Supporting Information

Photoredox-catalyzed 2,2,2-trifluoroethylation and 2,2-difluoroethylation of alkenes with concomitant introduction of a quinoxalin-2(1*H*)-one moiety

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1. General information

^{1}H NMR (TMS as the internal standard) were recorded on a Bruker AM 400 or 600 spectrometer, ^{13}C NMR and ^{19}F NMR ($CFCl_3$ as outside standard and low field is positive) spectra were recorded on a Bruker AM 400 or 600 spectrometer. For the determination of ^{19}F NMR yield, $PhCF_3$ was used as an internal standard and the relaxation delay (d1) was set to 5 s. Chemical shifts (δ) were reported in per million (ppm), and coupling constants (J) were in Hertz (Hz). The following abbreviations were used to explain the multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet. High resolution mass spectra (HRMS) were obtained on a GC-TOF mass spectrometer.

Materials: Unless otherwise noted, all reagents were obtained commercially and used without further purification. Substrates were purchased from commercial sources or prepared according to literature procedures. Reactions were performed using glassware that was flame-dried under vacuum.

2. Preparation of Substrates

Substrates **1a** (*CAS: 100-42-5*), **1b** (*CAS: 611-15-4*), **1c** (*CAS: 1746-23-2*), **1d** (*CAS: 637-69-4*), **1e** (*CAS: 2626-16-2*), **1f** (*CAS: 405-99-2*), **1g** (*CAS: 2039-82-9*), **1h** (*CAS: 2039-86-3*), **1i** (*CAS: 2234-20-0*), **1l** (*CAS: 768-56-9*) and **5** (*CAS: 3195-24-2*) were obtained commercially and used without further purification.

Substrates **1j** were prepared according to the reported literature.[1]

Substrates **1k** were prepared according to the reported literature.[2]

Substrates **1m** were prepared according to the reported literature.[3]

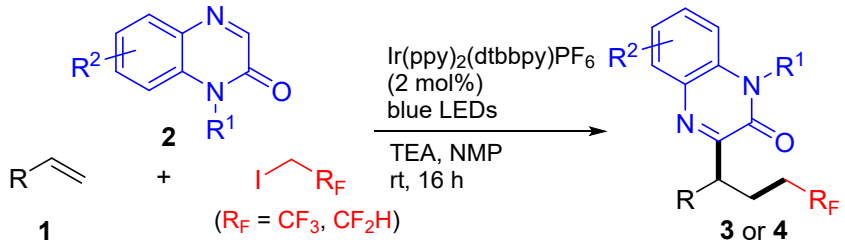
Substrates **2a, 2c, 2e - 2n** were prepared according to the reported literature.[4]

Substrates **2q, 2r** were prepared according to the reported literature.[5]

Substrates **2b** were prepared according to the reported literature.[6]

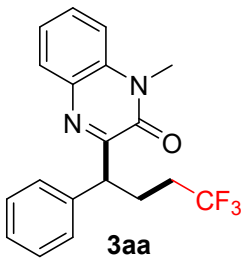
Substrates **2d** were prepared according to the reported literature.[7]

3. General procedure for the three-component coupling reaction of alkenes, quinoxalin-2(1*H*)-ones, and ICH_2CF_3/ICH_2CF_2H



To a sealed tube equipped with a stir bar were added quinoxalin-2(1*H*)-ones **2** (0.2 mmol, 1.0 equiv), $Ir(ppy)_2(dtbbpy)PF_6$ (3.7 mg, 0.004 mmol, 2 mol %). The tube was evacuated and backfilled with pure N_2 for three times. Afterwards, NMP (0.5 mL), alkenes **1** (2.5 equiv, 0.5 mmol), ICH_2CF_3/ICH_2CF_2H (2.0 equiv, 0.4 mmol) and TEA (3.0 equiv, 0.6 mmol) were added by syringe under N_2 atmosphere. The tightly sealed tube was then irradiated with a 20 W blue LEDs (the distance between the tube and the light source was about 7 cm) and simultaneously cooled by a fan to keep the reaction temperature at 25 ℃. After 16 hours, the mixture was transferred into a 125 mL separating funnel which contained 20 mL H_2O. The mixture was extracted with DCM (20 mL each) for three times and the combined organic layer was washed with brine (20 mL) once and dried by Na_2SO_4. After filtration, the filtrate was concentrated under reduced pressure to give the crude product, which was purified by flash chromatography on silica gel (PE/EtOAc = 10: 1) to give the product **3** or **4**.

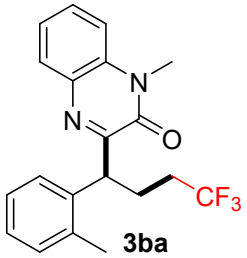
1-Methyl-3-(4,4,4-trifluoro-1-phenylbutyl)quinoxalin-2(1*H*)-one (3aa)



The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3aa** (49.1 mg, 71%) as a yellow solid. Mp 125-127 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.88 – 7.76 (m, 1H), 7.59 – 6.95 (m, 8H), 4.59 (t, *J* = 7.8 Hz, 1H), 3.48 (s, 3H), 2.55 – 2.18 (m, 2H), 2.14 – 1.77 (m, 2H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ -66.07 (t, *J* = 10.9 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 158.7, 153.3, 139.0, 131.9, 131.5, 129.1, 129.0, 127.6, 127.5, 126.2 (q, *J* = 277.3 Hz), 126.1, 122.5, 112.5, 45.2, 31.0 (q, *J* = 28.6 Hz), 28.0, 25.0 (q, *J* = 2.9 Hz); **IR** (thin film) ν 2944, 1648,

1602, 1252, 1132, 1104, 1018, 962, 763, 744, 515 cm^{-1}; **MS** (ESI): *m/z* 347.1 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{19}H_{18}F_3N_2O$ $[M+H]^+$: 347.1366; Found: 347.1374.

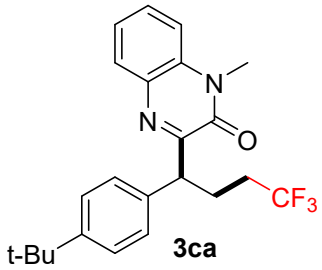
1-Methyl-3-(4,4,4-trifluoro-1-(o-tolyl)butyl)quinoxalin-2(1*H*)-one (3ba)



3ba

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3ba** (33.1 mg, 46%) as a white solid. Mp 114-116 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.89 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.53 – 7.41 (m, 1H), 7.30 (t, *J* = 7.6 Hz, 1H), 7.22 – 7.16 (m, 1H), 7.14 – 7.05 (m, 2H), 7.04 – 6.91 (m, 2H), 4.83 (t, *J* = 7.3 Hz, 1H), 3.53 (s, 3H), 2.57 (s, 3H), 2.52 – 2.38 (m, 1H), 2.17 – 2.13 (m, 2H), 1.98 – 1.94 (m, 1H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -66.14 (t, *J* = 10.5 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 160.1, 154.5, 138.9, 137.0, 133.0, 132.5, 130.8, 130.3, 130.1, 127.3 (q, *J* = 277.3 Hz), 126.8 (d, *J* = 12.1 Hz), 126.1, 123.6, 113.6, 41.6, 31.9 (q, *J* = 28.5 Hz), 29.7, 29.1, 26.4 (d, *J* = 3.1 Hz), 19.9; **IR** (thin film) ν 2920, 1650, 1597, 1471, 1295, 1256, 1132, 1085, 973, 749, 562 cm^{-1}; **MS** (ESI): *m/z* 361.2 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{20}H_{20}F_3N_2O$ $[M+H]^+$: 361.1522; Found: 361.1529.

3-(1-(4-(*Tert*-butyl)phenyl)-4,4,4-trifluorobutyl)-1-methylquinoxalin-2(1*H*)-one (3ca)

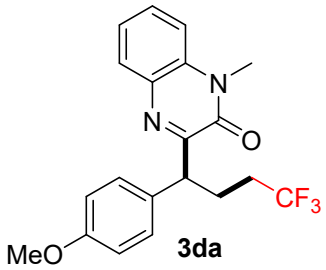


3ca

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3ca** (61.1 mg, 76%) as a white powder. Mp 109-111 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.86 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.46 – 7.42 (m, 1H), 7.34 – 7.08 (m, 6H), 4.59 (t, *J* = 7.8 Hz, 1H), 3.54 (s, 3H), 2.50 – 2.18 (m, 2H), 2.13 – 1.86 (m, 2H), 1.19 (s, 9H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ -66.11 (t, *J* = 11.0 Hz, 3F); **^{13}C**

NMR (101 MHz, $CDCl_3$) δ 158.9, 153.4, 148.8, 135.9, 132.0, 131.6, 129.2, 129.0, 127.1, 126.3 (q, *J* = 277.3 Hz), 124.5, 122.5, 112.5, 44.6, 33.4, 31.1 (q, *J* = 28.5 Hz), 30.3, 28.1, 25.1 (q, *J* = 2.7 Hz); **IR** (thin film) ν 2963, 1653, 1603, 1526, 1256, 1099, 1019, 980, 795, 757, 582, 459 cm^{-1}; **MS** (ESI): *m/z* 403.2 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{23}H_{26}F_3N_2O$ $[M+H]^+$: 403.1992; Found:403.1988.

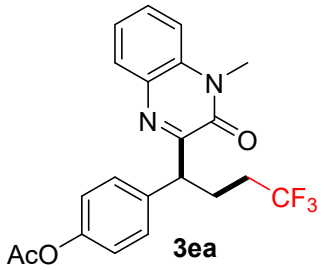
1-Methyl-3-(4,4,4-trifluoro-1-(4-methoxyphenyl)butyl)quinoxalin-2(1*H*)-one (3da)



3da

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3da** (75.3 mg, 77%) as a brown liquid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.82 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.47 – 7.32 (m, 1H), 7.31 – 7.18 (m, 3H), 7.16 – 7.07 (m, 1H), 6.82 – 6.67 (m, 2H), 4.53 (t, *J* = 7.8 Hz, 1H), 3.63 (s, 3H), 3.49 (s, 3H), 2.45 – 2.18 (m, 2H), 2.14 – 1.83 (m, 2H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -66.03 (t, *J* = 10.9 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 158.9, 157.6, 153.3, 132.0, 131.5, 130.9, 129.1, 128.9, 128.5, 126.3 (q, *J* = 276.5 Hz), 122.5, 113.0, 112.5, 54.1, 44.3, 31.0 (q, *J* = 28.4 Hz), 28.0, 25.0 (t, *J* = 2.9 Hz); **IR** (thin film) ν 2940, 1651, 1603, 1509, 1247, 1134, 1034, 981, 833, 752, 559 cm^{-1}; **MS** (ESI): *m/z* 377.1 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{20}H_{20}F_3N_2O_2$ $[M+H]^+$: 377.1471; Found: 377.1471.

4-(4,4,4-Trifluoro-1-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)butyl)phenyl acetate (3ea)

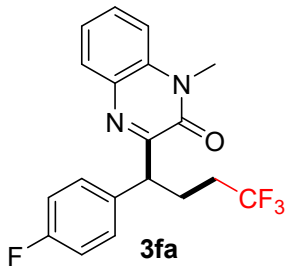


3ea

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3ea** (47.5 mg, 59%) as a yellow solid. Mp 187-189 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.83 (dd, *J* = 7.9, 1.5 Hz, 1H), 7.62 – 7.32 (m, 3H), 7.30 – 7.10 (m, 2H), 6.99 – 6.77 (m, 2H), 4.62 (t, *J* = 7.9 Hz, 1H), 3.53 (s, 3H), 2.46 – 2.43 (m, 1H),

2.29 – 2.26 (m, 1H), 2.16 (s, 3H), 2.11 – 1.88 (m, 2H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -66.07 (t, *J* = 10.9 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 168.4, 158.4, 153.3, 148.7, 136.5, 132.0, 131.5, 129.1, 128.5, 126.2 (q, *J* = 276.3 Hz), 122.6, 120.6, 112.6, 44.4, 31.0 (q, *J* = 28.6 Hz), 28.1, 25.0 (d, *J* = 2.9 Hz), 20.1; **IR** (thin film) ν 2962, 1769, 1645, 1602, 1471, 1258, 1188, 1016, 981, 795, 752, 570 cm^{-1}; **MS** (ESI): *m/z* 405.1 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{21}H_{20}F_3N_2O_3$ $[M+H]^+$: 405.1421; Found: 405.1416.

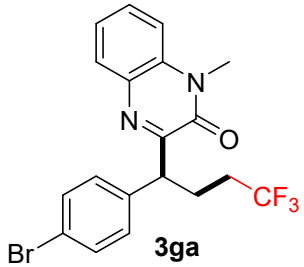
1-Methyl-3-(4,4,4-trifluoro-1-(4-fluorophenyl)butyl)quinoxalin-2(1*H*)-one (3fa)



3fa

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3fa** (51.6 mg, 71%) as a brown liquid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.83 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.50 – 7.34 (m, 1H), 7.35 – 7.22 (m, 3H), 7.21 – 7.10 (m, 1H), 6.87 (t, *J* = 8.5 Hz, 2H), 4.58 (t, *J* = 7.8 Hz, 1H), 3.52 (s, 3H), 2.51 – 2.33 (m, 1H), 2.33 – 2.15 (m, 1H), 2.06 – 1.90 (m, 2H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -66.08 (t, *J* = 10.8 Hz, 3F), -115.53 (m, 1F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 160.9 (d, *J* = 245.5 Hz), 158.5, 153.3, 134.7 (d, *J* = 3.2 Hz), 132.0, 131.5, 129.2, 129.0 (d, *J* = 8.0 Hz), 126.2 (q, *J* = 276.3 Hz), 122.7, 114.4 (d, *J* = 21.3 Hz), 112.6, 44.4, 30.9 (q, *J* = 28.6 Hz), 28.1, 25.1 (d, *J* = 3.1 Hz); **IR** (thin film) ν 2946, 1650, 1601, 1505, 1258, 1219, 1131, 979, 843, 749, 559 cm^{-1}; **MS** (ESI): *m/z* 387.1 $[M+Na]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{19}H_{16}F_4N_2ONa$ $[M+ Na]^+$: 387.1091; Found: 387.1090.

3-(1-(4-Bromophenyl)-4,4,4-trifluorobutyl)-1-methylquinoxalin-2(1*H*)-one (3ga)

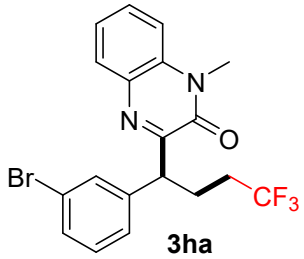


3ga

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3ga** (49.1 mg, 71%) as a brown liquid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ

7.84 (d, J = 7.9 Hz, 1H), 7.46 (t, J = 7.9 Hz, 1H), 7.33 – 7.18 (m, 6H), 4.56 (t, J = 7.7 Hz, 1H), 3.54 (s, 3H), 2.48 – 2.39 (m, 1H), 2.29 – 2.19 (m, 1H), 2.12 – 1.87 (m, 2H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ -66.11 (t, J = 10.6 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 158.2, 153.2, 138.1, 132.0, 131.5, 130.7, 129.3, 129.2, 126.1 (q, J = 276.3 Hz), 122.7, 120.1, 112.6, 44.6, 30.9 (q, J = 28.7 Hz), 28.1, 24.9 (d, J = 3.1 Hz); **IR** (thin film) ν 2925, 1652, 1601, 1472, 1255, 1135, 1010, 981, 753, 556 cm^{-1}; **MS** (ESI): *m/z* 447.0 $[M+Na]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{19}H_{16}BrF_3N_2ONa$ $[M+Na]^+$: 447.0290; Found: 447.0302.

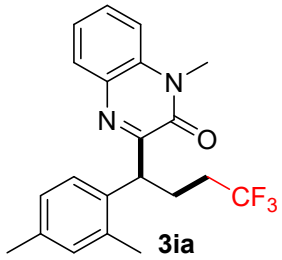
3-(1-(3-Bromophenyl)-4,4,4-trifluorobutyl)-1-methylquinoxalin-2(1*H*)-one (3ha)



3ha

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3ha** (45.8 mg, 54%) as a white solid. Mp 89-91 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.87 (dd, J = 8.0, 1.4 Hz, 1H), 7.58 – 7.41 (m, 2H), 7.35 – 7.15 (m, 4H), 7.09 (t, J = 7.8 Hz, 1H), 4.57 (t, J = 7.8 Hz, 1H), 3.56 (s, 3H), 2.52 – 2.37 (m, 1H), 2.29 – 2.19 (m, 1H), 2.13 – 1.91 (m, 2H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -66.12 (t, J = 10.8 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 158.0, 153.2, 141.5, 132.0, 131.5, 130.2, 129.3, 129.2, 126.4, 126.1 (q, J = 277.3 Hz), 122.7, 121.7, 112.6, 44.8, 31.0 (q, J = 28.7 Hz), 28.2, 25.1 (d, J = 3.0 Hz); **IR** (thin film) ν 2951, 1650, 1599, 1470, 1293, 1135, 984, 787, 749, 560 cm^{-1}; **MS** (ESI): *m/z* 447.0 $[M+Na]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{19}H_{16}BrF_3N_2ONa$ $[M+Na]^+$: 447.0290; Found: 447.0296.

