Supporting Information

Organophotocatalytic acyltrifluoromethylation of unactivated alkenes enabled the efficient synthesis of CF_3- substituted chroman-4-one

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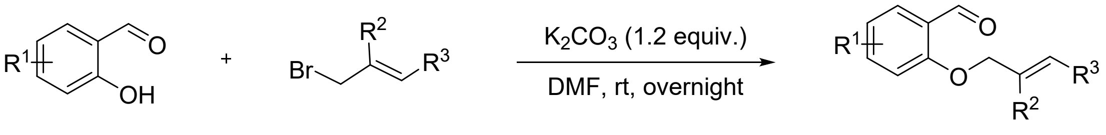
(A) General Information

All reactions and manipulations which are sensitive to moisture or air were performed under inert atmosphere of argon. All chemicals were purchased from J&K, Acros and Aldrich, and were used as received. Anhydrous THF, DMSO, 1,4-dioxane, DMF and MeCN were freshly distilled from calcium hydride. Anhydrous MeOH freshly distilled from magnesium. ^{1}H NMR, ^{13}C NMR spectra were recorded on a Bruker AVANCE 400 and chemical shifts are reported in δ (ppm) referenced to residual undeuterated solvent signal for ^{1}H NMR (7.26 ppm) and ^{13}C NMR (77 ppm). The following abbreviations were used to designate chemical shift multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet. All first-order splitting patterns were assigned on the basis of the appearance of the multiplet. HRMS spectra were recorded on a Waters Acquity UPLC/Xevo TQD-MS-MS quadrupole mass spectrometer. The light source for the photocatalytic reaction is manufactured by GeAo chemistry with a power of 24 W blue LED (450–465 nm). A fan was used to maintain the reaction temperature at room temperature (about 25-30 °C). The reactions were carried out in a borosilicate glass vessel and the distance from the light source to the irradiation vessel is about 1 cm.

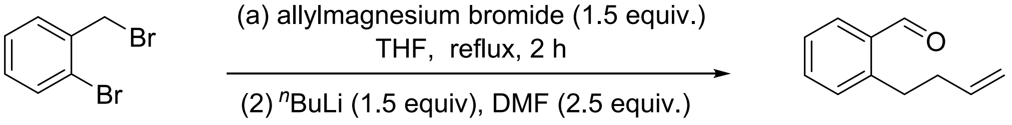
Photoreactor (GeAo)

(B) General procedure for the synthesis of compound 1



1a-1y, 1ca

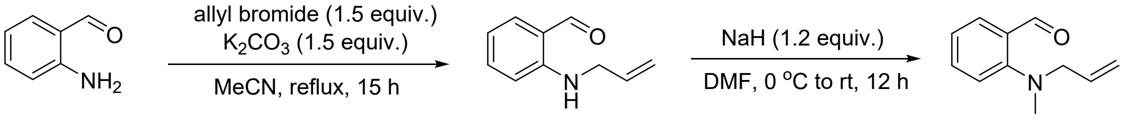
According to the literature.[1] To a solution of 2-hydroxyarylaldehyde (5 mmol, 1.0 equiv.) in DMF (15 mL) was added K_2CO_3 (828 mg, 6 mmol, 1.2 equiv.), followed by the dropwise addition of allyl bromide (726 mg, 6 mmol, 1.2 equiv.). The reaction mixture was then stirred for 12 h at room temperature, poured into brine and extracted with EtOAc. The combined extracts were dried over $MgSO_4$, filtered, and evaporated. The residue was purified by column chromatography (petroleum ether/ethyl acetate) to afford the desired 2-(allyloxy)arylaldehyde **1a-1y**, **1ca**.



1z

According to the literature.[2] To s solution of 2-bromobenzylbromide (2.0 g, 7.3 mmol, 1.0 equiv.) in anhydrous THF (6 mL) was added allylmagnesium bromide (11 mL, 1 M in THF, 11.0 mmol, 1.5 equiv.) at room temperature. The reaction mixture was heated to reflux in an oil bath for 2 h. The reaction mixture was cooled down to room temperature and quenched with saturated NH_4Cl (10 mL), extracted with diethyl ether (3 x 50 mL), dried over anhydrous magnesium sulfate, filtered and concentrated in vacuo, the remaining crude product was used directly for the next step without purification.

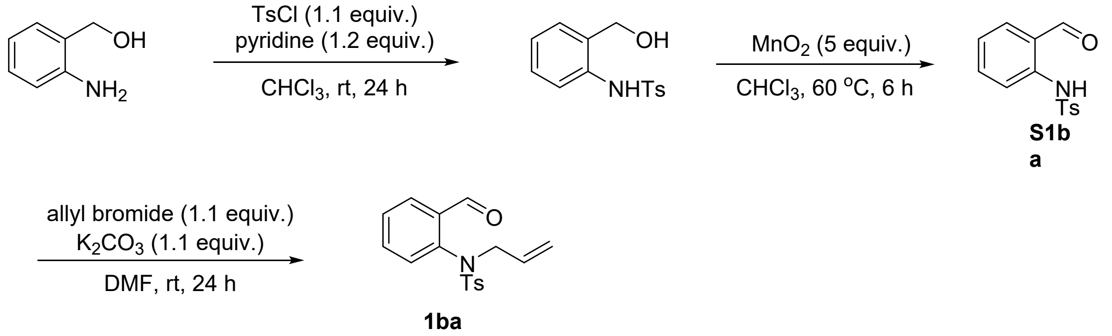
The crude product was redissolved in anhydrous THF (8 mL) at -78 °C and ^{n}BuLi(6.9 mL, 1.6 M in hexanes, 11.0 mmol, 1.5 equiv.) was added dropwise over 30 mins followed by the dropwise addition a solution of DMF (1.3 mL, 18.2 mmol, 2.5 equiv.) in THF (3.0 mL) over 30 mins. The reaction mixture solution was allowed to warm to room temperature overnight before quenching with saturated NH_4Cl (10 mL). The aqueous layer was extracted with diethyl ether (3 x 50 mL), dried over anhydrous magnesium sulfate, filtered, concentrated *in vacuo* and purified by flash column chromatography (petroleum ether/diethyl ether = 50:1) to afford **1z** (759 mg, 65%) as a colorless oil.



S1aa **1aa**

According to the literature.[3] To a solution of 2-aminobenzaldehyde (5 mmol, 1.0 equiv.) in anhydrous MeCN (25 mL) was added K_2CO_3 (1.04 g, 7.5 mmol, 1.5 equiv.), followed by the dropwise addition of allyl bromide (907 mg, 7.5 mmol, 1.5 equiv.). The reaction mixture was heated to reflux in an oil bath for 15 h, quenched with saturated NaCl (10 mL) and extracted with EtOAc (3 x 20 mL). The combined extracts were dried over $MgSO_4$, filtered, and evaporated. The crude product was then purified by silica gel chromatography (petroleum ether/ethyl acetate = 20:1) to afford **S1ca** (363 mg, 61% yield) as a colorless oil.

To a solution of **S1ca** in anhydrous DMF (20 mL) was added NaH (60% dispersion in mineral oil, 164 mg, 4.1 mmol, 1.2 equiv.) was added portionwise at 0 ^{o}C. And the reaction mixture was stirred at 0 °C for 10 min. Then MeI (582 mg, 4.1 mmol, 1.2 equiv.) was added to at 0 °C, and then reaction mixture was warmed to room temperature for 12 h. After completion of the reaction, the reaction mixture was quenched with H_2O (5 mL) at 0 °C, extracted with EtOAc (3 x 20 mL). The combined extracts were dried over $MgSO_4$, filtered, and evaporated. The crude product was then purified by silica gel chromatography (petroleum ether/ethyl acetate = 20:1) to afford **1ca** (578 mg, 72% yield) as a yellow oil.



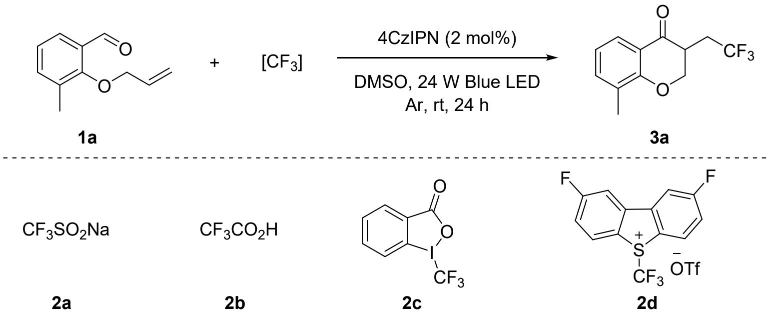
According to the literature.[4] To a solution of 2-aminobenzyl alcohol (1.23 g, 10 mmol, 1.0 equiv.) in $CHCl_3$ (35 mL) were added pyridine (949 mg, 12 mmol, 1.2 equiv.) and TsCl (2.10 g, 11 mmol, 1.1 equiv.). The mixture was stirred at room temperature for 24 h to complete the reaction. Then concentrated in vacuo, the remaining crude product was used directly for the next step without purification.

To a solution of the crude product in $CHCl_3$ (25 mL) was added activated MnO_2 (4.35 g, 50 mmol, 5 equiv.) at room temperature. The reaction mixture was warmed to 60 ^{o}C in an oil bath for 6 h. After completed, the mixture was cooled to room temperature and filtered. The filtrate was evaporated under reduced pressure and the crude product was purified by silica gel chromatography (petroleum ether/ethyl acetate = 8:1) to afford **S1aa** (1.68 g, 61% yield) as a white solid.

To a solution of **S1aa** in DMF (10 mL) was added K_2CO_3 (881 mg, 6.4 mmol, 1.1 equiv.), followed by the dropwise addition of allyl bromide (772 mg, 6.4 mmol, 1.1 equiv.). The reaction mixture was stirred for 24 h at room temperature. Water (50 mL) was then added and the mixture was extracted with EtOAc (3 × 25 mL). The combined organic extracts were washed with brine (50 mL), dried over anhydrous Na_2SO_4 and concentrated under reduced pressure. The crude product was then purified by silica gel chromatography (petroleum ether/ethyl acetate = 8:1) to afford **1aa** (1.03 g, 56% yield) as a white solid.

(C) Optimization of the reaction conditions

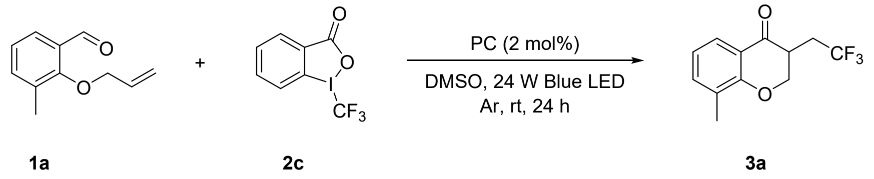
Table S1. Screening of trifluoromethyl reagents[a]



entry	[CF_3]	yield (%)[b]
1	**2a**	40
2	**2b**	n.r.
3	**2c**	53
4	**2d**	51

[a]Reaction conditions: **1a** (0.2 mmol), **2** (0.3 mmol), 4CzIPN (2 mol%), solvent (2.0 mL), irradiation with 24 W blue LED at rt under Ar atmosphere for 24 h. [b]NMR yield were determined by ^1H NMR analysis using 1,3,5-trimethoxybenzene as internal standard.

Table S2. Screening photocatalysts[a]

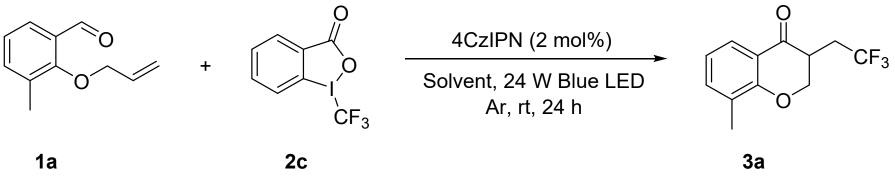


entry	PC	yield (%)[b]
1	4CZIPN	53
2	4DPAIPN	50
3	4CZPN-Ph	31
4	3DPAFIPN	49

5	4CZPN-Bu	53
6	Acr$^+$-MeS$^+$ ClO$_4^-$	47
7	[Ir{dFCF$_3$ppy}$_2$(bpy)]PF$_6$	34
8	Ru(dmbpy)$_3$](PF$_6$)$_2$	31

[a]Reaction conditions: **1a** (0.2 mmol), **2c** (0.3 mmol), photocatalyst (2 mol%), DMSO (2.0 mL), irradiation with 24 W blue LED at rt under Ar atmosphere for 24 h. [b]NMR yield were determined by ^{1}H NMR analysis using 1,3,5-trimethoxybenzene as internal standard.

Table S3. Screening solvents[a]



entry	solvent	yield (%)[b]
1	DMSO	53
2	DMF	49
3	EA	trace
4	1,4-Dioxane	45
5	THF	trace
6	DME	trace
7	CH$_3$CN	40
8	CH$_3$OH	36

[a]Reaction conditions: **1a** (0.2 mmol), **2c** (0.3 mmol), 4CzIPN (2 mol%), solvent (2.0 mL), irradiation with 24 W blue LED at rt under Ar atmosphere for 24 h. [b]NMR yield were determined by ^{1}H NMR analysis using 1,3,5-trimethoxybenzene as internal standard.

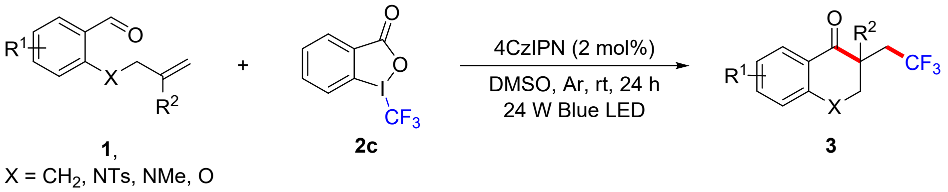
Table S4. Screening the ratio of **1a**/**2c**[a]

entry	**1a** (x mmol)	**2c** (y mmol)	yield (%)[b]
1	1	1	69
2	1	1.5	53
3	1	2	37

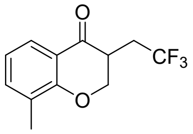
4	1.5	1	81 (78)^c
5	2	1	83

^{a}Reaction conditions: **1a** (x mmol), **2c** (y mmol), 4CzIPN (2 mol%), DMSO (2.0 mL), irradiation with 24 W blue LED at rt under Ar atmosphere for 24 h. ^{b}NMR yield were determined by ^{1}H NMR analysis using 1,3,5-trimethoxybenzene as internal standard. ^{c}Isolated yield

(D) General procedure for the synthesis of 3



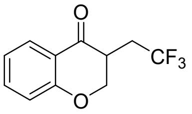
To a screw-capped vial with stirring bar were added 4CzIPN (3.2 mg, 0.004 mmol, 2 mol%), **1** (0.3 mmol, 1.5 equiv.), Togni II reagent **2c** (0.2 mmol, 1.0 equiv.) in an argon-filled glovebox. After the DMSO (2.0 mL) was added into the vial *via* a syringe, the vial was sealed with a cap containing a PTFE septum and removed out from the glovebox. The reaction mixture was stirred at room temperature for 24 h upon irradiation with 24 W blue LED under argon atmosphere. After completion of the reaction, quenched with saturated NaCl (2 mL) and extracted with EtOAc (3 x 5 mL). The combined extracts were dried over $MgSO_4$, filtered, and evaporated. The crude product was then purified by silica gel chromatography (petroleum ether/ethyl acetate) to afford **3aa-3ca.**



3a

(S)-8-methyl-3-(2,2,2-trifluoroethyl)chroman-4-one (3a)

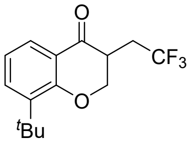
38.1 mg, 78% yield. White solid, mp 67–68 °C, R_f = 0.3 (petroleum ether/ethyl acetate = 80:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.75 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.36 (dd, *J* = 7.2, 0.8 Hz, 1H), 6.96–6.92 (m, 1H), 4.77 (dd, *J* = 11.2, 5.2 Hz, 1H), 4.23 (t, *J* = 11.9 Hz, 1H), 3.17–3.01 (m, 2H), 2.25 (s, 3H), 2.15–2.01 (m, 1H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 191.1, 159.8, 137.2, 127.6 (q, *J* = 274.7 Hz), 127.2, 125.2, 121.2, 119.7, 69.7 (d, *J* = 2.5 Hz), 40.4 (d, *J* = 1.7 Hz), 29.6 (q, *J* = 29.9 Hz), 15.5. **^{19}F NMR (376 MHz, CDCl$_3$)** δ -64.0 (s). **HRMS (ESI)** m/z: [M+H]$^+$ calcd for $C_{12}H_{12}F_3O_2$: 245.0784; Found: 245.0794.



3b

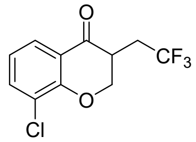
3-(2,2,2-trifluoroethyl)chroman-4-one (3b).

25.6 mg, 57% yield. White solid, mp 48–49 °C, R_f = 0.3 (petroleum ether/ethyl acetate = 120:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.90 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.53–7.49 (m, 1H), 7.10–7.03 (m, 1H), 6.99 (d, *J* = 8.0 Hz), 4.72 (dd, *J* = 11.4, 5.0 Hz, 1H), 4.24 (t, *J* = 11.8 Hz, 1H), 3.20–3.02 (m, 2H), 2.16–2.01 (m, 1H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 190.9, 161.7, 136.5, 127.7, 126.8 (q, *J* = 274.7 Hz), 121.9, 120.2, 118.0, 69.9 (d, *J* = 1.5 Hz), 40.6 (d, *J* = 2.0 Hz), 29.7 (q, *J* = 30.0 Hz). **^{19}F NMR (376 MHz, CDCl$_3$)** δ -64.0 (s). **HRMS (ESI)** m/z: [M+Na]$^+$ calcd for $C_{11}H_9F_3O_2Na$: 253.0447; Found: 253.0441.


3c

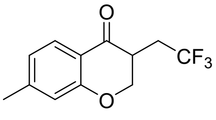
8-(*tert*-butyl)-3-(2,2,2-trifluoroethyl)chroman-4-one (3c).

36.0 mg, 62% yield. Colorless oil, R$_f$ = 0.4 (petroleum ether/ethyl acetate = 40:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.81 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.50 (dd, *J* = 7.6, 1.6 Hz, 1H), 7.00–6.96 (m), 4.79 (dd, *J* = 11.0, 5.0 Hz, 1H), 4.22 (t, *J* = 11.6 Hz, 1H), 3.19–3.02 (m, 2H), 2.16–2.02 (m), 1.39 (s, 9H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 191.4, 160.8, 139.1, 133.4, 126.7 (q, *J* = 274.7 Hz), 125.7, 121.4, 120.9, 69.3, 40.4 (d, *J* = 1.9 Hz), 34.9, 29.8 (q, *J* = 29.8 Hz). **^{19}F NMR (376 MHz, CDCl$_3$)** δ -64.0 (s). **HRMS (ESI)** m/z: [M+Na]$^+$ calcd for $C_{15}H_{17}F_3O_2Na$: 309.1073; Found: 309.1073.


3d

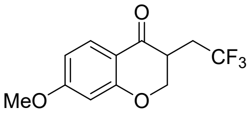
Chloro-3-(2,2,2-trifluoroethyl)chroman-4-one (3d).

29.2 mg, 55% yield. White solid, mp 87–88 °C, R$_f$ = 0.4 (petroleum ether/ethyl acetate = 40:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.83 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.60 (dd, *J* = 7.8, 1.4 Hz, 1H), 7.03–6.99 (m, 1H), 4.88 (dd, *J* = 11.6, 5.2 Hz, 1H), 4.32 (t, *J* = 12.0 Hz, 1H), 3.24–3.02 (m, 2H), 2.17–2.03 (m, 1H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 190.1, 157.2, 136.6, 126.6 (q, *J* = 274.7 Hz), 126.3, 122.9, 122.1, 121.5, 70.4, 40.4 (d, *J* = 1.9 Hz), 29.6 (q, *J* = 30.1 Hz). **^{19}F NMR (376 MHz, CDCl$_3$)** δ -64.0 (s). **HRMS (ESI)** m/z: [M+Na]$^+$ calcd for $C_{11}H_8ClF_3O_2Na$: 287.0057; Found: 257.0065.


3e

7-methyl-3-(2,2,2-trifluoroethyl)chroman-4-one (3e).

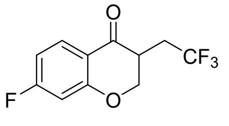
29.3 mg, 60% yield. White solid, mp 62–63 °C, R$_f$ = 0.3 (petroleum ether/ethyl acetate = 80:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.78 (d, *J* = 8.0 Hz, 1H), 6.86 (d, *J* = 8.4 Hz, 1H), 6.79 (s, 1H), 4.68 (dd, *J* = 11.8, 5.0 Hz, 1H), 4.21 (t, *J* = 11.6 Hz, 1H), 3.14–3.00 (m, 2H), 2.36 (s, 3H), 2.13–1.99 (m, 1H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 190.5, 161.8, 148.2, 127.6, 126.8 (q, *J* = 274.7 Hz), 123.4, 118.0, 69.9 (d, *J* = 1.4 Hz), 40.6 (d, *J* = 1.9 Hz), 29.8 (q, *J* = 29.9 Hz), 22.1. **^{19}F NMR (376 MHz, CDCl$_3$)** δ -64.0 (s). **HRMS (ESI)** m/z: [M+H]$^+$ calcd for $C_{12}H_{12}F_3O_2$: 245.0784; Found: 245.0777.


3f

7-methoxy-3-(2,2,2-trifluoroethyl)chroman-4-one (3f).

26.7 mg, 48% yield. White solid, mp 100–101 °C, R$_f$ = 0.4 (petroleum ether/ethyl acetate = 60:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.83 (d, *J* = 8.8 Hz, 1H), 6.60 (dd, *J* = 8.8, 2.4 Hz, 1H), 6.41 (d, *J* = 2.4 Hz, 1H), 4.69

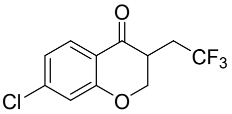
(dd, *J* = 11.2, 4.8 Hz, 1H), 4.22 (t, *J* = 11.4 Hz, 1H), 3.84 (s, 3H), 3.14–3.01 (m, 2H), 2.12–2.01 (m, 1H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 189.4, 166.4, 163.7, 129.5, 126.9 (q, *J* = 277.5 Hz), 114.0, 110.6, 100.8, 70.2, 55.8, 40.2, 29.8 (q, *J* = 30 Hz). **^{19}F NMR (376 MHz, CDCl$_3$)** δ -64.0 (s). **HRMS (ESI)** m/z: [M+H]$^+$ calcd for $C_{12}H_{12}F_3O_3$: 261.0733; Found: 261.0769.



3g

7-fluoro-3-(2,2,2-trifluoroethyl)chroman-4-one (3g).

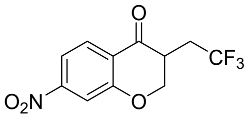
24.2 mg, 49% yield. White solid, mp 43–44 °C, R$_f$ = 0.3 (petroleum ether/ethyl acetate = 120:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.93 (dd, *J* = 8.8, 6.8 Hz, 1H), 6.77 (td, *J* = 8.6, 2.4 Hz, 1H), 6.68 (dd, *J* = 9.6, 2.4 Hz, 1H), 4.74 (dd, *J* = 11.4, 5.0 Hz, 1H), 4.25 (t, *J* = 11.8 Hz, 1H), 3.18–3.02 (m, 2H), 2.14–2.00 (m, 1H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 189.5, 167.8 (dd, *J* = 255.6 Hz), 163.4 (d, *J* = 13.6 Hz), 130.4 (d, *J* = 11.5 Hz), 126.7 (q, *J* = 274.6 Hz), 117.1 (d, *J* = 2.4 Hz), 110.5 (d, *J* = 22.8 Hz), 104.9 (d, *J* = 22.6 Hz), 70.3, 40.4 (d, *J* = 2.0 Hz), 29.6 (q, *J* = 29.9 Hz). **^{19}F NMR (376 MHz, CDCl$_3$)** δ -64.0 (s), -99.4 (s). **HRMS (ESI)** m/z: [M+H]$^+$ calcd for $C_{11}H_9F_4O_2$: 249.0533; Found: 249.0535.



3h

chloro-3-(2,2,2-trifluoroethyl)chroman-4-one (3h).

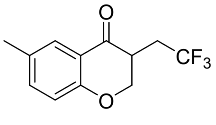
27.6 mg, 52% yield. White solid, mp 63–64 °C, R$_f$ = 0.4 (petroleum ether/ethyl acetate = 40:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.85–7.83 (m, 1H), 7.04 (dd, *J* = 6.6, 1.8 Hz, 2H), 4.74 (dd, *J* = 11.2, 5.2 Hz, 1H), 4.24 (t, *J* = 11.8 Hz, 1H), 3.18–3.00 (m, 2H), 2.15–2.01 (m, 1H). **^{13}C NMR (100 MHz, CHCl$_3$)** δ 189.8, 162.0, 142.5, 129.0, 126.7 (q, *J* = 274.8 Hz), 122.8, 118.8, 118.2, 77.2, 76.8, 29.7 (q, *J* = 30.1 Hz). **^{19}F NMR (376 MHz, CDCl$_3$)** δ -64.0 (s). **HRMS (ESI)** m/z: [M+H]$^+$ calcd for $C_{11}H_9ClF_3O_2$: 265.0238; Found: 265.0238.



3i

7-nitro-3-(2,2,2-trifluoroethyl)chroman-4-one (3i).

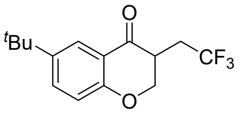
18.2 mg, 33% yield. Orange oil, R$_f$ = 0.4 (petroleum ether/ethyl acetate = 20:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 8.09–8.06 (m, 1H), 7.86 (dd, *J* = 6.8, 2.0 Hz, 2H), 4.85 (dd, *J* = 11.6, 5.2 Hz, 1H), 4.33 (t, *J* = 12.0 Hz, 1H), 3.29–3.22 (m, 1H), 3.18–3.04 (m, 1H), 2.19–2.04 (m, 1H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 189.6, 161.7, 152.5, 129.4, 126.4 (q, *J* = 274.7 Hz), 123.9, 116.3, 114.0, 70.3, 40.7 (d, *J* = 2.0 Hz), 29.5 (q, *J* = 30.3 Hz). **^{19}F NMR (376 MHz, CDCl$_3$)** δ -64.0 (s). **HRMS (ESI)** m/z: [M+Na]$^+$ calcd for $C_{11}H_8F_3NO_4Na$: 298.0298; Found: 298.0286.



3j

6-methyl-3-(2,2,2-trifluoroethyl)chroman-4-one (3j).

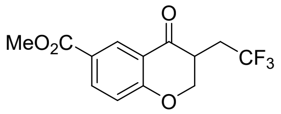
28.4 mg, 58% yield. White solid, mp 68–69 °C, R_f = 0.3 (petroleum ether/ethyl acetate = 120:1). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.69 (d, *J* = 1.2 Hz, 1H), 7.32 (dd, *J* = 8.4, 2.0 Hz, 1H), 6.89 (d, *J* = 8.4 Hz, 1H), 4.68 (dd, *J* = 11.0, 5.0 Hz, 1H), 4.21 (t, *J* = 11.6 Hz, 1H), 3.16–3.00 (m, 2H), 2.32 (s, 3H), 2.15–2.01 (m, 1H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 191.0, 159.7, 137.5, 131.3, 127.1, 126.6 (q, *J* = 274.6 Hz), 119.7, 117.7, 69.8, 40.6, 29.7 (q, *J* = 29.9 Hz), 20.4. **^{19}F NMR (376 MHz, $CDCl_3$)** δ -64.0 (s). **HRMS (ESI)** m/z: $[M+H]^+$ calcd for $C_{12}H_{12}F_3O_2$: 245.0784; Found: 245.0786.



3k

6-(tert-butyl)-3-(2,2,2-trifluoroethyl)chroman-4-one (3k).

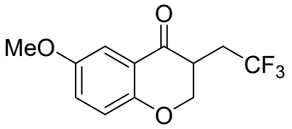
31.5 mg, 55% yield, White solid, mp 62–63 °C, R_f = 0.4 (petroleum ether/ethyl acetate = 40:1). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.89 (d, *J* = 2.4 Hz, 1H), 7.57 (dd, *J* = 8.6, 2.6 Hz, 1H), 6.93 (d, *J* = 8.8 Hz, 1H), 4.68 (dd, *J* = 11.4, 5.0 Hz, 1H), 4.22 (m, *J* = 11.8 Hz, 1H), 3.16–3.00 (m, 2H), 2.15–2.01 (m, 1H), 1.31 (s, 9H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 191.2, 159.7, 144.9, 134.3, 126.8 (q, *J* = 274.7 Hz), 123.6, 119.4, 117.6, 69.9 (d, *J* = 1.3 Hz), 40.7 (d, *J* = 1.9 Hz), 34.5, 31.4, 29.8 (q, *J* = 29.9 Hz). **^{19}F NMR (376 MHz, $CDCl_3$)** δ -64.0 (s). **HRMS (ESI) m/z**: $[M+Na]^+$ calcd for $C_{15}H_{17}F_3O_2Na$: 309.1073; Found: 309.1082.



3l

methyl4-oxo-3-(2,2,2-trifluoroethyl)chromane-6-carboxylate (3l).

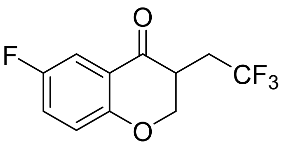
36.4 mg, 63% yield, White solid, mp 136–137 °C, R_f = 0.3 (petroleum ether/ethyl acetate = 20:1). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.57 (d, *J* = 2.4 Hz, 1H), 8.15 (dd, *J* = 8.8, 2.4 Hz, 1H), 7.03 (d, *J* = 8.4 Hz, 1H), 4.78 (dd, *J* = 11.6, 5.2 Hz, 1H), 4.28 (t, *J* = 11.8 Hz, 1H), 3.90 (s, 3H), 3.22–3.03 (m, 2H), 2.16–2.02 (m, 1H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 184.5, 160.6, 159.3, 131.8, 124.8, 121.3 (q, *J* = 274.7 Hz), 118.9, 114.4, 113.0, 64.7, 47.0, 35.2 (d, *J* = 1.9 Hz), 24.3 (q, *J* = 30.1 Hz). **^{19}F NMR (376 MHz, $CDCl_3$)** δ -64.0 (s). **HRMS (ESI)** m/z: $[M+Na]^+$ calcd for $C_{13}H_{11}F_3O_4Na$: 311.0502; Found: 311.0501.



3m

(S)-6-methoxy-3-(2,2,2-trifluoroethyl)chroman-4-one (3m)

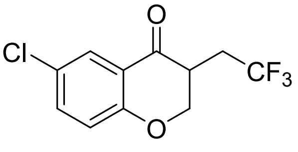
24.9 mg, 48% yield. Colorless oil, R_f = 0.3 (petroleum ether/ethyl acetate = 20:1). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.30 (d, *J* = 3.2 Hz, 1H), 7.11 (dd, *J* = 8.8, 3.2 Hz, 1H), 6.92 (d, *J* = 8.8 Hz, 1H), 4.67 (dd, *J* = 11.6, 5.2 Hz, 1H), 4.20 (t, *J* = 11.6 Hz, 1H), 3.80 (s, 3H), 3.16–2.99 (m, 2H), 2.16–2.01 (m, 1H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 191.0, 156.4, 154.5, 125.8, 125.7 (q, *J* = 274.8 Hz), 120.0, 119.3, 107.9, 70.0 (d, *J* = 1.3 Hz), 55.9, 40.6 (d, *J* = 1.9 Hz), 29.8 (q, *J* = 29.9 Hz). **^{19}F NMR (376 MHz, $CDCl_3$)** δ -64.0 (s). **HRMS (ESI) m/z**: $[M+H]^+$ calcd for $C_{12}H_{12}F_3O_3$: 261.0733; Found: 261.0739.



3n

(S)-6-fluoro-3-(2,2,2-trifluoroethyl)chroman-4-one (3n)

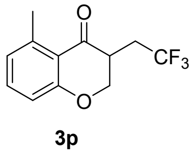
34.3 mg, 69% yield. White solid, mp 74–75 °C, R_f = 0.3 (petroleum ether/ethyl acetate = 120:1). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.56 (dd, *J* = 8.4, 3.2 Hz, 1H), 7.28–7.23 (m, 1H), 7.00 (dd, *J* = 9.0, 4.2 Hz, 1H), 4.73 (dd, *J* = 11.2, 5.2 Hz, 1H), 4.24 (t, *J* = 11.8 Hz, 1H), 3.20–3.02 (m, 2H), 2.18–2.03 (m, 1H). **^{13}C NMR (100 MHz, CDCl3)** δ 190.2, 158.4 (d, *J* = 75.4 Hz), 156.3, 126.6 (q, *J* = 274.7 Hz), 124.2 (d, *J* = 24.4 Hz), 120.6 (d, *J* = 6.6 Hz), 119.8 (d, *J* = 7.4 Hz), 112.6 (d, *J* = 23.3 Hz), 70.1 (d, *J* = 1.4 Hz), 40.6, 29.7 (q, *J* = 30.0 Hz). **^{19}F NMR (376 MHz, $CDCl_3$)** δ -64.0 (s), -120.7 (s). **HRMS (ESI)** m/z: $[M+H]^+$ calcd for $C_{11}H_9F_4O_2$: 249.0533; Found: 249.0532.



3o

(S)-6-chloro-3-(2,2,2-trifluoroethyl)chroman-4-one (3o)

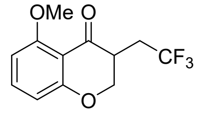
40.3 mg, 76% yield. White solid, mp 70–71 °C, R_f = 0.3 (petroleum ether/ethyl acetate = 100:1). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.86 (d, *J* = 2.8 Hz, 1H), 7.44 (dd, *J* = 8.8, 2.8 Hz, 1H), 6.96 (d, *J* = 8.8 Hz, 1H), 4.74 (dd, *J* = 11.6, 5.2 Hz, 1H), 4.23 (t, *J* = 11.8 Hz, 1H), 3.18–3.00 (m, 2H), 2.16–2.01 (m, 1H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 189.8, 160.2, 136.4, 127.6, 127.0, 126.6 (q, *J* = 273.5 Hz), 121.0, 119.8, 70.0 (d, *J* = 1.4 Hz), 40.5 (d, *J* = 1.9 Hz), 29.7 (q, *J* = 30.1 Hz). **^{19}F NMR (376 MHz, $CDCl_3$)** δ -64.0 (s). **HRMS (ESI)** m/z: $[M+Na]^+$ calcd for $C_{11}H_8ClF_3O_2Na$: 287.0057; Found: 257.0067.



3p

5-methyl-3-(2,2,2-trifluoroethyl)chroman-4-one (3p).

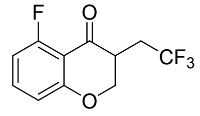
26.5 mg, 54% yield. White solid, mp 54–55 °C, R_f = 0.3 (petroleum ether/ethyl acetate = 120:1). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.35–7.31 (m, 1H), 6.85–6.81 (m, 2H), 4.66 (dd, *J* = 11.2, 4.8 Hz, 1H), 4.20 (t, *J* = 11.6 Hz, 1H), 3.15–2.97 (m, 2H), 2.62 (s, 3H), 2.14–2.00 (m, 1H). **^{13}C NMR (100 MHz, $CDCl_3$)** δ 191.1, 161.6, 141.6, 134.2, 125.9 (q, *J* = 274.7 Hz), 124.1, 117.8, 114.9, 68.2 (d, *J* = 1.6 Hz), 40.4 (d, *J* = 1.7 Hz), 28.8 (q, *J* = 29.7 Hz), 22.0. **^{19}F NMR (376 MHz, $CDCl_3$)** δ -64.0 (s). **HRMS (ESI)** m/z: $[M+H]^+$ calcd for $C_{12}H_{12}F_3O_2$: 245.0784; Found: 245.0792.



3q

5-methoxy-3-(2,2,2-trifluoroethyl)chroman-4-one (3q).

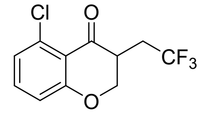
32.5 mg, 63% yield. Yellow oil, R_f = 0.3 (petroleum ether/ethyl acetate = 20:1). **^{1}H NMR (400 MHz, CDCl$_3$)** 7.41–7.37 (m, 1H), 6.58–6.52 (m, 2H), 4.64 (dd, *J* = 11.6, 4.8 Hz, 1H), 4.19 (t, *J* = 11.2 Hz, 1H), 3.90 (s, 3H), 3.12–2.98 (m, 2H), 2.12–1.97 (m, 1H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 189.1, 163.0, 161.0, 136.3, 126.8 (q, *J* = 274.6 Hz), 110.5, 109.8, 104.1, 69.2 (d, *J* = 1.3 Hz), 56.2, 41.3 (d, *J* = 2.0 Hz), 29.6 (q, *J* = 29.6 Hz). **^{19}F NMR (376 MHz, CDCl$_3$)** δ -64.0 (s). **HRMS (ESI)** m/z: $[M+H]^+$ calcd for $C_{12}H_{12}F_3O_3$: 261.0733; Found: 261.0725.



3r

5-fluoro-3-(2,2,2-trifluoroethyl)chroman-4-one (3r).

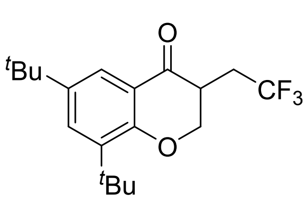
38.1 mg, 77% yield. White solid, mp 82–83 °C, R_f = 0.3 (petroleum ether/ethyl acetate = 20:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.46–7.41 (m, 1H), 6.80 (d, *J* = 8.8 Hz, 1H), 6.75–6.70 (m, 1H), 4.71 (dd, *J* = 11.6, 5.2 Hz, 1H), 4.24 (t, *J* = 11.8 Hz, 1H), 3.18–3.00 (m, 2H), 2.14–2.00 (m, 1H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 188.2, 161.8 (d, *J* = 264.9 Hz), 162.2 (d, *J* = 2.9 Hz), 136.4 (d, *J* = 11.7 Hz), 126.6 (q, *J* = 274.7 Hz), 113.6 (d, *J* = 4.0 Hz), 110.3 (d, *J* = 9.3 Hz), 109.2 (d, *J* = 10.9 Hz), 69.6 (d, *J* = 1.5 Hz), 41.1 (d, *J* = 1.8 Hz), 29.4 (q, *J* = 29.9 Hz). **^{19}F NMR (376 MHz, CDCl$_3$)** δ -64.0 (s), -110.1 (s). **HRMS (ESI)** m/z: $[M+H]^+$ calcd for $C_{11}H_9F_4O_2$: 249.0533; Found: 249.0530.



3s

5-chloro-3-(2,2,2-trifluoroethyl)chroman-4-one (3s).

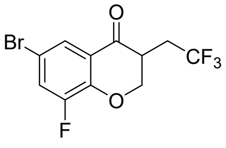
44.8 mg, 85% yield. Colorless oil, R_f = 0.3 (petroleum ether/ethyl acetate = 100:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.37–7.33 (m, 1H), 7.06 (d, *J* = 7.6 Hz, 1H), 6.91 (m, *J* = 8.4 Hz, 1H), 4.70 (dd, *J* = 11.2, 5.2 Hz, 1H), 4.23 (t, *J* = 11.8 Hz, 1H), 3.21–2.99 (m, 2H), 2.14–2.00 (m, 1H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 188.9, 163.0, 135.3, 134.9, 126.7 (q, *J* = 274.7 Hz) 125.2, 117.6, 117.1, 69.4, 41.2 (d, *J* = 1.9 Hz), 29.7 (q, *J* = 30.0 Hz). **^{19}F NMR (376 MHz, CDCl$_3$)** δ -64.0 (s). **HRMS (ESI)** m/z: $[M+H]^+$ calcd for $C_{11}H_9ClF_3O_2$: 265.0238; Found: 265.0247.



3t

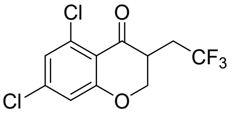
6,8-di-tert-butyl-3-(2,2,2-trifluoroethyl)chroman-4-one (3t).

36.7 mg, 68% yield. White solid, mp 69–70 °C, R_f = 0.3 (petroleum ether/ethyl acetate = 100:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.81 (d, *J* = 2.4 Hz, 1H), 7.58 (d, *J* = 2.4 Hz, 1H), 4.75 (dd, *J* = 11.2, 4.8 Hz, 1H), 4.21 (t, *J* = 11.6 Hz, 1H), 3.16–3.01 (m, 2H), 2.07–2.02 (m, 5.1 Hz, 1H), 1.40 (s, 9H), 1.32 (s, 9H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 191.7, 158.7, 143.8, 138.4, 131.1, 126.8 (q, *J* = 274.7 Hz), 121.6, 120.2, 69.3, 40.5 (d, *J* = 1.9 Hz), 35.1, 34.5, 31.3, 29.7, 29.9 (q, *J* = 29.8 Hz). **^{19}F NMR (376 MHz, $\mathrm{CDCl_3}$)** δ -63.9 (s). **HRMS (ESI)** m/z: [M+Na]$^+$ calcd for $\mathrm{C_{19}H_{25}F_3O_2Na}$: 365.1699; Found: 365.1693.



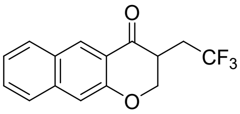
3u

6-bromo-8-fluoro-3-(2,2,2-trifluoroethyl)chroman-4-one (3u). 47.7 mg, 74% yield. White solid, mp 99–100 °C, R$_f$ = 0.3 (petroleum ether/ethyl acetate = 120:1). **^{1}H NMR (400 MHz, $\mathrm{CDCl_3}$)** δ 7.81 (d, *J* = 1.6 Hz, 1H), 7.47–7.44 (m, 1H), 4.84 (dd, *J* = 11.6, 5.2 Hz, 1H), 4.30 (t, *J* = 11.8 Hz, 1H), 3.24–3.00 (m, 2H), 2.18–2.04 (m, 1H). **^{13}C NMR (100 MHz, $\mathrm{CDCl_3}$)** δ 188.6 (d, *J* = 3.0 Hz), 151.6 (d, *J* = 253.7 Hz), 149.3 (d, *J* = 11.6 Hz), 126.5(q, *J* = 274.8 Hz) 125.6, 125.4 (d, *J* = 1.9 Hz), 122.9, 113.2 (d, *J* = 7.4 Hz), 70.6, 40.7 (d, *J* = 1.9 Hz), 29.6 (q, *J* = 30.3 Hz). **^{19}F NMR (376 MHz, $\mathrm{CDCl_3}$)** δ -64.0 (s), -131.3 (s). **HRMS (ESI)** m/z: [M+H]$^+$ calcd for $\mathrm{C_{11}H_8{}^{79}BrF_4O_2}$: 326.9638; Found: 326.9638; for $\mathrm{C_{11}H_8{}^{81}BrF_4O_2}$: 328.9618; Found: 328.9618.



