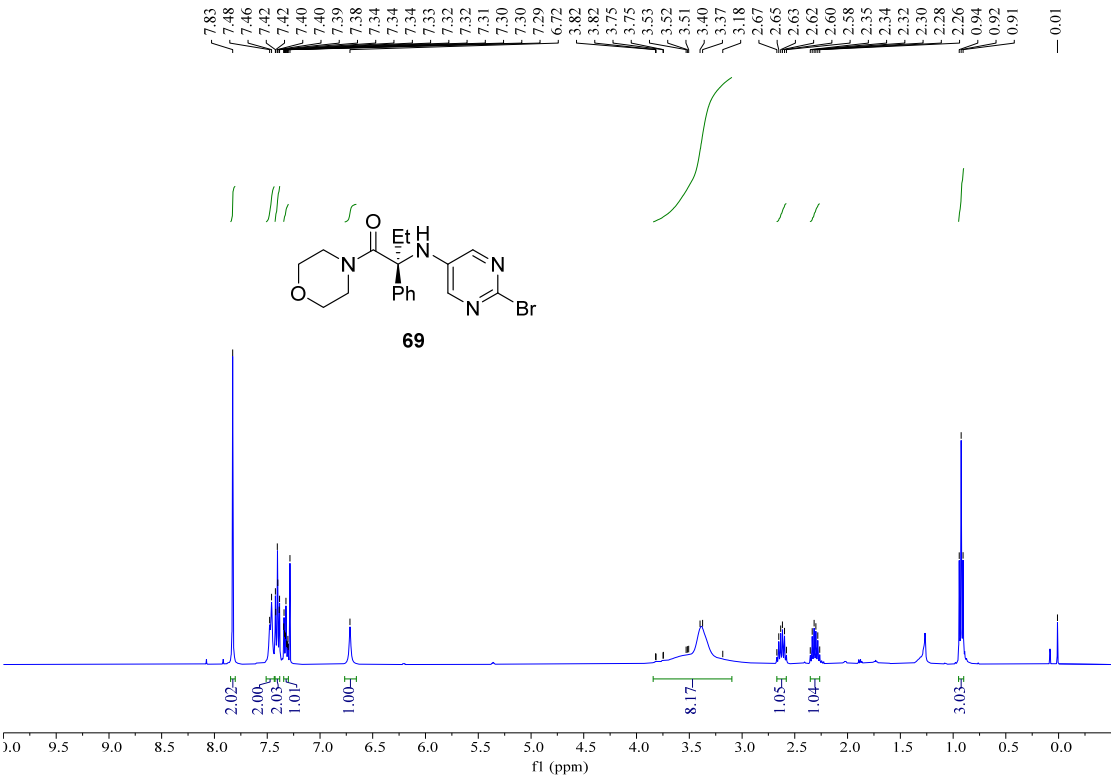
144.24
140.03
137.50
129.40
128.61
126.95
77.32
77.00
76.68
66.10
65.61
45.61
23.27
8.11
O
Et
H
N
N
O
N
Ph
N
Cl
68
f1 (ppm)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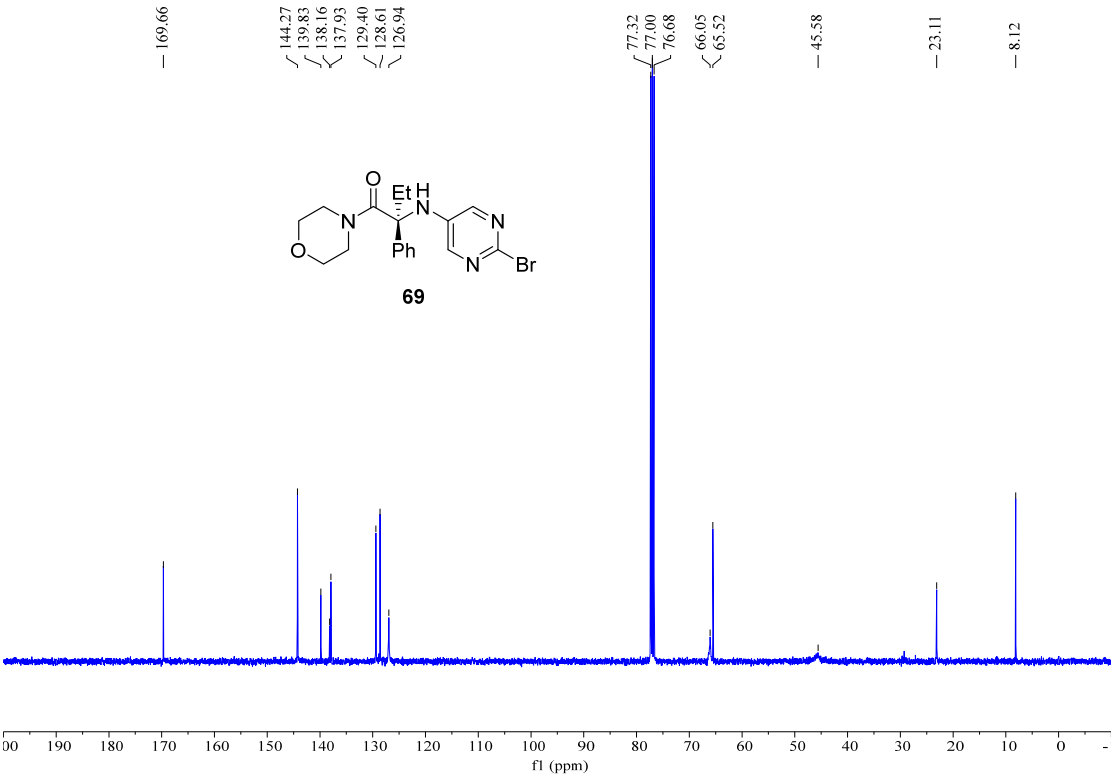
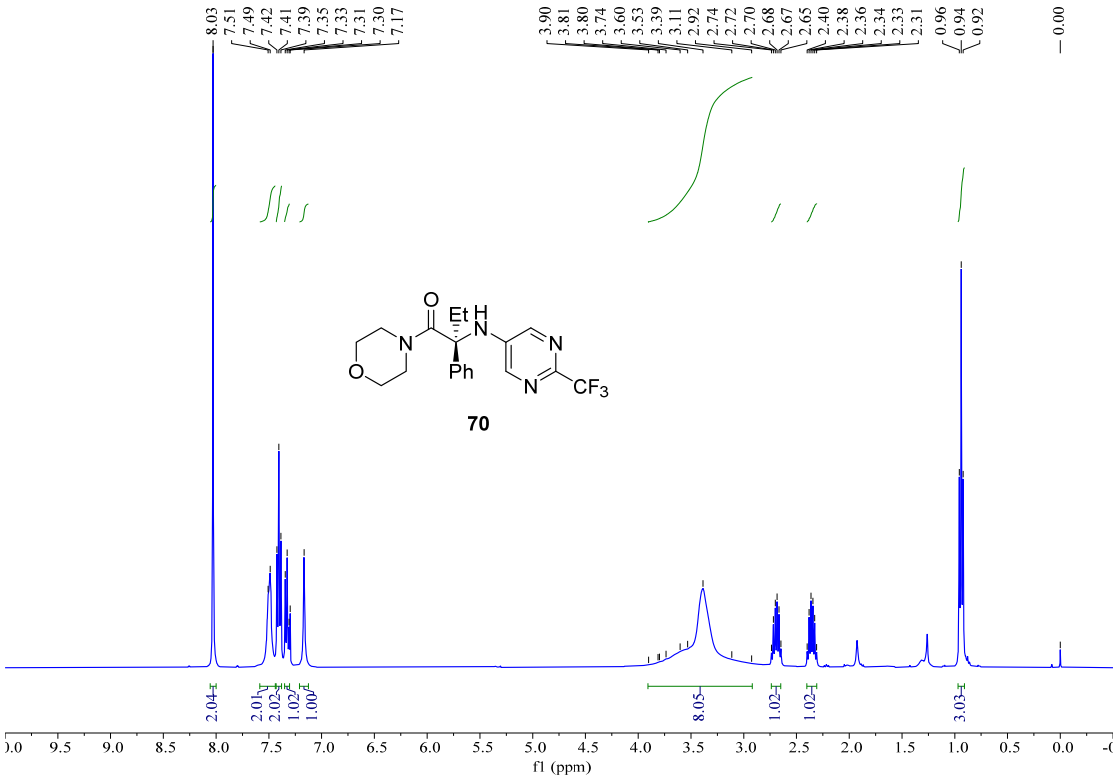
O
Et H
N
N
O
Ph
N
N
Br
69
2.02 2.00 2.03 1.01 1.00 8.17 1.05 1.04 3.03
f1 (ppm)


169.66 144.27 139.83 138.16 137.93 129.40 128.61 126.94 77.32 77.00 76.68 66.05 65.52 45.58 23.11 8.12
O
Et H
N
N
O
Ph
N
N
Br
69
f1 (ppm)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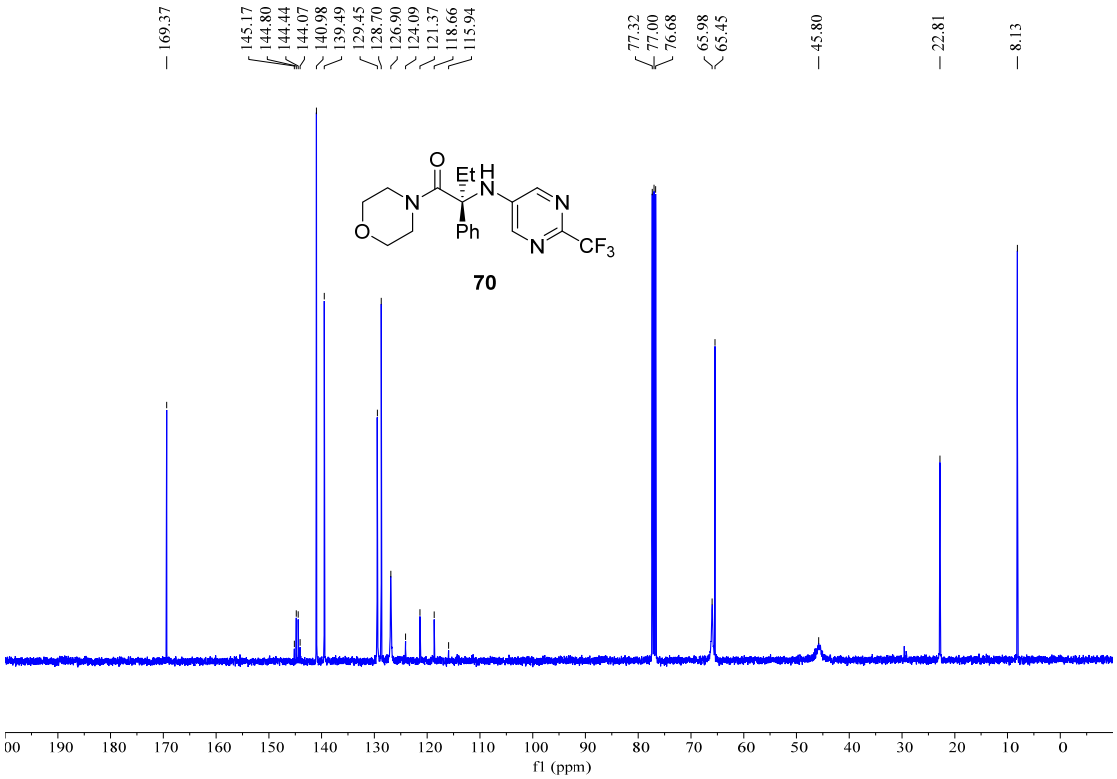
7.49
7.42
7.41
7.39
7.35
7.33
7.31
7.30
7.17
3.90
3.81
3.80
3.74
3.60
3.53
3.39
3.11
2.92
2.74
2.72
2.70
2.68
2.67
2.65
2.40
2.38
2.36
2.34
2.33
2.31
0.96
0.94
0.92
0.00
2.04
2.01
2.02
1.02
1.00
8.05
1.02
1.02
3.03
f1 (ppm)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144.80
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144.07
140.98
139.49
129.45
128.70
126.90
124.09
121.37
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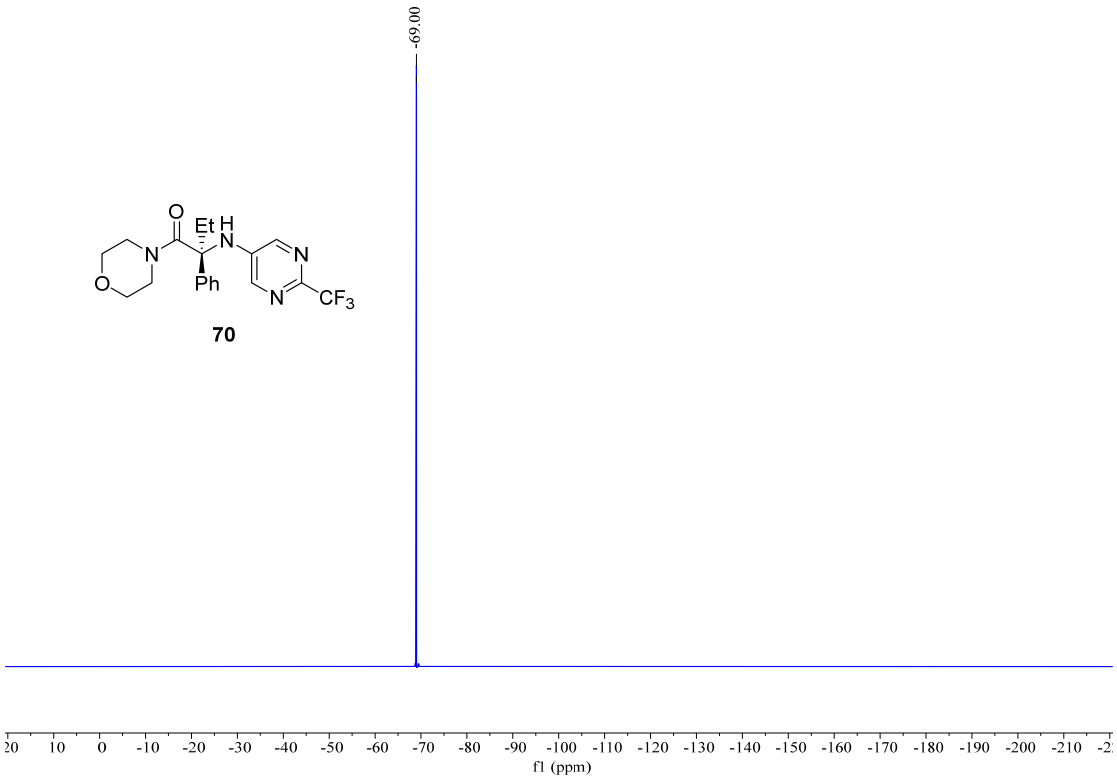
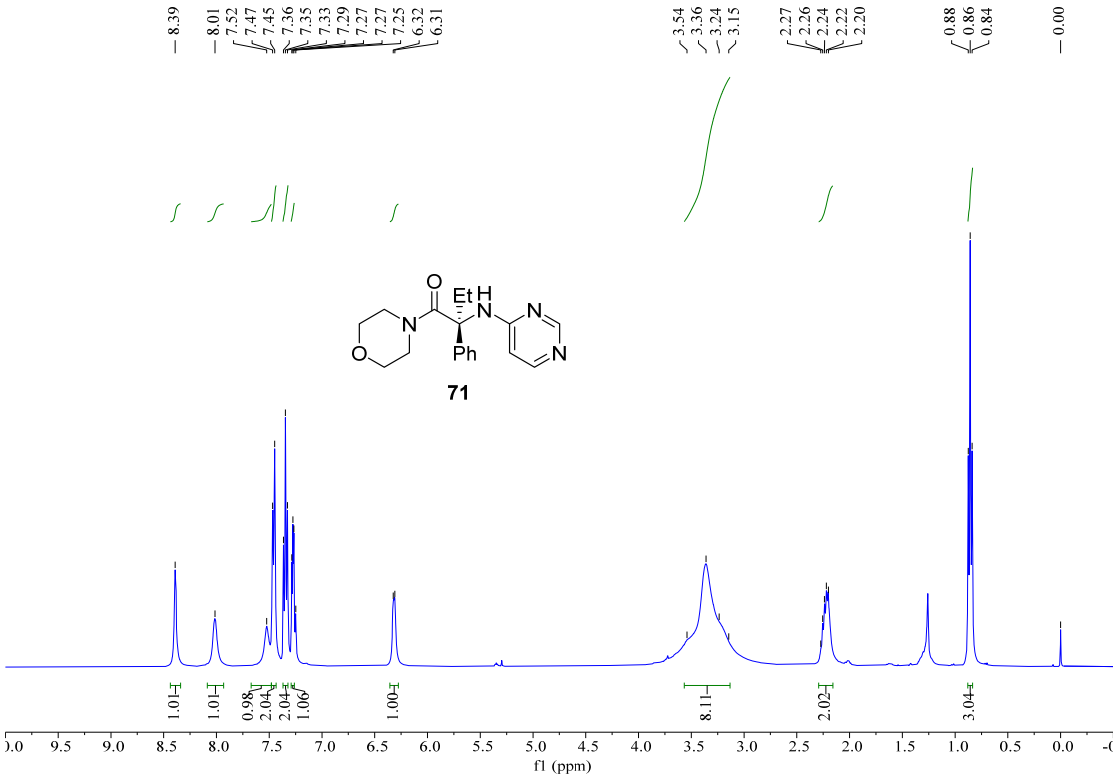
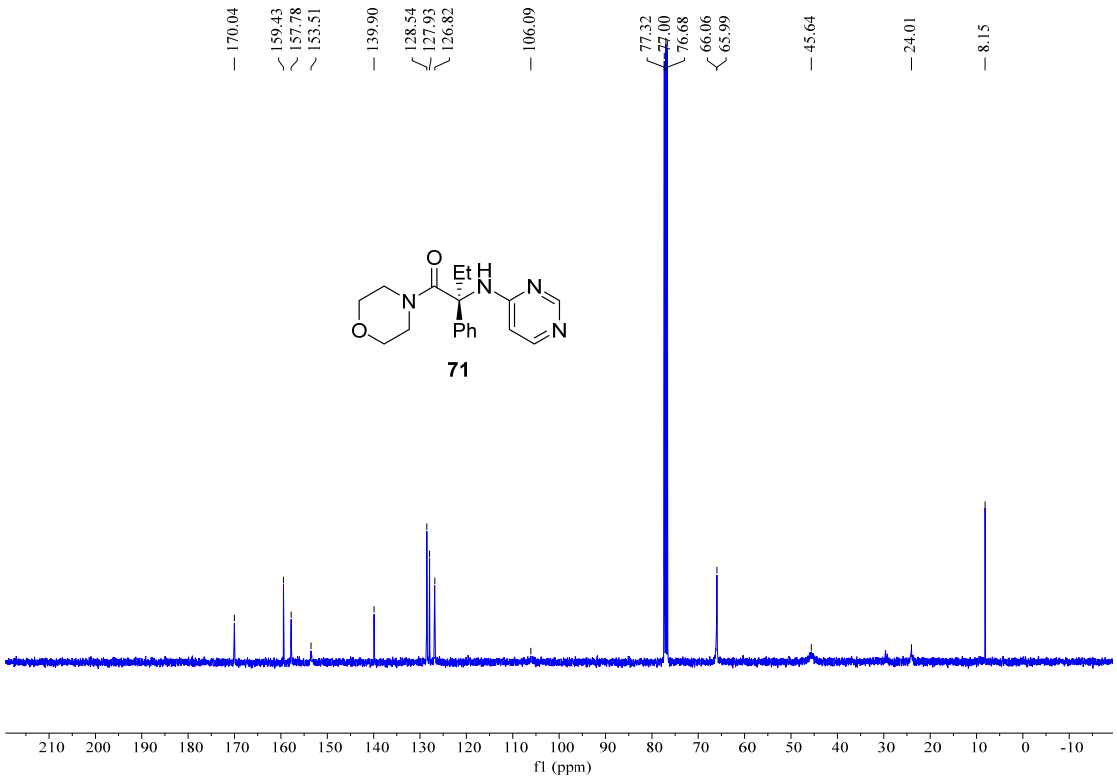
115.94
77.32
77.00
76.68
65.98
65.45
45.80
22.81
8.13
f1 (ppm)

70


-69.00
O
Et
H
N
N
O
Ph
N
CF3
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

70


8.39
8.01
7.52
7.47
7.45
7.36
7.35
7.33
7.29
7.27
7.27
7.25
6.32
6.31
3.54
3.36
3.24
3.15
2.27
2.26
2.24
2.22
2.20
0.88
0.86
0.84
0.00
Et
H
N
O
N
N
Ph
71
1.01
1.01
0.98
2.04
2.04
1.06
1.00
8.11
2.02
3.04
f1 (ppm)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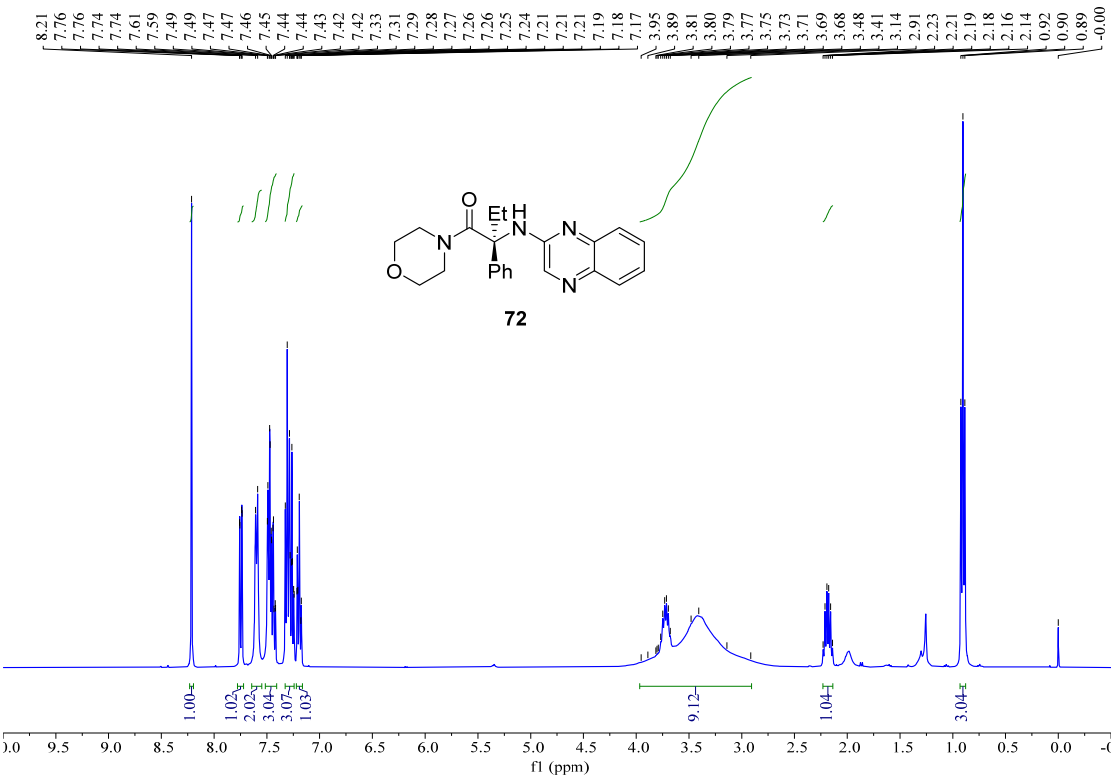
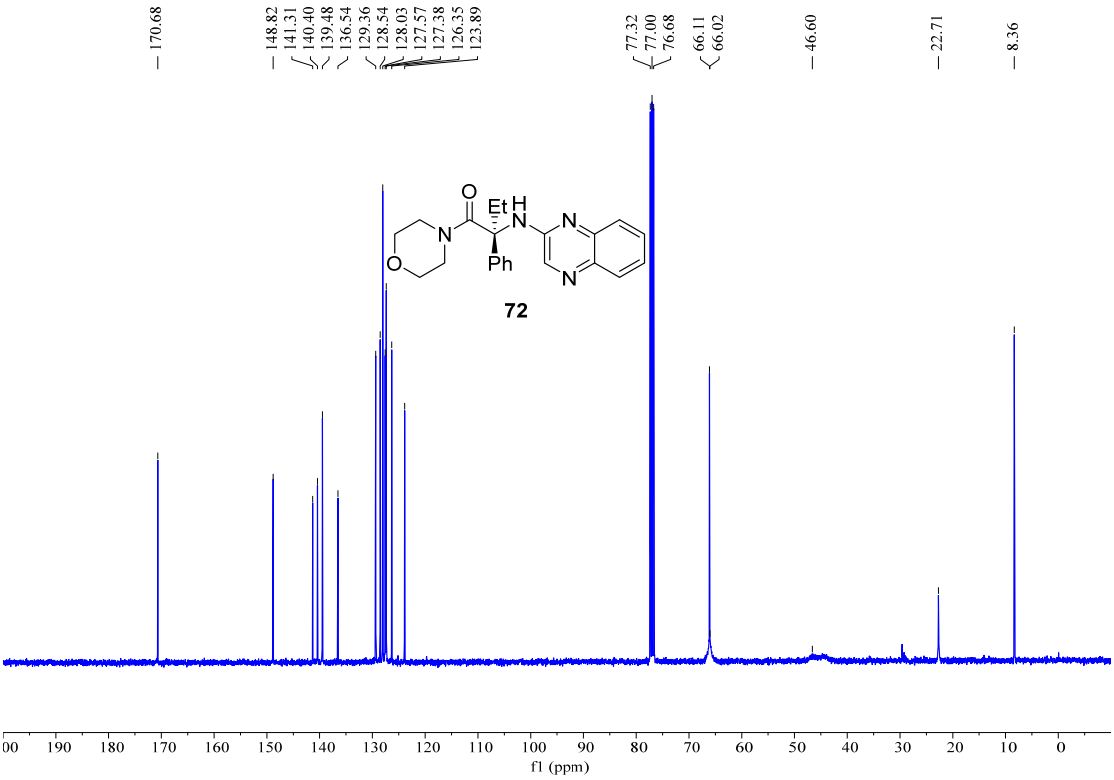
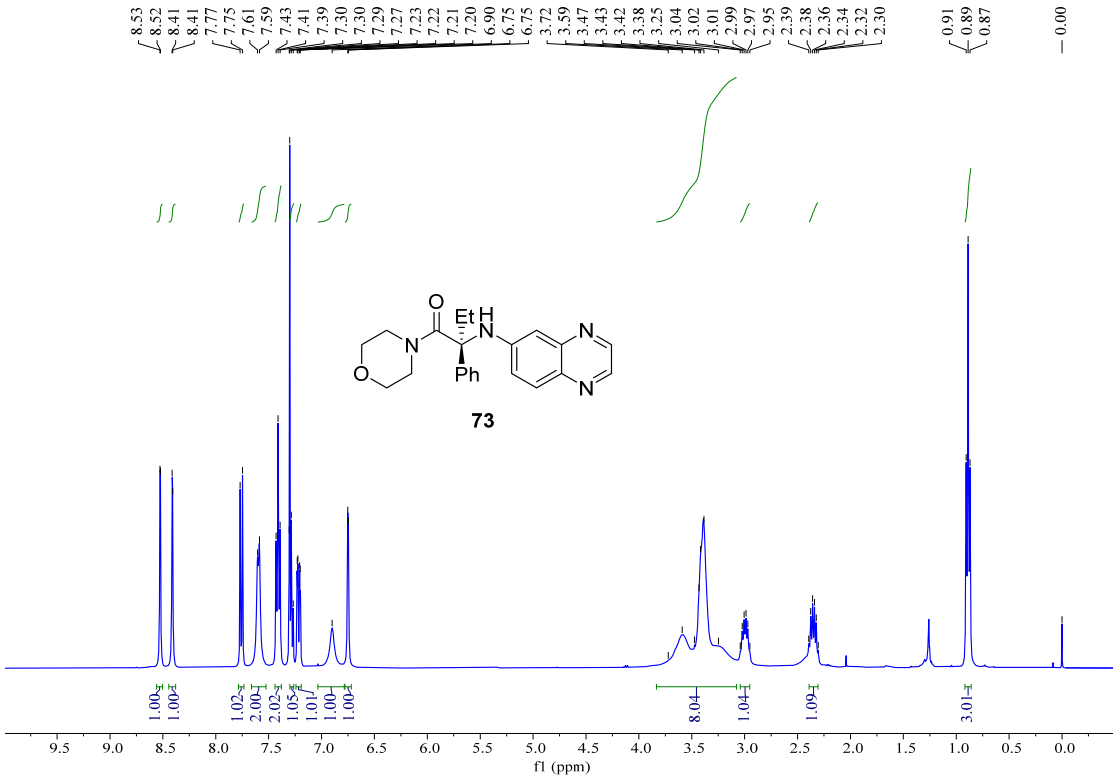
157.78
153.51
139.90
128.54
127.93
126.82
106.09
77.32
77.00
76.68
66.06
65.99
45.64
24.01
8.15
Et
H
N
O
N
N
Ph
71
f1 (ppm)


8.21 7.76 7.76 7.74 7.74 7.61 7.59 7.49 7.49 7.47 7.47 7.46 7.45 7.44 7.44 7.43 7.42 7.42 7.33 7.31 7.29 7.28 7.27 7.26 7.26 7.25 7.24 7.21 7.21 7.21 7.19 7.18 7.17 3.95 3.89 3.81 3.80 3.79 3.77 3.75 3.73 3.71 3.69 3.68 3.48 3.41 3.14 2.91 2.23 2.21 2.19 2.18 2.16 2.14 0.92 0.90 0.89 -0.00
O
Et H
N
N
N
O
Ph
N
72
1.00 1.02 2.02 3.04 3.07 1.03 9.12 1.04 3.04
f1 (ppm)


170.68 148.82 141.31 140.40 139.48 136.54 129.36 128.54 128.03 127.57 127.38 126.35 123.89 77.32 77.00 76.68 66.11 66.02 46.60 22.71 8.36
O
Et H
N
N
N
O
Ph
N
72
f1 (ppm)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8.52
8.41
8.41
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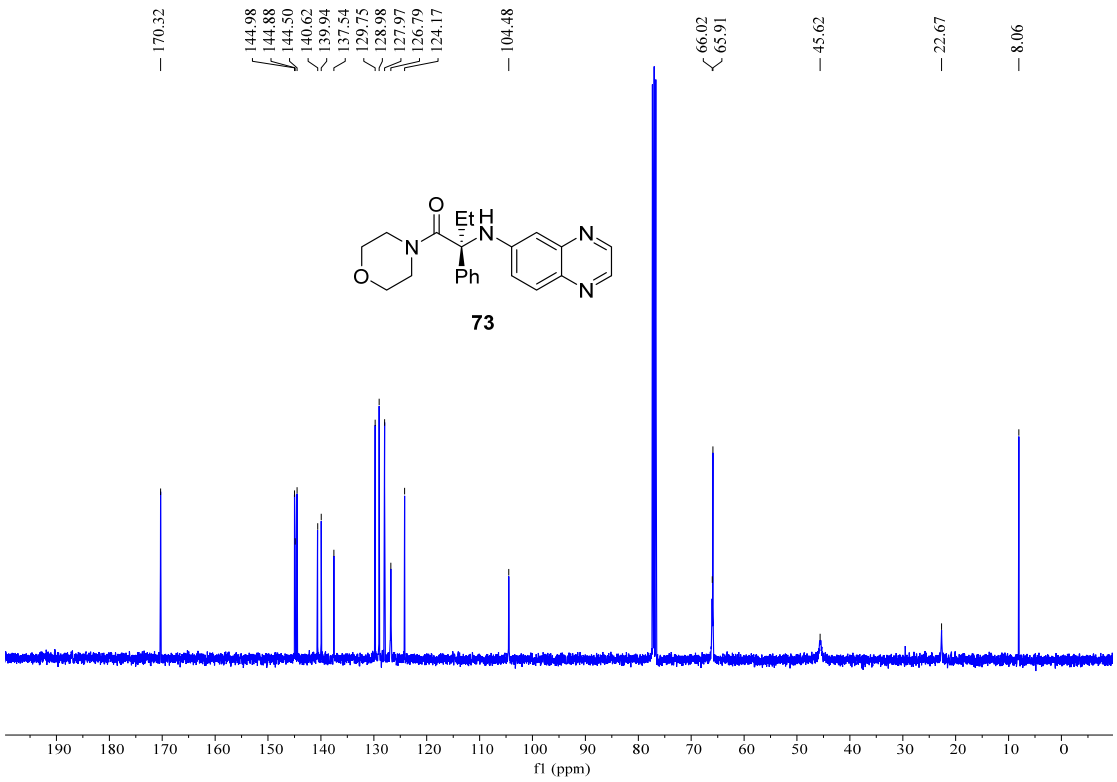
7.75
7.61
7.59
7.43
7.41
7.39
7.30
7.30
7.29
7.27
7.23
7.22
7.21
7.20
6.90
6.75
6.75
3.72
3.59
3.47
3.43
3.42
3.38
3.25
3.04
3.02
3.01
2.99
2.97
2.95
2.39
2.38
2.36
2.34
2.32
2.30
0.91
0.89
0.87
0.00
O
Et
H
N
N
O
N
Ph
N
73
1.00
1.00
1.02
2.00
2.02
1.05
1.01
1.00
1.00
8.04
1.04
1.09
3.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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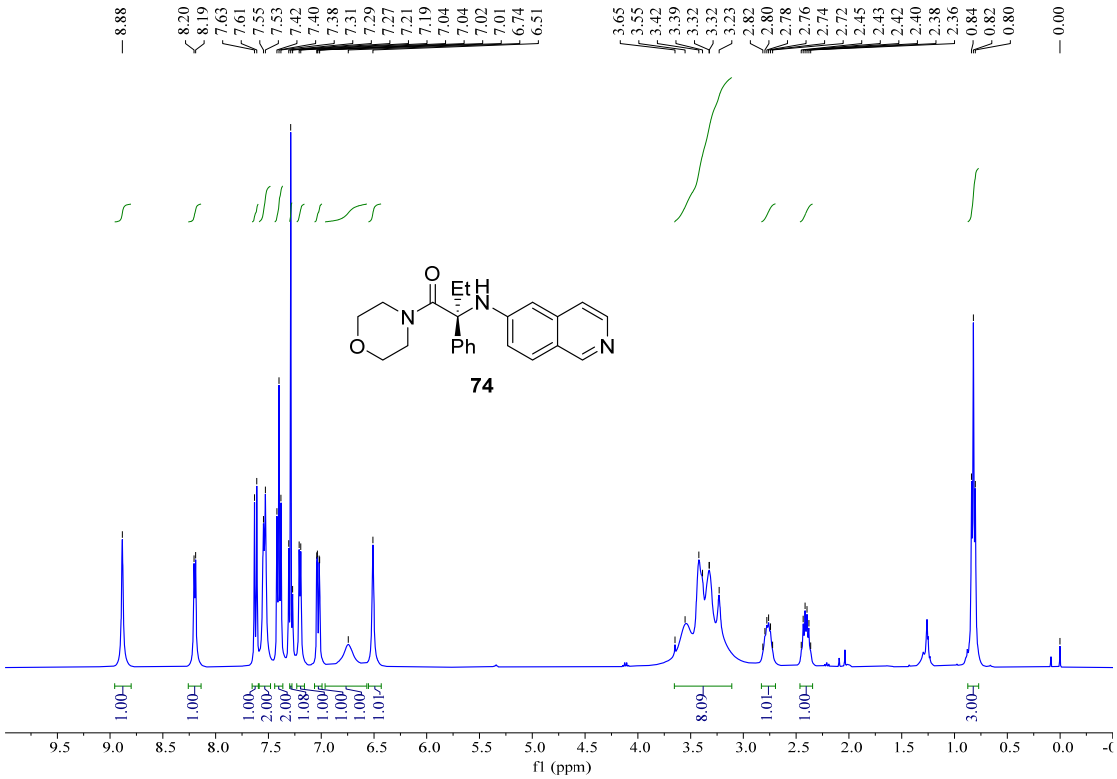
144.98
144.88
144.50
140.62
139.94
137.54
129.75
128.98
127.97
126.79
124.17
104.48
66.02
65.91
45.62
22.67
8.06
O
Et
H
N
N
O
N
Ph
N
73
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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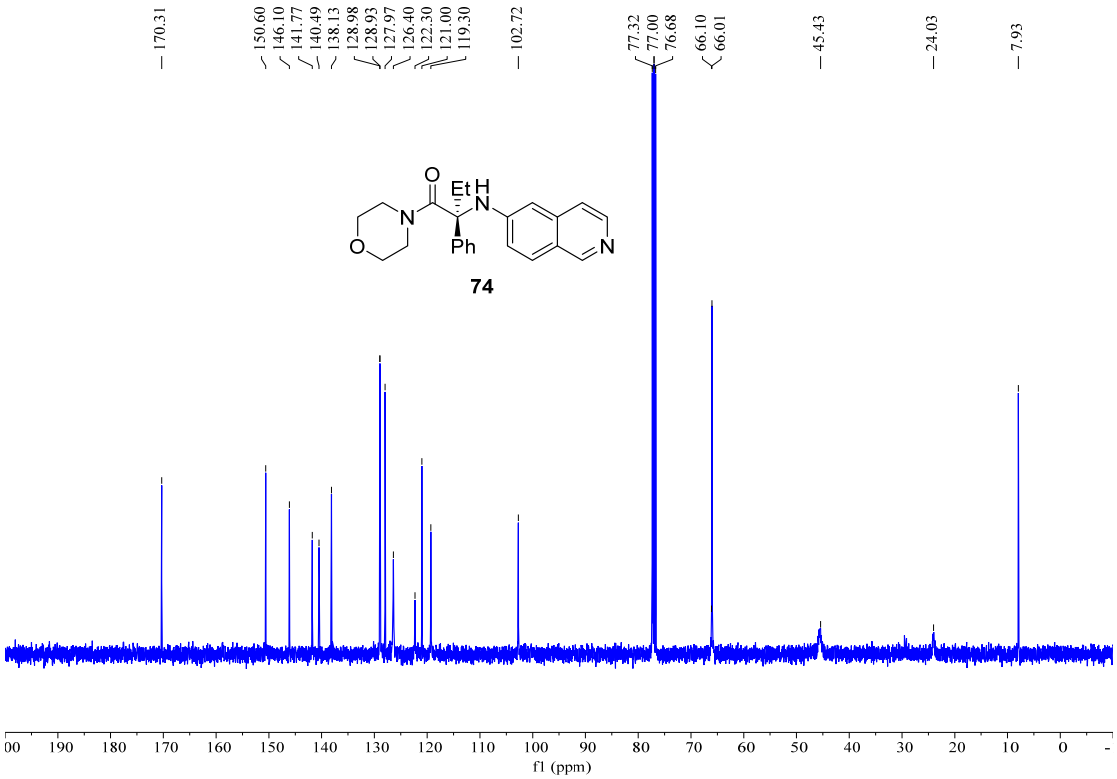
8.20
8.19
7.63
7.61
7.55
7.53
7.42
7.40
7.38
7.31
7.29
7.27
7.21
7.19
7.04
7.04
7.02
7.01
6.74
6.51
3.65
3.55
3.42
3.39
3.32
3.32
3.23
2.82
2.80
2.78
2.76
2.74
2.72
2.45
2.43
2.42
2.40
2.38
2.36
0.84
0.82
0.80
0.00
O
Et
H
N
N
O
Ph
N
74
1.00
1.00
1.00
2.00
2.00
1.08
1.00
1.00
1.00
1.01
8.09
1.01
1.00
3.00
f1 (ppm)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150.60
146.10
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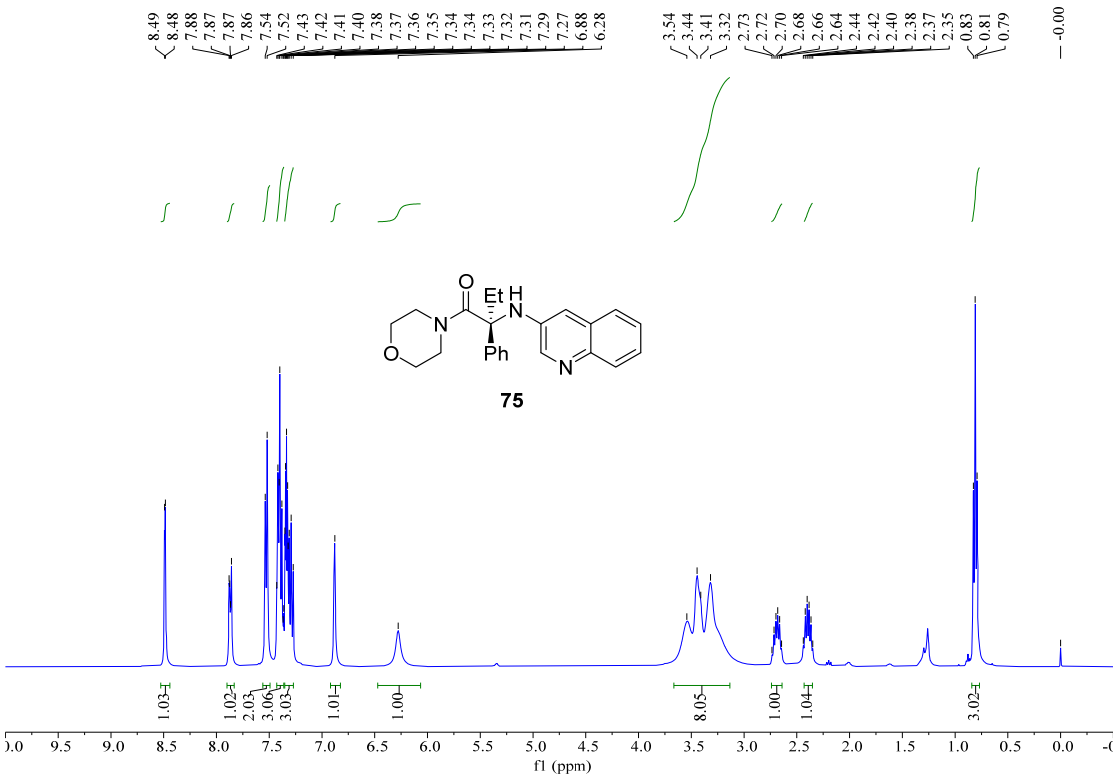
140.49
138.13
128.98
128.93
127.97
126.40
122.30
121.00
119.30
102.72
77.32
77.00
76.68
66.10
66.01
45.43
24.03
7.93
O
Et
H
N
N
O
Ph
N
74
f1 (ppm)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8.48
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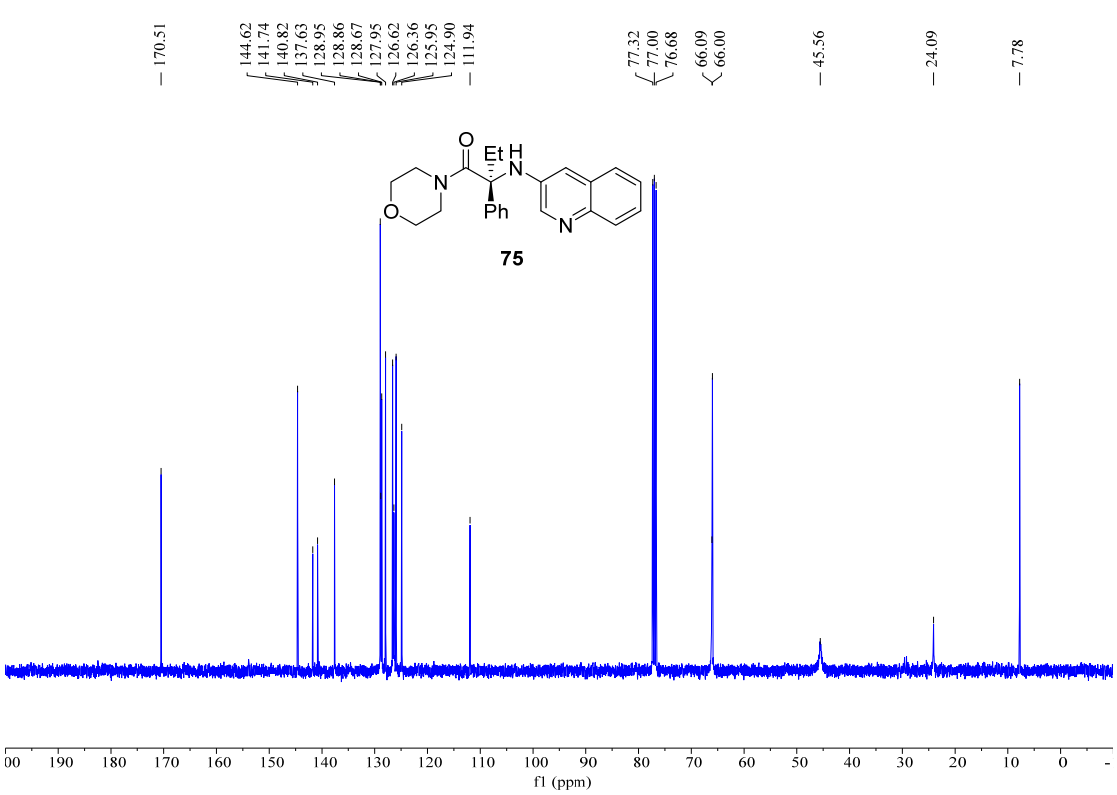
7.87
7.86
7.54
7.52
7.43
7.42
7.41
7.40
7.38
7.37
7.36
7.35
7.34
7.34
7.33
7.32
7.31
7.29
7.27
6.88
6.28
3.54
3.44
3.41
3.32
2.73
2.72
2.70
2.68
2.66
2.64
2.44
2.42
2.40
2.38
2.37
2.35
0.83
0.81
0.79
-0.00
O
Et H
N
N
O
Ph
N
75
1.03
1.02
2.03
3.06
3.03
1.01
1.00
8.05
1.00
1.04
3.02
f1 (ppm)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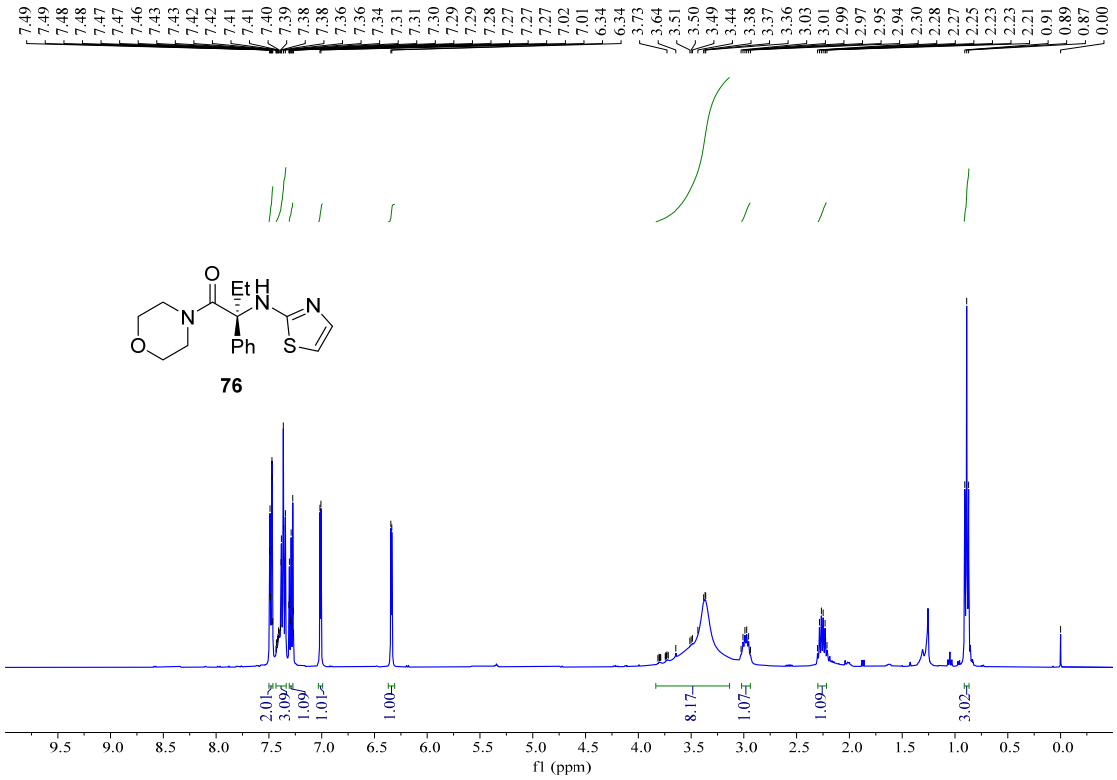
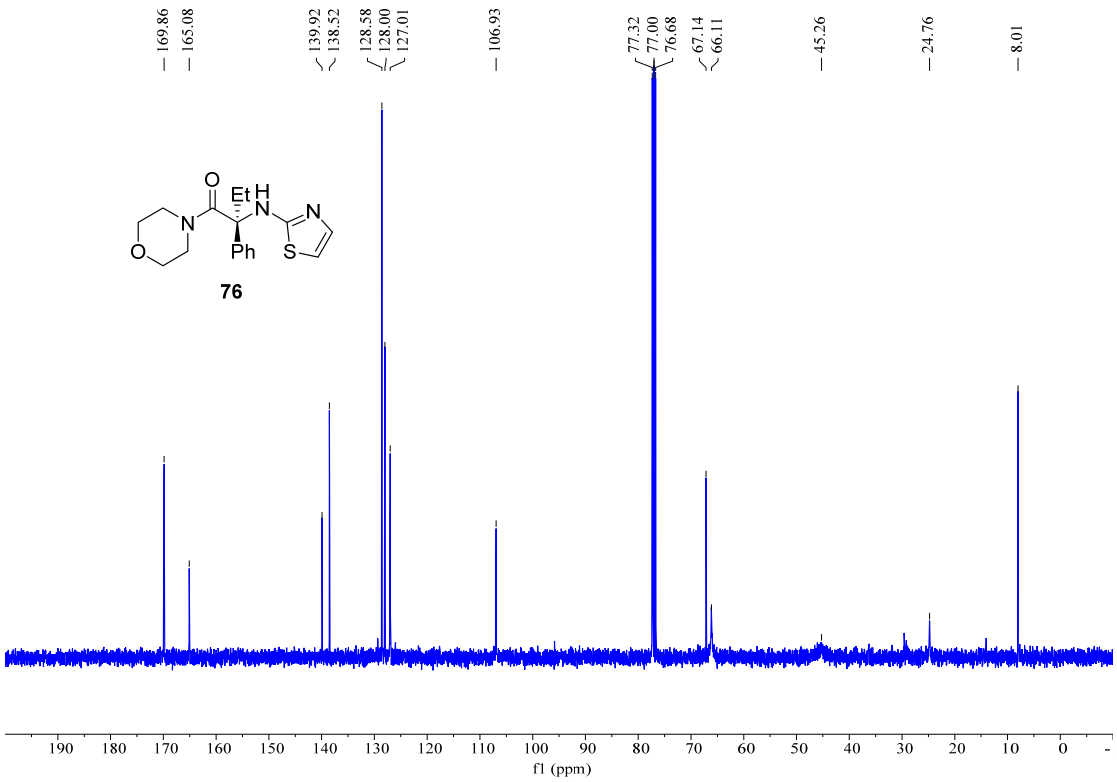
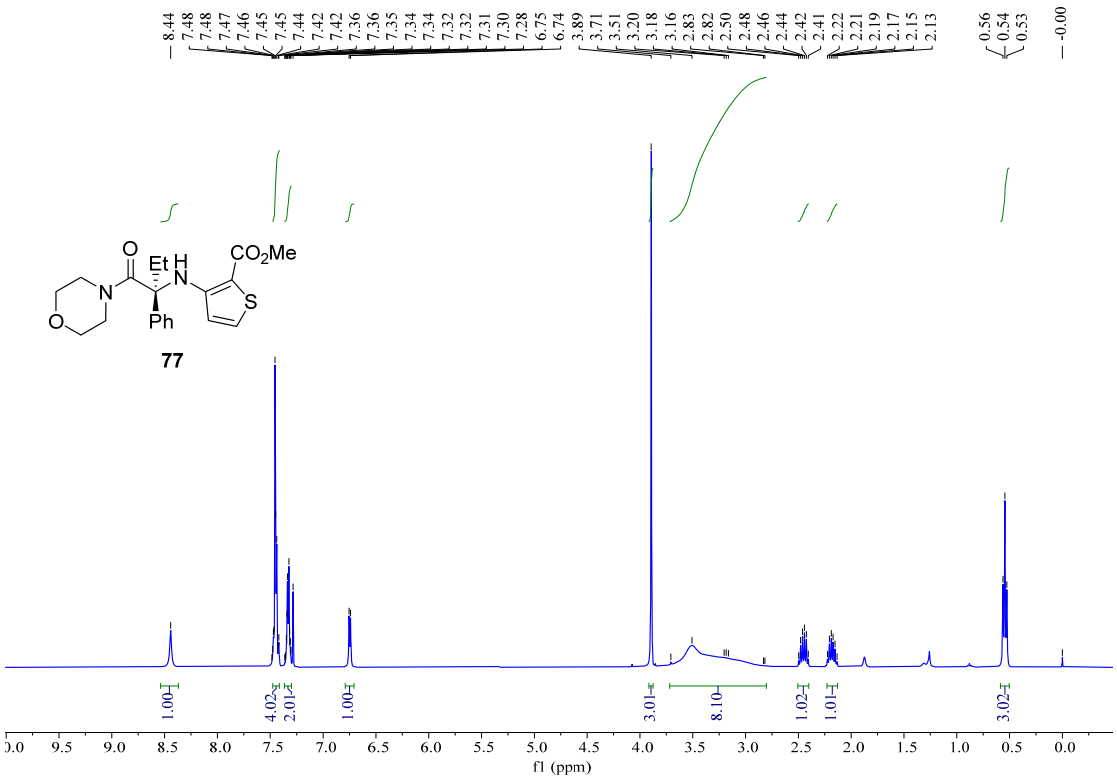
144.62
141.74
140.82
137.63
128.95
128.86
128.67
127.95
126.62
126.36
125.95
124.90
111.94
77.32
77.00
76.68
66.09
66.00
45.56
24.09
7.78
O
Et H
N
N
O
Ph
N
75
f1 (ppm)


7.49 7.49 7.48 7.48 7.47 7.47 7.46 7.43 7.43 7.42 7.42 7.41 7.41 7.40 7.39 7.38 7.38 7.36 7.36 7.34 7.31 7.31 7.30 7.29 7.29 7.28 7.27 7.27 7.27 7.27 7.02 7.01 6.34 6.34 3.73 3.64 3.51 3.50 3.49 3.44 3.38 3.37 3.36 3.03 3.01 2.99 2.97 2.95 2.94 2.30 2.28 2.27 2.25 2.23 2.23 2.21 0.91 0.89 0.87 0.00
O
Et
H
N
N
N
O
Ph
S
76
2.01
3.09
1.09
1.01
1.00
8.17
1.07
1.09
3.02
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


169.86
165.08
139.92
138.52
128.58
128.00
127.01
106.93
77.32
77.00
76.68
67.14
66.11
45.26
24.76
8.01
O
Et
H
N
N
N
O
Ph
S
76
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -
f1 (ppm)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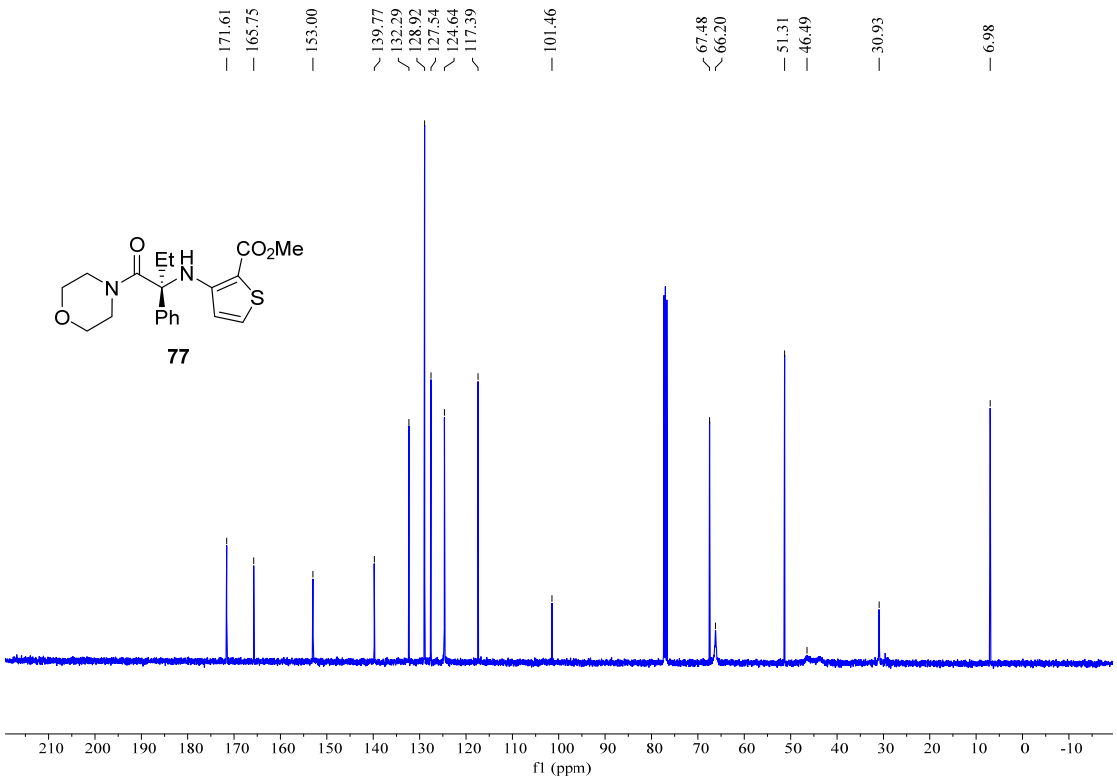
7.48
7.47
7.46
7.45
7.45
7.44
7.42
7.42
7.36
7.36
7.35
7.34
7.34
7.32
7.32
7.31
7.30
7.28
6.75
6.74
3.89
3.71
3.51
3.20
3.18
3.16
2.83
2.82
2.50
2.48
2.46
2.44
2.42
2.41
2.22
2.21
2.19
2.17
2.15
2.13
0.56
0.54
0.53
-0.00
O
Et H
N
CO2Me
N
S
O
Ph
77
1.00
4.02
2.01
1.00
3.01
8.10
1.02
1.01
3.02
f1 (ppm)


171.61
165.75
153.00
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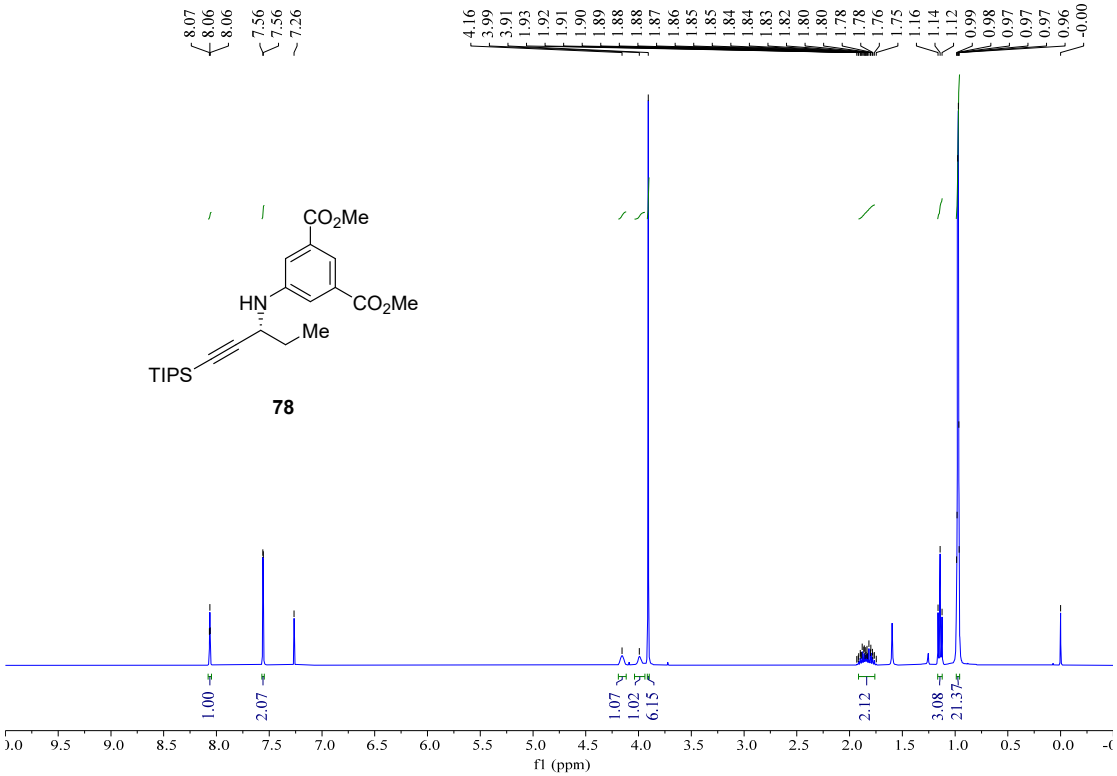
132.29
128.92
127.54
124.64
117.39
101.46
67.48
66.20
51.31
46.49
30.93
6.98
O
Et H
N
CO2Me
N
S
O
Ph
77
f1 (ppm)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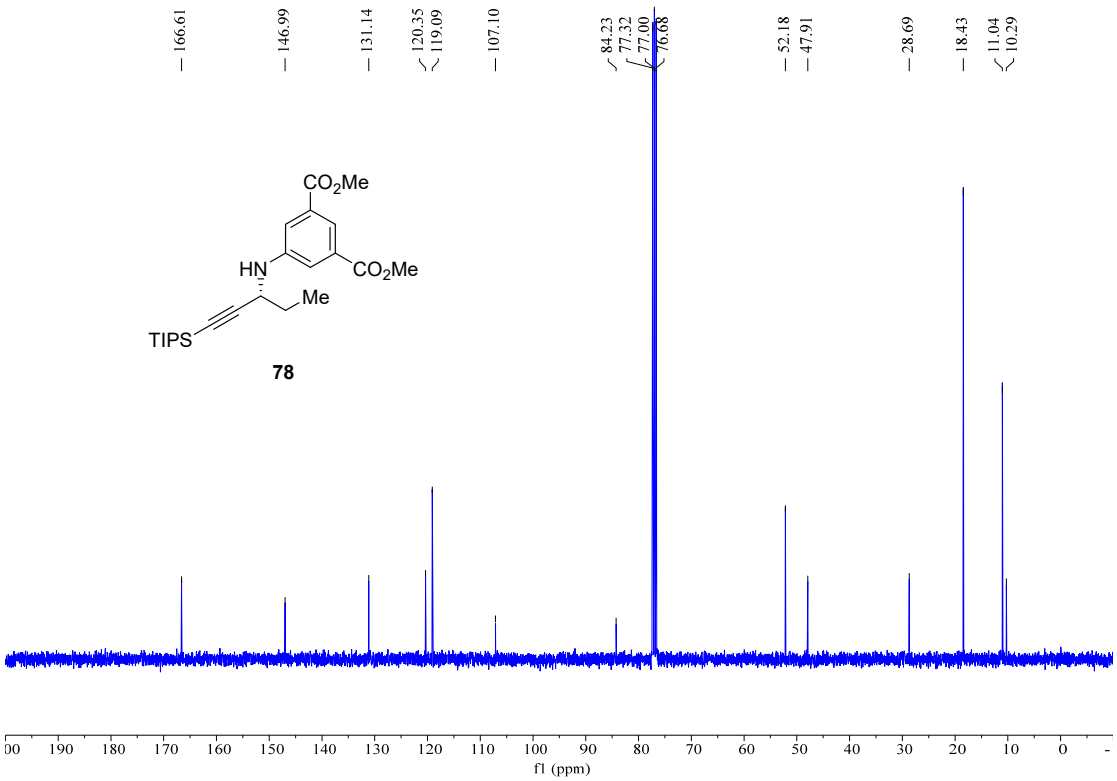
8.06
8.06
7.56
7.56
7.26
4.16
3.99
3.91
1.93
1.92
1.91
1.90
1.89
1.88
1.88
1.87
1.86
1.85
1.85
1.84
1.84
1.83
1.82
1.80
1.80
1.78
1.78
1.76
1.75
1.16
1.14
1.12
0.99
0.98
0.97
0.97
0.97
0.96
-0.00
CO2Me
HN
CO2Me
Me
TIPS
78
1.00
2.07
1.07
1.02
6.15
2.12
3.08
21.37
f1 (ppm)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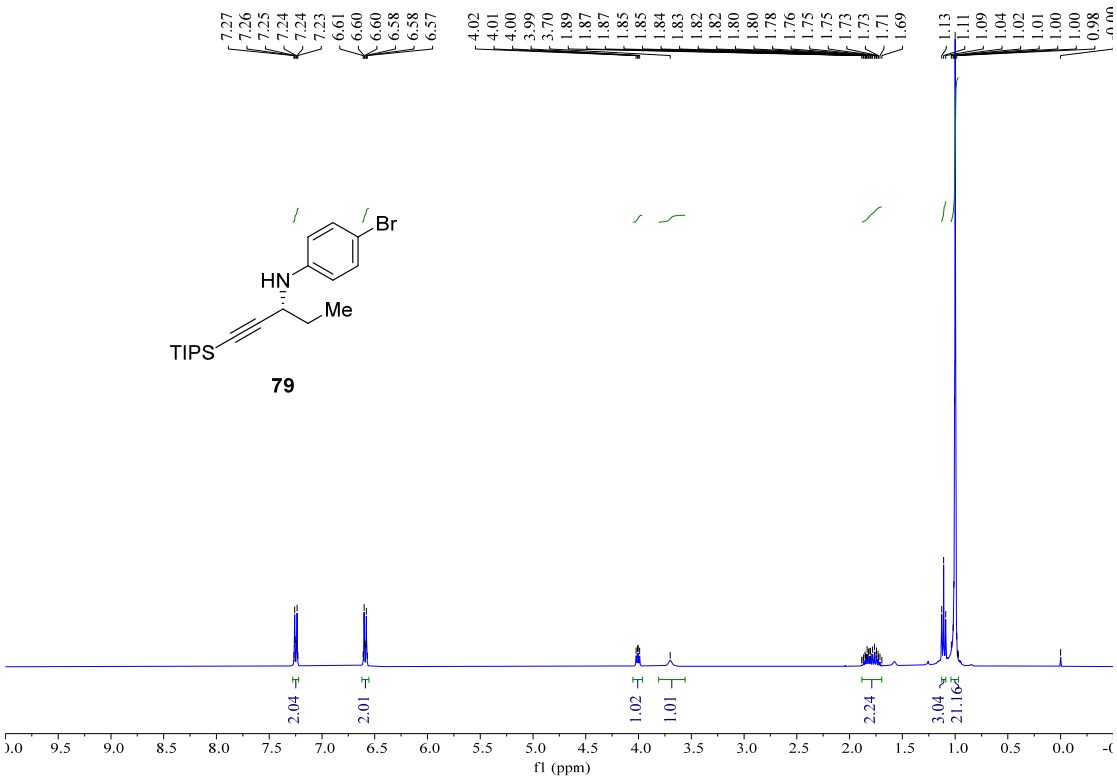
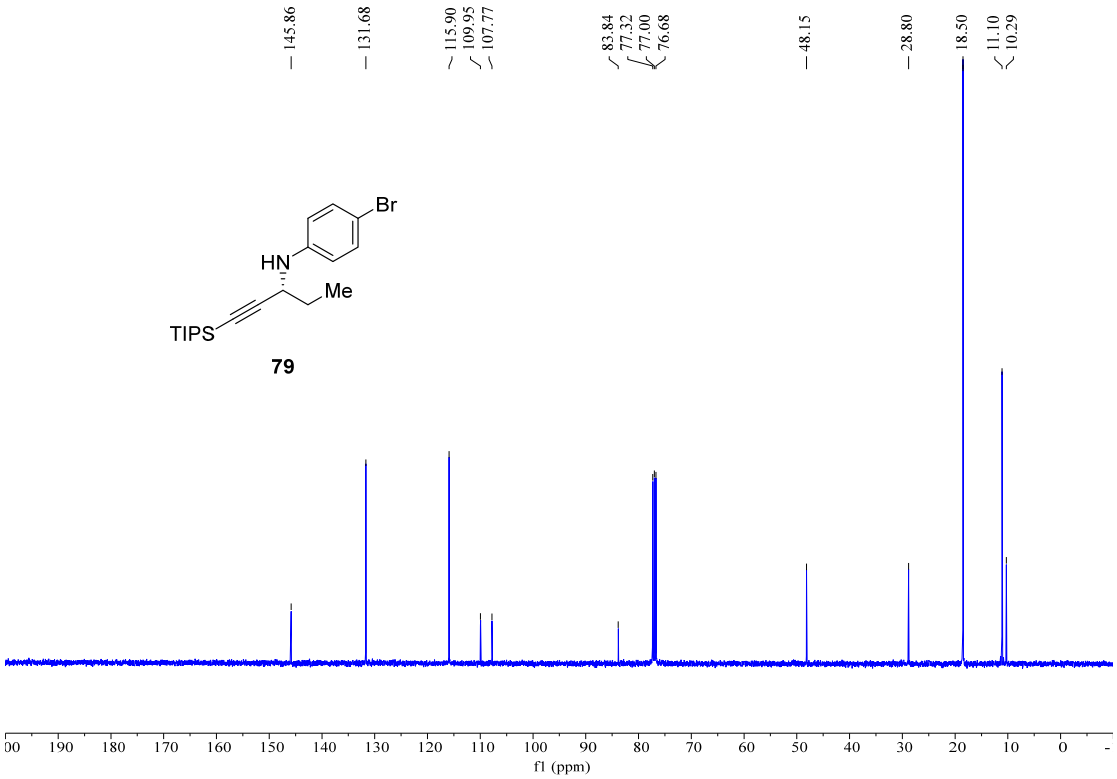
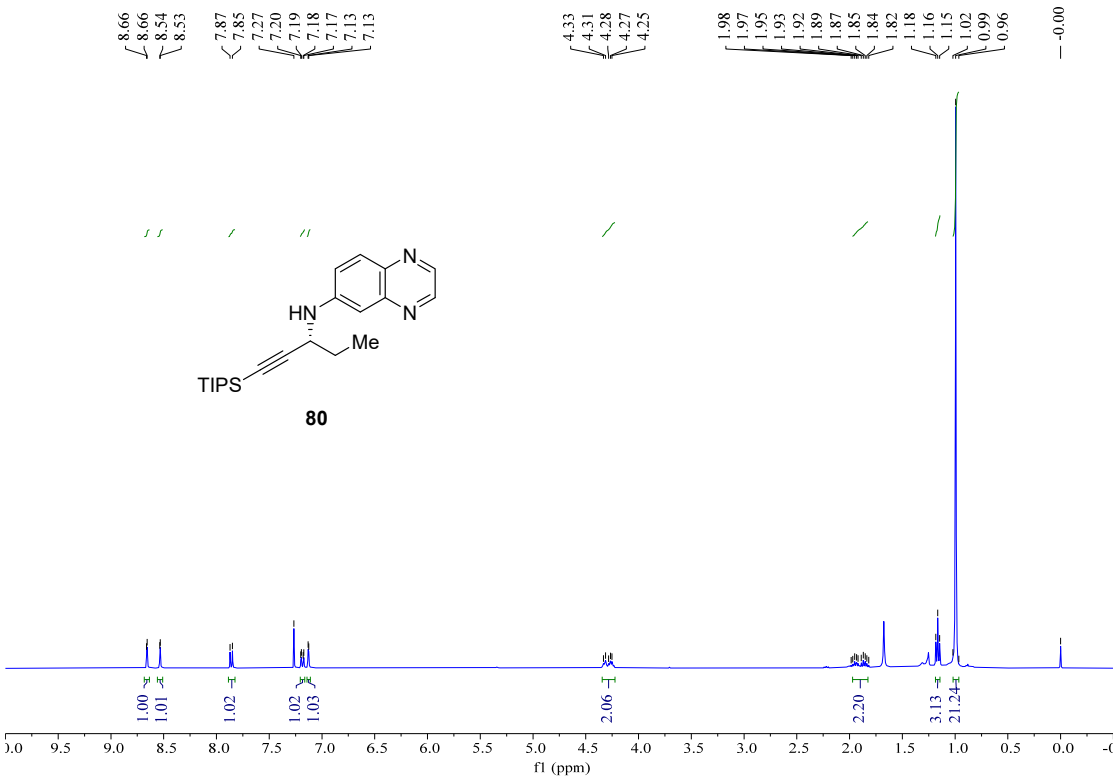
146.99
131.14
120.35
119.09
107.10
84.23
77.32
77.00
76.68
52.18
47.91
28.69
18.43
11.04
10.29
CO2Me
HN
CO2Me
Me
TIPS
78
f1 (ppm)


