Supporting Information

Alkyne Trifunctionalization via Divergent Gold Catalysis: Combining π-Acid Activation, Vinyl-Gold Addition and Redox Catalysis

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I. General Methods and Materials

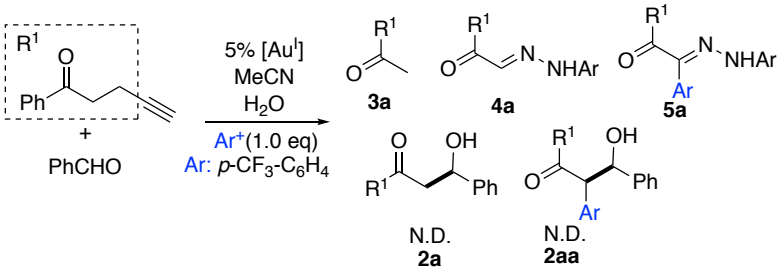
All of the reactions dealing with air and/or moisture-sensitive compounds were carried out under an atmosphere of argon using oven/flame-dried glassware and standard syringe/septa techniques. Unless otherwise noted, all commercial reagents and solvents were obtained from the commercial provider and used without further purification. Tetrahydrofuran (THF), toluene, 1,4-dioxane, dichloromethane (DCM) were used directly from solvent purification system. Other anhydride solvents were purchased from Acros Organic in AcroSeal glass bottle (extra dry over molecular sieve) and used directly.

^{1}H NMR and ^{13}C NMR spectra were recorded on Bruker Advance NEO-400 MHz spectrometer and Bruker Advance NEO-600 MHz. Chemical shifts were reported relative to internal tetramethylsilane (δ 0.00 ppm) for ^{1}H and $CDCl_3$ (δ 77.0 ppm),CD_3CN (δ 118.26 ppm)for ^{13}C. Flash column chromatography was performed on 230-430 mesh silica gel. Analytical thin layer chromatography was performed with pre-coated glass baked plates (250μ) and visualized by fluorescence and by charring after treatment with potassium permanganate stain. HRMS data were collected on Agilent 6320 TOF MS/Agilent 1200 HPLC spectrometer and an Agilent 7890 GC-MS QTOF 7200, Agilent 6540 LC/QTOF spectrometer in the mass-spec facility in the University of South Florida. For mechanistic studies, the nESI-MS spectra were collected by using a Thermo Scientific Orbitrap Q-Exactive instrument (Waltham, MA) in the positive ion mode in New Jersey Institute of Technology. A borosilicate glass capillary (Sutter Instrument Co., Navoto, CA) was used to make a spray emitter. The emitter tip opening size was pulled to 2 μm by a laser puller (Sutter Instrument Co., Model P-2000). The reaction solution was diluted 100 times by ACN solvent before loaded into the pulled spray emitter. A platinum wire (0.025 mm diameter, 99.99% purity) was inserted into the emitter for conductivity and ionization, and the applied potential was + 2.5 kV. High resolution MS data was obtained at different time points during the reaction.

The X-ray diffraction data was measured on Bruker D8 Venture PHOTON 100 CMOS system.

II. Extended Optimization

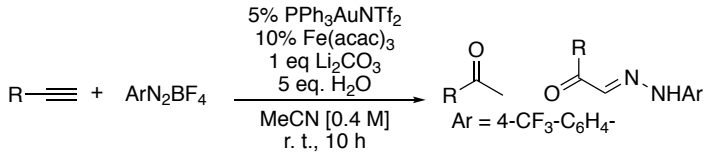
2.1 Integrate three reation modes of gold catalysis

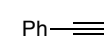
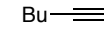
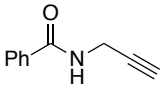
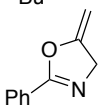
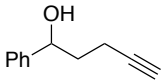
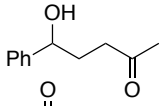
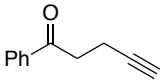
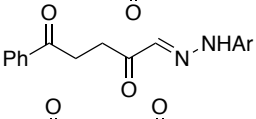
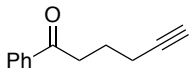
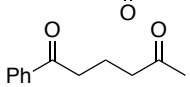
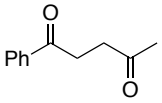


[Au] cat.	"Ar+"	3a	4a	5a
Me-Dal-PhosAuCl	Ar-I, $AgSbF_6$	95%	-	-
PPh_3AuNTf_2	$[ArN_2]BF_4$	95%	-	-
PPh_3AuNTf_2	$[ArN_2]BF_4$, Blue LED $Ru(bpy)_3(PF_6)_2$	90%	5%	-
PPh_3AuCl	$[ArN_2]BF_4$, Blue LED $Ru(bpy)_3(PF_6)_2$	45%	5%	-
PPh_3AuNTf_2	$[ArN_2]BF_4$, Blue LED	90%	<5 %	-
PPh_3AuCl	$[ArN_2]BF_4$, Blue LED	20	<5%	-
PPh_3AuNTf_2	$ArN_2]BF_4$, Blue LED $Ru(bpy)_3(PF_6)_2$ 10 % $Fe(acac)_3$	95%	-	
PPh_3AuNTf_2	$[ArN_2]BF_4$ + 10% $Fe(acac)_3$	60%	34%	-
PPh_3AuNTf_2	$[ArN_2]BF_4$ + 10% $Fe(acac)_3$ + 1 eq Li_2CO_3	12%	79%	2%

2.2 General procedure of screening alkynes scope of vinyl gold nucleophilic addition toward aryl diazonium salts

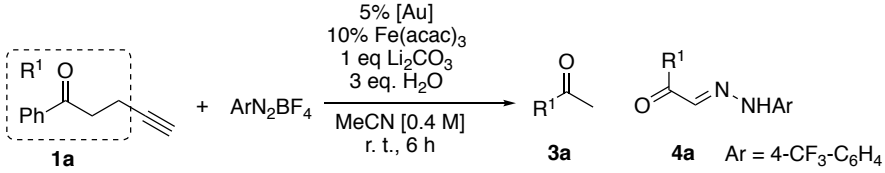
To a 0.5 mL THF solution of alkyne (0.2 mmol) and aryl diazonium salts (0.3 mmol) was added $Fe(acac)_3$ (0.1 equiv.,7 mg), H_2O (3 equiv., 10.8 μL), Li_2CO_3 (1 eq.) and PPh_3AuNTf_2 (0.05 equiv., 7.4 mg). The reaction was stirred at room temperature for 10 hours. After the reaction completed, the reaction was filtrated through a pad of silica gel. After evacuation of the solvent, conversion and the yield was obtained by ^1H NMR and ^{19}F NMR analysis of the crude mixture using 1,3,5-trimethoxybenzene and trifluorobenzene as the internal standard.



Entry	Alkyne	Major product	Conv. (%)	yield (%)
1			20	18
2			12	11
3			100	68
4			100	87
5			100	78
6			28	26
7		—	0	—

2.3 Optimization of difunctionalization of alkynes

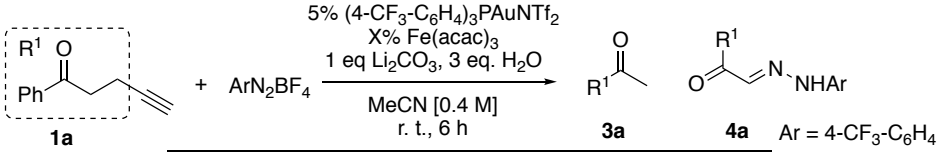
a) Screening of gold catalysts



To a 0.5 mL MeCN solution of keto-alkyne **1a** (0.2 mmol, 32mg) and aryl diazonium salt **(**0.4 mmol) was added $Fe(acac)_3$ (0.1 equiv.,3.5 mg), H_2O (3 equiv,10.8 μL), gold catalyst (0.05 equiv) and Li_2CO_3 (0.2 mmol). The reaction was stirred at room temperature for 6 hours. After the reaction completed, the reaction was filtrated through a pad of silica gel. After evacuation of the solvent, the NMR yield of **4a** and **3a** were obtained by ^{19}F HMR and ^{1}H NMR analysis of the crude mixture with the internal standard of trifluorobenzene and 1,3,5-trimethoxybenzene, respectively.

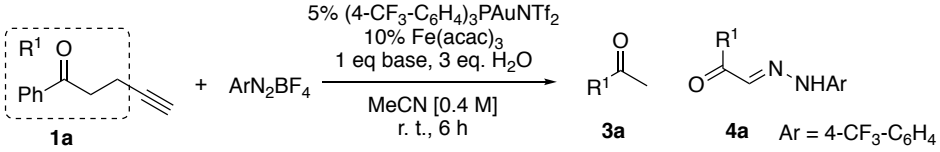
Entry	[Au]	yield (%) **3a**	yield(%) **4a**
1	None	0	0
2	PPh_3AuNTf_2	12	79
3	$IPrAuNTf_2$	83	0
4	$JohnPhosAuNTf_2$	65	28
5	$(ArO)_3PAuNTf_2$	93	0
6	$PPh_3Au(TA\text{-}H)OTf$	95	0
7	$PPh_3Au(TA\text{-}H)(MeCN)$	95	0
8	$Cy_3PAuNTf_2$	15	80
9	$P(p\text{-}F\text{-}C_6H_4)_3AuNTf_2$	10	85
10	$P(p\text{-}CF_3\text{-}C_6H_4)_3AuNTf_2$	7	90

b) Screening ratio of [Au]/[Fe]



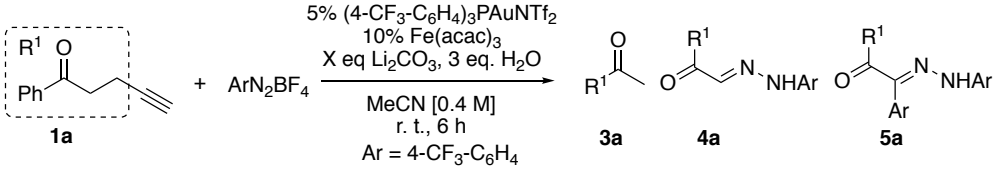
Entry	co-catalyst	yield (%) **3a**	yield (%) **4a**
1	0	95	0
2	1	91	<5
3	2	80	12
4	5	50	45
5	10	7	90
6	15	7	85

c) Screening of base



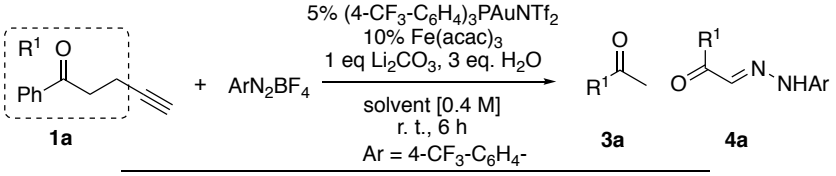
Entry	base	yield (%) **3a**	yield (%) **4a**
1	Li_2CO_3	7	90
2	Na_2CO_3	30	30
3	K_2CO_3	< 5	0
4	Cs_2CO_3	<5	0
5	Et_3N	N.D.	0

d) Screening the amount of base



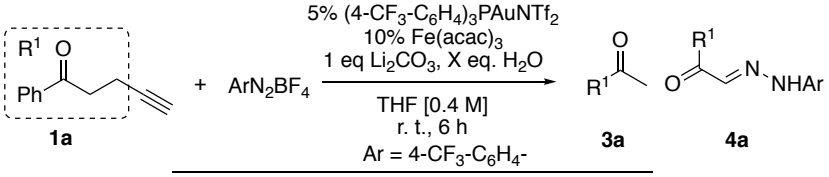
Entry	X	yield (%) **3a**	yield (%) **4a**	Yield (%) **5a**
1	0	60	34	0
2	1	7	90	0
3	2	5	80	10
4	3	< 5	68	12

e) Screening solvent



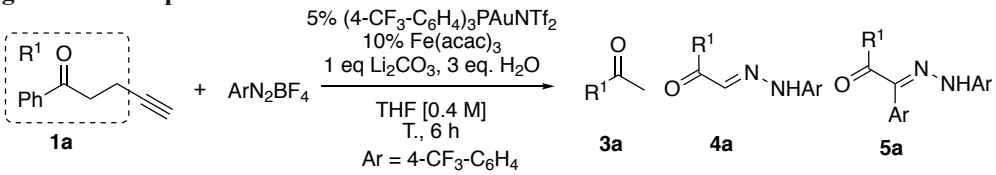
Entry	solvent	yield (%) **3a**	yield (%) **4a**
1	MeCN	7	90
2	THF	5	93
3	1,4-dioxane	40	50
4	toluene	60	23
5	DCM	74	18
6	Et_2O	50	32

f) Screening the amount of water



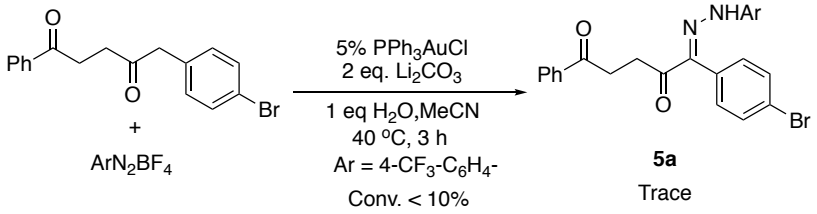
Entry	X	yield (%) **3a**	yield (%) **4a**
1	0	8	0
2	1	12	80
3	3	5	93
4	5	20	78

g) Screening reaction temperature



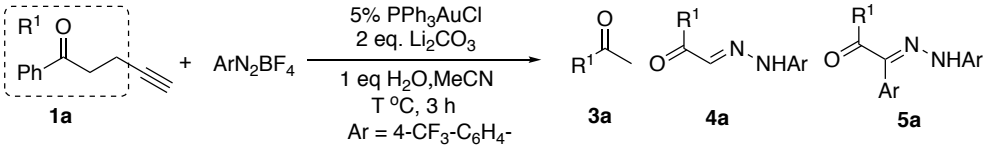
Entry	T(°C)	yield (%) **3a**	yield (%) **4a**	yield(%) **5a**
1	0	<5	n.d.	n.d.
2	25	5	93	n.d.
3	40	14	70	12
4	50	50	8	38

2.4 Control experiment of trifunctionalization



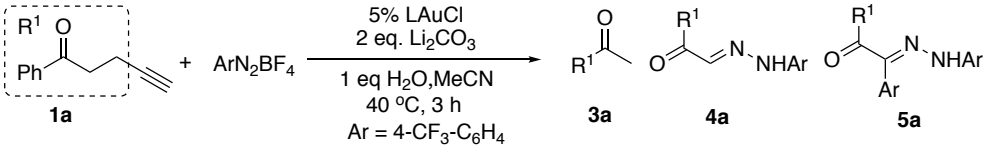
2.5 Optimization of trifunctionalization of alkynes

a) Screening reaction temperature



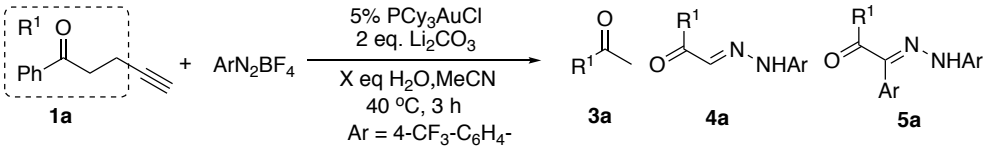
Entry	T(°C)	yield (%) **3a**	yield (%) **4a**	yield(%) **5a**
1	25	10	85	trace
2	40	8	n.d.	90
3	50	20	n.d.	67

b) Screening of gold catalysts



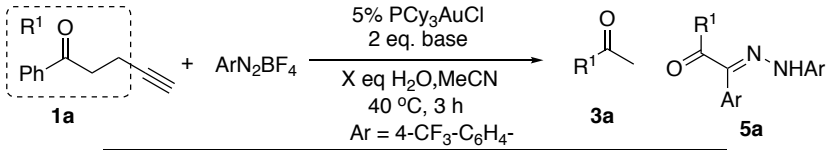
Entry	[Au]	yield (%) **3a**	yield(%) **4a**	Yield(%) **5a**
1	None	0	0	0
2	PPh_3AuCl	7	n.d.	90
3	IPrAuCl	50	trace	10
4	JohnPhosACl	35	8	trace
5	$(ArO)_3PAuCl$	0	0	0
6	Cy_3PAuCl	2	0	95
7	$(4\text{-}CF_3\text{-}C_6H_4)_3PAuCl$	12	0	85

c) Screening the amount of water



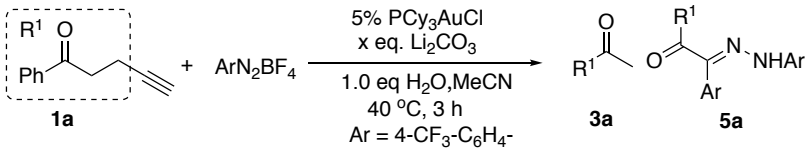
Entry	X	yield (%) **3a**	yield (%) **4a**	yield(%)**5a**
1	0	Trace	0	<5
2	1	2	0	95
3	3	20	0	73
4	5	30	0	63

d) Screening base



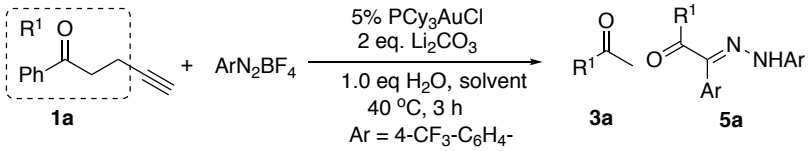
Entry	base	yield (%) **3a**	yield (%) 5**a**
1	Li_2CO_3	2	95
2	Na_2CO_3	15	30
3	K_2CO_3	< 5	0
4	Cs_2CO_3	<5	0
5	Et_3N	N.D.	0

e) Screening the amount of base



Entry	x	yield (%) **3a**	yield (%) 5**a**
1	0	0	0
2	1	15	72
3	2	2	95
4	3	2	90

f) Screening solvent



Entry	solvent	yield (%) **3a**	yield (%) 5**a**
1	MeCN	2	95
2	THF	8	89
3	1,4-dioxane	40	51
4	toluene	62	32
5	DCM	78	18

III. General Procedures

3.1 General procedure for the synthesis of aryl diazonium salts:

To a solution of the requisite aniline (4.87 mmol) in water (1.1 mL) and aqueous tetrafluoroboric acid (35% w/w; 2.4 mL) at 0°C , was dropwise added a solution of sodium nitrite (353 mg, 5.12 mmol) in water (0.8 mL). The mixture was stirred for 40 min, then diethyl ether (10 mL) was added and precipitate was collected by filtration. The solid was washed with diethyl ether (20 mL) and dried under vacuum. The characterization data for this compound matched that of a previous report.[i]

3.2 General procedure for the synthesis of Weinreb amide:

To a solution of 4-pentynoic acid (20 mmol) in DCM (50 mL), DMAP (2mmol, 0.1 eq), EDC (50 mmol, 2.5 eq), trimethylamine (22 mmol, 1.1 eq) and *N,O*-dimethylhedroxylamine· hydrochloride (22 mmol, 1.1 eq) were added. The reaction mixture was stirred at room temperature for 15 hours, then filtered through Celite and concentrated under reduced pressure. The crude mixture was purified by flash chromatography on silica gel (eluent: hexane: EtOAc = 2:1) to give Weinreb amide (75% yield, colorless oil). The characterization data for this compound matched that of a previous report.[2ii]

3.3 General procedure for the synthesis of 4-keto-pent-1-yne (terminal alkynes)

Method A:

Under argon protection, to a solution of Weinreb amide (2.0 mmol) in THF (10 mL) at 0 °C was slowly added to Grignard reagent solution (2.6 mmol). The resulting mixture was stirred at 0 °C for 3 hours and room temperature for another 3 h. A saturated aqueous NH_4Cl solution (20 mL) was added to quench the reaction and the reaction mixture was extracted with DCM (3 X 30 mL). The combined organic layers were washed with brine (30 mL), dried over Na_2SO_4, filtered and evaporated under reduced pressure. The residue was purified by silica gel column chromatography (Hexane/EtOAc 20:1) to give the keto-alkyne.

Method B:

In a mixture of β-keto ester (30 mmol) in a 50 mL of acetone was added 4.14 g of K_2CO_3 (30 mmol). After stirring the mixture for 15 min, alkyl bromide (1.1 eq.) and 0.45 g of NaI (450 mg, 3 mmol, 0.1 eq.) were added dropwise at 0 °C within 30 minutes. The resulting orange solution was stirred at 40 °C for 18 hours. After that, 1M HCl was slowly added to the mixture in ice bath to adjust pH around 4. The mixture was extracted three times by DCM, and combined all organic layer. The solution was dried by Na_2SO_4, filtered through a pad of Celite and concentrated. The residue was subjected to silica gel chromatography (Hexane:EtOAc = 20:1) to afford compound **A** as colorless oil. To a solution of compound **A** (20 mmol, 1.0eq.) in a 30 mL of MeOH was added

LiOH (30mmol, 1.5 eq) and 7.5 mL water. The reaction was stirred at 45°C for 10 hours. Then, the crude mixture was cooled to room temperature, acidified with conc. HCl to a pH of 4 and extracted with DCM (3x 50 mL). The combined organic layers were dried over $MgSO_4$ and the solvent were removed under reduced pressure. The resulting oil product was purified by silica column c**hromatography** (Hexane/EtOAc 40:1) to afford the desired alkyne product**.**

Method C:

Under argon protection, to a solution of compound **1a** (2 mmol, 1 eq.), aryl iodide (2.4 mmol, 1.2 eq.), CuI (0.1 mmol, 0.05 eq.) and $(PPh_3)_2PdCl_2$ (0.1 mmol, 0.05 eq.) in THF (10 mL) was added Et_3N (3mL). The reaction was stirred at 40 °C for 12 hrs. The mixture was diluted with EtOAc (15 mL) and water (15 mL); the pH if the aqueous phase was adjusted to neutral. The layers were separated; then the aqueous phase was extracted with EtOAc (2 X15 mL). The combined organic layers were dried over $MgSO_4$. The solvent was removed under reduced pressure, and the crude product was purified by column chromatography.

3.4 General procedure for difunctionalization of alkynes with aryl diazonium salts

To a 0.5 mL THF solution of alkyne (0.2 mmol) and aryl diazonium salts **(**0.4 mmol) was added $Fe(acac)_3$ (0.1 equiv), H_2O (3 equiv),$P(p\text{-}CF_3\text{-}C_6H_4)_3AuNTf_2$ (0.05 equiv) and Li_2CO_3 (1 equiv.). The reaction was stirred at room temperature for 6 hours. After the reaction completed, the reaction was filtrated through a pad of silica gel. After evacuation of the solvent, the resulting residue was directly purified by flash silica gel column chromatography.

3.5 General procedure for trifunctionalization of alkynes with aryl diazonium salts

To a 0.5 mL MeCN solution of alkyne (0.2 mmol) and aryl diazonium salts **(**0.6 mmol) were added H_2O (1 equiv),PCy_3AuCl (0.05 equiv) and Li_2CO_3 (2 equiv.). The reaction was stirred at 40 °C for 4 hours. After the reaction completed, the reaction was filtrated through a pad of silica gel. After evacuation of the solvent, the resulting residue was directly purified by flash silica gel column chromatography.

3.6 Gram scale synthesis of alkynes difunctionalization

To a 10 mL THF solution of alkyne (5 mmol) and aryl diazonium salts **(**10 mmol) was added $Fe(acac)_3$ (0.1 equiv), H_2O (3 equiv),$P(p\text{-}CF_3\text{-}C_6H_4)_3AuNTf_2$ (0.075 equiv) and Li_2CO_3 (1 equiv.). The reaction was stirred at room temperature for 8 hours. After the reaction completed, the reaction was filtrated through a pad of silica gel. After evacuation of the solvent, the resulting residue was directly purified by flash silica gel column chromatography.

3.7 Gram scale synthesis of alkynes trifunctionalization

To a 3.5 mL MeCN solution of alkyne (3 mmol) and aryl diazonium salts **(**9 mmol) were added H_2O (1 equiv),PCy_3AuCl (0.75 equiv) and Li_2CO_3 (2 equiv.). The reaction was stirred at 40 °C for 4 hours. After the reaction completed, the reaction was filtrated through a pad of silica gel. After

evacuation of the solvent, the resulting residue was directly purified by flash silica gel column chromatography.

3.8 General procedure for synthesis of thiophene (6a) from 1,4-diketone

To a 1.0 mL toluene solution of 1,4-diketone (0.2 mmol) was added Lawesson's reagent **(**0.22 mmol) The reaction was stirred at 80 ºC for 2 hours. After the reaction completed, the reaction was filtrated through a pad of silica gel. After evacuation of the solvent, the resulting residue was directly purified by flash silica gel column chromatography.

3.9 General procedure for synthesis of hydrazone (7ba,7br,7bb) from azo compound

To a 1.0 mL methanol solution of azo compound (0.4 mmol) was added 3M HCl **(**0.5 mL). The reaction was stirred at room temperature for 2 hours (for **7bb**, reaction temperature is 50 ºC, the completion of the reaction was monitored by TLC). After the reaction completed, the reaction was washed by water. The mixture was extracted by DCM. After evacuation of the solvent, the resulting residue was directly purified by flash silica gel column chromatography.

3.10 General procedure for Pd/C catalyzed hydrogenation

To a 2.0 mL methanol solution of compound substrate(1 mmol) was added 0.15 eq Pd/C (10%). The reaction was stirred under H_2 (1 atm) atomosphere at room temperature for 10 hours. After the reaction completed, the reaction was filtrated through a pad of Celite. After evacuation of the solvent, the resulting residue was directly purified by flash silica gel column chromatography.

3.11 General procedure for synthesis of diol

To a 1.0 mL methanol solution of compound **8a** (0.3 mmol) was added 2.0 eq $NaBH_4$ at 0 ºC. The reaction was stirred at room temperature for 2 hours. fter the reaction completed, the reaction was washed by water. The mixture was extracted by DCM. After evacuation of the solvent, the resulting residue was directly purified by flash silica gel column chromatography.

3.12 General procedure for synthesis of tetrafuryl hydrazone

Anhydrous zinc dichloride ($ZnCl_2$, 1.25 equiv.) was added to a stirred solution of substrate (1.0 equiv.) in distilled DCE under a flow of N_2. The reaction was stirred at reflux at 60 °C for 2h. The reaction mixture was cooled to ambient temperature and diluted with DCM and H_2O and then extracted with DCM (x 3). The combined organic layers were washed with brine, dried over MgSO4, and concentrated in vacuo. the resulting residue was directly purified by flash silica gel column chromatography.

3.13 General procedure for synthesis of compound 7b-1

To a solution of hydrazone (5 mmol) in dry THF (20 mL) was added NaH (95%, 1.2 g, 47.5 mmol) at 0 °C. The mixture was stirred for 15 min, and then methyl iodide (7.5 mmol) was added dropwise. After stirring at room temperature for 3 h, the reaction mixture was refluxed for another 2 h. The reaction mixture was cooled to the room temperature, and then the solvent was removed under reduced pressure. The residue was diluted with water (15 mL), extracted with ether (25 mL x 3), and dried over Na2SO4. After removal of the solvent, the residue was purified by flash chromatography column on silica gel (gradient eluent of EtOAc in hexanes: 1 ~ 5%, v/v) to yield the product **7b-1** as a yellow oil

Reference:

1. Tatunashvili, E.; Chan, B.; Nashar, P. E.; McErlean, C. S. P., σ-Bond initiated generation of aryl radicals from aryl diazonium salts. *Org. Biomol. Chem.* **2020,** *18* (9), 1812-1819.

2. Trost, B. M.; Shi, Y., Palladium-catalyzed cyclizations of polyenynes. A palladium zipper. *J. Am. Chem. Soc.* **1993,** *115* (21), 9421-9438.

IV. ORTEP Drawing for Crystal Structures

Single-Crystal X-Ray Diffraction

X-ray diffraction data were measured on Bruker D8 Venture PHOTON II CPAD diffractometer equipped with a Cu Kα INCOATEC ImuS micro-focus source (λ = 1.54178 Å). Indexing was performed using APEX3 [1] (Difference Vectors method). Data integration and reduction were performed using SaintPlus [2]. Absorption correction was performed by multi-scan method implemented in SADABS [3]. Space groups were determined using XPREP implemented in APEX3 [1]. Structure was solved using SHELXT [4] and refined using SHELXL-2018 [5] (full-matrix least-squares on F2) through OLEX2 interface program [6]. **4an**: -CF3 group and thiophene are disordered and were refined with restraints. **4a**: Disordered -CF3 group was refined with restraints. **5a**: -CF3 group and dichloromethane are disordered and were refined with restraints. R7: Disordered -CH=CH2 group was refined with restraints. **5e**: Disordered -NO2 was refined with restraints. Crystal data and refinement conditions are shown in Tables 1 - 8.

[1] Bruker (2019). APEX3 Bruker AXS Inc., Madison, Wisconsin, USA.
[2] Bruker (2019) SAINT V8.35A. Data Reduction Software.
[3] Sheldrick, G. M. (1996). SADABS. Program for Empirical Absorption Correction. University of Gottingen, Germany.
[4] XT, G.M. Sheldrick, Acta Cryst. (2015). A71, 3-8
[5] XL, Sheldrick, G. M. (2008). Acta Cryst. A64, 112-122.
[6] Dolomanov, O.V.; Bourhis, L.J.; Gildea, R.J.; Howard, J.A.K.; Puschmann, H., OLEX2: A complete structure solution, refinement and analysis program (2009). J. Appl. Cryst., 42, 339-341

Table 1 Crystal data and structure refinement for 4l.	
Identification code	**4l**
Empirical formula	$C_{17}H_{15}N_3O_4$
Formula weight	325.32
Temperature/K	100.0
Crystal system	triclinic
Space group	P-1
a/Å	5.4871(2)
b/Å	8.3867(3)
c/Å	16.9971(7)
α/°	98.6600(10)
β/°	92.5250(10)
γ/°	102.307(2)
Volume/Å^3	753.14(5)
Z	2
ρ_{calc}g/cm^3	1.435
μ/mm^{-1}	0.869
F(000)	340.0
Crystal size/mm^3	0.15 × 0.07 × 0.07
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/°	5.276 to 160.244
Index ranges	$-6 \le h \le 6$, $-10 \le k \le 10$, $-20 \le l \le 21$
Reflections collected	12999
Independent reflections	3140 [R_{int} = 0.0389, R_{sigma} = 0.0346]
Data/restraints/parameters	3140/0/221
Goodness-of-fit on F^2	1.038
Final R indexes [I>=2σ (I)]	R_1 = 0.0360, wR_2 = 0.0981
Final R indexes [all data]	R_1 = 0.0392, wR_2 = 0.1032
Largest diff. peak/hole / e Å^{-3}	0.26/-0.29

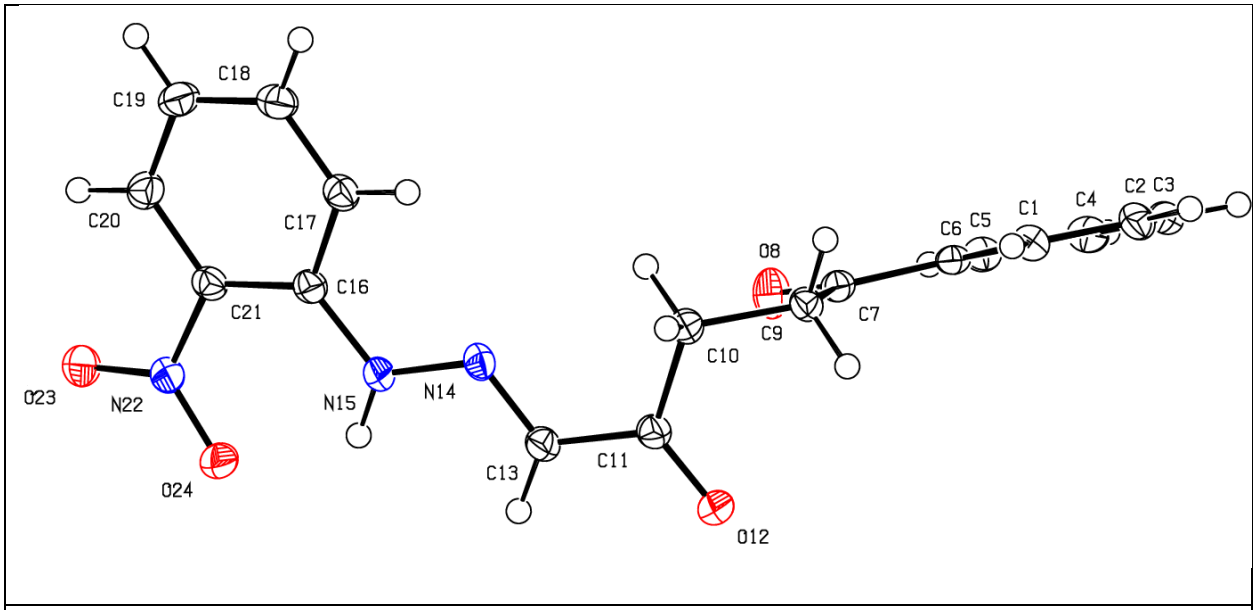


Fig.1. Asymmetric unit of **4l**. Anisotropic displacement parameters were drawn at 50% probability level. CCDC: 2044475

Table 2 Crystal data and structure refinement for 4an.	
Identification code	4an
Empirical formula	$C_{16}H_{13}F_3N_2O_2S$
Formula weight	354.34
Temperature/K	100.0
Crystal system	monoclinic
Space group	$P2_1/c$
a/Å	16.2770(6)
b/Å	8.2052(3)
c/Å	11.6507(4)
α/°	90
β/°	94.7940(10)
γ/°	90
Volume/Å^3	1550.58(10)
Z	4
ρ_{calc}g/cm^3	1.518
μ/mm^{-1}	2.287
F(000)	728.0
Crystal size/mm^3	0.33 × 0.09 × 0.06
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/°	5.448 to 159.724
Index ranges	$-20 \leq h \leq 20$, $-10 \leq k \leq 10$, $-14 \leq l \leq 14$
Reflections collected	26933
Independent reflections	3357 [R_{int} = 0.0449, R_{sigma} = 0.0271]
Data/restraints/parameters	3357/243/282
Goodness-of-fit on F^2	1.087
Final R indexes [I>=2σ (I)]	R_1 = 0.0293, wR_2 = 0.0770
Final R indexes [all data]	R_1 = 0.0297, wR_2 = 0.0773
Largest diff. peak/hole / e Å^{-3}	0.28/-0.24

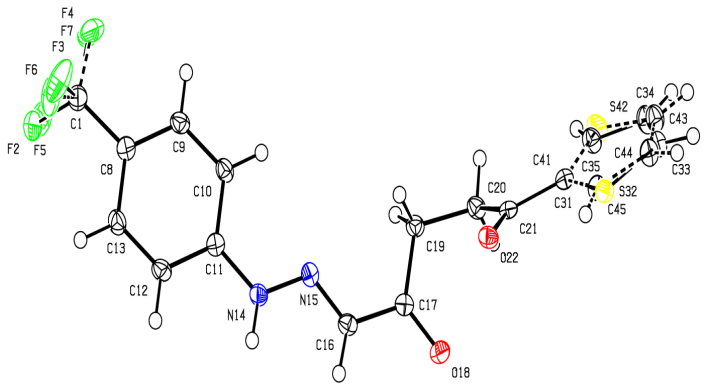


Fig.2. Asymmetric unit of **4an**. Anisotropic displacement parameters were drawn at 50% probability level. CCDC: 2044473

Table 3 Crystal data and structure refinement for 4bf.	
Identification code	4bf
Empirical formula	$C_{24}H_{18}F_3N_3O_4$
Formula weight	469.41
Temperature/K	100.0
Crystal system	monoclinic
Space group	C2/c
a/Å	22.6295(5)
b/Å	8.4268(2)
c/Å	23.1298(5)
α/°	90
β/°	102.5426(9)
γ/°	90
Volume/Å^3	4305.46(17)
Z	8
ρ_{calc}g/cm^3	1.448
μ/mm^{-1}	1.003
F(000)	1936.0
Crystal size/mm^3	0.36 × 0.06 × 0.06
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/°	7.832 to 160.162
Index ranges	$-24 \leq h \leq 27$, $-10 \leq k \leq 10$, $-29 \leq l \leq 29$
Reflections collected	49923
Independent reflections	4607 [R_{int} = 0.0608, R_{sigma} = 0.0326]
Data/restraints/parameters	4607/0/311
Goodness-of-fit on F^2	1.039
Final R indexes [I>=2σ (I)]	R_1 = 0.0387, wR_2 = 0.1027
Final R indexes [all data]	R_1 = 0.0418, wR_2 = 0.1089
Largest diff. peak/hole / e Å^{-3}	0.45/-0.31

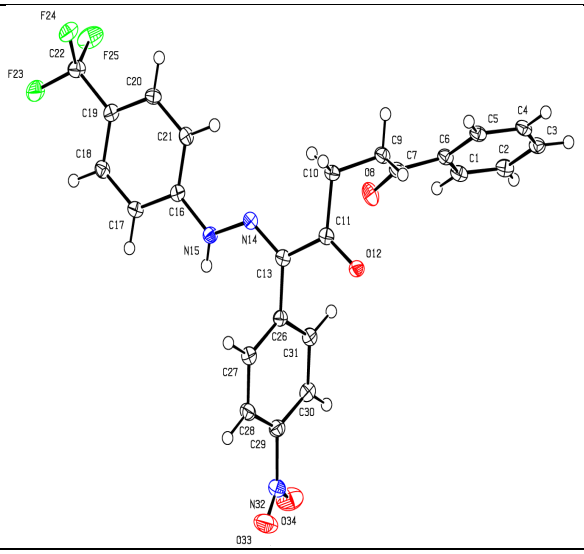


Fig.3. Asymmetric unit of **4bf**. Anisotropic displacement parameters were drawn at 50% probability level. CCDC: 2044474

Table 4 Crystal data and structure refinement for 5aa.	
Identification code	5aa
Empirical formula	$C_{25}H_{17}F_7N_2O_2$
Formula weight	510.40
Temperature/K	100.0
Crystal system	monoclinic
Space group	C2/c
a/Å	23.2438(8)
b/Å	8.1771(3)
c/Å	24.1474(9)
α/°	90
β/°	99.4140(10)
γ/°	90
Volume/Å^3	4527.8(3)
Z	8
ρ_{calc}g/cm^3	1.497
μ/mm^{-1}	1.184
F(000)	2080.0
Crystal size/mm^3	0.19 × 0.17 × 0.05
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/°	7.422 to 159.89
Index ranges	-29 ≤ h ≤ 29, -10 ≤ k ≤ 10, -30 ≤ l ≤ 28
Reflections collected	53709
Independent reflections	4889 [R_{int} = 0.0494, R_{sigma} = 0.0259]
Data/restraints/parameters	4889/0/329
Goodness-of-fit on F^2	1.063
Final R indexes [I>=2σ (I)]	R_1 = 0.0396, wR_2 = 0.1067
Final R indexes [all data]	R_1 = 0.0429, wR_2 = 0.1105
Largest diff. peak/hole / e Å^{-3}	0.27/-0.27

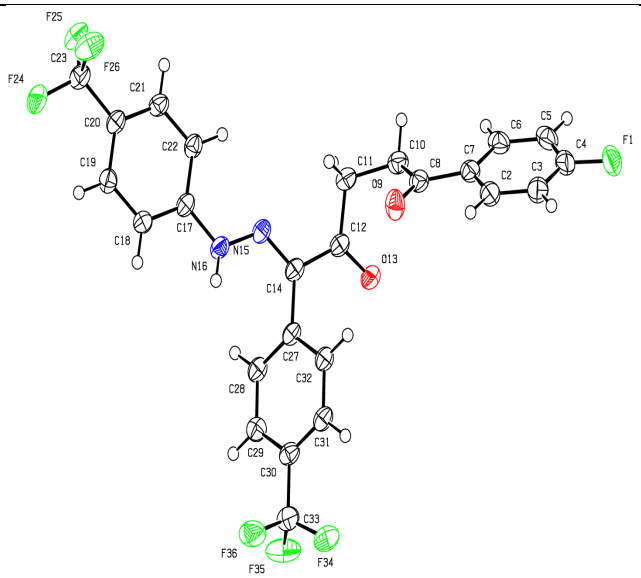


Fig.4. Asymmetric unit of **5aa**. Anisotropic displacement parameters were drawn at 50% probability level. CCDC: 2044477

Table 5 Crystal data and structure refinement for 4a.	
Identification code	4a
Empirical formula	$C_{18}H_{15}F_3N_2O_2$
Formula weight	348.32
Temperature/K	300.0
Crystal system	triclinic
Space group	P-1
a/Å	5.9095(2)
b/Å	7.7608(3)
c/Å	18.1267(6)
α/°	101.1140(10)
β/°	92.3050(10)
γ/°	90.718(6)
Volume/Å^3	814.91(5)
Z	2
ρ_{calc}g/cm^3	1.420
μ/mm^{-1}	1.000
F(000)	360.0
Crystal size/mm^3	0.08 × 0.06 × 0.05
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/°	4.972 to 160.106
Index ranges	$-7 \le h \le 7$, $-9 \le k \le 9$, $-22 \le l \le 23$
Reflections collected	16171
Independent reflections	3441 [R_{int} = 0.0453, R_{sigma} = 0.0403]
Data/restraints/parameters	3441/129/258
Goodness-of-fit on F^2	1.047
Final R indexes [I>=2σ (I)]	R_1 = 0.0428, wR_2 = 0.1254
Final R indexes [all data]	R_1 = 0.0498, wR_2 = 0.1348
Largest diff. peak/hole / e Å^{-3}	0.20/-0.15

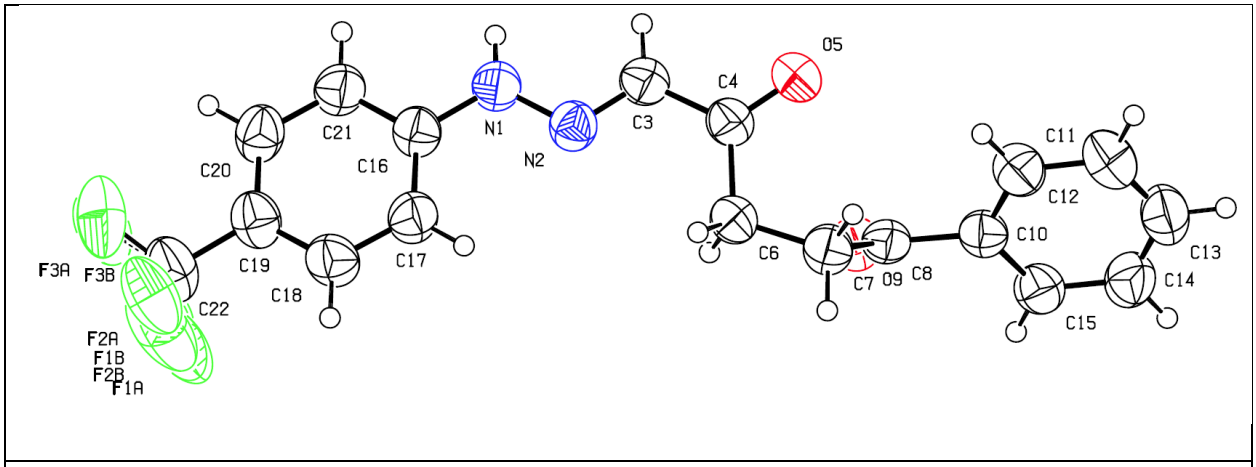


Fig.5. Ellipsoid plot of 4a. Asymmetric unit contains two independent halves of polyhedral molecule. Displacement parameters were drawn at 50% probability level. CCDC: 2044472

Table 6 Crystal data and structure refinement for 5a.	
Identification code	5a
Empirical formula	$C_{25.25}H_{18.5}Cl_{0.5}F_6N_2O_2$
Moiety formula	$C_{25}H_{18}F_6N_2O_2$, 0.25(CH_2Cl_2)
Formula weight	513.64
Temperature/K	100.0
Crystal system	monoclinic
Space group	$P2_1/c$
a/Å	25.6209(6)
b/Å	8.2069(2)
c/Å	24.8748(6)
α/°	90
β/°	115.7676(9)
γ/°	90
Volume/Å^3	4710.3(2)
Z	8
ρ_{calc}g/cm^3	1.449
μ/mm^{-1}	1.587
F(000)	2100.0
Crystal size/mm^3	0.21 × 0.04 × 0.03
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/°	7.118 to 160.04
Index ranges	$-31 \le h \le 32$, $-10 \le k \le 10$, $-31 \le l \le 31$
Reflections collected	64847
Independent reflections	10151 [R_{int} = 0.0565, R_{sigma} = 0.0323]
Data/restraints/parameters	10151/97/739
Goodness-of-fit on F^2	1.051
Final R indexes [I>=2σ (I)]	R_1 = 0.0411, wR_2 = 0.1035
Final R indexes [all data]	R_1 = 0.0500, wR_2 = 0.1113
Largest diff. peak/hole / e Å^{-3}	0.38/-0.32

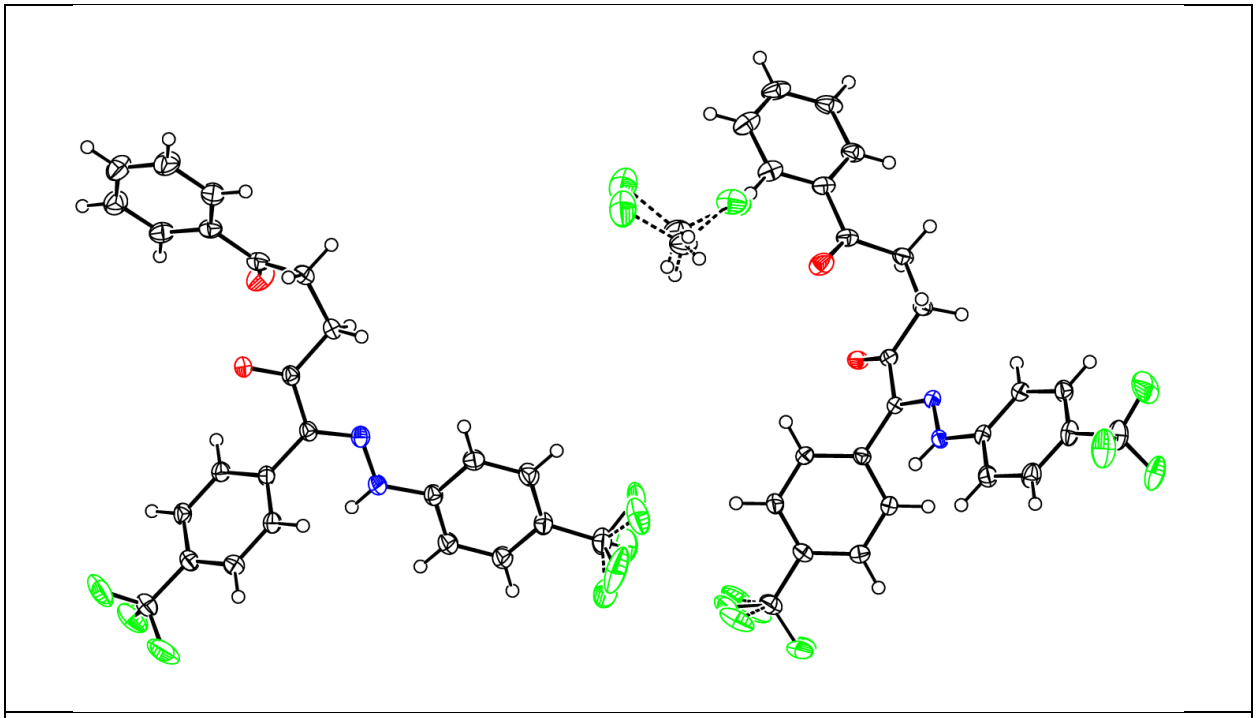


Fig.6. Asymmetric unit of **5a**. Anisotropic displacement parameters were drawn at 50% probability level. CCDC: 2044476

Table 7 Crystal data and structure refinement for 5al.	
Identification code	5al
Empirical formula	$C_{23}H_{20}F_6N_2O_2$
Formula weight	470.41
Temperature/K	100.0
Crystal system	monoclinic
Space group	$P2_1/n$
a/Å	13.5801(4)
b/Å	8.1549(2)
c/Å	19.7074(6)
α/°	90
β/°	101.5517(9)
γ/°	90
Volume/Å^3	2138.28(10)
Z	4
ρ_{calc}g/cm^3	1.461
μ/mm^{-1}	1.127
F(000)	968.0
Crystal size/mm^3	0.2 × 0.06 × 0.02
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/°	7.274 to 159.716
Index ranges	$-16 \le h \le 17$, $-10 \le k \le 9$, $-25 \le l \le 24$
Reflections collected	27943
Independent reflections	4555 [R_{int} = 0.0456, R_{sigma} = 0.0288]
Data/restraints/parameters	4555/10/320
Goodness-of-fit on F^2	1.063
Final R indexes [I>=2σ (I)]	R_1 = 0.0371, wR_2 = 0.1001
Final R indexes [all data]	R_1 = 0.0405, wR_2 = 0.1035
Largest diff. peak/hole / e Å^{-3}	0.33/-0.30

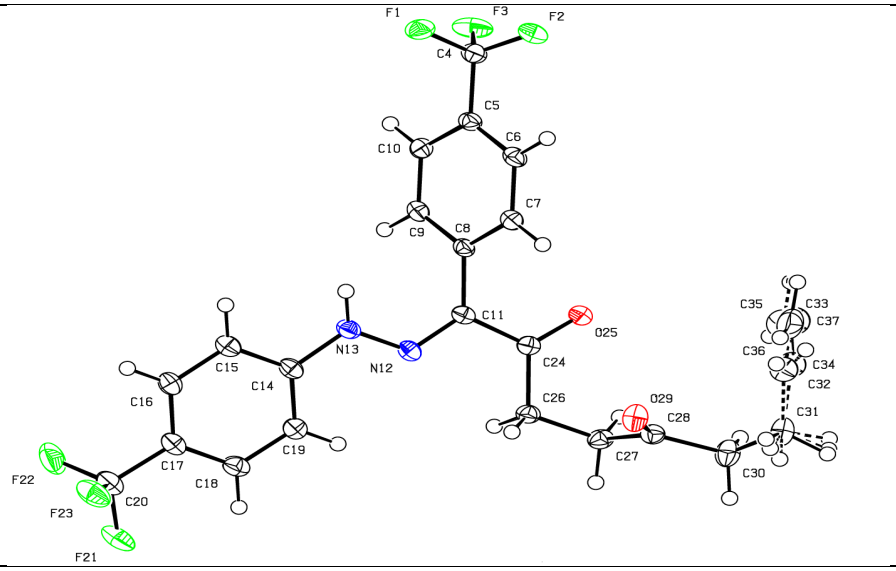


Fig.7. Asymmetric unit of 5al. Anisotropic displacement parameters were drawn at 50% probability level. CCDC: 2044478

Table 8 Crystal data and structure refinement for 5e.	
Identification code	5e
Empirical formula	$C_{23}H_{18}N_4O_6$
Formula weight	446.41
Temperature/K	100.0
Crystal system	monoclinic
Space group	$P2_1/n$
a/Å	11.5921(6)
b/Å	7.8227(4)
c/Å	23.1270(10)
α/°	90
β/°	99.162(2)
γ/°	90
Volume/Å^3	2070.44(18)
Z	4
ρ_{calc}g/cm^3	1.432
μ/mm^{-1}	0.888
F(000)	928.0
Crystal size/mm^3	0.28 × 0.1 × 0.1
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/°	7.744 to 160.034
Index ranges	$-14 \le h \le 14$, $-9 \le k \le 9$, $-28 \le l \le 29$
Reflections collected	36728
Independent reflections	4457 [R_{int} = 0.0528, R_{sigma} = 0.0322]
Data/restraints/parameters	4457/49/314
Goodness-of-fit on F^2	1.054
Final R indexes [I>=2σ (I)]	R_1 = 0.0378, wR_2 = 0.0978
Final R indexes [all data]	R_1 = 0.0394, wR_2 = 0.0995
Largest diff. peak/hole / e Å^{-3}	0.22/-0.31

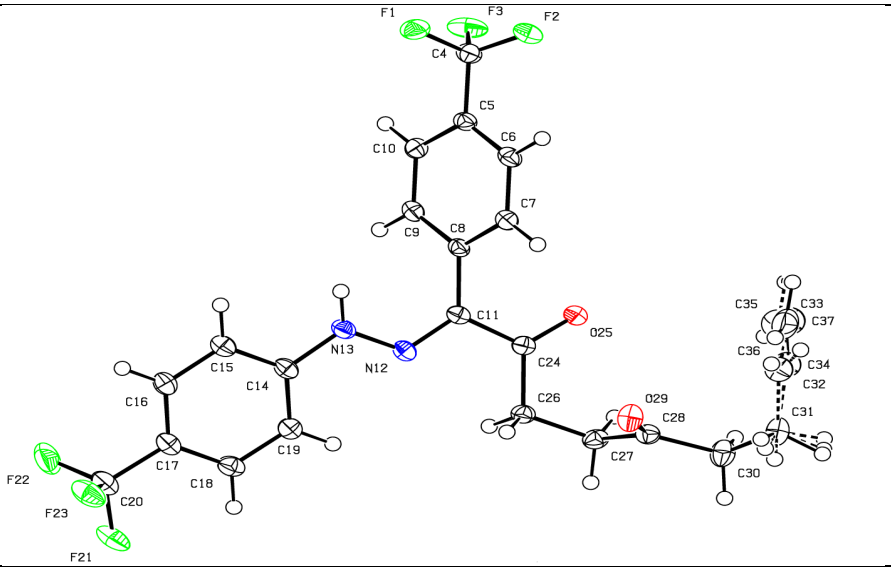
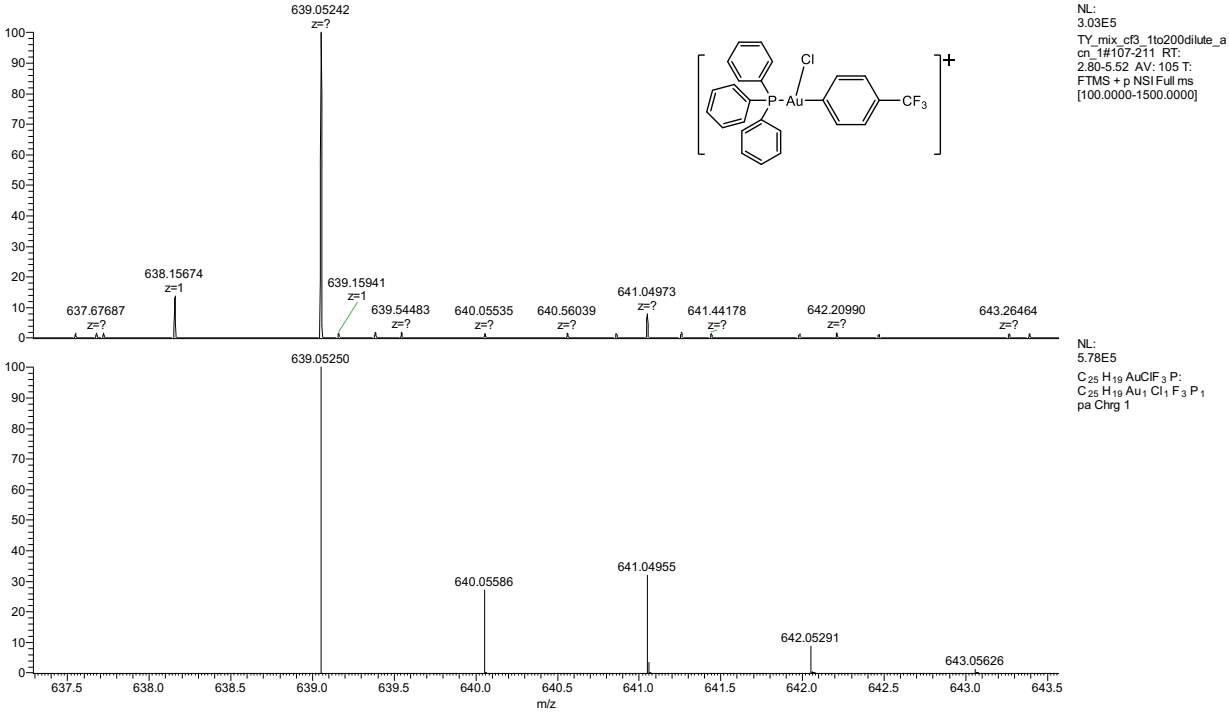
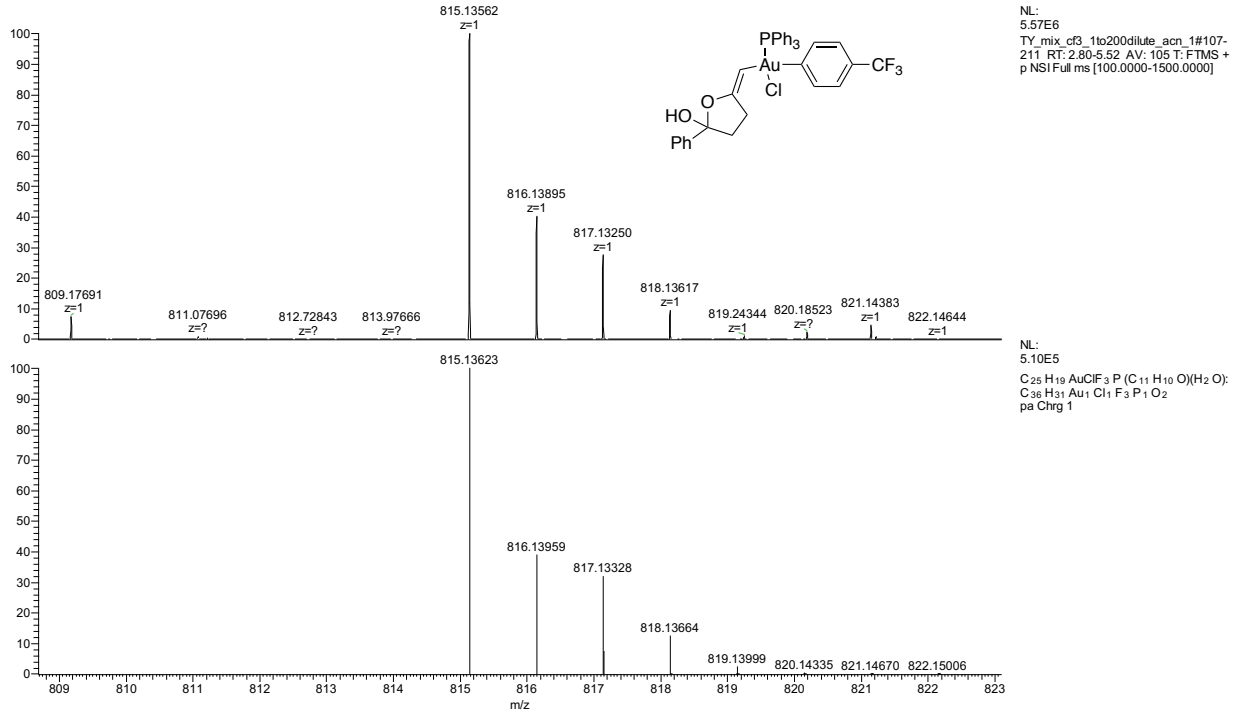
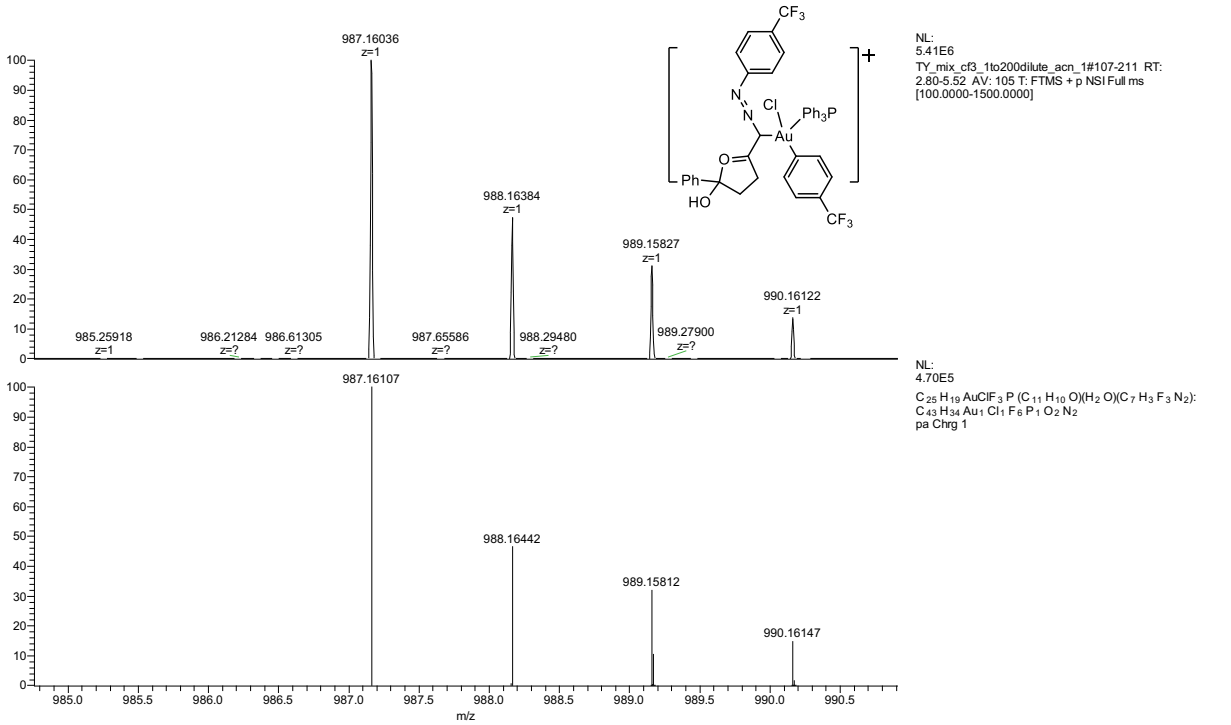


Fig.8. Asymmetric unit of **5e**. Anisotropic displacement parameters were drawn at 50% probability level. CCDC: 2044479

V. Mass Spectrometry Study



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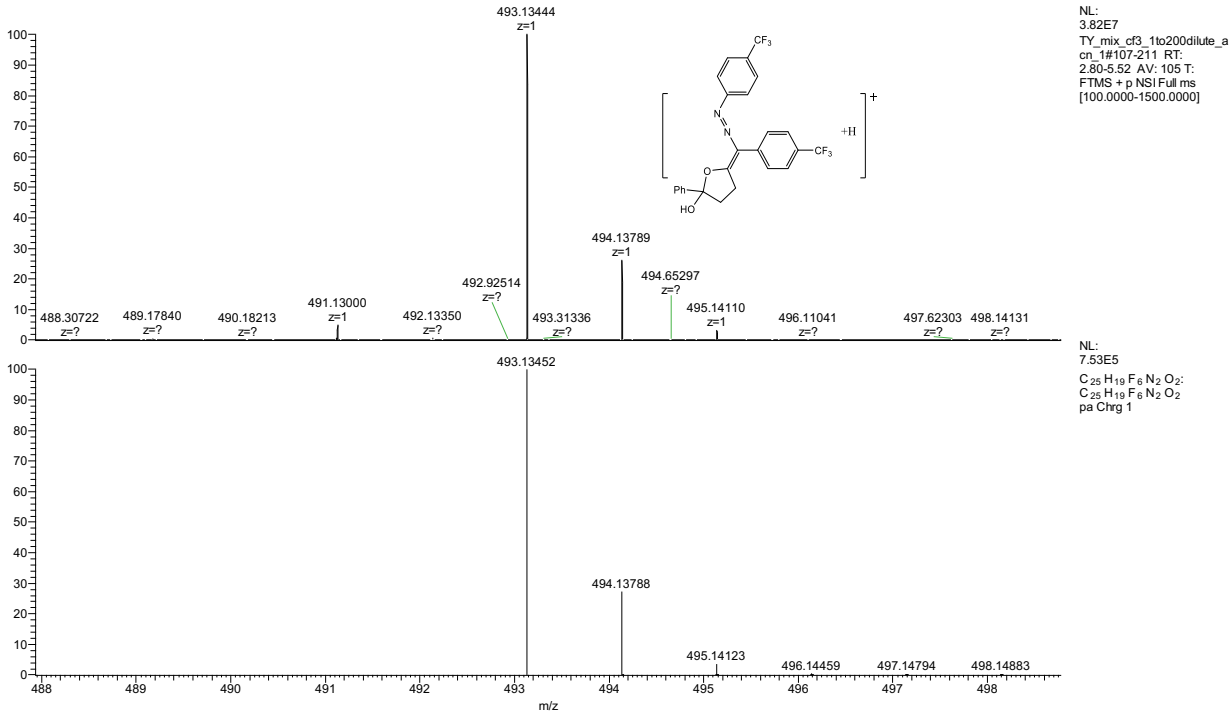
m/z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498.14131
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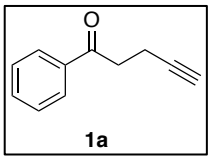
m/z

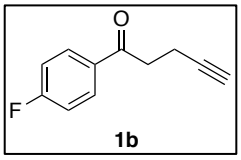
VI. Compounds Characterization

1-phenylpent-4-yn-1-one (1a)



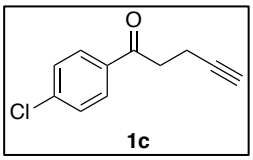
1a was prepared following the General Procedure 3.3 Method A as white solid. Yield:83%
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02-7.89 (m, 2H), 7.58 (t, *J* = 7.4 Hz, 1H), 7.47 (t, *J* = 7.6 Hz, 2H), 3.25 (dd, *J* = 8.2, 6.5 Hz, 2H), 2.64 (td, *J* = 7.4, 2.6 Hz, 2H), 1.98 (t, *J* = 2.7 Hz, 1H).
^{13}C-NMR (101 MHz; $CDCl_3$): δ 197.7, 136.4, 133.3, 128.6, 128.0, 83.3, 68.7, 37.6, 13.2.

1-(4-fluorophenyl)pent-4-yn-1-one (1b)



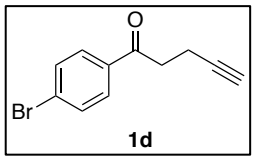
1b was prepared following the General Procedure 3.3 Method A as white solid. Yield:76%
^{1}H-NMR (400 MHz; $CDCl_3$): δ 8.07-7.71 (m, 2H), 7.12 (t, *J* = 8.6 Hz, 2H), 3.19 (dd, *J* = 8.2, 6.5 Hz, 2H), 2.73-2.51 (m, 2H), 1.97 (t, *J* = 2.7 Hz, 1H). **^{13}C-NMR** (101 MHz; $CDCl_3$): δ 196.0, 165.8 (d, *J* = 255.5 Hz), 132.9 (d, *J* = 3.0 Hz), 130.6 (d, *J* = 10.1 Hz), 115.7 (d, *J* =21.2 Hz), 83.1, 68.8, 37.4, 13.1. **^{19}F-NMR** (376 MHz; $CDCl_3$): δ -104.9
HRMS m/z (ESI) calcd. for $C_{11}H_{10}FO^+$ $[M+H]^+$ 177.0716, found 177.0702.

1-(4-chlorophenyl)pent-4-yn-1-one (1c)



1c was prepared following the General Procedure 3.3 Method A as white solid. Yield:80%
^{1}H-NMR (400 MHz; $CDCl_3$): δ 7.89 (dd, *J* = 8.6, 1.8 Hz, 2H), 7.43 (dd, *J* = 8.6, 1.9 Hz, 2H), 3.36-2.99 (m, 2H), 2.77-2.44 (m, 2H), 1.98 (t, *J* = 2.7 Hz, 1H). **^{13}C-NMR** (101 MHz; $CDCl_3$): δ 196.4, 139.7, 134.7, 129.4, 129.0, 128.9, 83.1, 68.9, 37.5, 13.2. **HRMS** m/z (ESI) calcd. for $C_{11}H_{10}ClO^+$ $[M+H]^+$ 193.0420, found 193.0407.

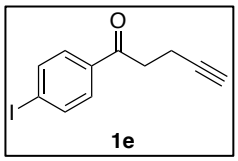
1-(4-bromophenyl)pent-4-yn-1-one (1d)



1d was prepared following the General Procedure 3.3 Method A as white solid. Yield:70%
^{1}H-NMR (400 MHz; $CDCl_3$): δ 7.92-7.76 (m, 2H), 7.66-7.51 (m, 2H), 3.27-3.06 (m, 2H), 2.70-2.54 (m, 2H), 1.98 (d, *J* = 2.6 Hz, 1H). **^{13}C-NMR** (101 MHz; $CDCl_3$): δ 196.6, 135.1, 131.9, 129.5, 128.5, 83.0, 68.9, 37.5, 13.2.
HRMS m/z (ESI) calcd. for $C_{11}H_{10}BrO^+$ $[M+H]^+$ 236.9915, found 236.9904.

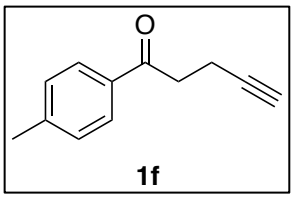
1-(4-iodophenyl)pent-4-yn-1-one (1e)

1e was prepared following the General Procedure 3.3 Method A as white solid Yield:60%



^{1}H-NMR (400 MHz; $CDCl_3$): δ 7.83 (d, *J* = 8.5 Hz, 2H), 7.66 (d, *J* = 8.5 Hz, 2H), 3.35-3.00 (m, 2H), 2.61 (td, *J* = 7.4, 2.7 Hz, 2H), 1.98 (d, *J* = 2.7 Hz, 1H). **^{13}C-NMR** (101 MHz; $CDCl_3$): δ 196.9, 138.0, 135.6, 129.4, 101.3, 83.0, 68.9, 37.4, 13.1. **HRMS** m/z (ESI) calcd. for $C_{11}H_{10}IO^+$ $(M+H)^+$ 284.9776, found 284.9763

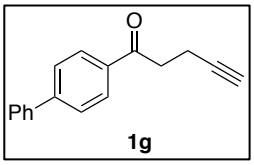
1-(*p*-tolyl)pent-4-yn-1-one (1f)



1f was prepared following the General Procedure 3.3 Method A as white solid. Yield:76%

^{1}H-NMR (400 MHz; $CDCl_3$): δ 7.89-7.74 (m, 2H), 7.24 (d, *J* = 8.0 Hz, 3H), 3.26-3.12 (m, 2H), 2.66-2.54 (m, 2H), 2.39 (s, 3H), 1.96 (t, *J* = 2.7 Hz, 1H). **^{13}C-NMR** (101 MHz; $CDCl_3$): δ 197.3, 144.1, 134.0, 129.3, 128.1, 83.4, 68.7, 37.4, 21.6, 13.2. **HRMS** m/z (ESI) calcd. for $C_{12}H_{13}O^+$ $[M+H]^+$ 173.0966, found 173.0955.

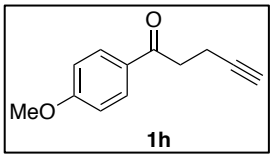
1-([1,1'-biphenyl]-4-yl)pent-4-yn-1-one (1g)



1g was prepared following the General Procedure 3.3 Method A as white solid Yield: 65%

^{1}H-NMR (400 MHz; $CDCl_3$): δ 8.05 (d, *J* = 8.4 Hz, 2H), 7.70 (d, *J* = 8.4 Hz, 2H), 7.65-7.59 (m, 2H), 7.48 (dd, *J* = 8.3, 6.5 Hz, 2H), 7.43-7.36 (m, 1H), 3.33-3.22 (m, 2H), 2.67 (ddd, *J* = 9.5, 6.5, 2.7 Hz, 2H), 2.00 (t, *J* = 2.7 Hz, 1H). **^{13}C-NMR** (101 MHz; $CDCl_3$): δ 197.2, 145.9, 139.8, 135.1, 128.9, 128.6, 128.3, 127.3, 127.2, 83.3, 68.8, 37.6, 13.3. **HRMS** m/z (ESI) calcd. for $C_{17}H_{15}O^+$ $[M+H]^+$ 235.1123, found 235.1111.

1-(4-methoxyphenyl)pent-4-yn-1-one (1h)

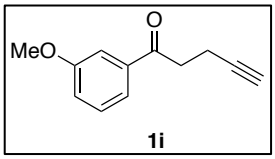


1h was prepared following the General Procedure 3.3 Method A as white solid Yield: 80%

^{1}H-NMR (400 MHz; $CDCl_3$): δ 7.95 (d, *J* = 8.6 Hz, 2H), 6.94 (d, *J* = 8.7 Hz, 2H), 3.87 (s, 3H), 3.24-3.07 (m, 2H), 2.70-2.53 (m, 2H), 1.98 (t, *J* = 2.6 Hz, 1H). **^{13}C-NMR** (101 MHz; $CDCl_3$): δ 196.2, 163.6, 130.3, 129.6, 113.8, 83.5, 68.6, 55.5, 37.1, 13.3. **HRMS** m/z (ESI) calcd. for $C_{12}H_{13}O_2^+$ $[M+H]^+$ 189.0916, found 189.0902.

1-(3-methoxyphenyl)pent-4-yn-1-one (1i)

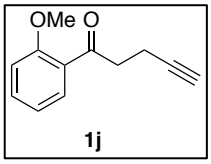
1i was prepared following the General Procedure 3.3 Method A as white solid. Yield: 73%



^{1}H-NMR (400 MHz; $CDCl_3$): δ 7.55 (dt, *J* = 7.7, 1.3 Hz, 1H), 7.50 (dd, *J* = 2.7, 1.5 Hz, 1H), 7.38 (t, *J* = 7.9 Hz, 1H), 7.15-7.08 (m, 1H), 3.86 (s, 3H), 3.23 (dd, *J* = 8.2, 6.5 Hz, 2H), 2.69-2.57 (m, 2H), 1.98 (s, 1H). **^{13}C-NMR**

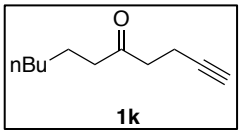
(101 MHz; $CDCl_3$): δ 197.5, 159.9, 137.8, 129.6, 120.6, 119.8, 112.2, 83.3, 68.8, 55.4, 37.7, 13.3. **HRMS** m/z (ESI) calcd. for $C_{12}H_{13}O_2^+$ $[M+H]^+$ 189.0916, found 189.0902.

1-(2-methoxyphenyl)pent-4-yn-1-one (1j)



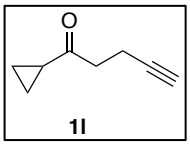
1j was prepared following the General Procedure 3.3 Method A as white solid. Yield: 77% **^{1}H-NMR** (400 MHz; $CDCl_3$): δ 7.75 (dd, *J* = 7.7, 1.8 Hz, 1H), 7.47 (ddd, *J* = 8.8, 7.3, 1.8 Hz, 1H), 7.05-6.87 (m, 2H), 3.91 (s, 3H), 3.25 (t, *J* = 7.4 Hz, 2H), 2.58 (td, *J* = 7.5, 2.6 Hz, 2H), 1.95 (t, *J* = 2.7 Hz, 1H). **^{13}C-NMR** (101 MHz; $CDCl_3$): δ 199.6, 158.8, 133.7, 130.4, 127.4, 120.7, 111.5, 83.9, 68.2, 55.5, 42.7, 13.4. **HRMS** m/z (ESI) calcd. for $C_{12}H_{13}O_2^+$ $[M+H]^+$ 189.0916, found 189.0900.

undec-1-yn-5-one (1k)



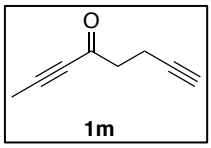
1k was prepared following the General Procedure 3.3 Method A as pale yellow oil. Yield: 70% **^{1}H-NMR** (400 MHz; $CDCl_3$): δ 2.65 (dd, *J* = 8.1, 6.5 Hz, 2H), 2.52-2.33 (m, 4H), 1.93 (t, *J* = 2.7 Hz, 1H), 1.57 (t, *J* = 6.9 Hz, 3H), 1.27 (d, *J* = 2.7 Hz, 5H), 0.87 (t, *J* = 6.6 Hz, 3H). **^{13}C-NMR** (101 MHz; $CDCl_3$): δ 208.8, 83.2, 68.6, 42.8, 41.2, 31.5, 28.8, 23.7, 22.5, 14.0, 12.9. **HRMS** m/z (ESI) calcd. for $C_{11}H_{19}O^+$ $[M+H]^+$ 167.1436, found 167.1431

1-cyclopropylpent-4-yn-1-one (1l)



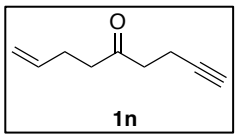
1l was prepared following the General Procedure 3.3 Method A as colorless oil. Yield: 56%.
^{1}H-NMR (400 MHz; $CDCl_3$): δ 2.80 (t, *J* = 7.3 Hz, 2H), 2.44 (td, *J* = 7.4, 7.0, 2.6 Hz, 2H), 2.03-1.74 (m, 2H), 1.10-0.97 (m, 2H), 0.87 (dd, *J* = 7.7, 3.6 Hz, 2H).
^{13}C-NMR (101 MHz; $CDCl_3$): δ 208.4, 83.2, 68.5, 41.9, 29.7, 20.4, 13.0, 10.8.

octa-2,7-diyn-4-one (1m)



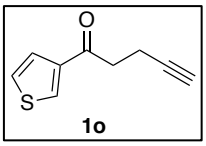
1m was prepared following the General Procedure 3.3 Method A as pale yellow oil. Yield: 60%.
^{1}H-NMR (400 MHz; $CDCl_3$): δ 2.85-2.69 (m, 2H), 2.56-2.41 (m, 2H), 2.01 (s, 3H), 1.98-1.91 (m, 1H).
^{13}C-NMR (101 MHz; $CDCl_3$): δ 208.4, 83.2, 68.5, 41.9, 29.7, 20.4, 13.0, 10.8.

non-1-en-8-yn-5-one (1n)



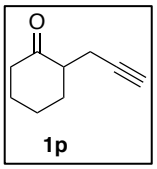
1n was prepared following the General Procedure 3.3 Method A as colorless oil. Yield: 84%
^{1}H-NMR (400 MHz; $CDCl_3$): δ 5.88-5.69 (m, 1H), 5.08-4.89 (m, 2H), 2.66 (dd, *J* = 8.0, 6.5 Hz, 2H), 2.53 (t, *J* = 7.4 Hz, 2H), 2.45 (ddd, *J* = 9.4, 6.5, 2.7 Hz, 2H), 2.34 (ddd, *J* = 6.4, 4.6, 3.2 Hz, 2H), 1.94 (t, *J* = 2.7 Hz, 1H). **^{13}C-NMR** (101 MHz; $CDCl_3$): δ 207.7, 136.9, 115.4, 83.1, 68.7, 41.8, 41.3, 27.6, 12.9.

1-(thiophen-3-yl)pent-4-yn-1-one (1o)



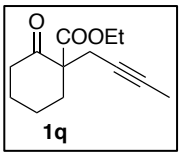
1o was prepared following the General Procedure 3.3 Method A as brown oil. **^{1}H-NMR** (400 MHz; $CDCl_3$): δ 7.73 (d, *J* = 3.8 Hz, 1H), 7.64 (d, *J* = 4.9 Hz, 1H), 7.16-7.07 (m, 1H), 3.16 (t, *J* = 7.5 Hz, 2H), 2.62 (td, *J* = 6.9, 6.3, 3.5 Hz, 2H), 1.98 (t, *J* = 2.7 Hz, 1H). **^{13}C-NMR** (101 MHz; $CDCl_3$): δ 190.5, 143.6, 133.8, 132.0, 128.1, 82.9, 68.9, 38.0, 13.3. **HRMS** m/z (ESI) calcd. for $C_9H_9OS^+$ $[M+H]^+$ 165.0374, found 165.0363

2-(prop-2-yn-1-yl)cyclohexan-1-one (1p)



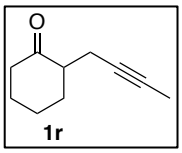
1p was prepared following the General Procedure 3.3 Method B as colorless oil. Yield: 50% (2 steps in total)
^{1}H-NMR (400 MHz; $CDCl_3$): δ 2.61 (ddd, *J* = 17.0, 4.7, 2.7 Hz, 1H), 2.55-2.36 (m, 3H), 2.36-2.24 (m, 1H), 2.19 (ddd, *J* = 17.0, 8.3, 2.7 Hz, 1H), 2.10 (dt, *J* = 6.2, 3.0 Hz, 1H), 1.99-1.88 (m, 2H), 1.76-1.62 (m, 2H), 1.42 (dd, *J* = 12.6, 3.7 Hz, 1H). **^{13}C-NMR** (101 MHz; $CDCl_3$): δ 210.8, 82.5, 69.4, 49.4, 41.9, 33.2, 27.8, 25.0, 18.8.

ethyl 1-(but-2-yn-1-yl)-2-oxocyclohexane-1-carboxylate (1q)



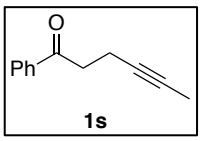
1q was prepared following the General Procedure 3.3 Method B as colorless oil. yield: 88%.
^{1}H NMR (600 MHz, $CDCl_3$) δ 4.19 (q, *J* = 7.1 Hz, 2H), 2.70 – 2.59 (m, 2H), 2.50 – 2.35 (m, 3H), 2.05 – 1.95 (m, 1H), 1.82 – 1.74 (m, 2H), 1.73 (t, *J* = 2.6 Hz, 3H), 1.67 – 1.51 (m, 2H), 1.23 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 206.4, 170.6, 78.6, 73.9, 61.4, 60.2, 40.8, 35.3, 27.3, 25.0, 22.3, 14.0, 3.5. **HRMS** m/z (ESI) calcd. for $C_{13}H_{19}O_3^+$ $[M+H]^+$ 223.1334, found 223.1334

2-(but-2-yn-1-yl)cyclohexan-1-one (1r)



1r was prepared following the General Procedure 3.3 Method B as colorless oil. yield: 85%
^{1}H NMR (600 MHz, $CDCl_3$) δ 2.52 (ddt, J = 16.8, 4.8, 2.5 Hz, 1H), 2.44 – 2.32 (m, 3H), 2.28 (td, J = 13.4, 11.7, 6.6 Hz, 1H), 2.08 (dddt, J = 21.8, 12.8, 6.3, 2.8 Hz, 2H), 1.92 – 1.83 (m, 1H), 1.74 (dt, J = 5.3, 2.6 Hz, 3H), 1.64 (dddd, J = 25.8, 16.4, 10.8, 3.5 Hz, 2H), 1.41 – 1.30 (m, 1H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 211.5, 77.2, 76.6, 49.9, 41.9, 33.3, 27.8, 25.0, 19.0, 3.5. **HRMS** m/z (ESI) calcd. for $C_{10}H_{15}O^+$ $[M+H]^+$ 151.1123, found 151.1118

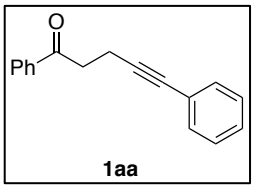
1-phenylhex-4-yn-1-one (1s)



1s was prepared following the General Procedure 3.3 Method B as colorless oil. Yield: 65% (2 steps in total)

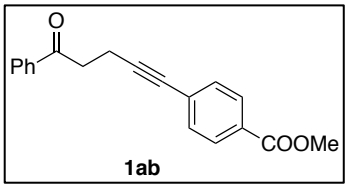
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.01 – 7.92 (m, 2H), 7.60 – 7.54 (m, 1H), 7.47 (t, J = 7.7 Hz, 2H), 3.19 (dd, J = 8.2, 6.6 Hz, 2H), 2.57 (ddt, J = 7.2, 5.1, 2.6 Hz, 2H), 1.77 (t, J = 2.6 Hz, 3H).**^{13}C NMR** (151 MHz, $CDCl_3$) δ 198.2, 136.5, 133.1, 128.5, 128.0, 77.9, 76.1, 38.1, 13.5, 3.4. **HRMS** m/z (ESI) calcd. for $C_{12}H_{13}O^+$ $[M+H]^+$ 173.0966, found 173.0959

1,5-diphenylpent-4-yn-1-one (1aa)



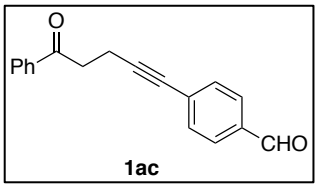
1aa was prepared following the General Procedure 3.3 Method C as white solid. Yield: 85%
^{1}H-NMR (400 MHz; $CDCl_3$): δ 8.03-7.93 (m, 2H), 7.57 (s, 0H), 7.48 (d, *J* = 7.9 Hz, 2H), 7.40-7.32 (m, 2H), 7.27 (dd, *J* = 4.8, 1.9 Hz, 3H), 3.38-3.19 (m, 2H), 2.92-2.77 (m, 2H). **^{13}C-NMR** (101 MHz; $CDCl_3$): δ 197.9, 136.5, 133.2, 131.5, 128.6, 128.2, 128.0, 127.7, 123.6, 88.8, 81.0, 37.8, 14.3. **HRMS** m/z (ESI) calcd. for $C_{17}H_{15}O^+$ $[M+H]^+$ 235.1123, found 235.1109

methyl 4-(5-oxo-5-phenylpent-1-yn-1-yl)benzoate (1ab)



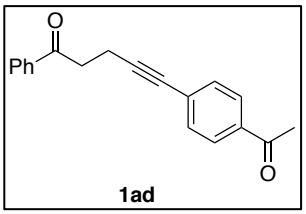
1ab was prepared following the General Procedure 3.3 Method C as white solid. Yield: 85%
^{1}H NMR (600 MHz, $CDCl_3$): δ 8.01 (d, J = 8.0 Hz, 2H), 7.95 (d, J = 8.0 Hz, 2H), 7.63 – 7.55 (m, 1H), 7.49 (t, J = 7.6 Hz, 2H), 7.43 (d, J = 8.1 Hz, 2H), 3.91 (s, 3H), 3.34 (dd, J = 8.0, 6.7 Hz, 2H), 2.88 (dd, J = 8.2, 6.6 Hz, 2H). **^{13}C NMR** (151 MHz, CDCl3) δ 197.8, 166.7, 136.5, 133.4, 131.5, 129.4, 129.1, 128.7, 128.5, 128.1, 92.3, 80.6, 52.2, 37.6, 14.4. **HRMS** m/z (ESI) calcd. for $C_{19}H_{17}O_3^+$ $[M+H]^+$ 293.1178, found 293.1178

4-(5-oxo-5-phenylpent-1-yn-1-yl)benzaldehyde (1ac)



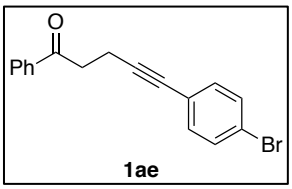
1ac was prepared following the General Procedure 3.3 Method C as white solid. Yield: 78%
^{1}H NMR (600 MHz, $CDCl_3$) δ 9.98 (d, *J* = 1.9 Hz, 1H), 8.05 – 7.98 (m, 2H), 7.79 (dd, *J* = 8.2, 1.8 Hz, 2H), 7.63 – 7.56 (m, 1H), 7.54 – 7.47 (m, 4H), 3.40 – 3.31 (m, 2H), 2.89 (dd, *J* = 8.2, 6.5 Hz, 2H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 197.6, 191.5, 136.4, 135.0, 133.4, 132.1, 130.0, 129.5, 128.7, 128.0, 93.6, 80.5, 37.5, 14.4. **HRMS** m/z (ESI) calcd. for $C_{18}H_{15}O_2^+$ $[M+H]^+$ 263.1072, found 263.1069

5-(4-acetylphenyl)-1-phenylpent-4-yn-1-one (1ad)



1ad was prepared following the General Procedure 3.3 Method C as white solid. Yield:80%.
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.08 – 7.93 (m, 2H), 7.86 (d, J = 8.3 Hz, 2H), 7.62 – 7.55 (m, 1H), 7.52 – 7.36 (m, 4H), 3.39 – 3.30 (m, 2H), 2.88 (dd, J = 8.2, 6.5 Hz, 2H), 2.58 (d, J = 1.6 Hz, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 197.7, 197.4, 136.4, 135.8, 133.3, 131.7, 128.7, 128.6, 128.1, 128.0, 92.7, 80.5, 37.5, 26.6, 14.3. **HRMS** m/z (ESI) calcd. for $C_{19}H_{17}O_2^+$ $[M+H]^+$ 277.1229, found 277.1225

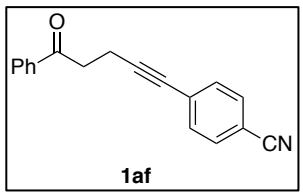
5-(4-bromophenyl)-1-phenylpent-4-yn-1-one (1ae)



1ae

1ae was prepared following the General Procedure 3.3 Method C as white solid. Yield: 90%
^{1}H-NMR (400 MHz; $CDCl_3$): δ 8.05-7.92 (m, 2H), 7.58 (t, *J* = 7.4 Hz, 1H), 7.48 (t, *J* = 7.6 Hz, 2H), 7.40 (d, *J* = 8.5 Hz, 2H), 7.23 (d, *J* = 8.5 Hz, 2H), 3.31 (dd, *J* = 8.4, 6.4 Hz, 2H), 2.84 (dd, *J* = 8.3, 6.4 Hz, 2H). **^{13}C-NMR** (101 MHz; $CDCl_3$): δ 197.8, 136.5, 133.3, 133.0, 131.4, 128.6, 128.0, 122.6, 121.8, 90.1, 80.0, 37.6, 14.3. **HRMS** m/z (ESI) calcd. for $C_{17}H_{14}BrO^+$ $[M+H]^+$ 313.0228, found 313.0217

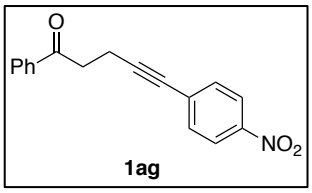
4-(5-oxo-5-phenylpent-1-yn-1-yl)benzonitrile (1af)



1af

1af was prepared following the General Procedure 3.3 Method C as white solid. Yield: 81%
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.03 – 7.98 (m, 2H), 7.62 – 7.57 (m, 1H), 7.57 – 7.53 (m, 2H), 7.49 (t, J = 7.7 Hz, 2H), 7.45 – 7.41 (m, 2H), 3.46 – 3.25 (m, 2H), 3.01 – 2.65 (m, 2H). **^{13}C NMR** (151 MHz, CDCl3) δ 197.5, 136.3, 133.4, 132.1, 131.9, 128.7, 128.6, 128.0, 118.5, 111.0, 94.0, 79.7, 37.3, 14.3. **HRMS** m/z (ESI) calcd. for $C_{18}H_{14}NO^+$ $[M+H]^+$ 260.1075, found 260.1072

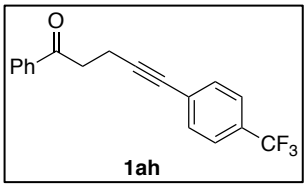
5-(4-nitrophenyl)-1-phenylpent-4-yn-1-one (1ag)



1ag

1ag was prepared following the General Procedure 3.3 Method C as orange solid. Yield: 77%
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.17 – 8.10 (m, 2H), 8.00 (d, J = 7.8 Hz, 2H), 7.64 – 7.56 (m, 1H), 7.49 (dd, J = 8.8, 7.3 Hz, 4H), 3.35 (t, J = 7.3 Hz, 2H), 2.90 (t, J = 7.2 Hz, 2H). **^{13}C NMR** (151 MHz, CDCl3) δ 197.4, 146.6, 136.3, 133.4, 132.3, 130.6, 128.7, 128.0, 123.4, 95.0, 79.6, 37.3, 14.3. **HRMS** m/z (ESI) calcd. for $C_{17}H_{14}NO_3^+$ $(M+H)^+$ 280.0974, found 280.0969

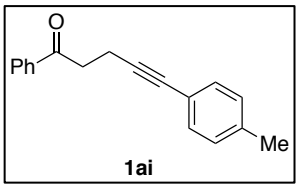
1-phenyl-5-(4-(trifluoromethyl)phenyl)pent-4-yn-1-one (1ah)



1ah

1ah was prepared following the General Procedure 3.3 Method C as white solid. Yield: 81%
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.01 (dd, J = 8.1, 1.4 Hz, 2H), 7.62 – 7.57 (m, 1H), 7.53 (d, J = 8.2 Hz, 2H), 7.48 (q, J = 7.9 Hz, 4H), 3.34 (dd, *J* = 8.3, 6.4 Hz, 2H), 2.88 (dd, *J* = 8.2, 6.5 Hz, 2H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 197.7, 136.5, 133.4, 131.8, 129.5 (q, *J* = 32.7 Hz), 128.7, 128.1, 127.5, 125.1 (d, J = 4.4 Hz),124.0 (d, J = 273.3 Hz), 91.7, 80.0, 37.6, 14.3. **^{19}F NMR** (565 MHz, $CDCl_3$) δ -62.7. **HRMS** m/z (ESI) calcd. for $C_{18}H_{14}F_3O^+$ $[M+H]^+$ 303.0997, found 303.0992

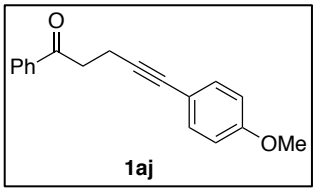
1-phenyl-5-(p-tolyl)pent-4-yn-1-one (1ai)



1ai

1ai was prepared following the General Procedure 3.3 Method C as white solid. Yield: 80%
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.00 (dd, *J* = 8.4, 1.4 Hz, 2H), 7.62 – 7.55 (m, 1H), 7.48 (t, *J* = 7.8 Hz, 2H), 7.29 (d, *J* = 8.2 Hz, 2H), 7.09 (d, *J* = 7.8 Hz, 2H), 3.44 – 3.18 (m, 2H), 2.97 – 2.70 (m, 2H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 198.0, 137.6, 136.5, 133.2, 131.4, 128.9, 128.6, 128.0, 120.5, 88.0, 81.0, 37.8, 21.3, 14.3. **HRMS** m/z (ESI) calcd. for $C_{18}H_{17}O^+$ $[M+H]^+$ 249.1279 found 249.1278

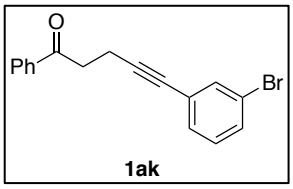
5-(4-methoxyphenyl)-1-phenylpent-4-yn-1-one (1aj)



1aj

1aj was prepared following the General Procedure 3.3 Method C as white solid. Yield: 82%
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.04 – 7.94 (m, 2H), 7.62 – 7.54 (m, 1H), 7.47 (t, *J* = 7.7 Hz, 2H), 7.36 – 7.30 (m, 2H), 6.84 – 6.76 (m, 2H), 3.78 (s, 3H), 3.36 – 3.27 (m, 2H), 2.84 (dd, *J* = 8.4, 6.4 Hz, 2H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 198.0, 159.1, 133.2, 132.9, 128.6, 128.0, 115.7, 113.7, 87.2, 80.7, 55.2, 37.9, 14.3. **HRMS** m/z (ESI) calcd. for $C_{18}H_{17}O_2^+$ $[M+H]^+$ 249.1229 found 249.1227

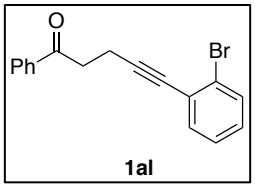
5-(3-bromophenyl)-1-phenylpent-4-yn-1-one (1ak)



1ak

1ak was prepared following the General Procedure 3.3 Method C as white solid. Yield: 86%
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.01 – 7.94 (m, 2H), 7.60 – 7.55 (m, 1H), 7.52 (t, *J* = 1.8 Hz, 1H), 7.47 (t, *J* = 7.8 Hz, 2H), 7.38 (ddd, *J* = 8.0, 2.0, 1.1 Hz, 1H), 7.29 (dt, *J* = 7.7, 1.3 Hz, 1H), 7.12 (t, *J* = 7.9 Hz, 1H), 3.35 – 3.25 (m, 2H), 2.89 – 2.78 (m, 2H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 197.7, 136.4, 134.3, 133.3, 130.8, 130.0, 129.6, 128.6, 128.0, 125.5, 121.9, 90.4, 79.6, 37.5, 14.2. **HRMS** m/z (ESI) calcd. for $C_{17}H_{14}BrO^+$ $[M+H]^+$ 313.0228, found 313.0228

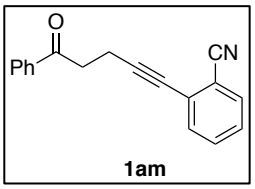
5-(2-bromophenyl)-1-phenylpent-4-yn-1-one (1al)



1al

1al was prepared following the General Procedure 3.3 Method C as white solid. Yield: 80%
^{1}H NMR (600 MHz, $CDCl_3$) δ 7.99 (dd, *J* = 8.3, 1.4 Hz, 2H), 7.59 – 7.54 (m, 1H), 7.53 (dd, *J* = 8.1, 1.2 Hz, 1H), 7.46 (t, *J* = 7.8 Hz, 2H), 7.41 (dd, *J* = 7.7, 1.7 Hz, 1H), 7.20 (td, J = 7.6, 1.2 Hz, 1H), 7.10 (td, J = 7.8, 1.7 Hz, 1H), 3.38 – 3.27 (m, 2H), 2.94 – 2.85 (m, 2H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 197.6, 136.3, 133.2, 133.1, 132.1, 128.8, 128.5, 127.9, 126.8, 125.5, 125.3, 93.9, 79.7, 37.5, 14.3. **HRMS** m/z (ESI) calcd. for $C_{17}H_{14}BrO^+$ $[M+H]^+$ 313.0228, found 313.0225

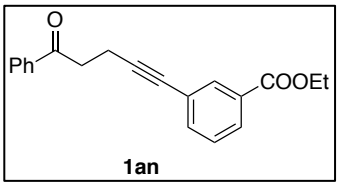
2-(5-oxo-5-phenylpent-1-yn-1-yl)benzonitrile (1am)



1am

1am was prepared following the General Procedure 3.3 Method C as white solid. Yield: 83%
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.04 – 7.98 (m, 2H), 7.63 – 7.56 (m, 2H), 7.53 – 7.45 (m, 4H), 7.36 (td, *J* = 7.4, 2.0 Hz, 1H), 3.44 – 3.36 (m, 2H), 3.00 – 2.89 (m, 2H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 197.6, 136.4, 133.4, 132.5, 132.3, 132.3, 128.7, 128.1, 127.9, 127.6, 117.8, 115.4, 96.4, 77.7, 37.5, 14.4. **HRMS** m/z (ESI) calcd. for $C_{18}H_{14}NO^+$ $[M+H]^+$ 260.1075, found 260.1072

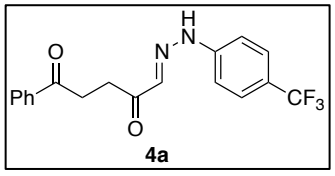
methyl 3-(5-oxo-5-phenylpent-1-yn-1-yl)benzoate(1an)



1an

1an was prepared following the General Procedure 3.3 Method C as white solid. Yield: 82%
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.06 (t, J = 1.7 Hz, 1H), 8.02 – 7.98 (m, 2H), 7.94 (dt, J = 7.9, 1.5 Hz, 1H), 7.63 – 7.51 (m, 2H), 7.48 (t, *J* = 7.8 Hz, 2H), 7.35 (t, *J* = 7.8 Hz, 1H), 4.36 (q, *J* = 7.1 Hz, 2H), 3.42 – 3.29 (m, 2H), 2.92 – 2.80 (m, 2H), 1.38 (t, *J* = 7.2 Hz, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 197.9, 166.0, 136.5, 135.7, 133.4, 132.7, 130.6, 128.8, 128.7, 128.3, 128.1, 124.0, 89.9, 80.2, 61.2, 37.7, 14.3, 14.3. **HRMS** m/z (ESI) calcd. for $C_{20}H_{19}O_3^+$ $[M+H]^+$ 307.1334, found 307.1335

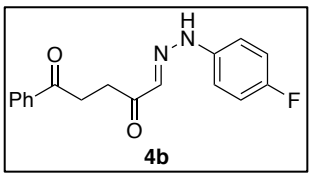
(E)-1-phenyl-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4a)



4a

4a was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 88% (80% for gram scale synthesis following General Procedure 3.6)
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.67 (s, 1H), 8.06 – 8.00 (m, 2H), 7.61 – 7.57 (m, 1H), 7.54 (d, *J* = 8.4 Hz, 2H), 7.48 (t, *J* = 7.6 Hz, 2H), 7.28 – 7.19 (m, 3H), 3.43 (dd, *J* = 7.1, 5.5 Hz, 2H), 3.35 (dd, *J* = 6.8, 5.2 Hz, 2H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 198.9, 197.7, 145.1, 136.7, 136.1, 133.3, 128.6, 128.1, 126.8 (q, *J* = 4.3 Hz), 124.3 (q, *J* = 271.8 Hz), 124.3 (q, *J* = 32.6 Hz), 113.6, 32.5, 30.9. **^{19}F NMR** (565 MHz, $CDCl_3$) δ -61.7. **HRMS** m/z (ESI) calcd. for $C_{18}H_{15}N_2O_2F_3^+$ $[M+H]^+$ 349.1164, found 349.1160

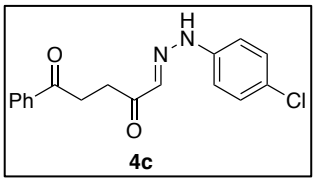
(E)-5-(2-(4-fluorophenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (4b)



4b

4b was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 89%
^{1}H NMR (600 MHz, CD_3CN) δ 9.51 (s, 1H), 8.03 (d, *J* = 7.0 Hz, 2H), 7.64 (t, *J* = 7.4 Hz, 1H), 7.53 (t, *J* = 7.8 Hz, 2H), 7.25 – 7.20 (m, 3H), 7.10 (t, *J* = 8.9 Hz, 2H), 3.39 – 3.32 (m, 2H), 3.28 – 3.23 (m, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 199.9, 198.5, 159.1 (d, *J* = 237.8 Hz), 140.7, 137.9, 135.3, 134.0, 129.6, 128.8, 116.8 (d, *J* = 23.2 Hz), 115.7 (d, *J* = 7.9 Hz), 33.3, 31.5. **^{19}F NMR** (565 MHz, CD_3CN) δ -123.9. **HRMS** m/z (ESI) calcd. for $C_{17}H_{16}N_2O_2F^+$ $[M+H]^+$ 299.1196, found 299.1191

(E)-5-(2-(4-chlorophenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (4c)

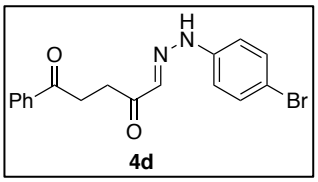


4c

4c was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 77%

^{1}H NMR (600 MHz, CD_3CN) δ 9.57 (s, 1H), 8.03 (d, *J* = 6.8 Hz, 1H), 7.64 (t, *J* = 7.4 Hz, 1H), 7.53 (t, *J* = 7.7 Hz, 2H), 7.33 (d, *J* = 8.8 Hz, 2H), 7.26 – 7.16 (m, 3H), 3.36 (t, *J* = 6.2 Hz, 2H), 3.26 (t, *J* = 6.2 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 199.9, 198.5, 143.1, 137.9, 135.9, 134.0, 130.2, 129.6, 128.8, 127.0, 115.9, 33.3, 31.5. HRMS m/z (ESI) calcd. for $C_{17}H_{16}N_2O_2Cl^+$ $[M+H]^+$ 315.0900, found 315.0899

(E)-5-(2-(4-bromophenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (4d)

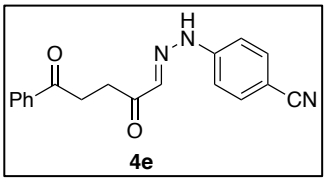


4d

4d was prepared following the General Procedure 3.4 as dark yellow solid. Yield: 72%

^{1}H NMR (600 MHz, CD_3CN) δ 9.56 (s, 1H), 8.07 – 7.97 (m, 2H), 7.87 (d, *J* = 7.2 Hz, 1H), 7.64 (t, *J* = 7.4 Hz, 1H), 7.53 (t, *J* = 7.6 Hz, 2H), 7.47 (d, *J* = 8.7 Hz, 2H), 7.27 – 7.19 (m, 1H), 7.19 – 7.08 (m, 2H), 3.36 (dd, *J* = 7.2, 5.4 Hz, 2H), 3.26 (dd, *J* = 7.1, 5.4 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 199.8, 198.5, 143.5, 137.8, 136.0, 133.9, 133.0, 129.5, 128.7, 116.2, 114.3, 33.2, 31.4. HRMS m/z (ESI) calcd. for $C_{17}H_{16}N_2O_2Cl^+$ $[M+H]^+$ 359.0395, found 359.0390

(E)-4-(2-(2,5-dioxo-5-phenylpentylidene)hydrazineyl)benzonitrile (4e)

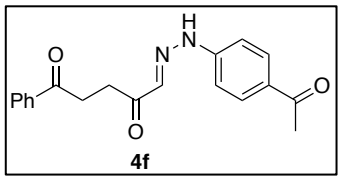


4e

4e was prepared following the General Procedure 3.4 as yellow solid. Yield: 87%.

^{1}H NMR (400 MHz, CD_3CN) δ 9.79 (s, 1H), 8.04 (dt, *J* = 7.1, 1.4 Hz, 2H), 7.67 (dd, *J* = 8.1, 6.3 Hz, 2H), 7.54 (t, *J* = 7.7 Hz, 2H), 7.32 (d, *J* = 8.6 Hz, 3H), 3.38 (dd, *J* = 7.0, 4.9 Hz, 2H), 3.32 – 3.26 (m, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.7, 198.6, 147.8, 137.9, 134.7, 134.0, 129.5, 128.8, 120.1, 114.6, 104.6, 33.2, 31.5. HRMS m/z (ESI) calcd. for $C_{18}H_{16}N_3O_2Cl^+$ $[M+H]^+$ 306.1243, found 306.1241

(E)-5-(2-(4-acetylphenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (4f)



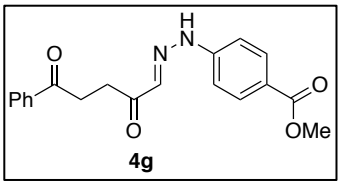
4f

4f was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 86%

^{1}H NMR (400 MHz, CD_3CN) δ 9.77 (s, 1H), 8.03 (dt, *J* = 7.0, 1.4 Hz, 2H), 8.00 – 7.92 (m, 2H), 7.64 (d, *J* = 7.4 Hz, 1H), 7.54 (t, *J* = 7.6 Hz, 2H), 7.38 – 7.20 (m, 3H), 3.38 (dd, *J* = 6.9, 4.8 Hz, 2H), 3.29 (dd, *J* = 6.9, 4.9 Hz, 2H), 2.53 (s, 3H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.8, 198.7, 197.3, 148.1, 137.4, 134.8, 134.0, 131.2, 129.6, 128.4, 114.7, 113.8, 33.2, 31.5, 26.6. HRMS m/z (ESI) calcd. for $C_{19}H_{19}N_3O_3^+$ $[M+H]^+$ 323.1396, found 323.1392

methyl (E)-4-(2-(2,5-dioxo-5-phenylpentylidene)hydrazineyl)benzoate (4g)

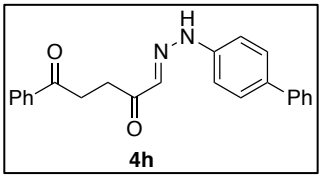
4g was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 85%



4g

^{1}H NMR (400 MHz, CD_3CN) δ 9.74 (s, 1H), 8.08 – 8.00 (m, 2H), 8.00 – 7.92 (m, 2H), 7.64 (dd, *J* = 8.3, 6.3 Hz, 1H), 7.54 (t, *J* = 7.6 Hz, 2H), 7.32 – 7.21 (m, 3H), 3.86 (s, 3H), 3.38 (dd, *J* = 7.3, 5.2 Hz, 2H), 3.28 (dd, *J* = 7.2, 5.2 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.8, 198.6, 167.3, 148.1, 137.3, 134.1, 132.0, 129.6, 128.8, 124.1, 113.9, 52.3, 33.2, 31.5. HRMS m/z (ESI) calcd. for $C_{19}H_{19}N_2O_4^+$ $[M+H]^+$ 339.1345, found 339.1346.

(E)-5-(2-([1,1'-biphenyl]-4-yl)hydrazineylidene)-1-phenylpentane-1,4-dione (4h)

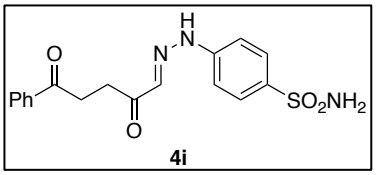


4h

4h was prepared following the General Procedure 3.4 as white yellow solid. Yield: 60%.

^{1}H NMR (400 MHz, CD_3CN) δ 9.63 (s, 1H), 8.03 (d, *J* = 7.7 Hz, 2H), 7.70 – 7.58 (m, 5H), 7.53 (t, *J* = 7.6 Hz, 2H), 7.45 (t, *J* = 7.5 Hz, 2H), 7.38 – 7.22 (m, 4H), 3.41 – 3.33 (m, 2H), 3.28 (t, *J* = 6.3 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.9, 198.5, 143.7, 141.3, 137.9, 135.5, 135.3, 134.0, 129.8, 129.6, 128.8, 127.8, 127.2, 114.9, 33.3, 31.5. HRMS m/z (ESI) calcd. for $C_{23}H_{21}N_2O_2^+$ $[M+H]^+$ 357.1603, found 357.1600.

(E)-4-(2-(2,5-dioxo-5-phenylpentylidene)hydrazineyl)benzenesulfonamide (4i)

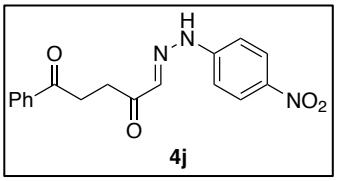


4i

4i was prepared following the General Procedure 3.4 as orange solid. Yield: 87%

^{1}H NMR (600 MHz, CD_3CN) δ 9.81 (s, 1H), 8.08 – 8.00 (m, 2H), 7.85 – 7.77 (m, 2H), 7.69 – 7.61 (m, 1H), 7.55 (t, *J* = 7.8 Hz, 2H), 7.38 – 7.27 (m, 3H), 5.61 (s, 2H), 3.39 (dd, *J* = 7.3, 5.5 Hz, 2H), 3.30 (dd, *J* = 7.2, 5.3 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 199.8, 198.7, 147.4, 137.8, 137.5, 136.7, 134.1, 129.6, 128.8, 128.8, 114.2, 33.2, 31.6. HRMS m/z (ESI) calcd. for $C_{17}H_{17}N_3O_4S^+$ $[M+H]^+$ 360.1018, found 360.1015.

(E)-5-(2-(4-nitrophenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (4j)



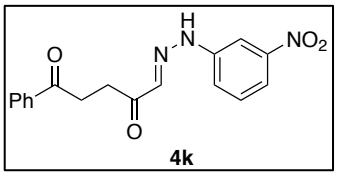
4j

4j was prepared following the General Procedure 3.4 as dark yellow solid. Yield: 93%

^{1}H NMR (600 MHz, CD_3CN) δ 9.91 (s, 1H), 8.22 (d, *J* = 9.0 Hz, 2H), 8.08 – 8.00 (m, 2H), 7.68 – 7.62 (m, 1H), 7.54 (t, *J* = 7.7 Hz, 2H), 7.37 – 7.28 (m, 3H), 3.39 (dd, *J* = 7.2, 5.2 Hz, 2H), 3.30 (dd, *J* = 7.1, 5.3 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 199.7, 198.7, 490.7, 142.7, 138.9, 137.8, 134.0, 129.6, 128.8, 126.8, 114.0, 33.2, 31.6. HRMS m/z (ESI) calcd. for $[M+H]^+$ $C_{17}H_{16}N_3O_4^+$ 326.1141, found 326.1136.

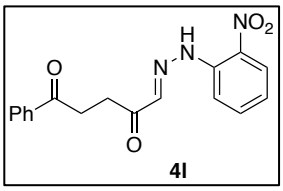
(E)-5-(2-(3-nitrophenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (4k)

4k was prepared following the General Procedure 3.4 as orange solid. Yield: 87%



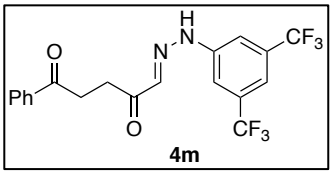
^{1}H NMR (400 MHz, CD_3CN) δ 9.74 (s, 1H), 8.07 – 7.96 (m, 3H), 7.83 – 7.77 (m, 1H), 7.68 – 7.60 (m, 1H), 7.58 – 7.48 (m, 4H), 7.30 (s, 1H), 3.38 (dd, *J* = 7.5, 5.4 Hz, 2H), 3.29 (dd, *J* = 7.0, 5.0 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.8, 199.6, 150.3, 145.6, 137.9, 137.2, 134.0, 131.5, 129.6, 128.9, 120.4, 117.0, 108.7, 33.4, 31.6. HRMS m/z (ESI) calcd. for $C_{17}H_{16}N_3O_4^+$ $[M+H]^+$ 326.1141, found 326.1137.

(E)-5-(2-(2-nitrophenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (4l)



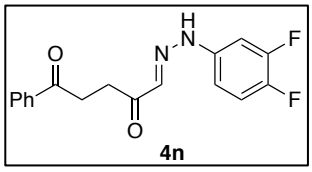
4l was prepared following the General Procedure 3.4 as dark yellow solid. Yield: 85% **^{1}H NMR** (600 MHz, CD_3CN) δ 11.13 (s, 1H), 8.23 (dd, *J* = 8.5, 1.5 Hz, 1H), 8.05 (dt, *J* = 8.4, 1.8 Hz, 3H), 7.73 (ddd, *J* = 8.6, 7.0, 1.5 Hz, 1H), 7.68 – 7.63 (m, 1H), 7.62 (s, 1H), 7.55 (t, *J* = 7.8 Hz, 2H), 7.12 (ddd, *J* = 8.4, 7.0, 1.3 Hz, 1H), 3.41 (dd, *J* = 7.4, 5.3 Hz, 2H), 3.34 (dd, *J* = 6.8, 4.8 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 199.7, 198.9, 141.3, 140.9, 137.8, 137.4, 129.6, 128.8, 126.8, 121.7, 117.4, 33.2, 31.8. **HRMS** m/z (ESI) calcd. for $C_{17}H_{16}N_3O_4^+$ $[M+H]^+$ 326.1141, found 326.1138.

(E)-5-(2-(2,4-bis(trifluoromethyl)phenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (4m)



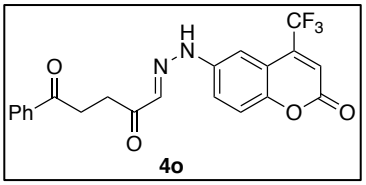
4m was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 77%.
^{1}H NMR (400 MHz, CD_3CN) δ 9.85 (s, 1H), 8.03 (d, *J* = 7.7 Hz, 2H), 7.72 – 7.62 (m, 3H), 7.54 (d, *J* = 8.5 Hz, 3H), 7.33 (s, 1H), 3.38 (dd, *J* = 7.2, 5.1 Hz, 2H), 3.30 (t, *J* = 6.2 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.7, 198.6, 145.9, 138.2, 134.0, 133.0 (q, *J* = 33.3 Hz), 129.6, 128.7, 124.4 (q, *J* = 271.9 Hz), 115.2 (q, *J* = 3.5 Hz), 114.3, 33.1, 31.6 **^{19}F NMR** (565 MHz, CD_3CN) δ -63.7 **HRMS** m/z (ESI) calcd. for $C_{19}H_{14}N_2O_2F_6^+$ $[M+H]^+$ 417.1038, found 417.1043.

(E)-5-(2-(3,4-difluorophenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (4n)



4n was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 90%
^{1}H NMR (400 MHz, CD_3CN) δ 9.54 (s, 1H), 8.10 – 7.92 (m, 2H), 7.72 – 7.59 (m, 1H), 7.53 (dd, *J* = 8.4, 7.0 Hz, 2H), 7.37 – 7.14 (m, 3H), 6.94 – 6.80 (m, 1H), 3.42 – 3.32 (m, 2H), 3.32 – 3.22 (m, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.9, 198.6, 151.7 (dd, *J* = 242.4 Hz, 13.7 Hz), 146.4 (dd, *J* = 242.4, 13.0 Hz), 141.5 (d, *J* = 8.9 Hz), 138.3, 136.7, 134.4, 130.0, 129.2, 118.8 (d, *J* = 18.6 Hz), 110.3 (dd, *J* = 6.1, 3.3 Hz), 103.50 (d, *J* = 22.2 Hz), 33.7, 32.0. **^{19}F NMR** (565 MHz, CD_3CN) δ -138.3, -149.3. **HRMS** m/z (ESI) calcd. for $C_{17}H_{14}N_2O_2F_2^+$ $[M+H]^+$ 317.1102, found 317.1105.

(E)-5-(2-(2-oxo-4-(trifluoromethyl)-2H-chromen-6-yl)hydrazineylidene)-1-phenylpentane-1,4-dione (4o)

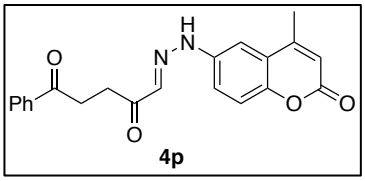


4o

4o was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 72%

^{1}H NMR (600 MHz, CD_3CN) δ 9.93 (s, 1H), 8.06 – 8.03 (m, 2H), 7.70 (dd, *J* = 8.9, 2.2 Hz, 1H), 7.65 (d, *J* = 7.4 Hz, 1H), 7.55 (t, *J* = 7.8 Hz, 2H), 7.34 (s, 1H), 7.26 (d, *J* = 2.1 Hz, 1H), 7.22 – 7.16 (m, 1H), 6.68 (s, 1H), 3.39 (dd, *J* = 7.0, 4.8 Hz, 2H), 3.32 (td, *J* = 6.1, 1.5 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.8, 198.7, 160.2, 157.2, 148.5, 141.4 (q, *J* = 33.3 Hz), 138.6, 137.8, 134.0, 129.6, 128.8, 127.3, 125.7 (q, *J* = 274.8 Hz), 113.5 (q, *J* = 5.9 Hz), 112.0, 108.4, 101.6, 33.6, 32.1. **^{19}F NMR** (565 MHz, CD_3CN) δ -65.3. **HRMS** m/z (ESI) calcd. for $C_{21}H_{15}N_2O_4F_3^+$ $[M+H]^+$ 417.1062, found 417.1056.

(E)-5-(2-(4-methyl-2-oxo-2H-chromen-6-yl)hydrazineylidene)-1-phenylpentane-1,4-dione (4p)

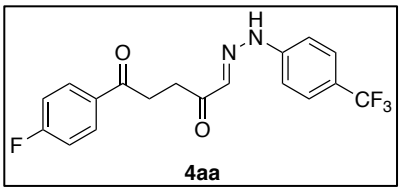


4p

4p was prepared following the General Procedure 3.4 as pale yellow solid. Yield:28%

^{1}H NMR (400 MHz, DMSO-d_6) δ 11.72 (s, 1H), 8.06 – 7.93 (m, 2H), 7.76 – 7.60 (m, 2H), 7.54 (t, *J* = 7.6 Hz, 2H), 7.35 (s, 1H), 7.16 – 7.04 (m, 2H), 6.22 – 6.12 (m, 1H), 3.36 – 3.29 (m, 2H), 3.23 (dd, *J* = 7.2, 4.9 Hz, 2H), 2.39 (s, 3H). **^{13}C NMR** (101 MHz, DMSO) δ 198.8, 197.5, 160.2, 154.8, 153.5, 146.7, 136.6, 136.5, 133.3, 128.8, 127.9, 126.9, 113.7, 111.0, 110.3, 99.7, 32.3, 30.4, 18.2. **HRMS** m/z (ESI) calcd. for $C_{21}H_{18}N_2O_4^+$ $[M+H]^+$ 363.1345, found 363.1338.

(E)-1-(4-fluorophenyl)-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4aa)

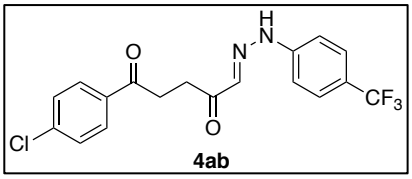


4aa

4aa was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 91%

^{1}H NMR (600 MHz, $CDCl_3$) δ 8.47 (s, 1H), 8.05 (dd, *J* = 8.7, 5.5 Hz, 2H), 7.57 (d, *J* = 8.4 Hz, 2H), 7.25 (d, *J* = 8.6 Hz, 3H), 7.15 (t, *J* = 8.6 Hz, 2H), 3.41 – 3.30 (m, *J* = 3.8 Hz, 4H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 197.8, 197.7, 165.9 (d, *J* = 255.2 Hz), 145.1, 135.7, 132.9 (d, *J* = 3.0 Hz), 130.8 (d, *J* = 9.3 Hz), 126.7 (d, *J* = 4.0 Hz), 124.3 (q, *J* = 271.8 Hz), 124.1(q, *J* = 32.9 Hz), 115.8 (d, *J* = 21.9 Hz), 113.5, 32.4, 30.7. **^{19}F NMR** (565 MHz, $CDCl_3$) δ -61.7, -105.0. **HRMS** m/z (ESI) calcd. for $C_{18}H_{14}N_2O_2F_4^+$ $[M+H]^+$ 367.1070, found 367.1070.

(E)-1-(4-chlorophenyl)-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4ab)



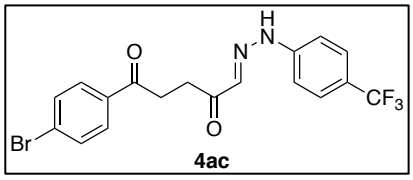
4ab

4ab was prepared following the General Procedure 3.4 as pale yellow solid. Yield:90%.

^{1}H NMR (600 MHz, $CDCl_3$) δ 9.04 (s, 1H), 7.99 – 7.90 (m, 2H), 7.49 (d, *J* = 8.3 Hz, 2H), 7.44 (d, *J* = 8.5 Hz, 2H), 7.21 (s, 1H), 7.17 (d, *J* = 8.3 Hz, 2H), 3.40 – 3.35 (m, 2H), 3.35 – 3.29 (m, 2H). **^{13}C NMR** (101 MHz, **$CDCl_3$**) δ 198.0, 197.7, 145.1, 139.8, 135.7, 134.8, 129.5, 129.0, 126.7

(q, J = 3.9 Hz), 124.2 (q, J = 272.7 Hz), 124.1 (q, J = 33.3 Hz), 113.5, 32.4, 30.7. **^{19}F NMR** (565 MHz, $CDCl_3$) δ -61.7. **HRMS** m/z (ESI) calcd. for $C_{18}H_{14}N_2O_2F_3Cl^+$ $[M+H]^+$ 383.0774, found 383.0769.

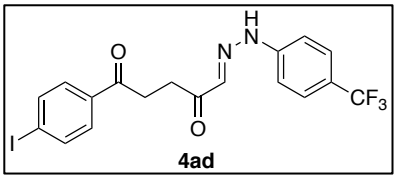
(E)-1-(4-bromophenyl)-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4ac)



4ac

4ac was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 89%.
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.71 (s, 1H), 7.88 (d, J = 8.2 Hz, 2H), 7.62 (d, J = 8.3 Hz, 2H), 7.54 (d, J = 8.4 Hz, 2H), 7.25 – 7.19 (m, 3H), 3.36 (h, J = 5.3 Hz, 4H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 198.1, 197.7, 145.1, 135.8, 135.2, 131.9, 129.6, 128.5, 126.7, 124.2 (q, J = 293.9 Hz), 124.2 (q, J = 32.3 Hz), 113.5, 32.4, 30.7. **^{19}F NMR** (565 MHz, $CDCl_3$) δ -61.7. **HRMS** m/z (ESI) calcd. for $C_{18}H_{14}N_2O_2F_3Br^+$ $[M+H]^+$ 427.0269, found 427.0264.

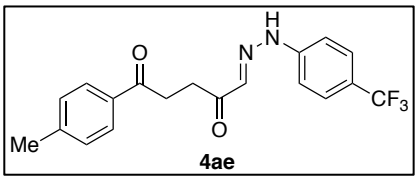
(E)-1-(4-iodophenyl)-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4ad)



4ad

4ad was prepared following the General Procedure 3.4 as pale yellow solid. Yield:87%.
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.40 (s, 1H), 7.87 – 7.83 (m, 2H), 7.75 – 7.71 (m, 2H), 7.58 (d, J = 8.4 Hz, 2H), 7.26 – 7.20 (m, 3H), 3.36 (s, 4H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 198.3, 197.6, 145.0, 137.9, 135.8, 135.8, 129.5, 126.8 (q, J = 3.9 Hz), 124.2 (q, J = 33.2 Hz), 124.0 (q, J = 271.8 Hz), 113.6, 101.3, 32.3, 30.8. **^{19}F NMR** (565 MHz, $CDCl_3$) δ -61.7. **HRMS** m/z (ESI) calcd. for $C_{18}H_{14}N_2O_2F_3I^+$ $[M+H]^+$ 475.0130, found 475.0125.

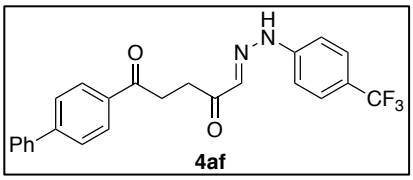
(E)-1-(p-tolyl)-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4ae)



4ae

4ae was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 84%
^{1}H NMR (600 MHz, CD_3CN) δ 9.76 (s, 1H), 7.92 (d, J = 7.9 Hz, 2H), 7.63 (d, J = 8.4 Hz, 2H), 7.34 (dd, J = 8.5, 2.8 Hz, 4H), 7.29 (s, 1H), 3.34 (dd, J = 7.2, 5.2 Hz, 2H), 3.26 (dd, J = 7.1, 5.3 Hz, 2H), 2.42 (s, 3H). **^{13}C NMR** (151 MHz, CD_3CN) δ 199.3, 198.7, 147.3, 144.9, 137.3, 135.3, 130.2, 128.9, 127.6 (q, J = 4.1 Hz), 125.7 (q, J = 270.3 Hz), 123.3 (q, J = 31.7 Hz), 114.3, 33.1, 31.5, 21.6. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0. **HRMS** m/z (ESI) calcd. for $C_{19}H_{18}N_2O_2F_3^+$ $[M+H]^+$ 363.1320, found 363.1317.

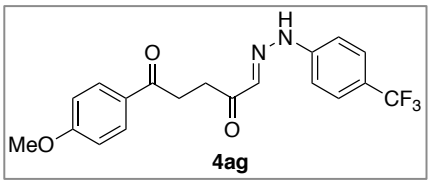
(E)-1-([1,1'-biphenyl]-4-yl)-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4af)



4af

4af was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 91%
^{1}H NMR (600 MHz, CD_3CN) δ 9.73 (s, 1H), 8.13 – 8.07 (m, 2H), 7.83 – 7.76 (m, 2H), 7.75 – 7.69 (m, 2H), 7.63 (d, *J* = 8.4 Hz, 2H), 7.51 (t, *J* = 7.7 Hz, 2H), 7.47 – 7.41 (m, 1H), 7.34 (d, *J* = 8.4 Hz, 2H), 7.30 (d, *J* = 1.2 Hz, 1H), 3.40 (dd, *J* = 7.2, 5.3 Hz, 2H), 3.30 (dd, *J* = 7.1, 5.3 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.4, 198.7, 147.3, 146.2, 140.5, 137.3, 136.7, 133.6, 130.0, 129.5, 129.2, 128.1 (q, *J* = 5.2 Hz), 127.6 (q, *J* = 3.9 Hz), 125.7 (q, *J* = 270.8 Hz), 123.4 (q, *J* = 32.4 Hz), 114.4, 33.3, 31.6. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0. **HRMS** m/z (ESI) calcd. for $C_{24}H_{20}N_2O_2F_3^+$ $[M+H]^+$ 425.1477, found 425.1472.

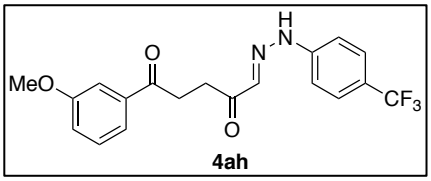
(E)-1-(4-methoxyphenyl)-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4ag)



4ag

4ag was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 85%
^{1}H NMR (600 MHz, CD_3CN) δ 9.64 (s, 1H), 7.98 – 7.82 (m, 2H), 7.53 (d, *J* = 8.4 Hz, 2H), 7.27 – 7.11 (m, 3H), 6.96 – 6.87 (m, 2H), 3.29 – 3.21 (m, 2H), 3.16 (dd, *J* = 7.0, 5.0 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.4, 198.2, 164.5, 147.4, 137.3, 131.1, 127.6, 124.4 (q, *J* = 272 Hz), 123.42 (q, *J* = 32.5 Hz), 114.7, 114.3, 56.2, 32.9, 31.6. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0. **HRMS** m/z (ESI) calcd. for $C_{19}H_{18}N_2O_3F_3^+$ $[M+H]^+$ 379.1270, found 379.1268.

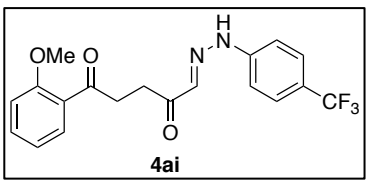
(E)-1-(3-methoxyphenyl)-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4ah)



4ah

4ah was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 80%
^{1}H NMR (600 MHz, $CDCl_3$) δ 9.05 (s, 1H), 7.62 (d, *J* = 7.6 Hz, 1H), 7.51 (dd, *J* = 11.9, 5.4 Hz, 3H), 7.39 (t, *J* = 7.9 Hz, 1H), 7.25 (d, *J* = 14.4 Hz, 1H), 7.19 (d, *J* = 8.3 Hz, 2H), 7.13 (dd, *J* = 8.3, 2.6 Hz, 1H), 3.85 (s, 3H), 3.41 (d, *J* = 6.3 Hz, 2H), 3.34 (d, *J* = 6.1 Hz, 1H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 199.0, 197.9, 159.8, 145.1, 137.9, 135.9, 129.6, 126.7 (q, *J* = 3Hz), 124.3 (q, *J* = 271.8 Hz), 124.1 (q, *J* = 31.7 Hz), 120.8, 119.7, 113.5, 112.3, 55.4, 32.7, 30.8. **^{19}F NMR** (565 MHz, $CDCl_3$) δ -61.7. **HRMS** m/z (ESI) calcd. for $C_{19}H_{18}N_2O_3F_3^+$ $[M+H]^+$ 379.1270, found 379.1271.

(E)-1-(2-methoxyphenyl)-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4ai)

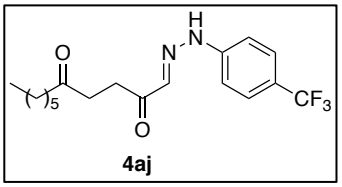


4ai

4ai was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 79%
^{1}H NMR (600 MHz, CD_3CN) δ 9.62 (s, 1H), 7.56 – 7.49 (m, 3H), 7.43 (ddd, *J* = 8.8, 7.3, 1.9 Hz, 1H), 7.22 (d, *J* = 8.4 Hz, 2H), 7.17

(d, J = 1.3 Hz, 1H), 7.03 (d, J = 8.3 Hz, 1H), 6.93 (td, J = 7.5, 1.0 Hz, 1H), 3.82 (s, 3H), 3.22 (dd, J = 7.2, 5.5 Hz, 2H), 3.12 (dd, J = 7.0, 5.6 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 201.6, 198.9, 159.7, 147.3, 137.3, 134.5, 130.7, 128.8, 127.6 (d, J = 4.5 Hz), 125.7 (d, J = 270.1 Hz), 123.4 (d, J = 32.3 Hz), 121.8, 114.3, 113.1, 56.4, 38.6, 31.9. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0. **HRMS** m/z (ESI) calcd. for $C_{19}H_{18}N_2O_3F_3^+$ $[M+H]^+$ 379.1270, found 379.1267.

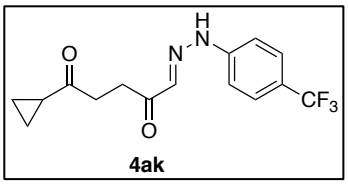
(E)-1-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)undecane-2,5-dione (4aj)



4aj

4aj was prepared following the General Procedure 3.4 as pale yellow oil. Yield: 79%
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.92 (s, 1H), 7.51 (d, J = 8.0 Hz, 2H), 7.23 – 7.06 (m, 2H), 3.15 (dd, J = 7.4, 4.9 Hz, 2H), 2.82 (t, J = 6.3 Hz, 2H), 2.50 (t, J = 7.5 Hz, 2H), 1.65 – 1.51 (m, 2H), 1.28 (s, 7H), 0.87 (t, J = 6.6 Hz, 3H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 209.6, 196.7, 144.1, 134.9, 125.7 (d, J = 4 Hz), 123.3 (q, J = 271.7 Hz), 123.1 (q, J = 32.3 Hz), 112.5, 41.9, 35.1, 30.6, 29.6, 27.9, 22.8, 21.5, 13.0. **^{19}F NMR** (565 MHz, $CDCl_3$) δ -61.7. **HRMS** m/z (ESI) calcd. for $C_{18}H_{24}N_2O_2F_3^+$ 357.1790, found 357.1787.

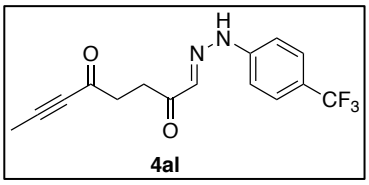
(E)-1-cyclopropyl-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4ak)



4ak

4ak was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 86%.
^{1}H NMR (600 MHz, CD_3CN) δ 9.60 (s, 1H), 7.52 (d, J = 8.3 Hz, 2H), 7.21 (d, J = 8.4 Hz, 2H), 7.14 (d, J = 1.2 Hz, 1H), 3.00 (dd, J = 7.2, 5.6 Hz, 2H), 2.82 (dd, J = 7.2, 5.6 Hz, 2H), 1.96 (tt, J = 7.2, 5.3 Hz, 1H), 0.84 – 0.75 (m, 4H). **^{13}C NMR** (151 MHz, CD_3CN) δ 210.1, 198.6, 147.3, 137.2, 127.6 (d, J = 4.5 Hz), 125.7 (q, J = 270.3Hz), 123.4 (q, J = 31.7 Hz), 114.3, 37.2, 31.2, 20.8, 10.5. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0. **HRMS** m/z (ESI) calcd. for $C_{15}H_{16}N_2O_2F_3^+$ $[M+H]^+$ 313.1164, found 313.1161.

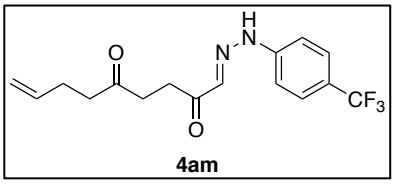
(E)-1-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)oct-6-yne-2,5-dione (4al)



4al

4al was prepared following the General Procedure 3.4 as pale yellow oil. Yield: 68%
^{1}H NMR (600 MHz, CD_3CN) δ 9.74 (s, 1H), 7.64 (d, J = 8.4 Hz, 2H), 7.34 (d, J = 8.4 Hz, 2H), 7.27 (d, J = 1.2 Hz, 1H), 3.20 (dd, J = 7.2, 5.6 Hz, 2H), 2.88 (dd, J = 7.2, 5.6 Hz, 2H), 2.04 (s, 3H). **^{13}C NMR** (151 MHz, CD_3CN) δ 198.0, 187.4, 147.3, 137.0, 127.6, 125.7 (q, J = 269.9 Hz), 123.5 (q, J = 32.5 Hz), 114.8, 91.7, 80.7, 40.2, 31.8, 4.3. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0. **HRMS** m/z (ESI) calcd. for $C_{15}H_{16}N_2O_2F_3^+$ $[M+H]^+$ 311.1007, found 311.1011.

(E)-1-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)non-8-ene-2,5-dione (4am)

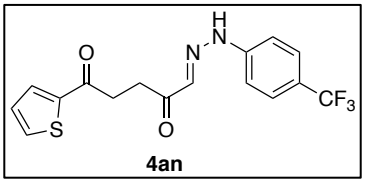


4am

4am was prepared following the General Procedure 3.4 as pale yellow oil. Yield: 65%

^{1}H NMR (600 MHz, CD_3CN) δ 9.59 (s, 1H), 7.53 (d, *J* = 8.8 Hz, 2H), 7.22 (d, *J* = 8.7 Hz, 2H), 7.15 (s, 1H), 5.76 (ddt, *J* = 16.9, 10.2, 6.5 Hz, 1H), 4.96 (dd, *J* = 17.2, 1.8 Hz, 1H), 4.87 (dd, *J* = 10.1, 1.7 Hz, 1H), 3.00 (t, *J* = 6.4 Hz, 2H), 2.67 (t, *J* = 6.4 Hz, 2H), 2.50 (t, *J* = 7.4 Hz, 2H), 2.25 – 2.15 (m, 2H), 2.10 (d, *J* = 2.7 Hz, 1H). **^{13}C NMR** (101 MHz, CD_3CN) δ 209.7, 198.7, 147.4, 138.7, 137.2, 127.6, 125.7 (q, *J* = 272.7 Hz), 123.5 (q, *J* = 32.3 Hz), 115.3, 114.3, 42.2, 36.9, 31.4, 28.4 **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0. **HRMS** m/z (ESI) calcd. for $C_{16}H_{18}N_2O_2F_3^+$ $[M+H]^+$ 327.1320, found 327.1317.

(E)-1-(thiophen-2-yl)-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4an)

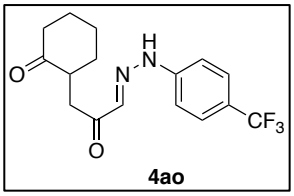


4an

4an was prepared following the General Procedure 3.4 as yellow solid. Yield: 85%

^{1}H NMR (600 MHz, CD_3CN) δ 9.74 (s, 1H), 7.91 (dd, *J* = 3.8, 1.1 Hz, 1H), 7.80 (dd, *J* = 5.0, 1.1 Hz, 1H), 7.64 (d, *J* = 8.5 Hz, 2H), 7.34 (d, *J* = 8.4 Hz, 2H), 7.28 (d, *J* = 1.2 Hz, 1H), 7.22 (dd, *J* = 5.0, 3.8 Hz, 1H), 3.36 – 3.30 (m, 2H), 3.29 (d, *J* = 6.4 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 198.4, 193.0, 147.3, 144.9, 137.2, 134.7, 133.5, 129.4, 127.7, 125.7 (q, *J* = 270.7 Hz), 123.5 (q, *J* = 32.3 Hz), 114.4, 33.7, 31.6. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0. **HRMS** m/z (ESI) calcd. for $C_{16}H_{14}N_2O_2F_3S^+$ $[M+H]^+$ 355.0728, found 355.0725.

(E)-2-(2-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)acetyl)cyclohexan-1-one (4ao)



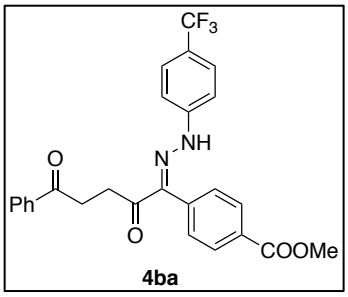
4ao

4ao was prepared following the General Procedure 3.4 as colorless oil. Yield: 83%

^{1}H NMR (600 MHz, CD_3CN) δ 9.61 (s, 1H), 7.52 (dd, *J* = 8.8, 3.1 Hz, 2H), 7.21 (dd, *J* = 8.8, 3.3 Hz, 2H), 7.14 (s, 1H), 3.28 (dd, *J* = 17.2, 7.9 Hz, 1H), 2.98 – 2.89 (m, 1H), 2.44 (dd, *J* = 17.2, 5.2 Hz, 1H), 2.34 (td, *J* = 13.5, 5.9 Hz, 1H), 2.23 – 2.16 (m, 2H), 2.00 (ddq, *J* = 9.2, 6.2, 3.3 Hz, 2H), 1.76 (dt, *J* = 13.4, 3.7 Hz, 1H), 1.72 – 1.62 (m, 1H), 1.53 (dddd, *J* = 17.3, 13.2, 8.7, 4.1 Hz, 1H), 1.39 (qd, *J* = 12.9, 3.9 Hz, 1H). **^{13}C NMR** (151 MHz, CD_3CN) δ 212.2, 198.5, 147.4, 137.5, 127.6, 125.7 (q, *J* = 270.3 Hz), 123.4 (q, *J* = 31.7 Hz), 114.3, 47.2, 42.4, 37.5, 34.7, 28.6, 25.9. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0. **HRMS** m/z (ESI) calcd. for $C_{15}H_{16}N_2O_2F_3^+$ $[M+H]^+$ 327.1320, found 327.1323.

methyl (E)-4-(2,5-dioxo-5-phenyl-1-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pent-yl)benzoate (4ba)

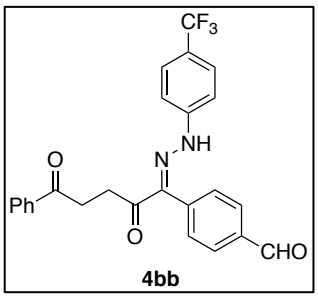
4ba was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 79%



4ba

^{1}H NMR (400 MHz, CD_3CN) δ 8.98 (s, 1H), 8.16 (d, *J* = 8.0 Hz, 2H), 8.07 – 8.02 (m, 2H), 7.63 (dd, *J* = 7.9, 3.4 Hz, 3H), 7.54 (t, *J* = 7.6 Hz, 2H), 7.42 (d, *J* = 8.2 Hz, 4H), 3.94 (s, 3H), 3.52 (dd, *J* = 7.2, 5.3 Hz, 2H), 3.42 (dd, *J* = 7.3, 5.3 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 200.0, 197.9, 167.3, 147.4, 143.8, 137.8, 135.9, 134.0, 131.9, 130.9 130.7, 129.6, 128.8, 127.5 (q, *J* = 4.0 Hz), 125.7 (q, *J* = 270.3 Hz), 123.7 (q, *J* = 33.2 Hz), 115.1, 52.9, 33.7, 31.9. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0. **HRMS** m/z (ESI) calcd. for $C_{26}H_{22}F_3N_2O_4^+$ $[M+H]^+$ 483.1532, found 483.1530.

(E)-4-(2,5-dioxo-5-phenyl-1-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentyl)benzaldehyde (4bb)

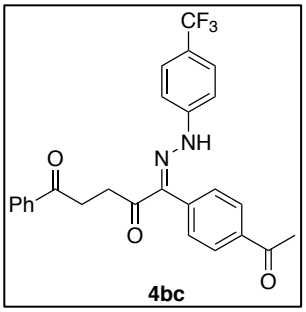


4bb

4bb was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 76%.

^{1}H NMR (400 MHz, CD_3CN) δ 10.10 – 10.09 (m, 1H), 9.02 (s, 1H), 8.06 – 8.03 (m, 4H), 7.63 (d, *J* = 8.5 Hz, 3H), 7.58 – 7.46 (m, 4H), 7.42 (d, *J* = 8.4 Hz, 2H), 3.52 (t, *J* = 6.3 Hz, 2H), 3.45 – 3.38 (m, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 200.0, 197.9, 193.5, 147.4, 143.6, 137.9, 137.3, 134.0, 131.3, 131.0, 129.6, 128.8, 127.5, 125.7 (q, *J* = 271.7 Hz), 124.2 (q, *J* = 32.3 Hz), 115.5, 33.7, 31.9. **^{19}F NMR** (565 MHz, CD3CN) δ -62.0. **HRMS** m/z (ESI) calcd. for $C_{25}H_{20}N_2O_3F_3^+$ $[M+H]^+$ 453.1426, found 453.1425.

(E)-5-(4-acetylphenyl)-1-phenyl-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4bc)



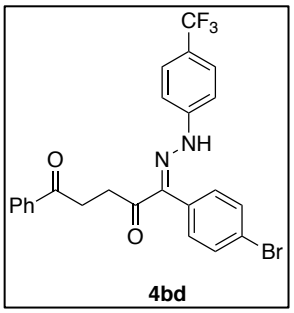
4bc

4bc was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 72%.

^{1}H NMR (400 MHz, CD_3CN) δ 9.02 (s, 1H), 8.18 – 8.08 (m, 2H), 8.07 – 7.99 (m, 2H), 7.68 – 7.60 (m, 3H), 7.54 (dd, *J* = 8.4, 7.0 Hz, 2H), 7.43 (dd, *J* = 8.4, 1.9 Hz, 4H), 3.52 (td, *J* = 5.9, 1.2 Hz, 2H), 3.45 – 3.35 (m, 2H), 2.64 (s, 3H). **^{13}C NMR** (101 MHz, CD_3CN) δ 200.0, 198.8, 198.0, 147.5, 143.9, 138.6, 137.9, 135.8, 134.0, 130.8, 129.7, 129.6, 128.8, 127.5, 125.7 (q, *J* = 271.7 Hz), 123.6 (q, *J* = 32.4 Hz).115.0, 33.7, 31.9, 27.1. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0. **HRMS** m/z (ESI) calcd. for $C_{26}H_{21}N_2O_3F_3^+$ $[M+H]^+$ 467.1583, found 467.1582

(E)-5-(4-bromophenyl)-1-phenyl-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4bd)

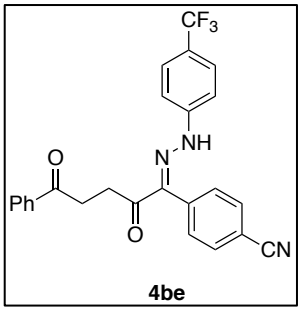
4bd was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 83%.



4bd

^{1}H NMR (400 MHz, CD_3CN) δ 9.01 (d, *J* = 2.8 Hz, 1H), 8.04 (d, *J* = 8.6 Hz, 2H), 7.71 (ddd, *J* = 6.2, 4.1, 1.9 Hz, 2H), 7.62 (d, *J* = 8.8 Hz, 3H), 7.53 (t, *J* = 7.6 Hz, 2H), 7.41 (d, *J* = 8.4 Hz, 2H), 7.21 (ddd, *J* = 8.5, 3.2, 1.7 Hz, 2H), 3.54 – 3.45 (m, 2H), 3.44 – 3.35 (m, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 200.0, 197.9, 147.5, 143.7, 137.9, 134.0, 133.2, 132.4, 130.2, 130.0, 128.8, 127.4, 125.7 (q, *J* = 271.7 Hz), 124.1, 123.6 (q, *J* = 32.3 Hz), 115.4, 34.1, 32.3. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0. **HRMS** m/z (ESI) calcd. for $C_{24}H_{19}N_2O_2F_3Br^+$ $[M+H]^+$ 503.0582, found 503.0575

(E)-4-(2,5-dioxo-5-phenyl-1-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentyl)benzonitrile (4be)

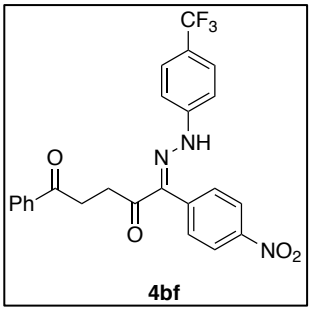


4be

4be was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 78%.

^{1}H NMR (600 MHz, CD_3CN) δ 9.00 (s, 1H), 8.11 – 7.99 (m, 2H), 7.93 – 7.88 (m, 2H), 7.69 – 7.61 (m, 3H), 7.54 (t, *J* = 7.7 Hz, 2H), 7.48 – 7.45 (m, 2H), 7.43 (d, *J* = 8.5 Hz, 2H), 3.51 (dd, *J* = 7.1, 5.3 Hz, 2H), 3.42 (dd, *J* = 7.1, 5.3 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 199.9, 197.7, 147.3, 142.9, 137.8, 136.2, 133.9, 133.8, 131.4, 129.5, 128.8, 127.4, 125.7 (q, *J* = 269.9 Hz), 123.8 (q, *J* = 32.4 Hz), 119.3, 115.0, 113.6, 33.7, 31.9. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.1. **HRMS** m/z (ESI) calcd. for $C_{25}H_{19}N_3O_2F_3^+$ $[M+H]^+$ 450.1429, found 450.1431

(E)-5-(4-nitrophenyl)-1-phenyl-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4bf)

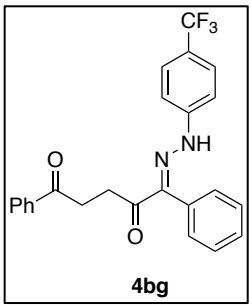


4bf

4bf was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 95%.

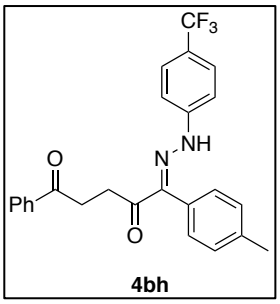
^{1}H NMR (400 MHz, CD_3CN) δ 9.03 (s, 1H), 8.43 – 8.34 (m, 2H), 8.09 – 8.00 (m, 2H), 7.64 (dd, *J* = 7.8, 1.7 Hz, 3H), 7.58 – 7.51 (m, 4H), 7.44 (d, *J* = 8.5 Hz, 2H), 3.53 (td, *J* = 5.9, 5.4, 1.1 Hz, 2H), 3.46 – 3.36 (m, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 200.0, 197.8, 149.4, 147.4, 142.6, 138.1, 137.8, 134.0, 132.0, 129.6, 128.8, 127.5, 125.6 (q, *J* = 270.1 Hz), 125.0, 123.3 (q, *J* = 32.3 Hz), 115.5, 34.1, 32.3. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0 **HRMS** m/z (ESI) calcd. for $C_{24}H_{19}N_3O_4F_3^+$ $[M+H]^+$ 470.1328, found 470.1323

(E)-1,5-diphenyl-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4bg)



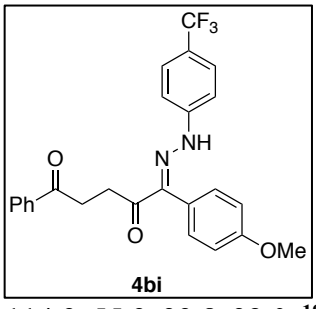
4bg was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 89%.
^{1}H NMR (600 MHz, CD_3CN) δ 8.96 (s, 1H), 8.10 – 7.96 (m, 2H), 7.63 (dd, *J* = 10.5, 8.4 Hz, 3H), 7.59 – 7.48 (m, 5H), 7.47 – 7.38 (m, 2H), 7.29 (dd, *J* = 6.4, 1.8 Hz, 2H), 3.54 – 3.49 (m, 2H), 3.41 (dd, *J* = 7.0, 5.1 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 200.0, 198.1, 147.6, 143.9, 137.9, 134.0, 138.8, 130.3, 130.0, 129.6, 128.8, 127.4, 126.7 (q, *J* = 270.9 Hz), 123.5 (q, *J* = 32.4 Hz), 118.3, 115.0, 32.9, 31.2. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0. **HRMS** m/z (ESI) calcd. for $C_{24}H_{20}N_2O_2F_3^+$ $[M+H]^+$ 425.1477, found 425.1481

(E)-1-phenyl-5-(p-tolyl)-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4bh)



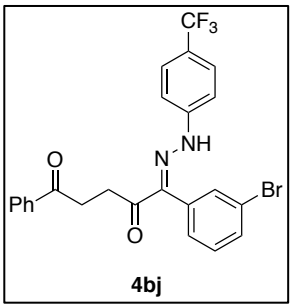
4bh was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 88%.
^{1}H NMR (400 MHz, CD_3CN) δ 8.97 (s, 1H), 8.09 – 8.00 (m, 2H), 7.62 (dd, *J* = 8.8, 7.0 Hz, 3H), 7.57 – 7.49 (m, 2H), 7.44 – 7.34 (m, 4H), 7.23 – 7.13 (m, 2H), 3.50 (dd, *J* = 7.2, 5.2 Hz, 2H), 3.40 (dd, *J* = 7.2, 5.2, Hz, 2H), 2.42 (s, 1H) **^{13}C NMR** (101 MHz, CD_3CN) δ 200.0, 198.2, 147.6, 145.1, 140.3, 138.0, 134.0, 130.1, 129.6, 128.8, 127.4, 127.4, 125.8 (q, *J* = 271.7 Hz), 123.4 (q, *J* = 32.3 Hz), 118.3, 114.9, 33.7, 32.0, 21.9. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0. **HRMS** m/z (ESI) calcd. for $C_{25}H_{22}N_2O_2F_3^+$ $[M+H]^+$ 439.1633, found 439.1633

(E)-5-(2-(4-methoxyphenyl)hydrazineylidene)-1-phenyl-5-(4-(trifluoromethyl)phenyl)pentane-1,4-dione (4bi)



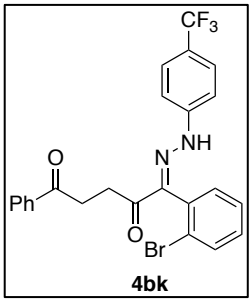
4bi was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 72%.
^{1}H NMR (400 MHz, CD_3CN) δ 9.00 (s, 1H), 8.04 (d, *J* = 7.7 Hz, 2H), 7.62 (t, *J* = 7.6 Hz, 3H), 7.54 (t, *J* = 7.6 Hz, 2H), 7.40 (d, *J* = 8.4 Hz, 2H), 7.22 (d, *J* = 8.2 Hz, 2H), 7.13 – 7.03 (m, 2H), 3.86 (s, 3H), 3.50 (t, *J* = 6.4 Hz, 2H), 3.44 – 3.33 (m, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 200.0, 198.3, 161.4, 147.6, 144.9, 137.9, 134.0, 131.8, 129.6, 128.8, 127.4, 125.7 (q, *J* = 270.2 Hz), 123.3 (q, *J* = 32.3 Hz), 122.6, 115.4, 114.9, 55.9, 33.8, 32.0. **^{19}F NMR** (565 MHz, CD_3CN) δ -61.9. **HRMS** m/z (ESI) calcd. for $[M+H]^+$ $C_{25}H_{22}N_2O_3F_3^+$ 455.1583, found 455.1584

(E)-5-(3-bromophenyl)-1-phenyl-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4bj)



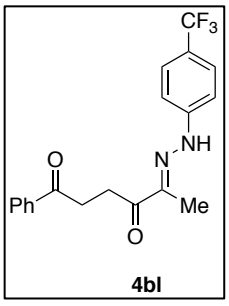
4bj was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 84%.
^{1}H NMR (600 MHz, CD_3CN) δ 8.99 (s, 1H), 8.06 – 7.98 (m, 2H), 7.72 (dd, *J* = 8.4, 1.8 Hz, 2H), 7.65 – 7.60 (m, 3H), 7.53 (t, *J* = 7.7 Hz, 2H), 7.42 (d, *J* = 8.4 Hz, 2H), 7.21 (dd, *J* = 8.3, 1.4 Hz, 2H), 3.49 (dd, *J* = 7.1, 5.4 Hz, 2H), 3.40 (dd, *J* = 7.3, 5.3 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 200.0, 197.9, 147.5, 143.8, 137.9, 134.0, 133.2, 132.4, 130.2, 129.6, 128.8, 127.5 (q, *J* = 3.3 Hz), 125.7 (q, *J* = 270.0 Hz) ,124.0, 123.6 (q, *J* = 32.4 Hz) 115.0, 33.7, 31.9. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0. **HRMS** m/z (ESI) calcd. for $C_{24}H_{19}N_2O_2F_3^+$ $[M+H]^+$ 503.0582, found 503.0576

(E)-5-(2-bromophenyl)-1-phenyl-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (4bk)



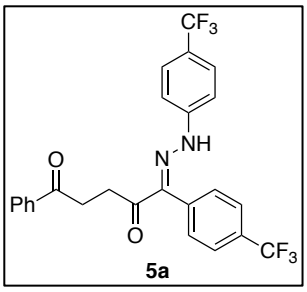
4bk was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 84%.
^{1}H NMR (600 MHz, CD_3CN) δ 8.91 (s, 1H), 8.05 – 8.02 (m, 2H), 7.79 (d, *J* = 8.1 Hz, 1H), 7.68 – 7.60 (m, 3H), 7.55 (t, *J* = 7.6 Hz, 3H), 7.49 – 7.42 (m, 3H), 7.24 (dd, *J* = 7.6, 1.6 Hz, 1H), 3.62 (dt, *J* = 16.9, 6.1 Hz, 1H), 3.50 – 3.38 (m, 3H). **^{13}C NMR** (151 MHz, CD_3CN) δ 199.8, 197.4, 147.5, 143.8, 137.9, 134.0, 134.0, 133.0, 132.4, 132.4, 129.6, 129.3, 128.8, 127.5, 125.7 (q, *J* = 270.1 Hz), 123.8 (q, *J* = 32.3 Hz), 123.8, 115.1, 33.6, 32.0. ^{19}F NMR (565 MHz, CD_3CN) δ -62.0. **HRMS** m/z (ESI) calcd. for $C_{24}H_{19}N_2O_2F_3^+$ $[M+H]^+$ 503.0582, found 503.0577

(E)-1-phenyl-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)hexane-1,4-dione (4bl)



4bl was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 76%.
^{1}H NMR (600 MHz, CD_3CN) δ 8.89 (s, 1H), 8.04 (dd, *J* = 8.0, 1.4 Hz, 2H), 7.64 (dd, *J* = 8.0, 5.8 Hz, 3H), 7.53 (t, *J* = 7.6 Hz, 2H), 7.46 (d, *J* = 8.4 Hz, 2H), 3.36 (h, *J* = 1.8 Hz, 4H), 2.01 (s, 3H). **^{13}C NMR** (101 MHz, CD_3CN) δ 200.0, 198.3, 148.1, 143.6, 137.9, 134.0, 129.5, 128.8, 127.5, 125.8 (q, *J* = 270.1 Hz), 123.1 (q, *J* = 32.4 Hz), 114.7, 33.6, 31.2, 9.2. **^{19}F NMR** (565 MHz, CD_3CN) δ -61.9. **HRMS** m/z (ESI) calcd. for $C_{24}H_{19}N_2O_2F_3^+$ $[M+H]^+$ 363.1320, found 363.1317

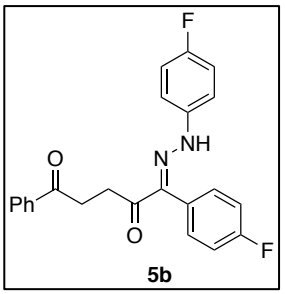
(E)-1-phenyl-5-(4-(trifluoromethyl)phenyl)-5-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (5a)



5a

5a was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 95%. (yield: 85% for gram scale.) **^{1}H NMR** (400 MHz, CD_3CN) δ 8.99 (s, 1H), 8.09 – 8.02 (m, 2H), 7.87 (d, *J* = 8.0 Hz, 2H), 7.68 – 7.60 (m, 3H), 7.54 (dd, *J* = 8.4, 7.0 Hz, 2H), 7.49 (d, *J* = 8.0 Hz, 2H), 7.44 (d, *J* = 8.5 Hz, 2H), 3.53 (td, *J* = 5.9, 5.4, 1.1 Hz, 2H), 3.46 – 3.40 (m, 2H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 198.9, 196.6, 144.9, 142.1, 136.6, 133.2, 132.5, 131.7 (q, *J* = 32.8 Hz), 129.7, 128.6, 128.0, 126.74 (q, *J* = 3.9 Hz), 124.2 (q, *J* = 272.7 Hz), 123.6 (q, *J* = 273.7 Hz), 126.3 (q, *J* = 3.9 Hz), 124.5 (q, *J* = 32.8 Hz), 113.9, 32.7, 30.9. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.1, -63.2. **HRMS** m/z (ESI) calcd. for $C_{25}H_{19}N_2O_2F_6^+$ $[M+H]^+$ 493.1351, found 493.1348

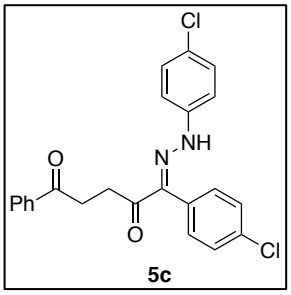
(E)-5-(4-fluorophenyl)-5-(2-(4-fluorophenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (5b)



5b

5b was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 91%. **^{1}H NMR** (600 MHz, CD_3CN) δ 8.75 (s, 1H), 8.03 (dd, *J* = 8.2, 1.4 Hz, 2H), 7.63 (t, *J* = 7.4 Hz, 1H), 7.53 (t, *J* = 7.6 Hz, 2H), 7.35 – 7.23 (m, 6H), 7.08 (t, *J* = 8.9 Hz, 2H), 3.47 (dd, *J* = 7.2, 5.5 Hz, 2H), 3.38 (dd, *J* = 7.2, 5.5 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 200.2, 197.9, 164.0 (d, *J* = 245.6 Hz), 159.3 (d, *J* = 238.0 Hz), 142.3, 141.0, 138.1, 134.0, 132.8 (d, *J* = 8.2 Hz), 129.6, 128.9, 127.5, 117.0 (d, *J* = 21.8 Hz), 116.7 (d, *J* = 23.0 Hz), 116.5 (d, *J* = 7.8 Hz), 33.9, 31.9. **^{19}F NMR** (565 MHz, CD_3CN) δ -113.8, -123.7. **HRMS** m/z (ESI) calcd. for $[M+H]^+$ $C_{23}H_{19}N_2O_2F_2^+$ 393.1415, found 393.1408

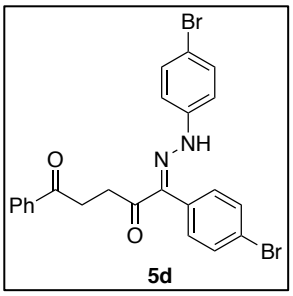
(E)-5-(4-chlorophenyl)-5-(2-(4-chlorophenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (5c)



5c

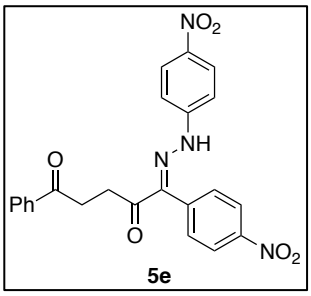
5c was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 85%.
^{1}H NMR (400 MHz, CD_3CN) δ 8.83 (s, 1H), 8.11 – 7.99 (m, 2H), 7.69 – 7.61 (m, 1H), 7.59 – 7.49 (m, 4H), 7.36 – 7.19 (m, 6H), 3.47 (dd, *J* = 6.9, 5.2 Hz, 2H), 3.39 (dd, *J* = 7.5, 5.3 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 200.0, 197.7, 143.3, 142.4, 137.9, 135.5, 134.0, 132.2, 130.2, 130.0, 129.6, 128.8, 127.2, 121.9, 116.5, 33.7, 31.8. **HRMS** m/z (ESI) calcd. for $[M+H]^+$ $C_{23}H_{19}N_2O_2Cl_2^+$ 425.0824, found 425.0820

(E)-5-(4-bromophenyl)-5-(2-(4-bromophenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (5d)



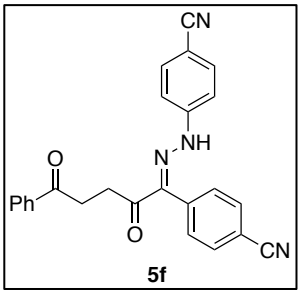
5d was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 81%.
^{1}H NMR (400 MHz, CD_3CN) δ 8.75 (s, 1H), 7.93 (d, *J* = 7.6 Hz, 2H), 7.62 – 7.49 (m, 3H), 7.43 (t, *J* = 7.4 Hz, 2H), 7.37 – 7.30 (m, 2H), 7.10 (dd, *J* = 11.7, 8.2 Hz, 4H), 3.40 – 3.31 (m, 2H), 3.28 (t, *J* = 6.4 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 200.0, 197.7, 143.7, 142.5, 137.9, 134.0, 133.2, 132.9, 132.4, 130.3, 129.6, 128.8, 123.8, 116.9, 114.6, 33.7, 31.8. **HRMS** m/z (ESI) calcd. for $C_{23}H_{19}N_2O_2Br_2^+$ $[M+H]^+$ 514.9793, found 514.9788

(E)-5-(4-nitrophenyl)-5-(2-(4-nitrophenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (5e)



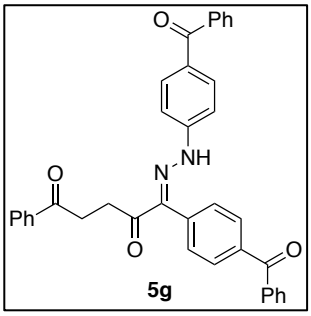
5e was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 95%
^{1}H NMR (400 MHz, CD_3CN) δ 9.20 (s, 1H), 8.45 – 8.34 (m, 2H), 8.25 – 8.18 (m, 2H), 8.07 – 8.02 (m, 2H), 7.68 – 7.63 (m, 1H), 7.59 – 7.51 (m, 4H), 7.46 – 7.40 (m, 2H), 3.54 (td, *J* = 5.8, 5.3, 1.1 Hz, 2H), 3.48 – 3.41 (m, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.9, 197.9, 149.7, 149.5, 144.1, 143.0, 137.8, 137.8, 134.0, 132.0, 129.6, 128.8, 126.5, 125.0, 114.8, 33.7, 32.0. **HRMS** m/z (ESI) calcd. for $C_{23}H_{19}N_4O_6^+$ $[M+H]^+$ 447.1305, found 447.1300

(E)-4-(2-(1-(4-cyanophenyl)-2,5-dioxo-5-phenylpentylidene)hydrazineyl)benzonitrile (5f)



5f was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 91%.
^{1}H NMR (400 MHz, CD_3CN) δ 9.04 (s, 1H), 8.03 (dt, *J* = 7.1, 1.4 Hz, 2H), 7.90 – 7.85 (m, 2H), 7.68 – 7.59 (m, 3H), 7.52 (dd, *J* = 8.4, 7.0 Hz, 2H), 7.45 (d, *J* = 8.3 Hz, 2H), 7.37 (d, *J* = 8.8 Hz, 2H), 3.54 – 3.44 (m, 2H), 3.44 – 3.35 (m, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.9, 197.8, 147.9, 143.6, 137.8, 134.6, 134.0, 133.9, 131.4, 129.6, 128.8, 121.1, 120.1, 119.3, 115.4, 113.7, 105.1, 33.7, 31.9. **HRMS** m/z (ESI) calcd. for $C_{25}H_{19}N_4O_2^+$ $[M+H]^+$ 407.1508, found 407.1508

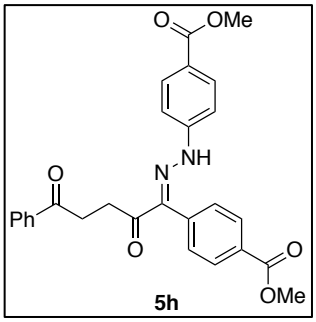
(E)-5-(4-benzoylphenyl)-5-(2-(4-benzoylphenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (5g)



5g was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 90%.

