Supporting Information

Visible-Light-Induced Defluorinative Carbonylative Coupling of Alkyl Iodides with α-Trifluoromethyl Substituted Styrenes

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1 General information

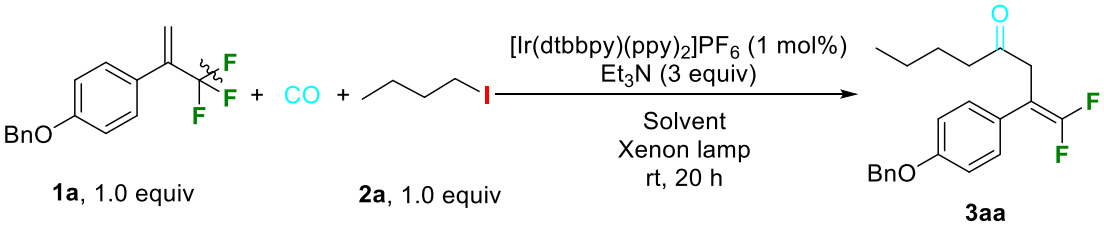
Reagents, solvents and analytical methods:

Unless otherwise noted, all reactions were carried out under a carbon monoxide or nitrogen atmosphere. All the α-trifluoromethyl substituted arylalkenes[1] and some alkyl iodides[2]: **2v**, **2w**, **2x**, **2y**, **2z** were synthesized by related references. All solvents were dried by standard techniques, and distilled prior to use. Column chromatography was performed on silica gel (200-300 meshes) using petroleum ether (b. p. 30-60 °C) and ethyl acetate as eluent. ^{1}H, and ^{13}C spectra were taken on Bruker AVANCE III 400 or 700 MHz spectrometers, ^{19}F NMR was taken on Oxford instrument X-pulse 60 MHz and $CDCl_3$ (^{1}H NMR δ 7.26, ^{13}C NMR δ 77.0) as solvent. All coupling constants (*J*) are reported in Hz with the following abbreviations: s = singlet, d = doublet, dd = double doublet, t = triplet, dt = double triplet, q = quatriplet, m = muLtiplet, br = broad. Light source was from CEL-PE300L-3A (325w). Gas chromatography (GC) analyses were performed on an Agilent HP-7890A instrument with a FID detector and HP-5 capillary column (polydimethylsiloxane with 5% phenyl groups, 30 m, 0.32 mm i.d. 0.25 µm film thickness) using argon as carrier gas. Gas chromatography mass spectrometer (GC-MS) analyses were performed on a Shimadzu QP2020 NX instrument. High resolution mass spectra (HRMS) were recorded on Agilent Q-TOF 6540. Because of the high toxicity of carbon monoxide, all of the reactions should be performed in an autoclave. The laboratory should well-equipped with a CO detector and alarm system.

[1] R.-Q. Pan, X.-X. Liu and M.-Z. Deng, *J. Fluorine Chem.* 1999, **95**, 167-170.
[2] J. E. Baldwin, L. Bischoff, T. D.W. Claridge, F. A. Heupel, D. R. Spring and R. C. Whitehead, *Tetrahedron* 1997, **53**, 2271-2290.

2. Optimization of reaction conditions

Screen for solvents[a]

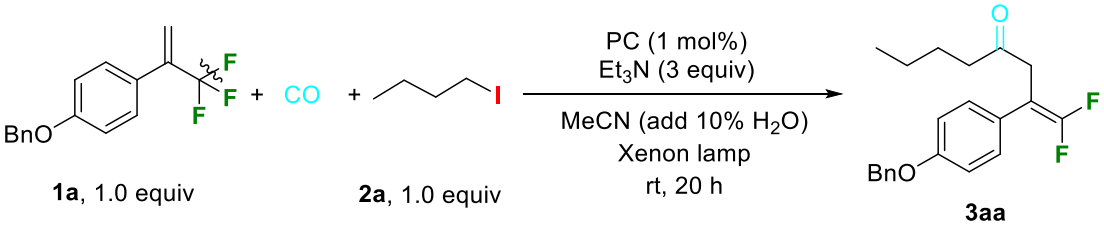


1a, 1.0 equiv **2a**, 1.0 equiv **3aa**

Entry	Solvent	Yield %[b]
1	MeCN	20
2	DCE	1
3	DMSO	0
4	EA	7
5	MeCN + 10% H_2O	35
6[c]	MeCN + 10% H_2O	21

a) Reaction conditions: **1a** (0.10 mmol, 1.0 equiv), **2a** (0.10 mmol, 1.0 equiv), [Ir(dtbbpy)(ppy)$_2$]PF_6 (1 mol%), Et_3N (0.30 mmol, 3.0 equiv), and MeCN (1.0 mL) under CO (60 bar) and stirred at rt for 20 h under Xenon lamp irradiation. b) The yields were determined by GC using hexadecane as the internal standard. c) **2a** (0.15 mmol).

Screen for photocatalyst[a]

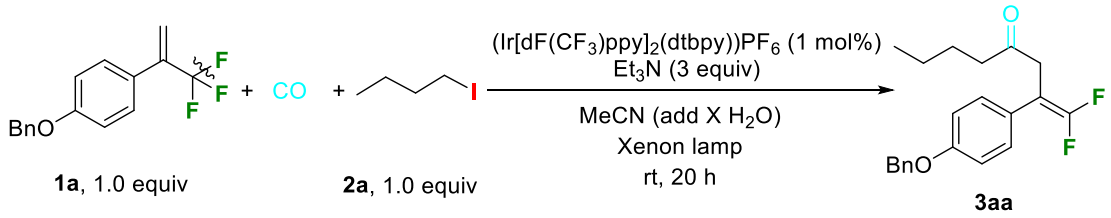


1a, 1.0 equiv **2a**, 1.0 equiv **3aa**

Entry	Photocatalyst	Yield %[b]
1	*fac*-Ir(ppy)$_3$	6
2	(Ir[dF(CF_3)ppy]$_2$(dtbpy))PF_6	47
3	Ru(bpy)$_2$(PF_6)$_2$	9
4[c]	Phenol Red	0
5[c]	Eosin Y	0
6[c]	Rhodamine B	0
7[c]	Methylene Blue	0

a) Reaction conditions: **1a** (0.10 mmol, 1.0 equiv), **2a** (0.10 mmol, 1.0 equiv), PC (1 mol%), Et_3N (0.30 mmol, 3.0 equiv), and MeCN (1.0 mL, add 10 % H_2O) under CO (60 bar) and stirred at rt for 20 h under Xenon lamp irradiation. b) The yields were determined by GC using hexadecane as the internal standard. c) photocatalyst (5 mol%).

Screen for the amount of water[a]

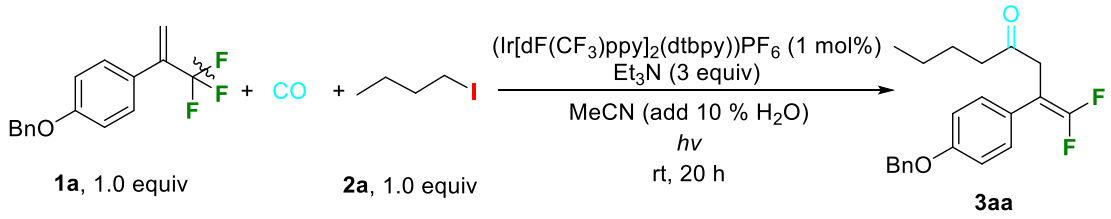


1a, 1.0 equiv **2a**, 1.0 equiv **3aa**

Entry	Addition of water	Yield %[b]
1	1 mL MeCN + 0.2 mL H_2O	38
2	1 mL MeCN + 0.4 mL H_2O	33
3	1 mL MeCN + 1.0 mL H_2O	28
4	0.5 mL MeCN + 1.0 mL H_2O	26
5	0.1 mL MeCN + 1.0 mL H_2O	7

a) Reaction conditions: **1a** (0.10 mmol, 1.0 equiv), **2a** (0.10 mmol, 1.0 equiv), $(Ir[dF(CF_3)ppy]_2(dtbpy))PF_6$ (1 mol%), Et_3N (0.30 mmol, 3.0 equiv) and solvent under CO (60 bar) and stirred at rt for 20 h under Xenon lamp irradiation. b) The yields were determined by GC using hexadecane as the internal standard.

Screen for other factors[a]



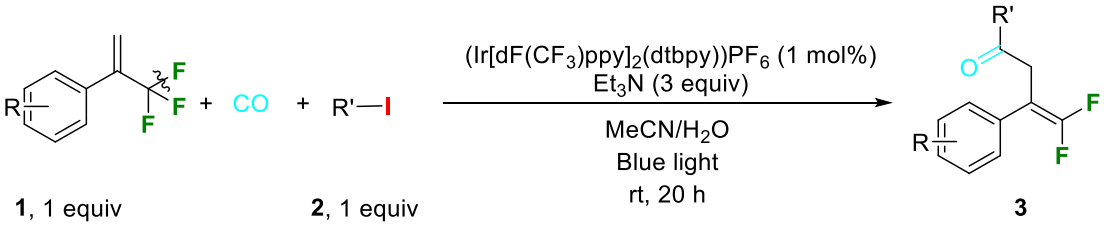
1a, 1.0 equiv **2a**, 1.0 equiv **3aa**

Entry	Light source	Yield %[b]
1	Blue light	13
2[d]	Blue light	11
3[e]	Blue light	53
4[f]	Blue light	70
5[g]	Blue light	75 (72[c])

a) Reaction conditions: **1a** (0.10 mmol, 1.0 equiv), **2a** (0.10 mmol, 1.0 equiv), $(Ir[dF(CF_3)ppy]_2(dtbpy))PF_6$ (1 mol %), Et_3N (0.30 mmol, 3.0 equiv) and MeCN (1.0 mL add 0.1 mL H_2O) under CO (60 bar) and stirred at rt for 20 h under blue light irradiation. b) The yields were determined by GC using hexadecane as the internal standard. c) Isolated yields. d) without water. e) 2.0 mL MeCN add 0.2 mL water. f) 3.0 mL MeCN add 0.3 mL water. g) 0.2 mmol scale reaction, 6.0 mL MeCN add 0.6 mL water.

3. General procedure

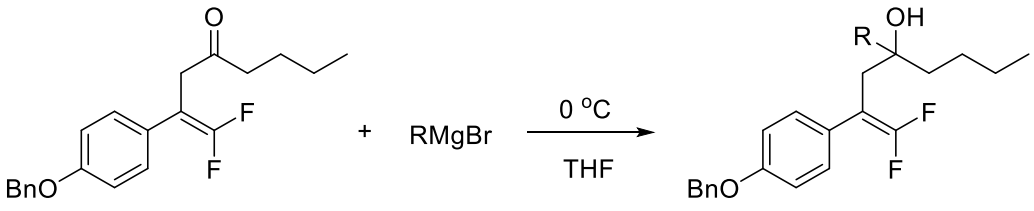
General procedure 1



1, 1 equiv **2**, 1 equiv **3**

A 10 mL screw-cap vial was charged with α-trifluoromethyl arylalkene (0.20 mmol), alkyl iodide (0.20 mmol), $(Ir[dF(CF_3)ppy]_2(dtbpy))PF_6$ (1 mol%, 2.3 mg), Et_3N (0.6 mmol, 121 mg) and an oven-dried stirring bar. The vial was closed with a Teflon septum and cap and connected to the atmosphere via a needle. After MeCN (6.0 mL) and H_2O (0.6 mL) was added with a syringe under N_2 atmosphere, the vial was moved to an alloy plate and put into a perspective pressure reactor (500 mL) under N_2 atmosphere. At room temperature, the autoclave was flushed with CO three times and charged with 60 bar CO. The autoclave was placed on a magnetic stirrer. The reaction was irradiated by blue light at room temperature for 20 h. The reaction mixture was then diluted with EtOAc, filtered through silica gel with copious washings (Et_2O or EtOAc), concentrated, and purified by column chromatography.

General procedure 2

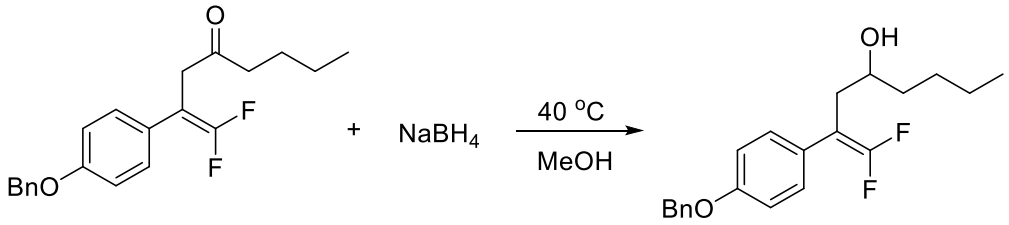


3aa

A flame dried Schlenk tube was charged with **3aa** (0.2 mmol, 69 mg) under nitrogen, and the compound was dissolved in dry THF (2.0 mL), resulting in a light yellow solution. The solution was stirred at 0 °C (ice bath). RMgBr (0.32 mmol, 0.32 mL of 1 M sol. in THF) was added dropwise over 10 min. The reaction mixture was stirred at room temperature and monitored by TLC until full conversion to the product was observed. The reaction mixture was quenched with aqueous saturated NH_4Cl and

extracted with ethyl acetate (5.0 ml × 3). The organic extracts are combined, concentrated and the residue was purified by silica gel column chromatography to afford the product.

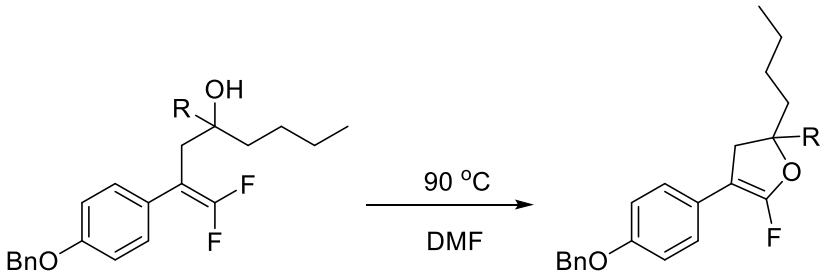
General procedure 3



3aa

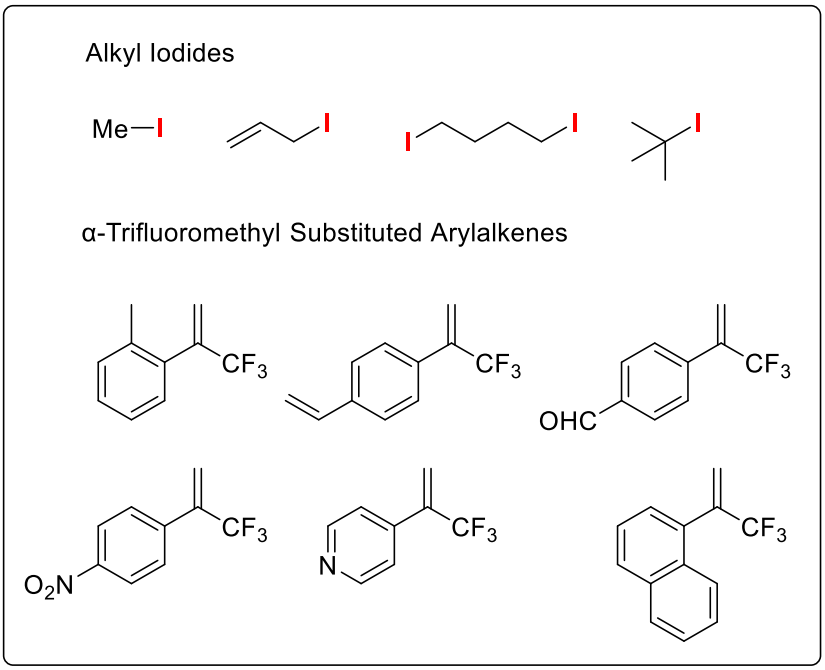
A flame dried Schlenk tube was charged with the requisite **3aa** (0.2 mmol, 69 mg), MeOH (10.0 mL) and NaBH4 (0.4 mmol, 31 mg). The reaction mixture was stirred for 6 h at 40 °C. and monitored by TLC until full conversion to the product was observed. Then the reaction mixture was diluted with ethyl acetate, filtered and dried with $NaSO_4$, and concentrated in vacuo. The residue was chromatographed on silica gel to afford the product.

General procedure 4

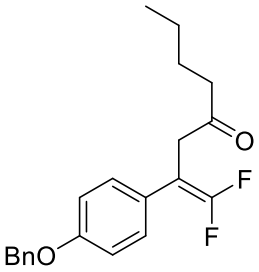


A separate flask is charged with the requisite γ,γ-difluoro allylic alcohols (0.2 mmol), DMF (2.0 mL) and NaH (7.2 mg, 0.3 mmol). The reaction mixture is then heated to 90 ℃ with stirring, and monitored by TLC until full conversion to the product was observed. The mixture is then cooled to room temperature, filtrated through celite, and concentrated. The residue chromatographed on silica gel to afford the product.

4. Failed examples



5. Spectroscopic data of products



2-(4-(benzyloxy)phenyl)-1,1-difluorooct-1-en-4-one (3aa)

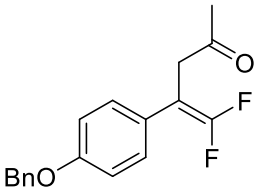
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and 1-iodobutane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 40:1) to give the product as a colorless oil (49 mg, 72%).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.36 – 7.22 (m, 5H), 7.13 (d, *J* = 8.3 Hz, 2H), 6.86 (d, *J* = 8.3 Hz, 2H), 4.97 (s, 2H), 3.32 (s, 2H), 2.34 (t, *J* = 7.4 Hz, 2H), 1.45 (p, *J* = 7.4 Hz, 2H), 1.18 (q, *J* = 7.7 Hz, 2H), 0.79 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 207.0 (dd, *J* = 2.8, 3.0 Hz), 158.1, 154.6 (dd, *J* = 294.1, 290.7 Hz), 136.8, 130.1, 129.1 (t, *J* = 3.2 Hz), 128.6, 128.1, 127.5, 125.6 (t, *J* = 3.2 Hz), 115.0, 86.8 (dd, *J* = 21.8, 22.1 Hz), 70.0, 42.3 (d, *J* = 2.0 Hz), 41.7, 25.7, 22.2, 13.8.

^{19}F NMR (376 MHz, Chloroform-*d*) δ -89.1 (d, *J* = 39.0 Hz), -90.2 (d, *J* = 39.0 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{21}H_{22}F_2O_2$ 345.1661; Found: 345.1660.



4-(4-(benzyloxy)phenyl)-5,5-difluoropent-4-en-2-one (3ab)

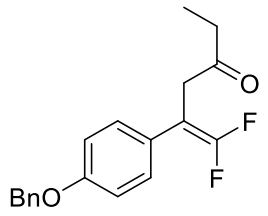
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and (iodomethyl)trimethylsilane (43 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 20:1) to give the product as a colorless oil (31 mg, 49%).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.37 – 7.28 (m, 4H), 7.27 – 7.22 (m, 1H), 7.19 – 7.12 (m, 2H), 6.91 – 6.84 (m, 2H), 4.97 (s, 2H), 3.34 (t, *J* = 2.2 Hz, 2H), 2.07 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 204.7 (dd, *J* = 2.2, 3.7 Hz), 158.1, 154.6 (dd, *J* = 293.0, 293.0 Hz), 136.8, 129.1 (t, *J* = 3.3 Hz), 128.6, 128.1, 127.5, 125.4 (t, *J* = 4.4 Hz), 115.0, 86.8 (dd, *J* = 21.7, 22.0 Hz), 70.0, 43.1 (d, *J* = 2.0 Hz), 29.2.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.4 (d, *J* = 40.6 Hz), -89.7 (d, *J* = 37.4 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{18}H_{16}F_2O_2$ 303.1191; Found: 303.1190.



5-(4-(benzyloxy)phenyl)-6,6-difluorohex-5-en-3-one (3ac)

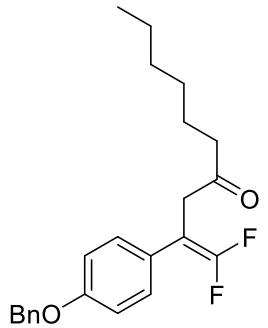
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and iodoethane (32 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 40:1) to give the product as a colorless oil (37 mg, 59%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.33 (dd, *J* = 21.6, 7.6 Hz, 4H), 7.25 (t, *J* = 7.3 Hz, 1H), 7.14 (d, *J* = 8.6 Hz, 2H), 6.89 – 6.84 (m, 2H), 4.98 (s, 2H), 3.34 (s, 2H), 2.38 (q, *J* = 7.4 Hz, 2H), 0.95 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 206.3 (dd, *J* = 2.0, 3.4 Hz), 157.1, 154.4 (q, *J* = 290.2 Hz), 135.8, 129.0, 128.0 (t, *J* = 3.7 Hz), 127.6, 127.0, 126.4, 124.6 (t, *J* = 3.8 Hz), 85.8 (dd, *J* = 21.9, 22.3 Hz), 69.0, 40.9 (d, *J* = 2.0 Hz), 34.1, 6.6.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.7 (d, *J* = 38.2 Hz), -89.9 (d, *J* = 40.2 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{19}H_{18}F_2O_2$ 317.1348; Found: 317.1346.



2-(4-(benzyloxy)phenyl)-1,1-difluorodec-1-en-4-one (3ad)

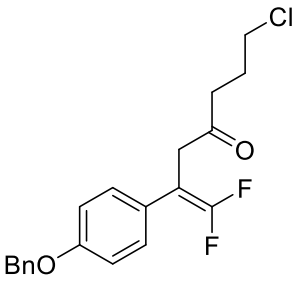
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and 1-iodohexane (43 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 40:1) to give the product as a yellow oil (47 mg, 63%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.34 (d, *J* = 7.1 Hz, 2H), 7.30 (t, *J* = 7.5 Hz, 2H), 7.24 (t, *J* = 7.1 Hz, 1H), 7.13 (d, *J* = 8.4 Hz, 2H), 6.86 (d, *J* = 8.8 Hz, 2H), 4.96 (s, 2H), 3.32 (s, 2H), 2.33 (t, *J* = 7.4 Hz, 2H), 1.45 (dd, *J* = 9.0, 5.5 Hz, 2H), 1.19 (td, *J* = 9.2, 8.4, 4.3 Hz, 2H), 1.15 (dt, *J* = 7.6, 3.6 Hz, 4H), 0.78 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 207.1 (dd, *J* = 2.9, 3.0 Hz), 158.1, 154.6 (dd, *J* = 292.1, 292.6 Hz), 136.8, 129.1 (t, *J* = 3.6 Hz), 128.6, 128.1, 127.5, 125.6 (t, *J* = 4.3 Hz), 115.0, 86.8 (dd, *J* = 22.3, 22.4 Hz), 70.0, 42.3 (d, *J* = 1.5 Hz), 42.0, 31.6, 28.8, 23.6, 22.5, 14.0.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.7 (d, *J* = 38.9 Hz), -90.0 (d, *J* = 38.9 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{23}H_{26}F_2O_2$ 373.1974; Found: 373.1972.



2-(4-(benzyloxy)phenyl)-7-chloro-1,1-difluorohept-1-en-4-one (3ae)

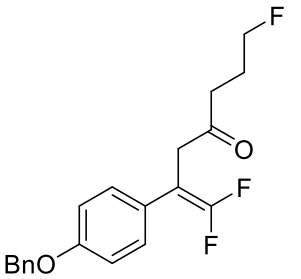
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and 1-chloro-3-iodopropane (41 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (37 mg, 51%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.35 – 7.30 (m, 4H), 7.25 (t, *J* = 7.2 Hz, 1H), 7.14 (d, *J* = 8.4 Hz, 2H), 6.88 (d, *J* = 8.6 Hz, 2H), 4.98 (s, 2H), 3.44 (t, *J* = 6.3 Hz, 2H), 3.37 (s, 2H), 2.56 (t, *J* = 7.0 Hz, 2H), 1.97 – 1.91 (m, 2H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 204.6 (dd, *J* = 2.8, 3.3 Hz), 157.1, 153.6 (dd, *J* = 292.8, 292.0 Hz), 135.7, 128.0 (t, *J* = 3.5 Hz), 127.6, 127.0, 126.4, 124.3 (t, *J* = 4.1 Hz), 114.0, 85.6 (dd, *J* = 21.9, 22.5 Hz), 69.0, 43.2, 41.4 (d, *J* = 1.7 Hz), 37.5, 25.1.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.3 (d, *J* = 40.0 Hz), -89.6 (d, *J* = 37.6 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{20}H_{19}ClF_2O_2$ 365.1114; Found: 365.1111.



2-(4-(benzyloxy)phenyl)-1,1,7-trifluorohept-1-en-4-one (3af)

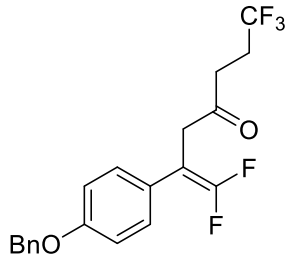
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and 1-fluoro-3-iodopropane (38 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 20:1) to give the product as a colorless oil (50 mg, 72%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.34 (d, *J* = 7.1 Hz, 2H), 7.30 (dd, *J* = 8.4, 6.6 Hz, 2H), 7.24 (t, *J* = 7.3 Hz, 1H), 7.13 (d, *J* = 8.7 Hz, 2H), 6.87 (d, *J* = 8.8 Hz, 2H), 4.97 (s, 2H), 4.35 (t, *J* = 5.8 Hz, 1H), 4.28 (t, *J* = 5.8 Hz, 1H), 3.36 (s, 2H), 2.51 (t, *J* = 7.1 Hz, 2H), 1.90 – 1.77 (m, 2H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 204.7 (dd, *J* = 2.9, 2.8 Hz), 157.1, 153.6 (dd, *J* = 292.2, 292.9 Hz), 135.7, 128.0 (t, *J* = 3.5 Hz), 127.6, 127.0, 126.4, 124.4 (t, *J* = 4.0 Hz), 114.0, 85.6 (dd, *J* = 22.0, 22.3 Hz), 81.9 (d, *J* = 165.0 Hz), 69.0, 41.3 (d, *J* = 1.7 Hz), 36.2 (d, *J* = 4.2 Hz), 23.3 (d, *J* = 21.1 Hz).

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.4 (d, *J* = 38.5 Hz), -89.6 (d, *J* = 38.5 Hz), -219.9 (m).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{20}H_{19}F_3O_2$ 349.1410; Found: 349.1408.



2-(4-(benzyloxy)phenyl)-1,1,7,7,7-pentafluorohept-1-en-4-one (3ag)

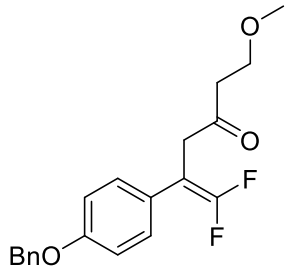
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and 1,1,1-trifluoro-3-iodopropane (45 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 20:1) to give the product as a colorless oil (45 mg, 59%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.34 (d, *J* = 7.1 Hz, 2H), 7.30 (t, *J* = 7.5 Hz, 2H), 7.25 (t, *J* = 7.2 Hz, 1H), 7.12 (d, *J* = 8.5 Hz, 2H), 6.87 (d, *J* = 8.8 Hz, 2H), 4.97 (s, 2H), 3.38 (s, 2H), 2.65 – 2.57 (m, 2H), 2.29 (tdd, *J* = 10.8, 7.8, 4.9 Hz, 2H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 203.1 (dd, *J* = 3.1, 3.0 Hz), 158.3, 154.7 (dd, *J* = 293.6, 292.3 Hz), 136.7, 129.0 (t, *J* = 3.7 Hz), 128.7, 128.1, 127.5, 125.1 (t, *J* = 4.0 Hz), 115.1, 86.3 (dd, *J* = 21.7, 22.3 Hz), 70.0, 42.2 (d, *J* = 2.1 Hz), 34.2 (d, *J* = 2.8 Hz), 27.9 (q, *J* = 30.1 Hz).

^{19}F NMR (56 MHz, Chloroform-*d*) δ -66.2, -88.3 (d, *J* = 37.2 Hz), -89.3 (d, *J* = 36.4 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{20}H_{17}F_5O_2$ 385.1221; Found: 385.1220.



5-(4-(benzyloxy)phenyl)-6,6-difluoro-1-methoxyhex-5-en-3-one (3ah)

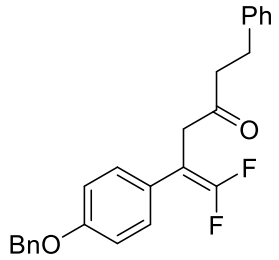
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and 1-iodo-2-methoxyethane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 5:1) to give the product as a colorless oil (44 mg, 64%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.34 (d, *J* = 7.2 Hz, 2H), 7.30 (dd, *J* = 8.6, 6.7 Hz, 2H), 7.27 – 7.22 (m, 1H), 7.16 – 7.12 (m, 2H), 6.86 (d, *J* = 8.8 Hz, 2H), 4.97 (s, 2H), 3.53 (t, *J* = 6.2 Hz, 2H), 3.39 (s, 2H), 3.22 (s, 3H), 2.59 (t, *J* = 6.2 Hz, 2H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 205.1 (dd, *J* = 2.9, 3.2 Hz), 158.1, 154.6 (dd, *J* = 293.0, 293.0 Hz), 136.8, 129.1 (t, *J* = 3.6 Hz), 128.6, 128.1, 127.5, 125.5 (t, *J* = 3.8 Hz), 115.0, 86.5 (dd, *J* = 21.8, 22.4 Hz), 70.0, 67.5, 58.9, 42.9 (d, *J* = 1.8 Hz), 42.1.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.3 (d, *J* = 37.7 Hz), -89.6 (d, *J* = 38.6 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{20}H_{20}F_2O_3$ 347.1453; Found: 347.1453.



5-(4-(benzyloxy)phenyl)-6,6-difluoro-1-phenylhex-5-en-3-one (3ai)

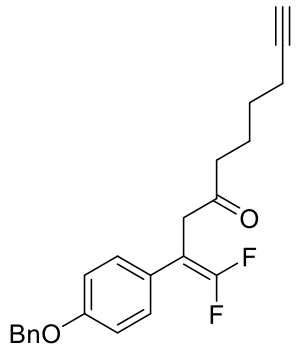
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and (2-iodoethyl)benzene (46 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 20:1) to give the product as a colorless oil (27 mg, 45%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.35 (d, *J* = 7.0 Hz, 2H), 7.31 (t, *J* = 7.6 Hz, 2H), 7.27 – 7.24 (m, 1H), 7.20 – 7.16 (m, 2H), 7.12 – 7.09 (m, 1H), 7.09 – 7.07 (m, 2H), 7.06 – 7.03 (m, 2H), 6.85 (d, *J* = 8.8 Hz, 2H), 4.98 (s, 2H), 3.31 (d, *J* = 2.3 Hz, 2H), 2.79 (t, *J* = 7.6 Hz, 2H), 2.68 (t, *J* = 7.6 Hz, 2H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 204.8 (dd, *J* = 2.1, 2.4 Hz), 157.0, 153.6 (dd, *J* = 292.4, 292.0 Hz), 139.7, 135.7, 128.0 (t, *J* = 4.2 Hz), 127.6, 127.5, 127.3, 127.0, 126.4, 125.2, 124.4 (t, *J* = 3.8 Hz), 113.9, 85.6 (dd, *J* = 22.1, 22.0 Hz), 69.0, 42.4, 41.5 (d, *J* = 1.7 Hz), 28.6.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.3 (d, *J* = 38.2 Hz), -89.6 (d, *J* = 38.2 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{25}H_{22}F_2O_2$ 393.1661; Found: 393.1659.



2-(4-(benzyloxy)phenyl)-1,1-difluorodec-1-en-9-yn-4-one (3aj)

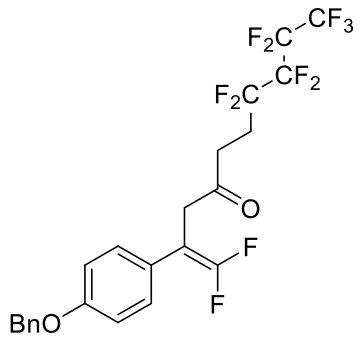
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and 6-iodohex-1-yne (42 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (33 mg, 45%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.35 (d, *J* = 7.3 Hz, 2H), 7.31 (dd, *J* = 8.3, 6.6 Hz, 2H), 7.27 – 7.24 (m, 1H), 7.15 – 7.11 (m, 2H), 6.87 (d, *J* = 8.8 Hz, 2H), 4.98 (s, 2H), 3.34 (s, 2H), 2.38 (t, *J* = 7.3 Hz, 2H), 2.08 (td, *J* = 7.0, 2.7 Hz, 2H), 1.86 (s, 1H), 1.59 (p, *J* = 7.4 Hz, 2H), 1.43 – 1.36 (m, 2H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 205.4 (dd, *J* = 2.0, 3.6 Hz), 157.1, 153.6 (dd, *J* = 292.8, 292.5 Hz), 135.7, 128.0 (t, *J* = 4.0 Hz), 127.6, 127.0, 126.4, 124.5 (t, *J* = 4.1 Hz), 113.9, 85.7 (dd, *J* = 21.9, 21.9 Hz), 82.9, 69.0, 67.6, 41.2 (d, *J* = 1.6 Hz), 40.2, 26.7, 21.6, 17.2.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.5 (d, *J* = 39.1 Hz), -89.8 (d, *J* = 36.4 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{23}H_{22}F_2O_2$ 369.1661; Found: 369.1660.



2-(4-(benzyloxy)phenyl)-1,1,7,7,8,8,9,9,10,10,10-undecafluorodec-1-en-4-one (3ak)

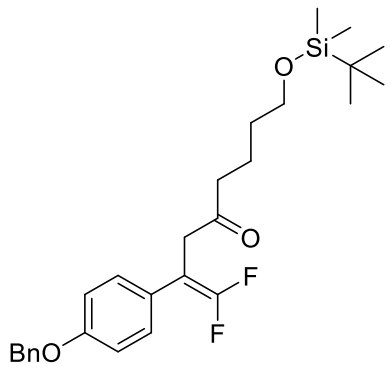
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and 1,1,1,2,2,3,3,4,4-nonafluoro-6-iodohexane (75 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (51 mg, 48%).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.36 – 7.24 (m, 5H), 7.16 – 7.09 (m, 2H), 6.88 (d, *J* = 8.8 Hz, 2H), 4.97 (s, 2H), 3.40 (s, 2H), 2.66 (dd, *J* = 8.5, 6.6 Hz, 2H), 2.39 – 2.20 (m, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 203.2 (dd, *J* = 3.0, 2.7 Hz), 158.3, 154.6 (dd, *J* = 292.9, 292.9 Hz), 136.7, 129.1 (t, *J* = 3.6 Hz), 128.6, 128.1, 127.5, 125.1 (t, *J* = 3.6 Hz), 115.1, 86.3 (dd, *J* = 22.0, 21.6 Hz), 70.0, 42.3 (d, *J* = 1.7 Hz), 32.5, 24.9 (t, *J* = 22.2 Hz).

^{19}F NMR (56 MHz, Chloroform-*d*) δ -80.6 (s), -88.2 (d, *J* = 36.8 Hz), -89.3 (d, *J* = 38.0 Hz), -114.0 (s), -124.0 (s), -125.6 (s).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{23}H_{17}F_{11}O_2$ 535.1126; Found: 535.1122.



2-(4-(benzyloxy)phenyl)-8-((*tert*-butyldimethylsilyl)oxy)-1,1-difluorooct-1-en-4-one (3al)

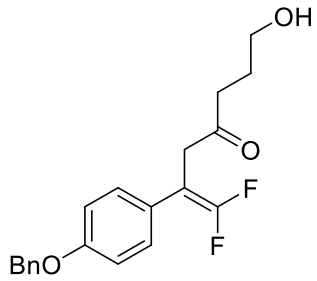
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and *tert*-butyl(4-iodobutoxy)dimethylsilane (63 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (45 mg, 47%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.39 (d, *J* = 7.4 Hz, 2H), 7.35 (t, *J* = 7.5 Hz, 2H), 7.32 – 7.27 (m, 1H), 7.20 – 7.16 (m, 2H), 6.94 – 6.87 (m, 2H), 5.02 (s, 2H), 3.54 (t, *J* = 6.3 Hz, 2H), 3.38 (t, *J* = 2.3 Hz, 2H), 2.43 (t, *J* = 7.4 Hz, 2H), 1.57 (q, *J* = 7.6 Hz, 2H), 1.46 – 1.41 (m, 2H), 0.85 (s, 9H), 0.00 (s, 6H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 205.7 (dd, *J* = 2.6, 2.9 Hz), 153.6 (dd, *J* = 293.3, 291.7 Hz), 151.9, 135.8, 128.0 (t, *J* = 3.3 Hz), 127.6, 127.0, 126.4, 124.6 (t, *J* = 4.8 Hz), 113.9, 85.7 (dd, *J* = 22.5, 21.9 Hz), 69.0, 61.7, 41.2 (d, *J* = 1.9 Hz), 40.7, 31.0, 24.9, 19.1, 17.3, -6.4.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.6 (d, *J* = 39.5 Hz), -89.9 (d, *J* = 38.6 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{27}H_{36}F_2O_3Si$ 475.2475; Found: 475.2474.



2-(4-(benzyloxy)phenyl)-1,1-difluoro-7-hydroxyhept-1-en-4-one (3am)

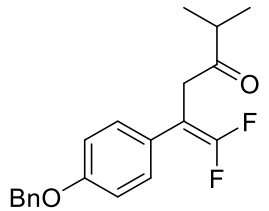
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and 3-iodopropan-1-ol (38 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 2:1) to give the product as a colorless oil (34 mg, 49%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.34 (d, *J* = 7.1 Hz, 2H), 7.31 (t, *J* = 7.7 Hz, 2H), 7.27 – 7.23 (m, 1H), 7.16 – 7.12 (m, 2H), 6.88 – 6.85 (m, 2H), 4.97 (s, 2H), 3.51 (t, *J* = 6.1 Hz, 2H), 3.37 (s, 2H), 2.50 (t, *J* = 6.9 Hz, 2H), 1.73 (t, *J* = 6.5 Hz, 2H), 1.58 (s, 1H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 207.2 (dd, *J* = 2.6, 2.9 Hz), 158.1, 154.6 (dd, *J* = 293.1, 293.1 Hz), 136.8, 129.1 (t, *J* = 3.4 Hz), 128.6, 128.1, 127.5, 125.5 (t, *J* = 4.1 Hz), 115.0, 86.7 (dd, *J* = 22.1, 22.0 Hz), 70.0, 62.0, 42.4 (d, *J* = 1.7 Hz), 38.6, 26.3.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -90.9 (d, *J* = 45.9 Hz), -92.3 (d, *J* = 41.8 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{20}H_{20}F_2O_3$ 347.1453; Found: 347.1450.



5-(4-(benzyloxy)phenyl)-6,6-difluoro-2-methylhex-5-en-3-one (3an)

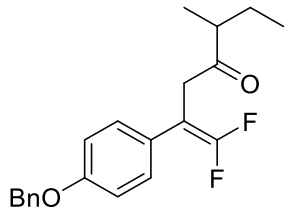
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and 2-iodopropane (34 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (39 mg, 59%).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.37 – 7.28 (m, 4H), 7.28 – 7.21 (m, 1H), 7.12 (dd, *J* = 8.9, 1.2 Hz, 2H), 6.86 (d, *J* = 8.8 Hz, 2H), 4.97 (s, 2H), 3.39 (t, *J* = 2.2 Hz, 2H), 2.59 (p, *J* = 6.9 Hz, 1H), 1.00 (d, *J* = 7.0 Hz, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 210.3 (dd, *J* = 2.6, 2.6 Hz), 158.1, 154.6 (dd, *J* = 292.7, 290.9 Hz), 136.8, 129.1 (t, *J* = 3.5 Hz), 128.6, 128.0, 127.5, 125.9 (t, *J* = 4.0 Hz), 114.9, 86.8 (dd, *J* = 22.0, 22.2 Hz), 70.0, 40.2, 40.1 (d, *J* = 2.2 Hz), 18.2.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -89.0 (d, *J* = 41.6 Hz), -90.2 (d, *J* = 39.1 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{20}H_{20}F_2O_2$ 331.1504; Found: 331.1501.



2-(4-(benzyloxy)phenyl)-1,1-difluoro-5-methylhept-1-en-4-one (3ao)

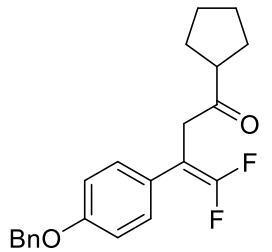
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and 2-iodobutane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 40:1) to give the product as a colorless oil (35 mg, 51%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.34 (d, *J* = 7.6 Hz, 2H), 7.31 (t, *J* = 7.5 Hz, 2H), 7.25 (t, *J* = 7.3 Hz, 1H), 7.13 (d, *J* = 8.3 Hz, 2H), 6.89 – 6.83 (m, 2H), 4.97 (s, 2H), 3.38 (s, 2H), 2.45 (q, *J* = 6.9 Hz, 1H), 1.58 (dq, *J* = 14.4, 7.2 Hz, 1H), 1.30 (dp, *J* = 14.2, 7.1 Hz, 1H), 0.97 (d, *J* = 6.8 Hz, 3H), 0.75 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 209.3 (dd, *J* = 2.7, 3.0 Hz), 157.0, 153.6 (dd, *J* = 291.8, 290.9 Hz), 135.8, 128.1 (t, *J* = 3.5 Hz), 127.6, 127.0, 126.4, 124.8 (t, *J* = 3.9 Hz), 113.8, 85.6 (dd, *J* = 22.2, 22.0 Hz), 69.0, 46.0, 39.9 (d, *J* = 2.2 Hz), 24.9, 14.9, 10.5.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -89.0 (d, *J* = 40.3 Hz), -90.2 (d, *J* = 40.3 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{21}H_{22}F_2O_2$ 345.1661; Found: 345.1658.



3-(4-(benzyloxy)phenyl)-1-cyclopentyl-4,4-difluorobut-3-en-1-one (3ap)

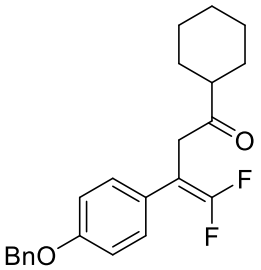
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and iodocyclopentane (39 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (37 mg, 52%).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.36 – 7.27 (m, 5H), 7.27 – 7.22 (m, 1H), 7.16 – 7.11 (m, 2H), 6.88 – 6.83 (m, 2H), 4.96 (s, 2H), 3.39 (t, *J* = 2.2 Hz, 2H), 2.89 – 2.78 (m, 1H), 1.72 – 1.46 (m, 8H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 209.0 (dd, *J* = 2.7, 2.8 Hz), 158.0, 154.6 (dd, *J* = 292.2, 291.5 Hz), 136.8, 129.1 (t, *J* = 3.5 Hz), 128.6, 128.1, 127.5, 125.9 (t, *J* = 4.1 Hz), 114.9, 86.8 (dd, *J* = 22.2, 22.0 Hz), 70.0, 50.6, 41.5 (d, *J* = 2.2 Hz), 29.0, 26.0.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.8 (d, *J* = 37.9 Hz), -90.1 (d, *J* = 40.2 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{22}H_{22}F_2O_2$ 357.1661; Found: 357.1657.



3-(4-(benzyloxy)phenyl)-1-cyclohexyl-4,4-difluorobut-3-en-1-one (3aq)

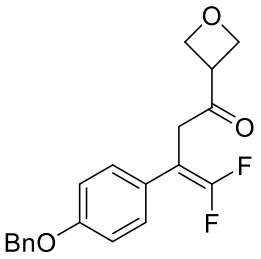
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and iodocyclohexane (42 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (43 mg, 58%).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.36 – 7.27 (m, 4H), 7.27 – 7.21 (m, 1H), 7.14 – 7.08 (m, 2H), 6.85 (d, *J* = 8.9 Hz, 2H), 4.96 (s, 2H), 3.37 (s, 2H), 2.41 – 2.27 (m, 1H), 1.80 – 1.62 (m, 4H), 1.43 – 0.76 (m, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 209.6 (dd, *J* = 2.1, 3.2 Hz), 158.0, 154.5 (dd, *J* = 291.9, 291.9 Hz), 136.8, 129.1 (t, *J* = 3.6 Hz), 128.6, 128.0, 127.5, 126.0 (t, *J* = 3.9 Hz), 114.9, 86.7 (dd, *J* = 22.4, 22.0 Hz), 70.0, 50.2, 40.3 (d, *J* = 2.1 Hz), 28.5, 25.8, 25.6.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -89.0 (d, *J* = 40.8 Hz), -90.2 (d, *J* = 40.8 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{23}H_{24}F_2O_2$ 371.1817; Found: 371.1812.



3-(4-(benzyloxy)phenyl)-4,4-difluoro-1-(oxetan-3-yl)but-3-en-1-one (3ar)

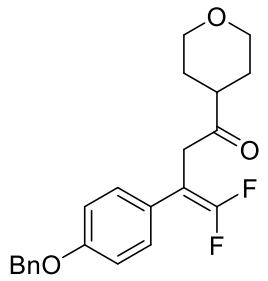
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and 3-iodooxetane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 2:1) to give the product as a colorless oil (47 mg, 68%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.34 (d, *J* = 7.2 Hz, 2H), 7.32 – 7.28 (m, 2H), 7.26 – 7.22 (m, 1H), 7.16 – 7.11 (m, 2H), 6.87 (d, *J* = 8.7 Hz, 2H), 4.97 (s, 2H), 4.67 – 4.58 (m, 4H), 3.88 (p, *J* = 7.6 Hz, 1H), 3.35 (s, 2H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 204.1 (dd, *J* = 2.7, 3.2 Hz), 158.3, 154.6 (dd, *J* = 292.7, 293.8 Hz), 136.7, 129.0 (t, *J* = 3.5 Hz), 128.7, 128.1, 127.5, 125.0 (t, *J* = 3.8 Hz), 115.1, 86.1 (dd, *J* = 21.4, 21.6 Hz), 72.2, 70.1, 44.5, 40.8 (d, *J* = 1.9 Hz).

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.4 (d, *J* = 38.1 Hz), -89.5 (d, *J* = 38.5 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{20}H_{18}F_2O_3$ 345.1297; Found: 345.1297.



3-(4-(benzyloxy)phenyl)-4,4-difluoro-1-(tetrahydro-2*H*-pyran-4-yl)but-3-en-1-one (3as)

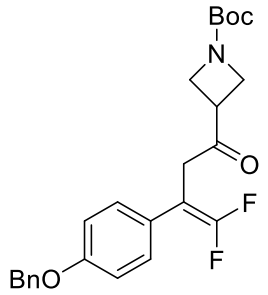
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and 4-iodotetrahydro-2*H*-pyran (43 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 2:1) to give the product as a colorless oil (43 mg, 58%).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.36 – 7.27 (m, 4H), 7.28 – 7.22 (m, 1H), 7.16 – 7.07 (m, 2H), 6.90 – 6.83 (m, 2H), 4.97 (s, 2H), 3.90 (dt, *J* = 11.5, 3.5 Hz, 2H), 3.39 (t, *J* = 2.2 Hz, 2H), 3.35 – 3.26 (m, 2H), 2.59 – 2.46 (m, 1H), 1.61 (ddd, *J* = 10.2, 7.2, 3.8 Hz, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 207.6 (dd, *J* = 2.6, 2.8 Hz), 158.1, 154.6 (dd, *J* = 292.6, 291.7 Hz), 136.8, 129.1 (t, *J* = 3.3 Hz), 128.6, 128.1, 127.5, 125.6 (t, *J* = 3.9 Hz), 115.0, 86.5 (dd, *J* = 22.3, 21.9 Hz), 70.0, 67.1, 46.9, 40.1 (d, *J* = 2.3 Hz), 28.1.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.7 (d, *J* = 40.8 Hz), -89.8 (d, *J* = 40.3 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{22}H_{22}F_2O_3$ 373.1610; Found: 373.1609.



***tert*-butyl 3-(3-(4-(benzyloxy)phenyl)-4,4-difluorobut-3-enoyl)azetidine-1-carboxylate (3at)**

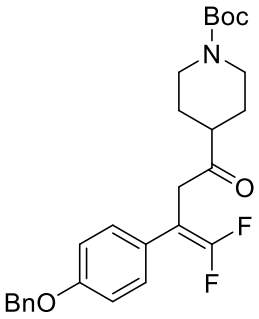
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and *tert*-butyl 3-iodoazetidine-1-carboxylate (57 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 2:1) to give the product as a colorless oil (56 mg, 63%).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.36 – 7.28 (m, 4H), 7.27 – 7.22 (m, 1H), 7.16 – 7.10 (m, 2H), 6.90 – 6.85 (m, 2H), 5.20 (s, 1H), 4.97 (s, 2H), 3.88 (q, *J* = 8.3, 7.6 Hz, 4H), 3.36 (t, *J* = 2.2 Hz, 2H), 1.34 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 204.3 (dd, *J* = 2.9, 3.3 Hz), 158.3, 156.1, 154.6 (dd, *J* = 293.3, 293.5 Hz), 136.7, 129.0 (t, *J* = 3.5 Hz), 128.7, 128.1, 127.5, 125.0 (t, *J* = 4.0 Hz), 115.1, 86.1 (dd, *J* = 21.5, 21.9 Hz), 79.9, 70.1, 53.5, 40.7 (d, *J* = 2.1 Hz), 37.8, 28.3.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -87.9 (d, *J* = 37.4 Hz), -89.0 (d, *J* = 35.9 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{25}H_{27}F_2NO_4$ 444.1981; Found: 444.1980.



***tert*-butyl 4-(3-(4-(benzyloxy)phenyl)-4,4-difluorobut-3-enoyl)piperidine-1-carboxylate (3au)**

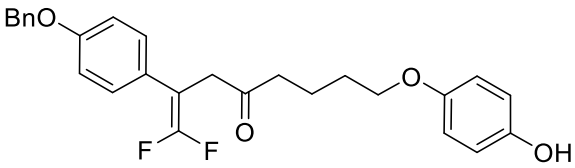
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and *tert*-butyl 4-iodopiperidine-1-carboxylate (62 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 2:1) to give the product as a colorless oil (52 mg, 55%).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.32 (dddd, *J* = 12.5, 7.6, 6.4, 1.7 Hz, 4H), 7.27 – 7.21 (m, 1H), 7.14 – 7.08 (m, 2H), 6.88 – 6.83 (m, 2H), 4.97 (s, 2H), 4.00 (s, 2H), 3.40 (t, *J* = 2.3 Hz, 2H), 2.67 (t, *J* = 12.7 Hz, 2H), 2.45 (tt, *J* = 11.4, 3.7 Hz, 1H), 1.67 (d, *J* = 12.8 Hz, 2H), 1.49 – 1.39 (m, 2H), 1.37 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 207.9 (dd, *J* = 1.8, 3.2 Hz), 158.1, 154.6, 154.5 (dd, *J* = 291.6, 292.0 Hz), 136.8, 129.1 (t, *J* = 4.0 Hz), 128.6, 128.1, 127.5, 125.6 (t, *J* = 3.6 Hz), 115.0, 86.5 (dd, *J* = 21.9, 22.2 Hz), 79.7, 70.0, 47.9, 40.3 (d, *J* = 2.0 Hz), 28.4, 27.4.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.7 (d, *J* = 37.8 Hz), -89.9 (d, *J* = 37.8 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{27}H_{31}F_2NO_4$ 472.2294; Found: 472.2295.



2-(4-(benzyloxy)phenyl)-1,1-difluoro-8-(4-hydroxyphenoxy)oct-1-en-4-one (3av)

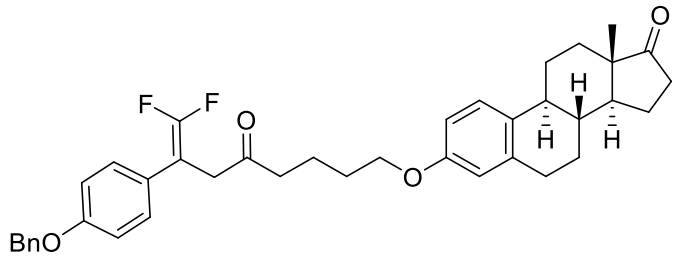
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and 4-(4-iodobutoxy)phenol (59 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 5:1) to give the product as a colorless oil (44 mg, 49%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.33 (d, *J* = 7.6 Hz, 2H), 7.30 (t, *J* = 7.5 Hz, 2H), 7.24 (t, *J* = 7.3 Hz, 1H), 7.13 (d, *J* = 8.5 Hz, 2H), 6.85 (d, *J* = 8.3 Hz, 2H), 6.64 (s, 4H), 4.95 (s, 2H), 4.90 (s, 1H), 3.75 (t, *J* = 5.9 Hz, 2H), 3.34 (s, 2H), 2.43 (t, *J* = 6.8 Hz, 2H), 1.62 (dq, *J* = 15.6, 6.2, 4.9 Hz, 4H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 207.1 (dd, *J* = 2.5, 3.1 Hz), 158.1, 154.6 (dd, *J* = 292.6, 291.6 Hz), 153.0, 149.6, 136.8, 129.1 (t, *J* = 3.1 Hz), 128.7, 128.1, 127.5, 125.5 (t, *J* = 3.8 Hz), 116.1, 115.6, 115.0, 86.7 (dd, *J* = 22.5, 22.5 Hz), 70.0, 68.2, 42.3 (d, *J* = 1.8 Hz), 41.5, 28.6, 20.3.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.6 (d, *J* = 37.1 Hz), -89.9 (d, *J* = 36.8 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{27}H_{26}F_2O_4$ 453.1872; Found: 453.1869.



(8R,9S,13S,14S)-3-((7-(4-(benzyloxy)phenyl)-8,8-difluoro-5-oxooct-7-en-1-yl)oxy)-13-methyl-6,7,8,9, 11,12,13,14,15,16-decahydro-17H-cyclopenta[a]phenanthren-17-one (3aw)

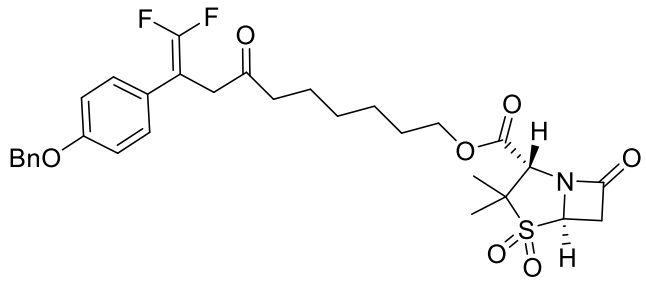
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and Estrone iodide (91 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 5:1) to give the product as a colorless oil (37 mg, 30%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.34 (d, *J* = 7.2 Hz, 2H), 7.30 (t, *J* = 7.5 Hz, 2H), 7.25 (t, *J* = 7.2 Hz, 1H), 7.13 (d, *J* = 8.5 Hz, 2H), 7.10 (d, *J* = 8.7 Hz, 1H), 6.86 (d, *J* = 8.8 Hz, 2H), 6.60 (dd, *J* = 8.6, 2.7 Hz, 1H), 6.53 (d, *J* = 2.7 Hz, 1H), 4.96 (s, 2H), 3.81 (t, *J* = 5.6 Hz, 2H), 3.34 (s, 2H), 2.85 – 2.75 (m, 2H), 2.46 – 2.38 (m, 3H), 2.33 – 2.28 (m, 1H), 2.16 (td, *J* = 11.0, 4.3 Hz, 1H), 2.06 (dt, *J* = 18.7, 9.0 Hz, 1H), 1.99 – 1.94 (m, 1H), 1.91 (ddd, *J* = 11.4, 5.7, 2.7 Hz, 1H), 1.88 – 1.84 (m, 1H), 1.64 (dq, *J* = 6.1, 3.3, 2.7 Hz, 4H), 1.56 – 1.47 (m, 2H), 1.42 (ddd, *J* = 12.2, 6.2, 3.8 Hz, 2H), 1.39 – 1.30 (m, 2H), 0.82 (s, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 206.5 (dd, *J* = 2.5, 3.1 Hz), 158.1, 157.0, 154.6 (dd, *J* = 293.0, 293.0 Hz), 137.8, 136.8, 132.0, 129.1 (t, *J* = 2.7 Hz), 128.6, 128.1, 127.5, 126.3, 125.5 (t, *J* = 4.3 Hz), 115.0, 114.5, 112.1, 86.8 (dd, *J* = 22.1, 22.1 Hz), 70.0, 67.4, 50.4, 48.0, 44.0, 42.3 (d, *J* = 1.4 Hz), 41.5, 38.4, 35.9, 31.6, 29.7, 28.6, 26.9, 26.6, 25.9, 21.6, 20.3, 13.9.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.5 (d, *J* = 39.4 Hz), -89.8 (d, *J* = 39.4 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{39}H_{42}F_2O_4$ 613.3124; Found: 613.3122.

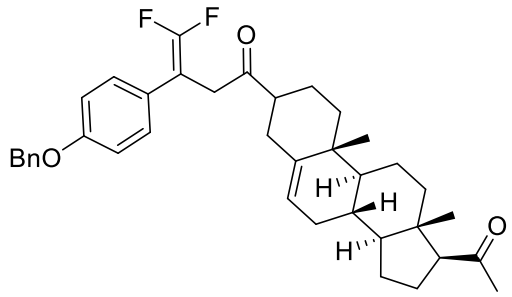


9-(4-(benzyloxy)phenyl)-10,10-difluoro-7-oxodec-9-en-1-yl (2S,5R)-3,3-dimethyl-7-oxo-4-thia-1-azabicyclo[3.2.0]heptane-2-carboxylate 4,4-dioxide (3ax)

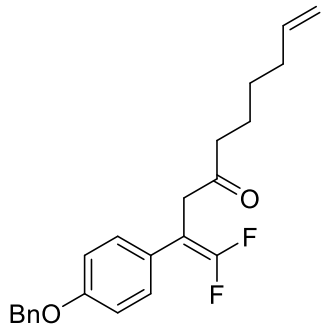
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and Sulbactam iodide (89 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 3:1) to give the product as a colorless oil (46 mg, 38%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.35 (d, *J* = 7.6 Hz, 2H), 7.31 (t, *J* = 7.5 Hz, 2H), 7.26 (t, *J* = 7.2 Hz, 1H), 7.14 (d, *J* = 8.4 Hz, 2H), 6.88 (d, *J* = 8.7 Hz, 2H), 4.98 (s, 2H), 4.53 (dd, *J* = 4.4, 2.1 Hz, 1H), 4.30 (s, 1H), 4.10 (t, *J* = 6.8 Hz, 2H), 3.40 – 3.32 (m, 3H), 2.37 (t, *J* = 7.2 Hz, 2H), 1.61 – 1.54 (m, 2H), 1.53 (s, 3H), 1.48 (p, *J* = 7.4 Hz, 2H), 1.33 (s, 3H), 1.23 (dq, *J* = 38.7, 8.2 Hz, 4H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 206.7 (dd, *J* = 2.3, 2.8 Hz), 170.8, 167.0, 158.1, 154.6 (dd, *J* = 293.5, 293.5 Hz), 136.8, 129.1 (t, *J* = 3.5 Hz), 128.6, 128.1, 127.5, 125.5 (t, *J* = 3.5 Hz), 115.0, 86.8 (dd, *J* = 22.0, 22.3 Hz), 70.0, 66.4, 63.3, 62.7, 61.1, 42.3 (d, *J* = 1.7 Hz), 41.6, 38.3, 28.5, 28.2, 25.7, 23.3, 20.4, 18.6.
^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.6 (d, *J* = 39.2 Hz), -89.9 (d, *J* = 39.2 Hz).
HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{31}H_{35}F_2NO_7S$ 604.2175; Found: 604.2173.



1-((8S,9S,10R,13S,14S,17S)-17-acetyl-10,13-dimethyl-2,3,4,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1H-cyclopenta[a]phenanthren-3-yl)-3-(4-(benzyloxy)phenyl)-4,4-difluorobut-3-en-1-one (3ay)
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and Pregnenolone iodide (85 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 10:1) to give the product as a colorless oil (47 mg, 40%).
^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.35 (d, *J* = 7.6 Hz, 2H), 7.31 (t, *J* = 7.5 Hz, 2H), 7.25 (t, *J* = 7.3 Hz, 1H), 7.12 (t, *J* = 8.6 Hz, 2H), 6.86 (t, *J* = 8.7 Hz, 2H), 5.26 (t, *J* = 6.4 Hz, 1H), 4.97 (s, 2H), 3.52 – 3.32 (m, 2H), 2.57 – 2.53 (m, 1H), 2.48 – 2.42 (m, 1H), 2.40 – 2.33 (m, 1H), 2.15 – 2.07 (m, 1H), 2.04 (d, *J* = 9.7 Hz, 3H), 2.00 – 1.87 (m, 3H), 1.62 – 1.49 (m, 5H), 1.36 (ddt, *J* = 22.1, 15.3, 6.3 Hz, 3H), 1.21 – 1.11 (m, 2H), 1.09 – 1.03 (m, 1H), 0.92 (d, *J* = 20.1 Hz, 4H), 0.83 – 0.71 (m, 1H), 0.55 (d, *J* = 10.7 Hz, 3H).
^{13}C NMR (176 MHz, $CDCl_3$) δ 209.6, 208.3 (dd, *J* = 3.0, 2.3 Hz), 158.0, 154.5 (dd, *J* = 291.8, 291.8 Hz), 141.1, 139.7, 136.8, 129.1 (t, *J* = 4.2 Hz), 128.6, 128.1, 127.5, 126.0 (t, *J* = 4.2 Hz), 121.7, 120.9, 114.9, 114.8, 86.7 (dd, *J* = 22.1, 22.8 Hz), 70.0, 63.7, 56.9, 51.3, 50.2, 49.9, 47.4, 44.0, 40.7, 40.0 (d, *J* = 1.7 Hz), 37.1, 37.0, 35.6, 34.3, 33.4, 31.8, 31.7, 31.7, 31.7, 31.6, 31.6, 26.9, 24.8, 24.5, 22.9, 22.8, 22.8, 20.9, 20.7, 19.4, 19.3, 13.2.
^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.9 (d, *J* = 44.4 Hz), -90.2 (d, *J* = 41.2 Hz).
HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{38}H_{44}F_2O_3$ 587.3331; Found: 587.3330.