3-(1-(2,4-Dimethylphenyl)-4,4,4-trifluorobutyl)-1-methylquinoxalin-2(1*H*)-one (3ia)

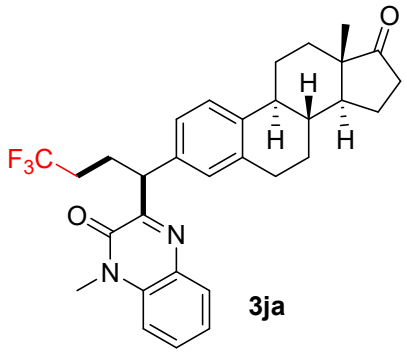


3ia

The product mixture was purified by silica gel column chromatography (PE/EtOAc =

10:1) to afford **3ia** (35.9 mg, 48%) as a white solid. Mp 131-133 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.88 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.50 – 7.42 (m, 1H), 7.35 – 7.25 (m, 1H), 7.23 – 7.14 (m, 1H), 6.99 – 6.90 (m, 2H), 6.78 (dd, *J* = 7.9, 1.9 Hz, 1H), 4.78 (t, *J* = 7.3 Hz, 1H), 3.53 (s, 3H), 2.53 (s, 3H), 2.47 – 2.37 (m, 1H), 2.20 – 2.09 (m, 5H), 1.99 – 1.91 (m, 1H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -66.14 (t, *J* = 10.5 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 159.2, 153.4, 135.7, 135.3, 134.7, 132.0, 131.5, 130.5, 129.2, 128.9, 126.3 (q, *J* = 277.3 Hz), 125.8, 125.7, 122.5, 112.5, 40.3, 30.9 (q, *J* = 28.4 Hz), 28.9, 25.3 (d, *J* = 2.9 Hz), 19.9, 18.8; **IR** (thin film) ν 2956, 1654, 1604, 1255, 1122, 1092, 1000, 966, 820, 753, 580 cm^{-1}; **MS** (ESI): *m/z* 375.2 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{21}H_{22}F_3N_2O$ $[M+H]^+$: 375.1679; Found: 375.1676.

1-Methyl-3-(4,4,4-trifluoro-1-((8*R*,9*S*,13*S*,14*S*)-13-methyl-17-oxo-7,8,9,11,12,13,14,15,16,17-decahydro-6*H*-cyclopenta[*a*]phenanthren-3-yl)butyl)quinoxalin-2(1*H*)-one (3ja)

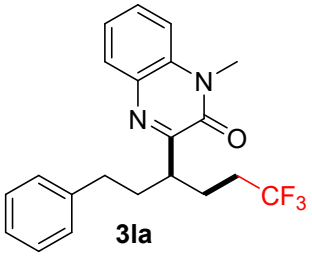


3ja

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3ja** (61.0 mg, 60%) as a white solid. Mp 119-121 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.87 (dt, *J* = 8.1, 1.6 Hz, 1H), 7.47 (tt, *J* = 7.2, 1.2 Hz, 1H), 7.33 – 7.26 (m, 1H), 7.20 (d, *J* = 9.1 Hz, 1H), 7.15 – 7.11 (m, 2H), 7.08 – 7.04 (m, 1H), 4.54 (td, *J* = 7.8, 1.7 Hz, 1H), 3.55 (s, 3H), 2.91 – 2.65 (m, 2H), 2.50 – 2.36 (m, 2H), 2.34 – 2.20 (m, 2H), 2.20 – 1.81 (m, 6H), 1.59 – 1.26 (m, 7H), 0.80 (d, *J* = 1.4 Hz, 3H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -66.10 (td, *J* = 10.6, 2.3 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 158.8 (d, *J* = 2.2 Hz), 153.4, 137.5, 136.5 (d, *J* = 1.7 Hz), 135.7 (d, *J* = 1.6 Hz), 132.0, 131.6, 129.2, 129.0, 128.0, 126.3 (d, *J* = 276.3 Hz), 124.8, 124.7, 124.6, 122.6, 112.5, 49.5, 46.9, 44.8 (d, *J* = 3.3 Hz), 43.3, 37.0, 34.8, 31.1 (q, *J* = 28.6 Hz), 30.6, 28.4, 28.1, 25.5, 24.6 (d, *J* = 4.3 Hz), 20.6, 12.8; **IR** (thin film) ν 2924, 1737, 1655, 1602, 1472, 1256, 1133, 1006, 755, 582 cm^{-1}; **MS** (ESI): *m/z* 523.3 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{31}H_{34}F_3N_2O_2$ $[M+H]^+$: 523.2567; Found:

523.2563.

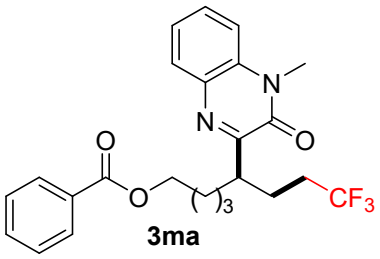
1-Methyl-3-(6,6,6-trifluoro-1-phenylhexan-3-yl)quinoxalin-2(1*H*)-one (3la)



3la

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3la** (32.2 mg, 43%) as a white solid. Mp 75-77 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.78 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.50 – 7.46 (m, 1H), 7.30 – 7.26 (m, 1H), 7.22 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.15 – 7.10 (m, 2H), 7.08 – 6.99 (m, 3H), 3.61 (s, 3H), 3.53 (tt, *J* = 8.2, 5.3 Hz, 1H), 2.64 – 2.48 (m, 2H), 2.26 – 2.08 (m, 2H), 2.06 – 1.96 (m, 2H), 1.94 – 1.82 (m, 2H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ -66.44 (t, *J* = 10.6 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 160.6, 153.7, 140.8, 131.9, 131.5, 129.0, 128.9, 127.4, 127.2, 126.2 (q, *J* = 277.1 Hz), 124.7, 122.6, 112.5, 39.2, 33.8, 32.6, 30.6 (q, *J* = 28.5 Hz), 28.2, 23.9 (t, *J* = 3.0 Hz); **IR** (thin film) ν 2933, 1645, 1593, 1258, 1134, 1034, 964, 751, 699, 458 cm^{-1}; **MS** (ESI): *m/z* 375 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{21}H_{22}F_3N_2O$ $[M+H]^+$: 375.1679; Found: 375.1679.

8,8,8-Trifluoro-5-(4-methyl-3-oxo-3,4-dihydroquinoxalin-2-yl)octyl benzoate (3ma)

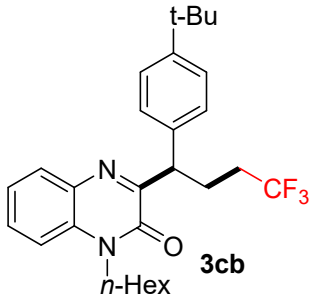


3ma

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3ma** (29.4 mg, 33%) as a brown liquid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.89 (d, *J* = 7.7 Hz, 2H), 7.76 (d, *J* = 7.9 Hz, 1H), 7.52 – 7.39 (m, 2H), 7.37 – 7.11 (m, 4H), 4.32 – 4.07 (m, 2H), 3.61 (s, 3H), 3.50 (t, *J* = 7.3 Hz, 1H), 2.15 – 1.94 (m, 4H), 1.95 – 1.81 (m, 2H), 1.71 (q, *J* = 7.1 Hz, 1H), 1.66 – 1.55 (m, 3H), 1.44 – 1.34 (m, 3H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -66.42 (t, *J* = 10.5 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 166.6, 161.7, 154.8, 132.9, 132.8, 132.6, 130.4, 130.1, 130.0, 129.5, 128.3,

127.2 (q, *J* = 277.3 Hz), 123.7, 113.6, 64.7, 40.0, 32.8, 31.7 (q, *J* = 28.5 Hz), 29.2, 28.7, 24.7 (d, *J* = 3.0 Hz), 23.6; **IR** (thin film) ν 2946, 1716, 1650, 1602, 1472, 1272, 1116, 754, 711, 426 cm^{-1}; **MS** (ESI): *m/z* 447.2 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{24}H_{26}F_3N_2O_3$ $[M+H]^+$: 447.1890; Found: 447.1890.

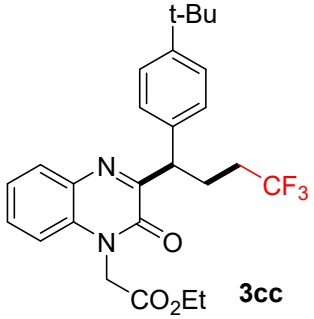
3-(1-(4-(*Tert*-butyl)phenyl)-4,4,4-trifluorobutyl)-1-hexylquinoxalin-2(1*H*)-one (3cb)



3cb

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3cb** (57.6 mg, 61%) as a white solid. Mp 139-141 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ ppm 7.85 (d, *J* = 7.7 Hz, 1H), 7.42 (t, *J* = 7.5 Hz, 1H), 7.30 – 7.13 (m, 6H), 4.59 (t, *J* = 7.8 Hz, 1H), 4.20 – 4.10 (m, 1H), 4.03 – 3.93 (m, 1H), 2.47 – 2.38 (m, 1H), 2.35 – 2.23 (m, 1H), 2.15 – 1.87 (m, 2H), 1.64 – 1.56 (m, 2H), 1.29 (q, *J* = 7.6, 7.0 Hz, 6H), 1.18 (s, 9H), 0.79 (t, *J* = 6.8 Hz, 3H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ ppm -66.12 (t, *J* = 10.9 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ ppm 159.0, 153.1, 148.7, 135.9, 131.9, 131.2, 129.4, 128.8, 127.1, 126.3 (q, *J* = 277.3 Hz), 124.5, 122.3, 112.5, 44.5, 41.5, 33.4, 31.1 (q, *J* = 28.6 Hz), 30.4, 30.3, 26.1, 25.6, 25.1 (d, *J* = 2.9 Hz), 21.5, 12.9; **IR** (thin film) ν 2960, 1651, 1602, 1308, 1257, 1099, 1002, 756, 587, 465 cm^{-1}; **MS** (ESI): *m/z* 473.3 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{28}H_{37}F_3N_2O$ $[M+H]^+$: 473.2774; Found: 473.2774.

Ethyl 2-(3-(1-(4-(*tert*-butyl)phenyl)-4,4,4-trifluorobutyl)-2-oxoquinoxalin-1(2*H*)-yl)acetate (3cc)

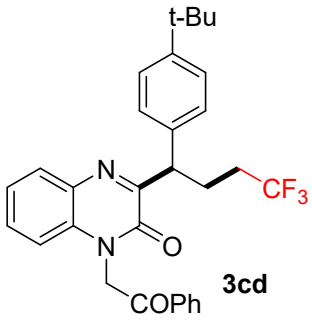


3cc

The product mixture was purified by silica gel column chromatography (PE/EtOAc =

10:1) to afford **3cc** (68.3 mg, 72%) as a white powder. Mp 127-129 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 7.6 Hz, 1H), 7.40 (t, *J* = 7.4 Hz, 1H), 7.30 – 7.15 (m, 5H), 6.94 (d, *J* = 8.3 Hz, 1H), 4.98 (d, *J* = 17.3 Hz, 1H), 4.72 (d, *J* = 17.3 Hz, 1H), 4.56 (t, *J* = 7.8 Hz, 1H), 4.17 – 4.02 (m, 2H), 2.46 – 2.38 (m, 1H), 2.35 – 2.25 (m, 1H), 2.13 – 1.88 (m, 2H), 1.18 (s, 9H), 1.12 (t, *J* = 7.1 Hz, 3H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -66.08 (t, *J* = 10.9 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 166.0, 158.8, 152.9, 148.9, 135.6, 131.6, 131.1, 129.5, 129.1, 127.1, 126.3 (q, *J* = 277.3 Hz), 124.6, 122.9, 112.0, 61.0, 44.7, 42.6, 33.4, 31.0 (q, *J* = 28.7 Hz), 30.3, 25.0 (d, *J* = 3.0 Hz), 13.0; **IR** (thin film) ν 2964, 1755, 1657, 1258, 1202, 1097, 1019, 794, 757, 575 cm^{-1}; **MS** (ESI): *m/z* 497.2 $[M+Na]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{26}H_{29}F_3N_2O_3Na$ $[M+Na]^+$: 497.2023; Found: 497.2021.

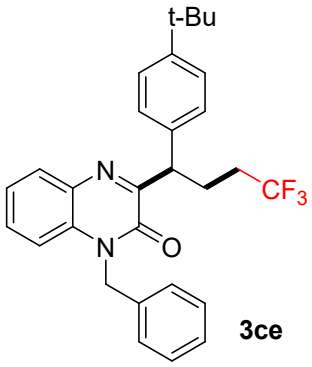
3-(1-(4-(*Tert*-butyl)phenyl)-4,4,4-trifluorobutyl)-1-(2-oxo-2-phenylethyl)quinoxalin-2(1*H*)-one (3cd)



3cd

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3cd** (51.6 mg, 51%) as a white solid. Mp 179-181 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.90 – 7.86 (m, 3H), 7.57 – 7.47 (m, 1H), 7.38 (t, *J* = 7.8 Hz, 2H), 7.32 – 7.16 (m, 6H), 6.78 (dd, *J* = 8.2, 1.3 Hz, 1H), 5.65 (d, *J* = 17.6 Hz, 1H), 5.36 (d, *J* = 17.5 Hz, 1H), 4.55 (t, *J* = 7.8 Hz, 1H), 2.49 – 2.39 (m, 1H), 2.35 – 2.25 (m, 1H), 2.13 – 1.87 (m, 2H), 1.18 (s, 9H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ -66.03 (t, *J* = 10.9 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 190.1, 158.6, 153.1, 148.8, 135.7, 133.4, 133.2, 131.7, 131.4, 129.4, 129.0, 128.0, 127.1, 127.0, 126.3 (q, *J* = 277.3 Hz), 124.6, 122.7, 112.4, 47.6, 44.7, 33.4, 31.0 (q, *J* = 28.5 Hz), 30.3, 25.0 (d, *J* = 3.1 Hz); **IR** (thin film) ν 2966, 1705, 1656, 1600, 1297, 1220, 981, 842, 751, 583 cm^{-1}; **MS** (ESI): *m/z* 507.2 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{30}H_{30}F_3N_2O_2$ $[M+H]^+$: 507.2254; Found: 507.2243.

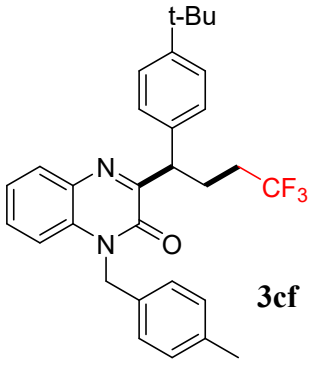
1-Benzyl-3-(1-(4-(*tert*-butyl)phenyl)-4,4,4-trifluorobutyl)quinoxalin-2(1*H*)-one (3ce)



3ce

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3ce** (51.6 mg, 54%) as a yellow solid. Mp 155-157 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.85 (d, *J* = 7.7 Hz, 1H), 7.41 – 6.91 (m, 14H), 5.44 (d, *J* = 15.6 Hz, 1H), 5.17 (d, *J* = 15.6 Hz, 1H), 4.65 (t, *J* = 7.7 Hz, 1H), 2.51 – 2.25 (m, 2H), 2.18 – 1.88 (m, 2H), 1.19 (s, 9H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ -66.04 (t, *J* = 10.9 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 159.2, 153.4, 148.8, 135.8, 134.1, 131.8, 131.3, 129.3, 128.9, 127.8, 127.1, 126.6, 126.3 (q, *J* = 277.3 Hz), 125.8, 124.5, 122.6, 113.3, 44.9, 44.7, 33.4, 31.1 (q, *J* = 28.5 Hz), 30.3, 25.1 (d, *J* = 3.1 Hz); **IR** (thin film) ν 2967, 1650, 1602, 1452, 1256, 1132, 1003, 756, 697, 581 cm^{-1}; **MS** (ESI): *m/z* 479.2 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{29}H_{30}F_3N_2O$ $[M+H]^+$: 479.2305; Found: 479.2299.

