

Supporting Information

Visible Light-Induced Carbonylation of Alkenes to Construct α -Branched Aryl Ketone Derivatives

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1. General Information

General Remarks. Catalytic reactions were performed under an atmosphere of Air in a glassware. All solvents were purchased from Energy Chemical, Macklin Biochemical or Sinopharm reagents. All chemicals were used directly without any further purification. Analytical TLC was performed with silica gel GF254 plates. For column chromatography, a 200-300 mesh silica gel was employed. Room temperature (r.t.) is 23-25 °C.

Instrumentation. Deuterated solvents were purchased from Cambridge Isotope Laboratories. ^1H NMR spectra were recorded on Bruker AVANCE III 400 and INOVA instruments with 400 MHz frequencies, and ^{13}C NMR spectra were recorded on Bruker AVANCE III 400 with 100 MHz frequencies. ^{19}F NMR spectra were recorded on a Bruker AVANCE III 400 spectrometer with 376 MHz. Chemical shifts (δ) were reported in ppm relative to the residual solvent signal (CDCl_3 $\delta = 7.26$ for ^1H NMR and $\delta = 77.0$ for ^{13}C NMR). Chemical shifts (ppm) were recorded with tetramethylsilane (TMS) as the internal reference standard. Multiplicities are given as s (singlet), d (doublet), t (triplet), dd (doublet of doublets), td (triplet of doublets) or m (multiplet). HRMS was obtained using a Q-TOF instrument equipped with an ESI source. Data collection for crystal structure was performed at room temperature using Mo $K\alpha$ radiation on a Bruker APEXII diffractometer.

Light source in detail. The light source used for photochemical experiments (**Figure S1**). LED: 3W ($\lambda = 420$ nm). Product model: D800X/H276155-S. Manufacturer: Howsuper Technology Co., Ltd (China). The reaction vessel is borosilicate glass test tube and no filters were applied.

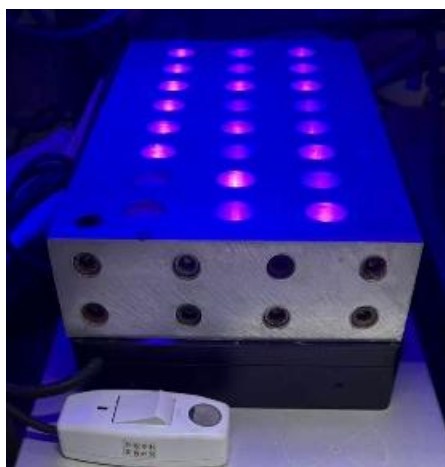


Figure S1. Reaction device

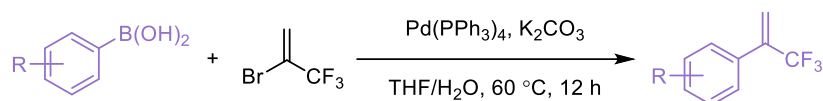
LED fixed lamp (**Figure S2**), 15-40 W ($\lambda = 420 \pm 15$ nm). Product model: PLS-LED 100. Manufacturer: Beijing Perfectlight Technology Co., Ltd (China). The reaction vessel is borosilicate glass test tube and no filters were applied. The distance from the light source to the irradiation vessel is 4-5 cm.



Figure S2. Photoreaction set-up for scale-up reaction.

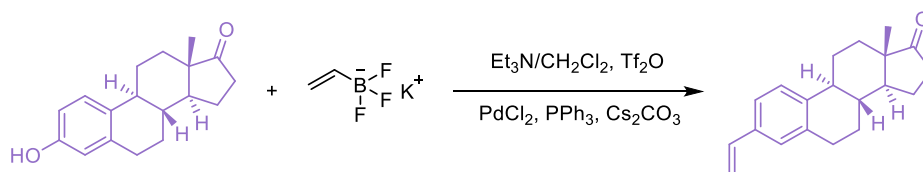
2. Synthesis of α -(trifluoromethyl)styrenes and drug-derived products

2.1 Preparation of α -(trifluoromethyl)styrenes¹



Under the N_2 atmosphere, arylboronic acid (10.0 mmol), $Pd(PPh_3)_4$ (346.7 mg, 0.3 mmol, 3 mol%), K_2CO_3 (2.76 g, 20.0 mmol) were dissolved in THF (30.0 mL) in a three-neck flask. Then, 2-bromo-3,3,3-trifluoroprop-1-ene (3.50 g, 20.0 mmol) was added dropwise into the mixture. The mixture was heated to 60 °C for 12 h. Then the mixed solution was extracted with H_2O and EA. The organic layer was washed with brine, dried over Na_2SO_4 , and then concentrated under reduced pressure. The resulting residue was purified by column chromatography (PE) to afford the α -(trifluoromethyl)styrenes.

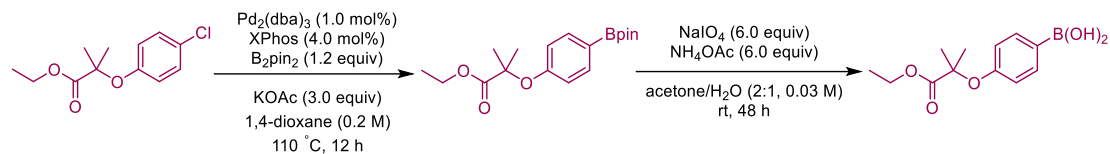
2.2 Preparation of estrone-derived alkenes²



Estrone (1.35 g, 5 mmol), CH_2Cl_2 (20 mL) and Et_3N (1.01 g, 10 mmol) were added to a 100 ml round-bottom flask. The mixture was cooled to 0 °C in an ice water bath and Tf_2O (1.55 g, 5.5 mmol) was added dropwise. The mixture was then warmed to room temperature and stirred under a N_2 atmosphere for 3 h. The resulting brown mixture was diluted with CH_2Cl_2 , washed with saturated NH_4Cl , and the aqueous layer was extracted with CH_2Cl_2 . The combined organic layer was dried over Na_2SO_4 , and the filtrate was concentrated under reduced pressure to afford a crude product. The crude product, potassium vinyltrifluoroborate (0.74 g, 5.5 mmol), Cs_2CO_3 (4.89 g, 15 mmol), PPh_3 (78.6 mg, 0.3 mmol), $PdCl_2$ (17.7 mg, 0.1 mmol), H_2O (2.0 mL) and THF (18 mL) were placed in the schlenk tube. The reaction system was stirred under N_2 atmosphere at 85 °C for 19 h. After completion of the reaction, the mixture was allowed to cool to room temperature and extracted with H_2O and CH_2Cl_2 . The combined organic layer was dried over Na_2SO_4 , and the filtrate was concentrated under reduced pressure. The crude product was purified by column

chromatography (PE/EA = 10/1) to give white solid.

2.2 Preparation of Clofibrate-derived boronic acids³

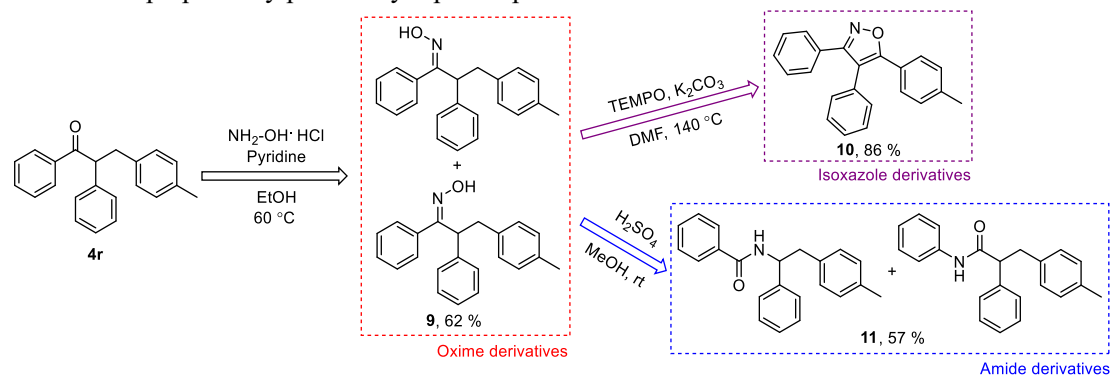


Under the N_2 atmosphere, $\text{Pd}_2(\text{dba})_3$ (27.5 mg, 0.03 mmol, 1.0 mol%), XPhos (57.2 mg, 0.12 mmol, 4.0 mol%), B_2pin_2 (914.2 mg, 3.6 mmol, 1.20 equiv), KOAc (883.3 mg, 9 mmol), dry 1,4-dioxane (15 ml) and clofibrate (728.1 g, 3 mmol) were added to a schlenk tube. The mixture was stirred at 110°C for 12 h, then allowed to cool to room temperature, and extracted with H_2O and EA. The combined organic layer was washed with saturated brine, dried over Na_2SO_4 , and concentrated under reduced pressure. The crude residue was purified by flash column chromatography to afford the clofibrate boronic ester. Then, the boronic ester (3 mmol, 1.0 equiv), NaIO_4 (3.85 g, 18 mmol) and NH_4OAc (1.39 g, 18 mmol) were dissolved in a mixed solvent of acetone/ H_2O (v/v = 2:1, 100 ml) under magnetic stirred at room temperature for 48 h, followed by extraction with EA and saturated brine. The combined organic layer was concentrated under reduced pressure to yield the clofibrate boronic acid.

All of the NMR spectra of the know compounds were in full accordance with the data in the literatures.

3. Synthesis of Oxime, Amide and Isoxazole

These were prepared by previously reported procedures.⁴



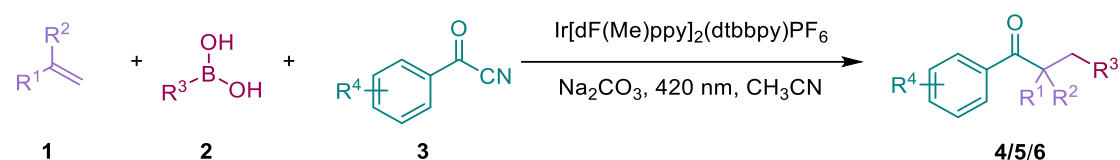
Synthesis of 1,2-diphenyl-3-(p-tolyl)propan-1-one oxime (9): To a solution of **4r** (300.4 mg, 1 mmol, 1 equiv) in EtOH (0.5 ml) was added hydroxylamine hydrochloride (104.2 mg, 1.5 mmol) and pyridine (197.7 mg, 2.5 mmol) under a N_2 atmosphere. The reaction mixture was then stirred at 60°C for 12 h. The solvent was evaporated, and extracted with H_2O and EA. The combined organic layers were washed with 1 N aqueous HCl and brine, dried over Na_2SO_4 , and concentrated. The crude product was purified by column chromatography to give **9** in 62% yield.

3,4-diphenyl-5-(p-tolyl)isoxazole (10): **9** (47.3 mg, 0.15 mmol, 1 equiv), TEMPO (70.4 mg, 0.45 mmol) and K_2CO_3 (41.4 mg, 0.3 mmol) were dissolved in DMF (1.5 mL). The reaction mixture was then stirred for 24 h at 140°C under a N_2 atmosphere. The resulting mixture was cooled to room temperature and extracted with H_2O and EA. The combined organic extracts were washed

with brine, dried over Na₂SO₄, and concentrated. The crude product was purified by column chromatography to give **10** in 86% yield.

N-(1-phenyl-2-(p-tolyl)ethyl)benzamide and N,2-diphenyl-3-(p-tolyl)propenamide (11): **9** (31.5 mg, 0.1 mmol) was dissolved in MeOH (0.5 ml). H₂SO₄ (0.5 ml) was added slowly to the above solution at room temperature and stirred 12 hours at room temperature. After completion of the reaction, the reaction mixture was slowly poured into 10 mL of ice water. Then, using Na₂CO₃ to adjust the pH to neutral and extracted with EA. The combined organic extracts were washed with brine, dried over Na₂SO₄, and concentrated. The crude product was purified by column chromatography to give N-(1-phenyl-2-(p-tolyl)ethyl)benzamide and N,2-diphenyl-3-(p-tolyl)propenamide in 57% yield.

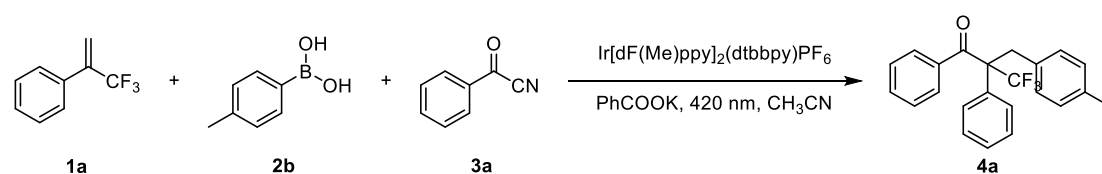
4. General Procedure for Synthesis of Pzproducts 4/5/6



CH₃CN (2.0 mL) was added to a 4 mL transparent glass bottle with magnetic stirring bars and rubber plugs, then Ir[dF(Me)ppy]₂(dtbbpy)PF₆ (1.2 mol%), alkene **1** (0.8 mmol, 4.0 equiv), boronic acid **2** (0.6 mmol, 3.0 equiv), Benzoyl cyanide **3** (0.2 mmol, 1.0 equiv), Na₂CO₃ (0.4 mmol, 2.0 equiv) were added to the bottle. The reaction mixture was irradiated with 3 W blue LEDs (420 nm, 100% intensity) for 24 hours at ambient temperature. After the reaction (monitored by TLC), The crude mixture was subjected to column chromatography on silica gel (eluted with PE:EA = 30:1). The combined eluents were subjected to anhydrous magnesium sulfate drying, vacuum concentration, and purification to obtain the desired product **4/5/6**.

5. Optimization Experiments

Table S1. Screen of ratio



Entry	1a (mmol)	2b (mmol)	3a (mmol)	PhCOOK	4a Yield (%)
1	0.2	0.6	0.2	0.4	32
2	0.4	0.6	0.2	0.4	42
3	0.6	0.6	0.2	0.4	44
4	0.8	0.6	0.2	0.4	48
5	1.0	0.6	0.2	0.4	48
6	0.8	0.7	0.2	0.4	48
7	0.8	0.5	0.2	0.4	44

Reaction conditions: Ir[dF(Me)ppy]₂(dtbbpy)PF₆ (1.2 mol%), CH₃CN (2 mL), room temperature, 3

W blue LEDs, 18 h. Isolated yield.

Table S2. Screen of Photocatalyst

Entry	Photocatalyst	4a Yield (%)
1	Mes-Acr ⁺ PF ₆ ⁻	NR
2	Ir[dF(Me)ppy] ₂ (dtbbpy)PF ₆	48
3	[Ir(dtbbpy)(ppy) ₂]PF ₆	11
4	Ir[dF(CF ₃)ppy] ₂ (bpy)PF ₆	24
5	Ir(ppy) ₃	NR
6	Ru(bpy) ₃ (PF ₆) ₂	NR
7	4CzIPN	43
8	Eosin Y	NR
9	3DPA2FBN	13

Reaction conditions: **1a** (4 equiv), **2b** (3 equiv), **3a** (0.2 mmol, 1 equiv), PhCOOK (2 equiv), photocatalyst (1.2 mol%), CH₃CN (2 mL), room temperature, 3 W blue LEDs, 18 h. Isolated yield.

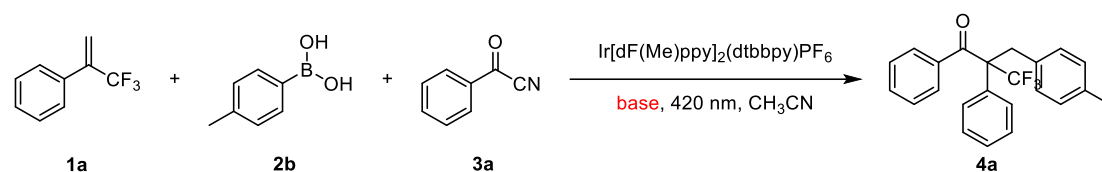
Table S3. Screen of Solvent

Entry	Solvent	4a Yield (%)
1	CH ₃ CN	48
2	DMF	Trace
3	1,4-dioxane	25
4	THF	18
5	DMSO	NR
6	NMP	NR
7	Tol	24
8	DCM	38
9	EA	34
10	EtOH	Trace
11	Cyclohexane	Trace
12	MTBE	Trace
13	MCB	35
14	Acetone	39

Reaction conditions: **1a** (4 equiv), **2b** (3 equiv), **3a** (0.2 mmol, 1 equiv), PhCOOK (2 equiv), Ir[dF(Me)ppy]₂(dtbbpy)PF₆ (1.2 mol%), solvent (2 mL), room temperature, 3 W blue LEDs, 18 h.

Isolated yield.

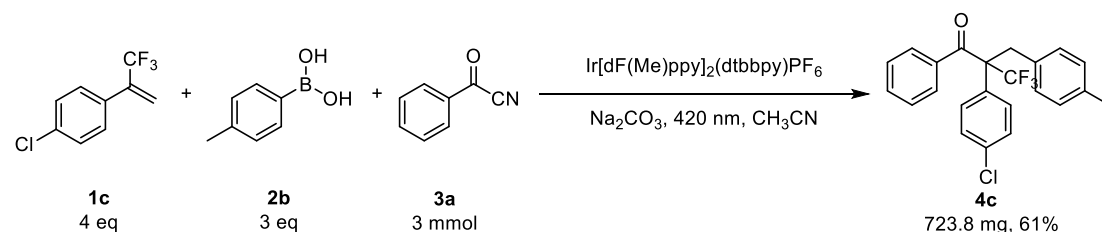
Table S4. Screen of Base



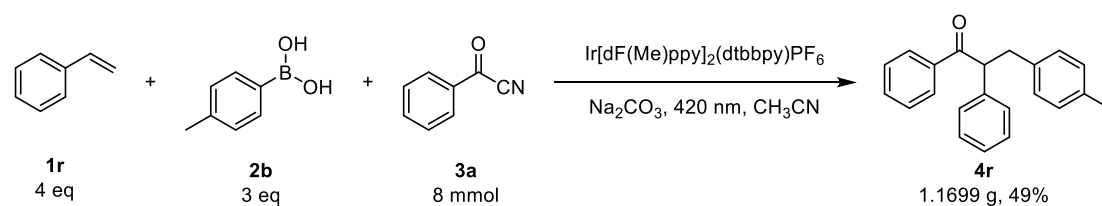
Entry	Base	4a Yield (%)
1	Cs_2CO_3	Trace
2	CsOAc	30
3	K_2CO_3	36
4	K_3PO_4	Trace
5	KOAc	35
6	KOH	29
7	Na_2CO_3	58
8	NaOH	40
9	PhCOOK	48

Reaction conditions: **1a** (4 equiv), **2b** (3 equiv), **3a** (0.2 mmol, 1 equiv), base (2 equiv), $\text{Ir}[\text{dF}(\text{Me})\text{ppy}]_2(\text{dtbbpy})\text{PF}_6$ (1.2 mol%), CH_3CN (2 mL), room temperature, 3 W blue LEDs, 18 h. Isolated yield.

6. Gram-Scale Reaction



In a 250 ml round bottom flask, **1c** (2.5 g, 12 mmol), **2b** (1.2 g, 9 mmol), **3a** (393.4 mg, 3 mmol), Na_2CO_3 (635.9 g, 6 mmol) and $\text{Ir}[\text{dF}(\text{Me})\text{ppy}]_2(\text{dtbbpy})\text{PF}_6$ (1.2 mol%) were dissolved in CH_3CN (30 ml). The reactants were mixed evenly and then irradiated with a 30 W blue LEDs for 24 h. After the reaction, it was then extracted with ethyl acetate (3×100 mL), and the combined organic extract was washed with saline (100 mL), dried with anhydrous sodium sulfate and concentrated in vacuo. The crude mixture was directly purified by column chromatography on silica gel (PE:EA = 30:1) by flash column chromatography to obtain the desired product **4c** (723.8 mg, 61%).



In a 250 ml round bottom flask, **1r** (3.3 g, 32 mmol), **2b** (3.3 g, 24 mmol), **3a** (1.0 g, 8 mmol), Na₂CO₃ (1.7 g, 16 mmol) and Ir[dF(Me)ppy]₂(dtbbpy)PF₆ (1.2 mol%) were dissolved in CH₃CN (80 ml). The reactants were mixed evenly and then irradiated with a 30 W blue LEDs for 24 h. After the reaction, it was then extracted with ethyl acetate (3×100 mL), and the combined organic extract was washed with saline (100 mL), dried with anhydrous sodium sulfate and concentrated in vacuo. The crude mixture was directly purified by column chromatography on silica gel (PE:EA = 30:1) by flash column chromatography to obtain the desired product **4r** (1.1699 g, 49%).

7. Mechanism Studies

7.1 TEMPO trapping experiment

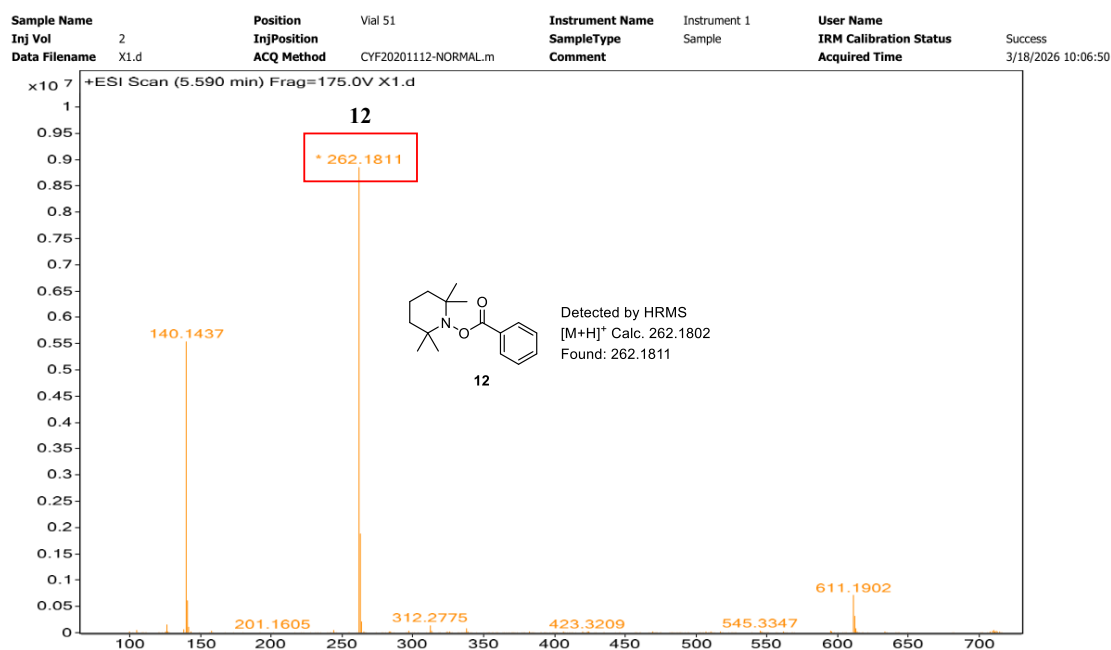
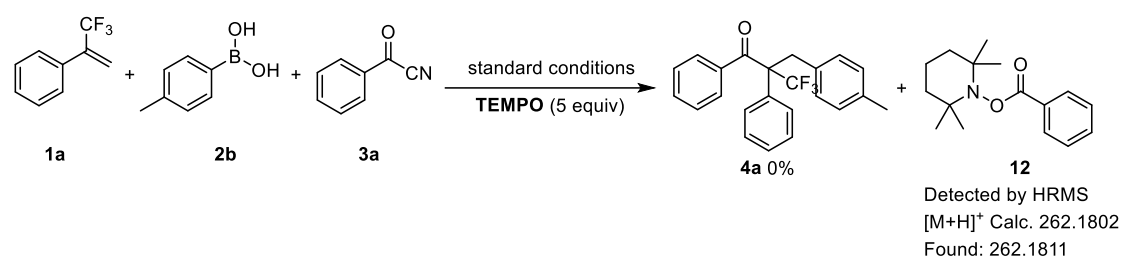
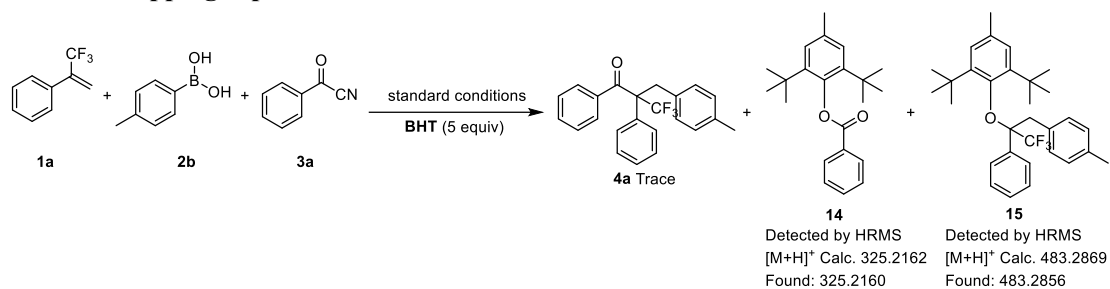


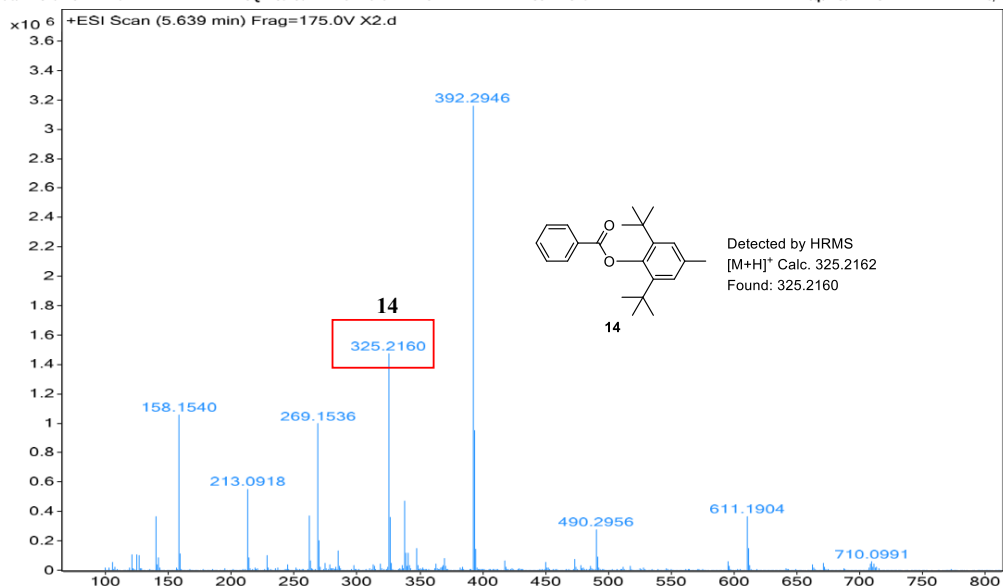
Figure S3. TEMPO trapping experiment

CH₃CN (2.0 mL) was added to a 4 mL transparent glass bottle with magnetic stirring bars and rubber plugs, then, **TEMPO** (1.0 mmol, 5.0 equiv), **1a** (0.8 mmol, 4.0 equiv), **2b** (0.6 mmol, 3.0 equiv), **3a** (0.2 mmol, 1.0 equiv), Na₂CO₃ (0.4 mmol, 2.0 equiv) and Ir[dF(Me)ppy]₂(dtbbpy)PF₆ (1.2 mol%) were added to the bottle. The reaction mixture was irradiated with 3 W blue LEDs (420 nm, 100% intensity) for 18 hours at ambient temperature. TLC analysis indicates that no product **4a**, and the TEMPO-trapped products **12** were obtained by HRMS.

7.2 BHT trapping experiment



Sample Name	Position	Vial 52	Instrument Name	Instrument 1	User Name
Inj Vol	2	InjPosition	SampleType	Sample	IRM Calibration Status
Data Filename	X2.d	ACQ Method	Comment		Acquired Time



Sample Name	Position	Vial 52	Instrument Name	Instrument 1	User Name
Inj Vol	2	InjPosition	SampleType	Sample	IRM Calibration Status
Data Filename	X2.d	ACQ Method	Comment		Acquired Time

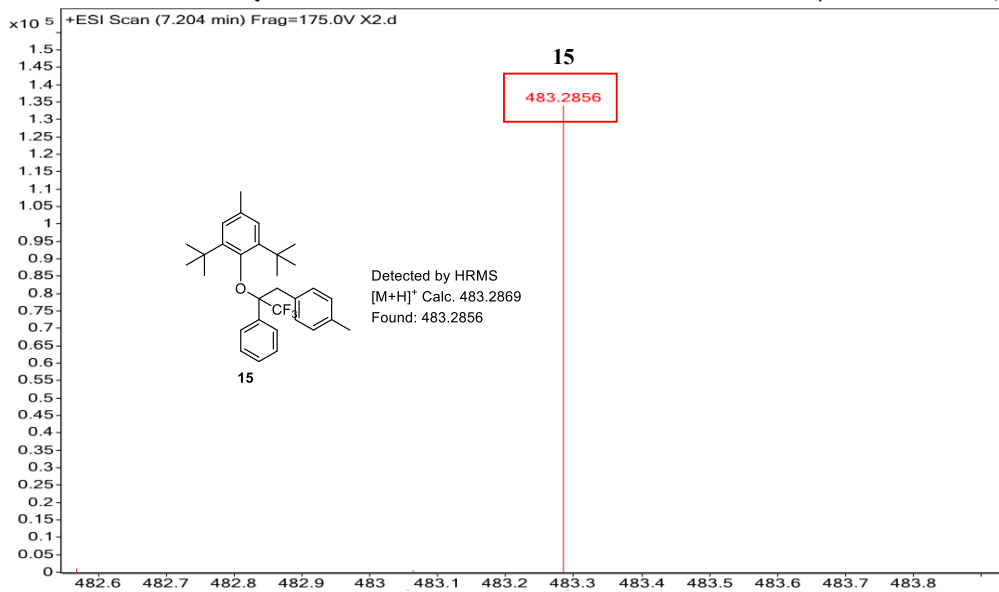


Figure S4. BHT trapping experiment

CH₃CN (2.0 mL) was added to a 4 mL transparent glass bottle with magnetic stirring bars and rubber plugs, then, **BHT** (1.0 mmol, 5.0 equiv), **1a** (0.8 mmol, 4.0 equiv), **2b** (0.6 mmol, 3.0 equiv),

3a (0.2 mmol, 1.0 equiv), Na₂CO₃ (0.4 mmol, 2.0 equiv) and Ir[dF(Me)ppy]₂(dtbbpy)PF₆ (1.2 mol%) were added to the bottle. The reaction mixture was irradiated with 3 W blue LEDs (420 nm, 100% intensity) for 18 hours at ambient temperature. After the reaction (monitored by TLC), TLC analysis indicates that **4a** was trace, and the BHT-trapped products **13** and **14** were obtained by HRMS.

8. Light on/off experiments

Six standard reaction mixtures were charged with **1a** (0.2 mmol, 1 equiv.), **2b** (0.6 mmol, 3 equiv.), **3a** (0.8 mmol, 4 equiv.) and Ir[dF(Me)ppy]₂(dtbbpy)PF₆ (1.2 mol%). The reaction mixture was irradiated with 3 W blue LEDs. After 15 min, the lamps were turned off, and one vial was removed from the irradiation setup for analysis. The remaining five vials were stirred in the absence of light for an additional 15 min. Then, one vial was removed for analysis, and the lamps were turned back on to irradiate the remaining for reaction mixtures. Carry out this repetitive operation until the last vial was reached. The reaction mixtures were analyzed by HPLC.

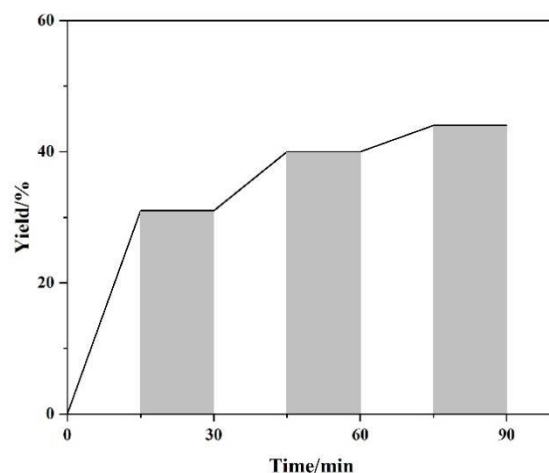


Figure S5. Light on/off experiments

9. Stern-Volmer emission quenching experiments

Emission quenching experiments were recorded using a Techcomp FL-970 Fluorescence Spectrometer. Ir[dF(Me)ppy]₂(dtbbpy)PF₆ solutions were excited at 400 nm and the emission intensity at 517 nm was observed. Prepare a 5×10^{-5} M CH₃CN solution of Ir[dF(Me)ppy]₂(dtbbpy)PF₆. Then an appropriate amount of quencher was added to the measured solution and the emission spectrum of the sample was collected.

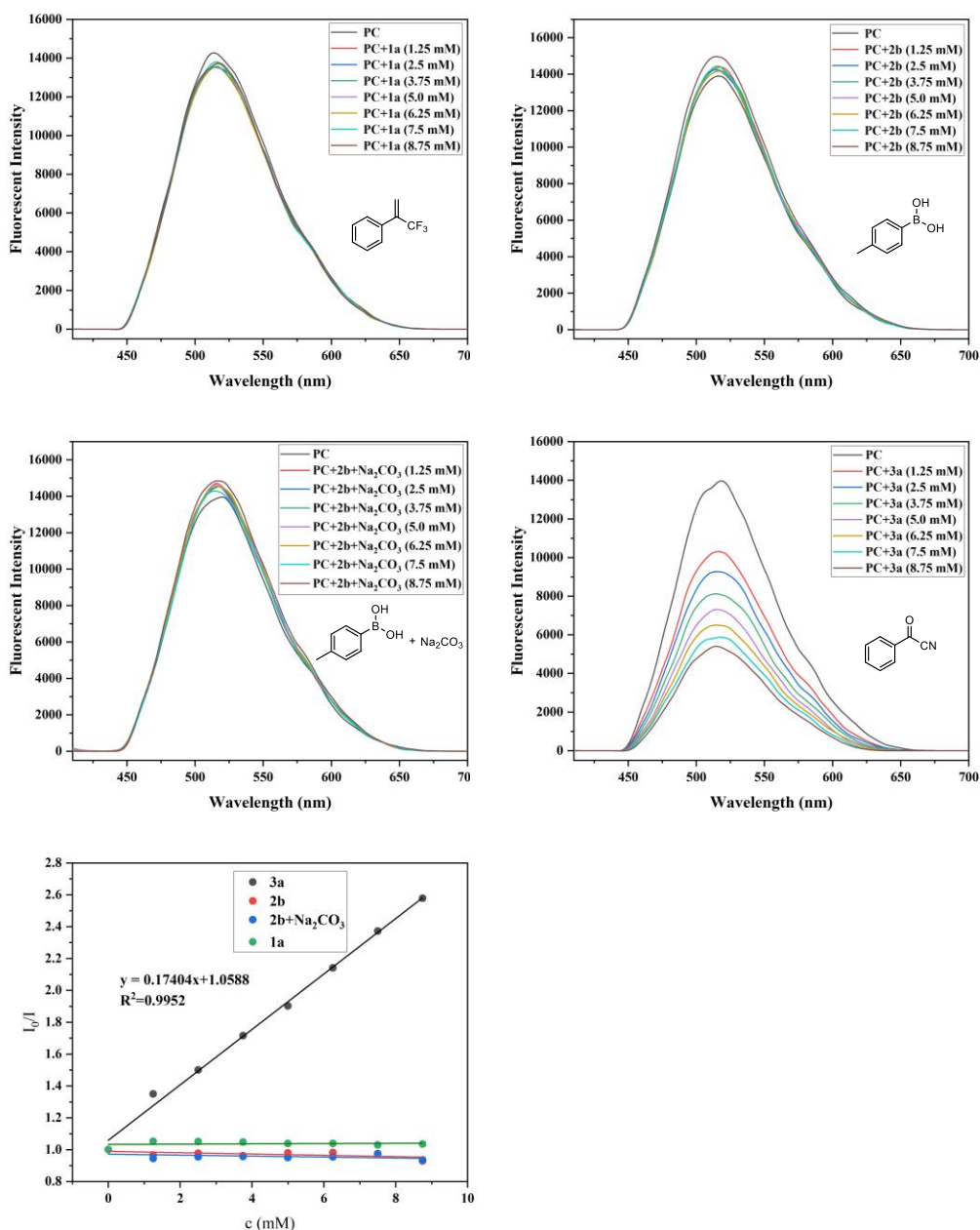


Figure S6. Ir[dF(Me)ppy]₂(dtbbpy)PF₆ emission quenching experiment by 1a, 2b, 2b+Na₂CO₃, 3a.

10. DFT Calculations

Density functional theory (DFT) calculations were carried out using Gaussian 09 program.⁵ Geometrical optimization calculations were carried out at the PBE0-D3(BJ)^{6,7}/def2-TZVP⁸ level with the SMD continuum solvent model⁹ for acetonitrile without any symmetry assumptions unless otherwise stated. Harmonic vibration frequency calculations were performed at the same level for verifying the resulting geometries as local minima (with all the frequencies real) or saddle points (with only one imaginary frequency).

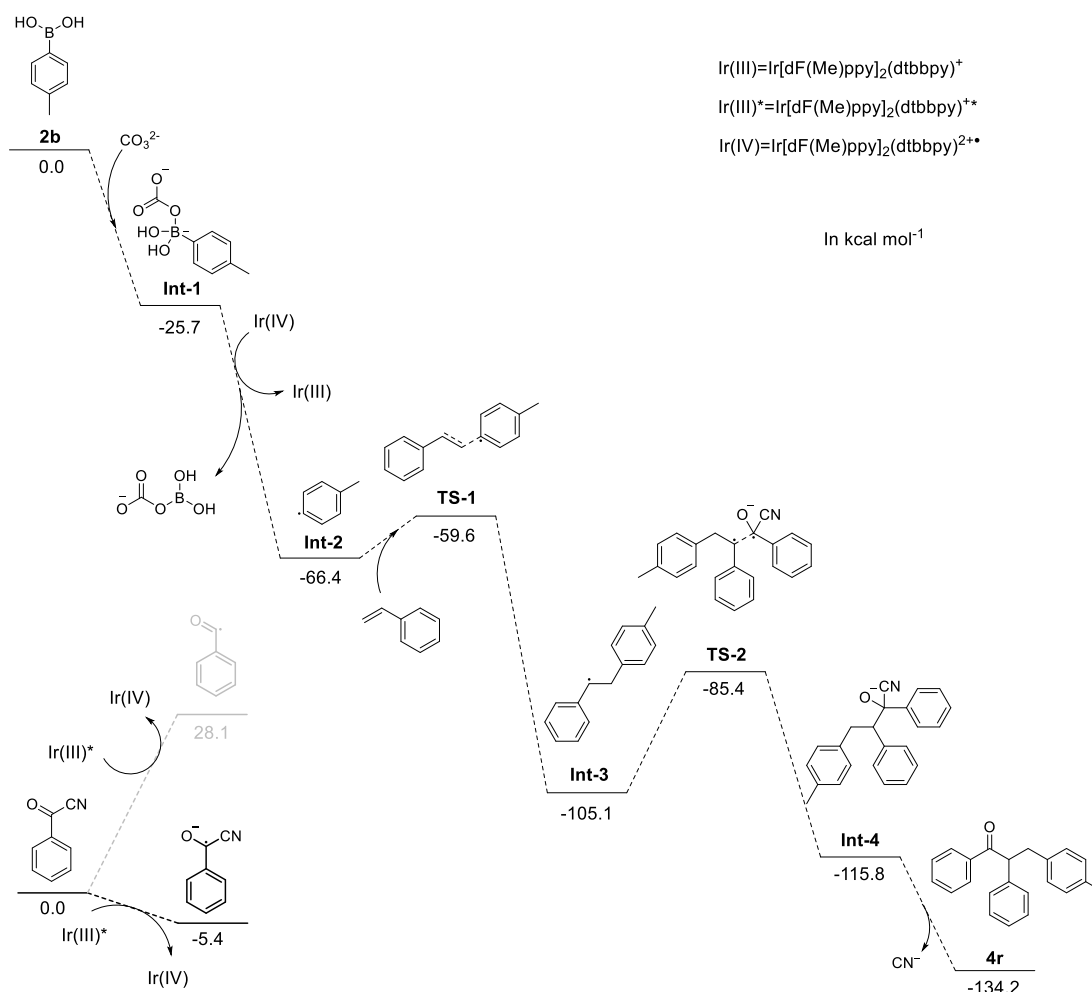


Figure S7. Energy profile of the reaction. Proposed reaction pathway. The Gibbs free energies were calculated at the PBE0-D3(BJ)/def2-TZVP level with the SMD continuum solvent model for acetonitrile.

DFT calculations indicate that the reaction is initiated by base-assisted formation of a boronate intermediate, followed by single-electron transfer (SET) with the photoexcited Ir(III)* species to generate an aryl radical. Using Na₂CO₃ as the base, this process is highly exergonic (**Int-1**, -25.7 kcal mol⁻¹; **Int-2**, -66.4 kcal mol⁻¹), facilitating efficient radical generation. The resulting aryl radical undergoes addition to the alkene via **TS-1** ($\Delta G^\ddagger = 6.8$ kcal mol⁻¹) to afford **Int-3** (-105.1 kcal mol⁻¹). In parallel, the reduced photocatalyst converts the benzoyl cyanide substrate into its corresponding radical anion (the energy to form the acyl radical from benzoyl cyanide was much higher than that for the acyl cyanide anion radical), which subsequently couples with **Int-3** through **TS-2** to form **Int-4**. Finally, spontaneous cyanide extrusion from **Int-4** delivers the desired product, rendering the overall reaction highly thermo-dynamically favorable.

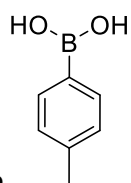
Energies of Stationary Points

Supplementary Table S5. Electronic energies (*EE*), thermal corrections to Gibbs free energies (*G_{corr}*), and Gibbs free energies (*G*) of the stationary points calculated at the PBE0-D3(BJ)/def2-TZVP level of theory with the SMD continuum solvent model for acetonitrile.

Table S5

	$G_{corr}(\text{Ha})$	$EE(\text{Ha})$	$G(\text{Ha})$
2b	0.117620	-447.267329	-447.149709
CO₃²⁻	-0.011364	-263.845662	-263.857026
Int-1	0.125449	-711.173154	-711.047705
-OCOO-B(OH)₂	0.020507	-440.348826	-440.328318
Int-2	0.085344	-270.662533	-270.577190
1r	0.102549	-309.400646	-309.298097
TS-1	0.202097	-580.066461	-579.864364
Int-3	0.207999	-580.144883	-579.936884
PhCOCN[•]	0.072665	-437.604428	-437.531762
TS-2	0.303396	-1017.740747	-1017.437351
Int-4	0.311018	-1017.796693	-1017.485675
CN⁻	-0.014051	-92.880289	-92.894340
4r	0.304872	-924.925642	-924.620770
PhCOCN	0.075074	-437.484821	-437.409746
PhCO[•]	0.066550	-344.665382	-344.598832
Ir(III)	0.649236	-2345.786293	-2345.137057
Ir(III)*	0.643968	-2345.689905	-2345.045938
Ir(IV)	0.646358	-2345.578772	-2344.932414

Cartesian coordinates of the optimized geometries

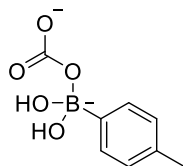


2b

C	0.06580700	1.19521700	-0.01573500
C	1.45324100	1.19820800	-0.01735600
C	2.17127500	0.00516700	-0.00032400
C	1.45480900	-1.19272600	0.01664400
C	0.07067400	-1.19303000	0.01548300
C	-0.65768000	0.00144900	0.00005200
C	3.66747800	-0.00145000	0.00045000
B	-2.21945900	-0.00109300	0.00040400
O	-2.86765800	1.20265800	0.03435600
O	-2.86297600	-1.20732500	-0.03396700
H	-0.46642100	2.14079300	-0.02873700
H	1.99174200	2.14084500	-0.03152600
H	1.99542700	-2.13453900	0.03080100
H	-0.46026400	-2.13933700	0.02856600
H	4.06903000	1.01307600	-0.00591100
H	4.05605100	-0.51759600	0.88327900
H	4.05735700	-0.52910800	-0.87493900
H	-3.82930500	1.14347000	0.02736600
H	-3.82486800	-1.15180500	-0.02931900

CO₃²⁻

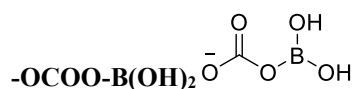
C	0.00000000	0.00025100	0.00000000
O	-1.25625600	0.30202200	0.00000000
O	0.89033600	0.93531700	0.00000000
O	0.36592000	-1.23752700	0.00000000



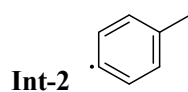
Int-1

O	3.04387400	-2.13254800	-0.23476100
C	2.50959300	-1.10696400	0.23972900
O	2.10432100	-0.17767100	-0.65036400
O	2.34054400	-0.87859500	1.47606300
B	1.23080900	1.00556800	-0.28484000
O	1.71201000	1.62503300	0.94588300
O	1.29726900	1.96170200	-1.39604200

C	-0.32848900	0.49440500	-0.17656100
C	-0.78268200	-0.69701300	-0.74516500
C	-2.10758300	-1.11546400	-0.64671600
C	-3.05283300	-0.35202500	0.03173300
C	-2.61980600	0.84514500	0.60345100
C	-1.29487800	1.24795200	0.49986200
C	-4.47646700	-0.80321800	0.16589700
H	1.99379700	0.83345600	1.45256500
H	2.16099500	2.38052200	-1.34715100
H	-0.06957000	-1.32553500	-1.27271900
H	-2.41500700	-2.05427500	-1.10158500
H	-3.33466700	1.46408800	1.14127300
H	-0.99220500	2.17930900	0.97278700
H	-4.68085100	-1.66345500	-0.47507200
H	-4.70552100	-1.09595700	1.19605300
H	-5.17629100	-0.00627400	-0.10157500

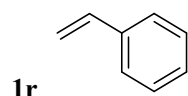


O	-2.25189000	-0.87009700	0.00040200
C	-1.30055700	-0.09978300	-0.00004800
O	-0.03863400	-0.73310600	-0.00050700
O	-1.29404100	1.15553200	-0.00020000
B	1.15773600	-0.03186100	-0.00001500
O	1.21668600	1.31870000	0.00024000
O	2.32141000	-0.75901800	0.00014300
H	0.24302400	1.56647900	-0.00013800
H	2.14339200	-1.70456100	-0.00011400

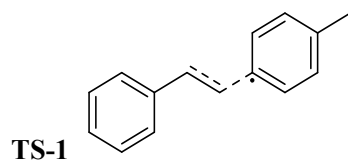


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C	-1.25968300	-1.22163600	0.00000100
C	-1.89074200	-0.00519200	0.00000400
C	-1.27129700	1.21425200	0.00000100
C	0.12562900	1.20315800	-0.00000400
C	0.83863700	0.00617400	-0.00000600
C	2.33726000	0.00416900	0.00000400
H	0.68061700	-2.13797800	-0.00001000
H	-1.80118700	-2.16143200	0.00000300
H	-1.81986100	2.14997900	-0.00000100
H	0.66496600	2.14566200	-0.00000700
H	2.73292000	1.02089700	-0.00017700

H	2.72977200	-0.51348900	0.87974900
H	2.72978600	-0.51381400	-0.87954200



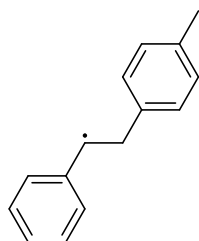
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C	-1.34824100	1.32407700	-0.00000200
C	-2.24900000	0.26370900	0.00000400
C	-1.77154000	-1.03866800	0.00000400
C	-0.40492700	-1.27674400	0.00000000
C	0.51114800	-0.22237500	-0.00000400
C	1.94273400	-0.53302800	-0.00000700
C	2.95100400	0.33730200	0.00000900
H	0.70179400	1.92440800	-0.00001100
H	-1.71410900	2.34509600	-0.00000400
H	-3.31626000	0.45513500	0.00000600
H	-2.46415500	-1.87323300	0.00000800
H	-0.03290600	-2.29648100	0.00000100
H	2.17426900	-1.59619800	-0.00002000
H	3.97827500	-0.00930400	0.00000600
H	2.79700300	1.41160600	0.00002500



C	2.76449500	1.46507700	0.41770500
C	3.83099400	0.56394900	0.37768400
C	3.66416900	-0.72994900	-0.11141400
C	2.40427500	-1.11983600	-0.56937800
C	1.32318500	-0.24103100	-0.54108600
C	1.55751400	1.01626500	-0.04711700
C	-0.77883500	2.47321000	0.26877900
C	-1.65698400	1.82895700	-0.50689600
C	-2.41076800	0.62880800	-0.15360300
C	-2.24007000	-0.04487900	1.06150900
C	-2.97012100	-1.18529900	1.34609700
C	-3.88699100	-1.68309200	0.42554500
C	-4.06457900	-1.02821800	-0.78491100
C	-3.33207200	0.11424000	-1.07023200
C	4.81056000	-1.69509000	-0.13708900
H	2.90468200	2.47080800	0.80059300
H	4.80797200	0.87796100	0.73365800

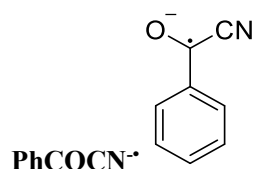
H	2.26398300	-2.12592900	-0.95480400
H	0.34606000	-0.55052500	-0.89729900
H	-0.58537800	2.18366200	1.29547300
H	-0.27269200	3.36146000	-0.09070600
H	-1.83139200	2.19878900	-1.51478800
H	-1.52401000	0.32382100	1.78730200
H	-2.82224700	-1.69477200	2.29215600
H	-4.45584600	-2.57796600	0.65211700
H	-4.77453500	-1.40897500	-1.51102600
H	-3.47000100	0.62369200	-2.01880000
H	5.74984700	-1.19922400	0.11306200
H	4.65690300	-2.50558200	0.58198500
H	4.91802200	-2.15589500	-1.12246900

Int-3

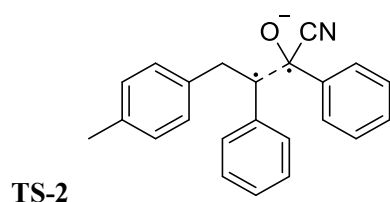


C	-2.30187100	1.09561200	0.81239900
C	-3.63831300	0.71514700	0.86126600
C	-4.14496100	-0.24374500	-0.00873200
C	-3.26709400	-0.81115100	-0.93403700
C	-1.93616000	-0.43264100	-0.98320500
C	-1.43050700	0.52948800	-0.10905500
C	0.01938400	0.91828900	-0.15703000
C	0.93177000	-0.16576900	0.30292500
C	2.33319200	-0.14063700	0.15948400
C	3.01881300	0.93624600	-0.45354000
C	4.39456100	0.92429200	-0.57374100
C	5.14125800	-0.14948800	-0.09342300
C	4.48729600	-1.22102700	0.51550800
C	3.11455000	-1.21998400	0.64160400
C	-5.58331600	-0.65824600	0.03677600
H	-1.93166200	1.84676300	1.50350200
H	-4.29891300	1.17347600	1.59084800
H	-3.63693400	-1.56009800	-1.62818200
H	-1.27473400	-0.88853700	-1.71408800
H	0.28479300	1.21199300	-1.18127000
H	0.17211900	1.82038000	0.45145700
H	0.49255700	-1.02310000	0.80381600
H	2.45640300	1.78191500	-0.83221300
H	4.89734300	1.76105400	-1.04710300

H	6.22079500	-0.15202800	-0.19174900
H	5.06142300	-2.06072200	0.89253300
H	2.60971800	-2.05539700	1.11641100
H	-6.12508600	-0.11998500	0.81634000
H	-6.08049700	-0.46411100	-0.91819800
H	-5.67893700	-1.72993000	0.23470300

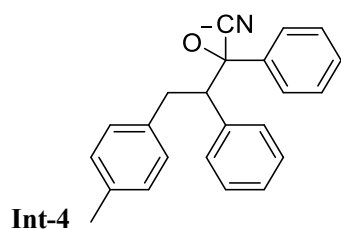


C	-1.80173900	-1.43429300	0.00540100
C	-2.75557700	-0.41587000	-0.00285000
C	-2.32704300	0.90849100	-0.00800600
C	-0.97748700	1.21554200	-0.00482700
C	-0.00417300	0.19831400	0.00360100
C	-0.45249900	-1.13717400	0.00848500
C	1.39935600	0.56257600	0.00555000
O	1.82847400	1.76066000	0.00789300
C	2.34862200	-0.50328400	0.00066700
N	3.16514500	-1.33411100	-0.01505800
H	-2.11962800	-2.47199300	0.00934800
H	-3.81331100	-0.65361800	-0.00526800
H	-3.05710300	1.71197600	-0.01495200
H	-0.64325000	2.24659700	-0.00994700
H	0.27273100	-1.94527800	0.01495000



C	-4.13198300	-0.25944100	-1.47520300
C	-4.45640000	-1.56720500	-1.11617700
C	-3.52128300	-2.35785900	-0.47971100
C	-2.24933500	-1.84488000	-0.19200900
C	-1.93358300	-0.52454500	-0.53847700
C	-2.87583300	0.25590100	-1.18601900
C	-1.23940900	-2.65501800	0.46534500
C	0.80104800	1.86206400	-0.03486700
O	-0.08731700	-2.32313700	0.69203000
C	1.45143500	0.94245700	0.95280800
C	-0.44607700	2.43135000	0.17629000

C	2.78224300	0.44475600	0.47030800
C	2.87861600	-0.71229300	-0.30131100
C	4.10192300	-1.15070800	-0.78566800
C	5.27713000	-0.44856300	-0.51816000
C	5.17976100	0.70781300	0.25005500
C	3.95353600	1.14631800	0.73621400
C	6.59927400	-0.94101600	-1.02244300
C	-1.03805200	3.35373500	-0.75336000
C	-2.29133800	3.88128600	-0.56503500
C	-3.06915200	3.54617900	0.55672600
C	-2.51596100	2.67273600	1.49057000
C	-1.25541200	2.12828700	1.32305200
C	-1.64915100	-4.00311400	0.89670000
N	-1.90060400	-5.06714400	1.25770500
H	-4.86662900	0.35947600	-1.97840900
H	-5.43968900	-1.96500000	-1.33873800
H	-3.77008700	-3.37830100	-0.20784500
H	-0.95586500	-0.12054100	-0.30541900
H	-2.62998900	1.27857700	-1.44725200
H	1.36720100	2.14448700	-0.91782500
H	1.59611900	1.43585300	1.92867800
H	0.80936700	0.07098700	1.16779200
H	1.97749800	-1.27845600	-0.51502000
H	4.14791500	-2.05789100	-1.38158100
H	6.07900800	1.27429600	0.47346100
H	3.90632200	2.05124500	1.33525400
H	6.91509600	-1.84112400	-0.48469000
H	6.54938400	-1.20389600	-2.08239400
H	7.37723800	-0.18656800	-0.89227700
H	-0.46829400	3.62880900	-1.63755400
H	-2.68980300	4.56983500	-1.30584100
H	-4.05693500	3.96886700	0.69888400
H	-3.08864600	2.40224900	2.37430700
H	-0.86843100	1.45274200	2.07852400

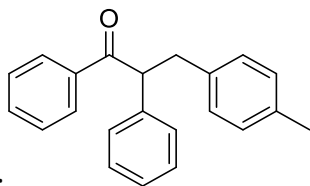


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C	-1.61950100	2.01573600	0.94231700

C	-1.54828400	1.41248600	-0.30990800
C	-2.64979500	1.47427400	-1.14959100
C	-3.81654800	2.10978500	-0.74247000
C	-0.30295700	0.62971100	-0.80112900
C	-0.14426800	-0.62365100	0.17185300
O	-0.30907700	0.32318200	-2.08311900
C	0.98892700	-1.54107400	-0.29819800
C	-1.43914400	-1.38136800	0.23989200
C	2.37458300	-1.00903200	-0.08076200
C	3.23293300	-0.76981300	-1.14731100
C	4.51083700	-0.26412100	-0.94302000
C	4.97673400	0.01695300	0.33669300
C	4.12064300	-0.23840300	1.40932400
C	2.84850200	-0.74391900	1.20473100
C	6.34967700	0.57001600	0.56565600
C	-2.18357500	-1.40812700	1.41764400
C	-3.39421600	-2.08397300	1.48819600
C	-3.88498200	-2.75015600	0.37331600
C	-3.15056300	-2.73644900	-0.80580300
C	-1.93879500	-2.06279900	-0.87097100
C	0.84781800	1.57929500	-0.50270900
N	1.69499200	2.35889200	-0.40889200
H	-4.79451000	3.20098000	0.83160300
H	-2.82244400	3.12363700	2.33091400
H	-0.76185400	1.98461000	1.60817900
H	-2.55907800	1.00633700	-2.12329500
H	-4.67410600	2.14518900	-1.40679300
H	0.07964700	-0.25475400	1.17773400
H	0.88911900	-2.49552500	0.23036300
H	0.83752200	-1.73461800	-1.36184100
H	2.88903100	-0.96525000	-2.15810500
H	5.15647800	-0.07886100	-1.79626700
H	4.46071500	-0.03634300	2.42098900
H	2.20463800	-0.92964100	2.05940600
H	6.87886900	0.71650600	-0.37754300
H	6.30587100	1.53304600	1.08289100
H	6.94799900	-0.10081100	1.18953500
H	-1.80888600	-0.88357900	2.29106800
H	-3.95599500	-2.08838400	2.41639700
H	-4.83095400	-3.27841600	0.42342200
H	-3.52573800	-3.25360600	-1.68297600
H	-1.38013400	-2.03132200	-1.79786900

CN*

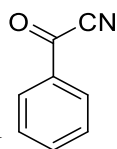
C	0.00000000	0.00000000	-0.62804500
N	0.00000000	0.00000000	0.53832400



4r

C	1.94875800	4.21470400	0.58493300
C	1.49656900	4.06703300	-0.72158100
C	1.01325400	2.84426800	-1.15024600
C	0.97069100	1.75247700	-0.28109600
C	1.42530900	1.91043400	1.02780400
C	1.91351500	3.13548600	1.45644000
C	0.44006200	0.46144800	-0.80262800
C	0.42469300	-0.75309100	0.11255300
O	0.06003200	0.37376000	-1.95231400
C	-0.64802700	-1.76344000	-0.31055200
C	1.80324000	-1.37809800	0.12117100
C	2.44253100	-1.64968600	1.32752800
C	3.69113200	-2.25484100	1.34769400
C	4.32017500	-2.59316900	0.15725800
C	3.69043300	-2.32514600	-1.05092500
C	2.44107800	-1.72182100	-1.06874300
C	-2.04554500	-1.25232600	-0.10752800
C	-2.87422600	-0.95249500	-1.18231100
C	-4.16205100	-0.47103800	-0.98180300
C	-4.66384100	-0.26876600	0.29971000
C	-3.83262400	-0.57383600	1.37804600
C	-2.54964600	-1.05568800	1.17824900
C	-6.04408100	0.26828800	0.52162100
H	2.32850100	5.17257600	0.92291500
H	1.52288200	4.90901100	-1.40415700
H	0.65965300	2.71460400	-2.16609900
H	1.40668700	1.08172200	1.72349800
H	2.26623100	3.24702600	2.47540000
H	0.20167600	-0.42645800	1.12953000
H	-0.49611500	-2.03266800	-1.35705000
H	-0.49656400	-2.66682100	0.28740200
H	1.95346000	-1.38373600	2.25931300
H	4.17449300	-2.46057200	2.29660300
H	5.29734400	-3.06297900	0.17072400
H	4.17507500	-2.58502100	-1.98576000
H	1.95785100	-1.51516500	-2.01776800

H	-2.50525400	-1.09543800	-2.19236500
H	-4.78905700	-0.24735500	-1.83961300
H	-4.20090700	-0.43514500	2.39027500
H	-1.92752800	-1.29012500	2.03721000
H	-6.61880100	0.27786500	-0.40615300
H	-6.58908000	-0.32913300	1.25727500
H	-6.00919700	1.29354800	0.90377300



PhCOCN

C	-1.76295100	-1.45536100	0.00000100
C	-2.72271800	-0.45231700	0.00000200
C	-2.34545900	0.88792900	0.00000100
C	-1.00754200	1.22711900	-0.00000200
C	-0.03891200	0.21964900	-0.00000300
C	-0.41939000	-1.12282800	-0.00000200
C	1.37112700	0.60416800	-0.00000600
O	1.80419700	1.73257800	0.00000500
C	2.36023200	-0.49916700	0.00000000
N	3.18054100	-1.30392100	0.00000200
H	-2.06242400	-2.49652200	0.00000200
H	-3.77483700	-0.71430400	0.00000500
H	-3.10145000	1.66435800	0.00000100
H	-0.69564100	2.26457800	-0.00000400
H	0.33065500	-1.90643600	-0.00000300

PhCO·

C	1.69507600	-1.05469800	-0.00029500
C	2.16328900	0.25252400	-0.00028200
C	1.27476400	1.32420400	0.00008700
C	-0.08755400	1.09119900	0.00032000
C	-0.55941000	-0.22527900	0.00036800
C	0.33098700	-1.29617400	0.00014600
C	-1.99639400	-0.49966300	0.00080100
O	-2.91878600	0.24281800	-0.00085300
H	2.39349400	-1.88330900	-0.00057300
H	3.23109900	0.44151500	-0.00052000
H	1.65094000	2.34084900	0.00016900
H	-0.79295500	1.91439200	0.00053300
H	-0.05683900	-2.30866500	0.00034600

Ir(III)

Ir	-0.69074400	-0.00473300	-0.00700000
C	-1.89014500	2.21462900	-3.40976000
C	-1.73853200	1.69246100	-2.12580700
N	-0.84037700	0.69902100	-1.92040300
C	-0.11035700	0.22808800	-2.93604800
C	-0.21150800	0.70119900	-4.23048400
C	-1.13249400	1.72231400	-4.45067700
C	0.92267700	2.58658800	0.52555400
N	0.99357600	1.28203400	0.25125000
C	2.20362500	0.71569900	0.10783700
C	3.36762800	1.45818100	0.25508600
C	3.31273700	2.81188900	0.55590900
C	2.04154700	3.37235400	0.68380800
N	0.98429800	-1.28997100	-0.32907300
C	0.90903700	-2.59008300	-0.60123800
C	2.02676100	-3.38581400	-0.76305500
C	3.29568700	-2.83198500	-0.64053200
C	3.35584200	-1.47020100	-0.35315600
C	2.20110800	-0.72388000	-0.20046900
C	-1.63596700	-1.70566700	2.15702400
C	-1.72756100	-2.22875100	3.44629700
C	-0.92422600	-1.73534200	4.45191700
C	-0.01688100	-0.71191400	4.19015100
C	0.02273600	-0.23686900	2.89318300
N	-0.75169100	-0.70879600	1.91140600
C	-3.76161800	-2.71540700	-1.33671800
C	-4.05960600	-3.44248000	-0.20059500
C	-3.36746300	-3.11272600	0.94424100
C	-2.40858000	-2.10361300	0.98875500
C	-2.12868500	-1.38426200	-0.19929800
C	-2.82361700	-1.70447400	-1.36315700
C	-4.06057000	3.41989800	0.33854700
C	-3.70859100	2.69428800	1.46008500
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C	-2.12269900	1.37001800	0.25050200
C	-2.45899000	2.08790600	-0.92382000
C	-3.41926200	3.09286200	-0.83625600
F	-3.76183300	3.80185400	-1.92481100
F	-4.32004300	2.99175900	2.61788300
F	-4.42282000	-3.01584100	-2.46605400
F	-3.65735100	-3.82357700	2.04681700
C	0.87146500	-0.14245000	5.24525200
C	4.57449000	-3.63383700	-0.80124700
C	5.39313800	-3.03613200	-1.94980500

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C	4.55254900	3.66591700	0.74623300
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C	4.52621700	4.25807500	2.15902300
C	0.62683600	0.13336600	-5.32678600
H	-2.60376600	3.00331900	-3.58821000
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H	0.00057300	-0.32789800	-6.09536700

Ir(III)*

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N	-0.86535600	0.68788500	-1.92039300
C	-0.12635500	0.20604200	-2.91923100
C	-0.19550800	0.69821300	-4.21188500
C	-1.08800500	1.74145600	-4.43813800
C	0.86300900	2.61036000	0.48294300
N	0.92290800	1.29094400	0.23952100
C	2.15870900	0.69578800	0.10285200
C	3.32647500	1.48136600	0.26151500
C	3.26396000	2.82121000	0.52758700
C	1.96764200	3.40057900	0.63273400
N	0.92290600	-1.28654900	-0.30836700
C	0.86166900	-2.60120600	-0.55532100
C	1.96710800	-3.39467500	-0.72007500
C	3.25751200	-2.81706900	-0.62465600
C	3.32065400	-1.47278300	-0.36060000
C	2.15924800	-0.68741500	-0.18921300
C	-1.58589100	-1.74290600	2.16455800
C	-1.62299800	-2.29658600	3.44113100
C	-0.81409300	-1.78405400	4.43469700
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C	0.02402100	-0.20996600	2.88278900
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C	-2.34413800	-2.16899000	0.99786400
C	-2.09007500	-1.45284000	-0.20573000
C	-2.74755500	-1.81071900	-1.38435600
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C	-2.42981300	2.13275200	-0.92504600
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F	-3.74103900	3.83279000	-1.92722100
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F	-3.57785300	-3.89031100	2.06074900
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C	5.78908300	2.90514100	0.57332400
C	4.47912800	4.80563500	-0.33955700
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C	0.64999100	0.12324200	-5.29678100
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H	-0.13038100	3.03192400	0.57445000
H	4.28562600	0.99355600	0.16590200
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H	1.82360000	-4.44542100	-0.92519800
H	4.28434500	-0.98811100	-0.27571000
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H	6.26757500	-3.62881700	-2.09552600
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H	6.27991700	-4.13392100	0.37770900
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H	5.63707900	-2.52413400	0.72671200
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H	3.67190200	-5.21472200	-2.02570200
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H	5.86523600	2.11317300	1.32315400
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H	5.34947500	5.45432500	-0.20725500

H	3.58343200	5.42537500	-0.26011700
H	4.51520100	4.38846000	-1.34958700
H	4.46400300	3.54960800	2.88532700
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H	1.23613700	0.90616100	-5.78449400
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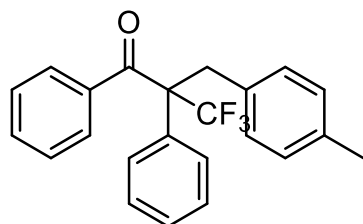
Ir(IV)

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C	-0.03579100	0.12119600	-2.91074800
C	-0.08577700	0.55311800	-4.22271500
C	-0.98994500	1.57212200	-4.51078100
C	0.91038000	2.59969600	0.51625000
N	0.95751600	1.28932800	0.26094200
C	2.18815500	0.68061900	0.12964600
C	3.36387000	1.45787300	0.29001700
C	3.31134800	2.79814900	0.56207400
C	2.02198900	3.38794300	0.67440800
N	0.94724300	-1.30821400	-0.28010500
C	0.88735700	-2.61459700	-0.53502300
C	1.99320500	-3.41750300	-0.69609400
C	3.28145500	-2.84147400	-0.58589400
C	3.34620900	-1.49739700	-0.31498500
C	2.18347600	-0.70815600	-0.15228400
C	-1.65986100	-1.62753800	2.21412600
C	-1.74869800	-2.10755600	3.52053000
C	-0.94670400	-1.57718500	4.50885600
C	-0.04305500	-0.56052100	4.21110700
C	-0.00600300	-0.12874800	2.89862300
N	-0.78036000	-0.63509500	1.93487900
C	-3.77489500	-2.76937600	-1.24585600
C	-4.07872500	-3.45151600	-0.08297100
C	-3.38894500	-3.07713900	1.04984700
C	-2.42843700	-2.06953000	1.05816600
C	-2.13926700	-1.39566500	-0.15659100
C	-2.83542900	-1.76286000	-1.30840000
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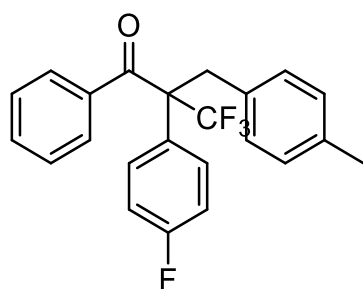
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F	-3.69736900	3.74848700	-2.15168200
F	-4.39234200	3.12506500	2.40335000
F	-4.43564100	-3.11477300	-2.36558900
F	-3.68726900	-3.74439000	2.18009100
C	0.84977200	0.04443200	5.24328600
C	4.55996300	-3.65445400	-0.75474000
C	5.37884600	-3.07746500	-1.91308500
C	5.38418000	-3.57616100	0.53363000
C	4.27110900	-5.12181300	-1.05350000
C	4.54965200	3.65916600	0.74353700
C	5.83963700	2.86096900	0.59886000
C	4.54473200	4.77217100	-0.30927400
C	4.52158700	4.28896200	2.13998600
C	0.79422300	-0.05399300	-5.26458400
H	-2.47731400	2.89477800	-3.74247700
H	0.64097200	-0.66926000	-2.61378600
H	-1.07471300	1.95144800	-5.52375900
H	-0.08389800	3.02395500	0.60263600
H	4.32038400	0.96484600	0.19199000
H	1.89558900	4.44222300	0.88118700
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H	1.84932100	-4.46802400	-0.90237200
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H	-2.44621200	-2.89558400	3.75698700
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H	1.49614700	0.80676900	4.80606700
H	0.26474700	0.50856300	6.04213300
H	6.29815100	-3.65509200	-2.04807400
H	4.81311100	-3.11503400	-2.84810400
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H	4.82306300	-3.97939800	1.38101400
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H	5.42216300	5.41275900	-0.18186600
H	3.65514400	5.40032400	-0.22712700
H	4.57158200	4.35378700	-1.31915600
H	4.52919400	3.51804700	2.91553000
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H	3.63295700	4.90689800	2.28577400
H	1.42242000	0.70693000	-5.73554500
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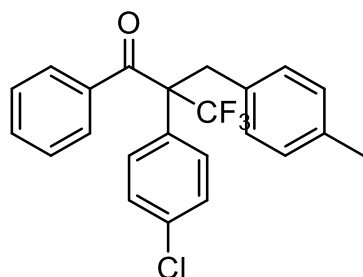
11. Characterization Data of Compounds



3,3,3-trifluoro-2-(4-methylbenzyl)-1,2-diphenylpropan-1-one (4a): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4a** (58%, 42.7 mg) as a light yellow liquid. ^1H NMR (400 MHz, CDCl_3) δ 7.50 – 7.45 (m, 2H), 7.44 – 7.36 (m, 6H), 7.26 – 7.21 (m, 2H), 6.87 (d, $J = 7.9$ Hz, 2H), 6.67 (d, $J = 8.0$ Hz, 2H), 3.84 (dd, $J = 65.5, 14.5$ Hz, 2H), 2.22 (s, 3H). ^{13}C $\{^1\text{H}\}$ NMR (101 MHz, CDCl_3) δ 194.5, 136.6, 136.2, 135.4, 132.6, 131.8, 130.7, 130.4, 128.9, 128.8, 128.6, 128.5, 128.2, 125.6 (d, $J = 285.6$ Hz), 65.6 (q, $J = 21.9$ Hz), 39.2 (d, $J = 1.1$ Hz), 21.0. ^{19}F NMR (377 MHz, CDCl_3) δ -64.63. HRMS (ESI-TOF) for $\text{C}_{23}\text{H}_{20}\text{F}_3\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 369.1460; found: 369.1452.

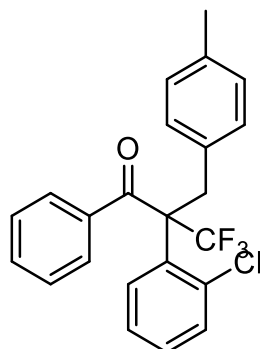


3,3,3-trifluoro-2-(4-fluorophenyl)-2-(4-methylbenzyl)-1-phenylpropan-1-one (4b): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4b** (71%, 55.2 mg) as a white solid (113-114 °C). ^1H NMR (400 MHz, CDCl_3) δ 7.51 – 7.42 (m, 3H), 7.39 – 7.32 (m, 2H), 7.31 – 7.23 (m, 2H), 7.12 – 7.04 (m, 2H), 6.88 (d, $J = 7.9$ Hz, 2H), 6.66 (d, $J = 7.9$ Hz, 2H), 3.81 (dd, $J = 73.4, 14.4$ Hz, 2H), 2.23 (s, 3H). ^{13}C $\{^1\text{H}\}$ NMR (101 MHz, CDCl_3) δ 194.1, 162.8 (d, $J = 249.7$ Hz), 136.7, 135.9, 132.8, 131.4, 131.2 (d, $J = 3.6$ Hz), 130.7, 130.5, 130.4, 128.6, 128.3, 125.5 (d, $J = 285.5$ Hz), 115.9 (d, $J = 21.6$ Hz), 65.1 (q, $J = 21.8$ Hz), 39.3, 21.0. ^{19}F NMR (377 MHz, CDCl_3) δ -64.96, -112.40. HRMS (ESI-TOF) for $\text{C}_{23}\text{H}_{19}\text{F}_4\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 387.1367; found: 387.1363.

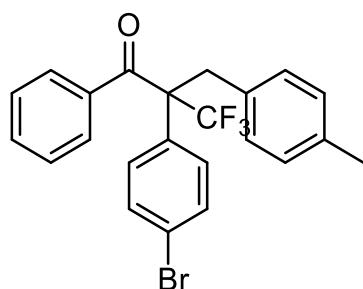


2-(4-chlorophenyl)-3,3,3-trifluoro-2-(4-methylbenzyl)-1-phenylpropan-1-one (4c): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4c** (82%, 65.8 mg) as a white solid (141-143 °C). ^1H NMR (400 MHz, CDCl_3) δ 7.52 – 7.42 (m, 3H), 7.37 – 7.23 (m, 6H), 6.88 (d, $J = 7.9$ Hz, 2H), 6.66 (d, $J = 7.9$ Hz, 2H), 3.80 (dd, $J = 73.6, 14.4$ Hz, 2H), 2.23 (s, 3H). ^{13}C $\{^1\text{H}\}$ NMR (101 MHz, CDCl_3) δ 194.0, 136.8, 135.8, 135.1, 133.9, 132.9, 131.3, 130.7, 130.4, 130.0, 129.1,

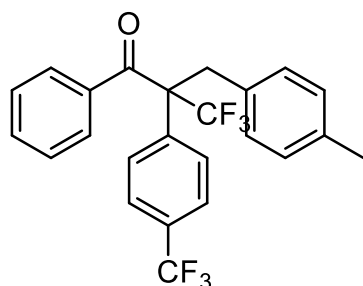
128.6, 128.3, 125.4 (d, $J = 285.6$ Hz), 65.2 (q, $J = 22.0$ Hz), 39.2 (d, $J = 0.9$ Hz), 21.0. ^{19}F NMR (377 MHz, CDCl_3) δ -64.78. HRMS (ESI-TOF) for $\text{C}_{23}\text{H}_{19}\text{ClF}_3\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 403.1071; found: 403.1062.