^{1}H NMR (400 MHz, CD_3CN) δ 9.13 (s, 1H), 8.08 – 8.02 (m, 2H), 7.92 (d, *J* = 7.9 Hz, 2H), 7.89 – 7.84 (m, 2H), 7.81 (d, *J* = 8.4 Hz, 2H), 7.77 – 7.73 (m, 2H), 7.72 – 7.50 (m, 9H), 7.44 (dd, *J* = 17.8, 8.2 Hz, 4H), 3.54 (dd, *J* = 7.0, 5.2 Hz, 2H), 3.43 (dd, *J* = 7.2, 5.1 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 200.4, 198.4, 197.3, 196.2, 148.5, 144.5, 139.6, 139.5, 138.5, 138.2, 135.6, 134.4, 134.1, 133.4, 133.2, 132.1, 131.7, 131.2, 130.9, 130.8, 130.0, 129.8, 129.6, 129.2, 114.9, 34.1, 32.4. **HRMS** m/z (ESI) calcd. for $C_{37}H_{29}N_2O_4^+$ $[M+H]^+$ 565.2127 , found 565.2122

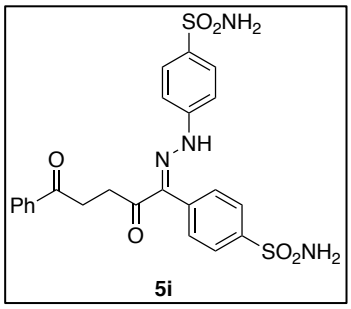
methyl (E)-4-(2-(1-(4-(methoxycarbonyl)phenyl)-2,5-dioxo-5-phenylpentylidene)hydrazineyl)benzoate (5h)



5h was prepared following the General Procedure 3.5 as pale yellow solid. Yield:77%.

^{1}H NMR (600 MHz, CD_3CN) δ 8.99 (s, 1H), 8.15 – 8.09 (m, 2H), 8.04 – 8.00 (m, 2H), 7.96 – 7.91 (m, 2H), 7.64 – 7.59 (m, 1H), 7.51 (t, *J* = 7.7 Hz, 2H), 7.40 – 7.35 (m, 2H), 7.35 – 7.31 (m, 2H), 3.91 (s, 3H), 3.84 (s, 3H), 3.48 (dd, *J* = 7.1, 5.4 Hz, 2H), 3.39 (dd, *J* = 7.1, 5.4 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 200.0, 197.9, 167.3, 148.2, 143.8, 137.8, 135.8, 134.0, 131.9, 130.8, 130.7, 129.6, 128.8, 124.3, 114.6, 52.9, 52.4, 33.7, 31.9. **HRMS** m/z (ESI) calcd. for $C_{27}H_{25}N_2O_6^+$ $[M+H]^+$ 473.1713 , found 473.1708

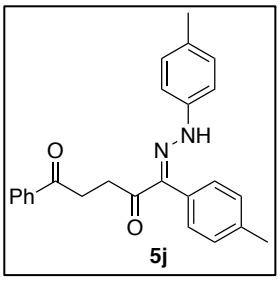
(E)-4-(2,5-dioxo-5-phenyl-1-(2-(4-sulfamoylphenyl)hydrazineylidene)pentyl)benzenesulfonamide (5i)



5i was prepared following the General Procedure 3.5 as pale yellow solid. Yield:84%.

^{1}H NMR (400 MHz, CD_3CN) δ 9.08 (s, 1H), 8.07 – 8.00 (m, 4H), 7.84 – 7.76 (m, 2H), 7.63 (d, *J* = 7.4 Hz, 1H), 7.53 (dd, *J* = 8.4, 7.0 Hz, 2H), 7.48 (d, *J* = 8.4 Hz, 2H), 7.42 (d, *J* = 8.9 Hz, 2H), 5.85 (s, 2H), 5.60 (s, 2H), 3.56 – 3.47 (m, 2H), 3.42 (dd, *J* = 7.2, 5.2 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 200.0, 198.0, 147.5, 144.9, 143.5, 137.8, 136.9, 135.3, 134.0, 131.3, 129.6, 128.8, 128.6, 127.6, 114.9, 33.7, 31.9. **HRMS** m/z (ESI) calcd. for $C_{23}H_{23}N_4O_6S_2^+$ $[M+H]^+$ 515.1059 , found 515.1052

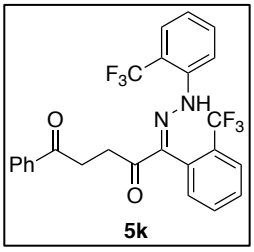
(E)-1,5-diphenyl-5-(2-phenylhydrazineylidene)pentane-1,4-dione (5j)



5j was prepared following the General Procedure 3.5 as pale yellow solid. Yield:65%

^{1}H NMR (600 MHz, CD_3CN) δ 8.69 (s, 1H), 8.06 – 8.02 (m, 2H), 7.65 – 7.61 (m, 1H), 7.53 (t, *J* = 7.8 Hz, 2H), 7.36 (d, *J* = 7.8 Hz, 2H), 7.18 – 7.11 (m, 6H), 3.50 – 3.44 (m, 2H), 3.38 (dd, *J* = 7.3, 5.6 Hz, 2H), 2.42 (s, 3H), 2.29 (s, 3H). **^{13}C NMR** (101 MHz, CD_3CN) δ 200.2, 198.0, 142.8, 142.1, 140.0, 138.1, 133.9, 132.4, 130.6, 130.3, 129.6, 128.8, 128.1, 115.1, 33.9, 31.9, 21.4, 20.7. **HRMS** m/z (ESI) calcd. for $C_{25}H_{25}N_2O_2^+$ $[M+H]^+$ 385.1916 , found 385.1910

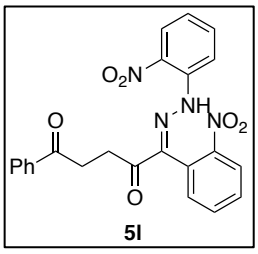
(E)-1-phenyl-5-(2-(trifluoromethyl)phenyl)-5-(2-(2-(trifluoromethyl)phenyl)hydrazineylidene)pentane-1,4-dione (5k)



5k was prepared following the General Procedure 3.5 as pale yellow solid. Yield:80%.

^{1}H NMR (400 MHz, CD_3CN) δ 8.05 – 7.97 (m, 2H), 7.91 (dd, *J* = 8.2, 3.5 Hz, 3H), 7.81 (t, *J* = 7.5 Hz, 1H), 7.73 (t, *J* = 7.8 Hz, 1H), 7.68 – 7.57 (m, 2H), 7.51 (dt, *J* = 15.2, 7.7 Hz, 3H), 7.35 (d, *J* = 7.5 Hz, 1H), 7.13 (t, *J* = 7.7 Hz, 1H), 3.67 – 3.57 (m, 1H), 3.43 – 3.34 (m, 3H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.6, 197.5, 144.6, 140.8, 137.8, 135.0, 134.4, 134.0, 133.4, 131.7, 131.7, 129.6, 128.8, 128.0 (q, *J* = 4.8 Hz), 127.4 (q, *J* = 5.4 Hz), 125.2 (q, *J* = 272.7 Hz), 123.6, 123.1, 122.8 (q, *J* = 272.4 Hz), 116.6, 114.9 (d, *J* = 30.4 Hz), 33.4, 31.9. **^{19}F NMR** (565 MHz, CD_3CN) δ -61.4, -62.0. **HRMS** m/z (ESI) calcd. for $C_{25}H_{19}F_6N_2O_2^+$ $[M+H]^+$ 493.1351, found 493.1350

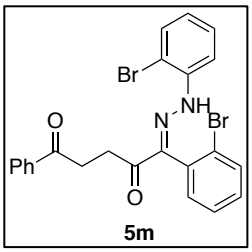
(E)-5-(2-nitrophenyl)-5-(2-(2-nitrophenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (5l)



5l was prepared following the General Procedure 3.5 as pale yellow solid. Yield:78%.

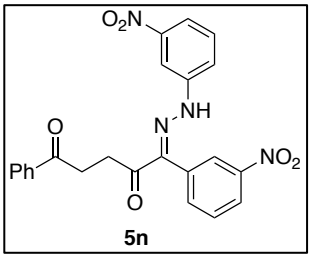
^{1}H NMR (400 MHz, CD_3CN) δ 10.88 (s, 1H), 8.35 (dd, *J* = 8.3, 1.2 Hz, 1H), 8.15 (ddd, *J* = 8.5, 3.8, 1.5 Hz, 2H), 8.03 (dd, *J* = 8.2, 1.5 Hz, 2H), 7.96 (td, *J* = 7.6, 1.2 Hz, 1H), 7.84 (td, *J* = 7.9, 1.4 Hz, 1H), 7.80 – 7.73 (m, 1H), 7.66 – 7.57 (m, 2H), 7.56 – 7.48 (m, 2H), 7.12 (ddd, *J* = 8.5, 7.1, 1.5 Hz, 1H), 3.71 (tdd, *J* = 11.6, 8.4, 4.6 Hz, 1H), 3.52 – 3.28 (m, 4H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.6, 197.4, 149.0, 145.5, 141.3, 140.5, 137.8, 137.6, 136.1, 134.1, 132.6, 131.7, 129.6, 128.9, 126.8, 126.4, 126.2, 122.2, 117.2, 33.4, 32.1. **HRMS** m/z (ESI) calcd. for $C_{23}H_{19}F_6N_4O_6^+$ $[M+H]^+$ 447.1305, found 447.1299

(E)-5-(2-bromophenyl)-5-(2-(2-bromophenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (5m)



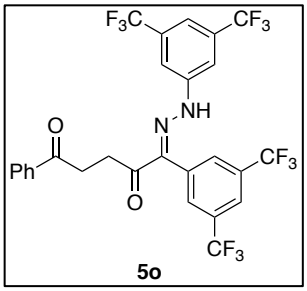
5m was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 73%. **^{1}H NMR** (600 MHz, CD_3CN) δ 8.31 (s, 1H), 8.08 – 8.03 (m, 2H), 7.83 (dd, *J* = 8.1, 1.1 Hz, 1H), 7.77 (dd, *J* = 8.3, 1.5 Hz, 1H), 7.67 – 7.62 (m, 1H), 7.60 (td, *J* = 7.6, 1.1 Hz, 1H), 7.57 – 7.51 (m, 3H), 7.48 (td, *J* = 7.8, 1.8 Hz, 1H), 7.46 – 7.42 (m, 1H), 7.32 (dd, *J* = 7.6, 1.7 Hz, 1H), 6.97 (td, *J* = 7.7, 1.6 Hz, 1H), 3.64 – 3.57 (m, 1H), 3.50 – 3.41 (m, 3H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.7, 197.1, 144.7, 140.3, 137.8, 134.9, 134.2, 134.0, 133.5, 132.7, 132.1, 130.0, 129.6, 128.8, 124.4, 123.1, 118.3, 116.2, 109.4, 33.5, 31.9. **HRMS** m/z (ESI) calcd. for $C_{23}H_{19}Br_2N_2O_2^+$ $[M+H]^+$ 514.9793, found 514.9789

(E)-5-(3-nitrophenyl)-5-(2-(3-nitrophenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (5n)



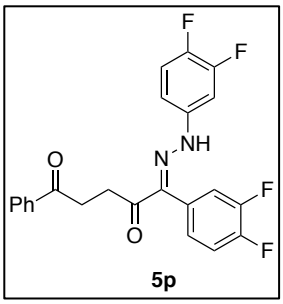
5n was prepared following the General Procedure 3.5 as yellow solid. Yield:87%
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.35 (d, *J* = 8.3 Hz, 1H), 8.26 (s, 1H), 8.20 (s, 1H), 8.05 – 7.97 (m, 3H), 7.88 (d, *J* = 8.1 Hz, 1H), 7.76 (t, *J* = 8.1 Hz, 1H), 7.66 (d, *J* = 7.5 Hz, 1H), 7.62 – 7.54 (m, 2H), 7.49 (dt, *J* = 15.1, 7.8 Hz, 3H), 3.59 (t, *J* = 6.0 Hz, 2H), 3.48 (t, *J* = 6.1 Hz, 2H). **^{13}C NMR** (101 MHz, DMSO-*d6*) δ 199.1, 196.3, 148.6, 148.0, 145.5, 140.6, 136.7, 136.6, 133.3, 132.4, 130.7, 130.4, 128.8, 128.0, 124.8, 123.9, 120.5, 116.1, 109.1, 32.8, 30.9. **HRMS** m/z (ESI) calcd. for $C_{23}H_{19}N_4O_6^+$ $[M+H]^+$ 447.1305, found 447.1298

(E)-5-(3,5-bis(trifluoromethyl)phenyl)-5-(2-(3,5-bis(trifluoromethyl)phenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (5o)



5o was prepared following the General Procedure 3.5 as pale yellow solid. Yield:92%
^{1}H NMR (600 MHz, CD_3CN) δ 9.16 (s, 1H), 8.18 (s, 1H), 8.04 (d, *J* = 7.1 Hz, 2H), 7.90 (d, *J* = 1.6 Hz, 2H), 7.79 (d, *J* = 1.5 Hz, 2H), 7.66 – 7.58 (m, 2H), 7.52 (d, *J* = 7.7 Hz, 2H), 3.57 – 3.51 (m, 2H), 3.43 (t, *J* = 6.2 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 199.8, 197.7, 145.9, 142.4, 137.8, 134.0, 133.8, 132.9 (q, *J* = 33.6 Hz), 131.5, 129.6, 128.8, 123.5 (q, *J* = 271.9 Hz), 123.4 (q, *J* = 271.9 Hz), 124.5, 118.5, 115.9, 115.2, 34.0, 32.3. **^{19}F NMR** (565 MHz, CD_3CN) δ -63.3, -63.7. **HRMS** m/z (ESI) calcd. for $C_{27}H_{17}F_{12}N_2O_2^+$ $[M+H]^+$ 629.1098, found 629.1094

(E)-5-(3,4-difluorophenyl)-5-(2-(3,4-difluorophenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (5p)

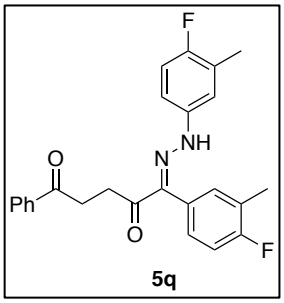


5p

5p was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 88%

^{1}H NMR (600 MHz, CD_3CN) δ 8.83 (s, 1H), 8.03 (dd, *J* = 7.9, 1.5 Hz, 2H), 7.66 – 7.60 (m, 1H), 7.53 (t, *J* = 7.8 Hz, 2H), 7.44 (dt, *J* = 10.7, 8.4 Hz, 1H), 7.28 – 7.16 (m, 3H), 7.08 (ddd, *J* = 8.5, 4.1, 1.9 Hz, 1H), 7.04 – 6.98 (m, 1H), 3.46 (dd, *J* = 7.1, 5.3 Hz, 2H), 3.38 (dd, *J* = 7.3, 5.2 Hz, 2H) **^{13}C NMR** (151 MHz, CD_3CN) δ 200.0, 197.6, 151.5 (td, *J* = 244.6 Hz, 11.0 Hz), 146.5 (dd, *J* = 239.7 Hz, 13.0 Hz), 141.6, 141.5 (d, *J* = 8.8 Hz), 137.9, 134.0, 129.6, 128.8, 128.2, 127.7, 119.8 (d, *J* = 16.8 Hz), 119.2 (d, *J* = 14.2 Hz), 118.6 (d, *J* = 18.6 Hz), 111.0, 104.3 (d, *J* = 22.2 Hz), 34.1, 32.2. **^{19}F NMR** (565 MHz, CD_3CN) δ -138.26 (d, J = 21.4 Hz), -139.00 (q, J = 20.9 Hz), -148.84 (d, J = 20.4 Hz). **HRMS** m/z (ESI) calcd. for $C_{23}H_{17}F_4N_2O_2^+$ $[M+H]^+$ 429.1226, found 429.1222

(E)-5-(4-fluoro-3-methylphenyl)-5-(2-(4-fluoro-3-methylphenyl)hydrazineylidene)-1-phenylpentane-1,4-dione (5q)

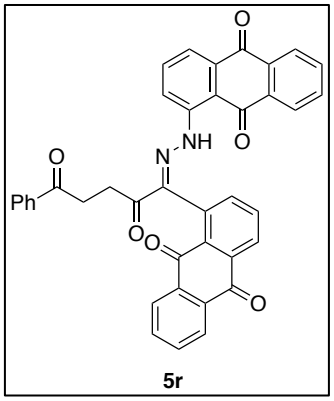


5q

5q was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 85%

^{1}H NMR (600 MHz, CD_3CN) δ 8.67 (s, 1H), 8.03 (d, *J* = 7.8 Hz, 2H), 7.67 – 7.60 (m, 1H), 7.53 (t, *J* = 7.6 Hz, 2H), 7.20 (t, *J* = 9.1 Hz, 1H), 7.17 – 7.11 (m, 2H), 7.07 (dq, *J* = 7.4, 4.1 Hz, 2H), 7.00 (t, *J* = 9.1 Hz, 1H), 3.47 (t, *J* = 6.3 Hz, 2H), 3.42 – 3.34 (m, 2H), 2.32 (s, 3H), 2.26 (s, 3H). **^{13}C NMR** (151 MHz, CD_3CN) δ 200.2, 197.9, 162.49 (d, *J* = 244.8 Hz), 157.8 (d, *J* = 237.2 Hz). 142.4, 140.6, 138.1, 134.0, 133.7 (d, *J* = 5.8 Hz), 129.9 (d, *J* = 8.7 Hz), 129.6, 128.9, 127.1, 126.8 (d, *J* = 18.3 Hz), 126.5 (d, *J* = 18.3 Hz), 117.7, 116.6 (d, *J* = 22.9 Hz), 116.3 (d, *J* = 24.0 Hz) 113.8 (d, *J* = 8.1 Hz), 34.3, 32.3, 15.2, 15.0. **^{19}F NMR** (565 MHz, CD_3CN) δ -118.3, -127.8. **HRMS** m/z (ESI) calcd. for $C_{25}H_{23}F_2N_2O_2^+$ $[M+H]^+$ 420.1728, found 420.1724

(E)-1-(2-(1-(9,10-dioxo-9,10-dihydroanthracen-1-yl)-2,5-dioxo-5-phenylpentylidene)hydrazineyl)anthracene-9,10-dione (5r)

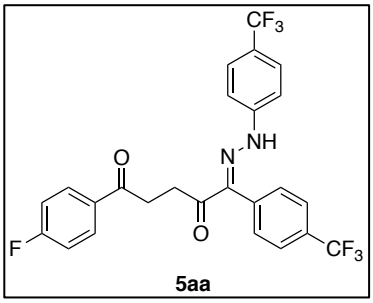


5r

5r was prepared following the General Procedure 3.5 as orange solid. Yield: 70%.

^{1}H NMR (400 MHz, $CDCl_3$) δ 12.45 (s, 1H), 8.64 (dd, *J* = 7.9, 1.3 Hz, 1H), 8.38 (dd, *J* = 8.6, 1.3 Hz, 1H), 8.33 (dd, *J* = 7.6, 1.5 Hz, 1H), 8.23 – 8.18 (m, 1H), 8.15 (dd, *J* = 7.5, 1.6 Hz, 1H), 8.09 – 8.02 (m, 3H), 7.98 – 7.94 (m, 1H), 7.90 (dd, *J* = 7.5, 1.2 Hz, 1H), 7.83 – 7.72 (m, 4H), 7.68 (pd, *J* = 7.3, 1.6 Hz, 2H), 7.60 – 7.54 (m, 1H), 7.48 (dd, *J* = 8.4, 7.0 Hz, 2H), 4.09 – 3.94 (m, 1H), 3.73 – 3.57 (m, 2H), 3.50 – 3.36 (m, 1H). **^{13}C NMR** (101 MHz, $CDCl_3$) δ 199.1, 197.3, 185.9, 183.1, 182.9, 147.6, 146.5, 136.9, 135.8, 135.5, 135.2, 134.8, 134.3, 134.3, 134.0, 133.9, 133.8, 133.5, 133.1, 132.8, 132.8, 132.1, 132.0, 129.5, 128.6, 128.1, 127.5, 127.1, 126.9, 120.6, 120.5, 114.6, 32.8, 31.7. **HRMS** m/z (ESI) calcd. for $C_{39}H_{25}N_6O_2^+$ $[M+H]^+$ 617.1713, found 617.1716

(E)-1-(4-fluorophenyl)-5-(4-(trifluoromethyl)phenyl)-5-(2-(4-(trifluoromethyl)phenyl)-hydrazineylidene)pentane-1,4-dione (5aa)

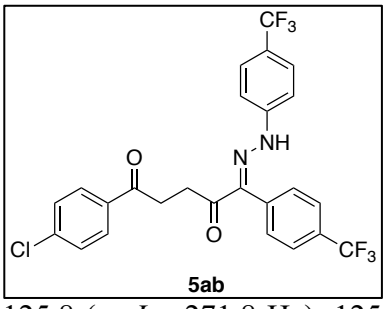


5aa

5aa was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 94%

^{1}H NMR (600 MHz, CD_3CN) δ 9.00 (s, 1H), 8.09 (dd, *J* = 8.6, 5.5 Hz, 2H), 7.85 (d, *J* = 7.9 Hz, 2H), 7.62 (d, *J* = 8.5 Hz, 2H), 7.47 (d, *J* = 8.0 Hz, 2H), 7.42 (d, *J* = 8.5 Hz, 2H), 7.24 (t, *J* = 8.6 Hz, 2H), 3.51 (dd, *J* = 7.2, 5.4 Hz, 2H), 3.38 (t, *J* = 6.3 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 198.2, 197.5, 166.13 (d, *J* = 252.0 Hz) , 147.1, 143.0, 135.0, 134.1, 131.4 (q, *J* = 32.4 Hz), 131.3, 130.9, 127.1, 126.6 , 125.3 (q, *J* = 271.8 Hz), 124.9 (q, *J* = 271.8 Hz), 123.5 (d, *J* = 32.3 Hz), 116.1 (d, *J* = 22.2 Hz), 114.7, 33.3, 31.5. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0, -63.2, -107.8. **HRMS** m/z (ESI) calcd. for $C_{25}H_{18}F_7N_2O_2^+$ $[M+H]^+$ 511.1257, found 511.1255

(E)-1-(4-chlorophenyl)-5-(4-(trifluoromethyl)phenyl)-5-(2-(4-(trifluoromethyl)phenyl)-hydrazineylidene)pentane-1,4-dione (5ab)

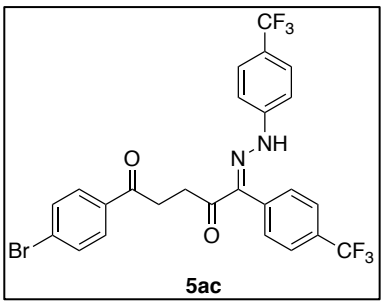


5ab

5ab was prepared following the General Procedure 3.4 as pale yellow solid. Yield: 90%.

^{1}H NMR (400 MHz, CD_3CN) δ 9.02 – 8.95 (m, 1H), 8.03 – 7.95 (m, 2H), 7.86 (d, *J* = 7.2 Hz, 2H), 7.61 (t, *J* = 6.0 Hz, 2H), 7.56 – 7.44 (m, 2H), 7.44 – 7.38 (m, 2H), 3.51 (t, *J* = 5.9 Hz, 2H), 3.38 (t, *J* = 6.2 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.0, 197.8, 147.5, 143.4, 139.7, 136.5, 135.4, 132.8, 131.6 (q, *J* = 32.4 Hz), 131.3, 130.7, 128.4, 127.5 (q, *J* = 4.3 Hz), 126.9 (q, *J* = 3.9 Hz), 125.8 (q, *J* = 271.8 Hz), 125.3 (q, *J* =270.2 Hz), 123.9 (d, *J* = 32.4 Hz), 115.2, 33.8, 32.0. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0, -63.2. **HRMS** m/z (ESI) calcd. for $C_{25}H_{18}F_6ClN_2O_2^+$ $[M+H]^+$ 527.0961, found 527.0955

(E)-1-(4-bromophenyl)-5-(4-(trifluoromethyl)phenyl)-5-(2-(4-(trifluoromethyl)phenyl)-hydrazineylidene)pentane-1,4-dione (5ac)



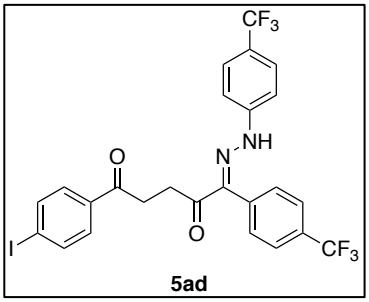
5ac

5ac was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 88%

^{1}H NMR (400 MHz, CD_3CN) δ 8.98 (s, 1H), 7.93 (d, *J* = 8.6 Hz, 1H), 7.86 (d, *J* = 8.0 Hz, 2H), 7.70 (d, *J* = 8.6 Hz, 1H), 7.62 (d, *J* = 8.4 Hz, 2H), 7.48 (d, *J* = 8.0 Hz, 2H), 7.42 (d, *J* = 8.5 Hz, 2H), 3.51 (dd, *J* = 7.1, 5.4 Hz, 2H), 3.38 (dd, *J* = 7.2, 5.2 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.2, 197.8, 147.5 143.4, 136.9, 135.4, 133.0 (q, J = 32.3 Hz), 133.2, 131.7, 131.1, 128.4, 127.5 (d, *J* = 4.0 Hz), 126.9 (d, *J* = 4.0 Hz), 125.8 (q, *J* = 271.7 Hz), 125.4 (q, *J* = 272.7 Hz), 124.3 (q, *J* = 32.3

Hz),115.1, 33.7, 31.9. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.1, -63.2. **HRMS** m/z (ESI) calcd. for $C_{25}H_{18}F_6BrN_2O_2^+$ $[M+H]^+$ 571.0456, found 571.0452

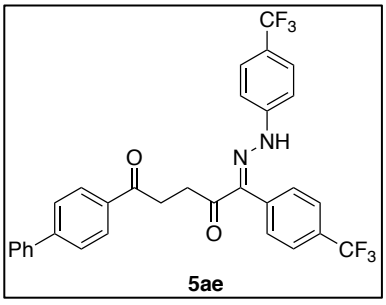
(E)-1-(4-iodophenyl)-5-(4-(trifluoromethyl)phenyl)-5-(2-(4-(trifluoromethyl)phenyl)-hydrazineylidene)pentane-1,4-dione (5ad)



5ad

5ad was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 86%
^{1}H NMR (400 MHz, CD_3CN) δ 8.98 (s, 1H), 7.92 (d, *J* = 8.0 Hz, 2H), 7.86 (d, *J* = 7.9 Hz, 2H), 7.77 (d, *J* = 8.0 Hz, 2H), 7.63 (d, *J* = 8.4 Hz, 2H), 7.48 (d, *J* = 8.0 Hz, 2H), 7.42 (d, *J* = 8.4 Hz, 2H), 3.51 (t, *J* = 6.3 Hz, 2H), 3.37 (t, *J* = 6.3 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.5, 197.8, 147.5, 143.4, 138.9, 137.3, 135.4, 131.5 (q, *J* = 32.3 Hz), 131.3, 130.5, 127.5, 126.9, 125.7 (q, *J* = 271.7 Hz), 125.4 (q, *J* = 272.7 Hz), 123.9 (d, *J* = 32.2 Hz), 115.2, 101.2, 33.7, 31.9. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.1, -63.2. **HRMS** m/z (ESI) calcd. for $C_{25}H_{18}F_6IN_2O_2^+$ $[M+H]^+$ 619.0317, found 619.0311

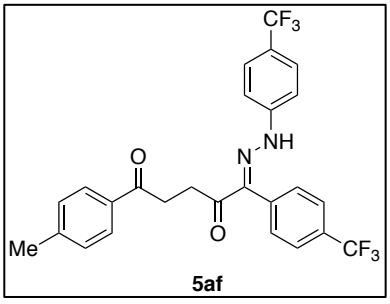
(E)-1-([1,1'-biphenyl]-4-yl)-5-(4-(trifluoromethyl)phenyl)-5-(2-(4-(trifluoromethyl)phenyl)-hydrazineylidene)pentane-1,4-dione (5ae)



5ae

5ae was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 88%.
^{1}H NMR (400 MHz, CD_3CN) δ 9.00 (s, 1H), 8.09 (d, *J* = 8.5 Hz, 2H), 7.85 (d, *J* = 7.9 Hz, 2H), 7.78 (s, 1H), 7.71 (d, *J* = 7.3 Hz, 1H), 7.62 (d, *J* = 8.5 Hz, 2H), 7.55 – 7.40 (m, 7H), 3.53 (dd, *J* = 7.0, 5.1 Hz, 2H), 3.46 – 3.39 (m, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.6, 197.9, 147.5, 146.2, 143.5, 140.6, 136.8, 135.5, 131.6 (q, *J* = 32.3 Hz), 131.3, 130.0, 129.6, 129.3, 128.1 (q, *J* = 5.9 Hz), 127.5 (q, *J* = 4.0 Hz), 126.9 (q, *J* = 4.0 Hz), 125.8 (q, *J* =272.7Hz), 125.3 (q, *J* = 271.7 Hz), 123.9 (q, *J* = 32.5 Hz), 115.4, 115.2, 33.9, 32.1. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0, -63.1. **HRMS** m/z (ESI) calcd. for $C_{31}H_{23}F_6N_2O_2^+$ $[M+H]^+$ 569.1664, found 569.1661

(E)-1-(p-tolyl)-5-(4-(trifluoromethyl)phenyl)-5-(2-(4-(trifluoromethyl)phenyl)hydra-zineylidene)pentane-1,4-dione (5af)

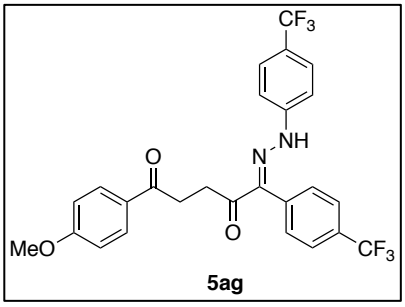


5af

5af was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 86%.
^{1}H NMR (600 MHz, , CD_3CN) δ 8.97 (s, 1H), 7.96 – 7.91 (m, 2H), 7.86 (d, *J* = 8.0 Hz, 2H), 7.62 (d, *J* = 8.5 Hz, 2H), 7.48 (d, *J* = 8.0 Hz, 2H), 7.42 (d, *J* = 8.6 Hz, 2H), 7.34 (d, *J* = 7.9 Hz, 2H), 3.49 (dd, *J* = 7.2, 5.4 Hz, 2H), 3.41 – 3.37 (m, 2H), 2.42 (s, 3H). **^{13}C NMR** (151 MHz, CD_3CN) δ 199.5, 198.0, 147.5, 145.0, 143.4, 135.4, 135.4, 131.5 (d, *J* = 32.0 Hz), 131.3, 130.2, 129.0, 127.5 (q, *J* = 4.1 Hz), 126.9 (q, *J* = 3.8 Hz), 125.7 (q, *J* =272.7 Hz), 125.3 (q, *J* = 271.8 Hz), 123.8 (q, *J* =

32.4 Hz), 115.2, 33.6, 31.9, 21.6. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.1, -63.2. **HRMS** m/z (ESI) calcd. for $C_{26}H_{21}F_6N_2O_2^+$ $[M+H]^+$ 507.1507, found 507.1504

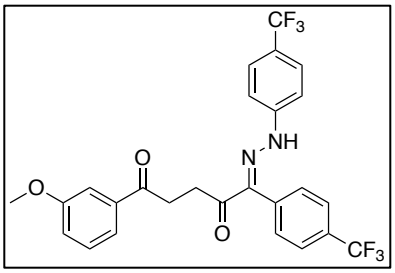
(E)-1-(4-methoxyphenyl)-5-(4-(trifluoromethyl)phenyl)-5-(2-(4-(trifluoromethyl)phenyl)-hydrazineylidene)pentane-1,4-dione (5ag)



5ag

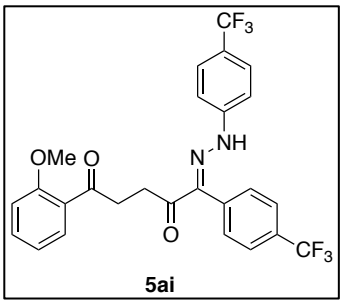
5ag was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 88%
^{1}H NMR (400 MHz, CD_3CN) δ 8.96 (s, 1H), 8.01 (d, *J* = 9.0 Hz, 1H), 7.86 (d, *J* = 8.0 Hz, 2H), 7.62 (d, *J* = 8.5 Hz, 2H), 7.48 (d, *J* = 8.0 Hz, 2H), 7.41 (d, *J* = 8.5 Hz, 2H), 7.01 (d, *J* = 8.9 Hz, 2H), 3.87 (s, 3H), 3.48 (t, *J* = 6.5 Hz, 2H), 3.36 (t, *J* = 6.3 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 198.4, 198.1, 164.5, 147.5, 143.5, 135.5, 131.3, 131.2, 130.8(q, *J* = 32.4 Hz),, 127.5 (q, *J* = 4.0 Hz), 127.0 (q, *J* = 3.9 Hz), 123.9 (q, *J* = 32.4 Hz), 123.8, 123.1 (q, *J* = 272.7 Hz), 122.6 (q, *J* = 272.7 Hz), 115.1, 114.7, 56.3, 33.5, 32.0. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.1, -63.2. **HRMS** m/z (ESI) calcd. for $C_{26}H_{21}F_6N_2O_3^+$ $[M+H]^+$ 523.1456, found 523.1449

(E)-1-(3-methoxyphenyl)-5-(4-(trifluoromethyl)phenyl)-5-(2-(4-(trifluoromethyl)phenyl)-hydrazineylidene)pentane-1,4-dione (5ah)



5ah was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 82%.
^{1}H NMR (400 MHz, CD_3CN) δ 8.98 (s, 1H), 7.86 (d, *J* = 8.0 Hz, 2H), 7.63 (dd, *J* = 8.0, 5.6 Hz, 3H), 7.53 (t, *J* = 2.1 Hz, 1H), 7.51 – 7.46 (m, 2H), 7.43 (dd, *J* = 8.2, 5.2 Hz, 3H), 7.19 (dd, *J* = 8.2, 2.7 Hz, 1H), 3.85 (s, 3H), 3.51 (t, *J* = 6.3 Hz, 2H), 3.41 (6, *J* = 6.3 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 199.8, 197.9, 160.9, 147.5, 143.4, 139.4, 135.5, 131.5 (q, *J* = 32.0 Hz), 131.3, 130.8, 125.7 (q, *J* = 270.7 Hz), 123.9 (q, *J* = 32.5 Hz), 122.6 (q, *J* = 271.7 Hz), 121.4, 120.0, 115.1, 113.4, 56.1, 34.0, 32.0. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.1, -63.2. **HRMS** m/z (ESI) calcd. for $C_{26}H_{21}F_6N_2O_3^+$ $[M+H]^+$ 523.1456, found 523.1460

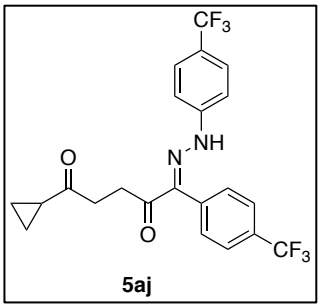
(E)-1-(2-methoxyphenyl)-5-(4-(trifluoromethyl)phenyl)-5-(2-(4-(trifluoromethyl)phenyl)-hydrazineylidene)pentane-1,4-dione (5ai)



5ai

5ai was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 78%.
^{1}H NMR (600 MHz, CD_3CN) δ 8.97 (s, 1H), 7.85 (d, *J* = 8.5 Hz, 2H), 7.68 – 7.59 (m, 3H), 7.52 (ddd, *J* = 8.8, 7.2, 1.8 Hz, 1H), 7.47 (d, *J* = 7.9 Hz, 2H), 7.41 (d, *J* = 8.6 Hz, 2H), 7.12 (d, *J* = 8.3 Hz, 1H), 7.02 (td, *J* = 7.6, 1.0 Hz, 1H), 3.92 (s, 3H), 3.45 (t, *J* = 6.1 Hz, 2H), 3.36 (t, *J* = 6.4 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 201.8, 198.1, 159.6, 147.5, 143.5, 135.5, 134.5, 131.4 (q, *J* = 32.6 Hz), 131.3, 130.7, 129.0, 127.5 (q, *J* = 4.0 Hz), 126.9 (t, *J* = 3.8 Hz). 125.7 (q, *J* = 270.3 Hz), 125.3 (q, *J* = 271.8 Hz), 124.0 (q, *J* = 32.5 Hz)， 121.4, 115.1, 113.1, 56.3, 39.1, 32.3. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.0, -63.2. **HRMS** m/z (ESI) calcd. for $C_{26}H_{21}F_6N_2O_3^+$ $[M+H]^+$ 523.1456, found 523.1459

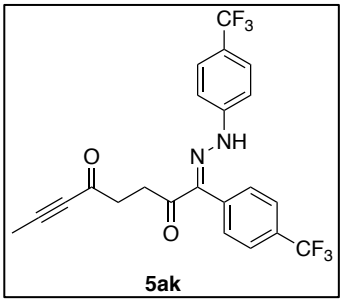
(E)-1-cyclopropyl-5-(4-(trifluoromethyl)phenyl)-5-(2-(4-(trifluoromethyl)phenyl)-hydrazineylidene)pentane-1,4-dione (5aj)



5aj

5aj was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 88%.
^{1}H NMR (600 MHz, CD_3CN) δ 8.93 (s, 1H), 7.86 (d, *J* = 8.0 Hz, 2H), 7.62 (d, *J* = 8.6 Hz, 2H), 7.46 (d, *J* = 8.0 Hz, 2H), 7.40 (d, *J* = 8.6 Hz, 2H), 3.37 – 3.30 (m, 2H), 2.96 (dd, *J* = 7.0, 5.8 Hz, 2H), 2.12 – 2.02 (m, 1H), 1.00 – 0.78 (m, 4H). **^{13}C NMR** (151 MHz, CD_3CN) δ 210.2, 197.8, 147.5, 143.4, 135.5, 131.5 (q, *J* = 33.2 Hz), 131.3, 127.5 (d, *J* = 4.4 Hz), 126.9 (d, *J* = 4.4 Hz), 125.7 (q, *J* = 270.3 Hz), 125.3 (q, J = 271.8 Hz), 123.8 (q, *J* = 32.5 Hz), 115.1, 38.1, 32.0, 21.3, 10.9. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.1, -63.2. **HRMS** m/z (ESI) calcd. for $C_{22}H_{19}F_6N_2O_2^+$ $[M+H]^+$ 457.1351, found 457.1348

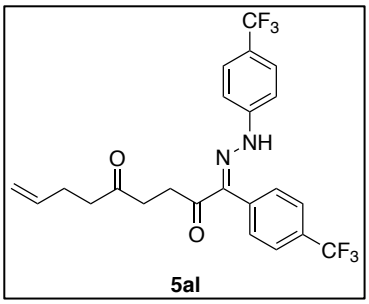
(E)-1-(4-(trifluoromethyl)phenyl)-1-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)oct-6-yne-2,5-dione (5ak)



5ak

5ak was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 80%.
^{1}H NMR (400 MHz, CD_3CN) δ 8.97 (s, 1H), 7.86 (d, *J* = 7.9 Hz, 2H), 7.80 (s, 0H), 7.63 (d, *J* = 8.5 Hz, 2H), 7.44 (dd, *J* = 18.5, 8.2 Hz, 4H), 3.42 (t, *J* = 6.3 Hz, 2H), 2.91 (t, *J* = 6.5 Hz, 2H), 2.04 (s, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 197.4, 187.6, 147.4, 143.2, 135.3, 131.6 (q, J = 32.3 Hz), 131.3, 127.5 (d, *J* = 4.0 Hz), 127.0 (d, *J* = 3.9 Hz), 126.1 (q, *J* = 270.7 Hz), 125.7 (q, *J* = 272.7 Hz), 124.4 (q, *J* = 32.3 Hz), 115.2, 91.4, 80.4, 40.3, 31.8, 3.9. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.1, -63.2. **HRMS** m/z (ESI) calcd. for $C_{22}H_{17}F_6N_2O_2^+$ $[M+H]^+$ 455.1194, found 455.1193

(E)-1-(4-(trifluoromethyl)phenyl)-1-(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)non-8-ene-2,5-dione (5al)

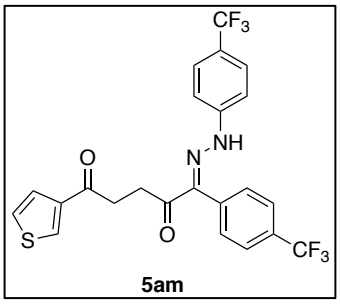


5al

5al was prepared following the General Procedure 3.5 as pale yellow solid. Yield: 77%.

^{1}H NMR (400 MHz, CD_3CN) δ 8.95 (s, 1H), 7.86 (d, *J* = 8.1 Hz, 2H), 7.62 (d, *J* = 8.6 Hz, 2H), 7.46 (d, *J* = 8.0 Hz, 2H), 7.41 (d, *J* = 8.5 Hz, 2H), 5.86 (ddt, *J* = 16.8, 10.3, 6.5 Hz, 1H), 5.05 (dd, *J* = 17.2, 1.8 Hz, 1H), 4.97 (dd, *J* = 10.2, 1.7 Hz, 1H), 3.33 (dd, *J* = 7.1, 5.8 Hz, 2H), 2.81 (t, *J* = 6.4 Hz, 2H), 2.60 (t, *J* = 7.4 Hz, 2H), 2.39 – 2.24 (m, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 209.8, 197.9, 147.5, 143.4, 138.7, 135.5, 131.9 (q, *J* = 32.3 Hz), 131.3, 127.5 (d, *J* = 4.0 Hz), 127.0 (d, *J* = 3.9 Hz), 125.8 (q, *J* = 271.7 Hz), 125.3 (q, *J* = 268.8 Hz), 123.9 (q, *J* = 32.4 Hz), 115.3, 115.1, 42.2, 37.4, 31.8, 28.5. ^{19}F NMR (565 MHz, CD_3CN) δ -62.1, -63.2. **HRMS** m/z (ESI) calcd. for $C_{23}H_{21}F_6N_2O_2^+$ $[M+H]^+$ 471.1507, found 471.1507

(E)-1-(thiophen-3-yl)-5-(4-(trifluoromethyl)phenyl)-5-(2-(4-(trifluoromethyl)phenyl)-hydrazineylidene)pentane-1,4-dione (5am)

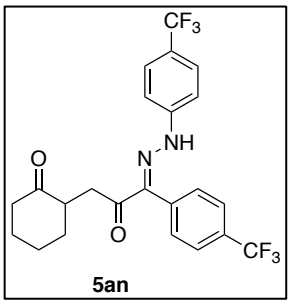


5am

5am was prepared following the General Procedure 3.5 as yellow solid. Yield: 84%.

^{1}H NMR (600 MHz, CD_3CN) δ 8.98 (s, 1H), 7.91 (dd, *J* = 3.7, 1.1 Hz, 1H), 7.86 (d, *J* = 8.0 Hz, 2H), 7.79 (dd, *J* = 5.0, 1.1 Hz, 1H), 7.62 (d, *J* = 8.7 Hz, 2H), 7.47 (d, *J* = 8.0 Hz, 2H), 7.42 (d, *J* = 8.5 Hz, 2H), 7.21 (dd, *J* = 5.0, 3.8 Hz, 1H), 3.50 (dd, *J* = 7.2, 5.6 Hz, 2H). **^{13}C NMR** (101 MHz, CD_3CN) δ 197.7, 193.2, 147.5, 145.0, 143.4, 135.4, 134.8, 133.5, 131.5 (q, *J* = 33.2 Hz), 131.3, 129.5, 127.5 (d, *J* = 4.0 Hz), 127.0 (d, *J* = 3.9 Hz), 125.4 (q, *J* = 271.7 Hz), 124.9 (q, *J* = 272.7 Hz), 123.9 (d, *J* = 32.4 Hz),115.2, 34.3, 32.0. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.1, -63.2. **HRMS** m/z (ESI) calcd. for $C_{23}H_{17}SF_6N_2O_2^+$ $[M+H]^+$ 499.0915, found 499.0917

(E)-2-(2-oxo-3-(4-(trifluoromethyl)phenyl)-3-(2-(4-(trifluoromethyl)phenyl)hydra-zineylidene)propyl)cyclohexan-1-one (5an)

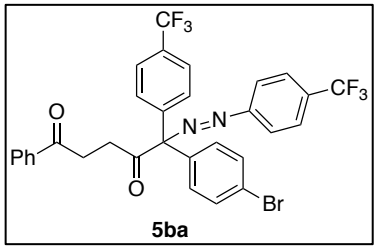


5an

5an was prepared following the General Procedure 3.5 as pale yellow oil. Yield: 79%.

^{1}H NMR (600 MHz, Acetonitrile-d_3) δ 8.92 (s, 1H), 7.87 (d, *J* = 7.7 Hz, 2H), 7.63 (d, *J* = 8.5 Hz, 2H), 7.47 (d, *J* = 7.8 Hz, 1H), 7.41 (d, *J* = 8.5 Hz, 2H), 3.64 (dd, *J* = 16.9, 7.9 Hz, 1H), 3.11 – 3.00 (m, 1H), 2.76 (dd, *J* = 16.9, 5.4 Hz, 1H), 2.45 (tdd, *J* = 13.6, 6.1, 1.2 Hz, 1H), 2.36 – 2.26 (m, 1H), 2.12 (dq, *J* = 9.5, 3.1 Hz, 1H), 1.93 – 1.86 (m, 1H), 1.84 – 1.72 (m, 1H), 1.74 – 1.61 (m, 1H), 1.57 (qd, *J* = 12.8, 3.8 Hz, 1H). **^{13}C NMR** (151 MHz, CD_3CN) δ 212.2, 197.8, 147.6, 143.8, 135.6, 131.5 (d, *J* = 32.6 Hz), 131.3, 127.5, 126.9, 125.8 (q, *J* = 271.8 Hz), 125.3 (q, *J* = 270.3 Hz), 123.8 (d, *J* = 32.6 Hz), 115.1, 47.9, 42.5, 37.7, 34.8, 28.6, 25.9. **^{19}F NMR** (565 MHz, CD_3CN) δ -62.1, -63.2. **HRMS** m/z (ESI) calcd. for $C_{23}H_{21}F_6N_2O_2^+$ $[M+H]^+$ 471.1507, found 471.1504

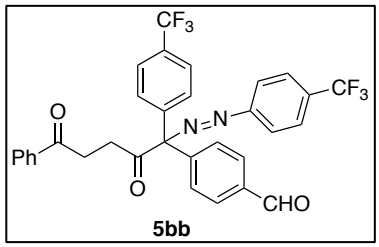
5-(4-bromophenyl)-1-phenyl-5-(4-(trifluoromethyl)phenyl)-5-((4-(trifluoromethyl)phenyl)-diazenyl)pentane-1,4-dione (5ba)



5ba

5ba was prepared following the General Procedure 3.5 as pale yellow oil. Yield: 88% (Yield: 82% for gram scale)
^{1}H NMR (600 MHz, CD_3CN) δ 7.99 – 7.94 (m, 4H), 7.90 (d, *J* = 8.5 Hz, 2H), 7.74 (d, *J* = 8.2 Hz, 2H), 7.65 – 7.60 (m, 3H), 7.51 (ddt, *J* = 8.7, 7.6, 1.5 Hz, 2H), 7.49 – 7.46 (m, 2H), 7.26 – 7.20 (m, 2H), 3.33 – 3.26 (m, 2H), 3.03 – 2.89 (m, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 206.4, 199.2, 154.6, 143.9, 138.5, 137.6, 134.1, 133.3 (q, *J* = 32.4 Hz), 132.4, 131.3 (q, *J* = 32.5 Hz), 129.6, 128.8, 127.6 (q, *J* = 4.3 Hz), 125.9 (q, *J* = 4.1 Hz),125.0 (q, J = 272.7 Hz), 124.7 (q, J = 271.8 Hz), 123.3, 93.5, 36.6, 33.5. **^{19}F NMR** (565 MHz, CD_3CN) δ -63.2, -63.2. **HRMS** m/z (ESI) calcd. for $C_{31}H_{21}BrF_6N_2O_2^+$ $[M+H]^+$ 647.0769, found 647.0765

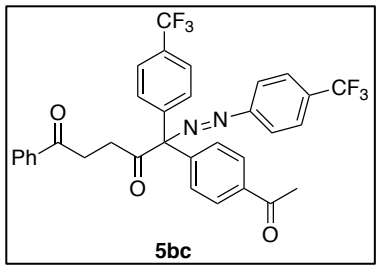
4-(2,5-dioxo-5-phenyl-1-(4-(trifluoromethyl)phenyl)-1-((4-(trifluoromethyl)phenyl)-diazenyl)pentyl)benzaldehyde (5bb)



5bb

5bb was prepared following the General Procedure 3.5 as pale yellow s oil. Yield: 80%. (Yield: 76% for gram scale)
^{1}H NMR (600 MHz, CD_3CN) δ 10.06 (s, 1H), 8.02 – 7.85 (m, 8H), 7.75 (d, *J* = 8.2 Hz, 2H), 7.63 (t, *J* = 7.2 Hz, 1H), 7.57 – 7.36 (m, 6H), 3.31 (t, *J* = 6.2 Hz, 2H), 3.02 (t, *J* = 6.2 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 206.3, 199.2, 193.2, 154.6, 144.6, 143.7, 137.5, 137.1, 134.1, 133.4 (q, *J* = 32.3 Hz), 131.4, 131.3, 130.6 (q, *J* = 32.1 Hz), 130.2, 129.6, 128.8, 127.6, 126.1, 125.2 (q, *J* = 272.7 Hz), 124.9 (q, *J* = 271.8 Hz), 124.1, 93.9, 36.7, 33.5. **^{19}F NMR** (565 MHz, CD_3CN) δ -63.2, -63.2. **HRMS** m/z (ESI) calcd. for $C_{32}H_{22}F_6N_2O_3^+$ $[M+H]^+$ 597.1613, found 597.1619

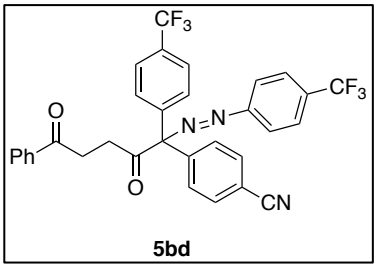
5-(4-acetylphenyl)-1-phenyl-5-(4-(trifluoromethyl)phenyl)-5-((4-(trifluoromethyl)phenyl)-diazenyl)pentane-1,4-dione (5bc)



5bc

5bc was prepared following the General Procedure 3.5 as pale yellow oil. Yield: 78%.
^{1}H NMR (600 MHz, CD_3CN) δ 8.00 (d, *J* = 8.2 Hz, 2H), 7.96 – 7.92 (m, 3H), 7.88 (d, *J* = 8.3 Hz, 2H), 7.73 (d, *J* = 8.3 Hz, 2H), 7.62 – 7.57 (m, 1H), 7.48 (dt, *J* = 7.6, 3.4 Hz, 4H), 7.44 (d, *J* = 8.2 Hz, 2H), 3.29 (t, *J* = 6.2 Hz, 2H), 3.00 (t, *J* = 6.2 Hz, 2H), 2.58 (s, 3H). **^{13}C NMR** (151 MHz, CD_3CN) δ 206.4, 199.2, 198.5, 154.6, 144.1, 143.9, 137.8, 137.6, 134.1, 133.4 (d, *J* = 32.5 Hz), 131.4, 130.8, 130.6 (d, *J* = 32.9 Hz), 129.6, 129.1, 128.8, 127.7, 126.1, 125.2 (q, *J* = 270.7 Hz), 124.9 (q, *J* = 271.8 Hz), 124.1, 93.8, 36.7, 33.5, 27.1. **^{19}F NMR** (565 MHz, CD_3CN) δ -63.1, -63.2. **HRMS** m/z (ESI) calcd. for $C_{33}H_{25}F_6N_2O_3^+$ $[M+H]^+$ 611.1769, found 611.1764

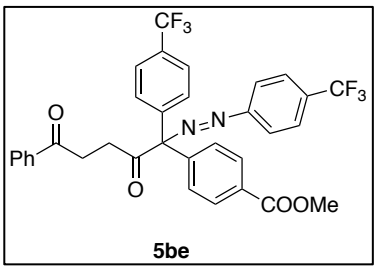
4-(2,5-dioxo-5-phenyl-1-(4-(trifluoromethyl)phenyl)-1-((4-(trifluoromethyl)phenyl)-diazenyl)pentyl)benzonitrile (5bd)



5bd

5bd was prepared following the General Procedure 3.5 as pale yellow oil. Yield: 84%
^{1}H NMR (600 MHz, CD_3CN) δ 7.99 – 7.92 (m, 4H), 7.92 – 7.87 (m, 2H), 7.80 – 7.73 (m, 4H), 7.61 (q, *J* = 9.0, 8.3 Hz, 1H), 7.50 (t, *J* = 8.0 Hz, 4H), 7.48 – 7.42 (m, 2H), 3.30 (t, *J* = 6.1 Hz, 2H), 3.00 (dd, *J* = 6.8, 5.4 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 206.1, 199.2, 154.5, 144.6, 143.5, 137.5, 134.2, 133.5 (q, *J* = 32.4 Hz), 133.1, 132.6, 131.3, 130.7 (q, *J* = 32.2 Hz), 129.6, 128.8, 127.6, 126.3, 125.2 (q, *J* = 271.8 Hz), 124.9 (q, *J* = 271.8 Hz), 124.1, 119.3, 112.9, 93.6, 36.7, 33.5. **^{19}F NMR** (565 MHz, CD3CN) δ -63.2, -63.2. **HRMS** m/z (ESI) calcd. for $C_{32}H_{22}F_6N_3O_2^+$ $[M+H]^+$ 594.1616, found 594.1615

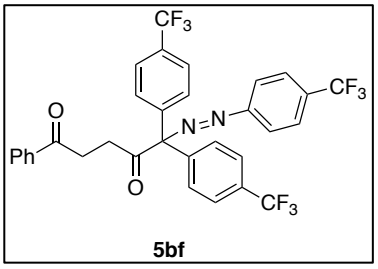
methyl 4-(2,5-dioxo-5-phenyl-1-(4-(trifluoromethyl)phenyl)-1-((4-(trifluoromethyl)-phenyl)diazenyl)pentyl)benzoate (5be)



5be

5be was prepared following the General Procedure 3.5 as pale yellow s oil. Yield: 76%.
^{1}H NMR (600 MHz, CD_3CN) δ 8.06 (d, *J* = 8.3 Hz, 2H), 7.97 (d, *J* = 7.8 Hz, 4H), 7.91 (d, *J* = 8.4 Hz, 2H), 7.75 (d, *J* = 8.3 Hz, 2H), 7.65 – 7.61 (m, 1H), 7.54 – 7.43 (m, 6H), 3.91 (s, 3H), 3.31 (t, *J* = 6.2 Hz, 2H), 3.02 (td, *J* = 6.0, 2.2 Hz, 2H). ^{13}C NMR (151 MHz, CD_3CN) δ 206.3, 199.1, 167.1, 154.6, 144.1, 143.8, 137.5, 134.1, 133.6 (q, *J* = 31.7 Hz), 131.4, 131.2 (q, *J* = 31.7 Hz), 130.6, 130.4, 129.6, 128.8, 127.6, 126.0, 125.1 (q, *J* =271.8 Hz), 124.8 (q, *J* = 271.8 Hz), 124.0, 93.9, 52.8, 36.7, 33.5. ^{19}F NMR (565 MHz, CD_3CN) δ -63.2, -63.2. **HRMS** m/z (ESI) calcd. for $C_{33}H_{25}F_6N_2O_4^+$ $[M+H]^+$ 627.1719, found 627.1721

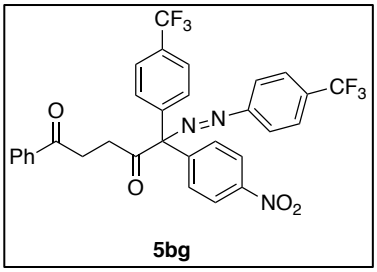
1-phenyl-5,5-bis(4-(trifluoromethyl)phenyl)-5-((4-(trifluoromethyl)phenyl)diazenyl)-pentane-1,4-dione (5bf)



5bf

5bf was prepared following the General Procedure 3.5 as pale yellow oil. Yield: 81%.
^{1}H NMR (600 MHz, CD_3CN) δ 7.99 – 7.94 (m, 4H), 7.91 (d, *J* = 8.3 Hz, 2H), 7.76 (d, *J* = 8.3 Hz, 4H), 7.65 – 7.61 (m, 1H), 7.51 (t, *J* = 7.6 Hz, 6H), 3.31 (t, *J* = 6.2 Hz, 2H), 3.01 (dd, *J* = 6.8, 5.6 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 206.3, 199.2, 154.6, 143.7, 137.6, 134.1, 133.5 (q, *J* = 32.5 Hz), 131.3, 130.6 (q, *J* = 32.3 Hz), 129.6, 128.8, 127.7, 126.2, 125.2 (q, *J* = 271.8 Hz), 124.9 (q, *J* = 271.8 Hz), 124.4, 93.6, 36.7, 33.5. **^{19}F NMR** (565 MHz, CD_3CN) δ -63.2, -63.2. **HRMS** m/z (ESI) calcd. for $C_{32}H_{21}F_9N_2O_2^+$ $[M+H]^+$ 637.1538, found 637.1532

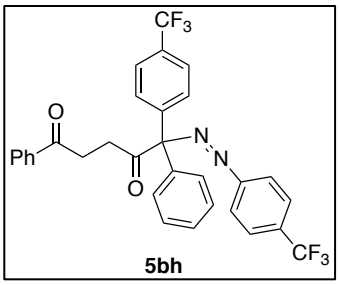
5-(4-nitrophenyl)-1-phenyl-5-(4-(trifluoromethyl)phenyl)-5-((4-(trifluoromethyl)phenyl)-diazenyl)pentane-1,4-dione (5bg)



5bg

5bg was prepared following the General Procedure 3.5 as orange oil. Yield: 93%.
^{1}H NMR (600 MHz, CD_3CN) δ 8.24 (d, *J* = 9.1 Hz, 1H), 8.00 – 7.94 (m, 4H), 7.91 (d, *J* = 8.4 Hz, 2H), 7.78 (d, *J* = 8.3 Hz, 2H), 7.65 – 7.60 (m, 1H), 7.56 – 7.47 (m, 6H), 3.32 (t, *J* = 6.2 Hz, 2H), 3.03 (td, *J* = 6.0, 3.4 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 206.0, 199.2, 154.5, 148.7, 146.5, 143.4, 137.5, 134.2, 133.6 (q, *J* = 32.5 Hz), 132.0, 131.2, 130.8 (q, *J* = 32.5 Hz), 129.6, 128.8, 127.7, 126.4, 125.2 (q, *J* = 271.8 Hz), 124.9 (q, *J* = 271.8 Hz), 124.2, 94.0, 37.1, 33.9. **^{19}F NMR** (565 MHz, CD_3CN) δ -63.2, -63.2. **HRMS** m/z (ESI) calcd. for $C_{31}H_{22}F_6N_3O_4^+$ $[M+H]^+$ 614.1515, found 614.1508

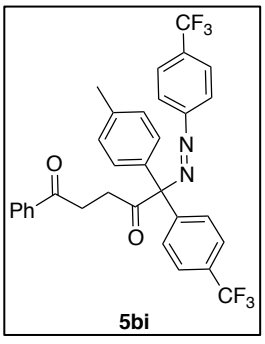
1,5-diphenyl-5-(4-(trifluoromethyl)phenyl)-5-((4-(trifluoromethyl)phenyl)diazenyl)pentane-1,4-dione (5bh)



5bh

5bh was prepared following the General Procedure 3.5 as pale yellow oil. Yield: 73%. The regioselectivity is determined by crude **^{19}F NMR** and **^{1}H NMR**.
^{1}H NMR (600 MHz, CD_3CN) δ 7.95 (dd, *J* = 8.7, 7.1 Hz, 4H), 7.89 (d, *J* = 8.6 Hz, 2H), 7.71 (d, *J* = 8.3 Hz, 2H), 7.61 (t, *J* = 7.4 Hz, 1H), 7.52 – 7.42 (m, 7H), 7.37 – 7.32 (m, 2H), 3.34 – 3.24 (m, 2H), 3.06 – 2.94 (m, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 206.8, 199.3, 154.7, 144.4, 139.1, 137.6, 134.1, 133.3 (q, *J* = 32.6 Hz), 131.6, 131.0 (q, *J* = 32.6 Hz), 130.2, 129.6, 129.5, 128.8, 127.6, 125.8, 125.3 (q, *J* = 271.8 Hz), 125.0 (q, *J* = 271.8 Hz), 124.0, 94.1, 36.6, 33.6. **^{19}F NMR** (565 MHz, CD_3CN) δ -63.1, -63.2. **HRMS** m/z (ESI) calcd. for $C_{31}H_{23}F_6N_2O_2^+$ $[M+H]^+$ 529.1327 found 529.1330

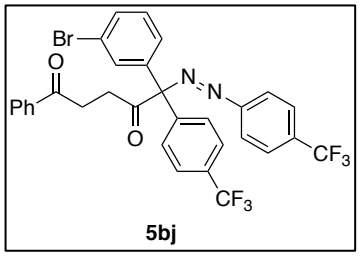
1-phenyl-5-(p-tolyl)-5-(4-(trifluoromethyl)phenyl)-5-((4-(trifluoromethyl)phenyl)diazenyl)-pentane-1,4-dione (5bi)



5bi

5bi was prepared following the General Procedure 3.5 as pale yellow oil. Yield: 68%. The regioselectivity is determined by crude **^{19}F NMR** and **^{1}H NMR**.
^{1}H NMR (600 MHz, CD_3CN) δ 7.95 (dd, *J* = 13.2, 7.9 Hz, 4H), 7.89 (d, *J* = 8.3 Hz, 2H), 7.71 (d, *J* = 8.3 Hz, 2H), 7.62 (t, *J* = 7.4 Hz, 1H), 7.50 (t, *J* = 7.6 Hz, 2H), 7.43 (d, *J* = 8.2 Hz, 2H), 7.29 (d, *J* = 8.0 Hz, 2H), 7.21 (d, *J* = 8.0 Hz, 2H), 3.29 (td, *J* = 6.3, 4.5 Hz, 2H), 3.05 – 2.92 (m, 2H), 2.38 (s, 3H). **^{13}C NMR** (151 MHz, CD_3CN) δ 206.9, 199.3, 154.7, 144.5, 139.5, 137.6, 136.0, 134.1, 133.2 (q, *J* = 32.4 Hz), 131.6, 130.3 (q, *J* = 32.4 Hz), 130.2, 130.1, 129.6, 128.8, 127.6, 125.8, 125.3 (q, *J* = 271.8 Hz), 124.6 (q, *J* =271.8Hz), 124.0, 93.9, 36.5, 33.6, 21.1. **^{19}F NMR** (565 MHz, CD_3CN) δ -63.1, -63.2. **HRMS** m/z (ESI) calcd. for $C_{32}H_{25}F_6N_2O_2^+$ $[M+H]^+$ 583.1820 found 583.1817.

5-(3-bromophenyl)-1-phenyl-5-(4-(trifluoromethyl)phenyl)-5-((4-(trifluoromethyl)phenyl)-diazenyl)pentane-1,4-dione (5bj)

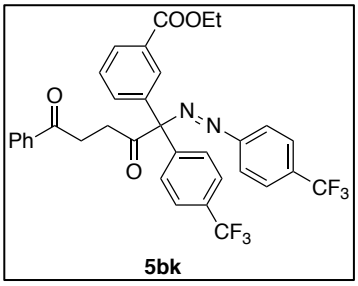


5bj

5bj was prepared following the General Procedure 3.5 as pale yellow oil. Yield: 82%.

^{1}H NMR (600 MHz, **CD_3CN**) δ 7.99 – 7.92 (m, 4H), 7.92 – 7.88 (m, 2H), 7.74 (d, *J* = 8.3 Hz, 2H), 7.65 – 7.59 (m, 2H), 7.55 – 7.47 (m, 5H), 7.37 (td, *J* = 7.9, 1.3 Hz, 1H), 7.28 – 7.23 (m, 1H), 3.30 (t, *J* = 6.2 Hz, 2H), 2.99 (dd, *J* = 6.9, 5.5 Hz, 2H). ^{13}C NMR (151 MHz, **CD_3CN**) δ 206.4, 199.2, 154.6, 143.8, 141.8, 137.6, 134.1, 133.4 (q, *J* = 31.6 Hz), 133.2, 132.4, 131.4, 131.3, 130.6 (q, *J* = 32.7 Hz), 129.6, 129.5, 128.8, 127.6, 126.1, 125.1 (q, *J* =271.8 Hz), 124.9 (q, *J* = 271.8 Hz), 124.1, 123.0, 93.4, 36.6, 33.5. **^{19}F NMR** (565 MHz, **CD_3CN**) δ -63.2, -63.2. **HRMS** m/z (ESI) calcd. for $C_{31}H_{22}BrF_6N_2O_2^+$ $[M+H]^+$ 647.0769 found 647.0764.

ethyl 3-(2,5-dioxo-5-phenyl-1-(4-(trifluoromethyl)phenyl)-1-((4-(trifluoromethyl)phenyl)-diazenyl)pentyl)benzoate (5bk)

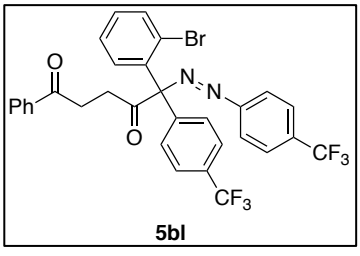


5bk

5bk was prepared following the General Procedure 3.5 as pale yellow oil. Yield: 84%.

^{1}H NMR (600 MHz, CD_3CN) δ 7.95 (d, *J* = 7.5 Hz, 1H), 7.87 – 7.83 (m, 4H), 7.80 (d, *J* = 8.5 Hz, 3H), 7.65 (d, *J* = 8.3 Hz, 2H), 7.51 (t, *J* = 7.4 Hz, 1H), 7.46 (t, *J* = 7.7 Hz, 1H), 7.44 – 7.37 (m, 5H), 4.21 (q, *J* = 7.1 Hz, 2H), 3.20 (t, *J* = 6.2 Hz, 2H), 2.92 (t, *J* = 6.2 Hz, 2H), 1.22 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR** (151 MHz, CD_3CN) δ 206.6, 199.2, 166.8, 154.7, 144.0, 139.8, 137.6, 135.0, 134.2 (q, *J* = 32.6 Hz), 134.1, 131.8, 131.4, 131.4 (q, *J* = 32.2 Hz), 131.2, 130.1, 129.8, 129.6, 128.8, 127.7, 126.2, 126.0 (q, *J* = 271.8 Hz), 125.7 (q, *J* = 271.8 Hz), 124.1, 93.8, 62.1, 36.6, 33.5, 14.5. **^{19}F NMR** (565 MHz, CD_3CN) δ -63.1, -63.2.

5-(2-bromophenyl)-1-phenyl-5-(4-(trifluoromethyl)phenyl)-5-((4-(trifluoromethyl)phenyl)-diazenyl)pentane-1,4-dione (5bl)

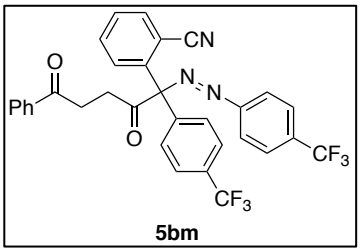


5bl

5bl was prepared following the General Procedure 3.5 as pale yellow oil. Yield: 80%

^{1}H NMR (600 MHz, CD_3CN) δ 8.01 (dd, *J* = 8.1, 1.4 Hz, 2H), 7.93 (s, 4H), 7.80 (d, *J* = 8.6 Hz, 2H), 7.69 – 7.62 (m, 2H), 7.53 (t, *J* = 7.7 Hz, 2H), 7.46 (d, *J* = 8.3 Hz, 2H), 7.31 (pd, *J* = 7.4, 1.8 Hz, 2H), 6.82 (dd, *J* = 7.3, 2.2 Hz, 1H), 3.54 – 3.40 (m, 3H), 3.35 – 3.28 (m, 1H). **^{13}C NMR** (151 MHz, CD_3CN) δ 206.4 , 199.3, 155.0, 141.7, 140.5, 137.8, 134.8, 134.3, 134.0, 133.2 (q, *J* = 32.2 Hz), 131.0, 130.8, 129.6, 129.4 (q, *J* = 32.2 Hz), 128.8, 128.1, 127.7, 126.6, 125.5, 125.2 (q, *J* = 271.8 Hz), 125.0 (q, *J* =271.8 Hz), 123.9, 95.5, 37.4, 32.9. **^{19}F NMR** (565 MHz, CD_3CN) δ -63.2, -63.2. **HRMS** m/z (ESI) calcd. for $C_{31}H_{22}BrF_6N_2O_2^+$ $[M+H]^+$ 647.0769 found 647.0769.

2-(2,5-dioxo-5-phenyl-1-(4-(trifluoromethyl)phenyl)-1-((4-(trifluoromethyl)phenyl)-diazenyl)pentyl)benzonitrile (5bm)

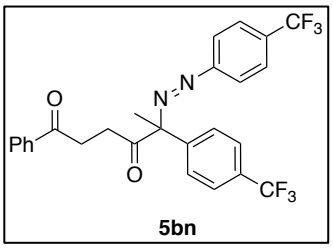


5bm

5bm was prepared following the General Procedure 3.5 as pale yellow oil. Yield: 88%

^{1}H NMR (600 MHz, CD_3CN) δ 7.97 (dd, *J* = 10.3, 8.4 Hz, 4H), 7.92 (d, *J* = 8.4 Hz, 2H), 7.82 (t, *J* = 7.9 Hz, 3H), 7.65 – 7.59 (m, 2H), 7.52 (dt, *J* = 21.3, 8.0 Hz, 5H), 7.01 (d, *J* = 8.0 Hz, 1H), 3.50 – 3.41 (m, 2H), 3.32 – 3.19 (m, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 206.0, 199.1, 154.5, 143.9, 141.4, 137.6, 135.1, 134.1, 133.6, 133.5 (q, *J* = 32.3 Hz), 132.6, 131.2 (q, *J* = 32.5 Hz), 130.8, 129.8, 129.6, 128.8, 127.8, 126.7, 124.9 (q, *J* = 271.8 Hz), 125.2 (q, *J* = 271.8 Hz), 124.1, 119.7, 115.1, 95.0, 37.6, 32.9. **^{19}F NMR** (565 MHz, CD_3CN) δ -63.2, -63.2. **HRMS** m/z (ESI) calcd. for $C_{32}H_{21}F_6N_3O_2Na^+$ $[M+Na]^+$ 616.1436 found 616.1436.

1-phenyl-5-(4-(trifluoromethyl)phenyl)-5-((4-(trifluoromethyl)phenyl)diazenyl)hexane-1,4-dione (5bn)

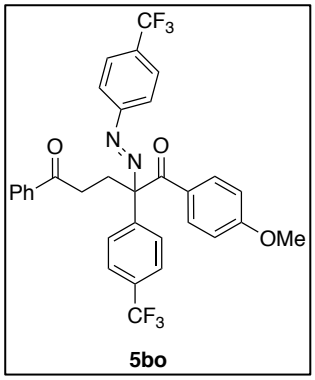


5bn

5bn was prepared following the General Procedure 3.5 as pale yellow oil. Yield: 83%.

^{1}H NMR (600 MHz, CD_3CN) δ 7.99 (d, *J* = 8.3 Hz, 2H), 7.97 – 7.94 (m, 2H), 7.91 (d, *J* = 8.4 Hz, 2H), 7.83 – 7.76 (m, 4H), 7.65 – 7.60 (m, 1H), 7.50 (t, *J* = 7.7 Hz, 2H), 3.30 – 3.16 (m, 2H), 2.90 (td, *J* = 6.2, 3.1 Hz, 2H), 1.79 (s, 3H). **^{13}C NMR** (151 MHz, CD_3CN) δ 206.9, 199.2, 154.9, 146.2, 137.6, 134.1, 133.0 (q, *J* = 32.3 Hz), 130.3 (q, *J* = 32.4 Hz), 129.6, 128.9, 128.8, 127.6, 126.5, 125.3 (q, *J* =271.8 Hz), 125.1 (q, *J* = 271.8 Hz), 123.9, 86.9, 35.2, 33.0, 22.3. **^{19}F NMR** (565 MHz, CD_3CN) δ -63.1, -63.2. **HRMS** m/z (ESI) calcd. for $C_{26}H_{21}F_6N_2O_2^+$ $[M+H]^+$ 529.1327 found 529.1330.

(E)-1-(4-methoxyphenyl)-5-phenyl-2-(4-(trifluoromethyl)phenyl)-2-((4-(trifluoromethyl)-phenyl)diazenyl)pentane-1,5-dione (5bo)

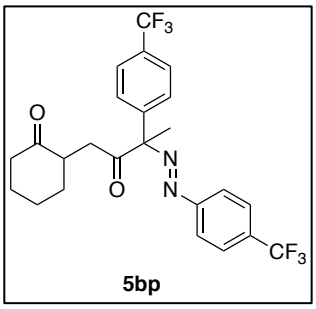


5bo

5bo was prepared following the General Procedure 3.5 as pale yellow oil. Yield: 80%

^{1}H NMR (600 MHz, CD_3CN) δ 8.02 (d, *J* = 8.2 Hz, 2H), 7.84 (q, *J* = 8.5 Hz, 4H), 7.79 (d, *J* = 8.3 Hz, 2H), 7.77 – 7.74 (m, 2H), 7.57 – 7.53 (m, 1H), 7.51 – 7.46 (m, 2H), 7.41 (t, *J* = 7.8 Hz, 2H), 6.79 – 6.71 (m, 2H), 3.71 (s, 3H), 2.86 (ddd, *J* = 8.9, 6.1, 3.1 Hz, 2H), 2.83 – 2.75 (m, 1H), 2.70 (ddd, *J* = 13.9, 8.6, 6.8 Hz, 1H). **^{13}C NMR** (151 MHz, CD_3CN) δ 199.7, 195.6, 164.0, 154.9, 146.2, 137.6, 134.2, 133.9, 133.2 (q, *J* = 32.7 Hz), 130.2 (q, *J* = 32.3 Hz), 129.4, 128.7, 128.5, 127.5, 127.1 (q, *J* = 271.8 Hz), 126.9, 126.8 (q, *J* = 271.8 Hz), 126.4, 123.8, 114.6, 87.2, 56.2, 36.8, 33.2. **^{19}F NMR** (565 MHz, CD_3CN) δ -63.0, -63.2. **HRMS** m/z (ESI) calcd. for $C_{32}H_{25}F_6N_2O_3^+$ $[M+H]^+$ 599.1769 found 599.1768.

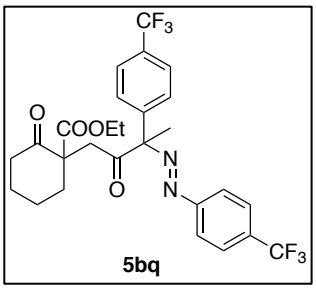
(E)-2-(2-oxo-3-(4-(trifluoromethyl)phenyl)-3-((4-(trifluoromethyl)phenyl)diazenyl)-butyl)cyclohexan-1-one (5bp)



5bp

5bp was prepared following the General Procedure 3.5 as pale yellow oil. Yield: 68%
^{1}H NMR (600 MHz, CD_3CN) δ 7.97 (dd, *J* = 11.3, 8.4 Hz, 2H), 7.91 (t, *J* = 6.8 Hz, 2H), 7.80 (s, 2H), 7.79 – 7.72 (m, 2H), 3.00 – 2.87 (m, 2H), 2.45 – 2.22 (m, 3H), 2.04 (ddt, *J* = 12.8, 6.3, 3.1 Hz, 1H), 1.96 – 1.90 (m, 1H), 1.81 – 1.64 (m, 5H), 1.53 (dtd, *J* = 17.6, 9.3, 4.5 Hz, 1H), 1.25 (ddt, *J* = 25.2, 12.7, 3.9 Hz, 1H). **^{13}C NMR** (151 MHz, CD_3CN) δ 211.2, 205.8, 154.5, 145.9, 132.60 (d, *J* = 32.2 Hz), 129.82 (d, *J* = 32.3 Hz), 128.6, 128.5, 127.2, 126.0, 124.9 (q, *J* = 271.8 Hz), 124.6 (q, *J* = 271.8 Hz), 123.5, 86.6, 86.4, 46.4, 46.2, 41.9, 41.8, 40.6, 40.5, 34.1, 33.8, 28.2, 28.1, 25.4, 25.3, 22.0, 21.6. **^{19}F NMR** (565 MHz, CD_3CN) δ -63.1, -63.1, -63.1, -63.2 **HRMS** m/z (ESI) calcd. for $C_{24}H_{22}F_6N_2O_2^+$ $[M+H]^+$ 485.1664 found 485.1660.

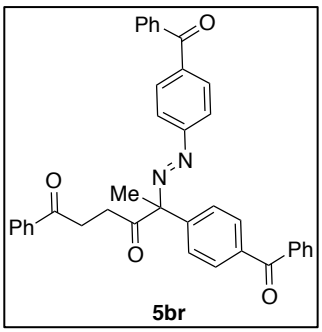
ethyl (E)-2-oxo-1-(2-oxo-3-(4-(trifluoromethyl)phenyl)-3-((4-(trifluoromethyl)phenyl)-diazenyl)butyl)cyclohexane-1-carboxylate (5bq)



5bq

5bq was prepared following the General Procedure 3.5 as pale yellow oil. Yield: 71%
^{1}H NMR (400 MHz, CD_3CN) δ 7.96 (d, *J* = 8.5 Hz, 2H), 7.90 (d, *J* = 8.7 Hz, 2H), 7.78 (s, 4H), 4.28 – 3.87 (m, 2H), 3.12 – 2.99 (m, 1H), 2.96 – 2.82 (m, 1H), 2.76 (ddt, *J* = 12.2, 10.4, 6.3 Hz, 1H), 2.36 – 2.27 (m, 1H), 1.87 – 1.78 (m, 1H), 1.77 – 1.70 (m, 3H), 1.26 – 1.12 (m, 3H). **^{13}C NMR** (101 MHz, CD_3CN) δ 208.0, 205.3, 172.8, 155.2, 146.4, 133.**42** (q, *J* = 32.5 Hz), 130.66 (q, *J* = 32.4 Hz), 129.4, 129.2, 128.0, 126.9,125.7 (q, *J* =271.7 Hz), 125.4 (q, *J* = 272.7 Hz), 124.3, 87.1, 62.0, 59.4, 45.8, 41.4, 41.0, 37.2, 36.0, 33.8, 33.5, 31.6, 28.0, 27.7, 27.4, 26.5, 25.5, 22.9, 22.4, 22.1, 21.9, 14.2. **^{19}F NMR** (565 MHz, CD_3CN) δ -63.1, -63.2.

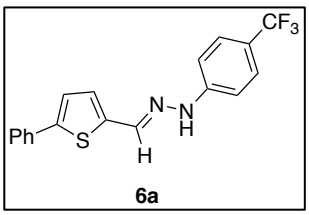
(E)-5-(4-benzoylphenyl)-5-((4-benzoylphenyl)diazenyl)-1-phenylhexane-1,4-dione (5br)



5br

5br was prepared following the General Procedure 3.7 as pale yellow oil. Yield: 79%
^{1}H NMR (600 MHz, CD_3CN) δ 7.94 (d, J = 1.5 Hz, 6H), 7.87 – 7.84 (m, 2H), 7.81 (ddd, J = 13.9, 8.3, 1.4 Hz, 3H), 7.76 – 7.71 (m, 2H), 7.70 – 7.64 (m, 2H), 7.60 (td, J = 7.3, 1.3 Hz, 1H), 7.58 – 7.52 (m, 4H), 7.49 (t, J = 7.8 Hz, 2H), 3.24 (td, J = 6.1, 1.8 Hz, 2H), 2.94 (q, J = 6.3 Hz, 2H), 1.81 (s, 3H).
^{13}C NMR (151 MHz, CD3CN) δ 207.2, 199.2, 196.7, 196.5, 154.7, 146.3, 140.7, 138.3, 138.0, 137.8, 137.6, 134.0, 133.8, 133.5, 131.9, 131.1, 130.8, 130.7, 129.5, 129.4, 129.3, 128.7, 128.0, 123.1, 87.0, 35.2, 33.1, 22.3.
HRMS m/z (ESI) calcd. for $C_{38}H_{21}N_2O_4^+$ $[M+H]^+$ 579.2284 found 579.2286.

(E)-1-((5-phenylthiophen-2-yl)methylene)-2-(4-(trifluoromethyl)phenyl)hydrazine (6a)

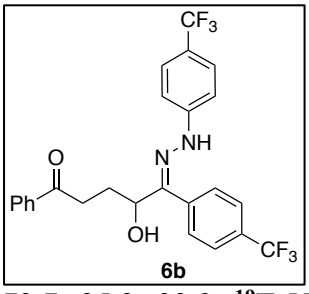


6a

6a was prepared following the General Procedure 3.8 as yellow oil. Yield: 87%

^{1}H NMR (600 MHz, CD_3CN) δ 9.07 (s, 1H), 8.03 (s, 1H), 7.74 – 7.68 (m, 2H), 7.56 (d, *J* = 8.5 Hz, 2H), 7.47 – 7.42 (m, 2H), 7.39 (d, *J* = 3.8 Hz, 1H), 7.37 – 7.34 (m, 1H), 7.22 (d, *J* = 3.9 Hz, 1H), 7.18 (d, *J* = 8.4 Hz, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 148.8, 145.2, 140.7, 135.3, 134.8, 130.1, 129.9, 129.0, 127.5, 126.5, 126.0 (q, *J* = 268.8 Hz), 124.8, 120.9 (q, *J* = 31.8 Hz), 112.7**. ^{19}F NMR** (565 MHz, CD_3CN) δ -61.6. **HRMS** m/z (ESI) calcd. for $C_{18}H_{14}F_3N_2S^+$ $[M+H]^+$ 347.0830 found 347.0827.

(E)-4-hydroxy-1-phenyl-5-(4-(trifluoromethyl)phenyl)-5-(2-(4-(trifluoromethyl)-phenyl)hydrazineylidene)pentan-1-one (6b)

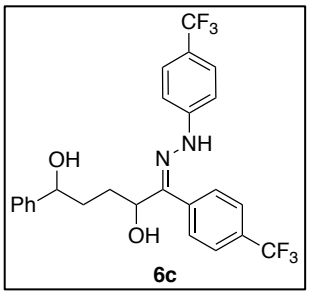


6b

6b was prepared following the General Procedure 3.10 as yellow oil. Yield: 87%

^{1}H NMR (600 MHz, CD_3CN)) δ 8.91 (s, 1H), 7.85 (d, *J* = 8.0 Hz, 2H), 7.61 (d, J = 8.5 Hz, 2H), 7.45 – 7.40 (m, 4H), 7.38 (t, *J* = 7.6 Hz, 2H), 7.34 – 7.28 (m, 3H), 4.77 (t, *J* = 6.4 Hz, 1H), 3.50 (s, 1H), 3.11 (td, *J* = 7.5, 4.6 Hz, 2H), 2.11 – 2.04 (m, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 199.2, 147.4, 146.3, 143.4, 135.5, 131.2, 129.1, 128.0, 127.5 (q, *J* = 271.8 Hz), 127.4, 127.0 (q, *J* = 271.8 Hz), 126.8, 123.7 (q, *J* = 32.3 Hz), 115.0, 73.7, 35.3, 33.9. **^{19}F NMR** (565 MHz, CD3CN) δ -62.0, -63.1. **HRMS** m/z (ESI) calcd. for $C_{25}H_{21}F_6N_2O_2^+$ $[M+H]^+$ 495.1507, found 495.1512.

(E)-1-phenyl-5-(4-(trifluoromethyl)phenyl)-5-(2-(4-(trifluoromethyl)phenyl)-hydrazineylidene)pentane-1,4-diol (6c)

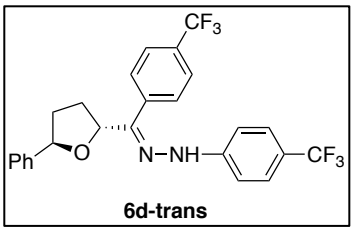


6c

6c was prepared following the General Procedure 3.11 as yellow oil. Yield: 93%. d.r. = 1:1

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.72 (dd, *J* = 13.1, 8.0 Hz, 2H), 7.41 (d, *J* = 8.3 Hz, 2H), 7.38 – 7.34 (m, 2H), 7.34 – 7.30 (m, 1H), 7.27 – 7.14 (m, 4H), 6.94 (d, *J* = 8.4 Hz, 2H), 4.64 (m, 1H), 4.57 (m, 1H), 1.89 – 1.80 (m, 2H), 1.71 (m, 1H), 1.55 (m, 1H).**^{13}C NMR** (151 MHz, $CDCl_3$) δ 146.5, 145.5, 143.5, 134.0, 127.5, 127.5, 126.6, 125.8, 125.6, 125.3 (q, *J* = 271.8 Hz), 125.0 (125.3 (q, *J* = 271.8 Hz), 124.7, 124.7, 120.6 (q, *J* = 32.5 Hz), 111.4, 73.2, 72.6, 33.7, 33.4, 30.2, 29.9. **^{19}F NMR** (565 MHz, $CDCl_3$) δ -61.4, -61.4, -62.9, -63.0. **HRMS** m/z (ESI) calcd. for $C_{25}H_{23}F_6N_2O_2^+$ $[M+H]^+$ 497.1664, found 497.1660.

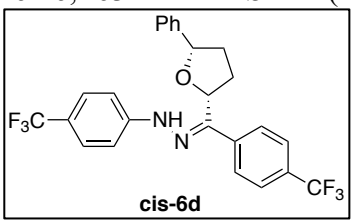
(E)-1-((5-phenyltetrahydrofuran-2-yl)(4-(trifluoromethyl)phenyl)methylene)-2-(4-(trifluoromethyl)phenyl)hydrazine (6d)



6d-trans

6d was prepared following the General Procedure 3.12 as yellow oil. Yield: 8%. d.r. = 1:1

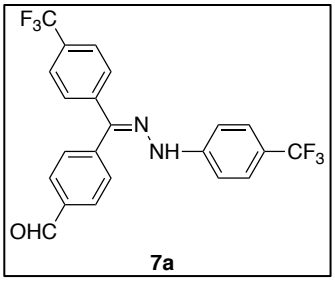
trans-6d: ^{1}H NMR (600 MHz, CD_3CN) δ 8.16 (s, 1H), 7.87 (d, *J* = 8.0 Hz, 2H), 7.62 (d, *J* = 8.0 Hz, 2H), 7.51 (d, *J* = 8.6 Hz, 2H), 7.35 (d, *J* = 5.8 Hz, 4H), 7.28 (dt, *J* = 5.1, 2.6 Hz, 1H), 7.19 (d, *J* = 8.5 Hz, 2H), 5.13 (dd, *J* = 7.7, 6.5 Hz, 1H), 4.80 (dd, *J* = 8.7, 5.9 Hz, 1H), 2.31 – 2.25 (m, 2H). **^{13}C NMR** (151 MHz, CD_3CN) δ 149.2, 147.9, 144.2, 137.6, 130.8, 129.2, 128.1, 127.2, 127.0, 126.6, 126.0 (q, *J* = 271.8 Hz), 125.3 (q, *J* = 271.8 Hz), 121.2 (q, *J* = 32.6 Hz), 118.3, 113.3, 83.7, 81.9, 36.0, 30.4. **^{19}F NMR** (565 MHz, CD_3CN) δ -61.6, -63.1. **HRMS** m/z (ESI) calcd. for $C_{25}H_{21}F_6N_2O_2^+$ $[M+H]^+$ 479.1558, found 479.1560.



cis-6d

cis-6d: ^{1}H NMR (600 MHz, CD_3CN) δ 10.62 (s, 1H), 7.94 (d, *J* = 8.2 Hz, 2H), 7.72 (d, *J* = 8.3 Hz, 2H), 7.51 (dt, *J* = 22.2, 7.2 Hz, 6H), 7.44 (d, *J* = 7.3 Hz, 1H), 7.00 (d, *J* = 8.4 Hz, 2H), 5.43 (dd, *J* = 9.3, 6.9 Hz, 1H), 5.08 (t, *J* = 7.4 Hz, 1H), 2.62 – 2.52 (m, 2H), 2.28 – 2.15 (m, 2H). **^{13}C NMR** (151 MHz, CD3CN) δ 148.6, 142.1, 142.1, 142.0, 129.8, 129.2, 127.6, 127.4, 127.4, 126.1, 126.0 (q, J = 271.8 Hz), 125.4 (q, J = 271.8 Hz), 121.6 (q, J = 32.2 Hz), 113.2, 83.0, 80.1, 33.2, 31.4. **^{19}F NMR** (565 MHz, CD_3CN) δ -61.7, -63.0.

(E)-4-((4-(trifluoromethyl)phenyl)(2-(4-(trifluoromethyl)phenyl)hydrazineylidene)methyl)-benzaldehyde (7a)



7a

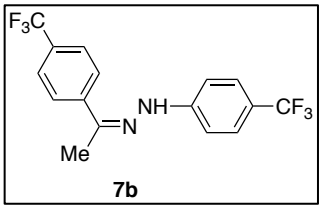
7a was prepared following the General Procedure 3.9 as yellow oil. Yield: 73%. E/Z ratio > 10:1

^{1}H NMR (600 MHz, $CDCl_3$) δ 10.02 (s, 1H), 7.92 (d, *J* = 7.8 Hz, 2H), 7.85 (d, *J* = 8.0 Hz, 2H), 7.70 (d, *J* = 7.4 Hz, 3H), 7.52 (dd, *J* = 12.0, 7.9 Hz, 4H), 7.18 (d, *J* = 8.3 Hz, 2H), 3.37 (br, 1H).

^{13}C NMR (151 MHz, CDCl3) δ 191.7, 146.1, 142.8, 135.9, 135.3, 129.8, 129.7, 127.2, 126.9, 126.8, 126.7, 126.5 (q, J = 271.8 Hz), 126.0 (q, J = 271.8 Hz), 124.8, 123.0, 122.7, 122.0 (q, J = 32.4 Hz)113.0.

^{19}F NMR (565 MHz, $CDCl_3$) δ -61.5, -62.9. **HRMS** m/z (ESI) calcd. for $C_{22}H_{15}F_6N_2O^+$ $[M+H]^+$ 437.1089, found 437.1087.

(Z)-1-(4-(trifluoromethyl)phenyl)-2-(1-(4-(trifluoromethyl)phenyl)ethylidene)hydrazine (7b)



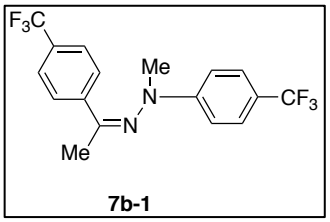
7b

7b was prepared following the General Procedure 3.9 as yellow oil. Yield: 92%.

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.90 (d, *J* = 8.2 Hz, 2H), 7.66 – 7.63 (m, 3H), 7.54 (d, *J* = 8.4 Hz, 2H), 7.24 (d, *J* = 8.4 Hz, 2H), 2.29 (s, 3H).**^{13}C NMR** (151 MHz, $CDCl_3$) δ 147.1, 141.9, 141.1, 126.7, 126.5 (q, *J* = 271.8 Hz), 126.0 (q, *J* = 271.8 Hz)125.8, 125.3, 122.3 (q, *J* = 32.4 Hz), 112.8, 11.9**. ^{19}F NMR** (565 MHz, $CDCl_3$) δ -61.3, -62.5. **HRMS** m/z (ESI) calcd. for $C_{16}H_{13}F_6N_2^+$

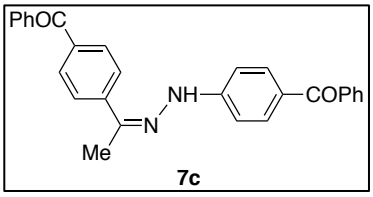
$[M+H]^+$ 497.1664, found 497.1660. **HRMS** m/z (ESI) calcd. for $C_{16}H_{13}F_6N_2^+$ $[M+H]^+$ 347.0983 found 347.0988.

(Z)-1-methyl-1-(4-(trifluoromethyl)phenyl)-2-(1-(4-(trifluoromethyl)phenyl)-ethylidene)hydrazine (7b-1)



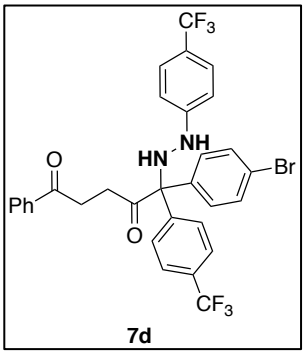
7b-1 was prepared following the general Procedure 3.13.
^{1}H NMR (600 MHz, Chloroform-d) δ 8.03 (d, J = 8.0 Hz, 2H), 7.74 – 7.65 (m, 2H), 7.52 (d, J = 8.4 Hz, 2H), 7.00 (d, J = 8.4 Hz, 2H), 3.23 (s, 3H), 2.40 (s, 3H).
^{13}C NMR (151 MHz, $CDCl_3$) δ 164.4, 153.0, 141.1, 131.81 (q, *J* = 32.6 Hz) 127.0, 126.1, 126.1, 126.1, 125.4, 125.4, 125.3 (q, *J* = 271.8 Hz), 124.5 (q, *J* = 271.8 Hz), 121.50 (q, *J* = 32.6 Hz) 114.3,, 42.1, 16.9. **^{19}F NMR** (565 MHz, $CDCl_3$) δ -61.3, -62.7.

(Z)-(4-(2-(1-(4-benzoylphenyl)ethylidene)hydrazineyl)phenyl)(phenyl)methanone (7c)



7c was prepared following the General Procedure 3.9 as yellow oil. Yield: 79%.
^{1}H NMR (600 MHz, $CDCl_3$) δ 7.94 – 7.89 (m, 3H), 7.86 (dd, *J* = 8.5, 4.2 Hz, 4H), 7.83 – 7.80 (m, 2H), 7.78 – 7.75 (m, 2H), 7.63 – 7.59 (m, 1H), 7.56 (d, *J* = 7.2 Hz, 1H), 7.49 (m, 4H), 7.27 (s, 1H), 2.34 (s, 3H). **^{13}C NMR** (151 MHz, $CDCl_3$) δ 196.2, 195.4, 148.2, 142.3, 142.0, 138.6, 137.6, 136.9, 132.7, 132.5, 131.7, 131.0, 130.4, 130.1, 130.0, 129.7, 129.5, 128.5, 128.3, 128.1, 125.4, 112.5, 12.0. **HRMS** m/z (ESI) calcd. for $C_{16}H_{13}F_6N_2^+$ $[M+H]^+$ 497.1664, found 497.1660.

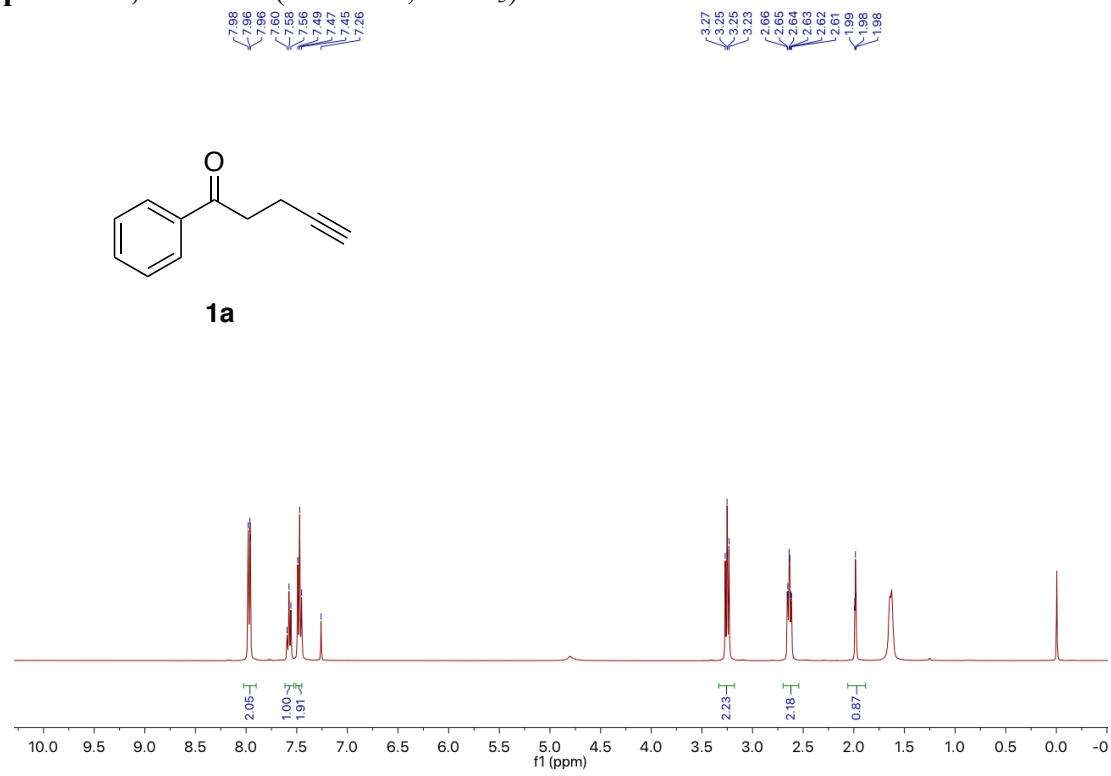
5-(4-bromophenyl)-1-phenyl-5-(4-(trifluoromethyl)phenyl)-5-(2-(4-(trifluoromethyl)-phenyl)hydrazineyl)pentane-1,4-dione (7d)



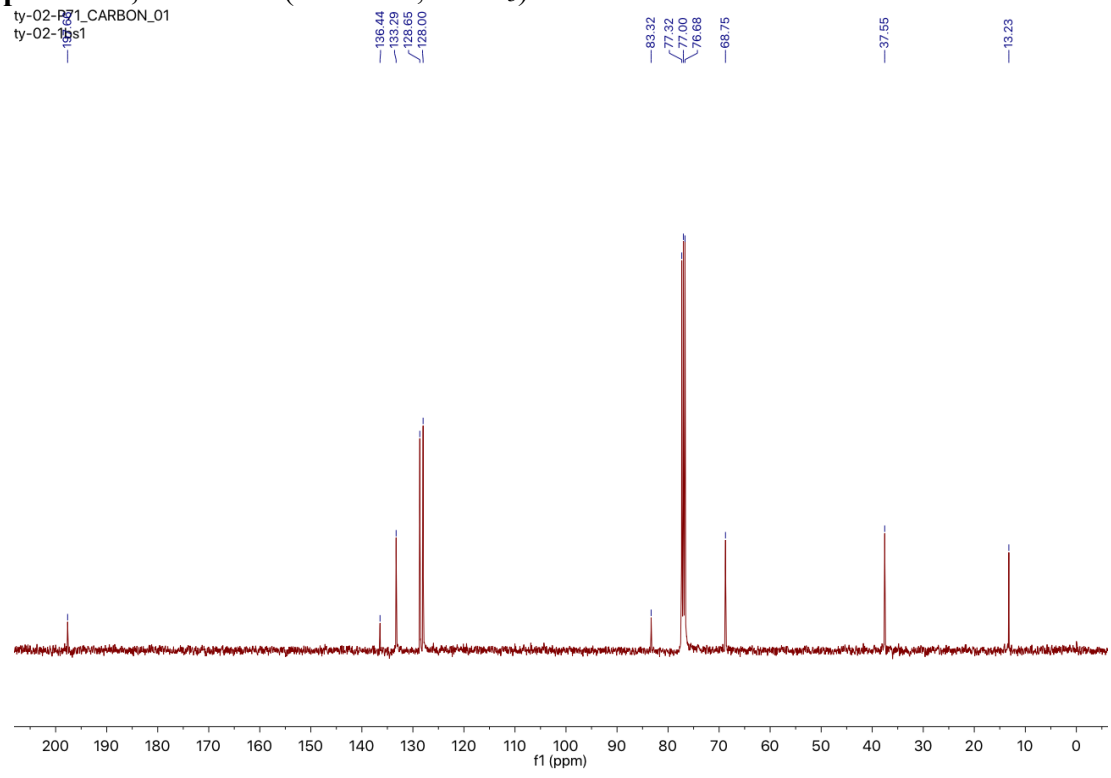
7d was prepared following the General Procedure 3.10 as yellow oil. Yield: 92%
^{1}H NMR (600 MHz, CD_3CN) δ 7.94 – 7.89 (m, 2H), 7.70 (d, J = 8.3 Hz, 2H), 7.63 – 7.59 (m, 3H), 7.57 (d, *J* = 8.6 Hz, 2H), 7.51 – 7.44 (m, 4H), 7.37 (d, J = 8.7 Hz, 2H), 7.16 (d, *J* = 8.5 Hz, 2H), 5.89 (br, 1H), 5.22 (br, 1H), 3.16 (dd, *J* = 6.9, 5.0 Hz, 2H), 3.09 (dd, *J* = 7.0, 4.9 Hz, 2H). **^{13}C NMR** (151 MHz, CD3CN) δ 208.8, 199.8, 153.5, 145.6, 140.2, 137.7, 134.1, 132.3, 131.9, 130.7, 130.11 (q, *J* = 32.3 Hz), 129.6, 128.8, 127.0, 126.1 (q, *J* = 271.8 Hz), 126.0, 125.3 (q, *J* = 271.8 Hz), 122.6, 120.7 (q, J = 32.5 Hz),114.2, 79.0, 33.4, 33.3. **^{19}F NMR** (565 MHz, CD_3CN) δ -61.5, -63.0. **HRMS** m/z (ESI) calcd. for $C_{31}H_{23}BrF_6N_2O_2^+$ $[M+H]^+$ 649.0925, found 649.0920.

VII. NMR Spectra

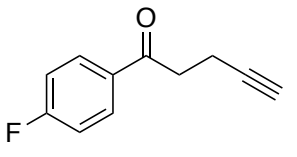
Compound 1a, ^{1}H NMR (400 MHz, $CDCl_3$)



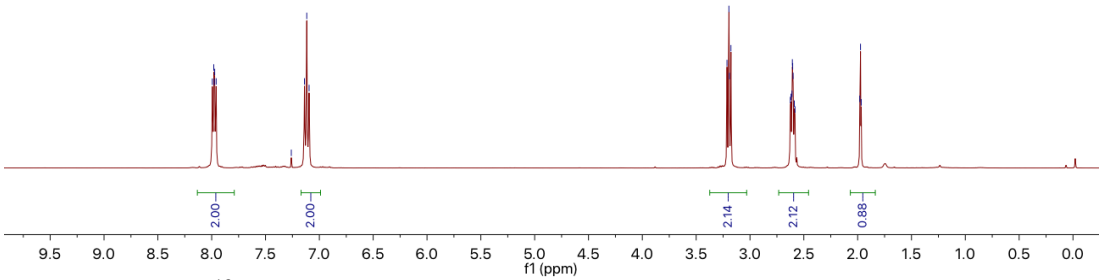
Compound 1a, ^{13}C-NMR (101 MHz; $CDCl_3$)



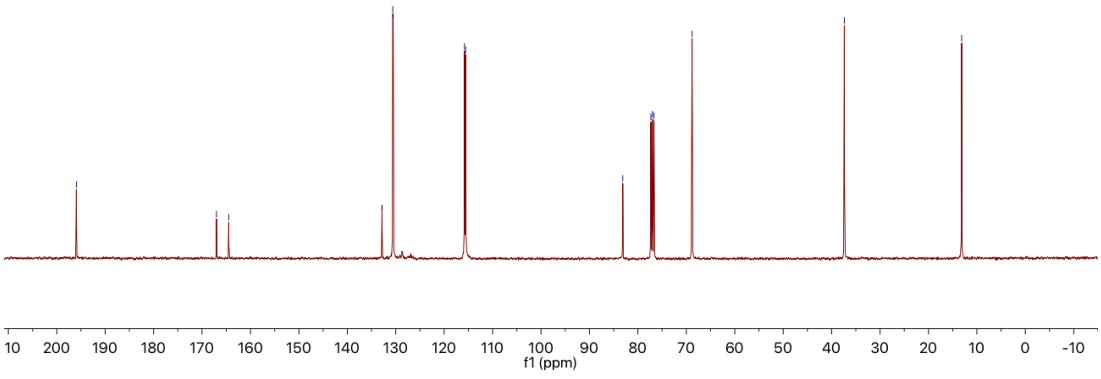
Compound 1b, ^{1}H NMR (400 MHz, $CDCl_3$)



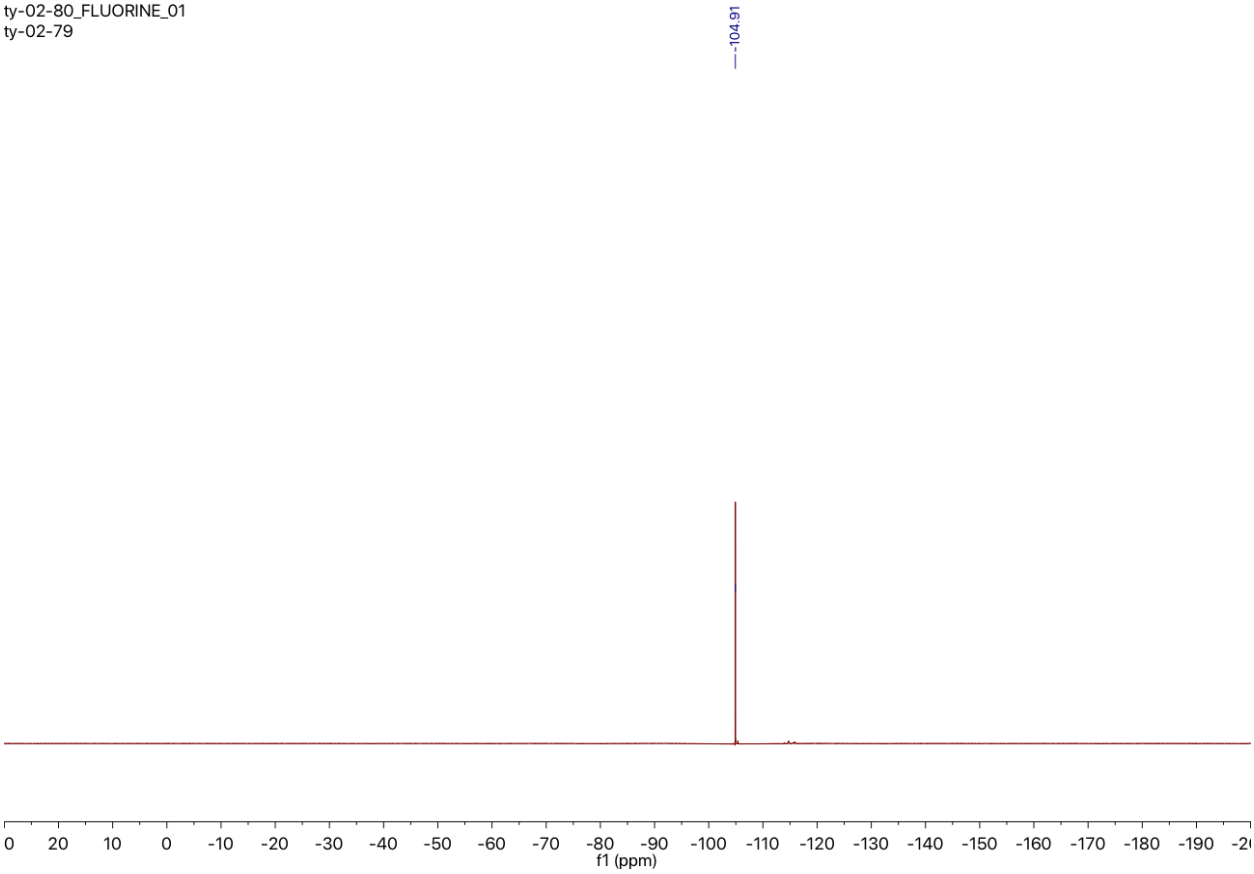
1b



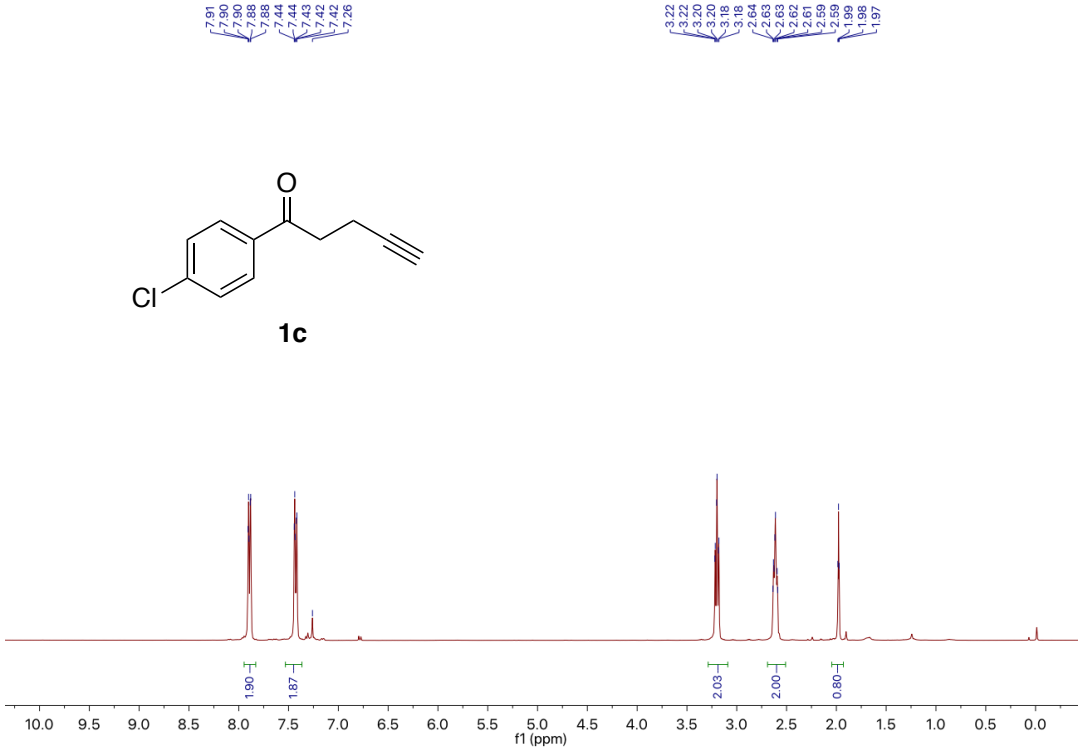
Compound 1b, ^{13}C-NMR (101 MHz; $CDCl_3$)



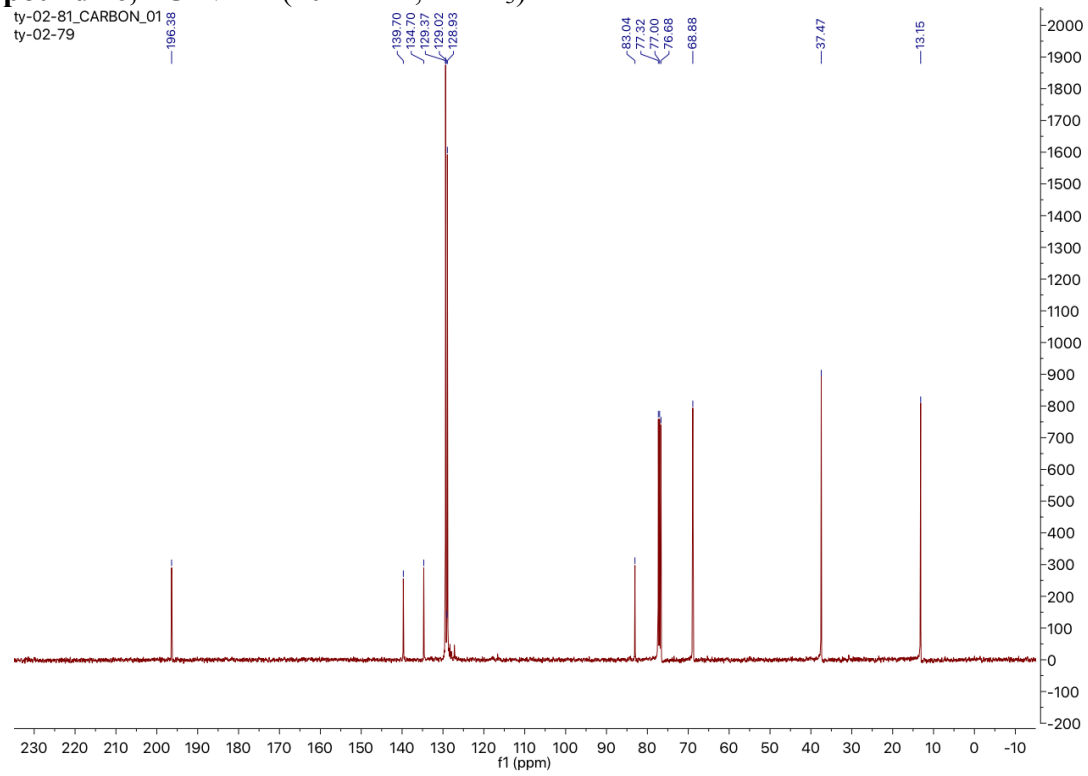
Compound 1b, ^{19}F-NMR (376 MHz; $CDCl_3$)



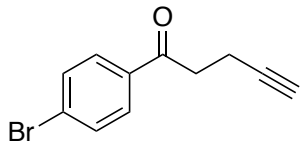
Compound 1c, ^{1}H NMR (400 MHz, $CDCl_3$)



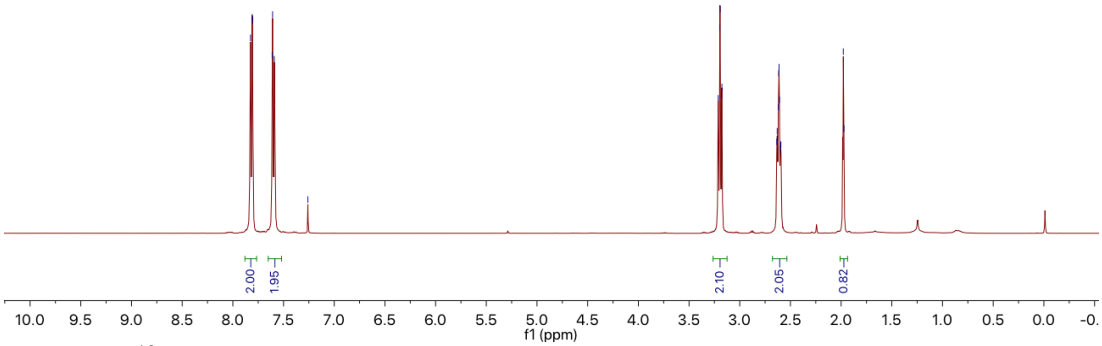
Compound 1c, ^{13}C-NMR (101 MHz; $CDCl_3$)



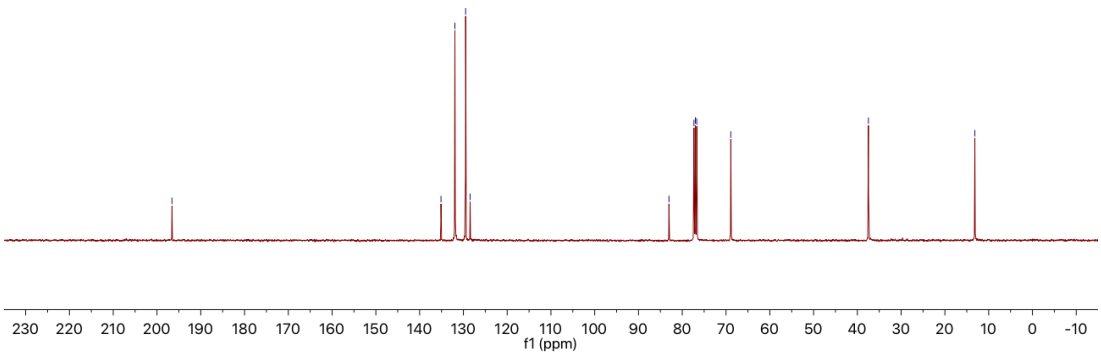
Compound 1d, ^{1}H NMR (400 MHz, $CDCl_3$)



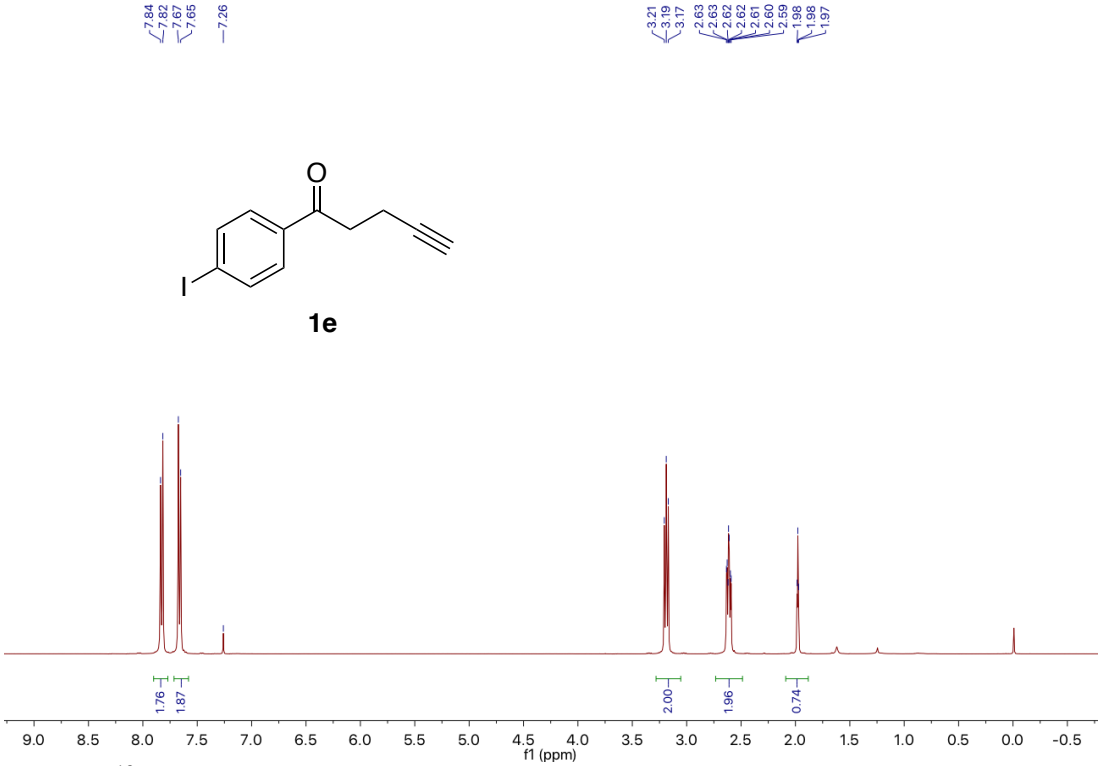
1d



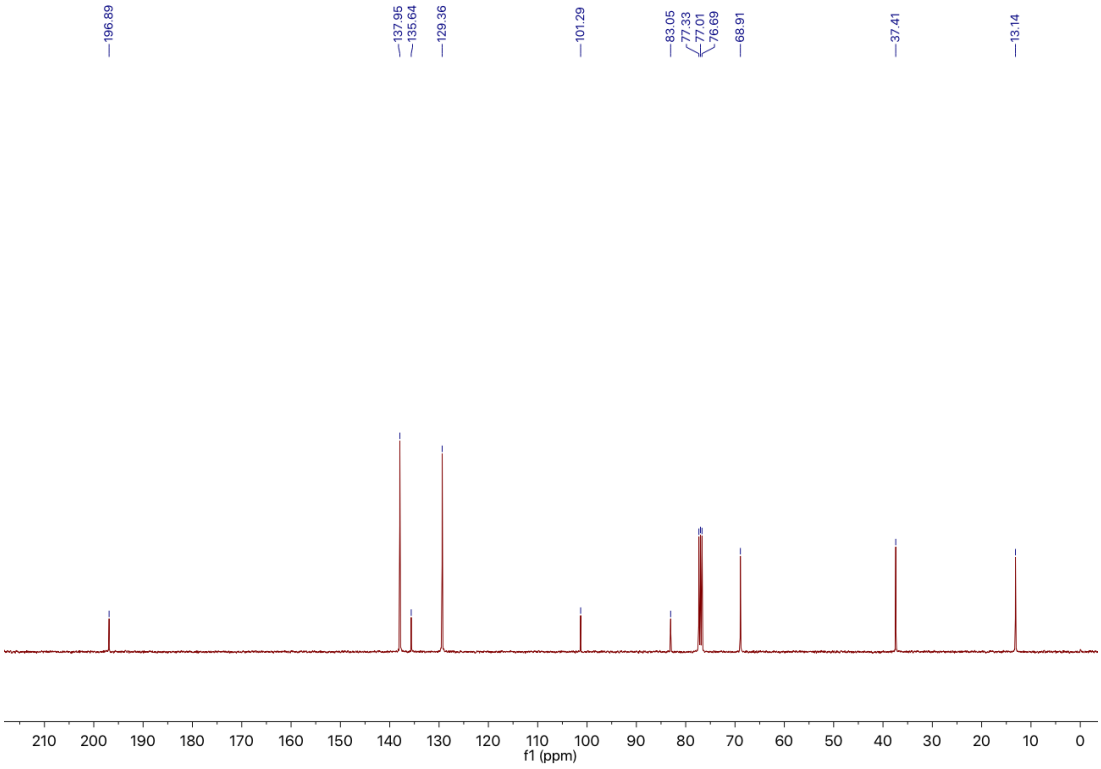
Compound 1d, ^{13}C-NMR (101 MHz; $CDCl_3$)



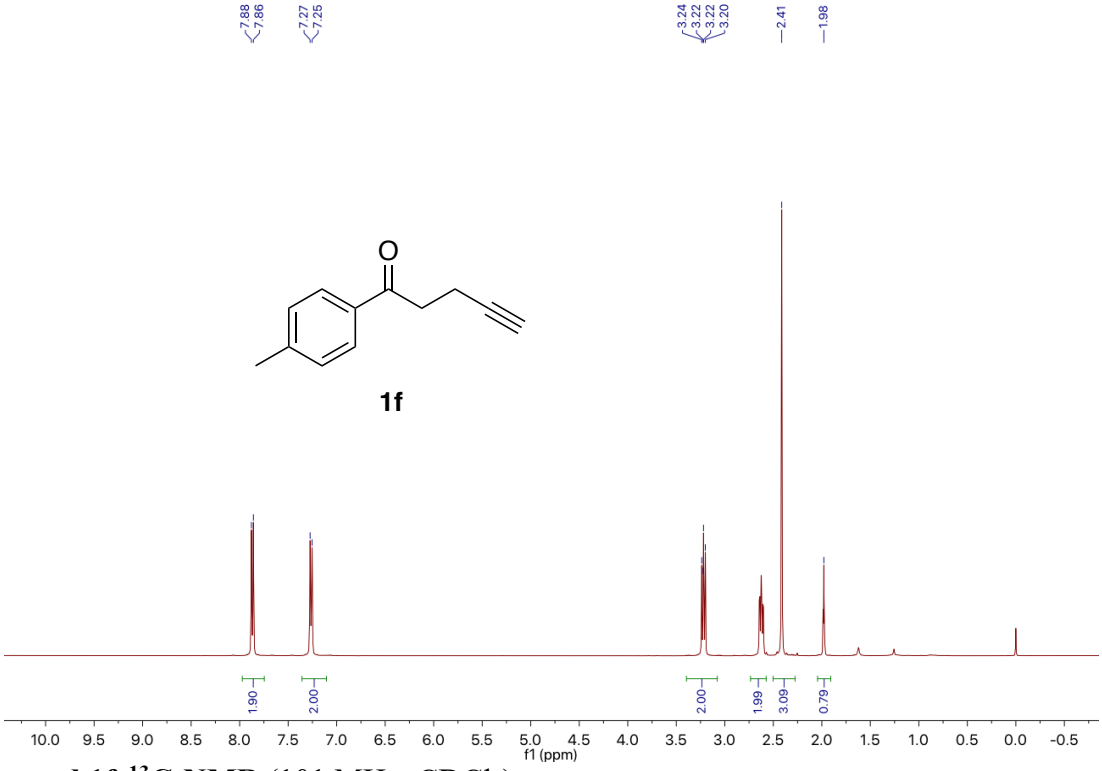
Compound 1e, ^{1}H NMR (400 MHz, $CDCl_3$)



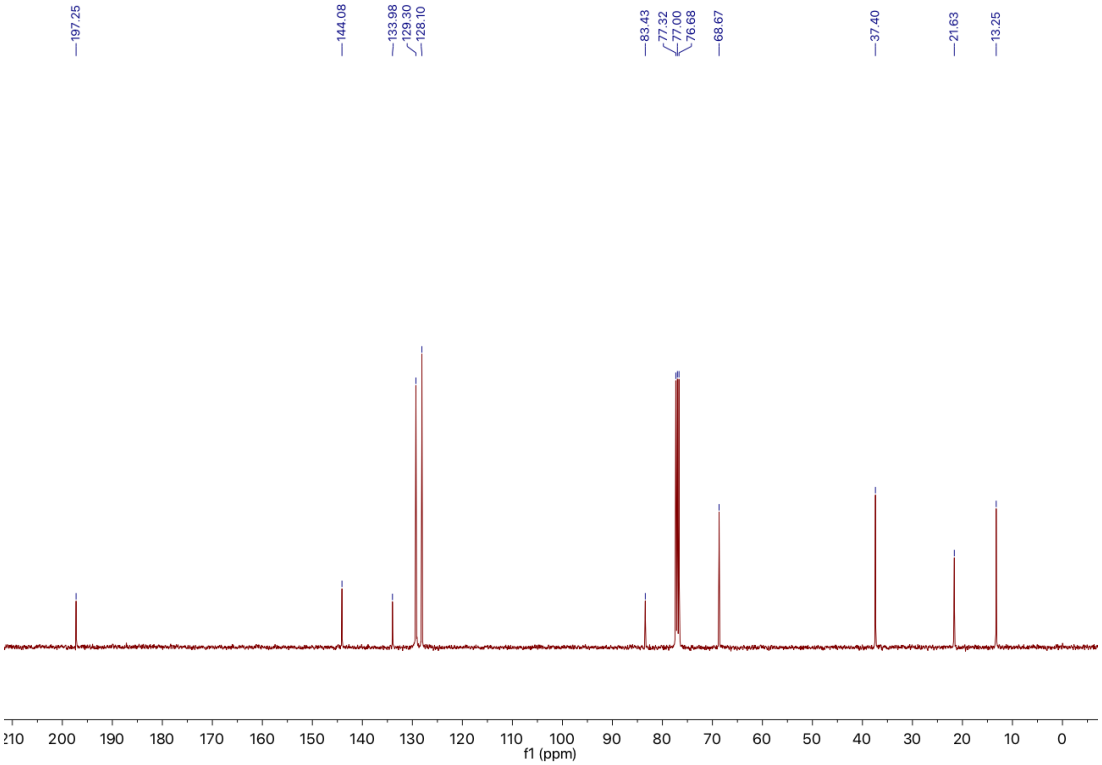
Compound 1e, ^{13}C-NMR (101 MHz; $CDCl_3$)



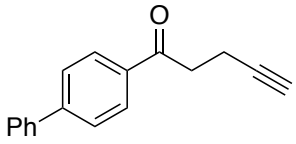
Compound 1f, ^{1}H NMR (400 MHz, $CDCl_3$)



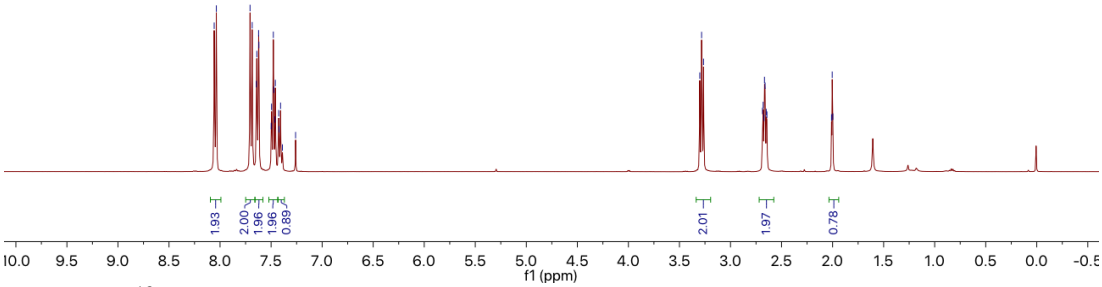
Compound 1f, ^{13}C-NMR (101 MHz; $CDCl_3$)



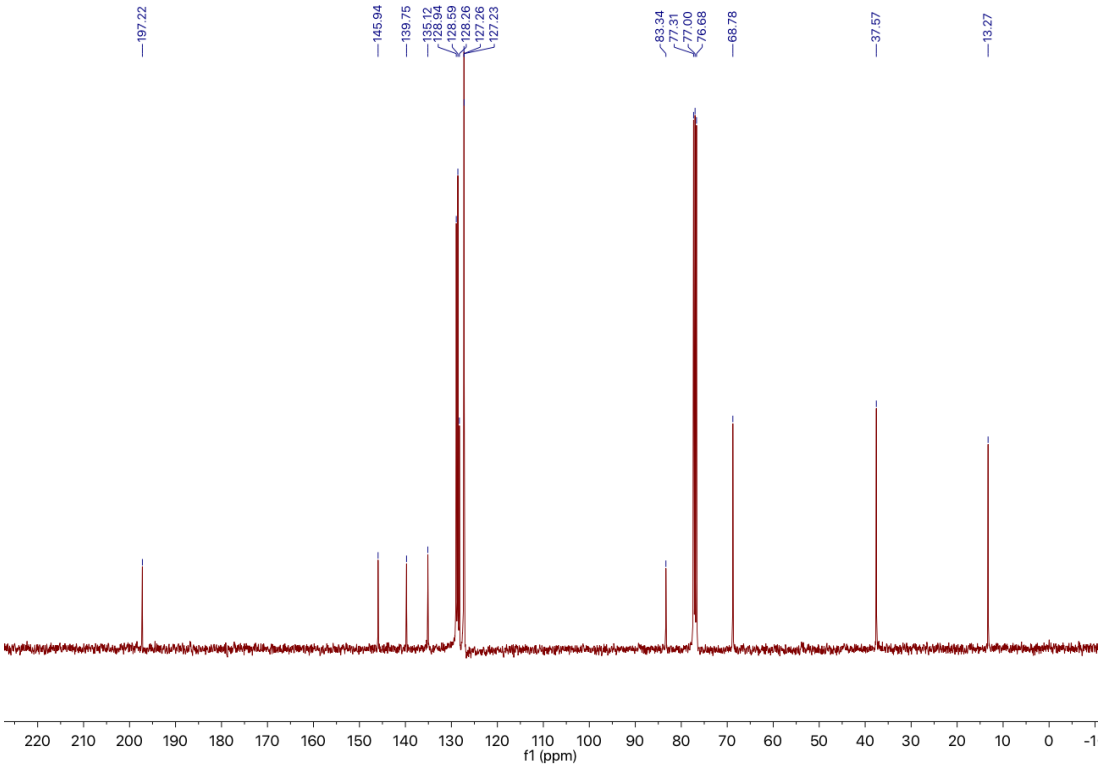
Compound 1g, ^{1}H NMR (400 MHz, $CDCl_3$)



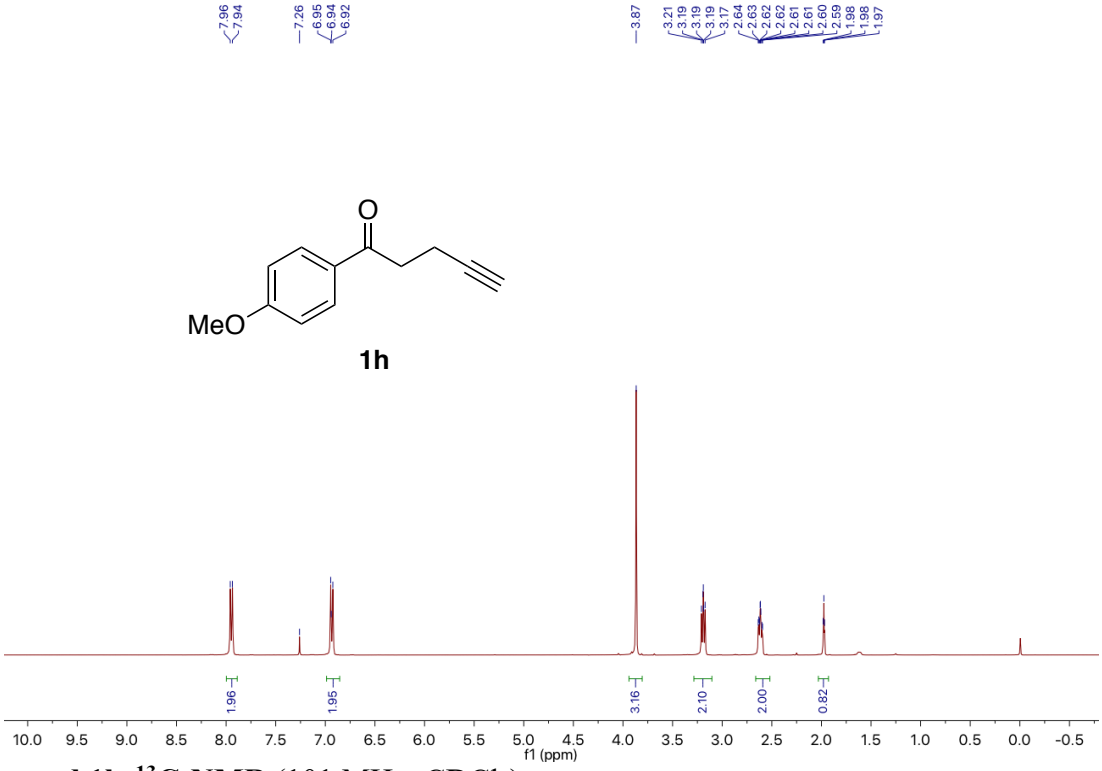
1g



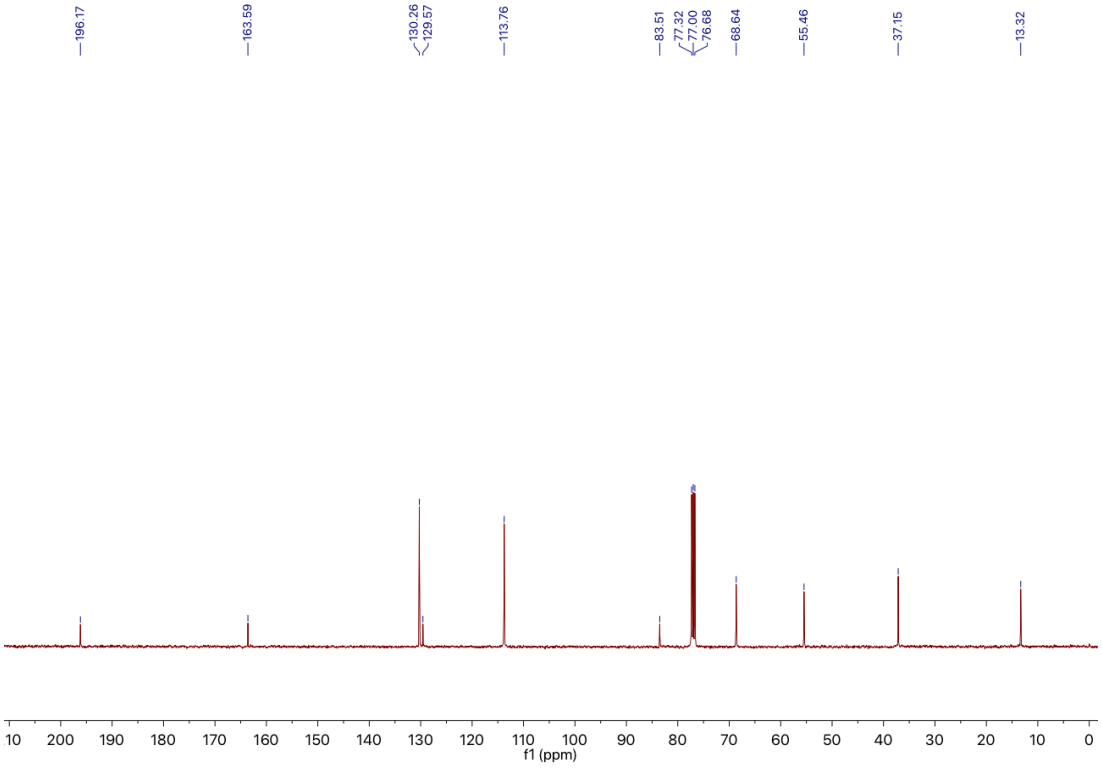
Compound 1g, ^{13}C-NMR (101 MHz; $CDCl_3$)



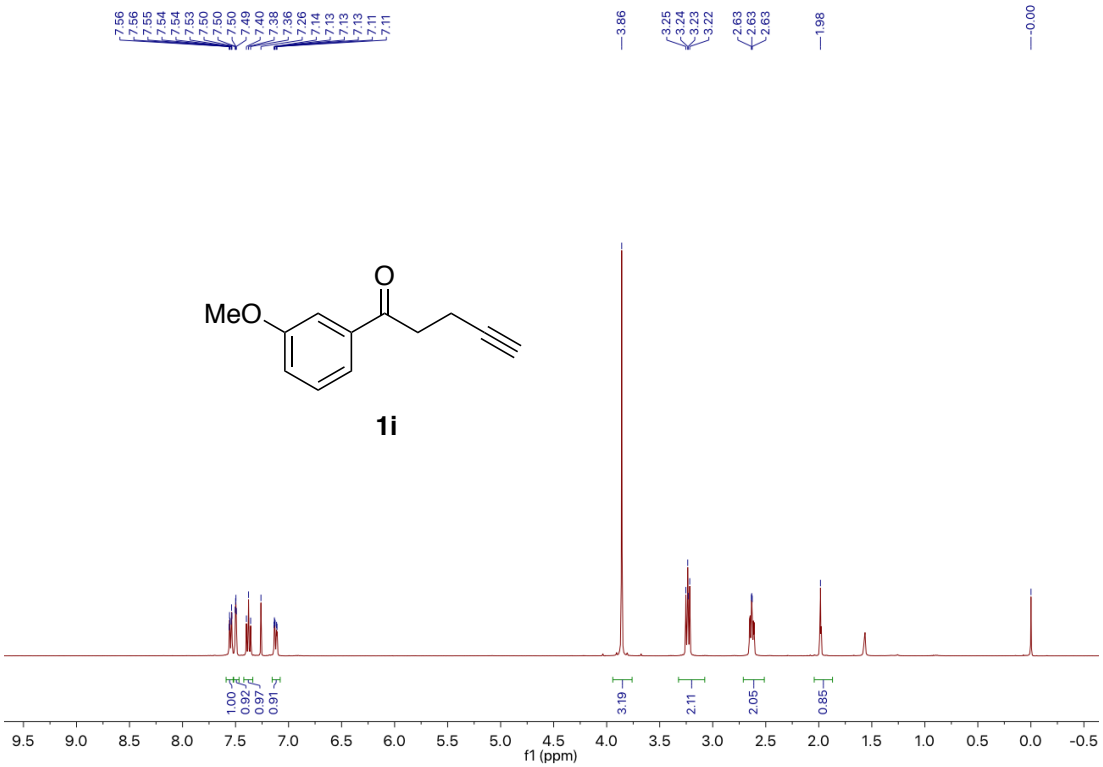
Compound 1h, ^{1}H NMR (400 MHz, $CDCl_3$)



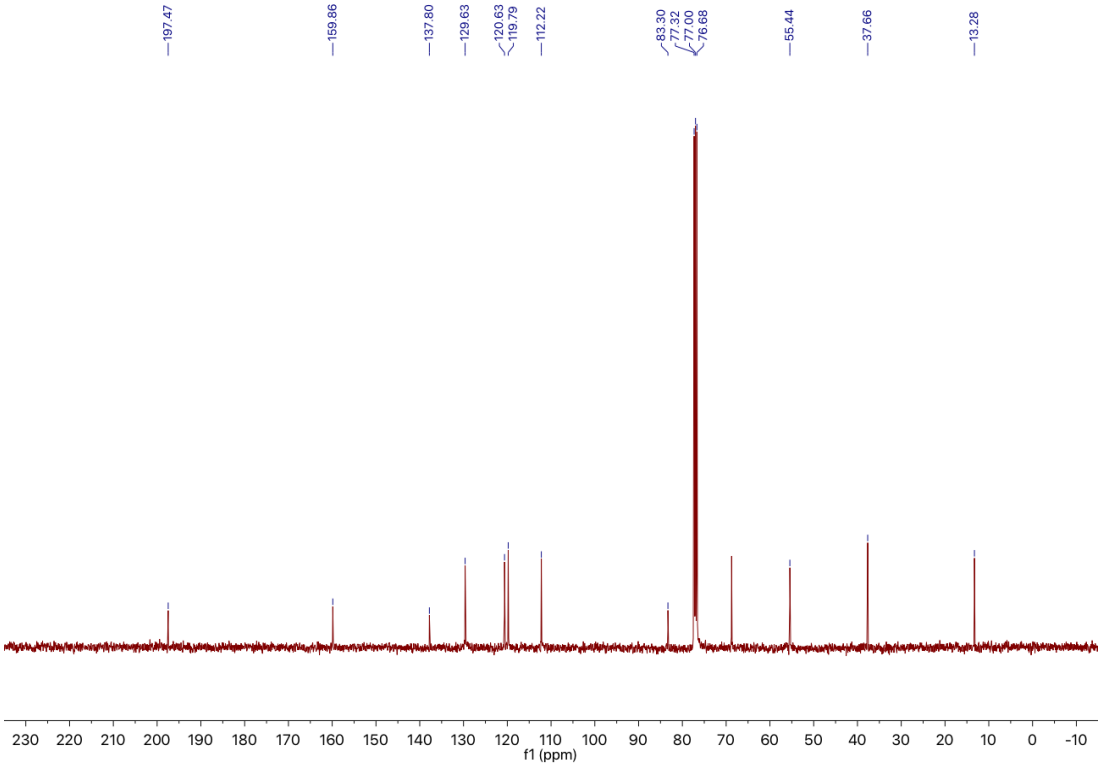
Compound 1h, ^{13}C-NMR (101 MHz; $CDCl_3$)



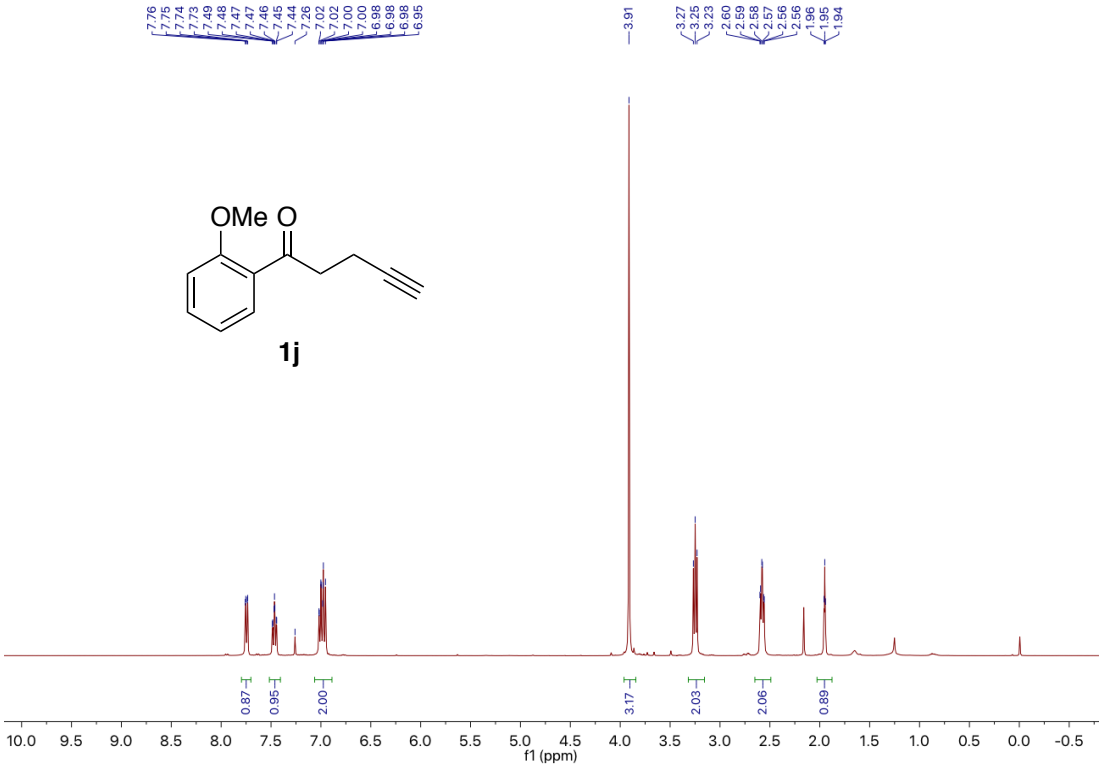
Compound 1i, ^{1}H NMR (400 MHz, $CDCl_3$)



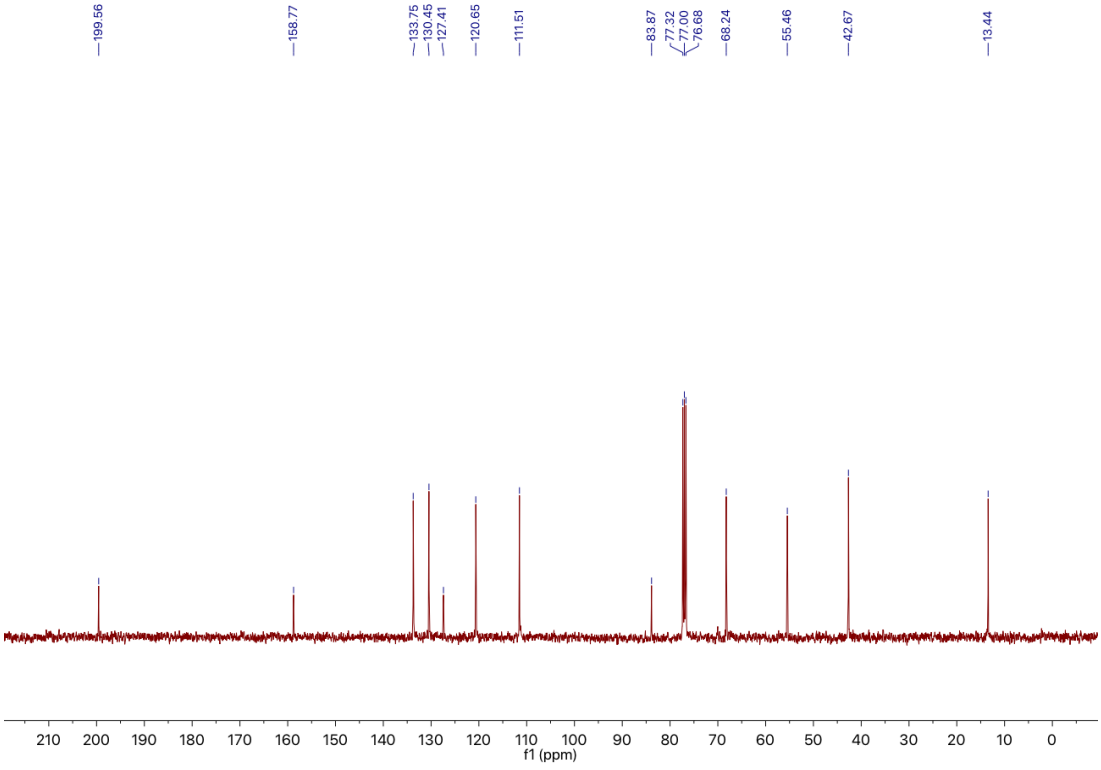
Compound 1h, ^{13}C-NMR (101 MHz; $CDCl_3$)



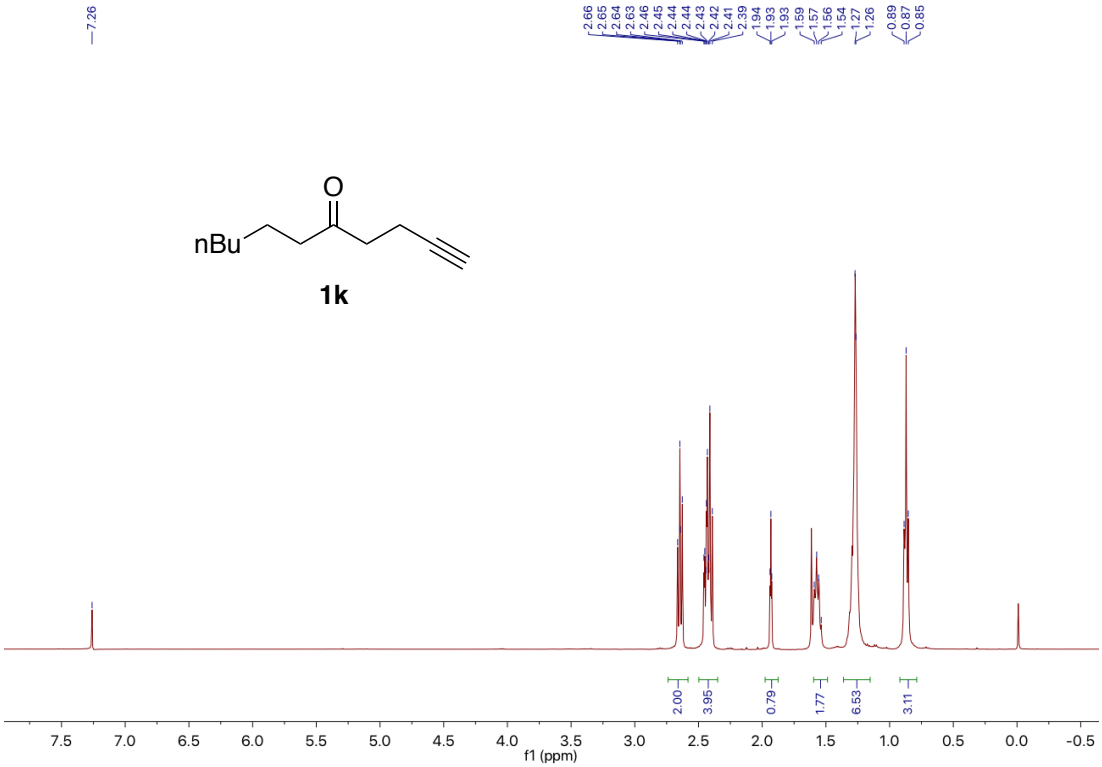
Compound 1j, ^{1}H NMR (400 MHz, $CDCl_3$)



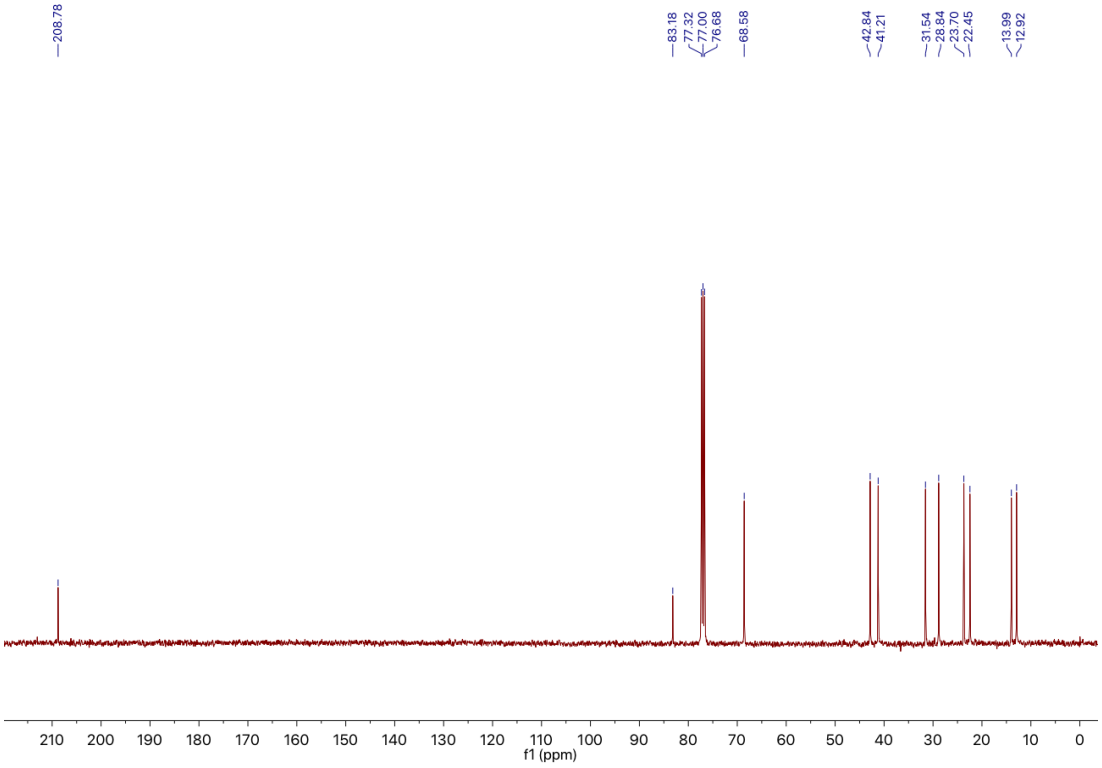
Compound 1j, ^{13}C-NMR (101 MHz; $CDCl_3$)



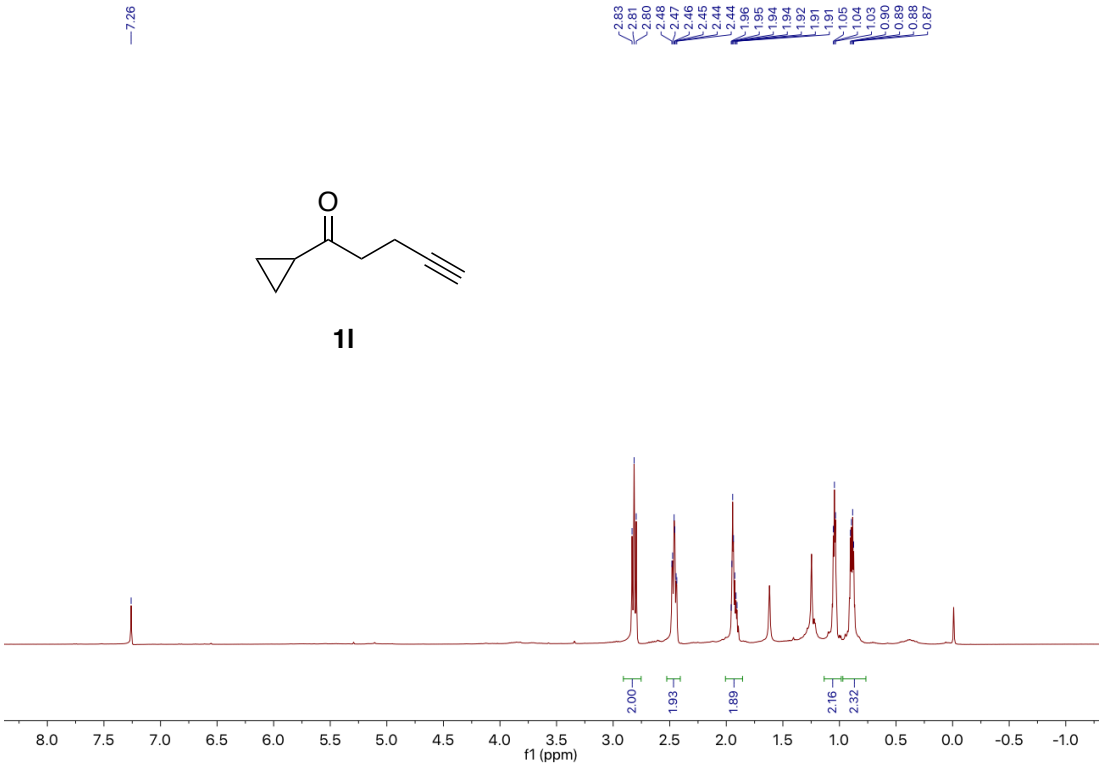
Compound 1k, ^{1}H NMR (400 MHz, $CDCl_3$)



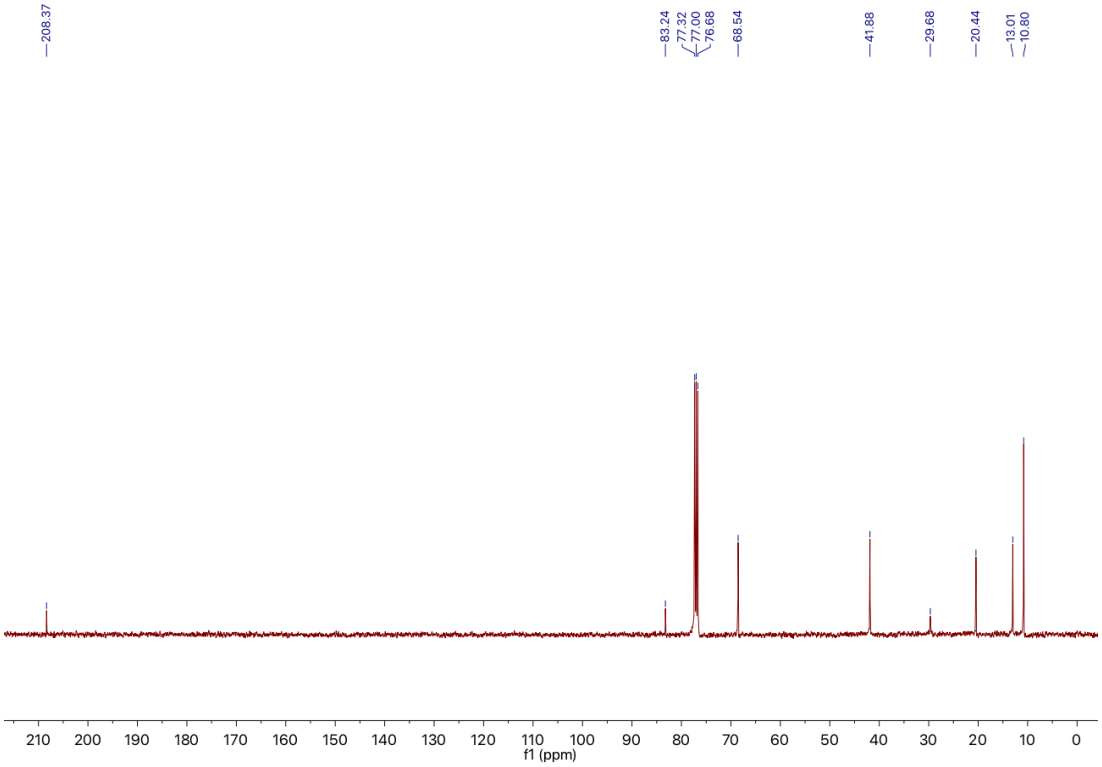
Compound 1k, ^{13}C-NMR (101 MHz; $CDCl_3$)