2-(4-(benzyloxy)phenyl)-1,1-difluorodeca-1,9-dien-4-one (3az)

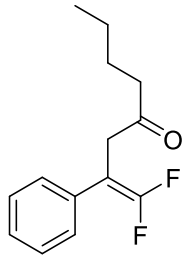
The title compound was prepared from 1-(benzyloxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (55 mg, 0.20 mmol) and 6-iodohex-1-ene (42 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (12 mg, 16%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.35 (d, *J* = 7.6 Hz, 2H), 7.31 (t, *J* = 7.5 Hz, 2H), 7.26 (t, *J* = 7.3 Hz, 1H), 7.14 (d, *J* = 8.4 Hz, 2H), 6.87 (d, *J* = 8.4 Hz, 2H), 5.69 (ddt, *J* = 16.9, 10.2, 6.7 Hz, 1H), 4.98 (s, 2H), 4.94 – 4.84 (m, 2H), 3.33 (s, 2H), 2.36 (q, *J* = 7.3 Hz, 2H), 1.95 (q, *J* = 7.2 Hz, 2H), 1.53 – 1.48 (m, 2H), 1.26 (p, *J* = 7.5 Hz, 2H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 206.8 (dd, *J* = 2.9, 2.9 Hz), 158.1, 154.5 (dd, *J* = 292.7, 292.9 Hz), 138.4, 136.8, 129.1 (t, *J* = 2.7 Hz), 128.6, 128.1, 127.5, 125.6 (t, *J* = 4.0 Hz), 115.0, 114.7, 86.8 (dd, *J* = 21.7, 22.2 Hz), 70.0, 42.3 (d, *J* = 2.0 Hz), 41.7, 33.5, 28.3, 23.1.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.6 (d, *J* = 38.9 Hz), -89.9 (d, *J* = 39.6 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{23}H_{24}F_2O_2$ 371.1817; Found: 371.1815.



1,1-difluoro-2-phenyloct-1-en-4-one (3ba)

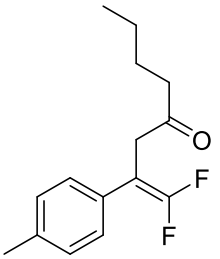
The title compound was prepared from (3,3,3-trifluoroprop-1-en-2-yl)benzene (35 mg, 0.20 mmol) and 1-iodobutane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 40:1) to give the product as a colorless oil (39 mg, 82%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.25 (t, *J* = 7.7 Hz, 2H), 7.22 – 7.19 (m, 2H), 7.19 – 7.16 (m, 1H), 3.36 (s, 2H), 2.35 (t, *J* = 7.5 Hz, 2H), 1.48 – 1.42 (m, 2H), 1.19 (q, *J* = 7.5 Hz, 2H), 0.79 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 206.7 (dd, *J* = 2.8, 2.9 Hz), 154.8 (dd, *J* = 293.5, 293.5 Hz), 133.3 (t, *J* = 4.1 Hz), 128.6, 127.9 (t, *J* = 3.7 Hz), 127.5, 87.3 (dd, *J* = 22.2, 22.7 Hz), 42.2 (d, *J* = 2.0 Hz), 41.8, 25.7, 22.2, 13.8.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -87.7 (d, *J* = 36.5 Hz), -89.2 (d, *J* = 36.5 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{14}H_{16}F_2O$ 239.1242; Found: 239.1239.



1,1-difluoro-2-(*p*-tolyl)oct-1-en-4-one (3ca)

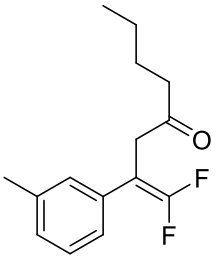
The title compound was prepared from 1-methyl-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (37 mg, 0.20 mmol) and 1-iodobutane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (37 mg, 74%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.10 (d, *J* = 8.0 Hz, 2H), 7.07 (d, *J* = 8.0 Hz, 2H), 3.35 (s, 2H), 2.35 (t, *J* = 7.4 Hz, 2H), 2.25 (s, 3H), 1.45 (p, *J* = 7.5 Hz, 2H), 1.19 (h, *J* = 7.4 Hz, 2H), 0.79 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 206.9 (dd, *J* = 3.0, 3.0 Hz), 154.7 (dd, *J* = 292.5, 292.8 Hz), 137.4, 130.2 (t, *J* = 4.5 Hz), 129.3, 127.7 (t, *J* = 3.9 Hz), 87.1 (dd, *J* = 21.7, 22.0 Hz), 42.2 (d, *J* = 2.0 Hz), 41.7, 25.7, 22.2, 21.1, 13.8.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.1 (d, *J* = 39.3 Hz), -89.5 (d, *J* = 39.3 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{15}H_{18}F_2O$ 253.1398; Found: 253.1398.



1,1-difluoro-2-(*m*-tolyl)oct-1-en-4-one (3da)

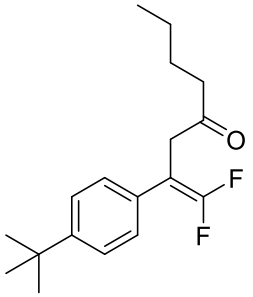
The title compound was prepared from 1-methyl-3-(3,3,3-trifluoroprop-1-en-2-yl)benzene (37 mg, 0.20 mmol) and 1-iodobutane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (30 mg, 60%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.22 (t, *J* = 7.7 Hz, 1H), 7.13 – 7.05 (m, 3H), 3.43 (s, 2H), 2.43 (t, *J* = 7.4 Hz, 2H), 2.33 (s, 3H), 1.53 (p, *J* = 7.5 Hz, 2H), 1.31 – 1.22 (m, 2H), 0.87 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 206.8 (dd, *J* = 2.7, 3.0 Hz), 154.7 (dd, *J* = 293.1, 293.1 Hz), 138.2, 133.2 (t, *J* = 3.5 Hz), 128.6 (t, *J* = 4.2 Hz), 128.5, 128.3, 124.9 (t, *J* = 3.5 Hz), 87.3 (dd, *J* = 21.6, 21.6 Hz), 42.2 (d, *J* = 1.9 Hz), 41.8, 25.7, 22.2, 21.4, 13.8.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -87.8 (d, *J* = 38.4 Hz), -89.1 (d, *J* = 37.7 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{15}H_{18}F_2O$ 253.1398; Found: 253.1399.



2-(4-(*tert*-butyl)phenyl)-1,1-difluorooct-1-en-4-one (3ea)

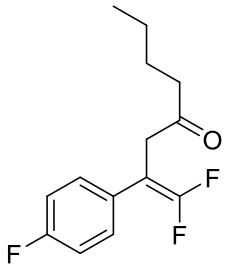
The title compound was prepared from 1-(*tert*-butyl)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (46 mg, 0.20 mmol) and 1-iodobutane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (44 mg, 75%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.39 (d, *J* = 8.8 Hz, 2H), 7.27 – 7.20 (m, 2H), 3.46 (s, 2H), 2.47 (t, *J* = 7.9 Hz, 2H), 1.34 (s, 9H), 1.35 – 1.30 (m, 4H), 0.91 – 0.89 (m, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 207.0 (dd, *J* = 2.1, 3.2 Hz), 154.8 (dd, *J* = 294.0, 292.6 Hz), 150.5, 130.2 (t, *J* = 4.4 Hz), 127.4 (t, *J* = 3.8 Hz), 125.5, 87.1 (dd, *J* = 21.6, 21.9 Hz), 42.1 (d, *J* = 2.0 Hz), 41.7, 34.5, 31.2, 25.7, 22.2, 13.8.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -87.9 (d, *J* = 37.7 Hz), -89.2 (d, *J* = 37.7 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{18}H_{24}F_2O$ 295.1868; Found: 295.1863.



1,1-difluoro-2-(4-fluorophenyl)oct-1-en-4-one (3fa)

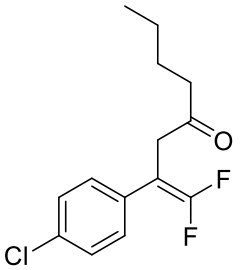
The title compound was prepared from 1-fluoro-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (38 mg, 0.20 mmol) and 1-iodobutane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (26 mg, 51%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.18 (ddd, *J* = 8.8, 5.1, 1.1 Hz, 2H), 6.95 (t, *J* = 8.7 Hz, 2H), 3.35 (s, 2H), 2.36 (t, *J* = 7.5 Hz, 2H), 1.46 (p, *J* = 7.5 Hz, 2H), 1.24 – 1.16 (m, 2H), 0.80 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 206.6 (dd, *J* = 2.6, 3.0 Hz), 162.0 (d, *J* = 248.5 Hz), 154.7 (dd, *J* = 293.7, 293.2 Hz), 129.7 (dt, *J* = 8.0, 7.5 Hz), 129.2 (q, *J* = 4.0 Hz), 115.6 (d, *J* = 21.7 Hz), 86.5 (dd, *J* = 22.4, 22.6 Hz), 42.2 (d, *J* = 1.8 Hz), 41.9, 25.7, 22.2, 13.8.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -87.9 (d, *J* = 35.3 Hz), -89.2 (d, *J* = 35.3 Hz), -113.7 (s).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{14}H_{15}F_3O$ 257.1148; Found: 257.1144.



2-(4-chlorophenyl)-1,1-difluorooct-1-en-4-one (3ga)

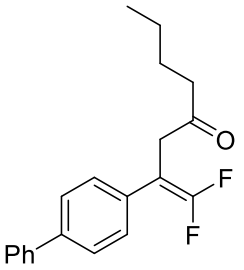
The title compound was prepared from 1-chloro-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (42 mg, 0.20 mmol) and 1-iodobutane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (30 mg, 55%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.23 (d, *J* = 8.4 Hz, 2H), 7.15 (d, *J* = 8.2 Hz, 2H), 3.35 (s, 2H), 2.36 (t, *J* = 7.5 Hz, 2H), 1.46 (p, *J* = 7.5 Hz, 2H), 1.21 (dt, *J* = 15.1, 7.5 Hz, 2H), 0.81 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 206.4 (dd, *J* = 2.6, 3.0 Hz), 154.8 (dd, *J* = 293.1, 294.1 Hz), 133.4, 129.2 (t, *J* = 3.8 Hz), 128.9, 128.8, 86.6 (dd, *J* = 23.2, 22.4 Hz), 42.0 (d, *J* = 1.8 Hz), 41.9, 25.7, 22.2, 13.8.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -87.0 (d, *J* = 36.6 Hz), -88.3 (d, *J* = 35.8 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{14}H_{15}ClF_2O$ 273.0852; Found: 273.0848.



2-([1,1'-biphenyl]-4-yl)-1,1-difluorooct-1-en-4-one (3ha)

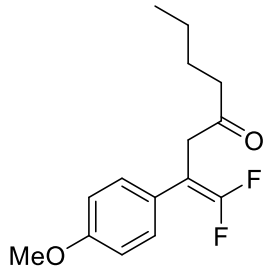
The title compound was prepared from 4-(3,3,3-trifluoroprop-1-en-2-yl)-1,1'-biphenyl (50 mg, 0.20 mmol) and 1-iodobutane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (43 mg, 69%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.49 (td, *J* = 8.3, 4.0 Hz, 4H), 7.35 (t, *J* = 7.6 Hz, 2H), 7.30 – 7.23 (m, 3H), 3.40 (s, 2H), 2.38 (t, *J* = 7.5 Hz, 2H), 1.48 (dd, *J* = 15.2, 7.6 Hz, 2H), 1.20 (dt, *J* = 14.7, 7.3 Hz, 2H), 0.80 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 206.8 (dd, *J* = 2.9, 2.7 Hz), 154.9 (dd, *J* = 293.5, 294.4 Hz), 140.4, 140.3, 132.2 (t, *J* = 4.1 Hz), 128.8, 128.2 (t, *J* = 3.8 Hz), 127.5, 127.3, 127.0, 87.1 (dd, *J* = 21.8, 22.1 Hz), 42.1 (d, *J* = 1.5 Hz), 41.8, 25.8, 22.3, 13.8.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -87.1 (d, *J* = 34.8 Hz), -88.4 (d, *J* = 37.7 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{20}H_{20}F_2O$ 315.1555; Found: 315.1557.



1,1-difluoro-2-(4-methoxyphenyl)oct-1-en-4-one (3ia)

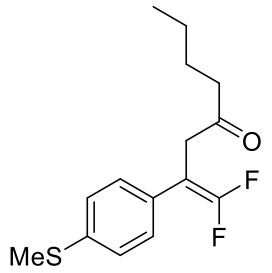
The title compound was prepared from 1-methoxy-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (41 mg, 0.20 mmol) and 1-iodobutane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 40:1) to give the product as a colorless oil (33 mg, 62%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.14 (d, *J* = 8.5 Hz, 2H), 6.80 (d, *J* = 8.7 Hz, 2H), 3.72 (s, 3H), 3.34 (s, 2H), 2.35 (t, *J* = 7.4 Hz, 2H), 1.45 (p, *J* = 7.5 Hz, 2H), 1.22 – 1.18 (m, 2H), 0.80 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 206.0 (dd, *J* = 2.9, 3.3 Hz), 157.8, 153.5 (dd, *J* = 292.0, 292.0 Hz), 128.0 (t, *J* = 3.3 Hz), 124.3 (t, *J* = 3.9 Hz), 113.0, 85.8 (dd, *J* = 22.2, 21.6 Hz), 54.2, 41.3 (d, *J* = 2.0 Hz), 40.7, 24.7, 21.2, 12.8.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.8 (d, *J* = 39.6 Hz), -90.0 (d, *J* = 39.6 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{15}H_{18}F_2O_2$ 269.1348; Found: 269.1347.



1,1-difluoro-2-(4-(methylthio)phenyl)oct-1-en-4-one (3ja)

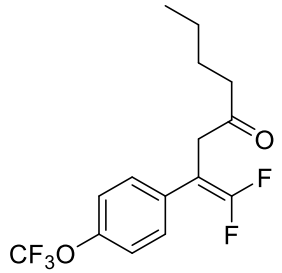
The title compound was prepared from methyl(4-(3,3,3-trifluoroprop-1-en-2-yl)phenyl)sulfane (44 mg, 0.20 mmol) and 1-iodobutane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (28 mg, 49%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.12-7.15 (m, 4H), 3.35 (s, 2H), 2.40 (s, 3H), 2.36 (t, *J* = 7.4 Hz, 2H), 1.46 (p, *J* = 7.5 Hz, 2H), 1.22 – 1.17 (m, 2H), 0.80 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 206.7 (dd, *J* = 2.6, 2.6 Hz), 154.7 (dd, *J* = 293.1, 293.4 Hz), 138.0, 129.8 (t, *J* = 4.3 Hz), 128.2 (t, *J* = 4.3 Hz), 126.5, 86.9 (dd, *J* = 22.3, 22.3 Hz), 42.0 (d, *J* = 1.9 Hz), 41.8, 25.7, 22.2, 15.6, 13.8.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -87.3 (d, *J* = 38.3 Hz), -88.6 (d, *J* = 39.6 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{15}H_{18}F_2OS$ 285.1119; Found: 285.1120.



1,1-difluoro-2-(4-(trifluoromethoxy)phenyl)oct-1-en-4-one (3ka)

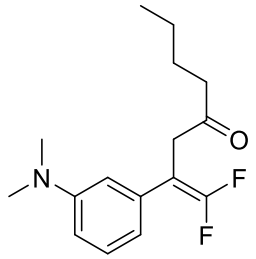
The title compound was prepared from 1-(trifluoromethoxy)-4-(3,3,3-trifluoroprop-1-en-2-yl)benzene (51 mg, 0.20 mmol) and 1-iodobutane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (32 mg, 50%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.24 (d, *J* = 8.4 Hz, 2H), 7.11 (d, *J* = 8.3 Hz, 2H), 3.37 (s, 2H), 2.37 (t, *J* = 7.4 Hz, 2H), 1.47 (p, *J* = 7.4 Hz, 2H), 1.20 (h, *J* = 7.4 Hz, 2H), 0.81 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 206.4 (dd, *J* = 2.8, 2.8 Hz), 154.8 (dd, *J* = 294.0, 293.4 Hz), 130.4, 129.4 (t, *J* = 4.0 Hz), 121.0, 120.3 (q, *J* = 257.2.0 Hz), 86.4 (dd, *J* = 22.9, 23.4 Hz), 42.0 (d, *J* = 2.0 Hz), 41.9, 25.7, 22.2, 13.8.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -57.5 (s), -86.9 (d, *J* = 36.0 Hz), -88.4 (d, *J* = 34.7 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{15}H_{15}F_5O_2$ 323.1065; Found: 323.1066.



2-(3-(dimethylamino)phenyl)-1,1-difluorooct-1-en-4-one (3la)

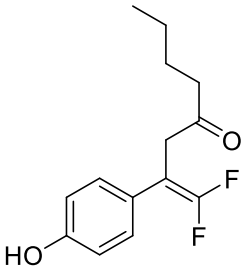
The title compound was prepared from *N*,*N*-dimethyl-3-(3,3,3-trifluoroprop-1-en-2-yl)aniline (43 mg, 0.20 mmol) and 1-iodobutane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 10:1) to give the product as a colorless oil (23 mg, 41%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.12 (ddd, *J* = 8.5, 6.6, 1.8 Hz, 1H), 6.56 (q, *J* = 7.3 Hz, 3H), 3.35 (s, 2H), 2.86 (s, 6H), 2.36 (t, *J* = 7.4 Hz, 2H), 1.46 (p, *J* = 7.5 Hz, 2H), 1.24 – 1.17 (m, 2H), 0.80 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 207.1 (dd, *J* = 2.5, 3.3 Hz), 154.7 (dd, *J* = 292.1, 292.4 Hz), 150.6, 134.0 (t, *J* = 4.0 Hz), 129.2, 116.1, 112.1, 111.9, 87.8 (dd, *J* = 22.3, 21.4 Hz), 42.5 (d, *J* = 1.8 Hz), 41.7, 40.5, 25.8, 22.2, 13.8.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.4.

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{16}H_{21}F_2NO$ 282.1664; Found: 282.1667.



1,1-difluoro-2-(4-hydroxyphenyl)oct-1-en-4-one (3ma)

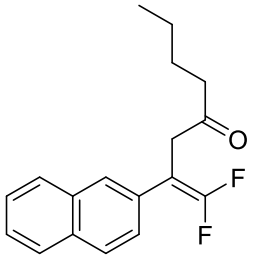
The title compound was prepared from 4-(3,3,3-trifluoroprop-1-en-2-yl)phenol (38 mg, 0.20 mmol) and 1-iodobutane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 5:1) to give the product as a colorless oil (24 mg, 48%).

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.05 (d, *J* = 8.4 Hz, 2H), 6.67 (d, *J* = 8.6 Hz, 2H), 5.85 (s, 1H), 3.36 (s, 2H), 2.38 (t, *J* = 7.4 Hz, 2H), 1.46 (p, *J* = 7.4 Hz, 2H), 1.18 (dt, *J* = 14.5, 7.4 Hz, 2H), 0.79 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 208.7 (dd, *J* = 2.3, 3.1 Hz), 155.3, 154.6 (dd, *J* = 292.5, 292.5 Hz), 129.1 (t, *J* = 3.7 Hz), 124.9 (t, *J* = 3.9 Hz), 115.6, 86.8 (dd, *J* = 21.8, 22.0 Hz), 42.3 (d, *J* = 1.9 Hz), 41.7, 25.7, 22.2, 13.8.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.7 (d, *J* = 39.5 Hz), -89.9 (d, *J* = 39.5 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{14}H_{16}F_2O_2$ 255.1191; Found: 255.1188.



1,1-difluoro-2-(naphthalen-2-yl)oct-1-en-4-one (3na)

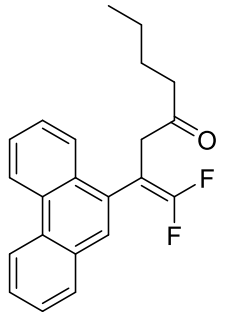
The title compound was prepared from 2-(3,3,3-trifluoroprop-1-en-2-yl)naphthalene (45 mg, 0.20 mmol) and 1-iodobutane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (19 mg, 33%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.75 – 7.70 (m, 3H), 7.65 (d, *J* = 1.8 Hz, 1H), 7.43 – 7.38 (m, 2H), 7.36 (dt, *J* = 8.5, 1.8 Hz, 1H), 3.47 (s, 2H), 2.41 – 2.31 (m, 2H), 1.46 (p, *J* = 7.5 Hz, 2H), 1.22 – 1.16 (m, 2H), 0.79 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 206.8 (dd, *J* = 2.8, 2.8 Hz), 155.0 (dd, *J* = 293.4, 293.7 Hz), 133.2, 132.5, 130.7 (t, *J* = 3.9 Hz), 128.3, 128.0, 127.6, 127.0 (t, *J* = 3.5 Hz), 126.4, 126.3, 125.6 (dd, *J* = 4.5, 4.5 Hz), 87.4 (dd, *J* = 21.7, 22.0 Hz), 42.3 (d, *J* = 1.7 Hz), 41.8, 25.8, 22.2, 13.8.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -87.1 (d, *J* = 35.8 Hz), -88.6 (d, *J* = 35.8 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{18}H_{18}F_2O$ 289.1398; Found: 289.1394.



1,1-difluoro-2-(phenanthren-9-yl)oct-1-en-4-one (3oa)

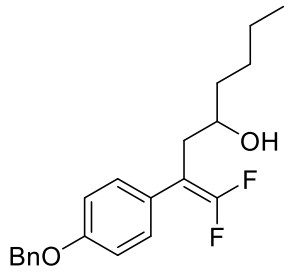
The title compound was prepared from 9-(3,3,3-trifluoroprop-1-en-2-yl)phenanthrene (55 mg, 0.20 mmol) and 1-iodobutane (37 mg, 0.20 mmol) according to general procedure 1. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (47 mg, 70%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 8.65 (d, *J* = 8.2 Hz, 1H), 8.58 (d, *J* = 8.3 Hz, 1H), 7.89 (d, *J* = 8.0 Hz, 1H), 7.79 (d, *J* = 7.8 Hz, 1H), 7.67 (s, 1H), 7.63 – 7.54 (m, 3H), 7.51 (t, *J* = 7.4 Hz, 1H), 3.45 (d, *J* = 127.8 Hz, 2H), 2.29 (dt, *J* = 15.0, 6.9 Hz, 2H), 1.41 (p, *J* = 7.5 Hz, 2H), 1.14 (h, *J* = 7.5 Hz, 2H), 0.73 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 205.0 (dd, *J* = 3.0, 3.1 Hz), 154.0 (dd, *J* = 290.5, 290.3 Hz), 130.2, 129.7, 129.2, 129.0 (d, *J* = 2.8 Hz), 128.4 (d, *J* = 4.7 Hz), 128.0 (dd, *J* = 3.0, 2.7 Hz), 127.8, 126.1, 125.9, 125.8, 125.7, 124.4, 122.2, 121.4, 83.9 (t, *J* = 22.4 Hz), 41.9, 41.4, 24.7, 21.1, 12.7.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -86.4 (d, *J* = 35.6 Hz), -89.1 (d, *J* = 38.3 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{22}H_{20}F_2O$ 339.1555; Found: 339.1556.



2-(4-(benzyloxy)phenyl)-1,1-difluorooct-1-en-4-ol (4a)

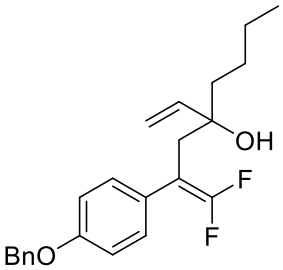
The title compound was prepared from **3aa** (69 mg, 0.20 mmol) general procedure 3. The crude residue was purified by flash chromatography (PE/EA = 10:1) to give the product as a colorless oil (69 mg, 99%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.42 (d, *J* = 7.6 Hz, 2H), 7.38 (t, *J* = 7.5 Hz, 2H), 7.32 (t, *J* = 7.3 Hz, 1H), 7.25 (d, *J* = 8.4 Hz, 2H), 6.96 (d, *J* = 8.4 Hz, 2H), 5.05 (s, 2H), 3.61 – 3.53 (m, 1H), 2.50 (d, *J* = 5.6 Hz, 2H), 1.51 – 1.35 (m, 4H), 1.27 (ddt, *J* = 21.3, 14.2, 7.2 Hz, 3H), 0.87 (t, *J* = 7.0 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 158.1, 154.3 (dd, *J* = 290.8, 290.1 Hz), 136.8, 129.5 (t, *J* = 3.3 Hz), 128.6, 128.1, 127.5, 125.8 (t, *J* = 4.0 Hz), 115.0, 89.4 (dd, *J* = 21.0, 21.5 Hz), 70.1, 69.9 (t, *J* = 2.5 Hz), 36.7, 36.0, 27.7, 22.7, 14.0.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -90.3.

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{21}H_{24}F_2O_2$ 347.1817; Found: 347.1815.



2-(4-(benzyloxy)phenyl)-1,1-difluoro-4-vinyloct-1-en-4-ol (4b)

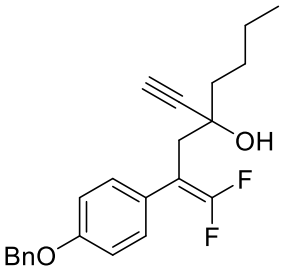
The title compound was prepared from **3aa** (69 mg, 0.20 mmol) general procedure 2. The crude residue was purified by flash chromatography (PE/EA = 20:1) to give the product as a colorless oil (49 mg, 66%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.34 (d, *J* = 7.2 Hz, 2H), 7.30 (t, *J* = 7.5 Hz, 2H), 7.24 (t, *J* = 7.2 Hz, 1H), 7.14 (d, *J* = 8.4 Hz, 2H), 6.87 (d, *J* = 8.8 Hz, 2H), 5.64 (dd, *J* = 17.3, 10.8 Hz, 1H), 5.04 (dd, *J* = 17.3, 1.4 Hz, 1H), 4.96 (d, *J* = 10.4 Hz, 3H), 2.54 (s, 2H), 1.43 (ddd, *J* = 13.3, 11.3, 4.1 Hz, 1H), 1.38 – 1.32 (m, 1H), 1.18 (s, 1H), 1.13 (dddd, *J* = 15.1, 9.7, 6.6, 2.3 Hz, 4H), 0.76 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 158.1, 154.5 (dd, *J* = 289.7, 289.9 Hz), 143.0, 136.9, 129.9 (t, *J* = 3.0 Hz), 128.6, 128.1, 127.5, 126.7 (dd, *J* = 4.3, 4.4 Hz), 114.9, 112.7, 88.6 (dd, *J* = 21.1, 21.5 Hz), 76.6 (t, *J* = 3.0 Hz), 70.1, 40.5, 39.4, 25.5, 23.0, 14.0.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -89.2 (d, *J* = 42.2 Hz), -91.2 (d, *J* = 42.3 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{23}H_{26}F_2O_2$ 373.1974; Found: 373.1970.



2-(4-(benzyloxy)phenyl)-4-ethynyl-1,1-difluorooct-1-en-4-ol (4c)

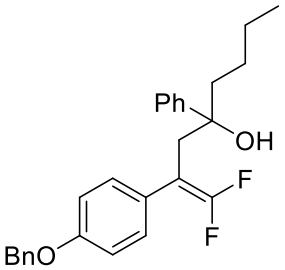
The title compound was prepared from **3aa** (69 mg, 0.20 mmol) general procedure 2. The crude residue was purified by flash chromatography (PE/EA = 20:1) to give the product as a colorless oil (47 mg, 64%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.34 (d, *J* = 7.6 Hz, 2H), 7.30 (t, *J* = 7.5 Hz, 2H), 7.24 (t, *J* = 7.5 Hz, 1H), 7.20 (d, *J* = 8.3 Hz, 2H), 6.88 (d, *J* = 8.3 Hz, 2H), 4.97 (s, 2H), 2.81 – 2.59 (m, 2H), 2.26 (s, 1H), 1.73 (s, 1H), 1.51 (ddt, *J* = 11.6, 7.8, 4.5 Hz, 2H), 1.40 – 1.32 (m, 2H), 1.24 – 1.16 (m, 2H), 0.79 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 158.1, 154.9 (t, *J* = 289.2 Hz), 136.8, 130.0 (t, *J* = 2.5 Hz), 128.6, 128.1, 127.5, 126.4 (dd, *J* = 4.1, 4.4 Hz), 114.9, 88.4 (dd, *J* = 21.1, 20.9 Hz), 85.6, 73.2, 71.5 (t, *J* = 2.4 Hz), 70.0, 41.4, 40.3, 26.3, 22.7, 14.0.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -88.5 (d, *J* = 39.0 Hz), -90.2 (d, *J* = 37.1 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{23}H_{24}F_2O_2$ 371.1817; Found: 371.1816.



2-(4-(benzyloxy)phenyl)-1,1-difluoro-4-phenyloct-1-en-4-ol (4d)

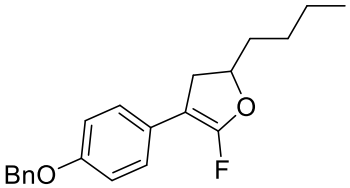
The title compound was prepared from **3aa** (69 mg, 0.20 mmol) general procedure 2. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (66 mg, 78%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.50 – 7.41 (m, 5H), 7.32 (s, 5H), 7.10 (d, *J* = 10.0 Hz, 2H), 6.94 (d, *J* = 9.2 Hz, 2H), 5.08 (s, 4H), 2.95 (t, *J* = 2.5 Hz, 3H), 1.60 (s, 1H), 0.83 – 0.81 (m, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 158.0, 154.4 (t, *J* = 288.6 Hz), 145.4, 136.9, 129.8 (t, *J* = 2.6 Hz), 128.6, 128.1, 127.9, 127.5, 126.5, 126.4 (t, *J* = 5.2 Hz), 125.3, 115.0, 88.7 (dd, *J* = 21.3, 21.1 Hz), 77.9 (t, *J* = 2.7 Hz), 70.0, 42.1, 41.5, 25.4, 23.0, 14.0.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -89.7 (d, *J* = 44.4 Hz), -91.2 (d, *J* = 37.9 Hz).

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{27}H_{28}F_2O_2$ 423.2130; Found: 423.2128.



4-(4-(benzyloxy)phenyl)-2-butyl-5-fluoro-2,3-dihydrofuran (4e)

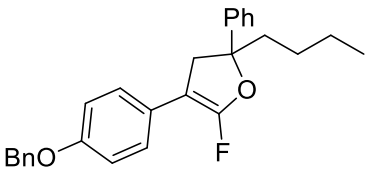
The title compound was prepared from **4a** (69 mg, 0.20 mmol) general procedure 4. The crude residue was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (40 mg, 62%).

^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.35 (d, *J* = 7.6 Hz, 2H), 7.30 (t, *J* = 7.5 Hz, 2H), 7.24 (t, *J* = 7.3 Hz, 1H), 7.13 – 7.06 (m, 2H), 6.88 – 6.83 (m, 2H), 4.97 (s, 2H), 4.61 (dq, *J* = 9.0, 6.6 Hz, 1H), 2.99 (ddd, *J* = 13.2, 9.7, 3.7 Hz, 1H), 2.58 (ddd, *J* = 12.5, 7.3, 4.1 Hz, 1H), 1.76 (qd, *J* = 11.1, 9.1, 5.8 Hz, 1H), 1.59 (ddt, *J* = 14.2, 11.1, 5.0 Hz, 1H), 1.39 – 1.28 (m, 4H), 0.86 (t, *J* = 6.8 Hz, 3H).

^{13}C NMR (176 MHz, $CDCl_3$) δ 156.2 (d, *J* = 2.2 Hz), 155.4 (d, *J* = 277.8 Hz), 137.1, 128.6, 127.9, 127.5, 125.9 (d, *J* = 6.2 Hz), 125.7 (d, *J* = 5.6 Hz), 115.0, 80.3 (d, *J* = 11.3 Hz), 79.6 (d, *J* = 2.3 Hz), 70.1, 35.9, 35.2 (d, *J* = 3.0 Hz), 27.0, 22.5, 14.0.

^{19}F NMR (56 MHz, Chloroform-*d*) δ -150.2.

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{21}H_{23}FO_2$ 327.1755; Found: 327.1752.



4-(4-(benzyloxy)phenyl)-2-butyl-5-fluoro-2-phenyl-2,3-dihydrofuran (4f)

The title compound was prepared from **4d** (85 mg, 0.20 mmol) general procedure 4. The crude residue

was purified by flash chromatography (PE/EA = 50:1) to give the product as a colorless oil (54 mg, 67%).

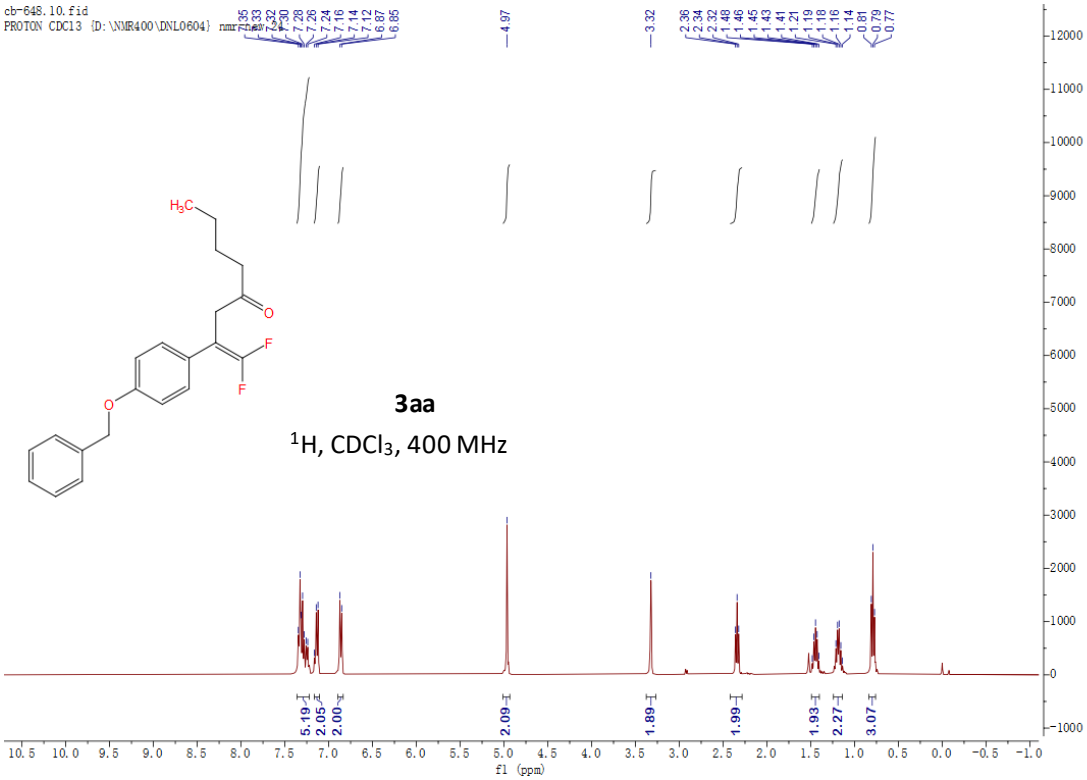
^{1}H NMR (700 MHz, Chloroform-*d*) δ 7.34 – 7.30 (m, 4H), 7.28 (td, *J* = 7.7, 2.1 Hz, 4H), 7.24 – 7.16 (m, 2H), 7.09 (d, *J* = 8.8 Hz, 2H), 6.83 (d, *J* = 8.8 Hz, 2H), 4.95 (s, 2H), 3.17 – 3.05 (m, 2H), 1.99 (ddd, *J* = 13.9, 11.7, 4.4 Hz, 1H), 1.88 (dddd, *J* = 13.9, 11.9, 4.5, 1.7 Hz, 1H), 1.33 – 1.26 (m, 1H), 1.23 – 1.15 (m, 2H), 1.11 – 1.01 (m, 1H), 0.76 (t, *J* = 7.4 Hz, 3H).

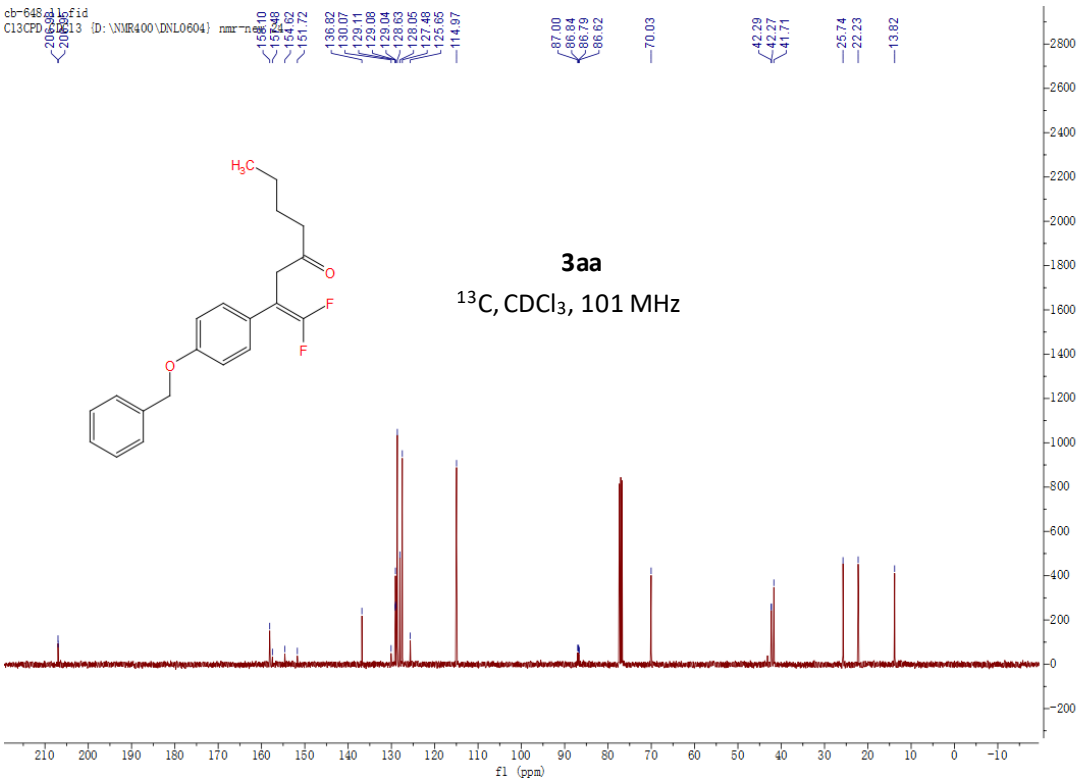
^{13}C NMR (176 MHz, $CDCl_3$) δ 155.2 (d, *J* = 1.8 Hz), 153.1 (d, *J* = 278.4 Hz), 144.1, 136.0, 127.5, 127.4, 126.9, 126.4, 126.1, 124.7 (d, *J* = 5.5 Hz), 124.5 (d, *J* = 6.4 Hz), 123.4, 114.0, 86.8, 79.2 (d, *J* = 10.9 Hz), 69.0, 42.4 (d, *J* = 2.7 Hz), 41.6, 24.6, 21.7, 12.9.

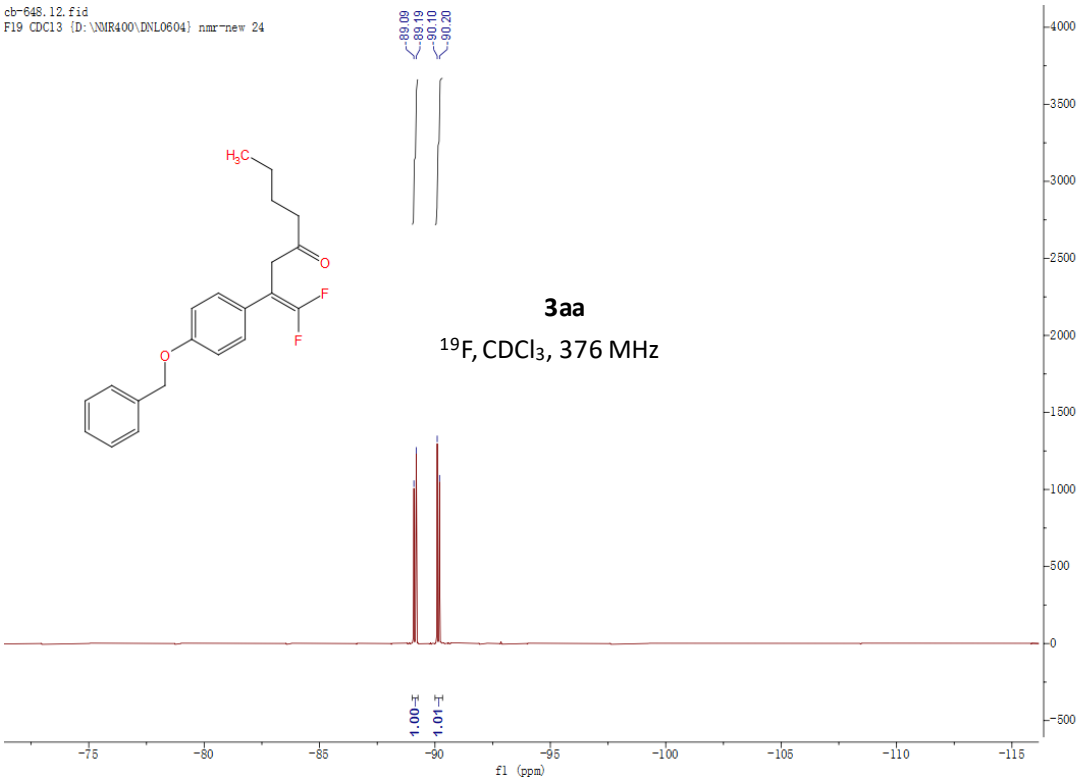
^{19}F NMR (56 MHz, Chloroform-*d*) δ -149.2.

HRMS (ESI-TOF) m/z: [M + H]+ Calcd for $C_{27}H_{27}FO_2$ 403.2068; Found: 403.2066.

6. Copies of NMR spectra for compounds



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89.19
90.10
90.20
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F
F
O
3aa
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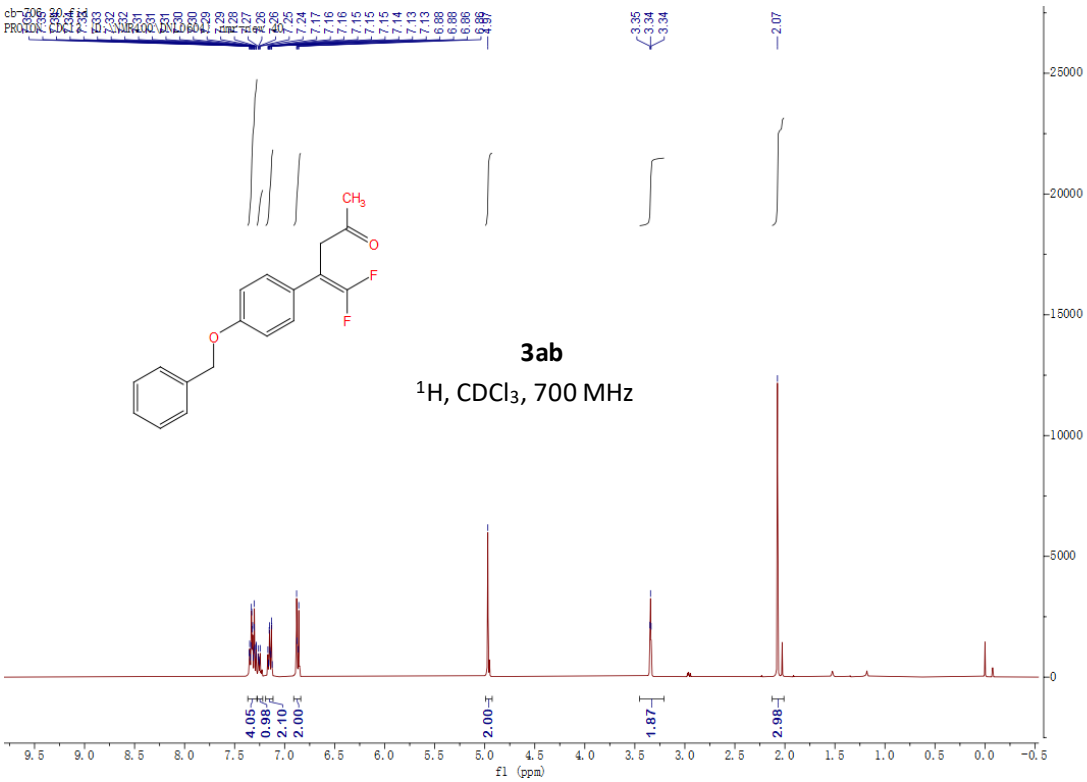
1.00
1.01
f1 (ppm)


3.35
3.34
3.34
2.07
CH3
O
F
F
O
3ab
1H, CDCl3, 700 MHz
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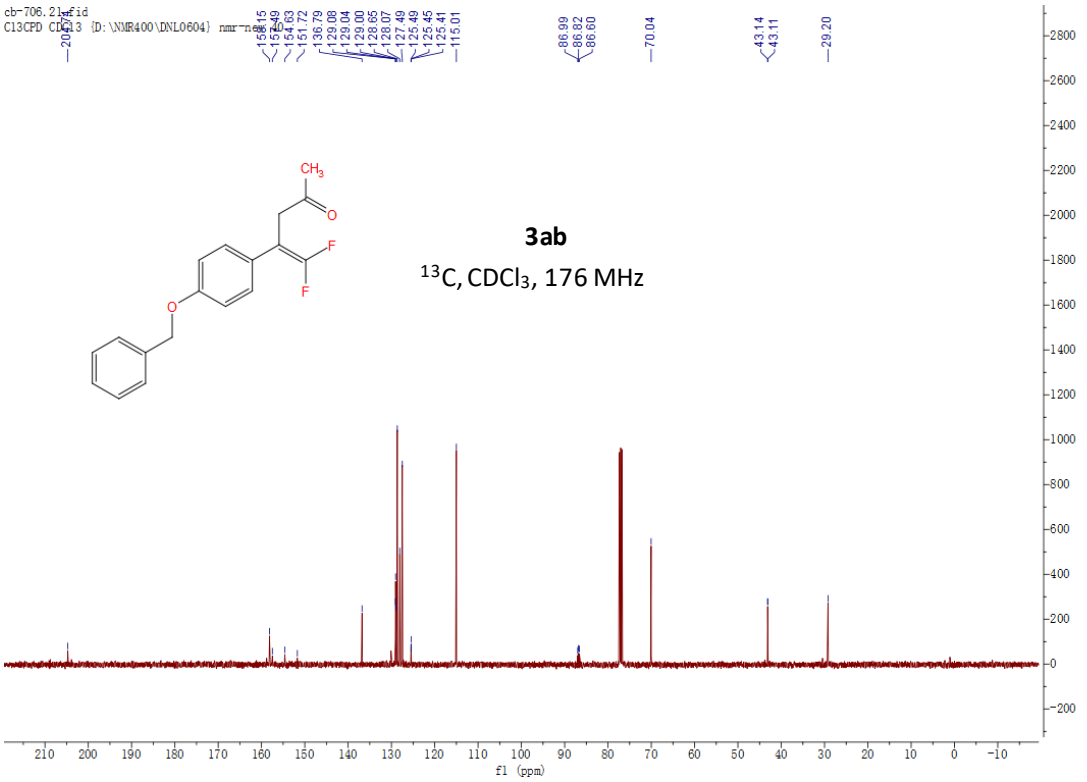
0.98
2.10
2.00
2.00
1.87
2.98
f1 (ppm)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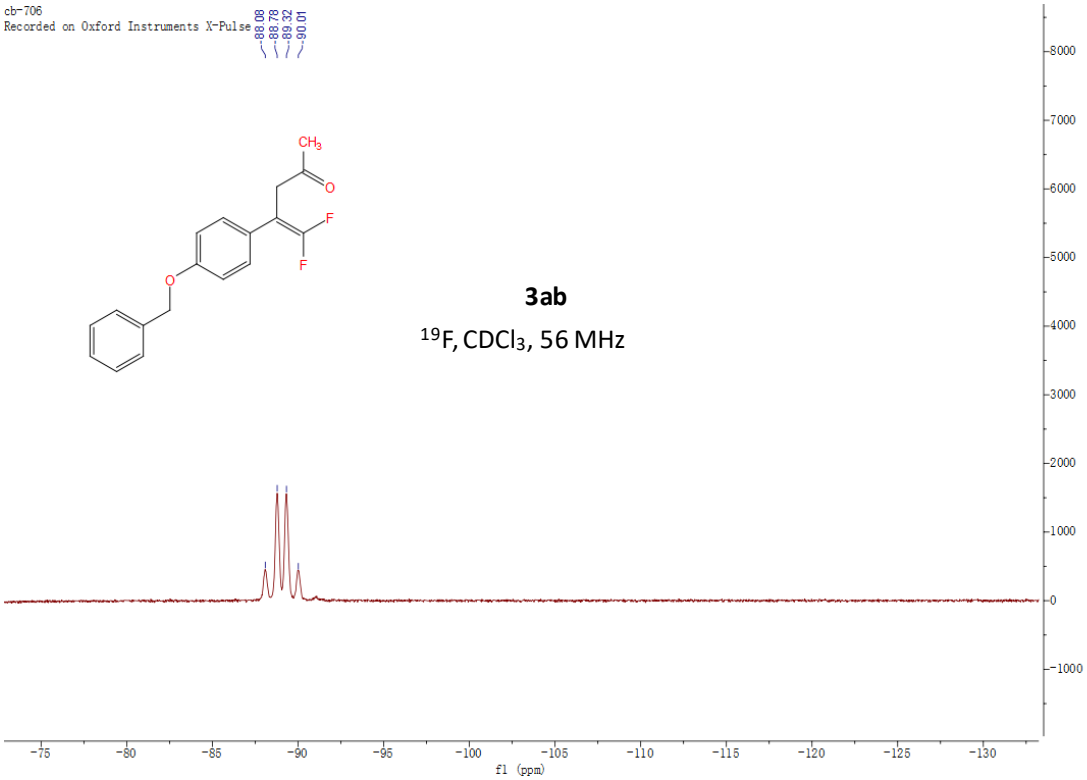
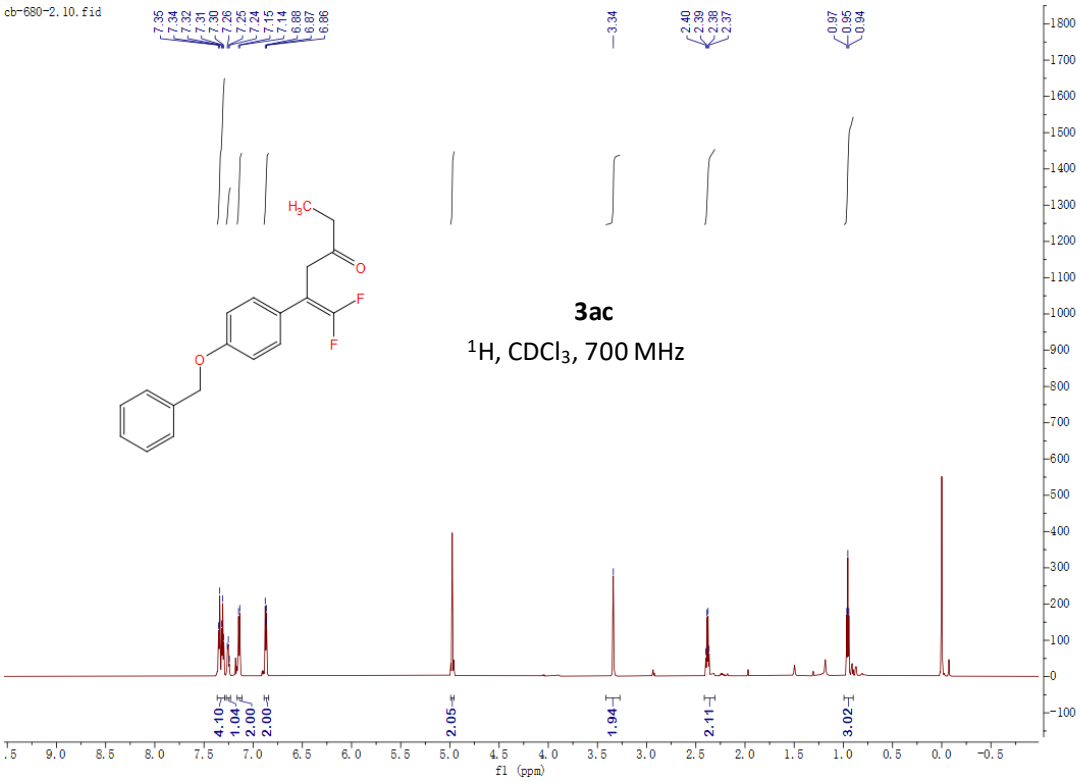
129.04
129.00
128.65
128.07
127.49
125.49
125.45
125.41
115.01
86.99
86.82
86.60
70.04
43.14
43.11
29.20
CH3
O
F
F
O
3ab
13C, CDCl3, 176 MHz
f1 (ppm)


cb-706
Recorded on Oxford Instruments X-Pulse
-88.08
-88.78
-89.32
-90.01
CH3
O
F
F
O
3ab
19F, CDCl3, 56 MHz
f1 (ppm)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7.34
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7.14
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6.87
6.86
3.34
2.40
2.39
2.38
2.37
0.97
0.95
0.94
H3C
O
F
F
O
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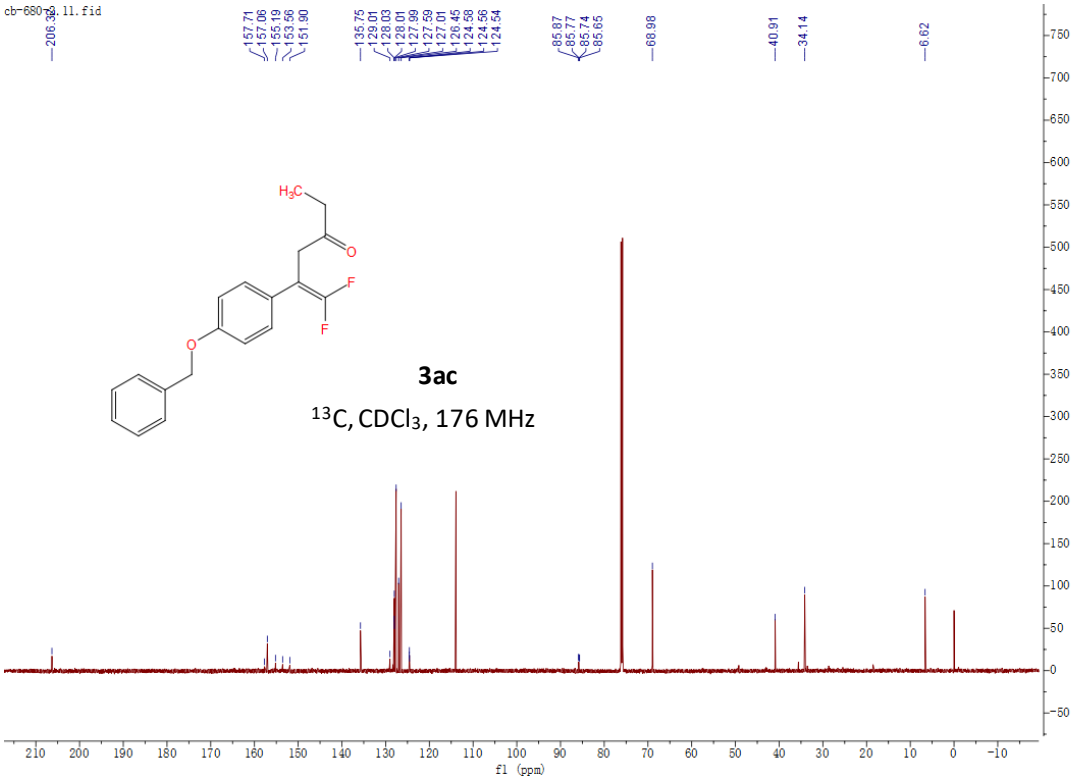
1.04
2.00
2.00
2.05
1.94
2.11
3.02
f1 (ppm)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124.58
124.56
124.54
85.87
85.77
85.74
85.65
68.98
40.91
34.14
6.62
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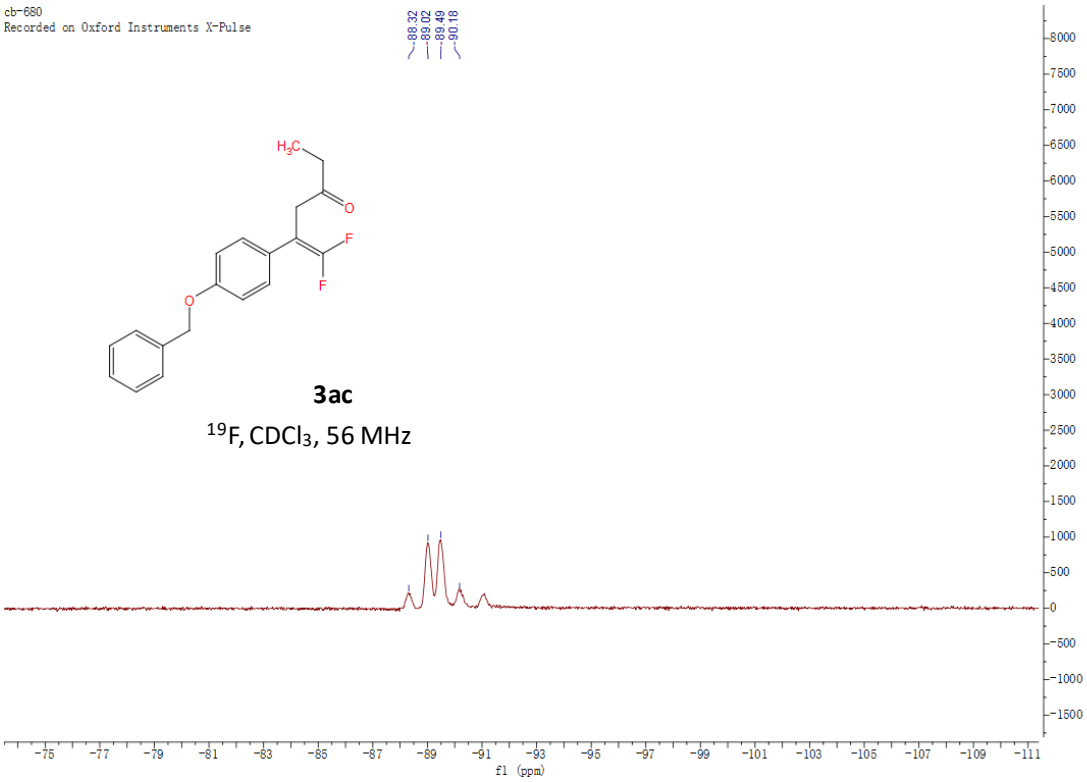
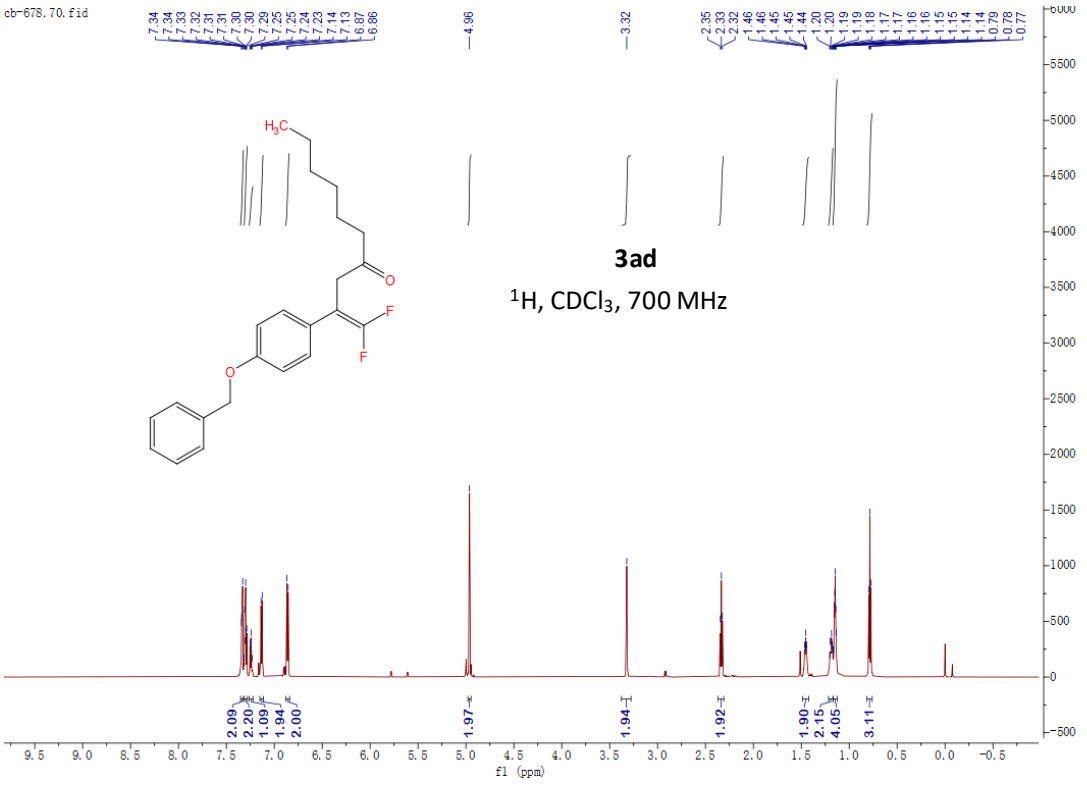
F
F
O
3ac
13C, CDCl3, 176 MHz
f1 (ppm)



