

Supporting Information for

Transition-Metal-Free Electrochemical Oxidative C(sp²)-H

Trifluoromethylation of Hydrazones

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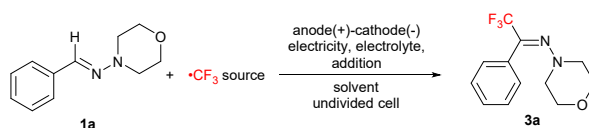
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General information

All reactions were carried out in dried sealed Schlenk tubes with magnetic stirring. All anhydrous and oxygen-free environments were performed under argon atmosphere in oven-dried glassware using Schlenk techniques. All the chemicals were obtained commercially and used without any prior purification. All products were isolated by short chromatography on a silica gel (200-300 mesh) column using hexane and ethyl acetate. ^1H , ^{13}C and ^{19}F NMR spectra were recorded on a Bruker Advance 400 spectrometer at ambient temperature with CDCl_3 as solvent and tetramethylsilane (TMS) as the internal standard. Analytical thin layer chromatography (TLC) was performed on Merk precoated TLC (silica gel 60 F254) plates.

Optimized reaction conditions:



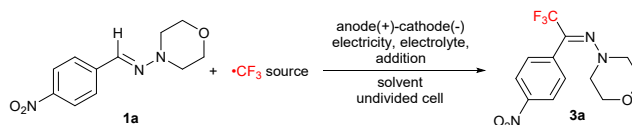
Entry	electrode	electricity	Solvent	$\cdot\text{CF}_3$ source	electrolyte	addition	atmosphere	Temperature($^{\circ}\text{C}$)	Yield(%) ^b
1	C(+)-Pt(-)	8mA	MeCN	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	air	50	32
2	C(+)-C(-)	8mA	MeCN	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	air	50	45
3	C(+)-Ni(-)	8mA	MeCN	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	air	50	32
4 ^[c]	C(+)-Ni(-)	8mA	MeCN	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	air	50	37
5	Pt(+)-Pt(-)	8mA	MeCN	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	air	50	37
6	RVC(+)-Pt(-)	8mA	MeCN	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	air	50	40
7	RVC(+)-Ni(-)	8mA	MeCN	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	air	50	37
8	C(+)-Cu(-)	8mA	MeCN	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	air	50	20
9	C(+)-Fe(-)	8mA	MeCN	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	air	50	40
10	RVC(+)-RVC(-)	8mA	MeCN	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	air	50	42
11 ^[d]	C(+)-C(-)	3mA	MeCN	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	Air	50	34
12 ^[d]	C(+)-C(-)	5mA	MeCN	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	Air	50	47
13	C(+)-C(-)	12mA	MeCN	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	Air	50	36
14	C(+)-C(-)	0mA	MeCN	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	Air	50	N.D.
15	C(+)-C(-)	8mA	HFIP	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	Air	50	35
16	C(+)-C(-)	8mA	DMF	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	Air	50	Trace
17	C(+)-C(-)	8mA	MeCN: H_2O = 1:1	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	Air	50	33
18	C(+)-C(-)	8mA	MeCN: H_2O = 3:1	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	Air	50	35
19	C(+)-C(-)	8mA	MeCN: MeOH= 1:1	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	Air	50	trace
20	C(+)-C(-)	8mA	acetone	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	Air	50	trace
21	C(+)-C(-)	8mA	DCE	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	Air	50	35
22	C(+)-C(-)	8mA	HFIP: DCE = 1:1	$\text{CF}_3\text{SO}_2\text{Na}$	$^t\text{Bu}_4\text{NBF}_4$	none	Air	50	27

23	C(+)-C(-)	8mA	TFA: H2O =10:1	CF ₃ SO ₂ Na	ⁿ Bu ₄ NBF ₄	none	Air	50	15
24 ^[e]	C(+)-C(-)	8mA	MeCN	Togni reagent	ⁿ Bu ₄ NBF ₄	none	Air	50	71
25 ^[e]	C(+)-C(-)	8mA	MeCN	Togni reagent	ⁿ Bu ₄ NPF ₆	none	Air	50	65
26	C(+)-C(-)	8mA	MeCN	Togni reagent	LiClO ₄	none	Air	50	22
27	C(+)-C(-)	8mA	MeCN	Togni reagent	NH ₄ BF ₄	none	Air	50	42
28 ^[e]	C(+)-C(-)	8mA	MeCN	Togni reagent	Et ₃ NBr	none	Air	50	60
29	C(+)-C(-)	8mA	MeCN	Togni reagent	ⁿ Bu ₄ NBF ₄	NaHCO ₃	Air	50	72
30	C(+)-C(-)	8mA	MeCN	Togni reagent	ⁿ Bu ₄ NBF ₄	NaOH	Air	50	42
31 ^[e]	C(+)-C(-)	8mA	MeCN	Togni reagent	ⁿ Bu ₄ NBF ₄	NaOAc	Air	50	80
32	C(+)-C(-)	8mA	MeCN	Togni reagent	ⁿ Bu ₄ NBF ₄	KOH	Air	50	30
33	C(+)-C(-)	8mA	MeCN	Togni reagent	ⁿ Bu ₄ NBF ₄	HOAc	Air	50	34
34 ^[e]	C(+)-C(-)	8mA	MeCN	Togni reagent	ⁿ Bu ₄ NBF ₄	NaOAc	N ₂	50	85
35 ^[e]	C(+)-C(-)	8mA	MeCN	Togni reagent	ⁿ Bu ₄ NBF ₄	NaOAc	N ₂	r.t.	64
36 ^[e]	C(+)-C(-)	8mA	MeCN	Togni reagent	ⁿ Bu ₄ NBF ₄	NaOAc	N ₂	70°C	82

^[a]Reaction conditions : 1 (0.3 mmol) , 3 (1.5 eq.), electrolyte (0.3 eq.), solvent (4 mL) ,constant current electricity, stirred, 2 h.

^[b]Isolated yield. ^[c]Nickel foam. ^[d]4 h. ^[e]1 h.

Optimized reaction conditions: substrates with para-electron-withdrawing groups



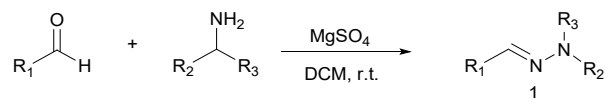
Entry	electrode	electricity	Solvent	•CF ₃ source	electrolyte	addition	atmosphere	Temperature(°C)	Yield(%) ^[e]
1	C(+)-C(-)	8mA	MeCN	Togni reagent	ⁿ Bu ₄ NBF ₄	NaOAc	N ₂	50	48
2	C(+)-Pt(-)	8mA	MeCN	Togni reagent	ⁿ Bu ₄ NBF ₄	NaOAc	N ₂	50	42
3	C(+)-Ni(-)	8mA	MeCN	Togni reagent	ⁿ Bu ₄ NBF ₄	NaOAc	N ₂	50	40
4 ^[e]	C(+)-Ni(-)	8mA	MeCN	Togni reagent	ⁿ Bu ₄ NBF ₄	NaOAc	N ₂	50	42
5	RVC(+)- Pt(-)	8mA	MeCN	Togni reagent	ⁿ Bu ₄ NBF ₄	NaOAc	N ₂	50	42
6	C(+)-C(-)	10mA	MeCN	Togni reagent	ⁿ Bu ₄ NBF ₄	NaOAc	N ₂	50	48
7	C(+)-C(-)	8mA	Acetone	Togni reagent	ⁿ Bu ₄ NBF ₄	NaOAc	N ₂	50	trace
8	C(+)-C(-)	8mA	Toluene	Togni reagent	ⁿ Bu ₄ NBF ₄	NaOAc	N ₂	50	N.R.
9	C(+)-C(-)	8mA	DMF	Togni reagent	ⁿ Bu ₄ NBF ₄	NaOAc	N ₂	50	30
^[b] 10	C(+)-C(-)	8mA	MeCN	CF ₃ SO ₂ Na	ⁿ Bu ₄ NBF ₄	NaOAc	N ₂	50	87
^[b] 11	C(+)-C(-)	8mA	MeCN	CF ₃ SO ₂ Na	KF	NaOAc	N ₂	50	25
^[b] 12	C(+)-C(-)	8mA	MeCN	CF ₃ SO ₂ Na	ⁿ Bu ₄ NPF ₆	NaOAc	N ₂	50	84
^[b] 13	C(+)-C(-)	8mA	MeCN	CF ₃ SO ₂ Na	LiClO ₄	NaOAc	N ₂	50	42
^[b] 14	C(+)-C(-)	8mA	MeCN	CF ₃ SO ₂ Na	ⁿ Bu ₄ NBF ₄	None	N ₂	50	65
^[b] 15	C(+)-C(-)	8mA	MeCN	CF ₃ SO ₂ Na	ⁿ Bu ₄ NBF ₄	NaOH	N ₂	50	66
^[b] 16	C(+)-C(-)	8mA	MeCN	CF ₃ SO ₂ Na	ⁿ Bu ₄ NBF ₄	NaHCO ₃	N ₂	50	75

^[a]Reaction conditions : 1 (0.3 mmol) , 3 (1.5 eq.), electrolyte (0.3 eq.), solvent (4 mL) ,constant current electricity, stirred, 1 h. ^[b]2h

^[c]Isolated yield.

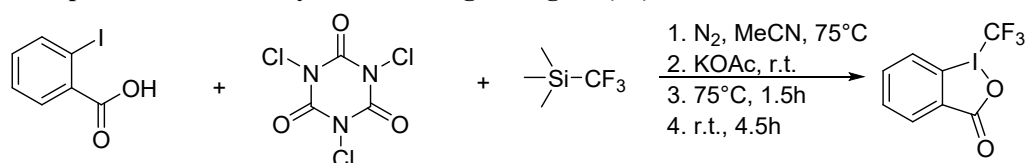
Experimental Section

General procedure for the synthesis of compounds 1



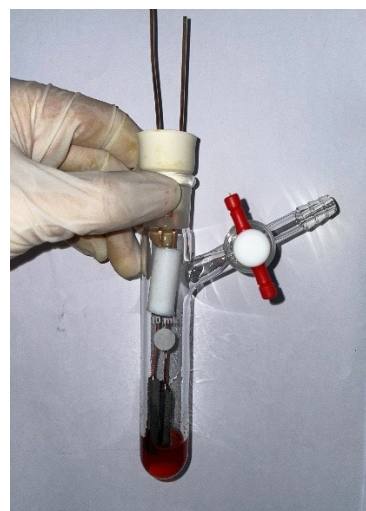
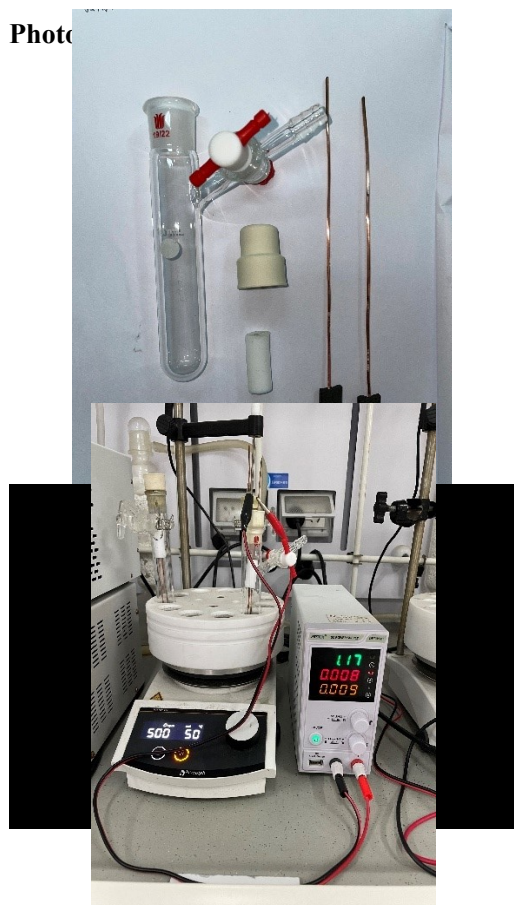
A mixture of hydrazine (2.4 mmol), aldehyde (2.0 mmol) and anhydrous MgSO_4 (2.0 mmol) in CH_2Cl_2 (10 mL) was stirred at room temperature in 6h. After filtration of MgSO_4 , CH_2Cl_2 was removed under reduced pressure and the mixture was subjected to recrystallize to give the desired product 1 with almost quantitative yields.

General procedure for the synthesis of Togni reagent (2b)



Add ortho-iodobenzoic acid (3.47 g, 14 mmol, 1.0 eq) into a 100mL three-neck flask in nitrogen atmosphere, add 30mL acetonitrile, heat to 75°C , then add trichloroisocyanuric acid (0.974 g, 4.74 mmol, 0.3 eq) in 5 minutes with a constant pressure drop funnel. After cool to room temperature, add dried potassium acetate (2.75 g, 28 mmol, 2.0 eq) at once. The reaction system was cooled to room temperature after 1.5 hours of reaction at 75°C . And then, TMSCF_3 (2.90 mL, 19.6 mmol, 1.4 eq) was added at once for 4.5h in room temperature. After concentration, the product crystallizes and is washed with cold acetonitrile to obtain white solid Togni reagent.

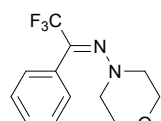
Photo



Cyclic voltammetry studies

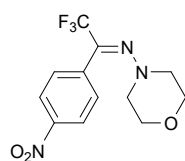
The cyclic voltammograms experiments were conducted in a Schlenk tube that contained the substance dissolved in a 0.1 M solution of tetrabutylammonium hexafluorophosphate in acetonitrile. A glassy carbon electrode working electrode, a platinum wire counter electrode and an Ag/AgCl reference electrode were used. The reference electrode was stored in saturated potassium chloride solution for activation before use. The relevant parameters were controlled by an electrochemical workstation CHI600E.

Characterization of the products



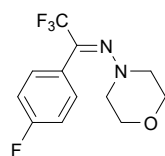
(E)-2,2,2-trifluoro-N-morpholino-1-phenylethan-1-imine (3a)

Colorless solid; m.p.= 40.1-41.0°C. ¹H NMR (400 MHz, CDCl₃) δ 7.85 – 7.28 (m, 5H), 3.88 – 3.37 (m, 4H), 3.20 – 2.55 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ 136.35 (q, ²J_{C,F} = 33.84Hz), 131.73, 129.95, 128.95, 128.60, 121.37 (q, ¹J_{C,F} = 275.73Hz), 66.22, 54.37. ¹⁹F NMR (376 MHz, CDCl₃) δ -66.75. Spectroscopic data are in accordance with those described in the literature.^[1]



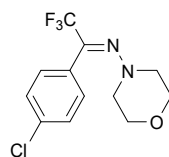
(E)-2,2,2-trifluoro-N-morpholino-1-(4-nitrophenyl)ethan-1-imine (3b)

Yellow solid; m.p.= 161.8-163.3 °C. ¹H NMR (400 MHz, CDCl₃) δ 8.55 – 7.91 (m, 2H), 7.76 – 7.45 (m, 2H), 4.02 – 3.42 (m, 4H), 3.18 – 2.70 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ 148.47, 138.28, 132.54 (q, ²J_{C,F} = 34.34 Hz), 129.97, 121.04 (q, ¹J_{C,F} = 275.73 Hz), 124.16, 66.07, 54.53. ¹⁹F NMR (376 MHz, CDCl₃) δ -79.87. Spectroscopic data are in accordance with those described in the literature.^[2]



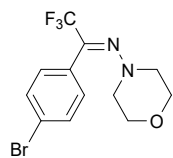
(E)-2,2,2-trifluoro-1-(4-fluorophenyl)-N-morpholinoethan-1-imine (3c)

Yellow solid; m.p.= 119.3- 121.4 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.51 – 7.36 (m, 2H), 7.17 – 7.05 (m, 2H), 3.71 – 3.55 (m, 4H), 3.08 – 2.86 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ 163.39 (d, ¹J_{C,F} = 252.53Hz), 135.76 (q, ²J_{C,F} = 33.33Hz), 130.73 (d, ³J_{C,F} = 9.09Hz), 127.57 (d, ⁴J_{C,F} = 4.04Hz), 121.25 (q, ¹J_{C,F} = 275.73Hz), 116.27 (d, ²J_{C,F} = 22.22Hz), 66.19, 54.36. ¹⁹F NMR (376 MHz, CDCl₃) δ -66.86, -109.46. Spectroscopic data are in accordance with those described in the literature.^[3]



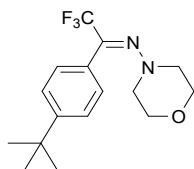
(E)-1-(4-chlorophenyl)-2,2,2-trifluoro-N-morpholinoethan-1-imine (3d)

Yellow solid; m.p.= 45.5- 47.0 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.49 – 7.32 (m, 4H), 3.72 – 3.51 (m, 4H), 3.14 – 2.86 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ 136.17, 135.02 (q, ²J_{C,F} = 35.35Hz), 130.03, 129.35, 121.21(q, ¹J_{C,F} = 275.73Hz), 66.17, 54.39. ¹⁹F NMR (376 MHz, CDCl₃) δ -66.23. HRMS (ESI) m/z [M+H]⁺ Calculated for C₁₂H₁₂ClF₃N₂O (293.0663), found 293.0668.



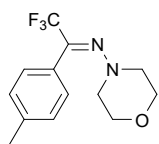
(E)-1-(4-bromophenyl)-2,2,2-trifluoro-N-morpholinoethan-1-imine (3e)

Yellow oil. ¹H NMR (400 MHz, CDCl₃) δ 7.72 (d, *J* = 8.0 Hz, 2H), 7.56 (d, *J* = 8.0 Hz, 2H), 3.63 (t, 4H), 3.00 (t, *J* = 4.9 Hz, 4H). ¹³C NMR (100 MHz, CDCl₃) δ 134.92 (q, ²J_{C,F} = 33.33Hz), 132.31, 130.53, 130.25, 124.43, 121.16 (q, ¹J_{C,F} = 275.73Hz), 66.15, 54.39. ¹⁹F NMR (376 MHz, CDCl₃) δ -66.65. Spectroscopic data are in accordance with those described in the literature.^[1]



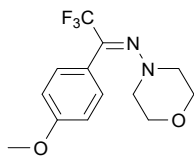
(E)-1-(4-(tert-butyl)phenyl)-2,2,2-trifluoro-N-morpholinoethan-1-imine (3f)

Yellow oil. ¹H NMR (400 MHz, CDCl₃) δ 7.46 – 7.38 (m, 2H), 7.39 – 7.31 (m, 2H), 3.88 – 3.39 (m, 4H), 3.33 – 2.76 (m, 4H), 1.33 (s, 9H). ¹³C NMR (100 MHz, CDCl₃) δ 153.31, 136.99(q, ²J_{C,F} = 32.32Hz) 128.51, 128.24, 125.82, 120.06(q, ¹J_{C,F} = 275.73Hz), 66.25, 54.36, 34.98, 31.32. ¹⁹F NMR (376 MHz, CDCl₃) δ -66.71. Spectroscopic data are in accordance with those described in the literature.^[2]



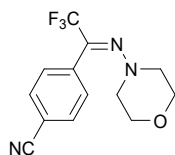
(E)-2,2,2-trifluoro-N-morpholino-1-(p-tolyl)ethan-1-imine (3g)

Yellow oil. ¹H NMR (400 MHz, CDCl₃) δ 7.32 (d, *J* = 8.0 Hz, 2H), 7.22 (d, *J* = 8.0 Hz, 2H), 3.71 – 3.54 (m, 4H), 3.08 – 2.92 (m, 4H), 2.38 (s, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 140.16, 136.93 (q, ²J_{C,F} = 33.33 Hz), 129.64, 128.64, 128.43, 121.40 (q, ¹J_{C,F} = 275.73 Hz), 66.26, 54.33, 21.57. ¹⁹F NMR (376 MHz, CDCl₃) δ -66.81. Spectroscopic data are in accordance with those described in the literature.^[4]



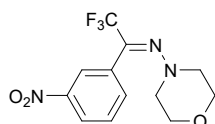
(E)-2,2,2-trifluoro-1-(4-methoxyphenyl)-N-morpholinoethan-1-imine (3h)

Yellow oil. ¹H NMR (400 MHz, CDCl₃) δ 7.39 (d, *J* = 8.7 Hz, 2H), 6.98 – 6.84 (m, 2H), 3.84 (s, 3H), 3.71 – 3.51 (m, 4H), 3.21 – 2.77 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ 160.69, 137.31(q, ²J_{C,F} = 33.33Hz), 129.98, 123.46, 121.39(q, ¹J_{C,F} = 276.74 Hz), 114.38, 66.28, 55.41, 54.30. ¹⁹F NMR (376 MHz, CDCl₃) δ -66.81. Spectroscopic data are in accordance with those described in the literature. ^[1]



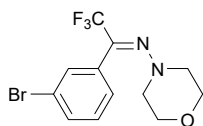
(E)-4-(2,2,2-trifluoro-1-(morpholinoimino)ethyl)benzonitrile (3i)

Yellow solid; m.p.= 149.4- 150.8 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.85 – 7.65 (m, 2H), 7.64 – 7.47 (m, 2H), 3.78 – 3.45 (m, 4H), 3.21 – 2.72 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ 136.46, 133.09 (q, ²J_{C,F}= 33.33Hz), 132.69, 129.61, 121.09 (q, ¹J_{C,F}= 275.73Hz), 117.96, 114.02, 66.07, 54.55. ¹⁹F NMR (376 MHz, CDCl₃) δ -66.22. HRMS (ESI) *m/z* [M+H]⁺ Calculated for C₁₃H₁₂F₃N₃O (283.0934), found 283.1005.



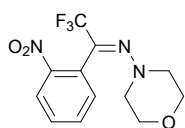
(E)-1-(3-bromophenyl)-2,2,2-trifluoro-N-morpholinoethan-1-imine (3j)

Yellow oil. ¹H NMR (400 MHz, CDCl₃) δ 8.17 (dd, *J* = 8.1, 1.4 Hz, 1H), 7.73 (td, *J* = 7.5, 1.4 Hz, 1H), 7.65 (td, *J* = 7.8, 1.6 Hz, 1H), 7.49 (dd, *J* = 7.5, 1.6 Hz, 1H), 3.76 – 3.42 (m, 4H), 3.18 – 2.87 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ 147.87, 134.04, 131.53(q, ²J_{C,F}= 33.3Hz), 131.38, 131.29, 127.28, 125.20, 120.89(q, ¹J_{C,F}= 275.73Hz), 66.24, 53.86. ¹⁹F NMR (376 MHz, CDCl₃) δ -66.48. HRMS (ESI) *m/z* [M+H]⁺ Calculated for C₁₂H₁₂F₃N₃O₃ (303.0836), found 303.0909.



(E)-1-(3-bromophenyl)-2,2,2-trifluoro-N-morpholinoethan-1-imine (3k)

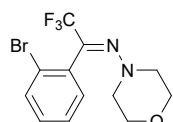
White solid; m.p.= 49.0- 50.2°C. ¹H NMR (400 MHz, CDCl₃) δ 7.63 – 7.50 (m, 2H), 7.46 – 7.27 (m, 2H), 3.83 – 3.45 (m, 4H), 3.19 – 2.83 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ 133.89 (q, ²J_{C,F}= 33.3Hz), 133.68, 133.13, 131.56, 130.49, 127.35, 121.21 (q, ¹J_{C,F}= 275.73Hz), 123.05, 66.17, 54.45. ¹⁹F NMR (376 MHz, CDCl₃) δ -66.54. HRMS (ESI) *m/z* [M+H]⁺ Calculated for C₁₂H₁₂BrF₃N₂O (336.0088), found 336.0061.



(E)-2,2,2-trifluoro-N-morpholino-1-(2-nitrophenyl)ethan-1-imine

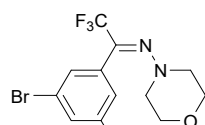
(3l)

Yellow solid; m.p.= 99.6- 101.3°C. ¹H NMR (400 MHz, CDCl₃) δ 7.69 (d, *J* = 8.1 Hz, 2H), 7.57 (d, *J* = 8.1 Hz, 2H), 3.83 – 3.48 (m, 4H), 3.16 – 2.79 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ 147.94, 134.01, 131.58 (q, ¹J_{C,F}= 35.35 Hz), 131.40, 131.28, 127.32, 125.20, 120.90 (q, ¹J_{C,F}= 275.73 Hz), 66.25, 53.89. ¹⁹F NMR (376 MHz, CDCl₃) δ -66.48. HRMS (ESI) *m/z* [M+H]⁺ Calculated for C₁₂H₁₂F₃N₃O₃ (303.0836), found 304.0860.



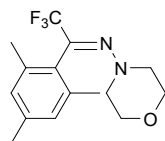
(E)-1-(2-bromophenyl)-2,2,2-trifluoro-N-morpholinoethan-1-imine (3m)

White solid; m.p.= 76.5- 77.2°C. ¹H NMR (400 MHz, CDCl₃) δ 7.63 (dd, 1H), 7.42 – 7.27 (m, 3H), 3.79 – 3.48 (m, 4H), 3.22 – 2.95 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ 134.09, 133.06, 131.32, 131.29, 129.20 (q, ²J_{C,F}= 35.35Hz), 127.57, 124.36, 121.50(q, ¹J_{C,F}= 276.74Hz), 66.57, 53.66. ¹⁹F NMR (376 MHz, CDCl₃) δ -66.03. HRMS (ESI) *m/z* [M+H]⁺ Calculated for C₁₂H₁₂BrF₃N₂O (336.0088), found 336.0108.



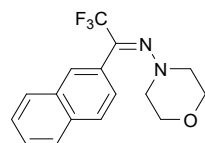
(E)-1-(3,5-dibromophenyl)-2,2,2-trifluoro-N-morpholinoethan-1-imine (3n)

White solid; m.p.= 143.0- 143.7°C. ¹H NMR (600 MHz, CDCl₃) δ 7.73 (t, *J* = 1.8 Hz, 1H), 7.52 (d, *J* = 1.8 Hz, 2H), 3.73 – 3.61 (m, 4H), 3.11 – 2.99 (m, 4H). ¹³C NMR (150 MHz, CDCl₃) δ 135.68, 134.98, 131.46 (q, ²J_{C,F}= 34.73Hz), 130.35, 121.06 (q, ¹J_{C,F}= 274.82Hz), 123.58, 66.09, 54.47. ¹⁹F NMR (565 MHz, CDCl₃) δ -66.27. HRMS (ESI) *m/z* [M+H]⁺ Calculated for C₁₂H₁₁Br₂F₃N₂O (414.9263), found 416.9268.