3-(1-(4-(*Tert*-butyl)phenyl)-4,4,4-trifluorobutyl)-1-(4-methylbenzyl)quinoxalin-2(1*H*)-one (3cf)

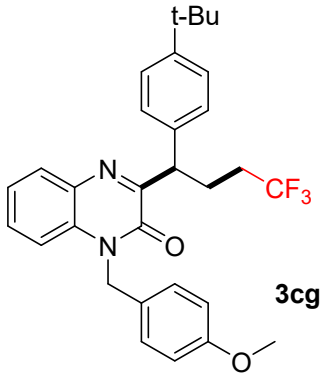


3cf

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3cf** (56.1 mg, 57%) as a white solid. Mp 169-171°C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.83 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.31 – 7.08 (m, 7H), 6.95 (s, 4H), 5.39 (d, *J* = 15.5 Hz, 1H), 5.10 (d, *J* = 15.5 Hz, 1H), 4.64 (t, *J* = 7.8 Hz, 1H), 2.49 – 2.24 (m, 2H), 2.16 (s, 3H), 2.11 – 1.88 (m, 2H), 1.18 (s, 9H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ -66.02 (t, *J* = 10.8 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 159.2, 153.4, 148.8, 136.3, 135.8, 131.8, 131.3, 131.2, 129.2, 128.9, 128.5, 127.1, 126.3 (q, *J* = 277.3 Hz),

125.8, 124.5, 122.5, 113.3, 44.7, 44.6, 33.4, 31.1 (q, J = 28.5 Hz), 30.3, 25.1 (d, J = 3.0 Hz), 21.3; **IR** (thin film) ν 2961, 1651, 1602, 1257, 1169, 1099, 1005, 795, 757, 580 cm^{-1}; **MS** (ESI): *m/z* 493.2 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{30}H_{32}F_3N_2O$ $[M+H]^+$: 493.2461; Found: 493.2449.

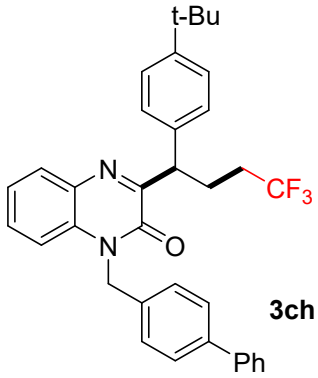
3-(1-(4-(*Tert*-butyl)phenyl)-4,4,4-trifluorobutyl)-1-(4-methoxybenzyl)quinoxalin-2(1*H*)-one (3cg)



3cg

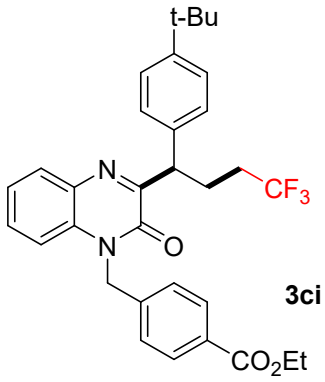
The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3cg** (52.9 mg, 52%) as a yellow solid. Mp 137-139 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.83 (dd, J = 7.9, 1.6 Hz, 1H), 7.31 – 7.09 (m, 7H), 7.00 (d, J = 8.7 Hz, 2H), 6.68 (d, J = 8.7 Hz, 2H), 5.36 (d, J = 15.4 Hz, 1H), 5.09 (d, J = 15.3 Hz, 1H), 4.64 (t, J = 7.8 Hz, 1H), 3.61 (s, 3H), 2.53 – 2.20 (m, 2H), 2.18 – 1.83 (m, 2H), 1.18 (s, 9H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ -66.02 (t, J = 10.9 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 159.2, 158.0, 153.4, 148.8, 135.9, 131.8, 131.3, 129.3, 128.8, 127.3, 127.1, 126.3 (q, J = 277.3 Hz), 126.2, 124.5, 122.5, 113.2, 113.1, 54.1, 44.7, 44.4, 33.4, 31.1 (q, J = 28.7 Hz), 30.3, 25.1 (d, J = 3.0 Hz); **IR** (thin film) ν 2962, 1652, 1602, 1516, 1254, 1099, 809, 758, 581 cm^{-1}; **MS** (ESI): *m/z* 509.2 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{30}H_{32}F_3N_2O_2$ $[M+H]^+$: 509.2410; Found: 509.2406.

1-([1,1'-Biphenyl]-4-ylmethyl)-3-(1-(4-(*tert*-butyl)phenyl)-4,4,4-trifluorobutyl)quinoxalin-2(1*H*)-one (3ch)



The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3ch** (59.8 mg, 54%) as a white solid. Mp 189-191 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.95 – 7.79 (m, 1H), 7.55 – 6.95 (m, 16H), 5.46 (d, *J* = 15.7 Hz, 1H), 5.16 (d, *J* = 15.8 Hz, 1H), 4.65 (t, *J* = 7.8 Hz, 1H), 2.52 – 2.25 (m, 2H), 2.15 – 1.84 (m, 2H), 1.18 (s, 9H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -65.93 (t, *J* = 10.8 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 159.1, 153.4, 148.8, 139.6, 139.4, 135.8, 133.1, 131.8, 131.3, 129.3, 128.9, 127.7, 127.1, 126.5, 126.4, 126.3 (q, *J* = 277.3 Hz), 126.2, 125.9, 124.5, 122.6, 44.7, 33.4, 31.1 (q, *J* = 28.5 Hz), 30.3, 25.1 (d, *J* = 3.1 Hz); **IR** (thin film) ν 2947, 1656, 1257, 1144, 1001, 959, 823, 757, 701, 583 cm^{-1}; **MS** (ESI): *m/z* 555.3 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{35}H_{34}F_3N_2O$ $[M+H]^+$: 555.2618; Found: 555.2632.

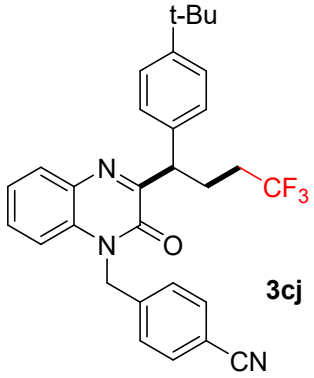
Ethyl 4-((3-(1-(4-(*tert*-butyl)phenyl)-4,4,4-trifluorobutyl)-2-oxoquinoxalin-1(2*H*)-yl)methyl)benzoate (3ci)



The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3ci** (66.0 mg, 60%) as a white solid. Mp 150-152 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.85 (t, *J* = 8.6 Hz, 3H), 7.46 – 7.14 (m, 6H), 7.05 (dd, *J* = 27.8, 8.1 Hz, 3H), 5.47 (d, *J* = 16.1 Hz, 1H), 5.23 (d, *J* = 16.0 Hz, 1H), 4.63 (t, *J* = 7.8 Hz, 1H), 4.24 (q, *J* = 7.1 Hz, 1H), 2.54 – 2.24 (m, 2H), 2.13 – 1.84 (m, 2H), 1.25 (t, *J* = 7.1 Hz,

3H), 1.19 (s, 9H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -66.02 (t, *J* = 10.8 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 165.0, 159.1, 153.3, 148.9, 139.2, 135.7, 131.8, 131.1, 129.4, 129.1, 129.0, 128.9, 127.1, 126.3 (q, *J* = 277.3 Hz), 125.7, 124.6, 122.8, 113.0, 60.0, 44.8, 44.7, 33.4, 31.1 (q, *J* = 28.6 Hz), 30.3, 25.0 (d, *J* = 3.0 Hz), 13.2; **IR** (thin film) ν 2965, 1716, 1664, 1602, 1468, 1277, 1255, 1103, 820, 750, 579 cm^{-1}; **MS** (ESI): *m/z* 573.2 $[M+Na]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{32}H_{33}F_3N_2O_3Na$ $[M+Na]^+$: 573.2336; Found: 573.2325.

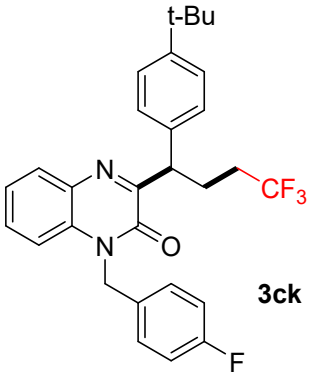
4-((3-(1-(4-(*Tert*-butyl)phenyl)-4,4,4-trifluorobutyl)-2-oxoquinoxalin-1(2*H*)-yl)methyl)benzonitrile (3cj)



3cj

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3cj** (43.3 mg, 43%) as a white solid. Mp 153-155 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.90 (dd, *J* = 7.9, 1.6 Hz, 1H), 7.48 (d, *J* = 8.0 Hz, 2H), 7.39 – 7.09 (m, 8H), 6.99 (dd, *J* = 8.3, 1.2 Hz, 1H), 5.47 (d, *J* = 16.3 Hz, 1H), 5.25 (d, *J* = 16.3 Hz, 1H), 4.62 (t, *J* = 7.8 Hz, 1H), 2.53 – 2.26 (m, 2H), 2.14 – 1.95 (m, 2H), 1.20 (s, 9H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -66.01 (t, *J* = 10.9 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 159.1, 153.2, 149.0, 139.5, 135.5, 131.8, 131.7, 130.9, 129.6, 129.2, 127.1, 126.5, 126.3 (q, *J* = 277.3 Hz), 124.6, 123.0, 117.3, 112.7, 110.7, 44.7, 44.6, 33.4, 31.0 (q, *J* = 28.6 Hz), 30.3, 25.0 (d, *J* = 3.0 Hz); **IR** (thin film) ν 2963, 2229, 1671, 1604, 1255, 1099, 962, 811, 760, 580 cm^{-1}; **MS** (ESI): *m/z* 504.2 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{30}H_{29}F_3N_3O$ $[M+H]^+$: 504.2257; Found: 504.2256.

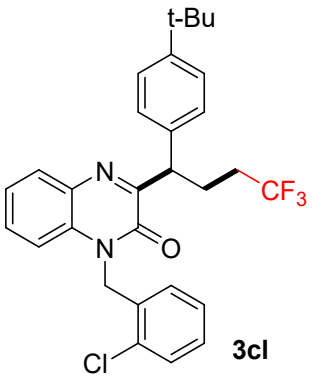
3-(1-(4-(*Tert*-butyl)phenyl)-4,4,4-trifluorobutyl)-1-(4-fluorobenzyl)quinoxalin-2(1*H*)-one (3ck)



3ck

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3ck** (39.7 mg, 40%) as a white solid. Mp 149-151 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.86 (d, *J* = 7.9 Hz, 1H), 7.43 – 6.95 (m, 9H), 6.84 (t, *J* = 8.4 Hz, 2H), 5.38 (d, *J* = 15.5 Hz, 1H), 5.28 – 5.07 (m, 1H), 4.63 (t, *J* = 7.8 Hz, 1H), 2.50 – 2.23 (m, 2H), 2.18 – 1.85 (m, 2H), 1.19 (s, 9H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ -66.04 (t, *J* = 11.0 Hz, 3F), -114.37 (m, 1F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 162.4, 159.9, 159.2, 153.4, 148.9, 135.7, 131.9, 131.2, 129.9 (d, *J* = 3.3 Hz), 129.4, 129.0, 127.7, 127.6, 127.1, 126.1 (q, *J* = 277.3 Hz), 124.6, 122.7, 114.9, 114.7, 113.0, 44.7, 44.3, 33.4, 31.1 (q, *J* = 28.5 Hz), 30.3, 25.0; **IR** (thin film) ν 2962, 1651, 1603, 1256, 1095, 1002, 820, 765, 580, 499 cm^{-1}; **MS** (ESI): *m/z* 519.2 $[M+Na]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{29}H_{28}F_4N_2ONa$ $[M+Na]^+$: 519.2030; Found: 519.2016.

3-(1-(4-(*Tert*-butyl)phenyl)-4,4,4-trifluorobutyl)-1-(2-chlorobenzyl)quinoxalin-2(1*H*)-one (3cl)

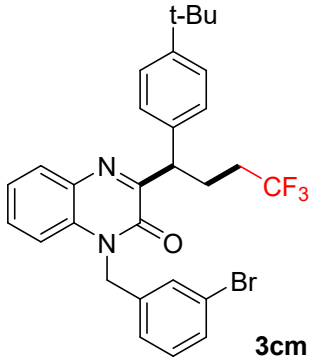


3cl

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3cl** (64.8 mg, 64%) as a white solid. Mp 182-184 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.87 (dd, *J* = 7.8, 1.7 Hz, 1H), 7.46 – 7.17 (m, 7H), 7.10 – 6.99 (m, 1H), 6.96 – 6.82 (m, 2H), 6.48 (d, *J* = 7.8 Hz, 1H), 5.47 (d, *J* = 16.8 Hz, 1H), 5.28 (d, *J* = 16.7 Hz, 1H), 4.64 (t, *J* = 7.8 Hz, 1H), 2.51 – 2.29 (m, 2H), 2.18 – 1.86 (m, 2H),

1.18 (s, 9H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -66.01 (t, *J* = 10.9 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 159.1, 153.4, 148.9, 135.7, 131.8, 131.6, 131.1, 131.0, 129.3, 129.1, 128.7, 127.7, 127.1, 126.3 (q, *J* = 277.3 Hz), 126.2, 125.7, 124.6, 122.8, 113.2, 44.7, 42.6, 33.4, 31.1 (q, *J* = 28.7 Hz), 30.3, 25.0 (d, *J* = 3.0 Hz); **IR** (thin film) ν 2963, 1655, 1604, 1447, 1258, 1099, 961, 822, 760, 582 cm^{-1}; **MS** (ESI): *m/z* 535.2 $[M+Na]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{29}H_{28}ClF_3N_2ONa$ $[M+Na]^+$: 535.1735; Found: 535.1746.

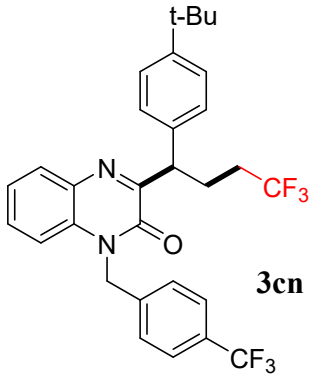
1-(3-Bromobenzyl)-3-(1-(4-(*tert*-butyl)phenyl)-4,4,4-trifluorobutyl)quinoxalin-2(1*H*)-one (3cm)



3cm

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3cm** (70.1 mg, 63%) as a white solid. Mp 157-159 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.84 (dd, *J* = 7.9, 1.6 Hz, 1H), 7.31 – 7.14 (m, 8H), 7.03 – 6.90 (m, 3H), 5.35 (d, *J* = 15.8 Hz, 1H), 5.09 (d, *J* = 15.8 Hz, 1H), 4.62 (t, *J* = 7.8 Hz, 1H), 2.49 – 2.26 (m, 2H), 2.14 – 1.90 (m, 2H), 1.17 (s, 9H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -65.95 (t, *J* = 10.9 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 159.1, 153.3, 148.9, 136.5, 135.7, 131.8, 131.0, 129.8, 129.4, 129.0, 128.8, 127.1, 126.3 (q, *J* = 277.3 Hz), 124.6, 124.4, 122.8, 121.9, 113.0, 44.7, 44.3, 33.4, 31.0 (q, *J* = 28.5 Hz), 30.3, 25.0 (d, *J* = 3.0 Hz); **IR** (thin film) ν 2965, 1647, 1601, 1256, 1099, 1002, 821, 759, 582 cm^{-1}; **MS** (ESI): *m/z* 579.1 $[M+Na]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{29}H_{28}BrF_3N_2ONa$ $[M+Na]^+$: 579.1229; Found: 579.1225.

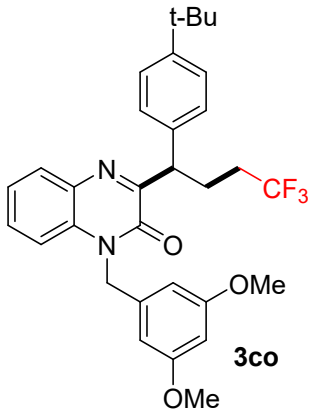
3-(1-(4-(*Tert*-butyl)phenyl)-4,4,4-trifluorobutyl)-1-(4-(trifluoromethyl)benzyl)quinoxalin-2(1*H*)-one (3cn)



3cn

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3cn** (61.2 mg, 56%) as a white solid. Mp 166-168 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.87 (dd, *J* = 8.0, 1.7 Hz, 1H), 7.41 (d, *J* = 8.0 Hz, 2H), 7.33 – 7.09 (m, 8H), 7.01 (d, *J* = 8.3 Hz, 1H), 5.45 (d, *J* = 16.1 Hz, 1H), 5.22 (d, *J* = 16.0 Hz, 1H), 4.62 (t, *J* = 7.8 Hz, 1H), 2.53 – 2.22 (m, 2H), 2.12 – 1.87 (m, 2H), 1.18 (s, 9H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ -62.63 (s, 3F), -66.02 (t, *J* = 10.8 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 159.1, 153.3, 149.0, 138.2 (d, *J* = 1.5 Hz), 135.6, 131.8, 131.0, 129.5, 129.1 (d, *J* = 3.7 Hz), 128.8, 126.3 (q, *J* = 277.3 Hz), 126.1, 124.8 (q, *J* = 3.9 Hz), 124.6, 122.9, 122.8 (q, *J* = 273.1 Hz), 112.9, 44.7, 44.48, 33.4, 31.0 (q, *J* = 28.6 Hz), 30.3, 25.1 (d, *J* = 2.9 Hz); **IR** (thin film) ν 2965, 1649, 1603, 1325, 1256, 1119, 1098, 818, 756, 584 cm^{-1}; **MS** (ESI): *m/z* 547.2 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{30}H_{29}F_6N_2O$ $[M+H]^+$: 547.2179; Found: 547.2170.