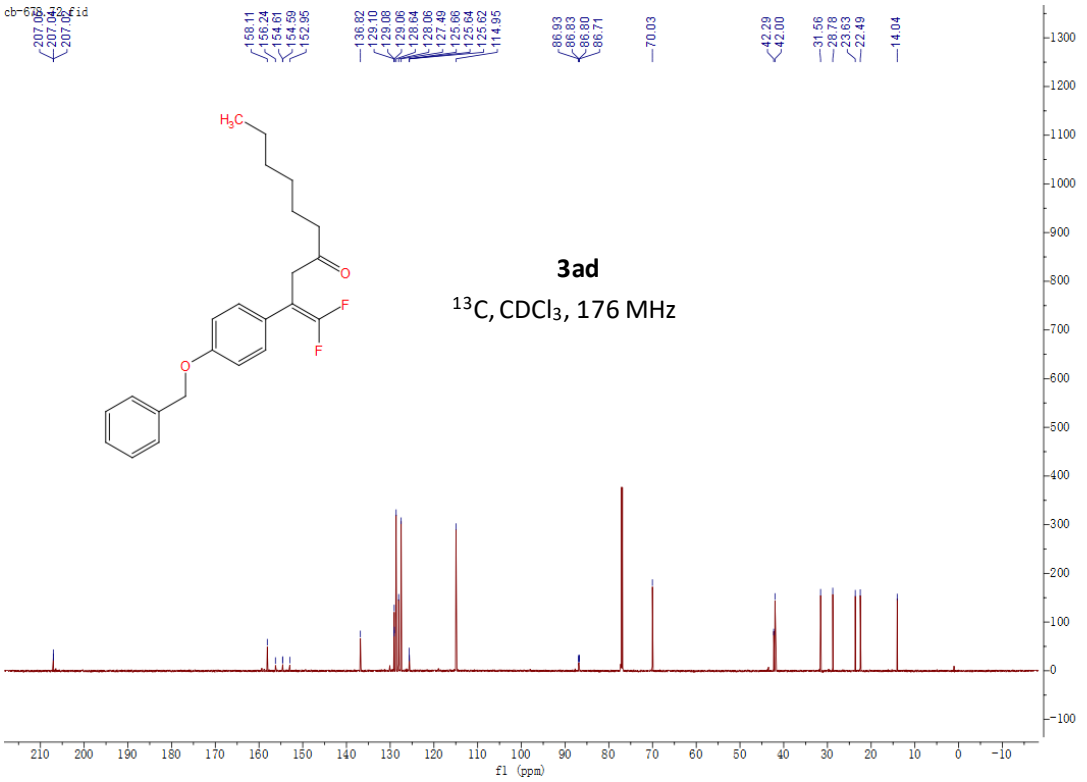
3ac

^{19}F, $CDCl_3$, 56 MHz



3ad

^{1}H, $CDCl_3$, 700 MHz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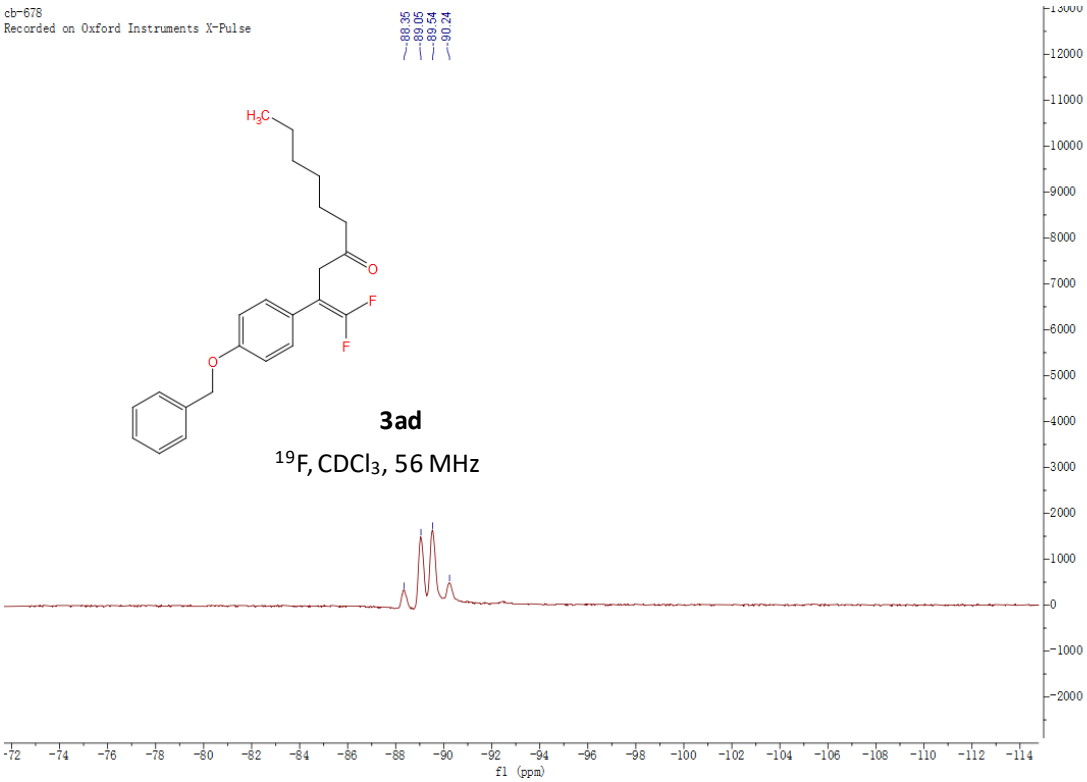
207.06
207.04
207.02
158.11
156.24
154.61
154.59
152.95
136.82
129.10
129.08
129.06
128.64
128.06
127.49
125.66
125.64
125.62
114.95
86.93
86.83
86.80
86.71
70.03
42.29
42.00
31.56
28.78
23.63
22.49
14.04
H3C
O
F
F
O
3ad
13C, CDCl3, 176 MHz
f1 (ppm)


cb-678
Recorded on Oxford Instruments X-Pulse
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89.54
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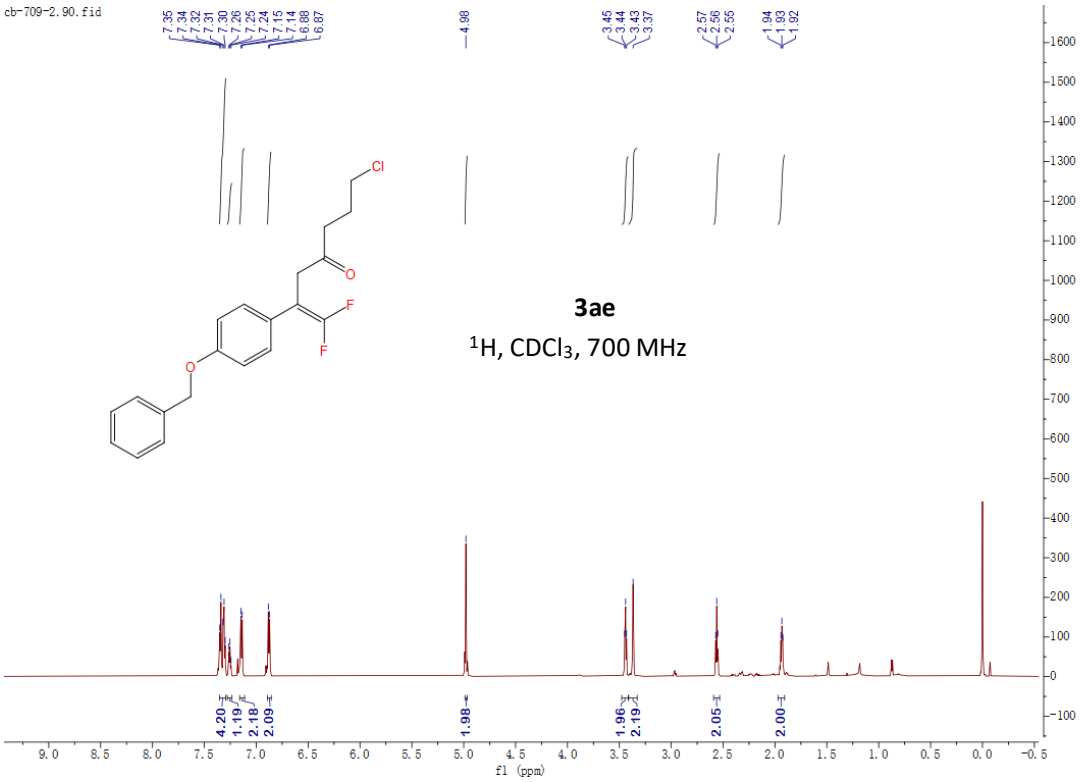
O
F
F
O
3ad
19F, CDCl3, 56 MHz
f1 (ppm)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7.34
7.32
7.31
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7.24
7.15
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3.45
3.44
3.43
3.37
2.57
2.56
2.55
1.94
1.93
1.92
Cl
O
F
F
O
3ae
1H, CDCl3, 700 MHz
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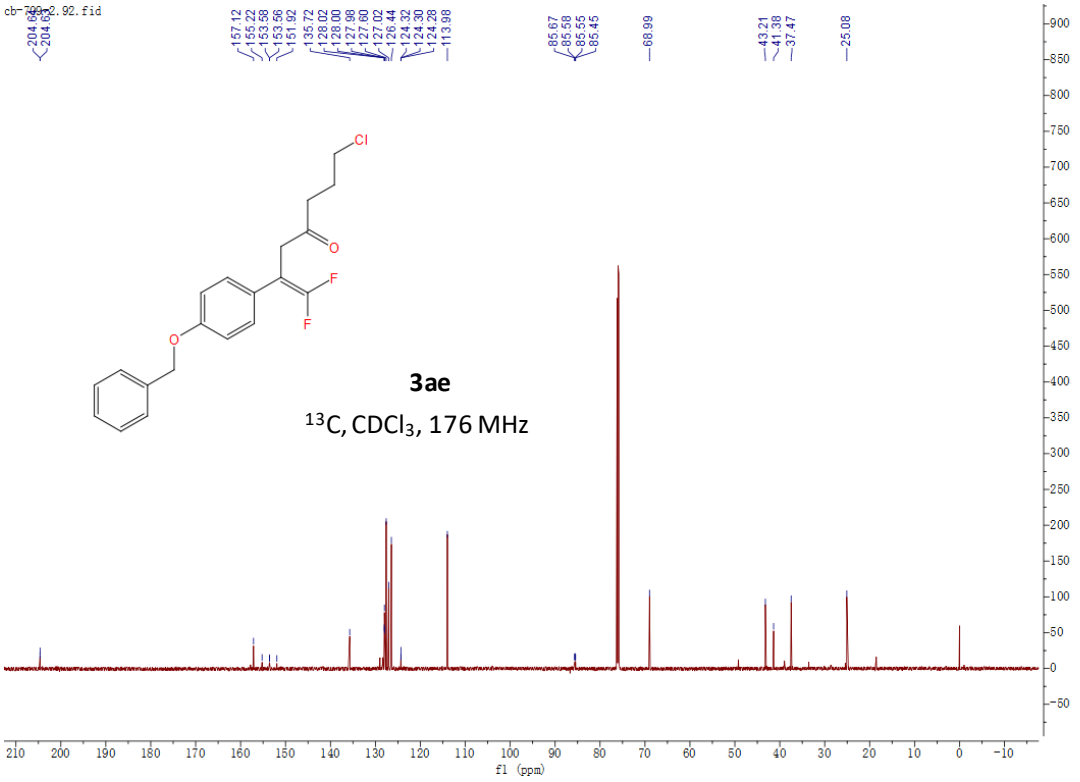
1.19
2.18
2.09
1.98
1.96
2.19
2.05
2.00
f1 (ppm)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204.47
157.12
155.22
153.58
153.56
151.92
135.72
128.02
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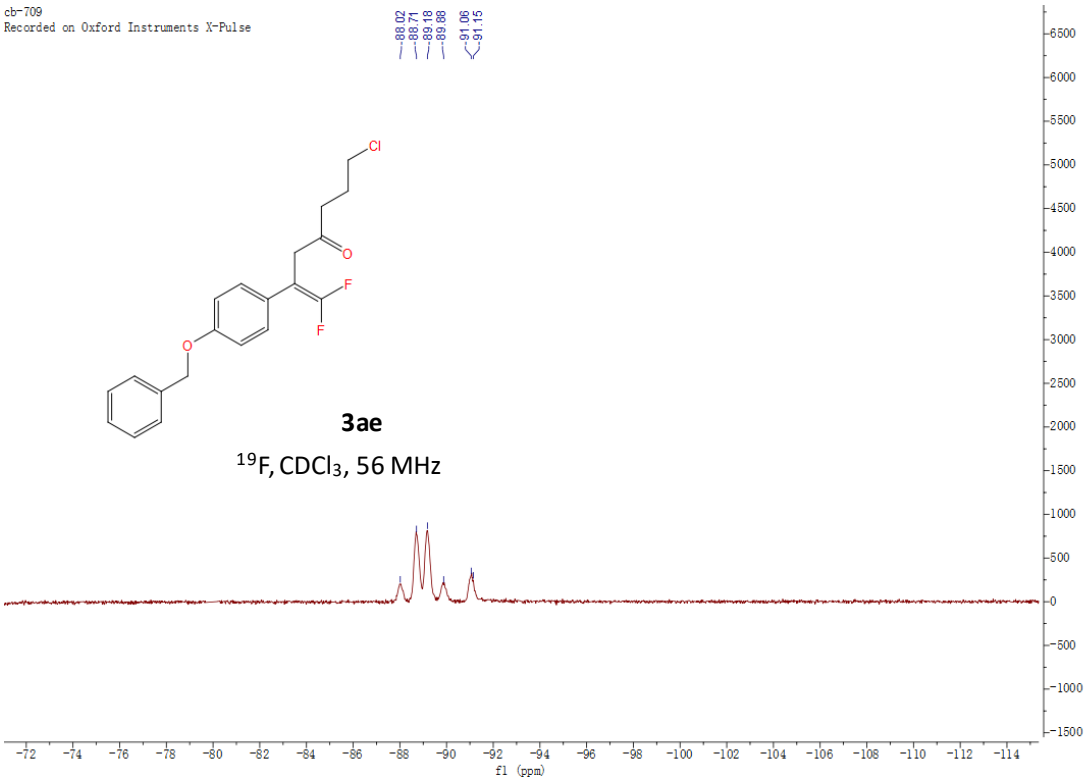
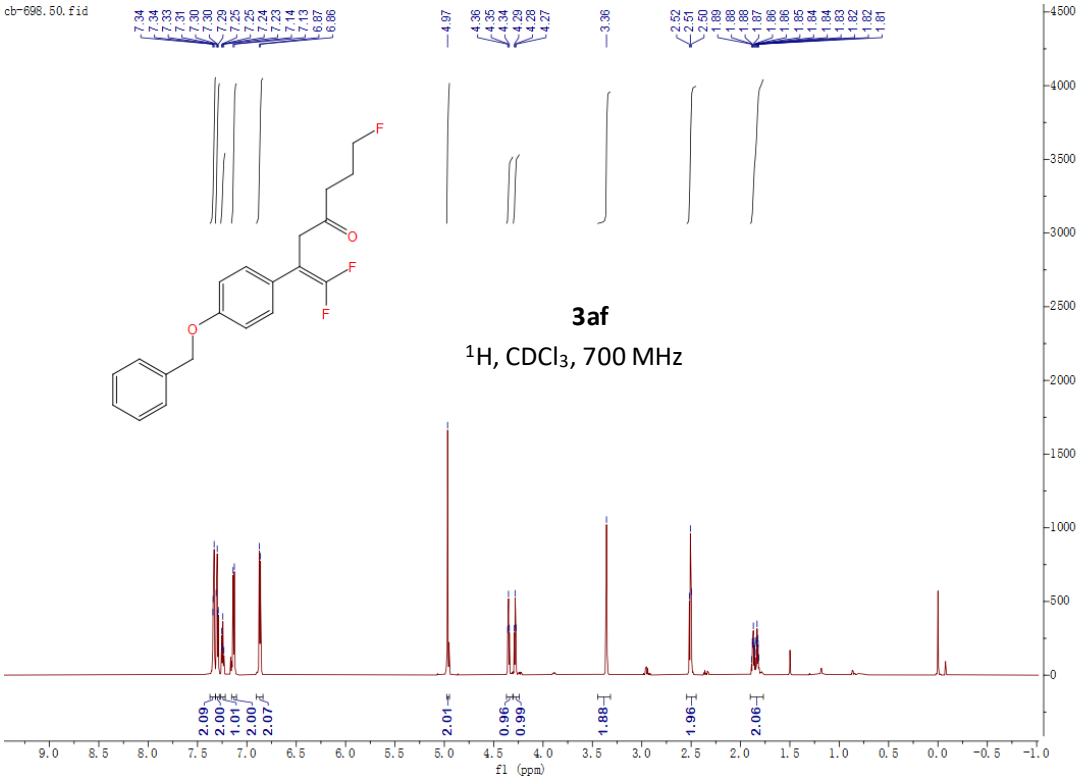
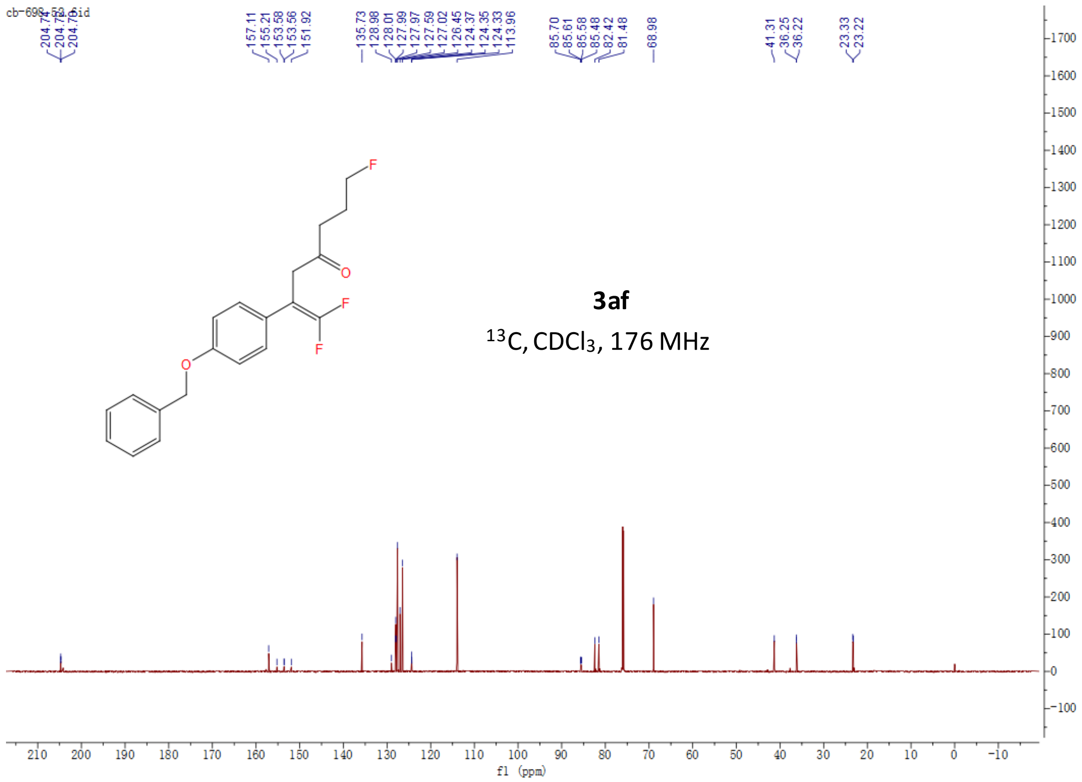
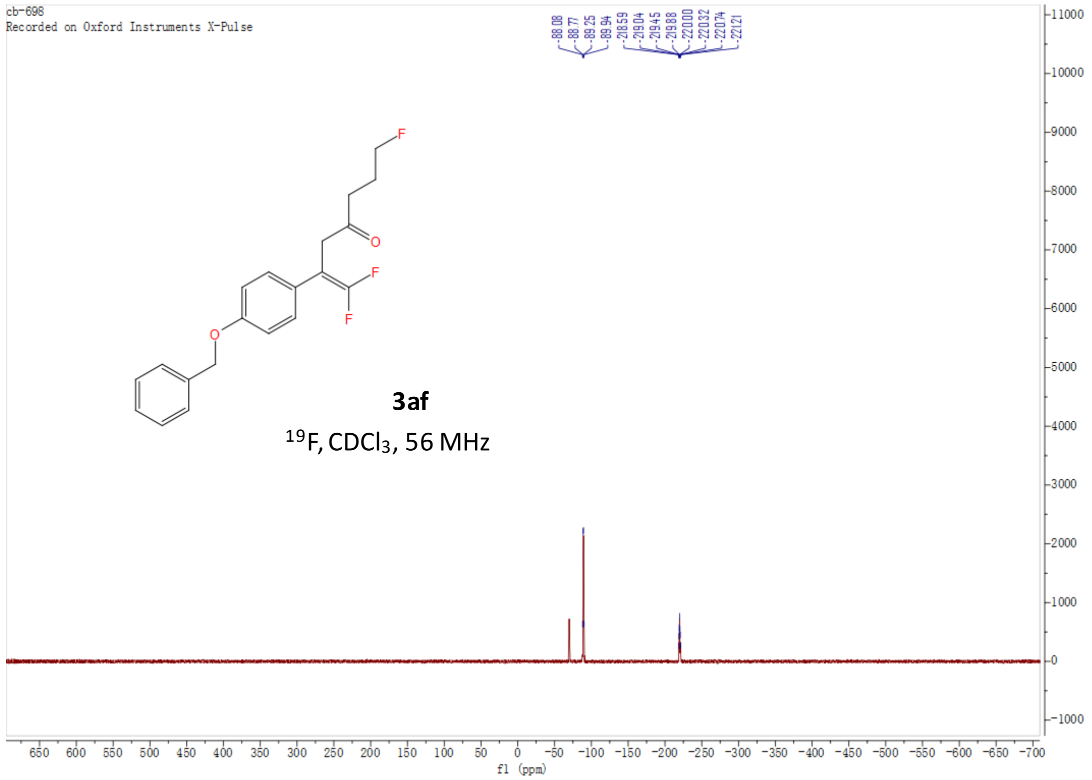
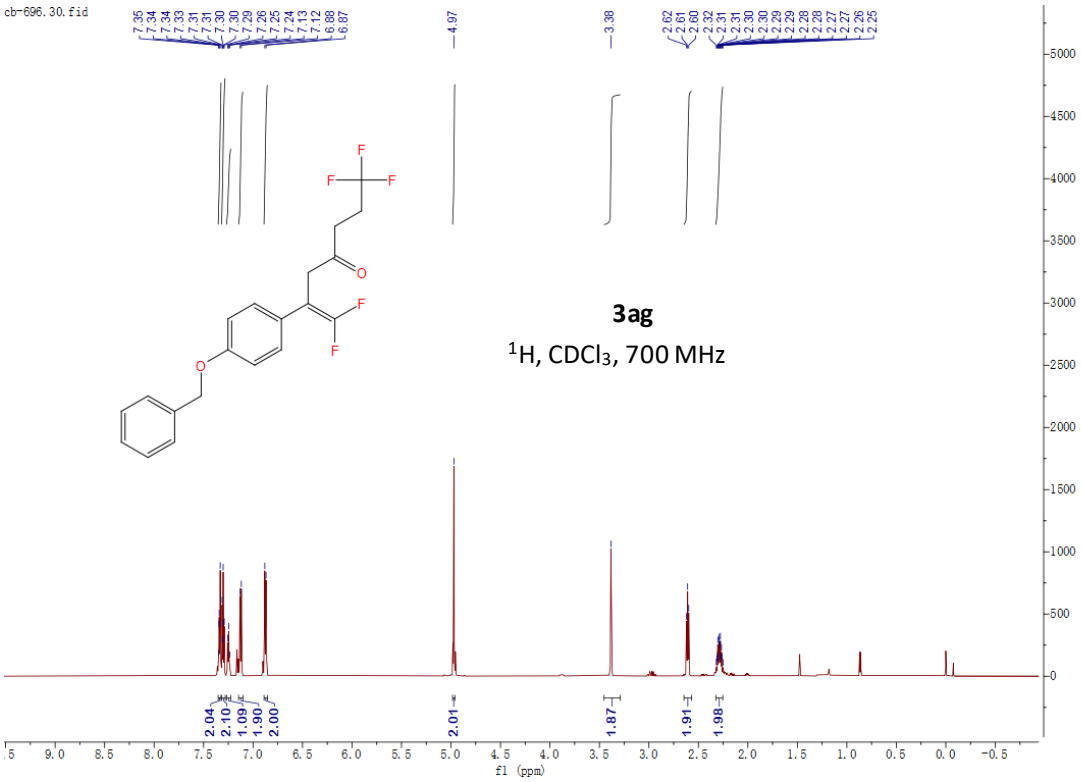
127.60
127.02
126.44
124.32
124.30
124.28
113.98
85.67
85.58
85.55
85.45
68.99
43.21
41.38
37.47
25.08
Cl
O
F
F
O
3ae
13C, CDCl3, 176 MHz
f1 (ppm)

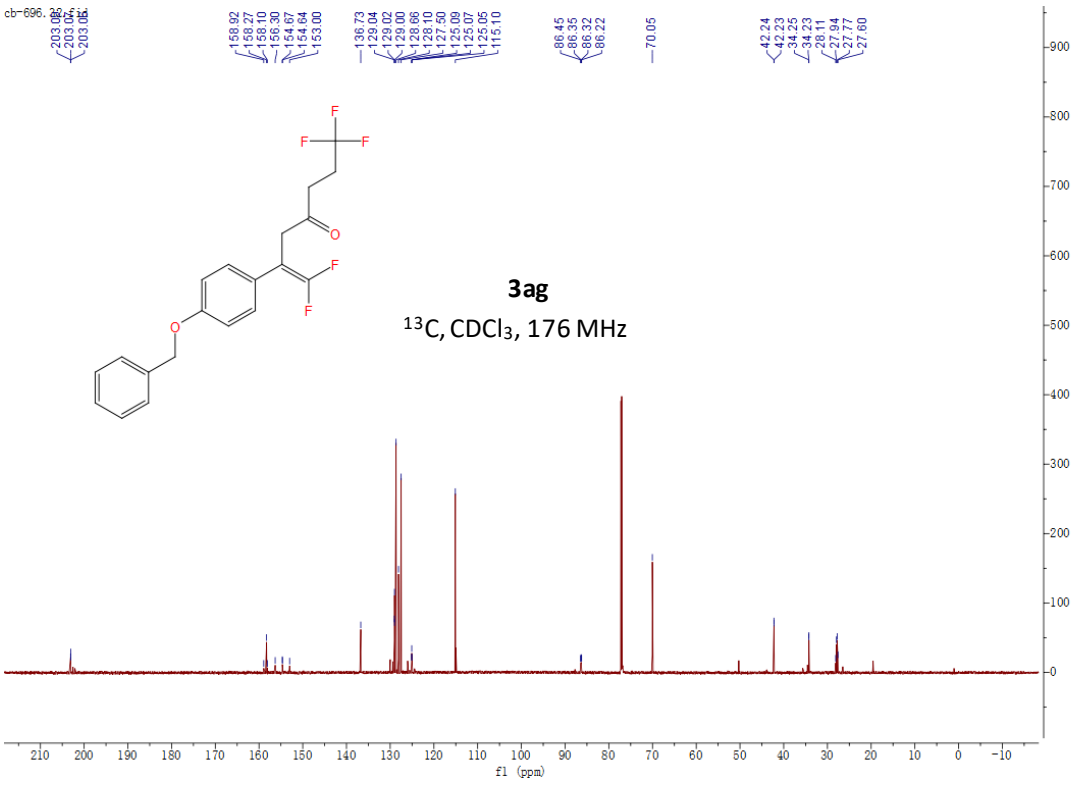

cb-709
Recorded on Oxford Instruments X-Pulse
-88.02
-88.71
-89.18
-89.88
-91.06
-91.15
Cl
O
F
F
O
3ae
19F, CDCl3, 56 MHz
f1 (ppm)

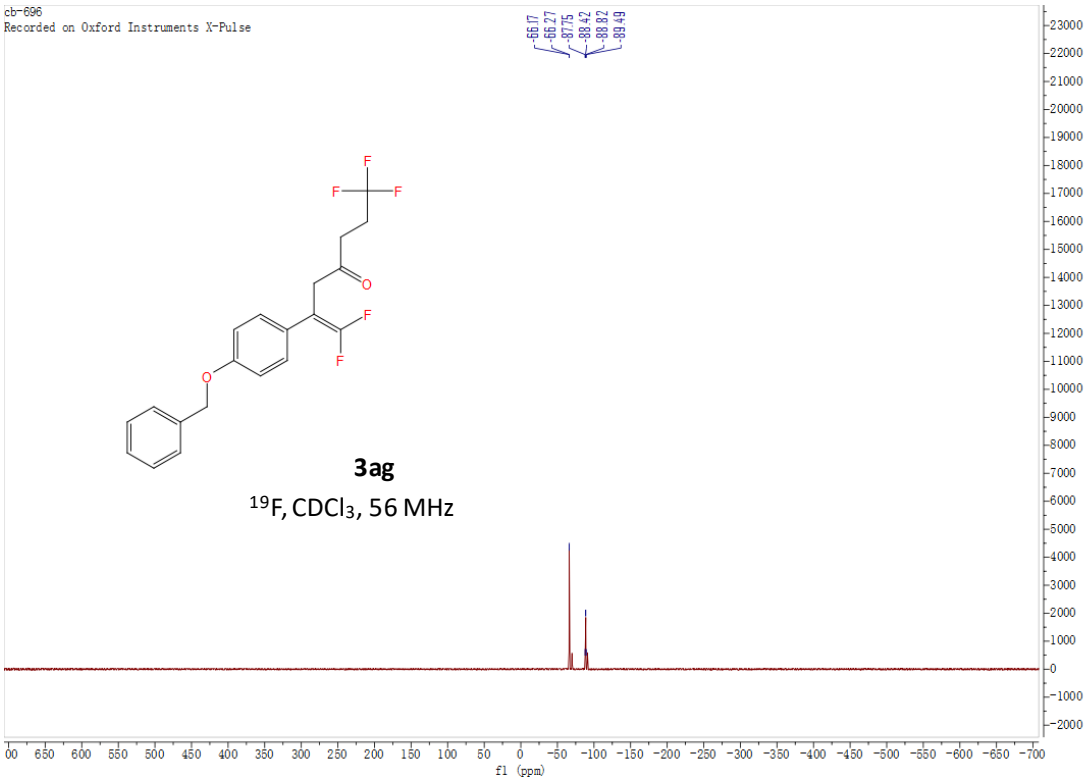

cb-698.50.fid
7.34
7.34
7.33
7.31
7.30
7.30
7.29
7.25
7.25
7.24
7.23
7.14
7.13
6.87
6.86
4.97
4.36
4.35
4.34
4.29
4.28
4.27
3.36
2.52
2.51
2.50
1.89
1.88
1.87
1.86
1.85
1.84
1.83
1.82
1.81
F
O
F
F
O
3af
1H, CDCl3, 700 MHz
2.09
2.00
1.01
2.00
2.07
2.01
0.96
0.99
1.88
1.96
2.06
f1 (ppm)

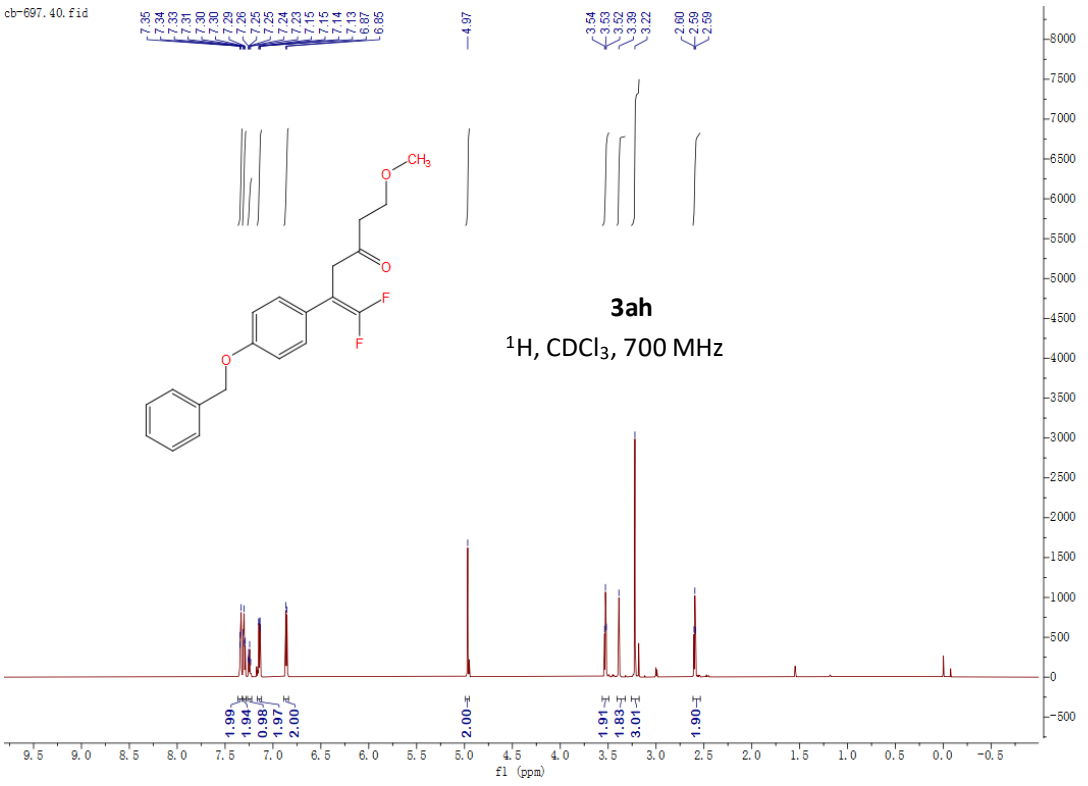

cb-698-59.fid
204.74
204.73
204.70
157.11
155.21
153.58
153.56
151.92
135.73
128.98
128.01
127.99
127.97
127.59
127.02
126.45
124.37
124.35
124.33
113.96
85.70
85.61
85.58
85.48
82.42
81.48
68.98
41.31
36.25
36.22
23.33
23.22
3af
^{13}C, $CDCl_3$, 176 MHz
f1 (ppm)

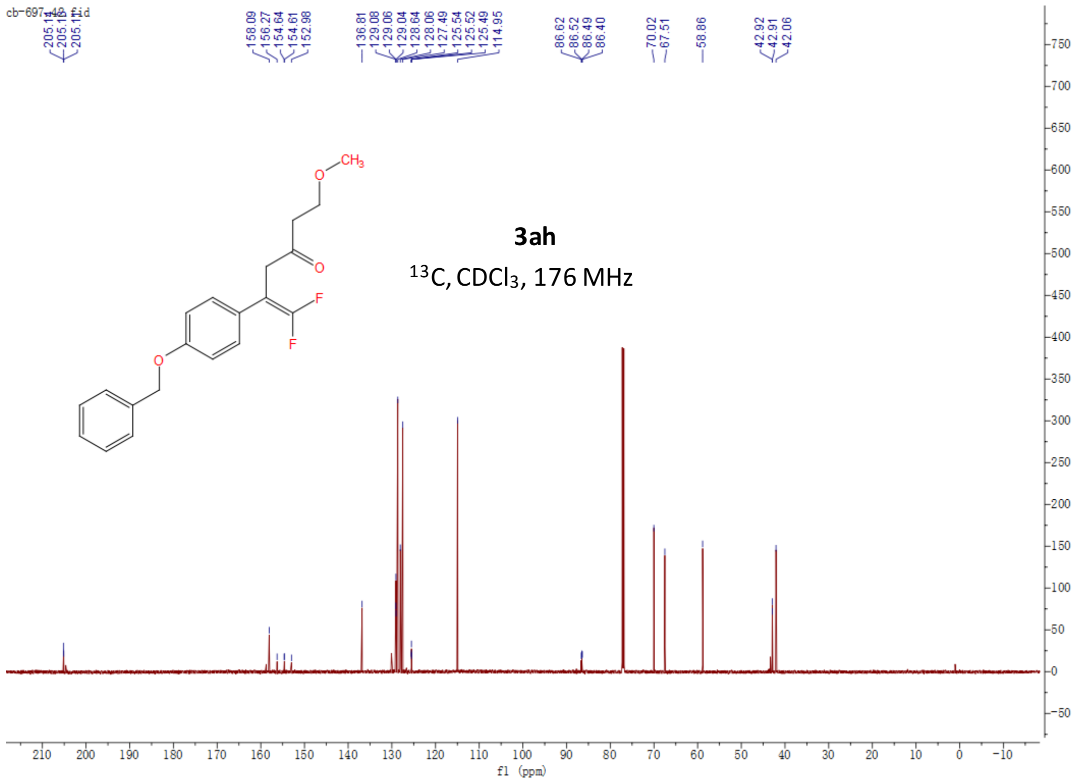

cb-698
Recorded on Oxford Instruments X-Pulse
-88.08
-88.77
-89.25
-89.94
-218.59
-219.04
-219.45
-219.88
-220.00
-220.32
-220.74
-221.21
3af
^{19}F, $CDCl_3$, 56 MHz
f1 (ppm)

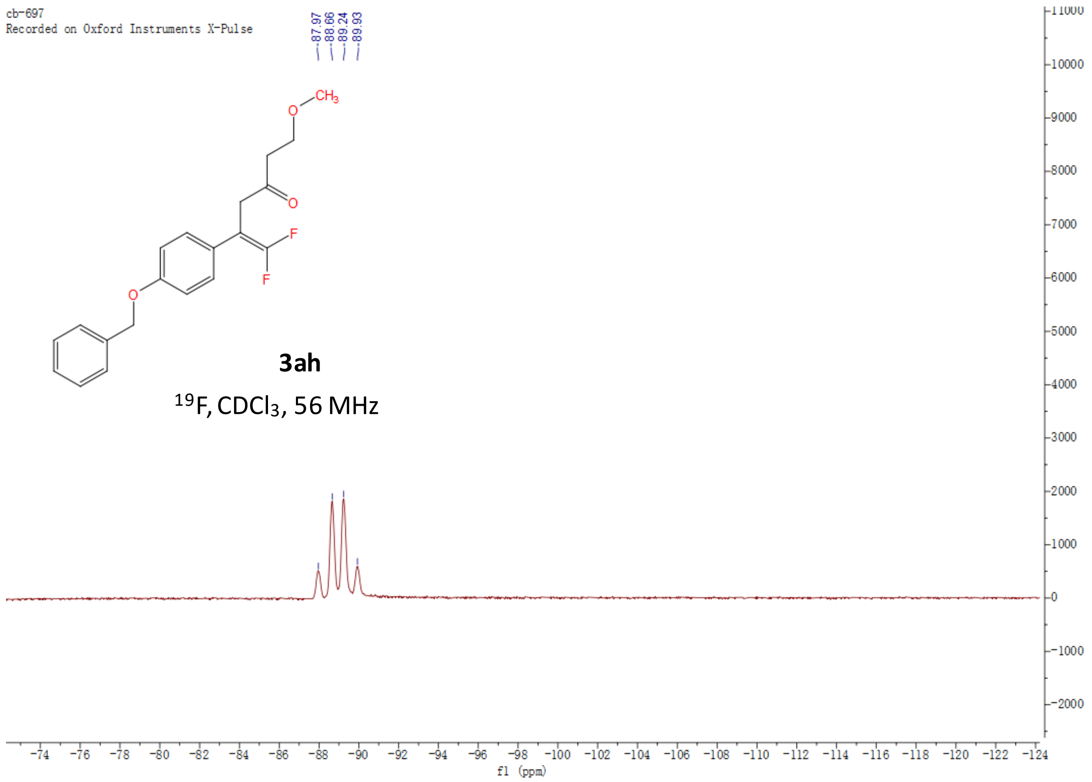

cb-696.30.fid
7.35
7.34
7.34
7.33
7.31
7.31
7.30
7.30
7.29
7.26
7.25
7.24
7.13
7.12
6.88
6.87
4.97
3.38
2.62
2.61
2.60
2.32
2.31
2.31
2.30
2.30
2.29
2.29
2.28
2.28
2.27
2.27
2.26
2.25
F
F
F
O
F
F
O
3ag
1H, CDCl3, 700 MHz
2.04
2.10
1.09
1.90
2.00
2.01
1.87
1.91
1.98
f1 (ppm)

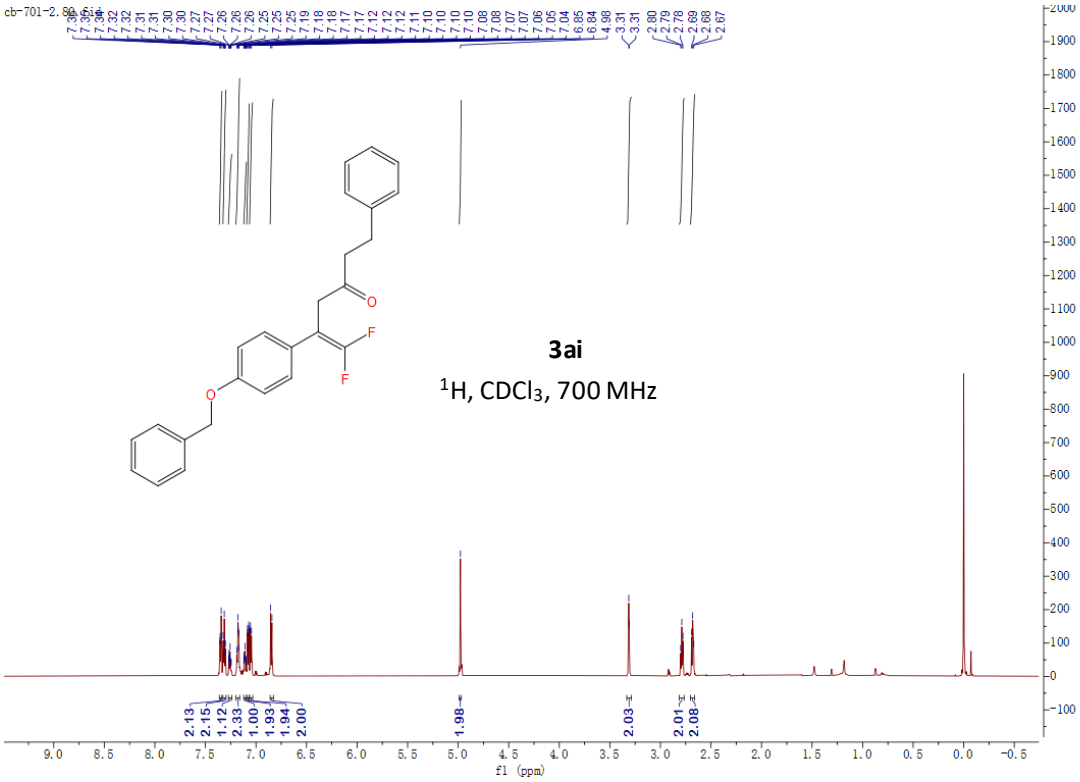

158.92
158.27
158.10
156.30
154.67
154.64
153.00
136.73
129.04
129.02
129.00
128.66
128.10
127.50
125.09
125.07
125.05
115.10
86.45
86.35
86.32
86.22
70.05
42.24
42.23
34.25
34.23
28.11
27.94
27.77
27.60
F
F
F
O
F
F
O
3ag
13C, CDCl3, 176 MHz
f1 (ppm)

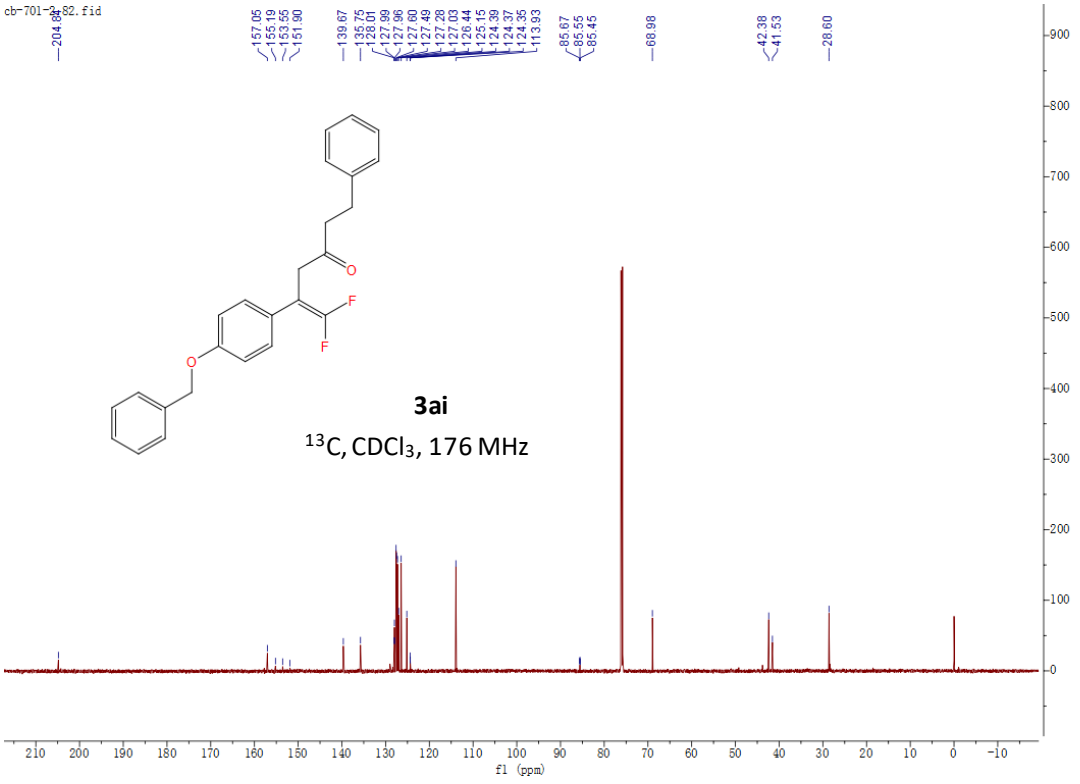

cb-696
Recorded on Oxford Instruments X-Pulse
-66.17
-66.27
-87.75
-88.42
-88.82
-89.49
F
F
F
O
F
F
O
3ag
19F, CDCl3, 56 MHz
f1 (ppm)

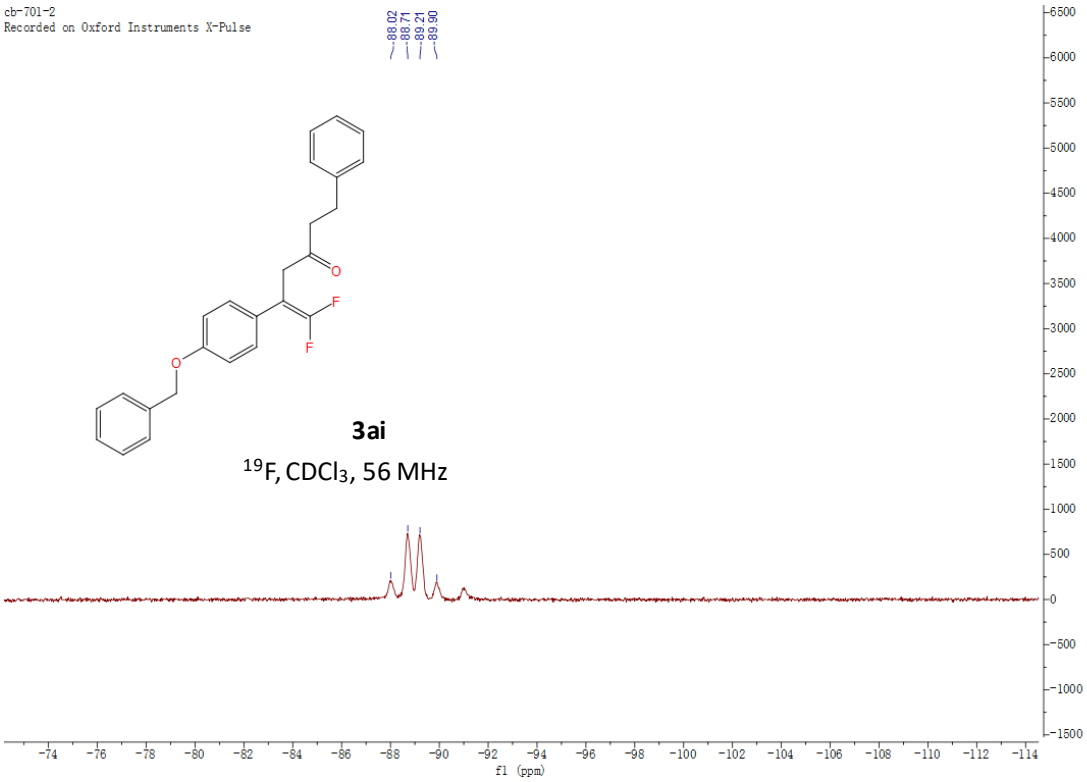

cb-697.40.fid
7.35
7.34
7.33
7.31
7.30
7.30
7.29
7.26
7.25
7.25
7.24
7.23
7.15
7.15
7.14
7.13
6.87
6.85
4.97
3.54
3.53
3.52
3.39
3.22
2.60
2.59
2.59
CH3
O
O
F
F
O
3ah
1H, CDCl3, 700 MHz
1.99
1.94
0.98
1.97
2.00
2.00
1.91
1.83
3.01
1.90
f1 (ppm)

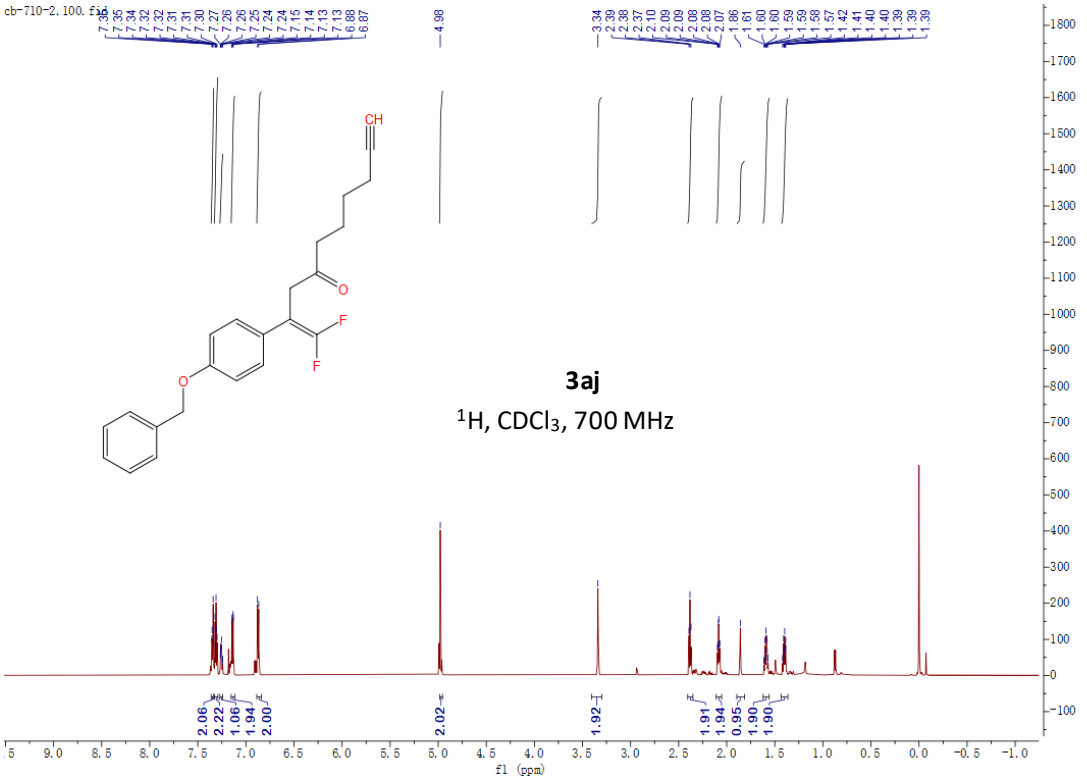

cb-697.40.fid
3ah
13C, CDCl3, 176 MHz
f1 (ppm)

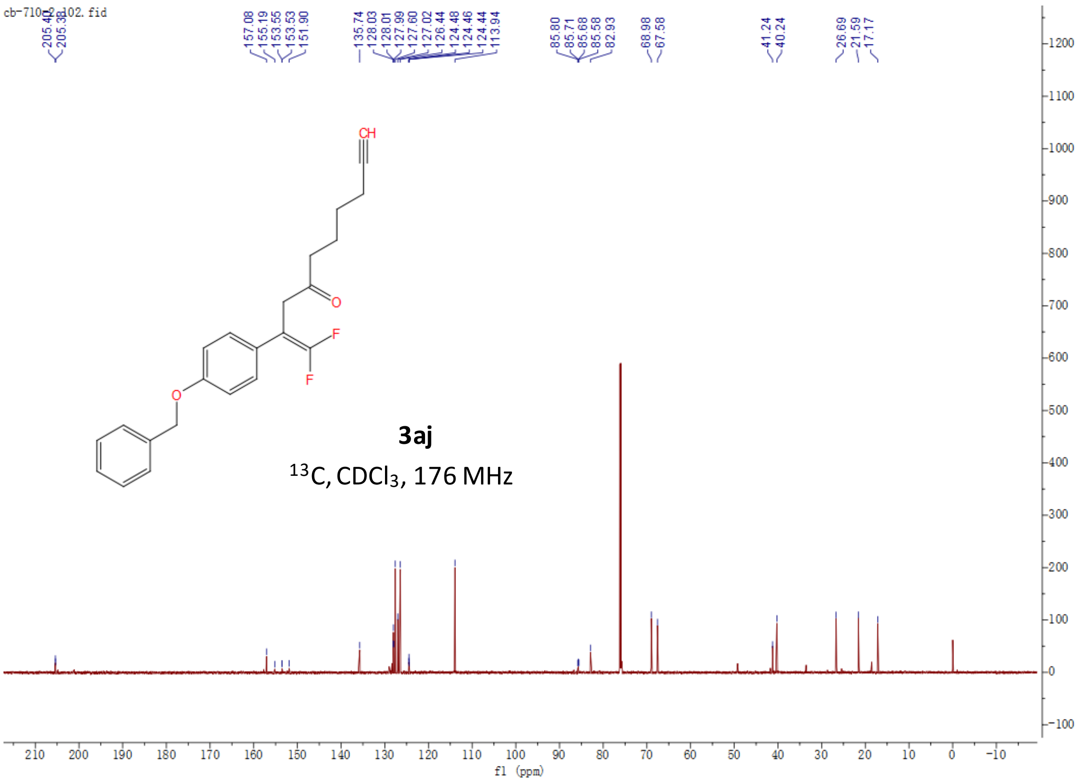

cb-697
Recorded on Oxford Instruments X-Pulse
3ah
19F, CDCl3, 56 MHz
f1 (ppm)

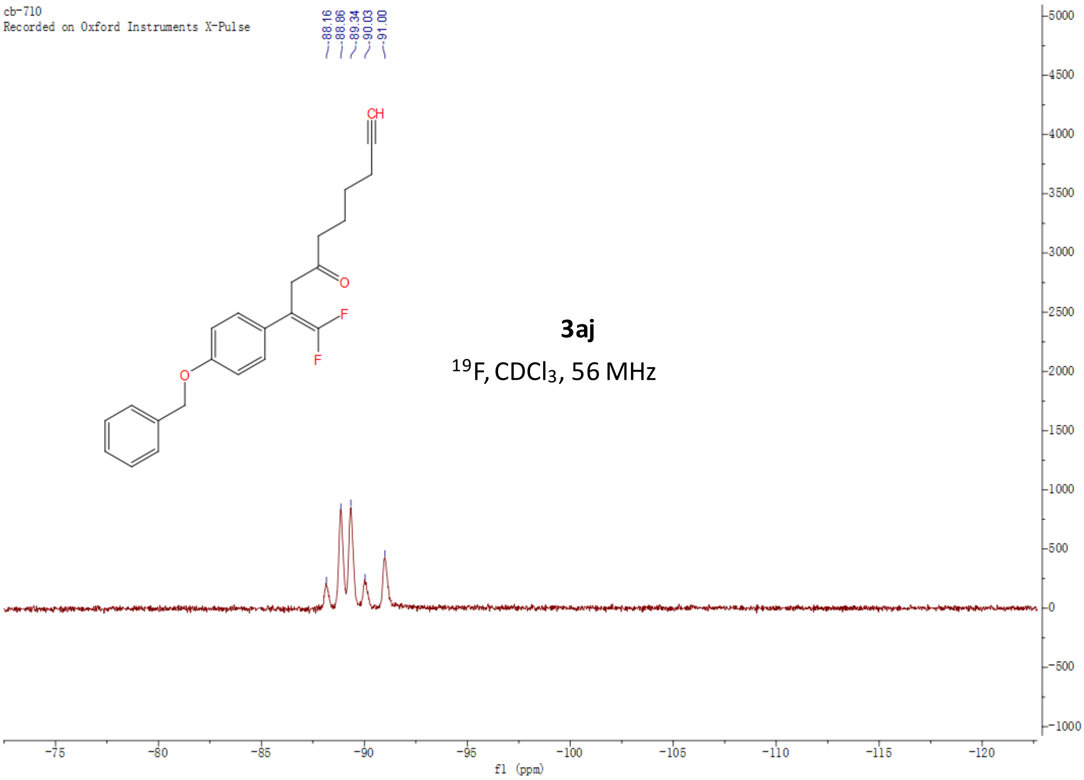

cb-701-2.80.fid
O
F
F
O
3ai
1H, CDCl3, 700 MHz
2.13
2.15
1.12
2.33
1.00
1.93
1.94
2.00
1.98
2.03
2.01
2.08
f1 (ppm)