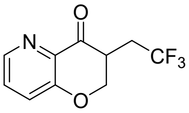
3v

5,7-dichloro-3-(2,2,2-trifluoroethyl)chroman-4-one (3v). 51.7 mg, 87% yield. White solid, mp 84–85 °C, R$_f$ = 0.3 (petroleum ether/ethyl acetate = 120:1). **^{1}H NMR (400 MHz, $\mathrm{CDCl_3}$)** δ 7.08 (d, *J* = 1.6 Hz, 1H), 6.95 (d, *J* = 2.0 Hz, 1H), 4.72 (dd, *J* = 11.6, 5.2 Hz, 1H), 4.24 (t, *J* = 11.8 Hz, 1H), 3.20–2.99 (m, 2H), 3.14–2.00 (m, 1H). **^{13}C NMR (100 MHz, $\mathrm{CDCl_3}$)** δ 187.8, 162.9, 140.9, 135.8, 126.5 (q, *J* = 274.7 Hz), 125.3, 117.1, 116.0, 69.5 (d, *J* = 1.4 Hz), 41.0 (d, *J* = 1.8 Hz), 29.5 (q, *J* = 30.0 Hz). **^{19}F NMR (376 MHz, $\mathrm{CDCl_3}$)** δ -64.0 (s). **HRMS (ESI)** m/z: [M+H]$^+$ calcd for $\mathrm{C_{11}H_8Cl_2F_3O_2}$: 298.9848; Found: 298.9848.



3w

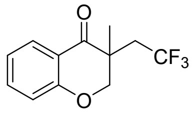
3-(2,2,2-trifluoroethyl)-2,3-dihydro-4H-benzo[g]chromen-4-one (3w). 23.3 mg, 42% yield. White solid, mp 62–63 °C, R$_f$ = 0.3 (petroleum ether/ethyl acetate = 120:1). **^{1}H NMR (400 MHz, $\mathrm{CDCl_3}$)** δ 9.39 (d, *J* = 8.4 Hz, 1H), 7.95 (d, *J* = 8.8 Hz, 1H), 7.77 (d, *J* = 8.0 Hz, 1H), 7.67–7.63 (m, 1H), 7.47–7.44(m, 1H), 7.11 (d, *J* = 8.8 Hz, 1H), 4.79 (dd, *J* = 11.2, 5.2 Hz, 1H), 4.37 (t, *J* = 11.6 Hz, 1H), 3.27–3.06 (m, 2H), 2.24–2.10 (m, 1H). **^{13}C NMR (100 MHz, $\mathrm{CDCl_3}$)** δ 191.6, 163.7, 138.1, 131.6, 130.0, 129.4, 128.7, 126.9 (q, *J* = 274.7 Hz), 125.8, 125.2, 118.6, 111.9, 69.8, 41.09 (d, *J* = 2.0 Hz), 30.1 (q, *J* = 29.6 Hz). **^{19}F NMR (376 MHz, $\mathrm{CDCl_3}$)** δ -63.8 (s). **HRMS (ESI)** m/z: [M+H]$^+$ calcd for $\mathrm{C_{15}H_{12}F_3O_2}$: 281.0784; Found: 281.0786.



3x

3-(2,2,2-trifluoroethyl)-2,3-dihydro-4H-pyrano[3,2-b]pyridin-4-one (3x).

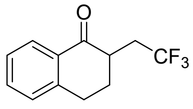
38.1 mg, 83% yield. Yellow oil, R_f = 0.4 (petroleum ether/ethyl acetate = 4:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 8.50 (dd, J = 3.8, 1.4 Hz, 1H), 7.47–7.41 (m, 2H), 4.80 (dd, J = 11.6, 5.2 Hz, 1H), 4.32 (t, J = 12.0 Hz, 1H), 3.35–3.27 (m, 1H), 3.18 (m, 1H), 3.25–3.12 (m, 1H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 189.3, 159.4, 144.8, 136.1, 129.6, 126.8, 126.4 (q, J = 274.7 Hz), 69.9 (d, J = 1.8 Hz), 41.3 (d, J = 2.1 Hz), 29.5 (q, J = 30.1 Hz). **^{19}F NMR (376 MHz, CDCl$_3$)** δ -64.0 (s). **HRMS (ESI)** m/z: [M+H]$^+$ calcd for $C_{10}H_9F_3NO_2$: 232.0580; Found: 232.0580.



3y

4-methyl-3-(2,2,2-trifluoroethyl)chroman-4-one (3y).

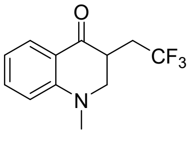
16.2 mg, 34% yield. Colorless oil, R_f = 0.3 (petroleum ether/ethyl acetate = 70:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.91 (dd, J = 7.8, 1.4 Hz, 1H), 7.53–7.49 (m, 1H), 7.08–7.04 (m, 1H), 6.99 (d, J = 8.4 Hz, 1H), 4.35 (q, J = 11.3 Hz, 2H), 2.57 (qd, J = 11.6, 1.2 Hz, 2H), 1.35 (s, 3H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 193.9, 160.8, 136.2, 128.2, 126.3 (q, J = 276.4 Hz), 122.0, 118.9, 117.8, 73.9 (d, J = 2.1 Hz), 36.3 (q, J = 28.6 Hz), 42.6, 18.6. **^{19}F NMR (376 MHz, CDCl$_3$)** δ -59.5 (s). **HRMS (ESI)** m/z: [M+H]$^+$ calcd for $C_{12}H_{12}F_3O_2$: 245.0784; Found:245.0775.



3z

2-(2,2,2-trifluoroethyl)-3,4-dihydronaphthalen-1(2H)-one (3z).

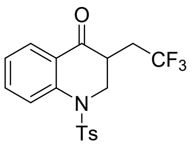
32.3 mg, 71% yield. White solid, mp 42–43 °C, R_f = 0.3 (petroleum ether/ethyl acetate = 30:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 8.04 (d, J = 7.6 Hz, 1H), 7.52–7.48 (m, 1H), 7.32 (t, J = 7.6 Hz, 1H), 7.27–7.25 (m, 1H), 3.27–3.08 (m, 2H), 3.04–2.97 (m, 1H), 2.86–2.79 (m, 1H), 2.52–2.45 (m, 1H), 2.18–2.03 (m, 1H), 2.01–1.90 (m, 1H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 196.7, 143.8, 133.8, 131.9, 128.9, 127.9, 127.4 (q, J = 274.8 Hz), 126.9, 42.8 (d, J = 2.0 Hz), 33.4 (q, J = 28.5 Hz), 29.8, 29.1 (d, J = 10.8 Hz). **^{19}F NMR (376 MHz, CDCl$_3$)** δ -63.6 (s). **HRMS (ESI)** m/z: [M+H]$^+$ calcd for $C_{12}H_{12}F_3O$: 229.0835; Found: 229.0840.



3aa

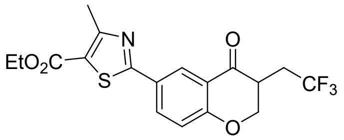
1-methyl-3-(2,2,2-trifluoroethyl)-2,3-dihydroquinolin-4(1H)-one (3aa).

29.9 mg, 62% yield. Yellow solid, mp 59–60 °C, R_f = 0.3 (petroleum ether/ethyl acetate = 120:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.91 (dd, J = 8.0, 1.6 Hz, 1H), 7.45–7.41 (m, 1H), 6.80–6.72 (m, 2H), 3.61 (dd, J = 12.0, 5.2 Hz, 1H), 3.33 (t, J = 12.4 Hz, 1H), 3.15–2.97 (m, 5H), 2.14–2.00 (m, 1H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 192.2, 152.3, 135.8, 128.6, 127.1 (q, J = 274.7 Hz), 118.8, 117.5, 113.2, 55.5, 41.0 (d, J = 1.7 Hz), 39.4. 30.8 (q, J = 29.3 Hz). **^{19}F NMR (376 MHz, CDCl$_3$)** δ 63.8 (s). **HRMS (ESI)** m/z: [M+H]$^+$ calcd for $C_{12}H_{13}F_3NO$: 244.0944; Found: 244.0945.



3ba

1-tosyl-3-(2,2,2-trifluoroethyl)-2,3-dihydroquinolin-4(1H)-one (3ba). 41.3 mg, 54% yield. White solid, mp 103–104 °C, R_f = 0.5 (petroleum ether/ethyl acetate = 10:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.90–7.86 (m, 2H), 7.55–7.49 (m, 3H), 7.22–7.49 (m, 3H), 4.68 (dd, *J* = 14.4, 4.8 Hz, 1H), 3.61 (t, *J* = 13.9 Hz, 1H), 2.98–2.84 (m, 1H), 2.44–2.37 (m, 1H), 2.32 (s, 3H), 1.89–1.75 (m, 1H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 191.6, 144.9, 142.2, 136.6, 135.2, 130.3, 128.3, 127.0 (*J* = 274.9 Hz), 126.8, 125.6, 124.3, 124.1, 50.1, 39.6 (d, *J* = 1.9 Hz), 30.8 (q, *J* = 29.7 Hz), 21.6. **^{19}F NMR (376 MHz, CDCl$_3$)** δ 63.8 (s). **HRMS (ESI)** m/z: [M+Na]$^+$ calcd for $C_{18}H_{16}F_3NO_3SNa$: 406.0695; Found: 406.0702.

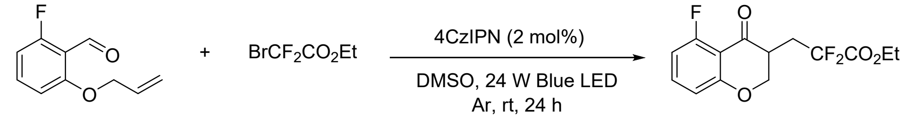


3ca

Ethyl 4-methyl-2-(4-oxo-3-(2,2,2-trifluoroethyl)chroman-6-yl)thiazole-5-carboxylate (3ca). 42.1 mg, 58% yield. White solid, mp 127–128 °C, R_f = 0.3 (petroleum ether/ethyl acetate = 8:1). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 8.41 (d, *J* = 2.0 Hz, 1H), 8.17 (dd, *J* = 8.6, 2.2 Hz, 1H), 7.07 (d, *J* = 8.8 Hz, 1H), 4.78 (dd, *J* = 11.6, 5.2 Hz, 1H), 4.37–4.32 (m, 2H), 4.32–4.26 (m, 1H), 3.23–3.04 (m, 2H), 2.75 (s, 3H), 2.18–2.04 (m, 1H), 1.38 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 188.8, 167.1, 162.2, 160.5 (d, *J* = 115.7 Hz), 133.3, 126.1, 125.5 (q, *J* = 275.0 Hz), 125.3, 120.9, 119.1, 117.9, 68.9, 60.3, 39.4, 30.4, 28.6 (q, *J* = 30.1 Hz), 16.4, 13.3. **^{19}F NMR (376 MHz, CDCl$_3$)** δ -64.0 (s). **HRMS (ESI)** m/z: [M+H]$^+$ calcd for $C_{18}H_{17}F_3NO_4S$: 400.0825; Found: 400.0835.

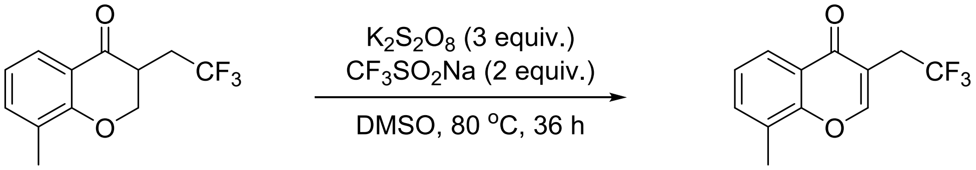
(E) Scale-up reaction and synthetic applications

To a screw-capped vial with stirring bar were added 4CzIPN (3.2 mg, 0.004 mmol, 2 mol%), **1a** (528 mg, 3 mmol, 1.5 equiv.), Togni II reagent **2c** (632 mg, 2 mmol, 1.0 equiv.) in an argon-filled glovebox. After the DMSO (20 mL) was added into the vial *via* a syringe, the vial was sealed with a cap containing a PTFE septum and removed out from the glovebox. The reaction mixture was stirred at room temperature for 48 h upon irradiation with 24 W blue LED under argon atmosphere. After completion of the reaction, quenched with saturated NaCl (20 mL) and extracted with EtOAc (3 x 5 mL). The combined extracts were dried over $MgSO_4$, filtered, and evaporated. The crude product was then purified by silica gel chromatography ((petroleum ether/ethyl acetate = 120:1)) to afford **3a** (278 mg, 54%).



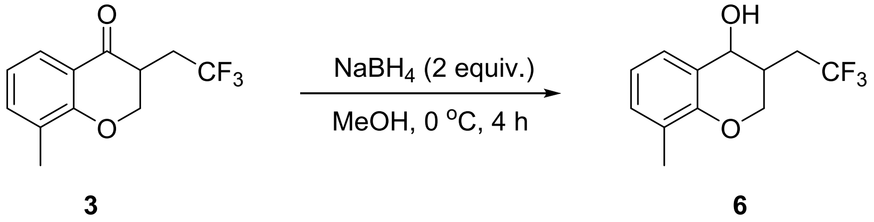
1r **2e** **4**

To a screw-capped vial with stirring bar were added 4CzIPN (3.2 mg, 0.004 mmol, 2 mol%), **1r** (54 mg, 0.3 mmol, 1.5 equiv.), ethyl bromodifluoroacetate **2e** (40 mg, 0.2 mmol, 1.0 equiv.) in an argon-filled glovebox. After the DMSO (2 mL) was added into the vial *via* a syringe, the vial was sealed with a cap containing a PTFE septum and removed out from the glovebox. The reaction mixture was stirred at room temperature for 48 h upon irradiation with 24 W blue LED under argon atmosphere. After completion of the reaction, quenched with saturated NaCl (2 mL) and extracted with EtOAc (3 x 5 mL). The combined extracts were dried over $MgSO_4$, filtered, and evaporated. The crude product was then purified by silica gel chromatography ((petroleum ether/ethyl acetate = 120:1)) to afford **4** (28 mg, 70%) as a colorless oil. **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.41 (dd, *J* = 8.4, 6.0 Hz, 1H), 6.78 (d, *J* = 8.4 Hz, 1H), 6.72–6.67 (m, 1H), 4.69 (dd, *J* = 11.2, 5.2 Hz, 1H), 4.34 (q, *J* = 7.2 Hz, 2H), 4.24 (t, *J* = 11.8 Hz, 1H), 3.19–3.12 (m, 1H), 3.04–2.89 (m, 1H), 2.09–1.94 (m, 1H), 1.35 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 189.0, 163.5 (t, *J* = 32.3 Hz), 162.3 (d, *J* = 2.9 Hz), 161.8, 136.2 (d, *J* = 11.7 Hz), 115.5 (t, *J* = 249.7 Hz), 113.6 (d, *J* = 3.9 Hz), 110.4 (d, *J* = 9.2 Hz), 109.0 (d, *J* = 20.9 Hz), 70.1 (d, *J* = 2.3 Hz), 63.3, 40.8, 13.9, 29.9 (t, *J* = 23.7 Hz). **^{19}F NMR (376 MHz, CDCl$_3$)** δ -101.7 (d, *J* = 259.1 Hz), -106.4 (d, *J* = 259.8 Hz), -110.3 (s). HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{14}H_{14}F_3O_4$: 303.0839; Found: 303.0847



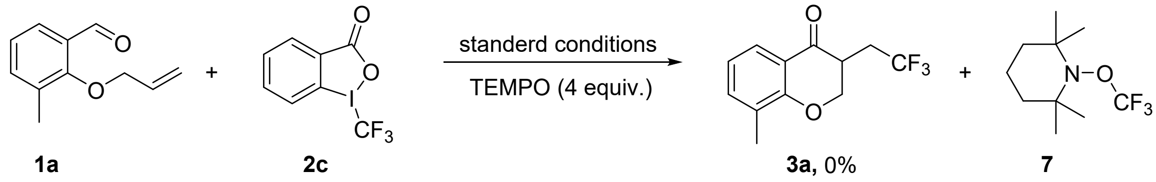
3a **5**

According to the literature.[5] To a solution of compound **3** (49 mg, 0.2 mmol, 1.0 equiv.) in anhydrous DMSO (4 mL) was added $K_2S_2O_8$ (162 mg, 0.6 mmol, 3.0 equiv.) and CF_3SO_2Na (96 mg, 0.4 mmol, 2.0 equiv.) at room temperature under nitrogen atmosphere. The reaction mixture was then heated to 80 ^{o}C in an oil bath and stirred for 36 h. Quenched with H_2O (5 mL) and the mixture was extracted with EA (3 × 5 mL). The combined organic extracts were washed with brine (5 mL), dried over anhydrous Na_2SO_4 and concentrated under reduced pressure. The resulting residue was purified by column chromatography (petroleum ether/ethyl acetate = 20:1) to afford **34** (35.8 mg, 74% yield) as white solid. **^{1}H NMR (400 MHz, CDCl$_3$)** δ 8.08 (d, *J* = 8.0 Hz, 1H), 8.04 (s, 1H), 7.53 (d, *J* = 6.8 Hz, 1H), 7.32 (m, 1H), 3.40 (q, *J* = 10.8 Hz, 2H), 2.48 (s, 3H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 176.8, 155.0, 154.9, 135.1, 127.8, 125.8 (q, *J* = 275.1 Hz), 125.3, 123.9, 123.6, 114.6, 29.2 (q, *J* = 31.4 Hz), 15.6. **^{19}F NMR (376 MHz, CDCl$_3$)** δ -65.8 (s). **HRMS (ESI)** m/z: [M+H]$^+$ calcd for $C_{12}H_{10}F_3O_2$: 243.0627; Found: 243.0621.



To a solution of compound **3** (48.8 mg, 0.2 mmol, 1.0 equiv.) in anhydrous MeOH (2 mL) was added NaBH$_4$ (3.5 mg, 0.4 mmol, 2 equiv.) at 0 °C. And the reaction mixture was stirred at the same temperature for 4 h. Quenched with saturated NaCl (5 mL) and the aqueous layer was extracted with EtOAc (5 mL x 3). The combined organic layers were dried over anhydrous Na$_2$SO$_4$, filtered, and concentrated under reduced pressure. The resulting residue was purified by column chromatography (petroleum ether/ethyl acetate = 20 : 1,) to afford **6** (33.3 mg, 68% yield) as a white solid. **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.15 (d, *J* = 7.6 Hz, 1H), 7.11 (d, *J* = 7.6 Hz, 1H), 6.89–6.85 (m, 1H), 4.51 (s, 1H), 4.41 (dd, *J* = 11.2, 1.2 Hz, 1H), 4.17 (dd, *J* = 11.2, 4.0 Hz, 1H), 2.36–2.30 (m, 1H), 2.20 (s, 3H), 2.18–2.06 (m, 2H), 1.93 (s, 1H). **^{13}C NMR (100 MHz, CDCl$_3$)** δ 152.2, 131.3, 127.6, 126.9 (q, *J* = 274.5 Hz), 126.5, 121.7, 120.7, 67.8, 64.7, 34.2, 32.5 (q, *J* = 28.7 Hz), 16.0. **^{19}F NMR (376 MHz, CDCl$_3$)** δ -64.0 (s). HRMS (ESI) m/z: [M+H]$^+$ calcd for $C_{12}H_{14}F_3O_2$: 247.0940; Found:247.0938.

(F) Radical trapping experiments



To a screw-capped vial with stirring bar were added 4CzIPN (3.2 mg, 0.004 mmol, 2 mol%), **1a** (52.8 mg, 0.3 mmol, 1.5 equiv.), Togni II reagent **2c** (63.2 mg, 0.2 mmol, 1.0 equiv.) and TEMPO (125.0 mg, 0.4 mmol, 4 equiv.) in an argon-filled glovebox. After the DMSO (2 mL) was added into the vial *via* a syringe, the vial was sealed with a cap containing a PTFE septum and removed out from the glovebox. The reaction mixture was stirred at room temperature for 48 h upon irradiation with 24 W blue LED under argon atmosphere. After completion of the reaction, quenched with saturated NaCl (2 mL) and extracted with EtOAc (3 x 5 mL). The combined extracts were dried over $MgSO_4$, filtered, and evaporated. The analysis of the crude reaction mixture by high resolution mass spectrometry (HRMS) identified compound **7**. **HRMS (ESI)** m/z: $[M+H]^+$ calcd for $C_{10}H_{19}F_3NO$: 226.1413; Found: 226.1421.

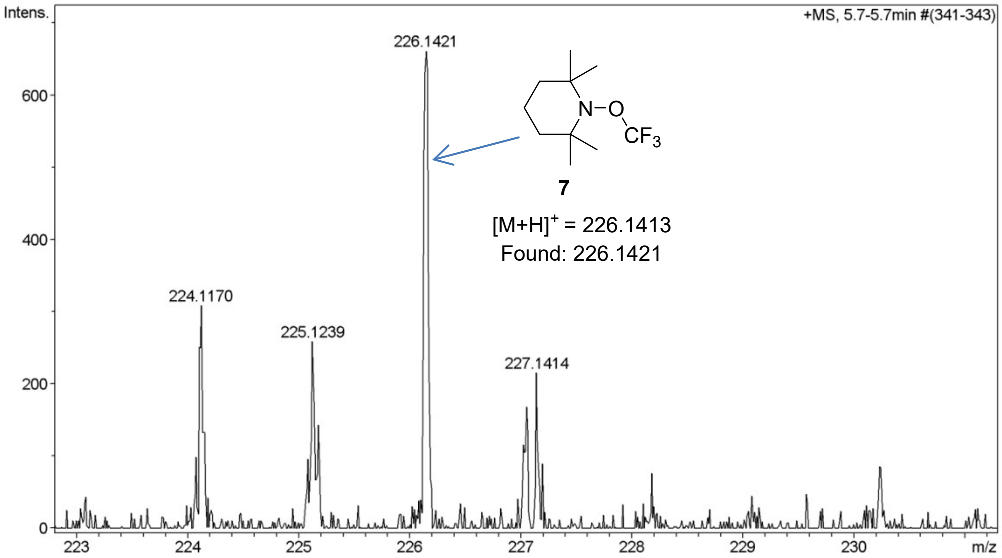
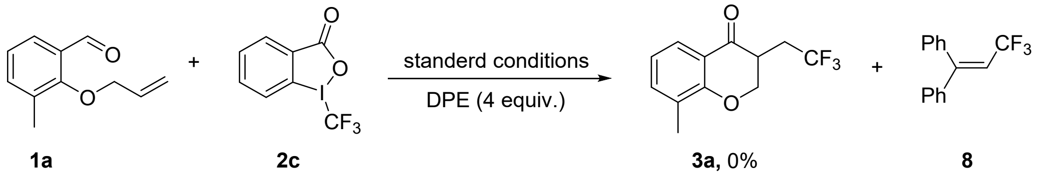


Figure S1. 2-(allyloxy)-3-methylbenzaldehyde **1a** and Togni II reagent **2c** under standard conditions with TEMPO (4.0 equiv.)



To a screw-capped vial with stirring bar were added 4CzIPN (3.2 mg, 0.004 mmol, 2 mol%), **1a** (52.8 mg, 0.3 mmol, 1.5 equiv.), Togni II reagent **2c** (63.2 mg, 0.2 mmol, 1.0 equiv.) and DPE (72.1 mg, 0.4 mmol, 4 equiv.) in an argon-filled glovebox. After the DMSO (2 mL) was added into the vial *via* a syringe, the vial was sealed with a cap containing a PTFE septum and removed out from the glovebox. The reaction mixture was stirred at room temperature for 48 h upon irradiation with 24 W blue LED under argon atmosphere. After completion of the reaction, quenched with saturated NaCl (2 mL) and extracted with EtOAc (3 x 5 mL). The combined extracts were dried over $MgSO_4$, filtered, and evaporated. The analysis of the crude reaction mixture by high resolution mass spectrometry (HRMS) identified compound **8**. **HRMS (ESI)** m/z: $[M+Na]^+$ calcd for $C_{15}H_{11}F_3Na$: 271.0705; Found: 271.0712.

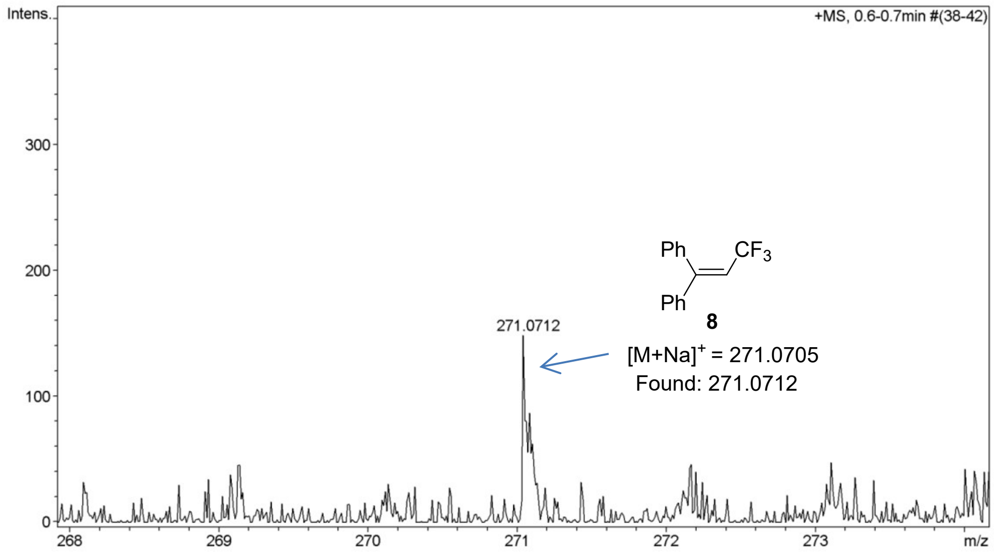


Figure S2. 2-(allyloxy)-3-methylbenzaldehyde **1a** and Togni II reagent **2c** under standard conditions with DPE (4.0 equiv.)

(G) Stern-Volmer fluorescence quenching experiments

Stern-Volmer fluorescence quenching experiments were run with freshly prepared solutions of 1.25 μM 4CzIPN, in anhydrous dry DMSO at room temperature. The solutions were irradiated at 370 nm and fluorescence was measured from 450 nm to 700 nm. Control experiments showed that the excited state 4CzIPN* was mainly quenched by Togni II reagent **2c**.

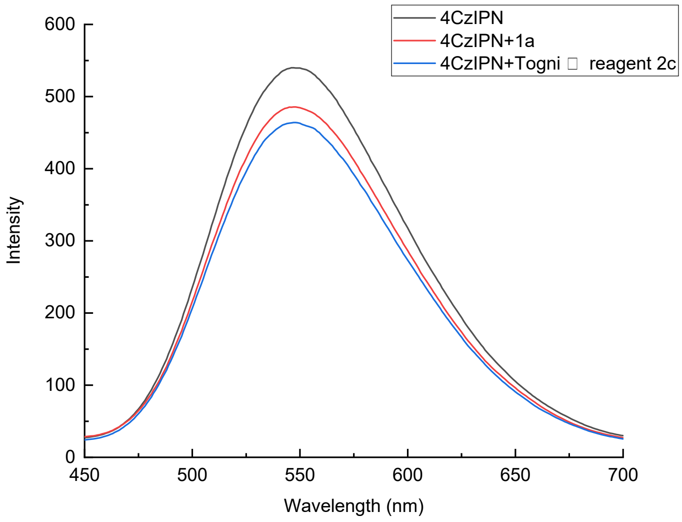


Figure S3. Fluorescence quenching of excited 4CzIPN with **1a**, Togni II reagent **2c** in DMSO (excitation wavelength: 370 nm). 4CzIPN (1.25 μM) in DMSO (black line), 4CzIPN (1.25 μM) with **1a** (5.0 mM) in DMSO (red line), 4CzIPN (1.25 μM) with Togni II reagent **2c** (5.0 mM) in DMSO (blue line).

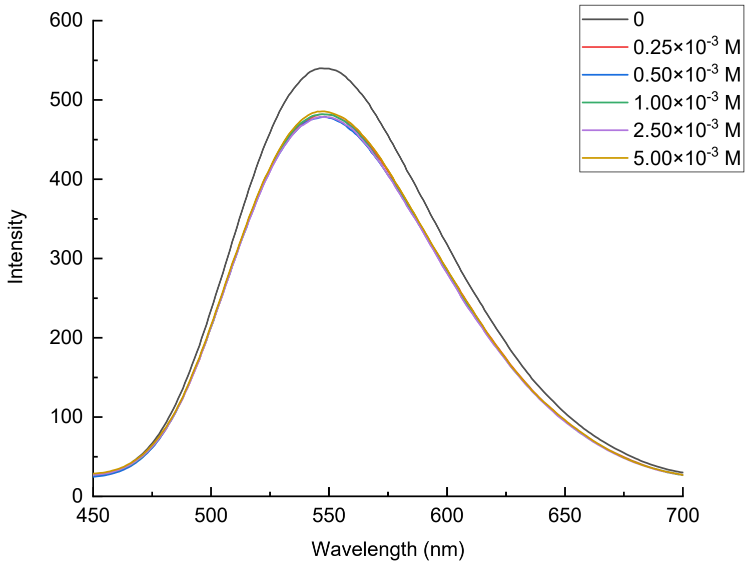


Figure S4. Luminescence quenching of 4CzIPN by **1a**

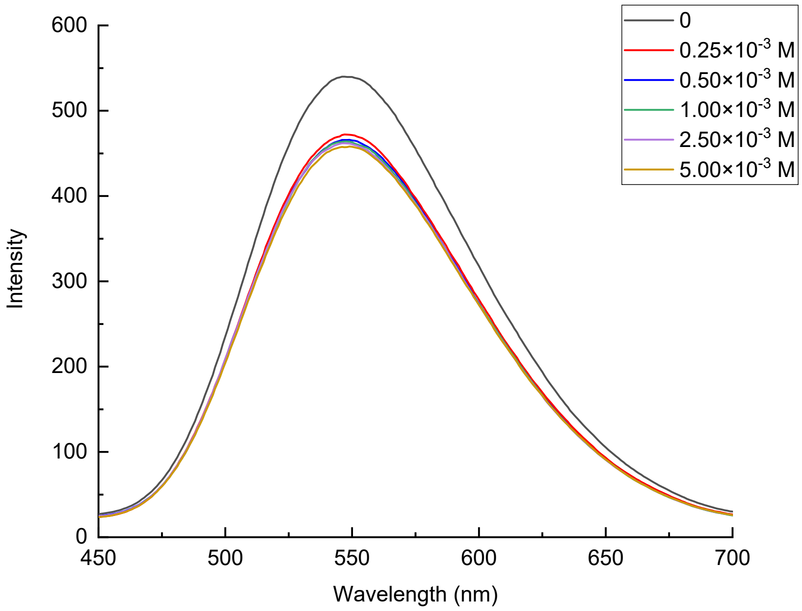


Figure S5. Luminescence quenching of 4CzIPN by Togni II reagent **2c**

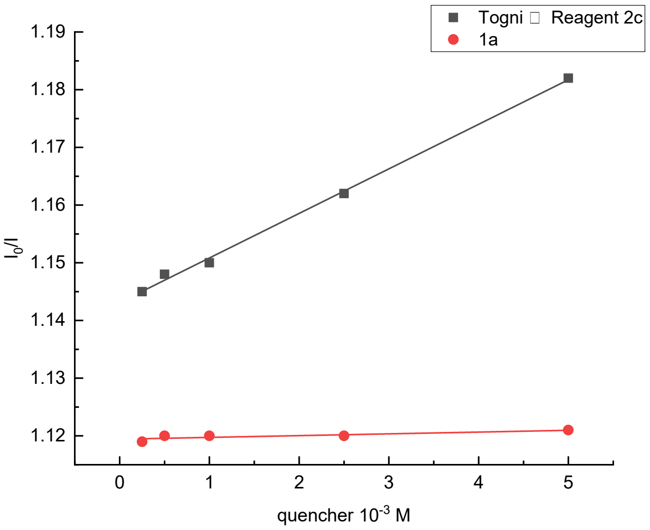


Figure S6 Stern-Volmer plots of 4CzIPN and two quenchers. I_0 and I are luminescence intensities in the absence and presence of the indicated concentrations (10^{-3} M) of the corresponding quencher.

These results suggested that the excited photocatalyst 4CzIPN was primarily quenched by Togni II reagent **2c**, while **1a** showed much less effect.

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1. Zhao, J.; Li, P.; Li, X.; Xia, C.; Li, F. Straightforward Synthesis of Functionalized Chroman-4-ones through Cascade Radical Cyclization-Coupling of 2-(allyloxy)arylaldehydes. *Chem. Commu.* **2016**, *52*, 3661-3664.

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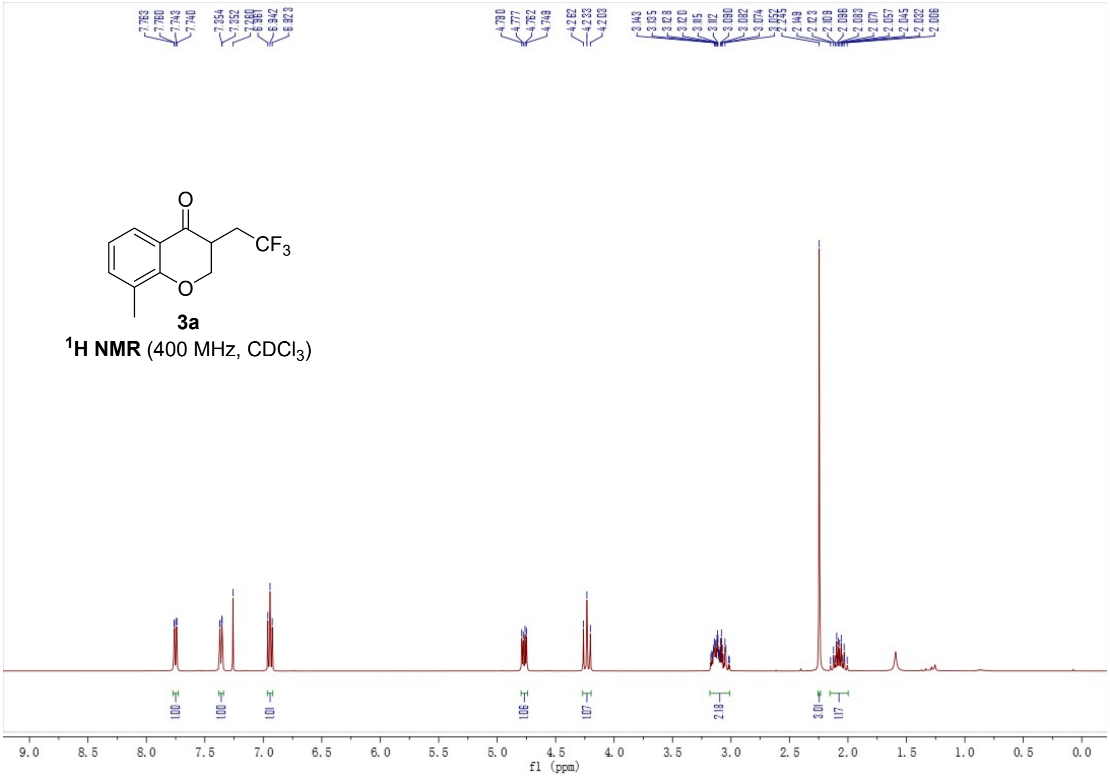
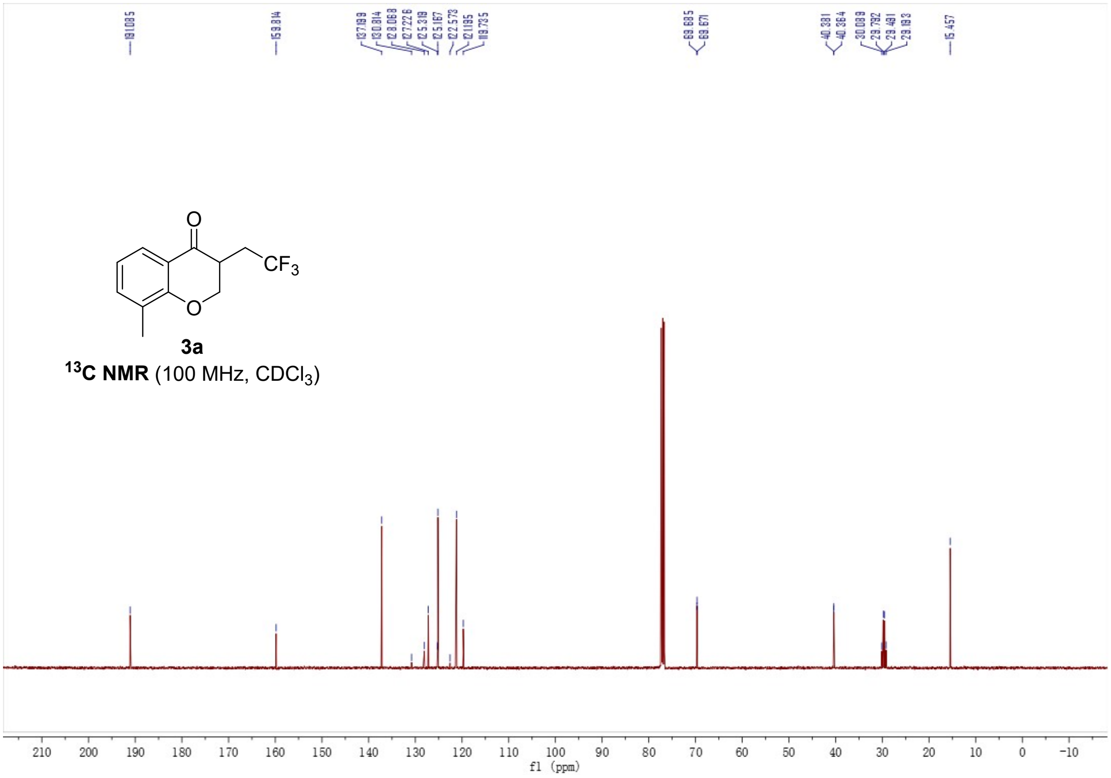
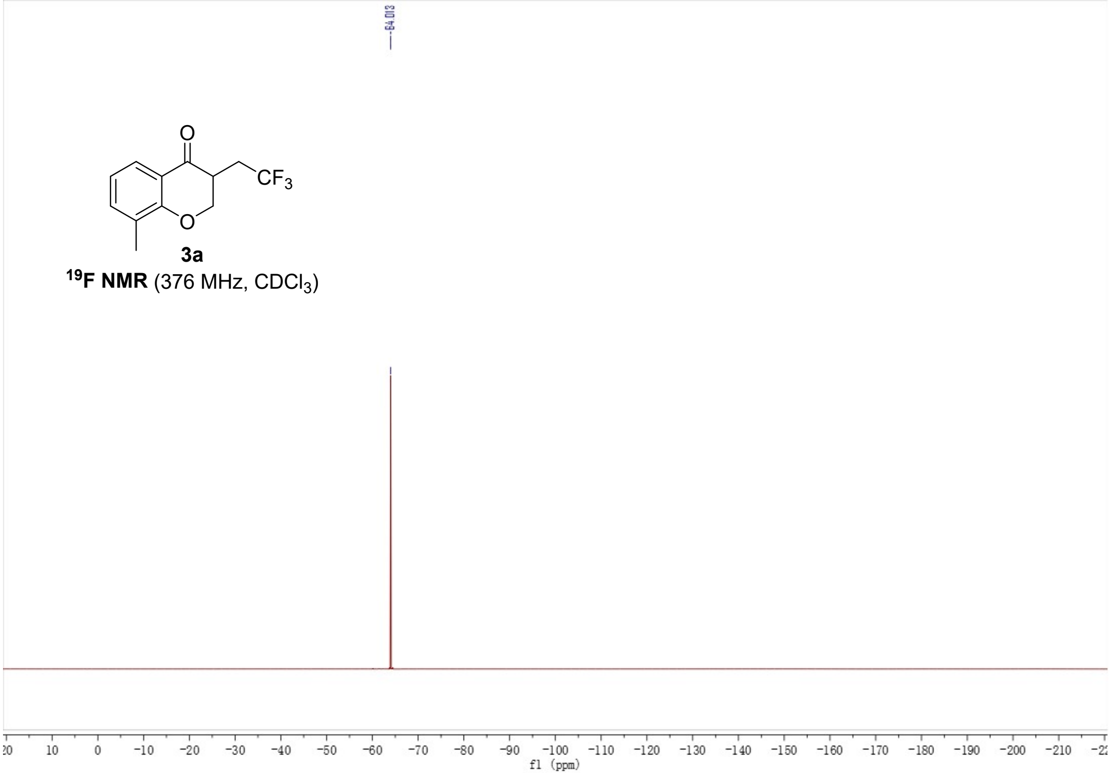
5. Gao, F.; Meng, F.-X.; Du, J.-Y.; Zhang, S.; Huang, H.-L. One-Step Synthesis of Trifluoroethylated Chromones via Radical Cascade Cyclization–Coupling of 2-(Allyloxy)arylaldehydes. *Eur. J. Org. Chem.* **2020**, *2020*, 209-212.