Br
HN
Me
TIPS
79
fl (ppm)


Br
HN
Me
TIPS
79
fl (ppm)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7.85
7.27
7.20
7.19
7.18
7.17
7.13
7.13
4.33
4.31
4.28
4.27
4.25
1.98
1.97
1.95
1.93
1.92
1.89
1.87
1.85
1.84
1.82
1.18
1.16
1.15
1.02
0.99
0.96
-0.00
N
HN
N
Me
TIPS
80
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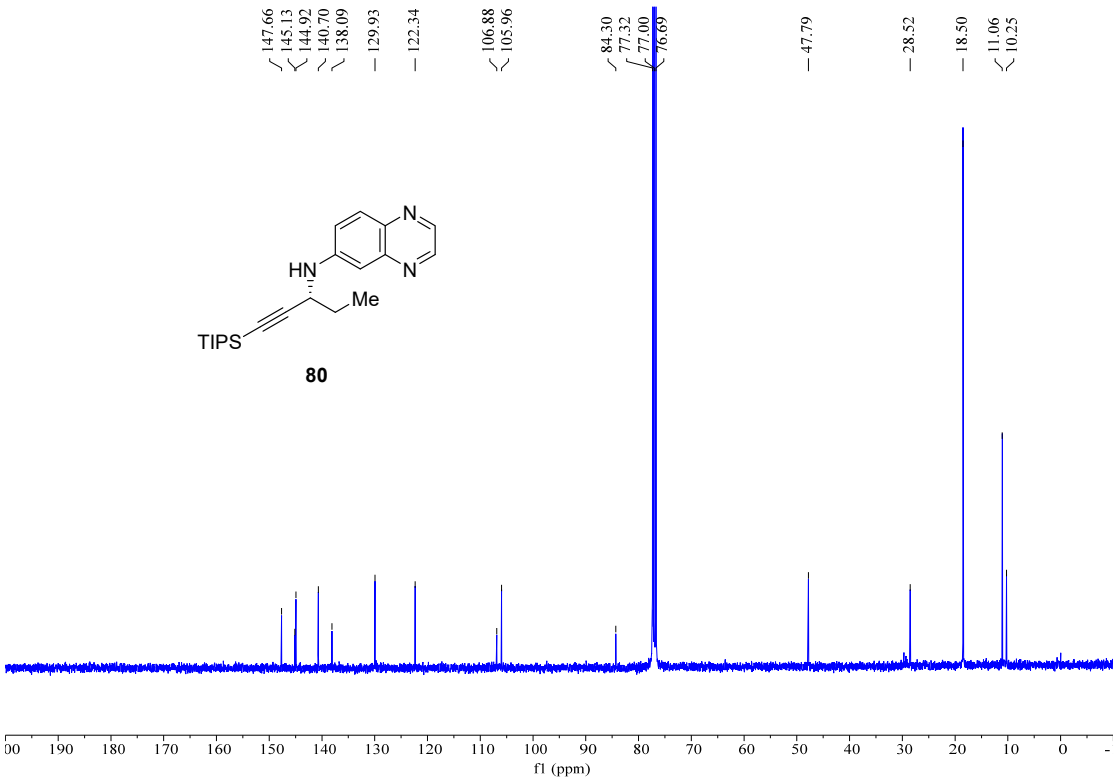
1.01
1.02
1.02
1.03
2.06
2.20
3.13
21.24
f1 (ppm)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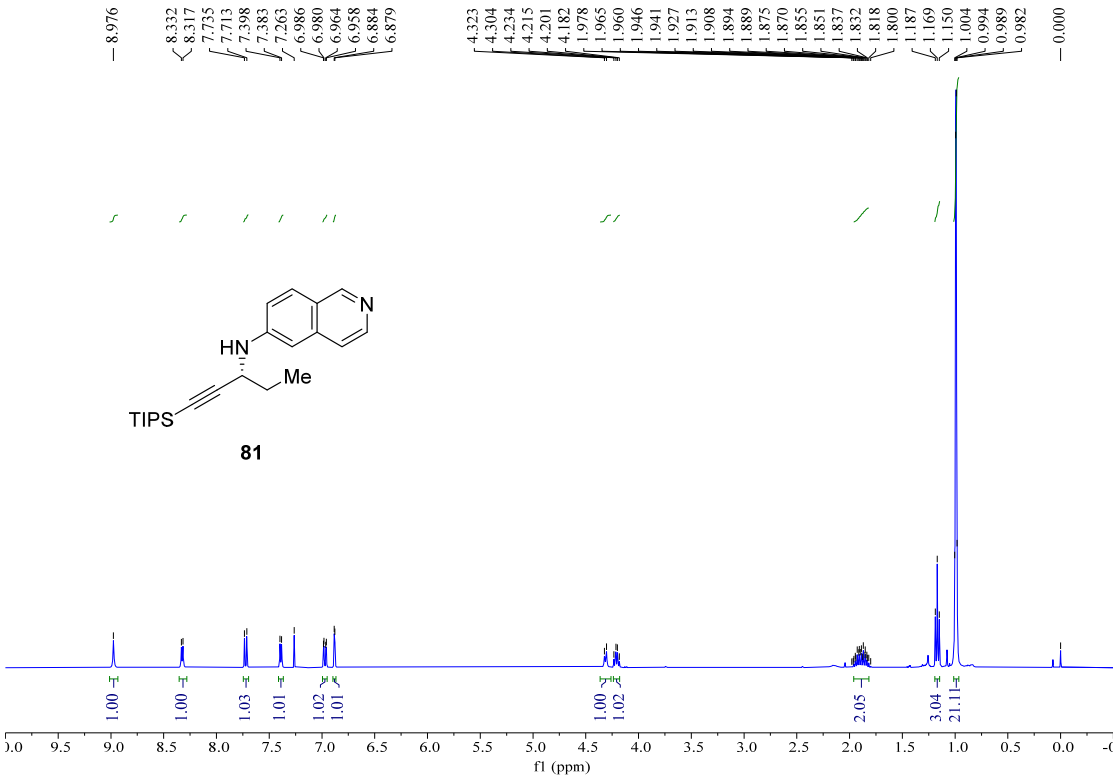
129.93
122.34
106.88
105.96
84.30
77.32
77.00
76.69
47.79
28.52
18.50
11.06
10.25
N
HN
N
Me
TIPS
80
f1 (ppm)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6.980
6.964
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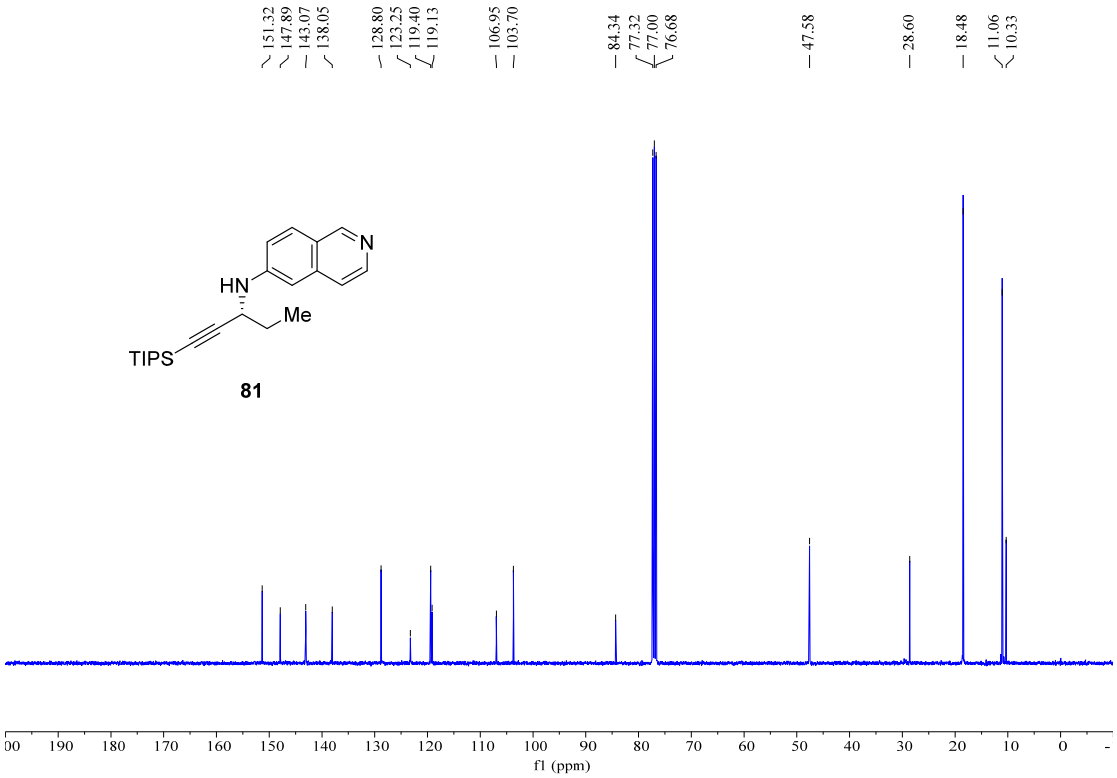
6.884
6.879
4.323
4.304
4.234
4.215
4.201
4.182
1.978
1.965
1.960
1.946
1.941
1.927
1.913
1.908
1.894
1.889
1.875
1.870
1.855
1.851
1.837
1.832
1.818
1.800
1.187
1.169
1.150
1.004
0.994
0.989
0.982
0.000
HN
N
Me
TIPS
81
1.00
1.00
1.03
1.01
1.02
1.01
1.00
1.02
2.05
3.04
21.11
f1 (ppm)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138.05
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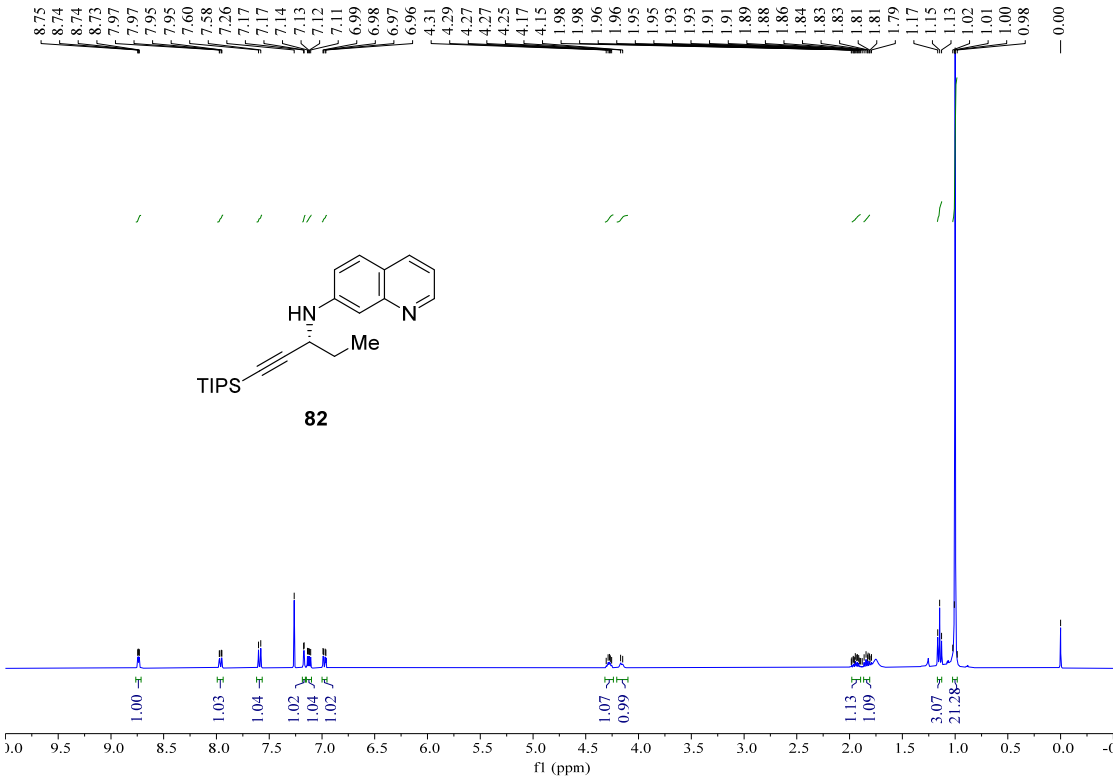
123.25
119.40
119.13
106.95
103.70
84.34
77.32
77.00
76.68
47.58
28.60
18.48
11.06
10.33
HN
N
Me
TIPS
81
f1 (ppm)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8.74
8.74
8.73
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7.97
7.95
7.95
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7.58
7.26
7.17
7.17
7.14
7.13
7.12
7.11
6.99
6.98
6.97
6.96
4.31
4.29
4.27
4.27
4.25
4.17
4.15
1.98
1.98
1.96
1.96
1.95
1.95
1.93
1.91
1.91
1.89
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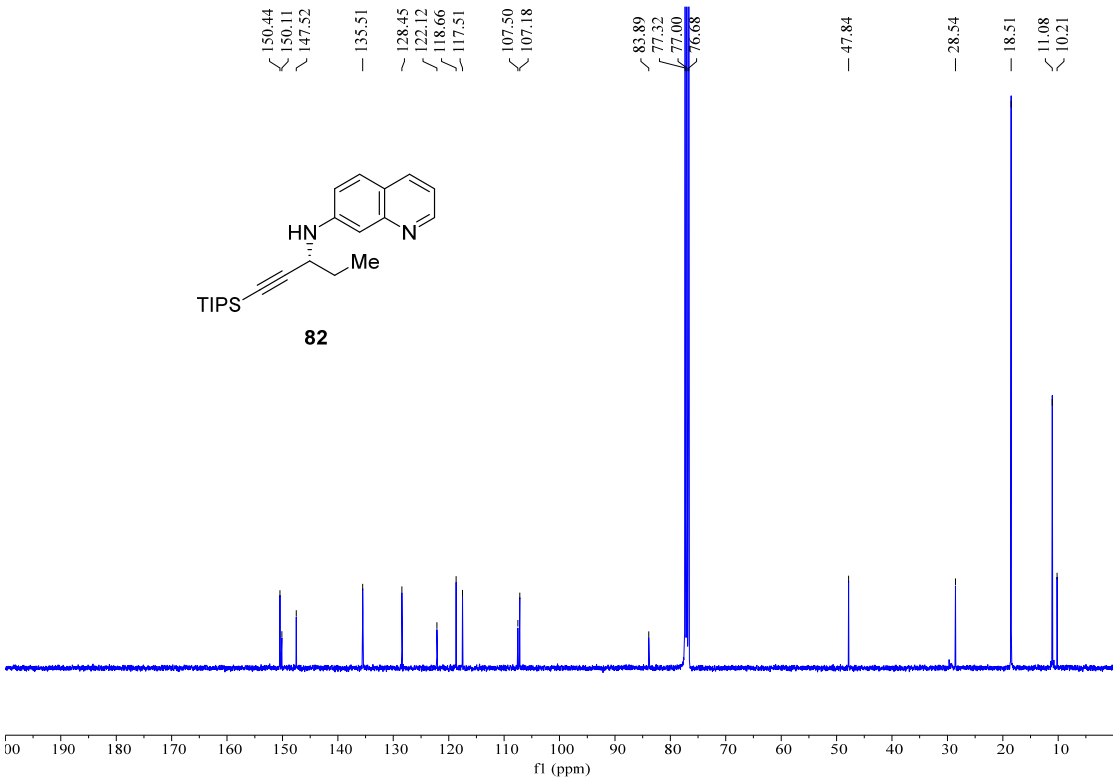
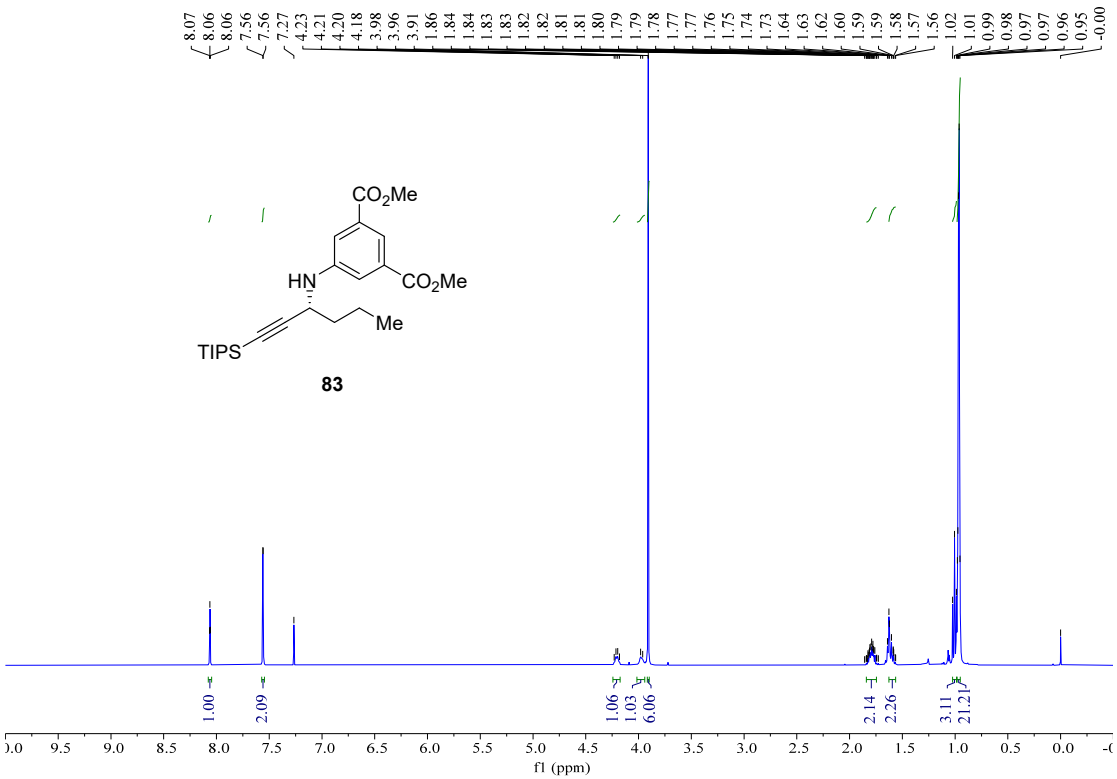
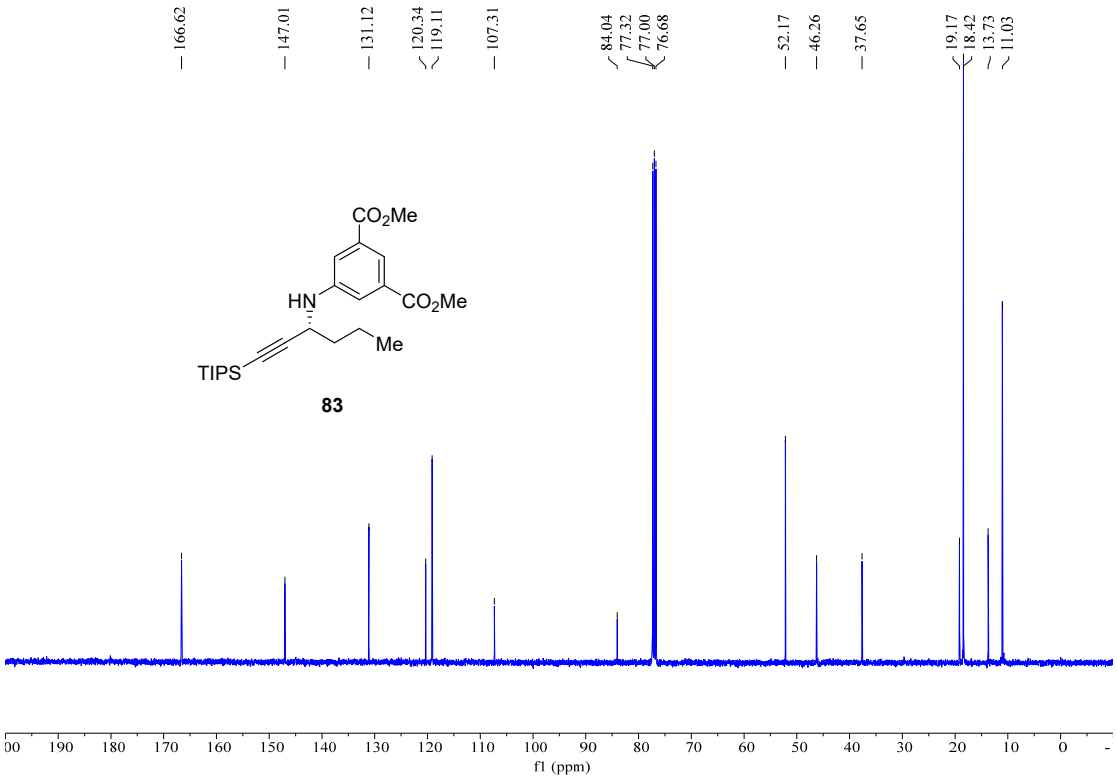
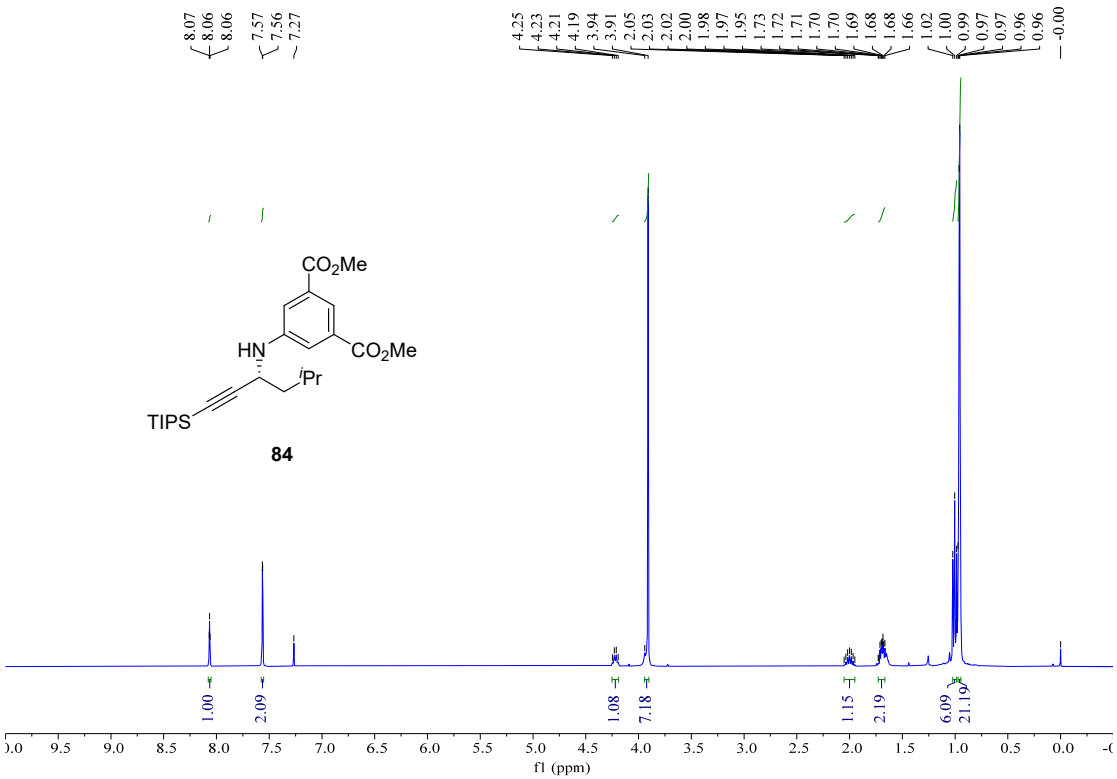
1.86
1.84
1.83
1.83
1.81
1.81
1.79
1.17
1.15
1.13
1.02
1.01
1.00
0.98
0.00
HN
N
Me
TIPS
82
1.00
1.03
1.04
1.02
1.04
1.02
1.07
0.99
1.13
1.09
3.07
21.28
f1 (ppm)


150.44
150.11
147.52
135.51
128.45
122.12
118.66
117.51
107.50
107.18
83.89
77.32
77.00
76.68
47.84
28.54
18.51
11.08
10.21
HN
N
Me
TIPS
82
f1 (ppm)


8.07 8.06 8.06 7.56 7.56 7.27 4.23 4.21 4.20 4.18 3.98 3.96 3.91 1.86 1.84 1.84 1.83 1.83 1.82 1.82 1.81 1.81 1.80 1.79 1.79 1.78 1.77 1.77 1.76 1.75 1.74 1.73 1.64 1.63 1.62 1.60 1.59 1.59 1.58 1.57 1.56 1.02 1.01 0.99 0.98 0.97 0.97 0.96 0.95 -0.00
CO2Me
HN
CO2Me
Me
TIPS
83
1.00 2.09 1.06 1.03 6.06 2.14 2.26 3.11 21.21
f1 (ppm)


166.62 147.01 131.12 120.34 119.11 107.31 84.04 77.32 77.00 76.68 52.17 46.26 37.65 19.17 18.42 13.73 11.03
CO2Me
HN
CO2Me
Me
TIPS
83
f1 (ppm)


8.07
8.06
8.06
7.57
7.56
7.27
4.25
4.23
4.21
4.19
3.94
3.91
2.05
2.03
2.02
2.00
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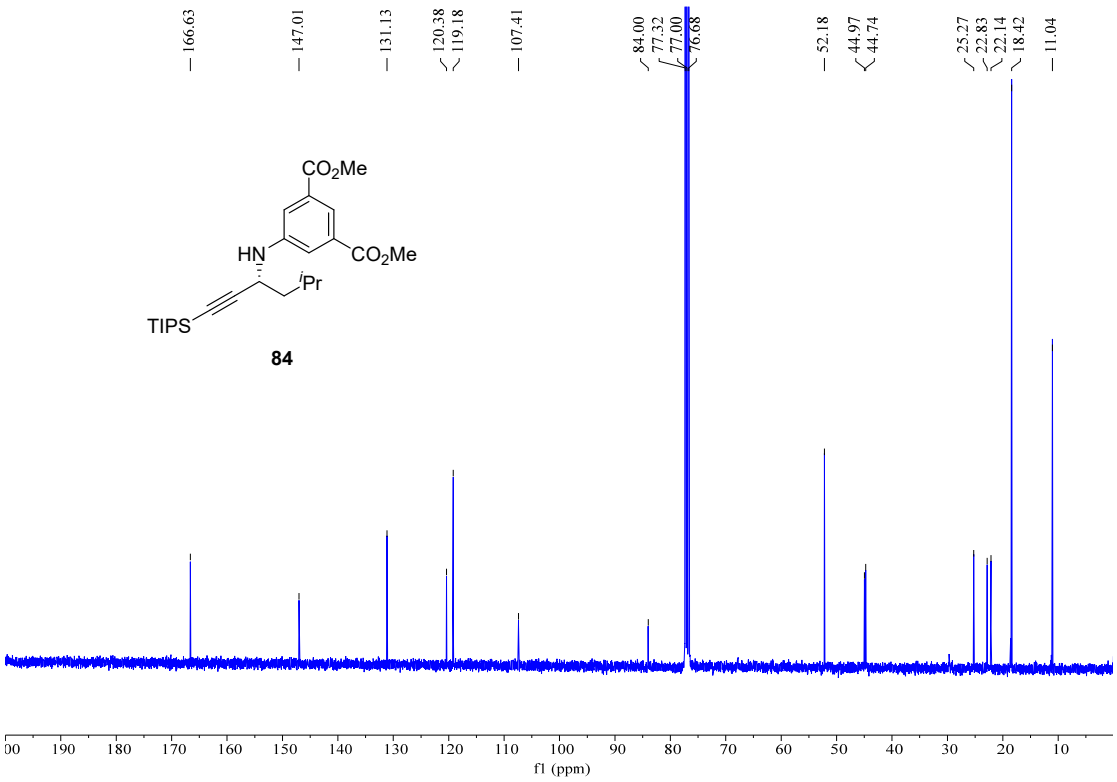
1.97
1.95
1.73
1.72
1.71
1.70
1.70
1.69
1.68
1.68
1.66
1.02
1.00
0.99
0.97
0.97
0.96
0.96
-0.00
CO2Me
HN
CO2Me
iPr
TIPS
84
1.00
2.09
1.08
7.18
1.15
2.19
6.09
21.19
f1 (ppm)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77.32
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76.68
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22.14
18.42
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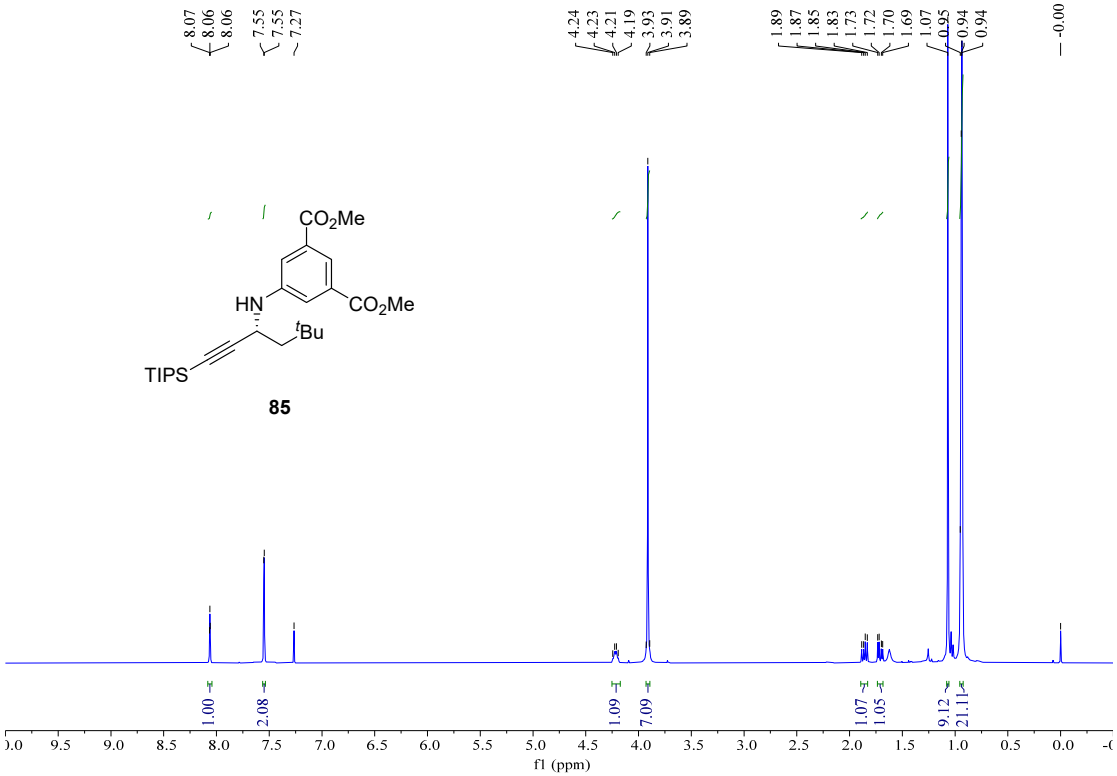
CO2Me
HN
CO2Me
iPr
TIPS
84
f1 (ppm)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8.06
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4.23
4.21
4.19
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3.91
3.89
1.89
1.87
1.85
1.83
1.73
1.72
1.70
1.69
1.07
0.95
0.94
0.94
-0.00
CO2Me
HN
CO2Me
tBu
TIPS
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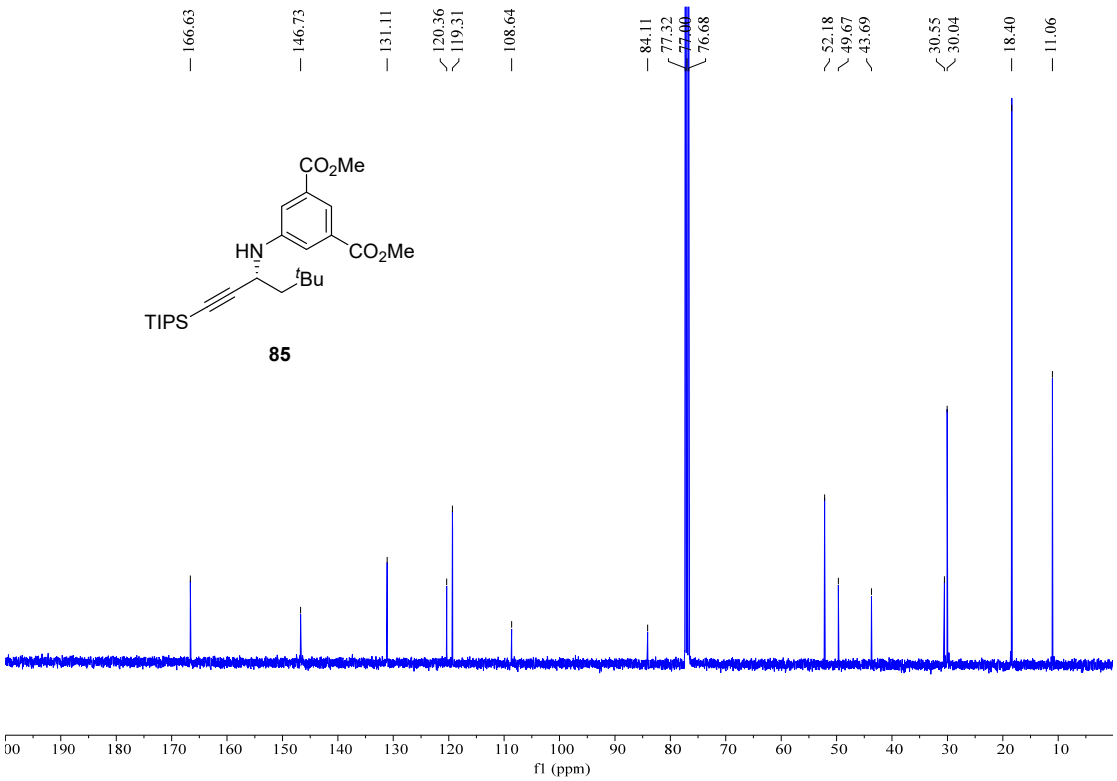
1.00
2.08
1.09
7.09
1.07
1.05
9.12
21.11
f1 (ppm)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77.32
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76.68
52.18
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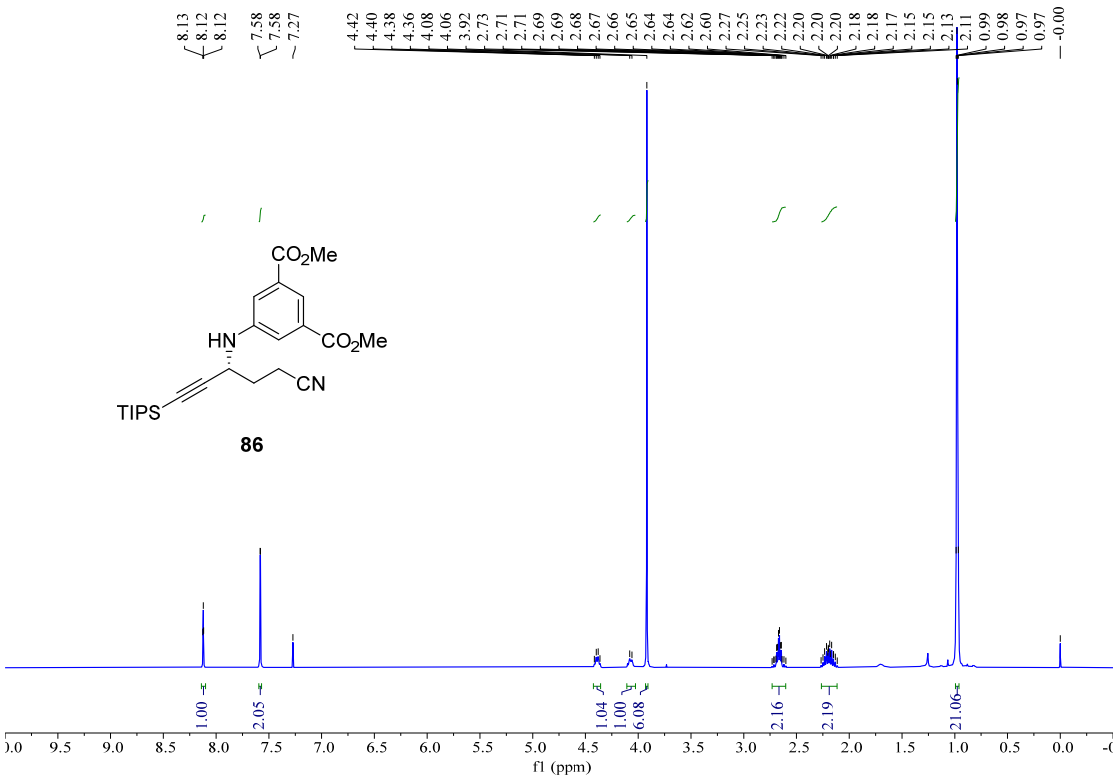
30.04
18.40
11.06
CO2Me
HN
CO2Me
tBu
TIPS
85
f1 (ppm)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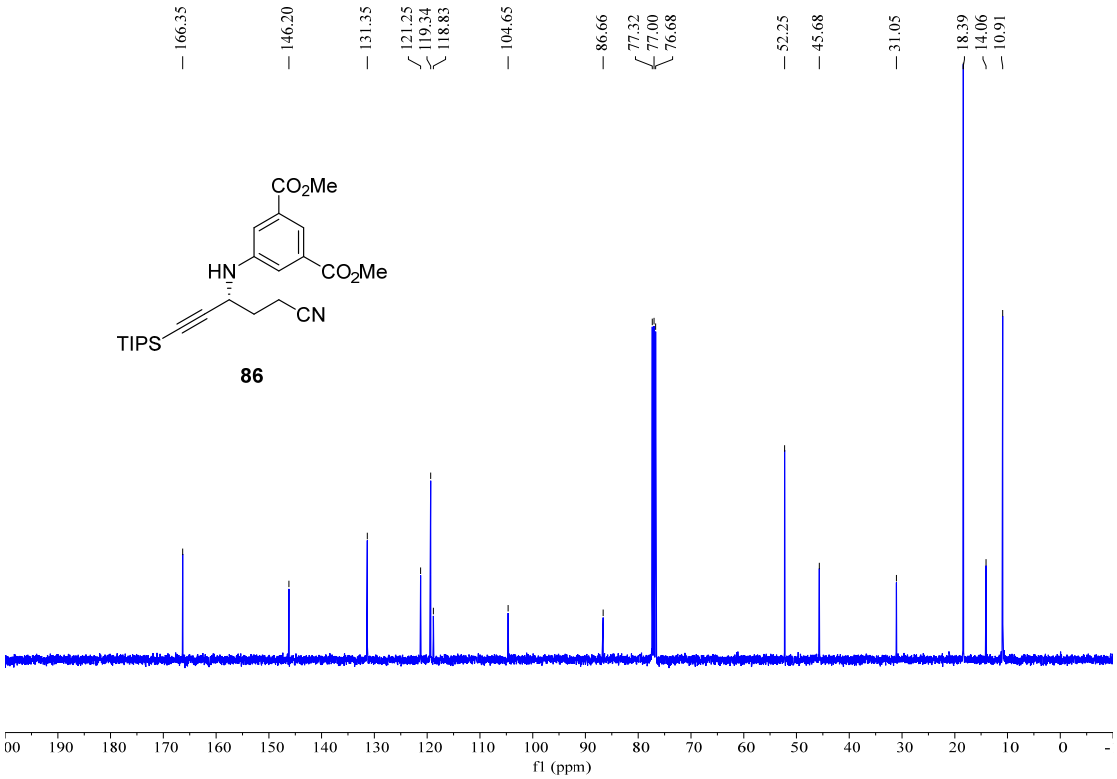
4.08
4.06
3.92
2.73
2.71
2.71
2.69
2.69
2.68
2.67
2.66
2.65
2.64
2.64
2.62
2.60
2.27
2.25
2.23
2.22
2.20
2.20
2.20
2.18
2.18
2.17
2.15
2.15
2.13
2.11
0.99
0.98
0.97
0.97
-0.00
CO2Me
HN
CO2Me
CN
TIPS
86
1.00
2.05
1.04
1.00
6.08
2.16
2.19
21.06
f1 (ppm)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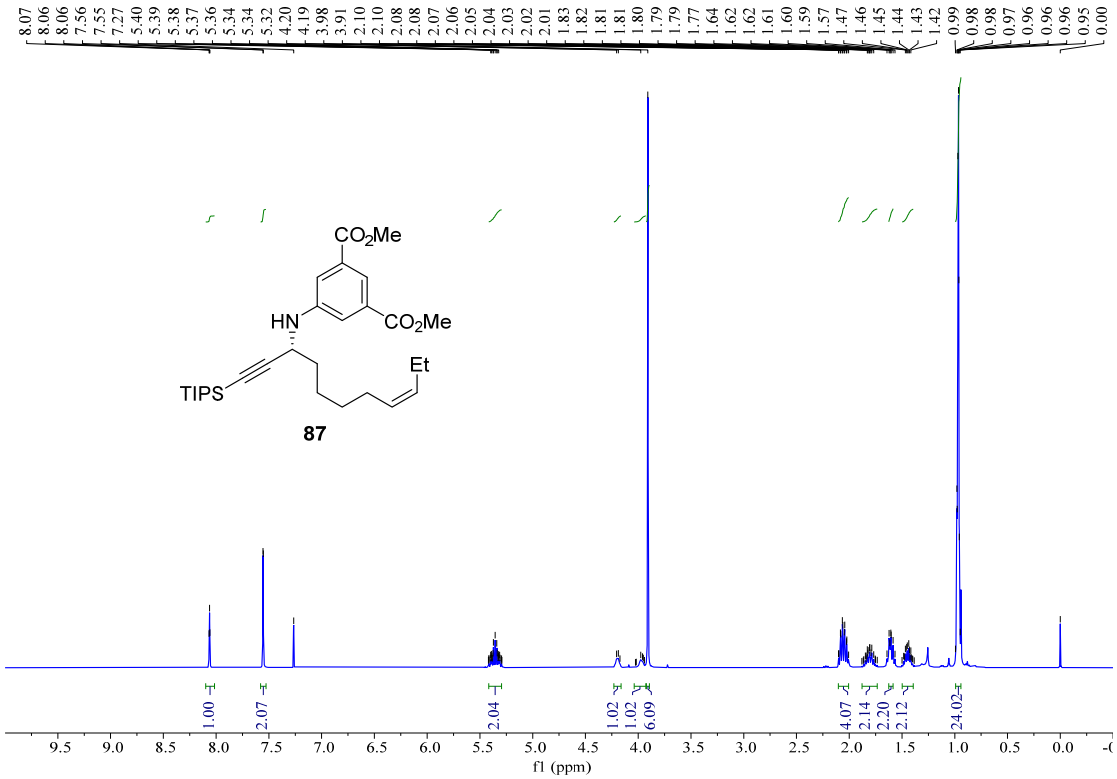
131.35
121.25
119.34
118.83
104.65
86.66
77.32
77.00
76.68
52.25
45.68
31.05
18.39
14.06
10.91
CO2Me
HN
CO2Me
CN
TIPS
86
f1 (ppm)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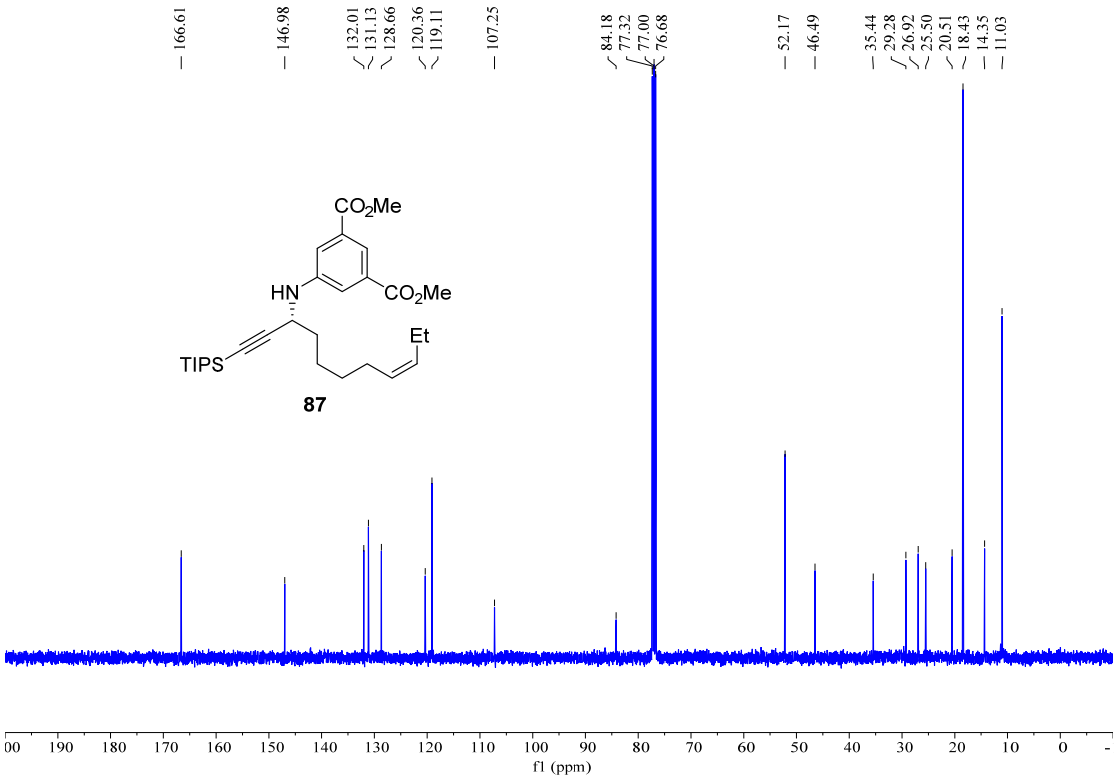
CO2Me
HN
CO2Me
Et
TIPS
87
1.00 2.07 2.04 1.02 1.02 6.09 4.07 2.14 2.20 2.12 24.02
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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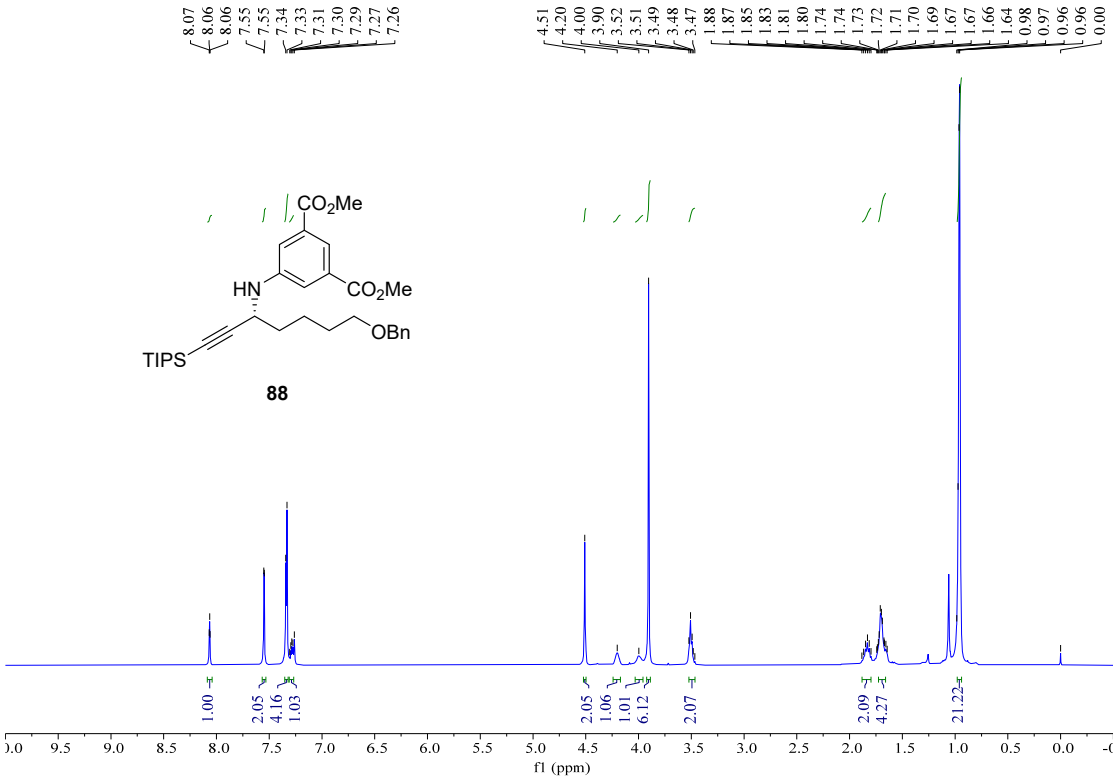
CO2Me
HN
CO2Me
Et
TIPS
87
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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8.06
8.06
7.55
7.55
7.34
7.33
7.31
7.30
7.29
7.27
7.26
4.51
4.20
4.00
3.90
3.52
3.51
3.49
3.48
3.47
1.88
1.87
1.85
1.83
1.81
1.80
1.74
1.74
1.73
1.72
1.71
1.70
1.69
1.67
1.67
1.66
1.64
0.98
0.97
0.96
0.96
0.00
CO2Me
HN
CO2Me
OBn
TIPS
88
1.00
2.05
4.16
1.03
2.05
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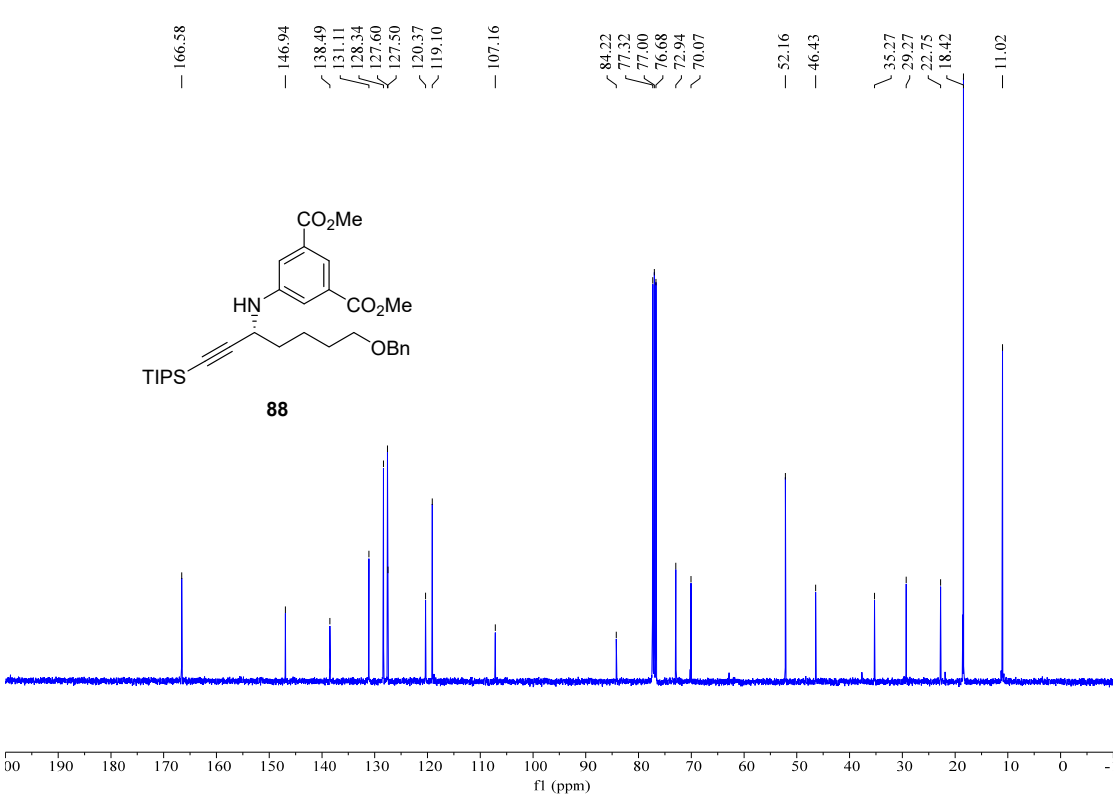
2.07
2.09
4.27
21.22
f1 (ppm)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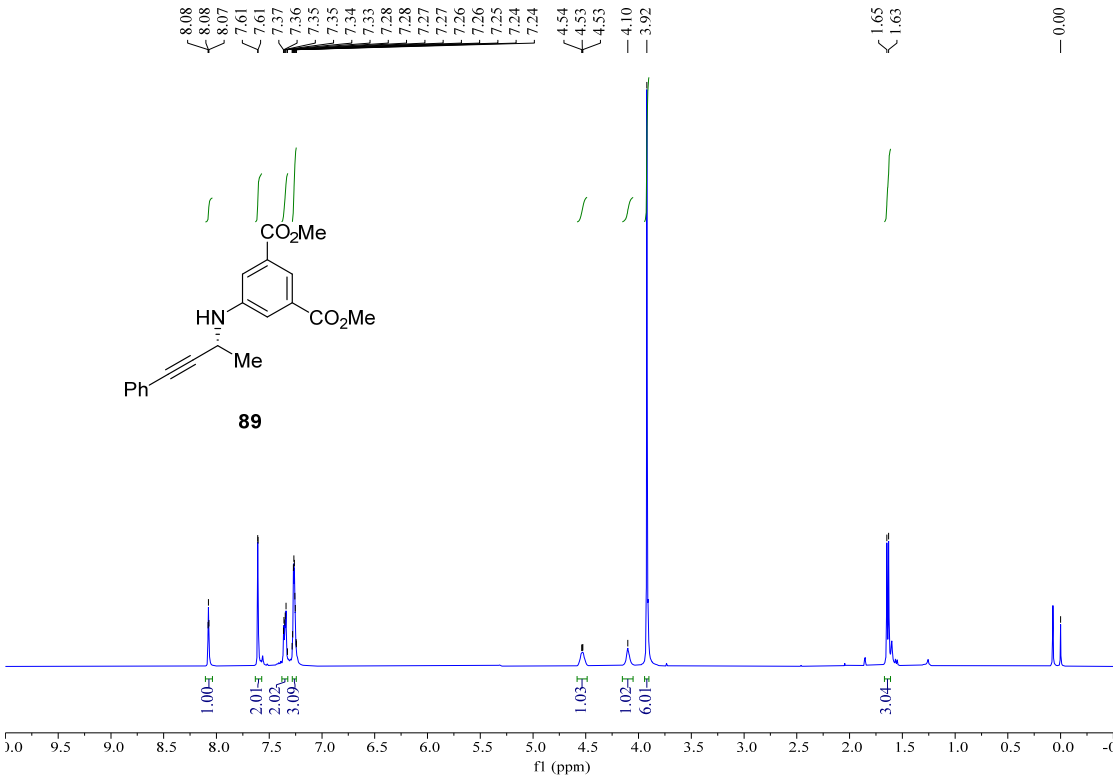
128.34
127.60
127.50
120.37
119.10
107.16
84.22
77.32
77.00
76.68
72.94
70.07
52.16
46.43
35.27
29.27
22.75
18.42
11.02
CO2Me
HN
CO2Me
OBn
TIPS
88
f1 (ppm)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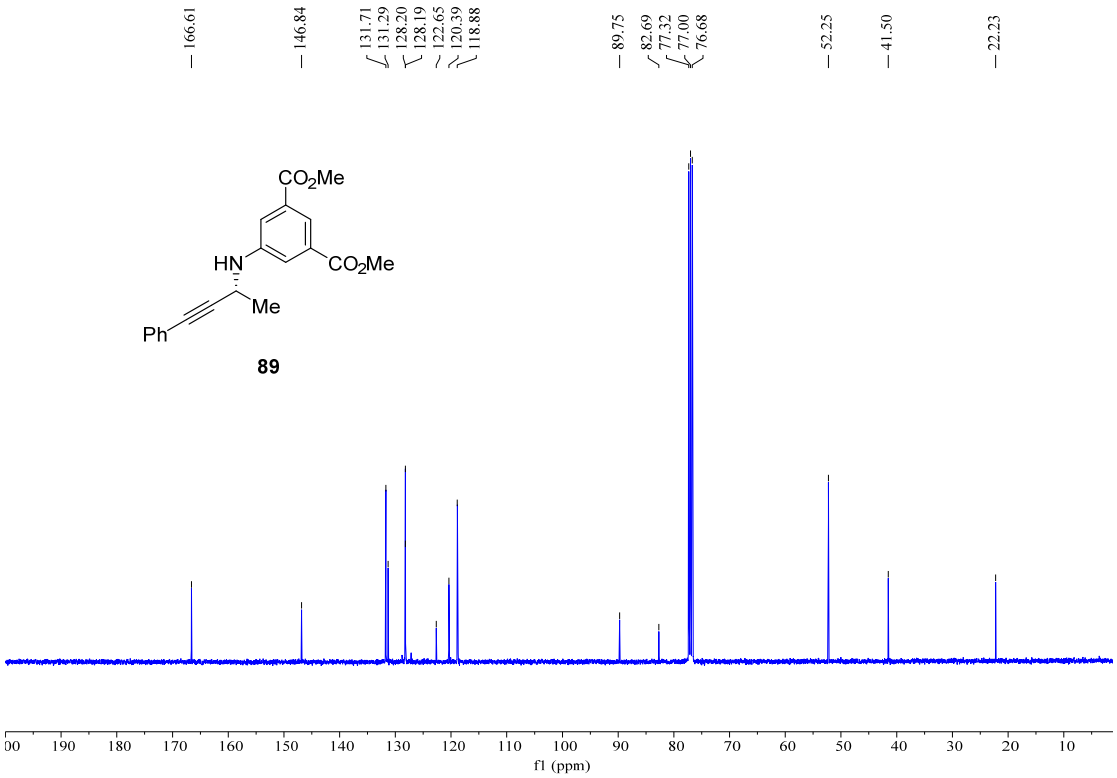
8.08
8.07
7.61
7.61
7.37
7.36
7.35
7.35
7.34
7.33
7.28
7.28
7.27
7.27
7.26
7.26
7.25
7.24
7.24
4.54
4.53
4.53
4.10
3.92
1.65
1.63
0.00
CO2Me
HN
CO2Me
Me
Ph
89
1.00
2.01
2.02
3.09
1.03
1.02
6.01
3.04
f1 (ppm)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128.19
122.65
120.39
118.88
89.75
82.69
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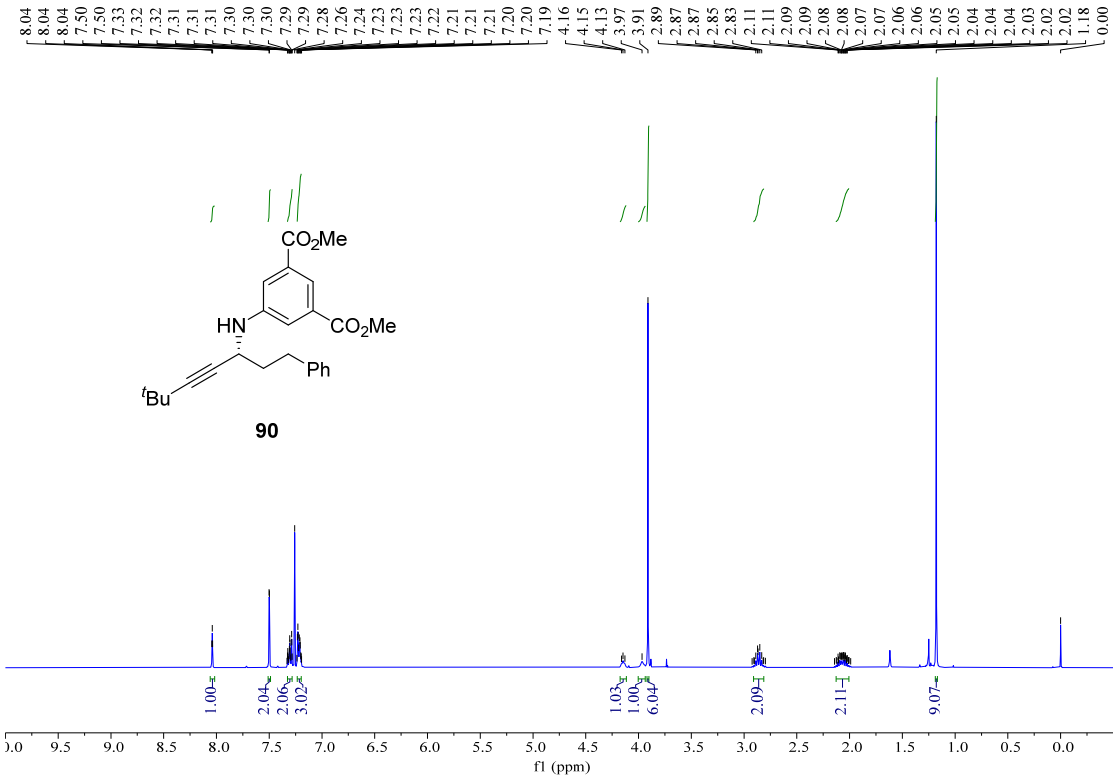
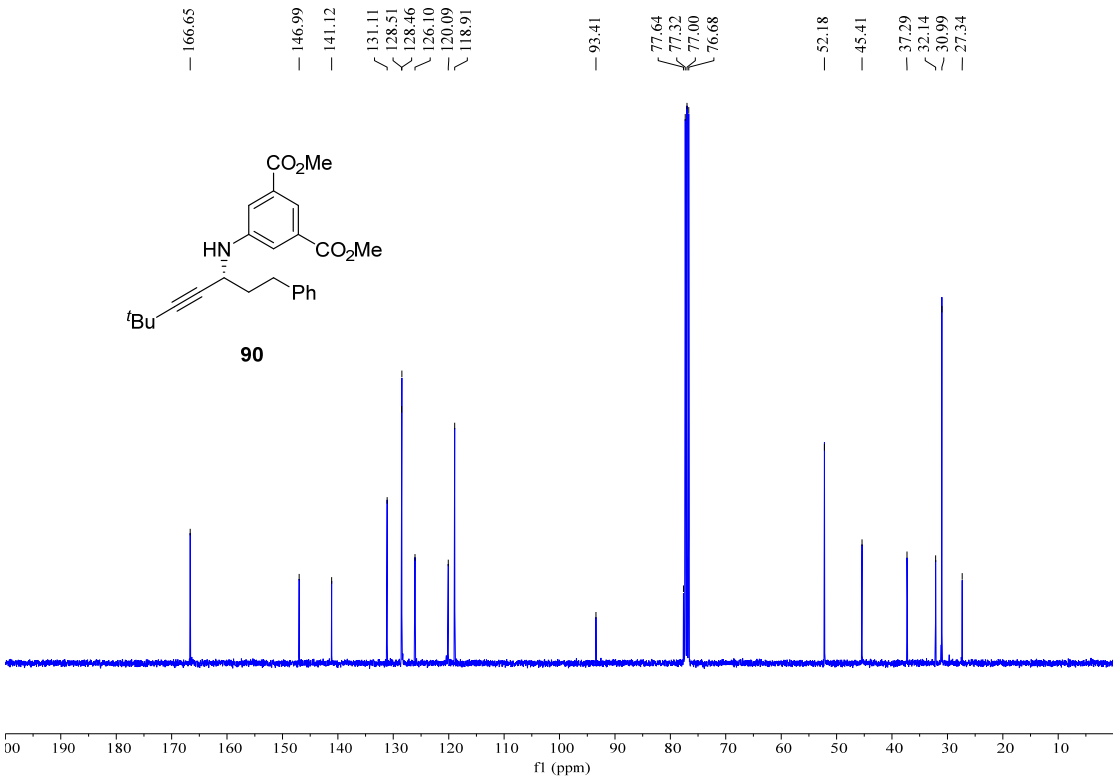
76.68
52.25
41.50
22.23
CO2Me
HN
CO2Me
Me
Ph
89
f1 (ppm)