2-(2-chlorophenyl)-3,3,3-trifluoro-2-(4-methylbenzyl)-1-phenylpropan-1-one (4d): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4d** (10%, 8.1 mg) as a colorless liquid. ^1H NMR (400 MHz, CDCl_3) δ 7.65 (d, $J = 7.8$ Hz, 2H), 7.50 – 7.40 (m, 2H), 7.29 (dt, $J = 6.8, 3.9$ Hz, 3H), 7.22 (dd, $J = 8.3, 7.6$ Hz, 2H), 6.84 (d, $J = 7.9$ Hz, 2H), 6.62 (d, $J = 7.9$ Hz, 2H), 3.93 (dd, $J = 89.7, 15.0$ Hz, 2H), 2.22 (s, 3H). ^{13}C $\{^1\text{H}\}$ NMR (101 MHz, CDCl_3) δ 193.1, 136.2, 134.1, 132.9, 132.2, 131.7, 130.9, 129.8, 129.7, 128.2, 127.9, 127.5, 125.6 (d, $J = 287.5$ Hz), 65.7 (q, $J = 22.4$ Hz), 29.7, 21.0. ^{19}F NMR (377 MHz, CDCl_3) δ -60.78. HRMS (ESI-TOF) for $\text{C}_{23}\text{H}_{19}\text{ClF}_3\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 403.1071 found: 403.1073.

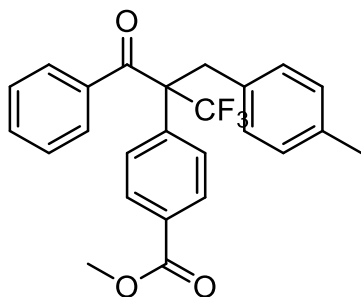


2-(4-bromophenyl)-3,3,3-trifluoro-2-(4-methylbenzyl)-1-phenylpropan-1-one (4e): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4e** (75%, 67.7 mg) as a white solid (138-139°C). ^1H NMR (400 MHz, CDCl_3) δ 7.54 – 7.43 (m, 5H), 7.31 – 7.22 (m, 4H), 6.88 (d, $J = 7.9$ Hz, 2H), 6.66 (d, $J = 7.8$ Hz, 2H), 3.80 (dd, $J = 73.7, 14.4$ Hz, 2H), 2.23 (s, 3H). ^{13}C $\{^1\text{H}\}$ NMR (101 MHz, CDCl_3) δ 193.9, 136.8, 135.8, 134.5, 132.9, 132.0, 131.3, 130.7, 130.4, 130.3, 128.6, 128.3, 125.3 (d, $J = 285.5$ Hz), 123.3, 65.3 (q, $J = 22.5$ Hz), 39.1, 21.0. ^{19}F NMR (377 MHz, CDCl_3) δ -64.77. HRMS (ESI-TOF) for $\text{C}_{23}\text{H}_{19}\text{BrF}_3\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 447.0566; found: 447.0569.



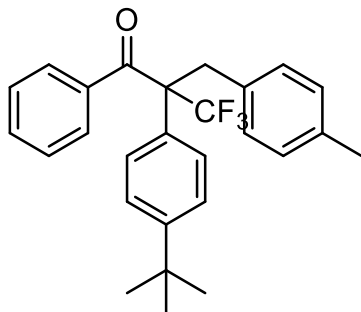
3,3,3-trifluoro-2-(4-methylbenzyl)-1-phenyl-2-(4-(trifluoromethyl)phenyl)propan-1-one (4f):

Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4f** (76%, 66.8 mg) as a white solid (117-118 °C). ¹H NMR (400 MHz, CDCl₃) δ 7.64 (d, *J* = 8.4 Hz, 2H), 7.53 – 7.41 (m, 5H), 7.30 – 7.25 (m, 2H), 6.88 (d, *J* = 7.9 Hz, 2H), 6.66 (d, *J* = 8.0 Hz, 2H), 3.84 (dd, *J* = 85.9, 14.4 Hz, 2H), 2.23 (s, 3H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 193.6, 139.4, 136.9, 135.5, 133.0, 131.1, 131.0 (d, *J* = 32.9 Hz), 130.8, 130.4, 129.1, 128.6, 128.3, 125.9 (d, *J* = 164.5 Hz), 125.7 (q, *J* = 3.6 Hz), 123.1 (d, *J* = 151.2 Hz), 65.7 (q, *J* = 22.0 Hz), 39.3, 21.0. ¹⁹F NMR (377 MHz, CDCl₃) δ -62.78, -64.46. HRMS (ESI-TOF) for C₂₄H₁₈F₆O₂Na ([M+Na]⁺): calcd. 459.1154; found: 459.1155.



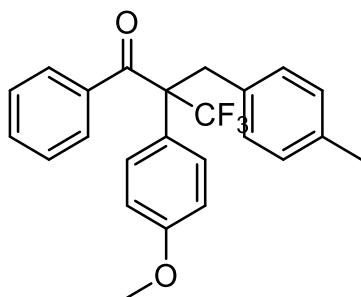
methyl 4-(1,1,1-trifluoro-2-(4-methylbenzyl)-3-oxo-3-phenylpropan-2-yl)benzoate (4g):

Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4g** (31%, 26.3 mg) as a light yellow liquid. ¹H NMR (400 MHz, CDCl₃) δ 8.03 (d, *J* = 8.6 Hz, 2H), 7.49 – 7.40 (m, 5H), 7.27 – 7.21 (m, 2H), 6.87 (d, *J* = 7.9 Hz, 2H), 6.66 (d, *J* = 8.0 Hz, 2H), 3.96 – 3.91 (m, 4H), 3.73 (d, *J* = 14.4 Hz, 1H), 2.23 (s, 3H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 193.8, 166.4, 140.3, 136.7, 135.7, 132.9, 131.3, 130.8, 130.4, 129.9, 128.8, 128.5, 128.2, 125.4 (d, *J* = 285.8 Hz), 65.8 (q, *J* = 22.4 Hz), 52.3, 39.4, 21.0. ¹⁹F NMR (377 MHz, CDCl₃) δ -64.19. HRMS (ESI-TOF) for C₂₅H₂₂F₃O₃ ([M+H]⁺): calcd. 427.1516; found: 427.1513.



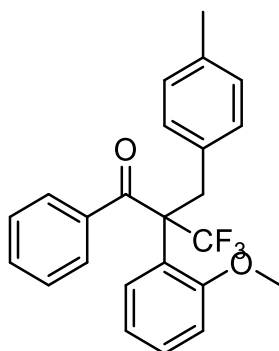
2-(4-(tert-butyl)phenyl)-3,3,3-trifluoro-2-(4-methylbenzyl)-1-phenylpropan-1-one (4h):

Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4h** (75%, 63.4 mg) as a colorless liquid. ¹H NMR (400 MHz, CDCl₃) δ 7.48 (d, *J* = 8.4 Hz, 2H), 7.45 – 7.37 (m, 3H), 7.33 (d, *J* = 8.3 Hz, 2H), 7.28 – 7.23 (m, 2H), 6.87 (d, *J* = 7.8 Hz, 2H), 6.66 (d, *J* = 7.6 Hz, 2H), 3.83 (dd, *J* = 58.9, 14.5 Hz, 2H), 2.22 (s, 3H), 1.33 (s, 9H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 194.7, 152.0, 136.5, 136.3, 132.6, 132.2, 131.9, 130.6, 130.4, 128.5, 128.2, 128.2, 125.8, 125.7 (d, *J* = 285.5 Hz), 65.2 (q, *J* = 21.8 Hz), 39.1, 34.6, 31.3, 21.0. ¹⁹F NMR (377 MHz, CDCl₃) δ -64.83. HRMS (ESI-TOF) for C₂₇H₂₈F₃O ([M+H]⁺): calcd. 425.2087; found: 425.2089.



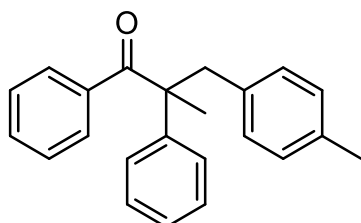
3,3,3-trifluoro-2-(4-methoxyphenyl)-2-(4-methylbenzyl)-1-phenylpropan-1-one (4i):

Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4i** (79%, 63.5 mg) as a white solid (120-122 °C). ¹H NMR (400 MHz, CDCl₃) δ 7.54 – 7.47 (m, 2H), 7.46 – 7.41 (m, 1H), 7.33 (d, *J* = 7.6 Hz, 2H), 7.26 (t, *J* = 8.0 Hz, 2H), 6.96 – 6.86 (m, 4H), 6.67 (d, *J* = 6.6 Hz, 2H), 3.92 – 3.72 (m, 5H), 2.23 (s, 3H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 194.6, 159.8, 136.6, 136.2, 132.6, 131.8, 130.6, 130.5, 129.8, 128.5, 128.2, 127.1, 124.2, 114.3, 64.9 (q, *J* = 21.9 Hz), 55.3, 39.1, 21.0. ¹⁹F NMR (377 MHz, CDCl₃) δ -65.23. HRMS (ESI-TOF) for C₂₄H₂₂F₃O₂ ([M+H]⁺): calcd. 399.1566; found: 399.1573.



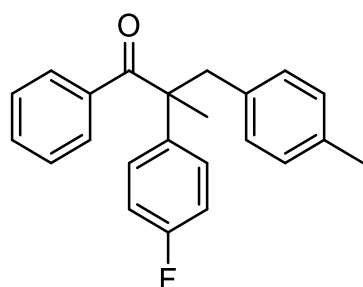
3,3,3-trifluoro-2-(2-methoxyphenyl)-2-(4-methylbenzyl)-1-phenylpropan-1-one (4j):

Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4j** (37%, 29.5 mg) as a colorless liquid. ¹H NMR (400 MHz, CDCl₃) δ 7.64 (d, *J* = 7.7 Hz, 2H), 7.43 – 7.35 (m, 2H), 7.35 – 7.29 (m, 1H), 7.19 (t, *J* = 7.9 Hz, 2H), 6.99 (t, *J* = 7.2 Hz, 1H), 6.84 (d, *J* = 7.9 Hz, 2H), 6.69 (d, *J* = 7.9 Hz, 1H), 6.61 (d, *J* = 7.9 Hz, 2H), 3.76 (dd, *J* = 71.8, 14.5 Hz, 2H), 3.20 (s, 3H), 2.21 (s, 3H). ¹³C NMR (101 MHz, CDCl₃) δ 193.8, 156.6, 136.2, 135.8, 132.9, 132.2, 131.0, 129.7, 128.9, 128.2, 128.0, 127.6, 125.5, 124.5, 121.3, 111.8, 63.40 (q, *J* = 21.9 Hz), 54.6, 38.0, 21.0. ¹⁹F NMR (377 MHz, CDCl₃) δ -62.43. HRMS (ESI-TOF) for C₂₄H₂₂F₃O₂ ([M+H]⁺): calcd. 399.1566; found: 399.1575.

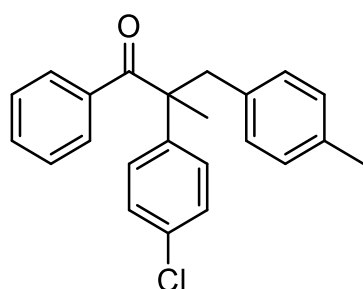


2-methyl-1,2-diphenyl-3-(p-tolyl)propan-1-one (4k): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4k** (37%, 23.3 mg) as a colorless liquid. ¹H NMR (400 MHz, CDCl₃) δ 7.47 (d, *J* = 7.3 Hz, 2H), 7.39 – 7.27 (m, 4H), 7.24 – 7.14 (m, 4H), 6.89 (d, *J* = 7.8 Hz, 2H), 6.52 (d, *J* = 7.9 Hz, 2H), 3.36 – 3.24 (m, 2H), 2.25 (s, 3H), 1.53 (s, 3H). ¹³C {¹H} NMR (101

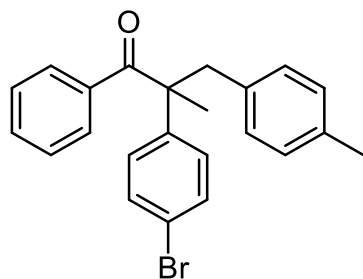
MHz, CDCl₃) δ 203.4, 142.9, 136.8, 135.6, 134.2, 131.6, 130.8, 129.7, 128.7, 128.2, 128.0, 127.0, 126.9, 55.4, 45.9, 22.6, 21.0. HRMS (ESI-TOF) for C₂₃H₂₃O ([M+H]⁺): calcd. 315.1743; found: 315.1748.



2-(4-fluorophenyl)-2-methyl-1-phenyl-3-(p-tolyl)propan-1-one (4l): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4l** (53%, 35.5 mg) as a white solid (60-62 °C). ¹H NMR (400 MHz, CDCl₃) δ 7.50 – 7.44 (m, 2H), 7.41 – 7.35 (m, 1H), 7.26 – 7.21 (m, 2H), 7.14 – 7.08 (m, 2H), 7.05 – 6.98 (m, 2H), 6.91 (d, *J* = 7.8 Hz, 2H), 6.51 (d, *J* = 8.0 Hz, 2H), 3.27 (s, 2H), 2.26 (s, 3H), 1.53 (s, 3H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 203.2, 161.8 (d, *J* = 246.2 Hz), 138.7 (d, *J* = 3.3 Hz), 136.6, 135.7, 133.9, 131.8, 130.8, 129.7, 128.5 (d, *J* = 7.9 Hz), 128.3, 128.0, 115.6 (d, *J* = 21.2 Hz), 54.9, 46.1, 22.7, 21.0. ¹⁹F NMR (377 MHz, CDCl₃) δ -115.51. HRMS (ESI-TOF) for C₂₃H₂₂FO ([M+H]⁺): calcd. 333.1649; found: 333.1641.

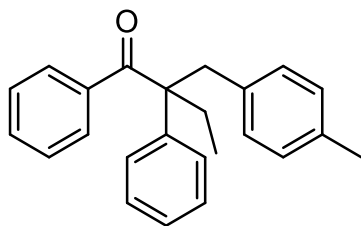


2-(4-chlorophenyl)-2-methyl-1-phenyl-3-(p-tolyl)propan-1-one (4m): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4m** (60%, 42.4 mg) as a colorless liquid. ¹H NMR (400 MHz, CDCl₃) δ 7.46 (d, *J* = 8.1 Hz, 2H), 7.38 (t, *J* = 7.4 Hz, 1H), 7.28 (d, *J* = 8.5 Hz, 2H), 7.26 – 7.21 (m, 2H), 7.08 (d, *J* = 8.4 Hz, 2H), 6.91 (d, *J* = 7.8 Hz, 2H), 6.52 (d, *J* = 7.8 Hz, 2H), 3.27 (q, *J* = 13.5 Hz, 2H), 2.26 (s, 3H), 1.53 (s, 3H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 202.9, 141.6, 136.5, 135.8, 133.8, 132.9, 131.8, 130.8, 129.7, 128.9, 128.3, 128.1, 55.1, 46.0, 22.6, 21.0. HRMS (ESI-TOF) for C₂₃H₂₂ClO ([M+H]⁺): calcd. 349.1354; found: 349.1352.

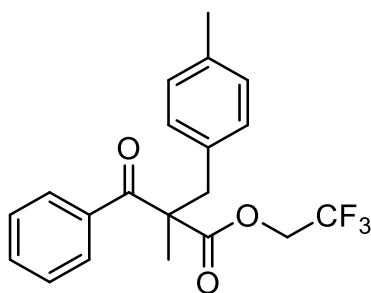


2-(4-bromophenyl)-2-methyl-1-phenyl-3-(p-tolyl)propan-1-one (4n): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4n** (44%, 34.7 mg) as a colorless liquid. ¹H NMR (400 MHz, CDCl₃) δ 7.47 (s, 1H), 7.46 – 7.44 (m, 2H), 7.43 – 7.42 (m, 1H), 7.41 – 7.35 (m,

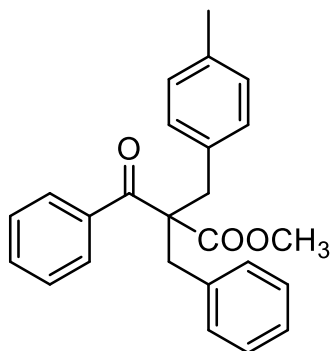
1H), 7.24 (t, $J = 5.8$ Hz, 2H), 7.05 – 6.99 (m, 2H), 6.91 (d, $J = 7.8$ Hz, 2H), 6.52 (d, $J = 8.0$ Hz, 2H), 3.27 (q, $J = 13.5$ Hz, 2H), 2.26 (s, 3H), 1.52 (s, 3H). ^{13}C $\{^1\text{H}\}$ NMR (101 MHz, CDCl_3) δ 202.8, 142.2, 136.4, 135.8, 133.7, 131.9, 130.8, 129.7, 128.7, 128.3, 128.1, 121.0, 55.1, 45.9, 22.6, 21.0. HRMS (ESI-TOF) for $\text{C}_{23}\text{H}_{22}\text{BrO}$ ($[\text{M}+\text{H}]^+$): calcd. 393.0843; found: 393.0848.



2-(4-methylbenzyl)-1,2-diphenylbutan-1-one (4o): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4o** (31%, 20.5 mg) as a light yellow liquid. ^1H NMR (400 MHz, CDCl_3) δ 7.49 (d, $J = 7.6$ Hz, 2H), 7.36 (t, $J = 7.4$ Hz, 1H), 7.31 – 7.25 (m, 3H), 7.21 (t, $J = 7.8$ Hz, 2H), 7.15 – 7.10 (m, 2H), 6.86 (d, $J = 7.9$ Hz, 2H), 6.41 (d, $J = 7.9$ Hz, 2H), 3.32 (dd, $J = 67.7, 13.8$ Hz, 2H), 2.24 (s, 3H), 2.14 – 1.97 (m, 2H), 0.85 (t, $J = 7.4$ Hz, 3H). ^{13}C $\{^1\text{H}\}$ NMR (101 MHz, CDCl_3) δ 203.0, 142.9, 137.1, 135.6, 134.0, 131.7, 130.4, 129.7, 128.7, 128.2, 128.0, 127.3, 127.0, 59.4, 40.8, 25.6, 21.0, 8.6. HRMS (ESI-TOF) for $\text{C}_{24}\text{H}_{25}\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 329.1900; found: 329.1887.

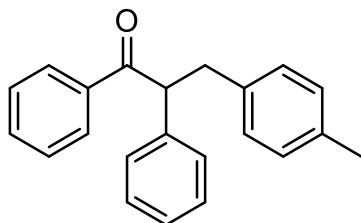


2,2,2-trifluoroethyl 2-methyl-2-(4-methylbenzyl)-3-oxo-3-phenylpropanoate (4p): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4p** (51%, 37.3 mg) as a colorless liquid. ^1H NMR (400 MHz, CDCl_3) δ 7.82 (d, $J = 7.5$ Hz, 2H), 7.58 – 7.52 (m, 1H), 7.44 (t, $J = 7.7$ Hz, 2H), 7.05 (d, $J = 7.8$ Hz, 2H), 6.91 (d, $J = 8.0$ Hz, 2H), 4.35 (q, $J = 8.4$ Hz, 2H), 3.43 – 3.33 (m, 2H), 2.30 (s, 3H), 1.55 (s, 3H). ^{13}C $\{^1\text{H}\}$ NMR (101 MHz, CDCl_3) δ 196.3, 172.4, 136.8, 135.6, 132.9, 132.3, 130.1, 129.0, 128.7, 128.4, 122.5 (d, $J = 277.6$ Hz), 60.8 (q, $J = 37.0$ Hz), 58.4, 41.8, 21.2, 21.0. ^{19}F NMR (377 MHz, CDCl_3) δ -73.46. HRMS (ESI-TOF) for $\text{C}_{20}\text{H}_{20}\text{F}_3\text{O}_3$ ($[\text{M}+\text{H}]^+$): calcd. 365.1395; found: 365.1372.

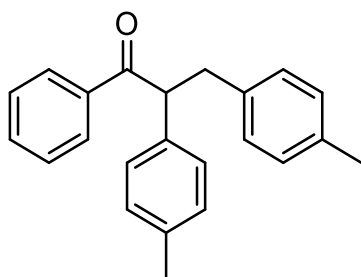


methyl 2-benzyl-2-(4-methylbenzyl)-3-oxo-3-phenylpropanoate (4q): Purification by column

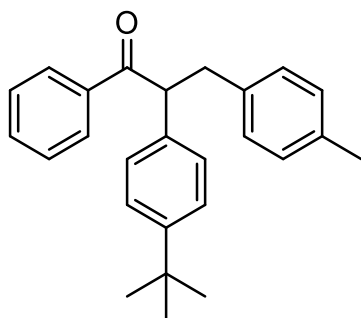
chromatography (silica gel, PE/EA = 30:1) afforded **4q** (33%, 24.5 mg) as a colorless liquid. ^1H NMR (400 MHz, CDCl_3) δ 7.65 (d, $J = 7.4$ Hz, 2H), 7.42 (t, $J = 7.4$ Hz, 1H), 7.31 (t, $J = 7.7$ Hz, 2H), 7.17 – 7.09 (m, 3H), 7.05 – 6.99 (m, 2H), 6.95 (d, $J = 8.0$ Hz, 2H), 6.88 (d, $J = 8.0$ Hz, 2H), 3.38 (s, 3H), 3.37 – 3.25 (m, 4H), 2.21 (s, 3H). ^{13}C $\{^1\text{H}\}$ NMR (101 MHz, CDCl_3) δ 196.7, 173.2, 136.6, 136.5, 136.3, 132.9, 132.6, 130.4, 130.2, 128.9, 128.6, 128.5, 128.2, 126.9, 63.5, 51.9, 40.1, 39.9, 21.1. HRMS (ESI-TOF) for $\text{C}_{25}\text{H}_{25}\text{O}_3$ ($[\text{M}+\text{H}]^+$): calcd. 373.1798; found: 373.1799.



1,2-diphenyl-3-(p-tolyl)propan-1-one (4r): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4r** (51%, 30.6 mg) as a white solid (67–69 °C). ^1H NMR (400 MHz, CDCl_3) δ 7.90 (d, $J = 7.5$ Hz, 2H), 7.45 (t, $J = 7.3$ Hz, 1H), 7.34 (t, $J = 7.6$ Hz, 2H), 7.25 (t, $J = 4.7$ Hz, 4H), 7.22 – 7.16 (m, 1H), 6.99 (q, $J = 8.1$ Hz, 4H), 4.80 (t, $J = 7.2$ Hz, 1H), 3.53 (dd, $J = 13.8, 7.6$ Hz, 1H), 3.02 (dd, $J = 13.8, 6.9$ Hz, 1H), 2.26 (s, 3H). ^{13}C $\{^1\text{H}\}$ NMR (101 MHz, CDCl_3) δ 199.4, 139.2, 136.8, 136.7, 135.6, 132.9, 129.02, 128.96, 128.9, 128.7, 128.5, 128.3, 127.2, 56.0, 39.7, 21.1. HRMS (ESI-TOF) for $\text{C}_{22}\text{H}_{20}\text{ONa}$ ($[\text{M}+\text{Na}]^+$): calcd. 323.1406; found: 323.1408.

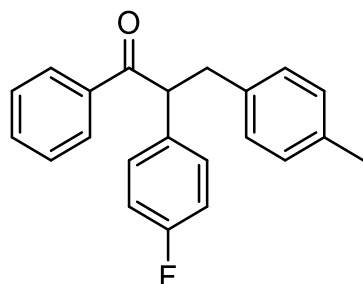


1-phenyl-2,3-di-p-tolylpropan-1-one (4s): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4s** (41%, 26.1 mg) as a white solid (95–97 °C). ^1H NMR (400 MHz, CDCl_3) δ 7.89 (d, $J = 7.3$ Hz, 2H), 7.42 (t, $J = 7.4$ Hz, 1H), 7.32 (t, $J = 7.6$ Hz, 2H), 7.13 (d, $J = 8.0$ Hz, 2H), 7.06 (d, $J = 8.0$ Hz, 2H), 7.00 – 6.97 (m, 4H), 4.77 (t, $J = 7.2$ Hz, 1H), 3.52 (dd, $J = 13.8, 7.7$ Hz, 1H), 2.99 (dd, $J = 13.8, 6.7$ Hz, 1H), 2.26 (s, 3H), 2.25 (s, 3H). ^{13}C $\{^1\text{H}\}$ NMR (101 MHz, CDCl_3) δ 199.4, 136.8, 136.7, 136.2, 135.5, 132.7, 129.6, 129.0, 128.9, 128.7, 128.4, 128.1, 55.5, 39.7, 21.0, 21.0. HRMS (ESI-TOF) for $\text{C}_{23}\text{H}_{23}\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 315.1743; found: 315.1748.

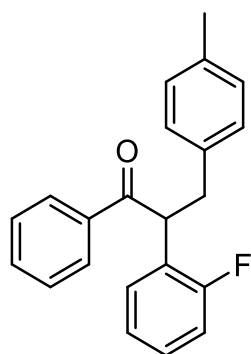


2-(4-(tert-butyl)phenyl)-1-phenyl-3-(p-tolyl)propan-1-one (4t): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4t** (57%, 41.1 mg) as a white solid (110–112 °C). ^1H NMR (400 MHz, CDCl_3) δ 7.90 (d, $J = 7.4$ Hz, 2H), 7.44 (t, $J = 7.3$ Hz, 1H), 7.34 (t, $J = 7.7$ Hz,

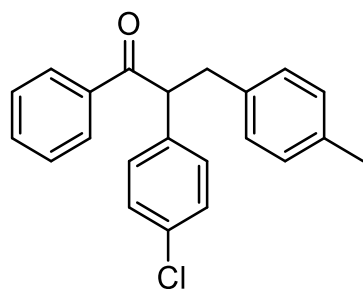
2H), 7.28 (d, $J = 8.3$ Hz, 2H), 7.20 (d, $J = 8.3$ Hz, 2H), 7.00 (s, 4H), 4.81 (dd, $J = 8.4, 5.9$ Hz, 1H), 3.56 (dd, $J = 13.8, 8.5$ Hz, 1H), 2.99 (dd, $J = 13.8, 5.9$ Hz, 1H), 2.26 (s, 3H), 1.26 (s, 9H). ^{13}C $\{^1\text{H}\}$ NMR (101 MHz, CDCl_3) δ 199.4, 149.9, 137.0, 137.0, 136.2, 135.5, 132.7, 129.0, 128.9, 128.7, 128.4, 127.8, 125.8, 55.3, 39.8, 34.4, 31.3, 21.0. HRMS (ESI-TOF) for $\text{C}_{26}\text{H}_{29}\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 357.2213; found: 357.2222.



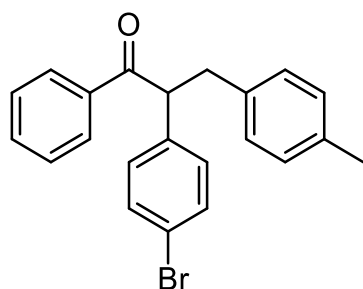
2-(4-fluorophenyl)-1-phenyl-3-(p-tolyl)propan-1-one (4u): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4u** (47%, 30.1 mg) as a yellow solid (85-87 °C). ^1H NMR (400 MHz, CDCl_3) δ 7.88 (d, $J = 7.3$ Hz, 2H), 7.46 (t, $J = 7.4$ Hz, 1H), 7.35 (t, $J = 7.6$ Hz, 2H), 7.21 – 7.16 (m, 2H), 7.00 (d, $J = 7.9$ Hz, 2H), 6.98 – 6.89 (m, 4H), 4.77 (t, $J = 7.3$ Hz, 1H), 3.48 (dd, $J = 13.8, 7.1$ Hz, 1H), 3.00 (dd, $J = 13.8, 7.4$ Hz, 1H), 2.26 (s, 3H). ^{13}C $\{^1\text{H}\}$ NMR (101 MHz, CDCl_3) δ 199.3, 161.9 (d, $J = 245.8$ Hz), 136.6, 136.3, 135.7, 134.8 (d, $J = 3.1$ Hz), 133.0, 129.8 (d, $J = 8.0$ Hz), 129.0, 128.6, 128.5, 115.7 (d, $J = 21.4$ Hz), 55.0, 39.7, 21.0. ^{19}F NMR (377 MHz, CDCl_3) δ -115.38. HRMS (ESI-TOF) for $\text{C}_{22}\text{H}_{20}\text{FO}$ ($[\text{M}+\text{H}]^+$): calcd. 319.1493; found: 319.1492.



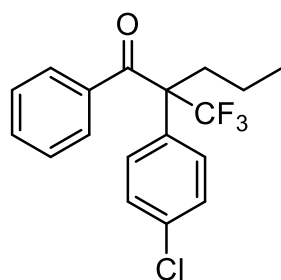
2-(2-fluorophenyl)-1-phenyl-3-(p-tolyl)propan-1-one (4v): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4v** (45%, 28.9 mg) as a colorless liquid. ^1H NMR (400 MHz, CDCl_3) δ 7.92 (d, $J = 7.5$ Hz, 2H), 7.46 (t, $J = 7.4$ Hz, 1H), 7.36 (t, $J = 7.6$ Hz, 2H), 7.29 (td, $J = 7.6, 1.6$ Hz, 1H), 7.20 – 7.13 (m, 1H), 7.08 – 6.96 (m, 6H), 5.22 (t, $J = 7.3$ Hz, 1H), 3.51 (dd, $J = 13.8, 7.7$ Hz, 1H), 3.01 (dd, $J = 13.8, 6.8$ Hz, 1H), 2.26 (s, 3H). ^{13}C $\{^1\text{H}\}$ NMR (101 MHz, CDCl_3) δ 198.7, 159.9 (d, $J = 245.2$ Hz), 136.3, 136.3, 135.7, 133.1, 129.0 (d, $J = 3.4$ Hz), 129.0, 128.9, 128.8 (d, $J = 8.4$ Hz), 128.6, 128.5, 126.4 (d, $J = 15.0$ Hz), 124.6 (d, $J = 3.4$ Hz), 115.7 (d, $J = 22.8$ Hz), 46.9, 38.6, 21.0. ^{19}F NMR (377 MHz, CDCl_3) δ -118.56. HRMS (ESI-TOF) for $\text{C}_{22}\text{H}_{20}\text{FO}$ ($[\text{M}+\text{H}]^+$): calcd. 319.1493; found: 319.1488.



2-(4-chlorophenyl)-1-phenyl-3-(p-tolyl)propan-1-one (4w): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4w** (62%, 41.8 mg) as a white solid (116-117 °C). ¹H NMR (400 MHz, CDCl₃) δ 7.87 (d, *J* = 7.6 Hz, 2H), 7.47 (t, *J* = 7.4 Hz, 1H), 7.36 (t, *J* = 7.7 Hz, 2H), 7.19 (dd, *J* = 26.9, 8.5 Hz, 4H), 6.97 (dd, *J* = 25.3, 7.9 Hz, 4H), 4.76 (t, *J* = 7.3 Hz, 1H), 3.48 (dd, *J* = 13.8, 7.1 Hz, 1H), 3.00 (dd, *J* = 13.8, 7.5 Hz, 1H), 2.27 (s, 3H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 199.0, 137.6, 136.5, 136.2, 135.7, 133.0, 129.7, 129.0, 129.0, 128.9, 128.6, 128.6, 55.2, 39.6, 21.0. HRMS (ESI-TOF) for C₂₂H₂₀ClO ([M+H]⁺): calcd. 335.1197; found: 335.1197.

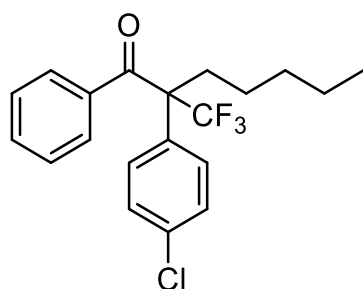


2-(4-bromophenyl)-1-phenyl-3-(p-tolyl)propan-1-one (4x): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **4x** (35%, 26.1 mg) as a white solid (145-146 °C). ¹H NMR (400 MHz, CDCl₃) δ 7.87 (d, *J* = 7.4 Hz, 2H), 7.47 (t, *J* = 7.4 Hz, 1H), 7.39 – 7.33 (m, 4H), 7.10 (d, *J* = 8.4 Hz, 2H), 6.97 (dd, *J* = 25.4, 7.9 Hz, 4H), 4.75 (t, *J* = 7.3 Hz, 1H), 3.48 (dd, *J* = 13.8, 7.1 Hz, 1H), 2.99 (dd, *J* = 13.8, 7.4 Hz, 1H), 2.26 (s, 3H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 199.0, 138.1, 136.5, 136.1, 135.7, 133.0, 132.0, 130.0, 129.0, 128.9, 128.6, 128.6, 121.1, 55.2, 39.5, 21.0. HRMS (ESI-TOF) for C₂₂H₂₀BrO ([M+H]⁺): calcd. 379.0692; found: 379.0679.

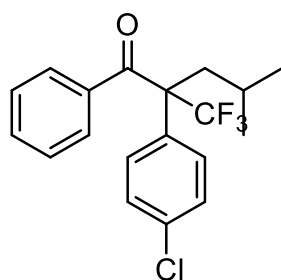


2-(4-chlorophenyl)-1-phenyl-2-(trifluoromethyl)pentan-1-one (5a): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **5a** (56%, 38.2 mg) as a white solid (88-89 °C). ¹H NMR (400 MHz, CDCl₃) δ 7.50 – 7.41 (m, 3H), 7.41 – 7.31 (m, 4H), 7.29 – 7.25 (m, 2H), 2.66 – 2.55 (m, 1H), 2.32 (t, *J* = 12.4 Hz, 1H), 1.70 – 1.58 (m, 1H), 1.15 – 1.01 (m, 1H), 0.79 (t, *J* = 7.3 Hz, 3H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 194.6, 135.4, 135.1, 134.3, 132.8, 129.9, 129.5, 129.2, 128.4, 125.7 (d, *J* = 284.8 Hz), 63.21 (q, *J* = 22.5 Hz), 35.8, 18.1, 14.8. ¹⁹F NMR (377 MHz, CDCl₃)

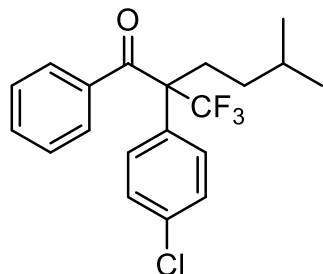
δ -68.03. HRMS (ESI-TOF) for $C_{18}H_{17}ClF_3O$ ($[M+H]^+$): calcd. 341.0915; found: 341.0913.



2-(4-chlorophenyl)-1-phenyl-2-(trifluoromethyl)heptan-1-one (5b): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **5b** (45%, 33.6 mg) as a colorless liquid. 1H NMR (400 MHz, $CDCl_3$) δ 7.47 – 7.42 (m, 3H), 7.40 – 7.32 (m, 4H), 7.29 – 7.24 (m, 2H), 2.66 – 2.56 (m, 1H), 2.39 – 2.28 (m, 1H), 1.69 – 1.53 (m, 1H), 1.26 – 1.01 (m, 5H), 0.72 (t, $J = 7.1$ Hz, 3H). ^{13}C { 1H } NMR (101 MHz, $CDCl_3$) δ 194.8, 135.4, 135.1, 134.3, 132.8, 129.9, 129.5, 129.2, 128.3, 125.8 (d, $J = 285.0$ Hz), 63.1 (q, $J = 22.5$ Hz), 33.5, 32.3, 24.2, 21.8, 13.7. ^{19}F NMR (377 MHz, $CDCl_3$) δ -67.96. HRMS (ESI-TOF) for $C_{20}H_{21}ClF_3O$ ($[M+H]^+$): calcd. 369.1228; found: 369.1229.

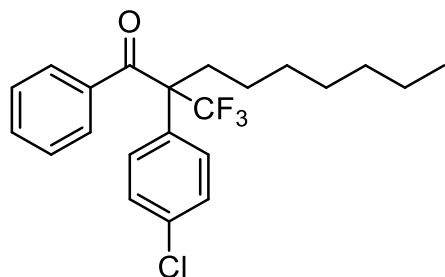


2-(4-chlorophenyl)-4-methyl-1-phenyl-2-(trifluoromethyl)pentan-1-one (5c): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **5c** (54%, 38.4 mg) as a white solid (64–65 °C). 1H NMR (400 MHz, $CDCl_3$) δ 7.47 – 7.40 (m, 3H), 7.40 – 7.33 (m, 4H), 7.29 – 7.24 (m, 2H), 2.63 – 2.55 (m, 1H), 2.37 – 2.28 (m, 1H), 1.85 – 1.73 (m, 1H), 0.97 (d, $J = 6.6$ Hz, 3H), 0.42 (d, $J = 6.7$ Hz, 3H). ^{13}C { 1H } NMR (101 MHz, $CDCl_3$) δ 195.4, 135.8, 135.2, 134.3, 132.8, 130.0, 129.9, 129.1, 128.3, 125.6 (d, $J = 284.8$ Hz), 63.4 (q, $J = 22.6$ Hz), 42.0, 24.9, 24.3. ^{19}F NMR (377 MHz, $CDCl_3$) δ -67.55. HRMS (ESI-TOF) for $C_{19}H_{19}ClF_3O$ ($[M+H]^+$): calcd. 355.1071; found: 355.1068.

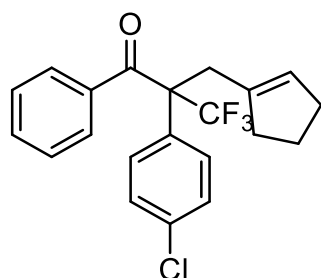


2-(4-chlorophenyl)-5-methyl-1-phenyl-2-(trifluoromethyl)hexan-1-one (5d): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **5d** (28%, 20.7 mg) as a white solid (103–104 °C). 1H NMR (400 MHz, $CDCl_3$) δ 7.48 – 7.42 (m, 3H), 7.42 – 7.35 (m, 4H), 7.29 – 7.25 (m, 2H), 2.68 – 2.56 (m, 1H), 2.41 – 2.27 (m, 1H), 1.56 – 1.47 (m, 1H), 1.38 – 1.28 (m, 1H), 0.94 – 0.84 (m, 1H), 0.78 (d, $J = 6.6$ Hz, 3H), 0.58 (d, $J = 6.6$ Hz, 3H). ^{13}C { 1H } NMR (101 MHz, $CDCl_3$)

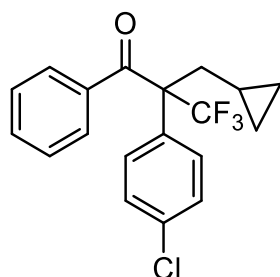
δ 194.9, 135.5, 135.2, 134.3, 132.8, 129.9, 129.5, 129.2, 128.3, 125.7 (d, $J = 285.2$ Hz), 63.1 (q, $J = 22.4$ Hz), 33.2, 31.4, 28.5, 22.2, 21.6. ^{19}F NMR (377 MHz, CDCl_3) δ -67.84. HRMS (ESI-TOF) for $\text{C}_{20}\text{H}_{21}\text{ClF}_3\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 369.1228; found: 369.1234.



2-(4-chlorophenyl)-1-phenyl-2-(trifluoromethyl)nonan-1-one (5e): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **5e** (29%, 23.2 mg) as a colorless liquid. ^1H NMR (400 MHz, CDCl_3) δ 7.50 – 7.41 (m, 3H), 7.41 – 7.32 (m, 4H), 7.29 – 7.25 (m, 2H), 2.69 – 2.54 (m, 1H), 2.33 (t, $J = 12.7$ Hz, 1H), 1.66 – 1.57 (m, 1H), 1.25 – 0.99 (m, 9H), 0.80 (t, $J = 7.1$ Hz, 3H). ^{13}C { ^1H } NMR (101 MHz, CDCl_3) δ 194.8, 135.4, 135.1, 134.3, 132.8, 129.9, 129.5, 129.2, 128.3, 125.7 (d, $J = 285.0$ Hz), 63.1 (q, $J = 22.4$ Hz), 33.5, 31.4, 30.0, 28.4, 24.4, 22.5, 14.0. ^{19}F NMR (377 MHz, CDCl_3) δ -68.00. HRMS (ESI-TOF) for $\text{C}_{22}\text{H}_{25}\text{ClF}_3\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 397.1541; found: 397.1461.

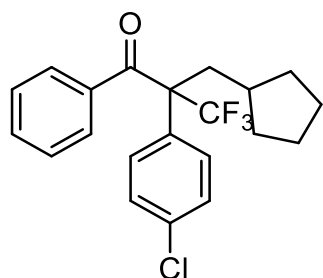


2-(4-chlorophenyl)-2-(cyclopent-1-en-1-ylmethyl)-3,3,3-trifluoro-1-phenylpropan-1-one (5f): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **5f** (28 %, 21.2 mg) as a white solid (105-106 °C). ^1H NMR (400 MHz, CDCl_3) δ 7.48 – 7.40 (m, 3H), 7.40 – 7.33 (m, 4H), 7.28 – 7.23 (m, 2H), 5.27 (s, 1H), 3.39 (dd, $J = 84.0, 15.1$ Hz, 2H), 2.18 – 2.06 (m, 2H), 2.01 – 1.86 (m, 2H), 1.66 (p, $J = 7.5$ Hz, 2H). ^{13}C { ^1H } NMR (101 MHz, CDCl_3) δ 194.9, 137.1, 135.7, 135.2, 134.1, 132.6, 131.2, 123.0, 129.9, 129.1, 128.2, 125.3 (d, $J = 284.8$ Hz), 63.3 (q, $J = 22.5$ Hz), 35.9, 35.1, 32.4, 23.7. ^{19}F NMR (377 MHz, CDCl_3) δ -67.40. HRMS (ESI-TOF) for $\text{C}_{21}\text{H}_{19}\text{ClF}_3\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 379.1071; found: 379.1073.



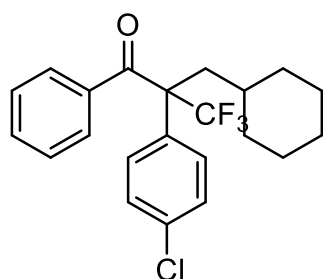
2-(4-chlorophenyl)-2-(cyclopropylmethyl)-3,3,3-trifluoro-1-phenylpropan-1-one (5g): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **5g** (26 %, 18.4 mg) as a white solid (77-78 °C). ^1H NMR (400 MHz, CDCl_3) δ 7.49 – 7.41 (m, 3H), 7.39 – 7.34 (m, 2H), 7.33 – 7.23 (m, 4H), 2.74 – 2.63 (m, 1H), 2.33 – 2.21 (m, 1H), 0.84 – 0.71 (m, 1H), 0.51 – 0.42 (m,

1H), 0.27 – 0.17 (m, 1H), 0.13 – 0.02 (m, 1H), -0.40 – -0.50 (m, 1H). ¹³C {1H} NMR (101 MHz, CDCl₃) δ 194.6 135.7, 135.1, 134.4 132.8, 129.9 129.8, 129.1, 128.3 125.7(d, *J* = 284.9 Hz), 63.5 (q, *J* = 22.4 Hz), 38.6, 6.6– 6.4(m), 6.1, 5.6. ¹⁹F NMR (377 MHz, CDCl₃) δ -67.39. HRMS (ESI-TOF) for C₁₉H₁₇ClF₃O ([M+H]⁺): calcd. 353.0915; found: 353.0917.



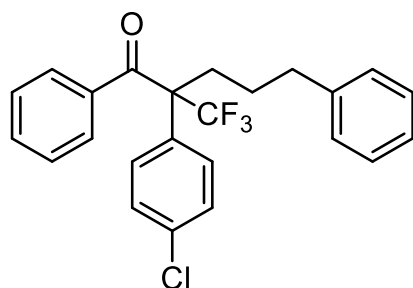
2-(4-chlorophenyl)-2-(cyclopentylmethyl)-3,3,3-trifluoro-1-phenylpropan-1-one (5h):

Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **5h** (44 %, 33.6 mg) as a white solid (76-77 °C). ¹H NMR (400 MHz, CDCl₃) δ 7.48 – 7.40 (m, 3H), 7.40 – 7.32 (m, 4H), 7.28 – 7.24 (m, 2H), 2.83 – 2.71 (m, 1H), 2.58 – 2.43 (m, 1H), 1.94 – 1.79 (m, 2H), 1.56 – 1.36 (m, 3H), 1.32 – 1.23 (m, 1H), 1.22 – 1.06 (m, 2H), 0.68 – 0.50 (m, 1H). ¹³C {1H} NMR (101 MHz, CDCl₃) δ 195.4, 135.6, 135.1, 134.4, 132.7, 130.0, 129.8, 129.1, 128.3, 125.6 (d, *J* = 284.7 Hz), 63.5 (q, *J* = 22.5 Hz), 39.8, 36.7, 34.8, 34.6, 24.9, 24.5. ¹⁹F NMR (377 MHz, CDCl₃) δ -67.73. HRMS (ESI-TOF) for C₂₁H₂₁ClF₃O ([M+H]⁺): calcd. 381.1228; found: 381.1225.



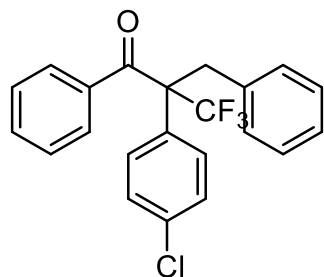
2-(4-chlorophenyl)-2-(cyclohexylmethyl)-3,3,3-trifluoro-1-phenylpropan-1-one (5i):

Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **5i** (37 %, 29.5 mg) as a white solid (124-125°C). ¹H NMR (400 MHz, CDCl₃) δ 7.48 – 7.32 (m, 7H), 7.28 – 7.24 (m, 2H), 2.52 (dd, *J* = 15.0, 4.5 Hz, 1H), 2.31 – 2.19 (m, 1H), 1.83 (d, *J* = 12.6 Hz, 1H), 1.67 – 1.59 (m, 1H), 1.55 – 1.46 (m, 1H), 1.45 – 1.32 (m, 2H), 1.25 – 1.12 (m, 1H), 1.08 – 0.87 (m, 3H), 0.75 – 0.67 (m, 1H), 0.61 – 0.49 (m, 1H). ¹³C {1H} NMR (101 MHz, CDCl₃) δ 195.5, 135.8, 135.2, 134.3, 132.7, 130.0, 129.8, 129.1, 128.3, 125.6 (d, *J* = 284.9 Hz), 63.2 (q, *J* = 22.5 Hz), 40.6, 35.2, 34.8, 34.2, 26.4, 26.3, 25.9. ¹⁹F NMR (377 MHz, CDCl₃) δ -67.78. HRMS (ESI-TOF) for C₂₂H₂₃ClF₃O ([M+H]⁺): calcd. 395.1384; found: 395.1373.

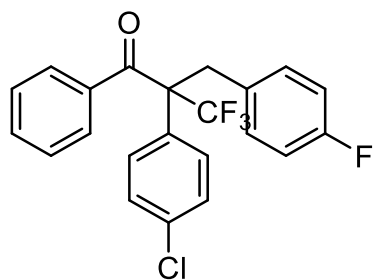


2-(4-chlorophenyl)-1,5-diphenyl-2-(trifluoromethyl)pentan-1-one (5j): Purification by column

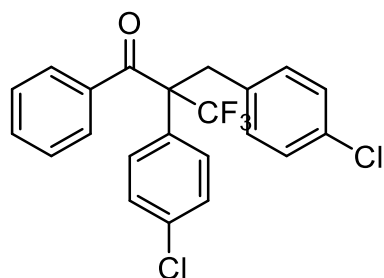
chromatography (silica gel, PE/EA = 30:1) afforded **5j** (65%, 54.3 mg) as a colorless liquid. ^1H NMR (400 MHz, CDCl_3) δ 7.47 – 7.41 (m, 1H), 7.40 – 7.27 (m, 6H), 7.25 – 7.20 (m, 2H), 7.19 – 7.09 (m, 3H), 6.89 (d, $J = 7.3$ Hz, 2H), 2.68 – 2.54 (m, 2H), 2.44 – 2.29 (m, 2H), 2.04 – 1.91 (m, 1H), 1.48 – 1.34 (m, 1H). ^{13}C { ^1H } NMR (101 MHz, CDCl_3) δ 194.6, 140.6, 135.2, 135.2, 134.1, 132.9, 129.8, 129.5, 129.2, 128.4, 128.2, 125.7 (d, $J = 285.0$ Hz), 126.0, 63.1 (q, $J = 22.5$ Hz), 36.0, 32.9, 25.7. ^{19}F NMR (377 MHz, CDCl_3) δ -67.81, -67.82. HRMS (ESI-TOF) for $\text{C}_{24}\text{H}_{21}\text{ClF}_3\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 417.1228; found: 417.1224.



2-benzyl-2-(4-chlorophenyl)-3,3,3-trifluoro-1-phenylpropan-1-one (5k): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **5k** (13%, 10.5 mg) as a white solid (91-92°C). ^1H NMR (400 MHz, CDCl_3) δ 7.51 – 7.43 (m, 3H), 7.39 – 7.34 (m, 2H), 7.29 (d, $J = 7.8$ Hz, 4H), 7.16 – 7.05 (m, 3H), 6.79 (d, $J = 7.3$ Hz, 2H), 3.83 (dd, $J = 81.1, 14.3$ Hz, 2H). ^{13}C { ^1H } NMR (101 MHz, CDCl_3) δ 193.9, 135.8, 135.1, 134.5, 133.8, 132.9, 130.9, 130.4, 130.0, 129.1, 128.3, 127.8, 127.1, 125.4 (d, $J = 285.5$ Hz), 65.3 (q, $J = 22.1$ Hz), 39.6. ^{19}F NMR (377 MHz, CDCl_3) δ -64.64. HRMS (ESI-TOF) for $\text{C}_{22}\text{H}_{17}\text{ClF}_3\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 389.0915; found: 389.0931.

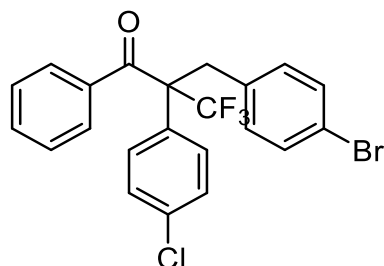


2-(4-chlorophenyl)-3,3,3-trifluoro-2-(4-fluorobenzyl)-1-phenylpropan-1-one (5l): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **5l** (9%, 7.5 mg) as a white solid (170-171°C). ^1H NMR (400 MHz, CDCl_3) δ 7.51 – 7.44 (m, 3H), 7.40 – 7.34 (m, 2H), 7.31 – 7.24 (m, 4H), 6.82 – 6.70 (m, 4H), 3.78 (dd, $J = 92.0, 14.4$ Hz, 2H). ^{13}C { ^1H } NMR (101 MHz, CDCl_3) δ 193.8, 162.0 (d, $J = 246.1$ Hz), 135.7, 135.1, 133.6, 133.0, 132.5 (d, $J = 7.9$ Hz), 130.4, 130.2 (d, $J = 3.4$ Hz), 129.9, 129.2, 128.3, 125.4 (d, $J = 285.6$ Hz), 114.7 (d, $J = 21.2$ Hz), 65.35 (q, $J = 21.2$ Hz), 38.9. ^{19}F NMR (377 MHz, CDCl_3) δ -64.41, -115.45. HRMS (ESI-TOF) for $\text{C}_{22}\text{H}_{16}\text{ClF}_4\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 407.0820; found: 407.0838.

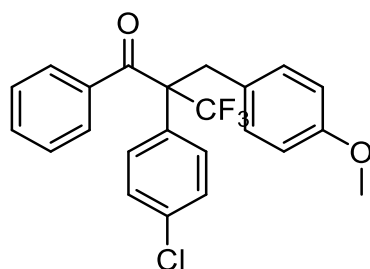


2-(4-chlorobenzyl)-2-(4-chlorophenyl)-3,3,3-trifluoro-1-phenylpropan-1-one (5m):

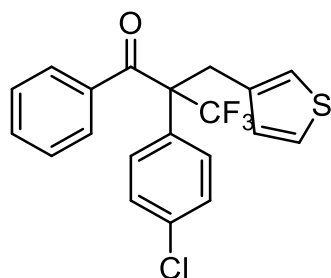
Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **5m** (25%, 21.4 mg) as a white solid (107-108 °C). ¹H NMR (400 MHz, CDCl₃) δ 7.50 – 7.44 (m, 3H), 7.40 – 7.34 (m, 2H), 7.30 – 7.24 (m, 4H), 7.09 – 7.02 (m, 2H), 6.71 (d, *J* = 8.4 Hz, 2H), 3.76 (dd, *J* = 88.0, 14.4 Hz, 2H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 193.7, 135.63, 135.2, 133.5, 133.1, 133.1, 133.0, 132.3, 130.4, 129.8, 129.2, 128.3, 128.0, 125.3 (d, *J* = 285.7 Hz), 65.4 (q, *J* = 22.1 Hz), 39.17. ¹⁹F NMR (377 MHz, CDCl₃) δ -64.29. HRMS (ESI-TOF) for C₂₂H₁₆Cl₂F₃O ([M+H]⁺): calcd. 423.0525; found: 423.0529.



2-(4-bromobenzyl)-2-(4-chlorophenyl)-3,3,3-trifluoro-1-phenylpropan-1-one (5n): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **5n** (24%, 22.5 mg) as a white solid (124-125 °C). ¹H NMR (400 MHz, CDCl₃) δ 7.50 – 7.44 (m, 3H), 7.40 – 7.34 (m, 2H), 7.31 – 7.19 (m, 6H), 6.64 (d, *J* = 8.4 Hz, 2H), 3.74 (dd, *J* = 87.1, 14.4 Hz, 2H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 193.7, 135.6, 135.2, 133.6, 133.4, 133.1, 132.7, 131.0, 130.4, 129.8, 129.2, 128.4, 126.7, 121.3, 65.3 (q, *J* = 22.3 Hz), 39.2. ¹⁹F NMR (377 MHz, CDCl₃) δ -64.25. HRMS (ESI-TOF) for C₂₂H₁₆BrClF₃O ([M+H]⁺): calcd. 467.0020; found: 467.0024.

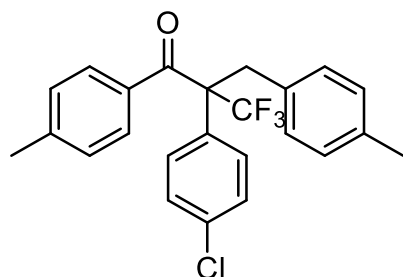


2-(4-chlorophenyl)-3,3,3-trifluoro-2-(4-methoxybenzyl)-1-phenylpropan-1-one (5o): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **5o** (62%, 52.1 mg) as a white solid (129-130 °C). ¹H NMR (400 MHz, CDCl₃) δ 7.52 – 7.43 (m, 3H), 7.39 – 7.33 (m, 2H), 7.32 – 7.24 (m, 4H), 6.73 – 6.66 (m, 2H), 6.65 – 6.57 (m, 2H), 3.89 (d, *J* = 14.5 Hz, 1H), 3.75 – 3.64 (m, 4H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 194.0, 158.6, 135.8, 135.0, 133.9, 132.9, 132.0, 130.4, 130.0, 129.1, 128.3, 126.3, 125.4 (d, *J* = 285.5 Hz), 113.2, 65.2 (q, *J* = 22.0 Hz), 55.1, 38.8. ¹⁹F NMR (377 MHz, CDCl₃) δ -64.82. HRMS (ESI-TOF) for C₂₃H₁₈ClF₃O₂Na ([M+Na]⁺): calcd. 441.0840; found: 441.0829.



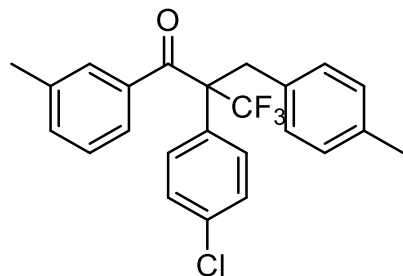
2-(4-chlorophenyl)-3,3,3-trifluoro-1-phenyl-2-(thiophen-3-ylmethyl)propan-1-one (5p):

Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **5p** (13%, 10.3 mg) as a white solid (130-131 °C). ¹H NMR (400 MHz, CDCl₃) δ 7.48 – 7.43 (m, 3H), 7.40 – 7.35 (m, 2H), 7.31 – 7.25 (m, 4H), 7.04 (dd, *J* = 4.9, 3.0 Hz, 1H), 6.56 (dd, *J* = 11.3, 3.7 Hz, 2H), 3.85 (dd, *J* = 91.0, 14.8 Hz, 2H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 193.9, 135.7, 135.1, 134.2, 133.8, 133.0, 130.2, 129.9, 129.8, 129.2, 128.3, 125.4 (d, *J* = 285.3 Hz), 124.9, 124.5, 64.68 (q, *J* = 22.3 Hz), 34.15. ¹⁹F NMR (377 MHz, CDCl₃) δ -65.79. HRMS (ESI-TOF) for C₂₀H₁₅ClF₃OS ([M+H]⁺): calcd. 395.0479; found: 395.0474.



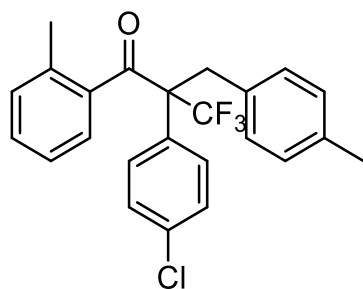
2-(4-chlorophenyl)-3,3,3-trifluoro-2-(4-methylbenzyl)-1-(p-tolyl)propan-1-one (6a):

Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **6a** (47%, 39.2 mg) as a white solid (181-182 °C). ¹H NMR (400 MHz, CDCl₃) δ 7.40 (d, *J* = 8.3 Hz, 2H), 7.37 – 7.32 (m, 2H), 7.32 – 7.26 (m, 2H), 7.07 (d, *J* = 8.2 Hz, 2H), 6.89 (d, *J* = 7.9 Hz, 2H), 6.68 (d, *J* = 7.9 Hz, 2H), 3.80 (dd, *J* = 70.1, 14.3 Hz, 2H), 2.34 (s, 3H), 2.23 (s, 3H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 193.4, 143.8, 136.7, 134.9, 134.2, 133.0, 131.4, 130.7, 130.6, 130.0, 129.0, 129.0, 128.6, 125.4 (d, *J* = 285.5 Hz), 65.1 (q, *J* = 22.0 Hz), 39.2, 21.6, 21.0. ¹⁹F NMR (377 MHz, CDCl₃) δ -64.90. HRMS (ESI-TOF) for C₂₄H₂₁ClF₃O ([M+H]⁺): calcd. 417.1228; found: 417.1217.



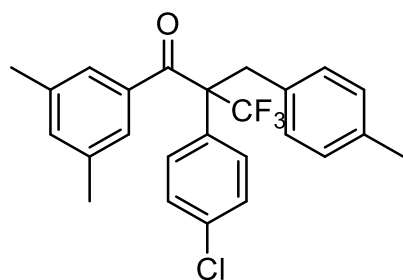
2-(4-chlorophenyl)-3,3,3-trifluoro-2-(4-methylbenzyl)-1-(m-tolyl)propan-1-one (6b):

Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **6b** (44%, 36.8 mg) as a white solid (166-167 °C). ¹H NMR (400 MHz, CDCl₃) δ 7.42 (s, 1H), 7.39 – 7.33 (m, 2H), 7.31 – 7.25 (m, 3H), 7.18 – 7.07 (m, 2H), 6.89 (d, *J* = 7.9 Hz, 2H), 6.68 (d, *J* = 8.0 Hz, 2H), 3.80 (dd, *J* = 65.5, 14.4 Hz, 2H), 2.28 (s, 3H), 2.24 (s, 3H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 194.1, 138.3, 136.7, 135.8, 135.0, 134.0, 133.6, 131.4, 131.0, 130.7, 130.0, 129.0, 128.6, 128.0, 127.6, 125.40 (d, *J* = 285.5 Hz), 65.3 (q, *J* = 22.0 Hz), 39.2, 21.4, 21.0. ¹⁹F NMR (377 MHz, CDCl₃) δ -64.78. HRMS (ESI-TOF) for C₂₄H₂₁ClF₃O ([M+H]⁺): calcd. 417.1228; found: 417.1215.



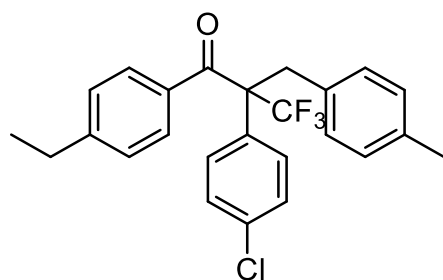
2-(4-chlorophenyl)-3,3,3-trifluoro-2-(4-methylbenzyl)-1-(o-tolyl)propan-1-one (6c):

Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **6c** (59%, 49.2 mg) as a white solid (70-72 °C). ¹H NMR (400 MHz, CDCl₃) δ 7.44 – 7.35 (m, 4H), 7.28 – 7.18 (m, 2H), 6.90 (t, *J* = 9.1 Hz, 3H), 6.73 (d, *J* = 7.8 Hz, 2H), 6.67 (d, *J* = 7.9 Hz, 1H), 3.66 (dd, *J* = 43.3, 14.5 Hz, 2H), 2.26 (s, 3H), 2.21 (s, 3H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 197.9, 139.1, 137.6, 136.6, 134.9, 133.6, 131.9, 131.7, 131.0, 130.9, 129.5, 129.2, 128.5, 128.0, 125.8 (d, *J* = 285.7 Hz), 124.6, 66.8 (q, *J* = 22.1 Hz), 40.2, 21.0, 20.7. ¹⁹F NMR (377 MHz, CDCl₃) δ -61.80. HRMS (ESI-TOF) for C₂₄H₂₀ClF₃ONa ([M+Na]⁺): calcd. 439.1047; found: 439.1065.



2-(4-chlorophenyl)-1-(3,5-dimethylphenyl)-3,3,3-trifluoro-2-(4-methylbenzyl)propan-1-one (6d):

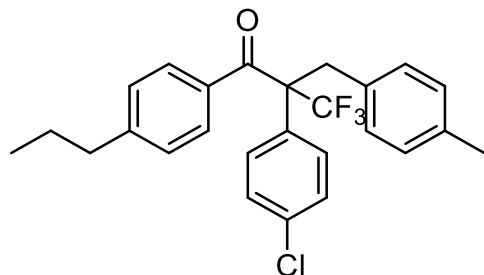
Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **6d** (50%, 43.1 mg) as a white solid (148-149 °C). ¹H NMR (400 MHz, CDCl₃) δ 7.39 – 7.28 (m, 4H), 7.08 (s, 3H), 6.90 (d, *J* = 7.9 Hz, 2H), 6.69 (d, *J* = 7.9 Hz, 2H), 3.80 (dd, *J* = 54.1, 14.4 Hz, 2H), 2.24 (s, 3H), 2.20 (s, 6H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 194.3, 137.8, 136.7, 135.9, 134.9, 134.5, 134.1, 131.5, 130.7, 130.0, 128.9, 128.5, 128.2, 125.4 (d, *J* = 285.6 Hz), 65.3 (q, *J* = 22.0 Hz), 39.2, 21.3, 21.0. ¹⁹F NMR (377 MHz, CDCl₃) δ -64.75. HRMS (ESI-TOF) for C₂₅H₂₃ClF₃O ([M+H]⁺): calcd. 431.1384; found: 431.1384.



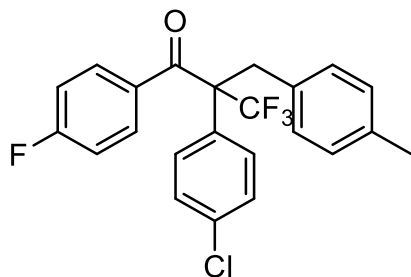
2-(4-chlorophenyl)-1-(4-ethylphenyl)-3,3,3-trifluoro-2-(4-methylbenzyl)propan-1-one (6e):

Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **6e** (37%, 31.9 mg) as a white solid (162-164 °C). ¹H NMR (400 MHz, CDCl₃) δ 7.42 (d, *J* = 8.4 Hz, 2H), 7.38 – 7.27 (m, 4H), 7.10 (d, *J* = 8.5 Hz, 2H), 6.89 (d, *J* = 7.9 Hz, 2H), 6.67 (d, *J* = 8.0 Hz, 2H), 3.80 (dd, *J* = 70.0, 14.3 Hz, 2H), 2.64 (q, *J* = 7.6 Hz, 2H), 2.23 (s, 3H), 1.21 (t, *J* = 7.6 Hz, 3H). ¹³C {¹H} NMR (101 MHz, CDCl₃) δ 193.5, 149.9, 136.7, 134.9, 134.2, 133.2, 131.5, 130.7, 130.0, 129.0, 128.5, 127.8,

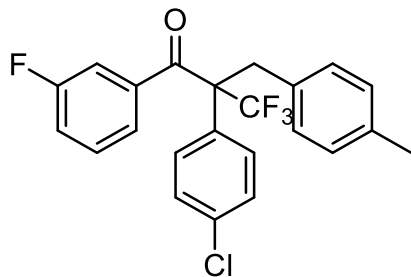
125.4 (d, $J = 285.6$ Hz), 65.1 (q, $J = 21.9$ Hz), 39.2, 28.8, 21.0, 14.9. ^{19}F NMR (377 MHz, CDCl_3) δ -64.86. HRMS (ESI-TOF) for $\text{C}_{25}\text{H}_{23}\text{ClF}_3\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 431.1384; found: 431.1391.



2-(4-chlorophenyl)-3,3,3-trifluoro-2-(4-methylbenzyl)-1-(4-propylphenyl)propan-1-one (6f): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **6f** (52%, 46.3 mg) as a white solid (122-123 °C). ^1H NMR (400 MHz, CDCl_3) δ 7.41 (d, $J = 8.2$ Hz, 2H), 7.38 – 7.28 (m, 4H), 7.07 (d, $J = 8.3$ Hz, 2H), 6.88 (d, $J = 7.9$ Hz, 2H), 6.66 (d, $J = 7.8$ Hz, 2H), 3.79 (dd, $J = 72.4, 14.3$ Hz, 2H), 2.57 (t, $J = 7.3$ Hz, 2H), 2.23 (s, 3H), 1.67 – 1.56 (m, 2H), 0.91 (t, $J = 7.3$ Hz, 3H). ^{13}C { ^1H } NMR (101 MHz, CDCl_3) δ 193.5, 148.4, 136.7, 134.9, 134.2, 133.3, 131.4, 130.7, 130.6, 130.0, 129.0, 128.5, 128.4, 125.4 (d, $J = 285.5$ Hz), 65.1 (q, $J = 22.0$ Hz), 39.2, 37.9, 24.0, 21.0, 13.7. ^{19}F NMR (377 MHz, CDCl_3) δ -64.89. HRMS (ESI-TOF) for $\text{C}_{26}\text{H}_{25}\text{ClF}_3\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 445.1541; found: 445.1550.

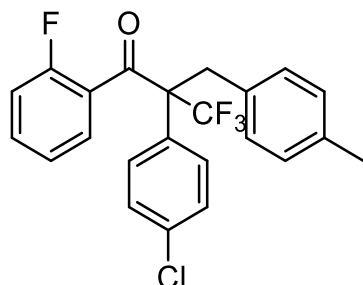


2-(4-chlorophenyl)-3,3,3-trifluoro-1-(4-fluorophenyl)-2-(4-methylbenzyl)propan-1-one (6g): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **6g** (35%, 29.5 mg) as a white solid (139-140 °C). ^1H NMR (400 MHz, CDCl_3) δ 7.51 (dd, $J = 8.4, 5.5$ Hz, 2H), 7.36 (d, $J = 8.6$ Hz, 2H), 7.28 – 7.24 (m, 2H), 6.95 (t, $J = 8.6$ Hz, 2H), 6.89 (d, $J = 7.9$ Hz, 2H), 6.67 (d, $J = 7.8$ Hz, 2H), 3.77 (dd, $J = 98.3, 14.4$ Hz, 2H), 2.24 (s, 3H). ^{13}C { ^1H } NMR (101 MHz, CDCl_3) δ 192.4, 165.2 (d, $J = 256.5$ Hz), 136.8, 135.1, 133.8, 133.2 (d, $J = 9.2$ Hz), 132.0, 131.2, 130.8, 130.0, 129.1, 128.6, 125.3 (d, $J = 285.7$ Hz), 115.4 (d, $J = 21.8$ Hz), 65.2 (q, $J = 22.4$ Hz), 39.3, 21.0. ^{19}F NMR (377 MHz, CDCl_3) δ -64.76, -104.41. HRMS (ESI-TOF) for $\text{C}_{23}\text{H}_{18}\text{ClF}_4\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 421.0977; found: 421.0988.

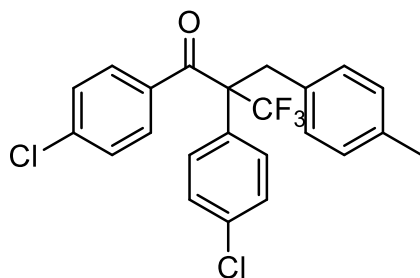


2-(4-chlorophenyl)-3,3,3-trifluoro-1-(3-fluorophenyl)-2-(4-methylbenzyl)propan-1-one (6h): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **6h** (67%, 56.5 mg) as a white solid (130-131 °C). ^1H NMR (400 MHz, CDCl_3) δ 7.41 – 7.35 (m, 2H), 7.30 – 7.24 (m, 3H),

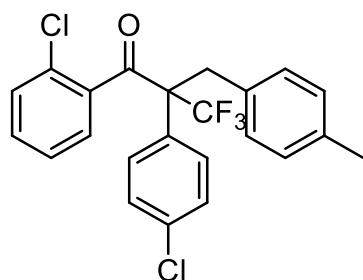
7.23 – 7.20 (m, 1H), 7.20 – 7.12 (m, 2H), 6.90 (d, $J = 7.9$ Hz, 2H), 6.67 (d, $J = 8.0$ Hz, 2H), 3.78 (dd, $J = 86.3, 14.4$ Hz, 2H), 2.24 (s, 3H). ^{13}C { ^1H } NMR (101 MHz, CDCl_3) δ 192.8, 162.2 (d, $J = 247.9$ Hz), 137.8 (d, $J = 6.5$ Hz), 136.9, 135.3, 133.5, 131.0, 130.7, 129.9, 129.8 (d, $J = 7.8$ Hz), 129.2, 128.6, 128.5, 126.1 (d, $J = 3.0$ Hz), 125.2 (d, $J = 285.6$ Hz), 120.0 (d, $J = 21.4$ Hz), 117.2 (d, $J = 23.4$ Hz), 65.4 (q, $J = 21.9$ Hz), 39.2, 21.0. ^{19}F NMR (377 MHz, CDCl_3) δ -64.78, -111.11. HRMS (ESI-TOF) for $\text{C}_{23}\text{H}_{18}\text{ClF}_4\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 421.0977; found: 421.0978.



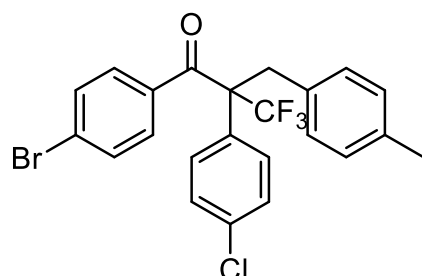
2-(4-chlorophenyl)-3,3,3-trifluoro-1-(2-fluorophenyl)-2-(4-methylbenzyl)propan-1-one (6i): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **6i** (77%, 64.8 mg) as a white solid (88-89 °C). ^1H NMR (400 MHz, CDCl_3) δ 7.44 – 7.33 (m, 3H), 7.29 (d, $J = 8.6$ Hz, 2H), 7.06 – 6.97 (m, 3H), 6.96 – 6.91 (m, 2H), 6.78 (d, $J = 8.0$ Hz, 2H), 3.71 (q, $J = 14.7$ Hz, 2H), 2.25 (s, 3H). ^{13}C { ^1H } NMR (101 MHz, CDCl_3) δ 193.5, 159.6 (d, $J = 255.9$ Hz), 136.7, 134.8, 133.6 (d, $J = 8.9$ Hz), 132.8, 131.6, 130.8, 130.0, 129.7, 129.0, 128.6, 126.6 (d, $J = 12.1$ Hz), 125.6 (d, $J = 285.6$ Hz), 123.6 (d, $J = 3.6$ Hz), 116.7 (d, $J = 22.9$ Hz), 67.0 (q, $J = 22.3$ Hz), 39.2, 21.0. ^{19}F NMR (377 MHz, CDCl_3) δ -62.73, -109.01. HRMS (ESI-TOF) for $\text{C}_{23}\text{H}_{17}\text{ClF}_4\text{ONa}$ ($[\text{M}+\text{Na}]^+$): calcd. 443.0796; found: 443.0784.



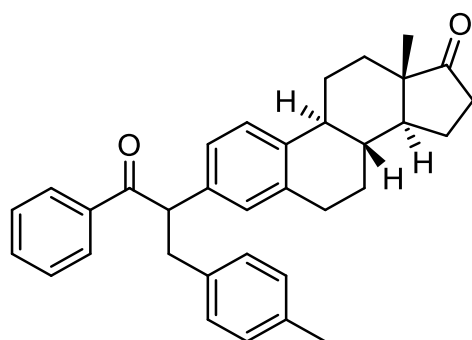
1,2-bis(4-chlorophenyl)-3,3,3-trifluoro-2-(4-methylbenzyl)propan-1-one (6j): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **6j** (33%, 28.9 mg) as a white solid (156-157 °C). ^1H NMR (400 MHz, CDCl_3) δ 7.45 – 7.39 (m, 2H), 7.39 – 7.33 (m, 2H), 7.24 (d, $J = 8.7$ Hz, 4H), 6.90 (d, $J = 7.9$ Hz, 2H), 6.67 (d, $J = 8.0$ Hz, 2H), 3.76 (dd, $J = 96.2, 14.4$ Hz, 2H), 2.24 (s, 3H). ^{13}C { ^1H } NMR (101 MHz, CDCl_3) δ 192.8, 139.4, 136.9, 135.2, 134.0, 133.6, 131.8, 131.1, 130.8, 130.0, 129.2, 128.6, 128.6, 125.3 (d, $J = 285.4$ Hz), 65.3 (q, $J = 22.3$ Hz), 39.2, 21.0. ^{19}F NMR (377 MHz, CDCl_3) δ -64.74. HRMS (ESI-TOF) for $\text{C}_{23}\text{H}_{18}\text{Cl}_2\text{F}_3\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 437.0681; found: 437.0684.



1-(2-chlorophenyl)-2-(4-chlorophenyl)-3,3,3-trifluoro-2-(4-methylbenzyl)propan-1-one (6k): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **6k** (38%, 33.3 mg) as a colorless liquid. ^1H NMR (400 MHz, CDCl_3) δ 7.41 – 7.31 (m, 5H), 7.28 – 7.23 (m, 1H), 7.00 – 6.92 (m, 3H), 6.81 (d, $J = 7.8$ Hz, 2H), 6.57 (d, $J = 7.8$ Hz, 1H), 3.66 (s, 2H), 2.26 (s, 3H). ^{13}C {1H} NMR (101 MHz, CDCl_3) δ 196.1, 138.0, 136.6, 134.8, 132.5, 132.0, 131.6, 131.3, 130.9, 130.8, 129.6, 129.2, 128.5, 128.1, 125.6, 125.7 (d, $J = 285.9$ Hz), 67.7 (q, $J = 22.9$ Hz), 40.7, 21.0. ^{19}F NMR (377 MHz, CDCl_3) δ -60.35. HRMS (ESI-TOF) for $\text{C}_{23}\text{H}_{18}\text{Cl}_2\text{F}_3\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 437.0681; found: 437.0684.