(H) NMR spectra of new compounds

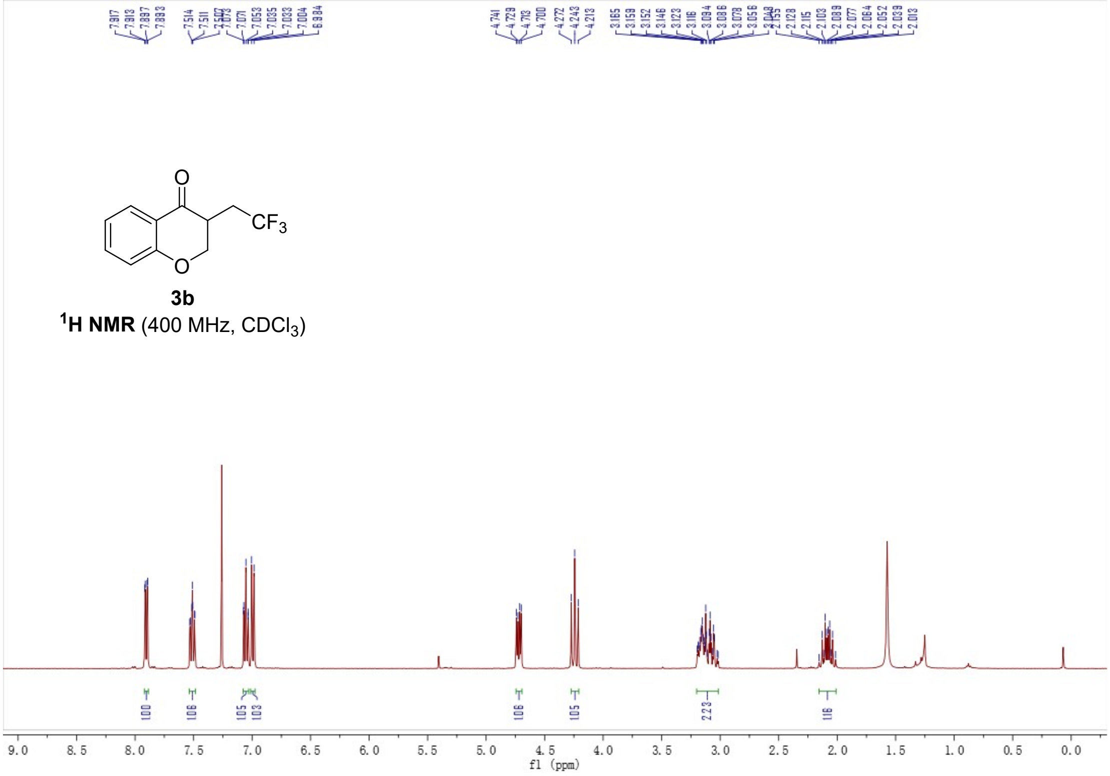
(S)-8-Methyl-3-(2,2,2-trifluoroethyl)chroman-4-one (3a)

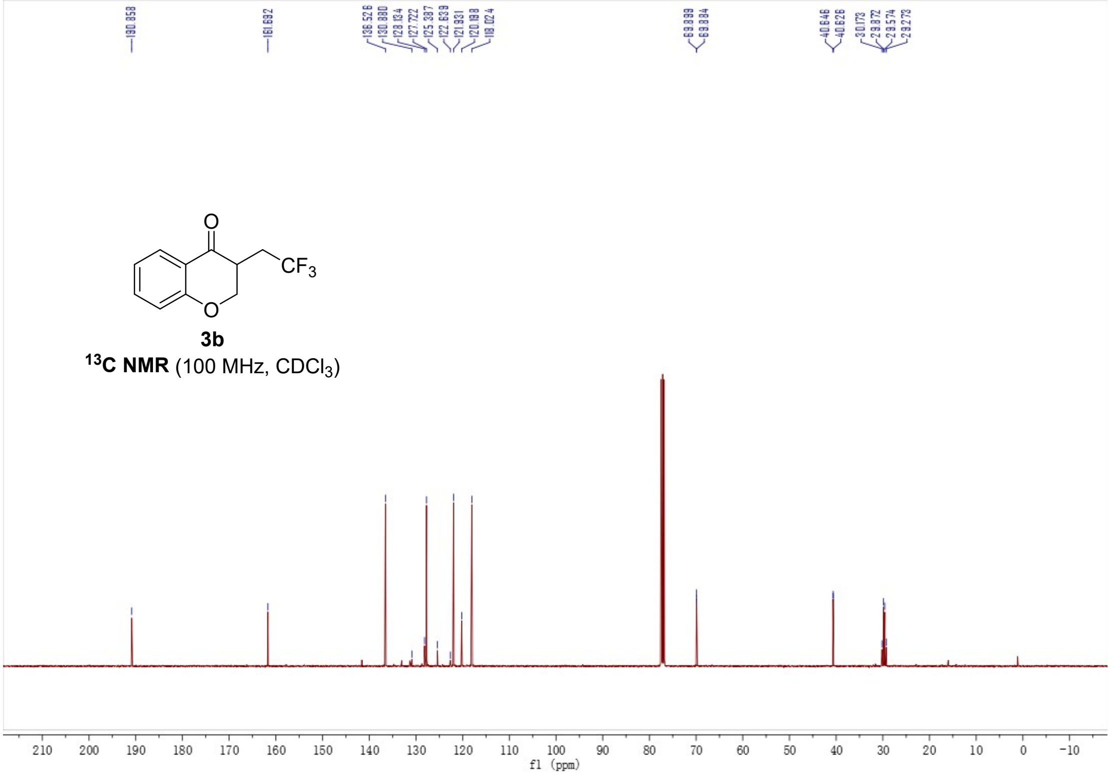




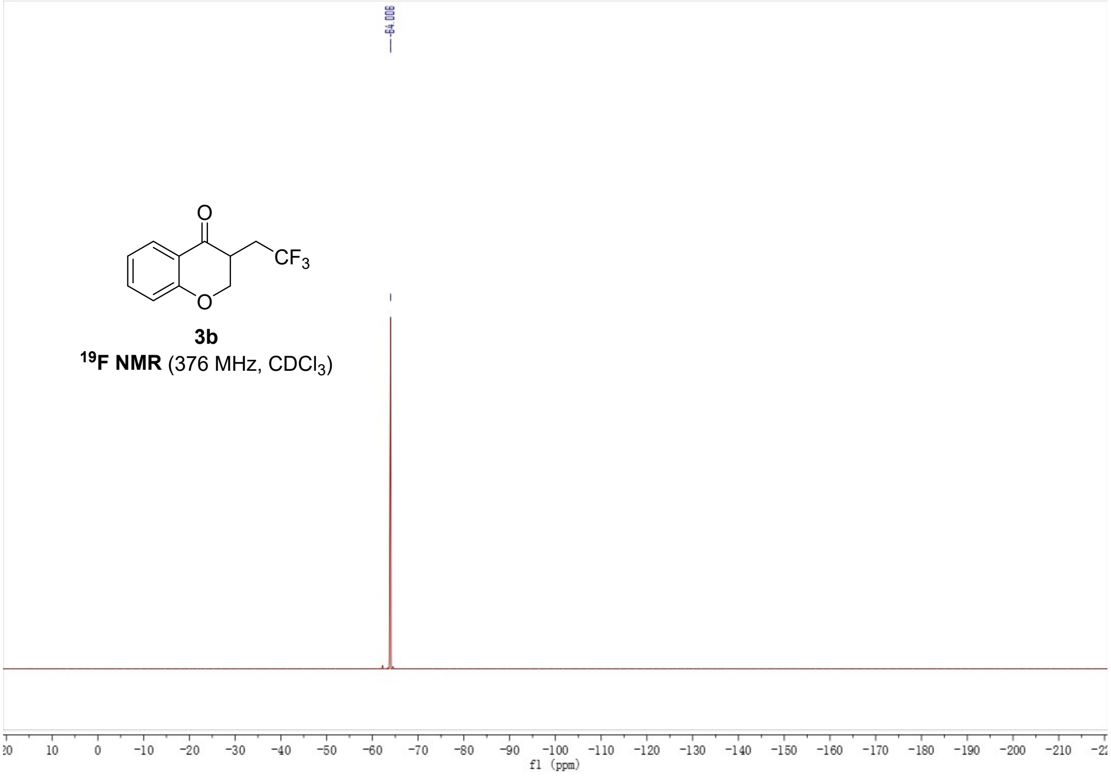


3-(2,2,2-trifluoroethyl)chroman-4-one (3b)



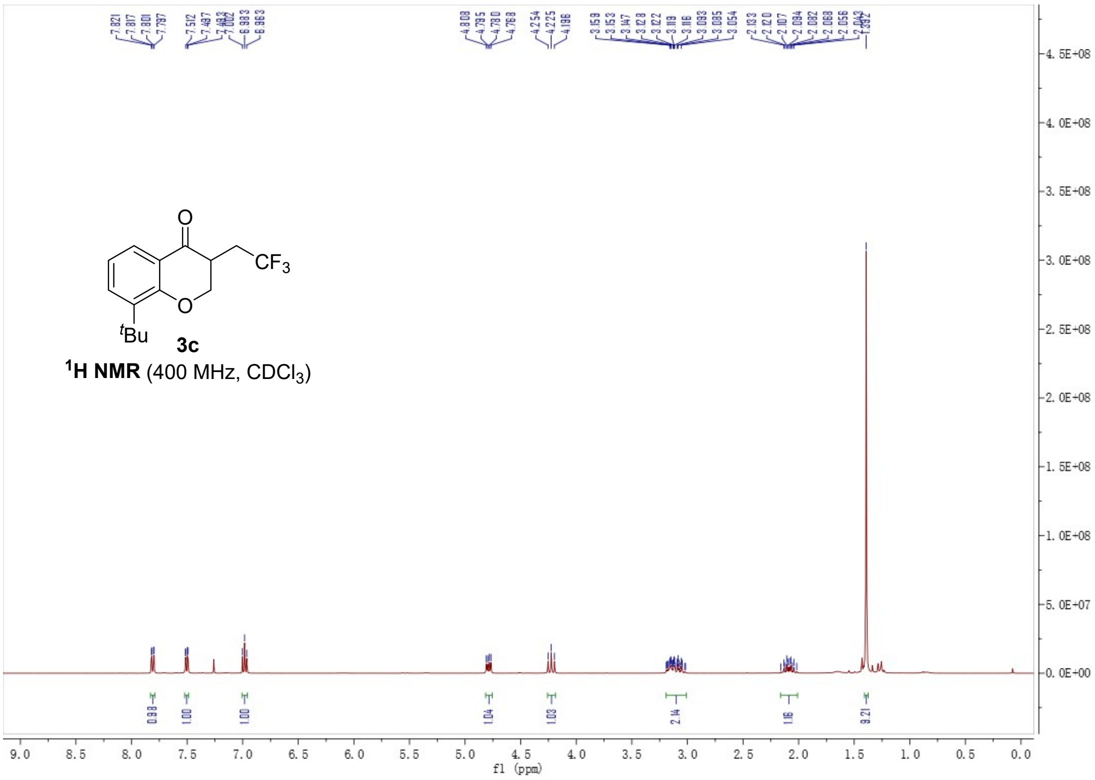


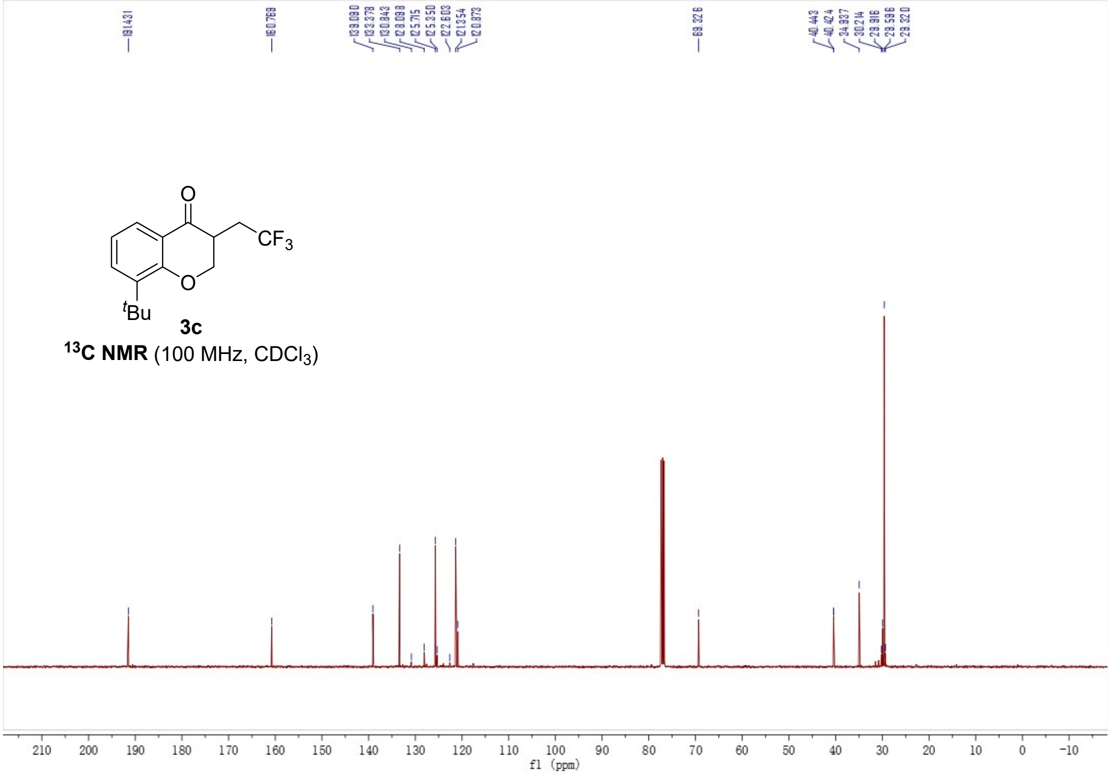
3b
^{13}C NMR (100 MHz, $CDCl_3$)

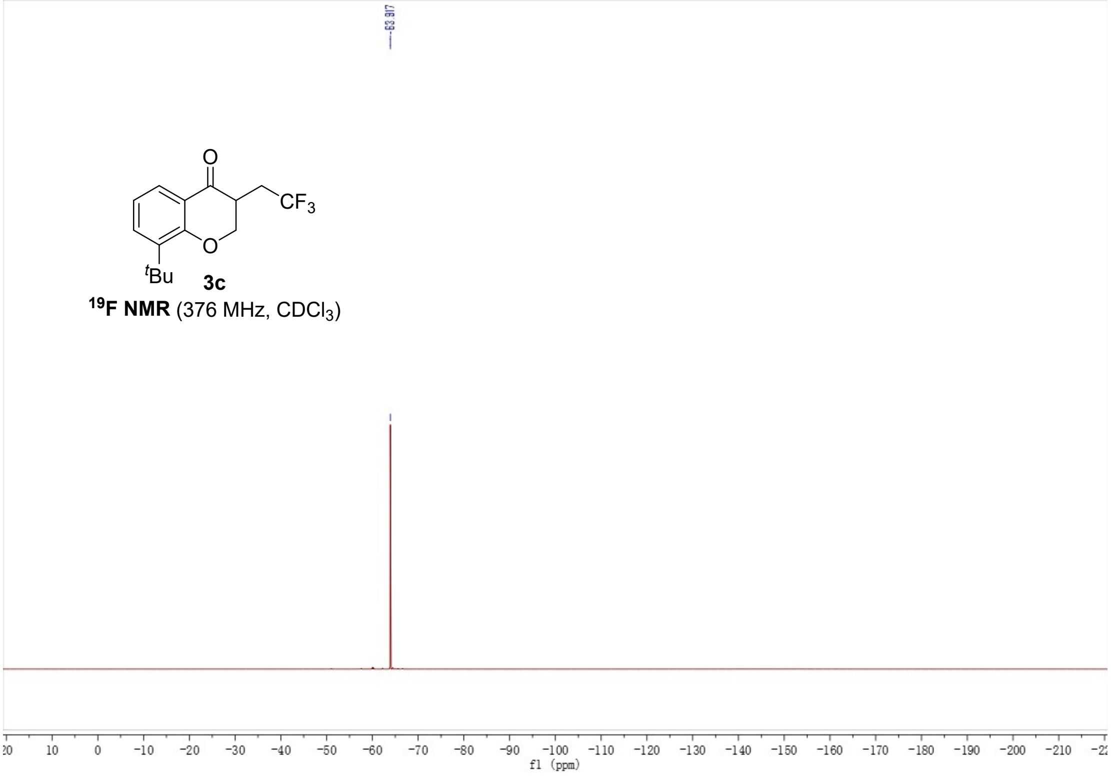


3b
^{19}F NMR (376 MHz, $CDCl_3$)

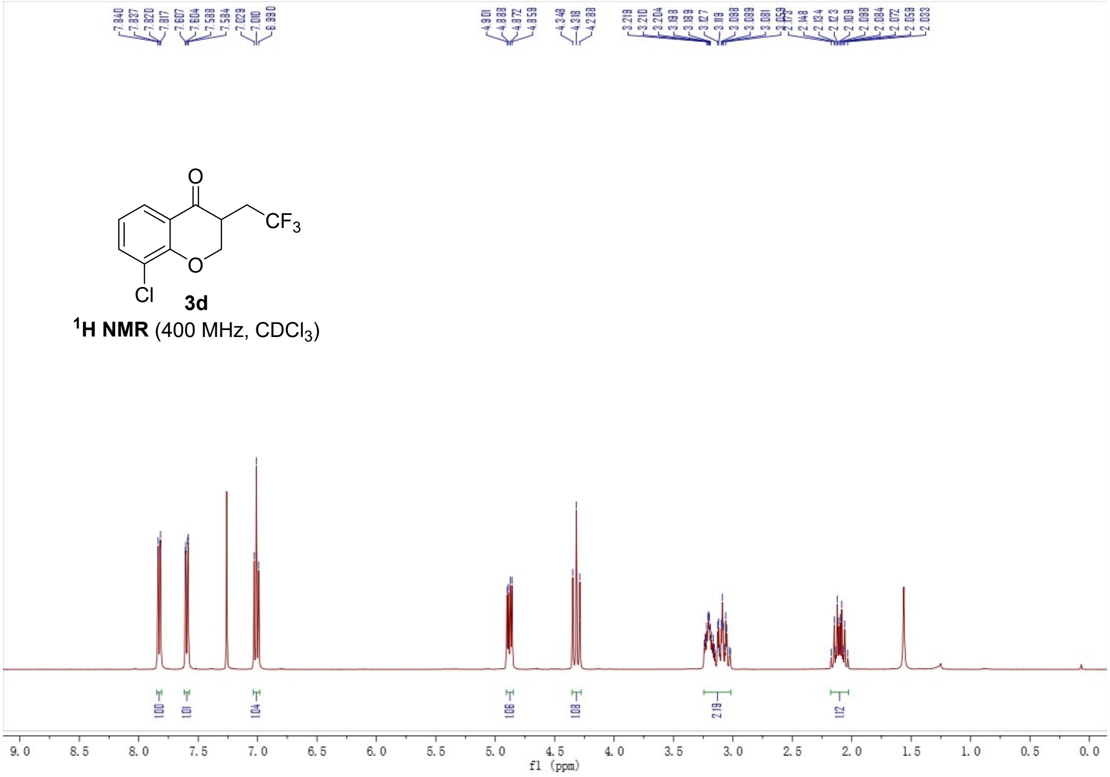
8-(tert-butyl)-3-(2,2,2-trifluoroethyl)chroman-4-one (3c)

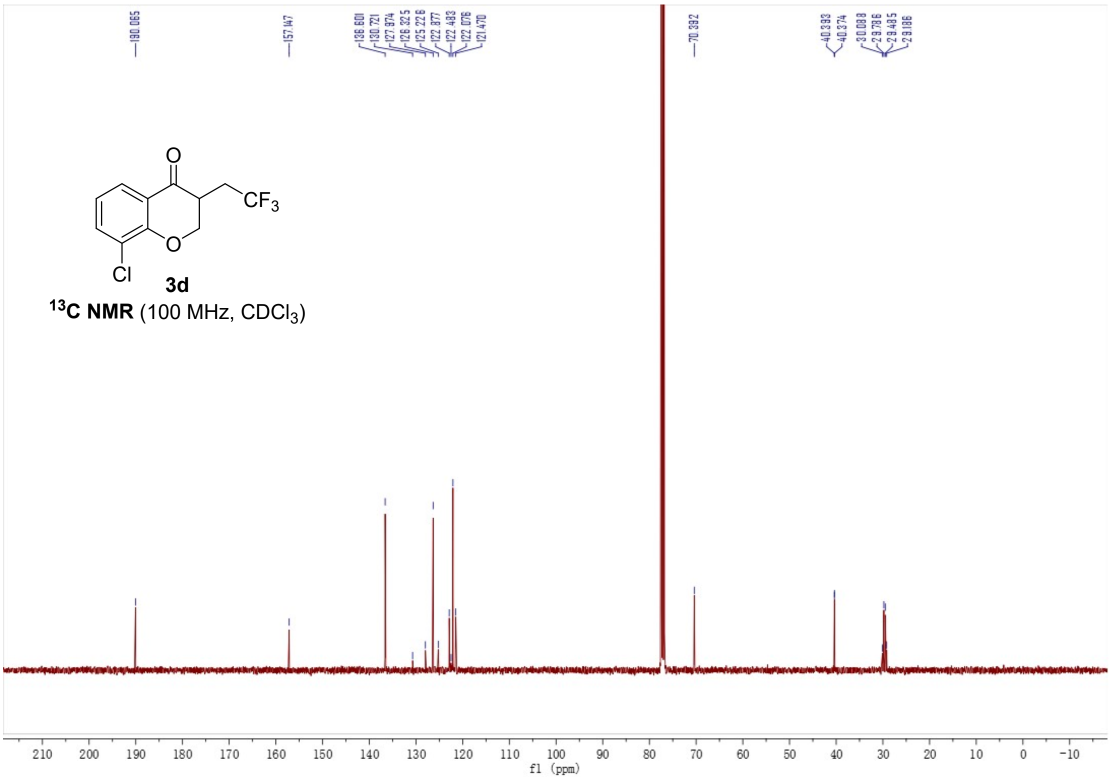






chloro-3-(2,2,2-trifluoroethyl)chroman-4-one (3d)

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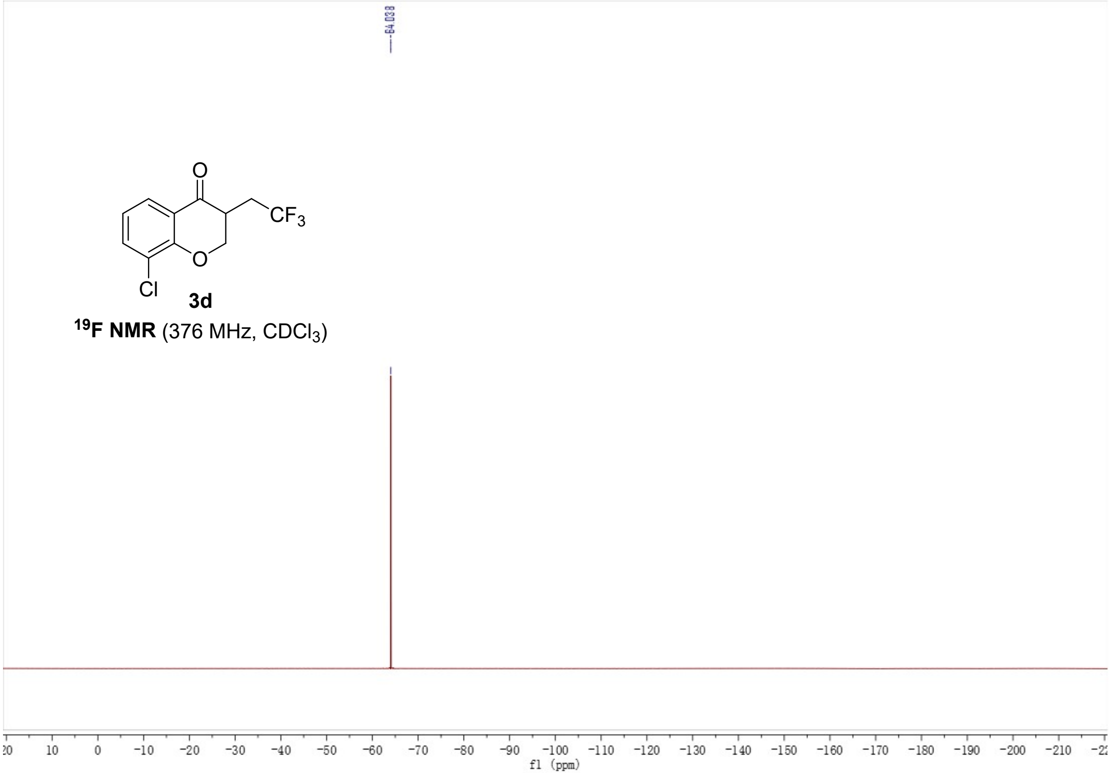
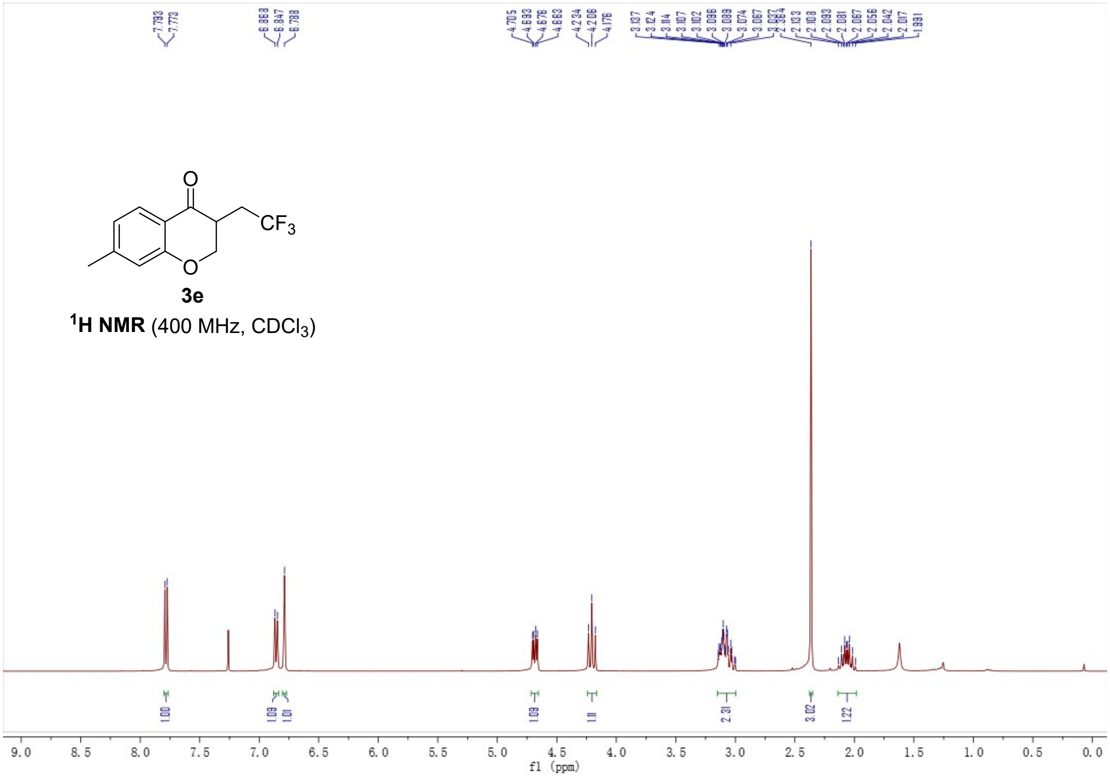
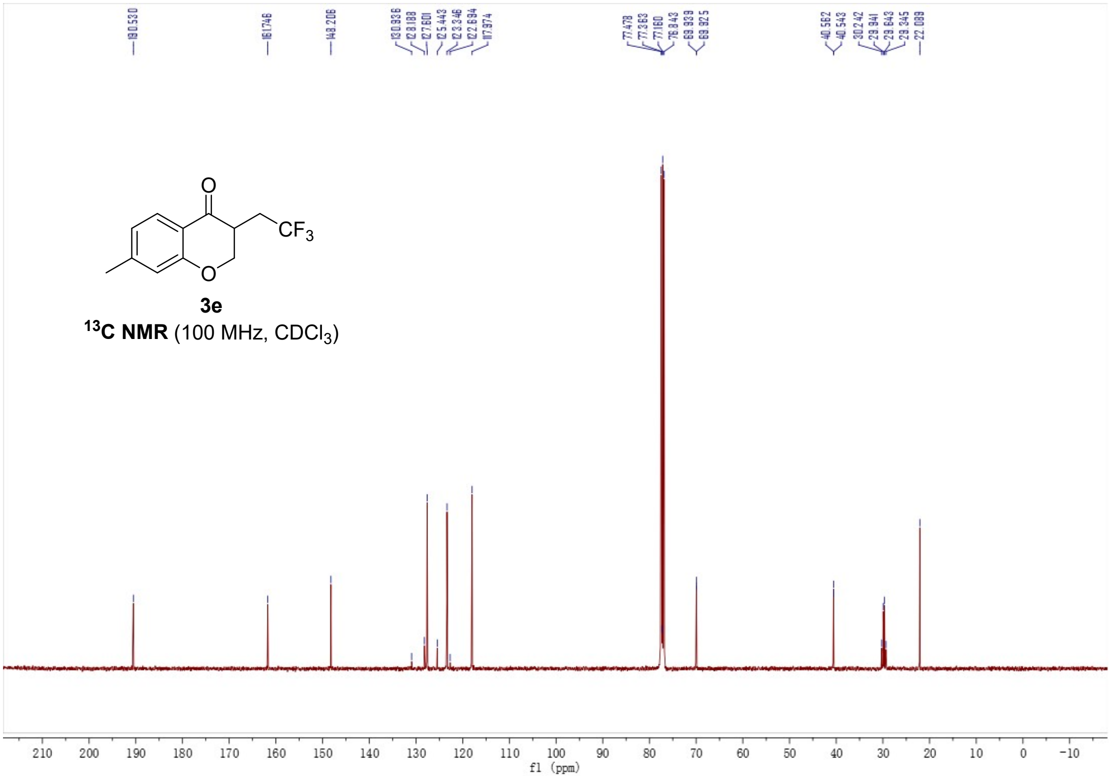
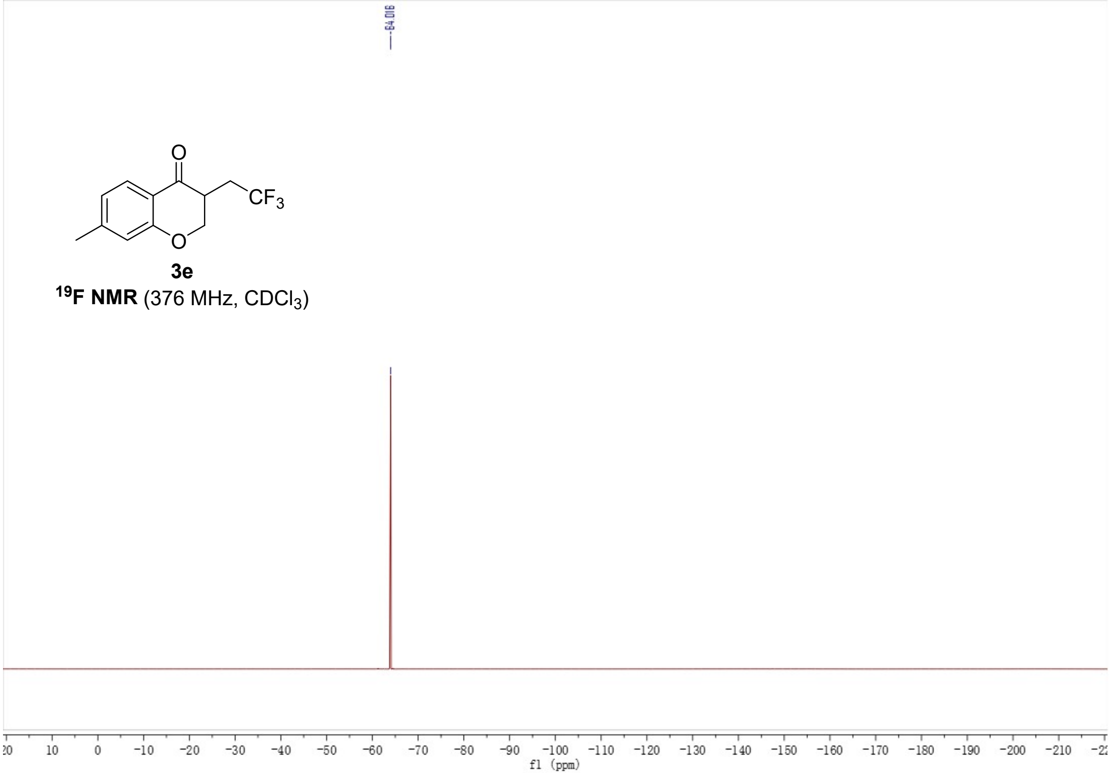
157.147
136.601
130.721
127.974
126.325
125.226
122.877
122.483
122.076
121.470
70.392
40.393
40.374
30.088
29.786
29.485
29.186
O
CF3
O
Cl
3d
13C NMR (100 MHz, CDCl3)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)


-64.038
O
CF3
O
Cl
3d
19F NMR (376 MHz, CDCl3)
20
10
0
−10
−20
−30
−40
−50
−60
−70
−80
−90
−100
−110
−120
−130
−140
−150
−160
−170
−180
−190
−200
−210
f1 (ppm)

7-methyl-3-(2,2,2-trifluoroethyl)chroman-4-one (3e)



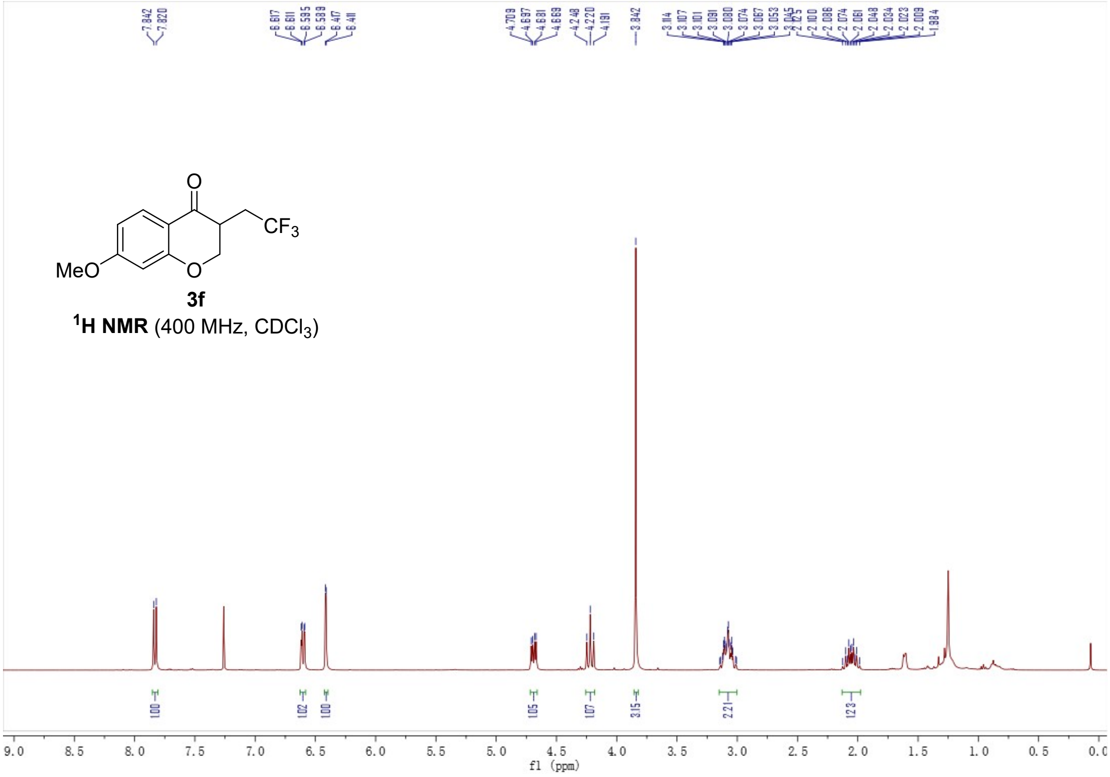




3e

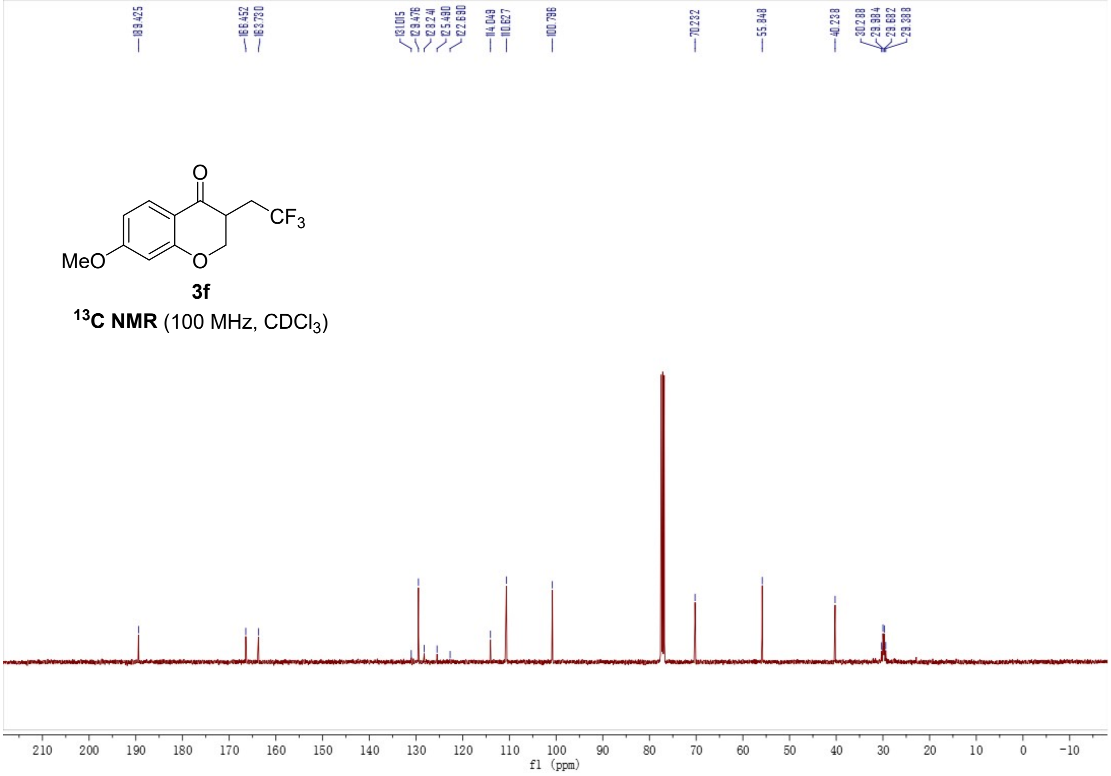
^{19}**F NMR** (376 MHz, CDCl$_3$)

7-methoxy-3-(2,2,2-trifluoroethyl)chroman-4-one (3f)



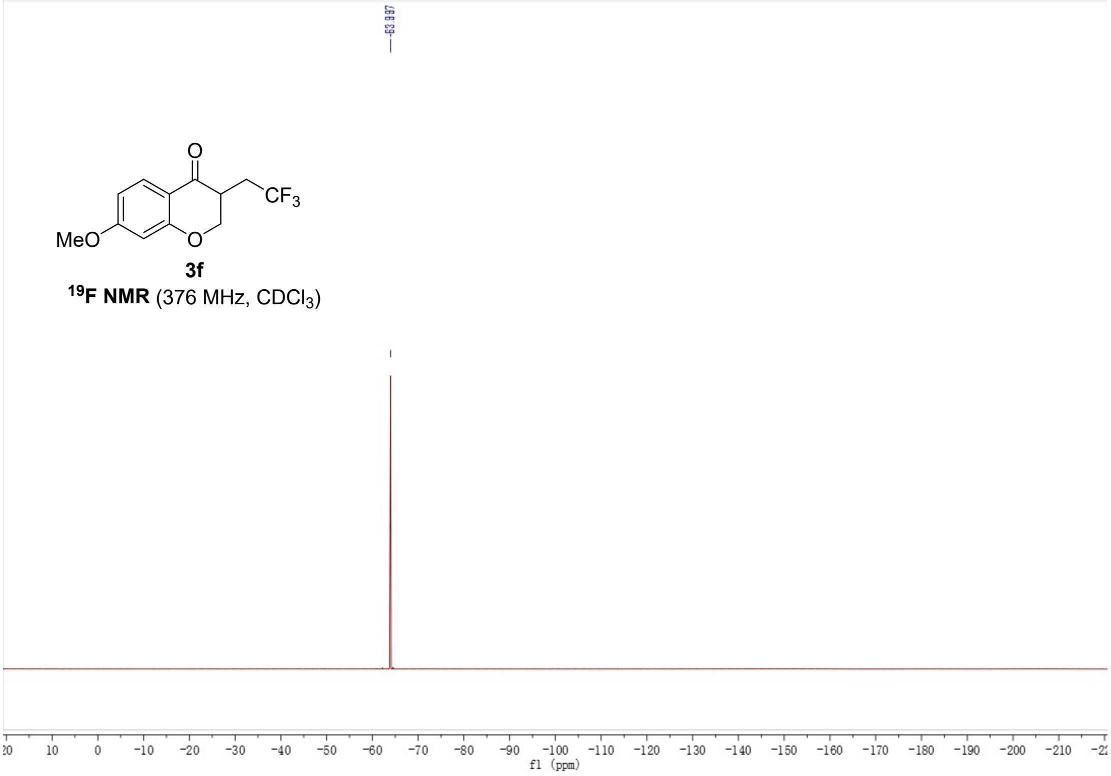
3f

^{1}**H NMR** (400 MHz, CDCl$_3$)



3f

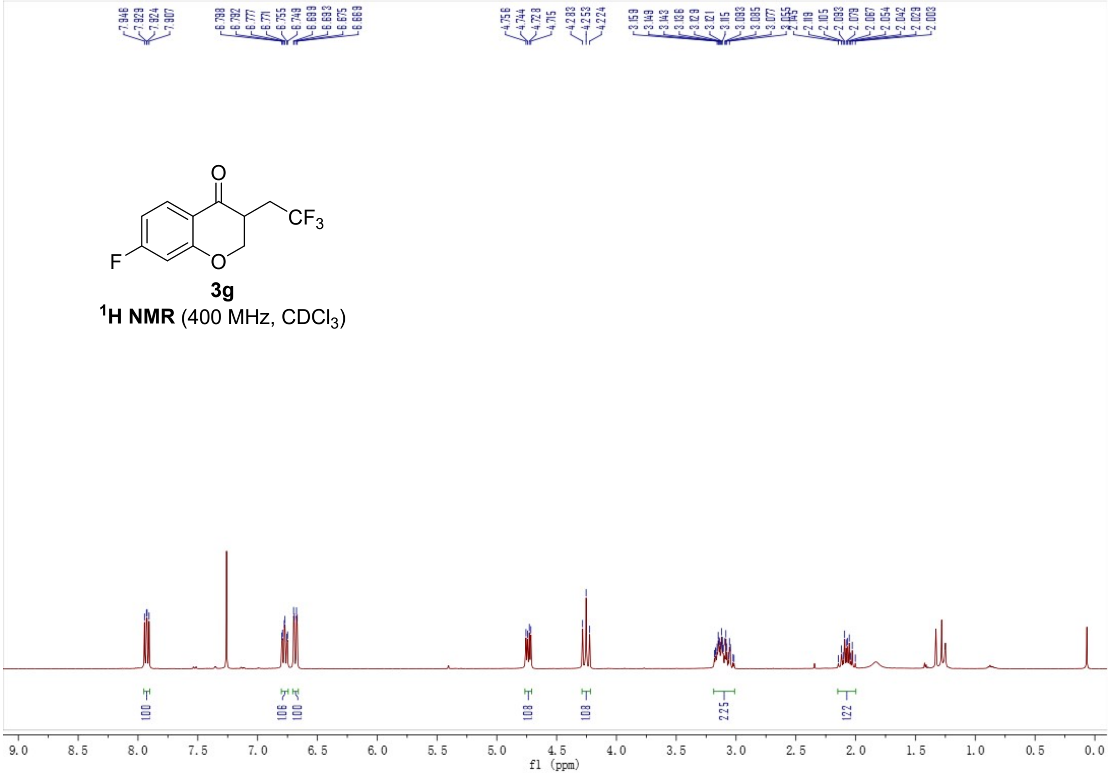
^{13}C NMR (100 MHz, $CDCl_3$)