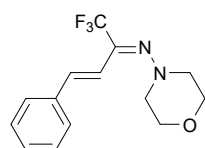
(E)-2,2,2-trifluoro-1-mesityl-N-morpholinoethan-1-imine (3o)

Yellow oil. ¹H NMR (400 MHz, CDCl₃) δ 6.94 – 6.82 (m, 2H), 3.73 – 3.44 (m, 4H), 3.27 – 2.86 (m, 4H), 2.39 (s, 1H), 2.29 (s, 3H), 2.23 (s, 5H). ¹³C NMR (100 MHz, CDCl₃) δ 139.62, 137.36, 133.48 (q, ²J_{C,F}= 34.34 Hz), 129.69, 128.95, 128.64, 121.81(q, ¹J_{C,F}= 274.82Hz), 66.76, 53.37, 21.26. ¹⁹F NMR (376 MHz, CDCl₃) δ -65.69. HRMS (ESI) *m/z* [M+H]⁺ Calculated for C₁₅H₁₉F₃N₂O (301.1522), found 301.1524.



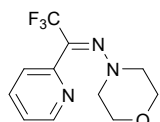
(E)-2,2,2-trifluoro-N-morpholino-1-(naphthalen-2-yl)ethan-1-imine (3p)

Yellow oil. ¹H NMR (400 MHz, CDCl₃) δ 8.20 – 7.73 (m, 4H), 7.73 – 7.43 (m, 3H), 3.87 – 3.42 (m, 4H), 3.28 – 2.71 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ 136.46 (q, ²J_{C,F}= 33.33Hz), 133.64, 133.00, 129.00, 128.72, 128.60, 128.37, 127.98, 127.63, 127.07, 125.35, 121.51(q, ¹J_{C,F}= 275.73Hz), 66.24, 54.48. ¹⁹F NMR (376 MHz, CDCl₃) δ -66.39. HRMS (ESI) *m/z* [M+H]⁺ Calculated for C₁₆H₁₅F₃N₂O (309.1209), found 308.1215.



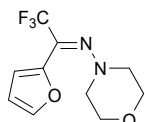
(2E,3E)-1,1,1-trifluoro-N-morpholino-4-phenylbut-3-en-2-imine (3q)

Yellow oil. ^1H NMR (400 MHz, CDCl_3) δ 7.43 – 7.31 (m, 5H), 7.05 (d, $J = 9.3$ Hz, 1H), 7.02 – 6.96 (m, 1H), 3.82 – 3.72 (m, 4H), 3.09 – 2.99 (m, 4H). ^{13}C NMR (100 MHz, CDCl_3) δ 132.17, 131.78 (q, $^3J_{\text{C,F}} = 5.05$ Hz), 131.52, 130.64 (q, $^2J_{\text{C,F}} = 30.30$ Hz), 129.96, 128.94, 128.73, 123.95 (q, $^1J_{\text{C,F}} = 272.7$ Hz), 66.23, 51.11. ^{19}F NMR (376 MHz, CDCl_3) δ -64.96. HRMS (ESI) m/z $[\text{M}+\text{H}]^+$ Calculated for $\text{C}_{14}\text{H}_{15}\text{F}_3\text{N}_2\text{O}$ (285.1138), found 285.1140.



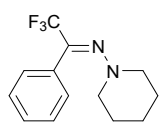
(E)-2,2,2-trifluoro-N-morpholino-1-(pyridin-3-yl)ethan-1-imine (3r)

Yellow oil. ^1H NMR (400 MHz, CDCl_3) δ 8.71 (ddd, $J = 4.9, 1.8, 1.0$ Hz, 1H), 7.76 (td, $J = 7.8, 1.8$ Hz, 1H), 7.49 (d, $J = 7.8$ Hz, 1H), 7.32 (ddd, $J = 7.7, 4.9, 1.2$ Hz, 1H), 3.77 – 3.48 (m, 4H), 3.13 – 2.85 (m, 4H). ^{13}C NMR (100 MHz, CDCl_3) δ 151.08, 150.14, 136.80, 132.74 (q, $^2J_{\text{C,F}} = 33.33$ Hz), 124.84, 124.28, 121.51 (q, $^1J_{\text{C,F}} = 275.73$ Hz), 66.16, 54.59. ^{19}F NMR (376 MHz, CDCl_3) δ -65.49. Spectroscopic data are in accordance with those described in the literature.^[4]



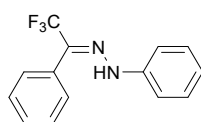
(E)-2,2,2-trifluoro-1-(furan-2-yl)-N-morpholinoethan-1-imine (3s)

White solid; m.p. = 97.3– 98.6 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.40 (s, 1H), 6.79 (d, $J = 3.5$ Hz, 1H), 6.54 (d, $J = 3.5$ Hz, 1H), 3.95 – 3.68 (m, 4H), 3.34 – 2.84 (m, 4H). ^{13}C NMR (100 MHz, CDCl_3) δ 154.35, 141.08 (q, $^2J_{\text{C,F}} = 42.42$ Hz), 124.56, 119.25 (q, $^1J_{\text{C,F}} = 267.65$ Hz), 113.37 (q, $^3J_{\text{C,F}} = 3.03$ Hz), 107.28, 66.35, 51.38. ^{19}F NMR (376 MHz, CDCl_3) δ -63.80. Spectroscopic data are in accordance with those described in the literature.^[1]



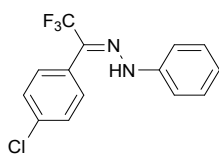
(E)-2,2,2-trifluoro-1-phenyl-N-(piperidin-1-yl)ethan-1-imine (3t)

Yellow oil. ^1H NMR (400 MHz, CDCl_3) δ 7.59 – 7.29 (m, 5H), 3.18 – 2.80 (m, 4H), 1.60 – 1.38 (m, 6H). ^{13}C NMR (100 MHz, CDCl_3) δ 132.63, 132.60 (q, $^2J_{\text{C,F}} = 32.32$ Hz), 132.12, 129.47, 128.74, 128.73, 121.87 (q, $^1J_{\text{C,F}} = 275.73$ Hz), 55.01, 25.04, 24.01. ^{19}F NMR (376 MHz, CDCl_3) δ -66.02. Spectroscopic data are in accordance with those described in the literature.^[3]



(E)-1-phenyl-2-(2,2,2-trifluoro-1-phenylethylidene)hydrazine (3u)

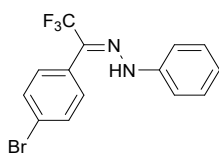
Brown oil. ^1H NMR (400 MHz, CDCl_3) δ 7.80 (s, 1H), 7.62 – 7.54 (m, 3H), 7.45 – 7.41 (m, 2H), 7.31 – 7.26 (m, 2H), 7.10 – 7.03 (m, 2H), 7.00 – 6.89 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 143.06, 131.74 (q, $^2J_{\text{C,F}} = 35.35$ Hz), 130.68, 129.99, 129.46, 129.12, 127.23, 122.03, 121.61 (q, $^1J_{\text{C,F}} = 273.71$ Hz), 113.74. ^{19}F NMR (376 MHz, CDCl_3) δ -66.35. HRMS (ESI) m/z $[\text{M}+\text{H}]^+$ Calculated for $\text{C}_{15}\text{H}_{12}\text{F}_3\text{N}_2$ (265.0947), found 265.0950.



(E)-1-(1-(4-chlorophenyl)-2,2,2-trifluoroethylidene)-2-phenylhydrazine

(3v)

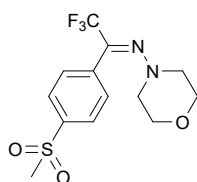
Brown oil. ¹H NMR (400 MHz, CDCl₃) δ 7.77 (s, 1H), 7.64 – 7.50 (m, 3H), 7.41 (dd, *J* = 7.5, 2.0 Hz, 2H), 7.25 – 7.17 (m, 2H), 7.04 – 6.95 (m, 2H). ¹³C NMR (100 MHz, CDCl₃) δ 141.70, 132.49 (q, ²*J*_{C,F} = 35.35 Hz), 130.85, 130.06, 129.41, 129.03, 126.98, 126.82, 121.45 (q, ¹*J*_{C,F} = 273.71Hz), 114.92. ¹⁹F NMR (376 MHz, CDCl₃) δ -66.54. HRMS (ESI) *m/z* [M+H]⁺ Calculated for C₁₄H₁₀ClF₃N₂ (299.0557), found 299.0560.



(E)-1-(1-(4-bromophenyl)-2,2,2-trifluoroethylidene)-2-phenylhydrazine

(3w)

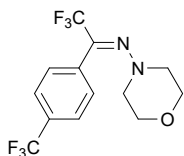
Brown oil. ¹H NMR (400 MHz, CDCl₃) δ 7.77 (s, 1H), 7.63 – 7.52 (m, 3H), 7.47 – 7.32 (m, 4H), 6.99 – 6.91 (m, 2H). ¹³C NMR (100 MHz, CDCl₃) δ 142.19, 132.65 (q, ²*J*_{C,F} = 35.35 Hz), 132.31, 130.86, 130.06, 129.02, 126.97, 121.45 (q, ¹*J*_{C,F} = 273.71Hz), 115.36, 114.15. ¹⁹F NMR (376 MHz, CDCl₃) δ -66.55. HRMS (ESI) *m/z* [M+H]⁺ Calculated for C₁₄H₁₀BrF₃N₂ (343.0052), found 292.0059.



(E)-2,2,2-trifluoro-1-(4-(methylsulfonyl)phenyl)-N-morpholinoethan-1-

imine

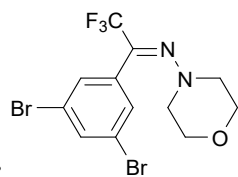
Yellow solid; m.p. = 133.6–135.0 °C. ¹H NMR (400 MHz, CDCl₃) δ 8.23 – 7.79 (m, 2H), 7.74 – 7.49 (m, 2H), 3.69 – 3.54 (m, 4H), 3.09 (s, 3H), 3.03 – 2.95 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ 141.92, 137.49, 132.51 (q, ²*J*_{C,F} = 33.33Hz), 129.91, 128.01, 121.16 (q, ¹*J*_{C,F} = 275.73Hz), 66.05, 54.53, 44.44. ¹⁹F NMR (376 MHz, CDCl₃) δ -66.15. HRMS (ESI) *m/z* [M+H]⁺ Calculated for C₁₃H₁₅F₃N₂O₃S (337.0828), found 337.0835.



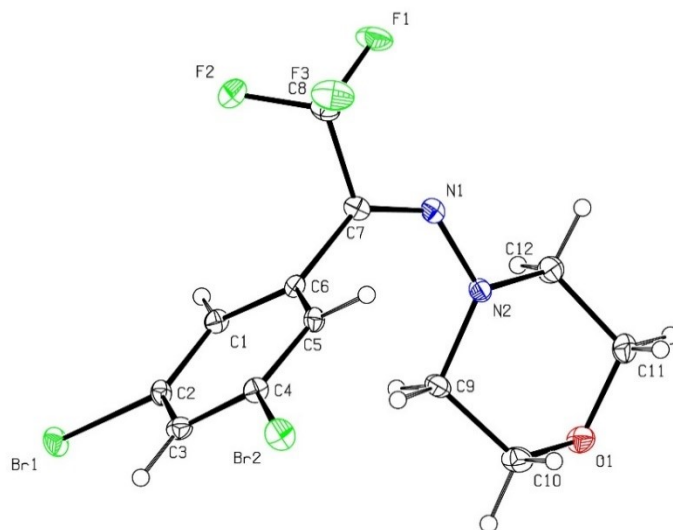
(E)-2,2,2-trifluoro-N-morpholino-1-(4(trifluoromethyl)phenyl)ethan-1-imine

White solid; m.p. = 92.6–93.6 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.69 (d, *J* = 8.0 Hz, 2H), 7.57 (d, *J* = 8.1 Hz, 2H), 3.73 – 3.46 (m, 4H), 3.14 – 2.72 (m, 4H). ¹³C NMR (100 MHz, CDCl₃) δ 135.55, 133.96 (q, ²*J*_{C,F} = 33.33Hz), 132.05 (q, ²*J*_{C,F} = 32.32Hz), 129.28, 123.73 (q, ¹*J*_{C,F} = 273.71Hz), 121.22 (q, ¹*J*_{C,F} = 275.73Hz), 125.98 (q, ³*J*_{C,F} = 3.535Hz), 66.13, 54.50. ¹⁹F NMR (376 MHz, CDCl₃) δ -63.05, -66.47. Spectroscopic data are in accordance with those described in the literature.^[4]

X. Crystal Data and Structure Refinement for 3n



Compound 3n:



CCDC number: 2178804

Table 1 Crystal data and structure refinement for 3n.

Identification code	3n
Empirical formula	C ₁₂ H ₁₁ Br ₂ F ₃ N ₂ O
Formula weight	416.05
Temperature/K	169.0
Crystal system	monoclinic
Space group	P2 ₁ /c
a/Å	11.9638(4)
b/Å	7.6176(2)
c/Å	16.0976(6)
α/°	90
β/°	111.5740(10)
γ/°	90
Volume/Å ³	1364.28(8)
Z	4
ρ _{calc} /g/cm ³	2.026
μ/mm ⁻¹	5.973
F(000)	808.0

Crystal size/mm ³	0.49 × 0.32 × 0.18
Radiation	MoK α (λ = 0.71073)
2 θ range for data collection/ $^{\circ}$	5.326 to 54.322
Index ranges	-15 \leq h \leq 15, -9 \leq k \leq 8, -20 \leq l \leq 20
Reflections collected	9355
Independent reflections	3005 [R _{int} = 0.0580, R _{sigma} = 0.0644]
Data/restraints/parameters	3005/0/181
Goodness-of-fit on F ²	1.050
Final R indexes [I \geq 2 σ (I)]	R ₁ = 0.0494, wR ₂ = 0.1232
Final R indexes [all data]	R ₁ = 0.0567, wR ₂ = 0.1276
Largest diff. peak/hole / e \AA^{-3}	1.15/-1.99

Table 2 Fractional Atomic Coordinates ($\times 10^4$) and Equivalent Isotropic Displacement Parameters ($\text{\AA}^2 \times 10^3$) for 3n. U_{eq} is defined as 1/3 of the trace of the orthogonalised U_{ij} tensor.

Atom	x	y	z	U(eq)
Br1	2940.1 (4)	9498.4 (5)	810.4 (3)	24.80 (16)
Br2	6175.9 (4)	9705.7 (5)	4396.4 (3)	27.41 (16)
F1	2329 (2)	2187 (3)	3418.0 (19)	35.6 (6)
F2	3063 (2)	3195 (3)	2484.1 (18)	34.2 (6)
F3	4087 (2)	3348 (3)	3884.9 (19)	37.4 (6)
O1	-564 (2)	9381 (3)	3875 (2)	24.9 (6)
N1	1565 (3)	5300 (4)	3573 (2)	17.6 (6)
N2	1013 (3)	6730 (4)	3731 (2)	18.2 (6)
C1	2782 (3)	7338 (4)	2195 (2)	17.8 (7)
C2	3427 (3)	8679 (5)	2000 (2)	17.6 (7)
C3	4429 (3)	9416 (5)	2646 (3)	20.5 (8)
C4	4781 (3)	8773 (5)	3509 (3)	18.5 (7)
C5	4147 (3)	7454 (5)	3736 (2)	17.1 (7)
C6	3136 (3)	6753 (4)	3076 (2)	15.7 (7)
C7	2454 (3)	5296 (4)	3314 (3)	18.4 (8)
C8	2967 (3)	3500 (5)	3277 (3)	23.8 (8)
C9	1001 (3)	8466 (5)	3338 (3)	23.0 (8)
C10	571 (4)	9812 (5)	3847 (3)	27.2 (9)
C11	-486 (4)	7734 (5)	4313 (3)	27.0 (9)
C12	-132 (3)	6293 (5)	3819 (3)	25.0 (8)

Table 3 Anisotropic Displacement Parameters ($\text{\AA}^2 \times 10^3$) for 3n. The Anisotropic

displacement factor exponent takes the form: $-2\pi^2[h^2a^*2U_{11}+2hka^*b^*U_{12}+\dots]$.

Atom	U_{11}	U_{22}	U_{33}	U_{23}	U_{13}	U_{12}
Br1	27.4 (2)	29.6 (2)	15.5 (3)	6.96 (14)	5.65 (19)	5.27 (14)
Br2	22.8 (2)	32.5 (2)	20.8 (3)	-3.96 (15)	0.83 (19)	-10.77 (15)
F1	33.5 (13)	18.2 (10)	61.1 (19)	4.3 (11)	24.5 (13)	-3.8 (9)
F2	44.4 (14)	28.5 (12)	36.5 (16)	-1.9 (11)	23.0 (13)	7.5 (11)
F3	23.3 (12)	30.6 (12)	45.3 (17)	9.1 (12)	-2.8 (12)	6.8 (10)
O1	20.6 (14)	23.4 (13)	33.2 (18)	-0.9 (12)	12.7 (13)	1.1 (10)
N1	16.8 (15)	20.6 (14)	11.1 (17)	0.6 (11)	0.1 (13)	-1.9 (11)
N2	18.6 (15)	18.6 (13)	18.6 (17)	2.1 (12)	8.2 (13)	0.1 (11)
C1	17.8 (17)	19.1 (15)	12.5 (18)	-1.3 (14)	0.9 (15)	0.7 (13)
C2	16.1 (16)	22.7 (16)	13.9 (19)	2.8 (14)	5.4 (15)	3.9 (13)
C3	18.7 (18)	16.9 (16)	27 (2)	-2.0 (14)	10.0 (18)	-1.0 (13)
C4	15.7 (16)	21.1 (16)	14.6 (19)	-1.8 (14)	0.7 (15)	-0.8 (13)
C5	17.0 (16)	20.6 (16)	13.1 (18)	0.2 (14)	5.0 (15)	0.7 (13)
C6	15.2 (16)	16.7 (15)	16.0 (19)	-3.0 (13)	6.6 (15)	-0.5 (13)
C7	14.3 (17)	18.8 (16)	17 (2)	1.0 (14)	0.5 (15)	-2.6 (12)
C8	19.6 (18)	20.5 (17)	31 (2)	2.3 (16)	8.9 (17)	-2.7 (14)
C9	25.2 (19)	17.9 (16)	29 (2)	5.7 (15)	14.0 (18)	1.5 (14)
C10	21.8 (19)	21.2 (17)	42 (3)	0.5 (17)	15 (2)	-2.3 (15)
C11	29 (2)	28.9 (19)	30 (2)	-1.5 (17)	18.4 (19)	-2.0 (16)
C12	24.0 (19)	23.7 (18)	31 (2)	-2.4 (16)	14.3 (18)	-3.8 (15)

Table 4 Bond Lengths for 3n.

Atom	Atom	Length/Å	Atom	Atom	Length/Å
Br1	C2	1.891 (4)	C1	C2	1.385 (5)
Br2	C4	1.892 (4)	C1	C6	1.395 (5)
F1	C8	1.327 (4)	C2	C3	1.385 (5)
F2	C8	1.342 (5)	C3	C4	1.383 (5)
F3	C8	1.343 (5)	C4	C5	1.386 (5)
O1	C10	1.414 (4)	C5	C6	1.391 (5)
O1	C11	1.425 (5)	C6	C7	1.508 (5)
N1	N2	1.346 (4)	C7	C8	1.510 (5)
N1	C7	1.278 (5)	C9	C10	1.515 (5)
N2	C9	1.464 (4)	C11	C12	1.505 (5)
N2	C12	1.465 (4)			

Table 5 Bond Angles for 3n.

Atom	Atom	Atom	Angle/°	Atom	Atom	Atom	Angle/°
C10	O1	C11	109.3 (3)	C5	C6	C1	120.5 (3)
C7	N1	N2	126.1 (3)	C5	C6	C7	119.2 (3)
N1	N2	C9	125.2 (3)	N1	C7	C6	132.4 (3)
N1	N2	C12	112.1 (3)	N1	C7	C8	114.5 (3)
C9	N2	C12	112.7 (3)	C6	C7	C8	113.1 (3)
C2	C1	C6	118.7 (3)	F1	C8	F2	106.7 (3)
C1	C2	Br1	118.9 (3)	F1	C8	F3	107.0 (3)
C1	C2	C3	122.0 (3)	F1	C8	C7	114.1 (3)
C3	C2	Br1	119.1 (3)	F2	C8	F3	105.5 (3)
C4	C3	C2	118.1 (3)	F2	C8	C7	111.8 (3)
C3	C4	Br2	118.9 (3)	F3	C8	C7	111.1 (3)
C3	C4	C5	121.8 (3)	N2	C9	C10	109.2 (3)
C5	C4	Br2	119.3 (3)	O1	C10	C9	112.4 (3)
C4	C5	C6	118.9 (3)	O1	C11	C12	111.1 (3)
C1	C6	C7	120.2 (3)	N2	C12	C11	109.9 (3)

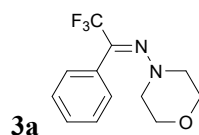
Table 6 Torsion Angles for 3n.

A	B	C	D	Angle/°	A	B	C	D	Angle/°
Br1	C2	C3	C4	-178.8 (3)	C2	C3	C4	C5	-1.3 (5)
Br2	C4	C5	C6	-178.8 (3)	C3	C4	C5	C6	0.6 (5)
O1	C11	C12	N2	57.1 (5)	C4	C5	C6	C1	1.5 (5)
N1	N2	C9	C10	-165.8 (4)	C4	C5	C6	C7	178.9 (3)
N1	N2	C12	C11	159.4 (3)	C5	C6	C7	N1	91.3 (5)
N1	C7	C8	F1	7.5 (5)	C5	C6	C7	C8	-85.4 (4)
N1	C7	C8	F2	128.8 (4)	C6	C1	C2	Br1	-179.2 (2)
N1	C7	C8	F3	-113.6 (4)	C6	C1	C2	C3	1.9 (5)
N2	N1	C7	C6	-2.3 (7)	C6	C7	C8	F1	-175.2 (3)
N2	N1	C7	C8	174.3 (3)	C6	C7	C8	F2	-53.9 (4)
N2	C9	C10	O1	-55.7 (5)	C6	C7	C8	F3	63.7 (4)
C1	C2	C3	C4	0.0 (5)	C7	N1	N2	C9	24.2 (6)
C1	C6	C7	N1	-91.3 (5)	C7	N1	N2	C12	166.9 (4)
C1	C6	C7	C8	92.1 (4)	C9	N2	C12	C11	-53.0 (4)
C2	C1	C6	C5	-2.7 (5)	C10	O1	C11	C12	-60.9 (4)
C2	C1	C6	C7	179.9 (3)	C11	O1	C10	C9	60.6 (5)
C2	C3	C4	Br2	178.0 (3)	C12	N2	C9	C10	51.6 (4)

Table 7 Hydrogen Atom Coordinates ($\text{\AA} \times 10^4$) and Isotropic Displacement Parameters ($\text{\AA}^2 \times 10^3$) for 3n.

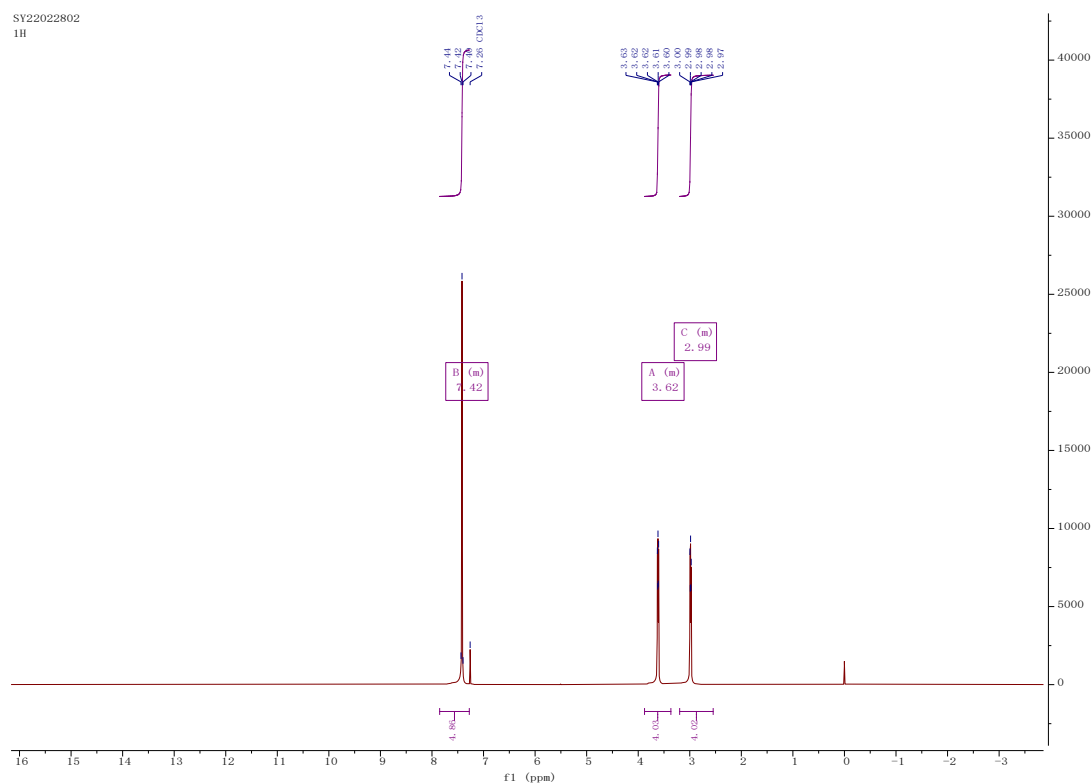
Atom	x	y	z	U(eq)
H1	2111.25	6825.53	1738.3	21
H3	4861.99	10336.67	2502.05	25
H5	4399.39	7037.27	4333.14	20
H9A	459.04	8457.17	2702.26	28
H9B	1819.71	8772.32	3369.1	28
H10A	1165.67	9900.2	4464.61	33
H10B	519.91	10973.63	3559.37	33
H11A	-1273.61	7449.74	4350.75	32
H11B	114.98	7814.92	4928.97	32
H12A	-51.28	5173.22	4148.31	30
H12B	-763.24	6143.62	3219.27	30