8.04 8.04 8.04 7.50 7.50 7.33 7.32 7.32 7.31 7.31 7.31 7.30 7.30 7.30 7.29 7.29 7.28 7.26 7.24 7.23 7.23 7.23 7.22 7.21 7.21 7.21 7.20 7.20 7.19 4.16 4.15 4.13 3.97 3.91 2.89 2.87 2.87 2.85 2.83 2.11 2.11 2.09 2.09 2.08 2.08 2.07 2.07 2.06 2.06 2.05 2.05 2.04 2.04 2.04 2.03 2.02 2.02 1.18 0.00
CO2Me
HN
CO2Me
Ph
tBu
90
1.00 2.04 2.06 3.02 1.03 1.00 6.04 2.09 2.11 9.07
f1 (ppm)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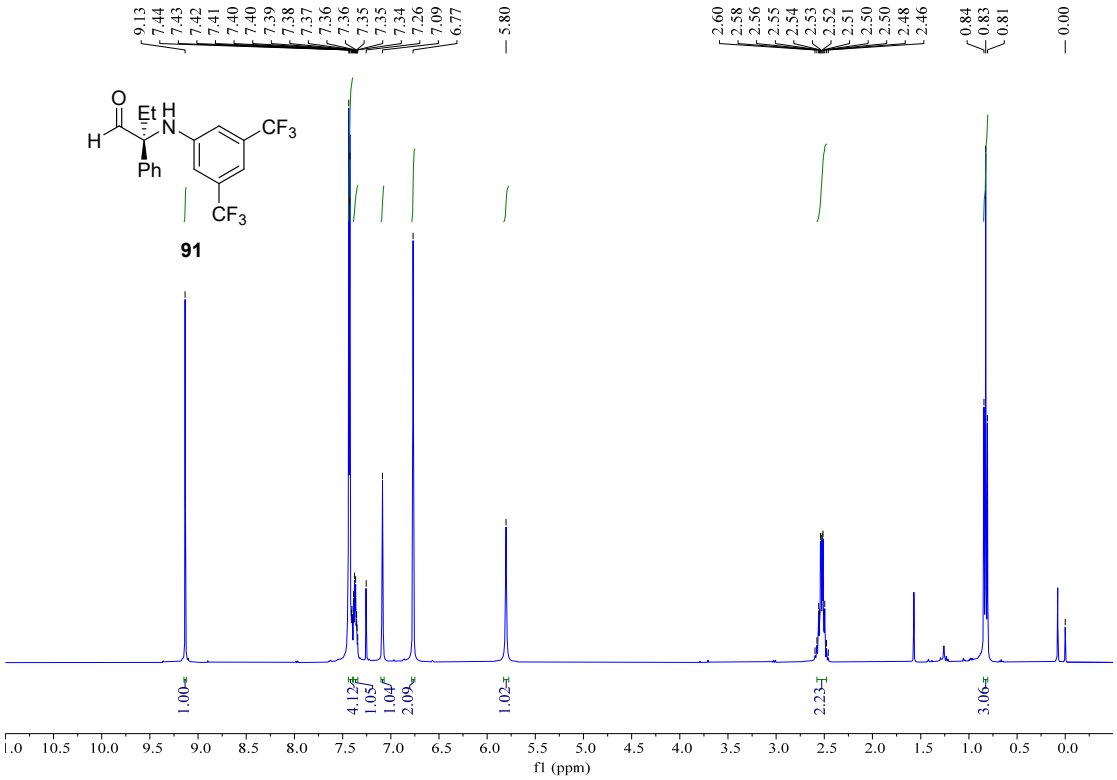
CO2Me
HN
CO2Me
Ph
tBu
90
f1 (ppm)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7.40
7.39
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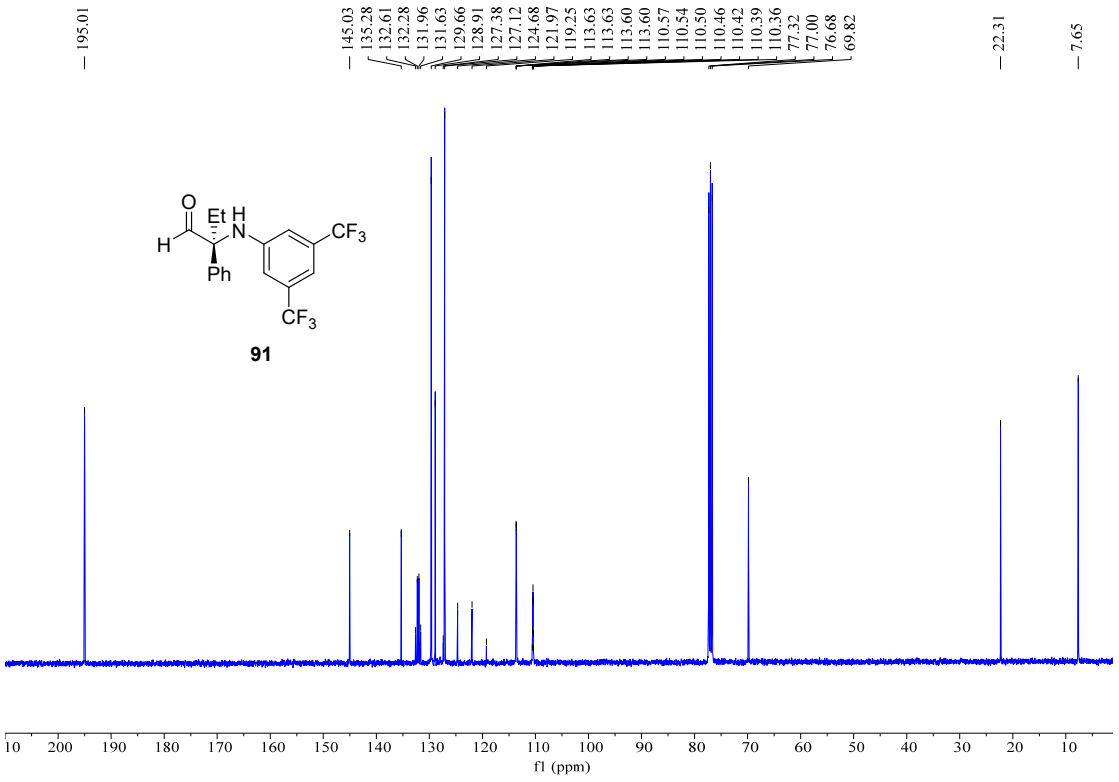
7.37
7.36
7.36
7.35
7.35
7.34
7.26
7.09
6.77
5.80
2.60
2.58
2.56
2.55
2.54
2.53
2.52
2.51
2.50
2.50
2.48
2.46
0.84
0.83
0.81
0.00
O
H
Et
H
N
Ph
CF3
CF3
91
1.00
4.12
1.05
1.04
2.09
1.02
2.23
3.06
f1 (ppm)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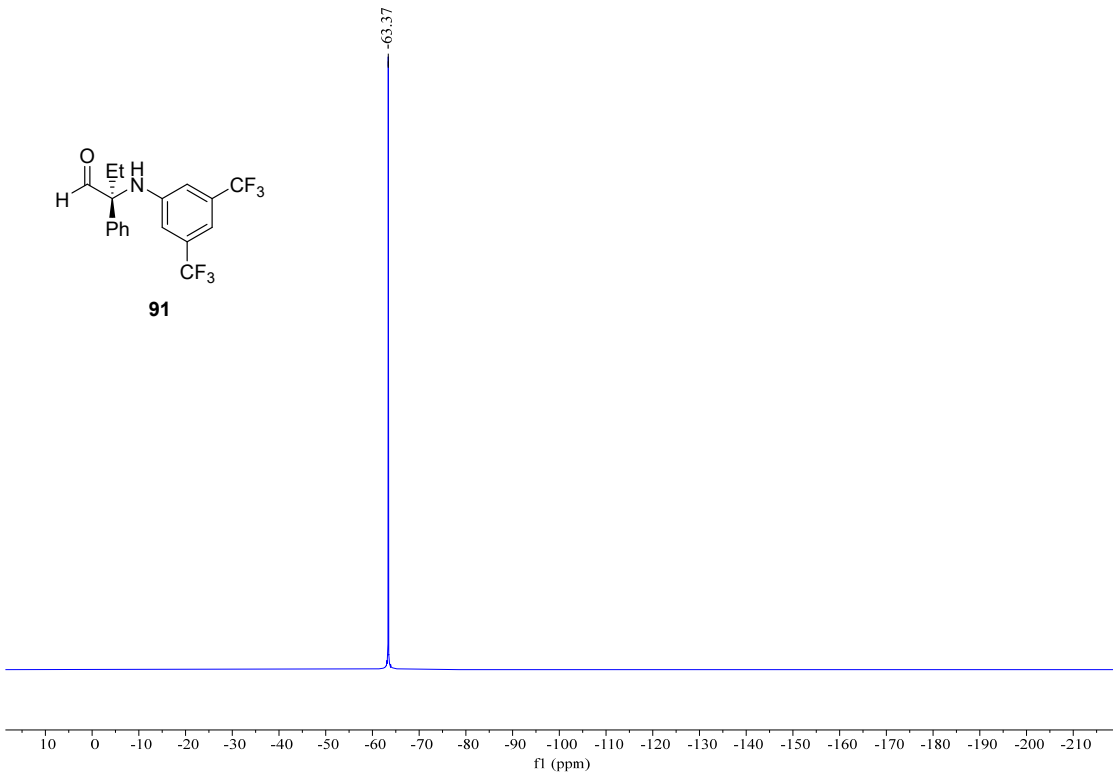
135.28
132.61
132.28
131.96
131.63
129.66
128.91
127.38
127.12
124.68
121.97
119.25
113.63
113.63
113.60
113.60
110.57
110.54
110.50
110.46
110.42
110.39
110.36
77.32
77.00
76.68
69.82
22.31
7.65
O
H
Et
H
N
Ph
CF3
CF3
91
f1 (ppm)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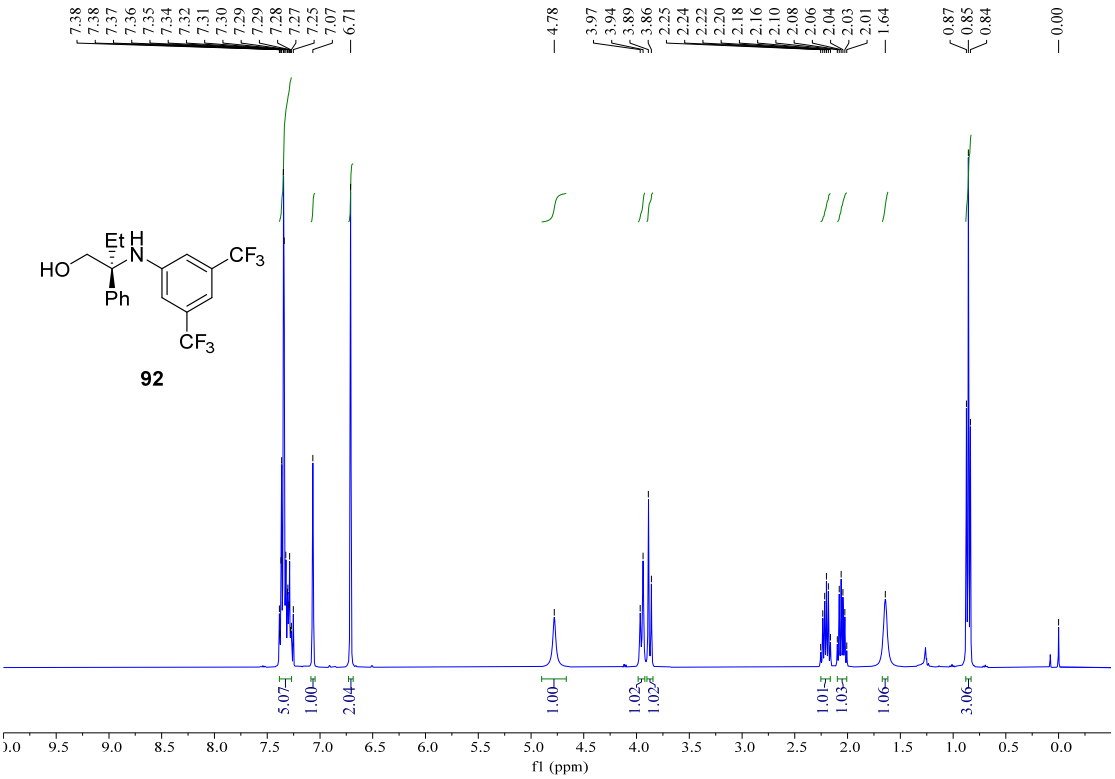
O
Et
H
N
H
Ph
CF3
CF3
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

91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7.38
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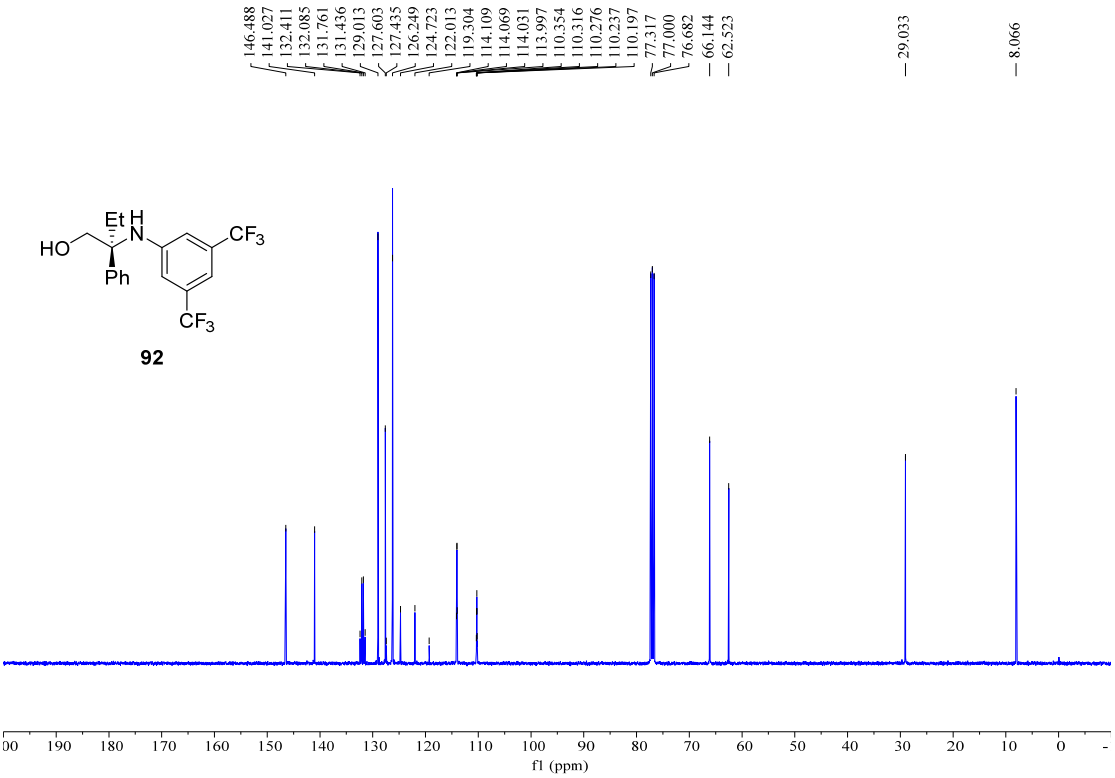
7.34
7.32
7.31
7.30
7.29
7.29
7.28
7.27
7.25
7.07
6.71
4.78
3.97
3.94
3.89
3.86
2.25
2.24
2.22
2.20
2.18
2.16
2.10
2.08
2.06
2.04
2.03
2.01
1.64
0.87
0.85
0.84
0.00
Et
H
N
HO
Ph
CF3
CF3
92
5.07
1.00
2.04
1.00
1.02
1.02
1.01
1.03
1.06
3.06
f1 (ppm)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127.603
127.435
126.249
124.723
122.013
119.304
114.109
114.069
114.031
113.997
110.354
110.316
110.276
110.237
110.197
77.317
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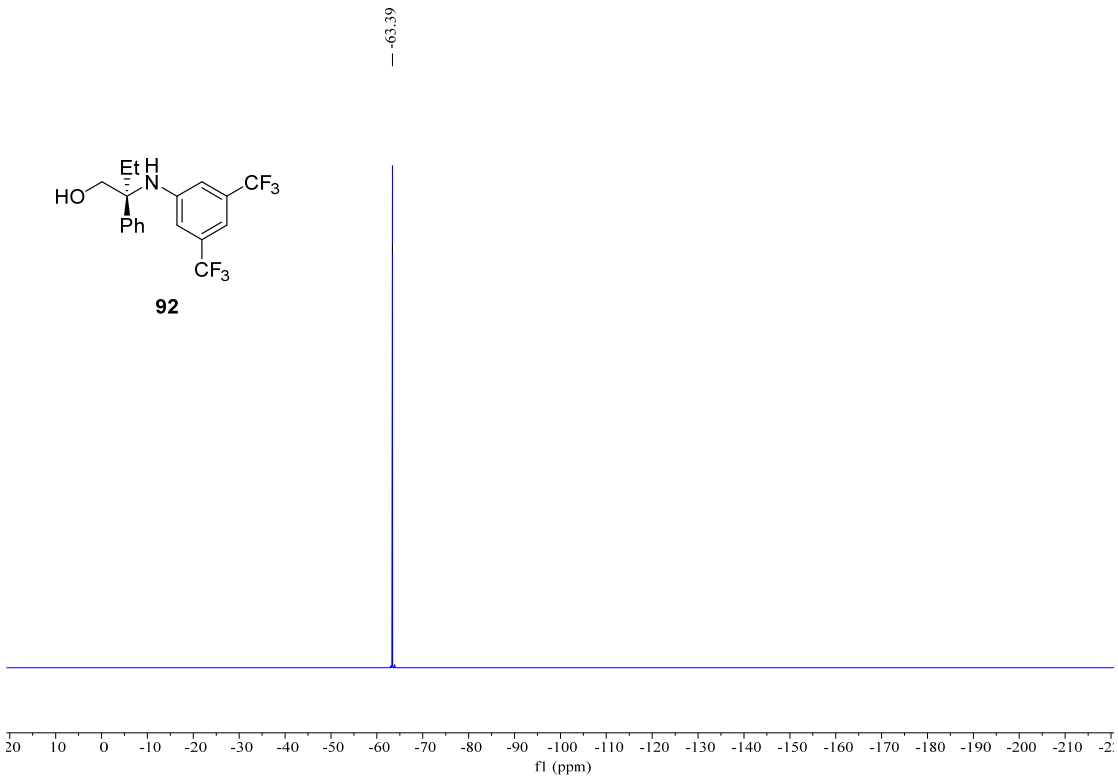
N
HO
Ph
CF3
CF3
92
f1 (ppm)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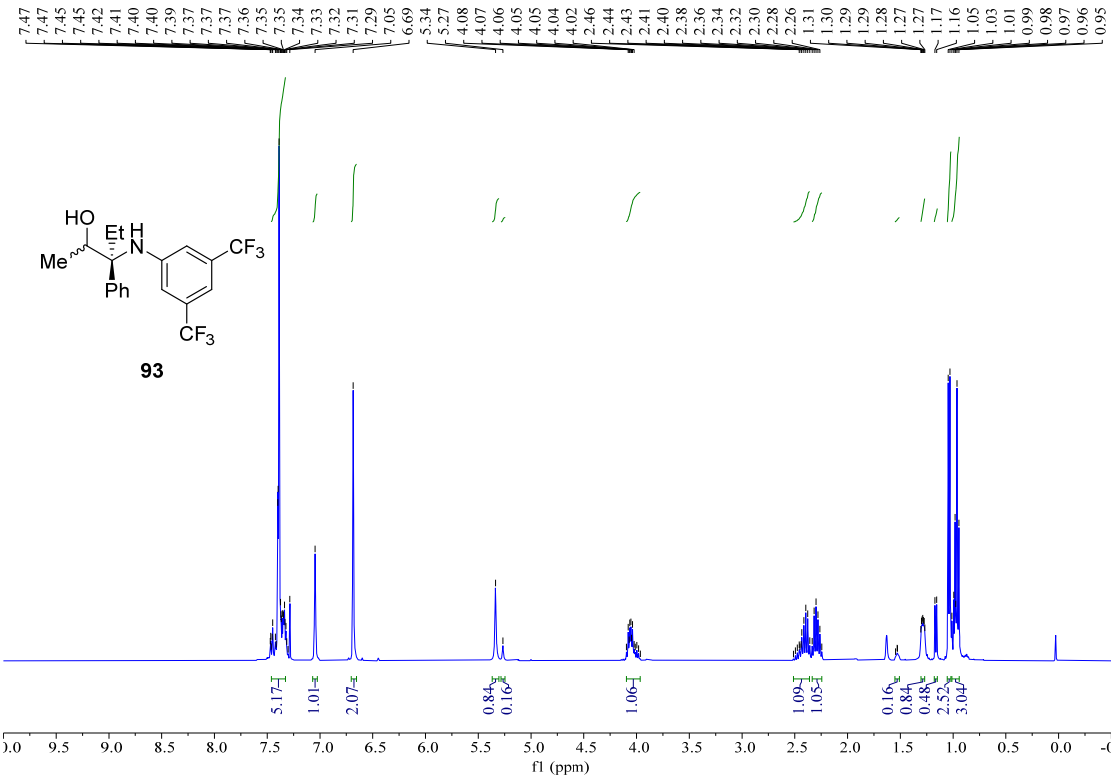
Et
H
N
HO
Ph
CF3
CF3
92
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)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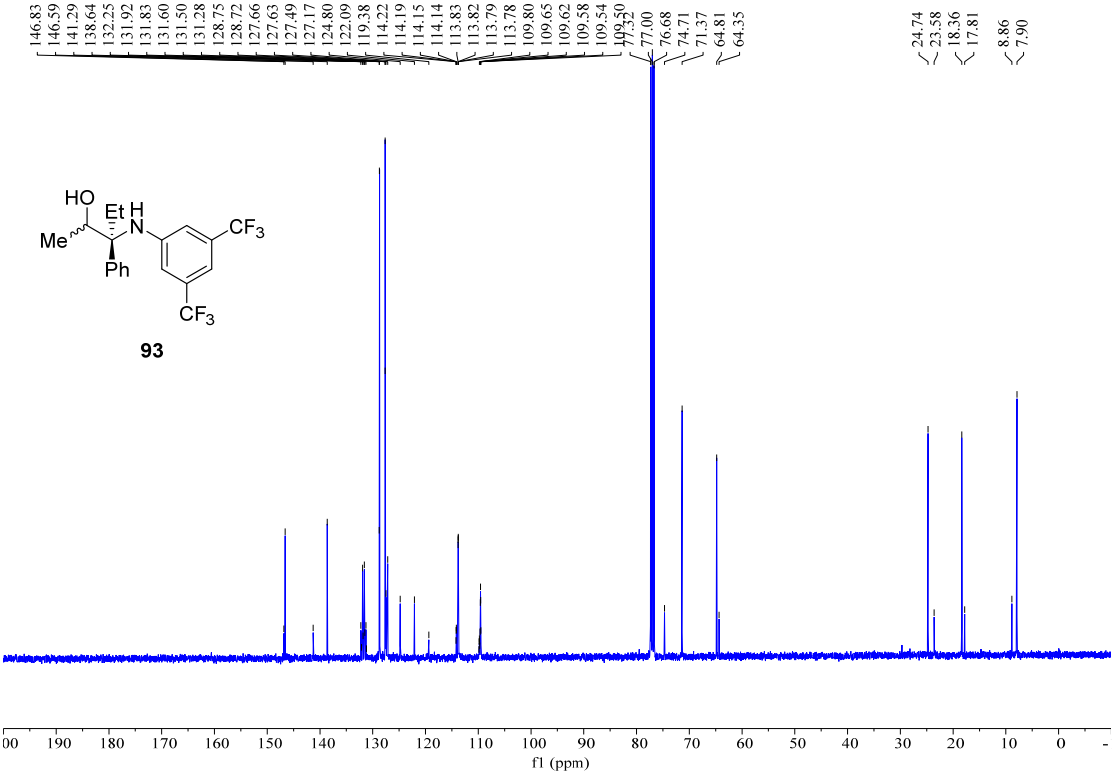
Et
H
N
Me
Ph
CF3
CF3
93
f1 (ppm)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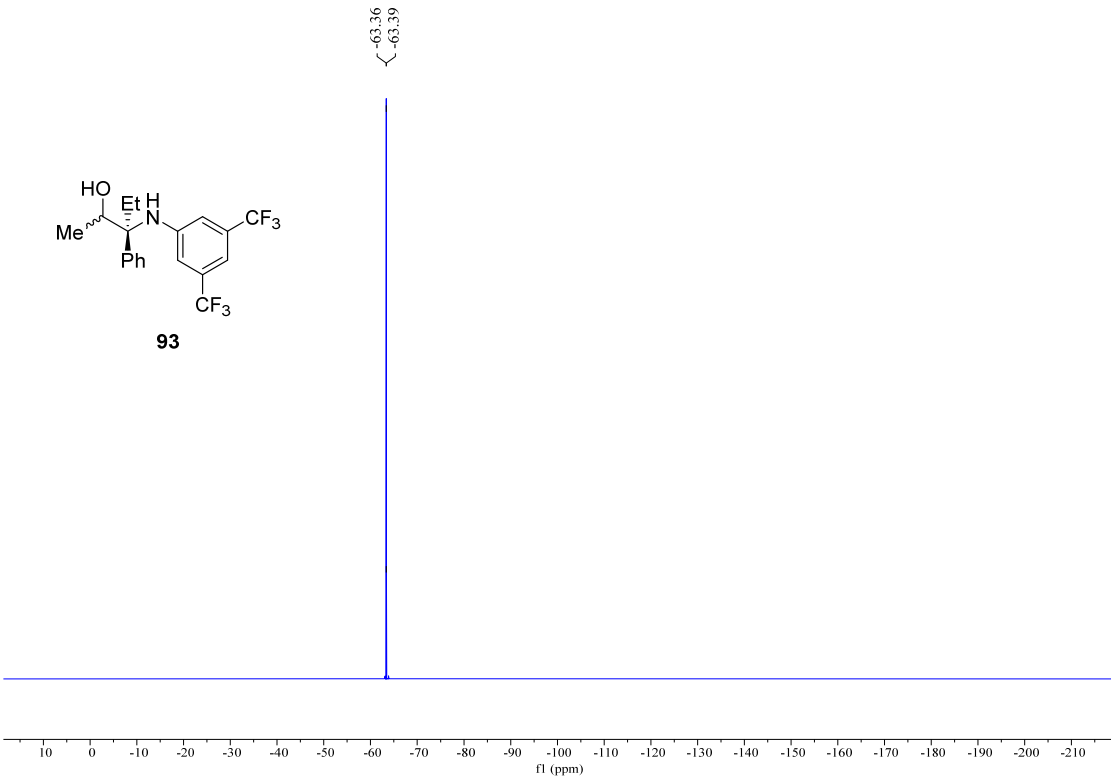
Et
H
N
Me
Ph
CF3
CF3
93
f1 (ppm)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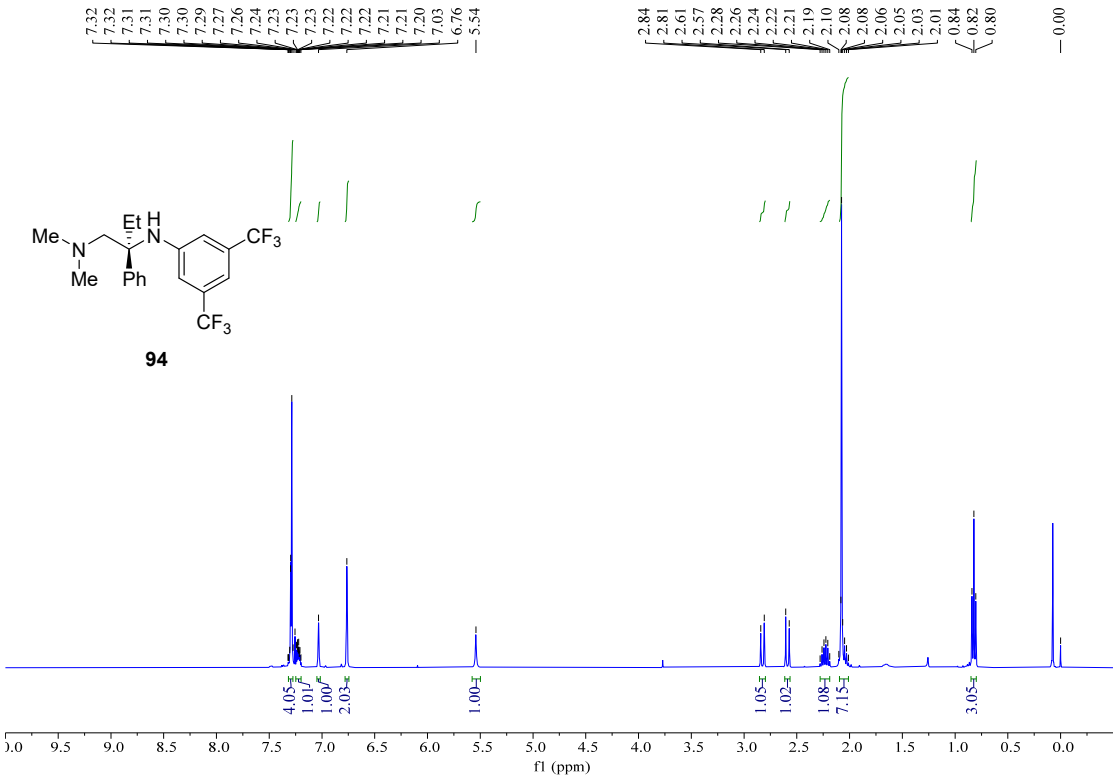
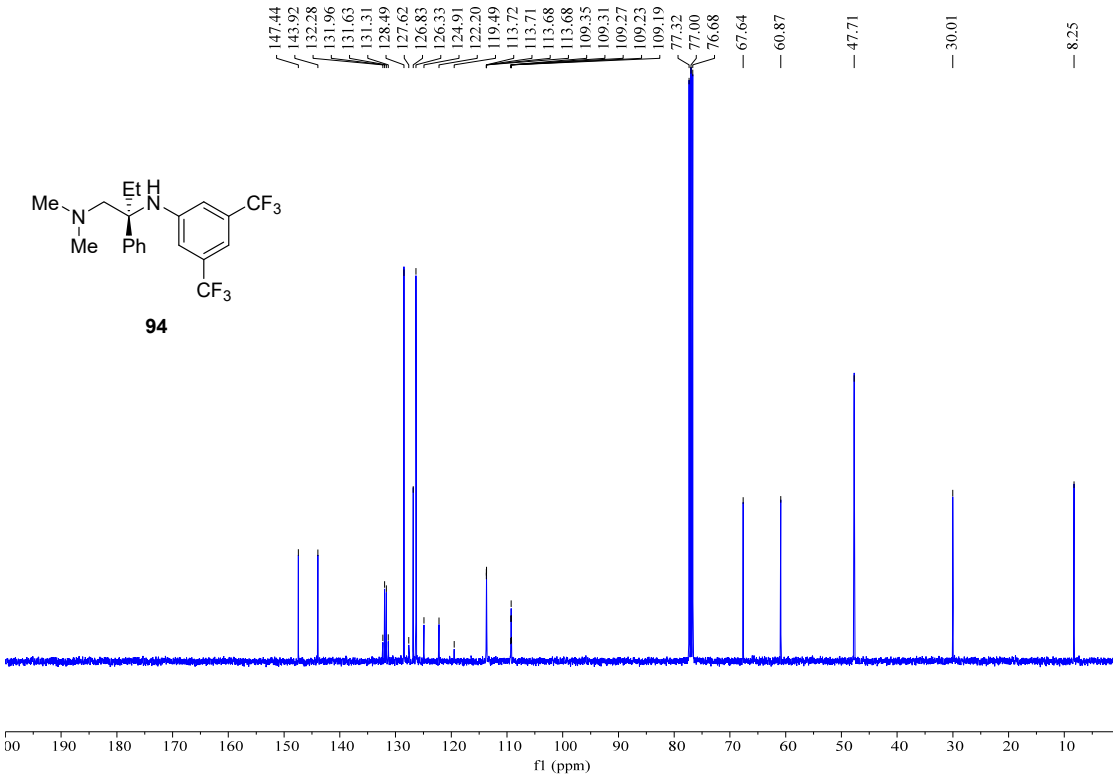
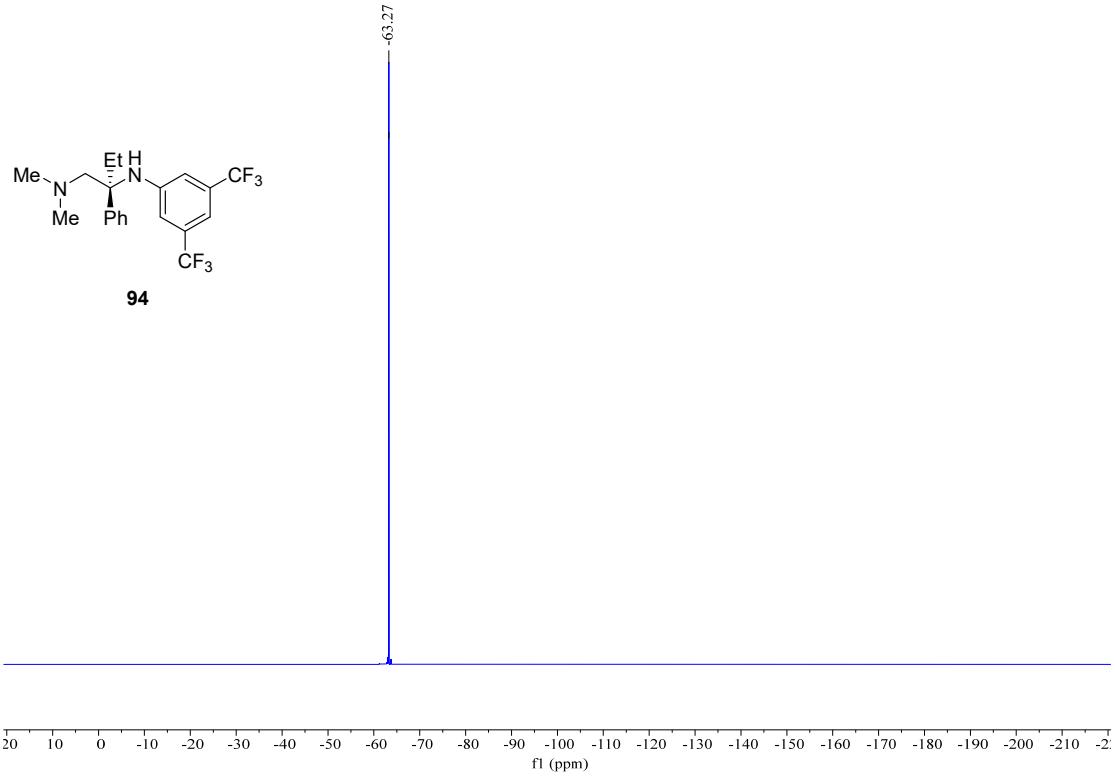
-63.39
HO
Et
H
N
Me
Ph
CF3
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

93


Me
N
Me
Et
H
N
Ph
CF3
CF3
94
f1 (ppm)


Me
N
Me
Et
H
N
Ph
CF3
CF3
94
f1 (ppm)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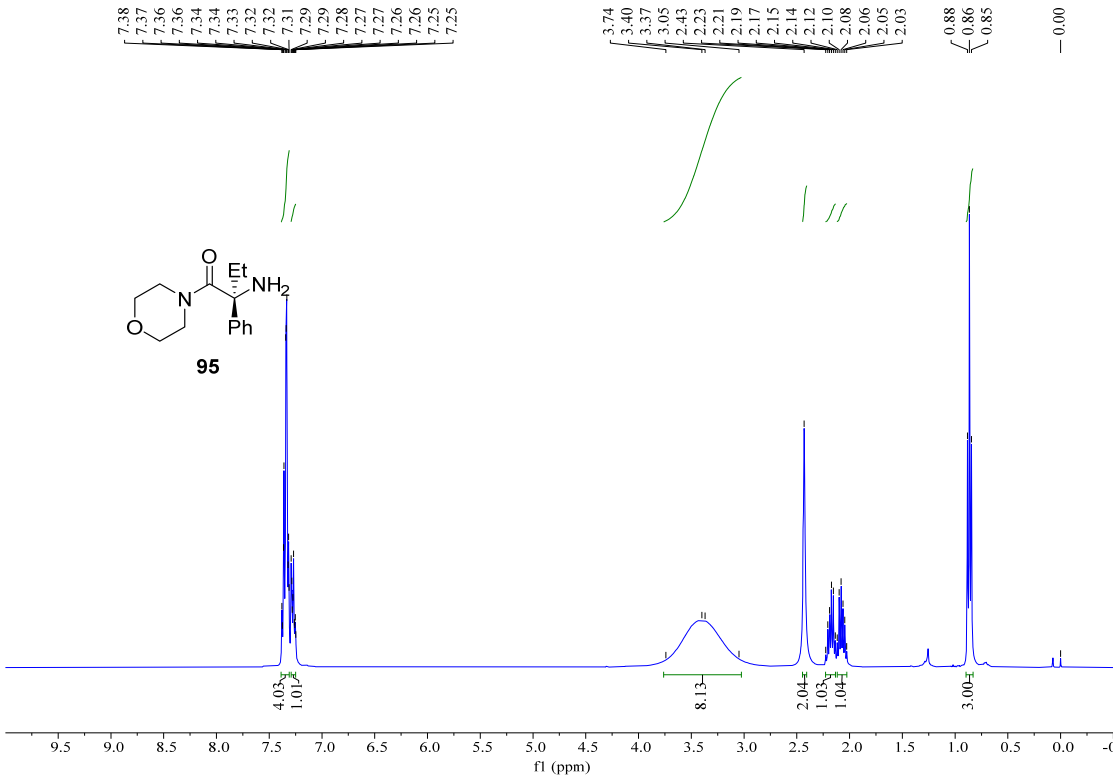
N
Me
Et
H
N
Ph
CF3
CF3
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

94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2.19
2.17
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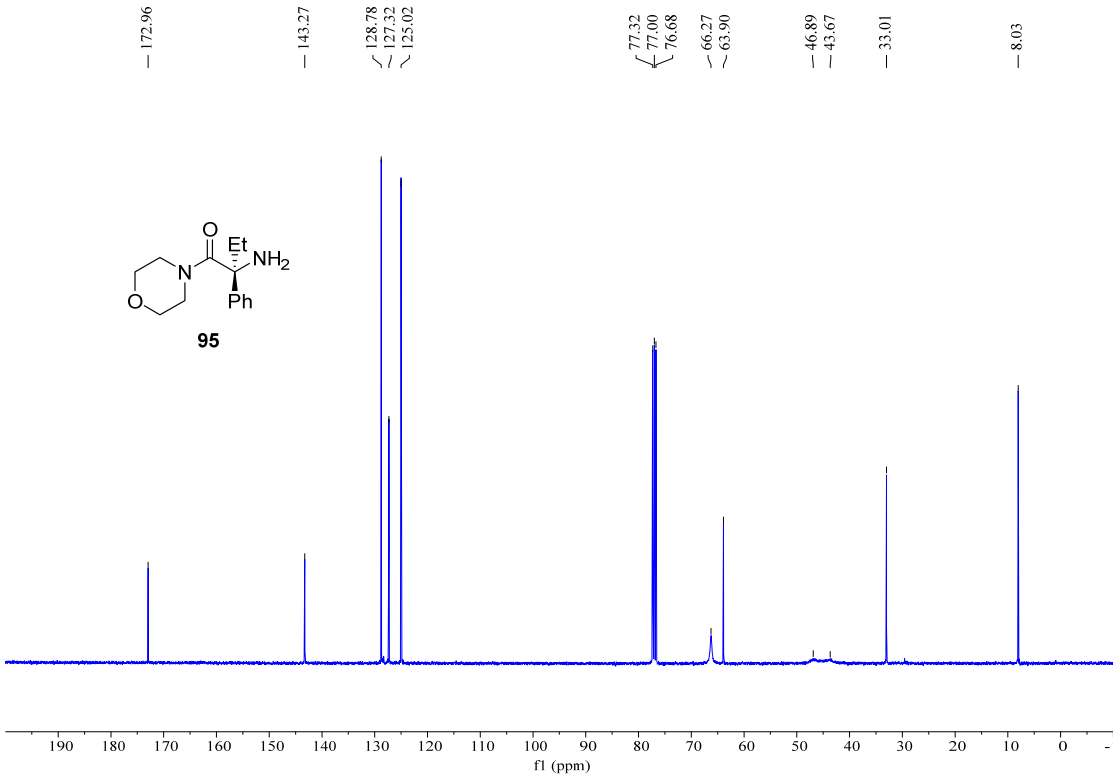
2.14
2.12
2.10
2.08
2.06
2.05
2.03
0.88
0.86
0.85
0.00
O
Et
NH2
N
O
Ph
95
4.03
1.01
8.13
2.04
1.03
1.04
3.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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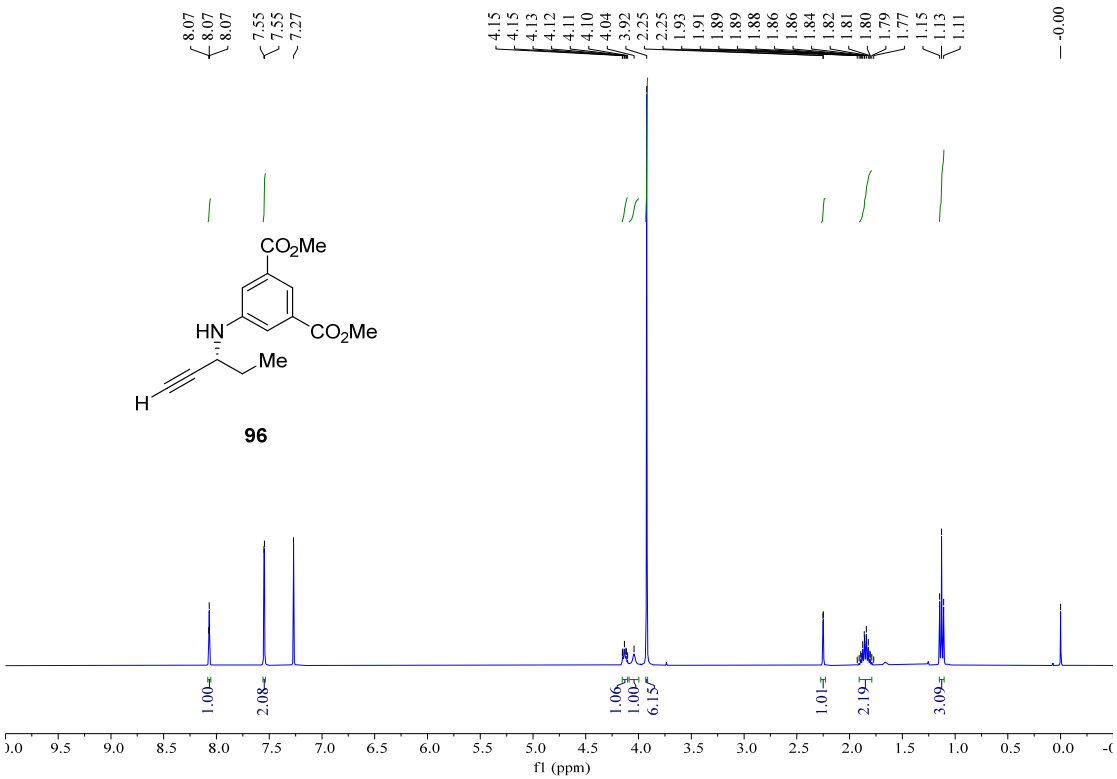
128.78
127.32
125.02
77.32
77.00
76.68
66.27
63.90
46.89
43.67
33.01
8.03
O
Et
NH2
N
O
Ph
95
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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8.07
8.07
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4.15
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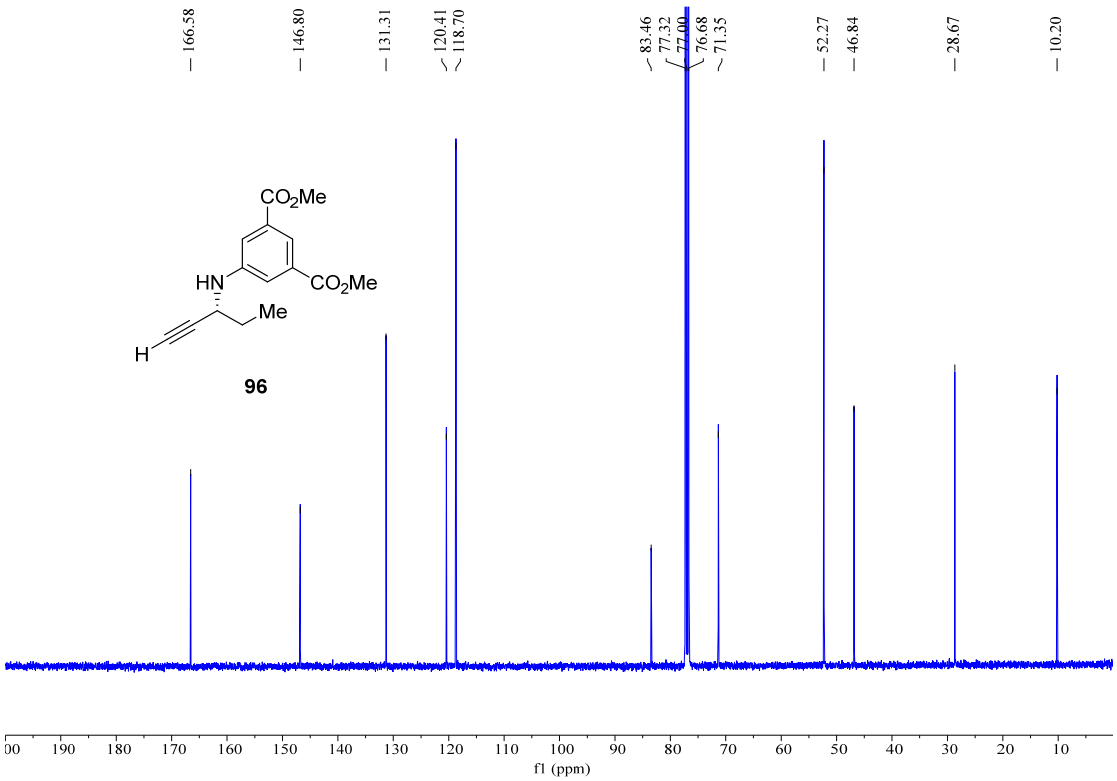
4.12
4.11
4.10
4.04
3.92
2.25
2.25
1.93
1.91
1.89
1.89
1.88
1.86
1.86
1.84
1.82
1.81
1.80
1.79
1.77
1.15
1.13
1.11
-0.00
CO2Me
HN
CO2Me
Me
H
96
1.00
2.08
1.06
1.00
6.15
1.01
2.19
3.09
f1 (ppm)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77.32
77.00
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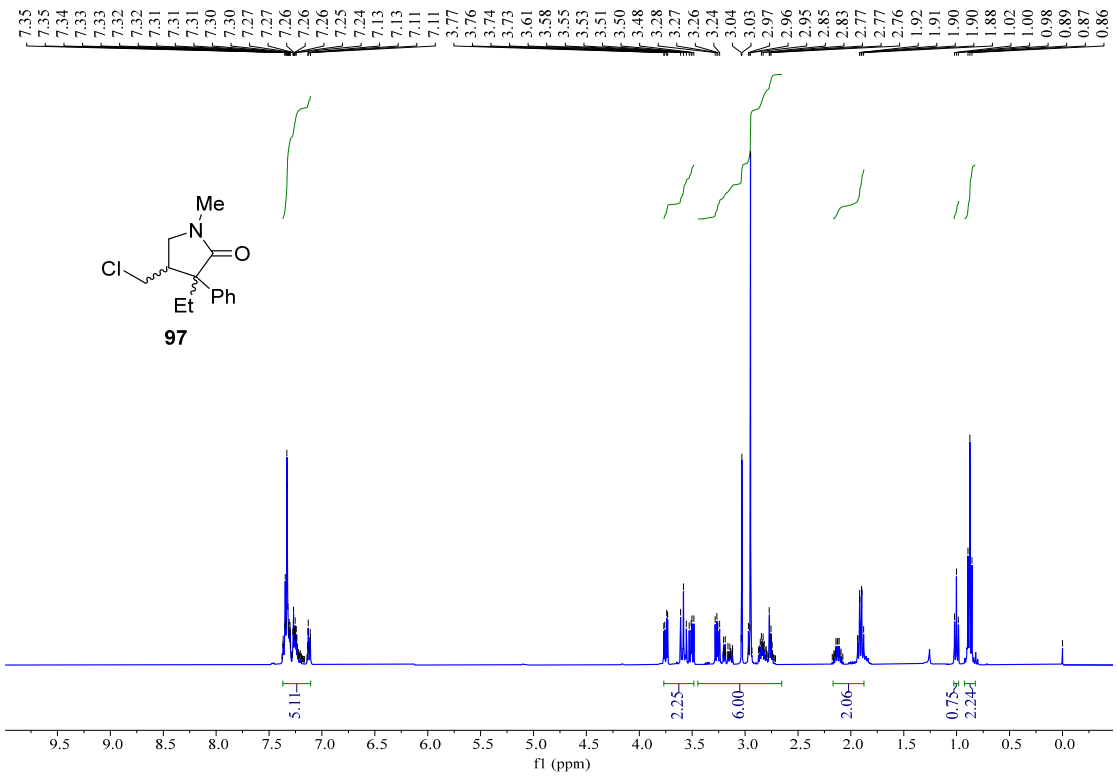
52.27
46.84
28.67
10.20
CO2Me
HN
CO2Me
Me
H
96
f1 (ppm)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Ph
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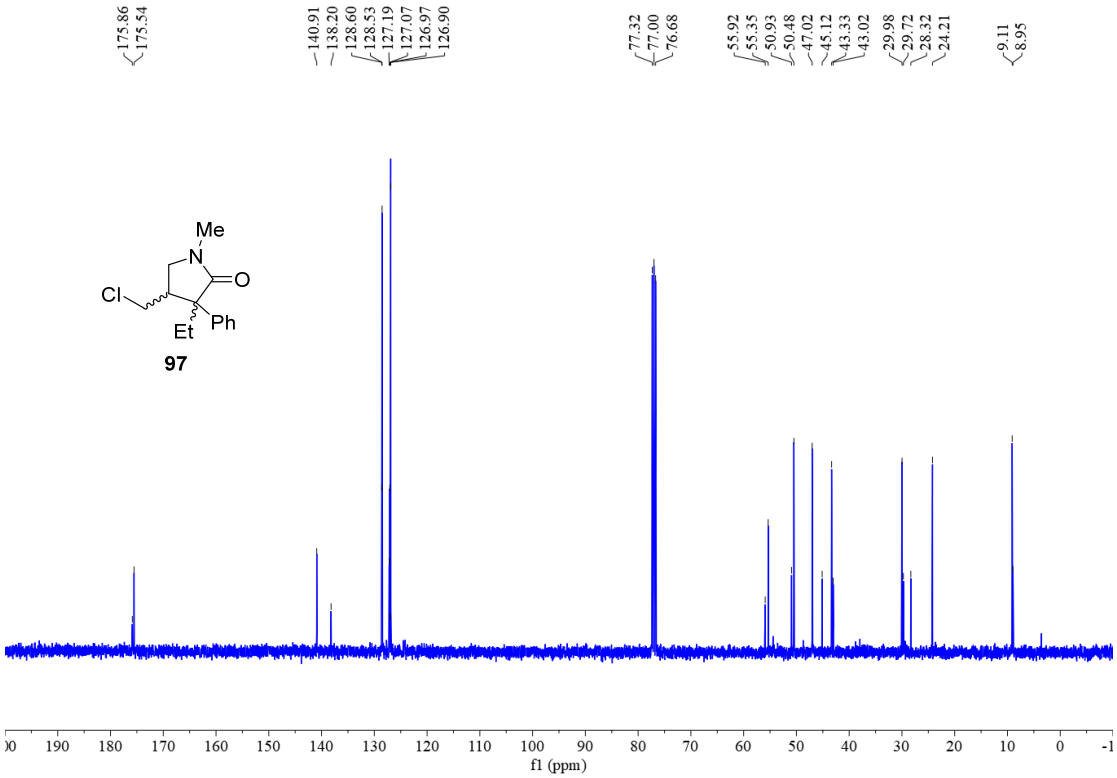
6.00
2.06
0.75
2.24
f1 (ppm)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Cl
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Ph
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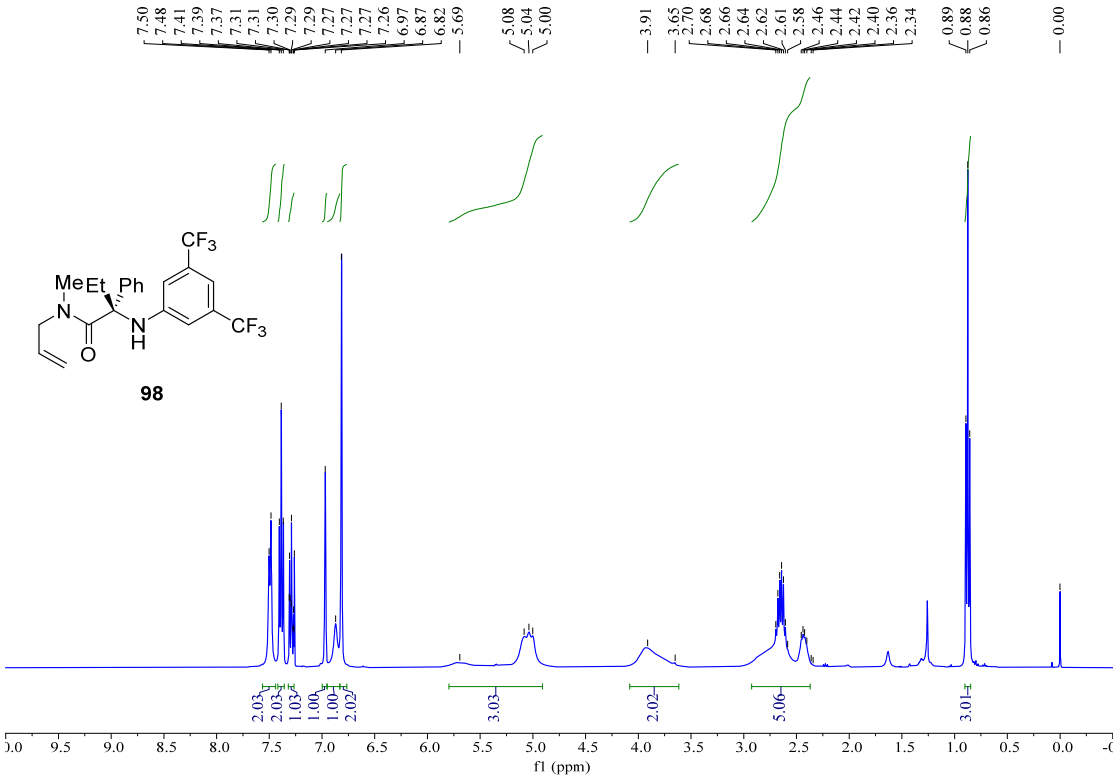
f1 (ppm)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7.30
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7.29
7.27
7.27
7.27
7.26
6.97
6.87
6.82
5.69
5.08
5.04
5.00
3.91
3.65
2.70
2.68
2.66
2.64
2.62
2.61
2.58
2.46
2.44
2.42
2.40
2.36
2.34
0.89
0.88
0.86
0.00
CF3
Me
Et
Ph
N
N
H
O
CF3
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1.03
1.00
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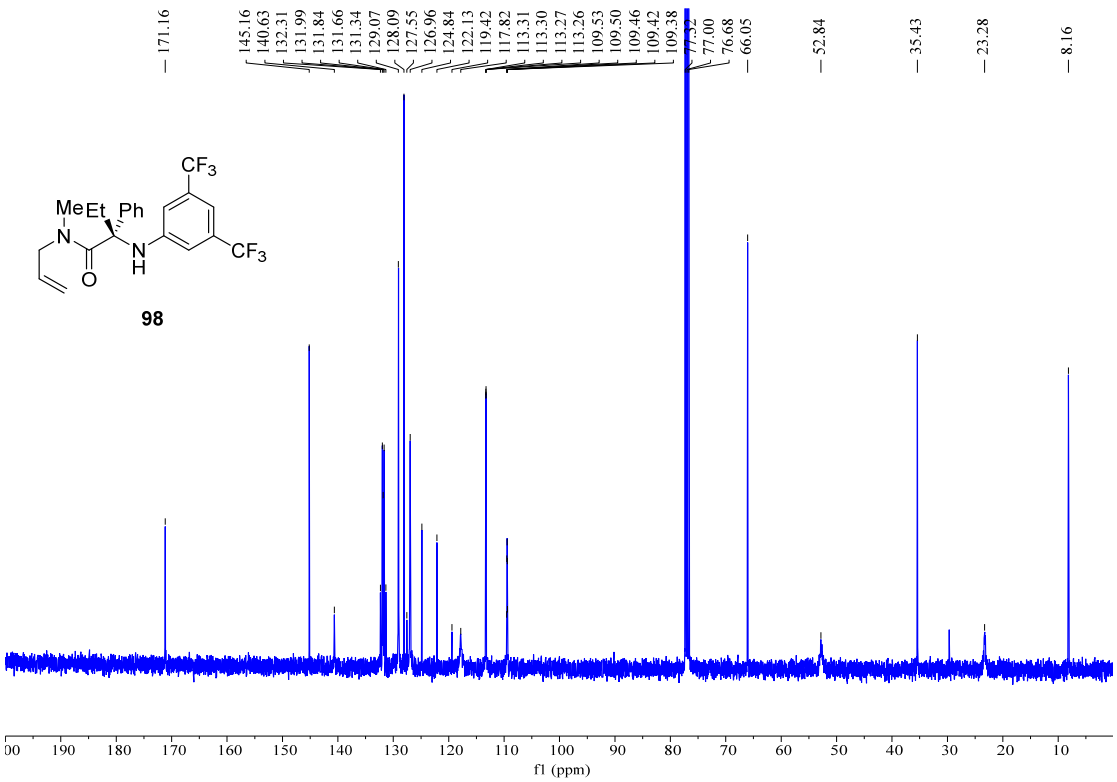
3.03
2.02
5.06
3.01
f1 (ppm)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131.34
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122.13
119.42
117.82
113.31
113.30
113.27
113.26
109.53
109.50
109.46
109.42
109.38
77.32
77.00
76.68
66.05
52.84
35.43
23.28
8.16
CF3
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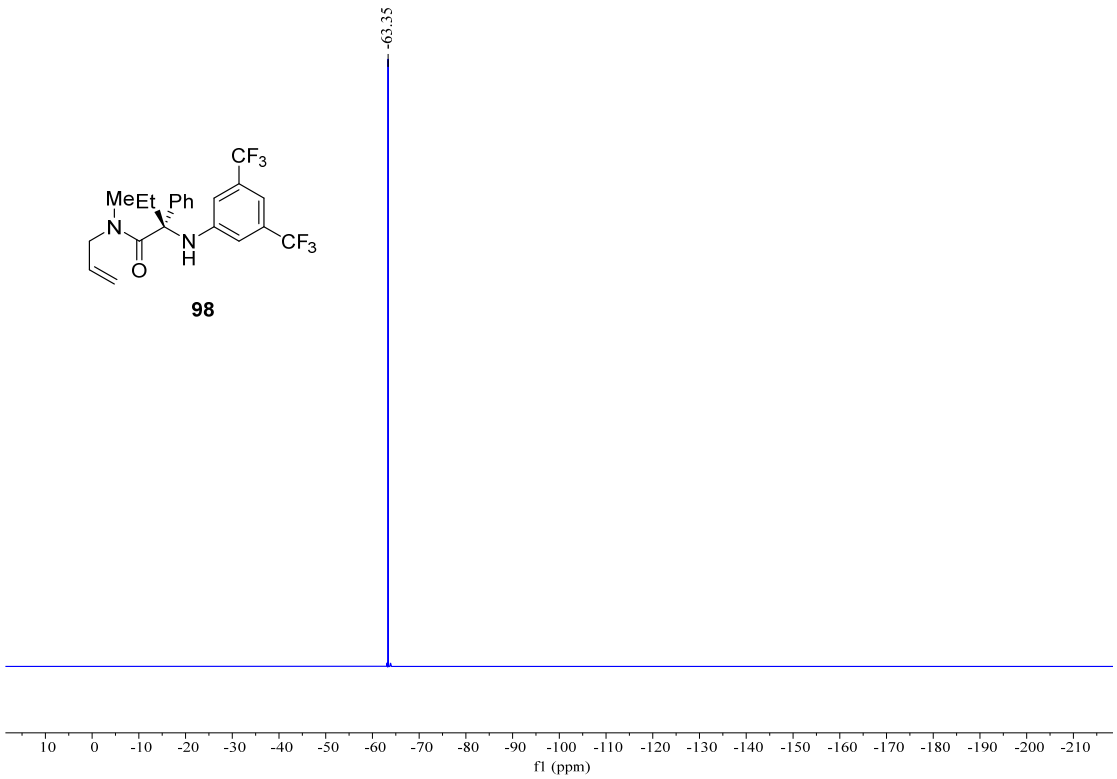
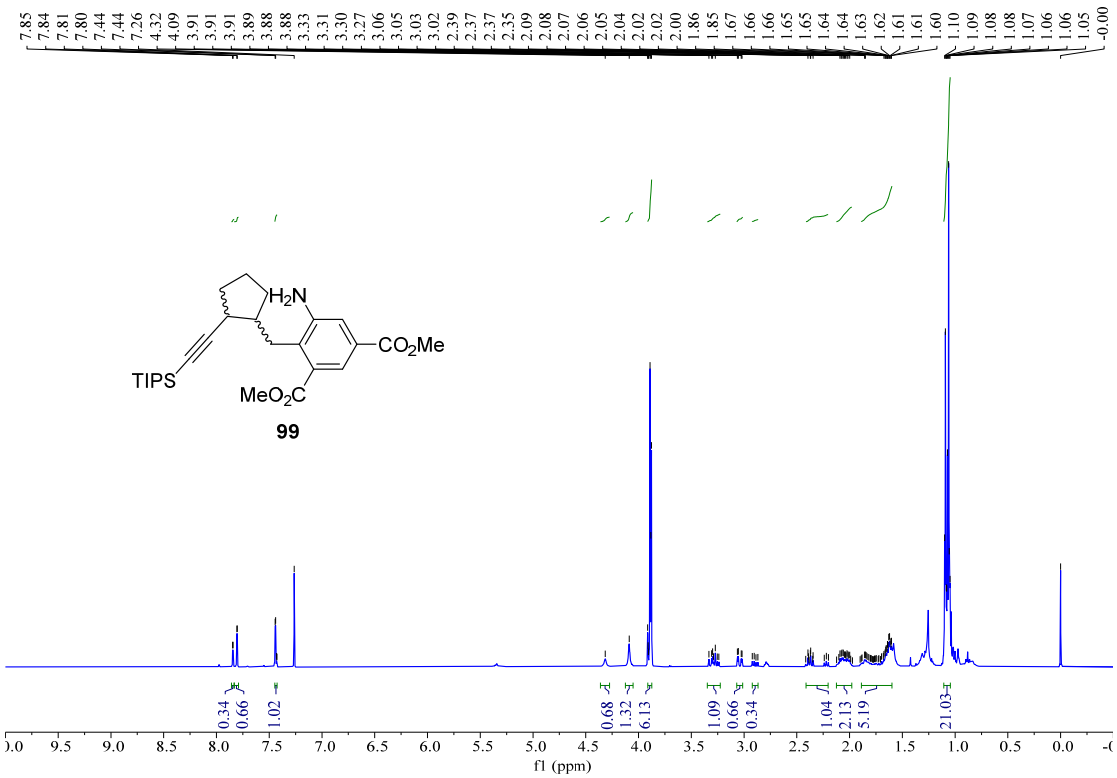
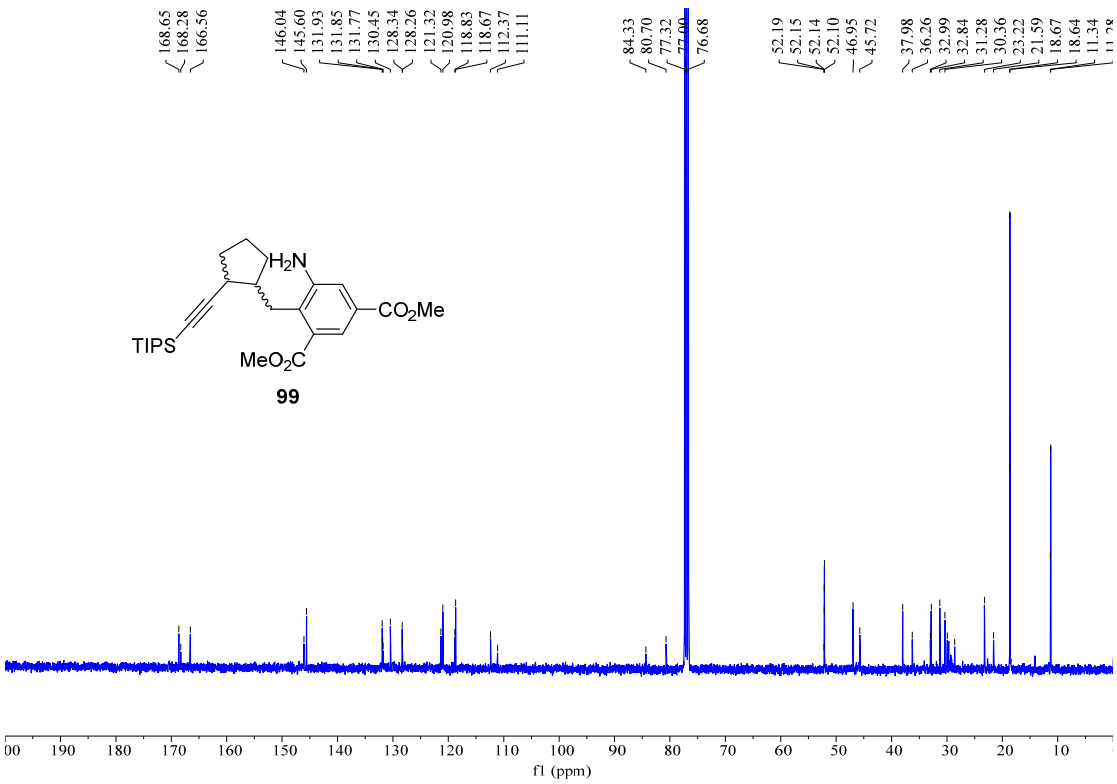
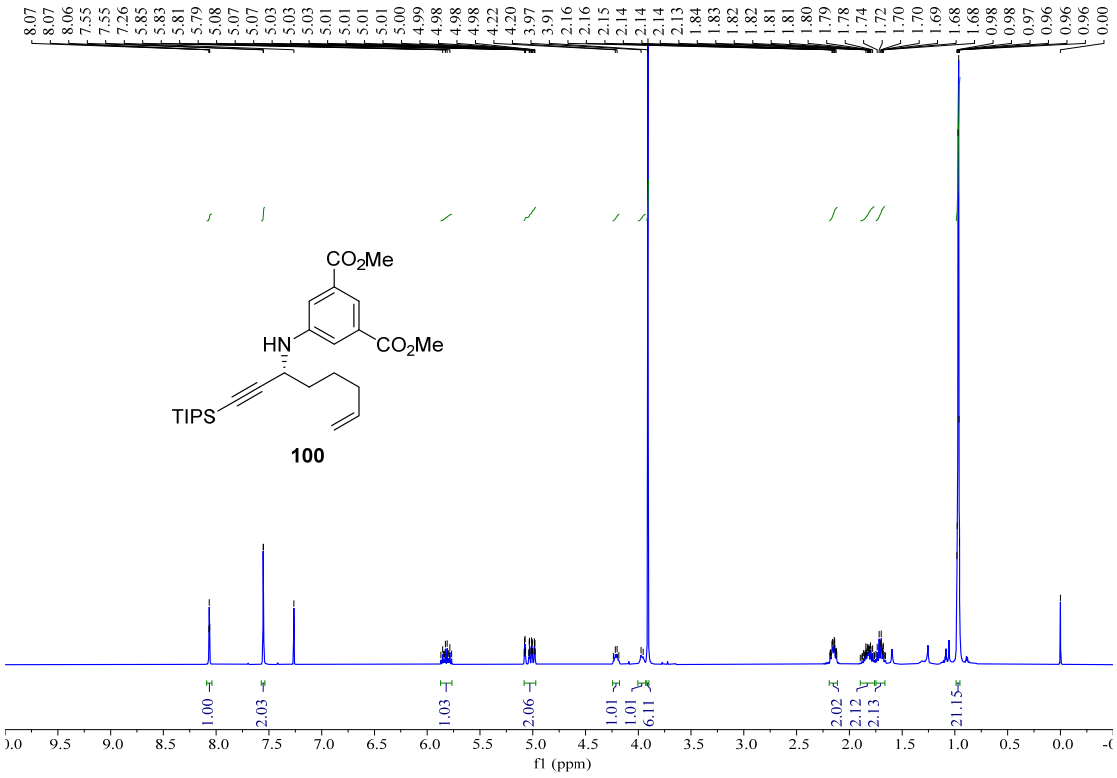
Et
Ph
N
N
H
O
CF3
98
f1 (ppm)

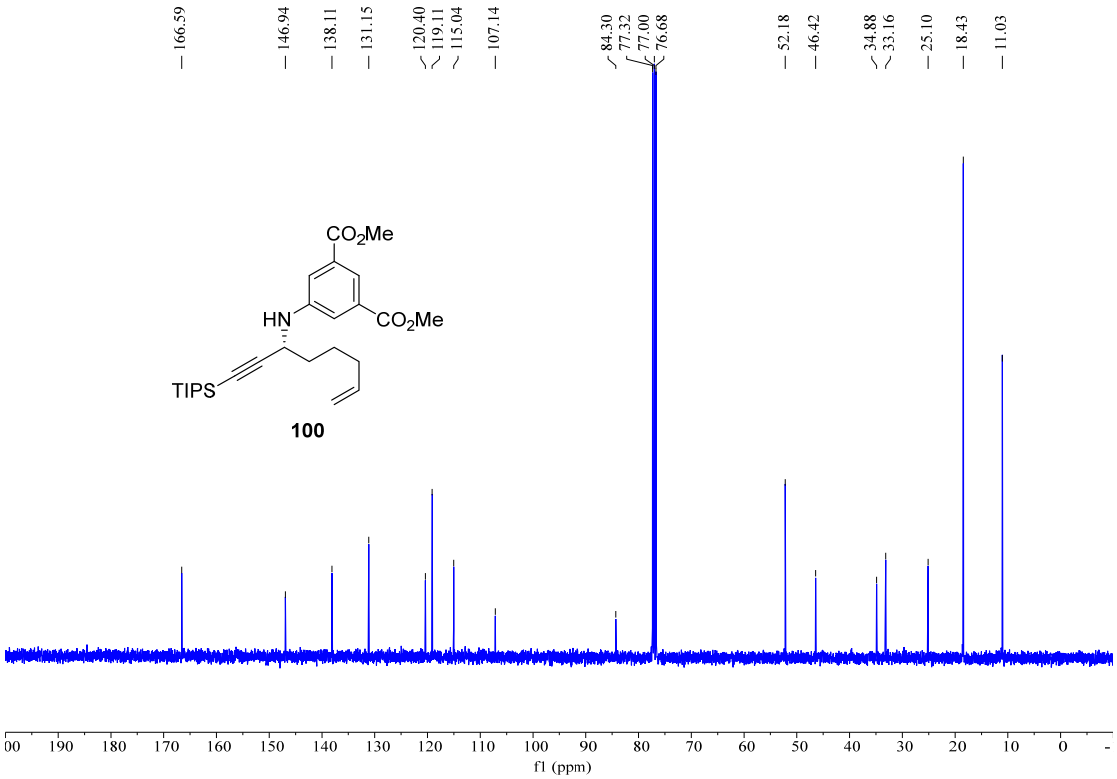

-63.35
CF3
MeEt
Ph
N
O
N
H
CF3
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

98

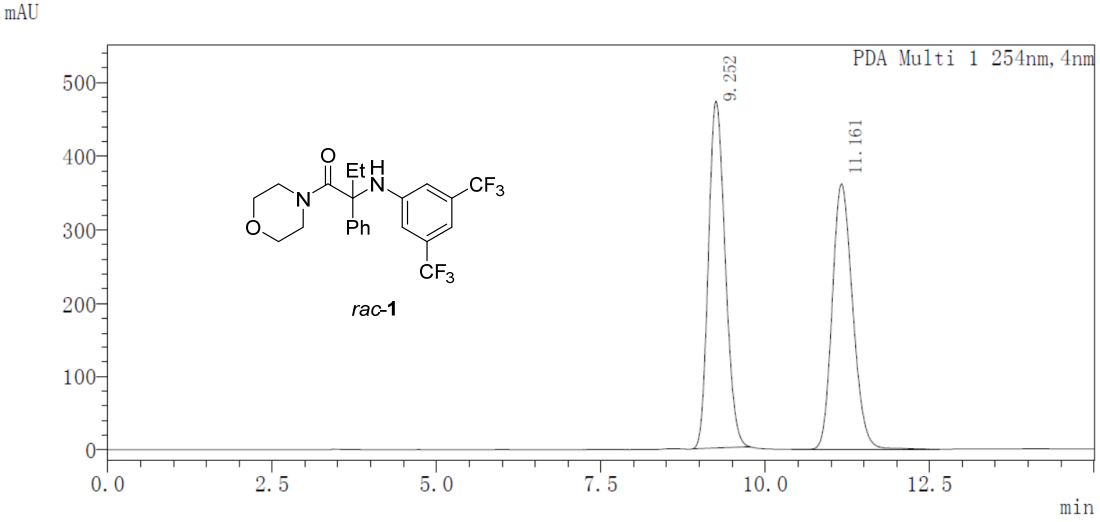

7.85 7.84 7.81 7.80 7.44 7.44 7.26 4.32 4.09 3.91 3.91 3.91 3.89 3.88 3.88 3.33 3.31 3.30 3.27 3.06 3.05 3.03 3.02 2.39 2.37 2.37 2.35 2.09 2.08 2.07 2.06 2.05 2.04 2.02 2.02 2.00 1.86 1.85 1.67 1.66 1.66 1.65 1.65 1.64 1.64 1.63 1.62 1.61 1.61 1.60 1.10 1.09 1.08 1.08 1.07 1.06 1.06 1.05 -0.00
H2N
CO2Me
TIPS
MeO2C
99
0.34 0.66 1.02 0.68 1.32 6.13 1.09 0.66 0.34 1.04 2.13 5.19 21.03
f1 (ppm)


168.65 168.28 166.56 146.04 145.60 131.93 131.85 131.77 130.45 128.34 128.26 121.32 120.98 118.83 118.67 112.37 111.11 84.33 80.70 77.32 77.00 76.68 52.19 52.15 52.14 52.10 46.95 45.72 37.98 36.26 32.99 32.84 31.28 30.36 23.22 21.59 18.67 18.64 11.34
H2N
CO2Me
TIPS
MeO2C
99
f1 (ppm)


CO2Me
HN
CO2Me
TIPS
100
f1 (ppm)


CO2Me
HN
CO2Me
TIPS
100
f1 (ppm)