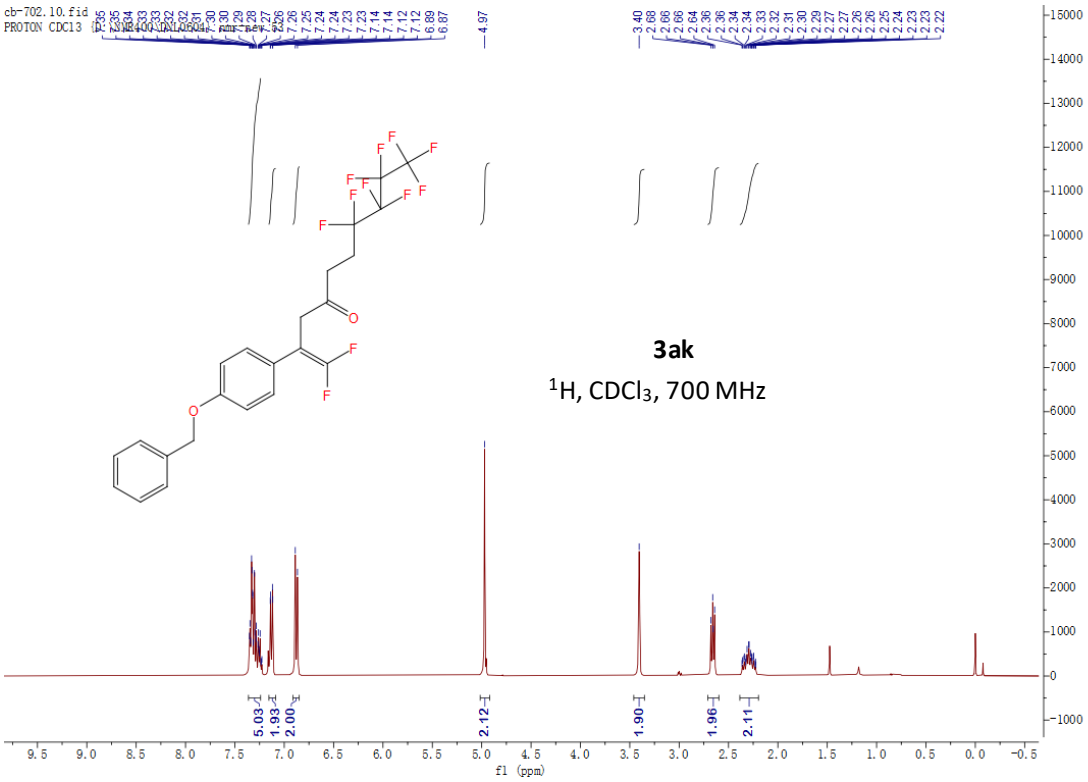

cb-701-2.82.fid
204.83
157.05
155.19
153.55
151.90
139.67
135.75
128.01
127.99
127.96
127.60
127.49
127.28
127.03
126.44
125.15
124.39
124.37
124.35
113.93
85.67
85.55
85.45
68.98
42.38
41.53
28.60
O
F
F
O
3ai
13C, CDCl3, 176 MHz
f1 (ppm)


cb-701-2
Recorded on Oxford Instruments X-Pulse
-88.02
-88.71
-89.21
-89.90
O
F
F
O
3ai
19F, CDCl3, 56 MHz
f1 (ppm)


cb-710-2.100.fid
7.36
7.35
7.34
7.32
7.32
7.31
7.31
7.30
7.27
7.26
7.26
7.25
7.24
7.24
7.15
7.14
7.13
7.13
6.88
6.87
4.98
3.34
2.39
2.38
2.37
2.10
2.09
2.09
2.08
2.08
2.07
1.86
1.61
1.60
1.60
1.59
1.59
1.58
1.57
1.42
1.41
1.40
1.40
1.39
1.39
CH
O
F
F
O
3aj
1H, CDCl3, 700 MHz
2.06
2.22
1.06
1.94
2.00
2.02
1.92
1.91
1.94
0.95
1.90
1.90
f1 (ppm)

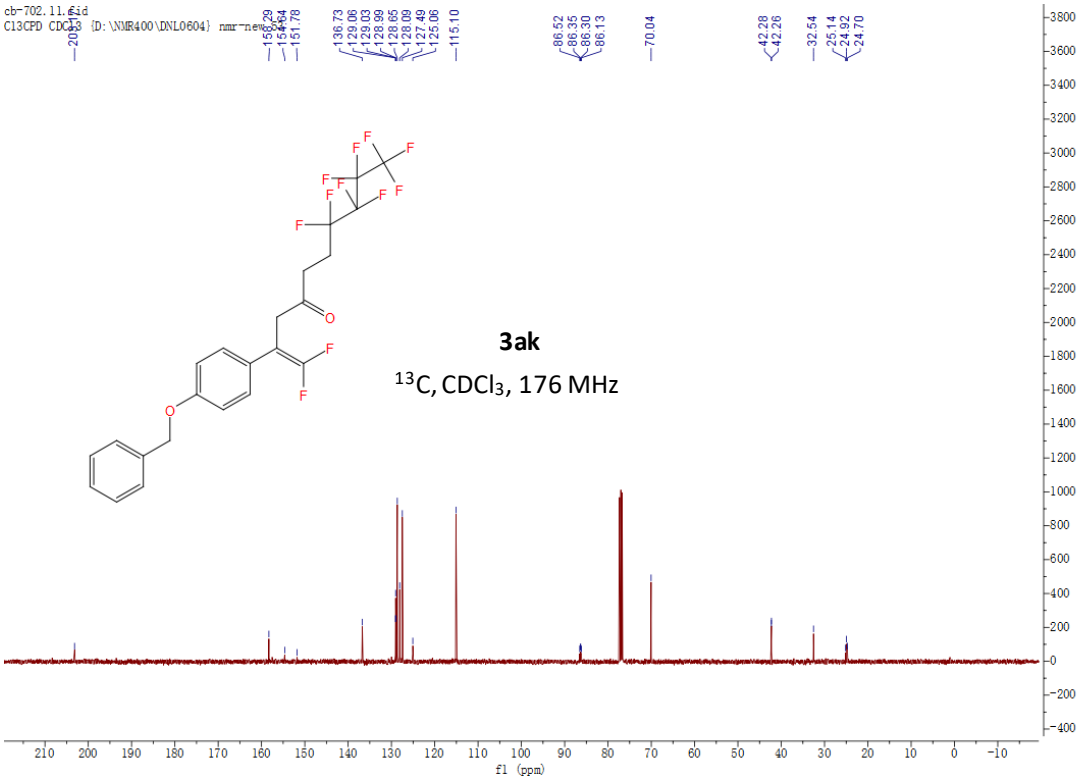

cb-710-2.102.fid
205.40
205.38
157.08
155.19
153.55
153.53
151.90
135.74
128.03
128.01
127.99
127.60
127.02
126.44
124.48
124.46
124.44
113.94
85.80
85.71
85.68
85.58
82.93
68.98
67.58
41.24
40.24
26.69
21.59
17.17
3aj
13C, CDCl3, 176 MHz
f1 (ppm)


cb-710
Recorded on Oxford Instruments X-Pulse
-88.16
-88.86
-89.34
-90.03
-91.00
3aj
19F, CDCl3, 56 MHz
f1 (ppm)



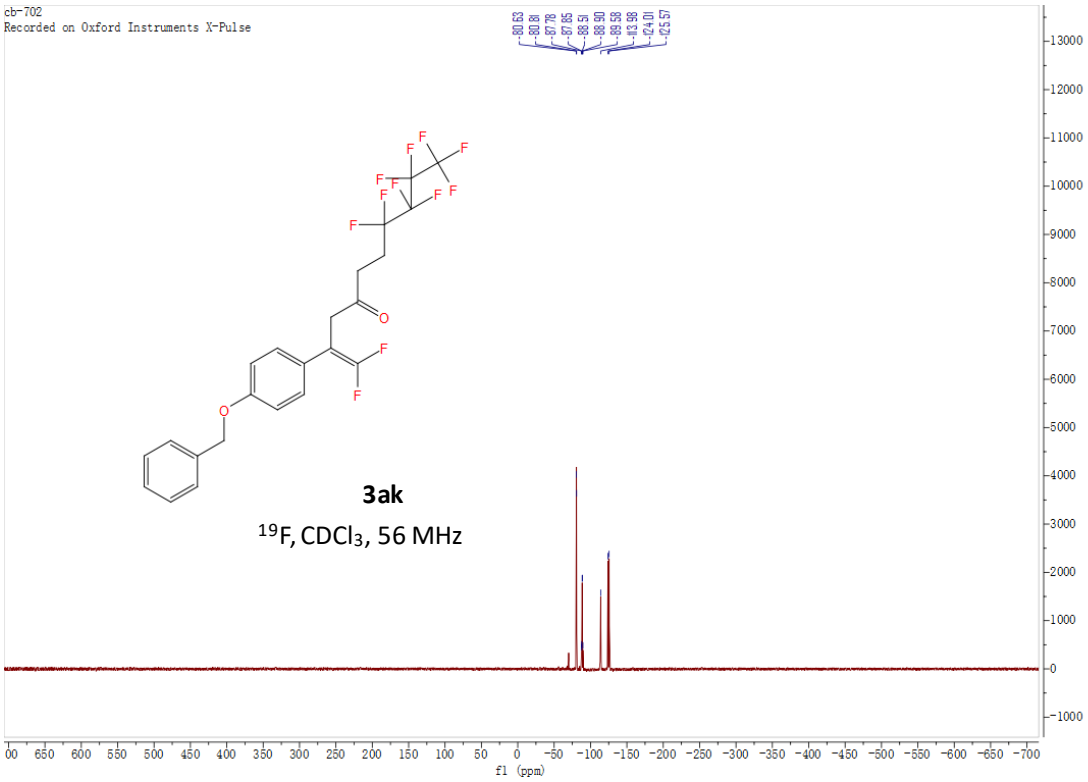
3ak

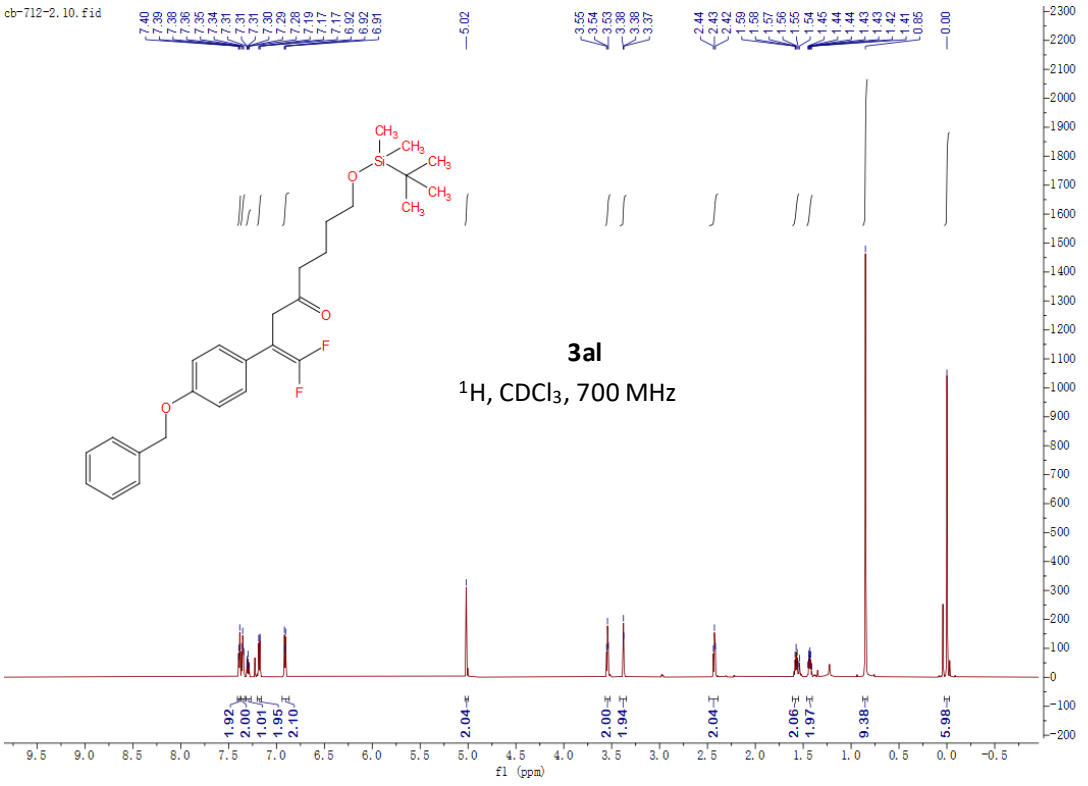
^{1}H, $CDCl_3$, 700 MHz

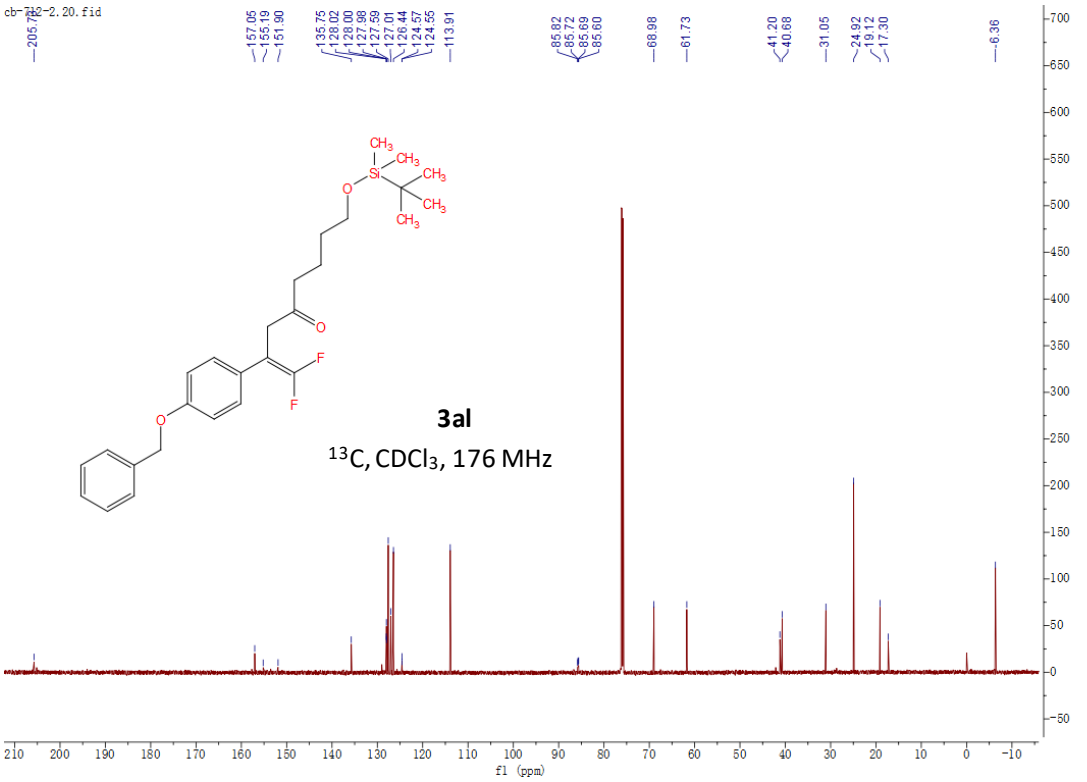


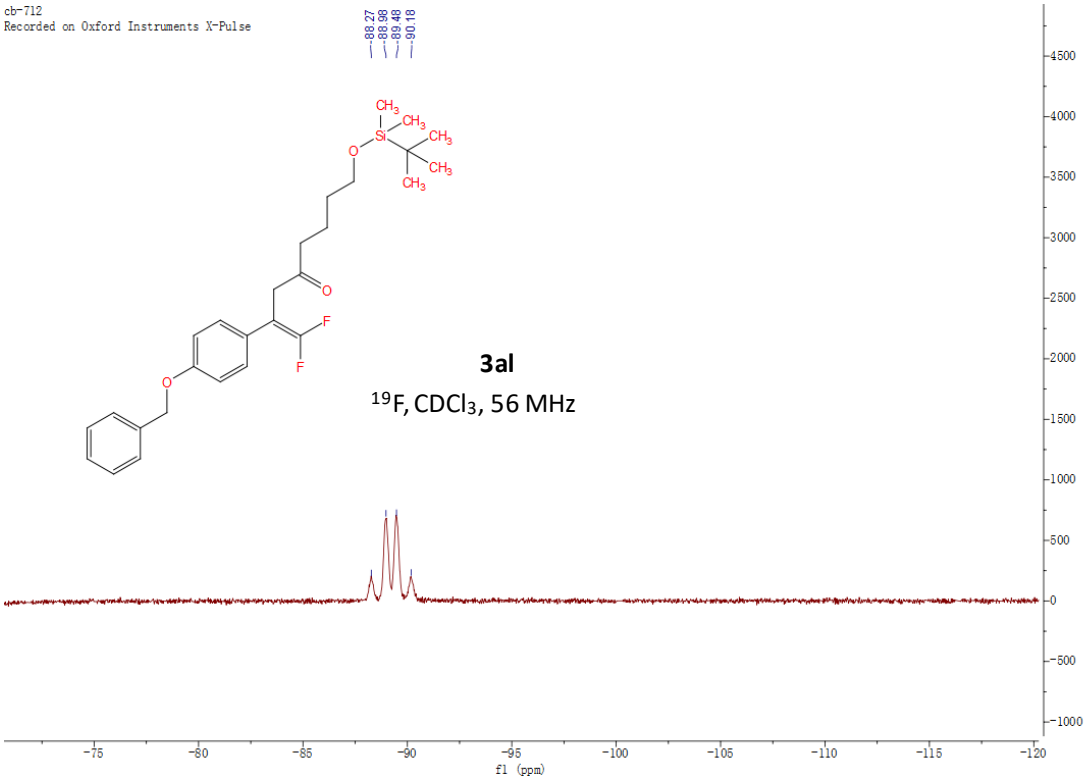
3ak

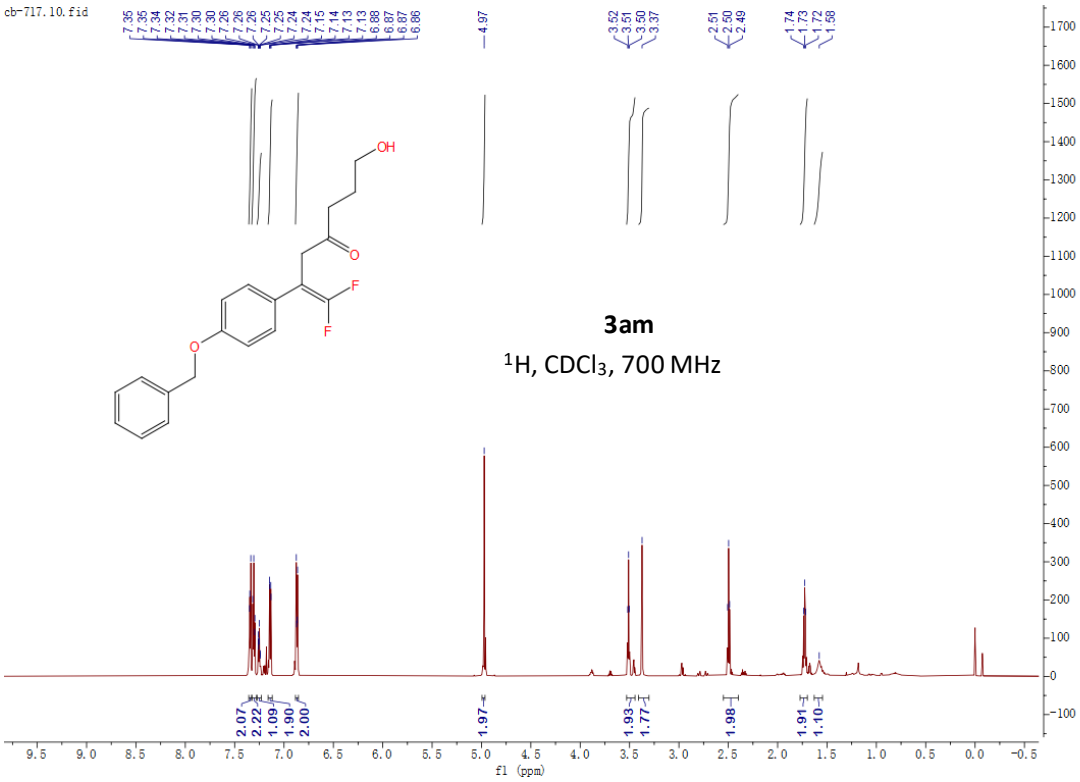
^{13}C, $CDCl_3$, 176 MHz

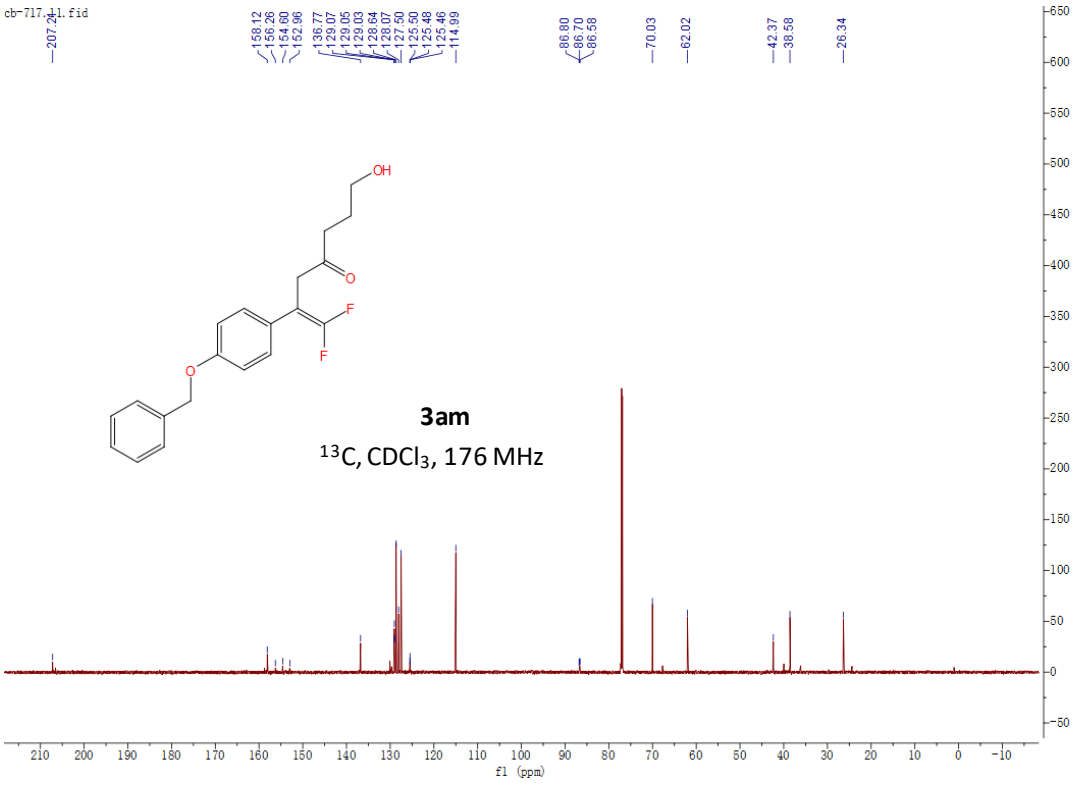

cb-702
Recorded on Oxford Instruments X-Pulse
3ak
19F, CDCl3, 56 MHz
f1 (ppm)

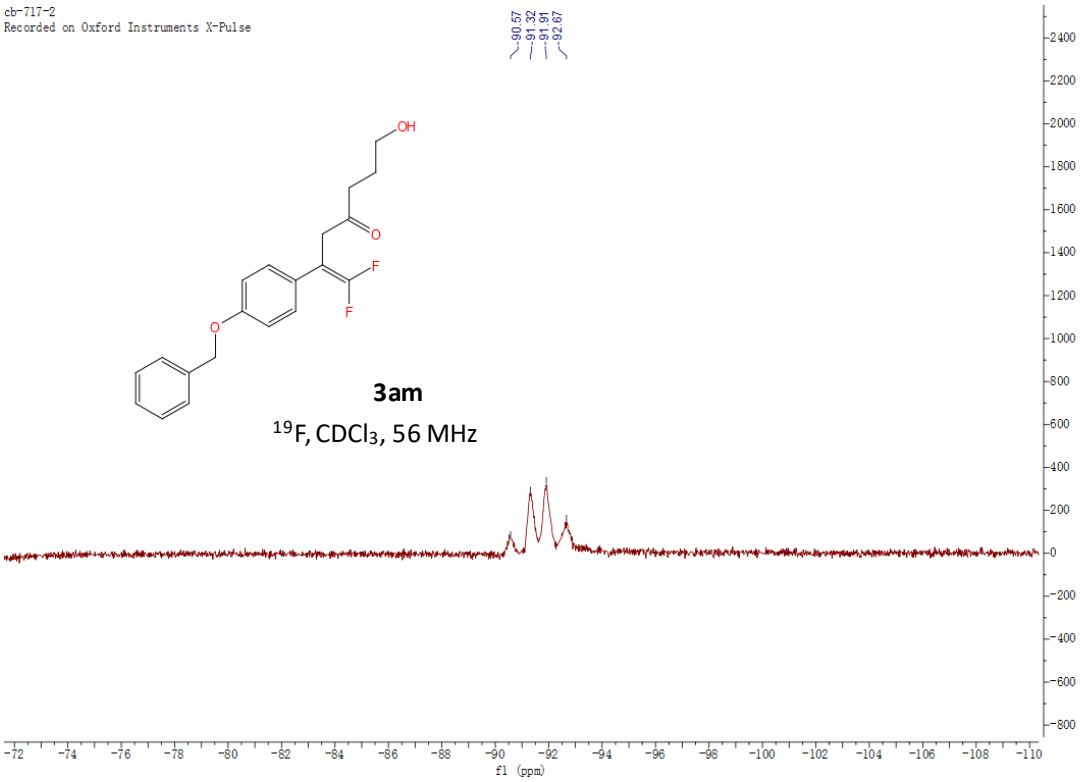

cb-712-2.10.fid
3al
1H, CDCl3, 700 MHz
f1 (ppm)


cb-712-2.20.fid
205.78
157.05
155.19
151.90
135.75
128.02
128.00
127.98
127.59
127.01
126.44
124.57
124.55
113.91
85.82
85.72
85.69
85.60
68.98
61.73
41.20
40.68
31.05
24.92
19.12
17.30
6.36
3al
13C, CDCl3, 176 MHz
f1 (ppm)


cb-712
Recorded on Oxford Instruments X-Pulse
88.27
88.98
89.48
90.18
3al
19F, CDCl3, 56 MHz
f1 (ppm)

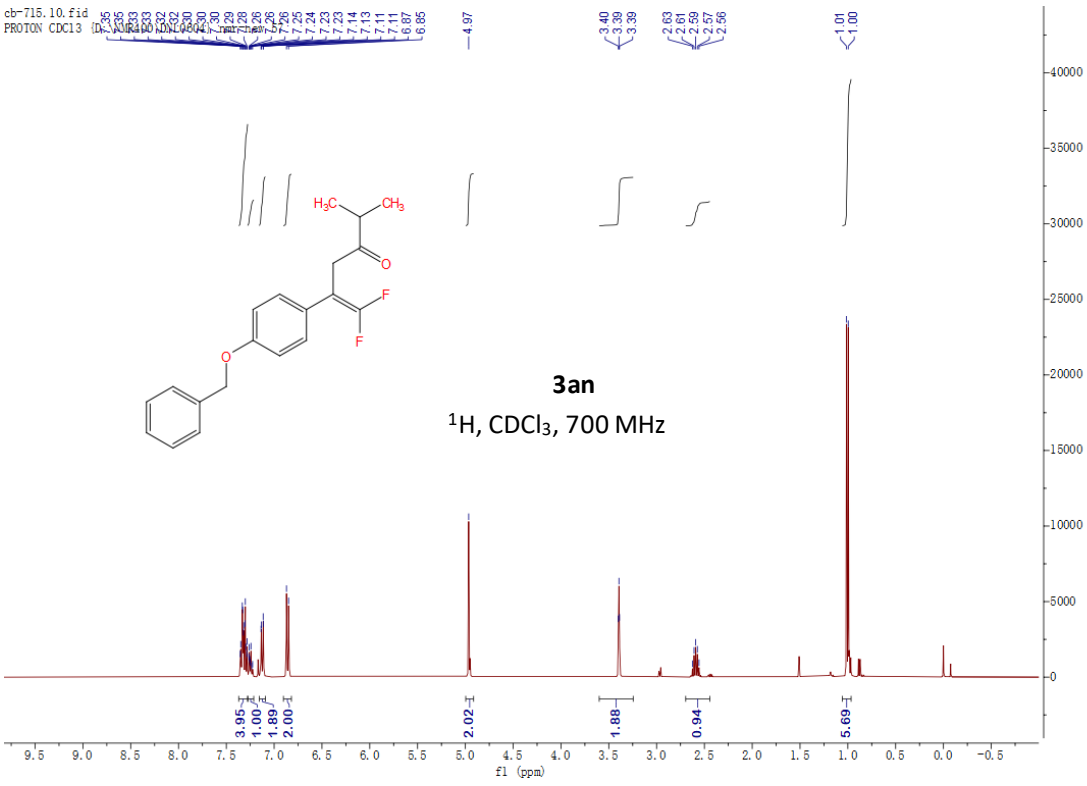

cb-717.10.fid
OH
O
F
F
O
3am
1H, CDCl3, 700 MHz
f1 (ppm)


cb-717.11.fid
OH
O
F
F
O
3am
13C, CDCl3, 176 MHz
f1 (ppm)



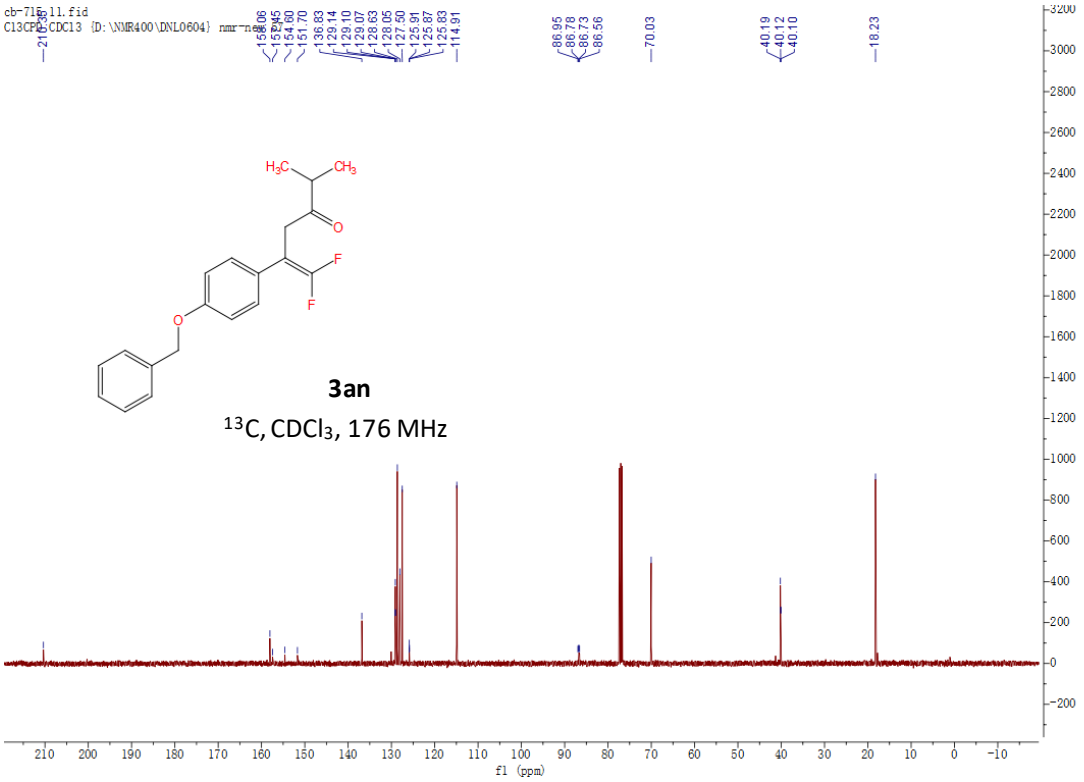
3am

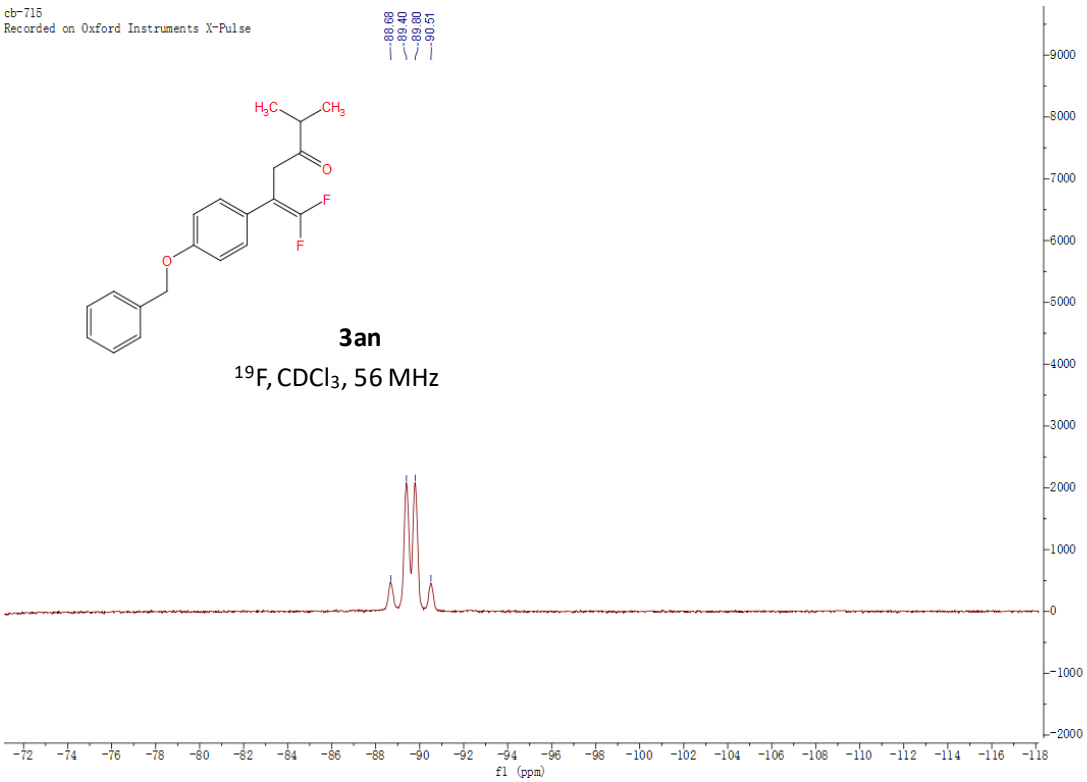
^{19}F, $CDCl_3$, 56 MHz

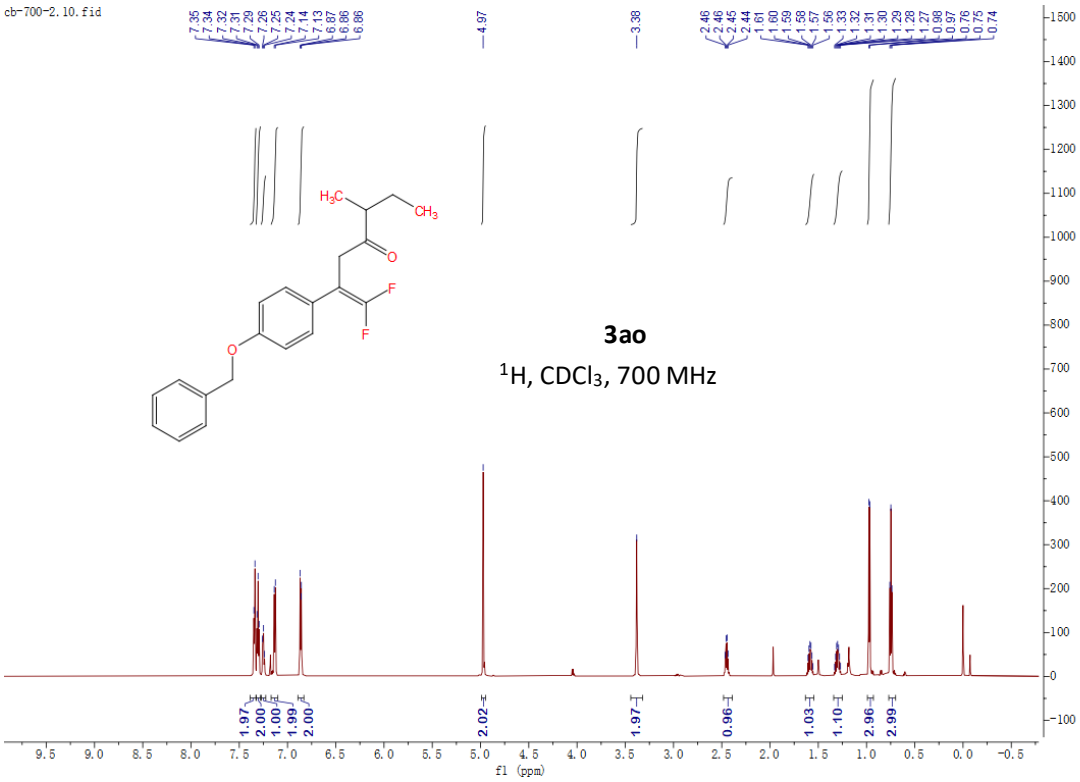


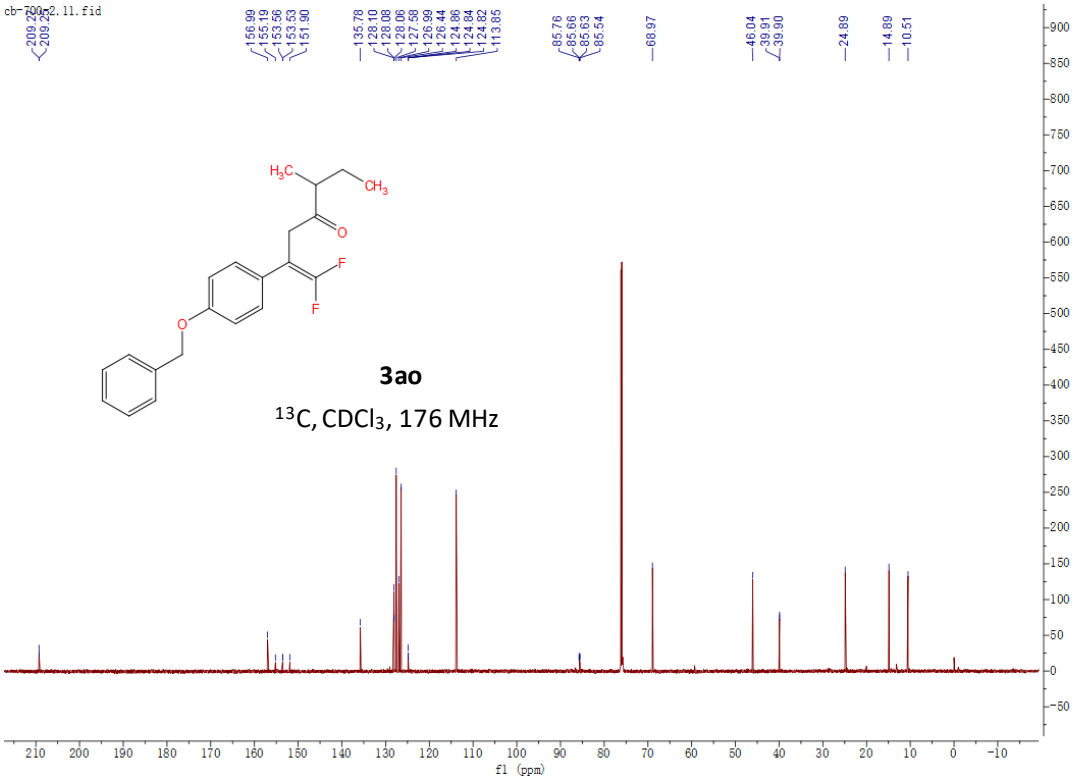
3an

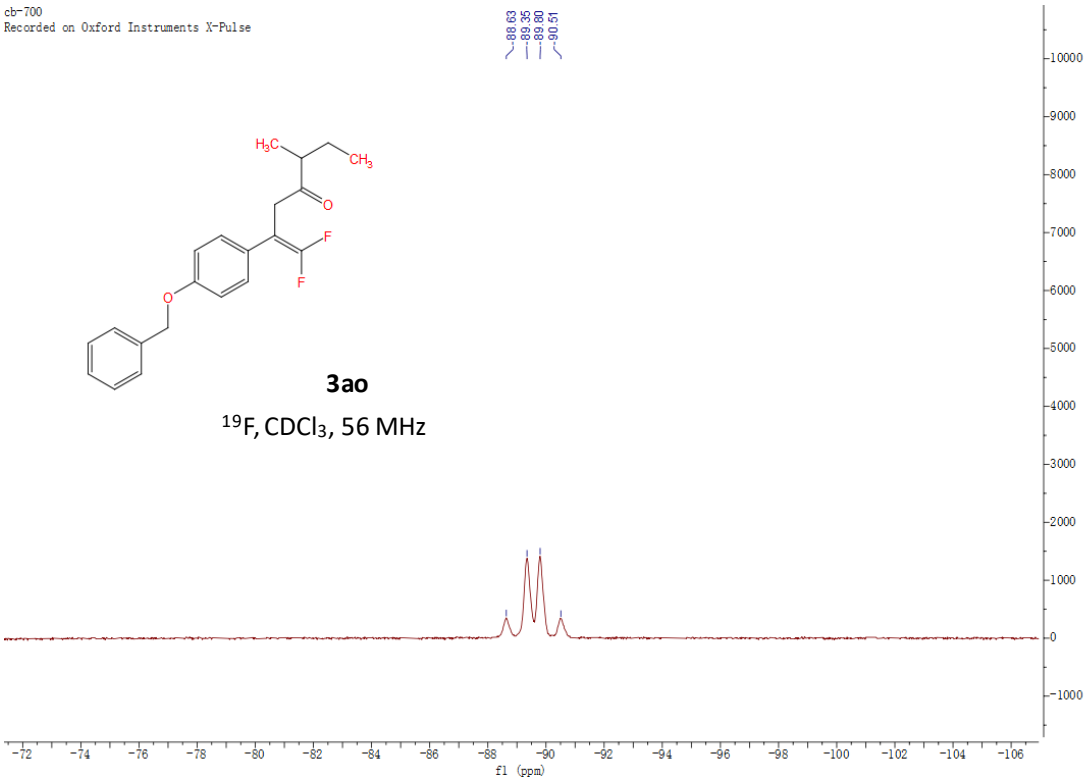
^{1}H, $CDCl_3$, 700 MHz


cb-715-11.fid
C13CPD CDCl3 (D:\NMR400\DNL0604) nmr-ne
156.06
155.45
154.60
151.70
136.83
129.14
129.10
129.07
128.63
128.05
127.50
125.91
125.87
125.83
114.91
86.95
86.78
86.73
86.56
70.03
40.19
40.12
40.10
18.23
H3C
CH3
O
F
F
O
3an
13C, CDCl3, 176 MHz
f1 (ppm)


cb-715
Recorded on Oxford Instruments X-Pulse
88.68
89.40
89.80
90.51
H3C
CH3
O
F
F
O
3an
19F, CDCl3, 56 MHz
f1 (ppm)

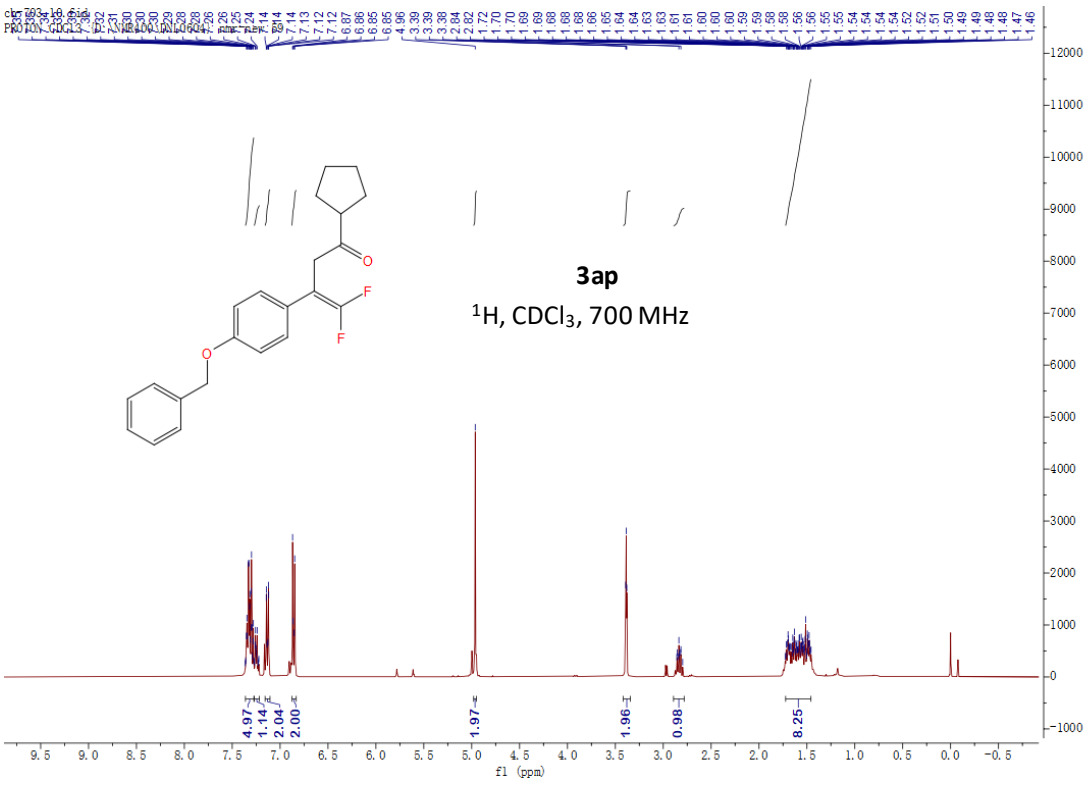

cb-700-2.10.fid
3ao
1H, CDCl3, 700 MHz
f1 (ppm)


cb-700-2.11.fid
3ao
13C, CDCl3, 176 MHz
f1 (ppm)



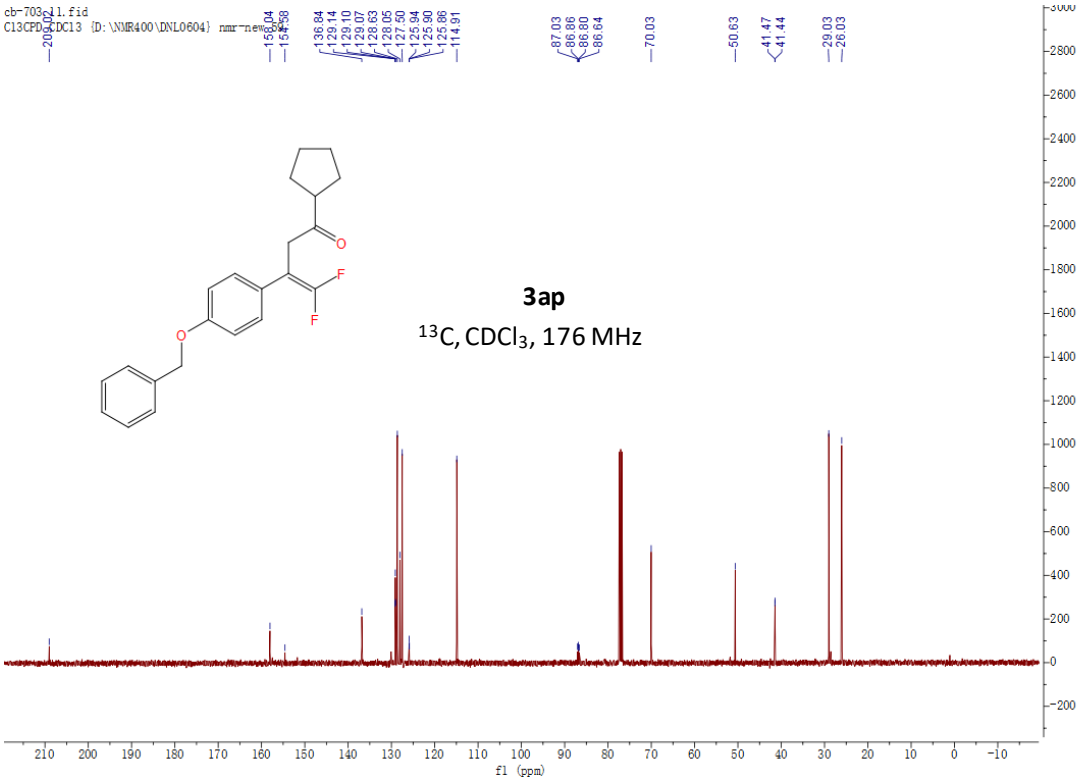
3ao

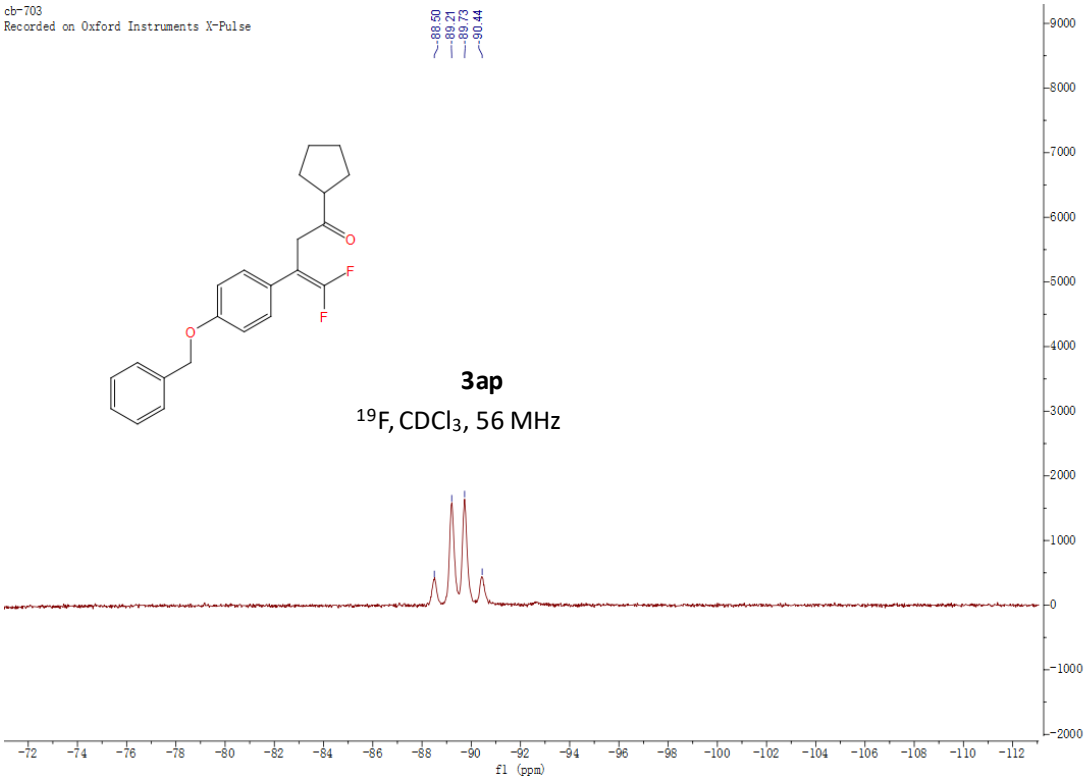
^{19}F, $CDCl_3$, 56 MHz

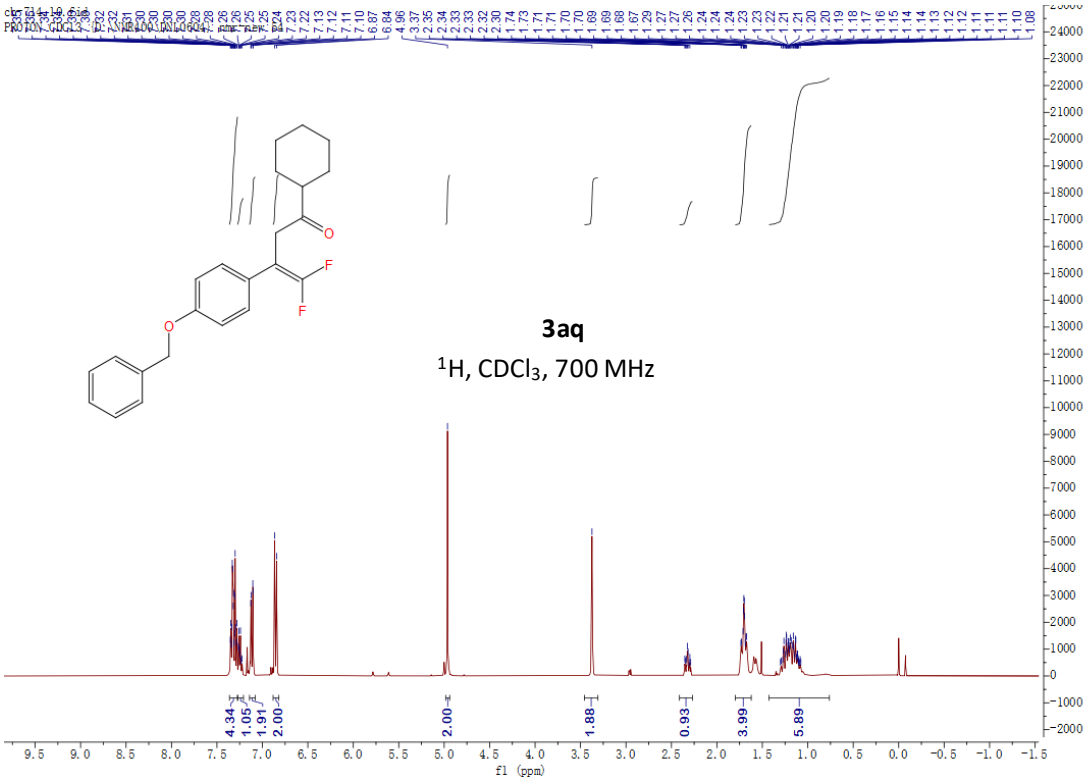


3ap

^{1}H, $CDCl_3$, 700 MHz

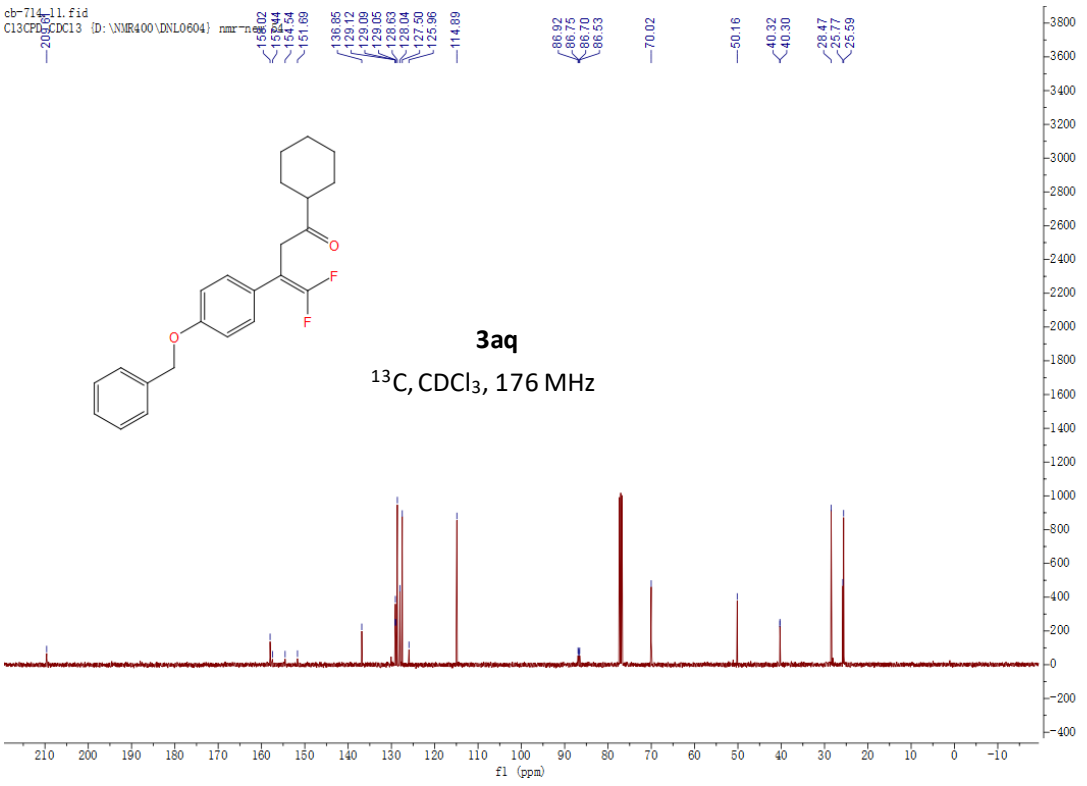

cb-703-2-1.fid
C13CPDDC13 (D:\NMR400\DNL0604) nmr-new
156.04
154.58
136.84
129.14
129.10
129.07
128.63
128.05
127.50
125.94
125.90
125.86
114.91
87.03
86.86
86.80
86.64
70.03
50.63
41.47
41.44
29.03
26.03
O
F
F
O
3ap
^{13}C, $CDCl_3$, 176 MHz
f1 (ppm)


cb-703
Recorded on Oxford Instruments X-Pulse
-88.50
-89.21
-89.73
-90.44
O
F
F
O
3ap
^{19}F, $CDCl_3$, 56 MHz
f1 (ppm)