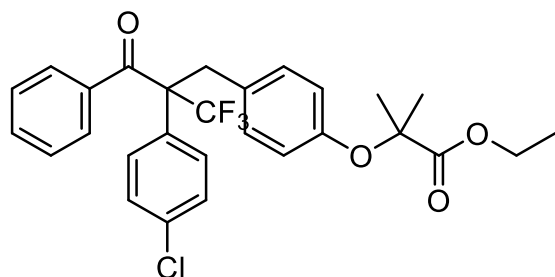


1-(4-bromophenyl)-2-(4-chlorophenyl)-3,3,3-trifluoro-2-(4-methylbenzyl)propan-1-one (6l): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **6l** (46%, 44.5 mg) as a white solid (155-156 °C). ^1H NMR (400 MHz, CDCl_3) δ 7.48 – 7.29 (m, 6H), 7.24 (d, $J = 8.2$ Hz, 2H), 6.90 (d, $J = 7.9$ Hz, 2H), 6.67 (d, $J = 7.9$ Hz, 2H), 3.76 (dd, $J = 95.4, 14.4$ Hz, 2H), 2.24 (s, 3H). ^{13}C {1H} NMR (101 MHz, CDCl_3) δ 193.0, 136.9, 135.2, 134.4, 133.6, 131.9, 131.6, 131.1, 130.7, 129.9, 129.2, 128.6, 128.2, 125.3 (d, $J = 285.7$ Hz), 65.3 (q, $J = 22.4$ Hz), 39.2, 21.0. ^{19}F NMR (377 MHz, CDCl_3) δ -64.72. HRMS (ESI-TOF) for $\text{C}_{23}\text{H}_{17}\text{BrClF}_3\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 481.0176; found: 481.0157.



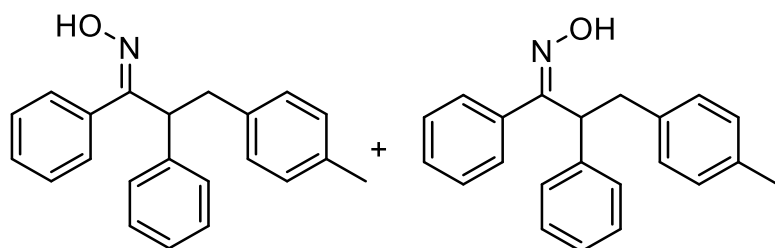
(8R,9S,13S,14S)-13-methyl-3-(1-oxo-1-phenyl-3-(p-tolyl)propan-2-yl)-6,7,8,9,11,12,13,14,15,16-decahydro-17H-cyclopenta[a]phenanthren-17-one (7): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **7** (29%, 13.8 mg) as a colorless liquid. ^1H NMR (400 MHz, CDCl_3) δ 7.93 – 7.88 (m, 2H), 7.48 – 7.41 (m, 1H), 7.38 – 7.31 (m, 2H), 7.19 (t, $J = 7.7$ Hz, 1H), 7.10 – 6.99 (m, 6H), 4.84 – 4.74 (m, 1H), 3.62 – 3.49 (m, 1H), 2.97 (ddd, $J =$

13.8, 5.6, 2.0 Hz, 1H), 2.91 – 2.80 (m, 2H), 2.49 (dd, $J = 18.8, 8.6$ Hz, 1H), 2.36 (d, $J = 9.5$ Hz, 1H), 2.26 (s, 3H), 2.24 – 1.92 (m, 5H), 1.66 – 1.56 (m, 2H), 1.53 – 1.38 (m, 4H), 0.89 (d, $J = 3.8$ Hz, 3H). ^{13}C { ^1H } NMR (101 MHz, CDCl_3) δ 221.0, 199.3, 138.6, 137.1, 137.0, 136.9, 136.7, 135.6, 132.8, 129.0, 128.8, 128.5, 125.9, 125.9, 125.8, 55.3, 50.5, 48.0, 44.3, 39.8, 38.0, 35.9, 31.6, 29.4, 26.5, 25.6, 21.6, 21.0, 13.9. HRMS (ESI-TOF) for $\text{C}_{34}\text{H}_{37}\text{O}_2$ ($[\text{M}+\text{H}]^+$): calcd. 477.2788; found: 477.2799.

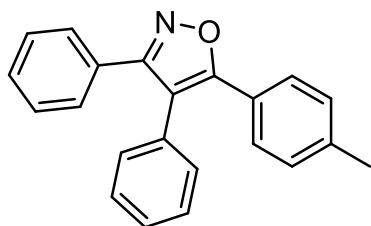


Ethyl 2-(4-(2-benzoyl-2-(4-chlorophenyl)-3,3,3-trifluoropropyl)phenoxy)-2-methylpropanoate (8)

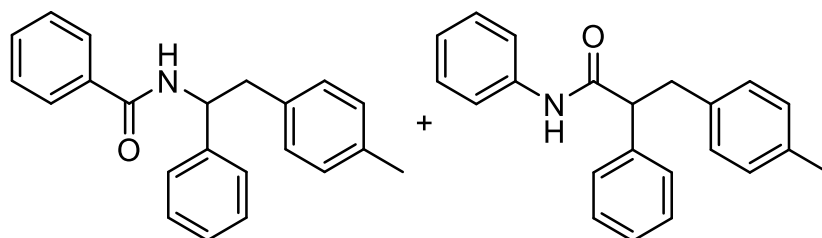
Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **8** (40%, 20.8 mg) as a colorless liquid. ^1H NMR (400 MHz, CDCl_3) δ 7.50 – 7.40 (m, 3H), 7.38 – 7.32 (m, 2H), 7.29 – 7.23 (m, 4H), 6.64 (d, $J = 8.7$ Hz, 2H), 6.58 – 6.50 (m, 2H), 4.19 (q, $J = 7.1$ Hz, 2H), 3.76 (dd, $J = 101.9, 14.5$ Hz, 2H), 1.53 (s, 6H), 1.20 (t, $J = 7.1$ Hz, 3H). ^{13}C { ^1H } NMR (101 MHz, CDCl_3) δ 193.9, 174.2, 154.5, 135.7, 135.0, 133.8, 132.9, 131.7, 130.4, 129.9, 129.0, 128.2, 127.9, 125.4 (d, $J = 285.5$ Hz), 118.2, 79.0, 65.3 (q, $J = 22.2$ Hz), 38.8, 25.3, 25.3, 14.0. ^{19}F NMR (377 MHz, CDCl_3) δ -64.78. ^1H NMR (400 MHz, CDCl_3) δ 7.86 – 7.78 (m, 2H), 7.32 – 7.28 (m, 2H), 7.26 – 7.24 (m, 2H), 7.23 – 7.16 (m, 3H), 6.98 (q, $J = 8.0$ Hz, 4H), 4.72 (t, $J = 7.2$ Hz, 1H), 3.51 (dd, $J = 13.8, 7.6$ Hz, 1H), 3.00 (dd, $J = 13.8, 6.8$ Hz, 1H), 2.26 (s, 3H). HRMS (ESI-TOF) for $\text{C}_{28}\text{H}_{27}\text{ClF}_3\text{O}_4$ ($[\text{M}+\text{H}]^+$): calcd. 519.1544; found: 519.1535.



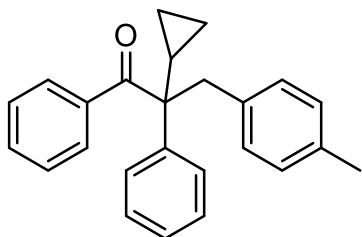
1,2-diphenyl-3-(p-tolyl)propan-1-one oxime (9): Purification by column chromatography (silica gel, PE/EA = 10:1) afforded **9** (62%, 195.1 mg) as a yellow solid (66-68 °C). ^1H NMR (400 MHz, CDCl_3) δ 7.42 (d, $J = 7.5$ Hz, 2H), 7.36 – 7.29 (m, 3H), 7.26 – 7.17 (m, 11H), 7.08 – 6.96 (m, 13H), 5.30 (dd, $J = 9.5, 6.7$ Hz, 1H), 4.06 (t, $J = 7.7$ Hz, 1H), 3.42 (dd, $J = 13.9, 7.5$ Hz, 1H), 3.38 – 3.24 (m, 2H), 3.06 (dd, $J = 13.9, 7.9$ Hz, 1H), 2.29 (s, 6H). ^{13}C { ^1H } NMR (101 MHz, CDCl_3) δ 161.5, 160.2, 140.2, 139.9, 136.8, 136.0, 135.7, 135.5, 133.9, 129.0, 128.9, 128.8, 128.8, 128.7, 128.5, 128.5, 128.4, 128.0, 128.0, 127.6, 126.9, 126.7, 53.8, 44.09, 39.2, 36.0, 21.0. HRMS (ESI-TOF) for $\text{C}_{22}\text{H}_{22}\text{NO}$ ($[\text{M}+\text{H}]^+$): calcd. 316.1696; found: 316.1710.



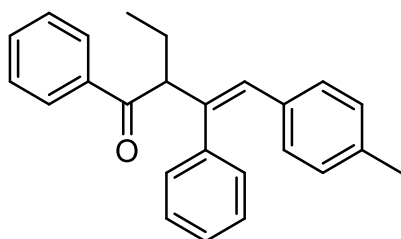
3,4-diphenyl-5-(p-tolyl)isoxazole (10): Purification by column chromatography (silica gel, PE/EA = 10:1) afforded **10** (86%, 40.2 mg) as a white solid (156-158 °C). ^1H NMR (400 MHz, CDCl_3) δ 7.43 (m, 4H), 7.40 – 7.35 (m, 3H), 7.35 – 7.32 (m, 1H), 7.32 – 7.28 (m, 2H), 7.27 – 7.24 (m, 2H), 7.13 (d, J = 8.1 Hz, 2H), 2.34 (s, 3H). ^{13}C $\{^1\text{H}\}$ NMR (101 MHz, CDCl_3) δ 165.8 162.2, 140.0, 130.8, 130.5, 129.4 129.3, 129.1, 129.0, 128.4, 128.4, 128.1, 126.9, 125.1 114.7, 21.4. HRMS (ESI-TOF) for $\text{C}_{22}\text{H}_{18}\text{NO}$ ($[\text{M}+\text{H}]^+$): calcd. 312.1383; found: 312.1396.



N-(1-phenyl-2-(p-tolyl)ethyl)benzamide (11): Purification by column chromatography (silica gel, PE/EA = 8:1) afforded **11** (57%, 18.1 mg) as a yellow solid (122-124 °C). ^1H NMR (400 MHz, CDCl_3) δ 7.42 (d, J = 7.7 Hz, 2H), 7.33 (t, J = 7.5 Hz, 2H), 7.28 – 7.26 (m, 4H), 7.24 – 7.16 (m, 8H), 7.07 – 6.97 (m, 12H), 5.30 (dd, J = 9.2, 7.0 Hz, 1H), 4.06 (t, J = 7.7 Hz, 1H), 3.42 (dd, J = 13.9, 7.4 Hz, 1H), 3.37 – 3.25 (m, 2H), 3.07 (dd, J = 13.9, 8.0 Hz, 1H), 2.29 (s, 6H). ^{13}C $\{^1\text{H}\}$ NMR (101 MHz, CDCl_3) δ 160.1, 140.1, 139.9, 136.7, 136.1, 135.6, 135.5, 135.5, 133.9, 129.0, 128.9, 128.9 128.7, 128.7, 128.5, 128.5, 128.4, 128.1 128.0, 127.6 126.9, 126.7, 53.8, 44.1, 39.2, 36.0, 21.0. HRMS (ESI-TOF) for $\text{C}_{22}\text{H}_{22}\text{NO}$ ($[\text{M}+\text{H}]^+$): calcd. 316.1696; found: 316.1698.



2-cyclopropyl-1,2-diphenyl-3-(p-tolyl)propan-1-one (16): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **16** (15%, 11.0 mg) as a colorless liquid. ^1H NMR (400 MHz, CDCl_3) δ 7.55 – 7.49 (m, 2H), 7.37 (t, J = 7.4 Hz, 1H), 7.31 – 7.26 (m, 3H), 7.24 – 7.18 (m, 4H), 6.88 (d, J = 7.8 Hz, 2H), 6.65 (d, J = 8.0 Hz, 2H), 3.49 (s, 2H), 2.24 (s, 3H), 1.55 – 1.48 (m, 1H), 0.70 – 0.55 (m, 1H), 0.52 – 0.41 (m, 1H), 0.23 – 0.11 (m, 1H), 0.09 – 0.00 (m, 1H). ^{13}C $\{^1\text{H}\}$ NMR (101 MHz, CDCl_3) δ 200.9, 139.8, 136.5, 135.4, 133.4, 131.3, 130.1, 123.0, 128.2, 127.8, 127.7, 127.4, 126.6, 59.2, 43.1, 20.5, 17.0, 2.9. HRMS (ESI-TOF) for $\text{C}_{25}\text{H}_{25}\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 341.1900; found: 341.1866.



(Z)-2-ethyl-1,3-diphenyl-4-(p-tolyl)but-3-en-1-one (17): Purification by column chromatography (silica gel, PE/EA = 30:1) afforded **17** (10%, 6.8 mg) as a colorless liquid. ^1H NMR (400 MHz, CDCl_3) δ 7.97 – 7.91 (m, 2H), 7.53 – 7.46 (m, 1H), 7.39 (t, $J = 7.6$ Hz, 2H), 7.30 – 7.26 (m, 2H), 7.24 – 7.19 (m, 3H), 7.17 – 7.11 (m, 4H), 5.53 (s, 1H), 5.43 (t, $J = 7.4$ Hz, 1H), 2.34 (s, 3H), 1.96 (p, $J = 7.4$ Hz, 2H), 0.86 (t, $J = 7.5$ Hz, 3H). ^{13}C { ^1H } NMR (101 MHz, CDCl_3) δ 198.1, 141.1, 137.8, 137.0, 136.8, 134.4, 134.3, 132.7, 129.6, 129.3, 128.7, 128.6, 128.5, 128.1, 126.8, 61.2, 22.6, 21.1, 14.2. HRMS (ESI-TOF) for $\text{C}_{25}\text{H}_{25}\text{O}$ ($[\text{M}+\text{H}]^+$): calcd. 341.1900; found: 341.1872.

12. X-ray Crystallographic Analysis

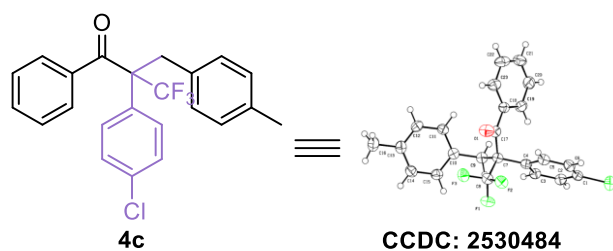


Table S6. Crystal data and structure refinement for **4c**

Identification code	4c
Empirical formula	$\text{C}_{23}\text{H}_{18}\text{ClF}_3\text{O}$
Formula weight	402.82
Temperature/K	170.00
Crystal system	triclinic
Space group	P-1
a/Å	9.5714(6)
b/Å	9.7703(6)
c/Å	10.9823(6)
$\alpha/^\circ$	96.121(3)
$\beta/^\circ$	101.991(2)
$\gamma/^\circ$	105.078(2)
Volume/Å ³	955.88(10)
Z	2
$\rho_{\text{calc}}/\text{cm}^3$	1.400
μ/mm^{-1}	0.239
F(000)	416.0
Crystal size/mm ³	0.18 × 0.13 × 0.1

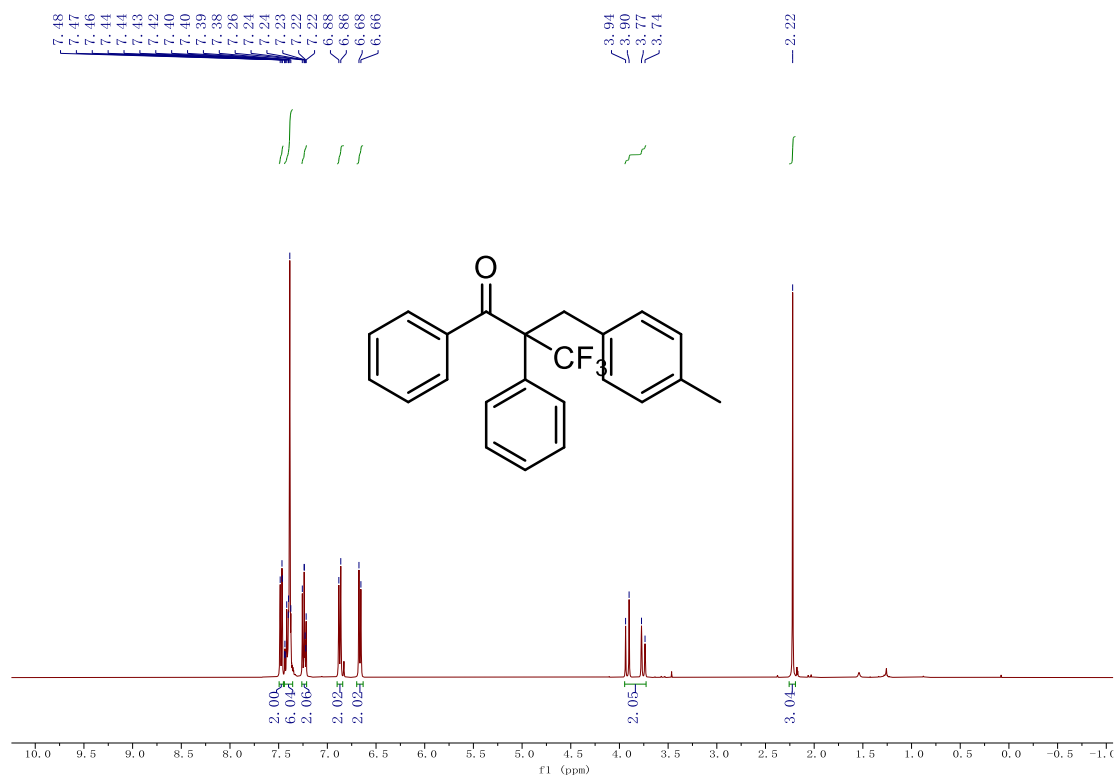
Radiation	MoK α ($\lambda = 0.71073$)
2 θ range for data collection/ $^{\circ}$	3.848 to 52.814
Index ranges	-11 \leq h \leq 11, -12 \leq k \leq 12, -13 \leq l \leq 13
Reflections collected	10663
Independent reflections	3817 [$R_{\text{int}} = 0.0679$, $R_{\text{sigma}} = 0.0701$]
Data/restraints/parameters	3817/0/254
Goodness-of-fit on F^2	1.052
Final R indexes [$I \geq 2\sigma(I)$]	$R_1 = 0.0492$, $wR_2 = 0.1063$
Final R indexes [all data]	$R_1 = 0.0693$, $wR_2 = 0.1236$
Largest diff. peak/hole / e \AA^{-3}	0.22/-0.23

13. References

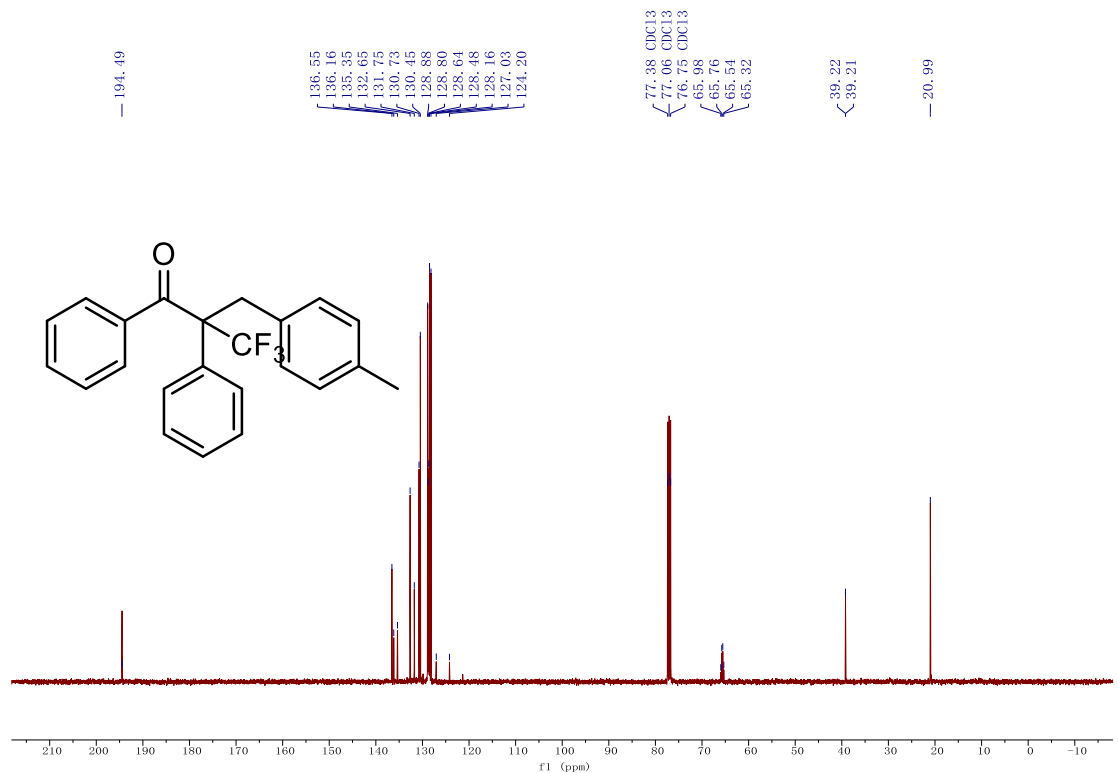
- (1) Li, Z.; Luo, M.; Zeng, X. Chromium(ii)-catalyzed defluorinative reductive cross-coupling of acetals with α -trifluoromethyl alkenes. *Org. Biomol. Chem.* **2025**, *23*, 5293-5297.
- (2) Rui, R.; Wang, B.; Xu, X.-J.; Zhang, Z.; Chen, X.; Liu, X.-Y. Cu-catalyzed alkylarylation of alkenes via N-directed remote C(sp³)-H functionalization. *Org. Chem. Front.* **2024**, *11*, 1484-1489.
- (3) Tang, J.; Zhao, Y.; Jin, Y.; Zhang, L.; Wang, Y.; Wu, W.; Jiang, H. Palladium-catalyzed modular biomimetic synthesis of lignans derivatives. *Chin. Chem. Lett.* **2025**, *36*, 110969.
- (4) Subaramanian, M.; Gouda, C.; Roy, T. K.; Ganesan, S.; Banerjee, S.; Vanka, K.; Balaraman, E. Dehydrogenative Coupling of Alcohols with Internal Alkynes under Nickel Catalysis: An Access to β -Deuterated Branched Ketones. *ACS Catal.* **2024**, *14*, 8294-8309.
- (5) Frisch, M. J.; Trucks, G. W.; Schlegel, H. B.; Scuseria, G. E.; Robb, M. A.; Cheeseman, J. R.; Scalmani, G.; Barone, V.; Mennucci, B.; Petersson, G. A.; Nakatsuji, H.; Caricato, M.; Li, X.; Hratchian, H. P.; Izmaylov, A. F.; Bloino, J.; Zheng, G.; Sonnenberg, J. L.; Hada, M.; Ehara, M.; Toyota, K.; Fukuda, R.; Hasegawa, J.; Ishida, M.; Nakajima, T.; Honda, Y.; Kitao, O.; Nakai, H.; Vreven, T.; Montgomery, J. A., Jr.; Peralta, J. E.; Ogliaro, F.; Bearpark, M.; Heyd, J. J.; Brothers, E.; Kudin, K. N.; Staroverov, V. N.; Kobayashi, R.; Normand, J.; Raghavachari, K.; Rendell, A.; Burant, J. C.; Iyengar, S. S.; Tomasi, J.; Cossi, M.; Rega, N.; Millam, N. J.; Klene, M.; Knox, J. E.; Cross, J. B.; Bakken, V.; Adamo, C.; Jaramillo, J.; Gomperts, R.; Stratmann, R. E.; Yazyev, O.; Austin, A. J.; Cammi, R.; Pomelli, C.; Ochterski, J. W.; Martin, R. L.; Morokuma, K.; Zakrzewski, V. G.; Voth, G. A.; Salvador, P.; Dannenberg, J. J.; Dapprich, S.; Daniels, A. D.; Farkas, Ö.; Foresman, J. B.; Ortiz, J. V.; Cioslowski, J., & Fox, D. J. Gaussian, Inc., Gaussian 09, Revision E.01. *Wallingford CT* **2013**.
- (6) Adamo, C.; Barone, V. *J. Chem. Phys.* **1999**, *110*, 6158-6170.
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- (9) Marenich, A. V.; Cramer, C. J.; Truhlar, D. G. *J. Phys. Chem. B* **2009**, *113*, 6378-6396.

14. ^1H NMR, ^{13}C NMR and ^{19}F NMR Spectra

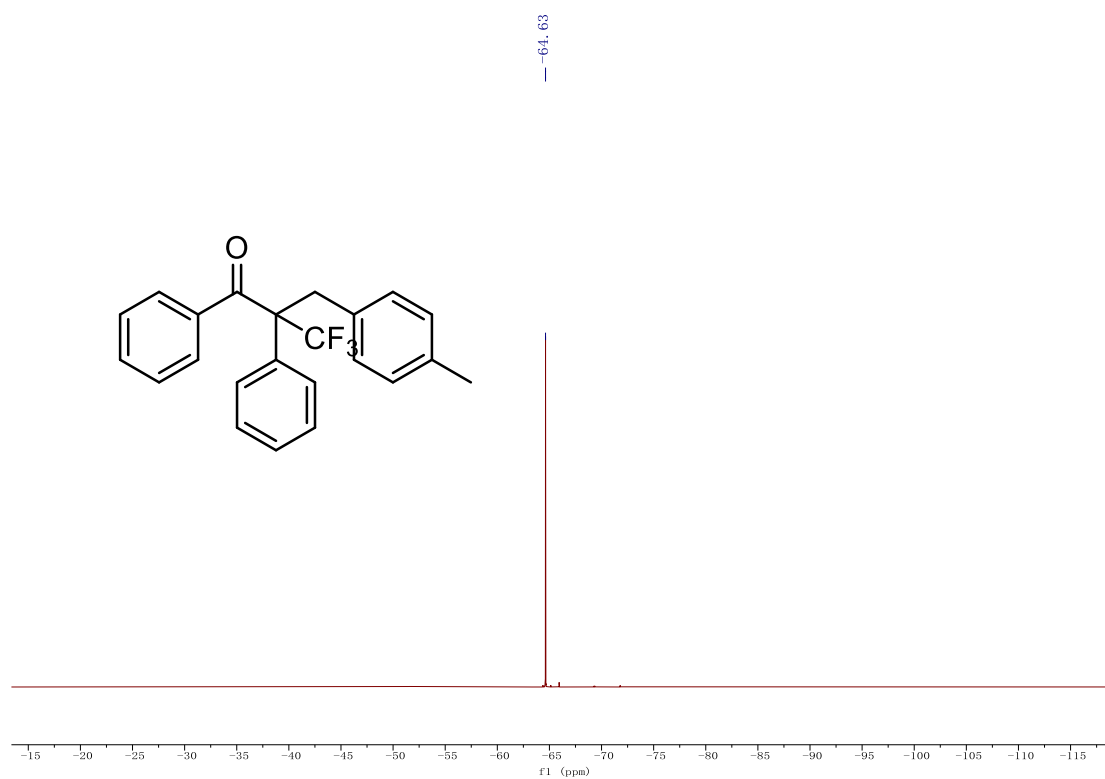
^1H NMR-spectrum (400MHz, CDCl_3) of 4a



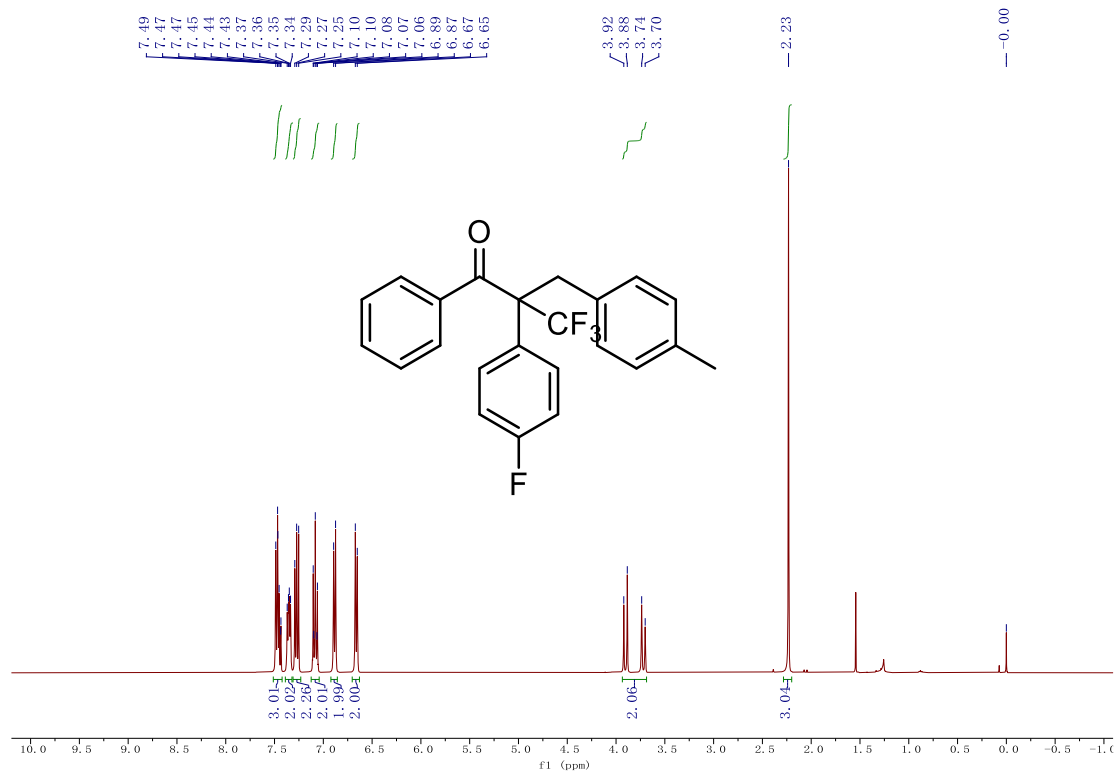
$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of 4a



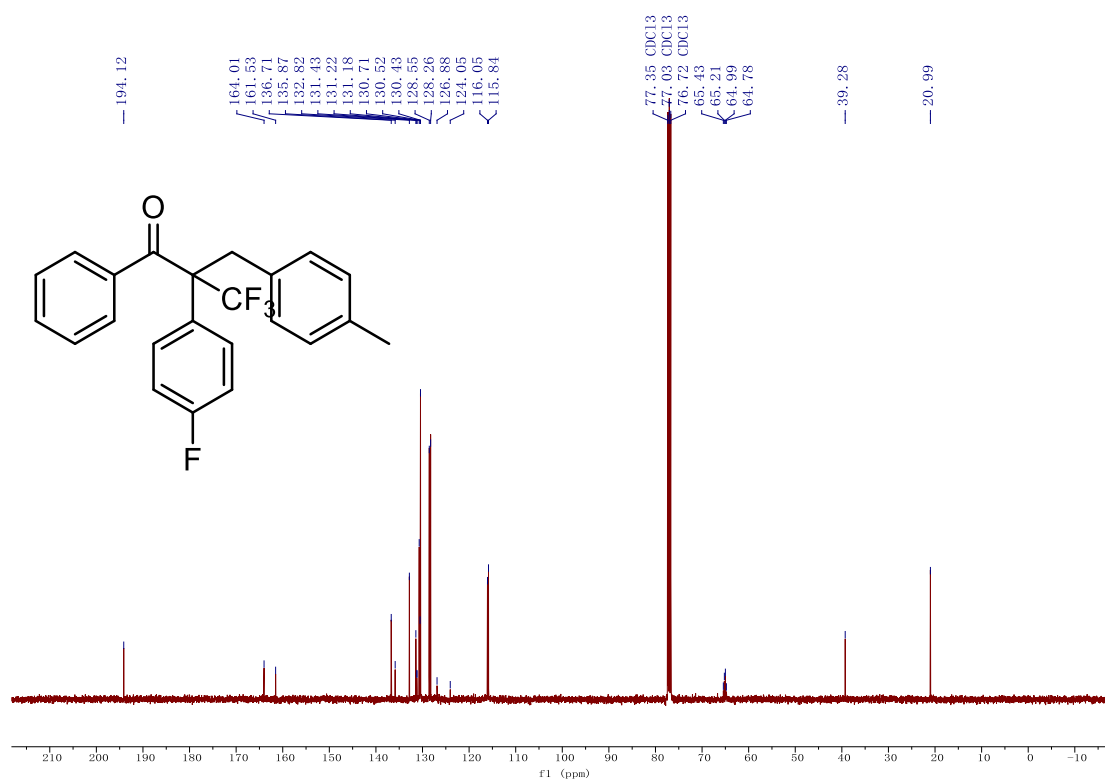
¹⁹F NMR-spectrum (376 MHz, CDCl₃) of 4a



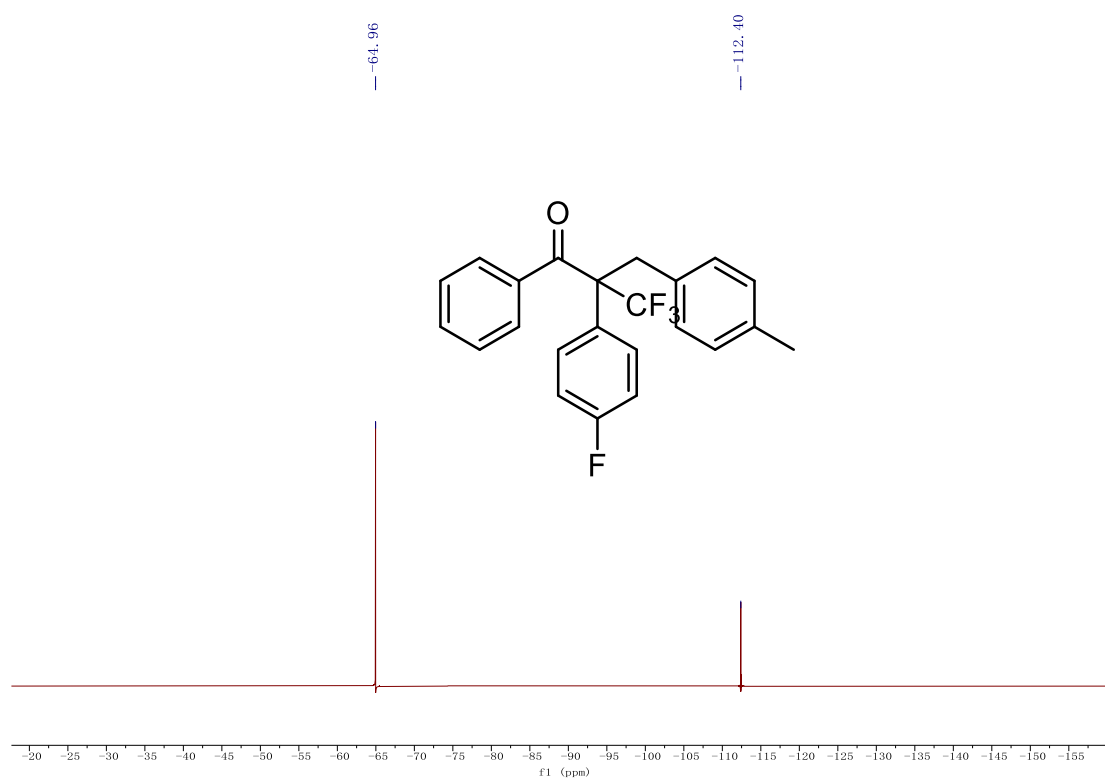
¹H NMR-spectrum (400MHz, CDCl₃) of 4b



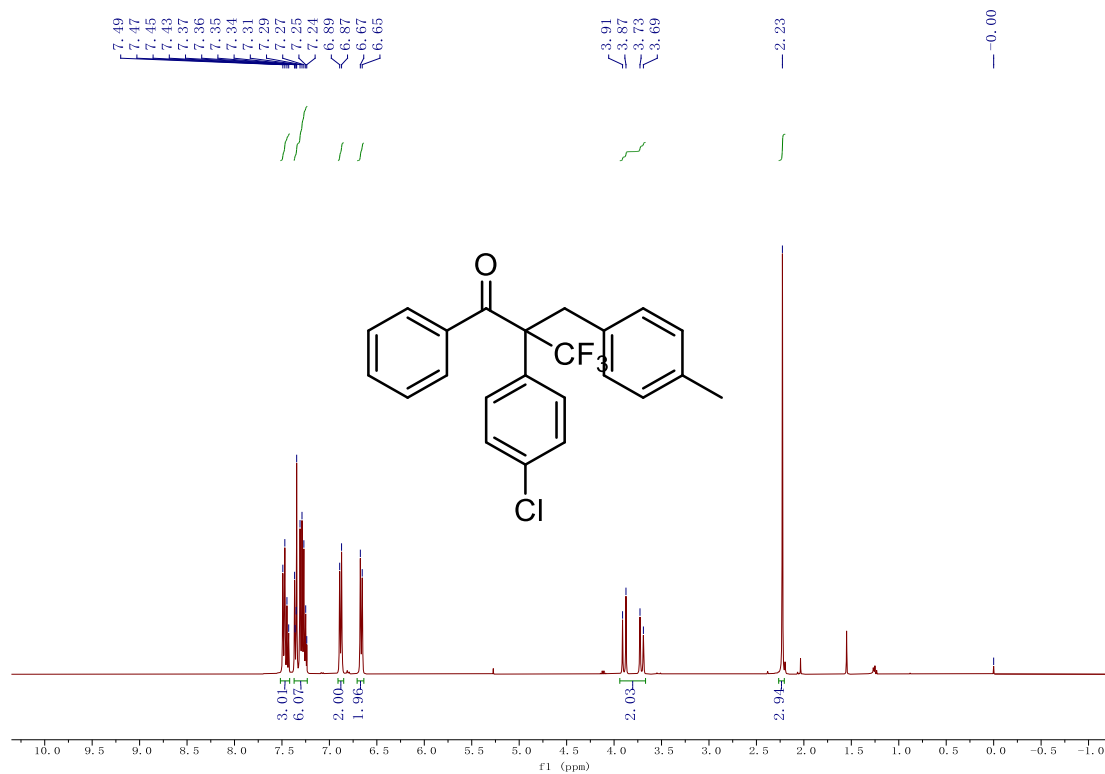
$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of 4b



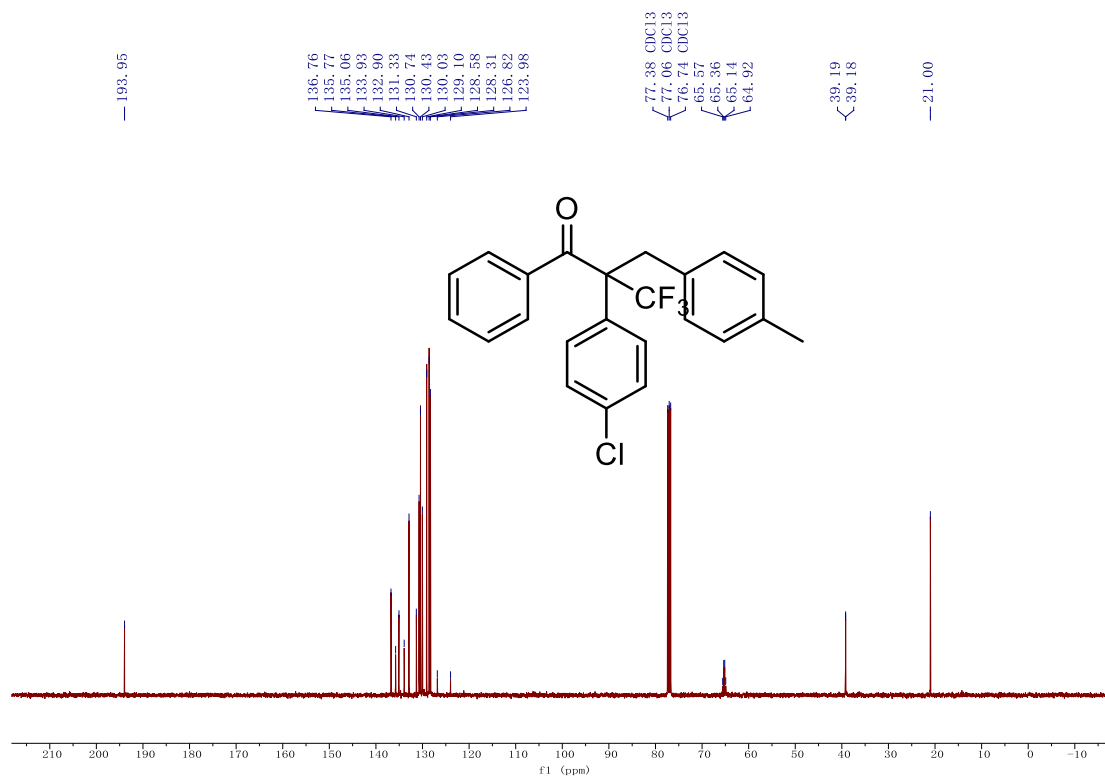
^{19}F NMR-spectrum (376 MHz, CDCl_3) of 4b



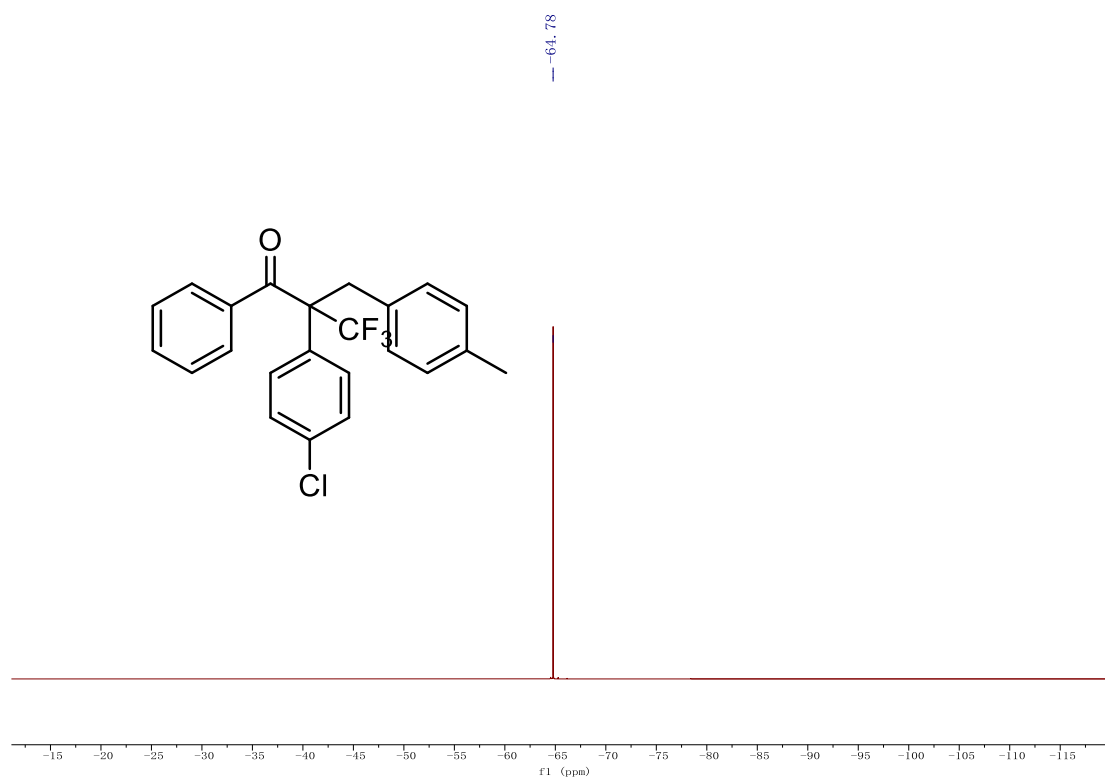
¹H NMR-spectrum (400MHz, CDCl₃) of 4c



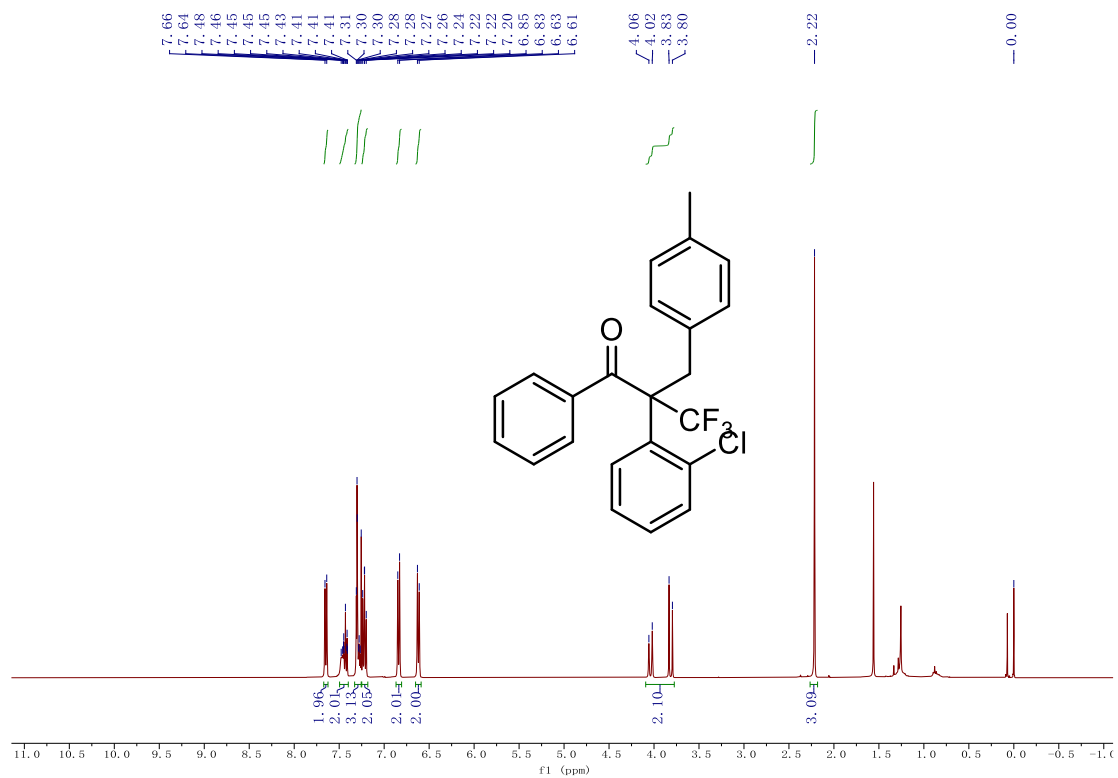
¹³C{¹H} NMR-spectrum (101MHz, CDCl₃) of 4c



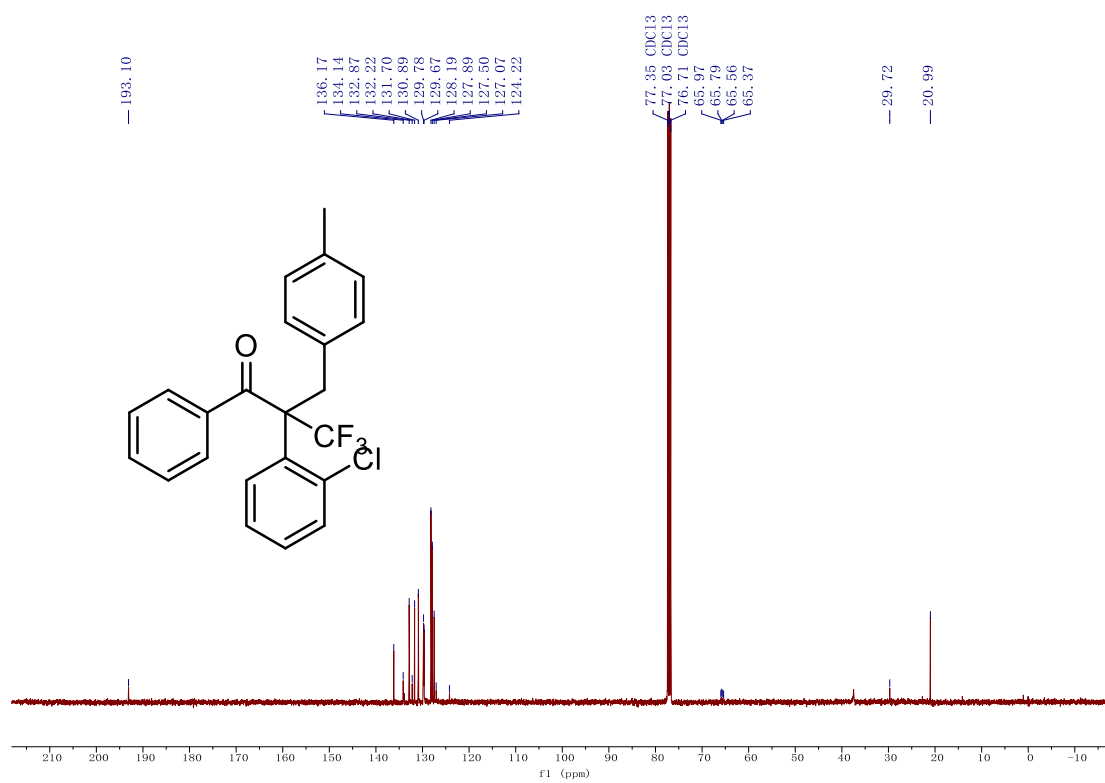
¹⁹F NMR-spectrum (376 MHz, CDCl₃) of 4c



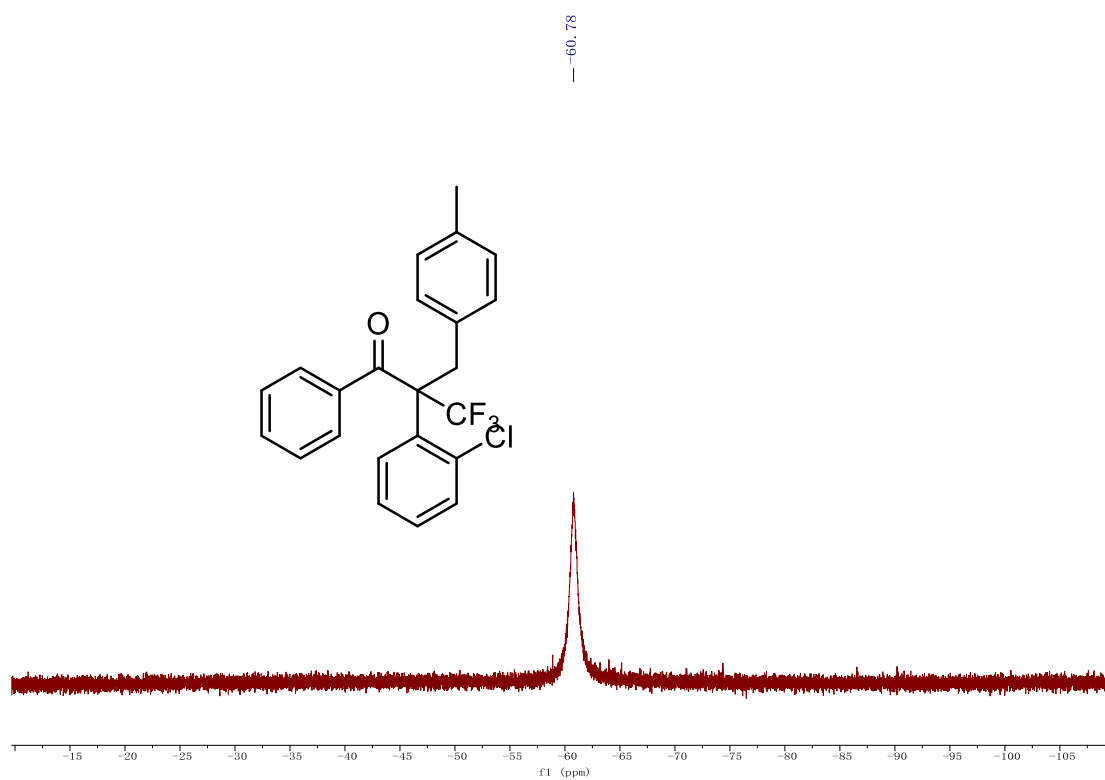
¹H NMR-spectrum (400MHz, CDCl₃) of 4d



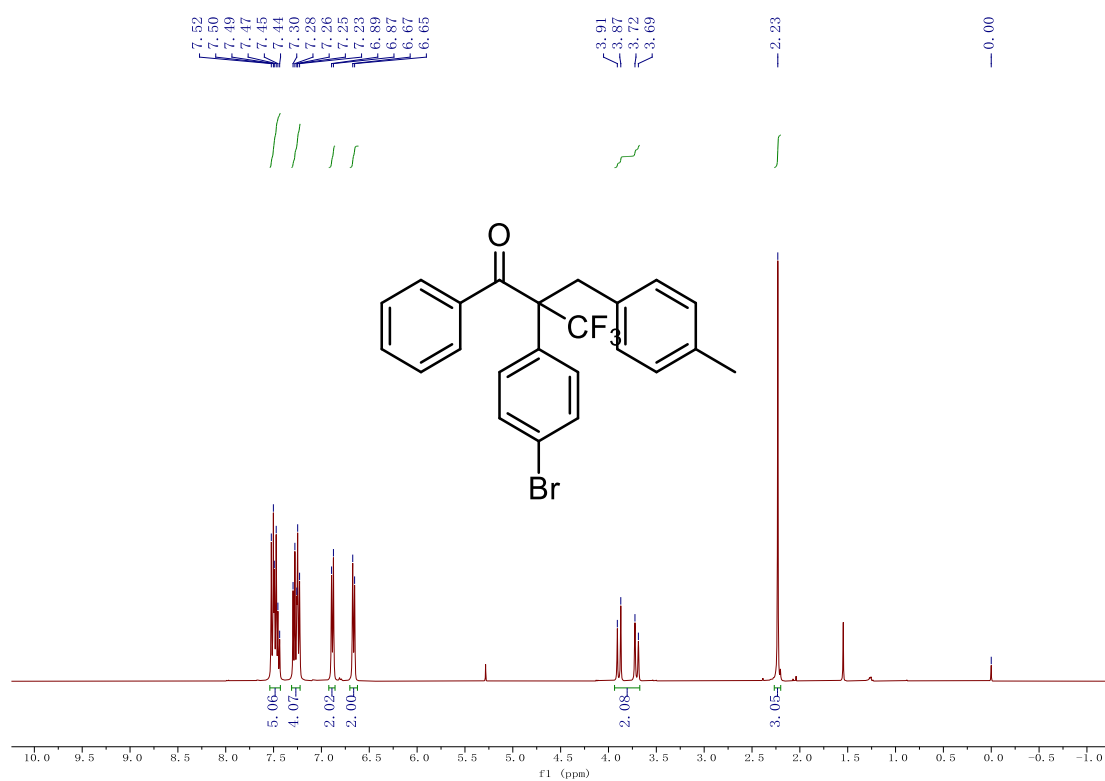
$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of 4d



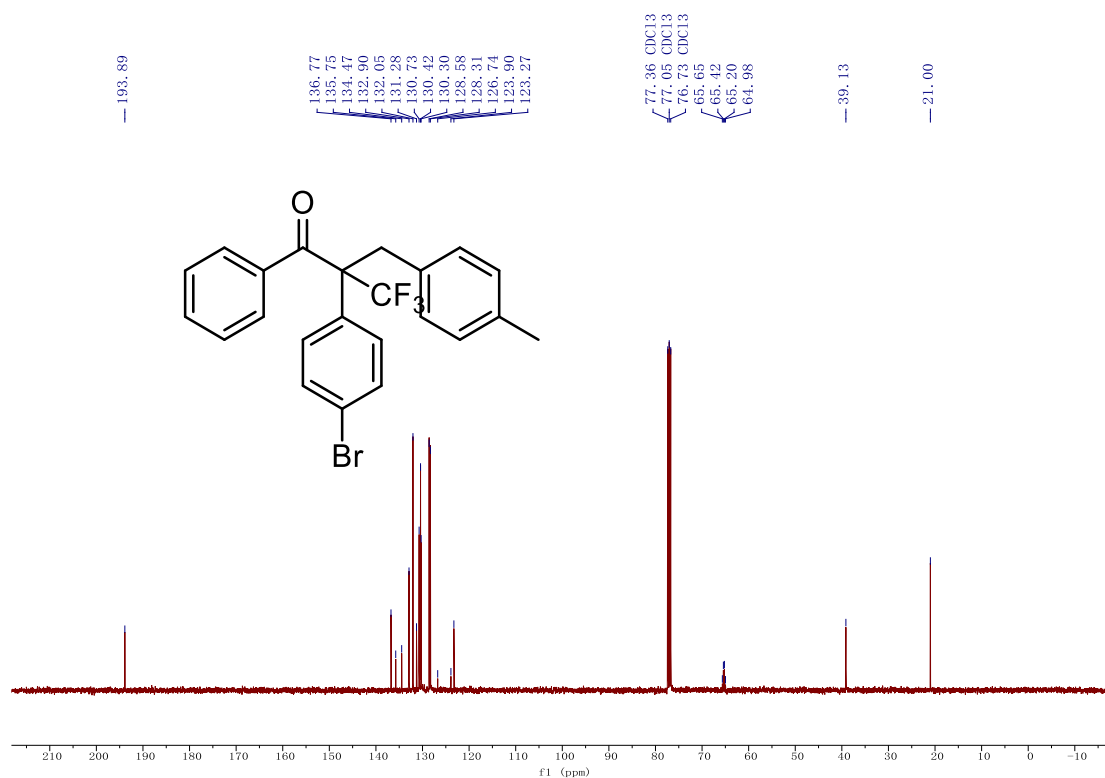
^{19}F NMR-spectrum (376 MHz, CDCl_3) of 4d



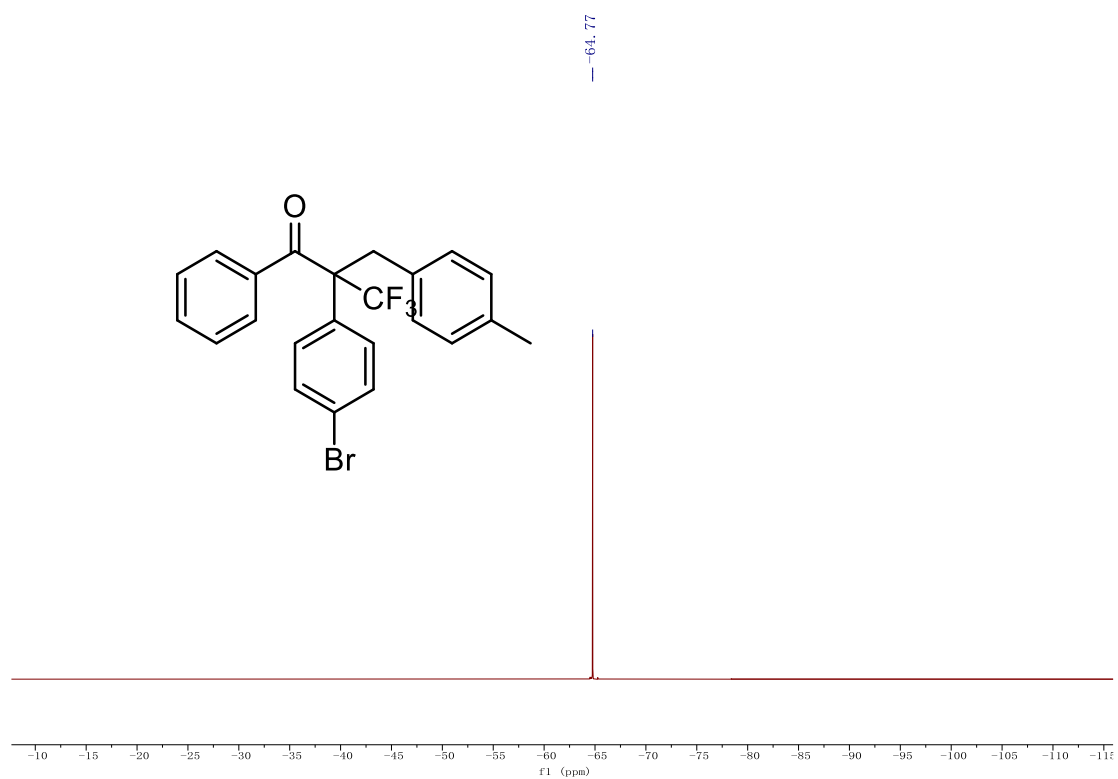
¹H NMR-spectrum (400MHz, CDCl₃) of 4e



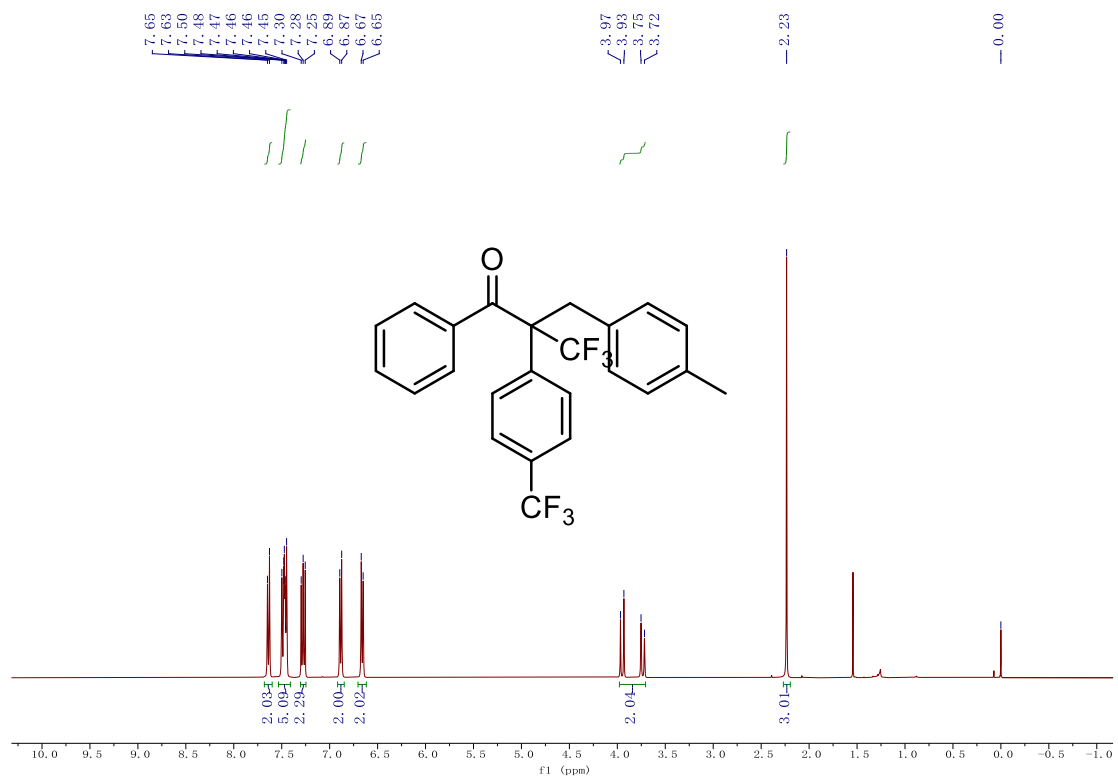
¹³C{¹H} NMR-spectrum (101MHz, CDCl₃) of 4e



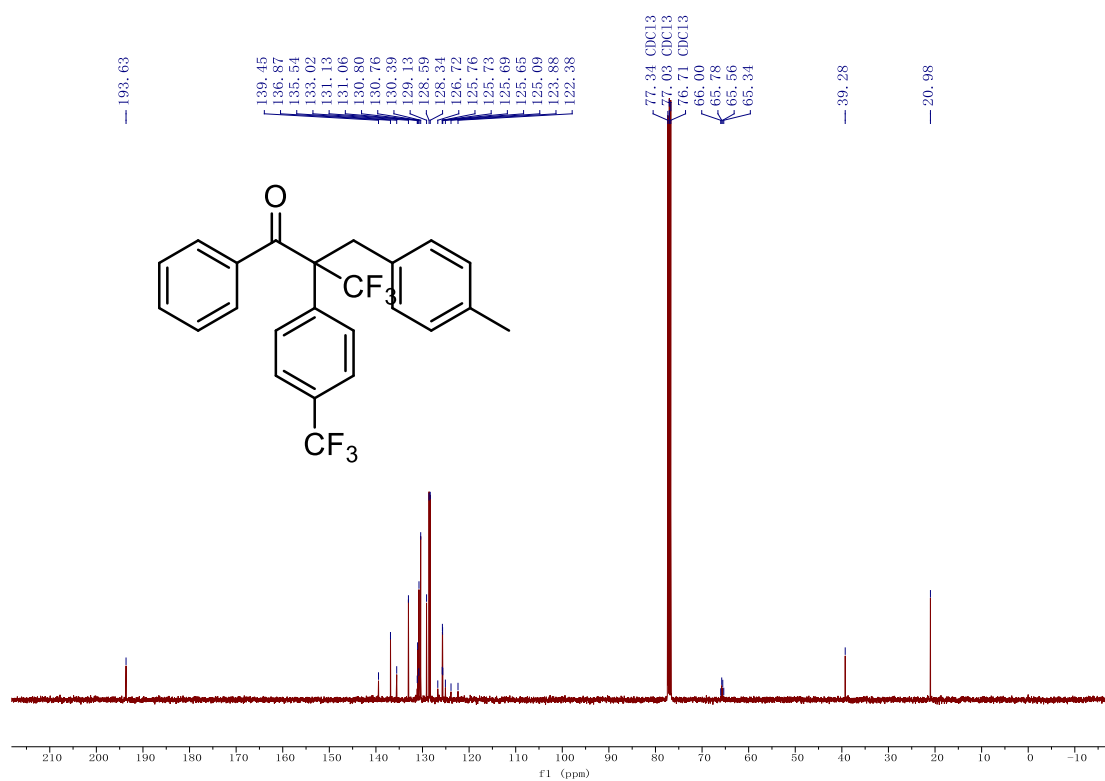
¹⁹F NMR-spectrum (376 MHz, CDCl₃) of 4e



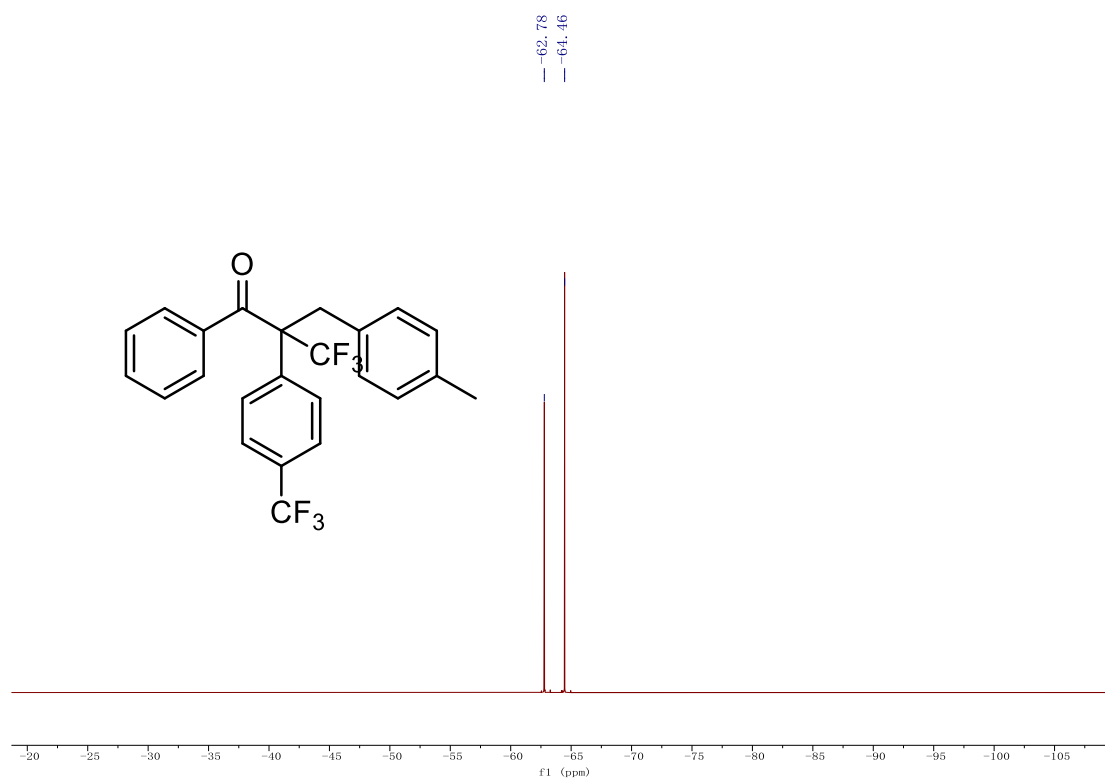
¹H NMR-spectrum (400MHz, CDCl₃) of 4f



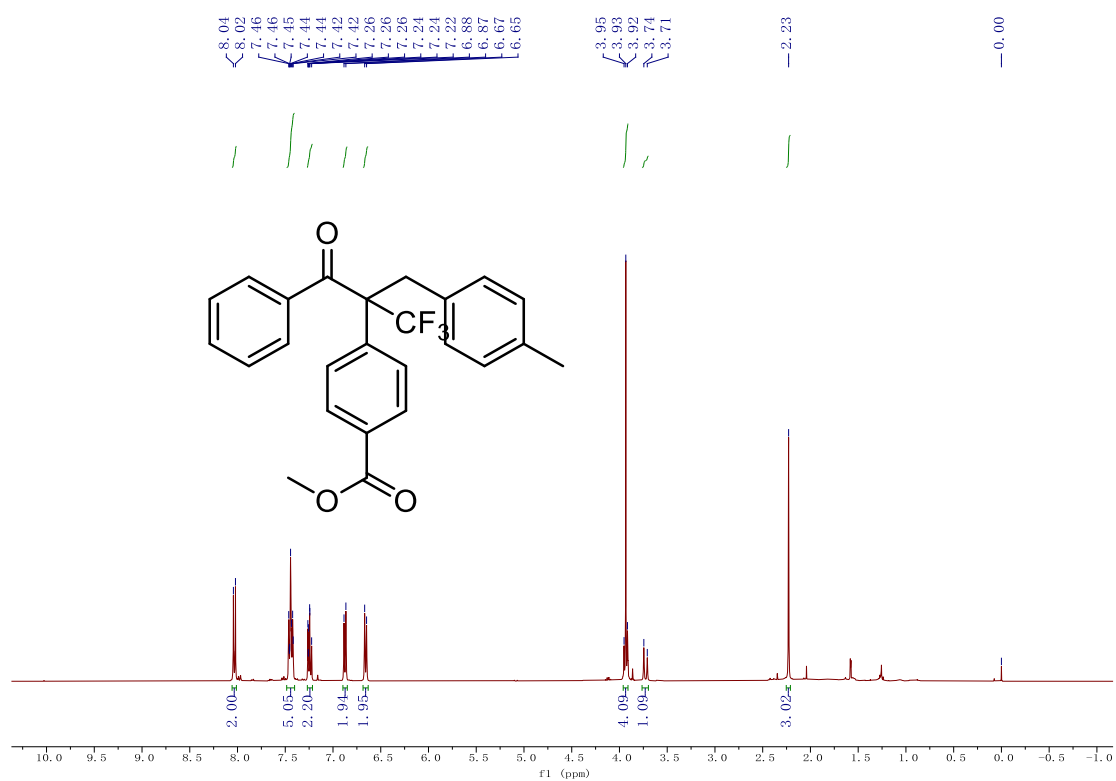
$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of 4f



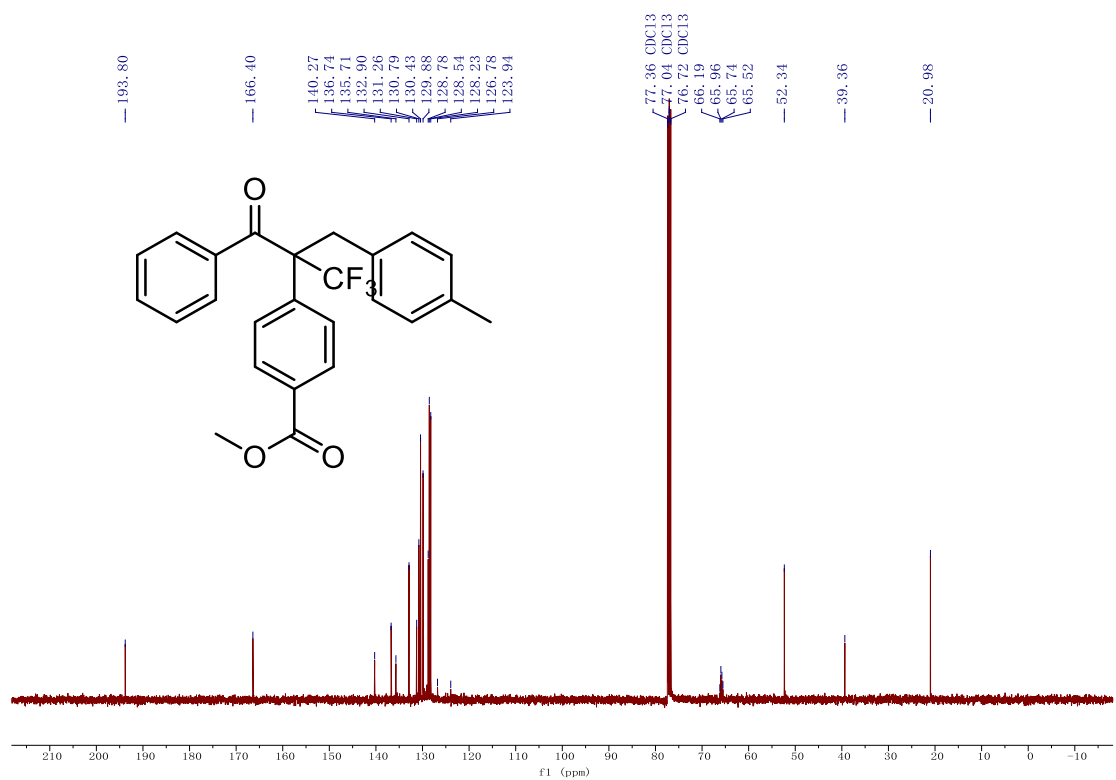
^{19}F NMR-spectrum (376 MHz, CDCl_3) of 4f