Copies of NMR spectra: ^1H -, ^{13}C - and ^{19}F -NMR spectra



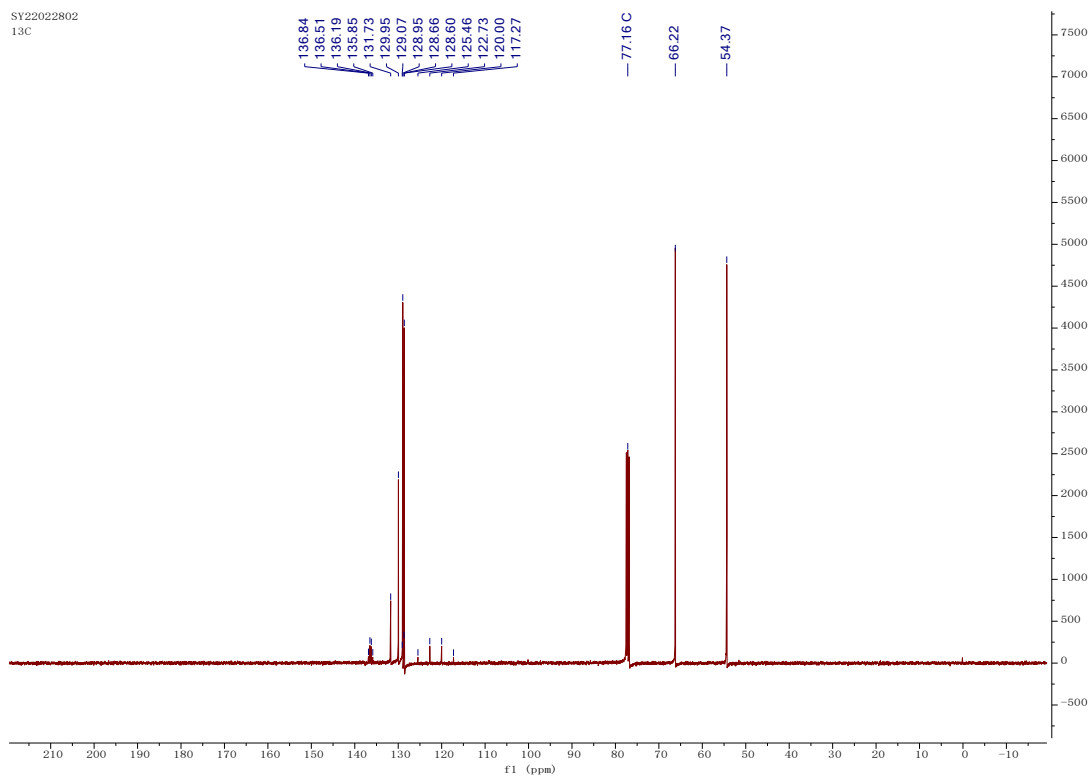
^1H NMR

SY22022802
1H



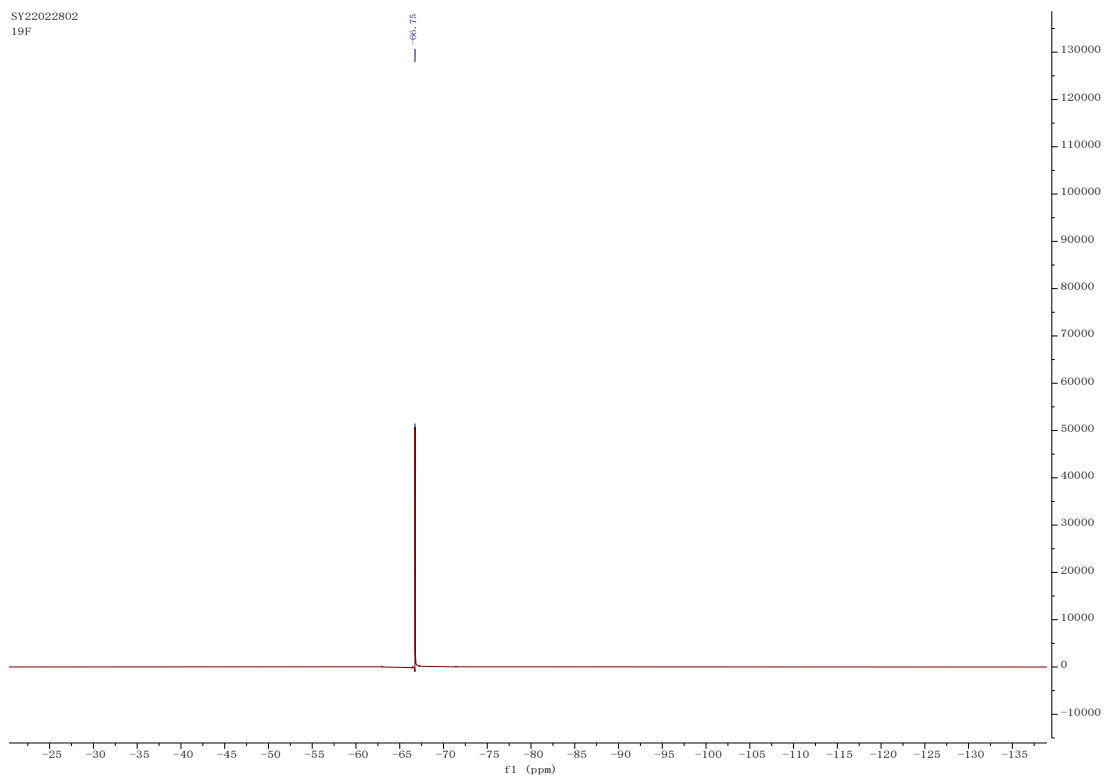
^{13}C NMR

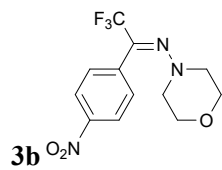
SY22022802
13C



¹⁹F NMR

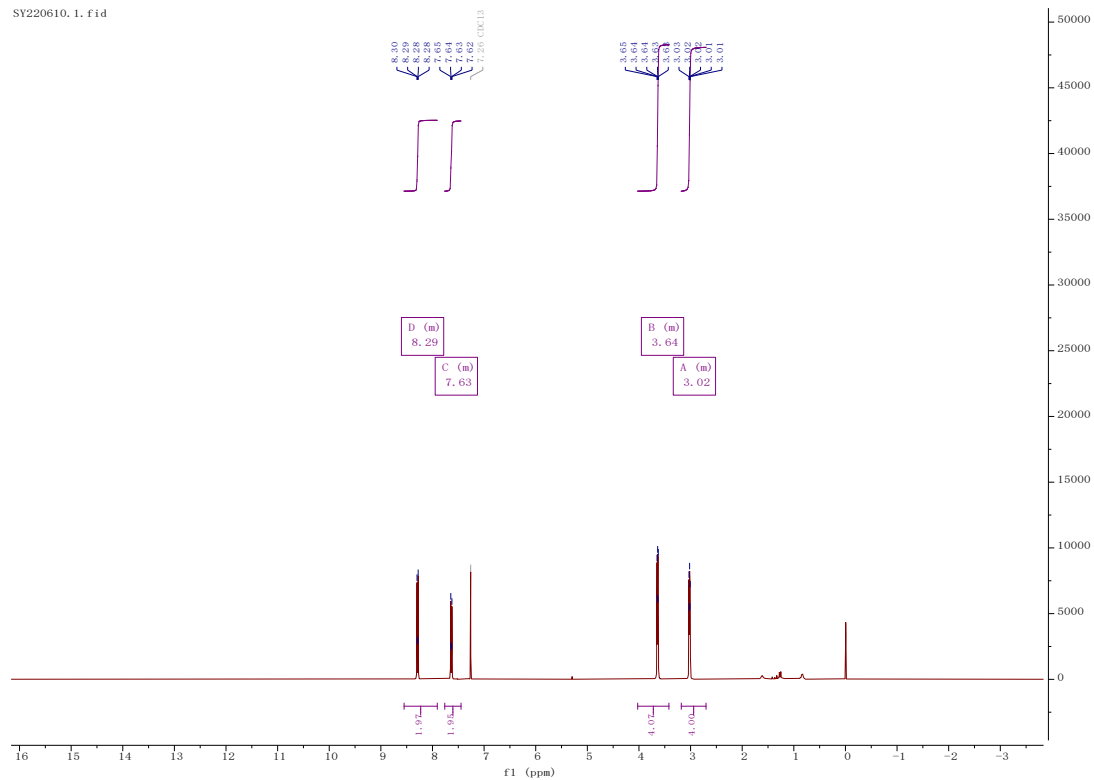
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19F





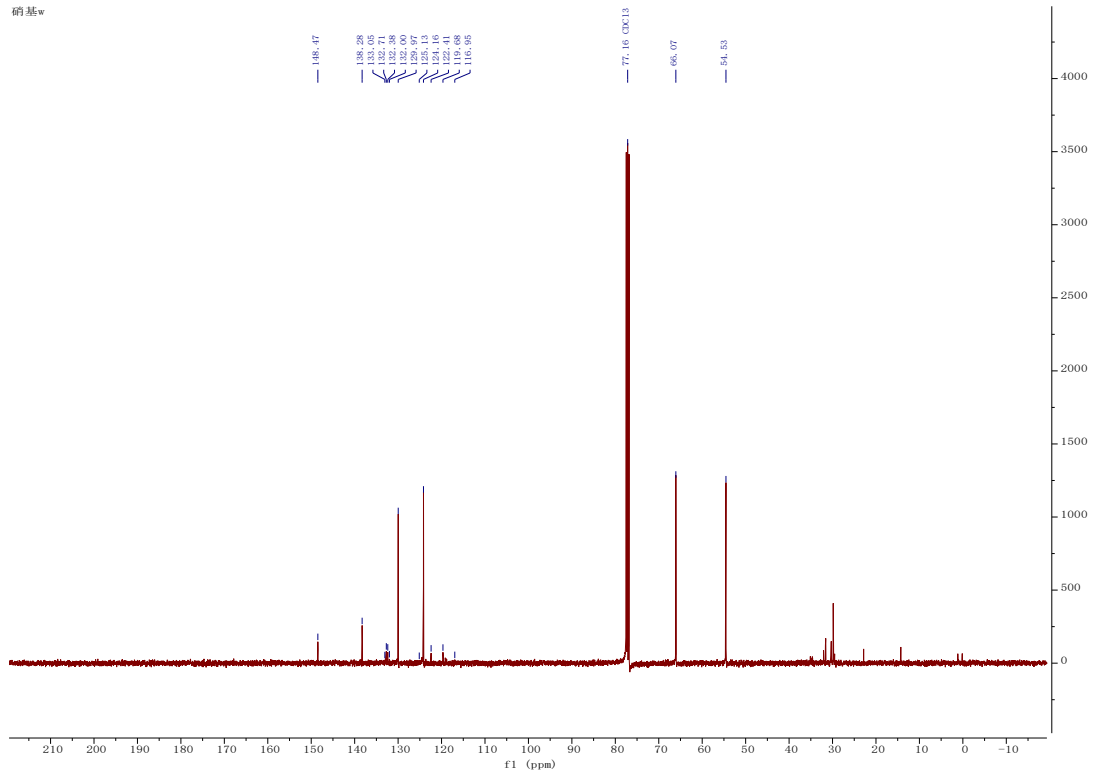
¹H NMR

SV220610.1.fid



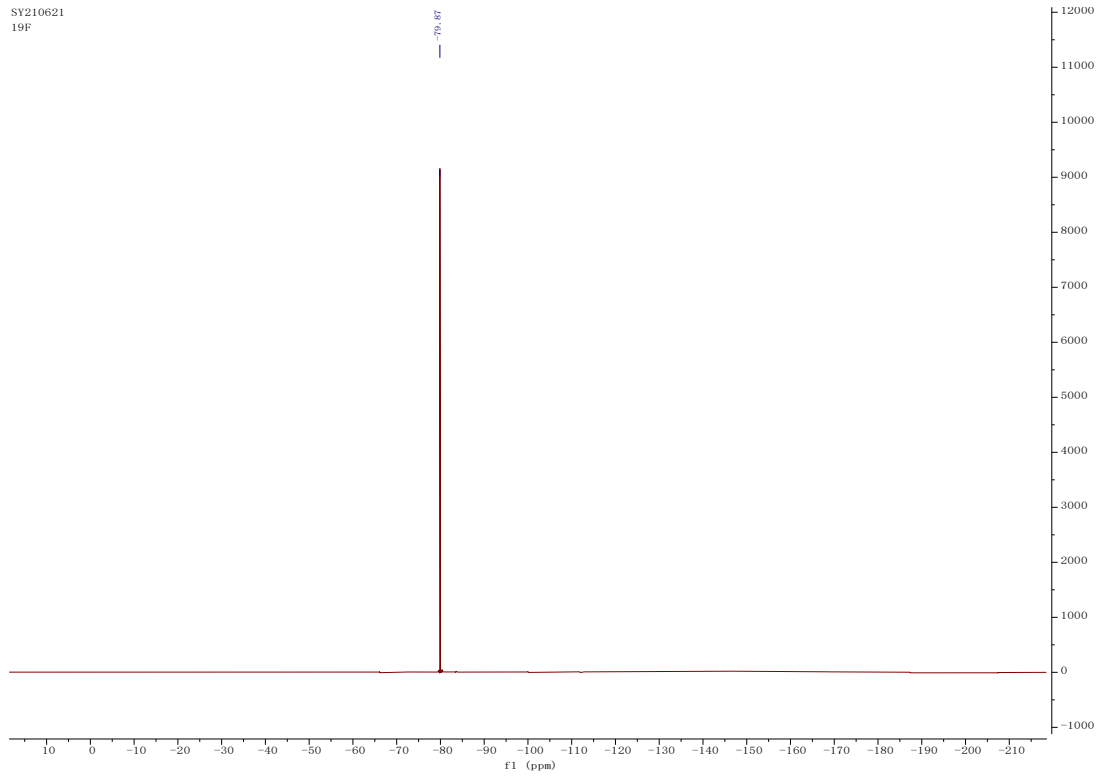
¹³C NMR

硝基^w



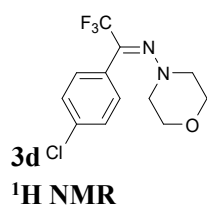
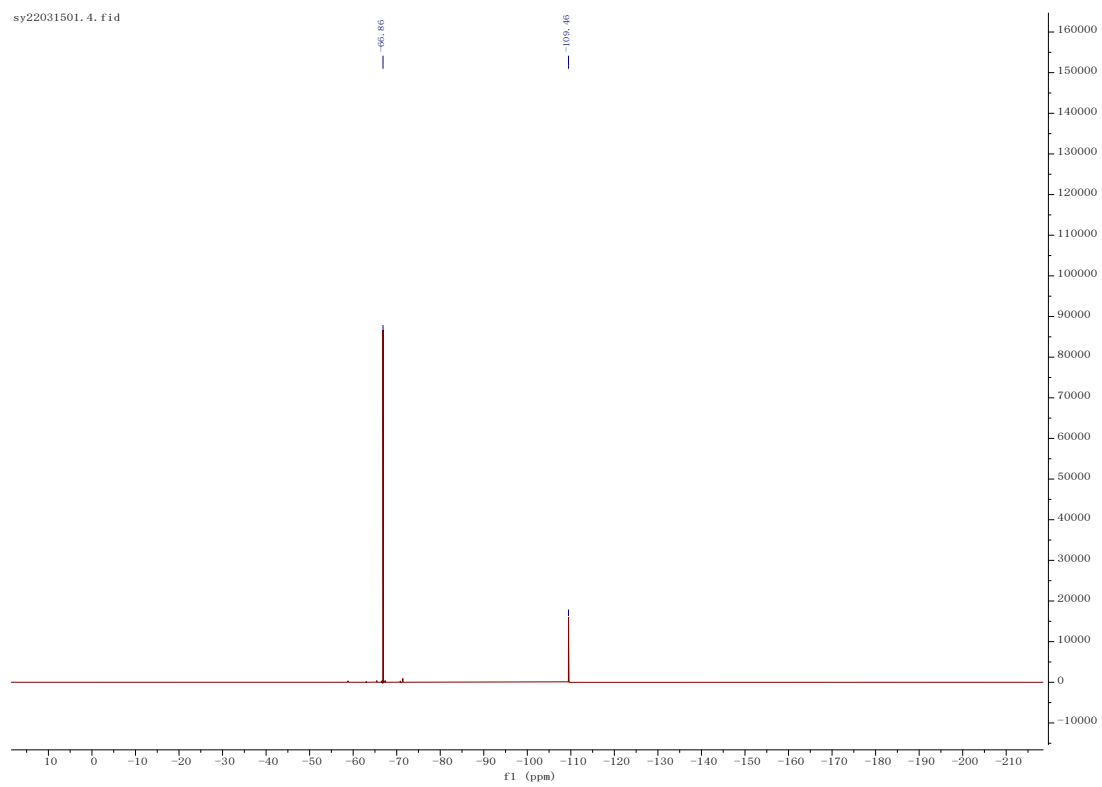
¹⁹F NMR

SY210621
19F

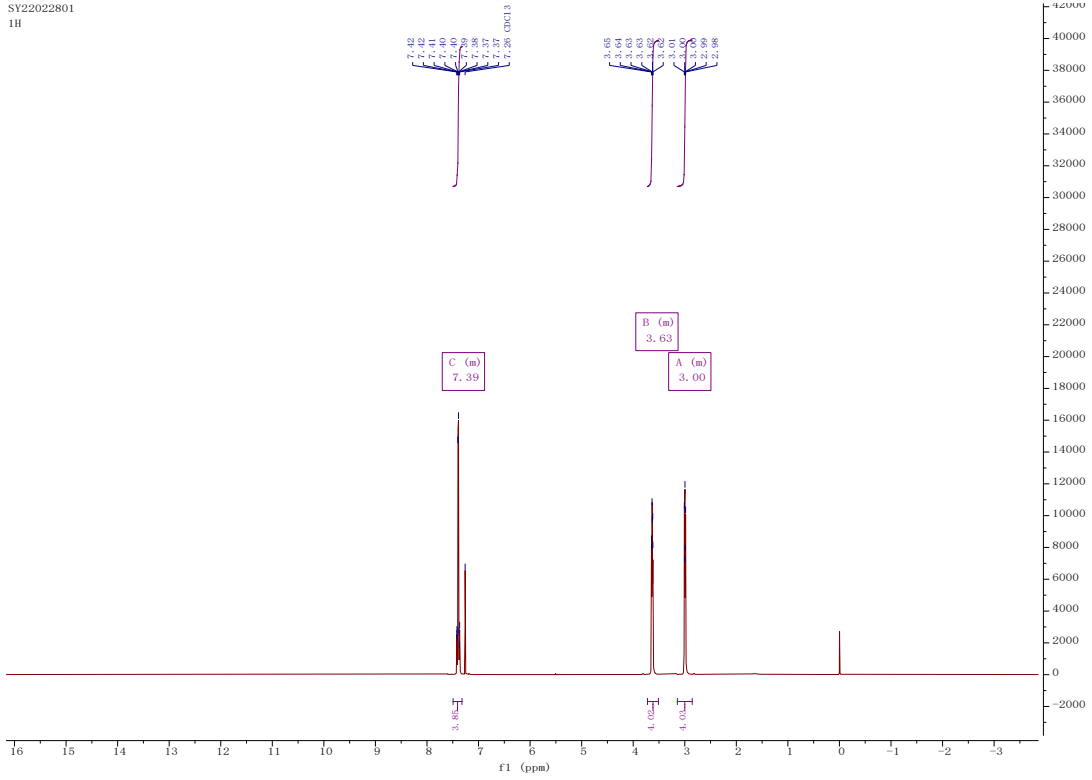


¹⁹F NMR

sy22031501.4.fid

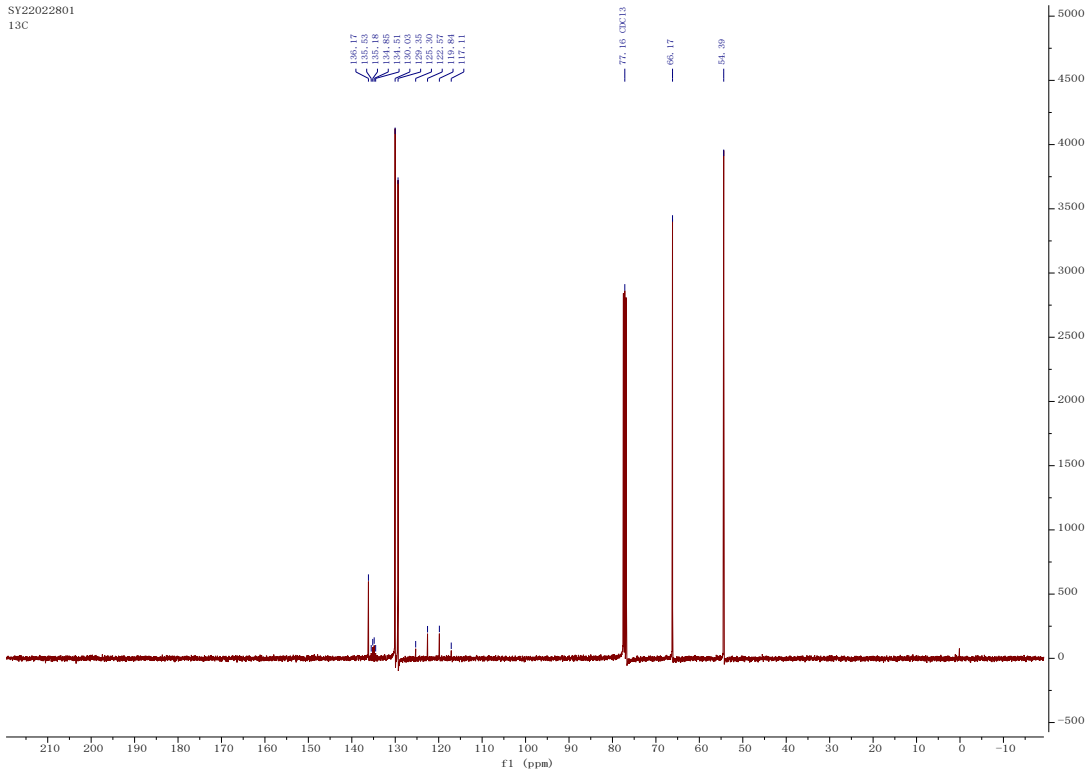


SY22022801
1H

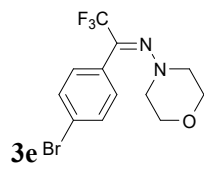
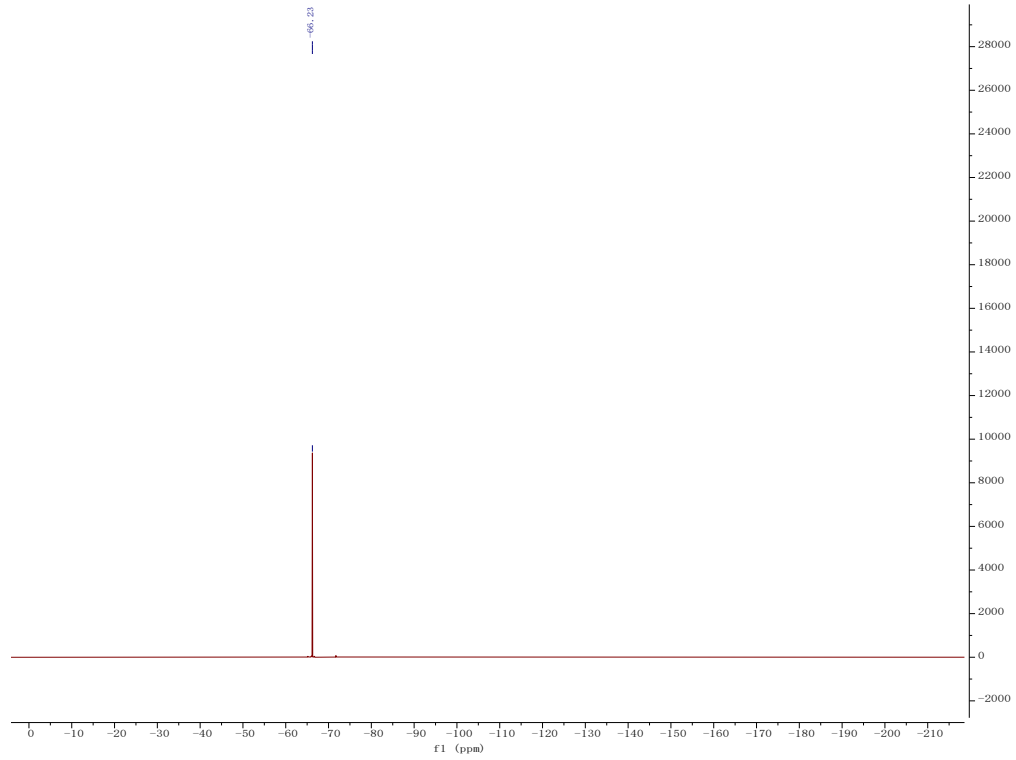