3-(1-(4-(*Tert*-butyl)phenyl)-4,4,4-trifluorobutyl)-1-(3,5-dimethoxybenzyl)quinoxalin-2(1*H*)-one (3co)

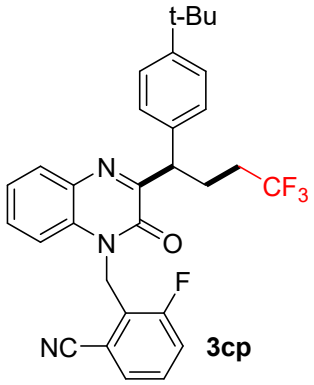


3co

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3co** (57.3 mg, 53%) as a white solid. Mp 146-148 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.84 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.29 – 7.25 (m, 3H), 7.23 – 7.18 (m, 3H), 7.14 – 7.08 (m, 1H), 6.24 – 6.08 (m, 3H), 5.23 (s, 2H), 4.63 (t, *J* = 7.8 Hz, 1H),

3.53 (s, 6H), 2.51 – 2.24 (m, 2H), 2.14 – 1.89 (m, 2H), 1.17 (s, 9H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ -65.99 (t, *J* = 10.8 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 160.1, 159.0, 153.4, 148.8, 136.5, 135.9, 131.8, 131.3, 129.2, 129.0, 127.0, 126.3 (q, *J* = 277.3 Hz), 124.5, 122.6, 113.3, 103.7, 98.2, 54.1, 44.9, 44.7, 33.4, 31.1 (q, *J* = 28.6 Hz), 30.3, 25.0 (d, *J* = 3.2 Hz); **IR** (thin film) ν 2960, 1651, 1596, 1472, 1258, 1138, 960, 822, 753, 584 cm^{-1}; **MS** (ESI): *m/z* 539.3 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{31}H_{34}F_3N_2O_3$ $[M+H]^+$: 539.2516; Found: 539.2517.

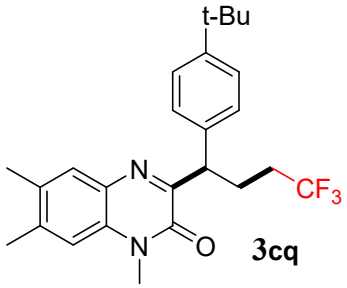
2-((3-(1-(4-(*Tert*-butyl)phenyl)-4,4,4-trifluorobutyl)-2-oxoquinoxalin-1(2*H*)-yl)methyl)-3-fluorobenzonitrile (3cp)



3cp

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3cp** (60.5 mg, 58%) as a yellow solid. Mp 184-186 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 7.8 Hz, 1H), 7.65 – 7.61 (m, 1H), 7.37 (t, *J* = 7.8 Hz, 1H), 7.31 – 7.22 (m, 5H), 6.99 – 6.90 (m, 2H), 6.41 (d, *J* = 8.8 Hz, 1H), 5.59 (d, *J* = 16.8 Hz, 1H), 5.44 (d, *J* = 16.8 Hz, 1H), 4.62 (t, *J* = 7.8 Hz, 1H), 2.55 – 2.26 (m, 2H), 2.16 – 1.96 (m, 2H), 1.19 (s, 9H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -66.04 (td, *J* = 11.7, 3.8 Hz, 3F), -100.58 (q, *J* = 8.1 Hz, 1F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 164.4 (d, *J* = 258.6 Hz), 159.1, 153.2, 149.1, 141.3 (d, *J* = 8.6 Hz), 135.4, 134.6 (d, *J* = 9.7 Hz), 131.8, 129.7, 129.5, 127.0, 126.3 (q, *J* = 277.3 Hz), 124.7, 123.3, 115.2 (d, *J* = 14.1 Hz), 114.9, 113.6 (d, *J* = 24.3 Hz), 112.4, 106.1, 44.9, 42.9, 33.4, 31.0 (q, *J* = 28.4 Hz), 30.3, 24.9 (d, *J* = 3.0 Hz); **IR** (thin film) ν 2962, 1658, 1606, 1587, 1435, 1257, 1174, 1021, 824, 760, 582 cm^{-1}; **MS** (ESI): *m/z* 522.2 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{30}H_{28}F_4N_3O$ $[M+H]^+$: 522.2163; Found: 522.2177.

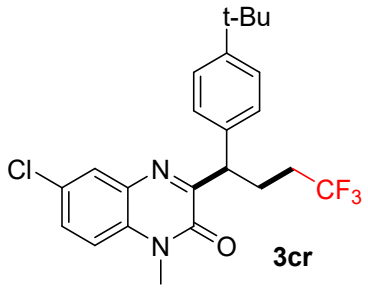
3-(1-(4-(*Tert*-butyl)phenyl)-4,4,4-trifluorobutyl)-1,6,7-trimethylquinoxalin-2(1*H*)-one (3cq)



3cq

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3cq** (39.6 mg, 46%) as a white solid. Mp 160-162 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ ppm 7.61 (s, 1H), 7.28 – 7.24 (m, 2H), 7.22 – 7.16 (m, 2H), 6.93 (s, 1H), 4.56 (t, *J* = 7.8 Hz, 1H), 3.50 (s, 3H), 2.44 – 2.37 (m, 1H), 2.31 (s, 3H), 2.28 (s, 3H), 2.26 – 2.20 (m, 1H), 2.12 – 1.87 (m, 2H), 1.18 (s, 9H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ ppm -66.11 (t, *J* = 11.0 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ ppm 157.6, 153.4, 148.6, 138.7, 136.2, 131.4, 130.0, 129.9, 129.3, 127.0, 126.3 (q, *J* = 277.3 Hz), 124.5, 113.1, 44.5, 33.4, 31.1 (q, *J* = 28.5 Hz), 30.3, 28.0, 25.1 (d, *J* = 2.9 Hz), 19.5, 18.1; **IR** (thin film) ν 2964, 1643, 1620, 1258, 1136, 995, 793, 583 cm^{-1}; **MS** (ESI): *m/z* 431.2 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{25}H_{30}F_3N_2O$ $[M+H]^+$: 431.2305; Found: 431.2302.

3-(1-(4-(*Tert*-butyl)phenyl)-4,4,4-trifluorobutyl)-6-chloro-1-methylquinoxalin-2(1*H*)-one (3cr)

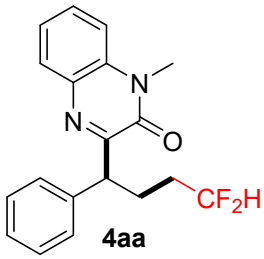


3cr

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **3cr** (36.6 mg, 42%) as a white solid. Mp 136-138 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ ppm 7.86 (d, *J* = 2.4 Hz, 1H), 7.40 (dd, *J* = 8.9, 2.5 Hz, 1H), 7.24 (q, *J* = 8.5 Hz, 4H), 7.10 (d, *J* = 8.9 Hz, 1H), 4.58 (t, *J* = 7.8 Hz, 1H), 3.52 (s, 3H), 2.45 – 2.18 (m, 2H), 2.12 – 1.84 (m, 2H), 1.19 (s, 9H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ ppm -66.11 (t, *J* = 10.9 Hz, 3F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ ppm 160.4, 153.0, 149.0, 135.4, 132.1, 130.7, 128.9, 128.5, 127.9, 127.1, 126.2 (q, *J* = 277.3 Hz), 124.6, 113.7, 44.7, 33.4, 31.0 (q, *J* = 28.6 Hz), 30.3, 28.3, 25.0 (d, *J* = 3.0 Hz); **IR** (thin film) ν 2962, 1655, 1256, 1216, 1145, 1099, 1004, 823, 797, 591 cm^{-1}; **MS** (ESI): *m/z* 437.2

[M+H]$^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{23}H_{25}ClF_3N_2O$ [M+H]$^+$: 437.1602; Found: 437.1613.

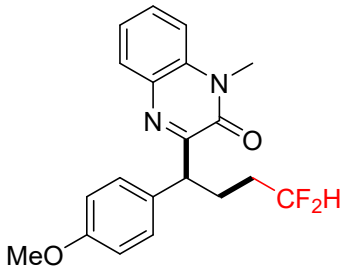
3-(4, 4-Difluoro-1-phenylbutyl)-1-methylquinoxalin-2(1*H*)-one (4aa)



4aa

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **4aa** (39.4 mg, 60%) as a yellow solid. Mp 123-125 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.83 (dd, *J* = 7.9, 1.5 Hz, 1H), 7.43 – 7.36 (m, 1H), 7.37 – 7.32 (m, 2H), 7.28 – 7.06 (m, 6H), 5.73 (tt, *J* = 56.9, 4.5 Hz, 1H), 4.59 (t, *J* = 7.8 Hz, 1H), 3.50 (s, 3H), 2.39 – 2.27 (m, 1H), 2.22 – 2.13 (m, 1H), 1.88 – 1.62 (m, 2H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ -115.59 (dt, *J* = 56.9, 17.6 Hz, 2F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 160.2, 154.4, 140.6, 133.0, 132.6, 130.2, 130.0, 128.6 (d, *J* = 4.1 Hz), 127.0, 123.6, 117.4 (t, *J* = 239.0 Hz), 113.6, 46.67, 32.4 (t, *J* = 21.0 Hz), 29.2, 26.4 (t, *J* = 5.5 Hz); **IR** (thin film) ν 2925, 1651, 1602, 1472, 1122, 957, 753, 701, 571 cm^{-1}; **MS** (ESI): *m/z* 329.1 [M+H]$^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{19}H_{19}F_2N_2O$ [M+H]$^+$: 329.1460; Found: 329.1458.

3-(4, 4-Difluoro-1-(4-methoxyphenyl)butyl)-1-methylquinoxalin-2(1*H*)-one (4da)

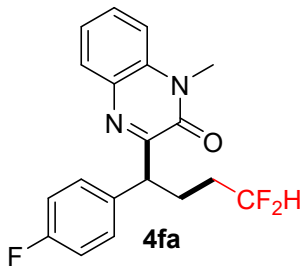


4da

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **4da** (53.0 mg, 74%) as a brown liquid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.91 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.52 – 7.47 (m, 1H), 7.42 – 7.28 (m, 3H), 7.23 (dd, *J* = 9.7, 1.5 Hz, 1H), 6.91 – 6.72 (m, 2H), 5.82 (tt, *J* = 56.9, 4.5 Hz, 1H), 4.62 (dd, *J* = 8.5, 7.2 Hz, 1H), 3.73 (s, 3H), 3.59 (s, 3H), 2.39 – 2.34 (m, 1H), 2.27 – 2.23 (m, 1H), 1.93 – 1.71 (m, 2H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ -115.53 (dt, *J* = 56.9, 17.6 Hz, 2F);

^{13}C NMR (101 MHz, $CDCl_3$) δ 160.4, 158.6, 154.4, 133.0, 132.6, 132.5, 130.0 (d, *J* = 19.5 Hz), 129.6, 127.0, 123.6, 117.4 (t, *J* = 238.9 Hz), 114.0, 113.6, 55.2, 45.8, 32.4 (t, *J* = 20.9 Hz), 29.1, 26.4 (t, *J* = 5.5 Hz); **IR** (thin film) ν 2928, 1651, 1602, 1508, 1471, 1246, 1034, 832, 752, 576 cm^{-1}; **MS** (ESI): *m/z* 359.2 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{20}H_{21}F_2N_2O_2$ $[M+H]^+$: 359.1566; Found: 359.1563.

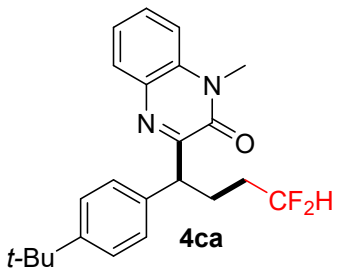
3-(4, 4-Difluoro-1-(4-fluorophenyl)butyl)-1-methylquinoxalin-2(1*H*)-one (4fa)



4fa

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **4fa** (49.8 mg, 72%) as a brown liquid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.91 (d, *J* = 7.9 Hz, 1H), 7.52 (t, *J* = 7.9 Hz, 1H), 7.43 – 7.38 (m, 2H), 7.35 (t, *J* = 7.7 Hz, 1H), 7.25 (d, *J* = 7.1 Hz, 1H), 6.96 (t, *J* = 8.2 Hz, 2H), 6.05 – 5.50 (m, 1H), 4.67 (t, *J* = 7.8 Hz, 1H), 3.61 (s, 3H), 2.41 (tt, *J* = 12.7, 6.0 Hz, 1H), 2.28 – 2.18 (m, 1H), 1.96 – 1.66 (m, 2H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -115.62 (dt, *J* = 56.9, 17.5 Hz, 2F), -115.82 (m, 1F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 161.9 (d, *J* = 245.2 Hz), 160.0, 154.4, 136.3 (d, *J* = 3.2 Hz), 133.0, 132.6, 130.2 – 130.0 (m), 123.7, 117.3 (t, *J* = 239.0 Hz), 115.5, 115.3, 113.6, 45.9, 32.3 (t, *J* = 21.0 Hz), 29.2, 26.4 (t, *J* = 5.5 Hz); **IR** (thin film) ν 2923, 1650, 1602, 1472, 1221, 1122, 834, 752, 734, 527 cm^{-1}; **MS** (ESI): *m/z* 347.1 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{19}H_{18}F_3N_2O$ $[M+H]^+$: 347.1366; Found: 347.1364.

3-(1-(4-(*Tert*-butyl)phenyl)-4,4-difluorobutyl)-1-methylquinoxalin-2(1*H*)-one (4ca)

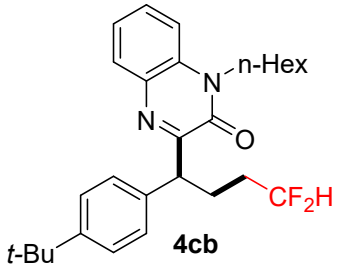


4ca

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **4ca** (46.9 mg, 61%) as a brown liquid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.82 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.42 – 7.35 (m, 1H), 7.30 – 7.18 (m, 5H), 7.15 – 7.09

(m, 1H), 5.73 (tt, *J* = 56.9, 4.5 Hz, 1H), 4.58 (t, *J* = 7.8 Hz, 1H), 3.50 (s, 3H), 2.37 – 2.25 (m, 1H), 2.23 – 2.10 (m, 1H), 1.84 – 1.62 (m, 2H), 1.17 (s, 9H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ -115.51 (dt, *J* = 56.9, 17.6 Hz, 2F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 160.4, 154.5, 149.7, 137.4, 133.0, 132.7, 130.1, 129.9, 128.2, 125.5, 123.5, 117.4 (t, *J* = 239.0 Hz), 113.5, 46.1, 34.4, 32.4 (t, *J* = 20.9 Hz), 31.4, 29.1, 26.4 (t, *J* = 5.5 Hz); **IR** (thin film) ν 2962, 1655, 1603, 1471, 1122, 1025, 931, 831, 756, 584 cm^{-1}; **MS** (ESI): *m/z* 385.2 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{23}H_{27}F_2N_2O$ $[M+H]^+$: 385.2086; Found: 385.2085.

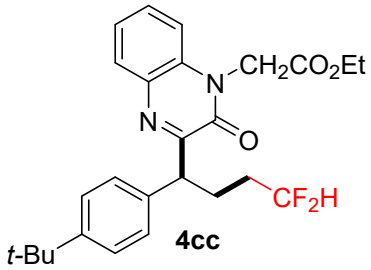
3-(1-(4-(*Tert*-butyl)phenyl)-4,4-difluorobutyl)-1-hexylquinoxalin-2(1*H*)-one (4cb)



4cb

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **4cb** (49.1 mg, 54%) as a white solid. Mp 130-132 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 7.9 Hz, 1H), 7.49 (t, *J* = 8.1 Hz, 1H), 7.37 – 7.23 (m, 6H), 6.19 – 5.42 (m, 1H), 4.67 (t, *J* = 7.8 Hz, 1H), 4.23 (dt, *J* = 15.1, 7.9 Hz, 1H), 4.07 (dt, *J* = 14.2, 7.8 Hz, 1H), 2.40 (tt, *J* = 12.6, 6.3 Hz, 1H), 2.29 – 2.24 (m, 1H), 1.89 – 1.75 (m, 2H), 1.67 (dd, *J* = 15.7, 8.0 Hz, 3H), 1.43 – 1.28 (m, 5H), 1.26 (s, 9H), 0.91 – 0.79 (m, 3H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -115.52 (dt, *J* = 57.0, 17.5 Hz, 2F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 160.5, 154.2, 149.6, 137.5, 132.9, 132.2, 130.4, 129.8, 128.1, 125.5, 123.3, 117.4 (t, *J* = 239.0 Hz), 113.5, 45.9, 42.5, 34.4, 32.5 (t, *J* = 20.9 Hz), 31.4, 31.3, 27.2, 26.7, 26.5 (t, *J* = 5.4 Hz), 22.6, 13.9; **IR** (thin film) ν 2960, 1650, 1603, 1468, 1121, 1023, 757, 587, 443 cm^{-1}; **MS** (ESI): *m/z* 455.3 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{28}H_{37}F_2N_2O$ $[M+H]^+$: 455.2868; Found: 455.2867.