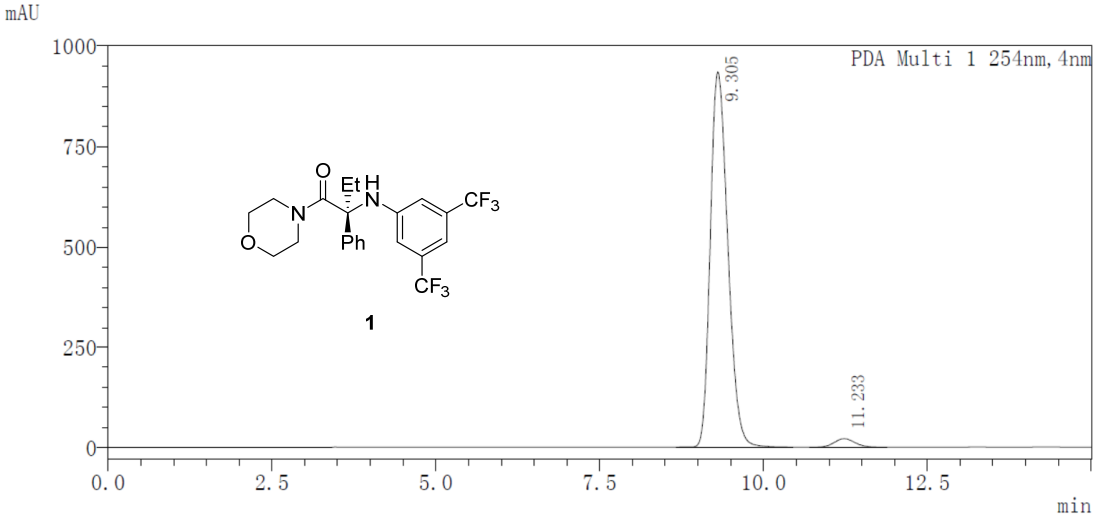
10. HPLC spectra



Peak Table

PDA Ch1 254nm

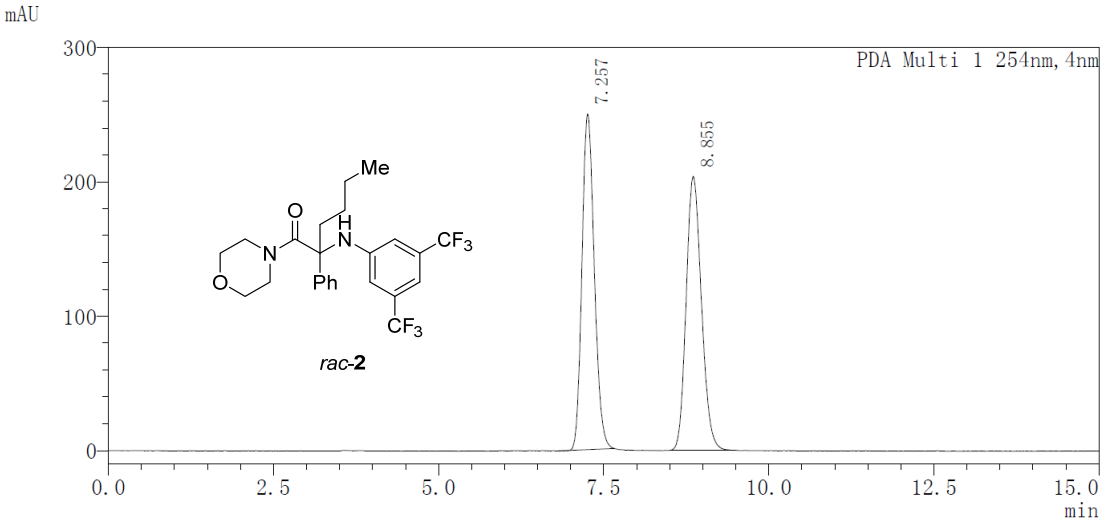
Peak#	Ret. Time	Area	Area%
1	9.252	8379238	51.690
2	11.161	7831270	48.310



Peak Table

PDA Ch1 254nm

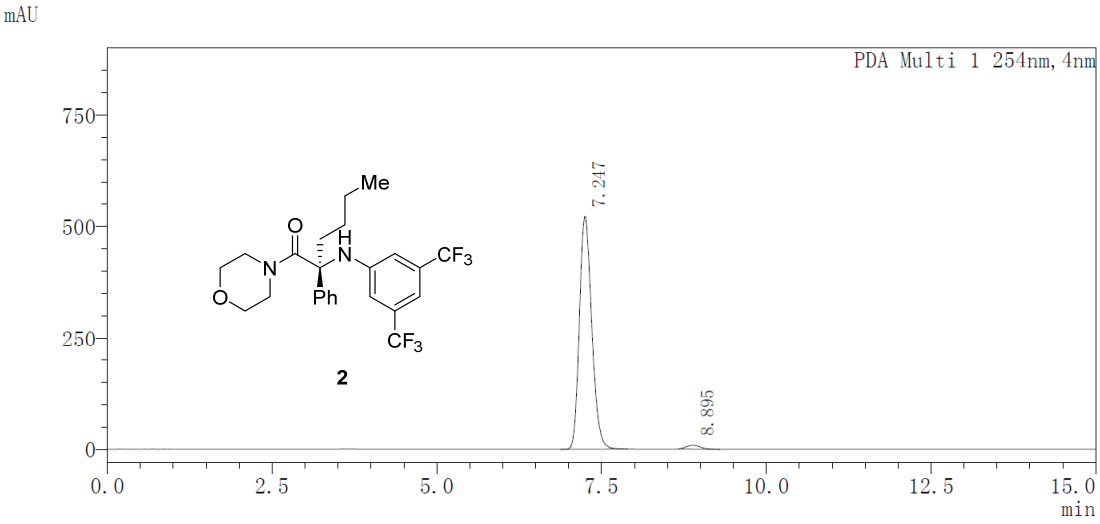
Peak#	Ret. Time	Area	Area%
1	9.305	17399663	97.424
2	11.233	460063	2.576



Peak Table

PDA Ch1 254nm

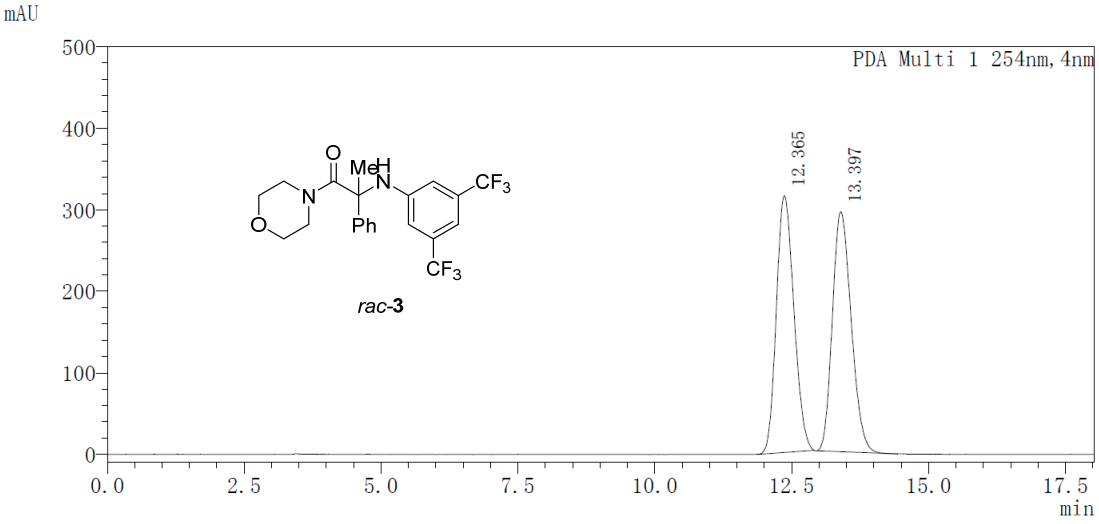
Peak#	Ret. Time	Area	Area%
1	7.257	3222722	49.807
2	8.855	3247758	50.193



Peak Table

PDA Ch1 254nm

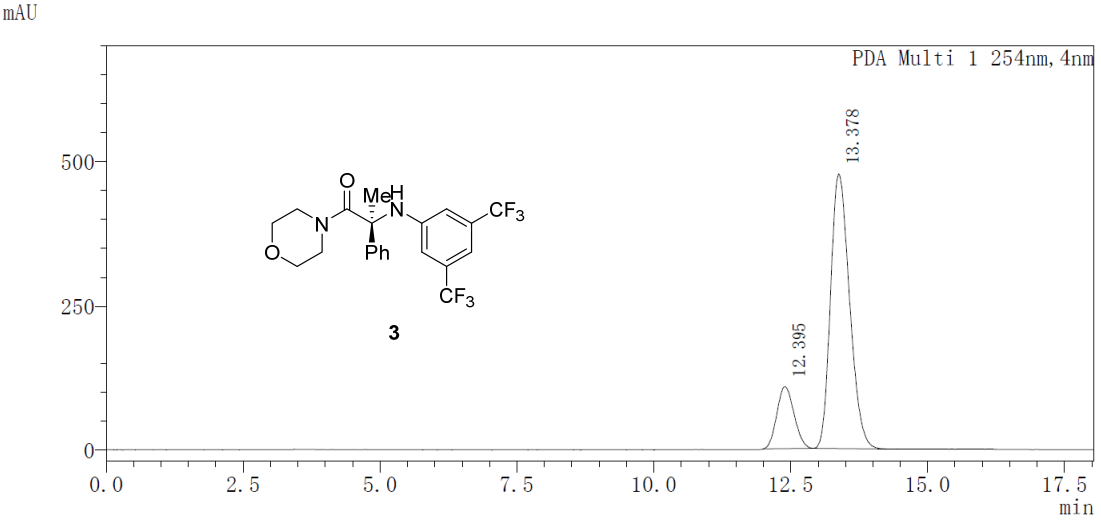
Peak#	Ret. Time	Area	Area%
1	7.247	6777471	98.206
2	8.895	123779	1.794



Peak Table

PDA Ch1 254nm

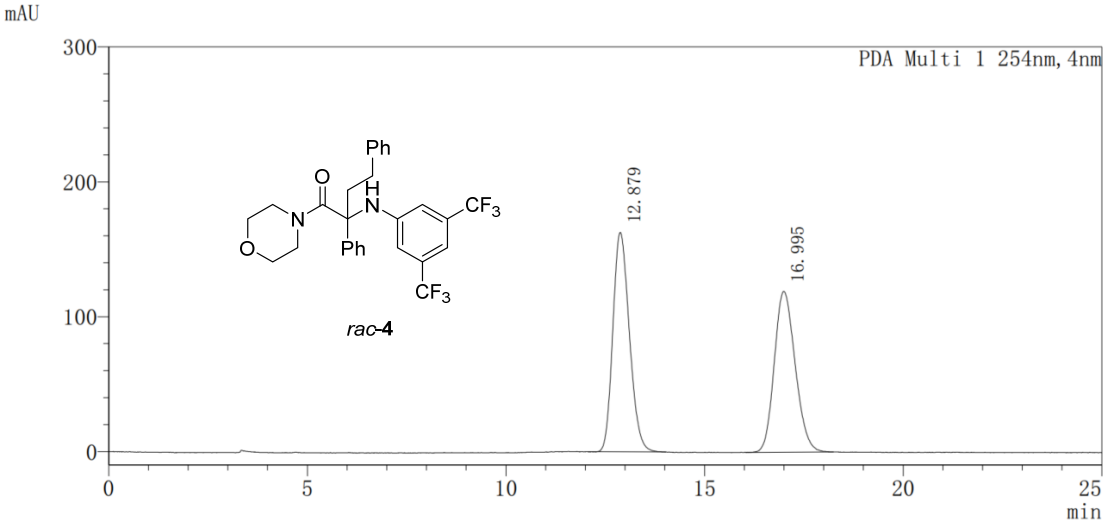
Peak#	Ret. Time	Area	Area%
1	12.365	7021775	49.953
2	13.397	7034969	50.047



Peak Table

PDA Ch1 254nm

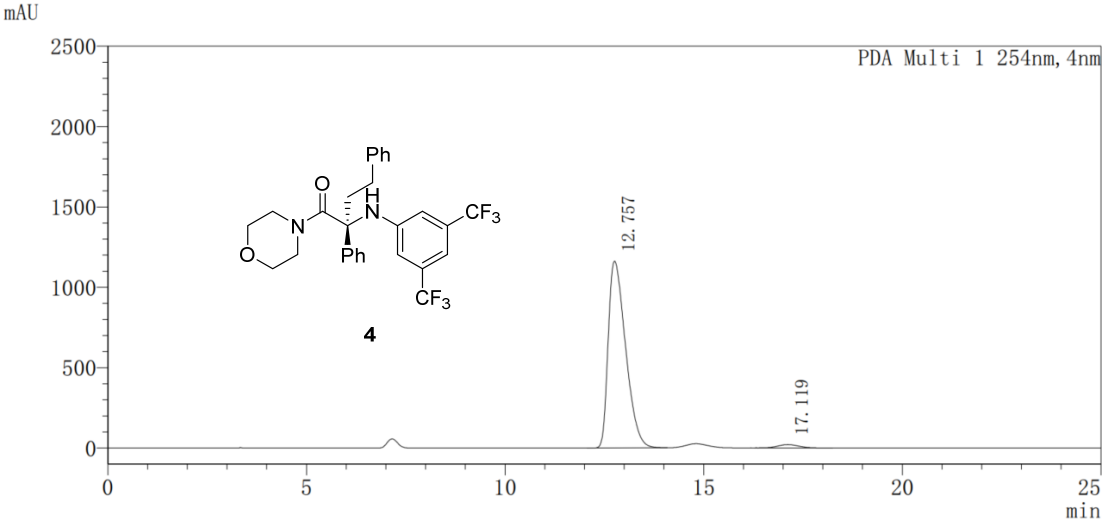
Peak#	Ret. Time	Area	Area%
1	12.395	2339293	16.884
2	13.378	11515513	83.116



Peak Table

PDA Ch1 254nm

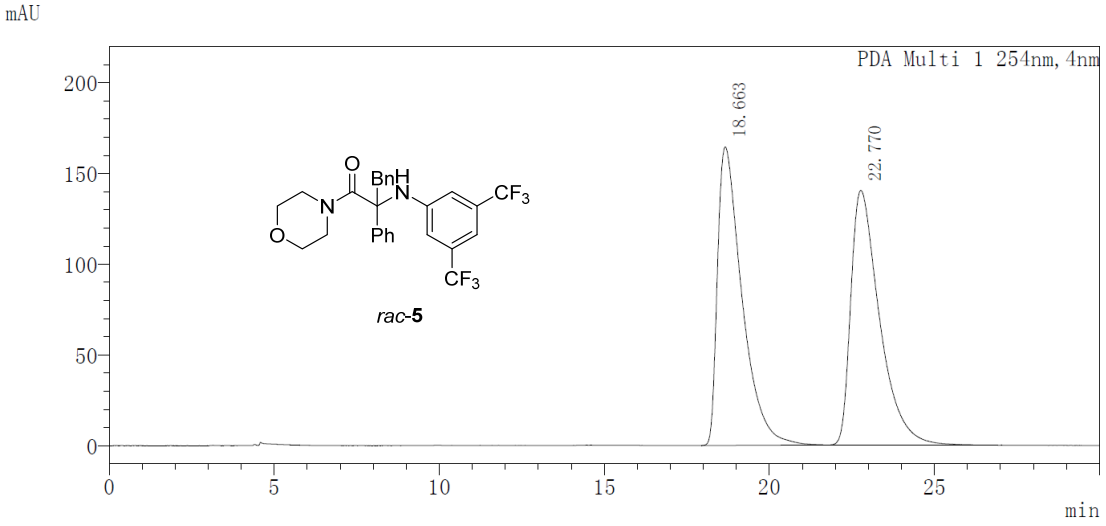
Peak#	Ret. Time	Area	Area%
1	12.879	4676537	51.825
2	16.995	4347134	48.175



Peak Table

PDA Ch1 254nm

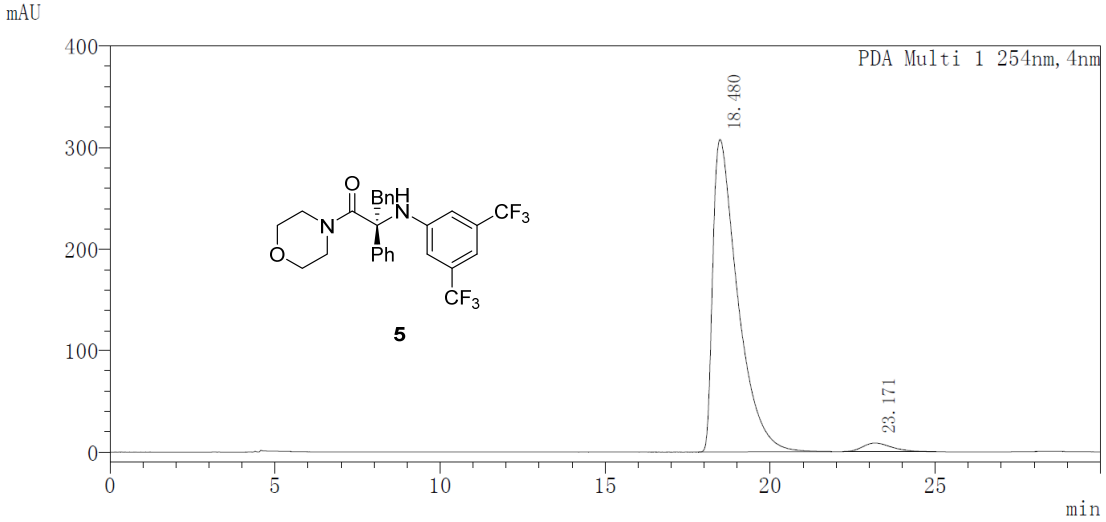
Peak#	Ret. Time	Area	Area%
1	12.757	35030685	97.887
2	17.119	756323	2.113



Peak Table

PDA Ch1 254nm

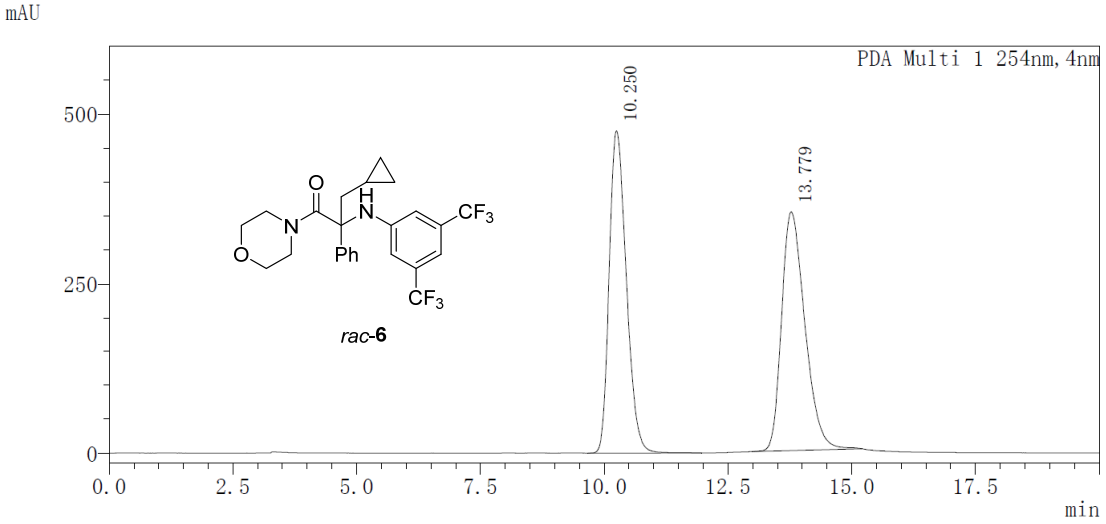
Peak#	Ret. Time	Area	Area%
1	18.663	8493199	50.028
2	22.770	8483577	49.972



Peak Table

PDA Ch1 254nm

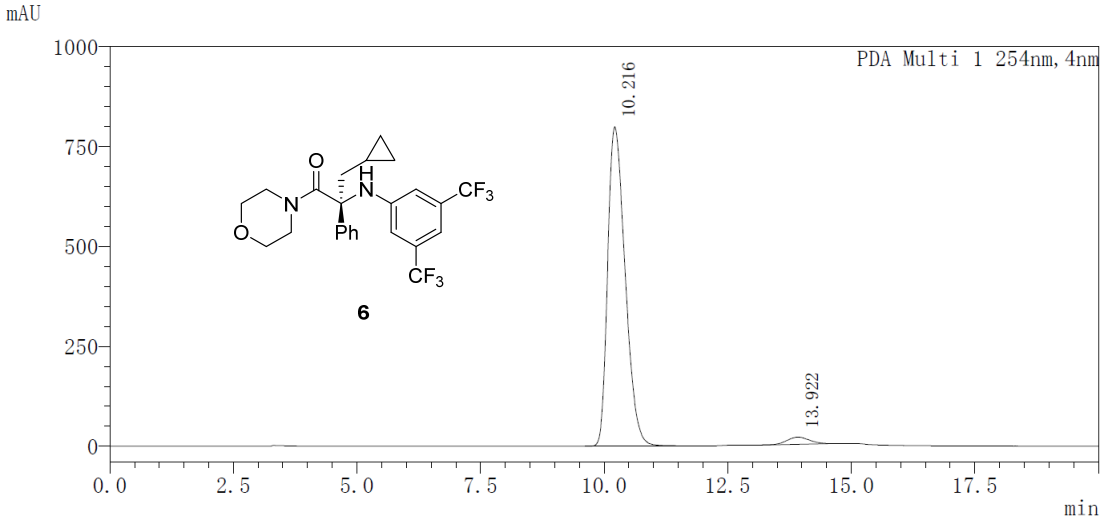
Peak#	Ret. Time	Area	Area%
1	18.480	16198915	96.909
2	23.171	516728	3.091



Peak Table

PDA Ch1 254nm

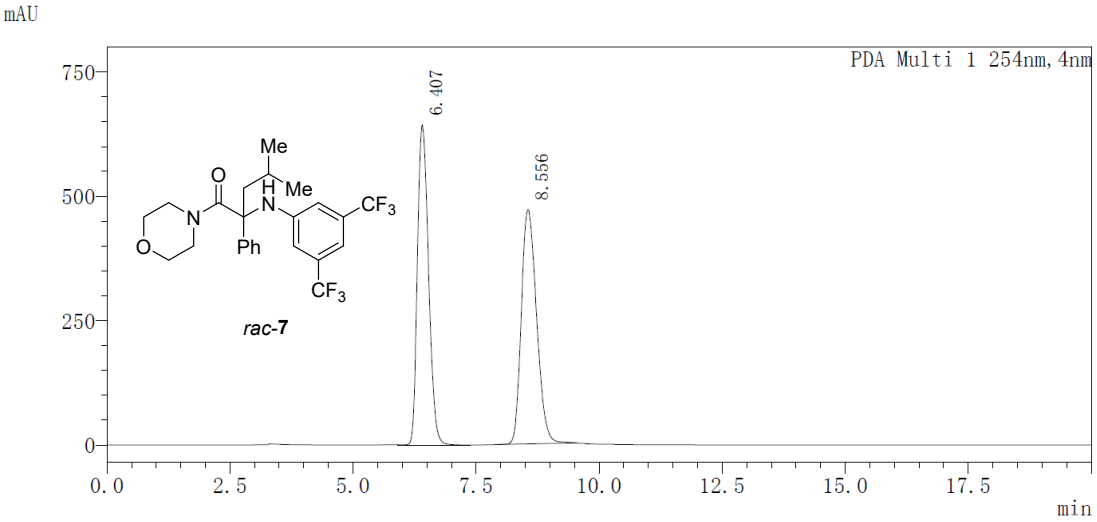
Peak#	Ret. Time	Area	Area%
1	10.250	11464718	49.790
2	13.779	11561382	50.210



Peak Table

PDA Ch1 254nm

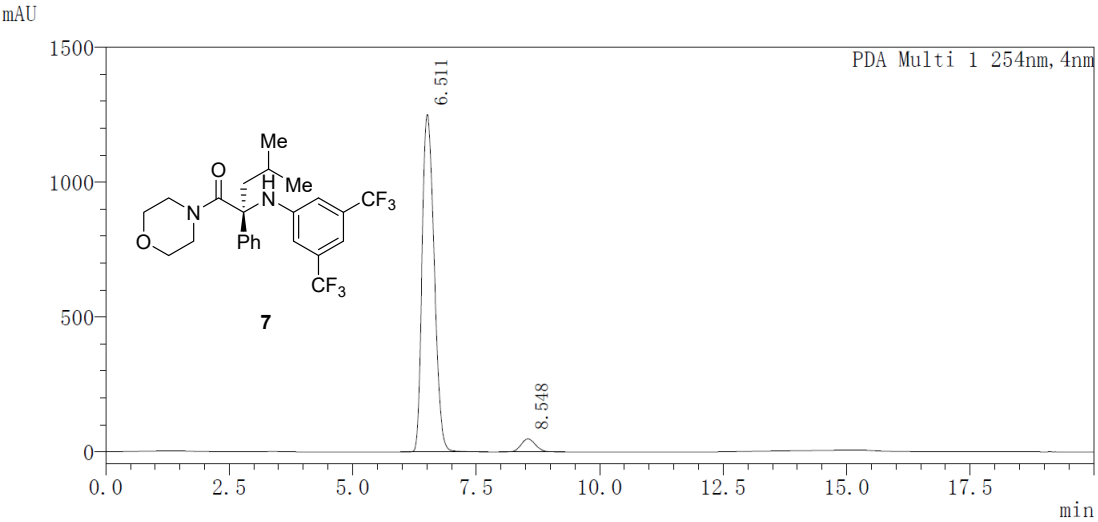
Peak#	Ret. Time	Area	Area%
1	10.216	19670775	97.147
2	13.922	577782	2.853



Peak Table

PDA Ch1 254nm

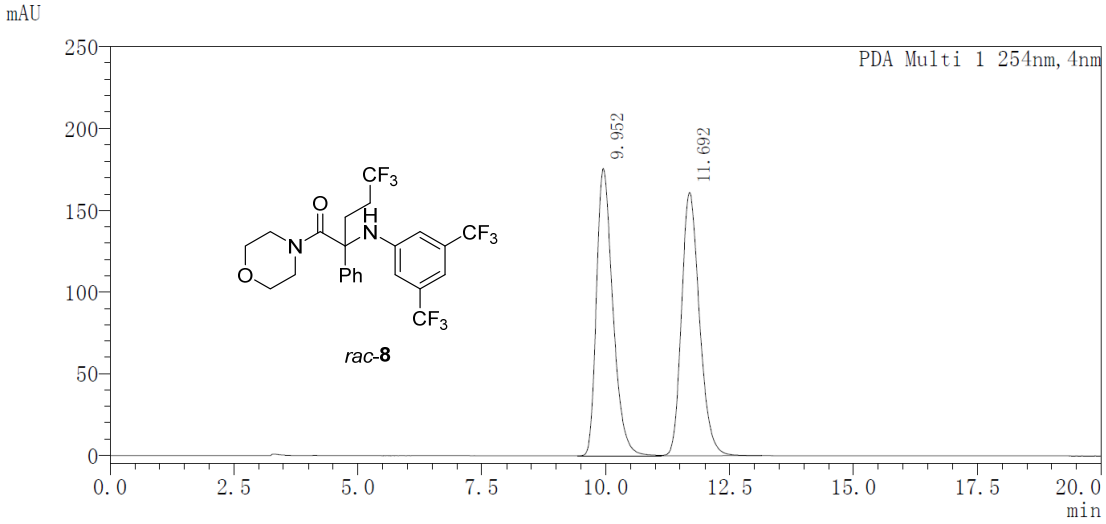
Peak#	Ret. Time	Area	Area%
1	6.407	10143934	49.924
2	8.556	10174849	50.076



Peak Table

PDA Ch1 254nm

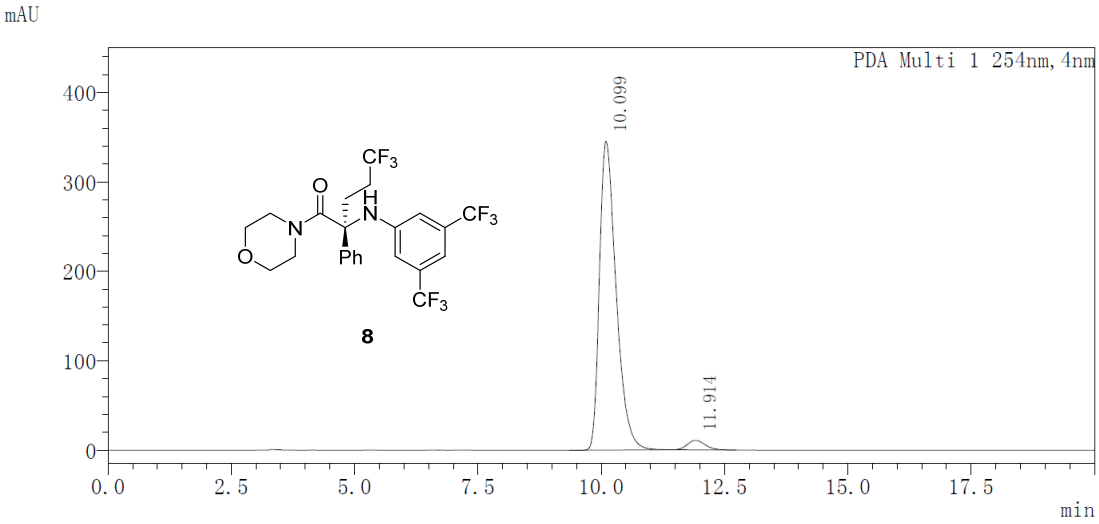
Peak#	Ret. Time	Area	Area%
1	6.511	21315167	95.560
2	8.548	990411	4.440



Peak Table

PDA Ch1 254nm

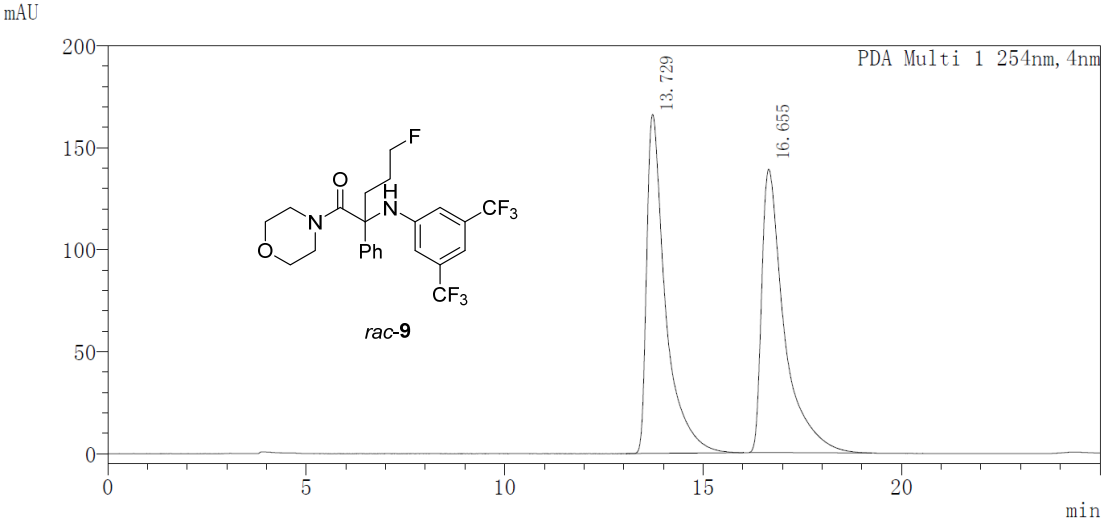
Peak#	Ret. Time	Area	Area%
1	9.952	4048646	49.926
2	11.692	4060634	50.074



Peak Table

PDA Ch1 254nm

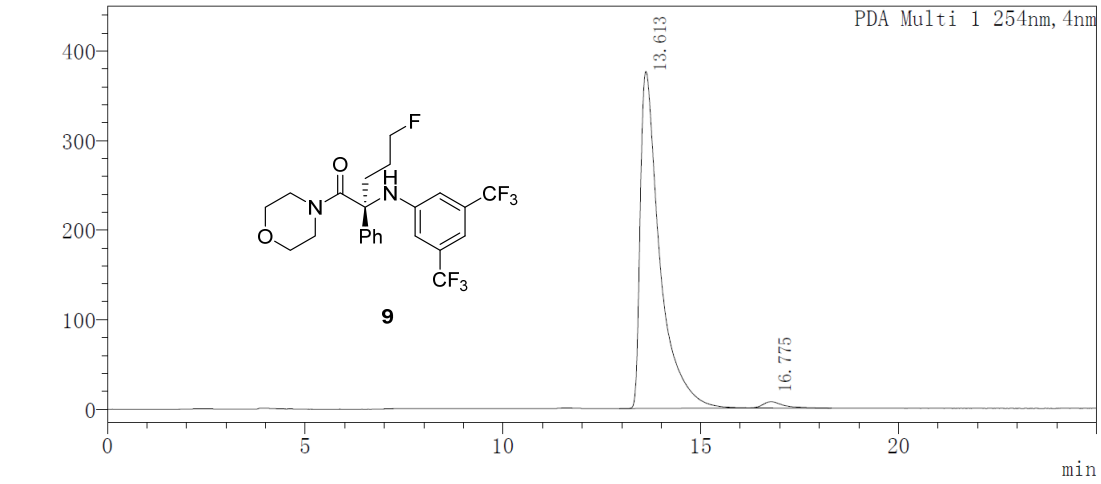
Peak#	Ret. Time	Area	Area%
1	10.099	8105783	96.805
2	11.914	267510	3.195



Peak Table

PDA Ch1 254nm

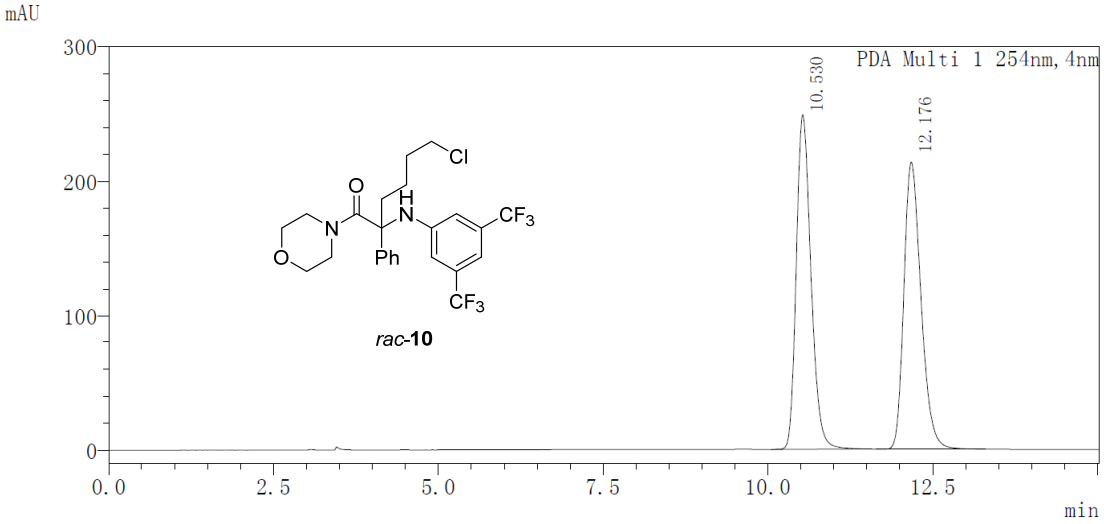
Peak#	Ret. Time	Area	Area%
1	13.729	5478731	49.913
2	16.655	5497730	50.087



Peak Table

PDA Ch1 254nm

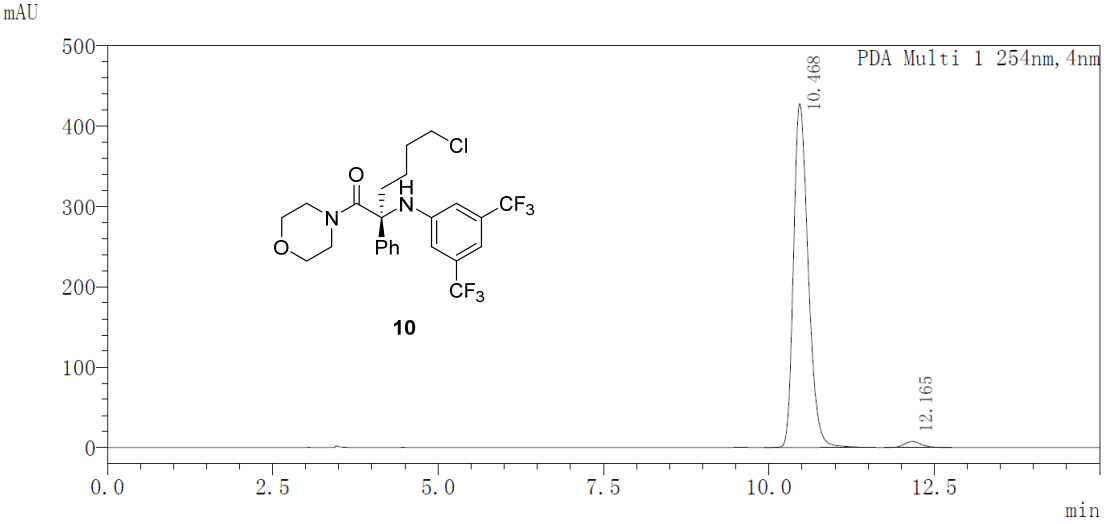
Peak#	Ret. Time	Area	Area%
1	13.613	12907360	98.084
2	16.775	252106	1.916



Peak Table

PDA Ch1 254nm

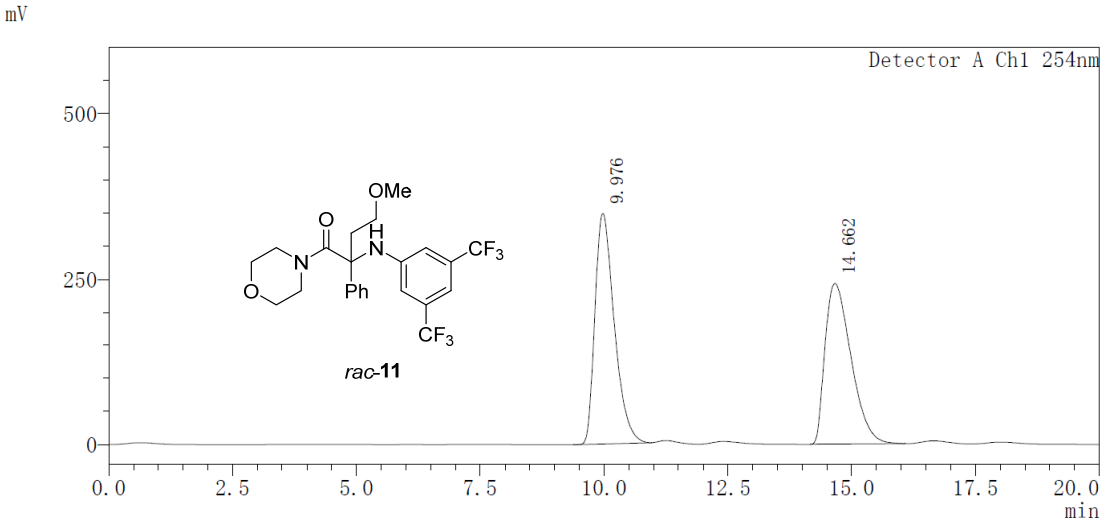
Peak#	Ret. Time	Area	Area%
1	10.530	3857316	49.999
2	12.176	3857437	50.001



Peak Table

PDA Ch1 254nm

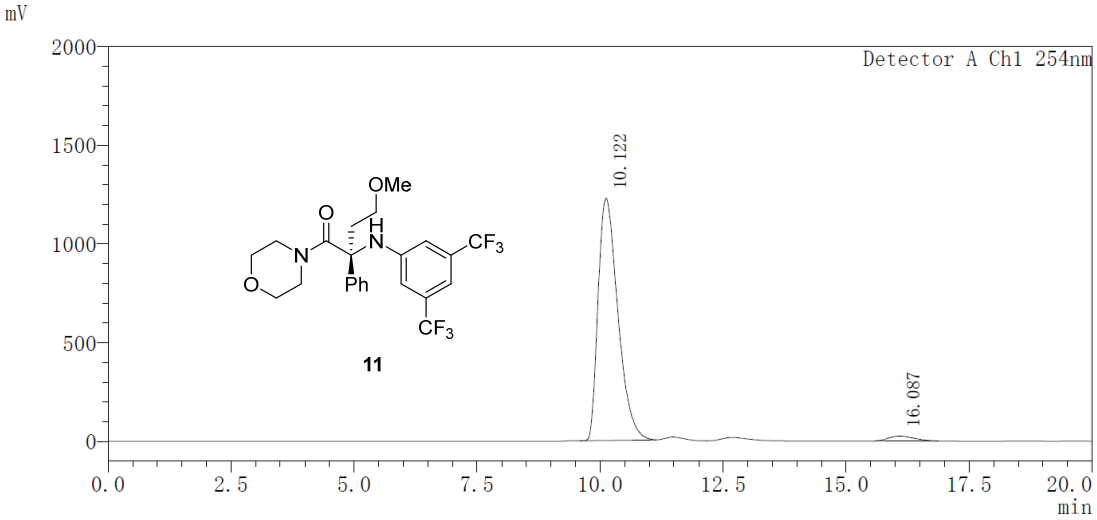
Peak#	Ret. Time	Area	Area%
1	10.468	6594309	98.025
2	12.165	132837	1.975



Peak Table

Detector A Ch1 254nm

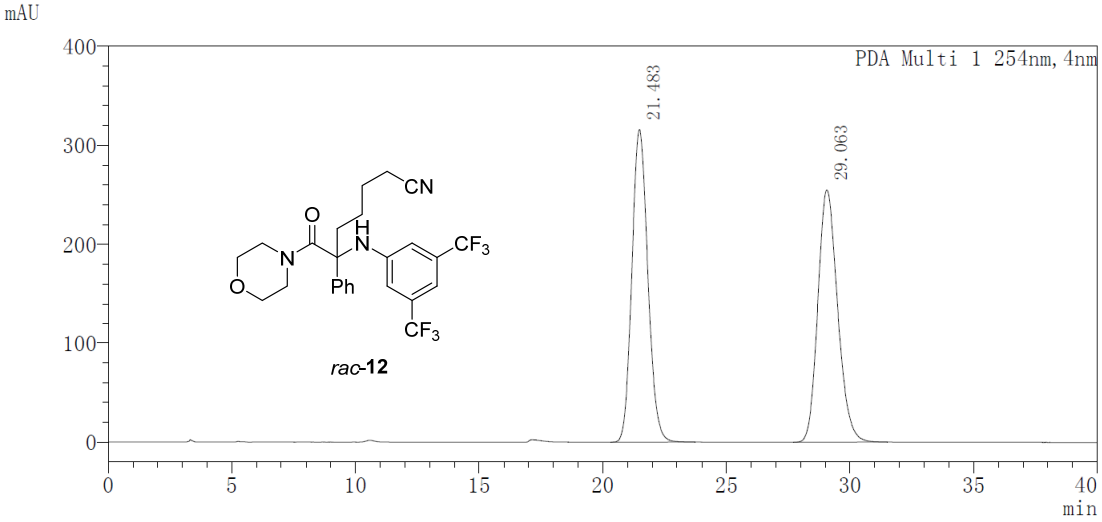
Peak#	Ret. Time	Area	Area%
1	9.976	9464796	51.601
2	14.662	8877439	48.399



Peak Table

Detector A Ch1 254nm

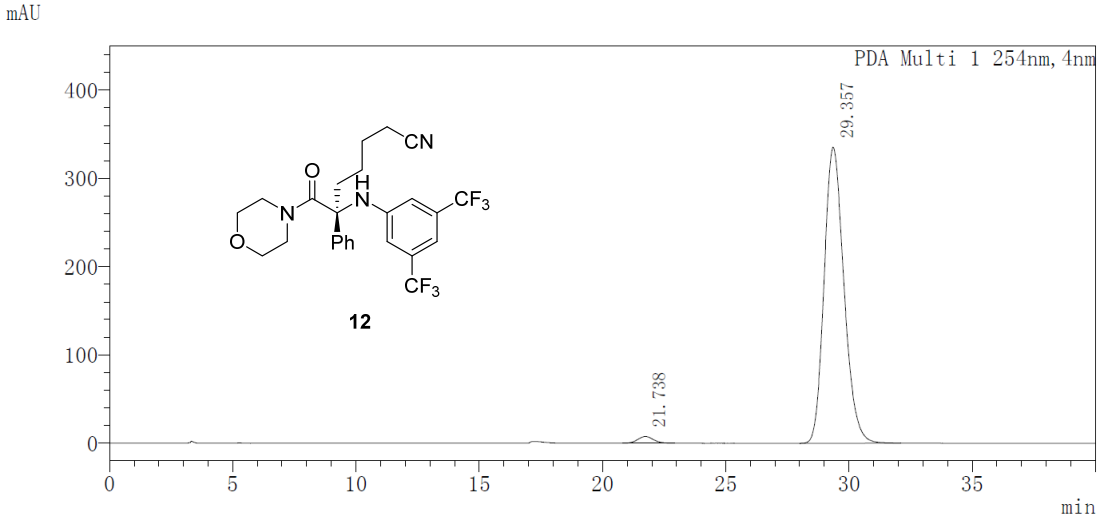
Peak#	Ret. Time	Area	Area%
1	10.122	34285364	97.522
2	16.087	871070	2.478



Peak Table

PDA Ch1 254nm

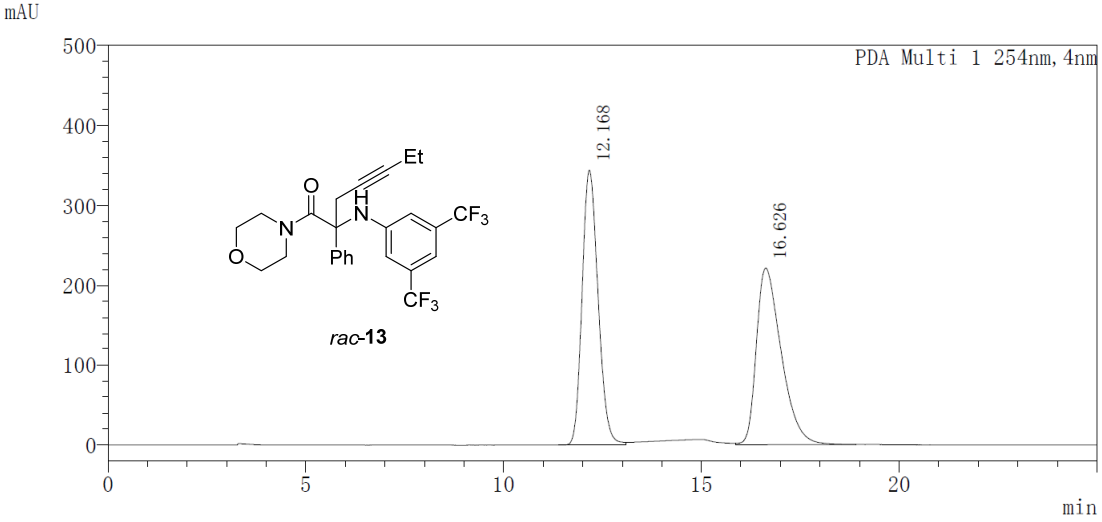
Peak#	Ret. Time	Area	Area%
1	21.483	14213513	50.050
2	29.063	14185330	49.950



Peak Table

PDA Ch1 254nm

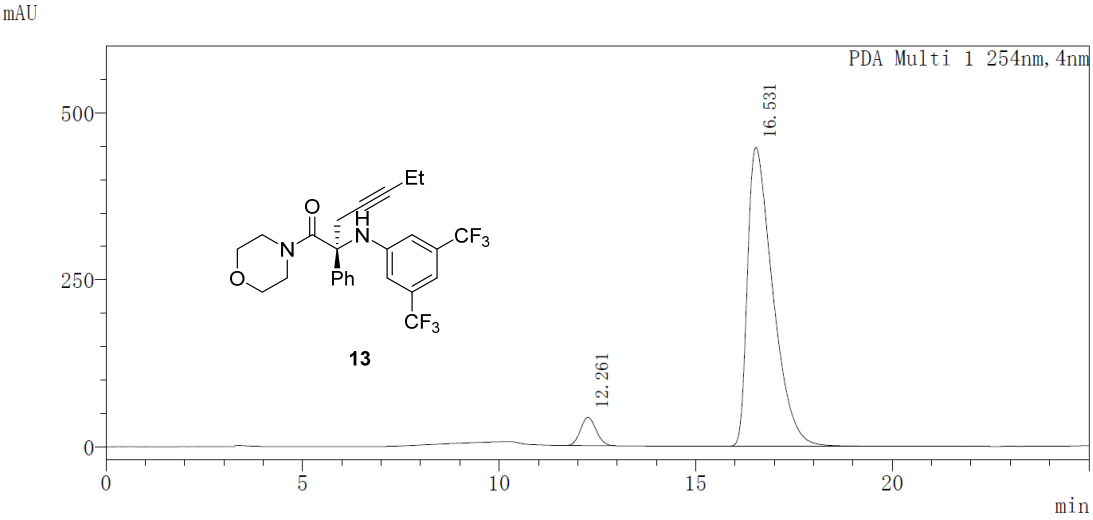
Peak#	Ret. Time	Area	Area%
1	21.738	336875	1.758
2	29.357	18826665	98.242



Peak Table

PDA Ch1 254nm

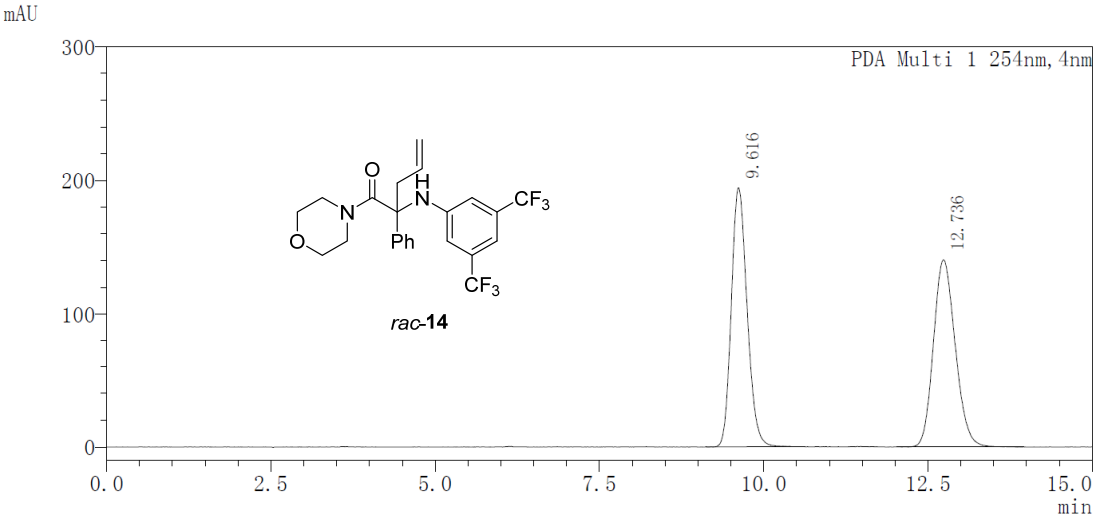
Peak#	Ret. Time	Area	Area%
1	12.168	9674697	49.989
2	16.626	9678875	50.011



Peak Table

PDA Ch1 254nm

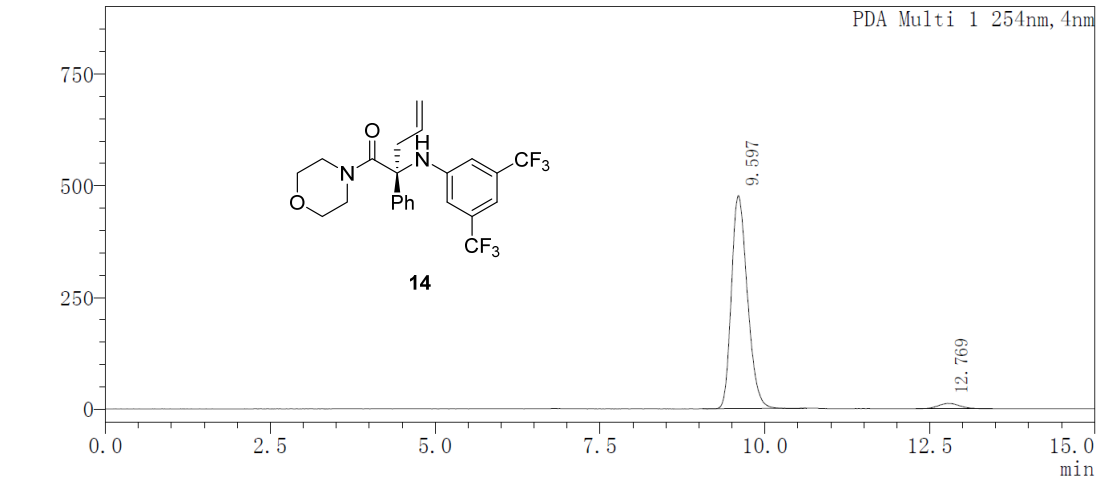
Peak#	Ret. Time	Area	Area%
1	12.261	1172923	5.527
2	16.531	20049411	94.473



Peak Table

PDA Ch1 254nm

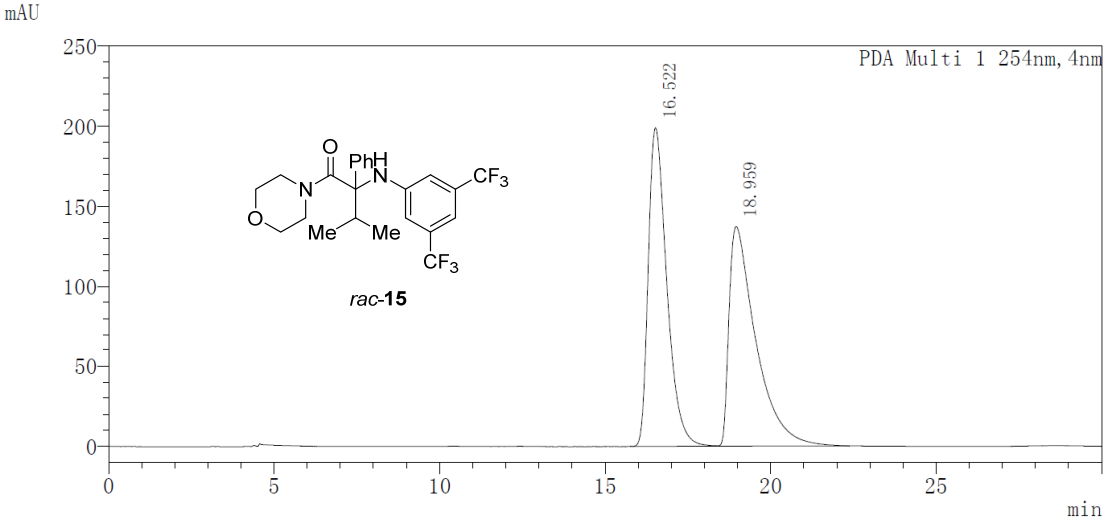
Peak#	Ret. Time	Area	Area%
1	9.616	3228188	50.111
2	12.736	3213837	49.889



Peak Table

PDA Ch1 254nm

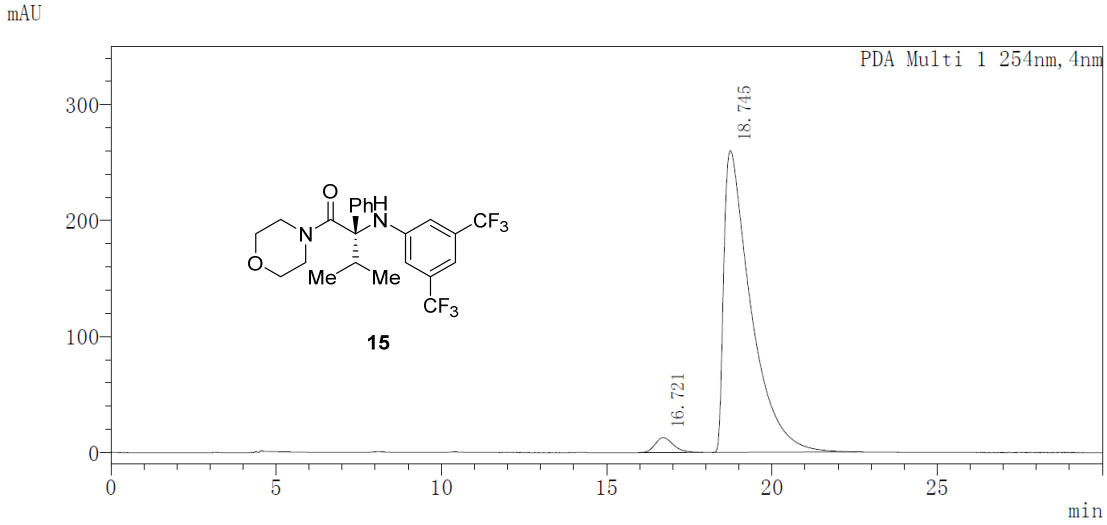
Peak#	Ret. Time	Area	Area%
1	9.597	8007732	96.682
2	12.769	274838	3.318



Peak Table

PDA Ch1 254nm

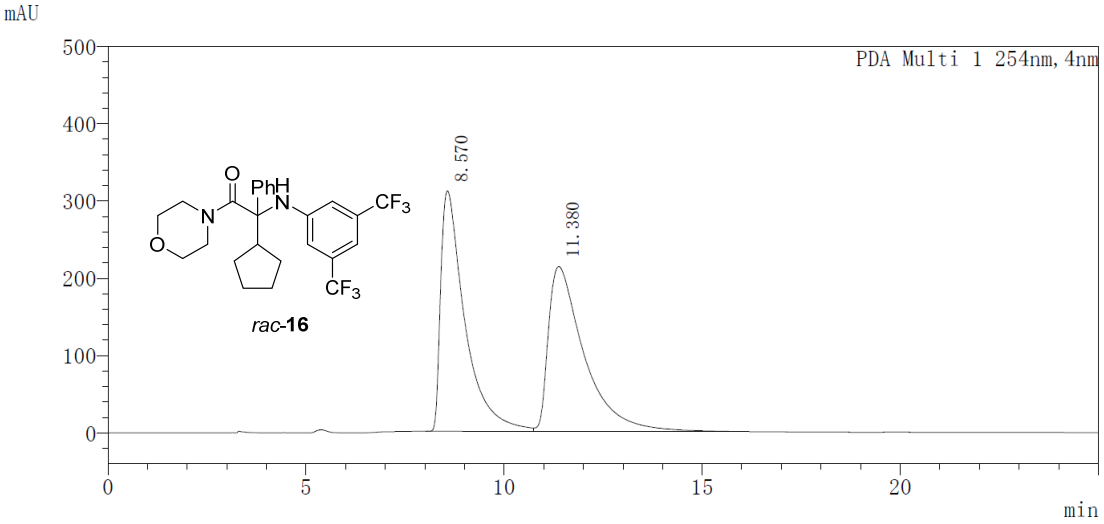
Peak#	Ret. Time	Area	Area%
1	16.522	7743454	50.110
2	18.959	7709434	49.890



Peak Table

PDA Ch1 254nm

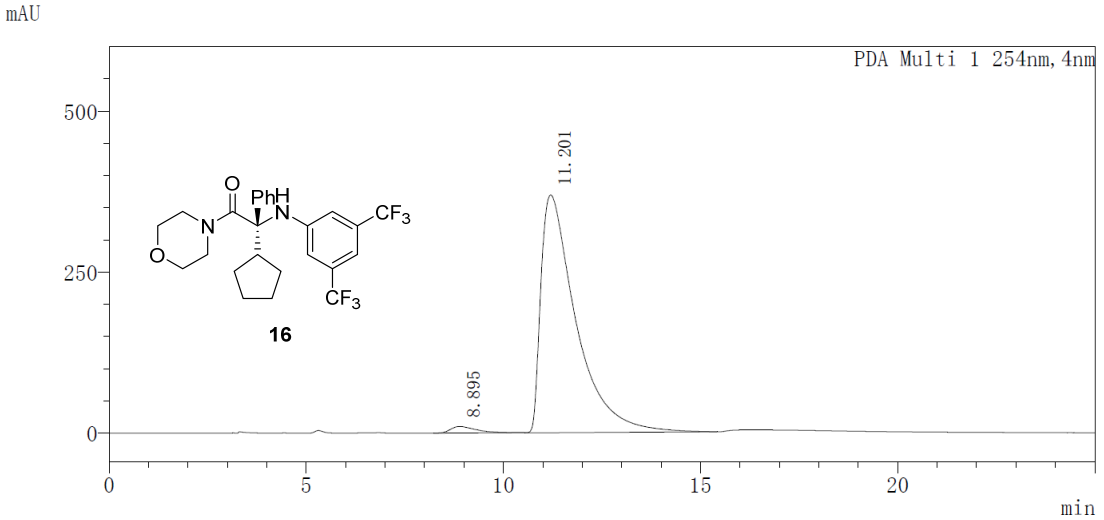
Peak#	Ret. Time	Area	Area%
1	16.721	495001	3.226
2	18.745	14847916	96.774



Peak Table

PDA Ch1 254nm

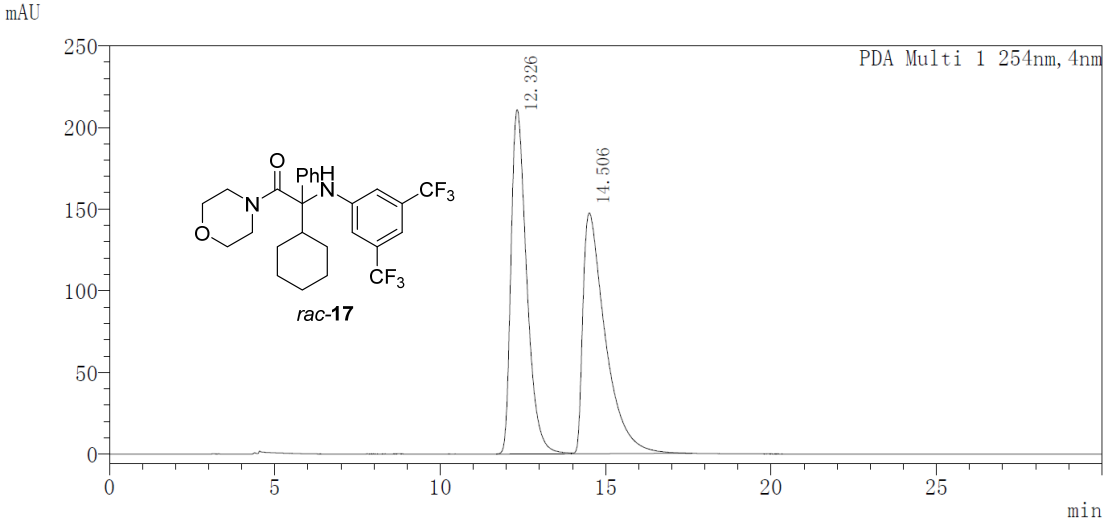
Peak#	Ret. Time	Area	Area%
1	8.570	13205326	49.520
2	11.380	13461129	50.480



Peak Table

PDA Ch1 254nm

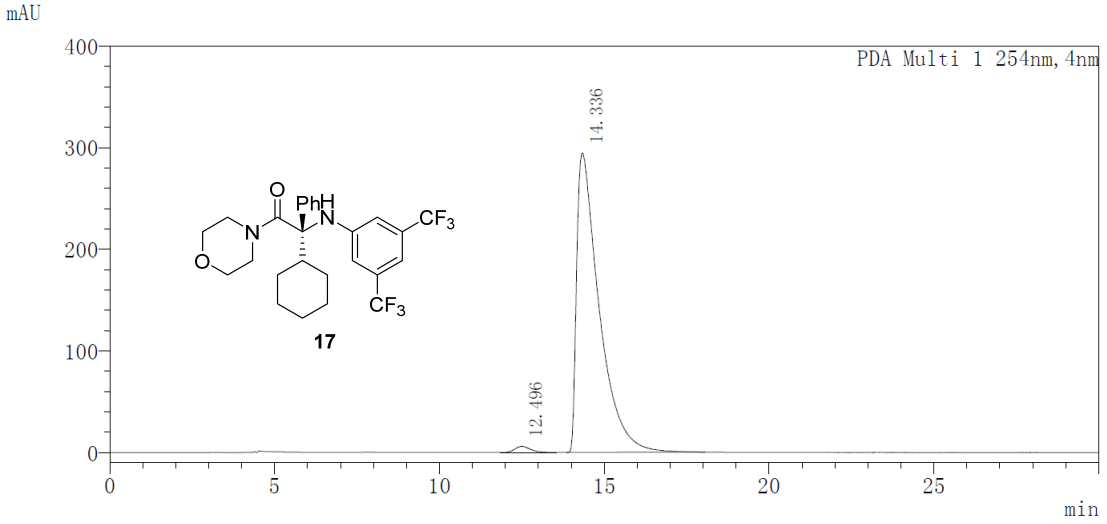
Peak#	Ret. Time	Area	Area%
1	8.895	461470	1.981
2	11.201	22838901	98.019



Peak Table

PDA Ch1 254nm

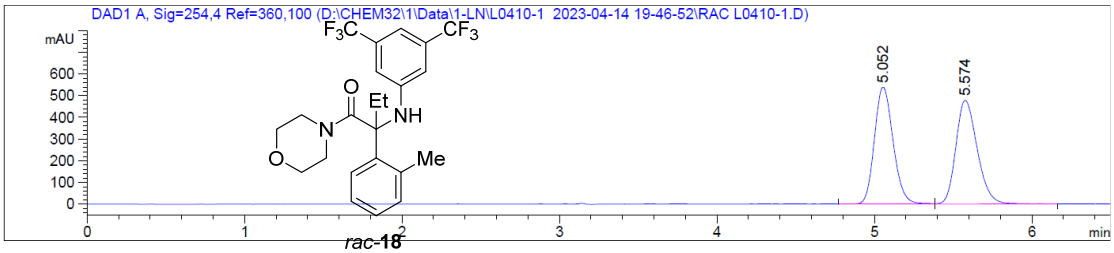
Peak#	Ret. Time	Area	Area%
1	12.326	6970413	50.052
2	14.506	6955913	49.948



Peak Table

PDA Ch1 254nm

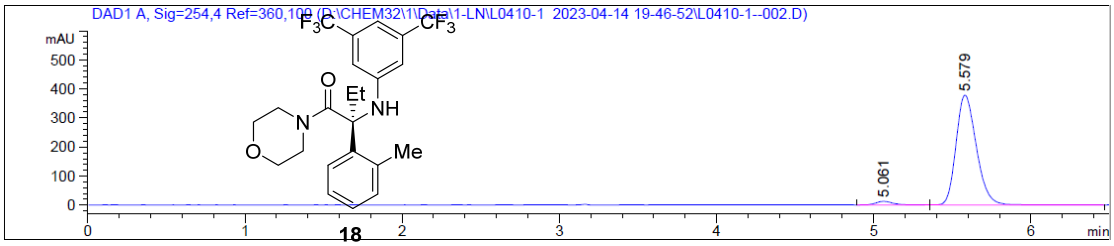
Peak#	Ret. Time	Area	Area%
1	12.496	200006	1.408
2	14.336	14007499	98.592



rac-**18**

Signal 1: DAD1 A, Sig=254,4 Ref=360,100

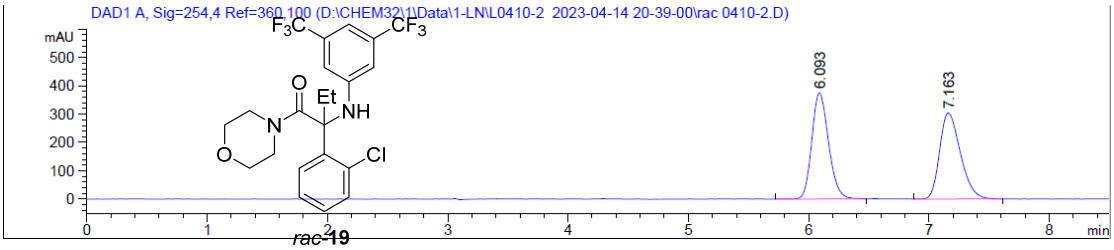
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.052	BV	0.1282	4452.68262	539.76074	49.6947
2	5.574	VV R	0.1458	4507.38721	478.70944	50.3053
Totals :				8960.06982	1018.47018	



18

Signal 1: DAD1 A, Sig=254,4 Ref=360,100

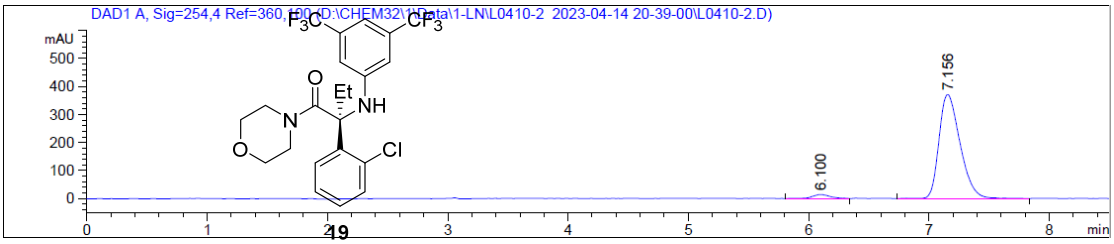
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.061	BB	0.1203	100.08549	12.65094	2.8531
2	5.579	BV R	0.1411	3407.86865	378.25522	97.1469
Totals :				3507.95414	390.90616	



rac-**19**

Signal 1: DAD1 A, Sig=254,4 Ref=360,100

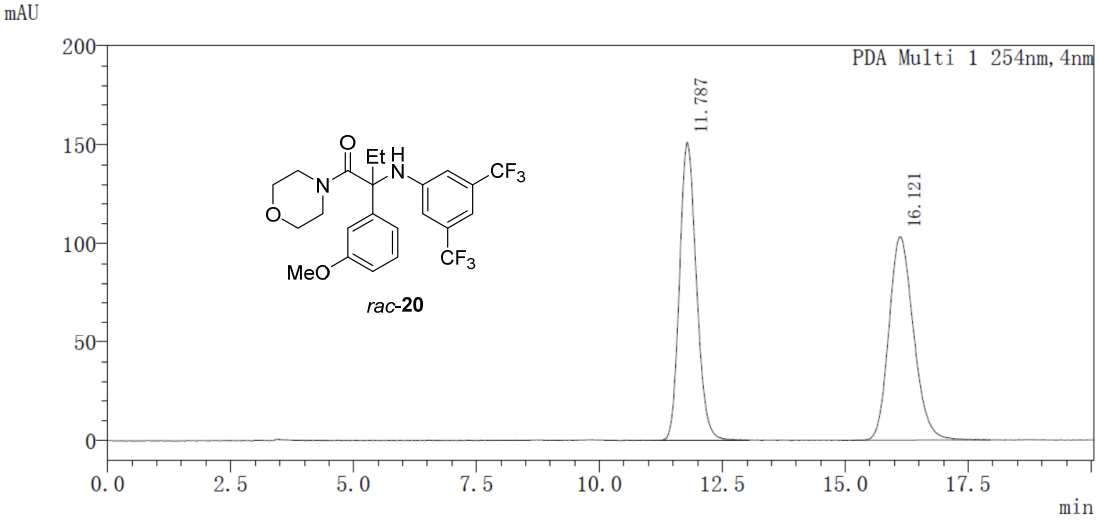
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.093	VV R	0.1509	3636.41284	375.78473	49.9678
2	7.163	BB	0.1816	3641.10156	304.37360	50.0322
Totals :				7277.51440	680.15833	