13C NMR

SY22022801
13C

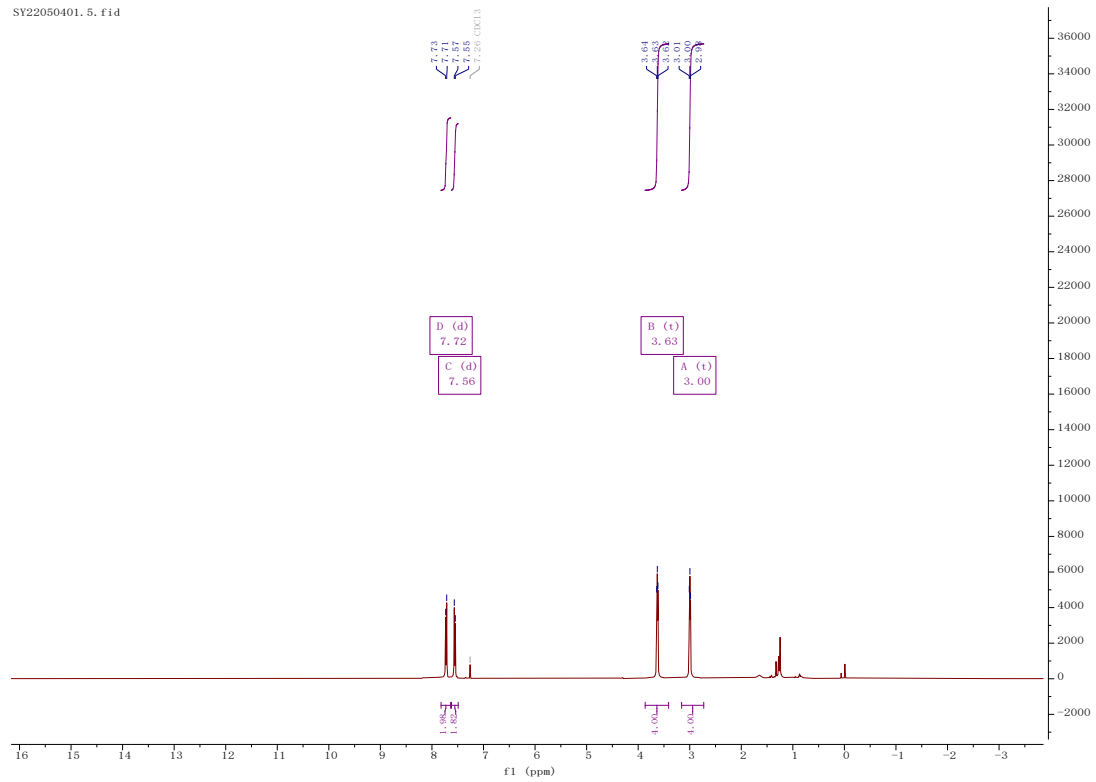


19F NMR



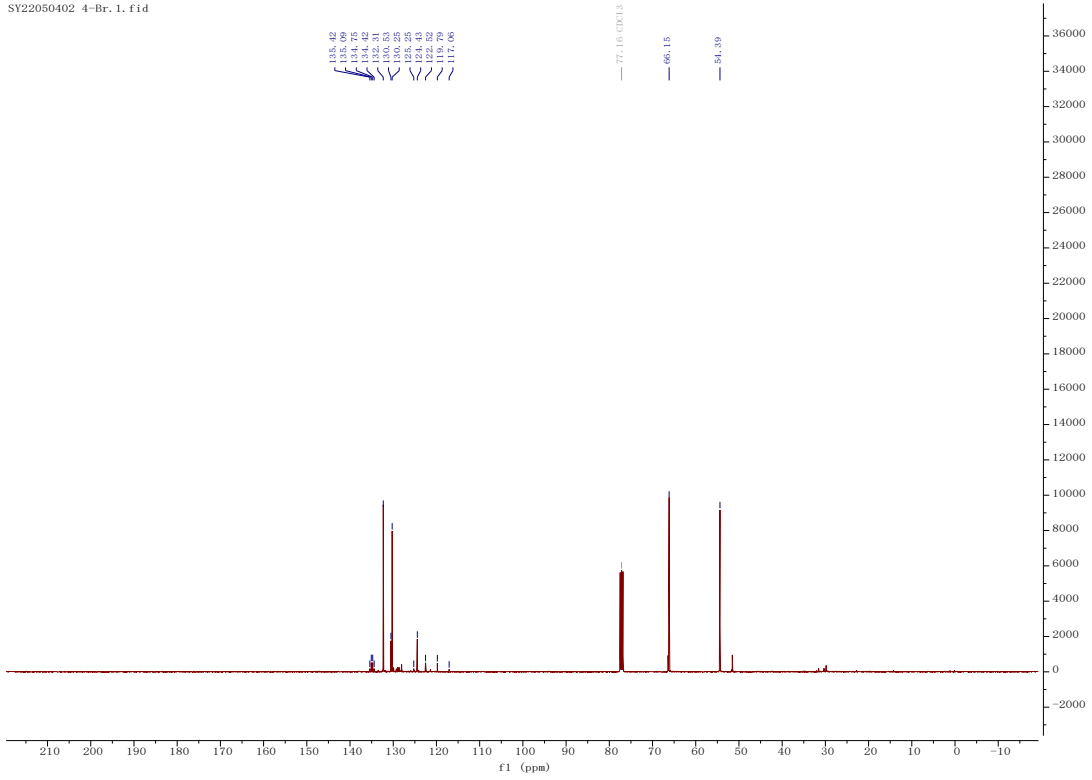
¹H NMR

SY22050401.5.fid



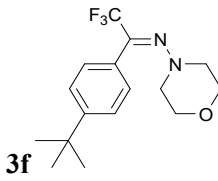
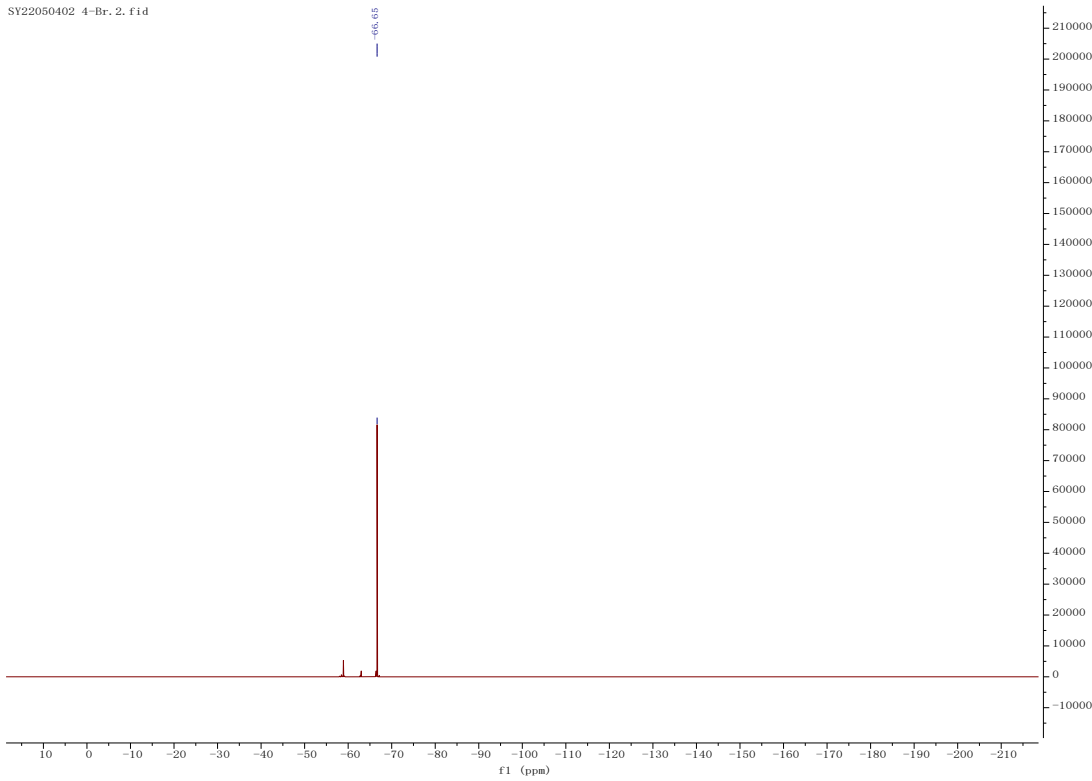
¹³C NMR

SY22050402 4-Br. 1. fid



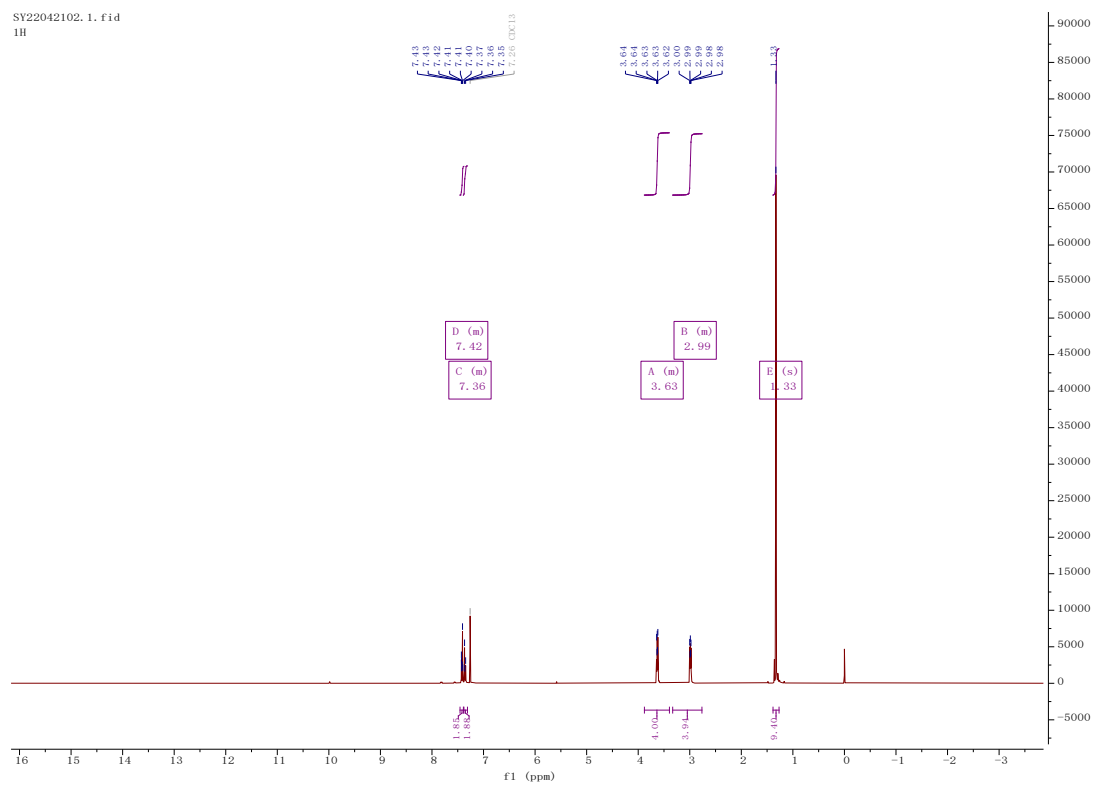
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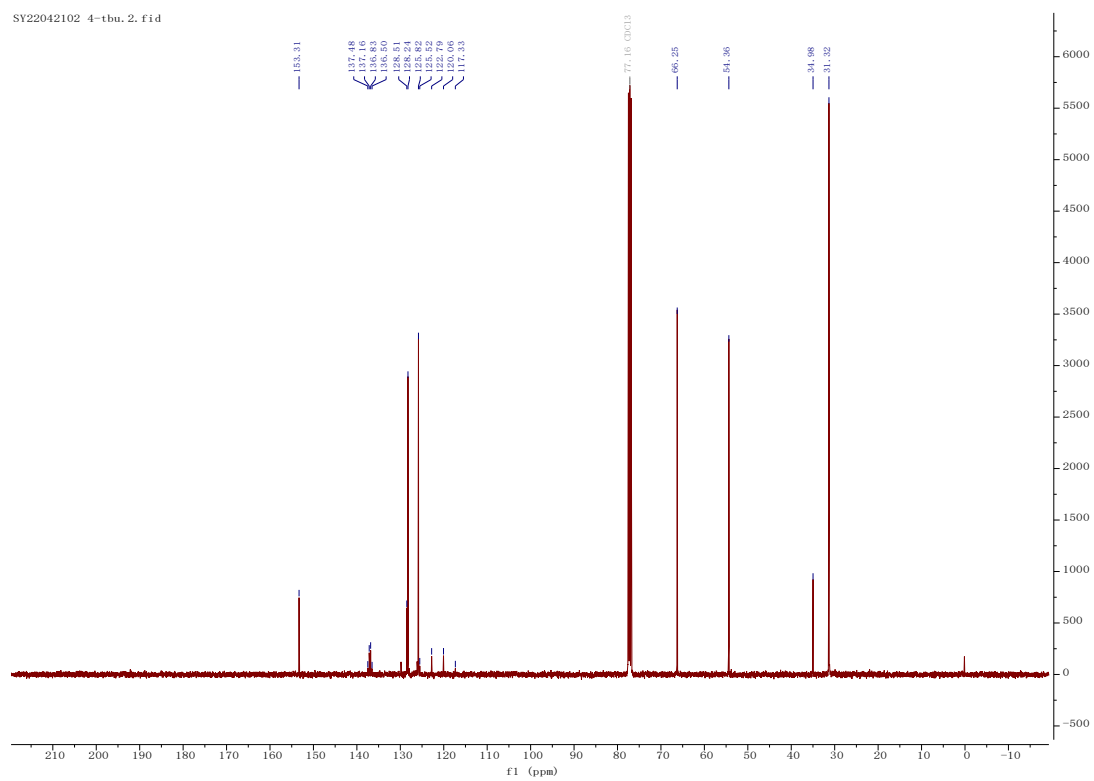
¹H NMR

SY22042102.1.fid
1H



¹³C NMR

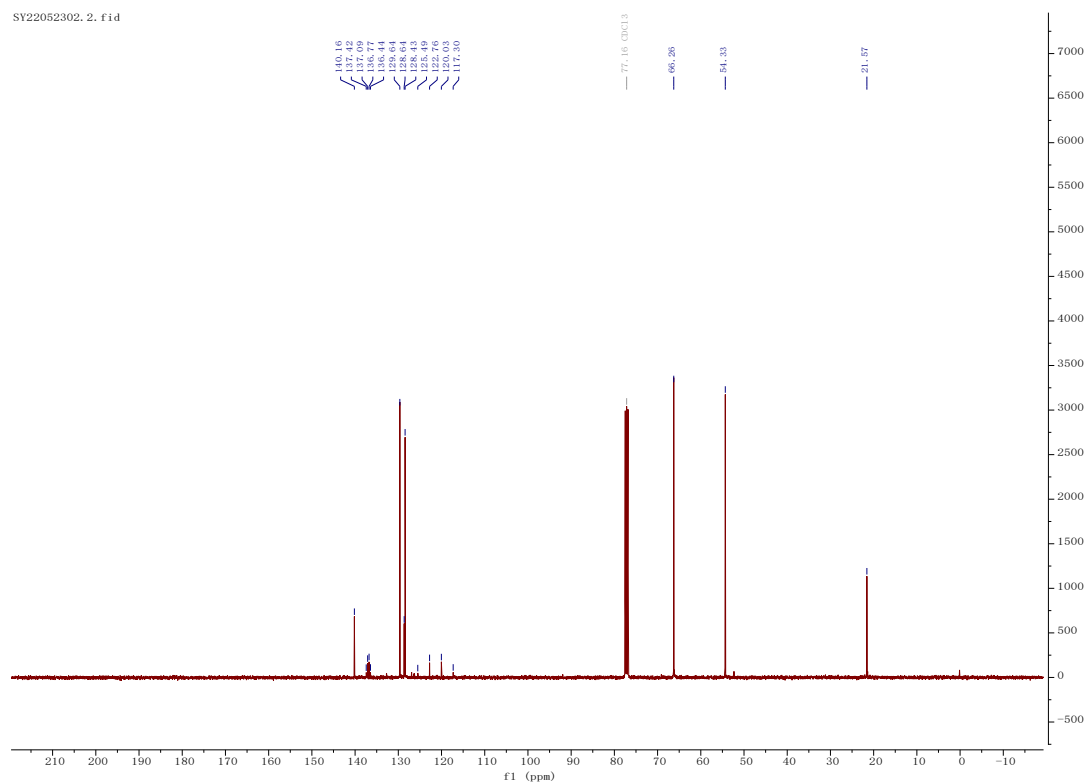
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¹⁹F NMR

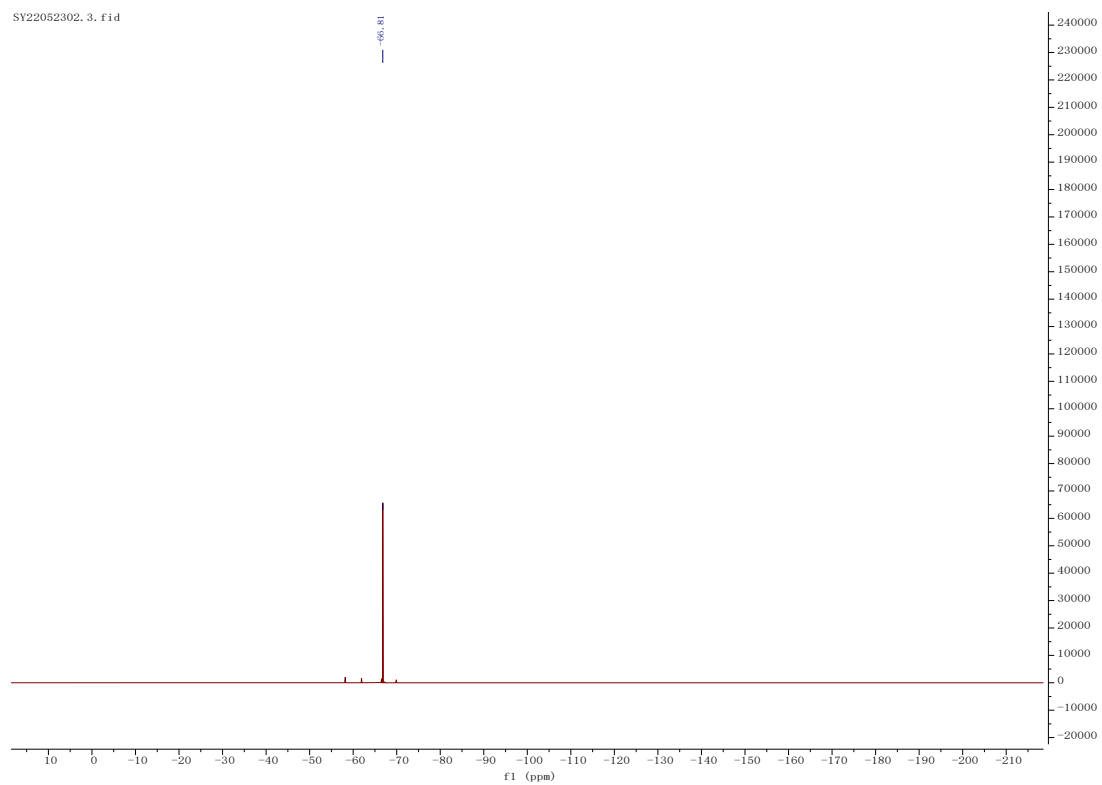
¹³C NMR

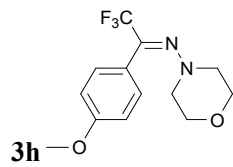
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¹⁹F NMR

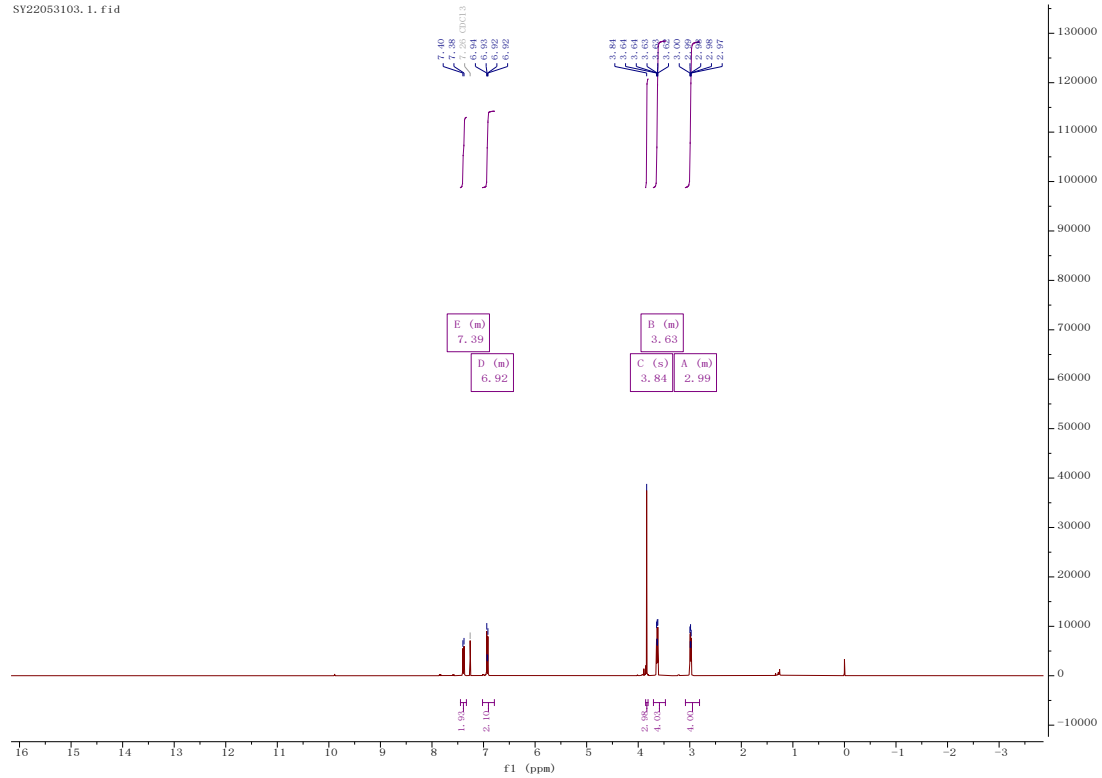
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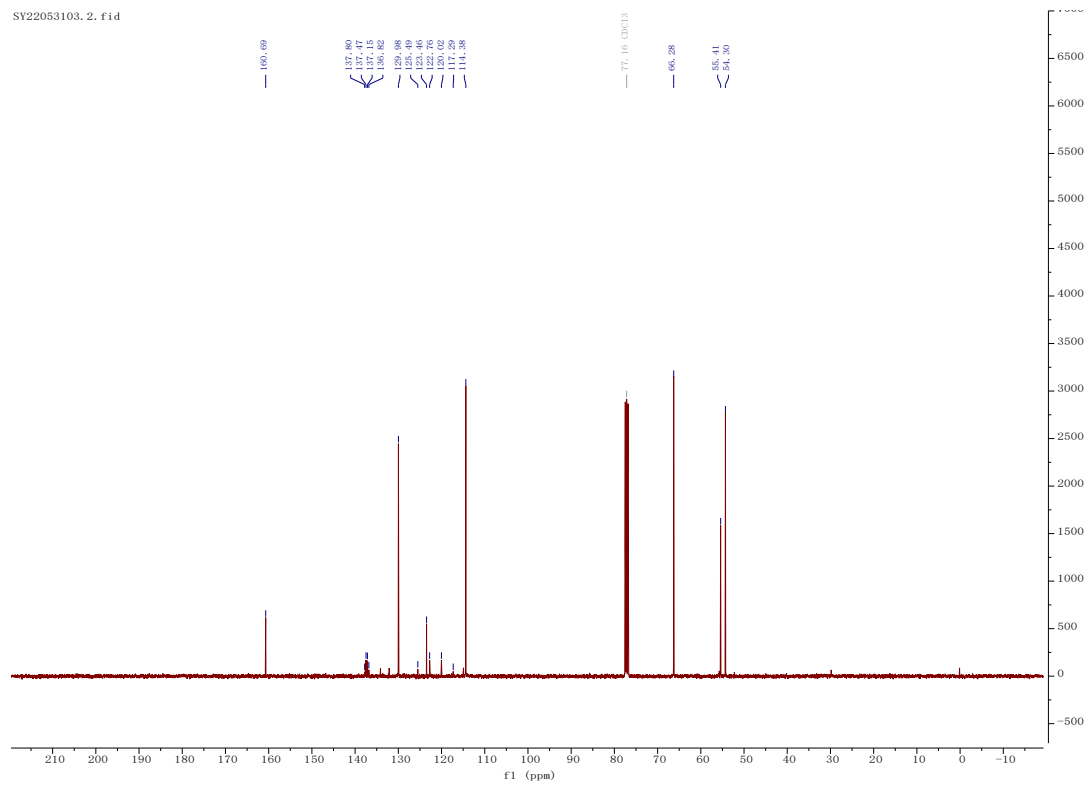
¹H NMR

SV22053103. 1. F1d



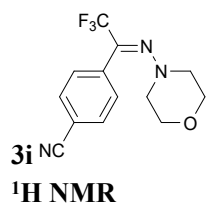
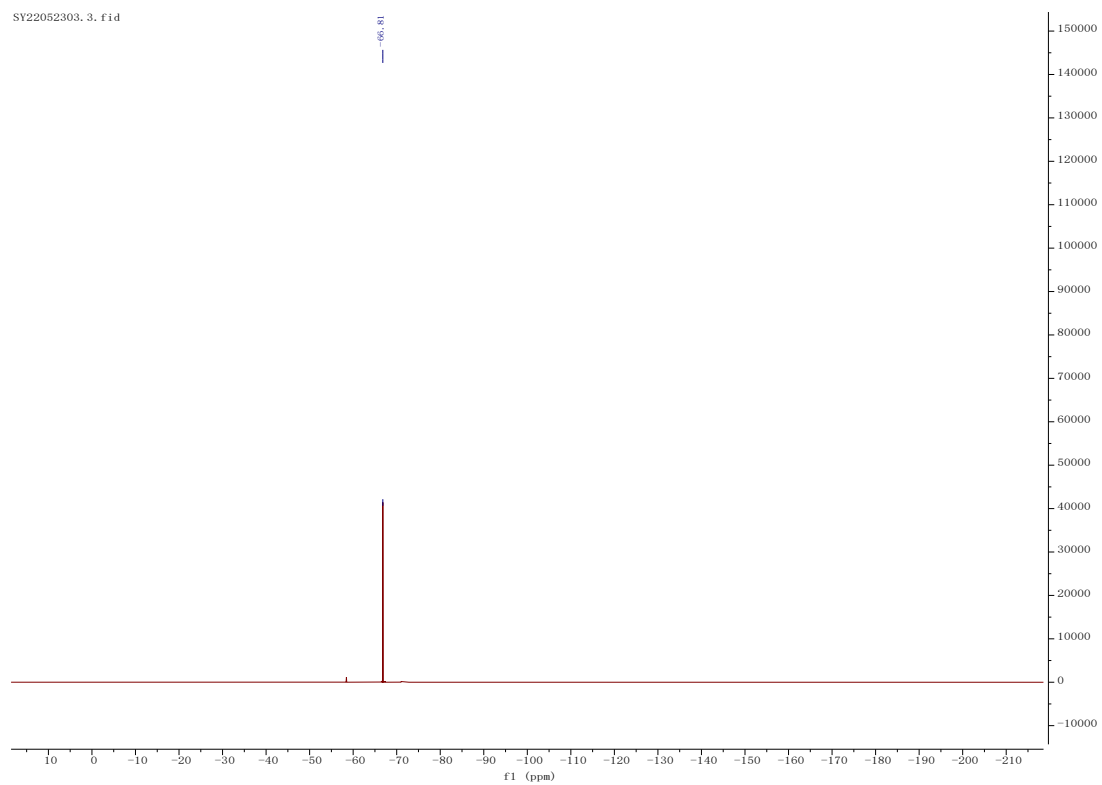
¹³C NMR