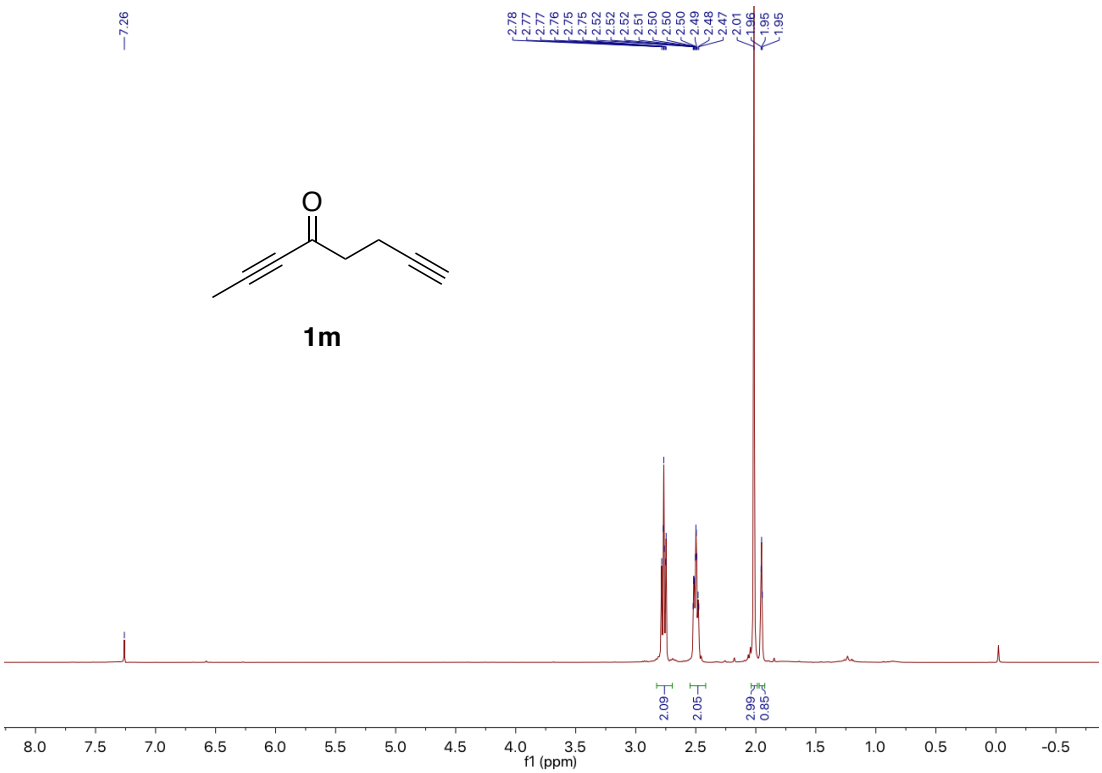
Compound 1l, ^{1}H NMR (400 MHz, $CDCl_3$)



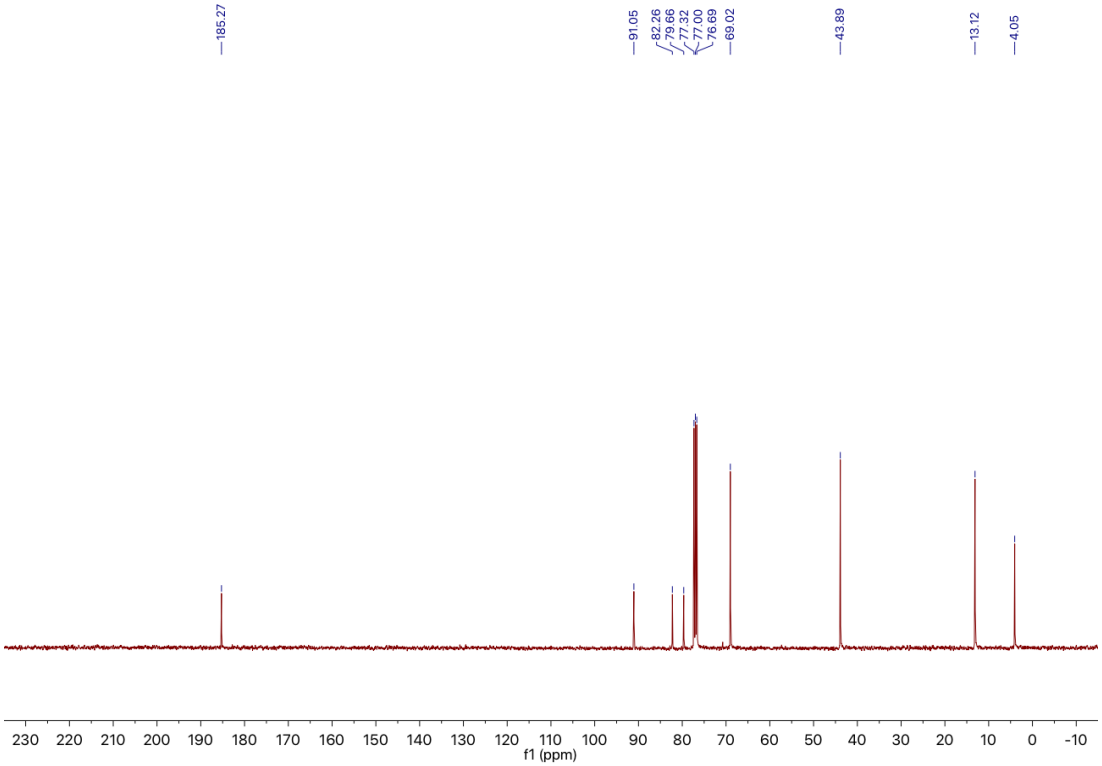
Compound 1l, ^{13}C-NMR (101 MHz; $CDCl_3$)



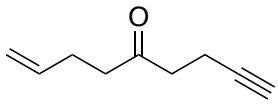
Compound 1m, ^{1}H NMR (400 MHz, $CDCl_3$)



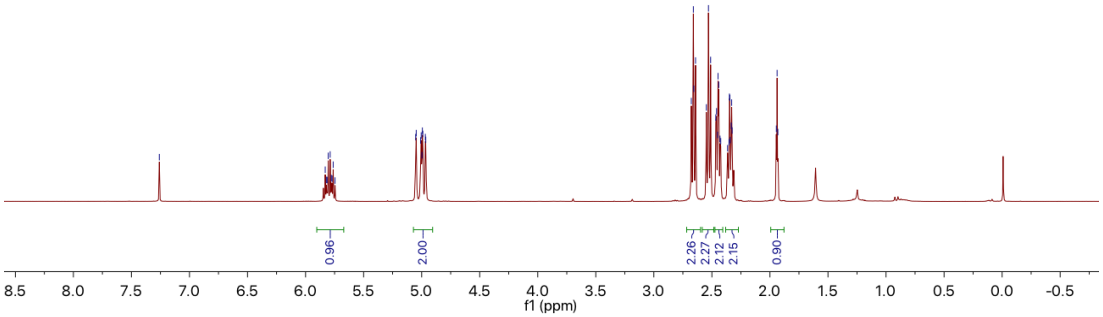
Compound 1m, ^{13}C-NMR (101 MHz; $CDCl_3$)



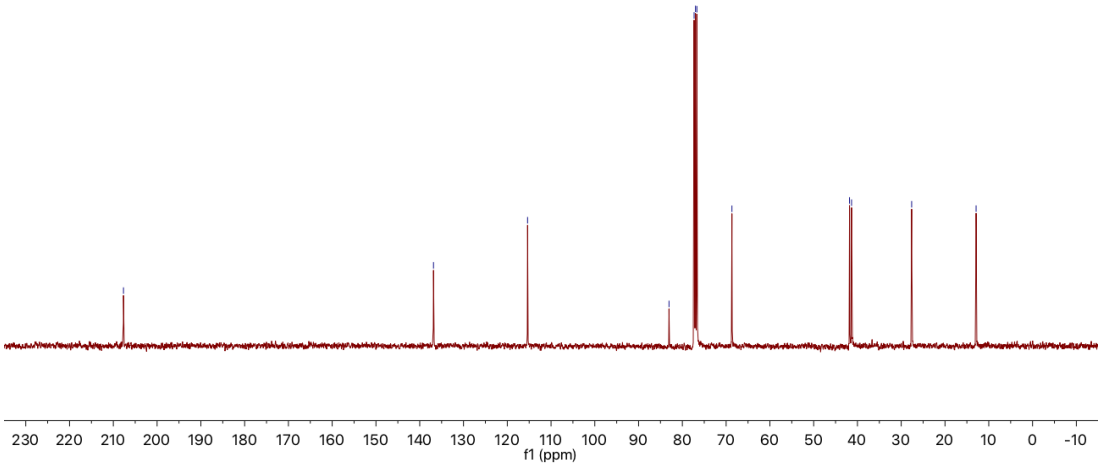
Compound 1n, ^{1}H NMR (400 MHz, $CDCl_3$)



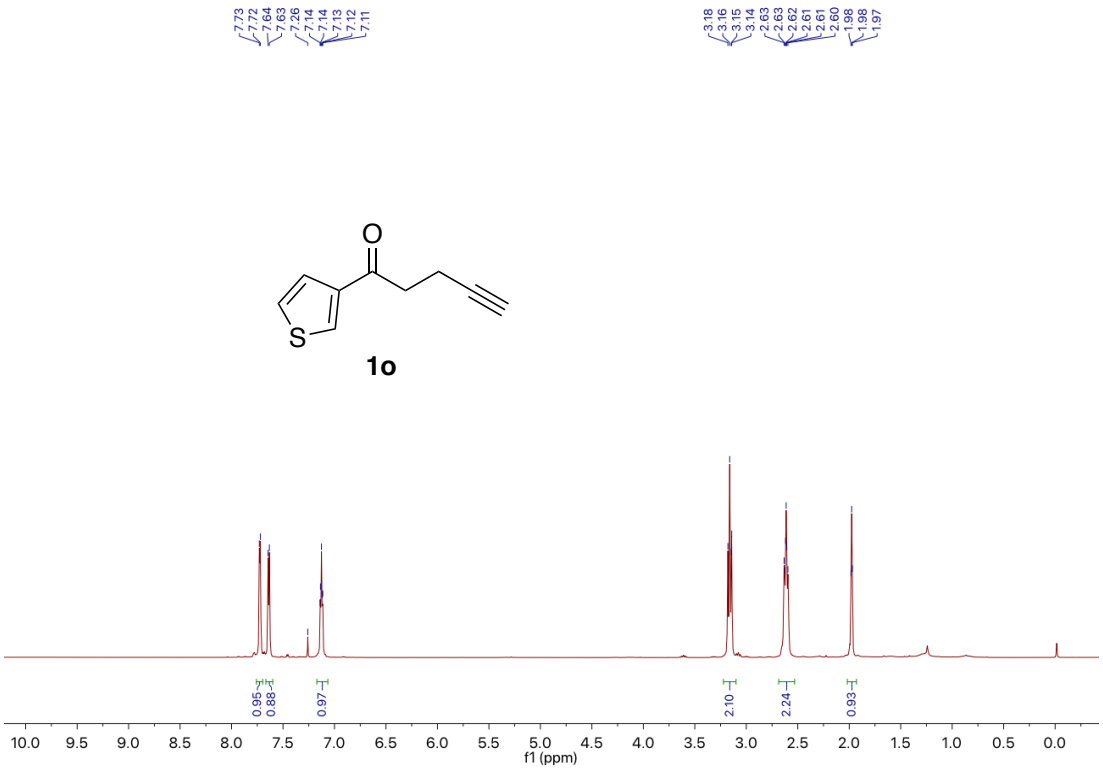
1n



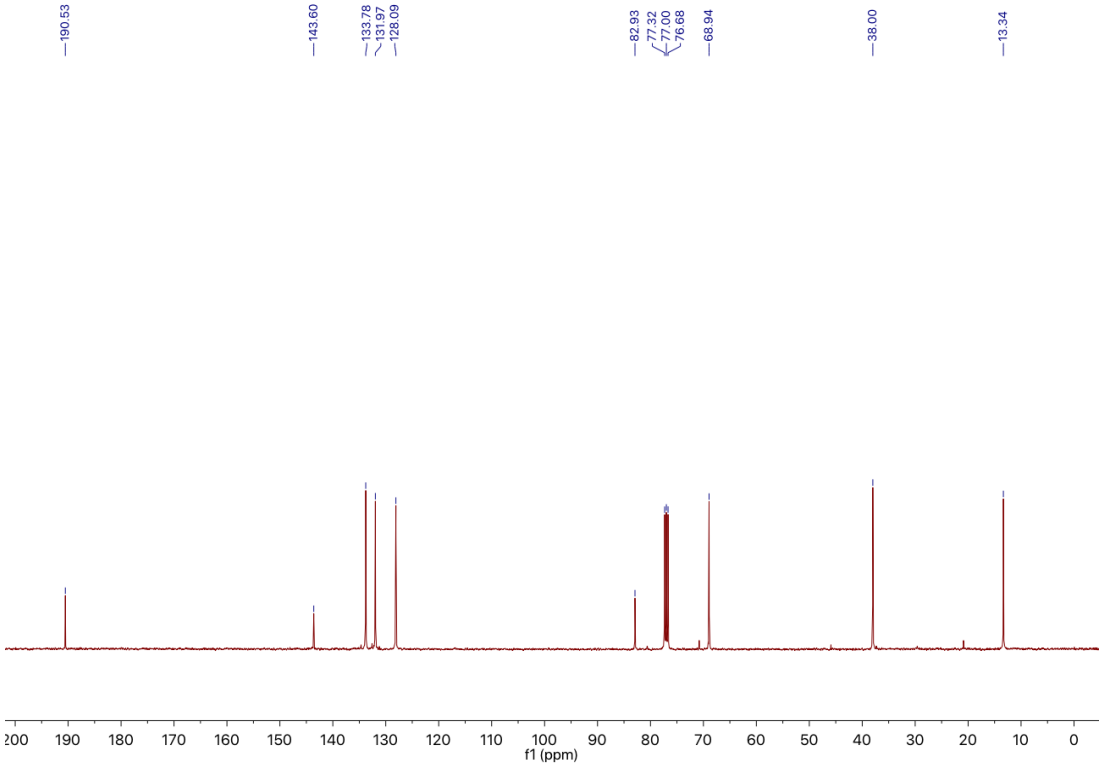
Compound 1n, ^{13}C-NMR (101 MHz; $CDCl_3$)



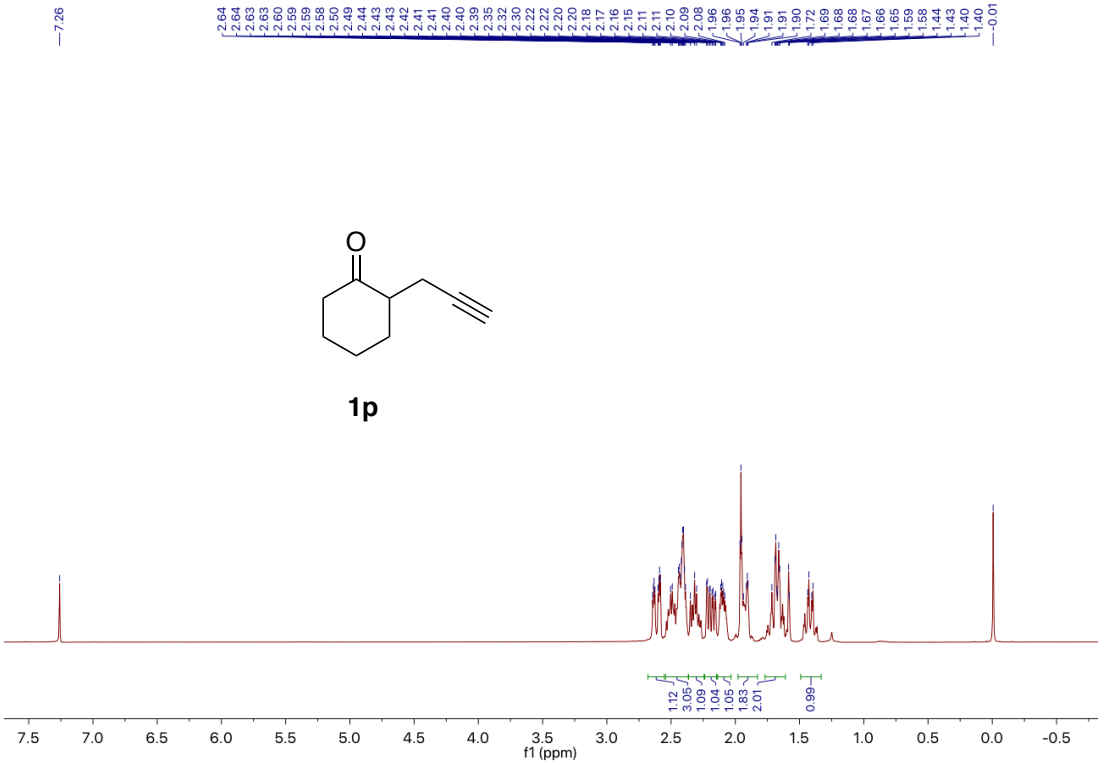
Compound 1o, ^{1}H NMR (400 MHz, $CDCl_3$)



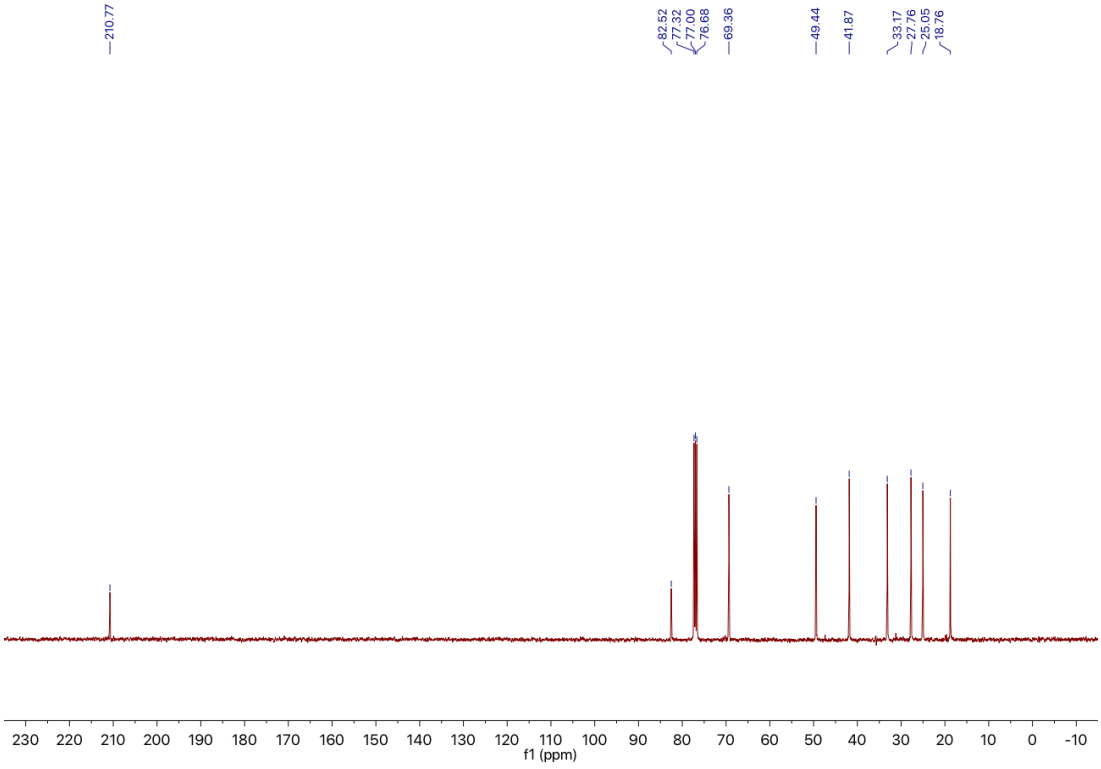
Compound 1o, ^{13}C-NMR (101 MHz; $CDCl_3$)



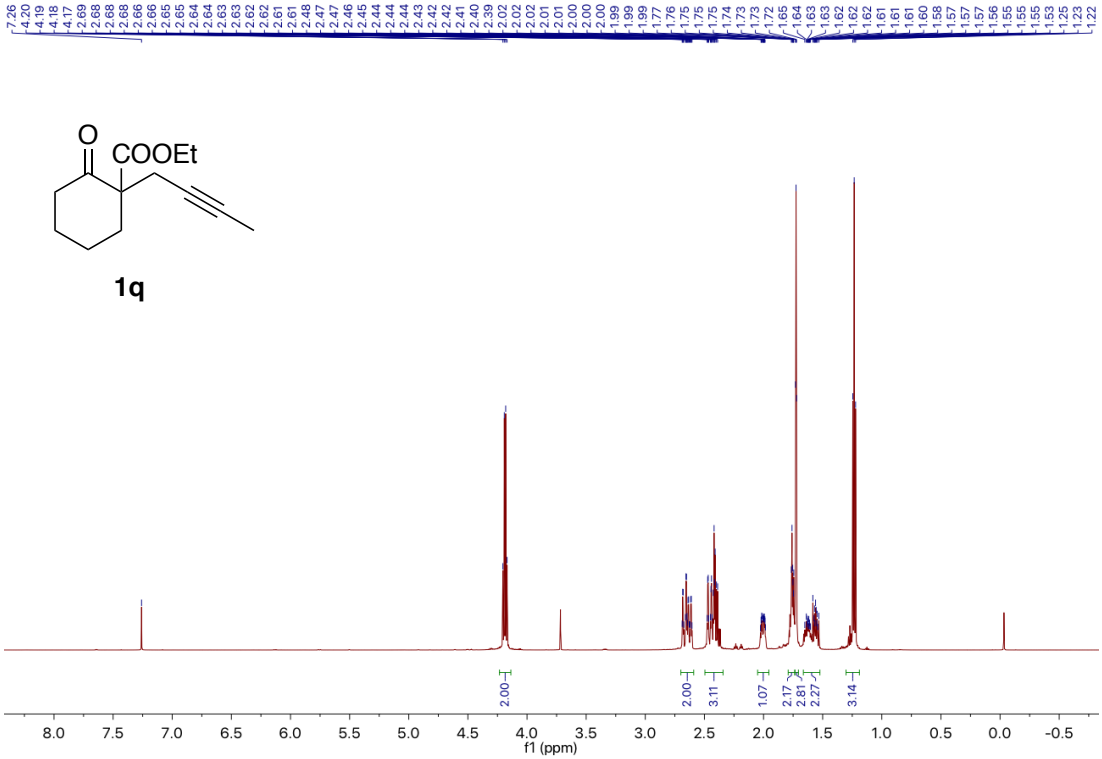
Compound 1p, ^{1}H NMR (400 MHz, $CDCl_3$)



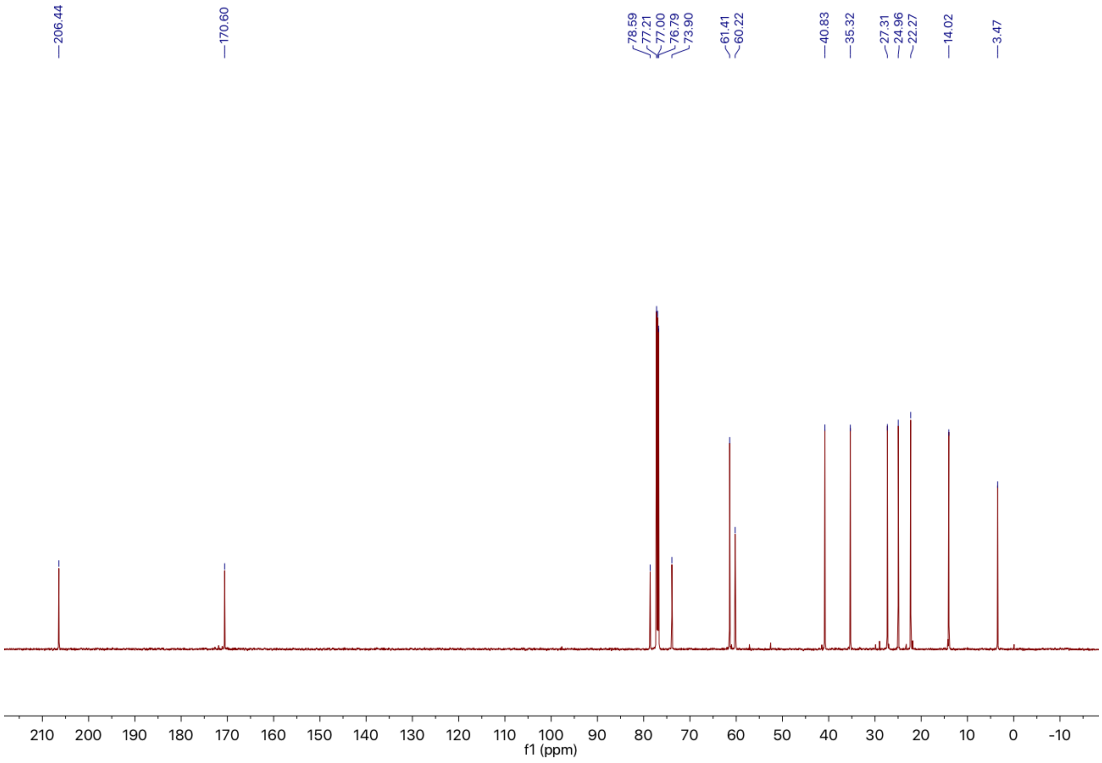
Compound 1p, ^{13}C-NMR (101 MHz; $CDCl_3$)



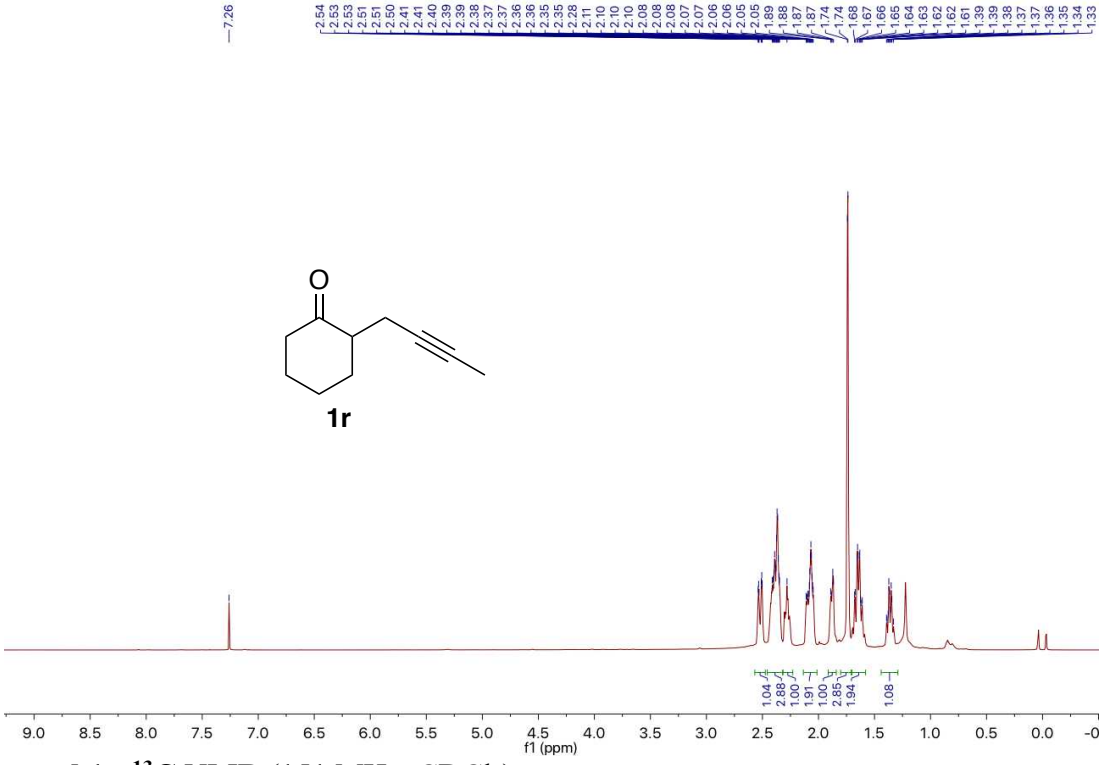
Compound 1q, ^{1}H NMR (600 MHz, $CDCl_3$)



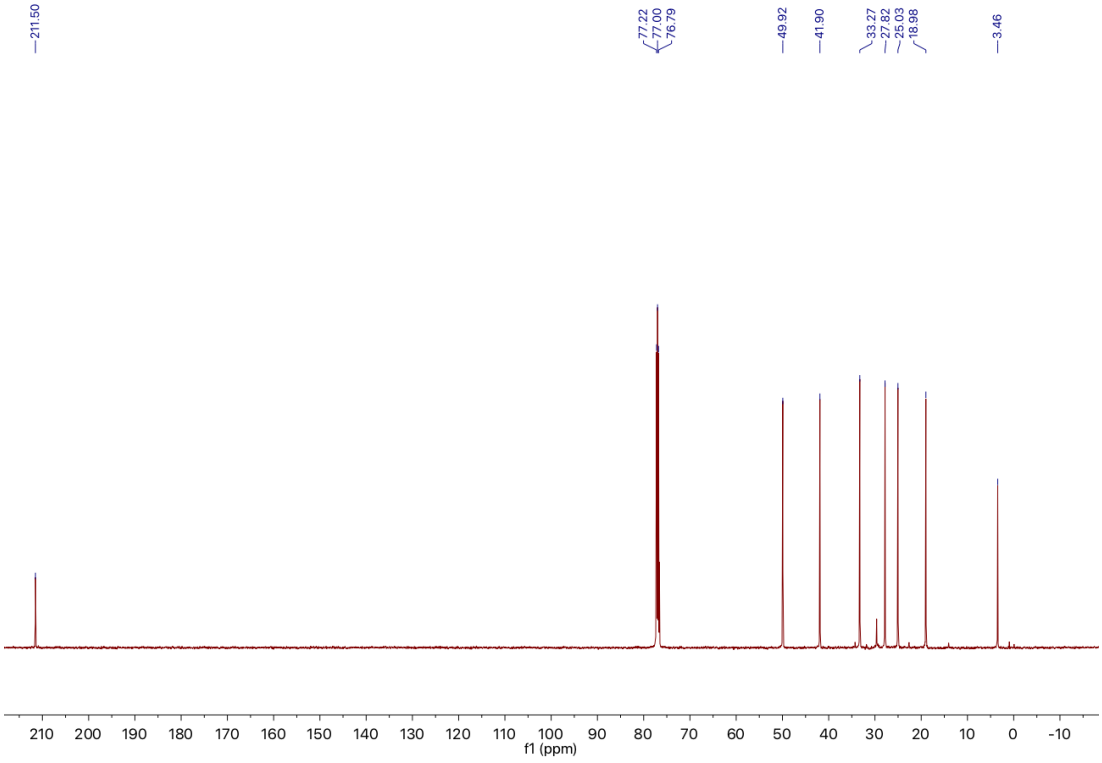
Compound 1q, ^{13}C NMR (151 MHz, $CDCl_3$)



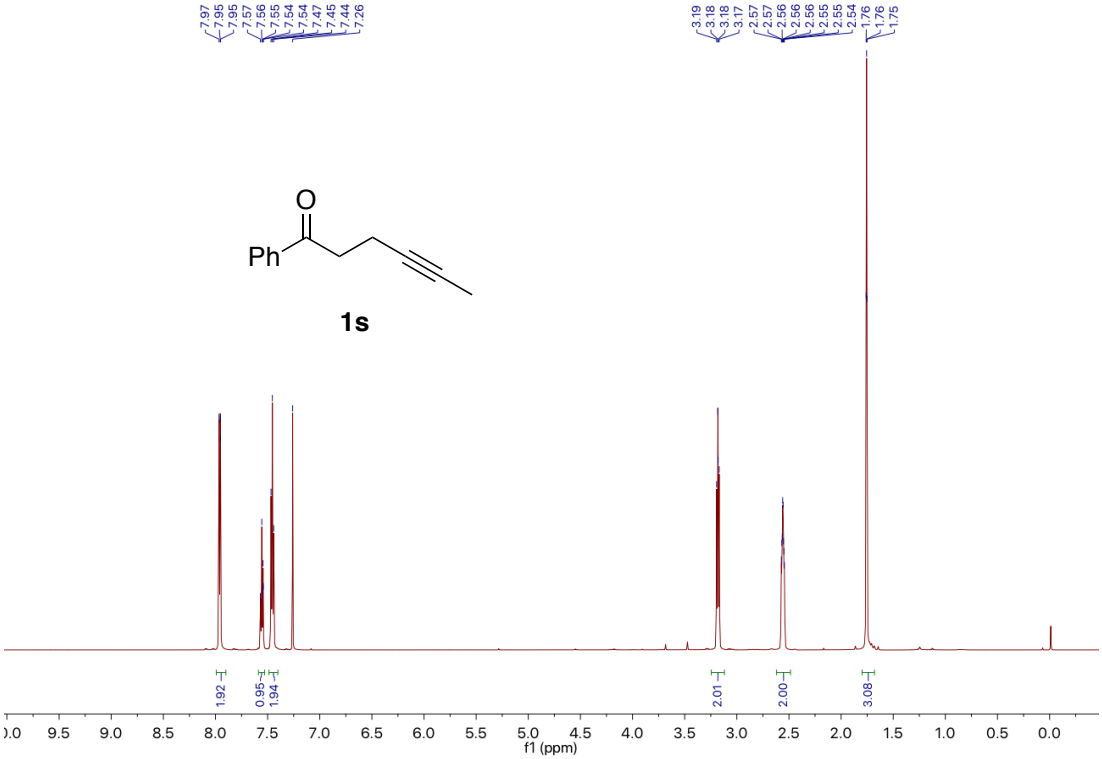
Compound 1r, ^{1}H NMR (600 MHz, $CDCl_3$)



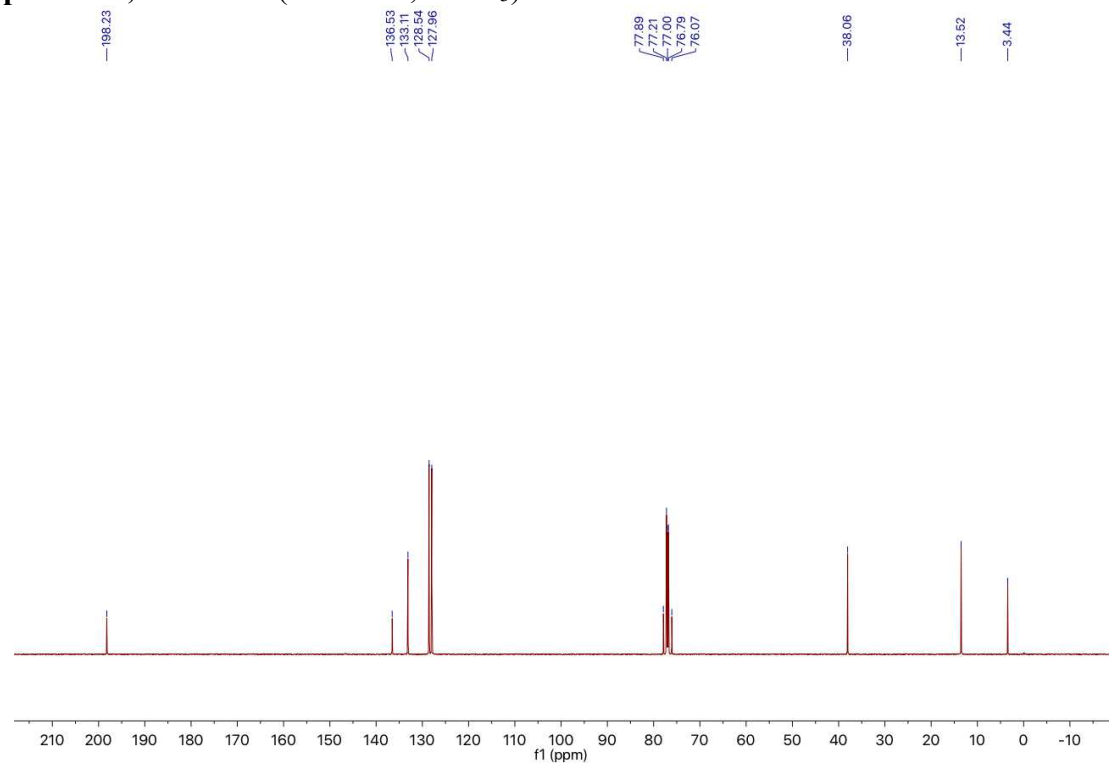
Compound 1r, ^{13}C NMR (151 MHz, $CDCl_3$)



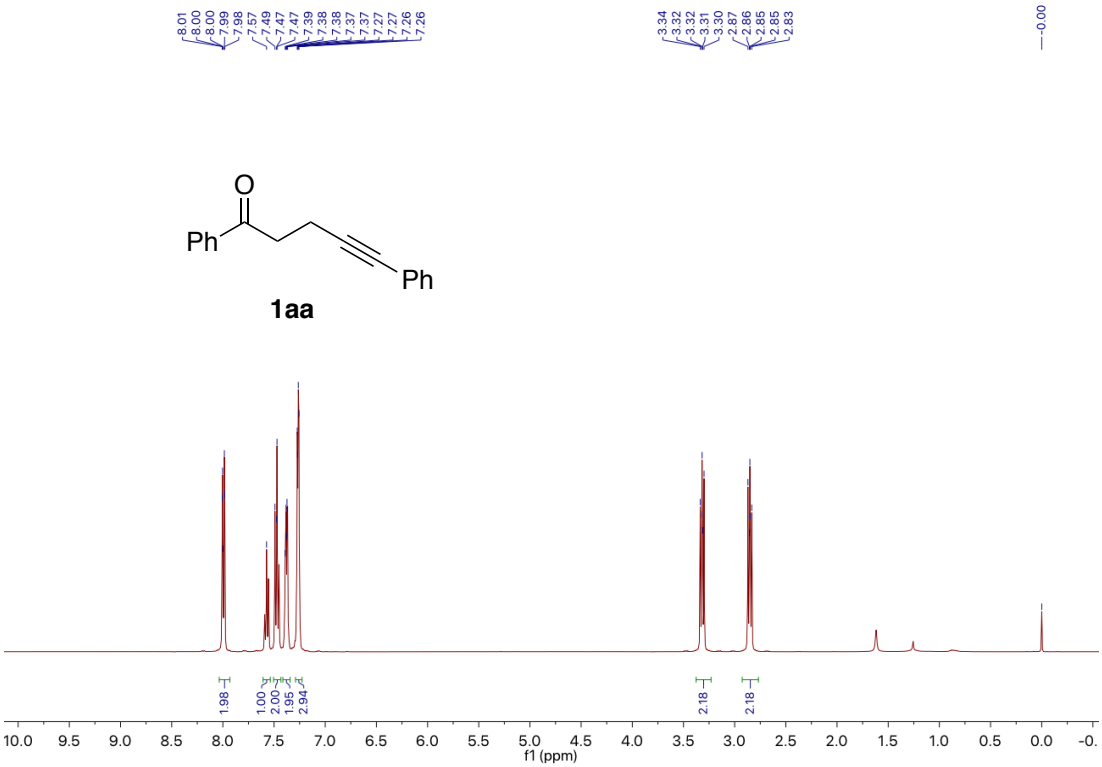
Compound 1s, ^{1}H NMR (600 MHz, $CDCl_3$)



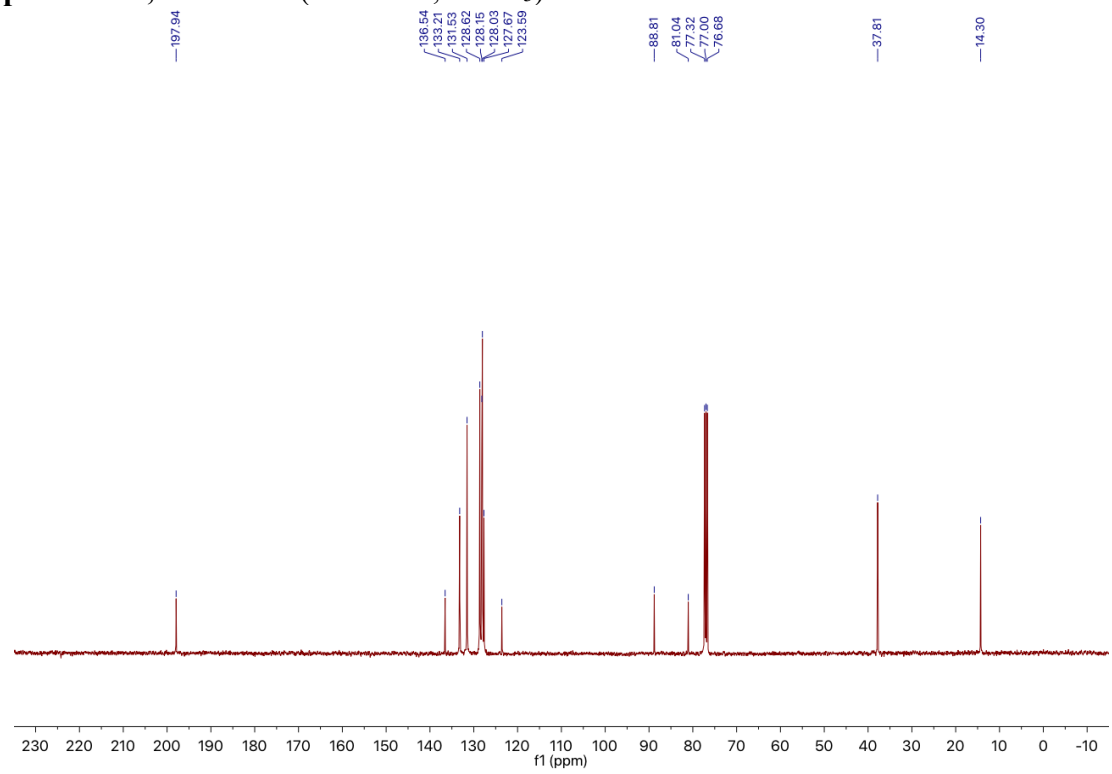
Compound 1s, ^{13}C NMR (151 MHz, $CDCl_3$)



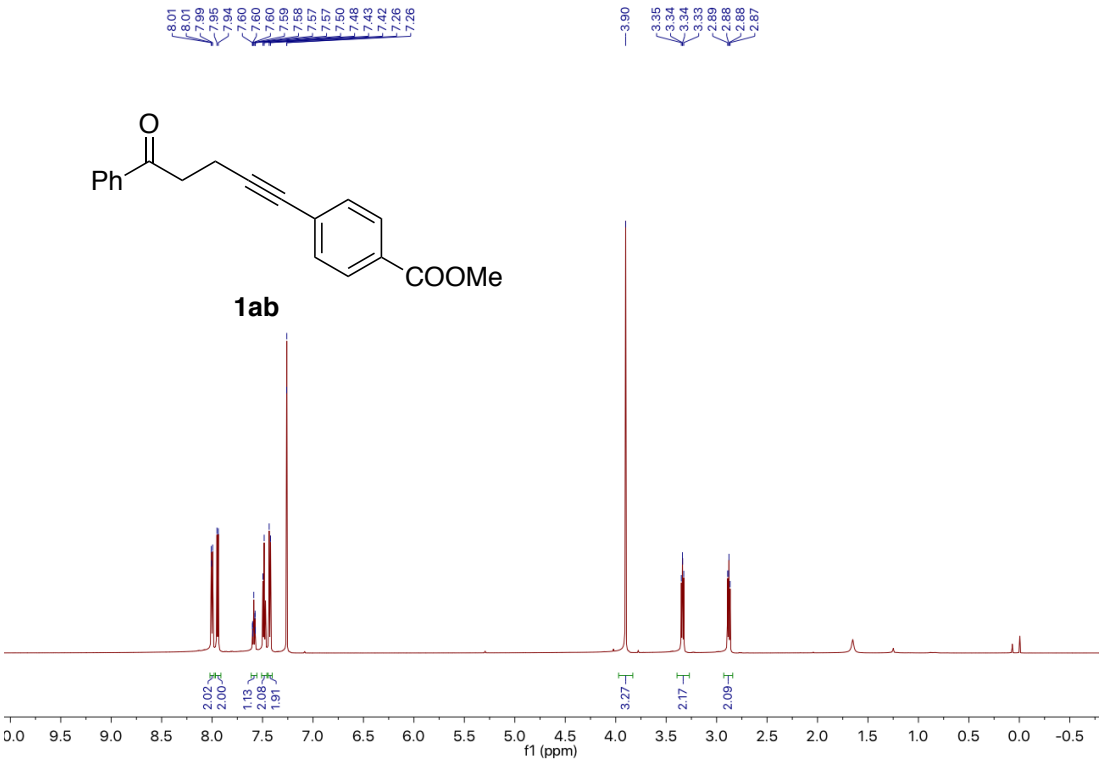
Compound 1aa, ^{1}H NMR (400 MHz, $CDCl_3$)



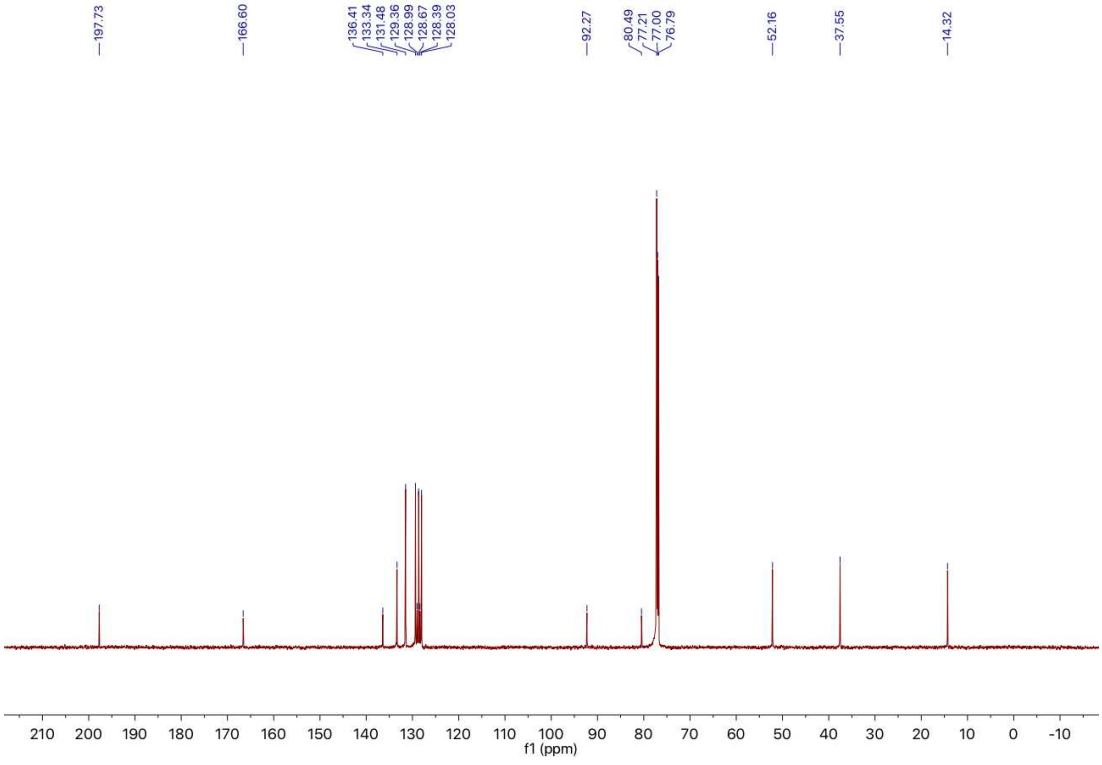
Compound 1aa, ^{13}C-NMR (101 MHz; $CDCl_3$)



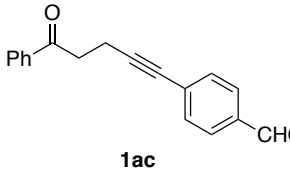
Compound 1ab, ^{1}H NMR (600 MHz, $CDCl_3$)



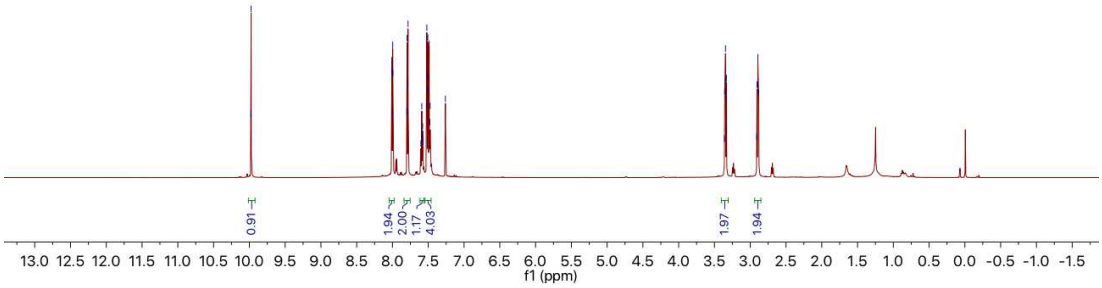
Compound 1ab, ^{13}C-NMR (151 MHz; $CDCl_3$)



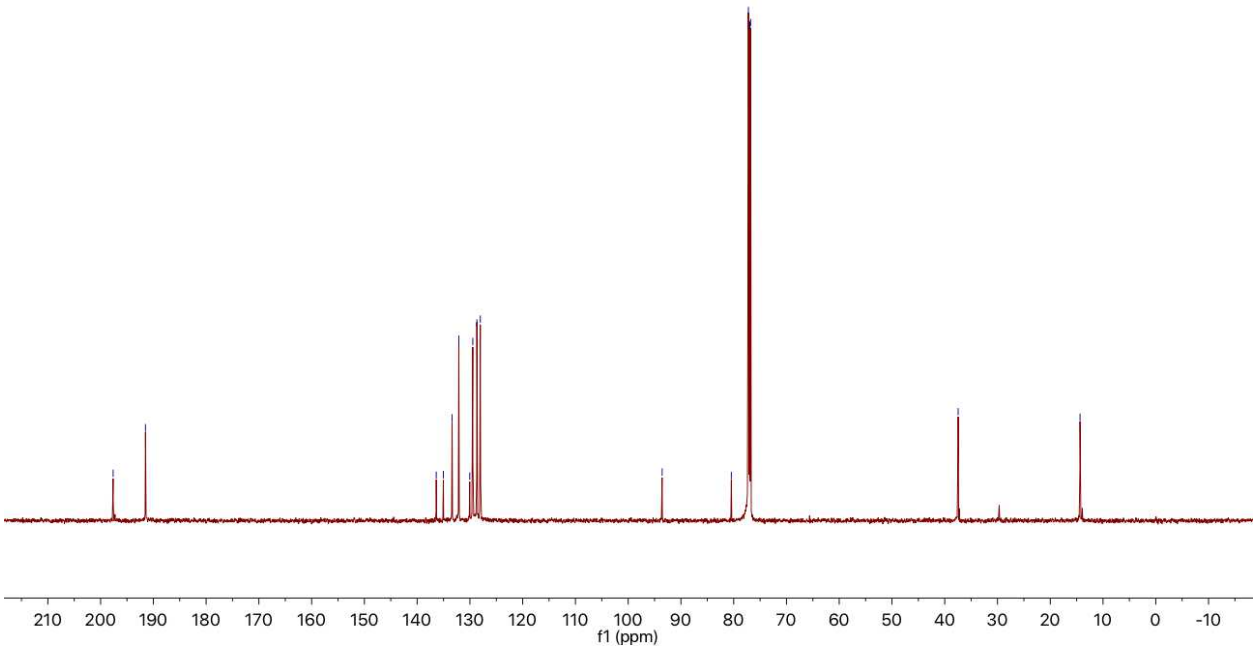
Compound 1ac, ^{1}H NMR (600 MHz, $CDCl_3$)



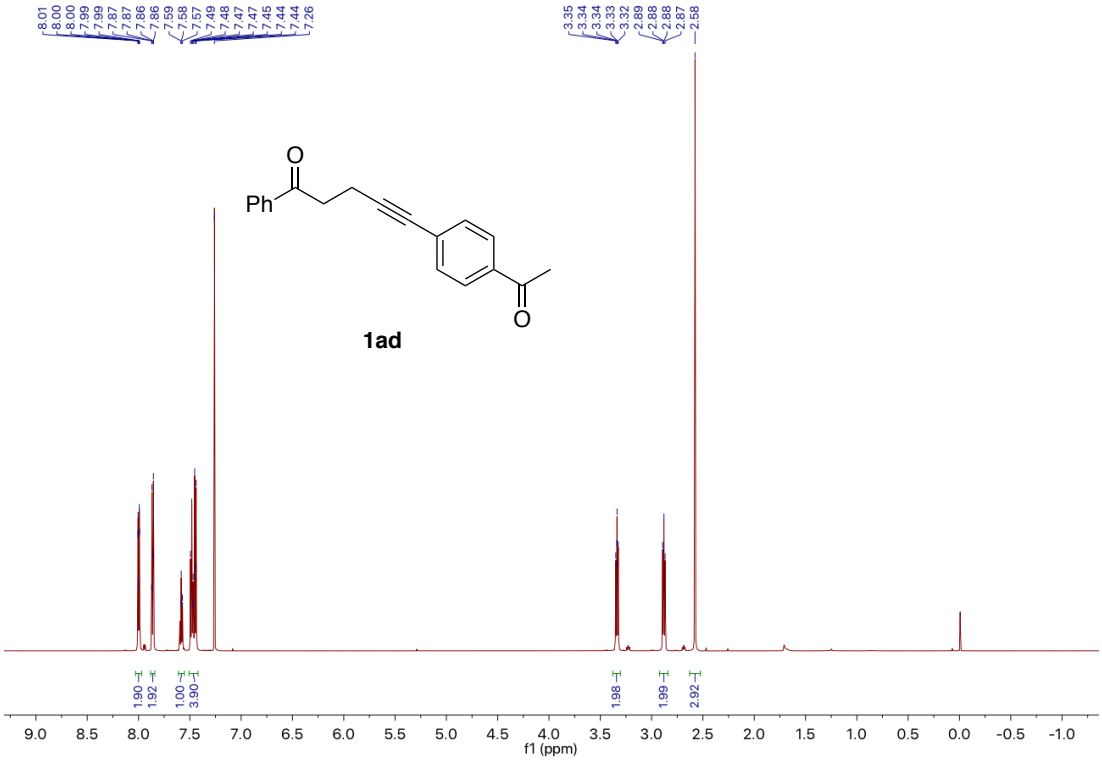
1ac



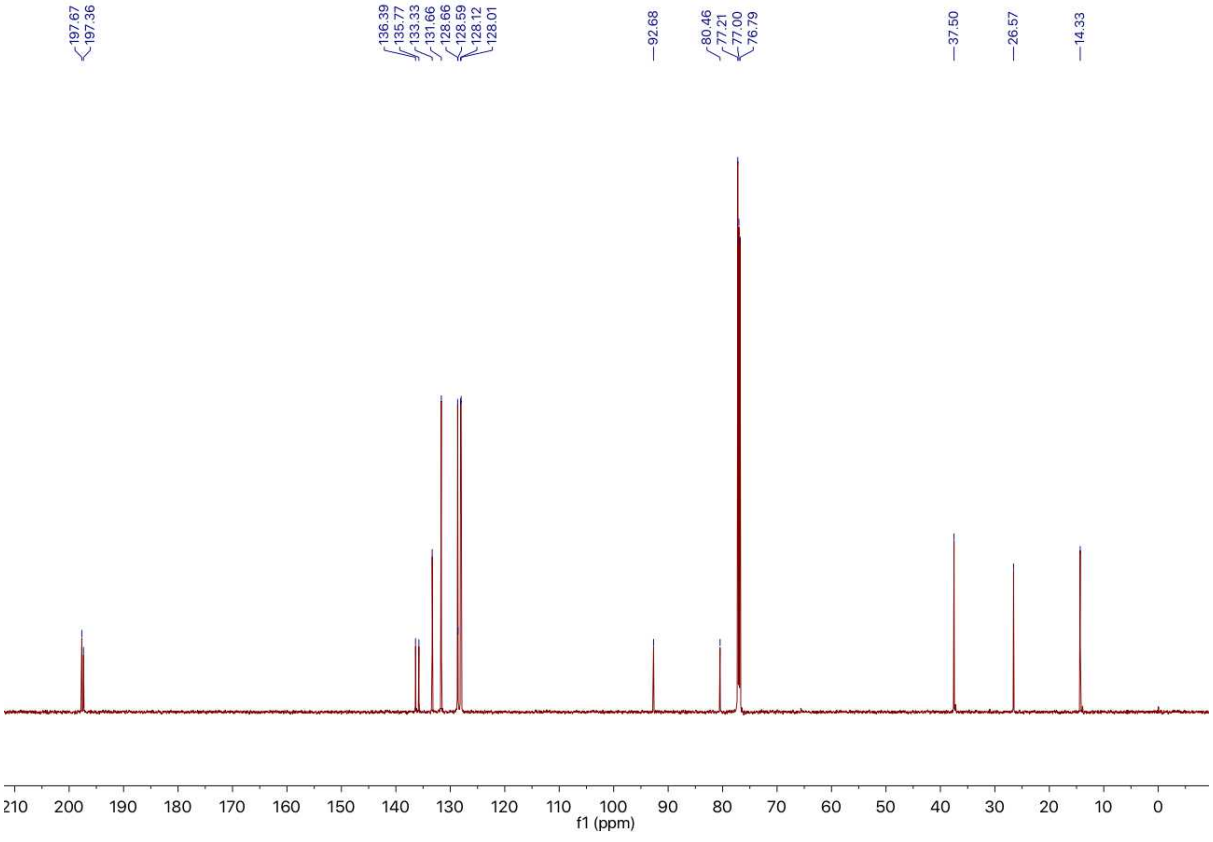
Compound 1ac, ^{13}C-NMR (151 MHz; $CDCl_3$)



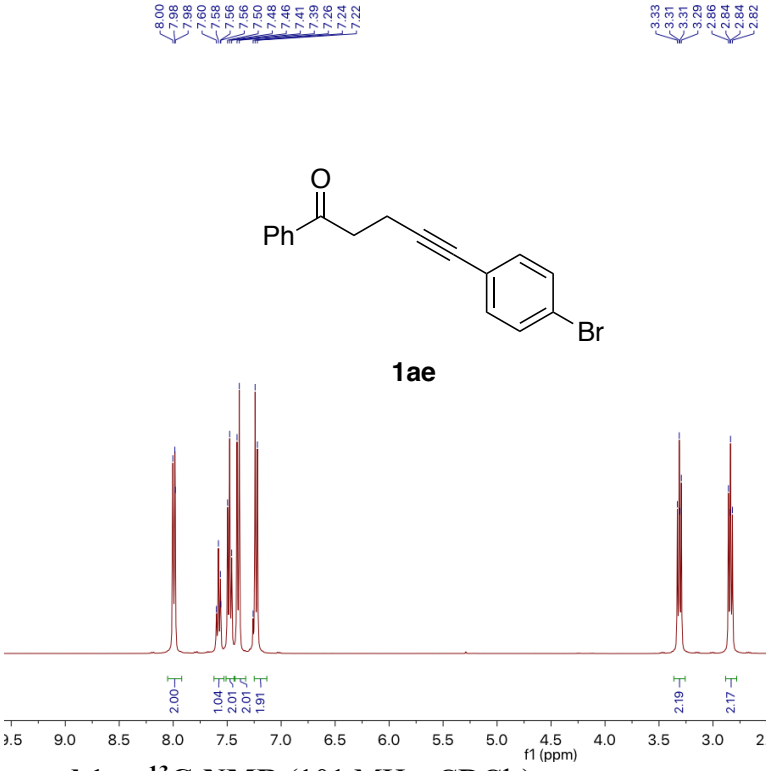
Compound 1ad, ^{1}H NMR (600 MHz, $CDCl_3$)



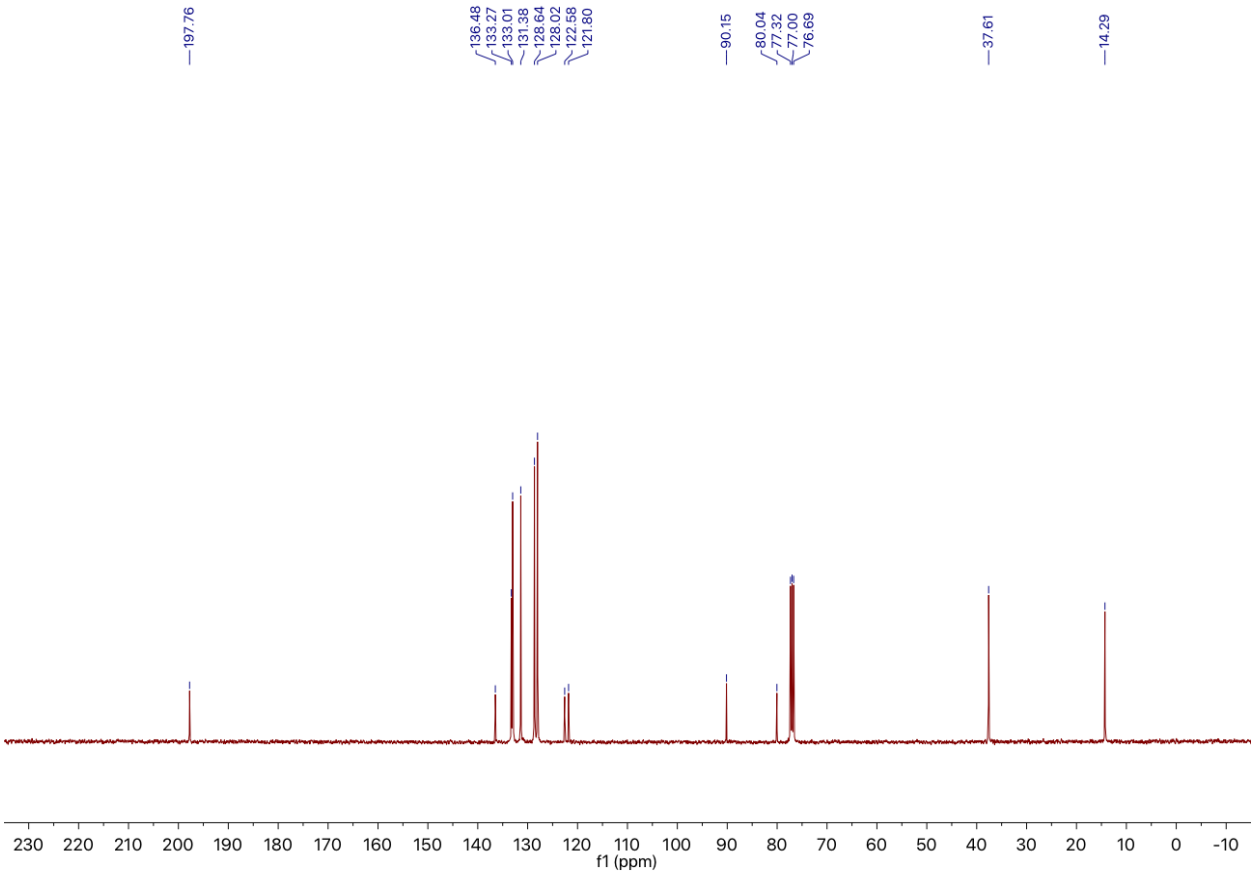
Compound 1ad, ^{13}C-NMR (151 MHz; $CDCl_3$)



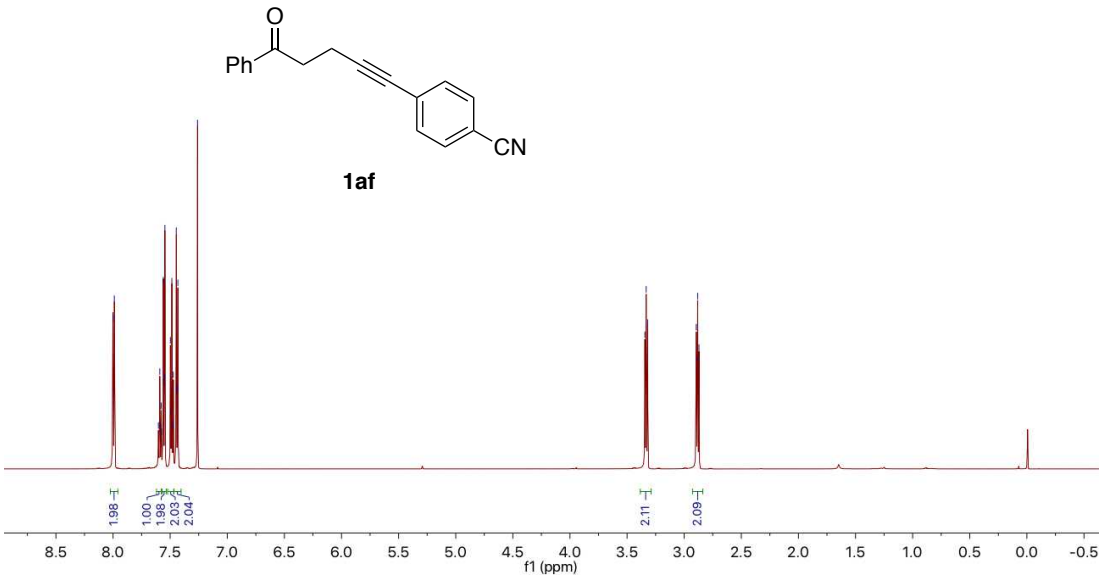
Compound 1ae, ^{1}H NMR (400 MHz, $CDCl_3$)



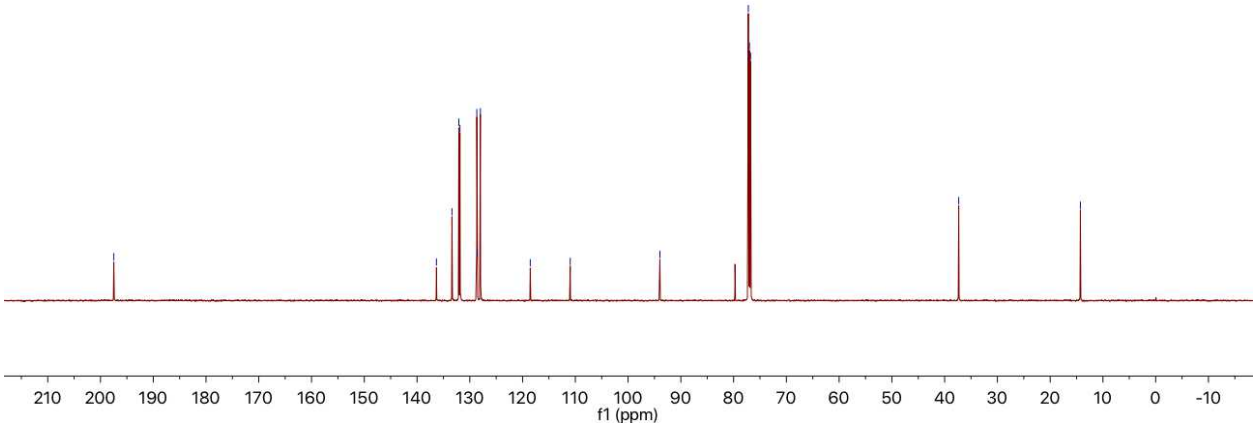
Compound 1ae, ^{13}C-NMR (101 MHz; $CDCl_3$)



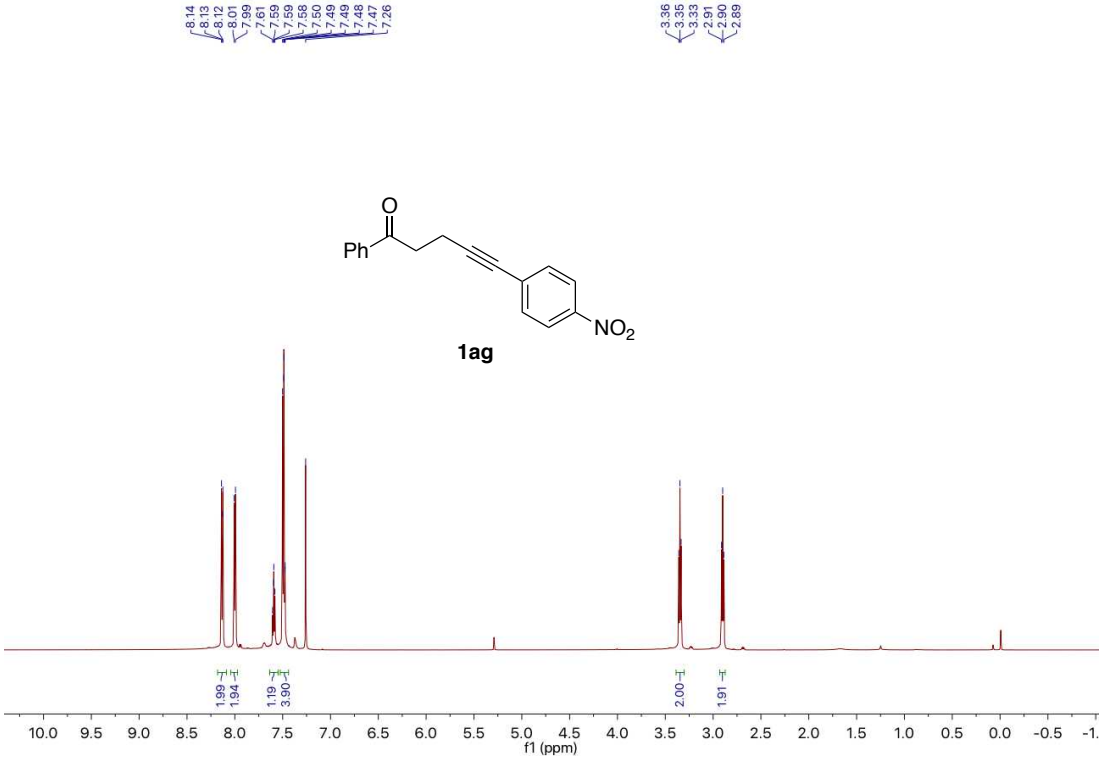
Compound 1af, ^{1}H NMR (600 MHz, $CDCl_3$)



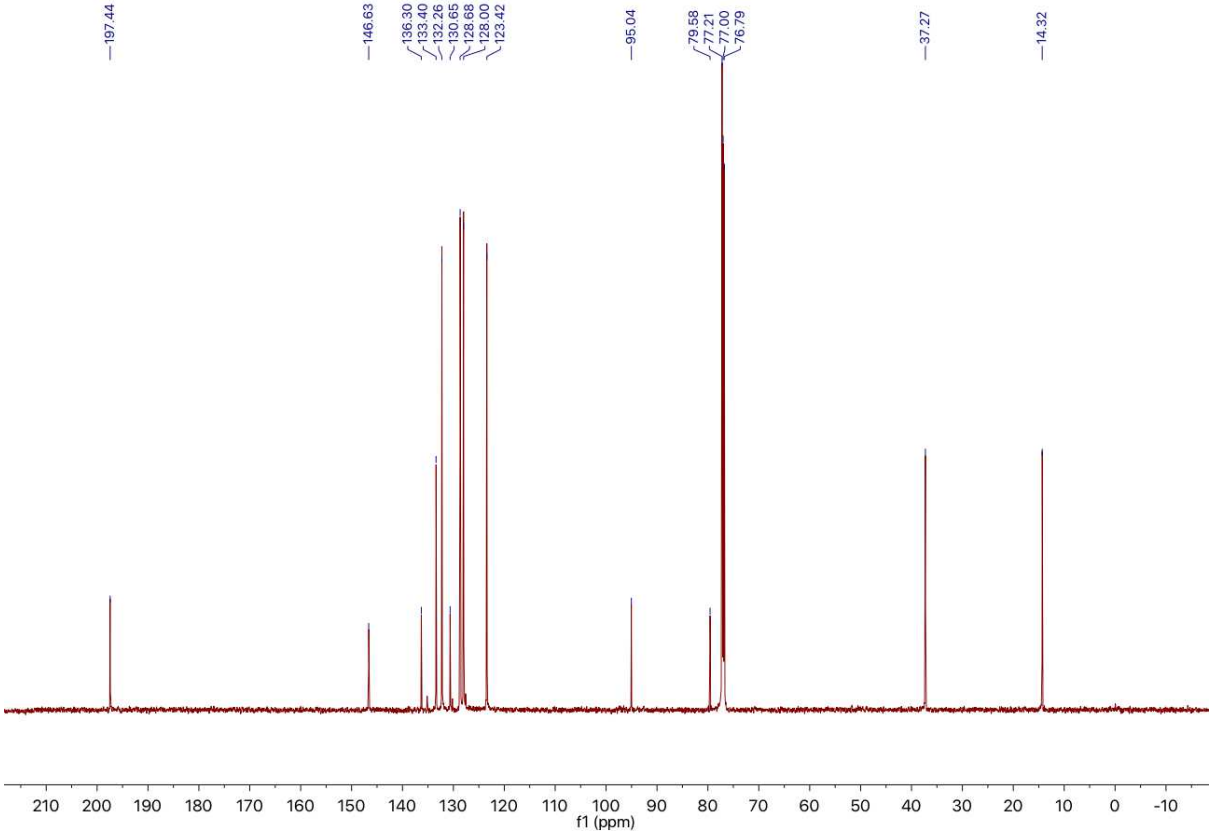
Compound 1af, ^{13}C-NMR (151 MHz; $CDCl_3$)



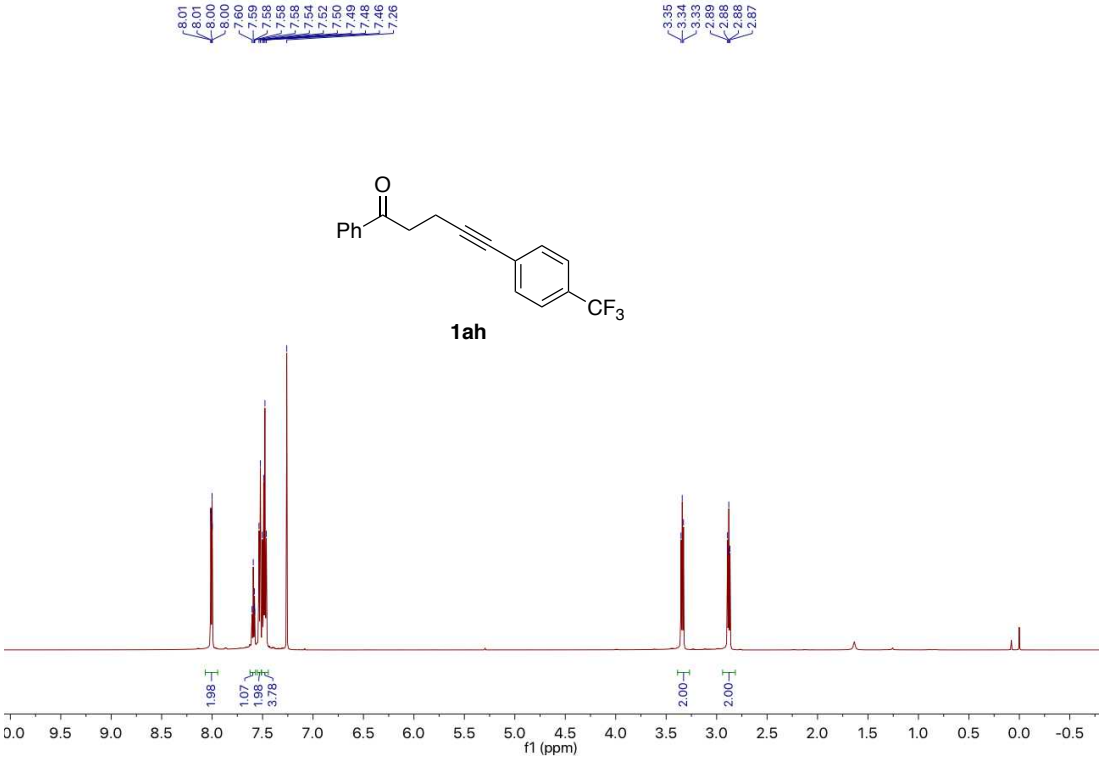
Compound 1ag, ^{1}H NMR (600 MHz, $CDCl_3$)



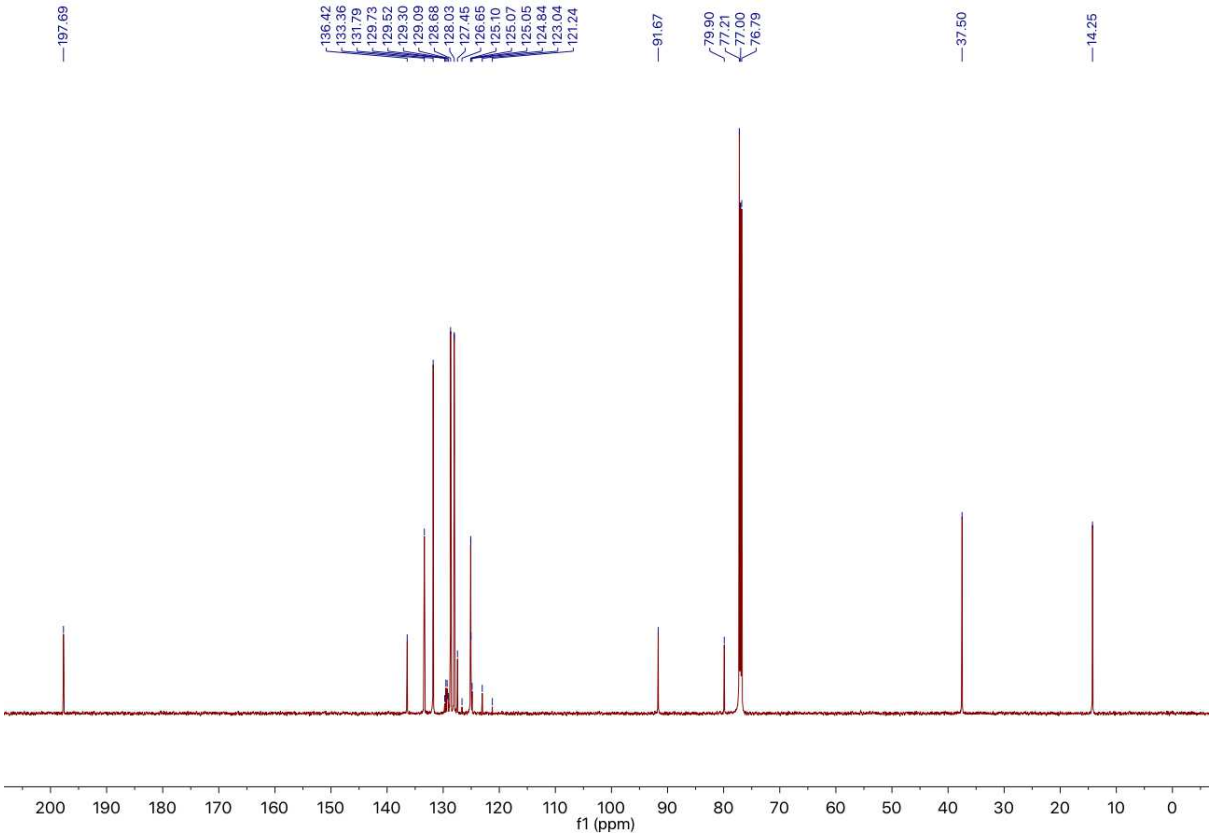
Compound 1ag, ^{13}C-NMR (151 MHz; $CDCl_3$)



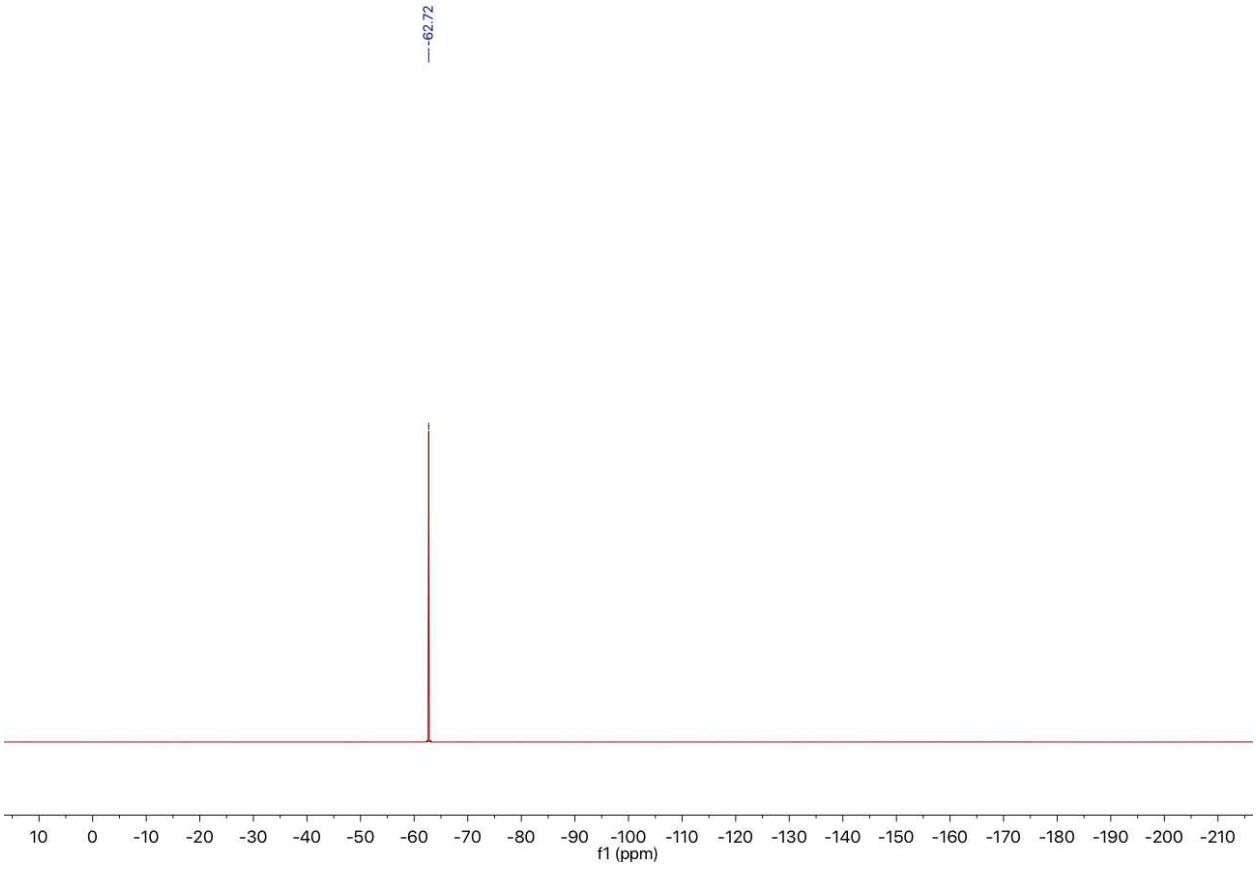
Compound 1ah, ^{1}H NMR (600 MHz, $CDCl_3$)



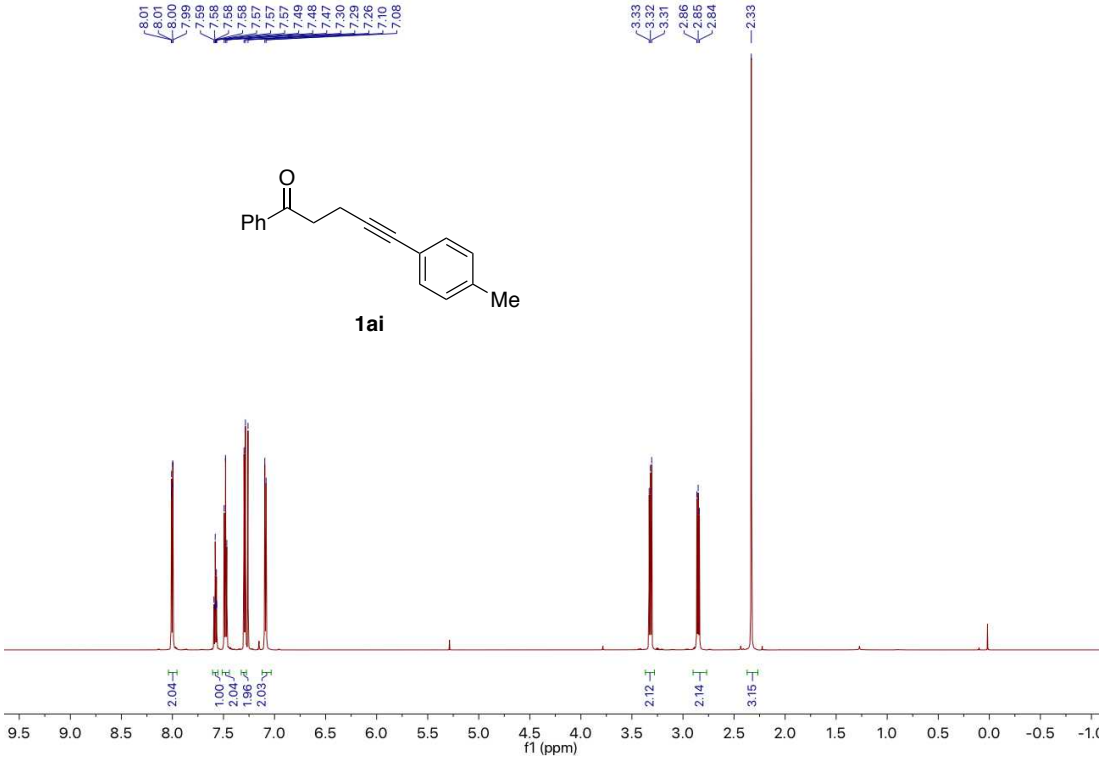
Compound 1ah, ^{13}C-NMR (151 MHz; $CDCl_3$)



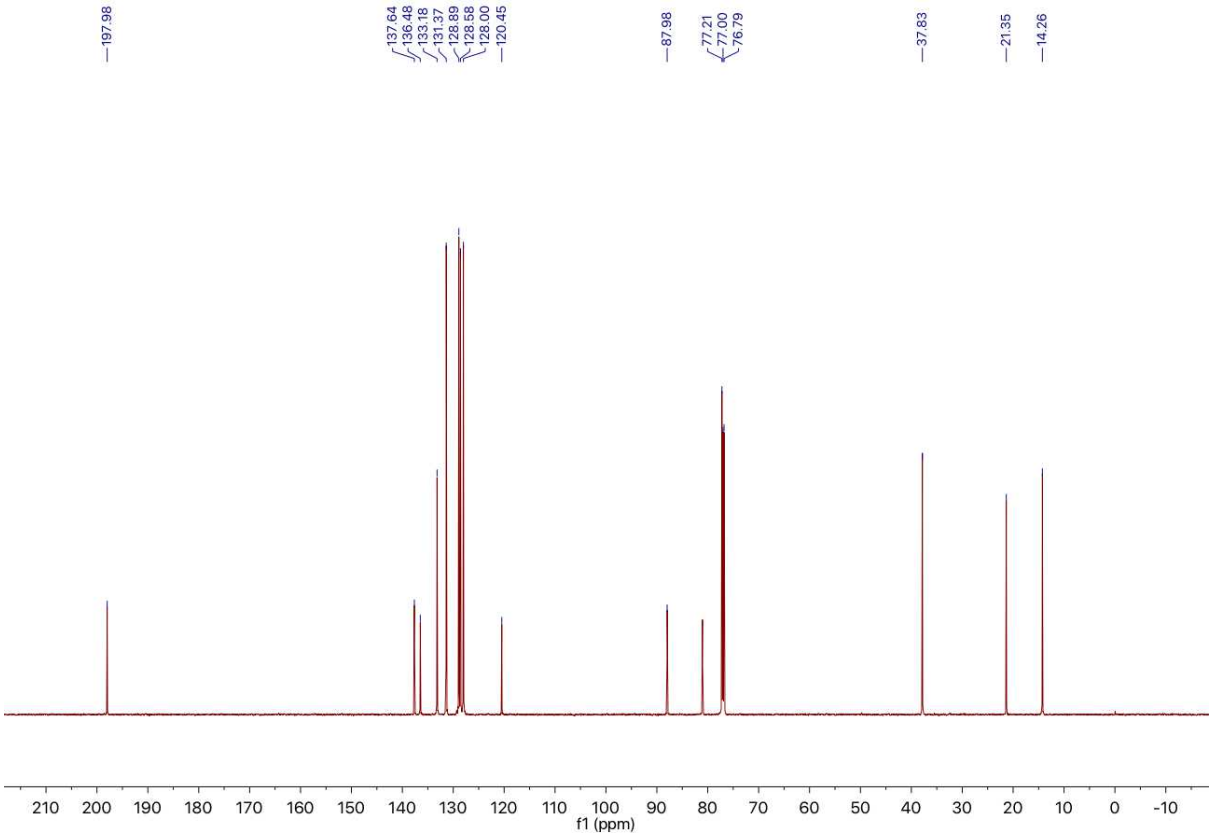
Compound 1ah, ^{19}F NMR (565 MHz, $CDCl_3$)



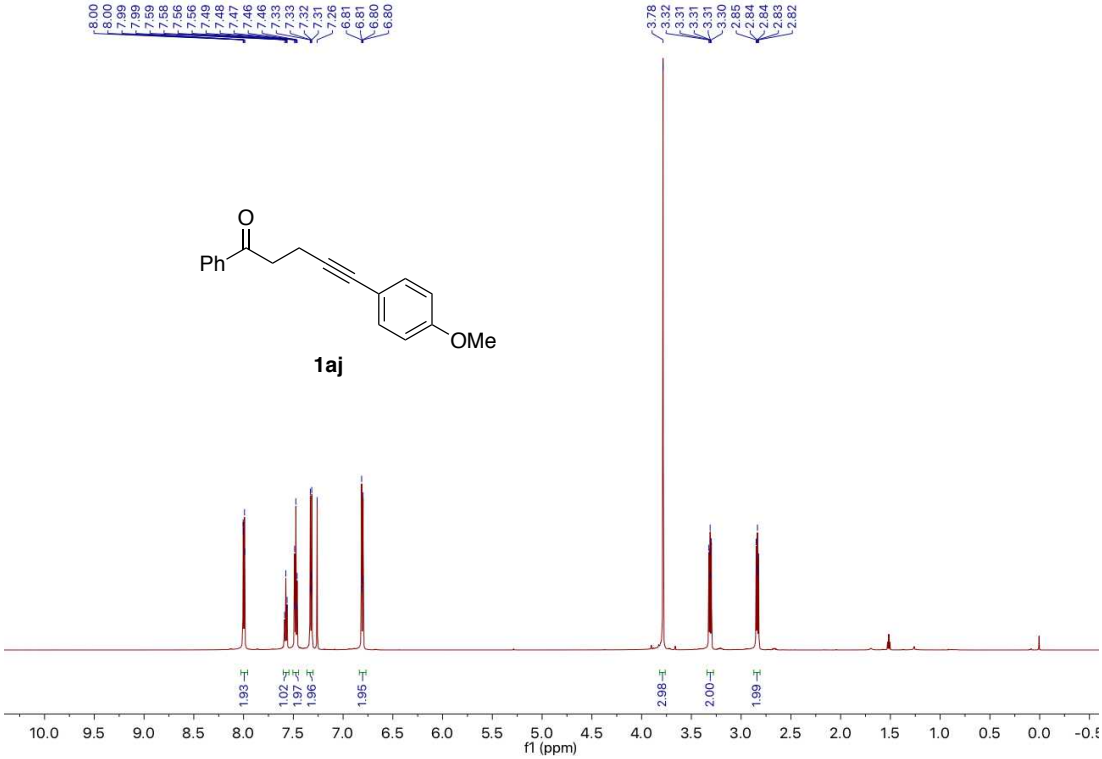
Compound 1ai, ^{1}H NMR (600 MHz, $CDCl_3$)



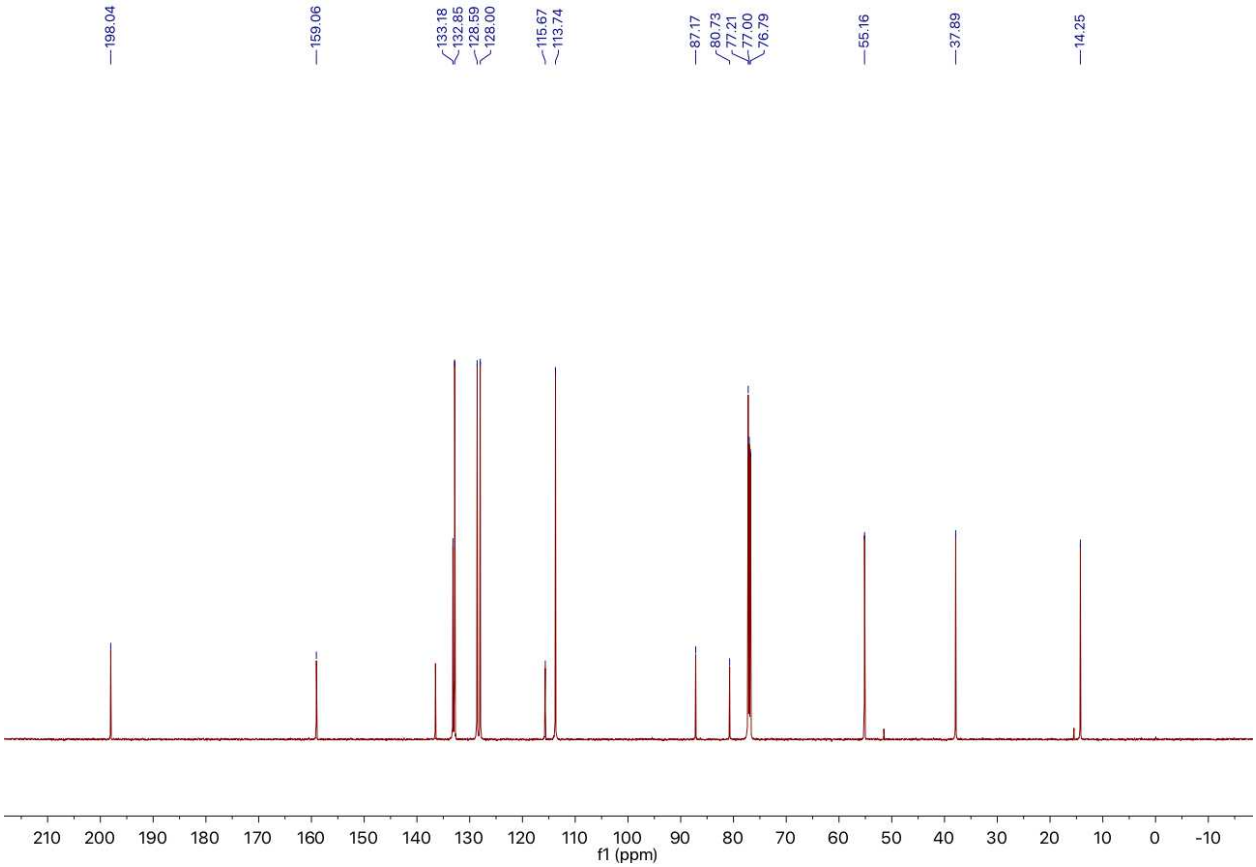
Compound 1ai, ^{13}C-NMR (151 MHz; $CDCl_3$)



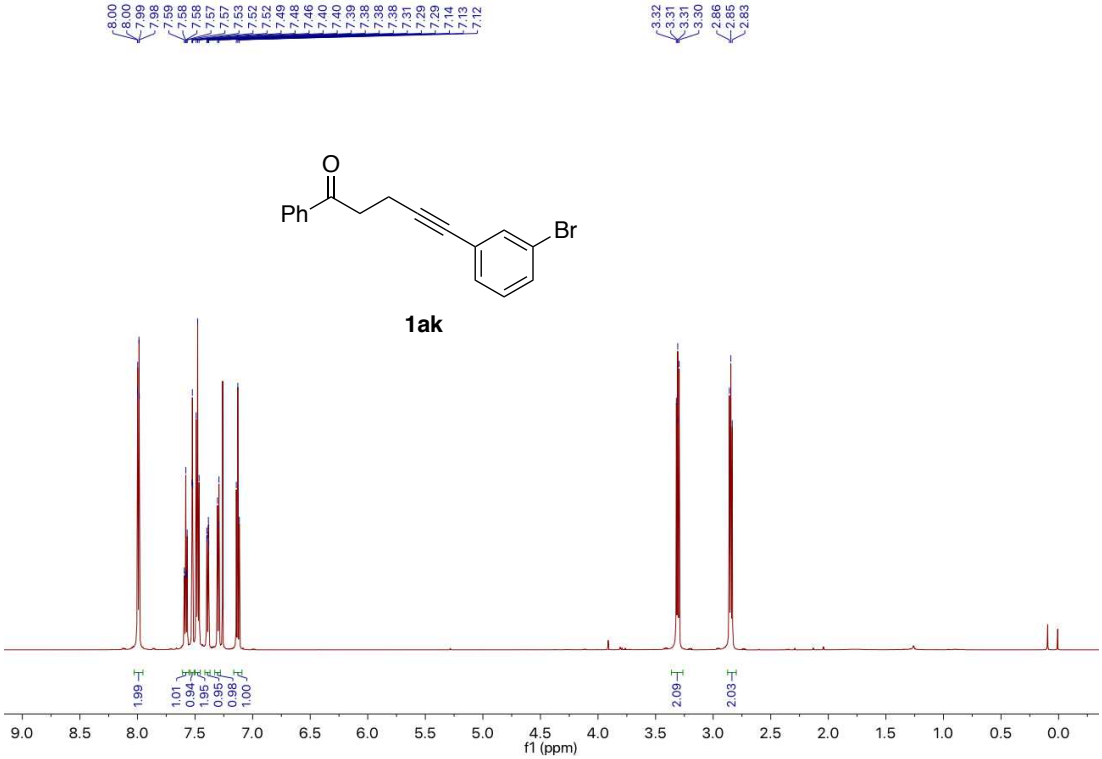
Compound 1aj, ^{1}H NMR (600 MHz, $CDCl_3$)



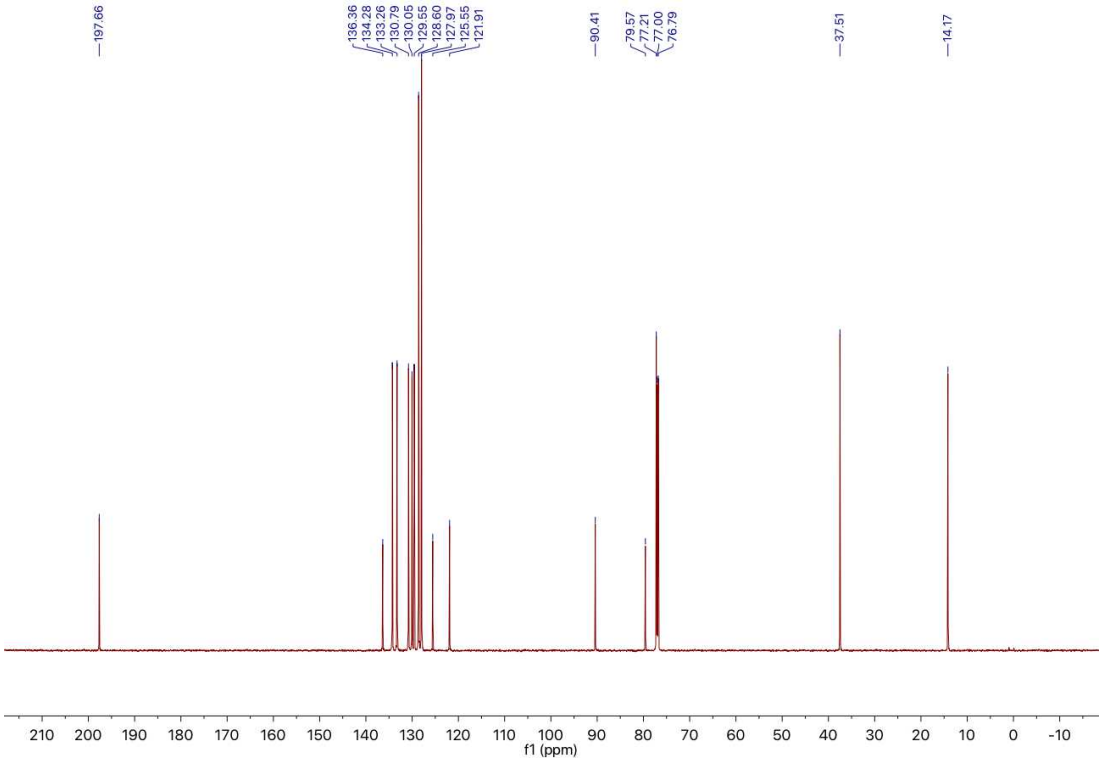
Compound 1aj, ^{13}C-NMR (151 MHz; $CDCl_3$)



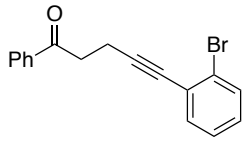
Compound 1ak, ^{1}H NMR (600 MHz, $CDCl_3$)



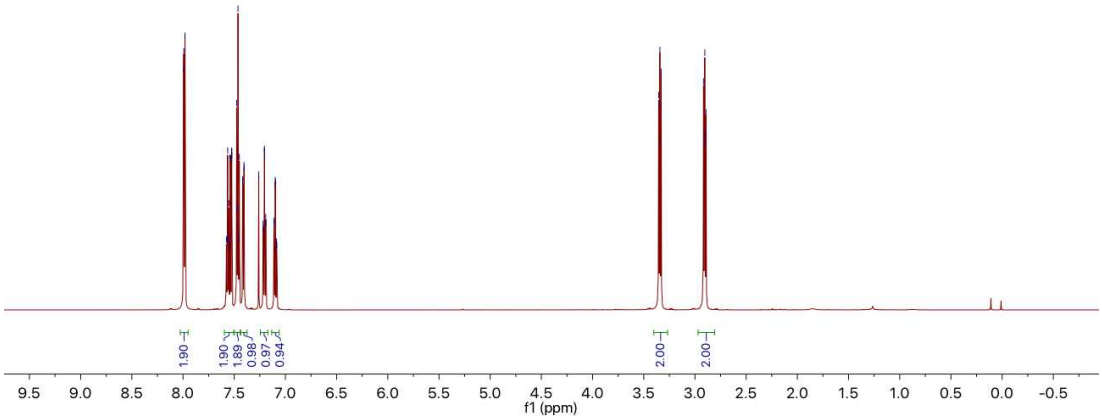
Compound 1ak, ^{13}C-NMR (151 MHz; $CDCl_3$)



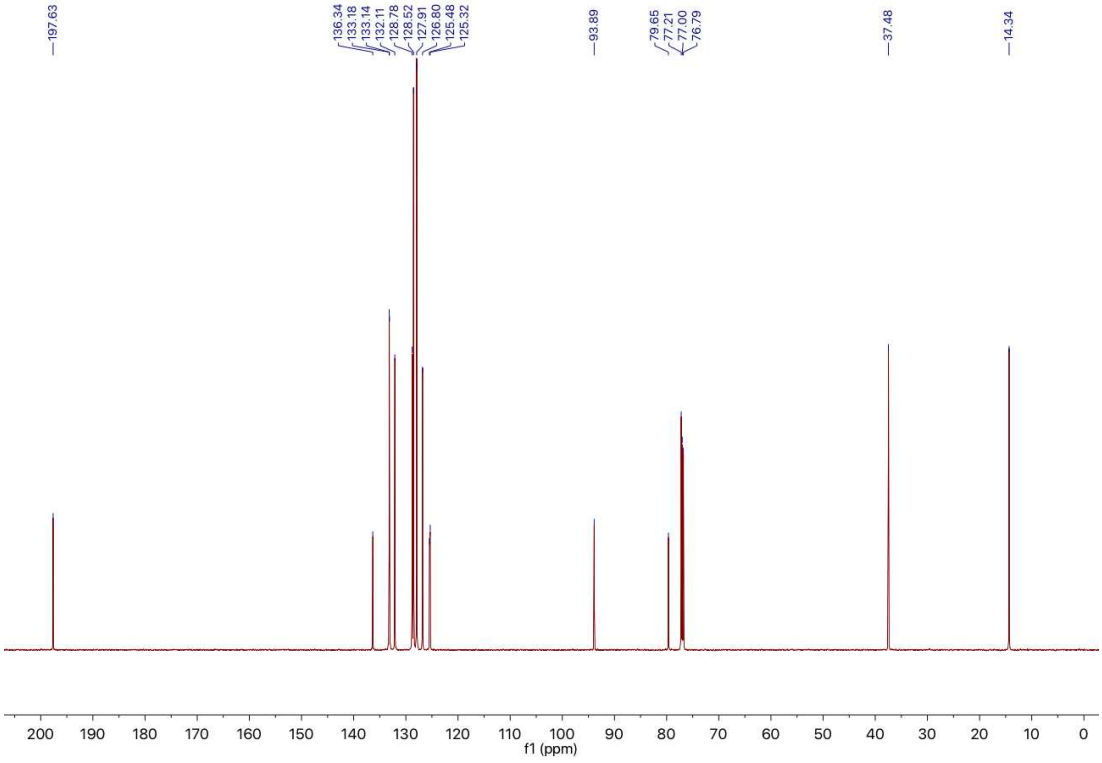
Compound 1al, ^{1}H NMR (600 MHz, $CDCl_3$)



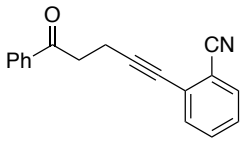
1al



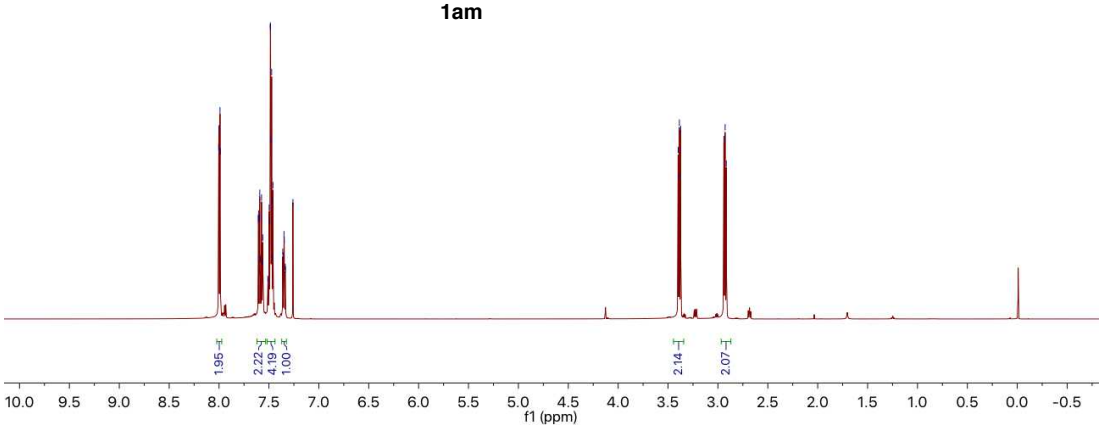
Compound 1al, ^{13}C-NMR (151 MHz; $CDCl_3$)



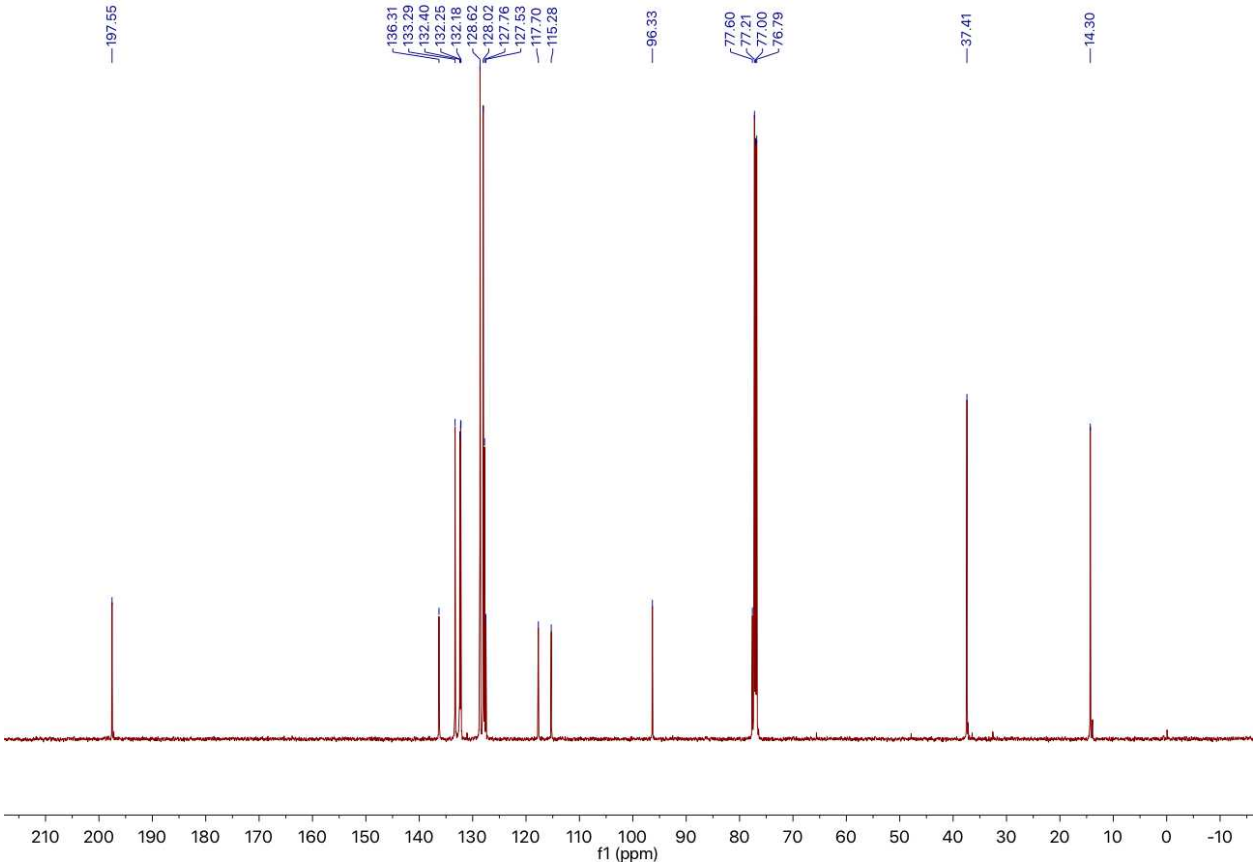
Compound 1am, ^{1}H NMR (600 MHz, $CDCl_3$)



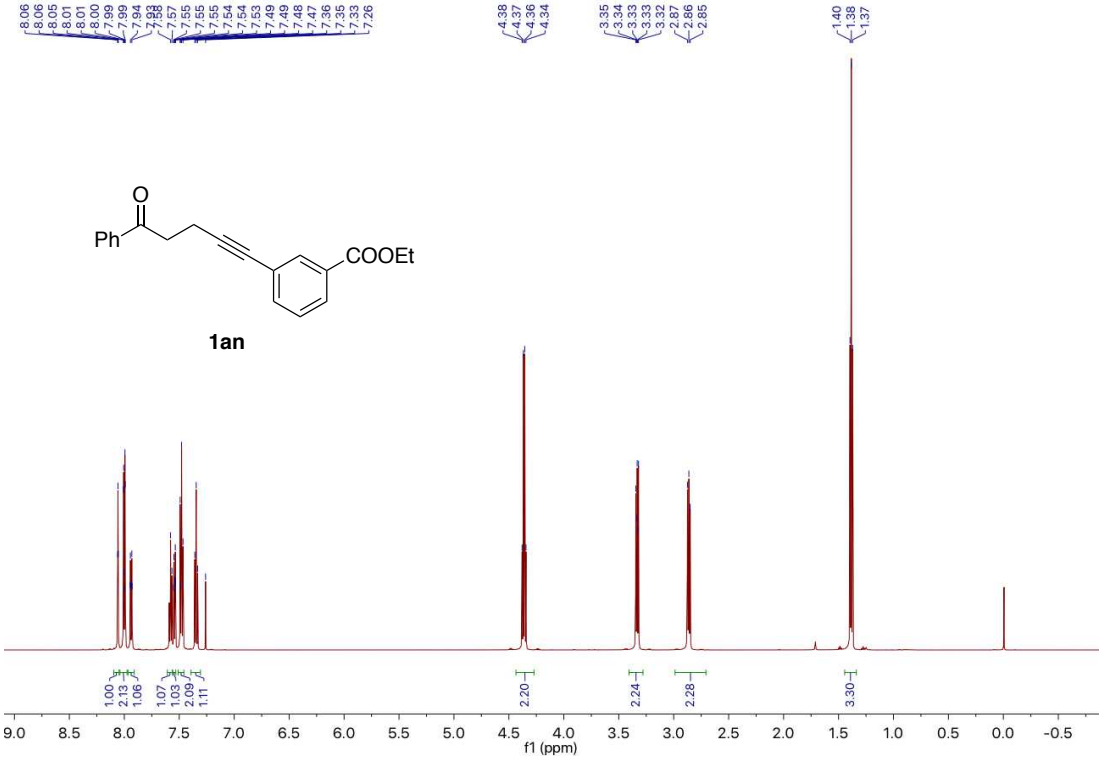
1am



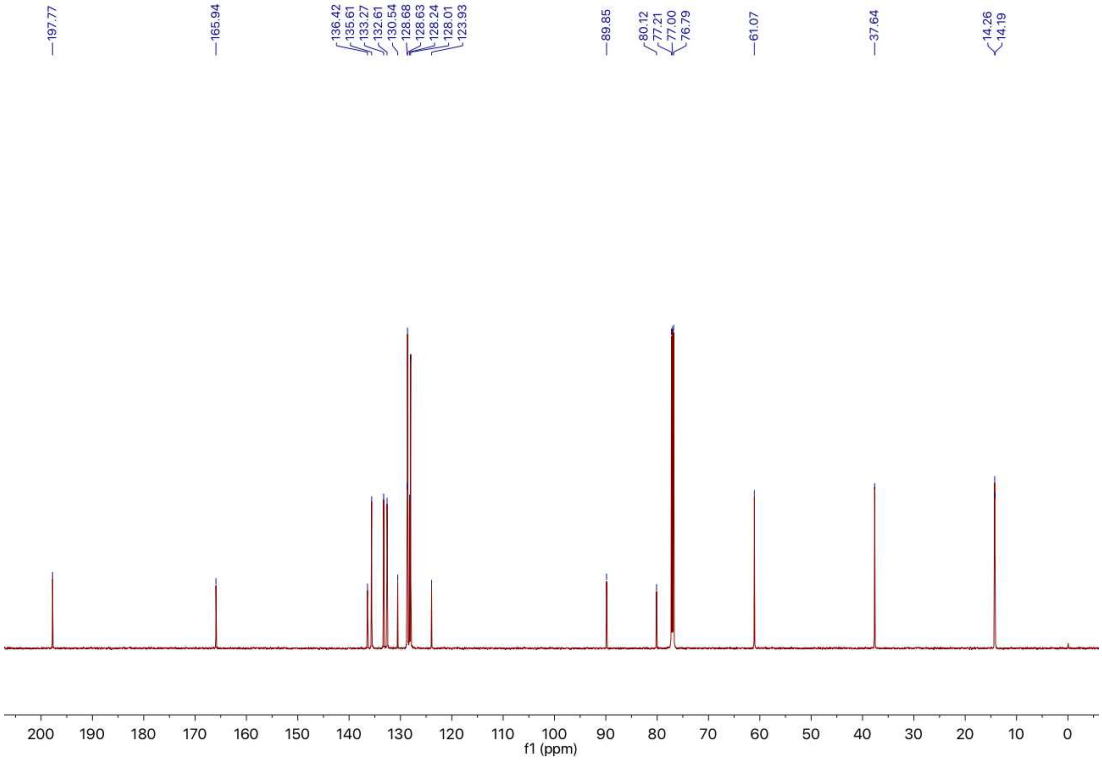
Compound 1am, ^{13}C-NMR (151 MHz; $CDCl_3$)



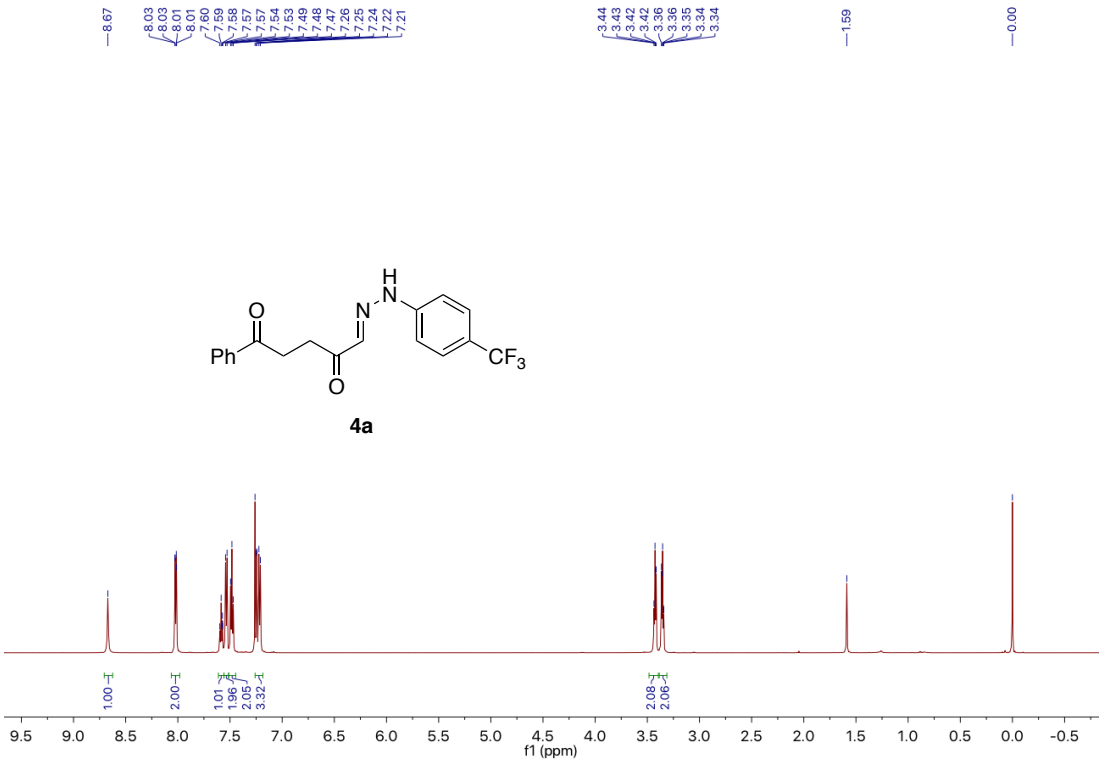
Compound 1an, ^{1}H NMR (600 MHz, $CDCl_3$)



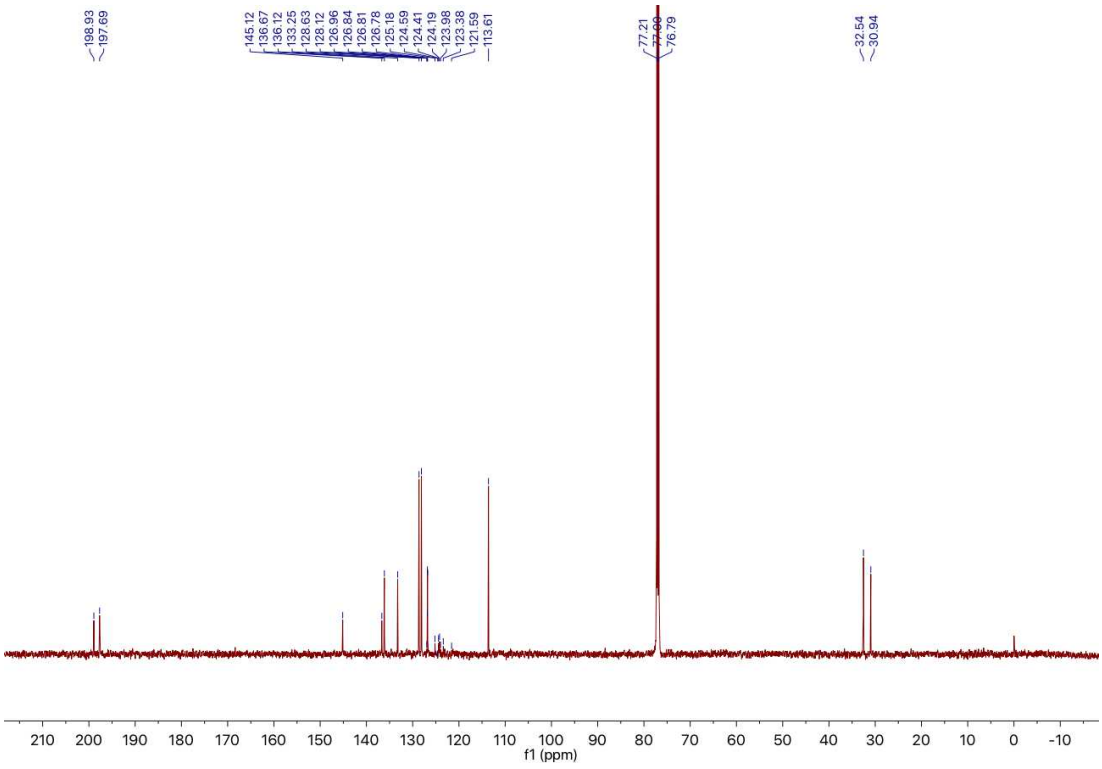
Compound 1an, ^{13}C-NMR (151 MHz; $CDCl_3$)



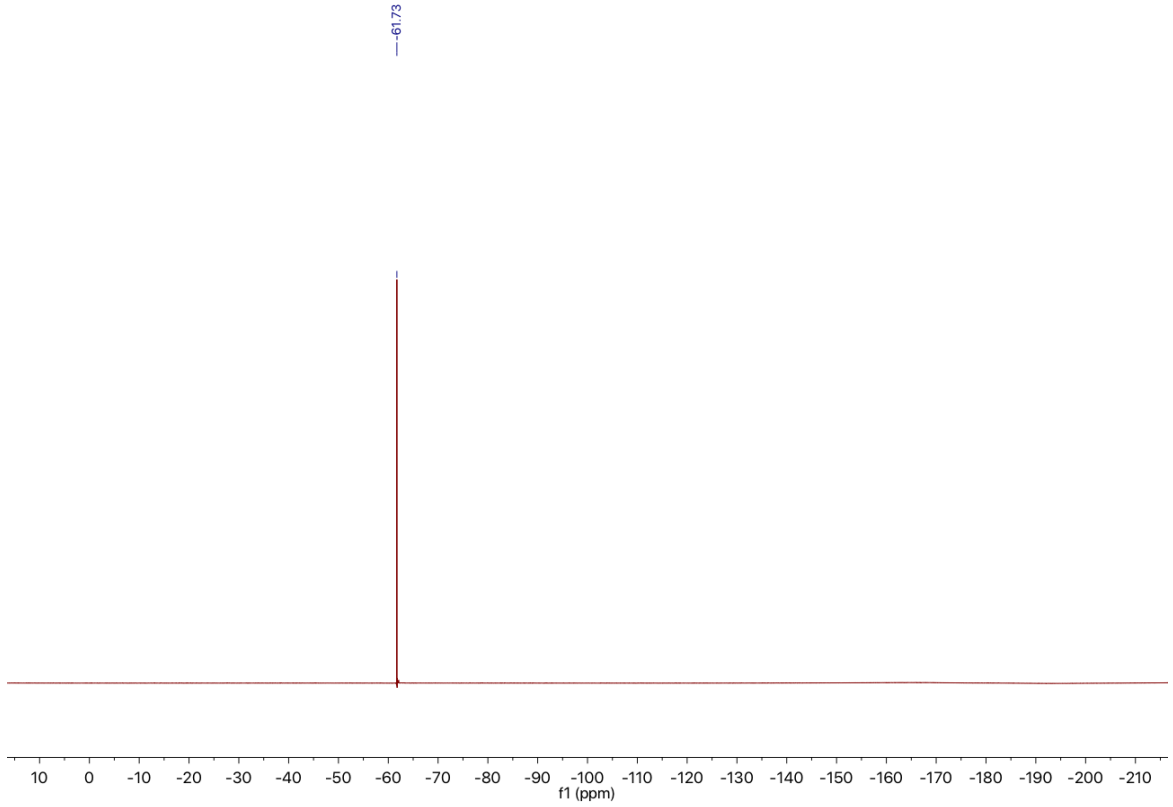
Compound 4a, ^{1}H NMR (600 MHz, $CDCl_3$)



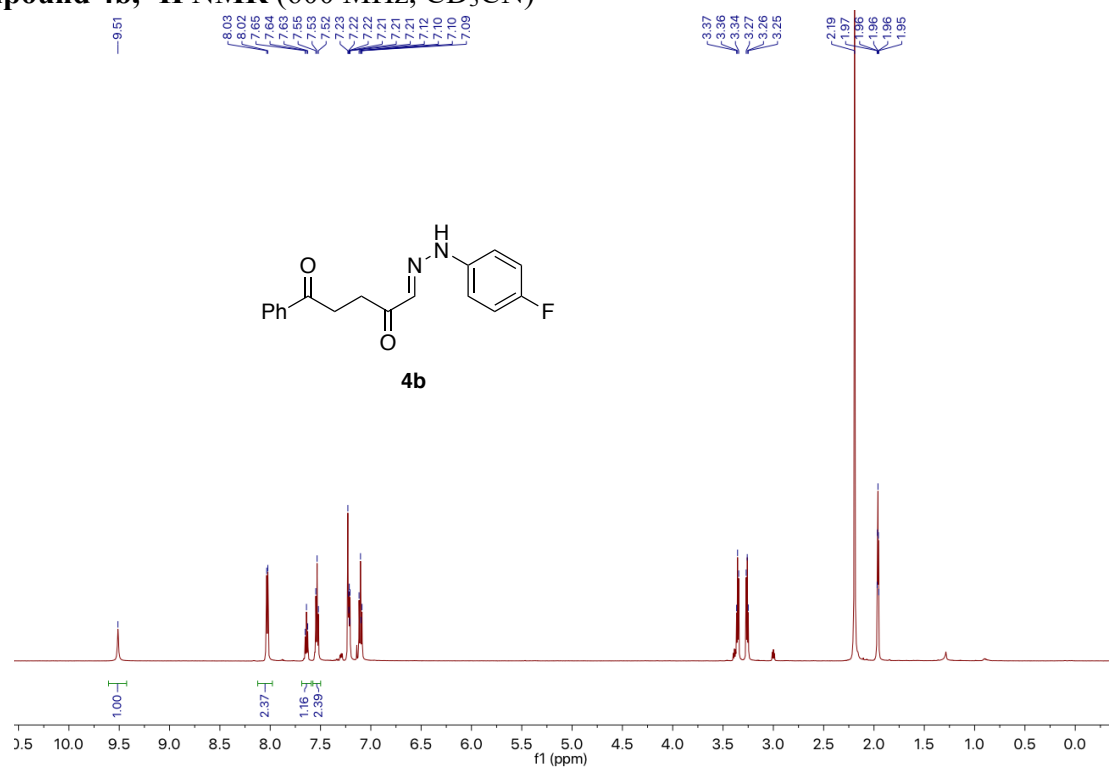
Compound 4a, ^{13}C-NMR (151 MHz; $CDCl_3$)



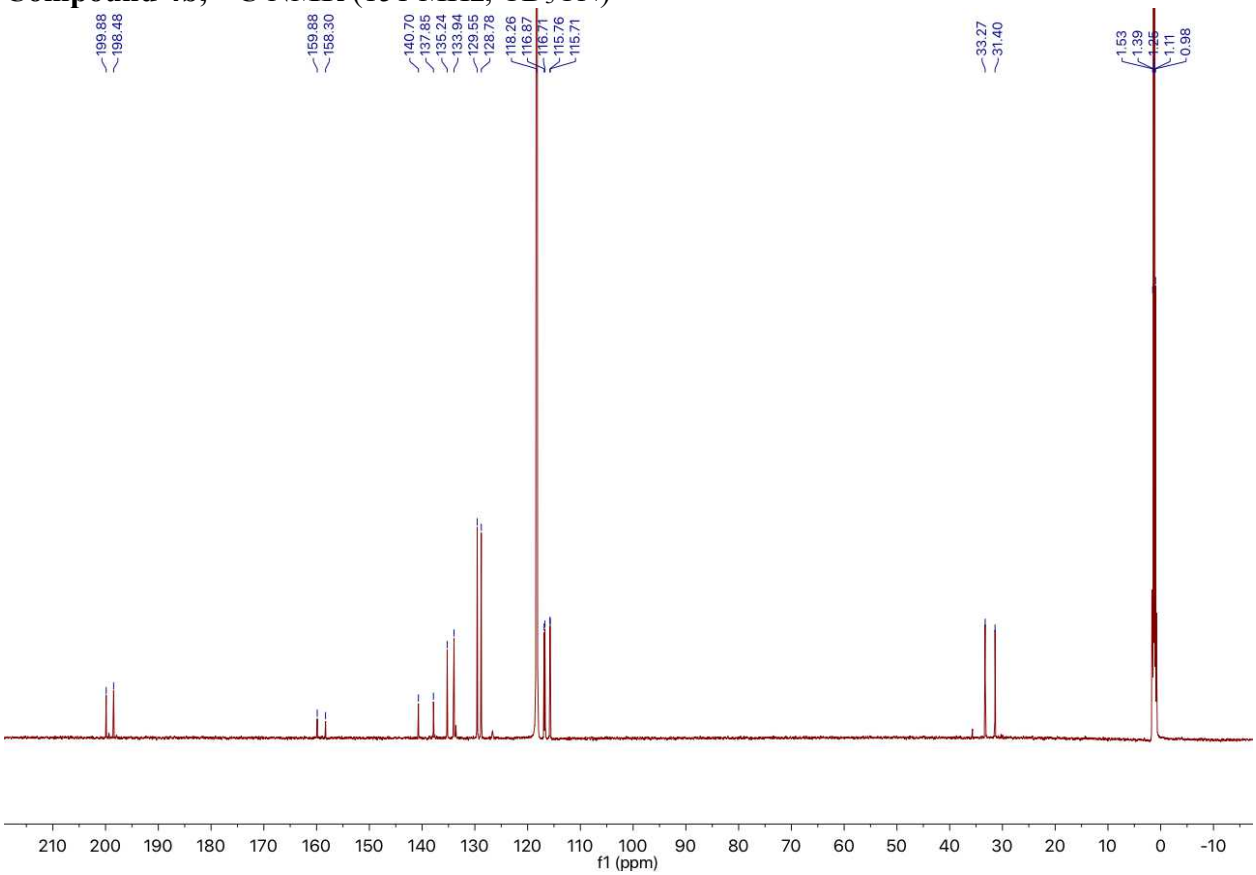
Compound 4a, ^{19}F NMR (565 MHz, $CDCl_3$)



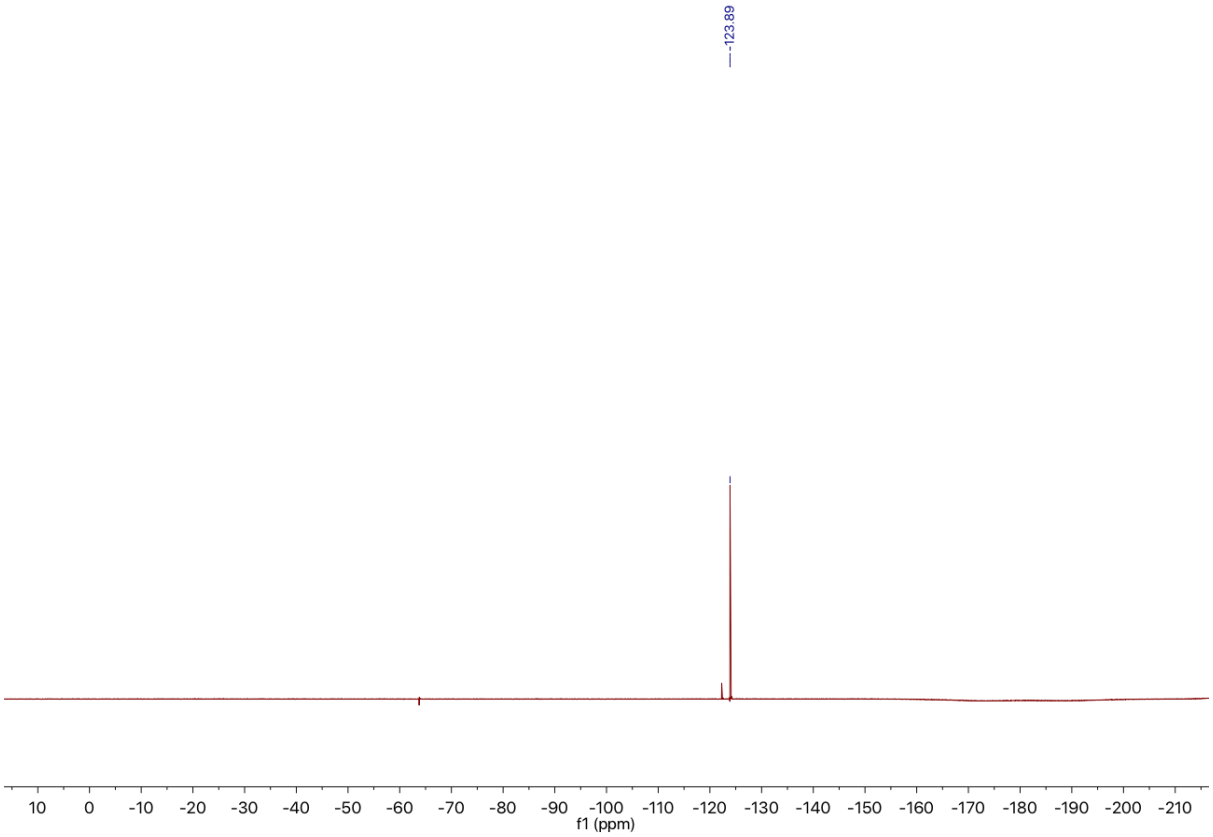
Compound 4b, ^{1}H NMR (600 MHz, CD_3CN)



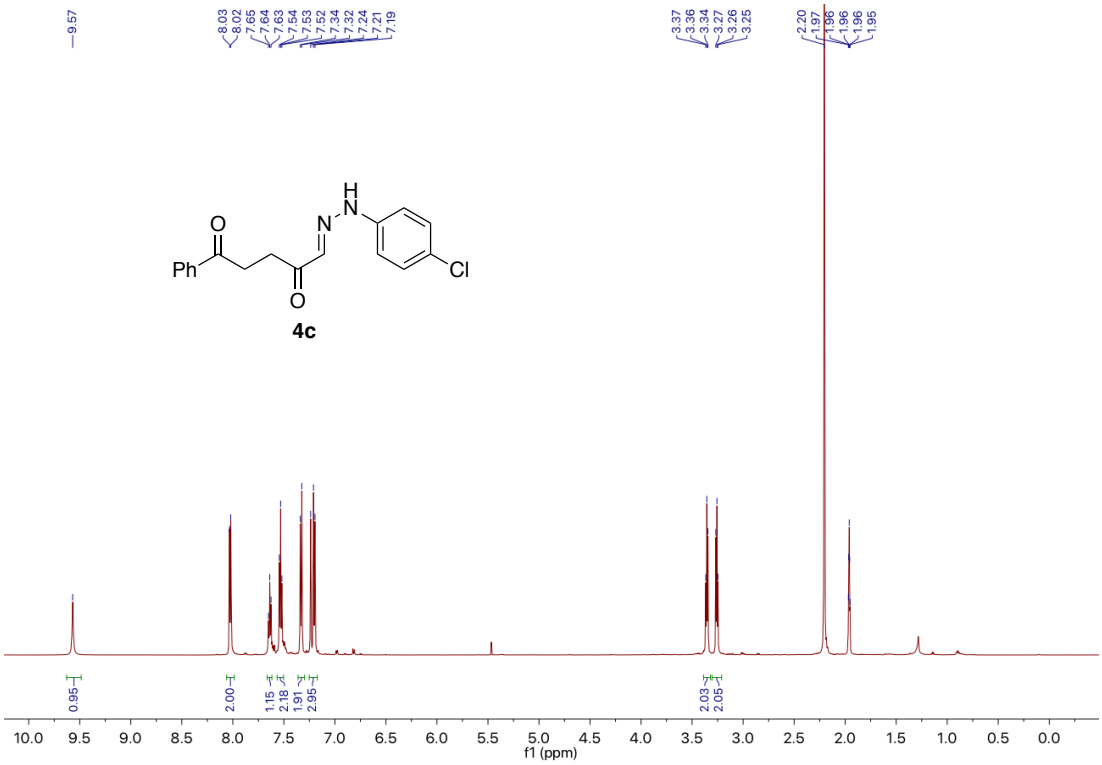
Compound 4b, ^{13}C NMR (151 MHz, CD_3CN)



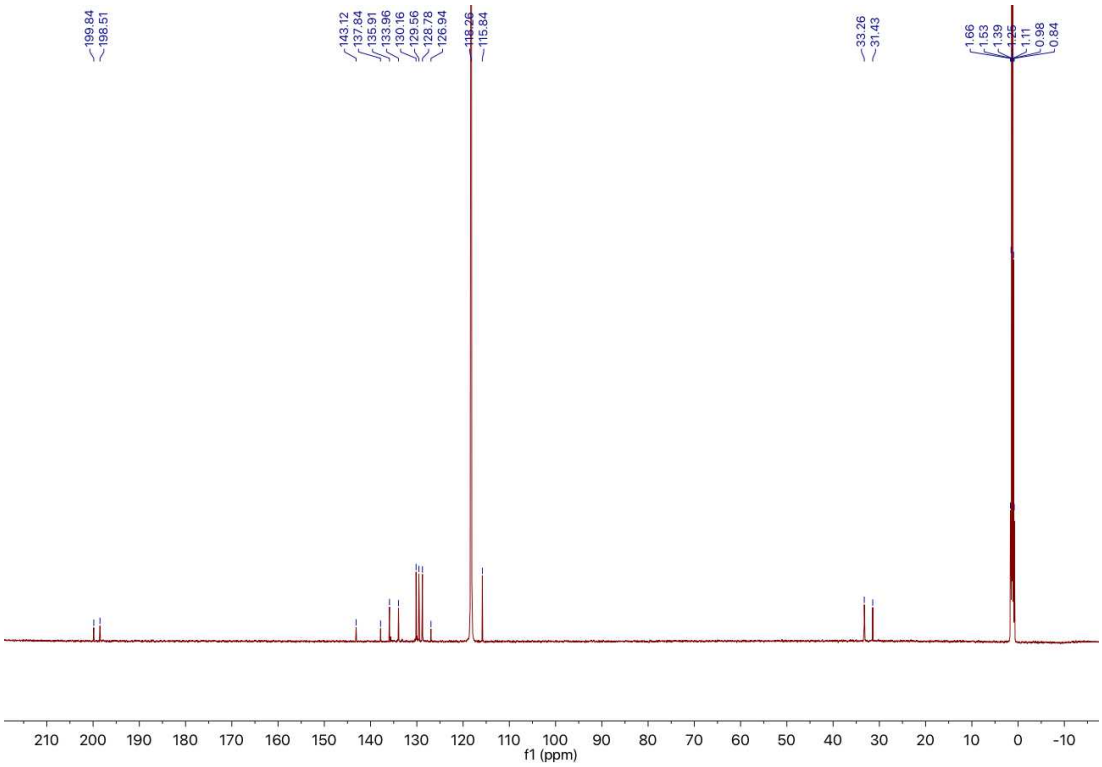
Compound 4b, ^{19}F NMR (565 MHz, CD_3CN)



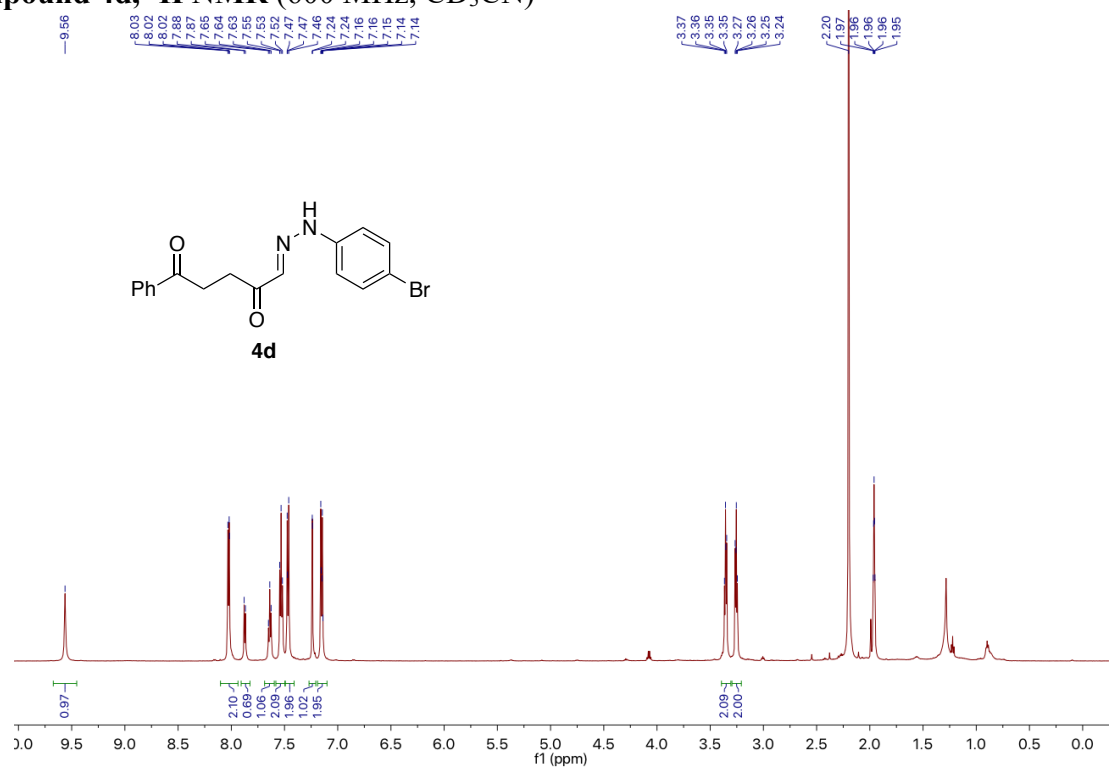
Compound 4c, ^{1}H NMR (600 MHz, CD_3CN)



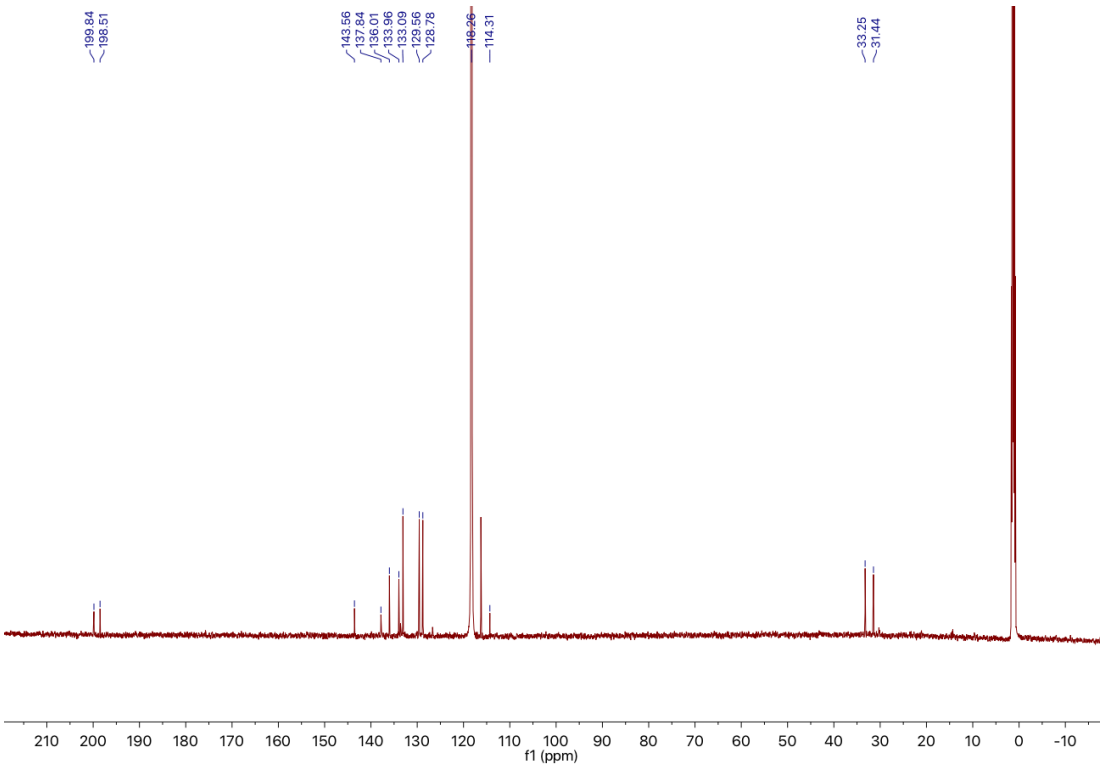
Compound 4c, ^{13}C NMR (151 MHz, CD_3CN)



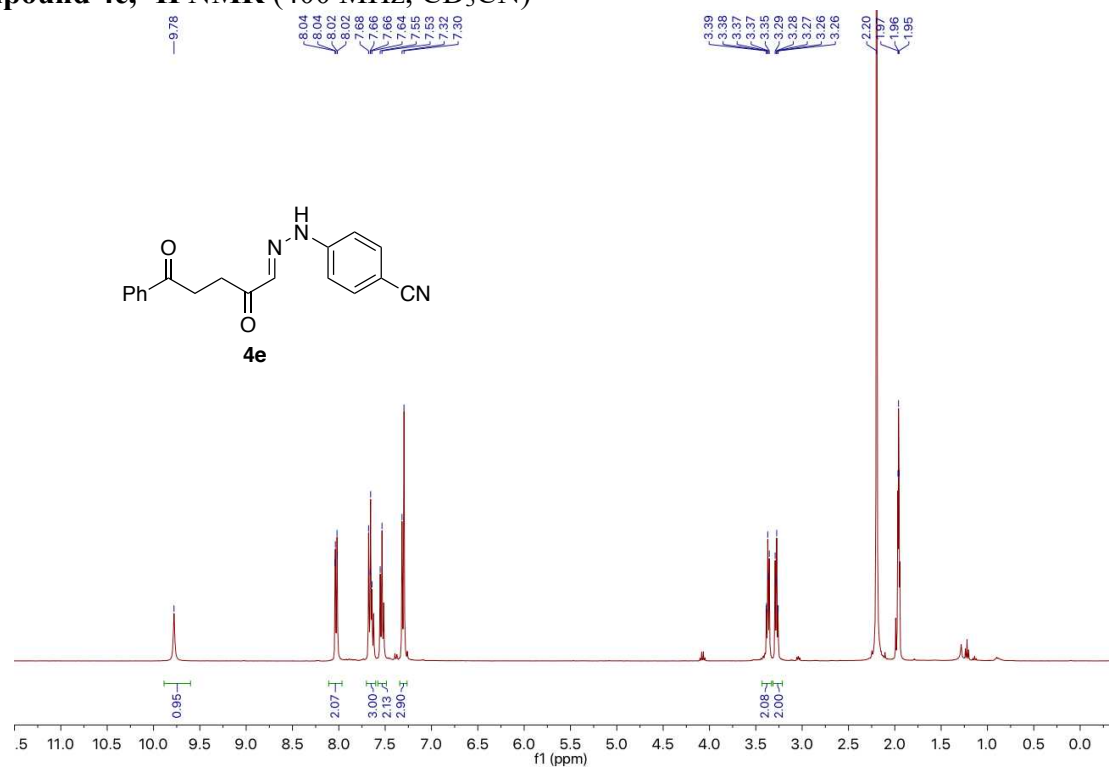
Compound 4d, ^{1}H NMR (600 MHz, CD_3CN)



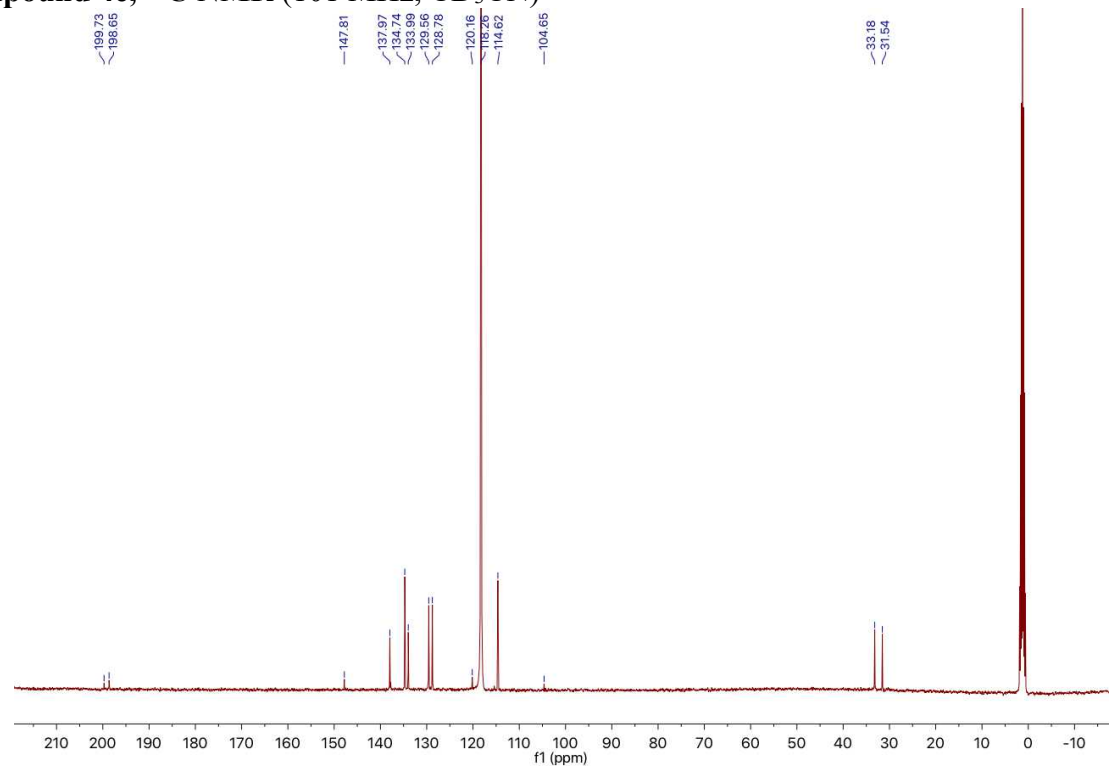
Compound 4d, ^{13}C NMR (151 MHz, CD_3CN)



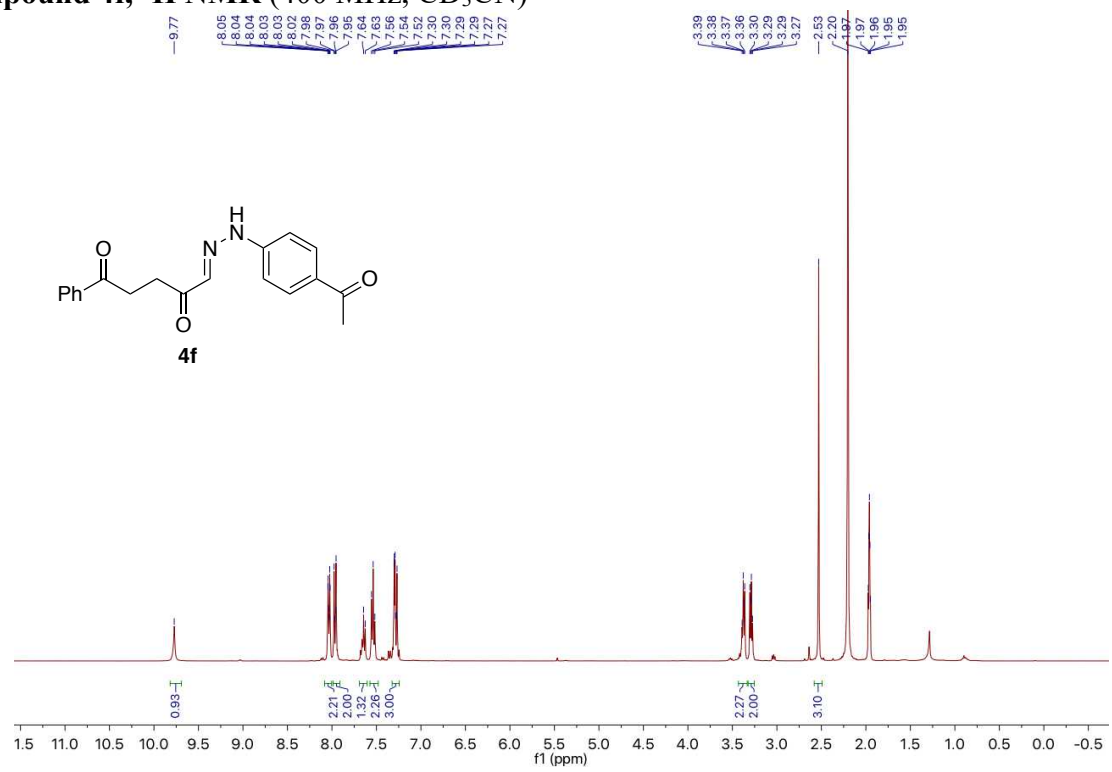
Compound 4e, ^{1}H NMR (400 MHz, CD_3CN)



Compound 4e, ^{13}C NMR (101 MHz, CD_3CN)

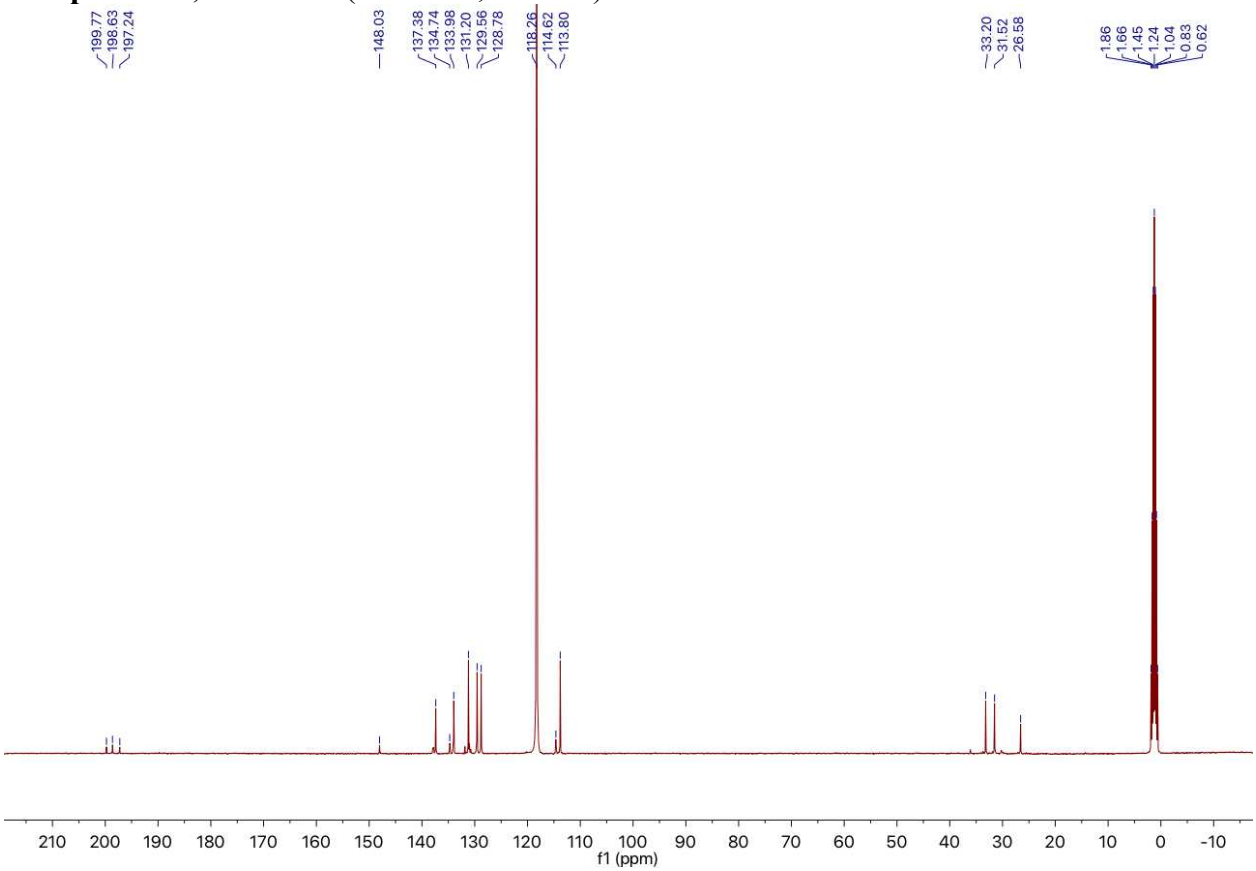


Compound 4f, ^{1}H NMR (400 MHz, CD_3CN)

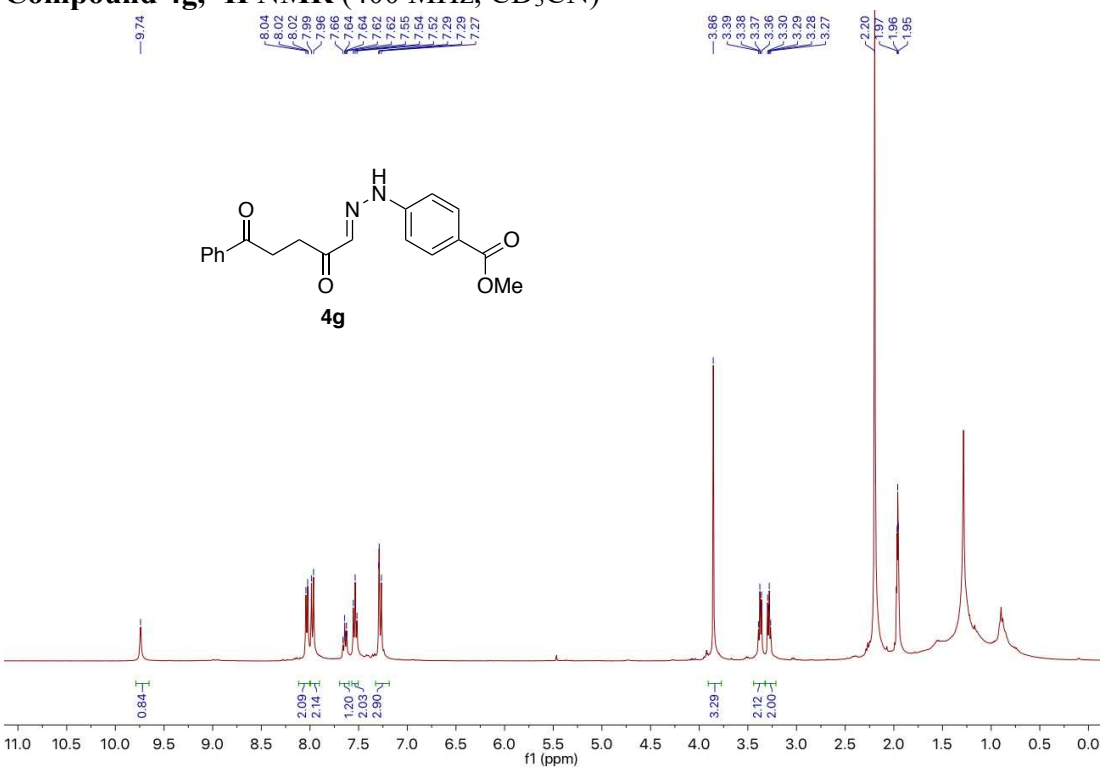


4f

Compound 4f, ^{13}C NMR (101 MHz, CD_3CN)

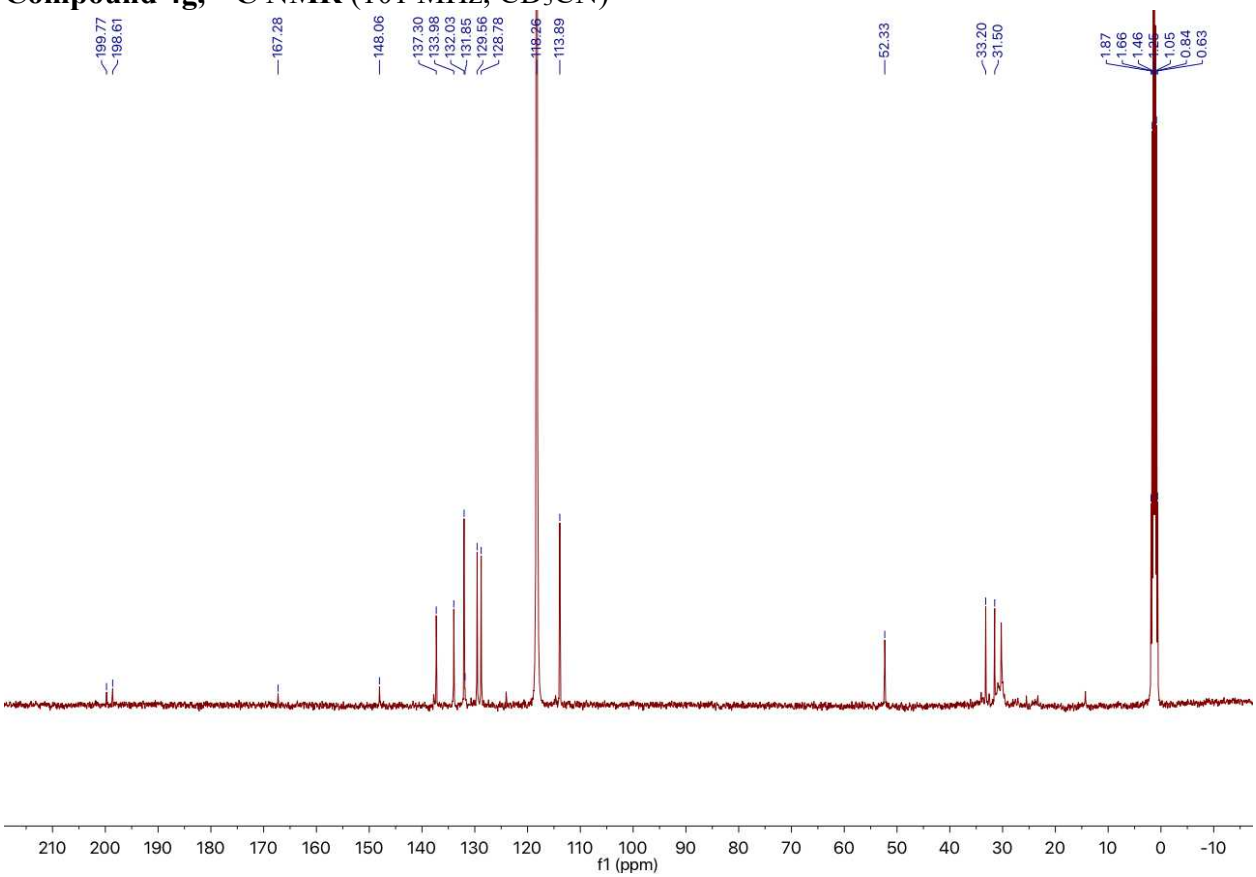


Compound 4g, ^{1}H NMR (400 MHz, CD_3CN)