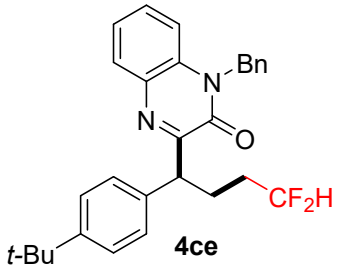
Ethyl 2-(3-(1-(4-(*tert*-butyl)phenyl)-4,4-difluorobutyl)-2-oxoquinoxalin-1(2*H*)-yl)acetate (4cc)



4cc

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **4cc** (48.4 mg, 53%) as a brown liquid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.86 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.46 (t, *J* = 7.7 Hz, 1H), 7.30 – 7.23 (m, 3H), 7.23 – 7.18 (m, 2H), 6.94 (dd, *J* = 8.4, 1.2 Hz, 1H), 5.74 (tt, *J* = 56.9, 4.5 Hz, 1H), 4.97 (d, *J* = 17.3 Hz, 1H), 4.73 (d, *J* = 17.3 Hz, 1H), 4.56 (dd, *J* = 8.4, 7.2 Hz, 1H), 4.20 – 3.98 (m, 2H), 2.45 – 2.36 (m, 1H), 2.31 – 2.22 (m, 1H), 1.87 – 1.63 (m, 2H), 1.18 (s, 9H), 1.11 (t, *J* = 7.1 Hz, 3H); **^{19}F NMR** (376 MHz, $CDCl_3$) δ -115.58 (dt, *J* = 56.9, 17.5 Hz, 2F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 167.1, 160.3, 154.1, 149.7, 137.1, 132.7, 132.2, 130.5, 130.1, 128.2, 125.5, 123.9, 117.4 (t, *J* = 239.0 Hz), 113.0, 62.0, 46.2, 43.6, 34.4, 32.4 (t, *J* = 21.0 Hz), 31.4, 26.4 (t, *J* = 5.5 Hz), 14.1; **IR** (thin film) ν 2963, 1749, 1658, 1604, 1469, 1203, 1121, 755, 582 cm^{-1}; **MS** (ESI): *m/z* 457.2 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{26}H_{31}F_2N_2O_3$ $[M+H]^+$: 457.2297; Found: 457.2298.

1-Benzyl-3-(1-(4-(*tert*-butyl)phenyl)-4,4-difluorobutyl)quinoxalin-2(1*H*)-one (4ce)

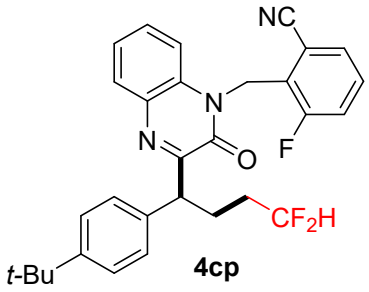


4ce

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 15:1) to afford **4ce** (58.9 mg, 64%) as a yellow solid. Mp 137-139 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 7.8 Hz, 1H), 7.42 – 7.33 (m, 3H), 7.32 – 7.15 (m, 8H), 7.12 (d, *J* = 7.3 Hz, 2H), 6.02 – 5.65 (m, 1H), 5.52 (d, *J* = 15.7 Hz, 1H), 5.25 (d, *J* = 15.7 Hz, 1H), 4.73 (t, *J* = 7.8 Hz, 1H), 2.48 – 2.39 (m, 1H), 2.35 – 2.25 (m, 1H), 1.95 – 1.27 (m, 2H), 1.27 (s, 9H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -115.45 (dt, *J* = 56.9, 17.8 Hz, 2F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 160.7, 154.6, 149.8, 137.4, 135.3, 132.9, 132.4, 130.3, 129.9, 128.9, 128.2, 127.7, 126.9, 125.5, 123.6, 117.5 (t, *J* = 239.0 Hz), 114.3, 46.1 (d, *J* = 20.6 Hz), 34.5, 32.5 (t, *J* = 20.9 Hz), 31.4, 26.4 (t, *J* = 5.4 Hz); **IR** (thin film) ν 2964, 1654, 1603, 1455, 1122, 909, 733, 583, 421 cm^{-1}; **MS** (ESI): *m/z*

461.2 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{29}H_{31}F_2N_2O$ $[M+H]^+$: 461.2399; Found: 461.2401.

2-((3-(1-(4-(*Tert*-butyl)phenyl)-4,4-difluorobutyl)-2-oxoquinoxalin-1(2*H*)-yl)methyl)-3-fluorobenzonitrile (4cp)

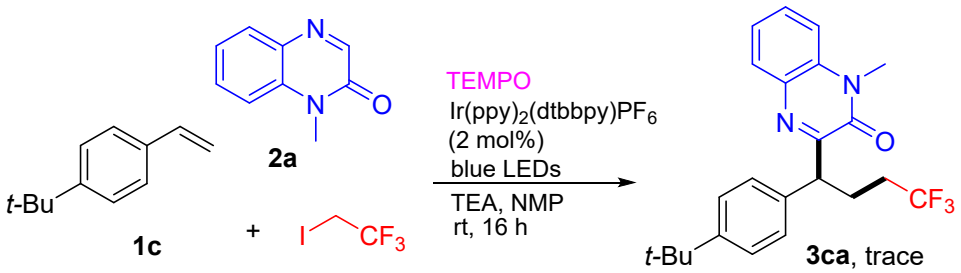


4cp

The product mixture was purified by silica gel column chromatography (PE/EtOAc = 10:1) to afford **4cp** (49.1 mg, 48%) as a white solid. Mp 176-178 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.99 (d, *J* = 7.9 Hz, 1H), 7.71 (dd, *J* = 8.7, 5.3 Hz, 1H), 7.43 (t, *J* = 7.8 Hz, 1H), 7.38 – 7.25 (m, 5H), 7.15 – 6.91 (m, 2H), 6.57 – 6.36 (m, 1H), 5.85 (tt, *J* = 56.7, 4.5 Hz, 1H), 5.66 (d, *J* = 16.8 Hz, 1H), 5.52 (d, *J* = 16.8 Hz, 1H), 4.70 (t, *J* = 7.8 Hz, 1H), 2.46 (tt, *J* = 12.4, 6.3 Hz, 1H), 2.36 – 2.27 (m, 1H), 1.99 – 1.79 (m, 2H), 1.27 (s, 9H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ -100.59 (td, *J* = 8.4, 5.6 Hz, 2F), -115.52 (dt, *J* = 56.9, 17.6 Hz, 1F); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 165.4 (d, *J* = 258.3 Hz), 160.6, 154.3, 149.9, 142.4 (d, *J* = 8.6 Hz), 136.9, 135.6 (d, *J* = 9.5 Hz), 132.9, 131.6, 130.7, 130.4, 128.1, 125.6, 124.3, 117.4 (t, *J* = 239.0 Hz), 116.4 – 115.8 (m), 114.7 (d, *J* = 24.3 Hz), 113.5, 107.1 (d, *J* = 3.6 Hz), 46.4, 43.9, 34.4, 32.4 (t, *J* = 20.9 Hz), 31.3, 26.2 (t, *J* = 5.4 Hz); **IR** (thin film) ν 2963, 2228, 1658, 1606, 1123, 932, 831, 758, 586 cm^{-1}; **MS** (ESI): *m/z* 504.2 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{30}H_{29}F_3N_3O$ $[M+H]^+$: 504.2257; Found: 504.2258.

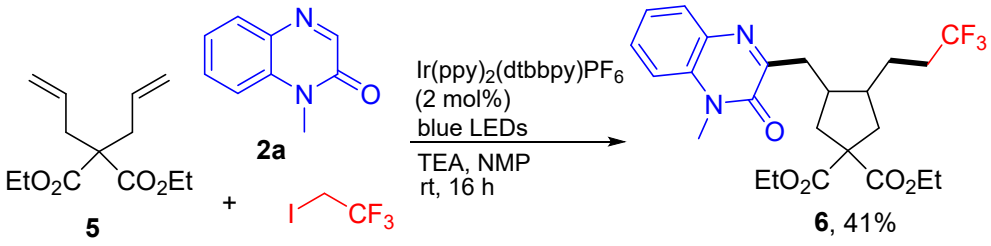
4. Control Experiments

Radical Inhibition Experiments



To a sealed tube equipped with a stir bar were added **2a** (0.2 mmol, 1.0 equiv), $Ir(ppy)_2(dtbbpy)PF_6$ (3.7 mg, 0.004 mmol, 2 mol %) and TEMPO (125.0mg, 0.8 mmol, 4.0 equiv). The tube was evacuated and backfilled with pure N_2 for three times. Afterwards, NMP (0.5 mL), 4-*tert*-Butylstyrene **1c** (2.5 equiv, 0.5 mmol), ICH_2CF_3 (2.0 equiv, 0.4 mmol) and TEA (3.0 equiv, 0.6 mmol) were added by syringe under N_2 atmosphere. The tightly sealed tube was then irradiated with a 20 W blue LEDs (the distance between the tube and the light source was about 7 cm) and simultaneously cooled by a fan to keep the reaction temperature at 25 °C. After 16 hours, the mixture was transferred into a 125 mL separating funnel which contained 20 mL H_2O. The mixture was extracted with DCM (20 mL each) for three times and the combined organic layer was washed with brine (20 mL) once and dried by Na_2SO_4. After filtration, the filtrate was concentrated under reduced pressure to give the crude product. The ^{19}F NMR spectroscopy of the crude product indicated that only trace of product **3ca** was formed.

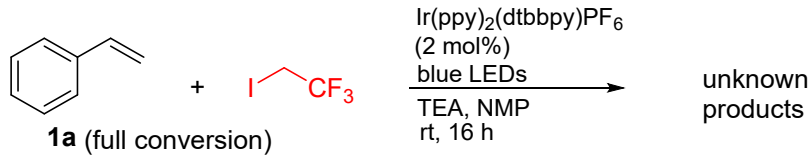
Radical Clock Experiments



To a sealed tube equipped with a stir bar were added **2a** (0.2 mmol, 1.0 equiv), $Ir(ppy)_2(dtbbpy)PF_6$ (3.7 mg, 0.004 mmol, 2 mol %). The tube was evacuated and backfilled with pure N_2 for three times. Afterwards, NMP (0.5 mL), Diethyl 2,2-Diallylmalonate **5** (2.5 equiv, 0.5 mmol), ICH_2CF_3 (2.0 equiv, 0.4 mmol) and TEA

(3.0 equiv, 0.6 mmol) were added by syringe under N_2 atmosphere. The tightly sealed tube was then irradiated with a 20 W blue LEDs (the distance between the tube and the light source was about 7 cm) and simultaneously cooled by a fan to keep the reaction temperature at 25 °C. After 16 hours, the mixture was transferred into a 125 mL separating funnel which contained 20 mL H_2O. The mixture was extracted with DCM (20 mL each) for three times and the combined organic layer was washed with brine (20 mL) once and dried by Na_2SO_4. After filtration, the filtrate was concentrated under reduced pressure to give the crude product, which was purified by flash chromatography on silica gel (PE/EtOAc = 10: 1) to give the product **6** (39.6 mg, 41%) as a brown liquid. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.72 (d, *J* = 7.8 Hz, 1H), 7.45 (t, *J* = 7.7 Hz, 1H), 7.24 (dd, *J* = 16.0, 8.0 Hz, 2H), 4.11 (s, 4H), 3.61 (s, 3H), 3.01 – 2.85 (m, 1H), 2.83 – 2.63 (m, 2H), 2.41 (dd, *J* = 14.0, 6.4 Hz, 1H), 2.28 (dd, *J* = 10.8, 6.1 Hz, 1H), 2.18 – 2.00 (m, 5H), 1.80 – 1.60 (m, 1H), 1.52 – 1.36 (m, 1H), 1.16 (q, *J* = 7.2 Hz, 6H); **^{19}F NMR** (377 MHz, $CDCl_3$) δ-66.34 (t, *J* = 10.9 Hz); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 172.5 (d, *J* = 10.5 Hz), 159.4, 154.8, 133.0, 132.6, 129.8, 127.2 (q, *J* = 276.4 Hz), 123.5, 113.6, 61.6, 61.5, 58.7, 41.3, 39.0, 38.4, 38.1, 33.1, 32.5 (q, *J* = 28.5 Hz), 29.0, 21.5 (d, *J* = 2.9 Hz), 14.0; **IR** (thin film) ν 2981, 1726, 1652, 1602, 1473, 1250, 1035, 860, 754, 561, 459 cm^{-1}; **MS** (ESI): *m/z* 483 $[M+H]^+$; **HRMS** (ESI-TOF): *m/z* Calculated for $C_{24}H_{30}F_3N_2O_5$ $[M+H]^+$: 483.2101; Found: 483.2103.

*Two-Component reaction of **1a** and ICH_2CF_3*

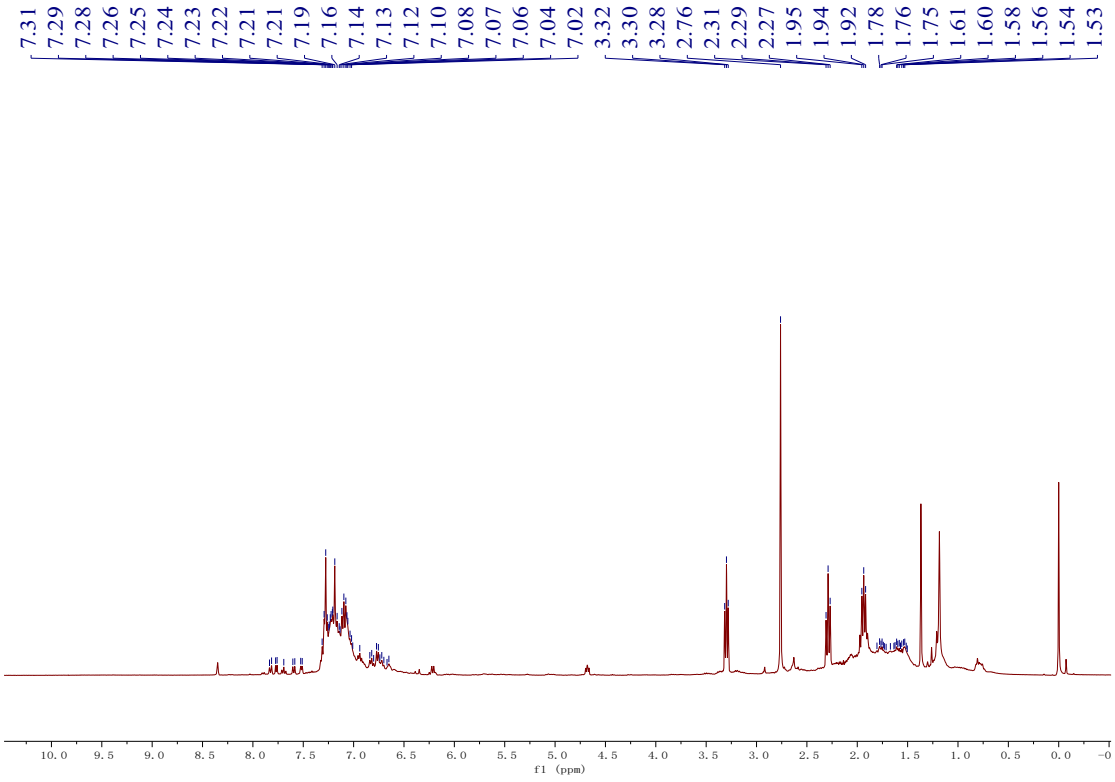


1a (full conversion)