3f

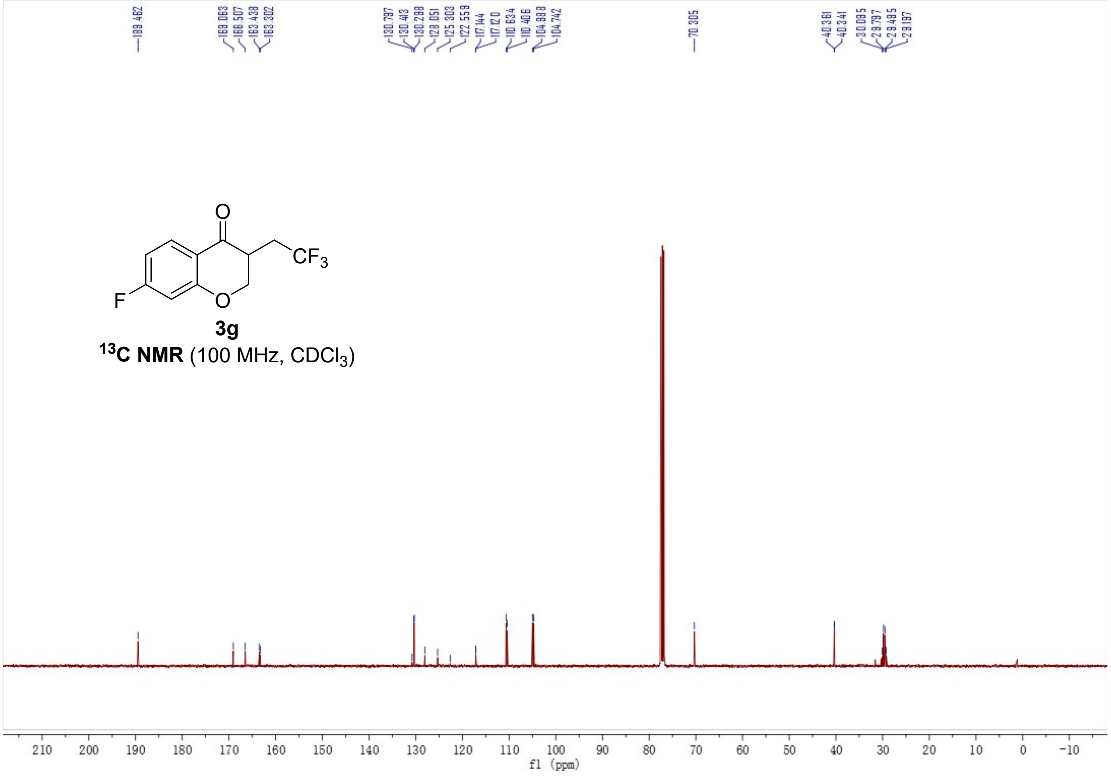
^{19}F NMR (376 MHz, $CDCl_3$)

7-fluoro-3-(2,2,2-trifluoroethyl)chroman-4-one (3g)



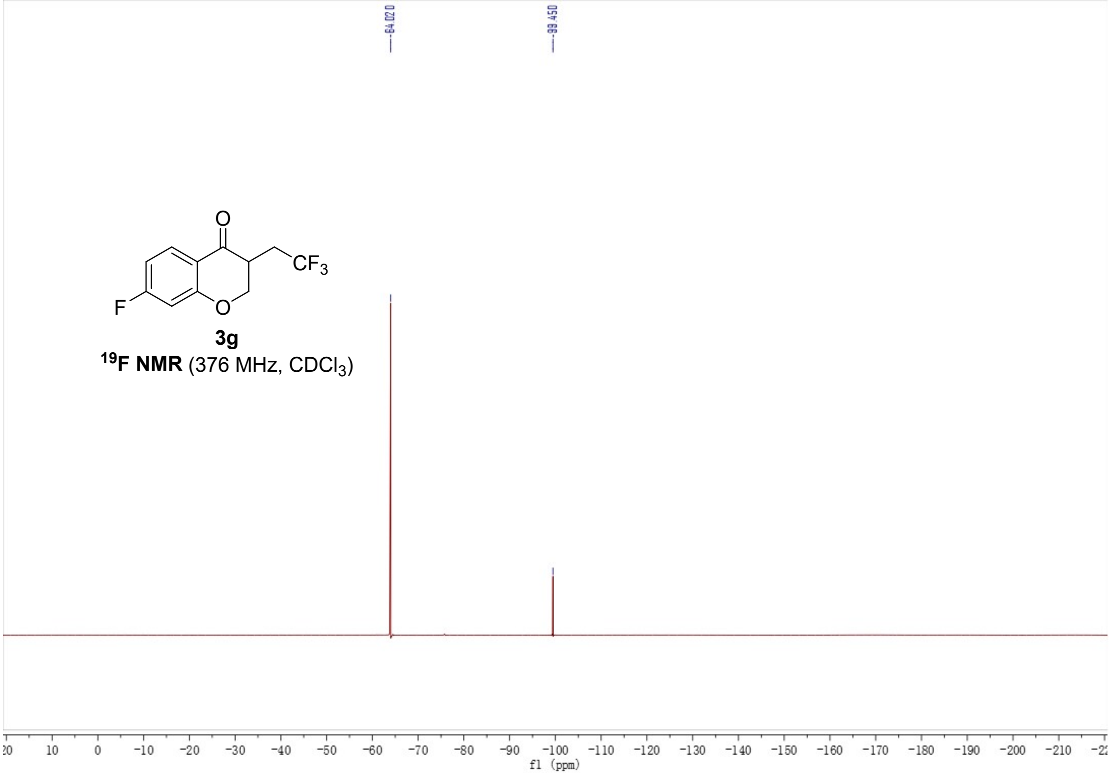
3g

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



3g

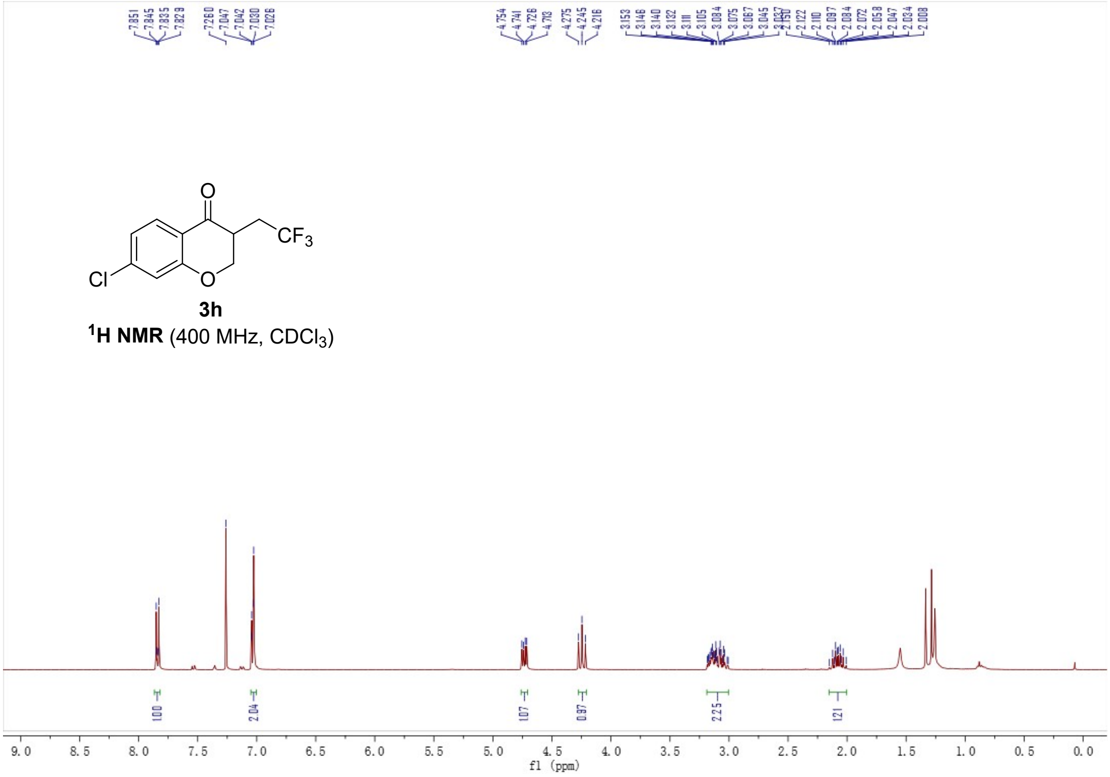
^{13}C NMR (100 MHz, $CDCl_3$)



3g

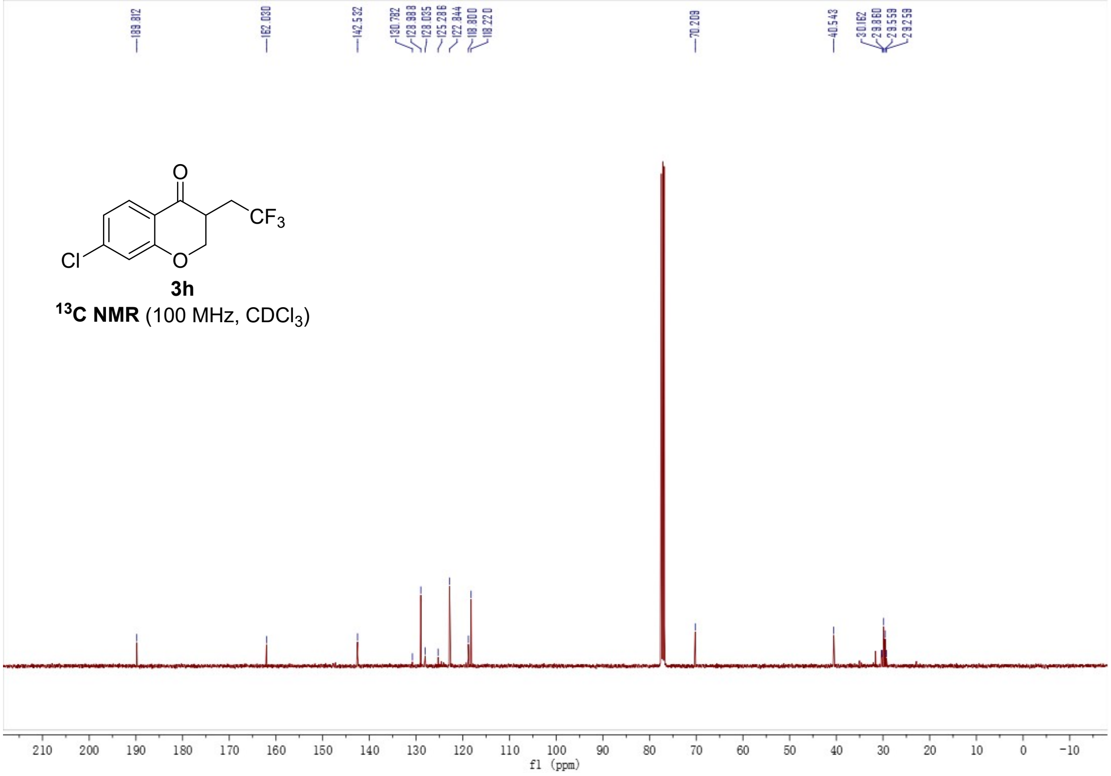
^{19}**F NMR** (376 MHz, $CDCl_3$)

chloro-3-(2,2,2-trifluoroethyl)chroman-4-one (3h)



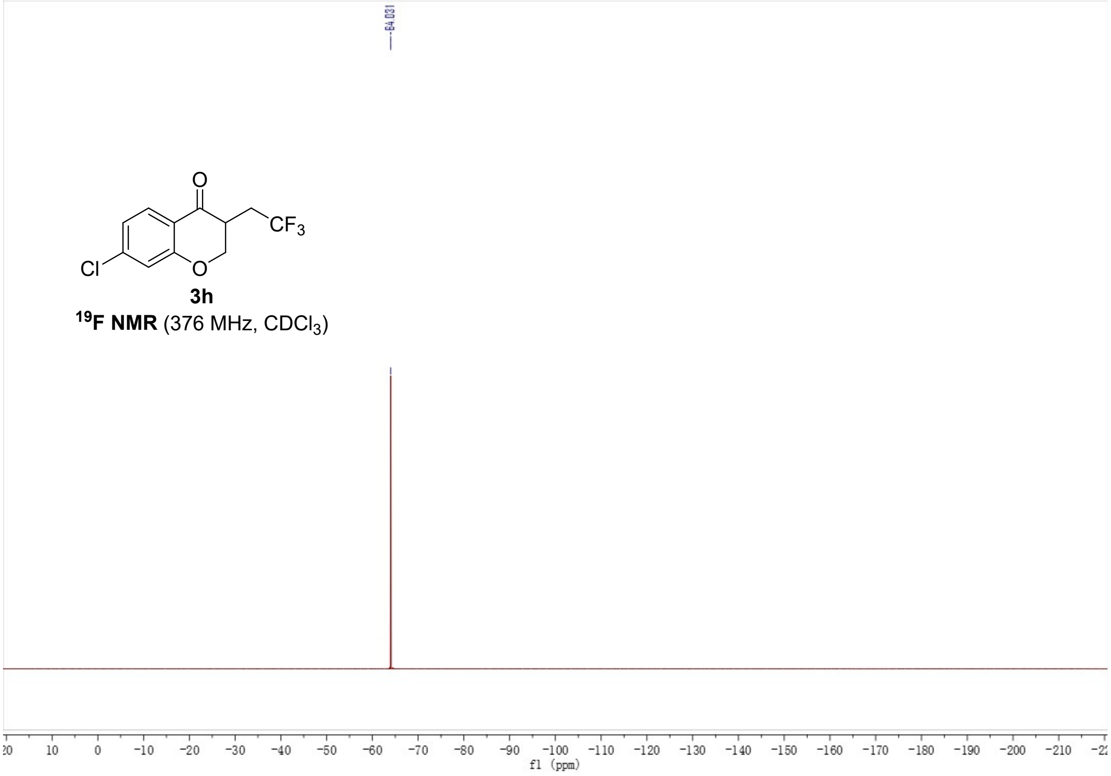
3h

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



3h

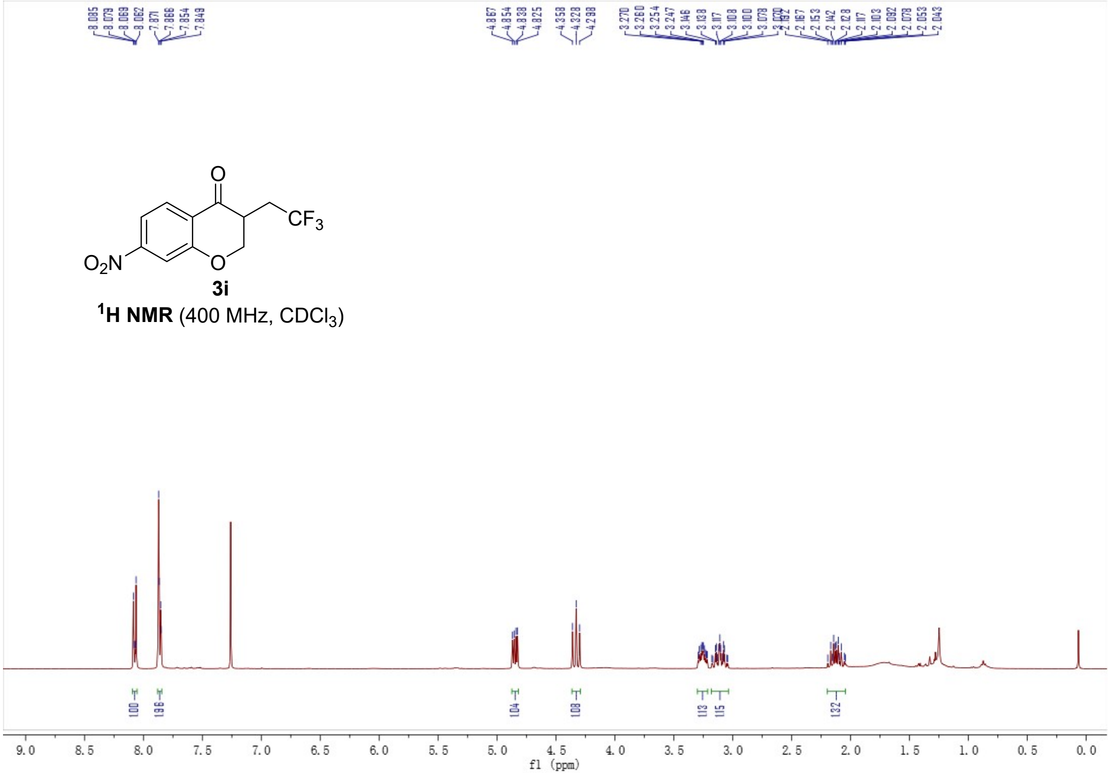
^{13}C NMR (100 MHz, $CDCl_3$)

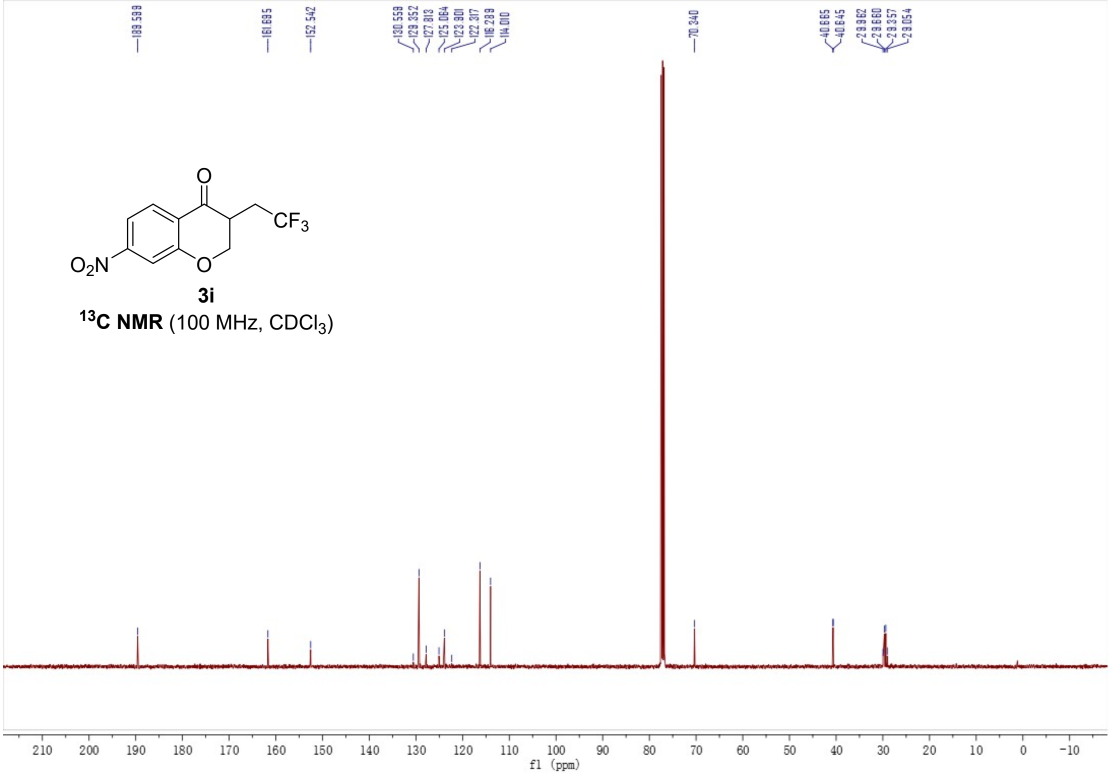


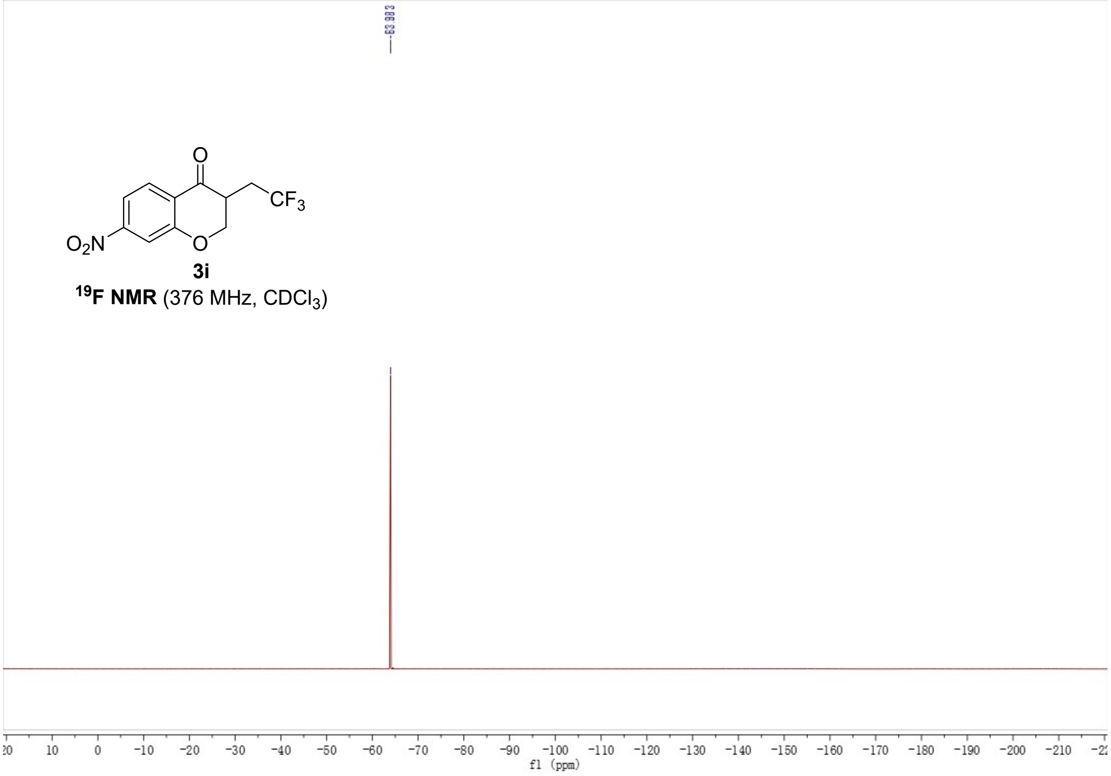
3h

^{19}F NMR (376 MHz, $CDCl_3$)

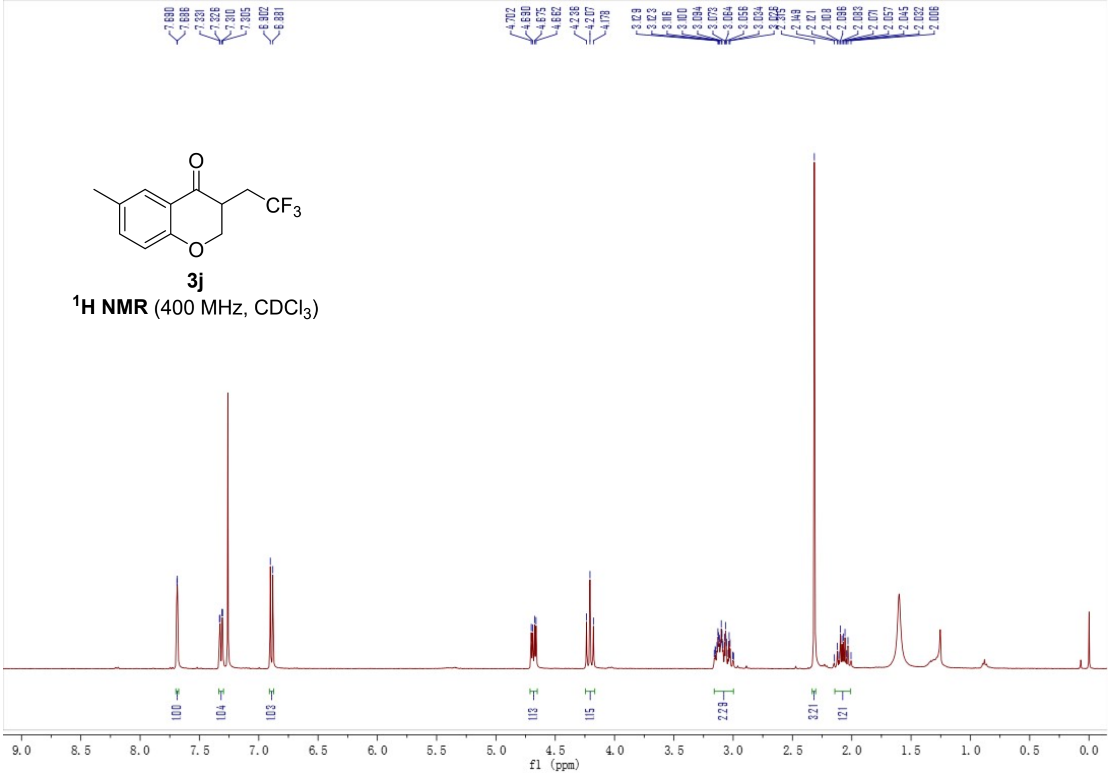
7-nitro-3-(2,2,2-trifluoroethyl)chroman-4-one (3i)

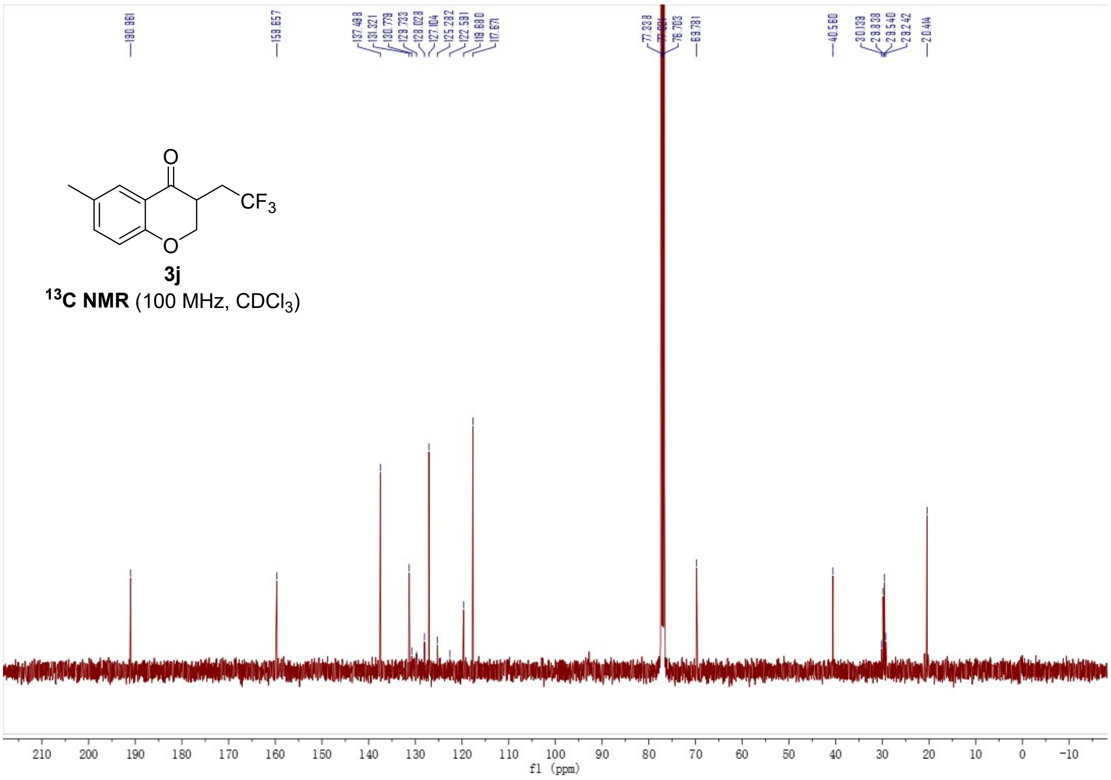






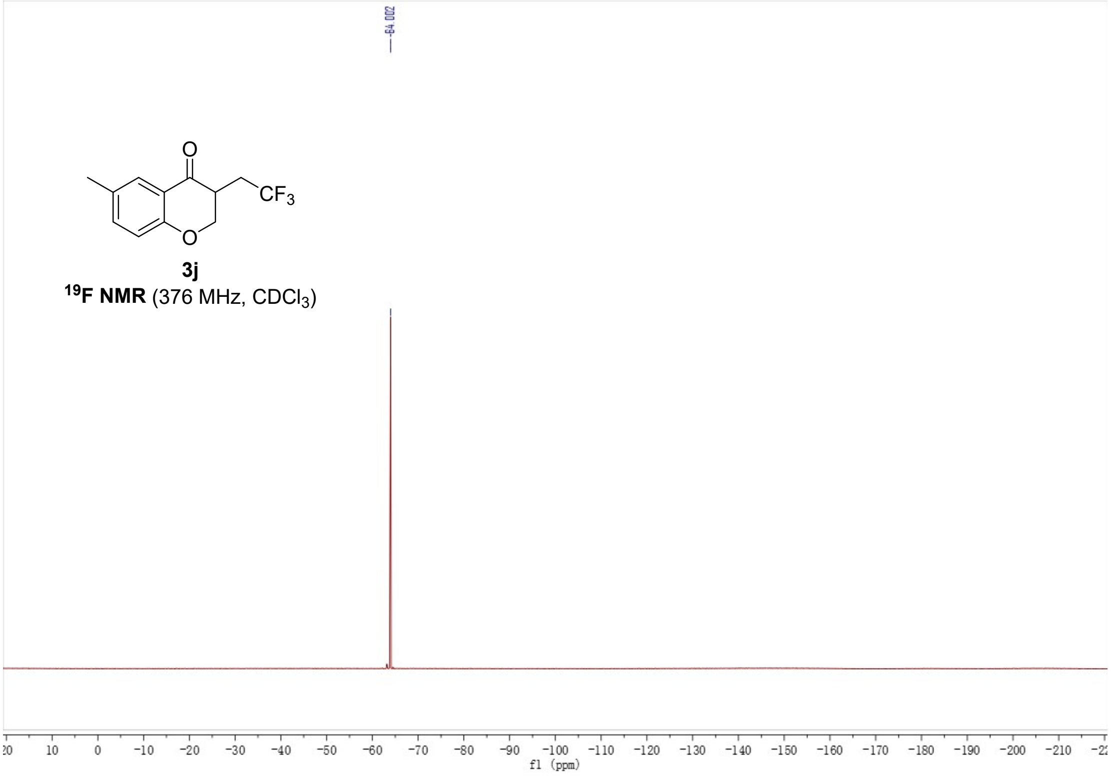
6-methyl-3-(2,2,2-trifluoroethyl)chroman-4-one (3j)





3j

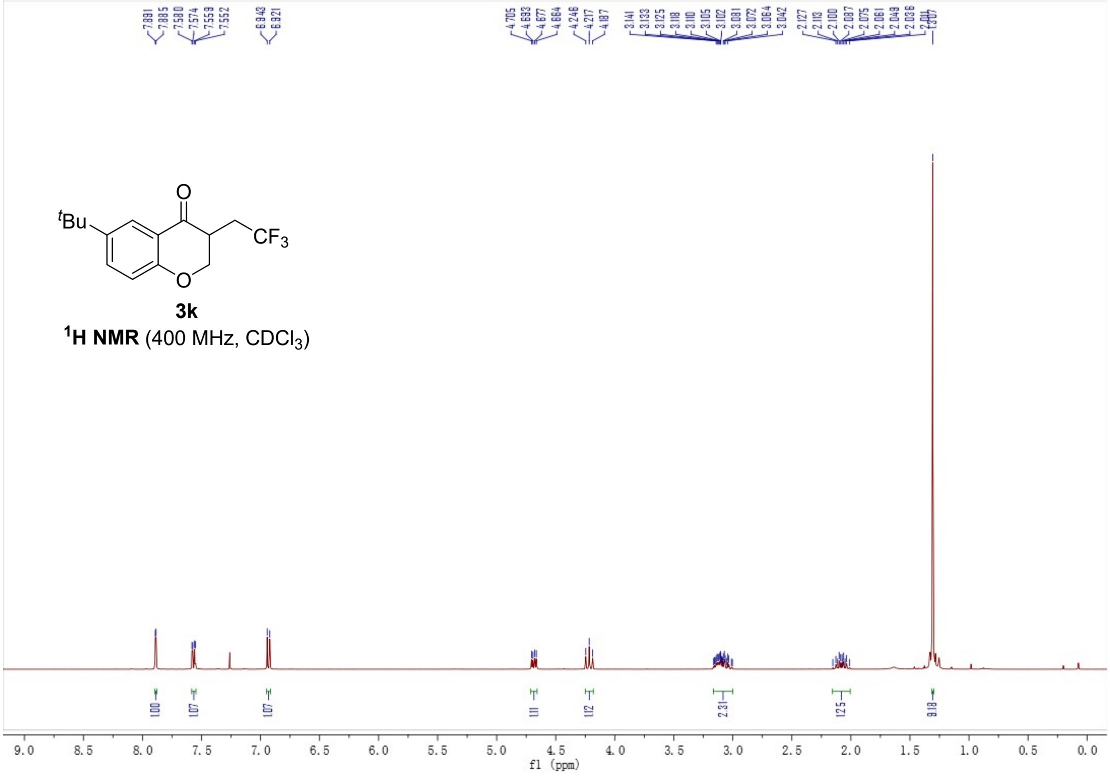
^{13}C NMR (100 MHz, $CDCl_3$)

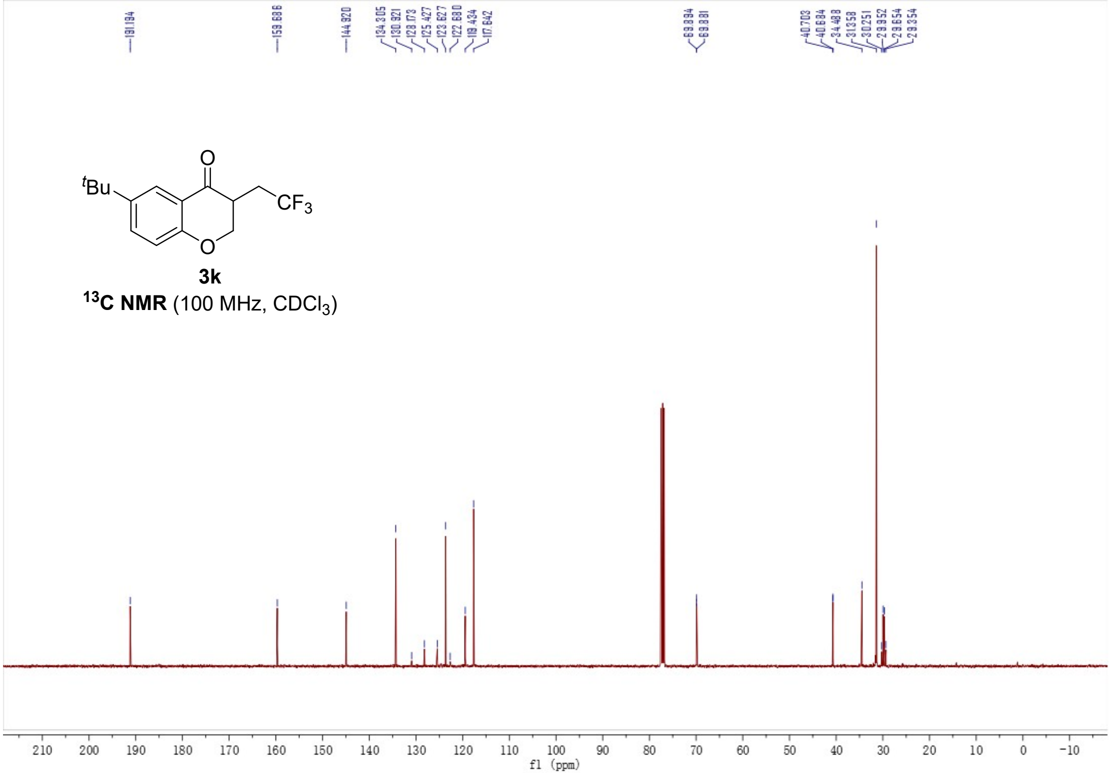


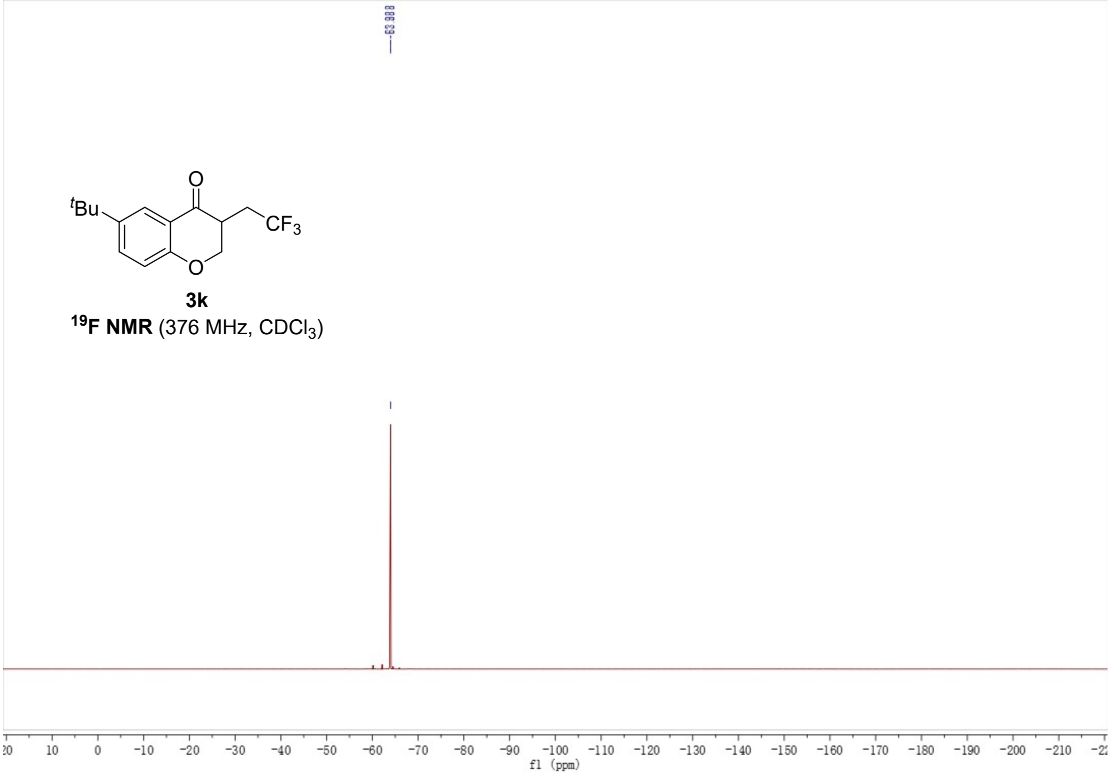
3j

^{19}F NMR (376 MHz, $CDCl_3$)

6-(tert-butyl)-3-(2,2,2-trifluoroethyl)chroman-4-one (3k)



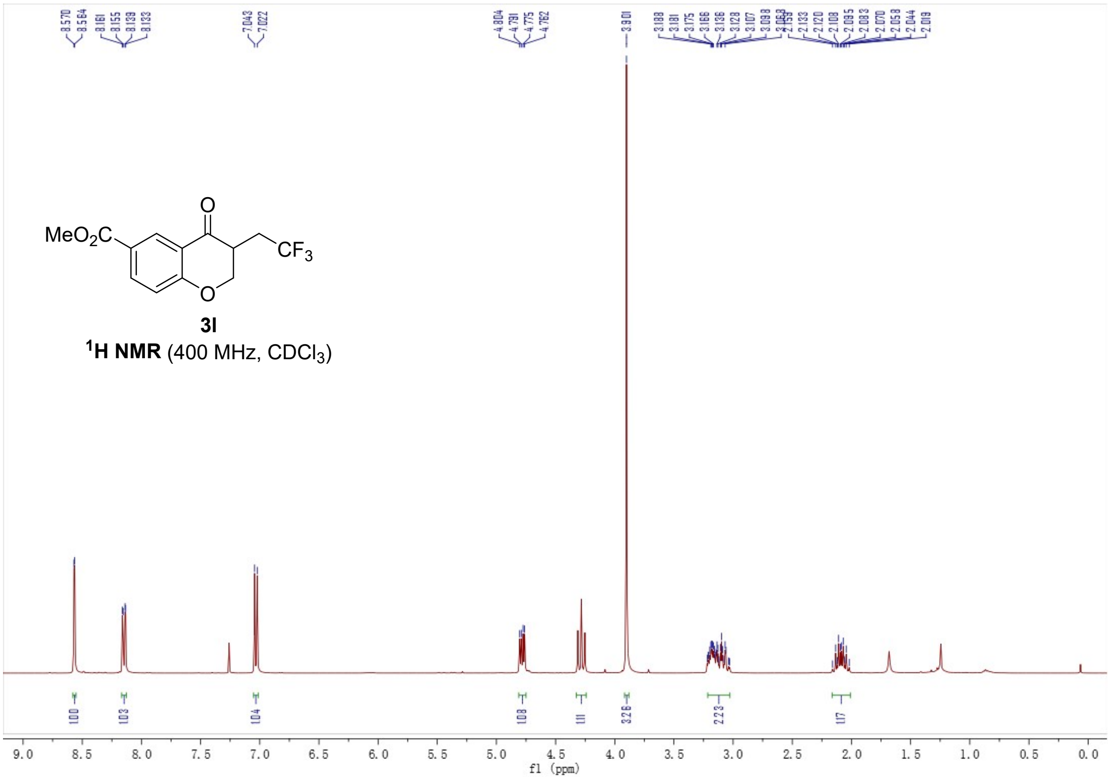




3k

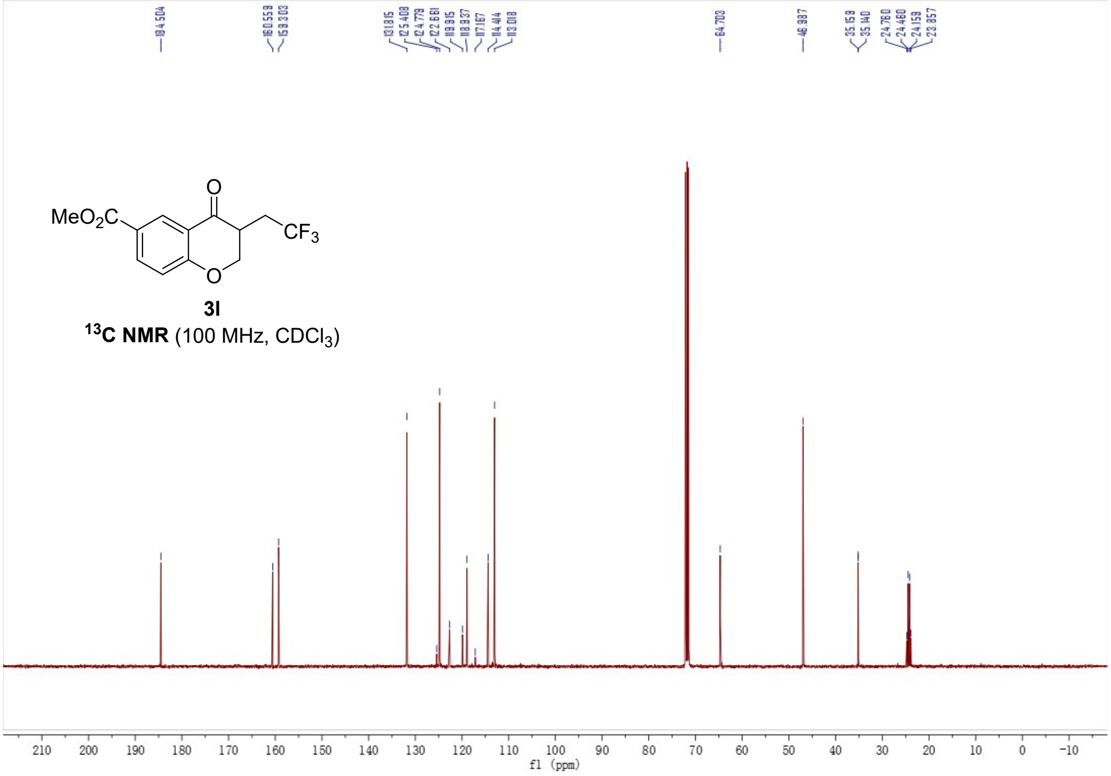
^{19}F NMR (376 MHz, CDCl$_3$)

methyl4-oxo-3-(2,2,2-trifluoroethyl)chromane-6-carboxylate (3l)