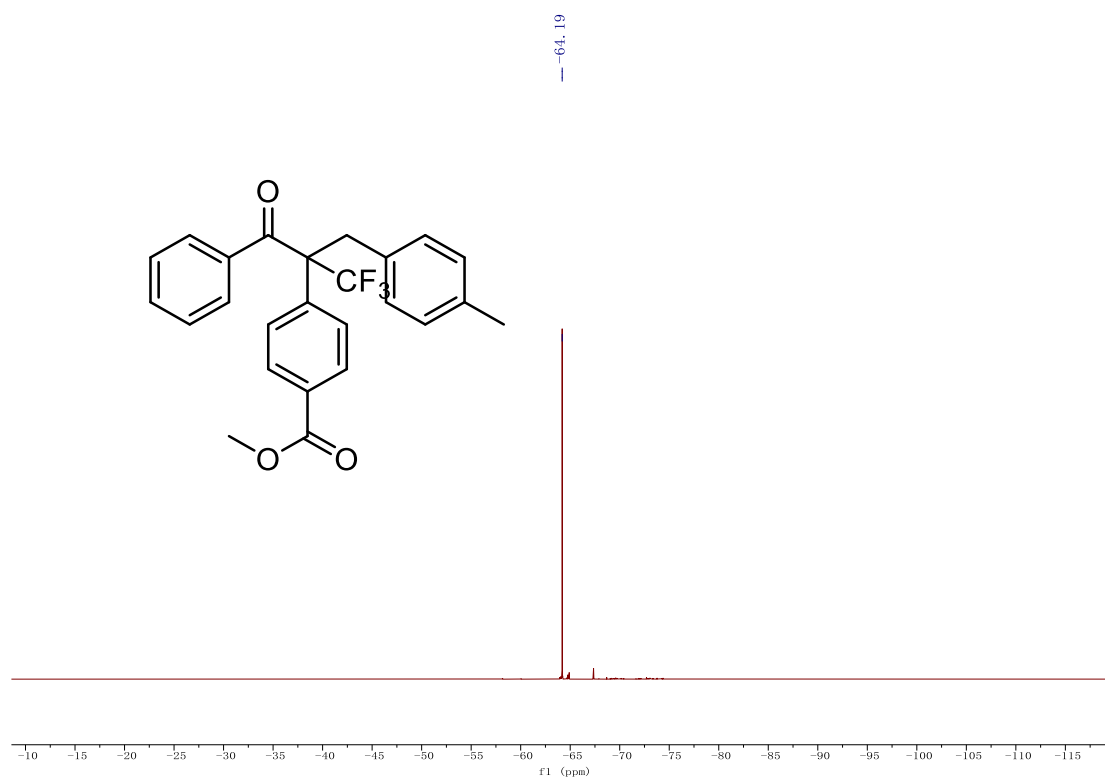
¹H NMR-spectrum (400MHz, CDCl₃) of 4g



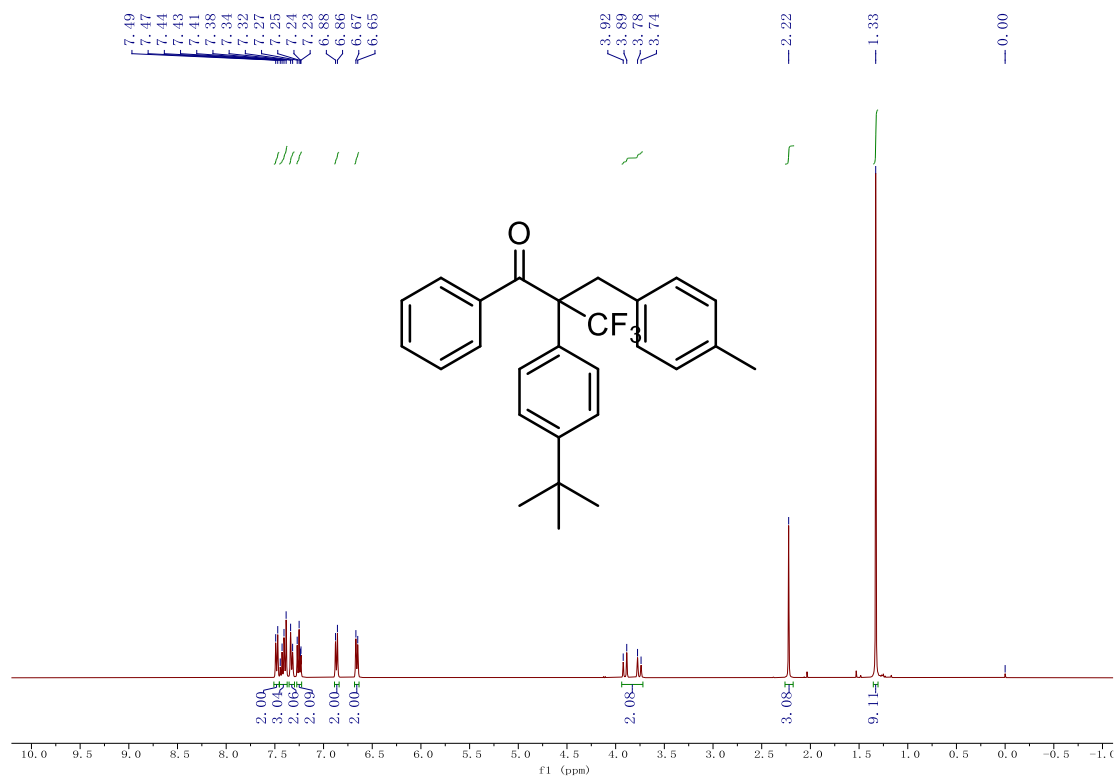
¹³C{¹H} NMR-spectrum (101MHz, CDCl₃) of 4g



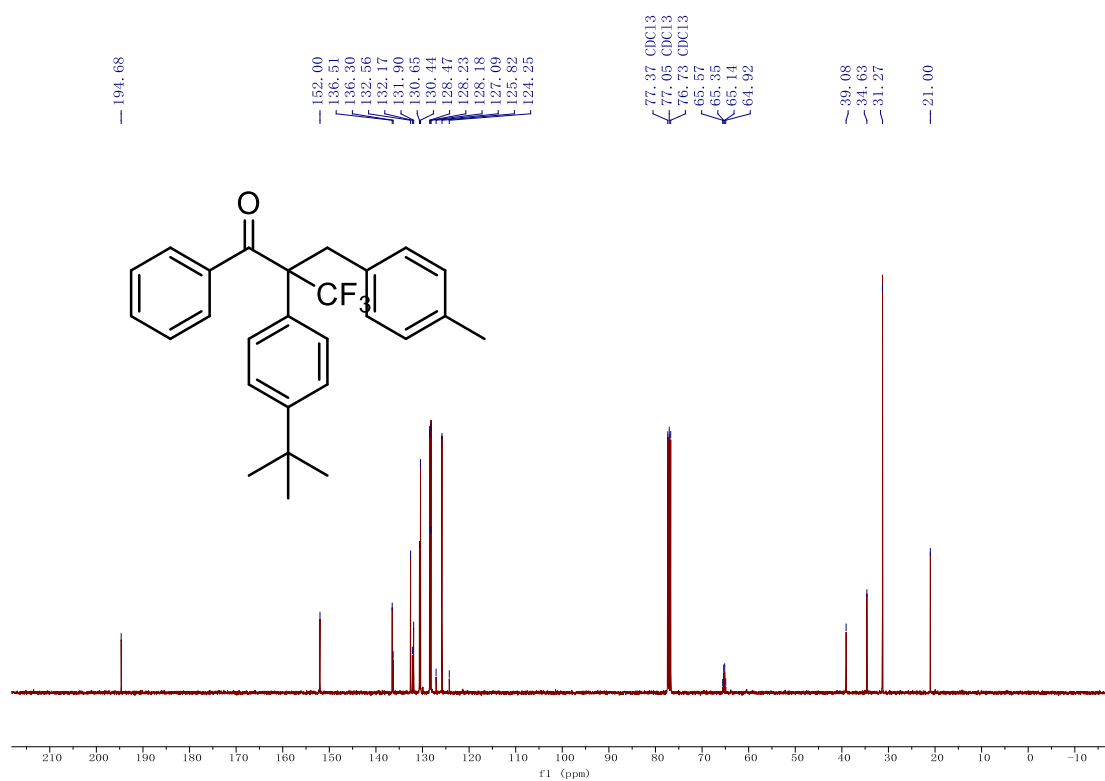
¹⁹F NMR-spectrum (376 MHz, CDCl₃) of 4g



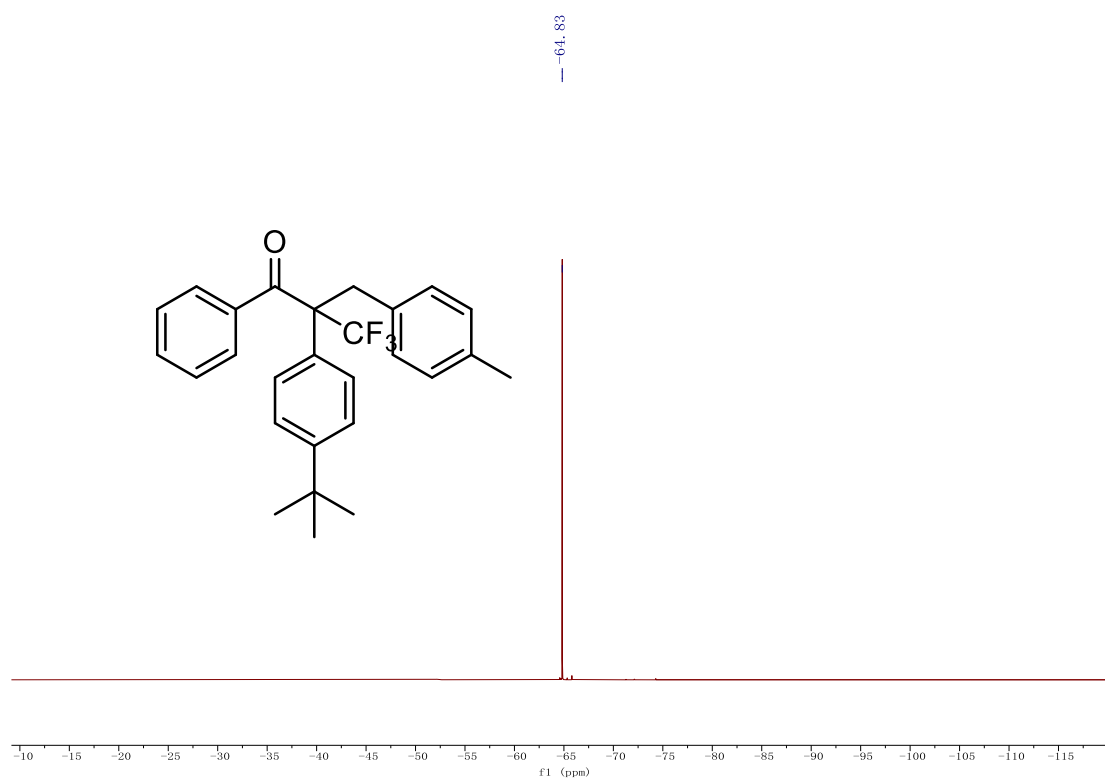
¹H NMR-spectrum (400MHz, CDCl₃) of 4h



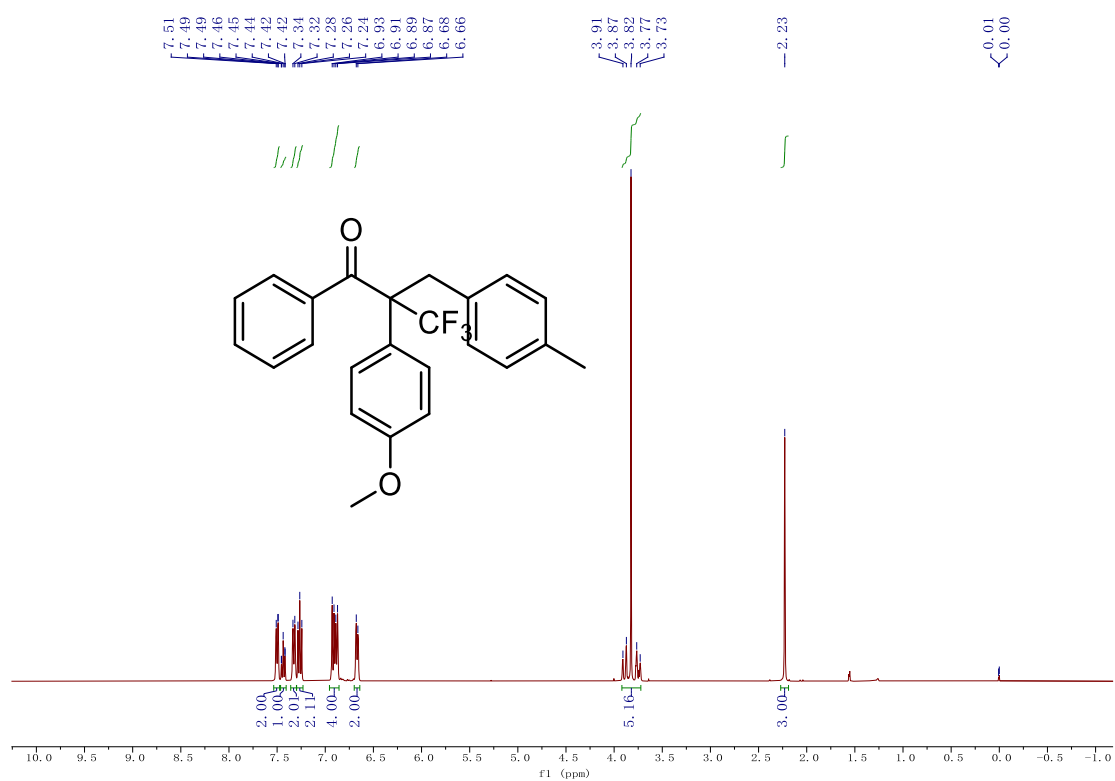
$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of 4h



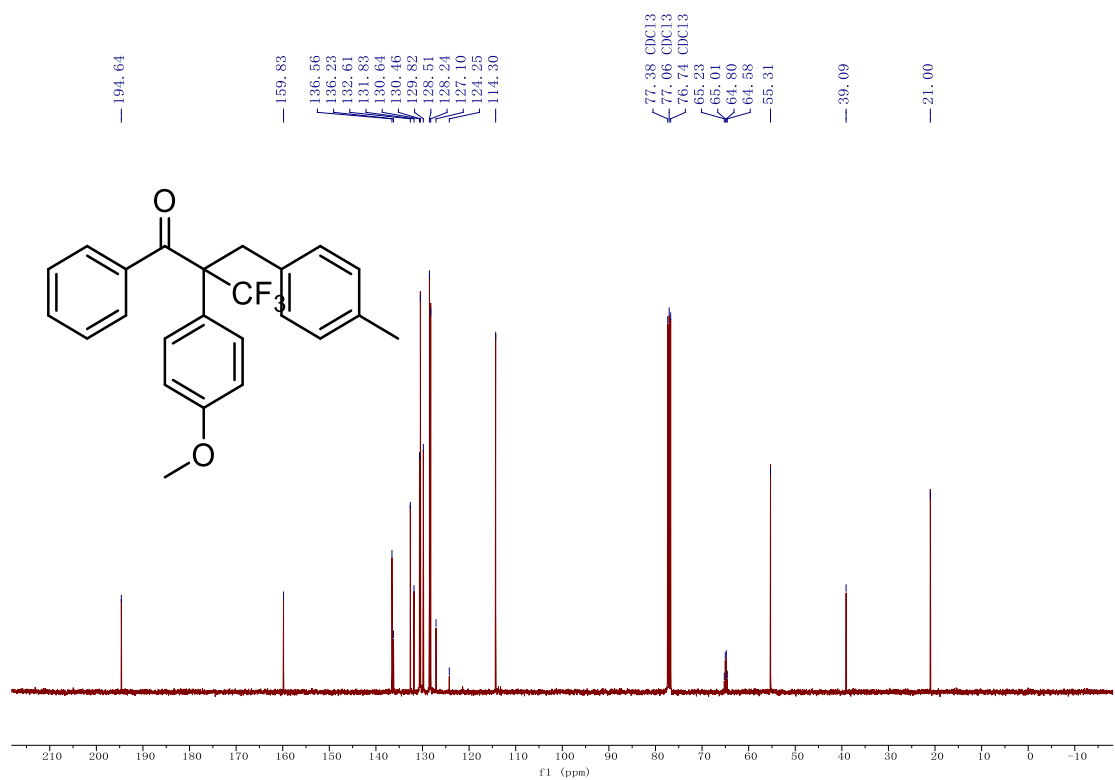
^{19}F NMR-spectrum (376 MHz, CDCl_3) of 4h



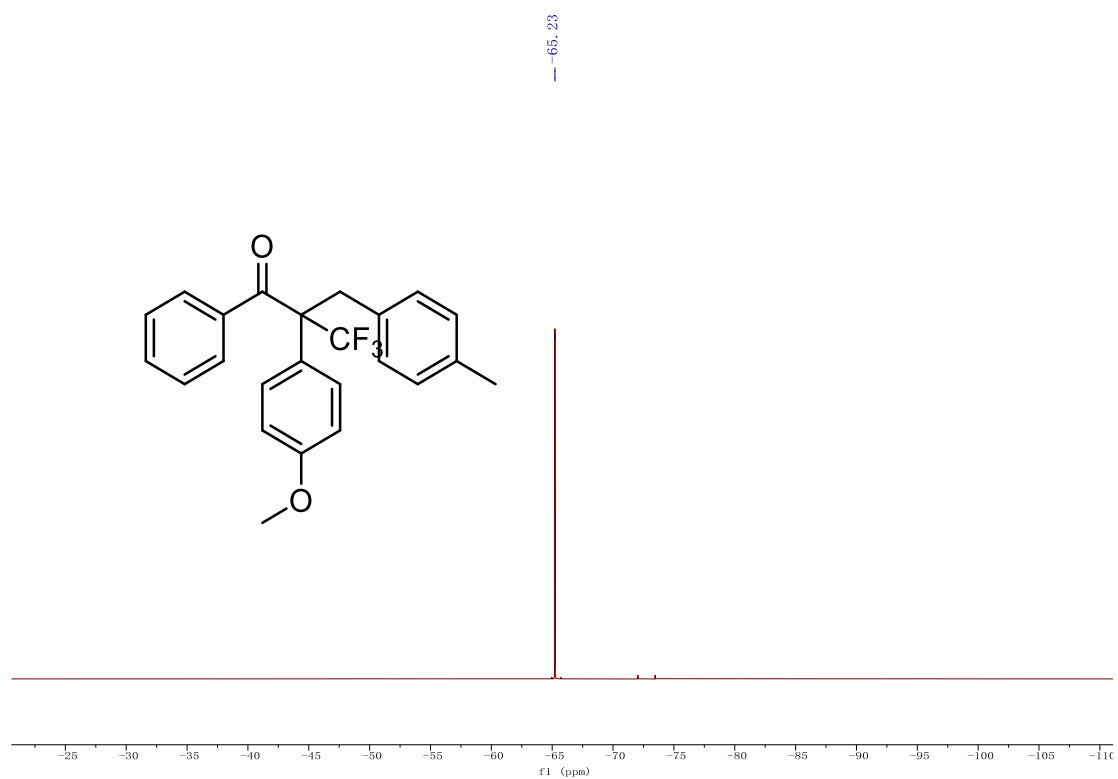
¹H NMR-spectrum (400MHz, CDCl₃) of 4i



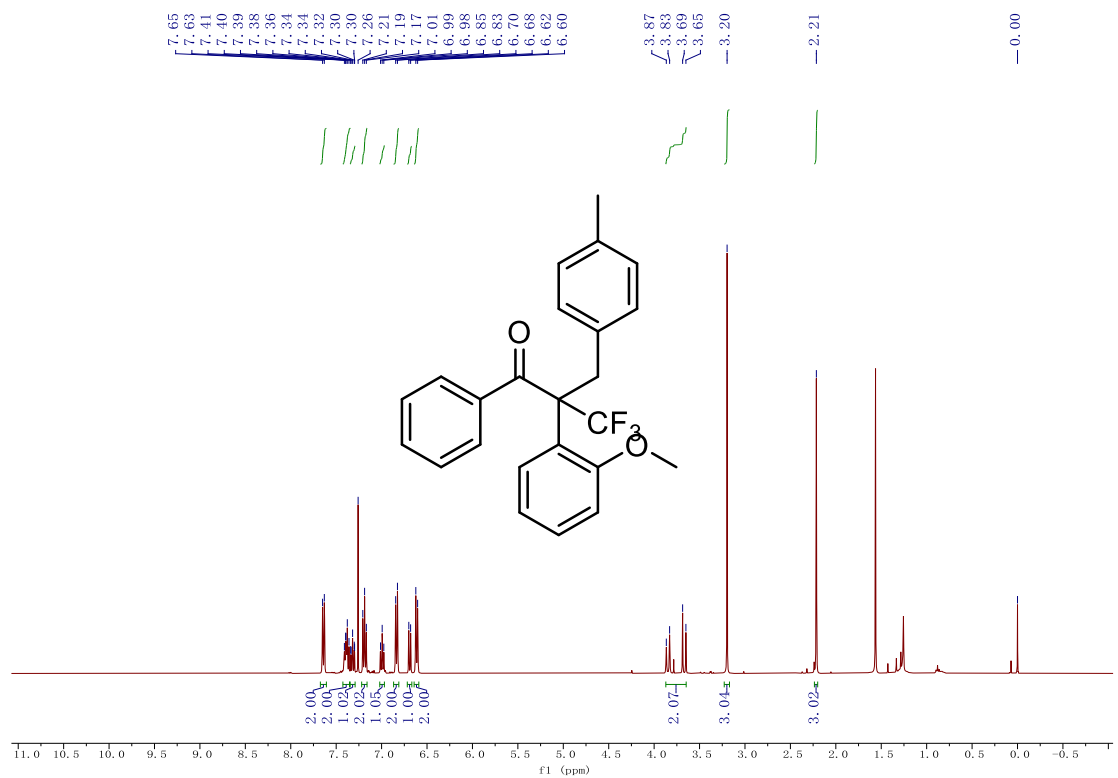
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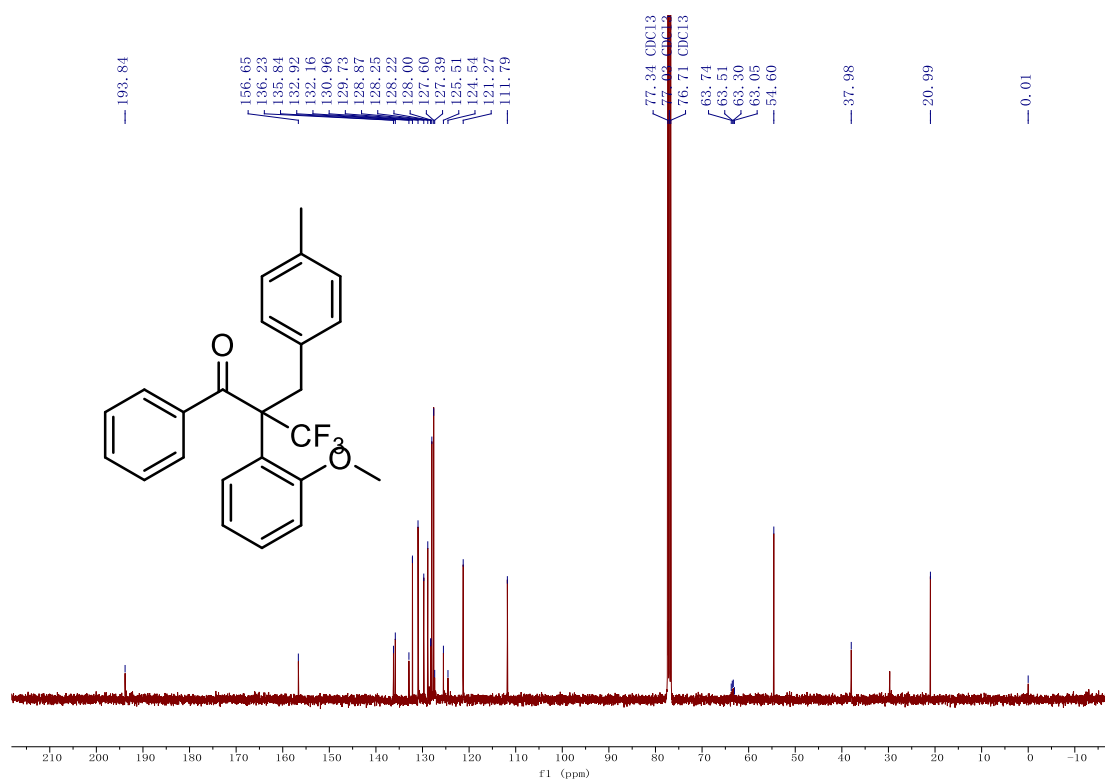
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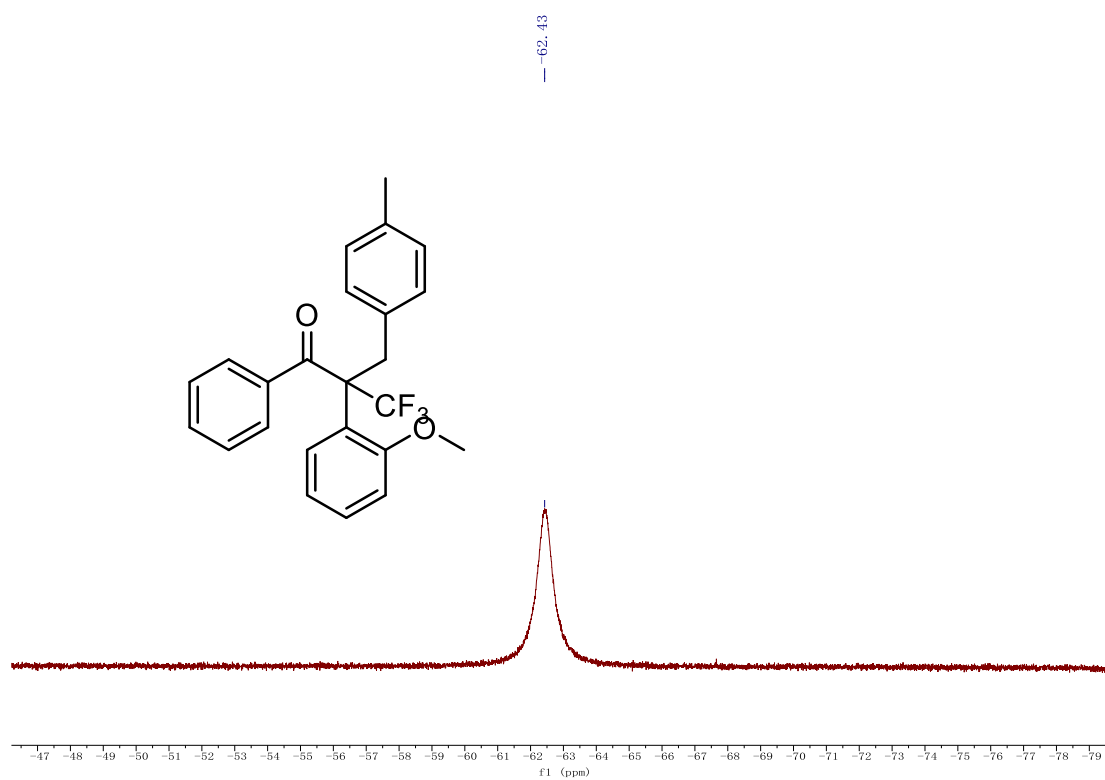
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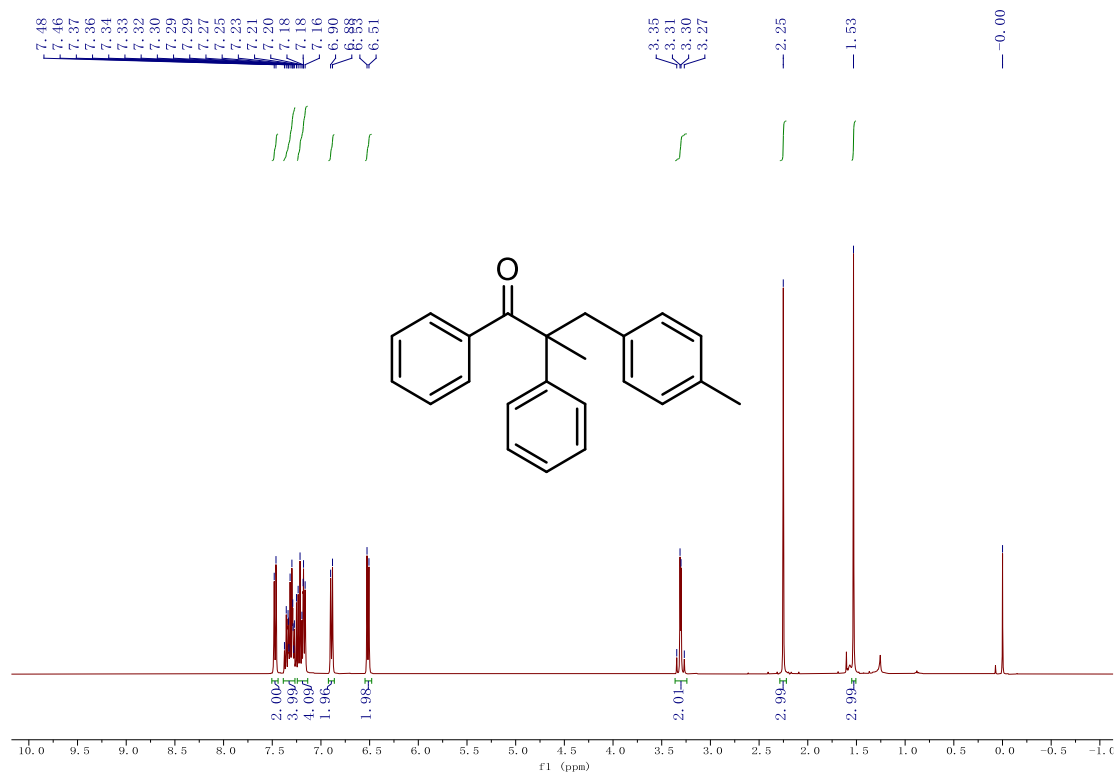
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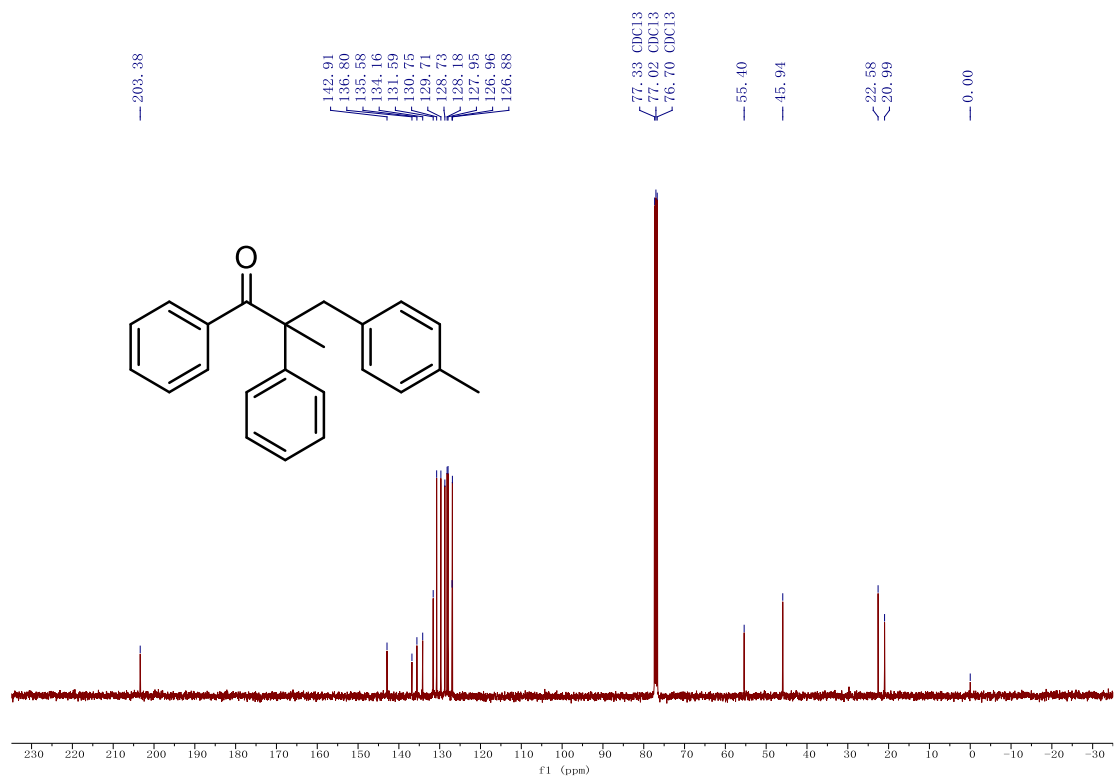
^{19}F NMR-spectrum (376 MHz, CDCl_3) of 4j



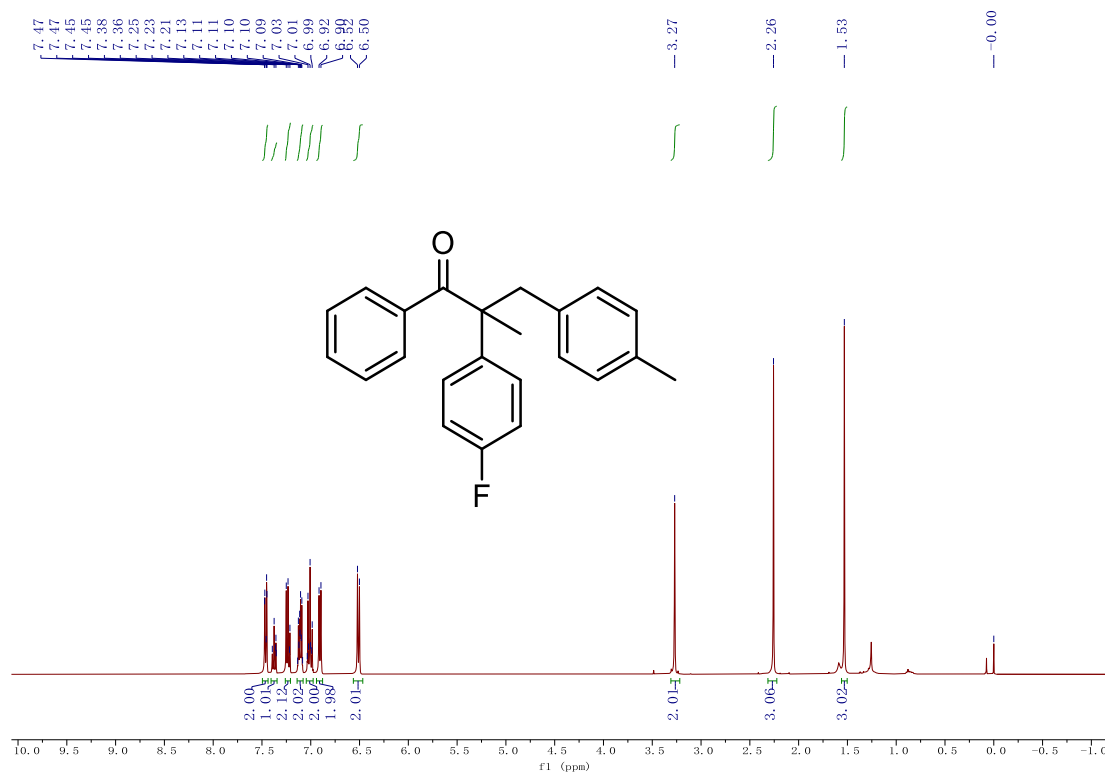
^1H NMR-spectrum (400MHz, CDCl_3) of 4k



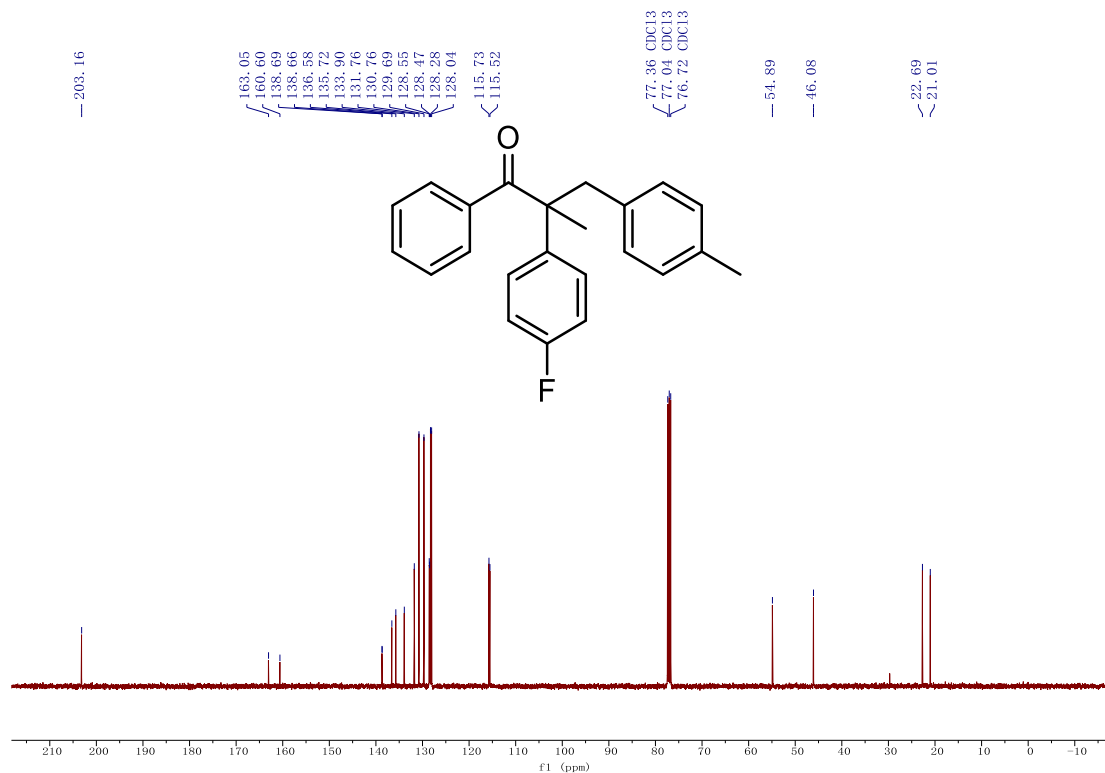
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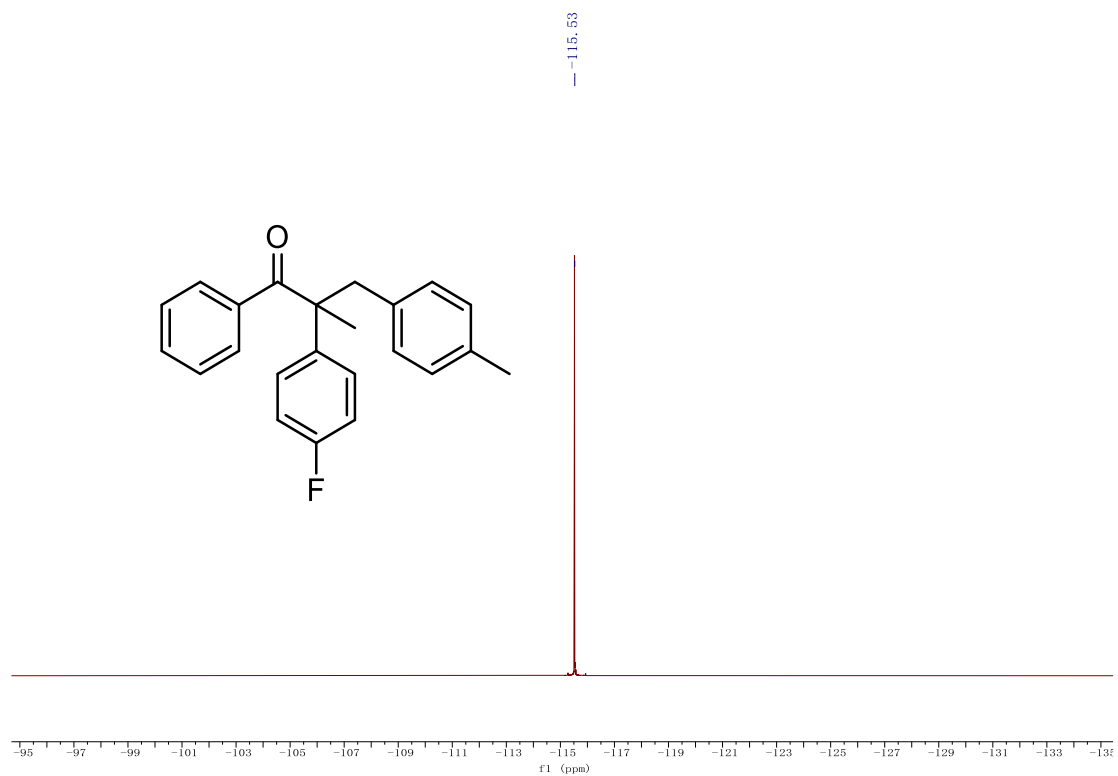
¹H NMR-spectrum (400MHz, CDCl₃) of 41



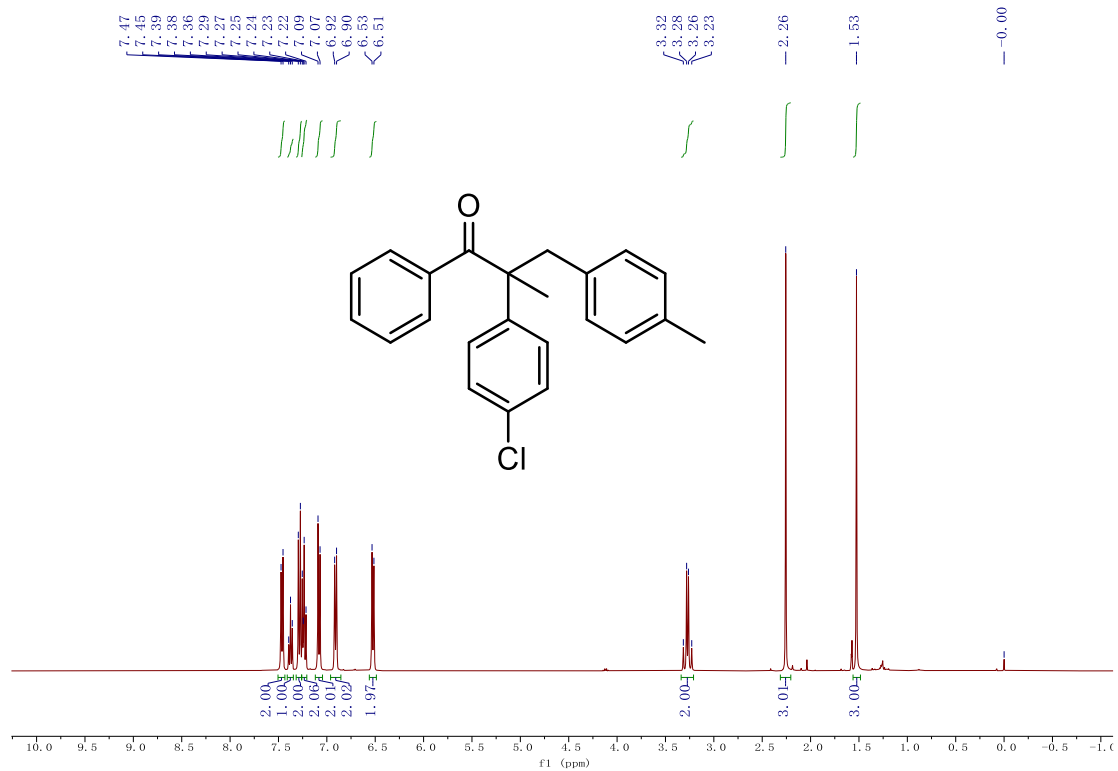
¹³C{¹H} NMR-spectrum (101MHz, CDCl₃) of 41



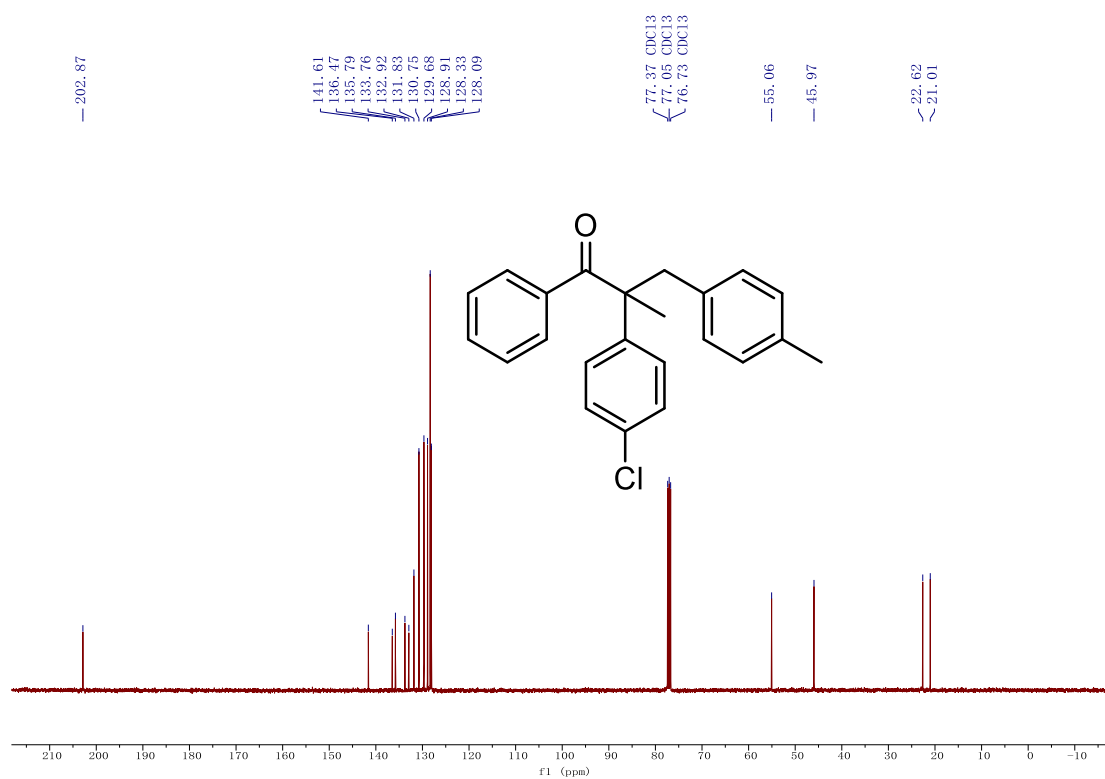
¹⁹F NMR-spectrum (376 MHz, CDCl₃) of **4l**



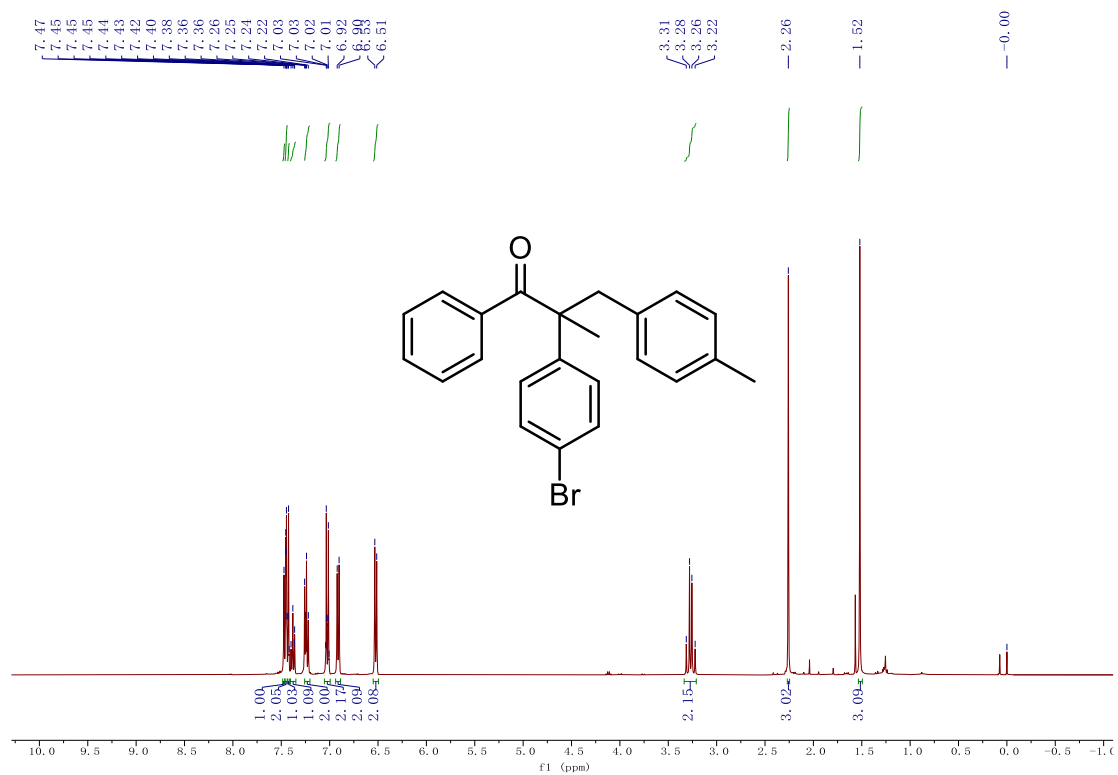
¹H NMR-spectrum (400MHz, CDCl₃) of **4m**



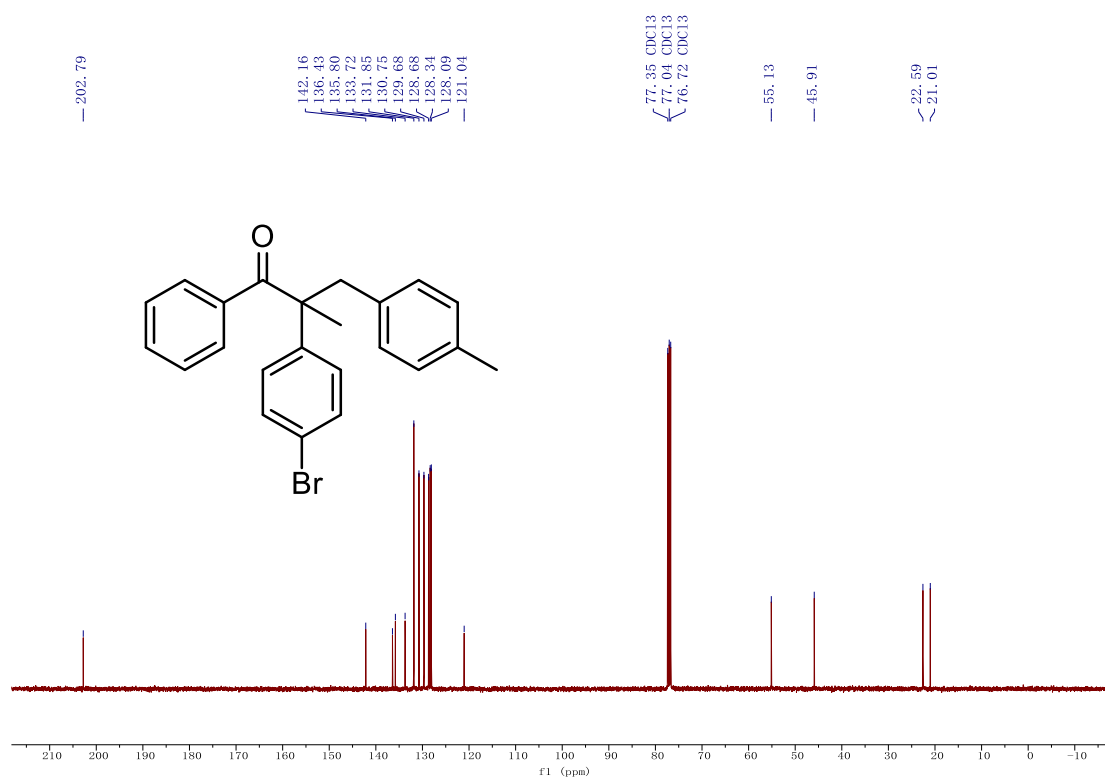
$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of **4m**



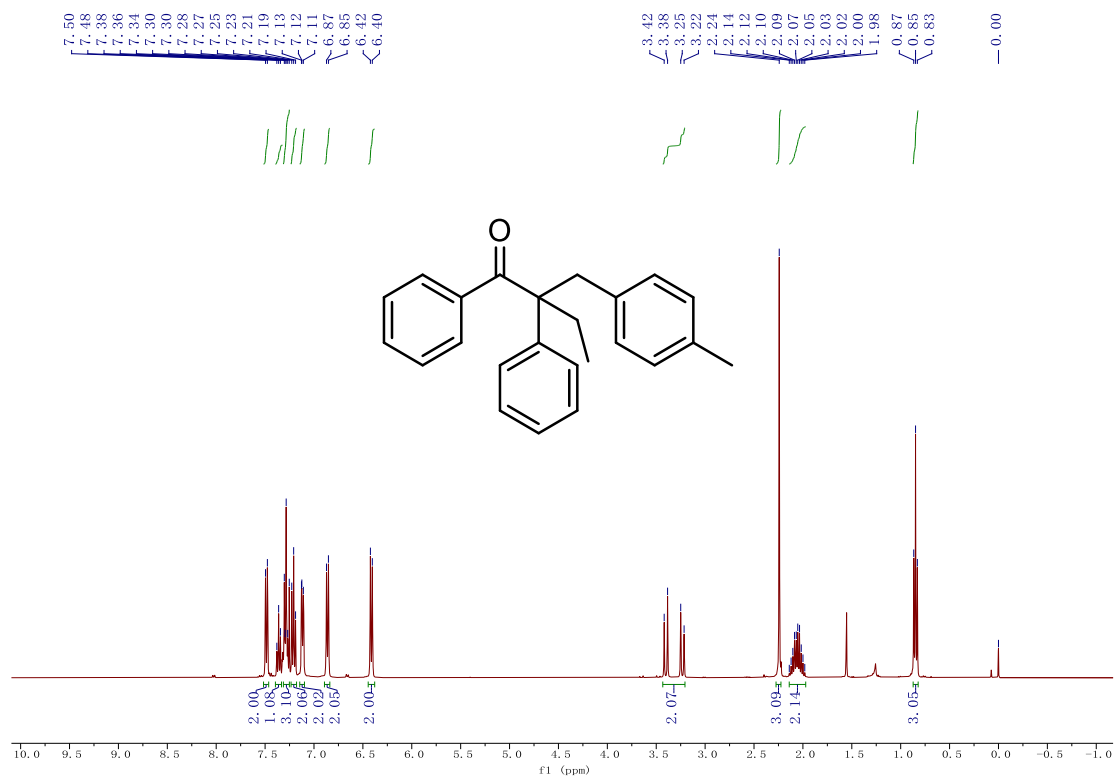
^1H NMR-spectrum (400MHz, CDCl_3) of **4n**



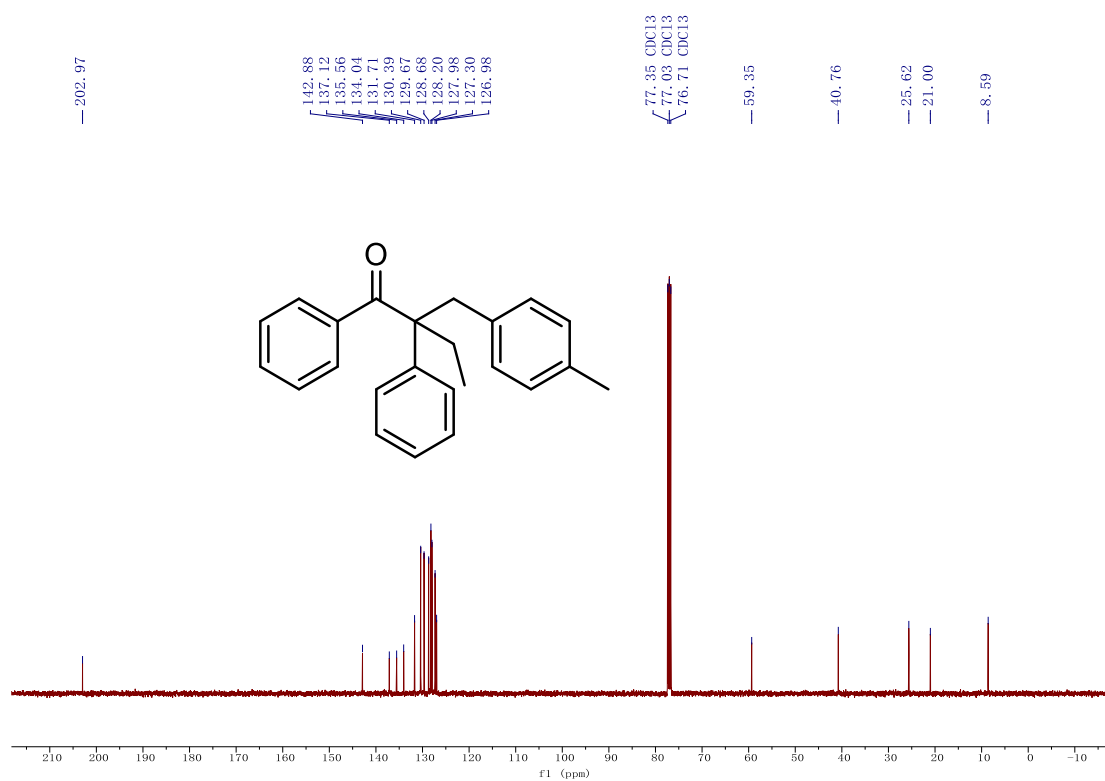
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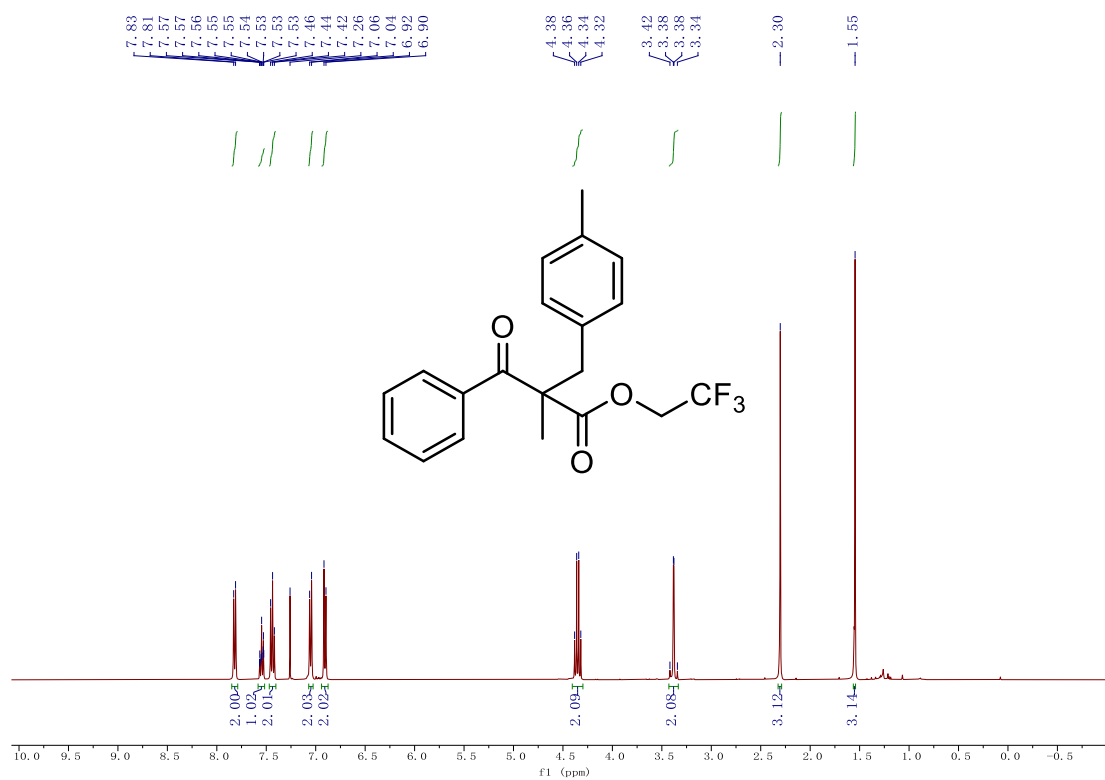
^1H NMR-spectrum (400MHz, CDCl_3) of **4o**



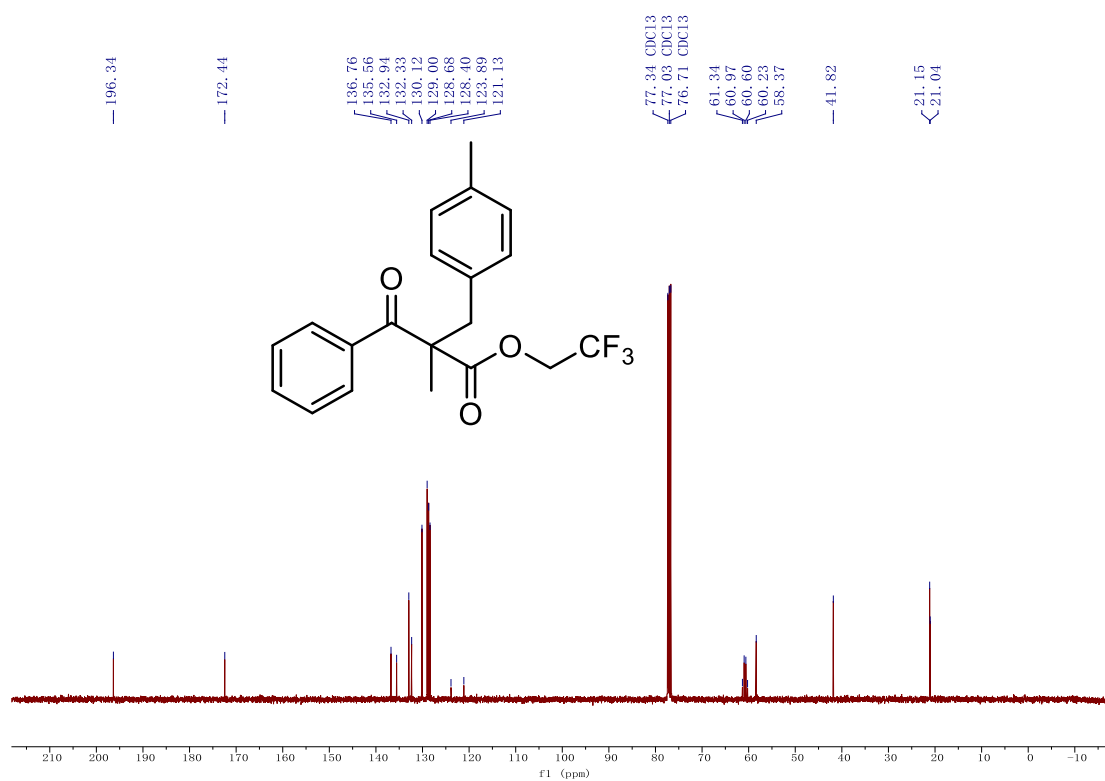
$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of **4o**



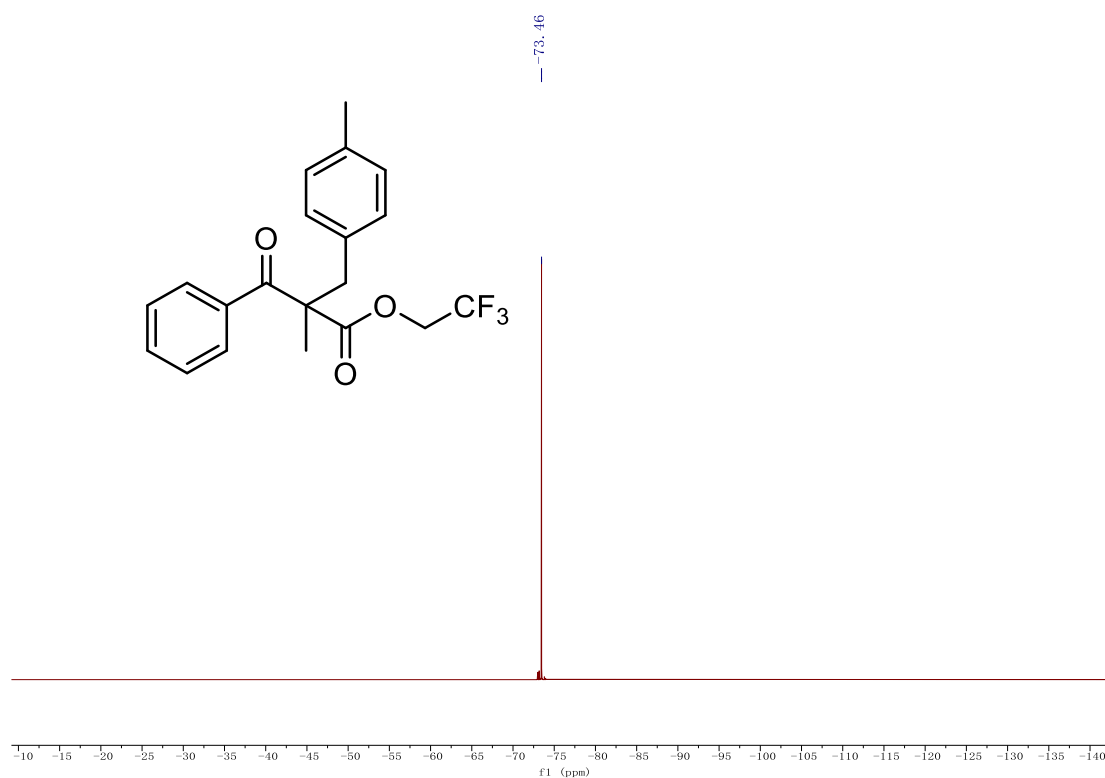
^1H NMR-spectrum (400MHz, CDCl_3) of **4p**



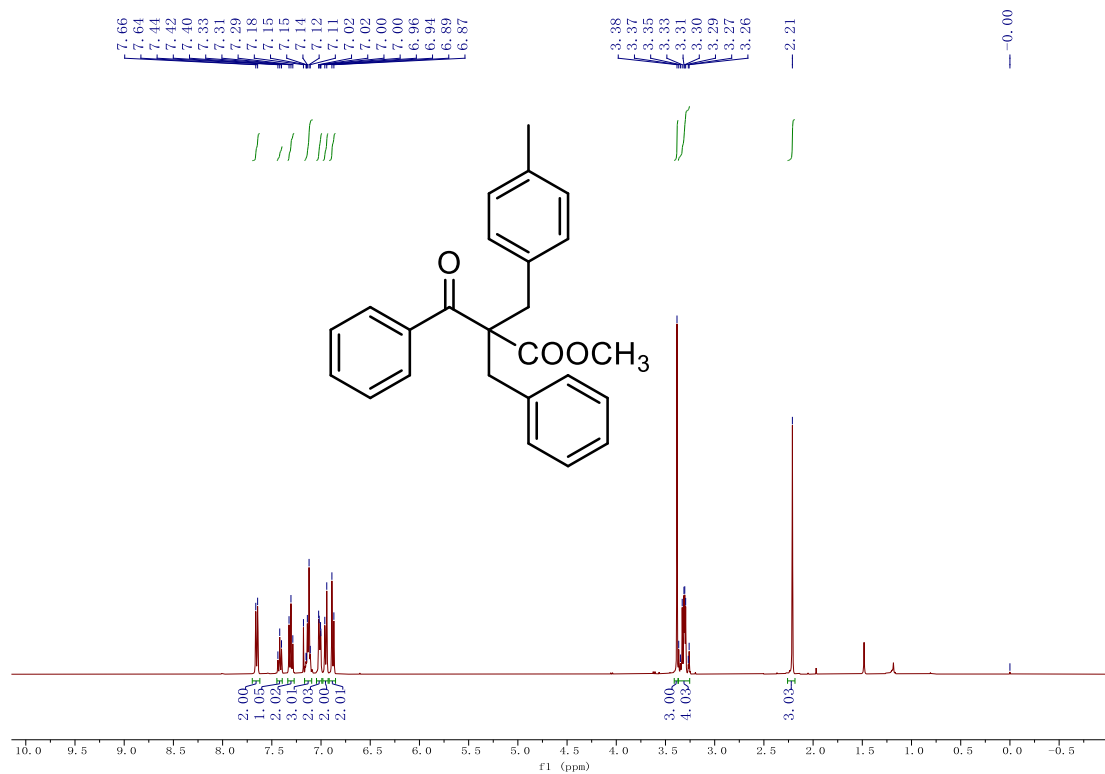
$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of **4p**



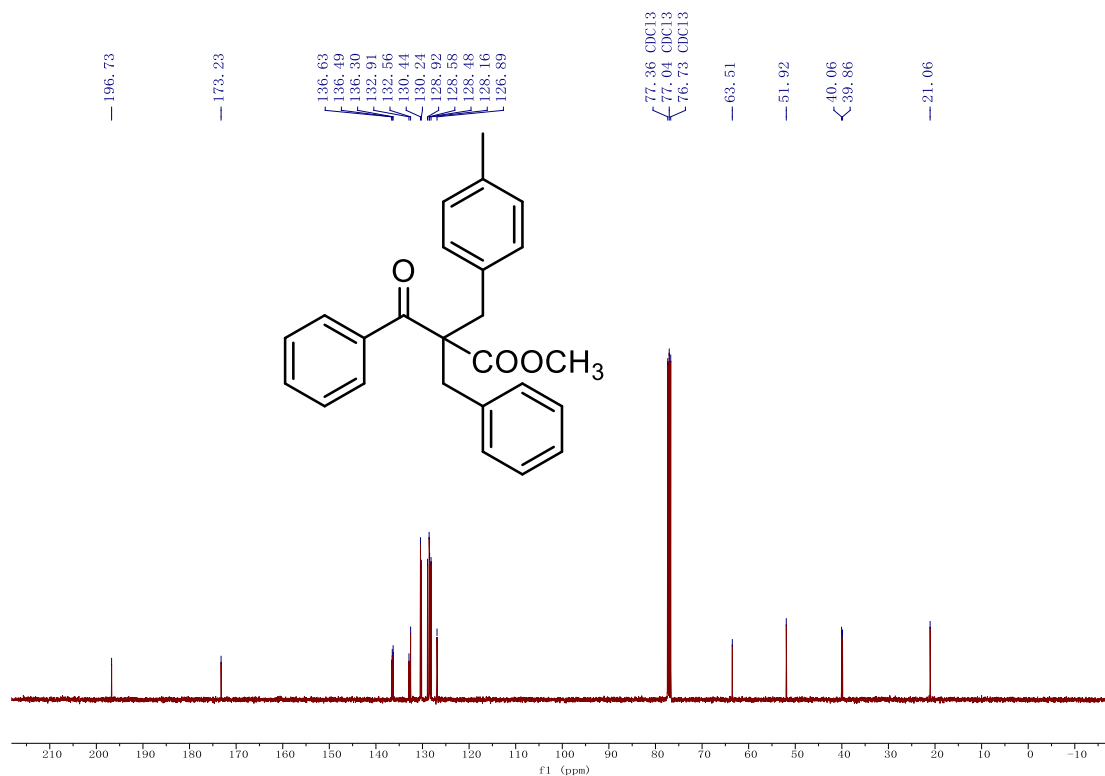
^{19}F NMR-spectrum (376 MHz, CDCl_3) of **4p**



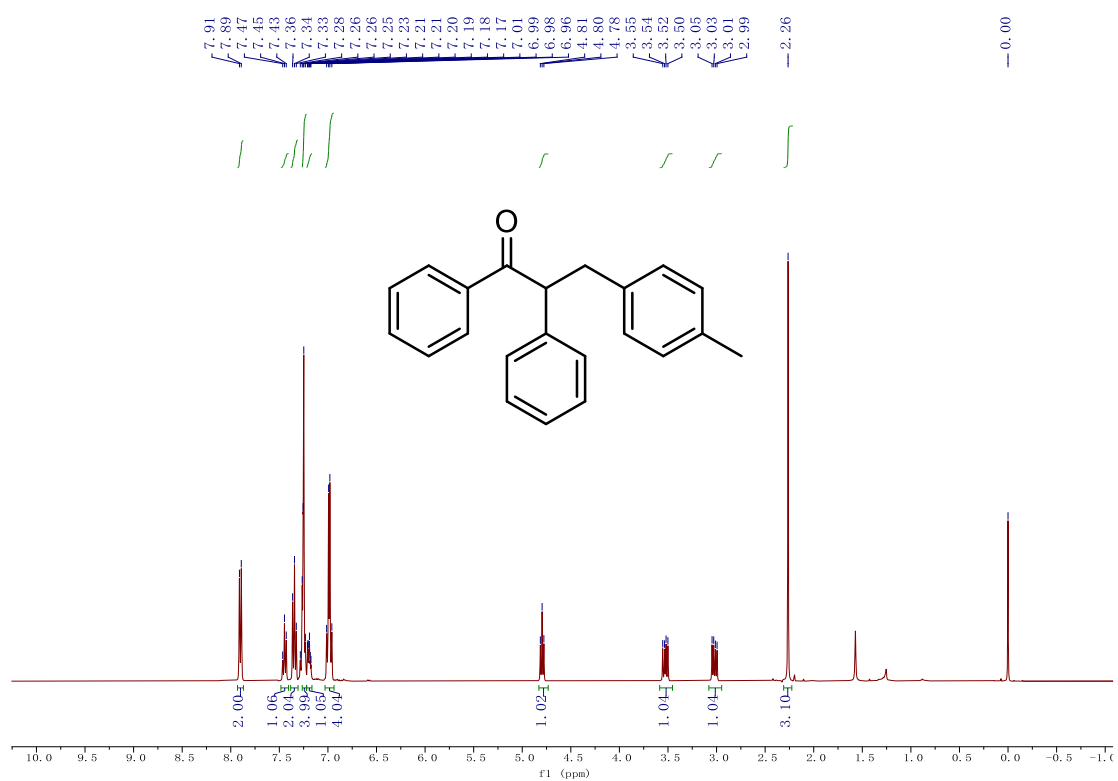
¹H NMR-spectrum (400MHz, CDCl₃) of **4q**



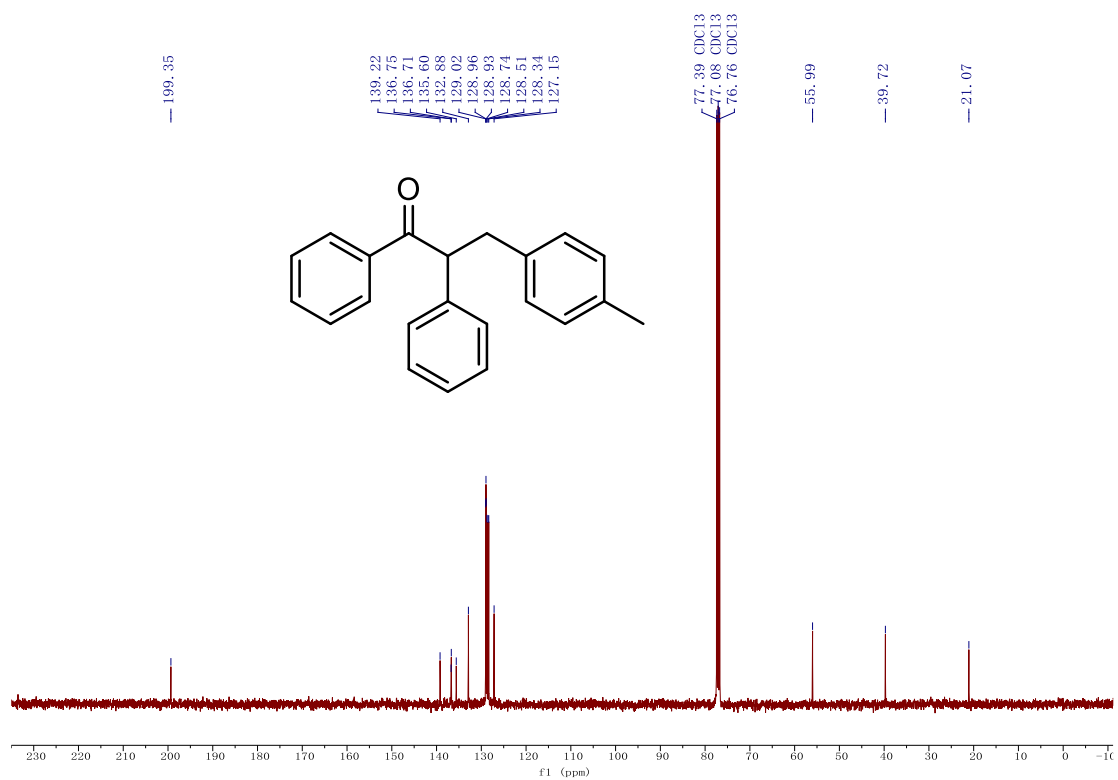
¹³C{¹H} NMR-spectrum (101MHz, CDCl₃) of **4q**