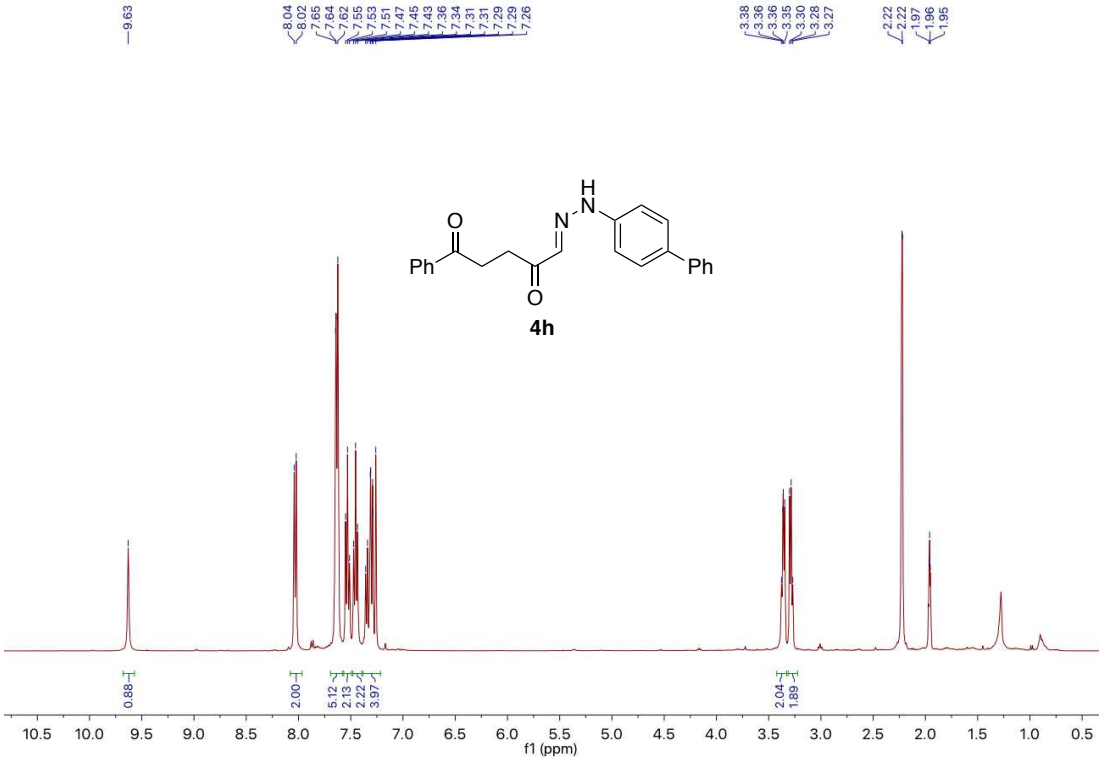


4g

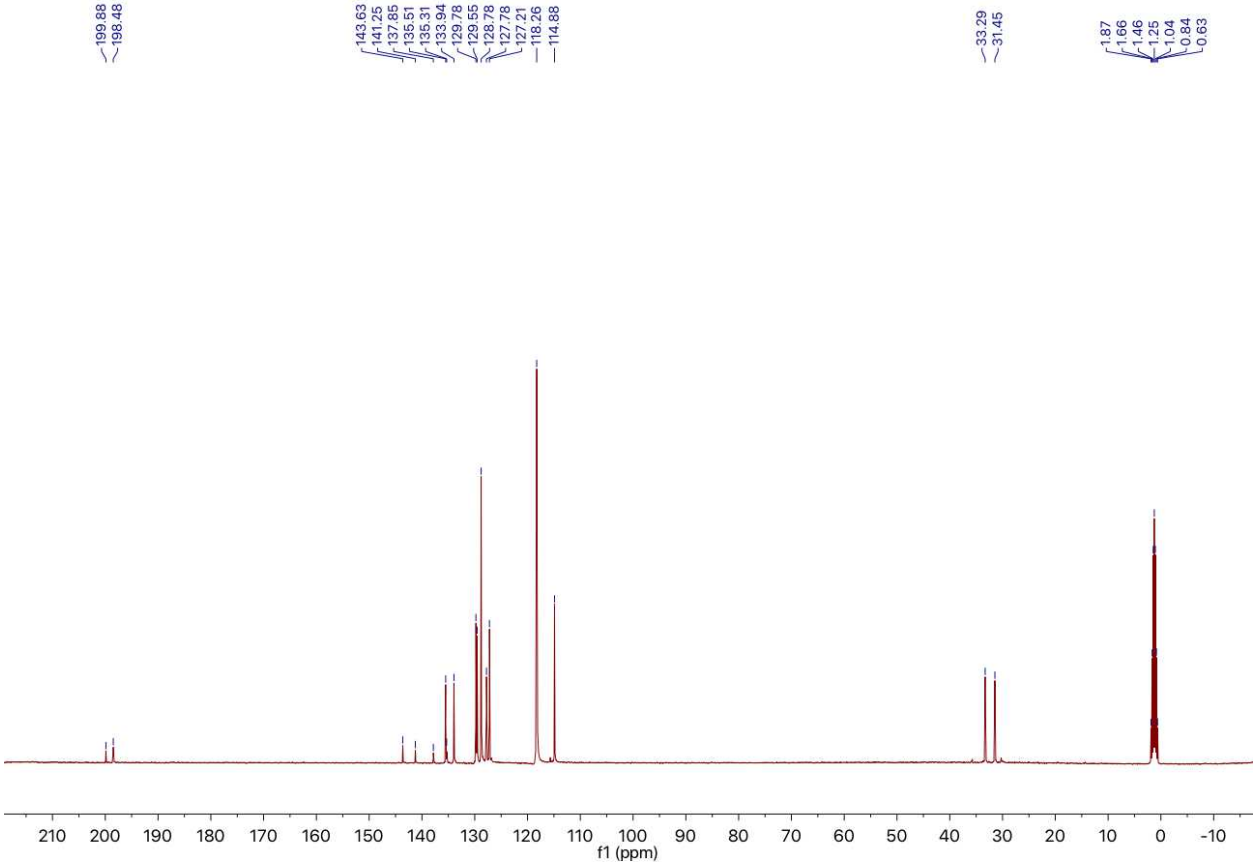
Compound 4g, ^{13}C NMR (101 MHz, CD_3CN)



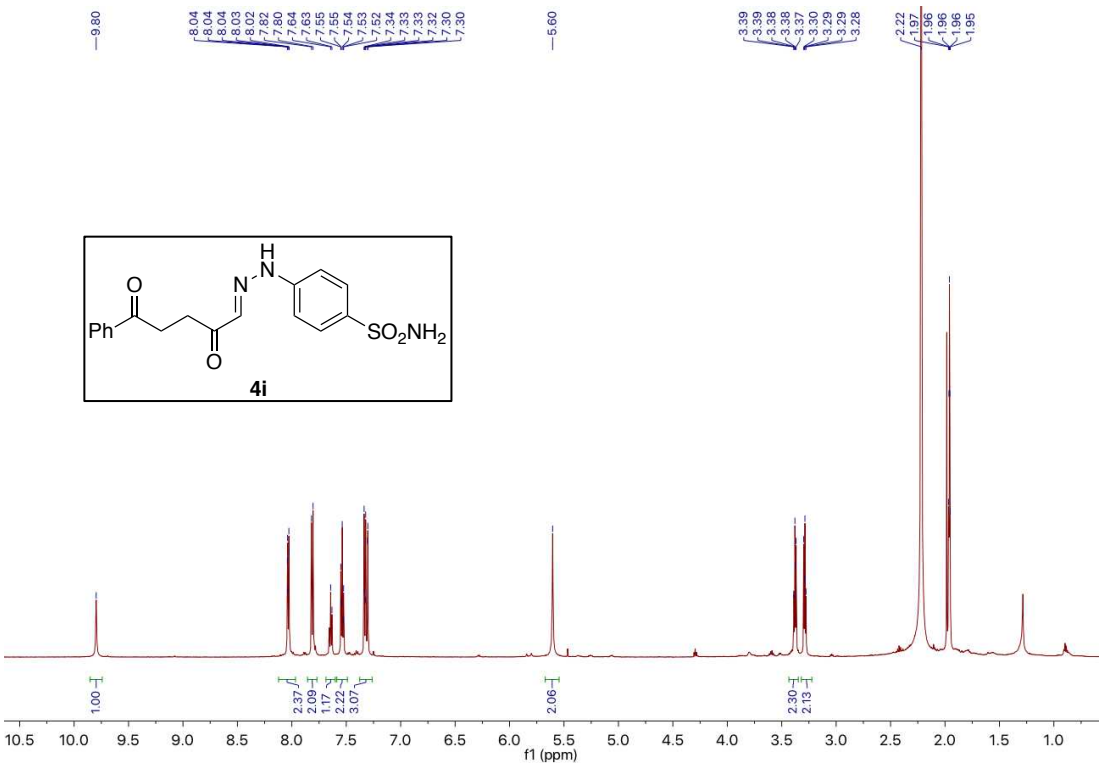
Compound 4h, ^{1}H NMR (400 MHz, CD_3CN)



Compound 4h, ^{13}C NMR (101 MHz, CD_3CN)

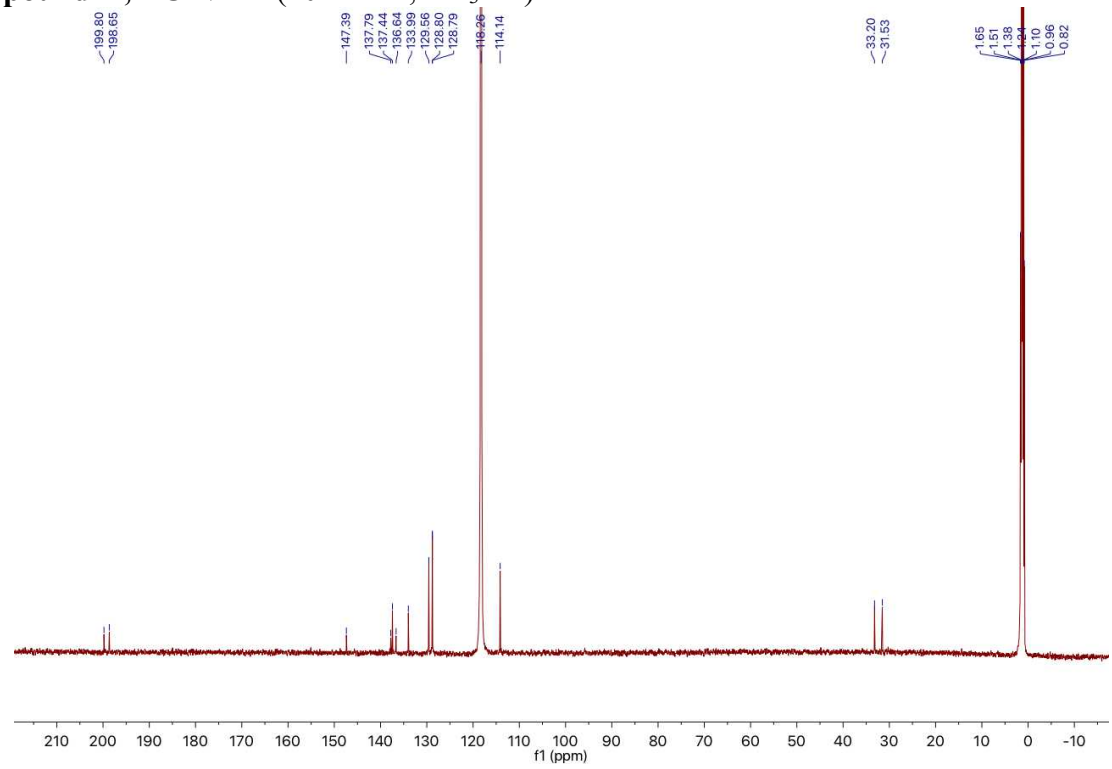


Compound 4i, ^{1}H NMR (600 MHz, CD_3CN)

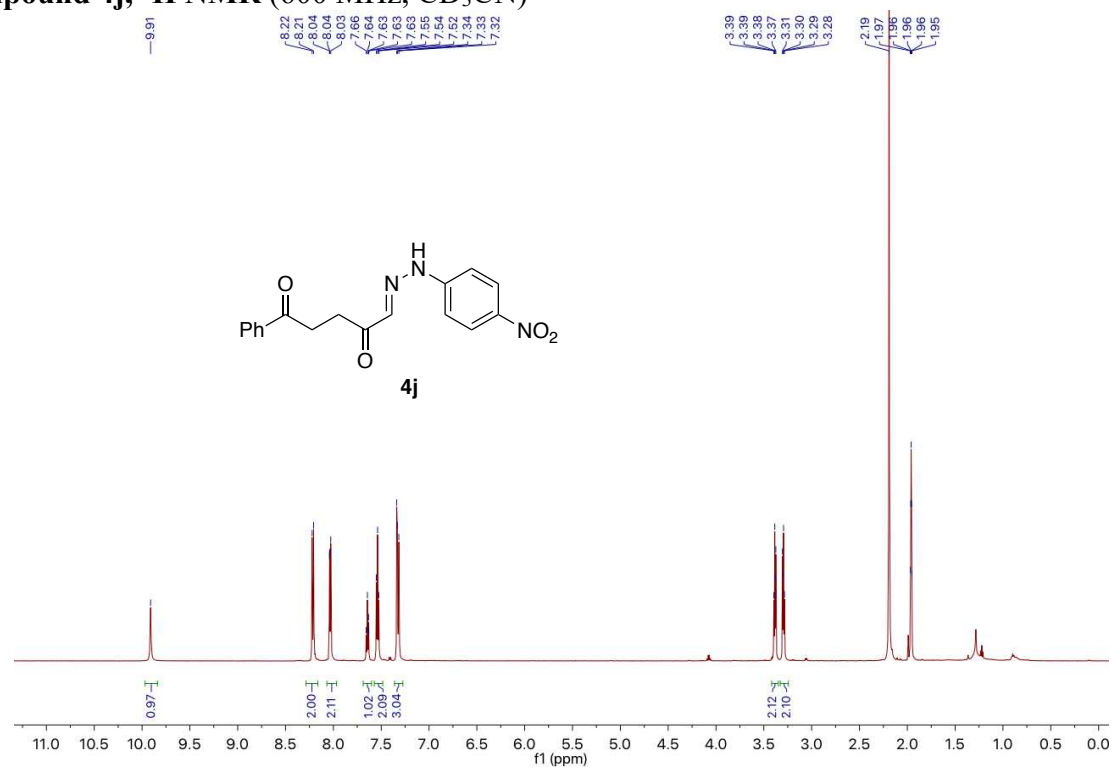


4i

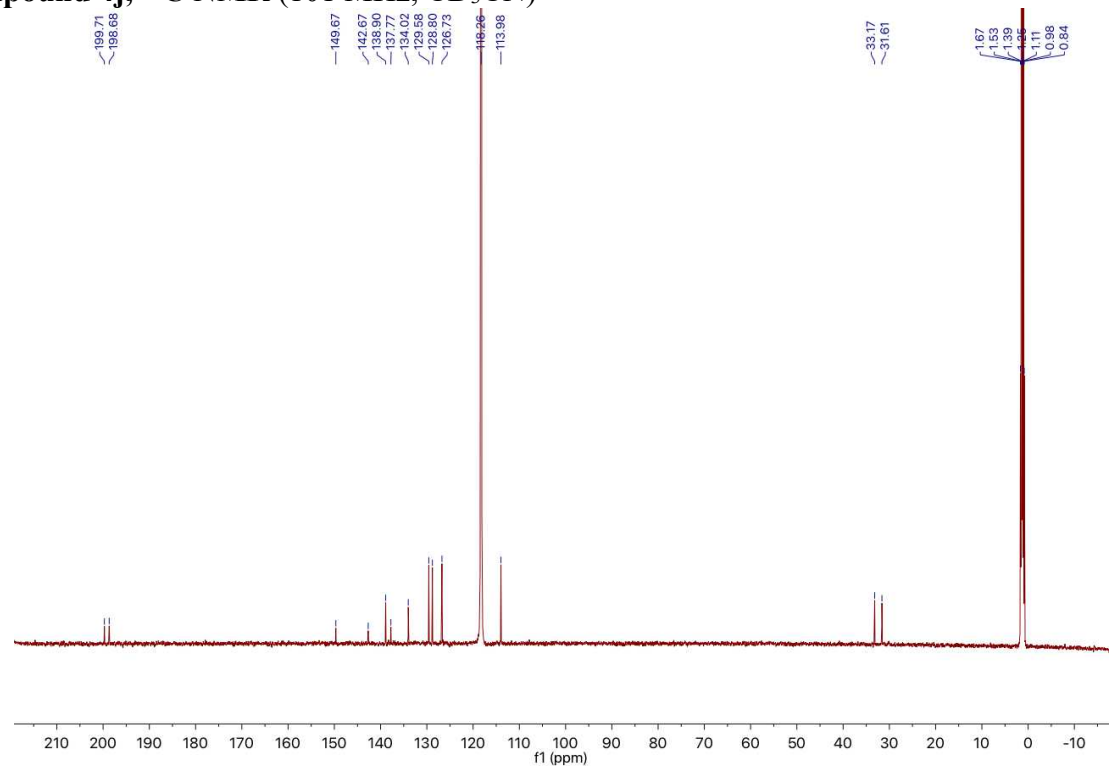
Compound 4i, ^{13}C NMR (101 MHz, CD_3CN)



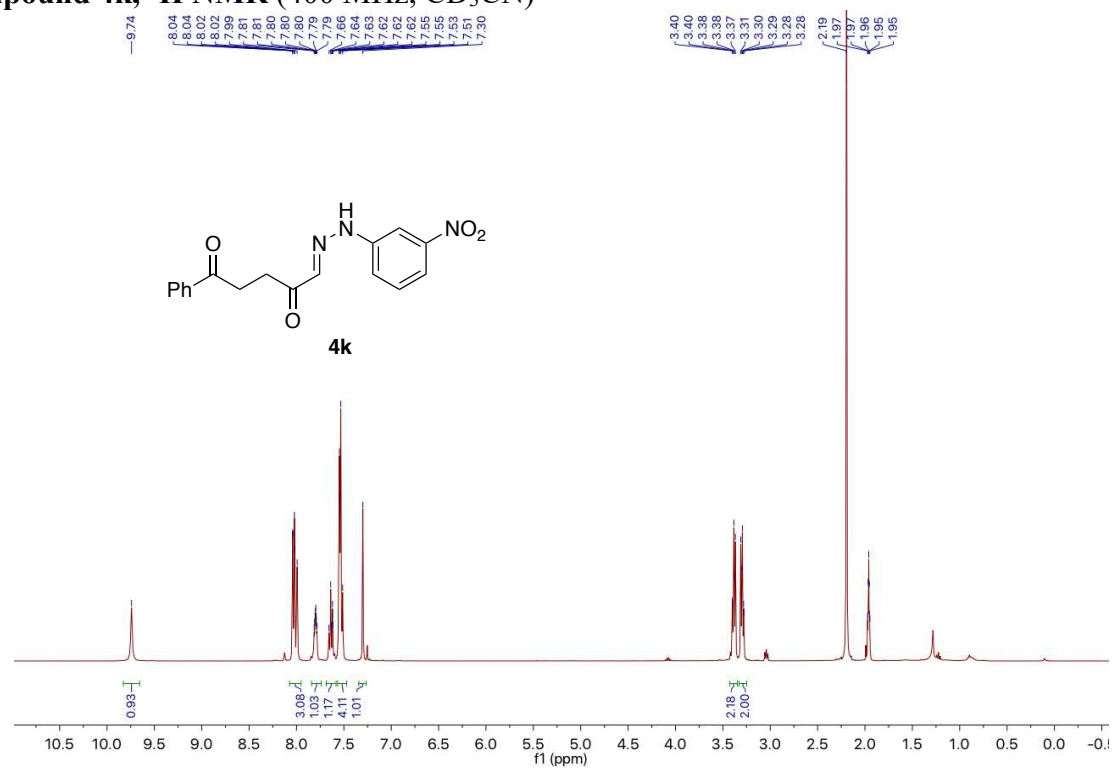
Compound 4j, ^{1}H NMR (600 MHz, CD_3CN)



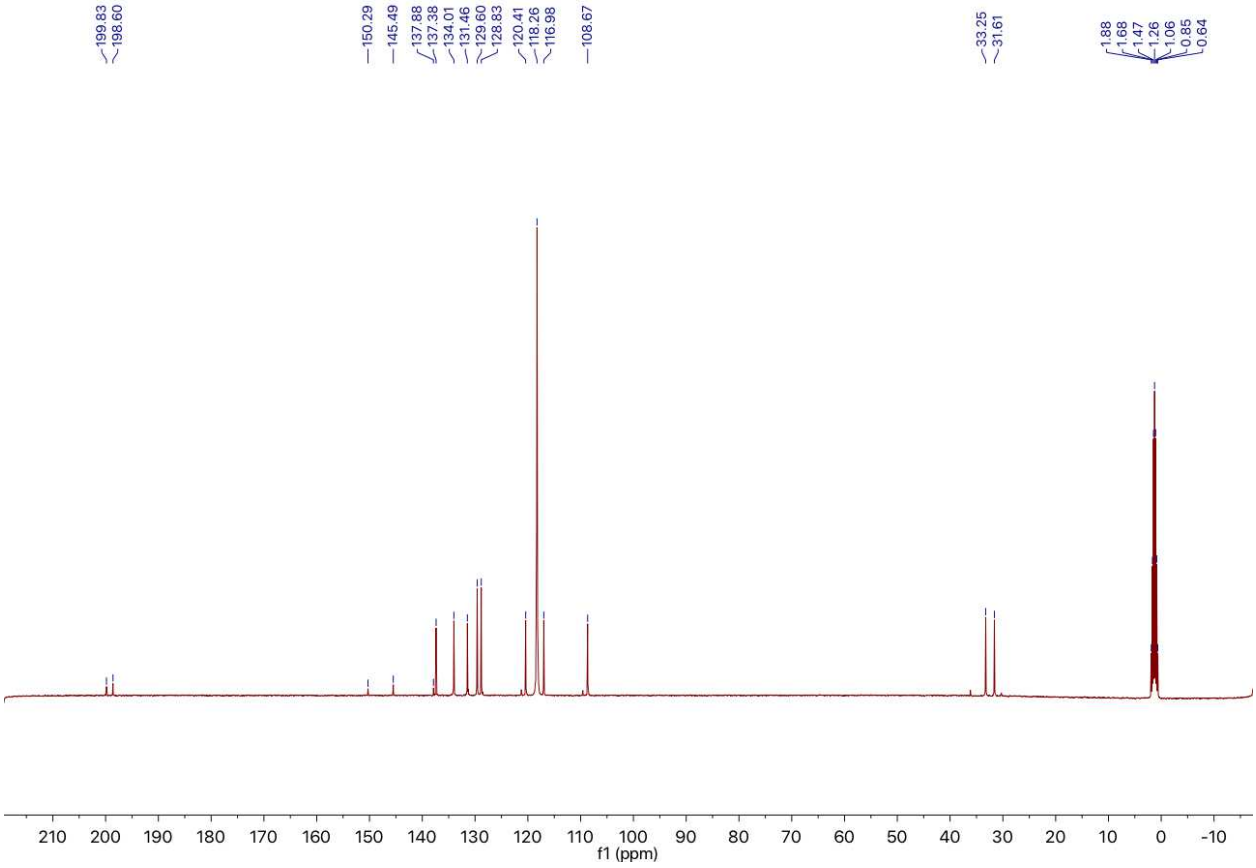
Compound 4j, ^{13}C NMR (101 MHz, CD_3CN)



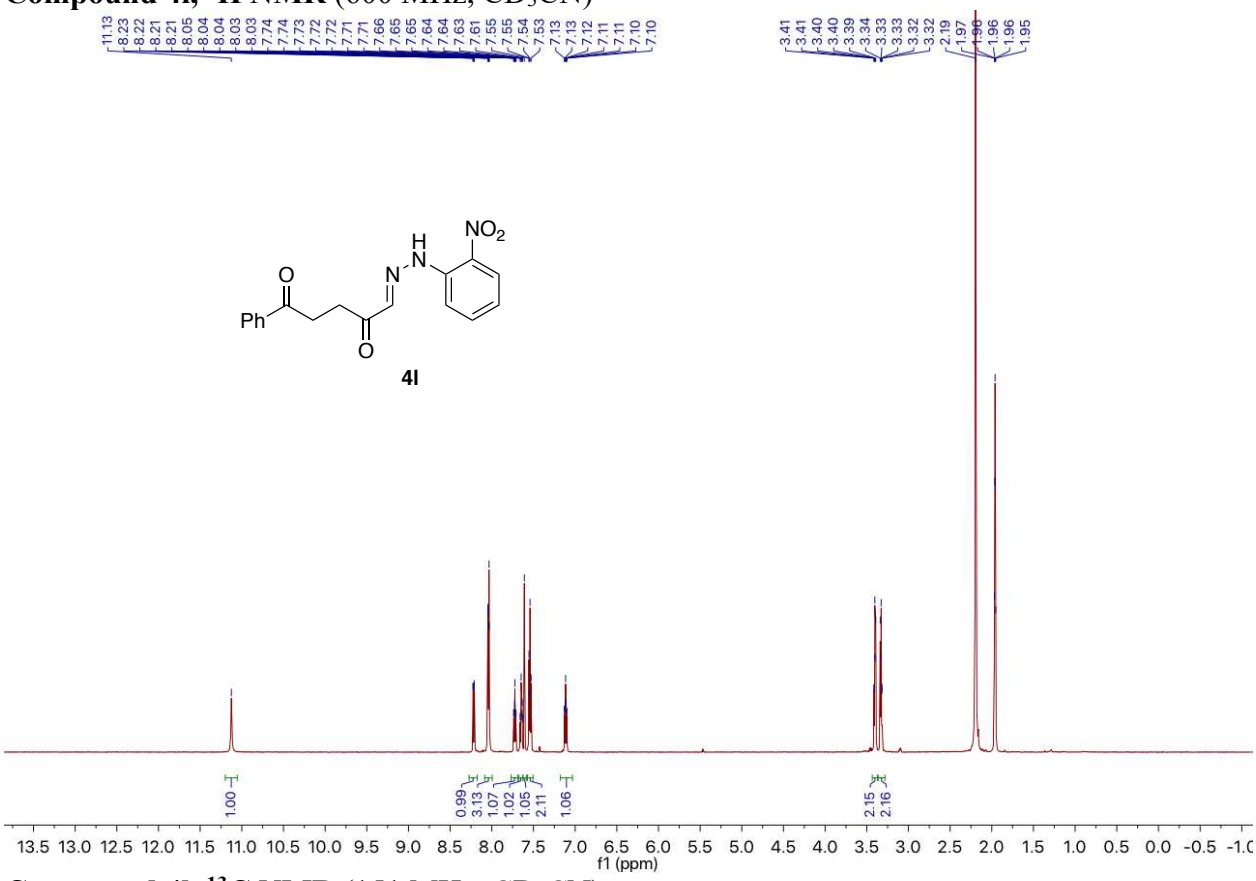
Compound 4k, ^{1}H NMR (400 MHz, CD_3CN)



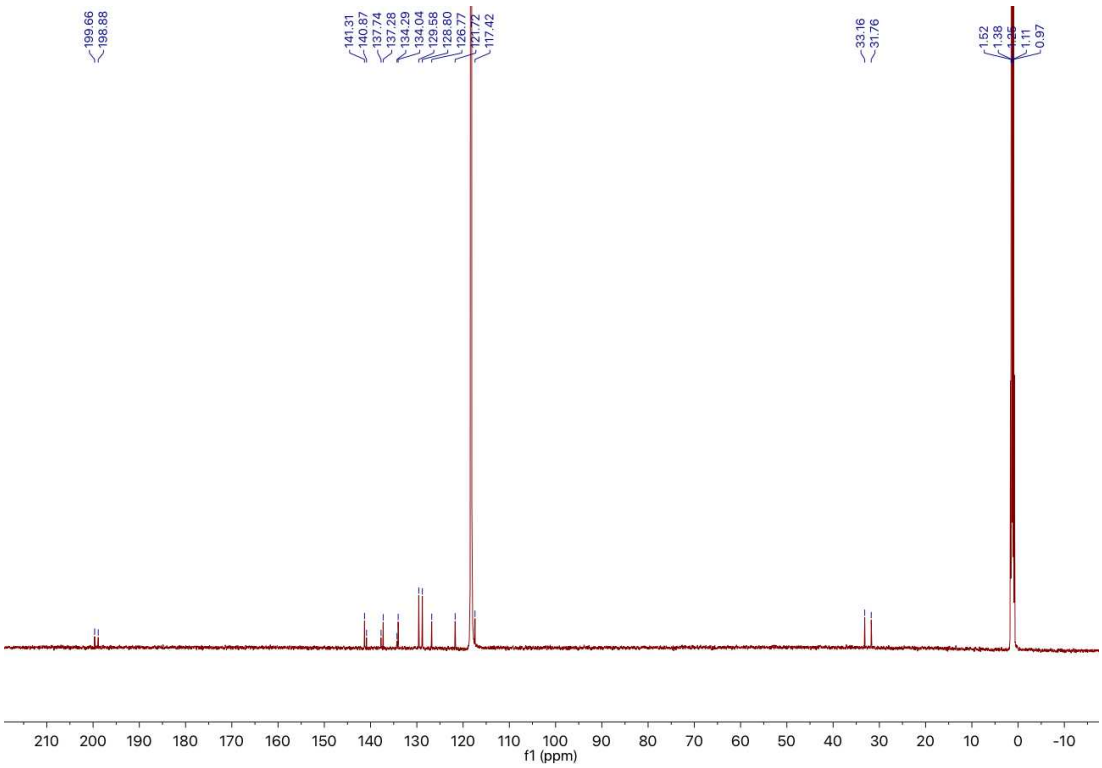
Compound 4k, ^{13}C NMR (101 MHz, CD_3CN)



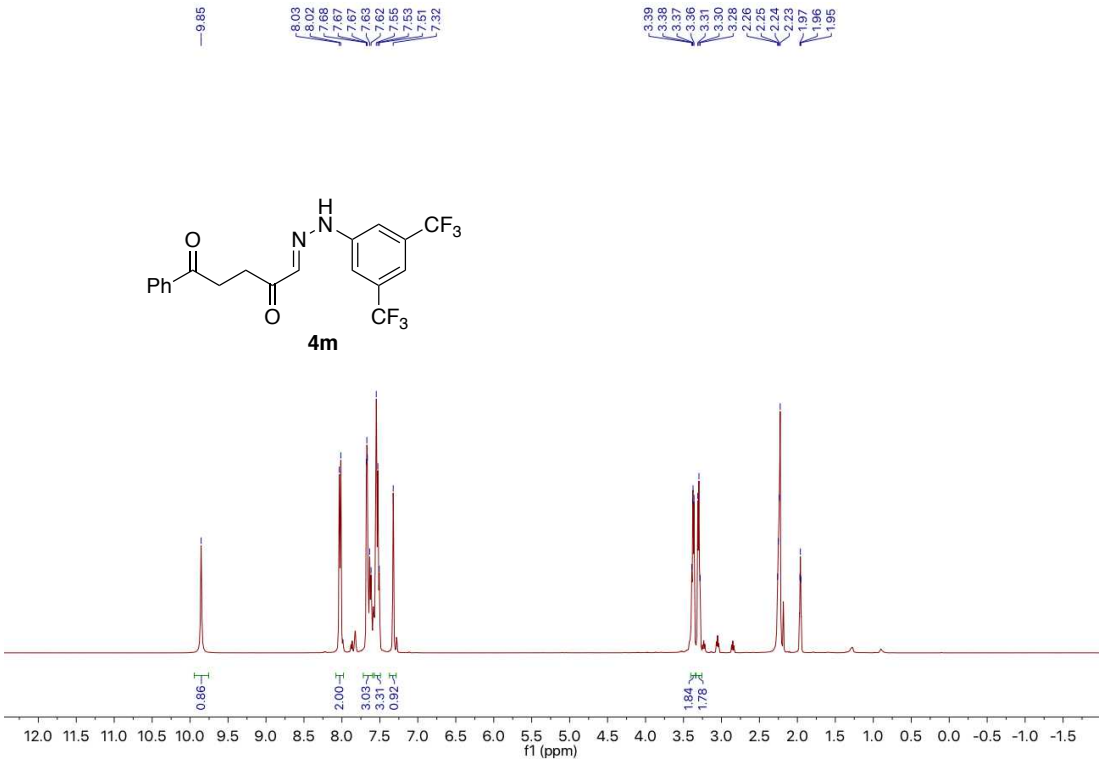
Compound 4l, ^{1}H NMR (600 MHz, CD_3CN)



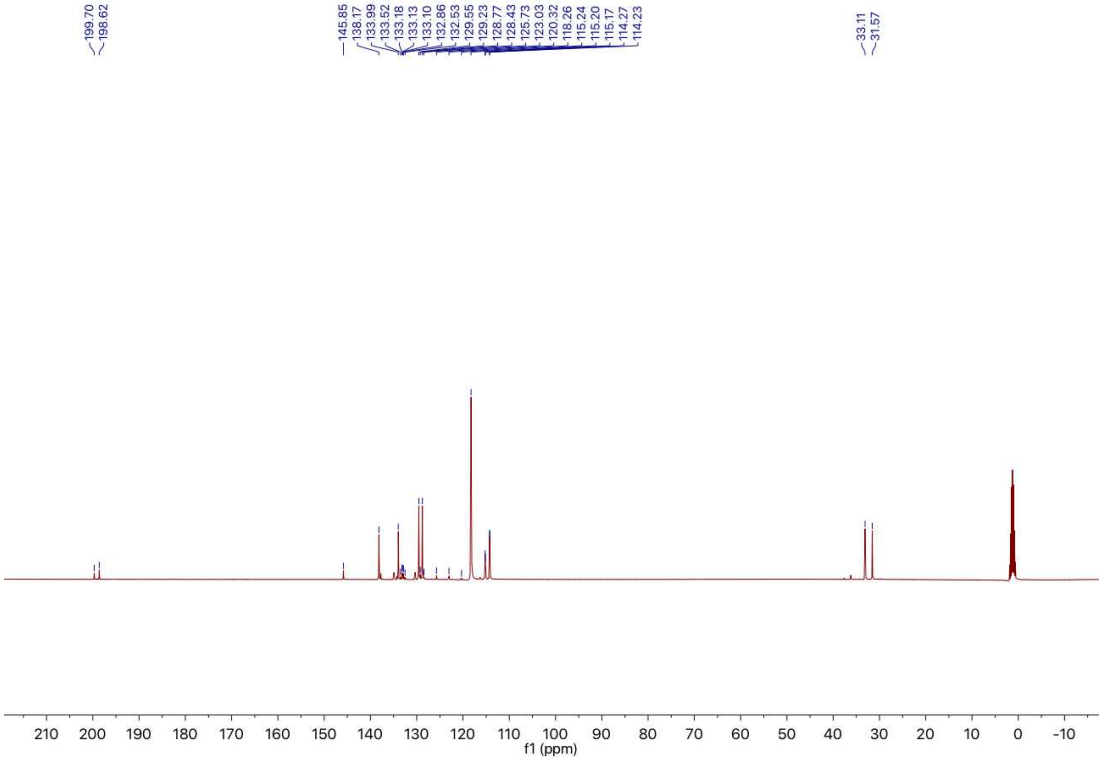
Compound 4l, ^{13}C NMR (151 MHz, CD_3CN)



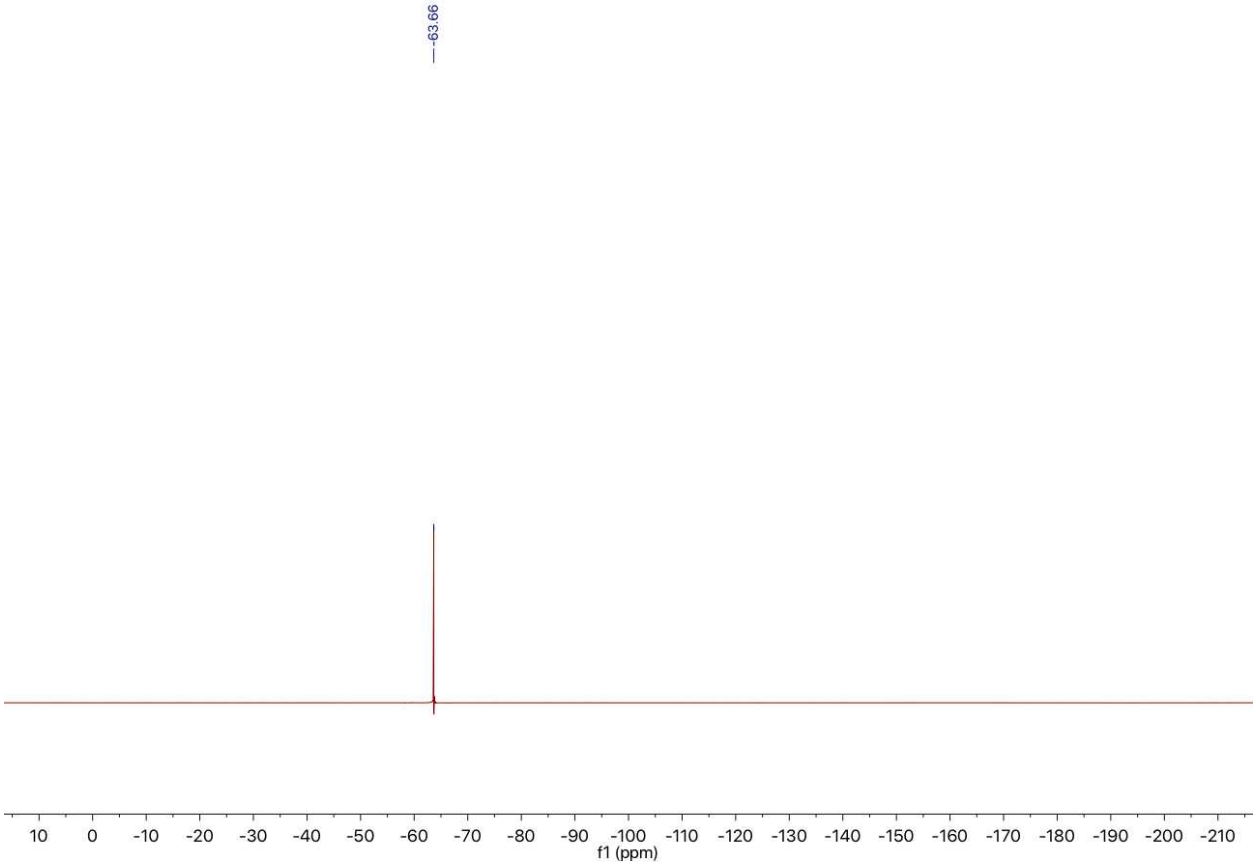
Compound 4m, ^{1}H NMR (400 MHz, CD_3CN)



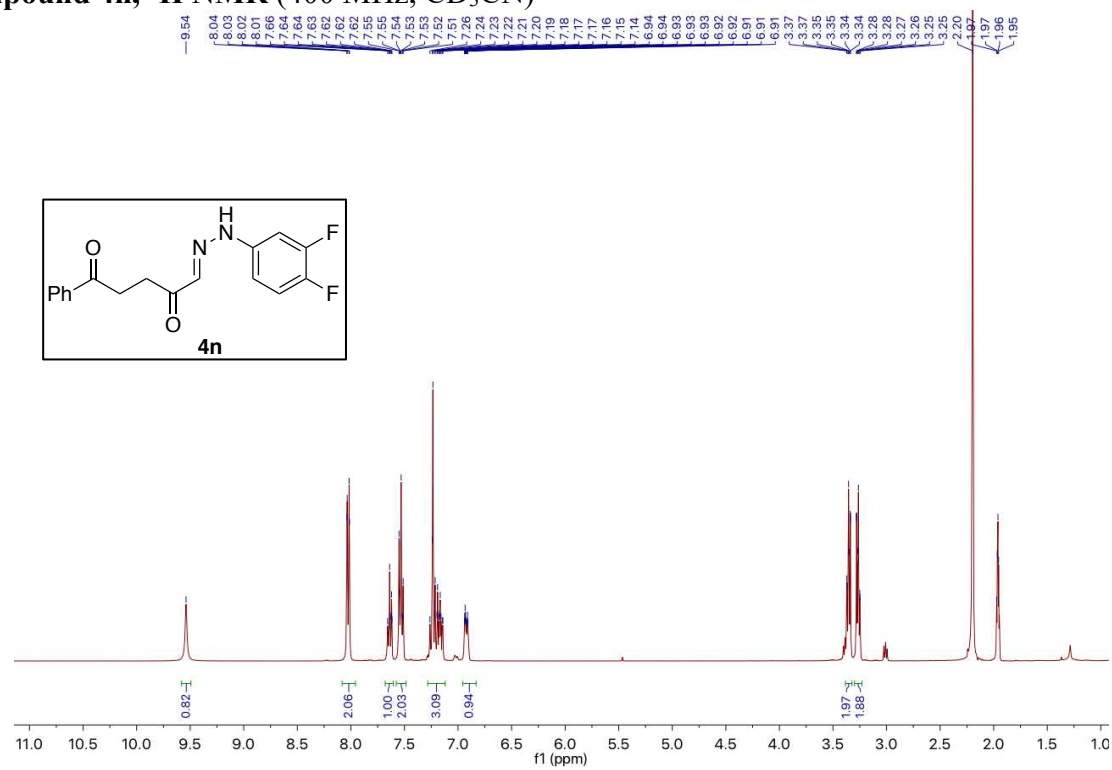
Compound 4m, ^{13}C NMR (101 MHz, CD_3CN)



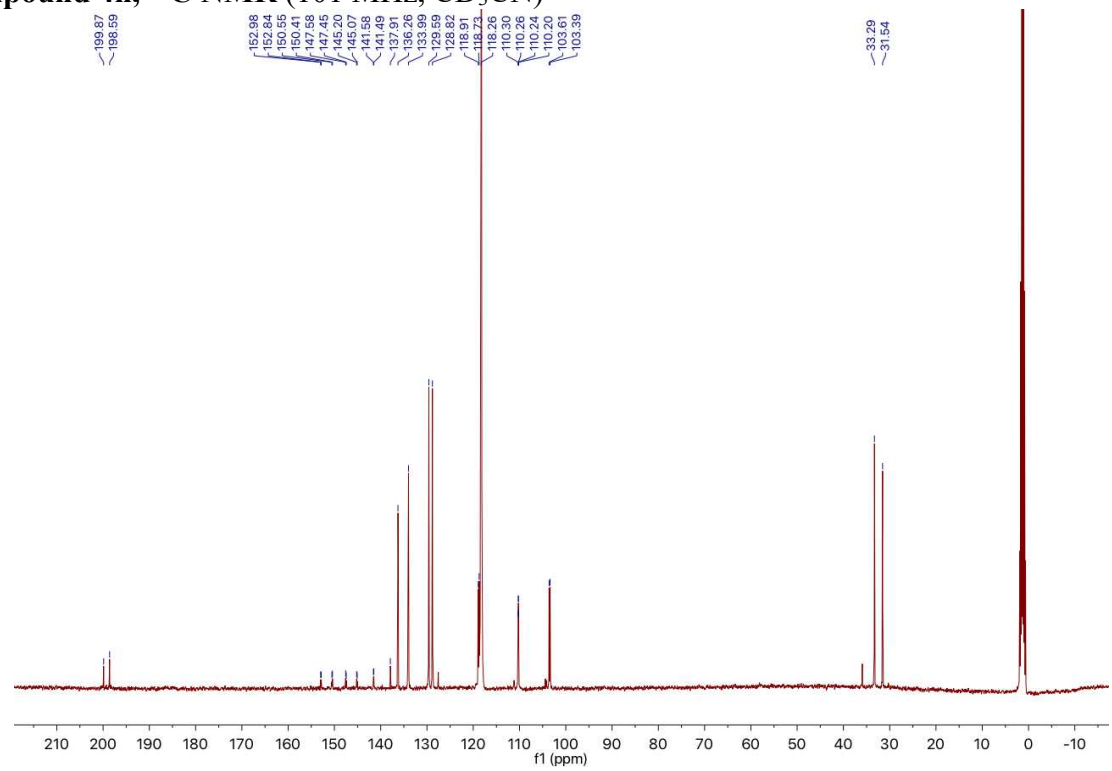
Compound 4m, ^{19}F NMR (565 MHz, CD_3CN)



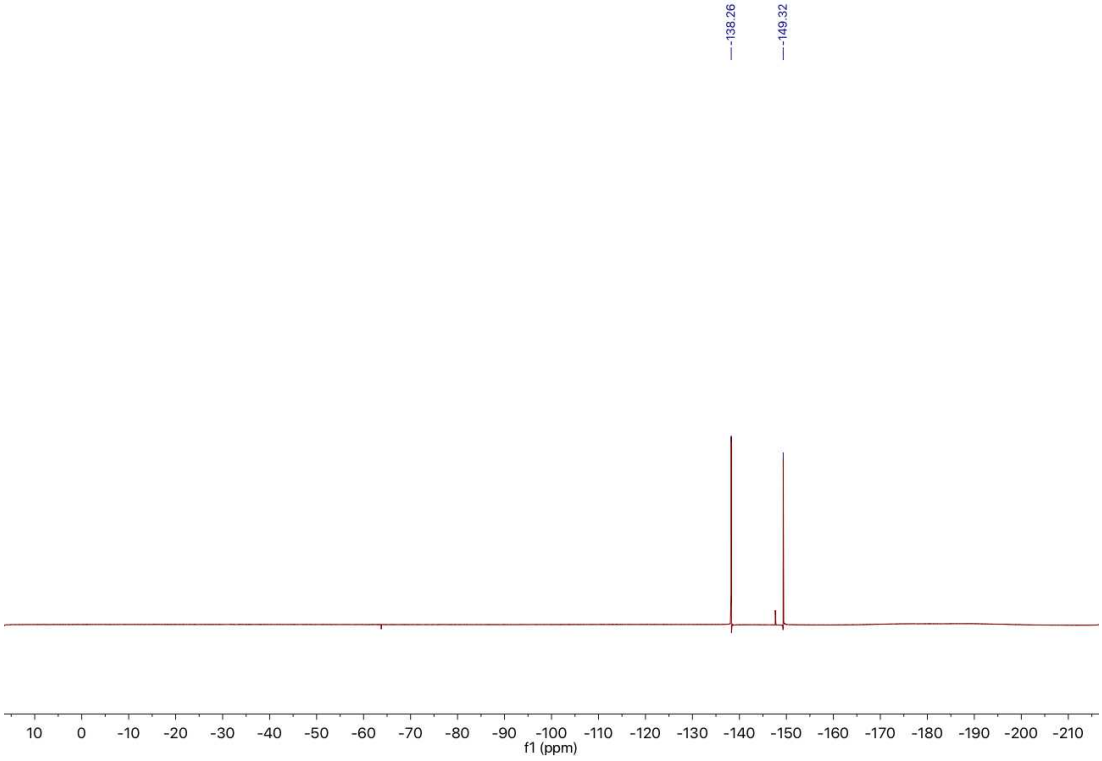
Compound 4n, ^{1}H NMR (400 MHz, CD_3CN)



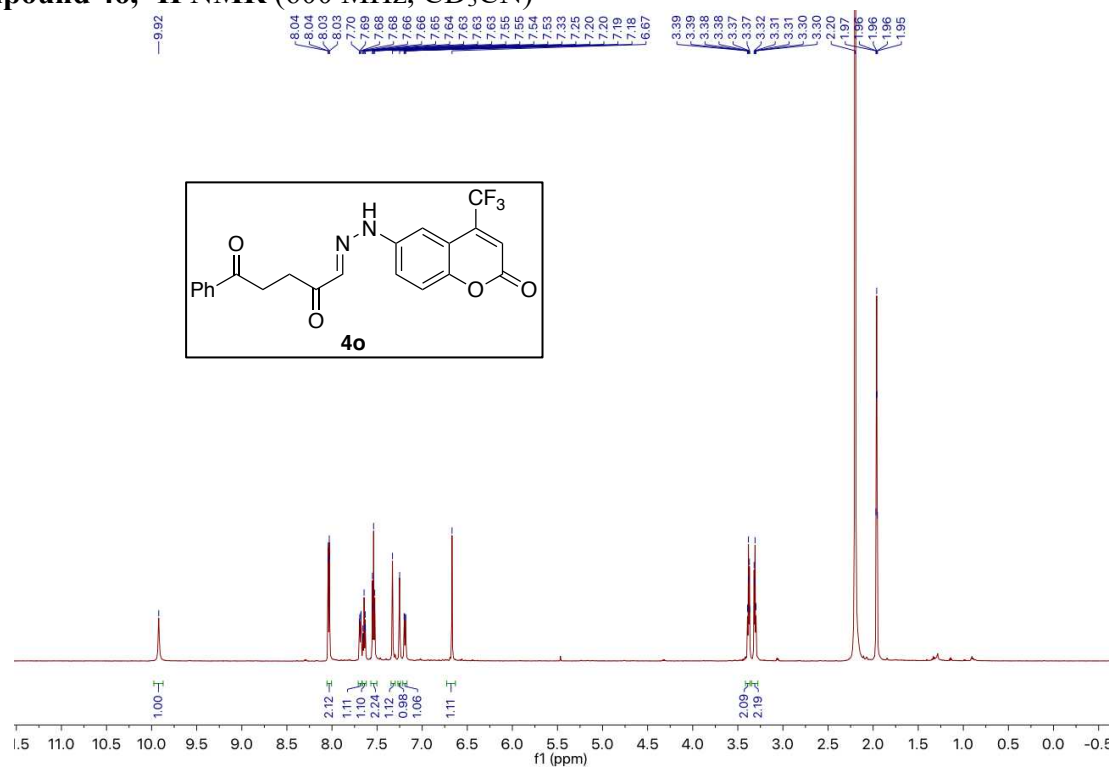
Compound 4n, ^{13}C NMR (101 MHz, CD_3CN)



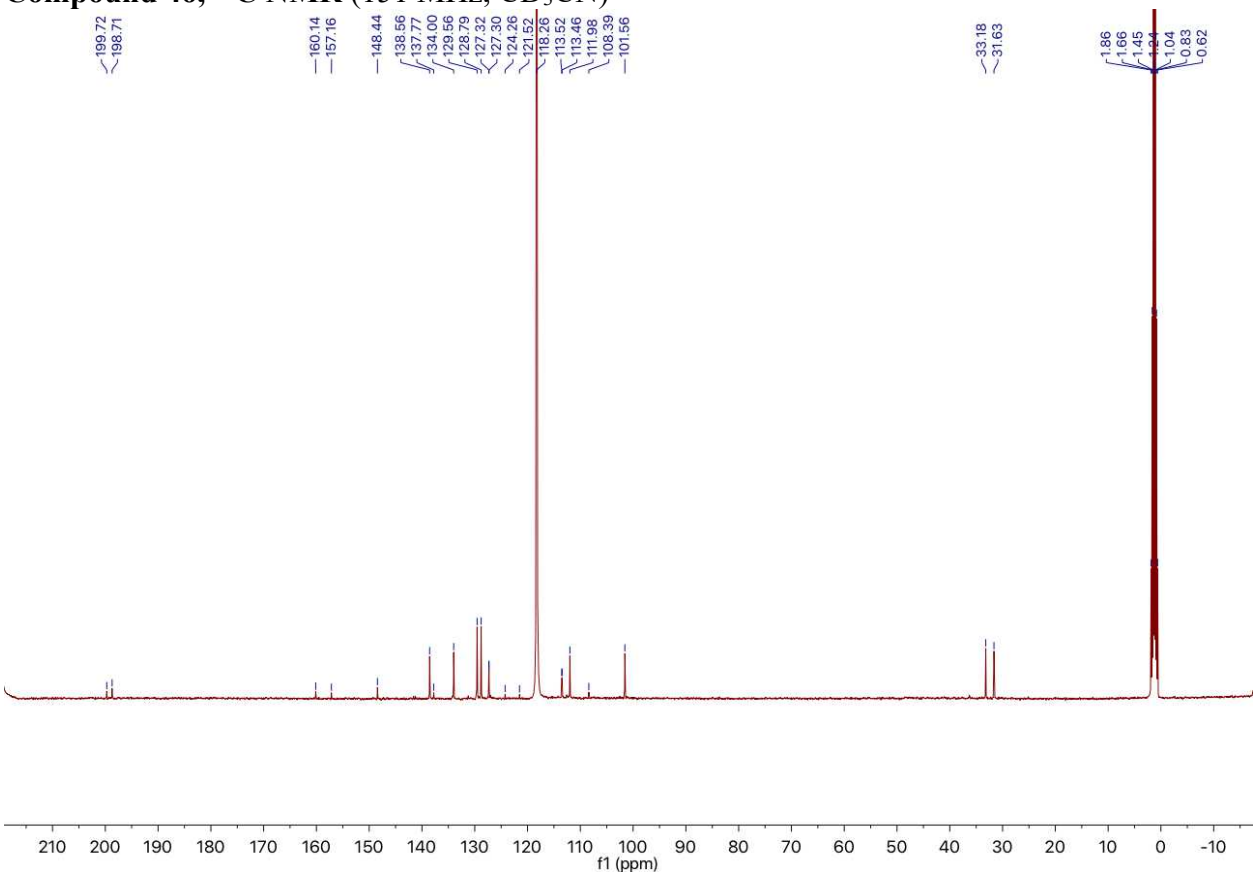
Compound 4n, ^{19}F NMR (565 MHz, CD_3CN)



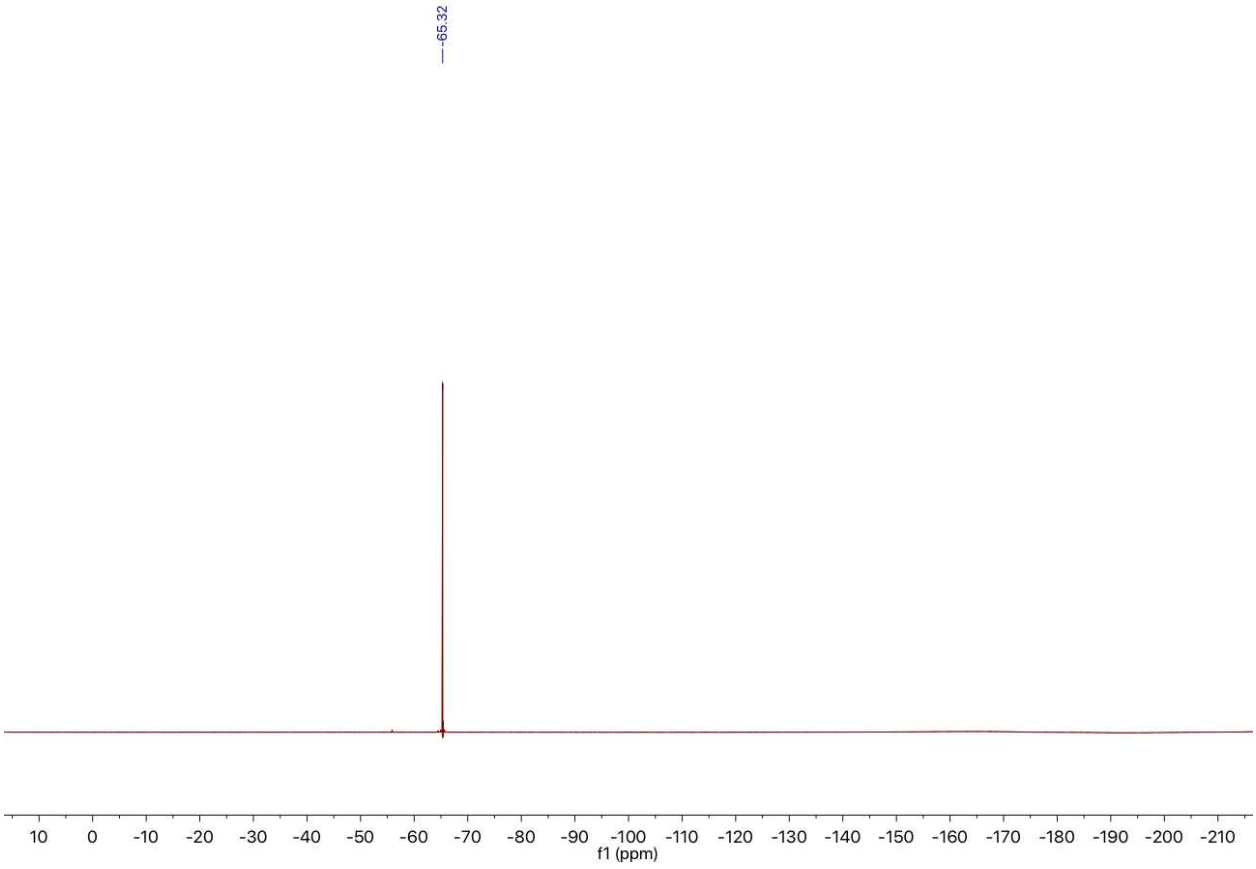
Compound 4o, ^{1}H NMR (600 MHz, CD_3CN)



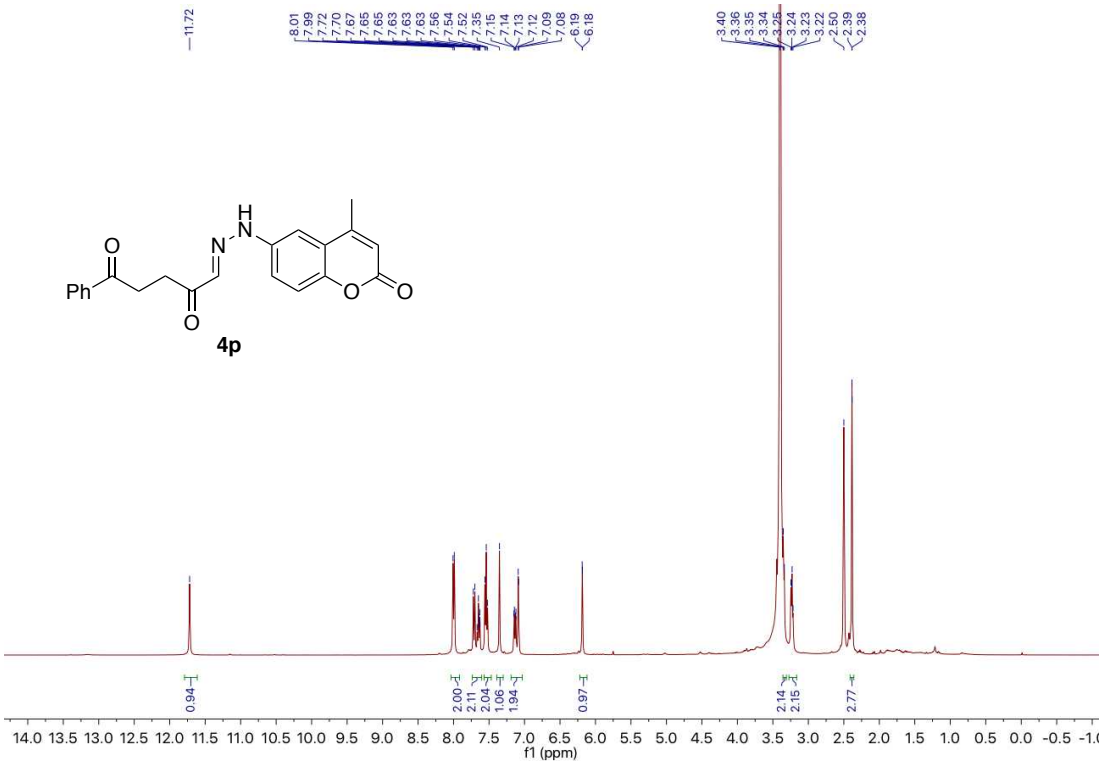
Compound 4o, ^{13}C NMR (151 MHz, CD_3CN)



Compound 4o, ^{19}F NMR (565 MHz, CD_3CN)

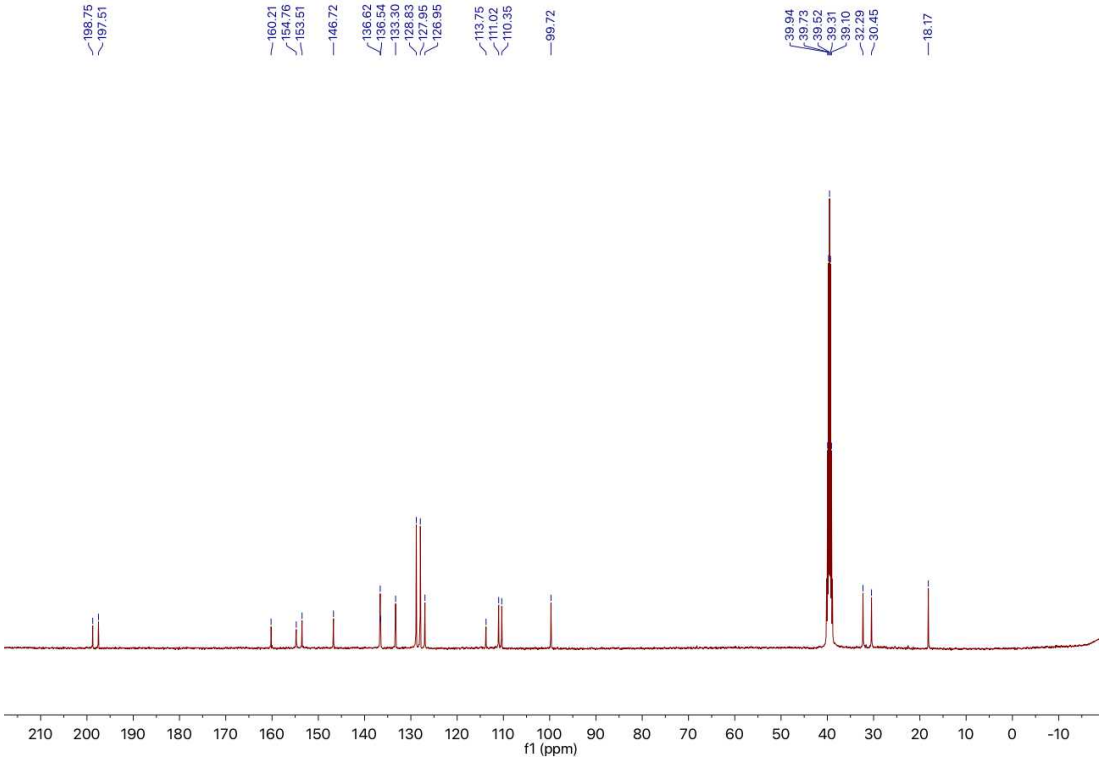


Compound 4p, ^{1}H NMR (400 MHz, DMSO-d_6)

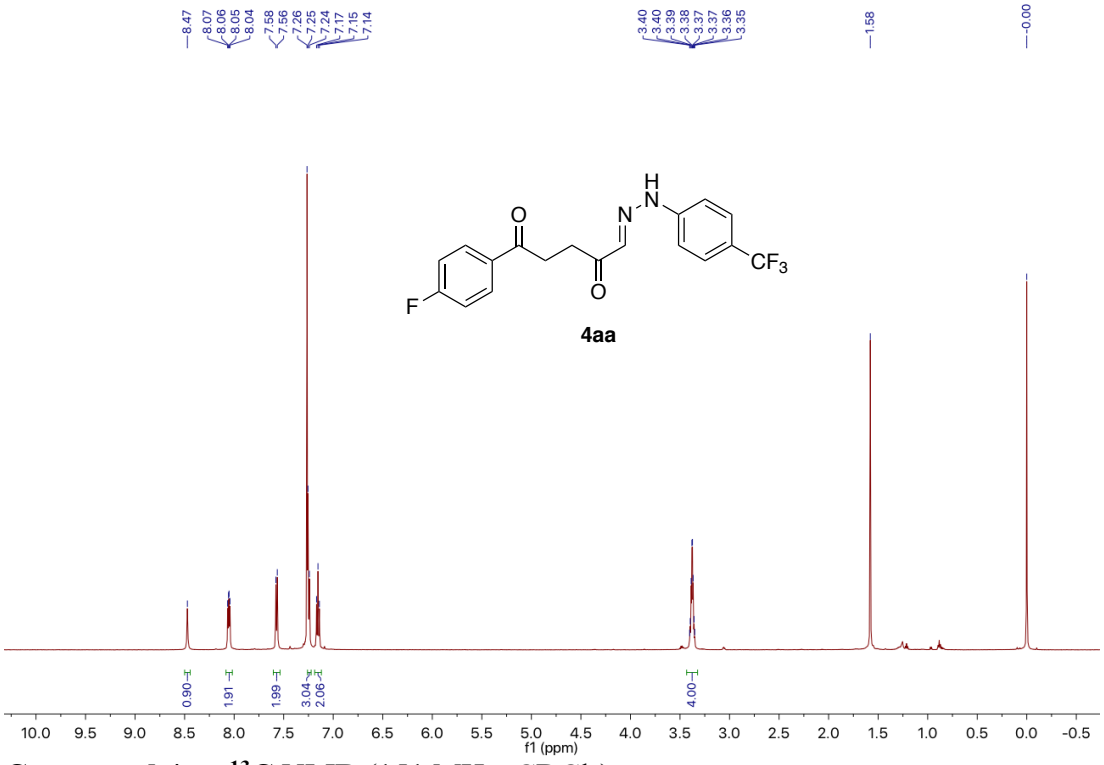


4p

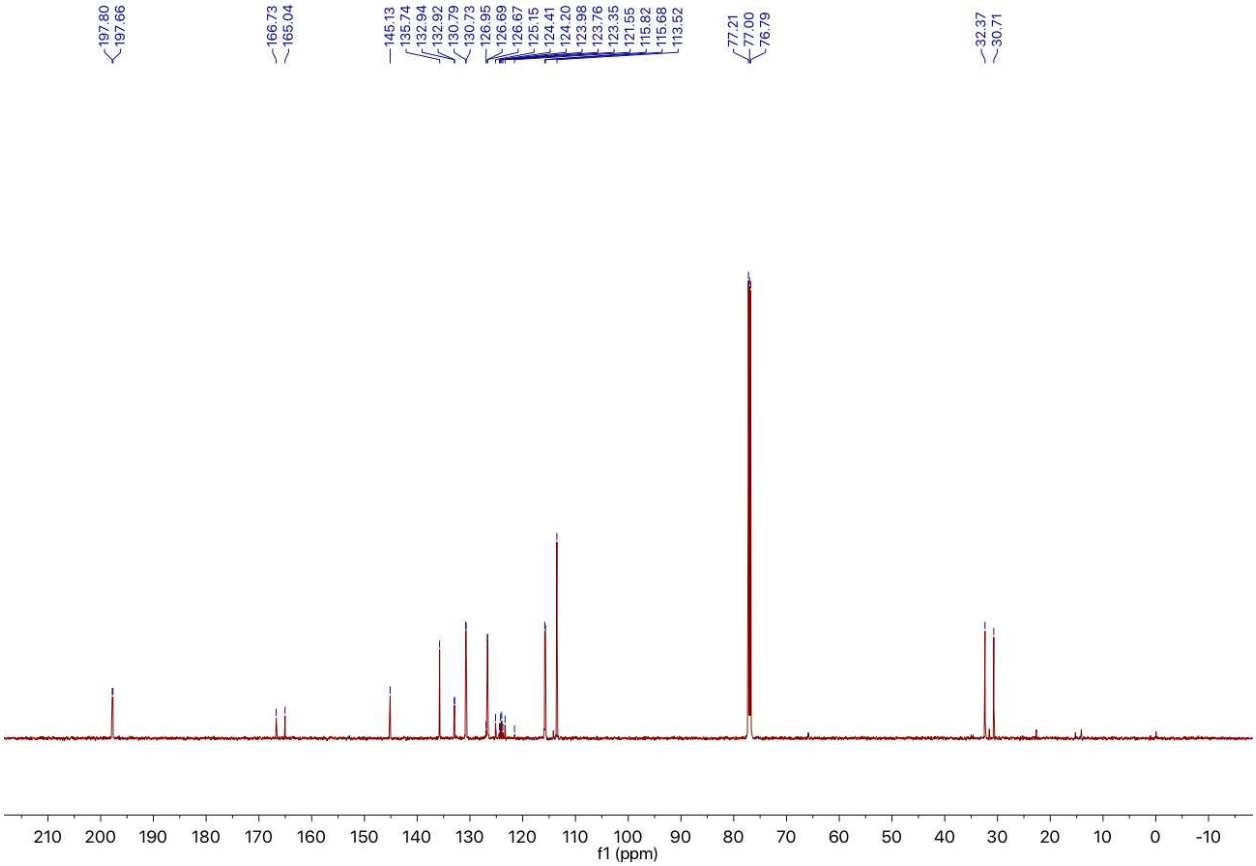
Compound 4p, ^{13}C NMR (101 MHz, DMSO-d_6)



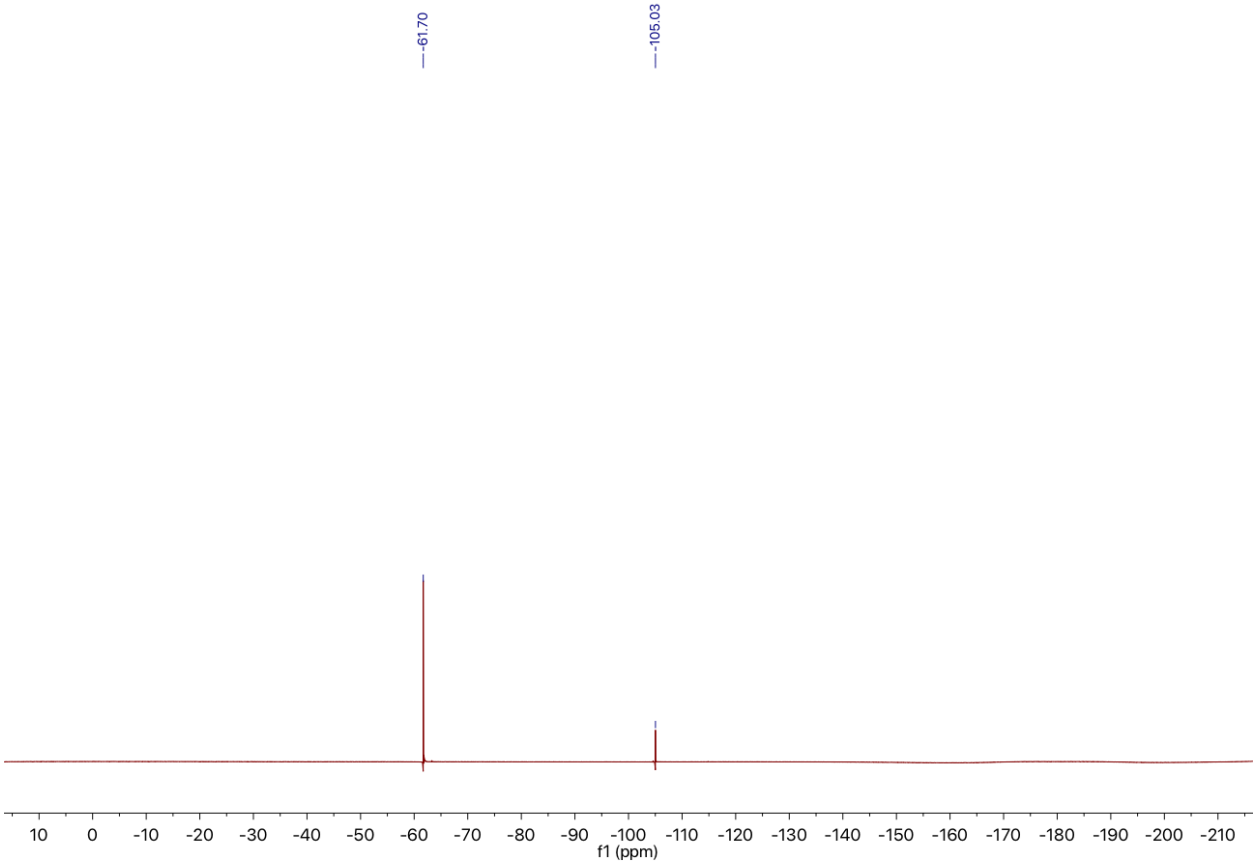
Compound 4aa, ^{1}H NMR (600 MHz, $CDCl_3$)



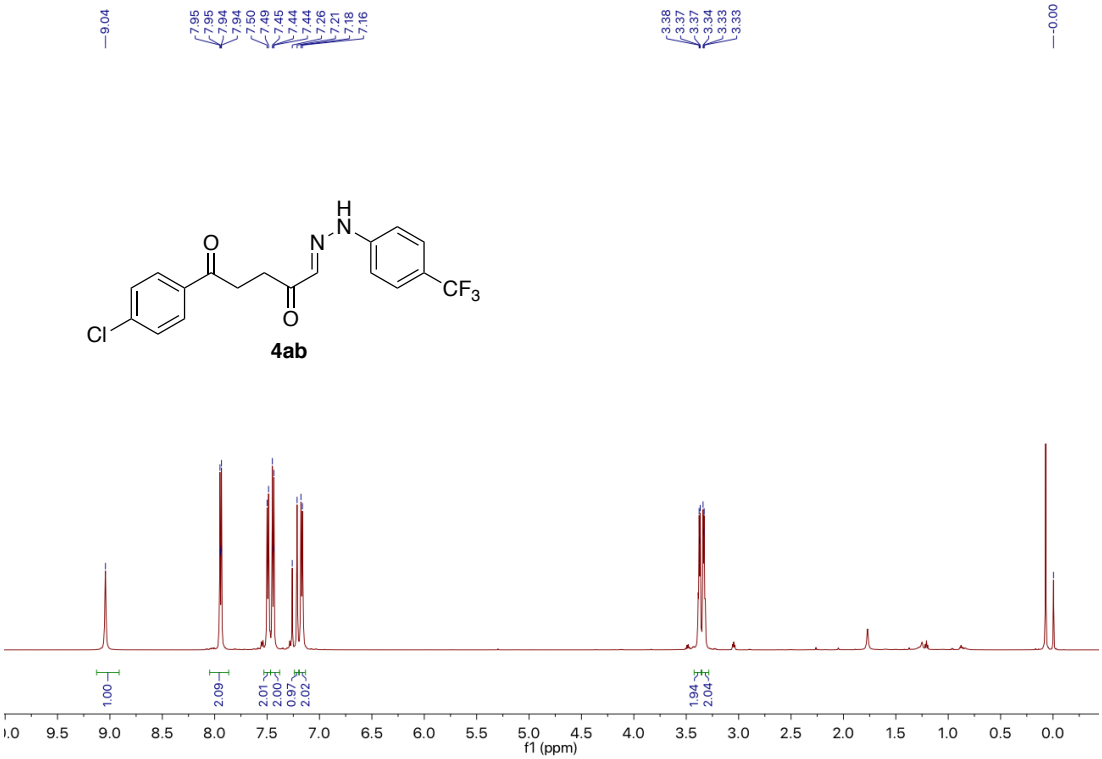
Compound 4aa, ^{13}C NMR (151 MHz, $CDCl_3$)



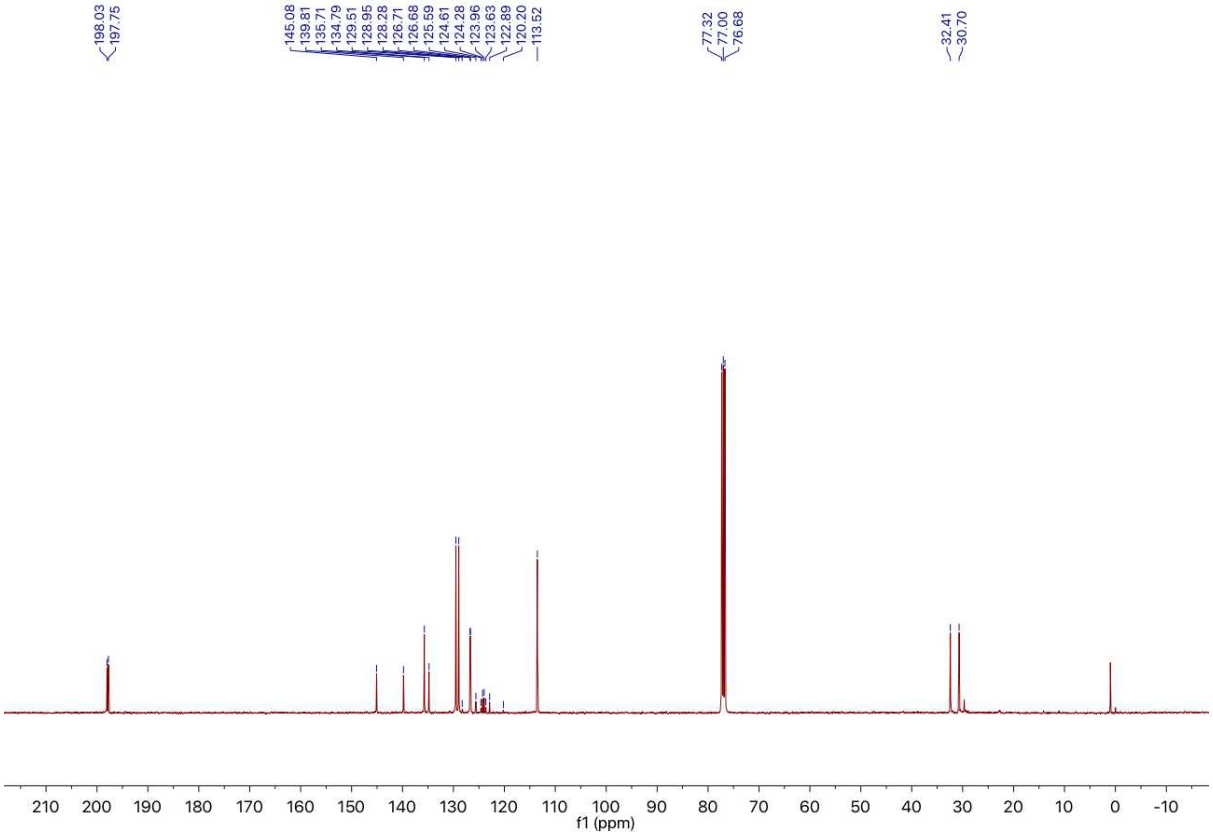
Compound 4aa, ^{19}F NMR (565 MHz, $CDCl_3$)



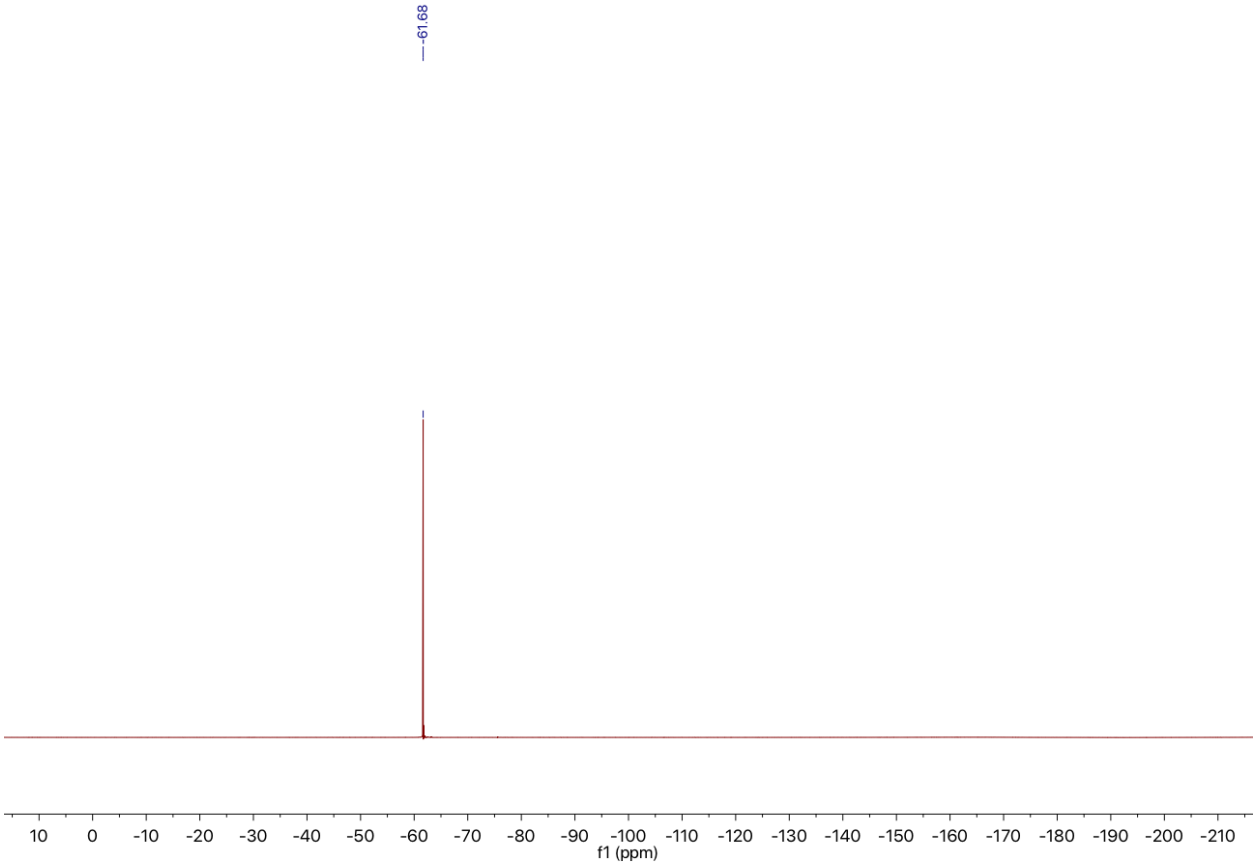
Compound 4ab, ^{1}H NMR (600 MHz, $CDCl_3$)



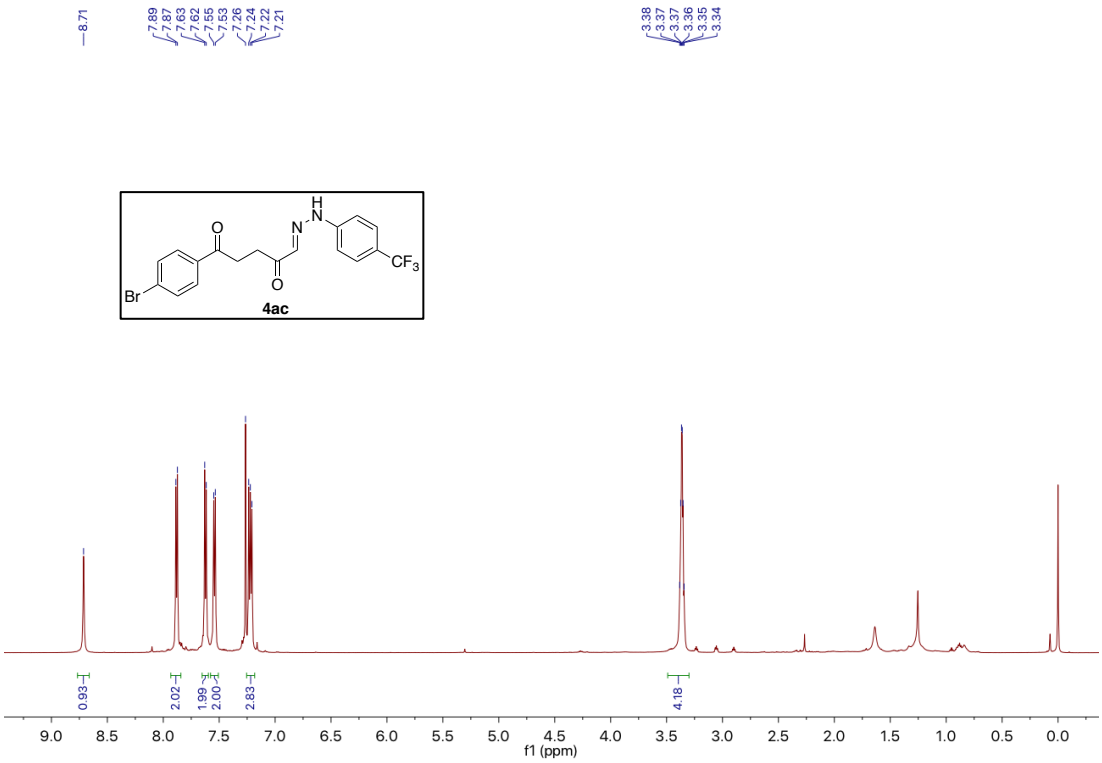
Compound 4ab, ^{13}C NMR (151 MHz, $CDCl_3$)



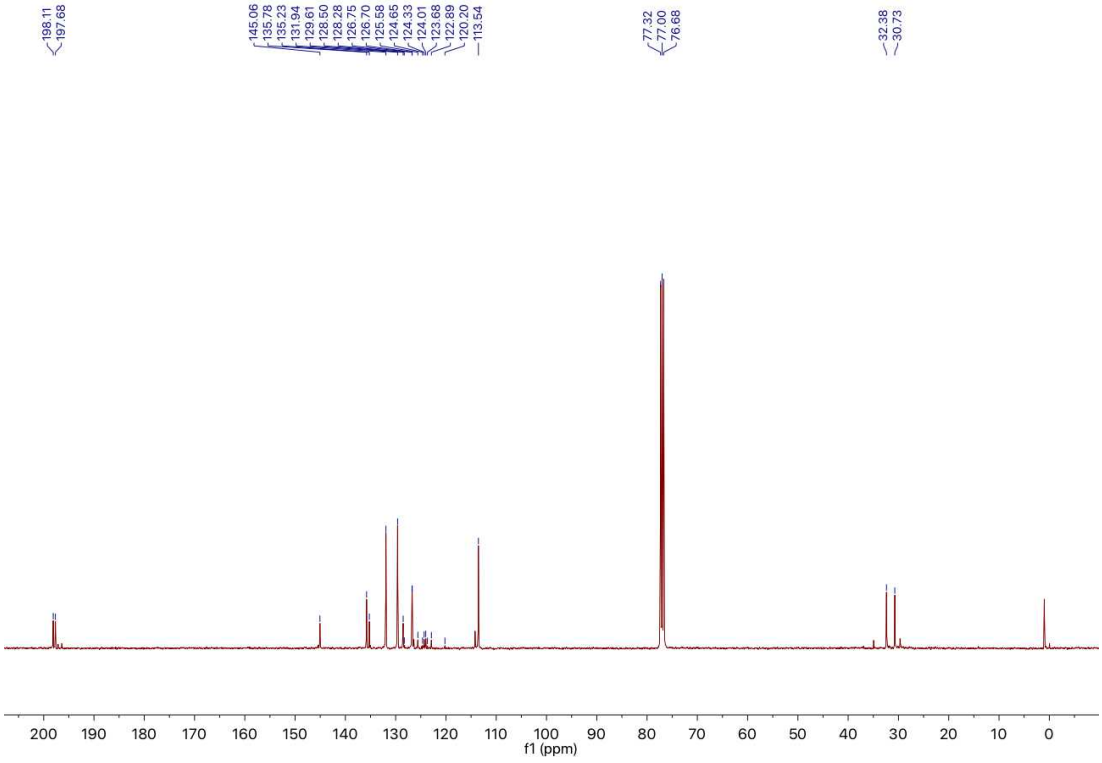
Compound 4ab, ^{19}F NMR (565 MHz, $CDCl_3$)



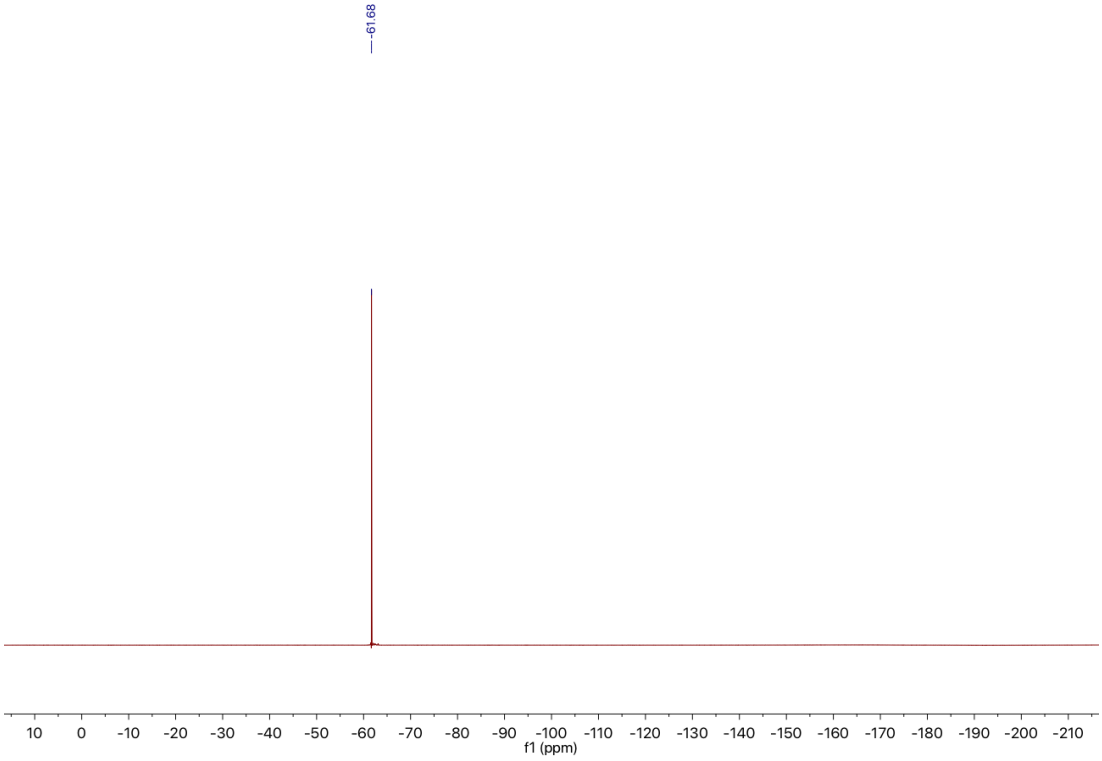
Compound 4ac, ^{1}H NMR (600 MHz, $CDCl_3$)



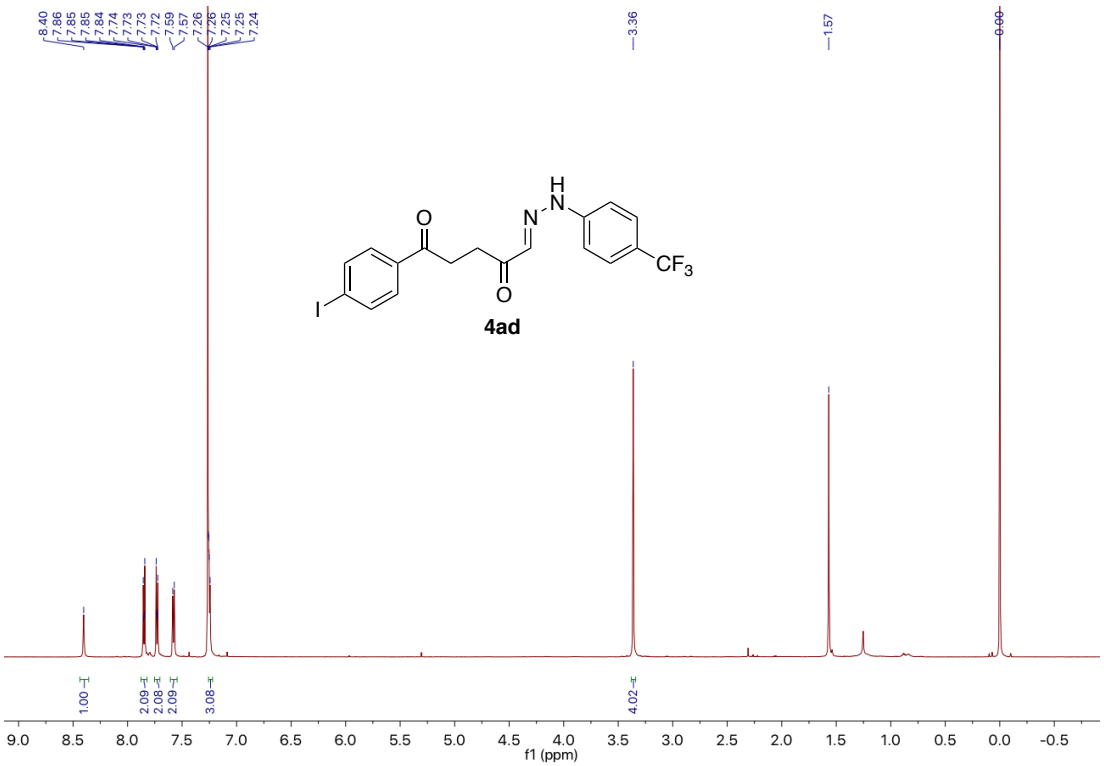
Compound 4ac, ^{13}C NMR (151 MHz, $CDCl_3$)



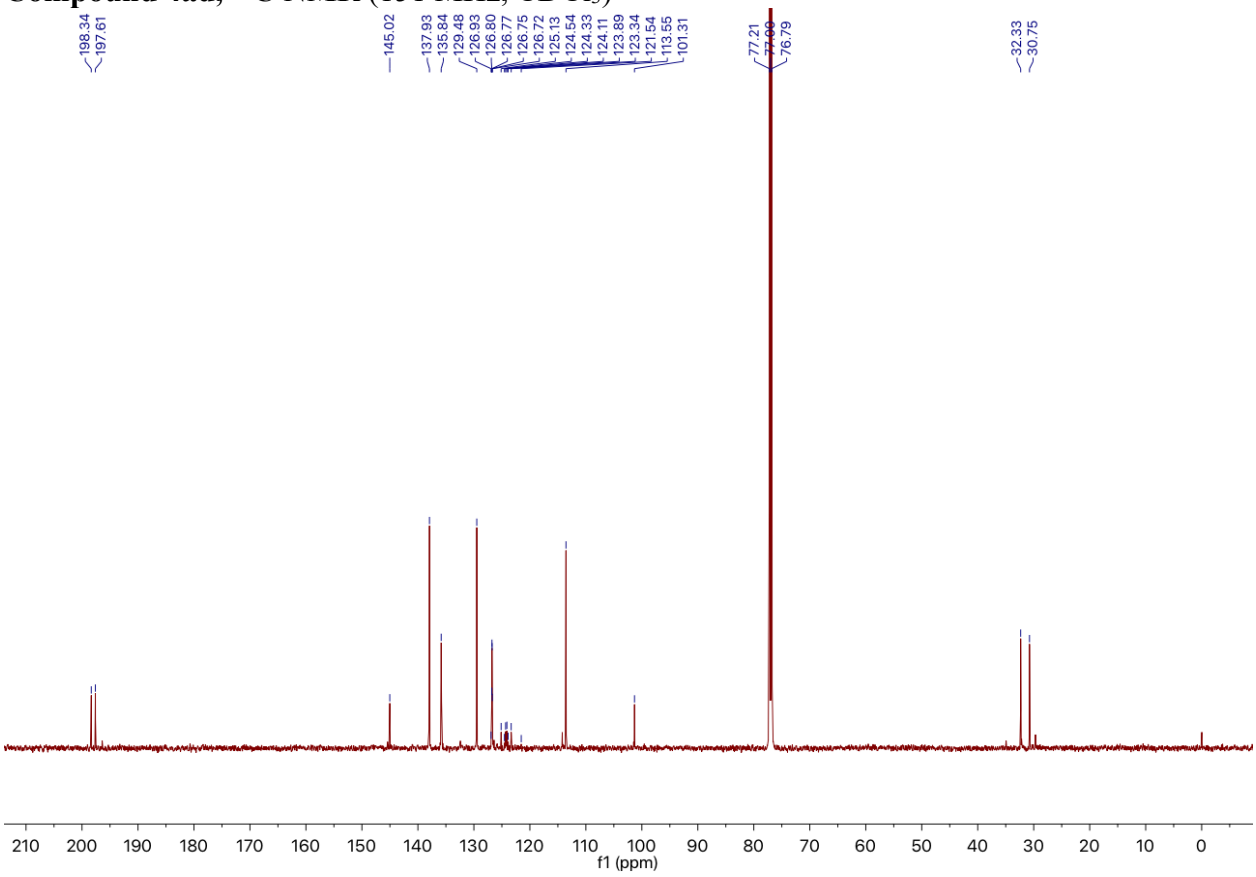
Compound 4ac, ^{19}F NMR (565 MHz, $CDCl_3$)



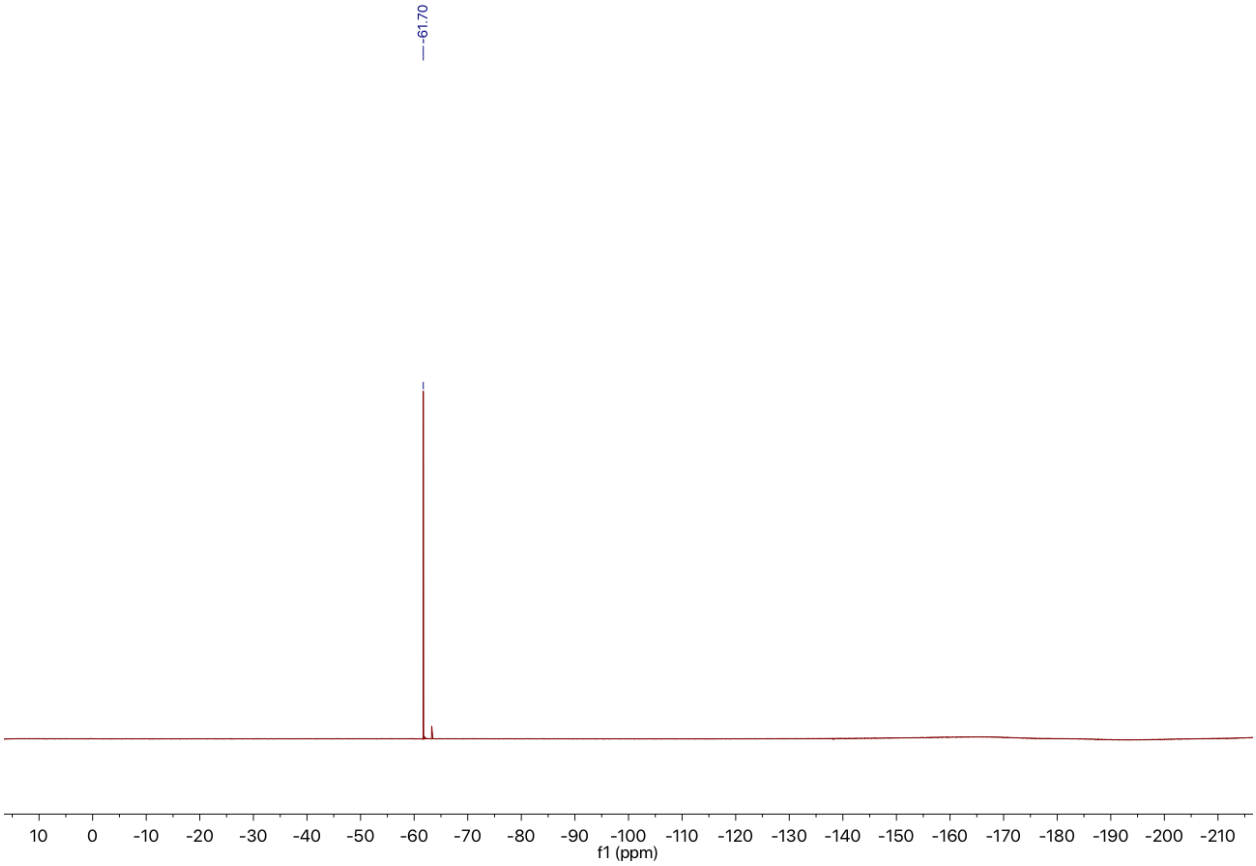
Compound 4ad, ^{1}H NMR (600 MHz, $CDCl_3$)



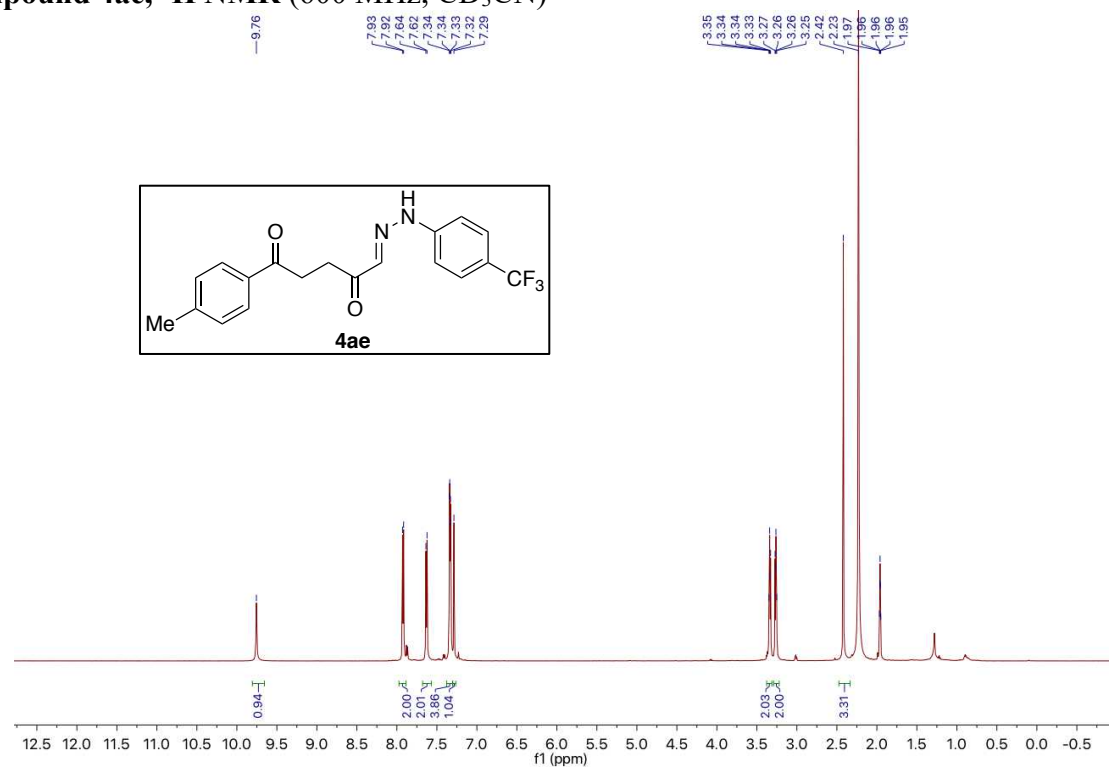
Compound 4ad, ^{13}C NMR (151 MHz, $CDCl_3$)



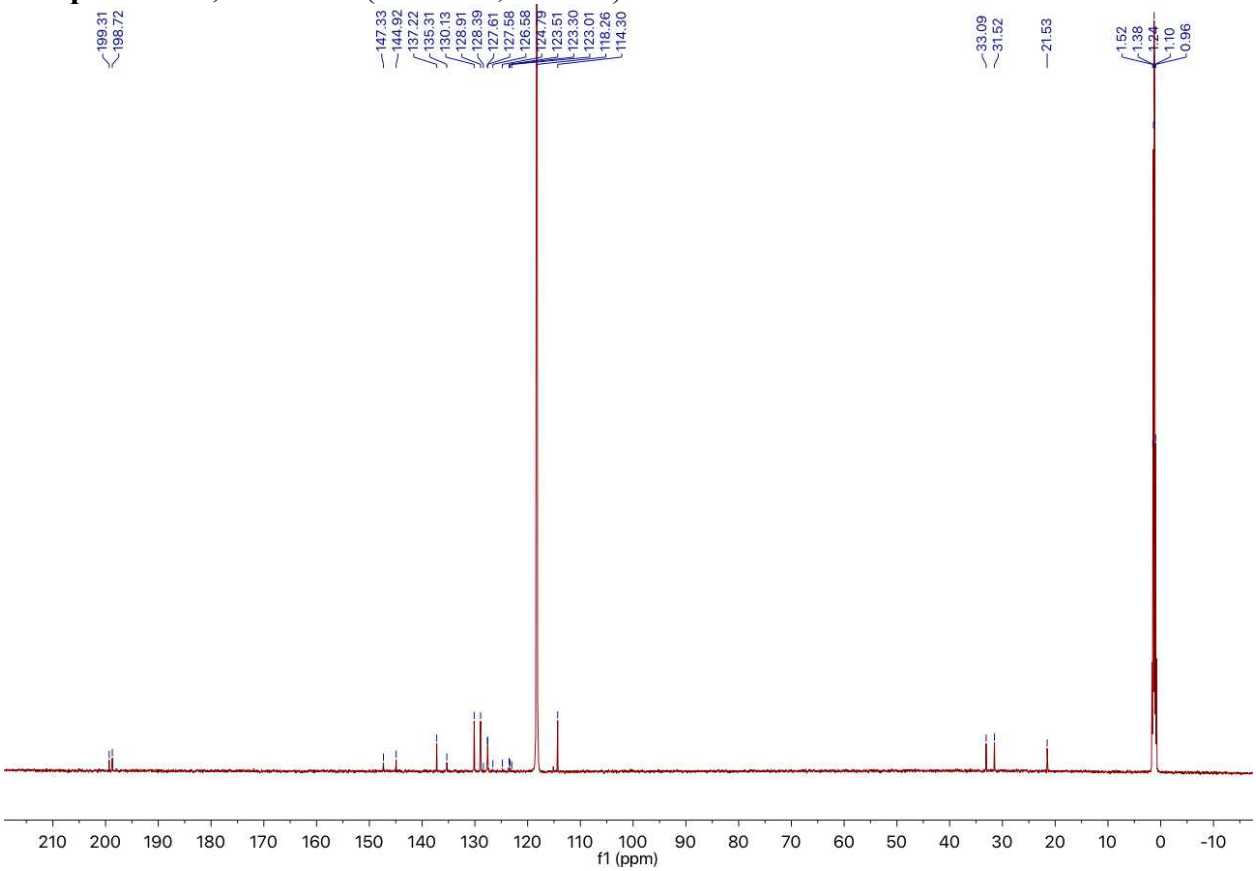
Compound 4ad, ^{19}F NMR (565 MHz, $CDCl_3$)



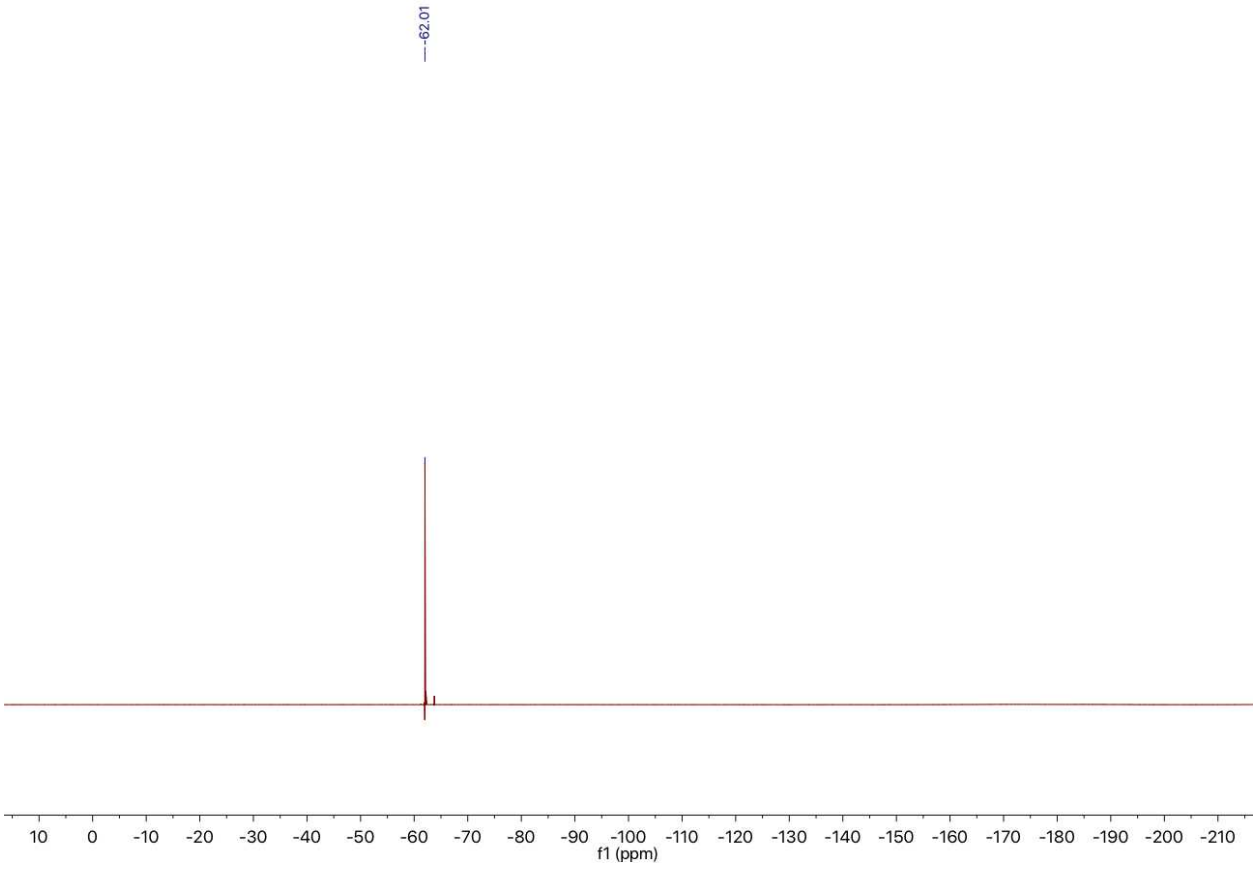
Compound 4ae, ^{1}H NMR (600 MHz, CD_3CN)



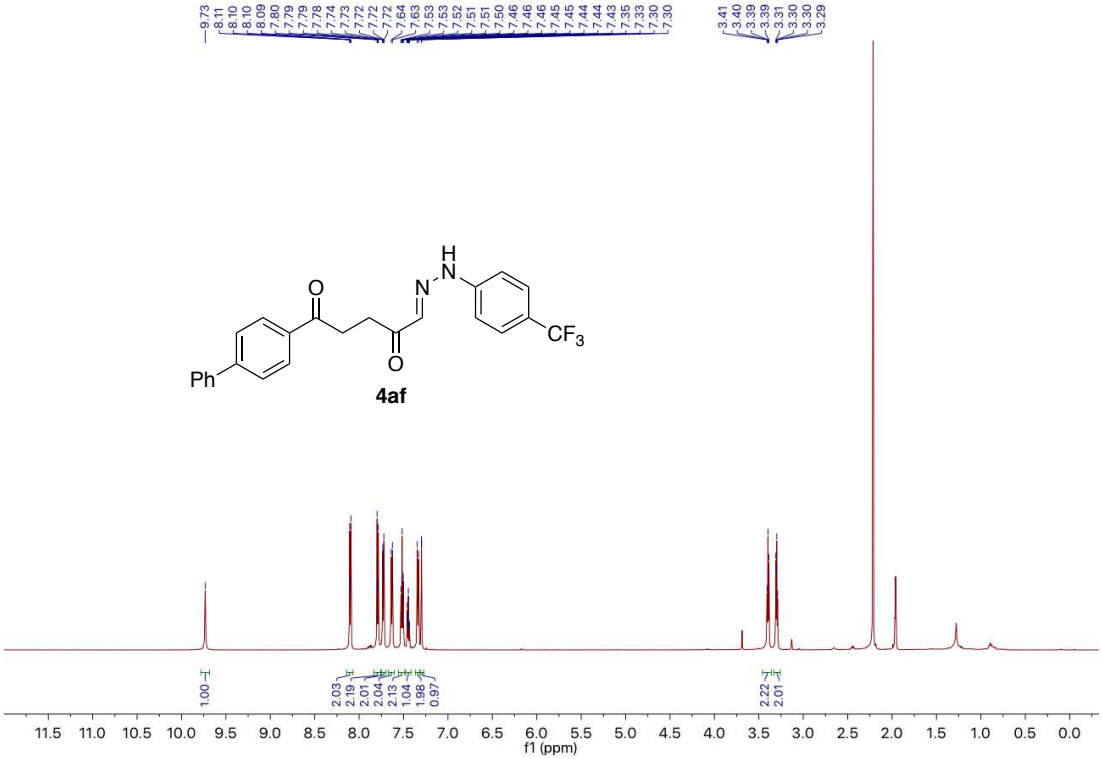
Compound 4ae, ^{13}C NMR (151 MHz, CD_3CN)



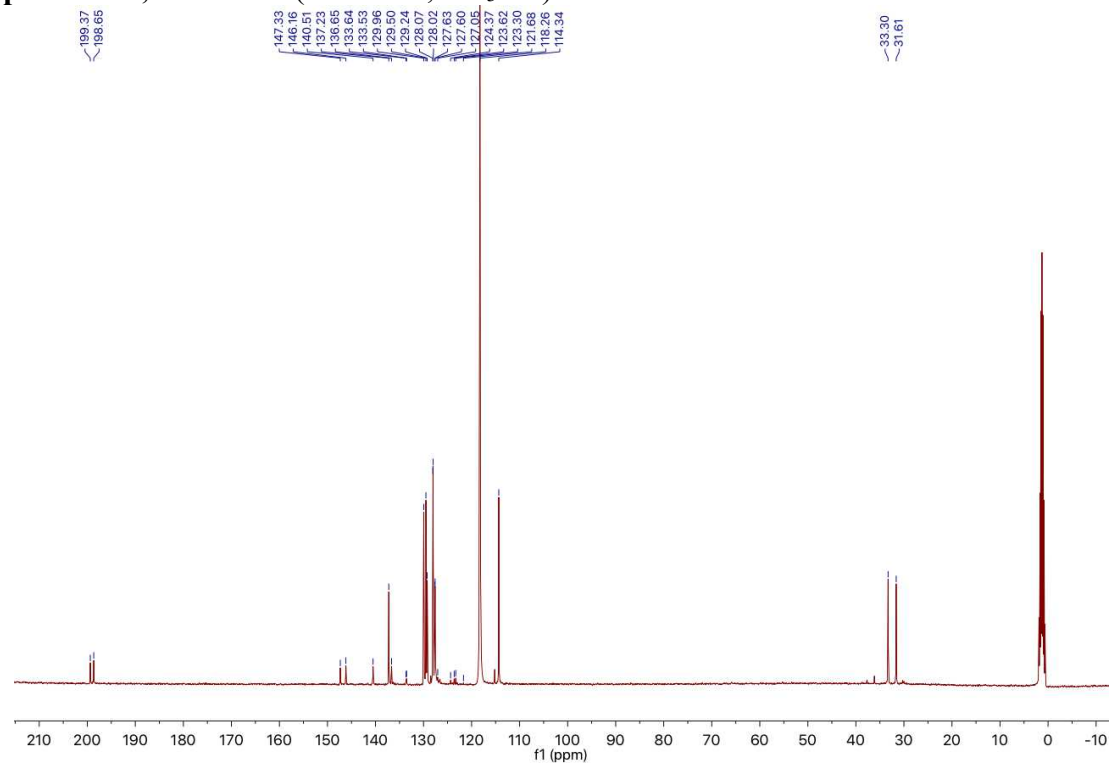
Compound 4ae, ^{19}F NMR (565 MHz, CD_3CN)



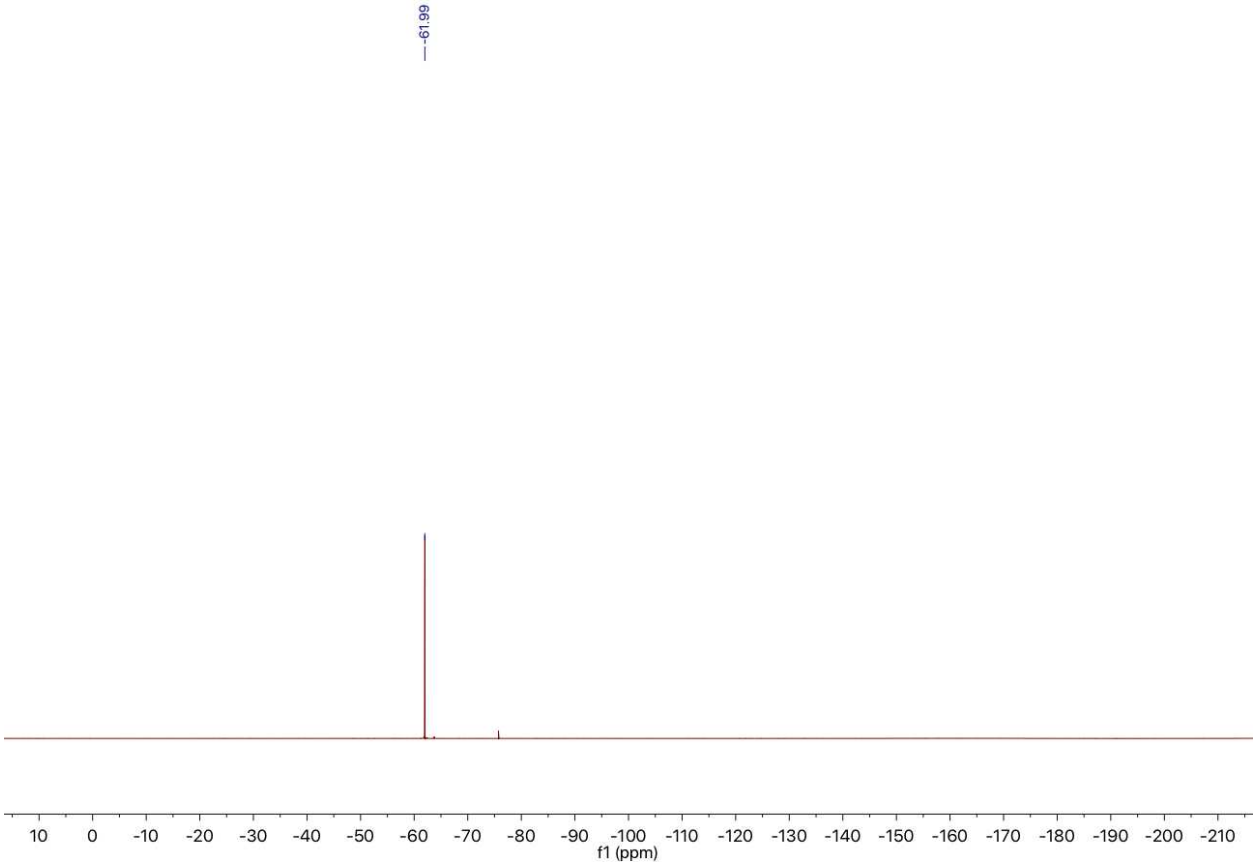
Compound 4af, ^{1}H NMR (600 MHz, CD_3CN)



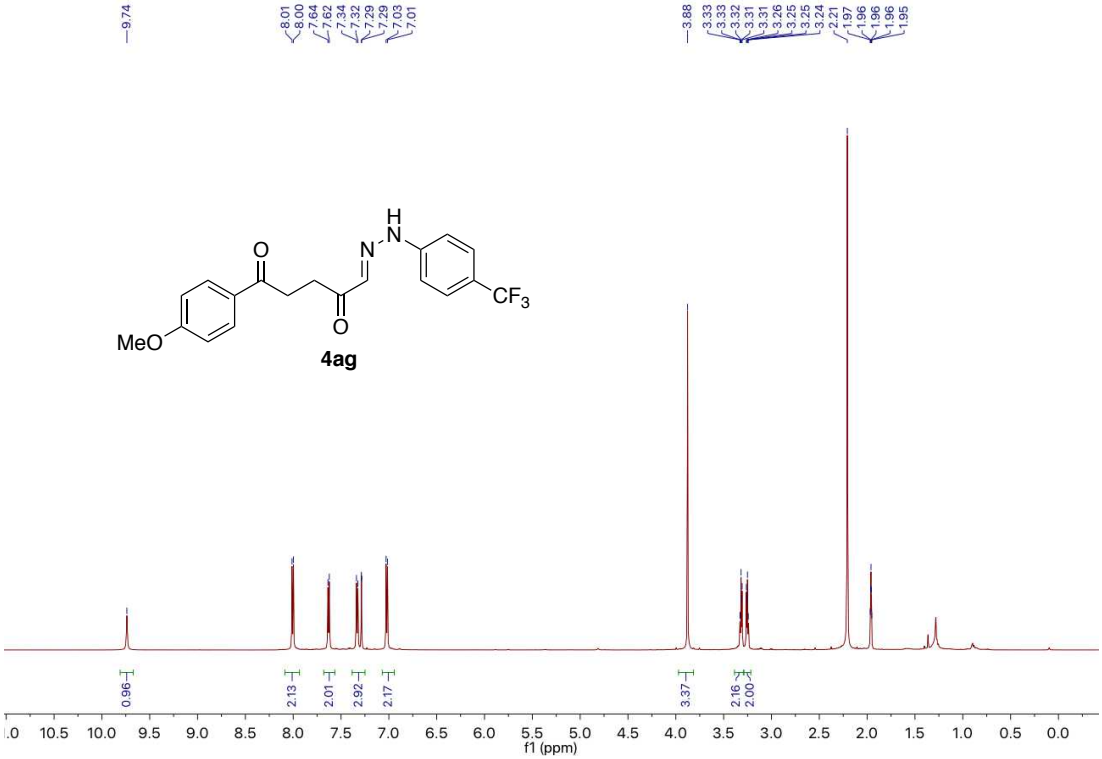
Compound 4af, ^{13}C NMR (151 MHz, CD_3CN)



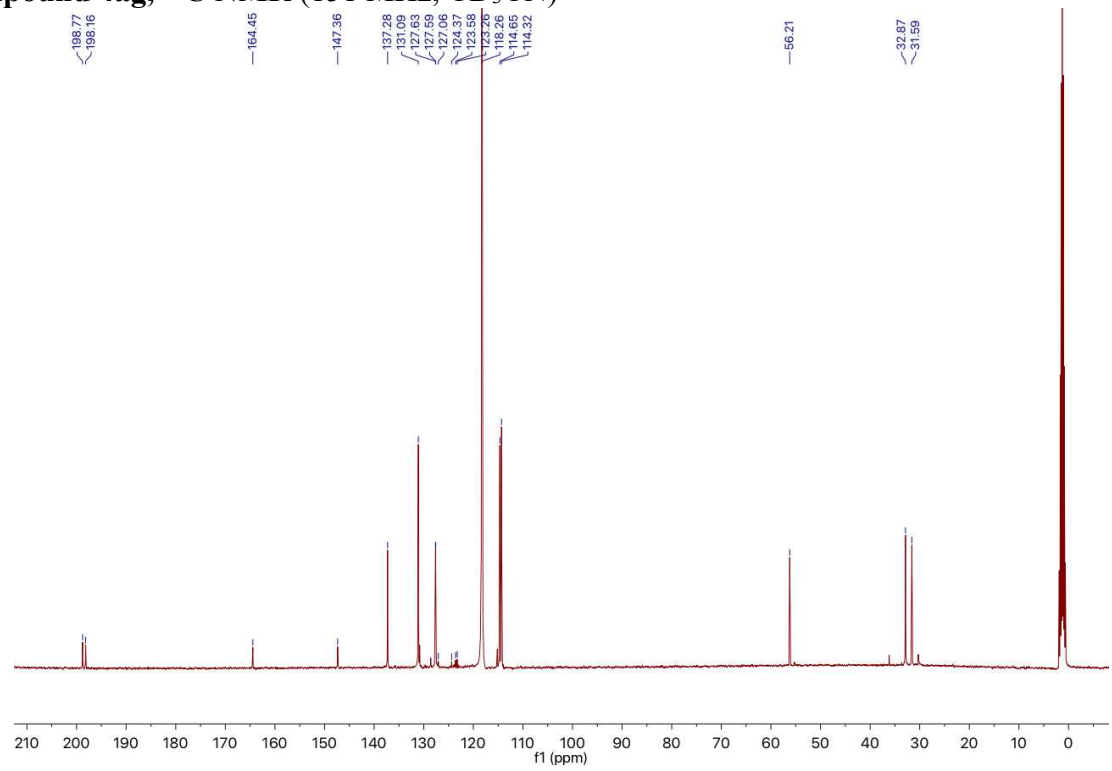
Compound 4af, ^{19}F NMR (565 MHz, CD_3CN)



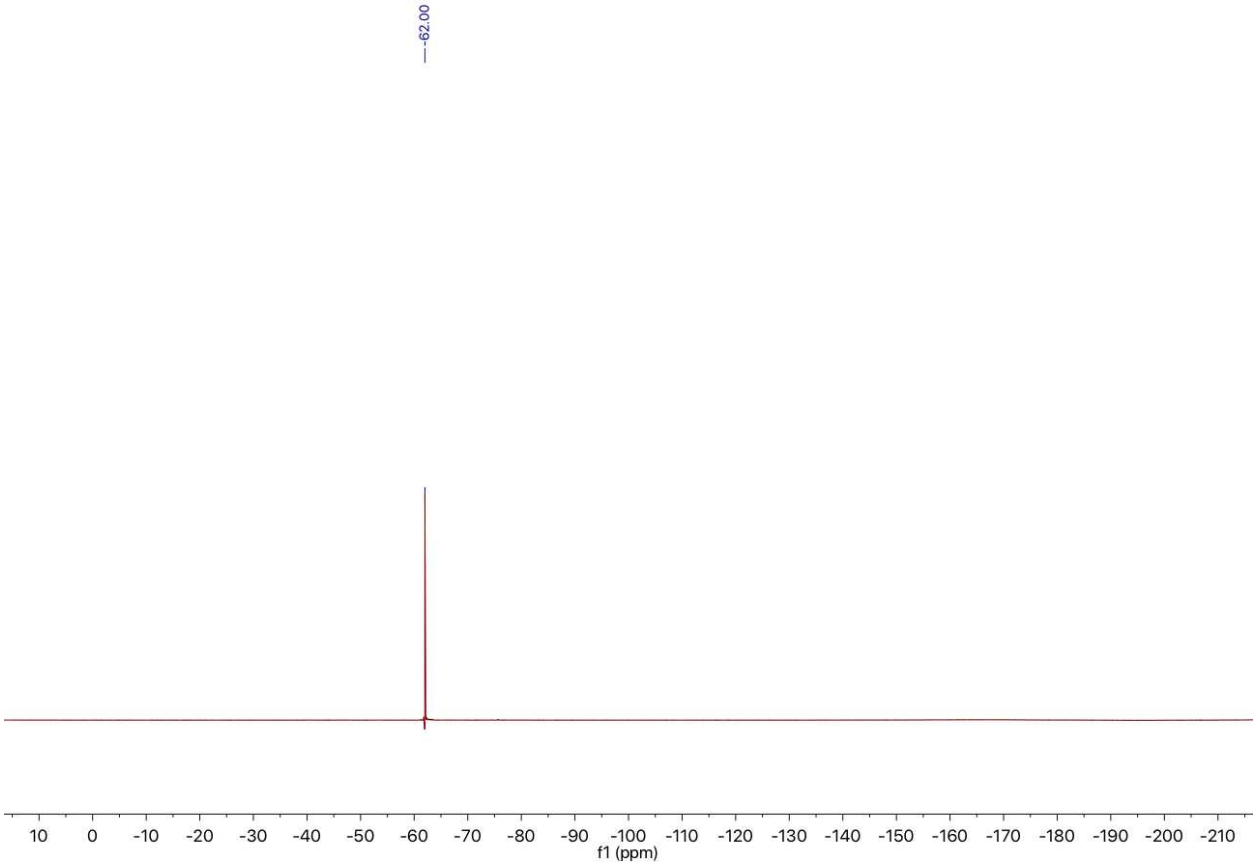
Compound 4ag, ^{1}H NMR (600 MHz, CD_3CN)



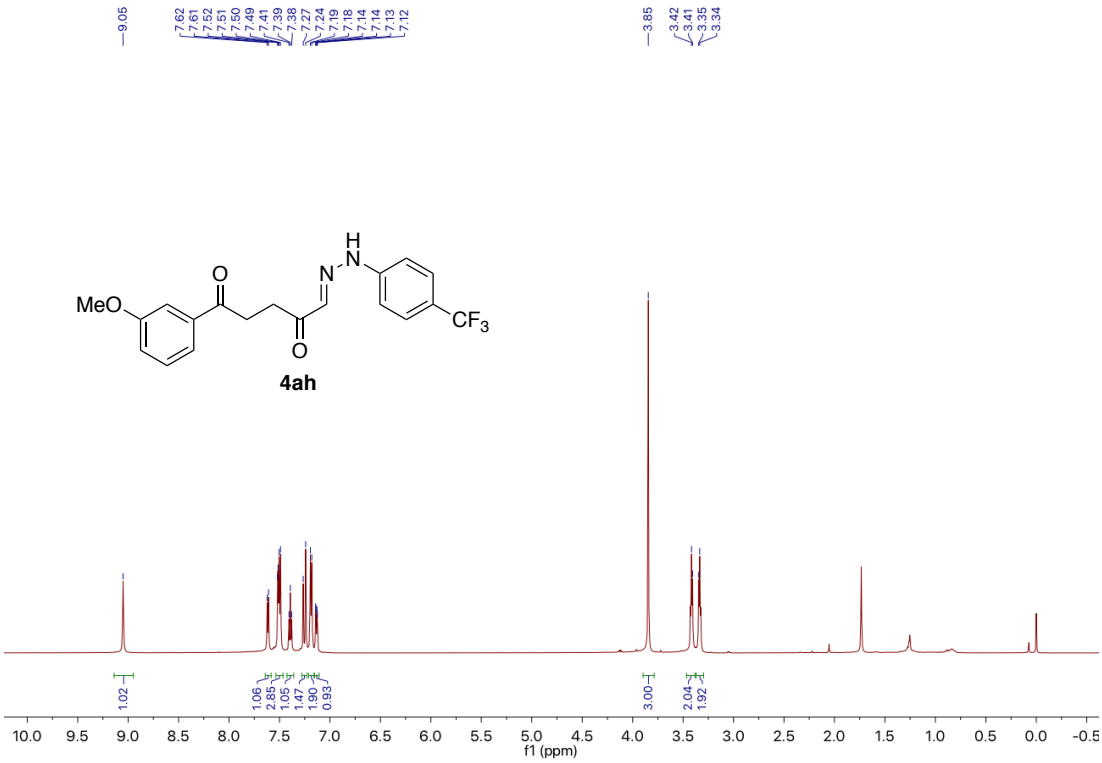
Compound 4ag, ^{13}C NMR (151 MHz, CD_3CN)



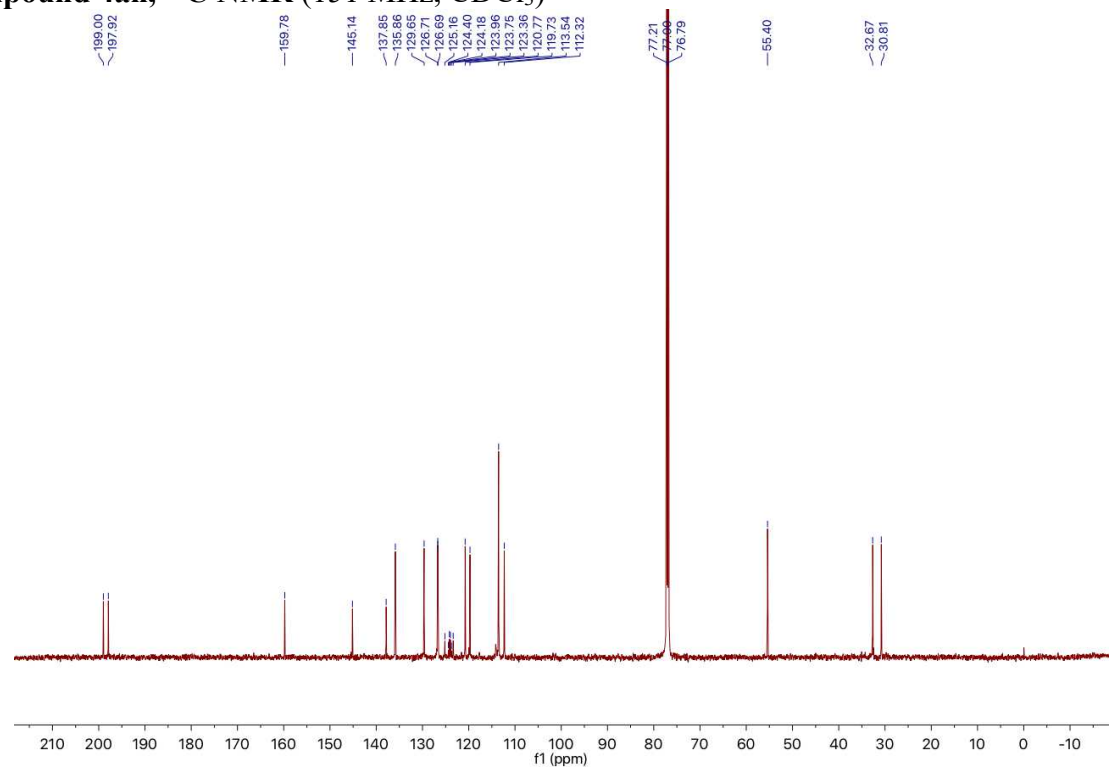
Compound 4ag, ^{19}F NMR (565 MHz, CD_3CN)



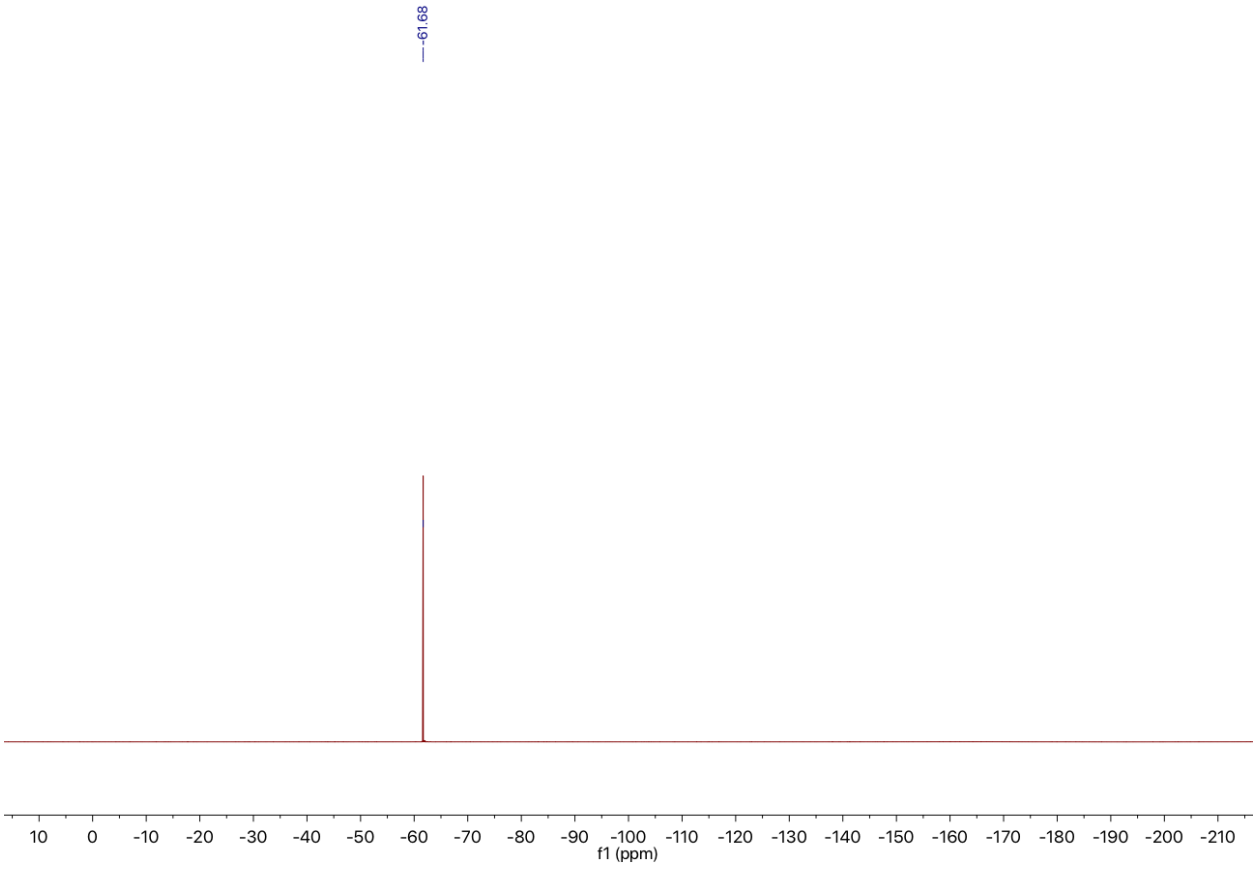
Compound 4ah, ^{1}H NMR (600 MHz, $CDCl_3$)



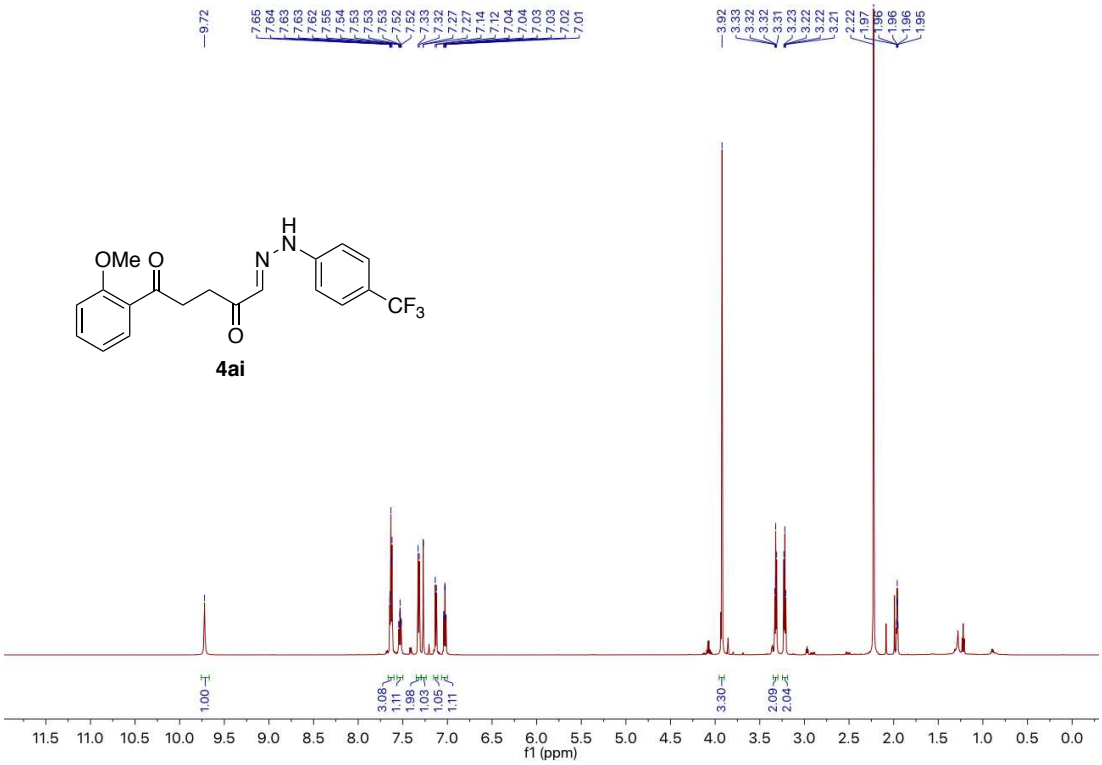
Compound 4ah, ^{13}C NMR (151 MHz, $CDCl_3$)



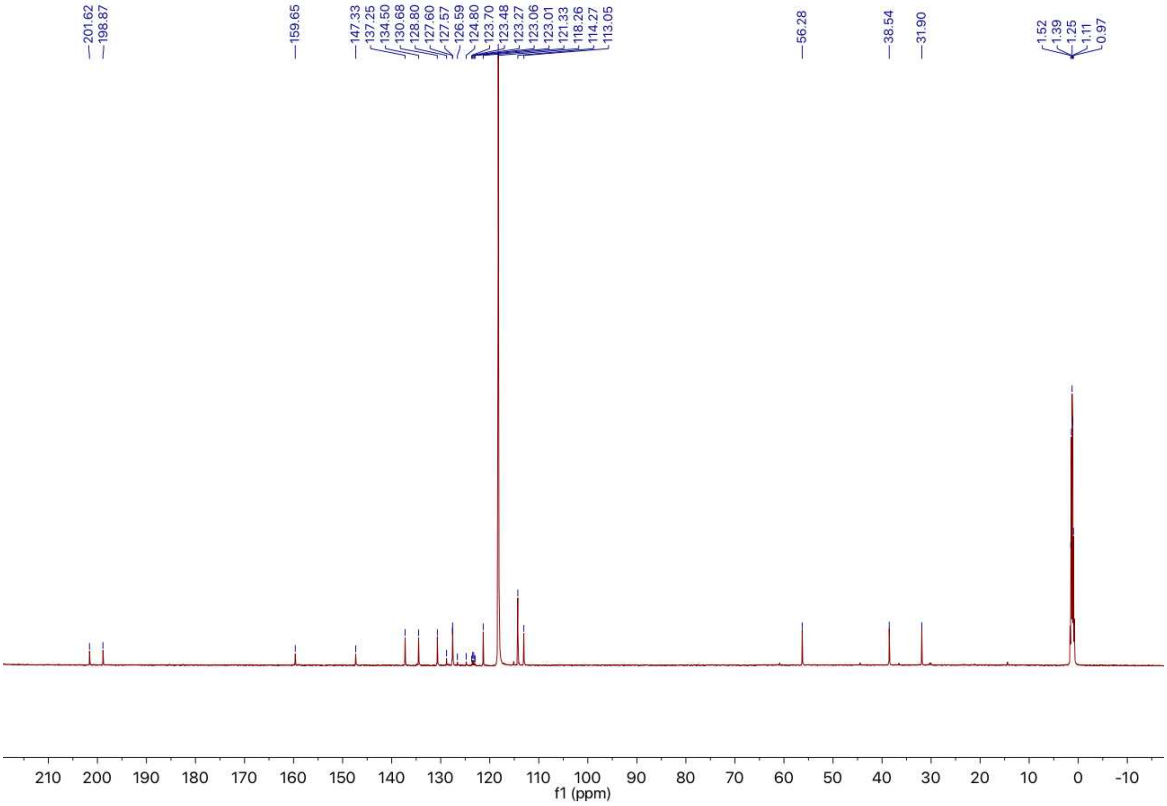
Compound 4ah, ^{19}F NMR (565 MHz, $CDCl_3$)



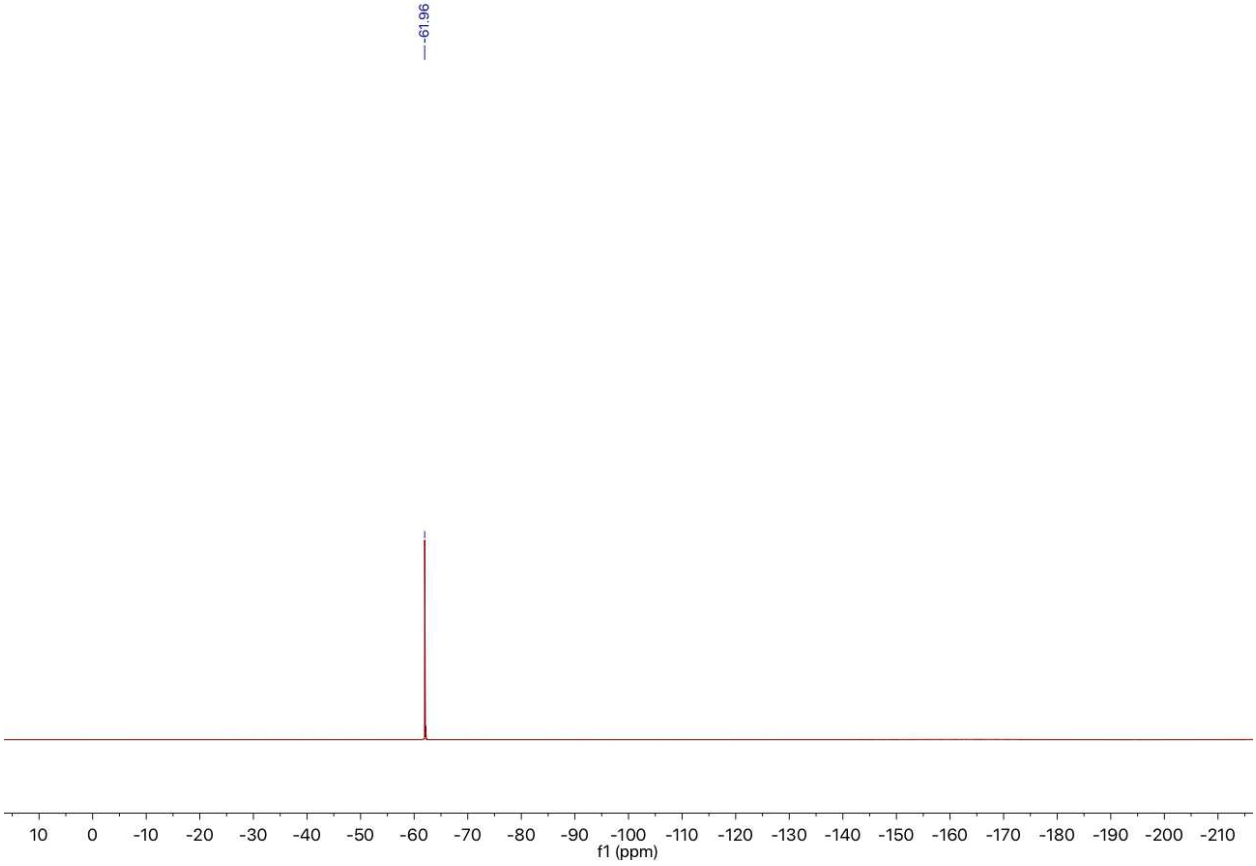
Compound 4ai, ^{1}H NMR (600 MHz, CD_3CN)



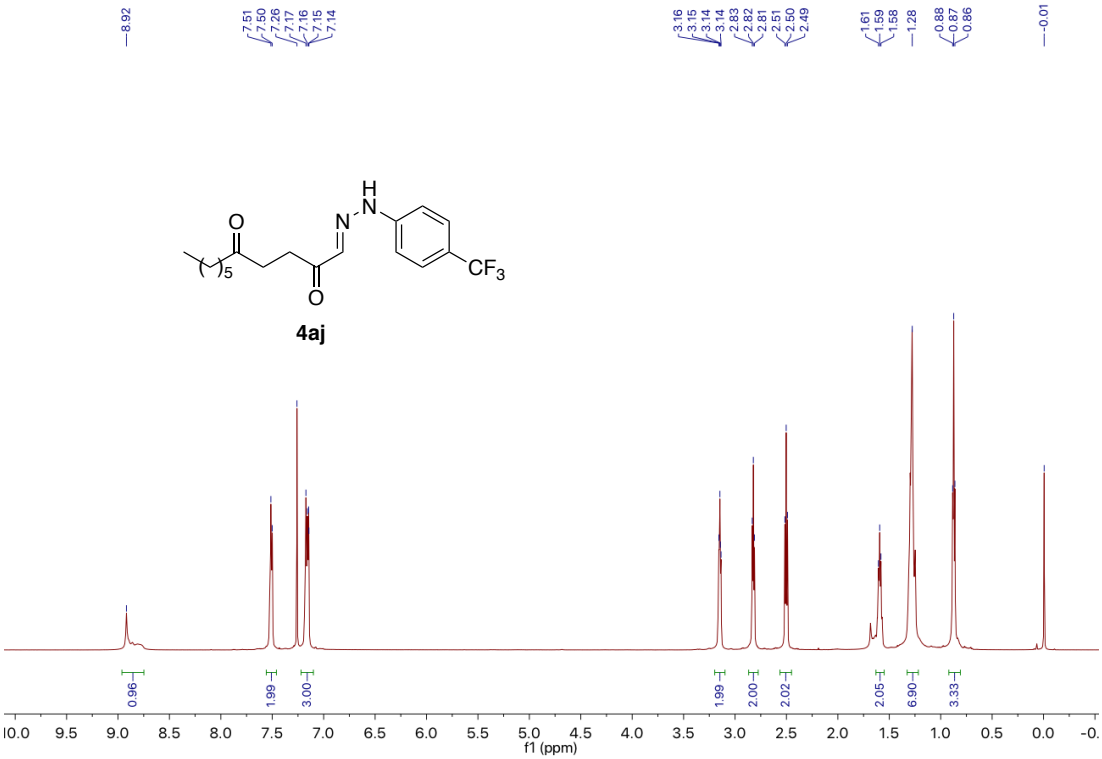
Compound 4ai, ^{13}C NMR (151 MHz, CD_3CN)



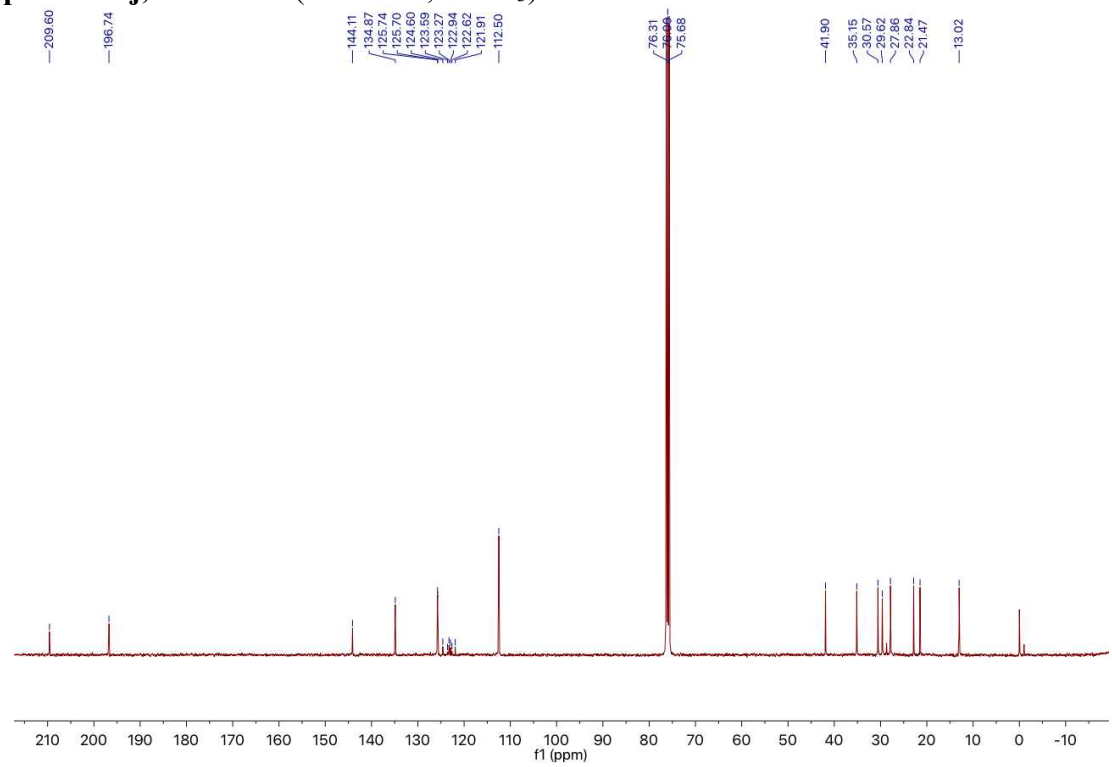
Compound 4ai, ^{19}F NMR (565 MHz, CD_3CN)



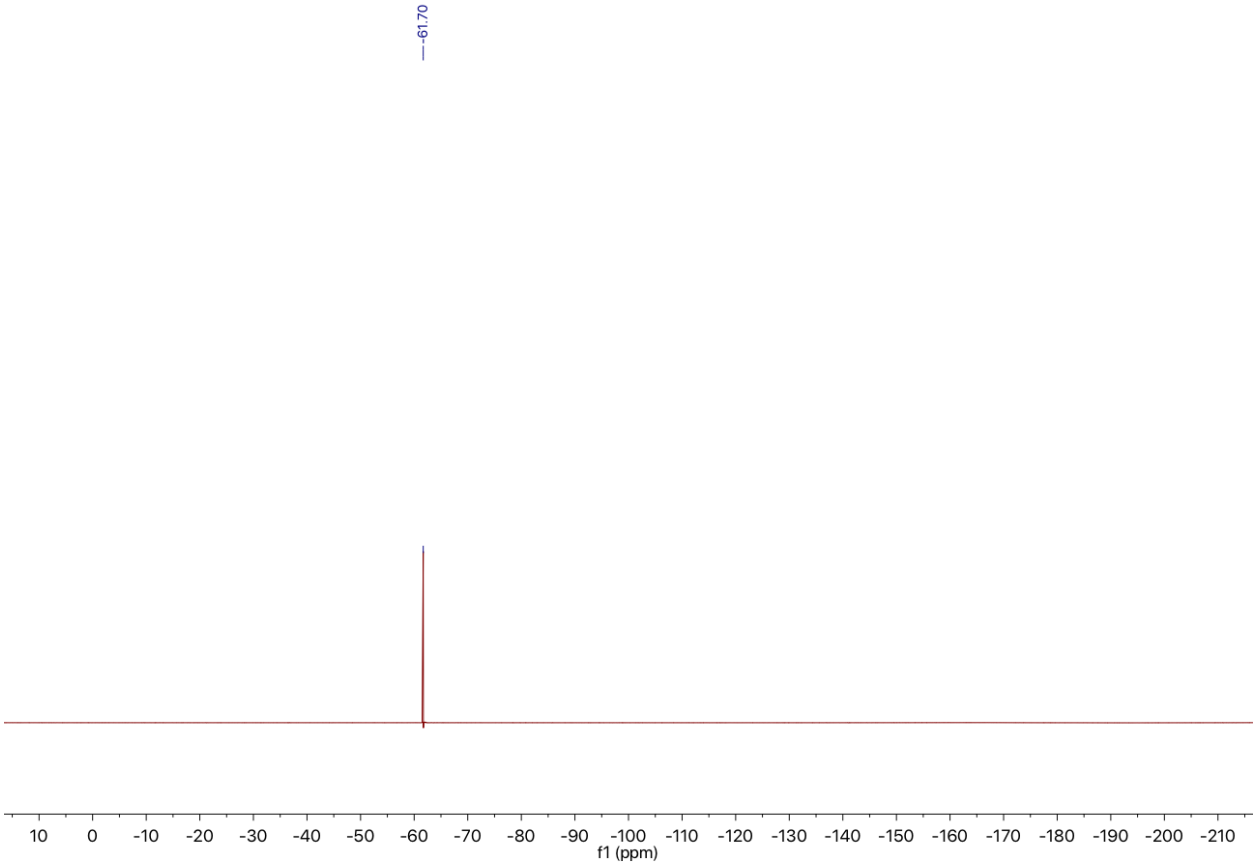
Compound 4aj, ^{1}H NMR (600 MHz, $CDCl_3$)



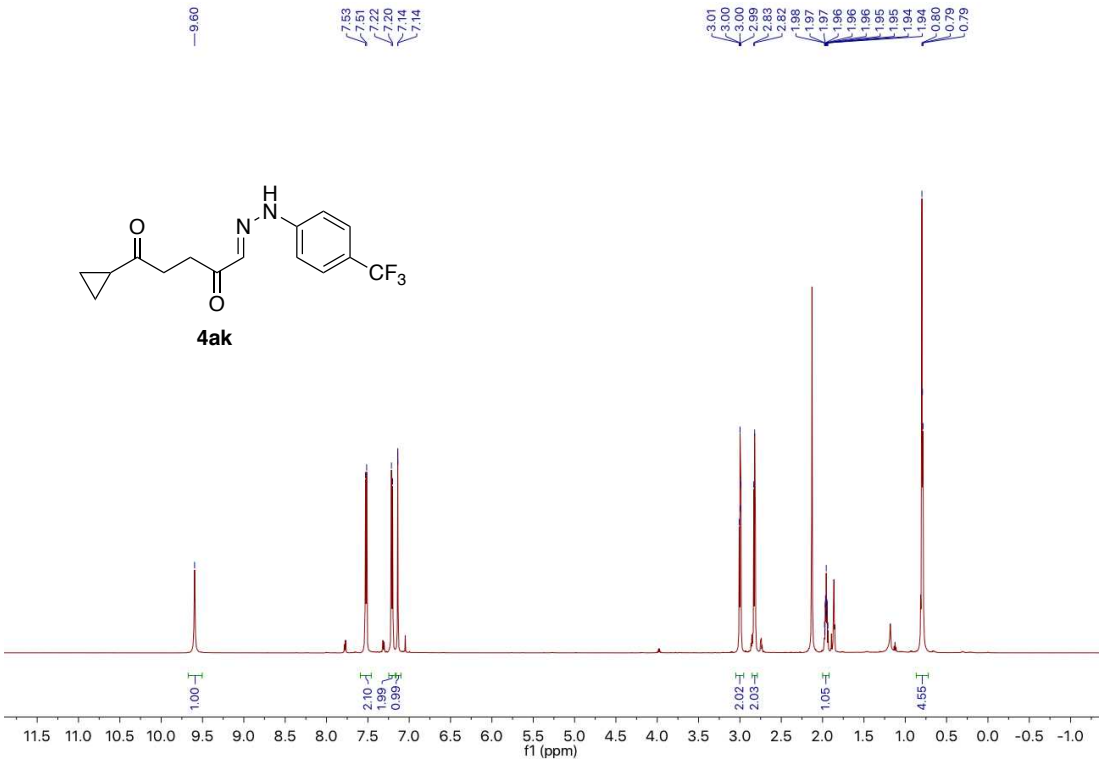
Compound 4aj, ^{13}C NMR (151 MHz, $CDCl_3$)



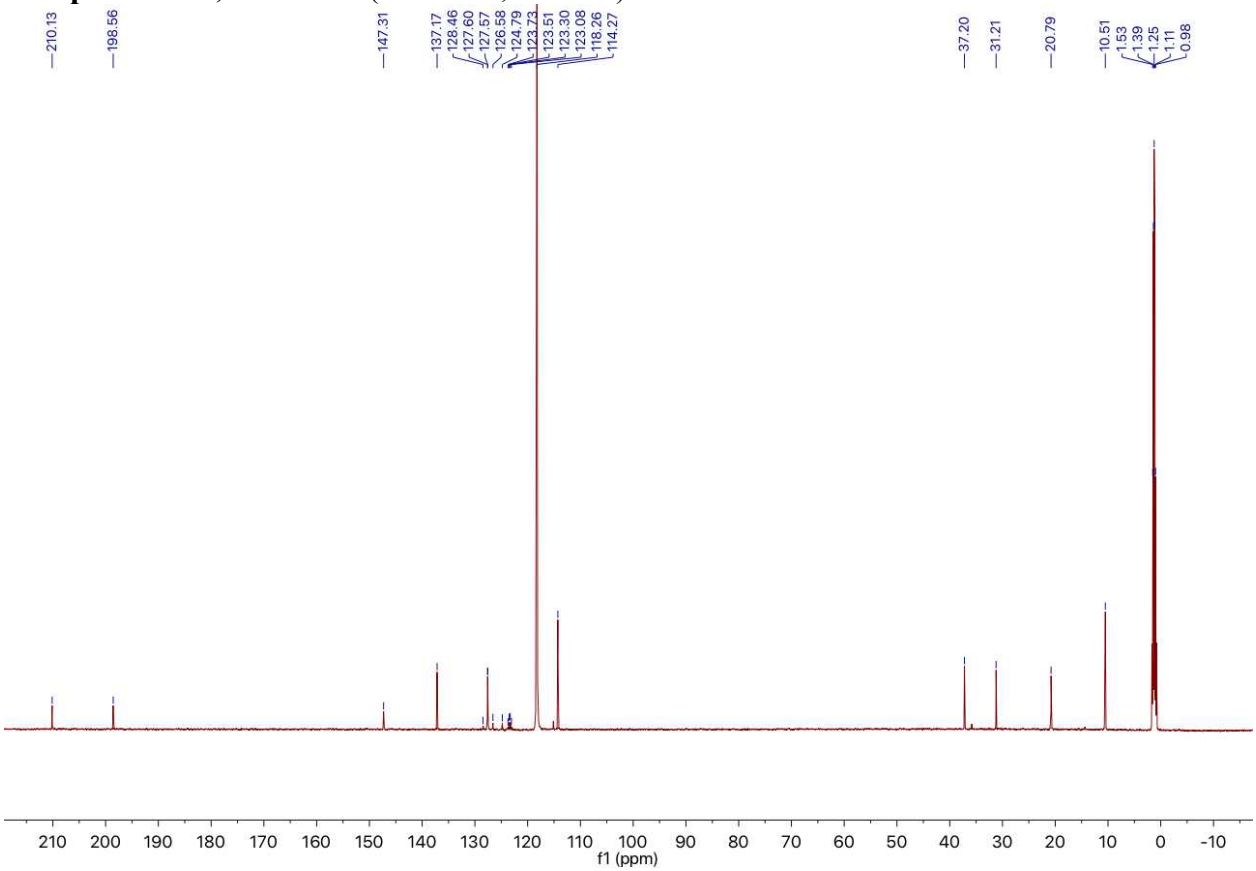
Compound 4aj, ^{19}F NMR (565 MHz, $CDCl_3$)



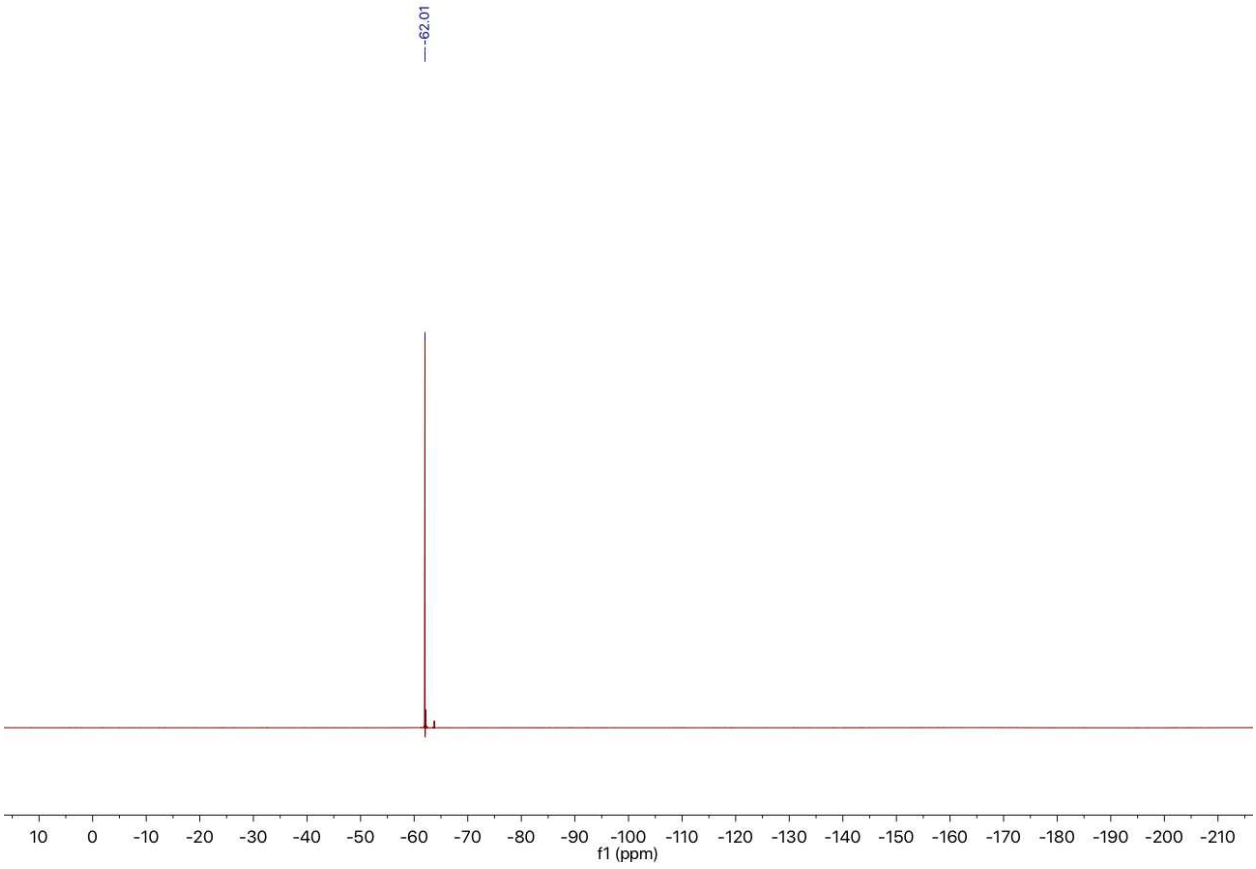
Compound 4ak, ^{1}H NMR (600 MHz, CD_3CN)