19

Signal 1: DAD1 A, Sig=254,4 Ref=360,100

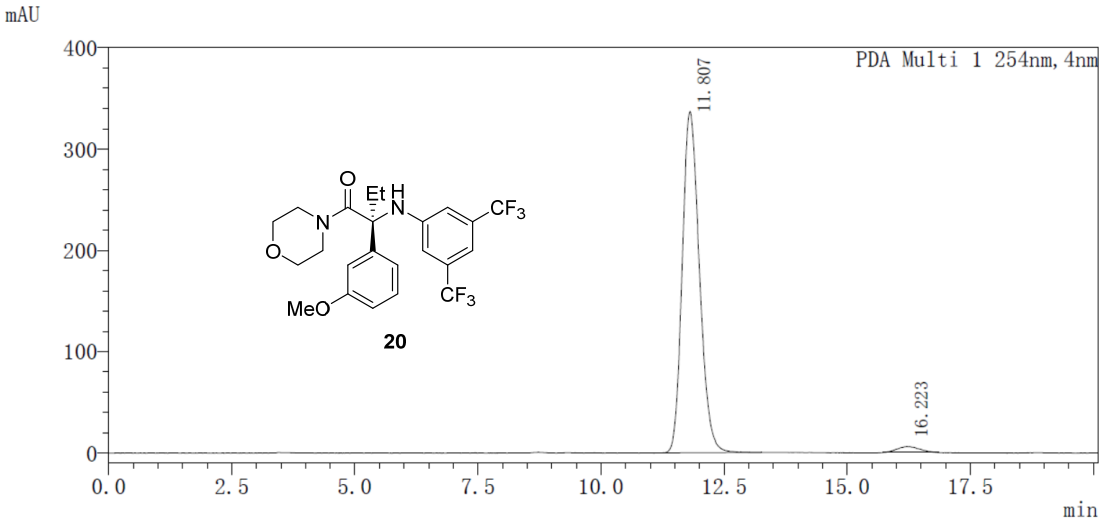
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.100	BV R	0.1475	145.91388	14.48500	3.1272
2	7.156	VV R	0.1876	4519.97510	371.99811	96.8728
Totals :				4665.88898	386.48311	



Peak Table

PDA Ch1 254nm

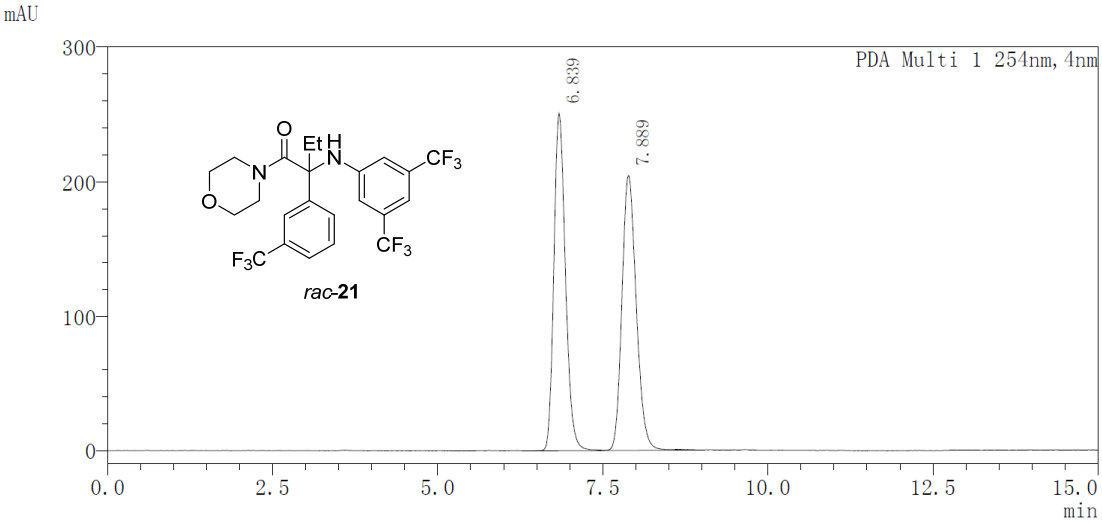
Peak#	Ret. Time	Area	Area%
1	11.787	3600654	49.995
2	16.121	3601319	50.005



Peak Table

PDA Ch1 254nm

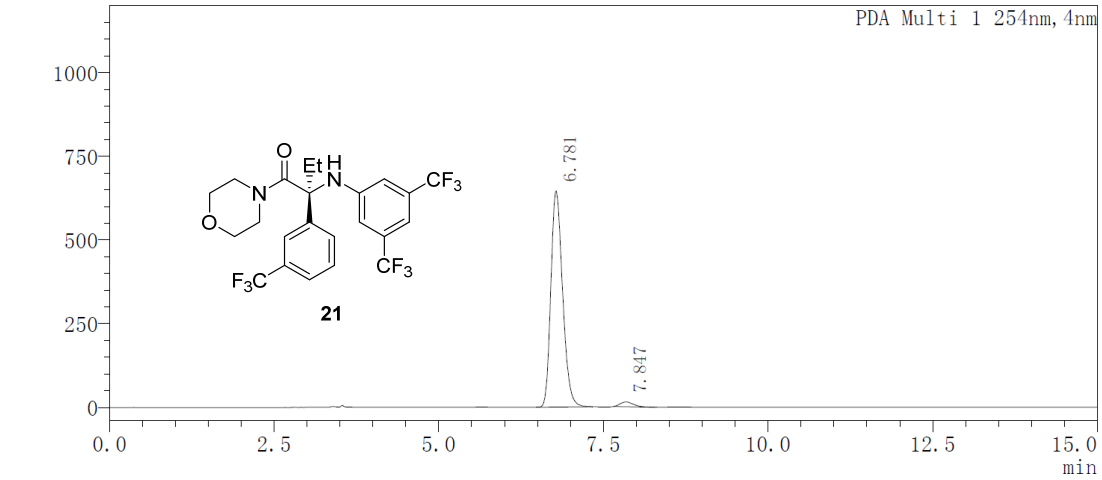
Peak#	Ret. Time	Area	Area%
1	11.807	8170260	97.783
2	16.223	185280	2.217



Peak Table

PDA Ch1 254nm

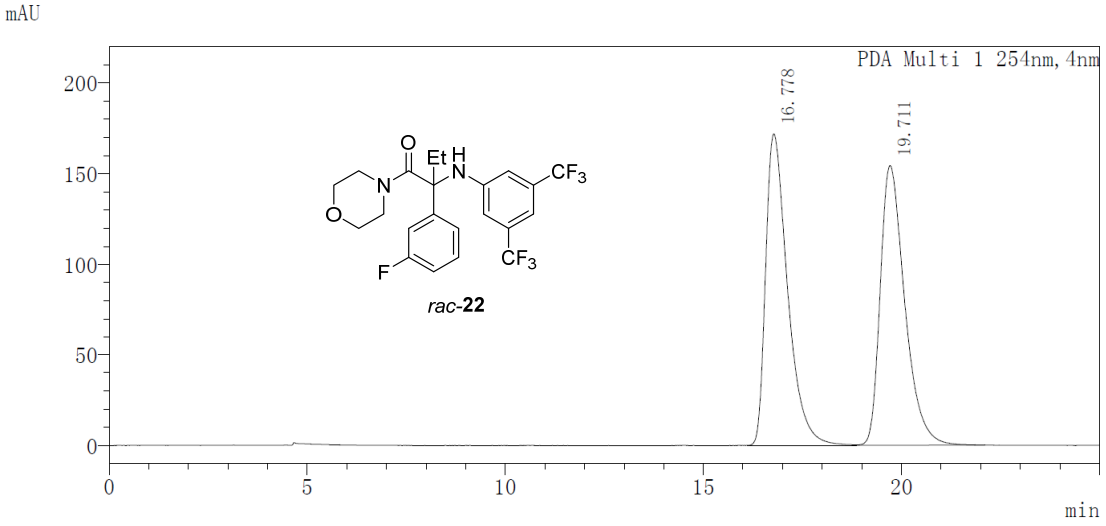
Peak#	Ret. Time	Area	Area%
1	6.839	3044656	49.786
2	7.889	3070876	50.214



Peak Table

PDA Ch1 254nm

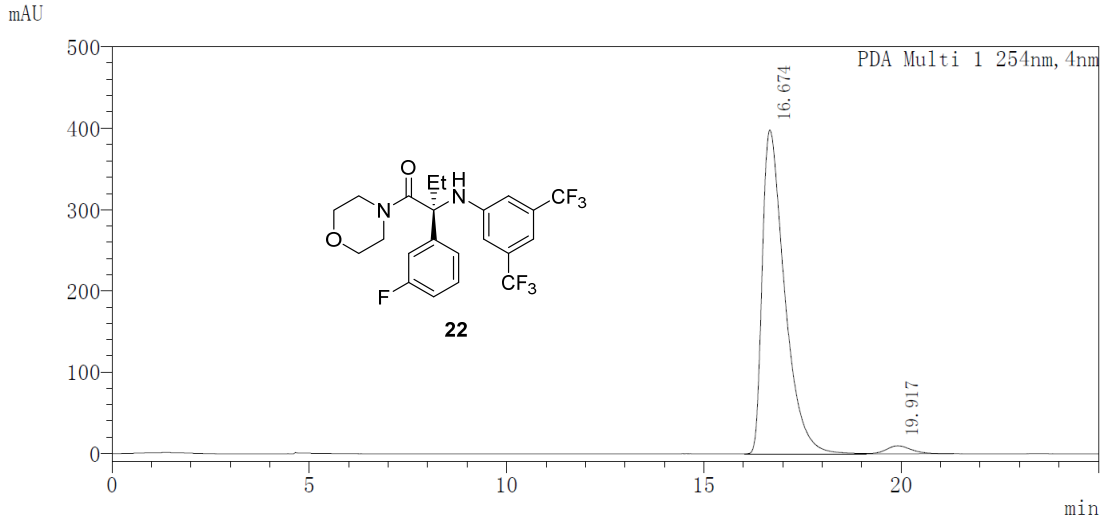
Peak#	Ret. Time	Area	Area%
1	6.781	7944768	97.680
2	7.847	188706	2.320



Peak Table

PDA Ch1 254nm

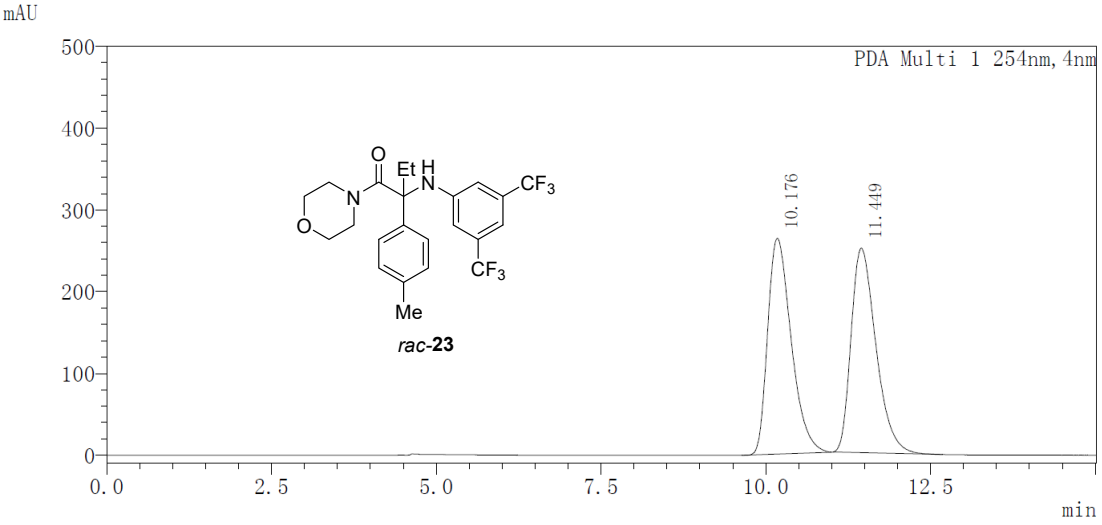
Peak#	Ret. Time	Area	Area%
1	16.778	6627952	49.948
2	19.711	6641669	50.052



Peak Table

PDA Ch1 254nm

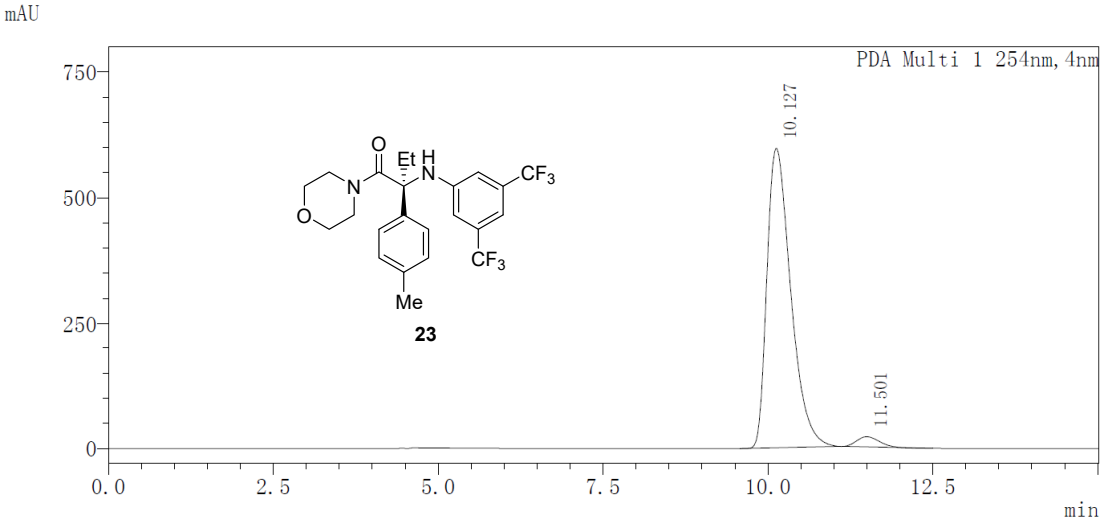
Peak#	Ret. Time	Area	Area%
1	16.674	15687285	97.323
2	19.917	431520	2.677



Peak Table

PDA Ch1 254nm

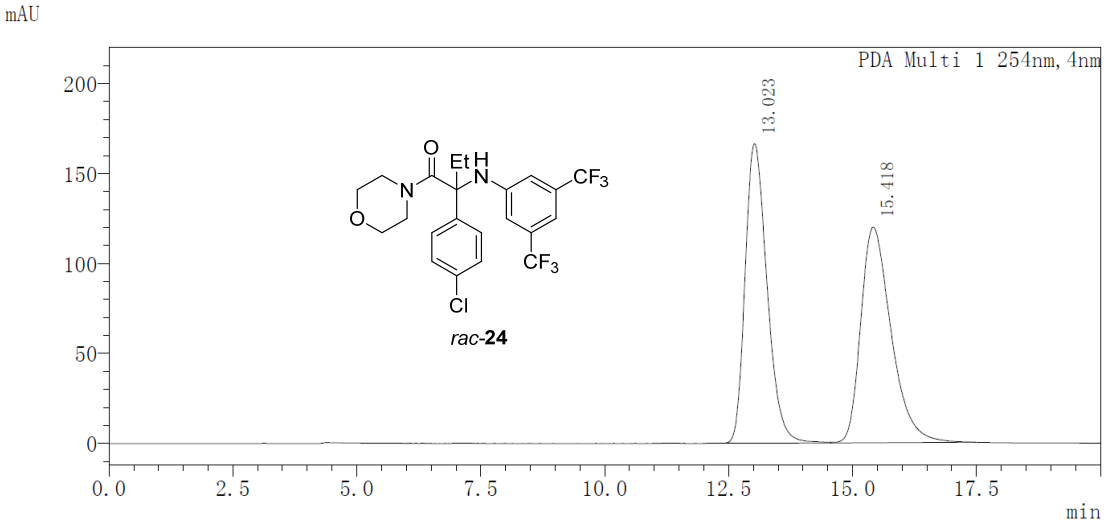
Peak#	Ret. Time	Area	Area%
1	10.176	6548523	49.956
2	11.449	6560090	50.044



Peak Table

PDA Ch1 254nm

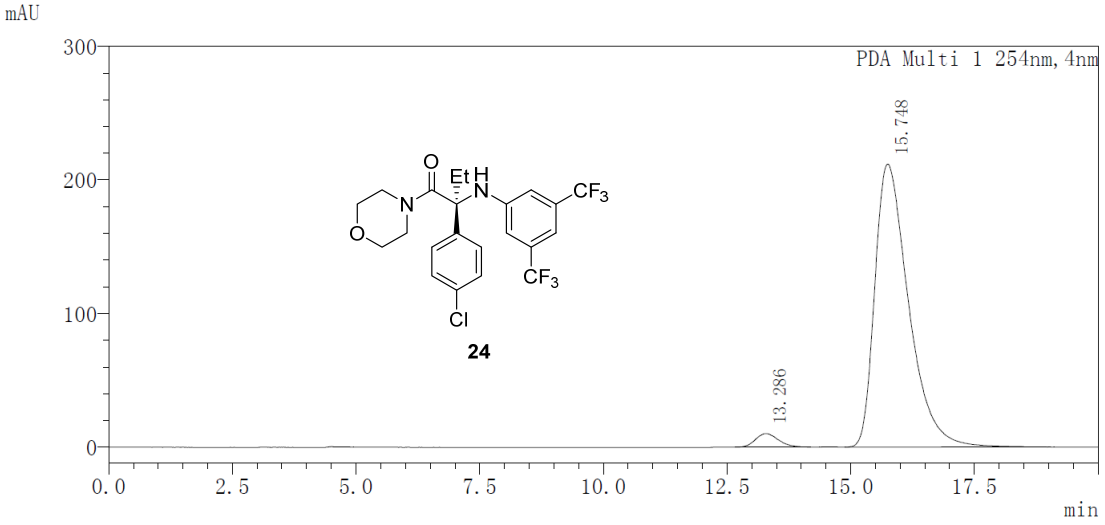
Peak#	Ret. Time	Area	Area%
1	10.127	15025437	96.906
2	11.501	479803	3.094



Peak Table

PDA Ch1 254nm

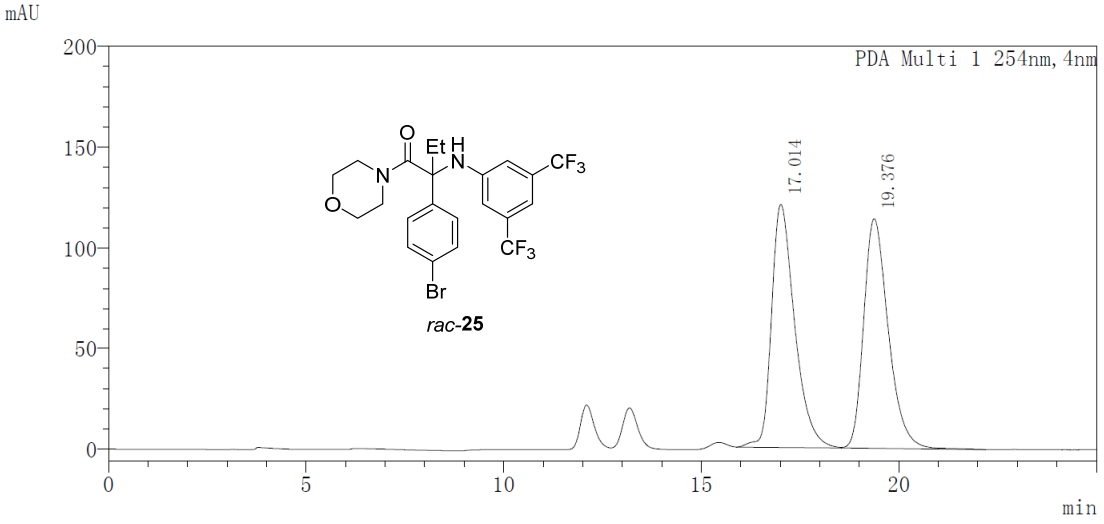
Peak#	Ret. Time	Area	Area%
1	13.023	5130529	50.116
2	15.418	5106760	49.884



Peak Table

PDA Ch1 254nm

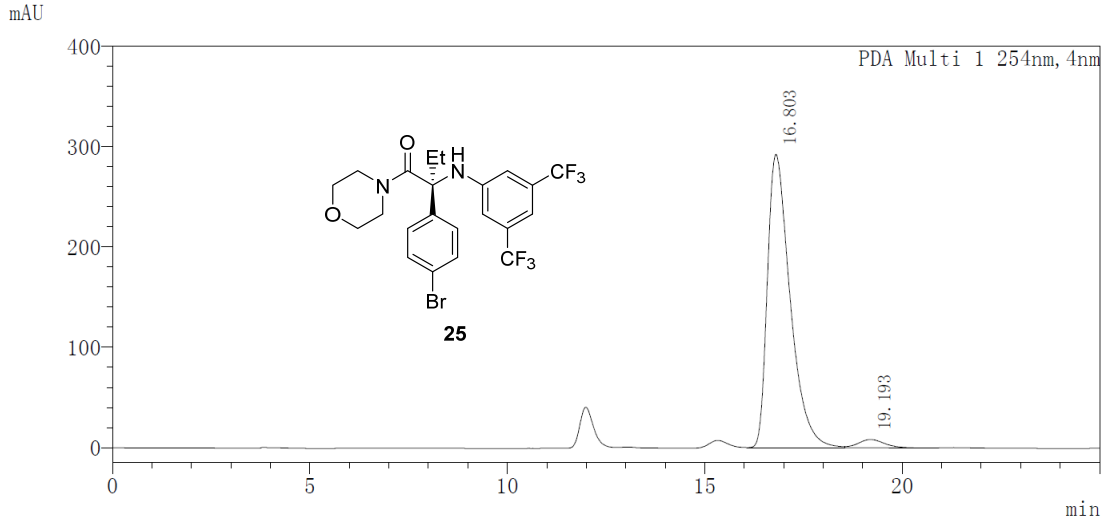
Peak#	Ret. Time	Area	Area%
1	13.286	327969	3.160
2	15.748	10050656	96.840



Peak Table

PDA Ch1 254nm

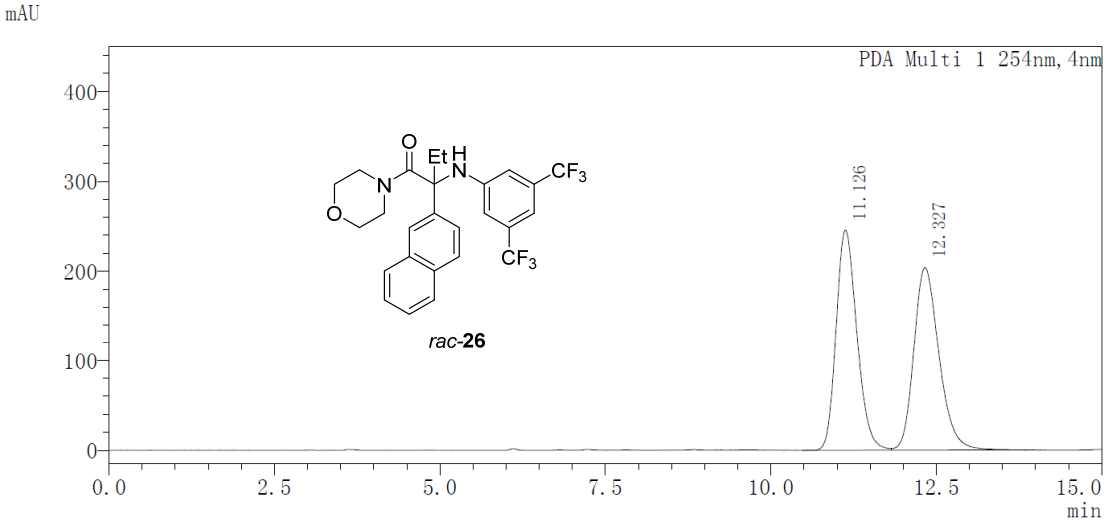
Peak#	Ret. Time	Area	Area%
1	17.014	4930785	49.841
2	19.376	4962197	50.159



Peak Table

PDA Ch1 254nm

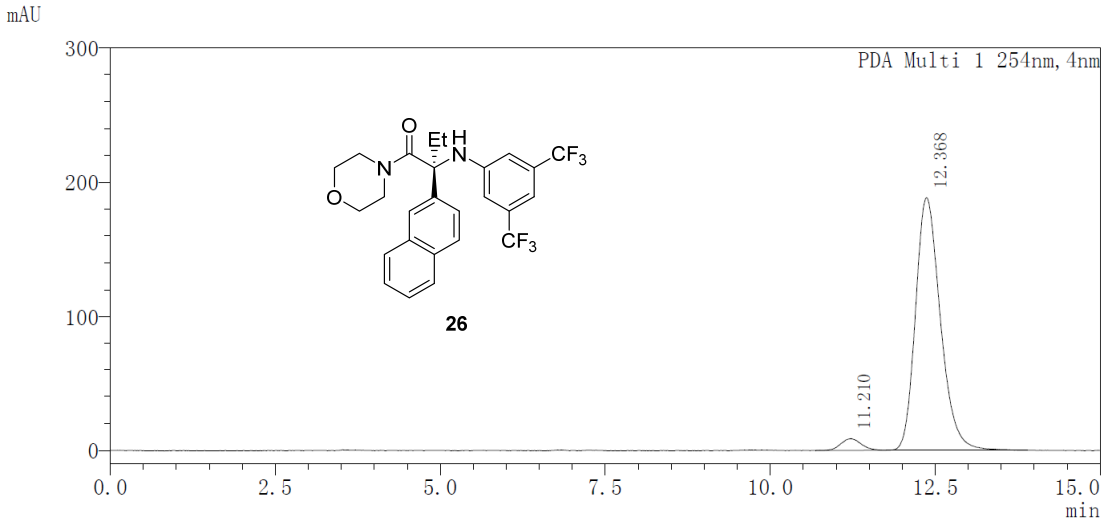
Peak#	Ret. Time	Area	Area%
1	16.803	11708387	96.792
2	19.193	388069	3.208



Peak Table

PDA Ch1 254nm

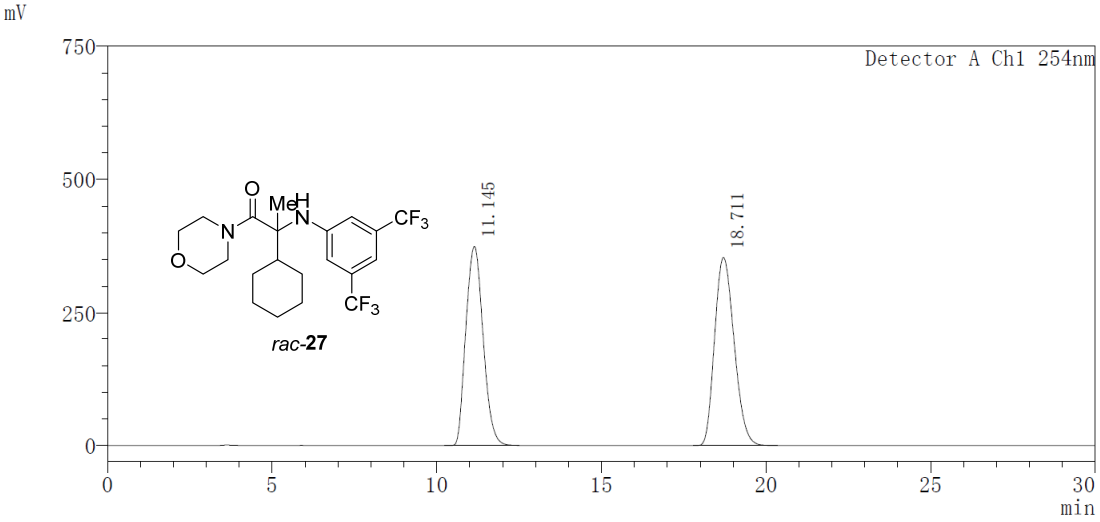
Peak#	Ret. Time	Area	Area%
1	11.126	5342231	49.852
2	12.327	5373959	50.148



Peak Table

PDA Ch1 254nm

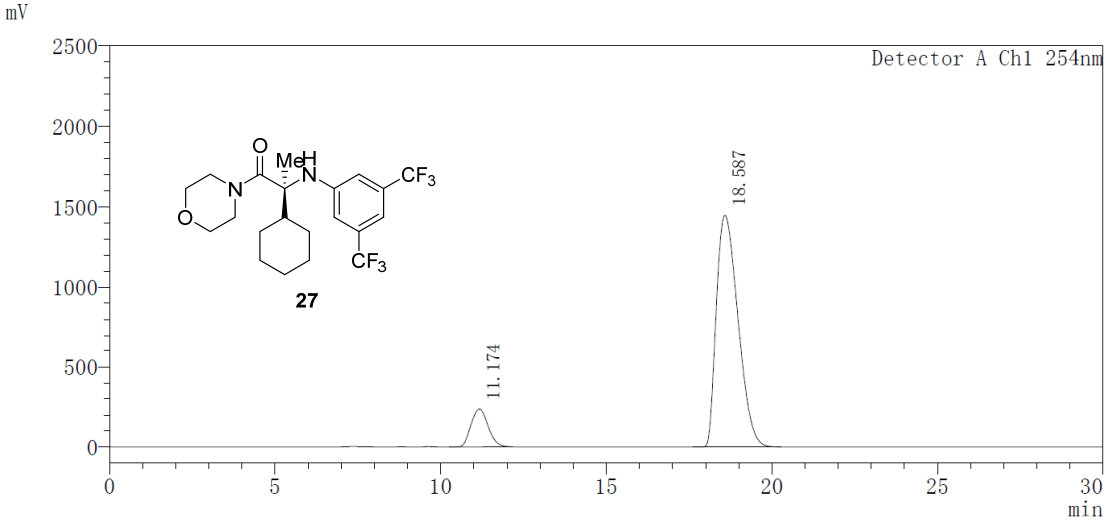
Peak#	Ret. Time	Area	Area%
1	11.210	185108	3.631
2	12.368	4912808	96.369



Peak Table

Detector A Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	11.145	13655774	48.280
2	18.711	14628540	51.720

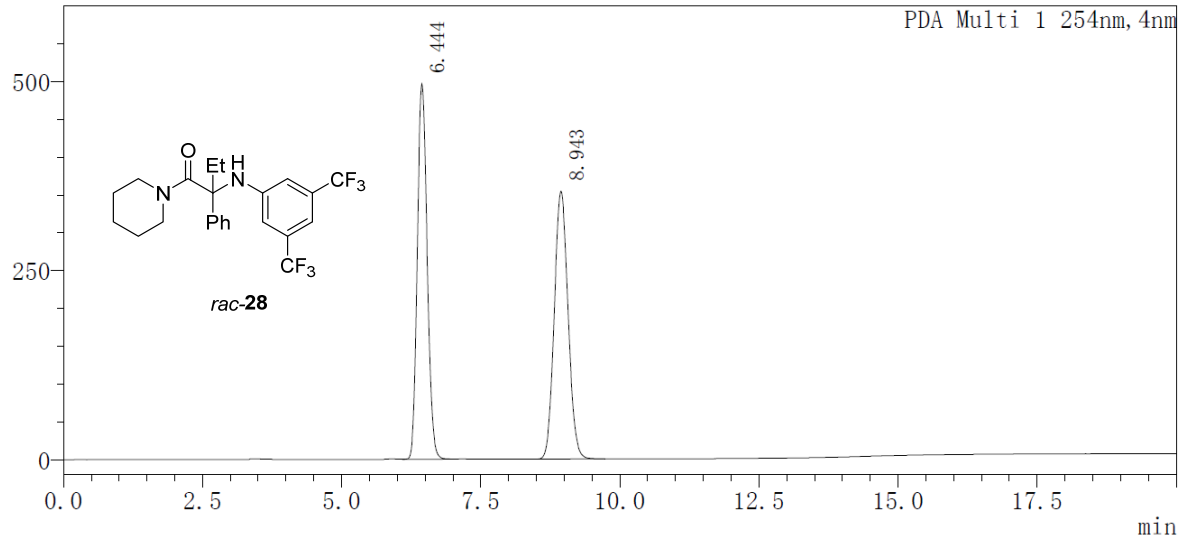


Peak Table

Detector A Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	11.174	8483914	11.407
2	18.587	65892596	88.593

mAU

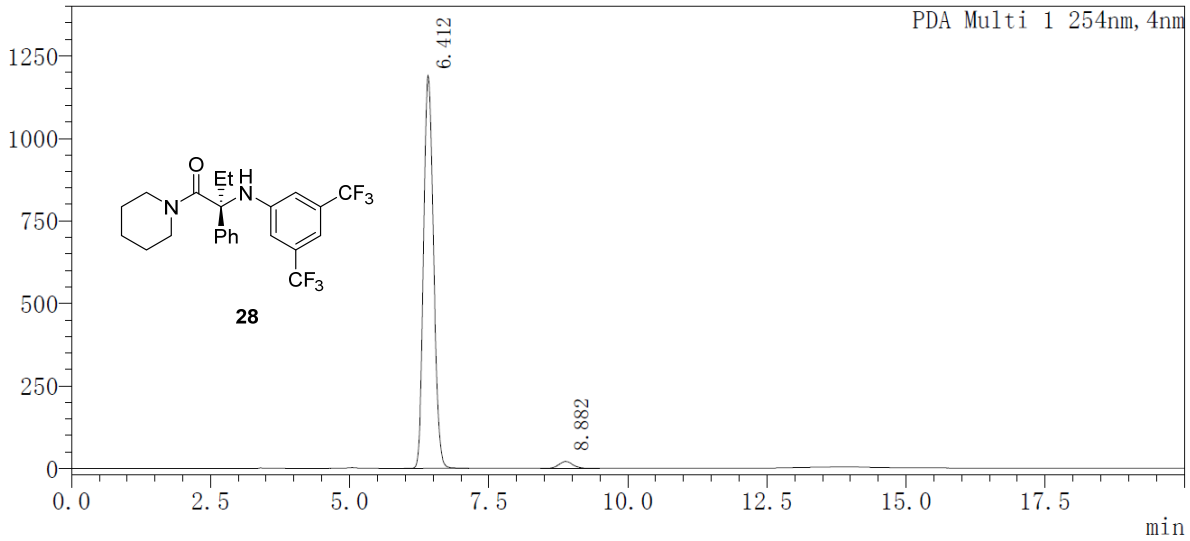


Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	6.444	6125469	50.035
2	8.943	6116790	49.965

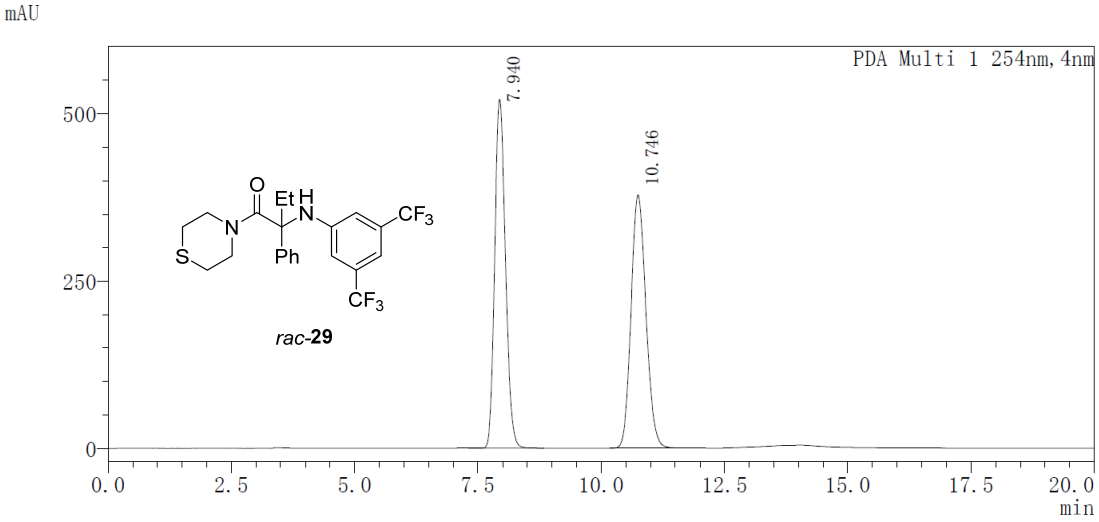
mAU



Peak Table

PDA Ch1 254nm

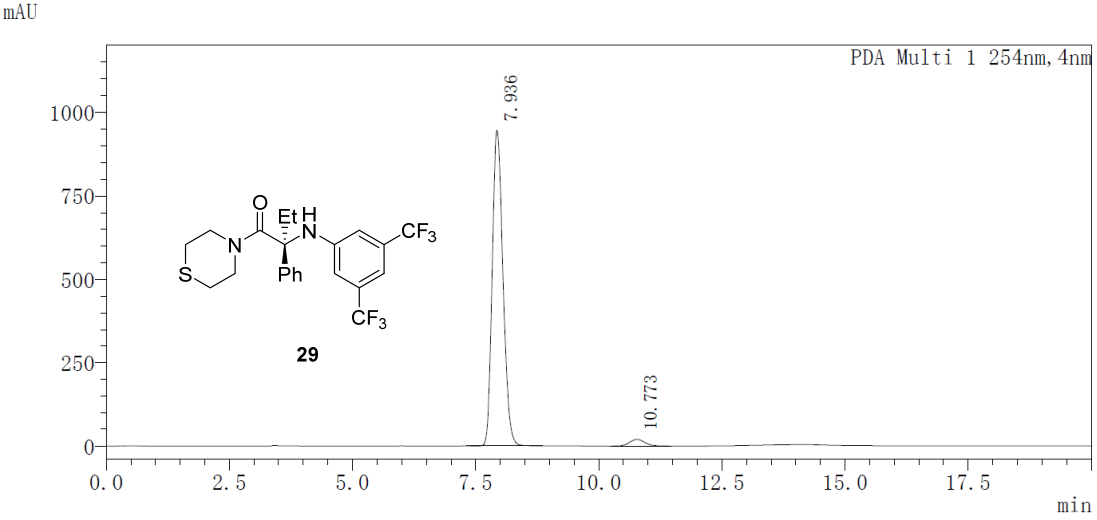
Peak#	Ret. Time	Area	Area%
1	6.412	14873363	97.688
2	8.882	352050	2.312



Peak Table

PDA Ch1 254nm

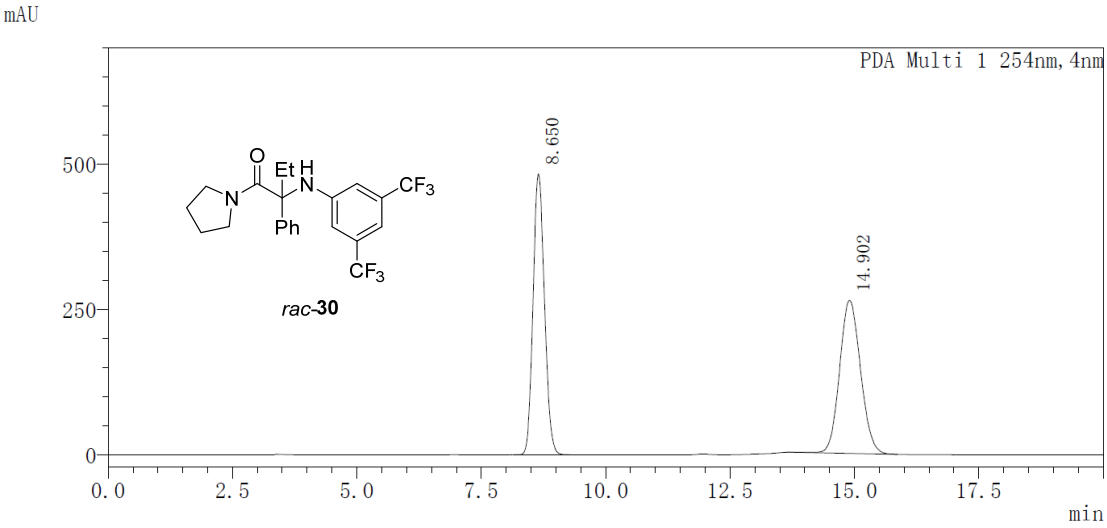
Peak#	Ret. Time	Area	Area%
1	7.940	7907943	49.883
2	10.746	7945040	50.117



Peak Table

PDA Ch1 254nm

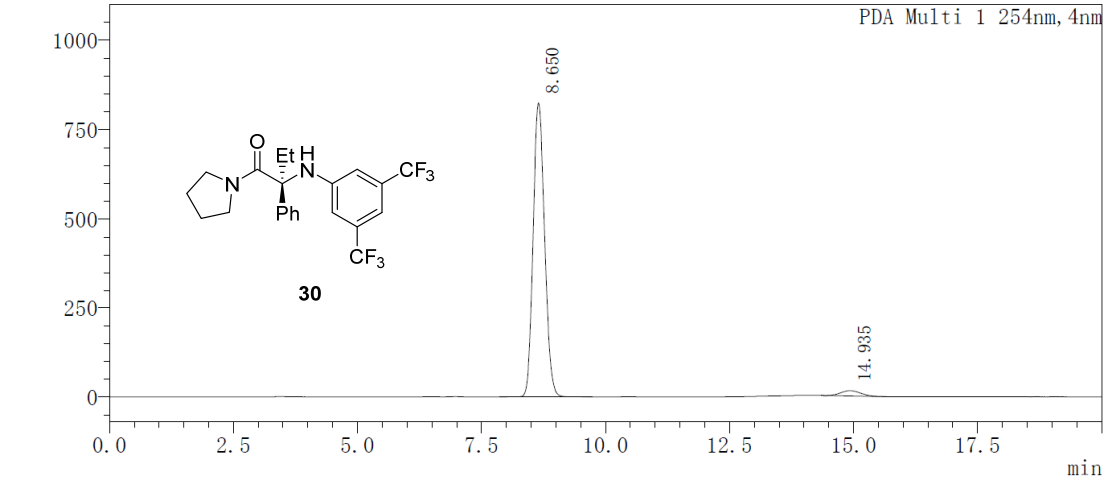
Peak#	Ret. Time	Area	Area%
1	7.936	14407645	97.145
2	10.773	423403	2.855



Peak Table

PDA Ch1 254nm

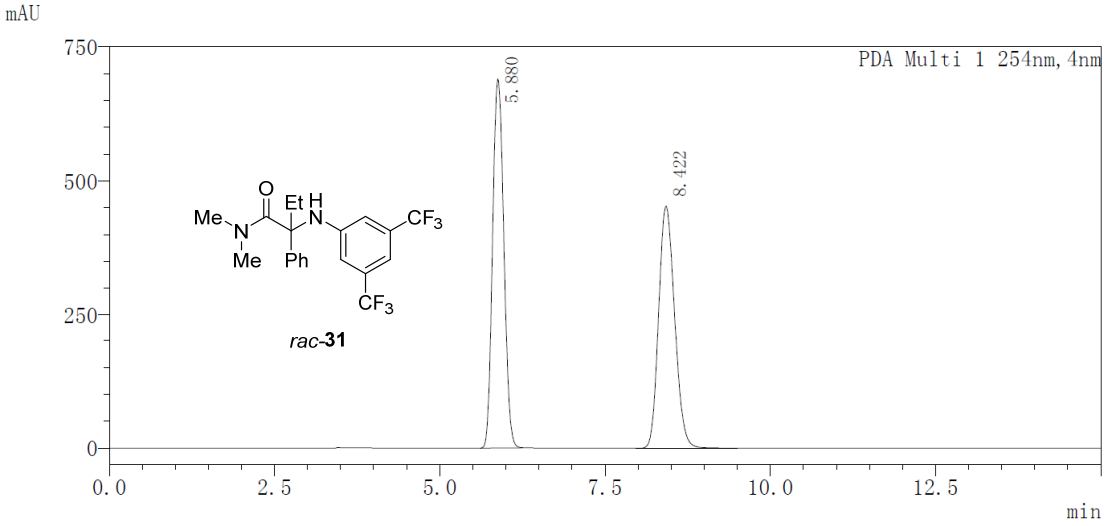
Peak#	Ret. Time	Area	Area%
1	8.650	7745635	50.080
2	14.902	7720820	49.920



Peak Table

PDA Ch1 254nm

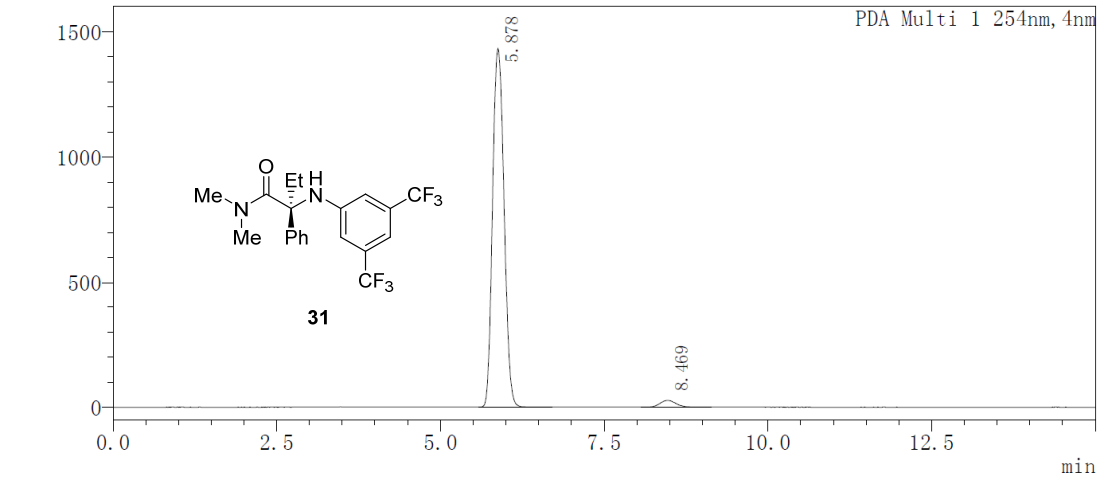
Peak#	Ret. Time	Area	Area%
1	8.650	13320985	97.009
2	14.935	410699	2.991



Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	5.880	8145381	51.682
2	8.422	7615214	48.318

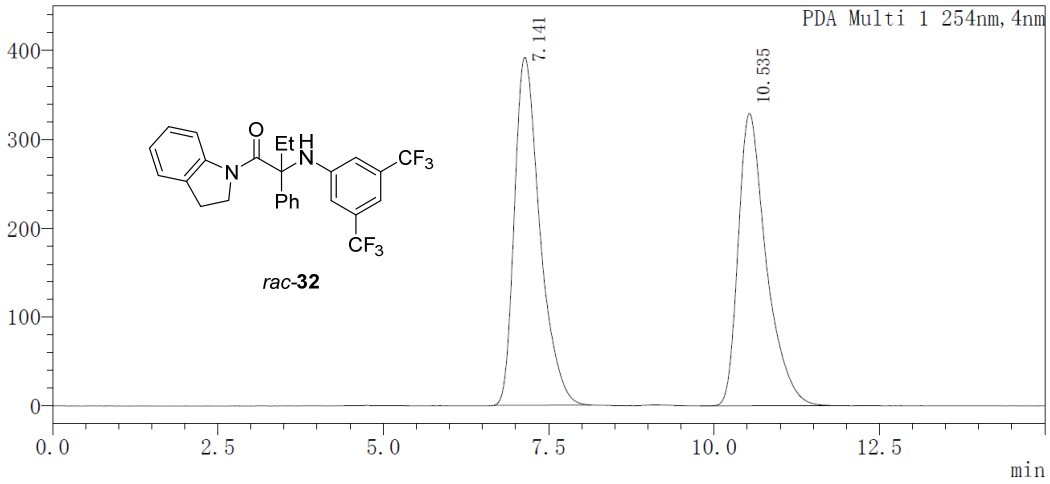


Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	5.878	17487935	97.434
2	8.469	460500	2.566

mAU

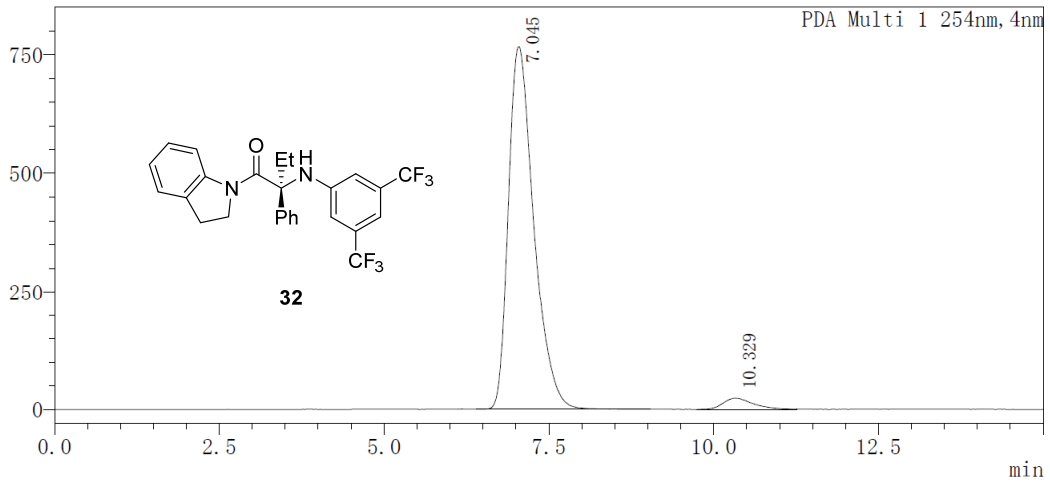


Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	7.141	10494892	51.846
2	10.535	9747684	48.154

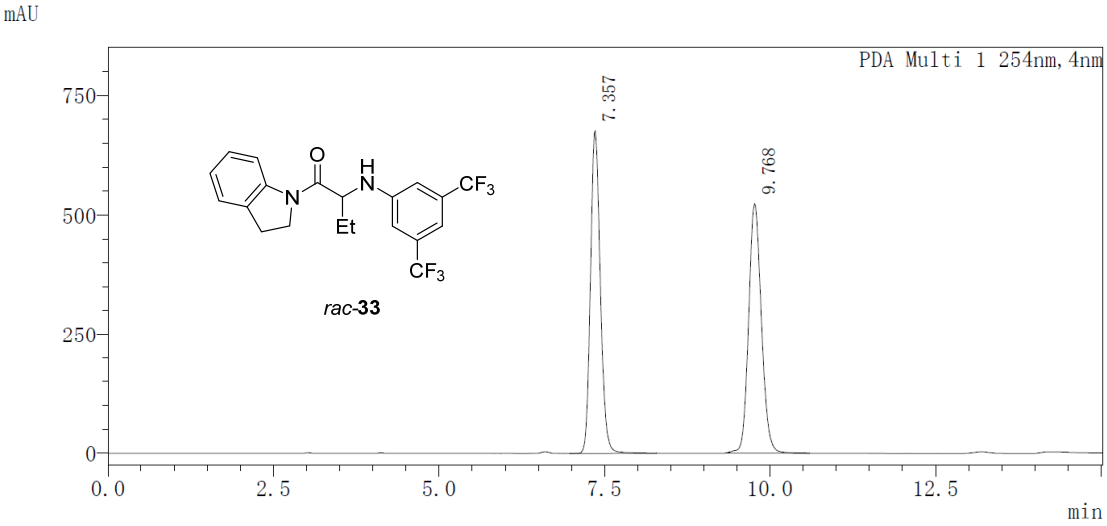
mAU



Peak Table

PDA Ch1 254nm

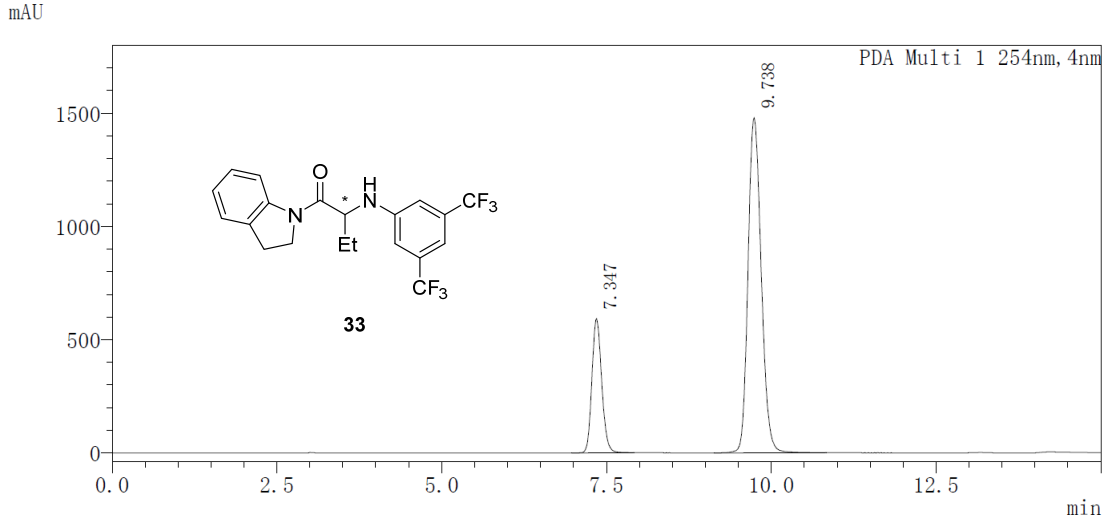
Peak#	Ret. Time	Area	Area%
1	7.045	20631337	96.444
2	10.329	760649	3.556



Peak Table

PDA Ch1 254nm

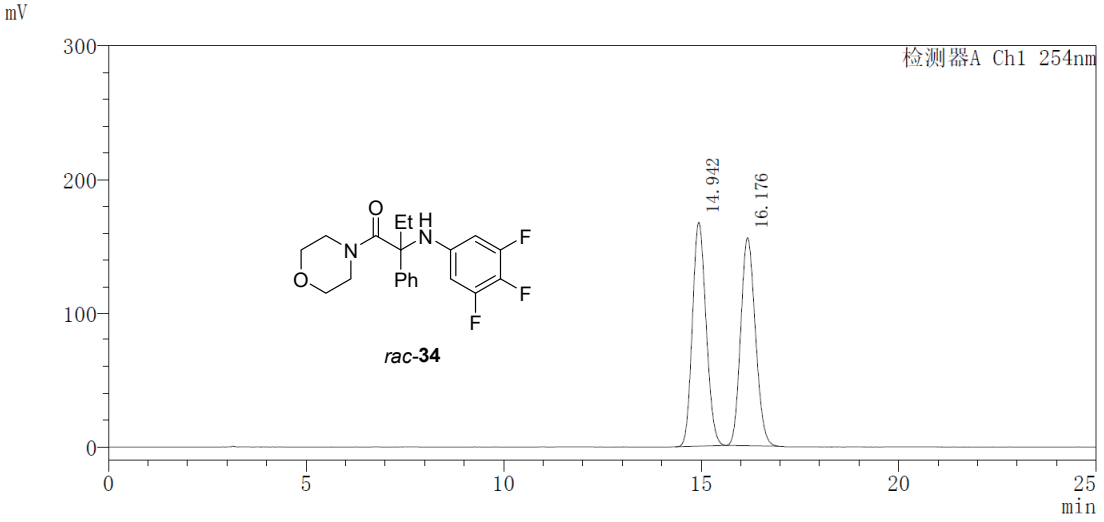
Peak#	Ret. Time	Area	Area%
1	7.357	6991462	49.865
2	9.768	7029192	50.135



Peak Table

PDA Ch1 254nm

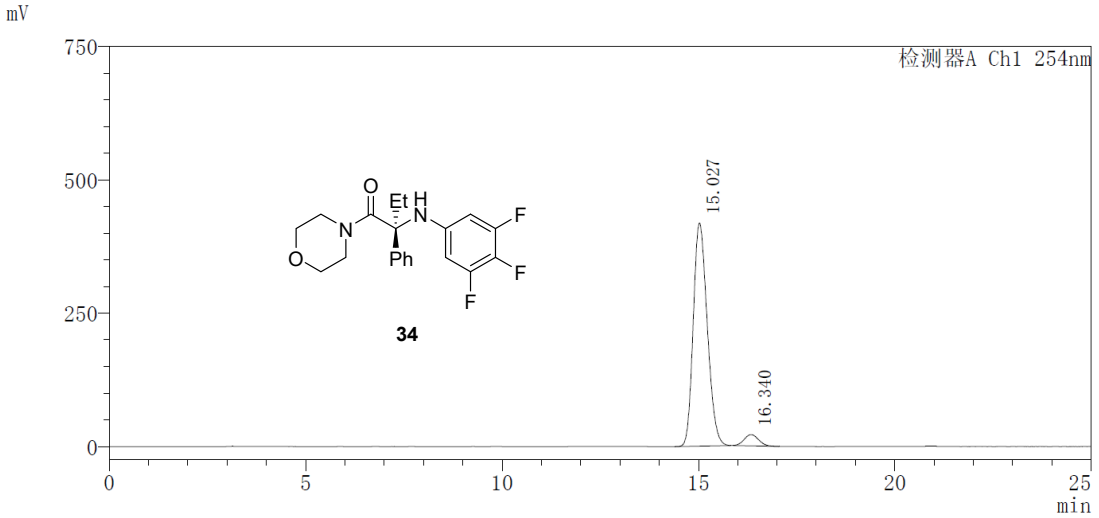
Peak#	Ret. Time	Area	Area%
1	7.347	6117244	22.862
2	9.738	20640030	77.138



Peak Table

检测器A Ch1 254nm

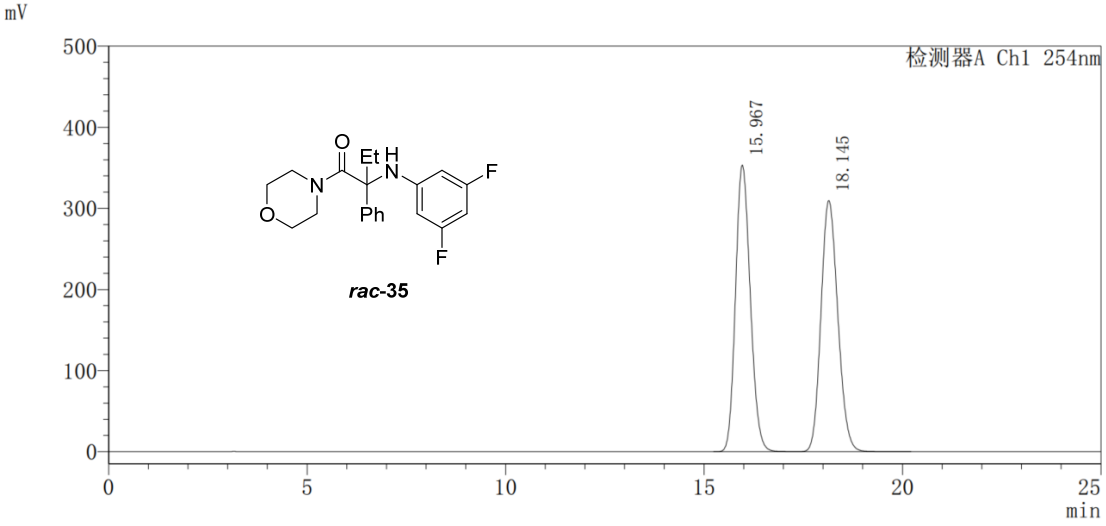
Peak#	Ret. Time	Area	Area%
1	14.942	4045653	50.067
2	16.176	4034769	49.933



Peak Table

检测器A Ch1 254nm

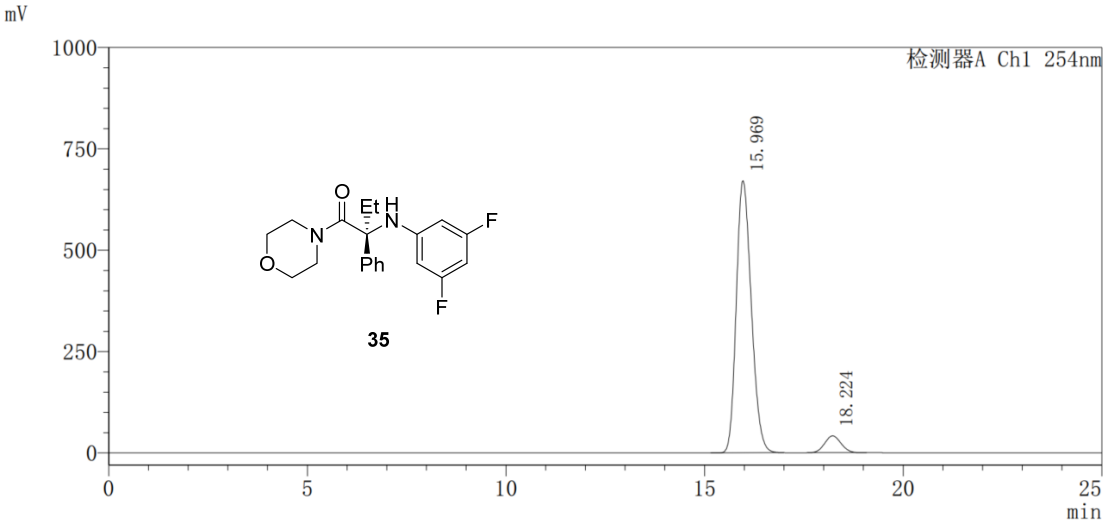
Peak#	Ret. Time	Area	Area%
1	15.027	10348277	95.089
2	16.340	534507	4.911



Peak Table

检测器A Ch1 254nm

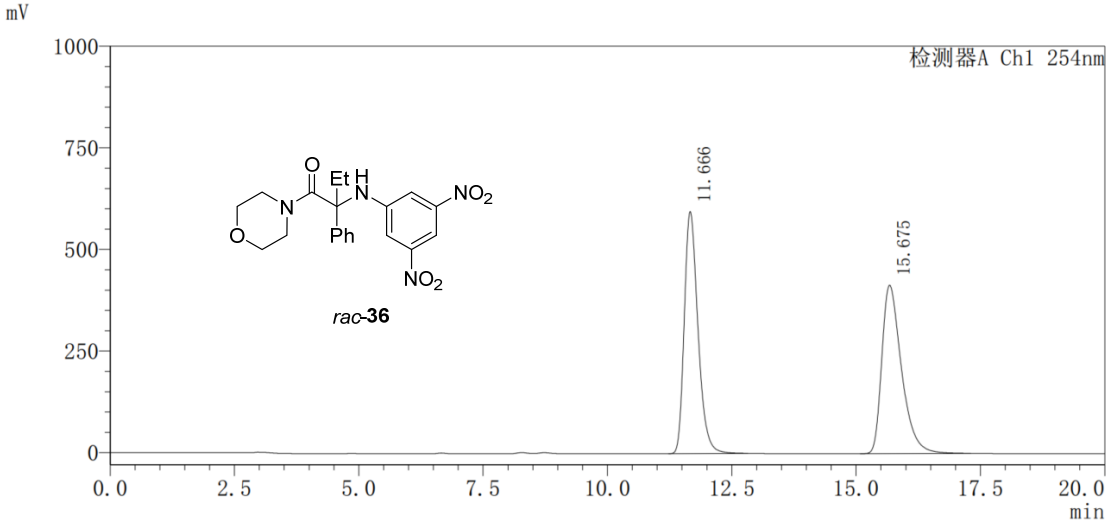
Peak#	Ret. Time	Area	Area%
1	15.967	9143908	49.970
2	18.145	9154984	50.030



Peak Table

检测器A Ch1 254nm

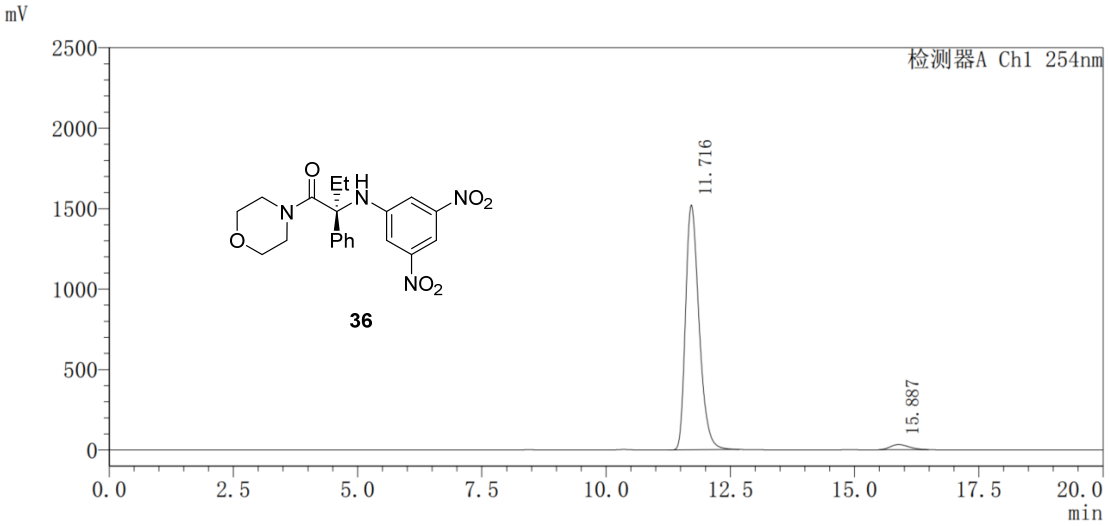
Peak#	Ret. Time	Area	Area%
1	15.969	17607721	93.714
2	18.224	1181058	6.286



Peak Table

检测器A Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	11.666	11422044	50.069
2	15.675	11390530	49.931

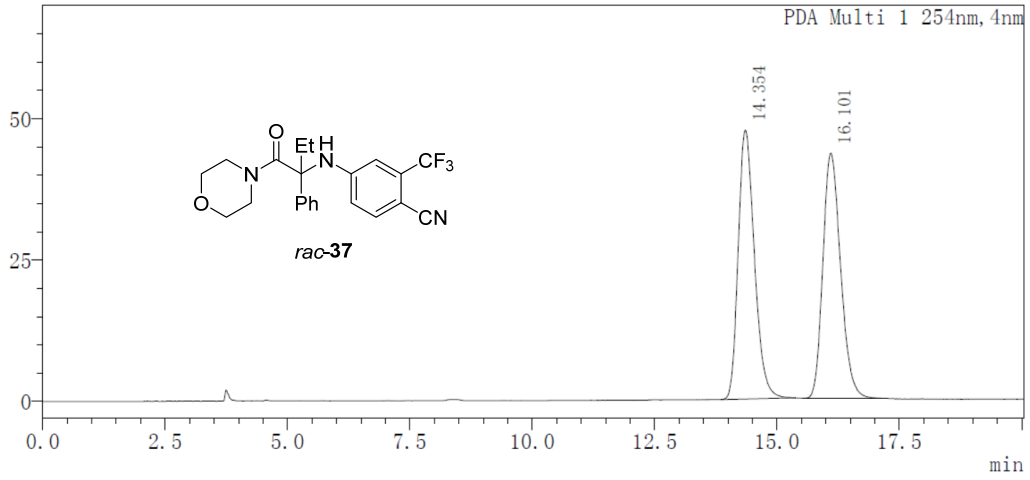


Peak Table

检测器A Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	11.716	28849839	97.165
2	15.887	841802	2.835

mAU



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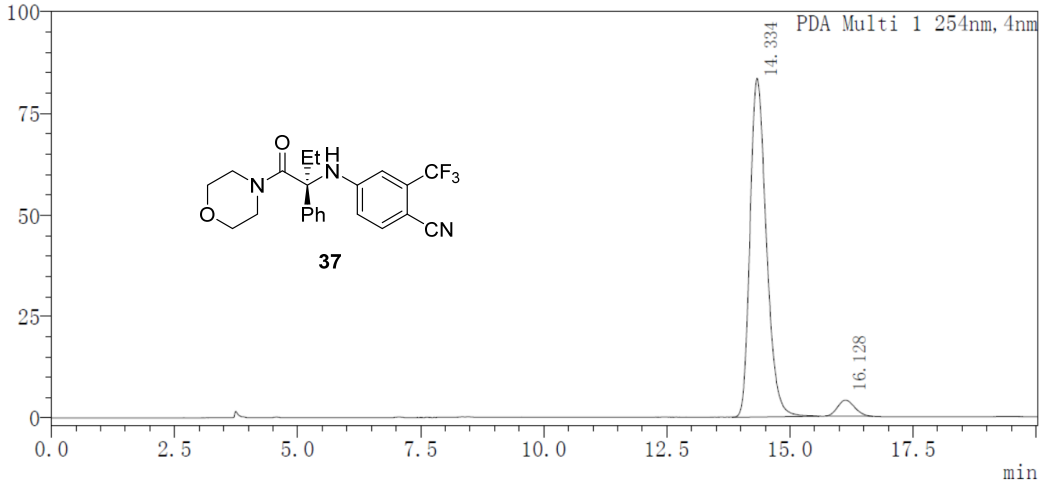
Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	14.354	1098143	50.062
2	16.101	1095442	49.938

mAU



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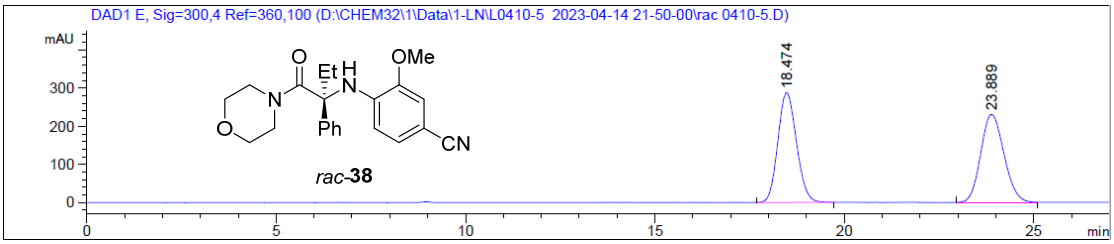
Peak Table

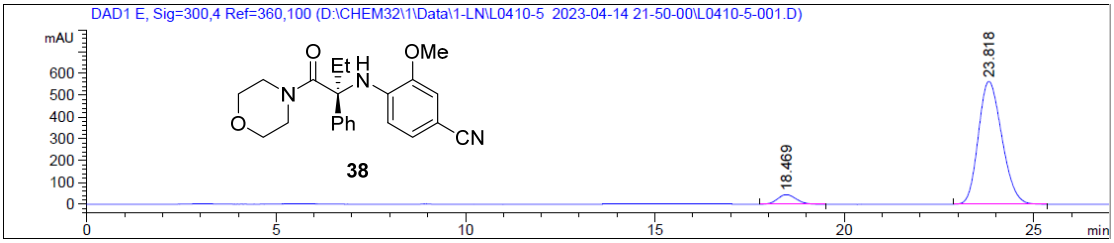
PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	14.334	1927152	95.304
2	16.128	94954	4.696