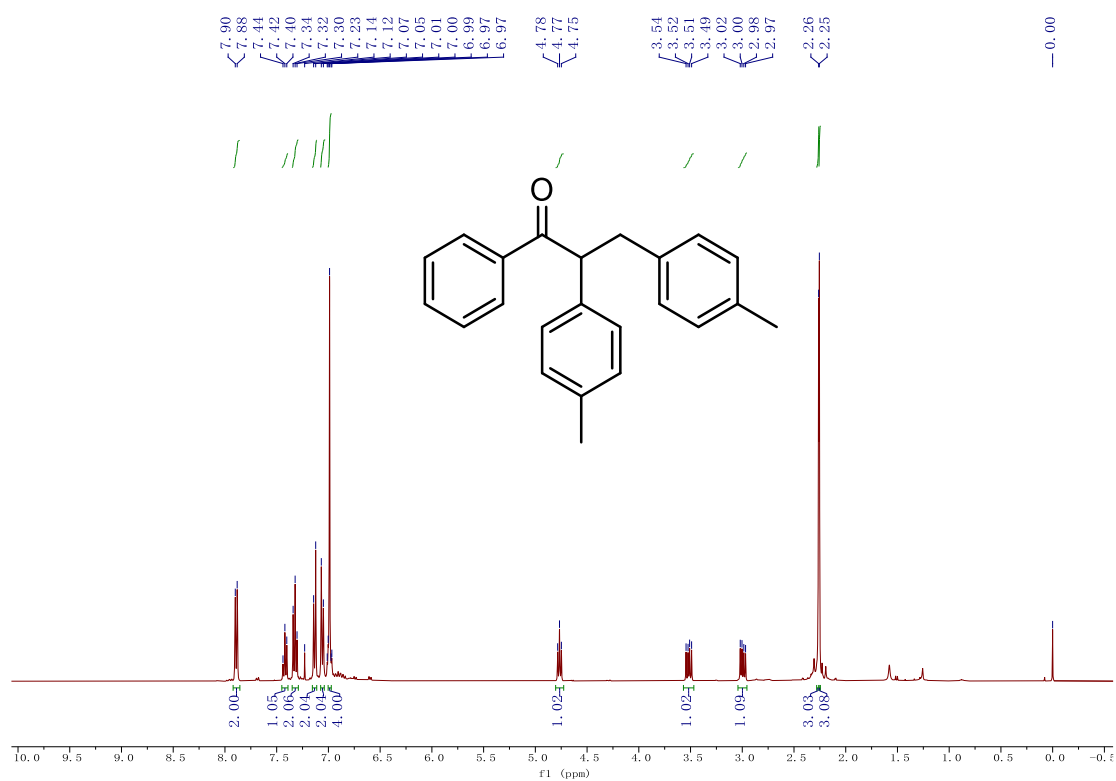
¹H NMR-spectrum (400MHz, CDCl₃) of 4r



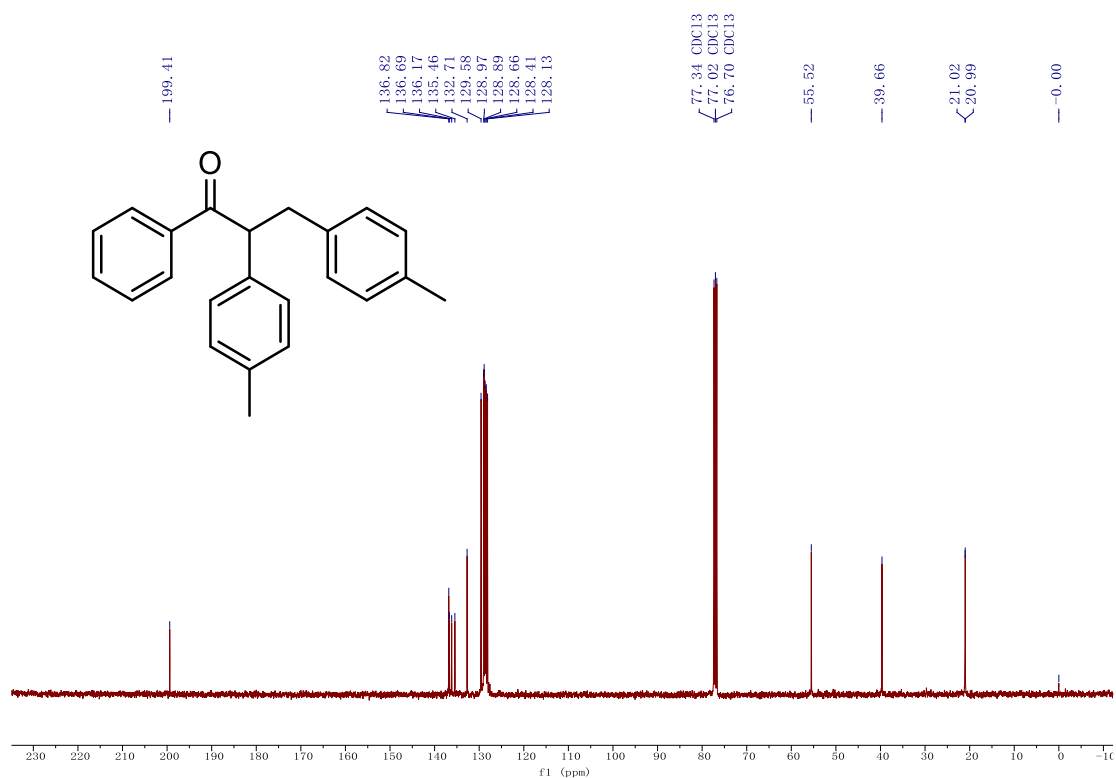
¹³C{¹H} NMR-spectrum (101MHz, CDCl₃) of 4r



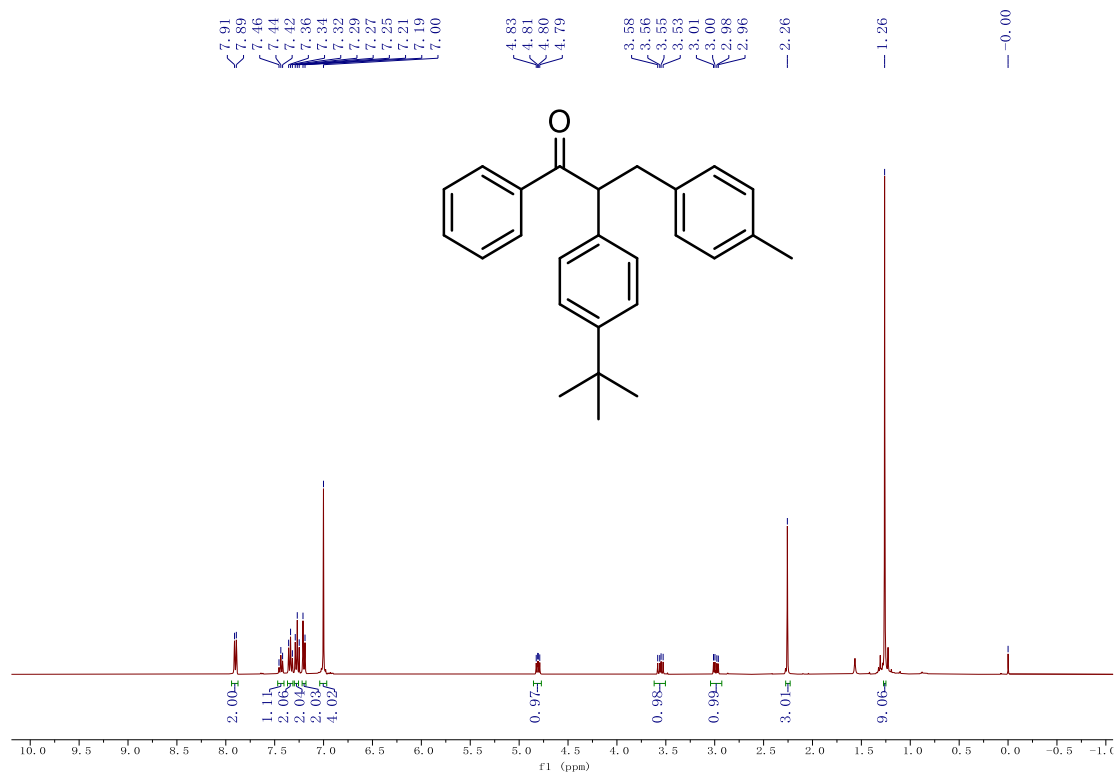
¹H NMR-spectrum (400MHz, CDCl₃) of 4s



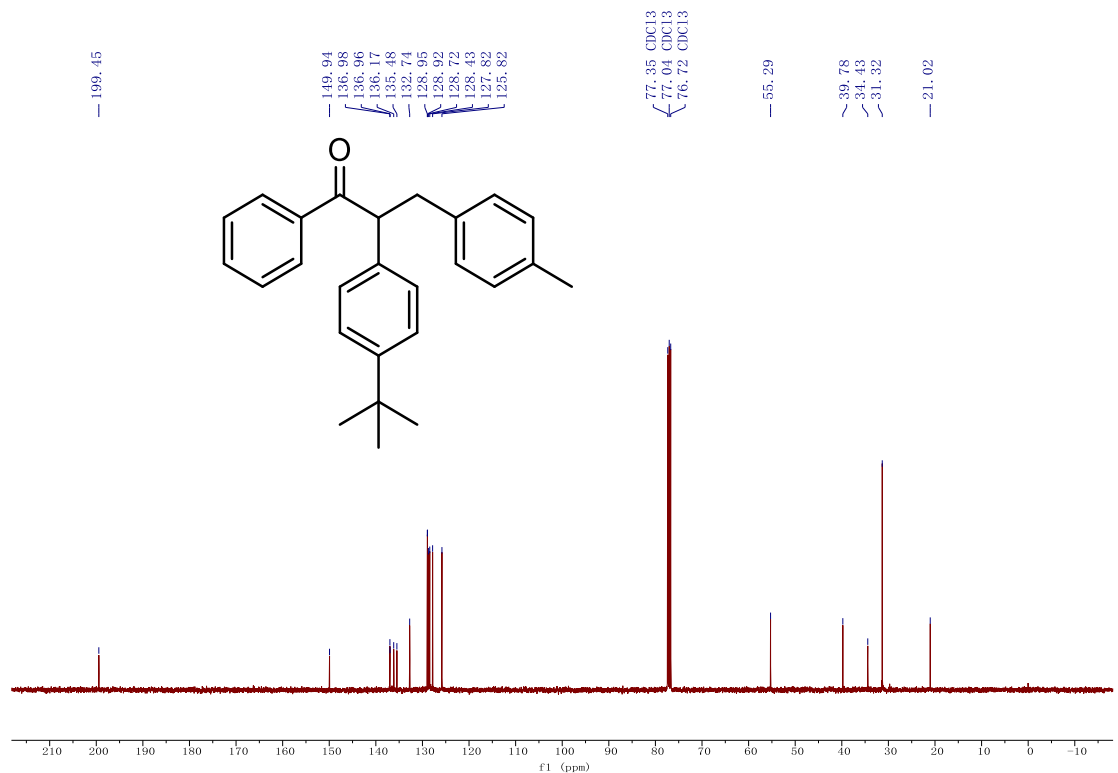
¹³C{¹H} NMR -spectrum (101MHz, CDCl₃) of 4s



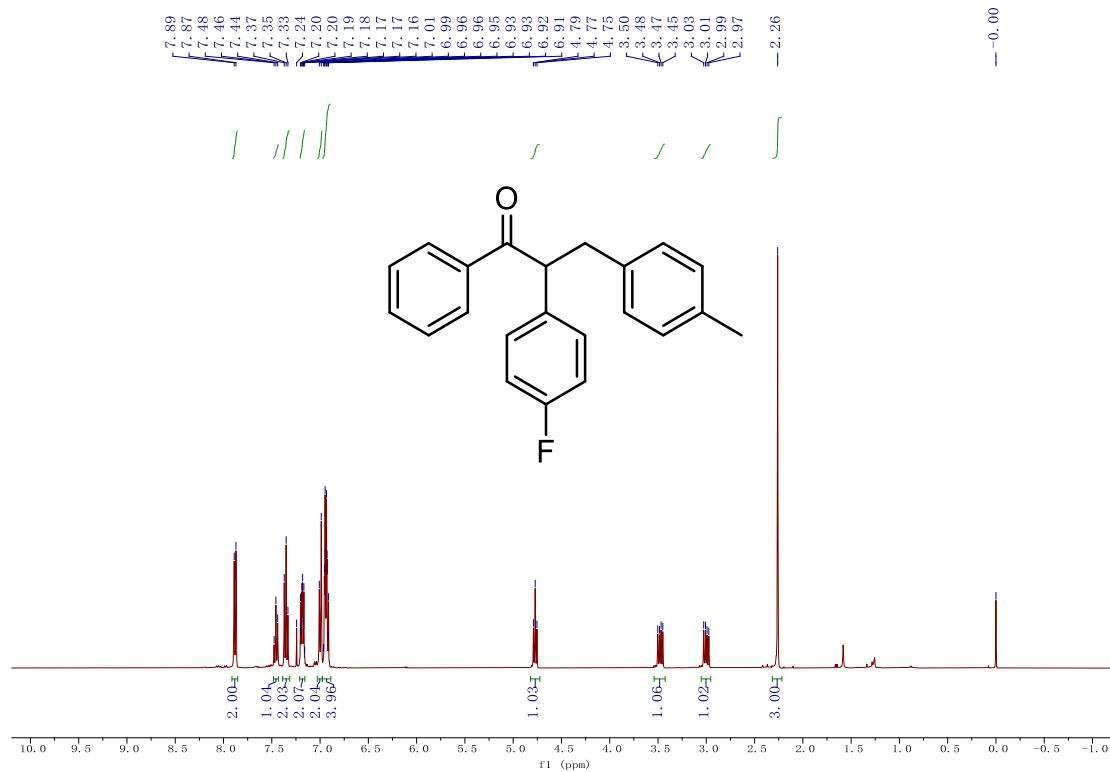
^1H NMR-spectrum (400MHz, CDCl_3) of **4t**



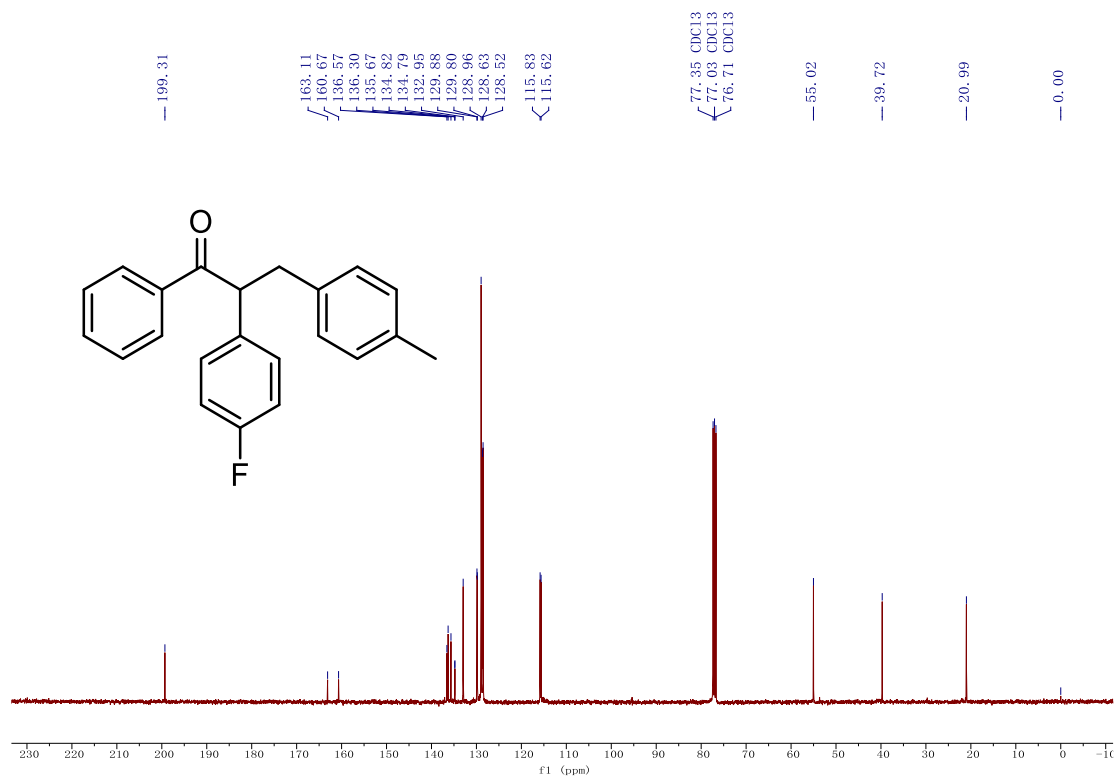
$^{13}\text{C}\{^1\text{H}\}$ NMR -spectrum (101MHz, CDCl_3) of **4t**



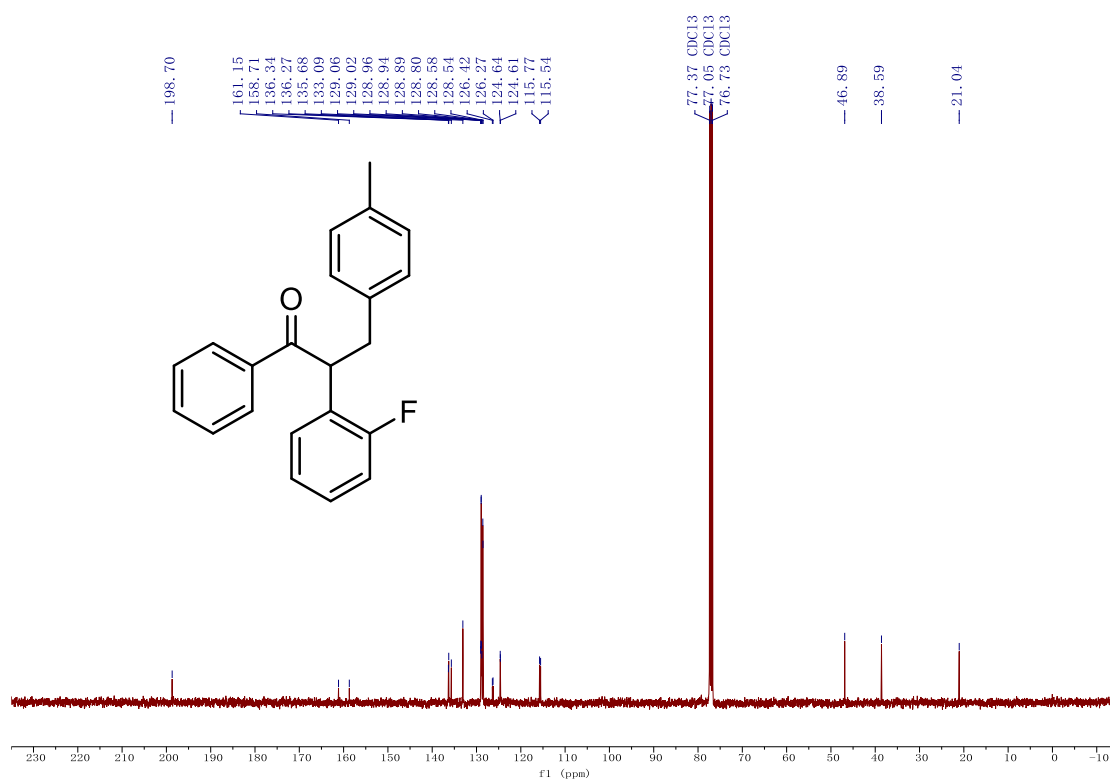
¹H NMR-spectrum (400MHz, CDCl₃) of **4u**



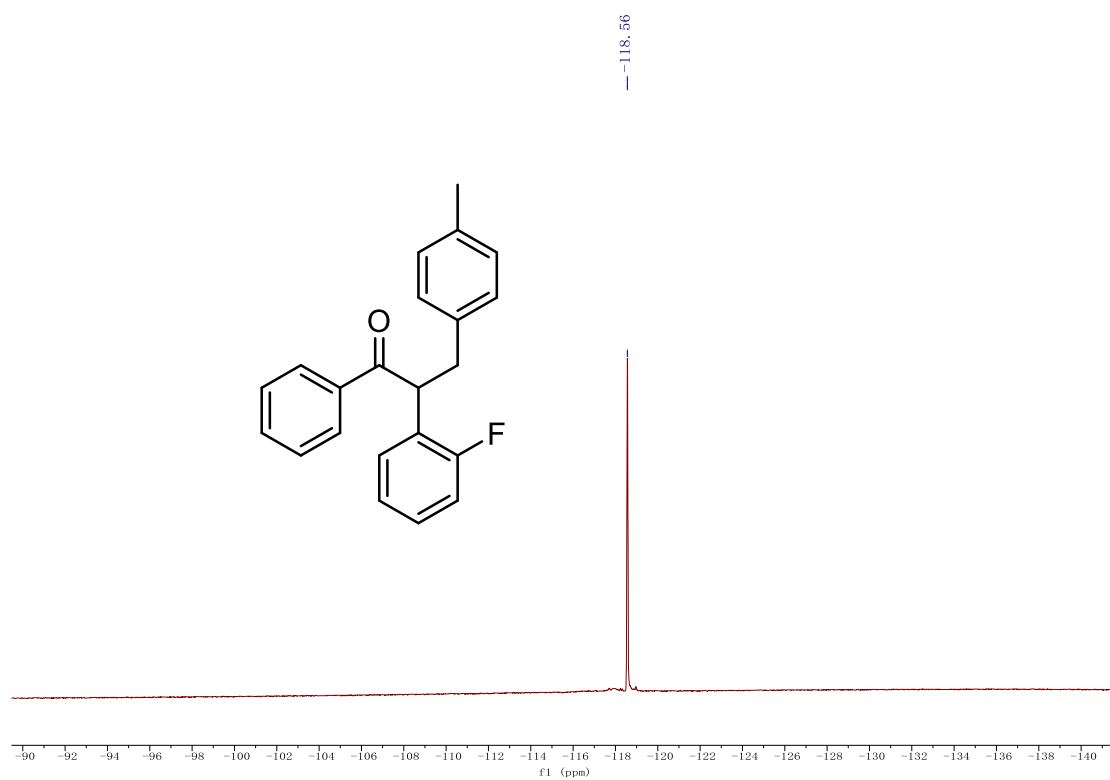
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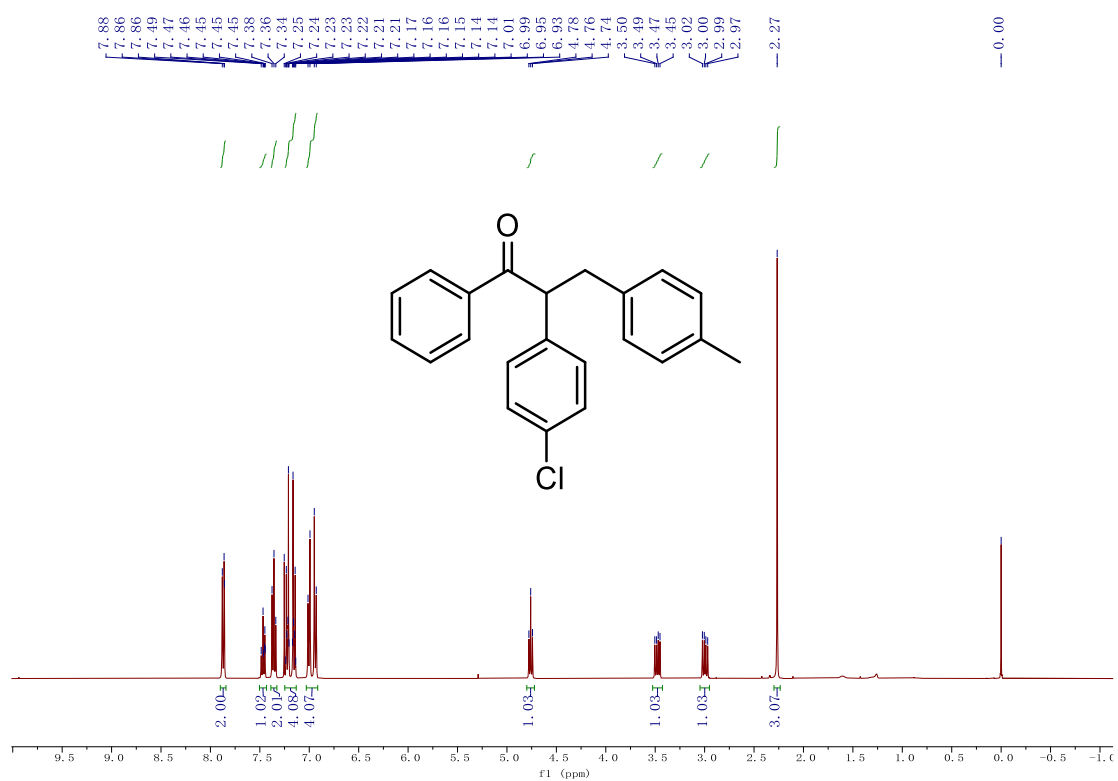
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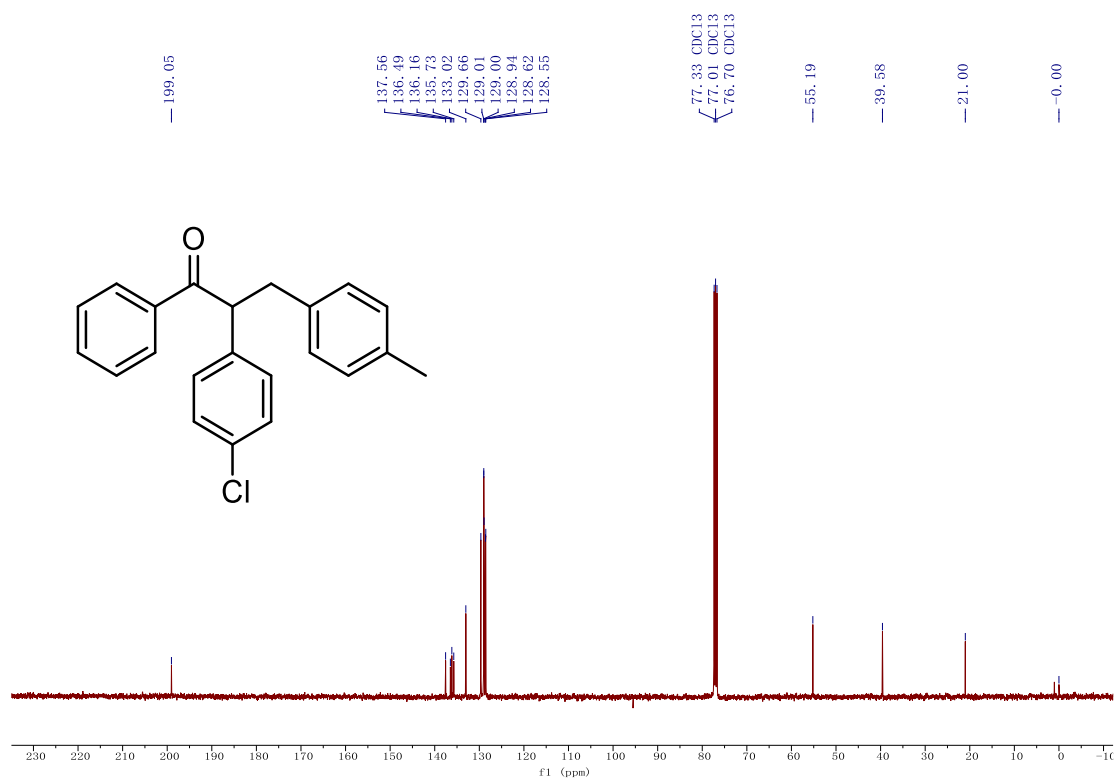
^{19}F NMR-spectrum (376 MHz, CDCl_3) of **4v**



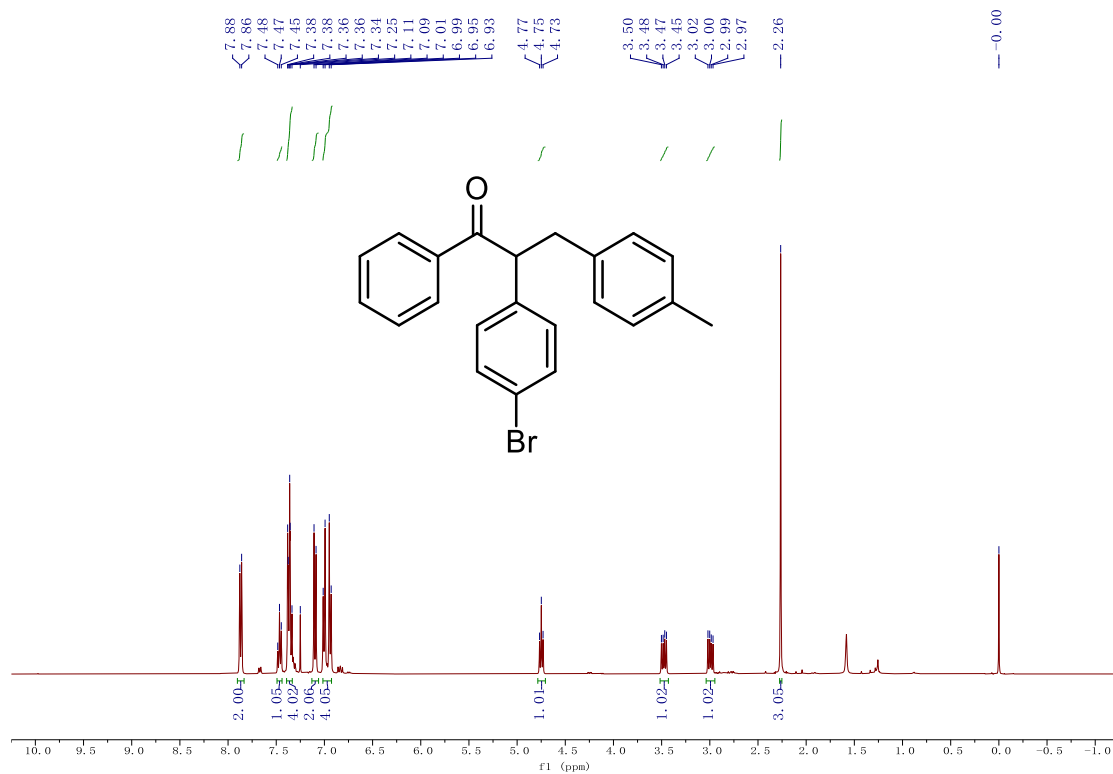
^1H NMR-spectrum (400MHz, CDCl_3) of **4w**



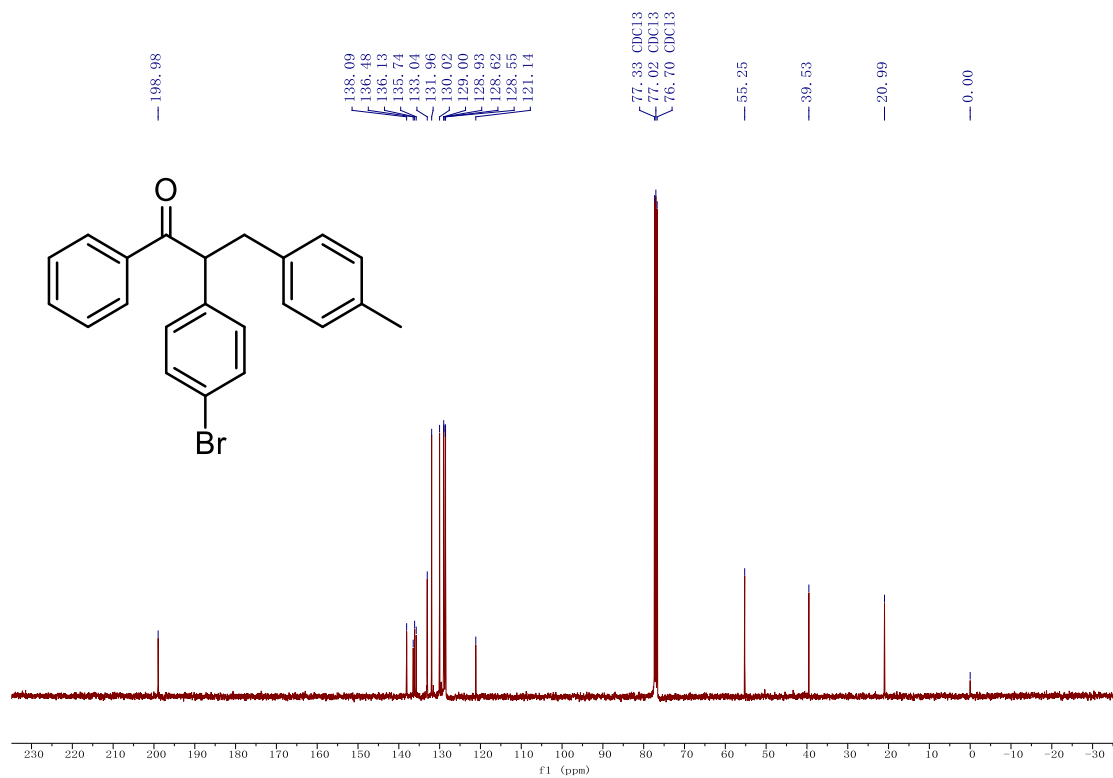
$^{13}\text{C}\{^1\text{H}\}$ NMR -spectrum (101MHz, CDCl_3) of **4w**



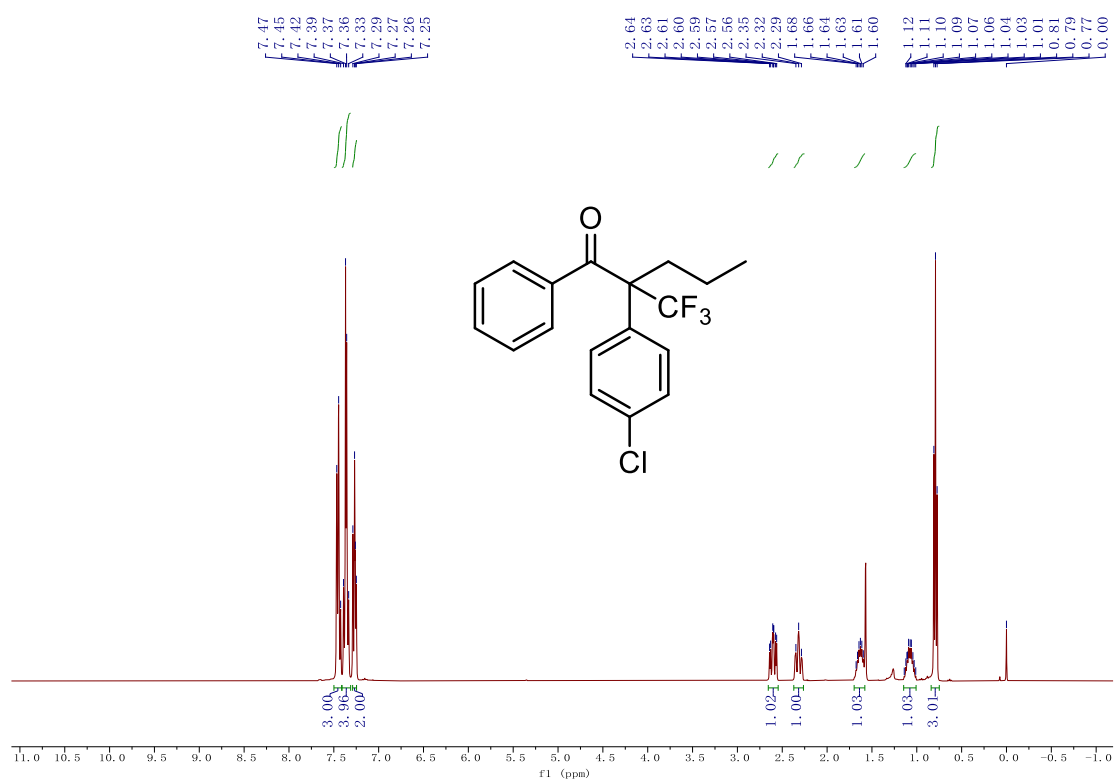
^1H NMR-spectrum (400MHz, CDCl_3) of **4x**



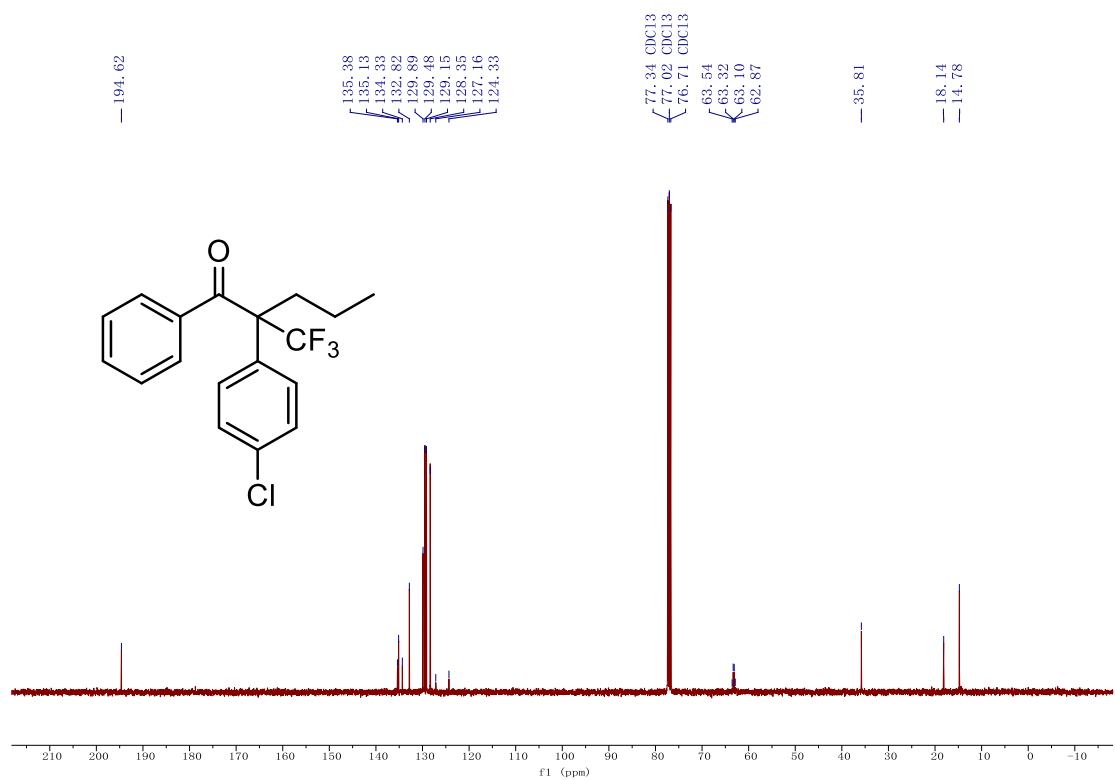
$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of **4x**



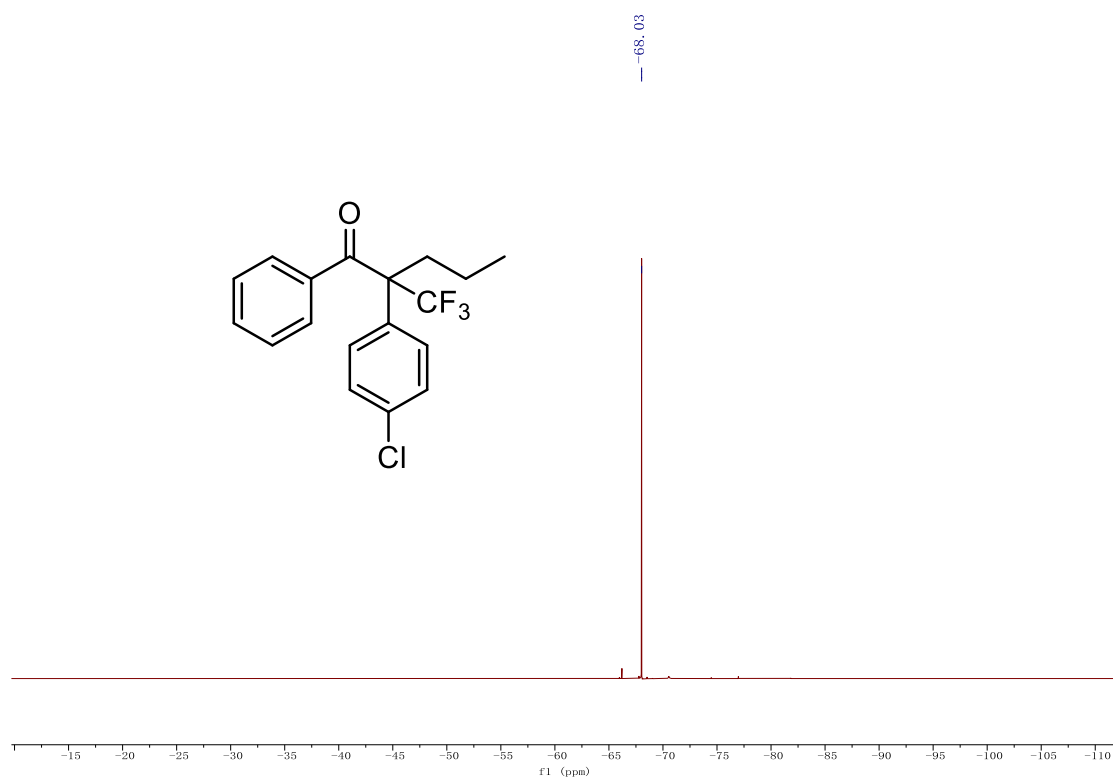
¹H NMR-spectrum (400MHz, CDCl₃) of **5a**



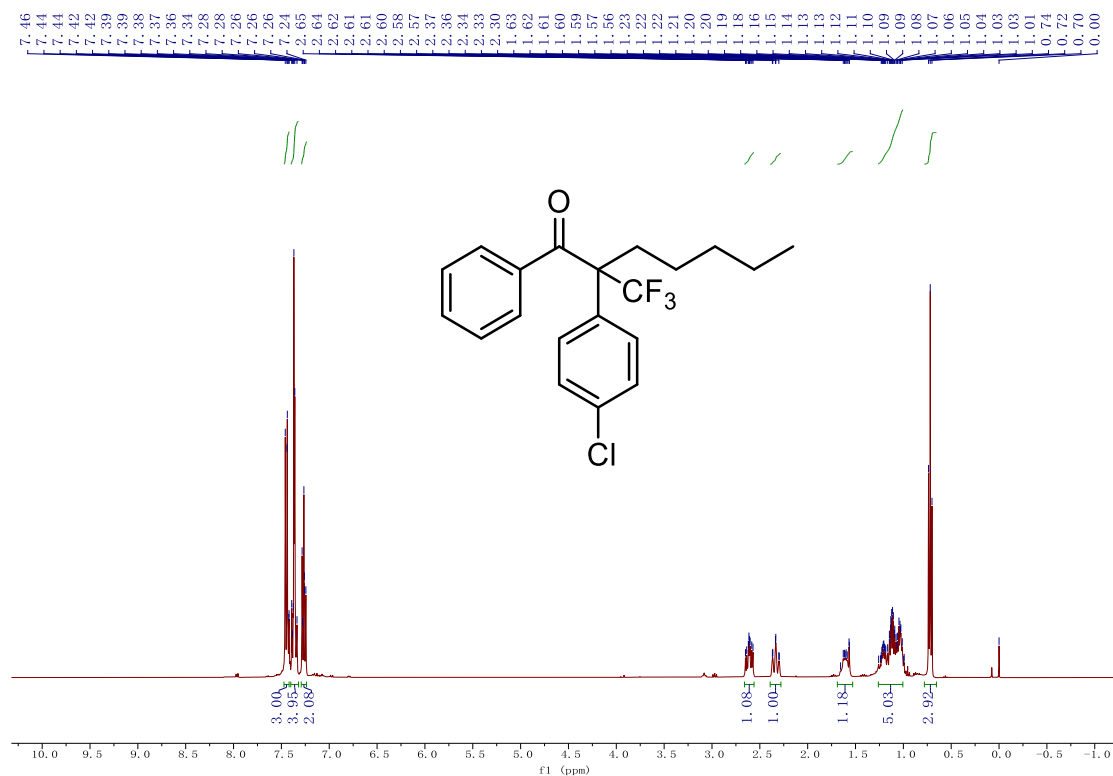
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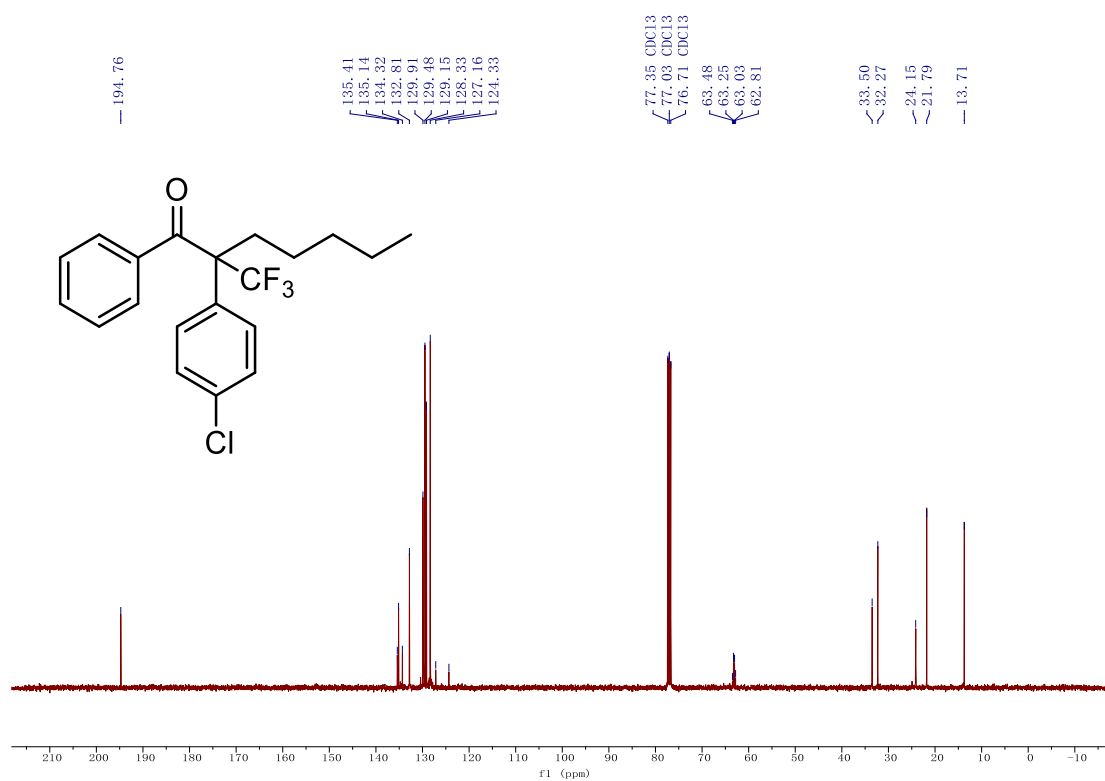
¹⁹F NMR-spectrum (376 MHz, CDCl₃) of 5a



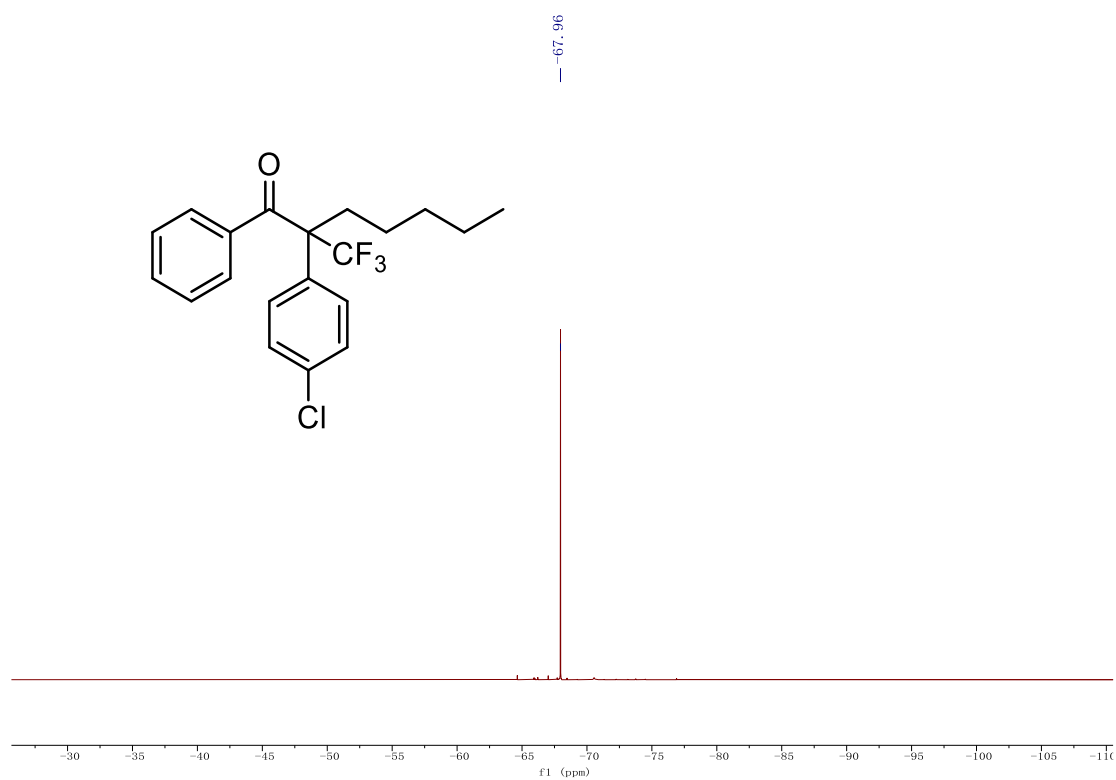
¹H NMR-spectrum (400MHz, CDCl₃) of 5b



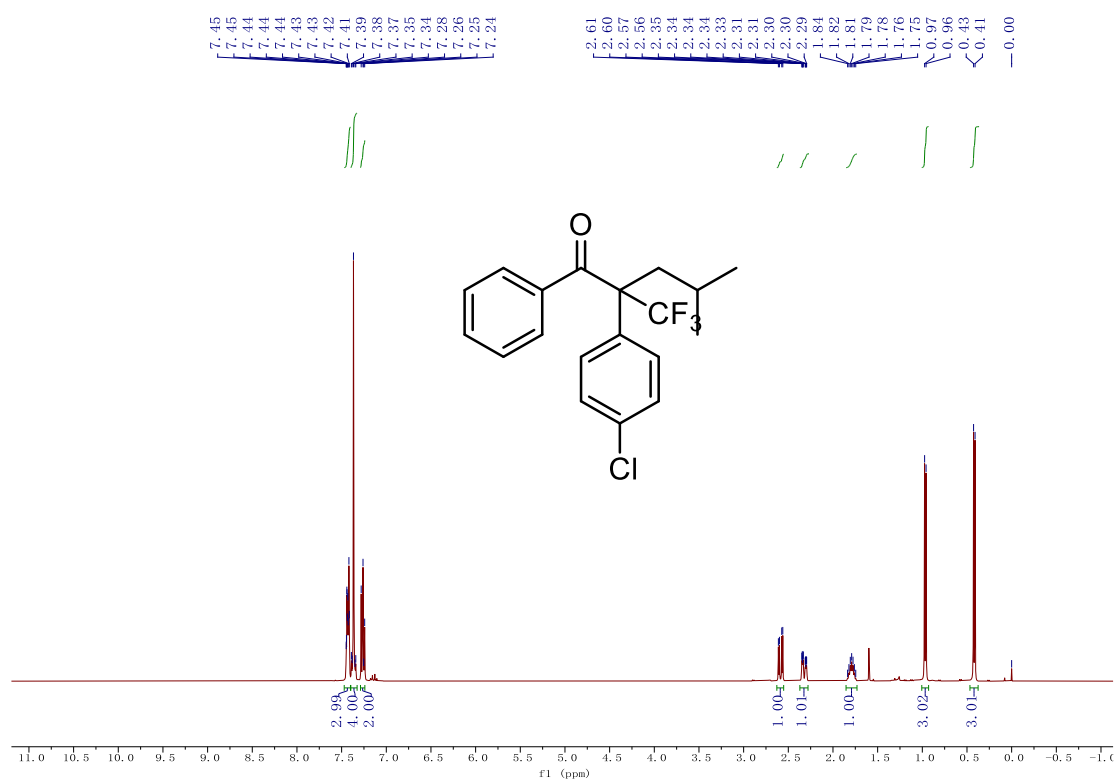
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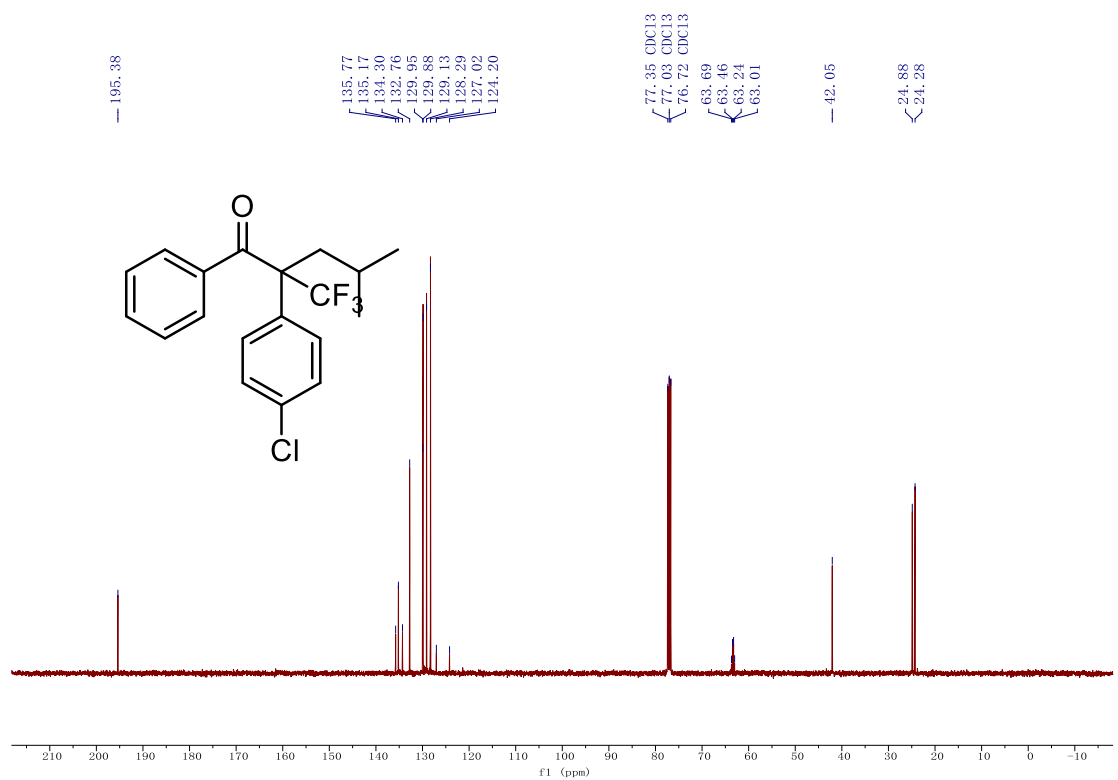
^{19}F NMR-spectrum (376 MHz, CDCl_3) of **5b**



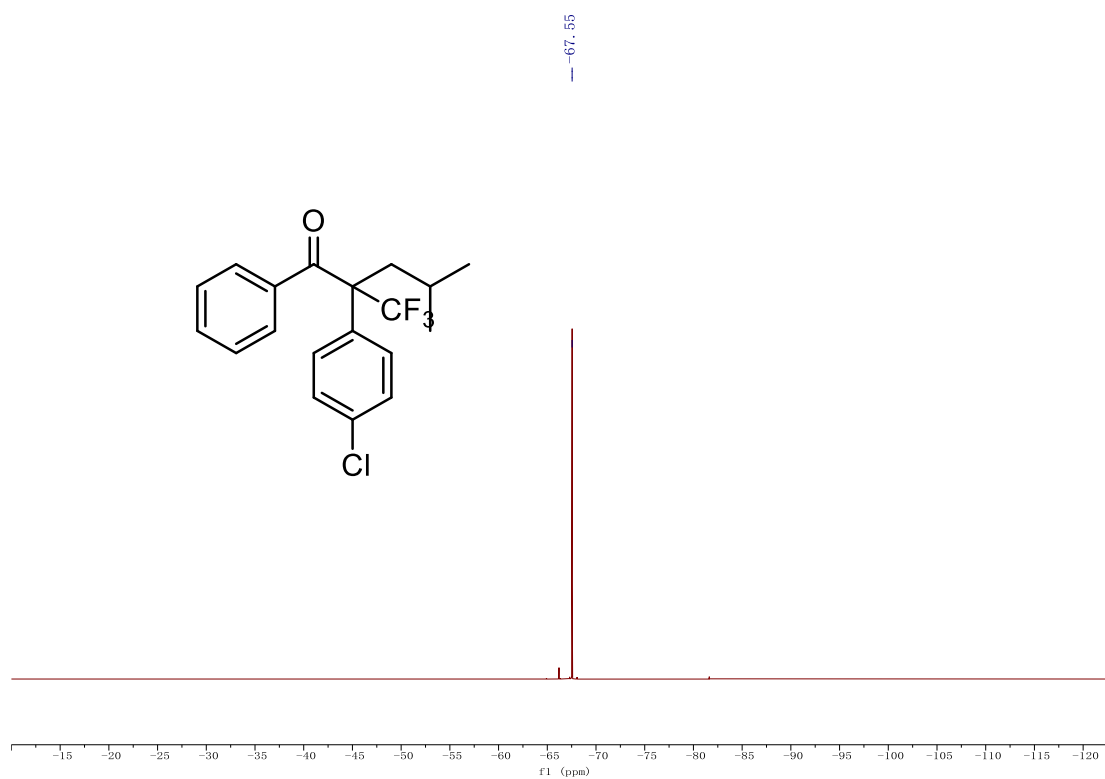
^1H NMR-spectrum (400MHz, CDCl_3) of **5c**



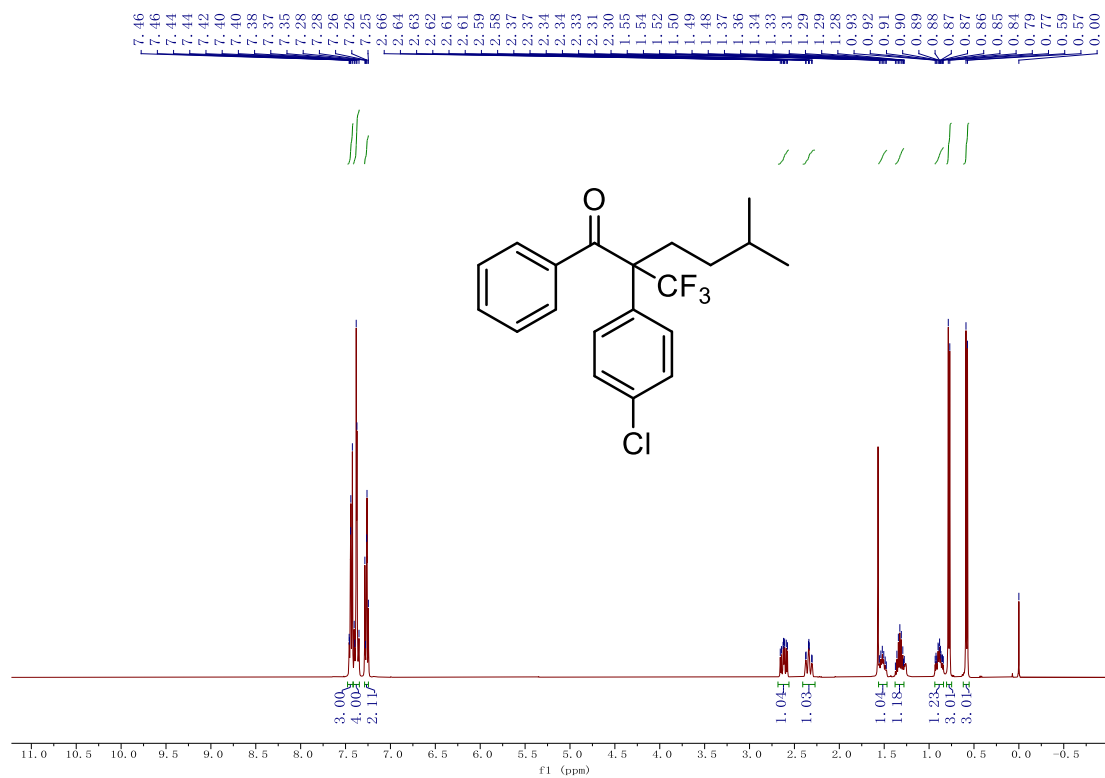
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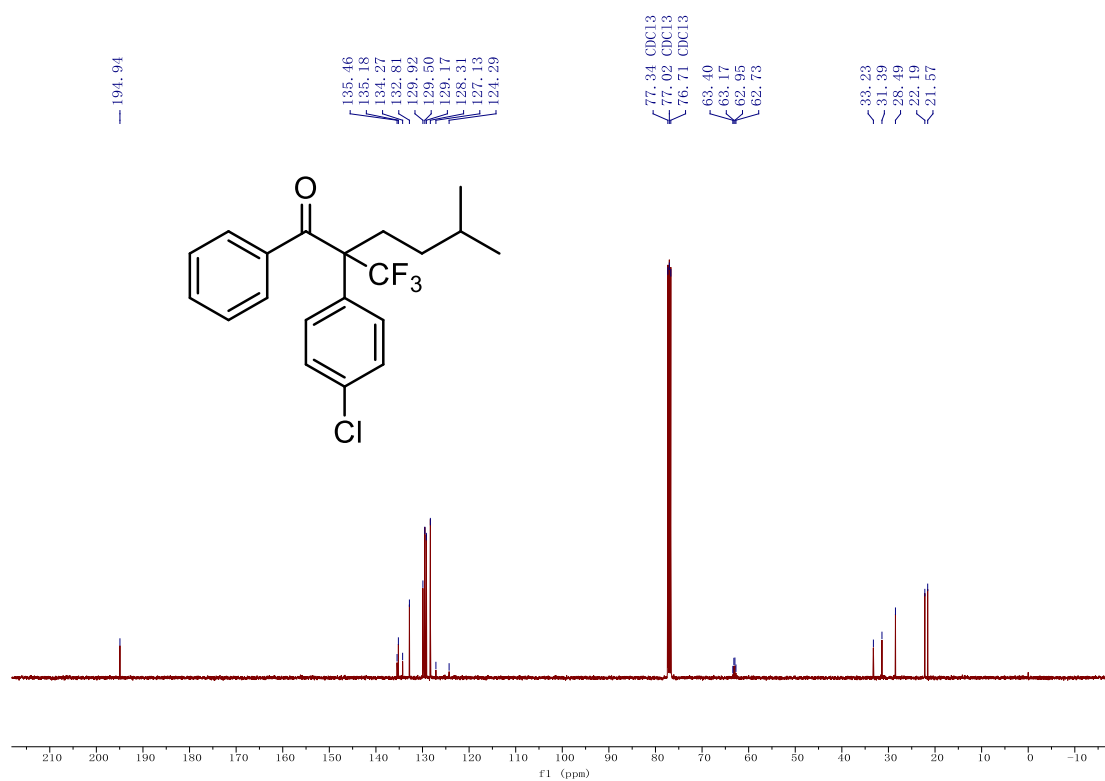
¹⁹F NMR-spectrum (376 MHz, CDCl₃) of **5c**