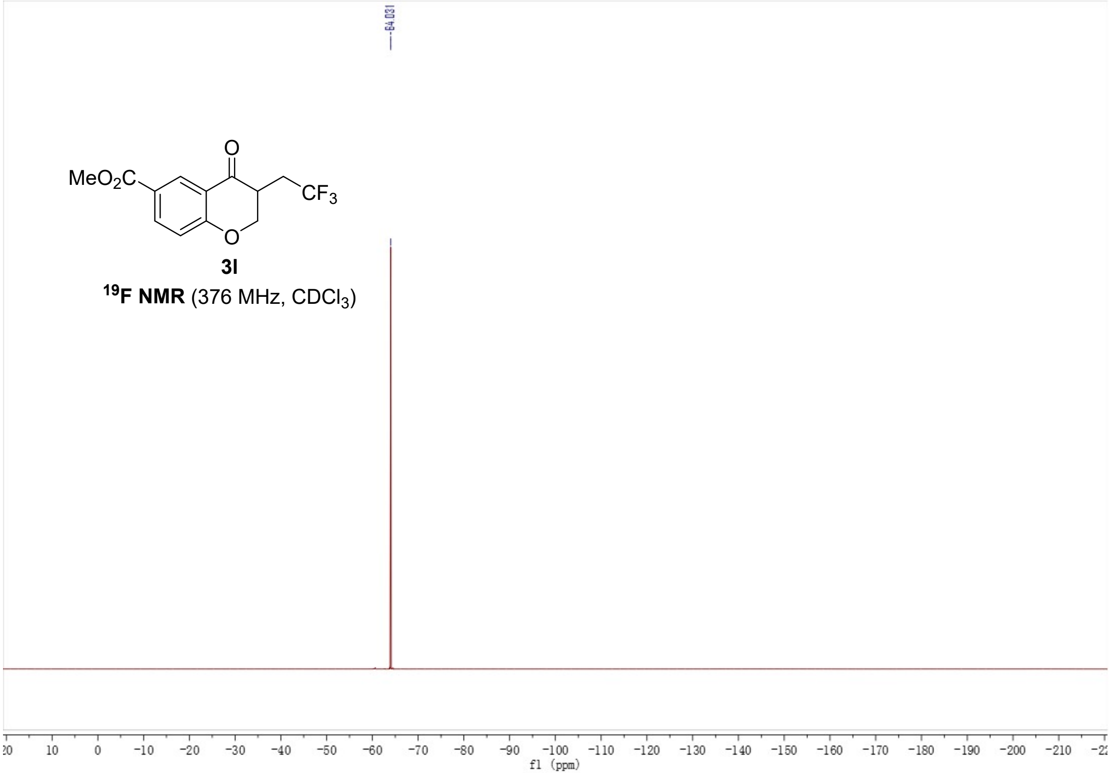
3l

^{1}H NMR (400 MHz, CDCl$_3$)



3l

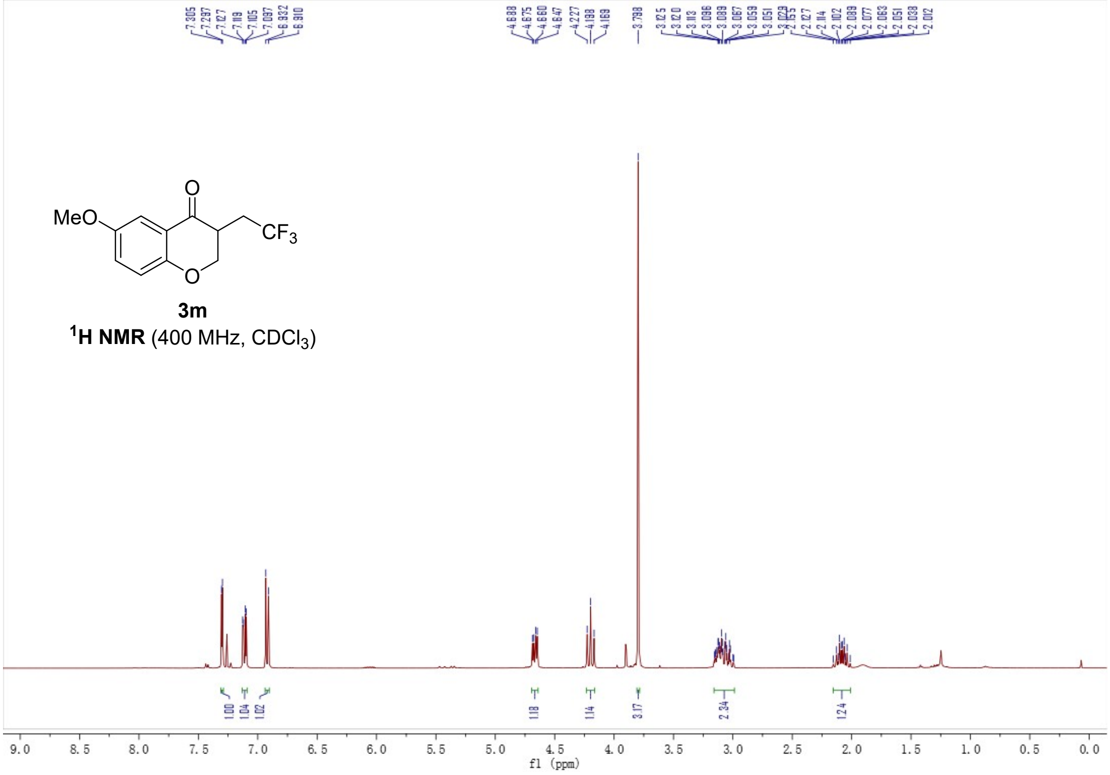
^{13}**C NMR** (100 MHz, CDCl$_3$)

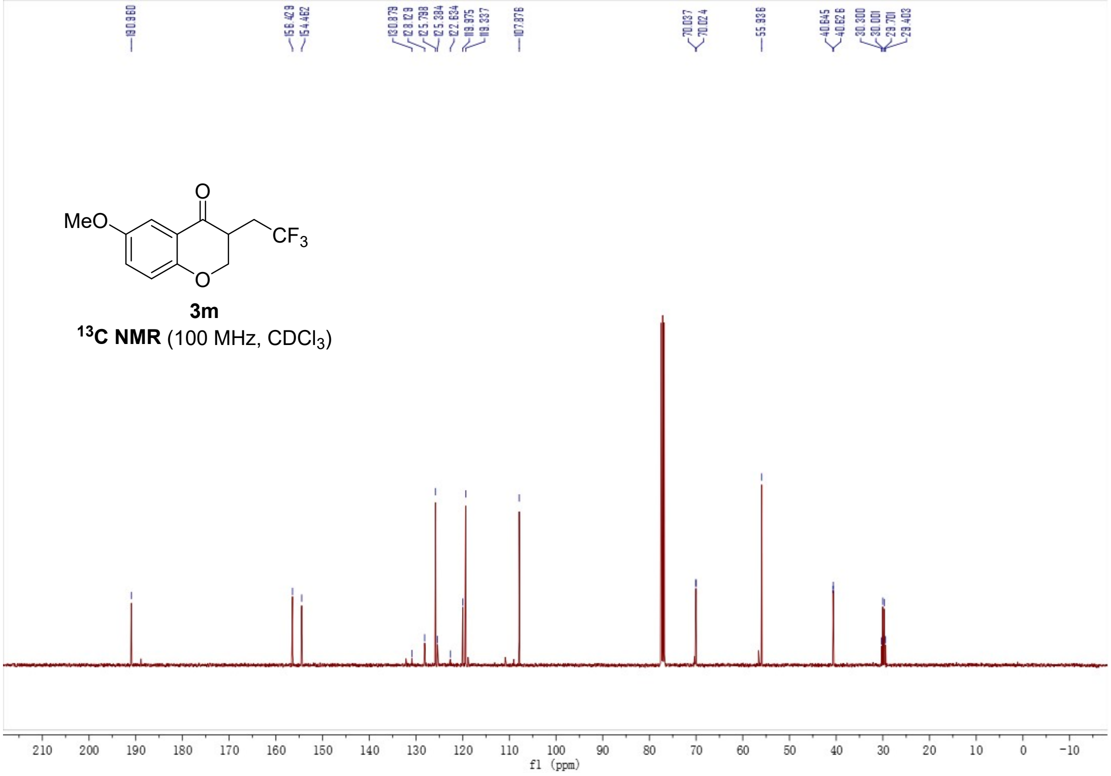


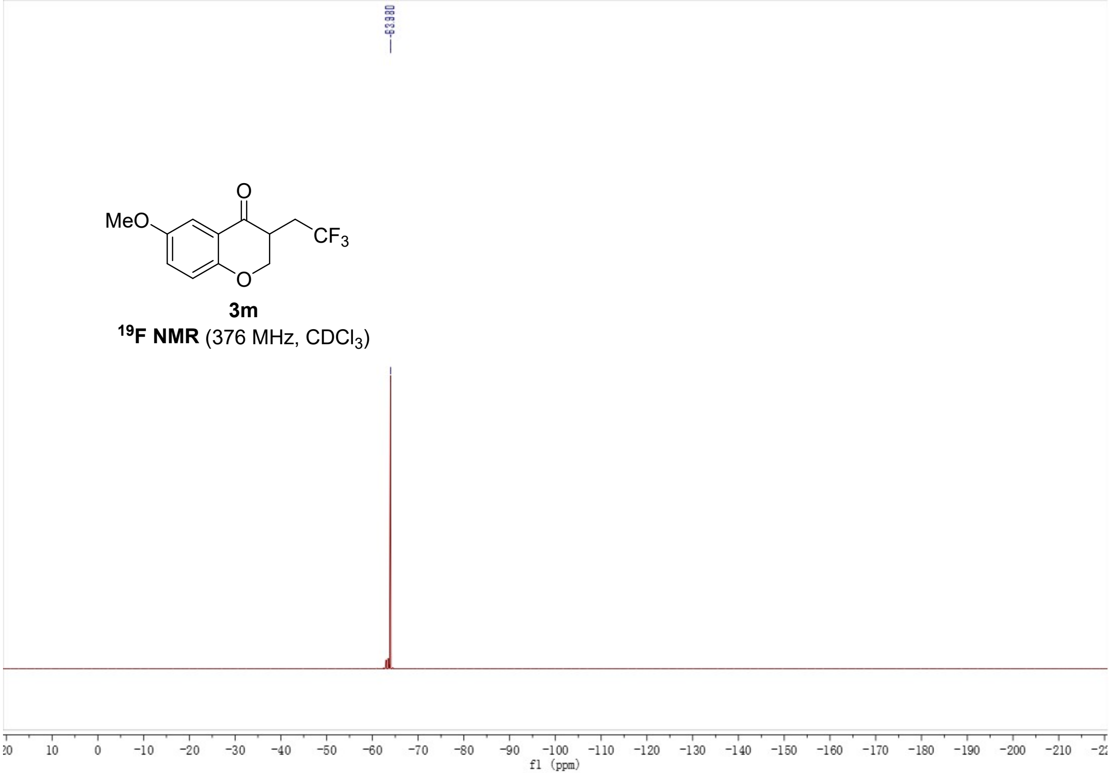
3l

^{19}**F NMR** (376 MHz, CDCl$_3$)

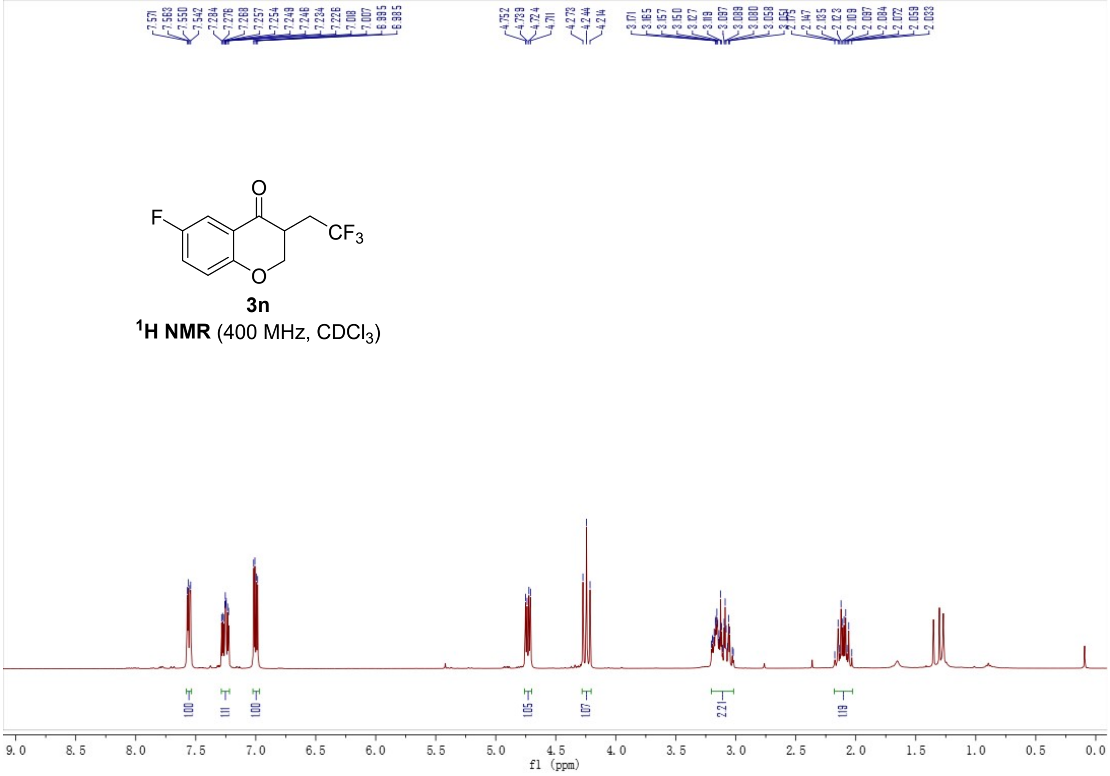
(S)-6-methoxy-3-(2,2,2-trifluoroethyl)chroman-4-one (3m)

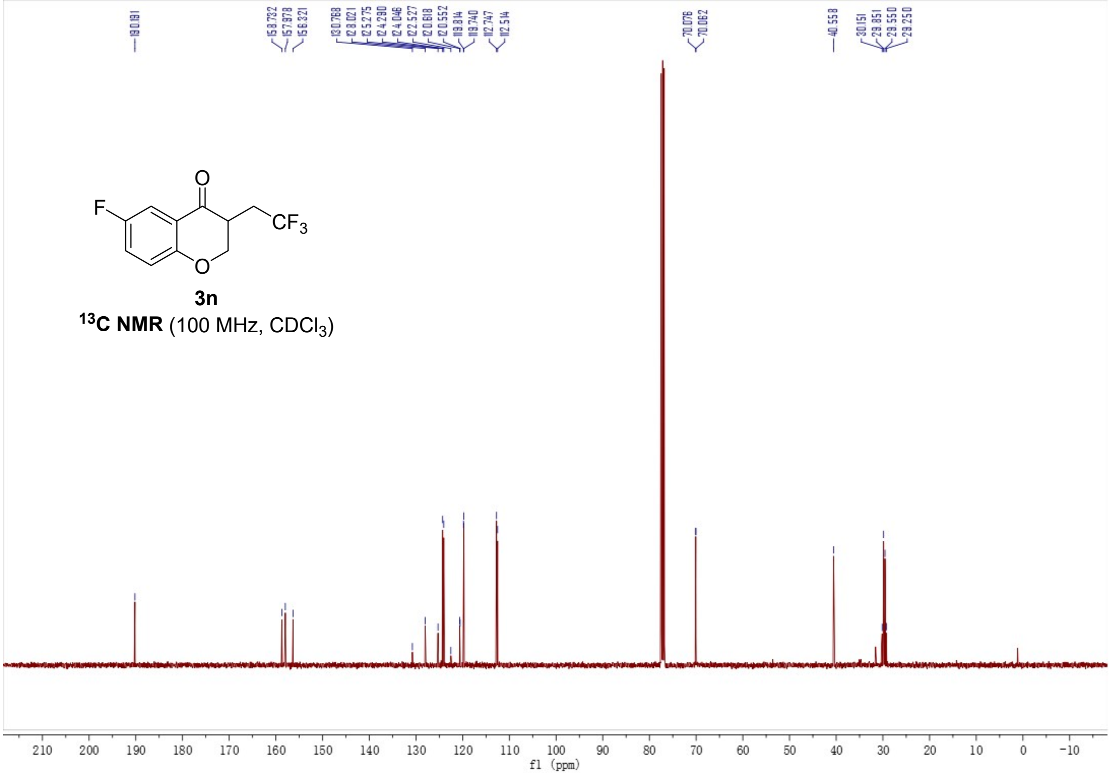






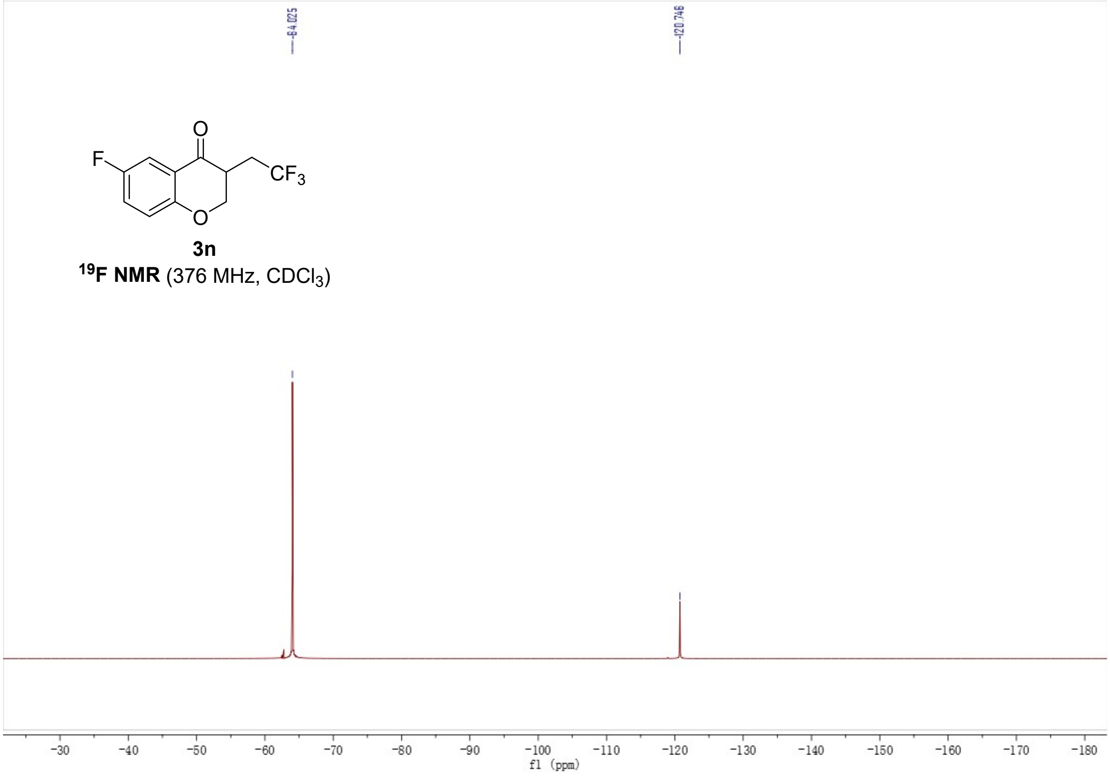
(S)-6-fluoro-3-(2,2,2-trifluoroethyl)chroman-4-one (3n)





3n

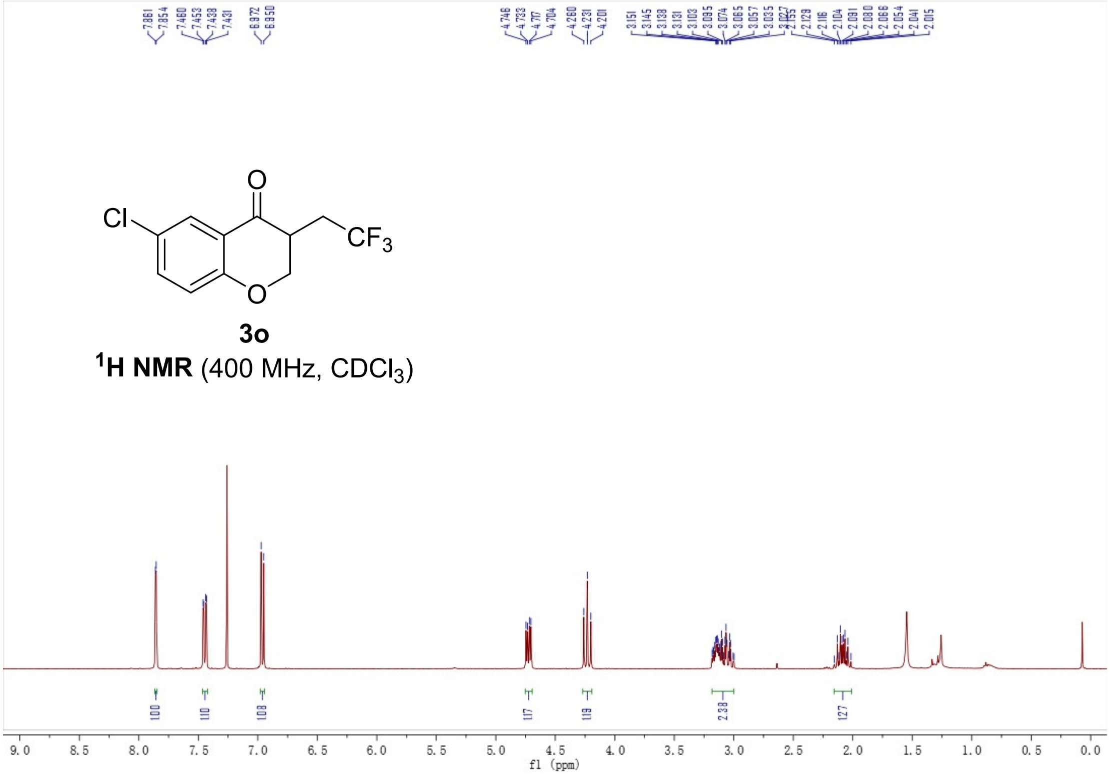
^{13}C NMR (100 MHz, $CDCl_3$)

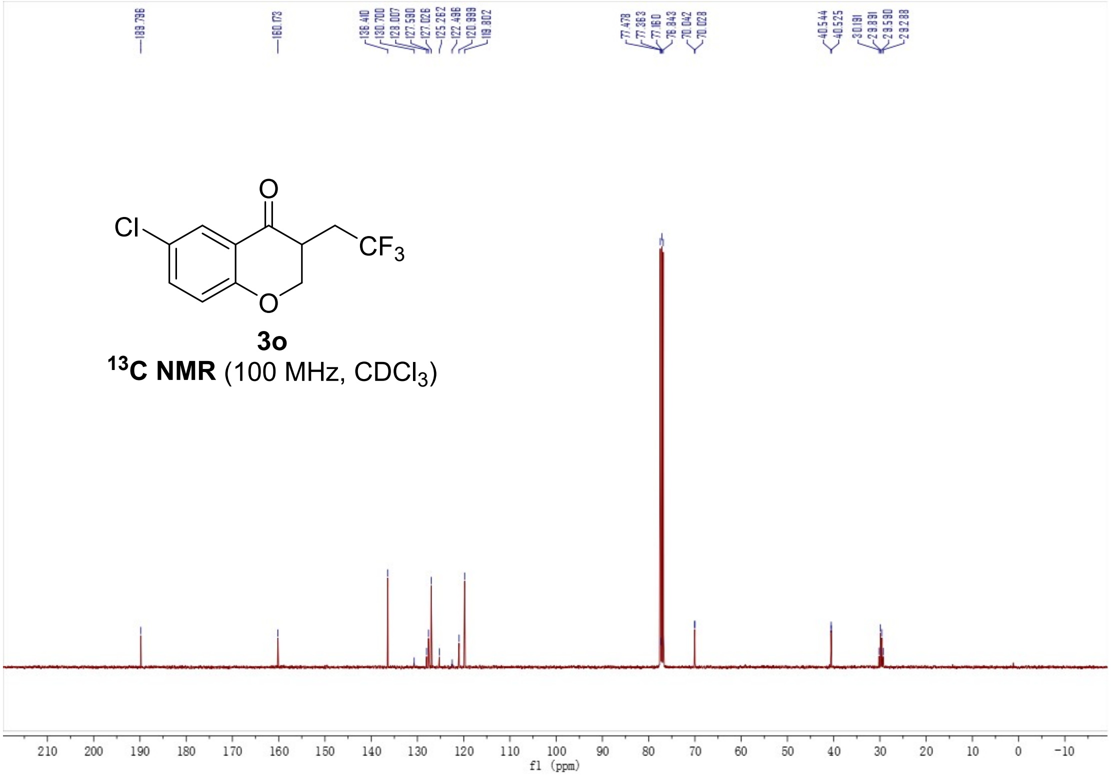


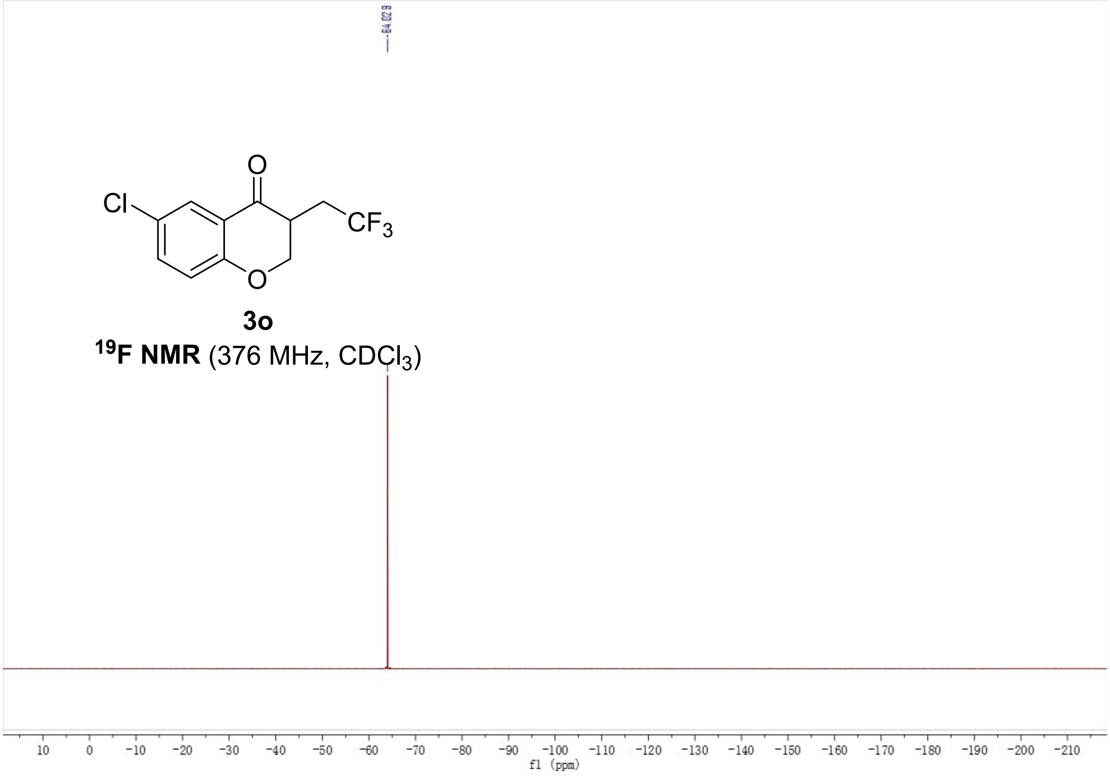
3n

^{19}F NMR (376 MHz, $CDCl_3$)

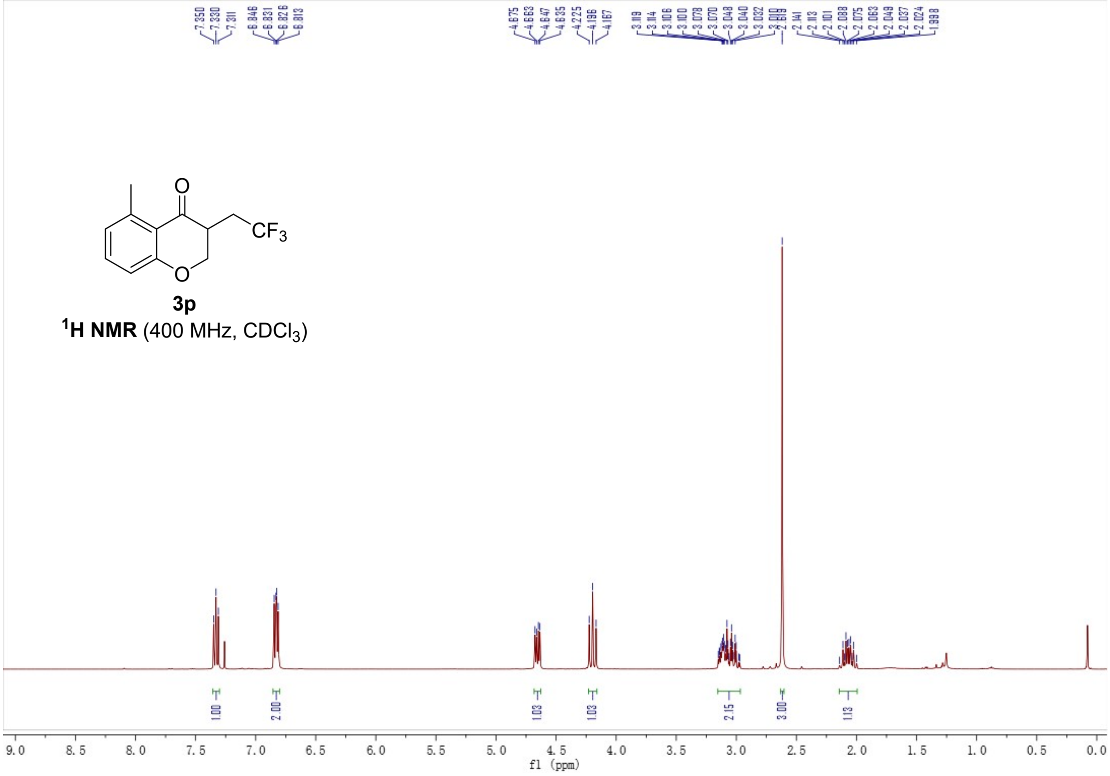
(S)-6-chloro-3-(2,2,2-trifluoroethyl)chroman-4-one (3o)

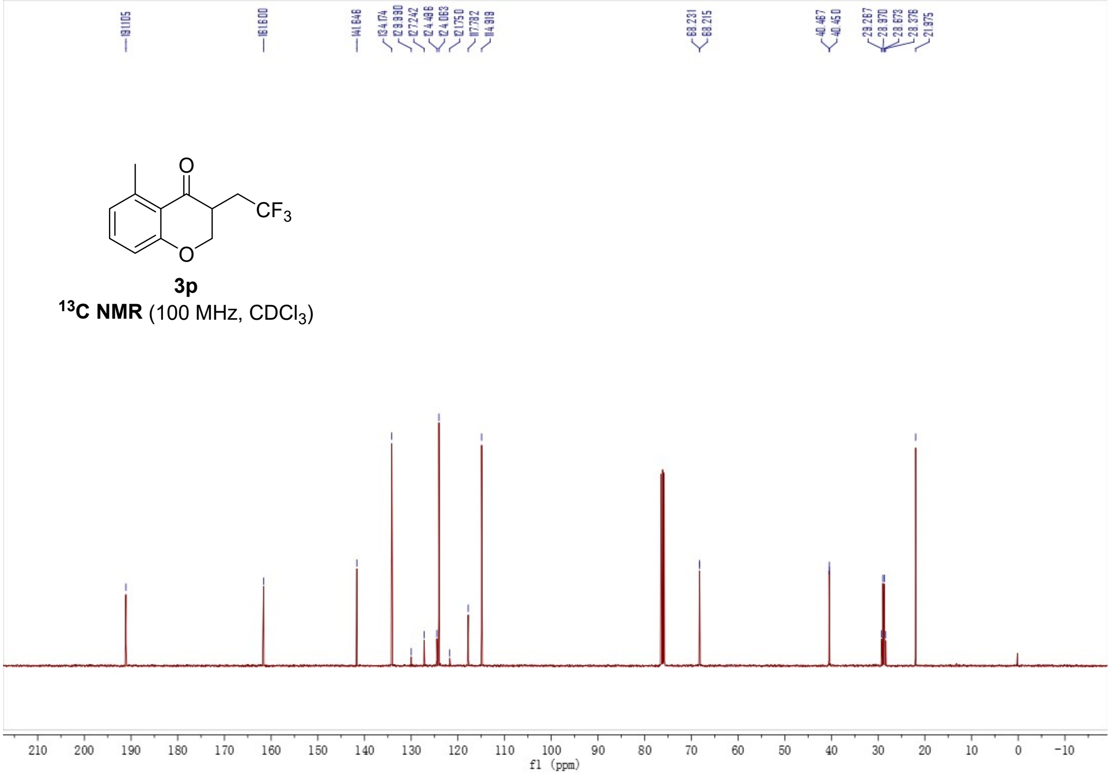






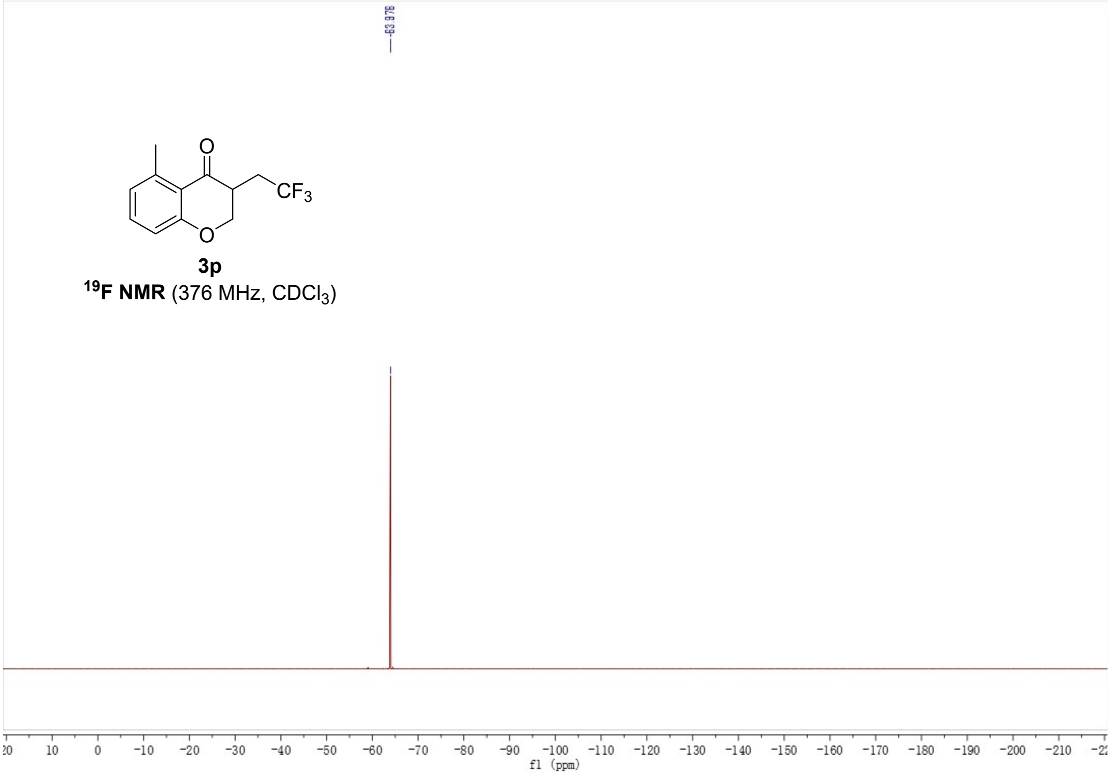
5-methyl-3-(2,2,2-trifluoroethyl)chroman-4-one (3p)





3p

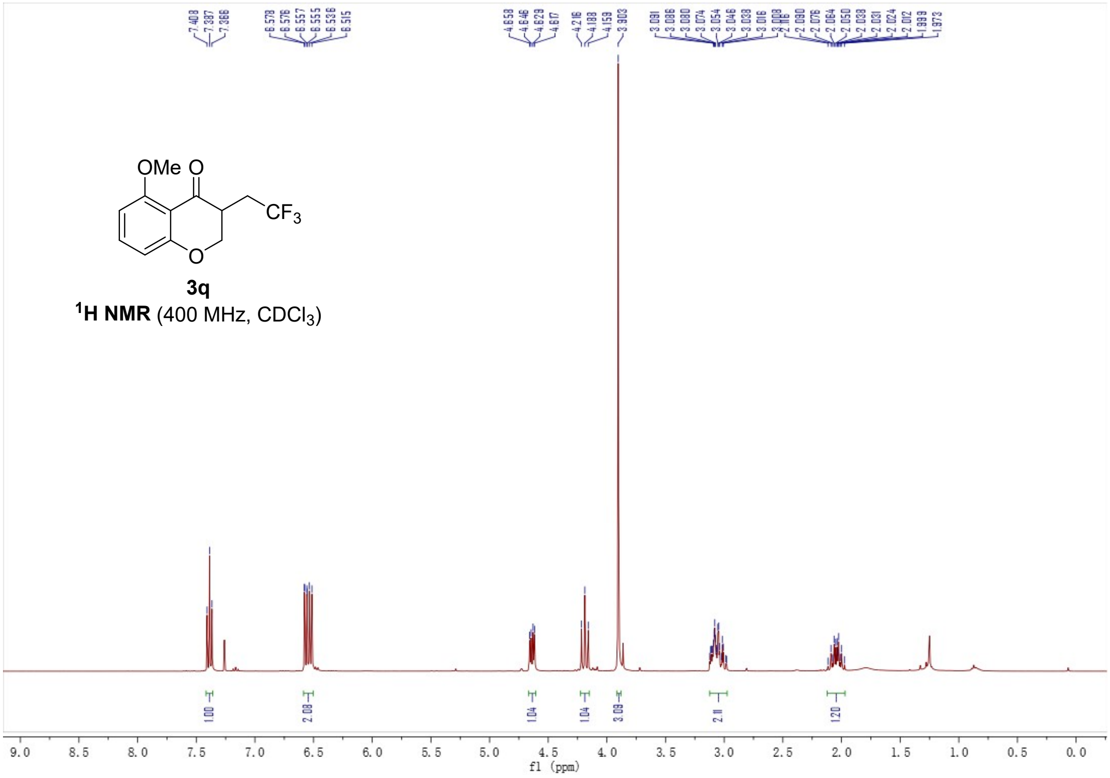
^{13}C NMR (100 MHz, CDCl$_3$)

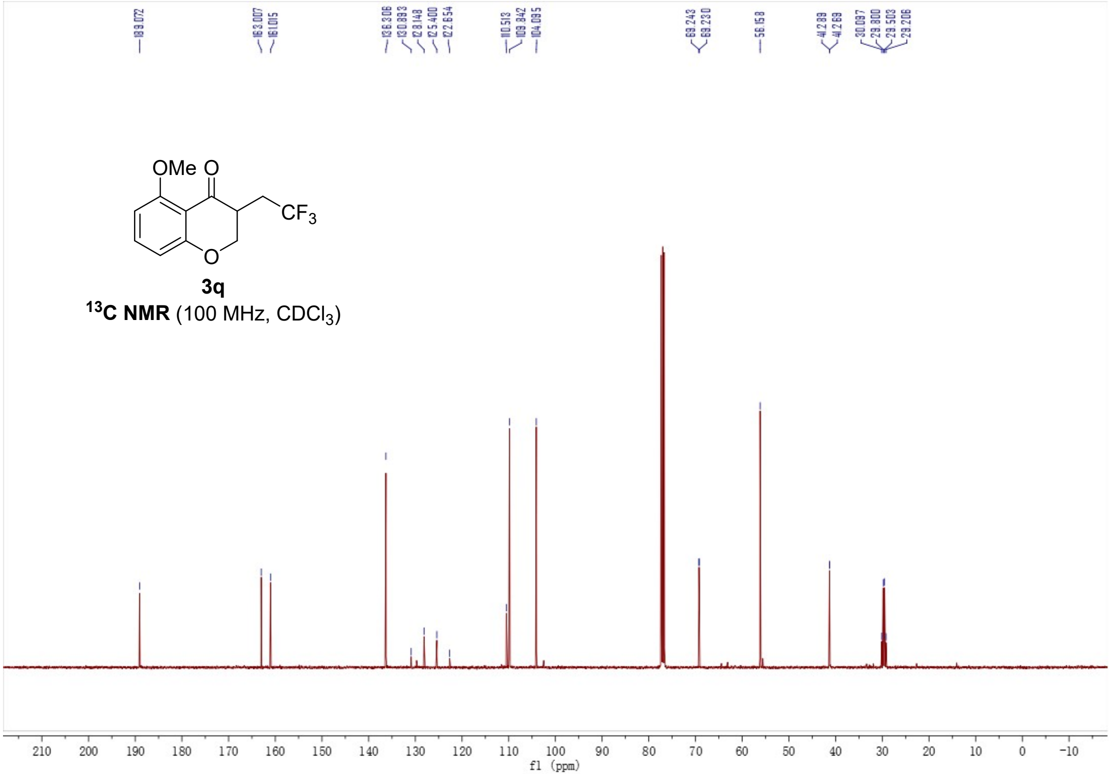


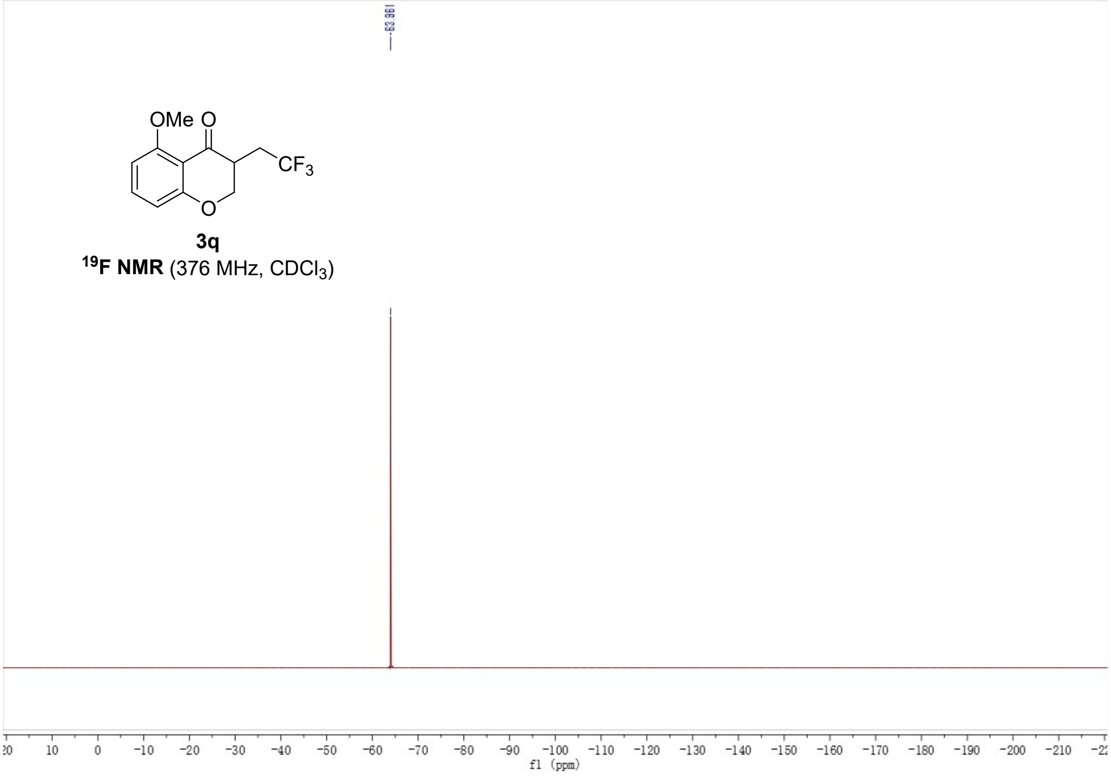
3p

^{19}F NMR (376 MHz, CDCl$_3$)