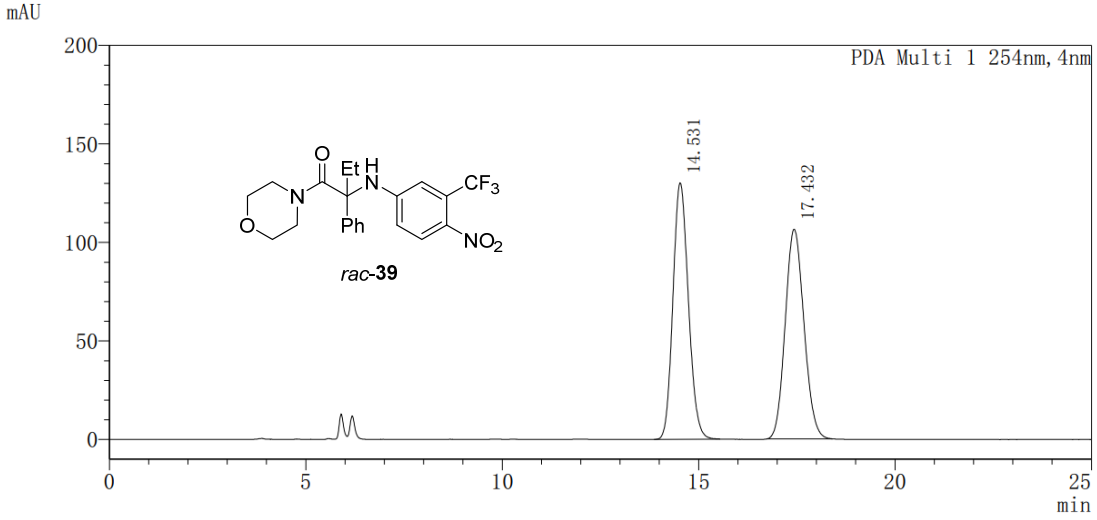
Signal 5: DAD1 E, Sig=300,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	18.474	BB	0.5309	9843.26270	287.87018	50.0811
2	23.889	BB	0.6183	9811.38770	230.64284	49.9189
Totals :				1.96547e4	518.51302	



Signal 5: DAD1 E, Sig=300,4 Ref=360,100

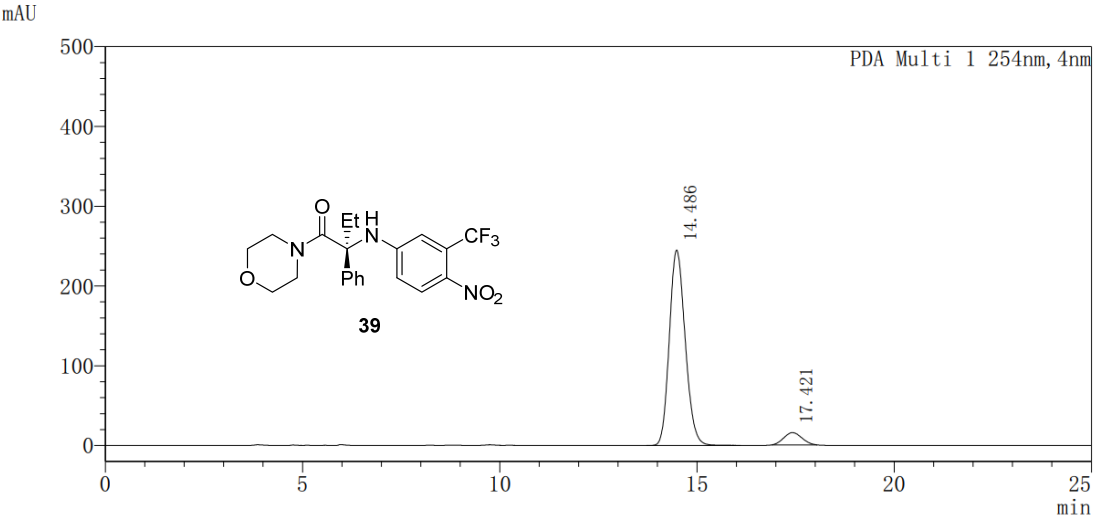
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	18.469	BB	0.4853	1535.05518	44.18349	5.9403
2	23.818	BB	0.6676	2.43063e4	563.11780	94.0597
Totals :				2.58414e4	607.30129	



Peak Table

PDA Ch1 254nm

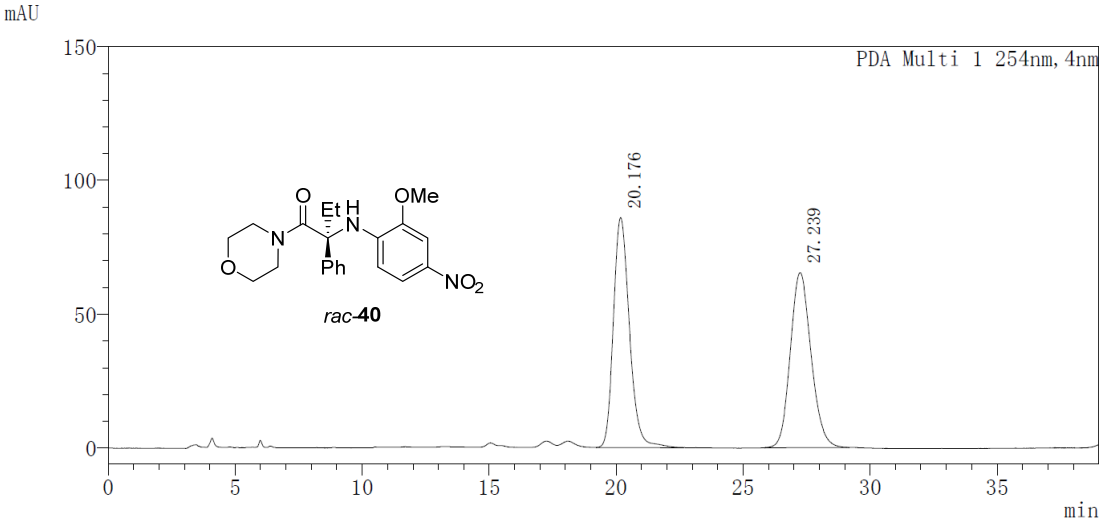
Peak#	Ret. Time	Area	Area%
1	14.531	3558422	50.126
2	17.432	3540462	49.874



Peak Table

PDA Ch1 254nm

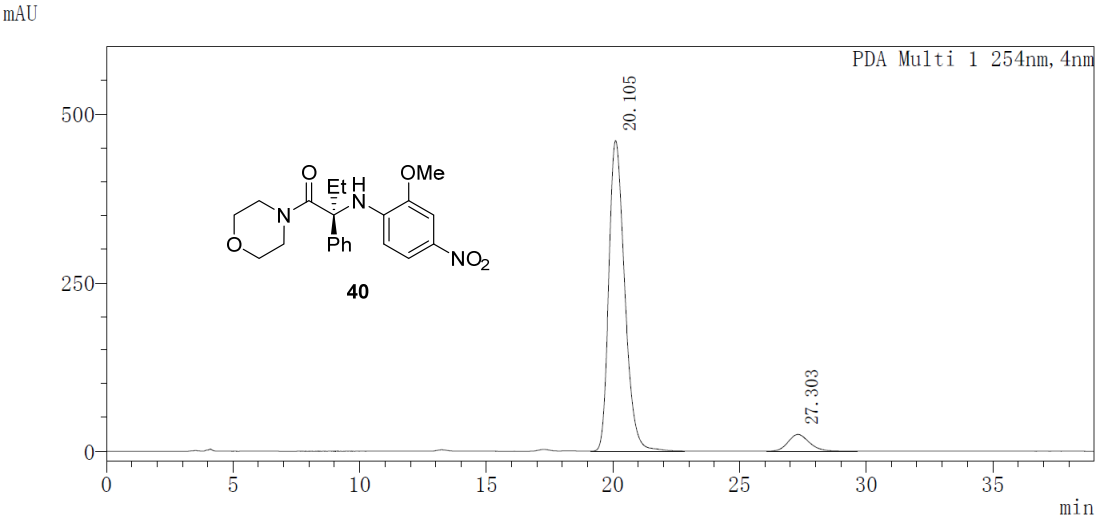
Peak#	Ret. Time	Area	Area%
1	14.486	6851154	93.319
2	17.421	490505	6.681



Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	20.176	3764110	50.303
2	27.239	3718733	49.697

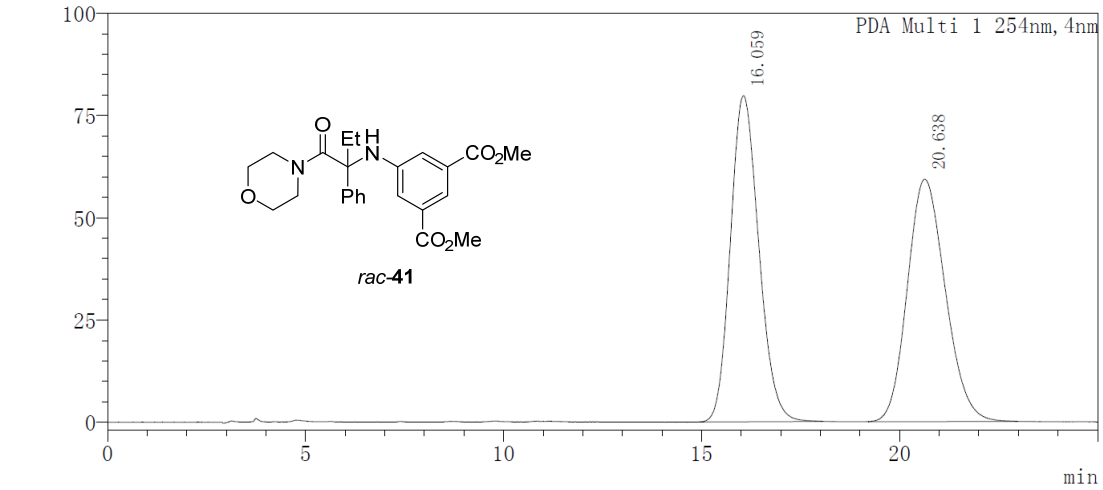


Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	20.105	20040465	93.387
2	27.303	1419237	6.613

mAU

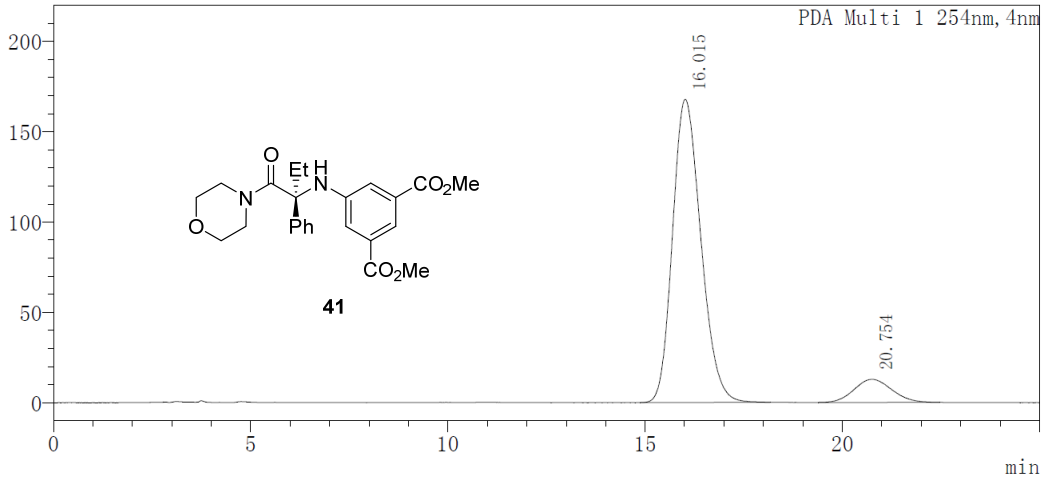


Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	16.059	3975340	50.153
2	20.638	3951069	49.847

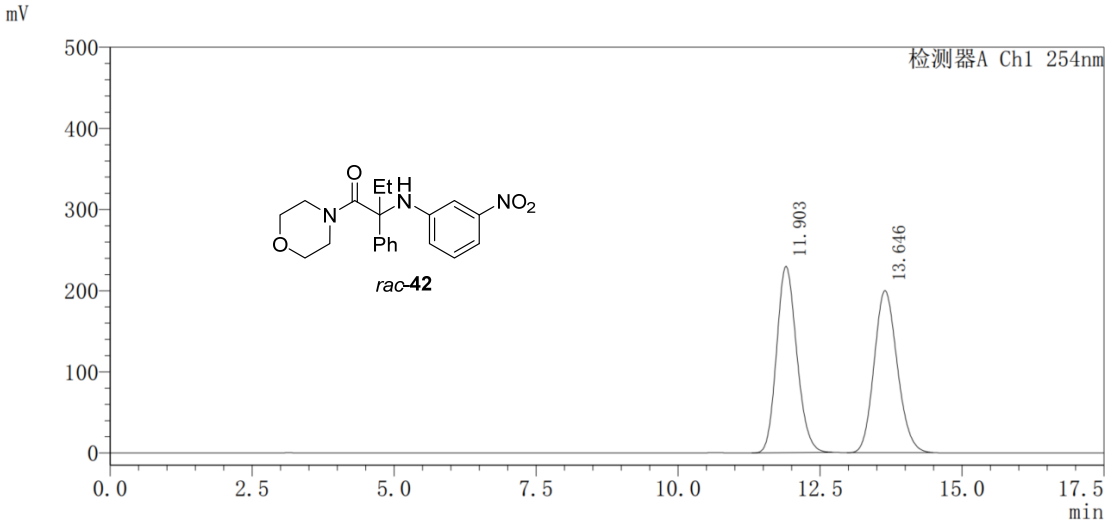
mAU



Peak Table

PDA Ch1 254nm

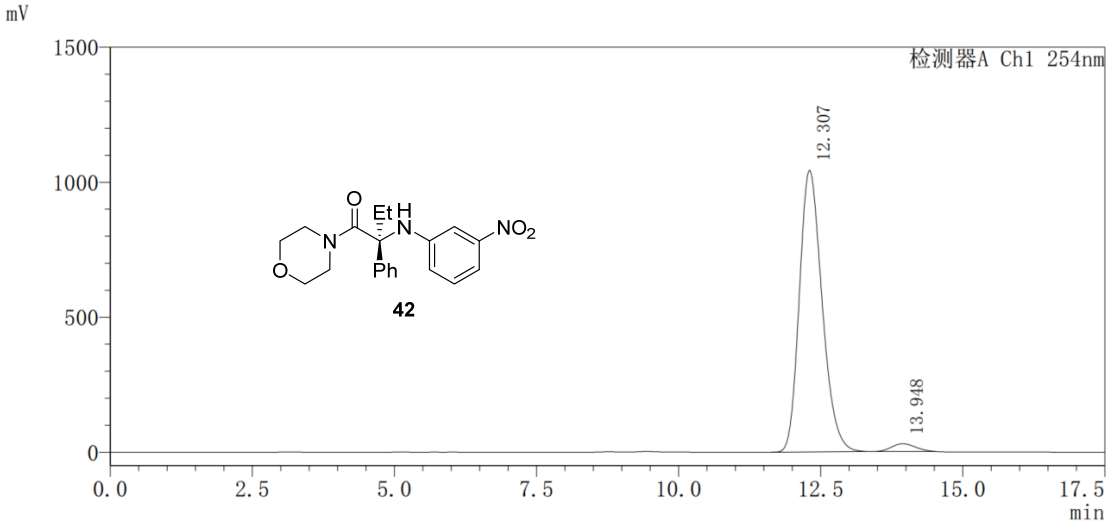
Peak#	Ret. Time	Area	Area%
1	16.015	8384574	90.759
2	20.754	853685	9.241



Peak Table

检测器A Ch1 254nm

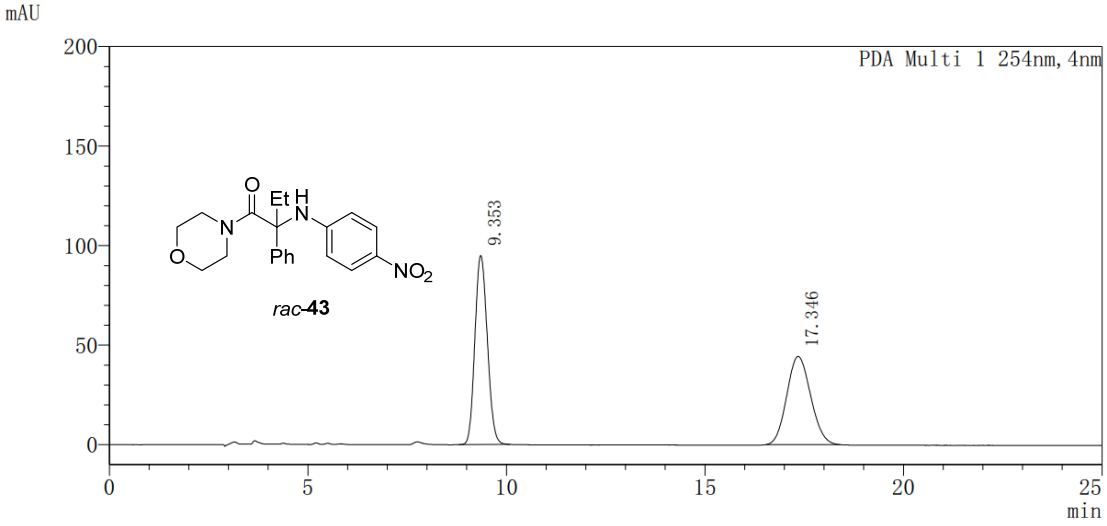
Peak#	Ret. Time	Area	Area%
1	11.903	5678932	50.027
2	13.646	5672797	49.973



Peak Table

检测器A Ch1 254nm

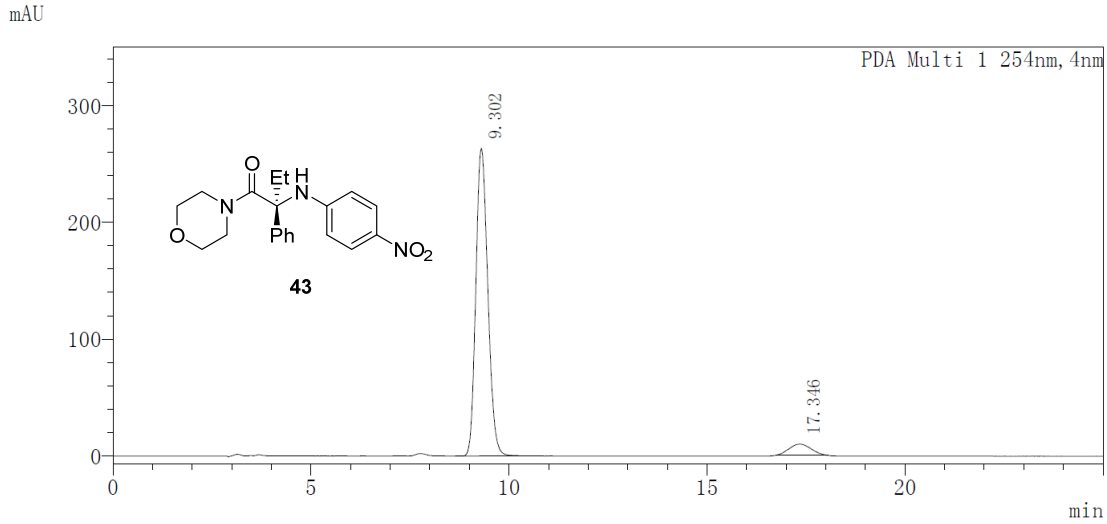
Peak#	Ret. Time	Area	Area%
1	12.307	29083474	97.210
2	13.948	834789	2.790



Peak Table

PDA Ch1 254nm

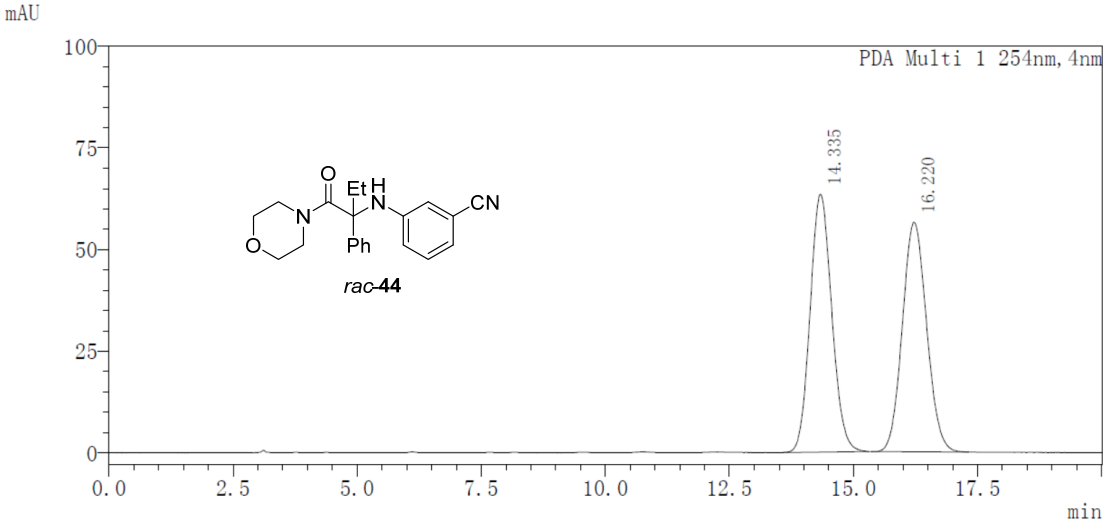
Peak#	Ret. Time	Area	Area%
1	9.353	2062856	52.675
2	17.346	1853353	47.325



Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	9.302	5529300	93.764
2	17.346	367712	6.236



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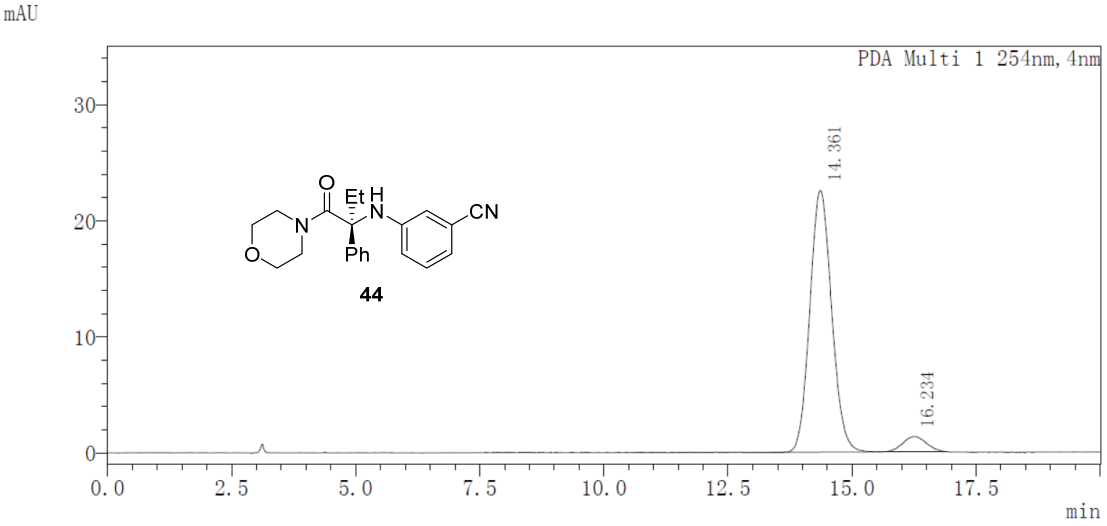
Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	14.335	1925871	50.036
2	16.220	1923134	49.964



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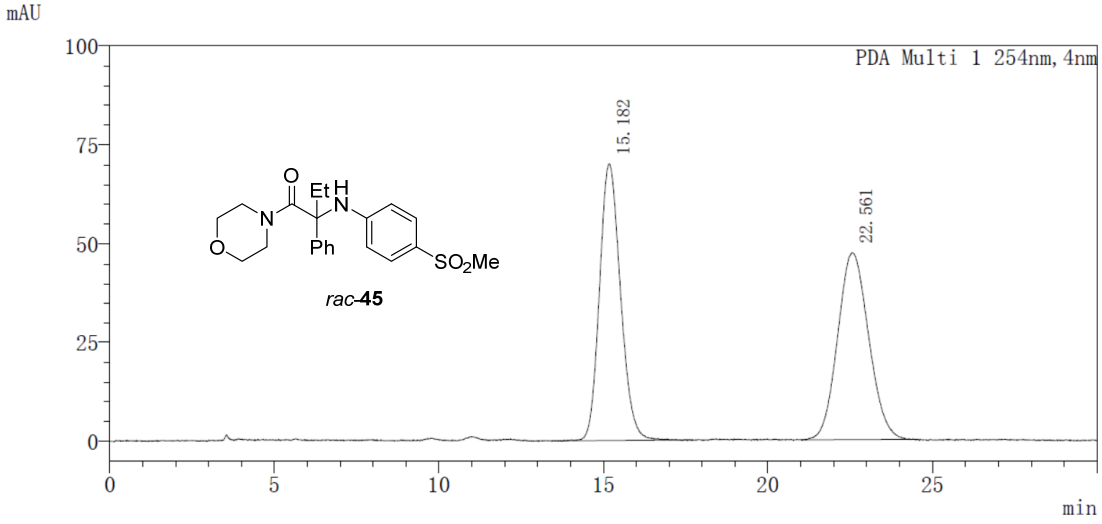
Peak Table

PDA Ch1 254nm

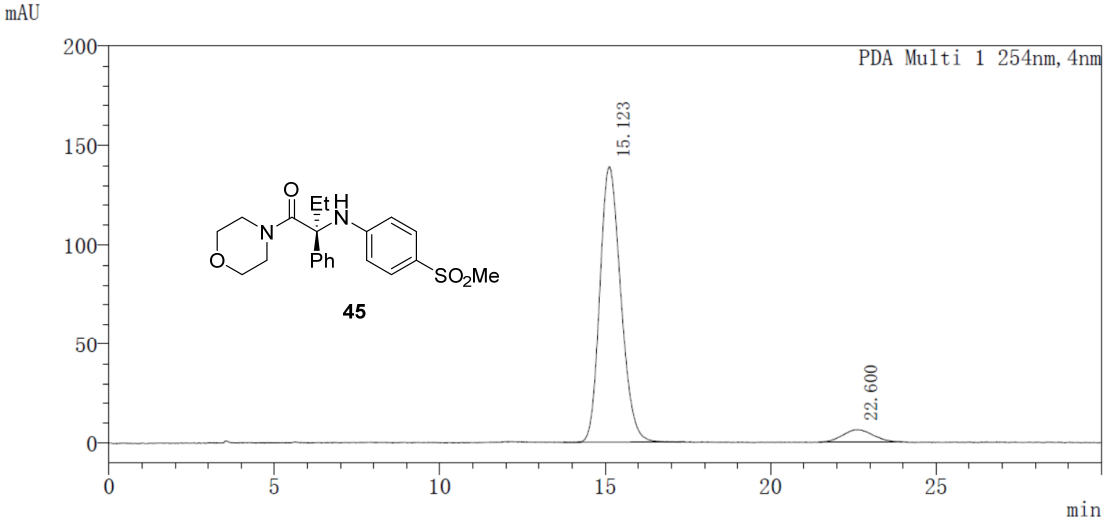
Peak#	Ret. Time	Area	Area%
1	14.361	688747	94.232
2	16.234	42158	5.768



Peak Table

PDA Ch1 254nm

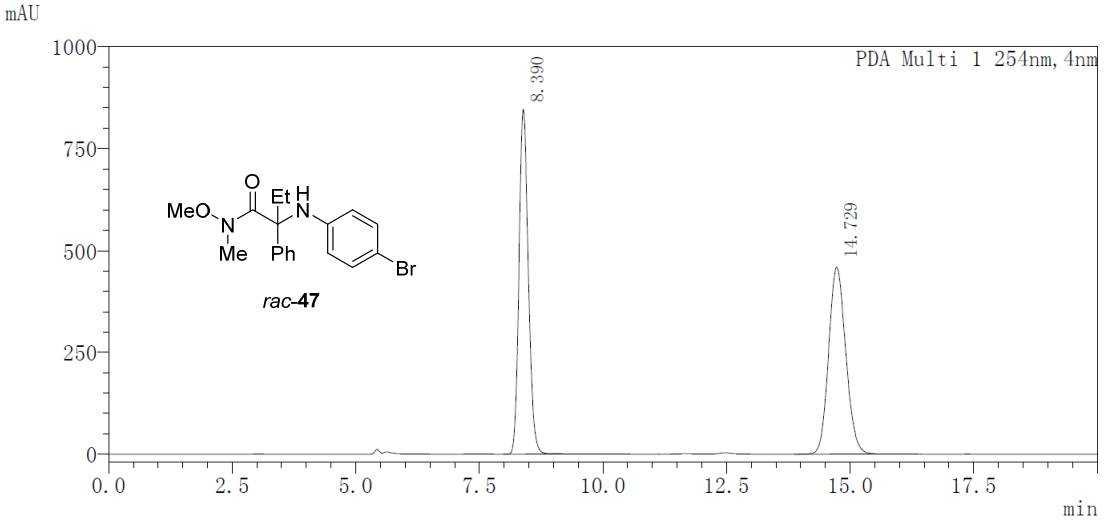
Peak#	Ret. Time	Area	Area%
1	15.182	3105445	49.980
2	22.561	3107889	50.020



Peak Table

PDA Ch1 254nm

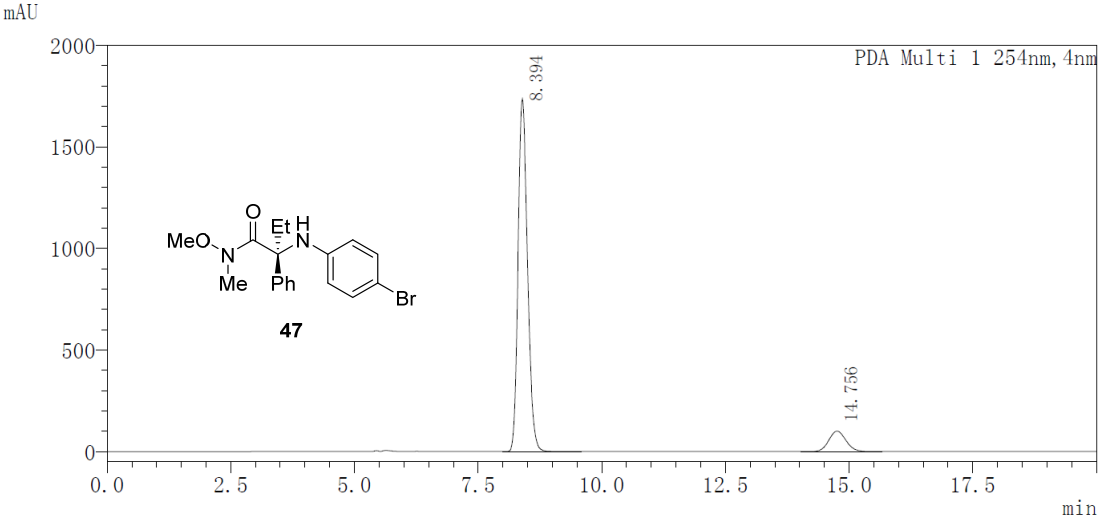
Peak#	Ret. Time	Area	Area%
1	15.123	6111308	94.000
2	22.600	390088	6.000



Peak Table

PDA Ch1 254nm

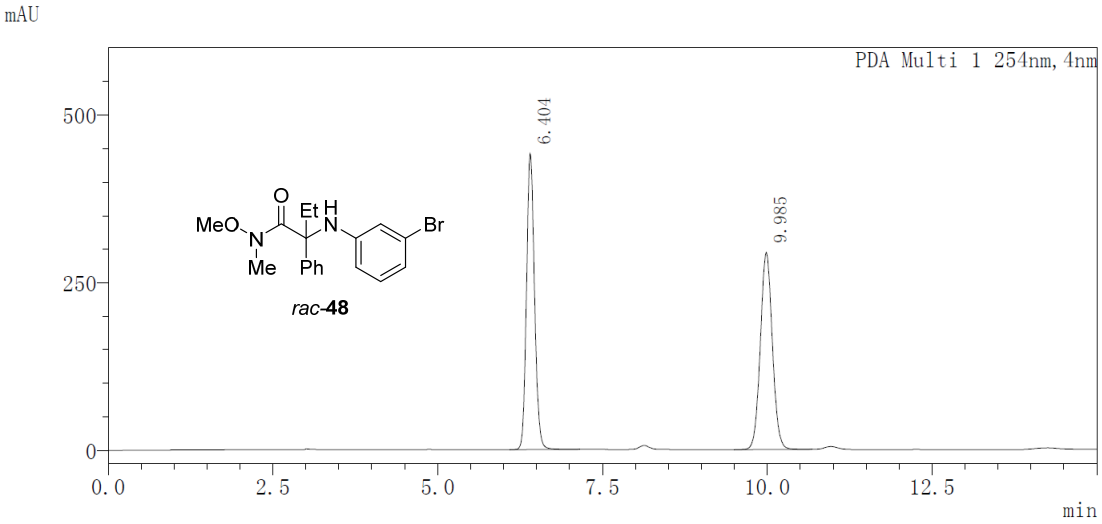
Peak#	Ret. Time	Area	Area%
1	8.390	11104062	50.023
2	14.729	11093782	49.977



Peak Table

PDA Ch1 254nm

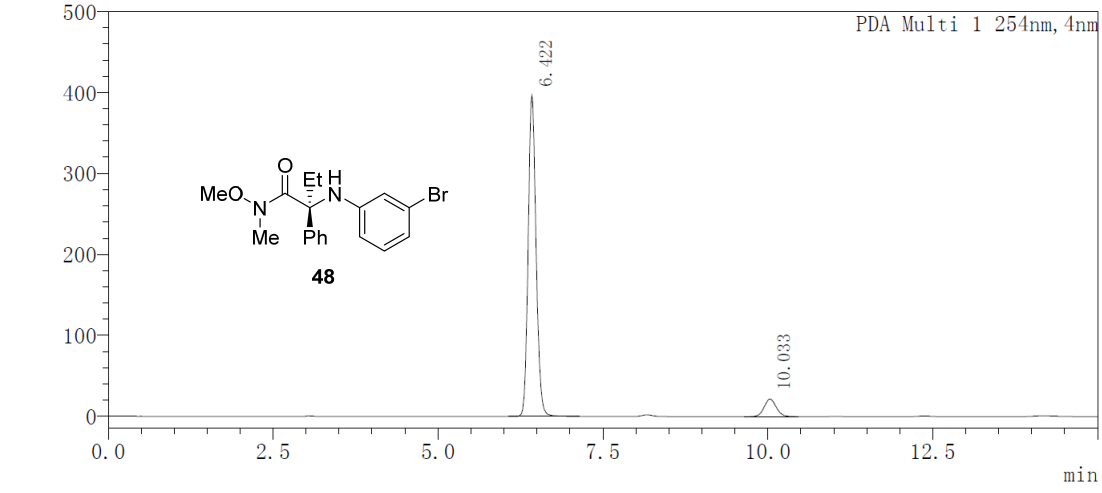
Peak#	Ret. Time	Area	Area%
1	8.394	23031345	90.426
2	14.756	2438490	9.574



Peak Table

PDA Ch1 254nm

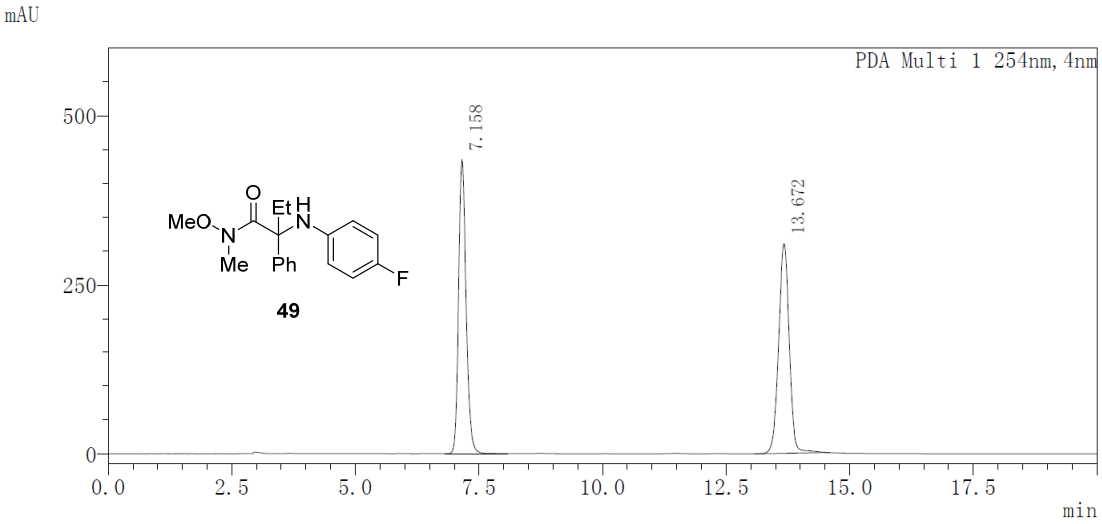
Peak#	Ret. Time	Area	Area%
1	6.404	3729709	49.992
2	9.985	3730854	50.008



Peak Table

PDA Ch1 254nm

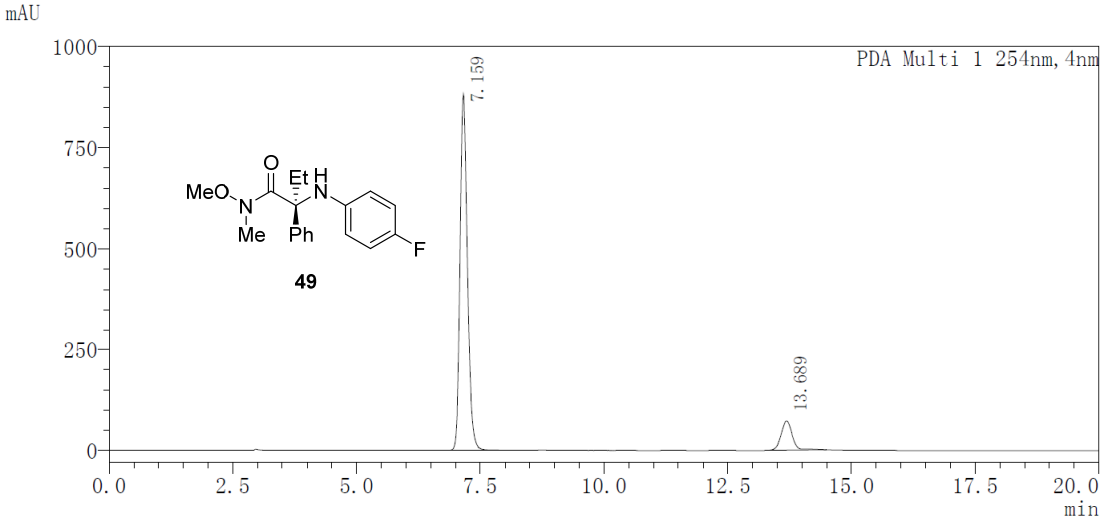
Peak#	Ret. Time	Area	Area%
1	6.422	3315330	92.325
2	10.033	275609	7.675



Peak Table

PDA Ch1 254nm

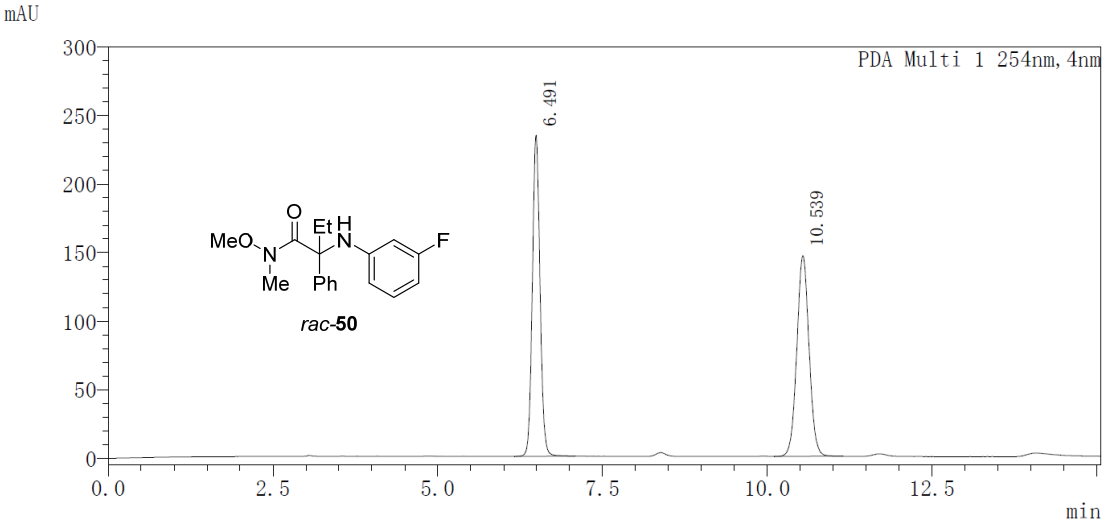
Peak#	Ret. Time	Area	Area%
1	7.158	4595424	49.657
2	13.672	4658990	50.343



Peak Table

PDA Ch1 254nm

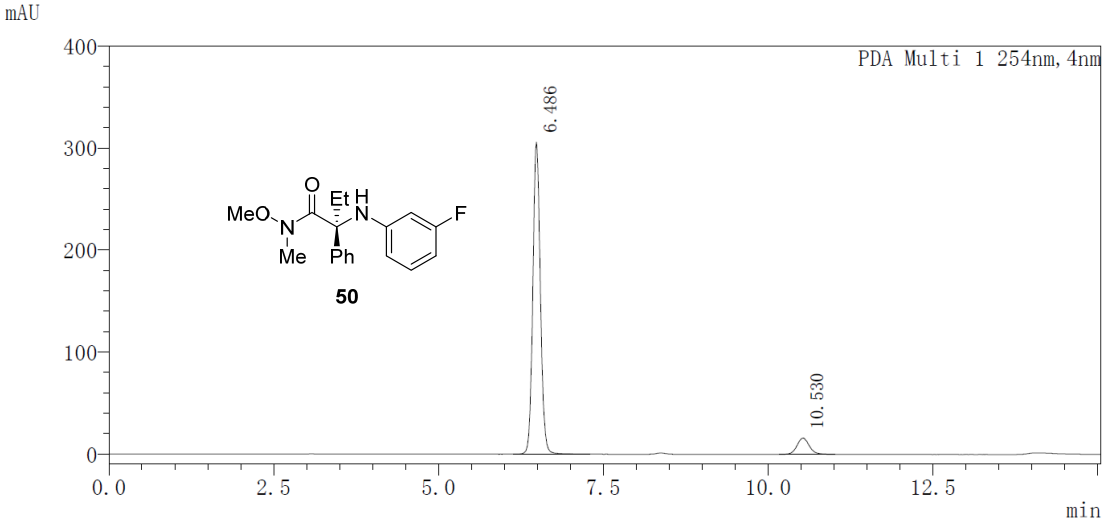
Peak#	Ret. Time	Area	Area%
1	7.159	9206389	88.895
2	13.689	1150078	11.105



Peak Table

PDA Ch1 254nm

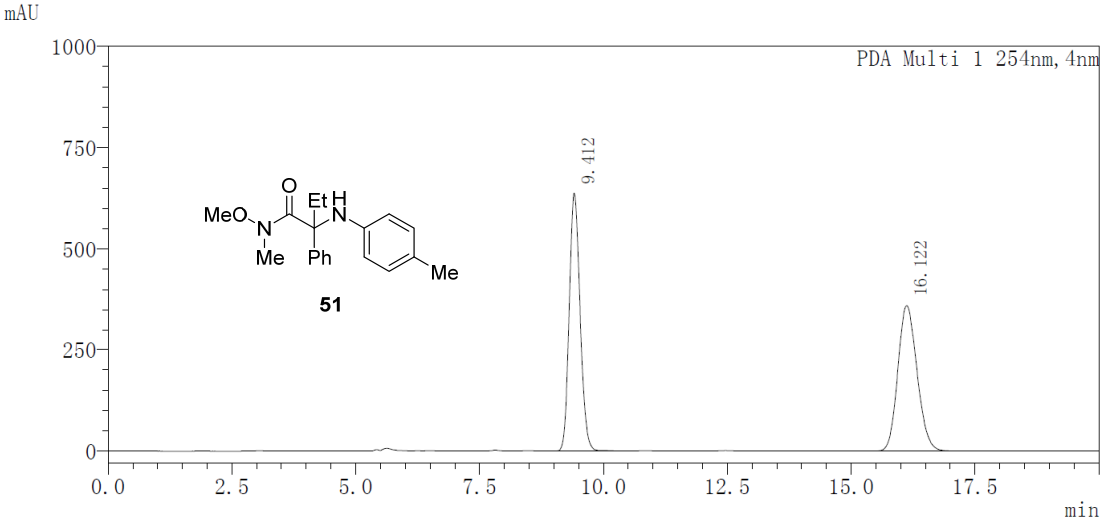
Peak#	Ret. Time	Area	Area%
1	6.491	1893278	49.993
2	10.539	1893782	50.007



Peak Table

PDA Ch1 254nm

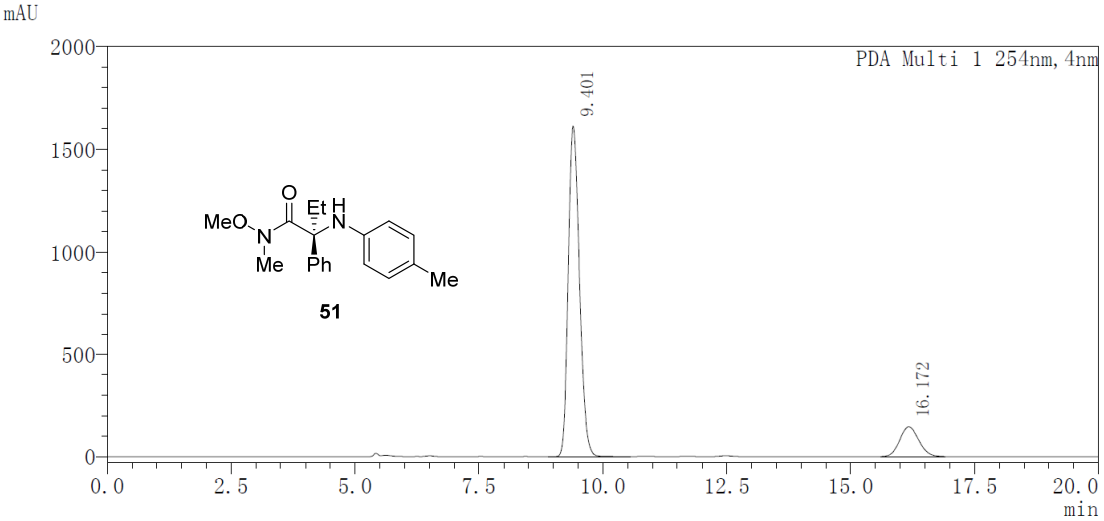
Peak#	Ret. Time	Area	Area%
1	6.486	2432257	92.069
2	10.530	209523	7.931



Peak Table

PDA Ch1 254nm

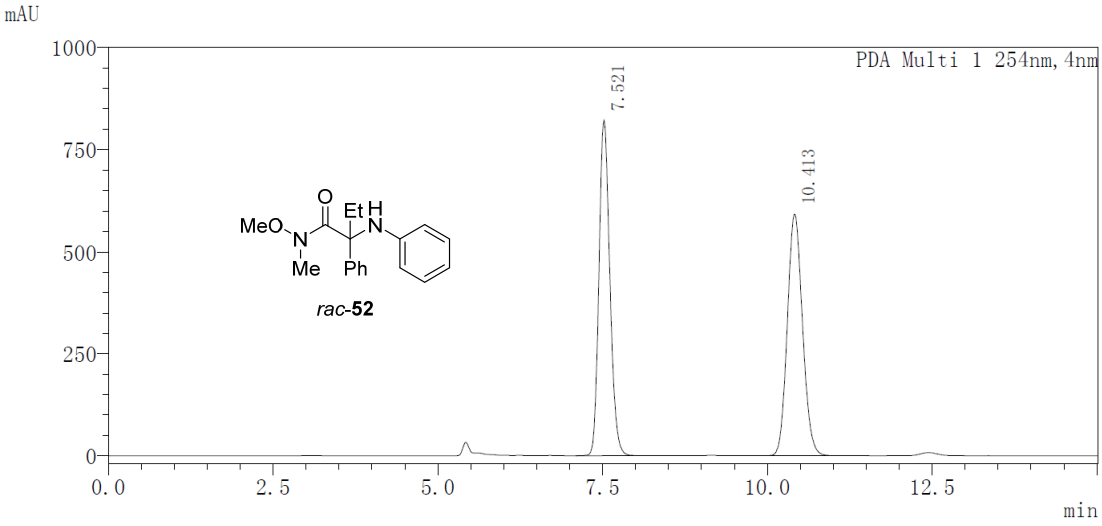
Peak#	Ret. Time	Area	Area%
1	9.412	9717773	50.015
2	16.122	9712016	49.985



Peak Table

PDA Ch1 254nm

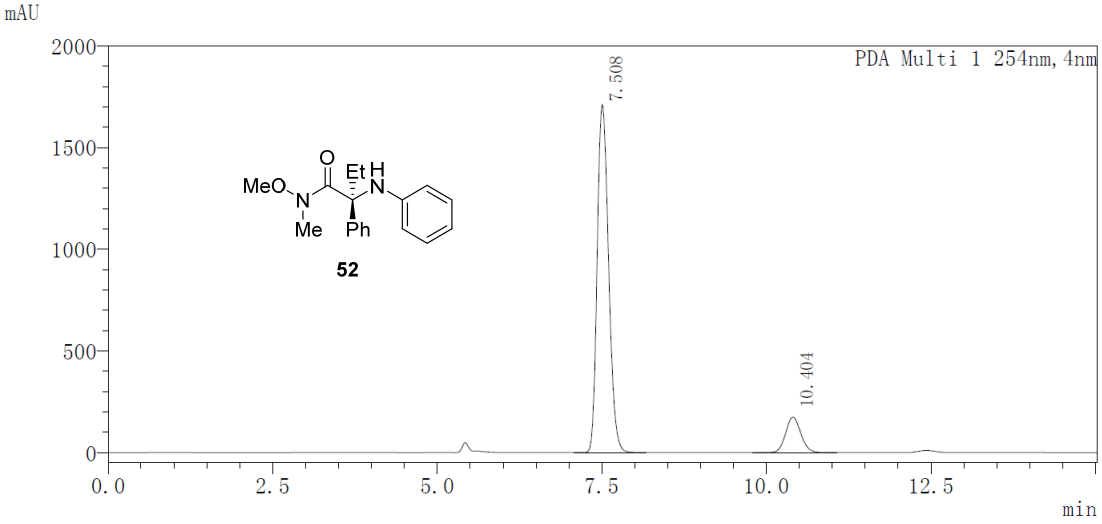
Peak#	Ret. Time	Area	Area%
1	9.401	25401843	86.762
2	16.172	3875709	13.238



Peak Table

PDA Ch1 254nm

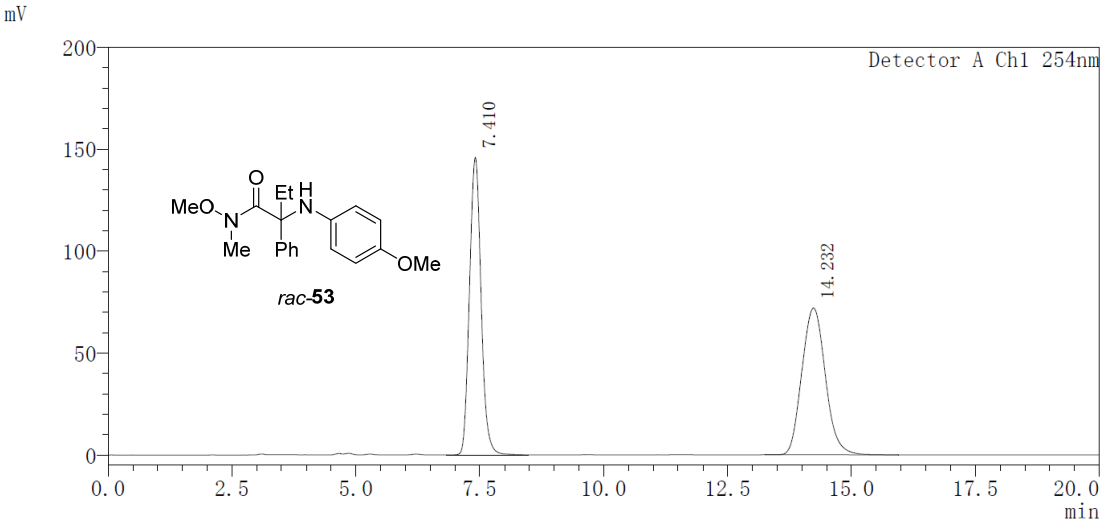
Peak#	Ret. Time	Area	Area%
1	7.521	9462229	49.938
2	10.413	9485886	50.062



Peak Table

PDA Ch1 254nm

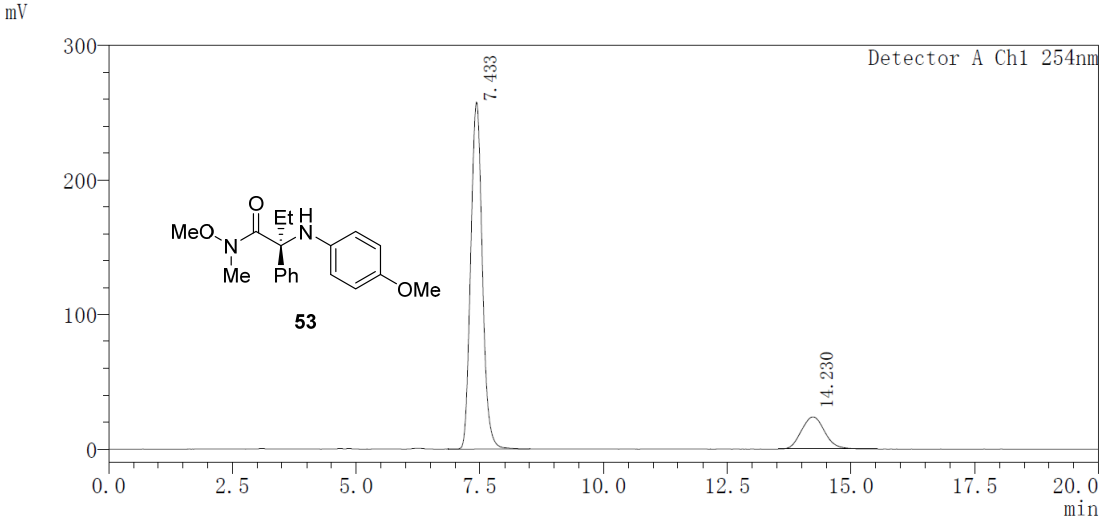
Peak#	Ret. Time	Area	Area%
1	7.508	20591031	88.034
2	10.404	2798868	11.966



Peak Table

Detector A Ch1 254nm

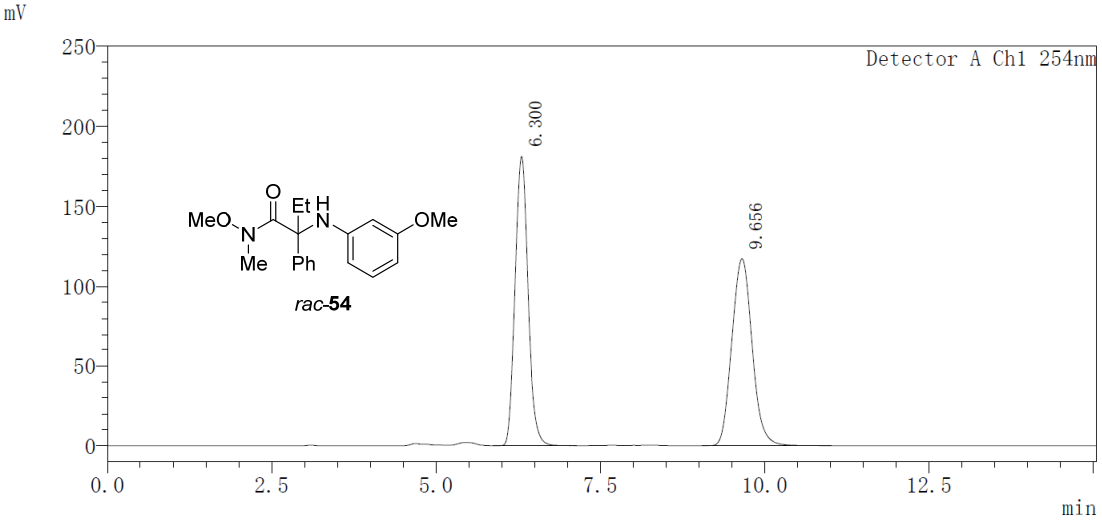
Peak#	Ret. Time	Area	Area%
1	7.410	2376763	50.104
2	14.232	2366883	49.896



Peak Table

Detector A Ch1 254nm

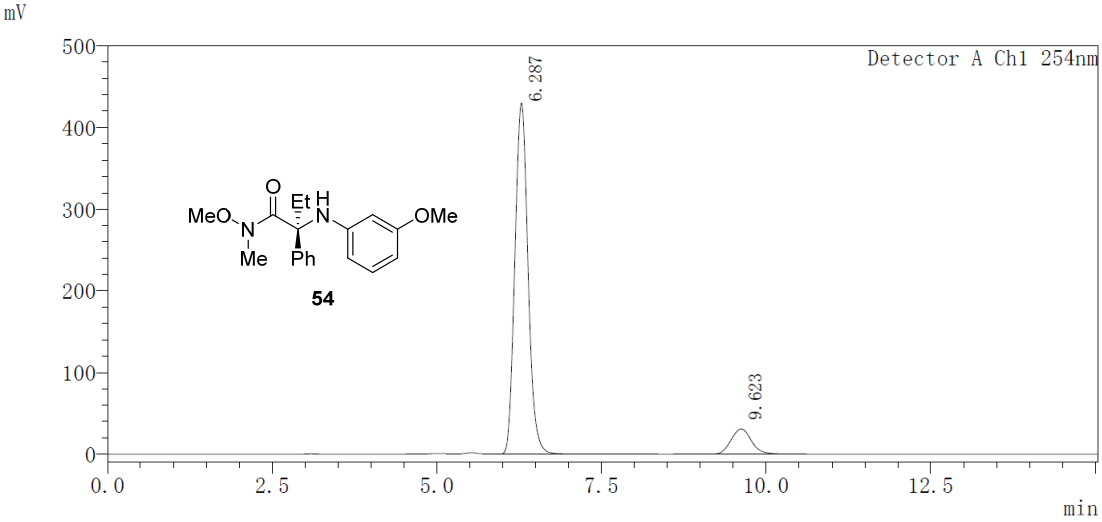
Peak#	Ret. Time	Area	Area%
1	7.433	4211974	84.336
2	14.230	782319	15.664



Peak Table

Detector A Ch1 254nm

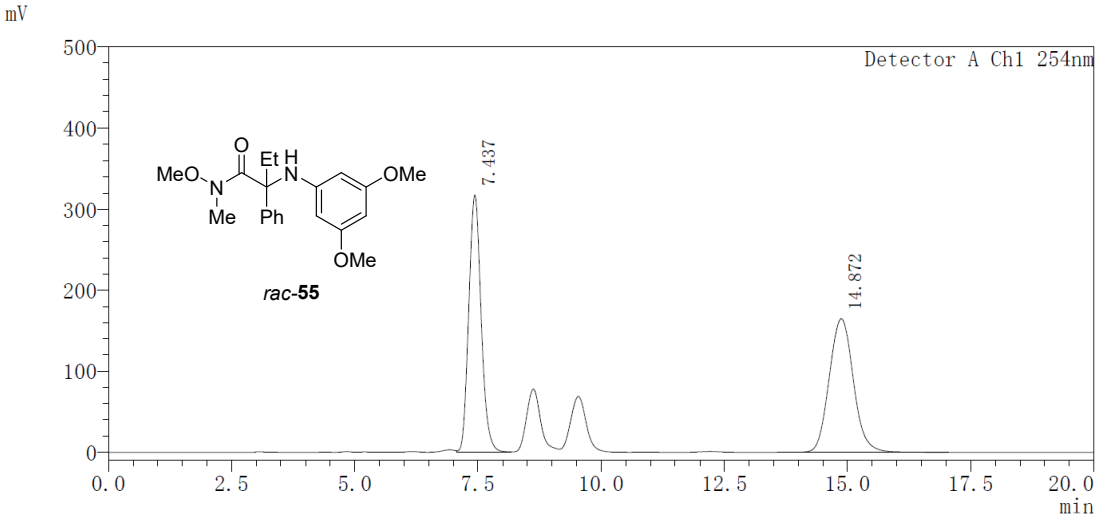
Peak#	Ret. Time	Area	Area%
1	6.300	2508697	49.936
2	9.656	2515108	50.064



Peak Table

Detector A Ch1 254nm

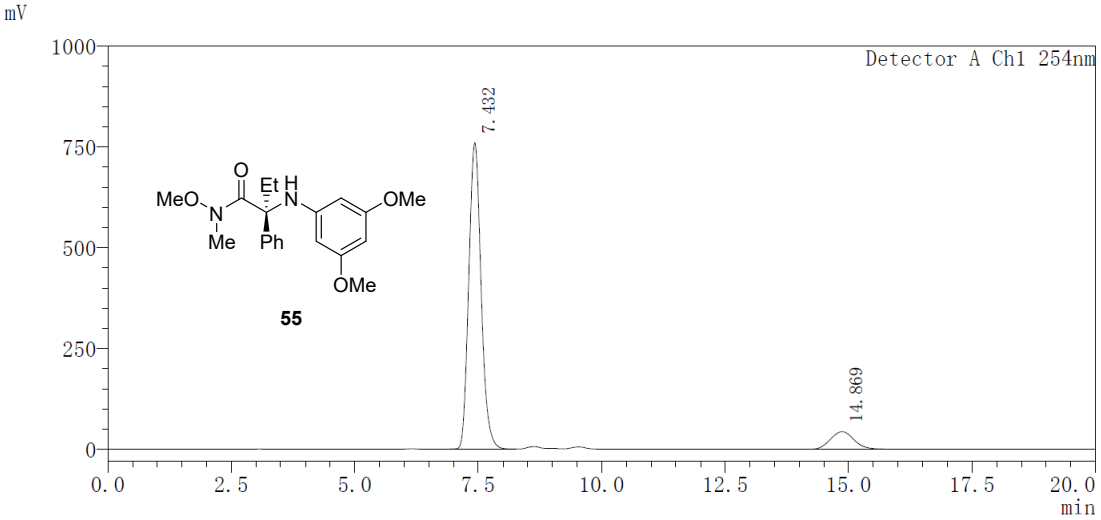
Peak#	Ret. Time	Area	Area%
1	6.287	5956501	90.264
2	9.623	642446	9.736



Peak Table

Detector A Ch1 254nm

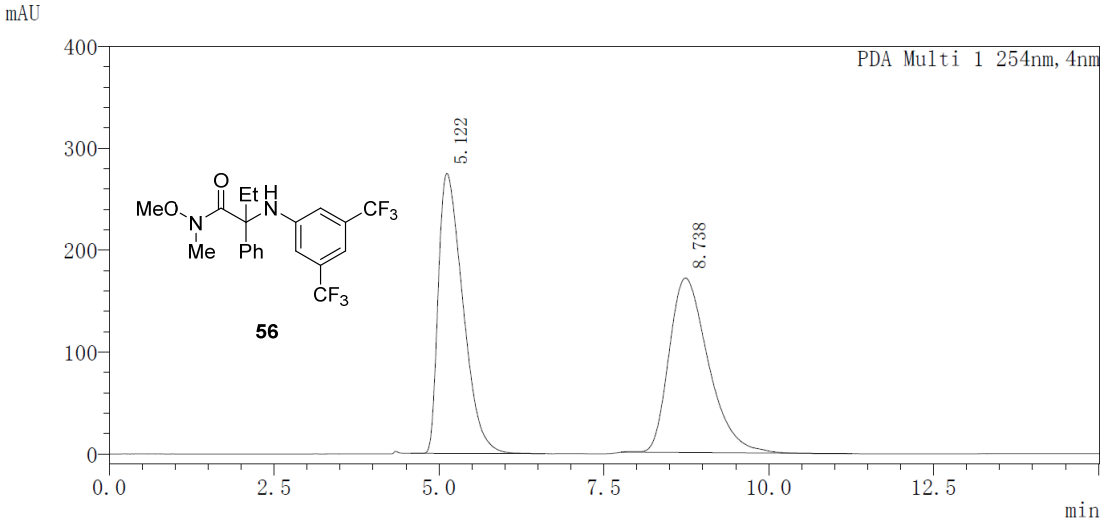
Peak#	Ret. Time	Area	Area%
1	7.437	5570584	49.764
2	14.872	5623416	50.236



Peak Table

Detector A Ch1 254nm

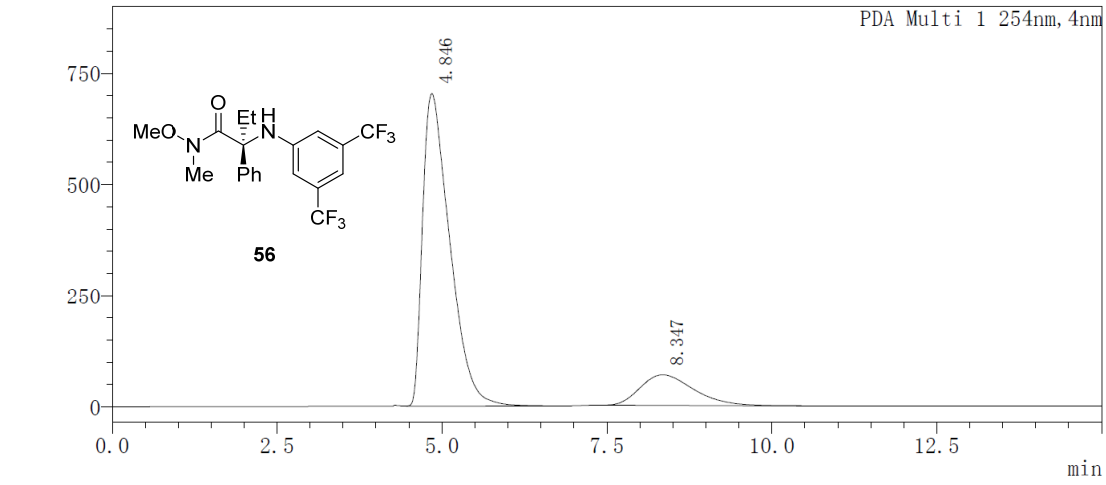
Peak#	Ret. Time	Area	Area%
1	7.432	13263270	89.975
2	14.869	1477832	10.025



Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	5.122	7111820	49.963
2	8.738	7122269	50.037

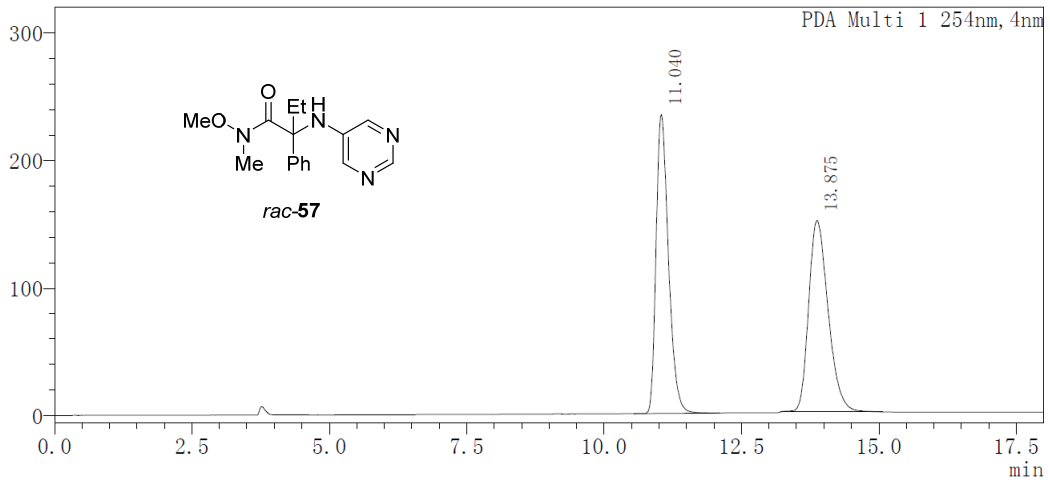


Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	4.846	20205970	83.909
2	8.347	3874918	16.091

mAU



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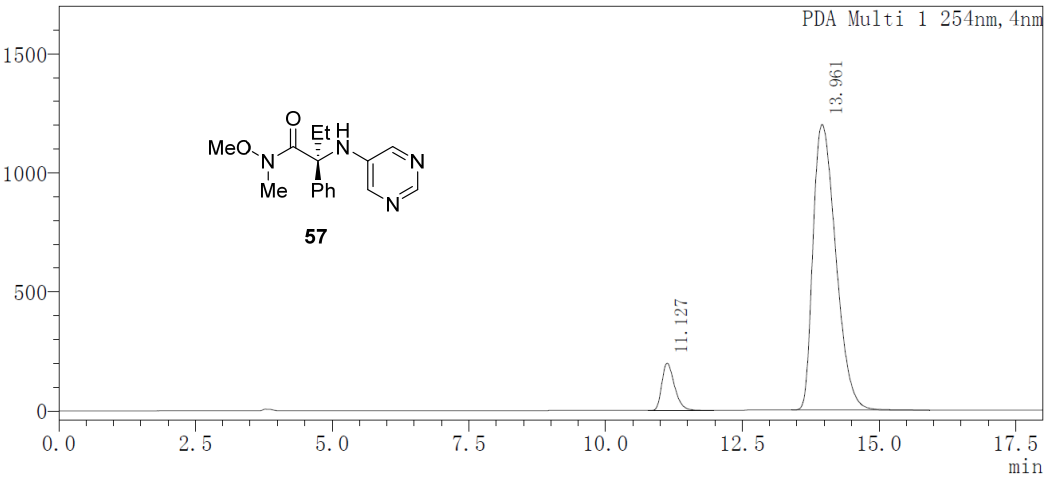
Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	11.040	3676900	49.755
2	13.875	3713121	50.245

mAU



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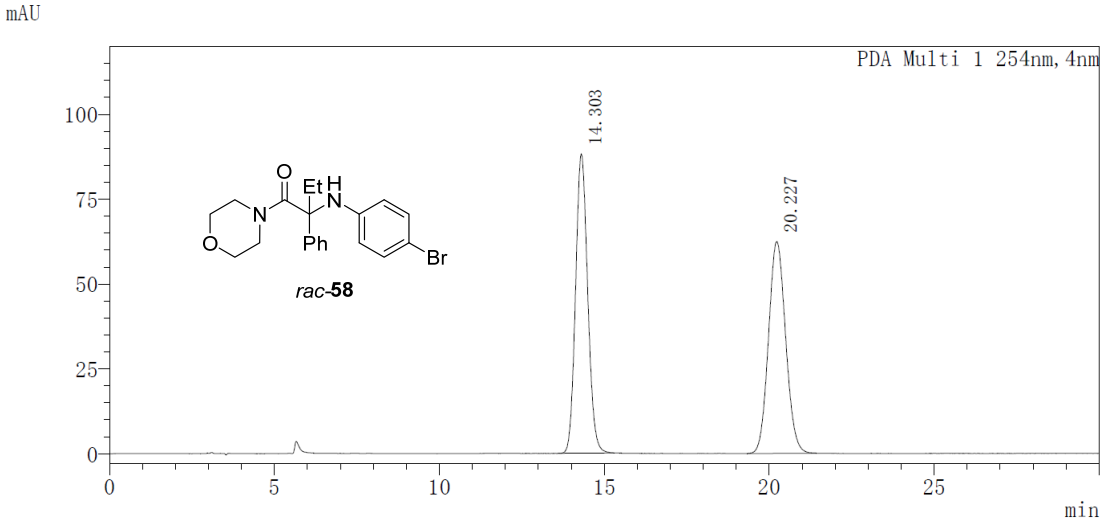
Peak Table