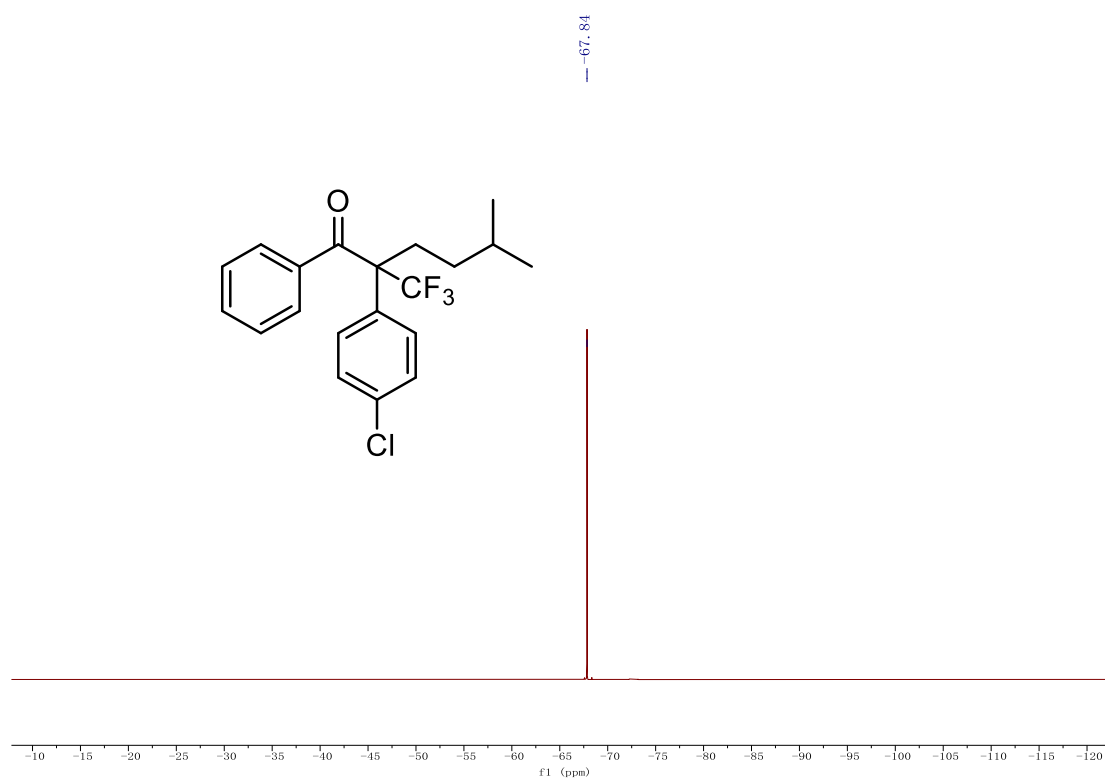
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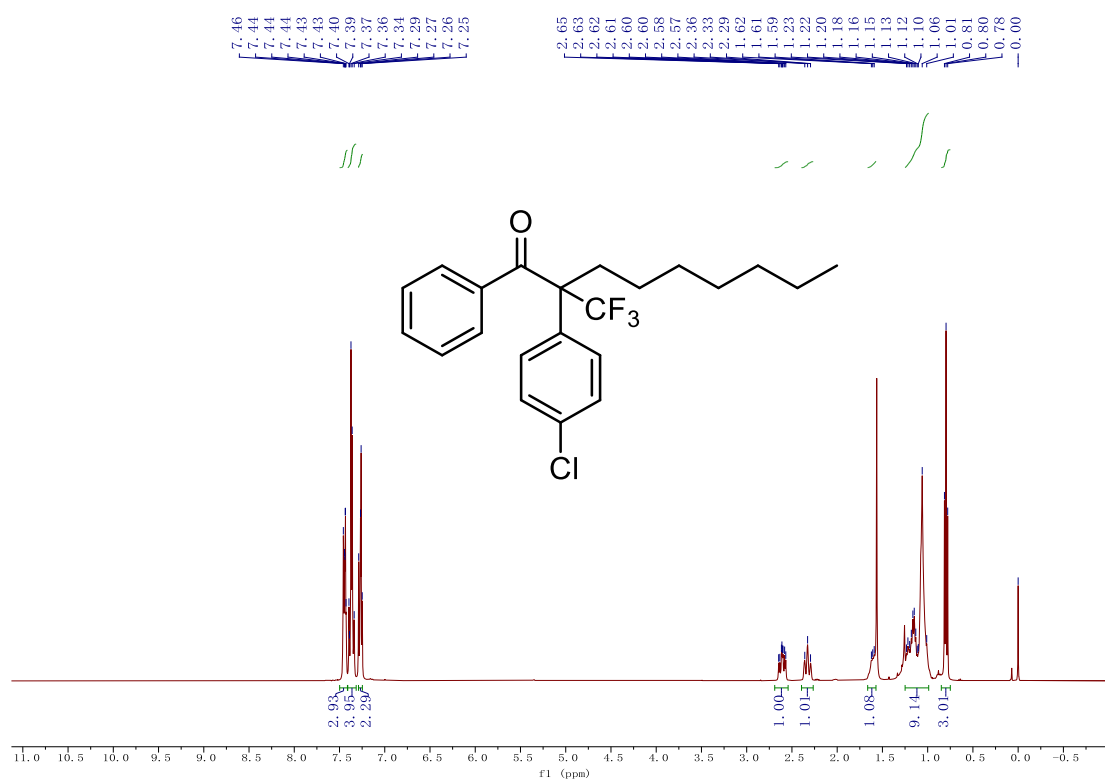
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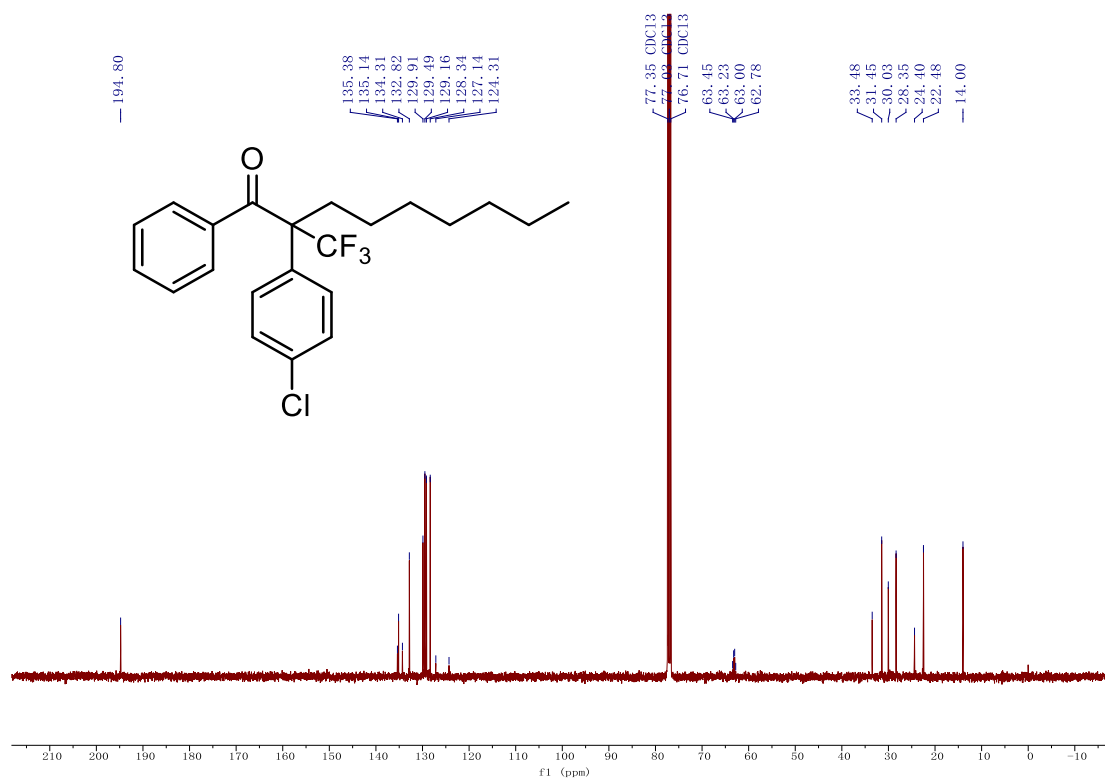
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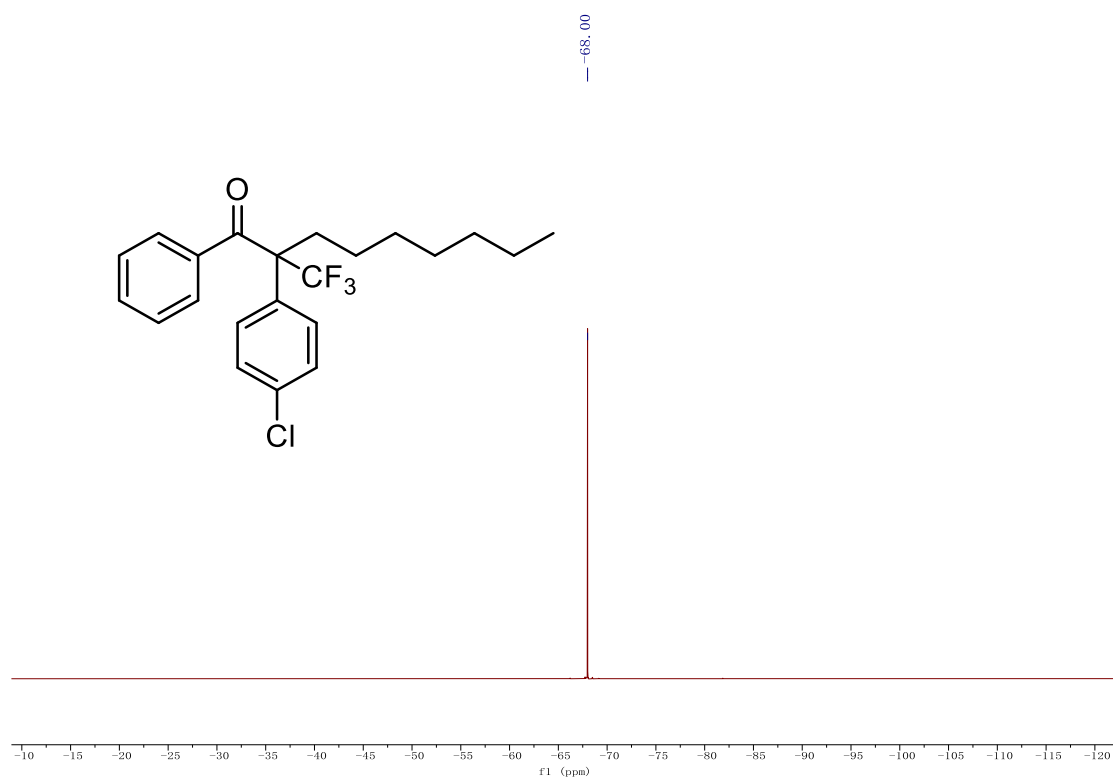
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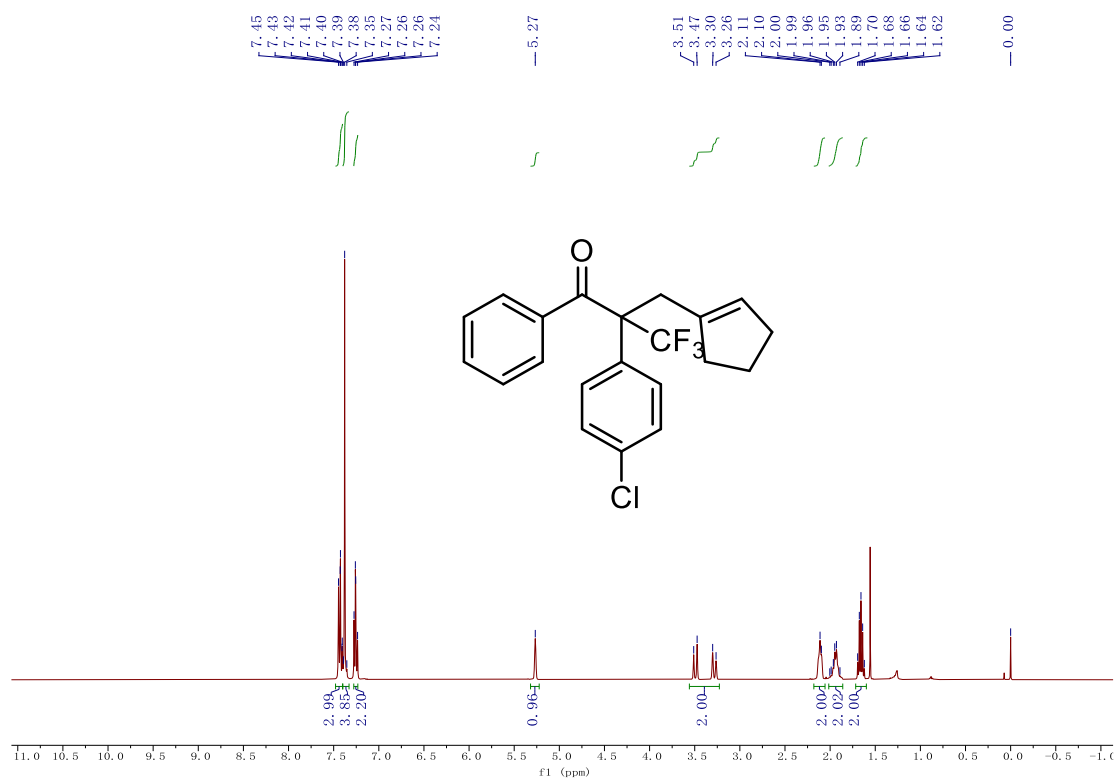
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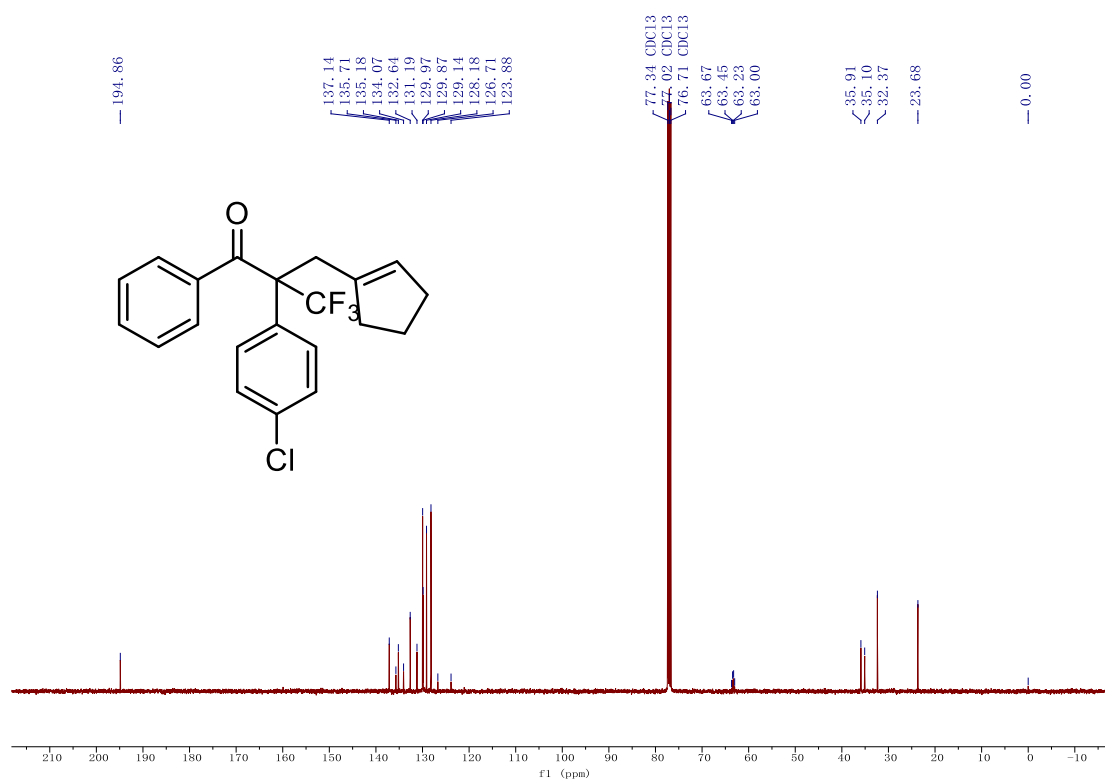
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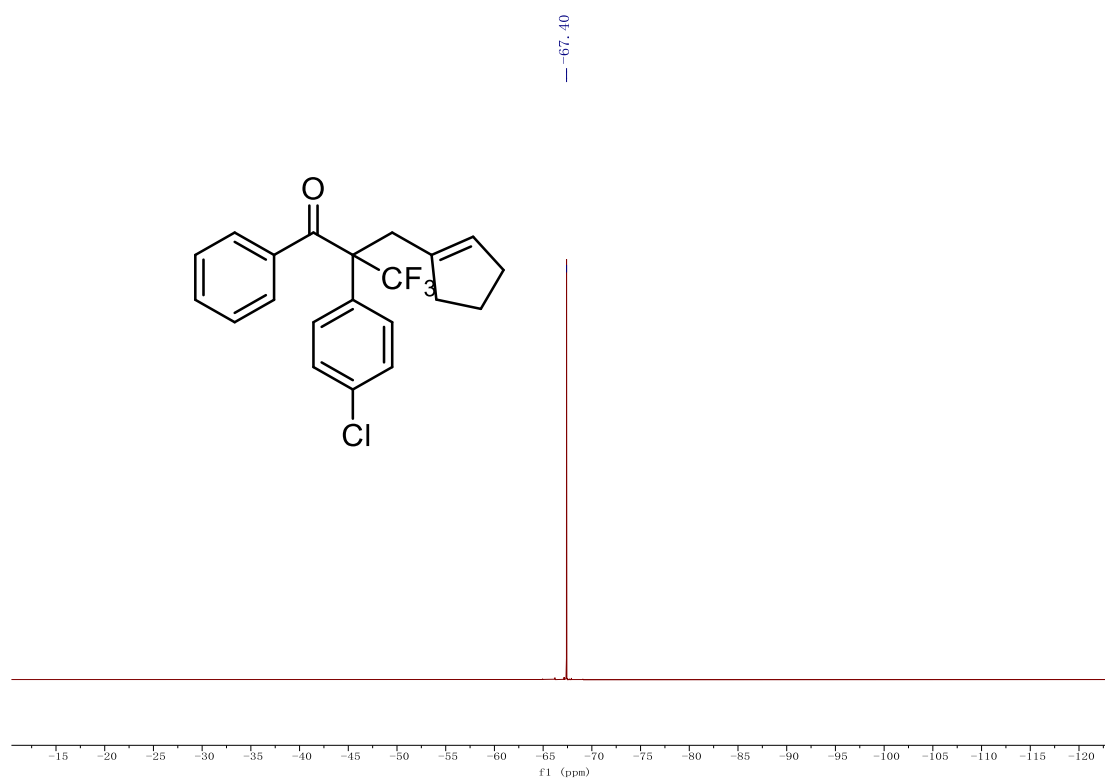
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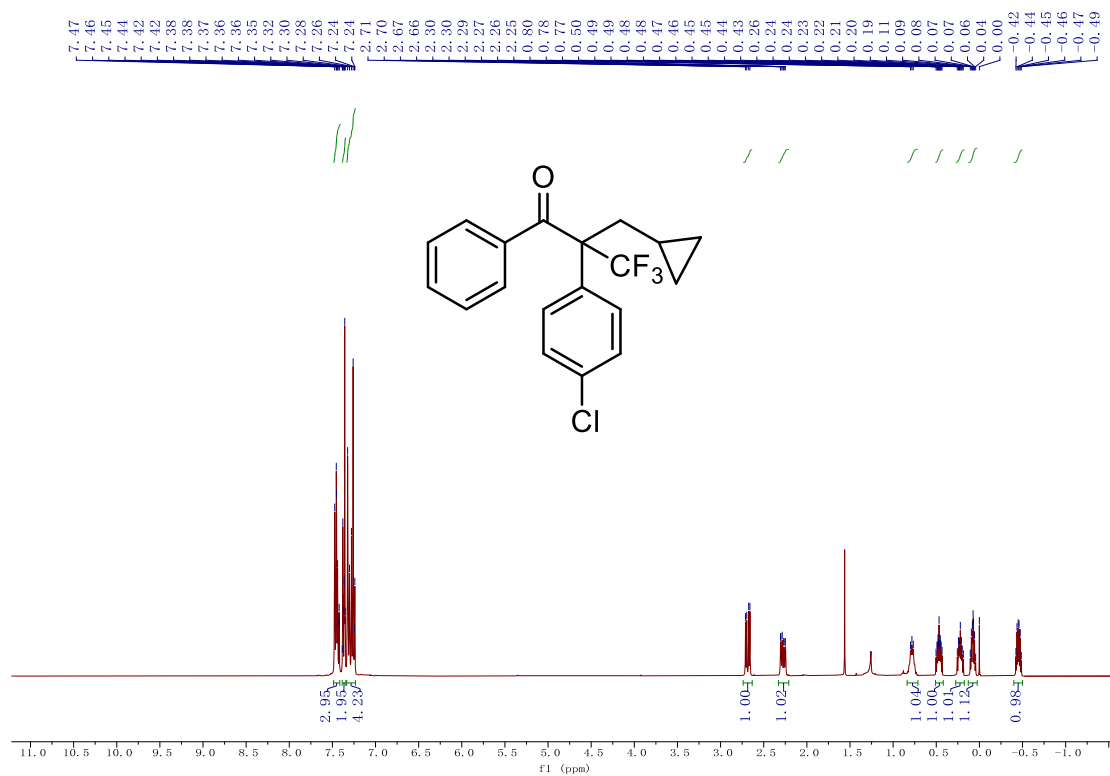
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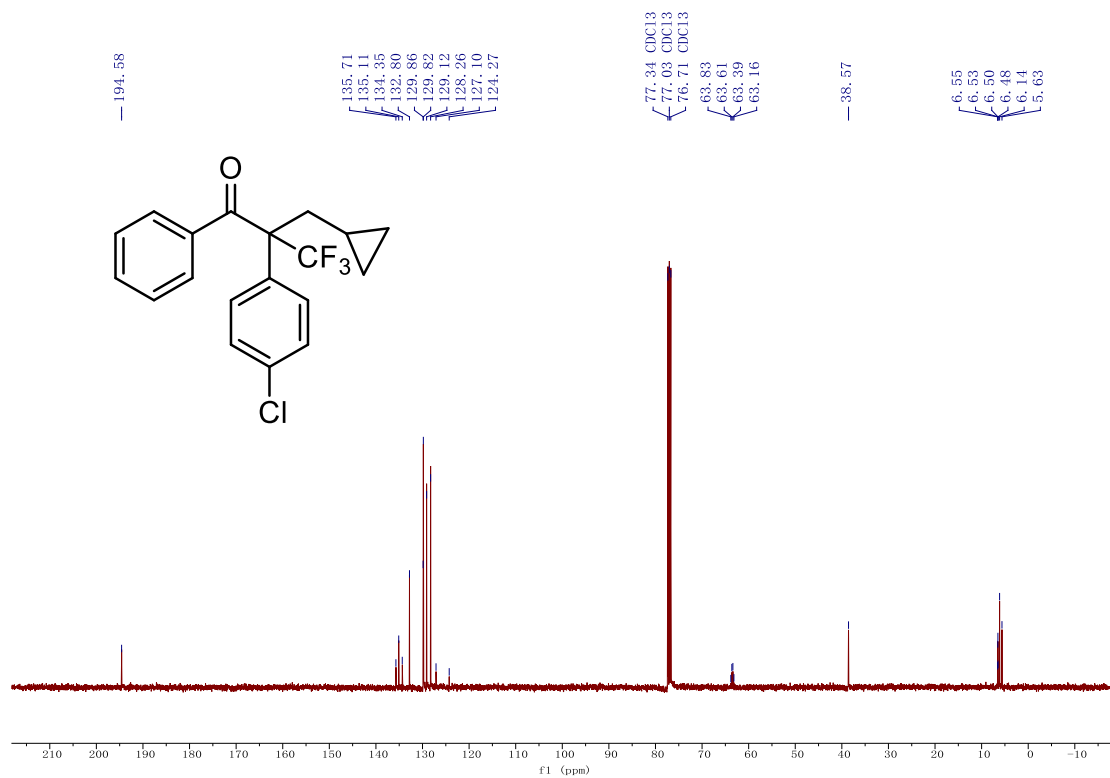
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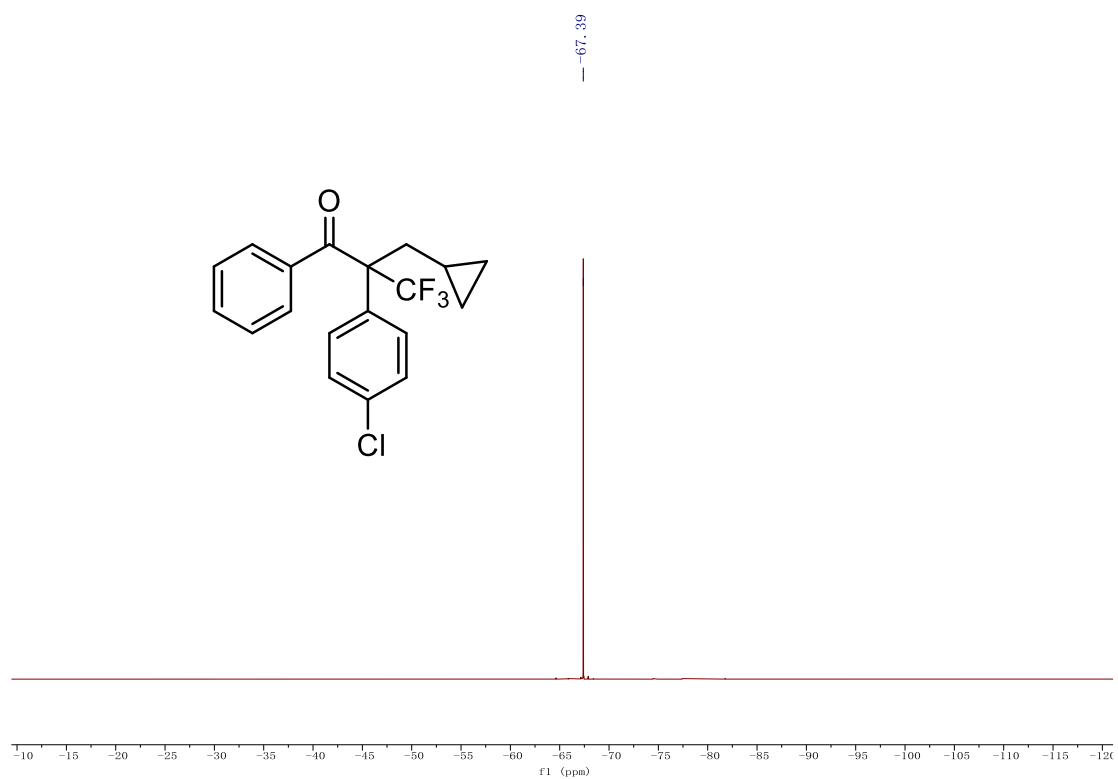
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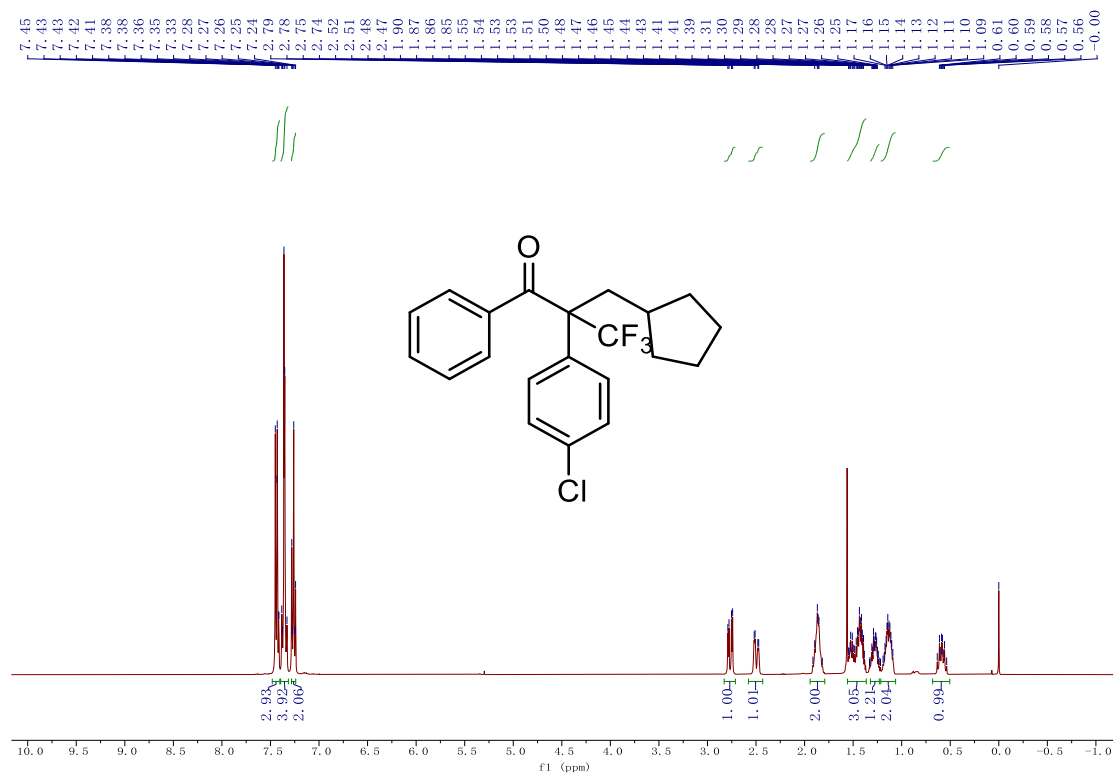
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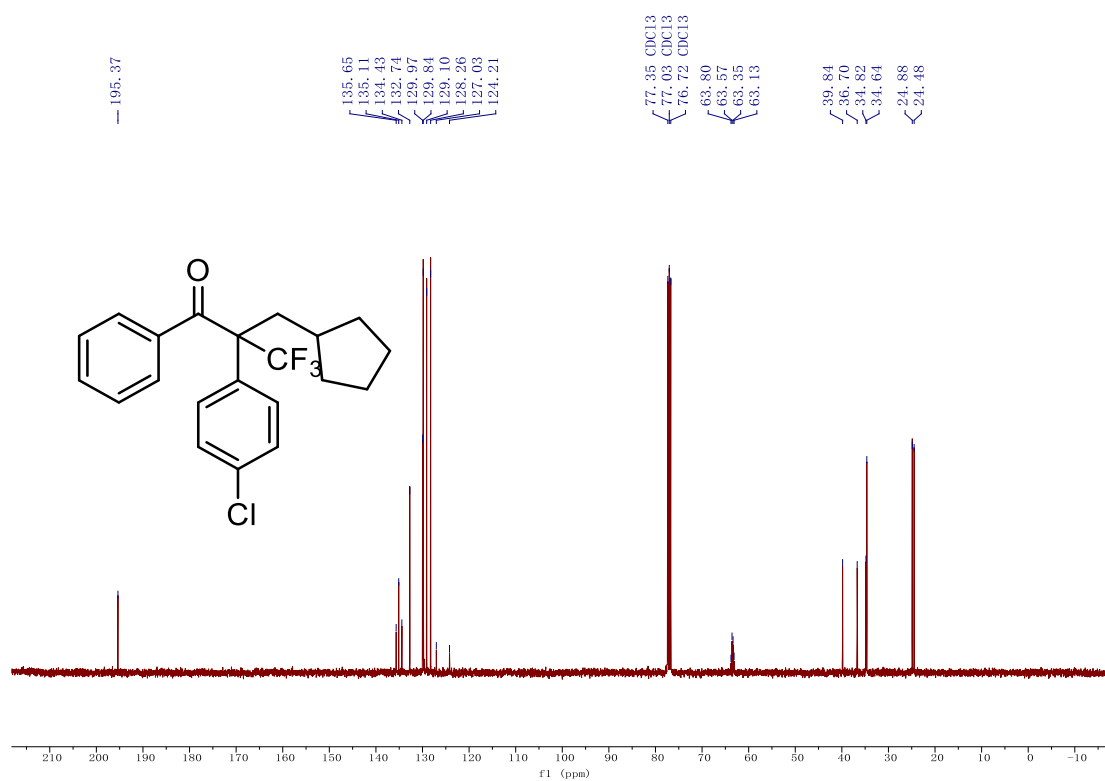
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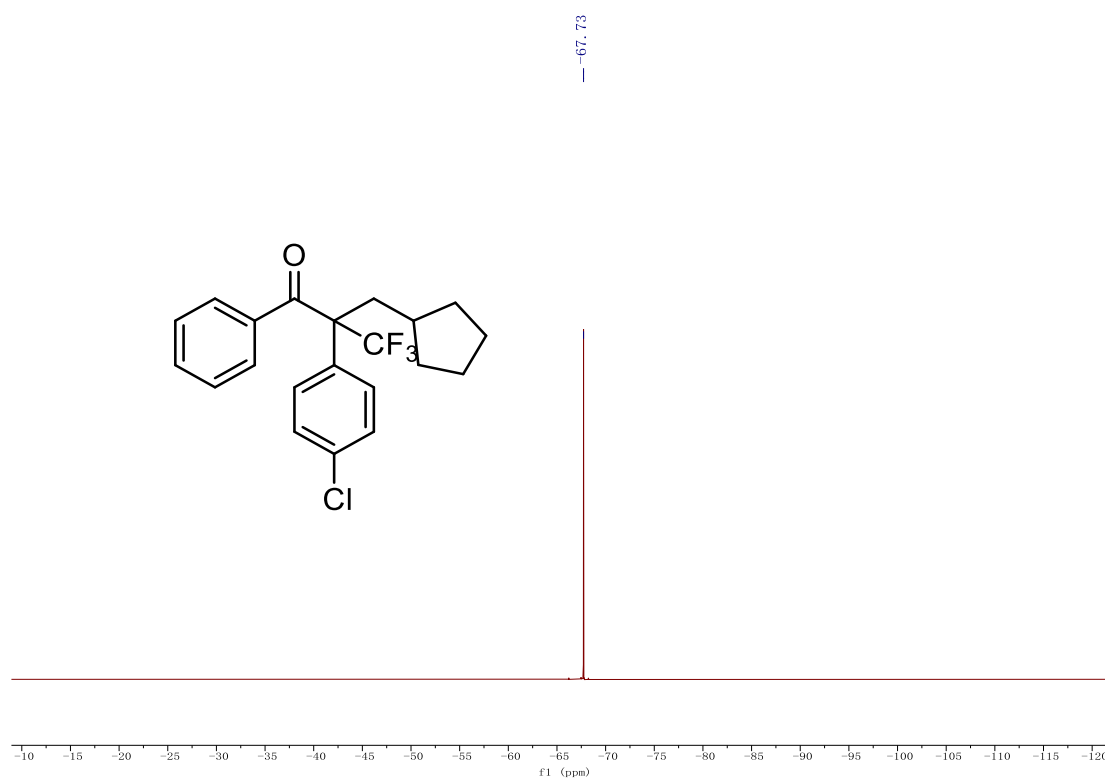
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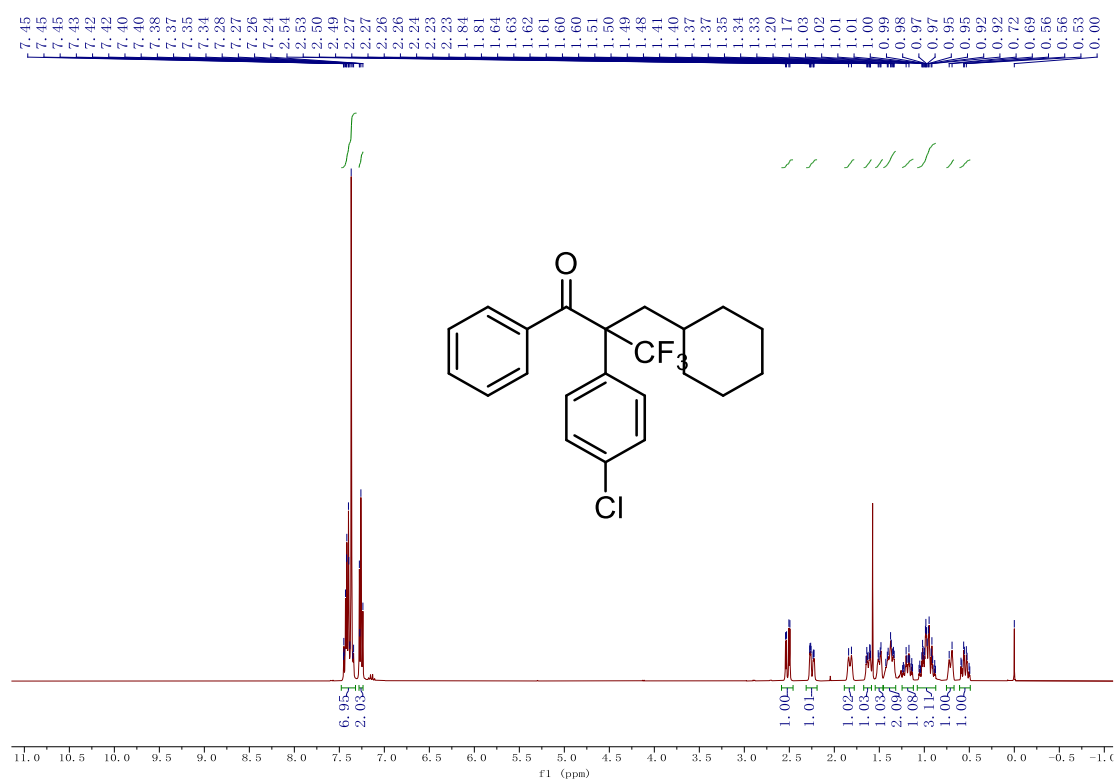
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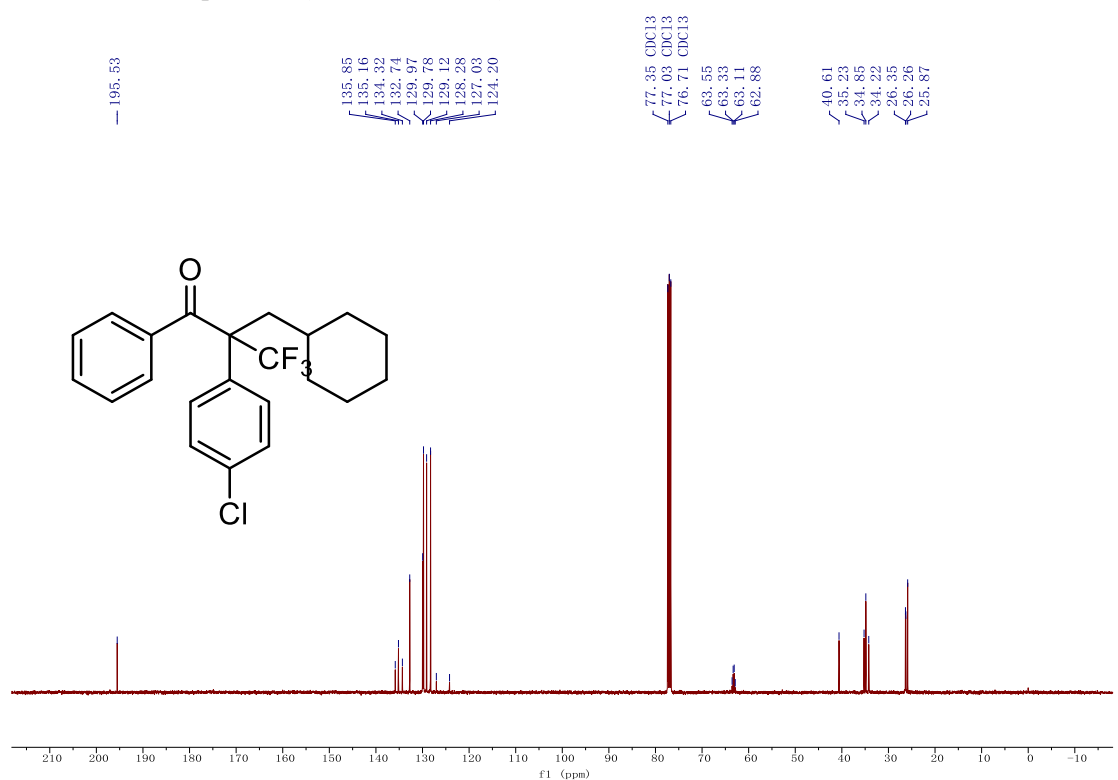
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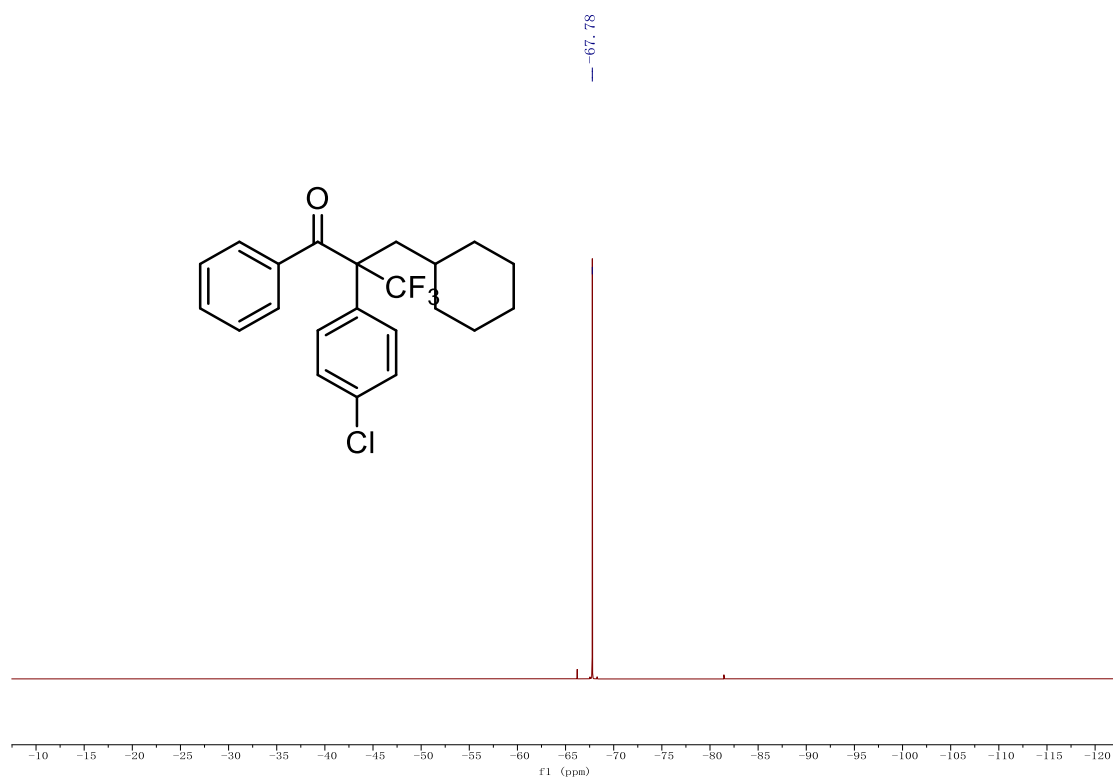
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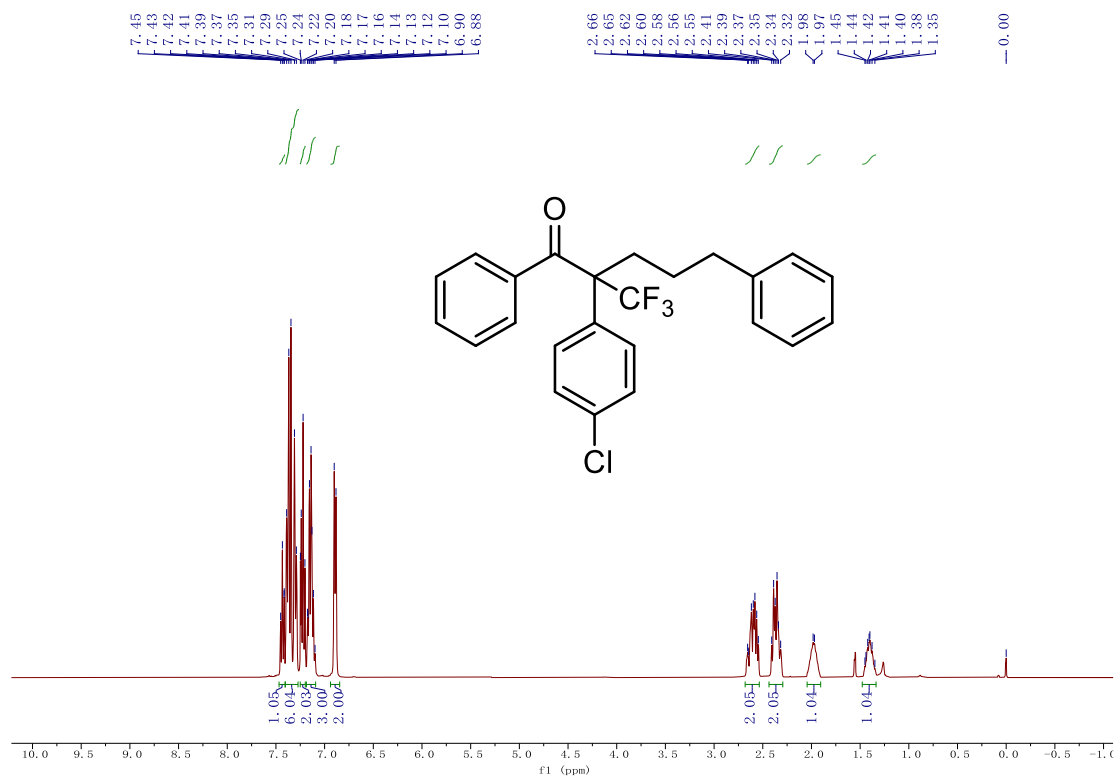
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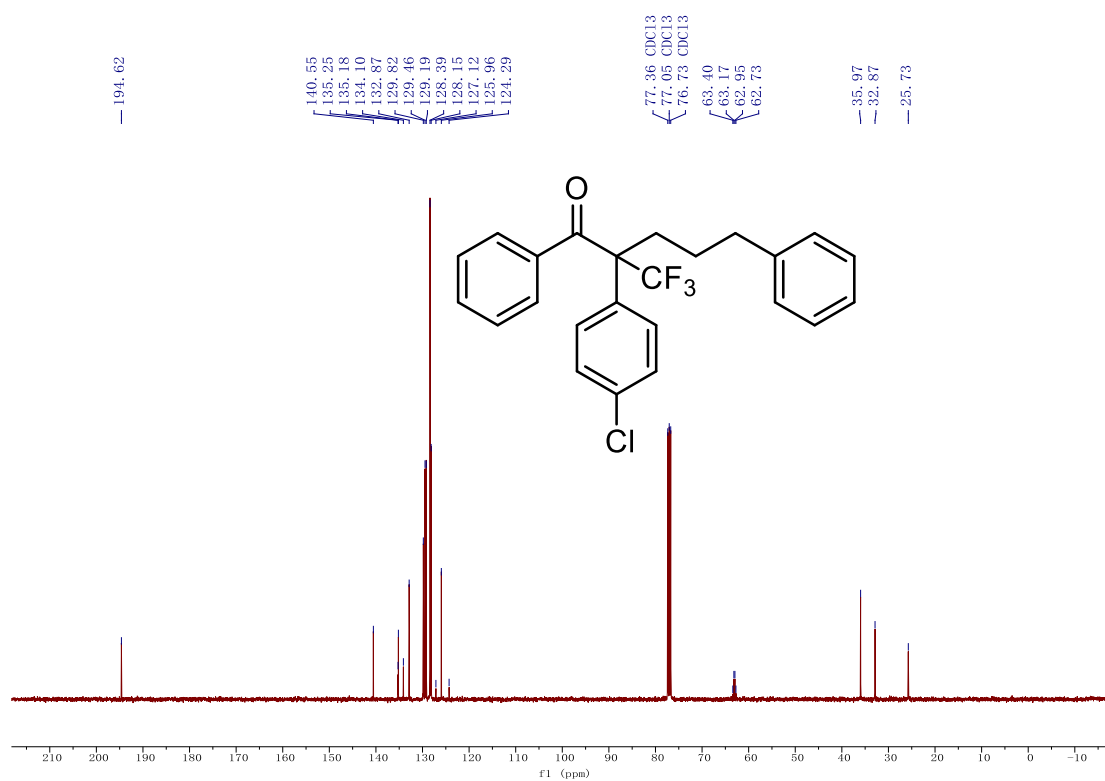
¹⁹F NMR-spectrum (376 MHz, CDCl₃) of 5i



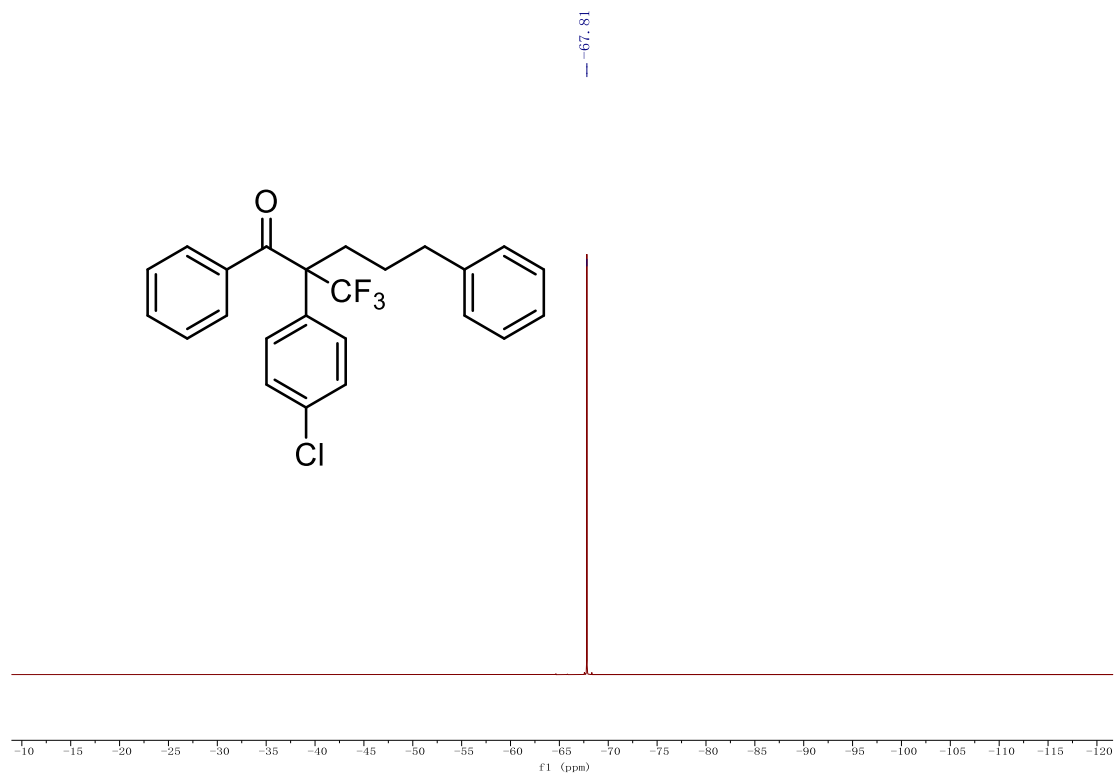
¹H NMR-spectrum (400MHz, CDCl₃) of 5j



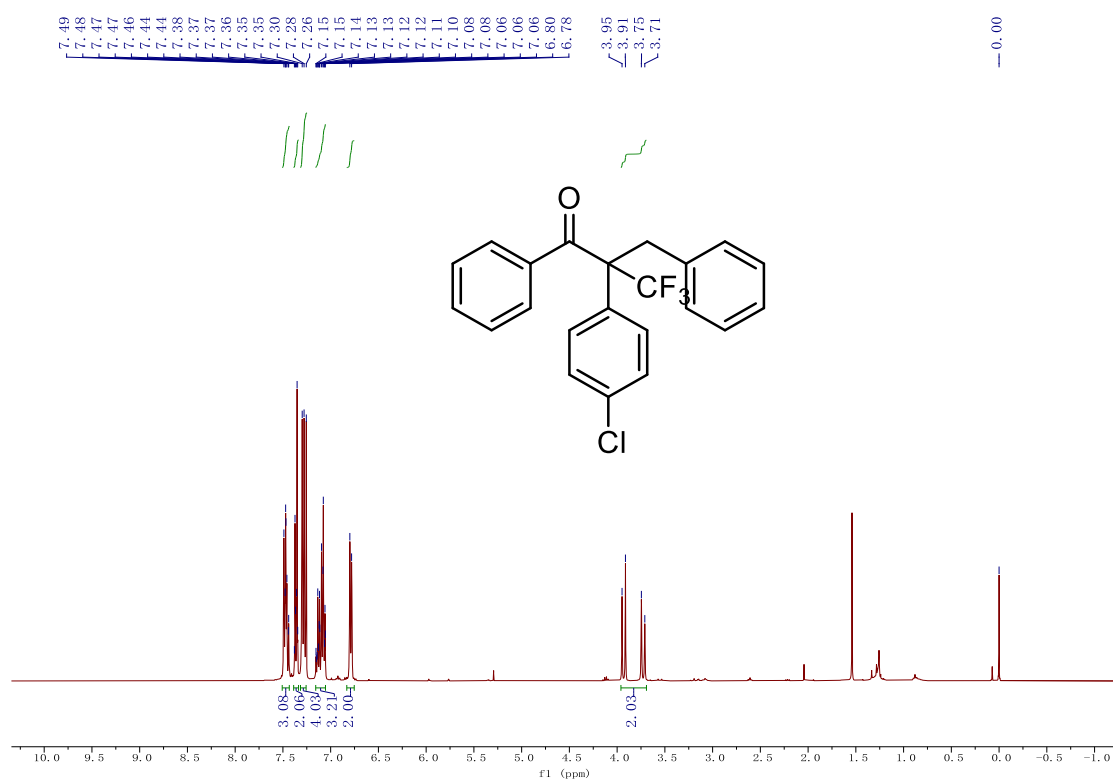
$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of **5j**



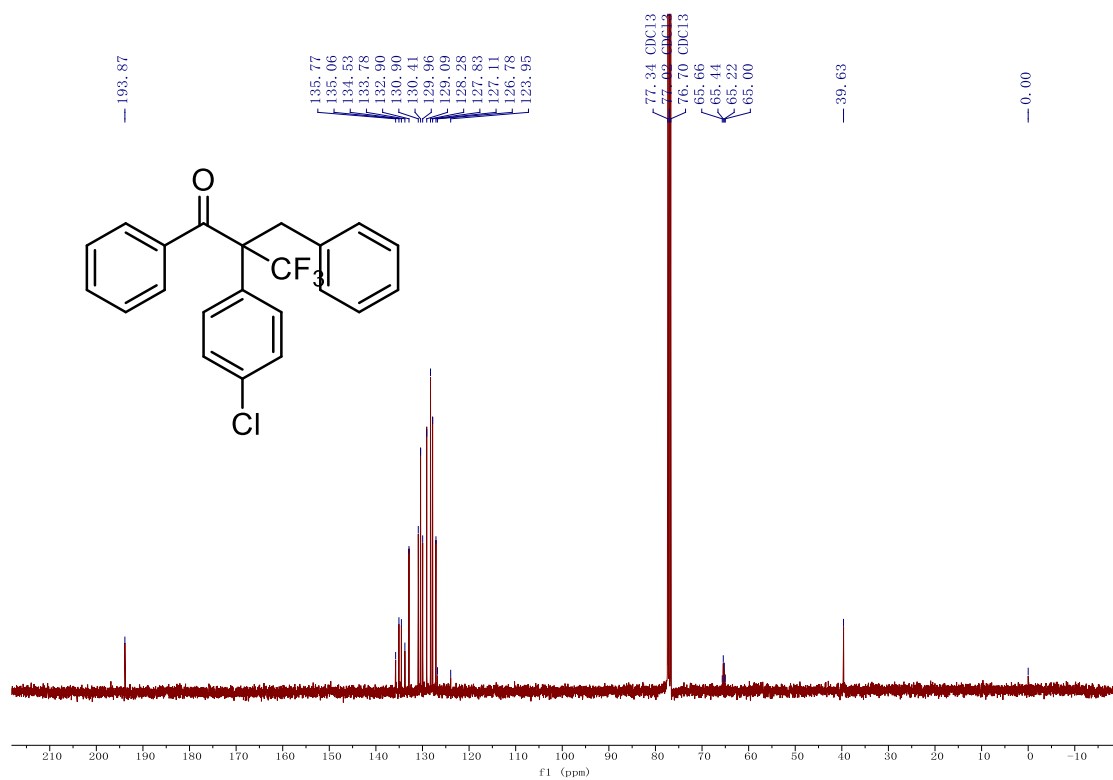
^{19}F NMR-spectrum (376 MHz, CDCl_3) of **5j**



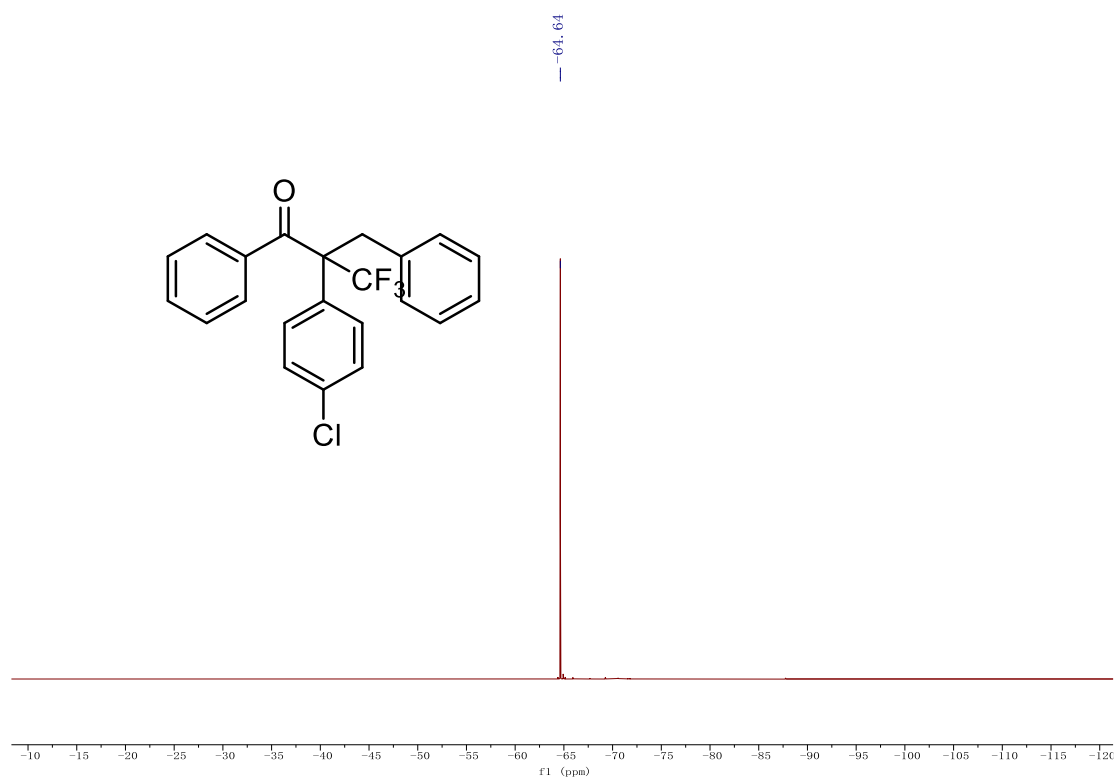
¹H NMR-spectrum (400MHz, CDCl₃) of **5k**



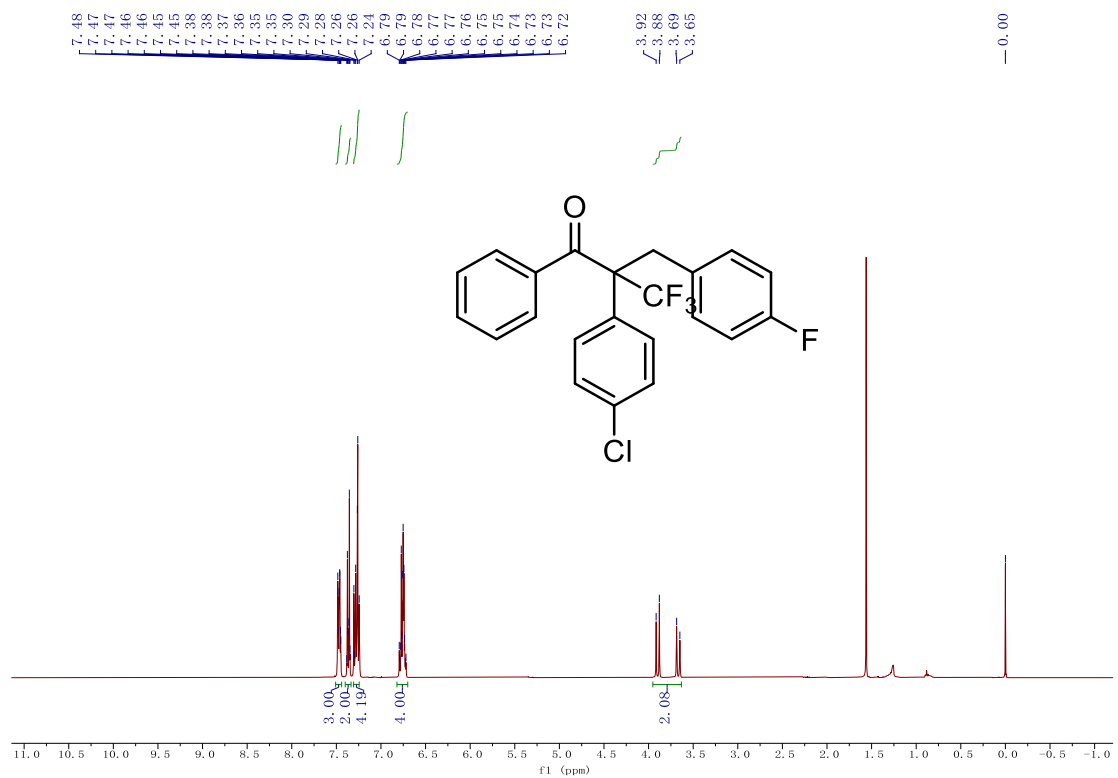
¹³C{¹H} NMR -spectrum (101MHz, CDCl₃) of **5k**



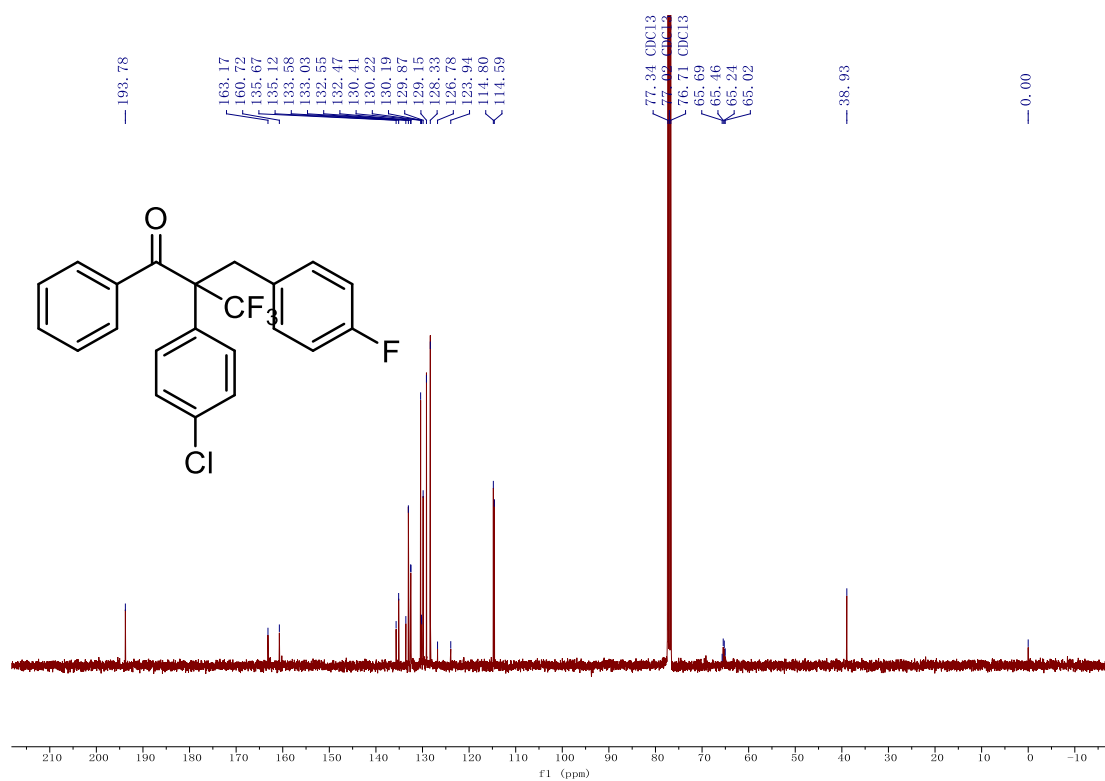
¹⁹F NMR-spectrum (376 MHz, CDCl₃) of **5k**



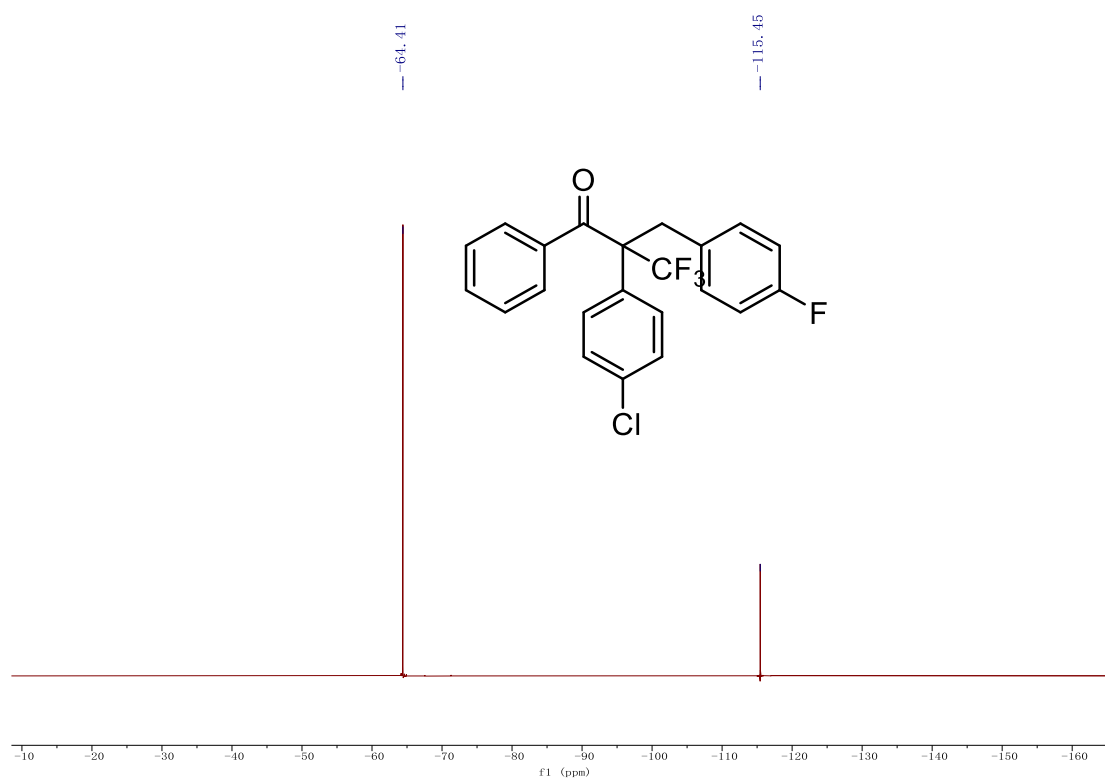
¹H NMR-spectrum (400MHz, CDCl₃) of **5l**



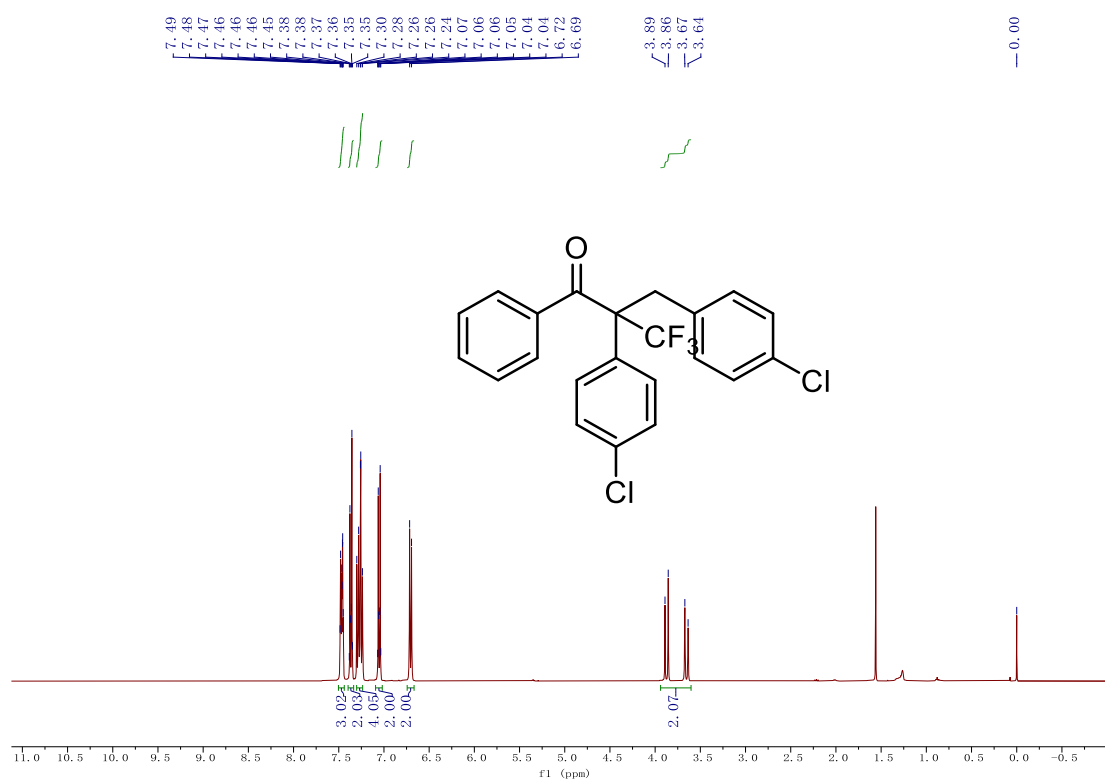
$^{13}\text{C}\{^1\text{H}\}$ NMR -spectrum (101MHz, CDCl_3) of **51**



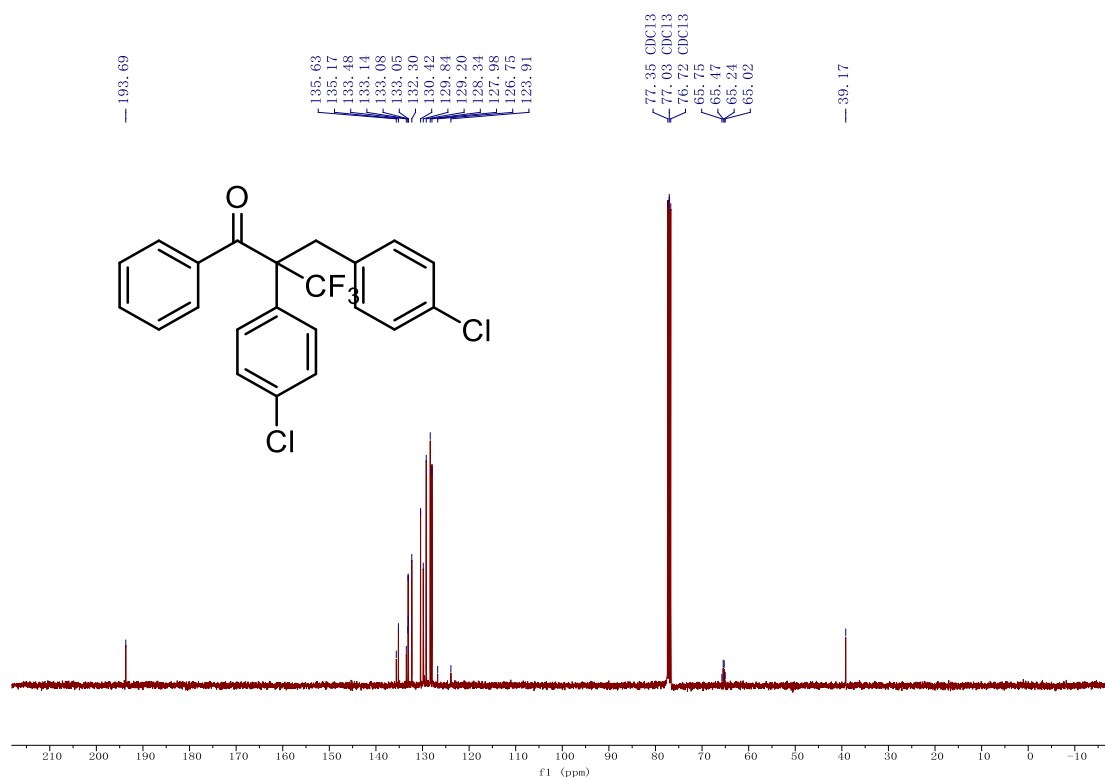
^{19}F NMR-spectrum (376 MHz, CDCl_3) of **51**



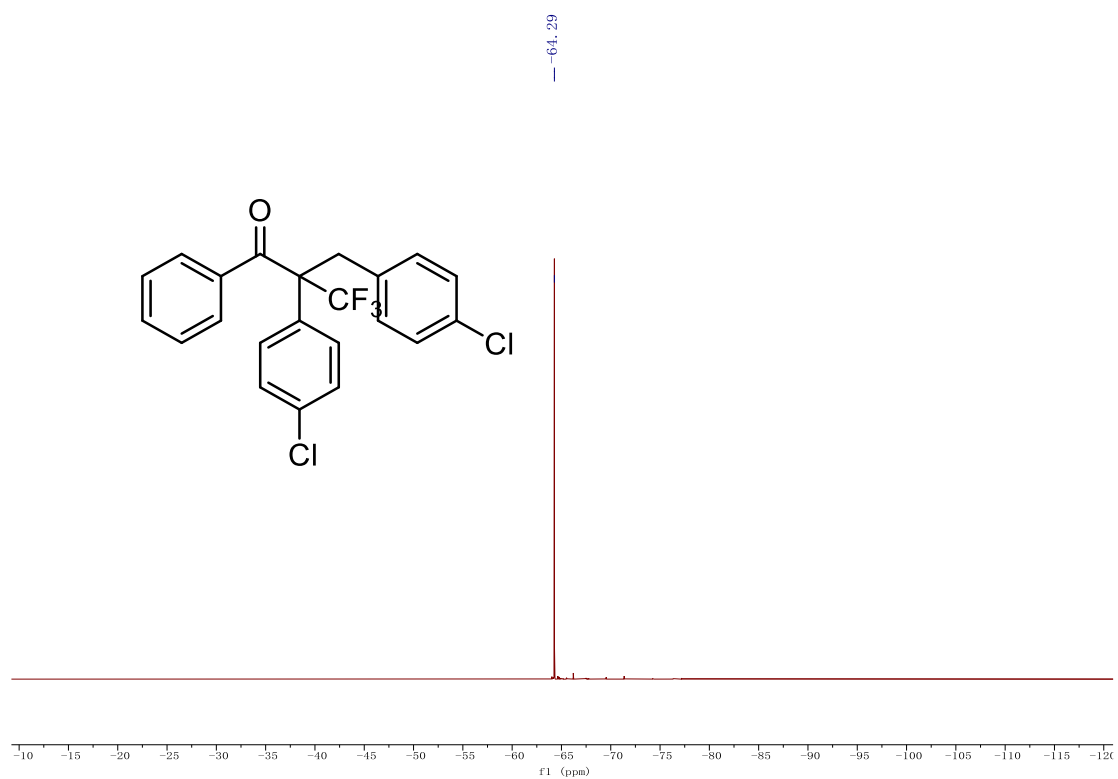
¹H NMR-spectrum (400MHz, CDCl₃) of **5m**



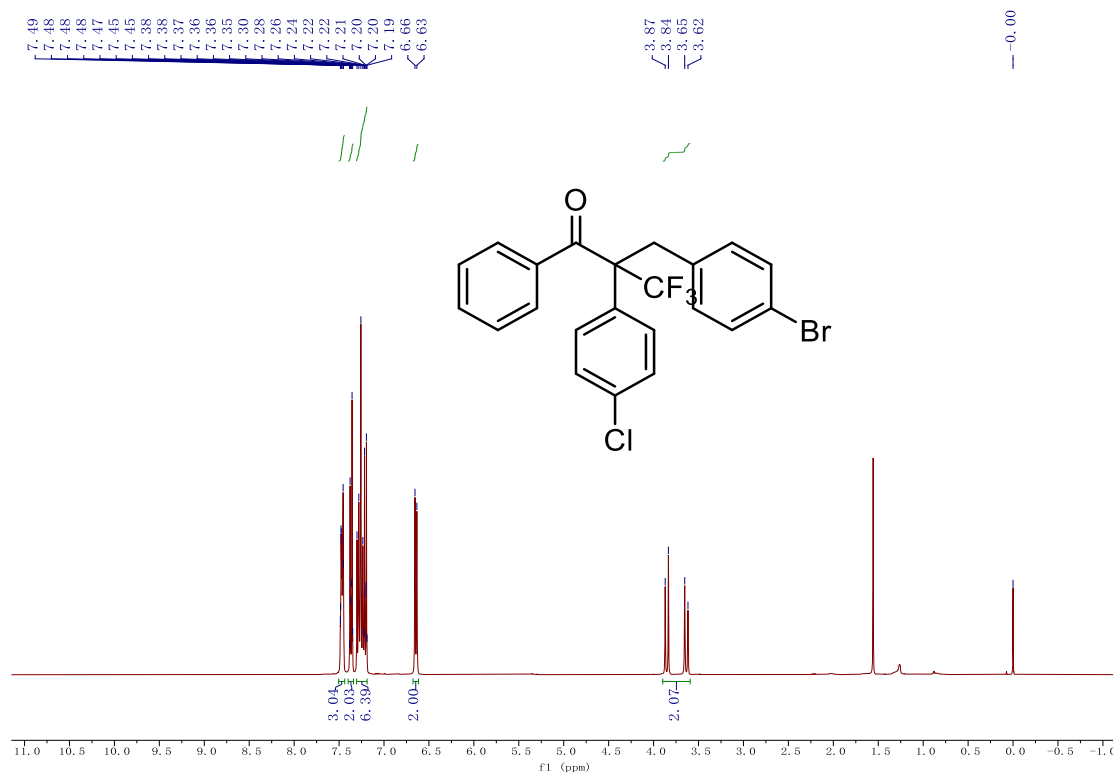
¹³C{¹H} NMR -spectrum (101MHz, CDCl₃) of **5m**



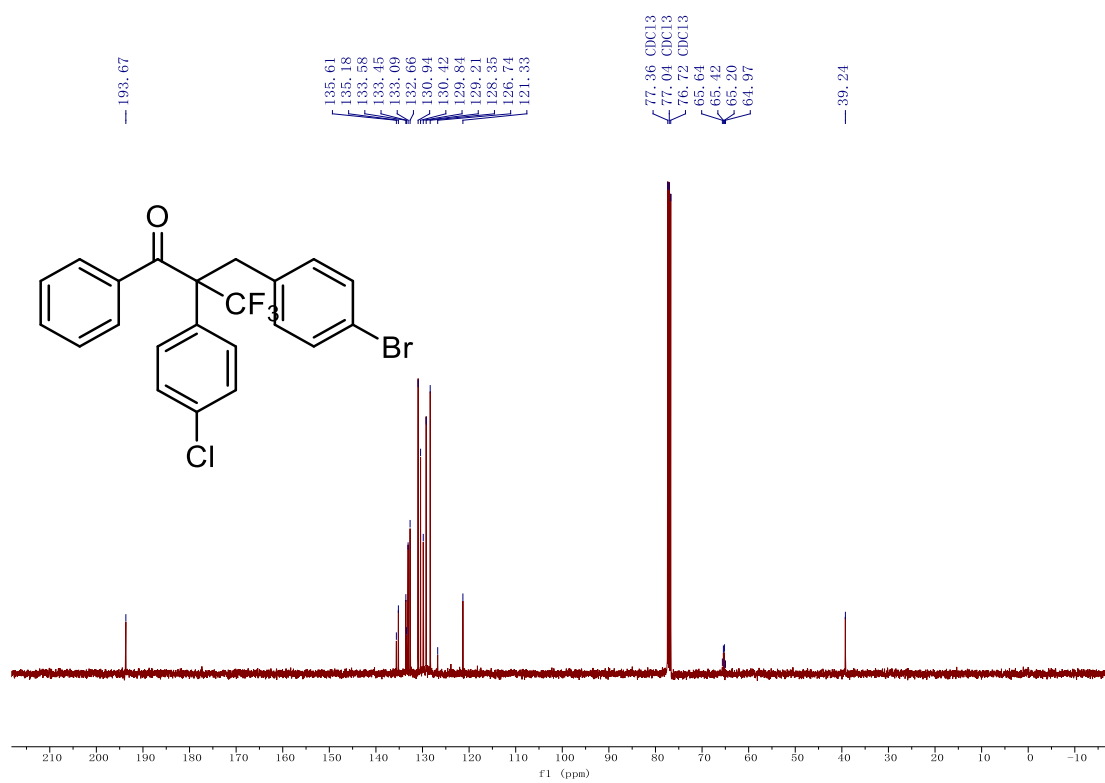
¹⁹F NMR-spectrum (376 MHz, CDCl₃) of **5m**



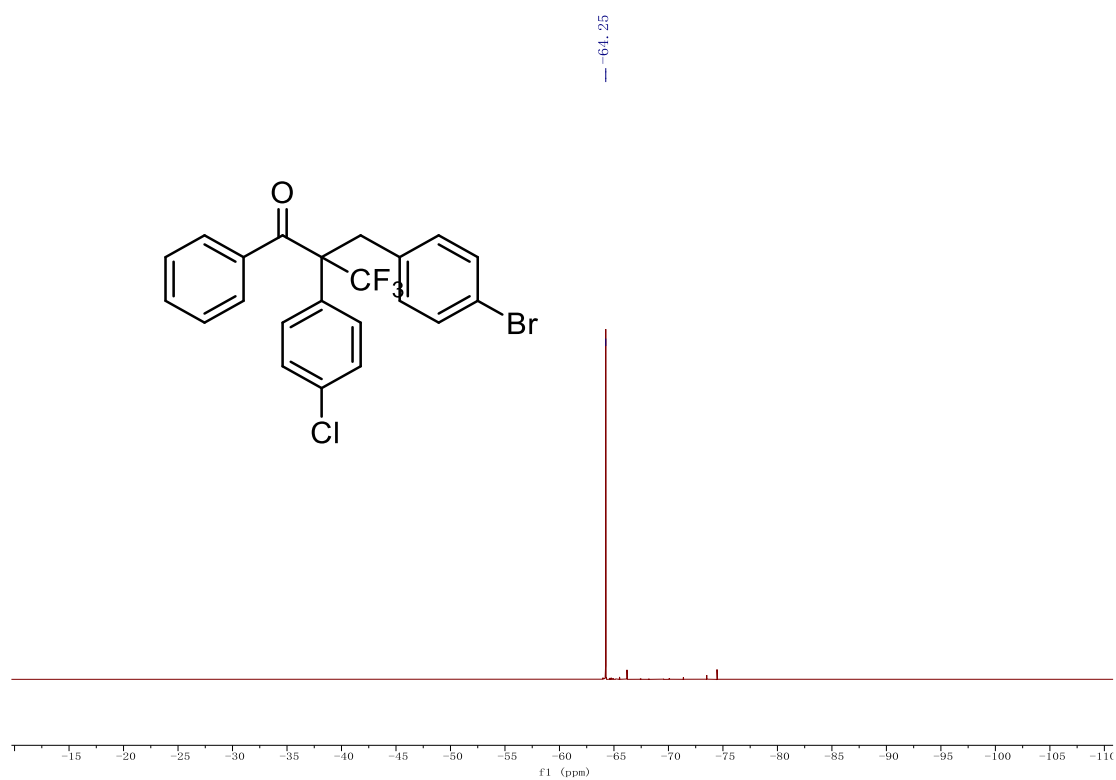
¹H NMR-spectrum (400MHz, CDCl₃) of **5n**



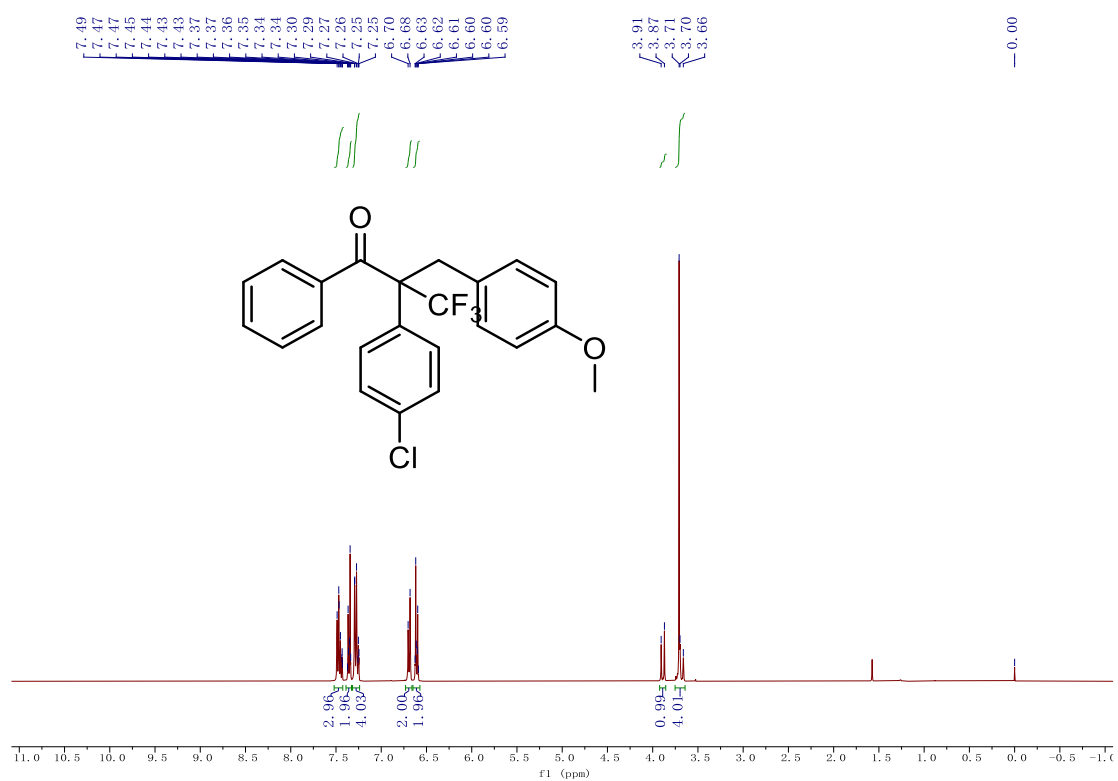
$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of **5n**