SV22053103. 2. F1d

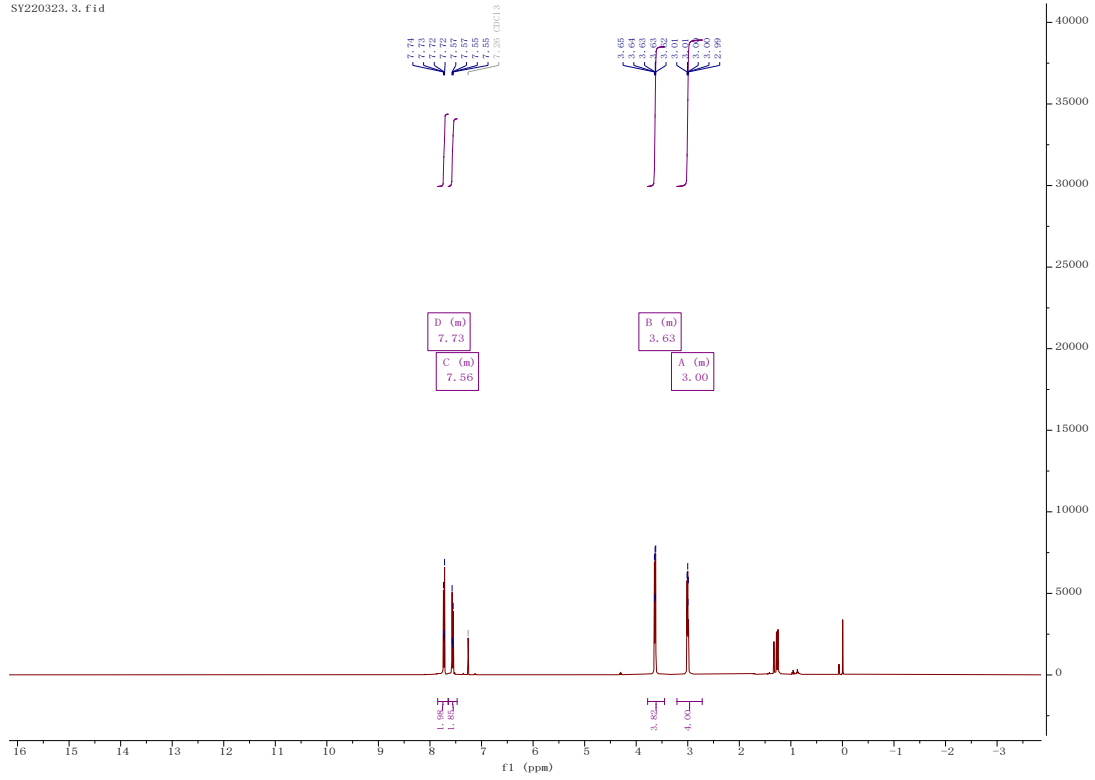


¹⁹F NMR

SY22052303.3.fid

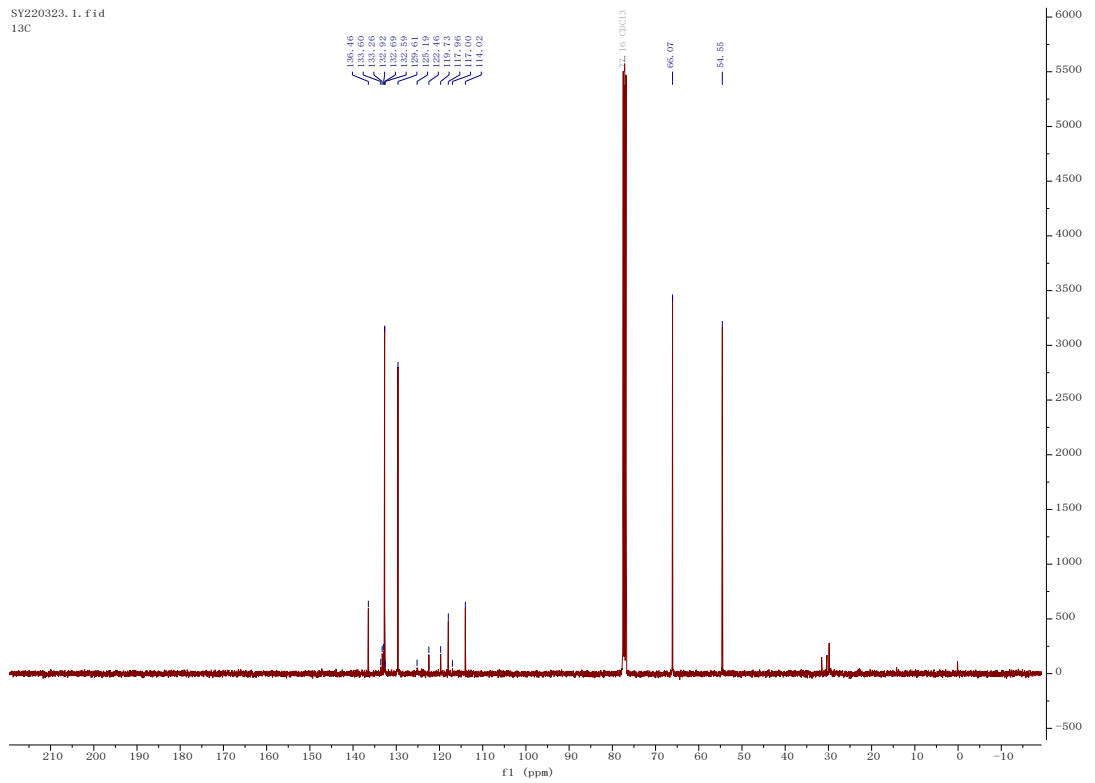


SY220323. 3. fid



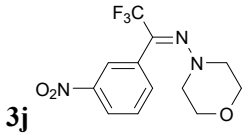
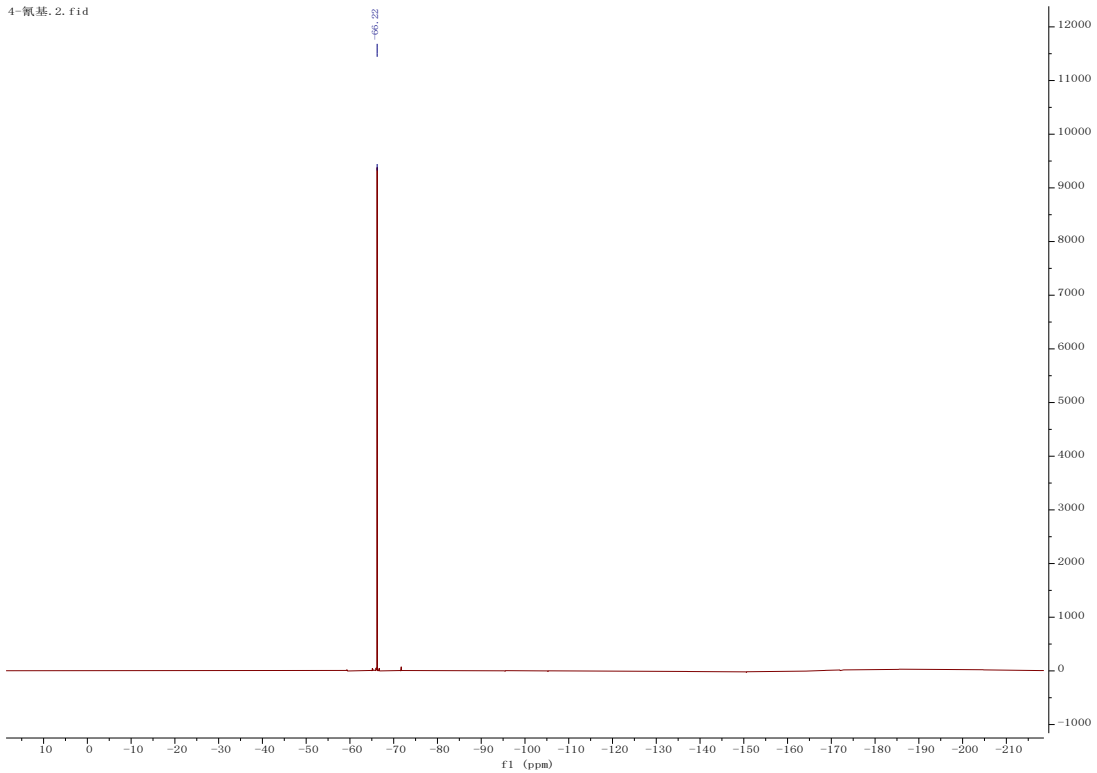
¹³C NMR

SY220323. 1. fid
13C



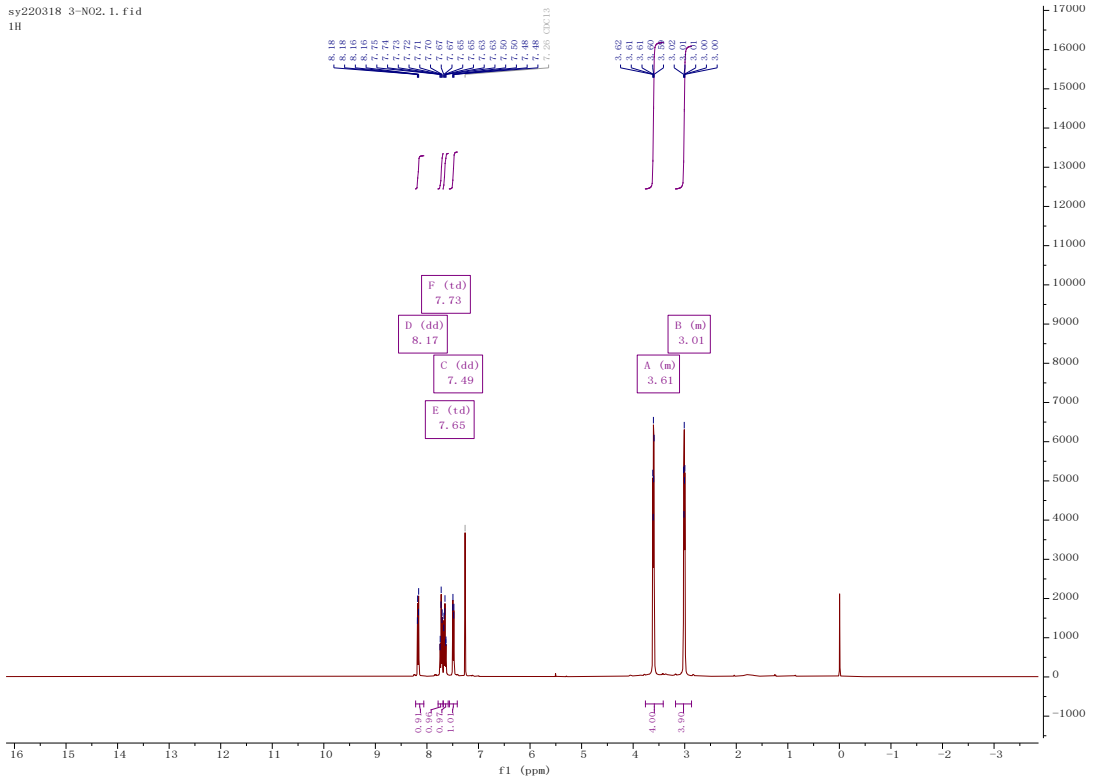
¹⁹F NMR

4-氟基.2.fid



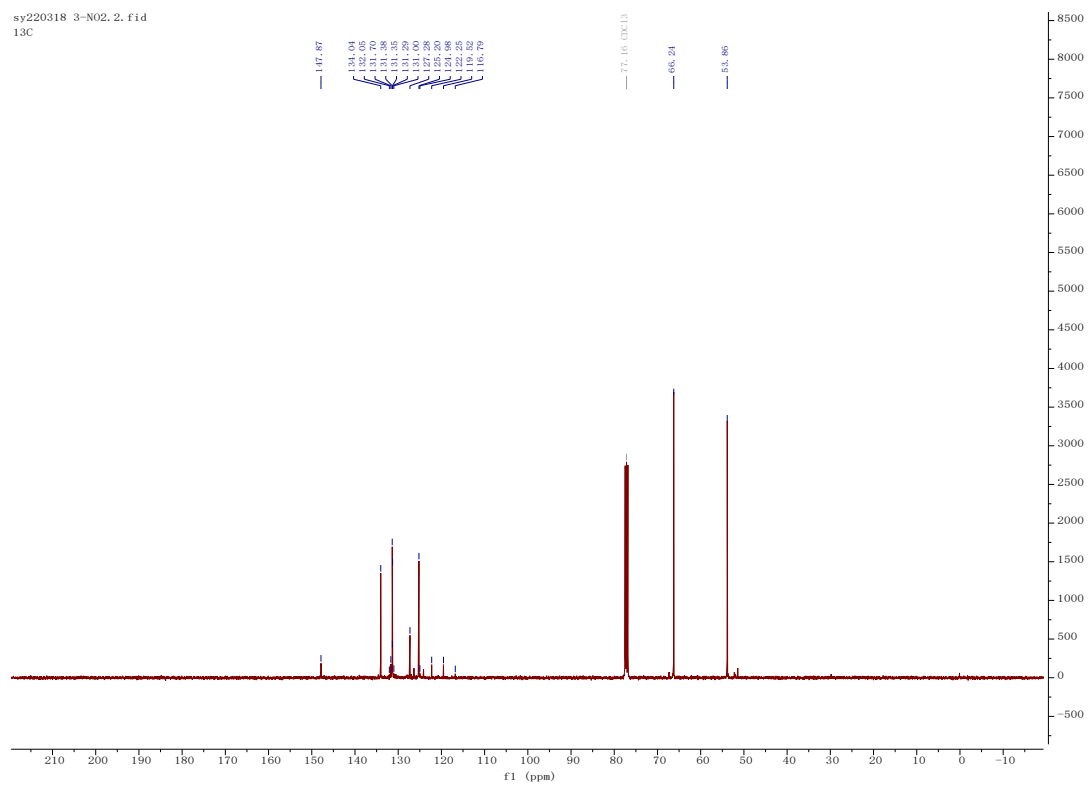
¹H NMR

sy220318 3-N02.1.fid
1H



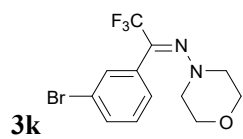
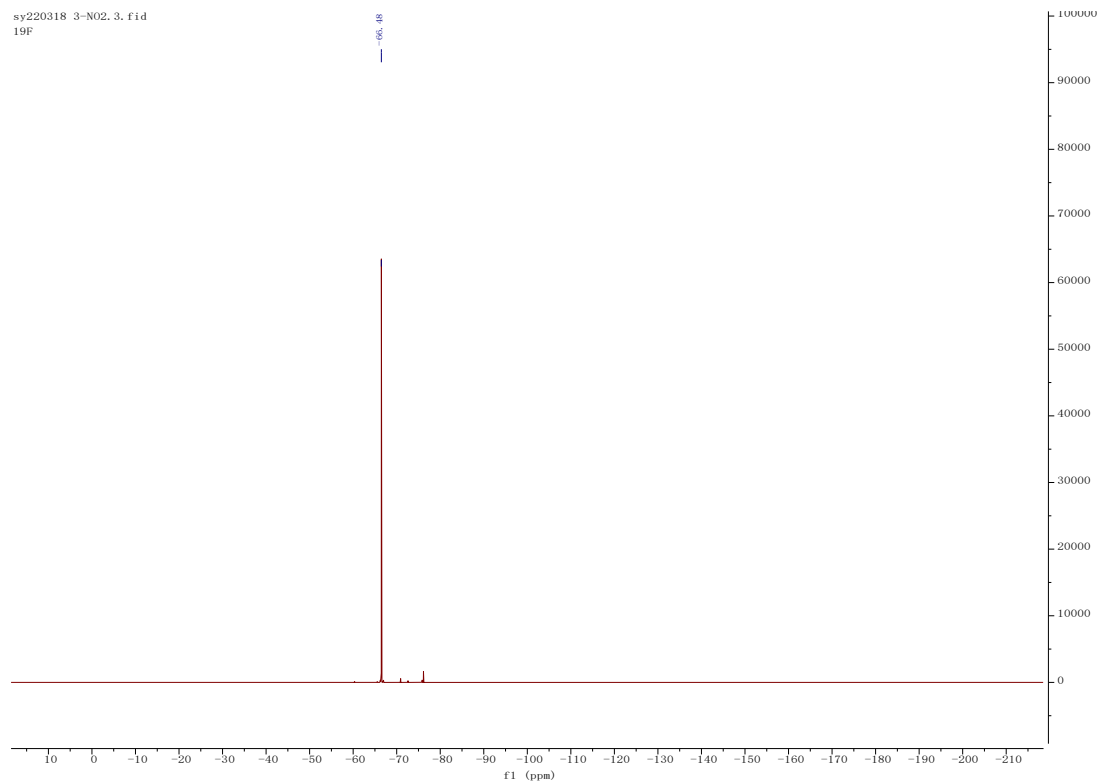
¹³C NMR

sy220318 3-N02.2.fid
13C

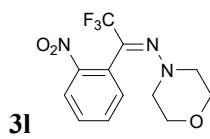
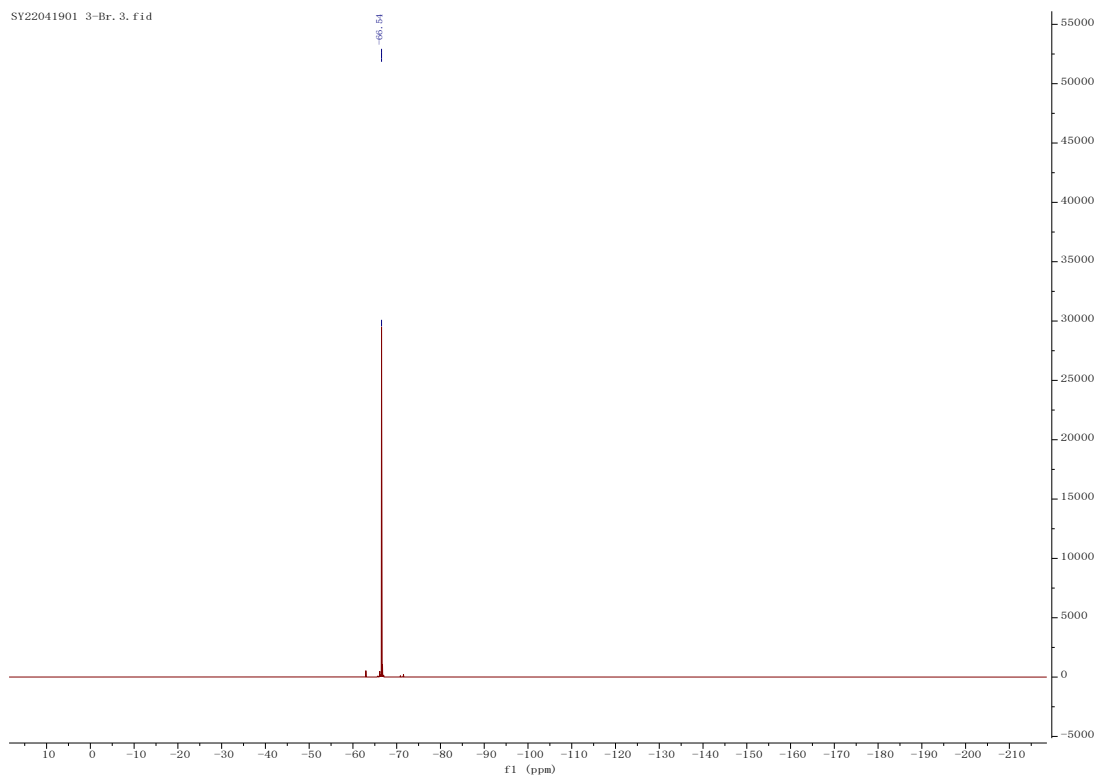


¹⁹F NMR

sy220318 3-N02.3.fid
19F

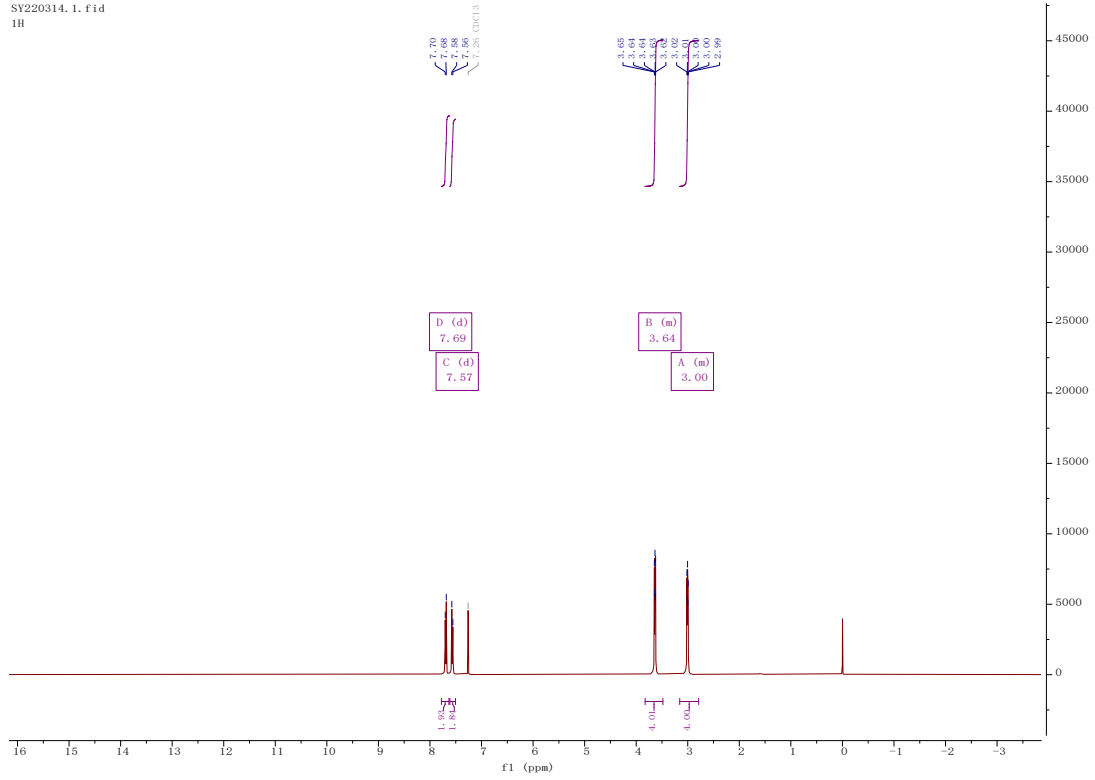


SY22041901 3-Br. 3. fid



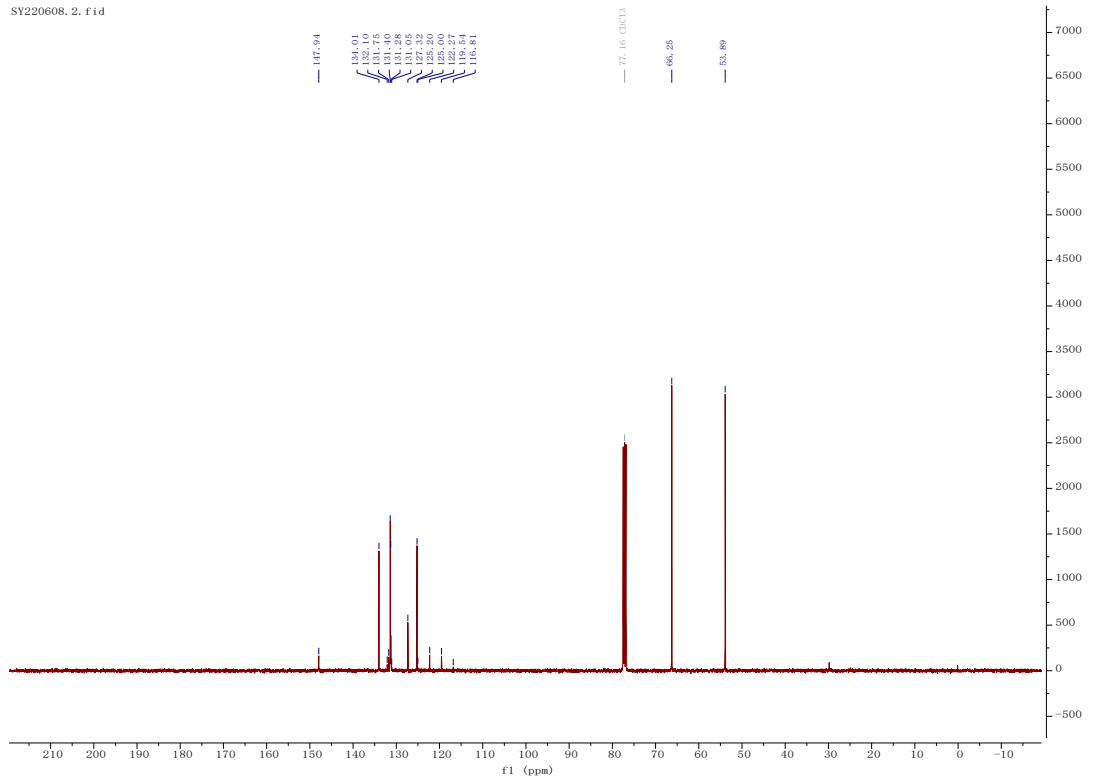
¹H NMR

SY220314.1.fid
1H



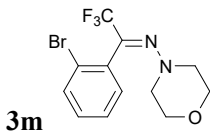
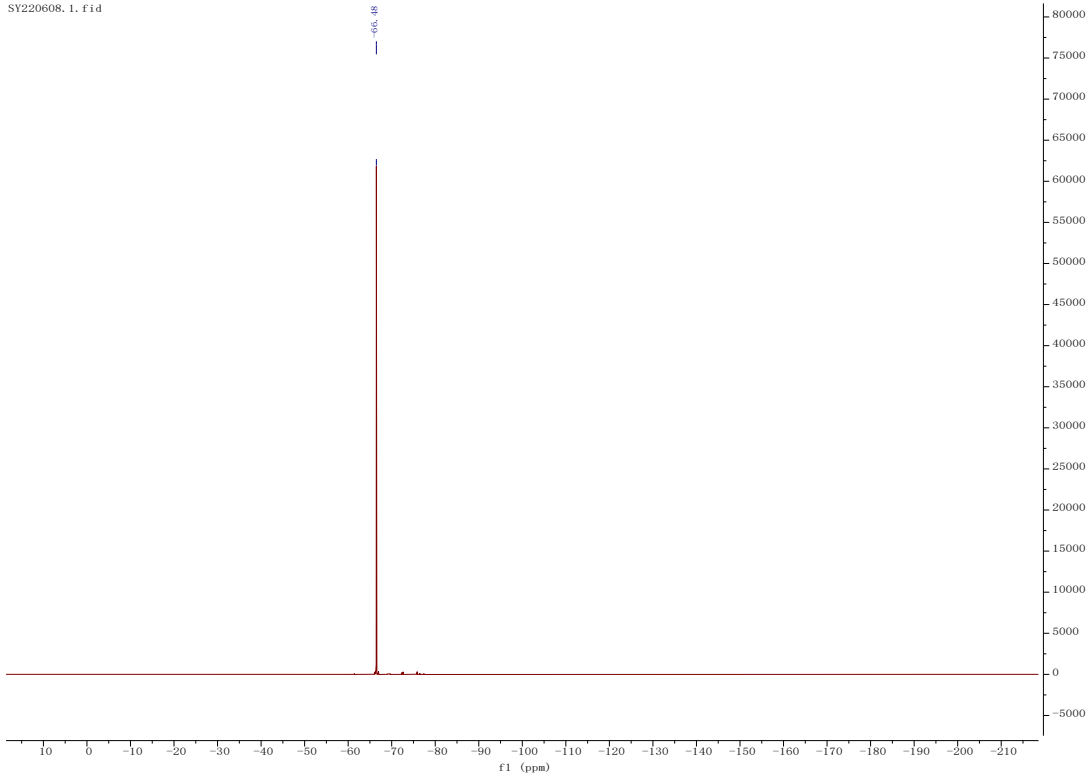
¹³C NMR