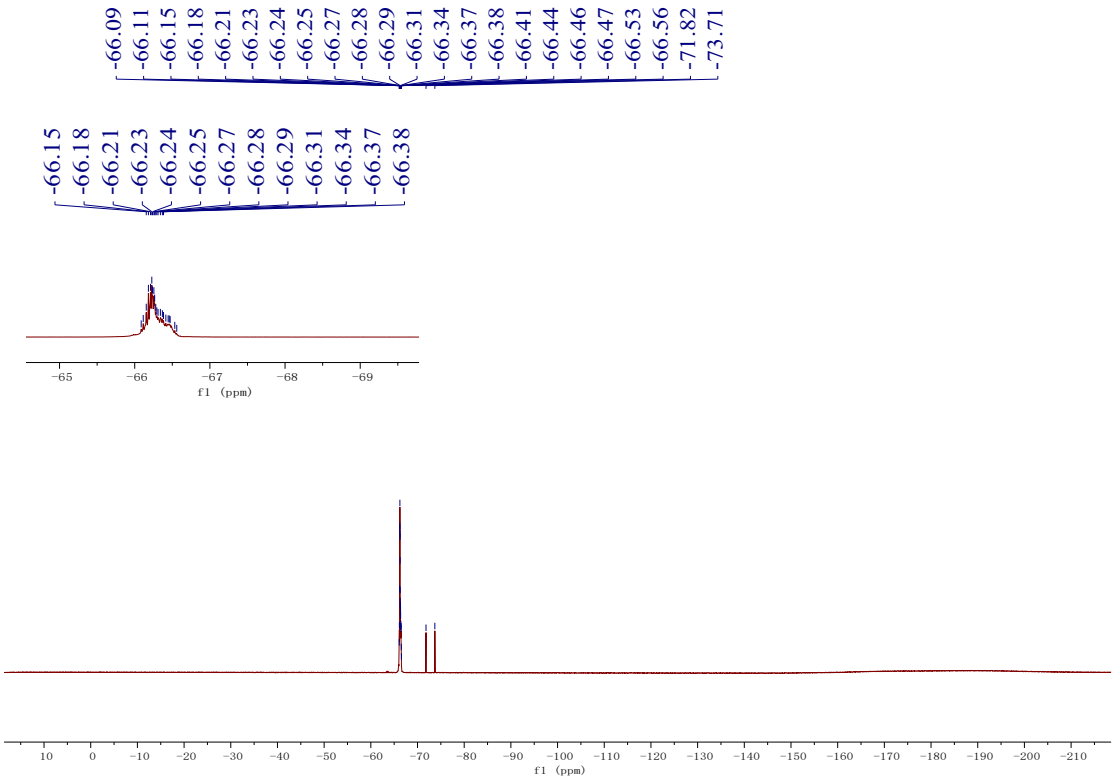
To a sealed tube equipped with a stir bar was added $Ir(ppy)_2(dtbbpy)PF_6$ (3.7 mg, 0.004 mmol, 2 mol %). The tube was evacuated and backfilled with pure N_2 for three times. Afterwards, NMP (0.5 mL), styrene **1a** (2.5 equiv, 0.5 mmol), ICH_2CF_3 (2.0 equiv, 0.4 mmol) and TEA (3.0 equiv, 0.6 mmol) were added by syringe under N_2 atmosphere. The tightly sealed tube was then irradiated with a 20 W blue LEDs (the distance between the tube and the light source was about 7 cm) and simultaneously cooled by a fan to keep the reaction temperature at 25 °C. After 16 hours, the mixture was transferred into a 125 mL separating funnel which contained 20 mL H_2O. The mixture was extracted with DCM (20 mL each) for three times and the combined organic layer was washed with brine (20 mL) once and dried by Na_2SO_4. After

filtration, the filtrate was concentrated under reduced pressure to give the crude product. Styrene **1a** was completely converted to unknown products.

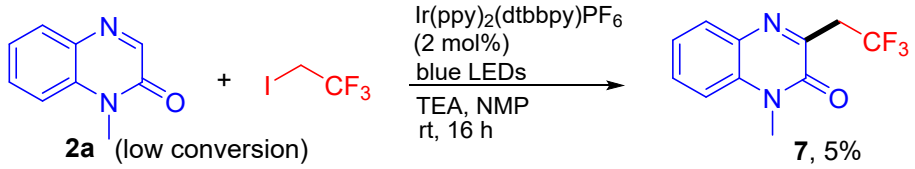
^{1}H NMR (400 MHz, $CDCl_3$)



^{19}F NMR (377 MHz, $CDCl_3$)

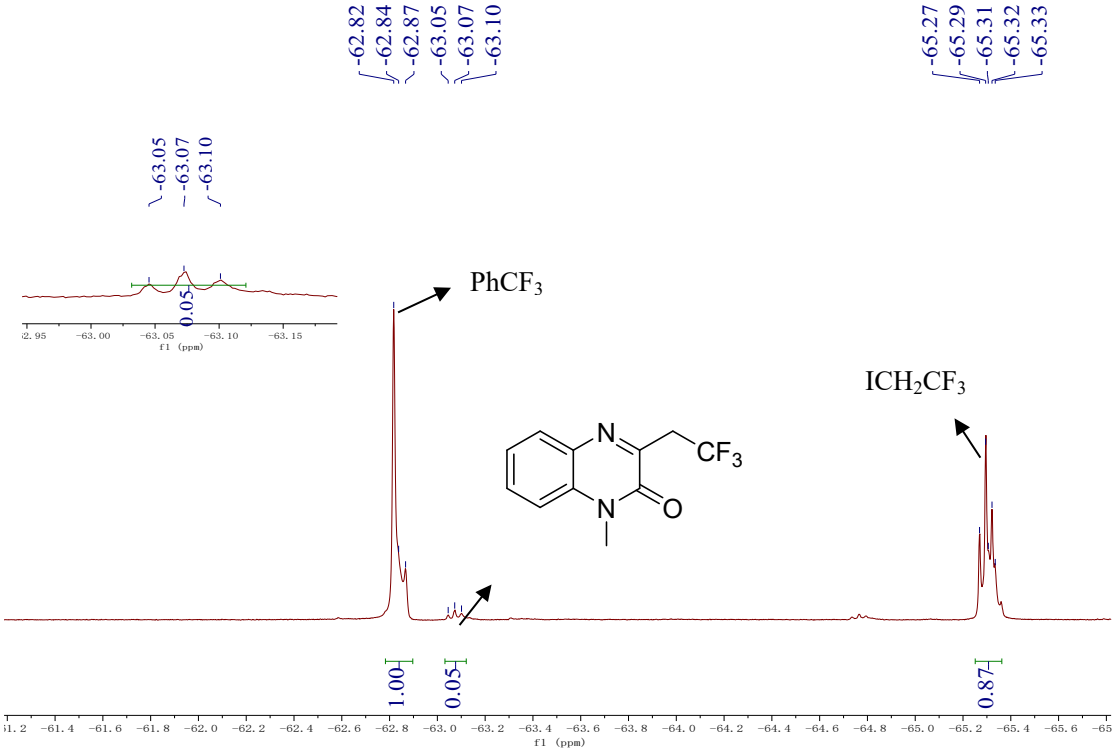


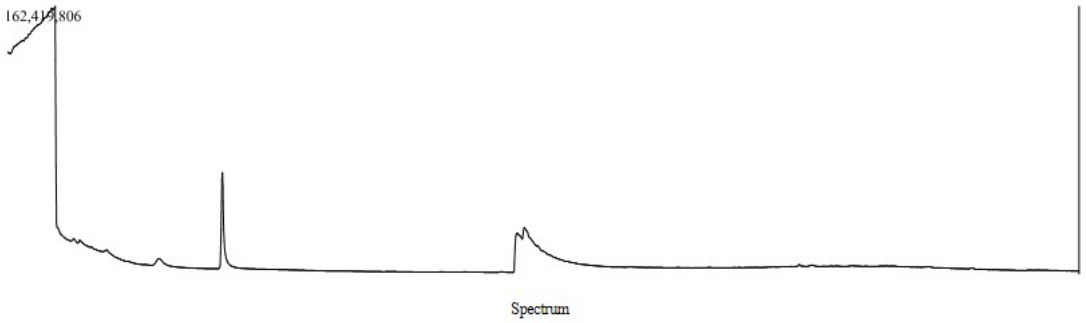
*Two-Component reaction of **2a** and ICH_2CF_3*

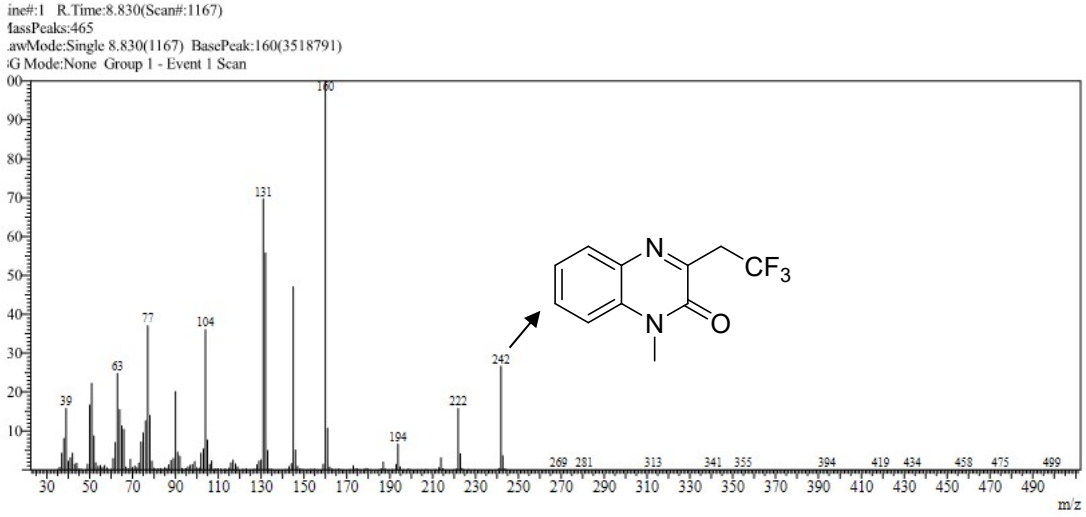


To a sealed tube equipped with a stir bar were added **2a** (0.2 mmol, 1.0 equiv) and $Ir(ppy)_2(dtbbpy)PF_6$ (3.7 mg, 0.004 mmol, 2 mol %). The tube was evacuated and backfilled with pure N_2 for three times. Afterwards, NMP (0.5 mL), ICH_2CF_3 (3.0 equiv, 0.6 mmol) and TEA (3.0 equiv, 0.6 mmol) were added by syringe under N_2 atmosphere. The tightly sealed tube was then irradiated with a 20 W blue LEDs (the distance between the tube and the light source was about 7 cm) and simultaneously cooled by a fan to keep the reaction temperature at 25 ℃. After 16 hours, the reaction mixture was monitored by TLC, ^{19}F NMR, and GC-MS. The TLC indicated that most of **2a** was not converted, whereas ^{19}F NMR[8] and GC-MS showed that trace of product **7** was formed.

^{19}F NMR (377 MHz, $CDCl_3$)

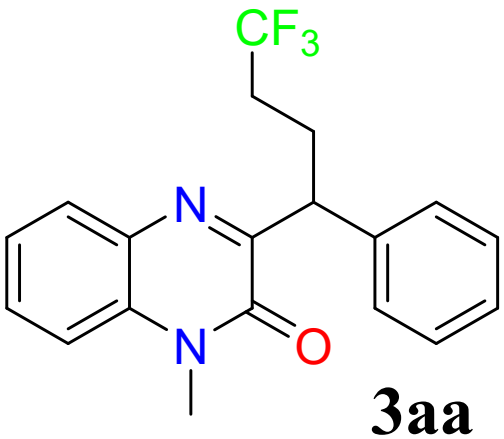



162,419,806
Spectrum

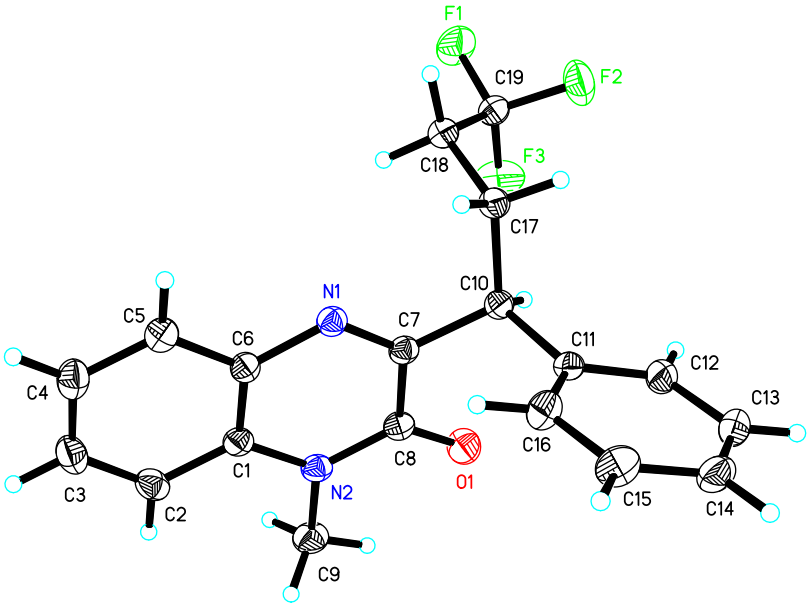

ine#:1 R.Time:8.830(Scan#:1167)
lassPeaks:465
awMode:Single 8.830(1167) BasePeak:160(3518791)
G Mode:None Group 1 - Event 1 Scan
160
131
77
104
63
39
242
222
194
N
CF3
N
O
m/z

5. ORTEP Drawing of the X-Ray Crystallographic Structure of Product 3aa

The crystals were obtained from a solution of Toluene slow volatilization. The X-ray intensity data were measured at 213(2) K



3aa



The crystal structure has been deposited at the Cambridge Crystallographic Date Center and allocated the deposition number CCDC 2100730

This data can be obtained free of charge from the Cambridge Crystallographic Date Center via www.ccdc.cam.ac.uk/data_request/cif

Crystal data and structure refinement for 3aa

Identification code	**3aa**	
Empirical formula	C19 H17 F3 N2 O	
Formula weight	346.34	
Temperature	213(2) K	
Wavelength	0.71073 Å	
Crystal system	Monoclinic	
Space group	P 21/n	
Unit cell dimensions	a = 11.9256(4) Å	a= 90°.
	b = 11.4661(4) Å	b= 108.6160(10)°.
	c = 12.6607(4) Å	g = 90°.
Volume	1640.65(10) $Å^3$	
Z	4	
Density (calculated)	1.402 Mg/m^3	
Absorption coefficient	0.111 mm^{-1}	
F(000)	720	
Crystal size	0.190 x 0.150 x 0.110 mm^3	
Theta range for data collection	3.353 to 26.000°.	
Index ranges	-14<=h<=13, -11<=k<=14, -15<=l<=15	
Reflections collected	8037	
Independent reflections	3205 [R(int) = 0.0222]	
Completeness to theta = 25.242°	99.1 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.7456 and 0.6765	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	3205 / 0 / 228	
Goodness-of-fit on F^2	1.033	
Final R indices [I>2sigma(I)]	R1 = 0.0399, wR2 = 0.0881	
R indices (all data)	R1 = 0.0528, wR2 = 0.0980	
Extinction coefficient	0.025(4)	
Largest diff. peak and hole	0.219 and -0.269 $e.Å^{-3}$	

6. References

(1) M. Mato, B. Herle and A. M. Echavarren, Cyclopropanation by Gold- or Zinc-Catalyzed Retro-Buchner Reaction at Room Temperature, *Org. Lett.*, 2018**, 20**, 4341-4345.

(2) M. Schedler, D. S. Wang and F. Glorius, NHC-catalyzed hydroacylation of styrenes. *Angew. Chem. Int. Ed.*, 2013**, 52**, 2585-2589.

(3) Y. Liu, H. Wu, Y. Guo, J.-C. Xiao, Q.-Y. Chen and C. Liu, Trifluoromethylfluorosulfonylation of Unactivated Alkenes Using Readily Available $Ag(O_2CCF_2SO_2F)$ and N-Fluorobenzenesulfonimide. *Angew. Chem. Int. Ed.*, 2017**, 56**, 15432-15435.

(4) S. Liu, Y. Huang, F.-L. Qing and X.-H. Xu, Transition-Metal-Free Decarboxylation of 3,3,3-Trifluoro-2,2-dimethylpropanoic Acid for the Preparation of $C(CF_3)Me_2$-Containing Heteroarenes. *Org. Lett.*, 2018, **20**, 5497-5501.

(5) J. Xu, H. Yang, H. Cai, H. Bao, W. Li and P. Zhang, Transition-Metal and Solvent-Free Oxidative C-H Fluoroalkoxylation of Quinoxalinones with Fluoroalkyl Alcohols. *Org. Lett.*, 2019, **21**, 4698-4702.