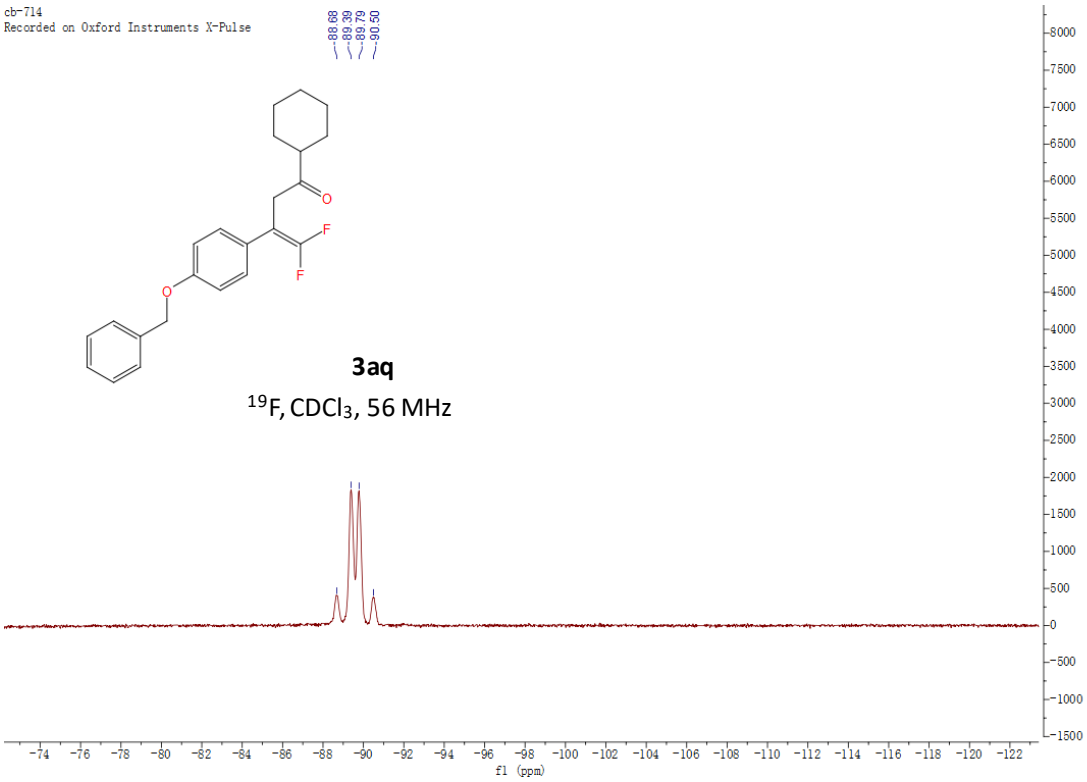
3aq

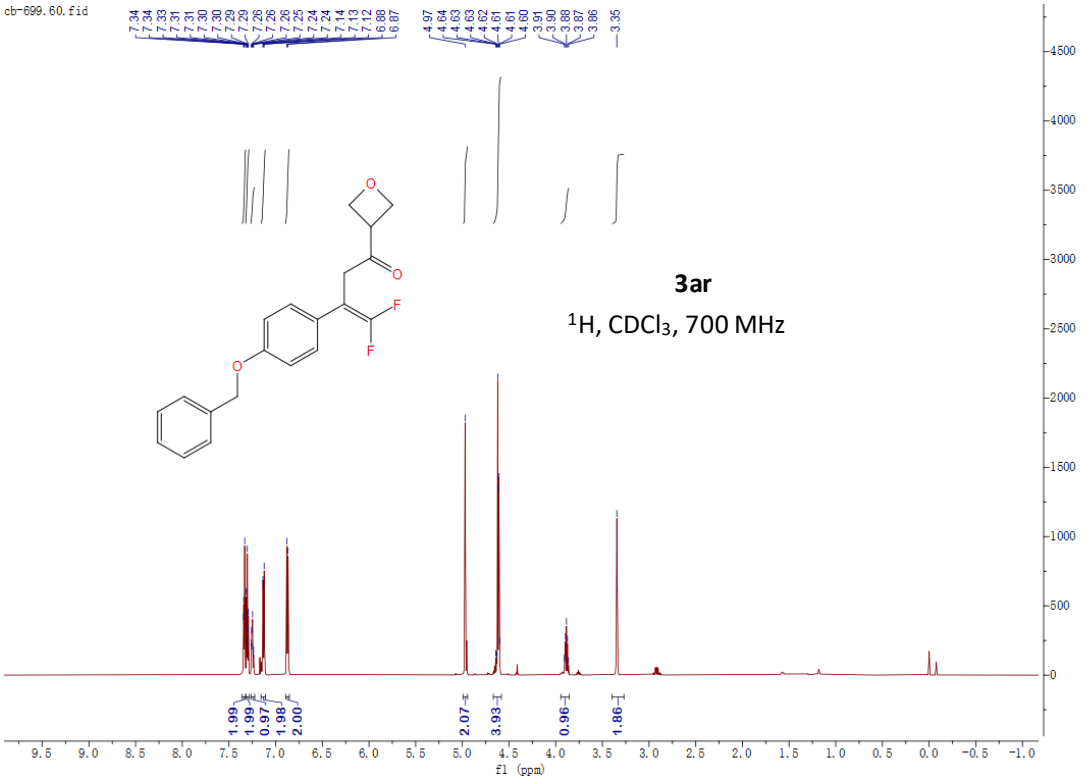
^{1}H, $CDCl_3$, 700 MHz

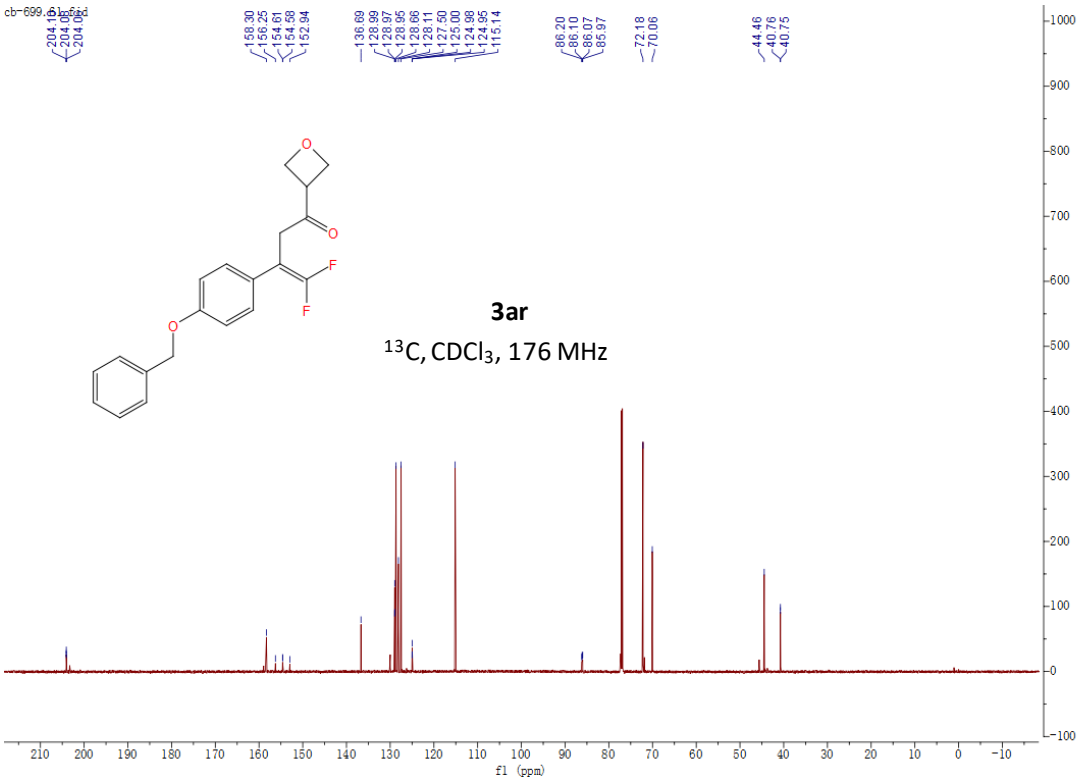


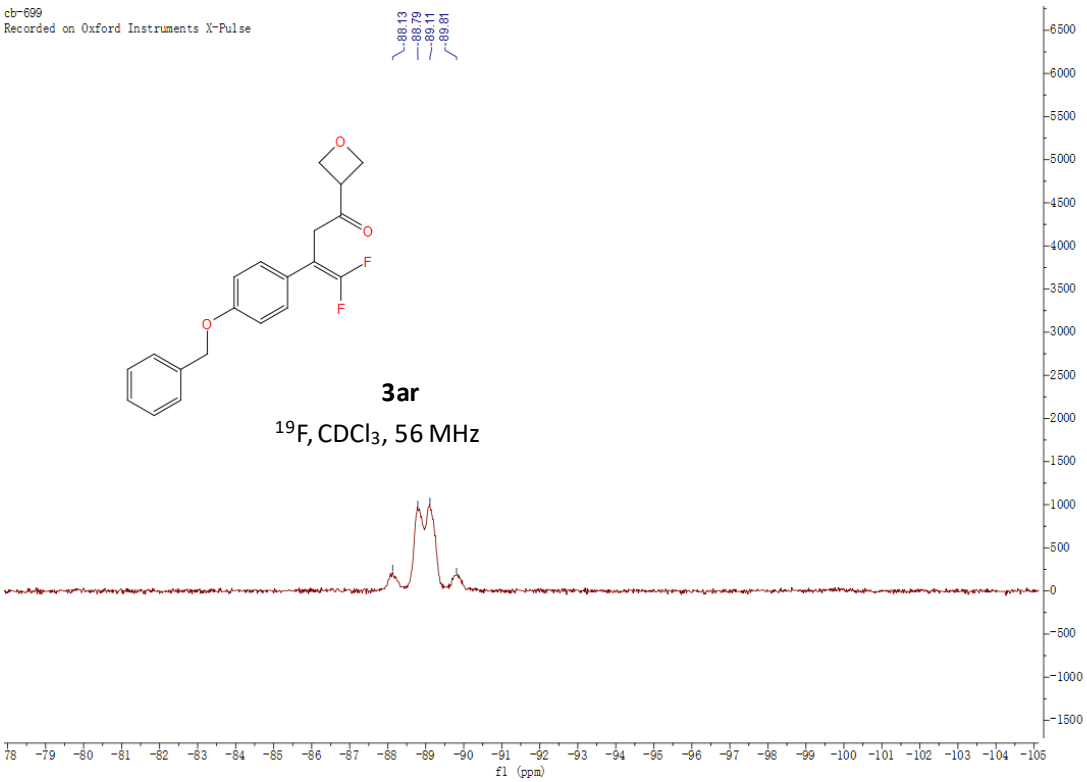
3aq

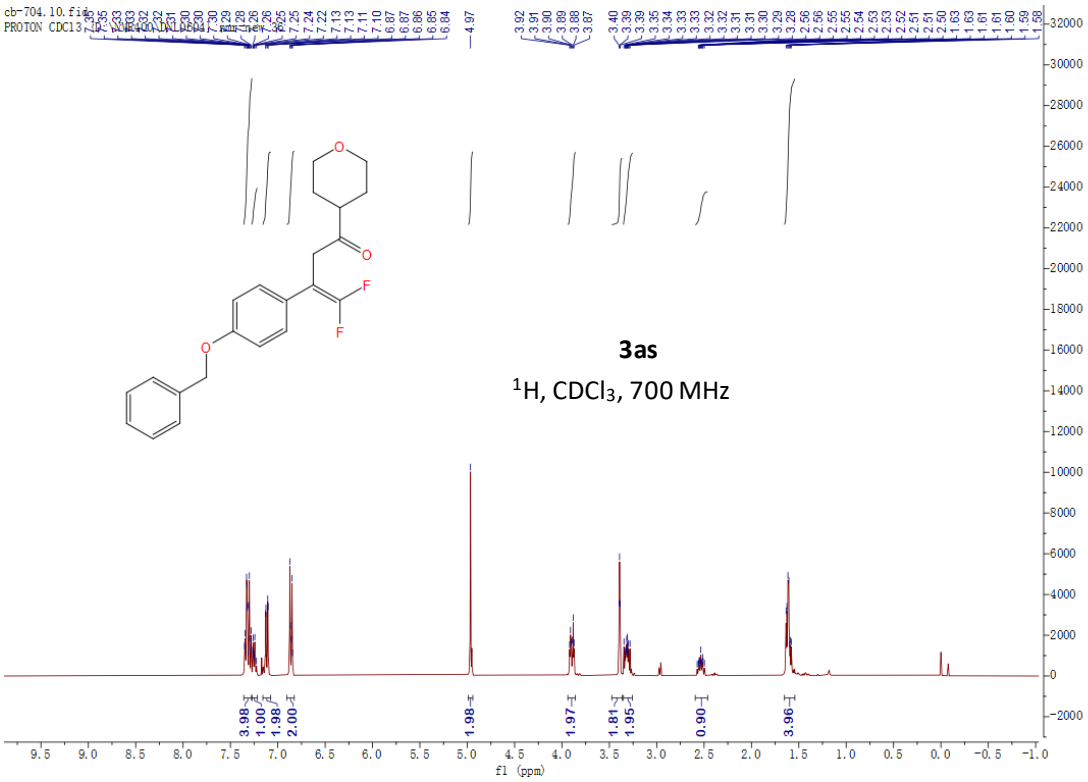
^{13}C, $CDCl_3$, 176 MHz

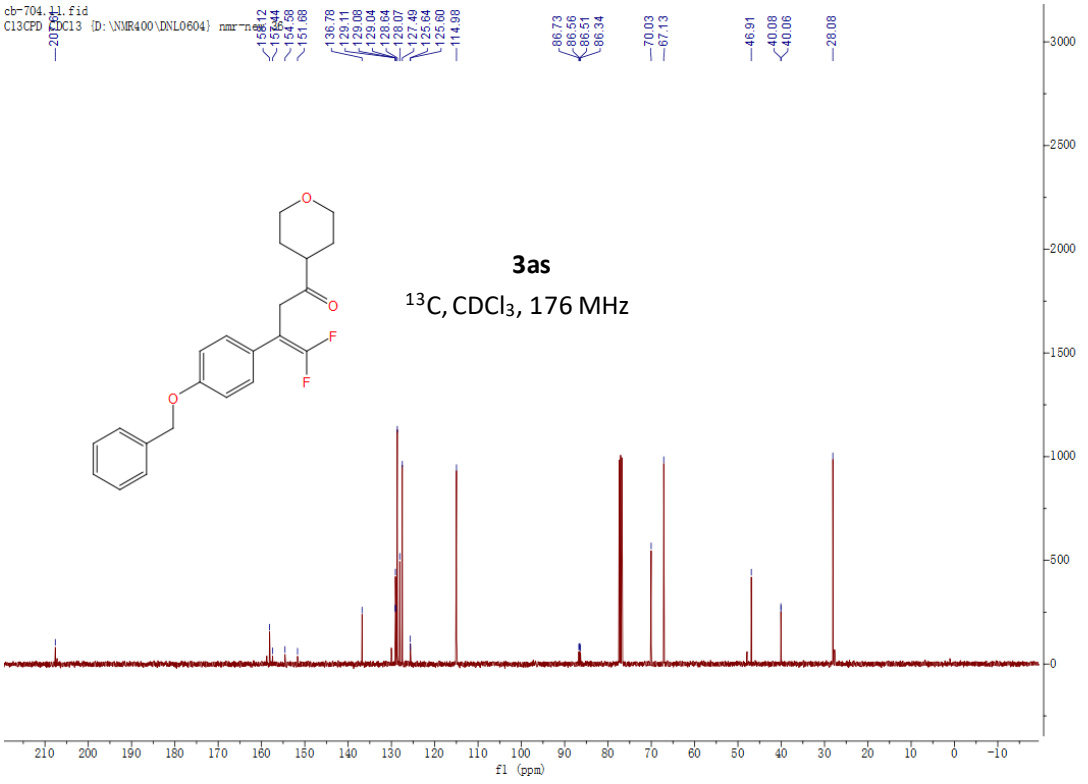

cb-714
Recorded on Oxford Instruments X-Pulse
-88.68
-89.39
-89.79
-90.50
O
F
F
O
3aq
19F, CDCl3, 56 MHz
f1 (ppm)

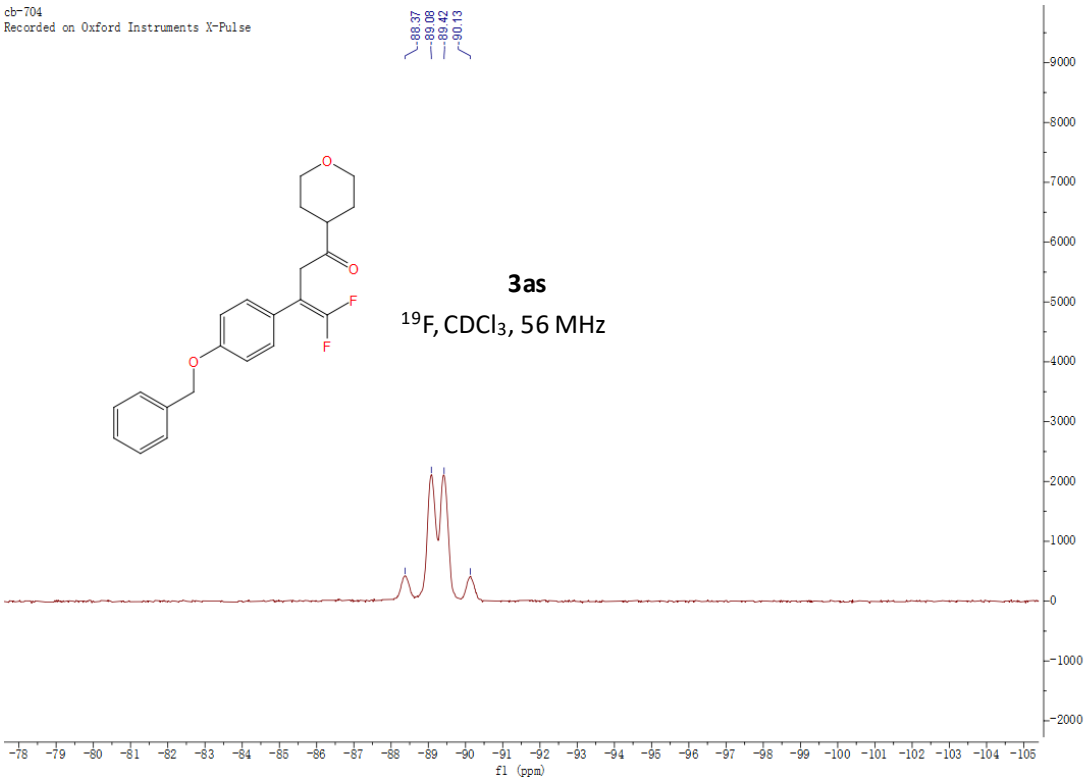

cb-699.60.fid
7.34
7.34
7.33
7.31
7.31
7.30
7.30
7.29
7.29
7.26
7.26
7.26
7.25
7.24
7.24
7.14
7.13
7.12
6.88
6.87
4.97
4.64
4.63
4.63
4.62
4.61
4.61
4.60
3.91
3.90
3.88
3.87
3.86
3.35
O
O
F
F
O
3ar
1H, CDCl3, 700 MHz
1.99
1.99
0.97
1.98
2.00
2.07
3.93
0.96
1.86
f1 (ppm)

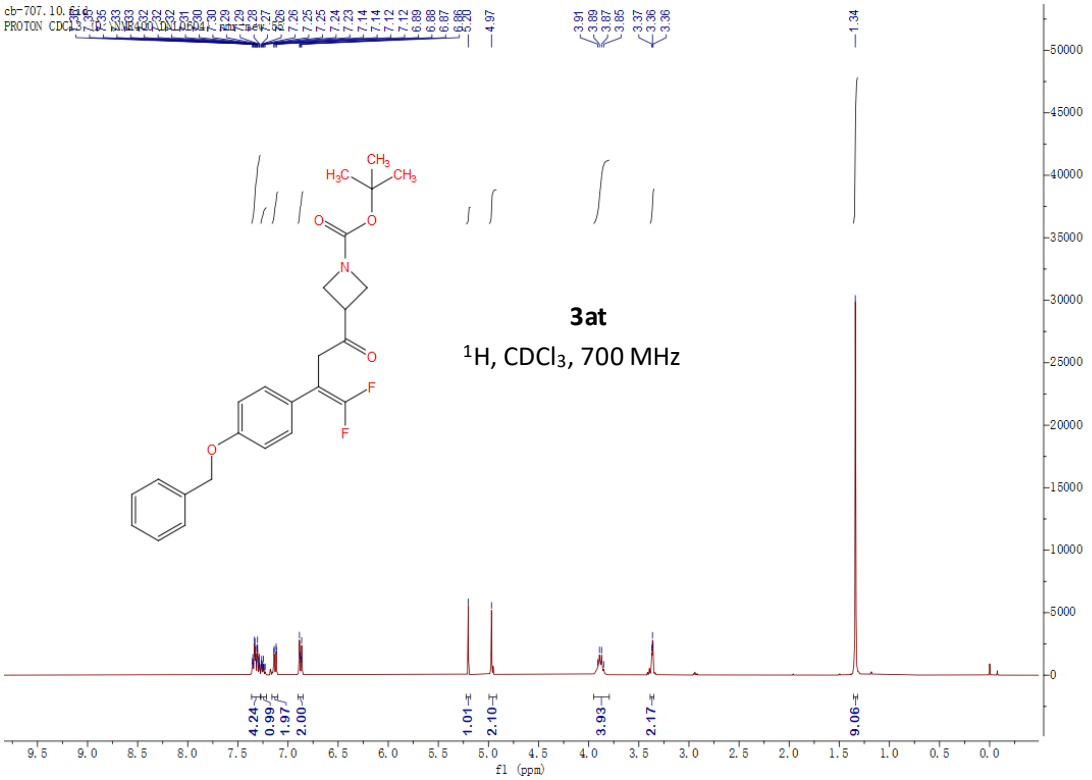

cb-699.6.1.ks.fid
204.16
204.05
204.00
158.30
156.25
154.61
154.58
152.94
136.69
128.99
128.97
128.95
128.66
128.11
127.50
125.00
124.98
124.95
115.14
86.20
86.10
86.07
85.97
72.18
70.06
44.46
40.78
40.75
O
O
F
F
O
3ar
13C, CDCl3, 176 MHz
f1 (ppm)

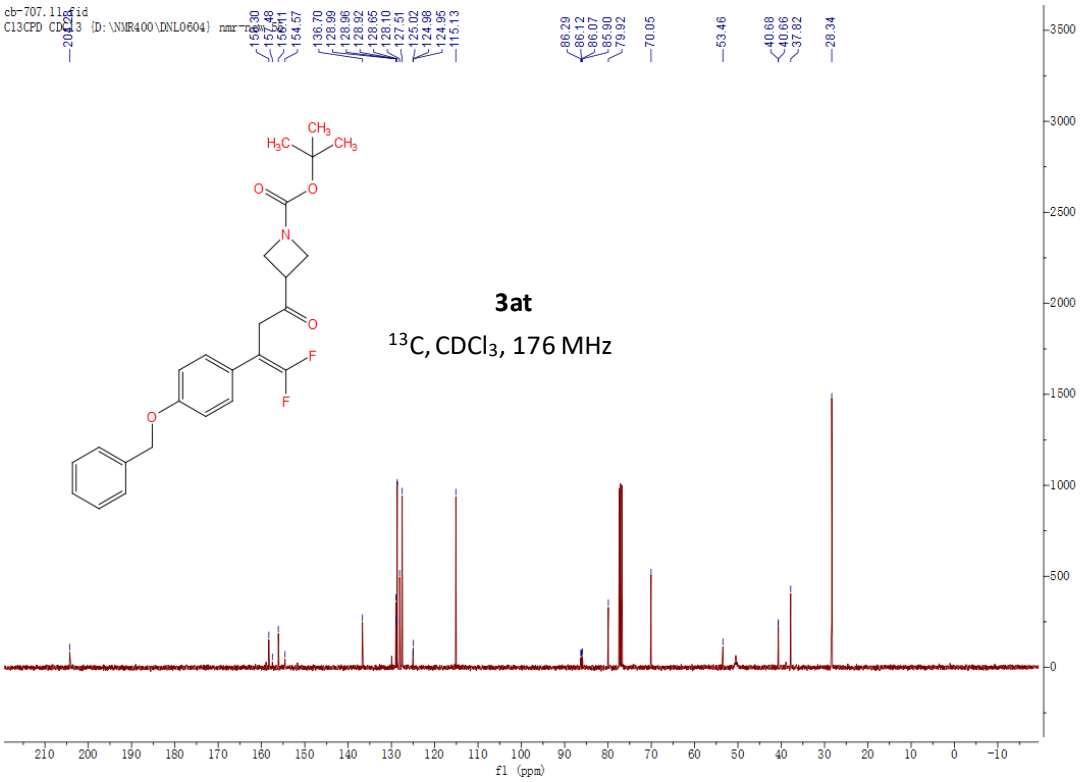

cb-699
Recorded on Oxford Instruments X-Pulse
88.13
88.79
89.11
89.81
O
O
F
F
O
3ar
19F, CDCl3, 56 MHz
f1 (ppm)

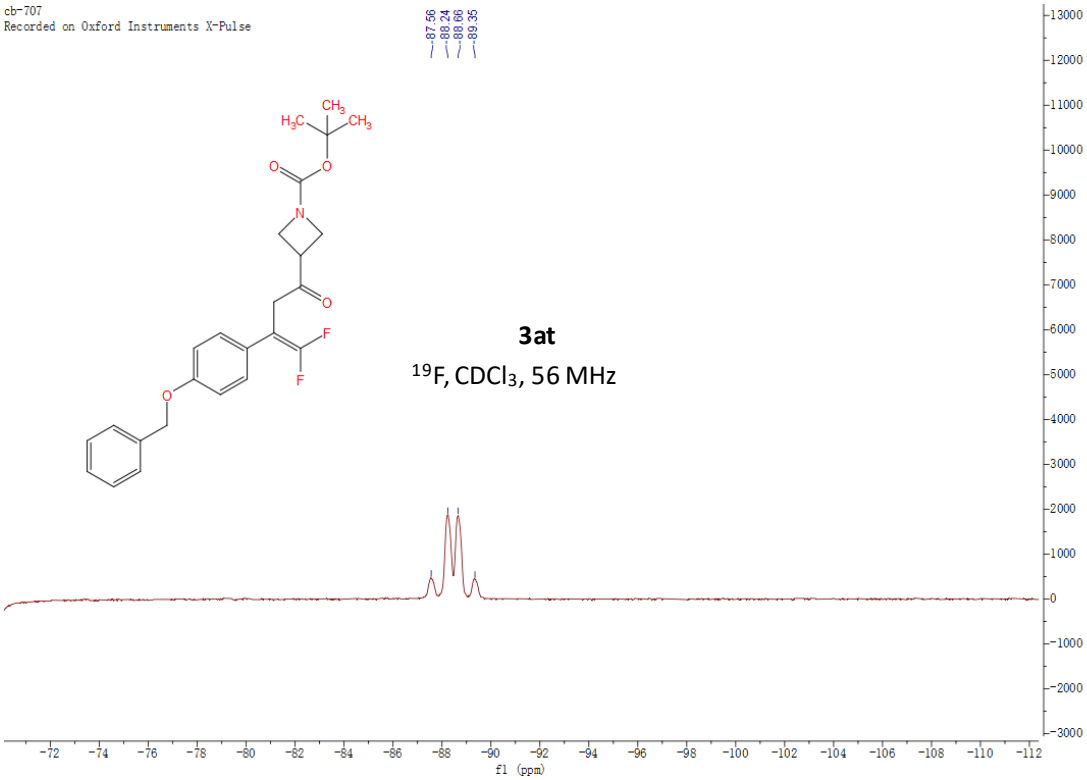

cb-704.10.fid
PROTON CDCl3
O
O
F
F
O
3as
1H, CDCl3, 700 MHz
3.98
1.00
1.98
2.00
1.98
1.97
1.81
1.95
0.90
3.96
f1 (ppm)

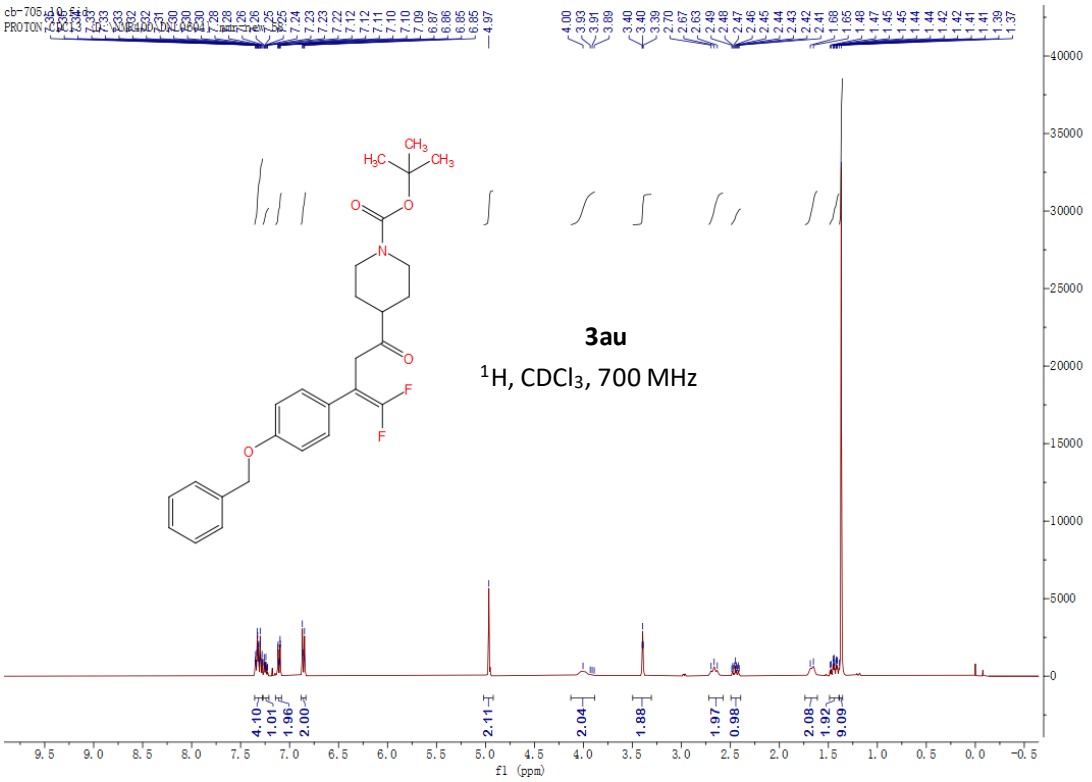

cb-704.11.fid
C13CPD CDCl3
O
O
F
F
O
3as
13C, CDCl3, 176 MHz
f1 (ppm)

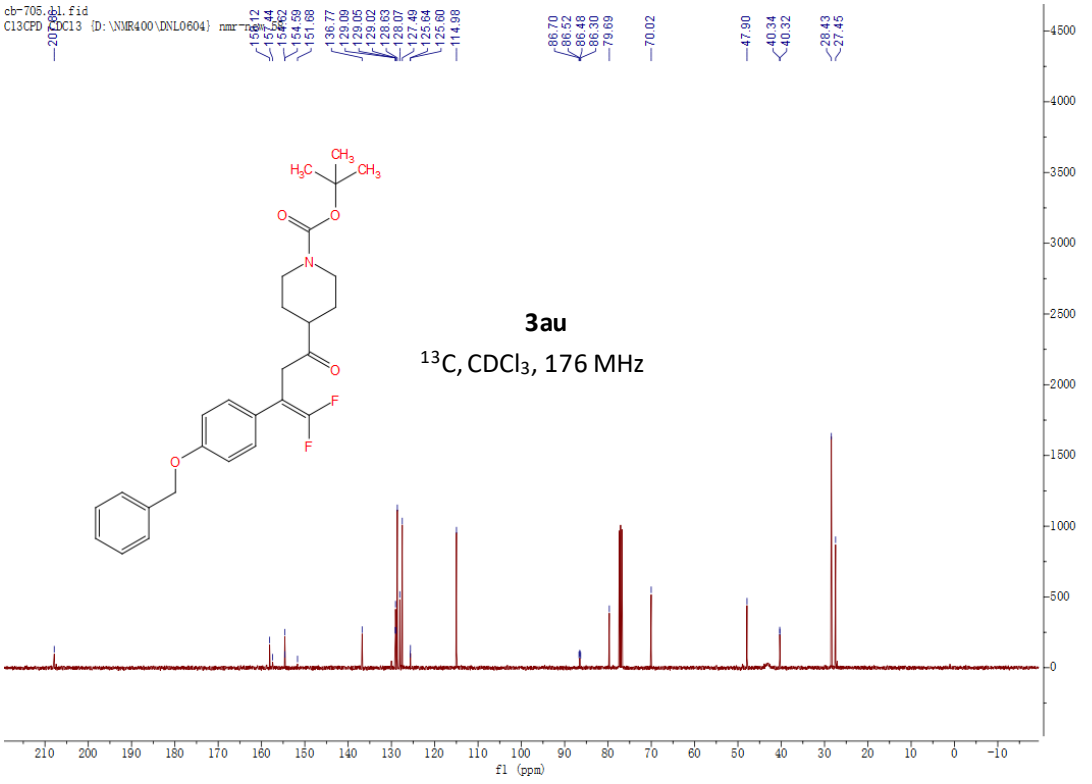

cb-704
Recorded on Oxford Instruments X-Pulse
88.37
89.08
89.42
90.13
3as
19F, CDCl3, 56 MHz
f1 (ppm)

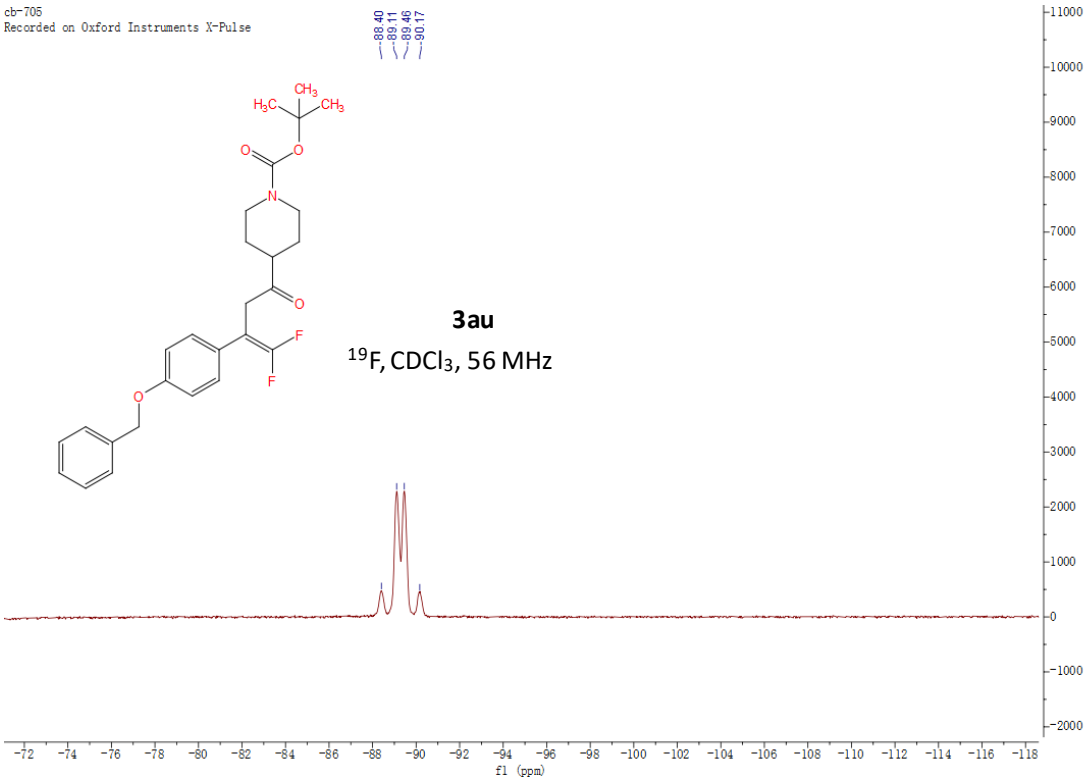

4.97
3.91
3.89
3.87
3.85
3.37
3.36
3.36
1.34
3at
1H, CDCl3, 700 MHz
4.24
0.99
1.97
2.00
1.01
2.10
3.93
2.17
9.06
f1 (ppm)

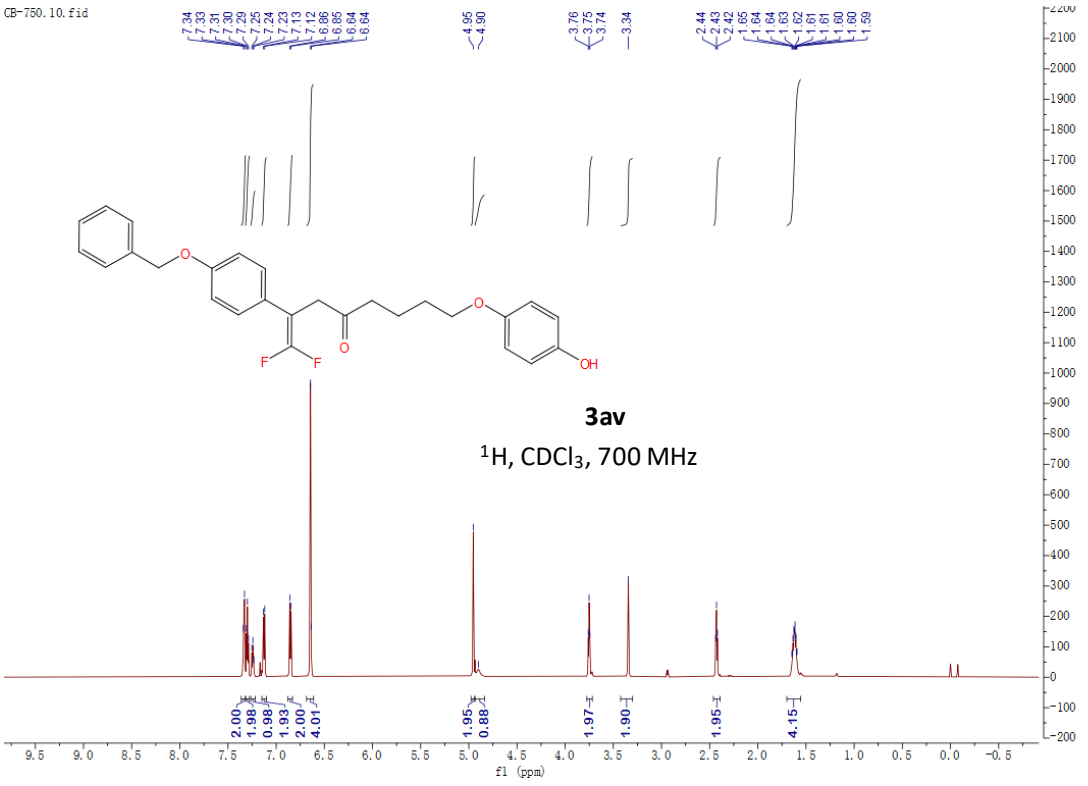

cb-707.11.fid
C13CPD CDCl3 (D:\NMR400\DNL0604) nmr
20.22
156.30
154.48
154.11
154.57
136.70
128.99
128.96
128.92
128.65
128.10
127.51
125.02
124.98
124.95
115.13
86.29
86.12
86.07
85.90
79.92
70.05
53.46
40.68
40.66
37.82
28.34
3at
13C, CDCl3, 176 MHz
f1 (ppm)

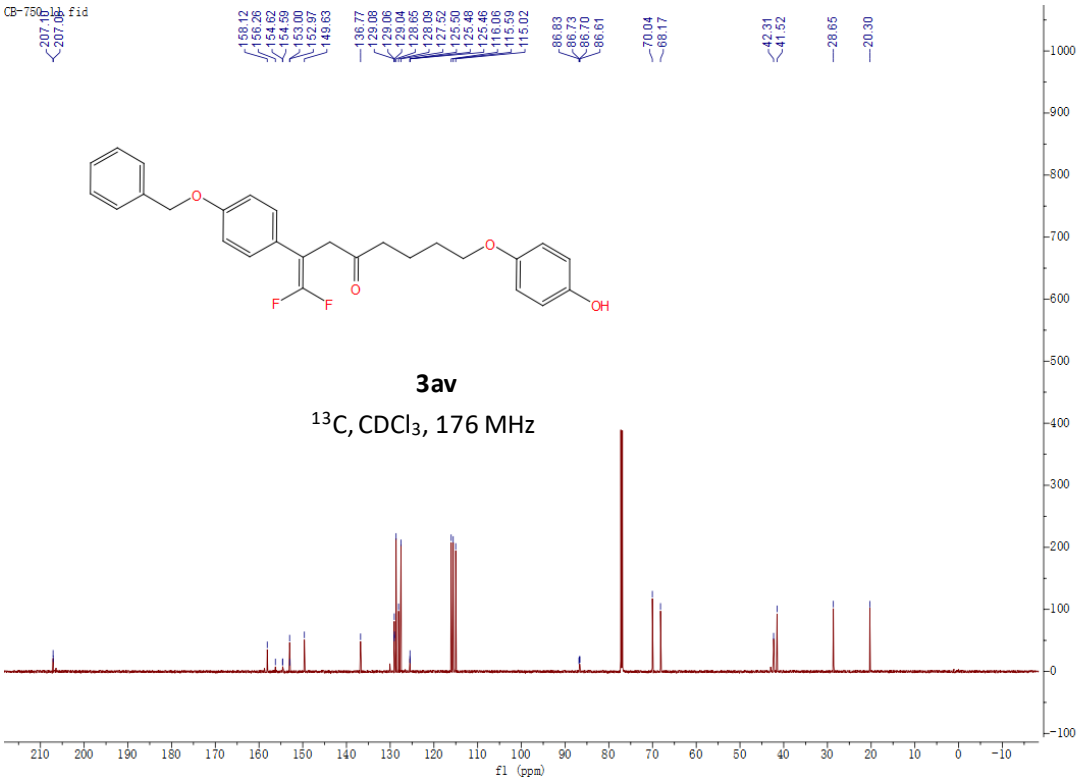

cb-707
Recorded on Oxford Instruments X-Pulse
87.56
88.24
88.66
89.35
3at
19F, CDCl3, 56 MHz
f1 (ppm)


3au
^{1}H, CDCl$_3$, 700 MHz
f1 (ppm)


3au
^{13}C, CDCl$_3$, 176 MHz
f1 (ppm)

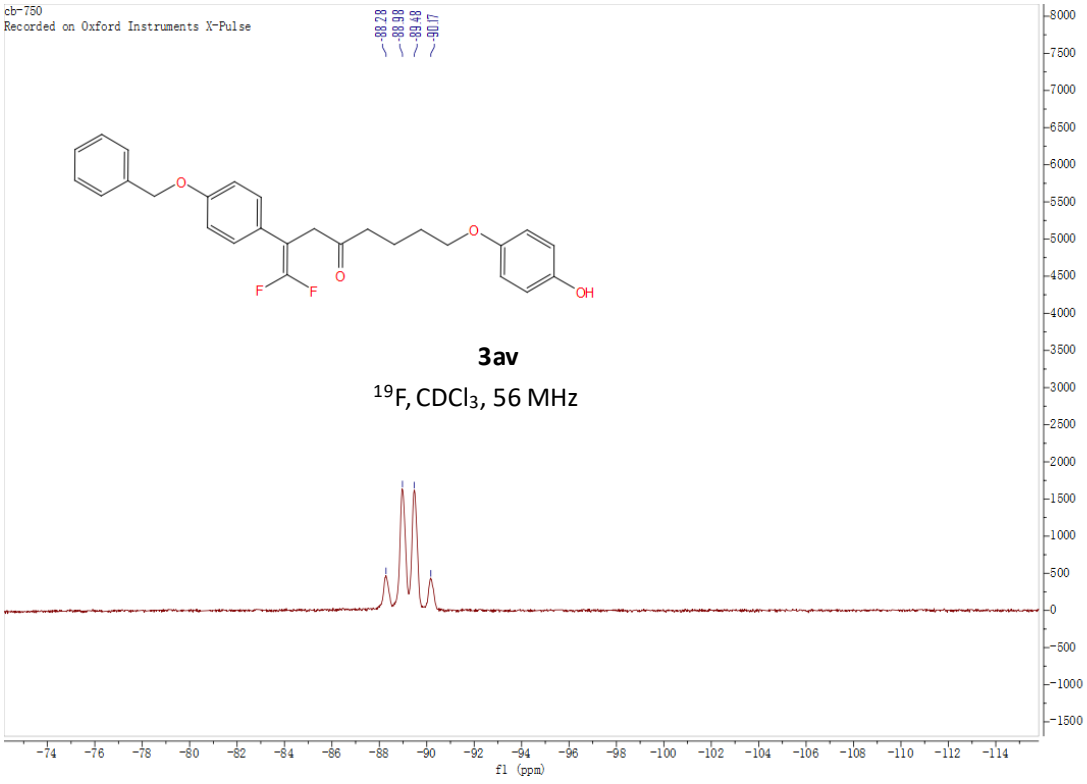

cb-705
Recorded on Oxford Instruments X-Pulse
-88.40
-89.11
-89.46
-90.17
3au
19F, CDCl3, 56 MHz
f1 (ppm)


CB-750.10.fid
7.34
7.33
7.31
7.30
7.29
7.25
7.24
7.23
7.13
7.12
6.86
6.85
6.64
6.64
4.95
4.90
3.76
3.75
3.74
3.34
2.44
2.43
2.42
2.05
1.64
1.64
1.63
1.62
1.61
1.61
1.60
1.60
1.59
OH
3av
1H, CDCl3, 700 MHz
2.00
1.98
0.98
1.93
2.00
4.01
1.95
0.88
1.97
1.90
1.95
4.15
f1 (ppm)



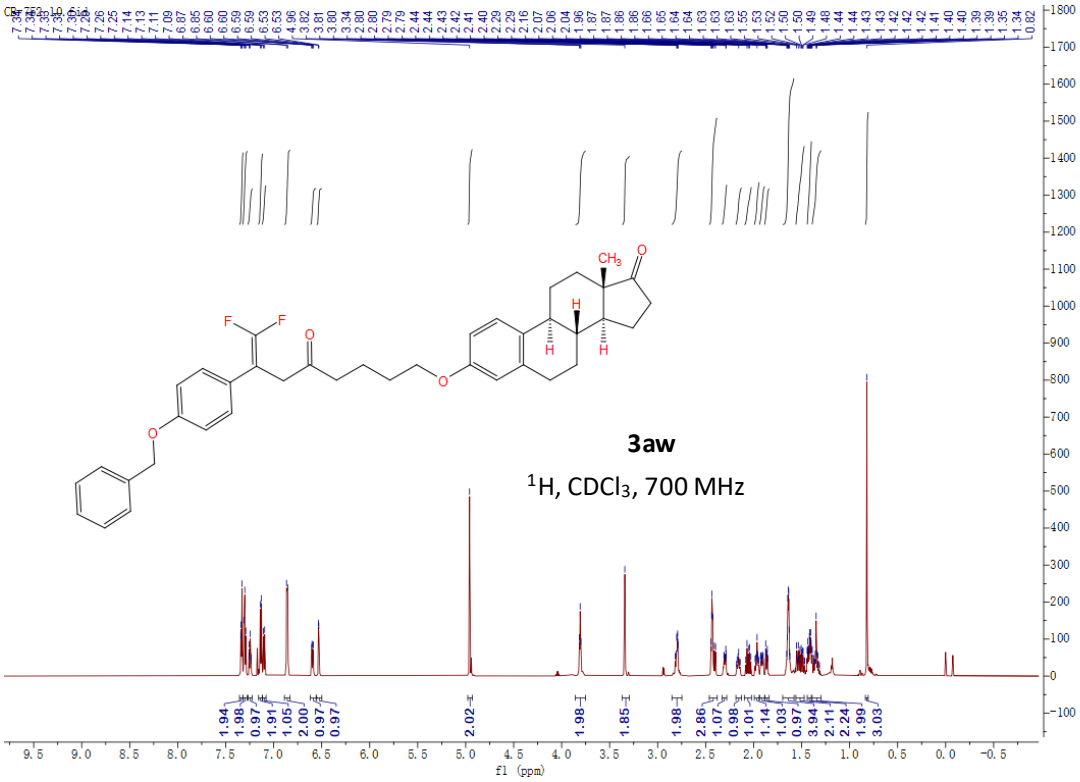
3av

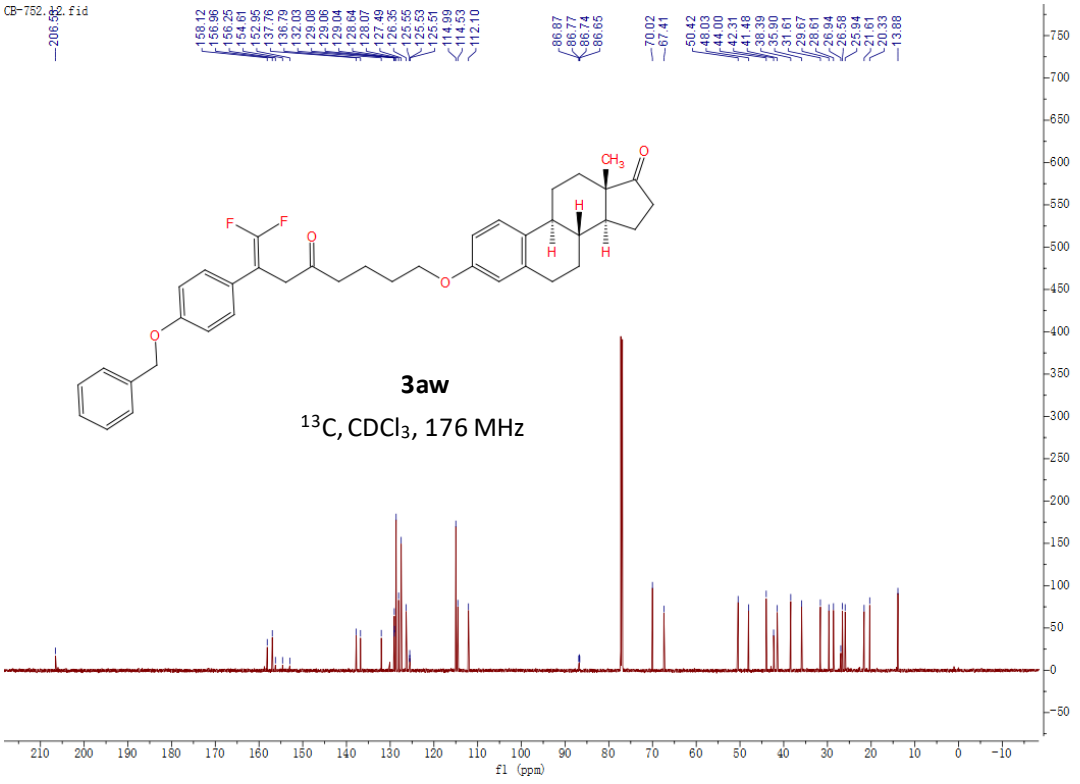
^{13}C, $CDCl_3$, 176 MHz

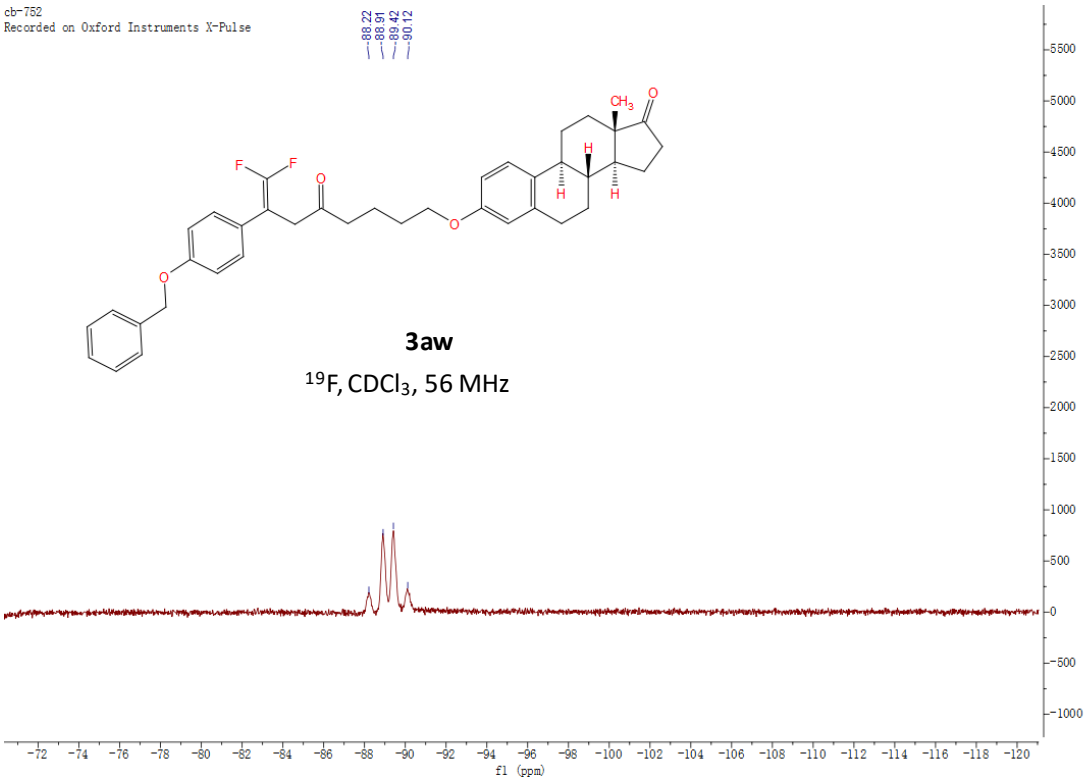


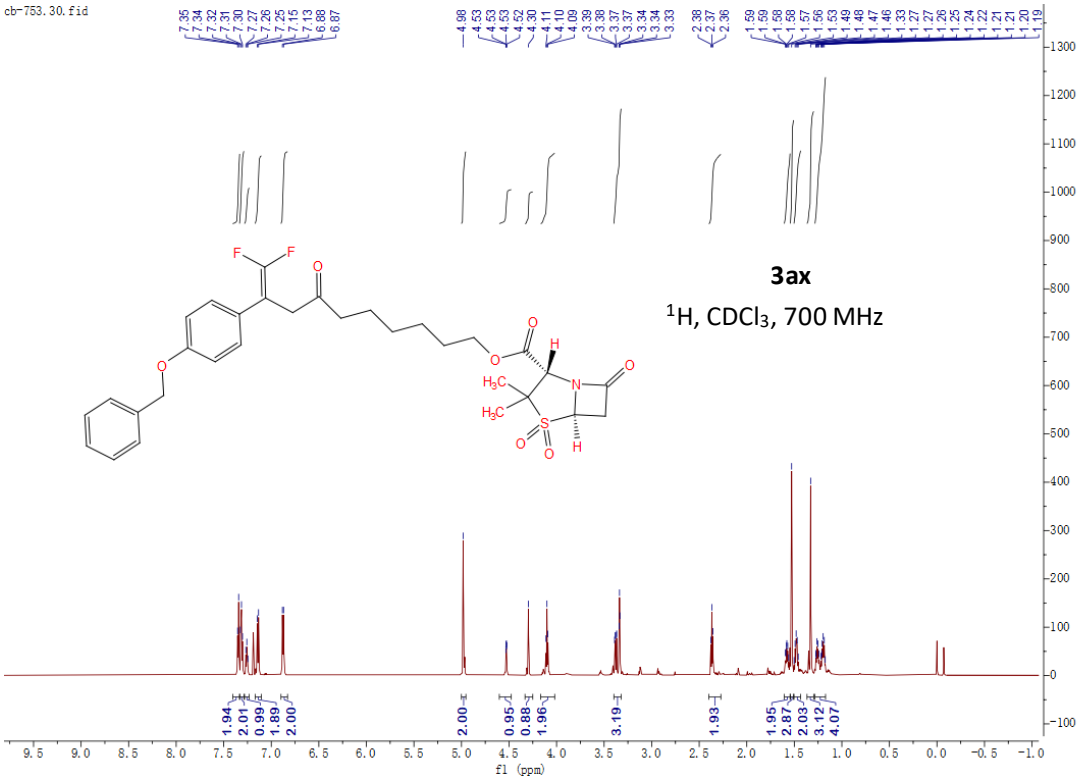
3av

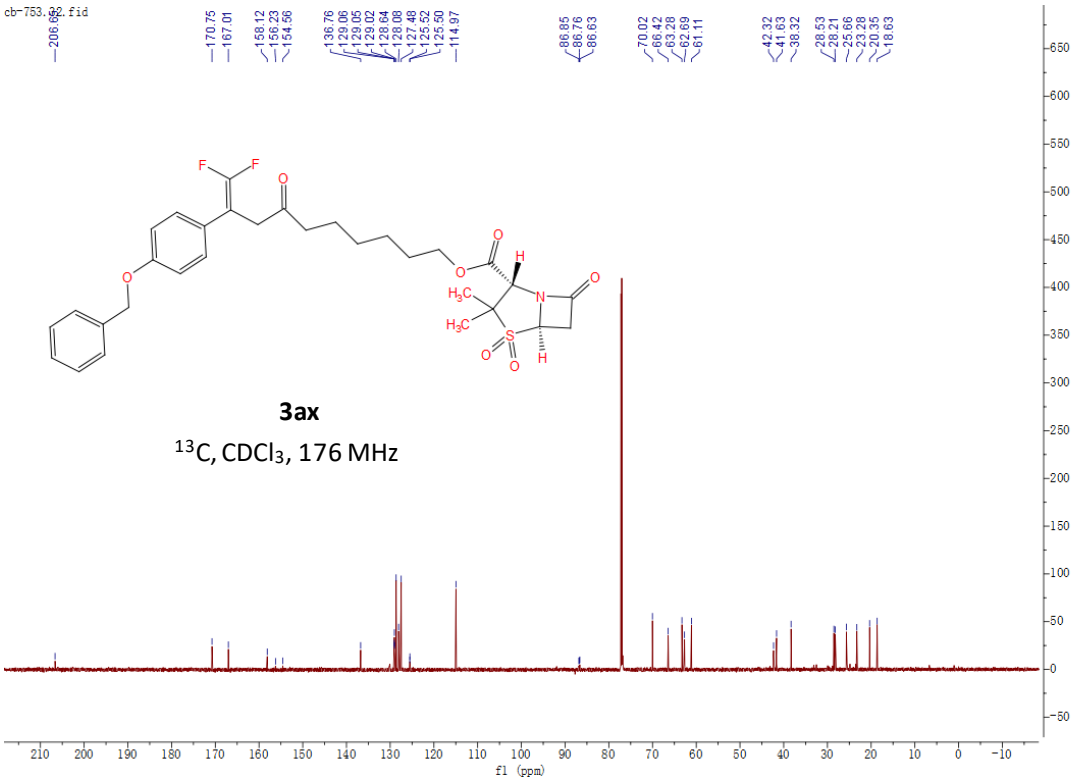
^{19}F, $CDCl_3$, 56 MHz


3aw
^{1}H, CDCl$_3$, 700 MHz
f1 (ppm)


3aw
^{13}C, CDCl$_3$, 176 MHz
f1 (ppm)

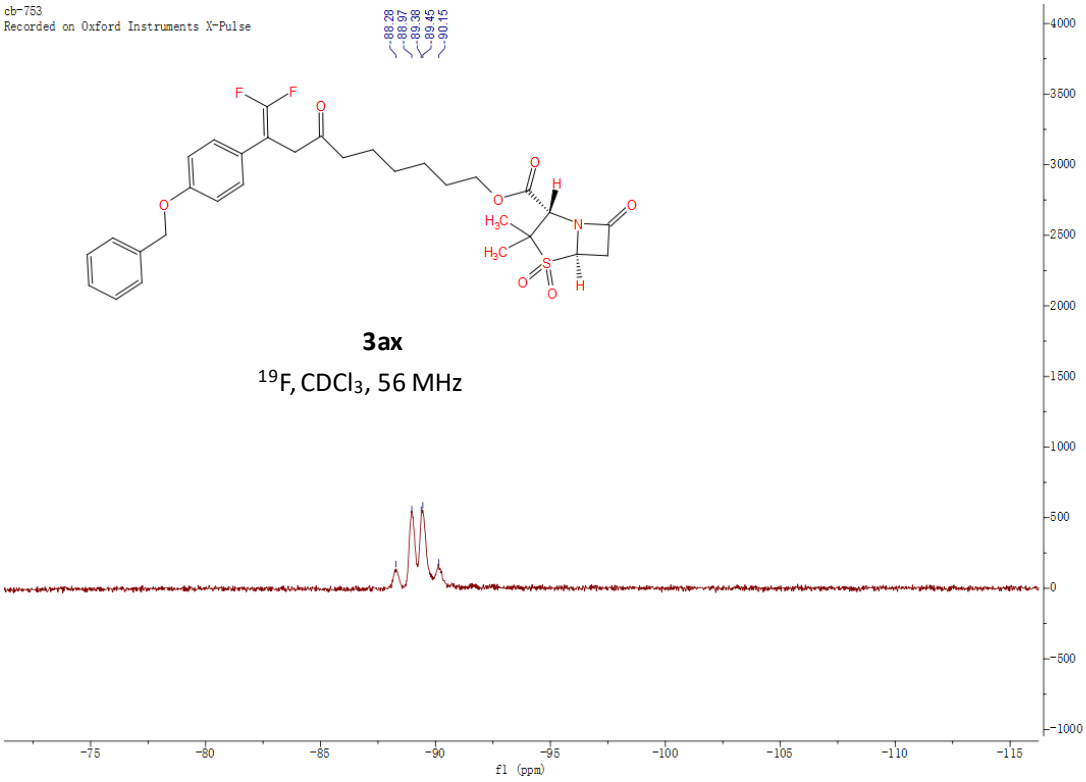

cb-752
Recorded on Oxford Instruments X-Pulse
-88.22
-88.91
-89.42
-90.12
F
F
O
O
O
CH3
O
H
H
H
3aw
19F, CDCl3, 56 MHz
fl (ppm)


cb-753.30.fid
F
F
O
O
O
O
H
H3C
H3C
N
O
S
O
O
H
3ax
1H, CDCl3, 700 MHz
1.94
2.01
0.99
1.89
2.00
2.00
0.95
0.88
1.96
3.19
1.93
1.95
2.87
2.03
3.12
4.07
fl (ppm)