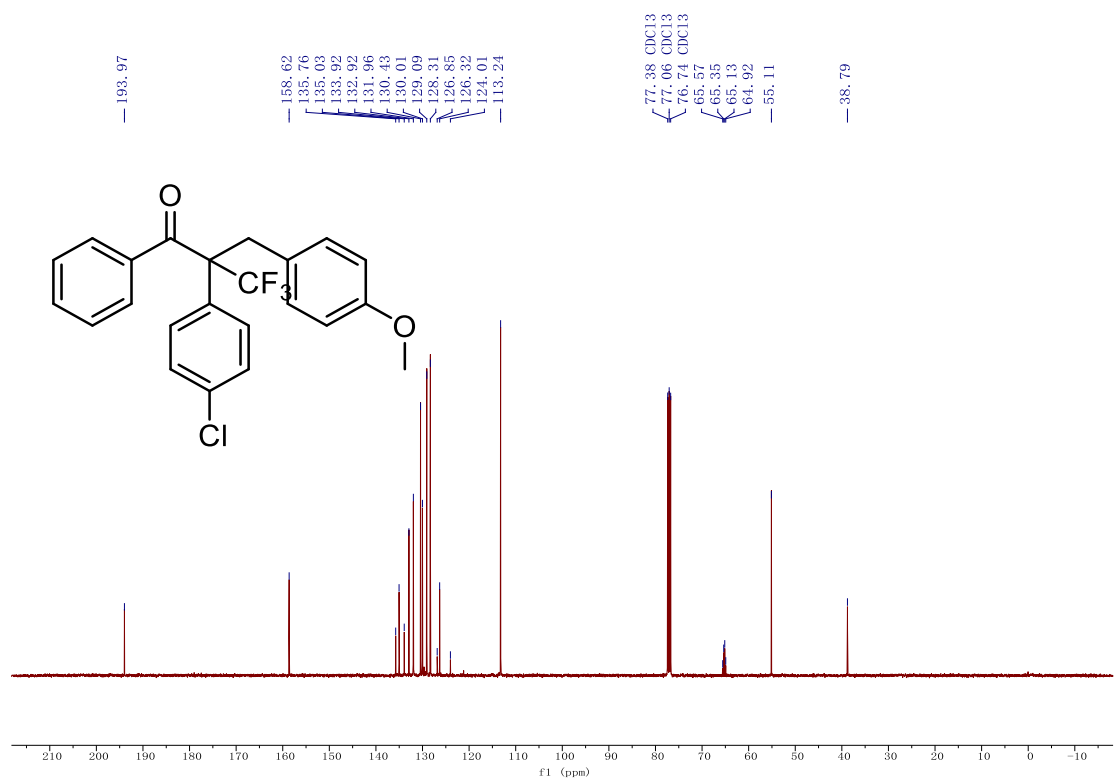
^{19}F NMR-spectrum (376 MHz, CDCl_3) of **5n**



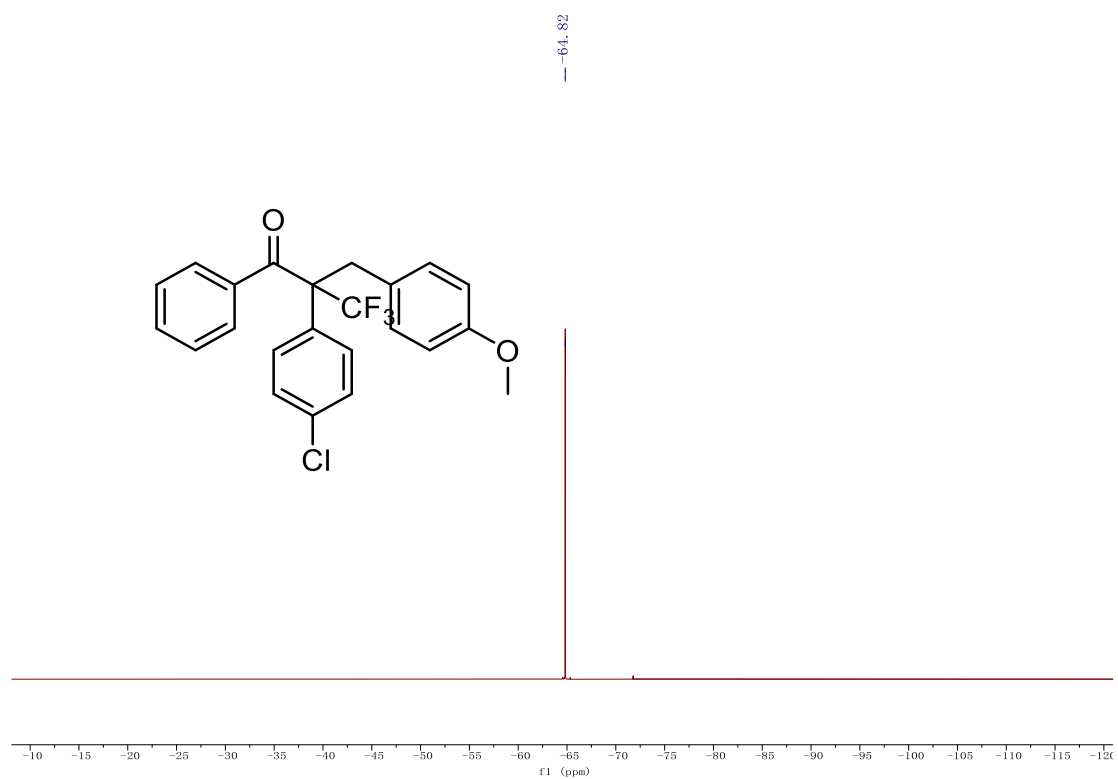
¹H NMR-spectrum (400MHz, CDCl₃) of **5o**



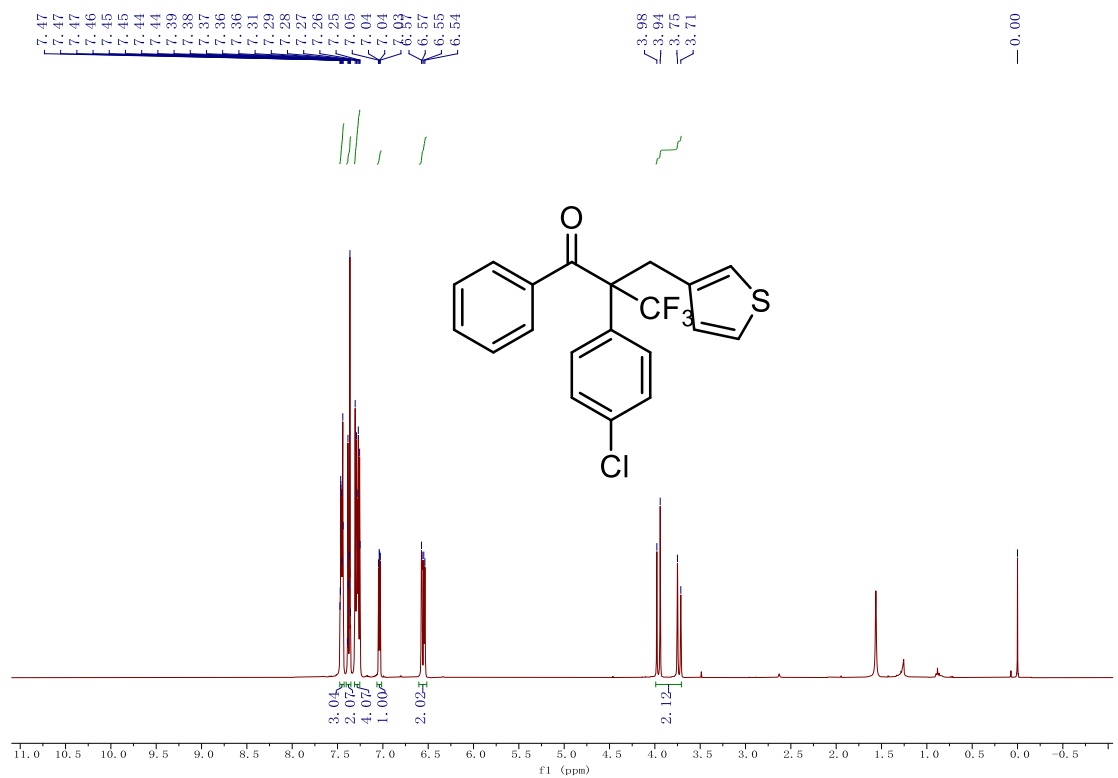
¹³C{¹H} NMR -spectrum (101MHz, CDCl₃) of **5o**



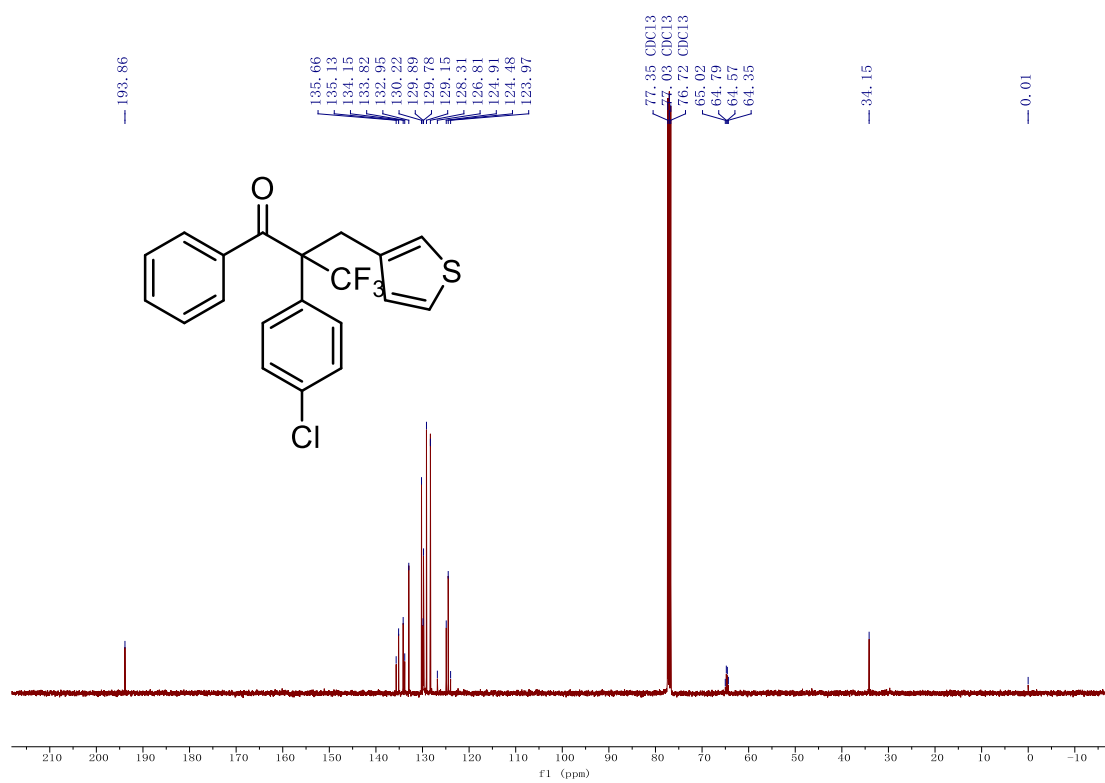
¹⁹F NMR-spectrum (376 MHz, CDCl₃) of **5o**



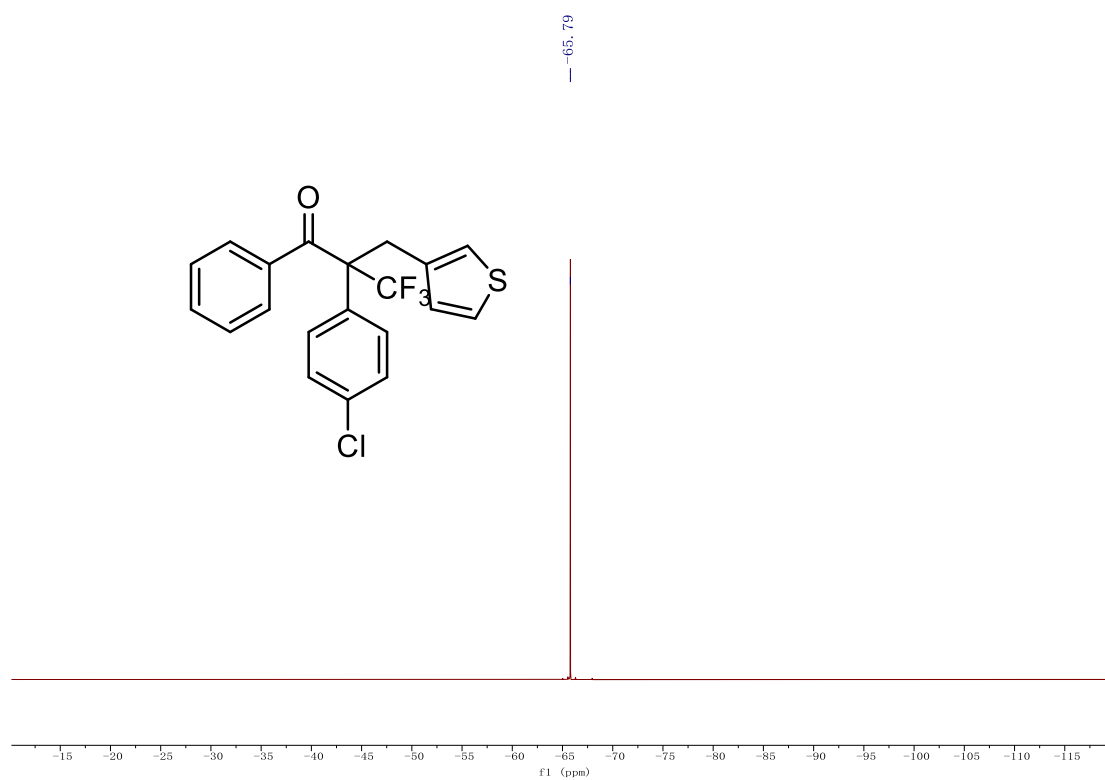
¹H NMR-spectrum (400MHz, CDCl₃) of **5p**



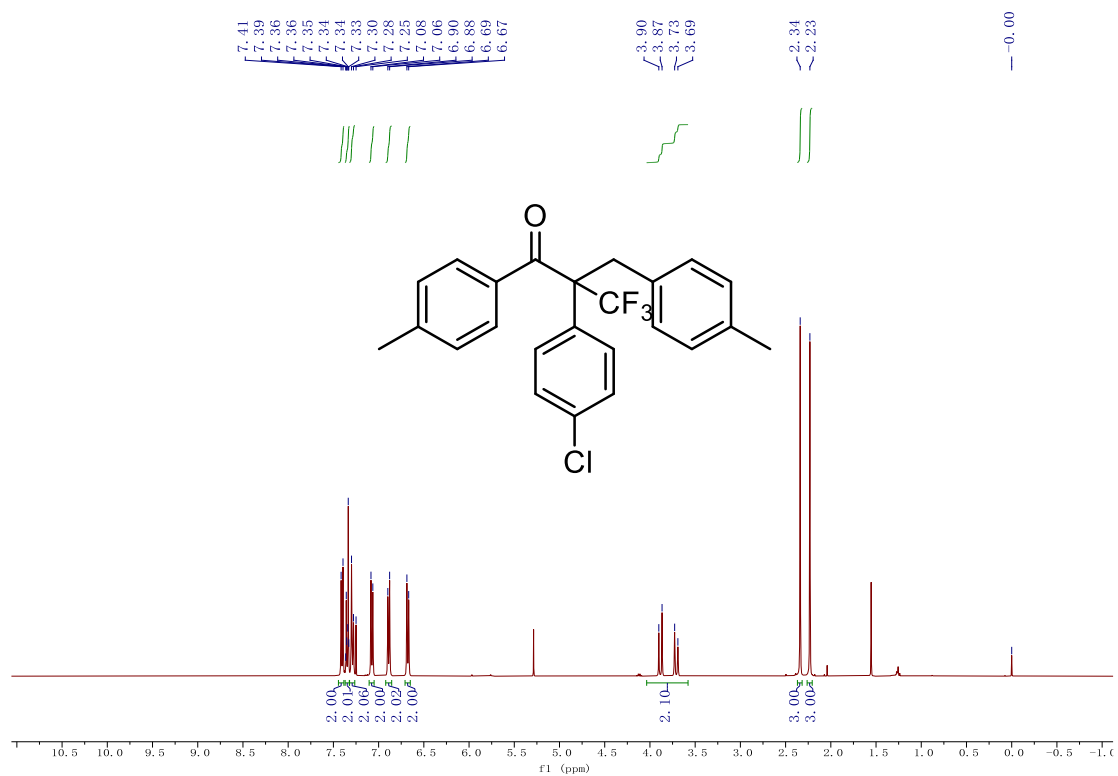
$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of **5p**



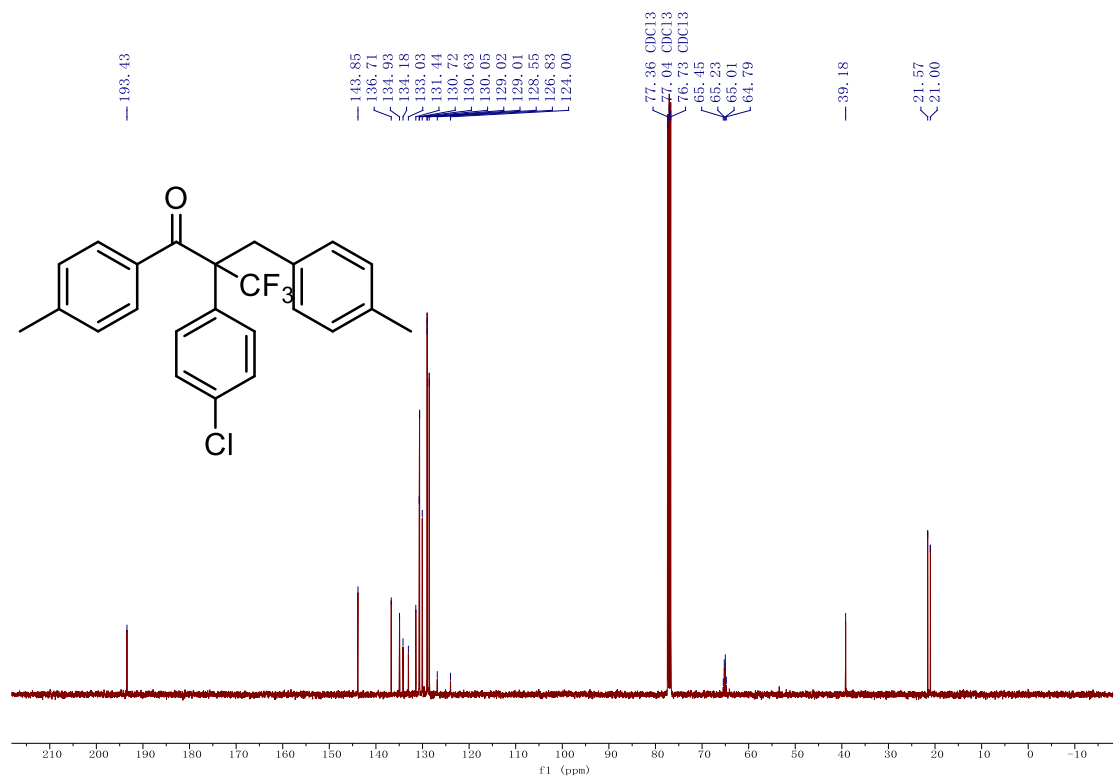
^{19}F NMR-spectrum (376 MHz, CDCl_3) of **5p**



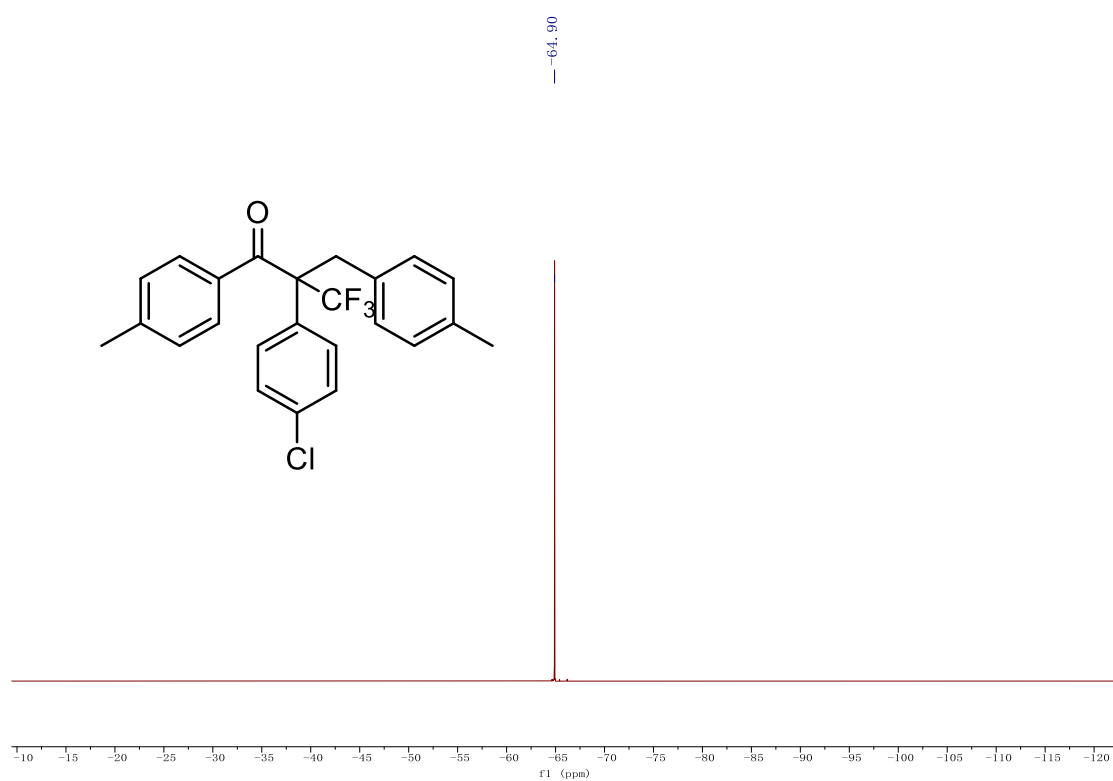
¹H NMR-spectrum (400MHz, CDCl₃) of **6a**



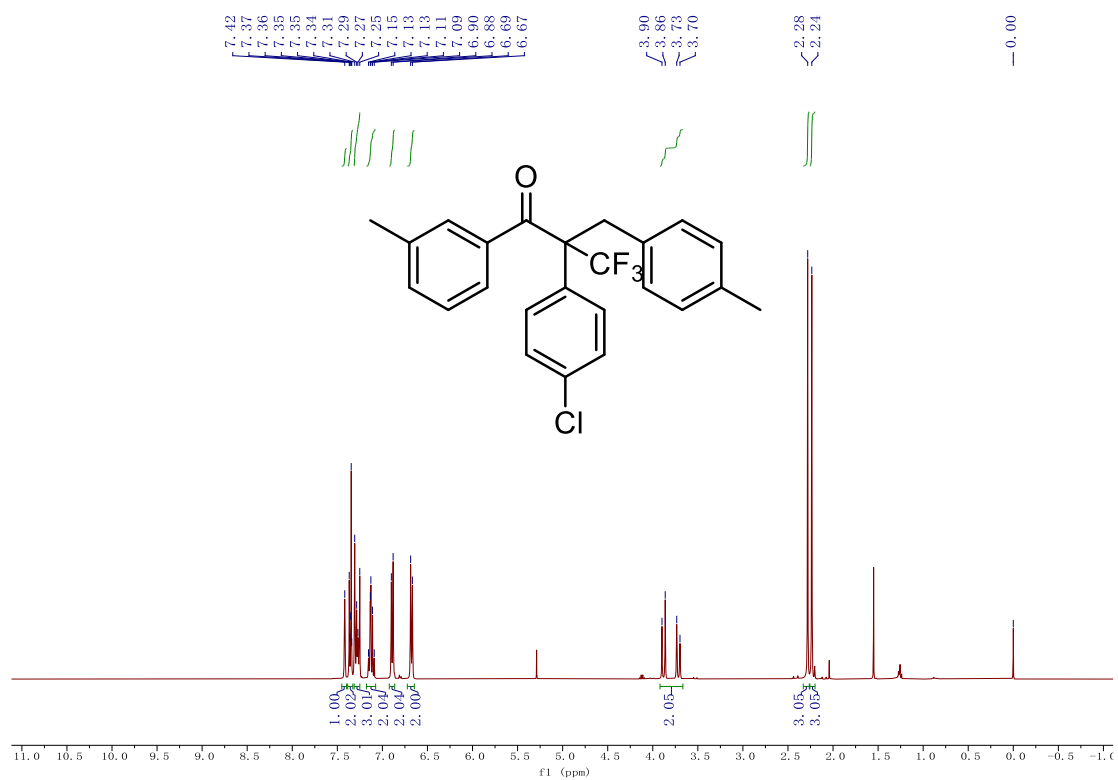
¹³C{¹H} NMR-spectrum (101MHz, CDCl₃) of **6a**



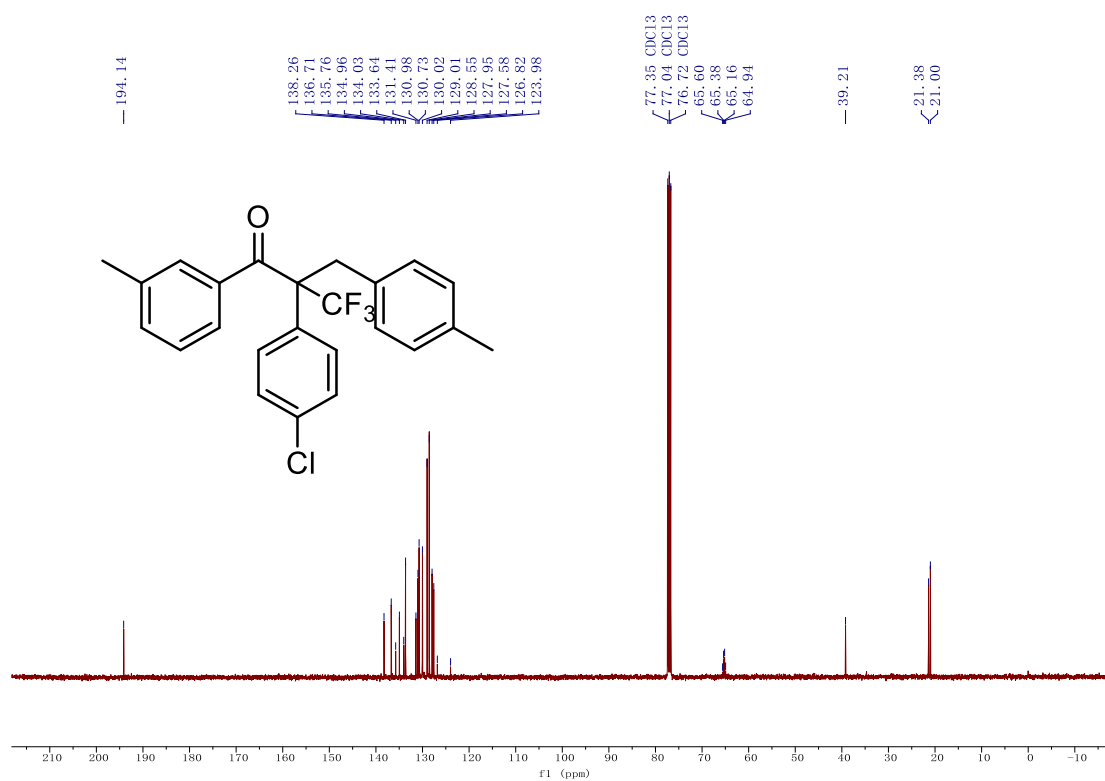
¹⁹F NMR-spectrum (376 MHz, CDCl₃) of **6a**



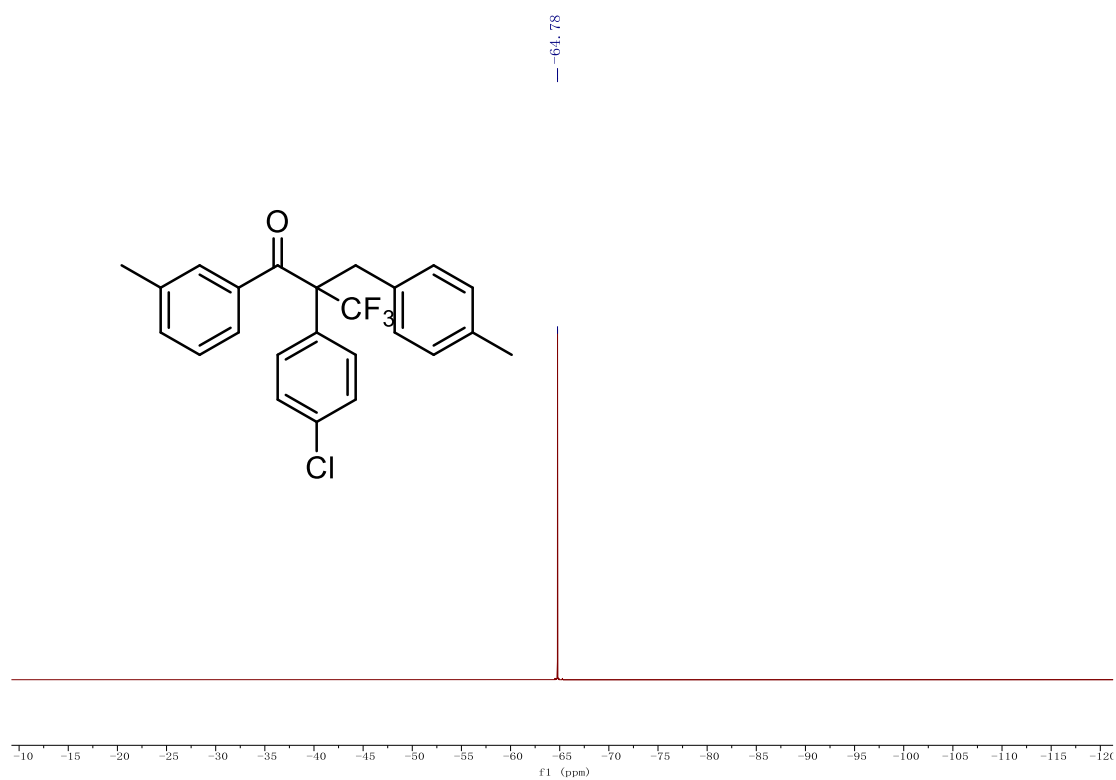
¹H NMR-spectrum (400MHz, CDCl₃) of **6b**



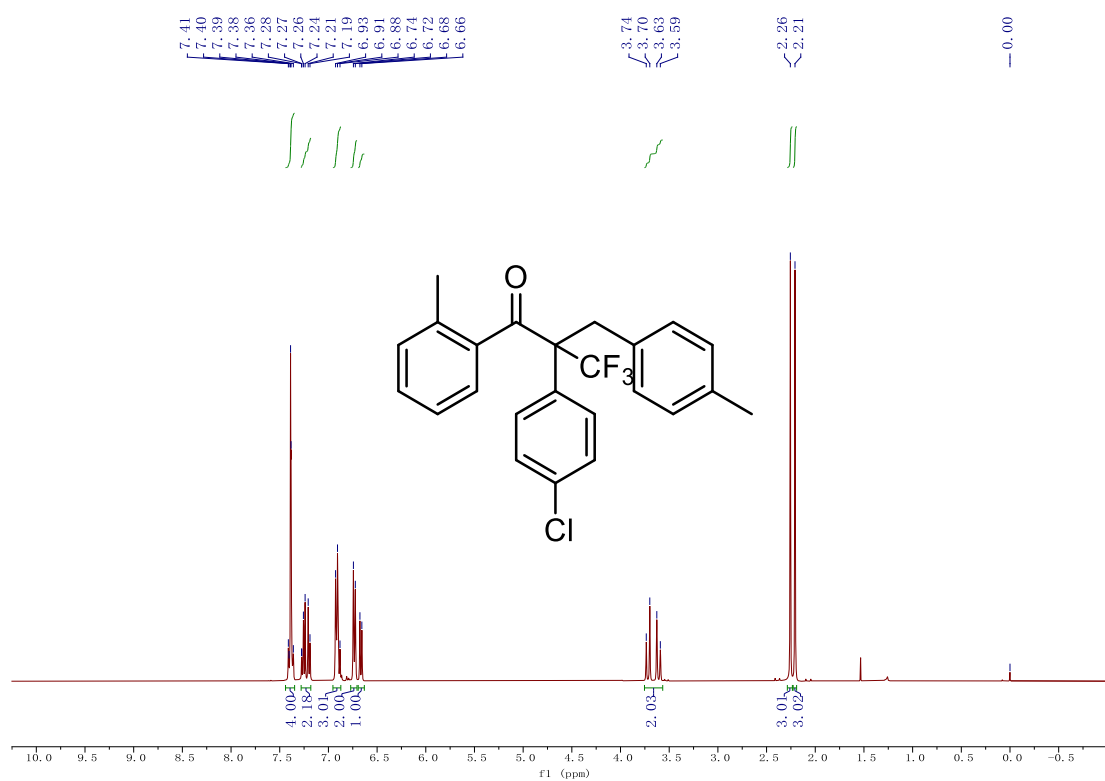
$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of **6b**



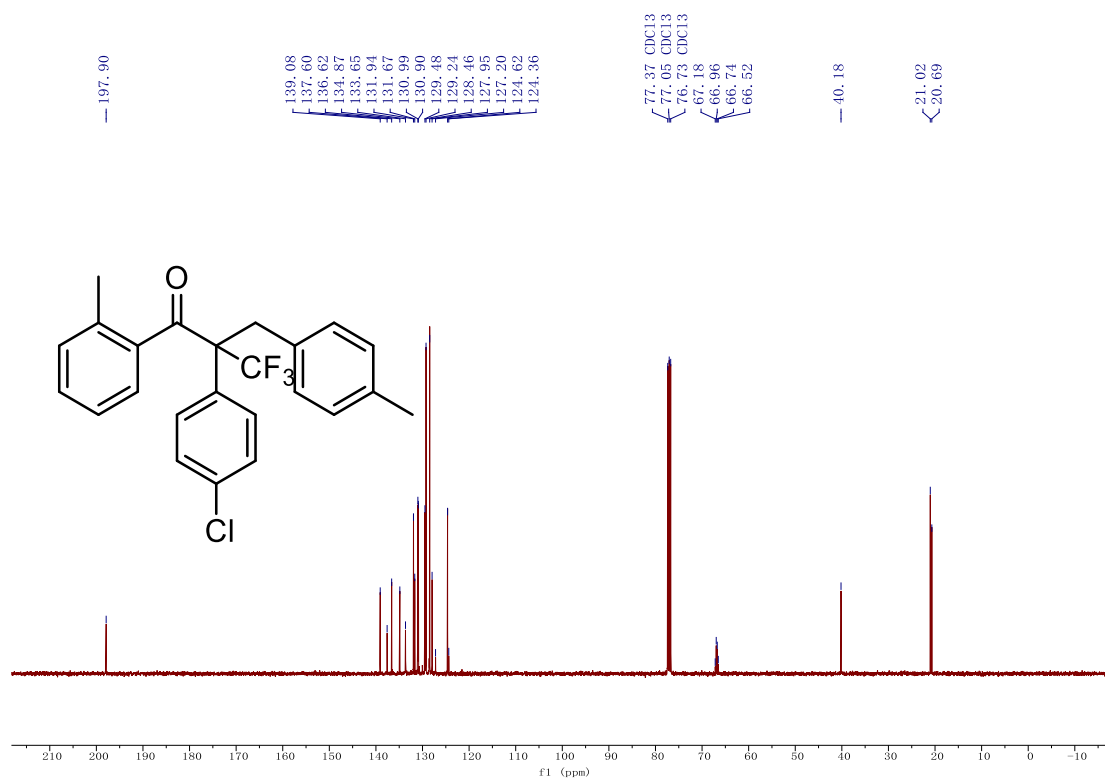
^{19}F NMR-spectrum (376 MHz, CDCl_3) of **6b**



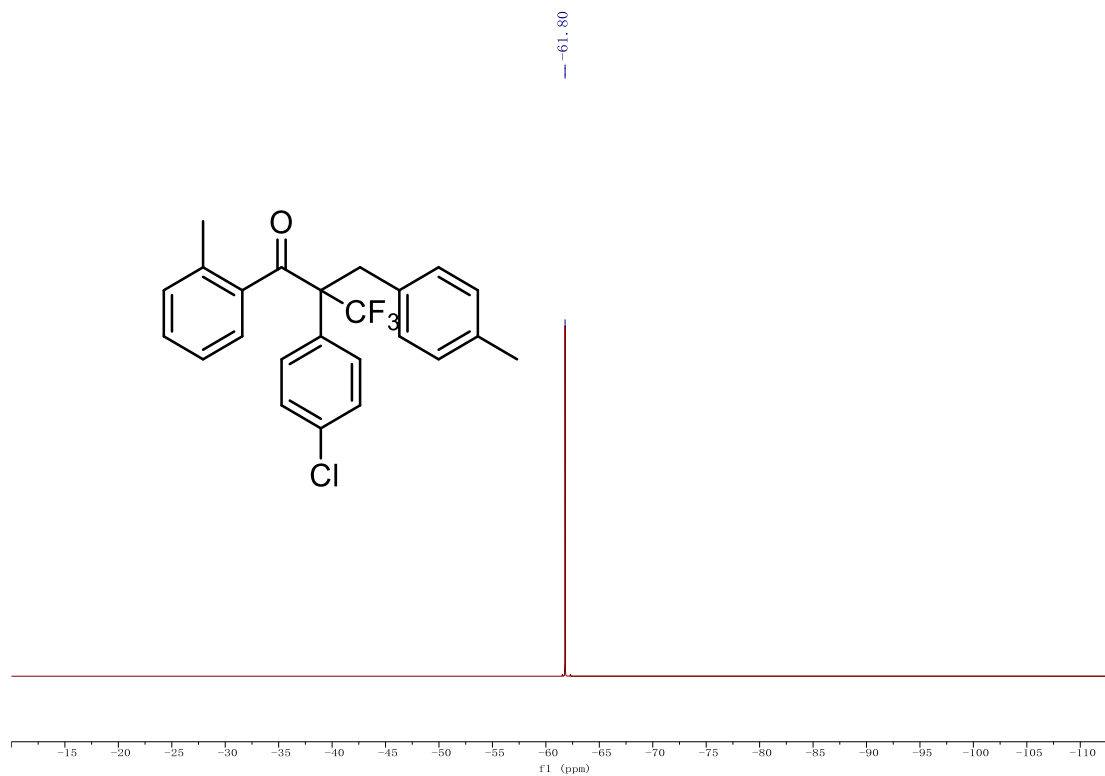
^1H NMR-spectrum (400MHz, CDCl_3) of **6c**



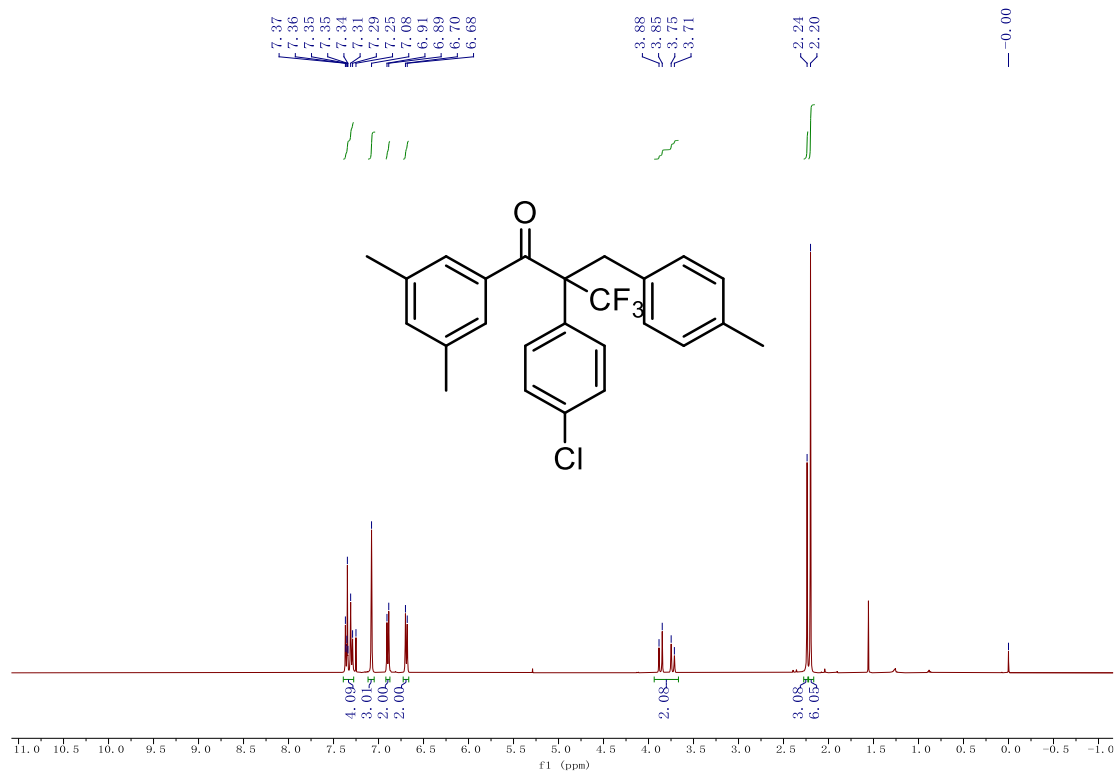
$^{13}\text{C}\{^1\text{H}\}$ NMR -spectrum (101MHz, CDCl_3) of **6c**



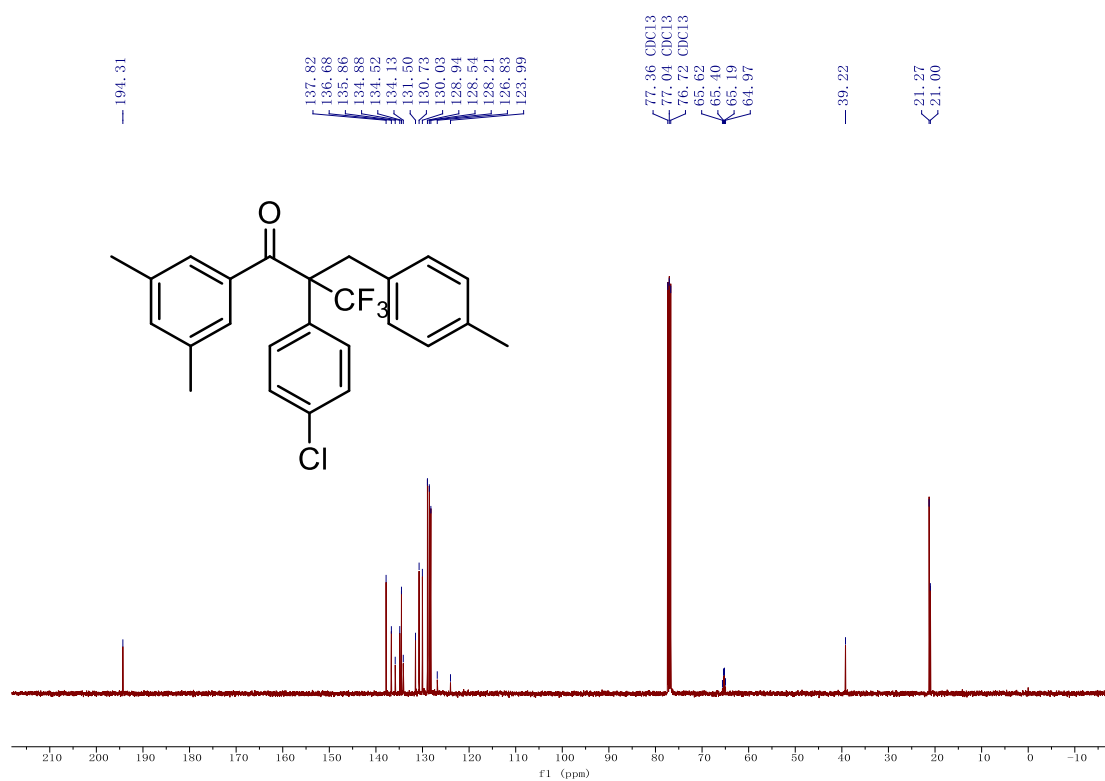
¹⁹F NMR-spectrum (376 MHz, CDCl₃) of **6c**



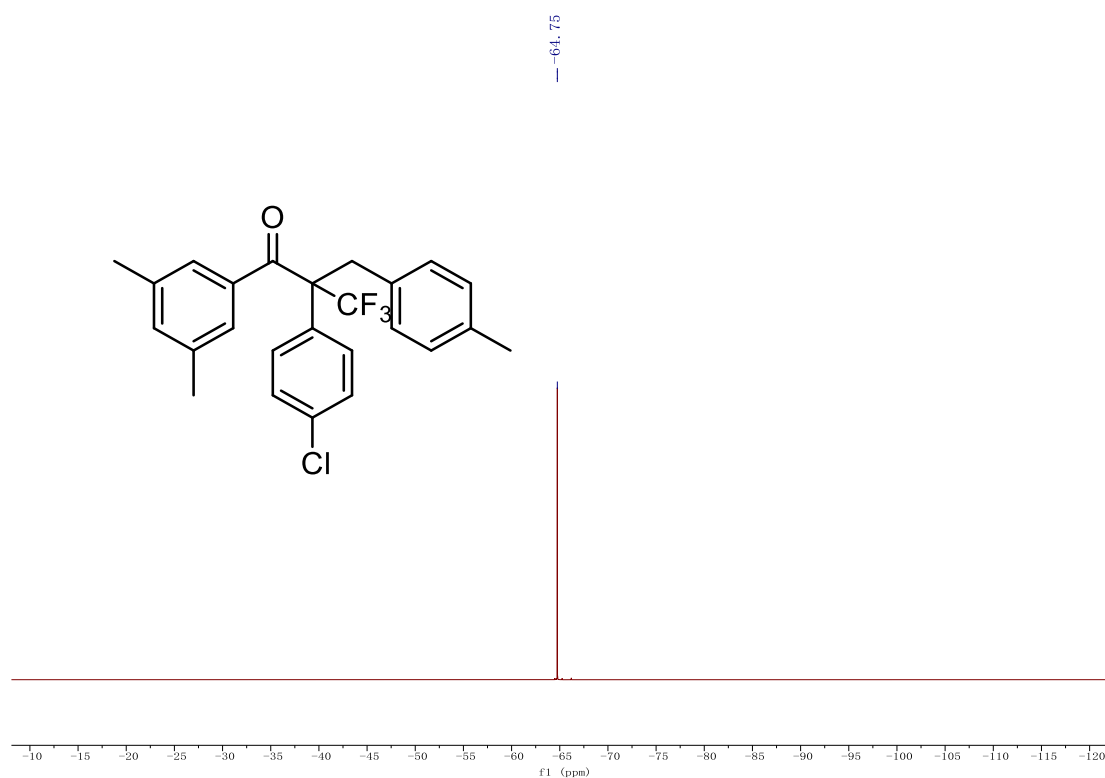
¹H NMR-spectrum (400MHz, CDCl₃) of **6d**



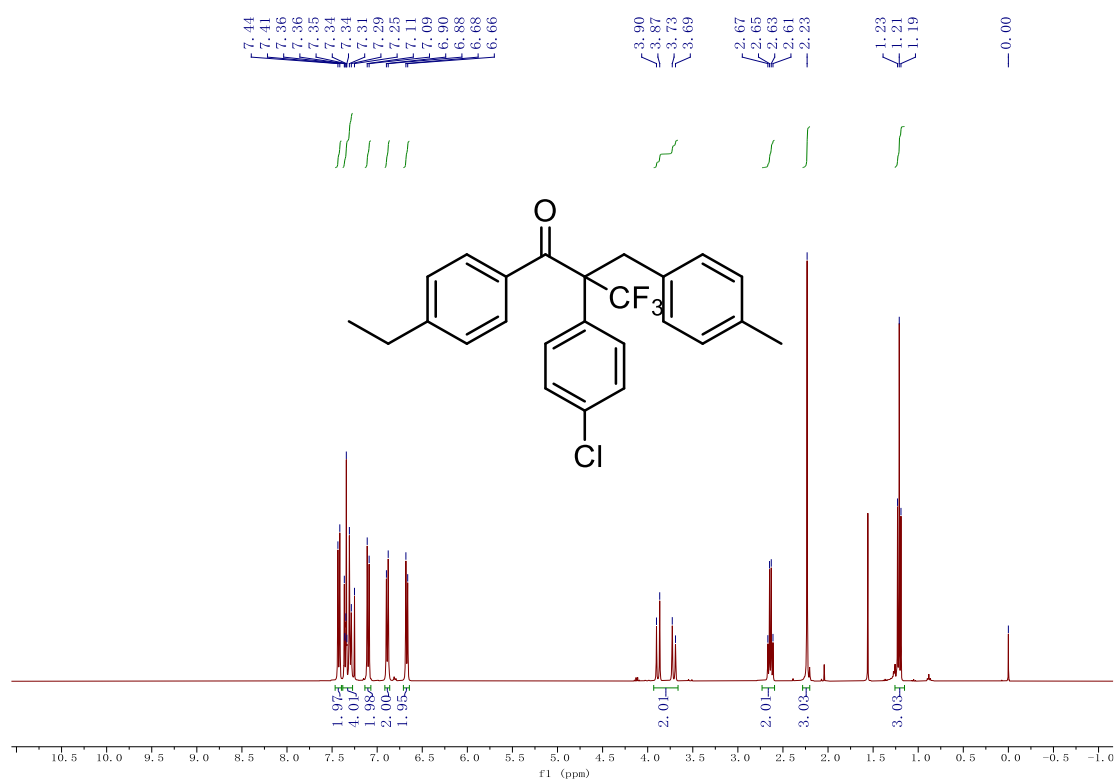
$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of **6d**



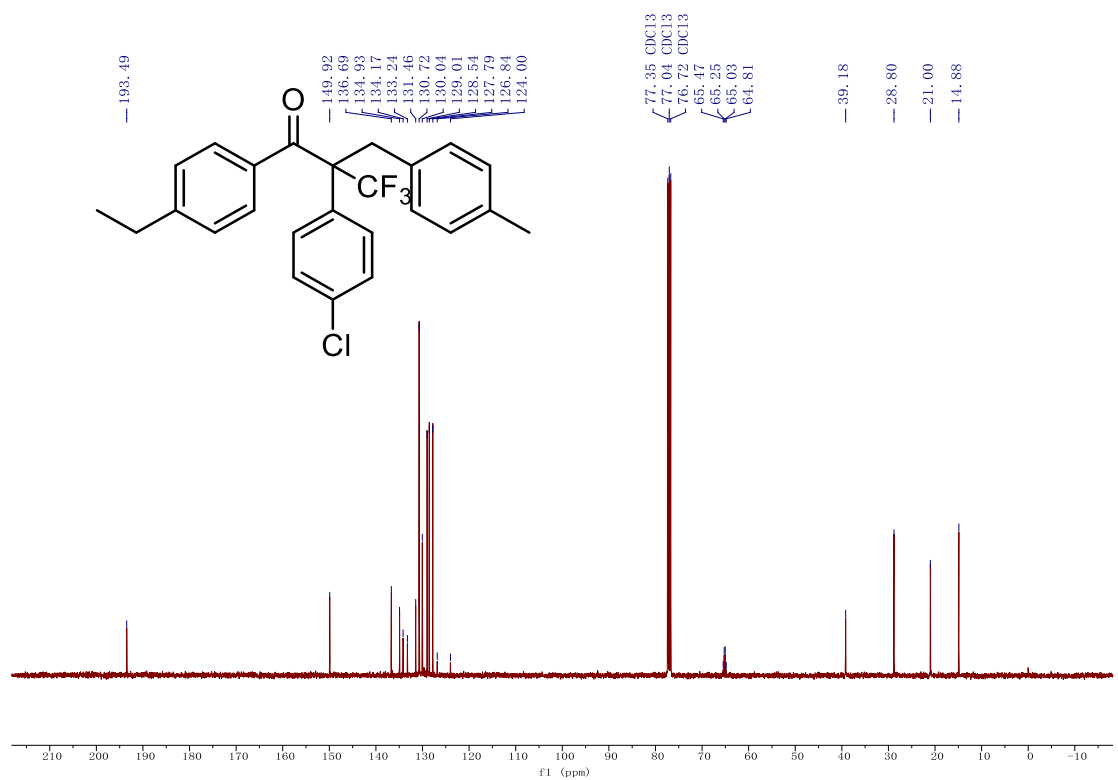
^{19}F NMR-spectrum (376 MHz, CDCl_3) of **6d**



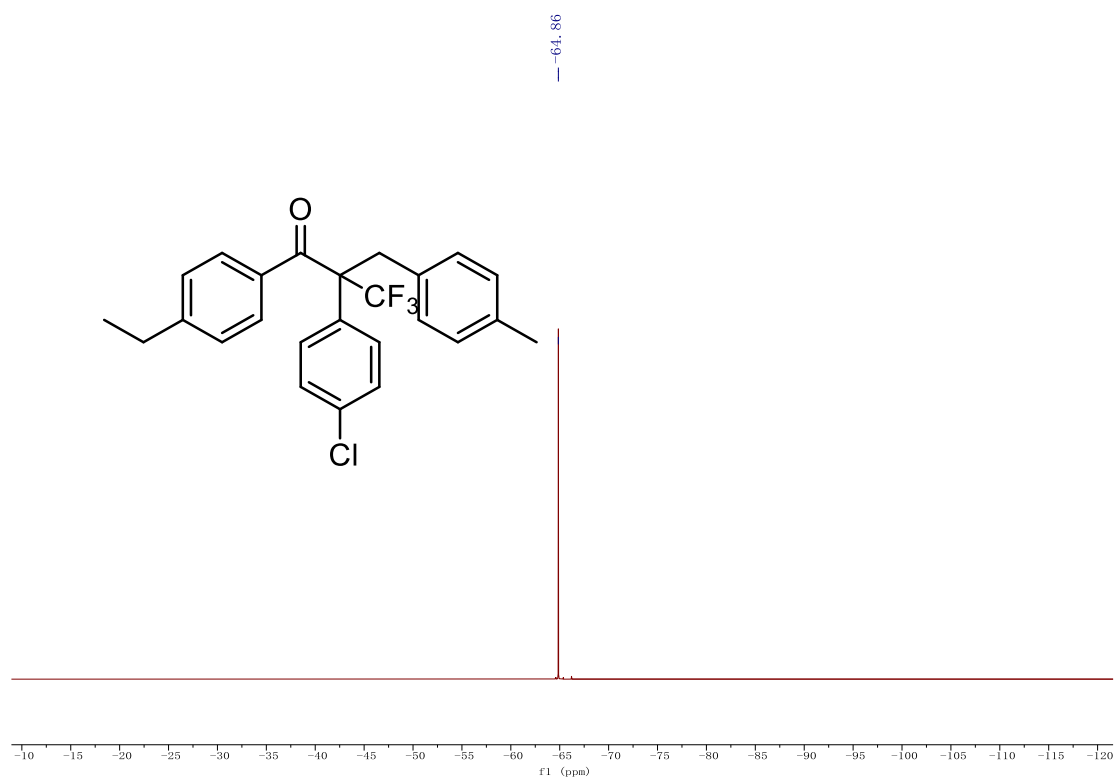
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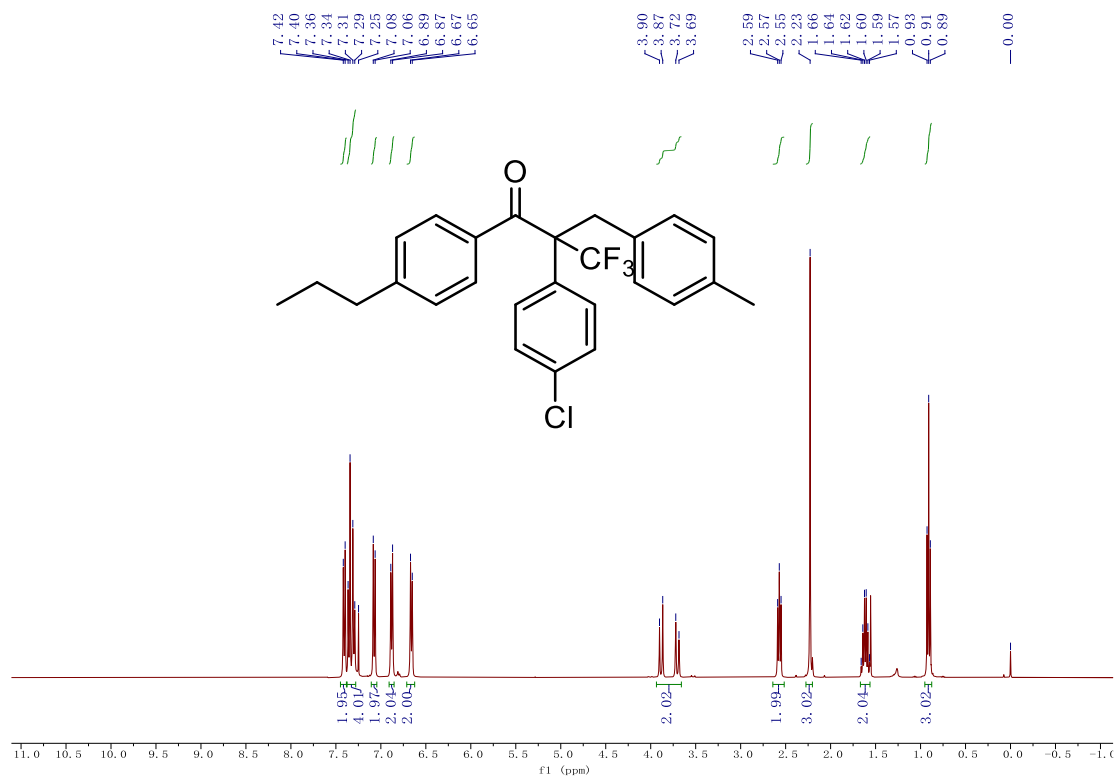
¹³C{¹H} NMR -spectrum (101MHz, CDCl₃) of **6e**



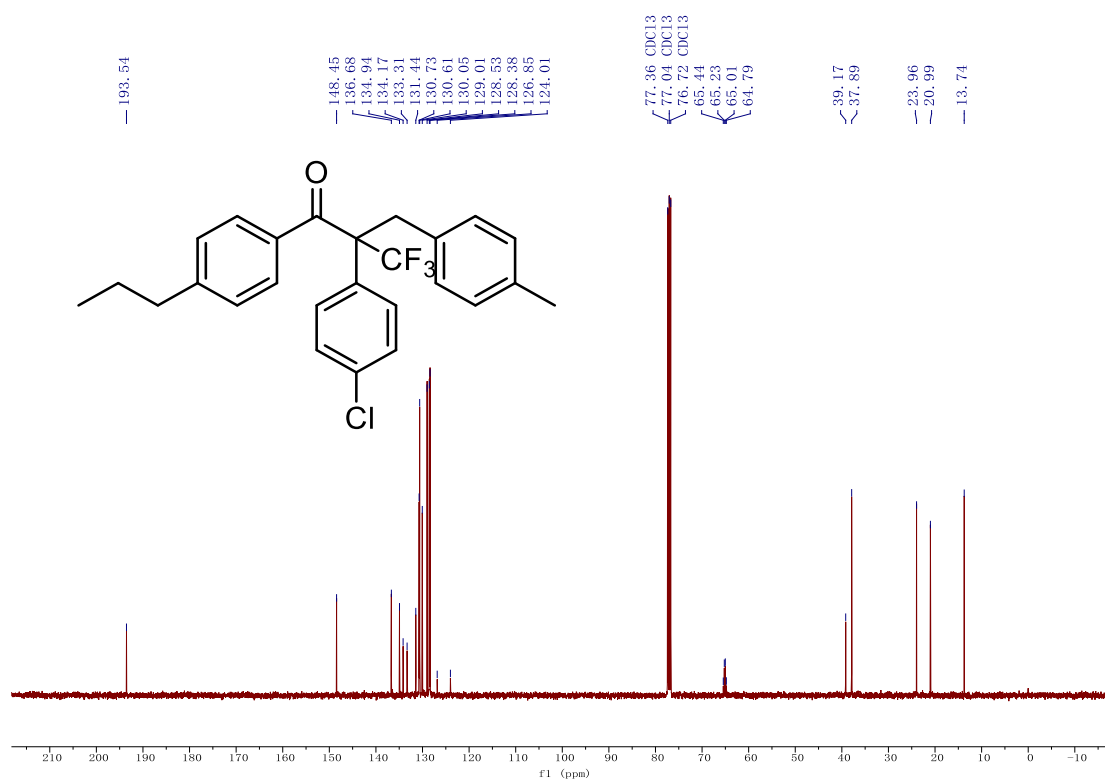
¹⁹F NMR-spectrum (376 MHz, CDCl₃) of **6e**



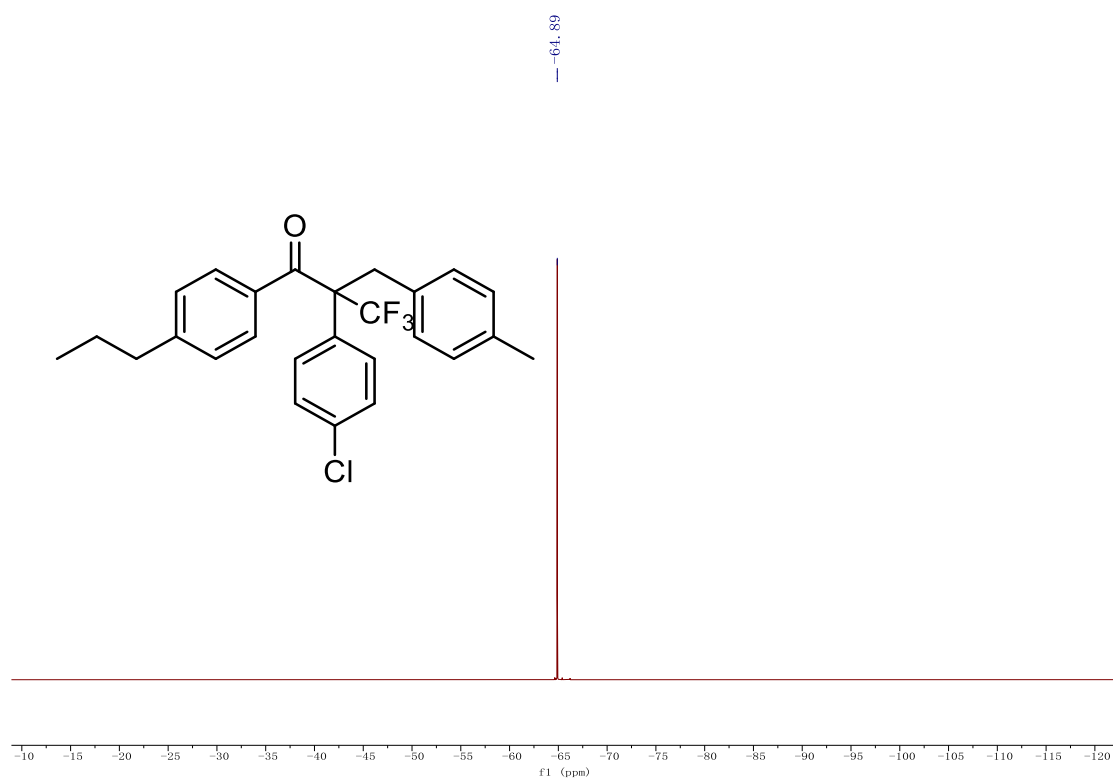
¹H NMR-spectrum (400MHz, CDCl₃) of **6f**



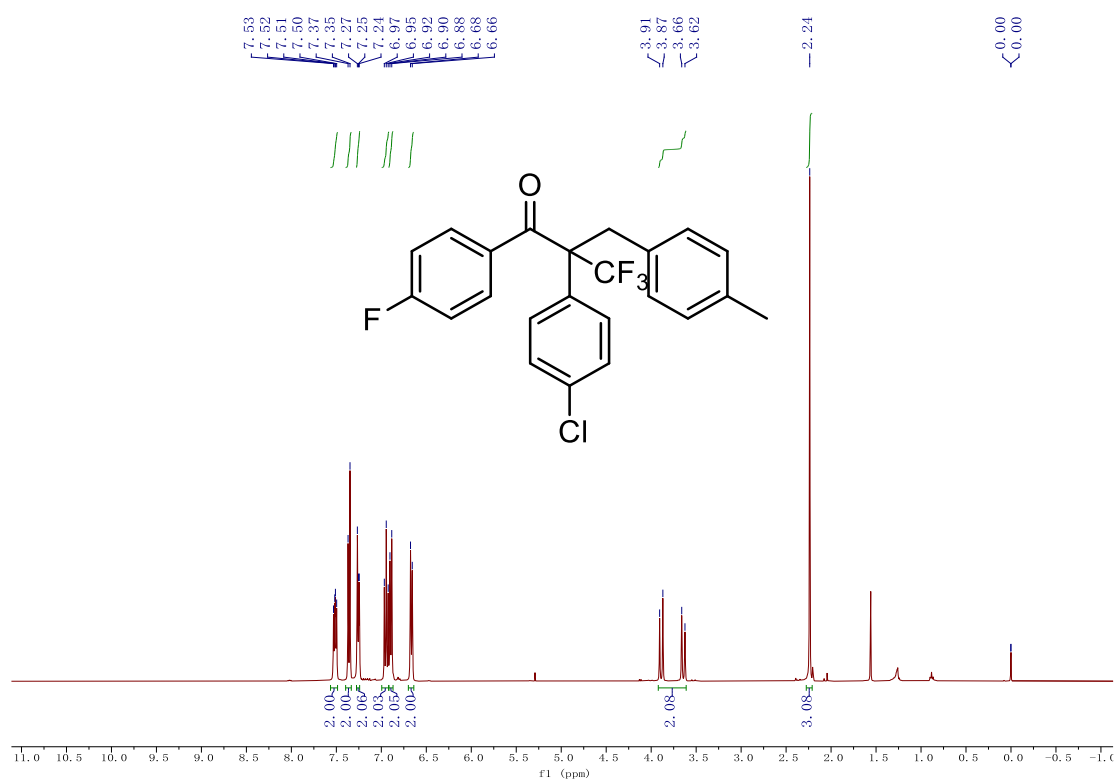
$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of **6f**



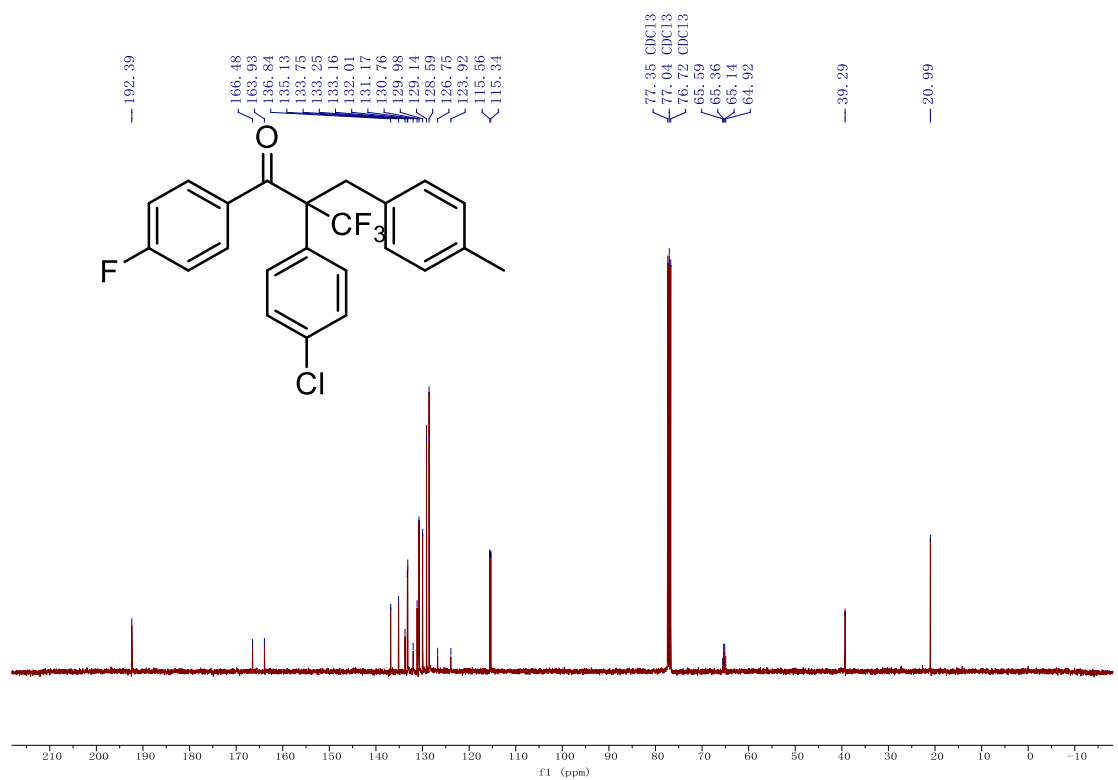
^{19}F NMR-spectrum (376 MHz, CDCl_3) of **6f**



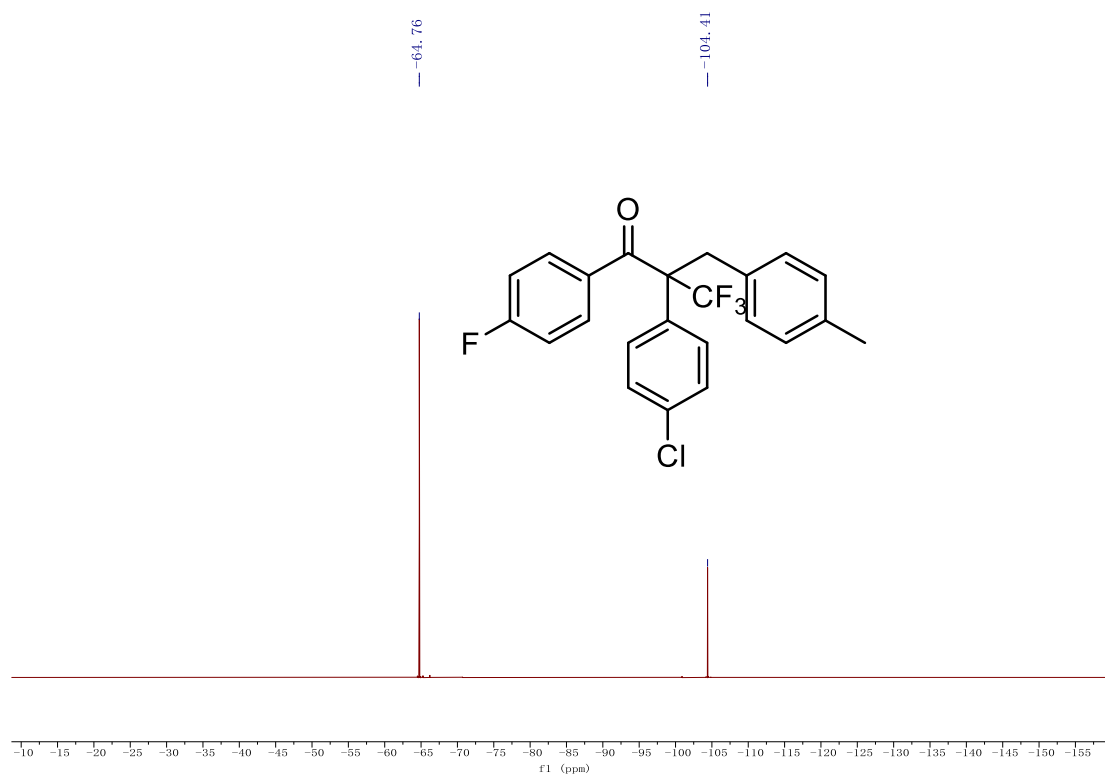
¹H NMR-spectrum (400MHz, CDCl₃) of **6g**



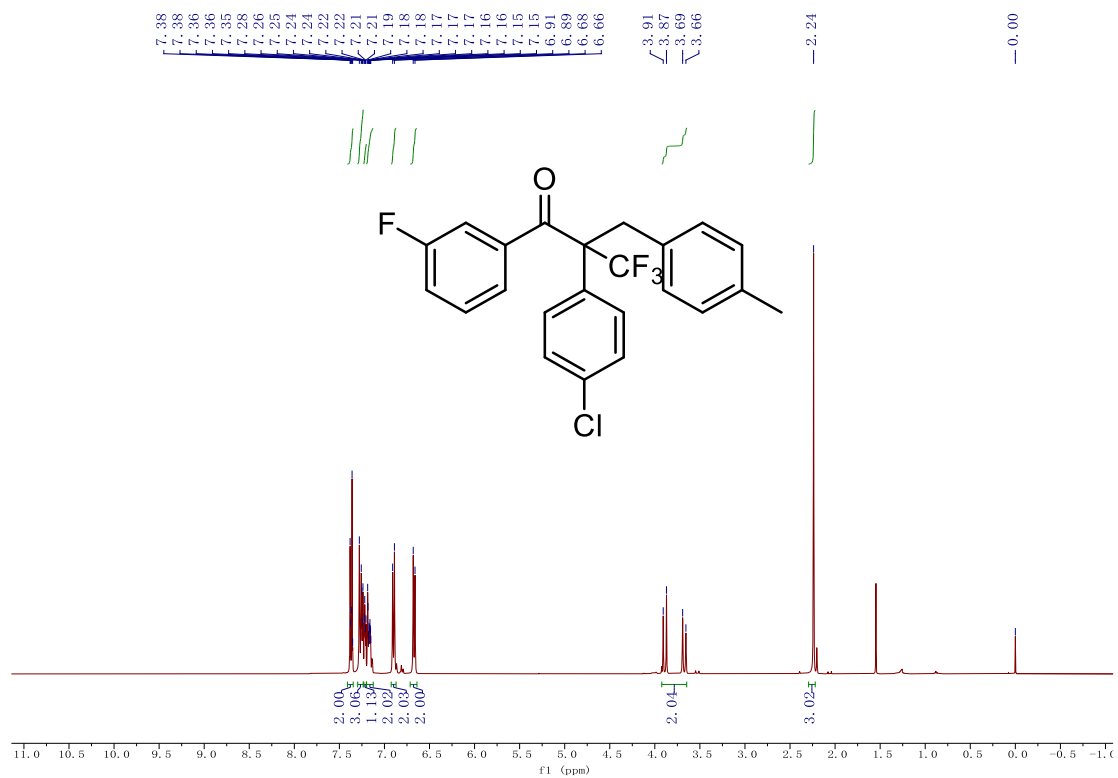
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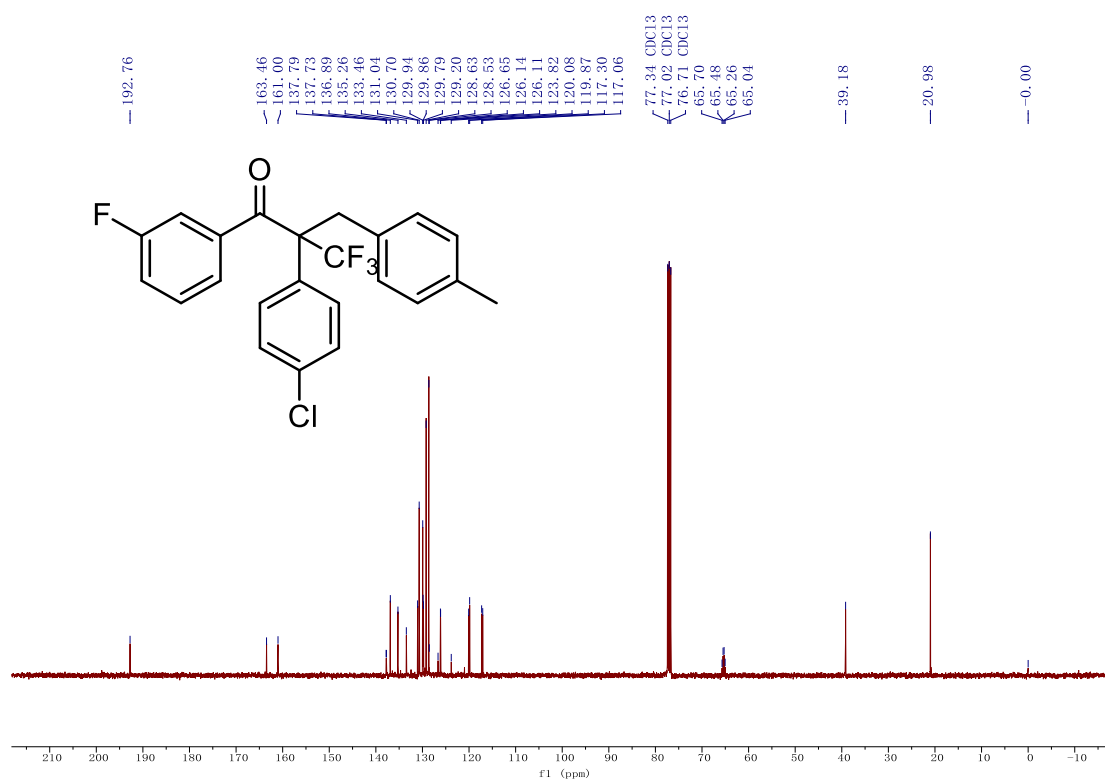
¹⁹F NMR-spectrum (376 MHz, CDCl₃) of **6g**