5-methoxy-3-(2,2,2-trifluoroethyl)chroman-4-one (3q)



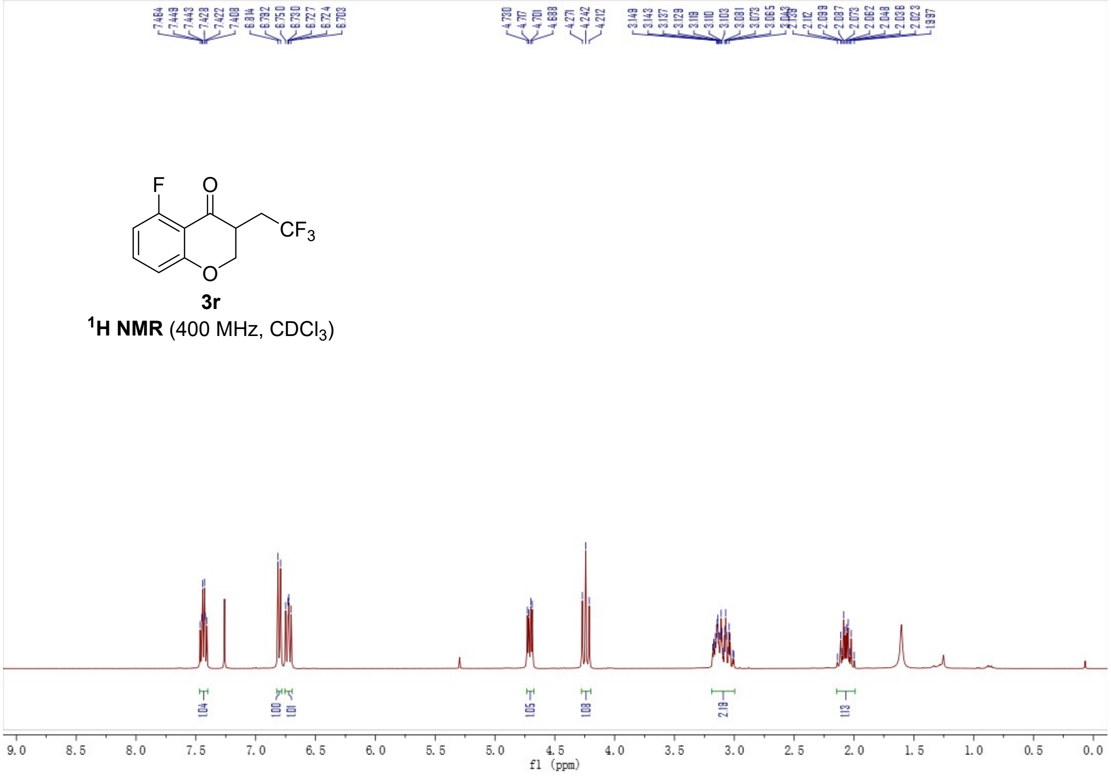




3q

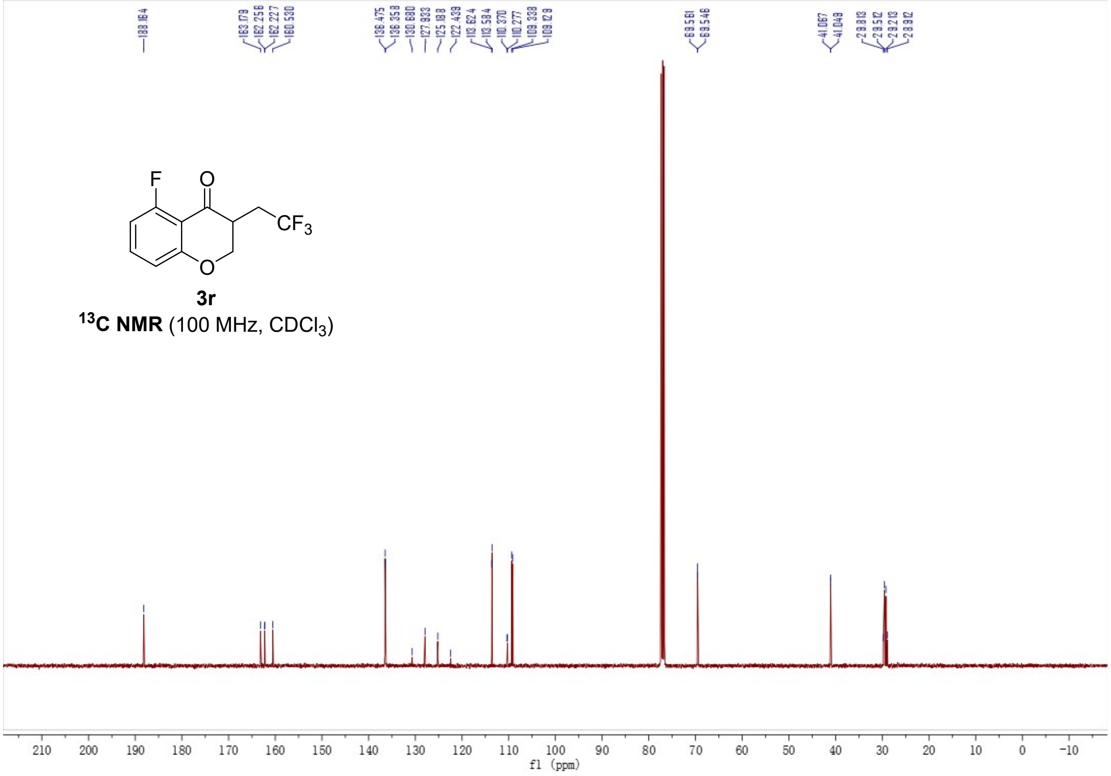
^{19}F NMR (376 MHz, $CDCl_3$)

5-fluoro-3-(2,2,2-trifluoroethyl)chroman-4-one (3r)



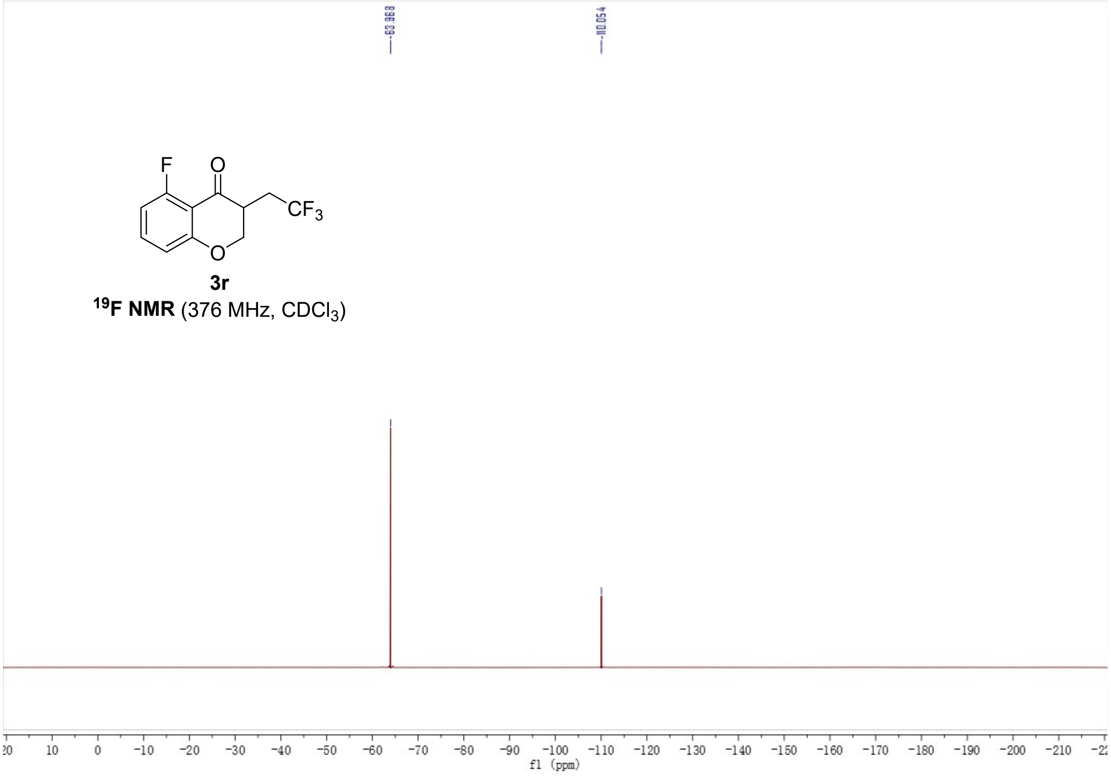
3r

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



3r

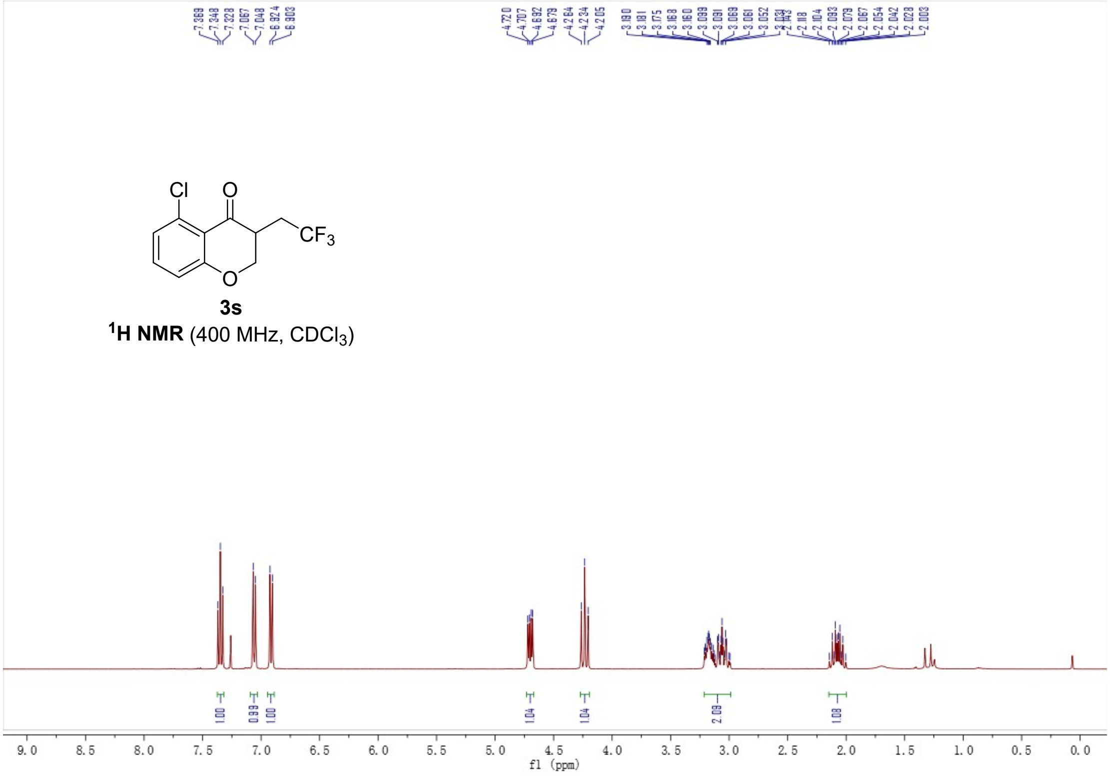
^{13}C NMR (100 MHz, $CDCl_3$)

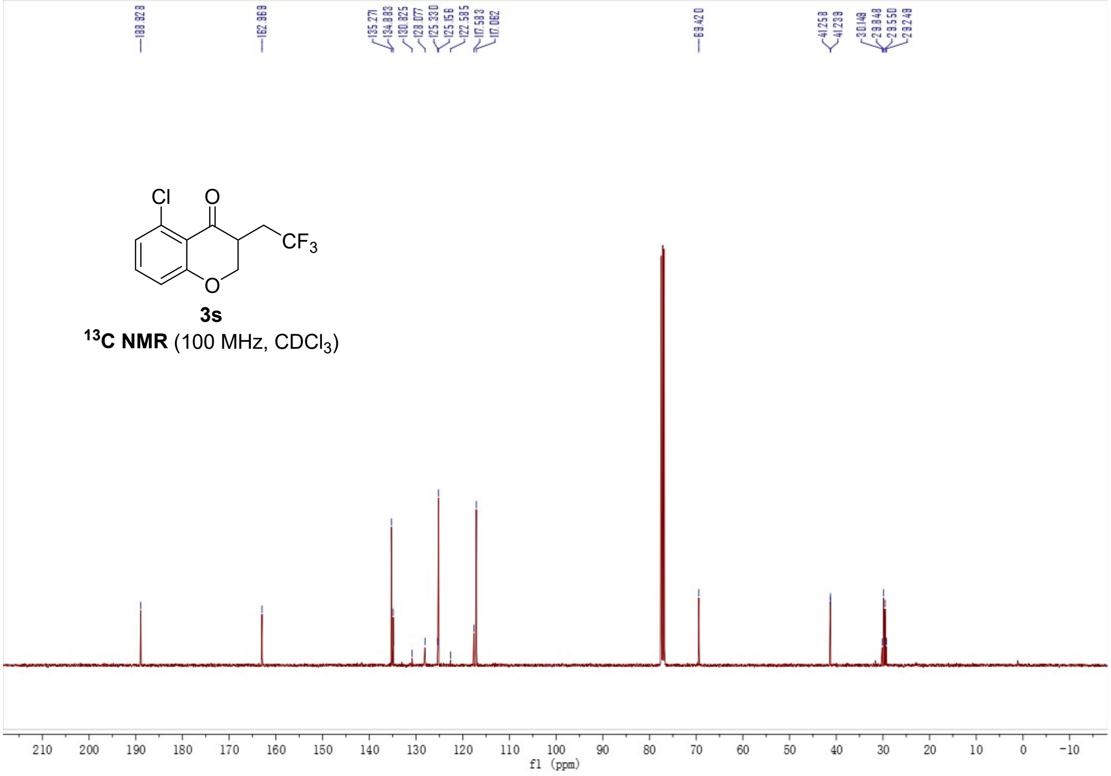


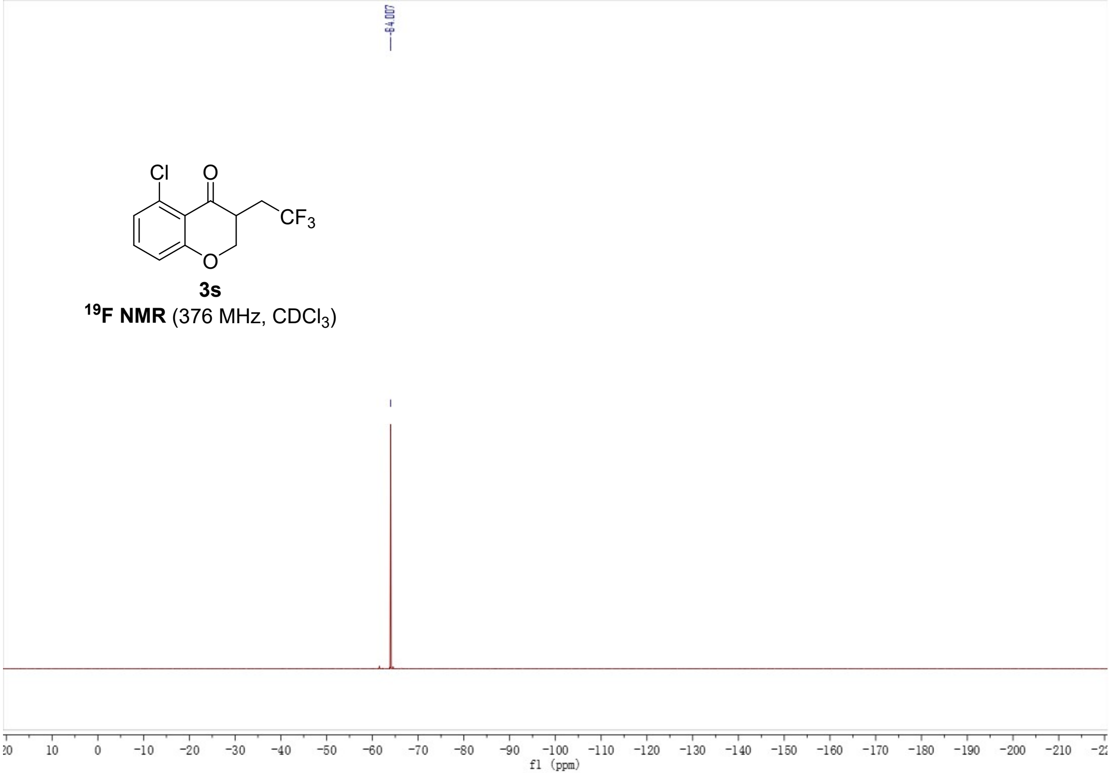
3r

^{19}F NMR (376 MHz, $CDCl_3$)

5-chloro-3-(2,2,2-trifluoroethyl)chroman-4-one (3s)



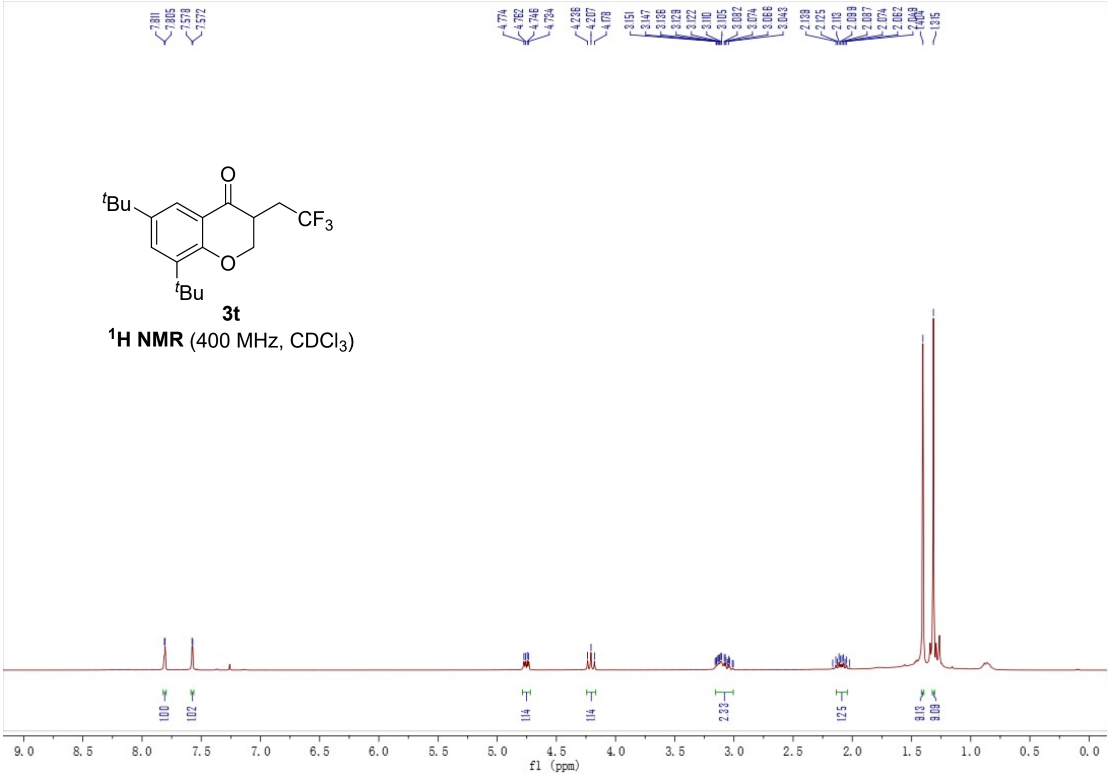




3s

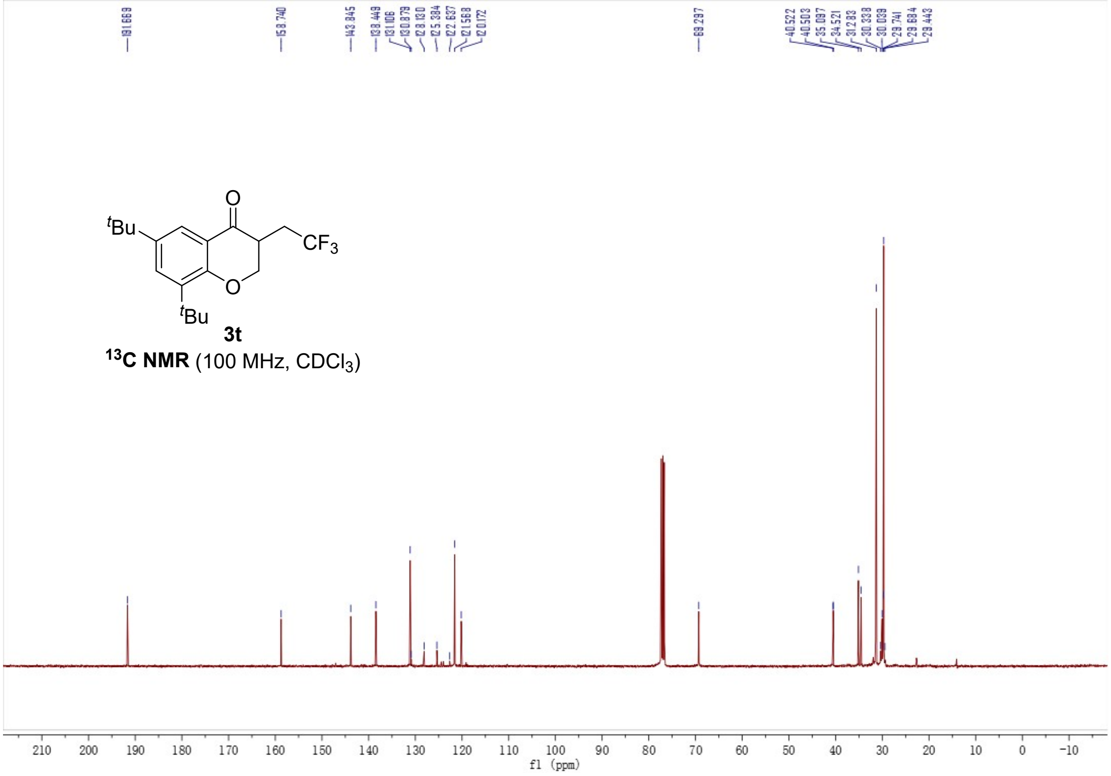
^{19}**F NMR** (376 MHz, $CDCl_3$)

6,8-di-tert-butyl-3-(2,2,2-trifluoroethyl)chroman-4-one (3t)



3t

^{1}**H NMR** (400 MHz, $CDCl_3$)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158.740
143.845
138.449
131.106
130.879
128.130
125.384
122.637
121.568
120.172
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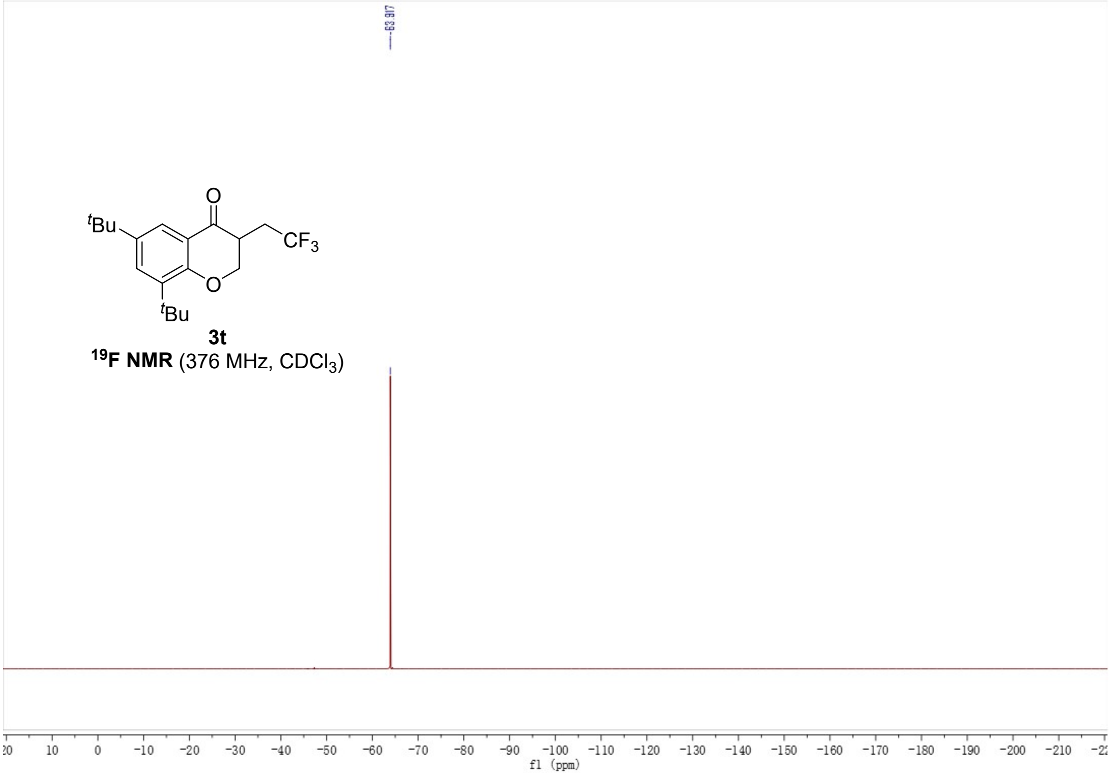
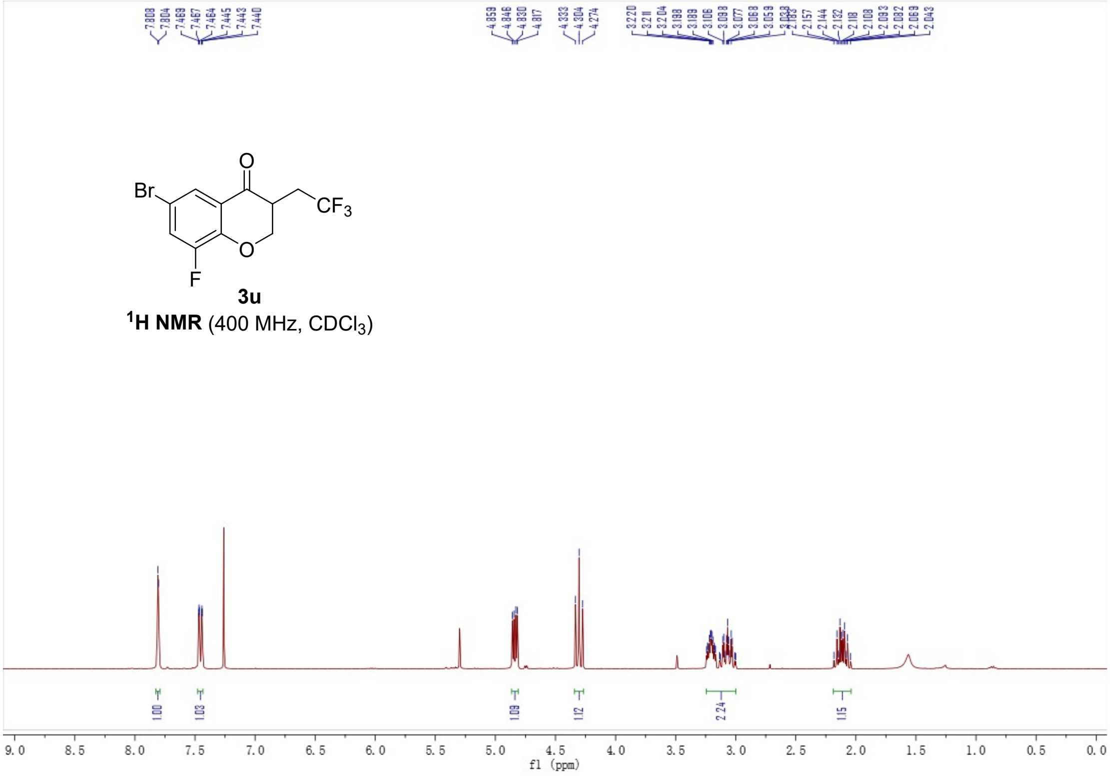
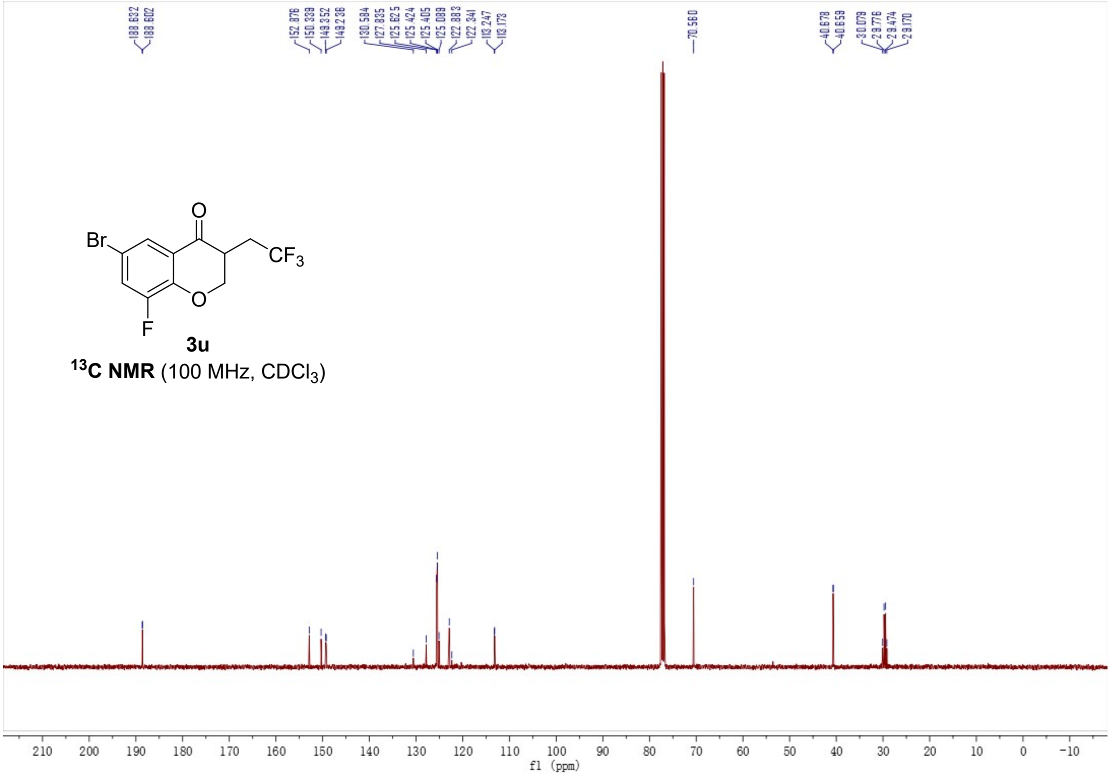
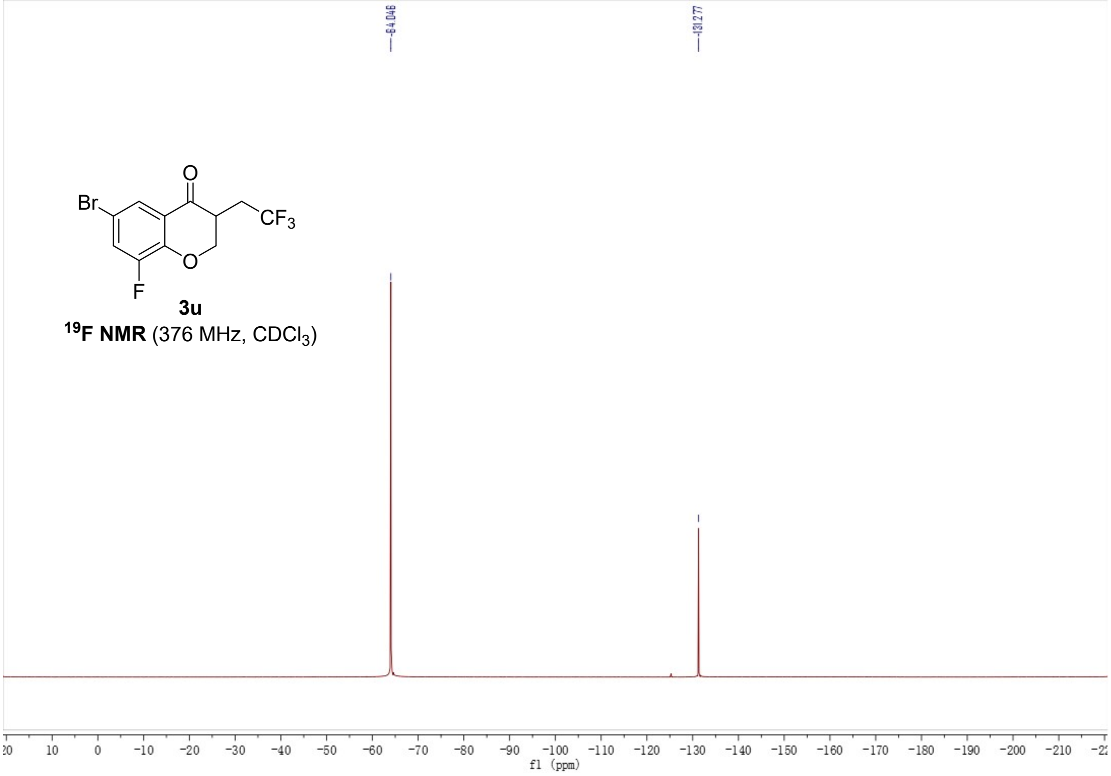
40.522
40.503
35.097
34.521
31.283
30.338
30.039
29.741
29.684
29.443
O
tBu
CF3
O
tBu
3t
13C NMR (100 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)


−63.917
O
tBu
CF3
O
tBu
3t
19F NMR (376 MHz, CDCl3)
20 10 0 −10 −20 −30 −40 −50 −60 −70 −80 −90 −100 −110 −120 −130 −140 −150 −160 −170 −180 −190 −200 −210 −22
f1 (ppm)

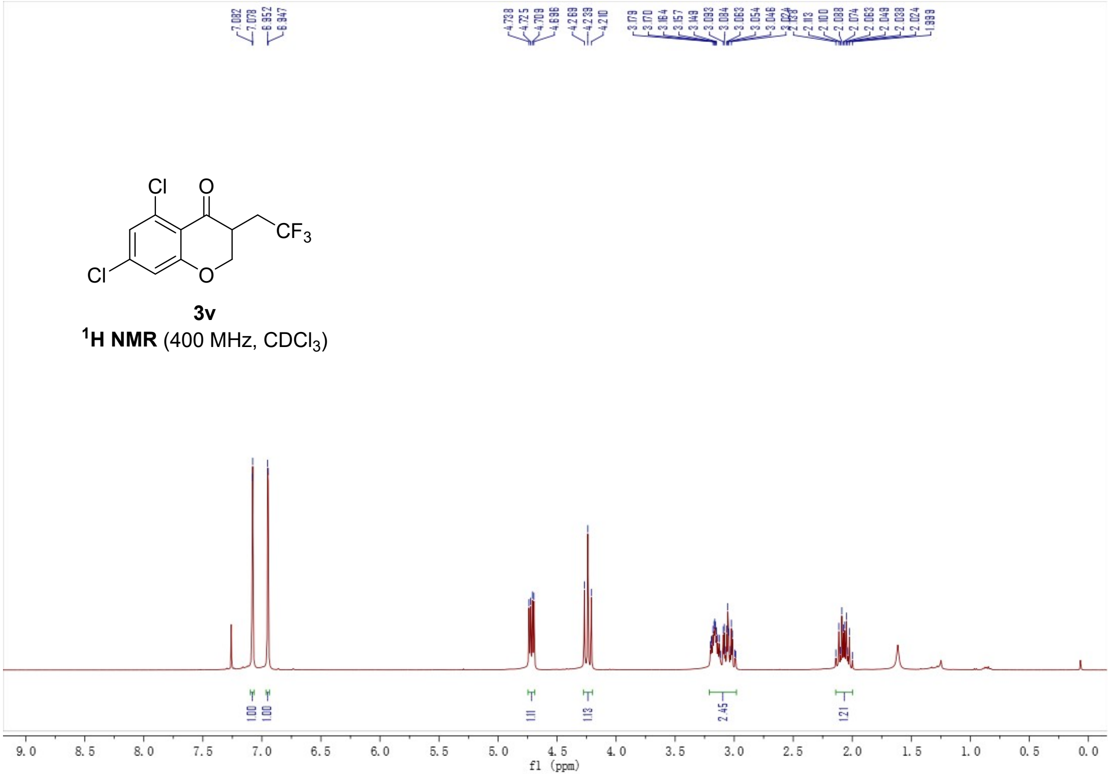
6-bromo-8-fluoro-3-(2,2,2-trifluoroethyl)chroman-4-one (3u)

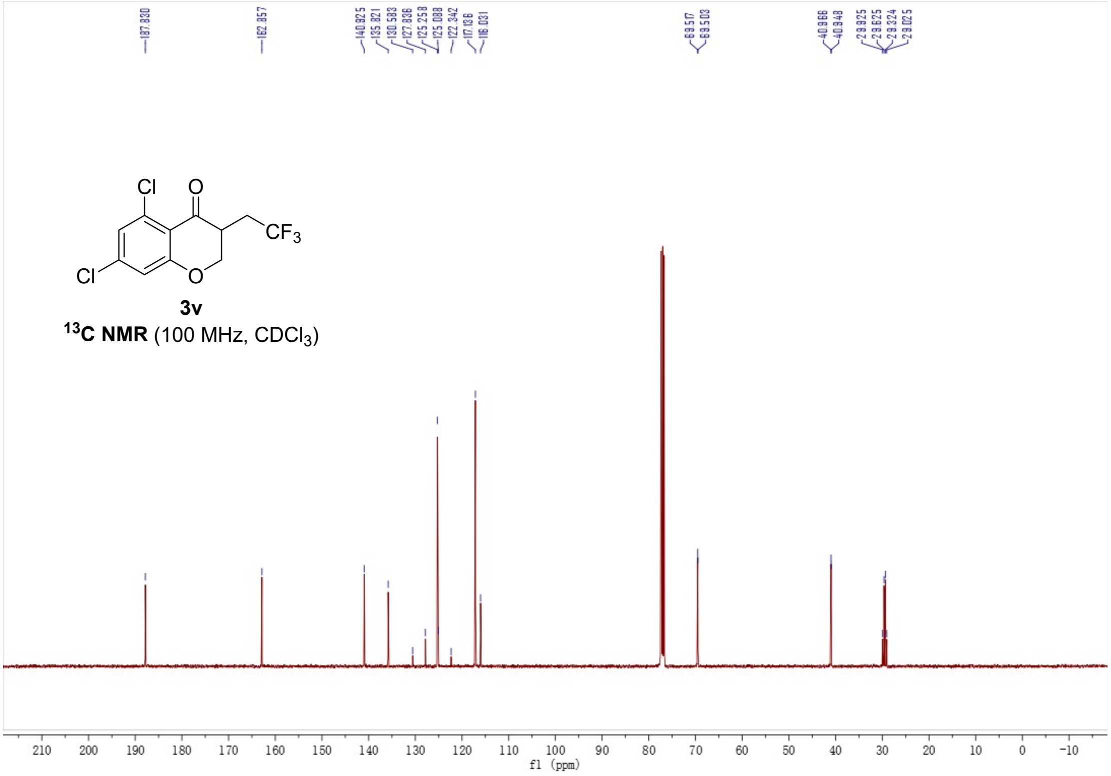






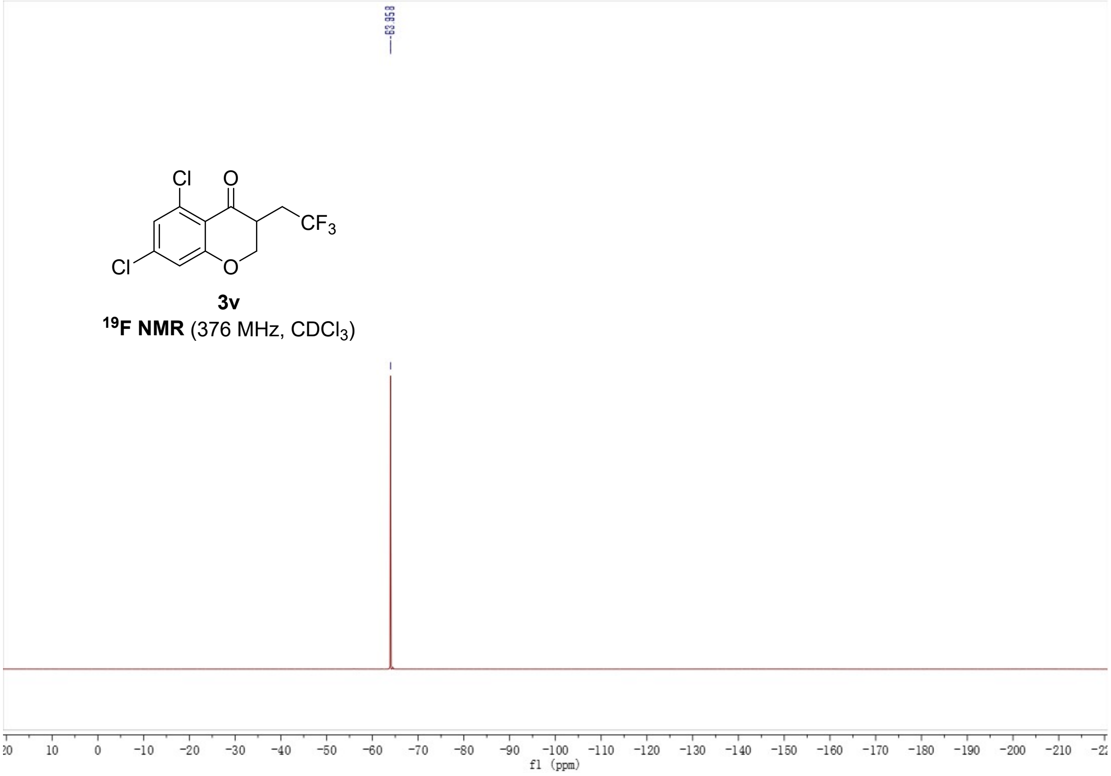
5,7-dichloro-3-(2,2,2-trifluoroethyl)chroman-4-one (3v)