PDA Ch1 254nm

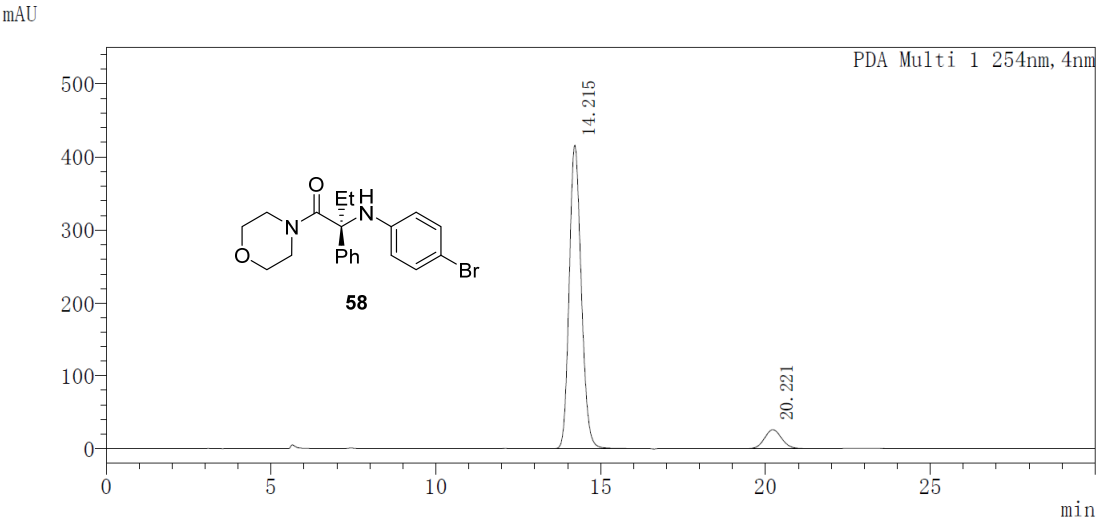
Peak#	Ret. Time	Area	Area%
1	11.127	3208091	8.435
2	13.961	34824810	91.565



Peak Table

PDA Ch1 254nm

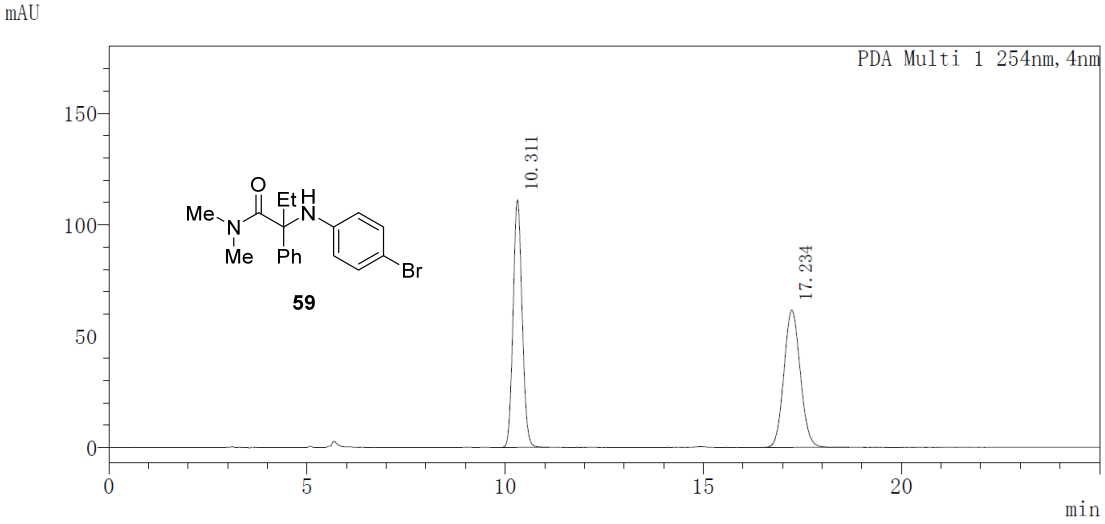
Peak#	Ret. Time	Area	Area%
1	14.303	2256512	50.000
2	20.227	2256524	50.000



Peak Table

PDA Ch1 254nm

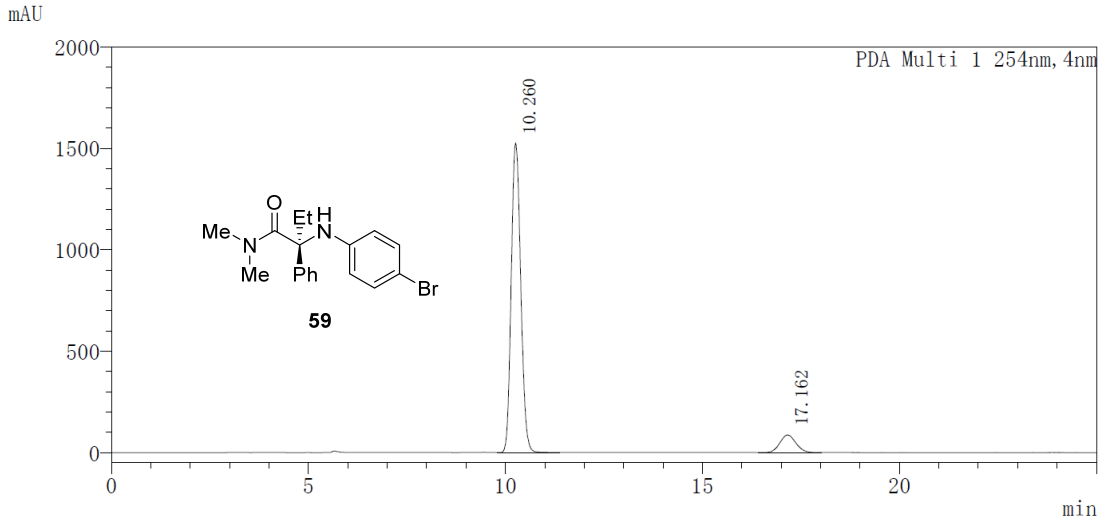
Peak#	Ret. Time	Area	Area%
1	14.215	10581378	91.952
2	20.221	926063	8.048



Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	10.311	1763680	49.956
2	17.234	1766765	50.044

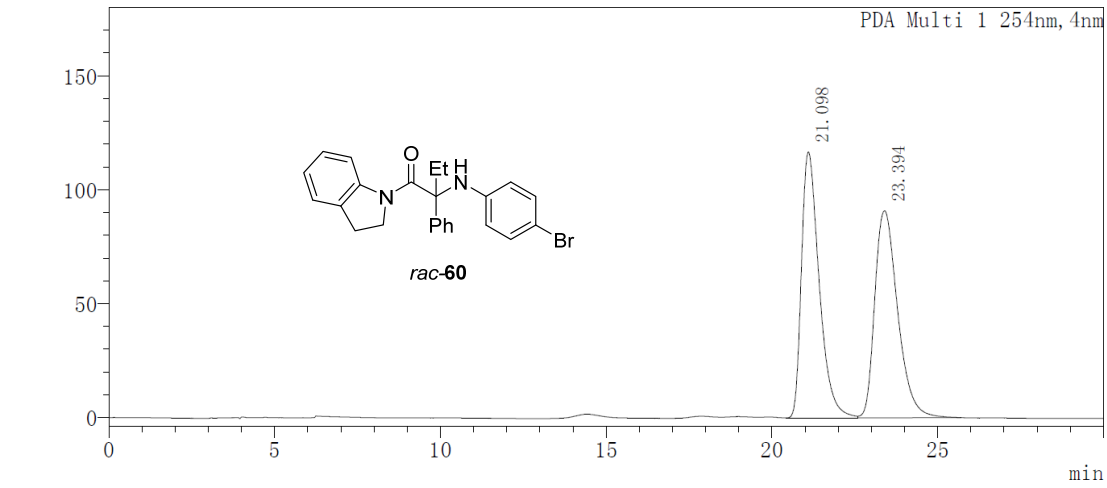


Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	10.260	25643105	91.254
2	17.162	2457824	8.746

mAU



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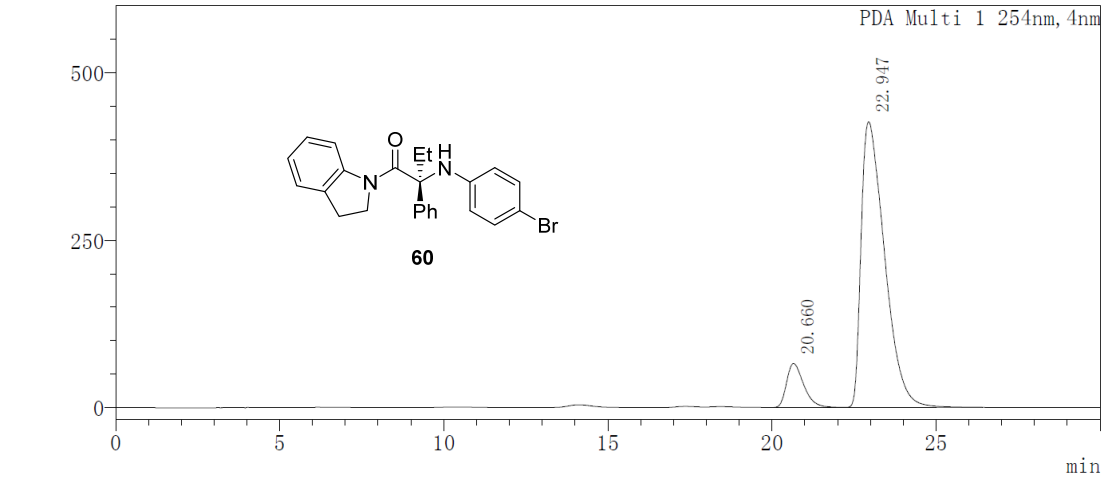
Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	21.098	4331047	49.826
2	23.394	4361257	50.174

mAU



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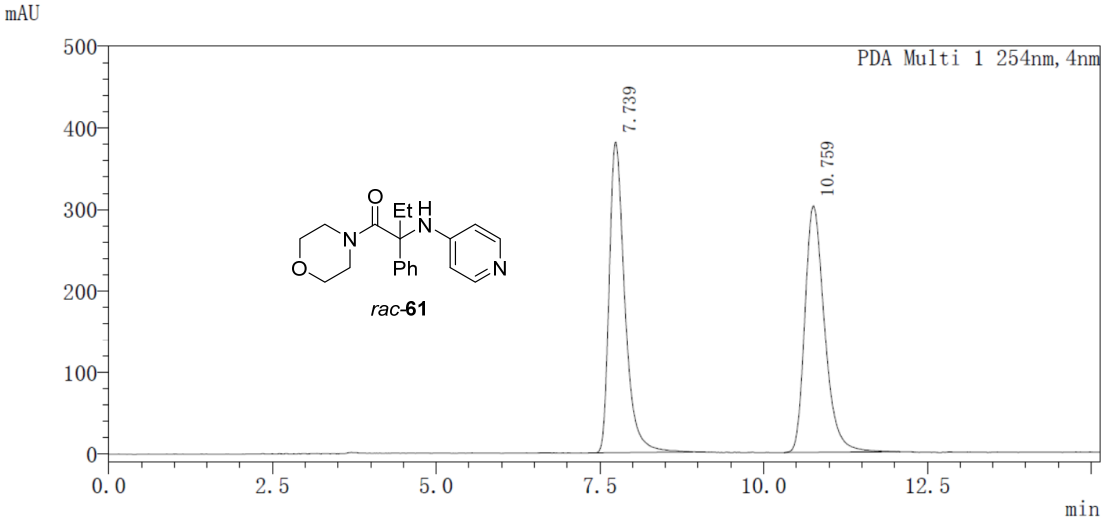
Peak Table

PDA Ch1 254nm

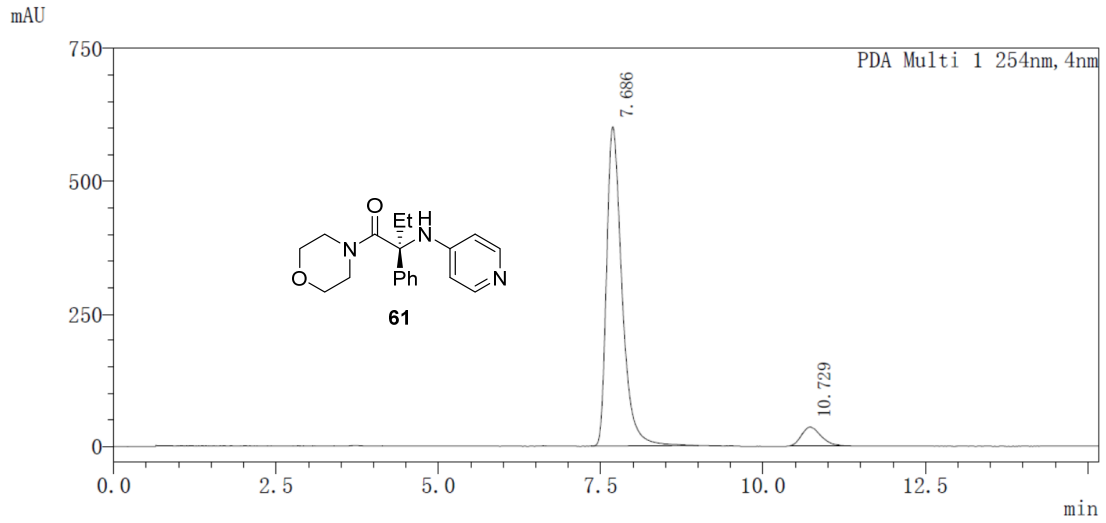
Peak#	Ret. Time	Area	Area%
1	20.660	2402919	10.149
2	22.947	21273067	89.851



Peak Table

PDA Ch1 254nm

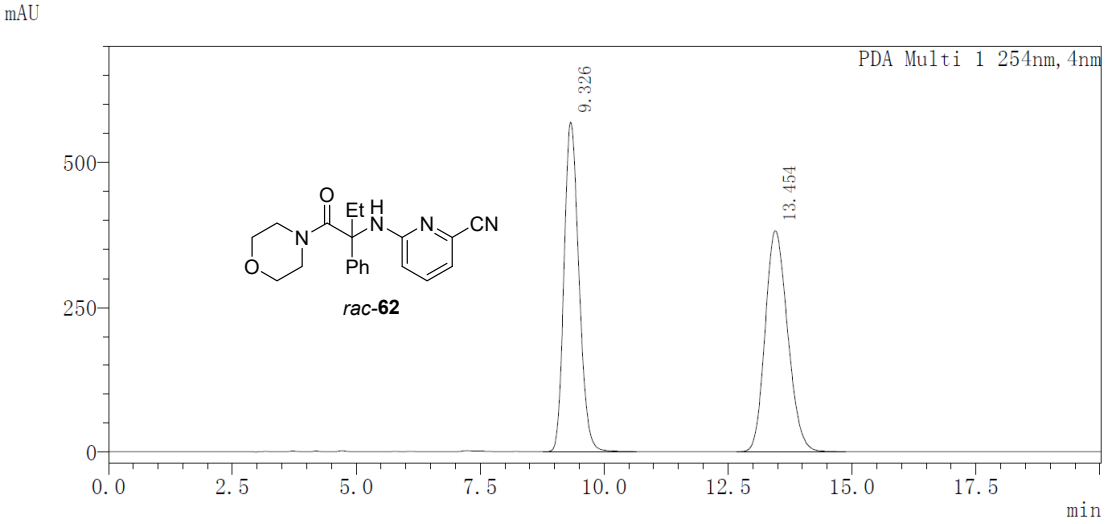
Peak#	Ret. Time	Area	Area%
1	7.739	6310975	49.921
2	10.759	6330868	50.079



Peak Table

PDA Ch1 254nm

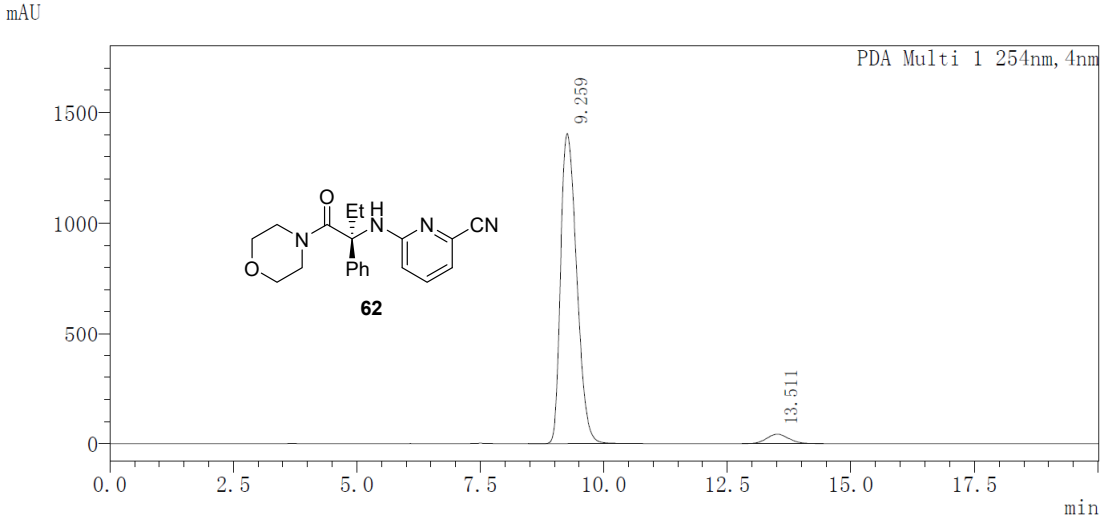
Peak#	Ret. Time	Area	Area%
1	7.686	9935014	93.327
2	10.729	710415	6.673



Peak Table

PDA Ch1 254nm

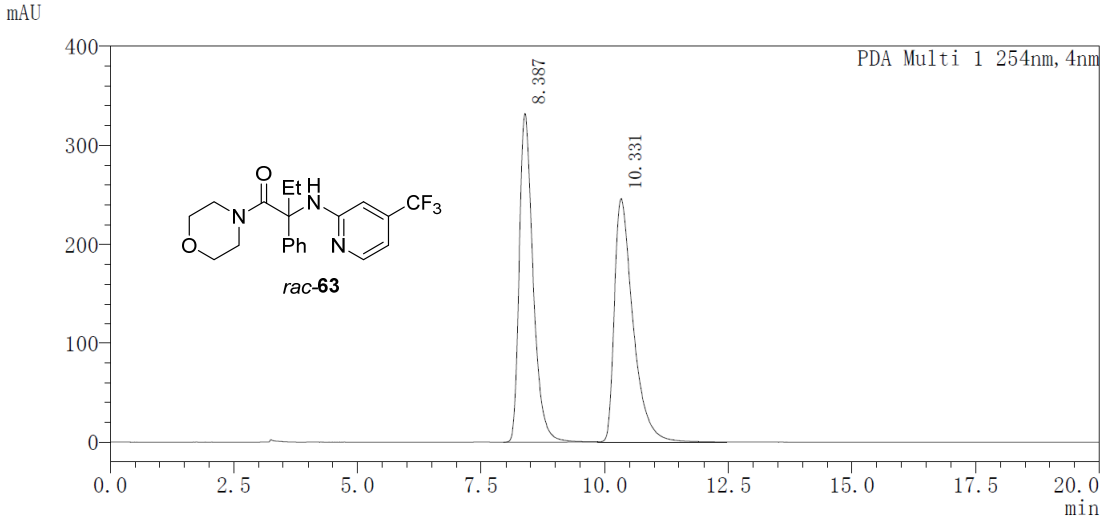
Peak#	Ret. Time	Area	Area%
1	9.326	11919880	49.672
2	13.454	12077277	50.328



Peak Table

PDA Ch1 254nm

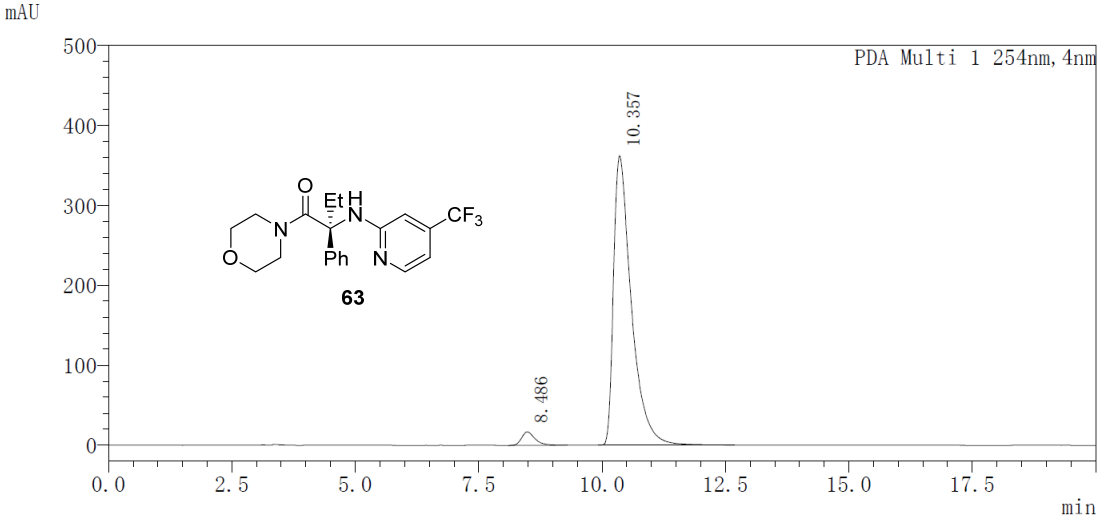
Peak#	Ret. Time	Area	Area%
1	9.259	31810698	96.015
2	13.511	1320373	3.985



Peak Table

PDA Ch1 254nm

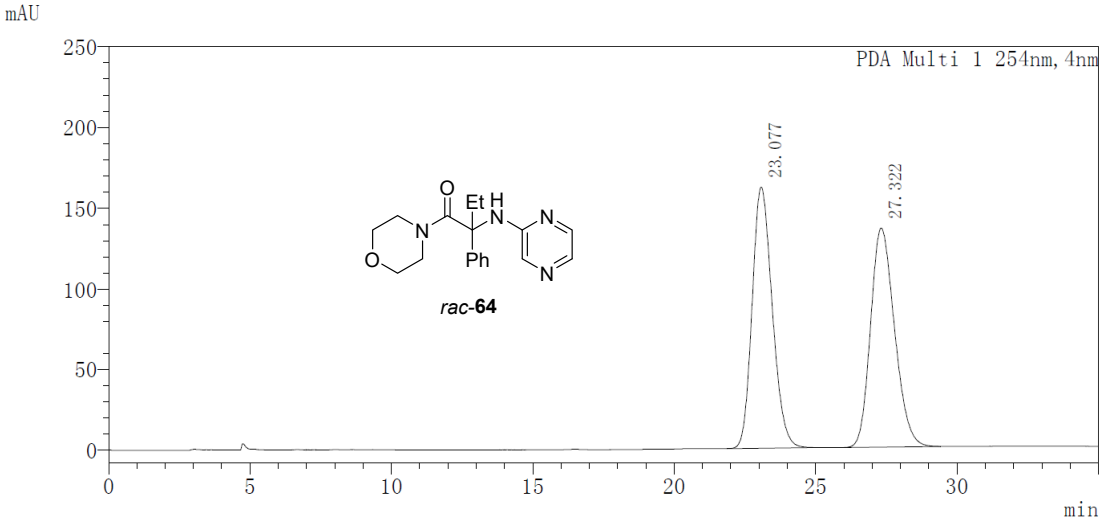
Peak#	Ret. Time	Area	Area%
1	8.387	6477019	50.027
2	10.331	6469922	49.973



Peak Table

PDA Ch1 254nm

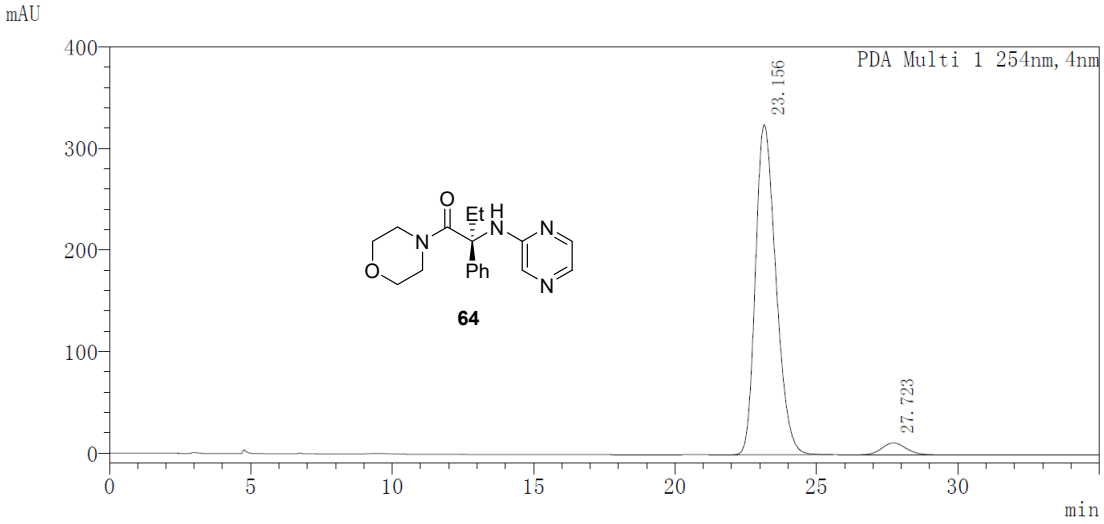
Peak#	Ret. Time	Area	Area%
1	8.486	314396	3.339
2	10.357	9102569	96.661



Peak Table

PDA Ch1 254nm

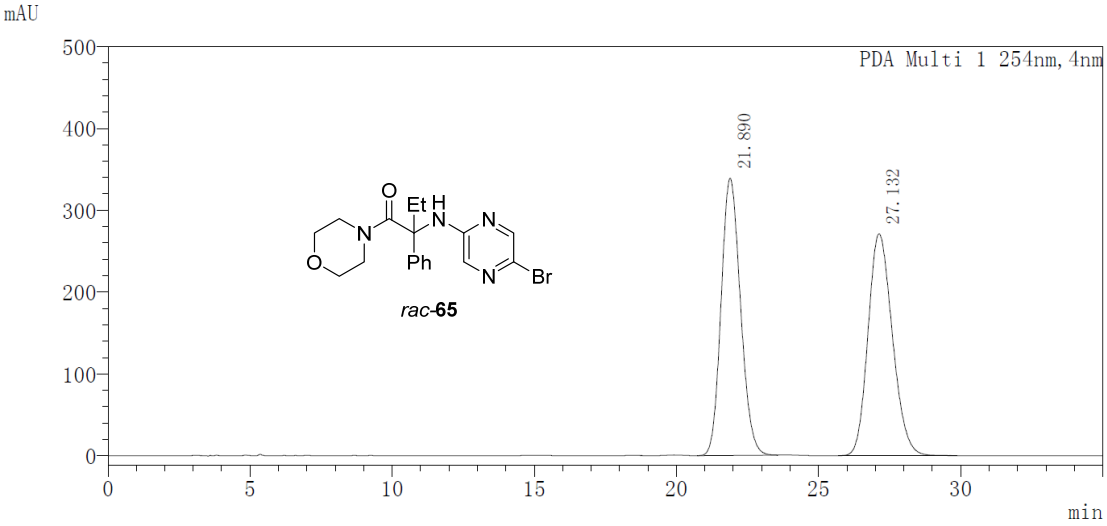
Peak#	Ret. Time	Area	Area%
1	23.077	8004812	49.994
2	27.322	8006623	50.006



Peak Table

PDA Ch1 254nm

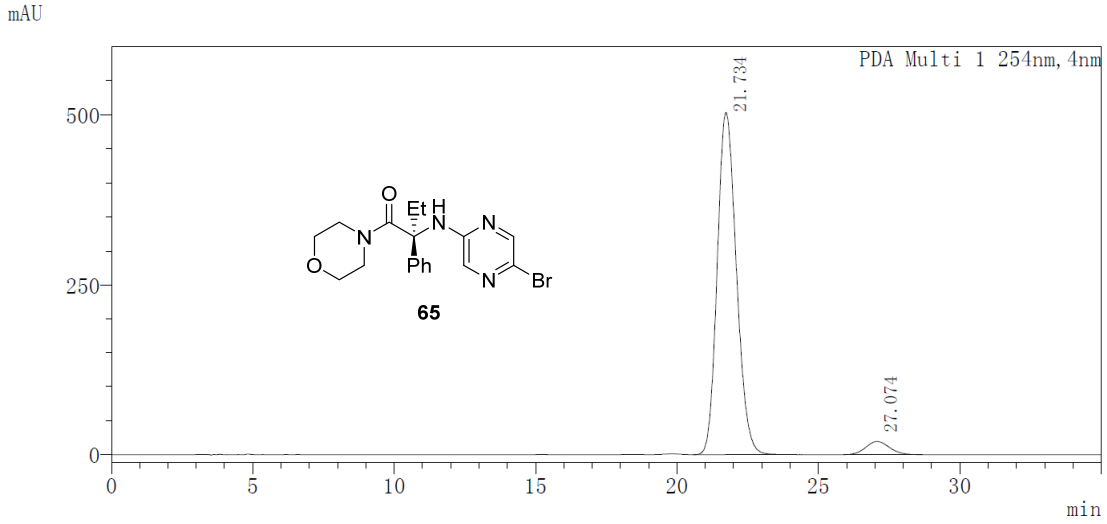
Peak#	Ret. Time	Area	Area%
1	23.156	16357015	95.915
2	27.723	696673	4.085



Peak Table

PDA Ch1 254nm

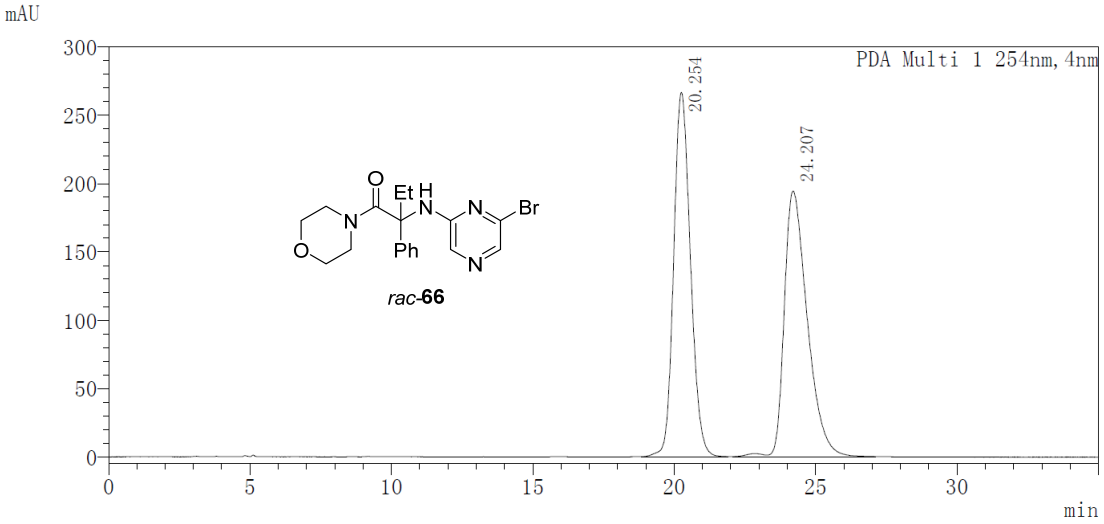
Peak#	Ret. Time	Area	Area%
1	21.890	16065238	49.825
2	27.132	16177974	50.175



Peak Table

PDA Ch1 254nm

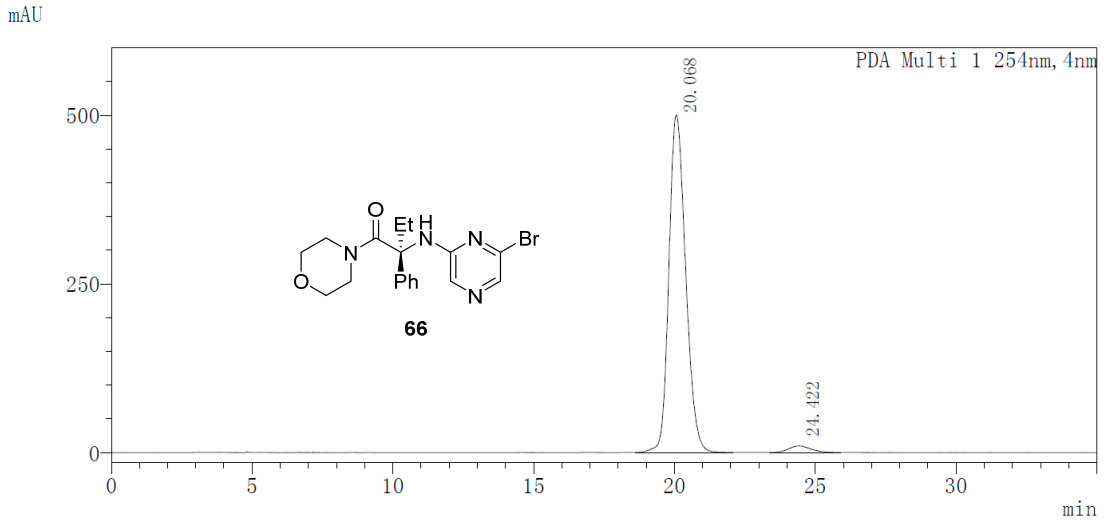
Peak#	Ret. Time	Area	Area%
1	21.734	23705205	95.477
2	27.074	1123003	4.523



Peak Table

PDA Ch1 254nm

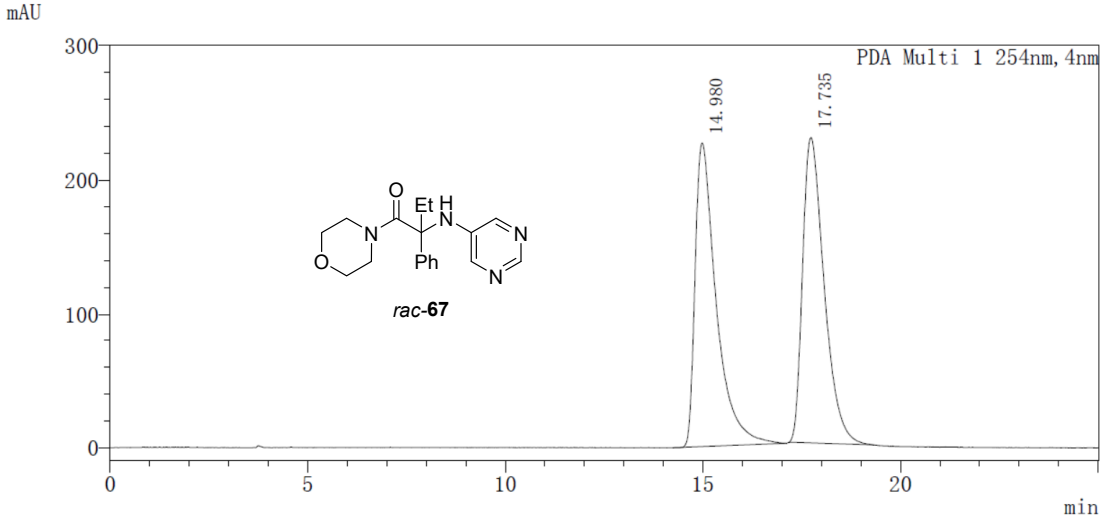
Peak#	Ret. Time	Area	Area%
1	20.254	11013818	50.017
2	24.207	11006387	49.983



Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	20.068	20681630	97.465
2	24.422	537962	2.535



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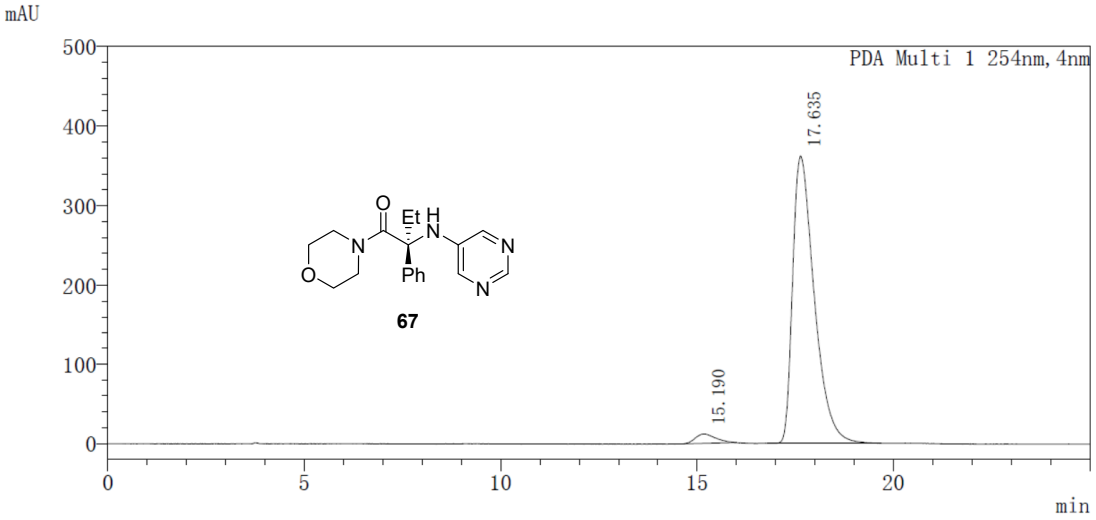
Peak Table

PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	14.980	8445272	49.382
2	17.735	8656785	50.618



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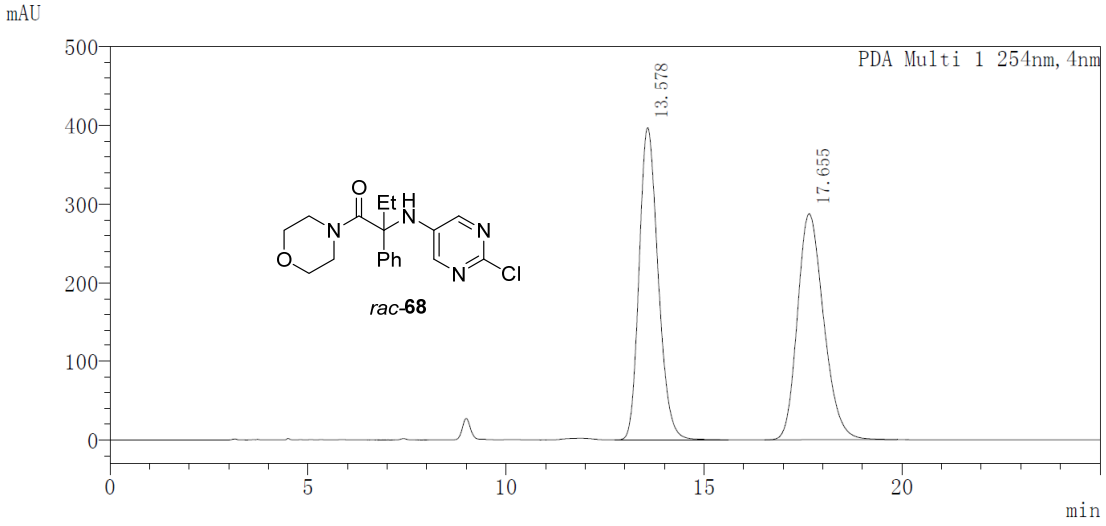
Peak Table

PDA Ch1 254nm

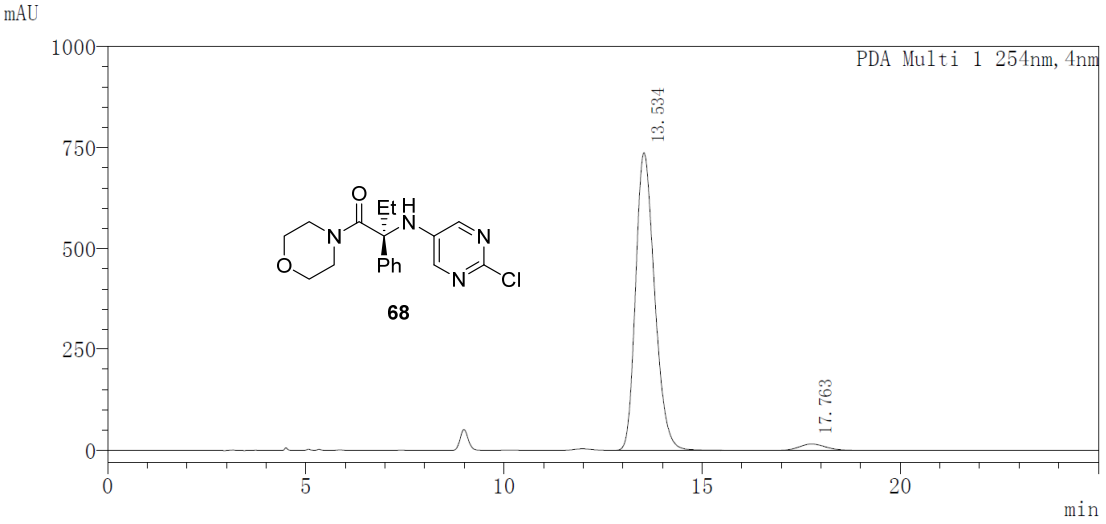
Peak#	Ret. Time	Area	Area%
1	15.190	425160	2.981
2	17.635	13835858	97.019



Peak Table

PDA Ch1 254nm

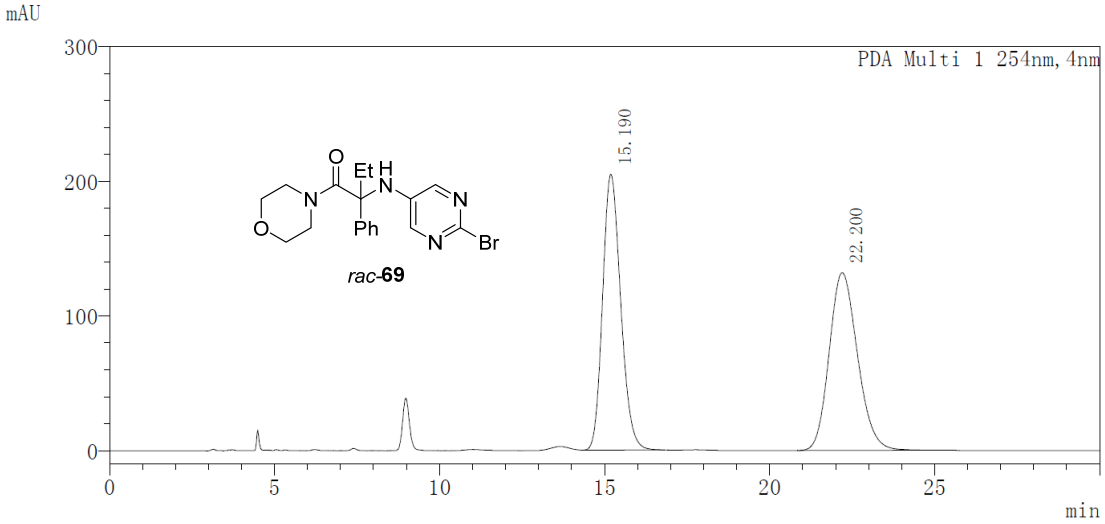
Peak#	Ret. Time	Area	Area%
1	13.578	13258084	50.010
2	17.655	13252858	49.990



Peak Table

PDA Ch1 254nm

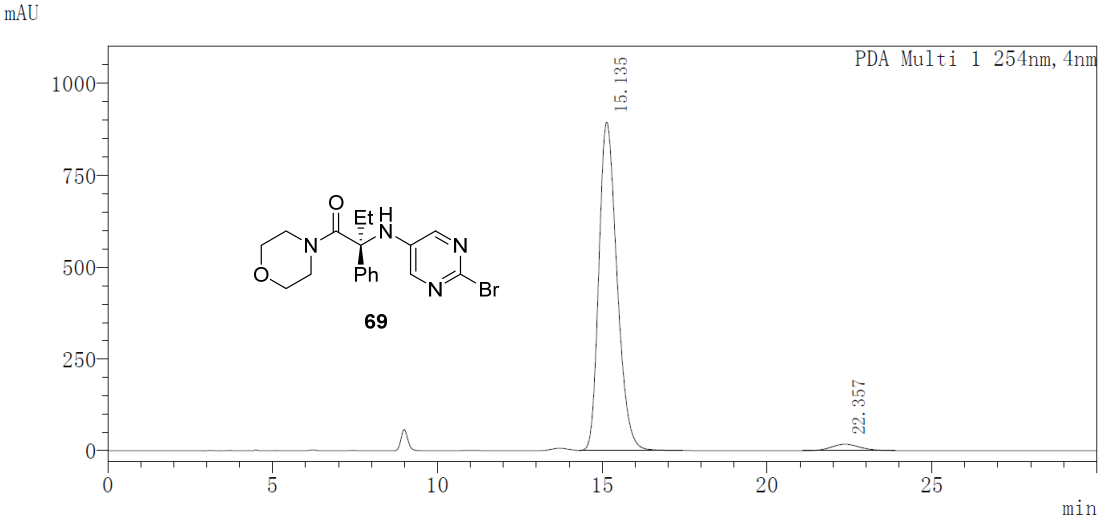
Peak#	Ret. Time	Area	Area%
1	13.534	24541569	97.120
2	17.763	727855	2.880



Peak Table

PDA Ch1 254nm

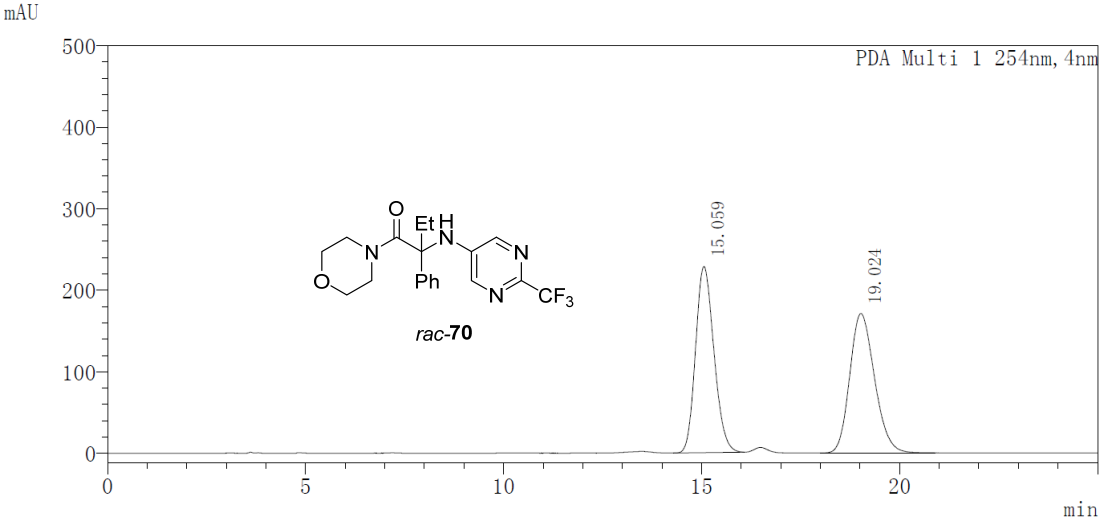
Peak#	Ret. Time	Area	Area%
1	15.190	7822092	49.900
2	22.200	7853514	50.100



Peak Table

PDA Ch1 254nm

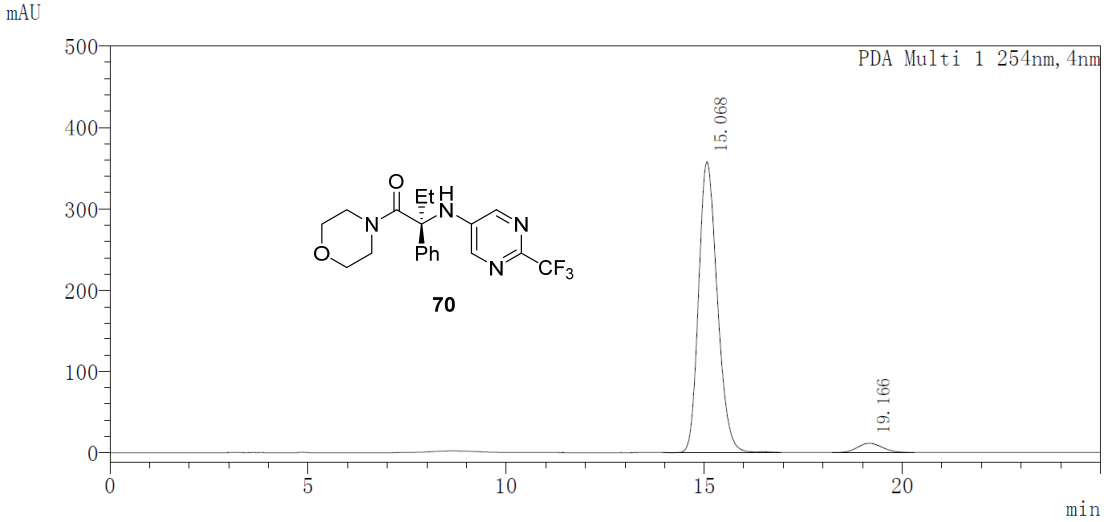
Peak#	Ret. Time	Area	Area%
1	15.135	34164773	97.078
2	22.357	1028313	2.922



Peak Table

PDA Ch1 254nm

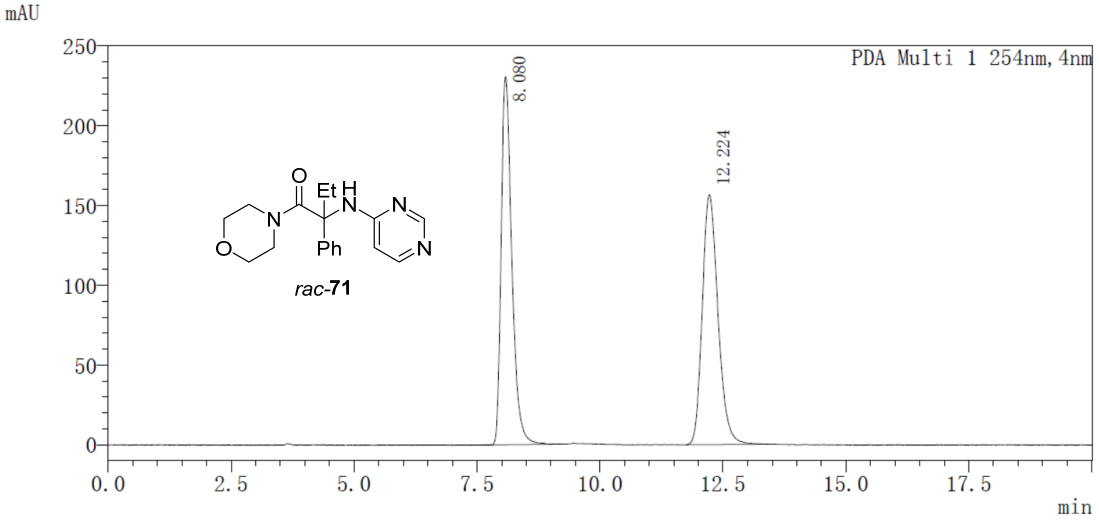
Peak#	Ret. Time	Area	Area%
1	15.059	7400563	49.791
2	19.024	7462680	50.209



Peak Table

PDA Ch1 254nm

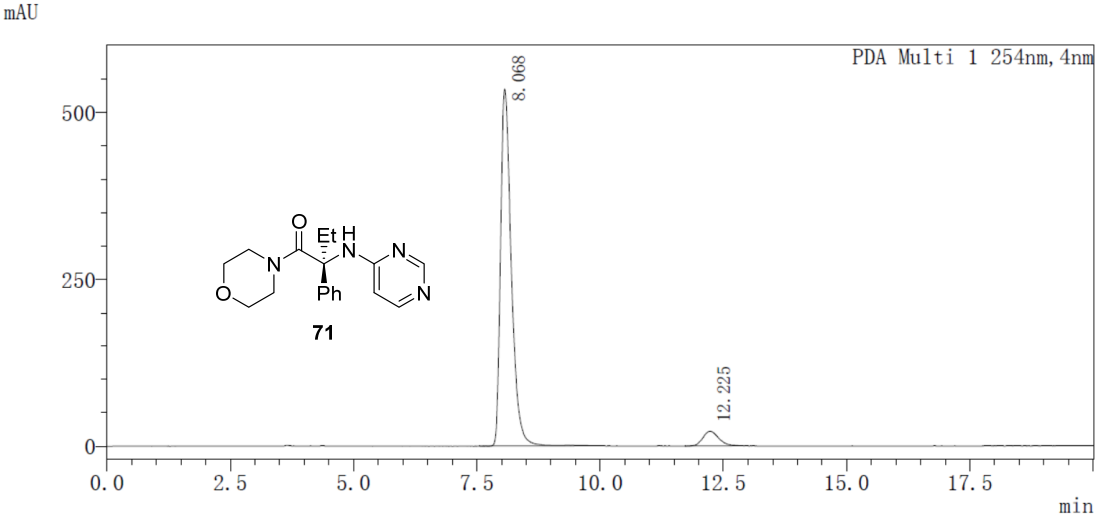
Peak#	Ret. Time	Area	Area%
1	15.068	11726374	95.931
2	19.166	497429	4.069



Peak Table

PDA Ch1 254nm

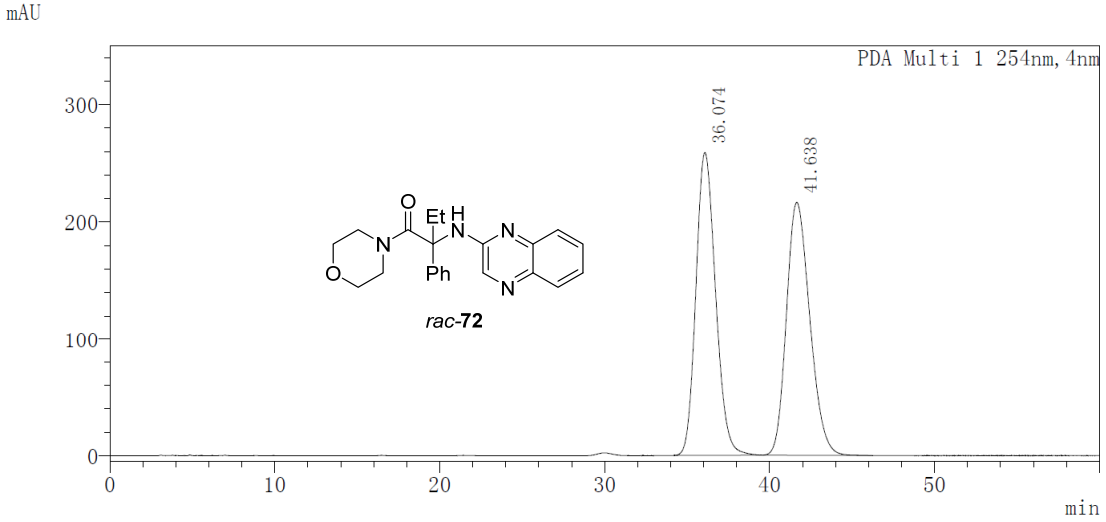
Peak#	Ret. Time	Area	Area%
1	8.080	3471036	49.889
2	12.224	3486483	50.111



Peak Table

PDA Ch1 254nm

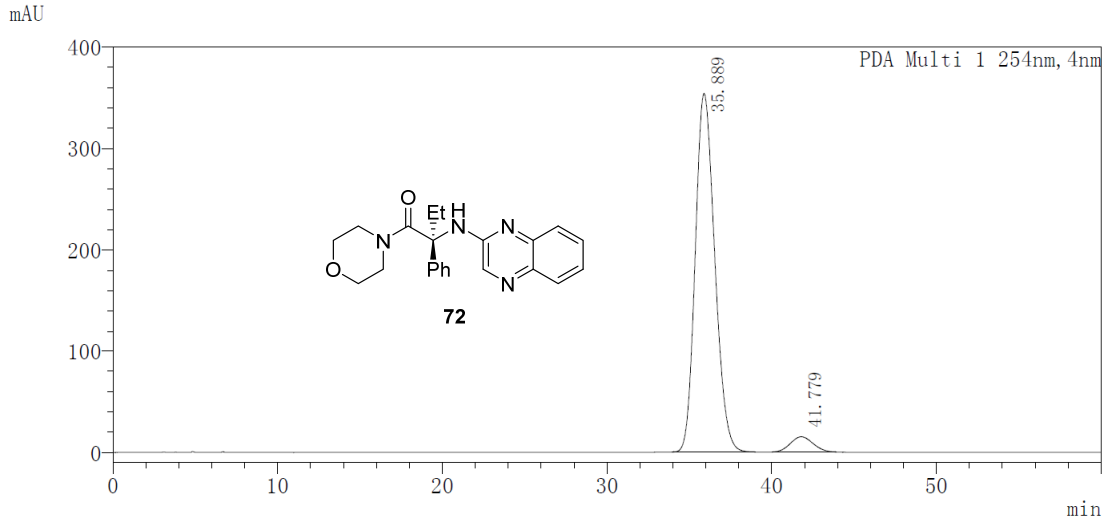
Peak#	Ret. Time	Area	Area%
1	8.068	8098968	94.344
2	12.225	485503	5.656



Peak Table

PDA Ch1 254nm

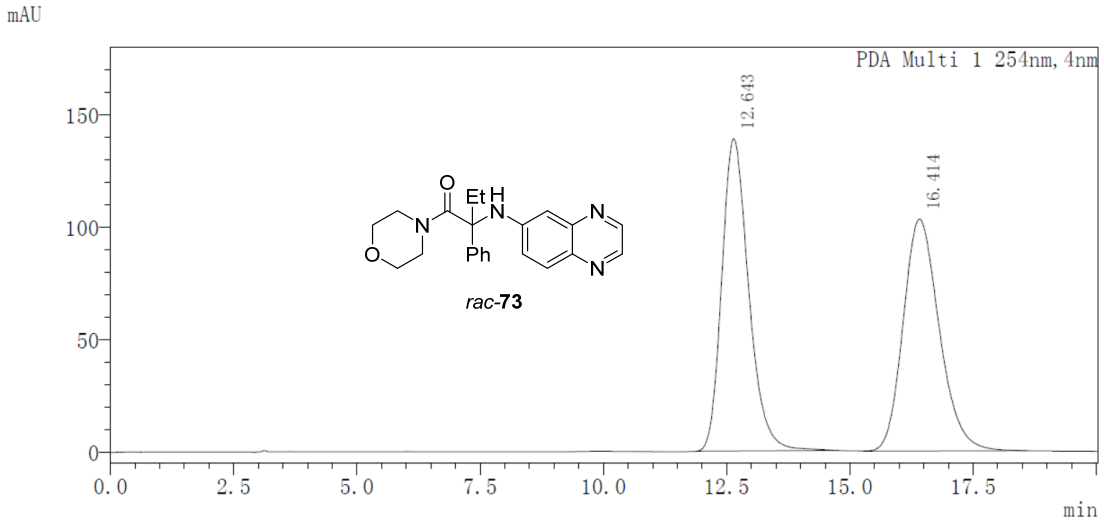
Peak#	Ret. Time	Area	Area%
1	36.074	21471042	50.151
2	41.638	21341475	49.849



Peak Table

PDA Ch1 254nm

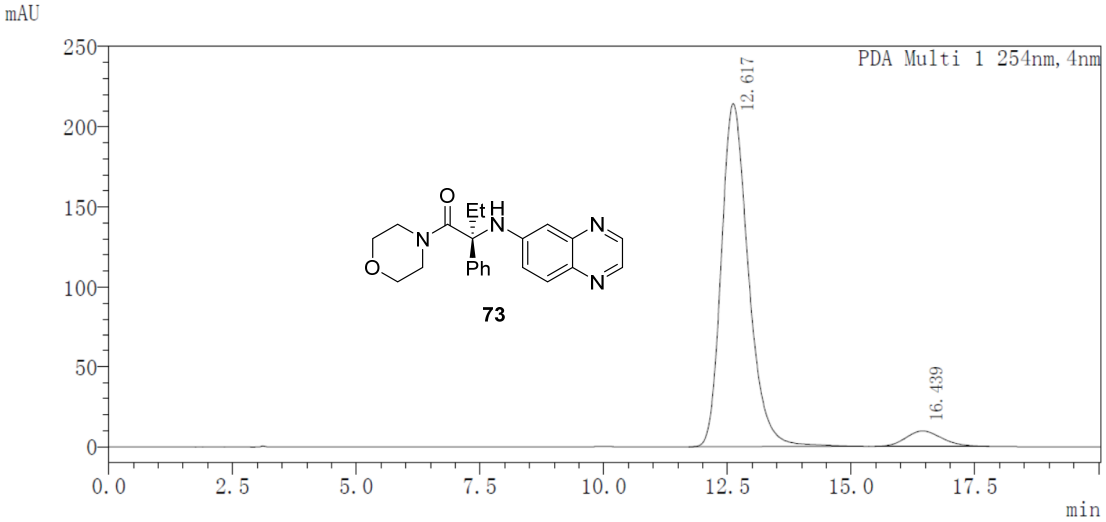
Peak#	Ret. Time	Area	Area%
1	35.889	29118625	95.308
2	41.779	1433407	4.692



Peak Table

PDA Ch1 254nm

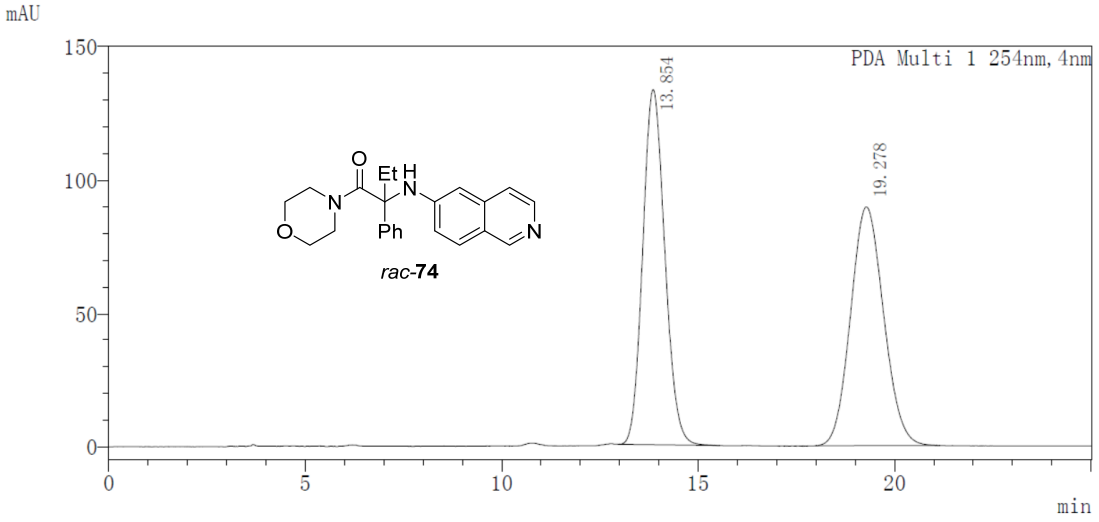
Peak#	Ret. Time	Area	Area%
1	12.643	5286564	50.091
2	16.414	5267412	49.909



Peak Table

PDA Ch1 254nm

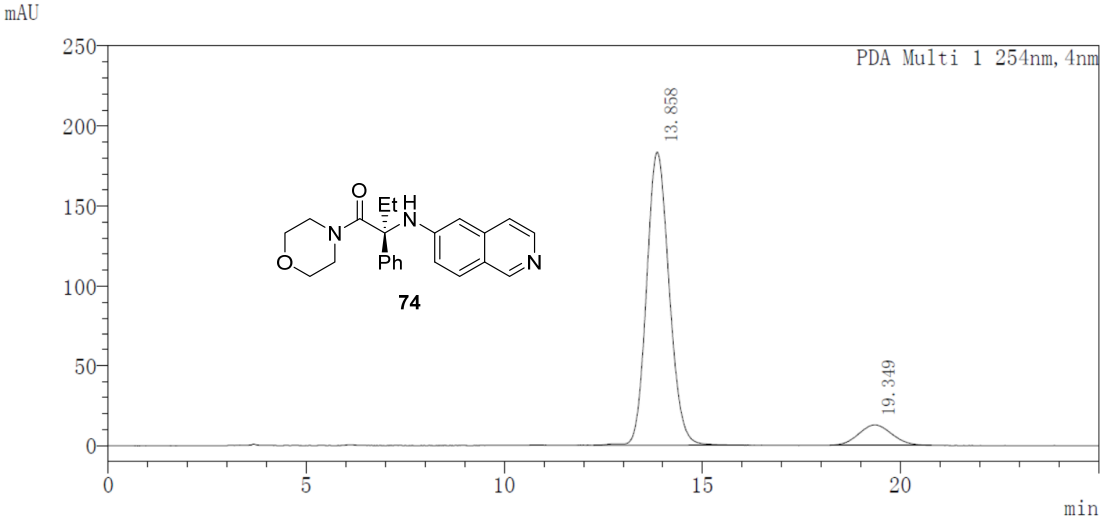
Peak#	Ret. Time	Area	Area%
1	12.617	8159426	94.392
2	16.439	484807	5.608



Peak Table

PDA Ch1 254nm

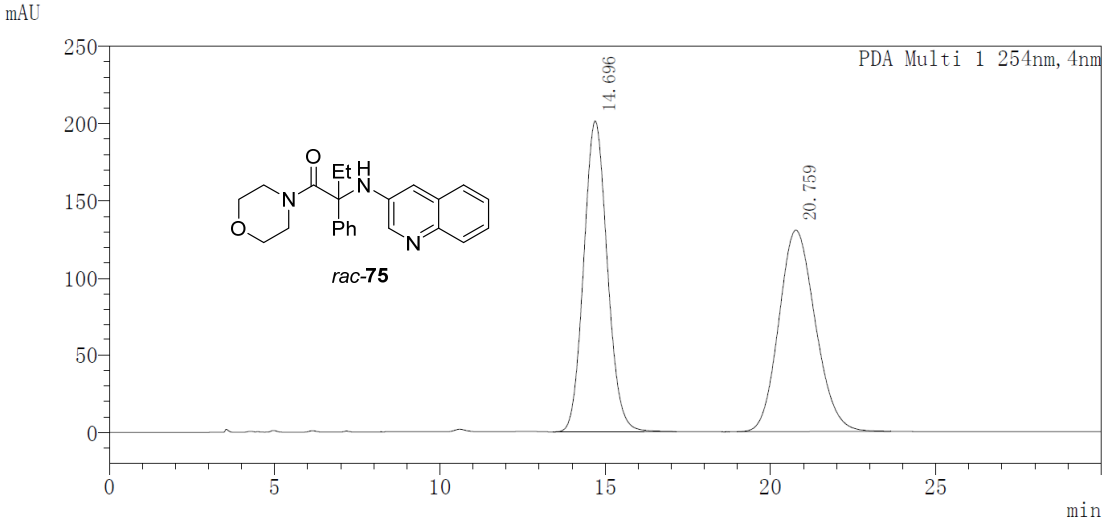
Peak#	Ret. Time	Area	Area%
1	13.854	5212710	49.831
2	19.278	5248017	50.169



Peak Table

PDA Ch1 254nm

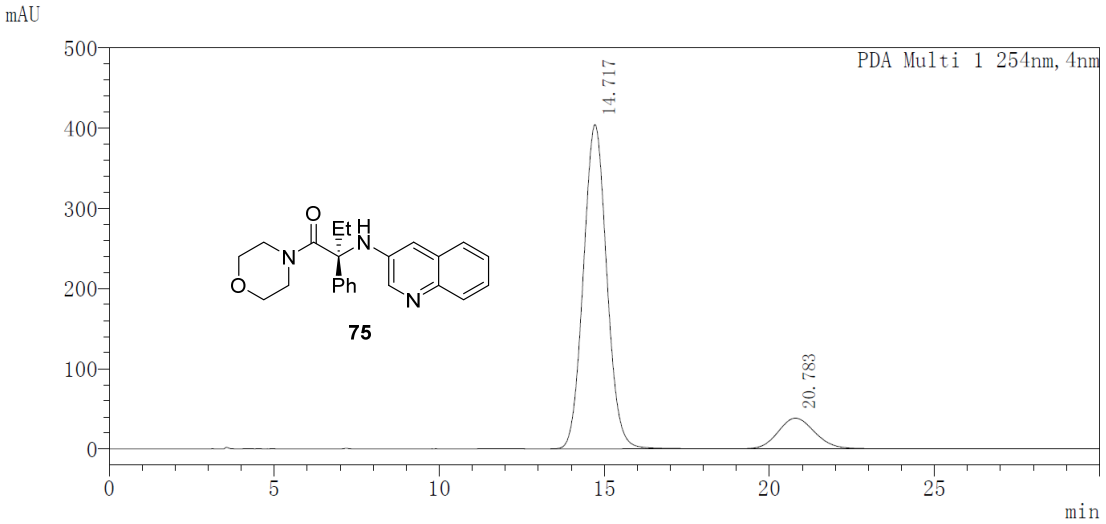
Peak#	Ret. Time	Area	Area%
1	13.858	7259074	90.815
2	19.349	734172	9.185