SY220608.2.fid



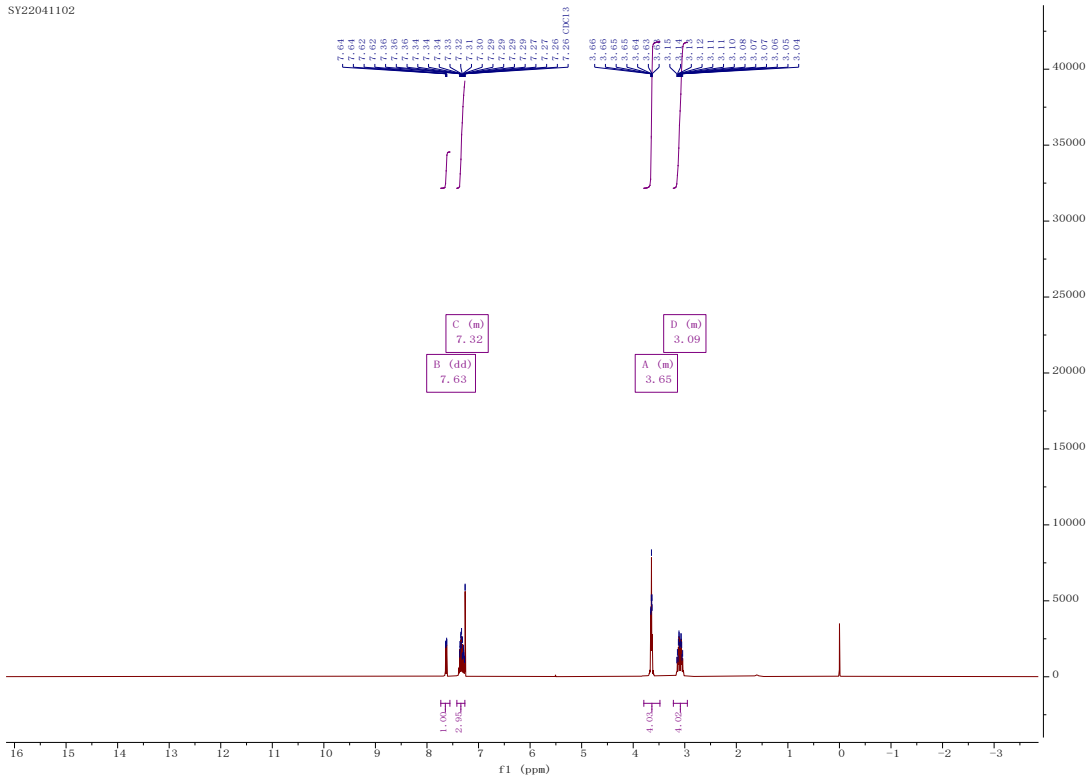
¹⁹F NMR

SY220608.1.fid



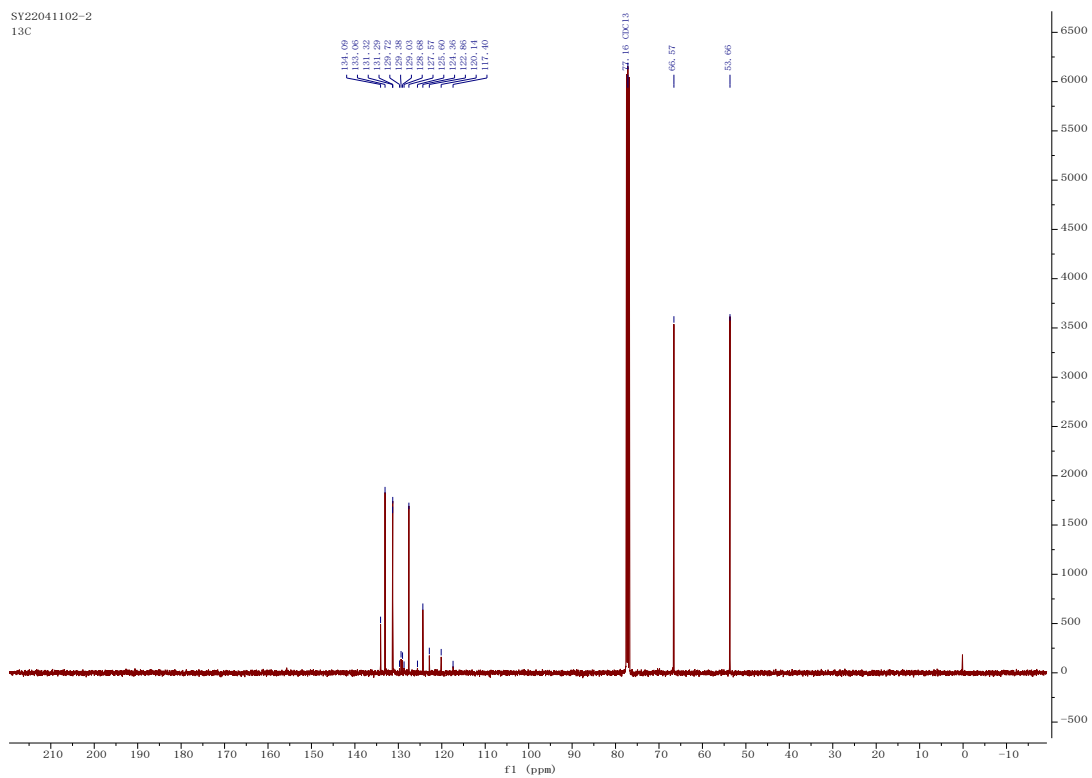
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SY22041102



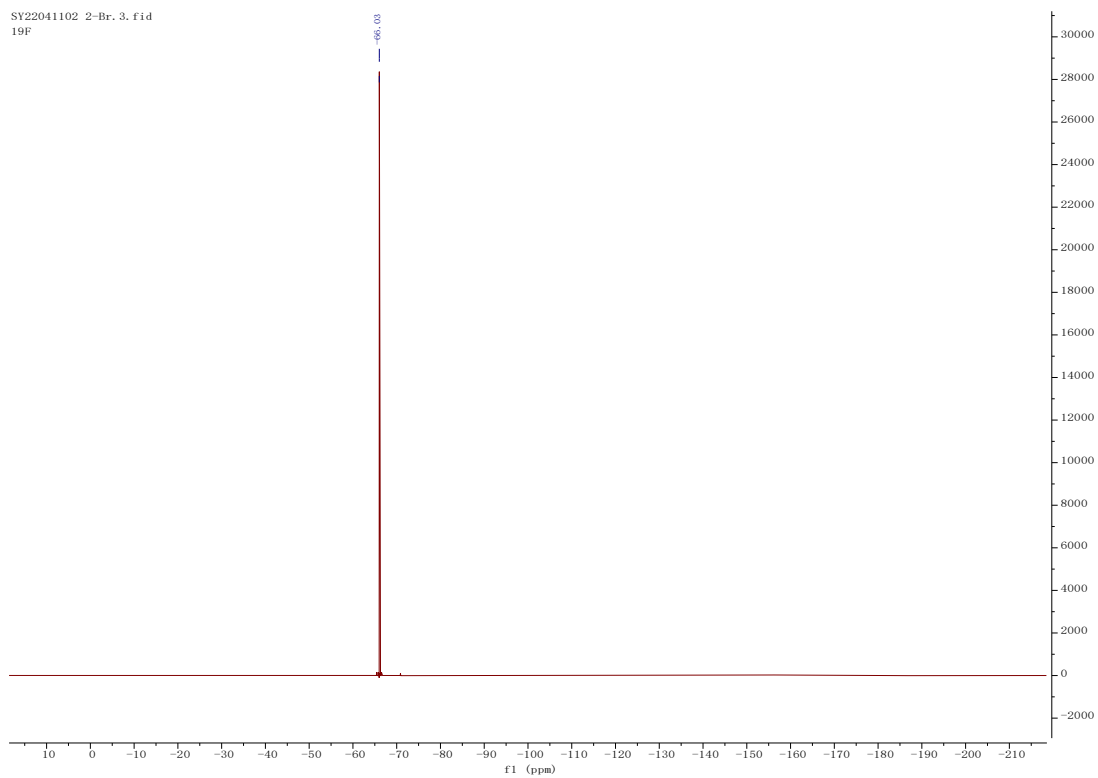
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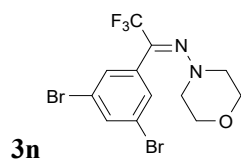
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13C



¹⁹F NMR

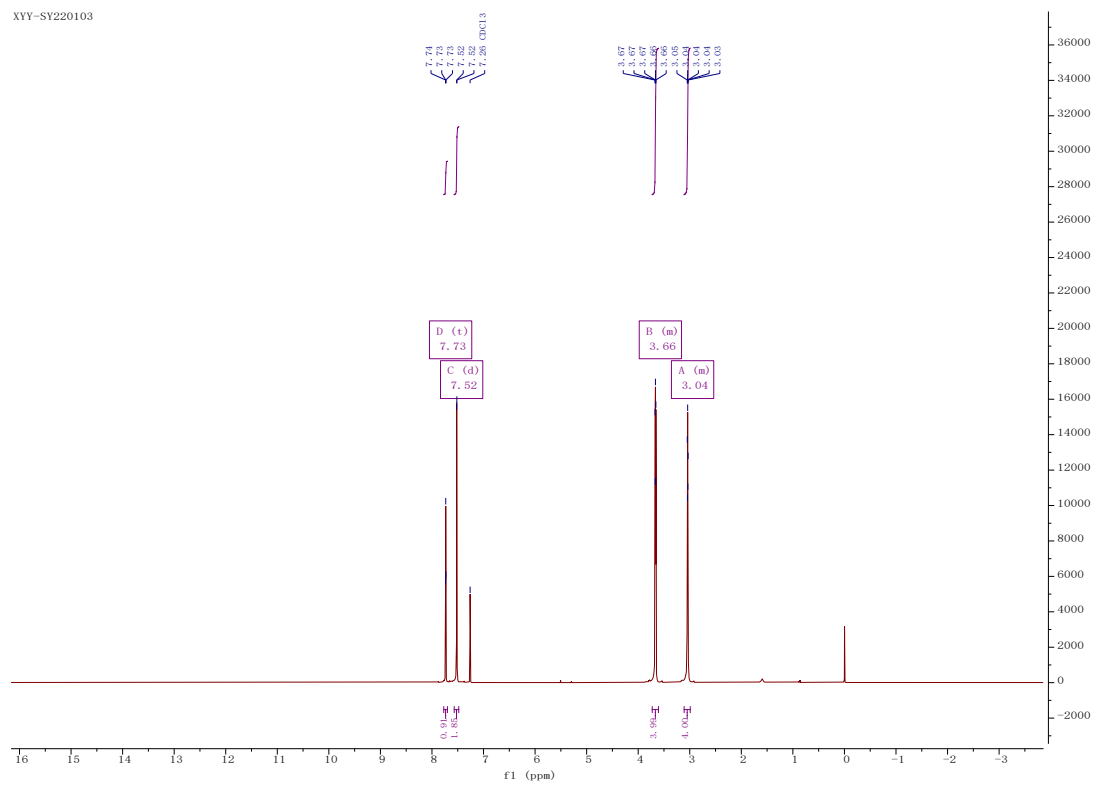
SY22041102 2-Br. 3. fid
19F





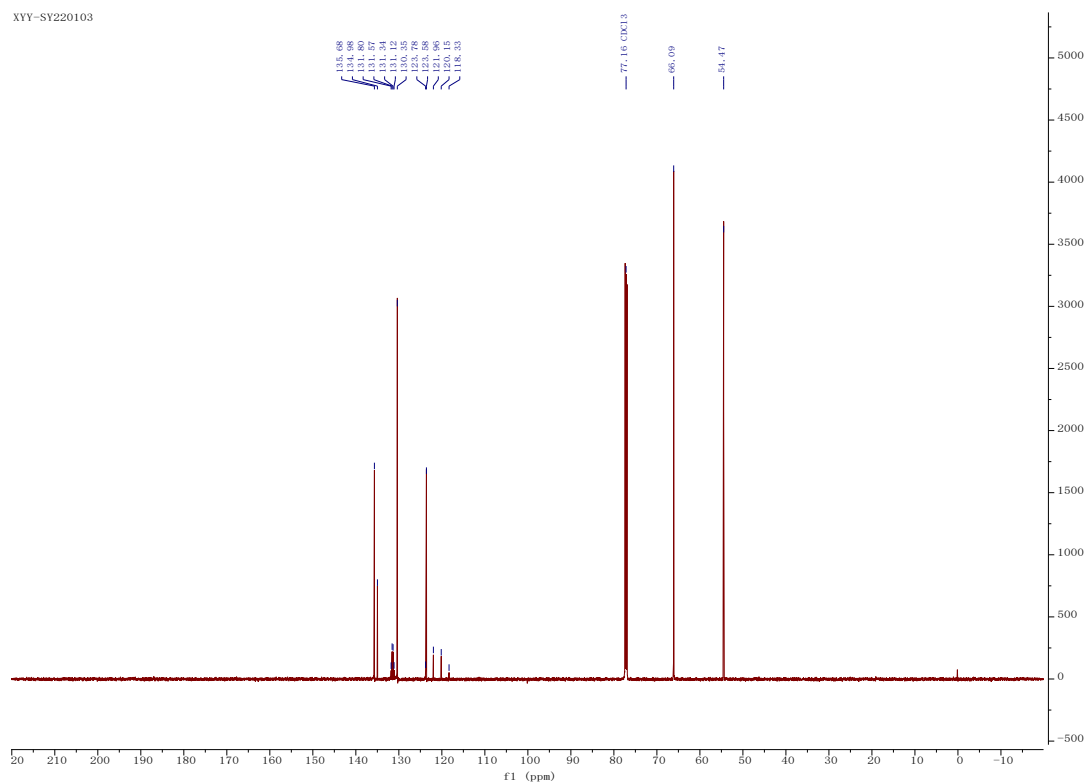
¹H NMR

XYX-SY220103



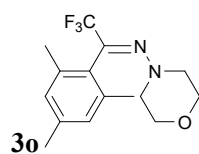
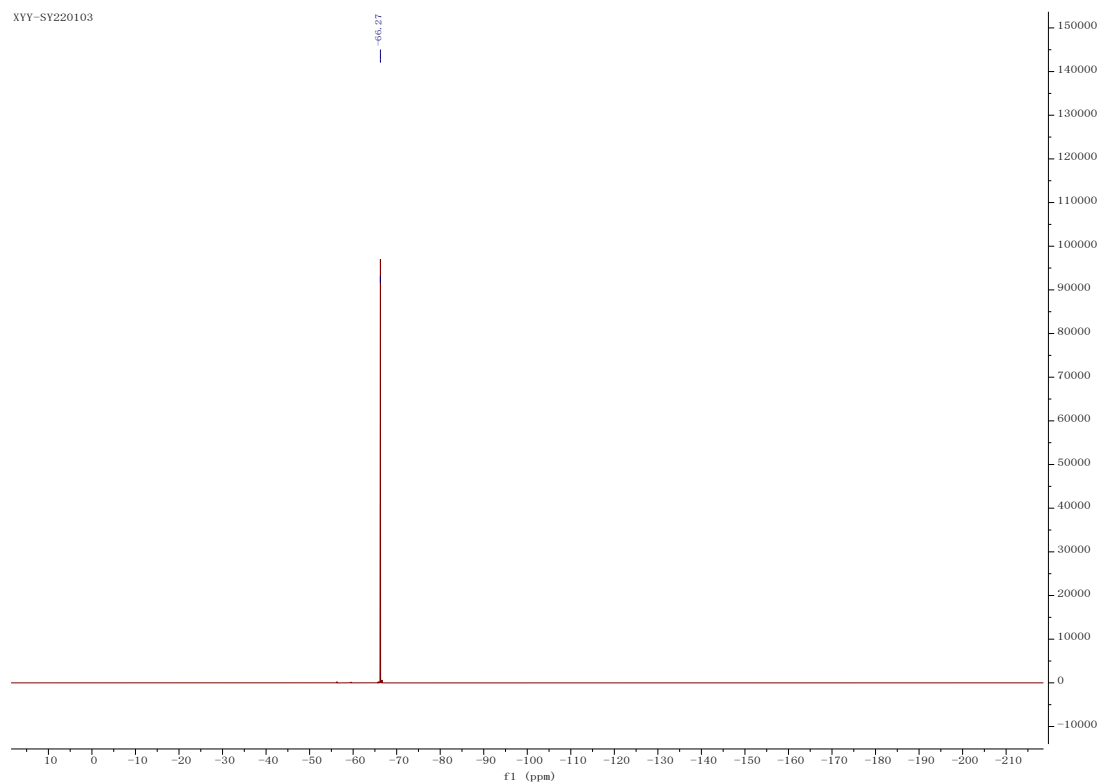
¹³C NMR

XYV-SY220103



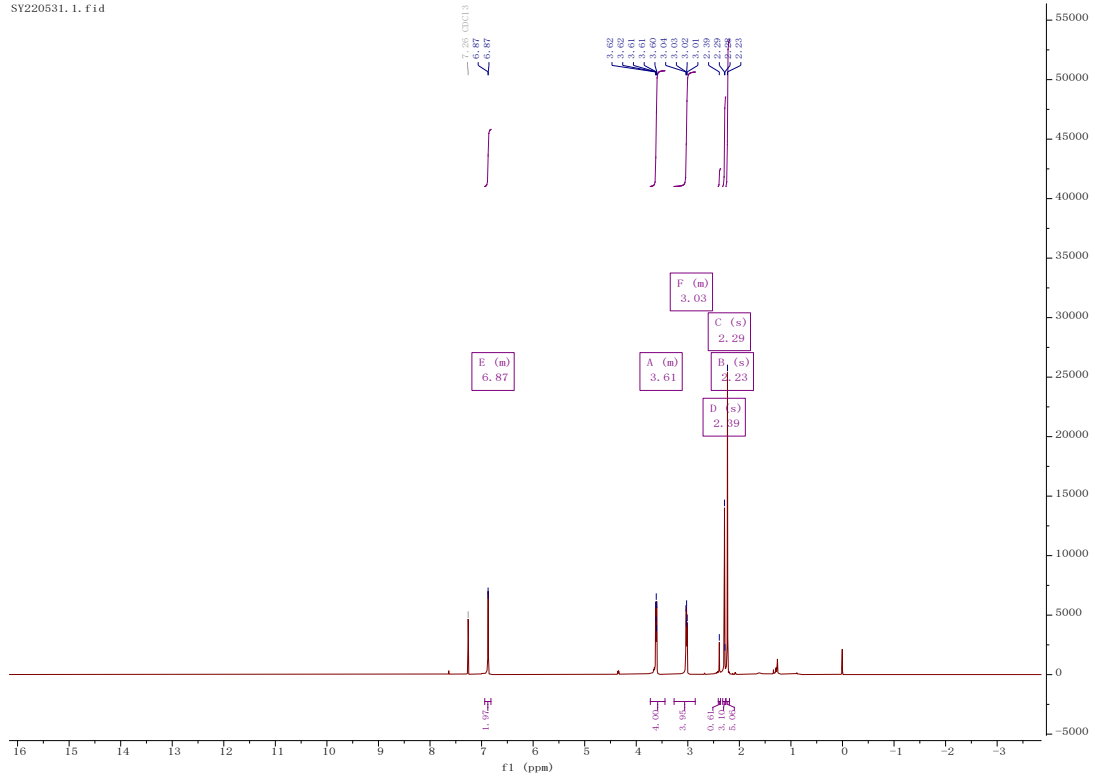
¹⁹F NMR

XYV-SY220103



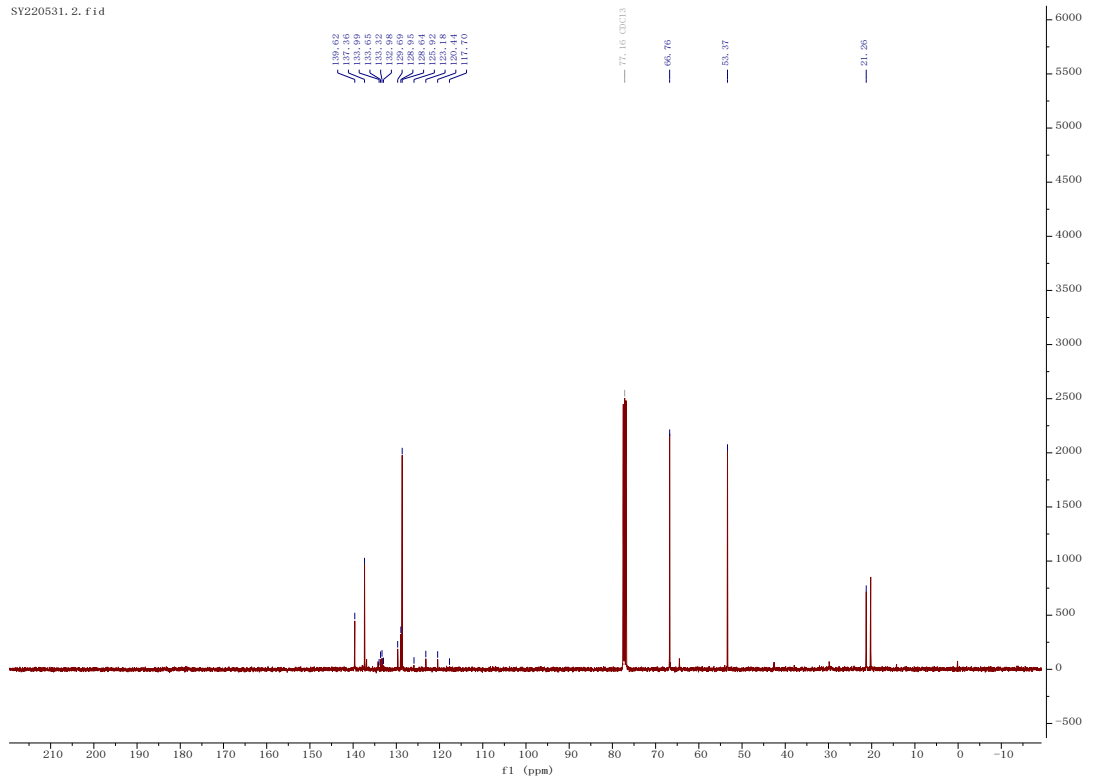
¹H NMR

SY220531.1.fid



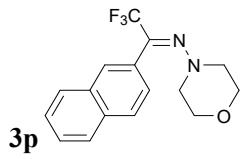
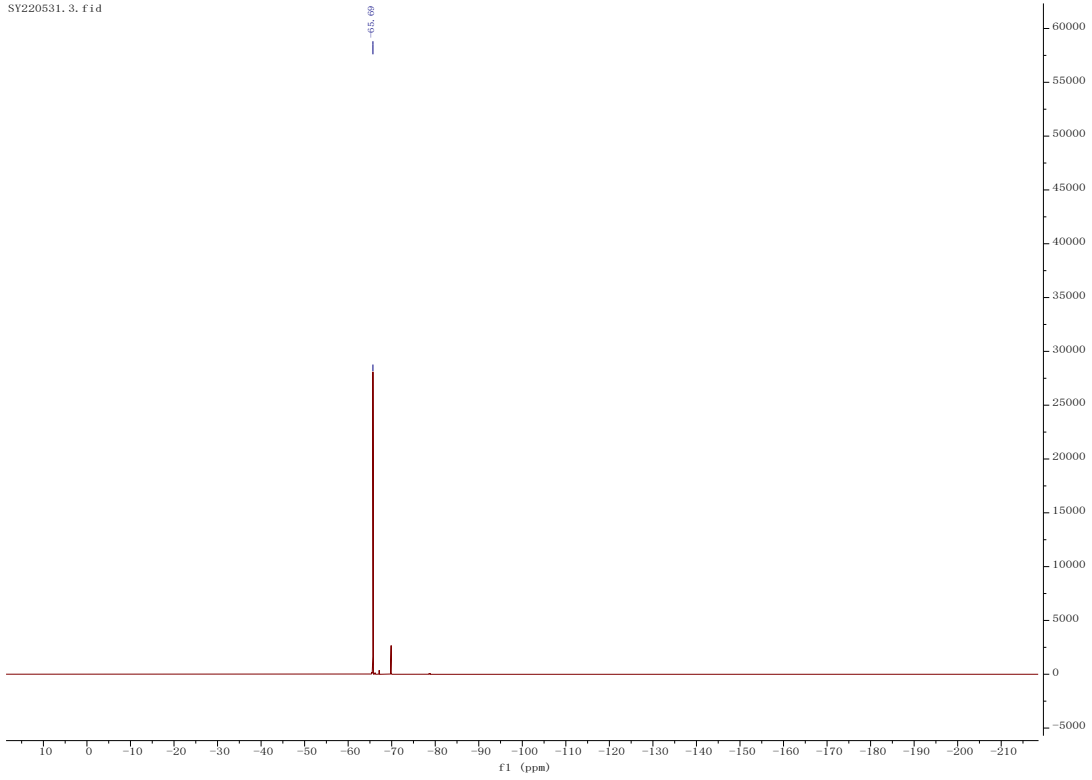
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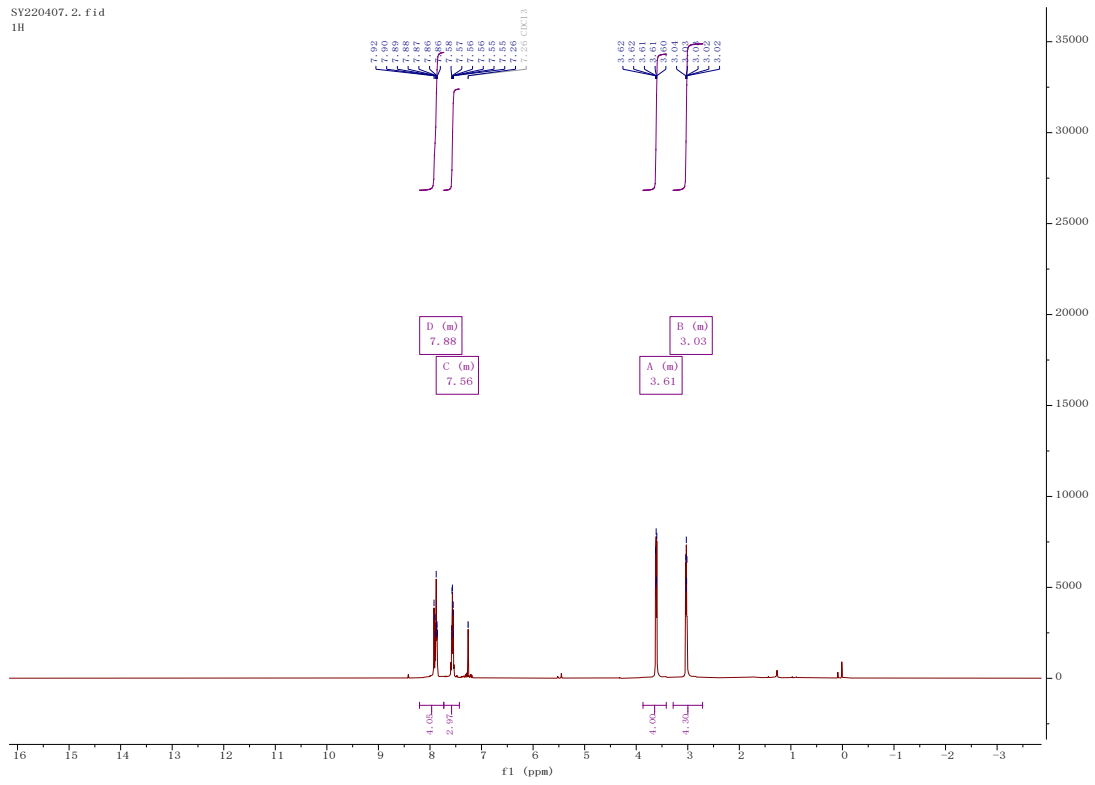
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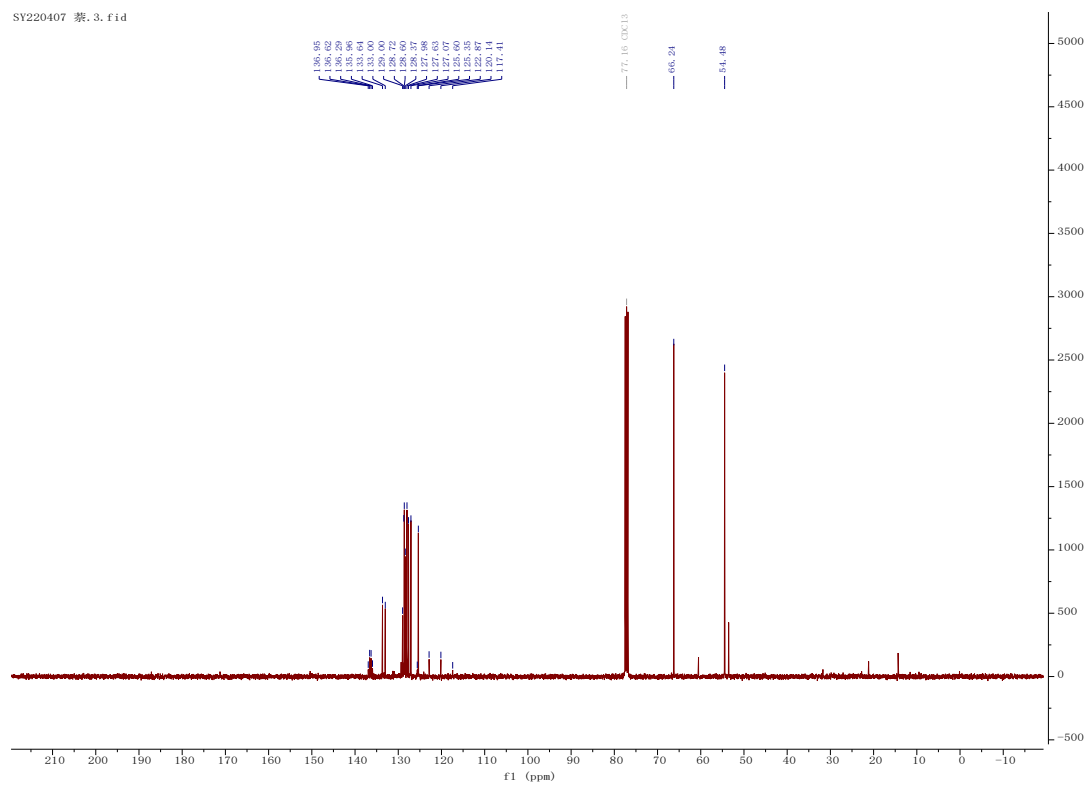
¹H NMR