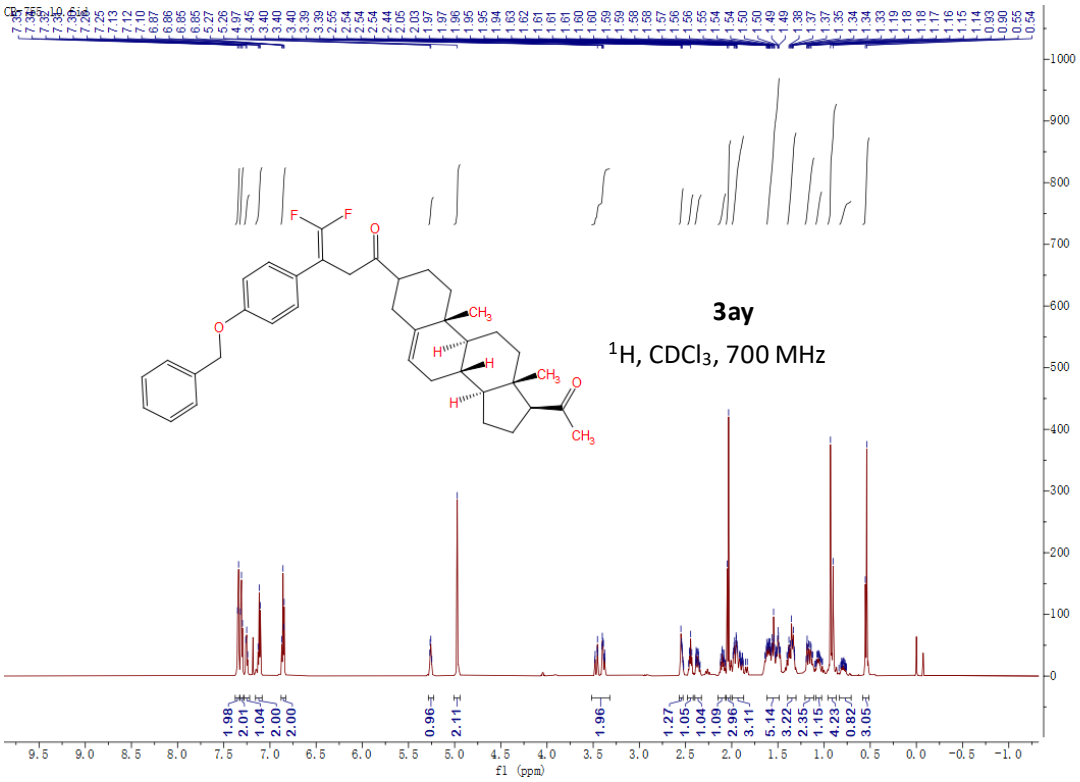
3ax

^{13}C, $CDCl_3$, 176 MHz



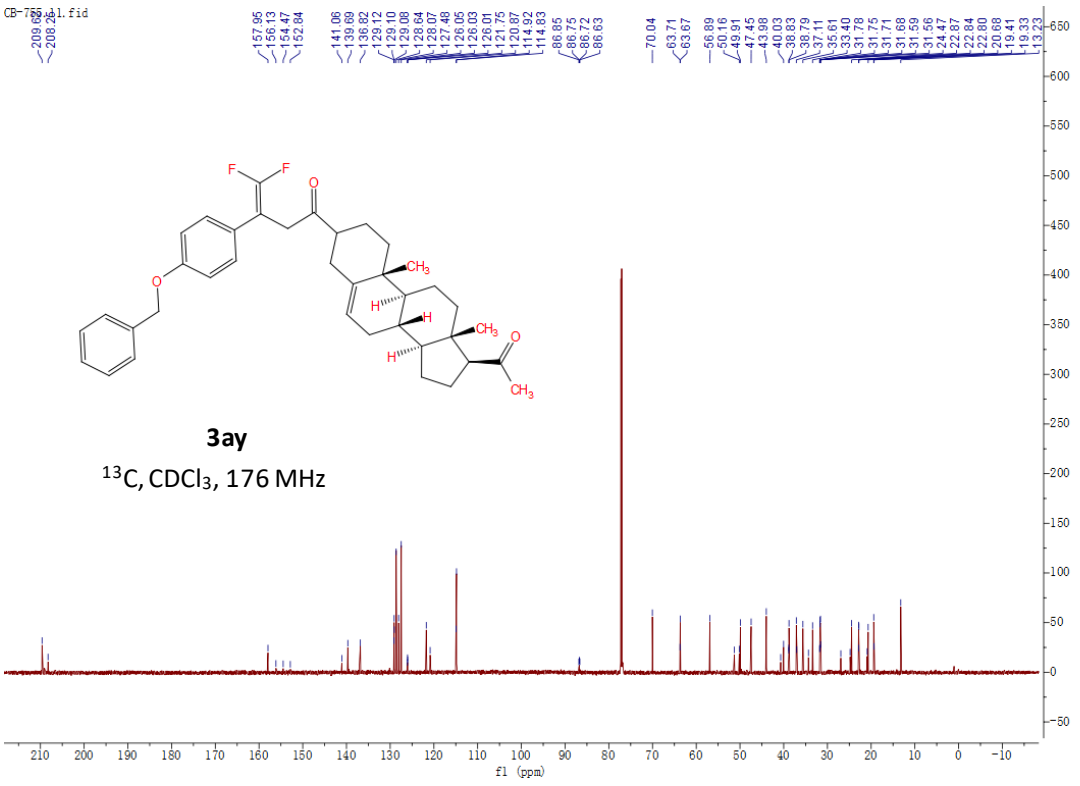
3ax

^{19}F, $CDCl_3$, 56 MHz



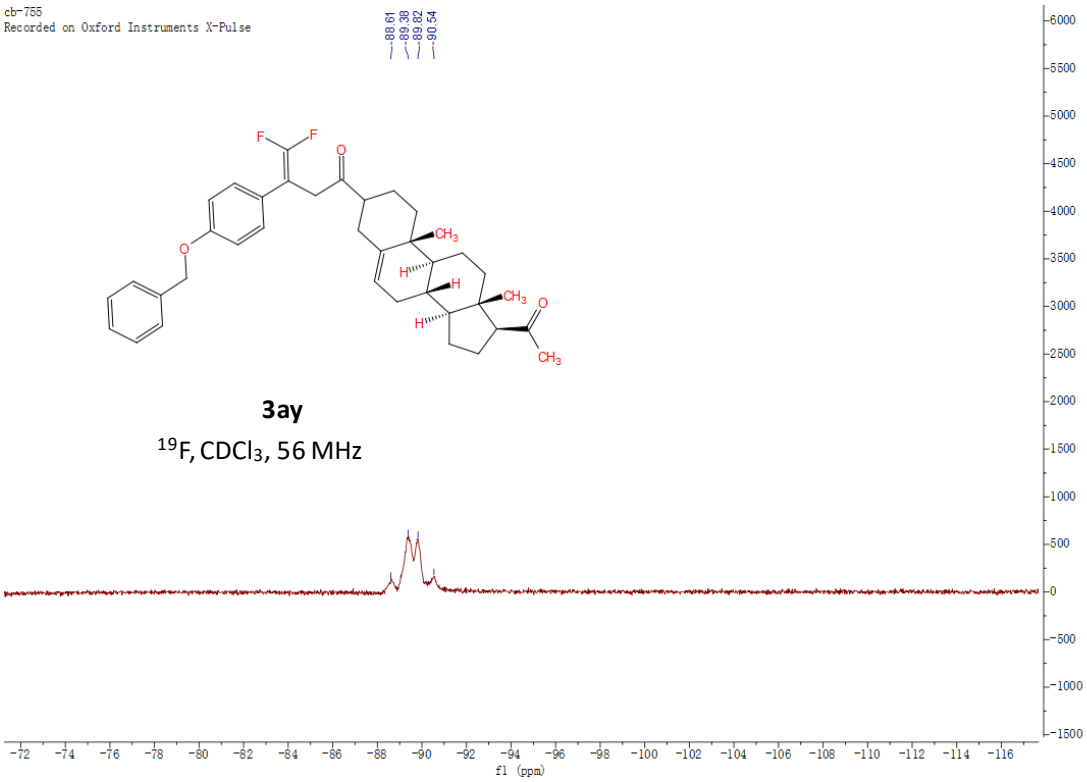
3ay

^{1}H, $CDCl_3$, 700 MHz



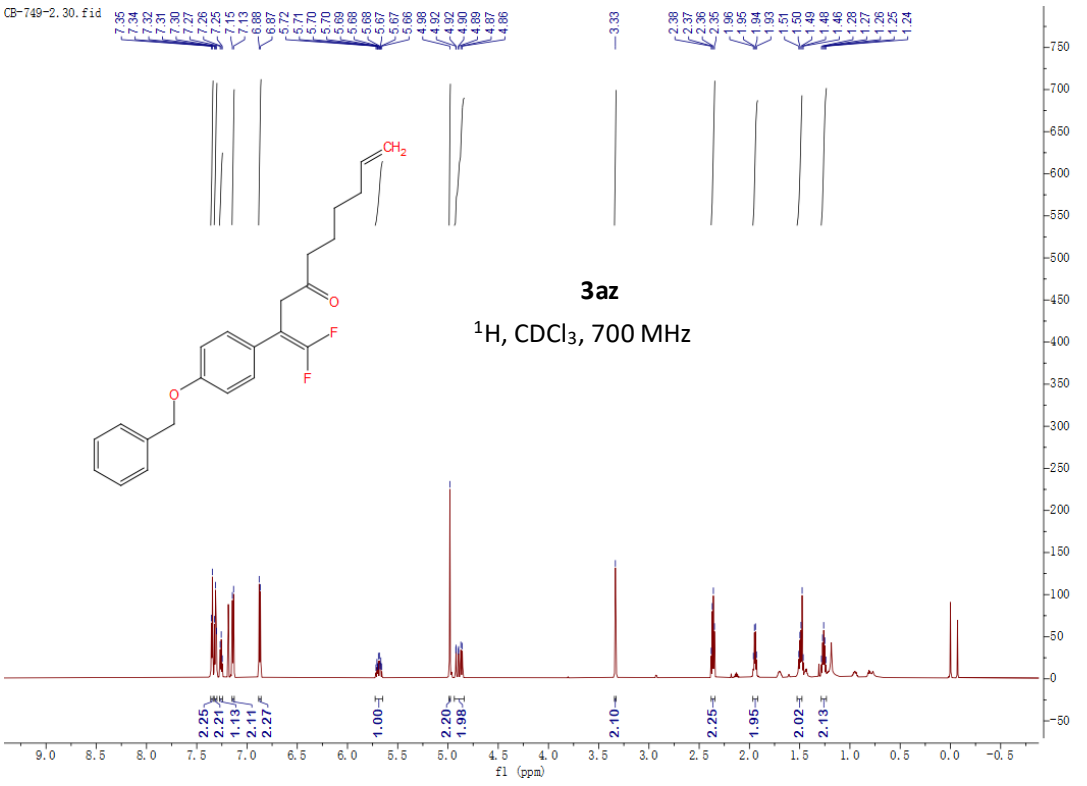
3ay

^{13}C, $CDCl_3$, 176 MHz



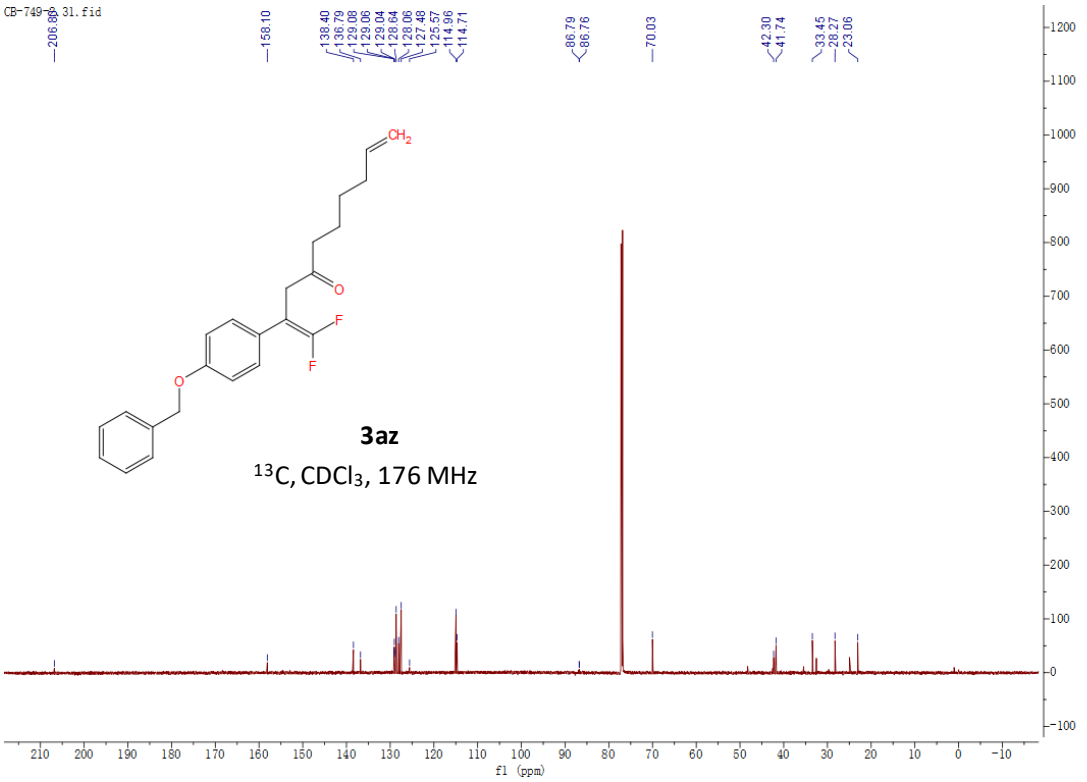
3ay

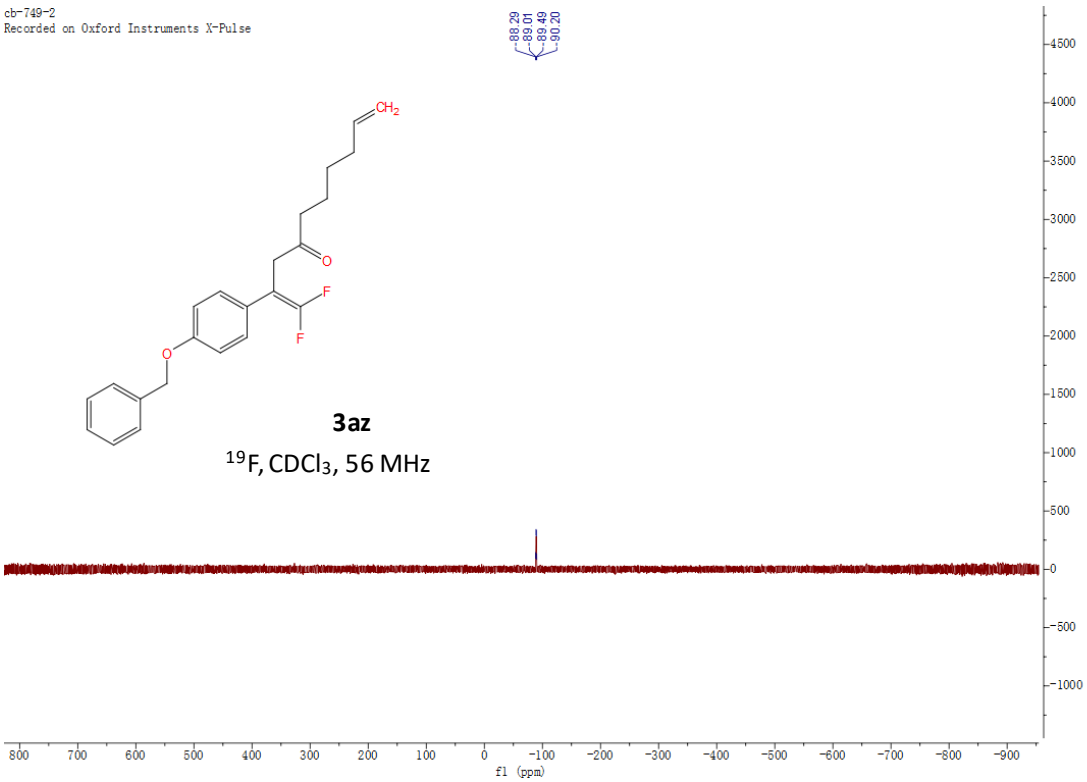
^{19}F, $CDCl_3$, 56 MHz

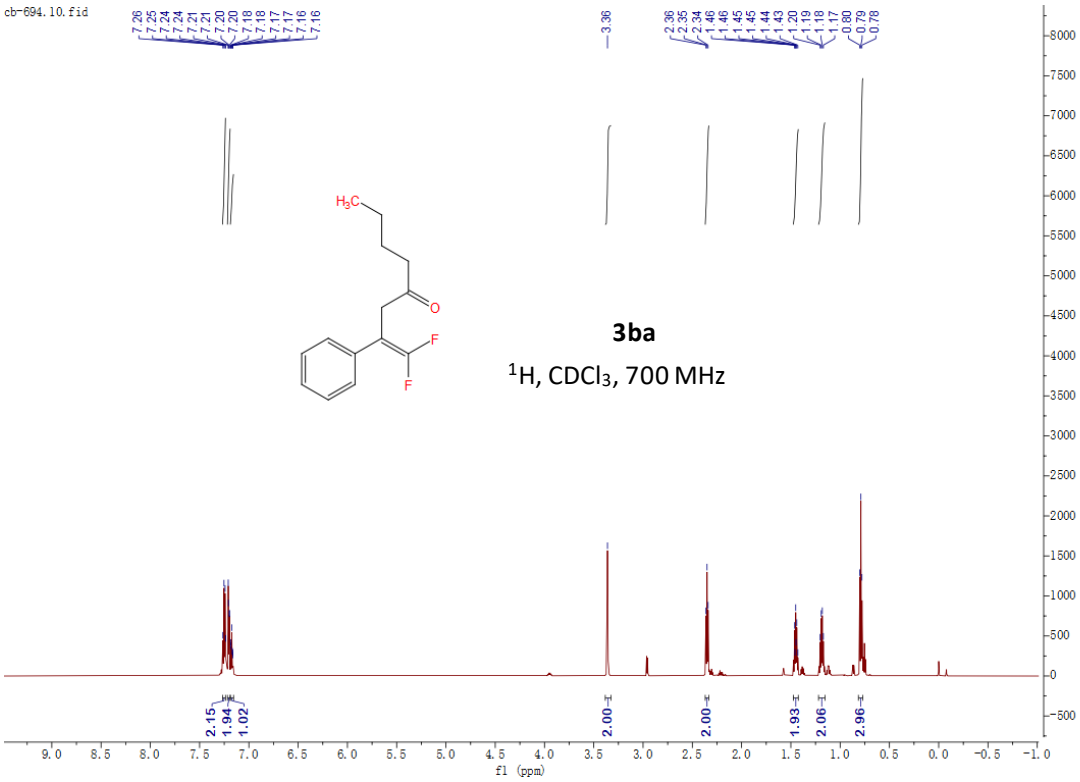


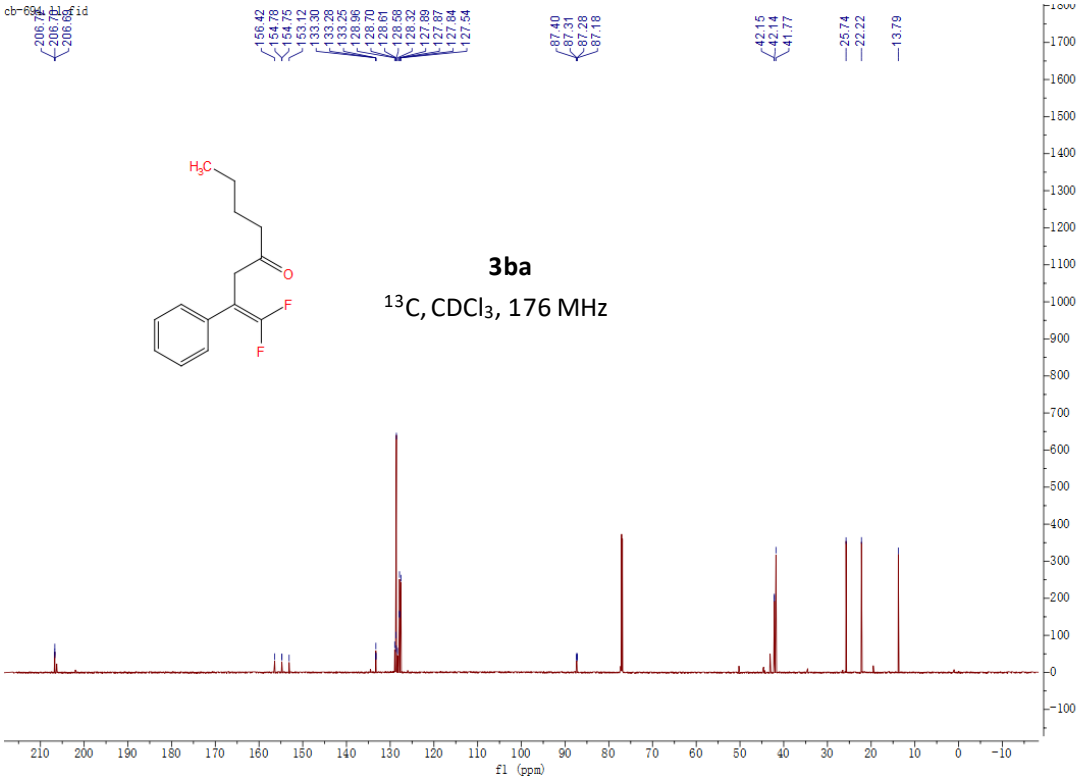
3az

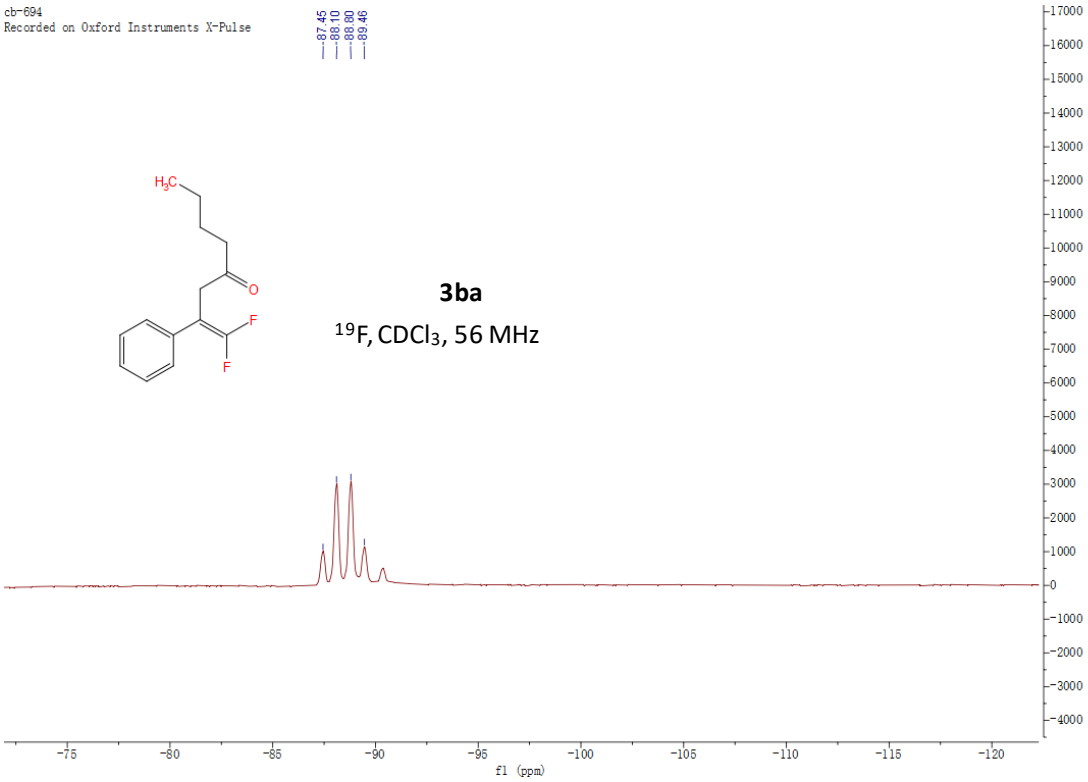
^{1}H, $CDCl_3$, 700 MHz


CB-749-3 31.fid
206.89
158.10
138.40
136.79
129.08
129.06
128.64
128.44
128.06
127.48
125.57
114.96
114.71
86.79
86.76
70.03
42.30
41.74
33.45
28.27
23.06
CH2
O
F
F
O
3az
13C, CDCl3, 176 MHz
f1 (ppm)


cb-749-2
Recorded on Oxford Instruments X-Pulse
88.29
89.01
89.49
90.20
CH2
O
F
F
O
3az
19F, CDCl3, 56 MHz
f1 (ppm)

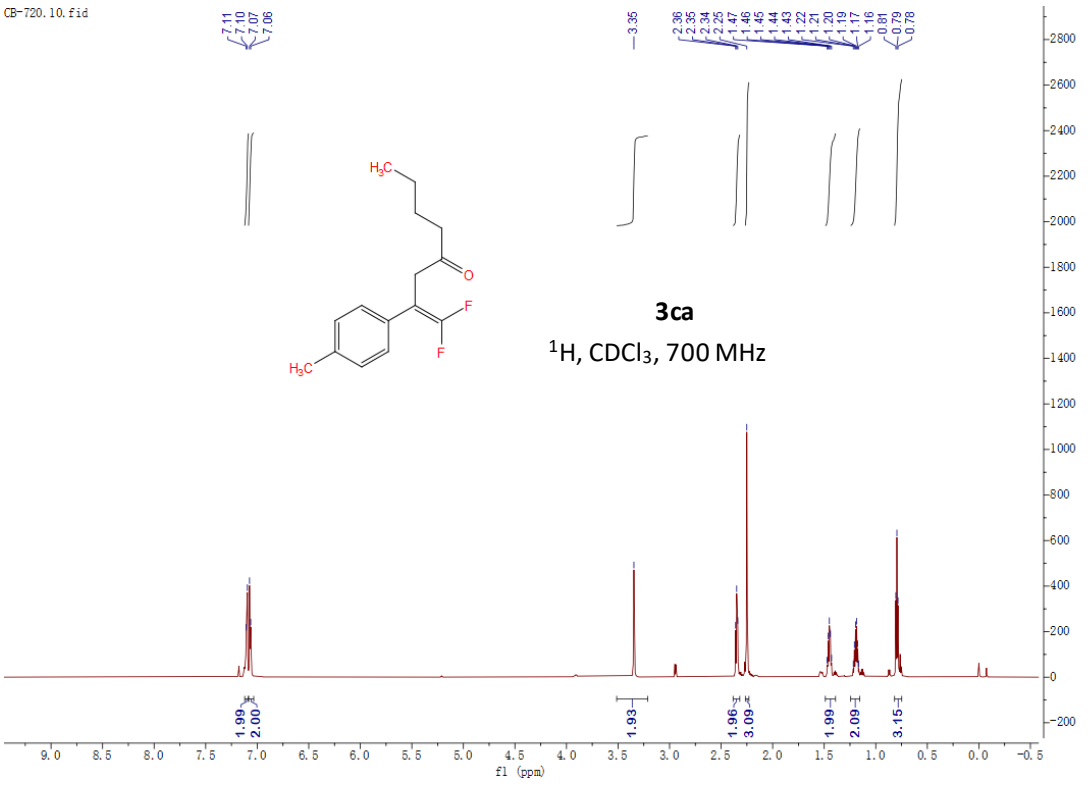

cb-694.10.fid
H3C
O
F
F
3ba
1H, CDCl3, 700 MHz
f1 (ppm)


H3C
O
F
F
3ba
13C, CDCl3, 176 MHz
f1 (ppm)



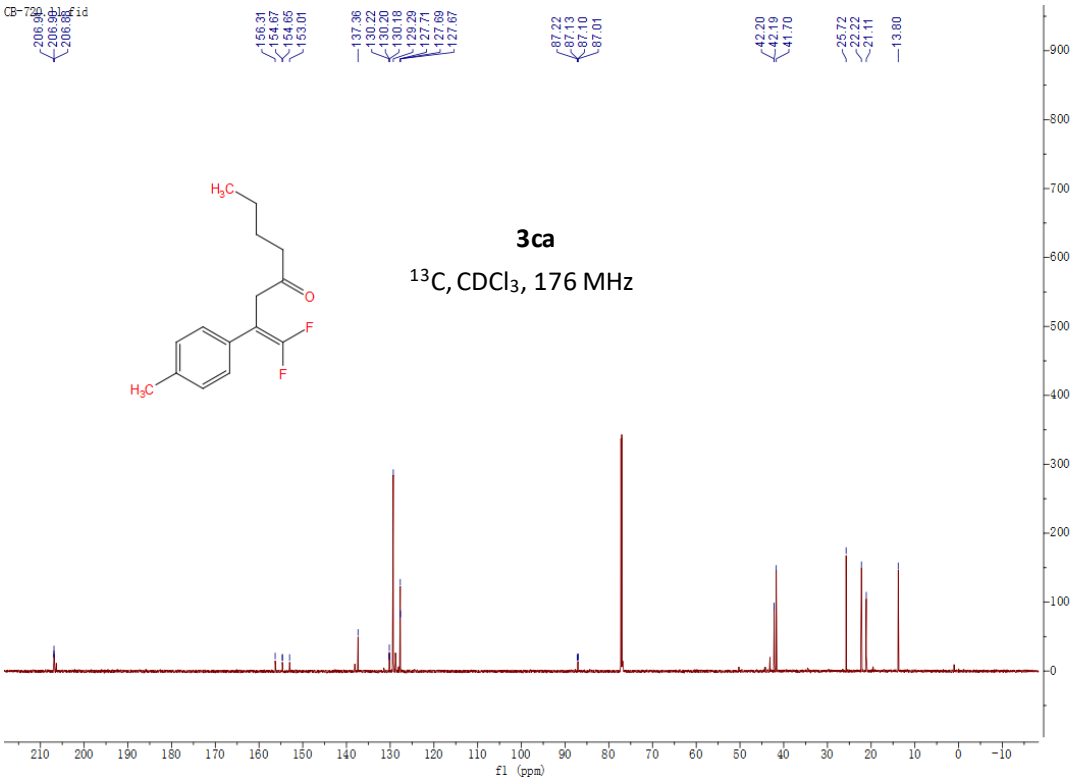
3ba

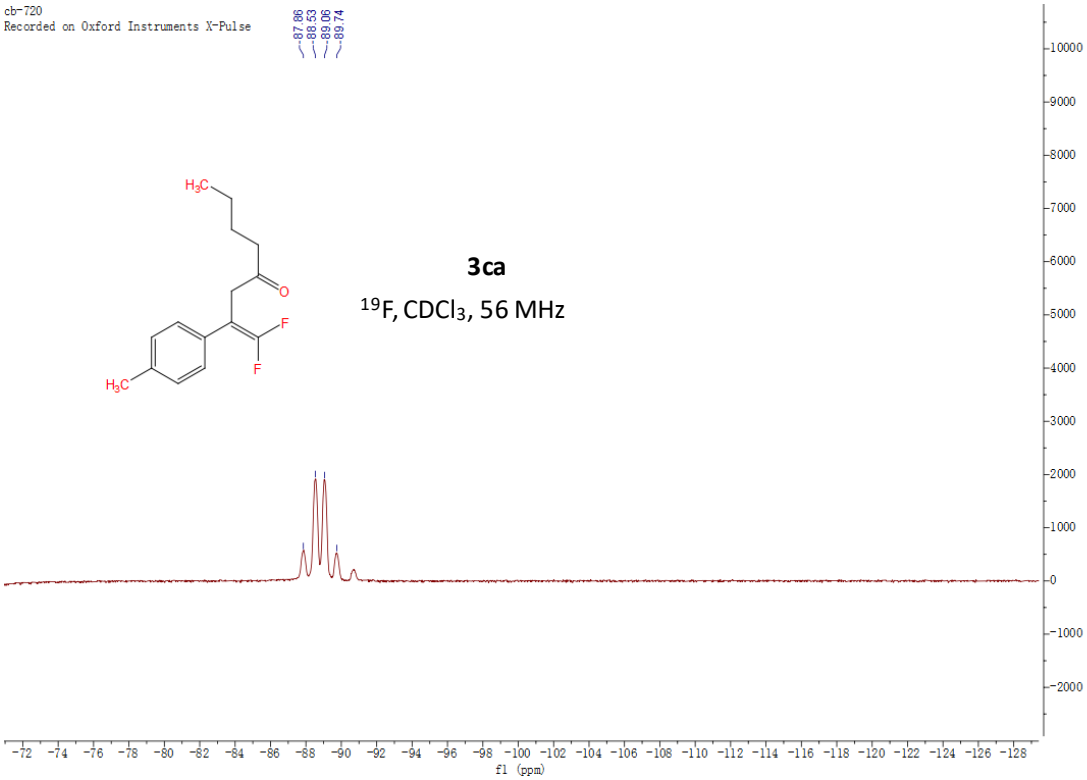
^{19}F, $CDCl_3$, 56 MHz

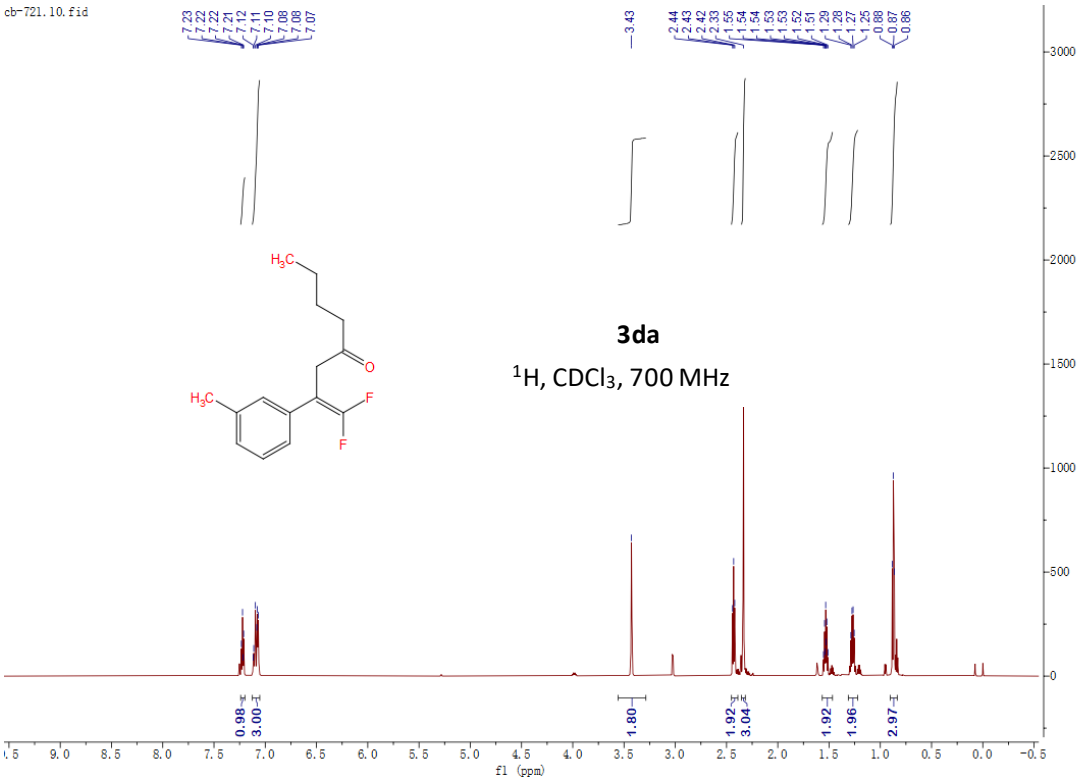


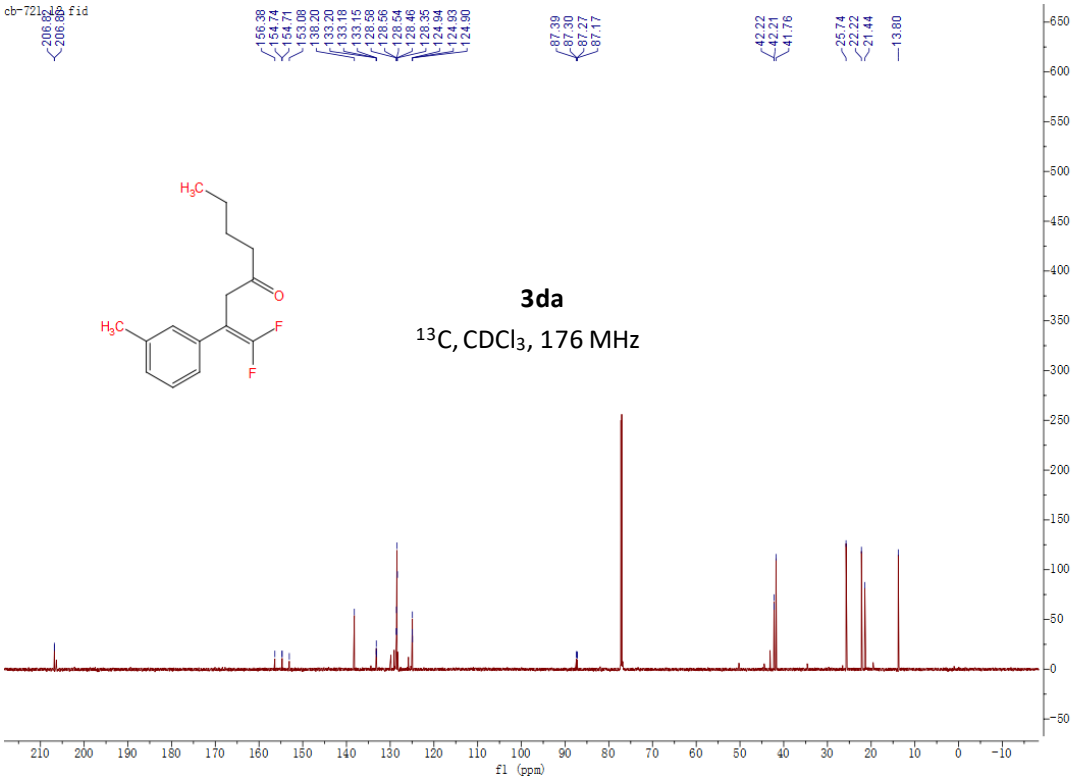
3ca

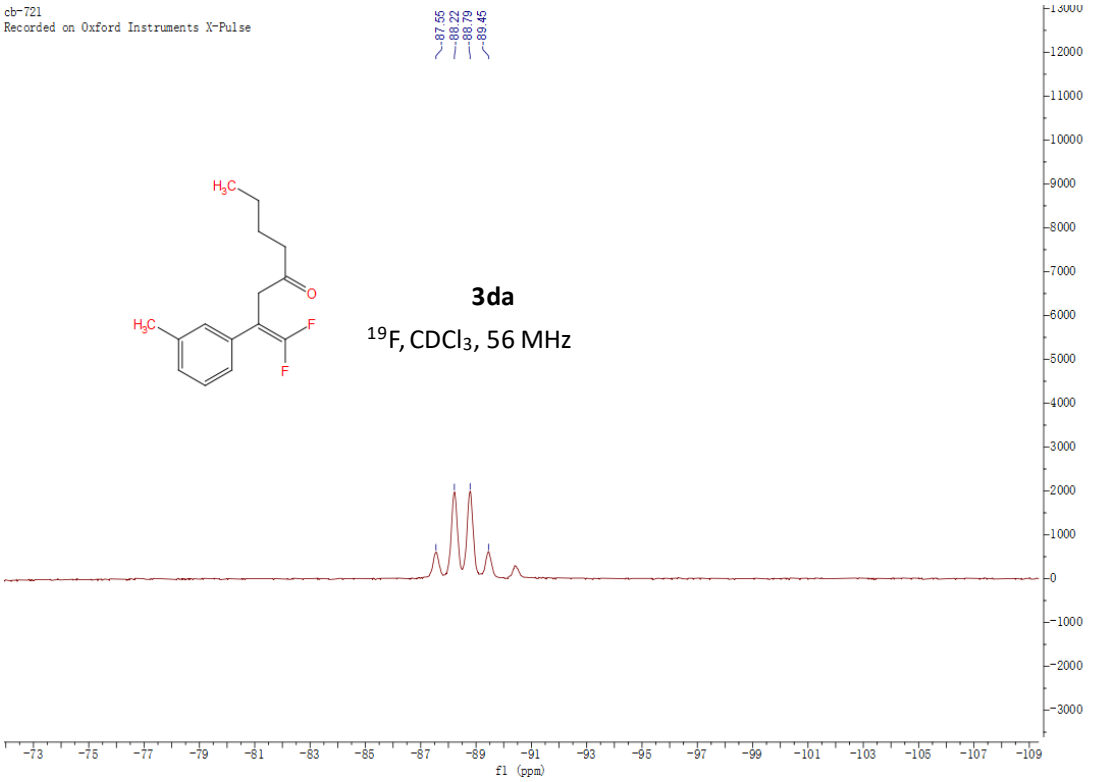
^{1}H, $CDCl_3$, 700 MHz

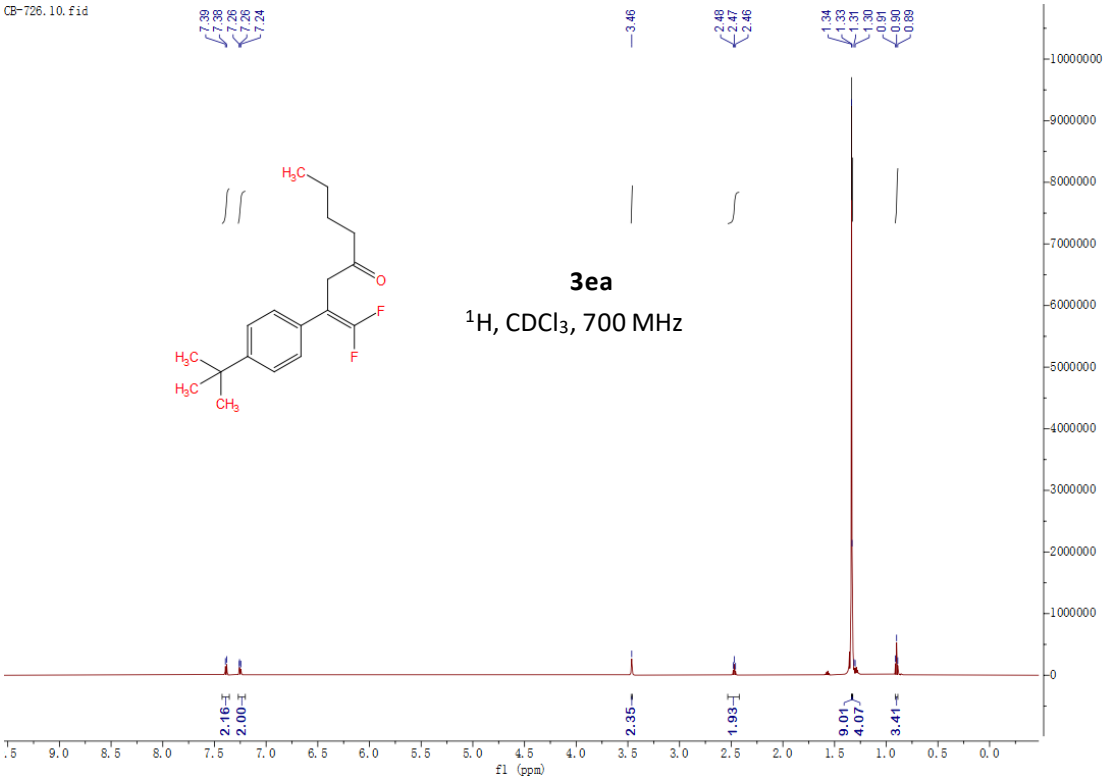

CB-720-1.esp.fid
206.96
206.88
156.31
154.67
154.65
153.01
137.36
130.22
130.20
130.18
129.29
127.71
127.69
127.67
87.22
87.13
87.10
87.01
42.20
42.19
41.70
25.72
22.22
21.11
13.80
H3C
O
F
F
H3C
3ca
13C, CDCl3, 176 MHz
f1 (ppm)

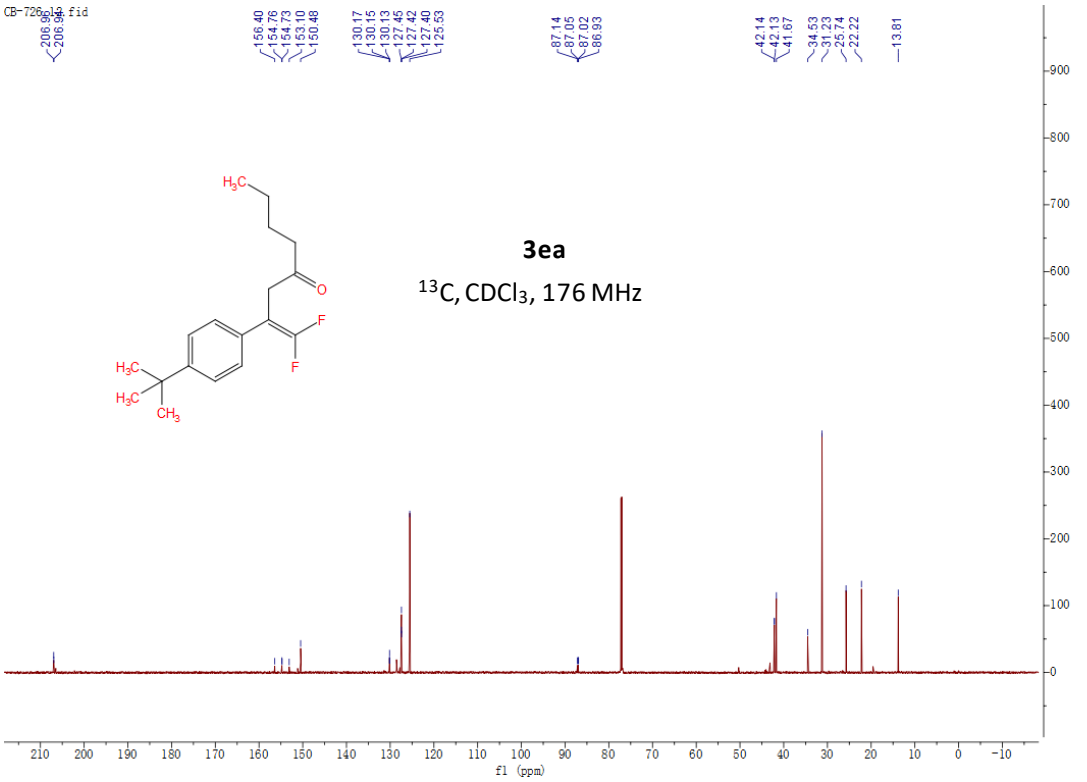

cb-720
Recorded on Oxford Instruments X-Pulse
87.86
88.53
89.06
89.74
H3C
O
F
F
H3C
3ca
19F, CDCl3, 56 MHz
f1 (ppm)


cb-721.10.fid
7.23
7.22
7.22
7.21
7.12
7.11
7.10
7.08
7.08
7.07
3.43
2.44
2.43
2.42
2.33
1.55
1.54
1.54
1.53
1.52
1.51
1.29
1.28
1.27
1.25
0.88
0.87
0.86
H3C
O
H3C
F
F
3da
1H, CDCl3, 700 MHz
0.98
3.00
1.80
1.92
3.04
1.92
1.96
2.97
f1 (ppm)


cb-721c.10.fid
206.62
206.60
156.38
154.74
154.71
153.08
138.20
133.20
133.18
133.15
128.58
128.56
128.54
128.46
128.35
124.94
124.93
124.90
87.39
87.30
87.27
87.17
42.22
42.21
41.76
25.74
22.22
21.44
13.80
H3C
O
H3C
F
F
3da
13C, CDCl3, 176 MHz
f1 (ppm)

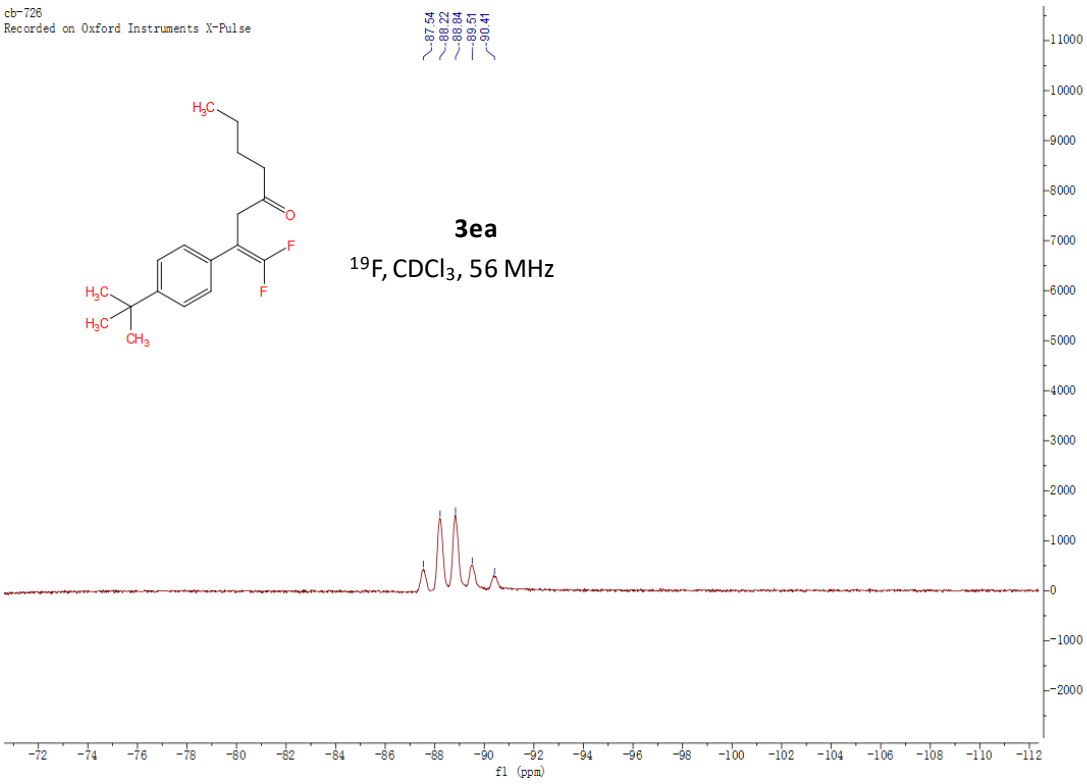

cb-721
Recorded on Oxford Instruments X-Pulse
-87.55
-88.22
-88.79
-89.45
H3C
O
F
H3C
F
3da
19F, CDCl3, 56 MHz
f1 (ppm)


CB-726.10.fid
7.39
7.38
7.26
7.26
7.24
3.46
2.48
2.47
2.46
1.34
1.33
1.31
1.30
0.91
0.90
0.89
H3C
O
F
F
H3C
H3C
CH3
3ea
1H, CDCl3, 700 MHz
2.16
2.00
2.35
1.93
9.01
4.07
3.41
f1 (ppm)



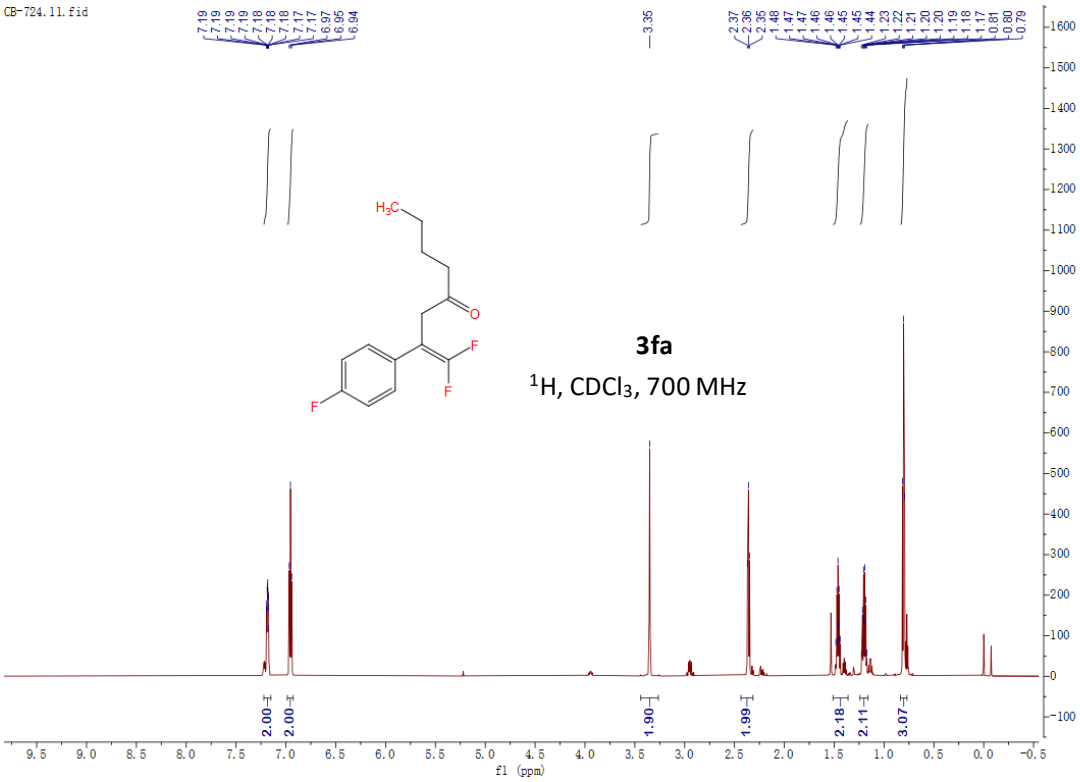
3ea

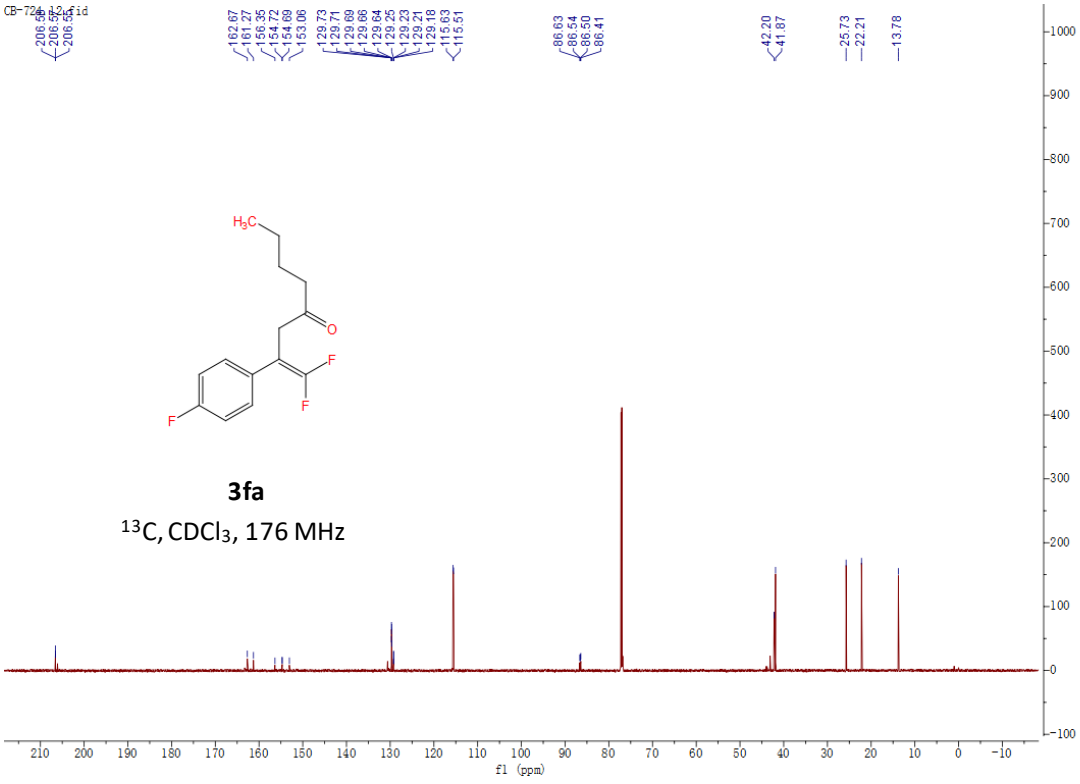
^{13}C, $CDCl_3$, 176 MHz

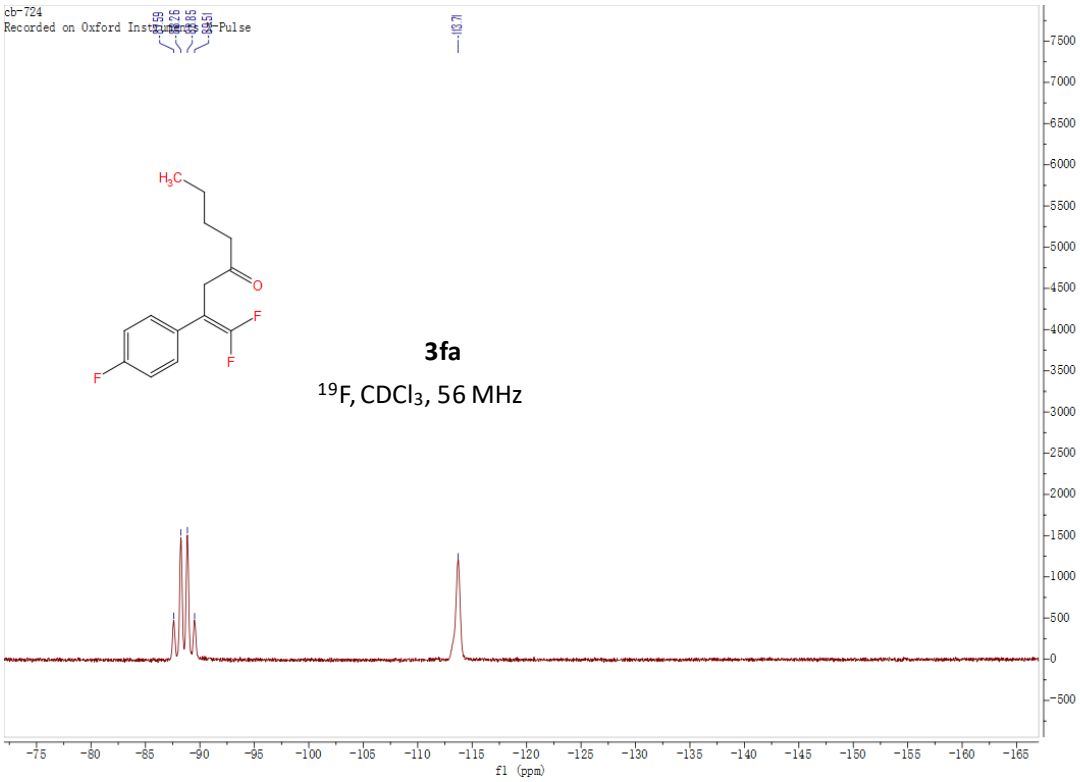


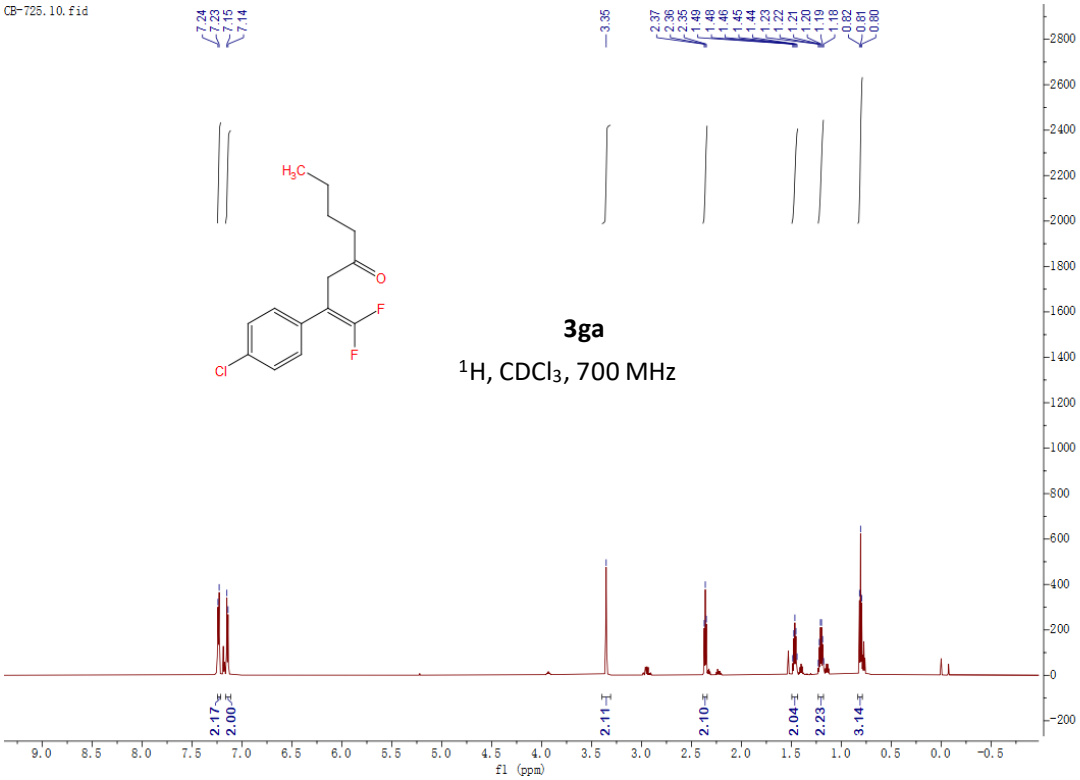
3ea

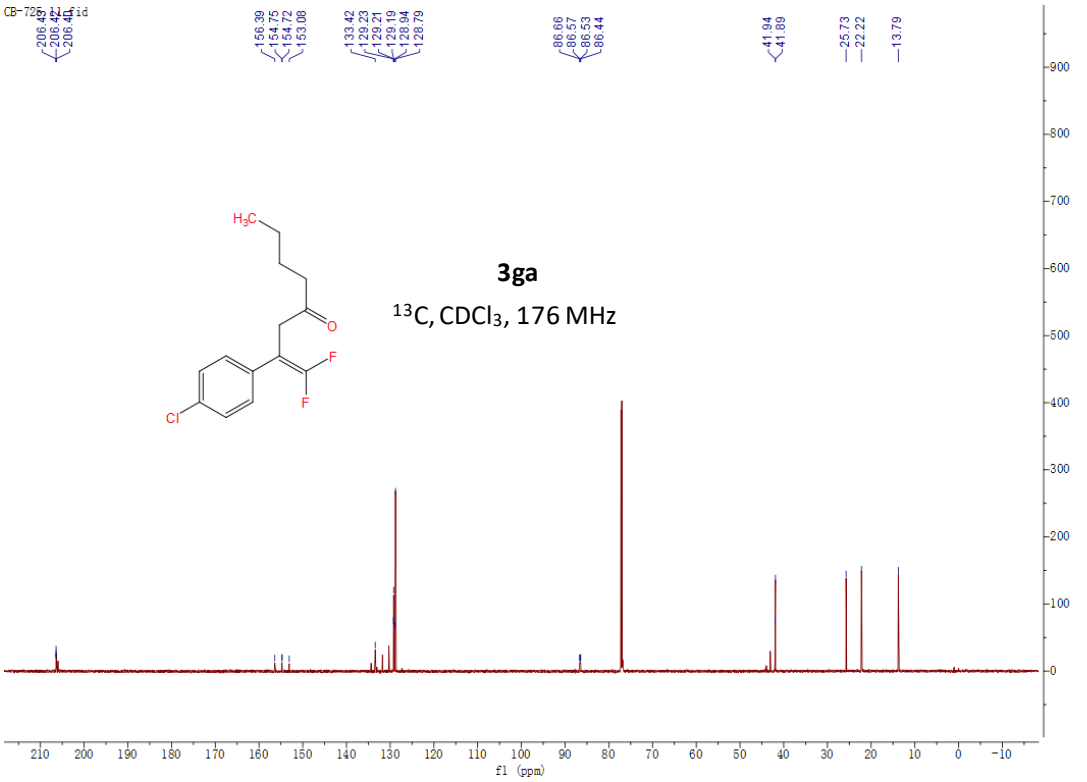
^{19}F, $CDCl_3$, 56 MHz


CB-724.11.fid
7.19
7.19
7.19
7.19
7.18
7.18
7.18
7.17
7.17
6.97
6.95
6.94
3.35
2.37
2.36
2.35
1.48
1.47
1.47
1.46
1.46
1.45
1.45
1.44
1.23
1.22
1.21
1.20
1.20
1.19
1.18
1.17
0.81
0.80
0.79
H3C
O
F
F
F
3fa
1H, CDCl3, 700 MHz
2.00
2.00
1.90
1.99
2.18
2.11
3.07
f1 (ppm)