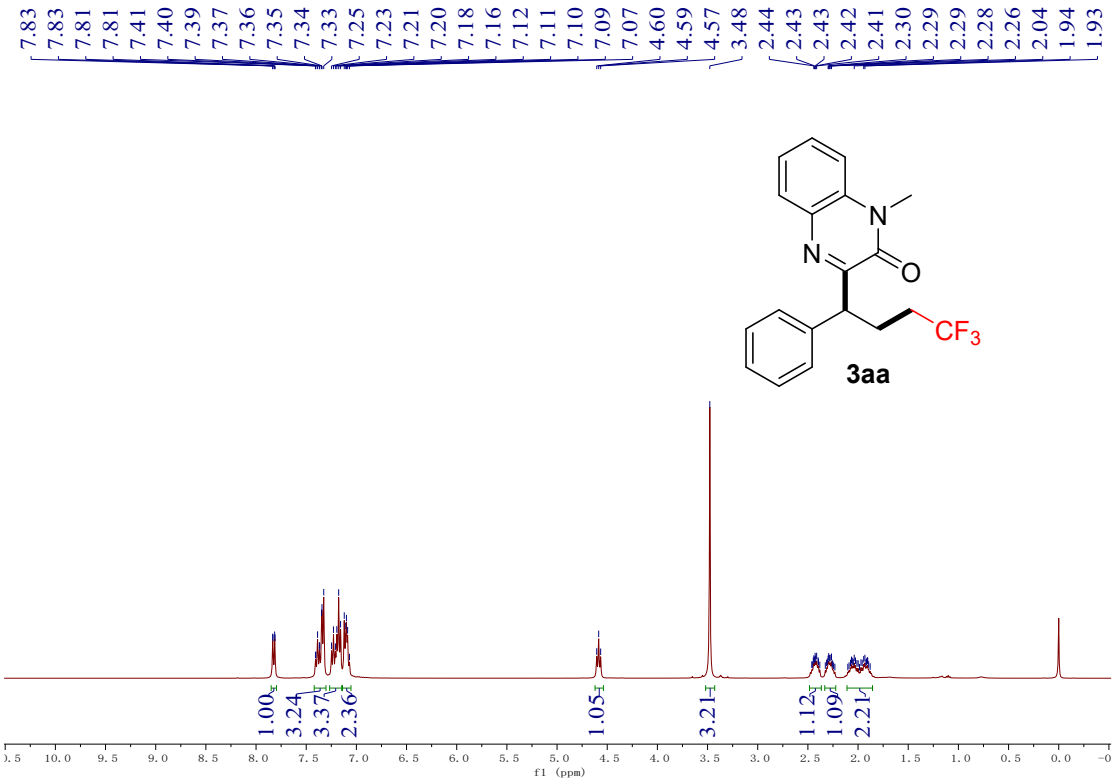
(6) H.-Y. Su, X.-L. Zhu, Y. Huang, X.-H. Xu, and F.-L. Qing, Copper-catalyzed chemoselective C-H functionalization of quinoxalin-2(1*H*)-ones with hexafluoroisopropanol. *Chem. Commun.*, 2020, **56**, 12805-12808.

(7) J. Wang, B. Sun, L. Zhang, T. Xu, Y. Xie and C. Jin, Transition-metal-free direct C-3 cyanation of quinoxalin-2(1H)-ones with ammonium thiocyanate as the "CN" source. *Org. Chem. Front.*, 2020, **7**, 113-118.

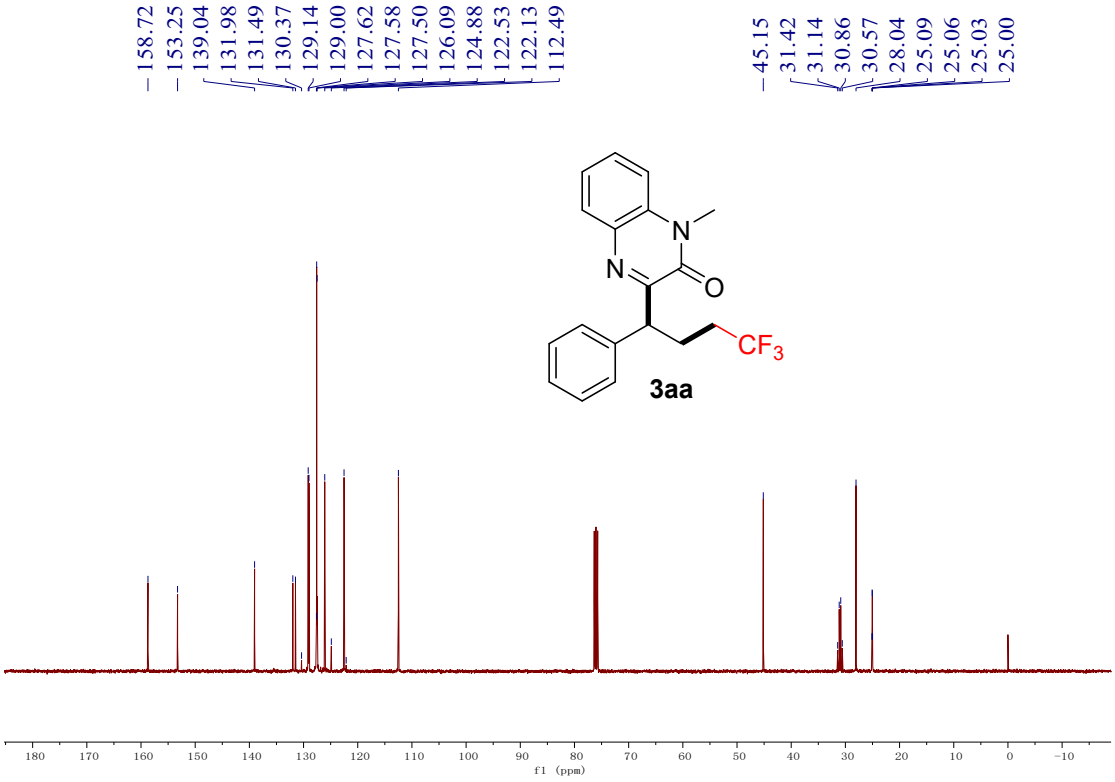
(8) T. Yang, H. Zhu and W. Yu, Copper-catalyzed radical reactions of 2-azido-N-arylacrylamides with 1-(trifluoromethyl)-1,2-benziodoxole and 1-azidyl-1,2-benziodoxole. *Org. Chem. Chem.*, 2016, **14**, 3376-3384.

7. Copies of ^{1}H NMR, ^{19}F NMR and ^{13}C NMR Spectra of Products

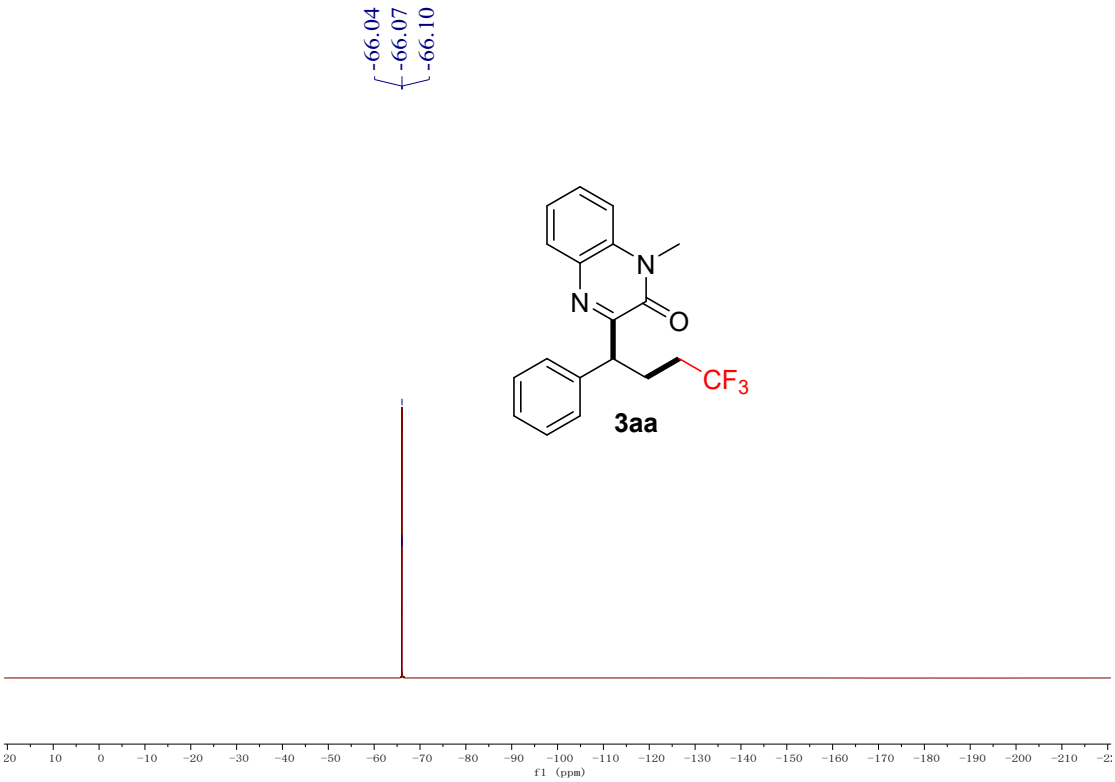
^{1}H NMR (400 MHz, $CDCl_3$)



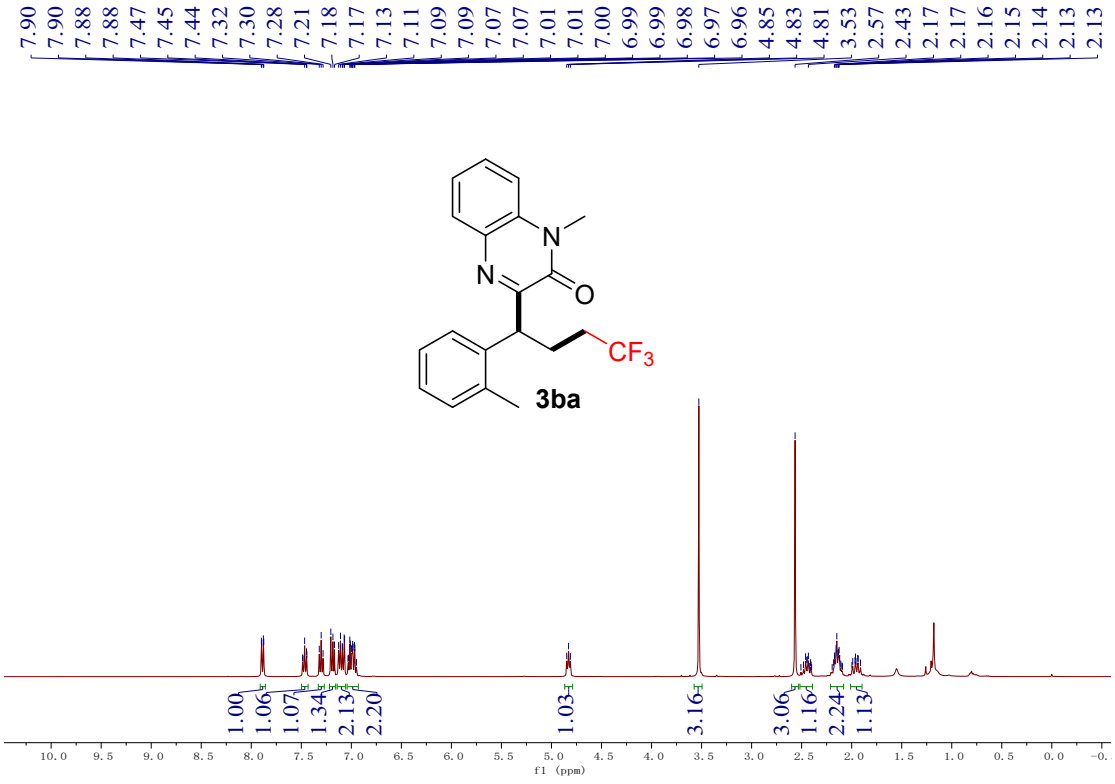
^{13}C NMR (101 MHz, $CDCl_3$)



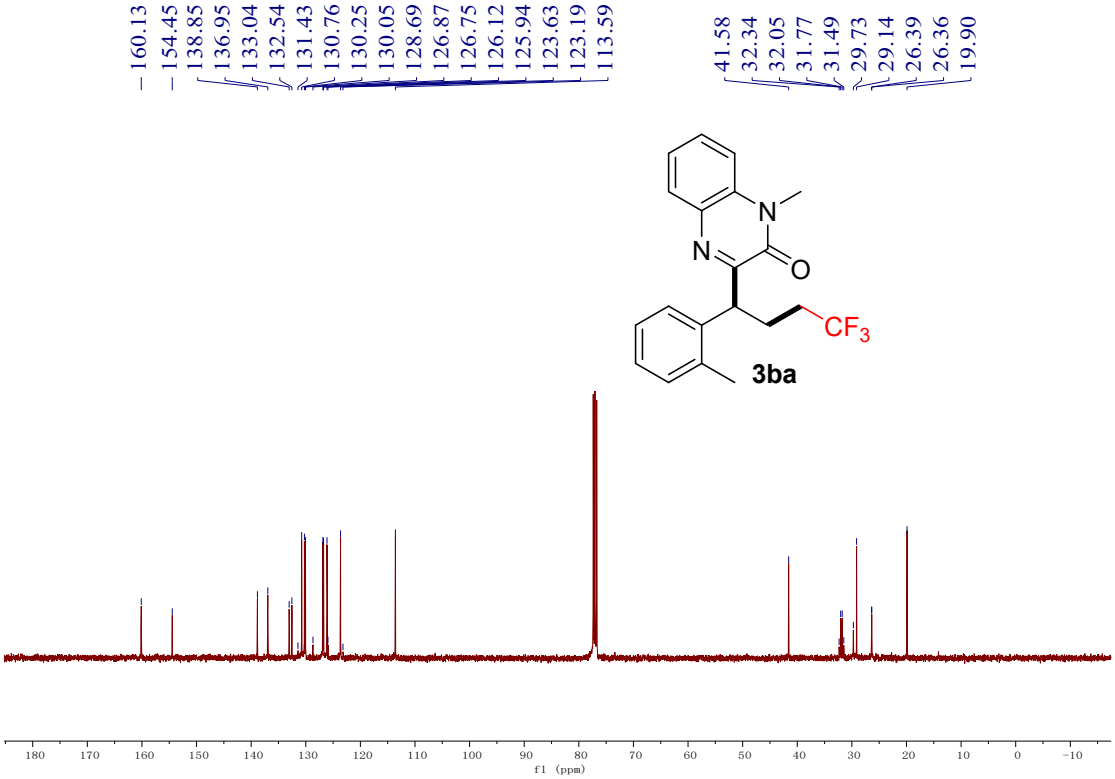
^{19}F NMR (377 MHz, $CDCl_3$)



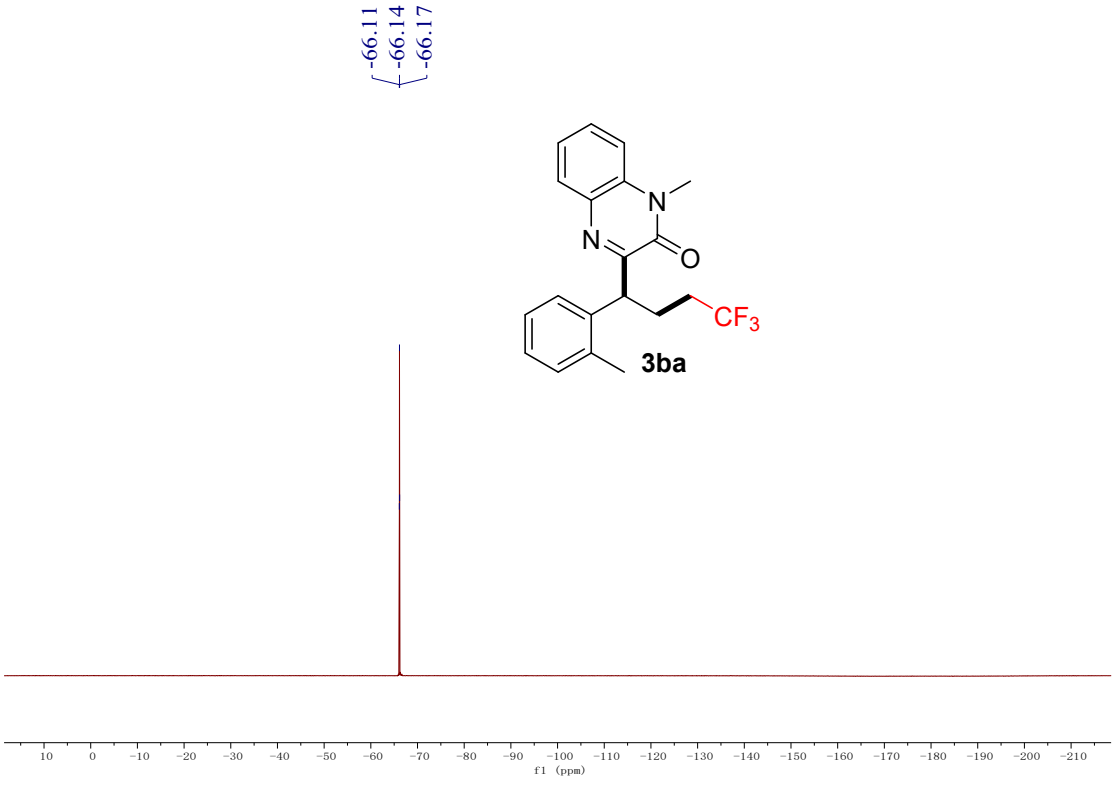
^{1}H NMR (400 MHz, $CDCl_3$)