SY220407.2.fid
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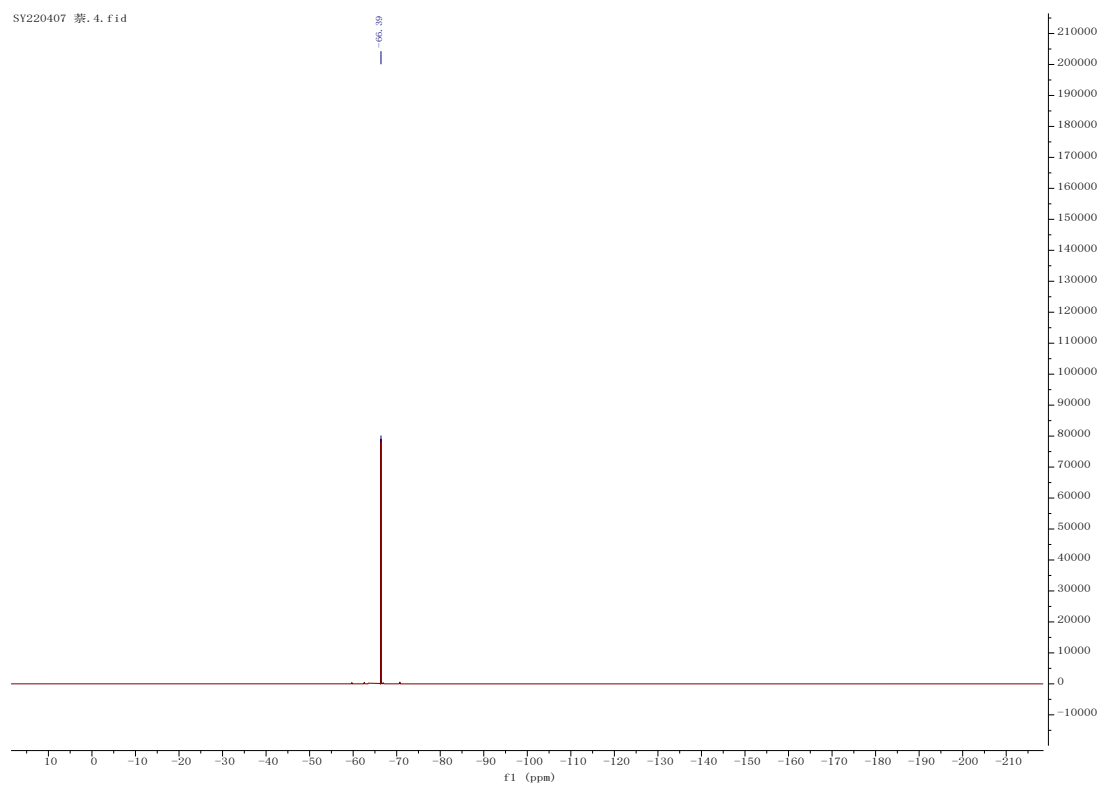
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SY220407 禁. 3. fid



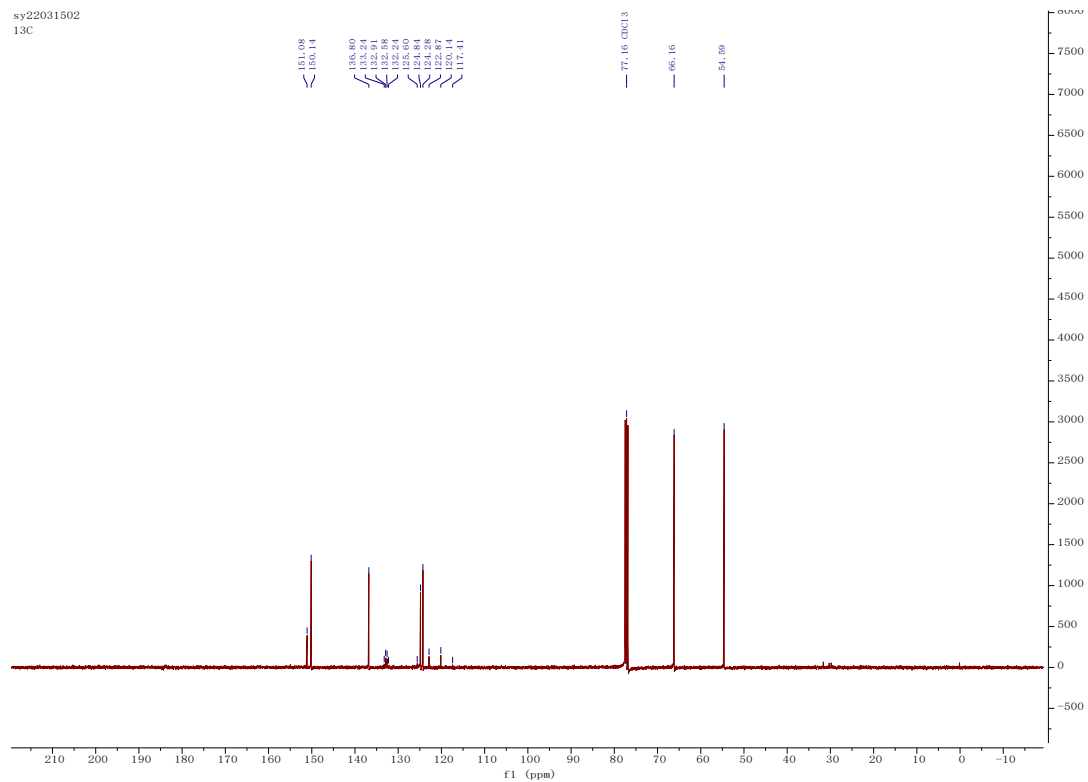
¹⁹F NMR

SY220407 禁. 4. fid



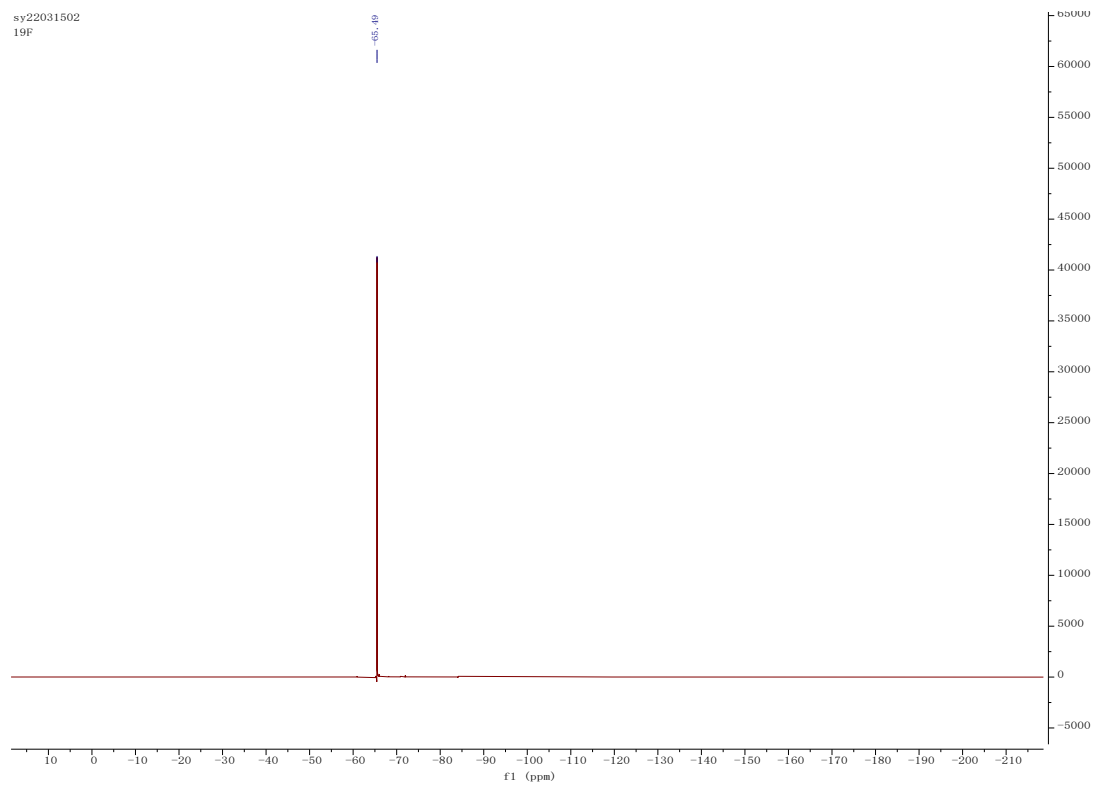
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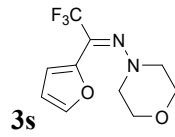
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¹⁹F NMR

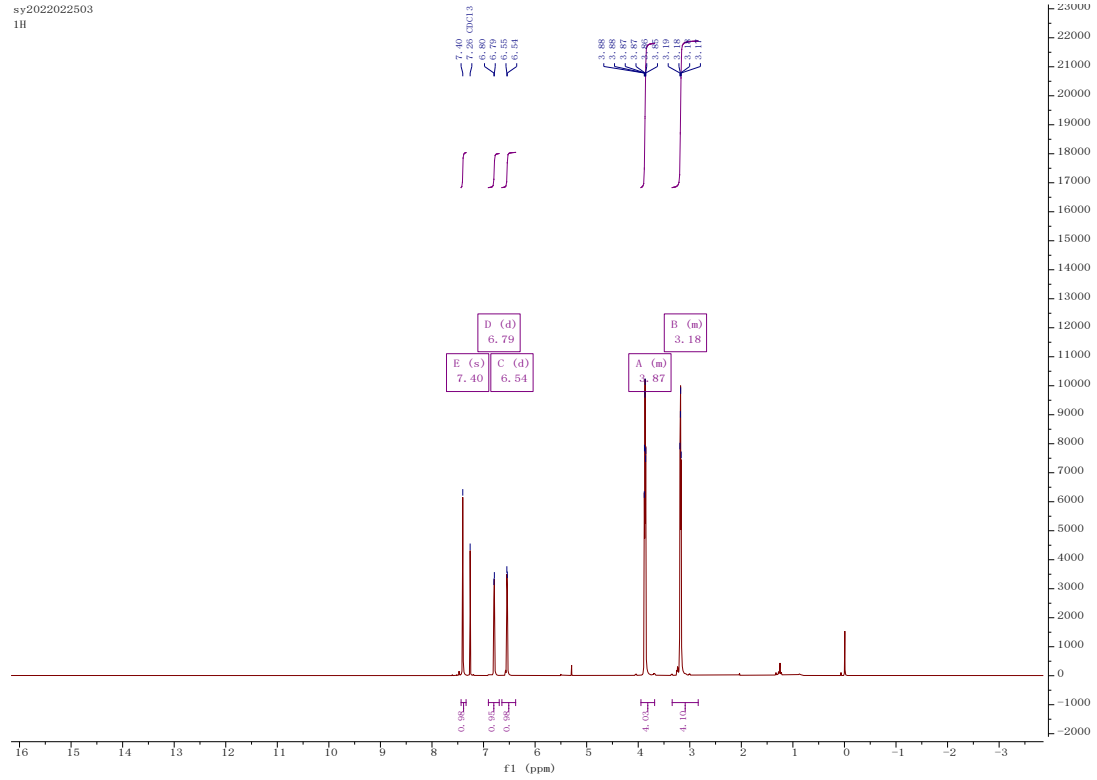
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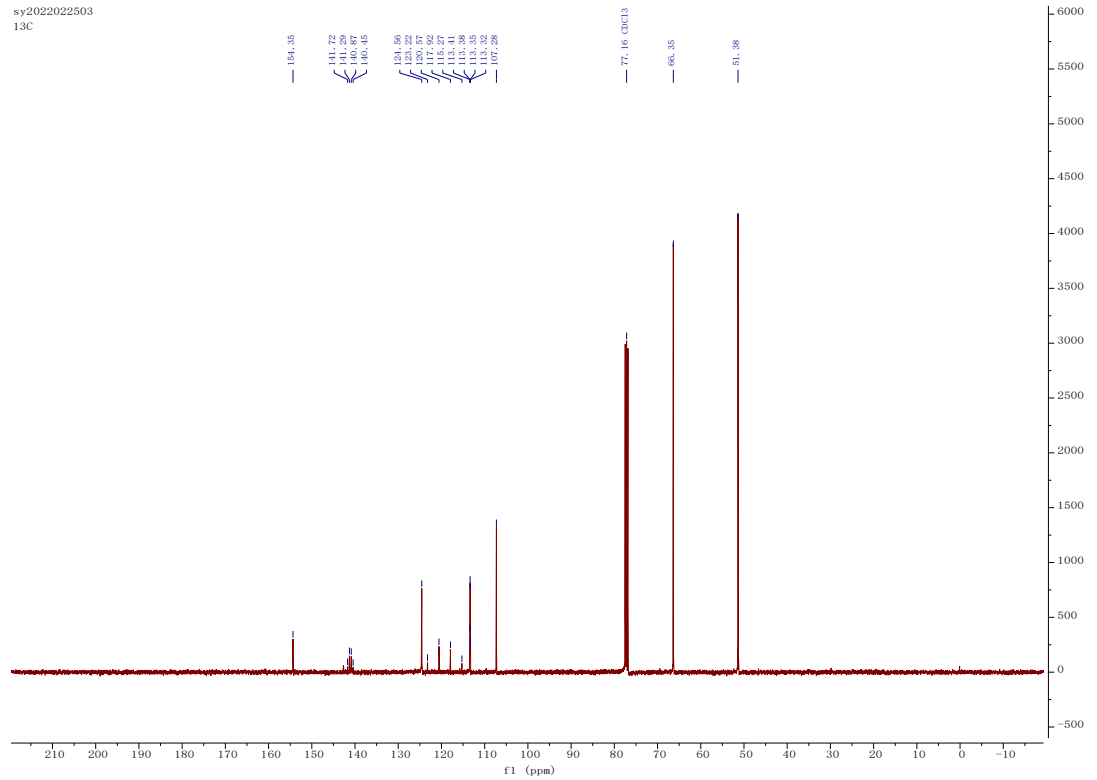
¹H NMR

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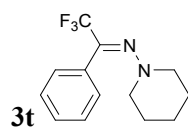
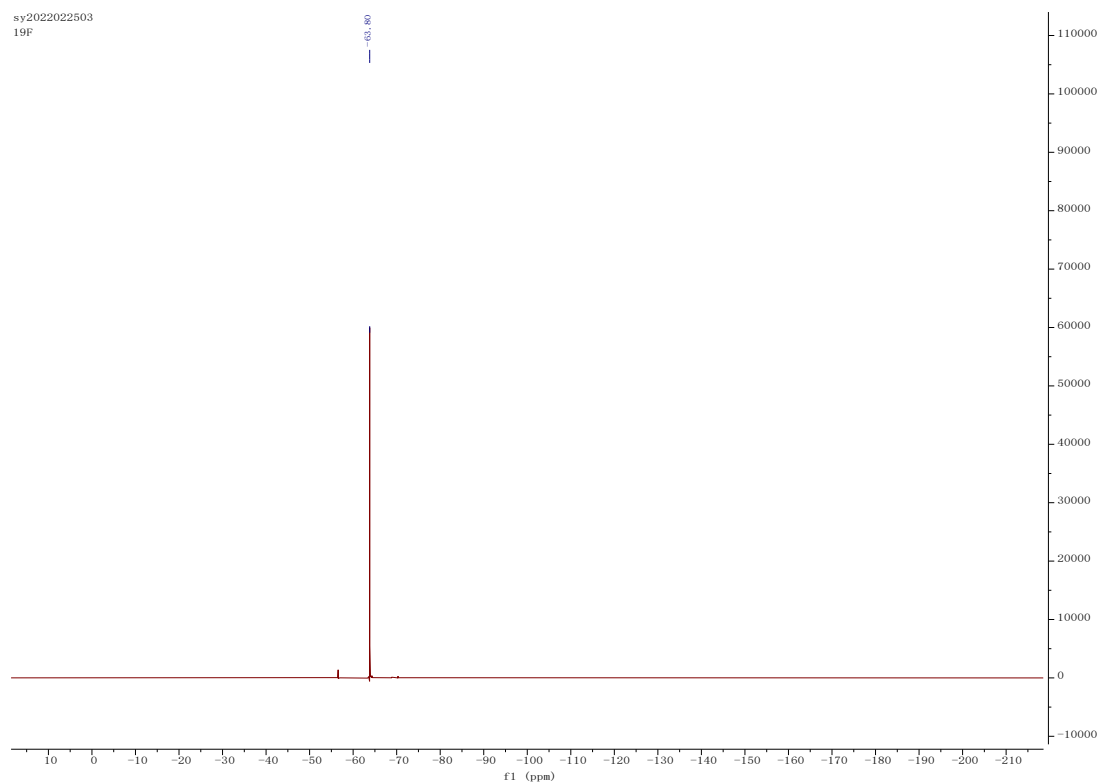
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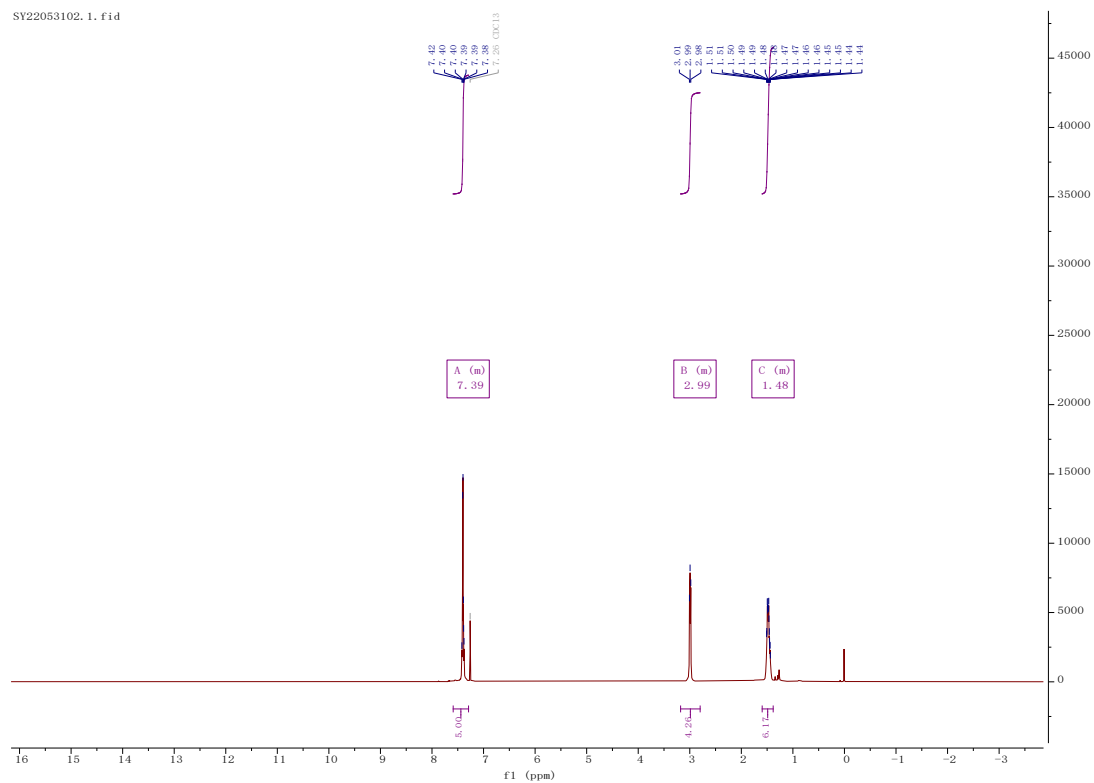
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sy2022022503
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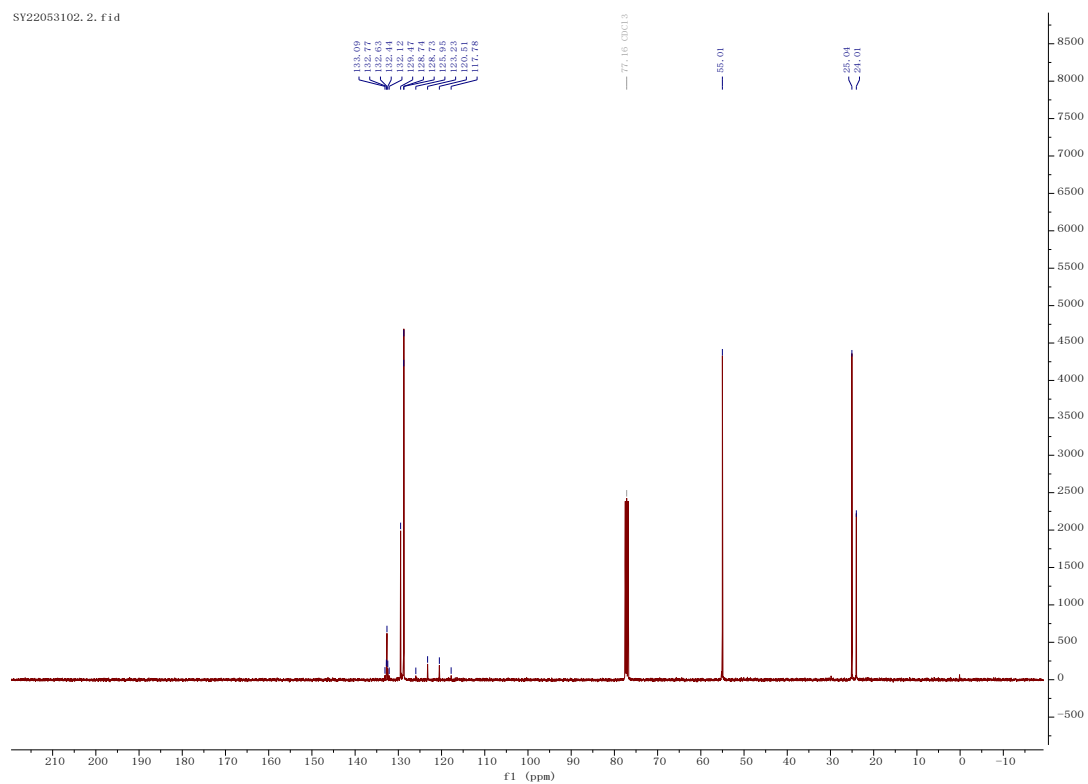
¹H NMR

SY22053102. 1. F1d



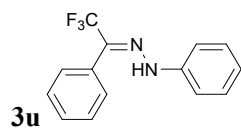
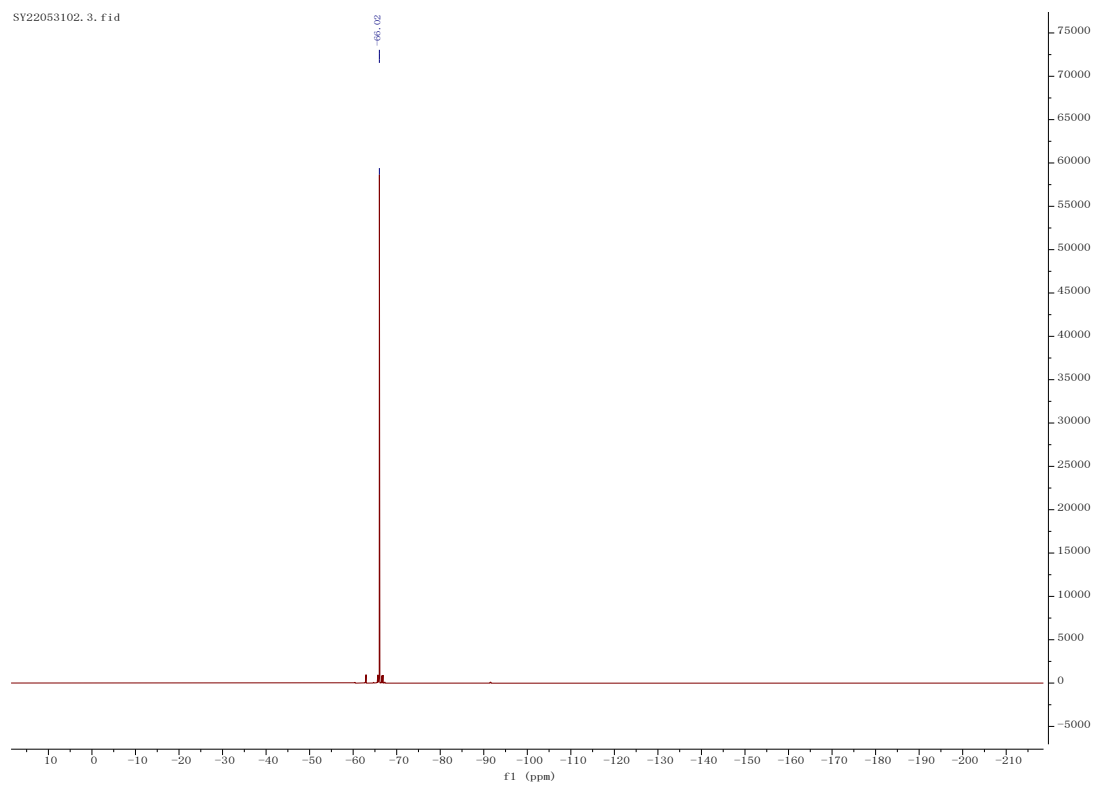
¹³C NMR