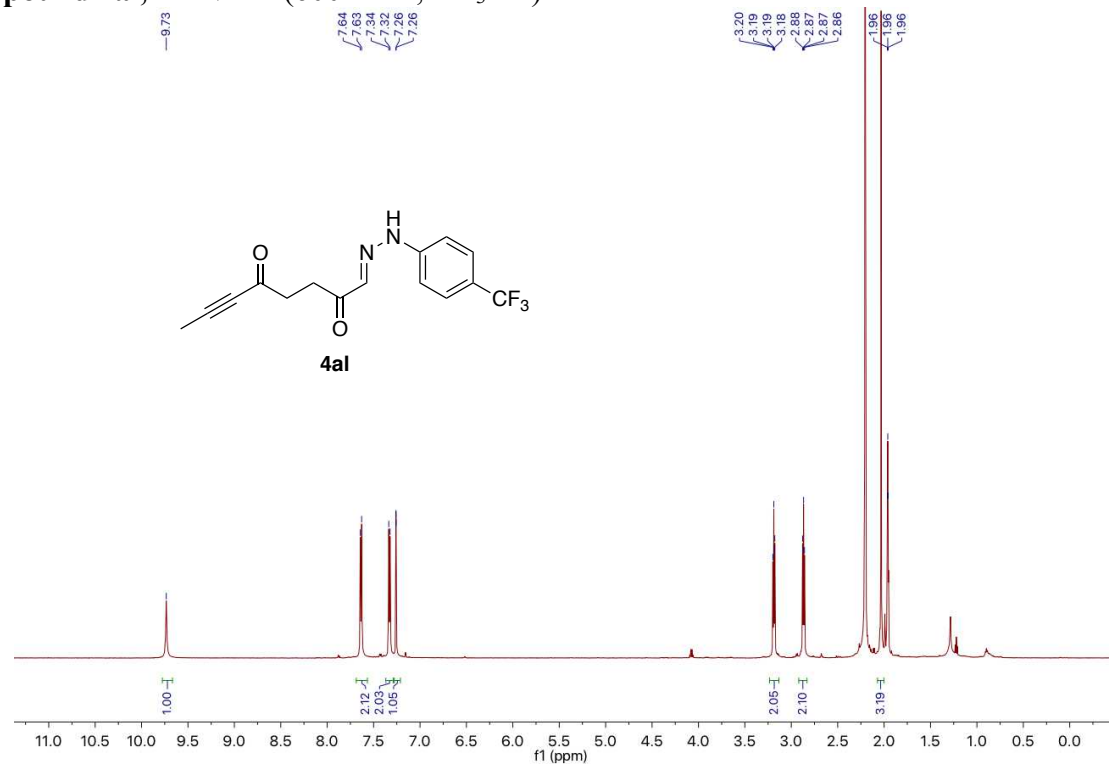
Compound 4ak, ^{13}C NMR (151 MHz, CD_3CN)



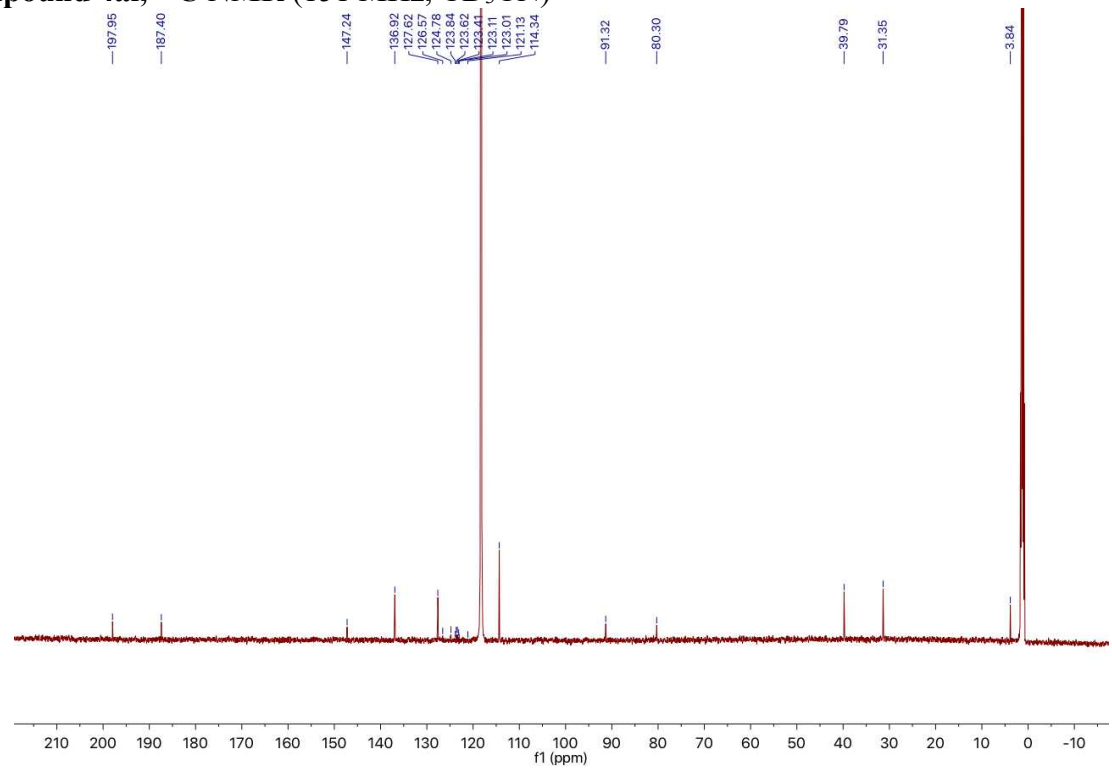
Compound 4ak ^{19}F NMR (565 MHz, CD_3CN)



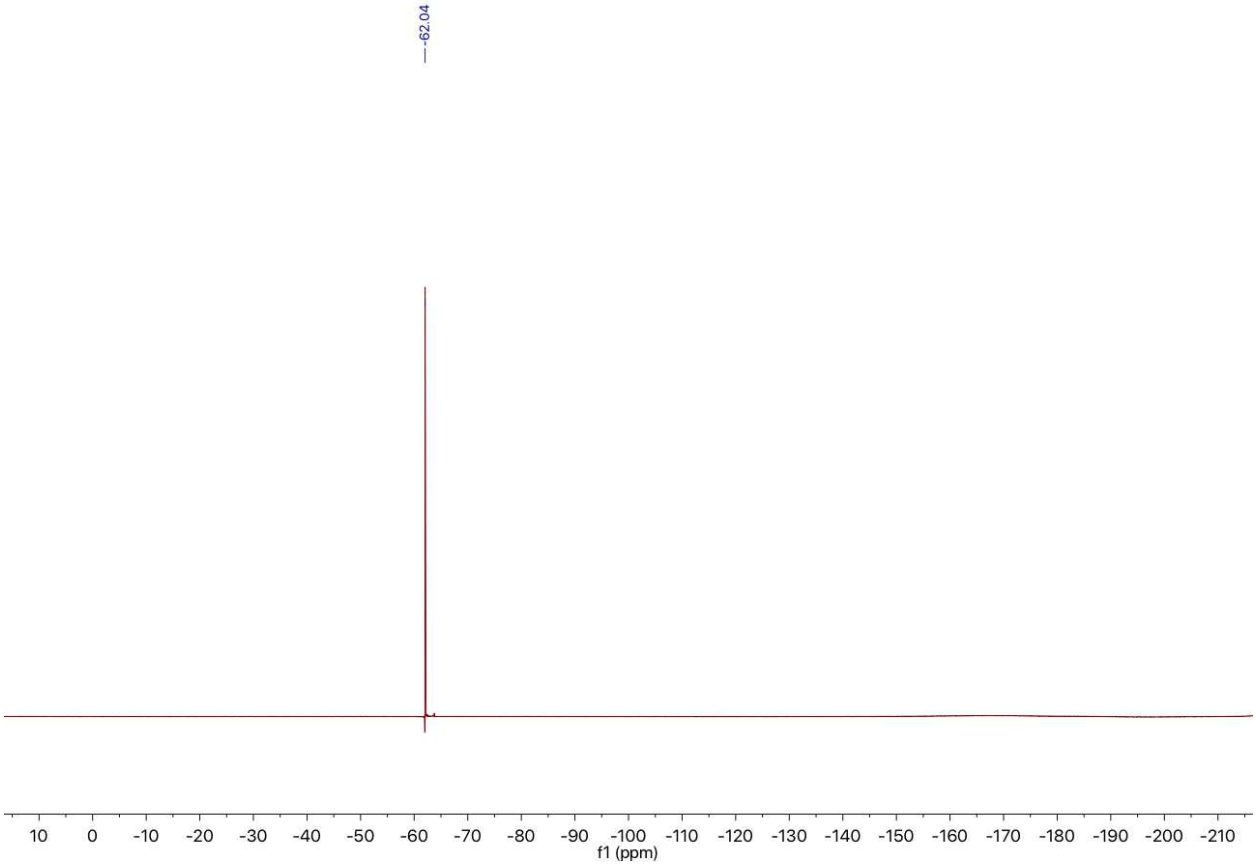
Compound 4al, ^{1}H NMR (600 MHz, CD_3CN)



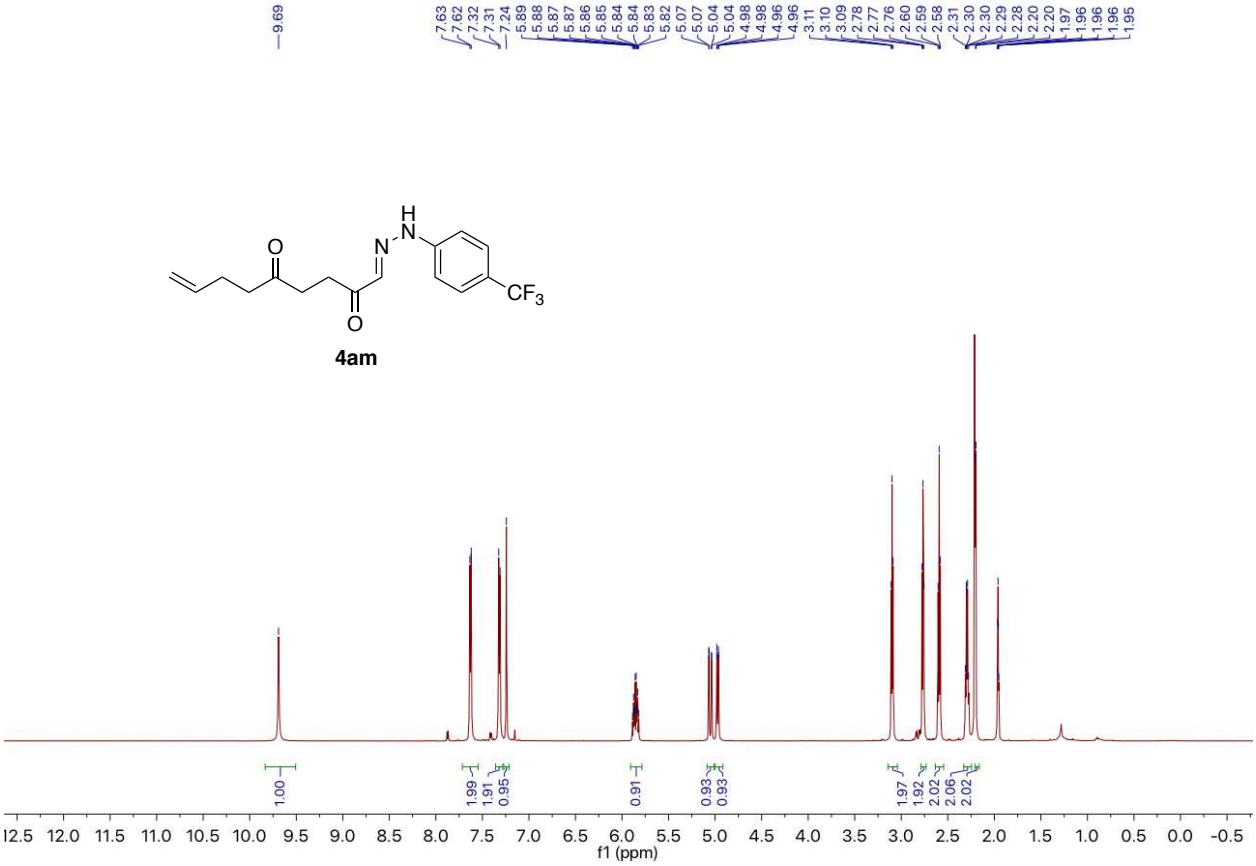
Compound 4al, ^{13}C NMR (151 MHz, CD_3CN)



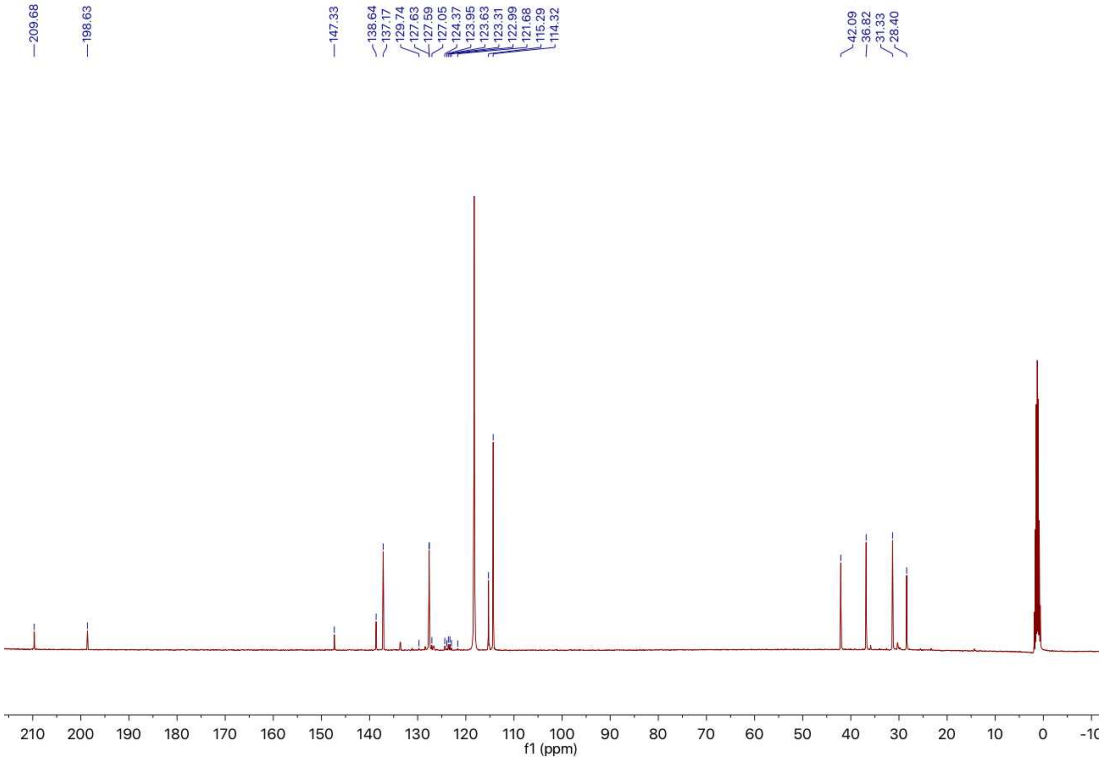
Compound 4al ^{19}F NMR (565 MHz, CD_3CN)



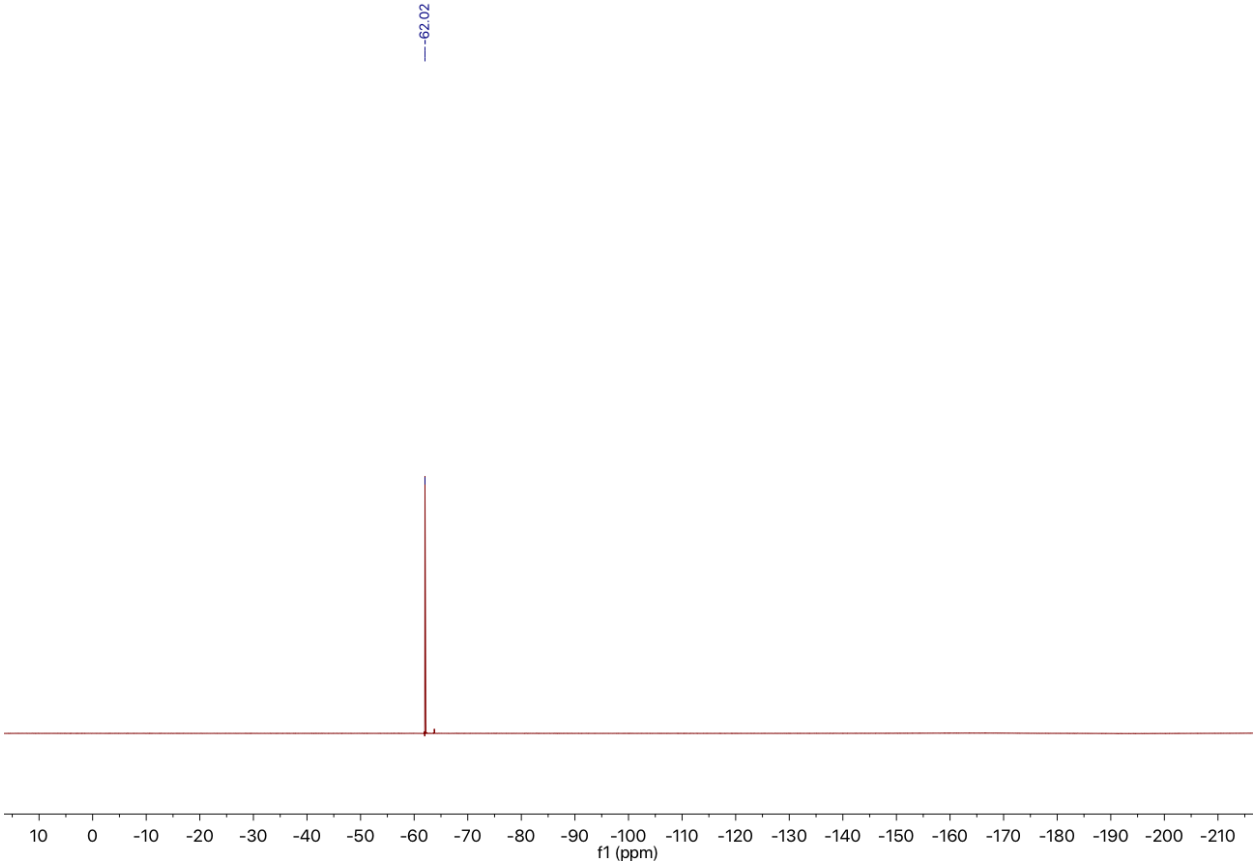
Compound 4am, ^{1}H NMR (600 MHz, CD_3CN)



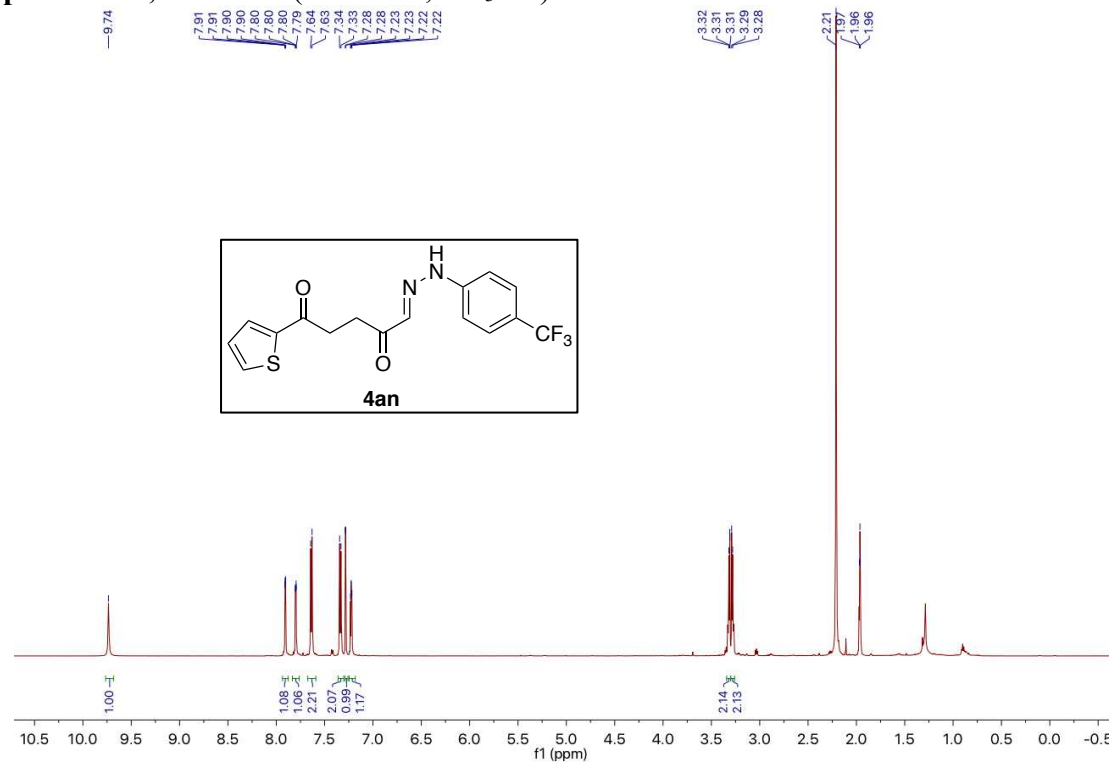
Compound 4am, ^{13}C NMR (151 MHz, CD_3CN)



Compound 4am ^{19}F NMR (565 MHz, CD_3CN)

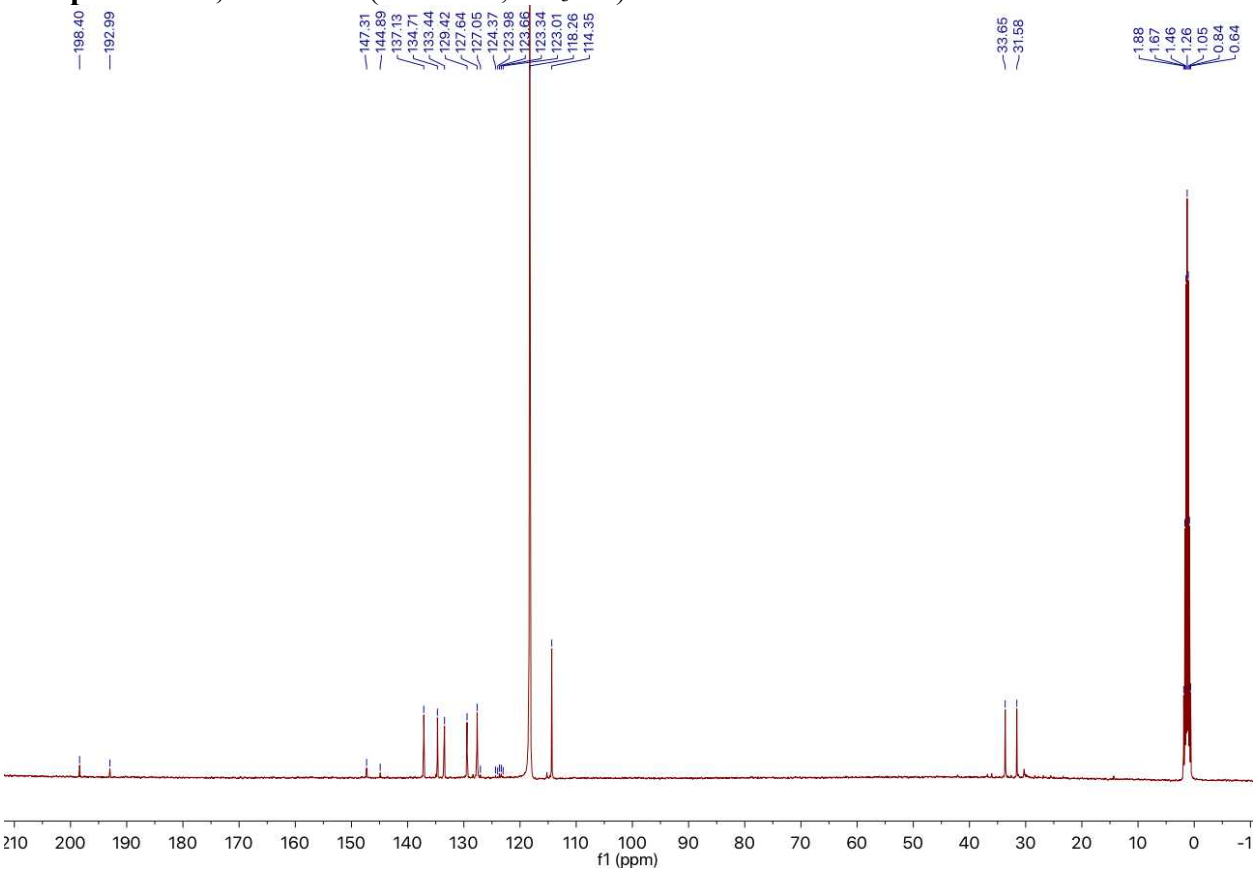


Compound 4an, ^{1}H NMR (600 MHz, CD_3CN)

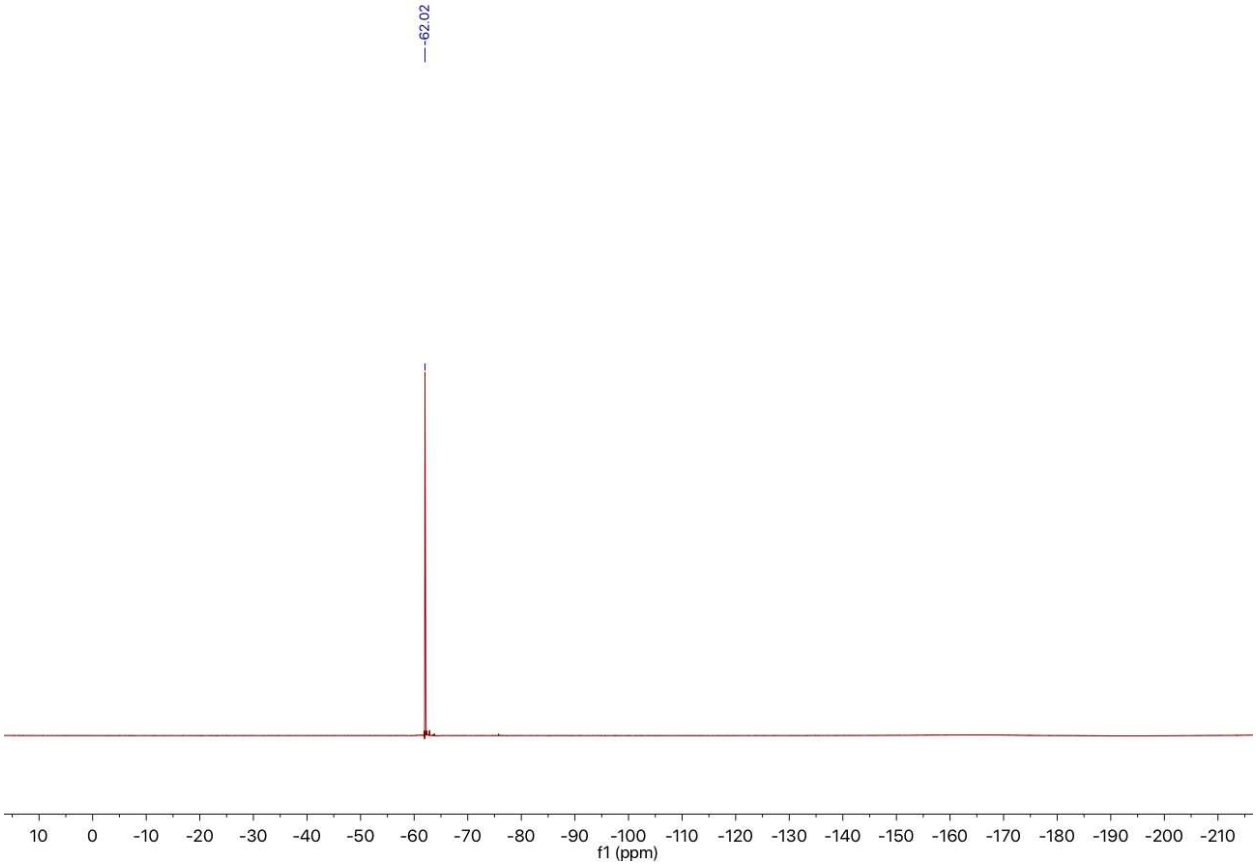


4an

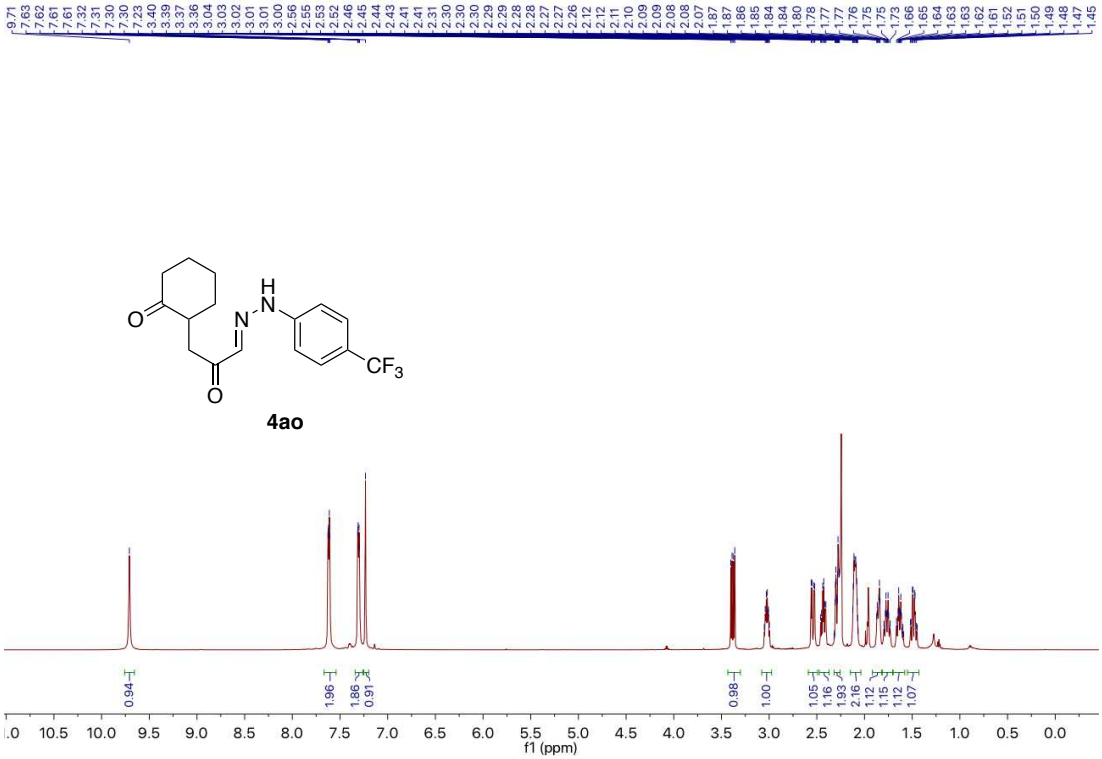
Compound 4an, ^{13}C NMR (151 MHz, CD_3CN)



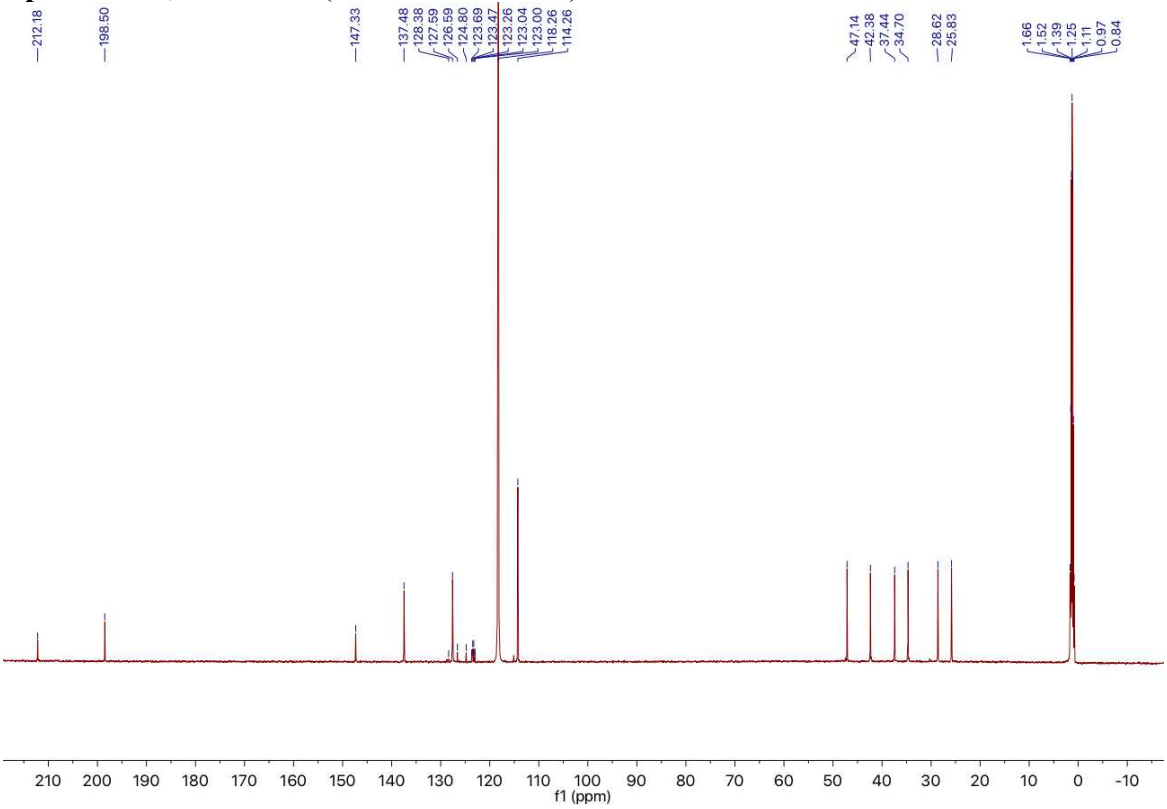
Compound 4an ^{19}F NMR (565 MHz, CD_3CN)



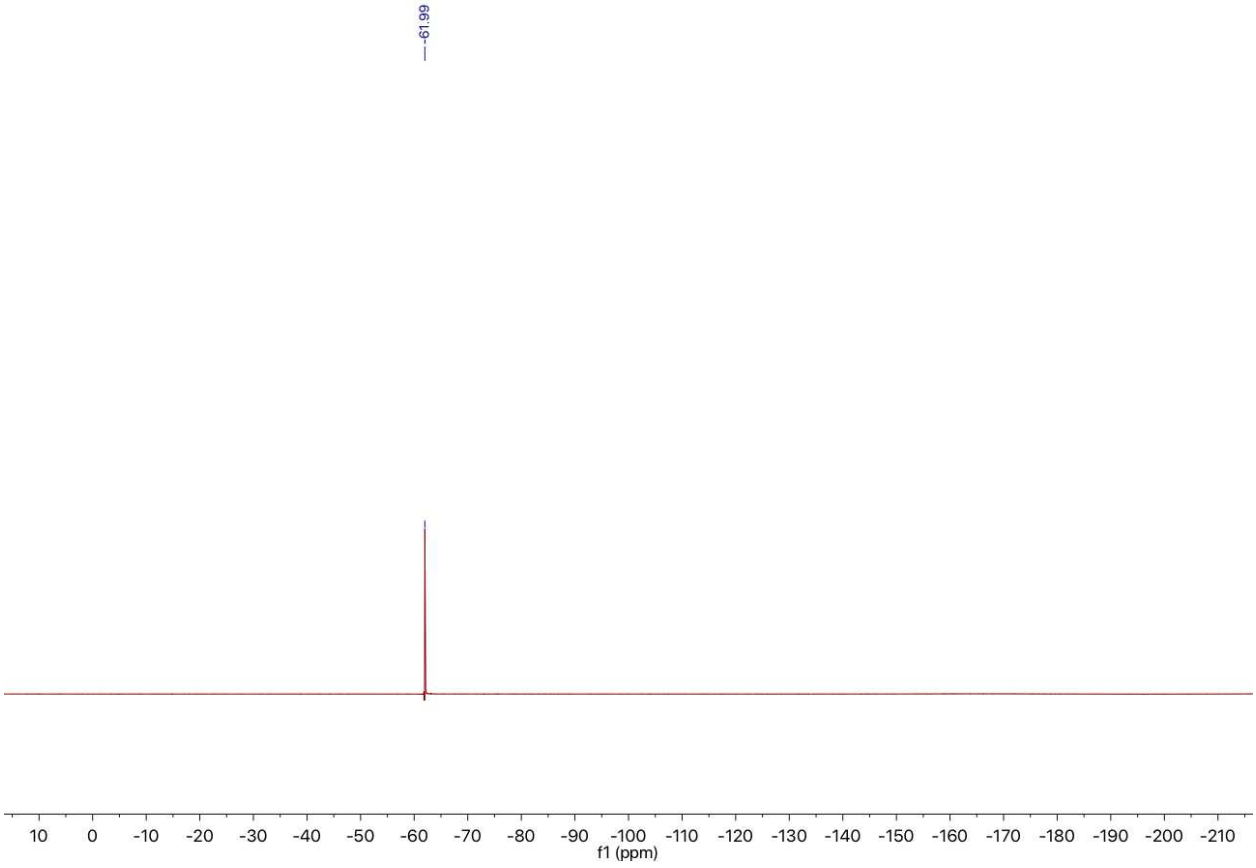
Compound 4ao, ^{1}H NMR (600 MHz, CD_3CN)



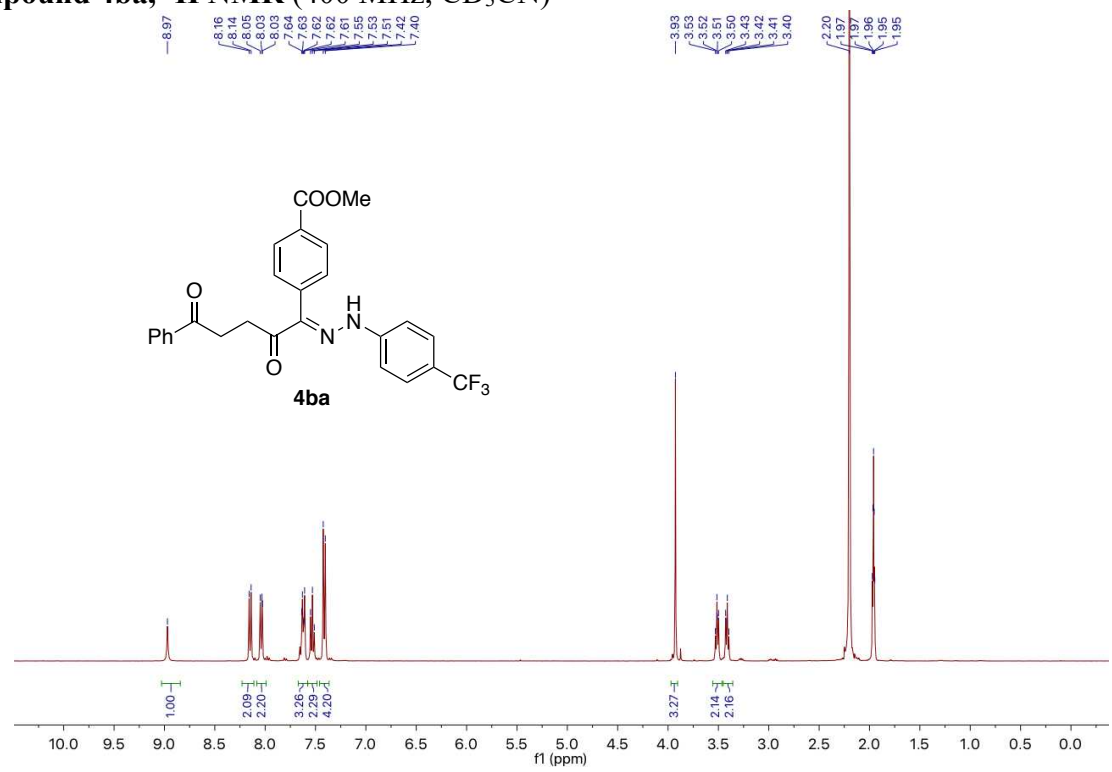
Compound 4ao, ^{13}C NMR (151 MHz, CD_3CN)



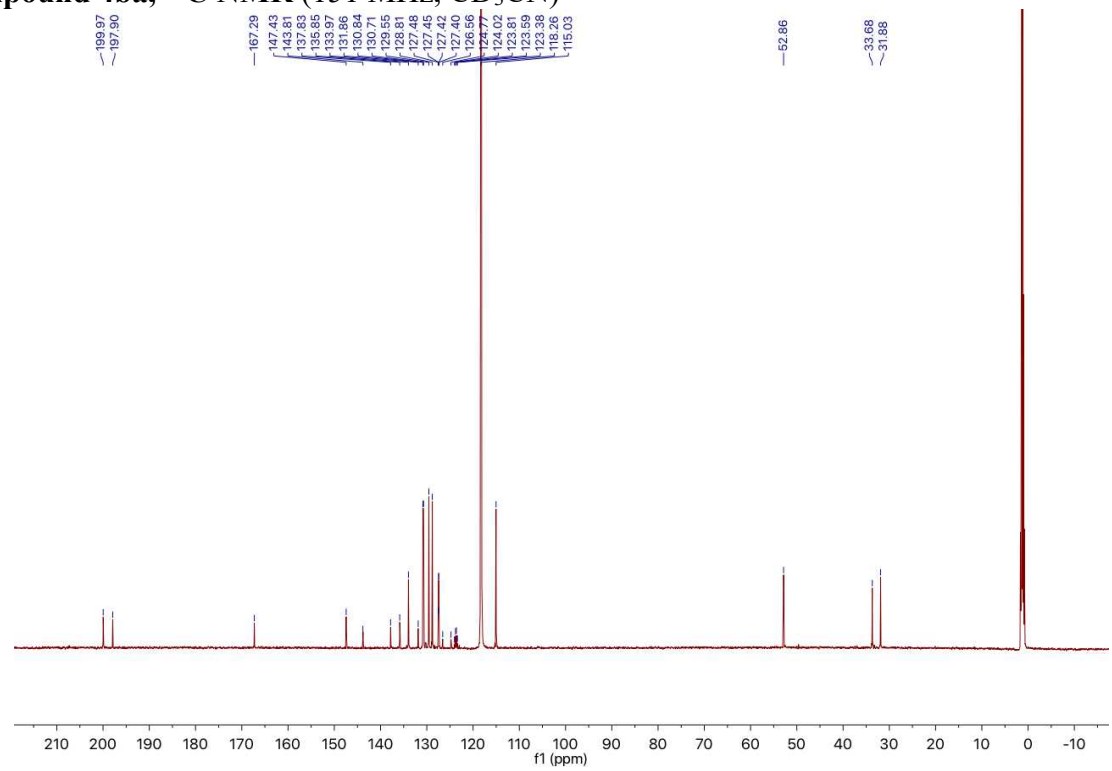
Compound 4ao ^{19}F NMR (565 MHz, CD_3CN)



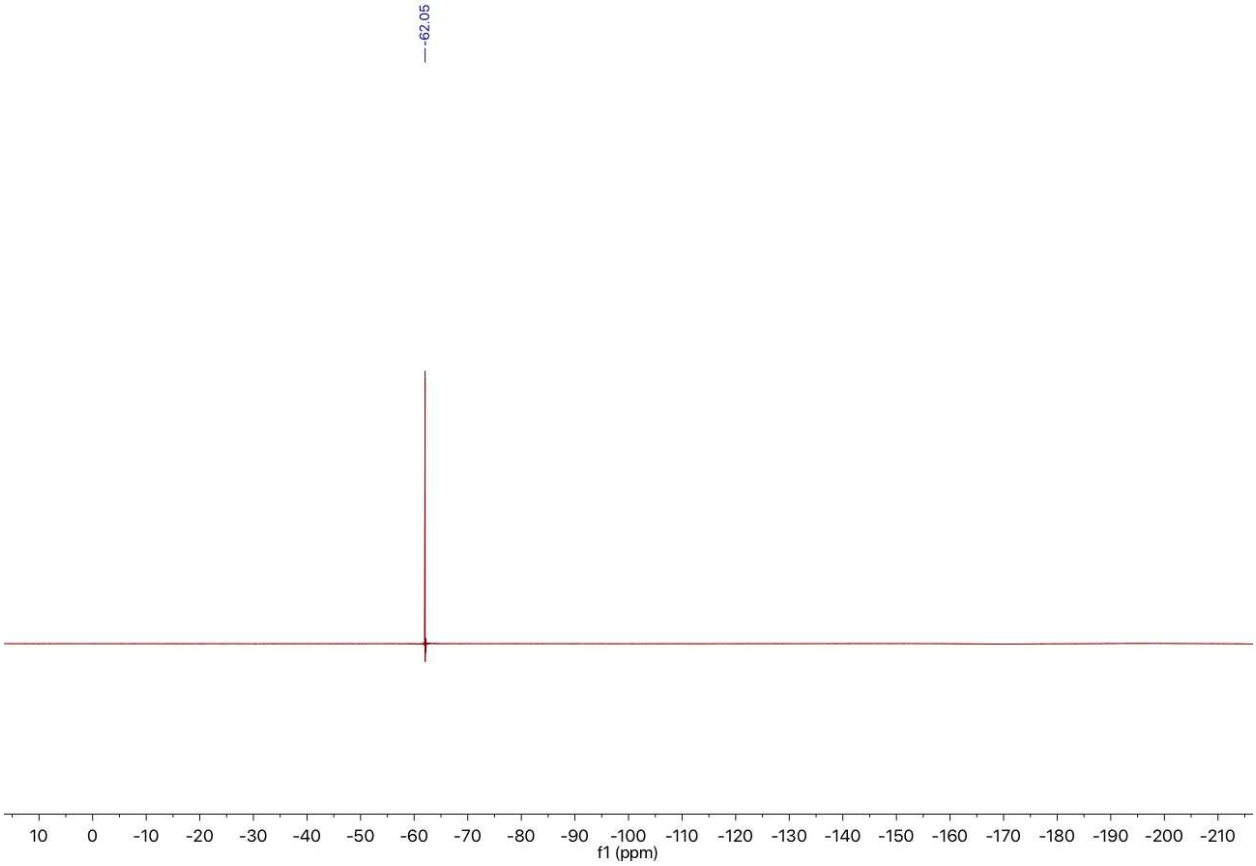
Compound 4ba, ^{1}H NMR (400 MHz, CD_3CN)



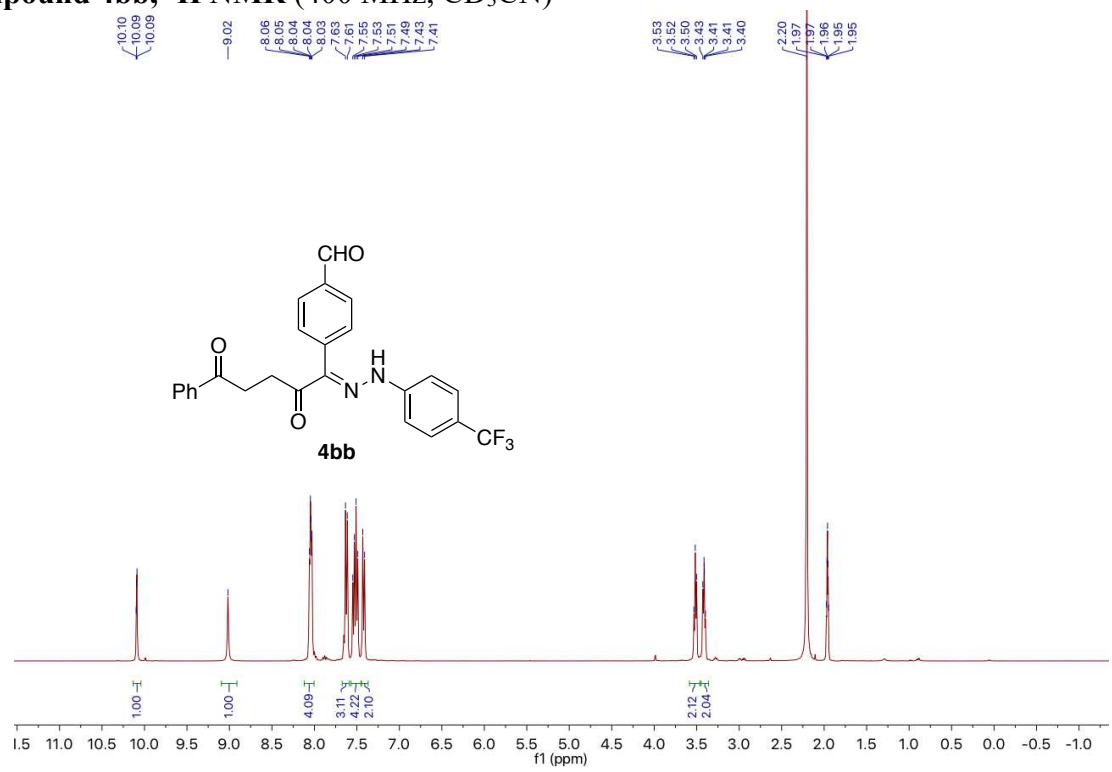
Compound 4ba, ^{13}C NMR (151 MHz, CD_3CN)



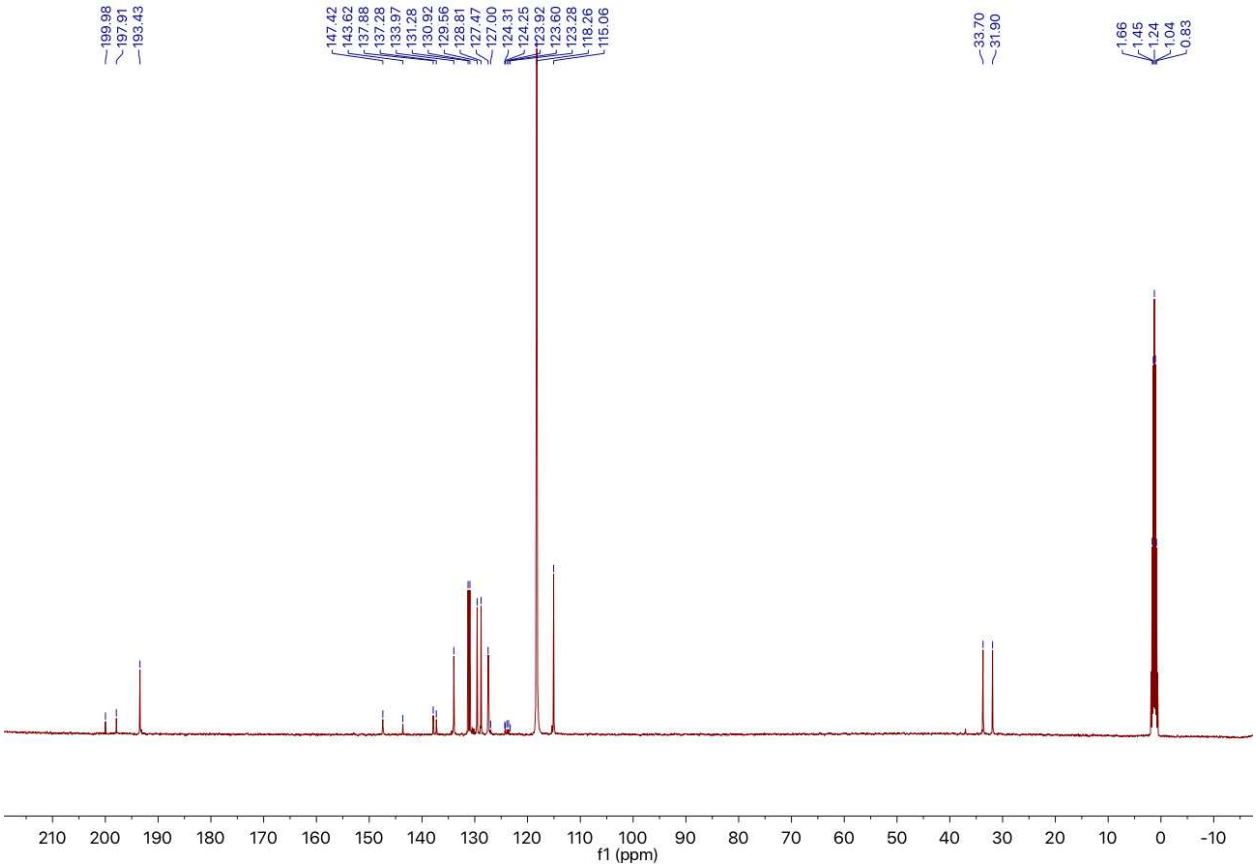
Compound 4ba ^{19}F NMR (565 MHz, CD_3CN)



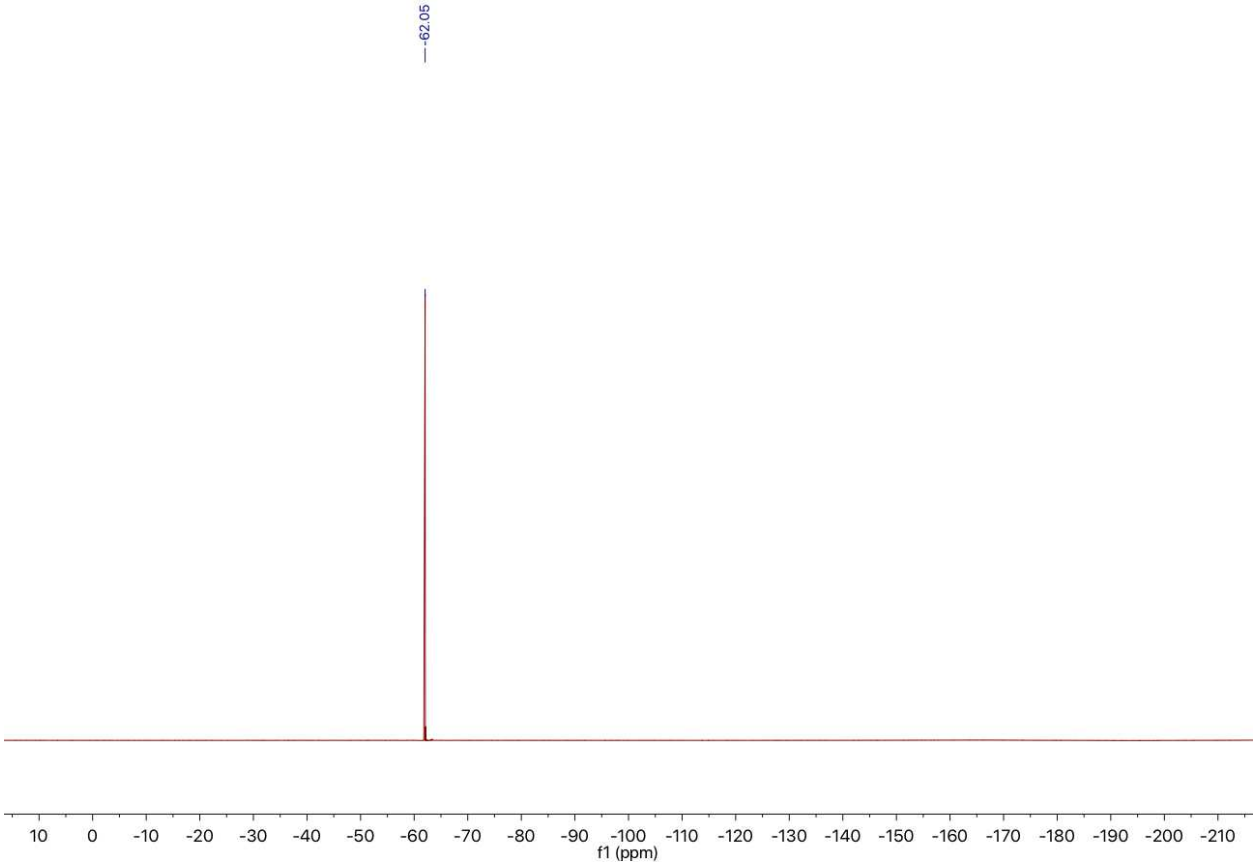
Compound 4bb, ^{1}H NMR (400 MHz, CD_3CN)



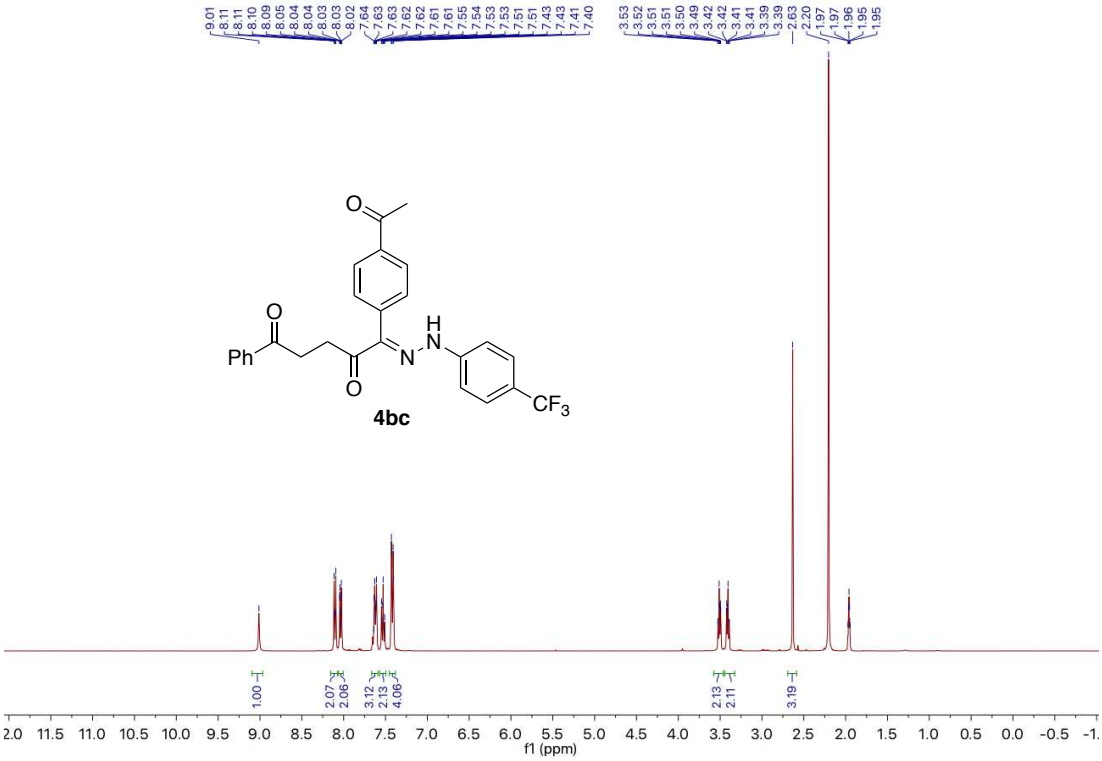
Compound 4bb, ^{13}C NMR (101 MHz, CD_3CN)



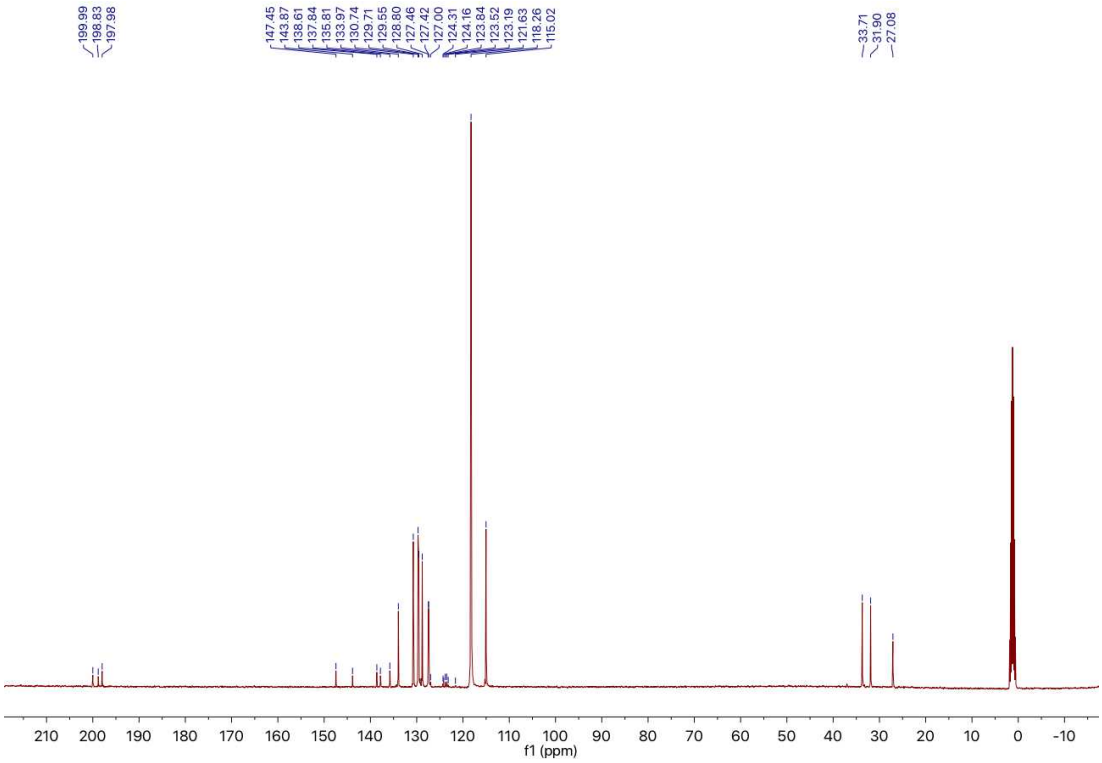
Compound 4bb ^{19}F NMR (565 MHz, CD_3CN)



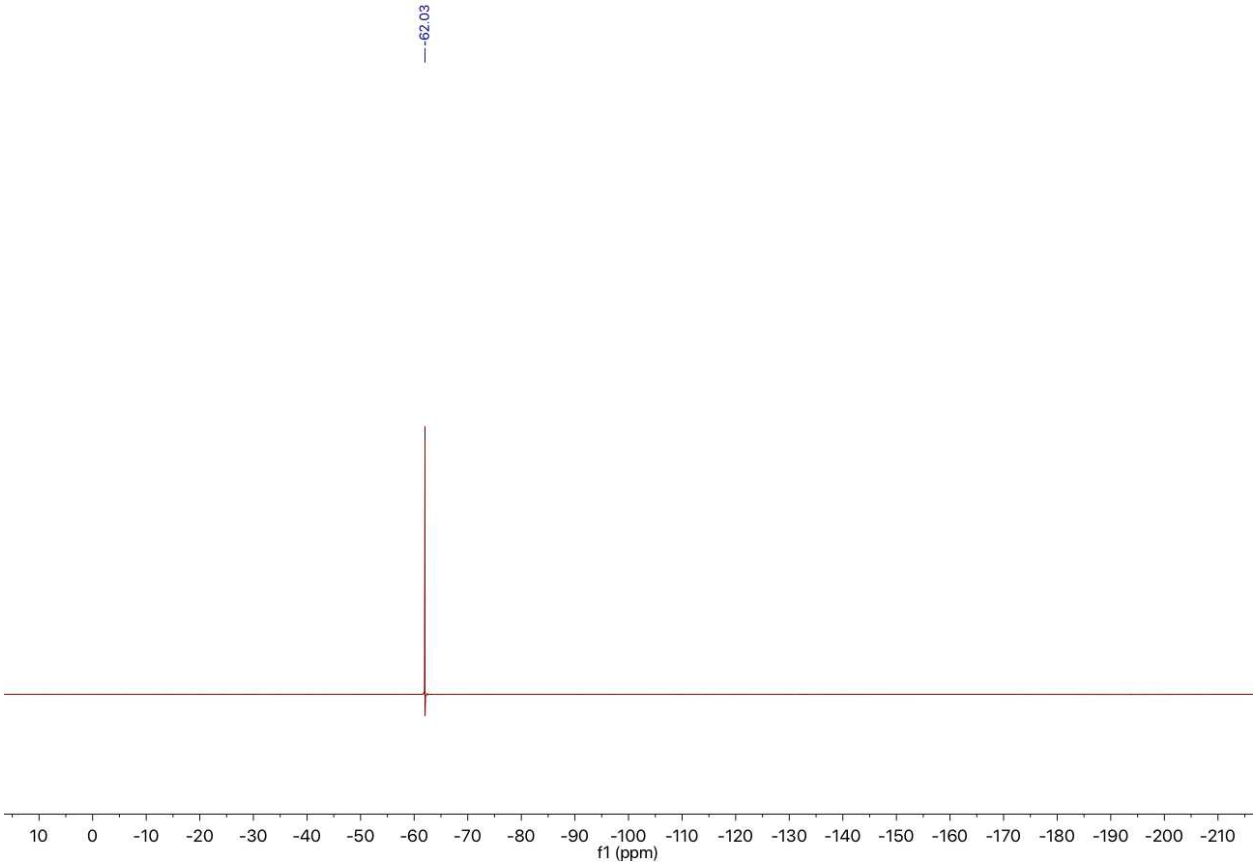
Compound 4bc, ^{1}H NMR (400 MHz, CD_3CN)



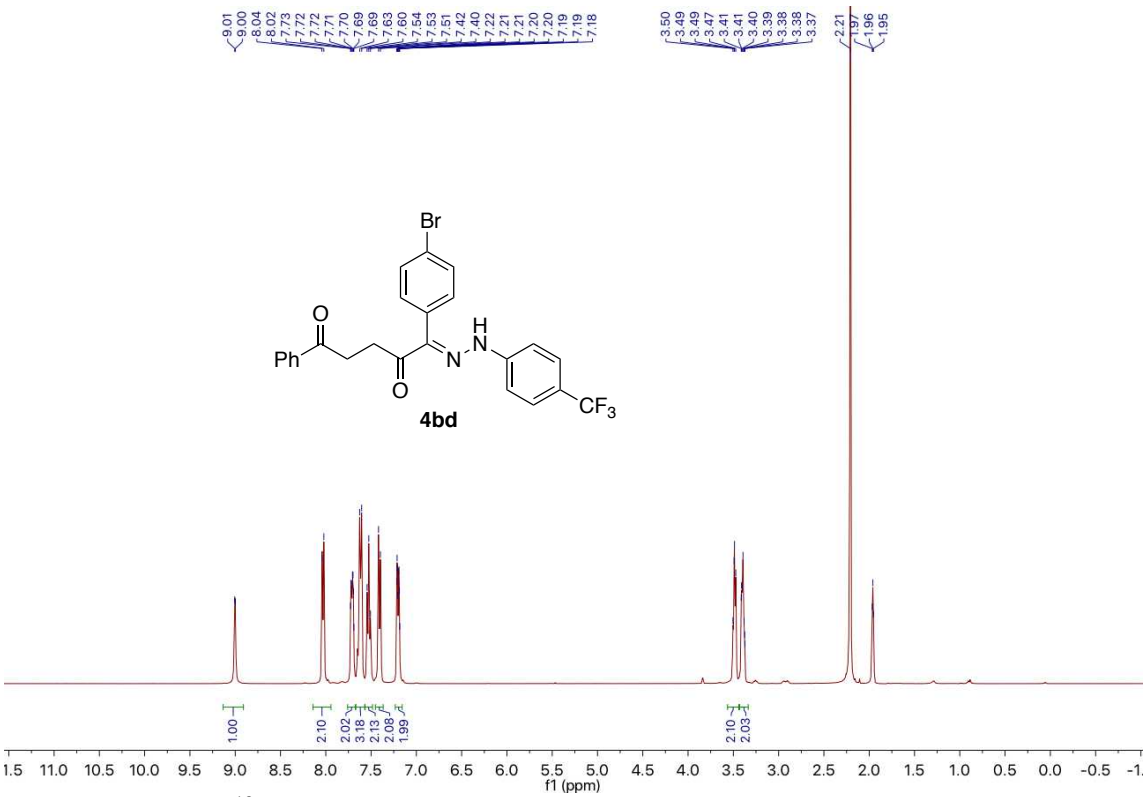
Compound 4bc, ^{13}C NMR (101 MHz, CD_3CN)



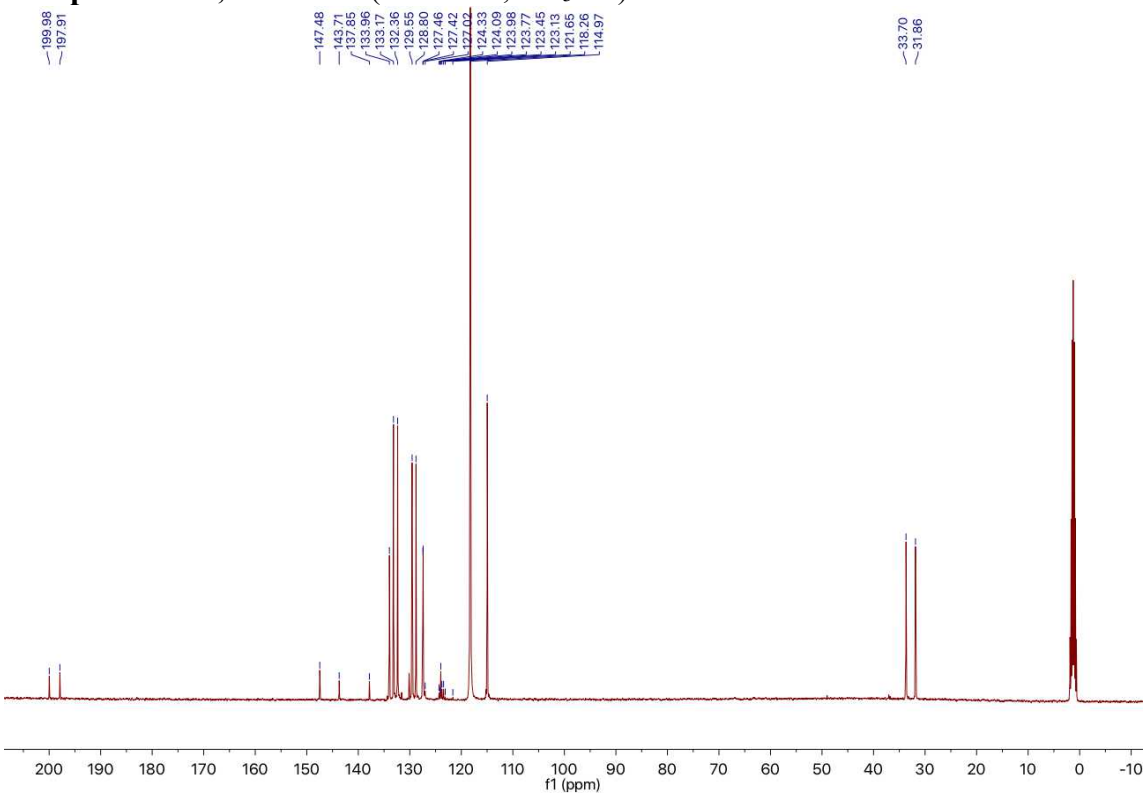
Compound 4bc ^{19}F NMR (565 MHz, CD_3CN)



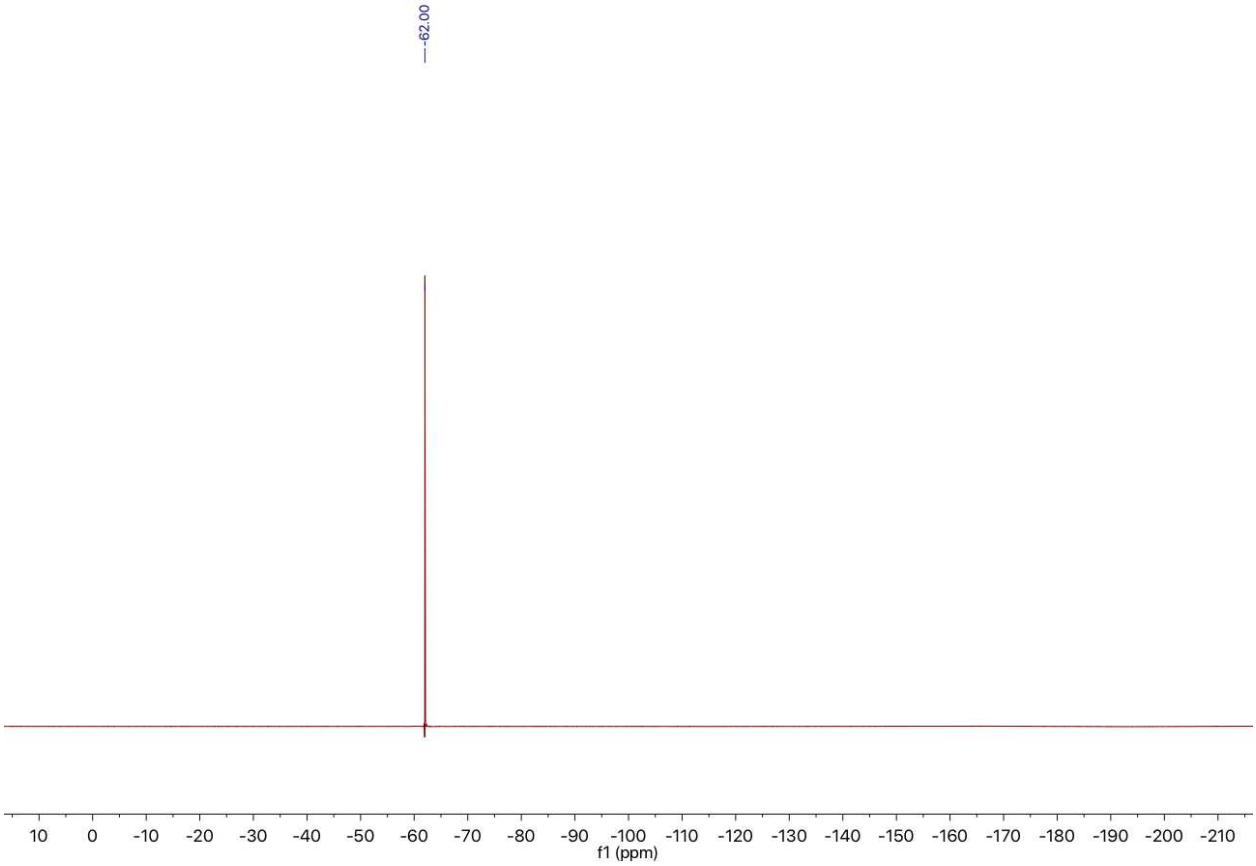
Compound 4bd, ^{1}H NMR (400 MHz, CD_3CN)



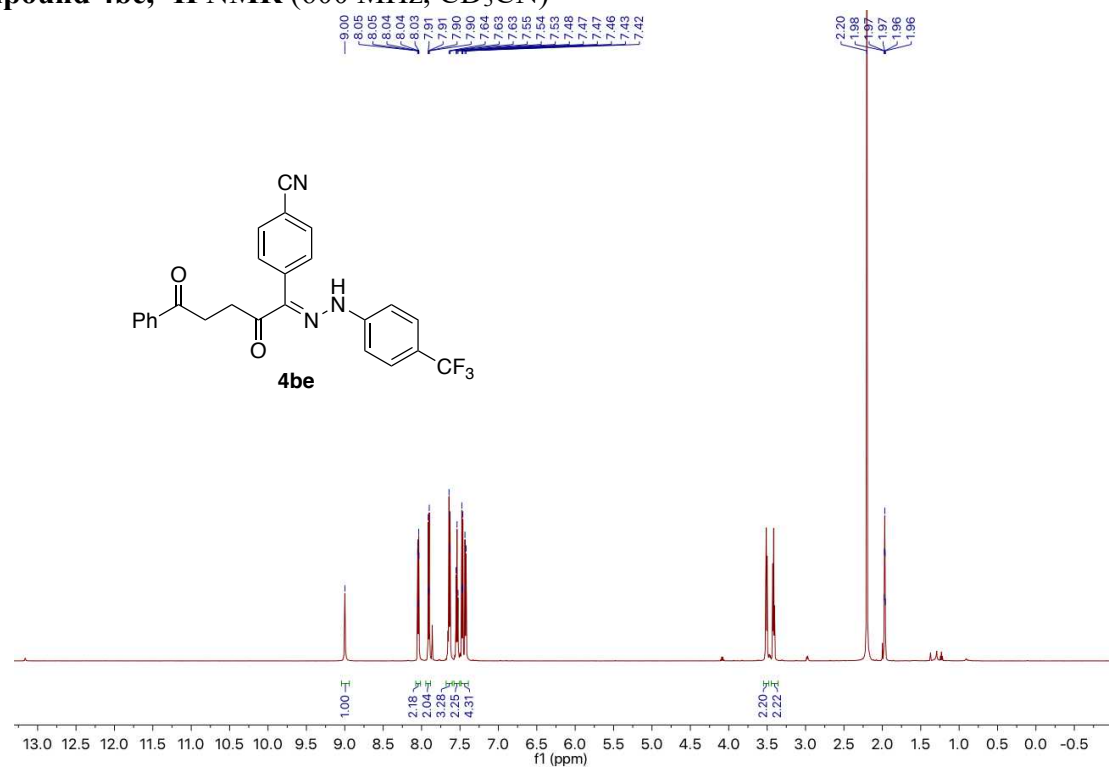
Compound 4bd, ^{13}C NMR (101 MHz, CD_3CN)



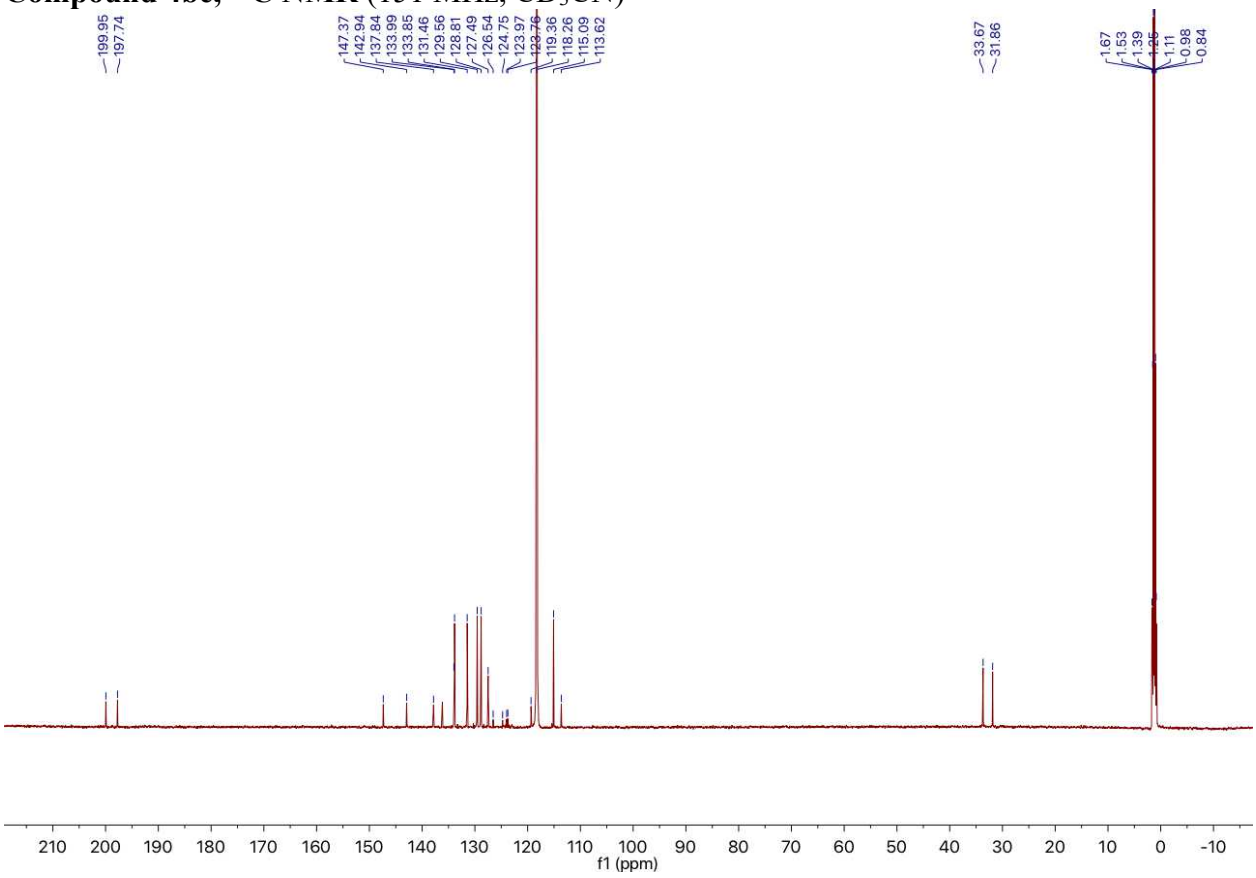
Compound 4bd ^{19}F NMR (565 MHz, CD_3CN)



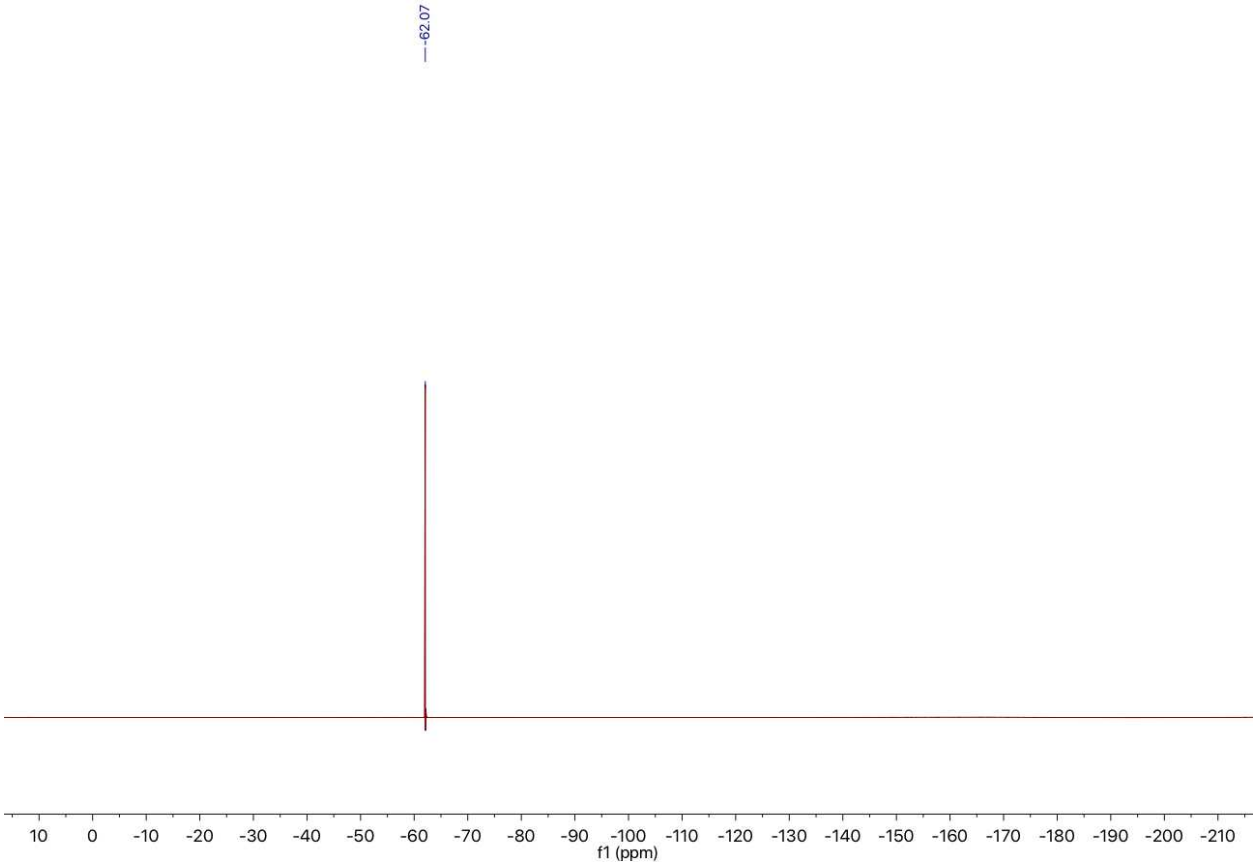
Compound 4be, ^{1}H NMR (600 MHz, CD_3CN)



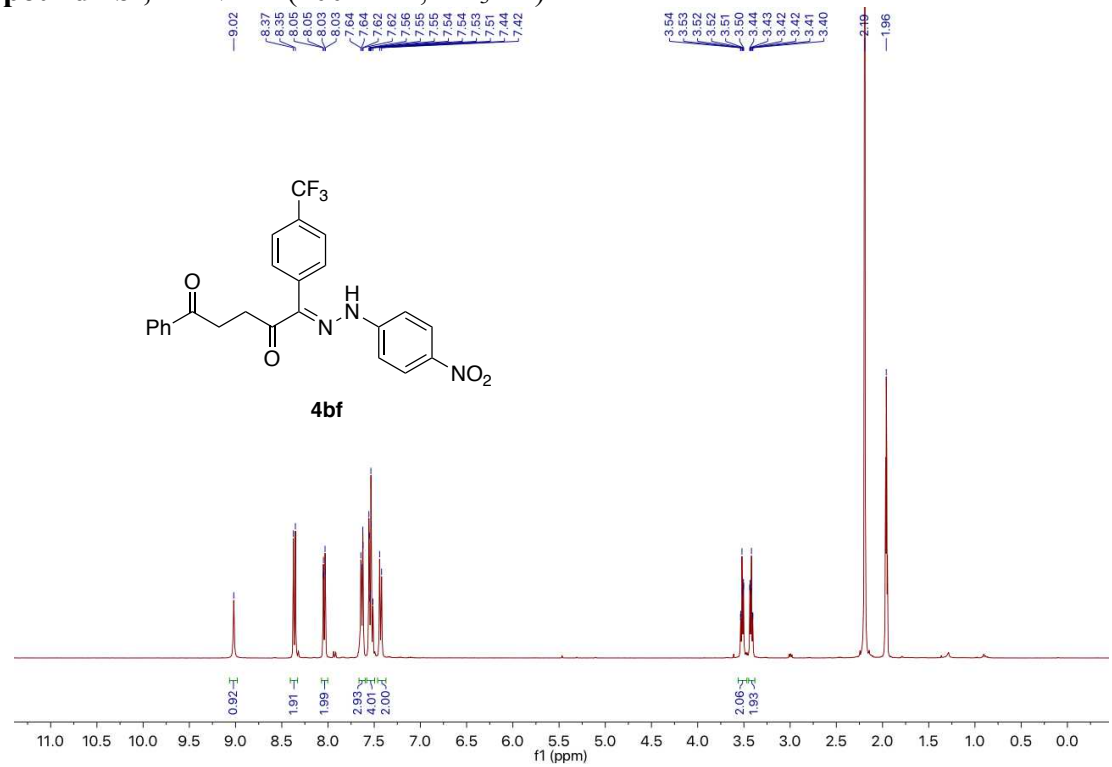
Compound 4be, ^{13}C NMR (151 MHz, CD_3CN)



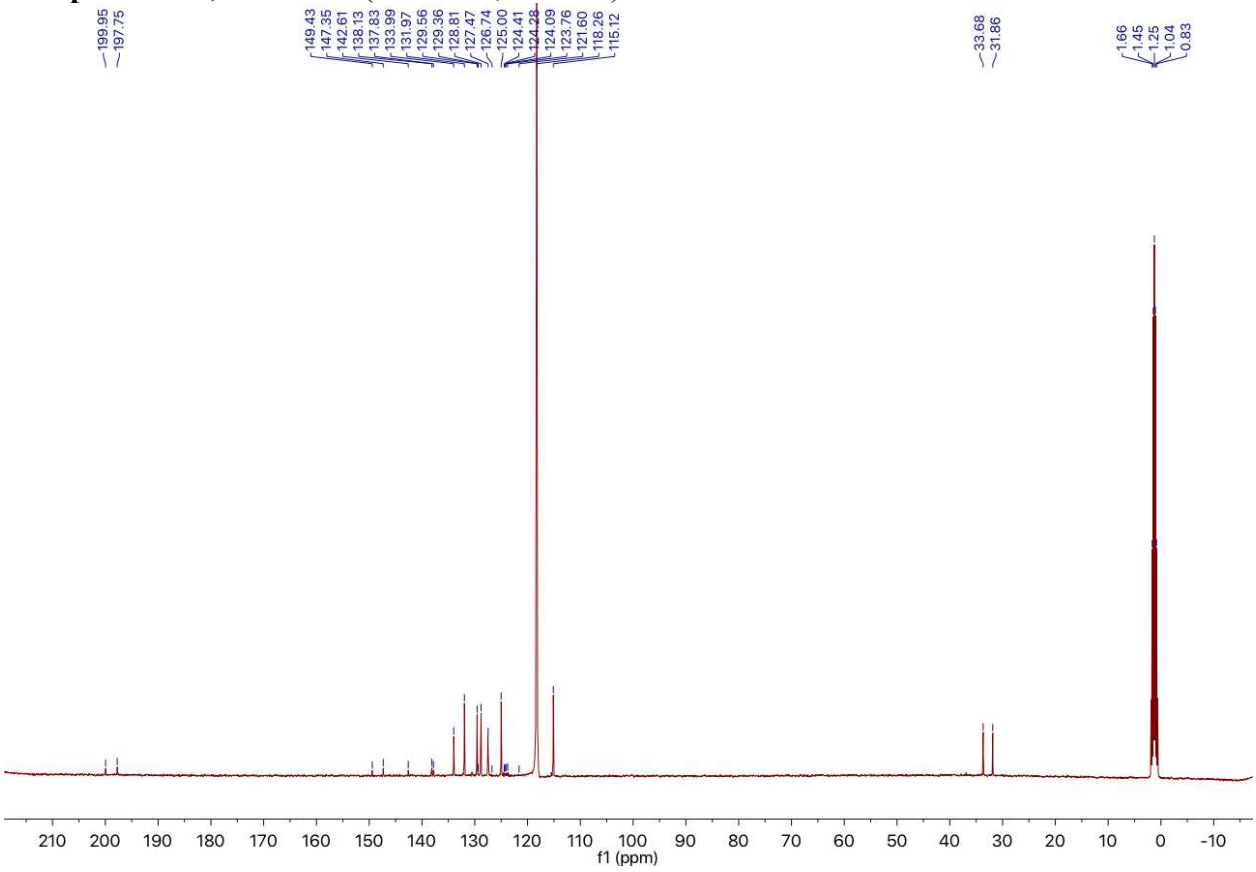
Compound 4be ^{19}F NMR (565 MHz, CD_3CN)



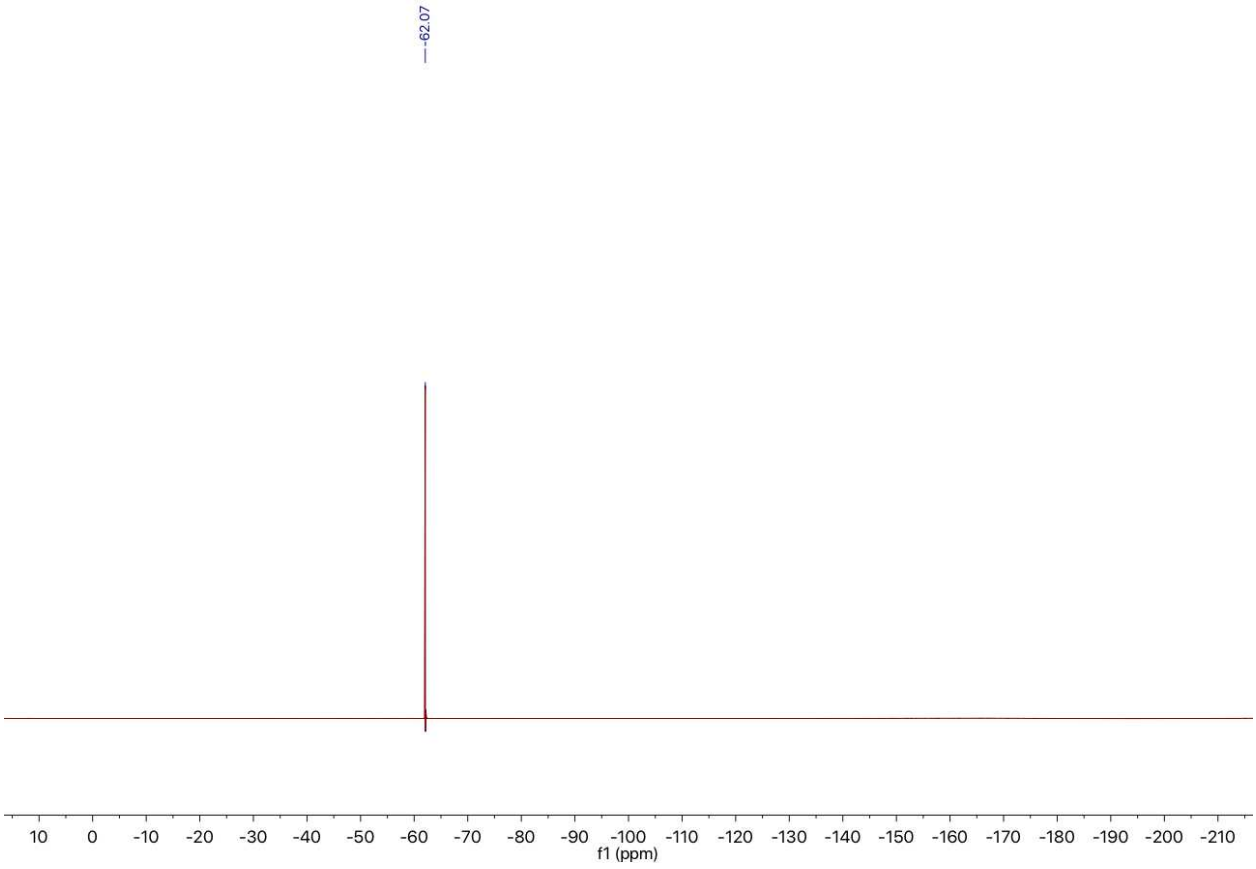
Compound 4bf, ^{1}H NMR (400 MHz, CD_3CN)



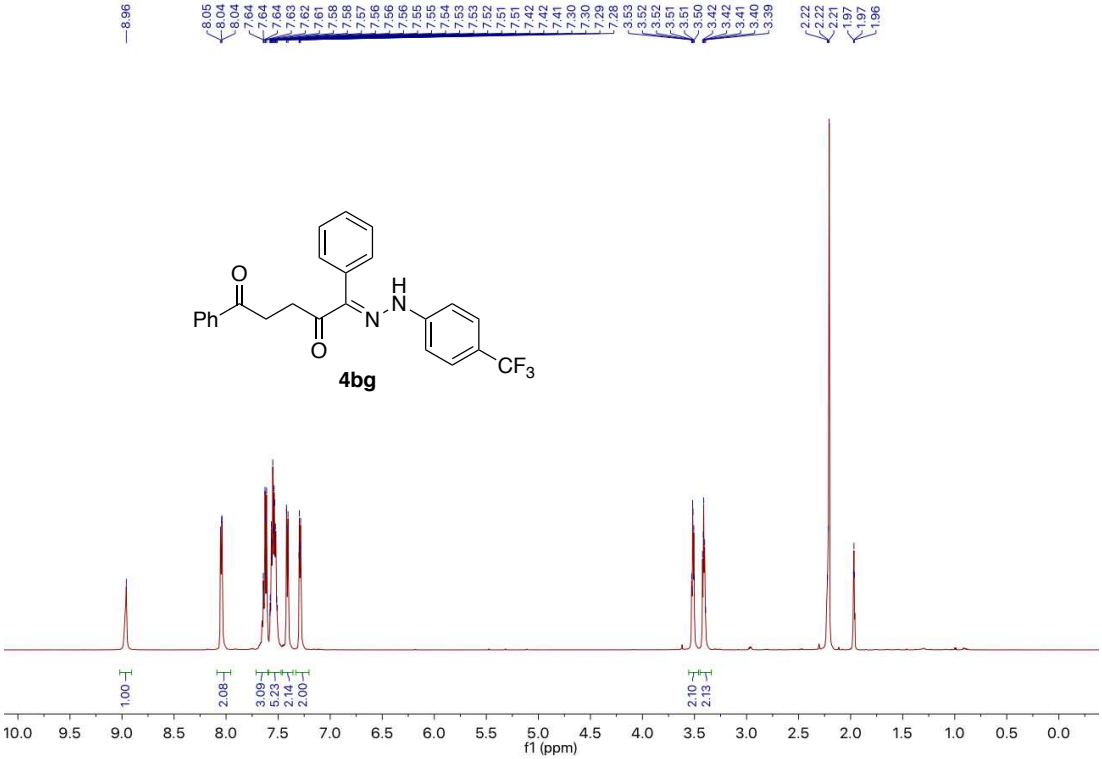
Compound 4bf, ^{13}C NMR (101 MHz, CD_3CN)



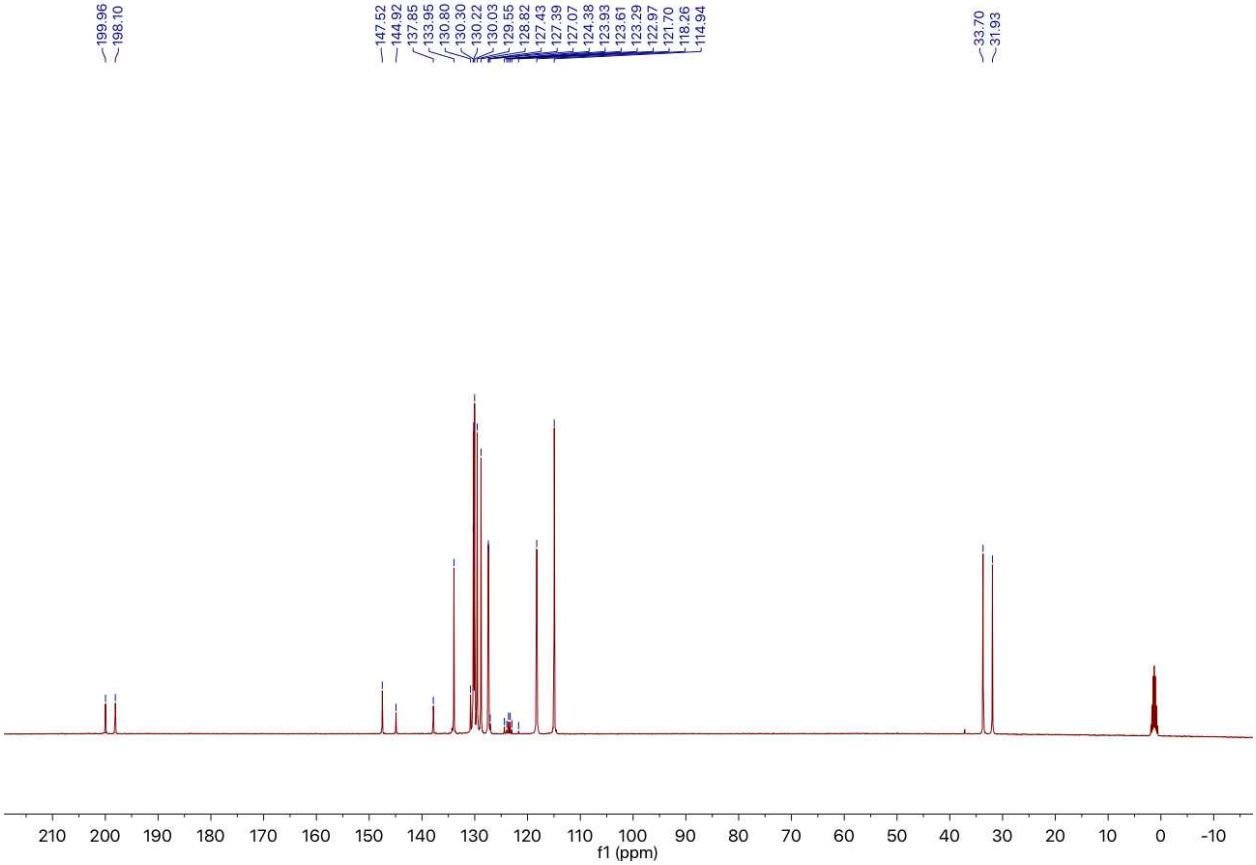
Compound 4bf ^{19}F NMR (565 MHz, CD_3CN)



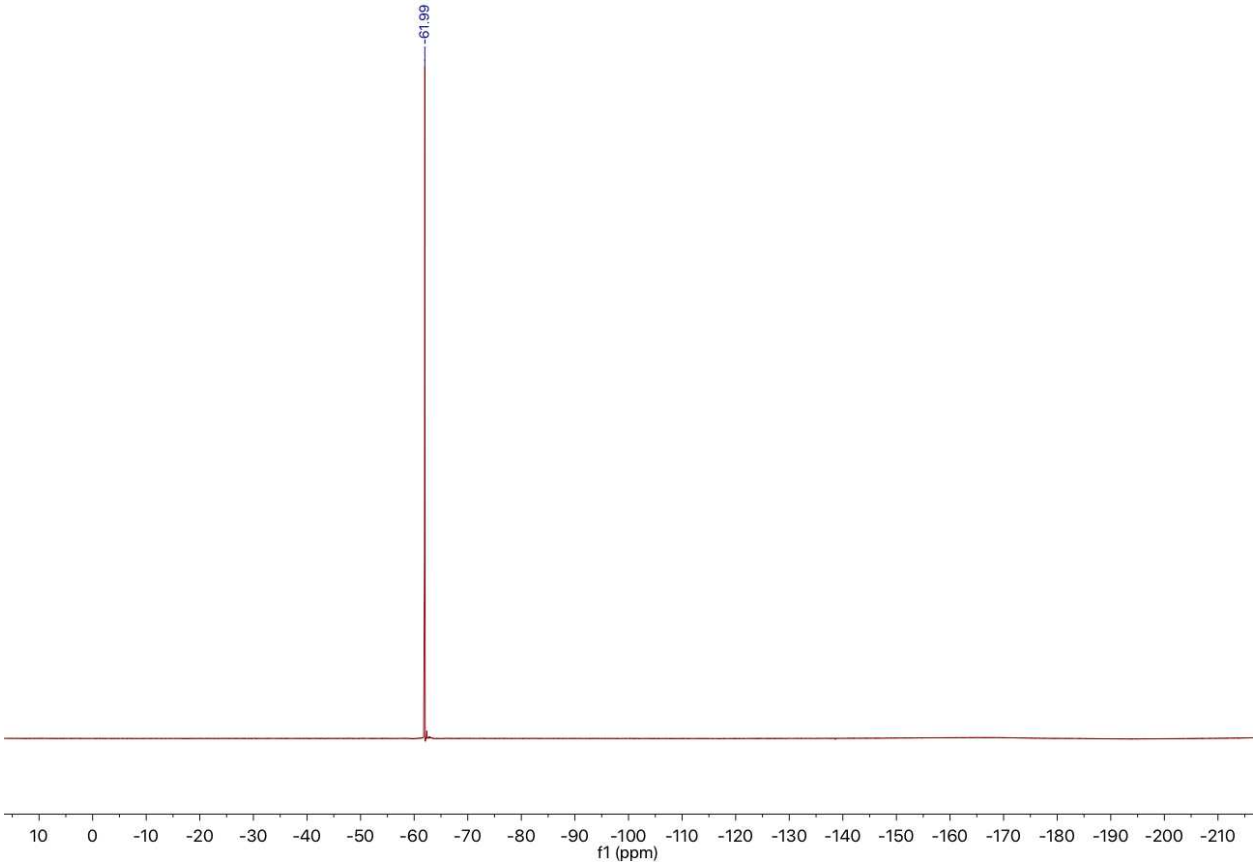
Compound 4bg, ^{1}H NMR (600 MHz, CD_3CN)



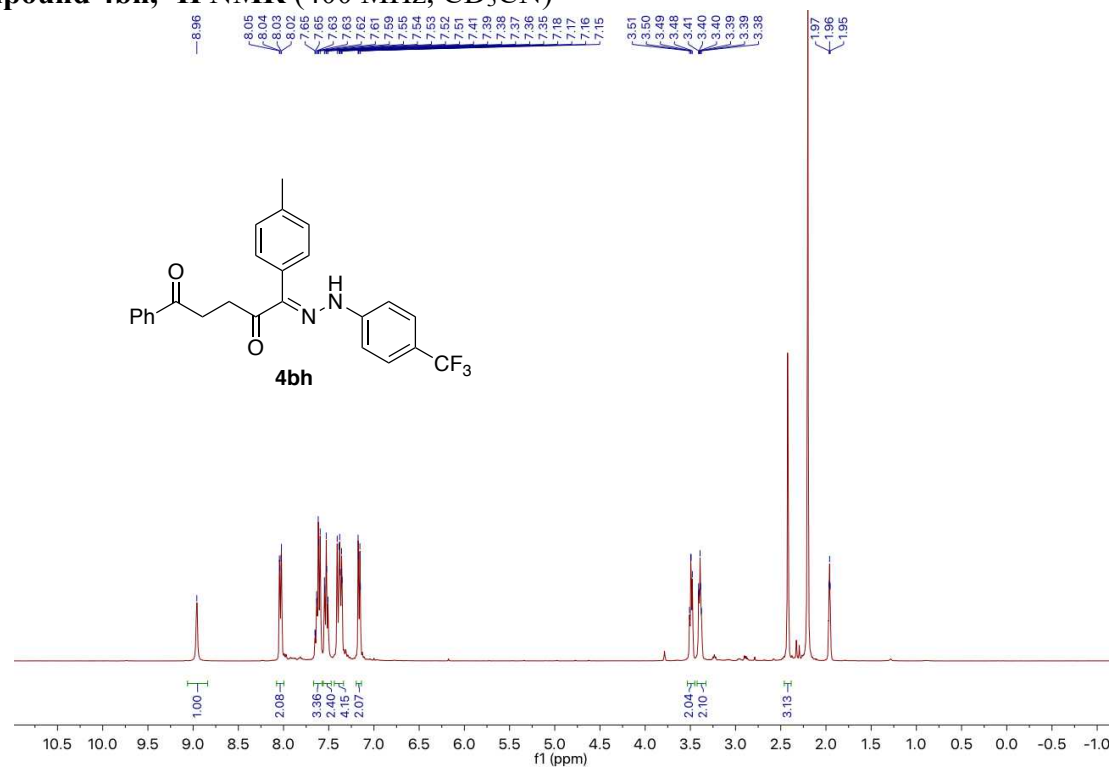
Compound 4bg, ^{13}C NMR (101 MHz, CD_3CN)



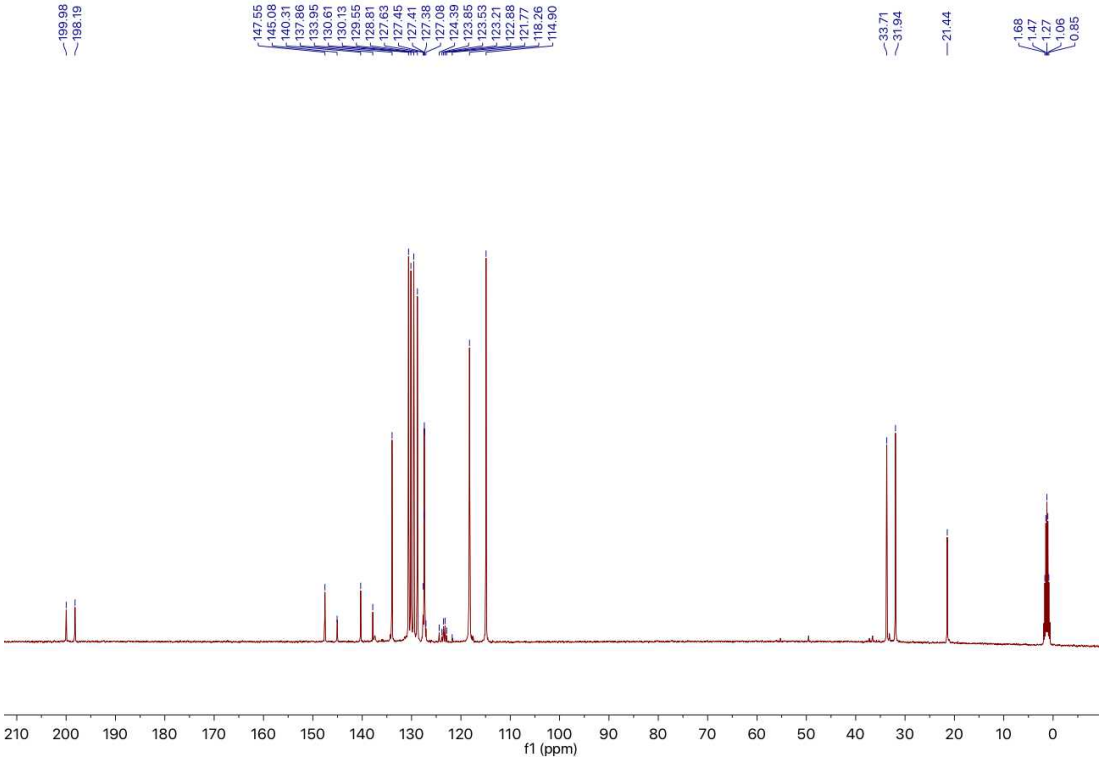
Compound 4bg ^{19}F NMR (565 MHz, CD_3CN)



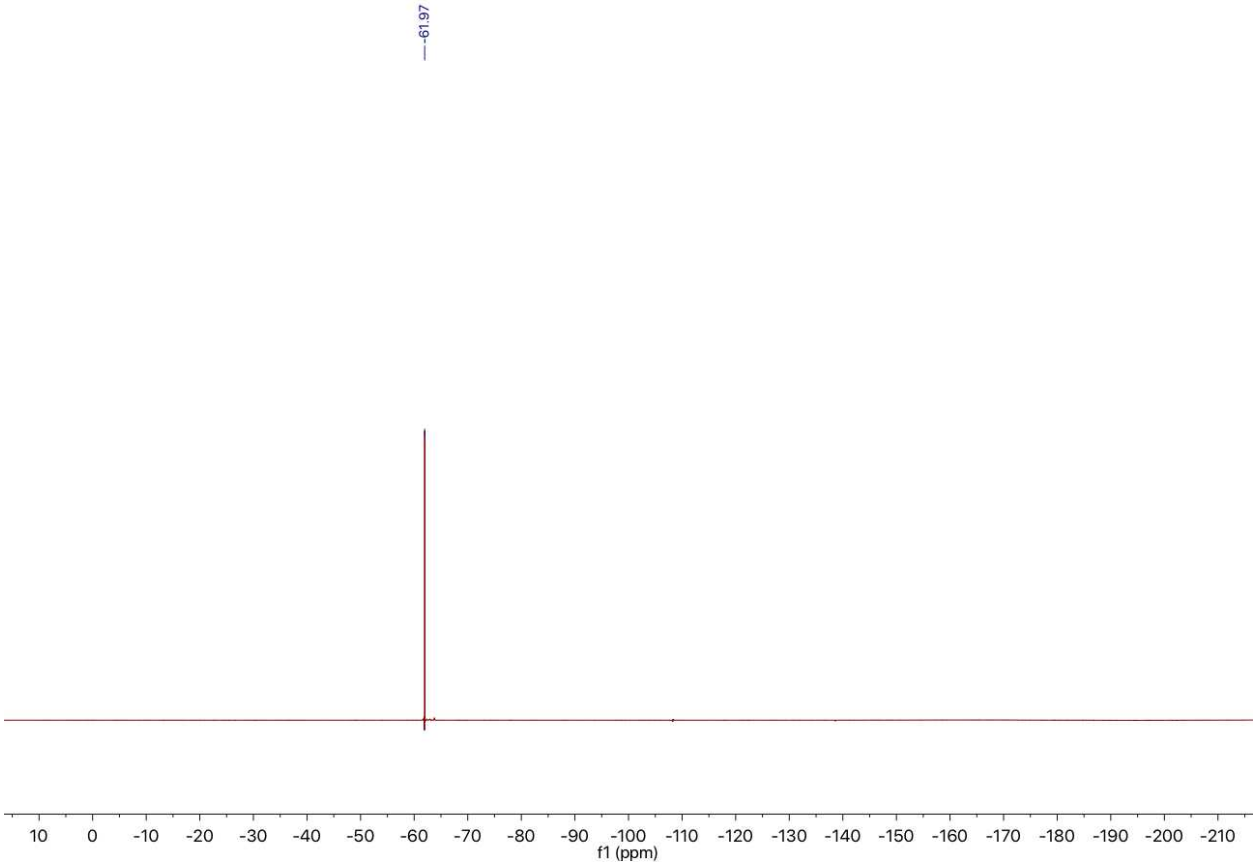
Compound 4bh, ^{1}H NMR (400 MHz, CD_3CN)



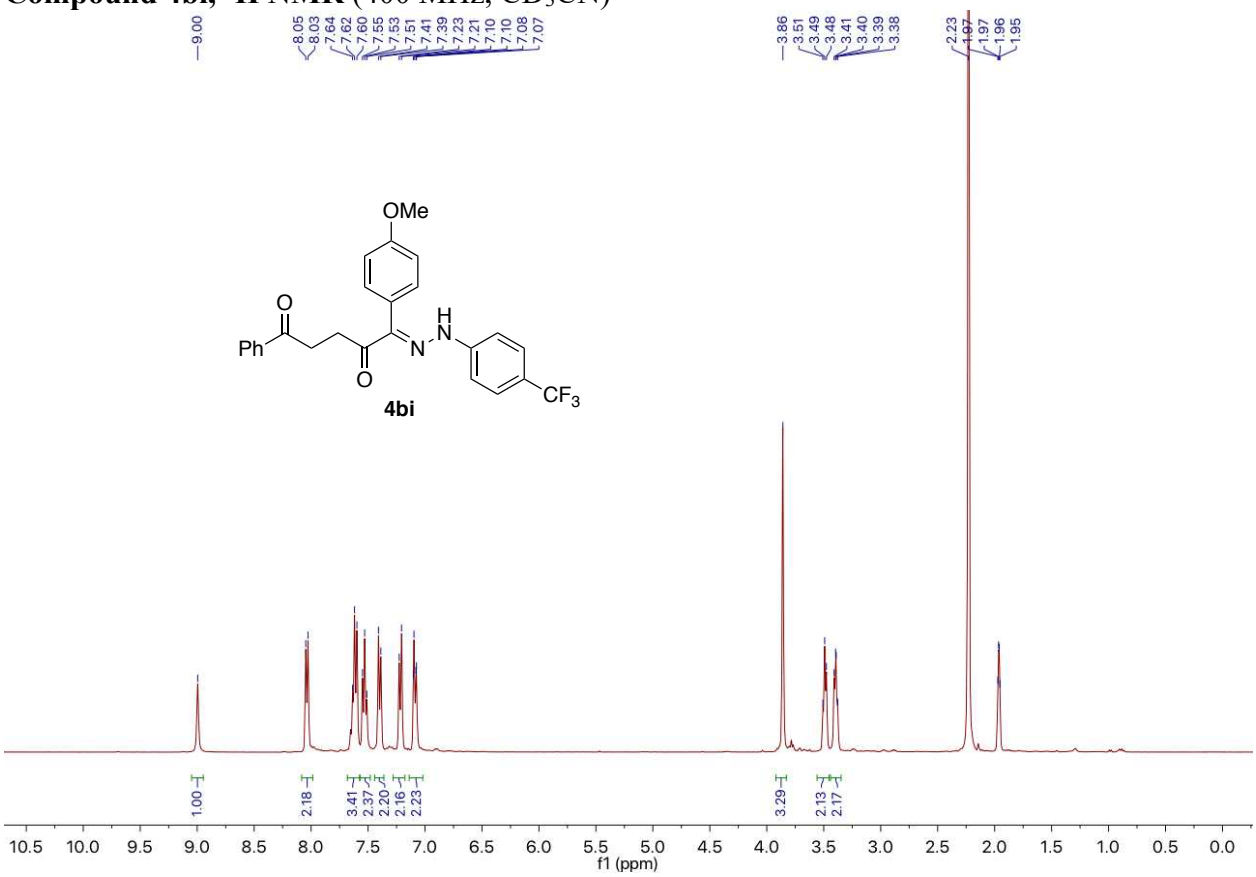
Compound 4bh, ^{13}C NMR (101 MHz, CD_3CN)



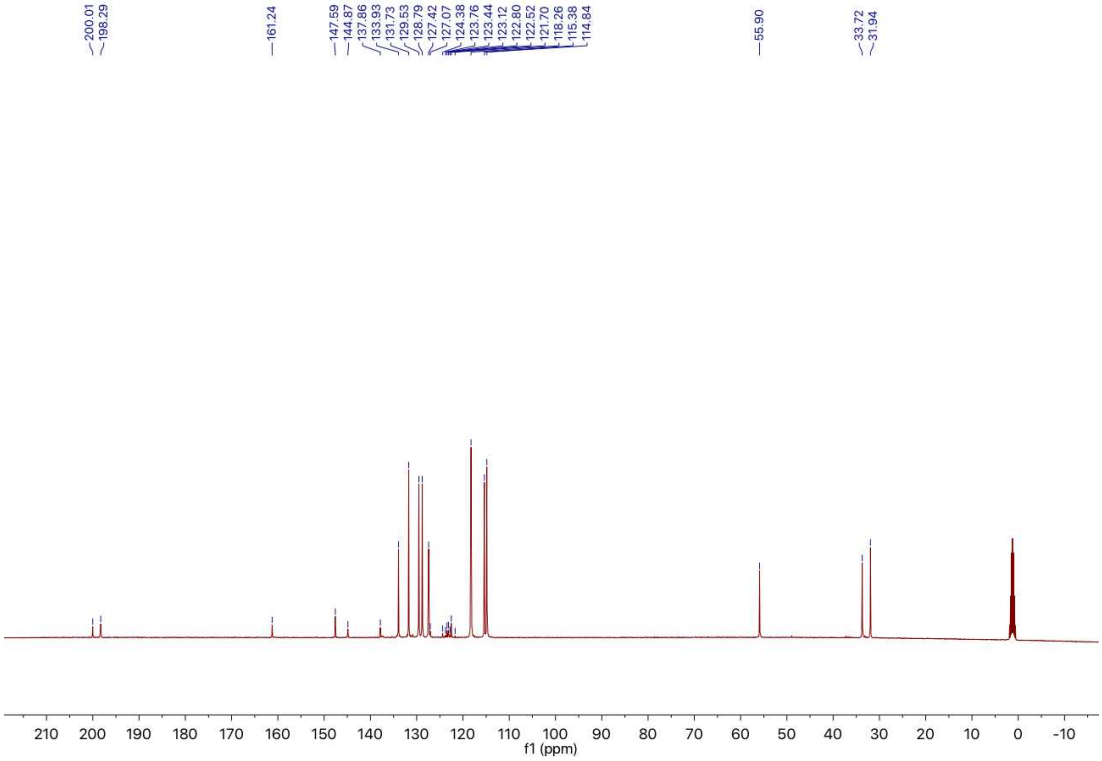
Compound 4bh ^{19}F NMR (565 MHz, CD_3CN)



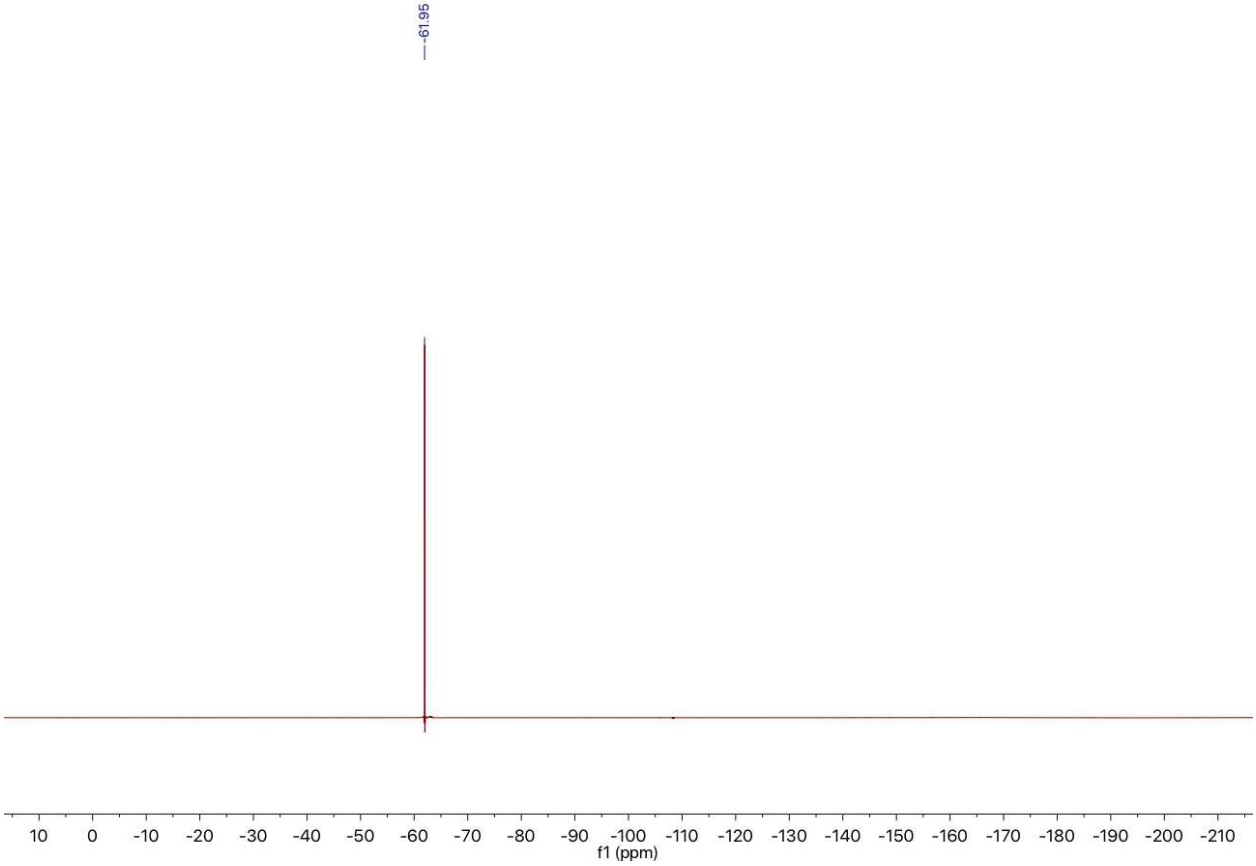
Compound 4bi, ^{1}H NMR (400 MHz, CD_3CN)



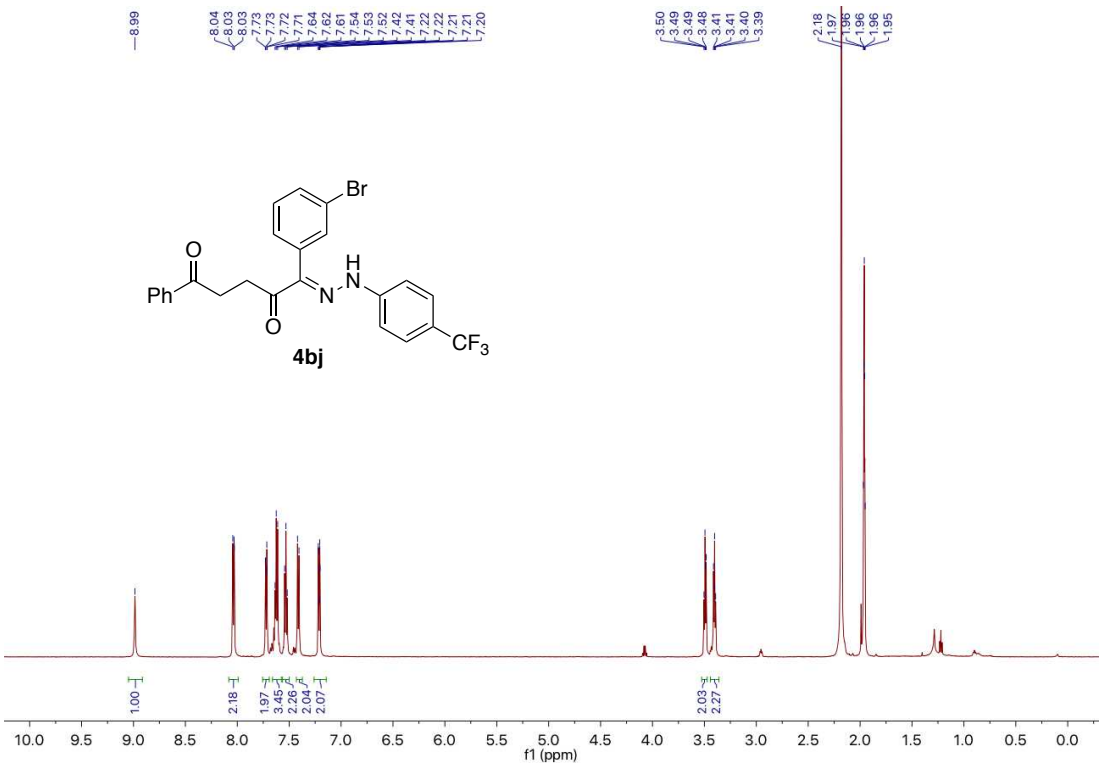
Compound 4bi, ^{13}C NMR (101 MHz, CD_3CN)



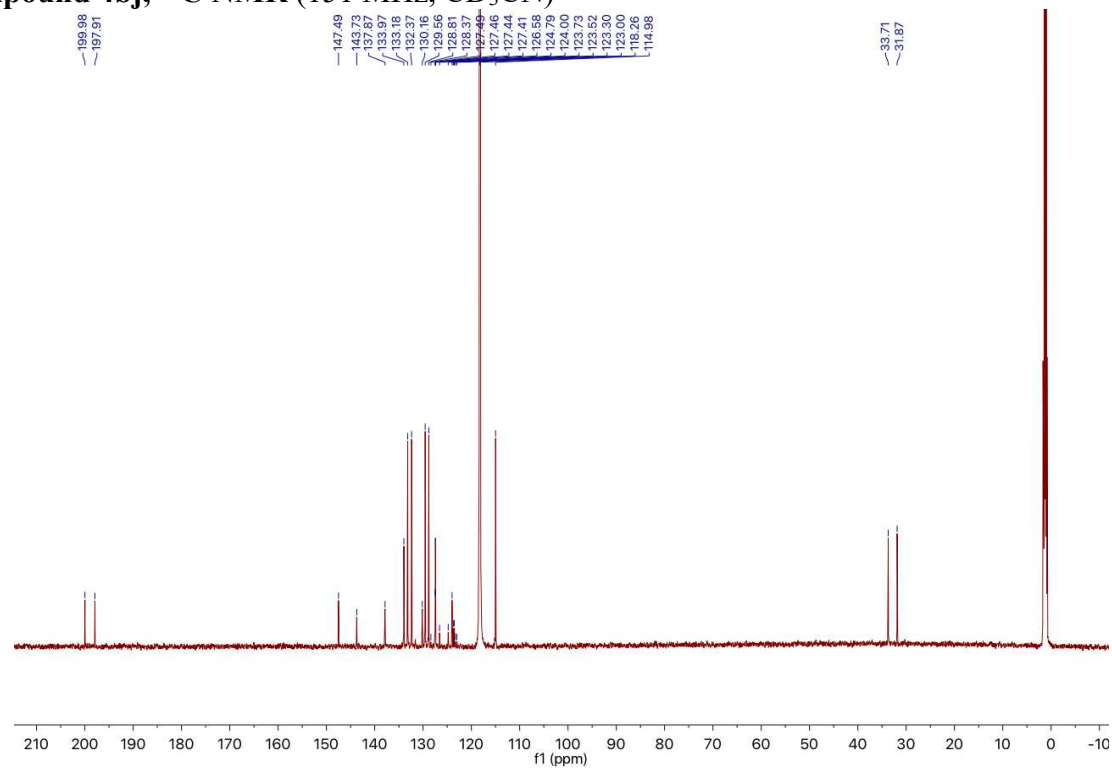
Compound 4bi ^{19}F NMR (565 MHz, CD_3CN)



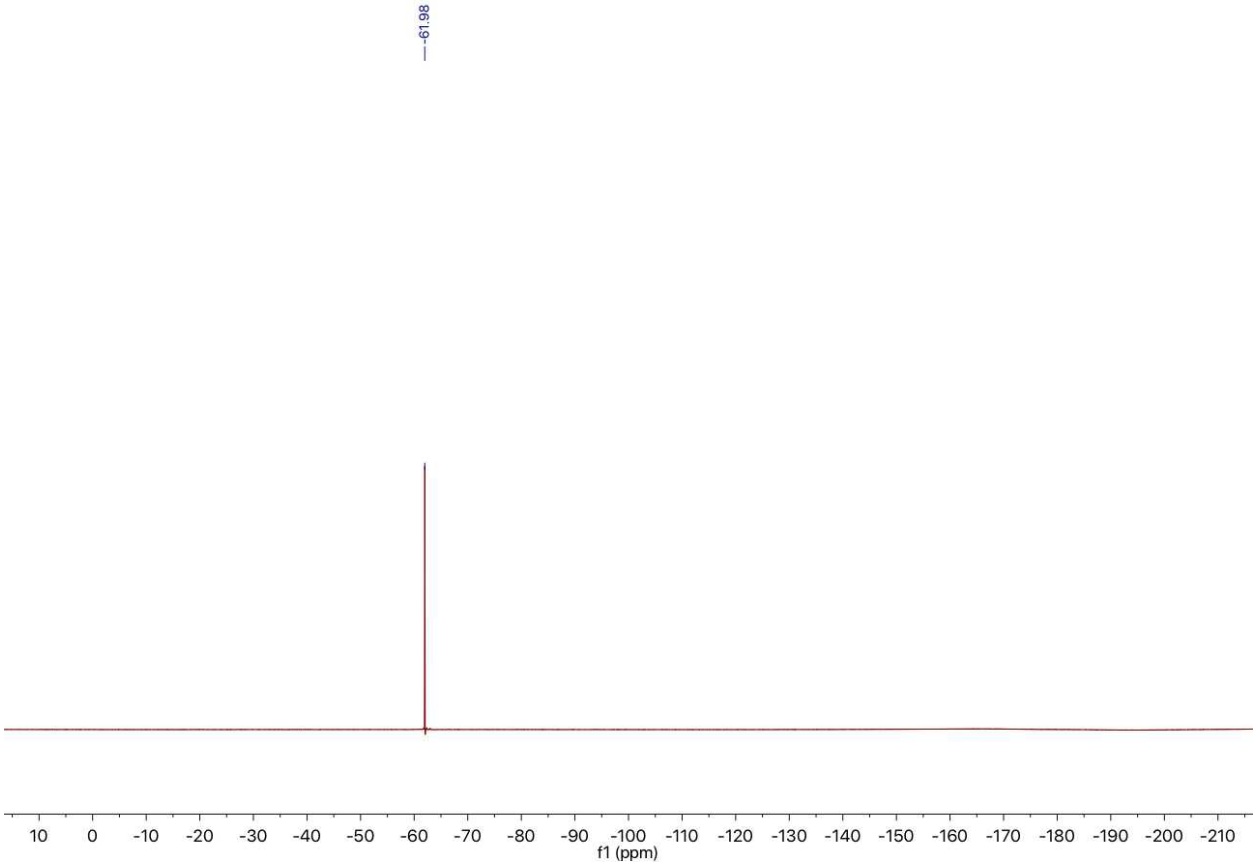
Compound 4bj, ^{1}H NMR (600 MHz, CD_3CN)



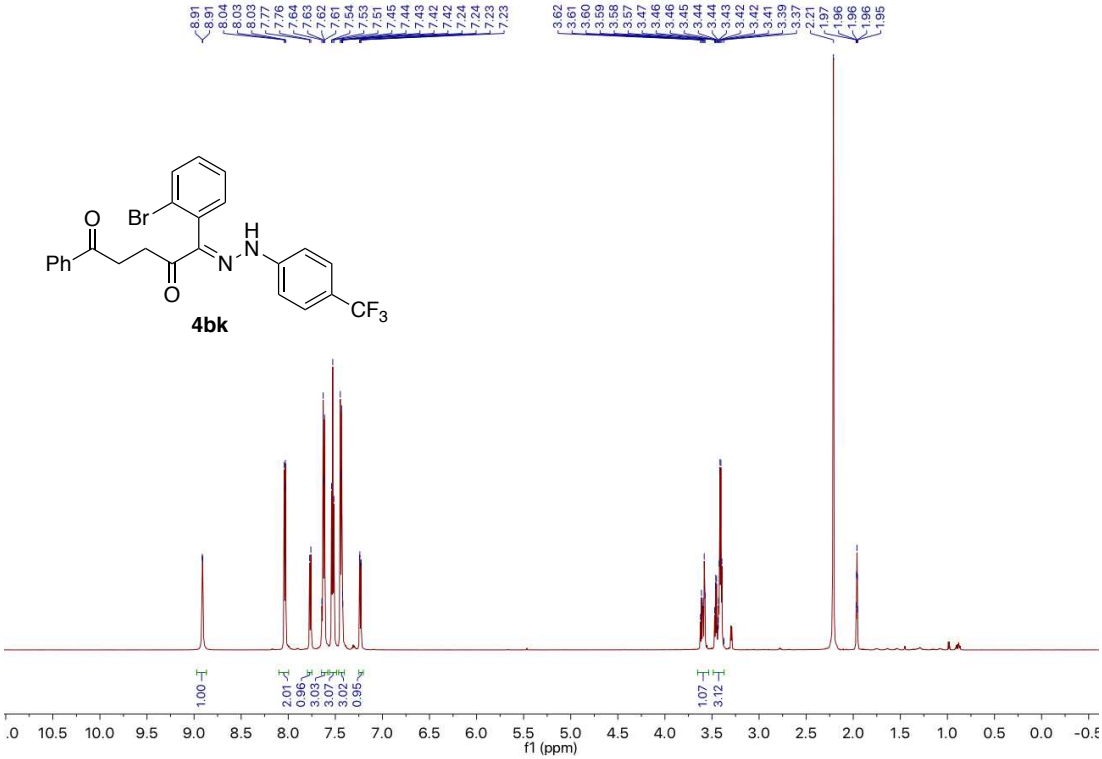
Compound 4bj, ^{13}C NMR (151 MHz, CD_3CN)



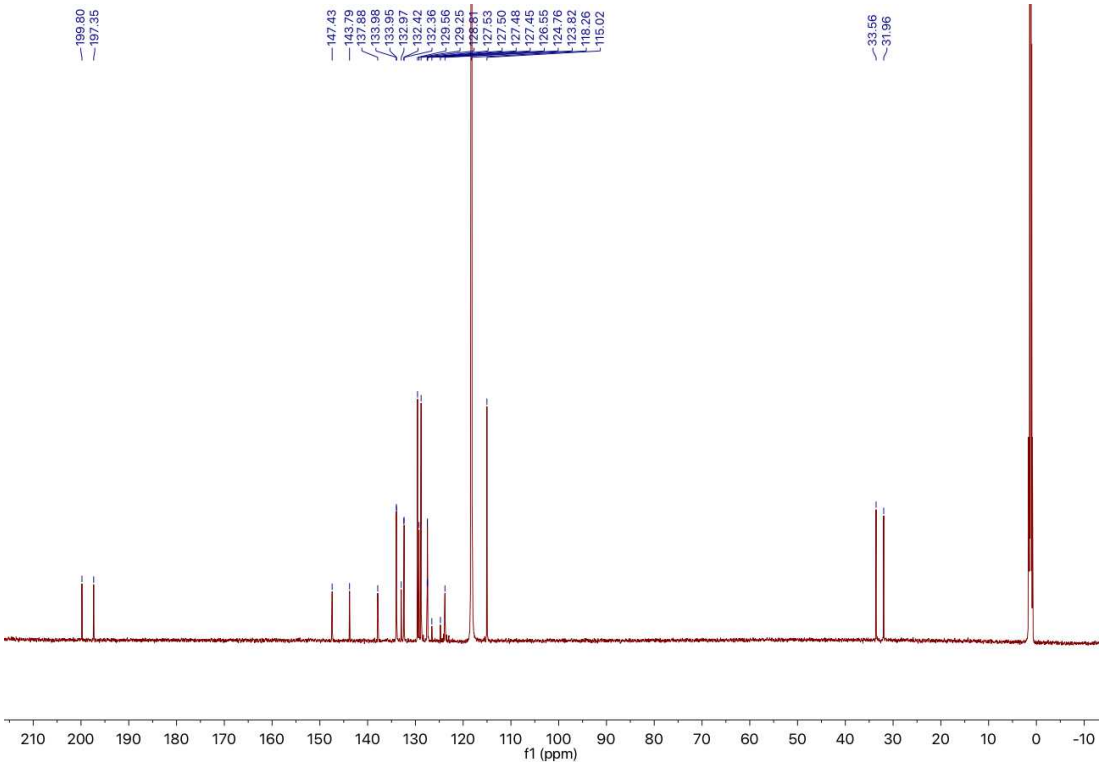
Compound 4bj ^{19}F NMR (565 MHz, CD_3CN)



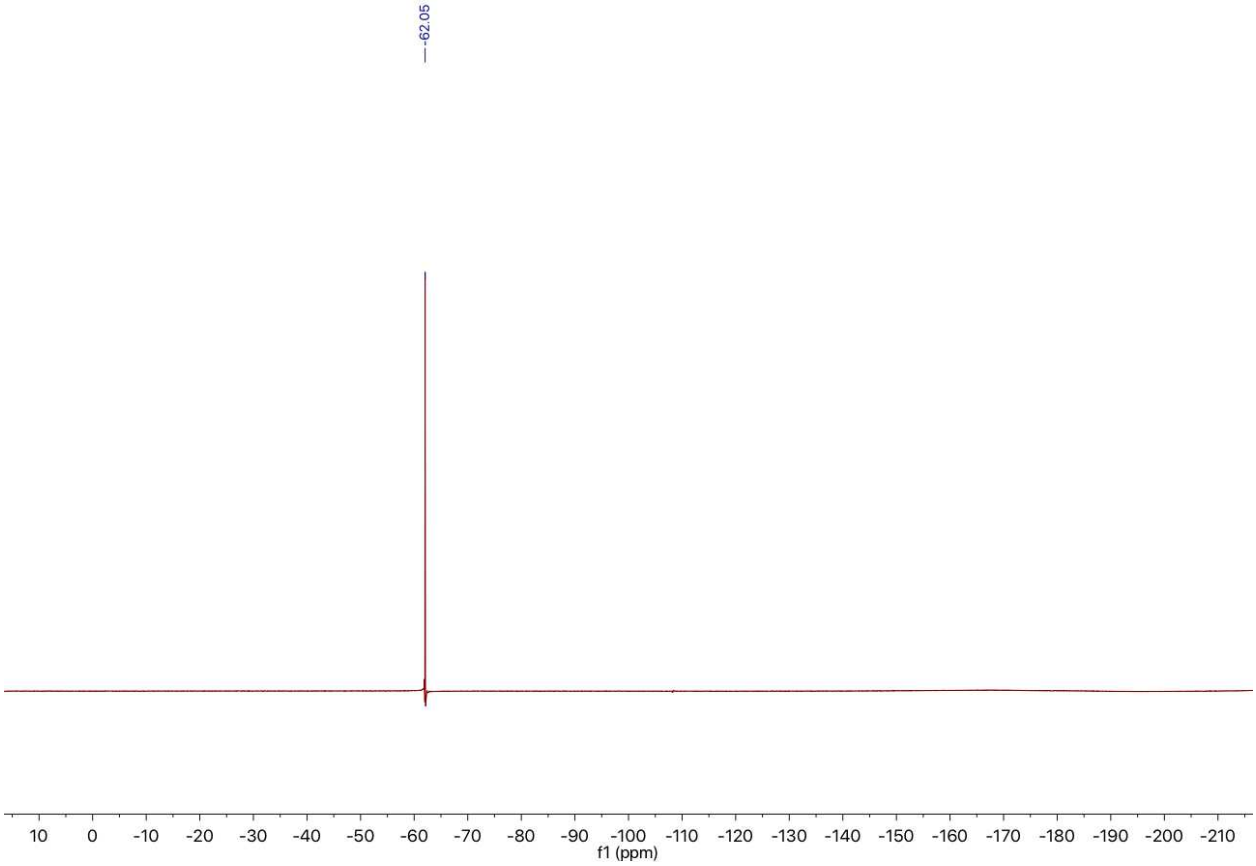
Compound 4bk, ^{1}H NMR (600 MHz, CD_3CN)



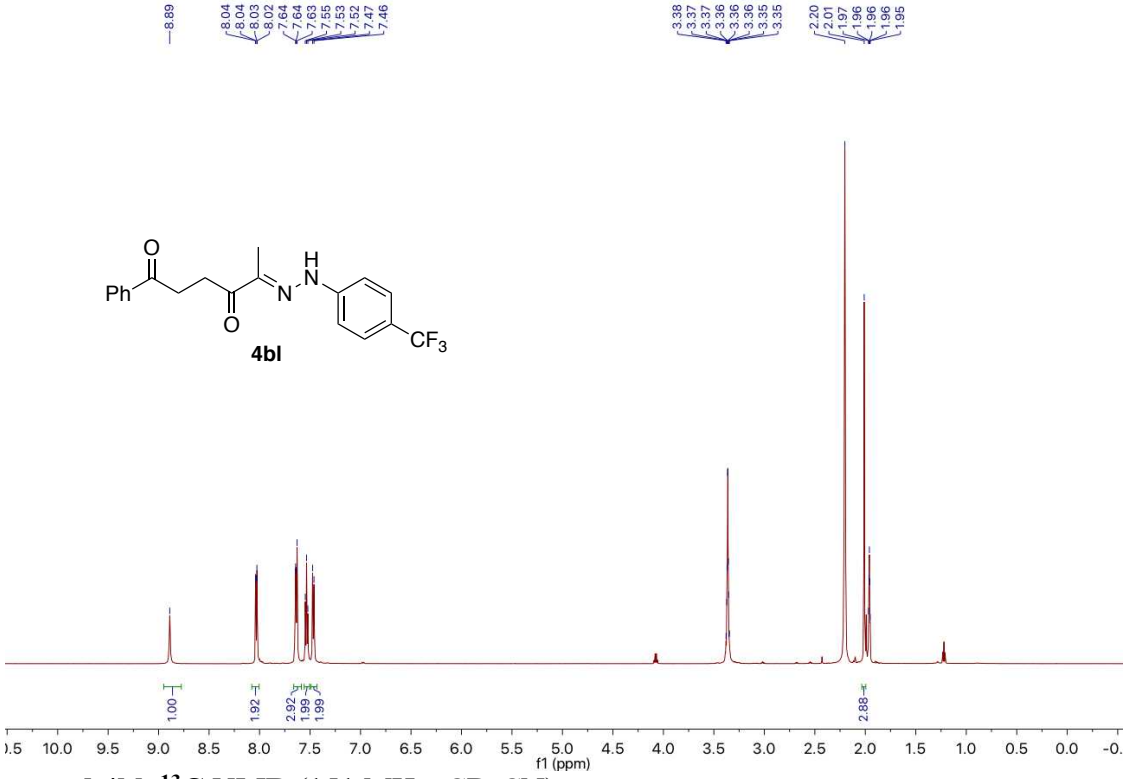
Compound 4bk, ^{13}C NMR (151 MHz, CD_3CN)



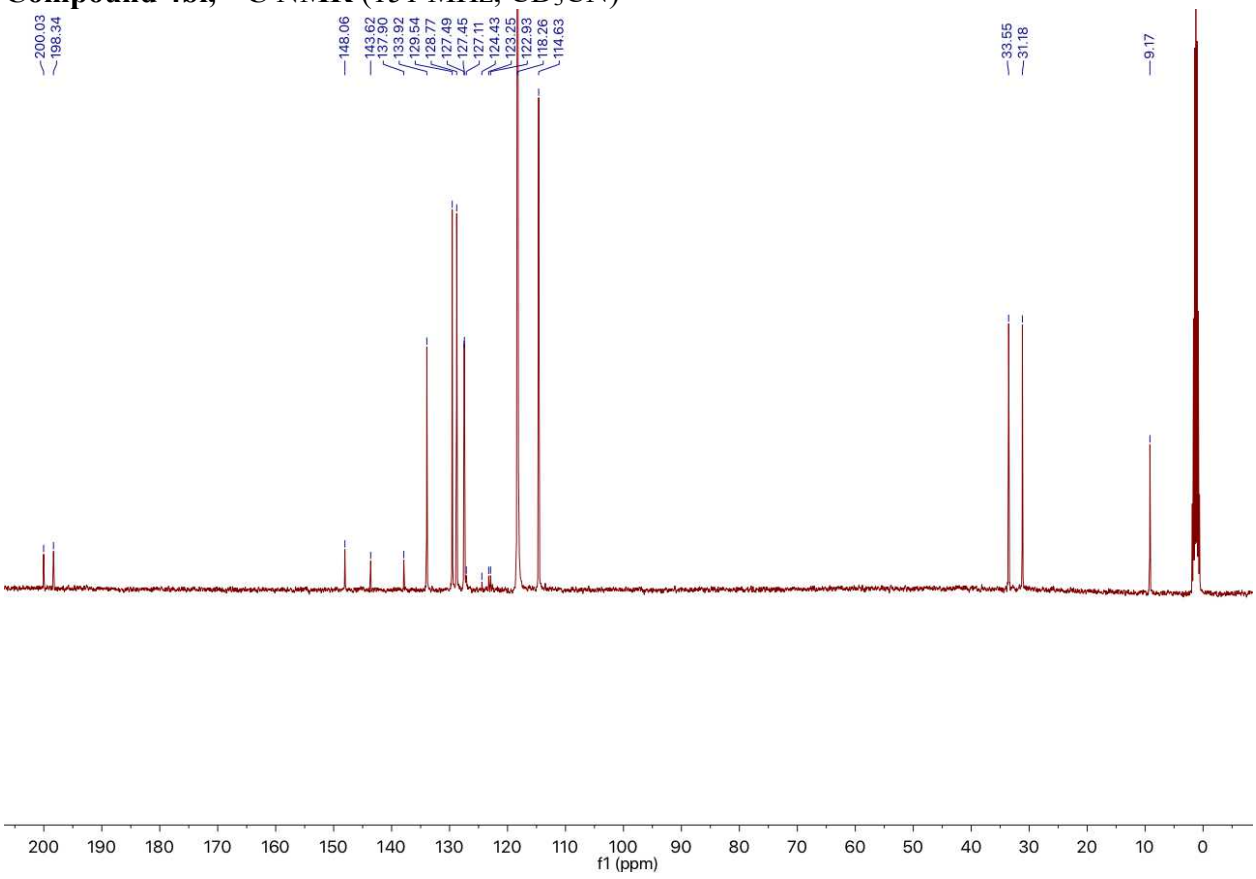
Compound 4bk ^{19}F NMR (565 MHz, CD_3CN)



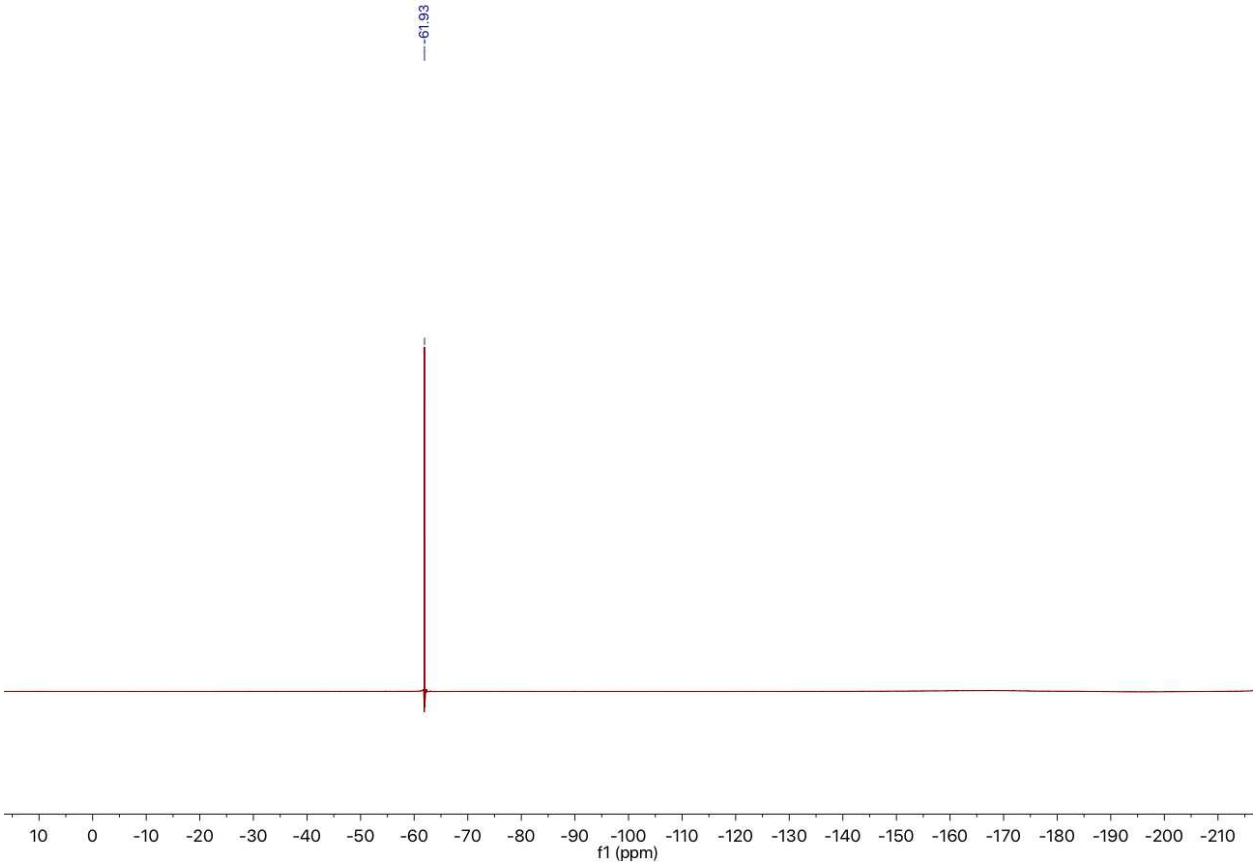
Compound 4bl, ^{1}H NMR (600 MHz, CD_3CN)



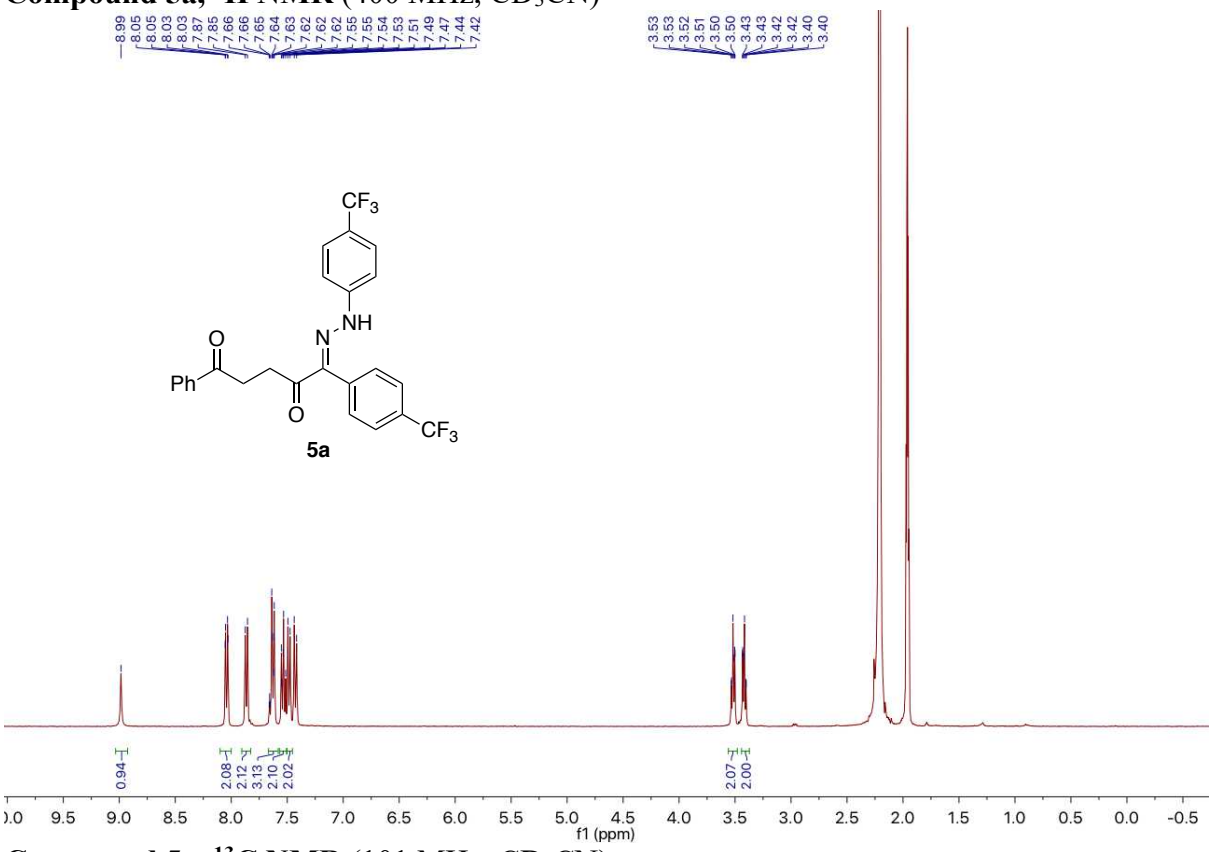
Compound 4bl, ^{13}C NMR (151 MHz, CD_3CN)



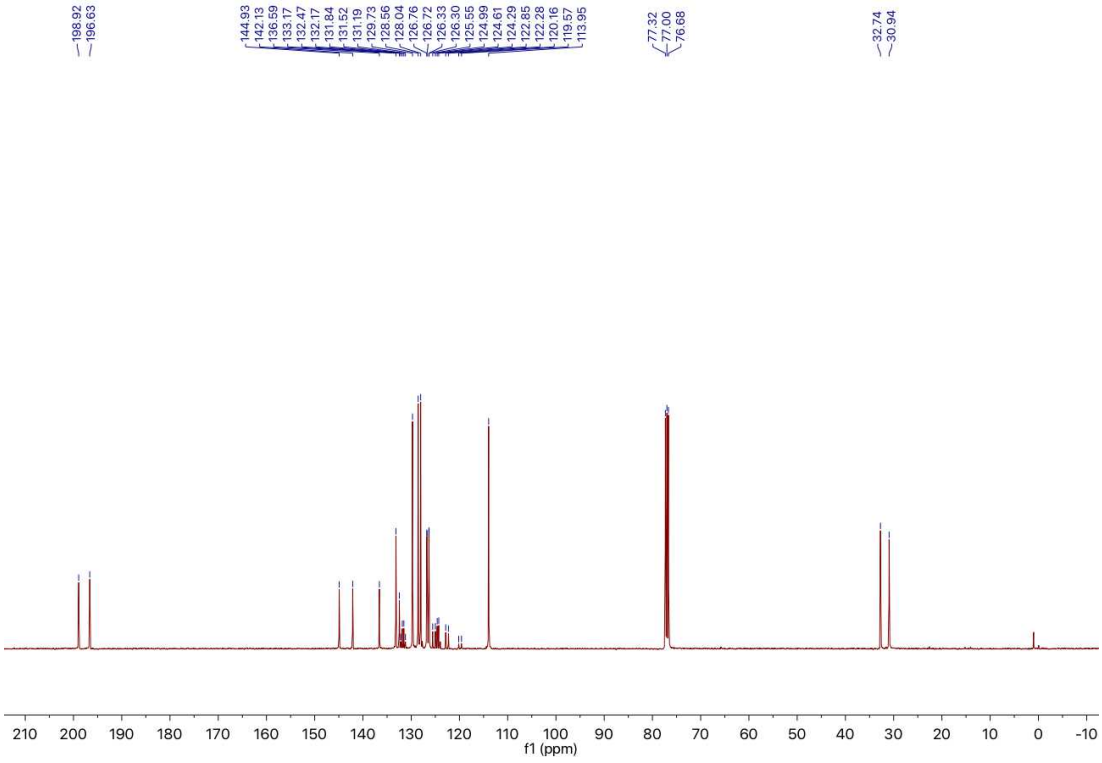
Compound 4bl ^{19}F NMR (565 MHz, CD_3CN)



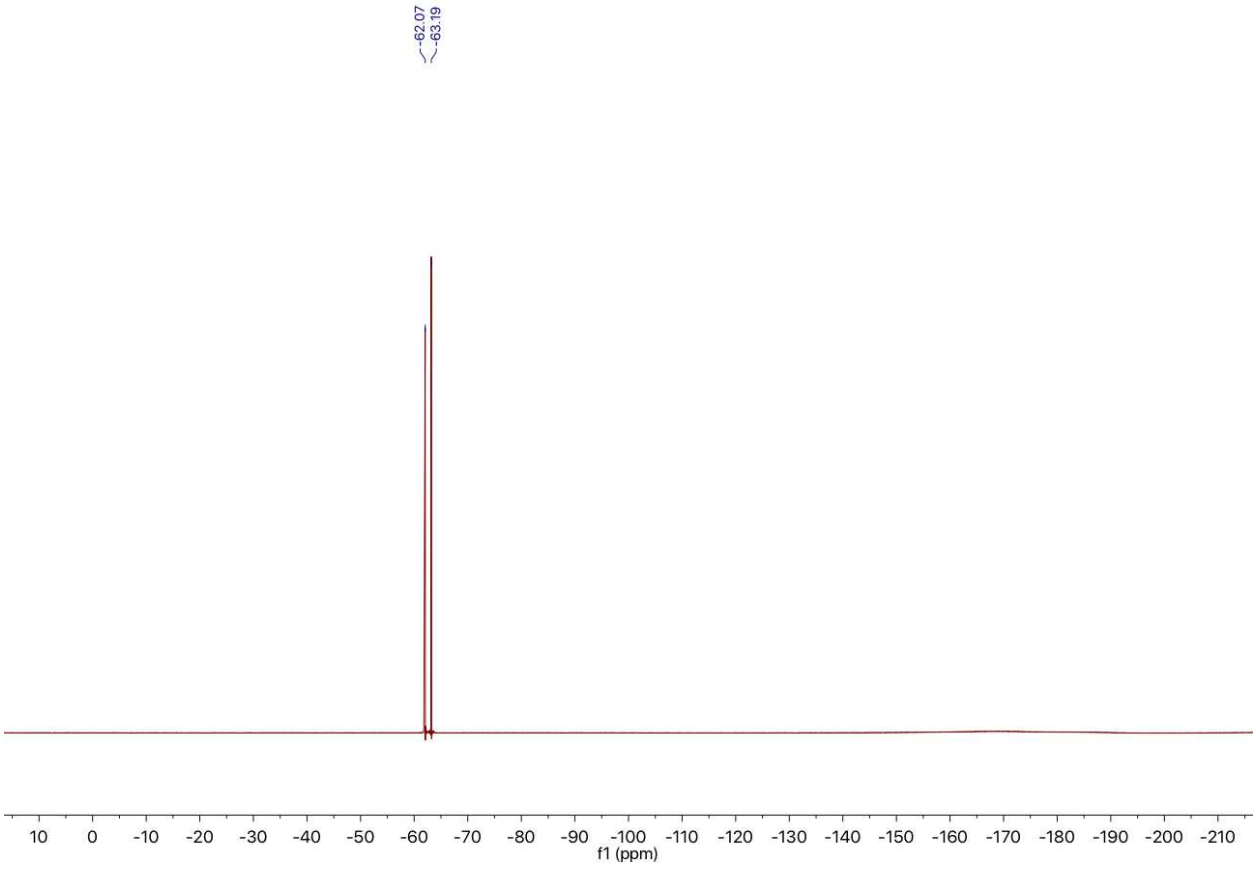
Compound 5a, ^{1}H NMR (400 MHz, CD_3CN)



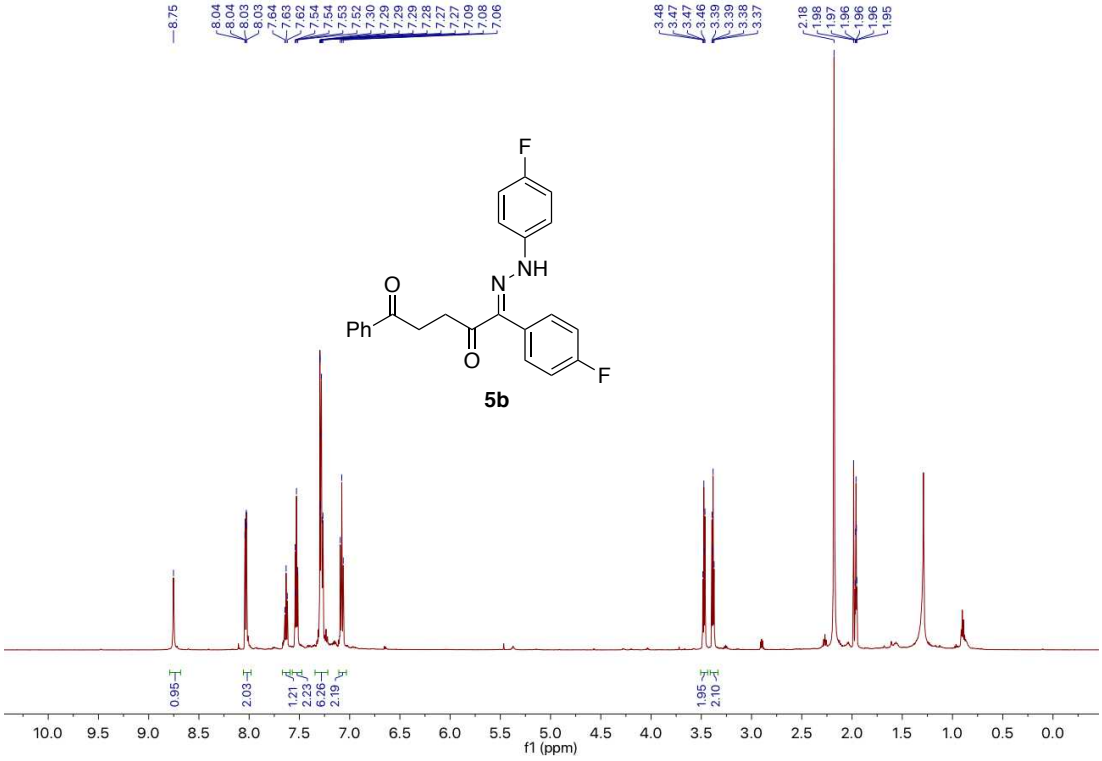
Compound 5a, ^{13}C NMR (101 MHz, CD_3CN)