3v

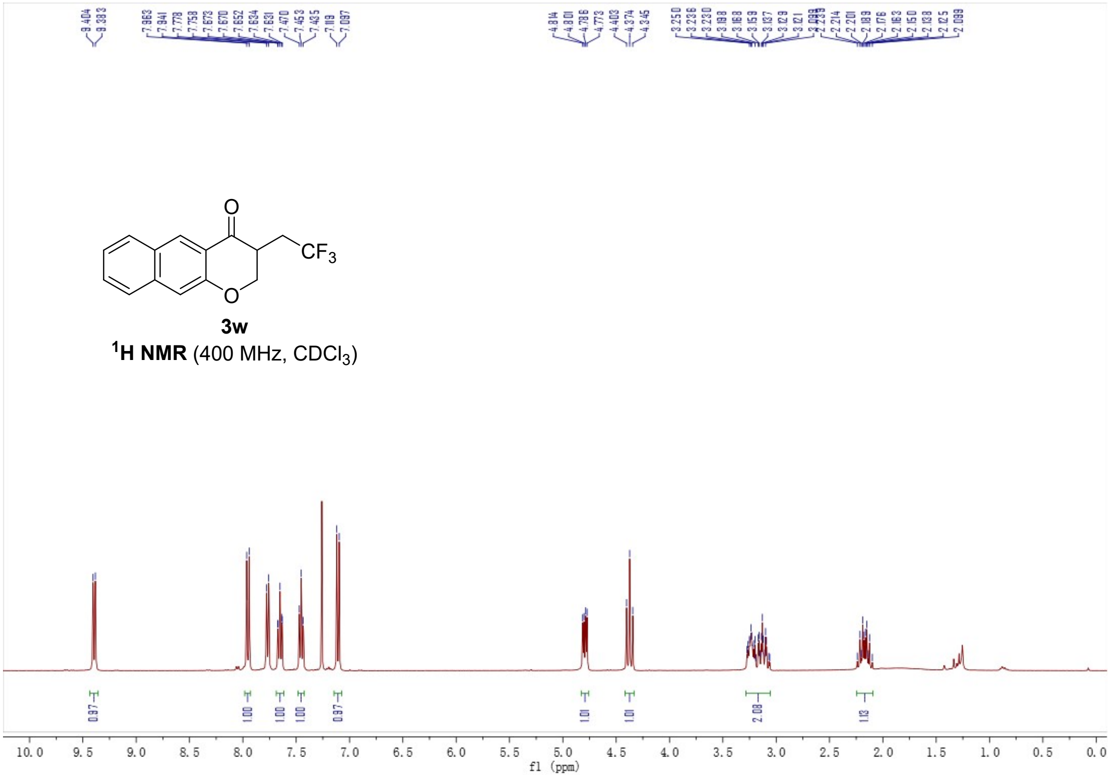
^{13}C NMR (100 MHz, CDCl$_3$)

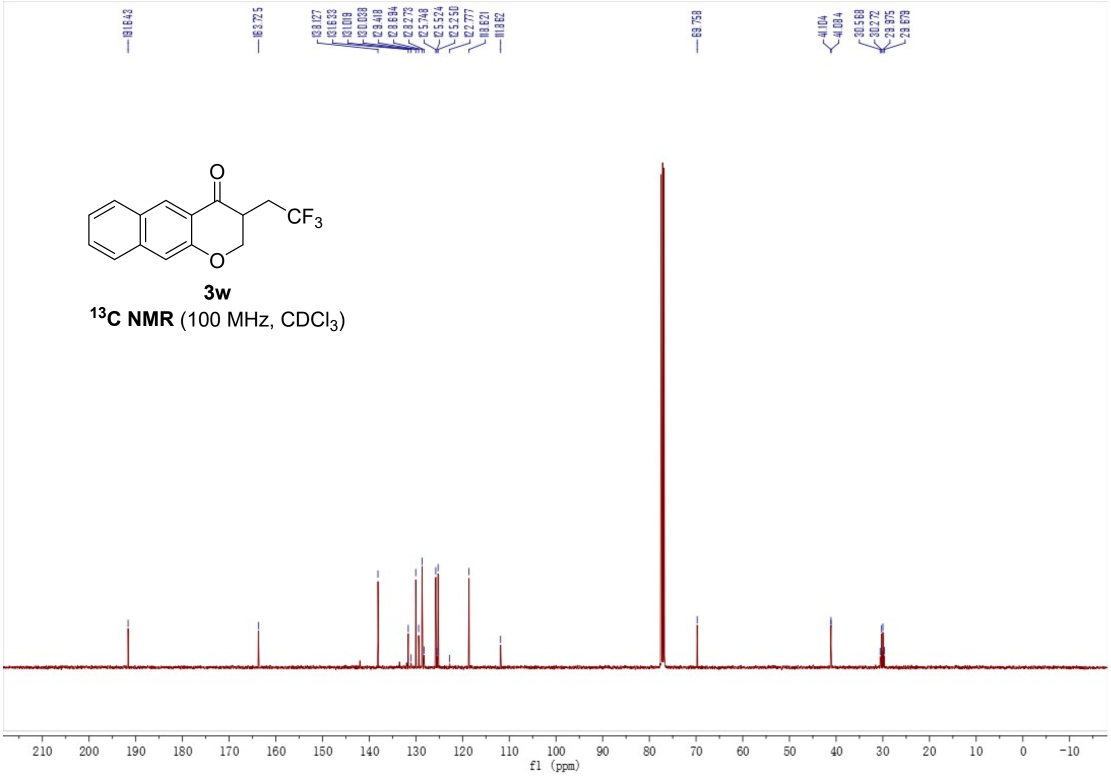


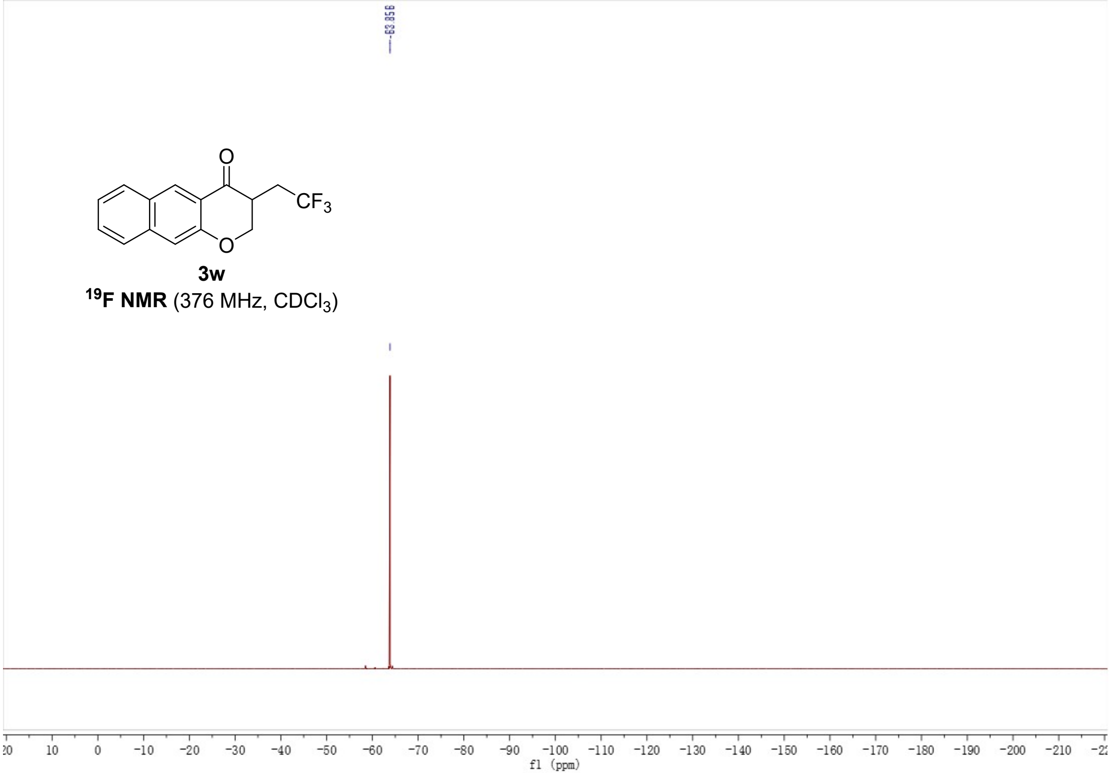
3v

^{19}F NMR (376 MHz, CDCl$_3$)

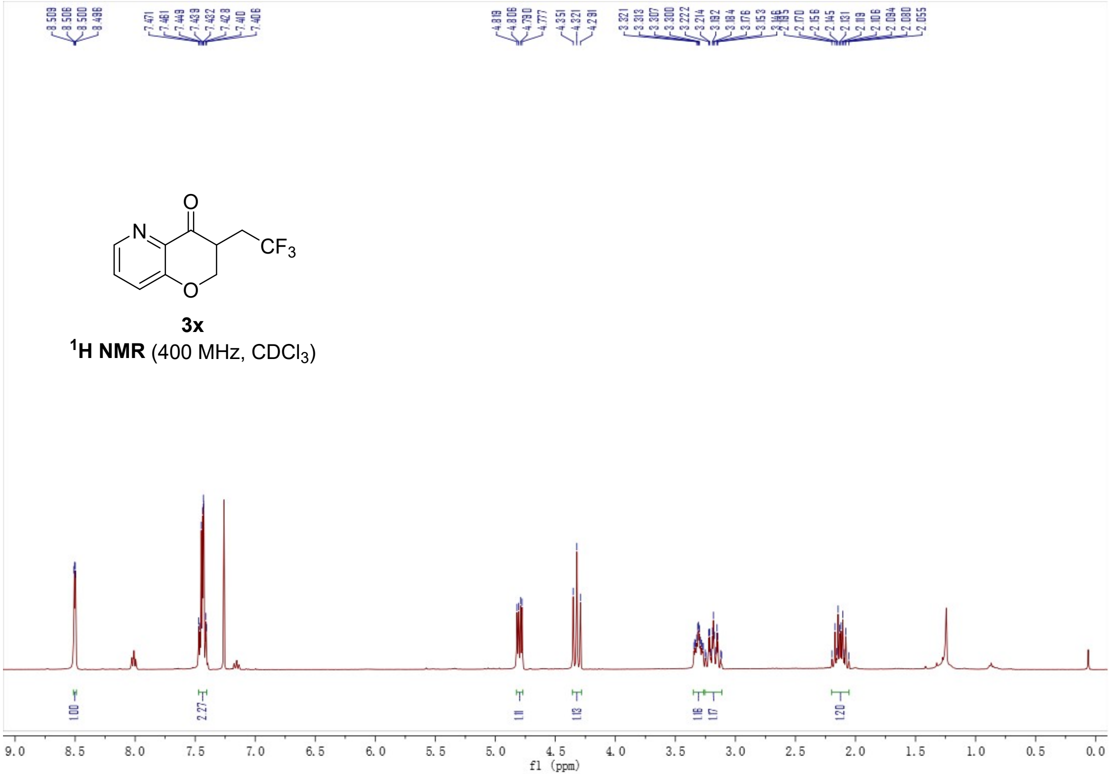
3-(2,2,2-trifluoroethyl)-2,3-dihydro-4H-benzo[g]chromen-4-one (3w)

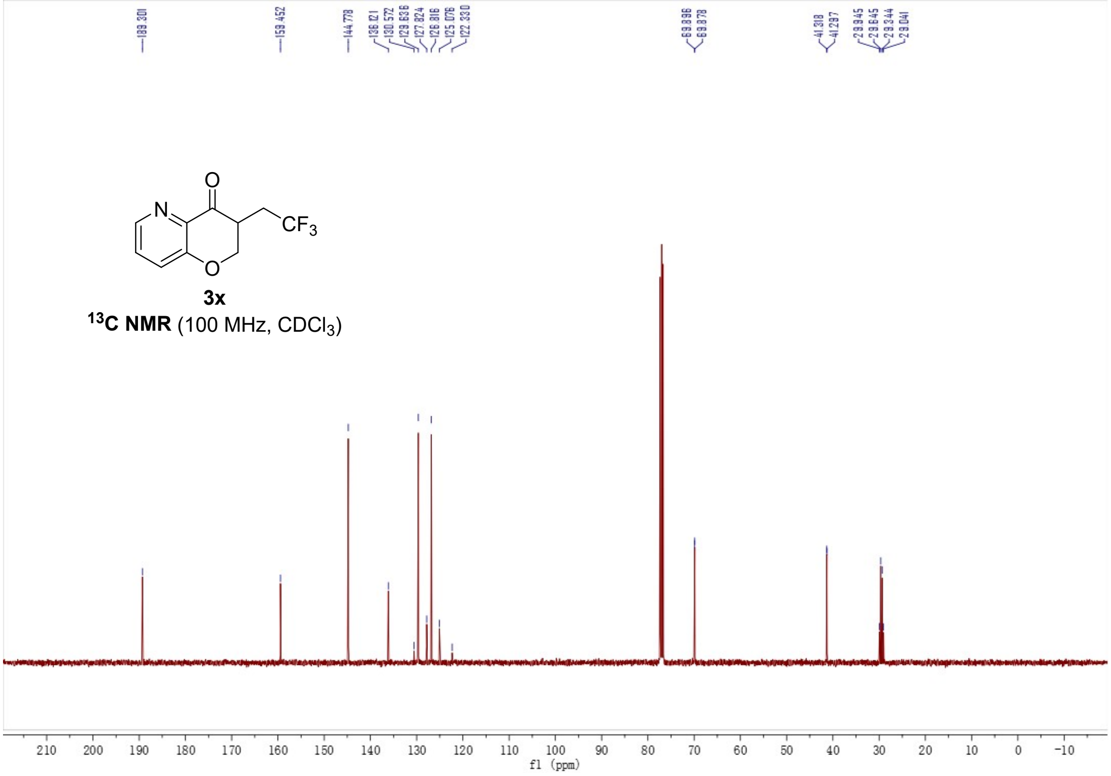


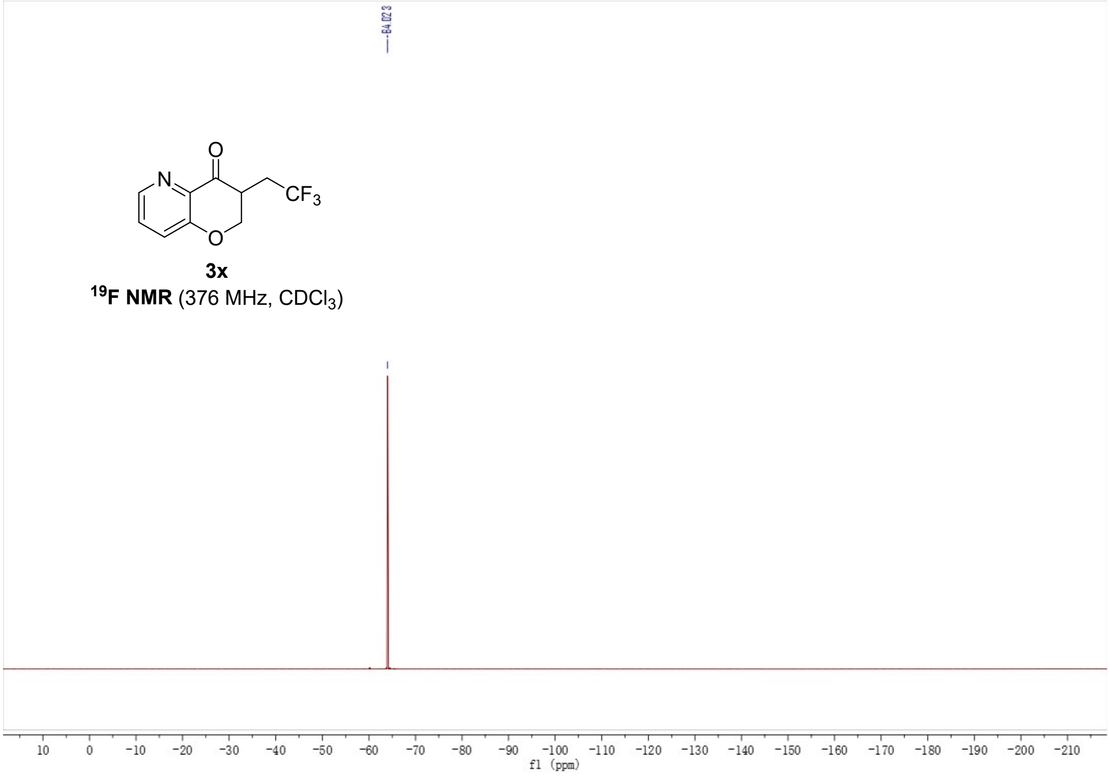




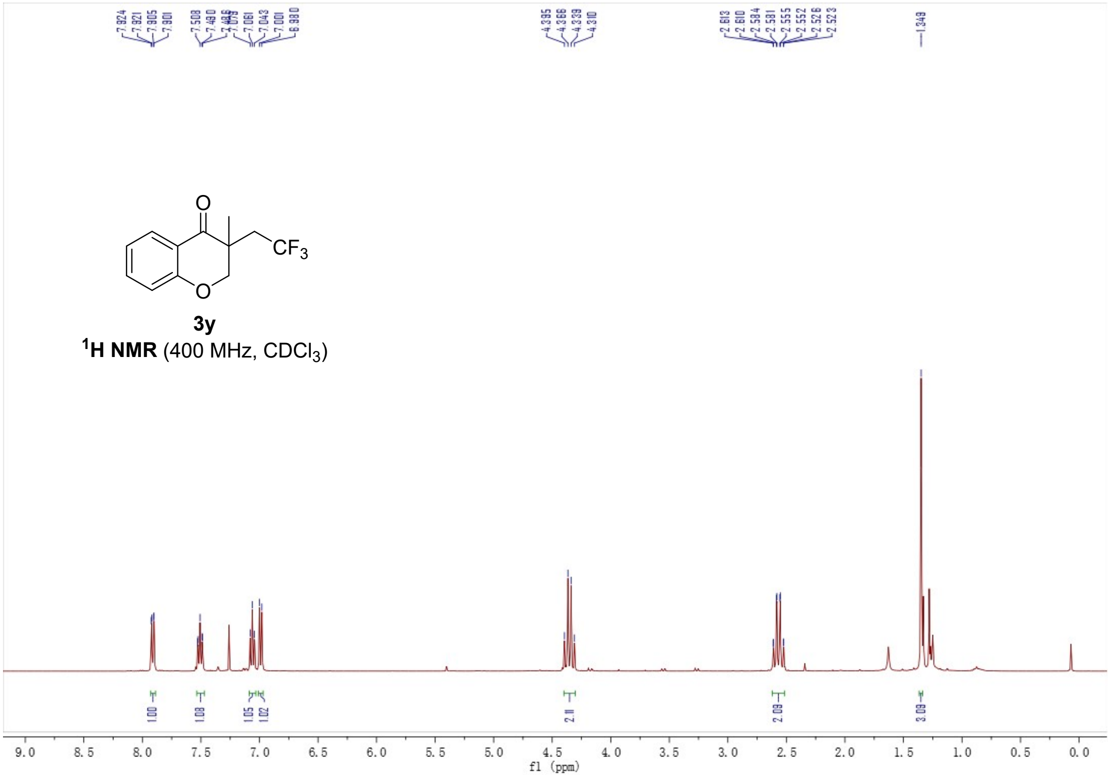
3-(2,2,2-trifluoroethyl)-2,3-dihydro-4H-pyrano[3,2-b]pyridin-4-one (3x)

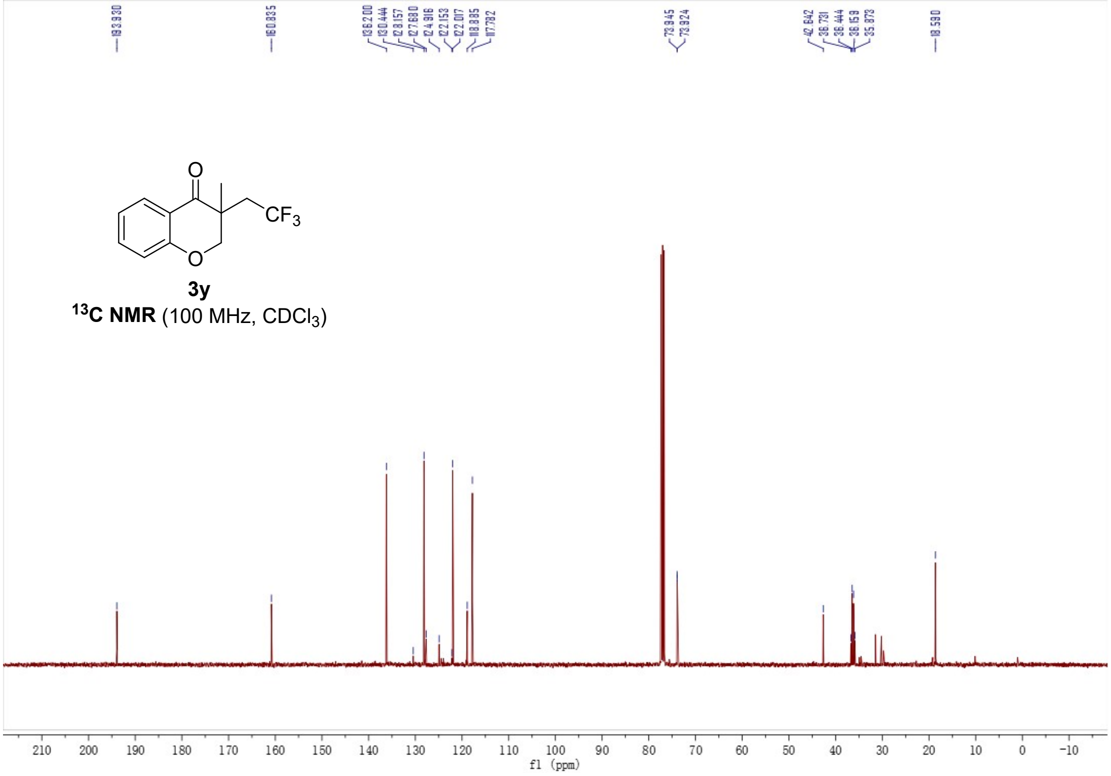


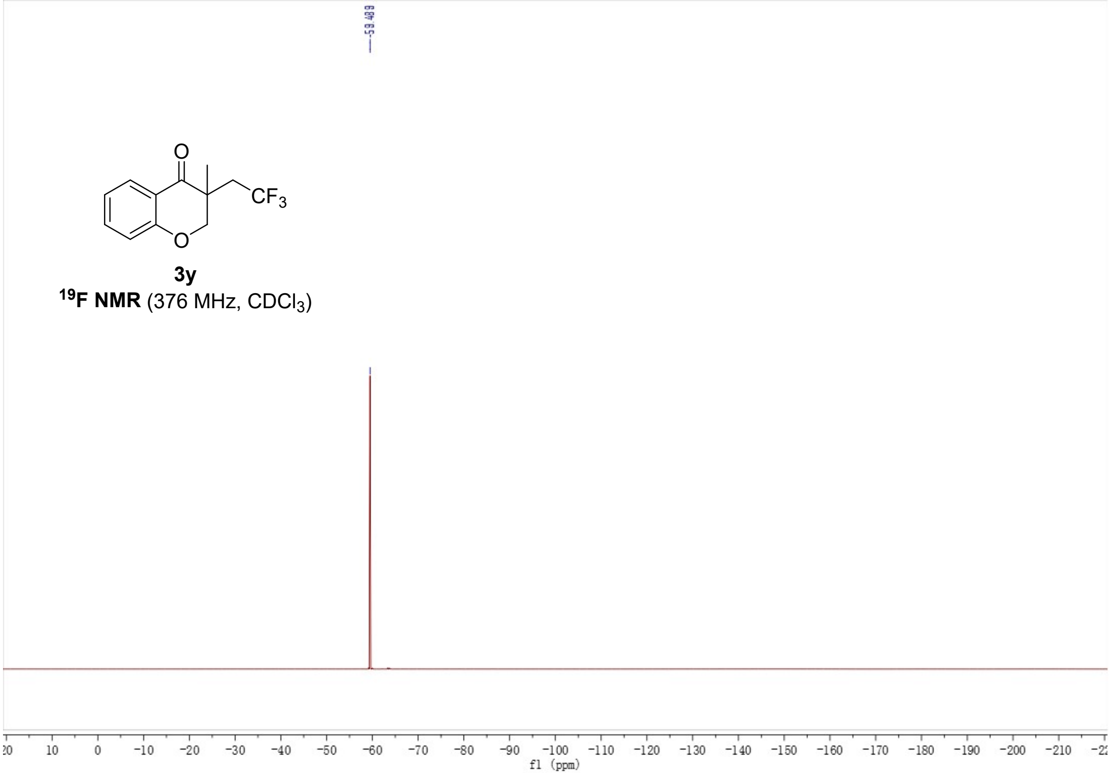

189.301
159.452
144.778
136.121
130.572
129.636
127.824
126.816
125.076
122.330
69.896
69.878
41.318
41.297
29.945
29.645
29.344
29.041
O
N
CF3
O
3x
13C NMR (100 MHz, CDCl3)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


-64.023
O
N
CF3
O
3x
19F NMR (376 MHz, CDCl3)
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

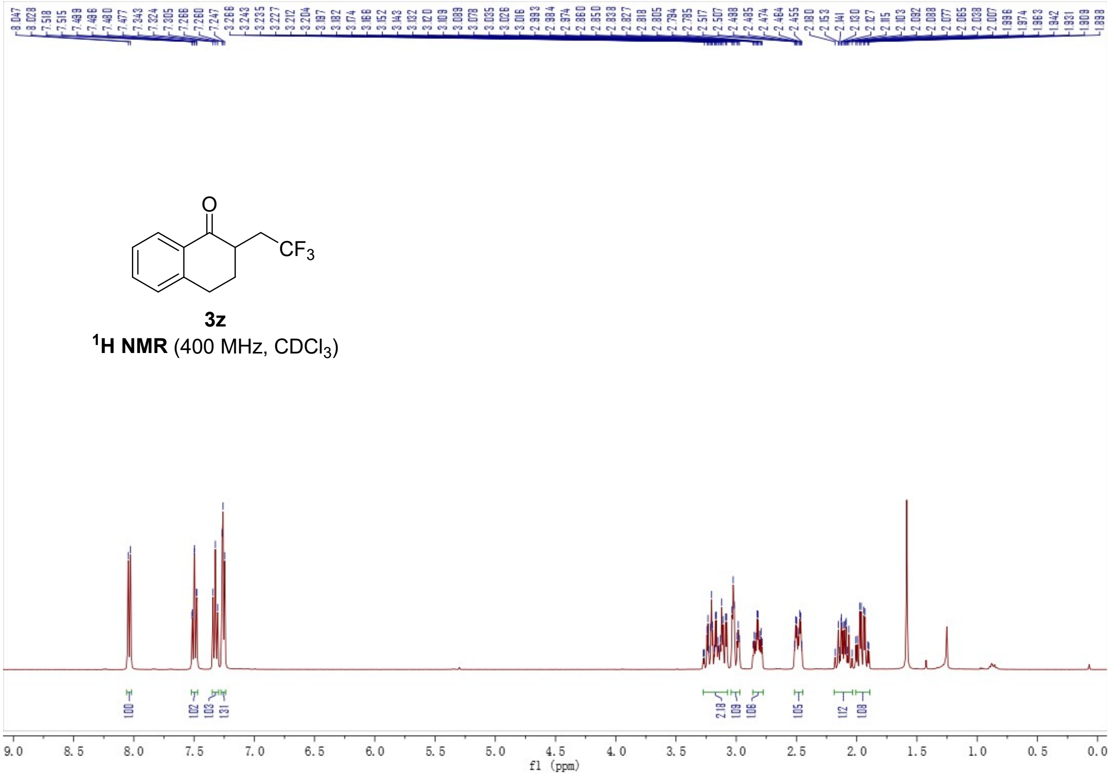
4-methyl-3-(2,2,2-trifluoroethyl)chroman-4-one (3y)

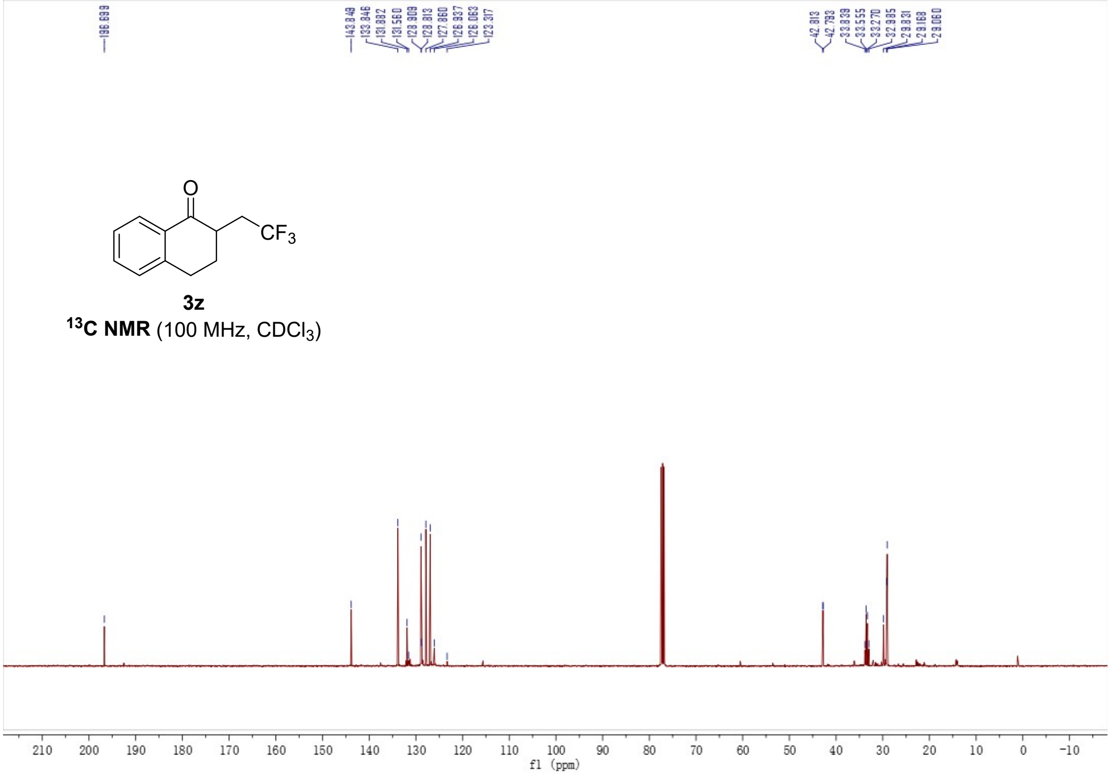






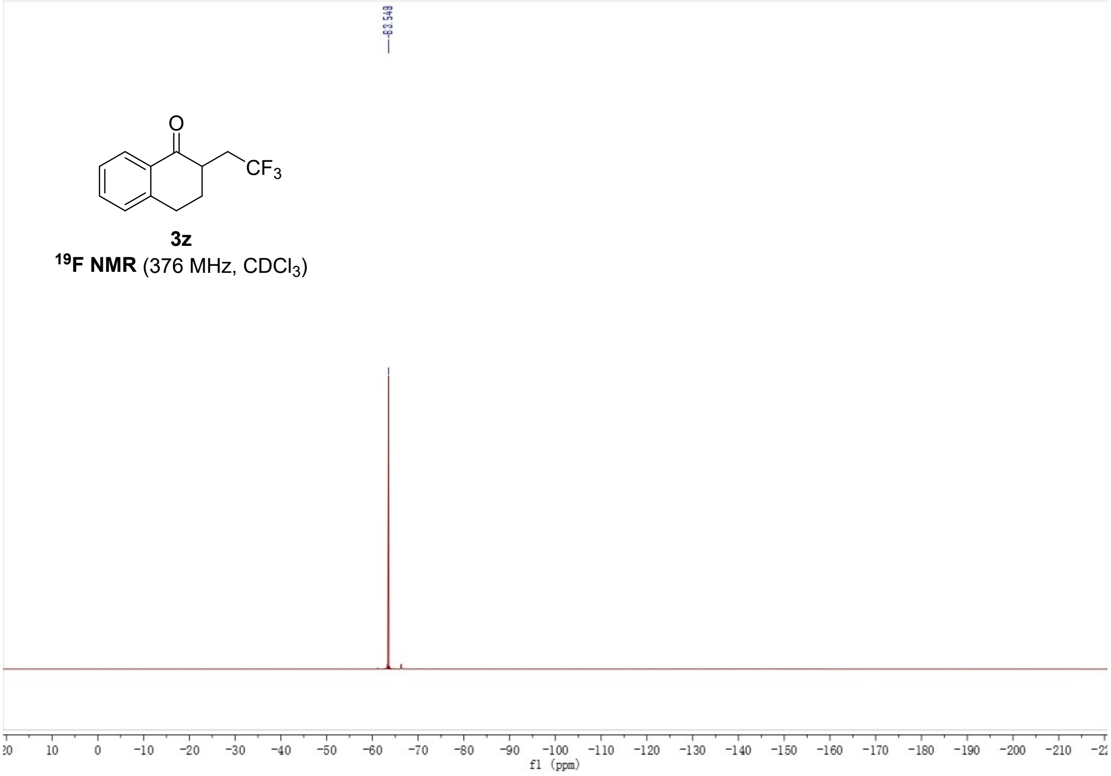
2-(2,2,2-trifluoroethyl)-3,4-dihydronaphthalen-1(2H)-one (3z)





3z

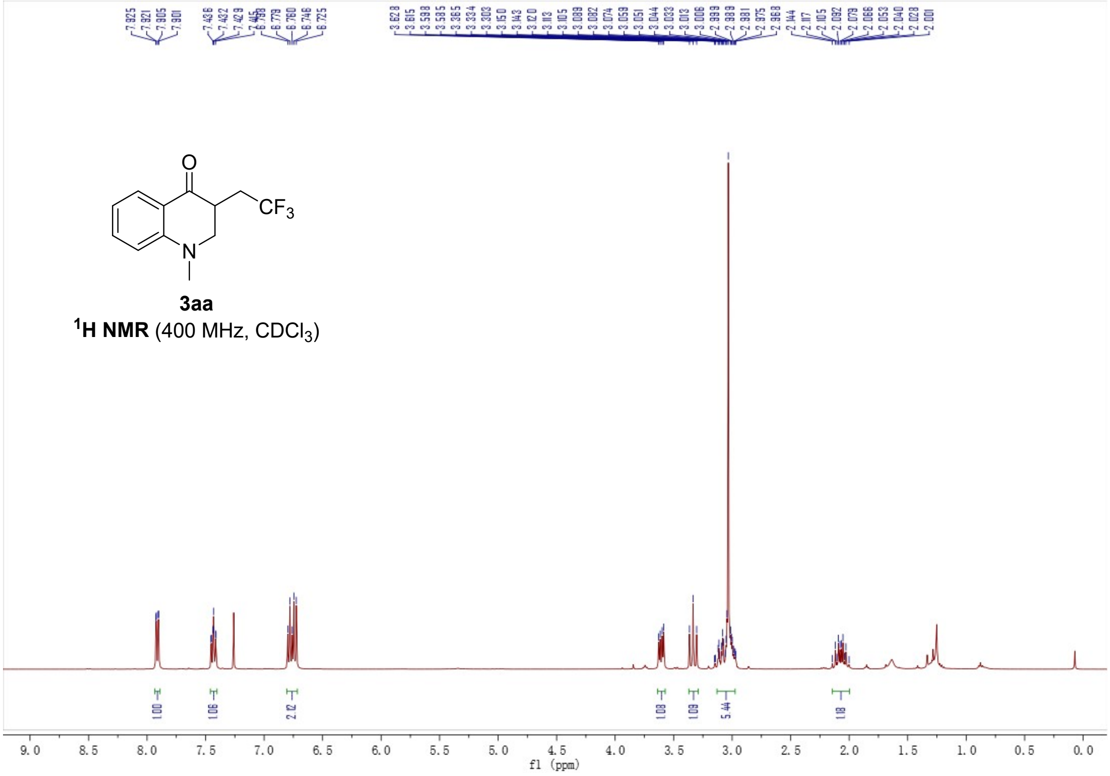
^{13}C NMR (100 MHz, CDCl$_3$)

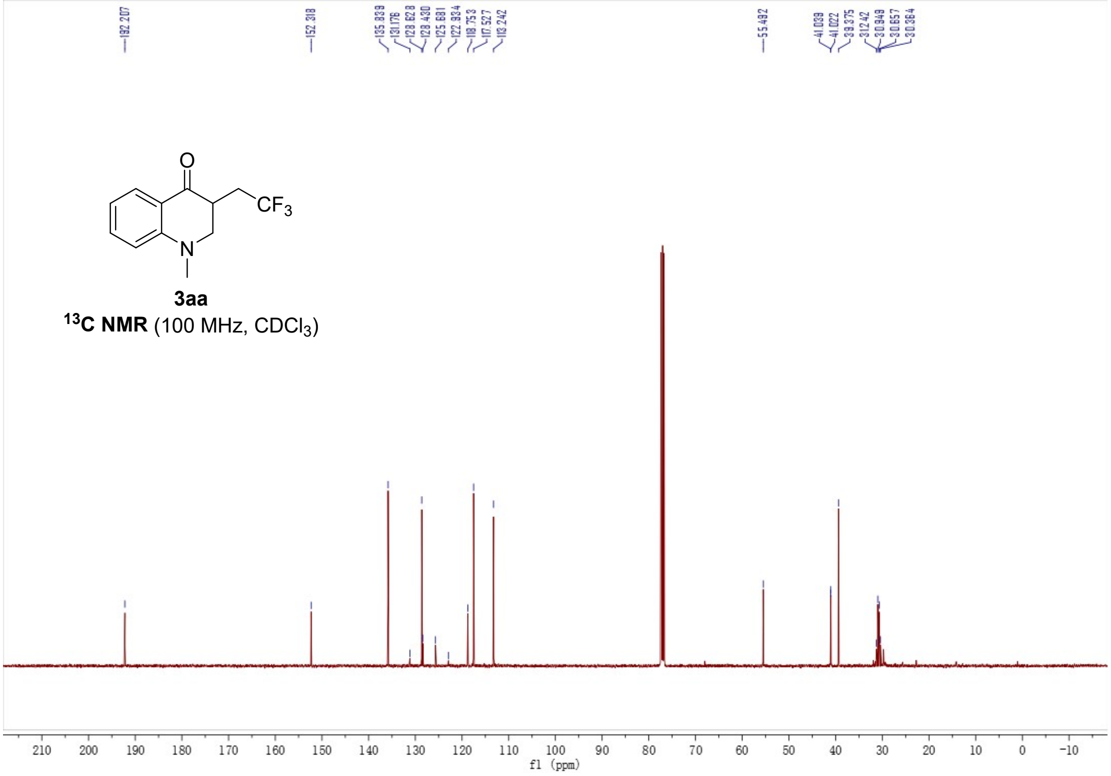


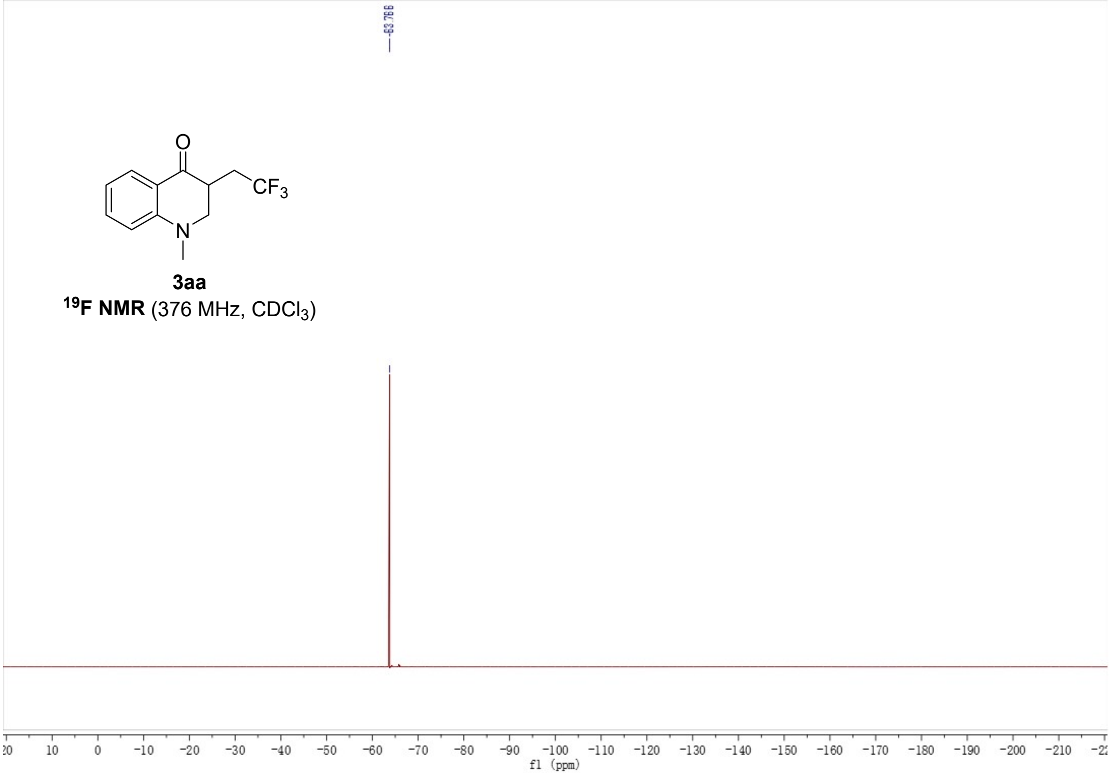
3z

^{19}F NMR (376 MHz, CDCl$_3$)