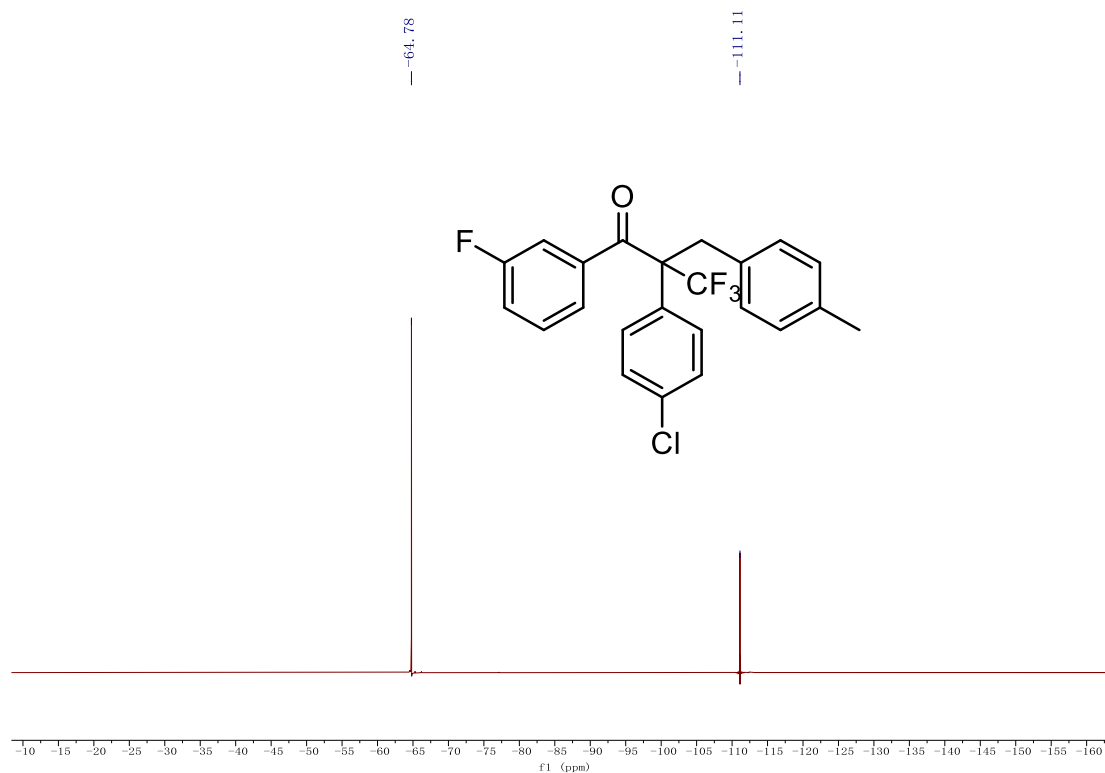
¹H NMR-spectrum (400MHz, CDCl₃) of **6h**



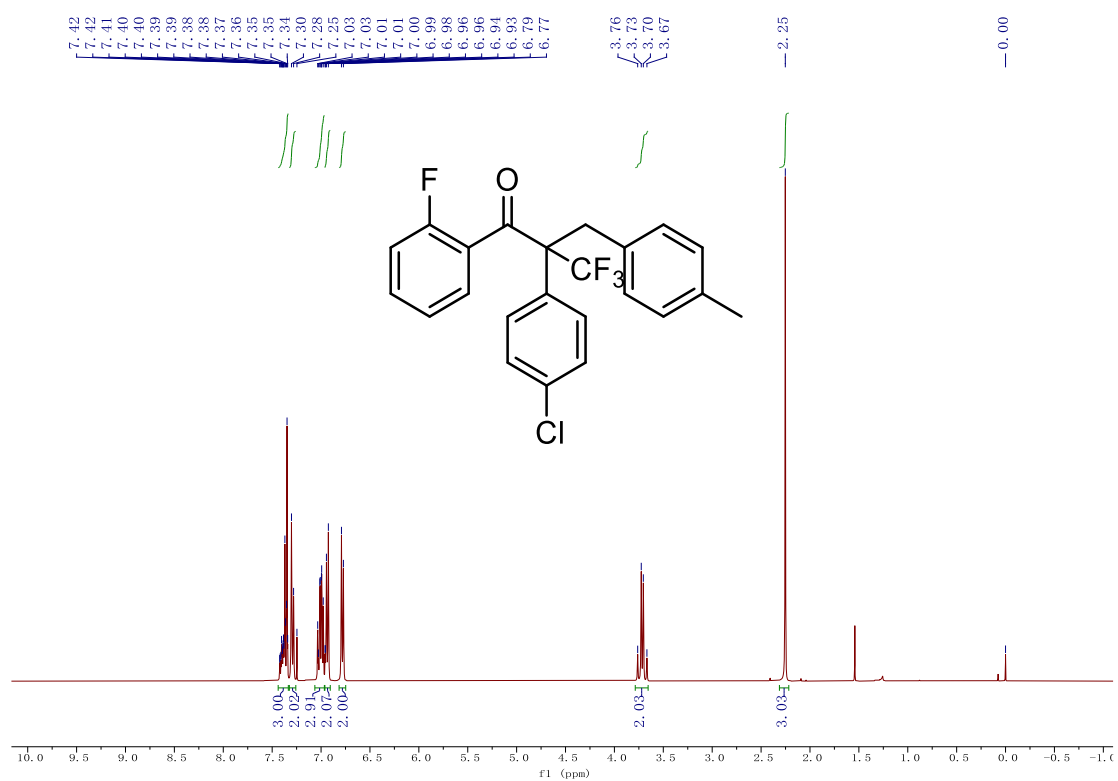
$^{13}\text{C}\{^1\text{H}\}$ NMR -spectrum (101MHz, CDCl_3) of **6h**



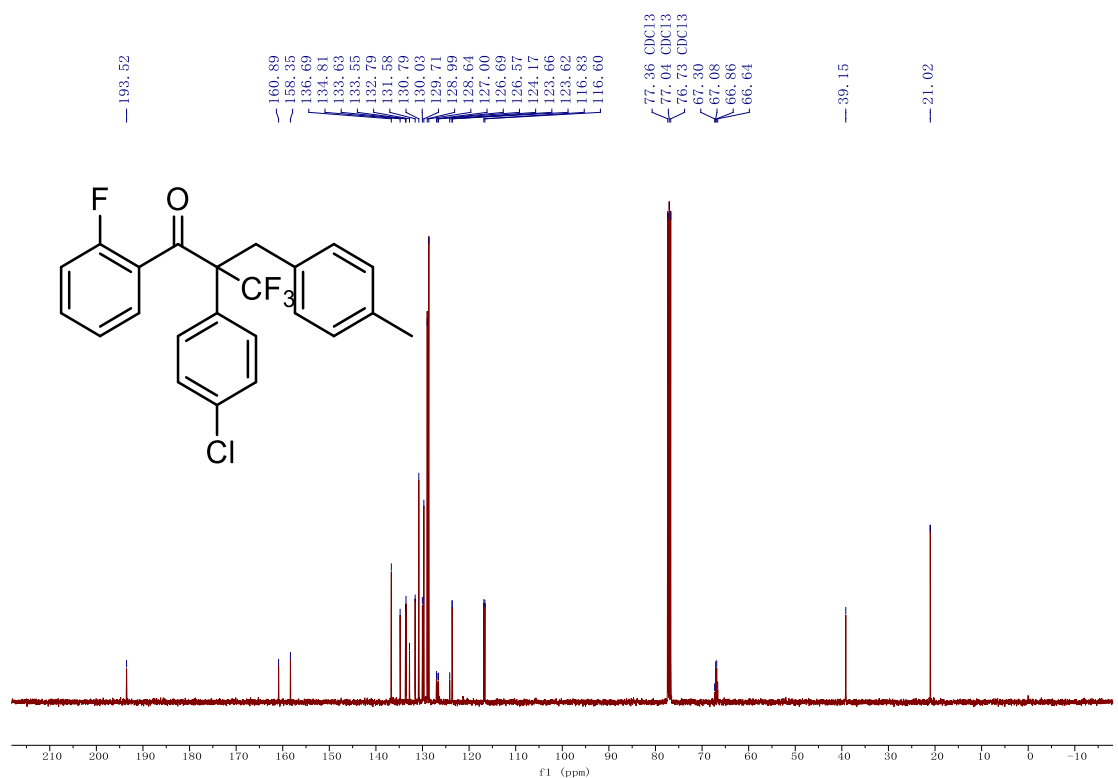
^{19}F NMR-spectrum (376 MHz, CDCl_3) of **6h**



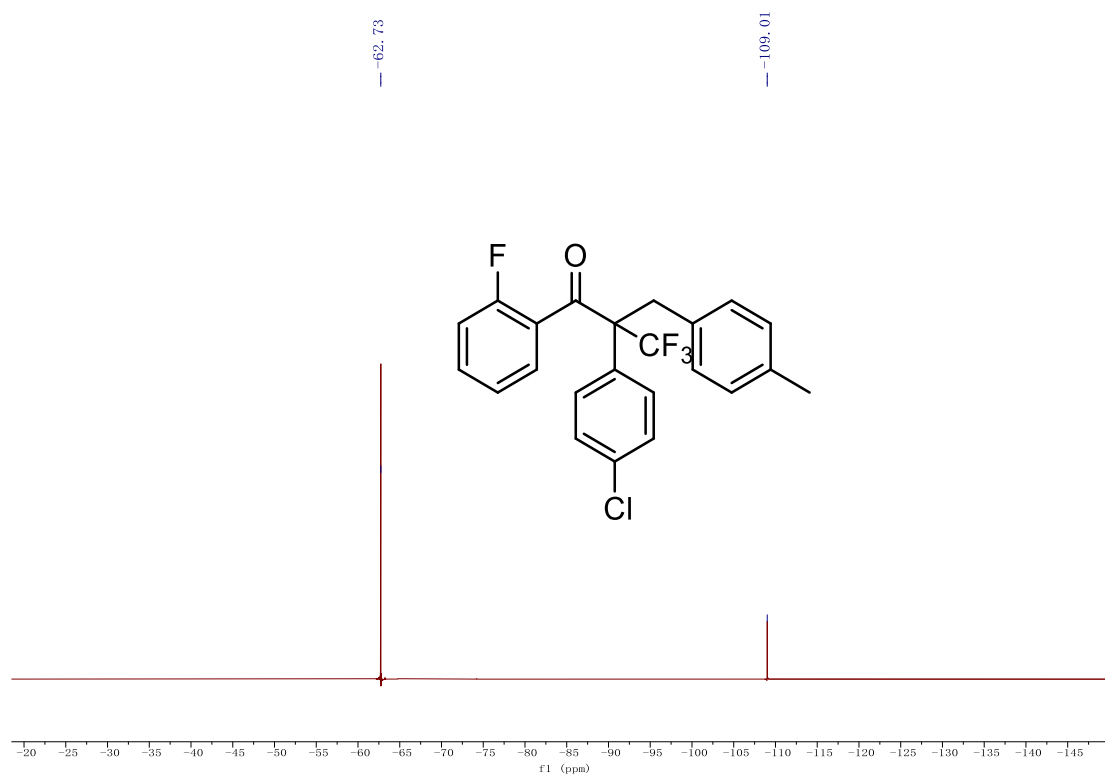
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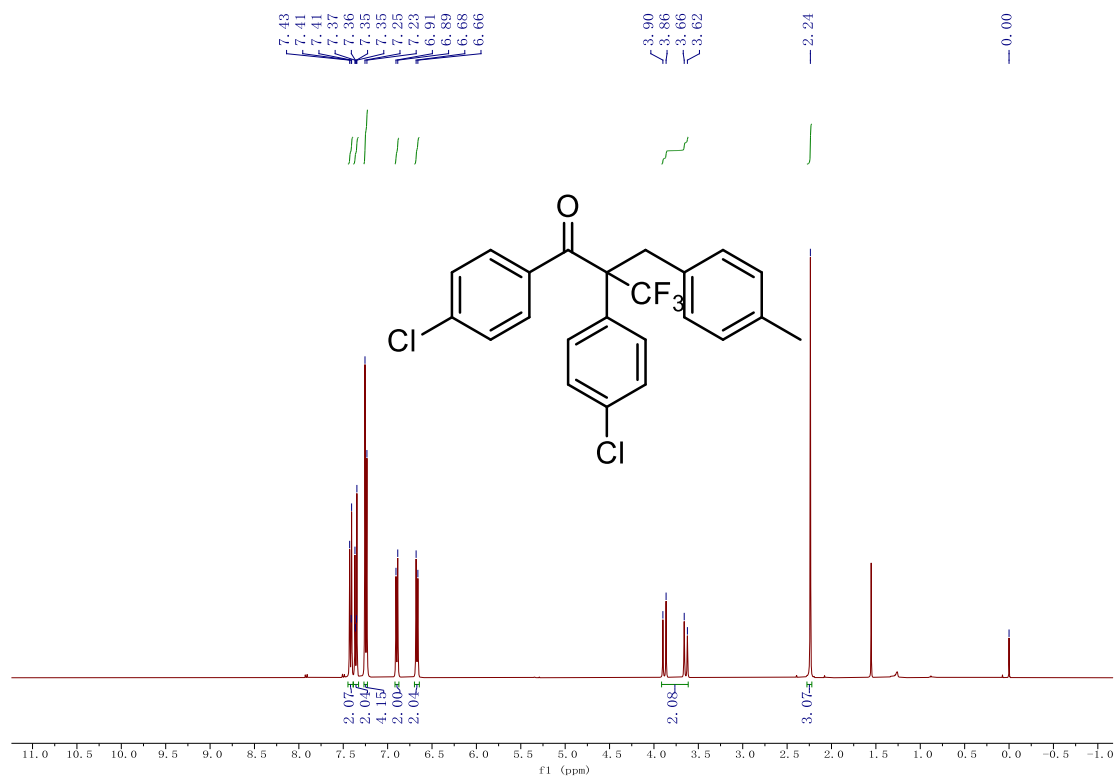
¹³C{¹H} NMR -spectrum (101MHz, CDCl₃) of **6i**



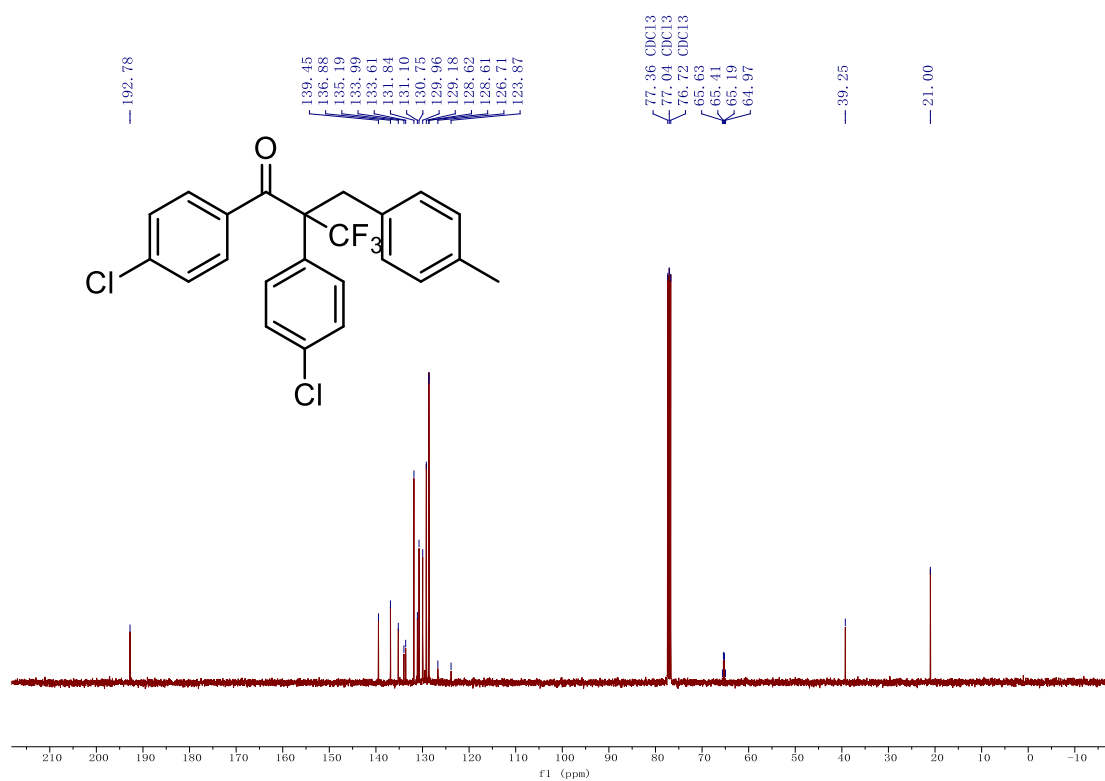
¹⁹F NMR-spectrum (376 MHz, CDCl₃) of 6i



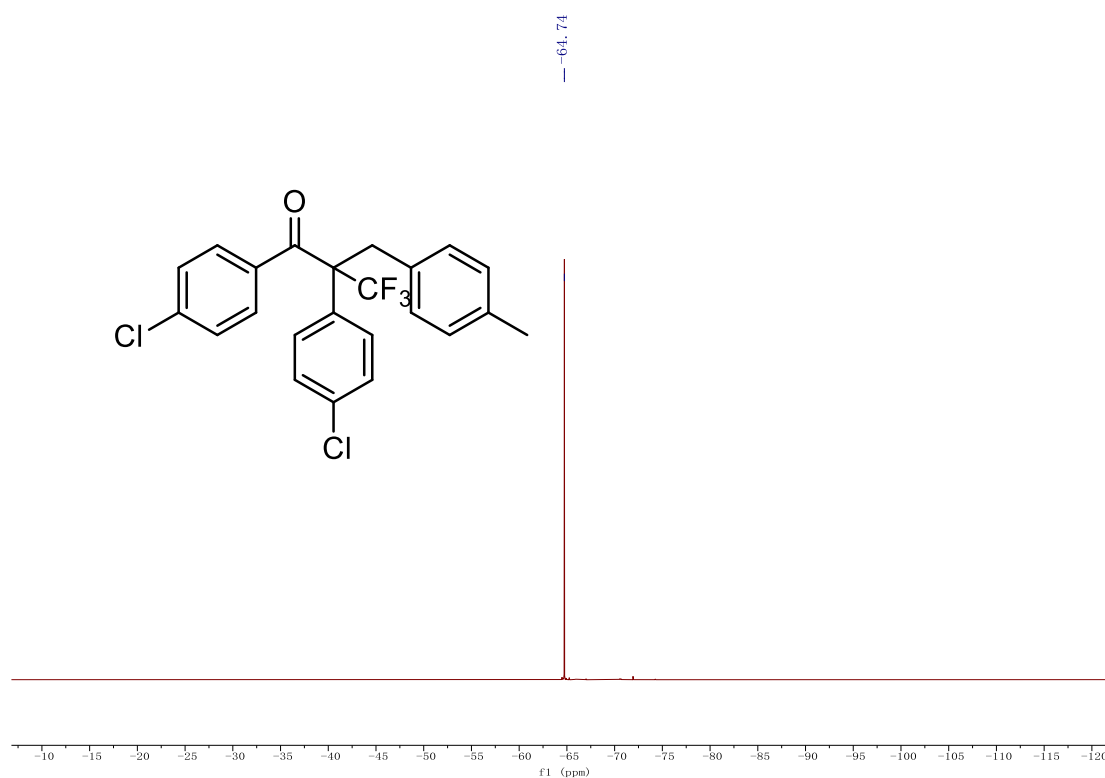
¹H NMR-spectrum (400MHz, CDCl₃) of 6j



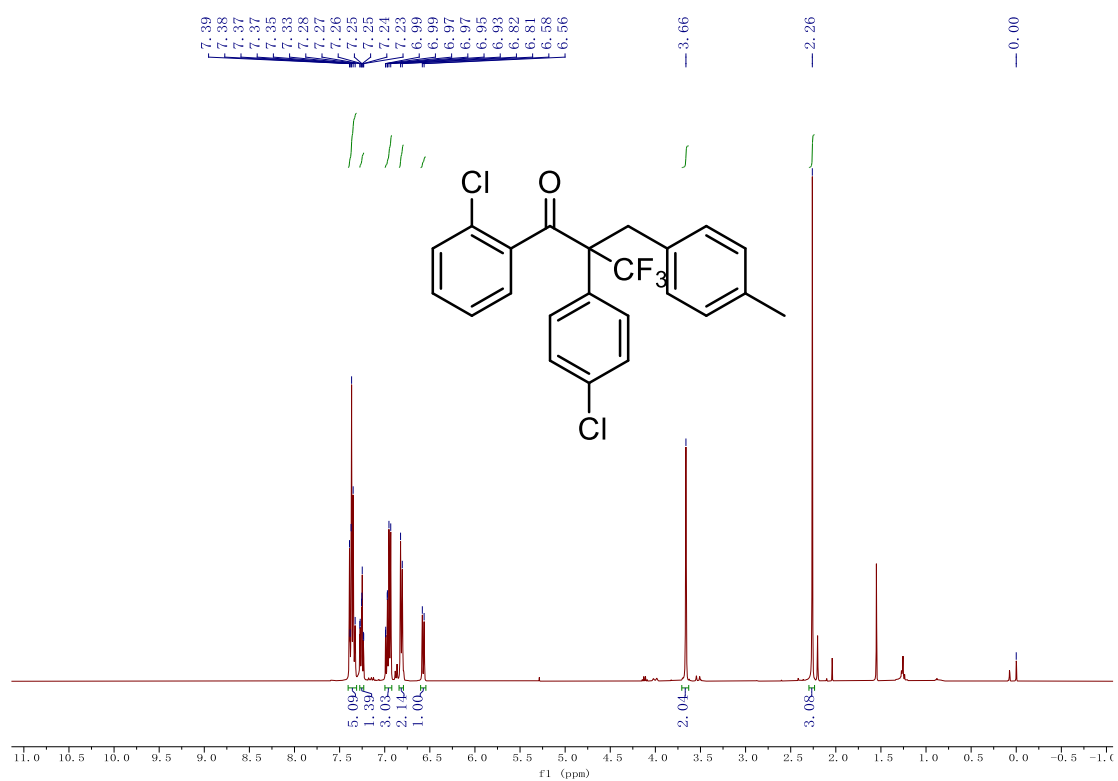
$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of **6j**



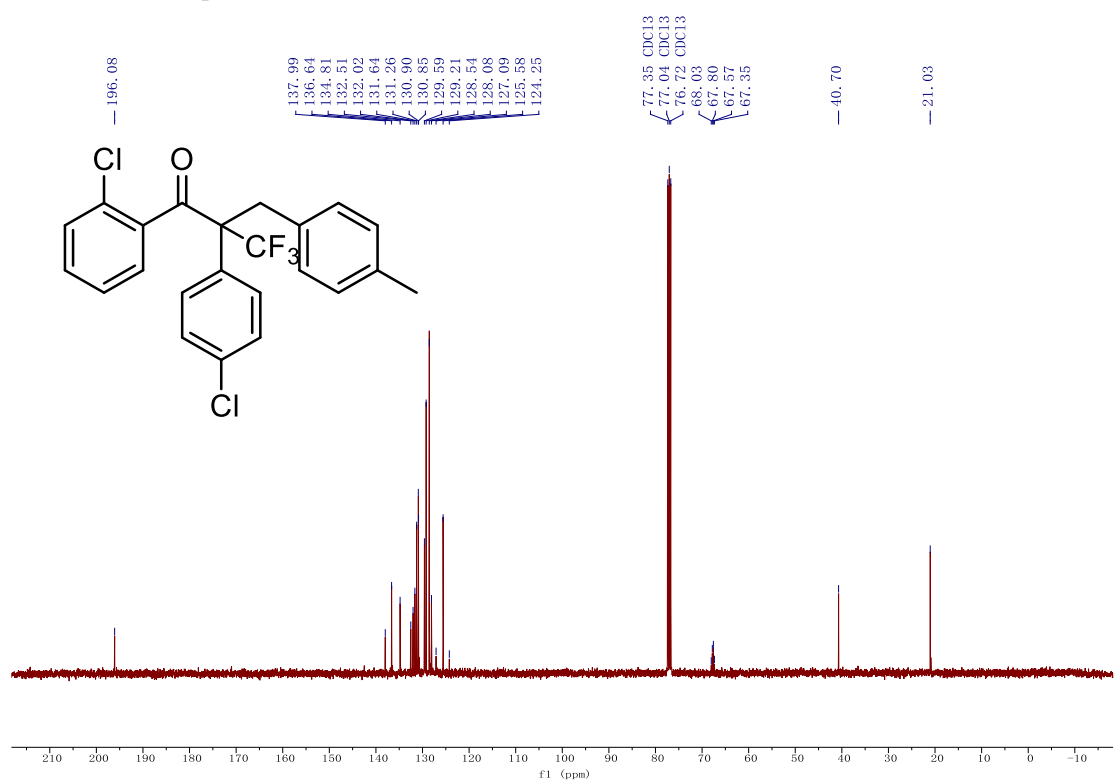
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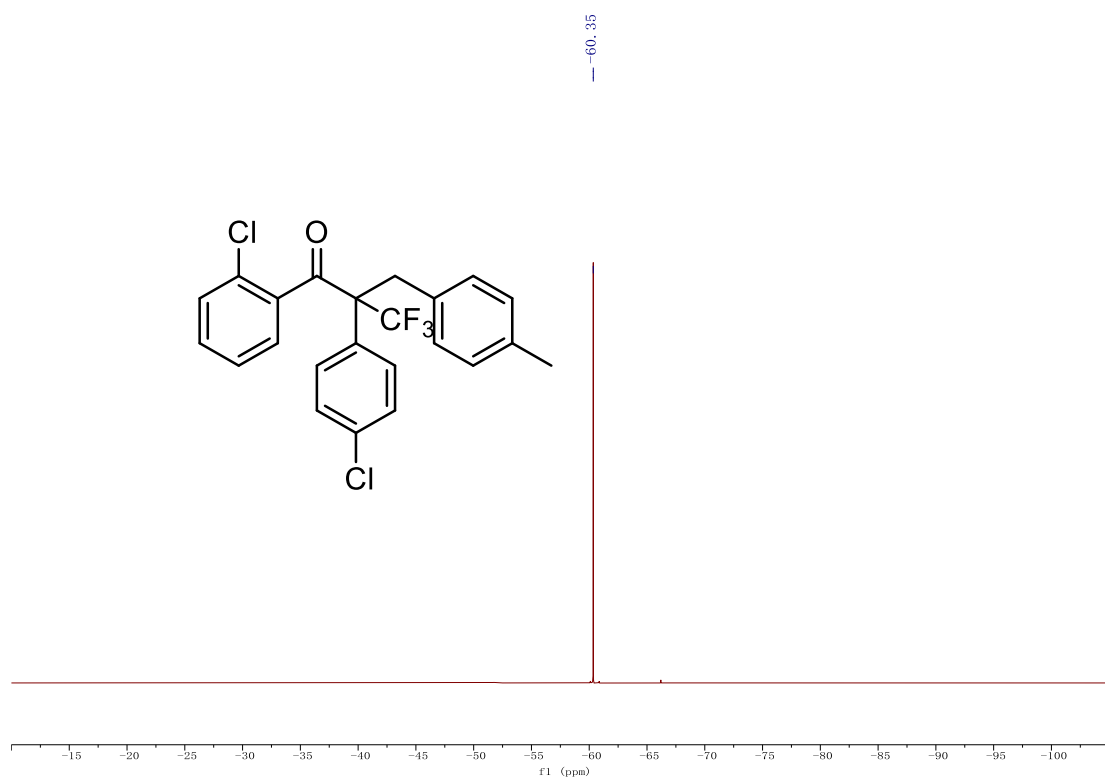
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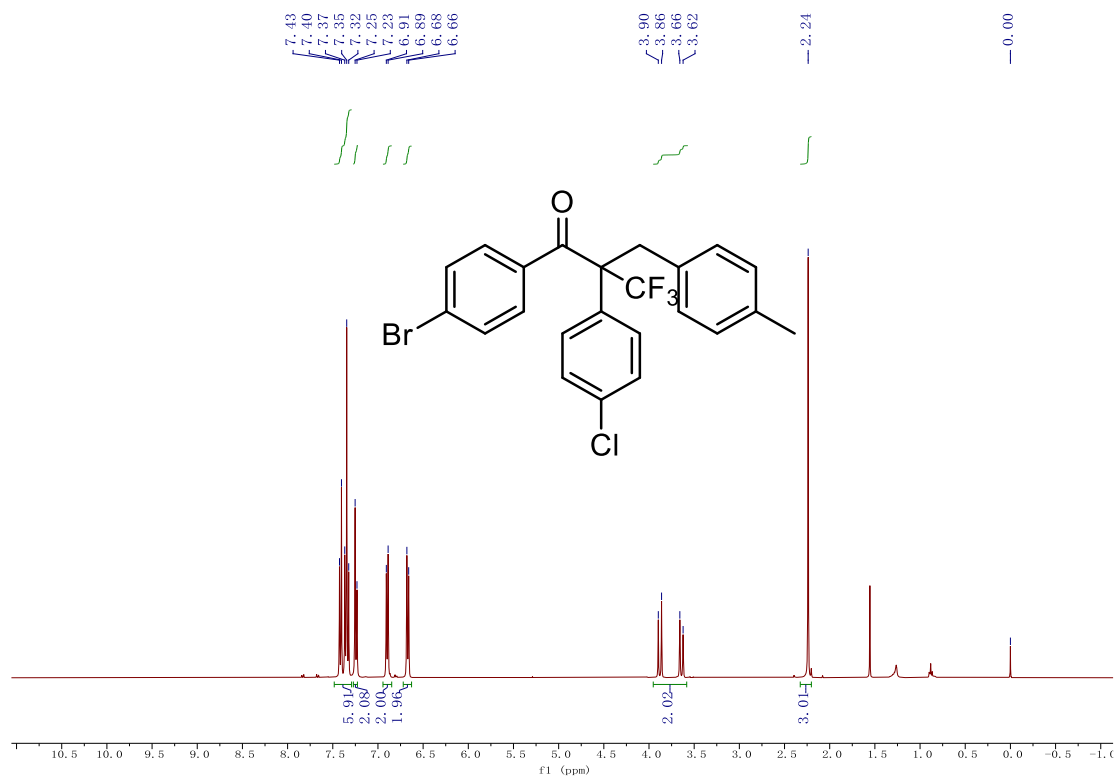
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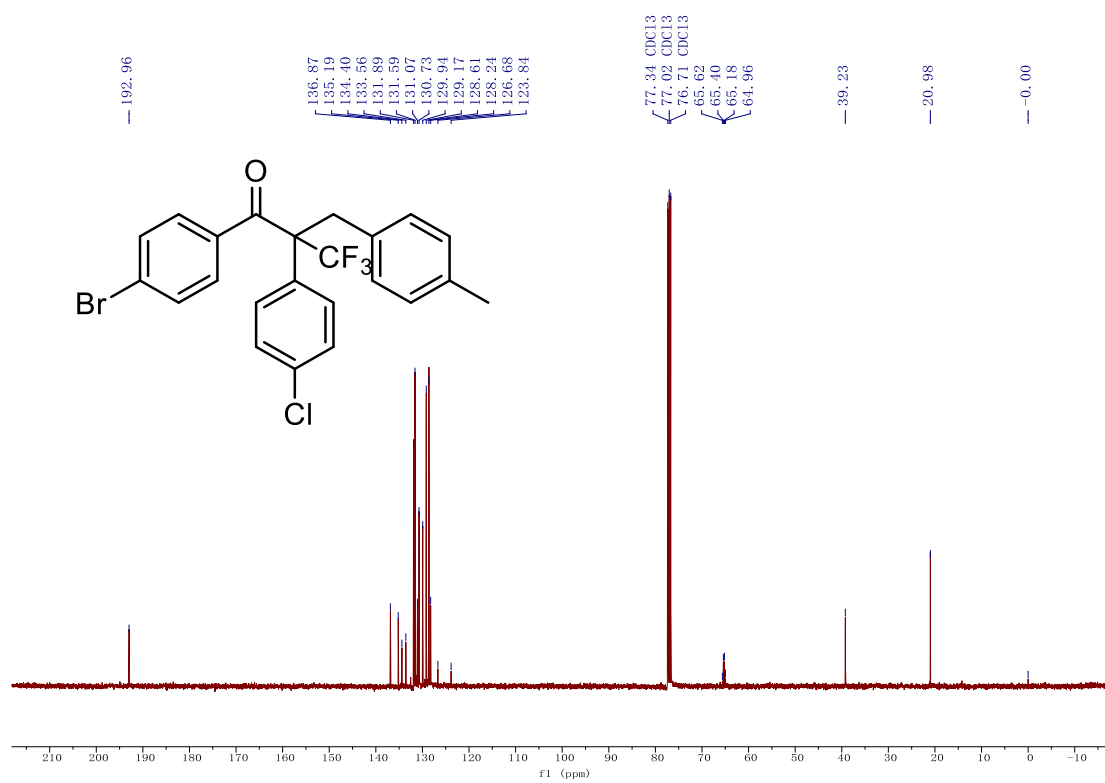
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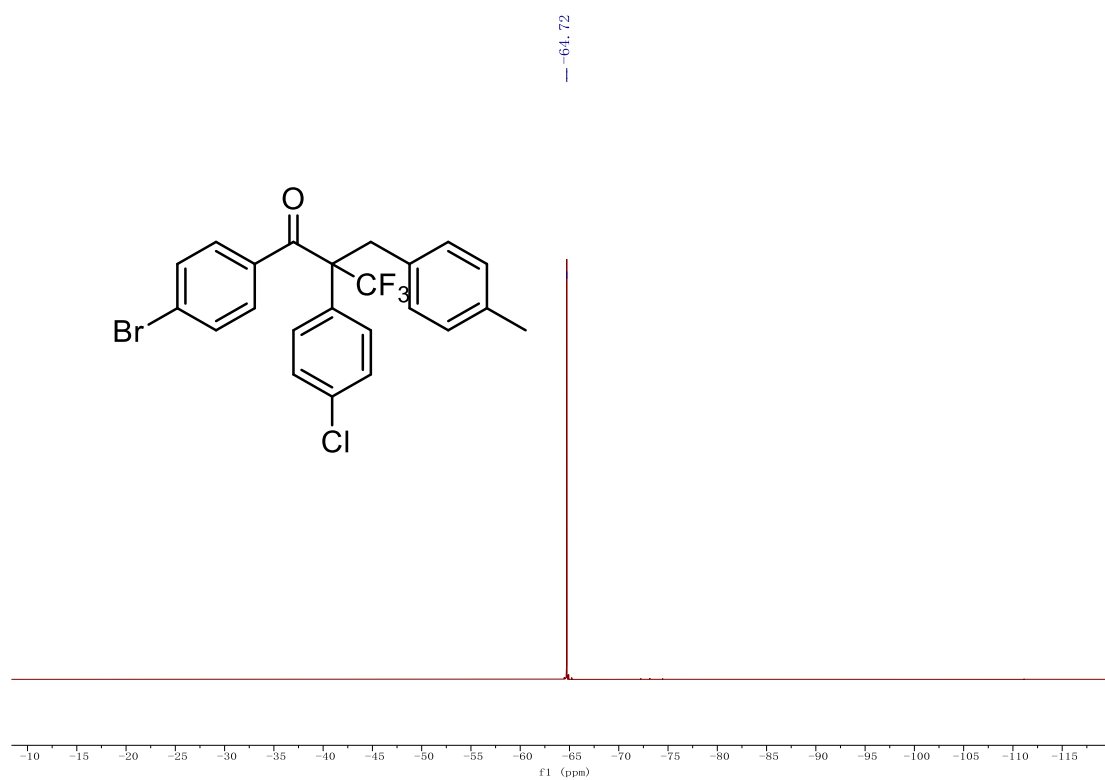
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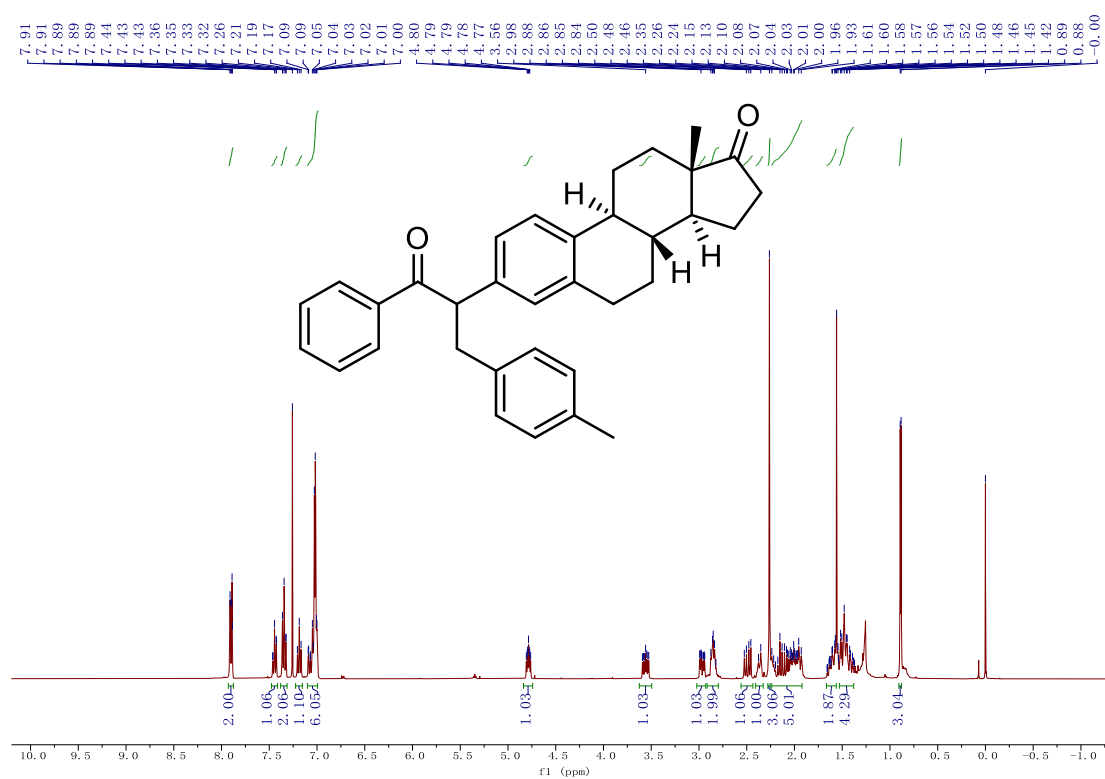
$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of **61**



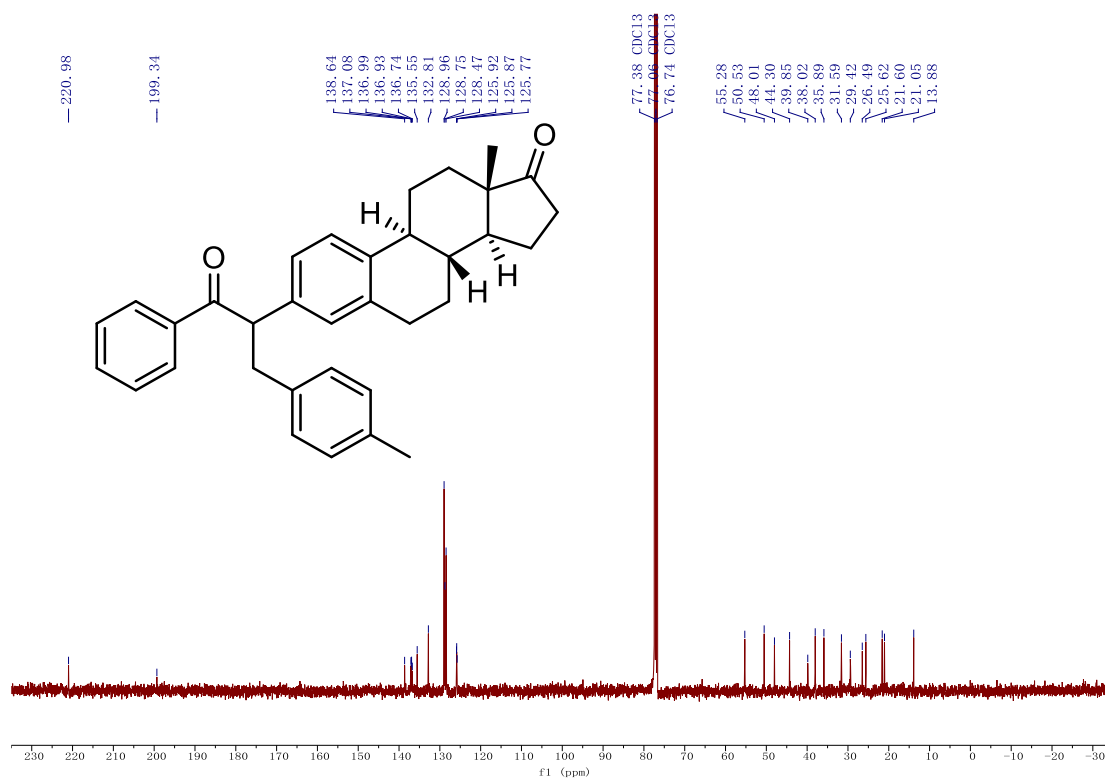
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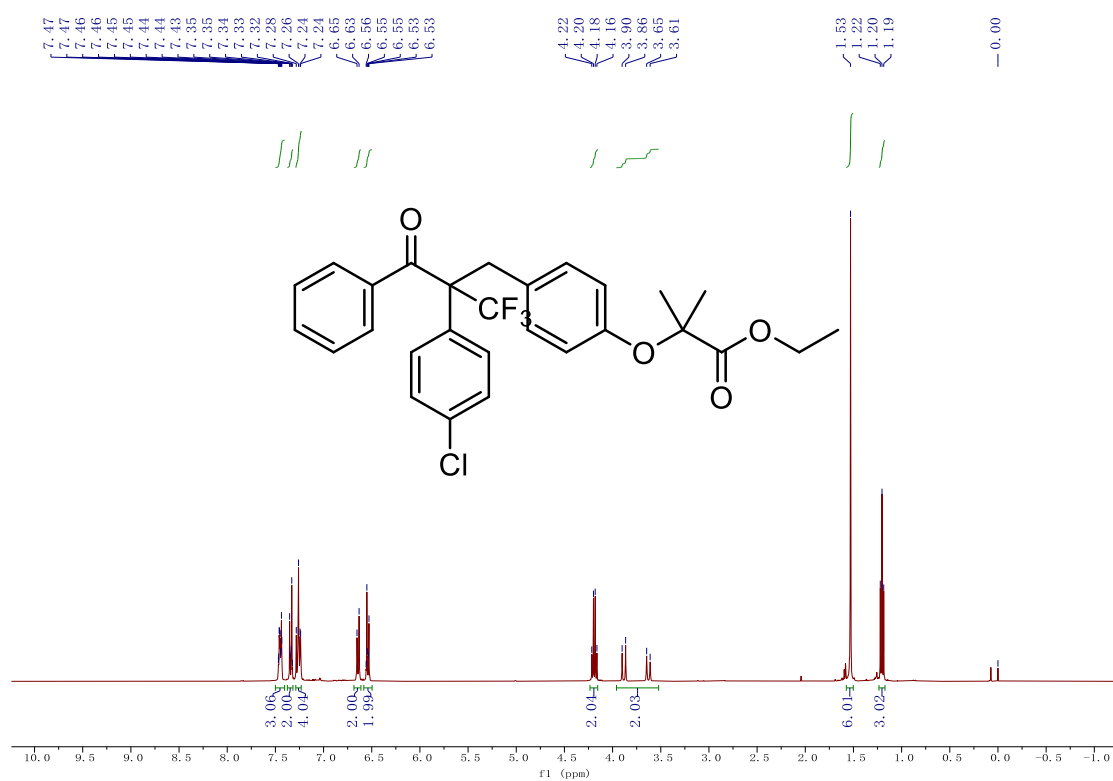
¹H NMR-spectrum (400MHz, CDCl₃) of 7



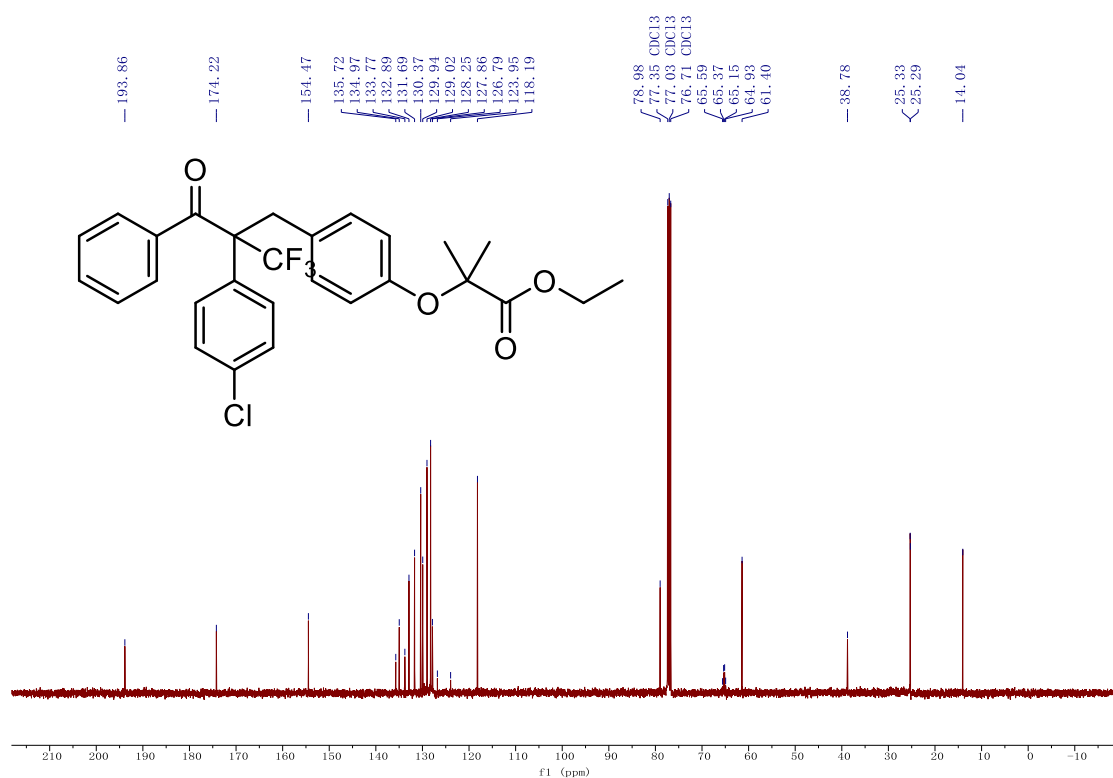
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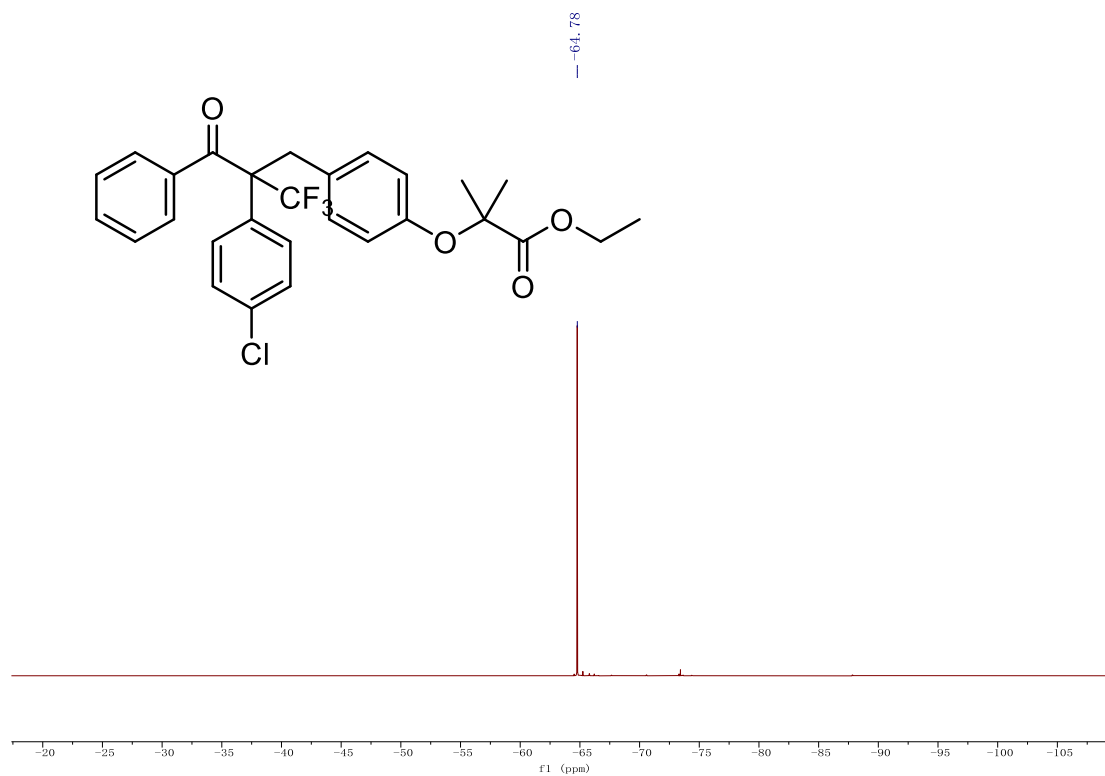
¹H NMR-spectrum (400MHz, CDCl₃) of **8**



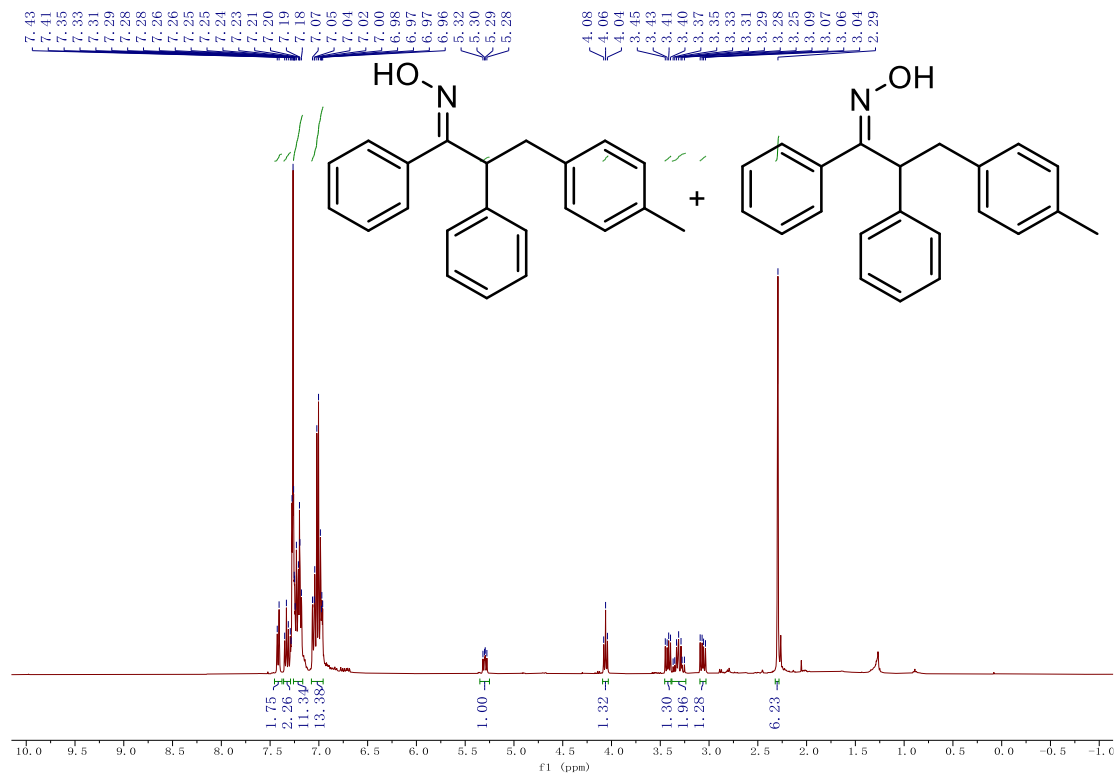
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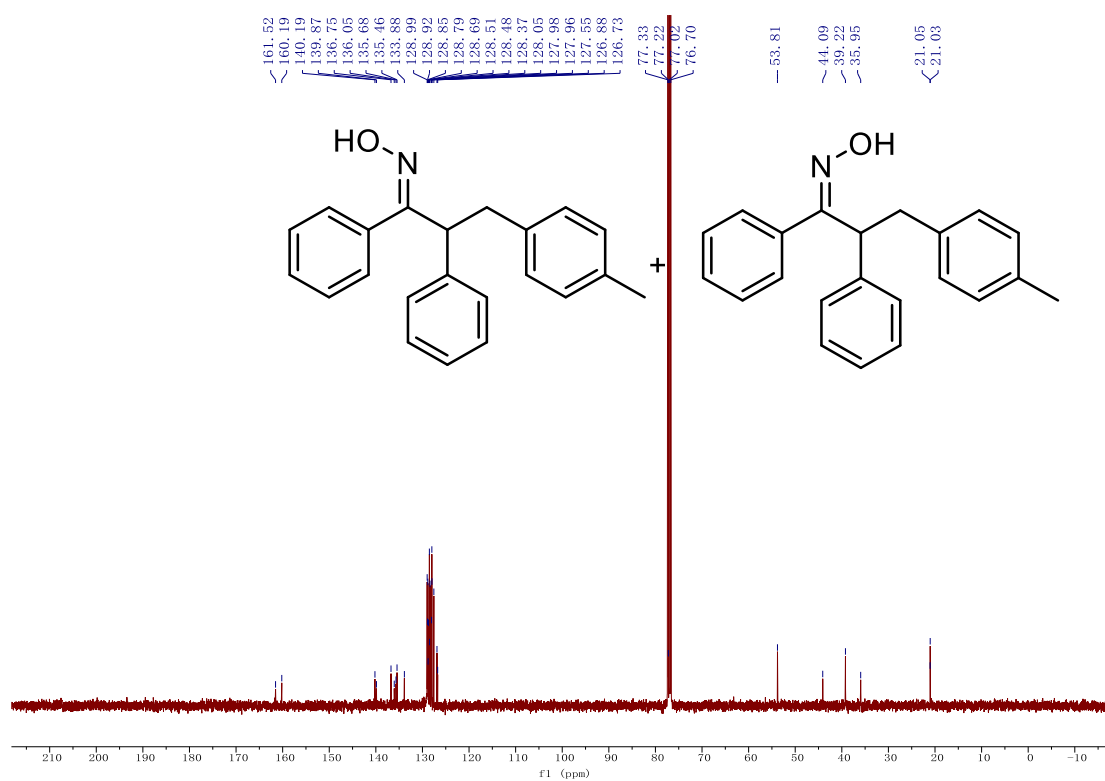
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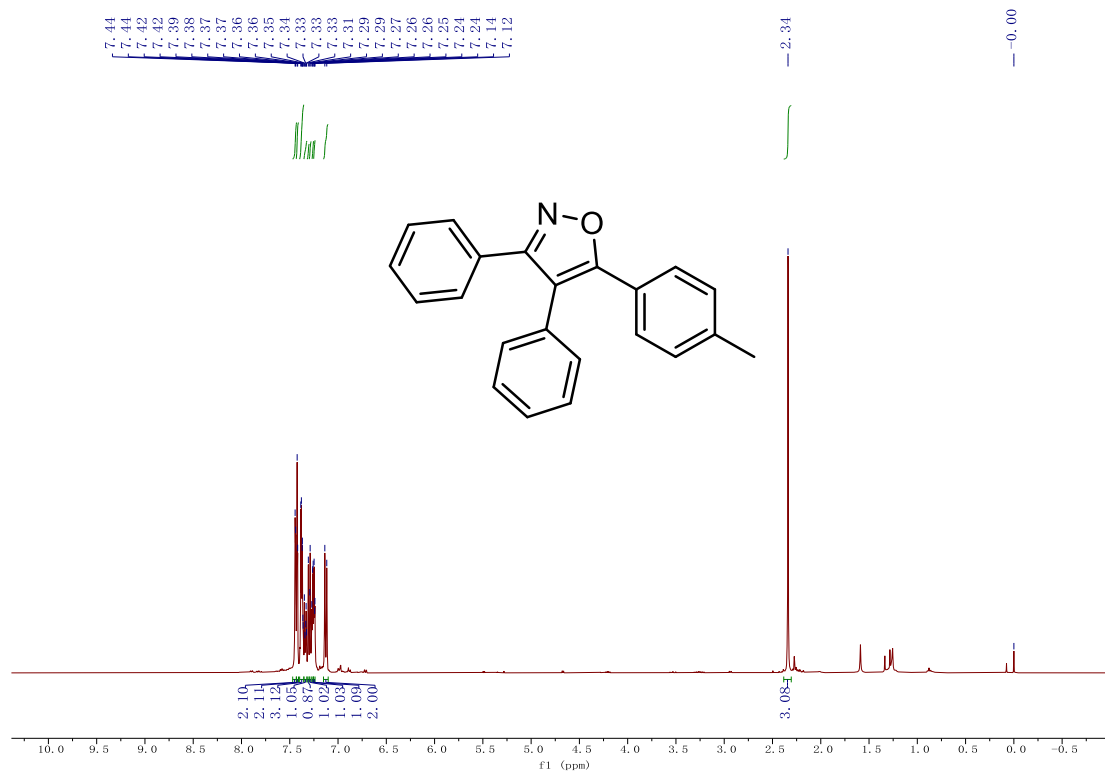
¹H NMR-spectrum (400MHz, CDCl₃) of **9**



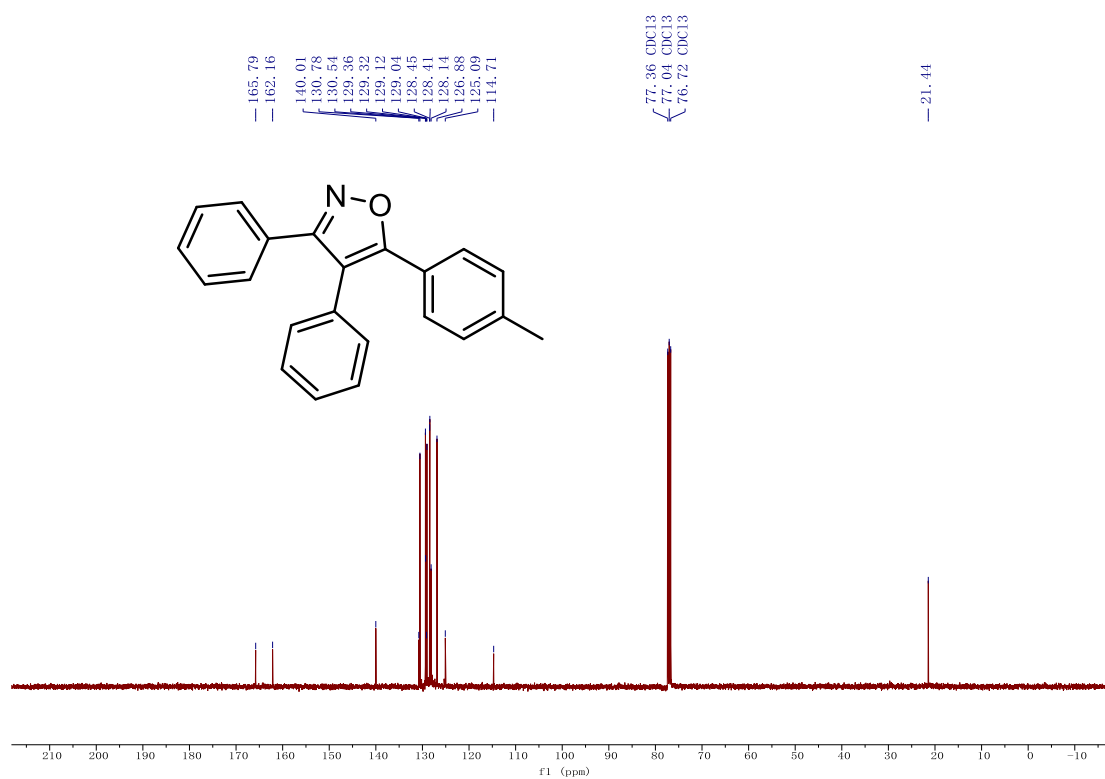
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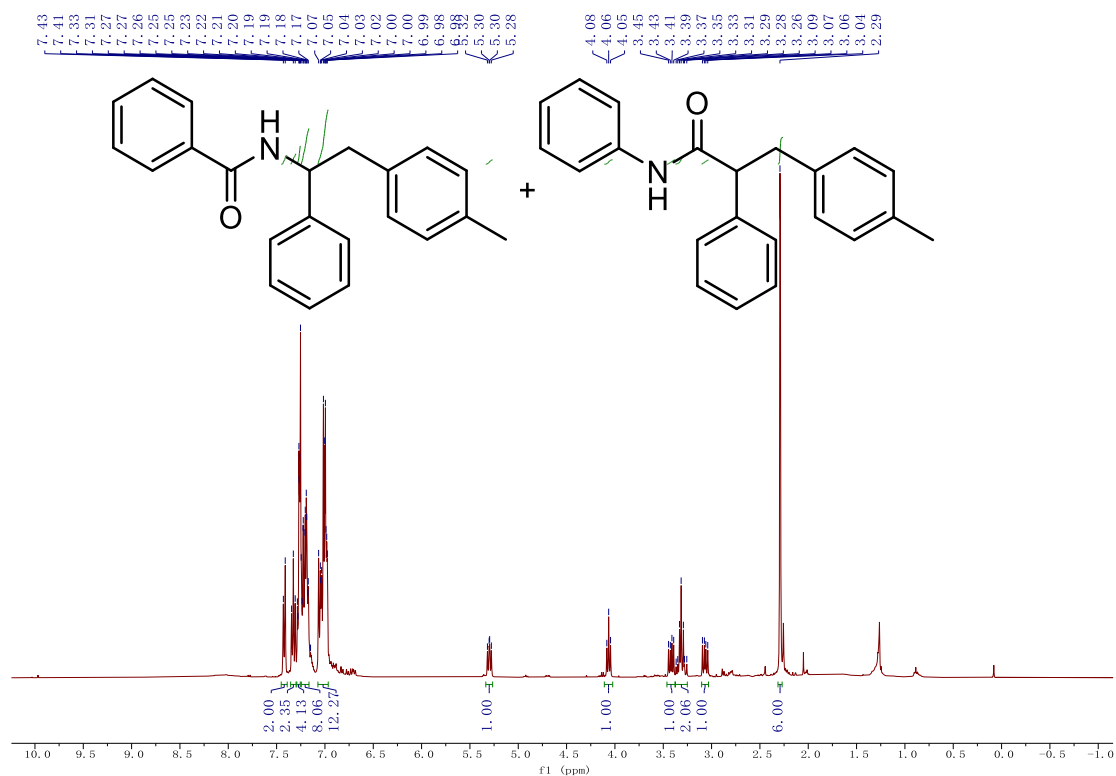
^1H NMR-spectrum (400MHz, CDCl_3) of **10**



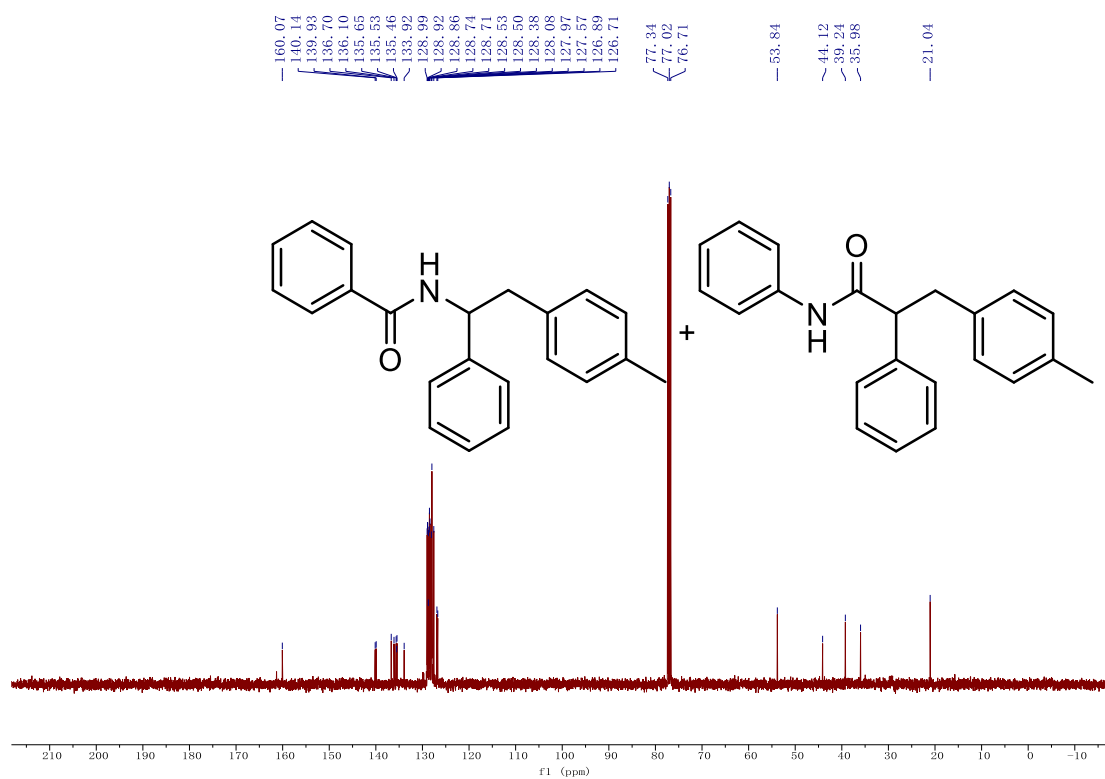
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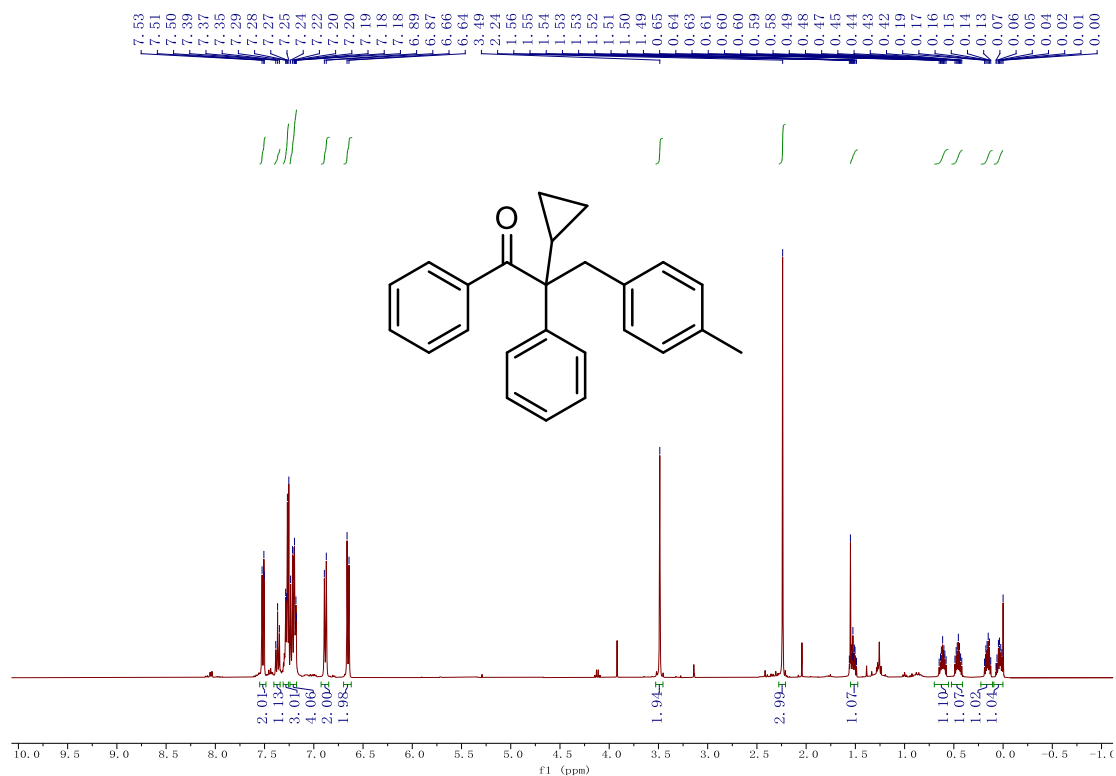
^1H NMR-spectrum (400MHz, CDCl_3) of **11**



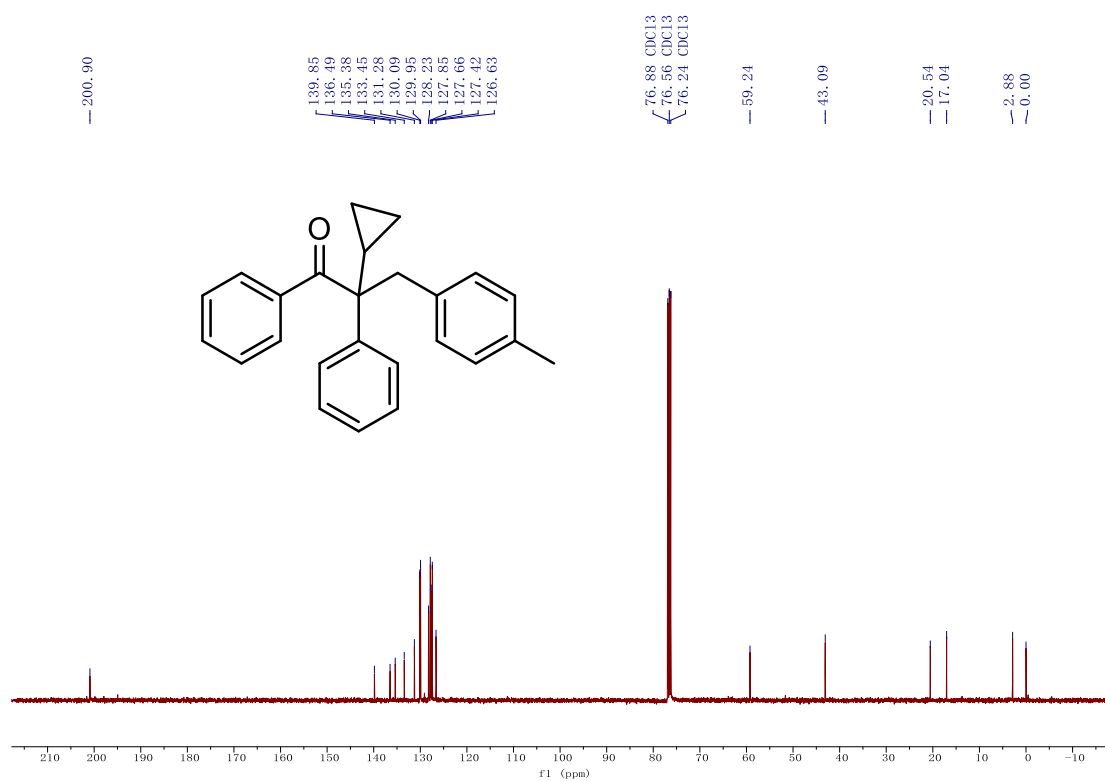
$^{13}\text{C}\{^1\text{H}\}$ NMR -spectrum (101MHz, CDCl_3) of **11**



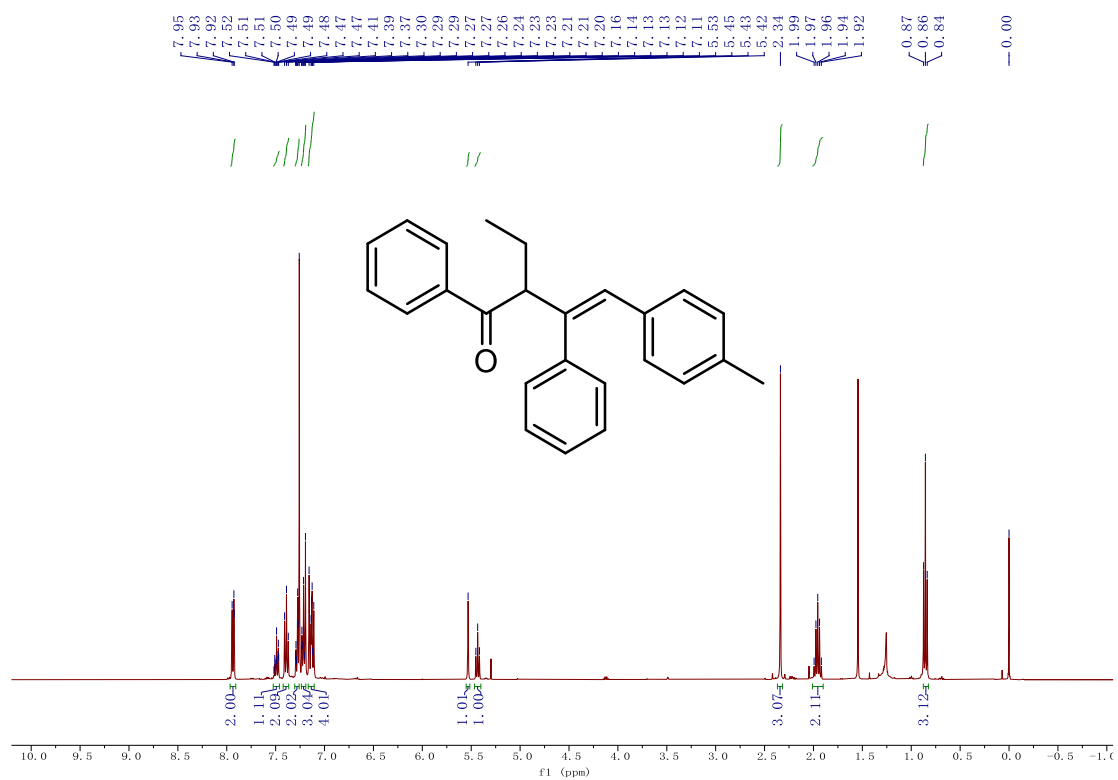
^1H NMR-spectrum (400MHz, CDCl_3) of **16**



$^{13}\text{C}\{^1\text{H}\}$ NMR-spectrum (101MHz, CDCl_3) of 16



^1H NMR-spectrum (400MHz, CDCl_3) of 17



$^{13}\text{C}\{^1\text{H}\}$ NMR -spectrum (101MHz, CDCl_3) of **17**