SY22053102. 2. fid



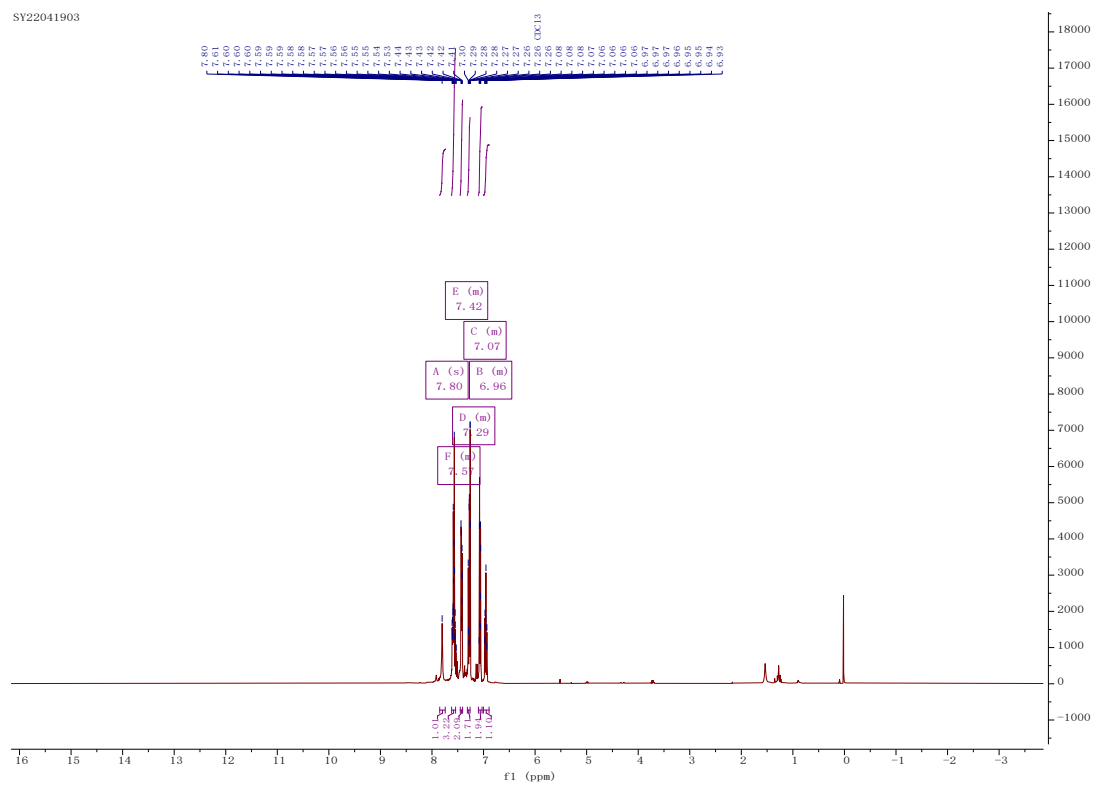
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SY22053102. 3. fid



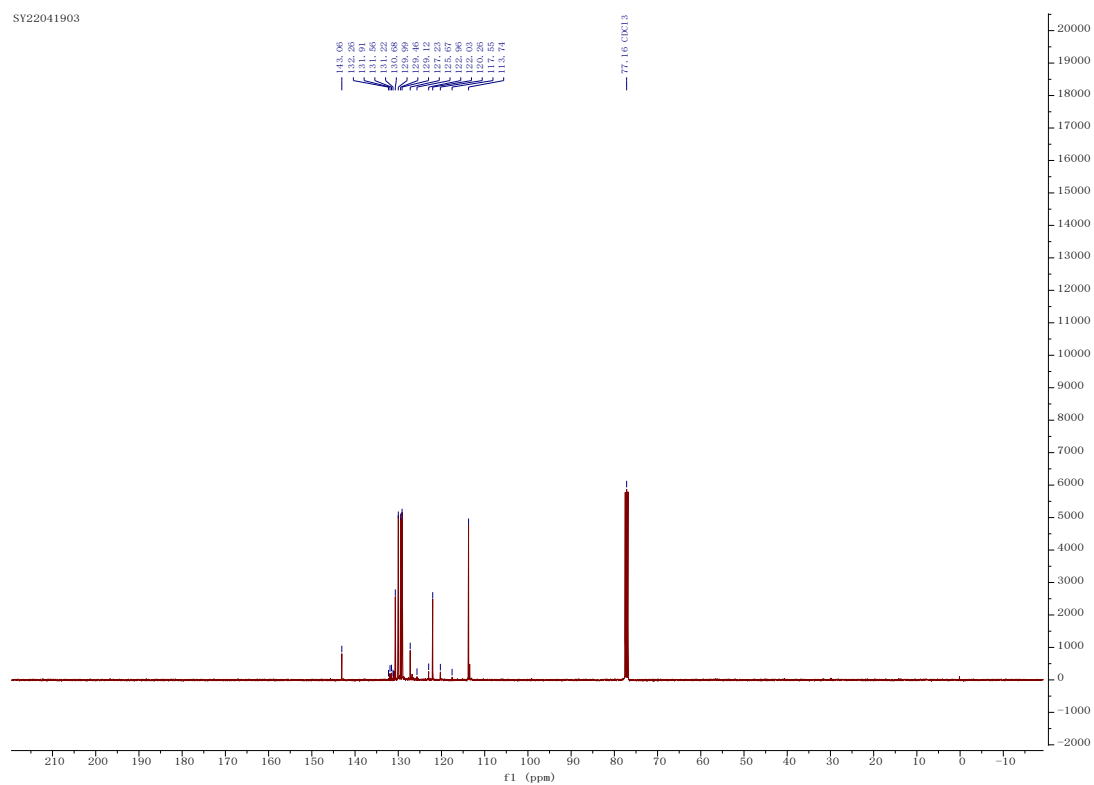
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SY22041903



¹³C NMR

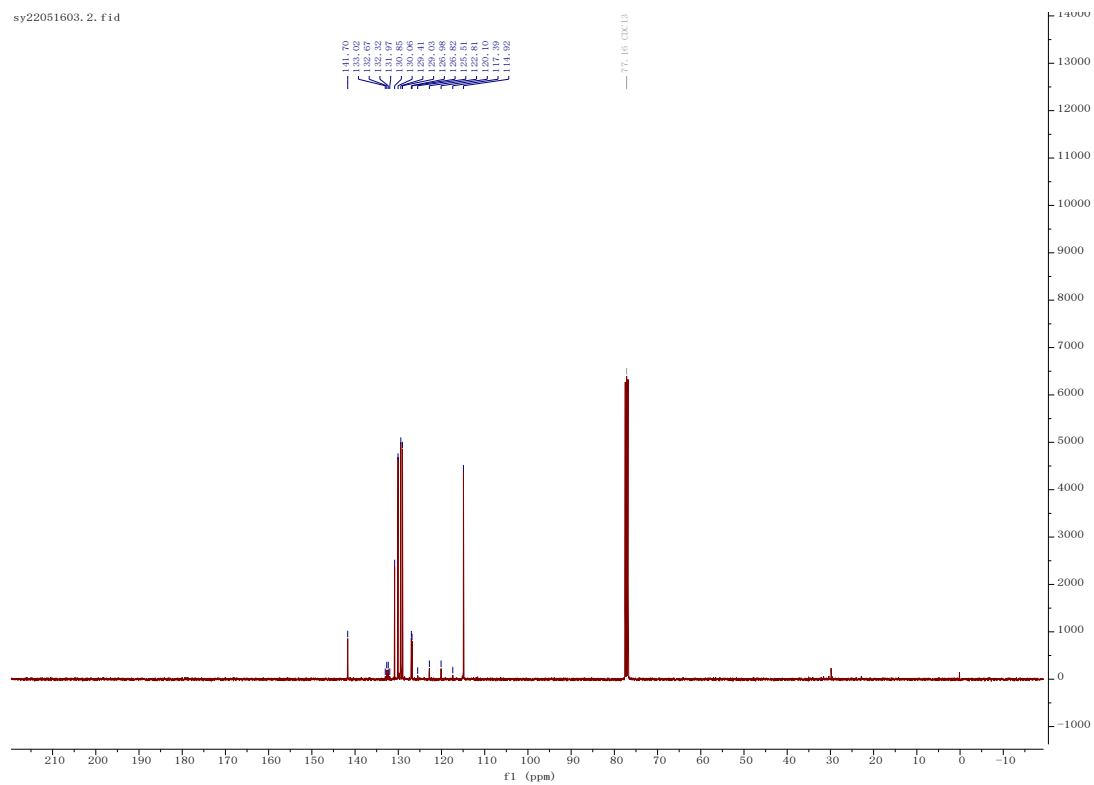
SY22041903



¹⁹F NMR

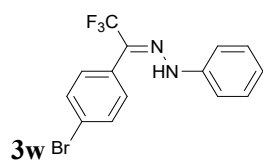
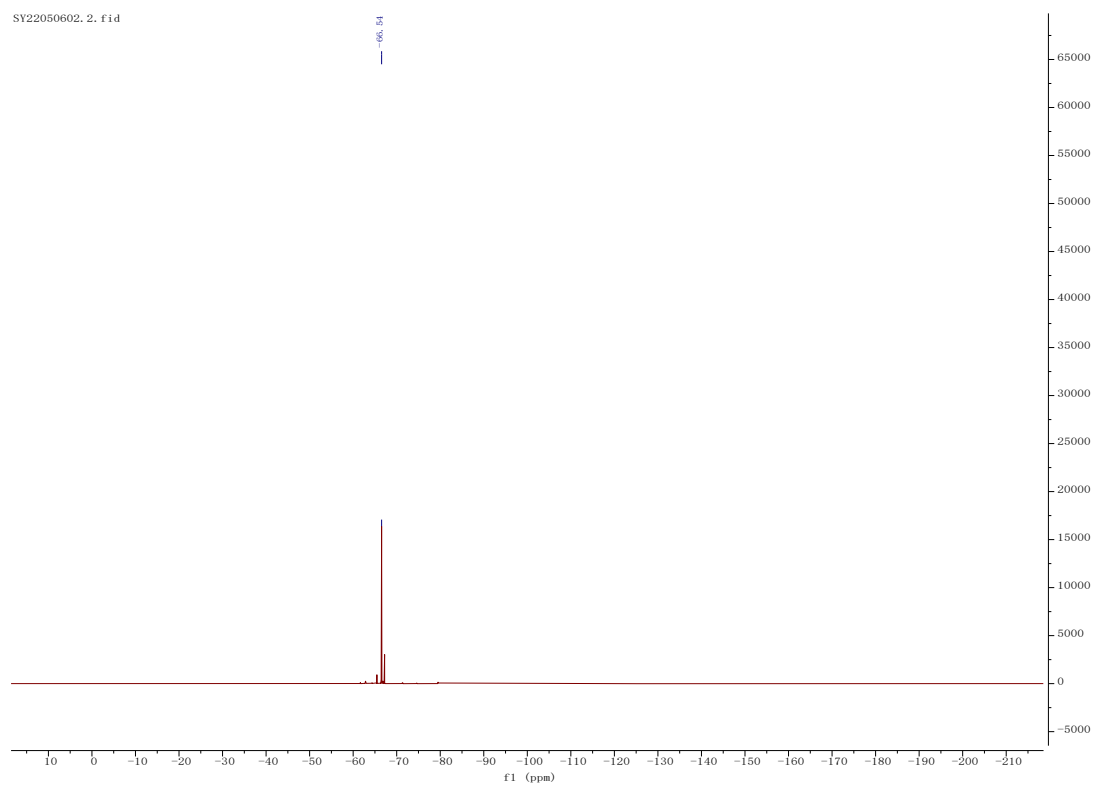
¹³C NMR

sy22051603.2.fid



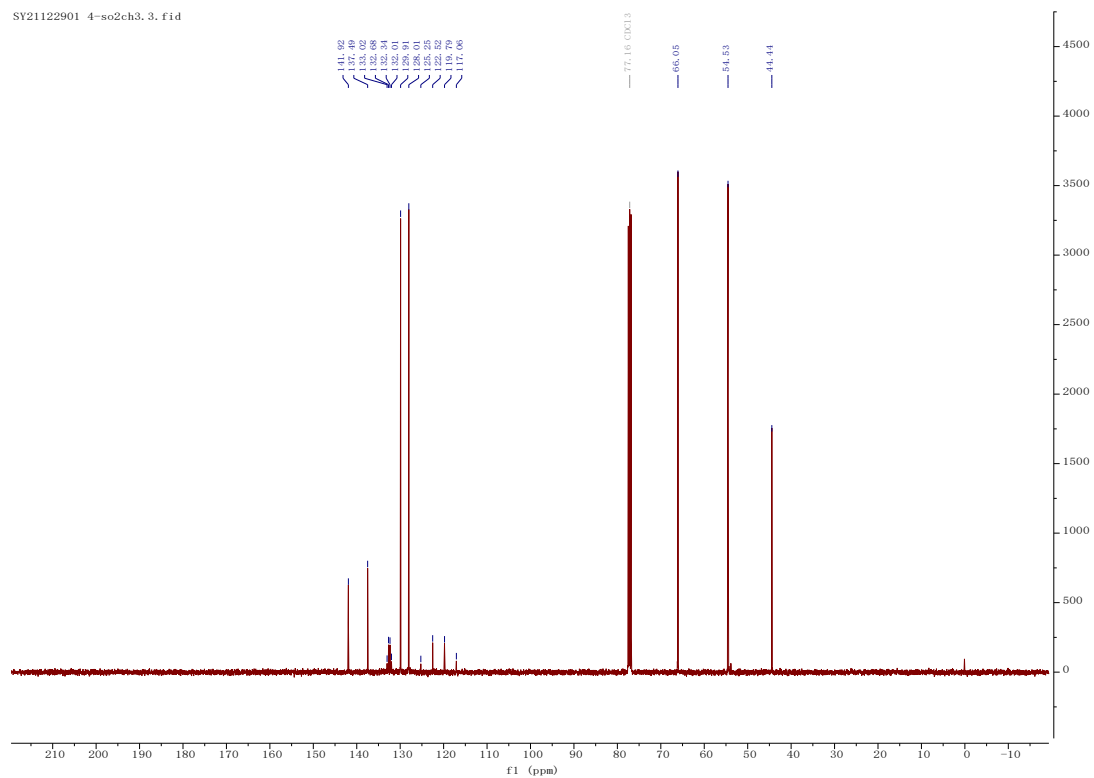
¹⁹F NMR

SY22050602.2.fid



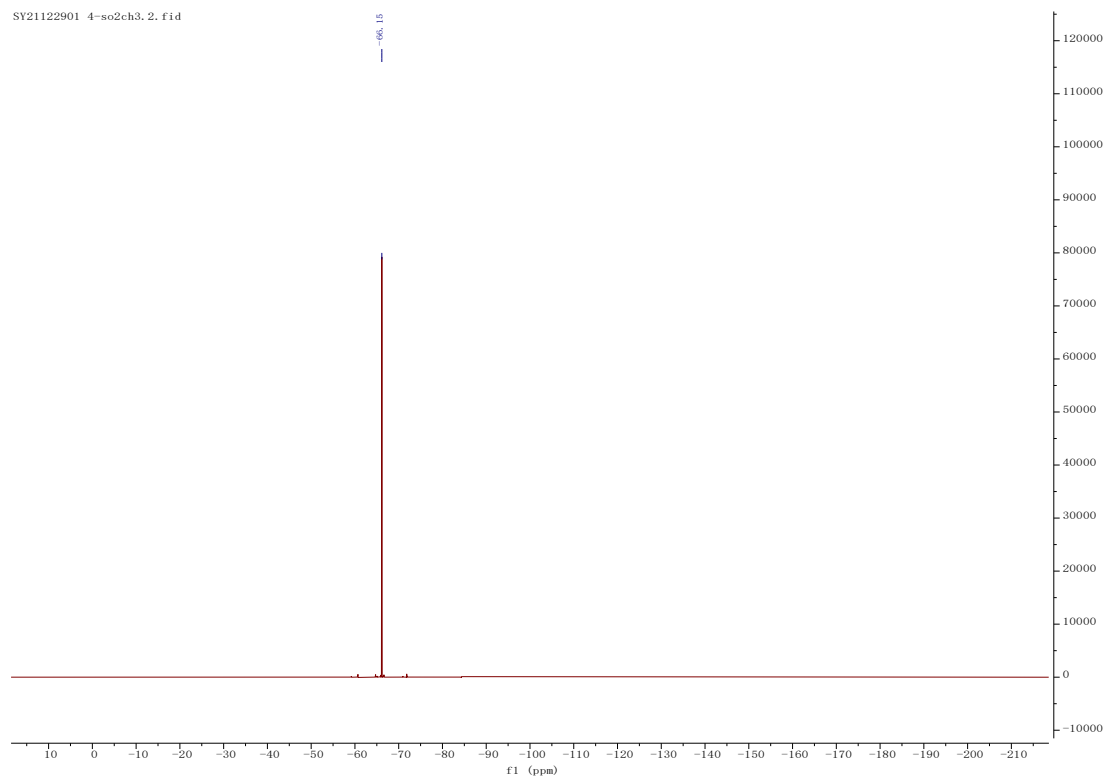
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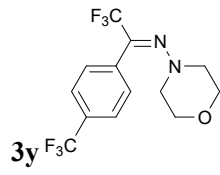
SV21122901 4-so2ch3. 3. fid



¹⁹F NMR

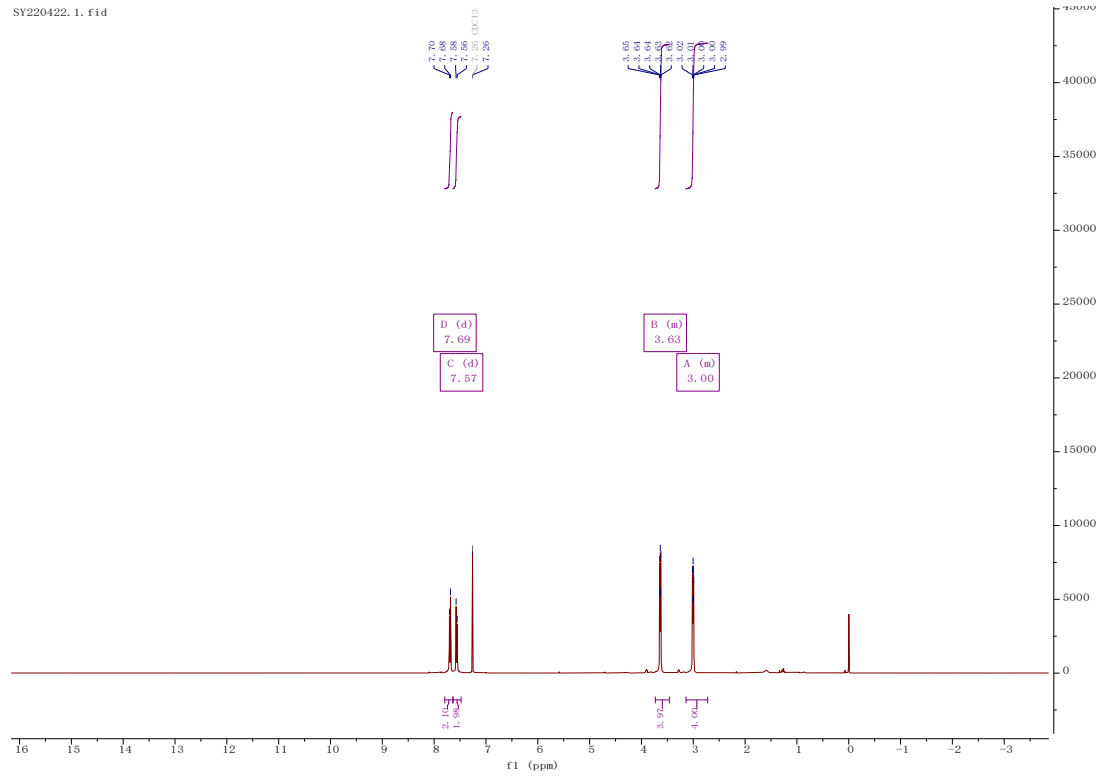
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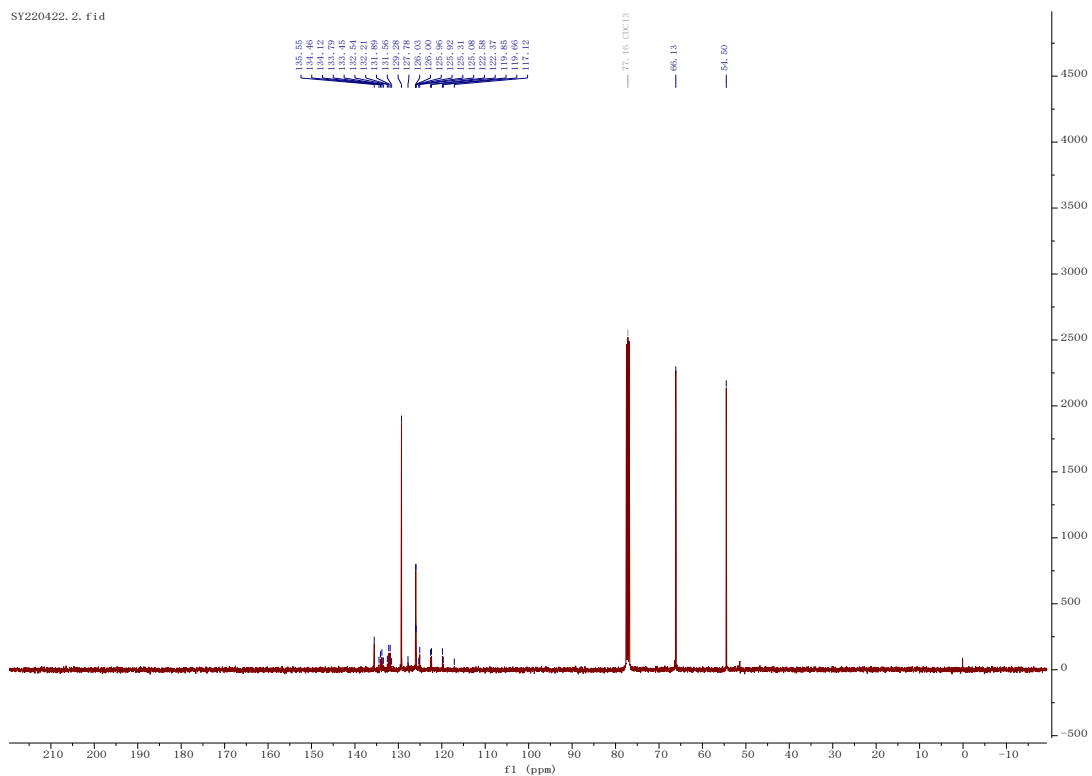
¹H NMR

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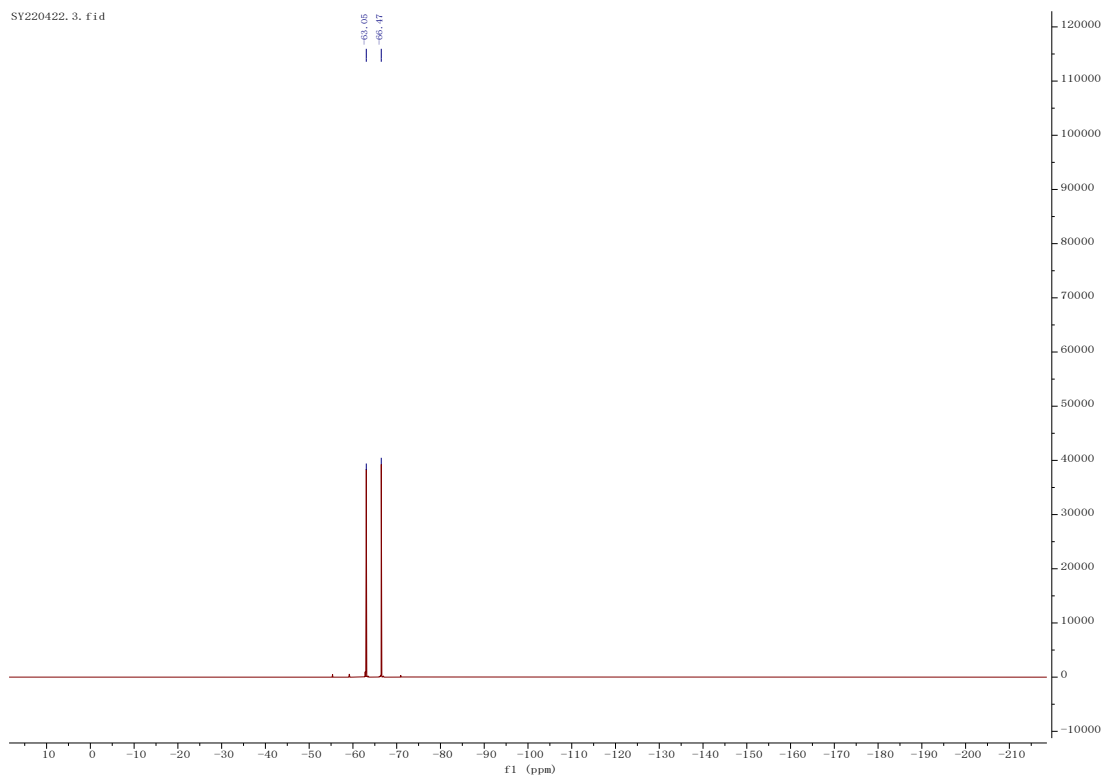
¹³C NMR

SV220422.2.fid



¹⁹F NMR

SV220422.3.fid



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