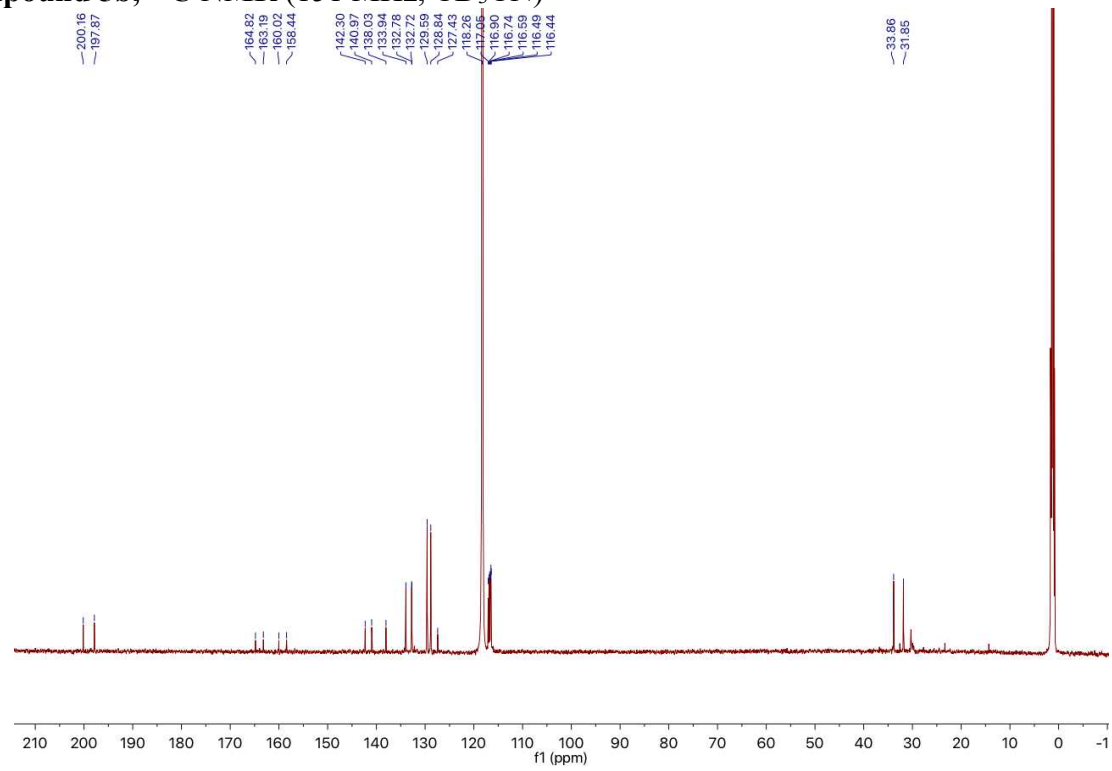
Compound 5a ^{19}F NMR (565 MHz, CD_3CN)



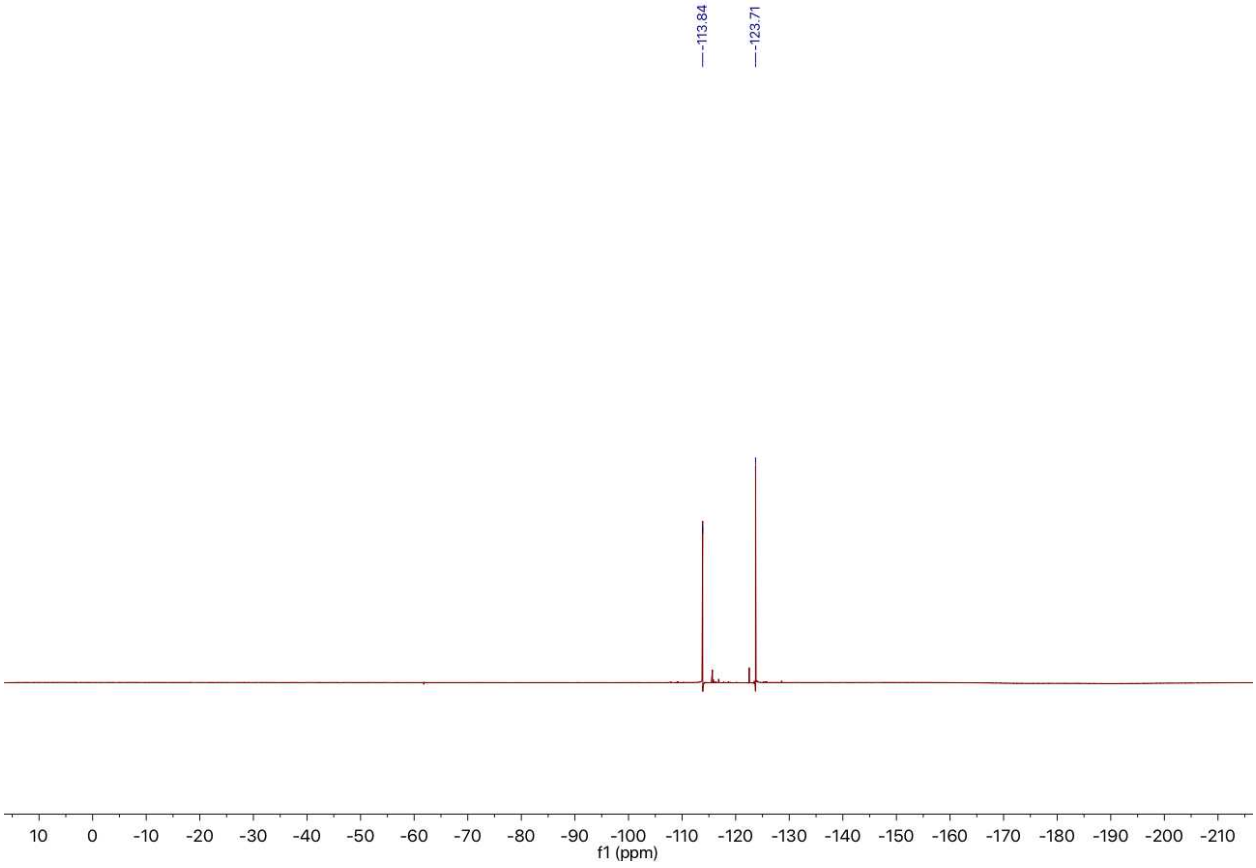
Compound 5b, ^{1}H NMR (600 MHz, CD_3CN)



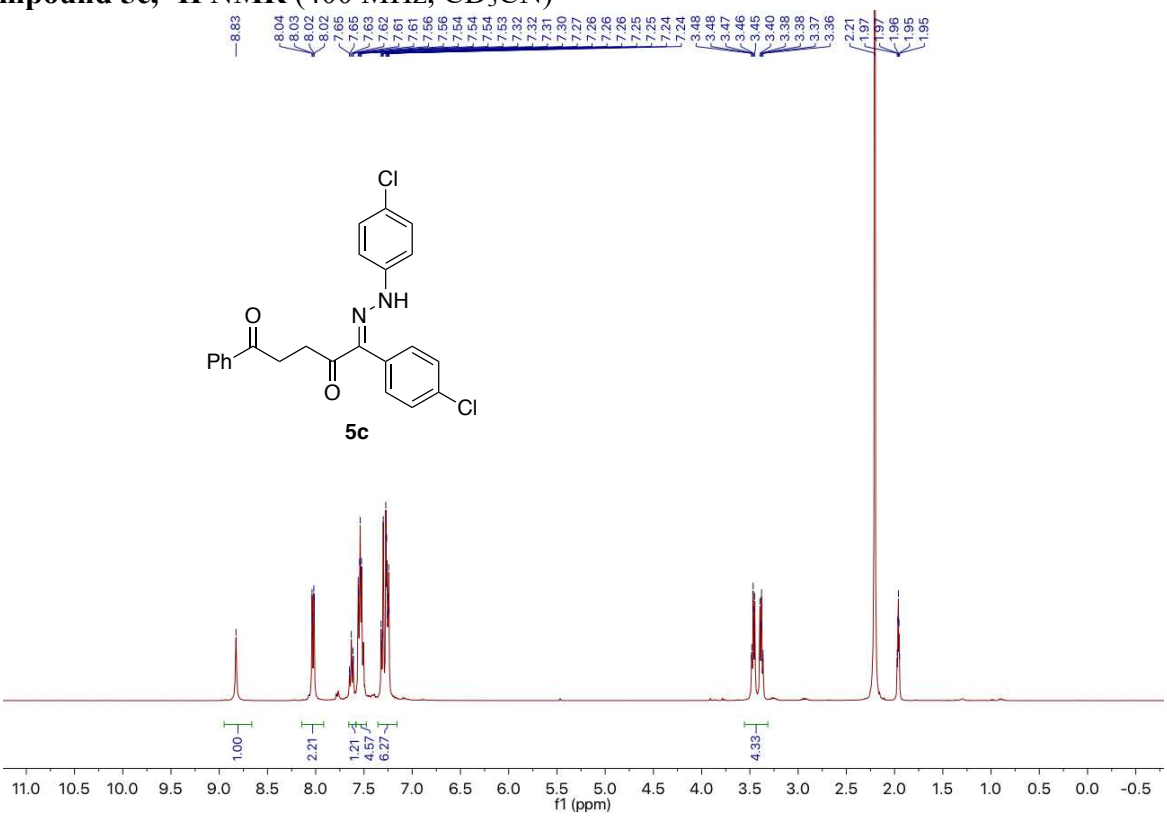
Compound 5b, ^{13}C NMR (151 MHz, CD_3CN)



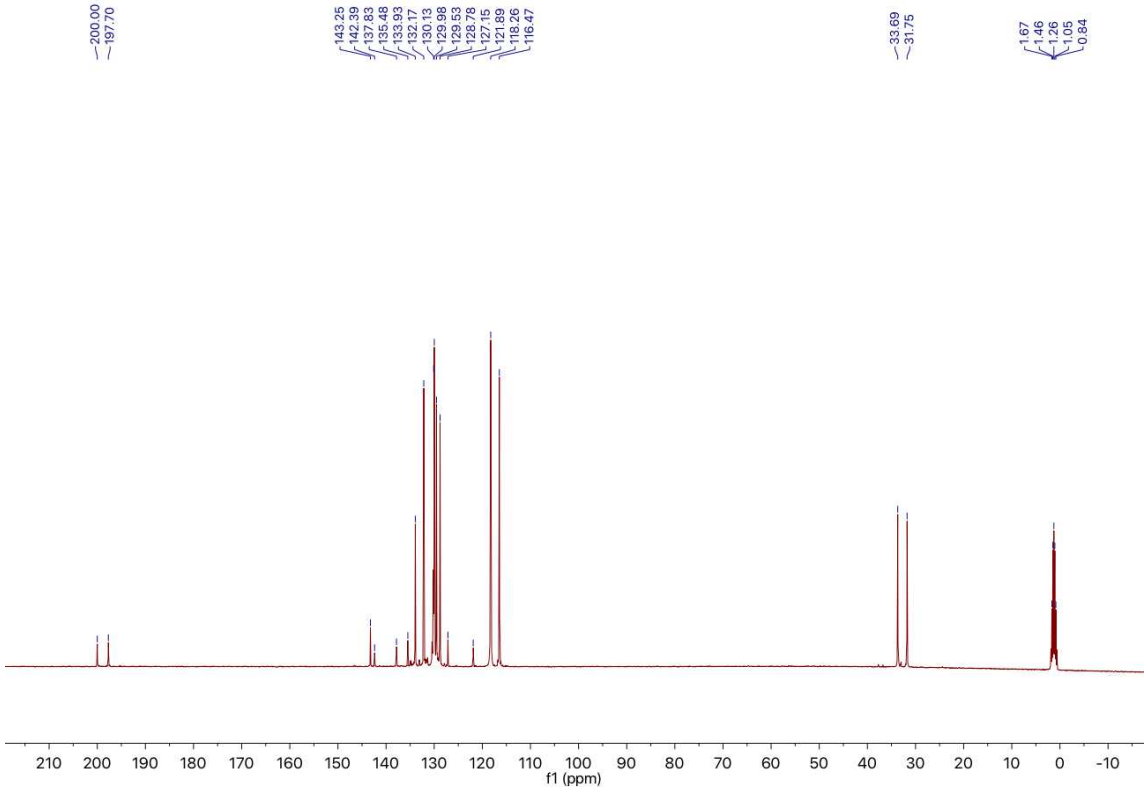
Compound 5b ^{19}F NMR (565 MHz, CD_3CN)



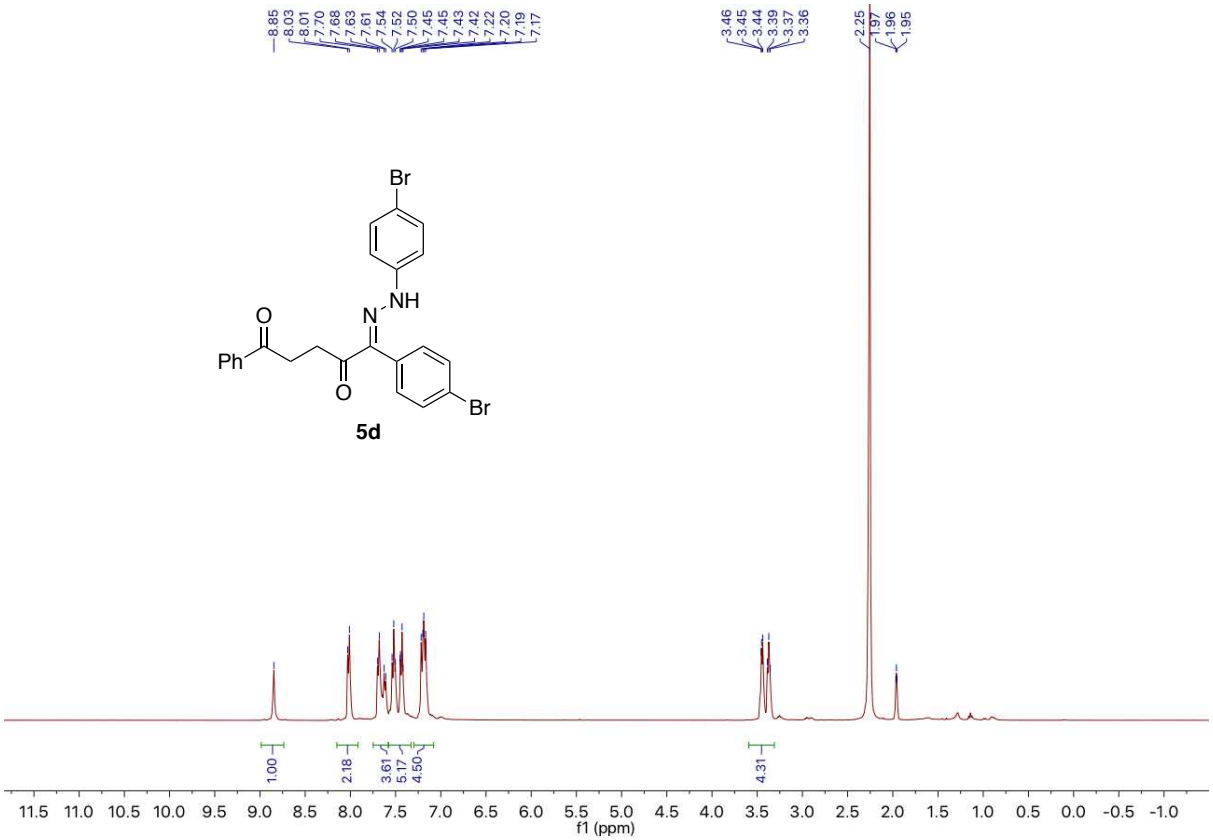
Compound 5c, ^{1}H NMR (400 MHz, CD_3CN)



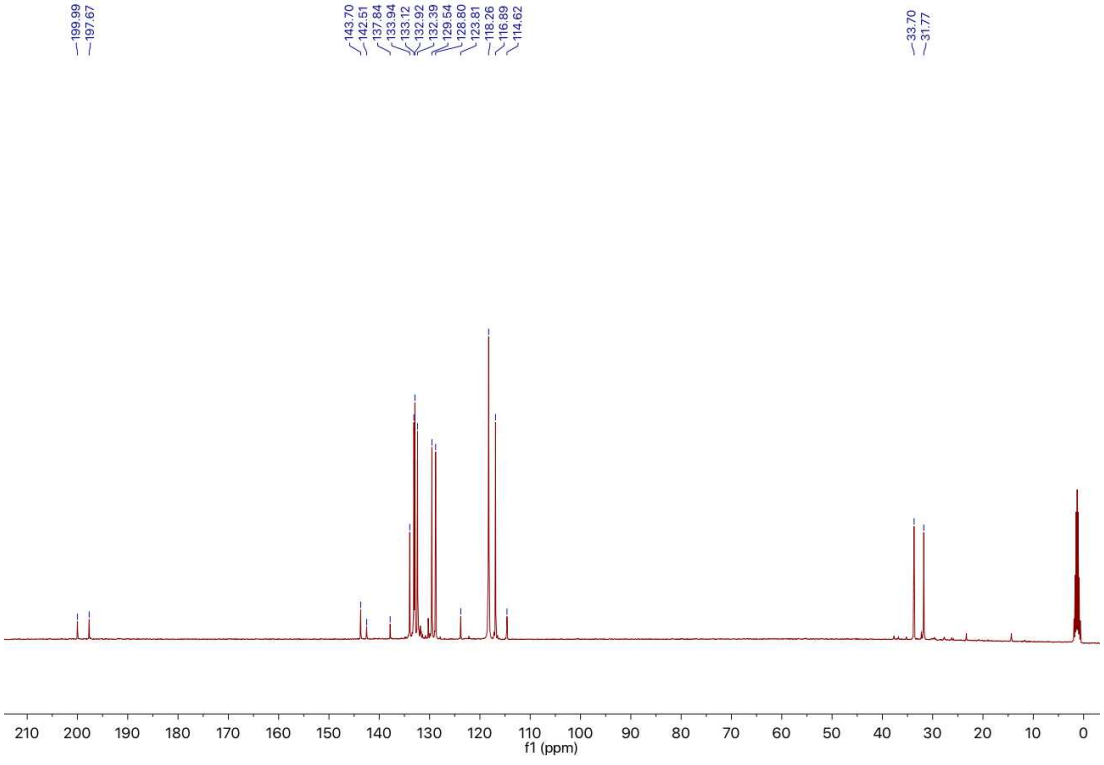
Compound 5c, ^{13}C NMR (101 MHz, CD_3CN)



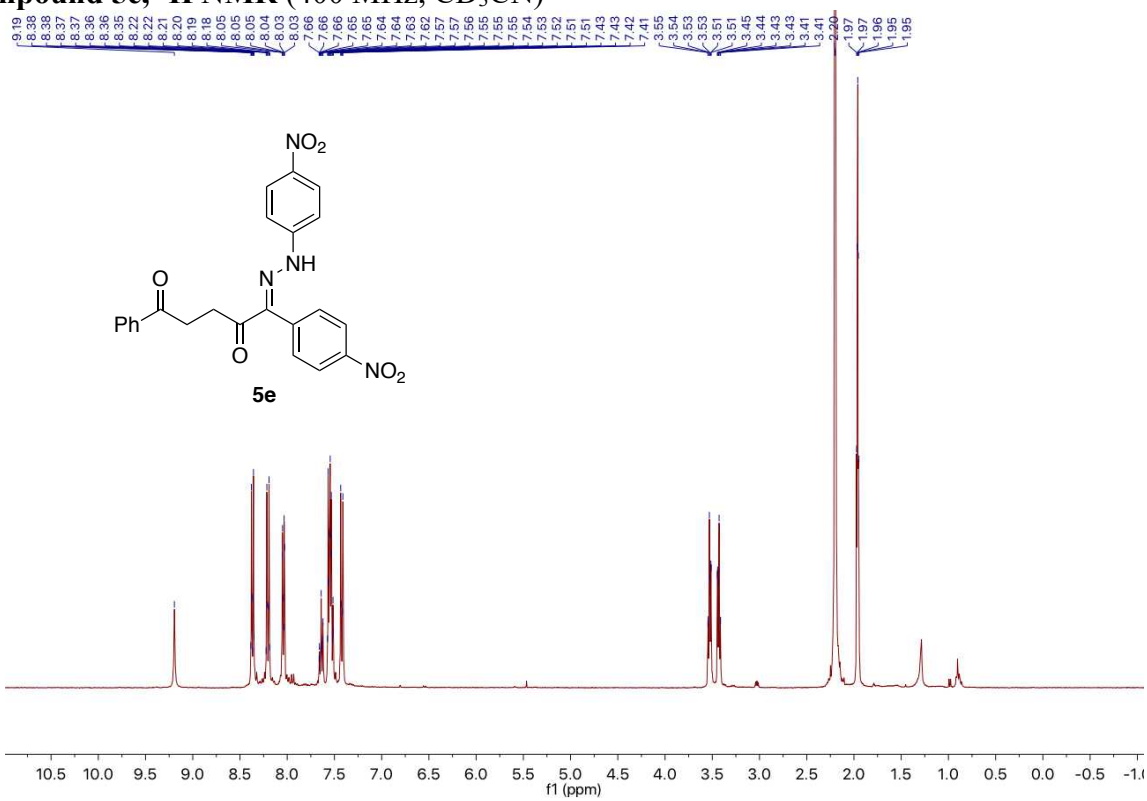
Compound 5d, ^{1}H NMR (400 MHz, CD_3CN)



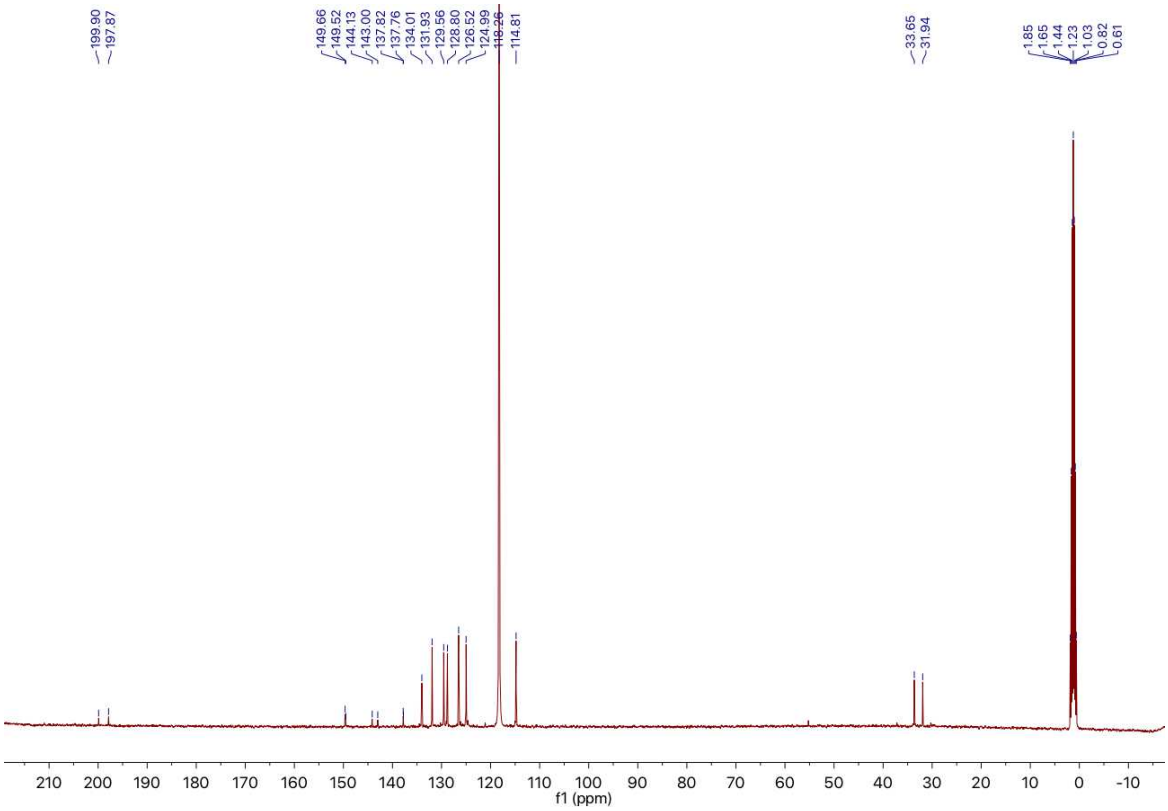
Compound 5d, ^{13}C NMR (101 MHz, CD_3CN)



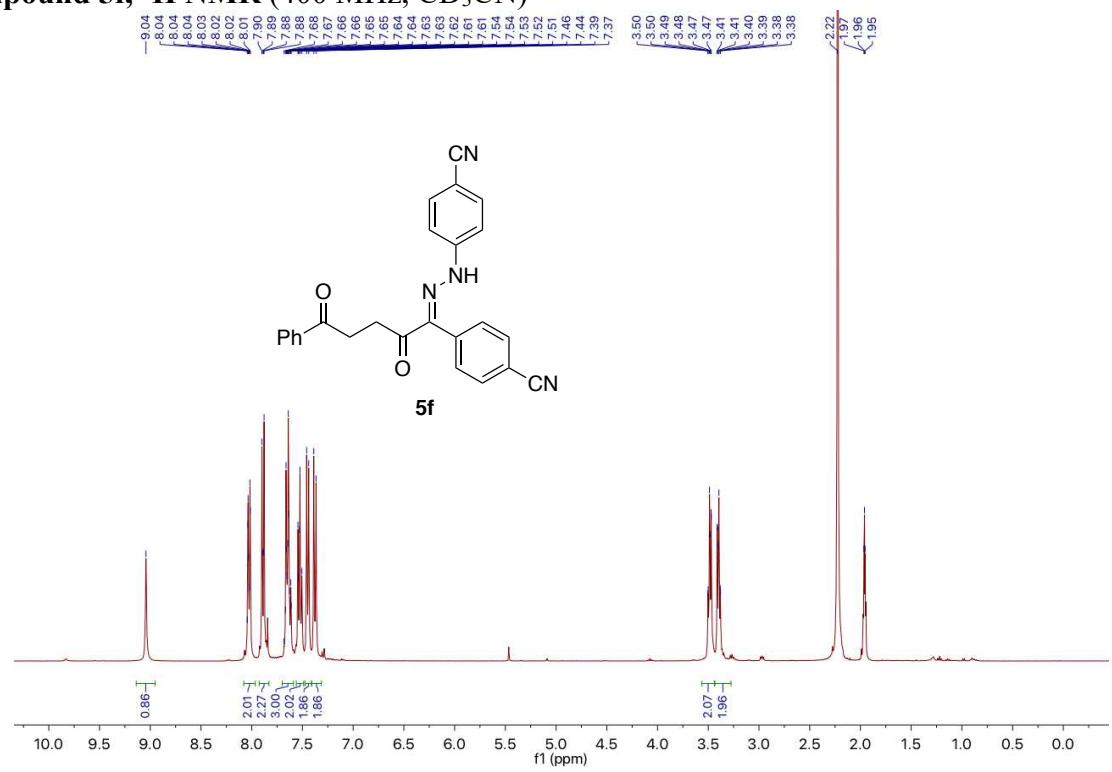
Compound 5e, ^{1}H NMR (400 MHz, CD_3CN)



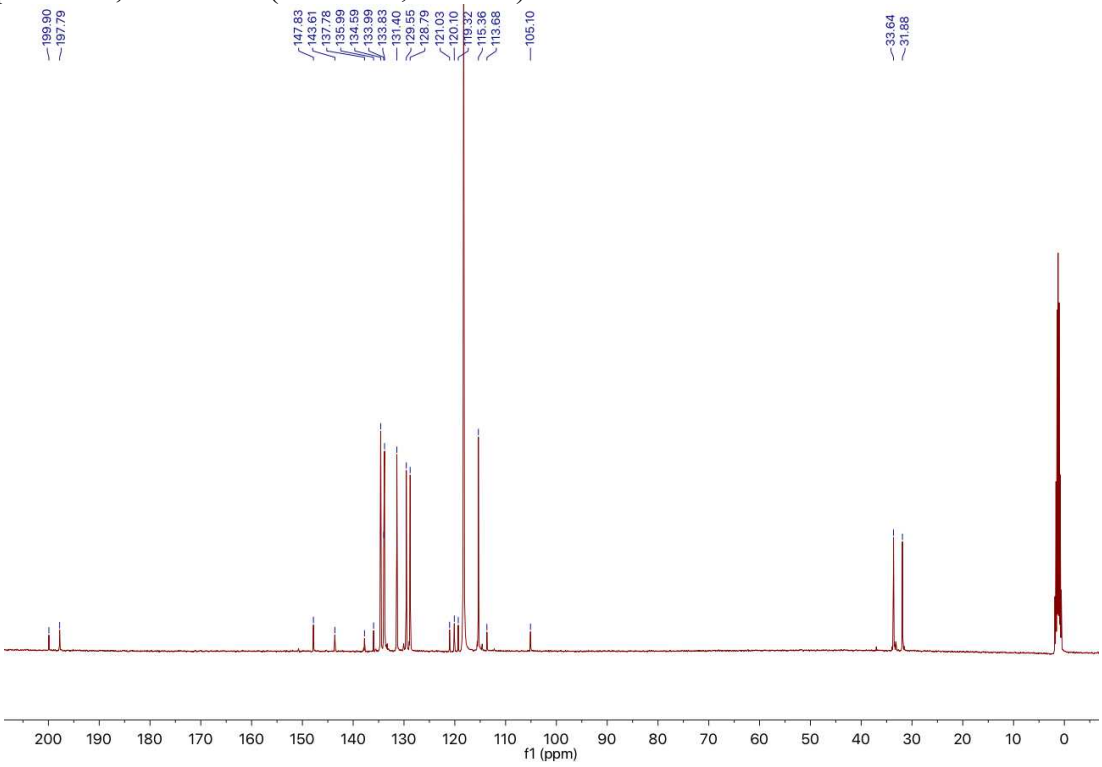
Compound 5e, ^{13}C NMR (101 MHz, CD_3CN)



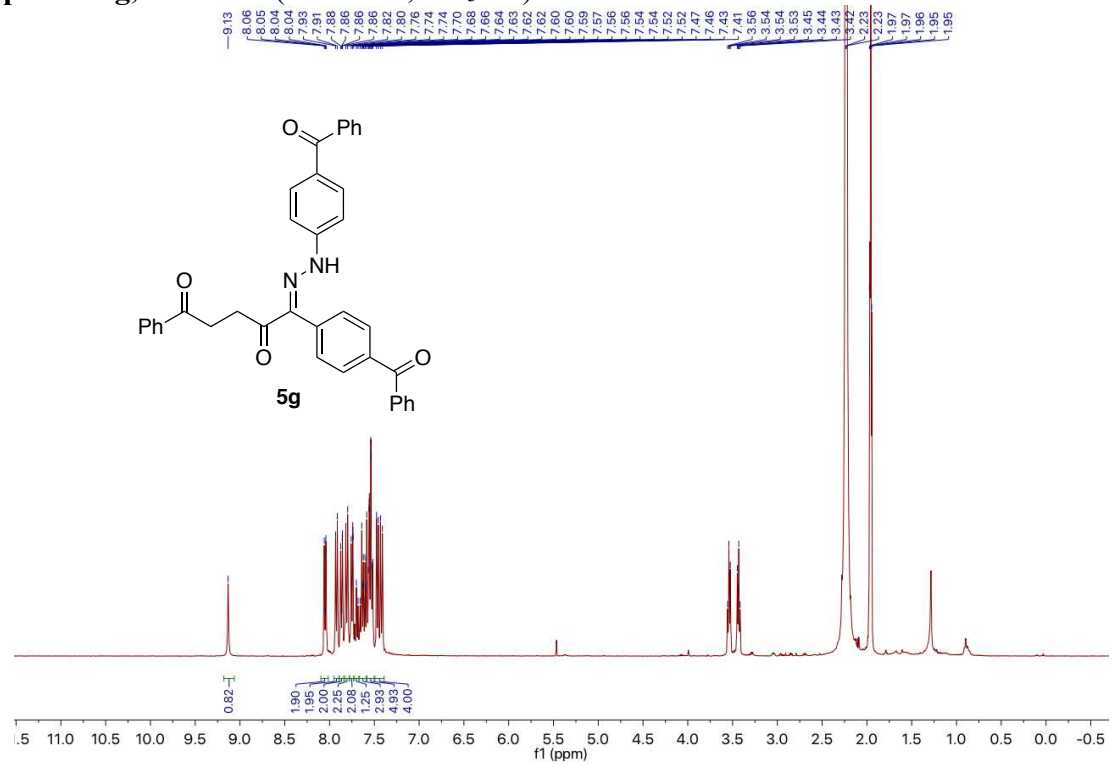
Compound 5f, ^{1}H NMR (400 MHz, CD_3CN)



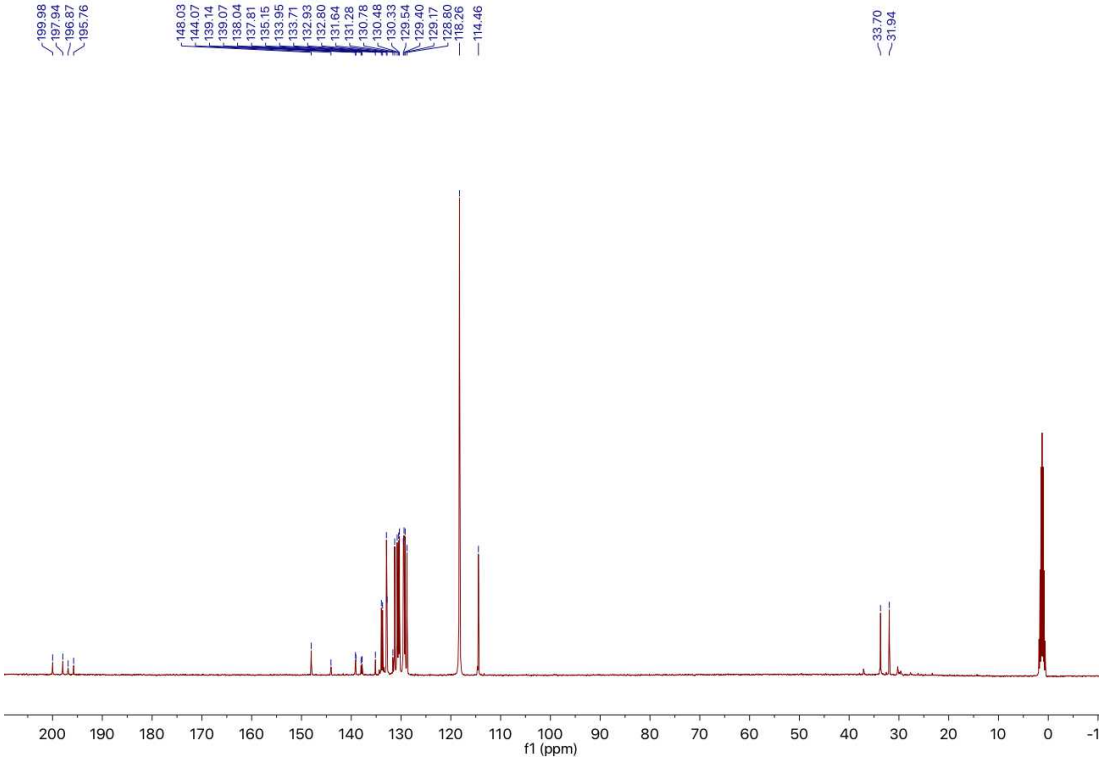
Compound 5f, ^{13}C NMR (101 MHz, CD_3CN)



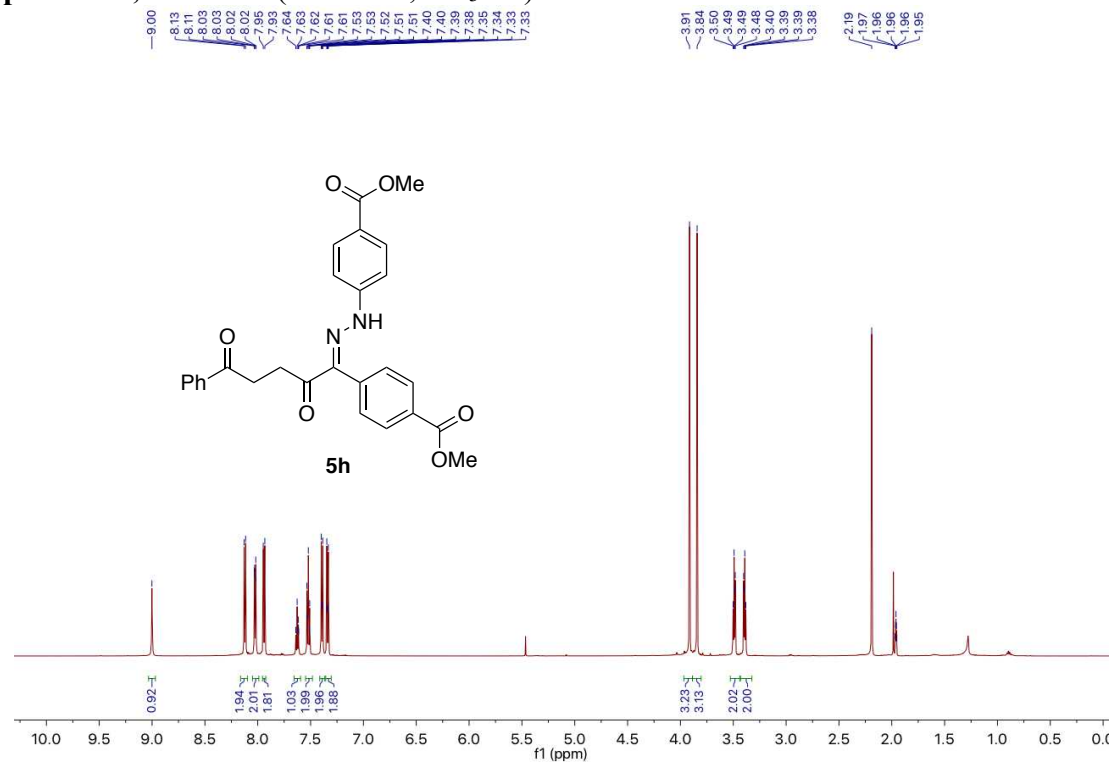
Compound 5g, ^{1}H NMR (400 MHz, CD_3CN)



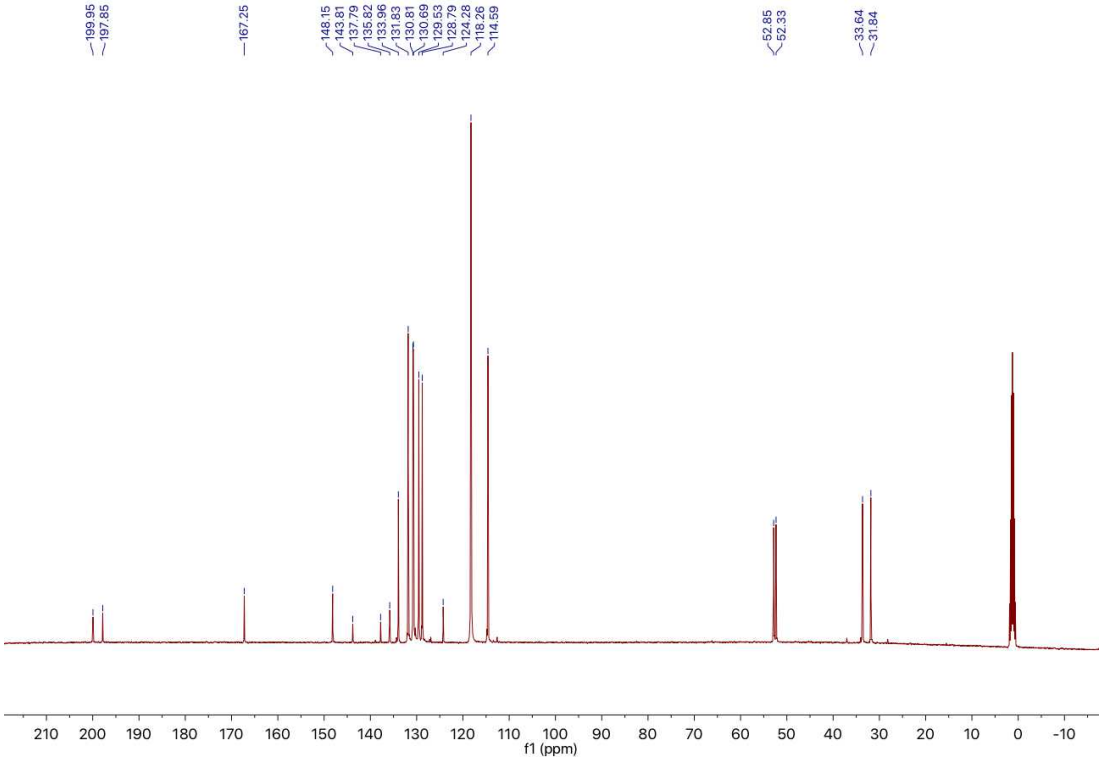
Compound 5g, ^{13}C NMR (101 MHz, CD_3CN)



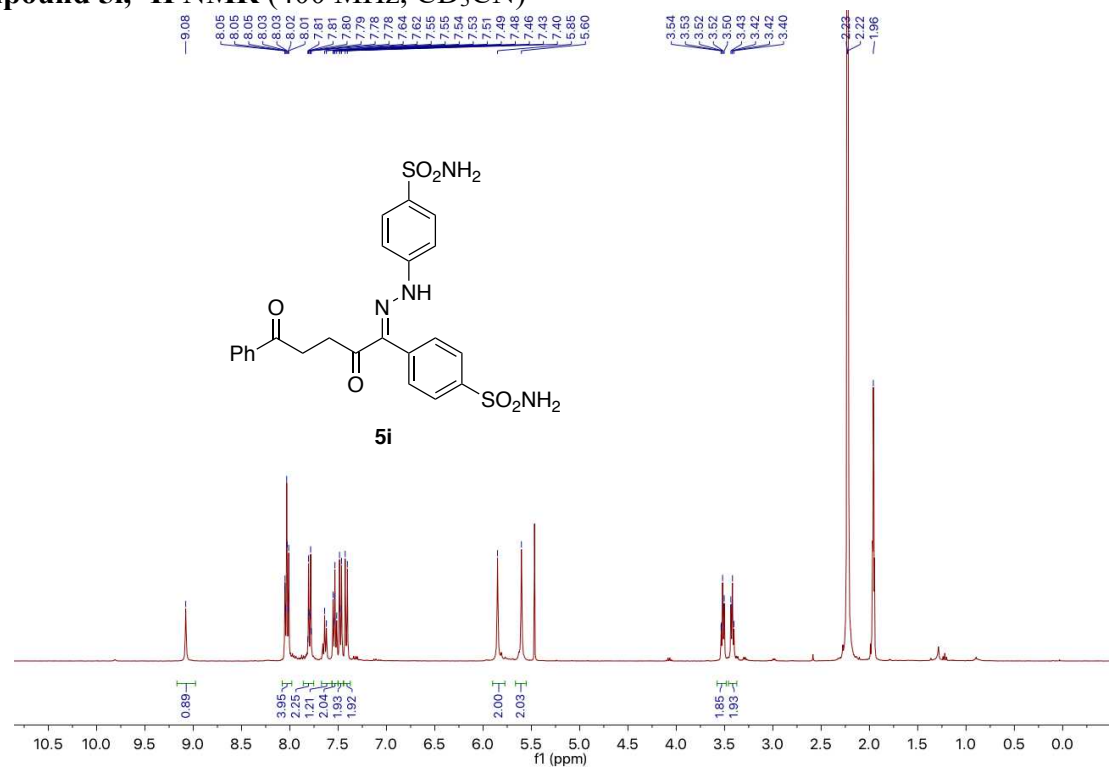
Compound 5h, ^{1}H NMR (600 MHz, CD_3CN)



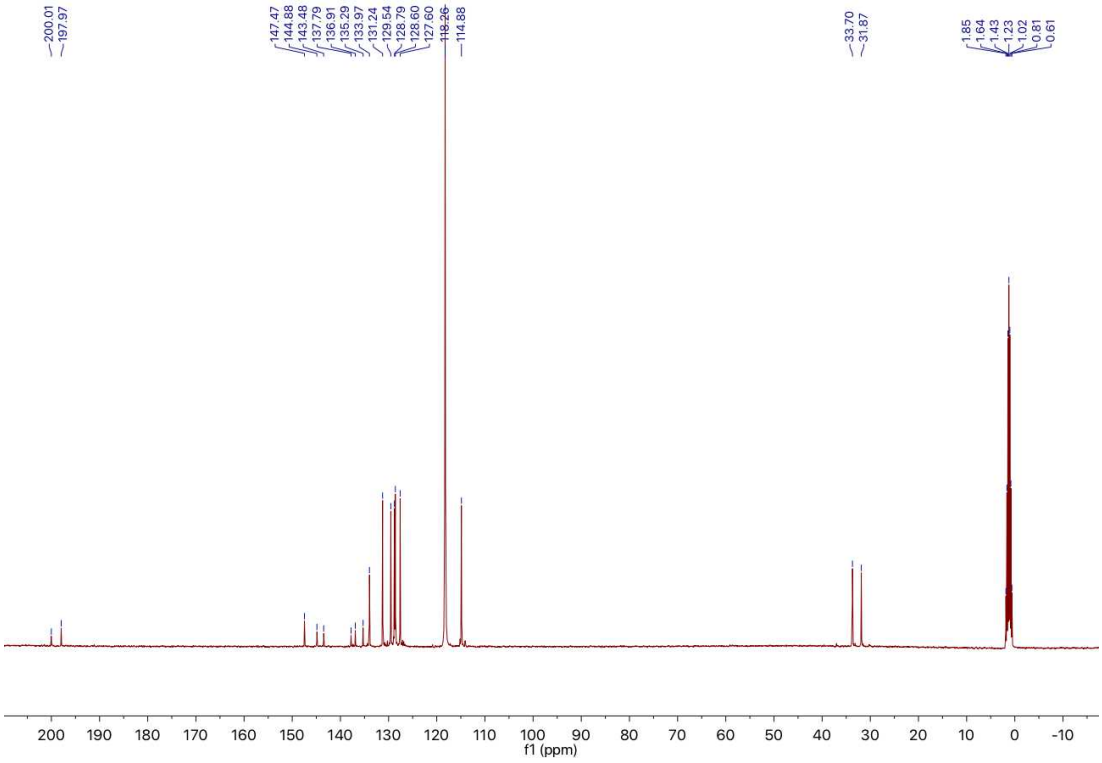
Compound 5h, ^{13}C NMR (101 MHz, CD_3CN)



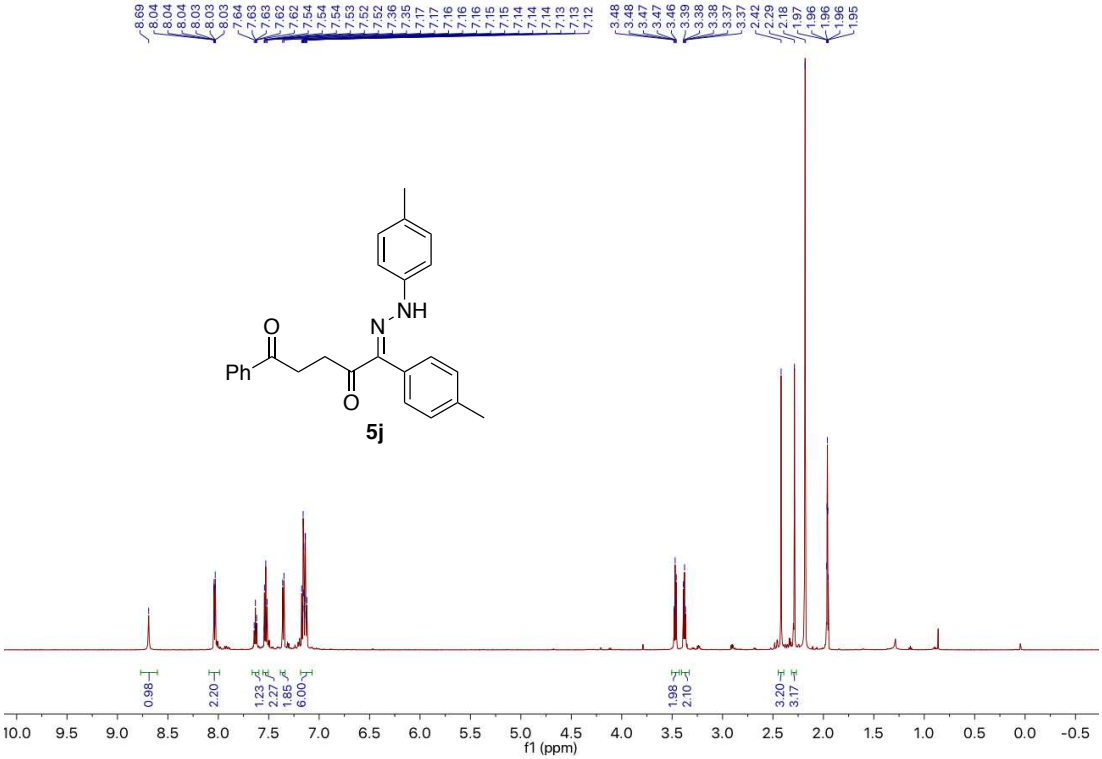
Compound 5i, ^{1}H NMR (400 MHz, CD_3CN)



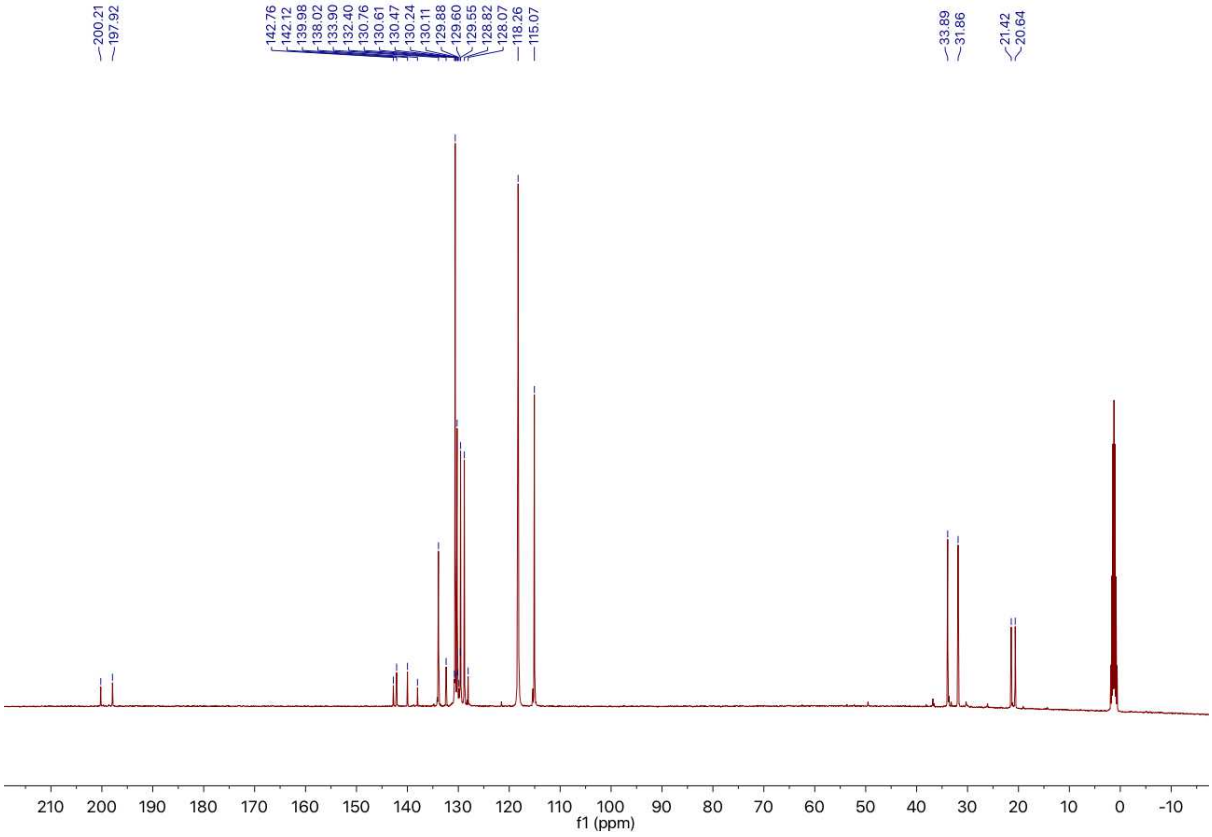
Compound 5i, ^{13}C NMR (101 MHz, CD_3CN)



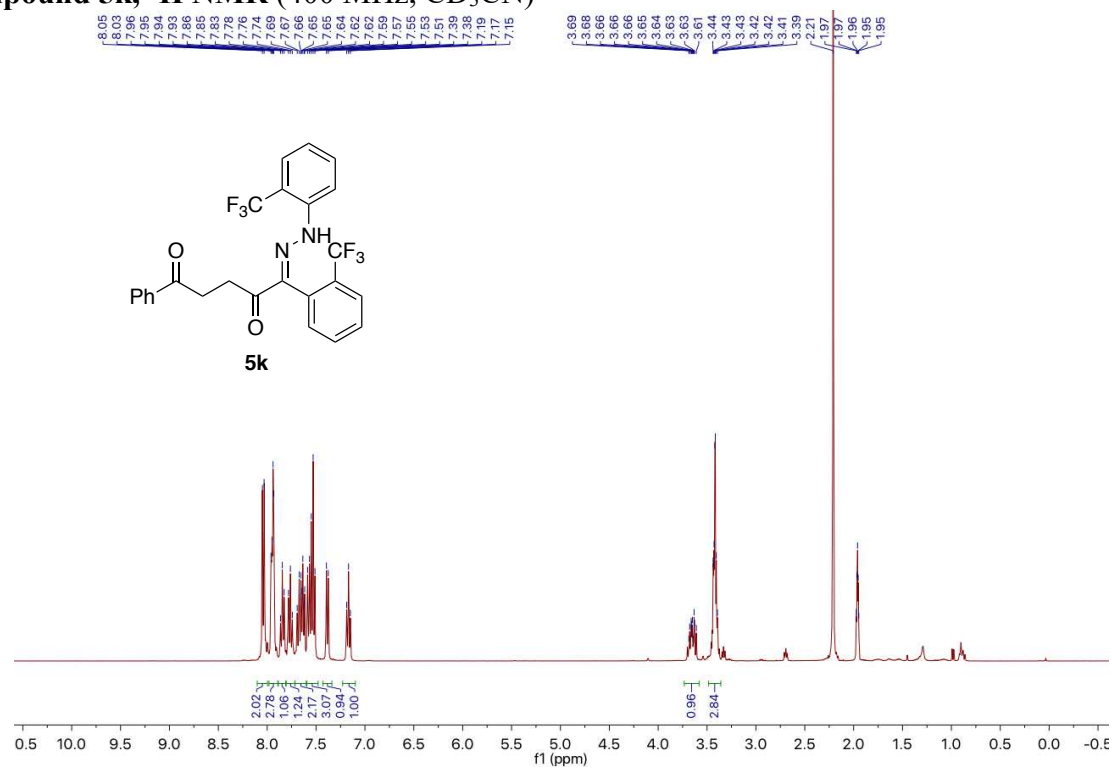
Compound 5j, ^{1}H NMR (600 MHz, CD_3CN)



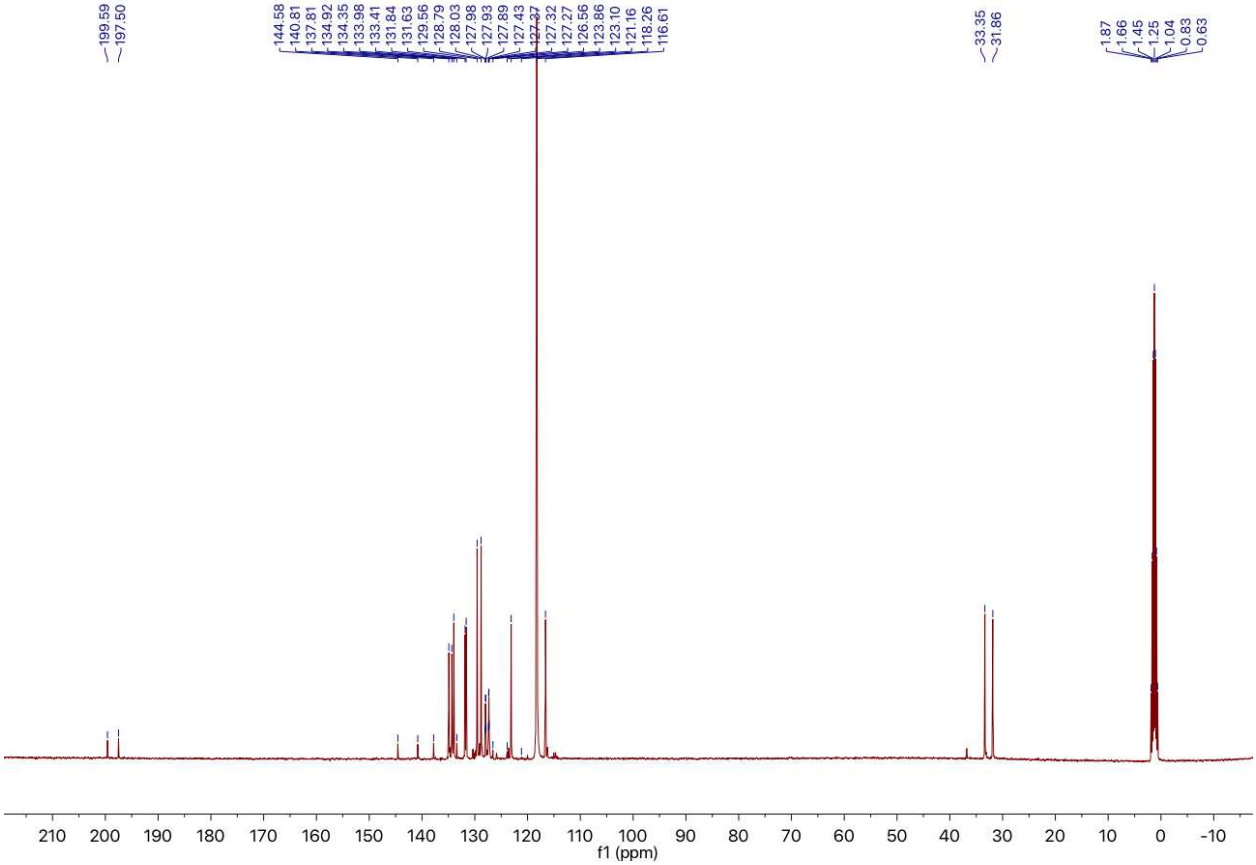
Compound 5j, ^{13}C NMR (101 MHz, CD_3CN)



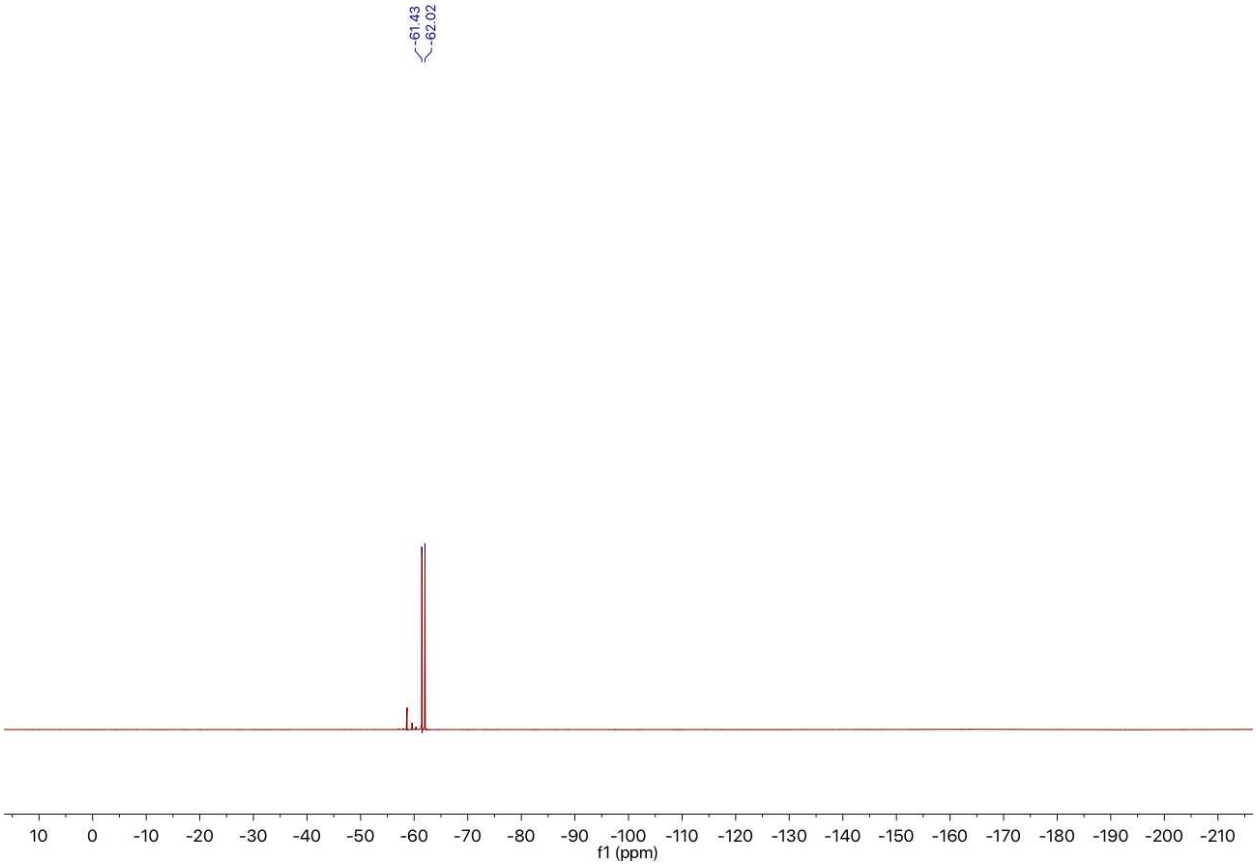
Compound 5k, ^{1}H NMR (400 MHz, CD_3CN)



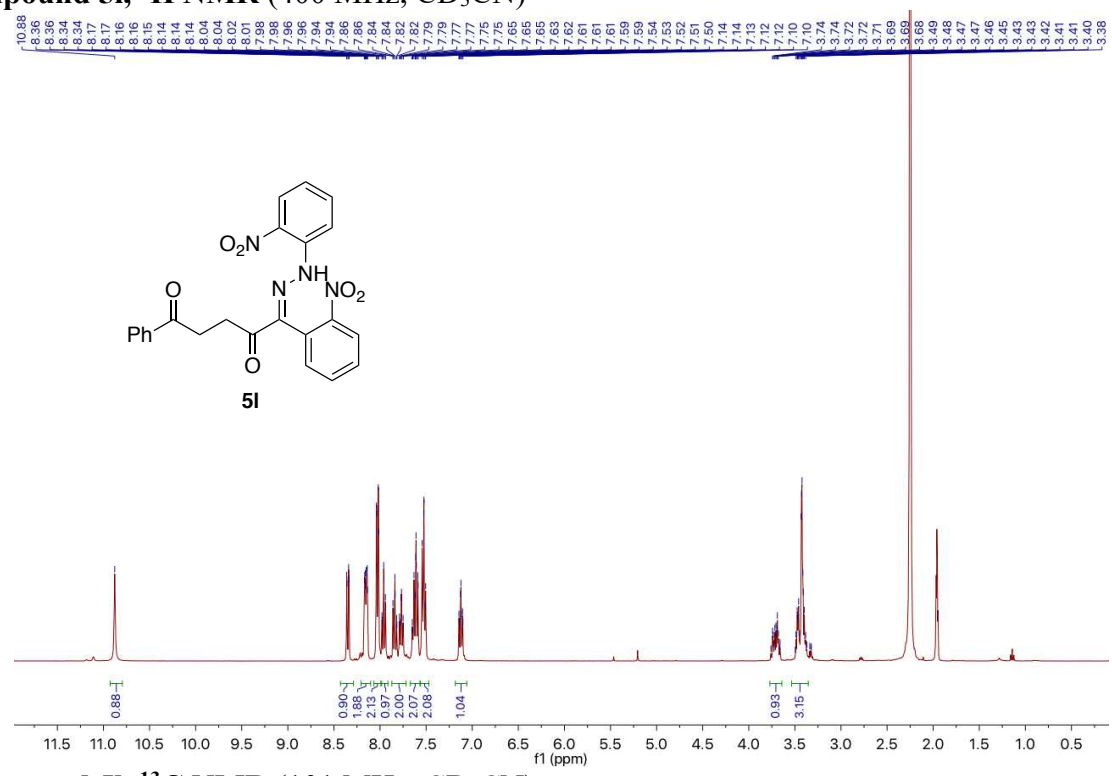
Compound 5k, ^{13}C NMR (101 MHz, CD_3CN)



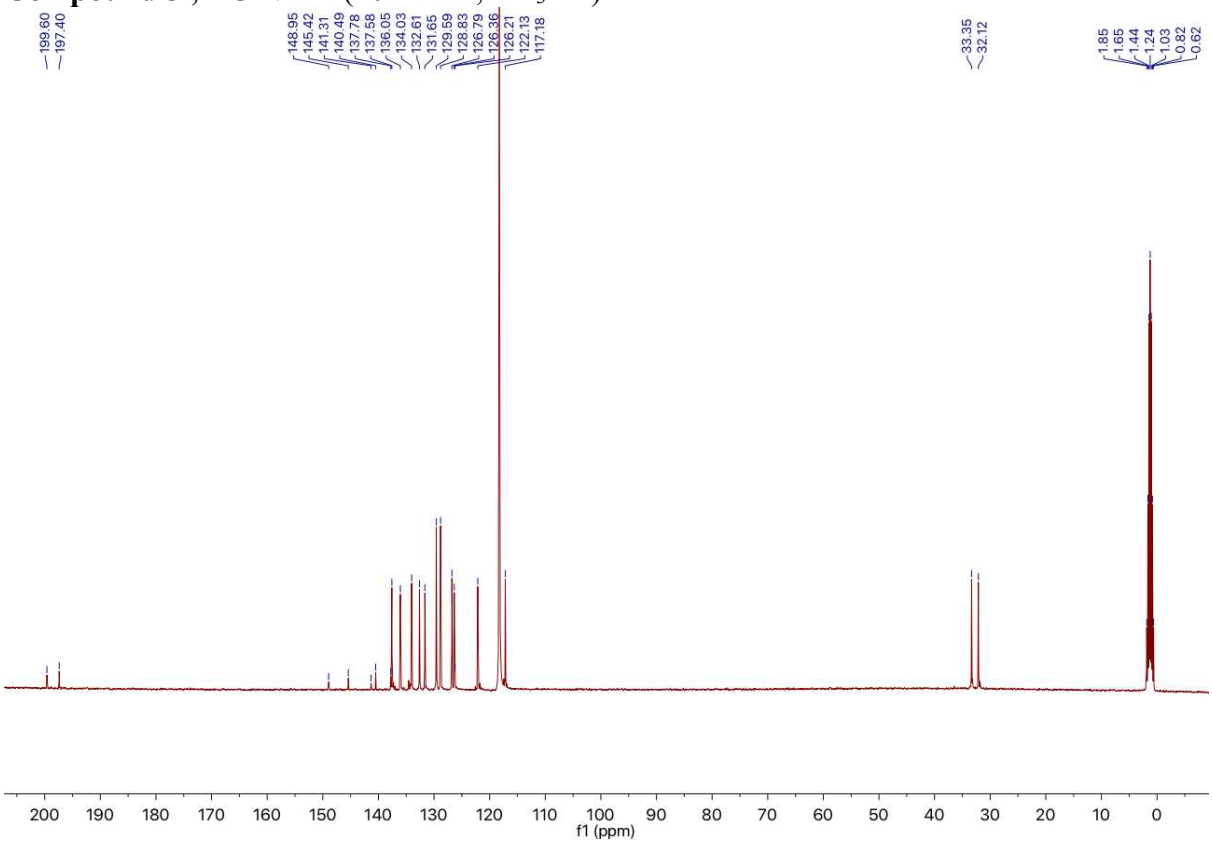
Compound 5k, ^{19}F NMR (565MHz, CD_3CN)



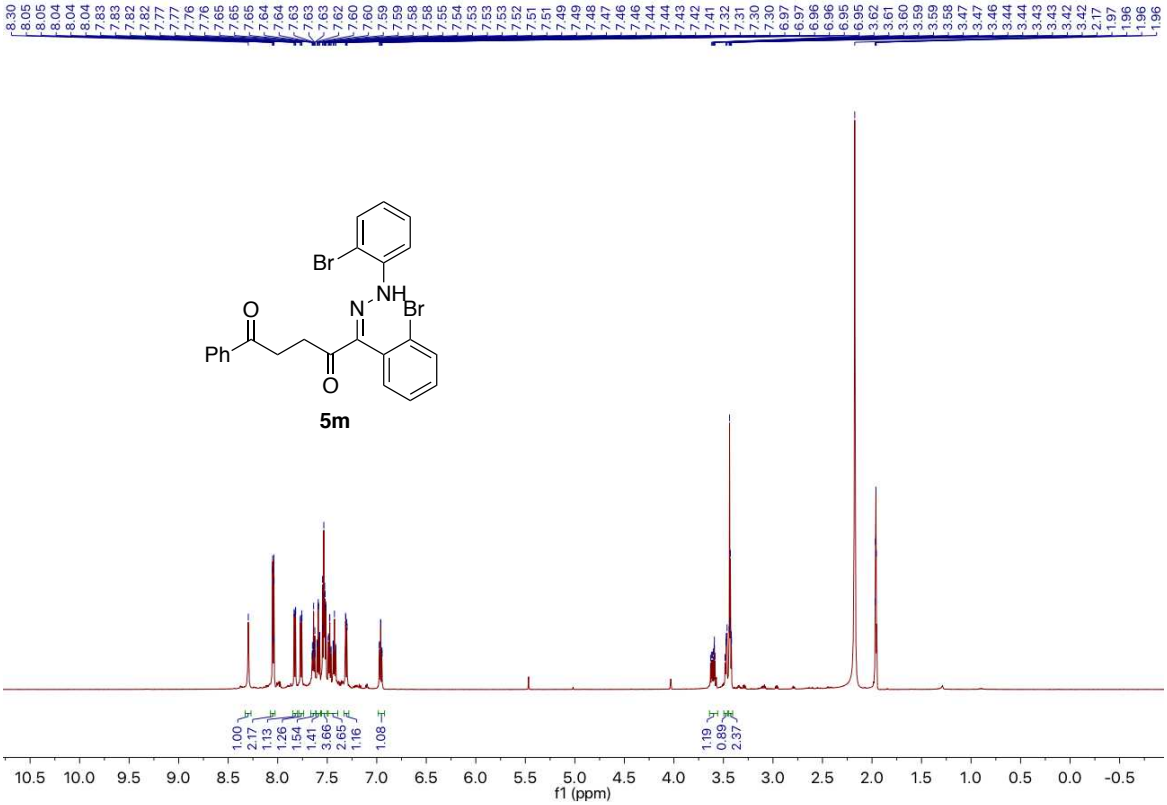
Compound 5l, ^{1}H NMR (400 MHz, CD_3CN)



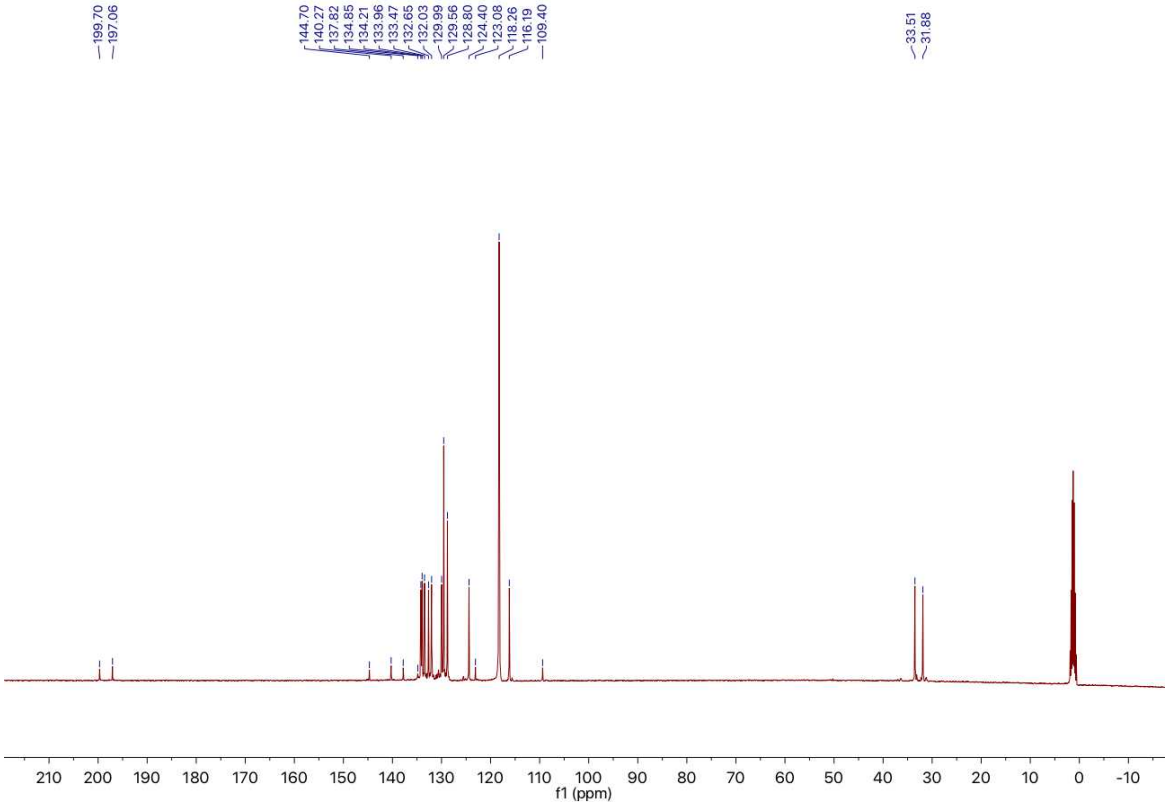
Compound 5l, ^{13}C NMR (101 MHz, CD_3CN)



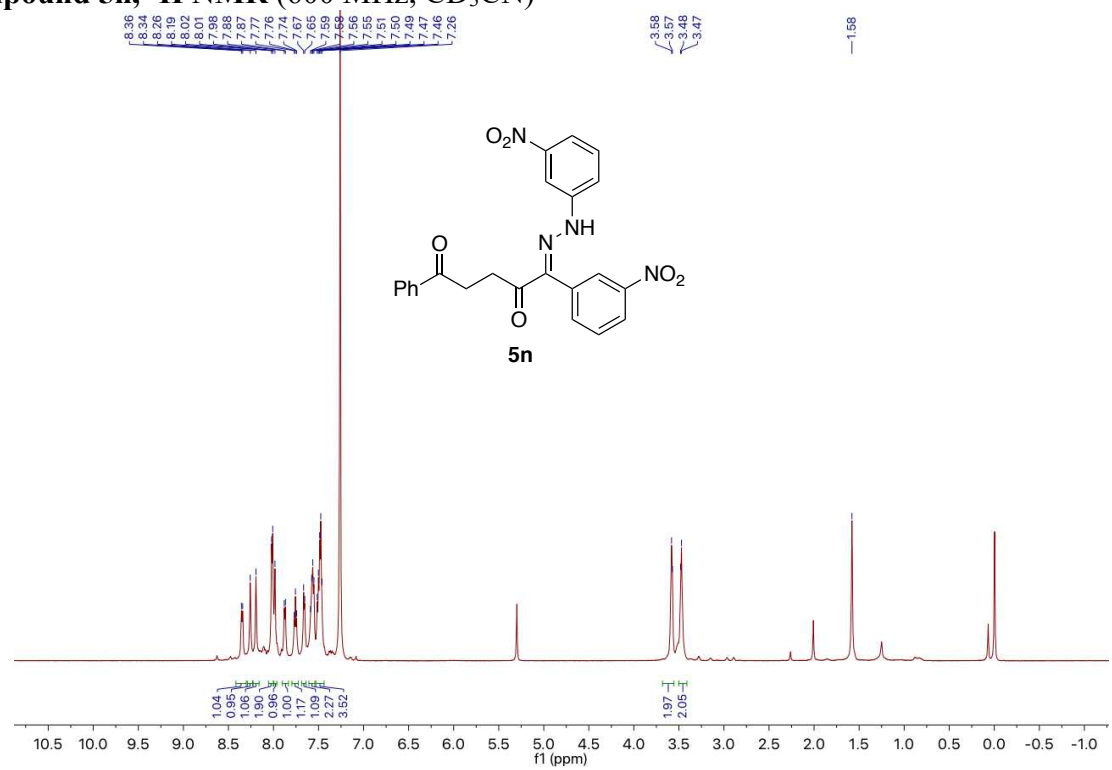
Compound 5m, ^{1}H NMR (600 MHz, CD_3CN)



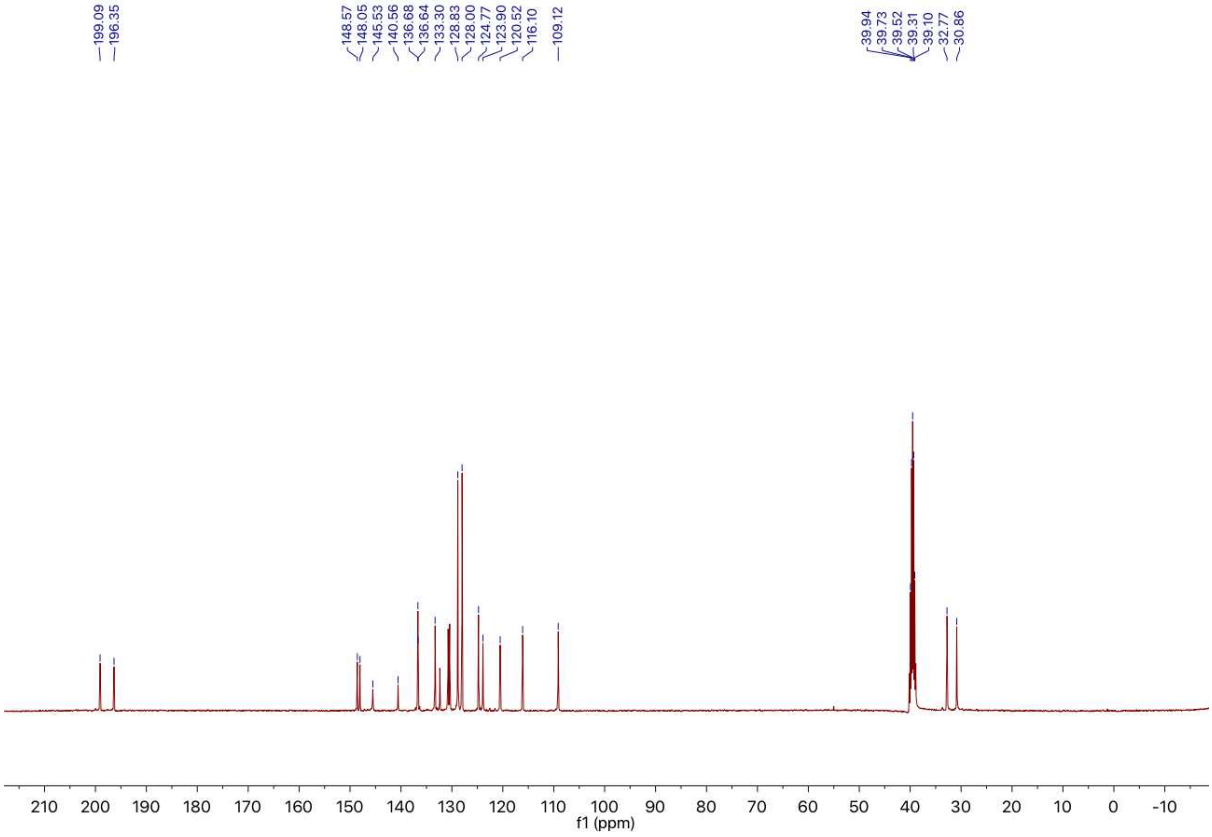
Compound 5m, ^{13}C NMR (101 MHz, CD_3CN)



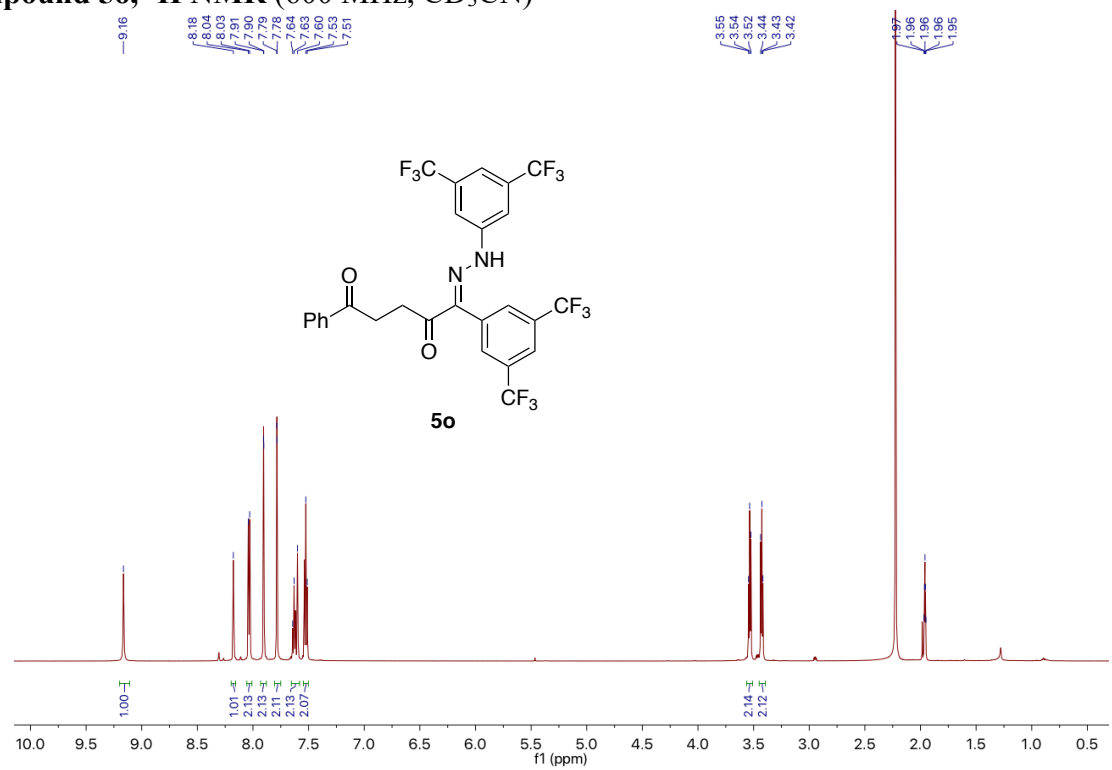
Compound 5n, ^{1}H NMR (600 MHz, CD_3CN)



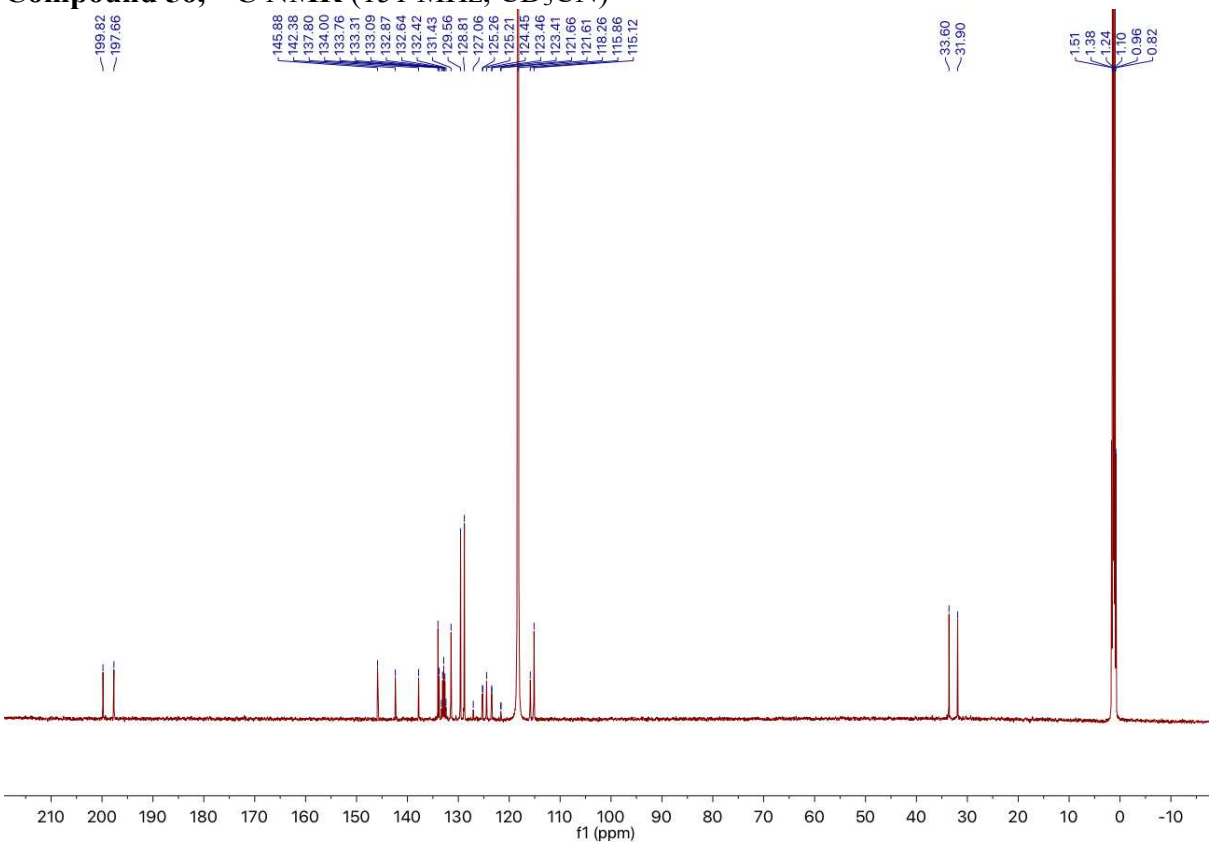
Compound 5n, ^{13}C NMR (101 MHz, DMSO-*d6*)



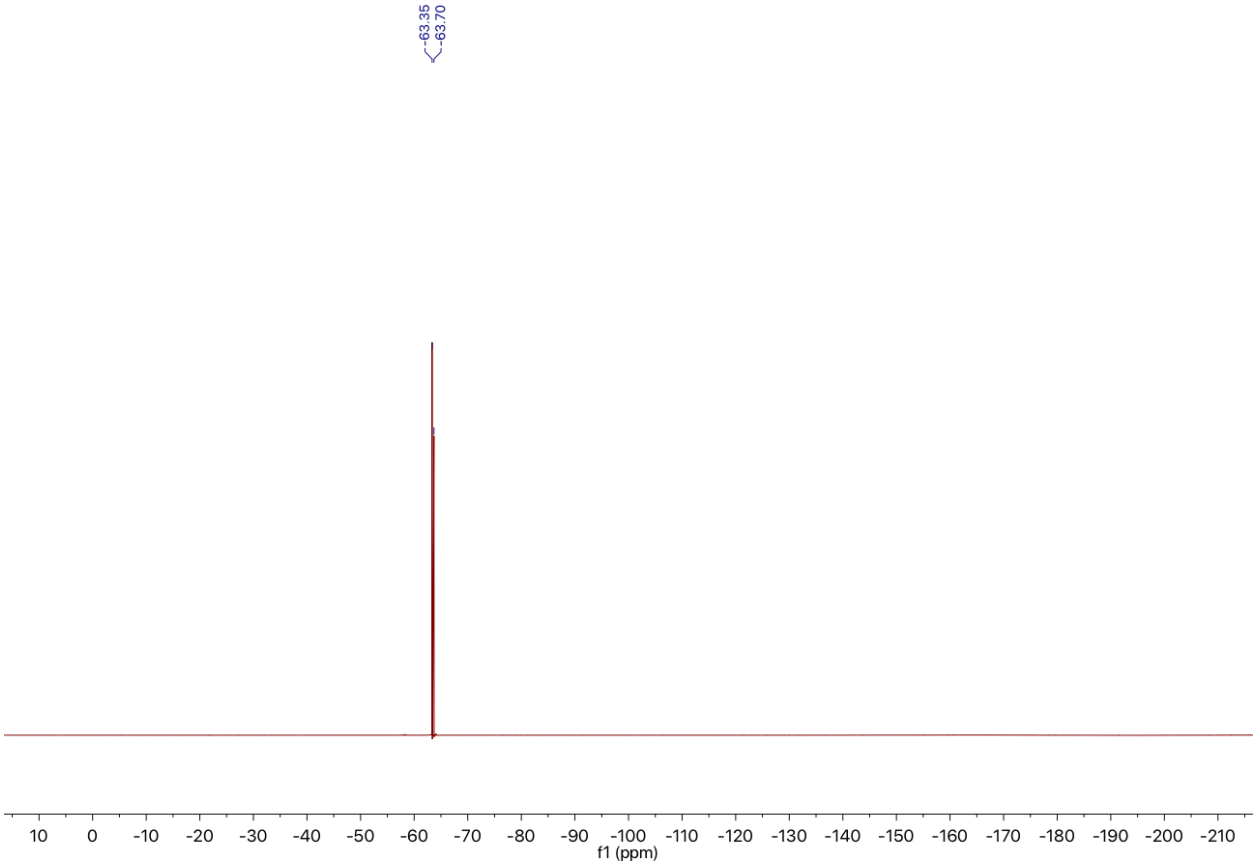
Compound 5o, ^{1}H NMR (600 MHz, CD_3CN)



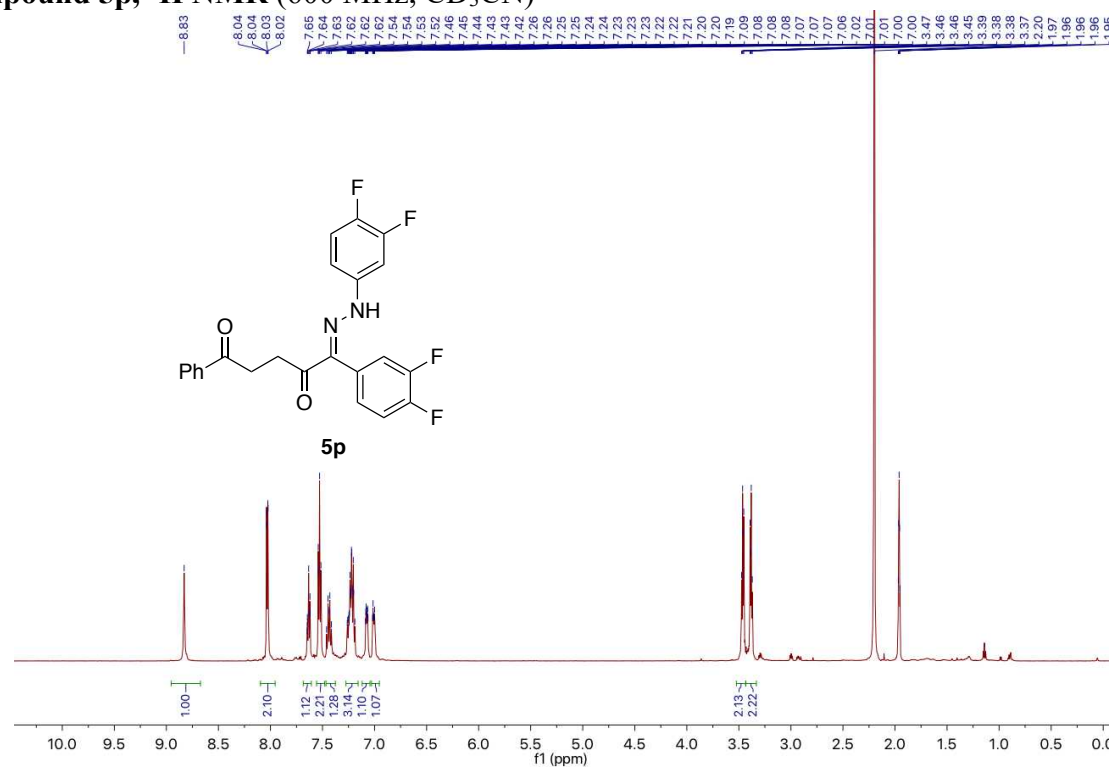
Compound 5o, ^{13}C NMR (151 MHz, CD_3CN)



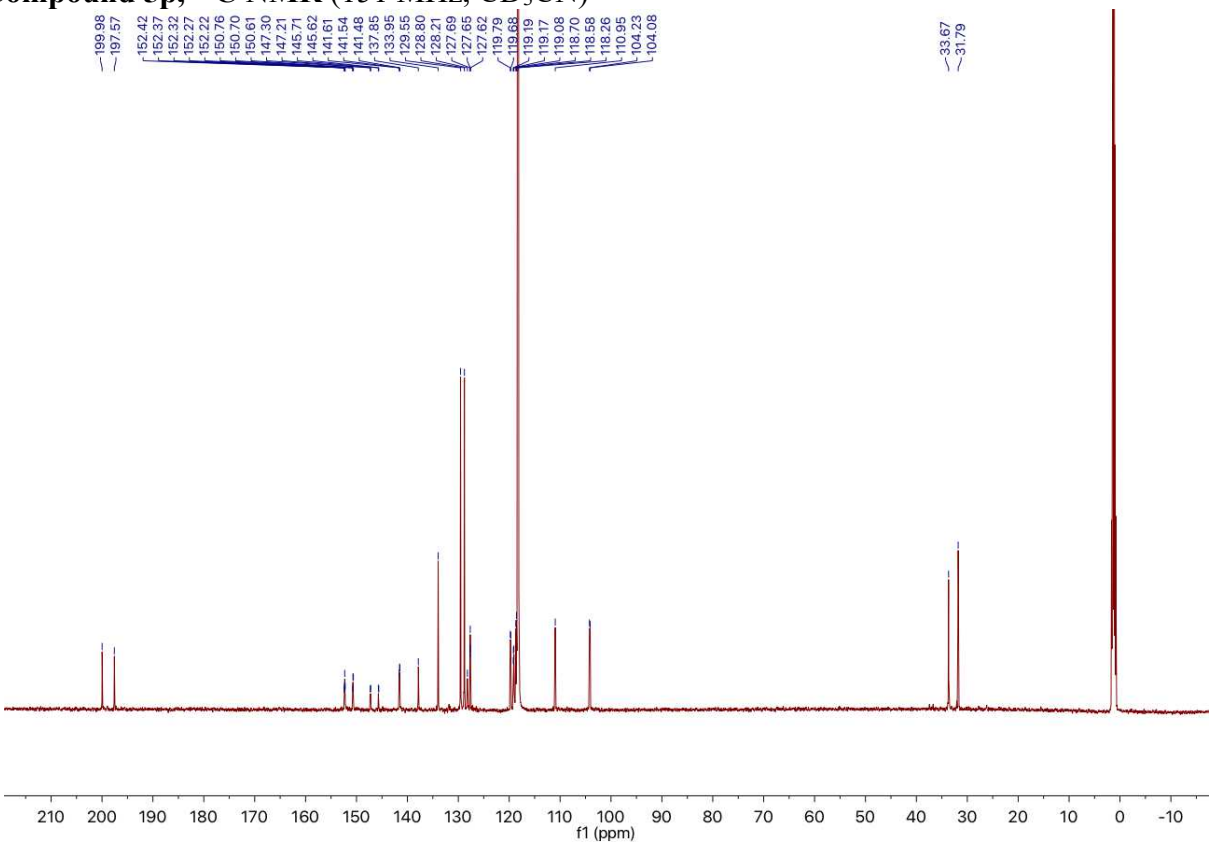
Compound 5o, ^{19}F NMR (565 MHz, CD_3CN)



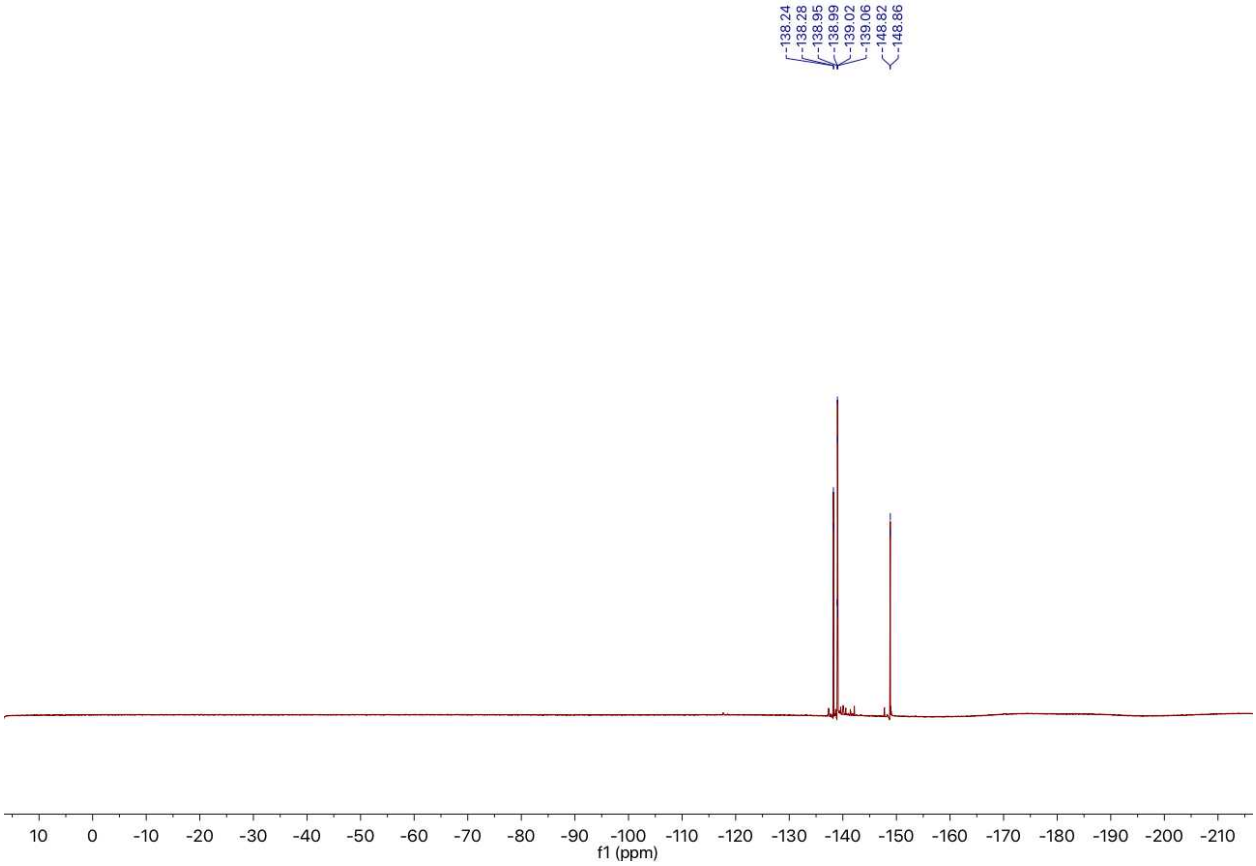
Compound 5p, ^{1}H NMR (600 MHz, CD_3CN)



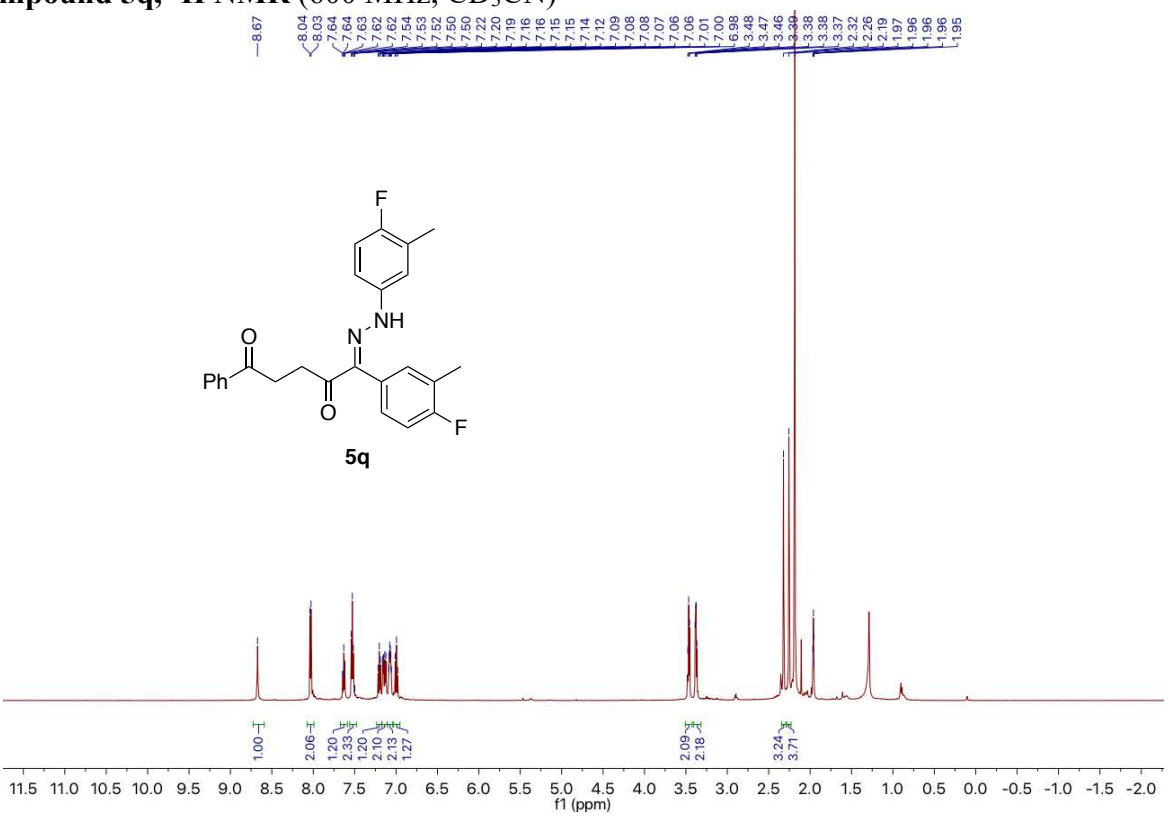
Compound 5p, ^{13}C NMR (151 MHz, CD_3CN)



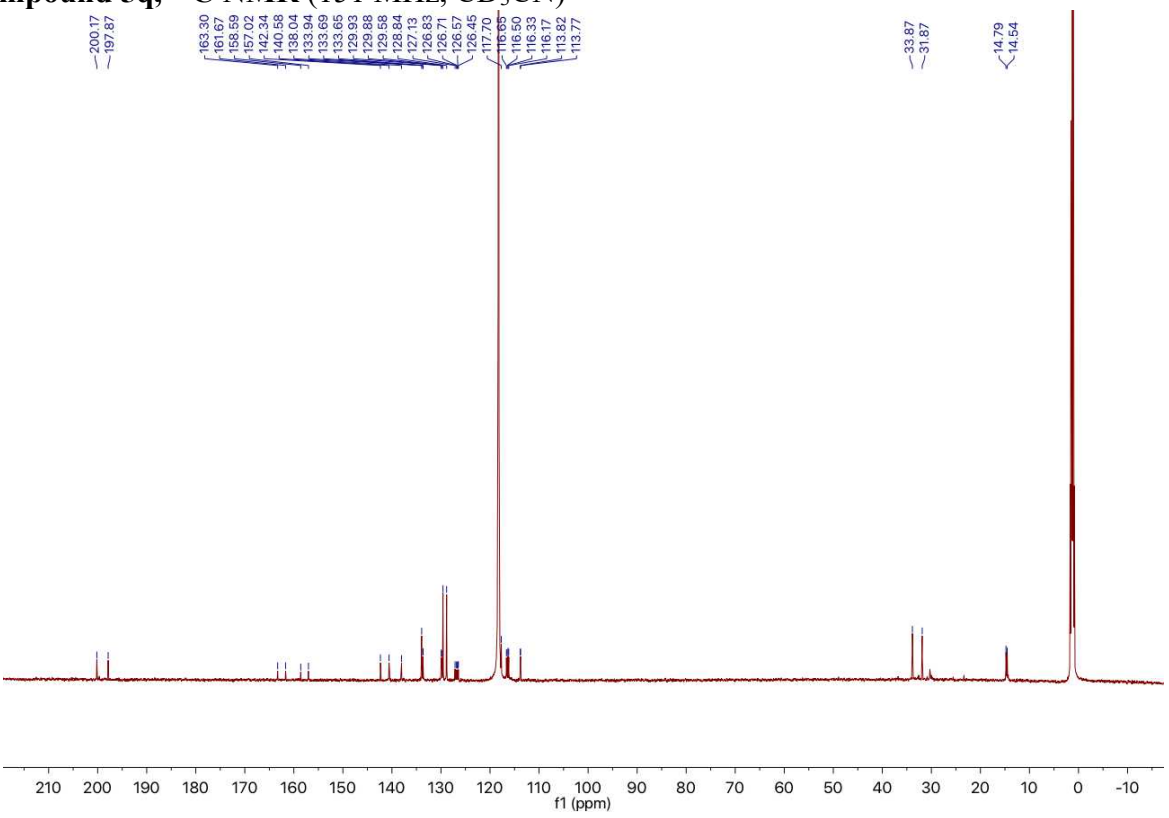
Compound 5p, ^{19}F NMR (565 MHz, CD_3CN)



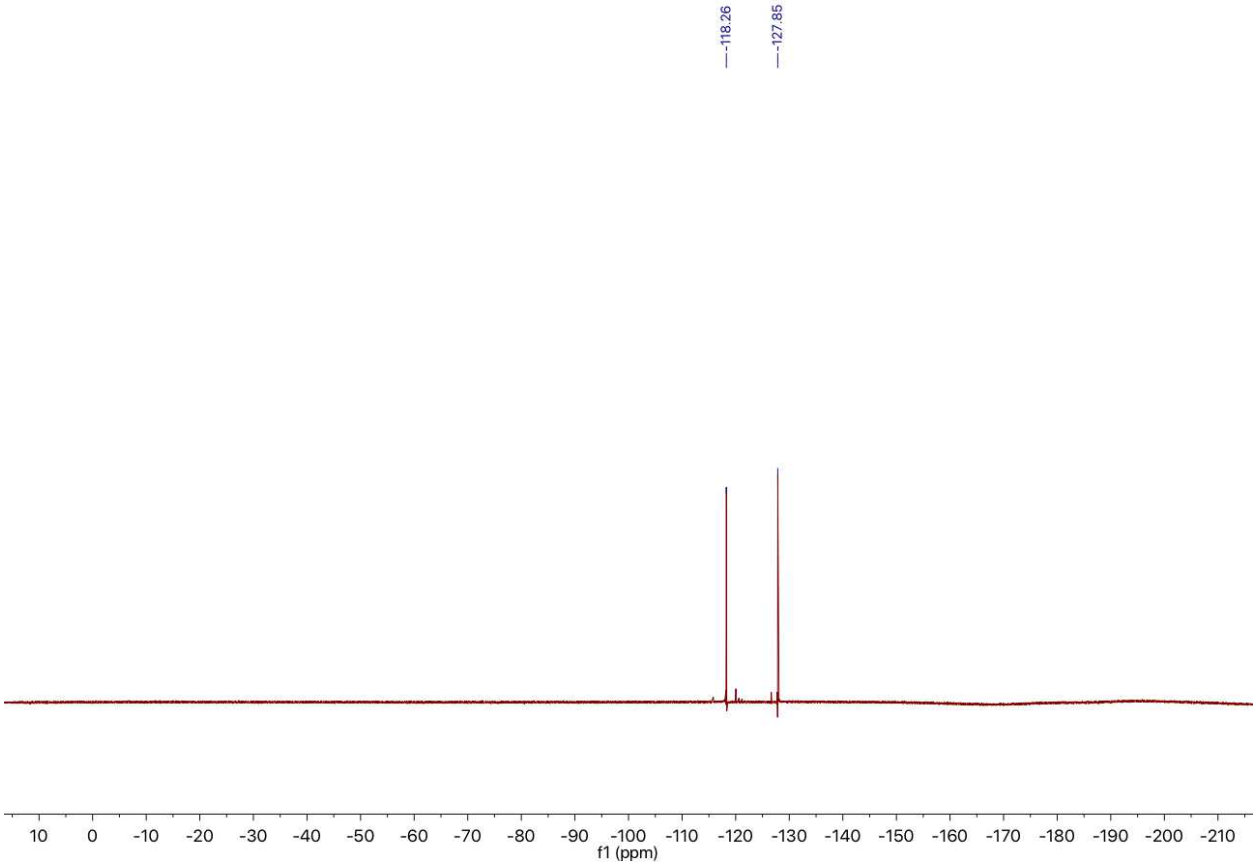
Compound 5q, ^{1}H NMR (600 MHz, CD_3CN)



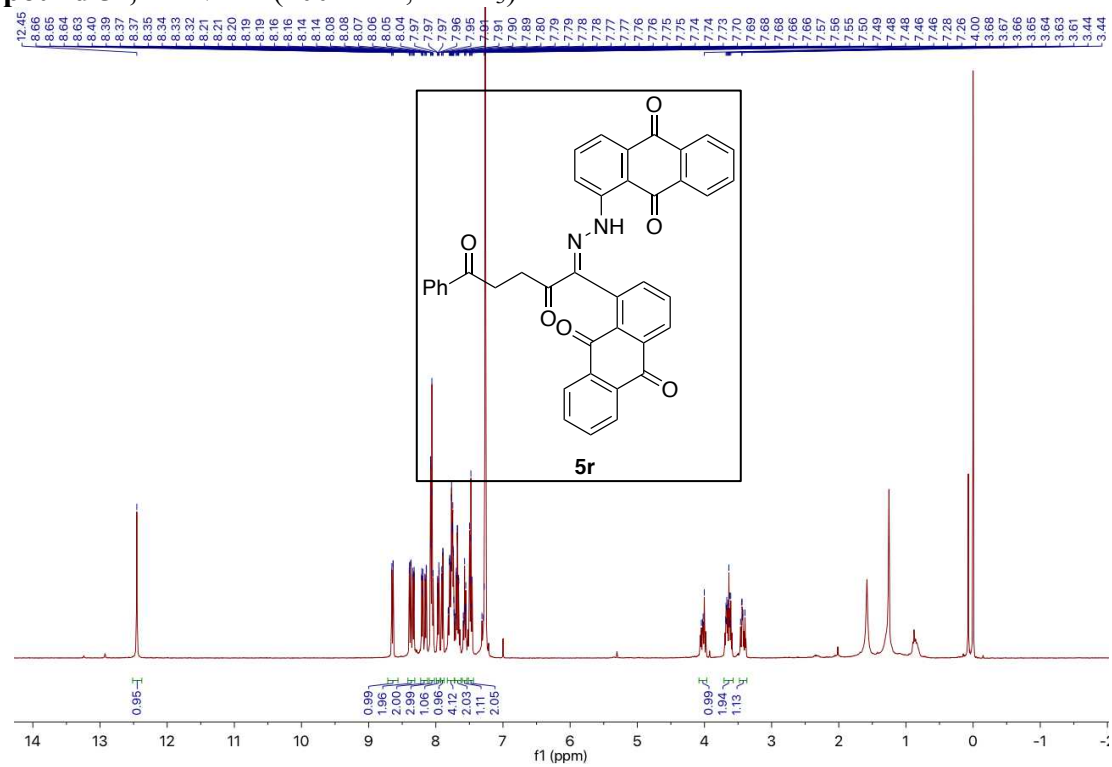
Compound 5q, ^{13}C NMR (151 MHz, CD_3CN)



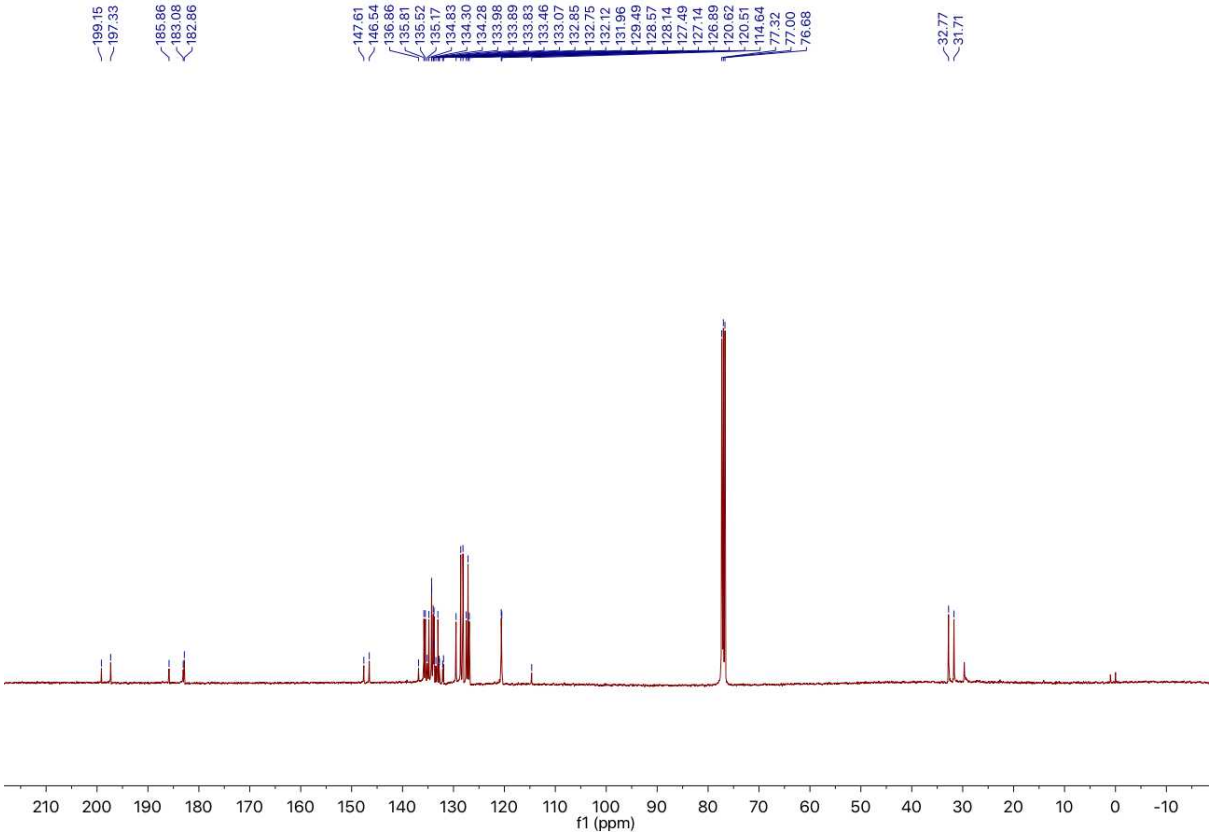
Compound 5q, ^{19}F NMR (565 MHz, CD_3CN)



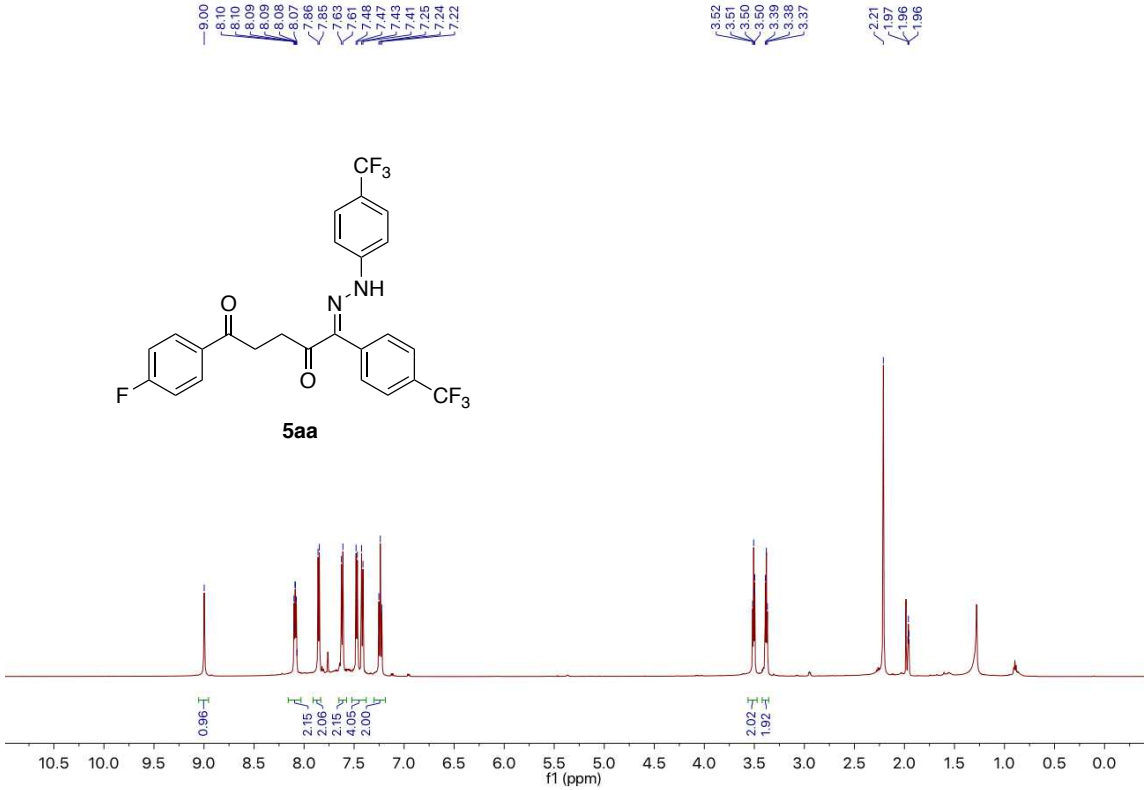
Compound 5r, ^{1}H NMR (400 MHz, $CDCl_3$)



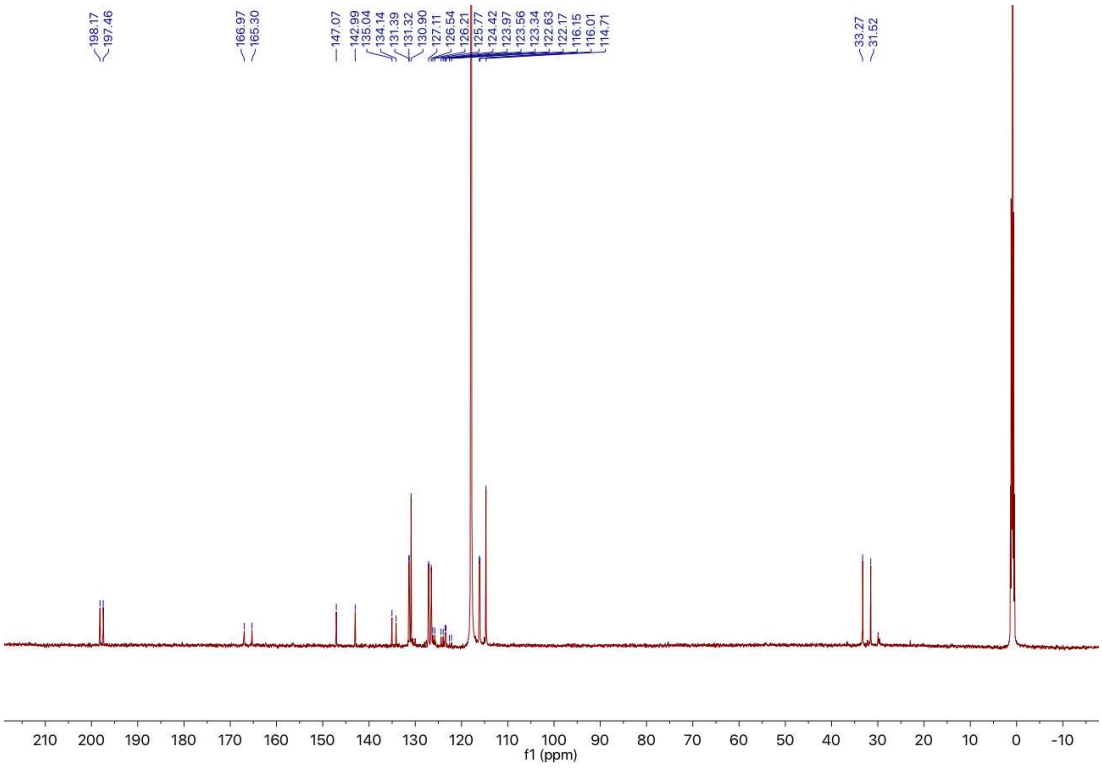
Compound 5r, ^{13}C NMR (101 MHz, $CDCl_3$)



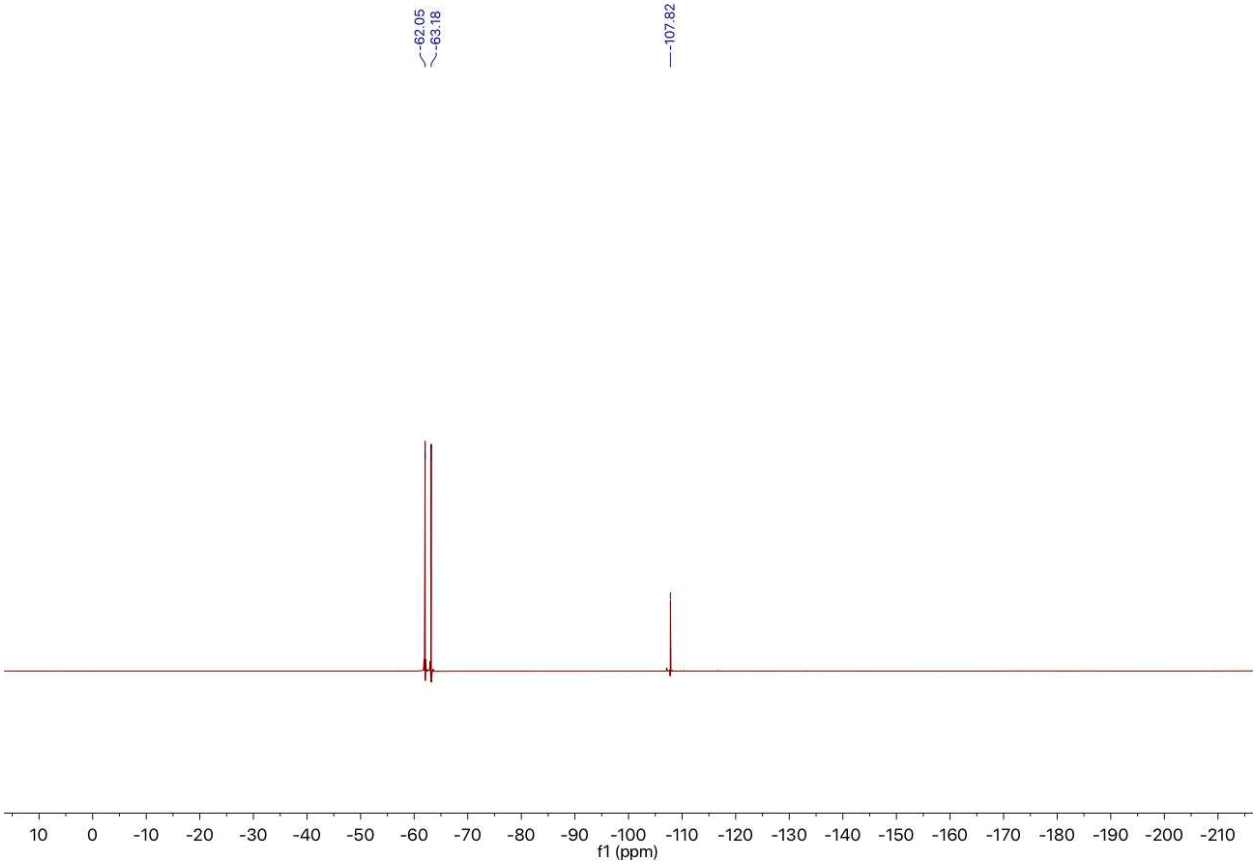
Compound 5aa, ^{1}H NMR (600 MHz, CD_3CN)



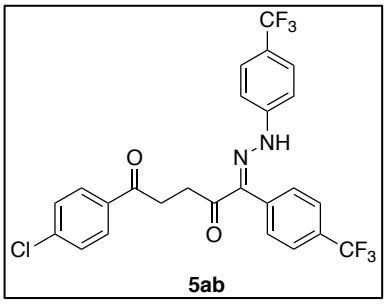
Compound 5aa, ^{13}C NMR (151 MHz, CD_3CN)



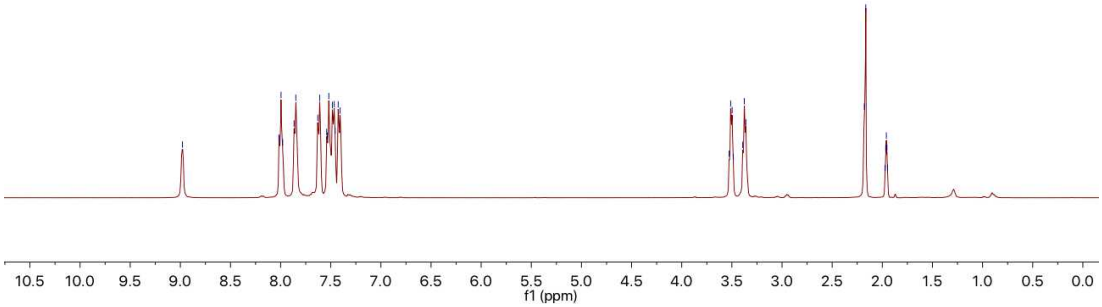
Compound 5aa, ^{19}F NMR (565 MHz, CD_3CN)



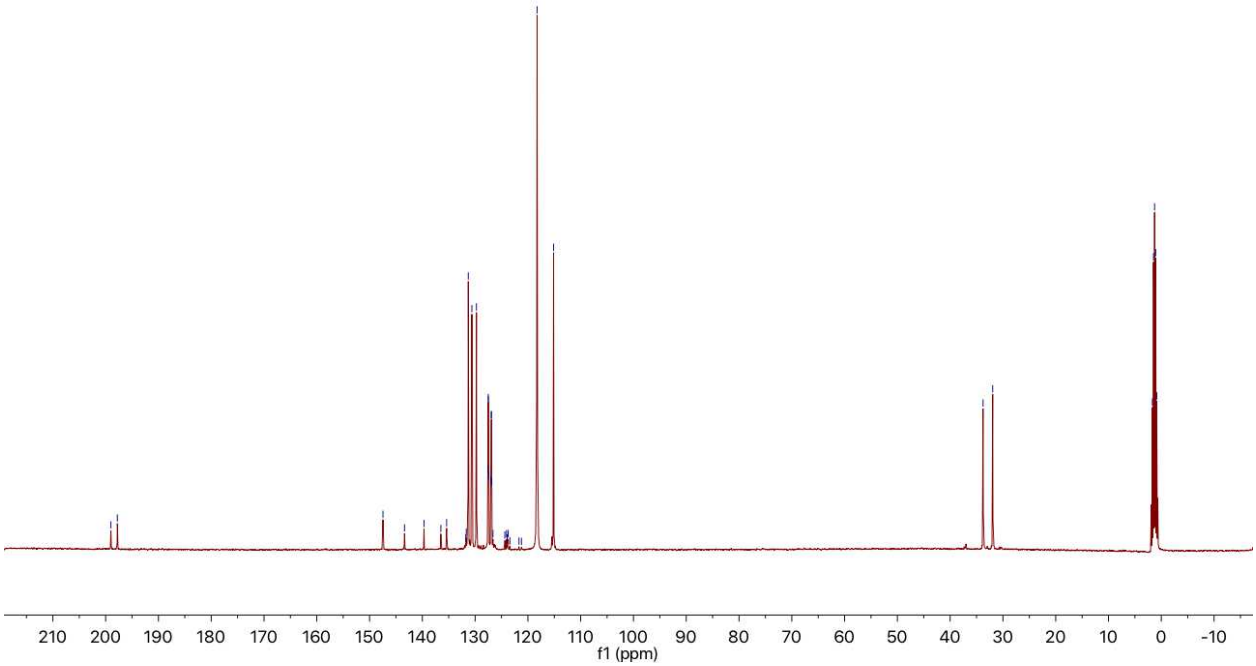
Compound 5ab, ^{1}H NMR (600 MHz, CD_3CN)



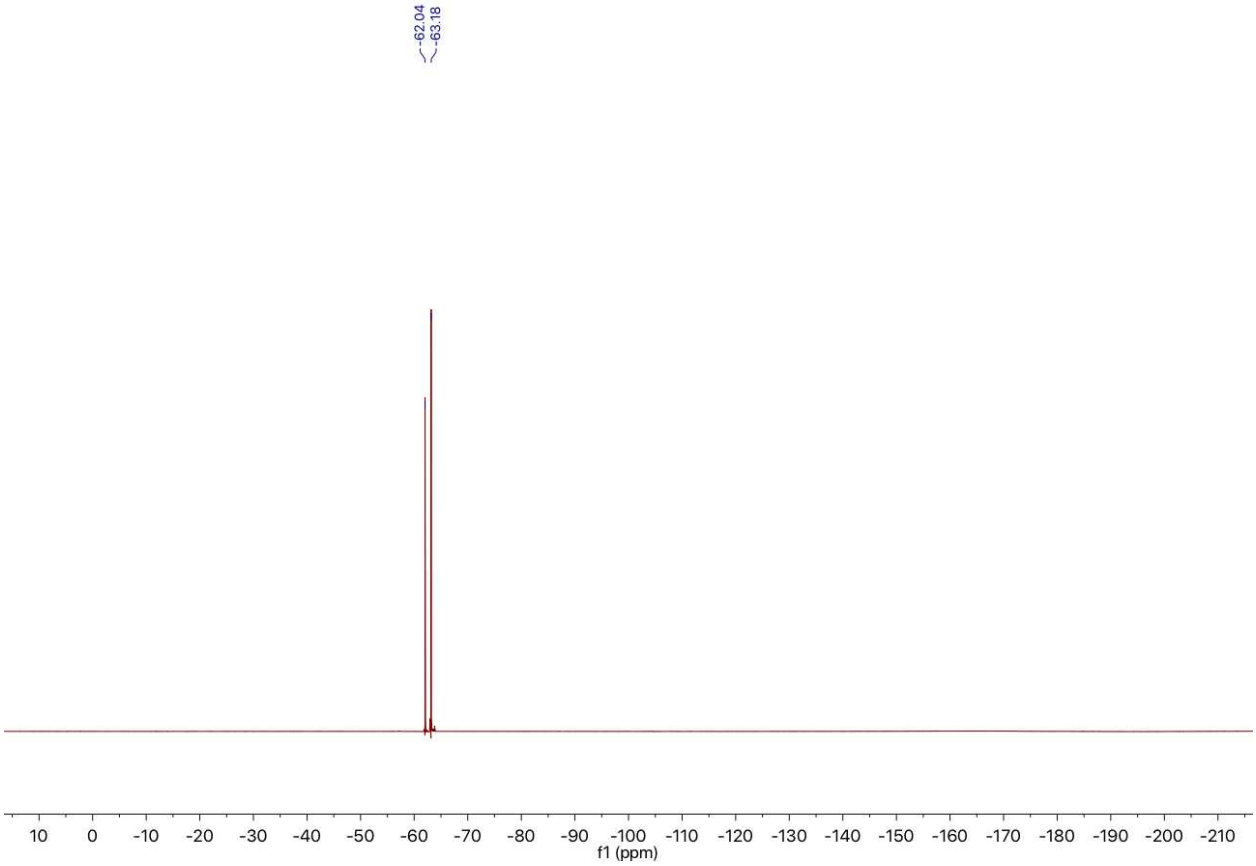
5ab



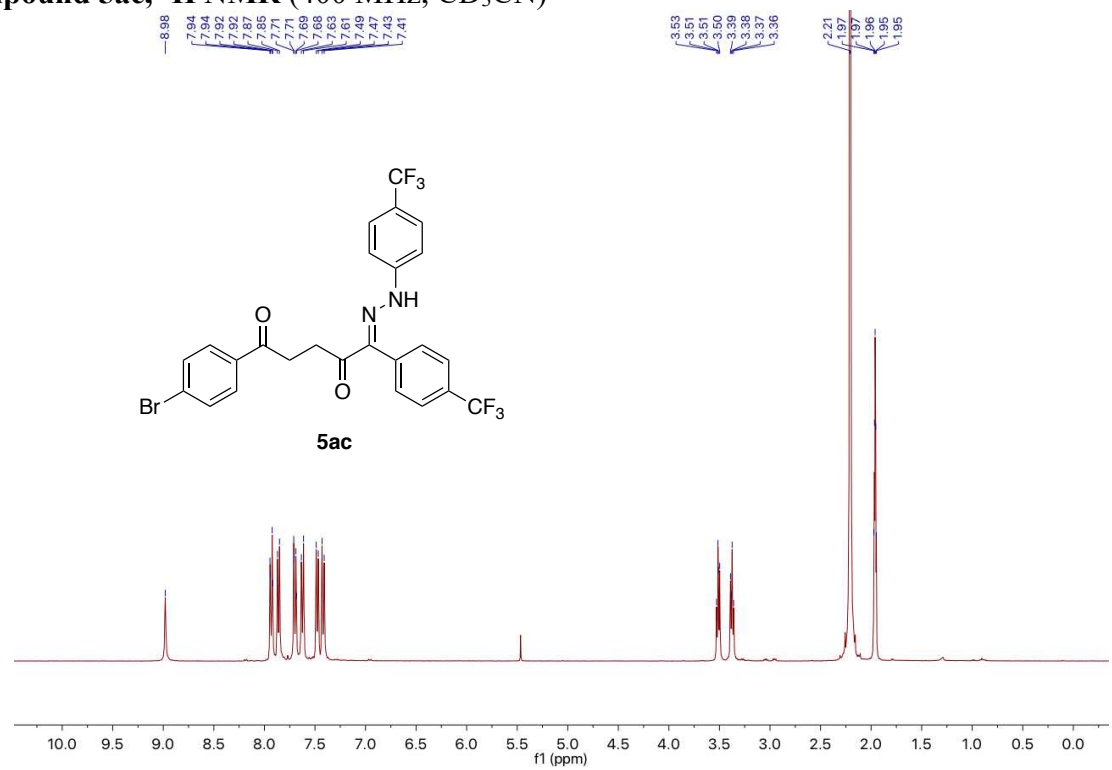
Compound 5ab, ^{13}C NMR (151 MHz, CD_3CN)



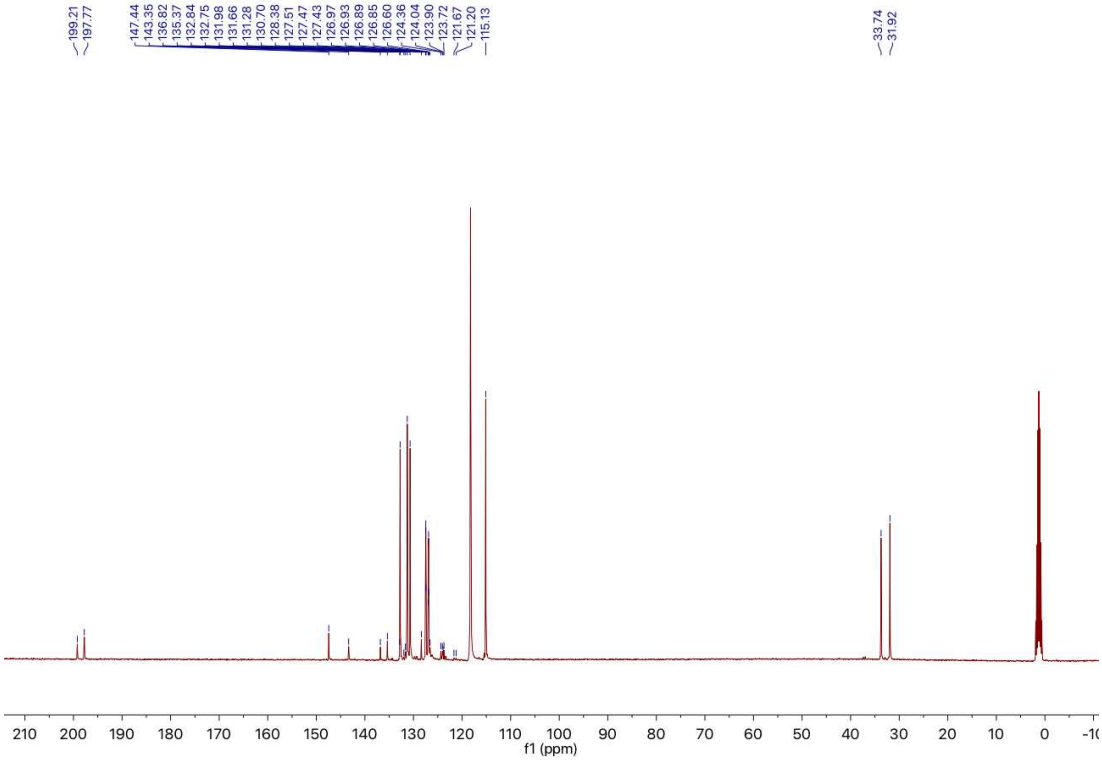
Compound 5ab, ^{19}F NMR (565 MHz, CD_3CN)



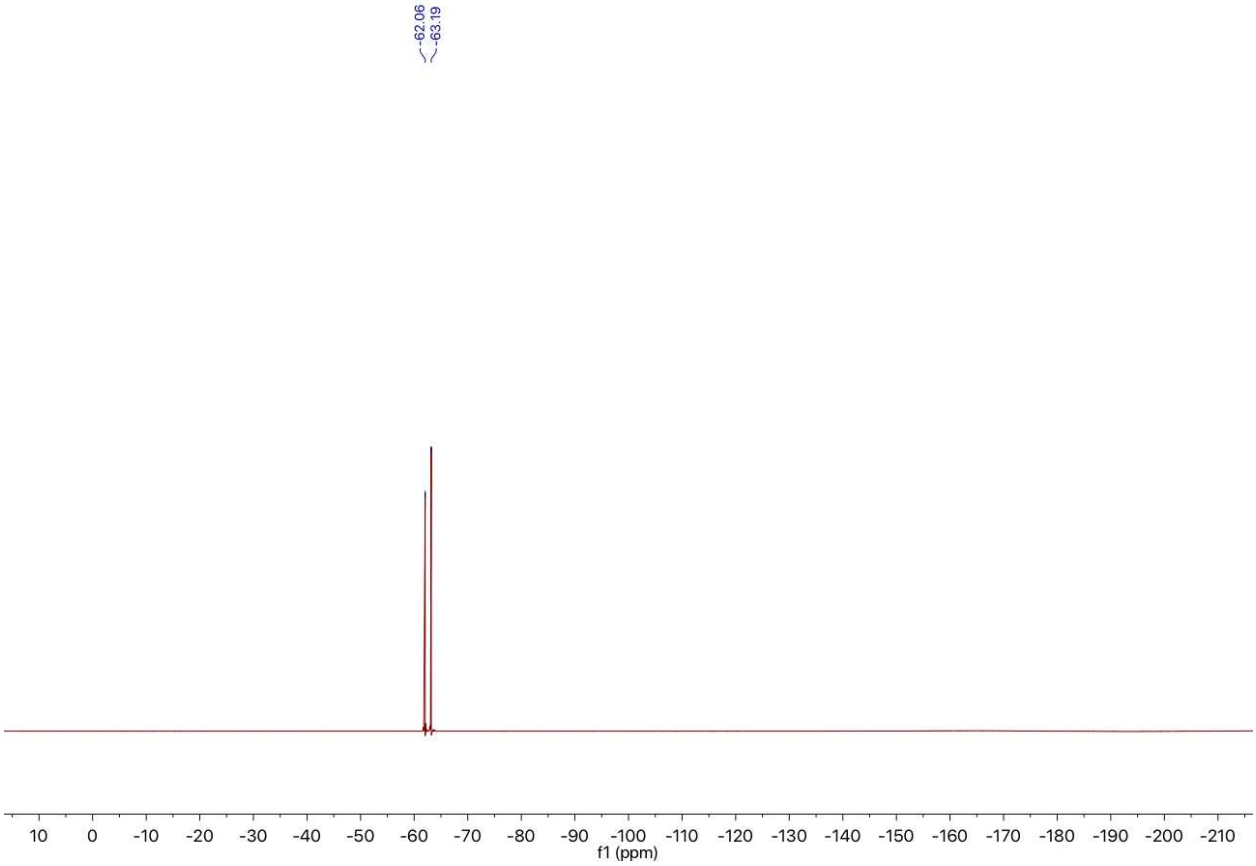
Compound 5ac, ^{1}H NMR (400 MHz, CD_3CN)



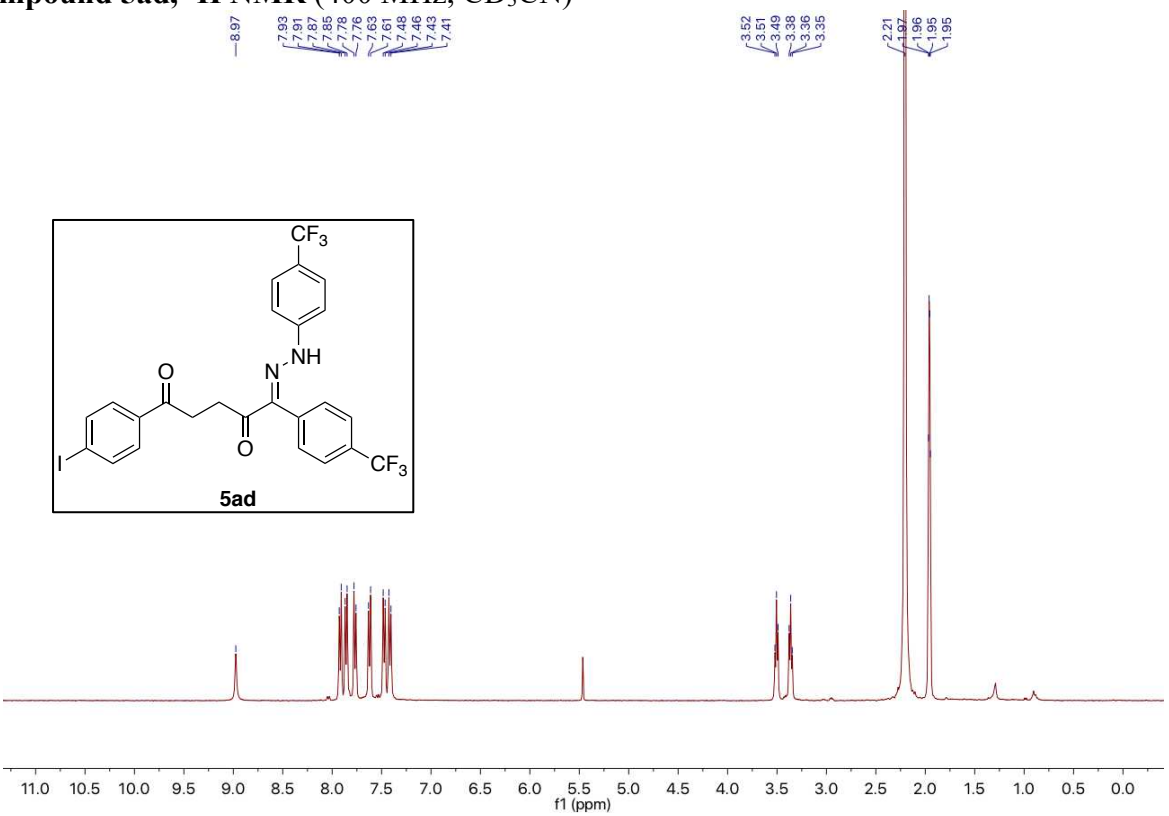
Compound 5ac, ^{13}C NMR (101 MHz, CD_3CN)



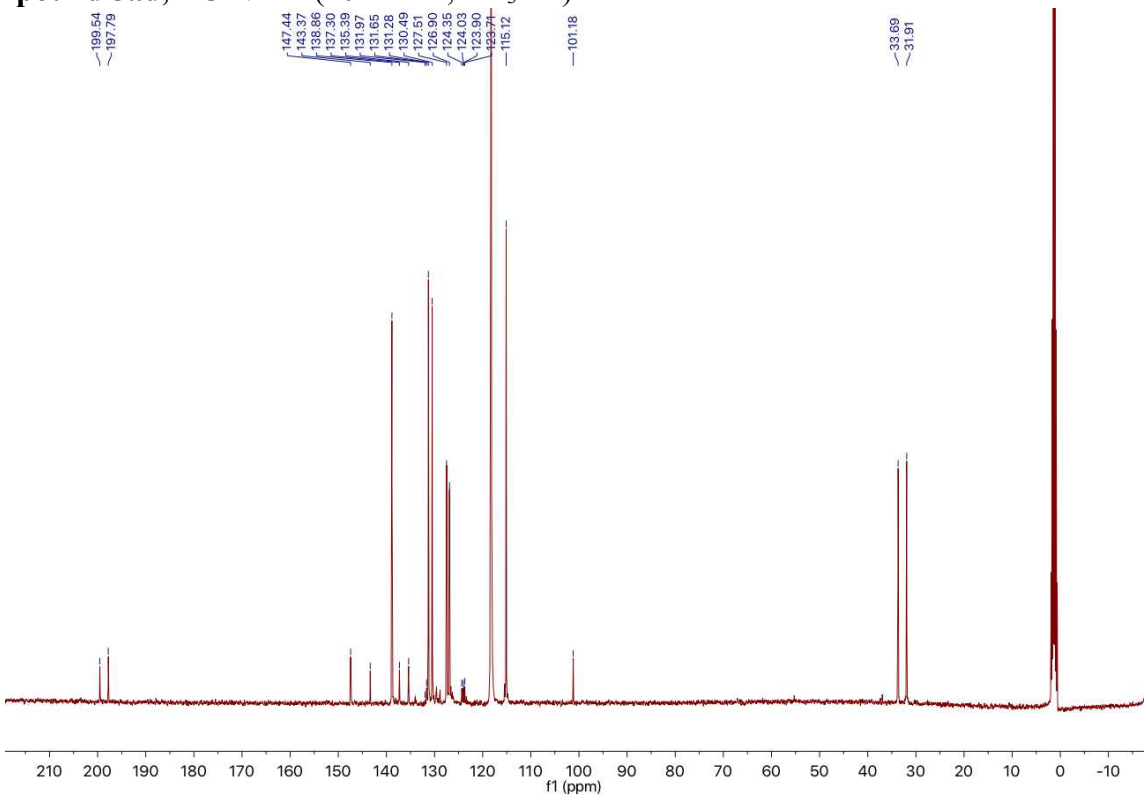
Compound 5ac, ^{19}F NMR (565 MHz, CD_3CN)



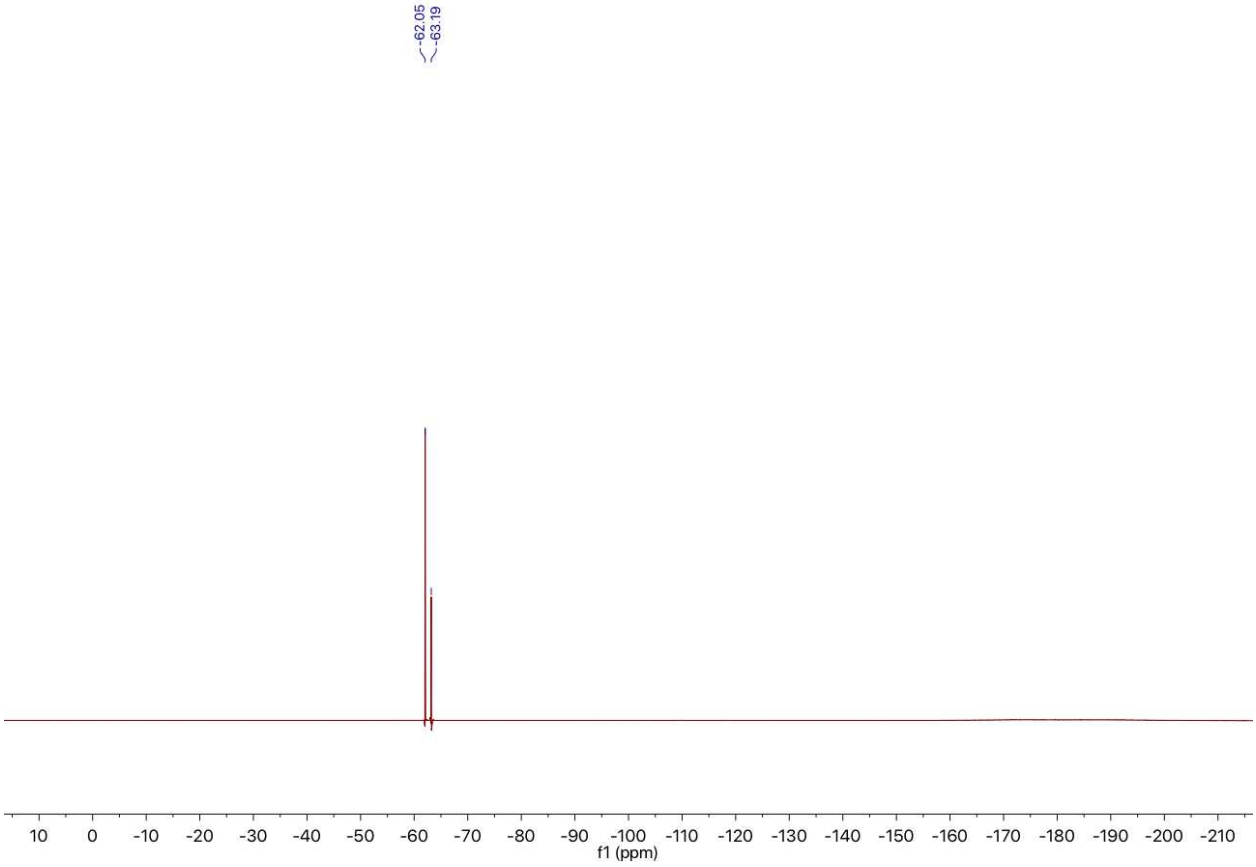
Compound 5ad, ^{1}H NMR (400 MHz, CD_3CN)



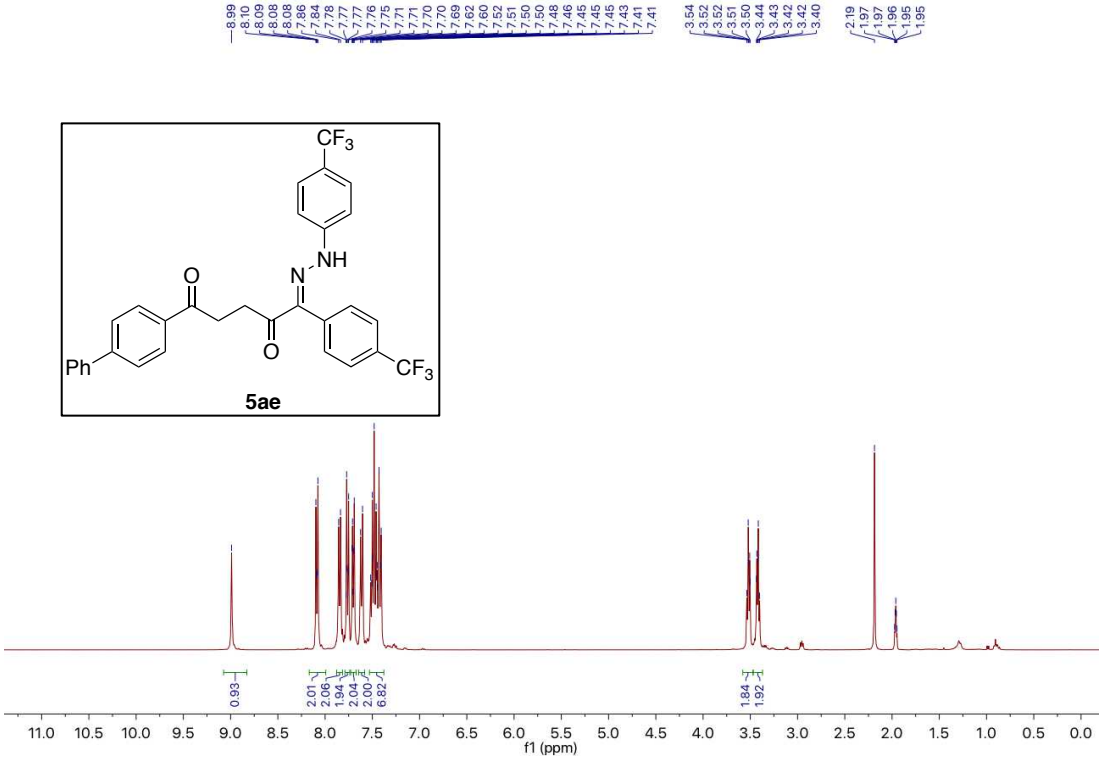
Compound 5ad, ^{13}C NMR (101 MHz, CD_3CN)



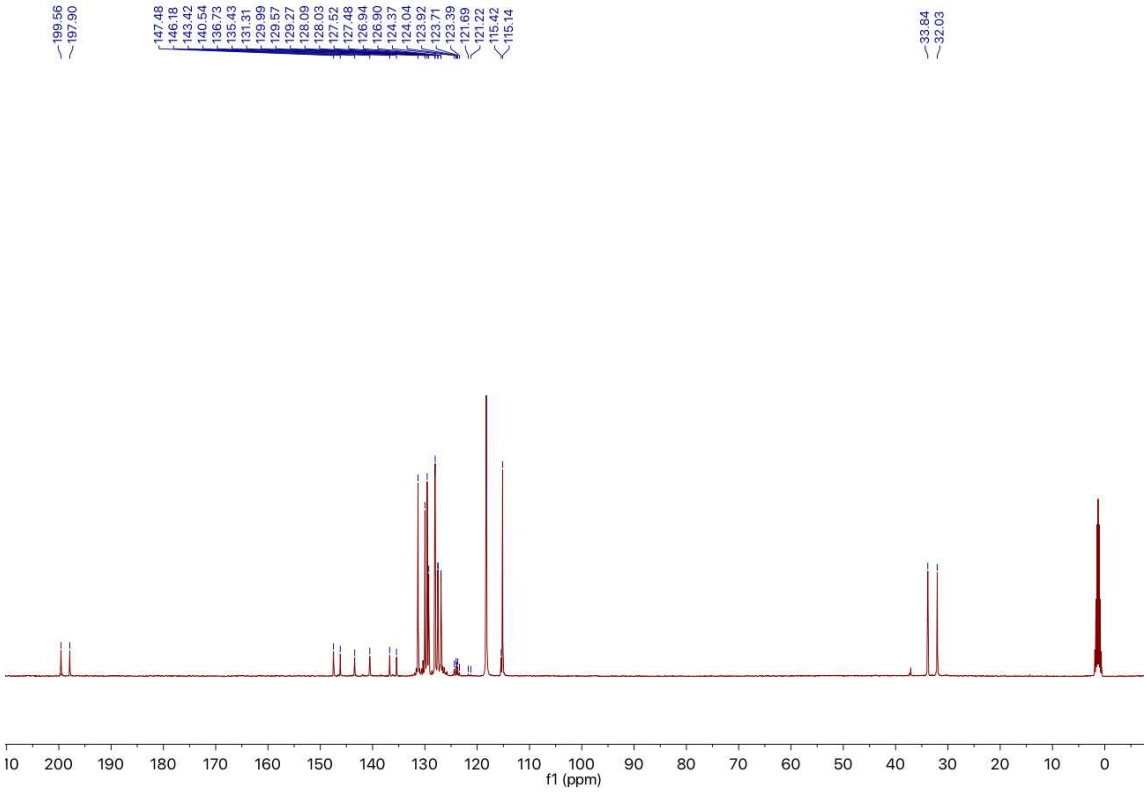
Compound 5ad, ^{19}F NMR (565 MHz, CD_3CN)



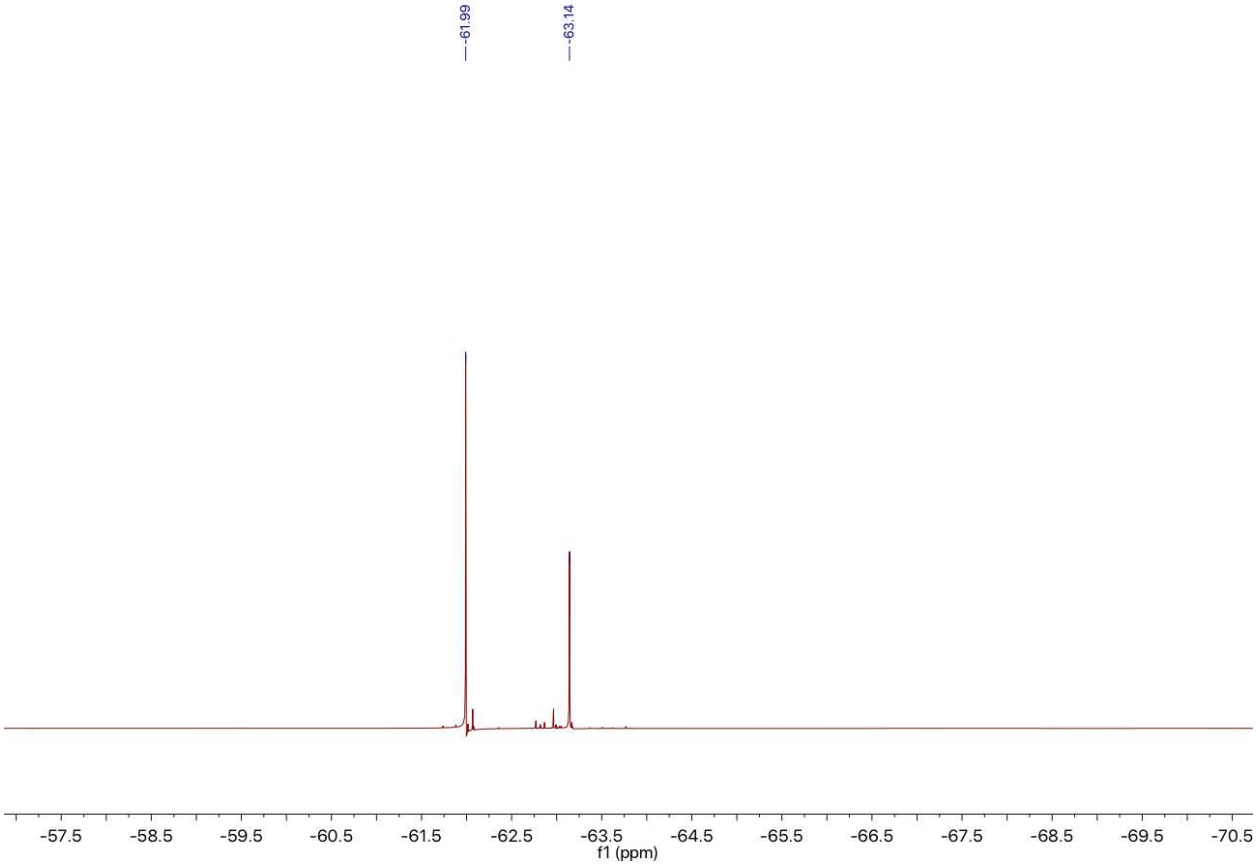
Compound 5ae, ^{1}H NMR (400 MHz, CD_3CN)



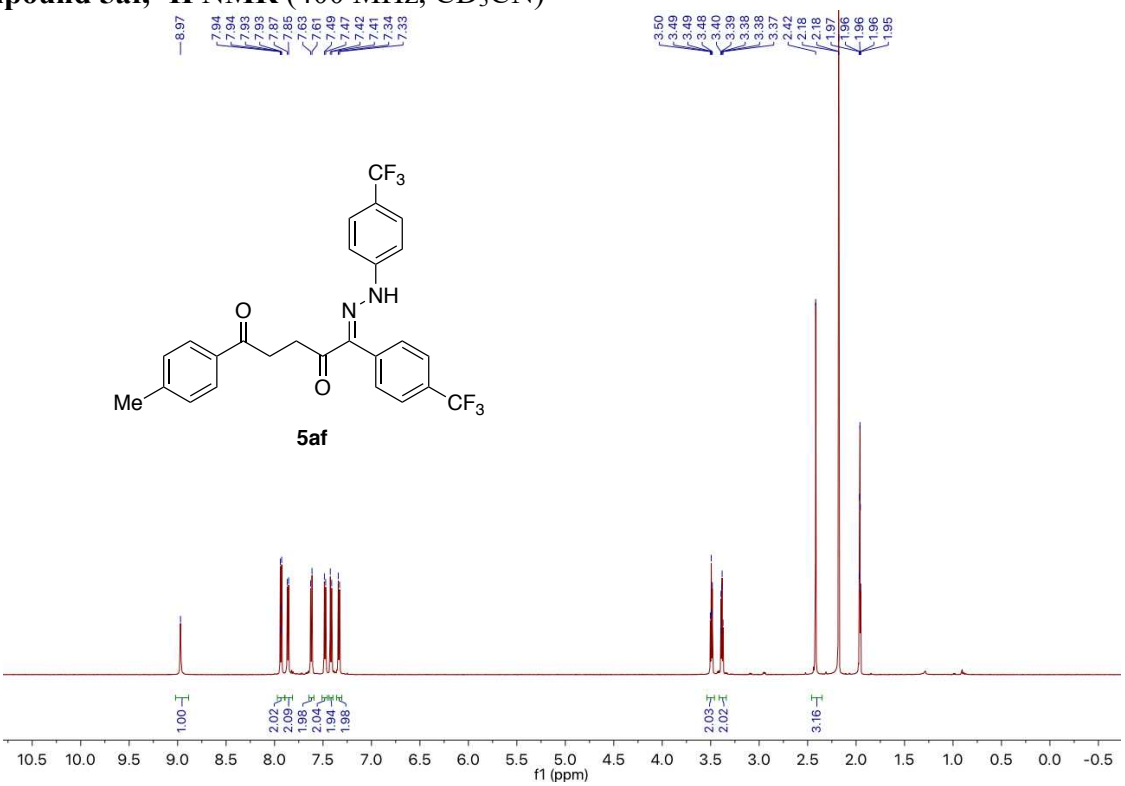
Compound 5ae, ^{13}C NMR (101 MHz, CD_3CN)