206.67
206.57
206.55
162.67
161.27
156.35
154.72
154.69
153.06
129.73
129.71
129.69
129.66
129.64
129.25
129.23
129.21
129.18
115.63
115.51
86.63
86.54
86.50
86.41
42.20
41.87
25.73
22.21
13.78
H3C
O
F
F
F
3fa
13C, CDCl3, 176 MHz
f1 (ppm)

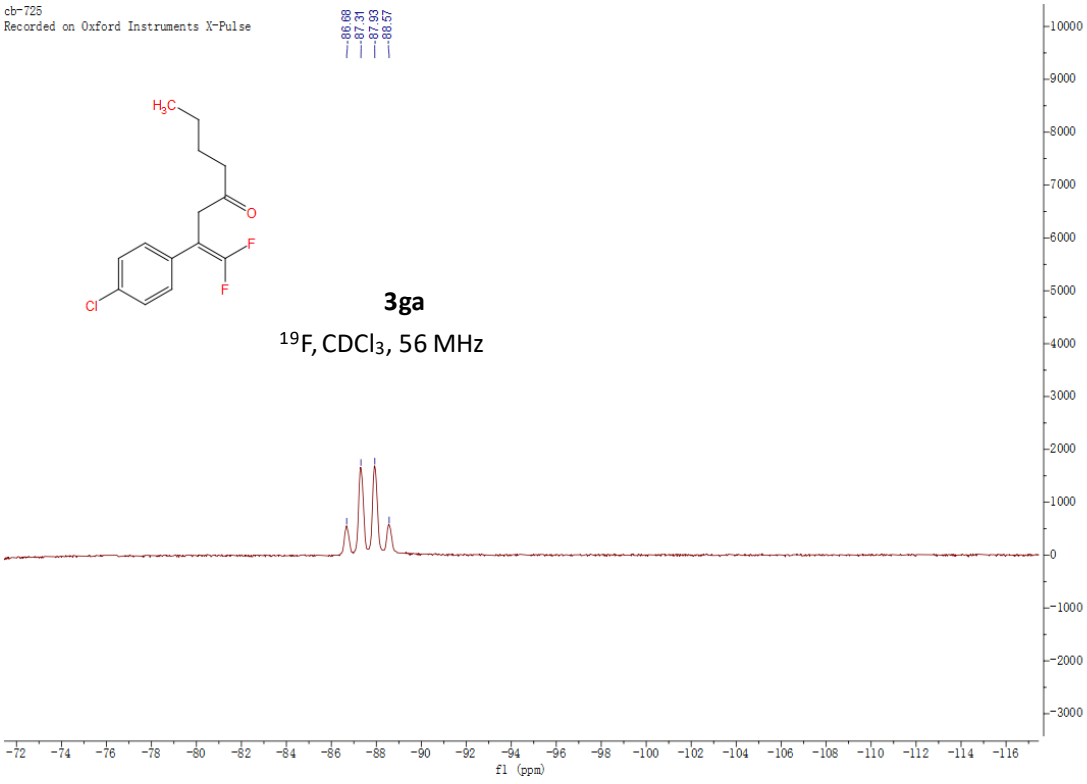

cb-724
Recorded on Oxford Instruments
-Pulse
-103.71
H3C
O
F
F
F
3fa
19F, CDCl3, 56 MHz
f1 (ppm)


CB-725.10.fid
7.24
7.23
7.15
7.14
3.35
2.37
2.36
2.35
1.49
1.48
1.46
1.45
1.44
1.23
1.22
1.21
1.20
1.19
1.18
0.82
0.81
0.80
H3C
O
F
F
Cl
3ga
1H, CDCl3, 700 MHz
2.17
2.00
2.11
2.10
2.04
2.23
3.14
f1 (ppm)



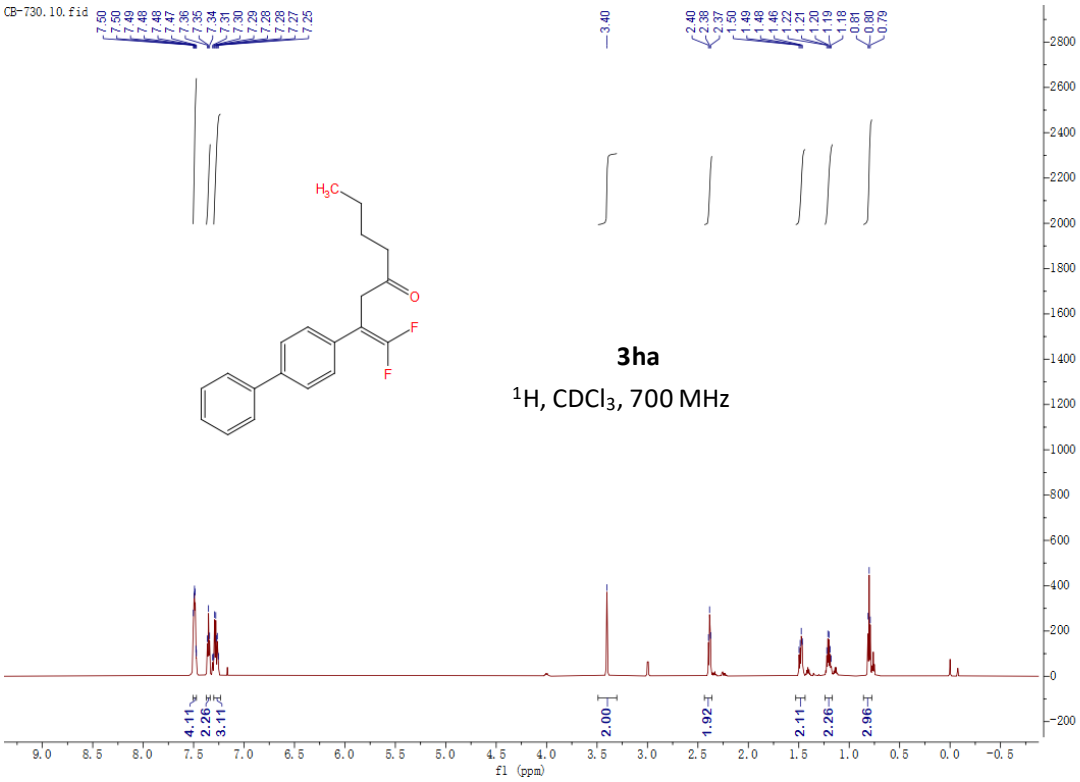
3ga

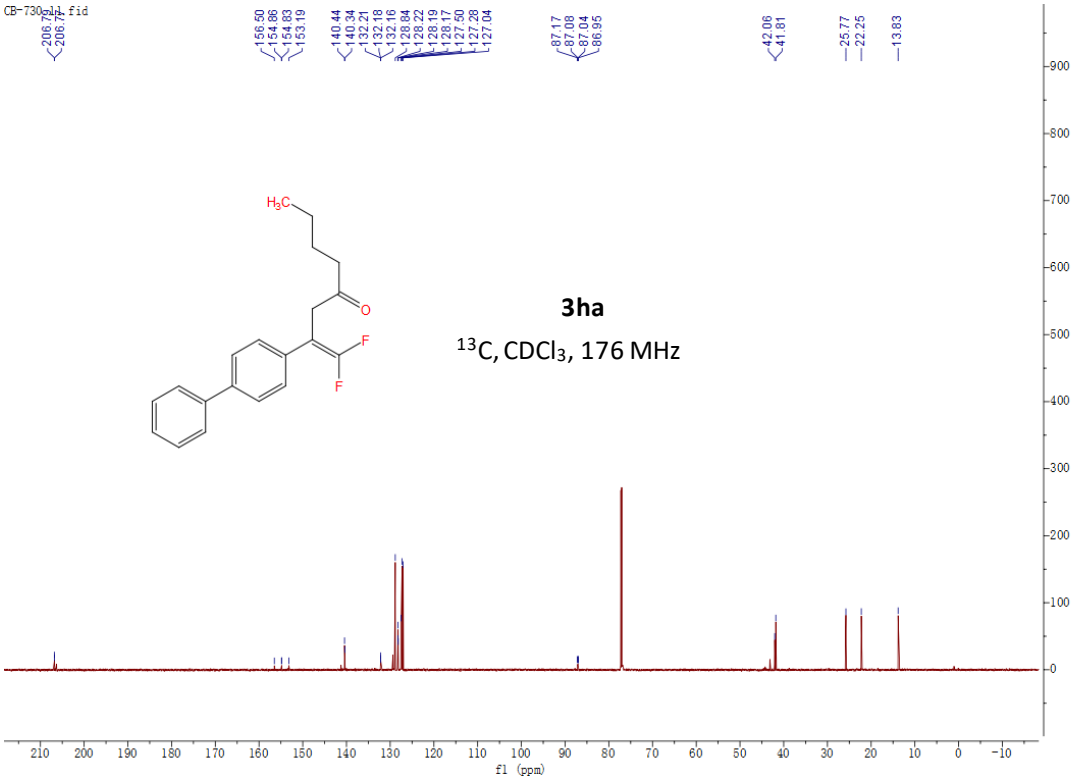
^{13}C, $CDCl_3$, 176 MHz

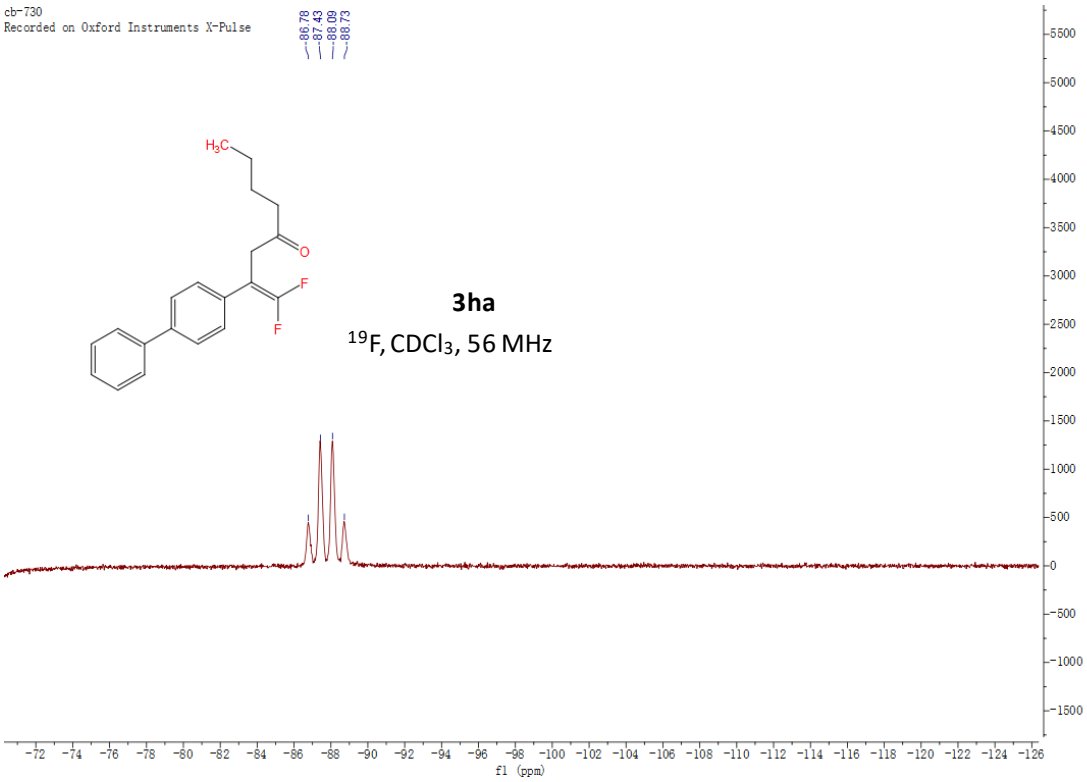


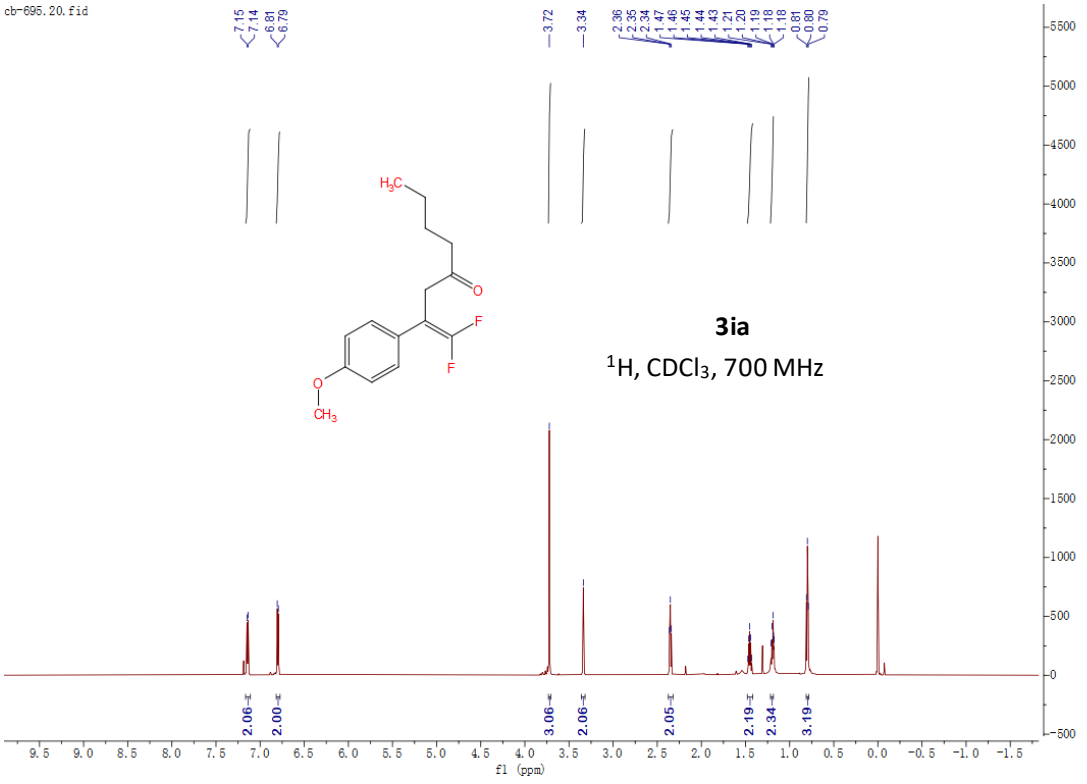
3ga

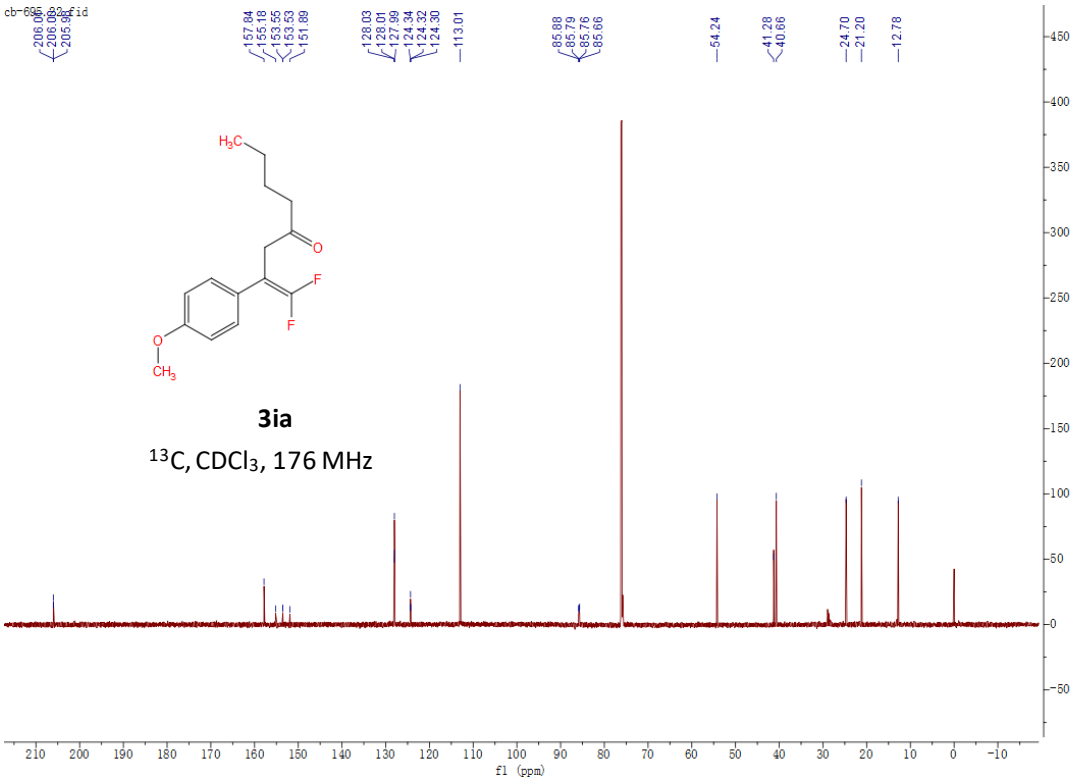
^{19}F, $CDCl_3$, 56 MHz


CB-730.10.fid
H3C
O
F
F
3ha
1H, CDCl3, 700 MHz
fl (ppm)


CB-730-p11.fid
H3C
O
F
F
3ha
13C, CDCl3, 176 MHz
fl (ppm)

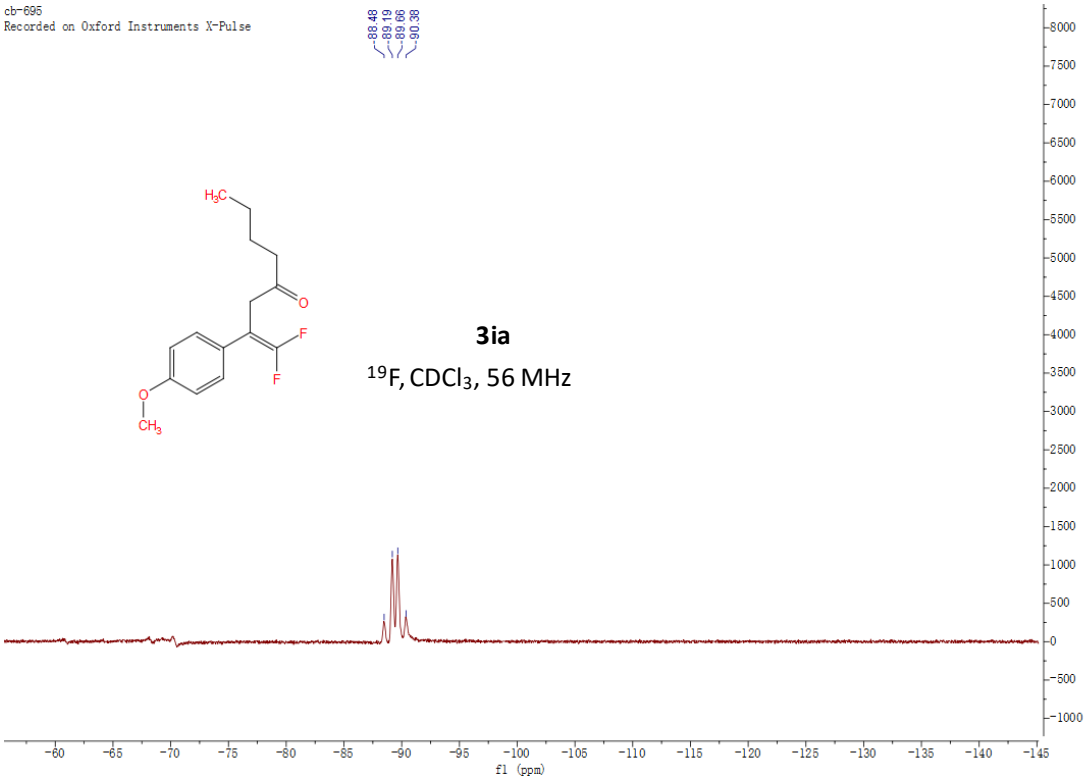

cb-730
Recorded on Oxford Instruments X-Pulse
-86.78
-87.43
-88.09
-88.73
H3C
O
F
F
3ha
19F, CDCl3, 56 MHz
f1 (ppm)


cb-695.20.fid
7.15
7.14
6.81
6.79
3.72
3.34
2.36
2.35
2.34
2.47
1.46
1.45
1.44
1.43
1.21
1.20
1.19
1.18
0.81
0.80
0.79
H3C
O
F
F
O
CH3
3ia
1H, CDCl3, 700 MHz
2.06
2.00
3.06
2.06
2.05
2.19
2.34
3.19
f1 (ppm)



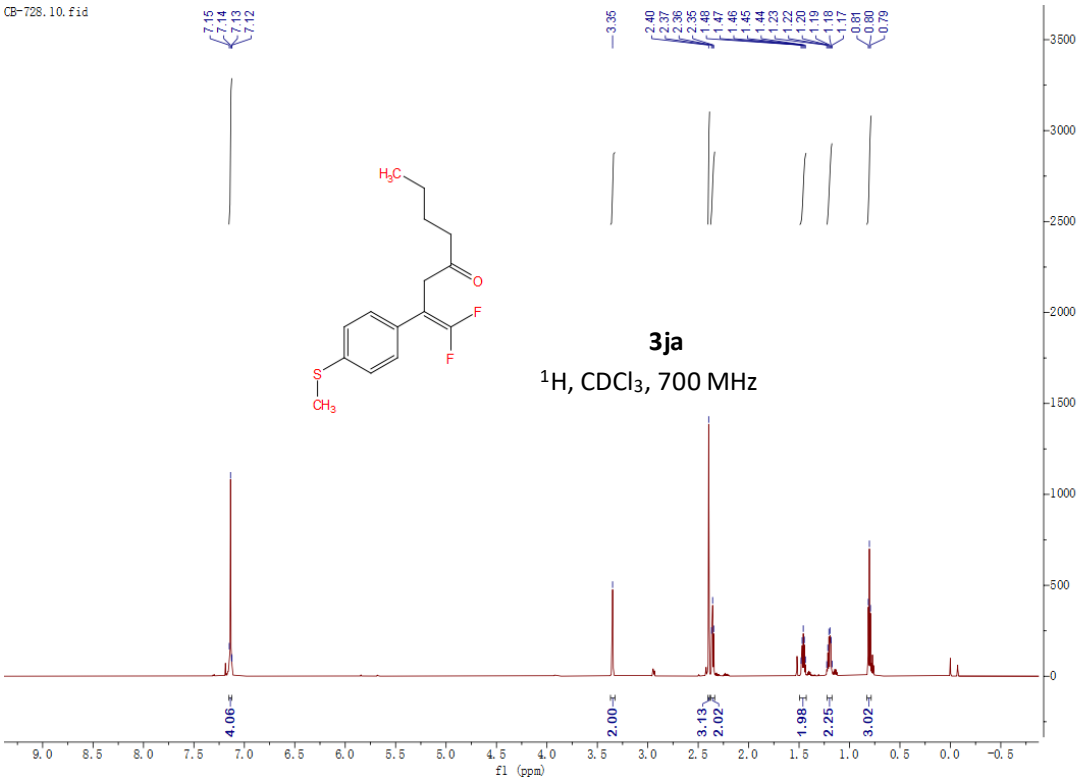
3ia

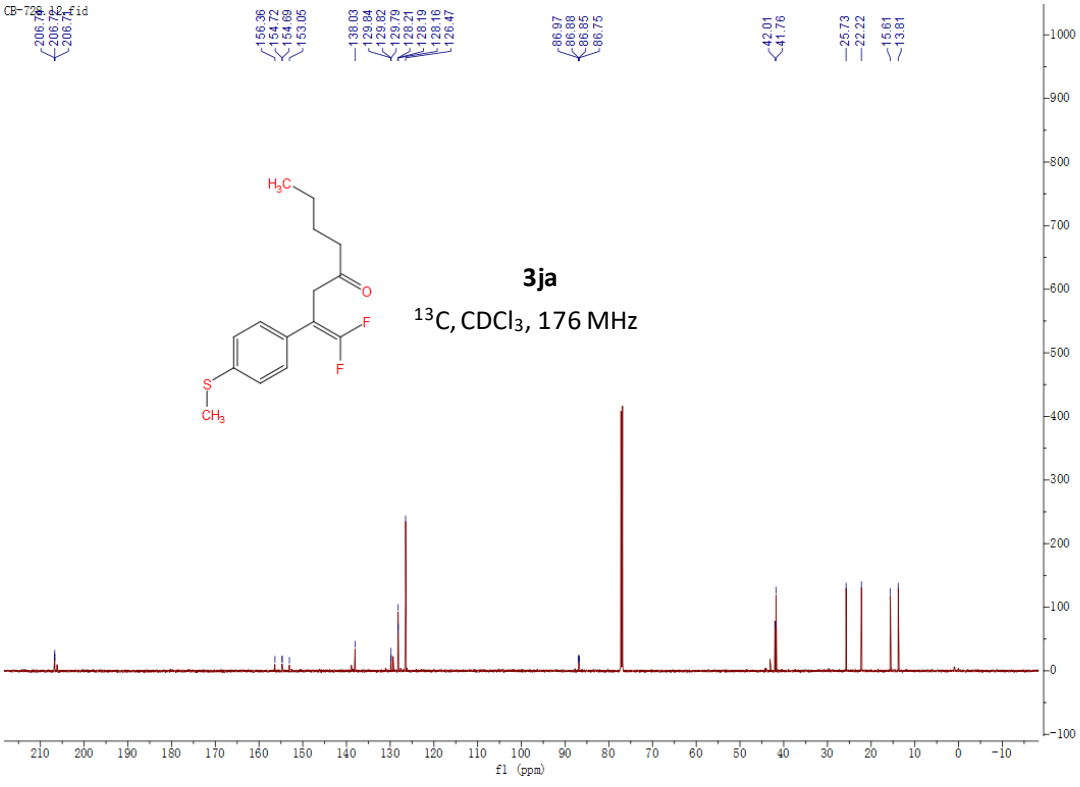
^{13}C, $CDCl_3$, 176 MHz

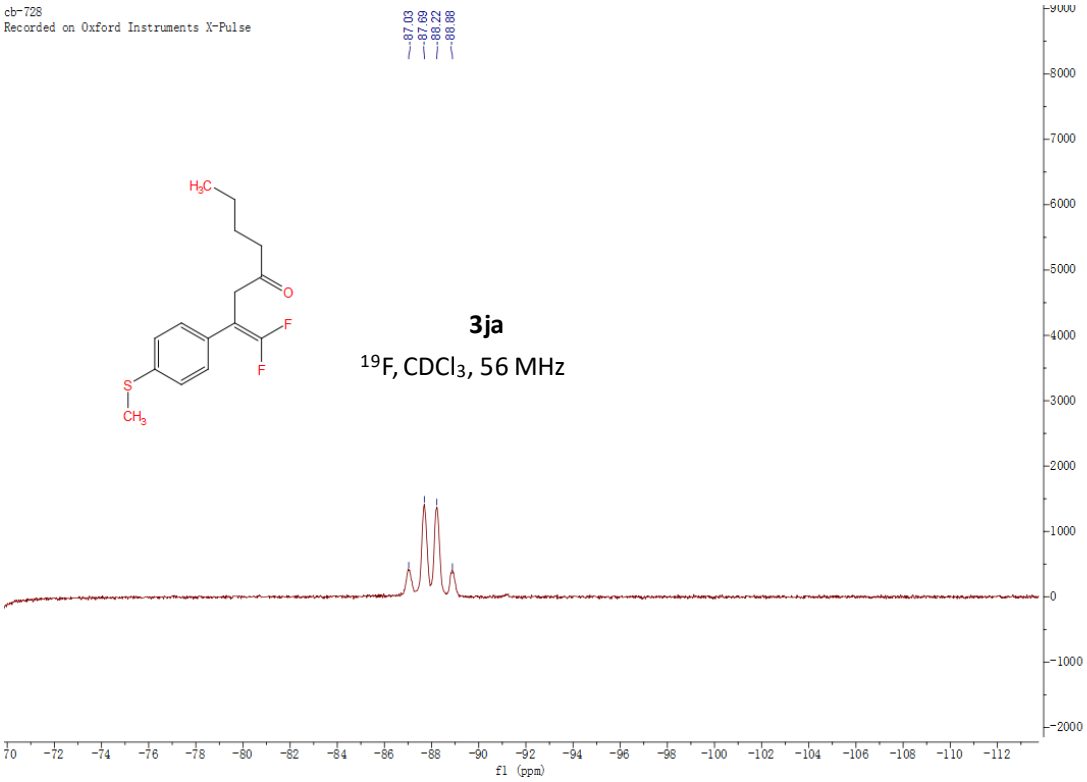


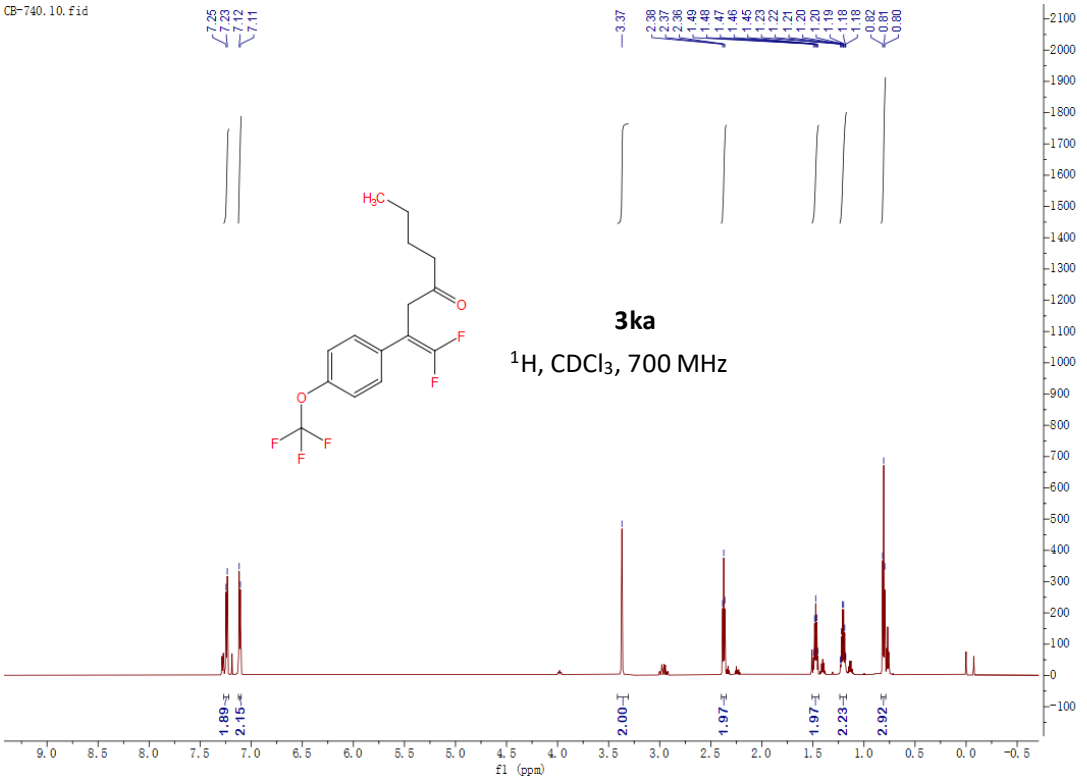
3ia

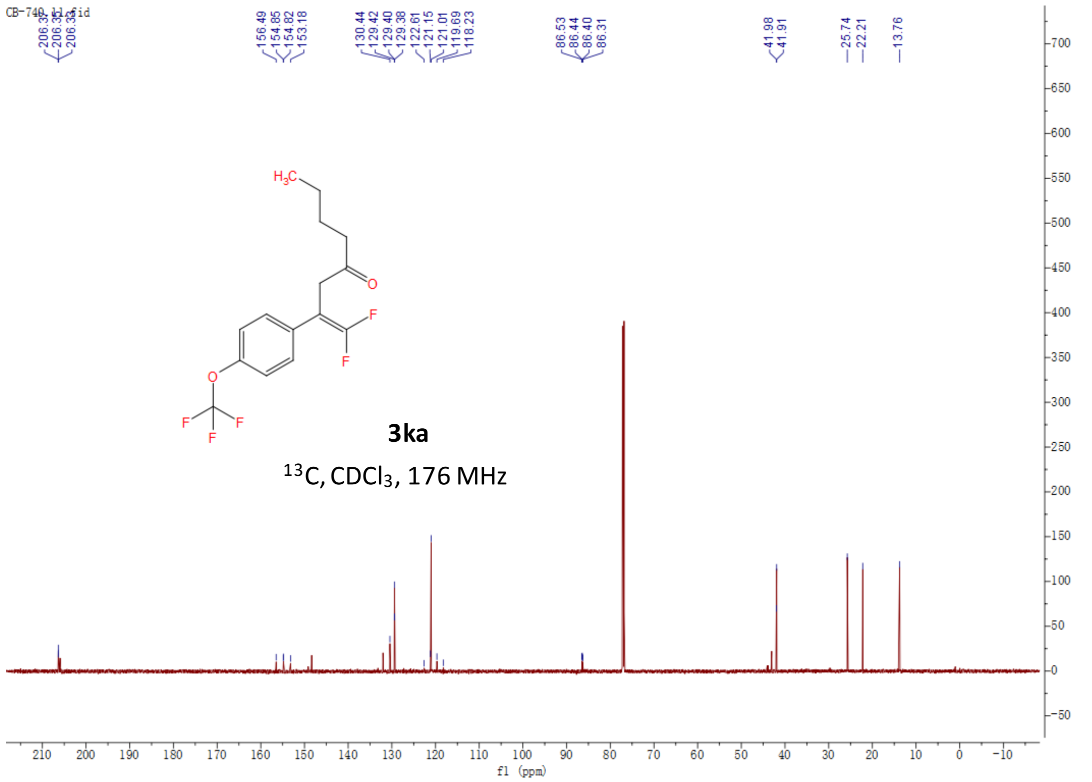
^{19}F, $CDCl_3$, 56 MHz

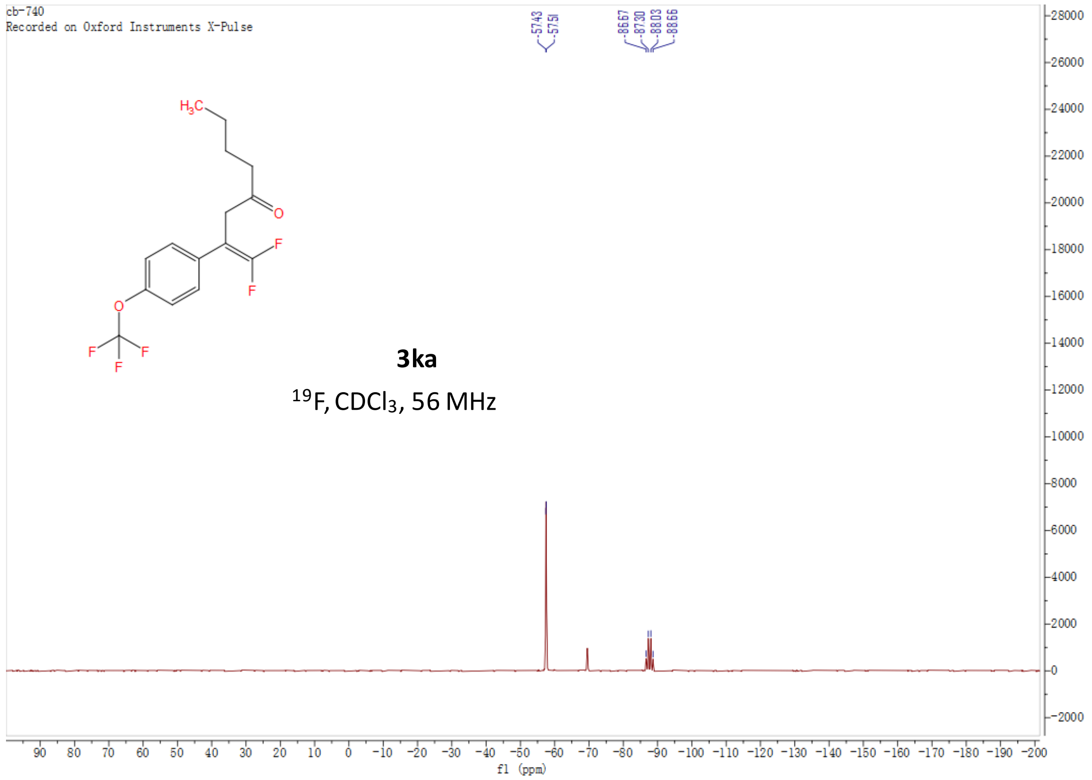

CB-728.10.fid
3ja
1H, CDCl3, 700 MHz
f1 (ppm)

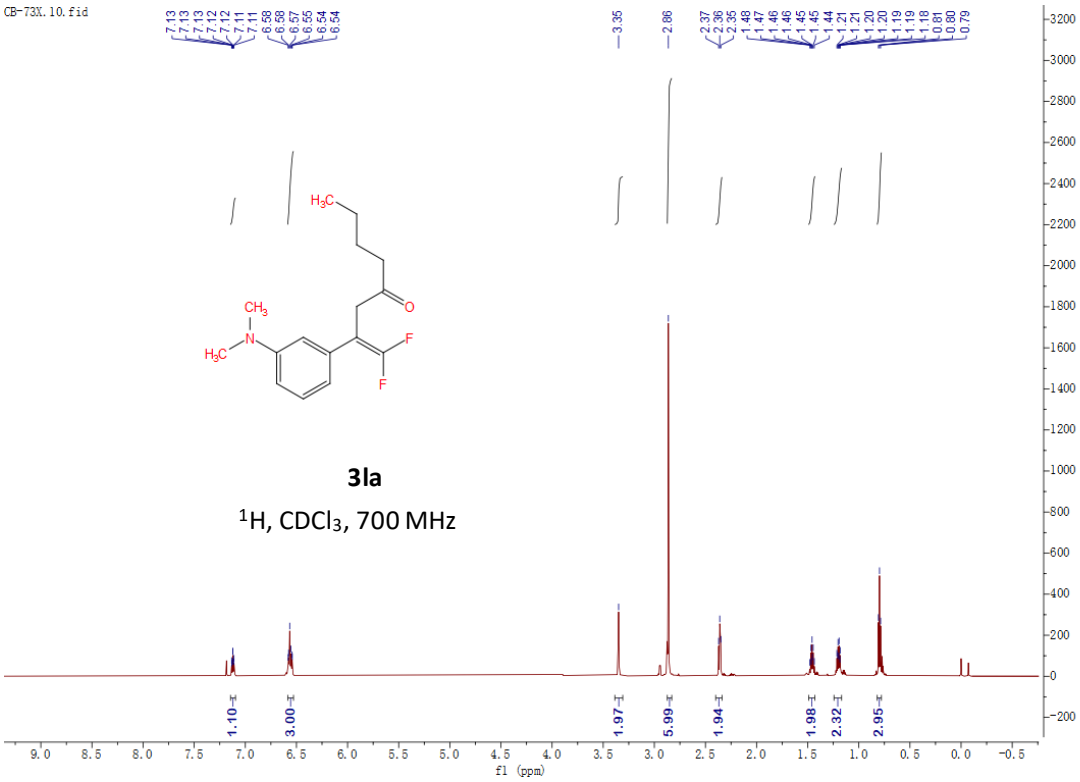

3ja
13C, CDCl3, 176 MHz
f1 (ppm)


cb-728
Recorded on Oxford Instruments X-Pulse
-87.03
-87.69
-88.22
-88.88
H3C
O
F
F
S
CH3
3ja
19F, CDCl3, 56 MHz
f1 (ppm)


CB-740.10.fid
7.25
7.23
7.12
7.11
3.37
2.38
2.37
2.36
1.49
1.48
1.47
1.46
1.45
1.23
1.22
1.21
1.20
1.20
1.19
1.18
1.18
0.82
0.81
0.80
H3C
O
F
F
O
F
F
F
3ka
1H, CDCl3, 700 MHz
1.89
2.15
2.00
1.97
1.97
2.23
2.92
f1 (ppm)

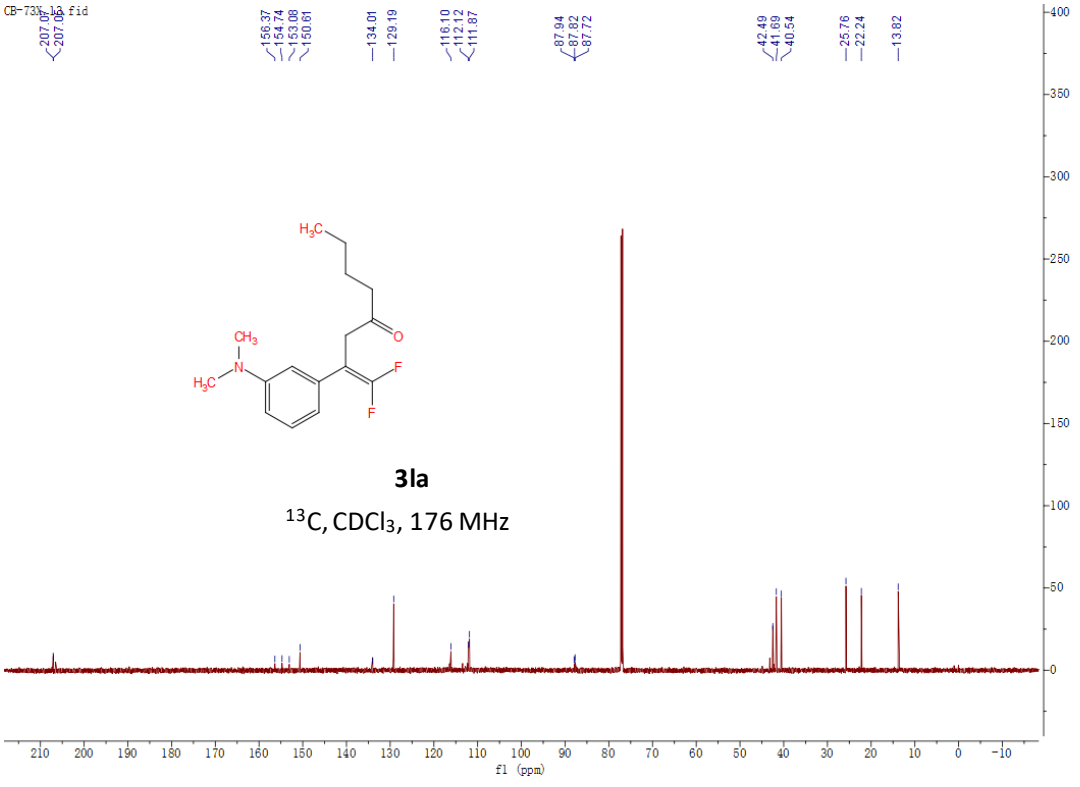

CB-740.11.fid
206.37
206.35
206.33
156.49
154.85
154.82
153.18
130.44
129.42
129.40
129.38
122.61
121.15
121.01
119.69
118.23
86.53
86.44
86.40
86.31
41.98
41.91
25.74
22.21
13.76
3ka
^{13}C, CDCl$_3$, 176 MHz
f1 (ppm)


cb-740
Recorded on Oxford Instruments X-Pulse
-57.43
-57.51
-86.67
-87.30
-88.03
-88.66
3ka
^{19}F, CDCl$_3$, 56 MHz
f1 (ppm)



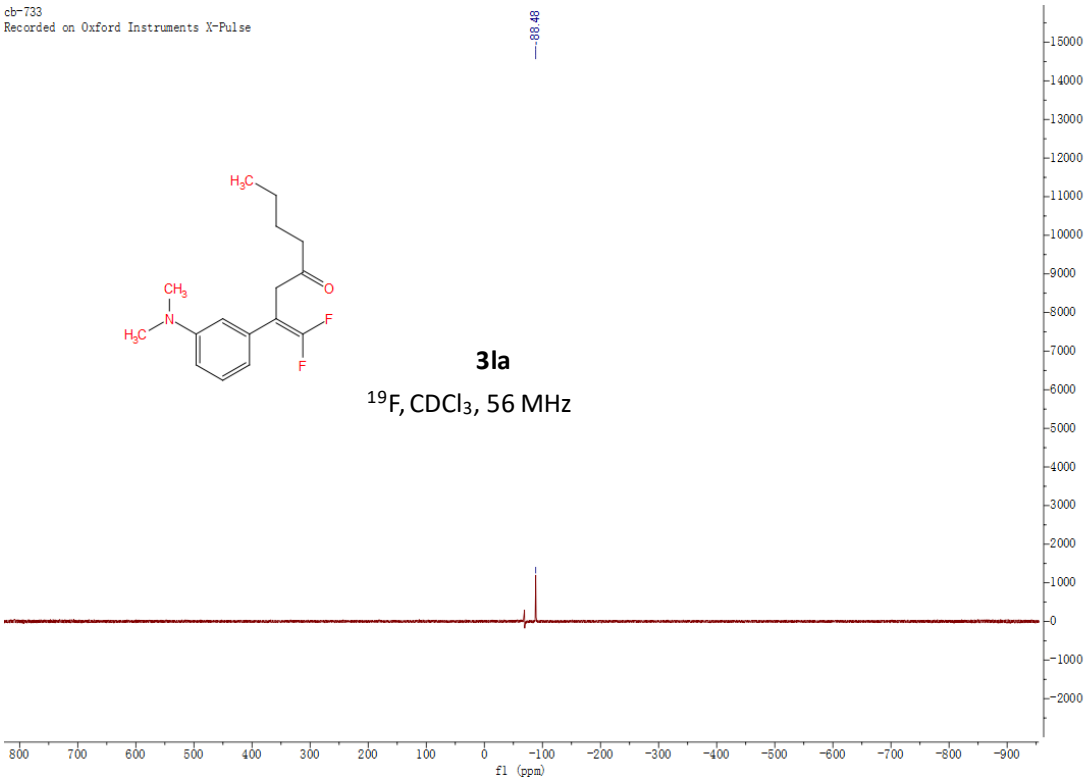
3la

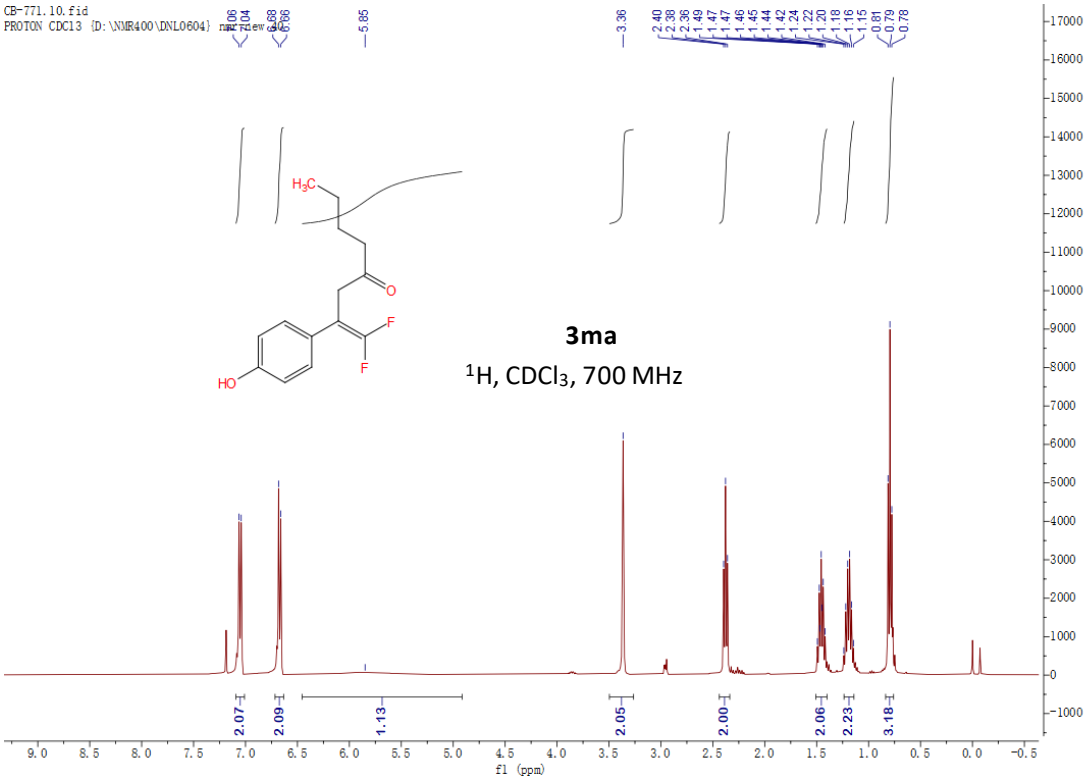
^{1}H, $CDCl_3$, 700 MHz

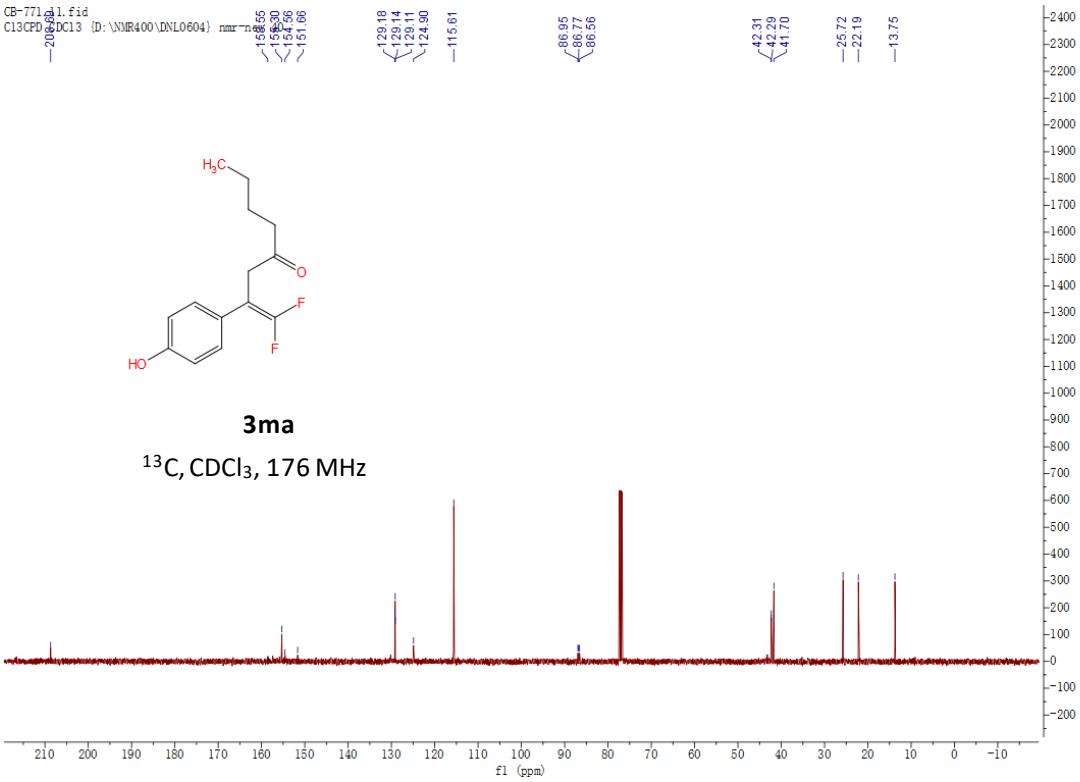


3la

^{13}C, $CDCl_3$, 176 MHz

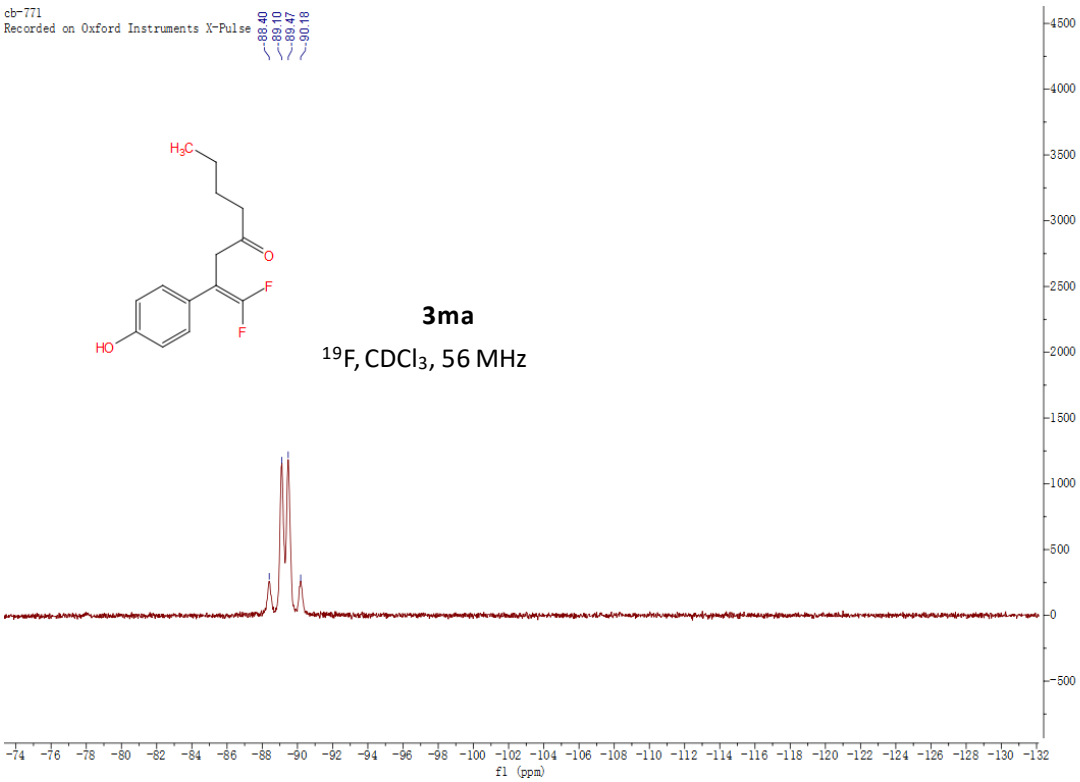

cb-733
Recorded on Oxford Instruments X-Pulse
-88.48
H3C
CH3
N
H3C
O
F
F
3la
19F, CDCl3, 56 MHz
f1 (ppm)


CB-771.10.fid
PROTON CDC13 (D:\NMR400\DNL0604)
7.06
7.04
6.68
6.66
5.85
3.36
2.40
2.38
2.36
1.49
1.47
1.47
1.46
1.45
1.44
1.42
1.24
1.22
1.20
1.18
1.16
1.15
0.81
0.79
0.78
H3C
O
F
F
HO
3ma
1H, CDCl3, 700 MHz
2.07
2.09
1.13
2.05
2.00
2.06
2.23
3.18
f1 (ppm)