Peak Table

PDA Ch1 254nm

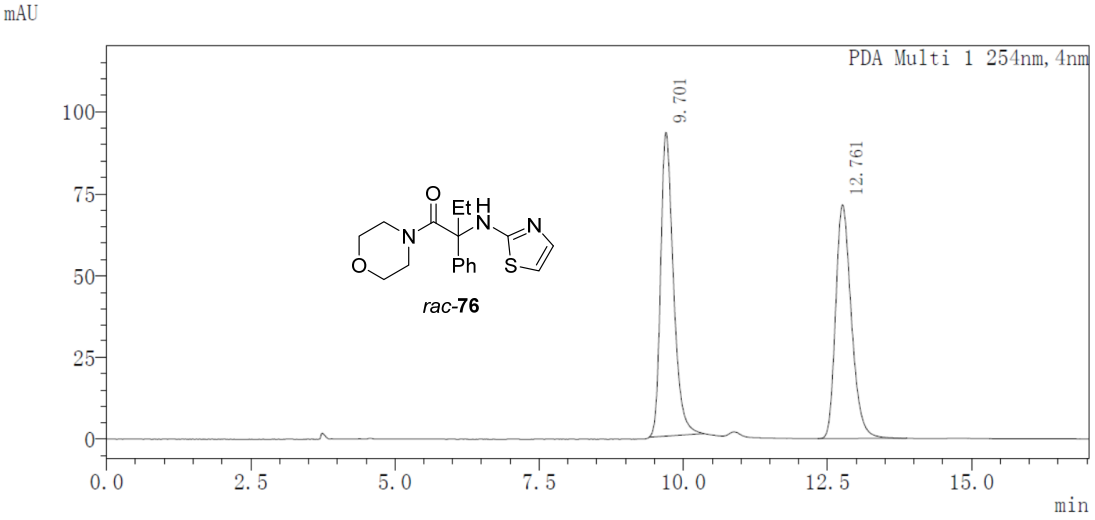
Peak#	Ret. Time	Area	Area%
1	14.696	9993401	49.977
2	20.759	10002616	50.023



Peak Table

PDA Ch1 254nm

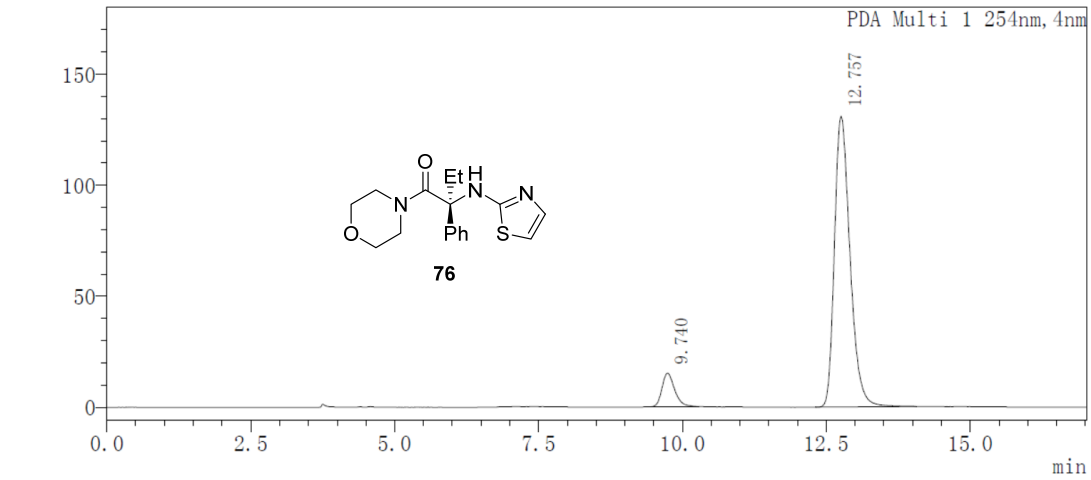
Peak#	Ret. Time	Area	Area%
1	14.717	19884282	87.230
2	20.783	2910882	12.770



Peak Table

PDA Ch1 254nm

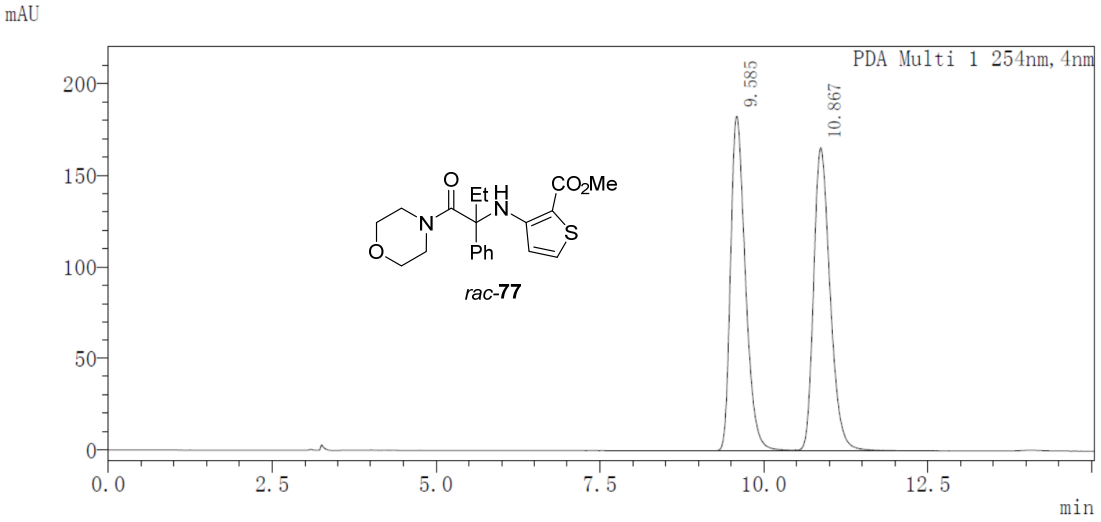
Peak#	Ret. Time	Area	Area%
1	9.701	1432957	51.343
2	12.761	1357998	48.657



Peak Table

PDA Ch1 254nm

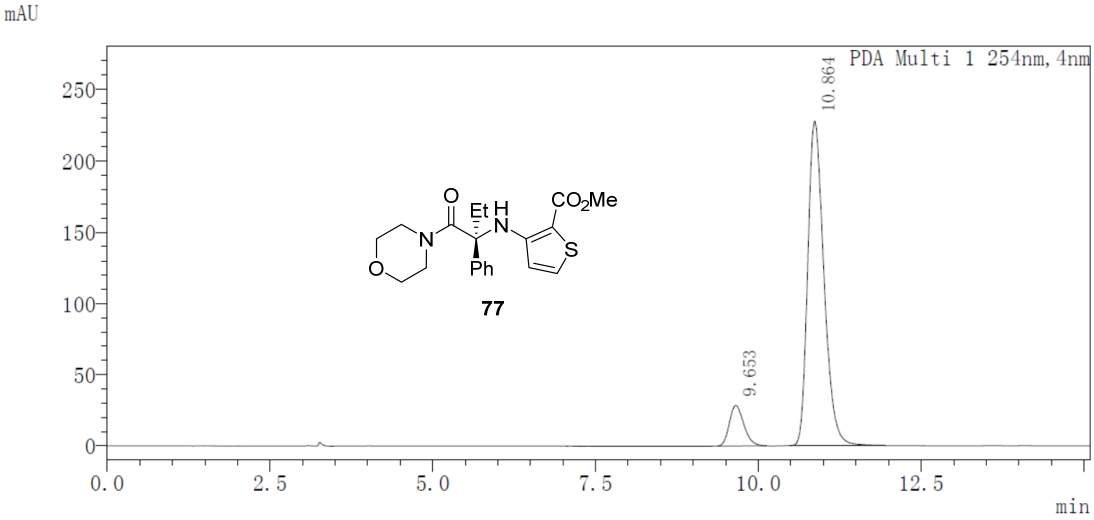
Peak#	Ret. Time	Area	Area%
1	9.740	226368	8.412
2	12.757	2464775	91.588



Peak Table

PDA Ch1 254nm

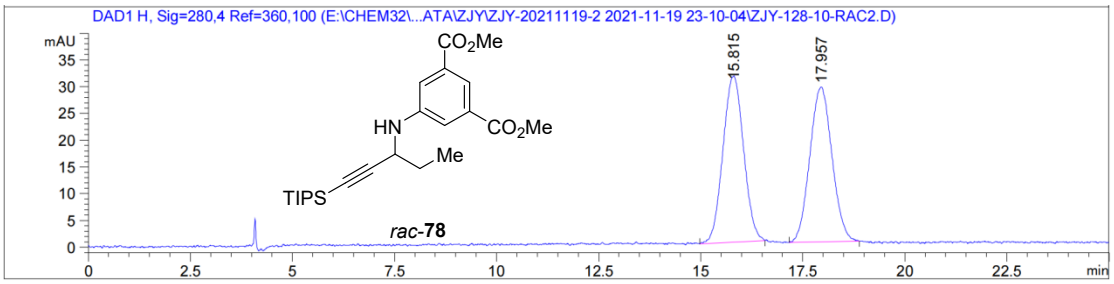
Peak#	Ret. Time	Area	Area%
1	9.585	2875966	49.856
2	10.867	2892594	50.144



Peak Table

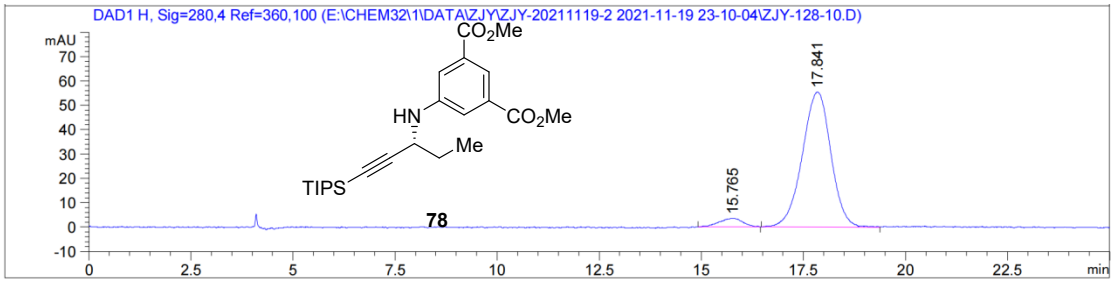
PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	9.653	437548	9.986
2	10.864	3944028	90.014



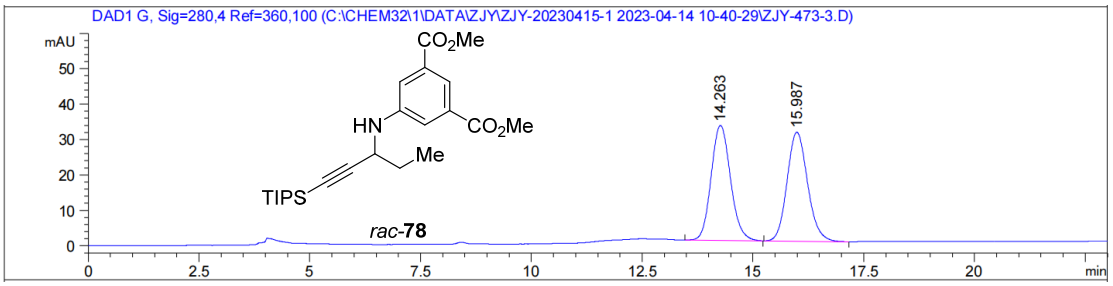
Signal 8: DAD1 H, Sig=280,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.815	VB R	0.4566	1092.95593	31.05813	49.9373
2	17.957	BV R	0.4873	1095.70178	28.96818	50.0627
Totals :				2188.65771	60.02631	



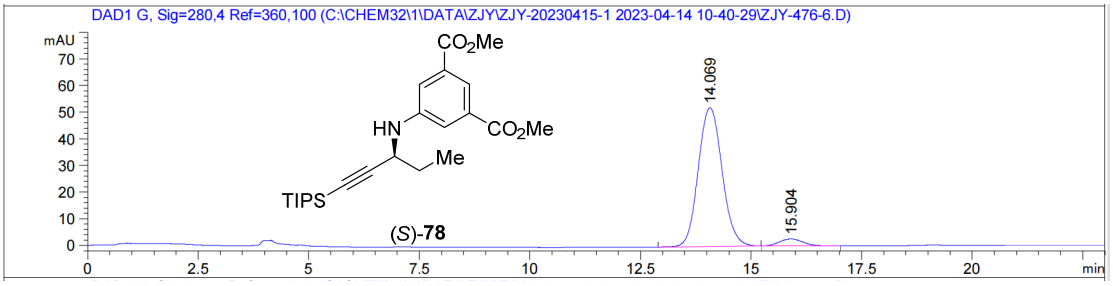
Signal 8: DAD1 H, Sig=280,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.765	MM R	0.6837	144.39362	3.51989	5.0695
2	17.841	MM R	0.8126	2703.87354	55.45856	94.9305
Totals :				2848.26715	58.97844	



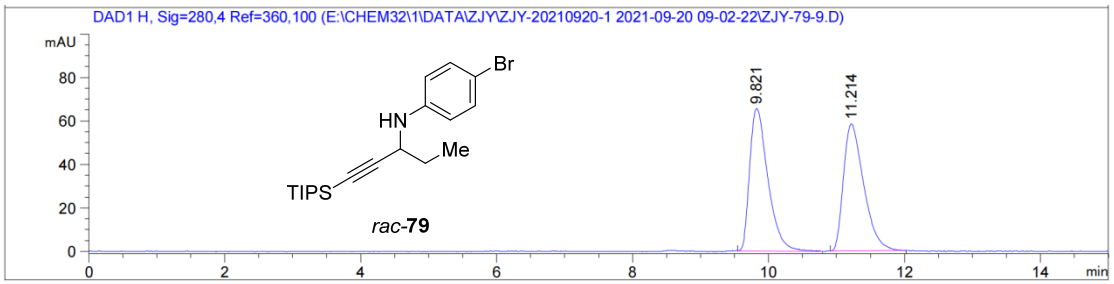
Signal 7: DAD1 G, Sig=280,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.263	BB	0.4742	984.46021	32.42763	49.8675
2	15.987	BB	0.5011	989.69073	30.78197	50.1325



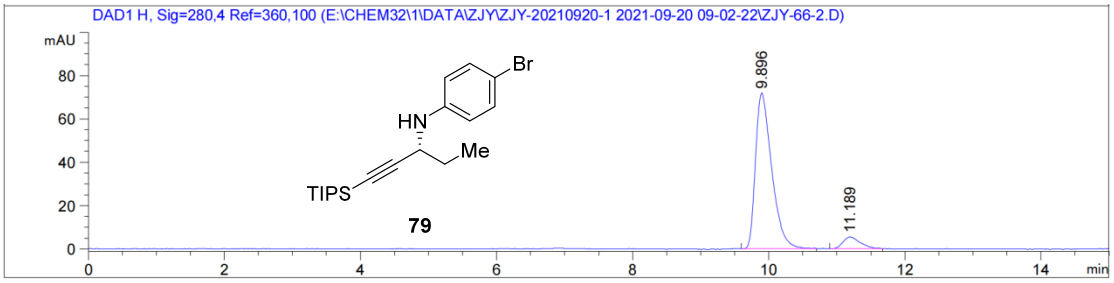
Signal 7: DAD1 G, Sig=280,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.069	BB	0.5908	1949.42114	52.06353	95.1626
2	15.904	BB	0.5473	99.09438	2.64386	4.8374
Totals :				2048.51552	54.70740	



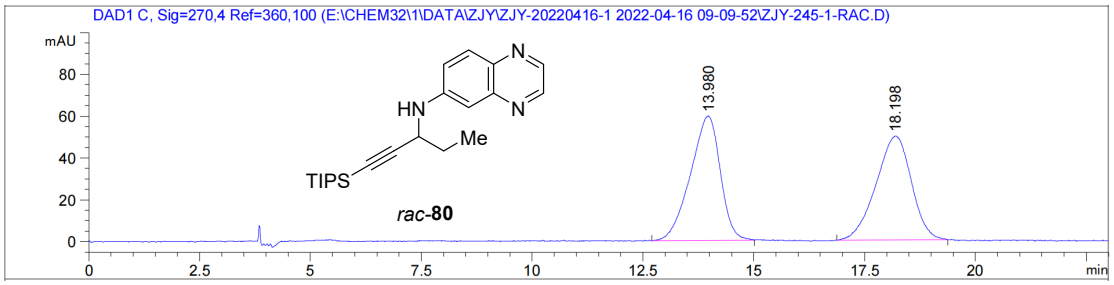
Signal 8: DAD1 H, Sig=280,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.821	BB	0.2851	1218.43982	65.46615	50.1681
2	11.214	BB	0.3238	1210.27637	58.40165	49.8319
Totals :				2428.71619	123.86779	



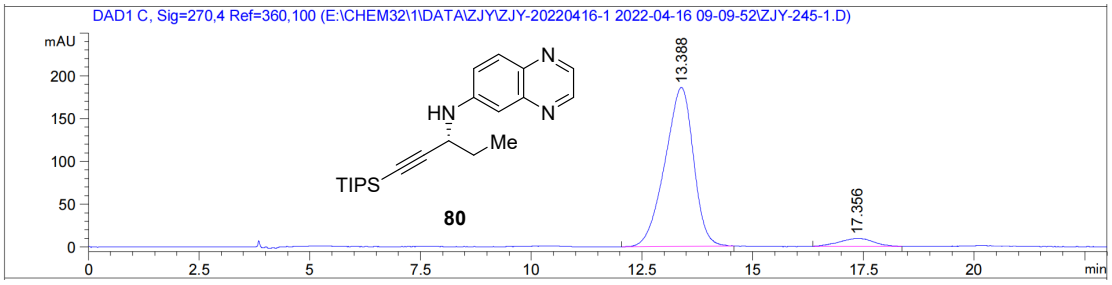
Signal 8: DAD1 H, Sig=280,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.896	BV R	0.2553	1188.84741	71.75516	92.5625
2	11.189	BB	0.2218	95.52575	5.41448	7.4375
Totals :				1284.37316	77.16964	



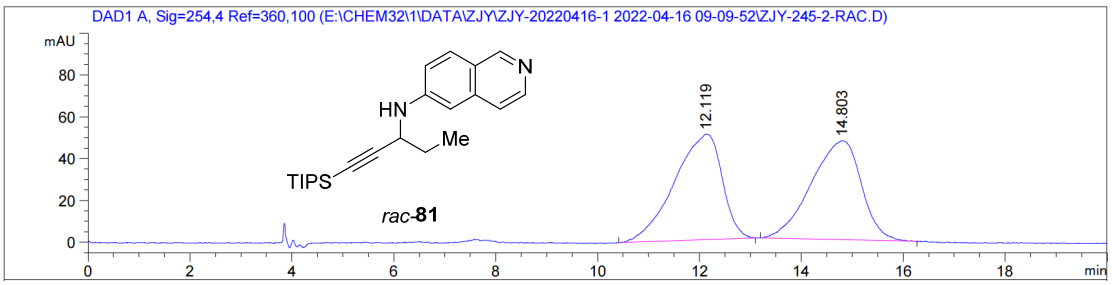
Signal 3: DAD1 C, Sig=270,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.980	BB	0.5804	2785.78638	59.47653	50.1998
2	18.198	BB	0.6576	2763.61157	49.78625	49.8002
Totals :				5549.39795	109.26278	



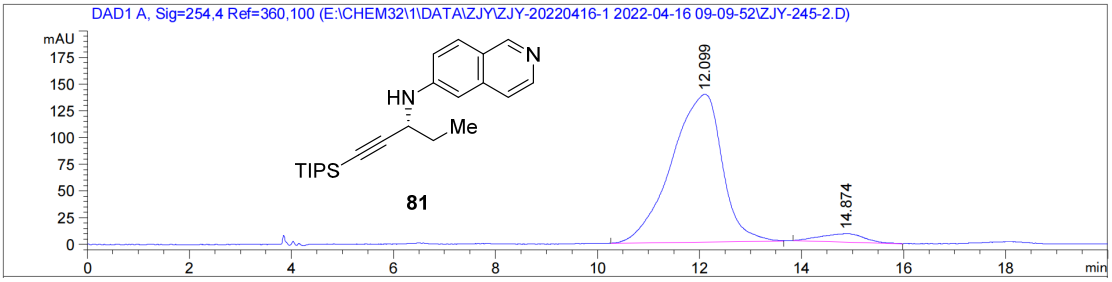
Signal 3: DAD1 C, Sig=270,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.388	BV R	0.6430	8319.38965	185.57851	94.3790
2	17.356	BV R	0.6316	495.48523	9.36040	5.6210
Totals :				8814.87488	194.93891	



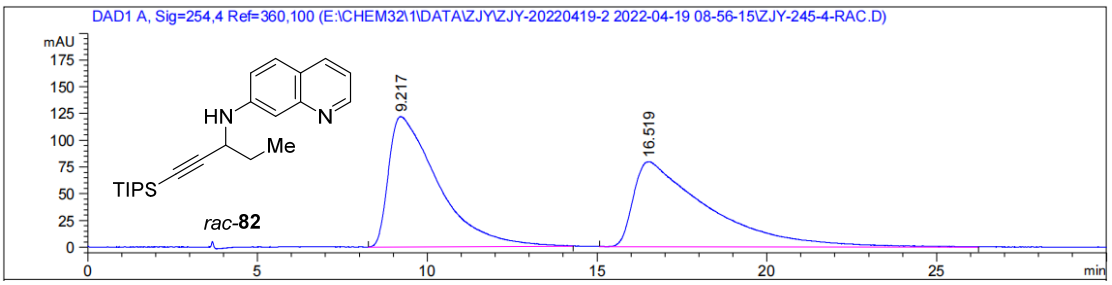
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.119	BB	0.7769	3286.73804	50.39703	50.2445
2	14.803	BV R	0.8237	3254.74658	47.36638	49.7555
Totals :				6541.48462	97.76340	



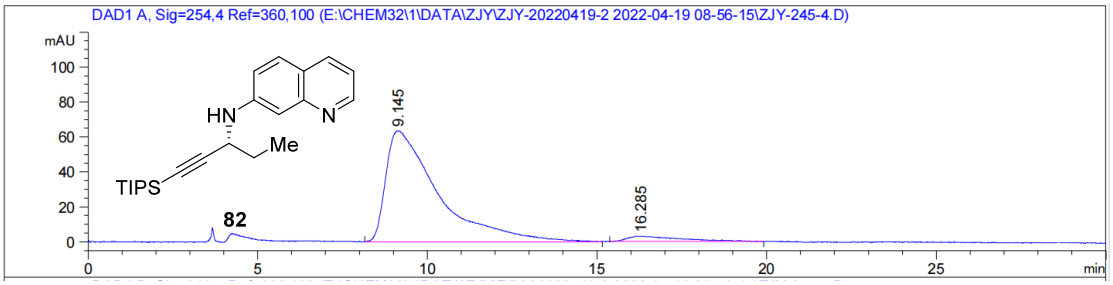
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.099	BB	0.9028	9520.75488	138.36673	95.3925
2	14.874	BB	0.6809	459.85623	7.94888	4.6075
Totals :				9980.61111	146.31561	



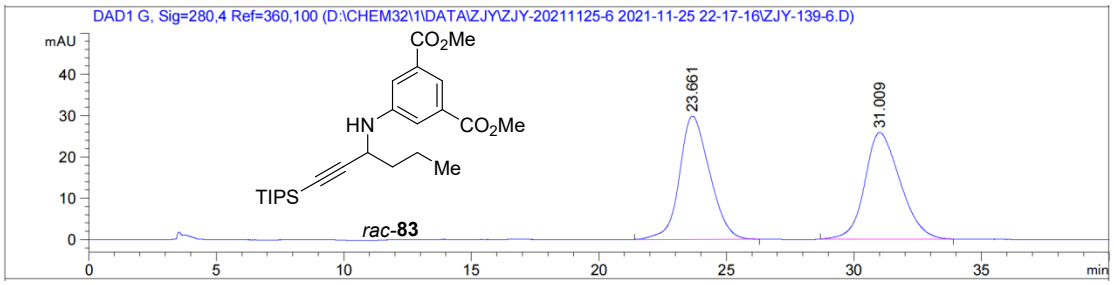
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.217	MM R	1.6884	1.23480e4	121.88744	50.2238
2	16.519	MM R	2.5620	1.22380e4	79.61347	49.7762
Totals :				2.45860e4	201.50092	



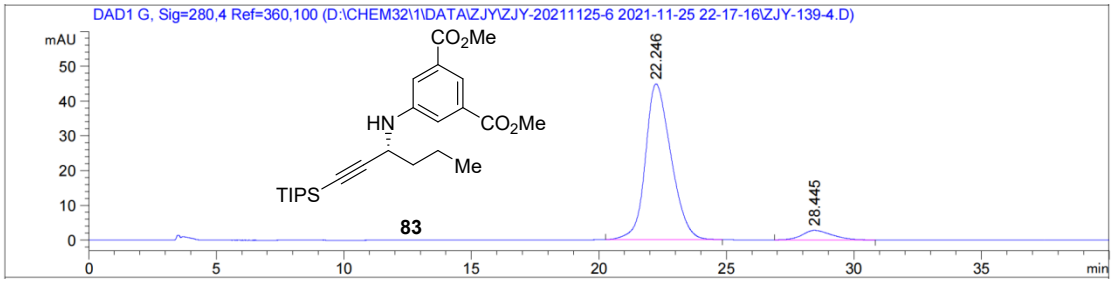
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.145	MM R	1.7848	6818.36426	63.67159	95.0881
2	16.285	MM R	1.9002	352.21371	3.08924	4.9119
Totals :				7170.57797	66.76084	



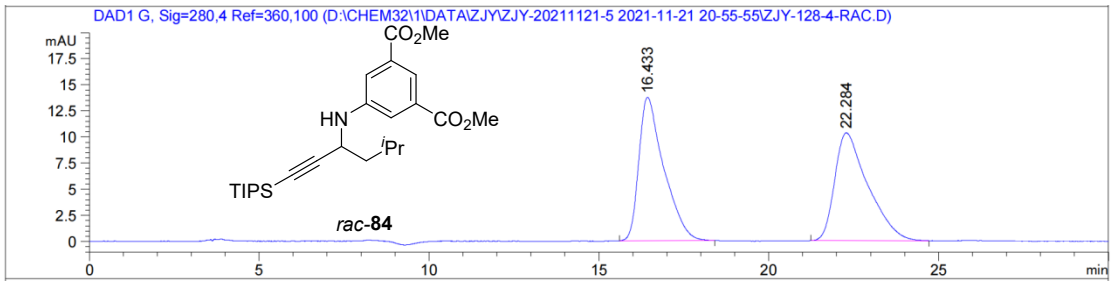
Signal 7: DAD1 G, Sig=280,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	23.661	BB	1.1542	2450.88354	29.83974	49.6308
2	31.009	BB	1.2105	2487.34912	25.80523	50.3692
Totals :				4938.23267	55.64497	



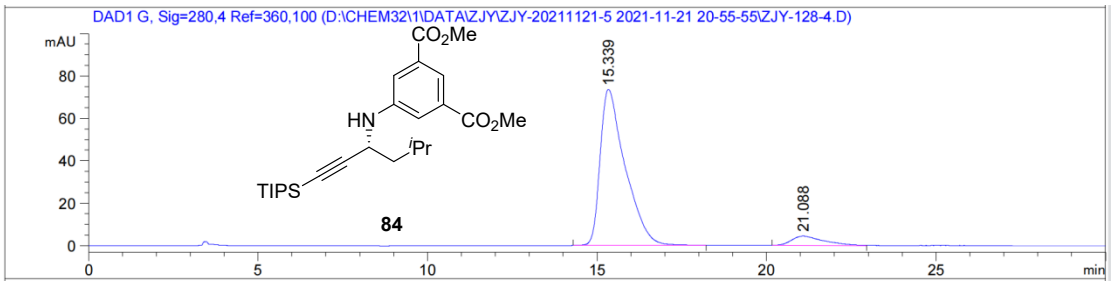
Signal 7: DAD1 G, Sig=280,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	22.246	BB	1.0165	3129.30835	44.82304	93.3188
2	28.445	MM R	1.3531	224.04297	2.75953	6.6812
Totals :				3353.35132	47.58257	



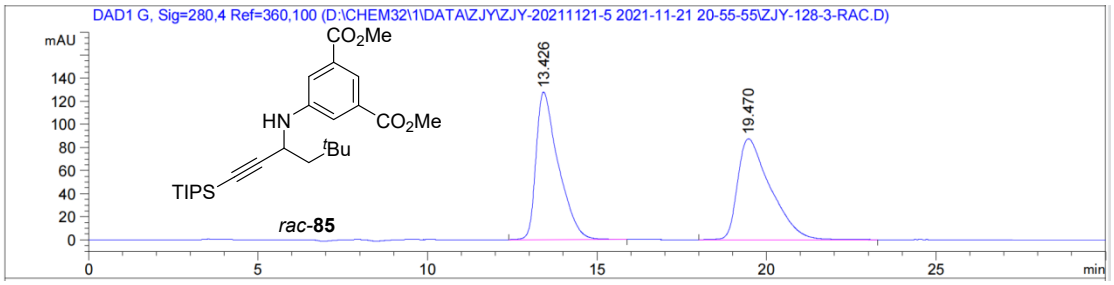
Signal 7: DAD1 G, Sig=280,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.433	BB	0.7081	701.60181	13.73113	49.9660
2	22.284	BB	0.9115	702.55725	10.32987	50.0340
Totals :				1404.15906	24.06100	



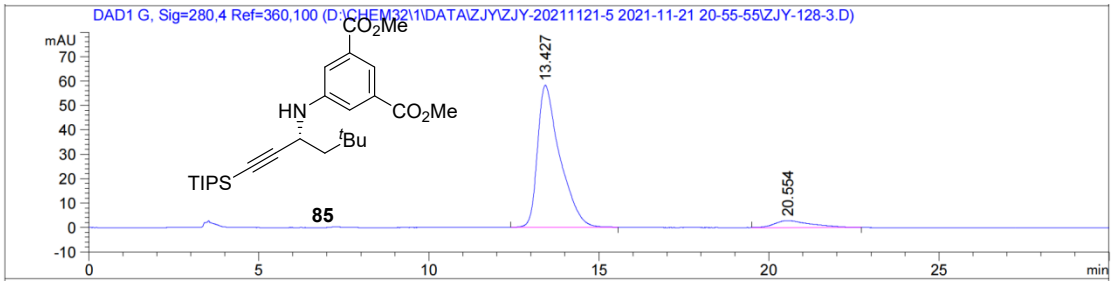
Signal 7: DAD1 G, Sig=280,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.339	BB	0.7442	3772.69067	73.57900	92.8931
2	21.088	MM R	1.0980	288.63312	4.38107	7.1069
Totals :				4061.32379	77.96007	



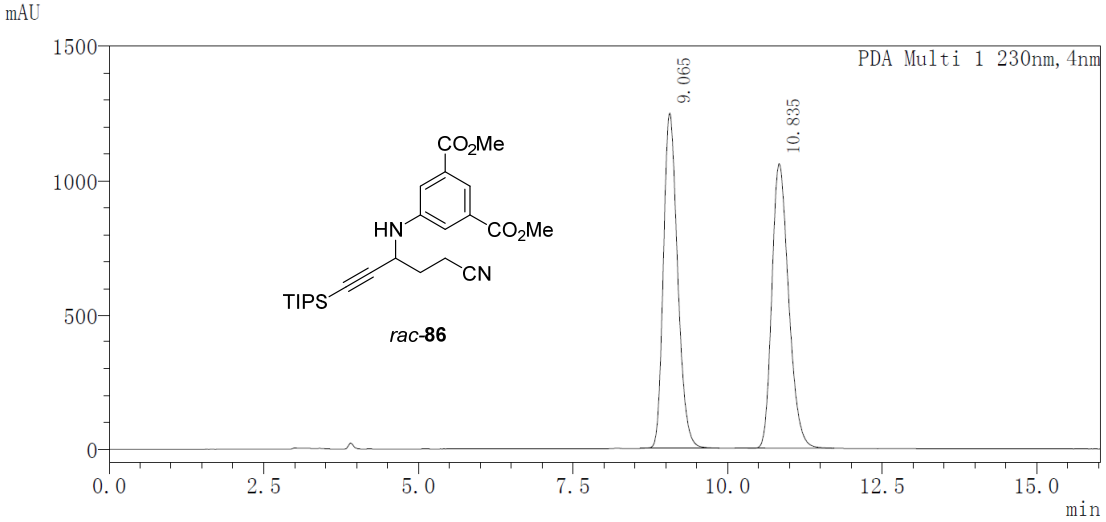
Signal 7: DAD1 G, Sig=280,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.426	BB	0.6636	5851.25488	127.92675	49.8832
2	19.470	BB	0.9708	5878.66699	87.38762	50.1168
Totals :				1.17299e4	215.31437	



Signal 7: DAD1 G, Sig=280,4 Ref=360,100

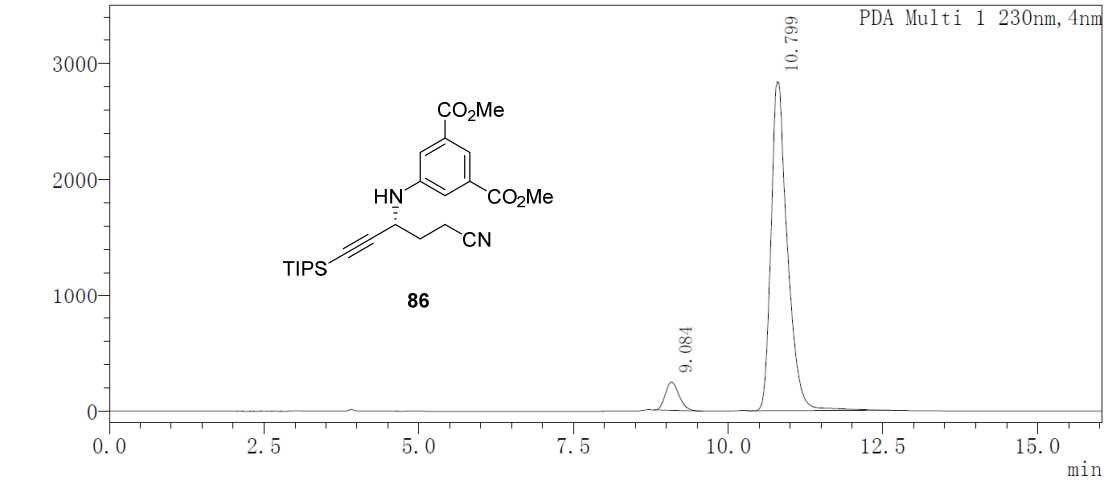
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.427	BB	0.6625	2655.62524	58.18132	92.6782
2	20.554	MM R	1.2305	209.80135	2.84160	7.3218
Totals :				2865.42659	61.02292	



Peak Table

PDA Ch1 230nm

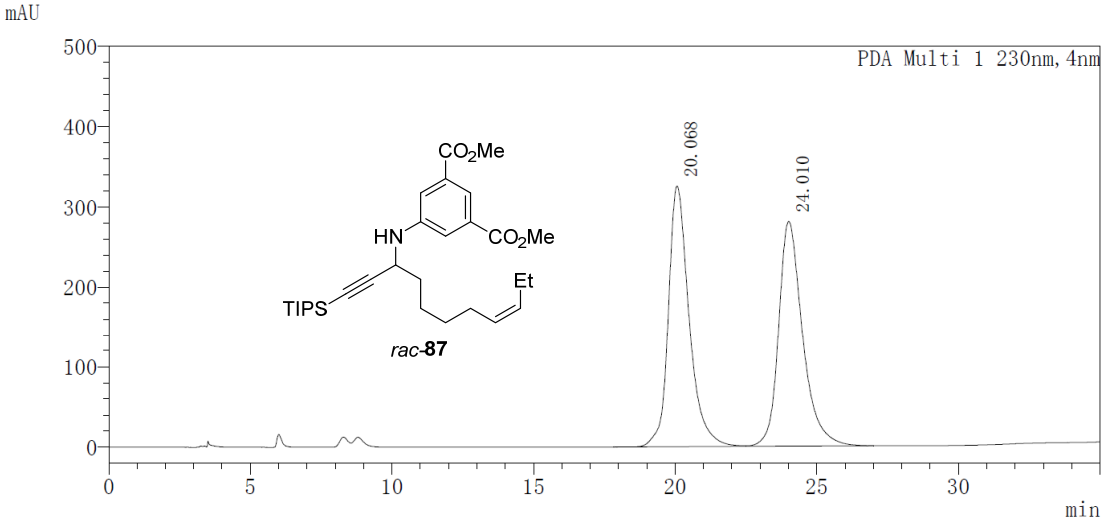
Peak#	Ret. Time	Area	Area%
1	9.065	20003293	49.953
2	10.835	20041014	50.047



Peak Table

PDA Ch1 230nm

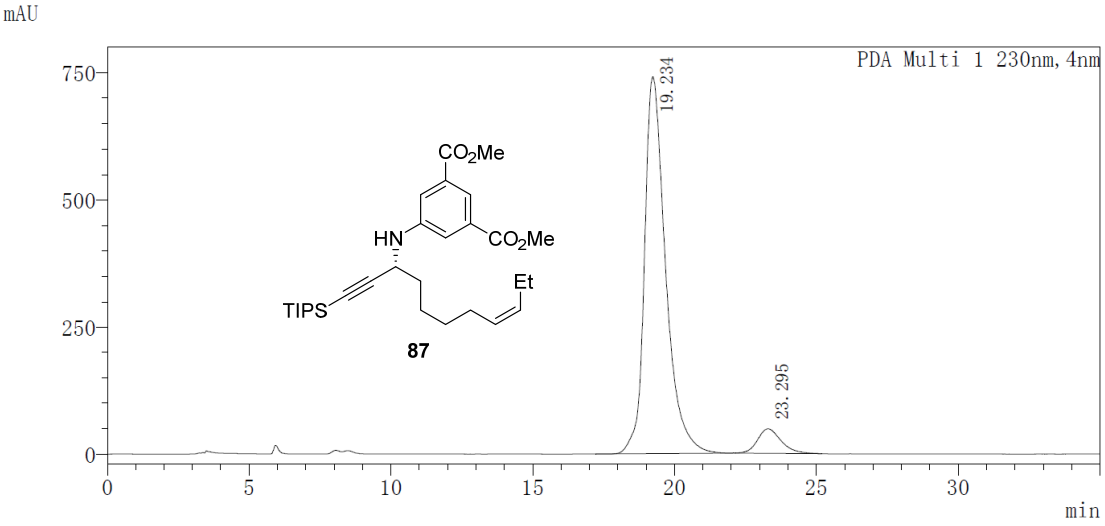
Peak#	Ret. Time	Area	Area%
1	9.084	3758088	6.699
2	10.799	52339530	93.301



Peak Table

PDA Ch1 230nm

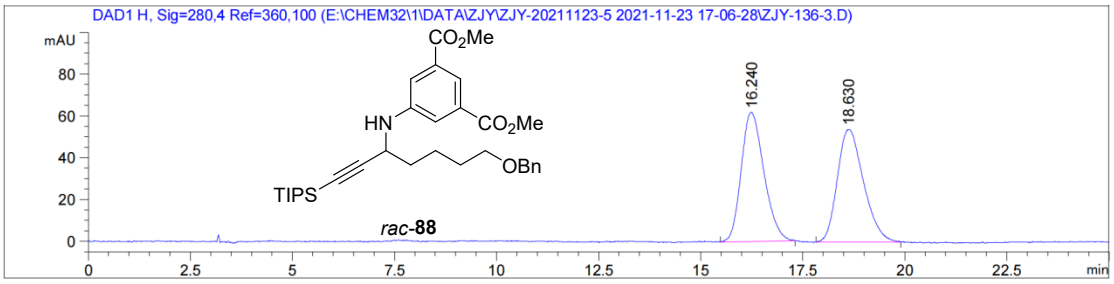
Peak#	Ret. Time	Area	Area%
1	20.068	16597175	50.089
2	24.010	16538014	49.911



Peak Table

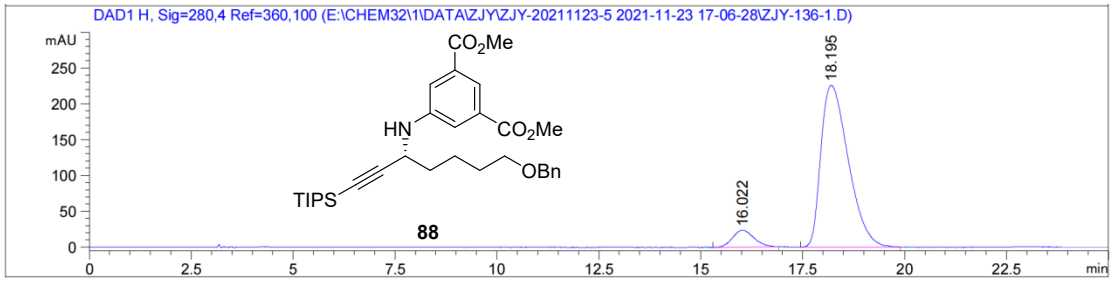
PDA Ch1 230nm

Peak#	Ret. Time	Area	Area%
1	19.234	38371028	93.261
2	23.295	2772472	6.739



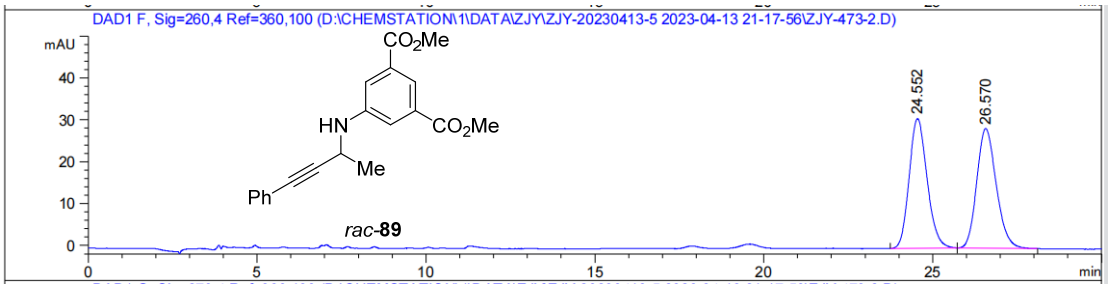
Signal 8: DAD1 H, Sig=280,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.240	BV R	0.5330	2390.43188	61.84201	49.8122
2	18.630	BV R	0.5532	2408.46021	53.91419	50.1878
Totals :				4798.89209	115.75620	



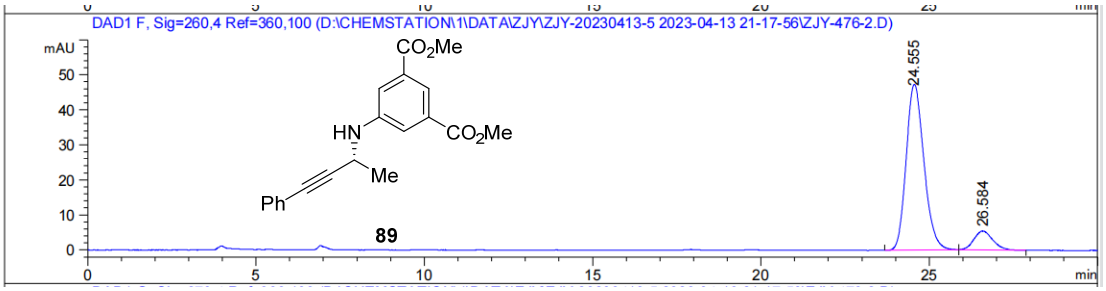
Signal 8: DAD1 H, Sig=280,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.022	BB	0.4696	865.90222	23.51558	7.5890
2	18.195	BB	0.6673	1.05441e4	225.59602	92.4110
Totals :				1.14100e4	249.11160	



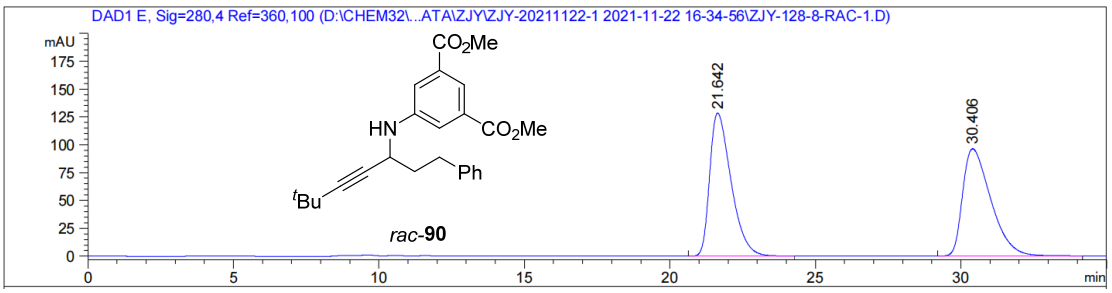
Signal 6: DAD1 F, Sig=260,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	24.552	BB	0.5614	1143.88599	30.93312	49.9439
2	26.570	BB	0.6119	1146.45374	28.58419	50.0561
Totals :				2290.33972	59.51730	



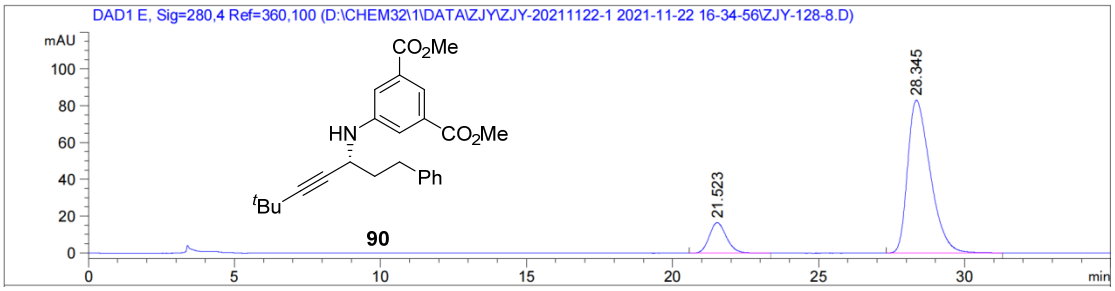
Signal 6: DAD1 F, Sig=260,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	24.555	BB	0.5654	1733.89319	47.33388	89.2366
2	26.584	BB	0.5313	209.13638	5.38235	10.7634
Totals :				1943.02957	52.71623	



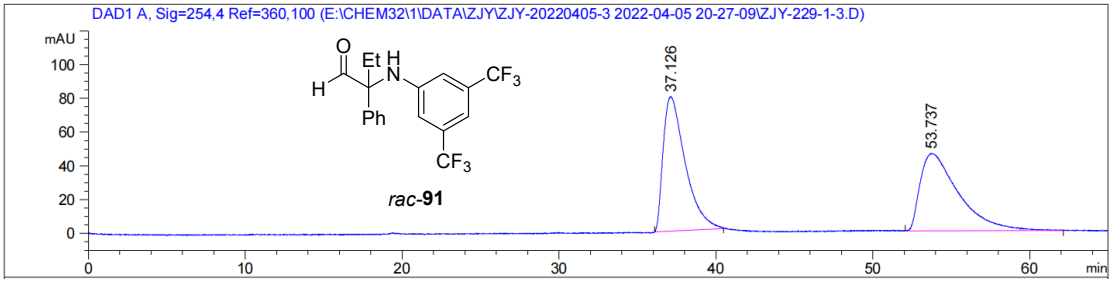
Signal 5: DAD1 E, Sig=280,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.642	BB	0.7816	6558.12402	128.45256	50.2562
2	30.406	BB	1.0163	6491.26221	96.30936	49.7438
Totals :				1.30494e4	224.76192	



Signal 5: DAD1 E, Sig=280,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.523	BB	0.6221	679.73840	16.58545	13.1903
2	28.345	BB	0.8344	4473.57520	83.05232	86.8097
Totals :				5153.31360	99.63777	



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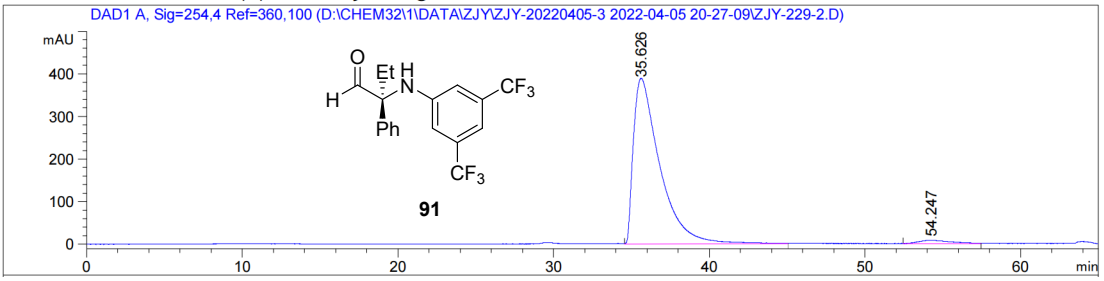
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

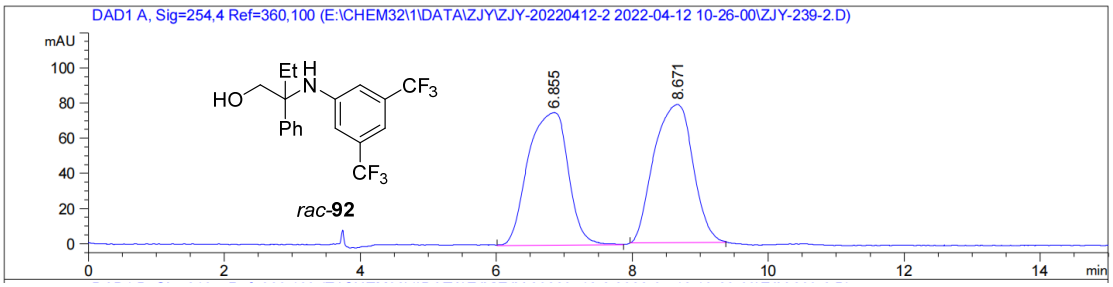
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	37.126	MM R	1.6273	7769.32324	79.57370	50.0616
2	53.737	MM R	2.8302	7750.20947	45.63988	49.9384
Totals :				1.55195e4	125.21358	



91

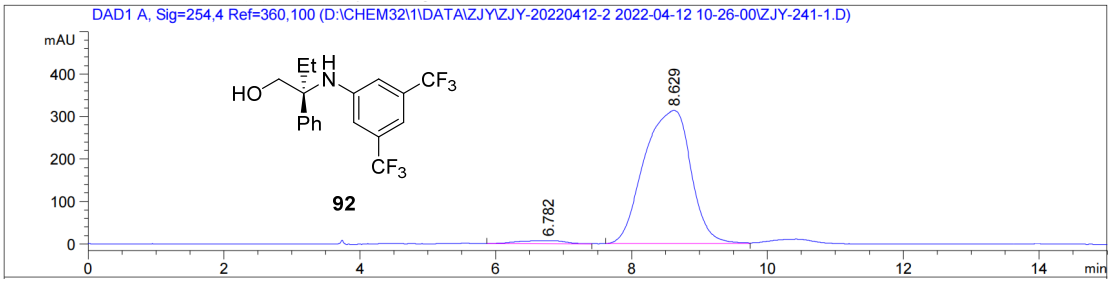
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	35.626	MM R	1.9642	4.58705e4	389.21210	97.5095
2	54.247	MM R	2.4557	1171.56604	7.95142	2.4905
Totals :				4.70421e4	397.16352	



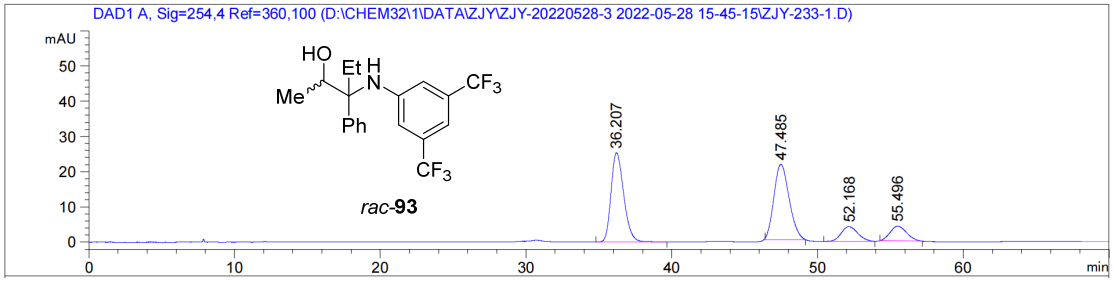
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.855	MM R	0.6837	3093.86011	75.42050	49.6644
2	8.671	MM R	0.6645	3135.67139	78.64387	50.3356
Totals :				6229.53149	154.06437	



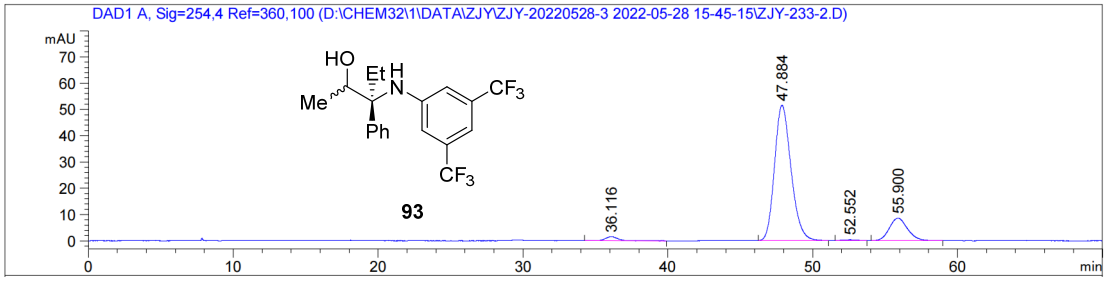
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.782	MM R	0.8319	362.84937	7.26934	2.3591
2	8.629	MM R	0.7988	1.50181e4	313.34598	97.6409
Totals :				1.53810e4	320.61532	



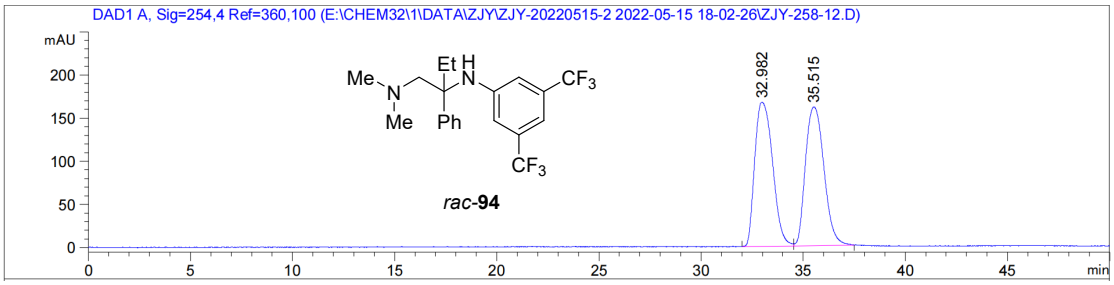
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	36.207	MM R	1.0070	1532.11865	25.35891	40.9048
2	47.485	MM R	1.2091	1547.77222	21.33422	41.3228
3	52.168	MM R	1.3267	333.82358	4.19354	8.9125
4	55.496	MM R	1.3174	331.85278	4.19832	8.8599
Totals :				3745.56723	55.08499	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	36.116	MM R	1.0405	97.93077	1.56864	1.9764
2	47.884	MM R	1.3217	4088.01074	51.54908	82.5016
3	52.552	MM R	1.1504	20.29354	2.94004e-1	0.4096
4	55.900	MM R	1.4640	748.83234	8.52524	15.1125
Totals :				4955.06739	61.93696	



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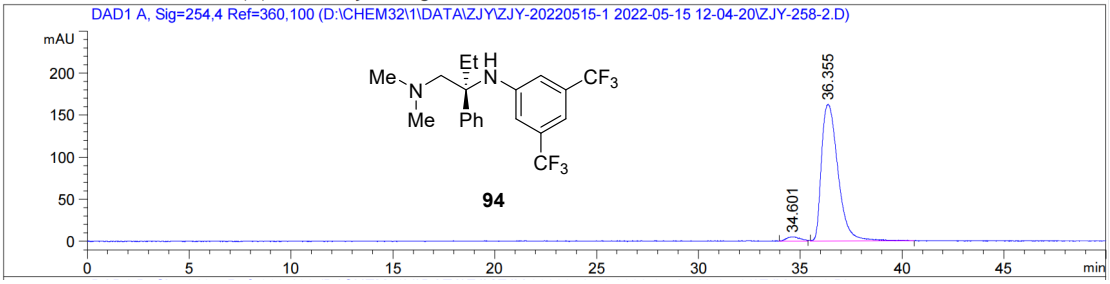
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	32.982	BV	0.7221	1.01445e4	167.15199	50.0722
2	35.515	VV R	0.7909	1.01153e4	160.58565	49.9278
Totals :				2.02598e4	327.73764	

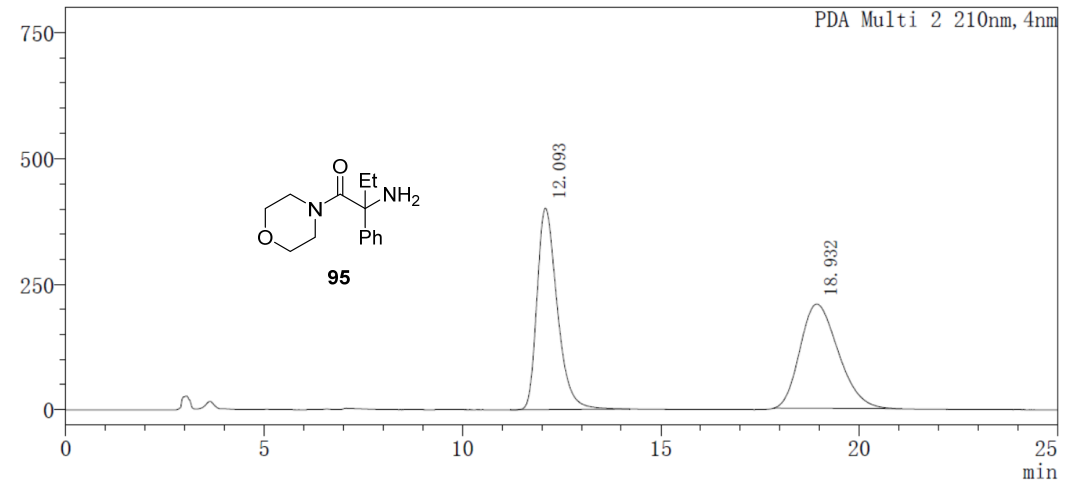


94

Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	34.601	MM R	0.7755	236.65259	5.08600	2.5348
2	36.355	MM R	0.9358	9099.63672	162.07326	97.4652
Totals :				9336.28931	167.15926	

mAU

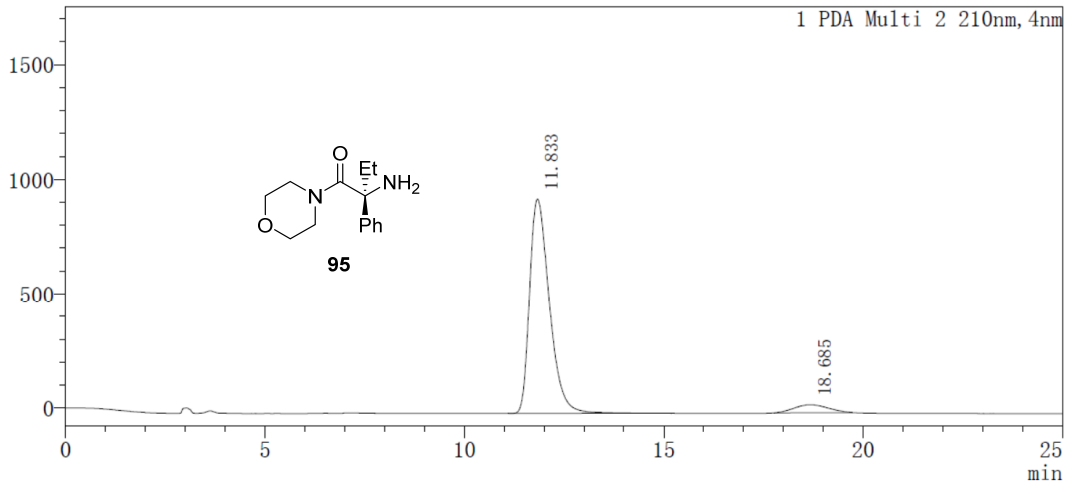


Peak Table

PDA Ch2 210nm

Peak#	Ret. Time	Area	Area%
1	12.093	14231037	50.516
2	18.932	13940084	49.484

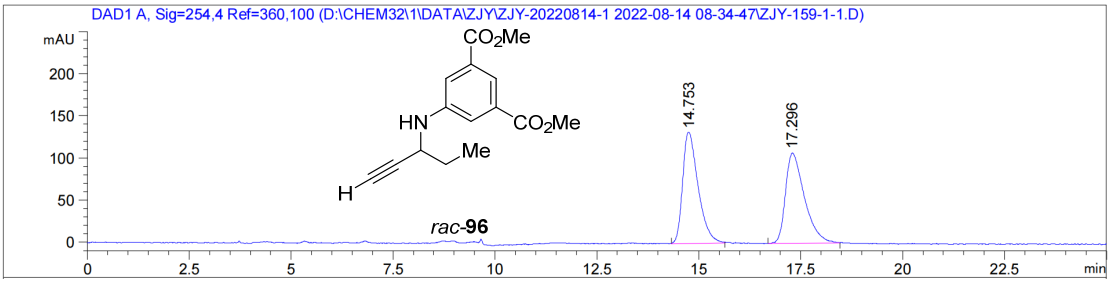
mAU



Peak Table

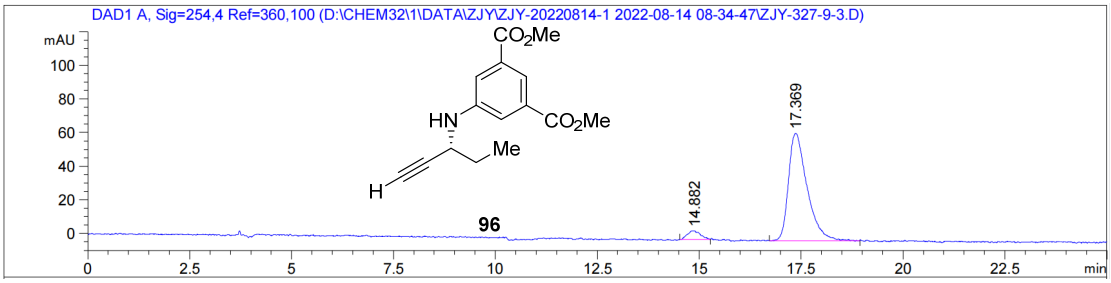
PDA Ch2 210nm

Peak#	Ret. Time	Area	Area%
1	11.833	32388943	94.081
2	18.685	2037768	5.919



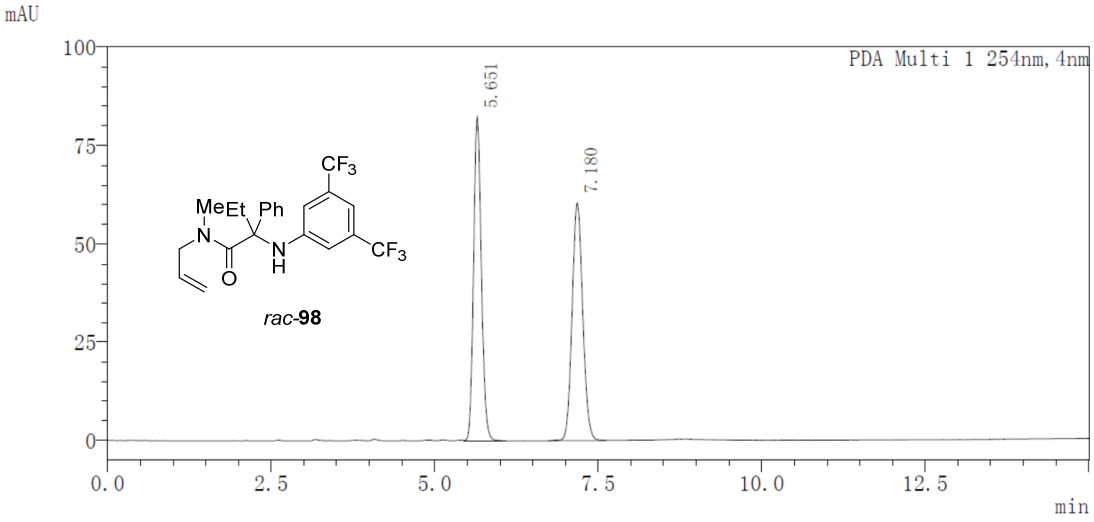
Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.753	MM R	0.4390	3473.65674	131.86581	50.0988
2	17.296	VV R	0.4589	3459.95532	107.10828	49.9012
Totals :				6933.61206	238.97410	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

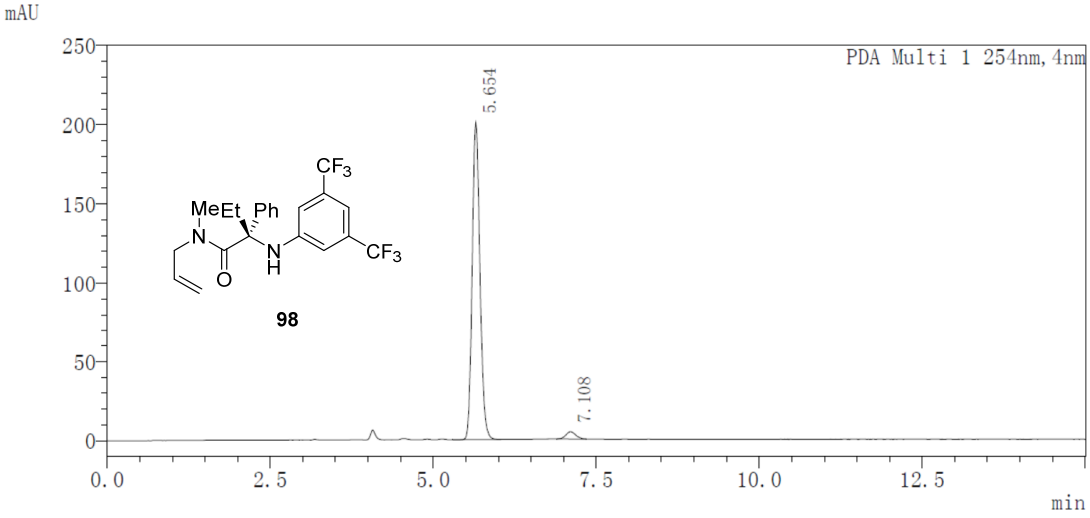
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.882	MM R	0.3694	112.32715	5.06845	5.2330
2	17.369	MM R	0.5303	2034.18628	63.93575	94.7670
Totals :				2146.51343	69.00420	



Peak Table

PDA Ch1 254nm

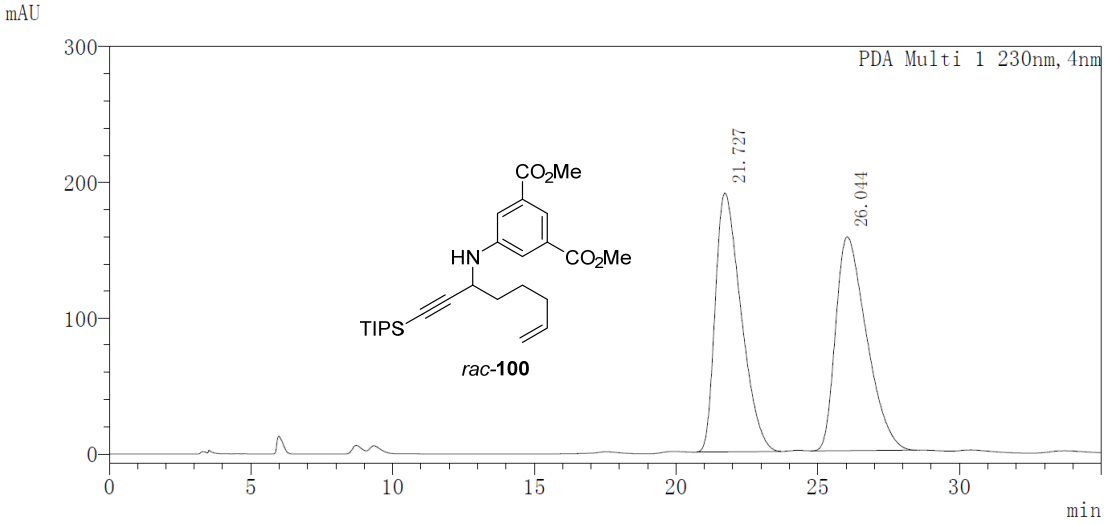
Peak#	Ret. Time	Area	Area%
1	5.651	682543	49.950
2	7.180	683900	50.050



Peak Table

PDA Ch1 254nm

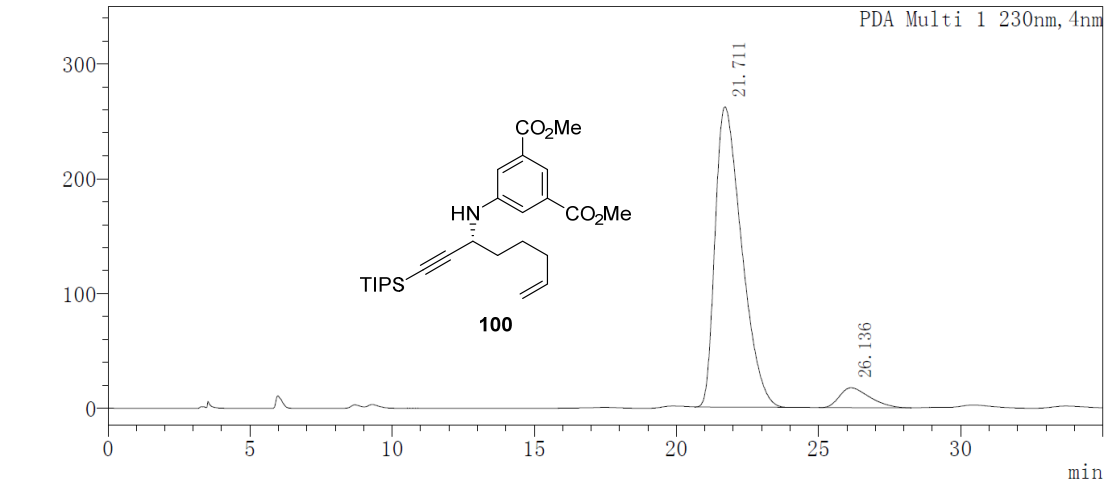
Peak#	Ret. Time	Area	Area%
1	5.654	1664081	97.253
2	7.108	47001	2.747



Peak Table

PDA Ch1 230nm

Peak#	Ret. Time	Area	Area%
1	21.727	12066639	50.210
2	26.044	11965789	49.790



Peak Table

PDA Ch1 230nm

Peak#	Ret. Time	Area	Area%
1	21.711	17003463	92.978
2	26.136	1284246	7.022