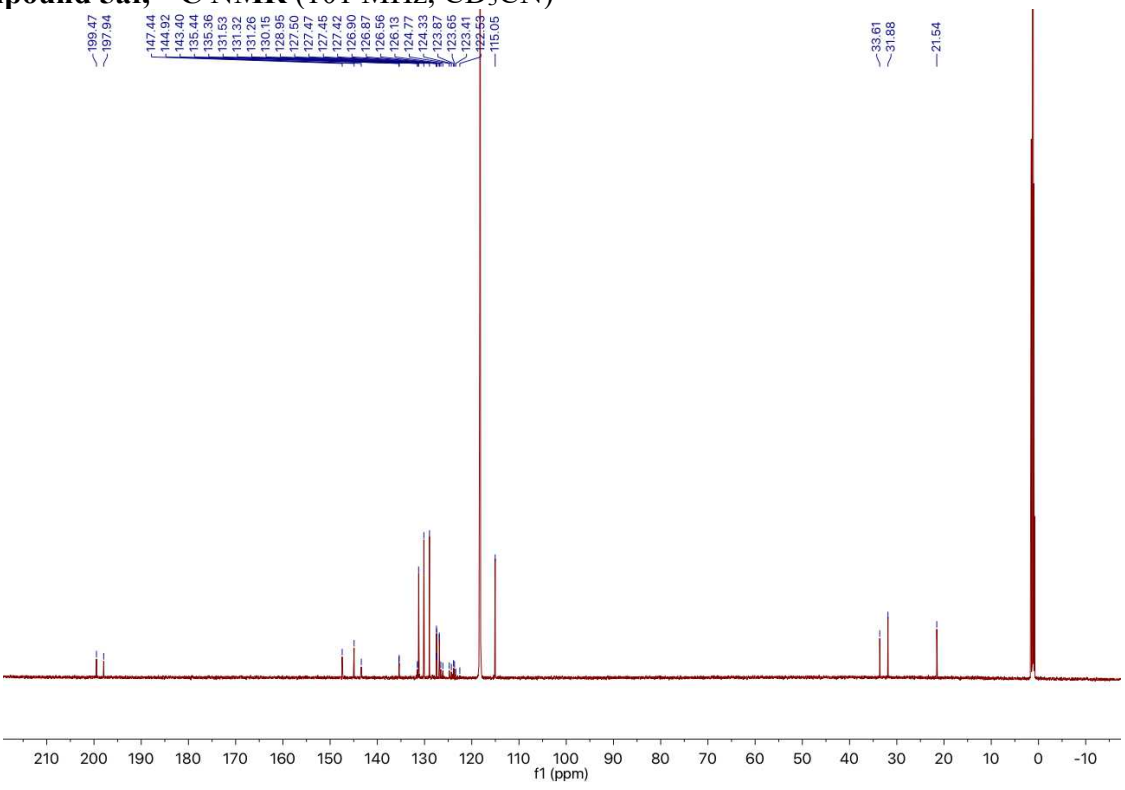
Compound 5ae, ^{19}F NMR (565 MHz, CD_3CN)



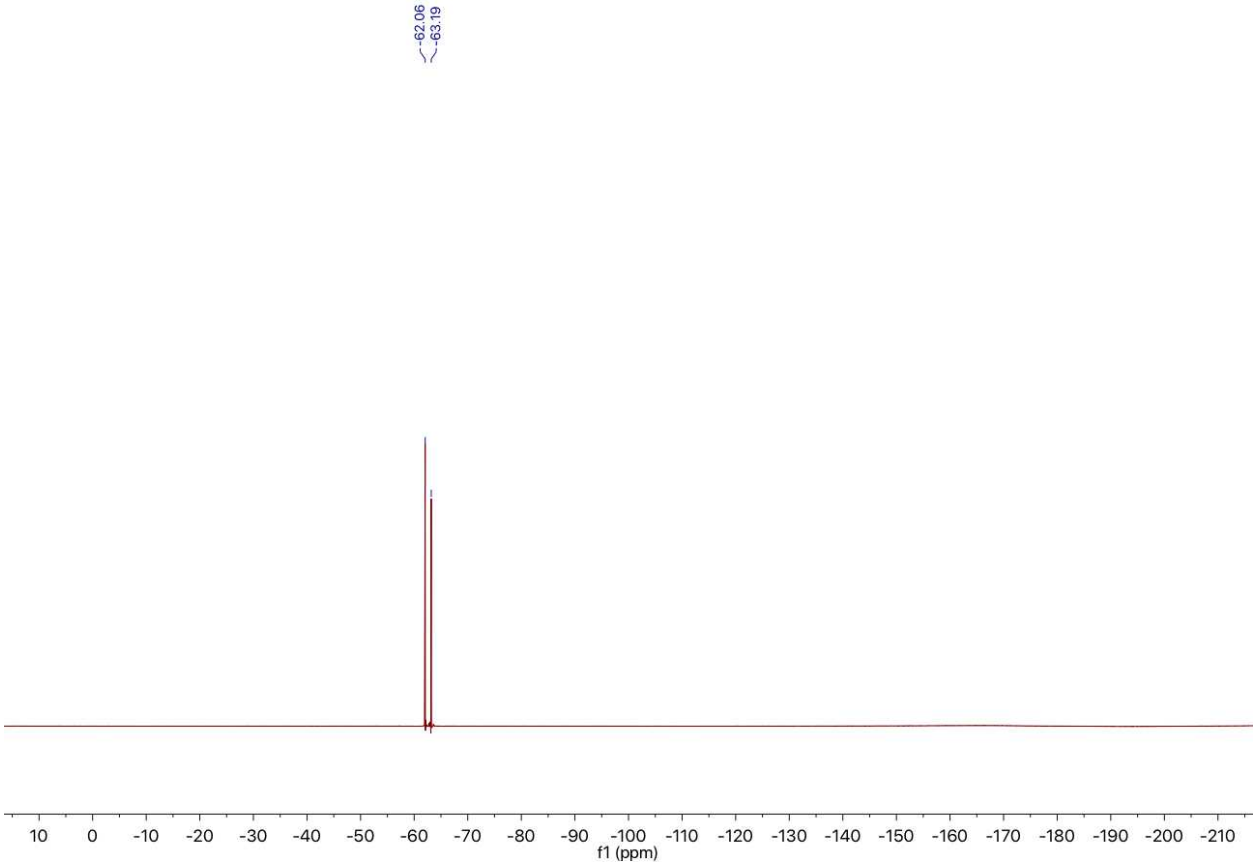
Compound 5af, ^{1}H NMR (400 MHz, CD_3CN)



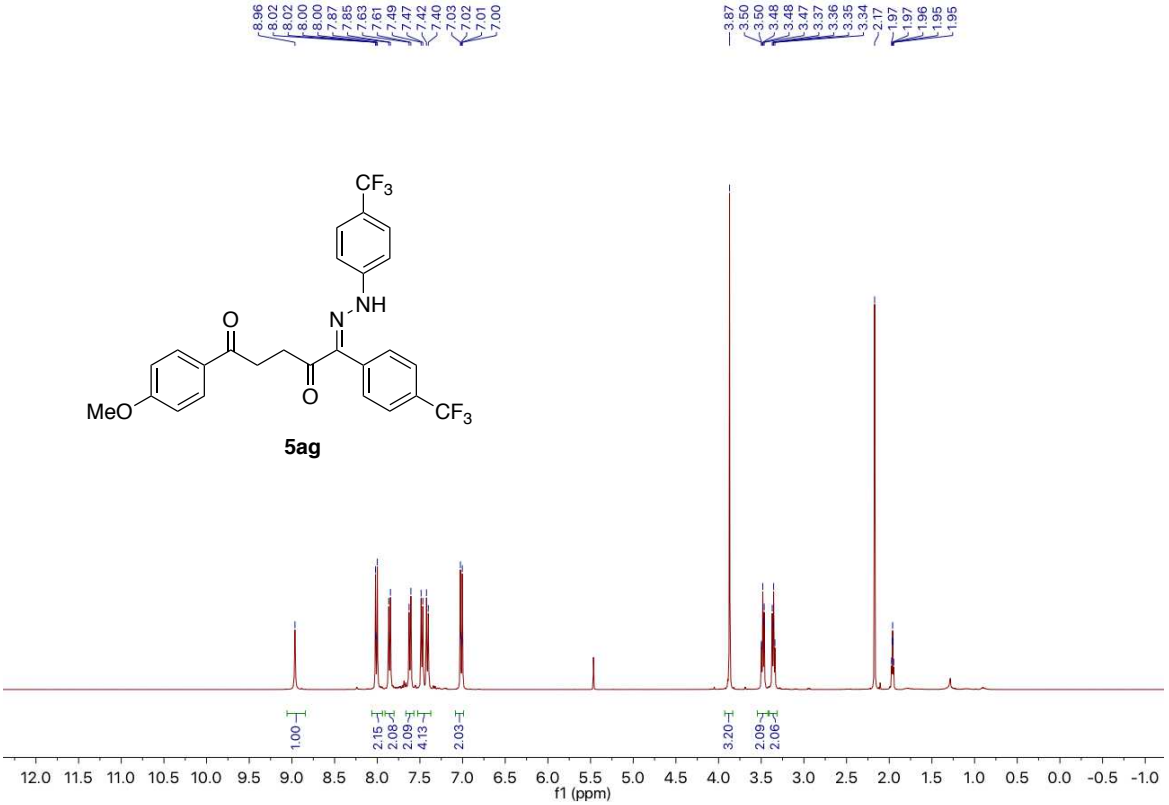
Compound 5af, ^{13}C NMR (101 MHz, CD_3CN)



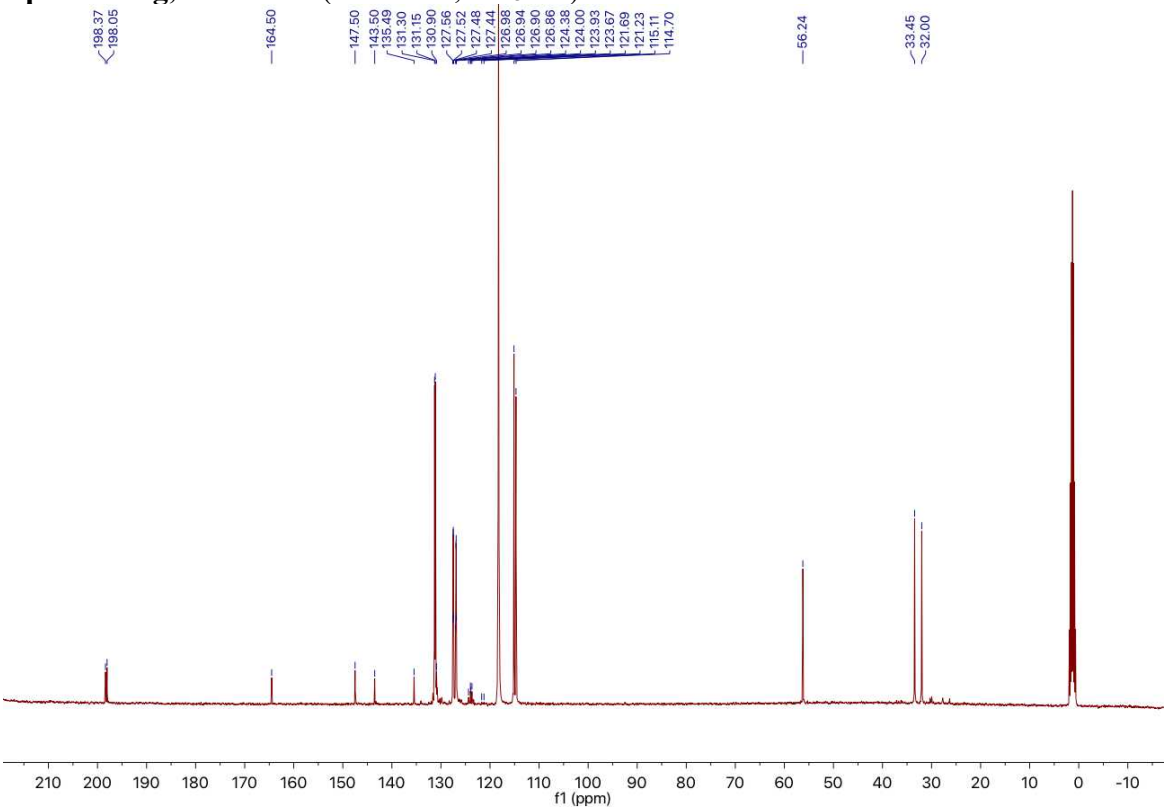
Compound 5af, ^{19}F NMR (565 MHz, CD_3CN)



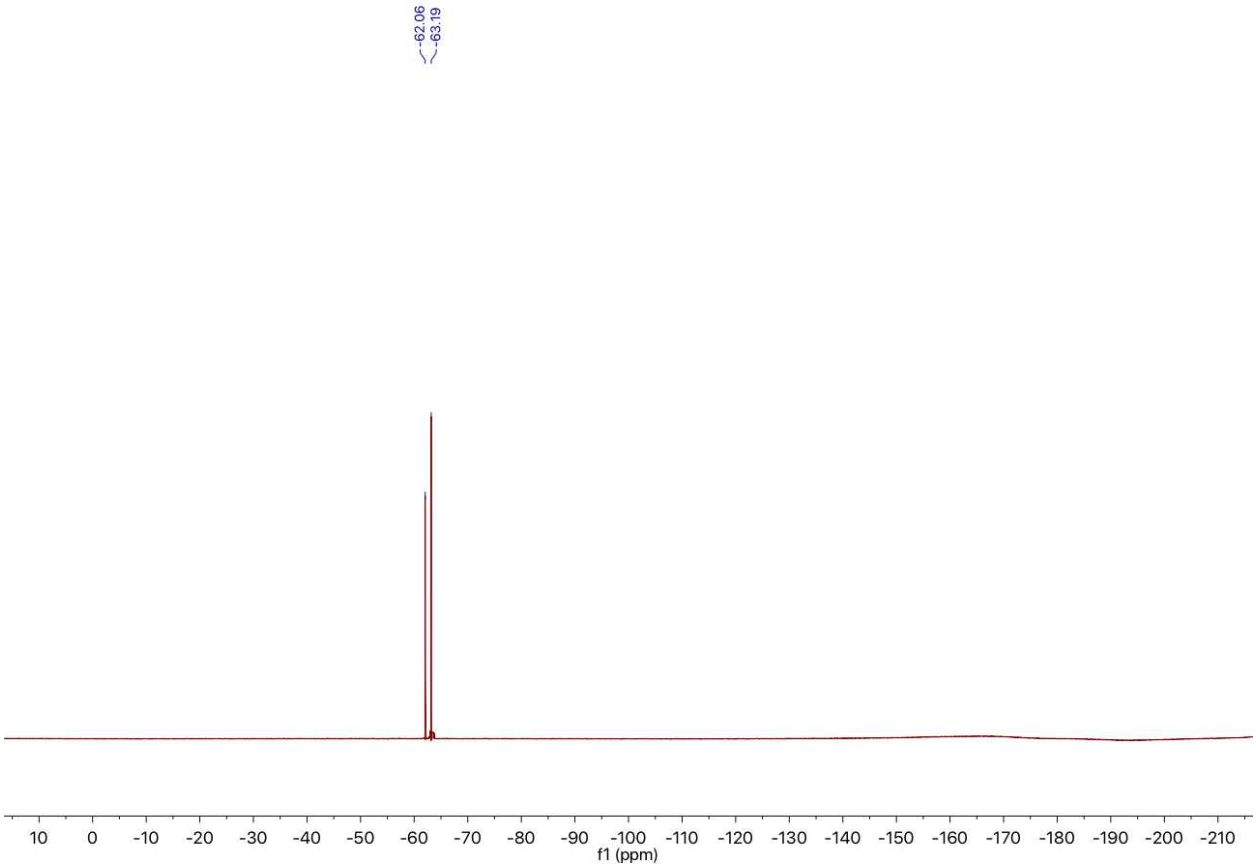
Compound 5ag, ^{1}H NMR (400 MHz, CD_3CN)



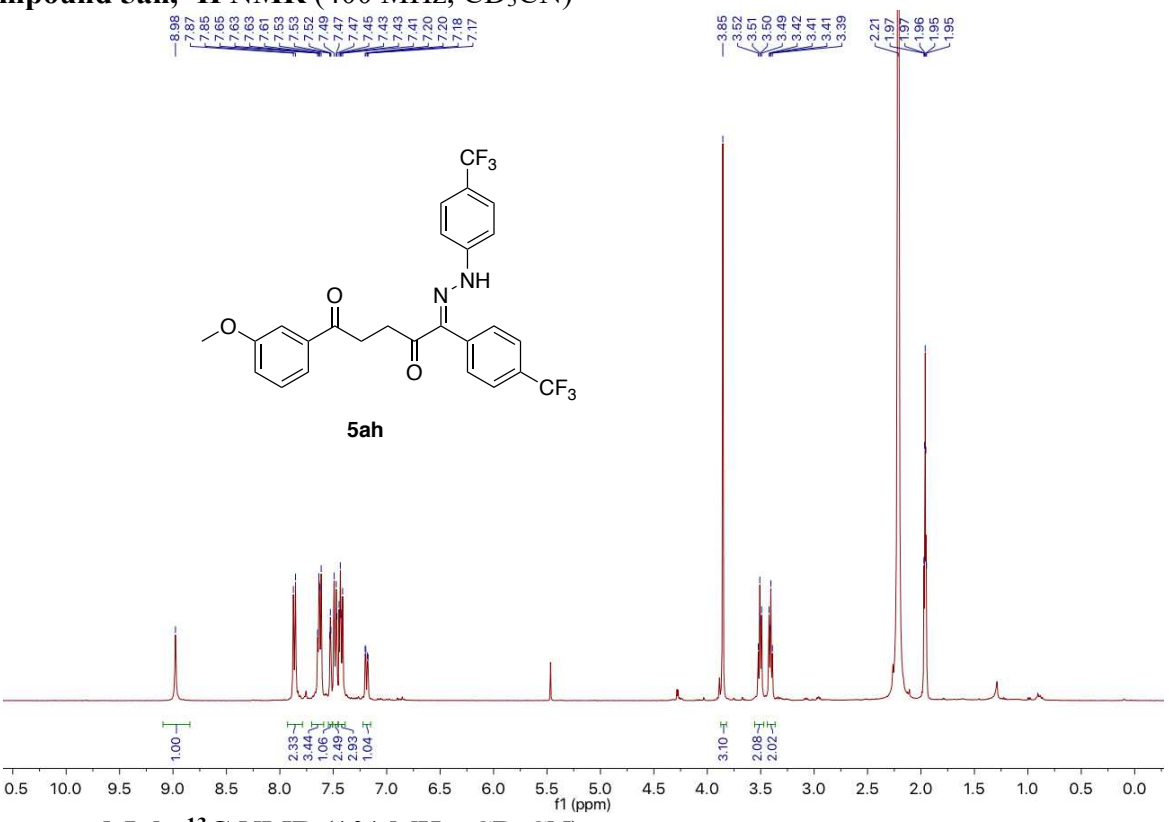
Compound 5ag, ^{13}C NMR (101 MHz, CD_3CN)



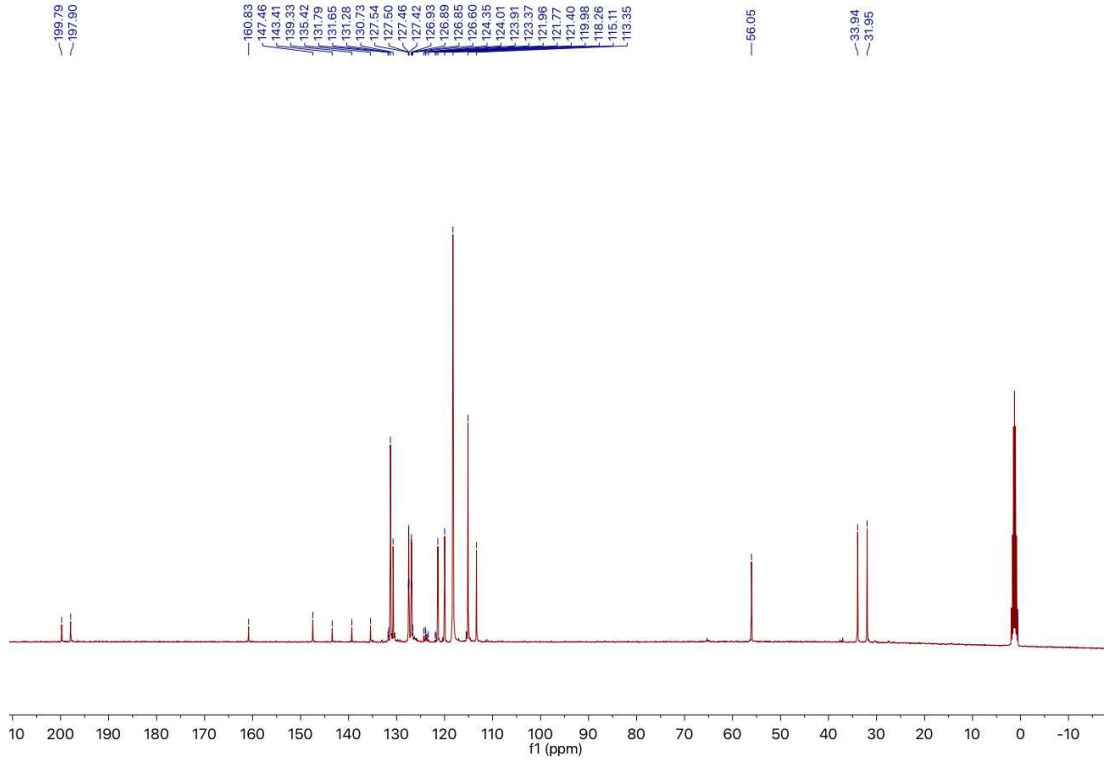
Compound 5ag, ^{19}F NMR (565 MHz, CD_3CN)


-62.06
-63.19
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)

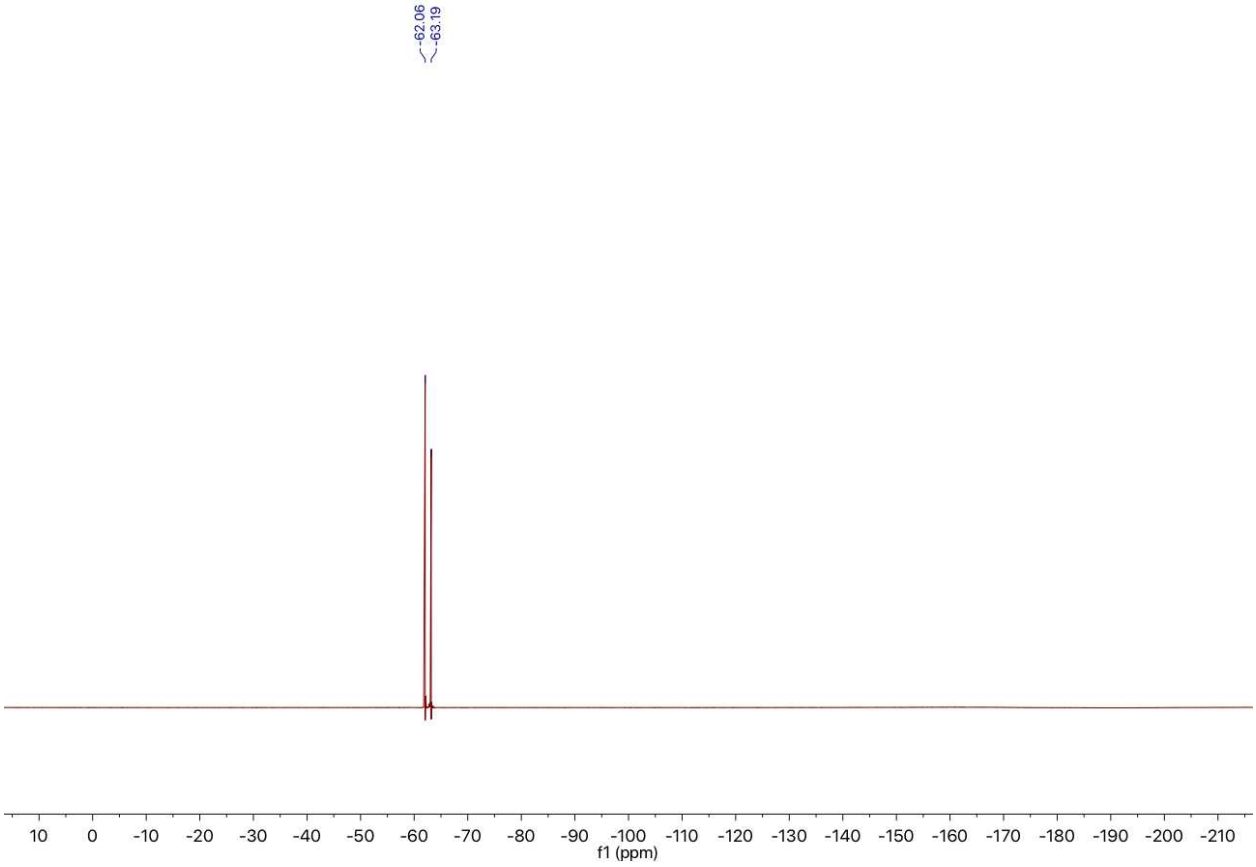
Compound 5ah, ^{1}H NMR (400 MHz, CD_3CN)



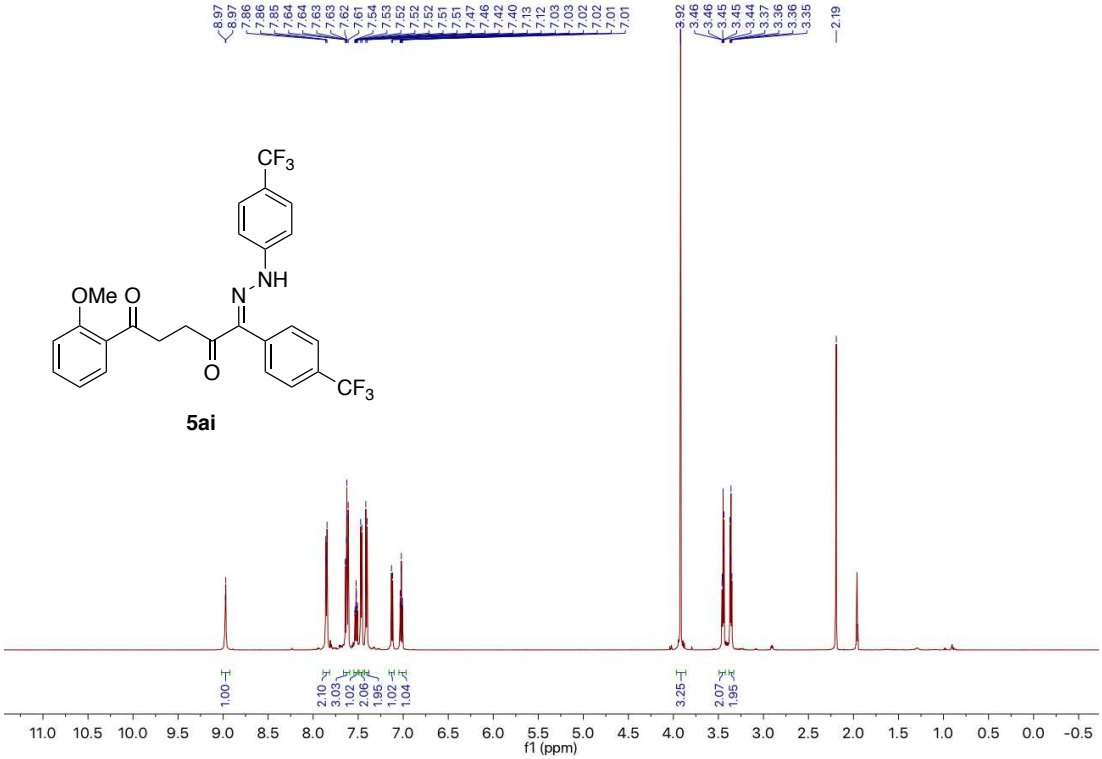
Compound 5ah, ^{13}C NMR (101 MHz, CD_3CN)



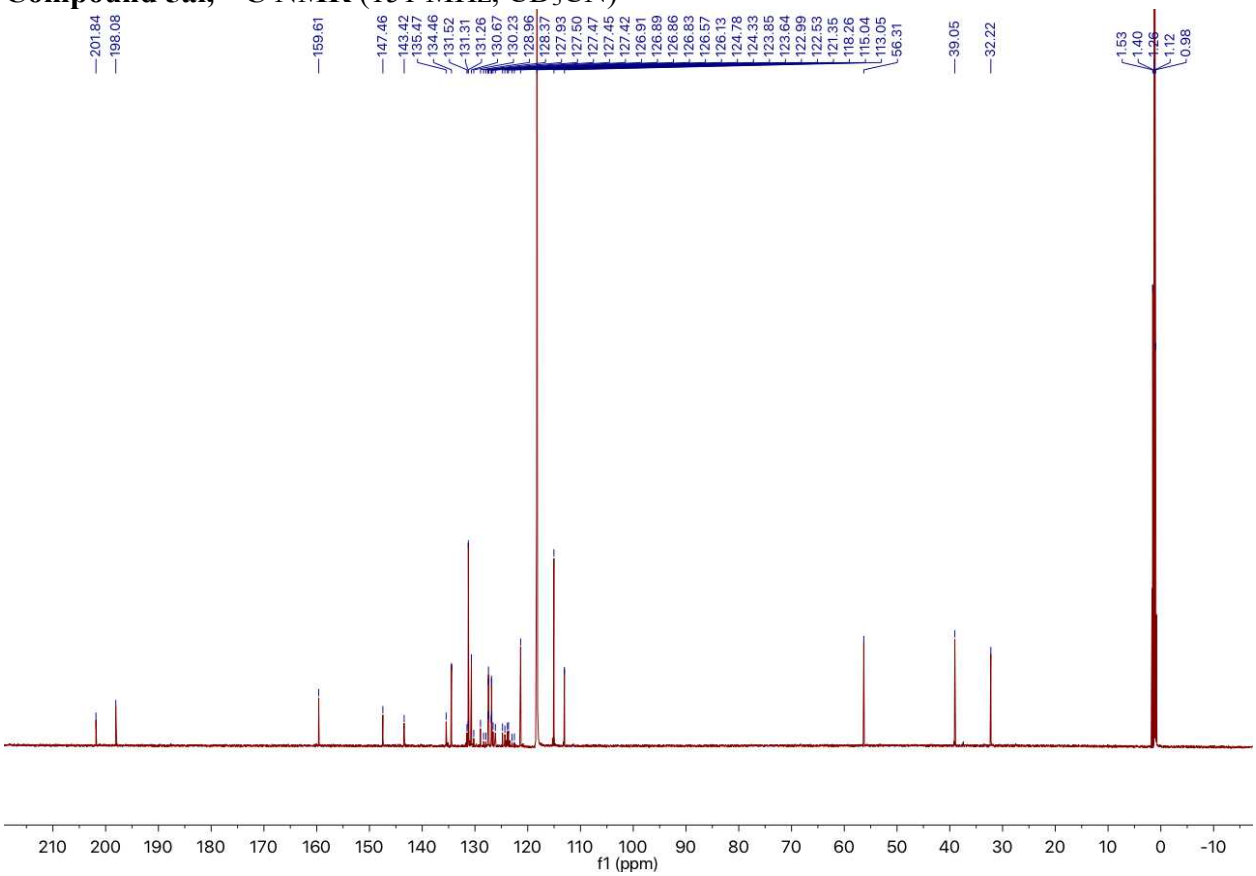
Compound 5ah, ^{19}F NMR (565 MHz, CD_3CN)



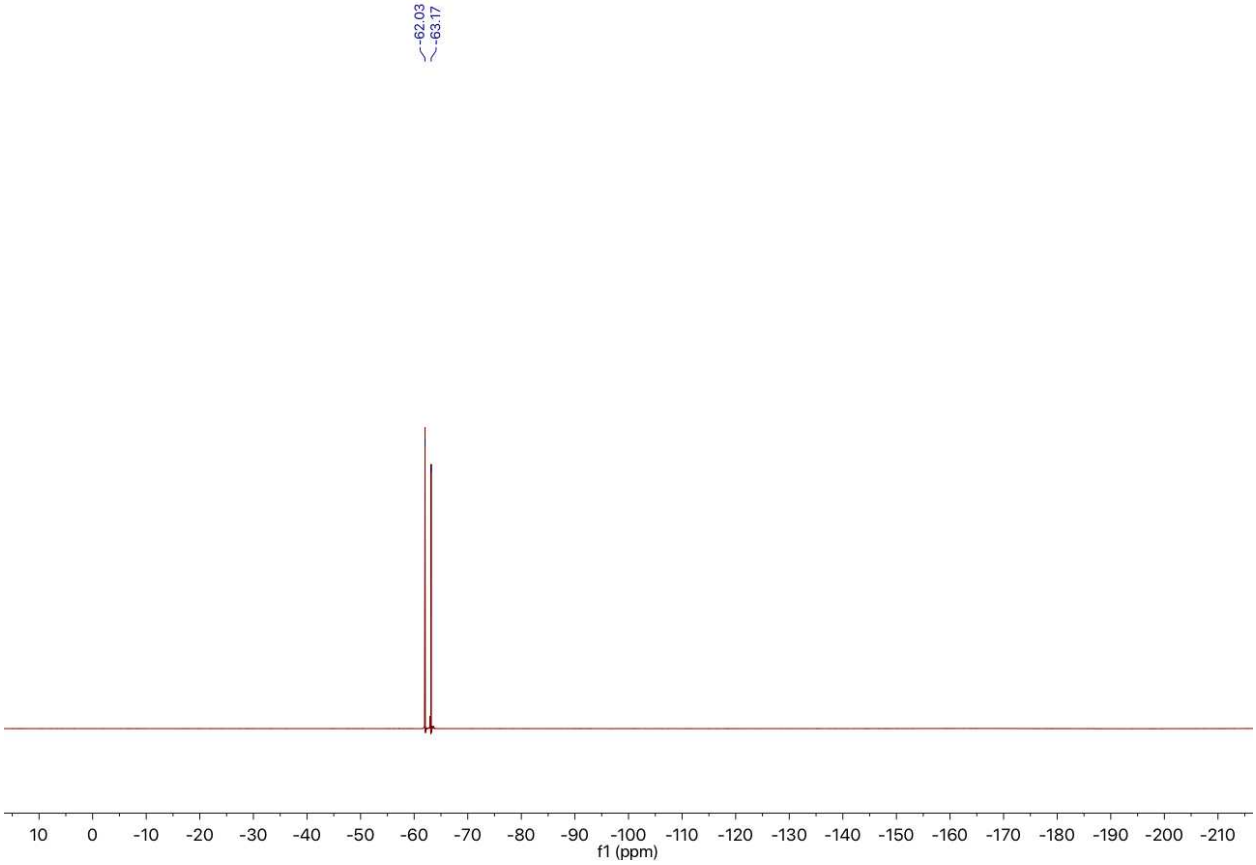
Compound 5ai, ^{1}H NMR (600 MHz, CD_3CN)



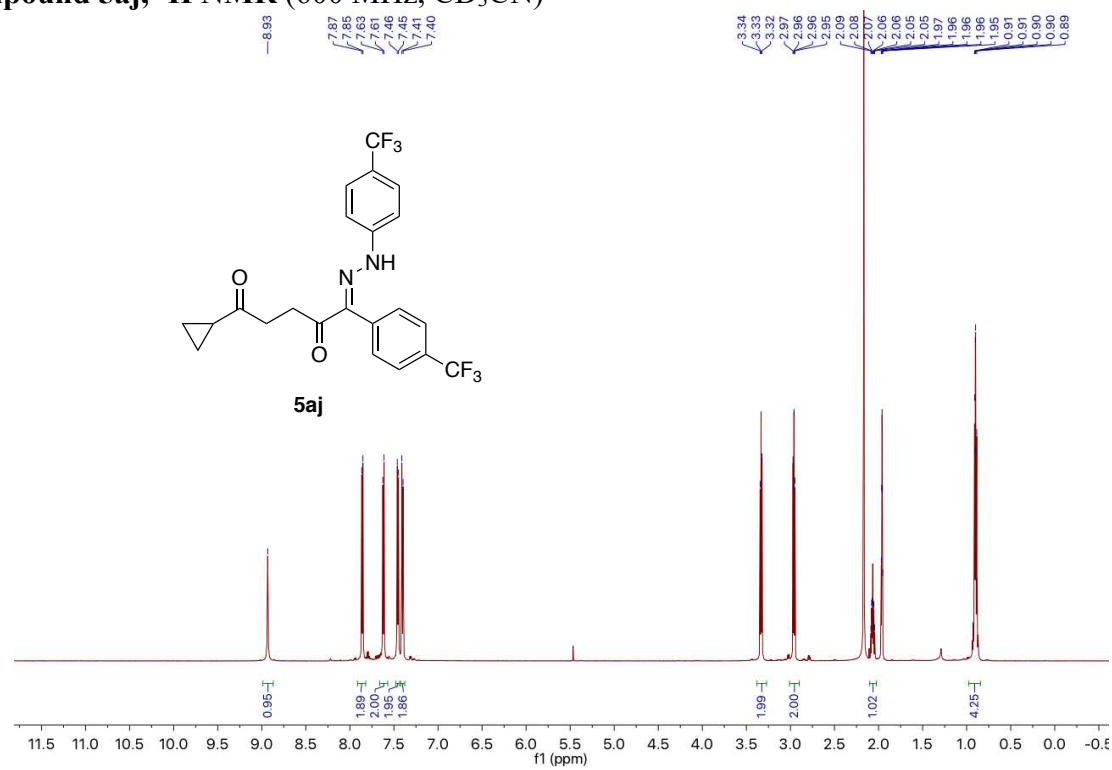
Compound 5ai, ^{13}C NMR (151 MHz, CD_3CN)



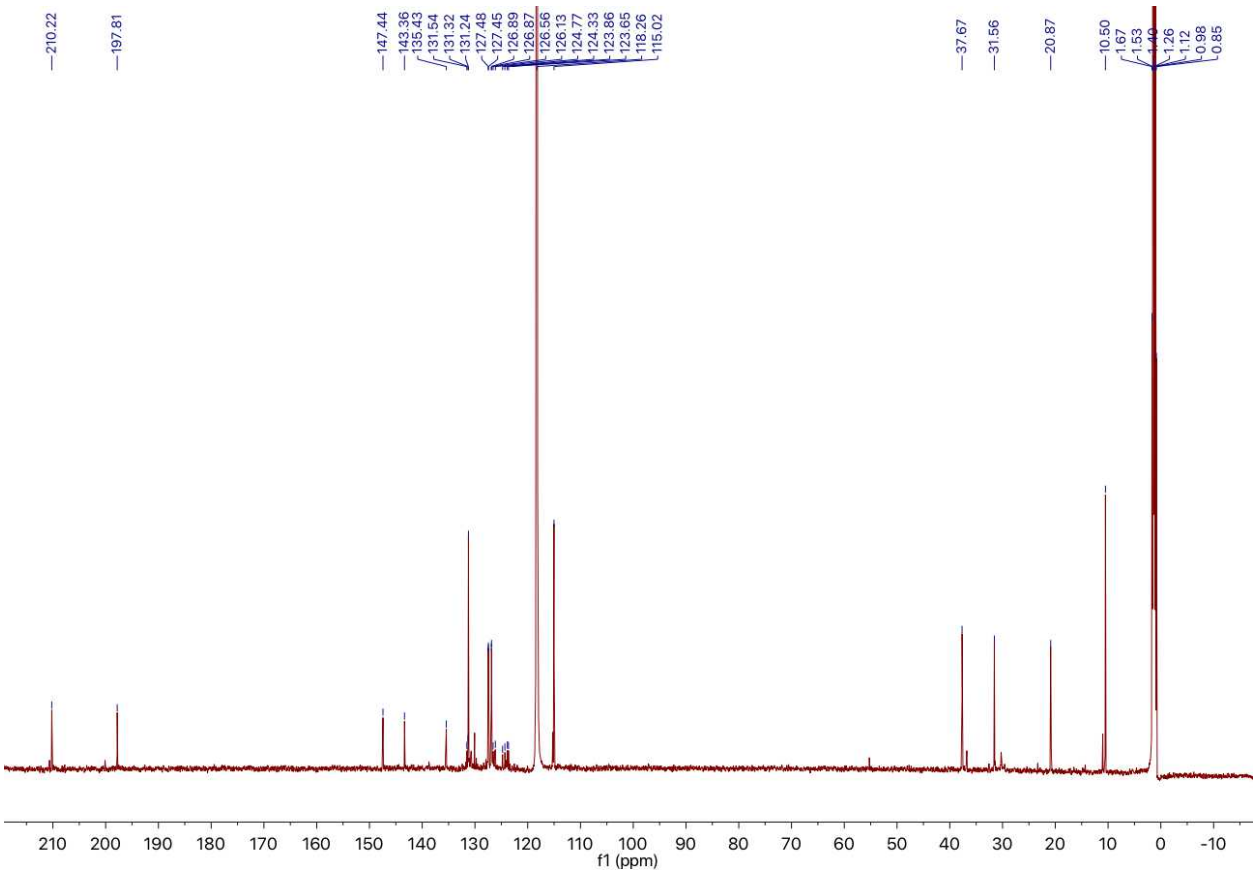
Compound 5ai, ^{19}F NMR (565 MHz, CD_3CN)



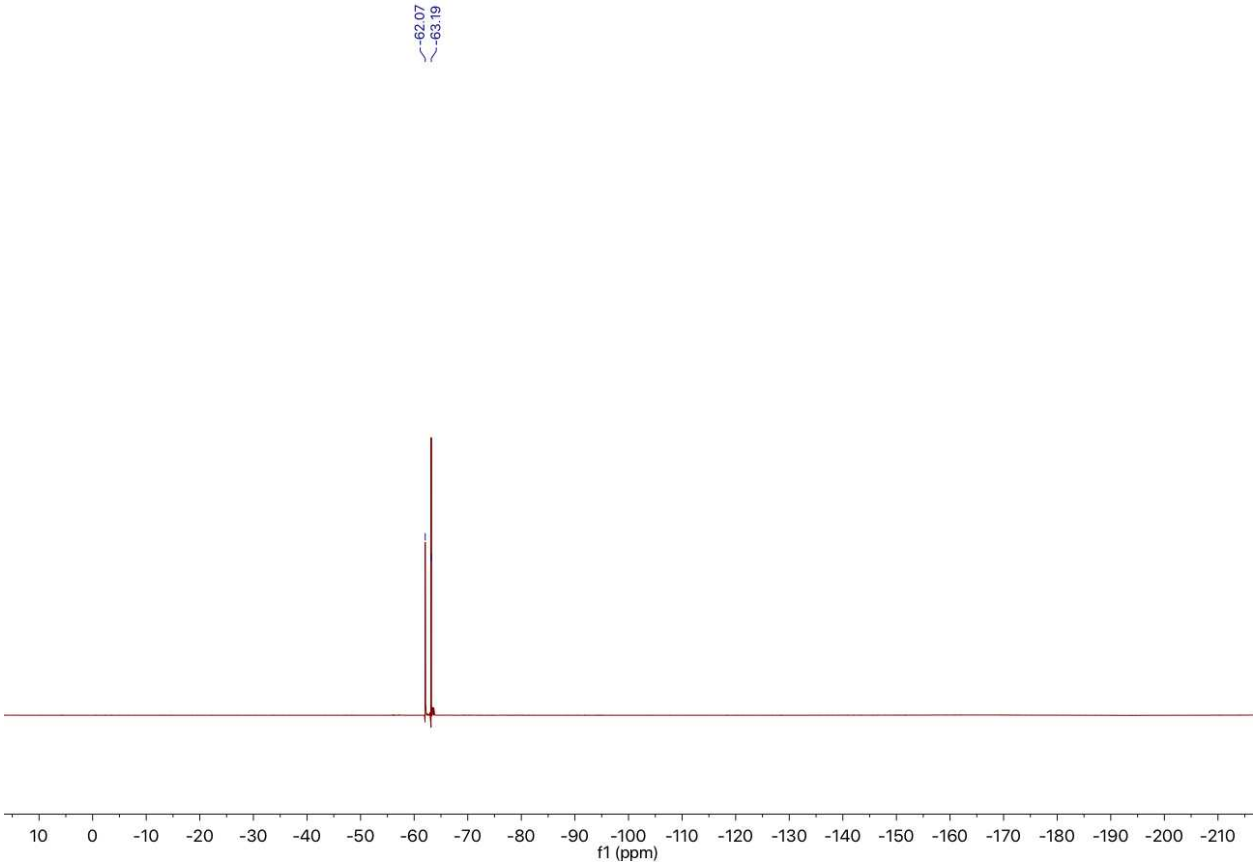
Compound 5aj, ^{1}H NMR (600 MHz, CD_3CN)



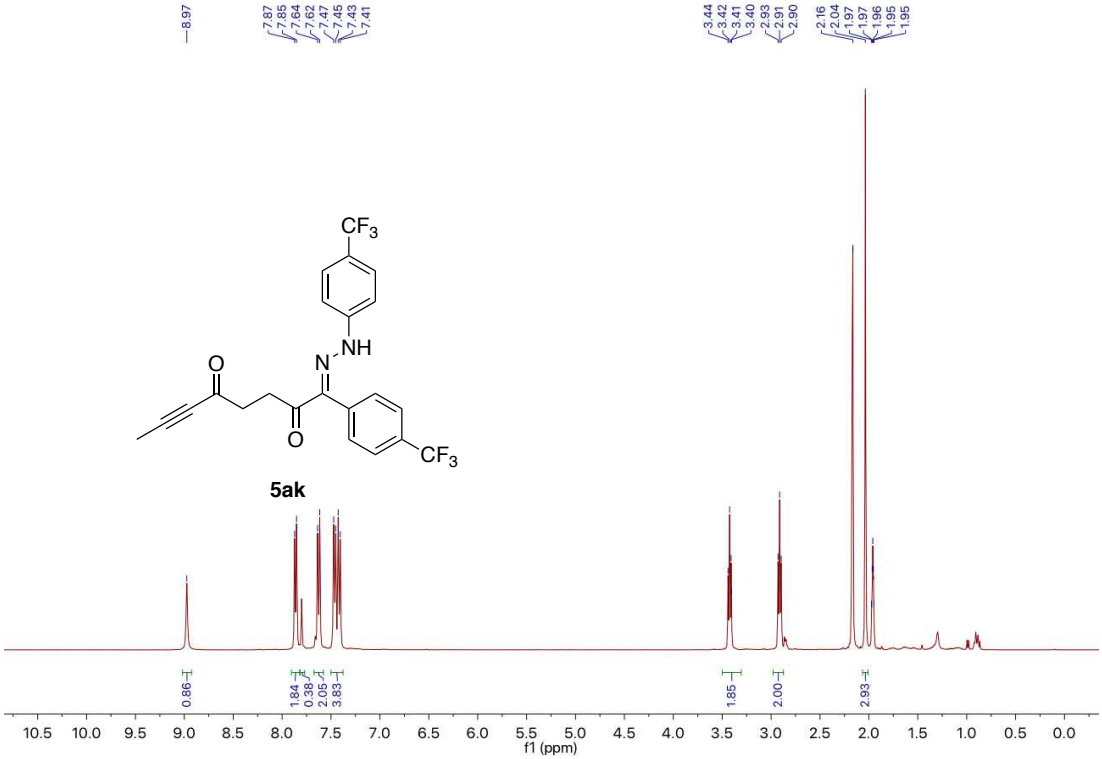
Compound 5aj, ^{13}C NMR (151 MHz, CD_3CN)



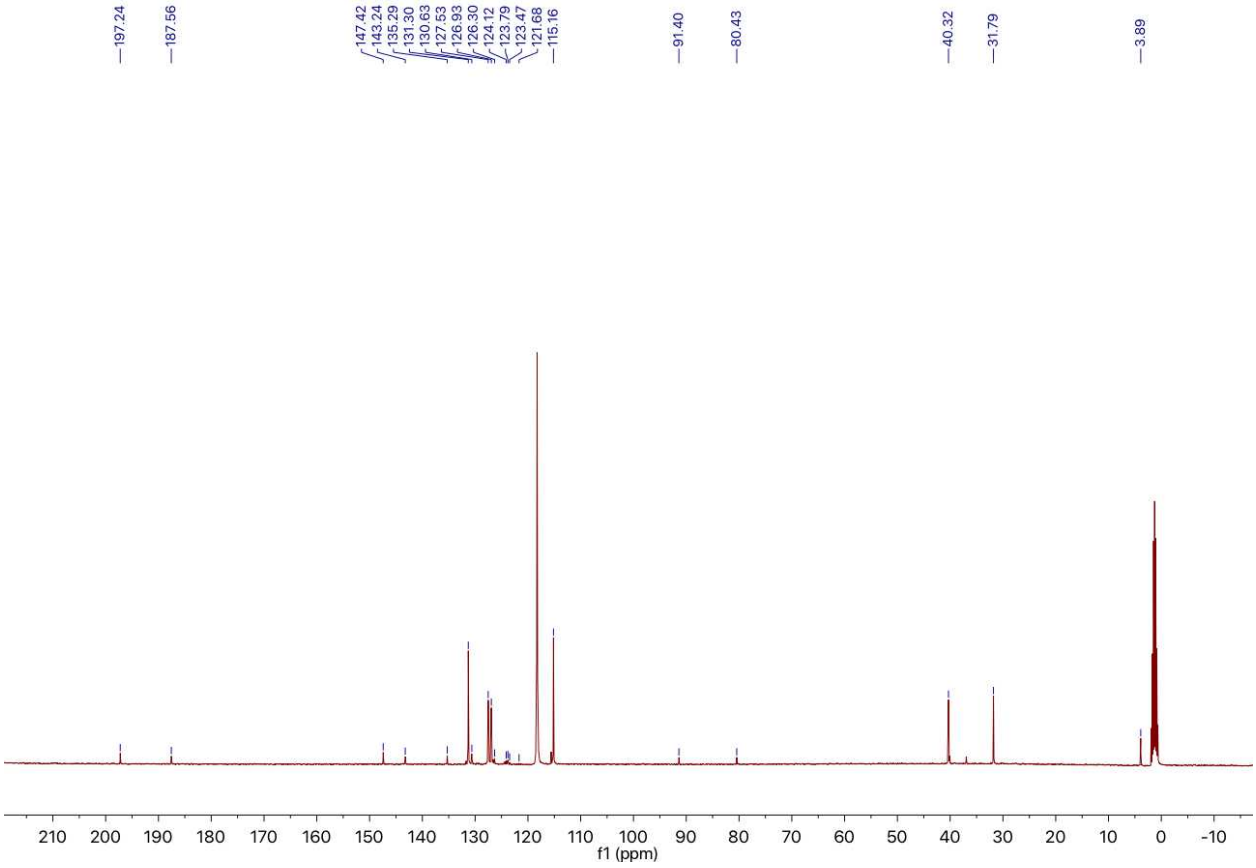
Compound 5aj, ^{19}F NMR (565 MHz, CD_3CN)



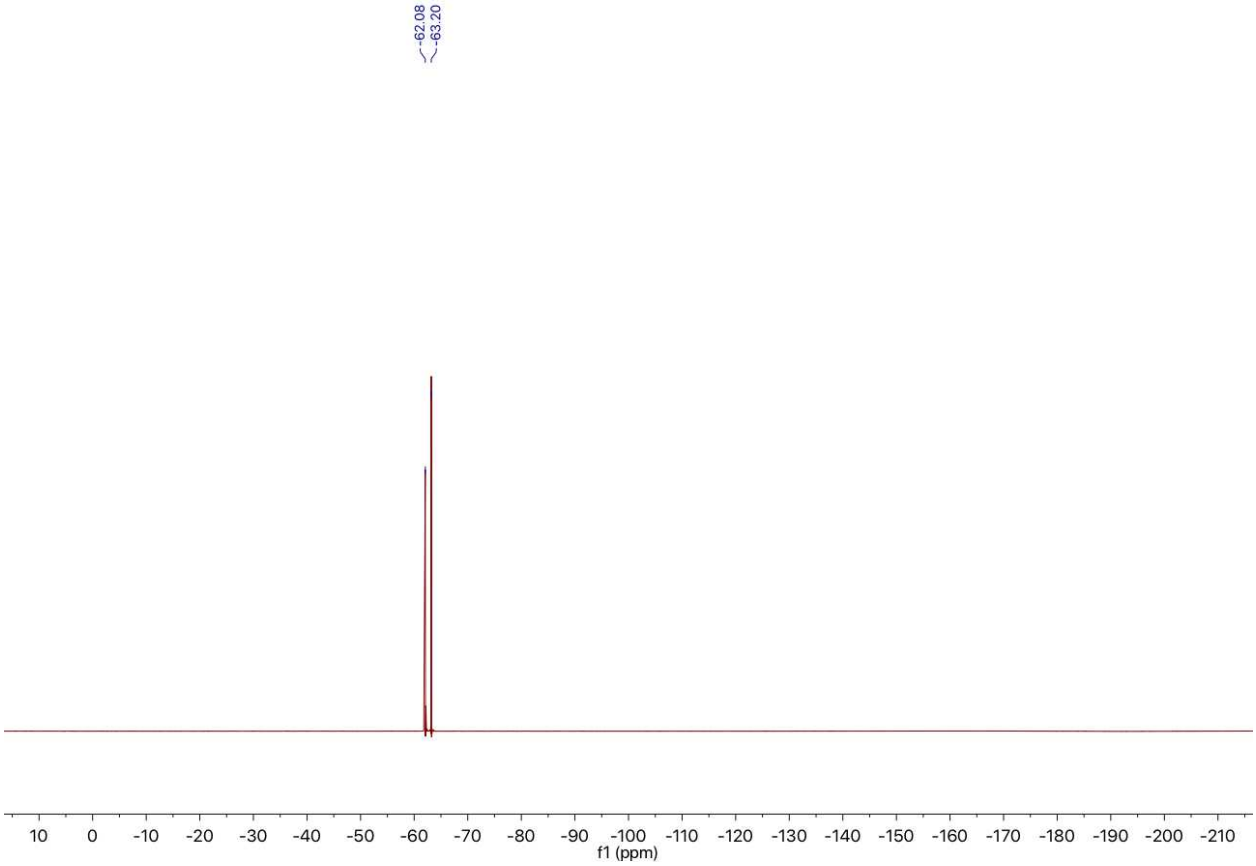
Compound 5ak, ^{1}H NMR (400 MHz, CD_3CN)



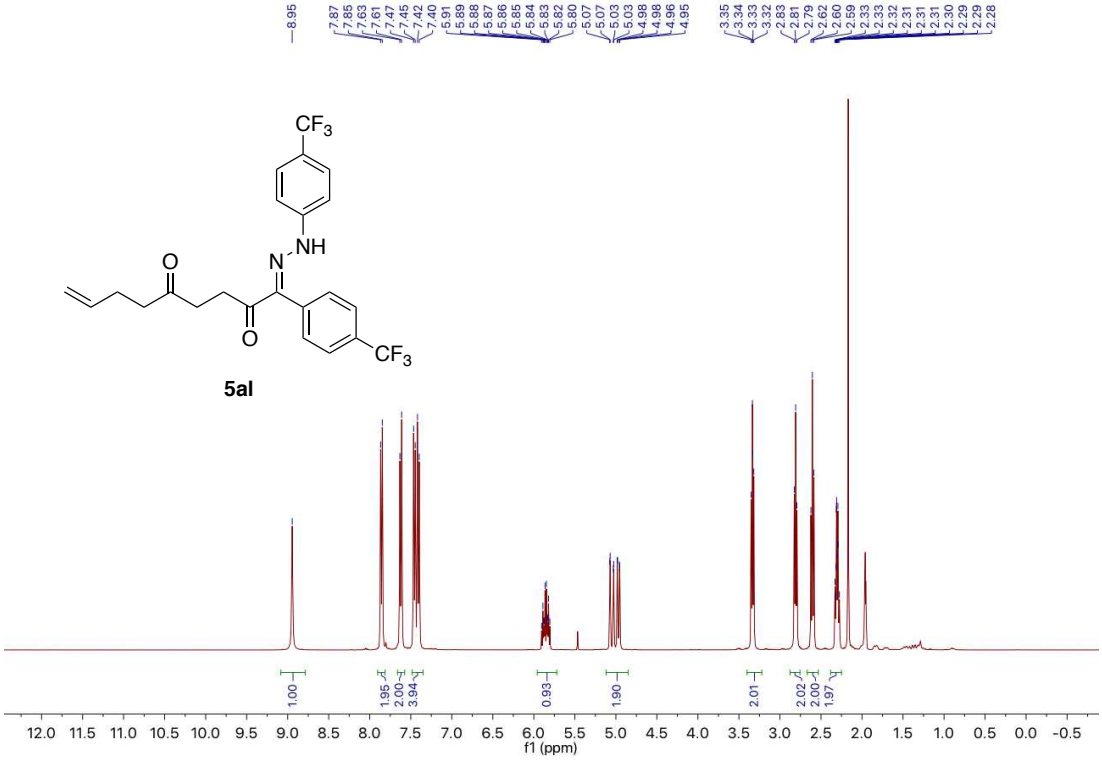
Compound 5ak, ^{13}C NMR (101 MHz, CD_3CN)



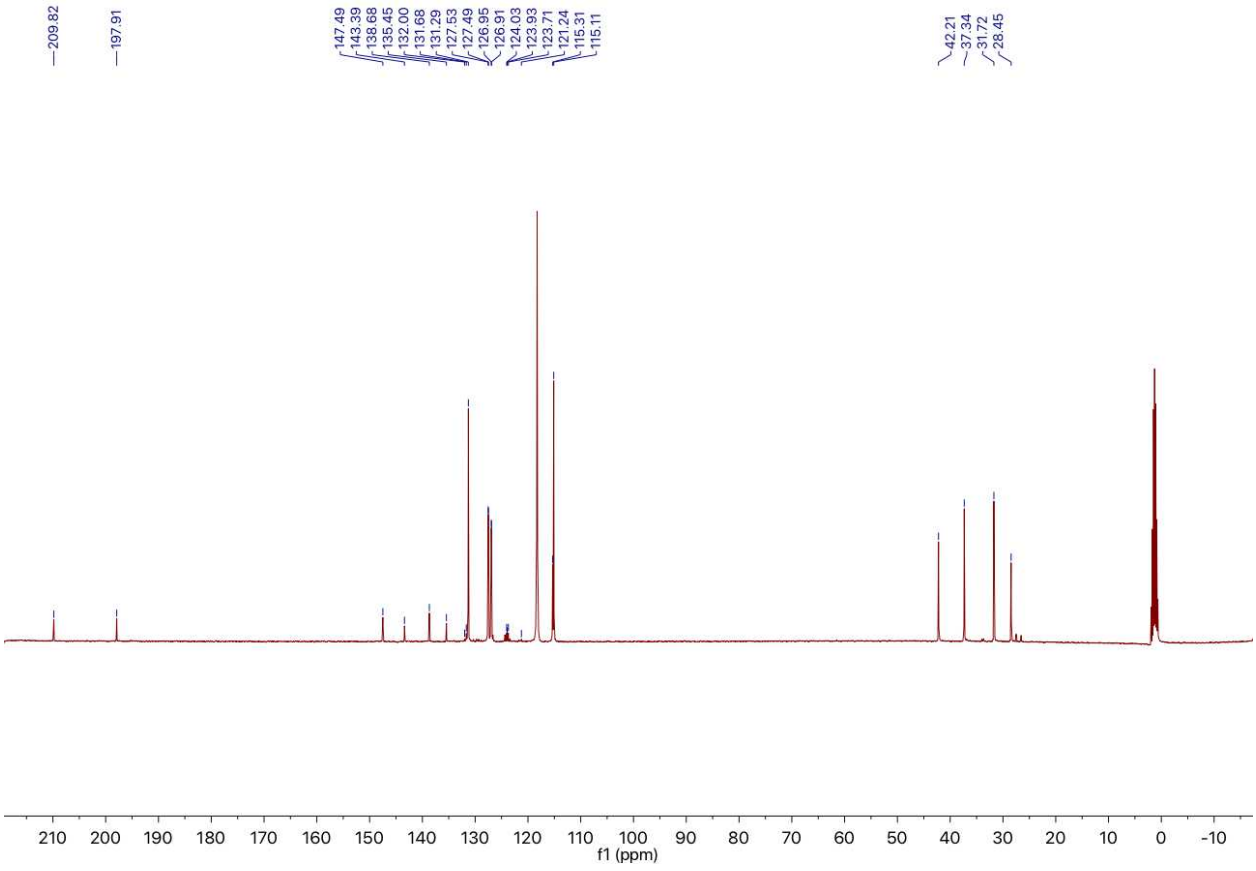
Compound 5ak, ^{19}F NMR (565 MHz, CD_3CN)



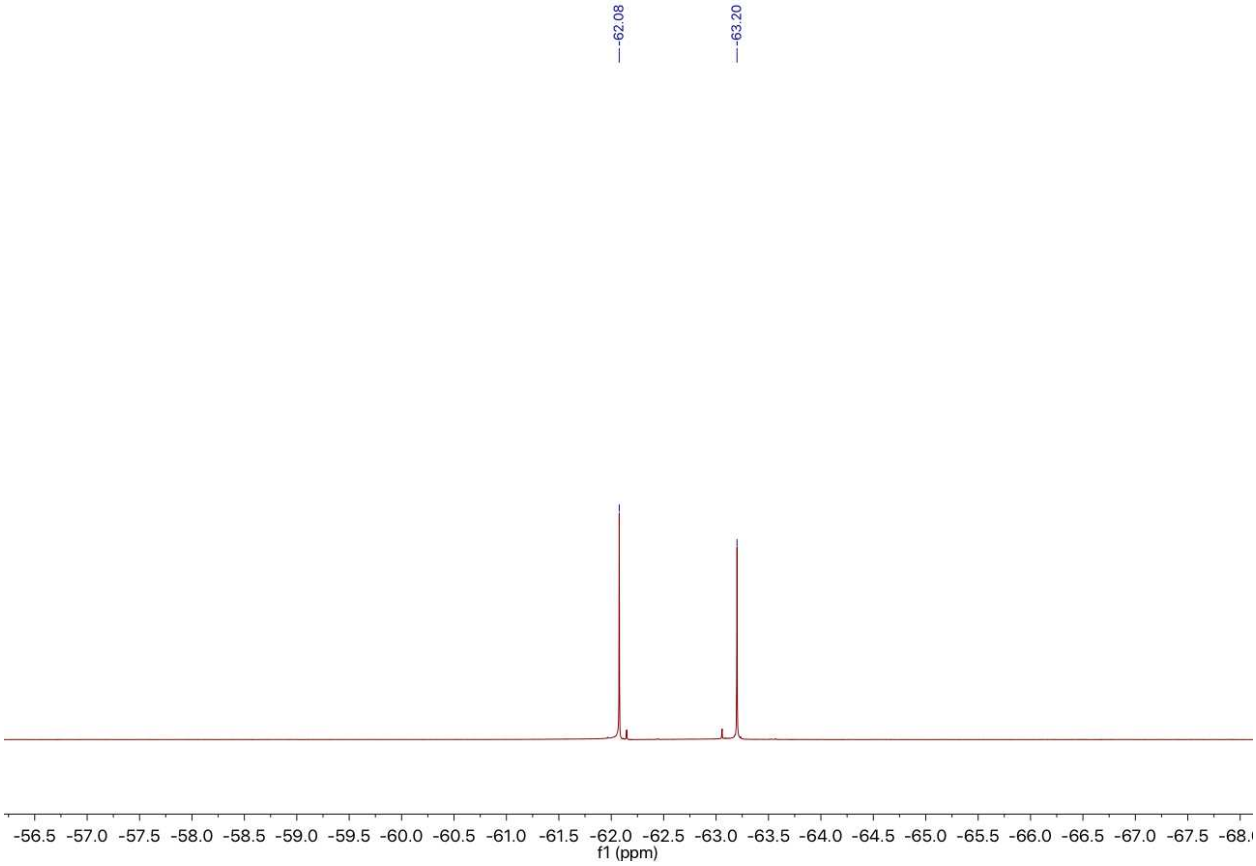
Compound 5al, ^{1}H NMR (400 MHz, CD_3CN)



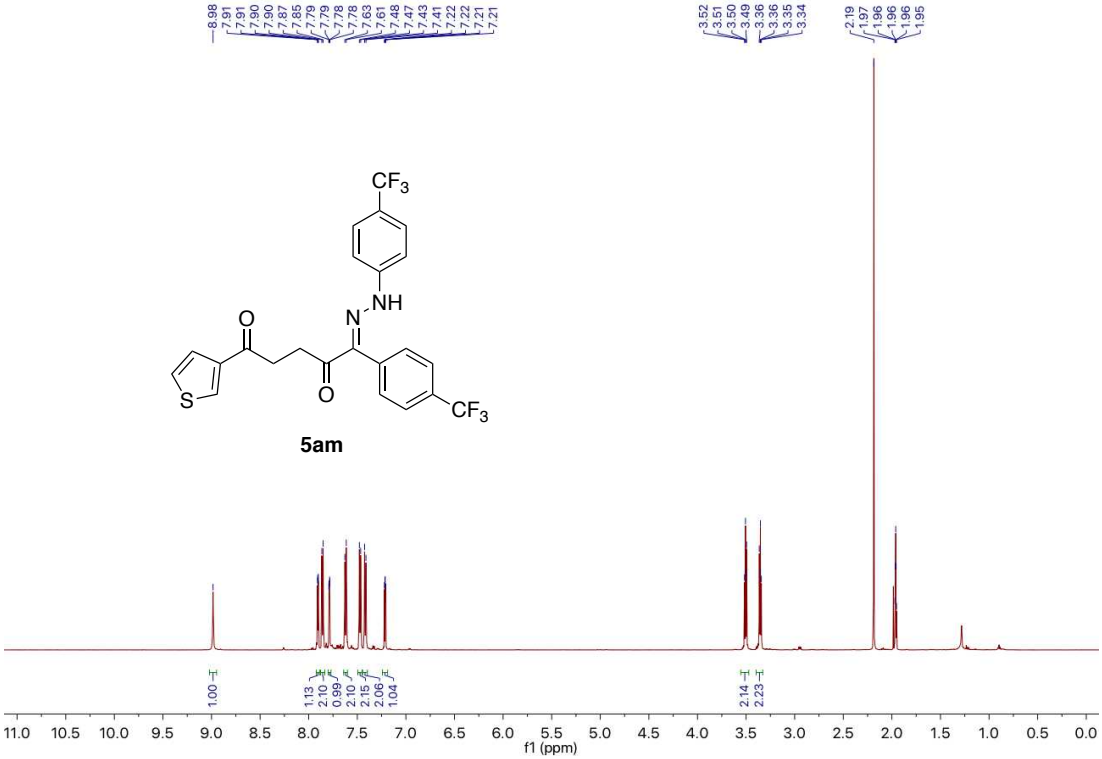
Compound 5al, ^{13}C NMR (101 MHz, CD_3CN)



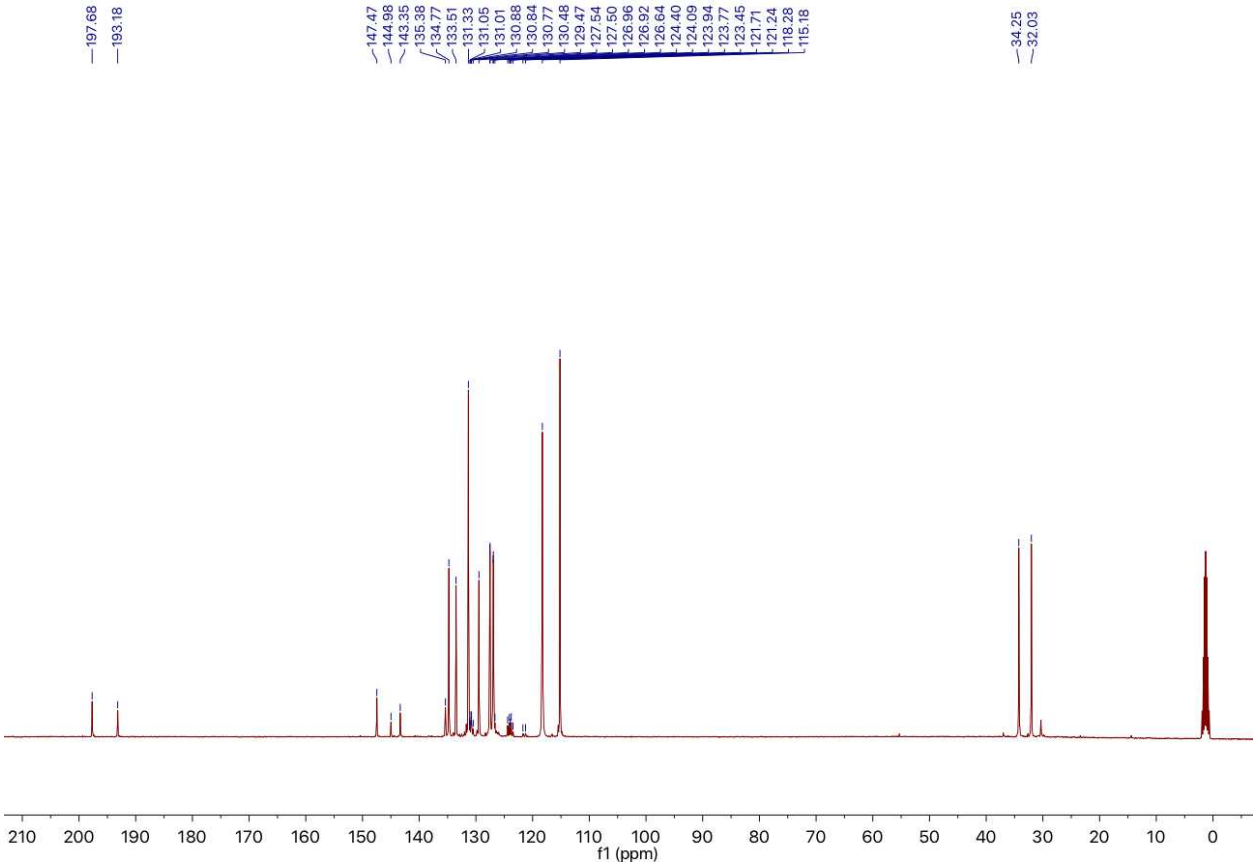
Compound 5al, ^{19}F NMR (565 MHz, CD_3CN)



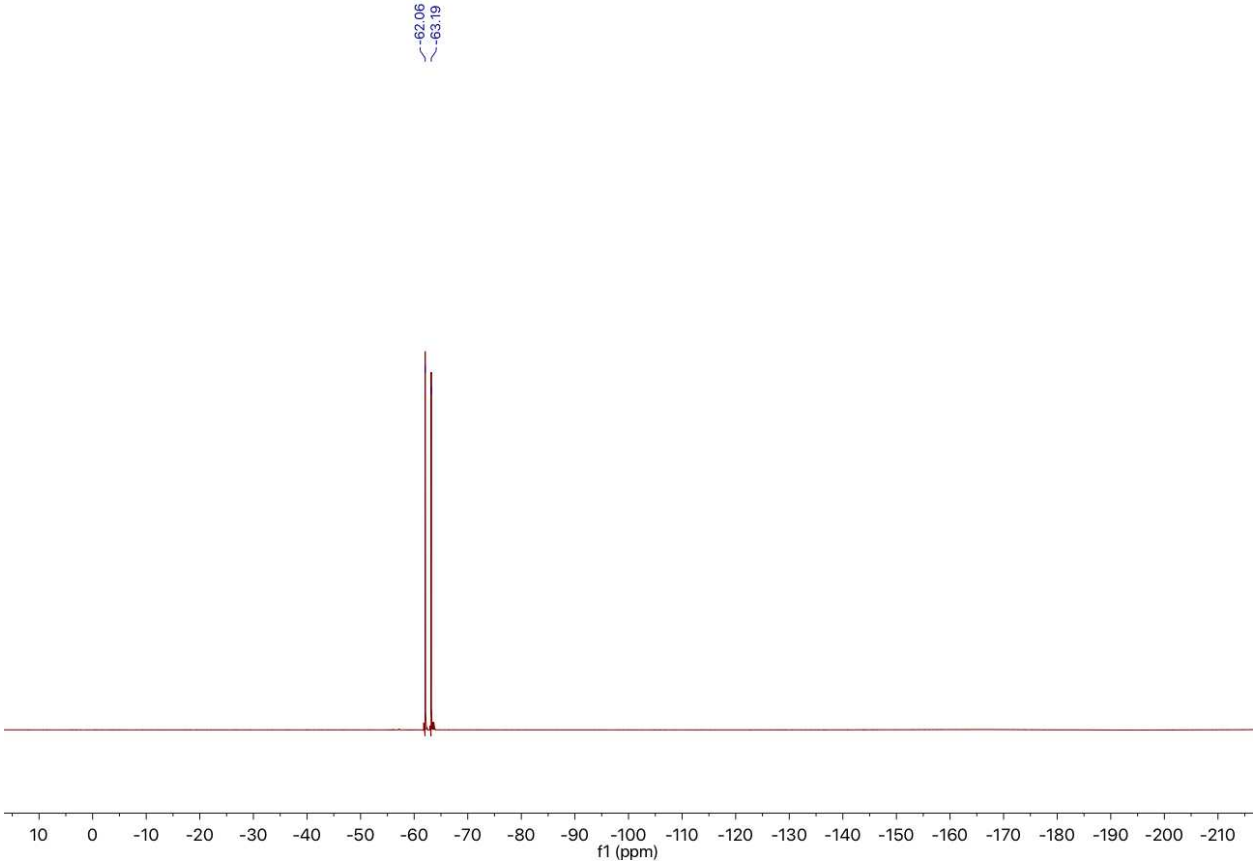
Compound 5am, ^{1}H NMR (600 MHz, CD_3CN)



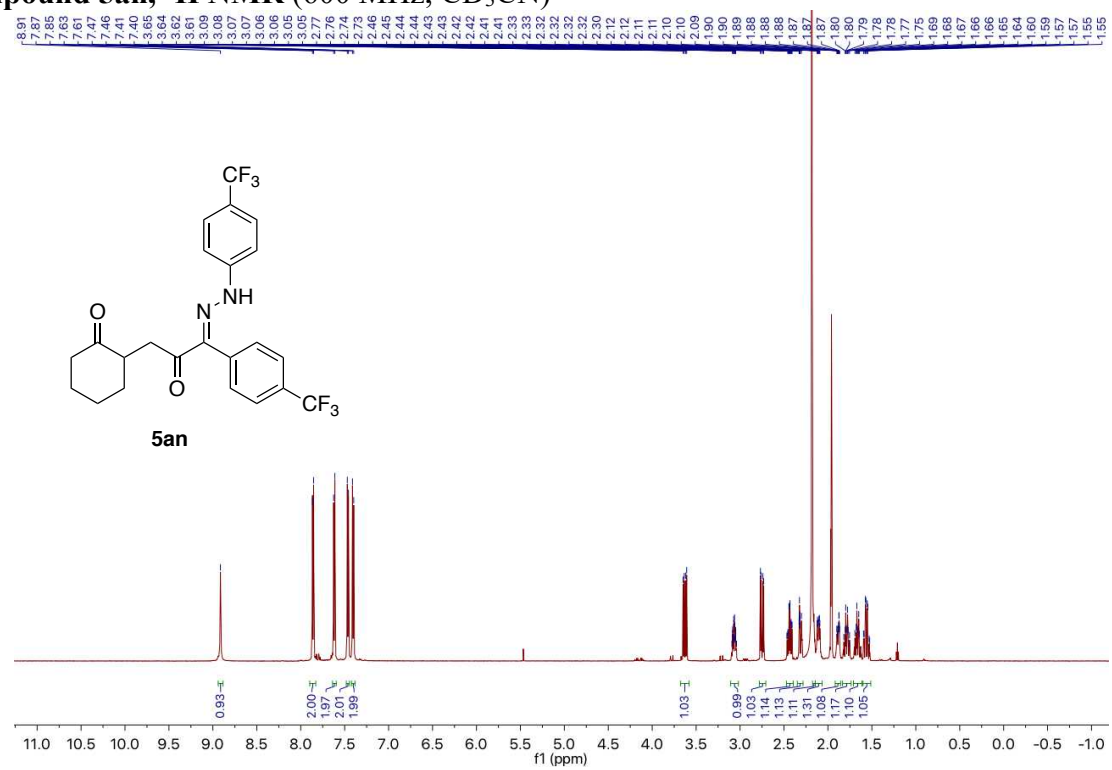
Compound 5am, ^{13}C NMR (101 MHz, CD_3CN)



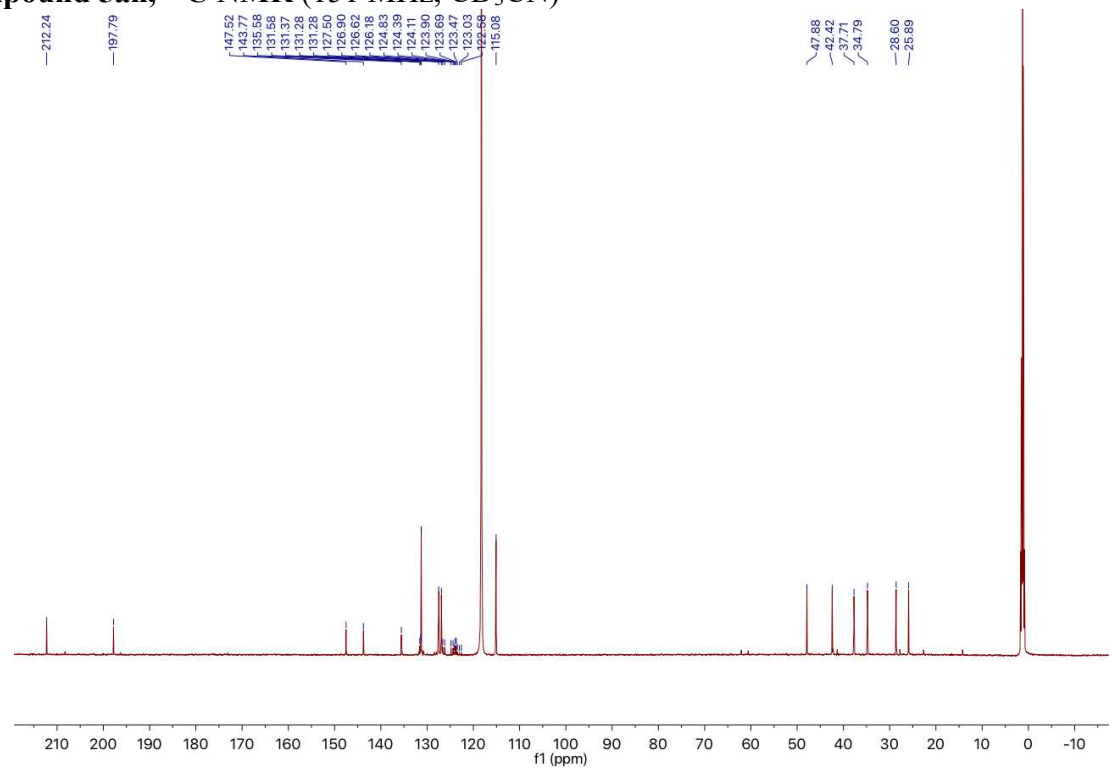
Compound 5am, ^{19}F NMR (565 MHz, CD_3CN)



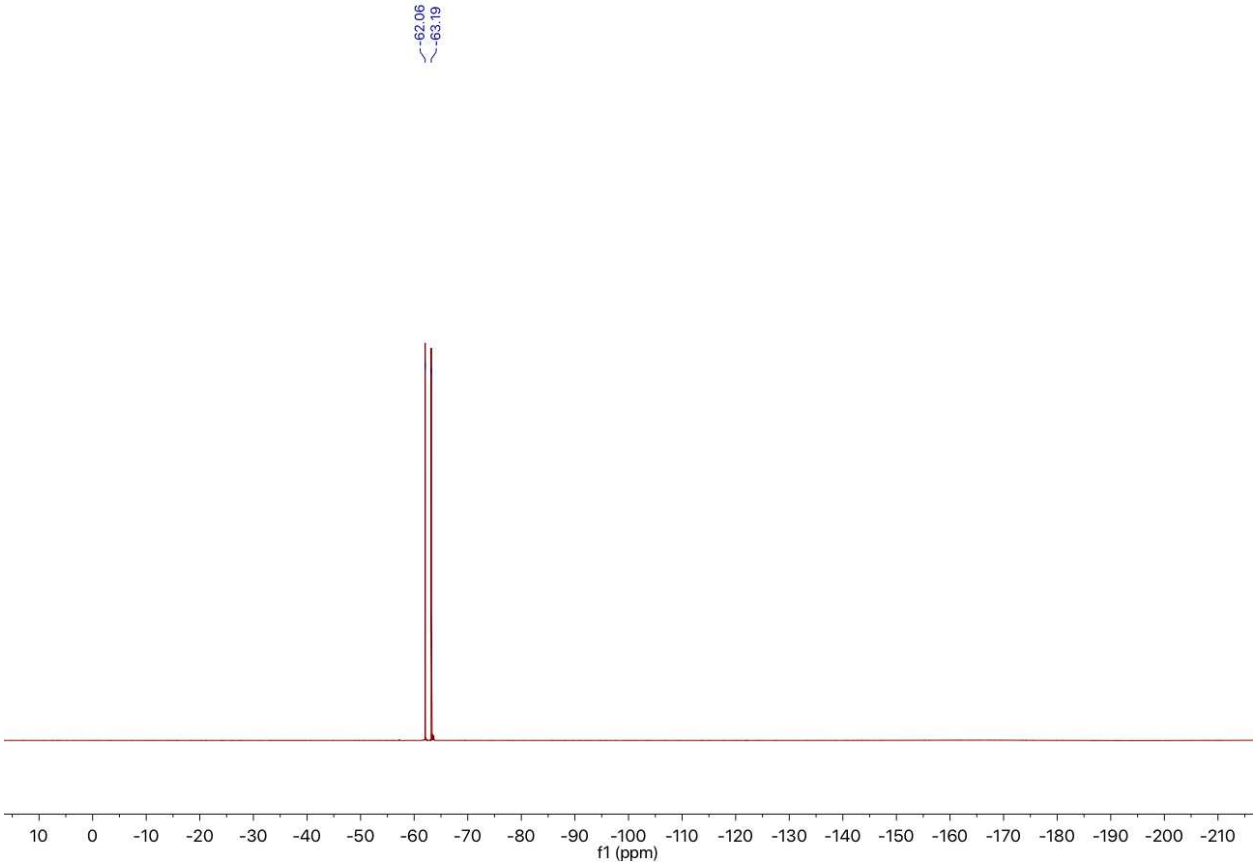
Compound 5an, ^{1}H NMR (600 MHz, CD_3CN)



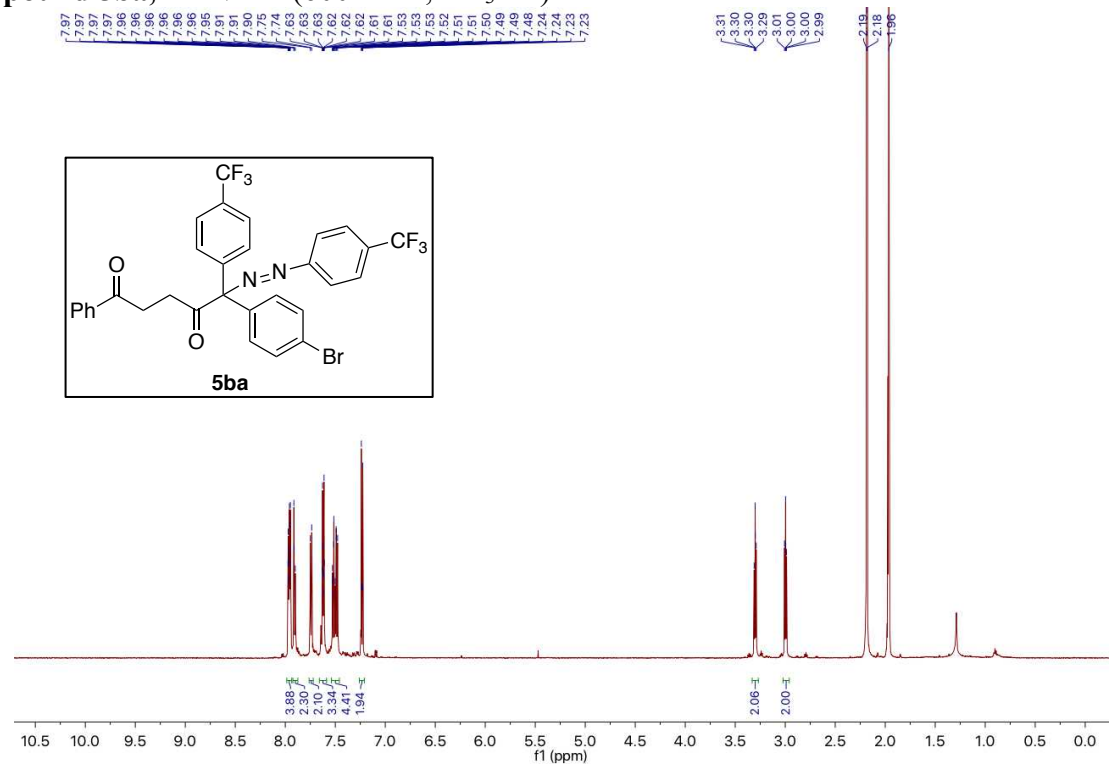
Compound 5an, ^{13}C NMR (151 MHz, CD_3CN)



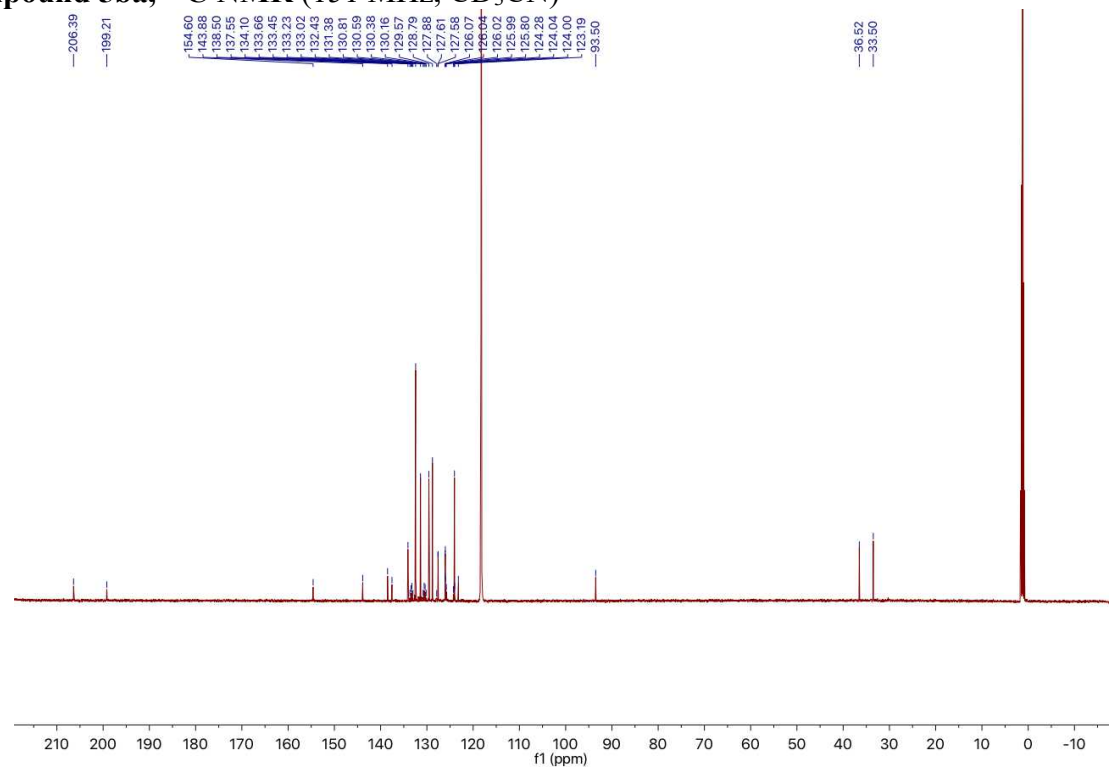
Compound 5an, ^{19}F NMR (565 MHz, CD_3CN)



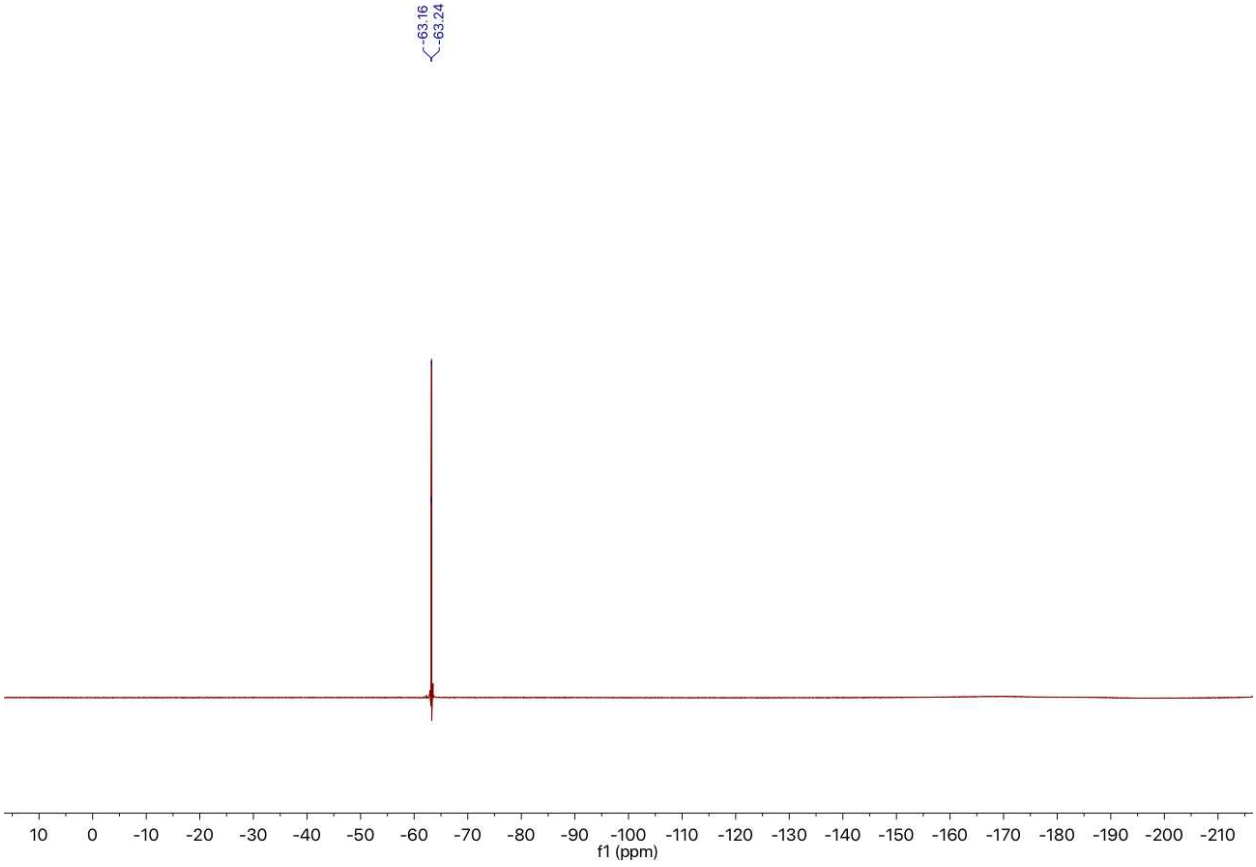
Compound 5ba, ^{1}H NMR (600 MHz, CD_3CN)



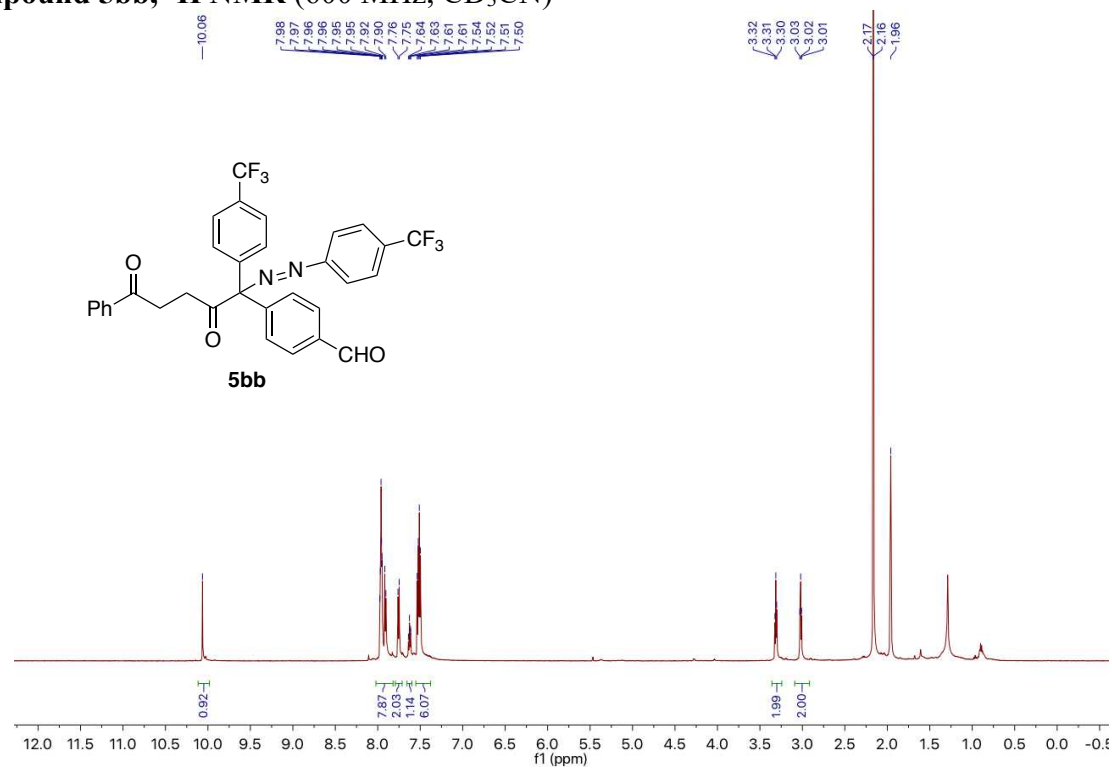
Compound 5ba, ^{13}C NMR (151 MHz, CD_3CN)



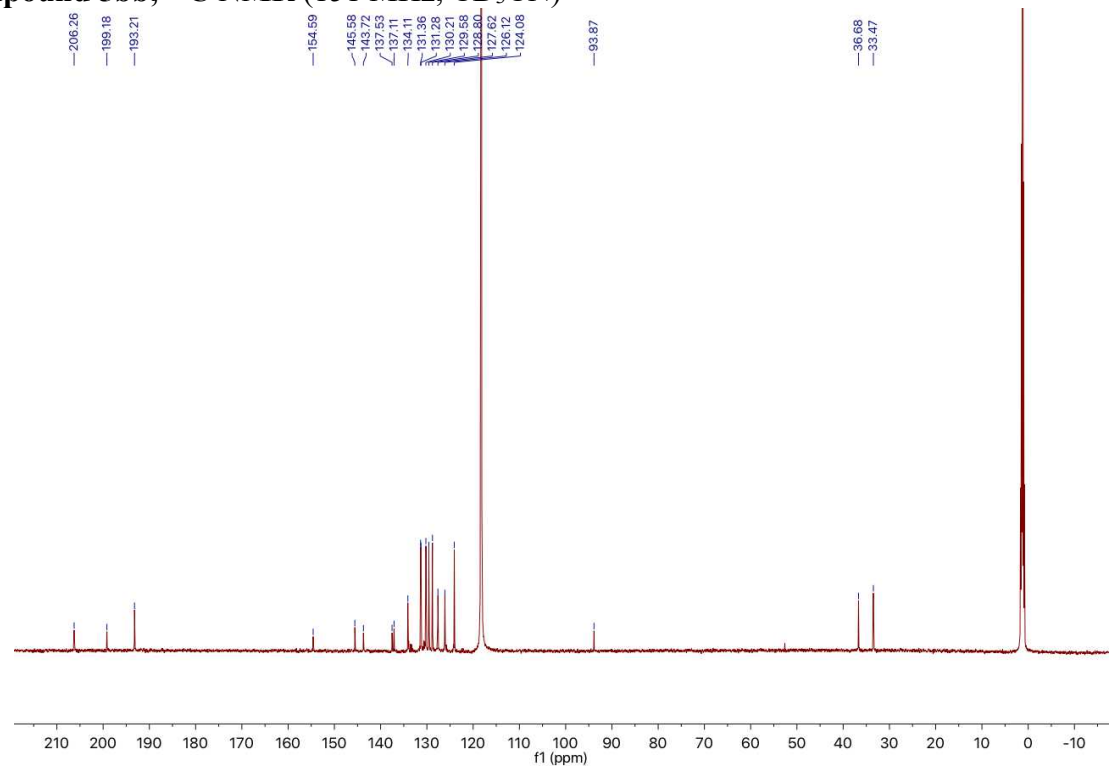
Compound 5ba, ^{19}F NMR (565 MHz, CD_3CN)



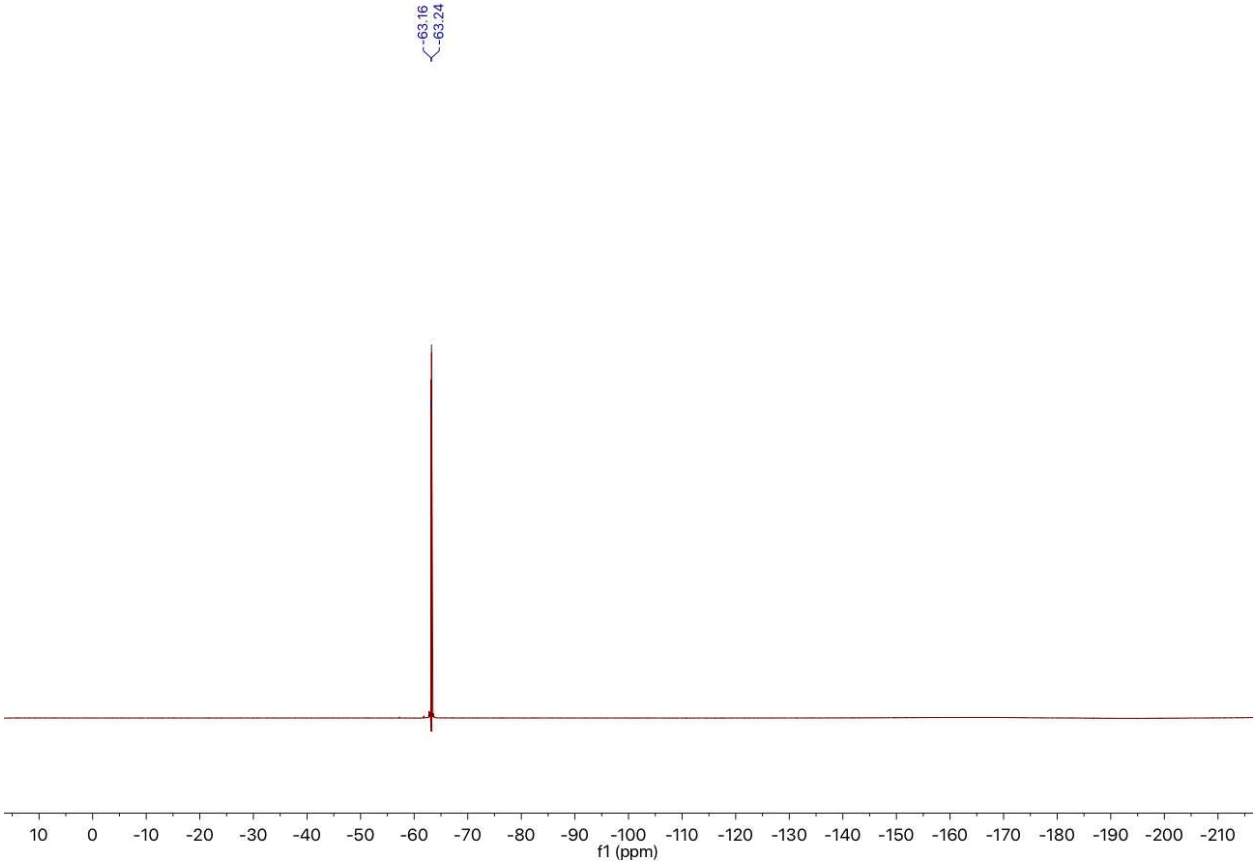
Compound 5bb, ^{1}H NMR (600 MHz, CD_3CN)



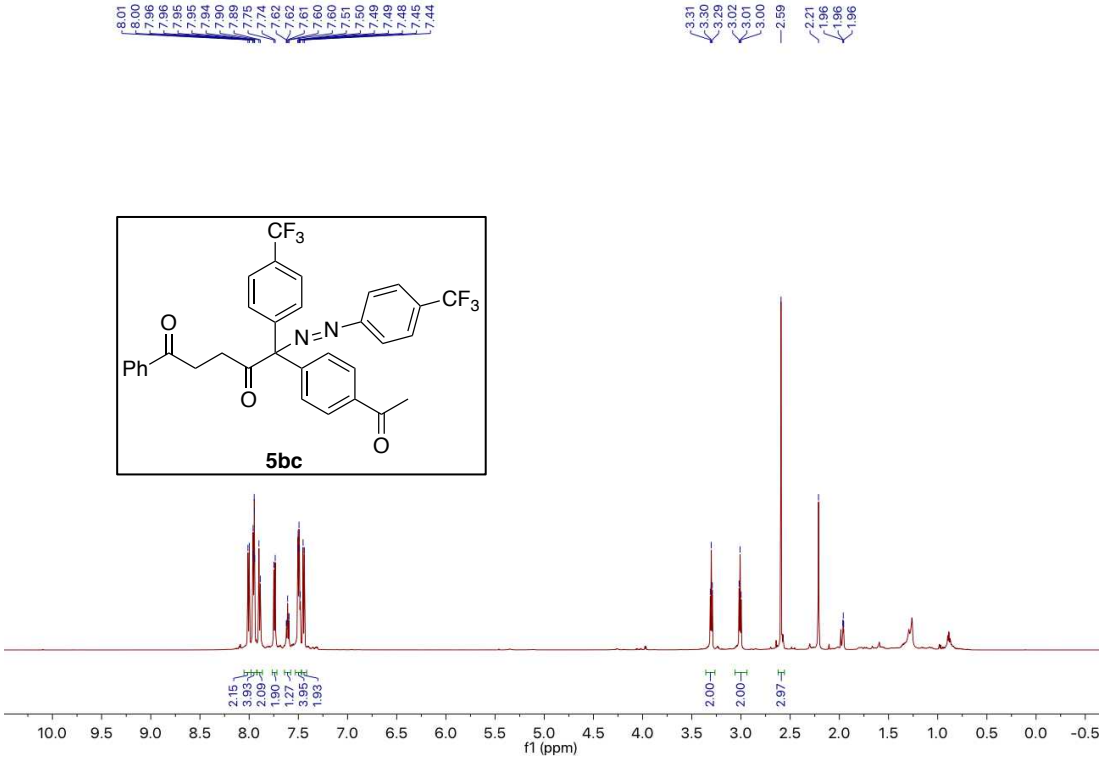
Compound 5bb, ^{13}C NMR (151 MHz, CD_3CN)



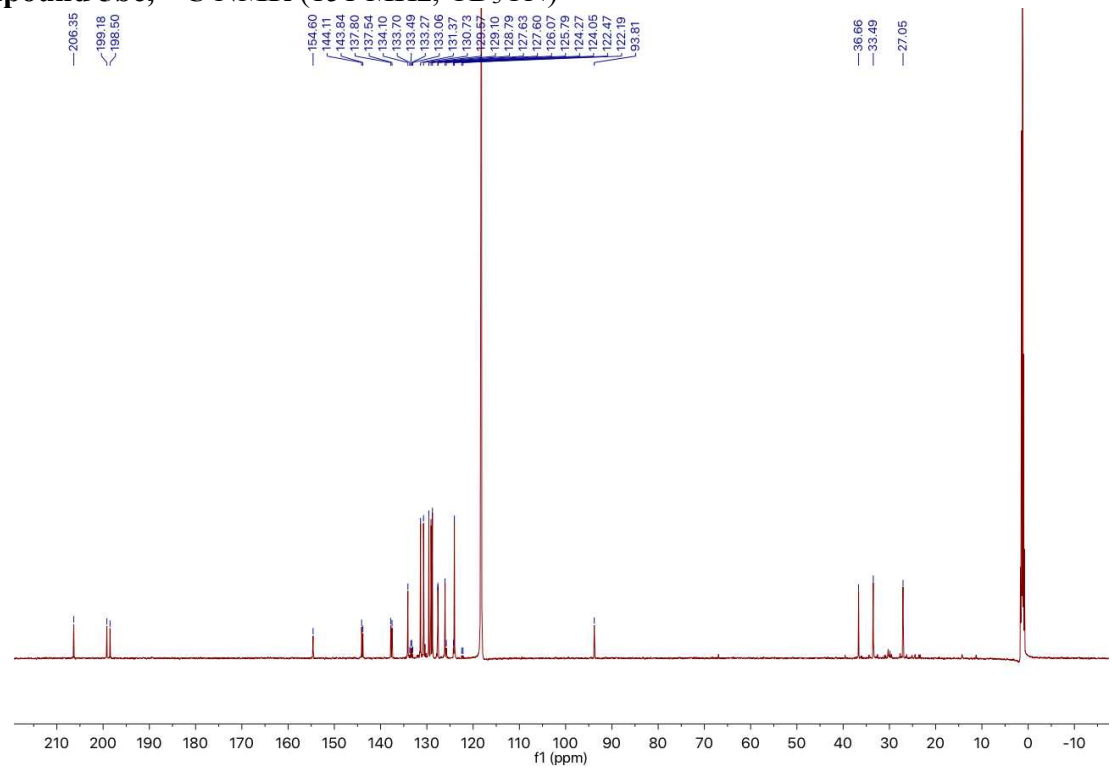
Compound 5bb, ^{19}F NMR (565 MHz, CD_3CN)



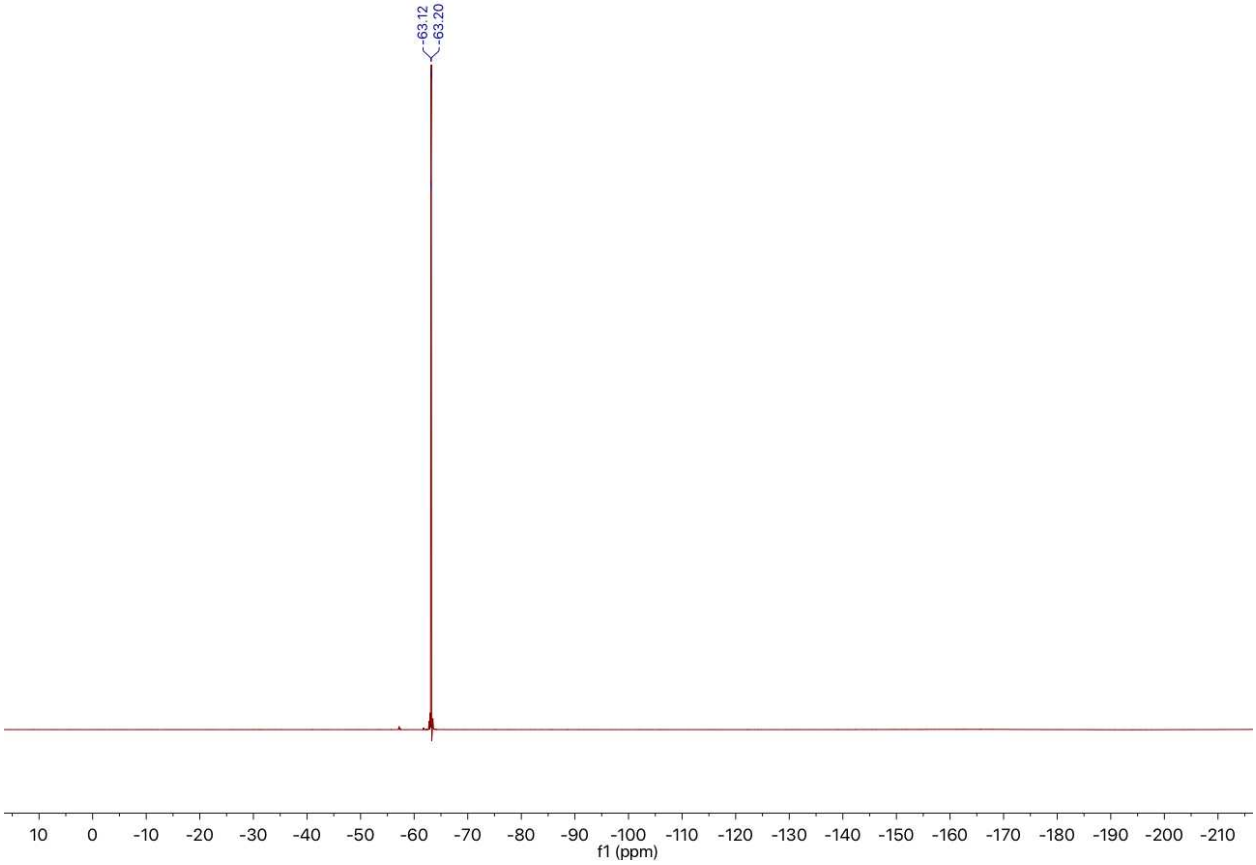
Compound 5bc, ^{1}H NMR (600 MHz, CD_3CN)



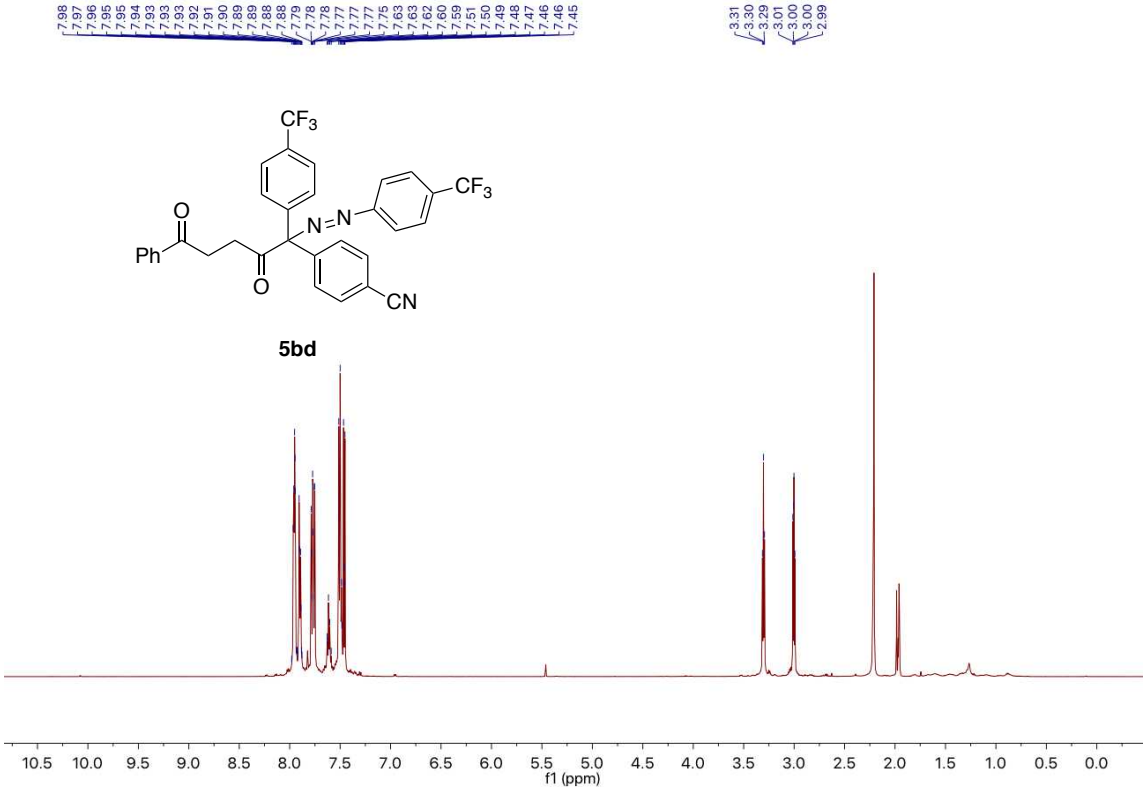
Compound 5bc, ^{13}C NMR (151 MHz, CD_3CN)



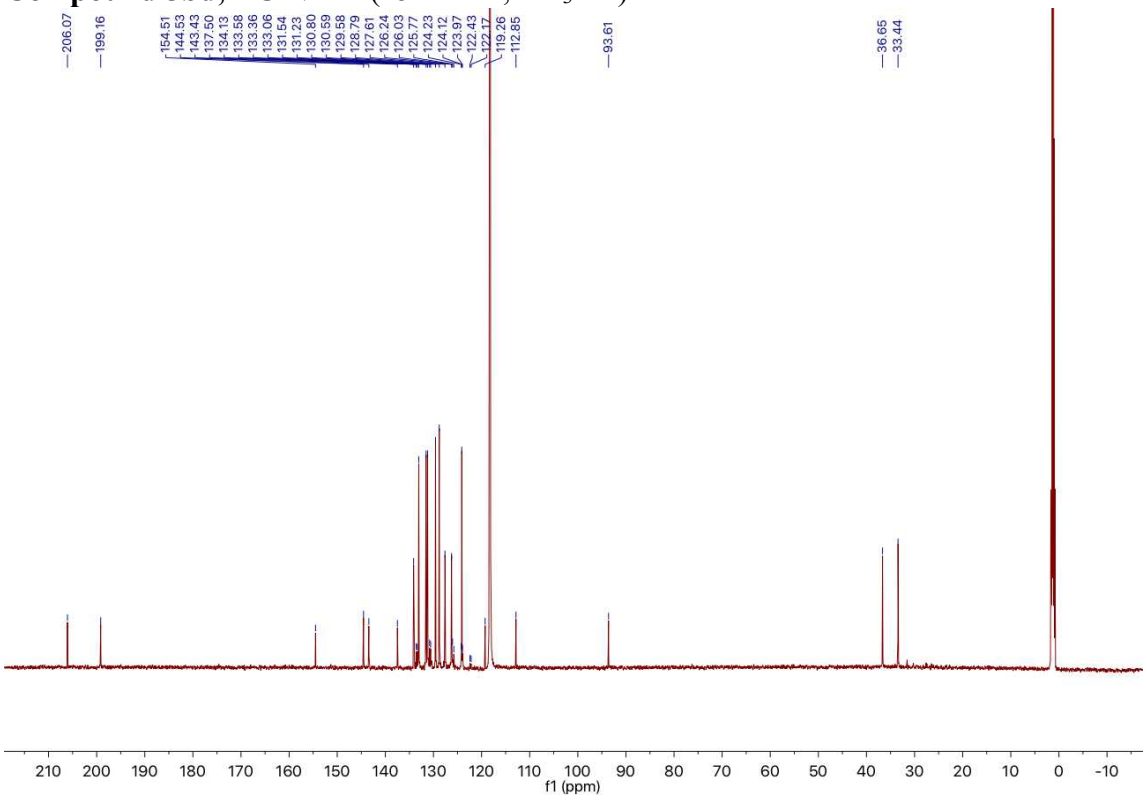
Compound 5bc, ^{19}F NMR (565 MHz, CD_3CN)



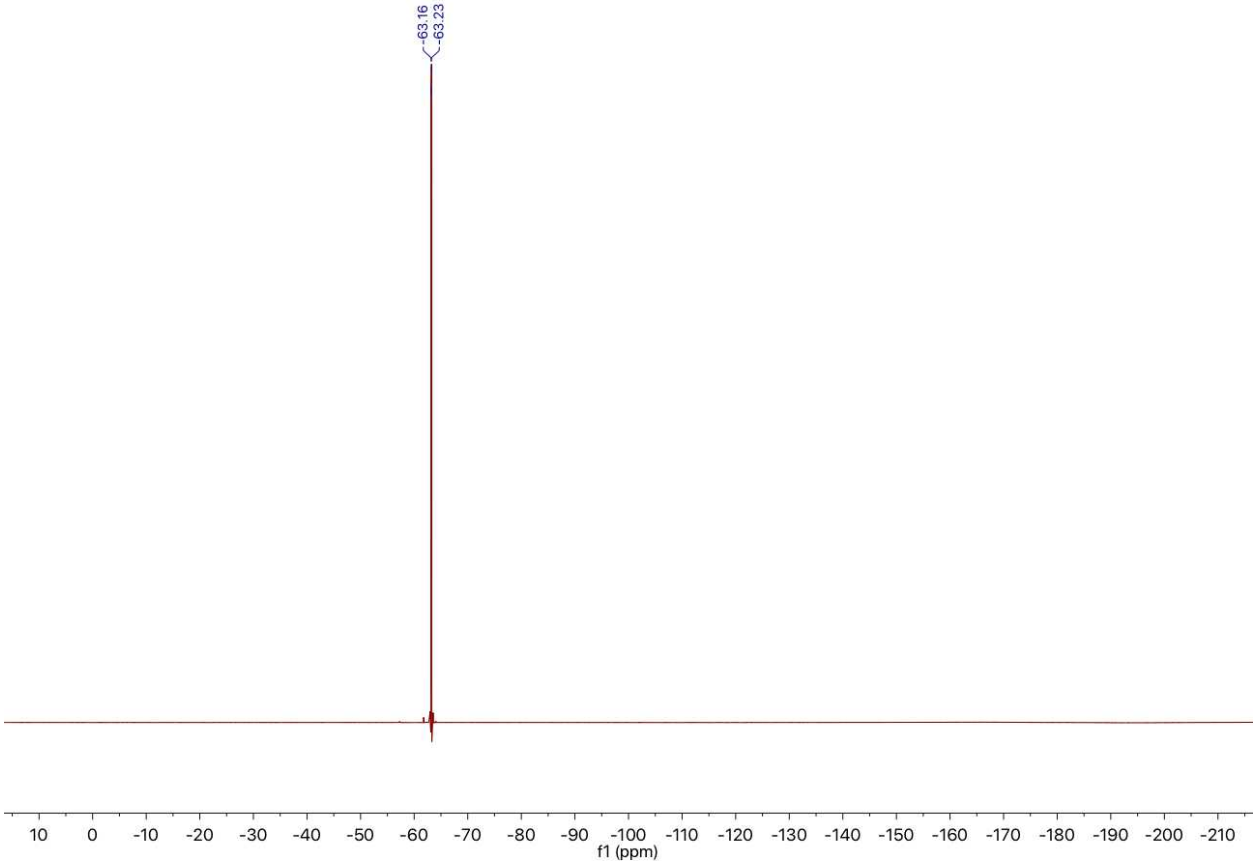
Compound 5bd, ^{1}H NMR (600 MHz, CD_3CN)



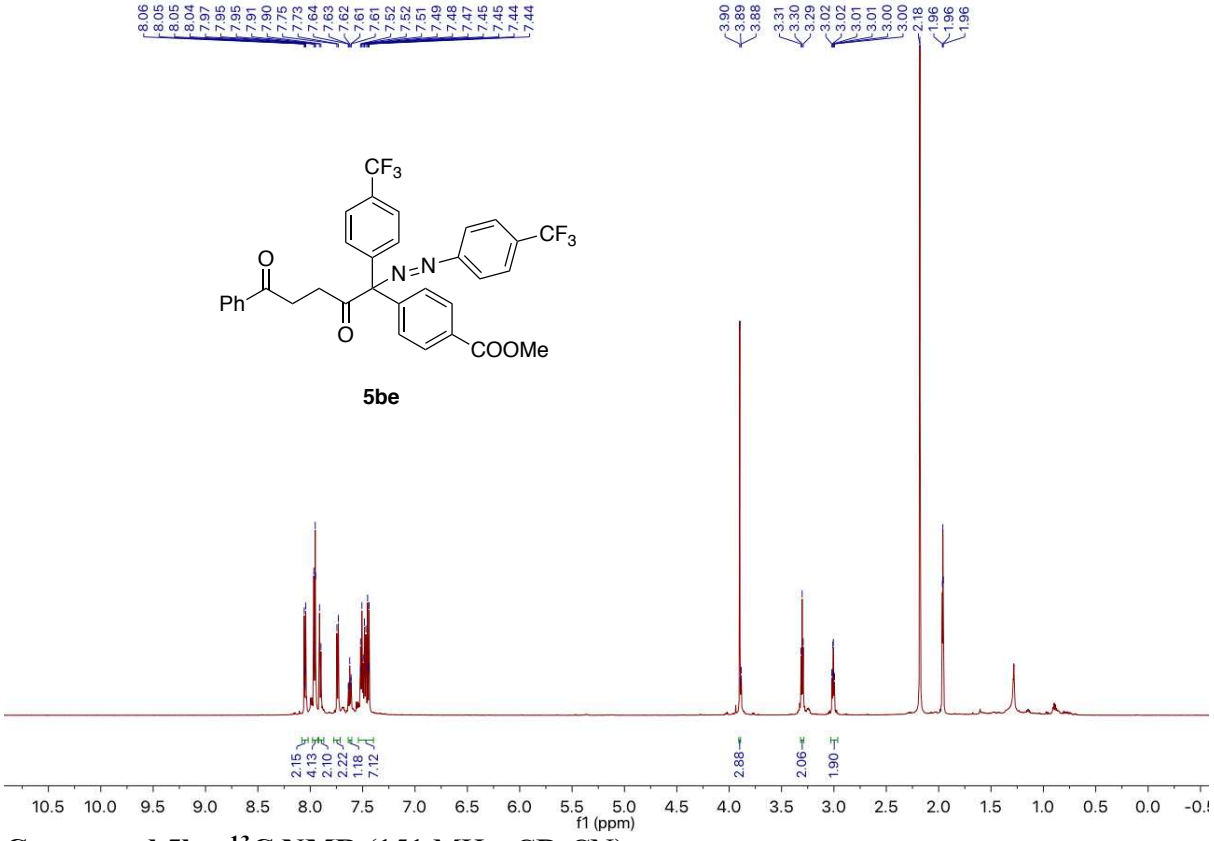
Compound 5bd, ^{13}C NMR (151 MHz, CD_3CN)



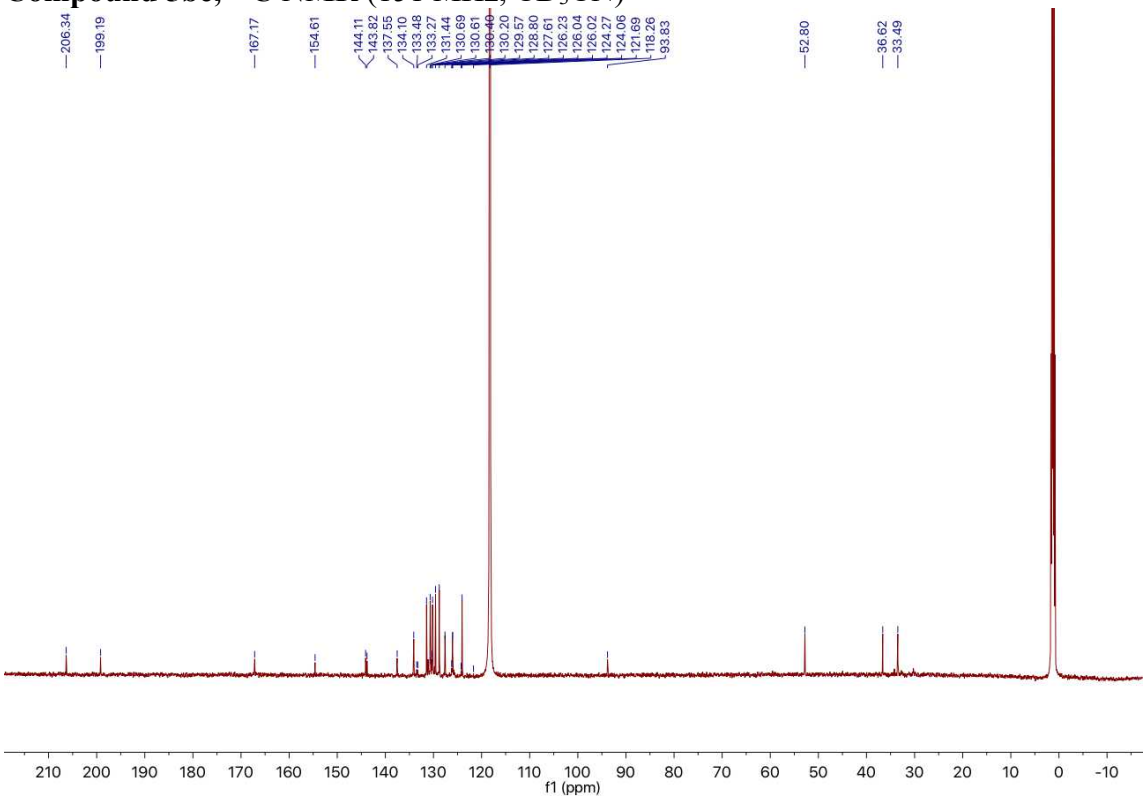
Compound 5bd, ^{19}F NMR (565 MHz, CD_3CN)



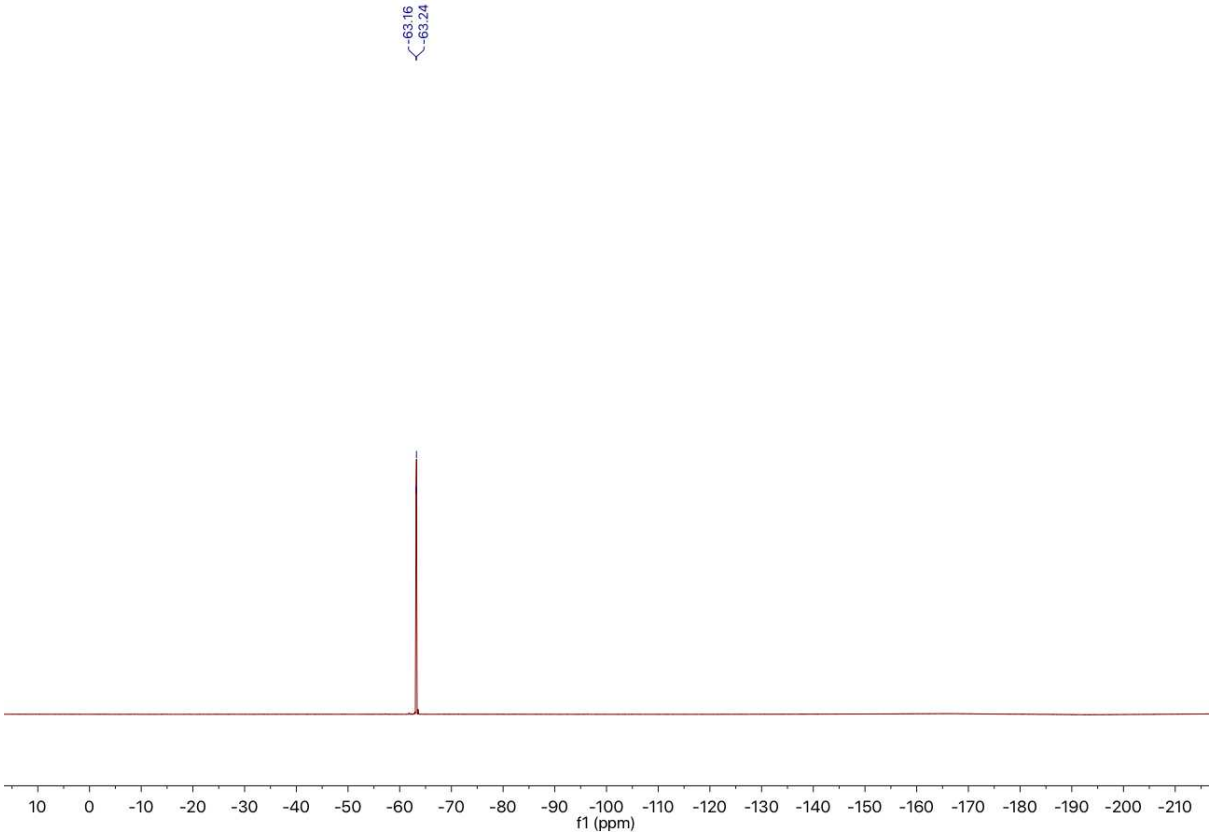
Compound 5be, ^{1}H NMR (600 MHz, CD_3CN)



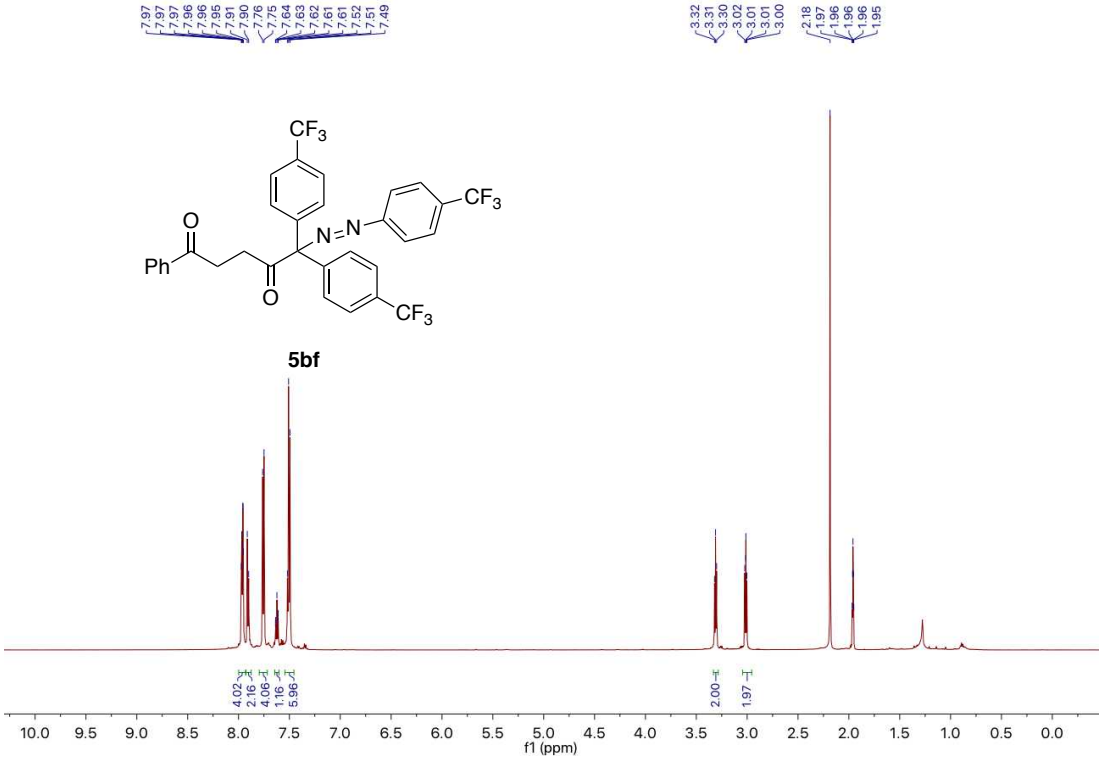
Compound 5be, ^{13}C NMR (151 MHz, CD_3CN)



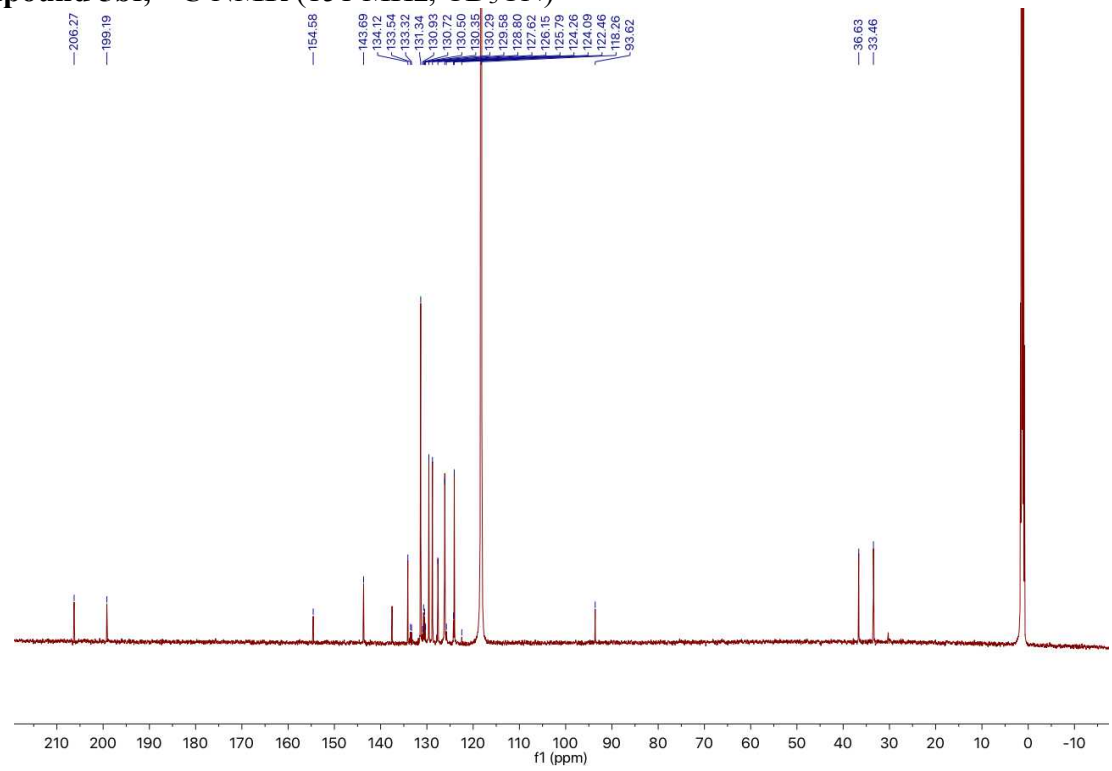
Compound 5be, ^{19}F NMR (565 MHz, CD_3CN)



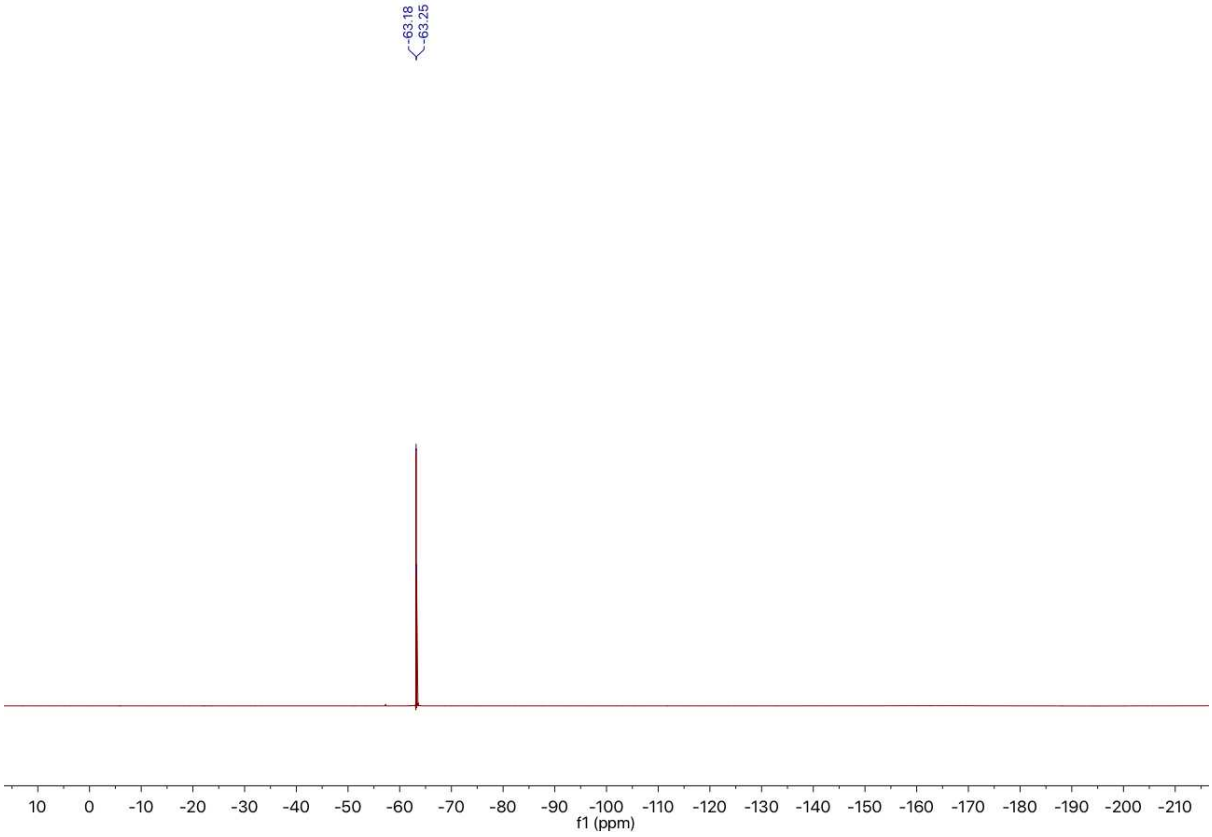
Compound 5bf, ^{1}H NMR (600 MHz, CD_3CN)



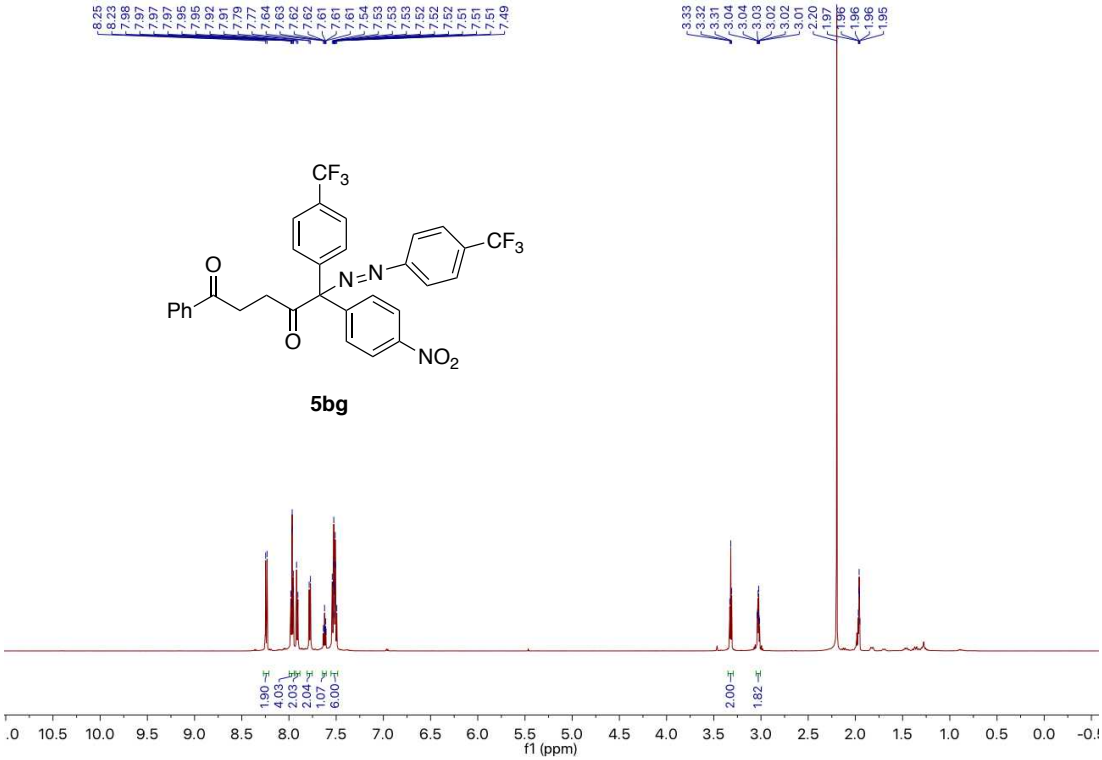
Compound 5bf, ^{13}C NMR (151 MHz, CD_3CN)



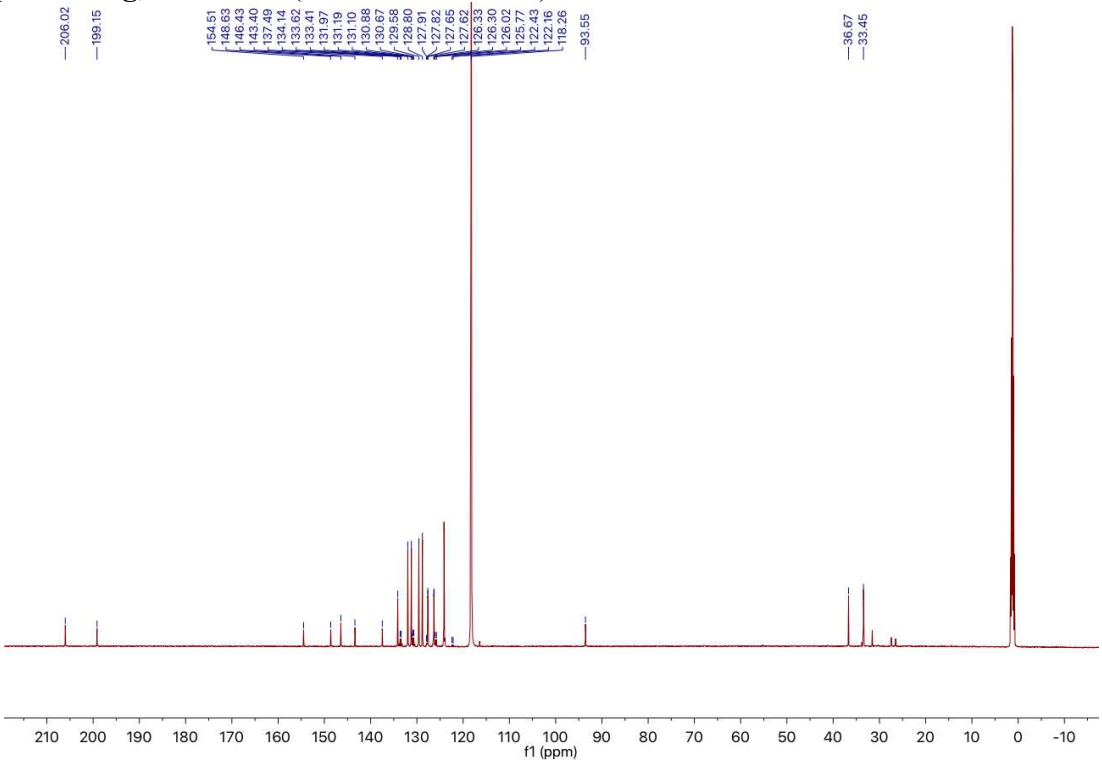
Compound 5bf, ^{19}F NMR (565 MHz, CD_3CN)



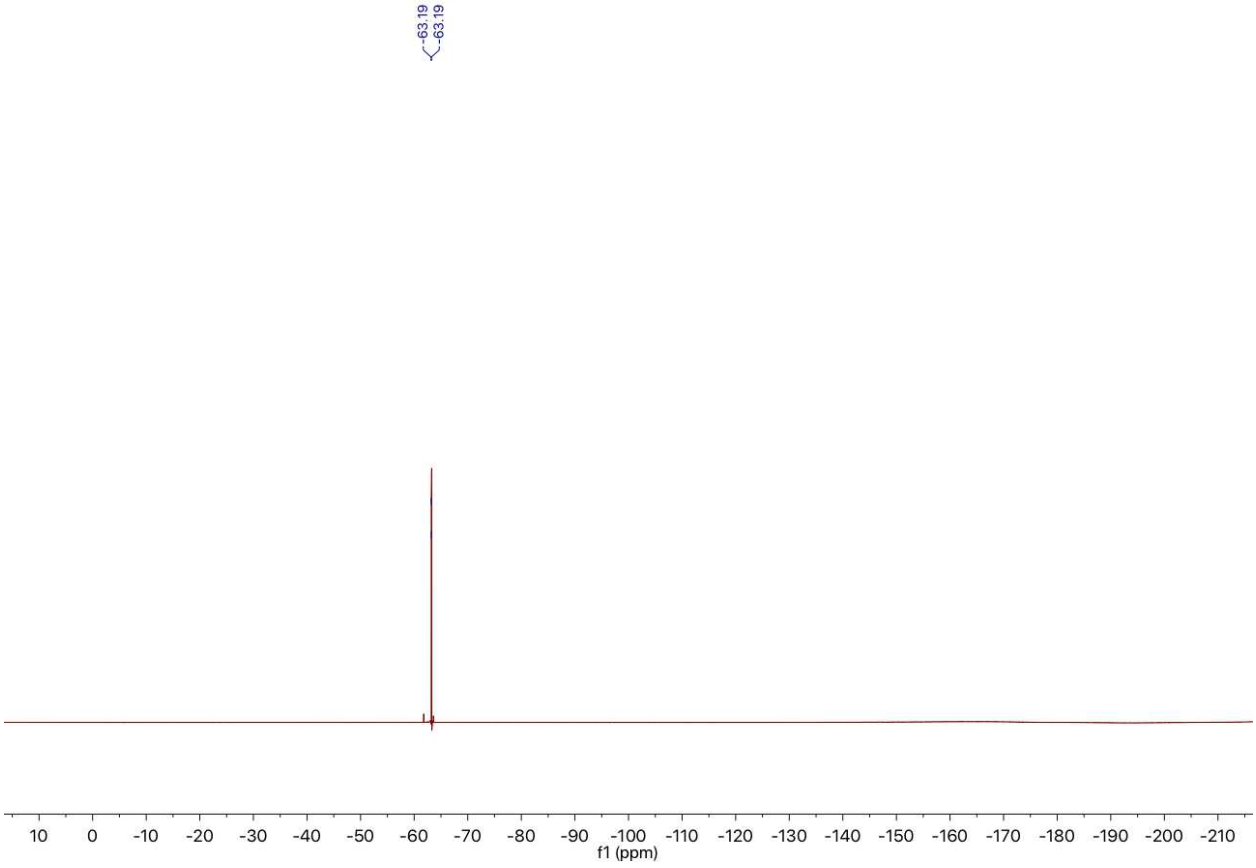
Compound 5bg, ^{1}H NMR (600 MHz, CD_3CN)



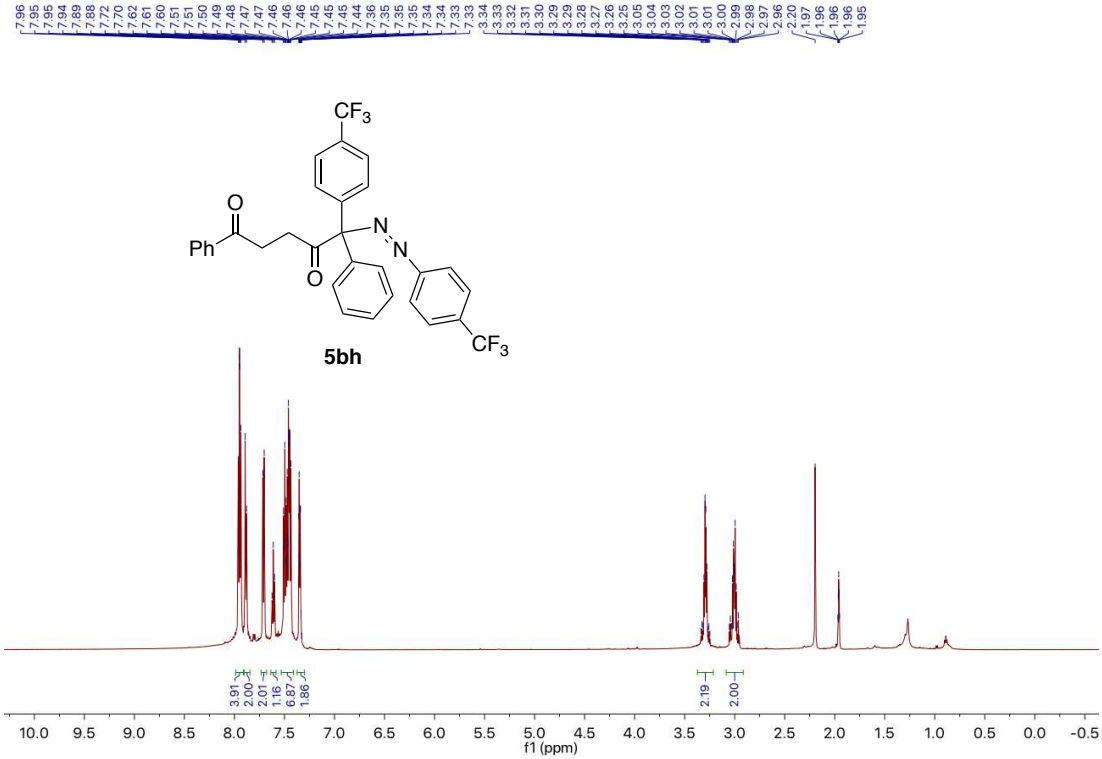
Compound 5bg, ^{13}C NMR (151 MHz, CD_3CN)



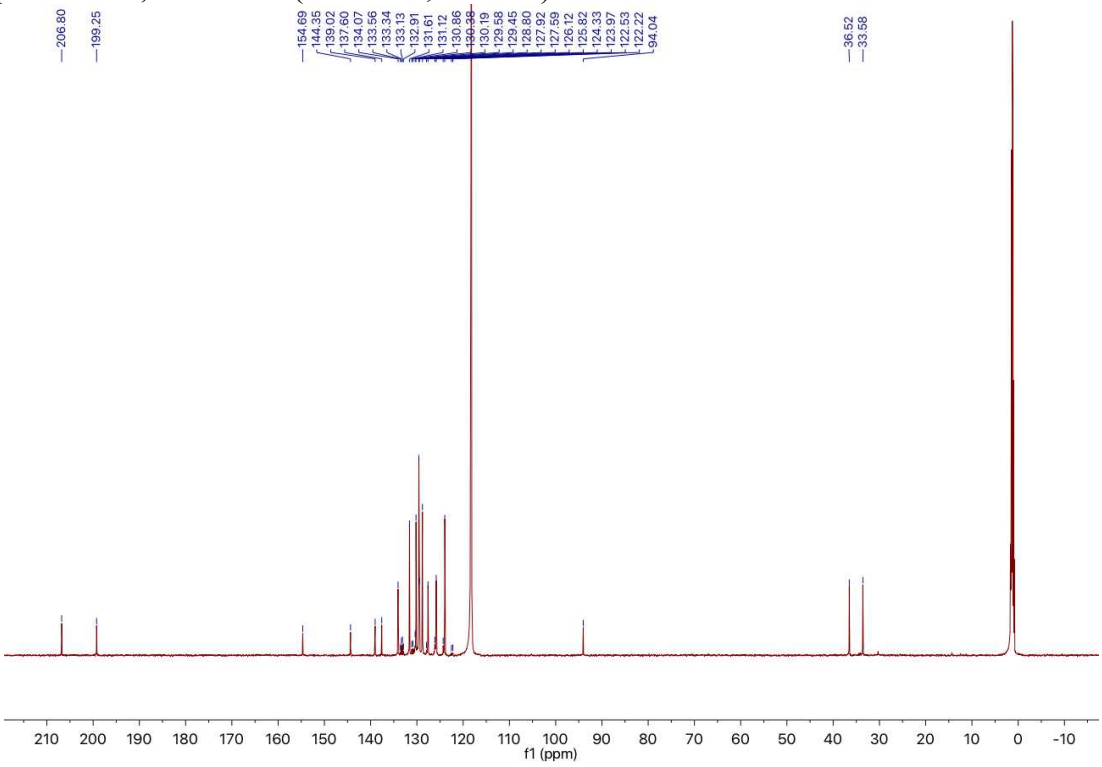
Compound 5bg, ^{19}F NMR (565 MHz, CD_3CN)



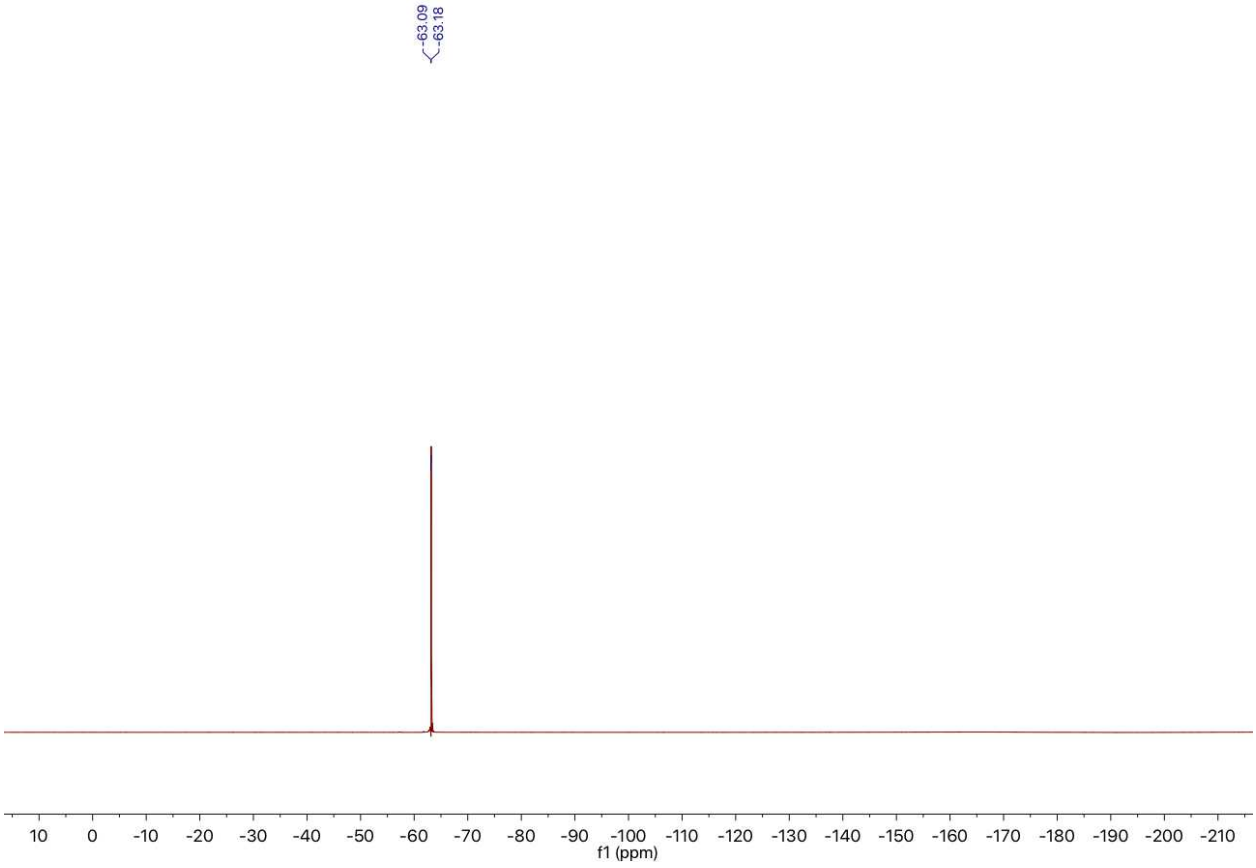
Compound 5bh, ^{1}H NMR (600 MHz, CD_3CN)



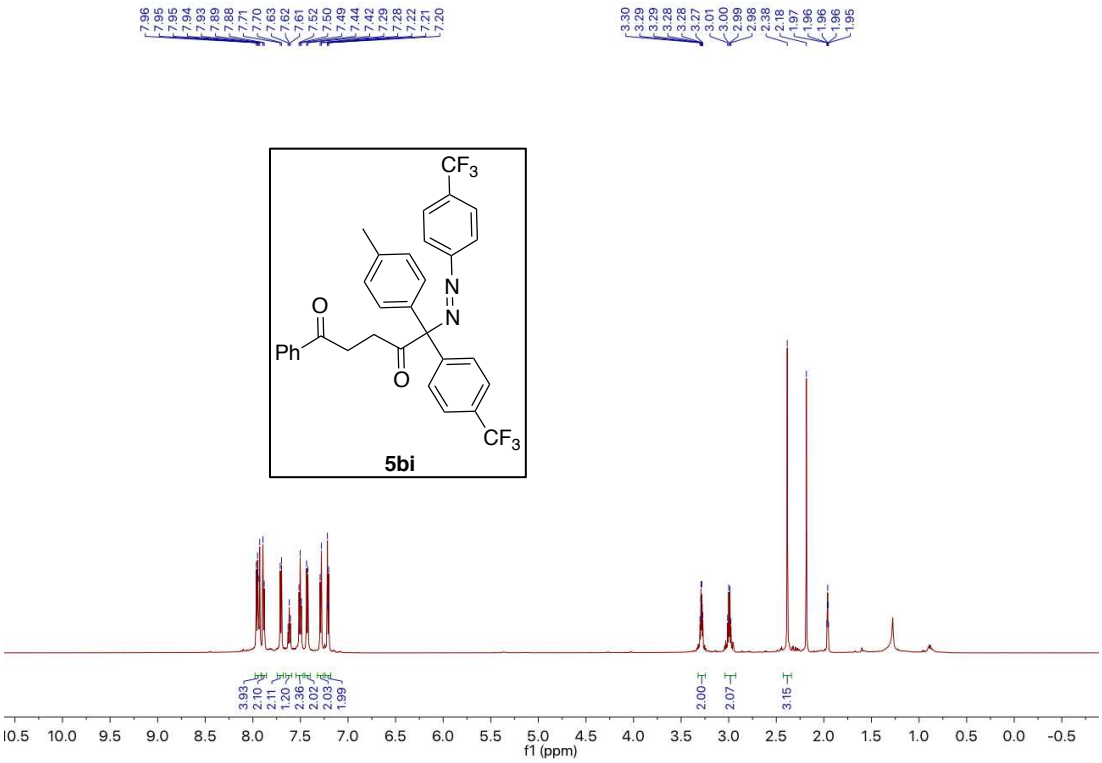
Compound 5bh, ^{13}C NMR (151 MHz, CD_3CN)



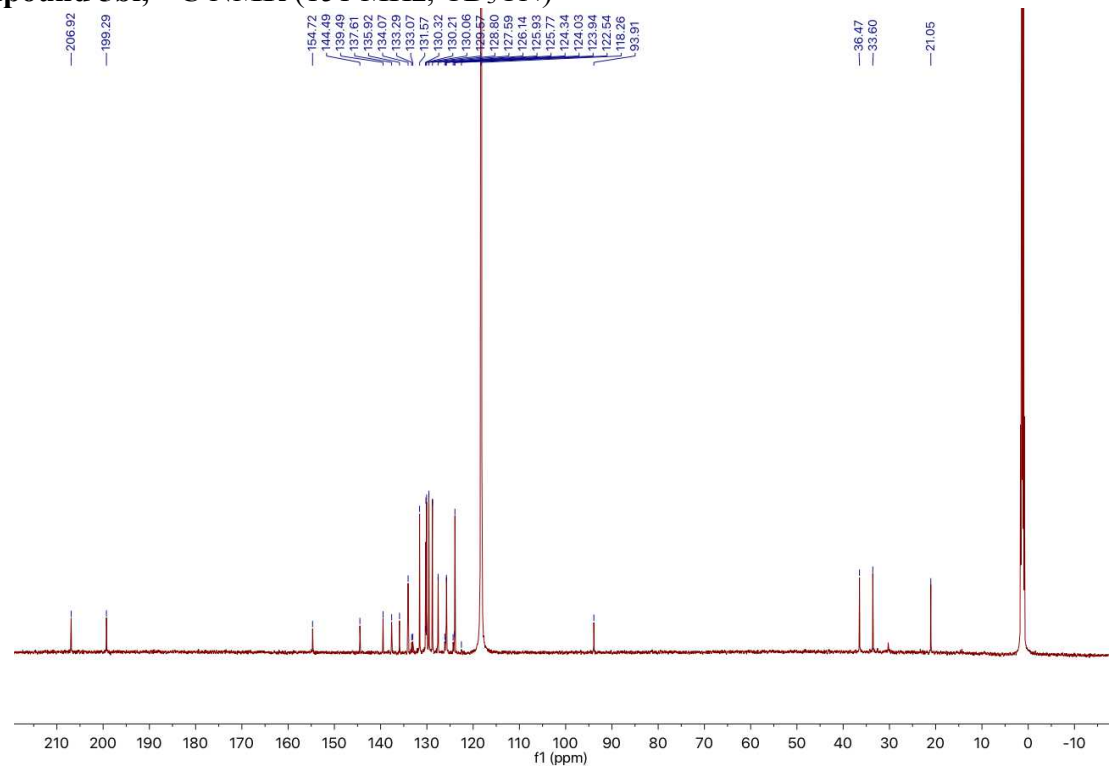
Compound 5bh, ^{19}F NMR (565 MHz, CD_3CN)



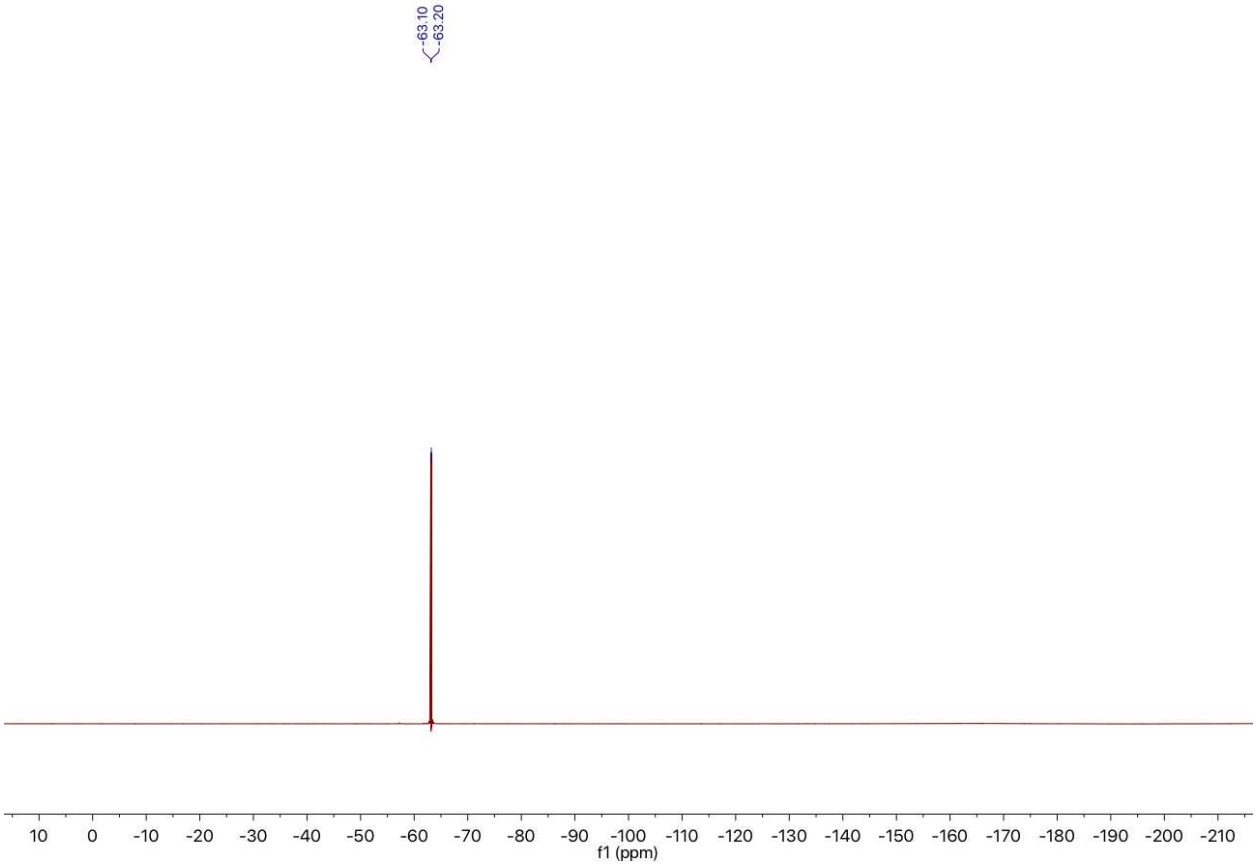
Compound 5bi, ^{1}H NMR (600 MHz, CD_3CN)