1-methyl-3-(2,2,2-trifluoroethyl)-2,3-dihydroquinolin-4(1H)-one (3aa)



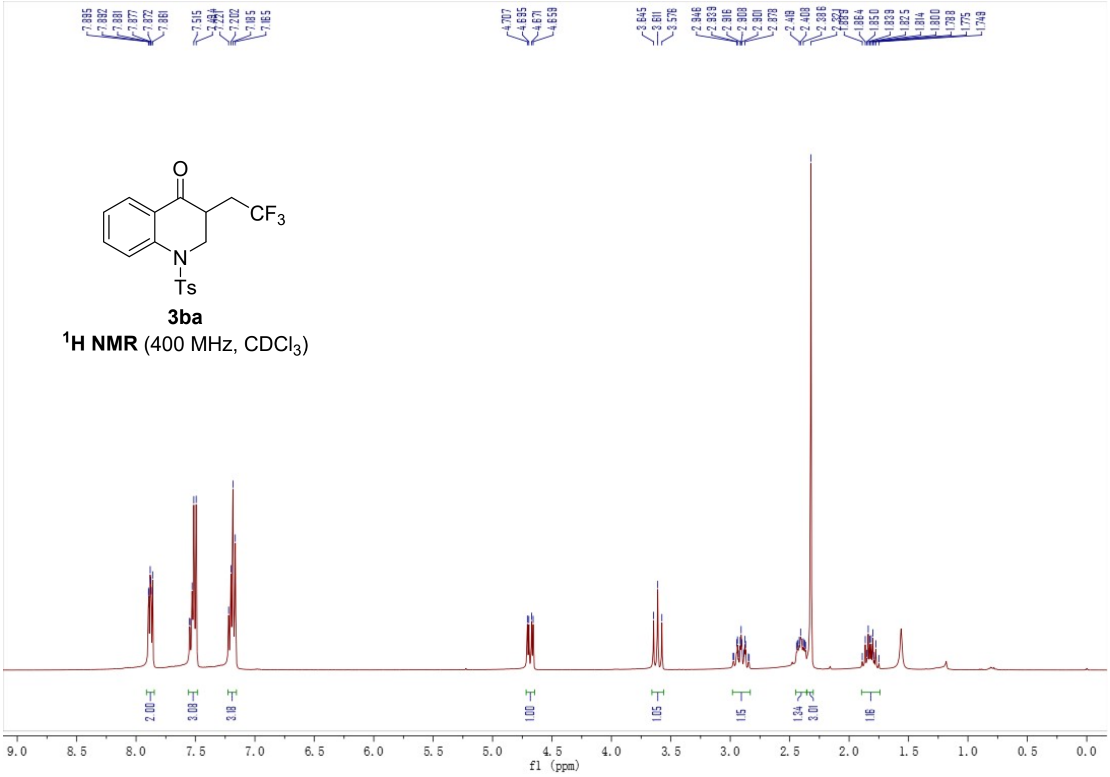




3aa

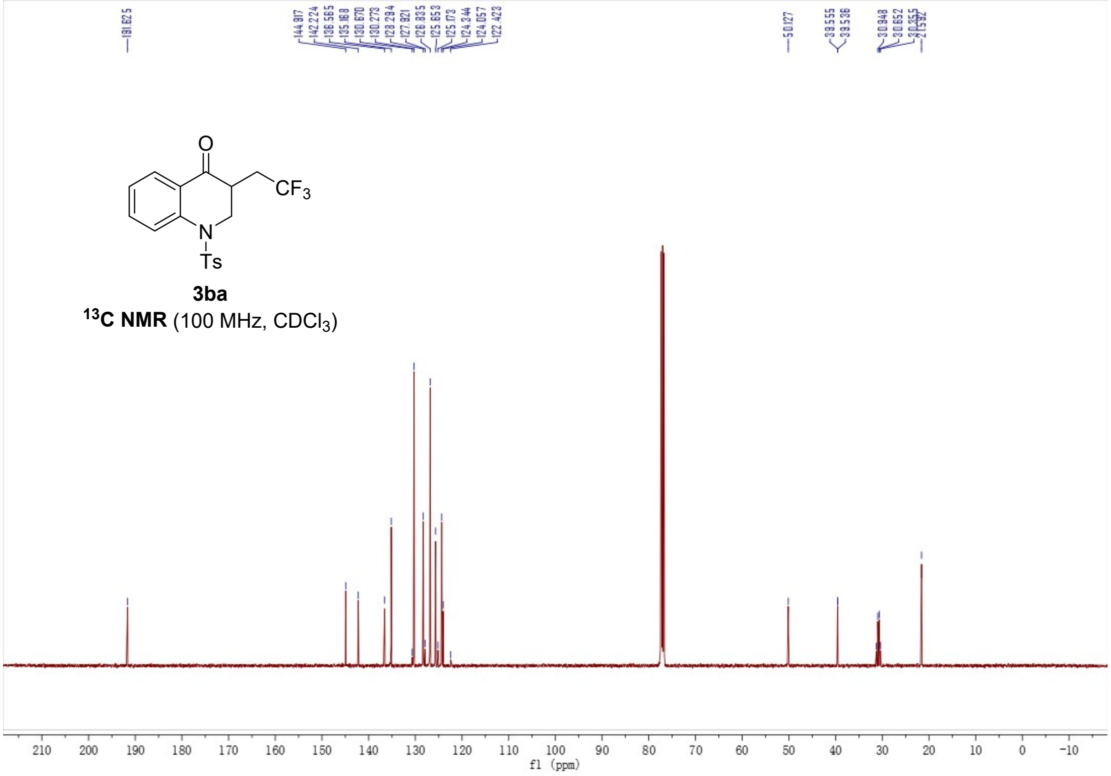
^{19}F NMR (376 MHz, $CDCl_3$)

1-tosyl-3-(2,2,2-trifluoroethyl)-2,3-dihydroquinolin-4(1H)-one (3ba)



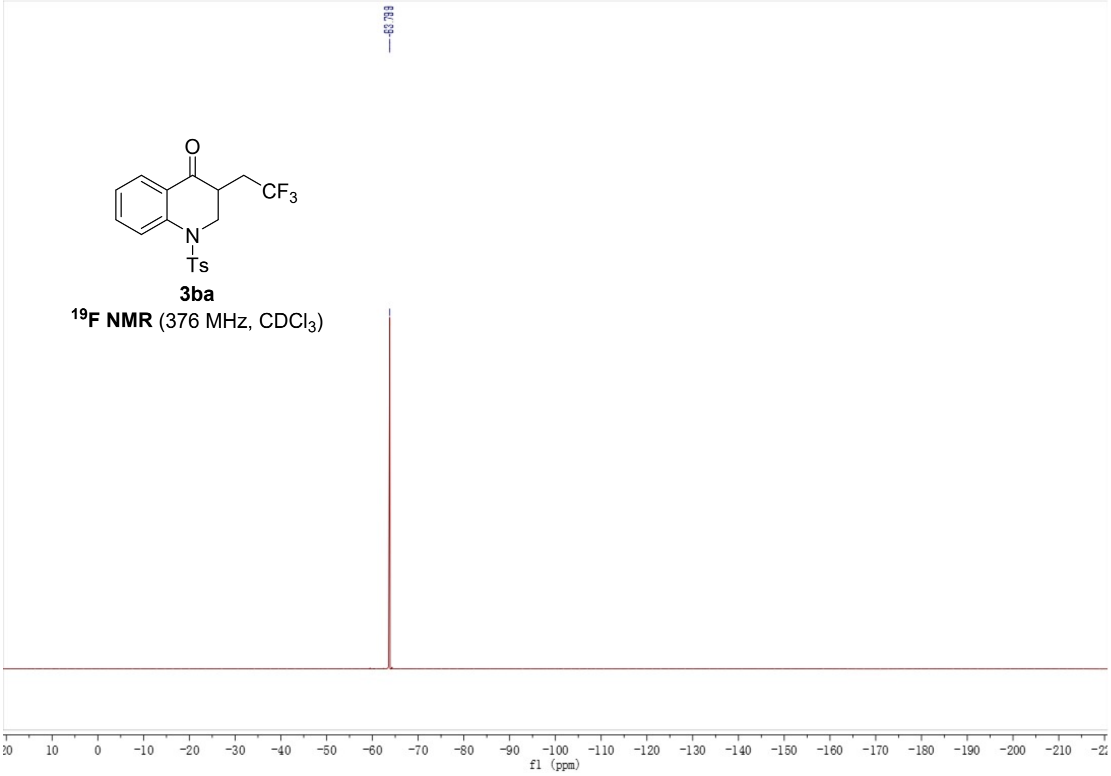
3ba

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



3ba

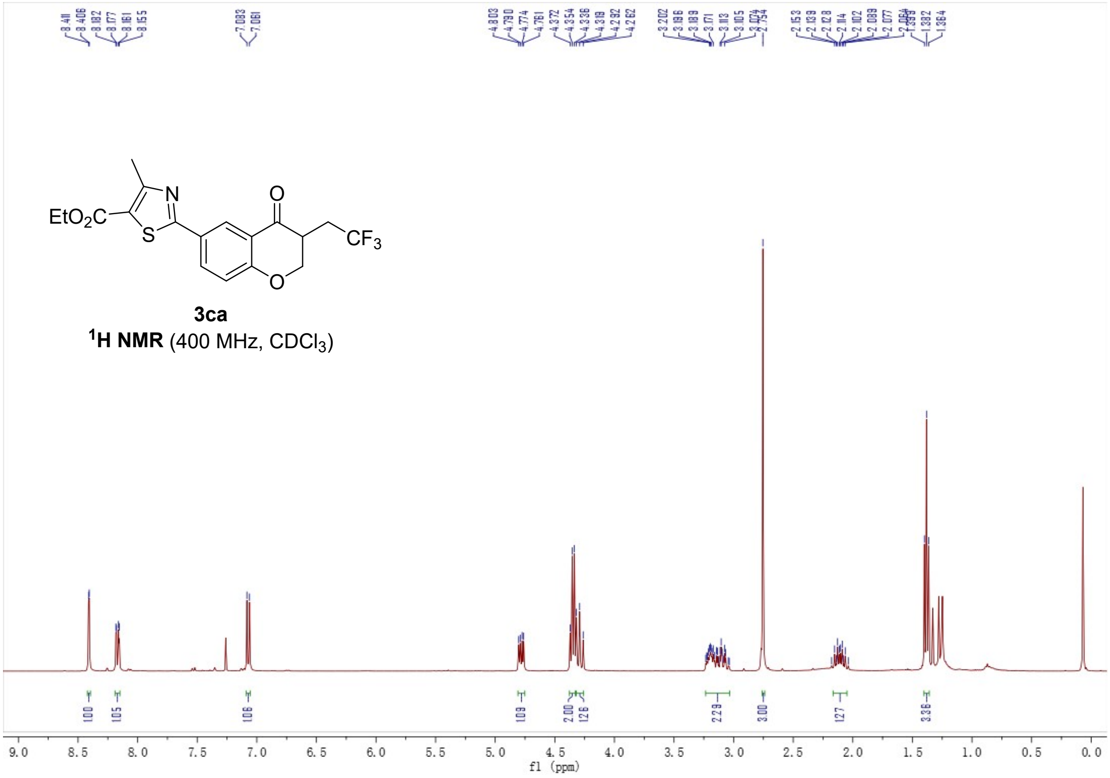
^{13}C NMR (100 MHz, CDCl$_3$)



3ba

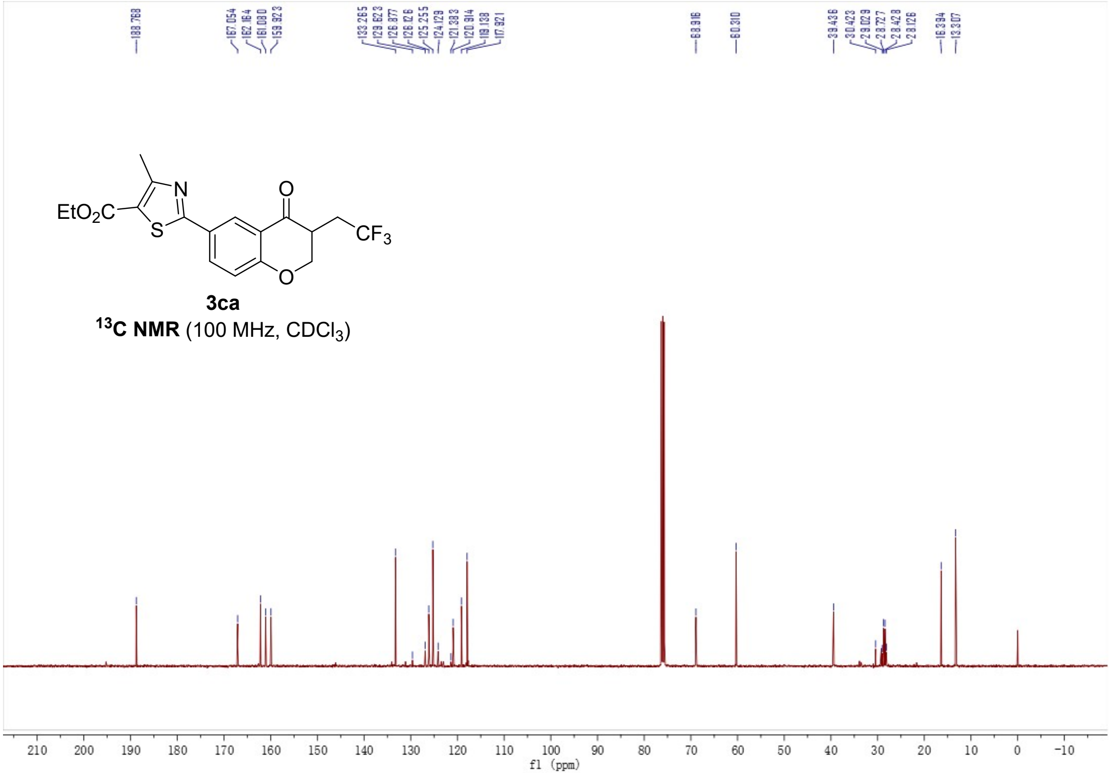
^{19}F NMR (376 MHz, CDCl$_3$)

Ethyl 4-methyl-2-(4-oxo-3-(2,2,2-trifluoroethyl)chroman-6-yl)thiazole-5-carboxylate (3ca)



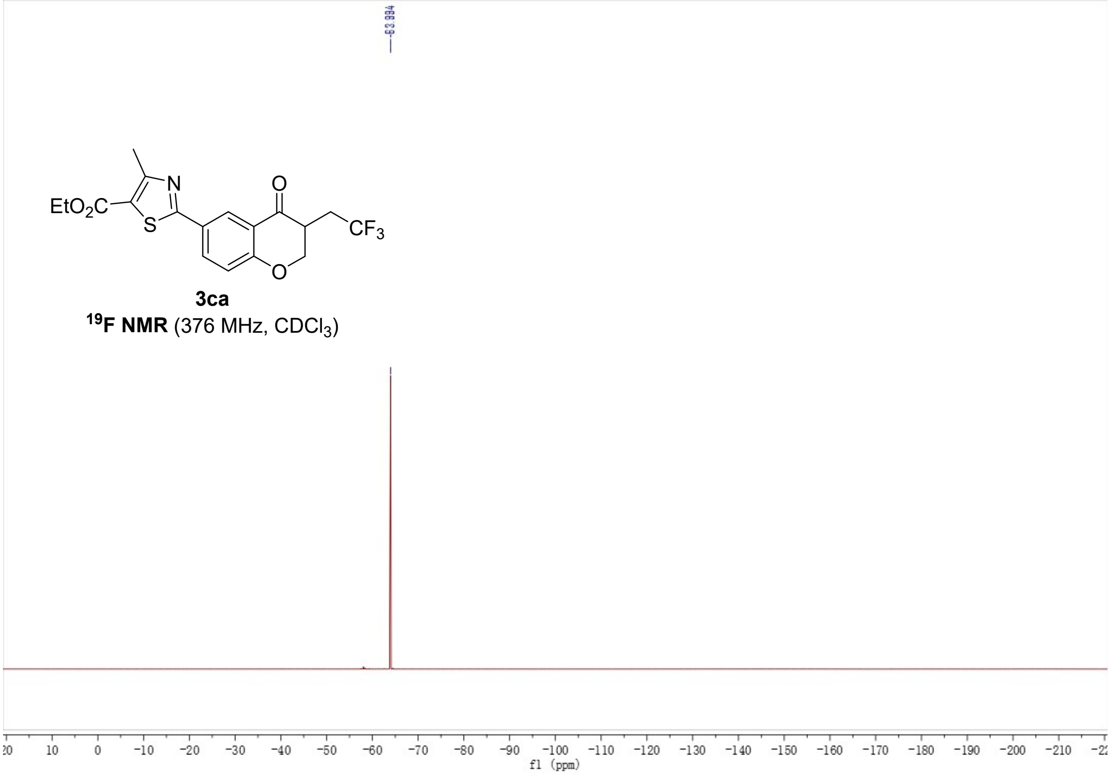
3ca

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

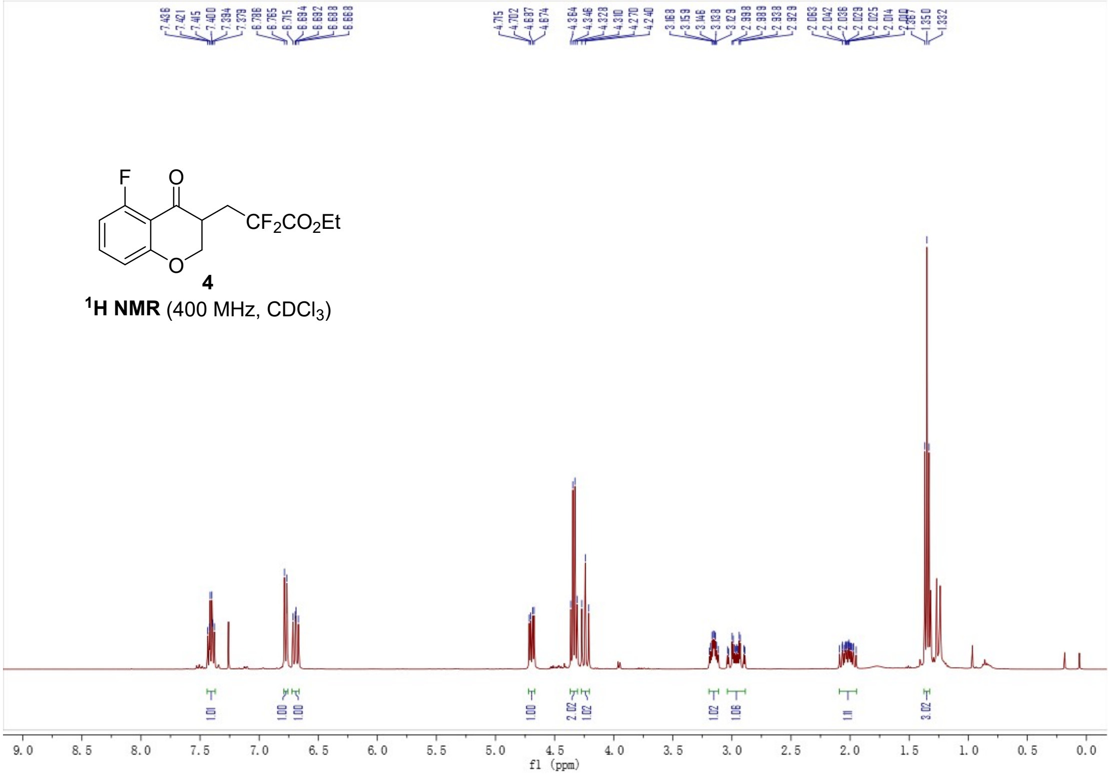


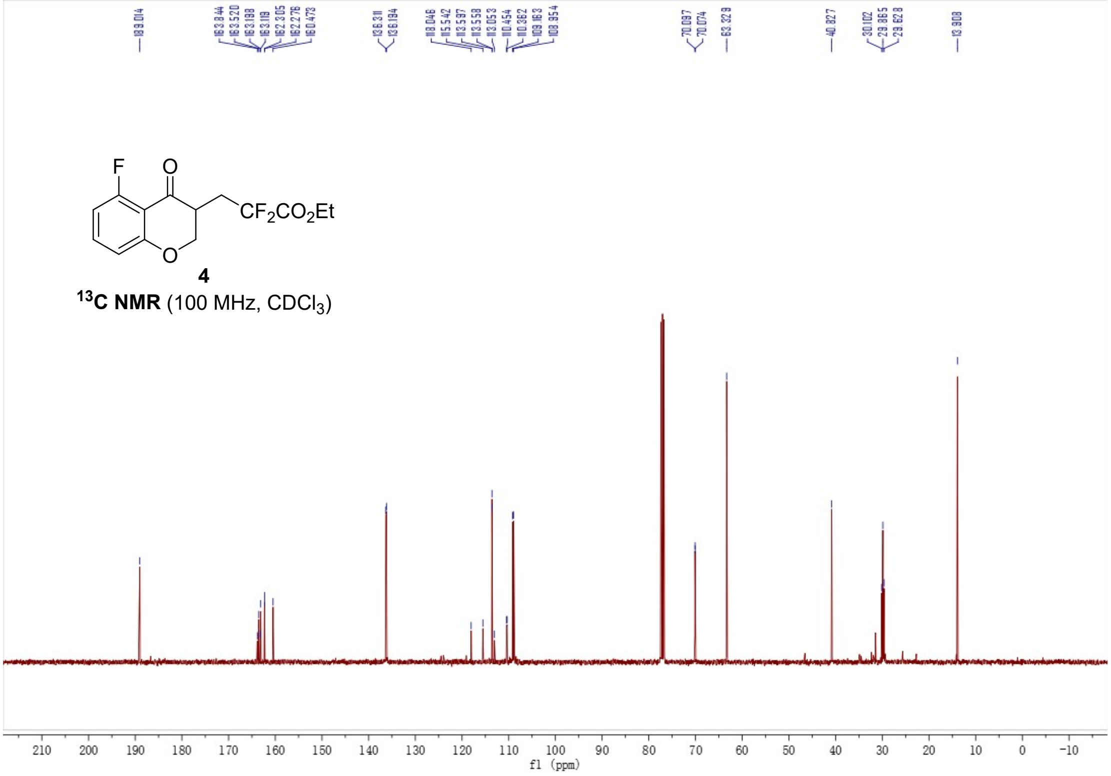
3ca

^{13}C NMR (100 MHz, $CDCl_3$)


-63.894
EtO2C
N
S
O
CF3
O
3ca
19F NMR (376 MHz, CDCl3)
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

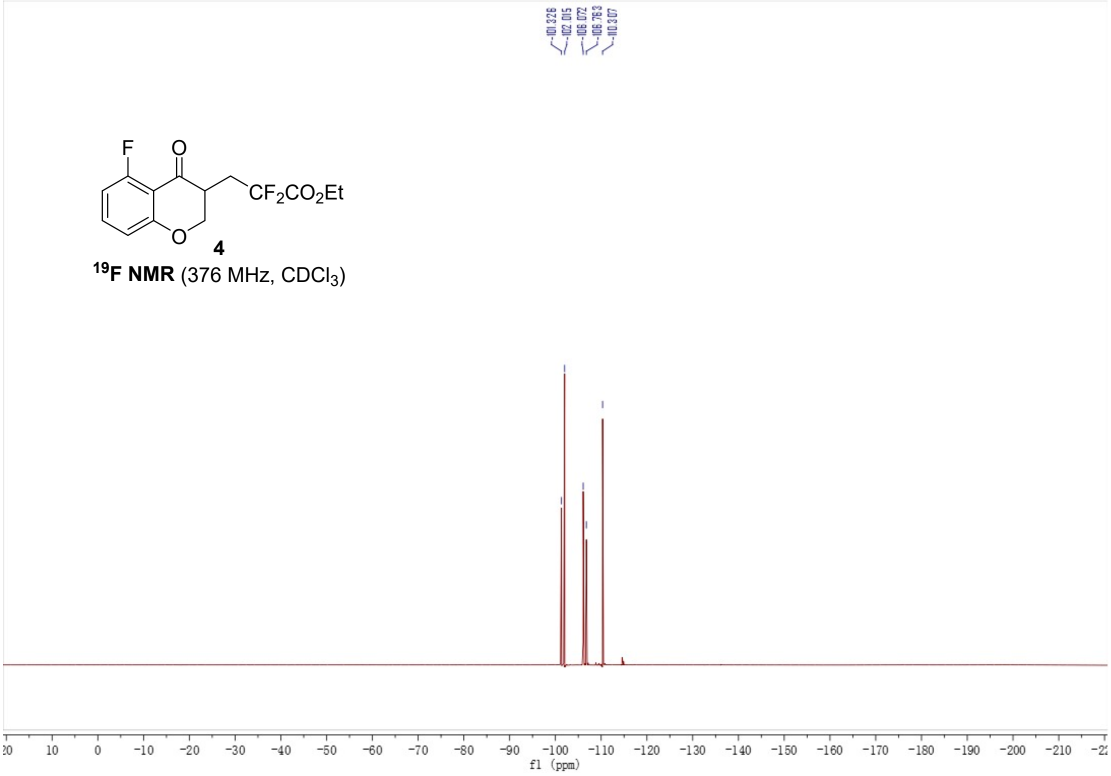
Compound 4


7.436 7.421 7.415 7.400 7.394 7.379 6.786 6.765 6.715 6.694 6.692 6.688 6.668
4.715 4.702 4.687 4.674 4.364 4.346 4.328 4.310 4.270 4.240
3.168 3.159 3.146 3.138 3.129 2.998 2.989 2.938 2.929
2.063 2.042 2.036 2.029 2.025 2.014 2.000 1.367 1.350 1.332
F
O
CF2CO2Et
O
4
1H NMR (400 MHz, CDCl3)
1.01 1.00 1.00 1.00 2.02 1.02 1.02 1.06 1.11 3.02
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)



4

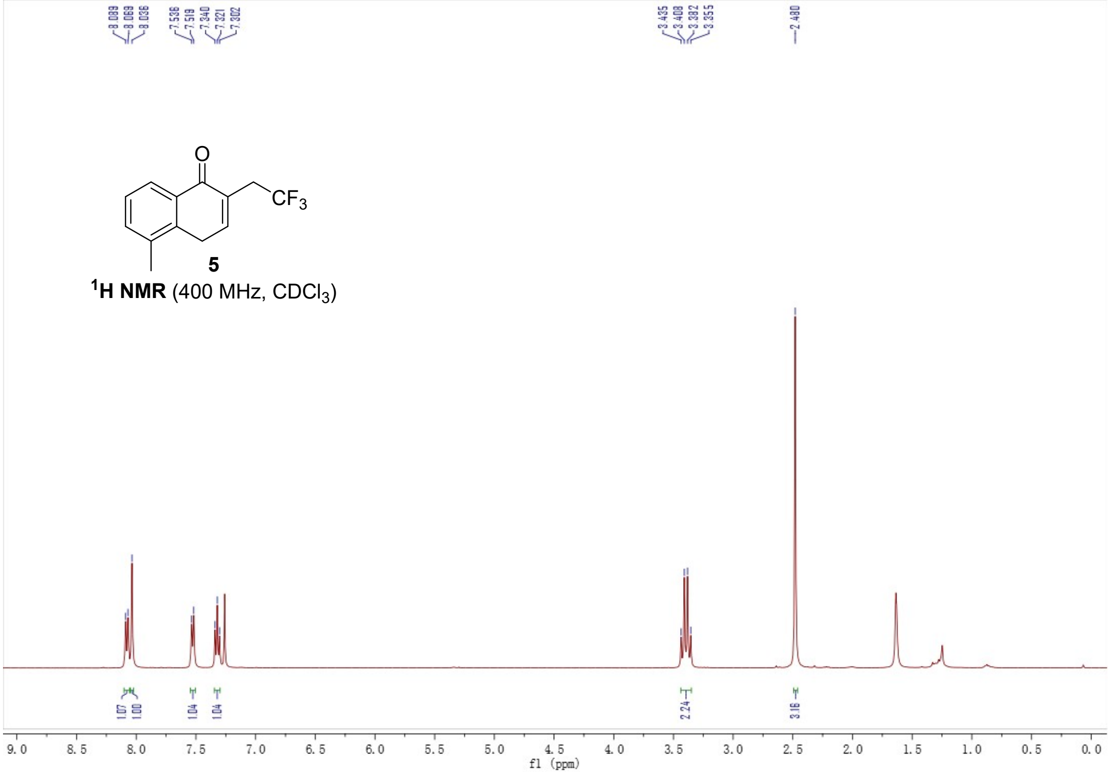
^{13}**C NMR** (100 MHz, CDCl$_3$)

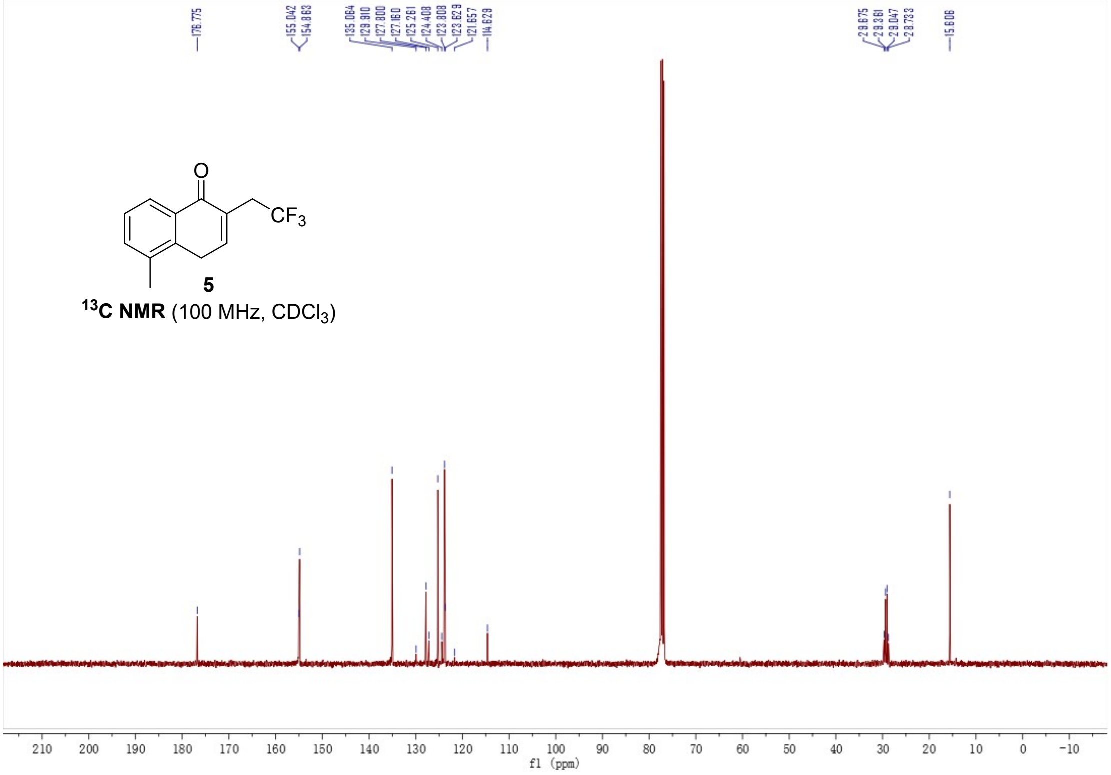


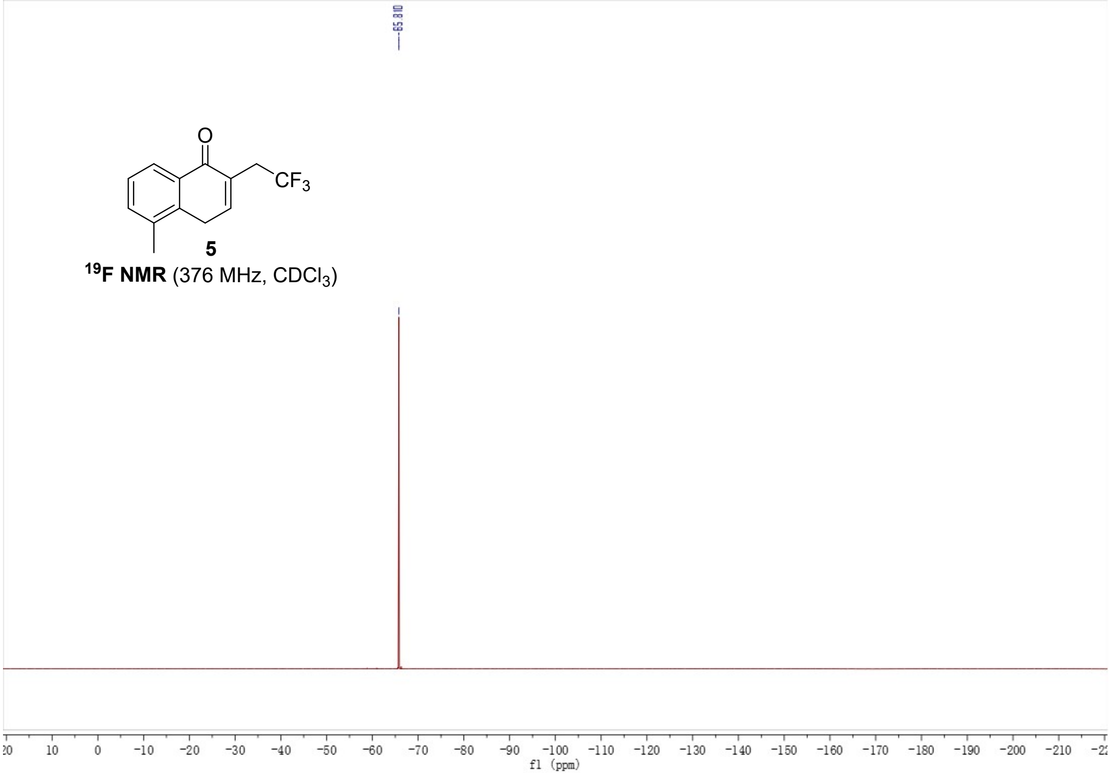
4

^{19}**F NMR** (376 MHz, CDCl$_3$)

Compound 5


8.089
8.069
8.036
7.536
7.519
7.340
7.321
7.302
3.435
3.408
3.382
3.355
2.480
O
CF3
5
1H NMR (400 MHz, CDCl3)
1.07
1.00
1.04
1.04
2.24
3.18
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

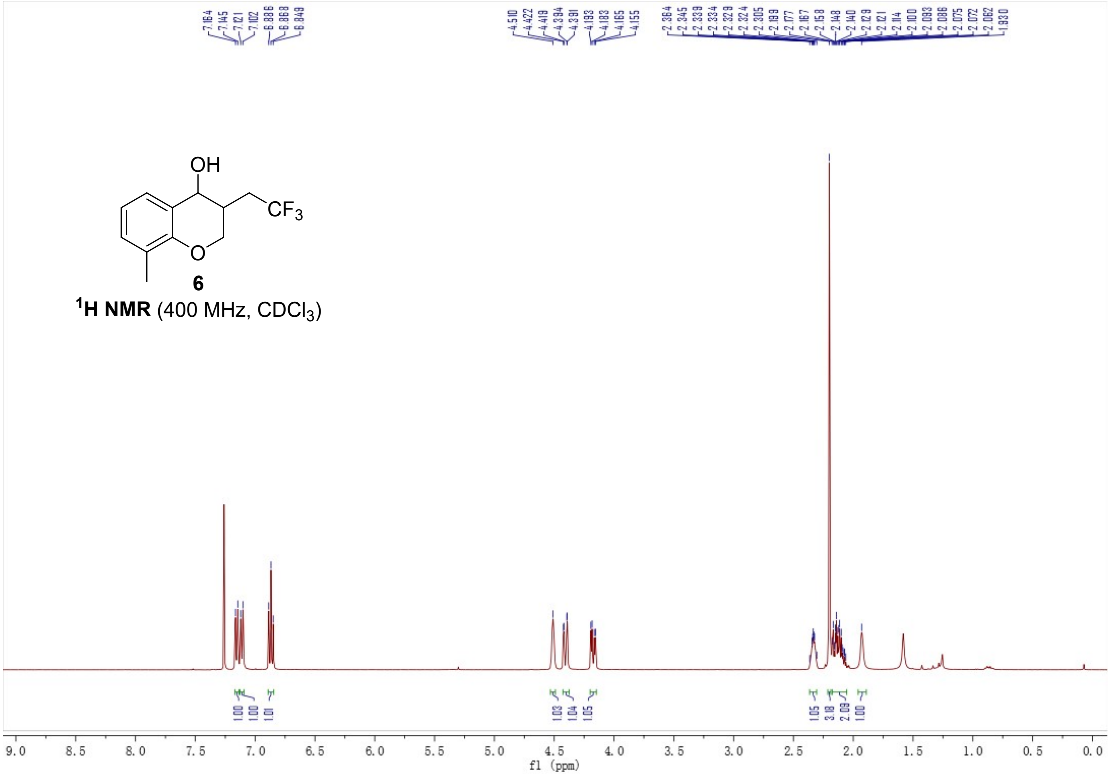

176.775
155.042
154.863
135.064
129.910
127.800
127.160
125.261
124.408
123.808
123.629
121.657
114.629
29.675
29.361
29.047
28.733
15.606
O
CF3
5
13C NMR (100 MHz, CDCl3)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)



5

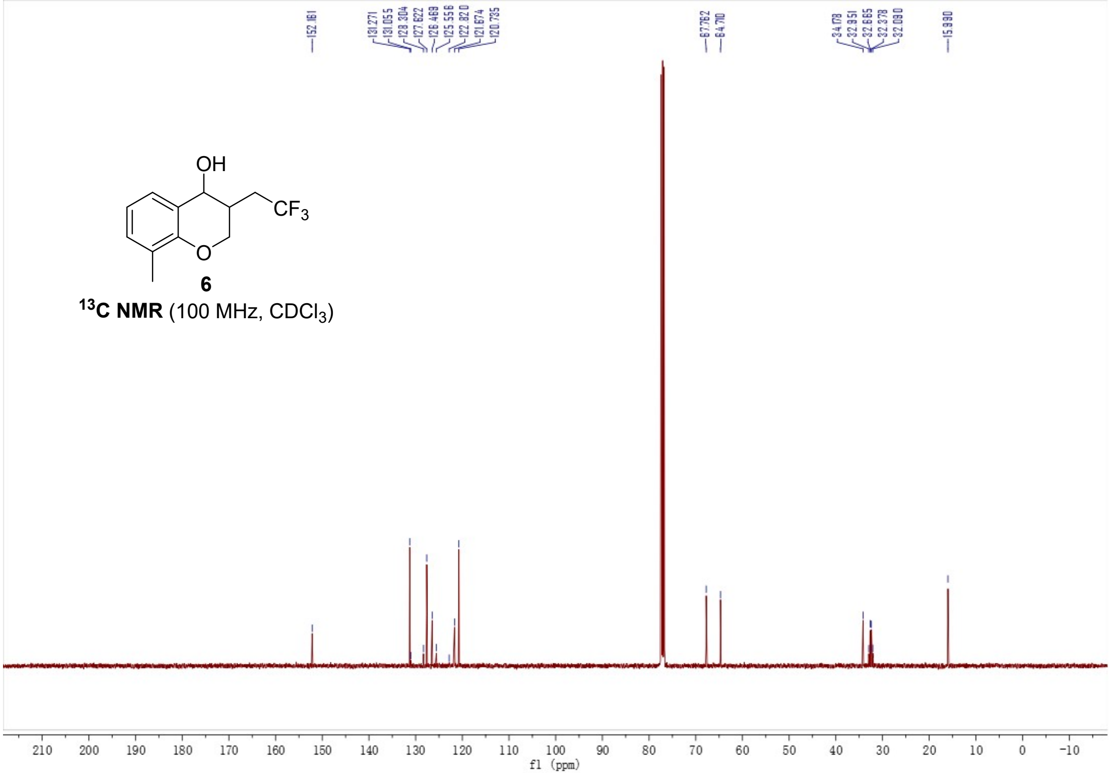
^{19}F NMR (376 MHz, CDCl$_3$)

Compound 6



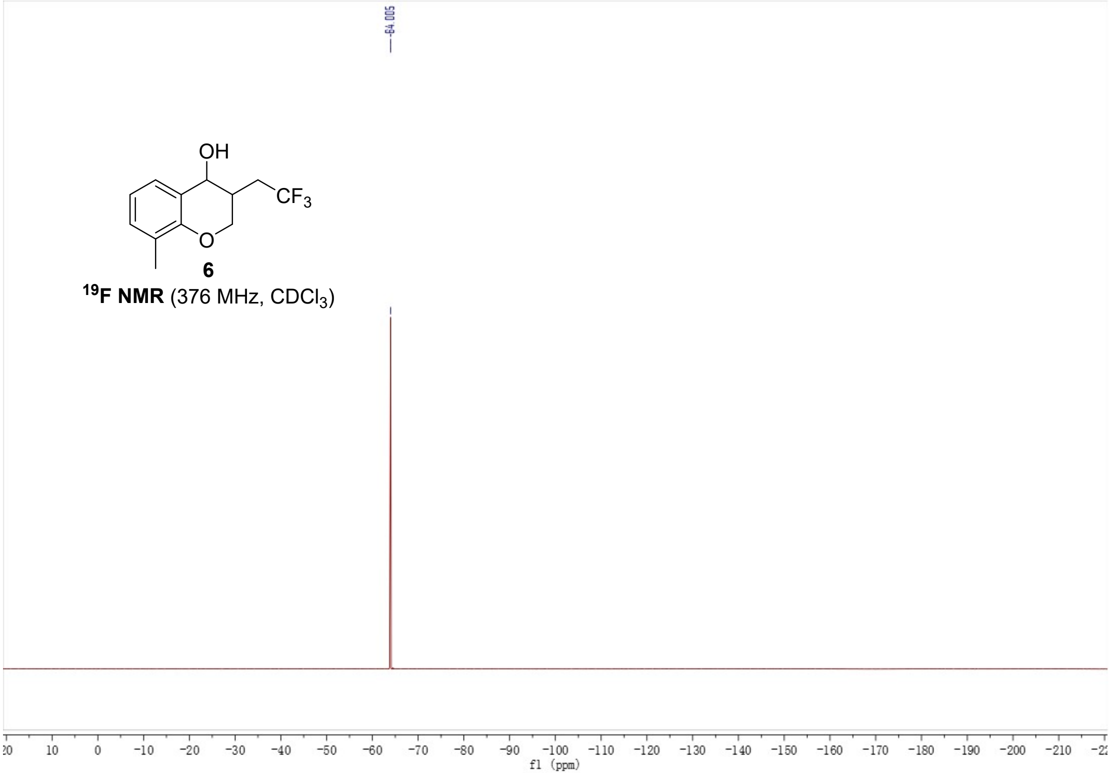
6

^{1}H NMR (400 MHz, CDCl$_3$)



6

^{13}C NMR (100 MHz, CDCl$_3$)



6

^{19}F NMR (376 MHz, CDCl$_3$)