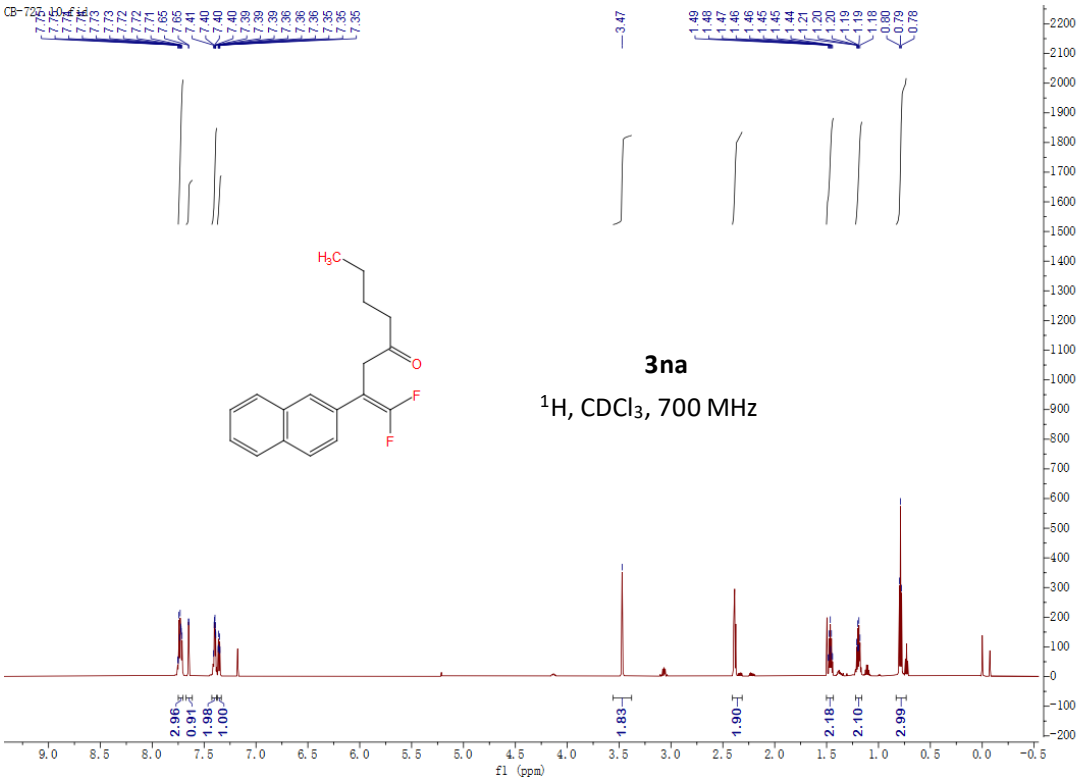
3ma

^{13}C, $CDCl_3$, 176 MHz



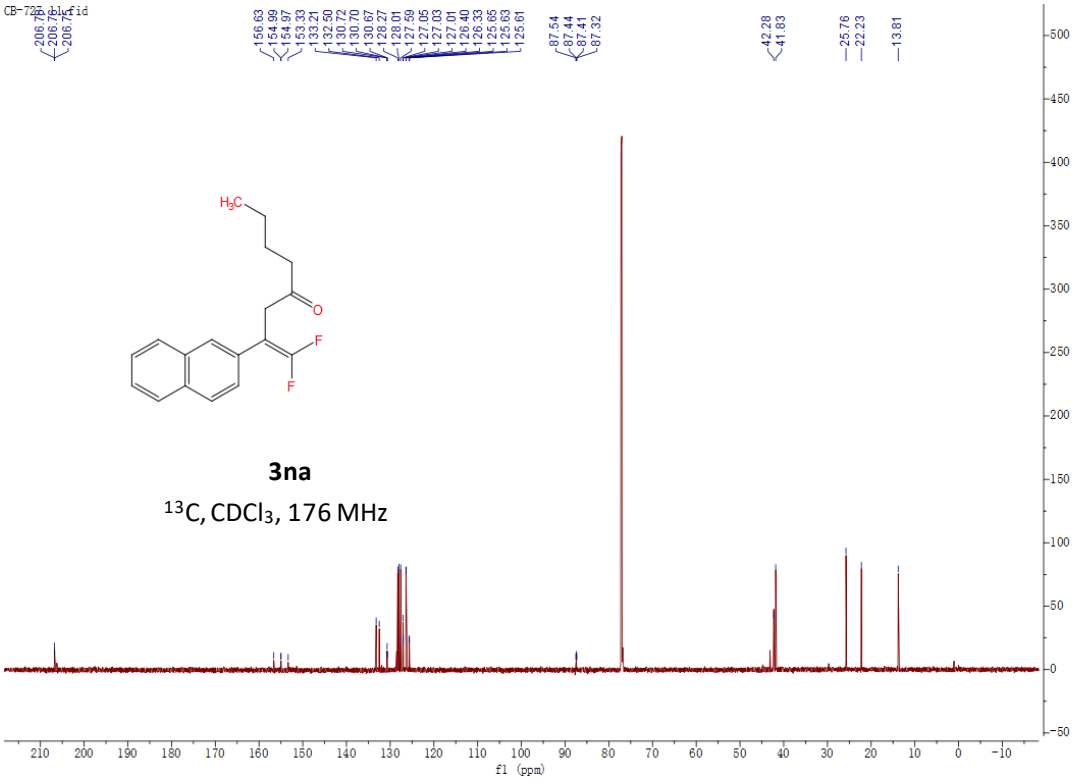
3ma

^{19}F, $CDCl_3$, 56 MHz



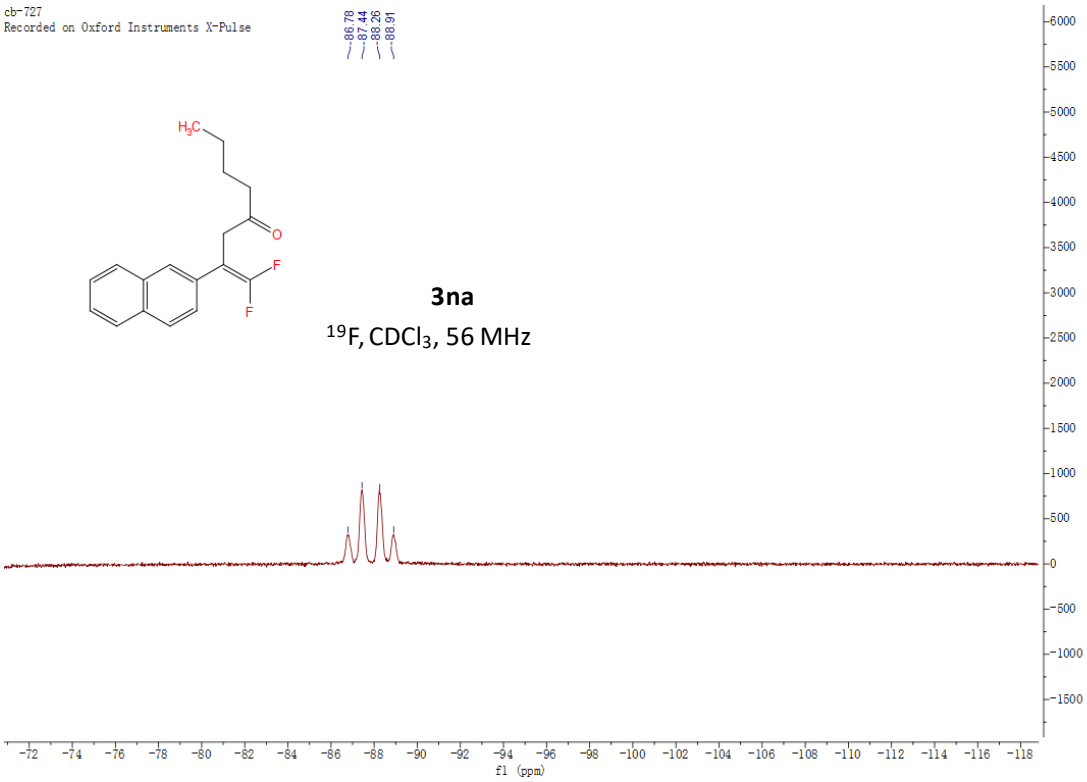
3na

^{1}H, $CDCl_3$, 700 MHz



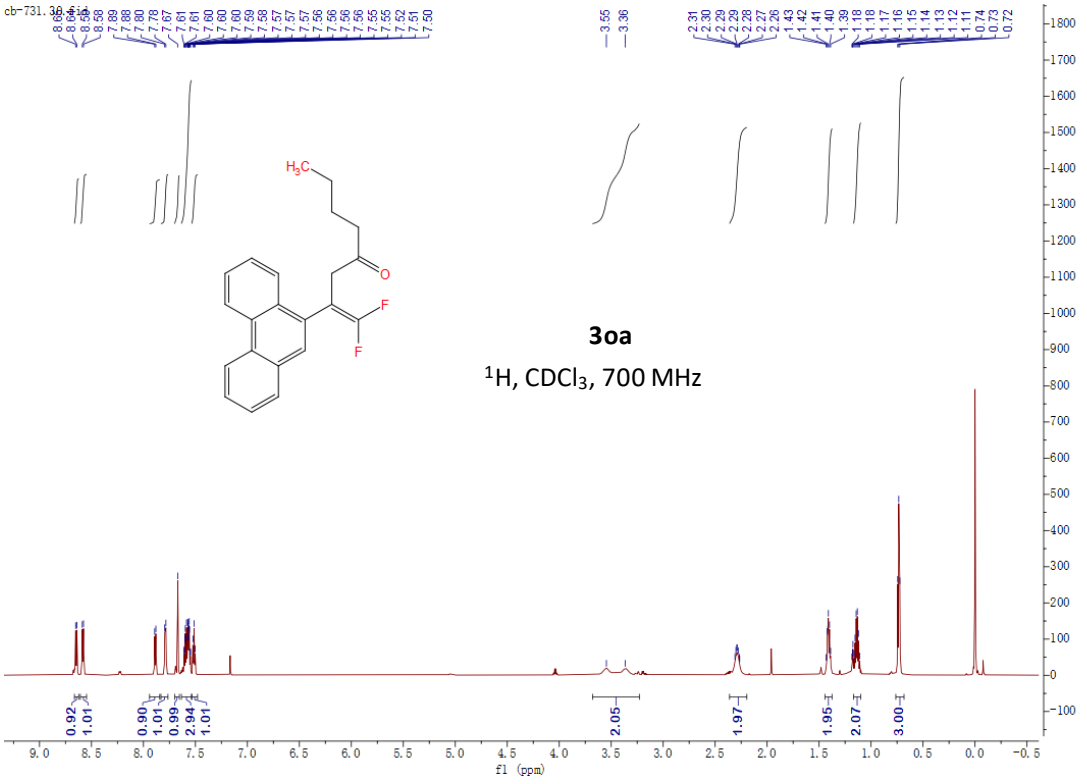
3na

^{13}C, $CDCl_3$, 176 MHz



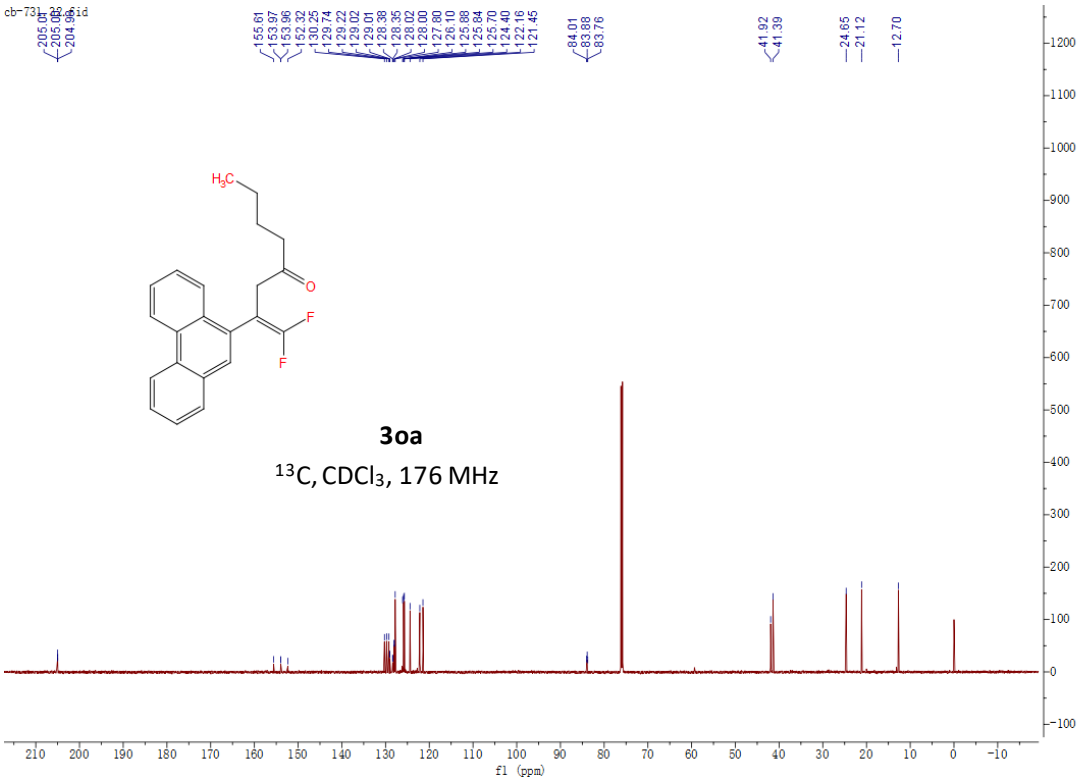
3na

^{19}F, $CDCl_3$, 56 MHz



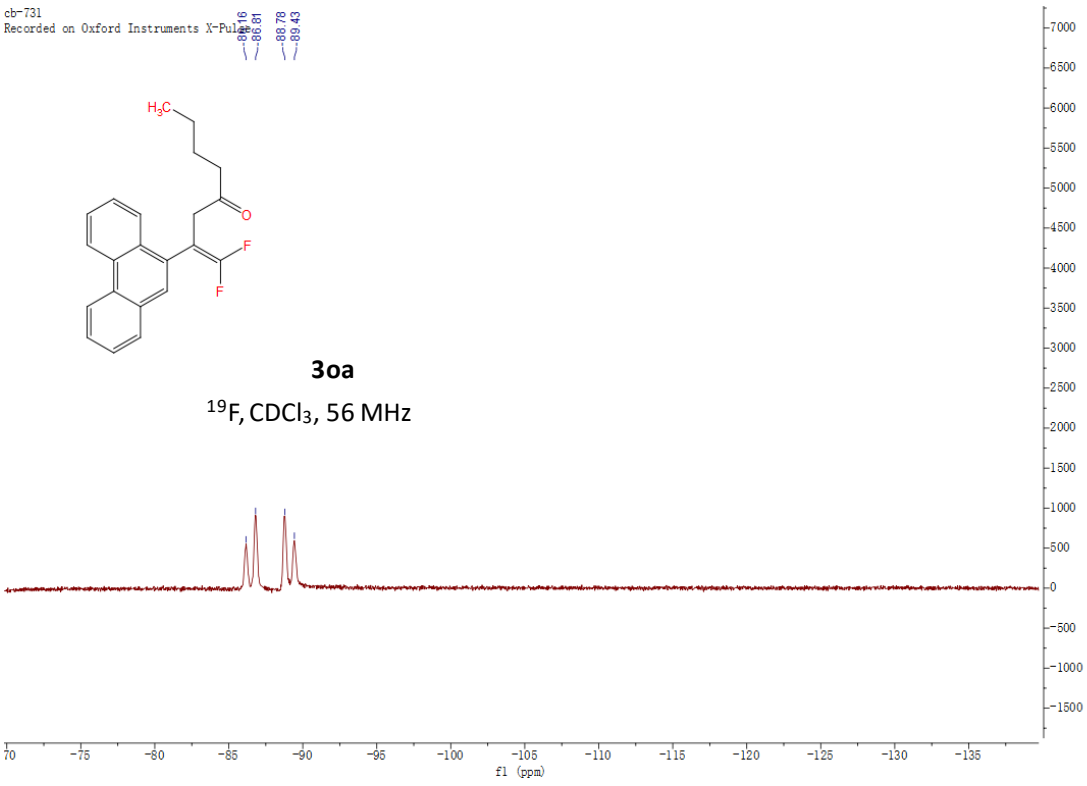
3oa

^{1}H, $CDCl_3$, 700 MHz



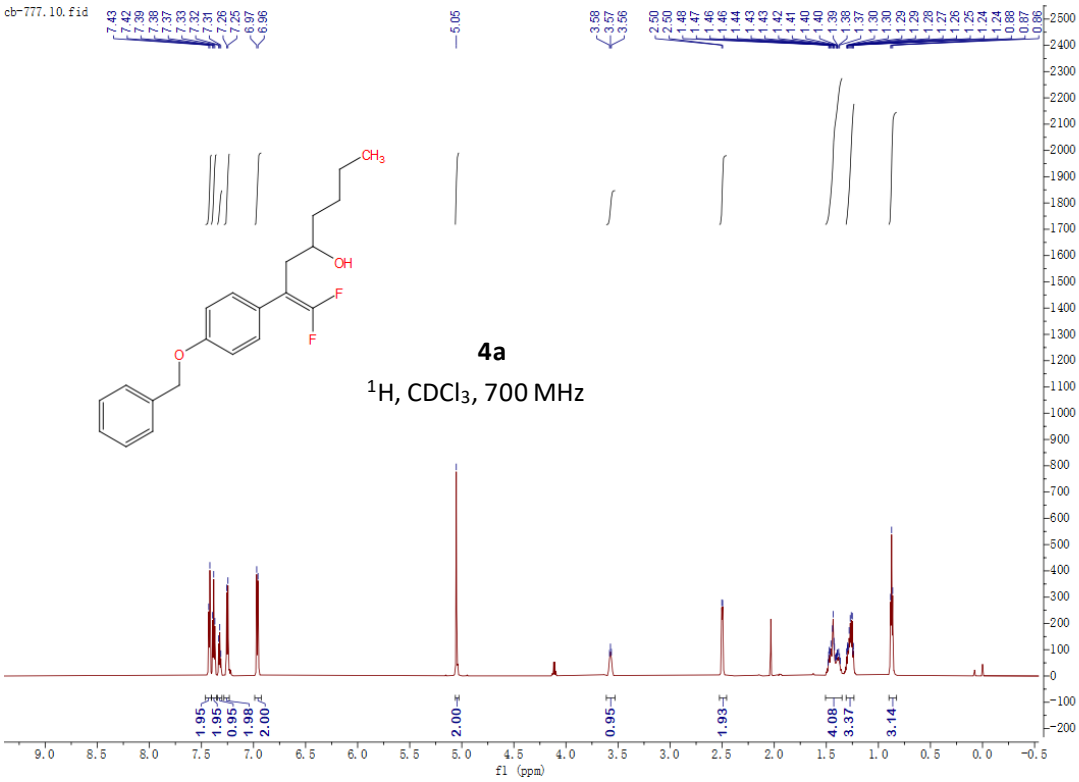
3oa

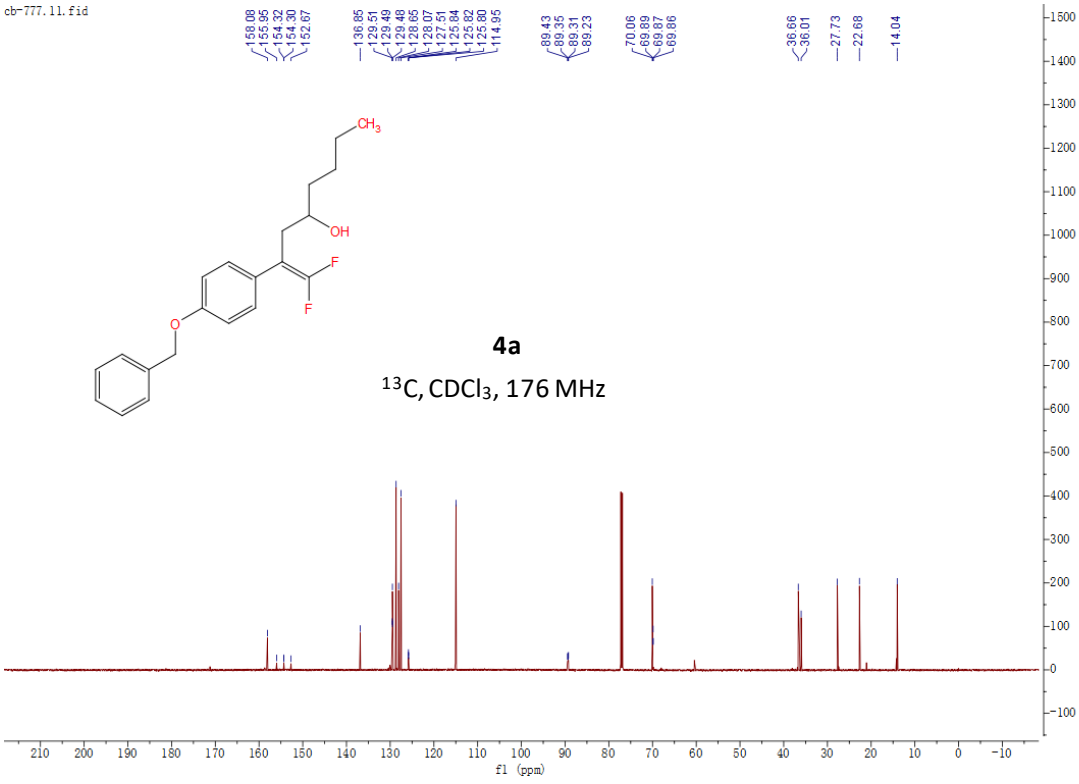
^{13}C, $CDCl_3$, 176 MHz

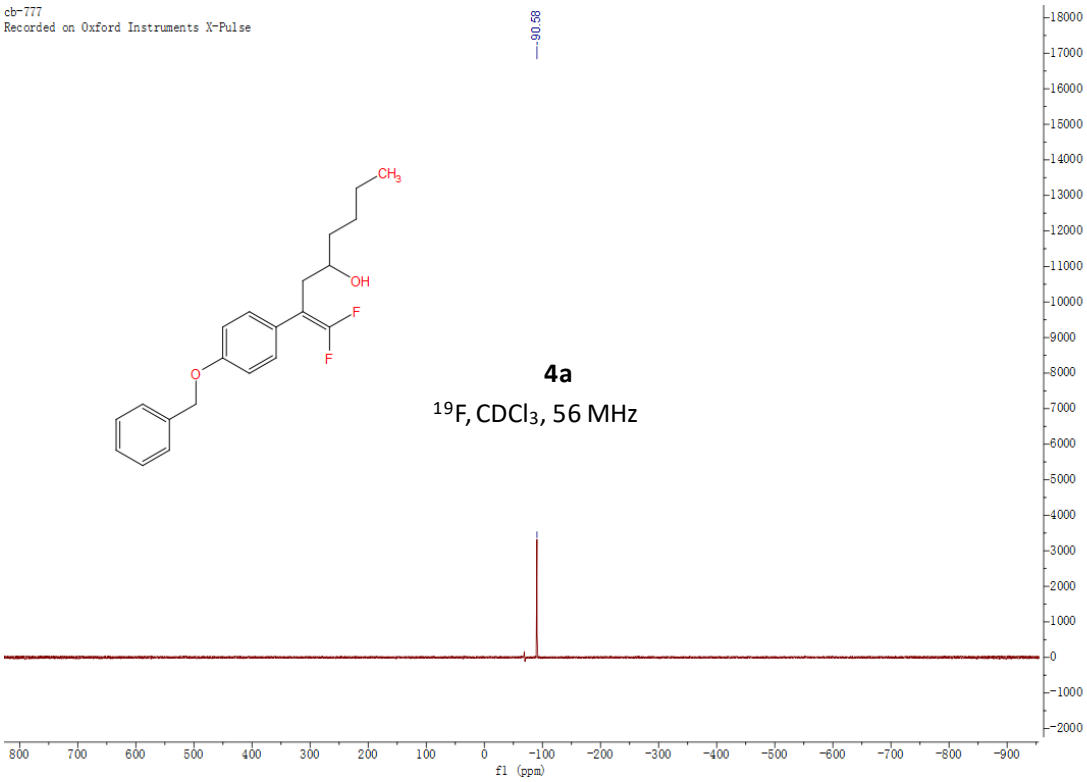


3oa

^{19}F, $CDCl_3$, 56 MHz

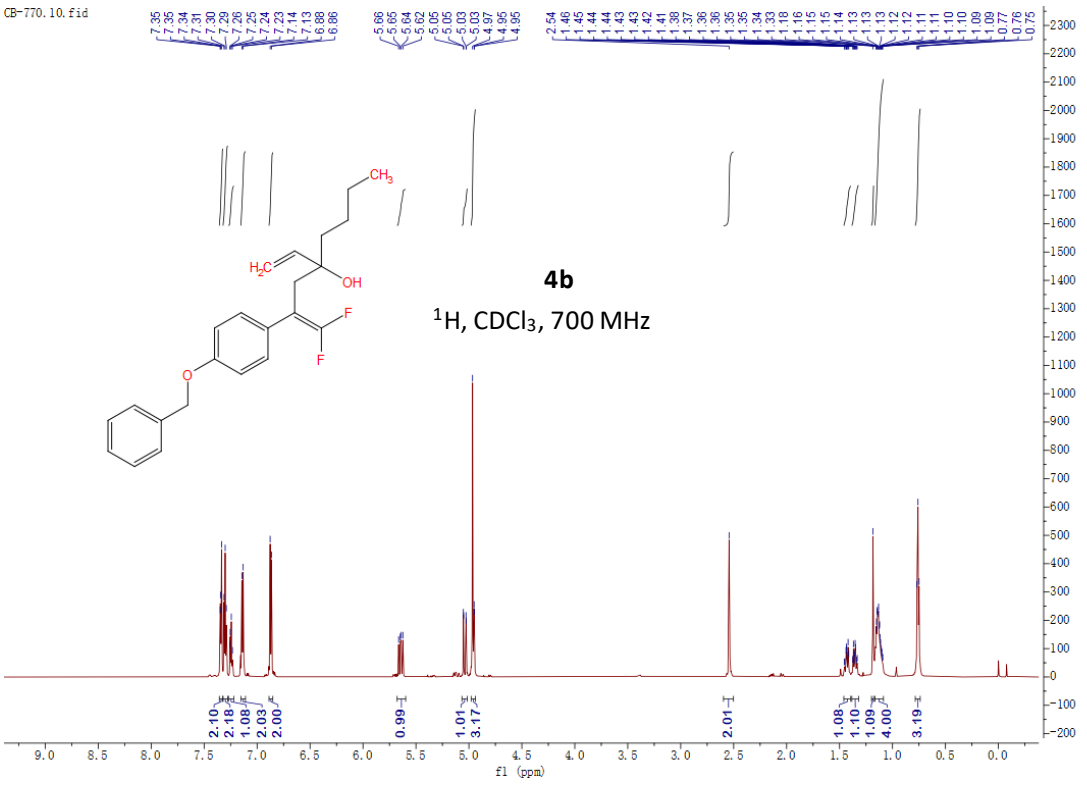

cb-777.10.fid
CH3
OH
F
F
O
4a
1H, CDCl3, 700 MHz
f1 (ppm)


cb-777.11.fid
CH3
OH
F
F
O
4a
13C, CDCl3, 176 MHz
f1 (ppm)



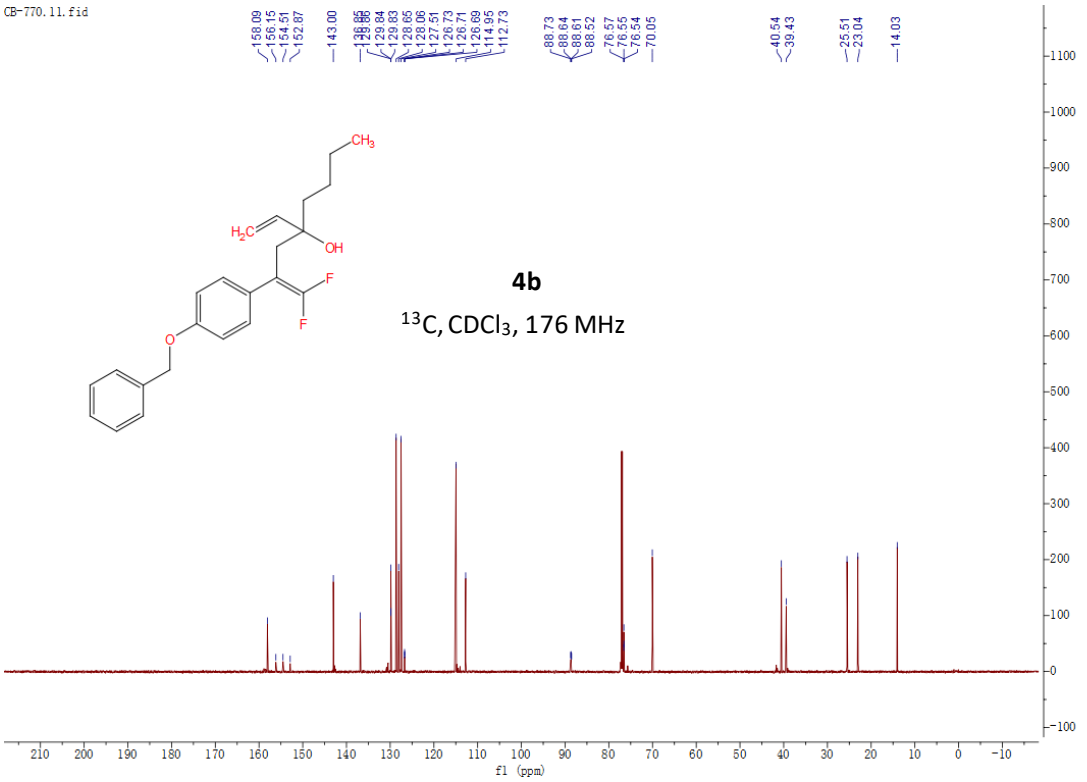
4a

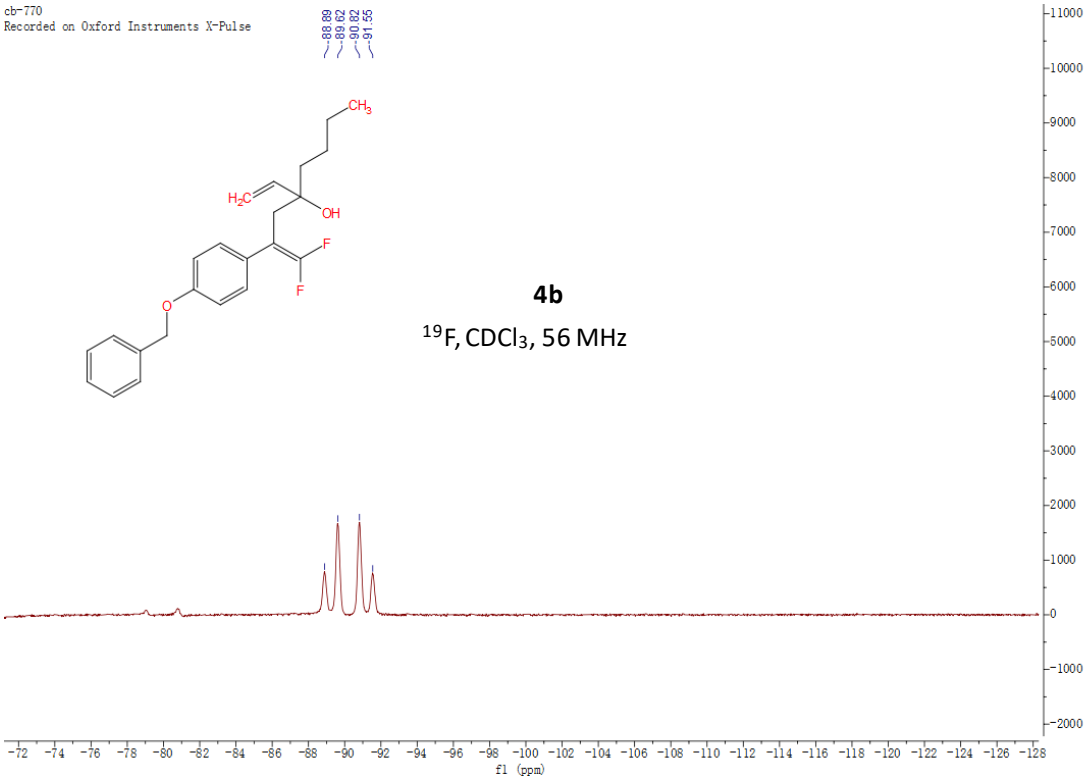
^{19}F, $CDCl_3$, 56 MHz

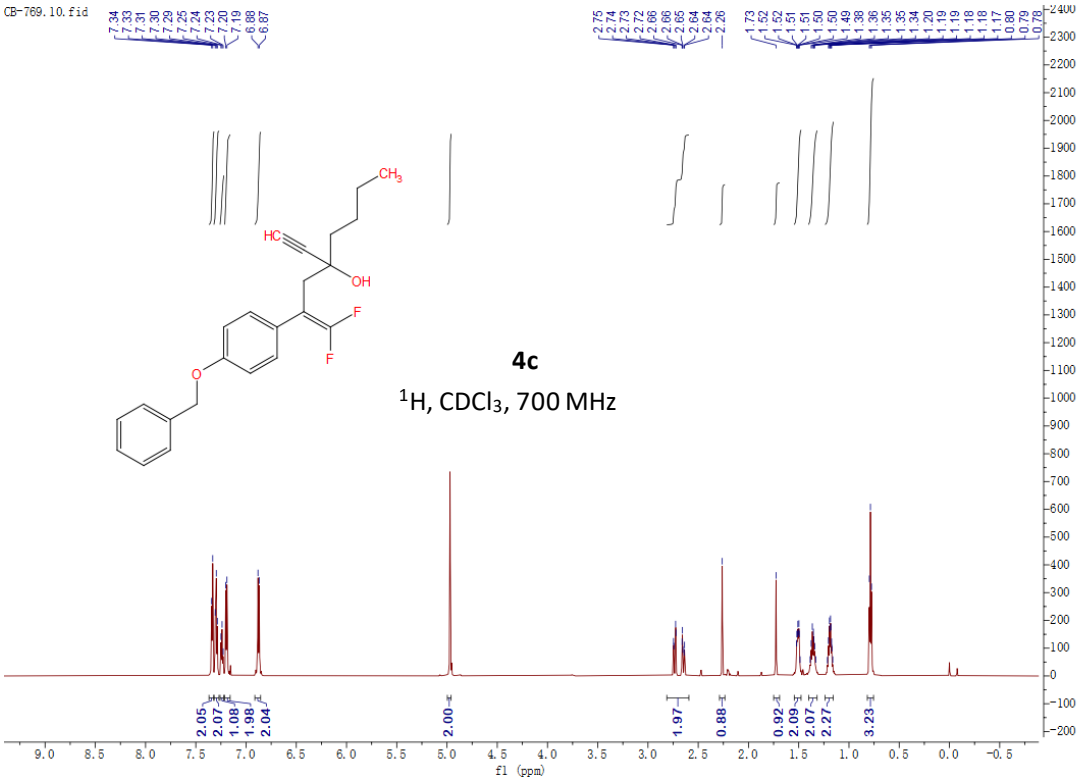


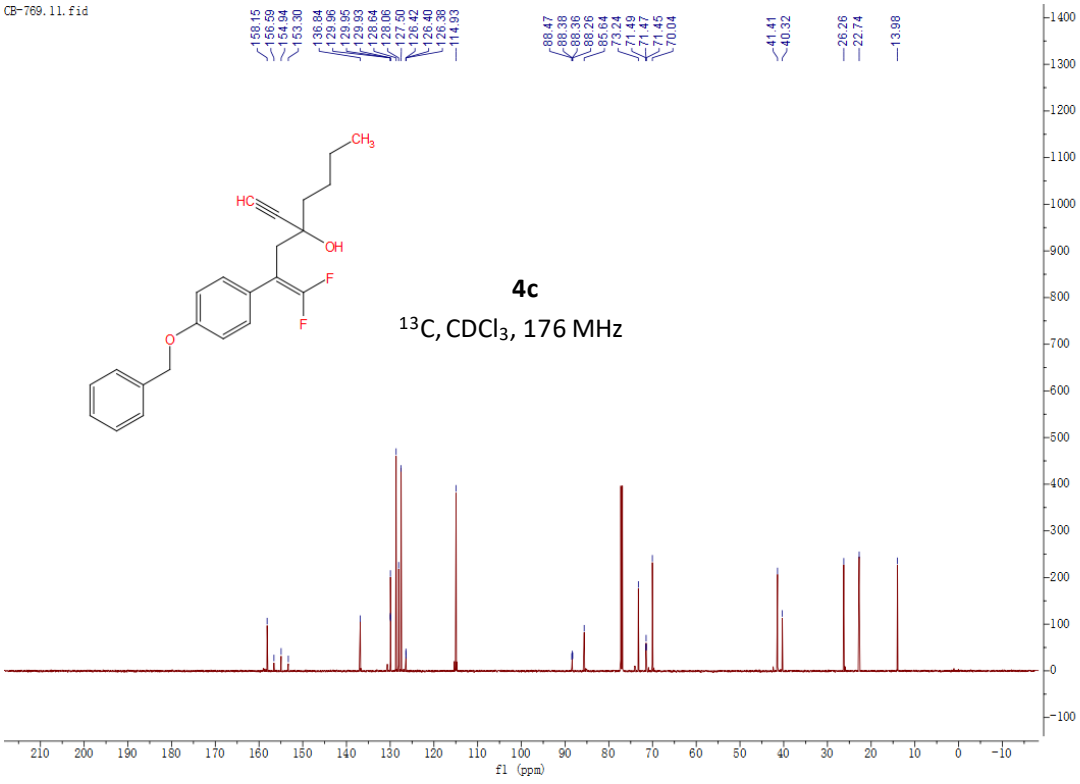
4b

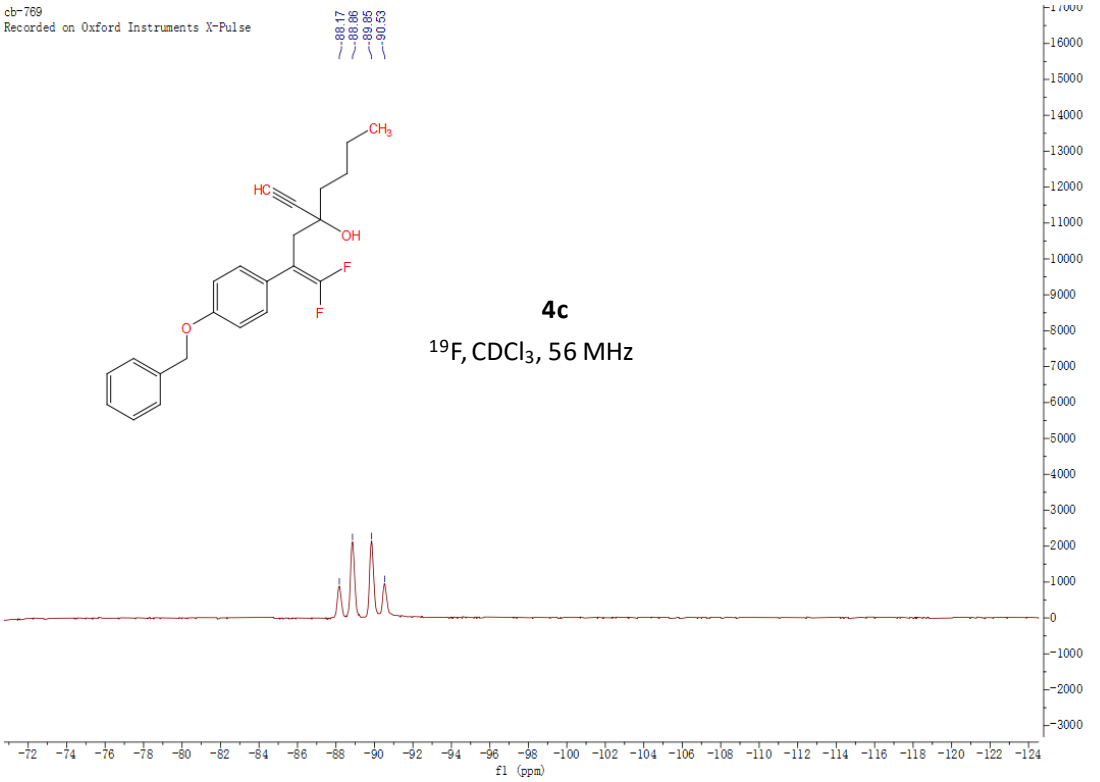
^{1}H, $CDCl_3$, 700 MHz

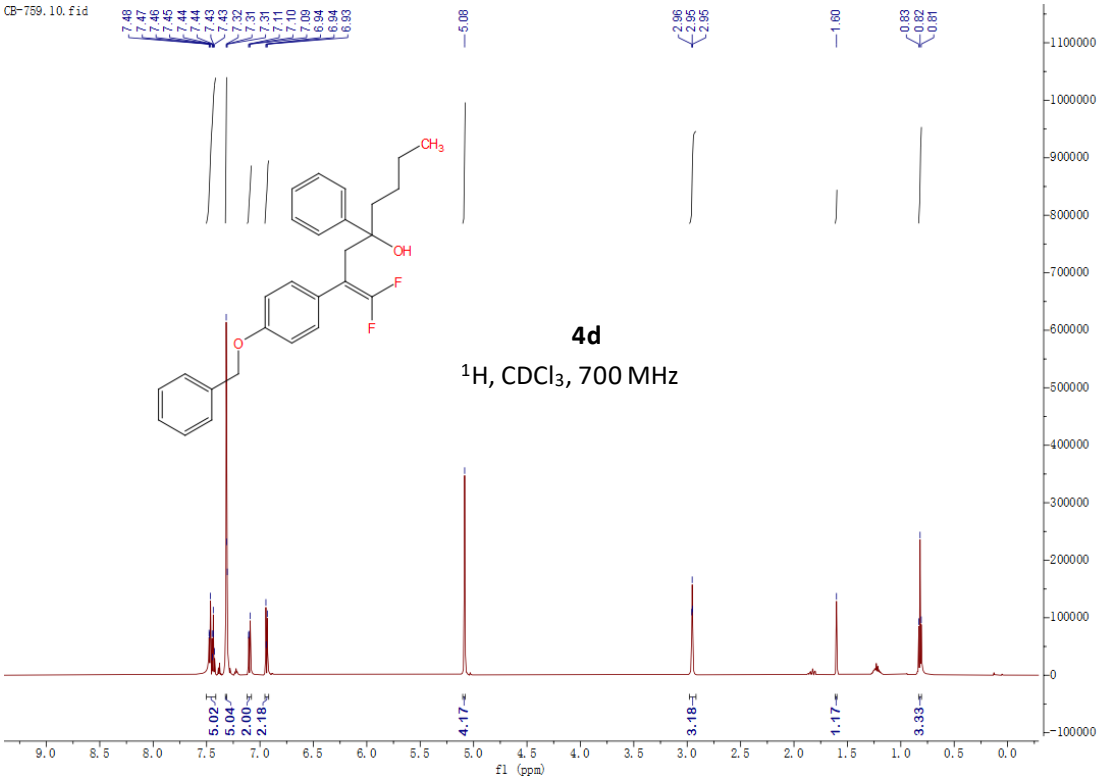

CB-770.11.fid
158.09
156.15
154.51
152.87
143.00
129.84
129.83
128.65
128.06
127.51
126.73
126.71
126.69
114.95
112.73
88.73
88.64
88.61
88.52
76.57
76.55
76.54
70.05
40.54
39.43
25.51
23.04
14.03
CH3
H2C
OH
F
F
O
4b
13C, CDCl3, 176 MHz
f1 (ppm)

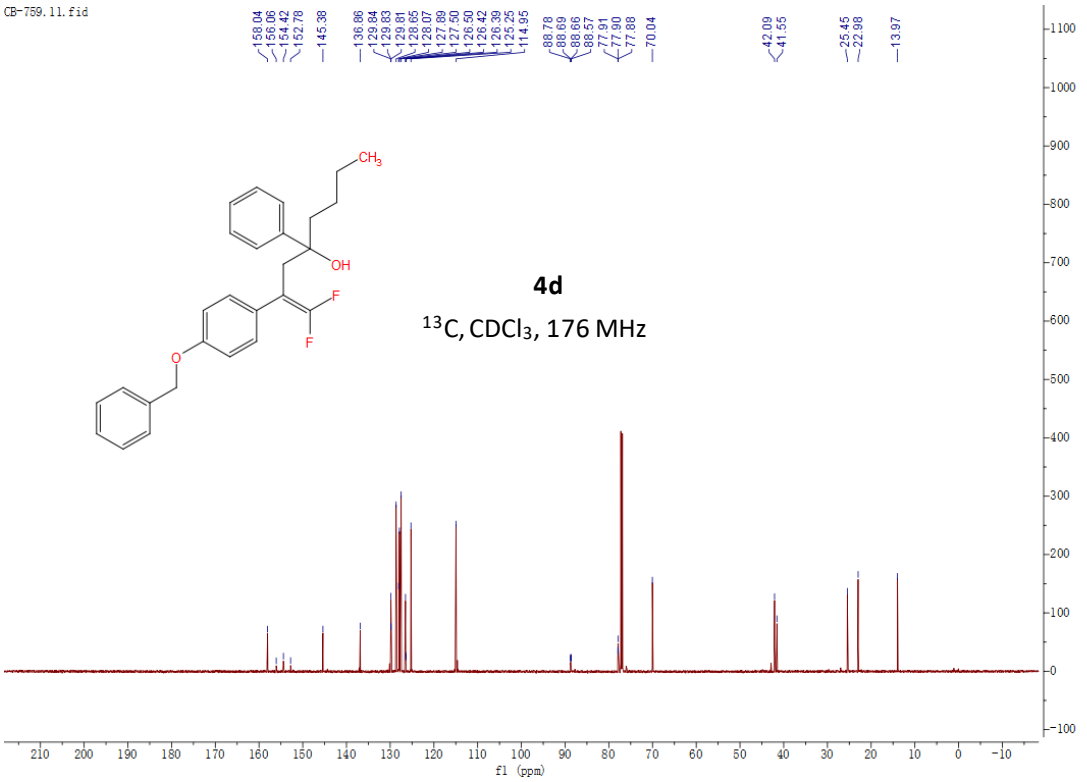

cb-770
Recorded on Oxford Instruments X-Pulse
88.89
89.62
90.62
91.55
CH3
H2C
OH
F
F
O
4b
19F, CDCl3, 56 MHz
f1 (ppm)

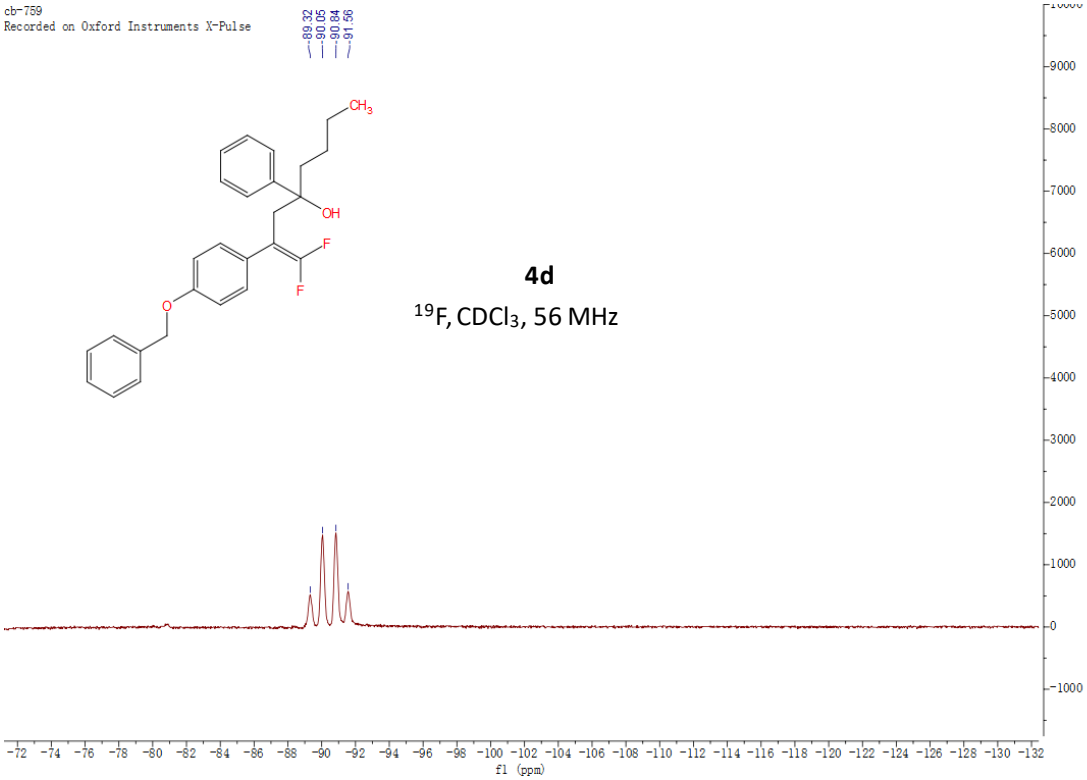

CB-769.10.fid
CH3
HC
OH
F
F
O
4c
1H, CDCl3, 700 MHz
f1 (ppm)

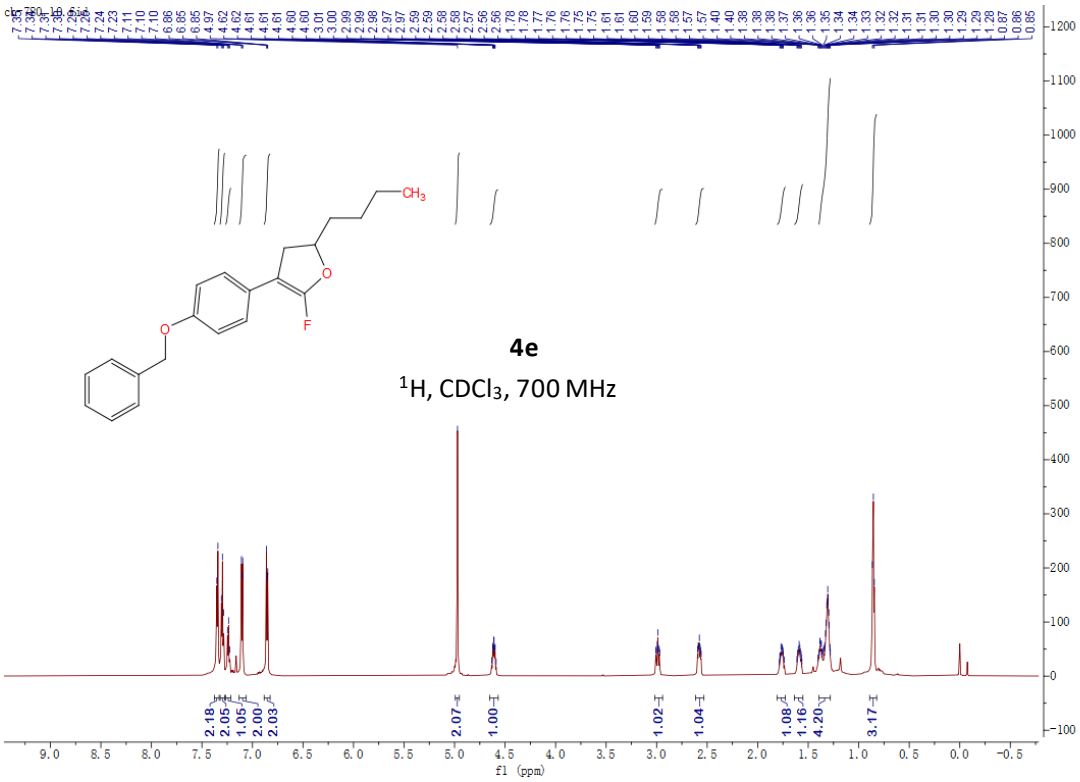

CB-769.11.fid
CH3
HC
OH
F
F
O
4c
13C, CDCl3, 176 MHz
f1 (ppm)


cb-769
Recorded on Oxford Instruments X-Pulse
-88.17
-88.86
-89.85
-90.53
CH3
HC
OH
F
F
O
4c
19F, CDCl3, 56 MHz
f1 (ppm)


CB-759.10.fid
7.48
7.47
7.46
7.45
7.44
7.43
7.32
7.31
7.31
7.11
7.10
7.09
6.94
6.94
6.93
5.08
2.96
2.95
2.95
1.60
0.83
0.82
0.81
CH3
OH
F
F
O
4d
1H, CDCl3, 700 MHz
5.02
5.04
2.00
2.18
4.17
3.18
1.17
3.33
f1 (ppm)

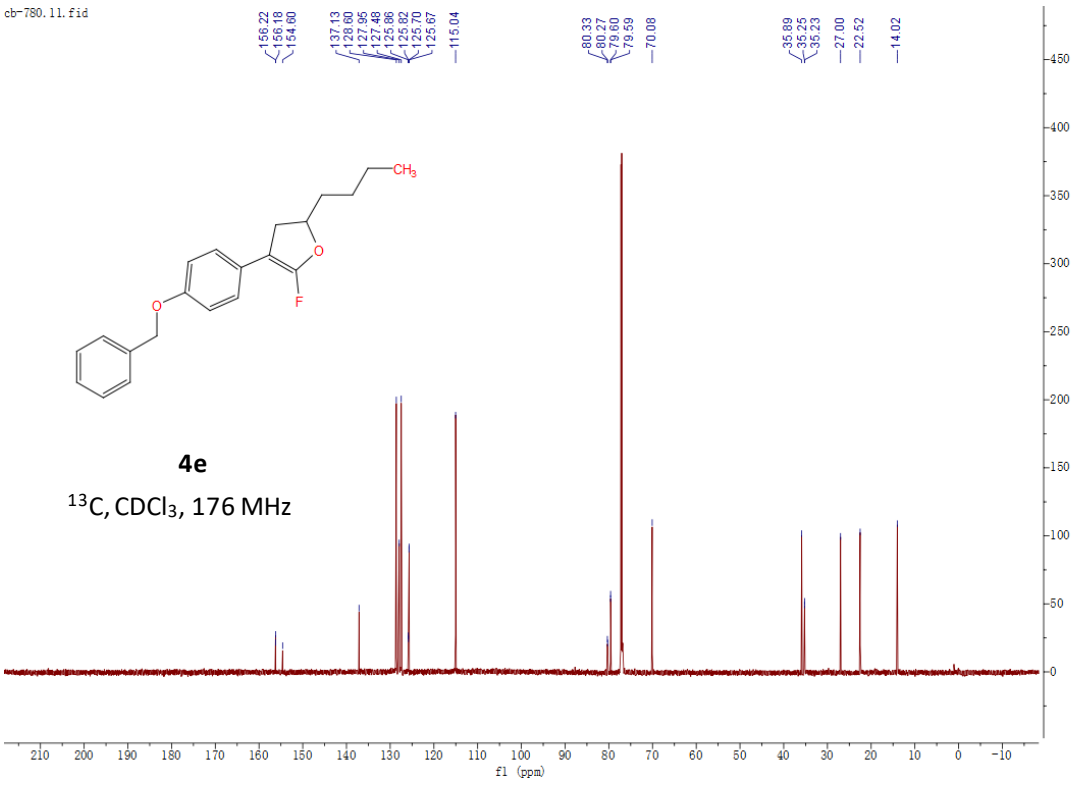

CB-759.11.fid
158.04
156.06
154.42
152.78
145.38
136.86
129.84
129.83
129.81
128.65
128.07
127.89
127.50
126.50
126.42
126.39
125.25
114.95
88.78
88.69
88.66
88.57
77.91
77.90
77.88
70.04
42.09
41.55
25.45
22.98
13.97
CH3
OH
F
F
O
4d
13C, CDCl3, 176 MHz
f1 (ppm)


cb-759
Recorded on Oxford Instruments X-Pulse
89.32
90.05
90.84
91.56
CH3
OH
F
F
O
4d
19F, CDCl3, 56 MHz
f1 (ppm)



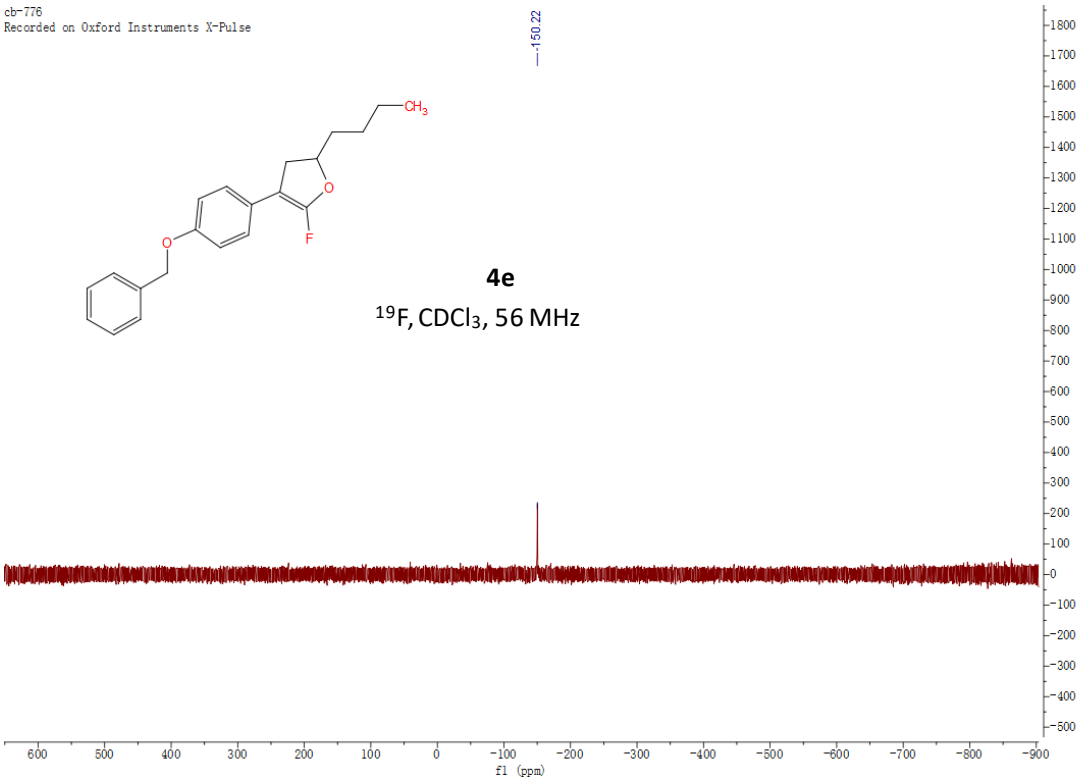
4e

^{1}H, $CDCl_3$, 700 MHz



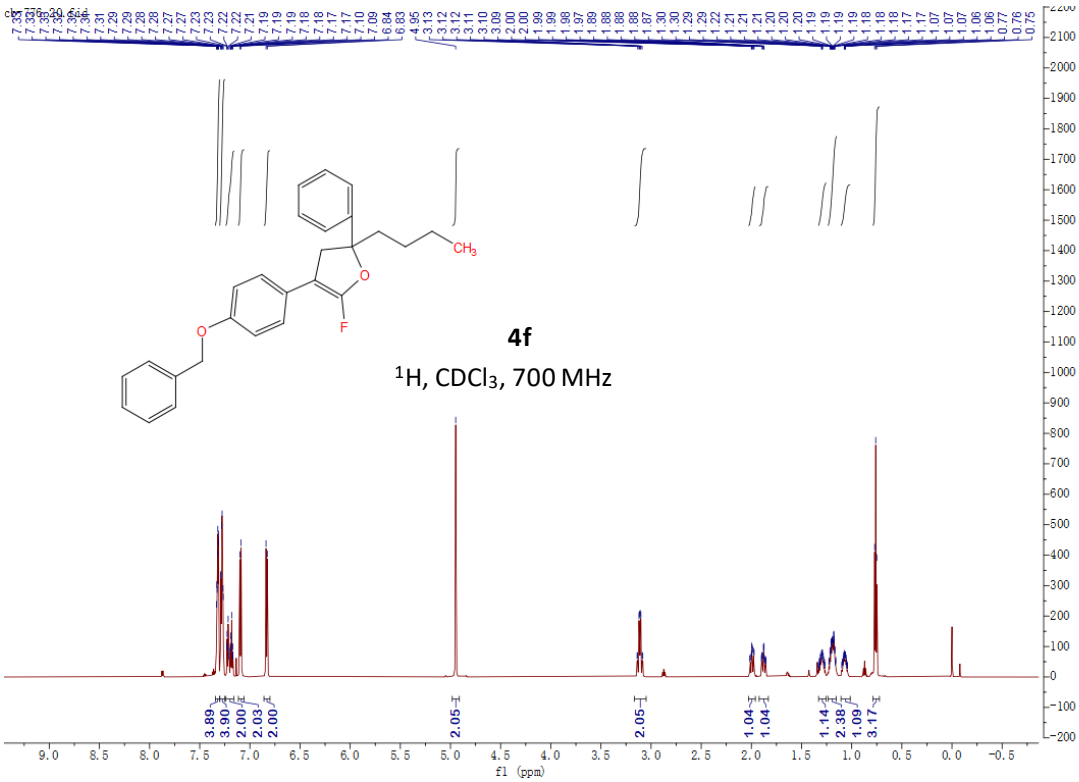
4e

^{13}C, $CDCl_3$, 176 MHz



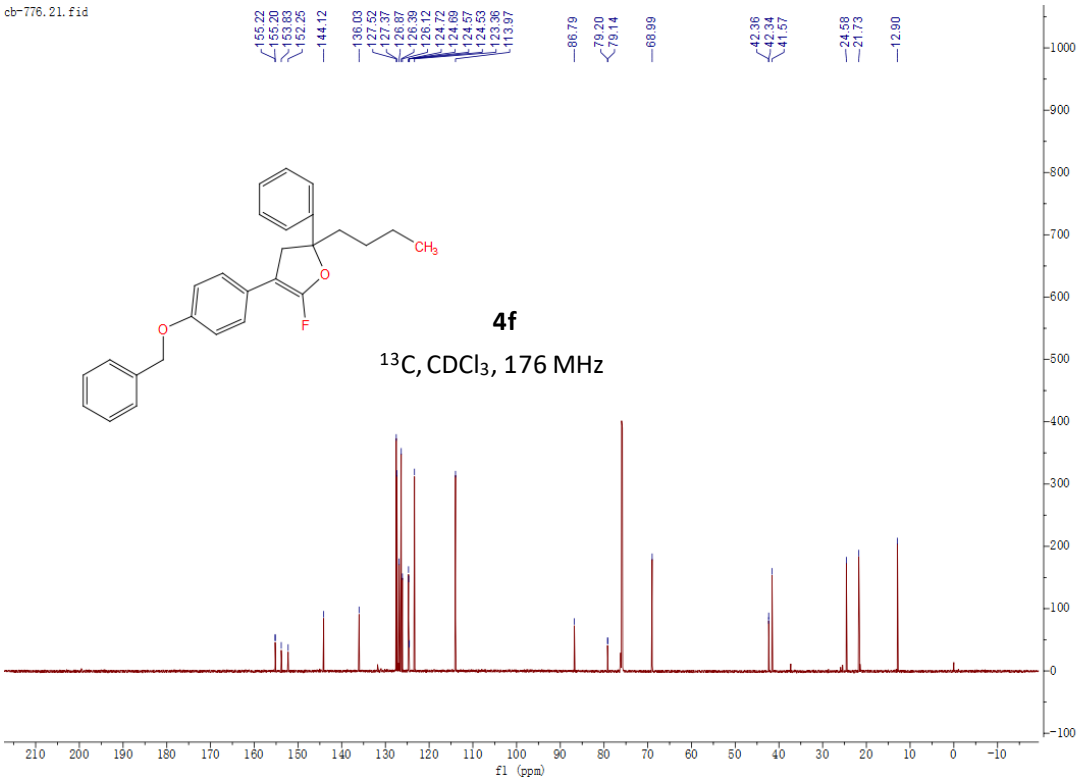
4e

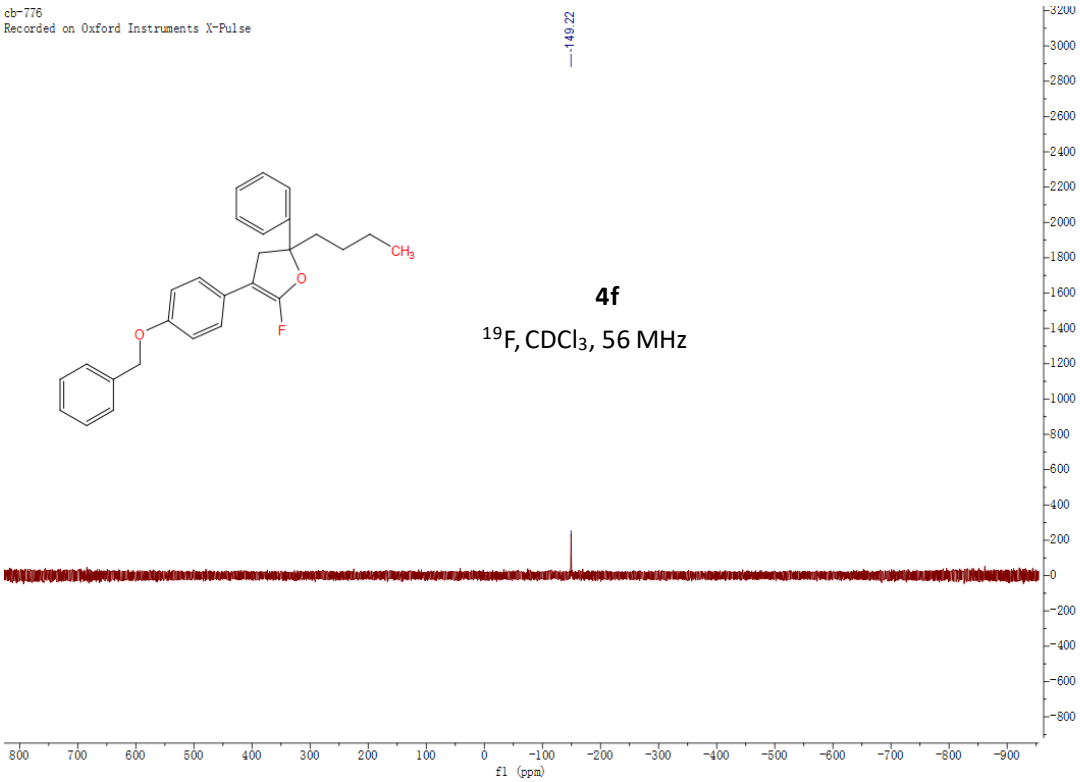
^{19}F, $CDCl_3$, 56 MHz



4f

^{1}H, $CDCl_3$, 700 MHz


cb-776.21.fid
155.22
155.20
153.83
152.25
144.12
136.03
127.52
127.37
126.87
126.39
126.12
124.72
124.69
124.57
124.53
123.36
113.97
86.79
79.20
79.14
68.99
42.36
42.34
41.57
24.58
21.73
12.90
CH3
O
O
F
4f
13C, CDCl3, 176 MHz
f1 (ppm)


cb-776
Recorded on Oxford Instruments X-Pulse
149.22
CH3
O
O
F
4f
19F, CDCl3, 56 MHz
f1 (ppm)