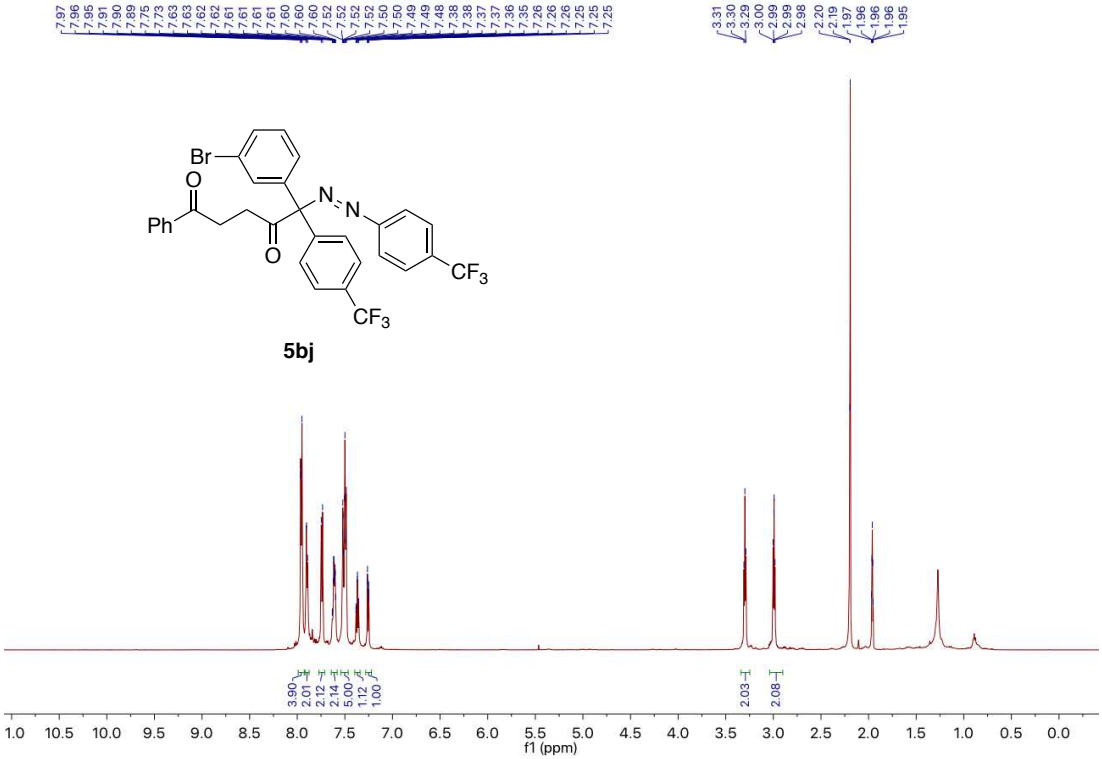
Compound 5bi, ^{13}C NMR (151 MHz, CD_3CN)



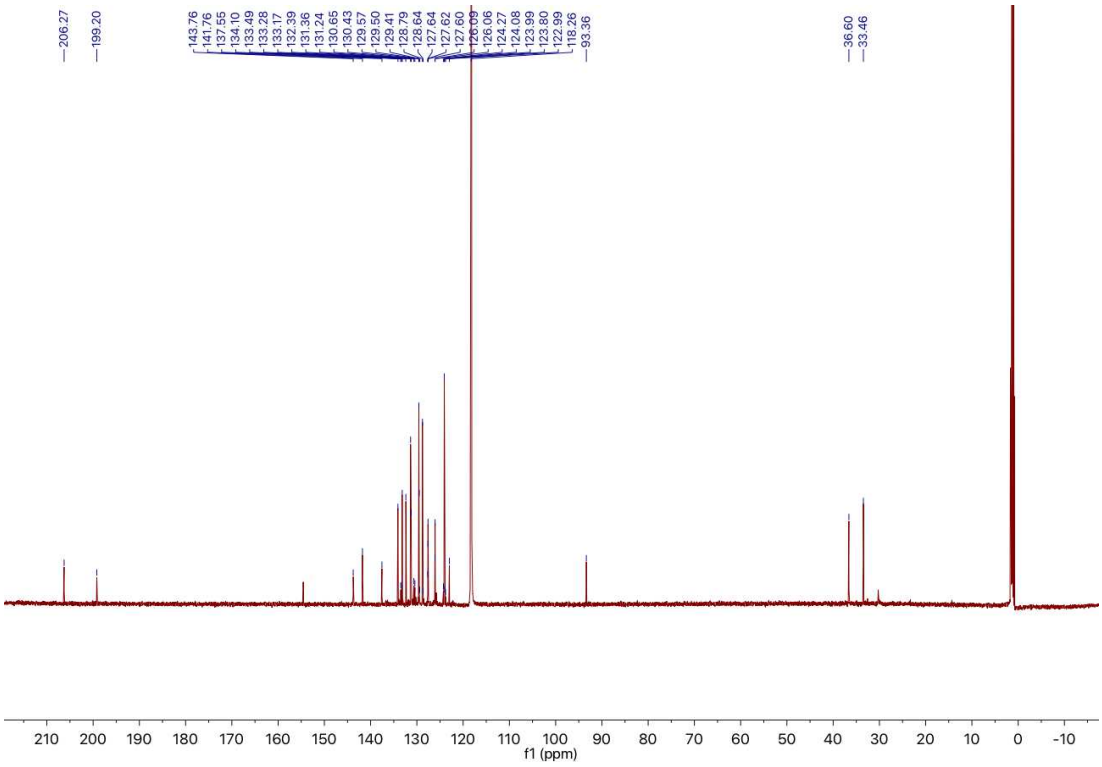
Compound 5bi, ^{19}F NMR (565 MHz, CD_3CN)



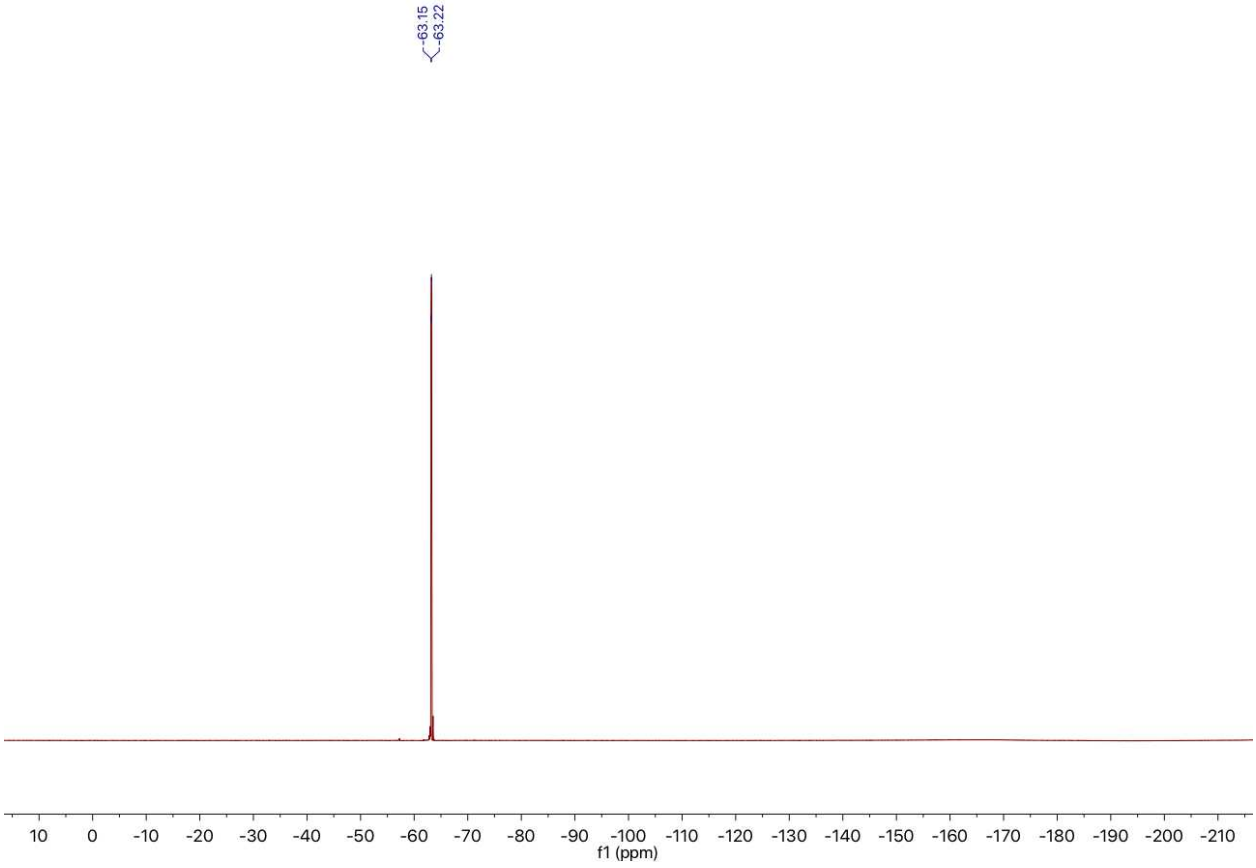
Compound 5bj, ^{1}H NMR (600 MHz, CD_3CN)



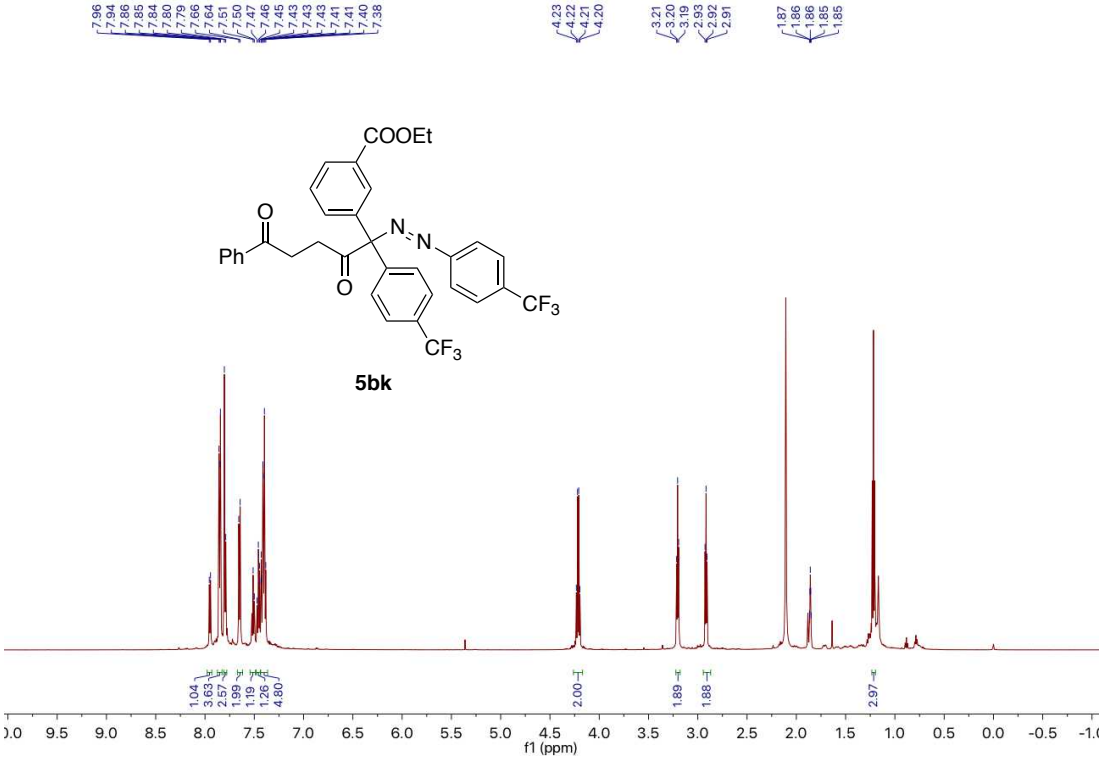
Compound 5bj, ^{13}C NMR (151 MHz, CD_3CN)



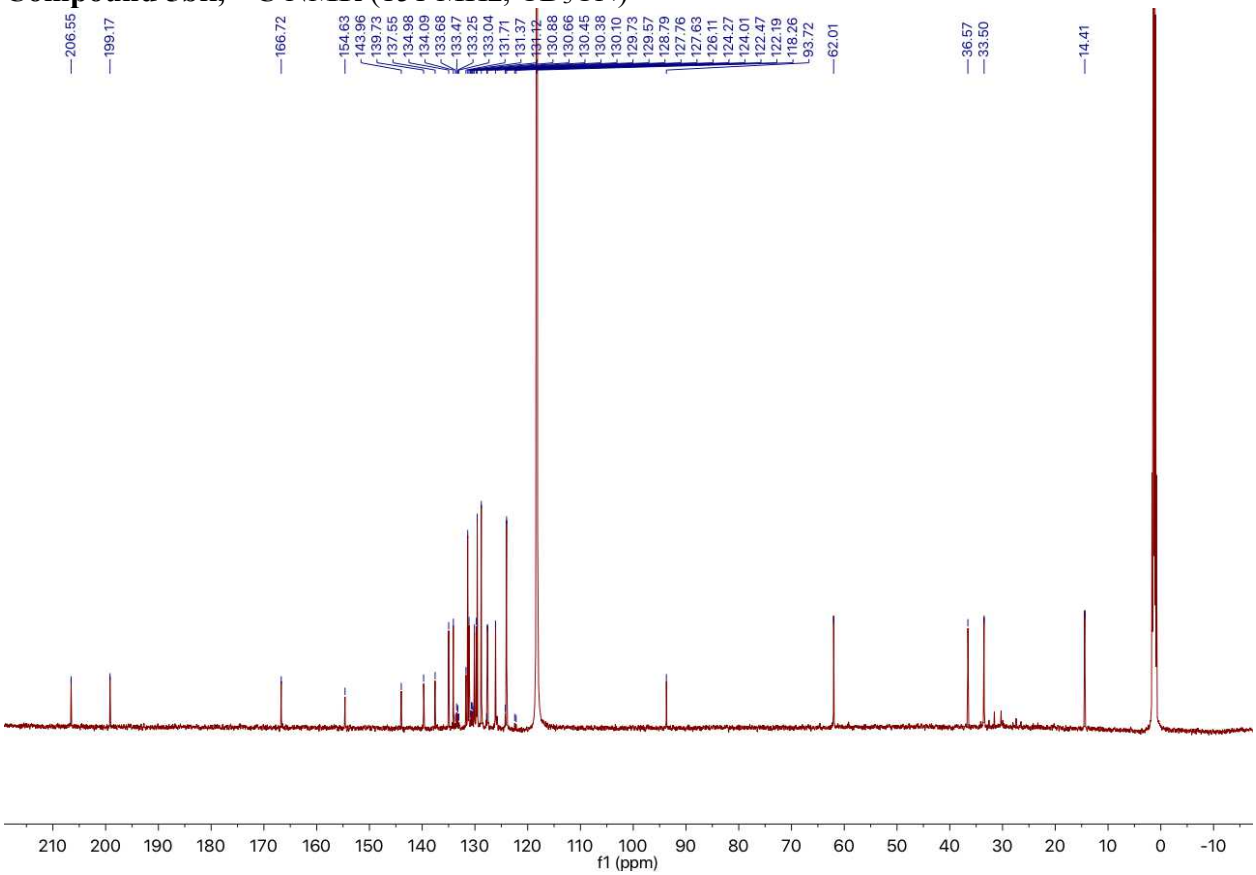
Compound 5bj, ^{19}F NMR (565 MHz, CD_3CN)



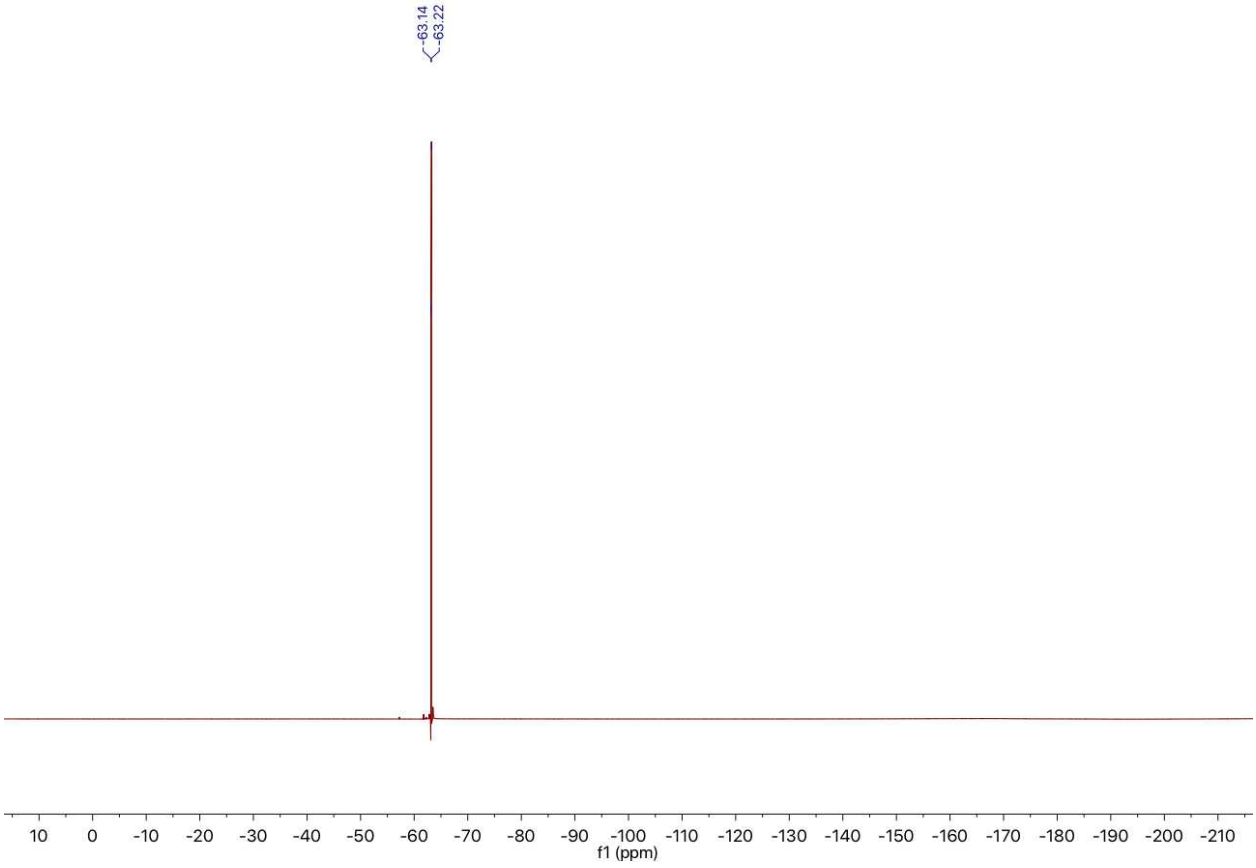
Compound 5bk, ^{1}H NMR (600 MHz, CD_3CN)



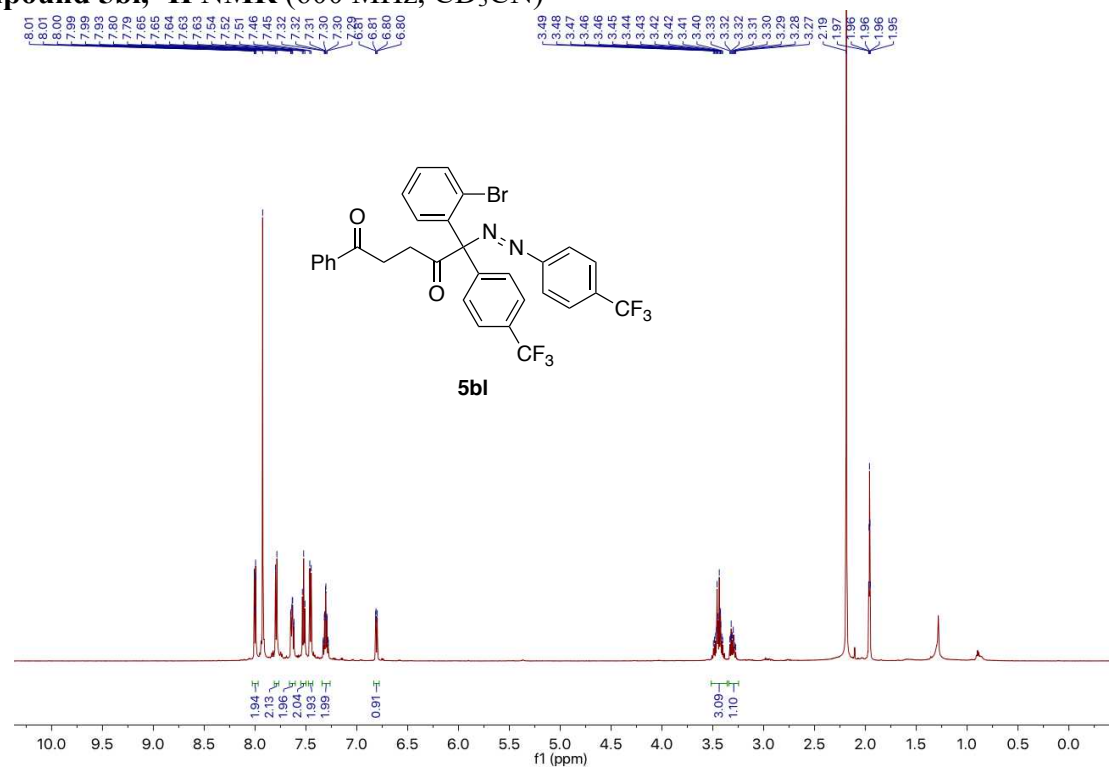
Compound 5bk, ^{13}C NMR (151 MHz, CD_3CN)



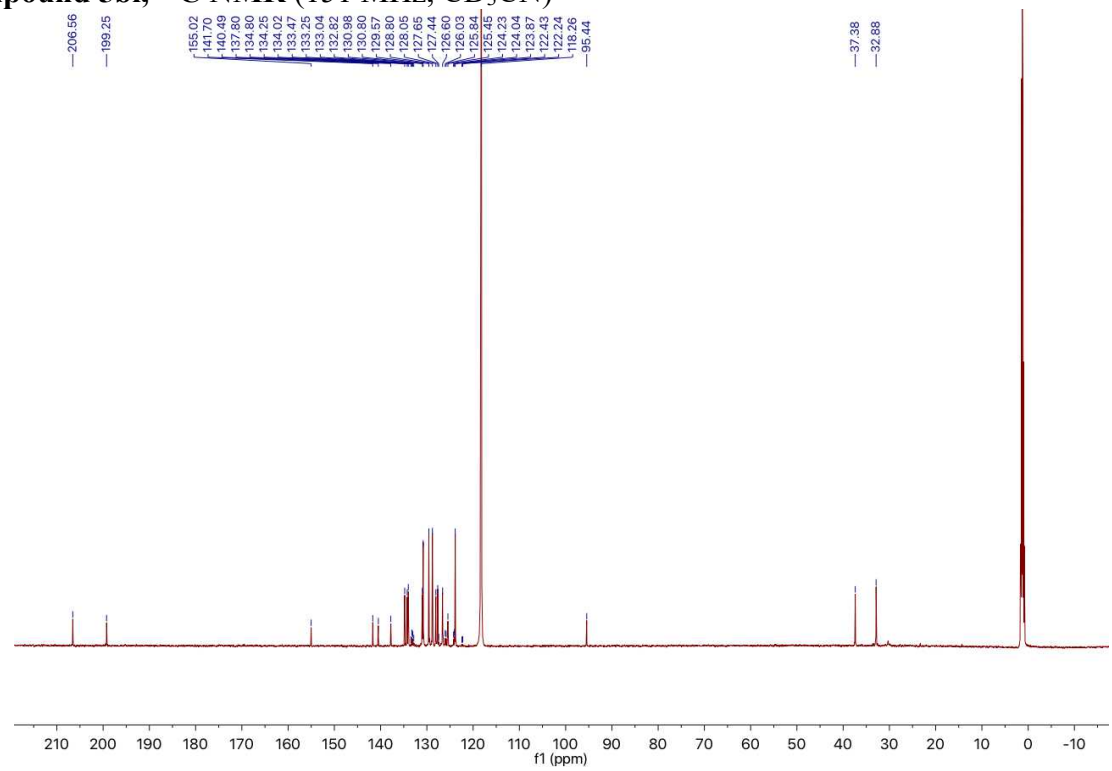
Compound 5bk, ^{19}F NMR (565 MHz, CD_3CN)



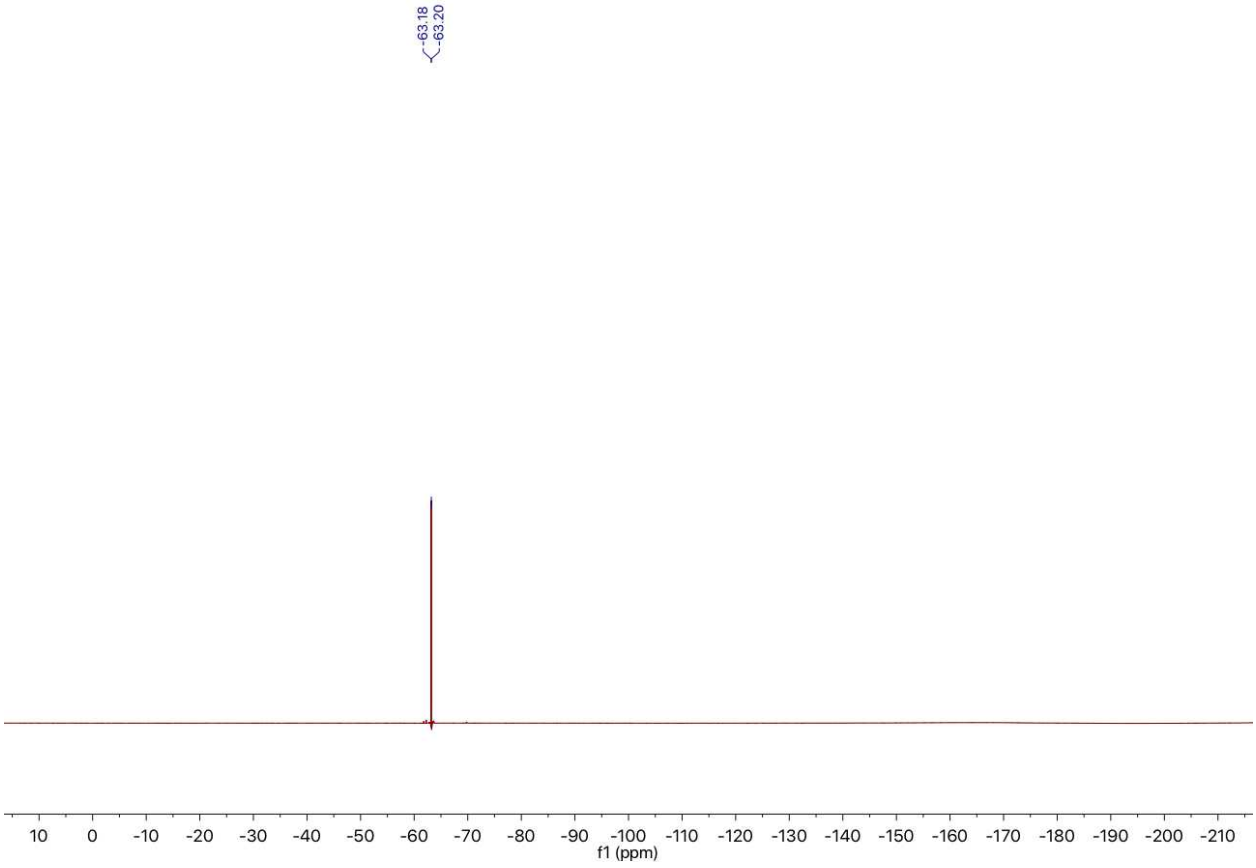
Compound 5bl, ^{1}H NMR (600 MHz, CD_3CN)



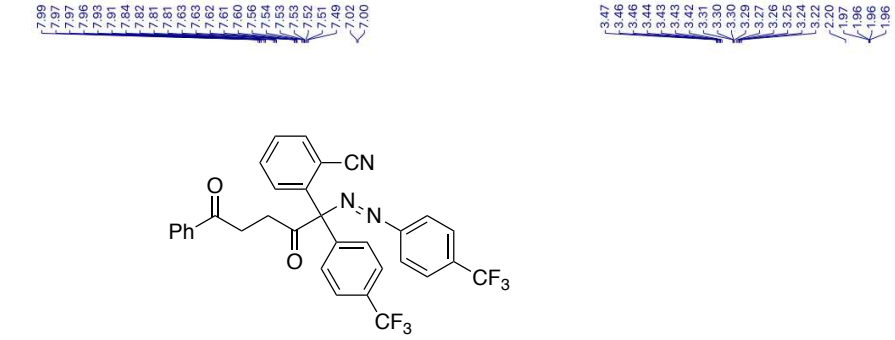
Compound 5bl, ^{13}C NMR (151 MHz, CD_3CN)



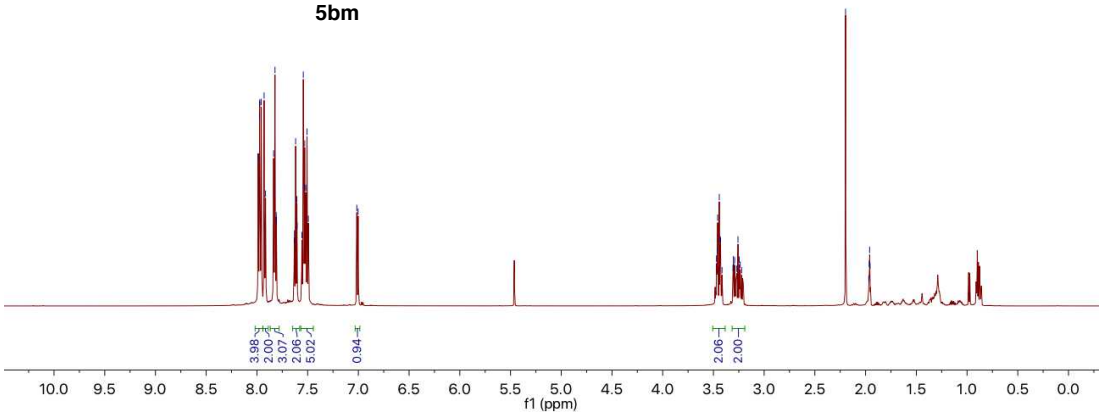
Compound 5bl, ^{19}F NMR (565 MHz, CD_3CN)



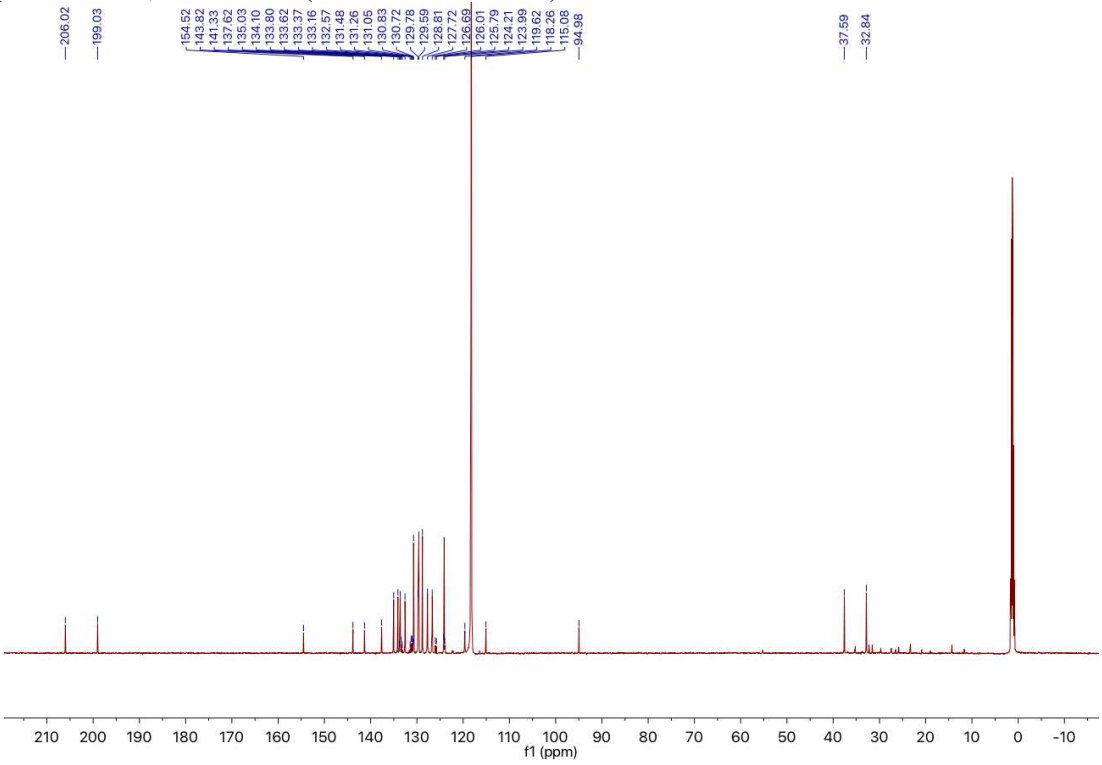
Compound 5bm, ^{1}H NMR (600 MHz, CD_3CN)



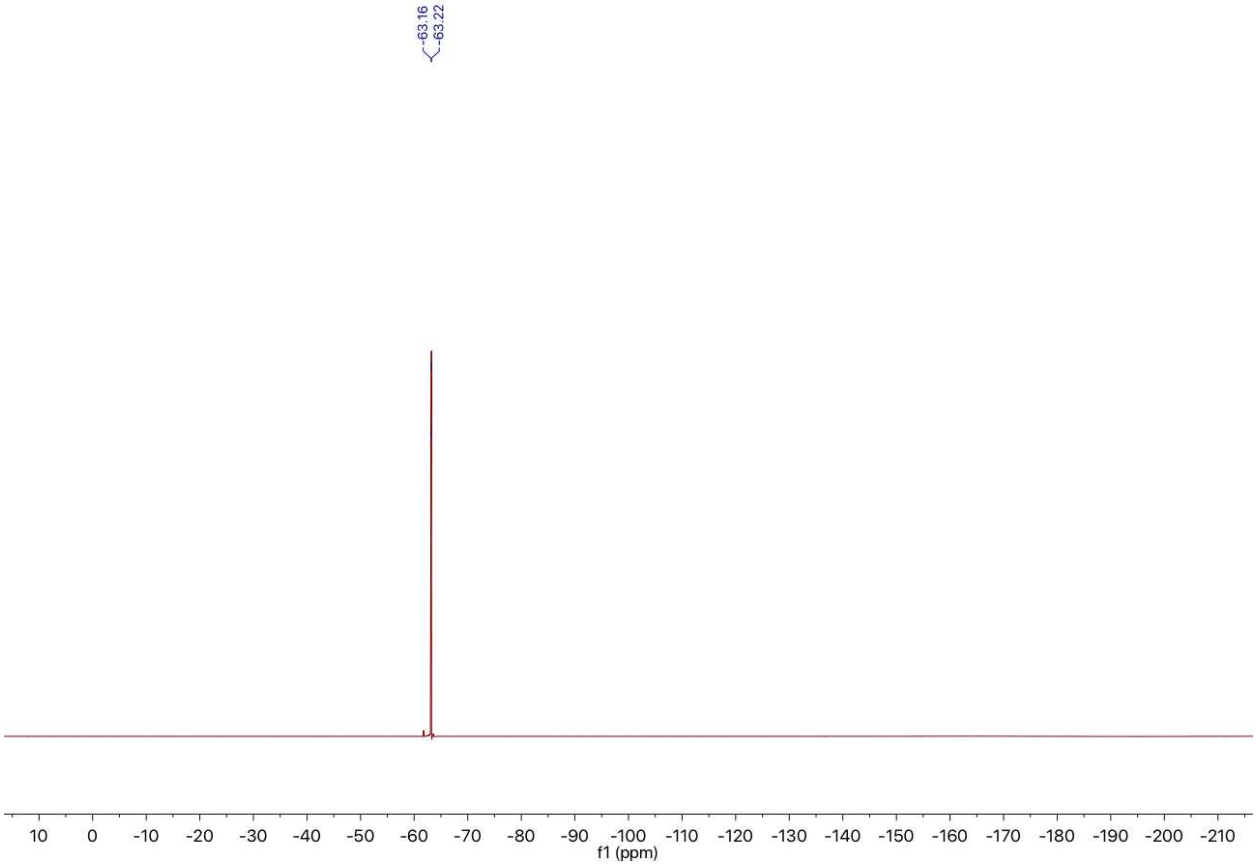
5bm



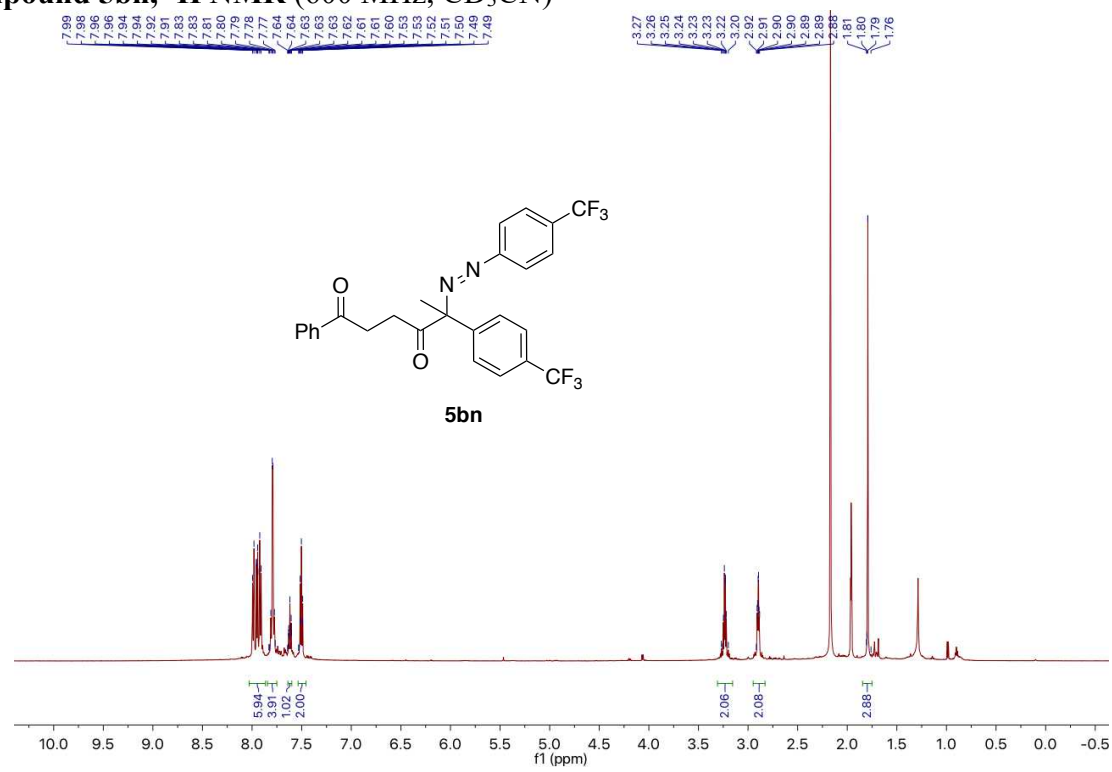
Compound 5bm, ^{13}C NMR (151 MHz, CD_3CN)



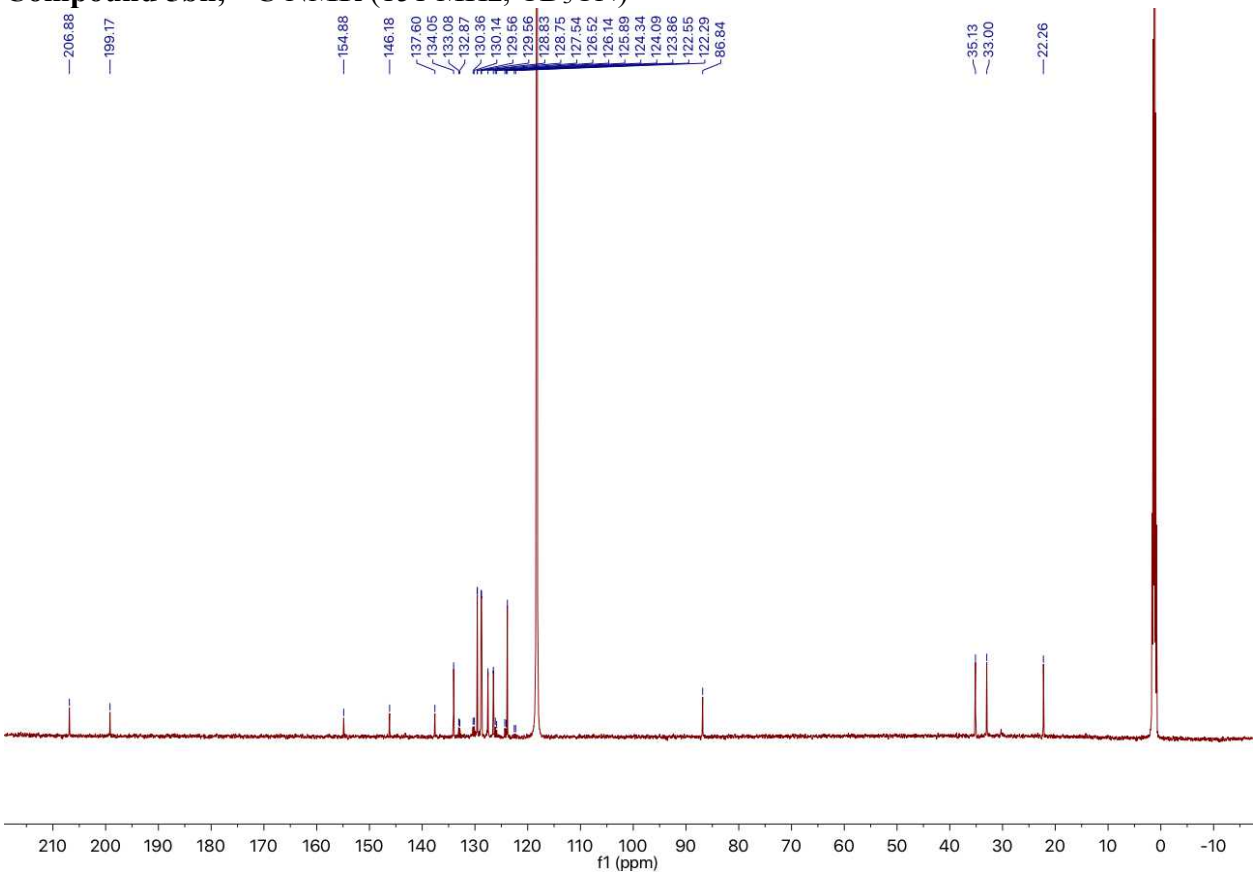
Compound 5bm, ^{19}F NMR (565 MHz, CD_3CN)



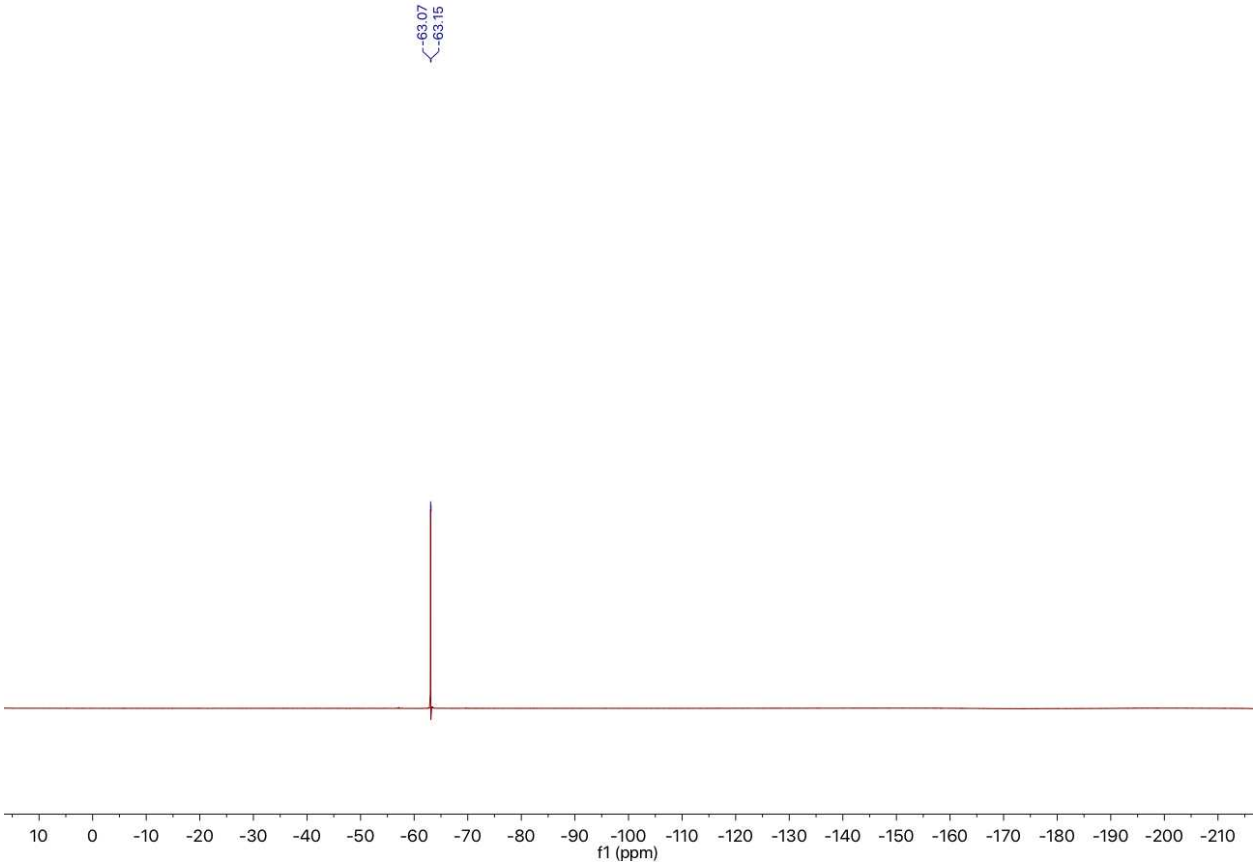
Compound 5bn, ^{1}H NMR (600 MHz, CD_3CN)



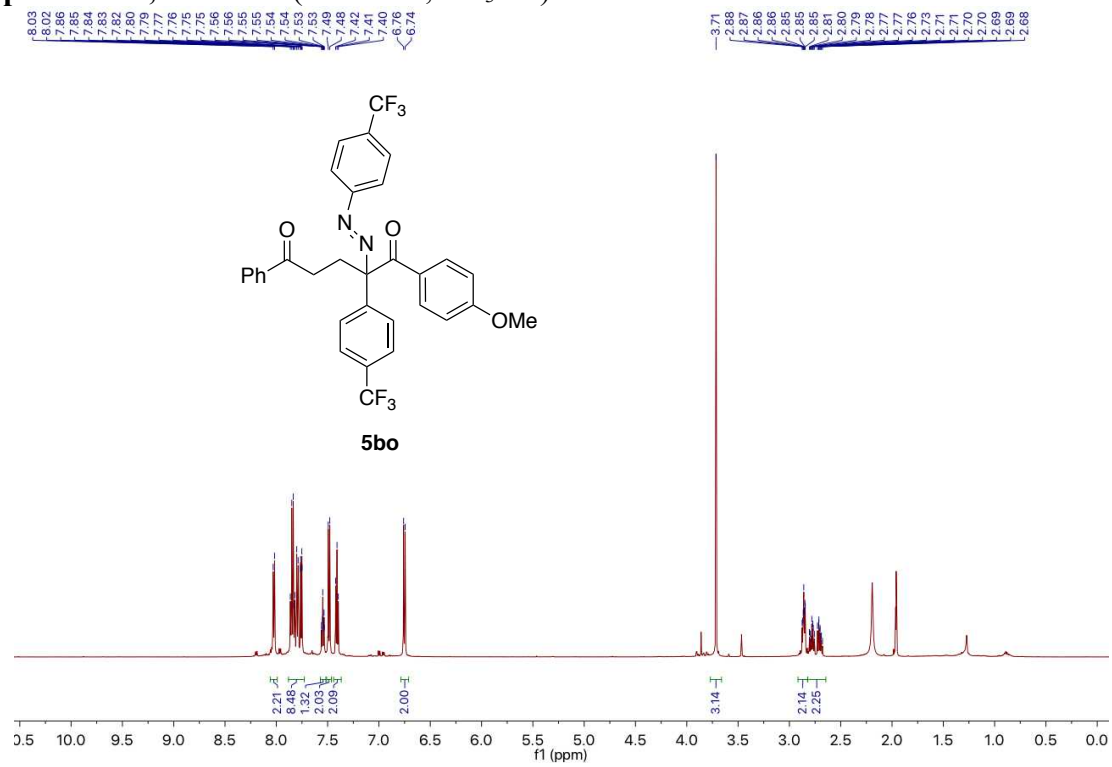
Compound 5bn, ^{13}C NMR (151 MHz, CD_3CN)



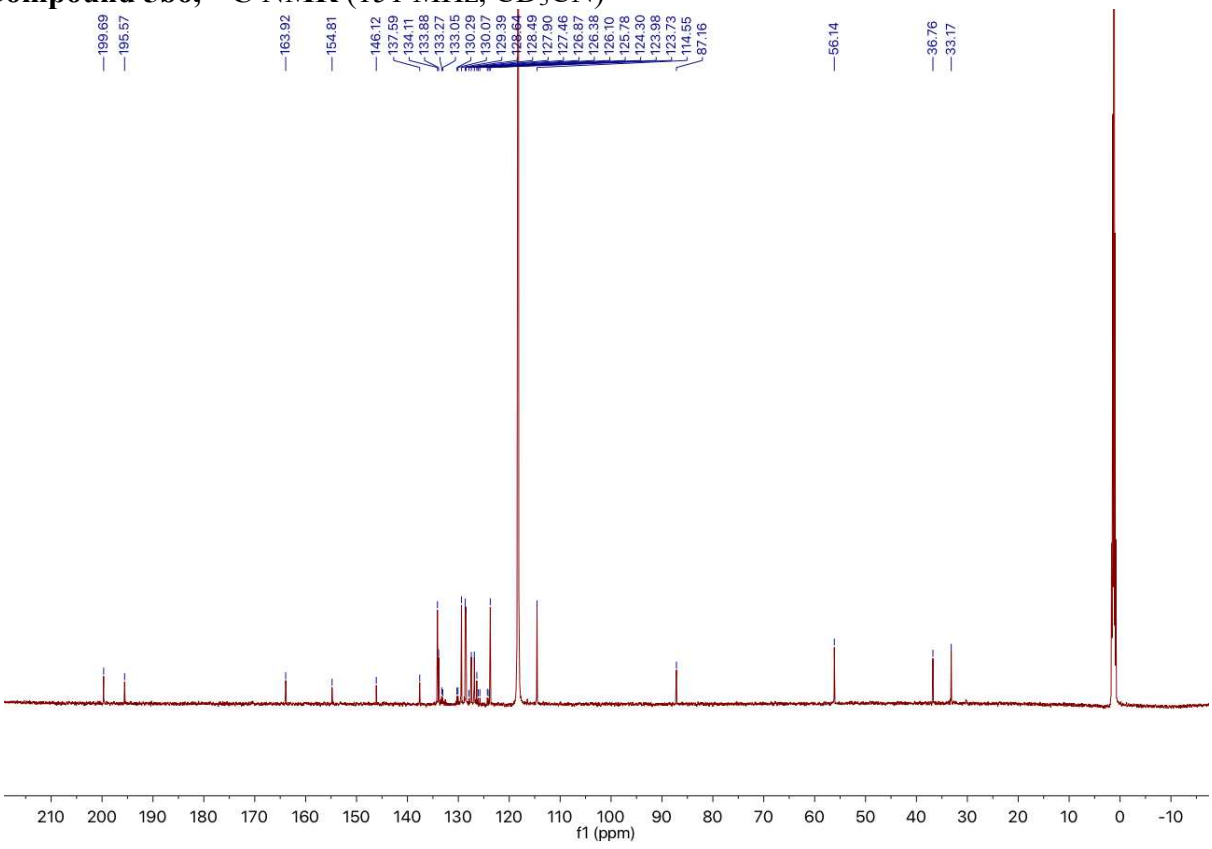
Compound 5bn, ^{19}F NMR (565 MHz, CD_3CN)



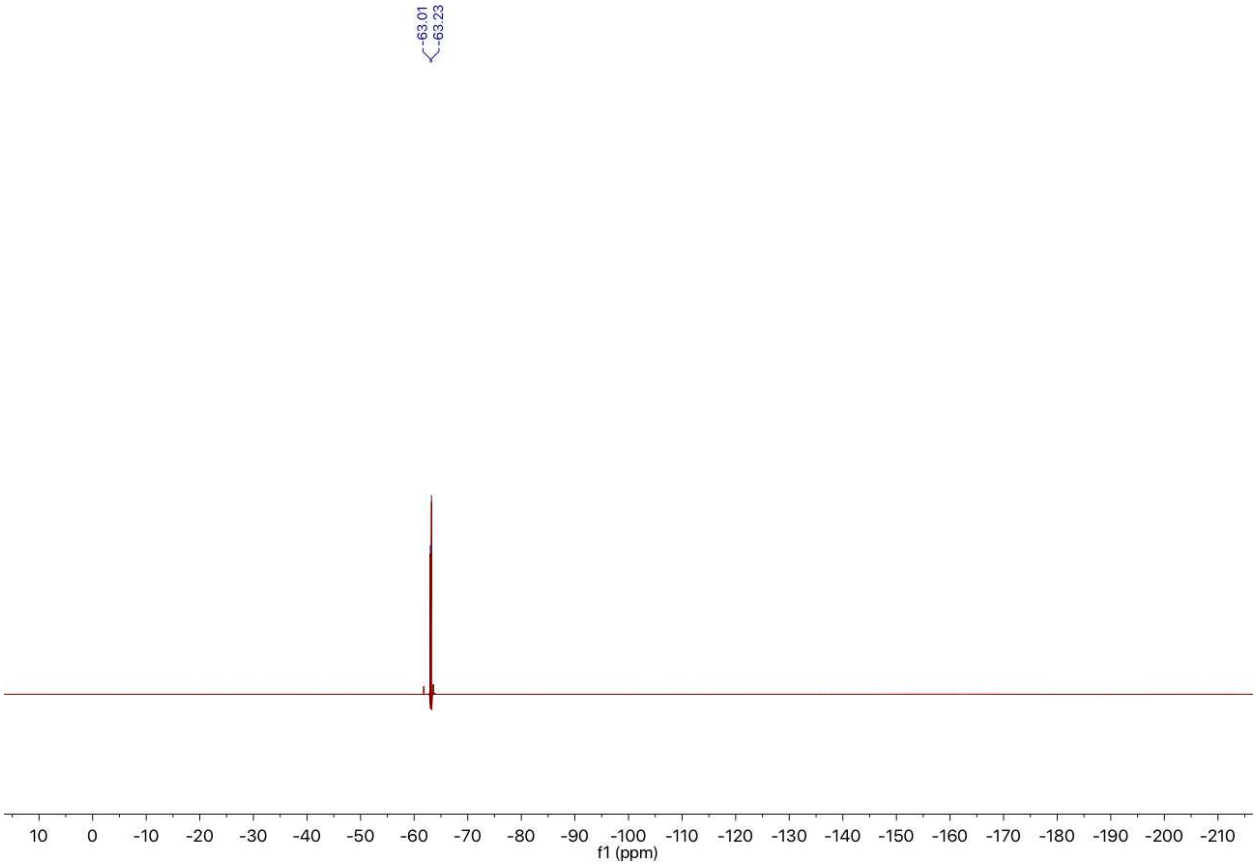
Compound 5bo, ^{1}H NMR (600 MHz, CD_3CN)



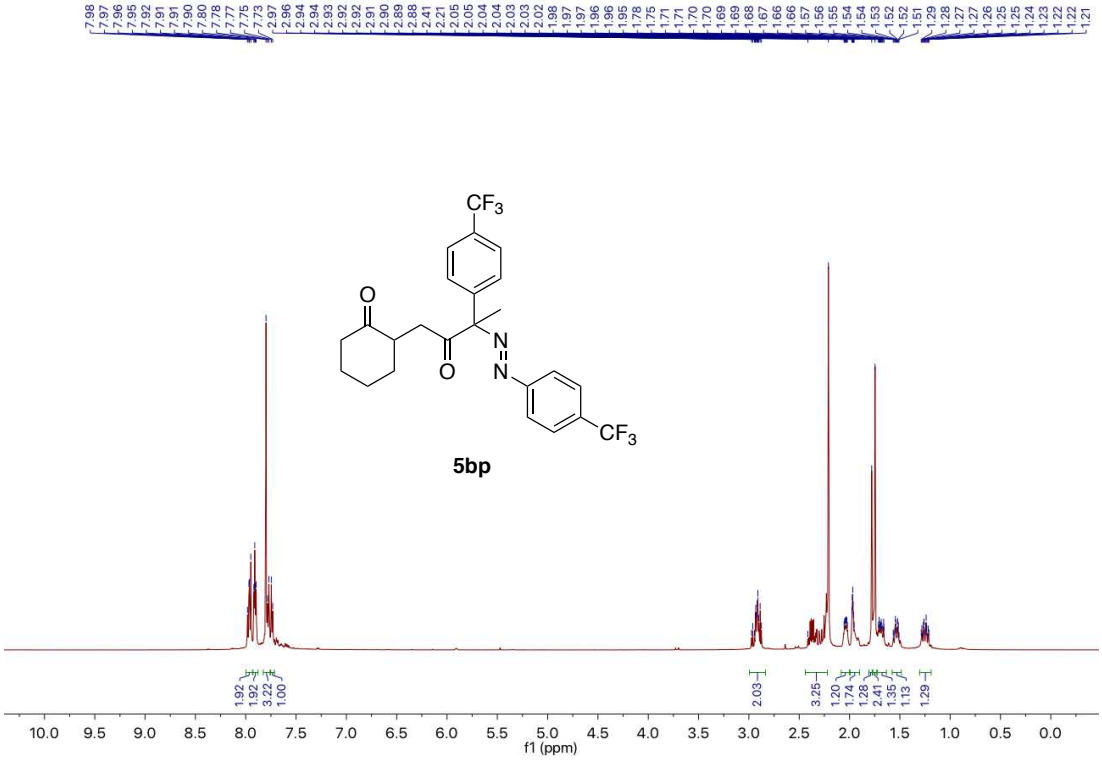
Compound 5bo, ^{13}C NMR (151 MHz, CD_3CN)



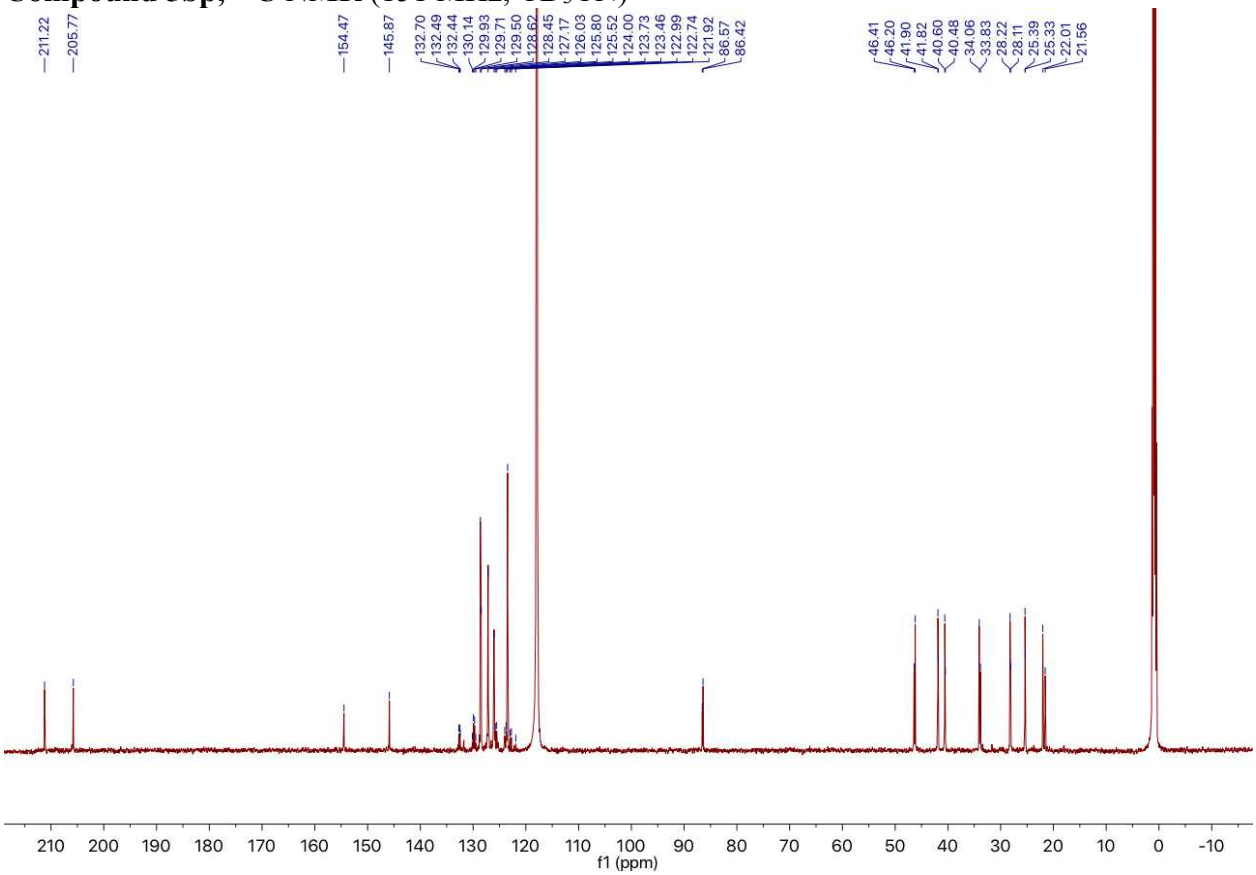
Compound 5bo, ^{19}F NMR (565 MHz, CD_3CN)



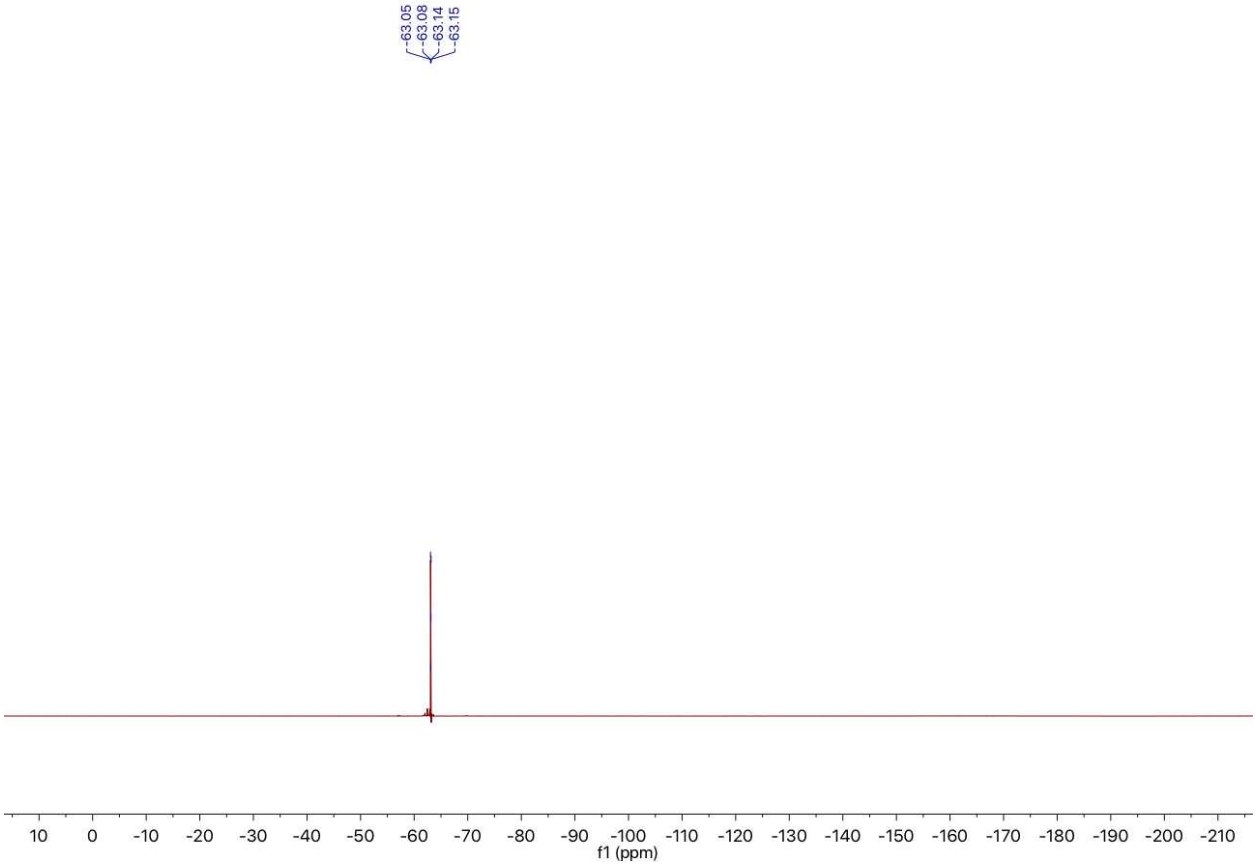
Compound 5bp, ^{1}H NMR (600 MHz, CD_3CN)



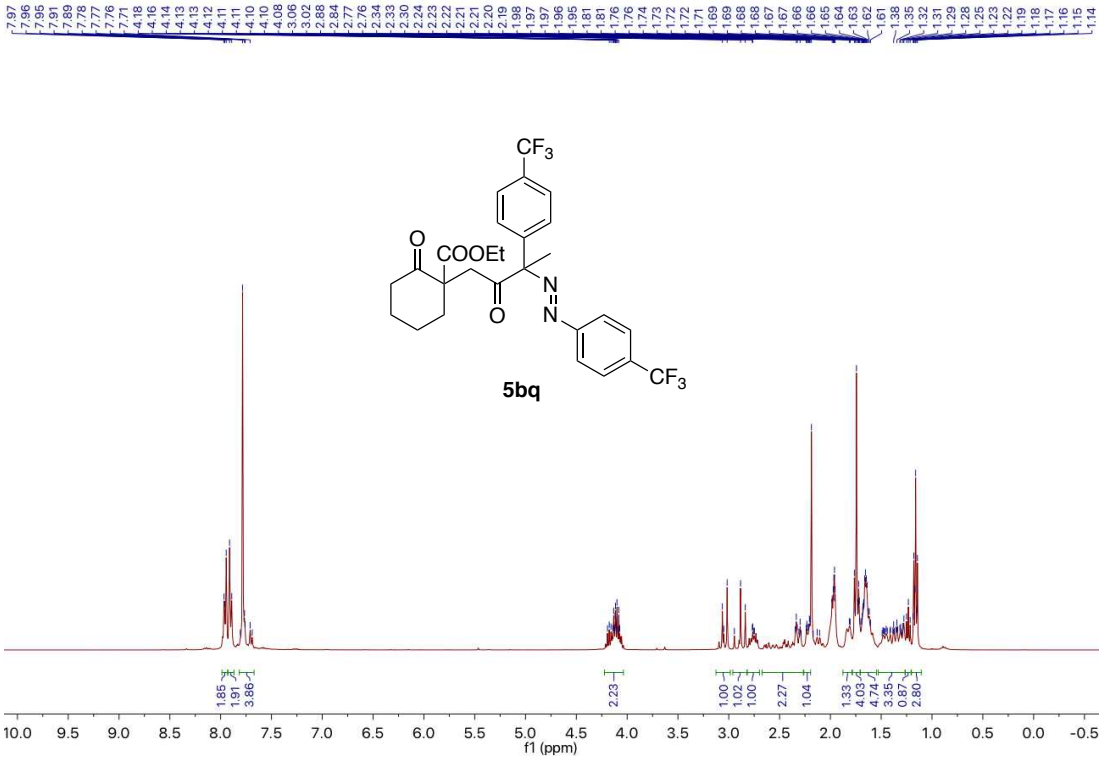
Compound 5bp, ^{13}C NMR (151 MHz, CD_3CN)



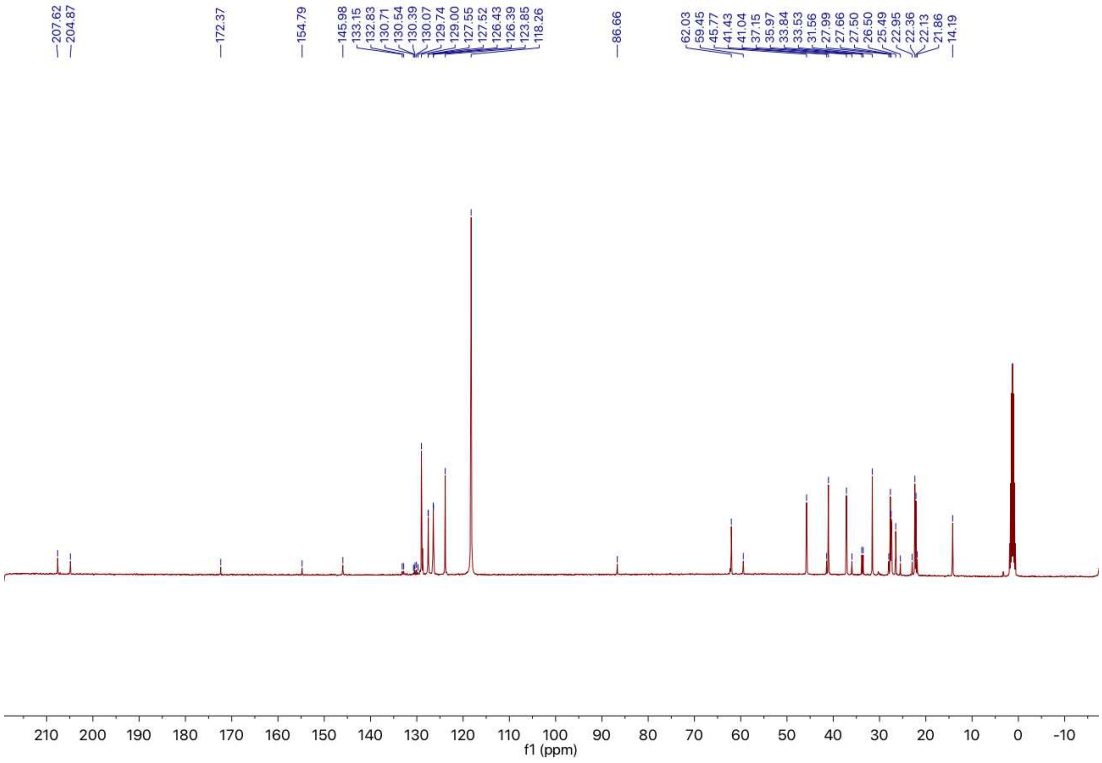
Compound 5bp, ^{19}F NMR (565 MHz, CD_3CN)



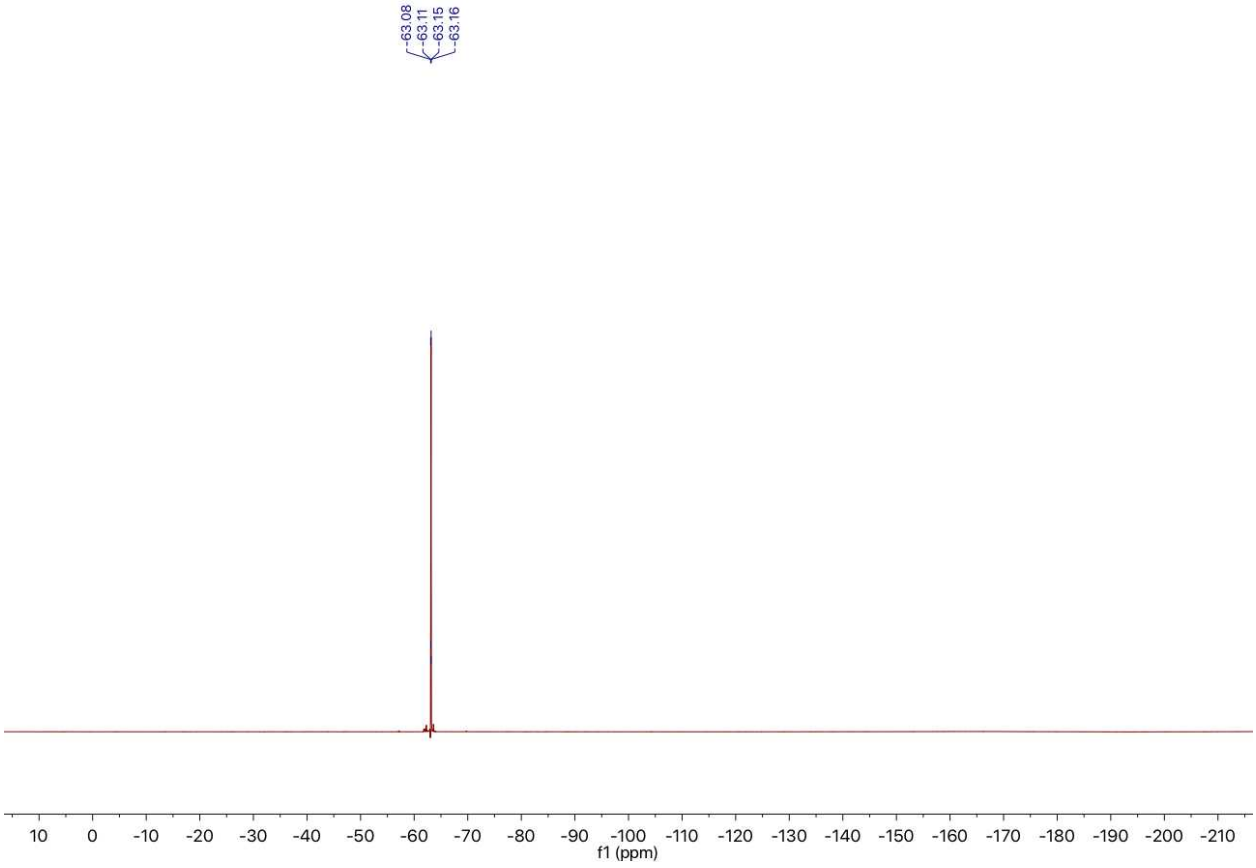
Compound 5bq, ^{1}H NMR (600 MHz, CD_3CN)



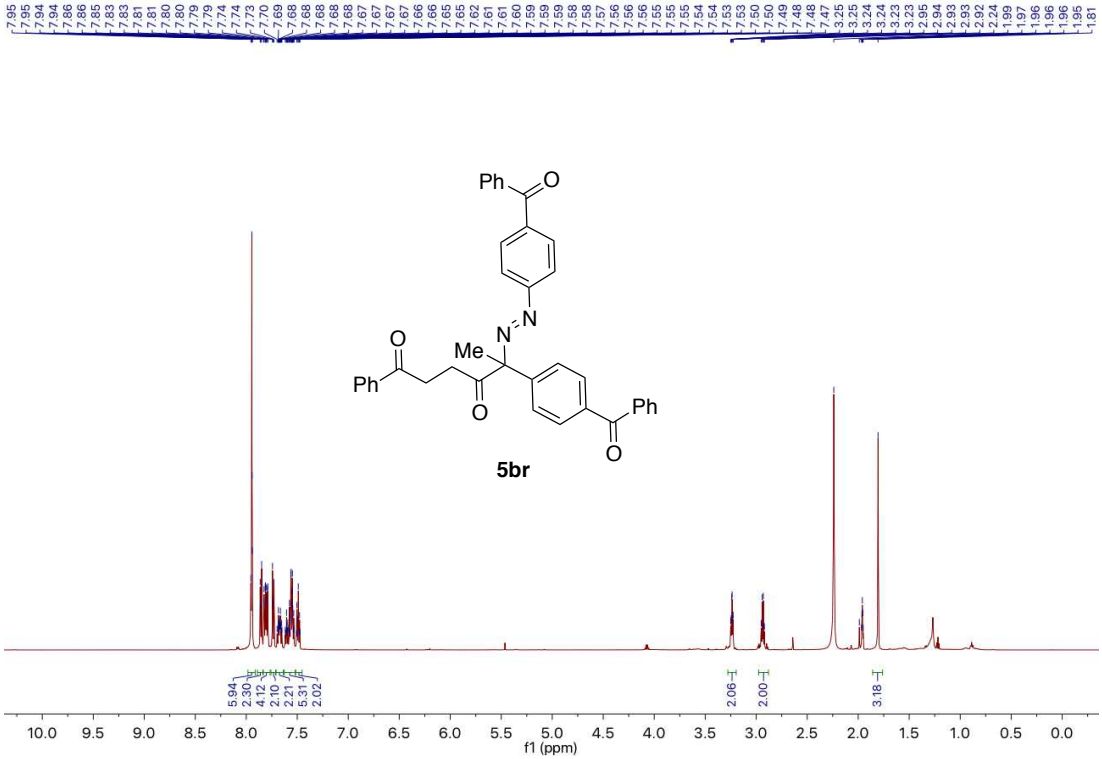
Compound 5bq, ^{13}C NMR (151 MHz, CD_3CN)



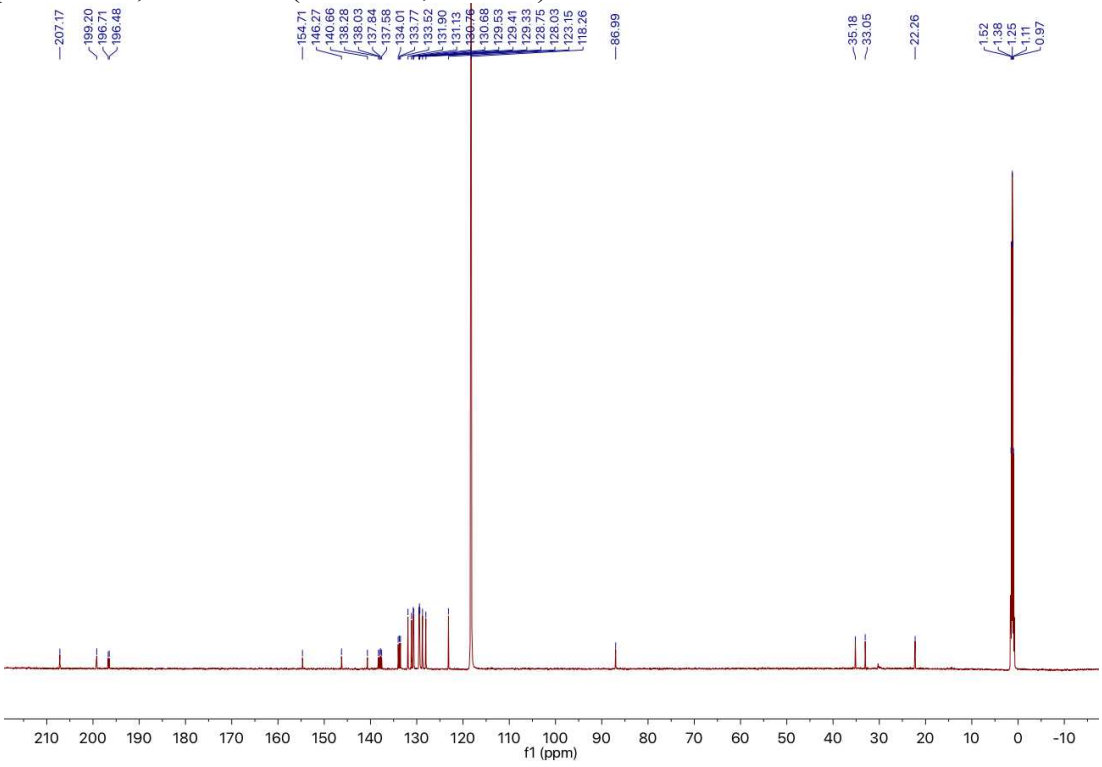
Compound 5bq, ^{19}F NMR (565 MHz, CD_3CN)



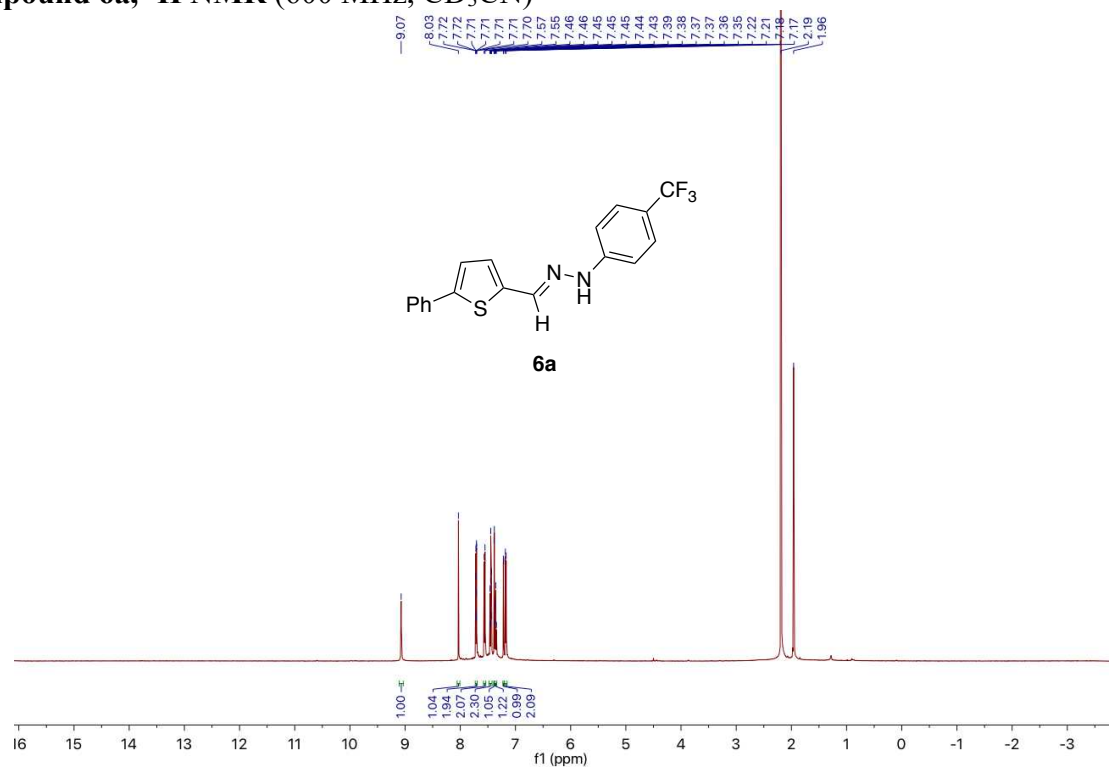
Compound 5br, ^{1}H NMR (600 MHz, CD_3CN)



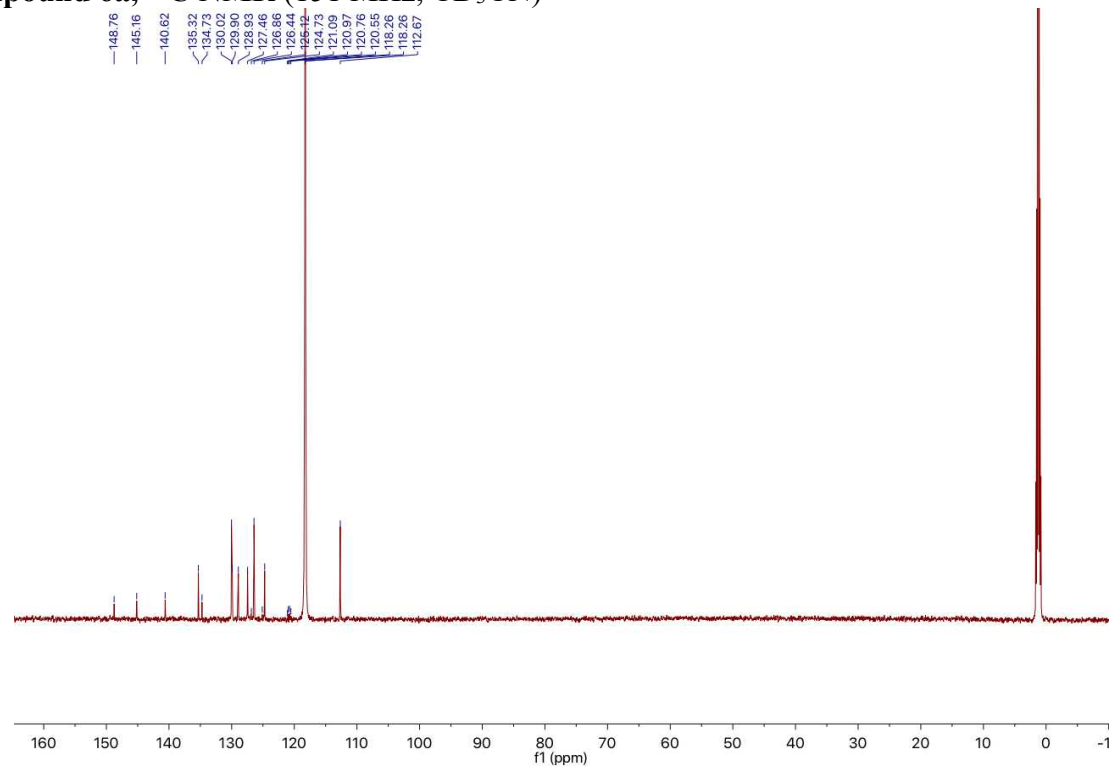
Compound 5br, ^{13}C NMR (151 MHz, CD_3CN)



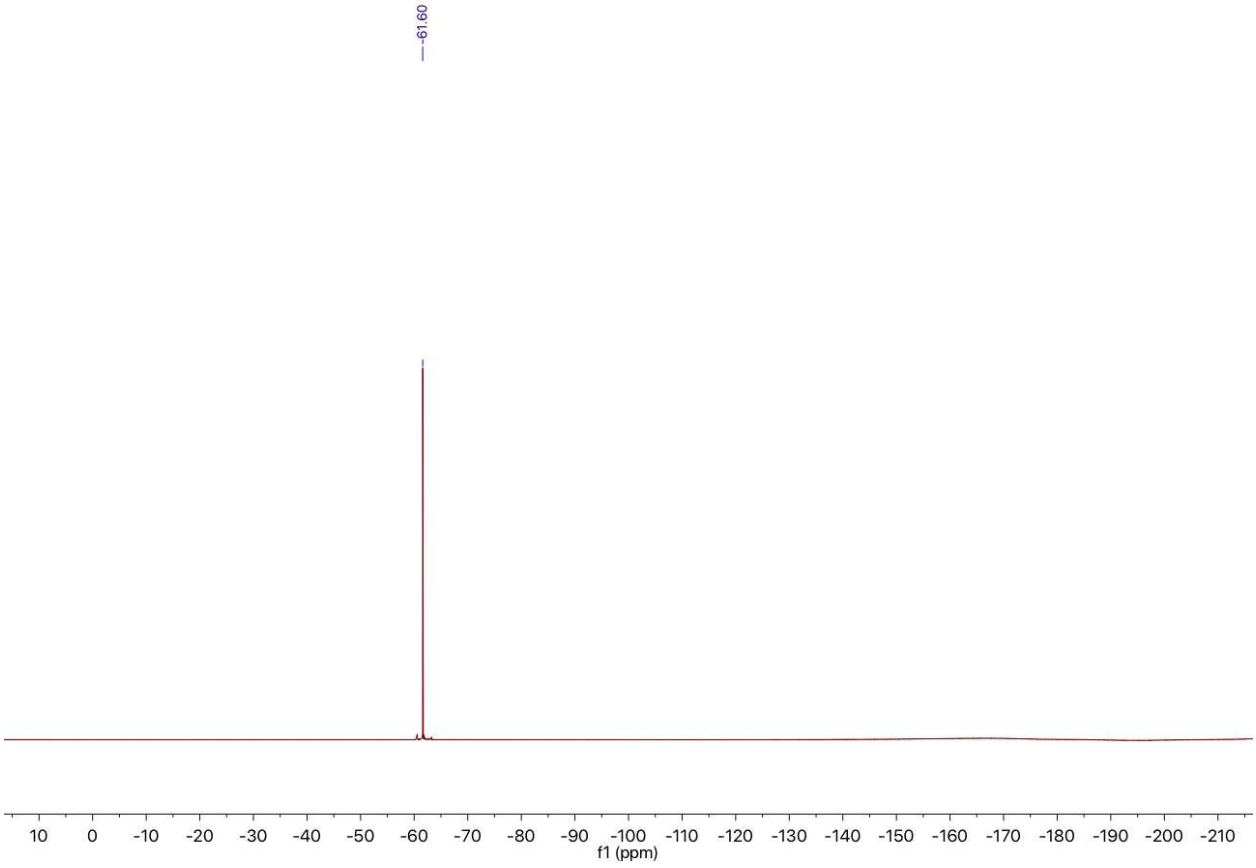
Compound 6a, ^{1}H NMR (600 MHz, CD_3CN)



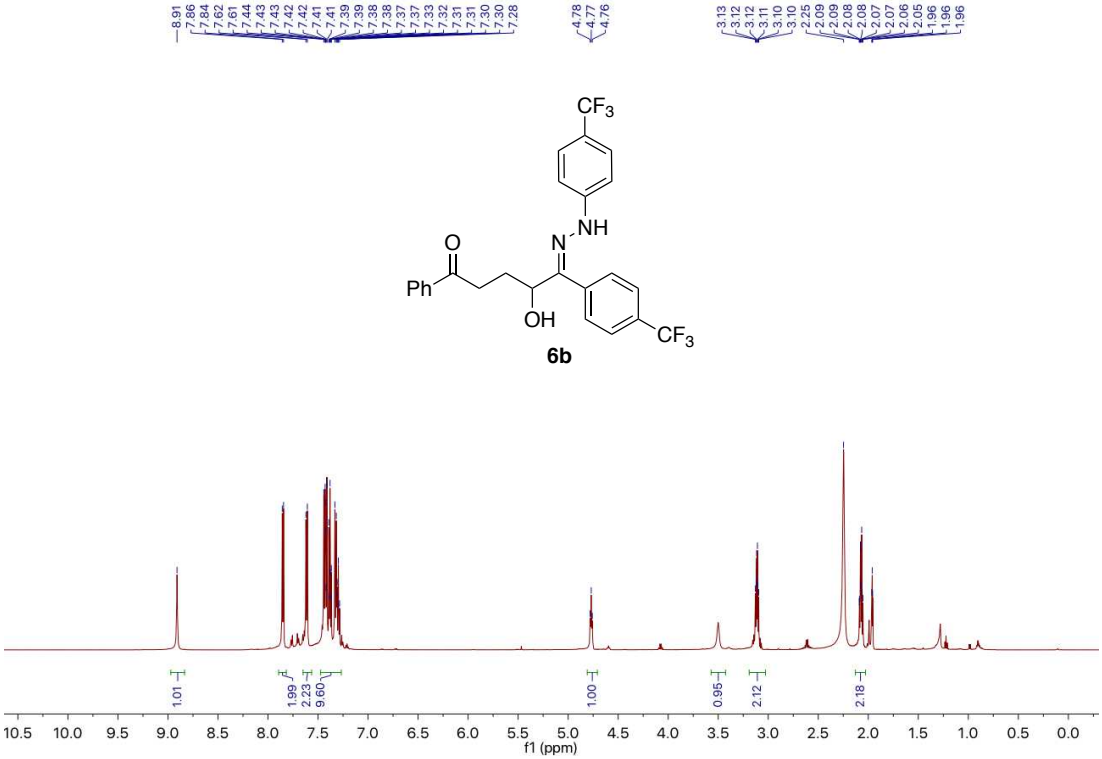
Compound 6a, ^{13}C NMR (151 MHz, CD_3CN)



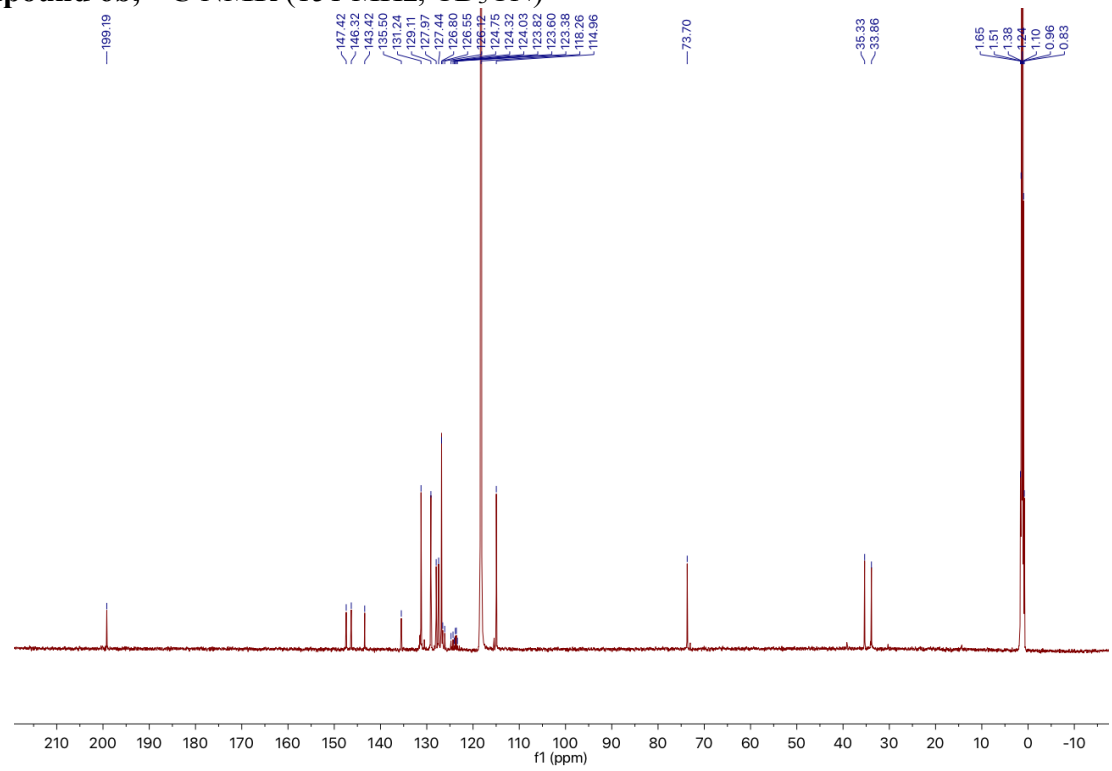
Compound 6a, ^{19}F NMR (565 MHz, CD_3CN)



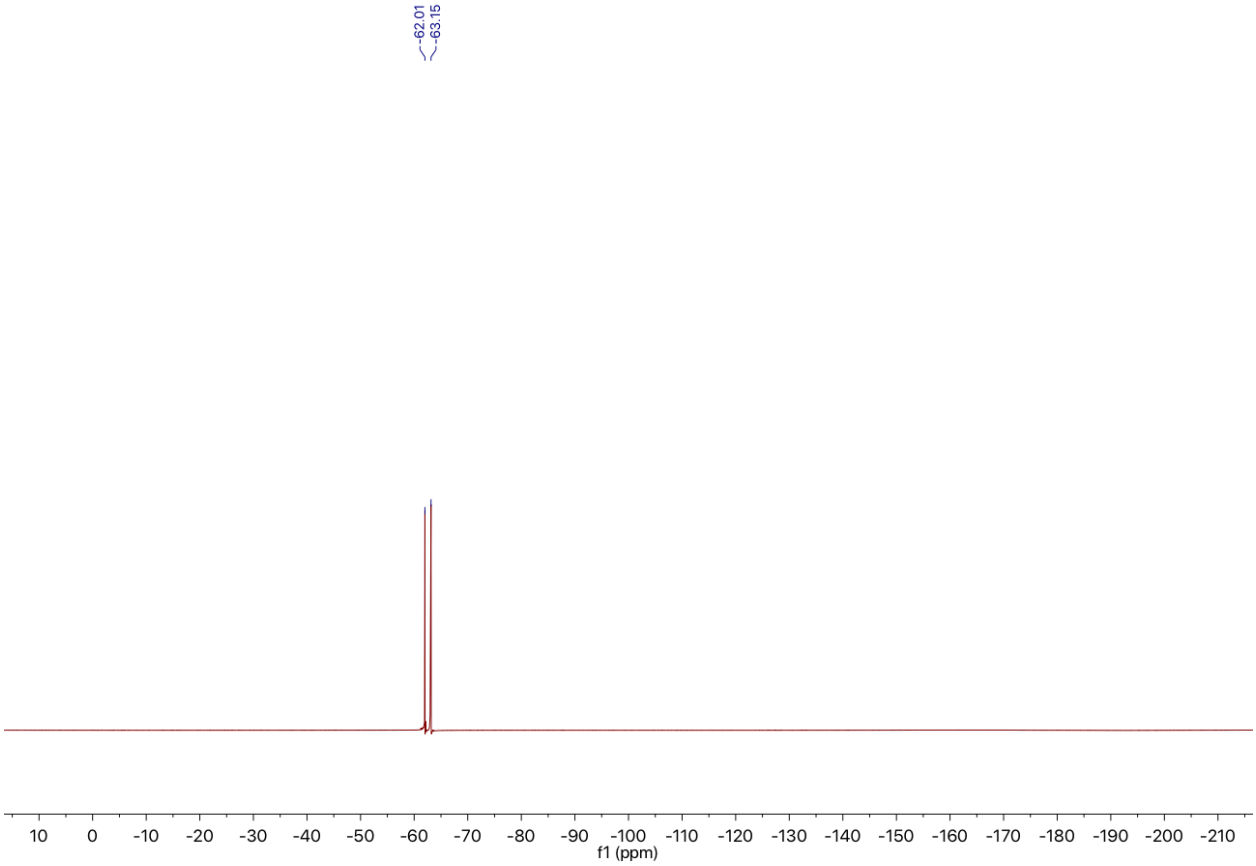
Compound 6b, ^{1}H NMR (600 MHz, CD_3CN)



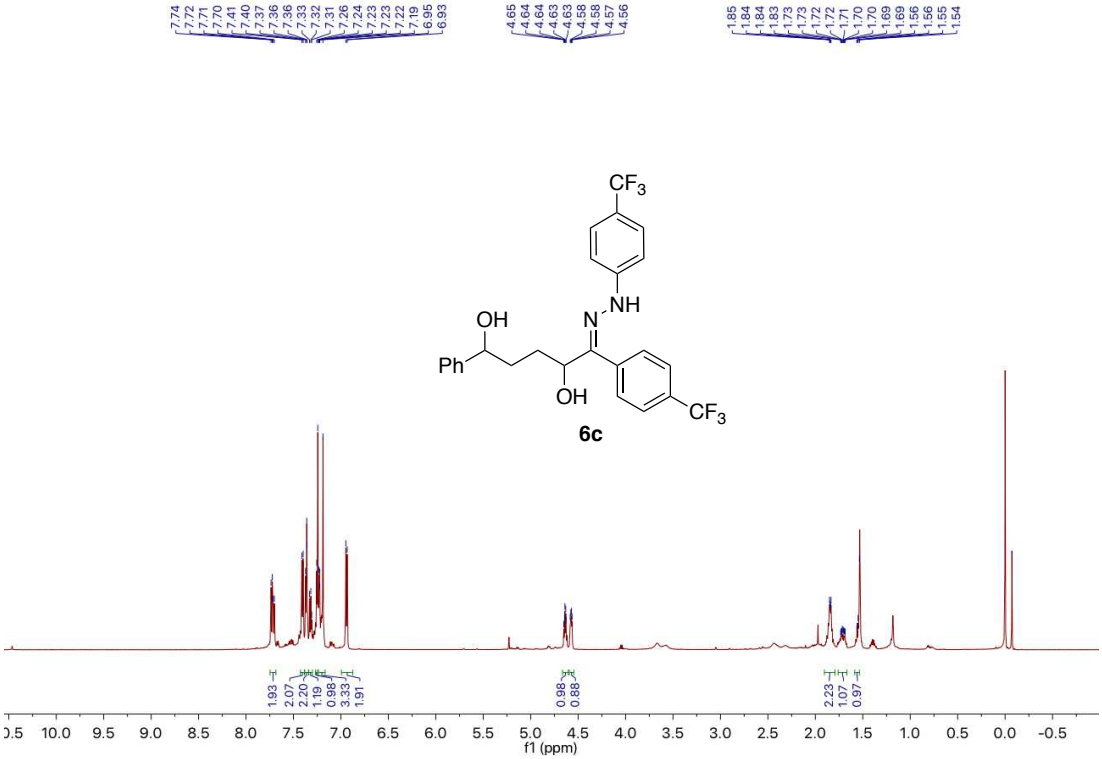
Compound 6b, ^{13}C NMR (151 MHz, CD_3CN)



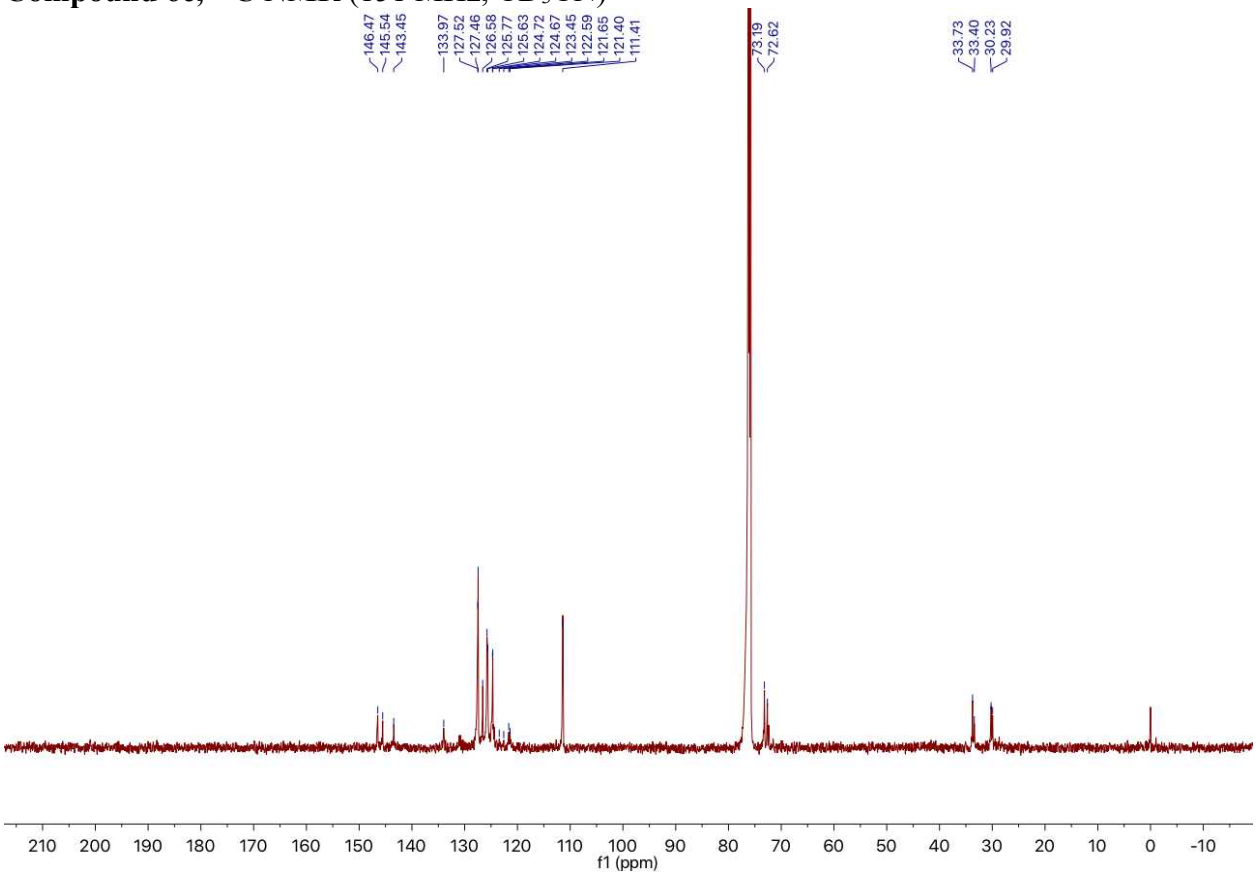
Compound 6b ^{19}F NMR (565 MHz, CD_3CN)



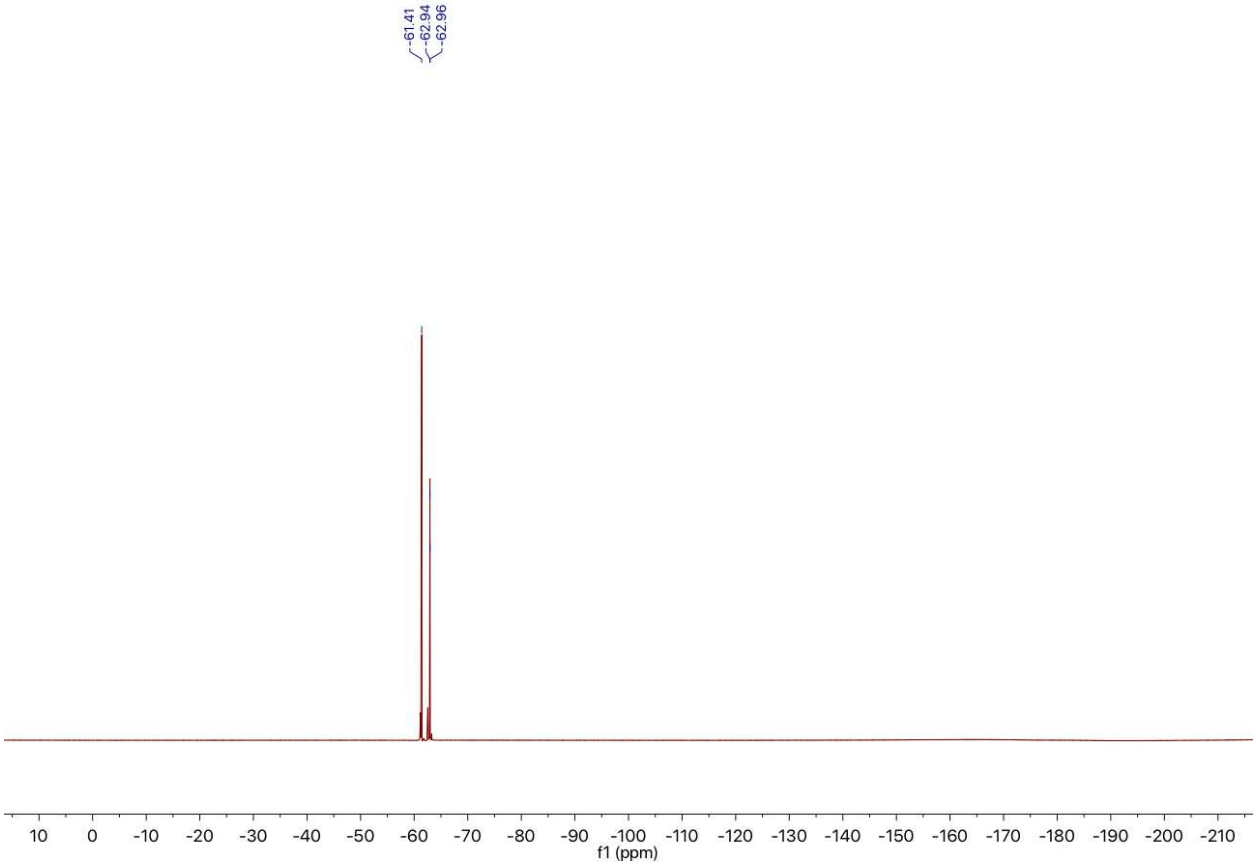
Compound 6c ^{1}H NMR (600 MHz, CD_3CN)



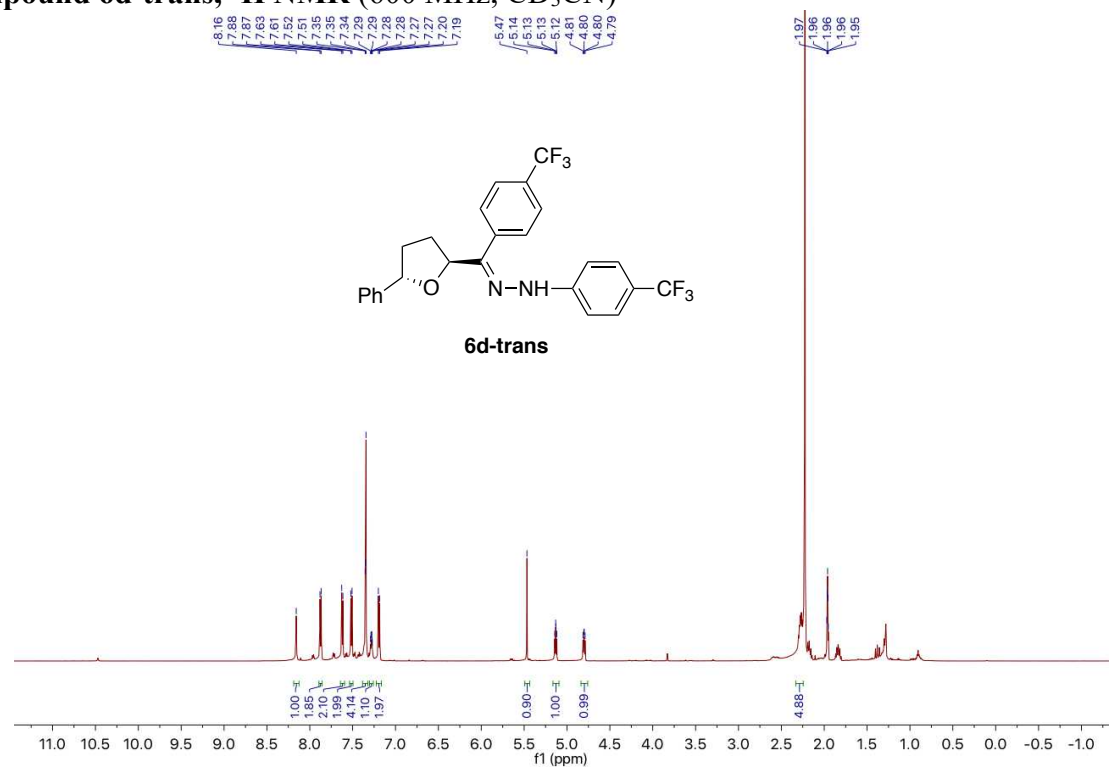
Compound 6c, ^{13}C NMR (151 MHz, CD_3CN)



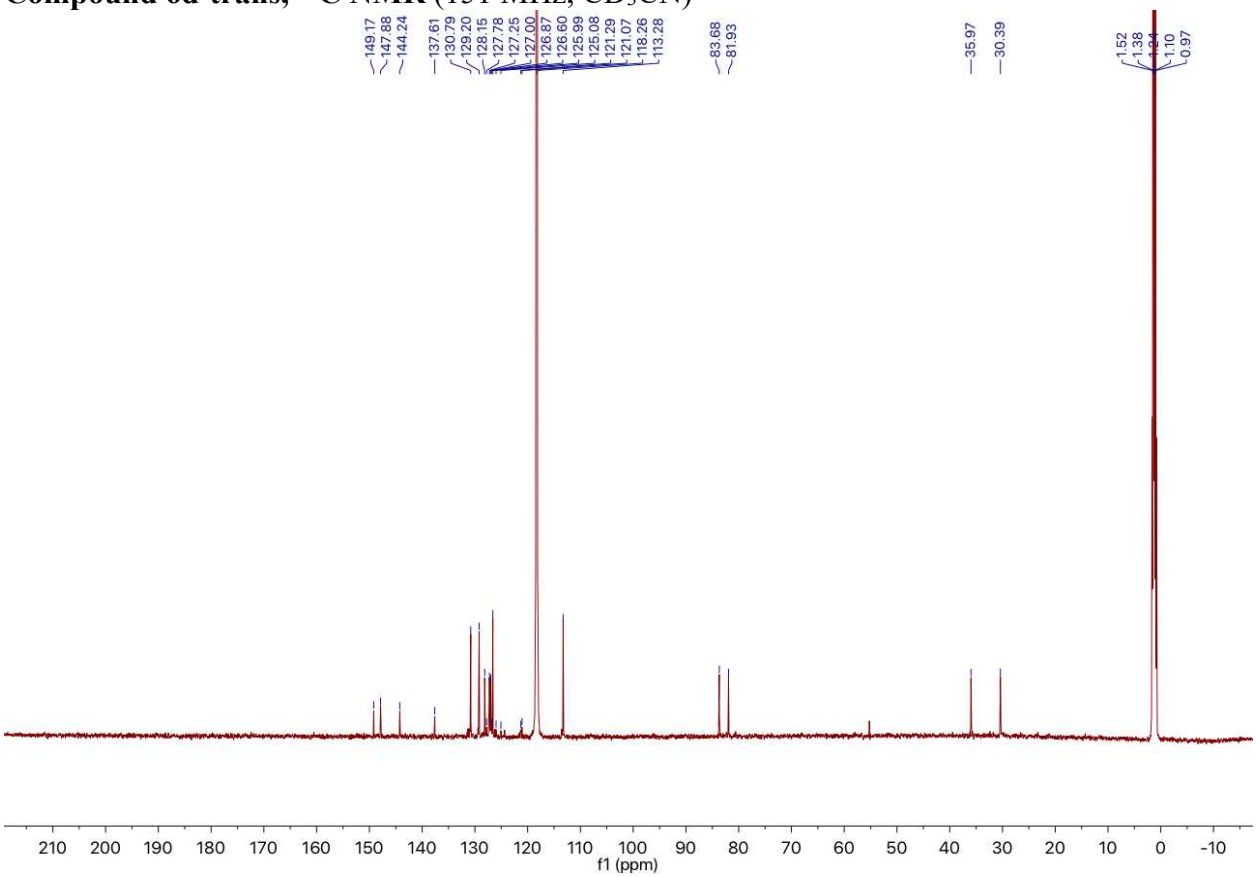
Compound 6c ^{19}F NMR (565 MHz, CD_3CN)



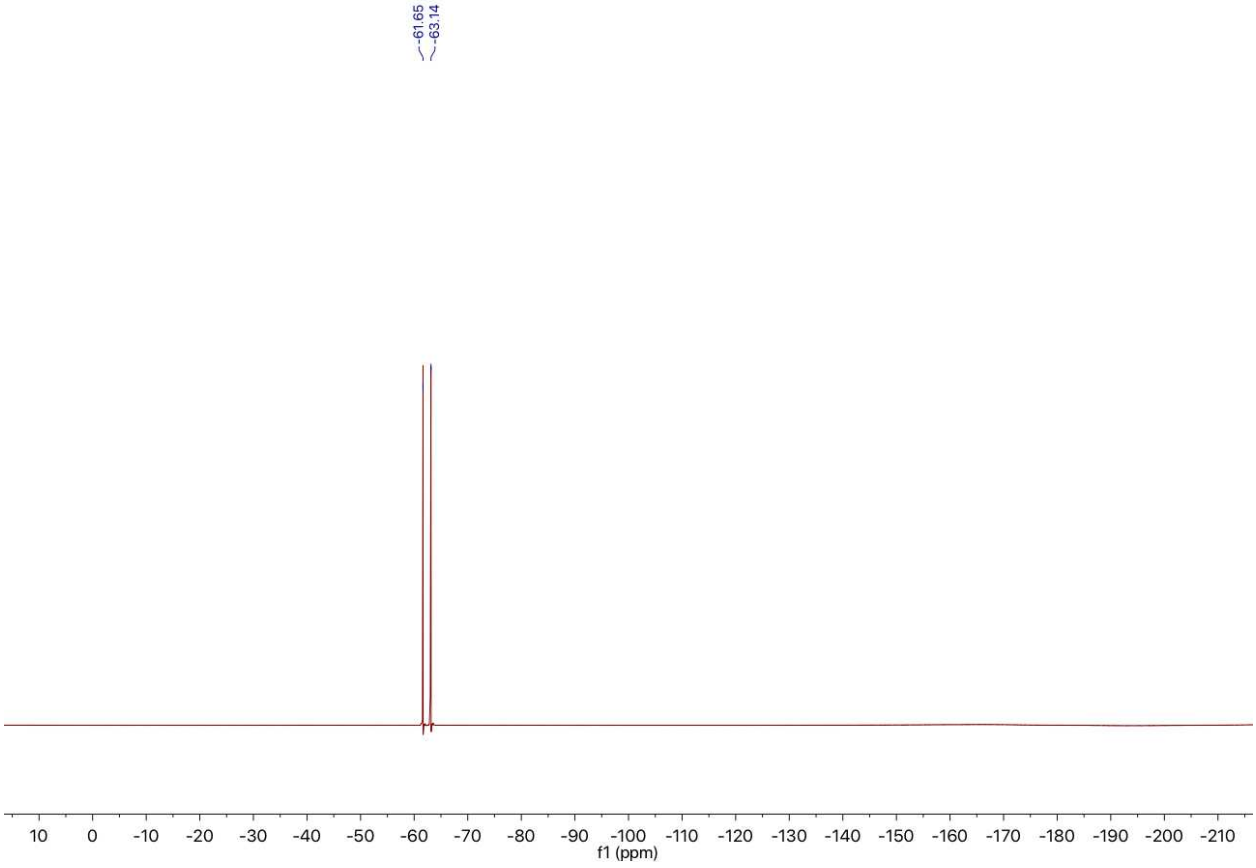
Compound 6d-trans, ^{1}H NMR (600 MHz, CD_3CN)



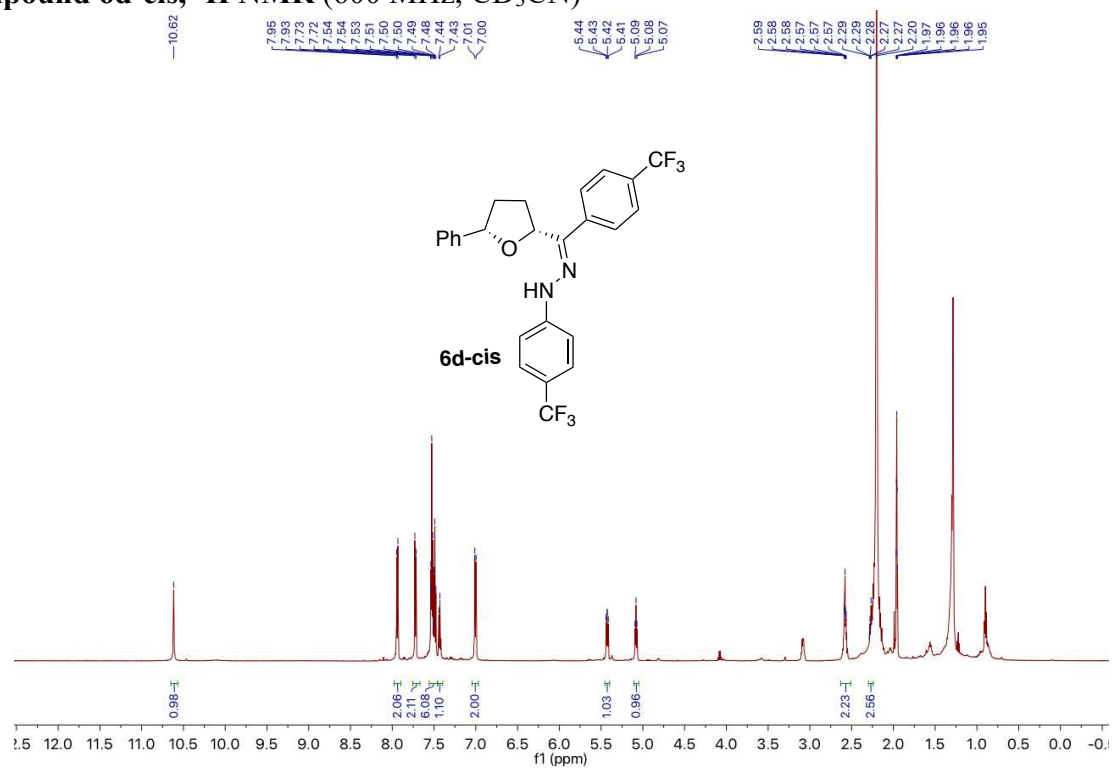
Compound 6d-trans, ^{13}C NMR (151 MHz, CD_3CN)



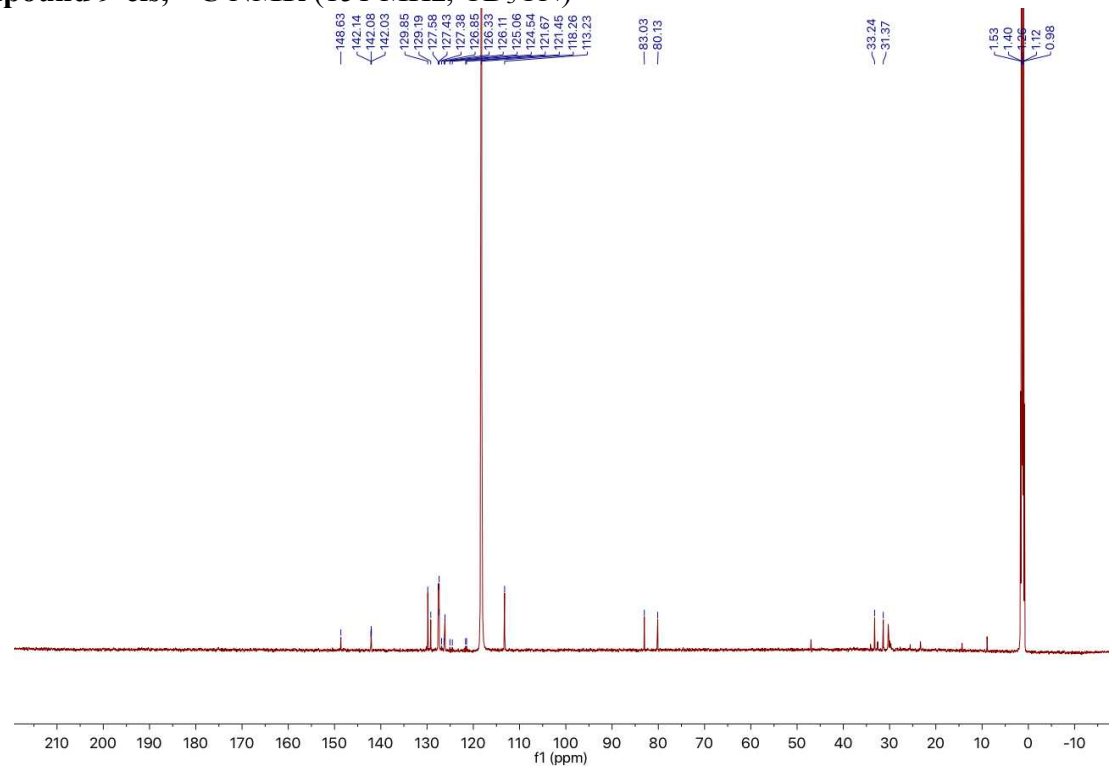
Compound 6d-trans ^{19}F NMR (565 MHz, CD_3CN)



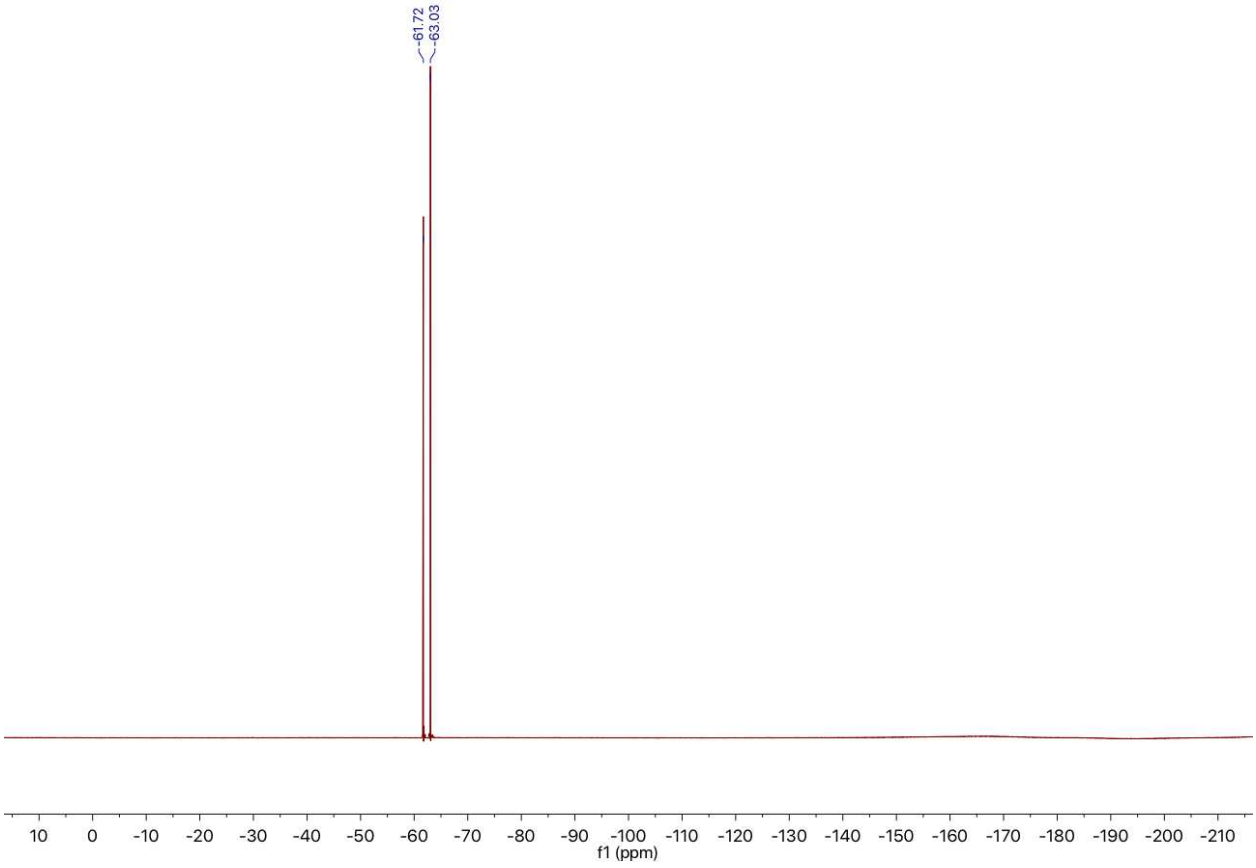
Compound 6d-cis, ^{1}H NMR (600 MHz, CD_3CN)



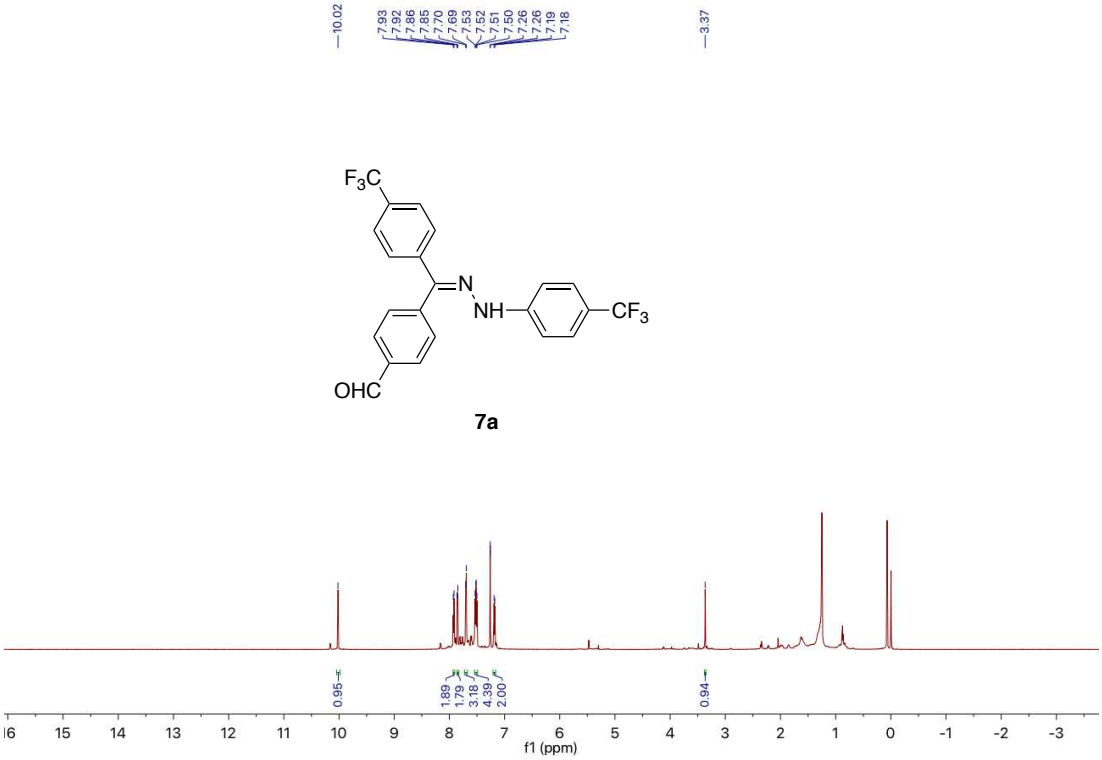
Compound 9-cis, ^{13}C NMR (151 MHz, CD_3CN)



Compound 9-cis ^{19}F NMR (565 MHz, CD_3CN)

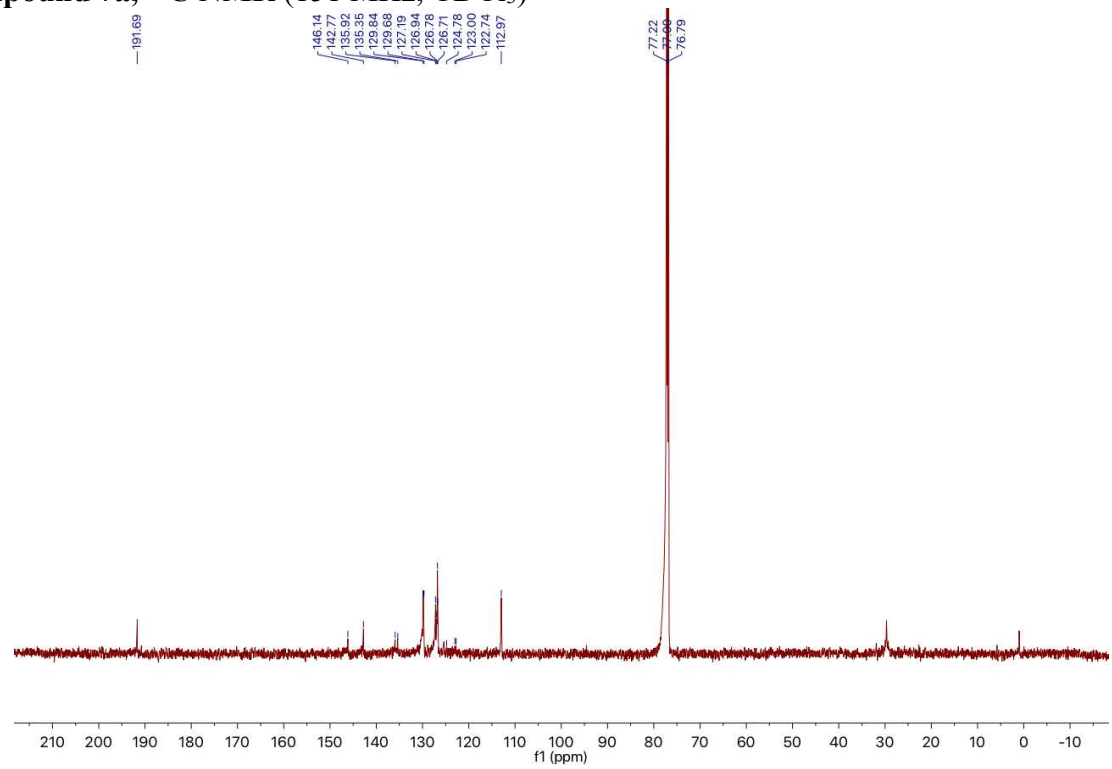


Compound 7a, ^{1}H NMR (600 MHz, $CDCl_3$)

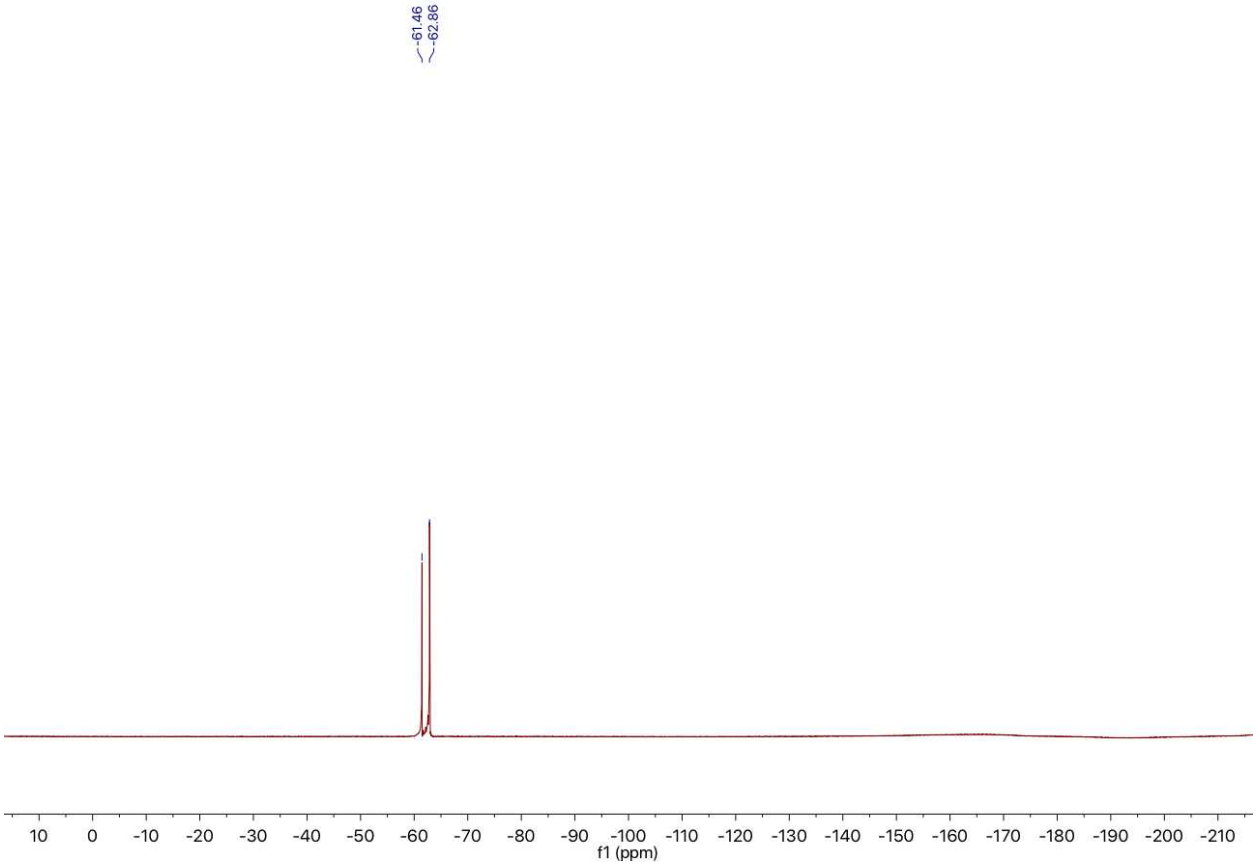


7a

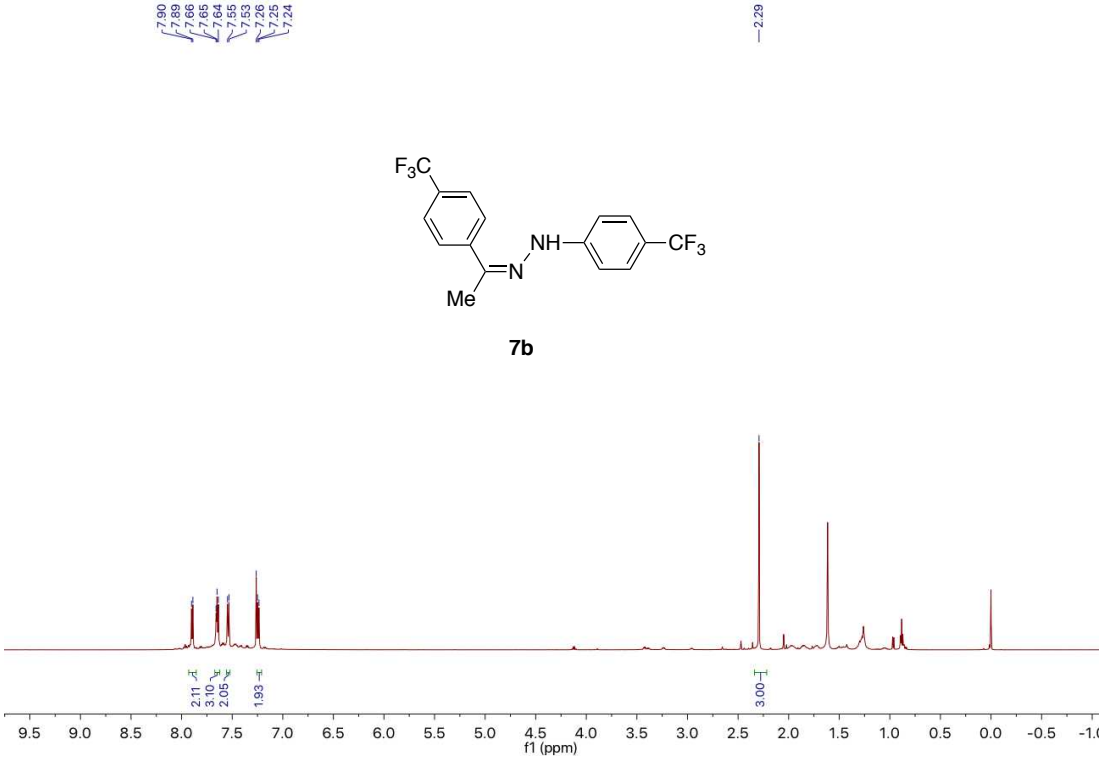
Compound 7a, ^{13}C NMR (151 MHz, $CDCl_3$)



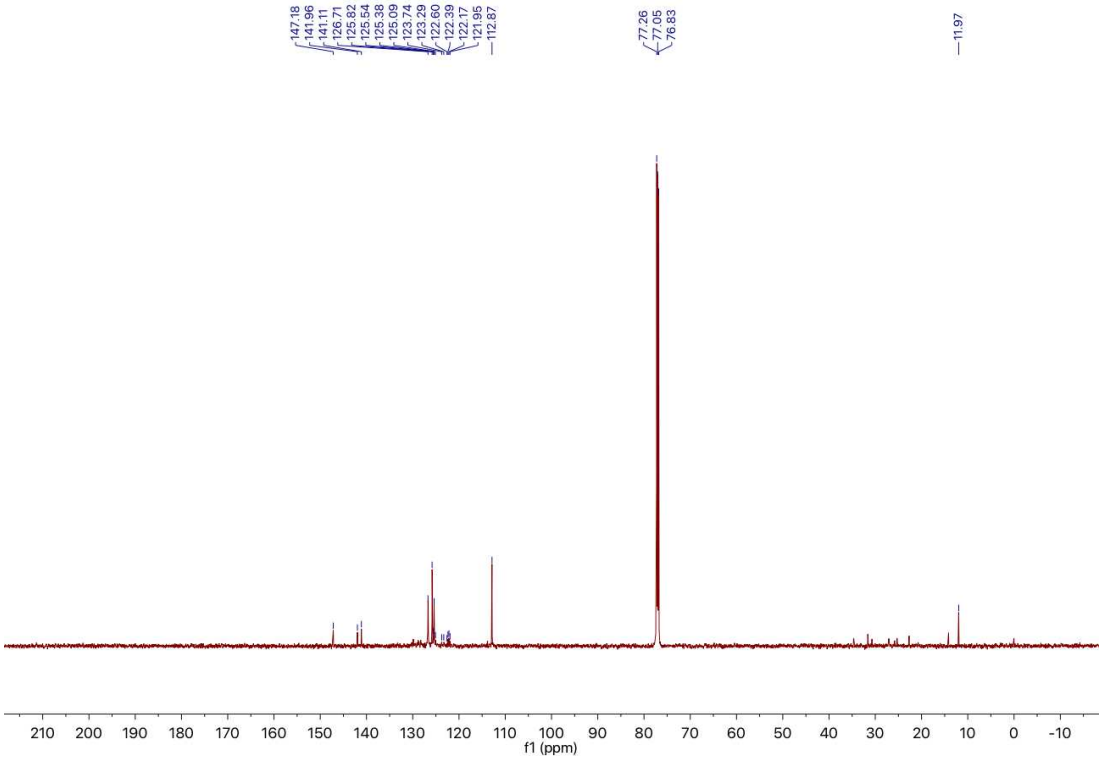
Compound 7a ^{19}F NMR (565 MHz, $CDCl_3$)



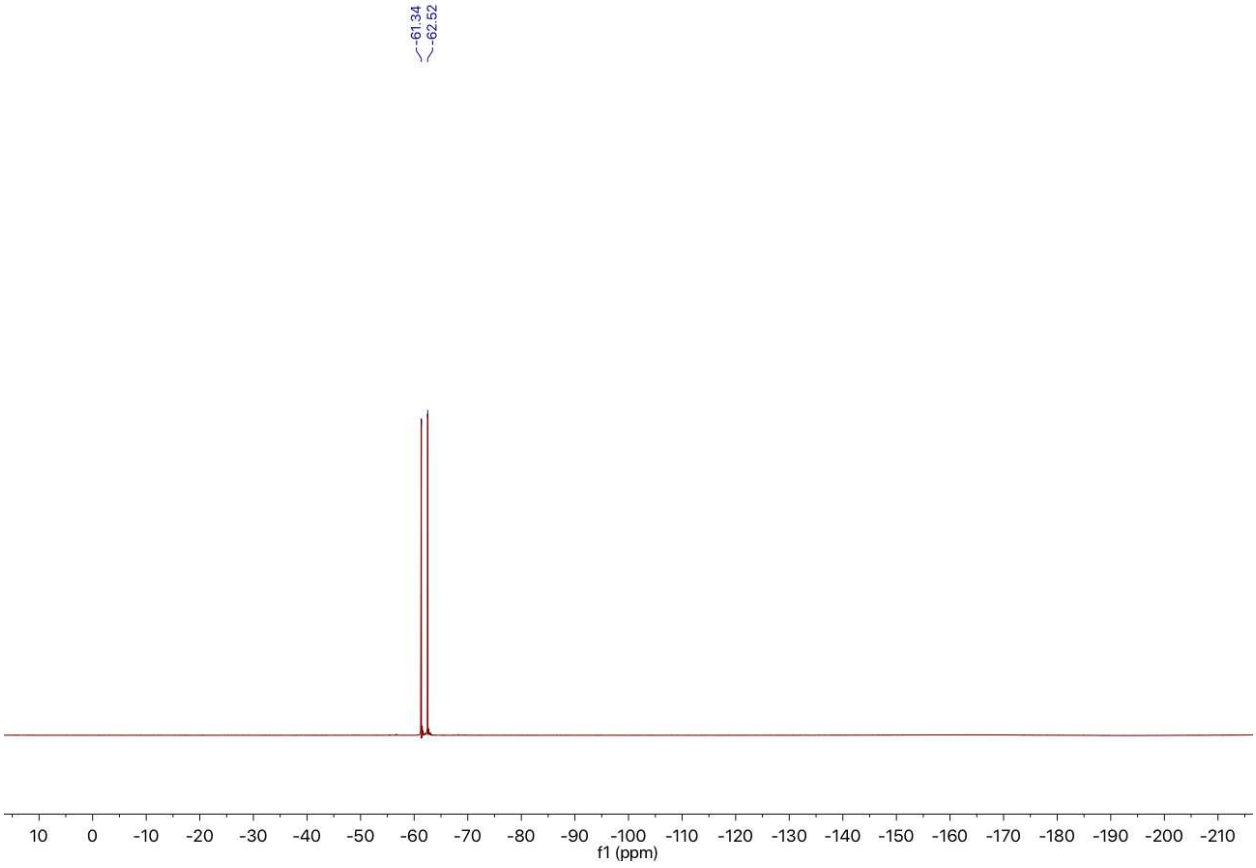
Compound 7b, ^{1}H NMR (600 MHz, $CDCl_3$)



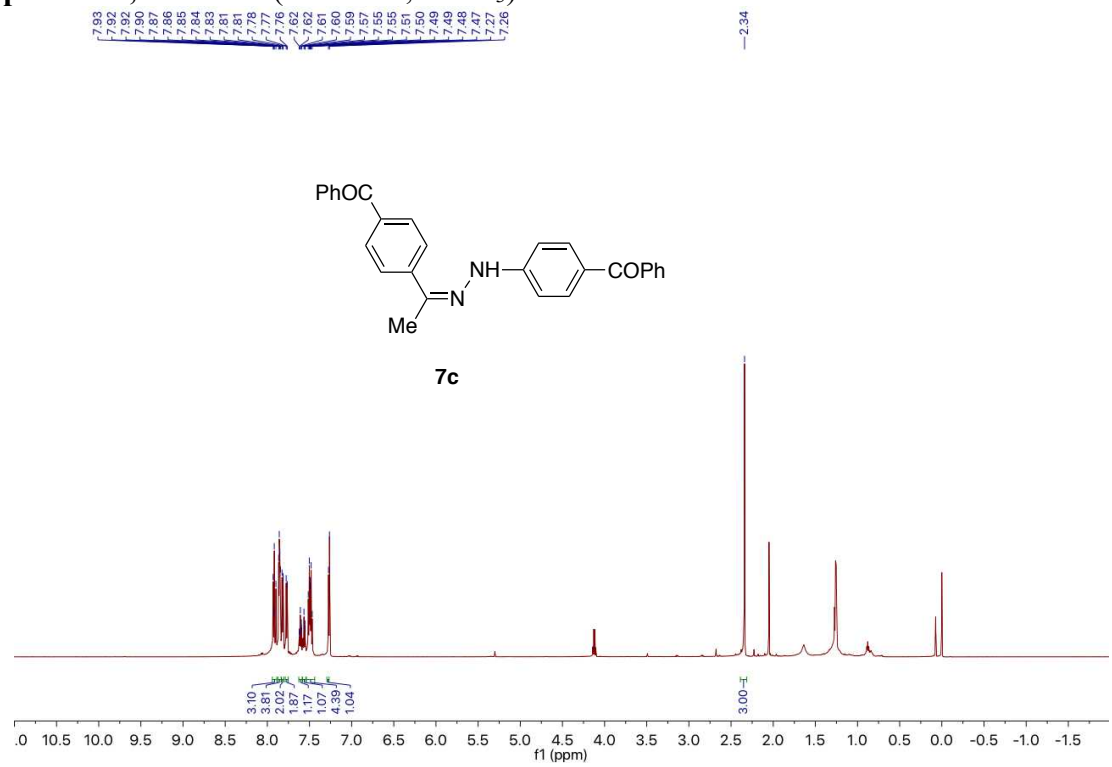
Compound 7b, ^{13}C NMR (151 MHz, $CDCl_3$)



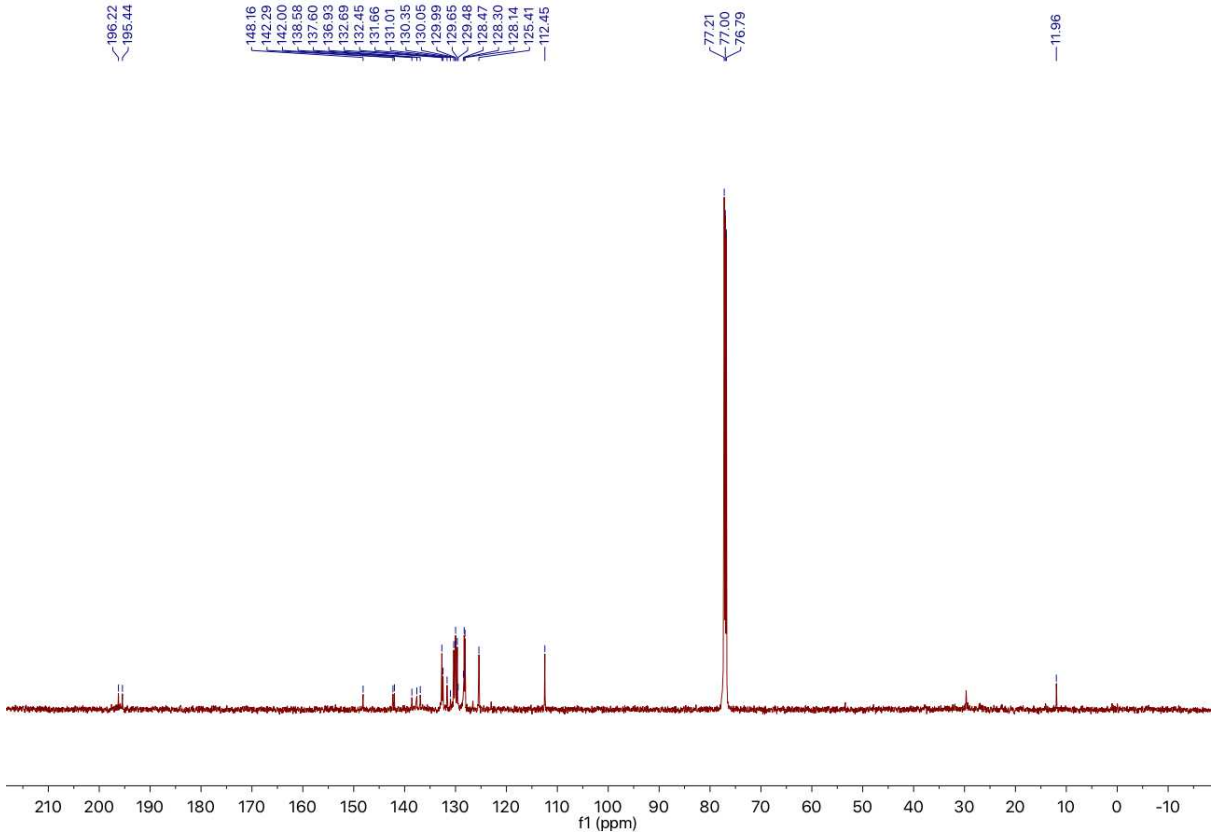
Compound 7b ^{19}F NMR (565 MHz, $CDCl_3$)



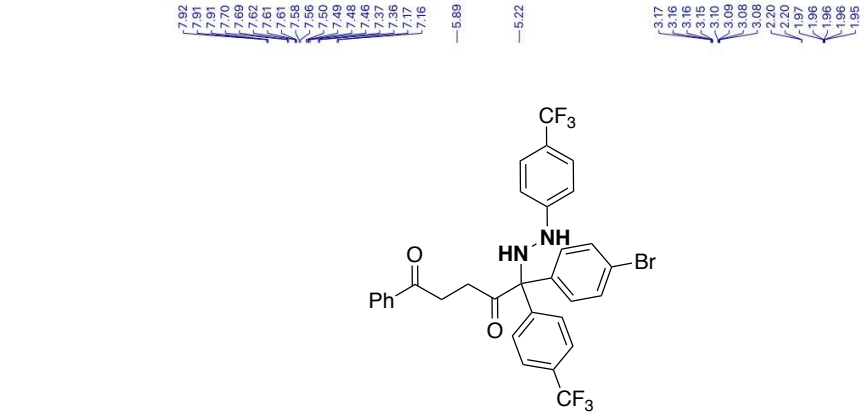
Compound 7c, ^{1}H NMR (600 MHz, $CDCl_3$)



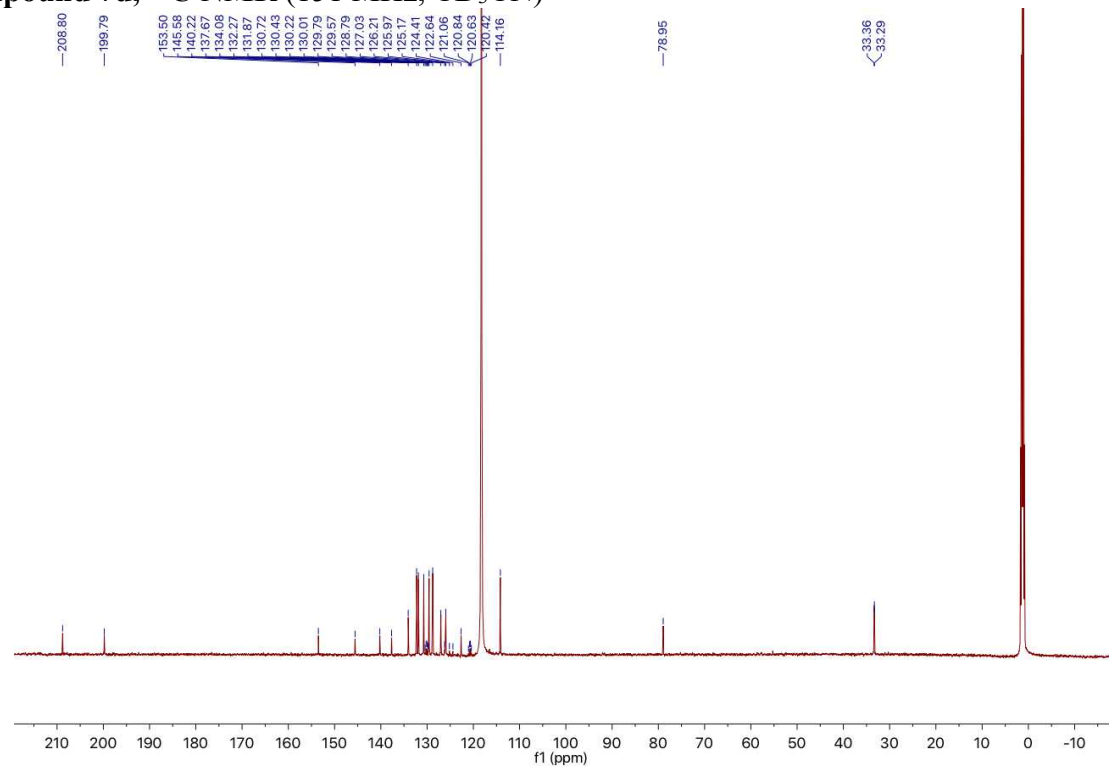
Compound 7c, ^{13}C NMR (151 MHz, $CDCl_3$)



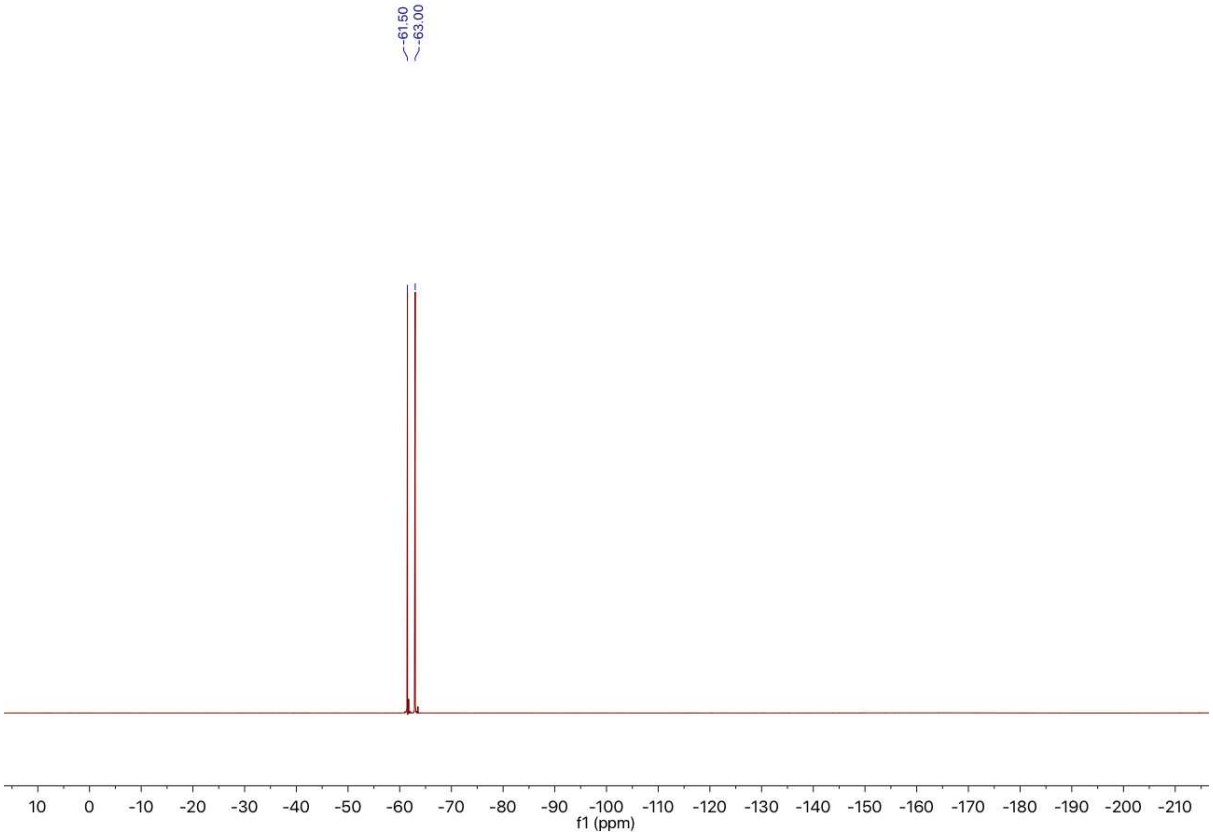
Compound 7d, ^{1}H NMR (600 MHz, CD_3CN)



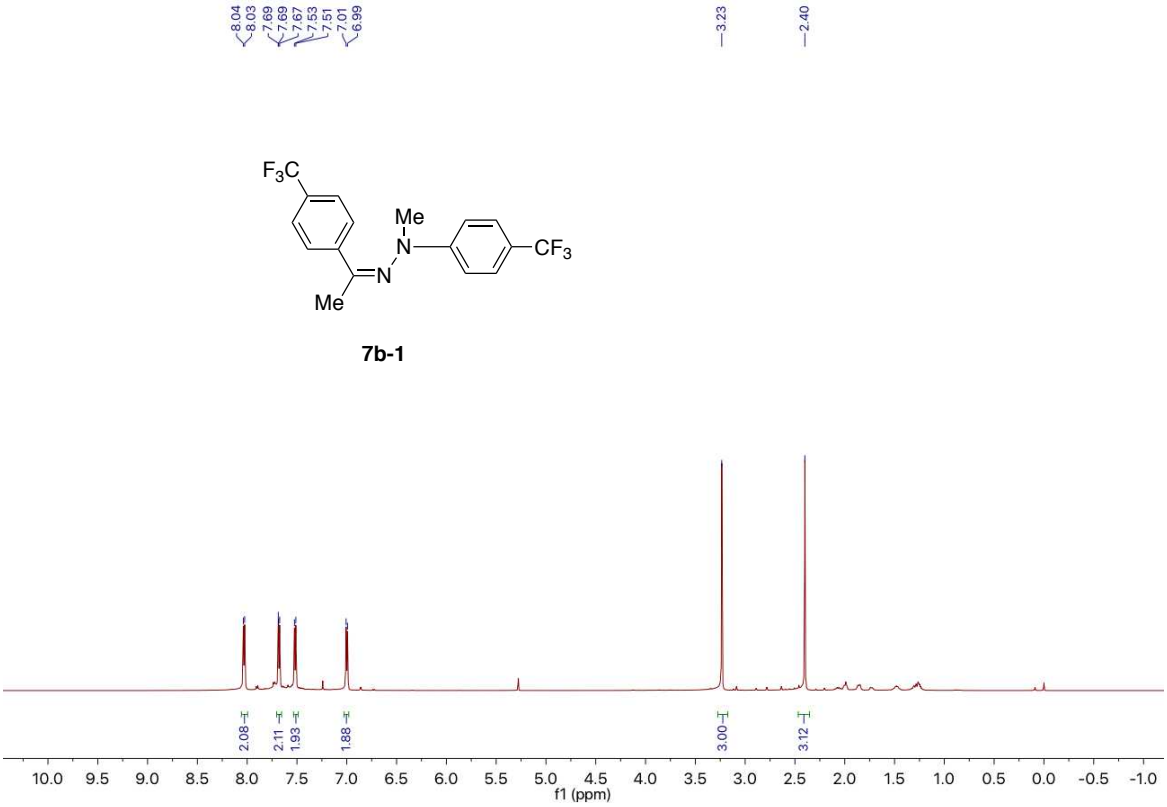
Compound 7d, ^{13}C NMR (151 MHz, CD_3CN)



Compound 7d ^{19}F NMR (565 MHz, CD_3CN)

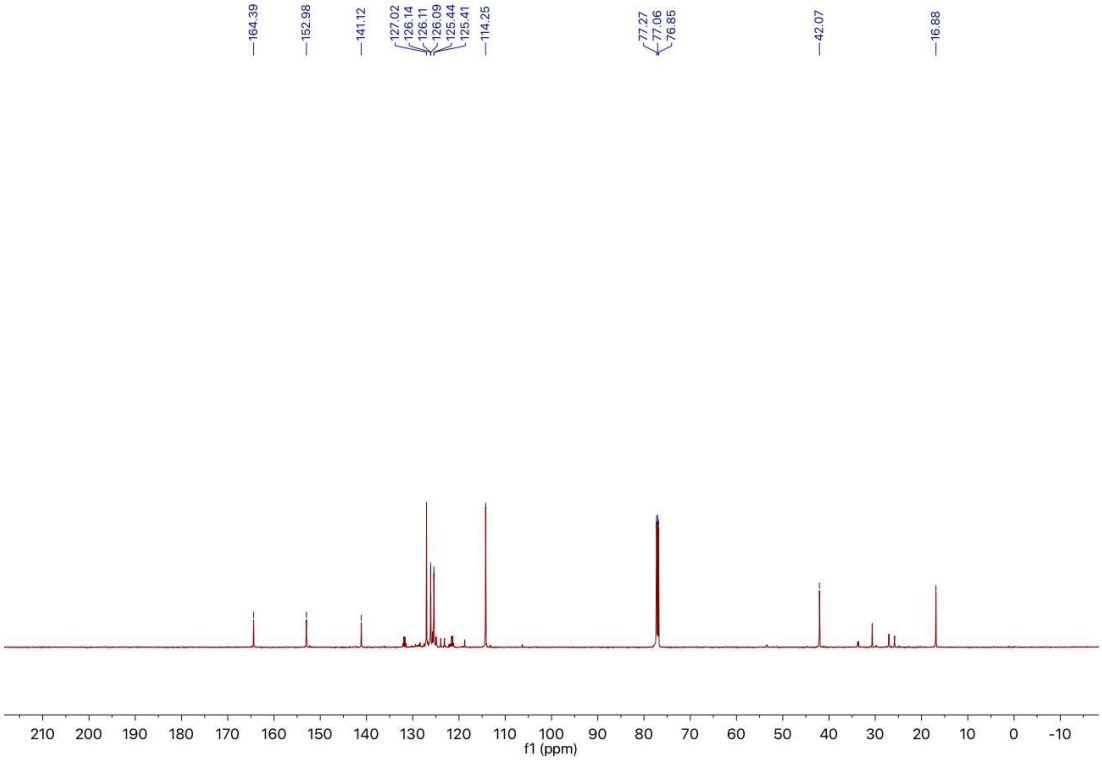


Compound 7b-1, ^{1}H NMR (600 MHz, $CDCl_3$)



7b-1

Compound 7b-1, ^{13}C NMR (151 MHz, $CDCl_3$)



Compound 7b-1, ^{19}F NMR (545 MHz, $CDCl_3$)