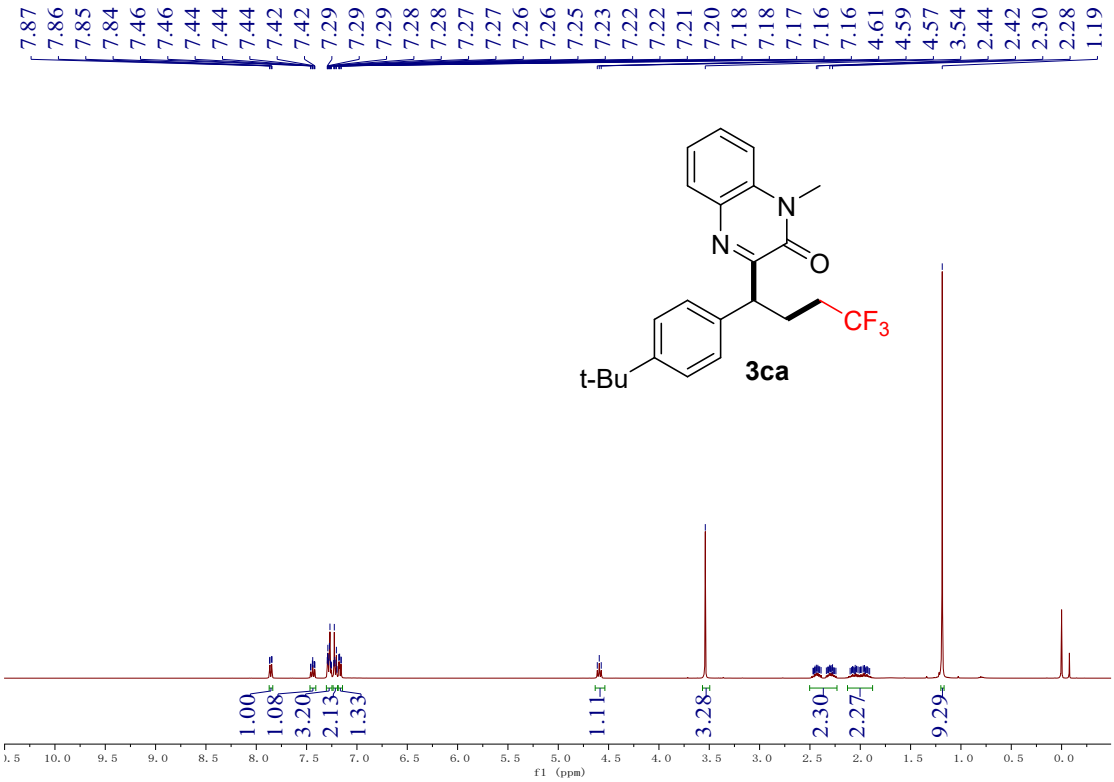
^{13}C NMR (101 MHz, $CDCl_3$)



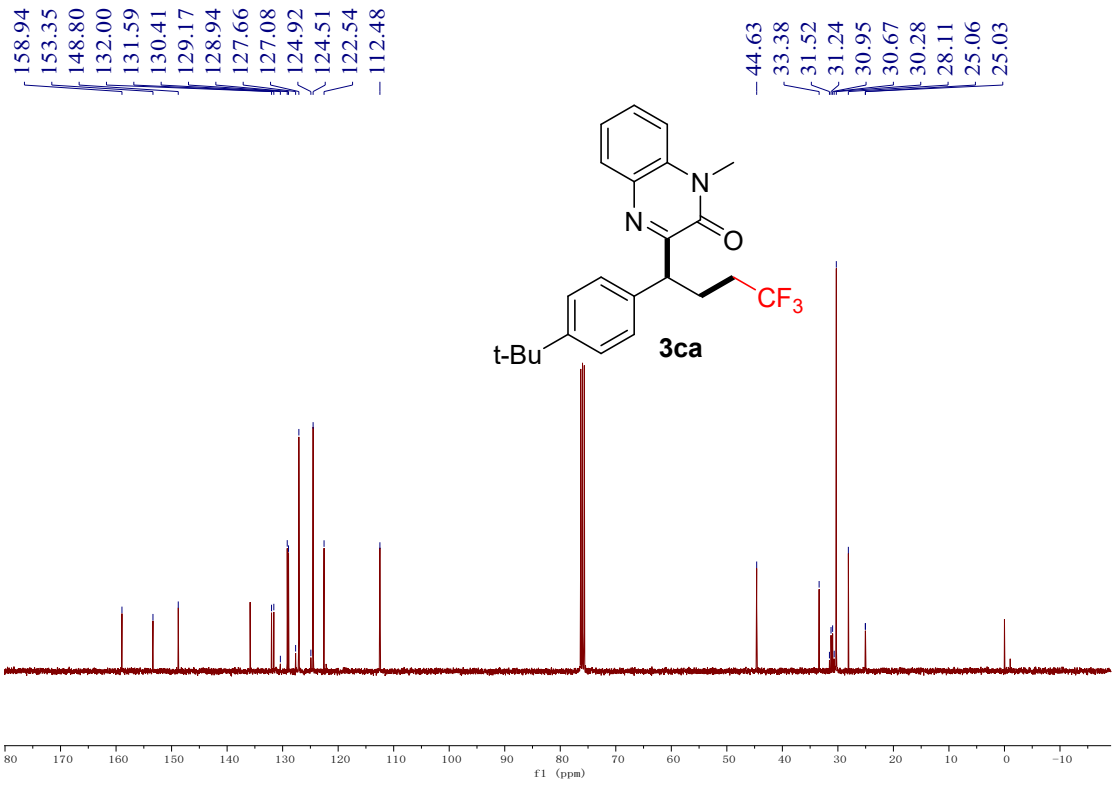
^{19}F NMR (377 MHz, $CDCl_3$)



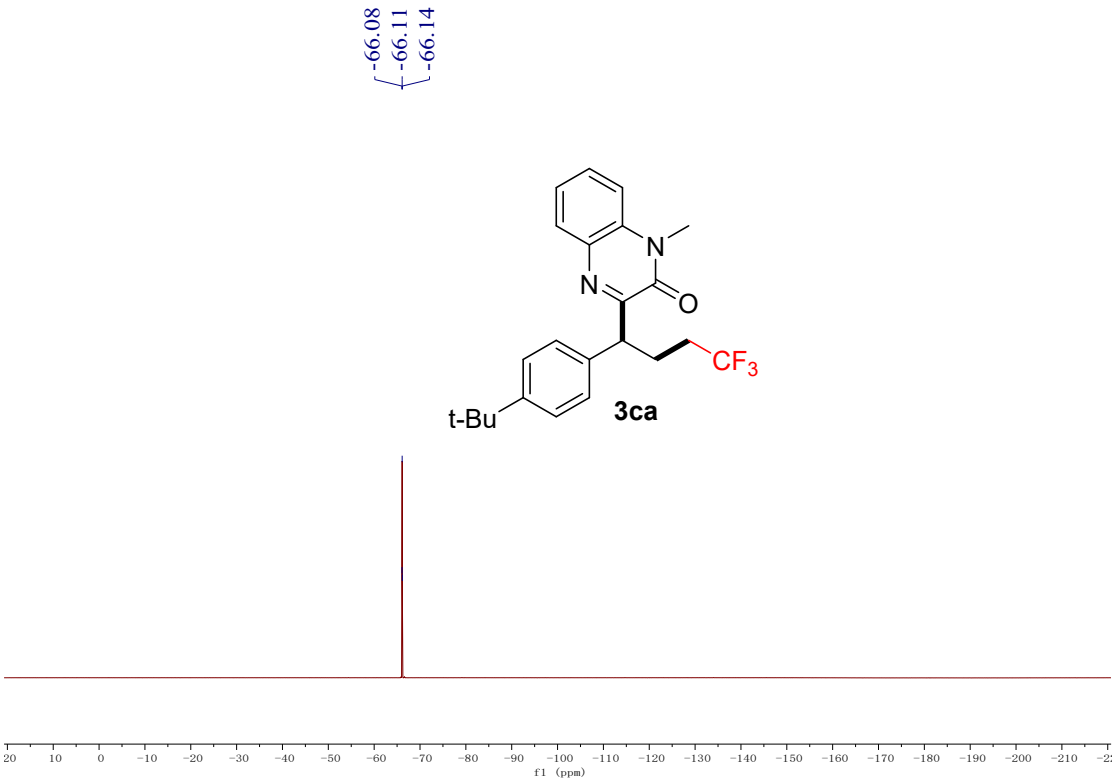
[1]H NMR (400 MHz, $CDCl_3$)



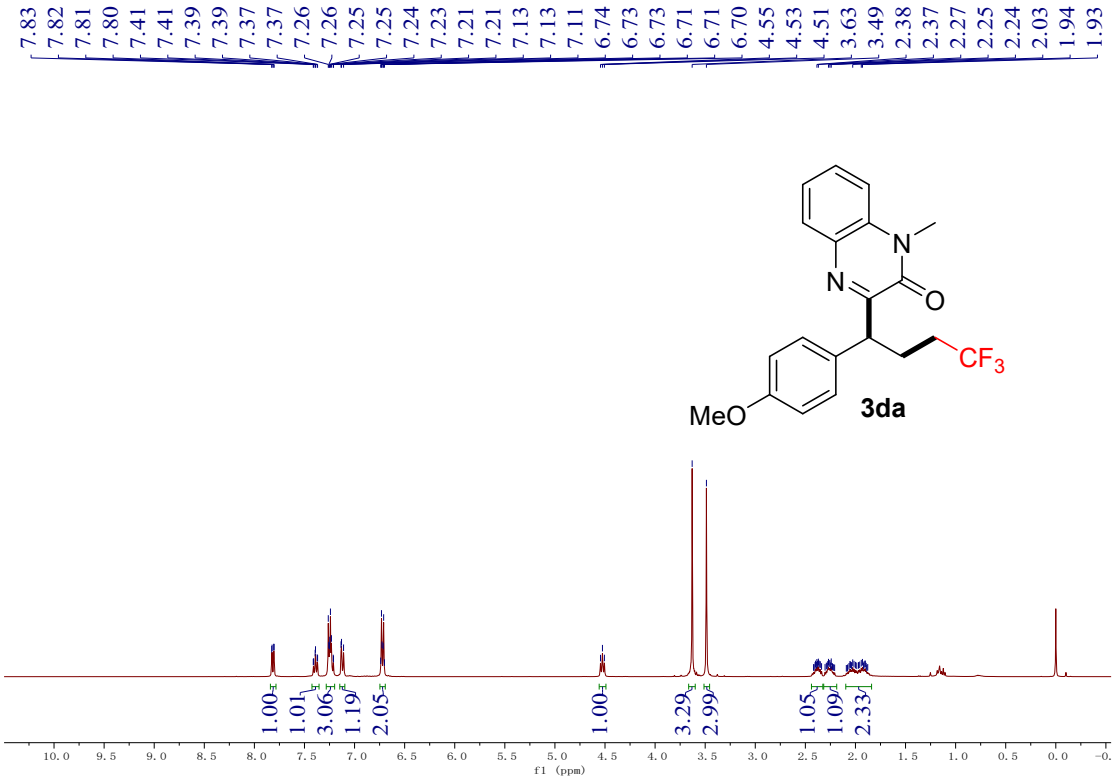
[13]C NMR (101 MHz, $CDCl_3$)



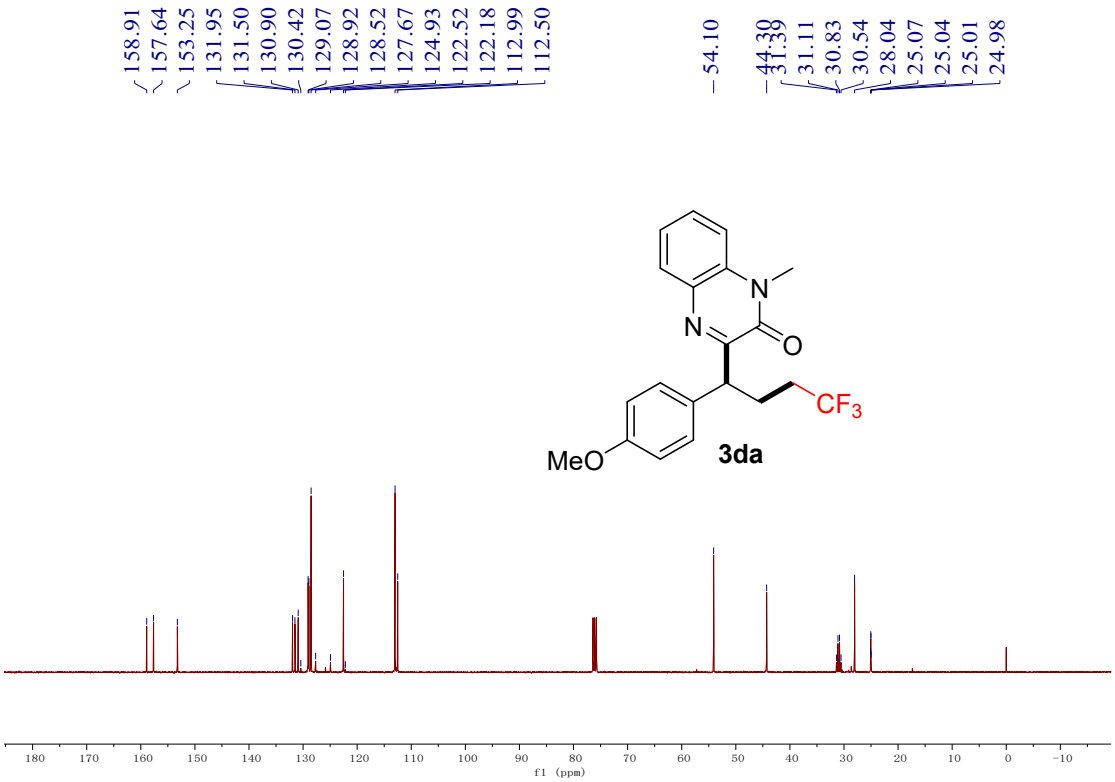
^{19}F NMR (377 MHz, $CDCl_3$)



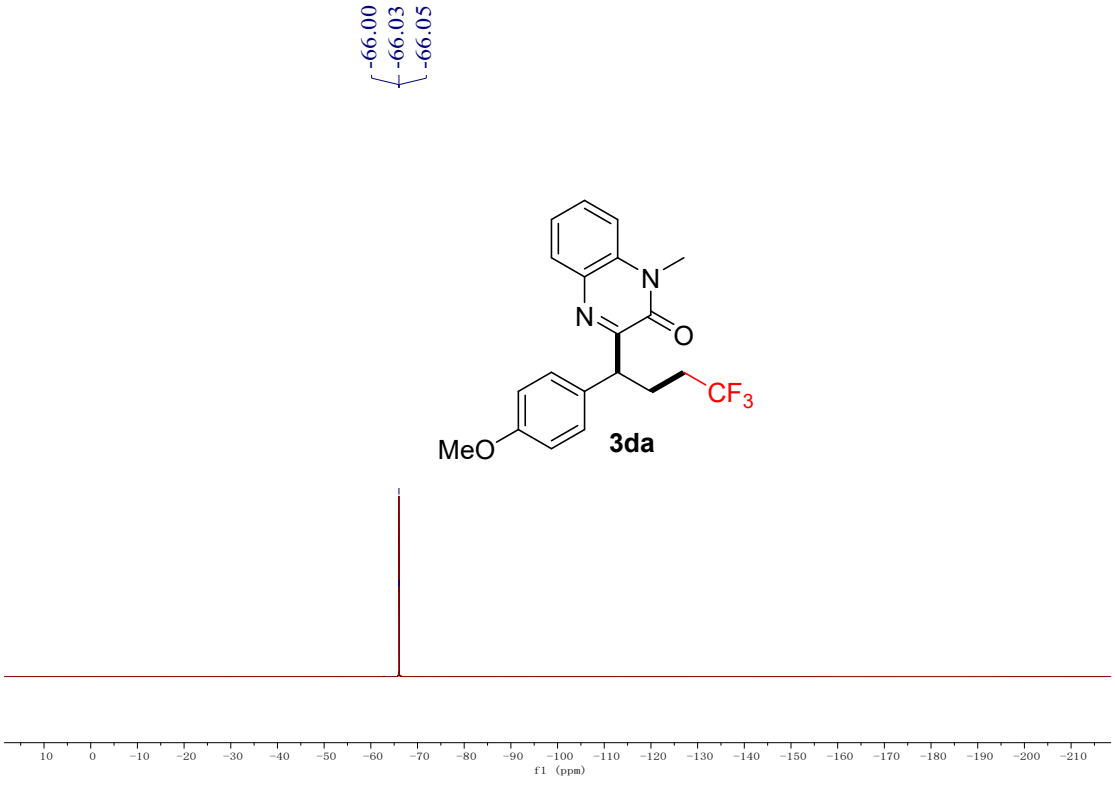
^{1}H NMR (400 MHz, $CDCl_3$)



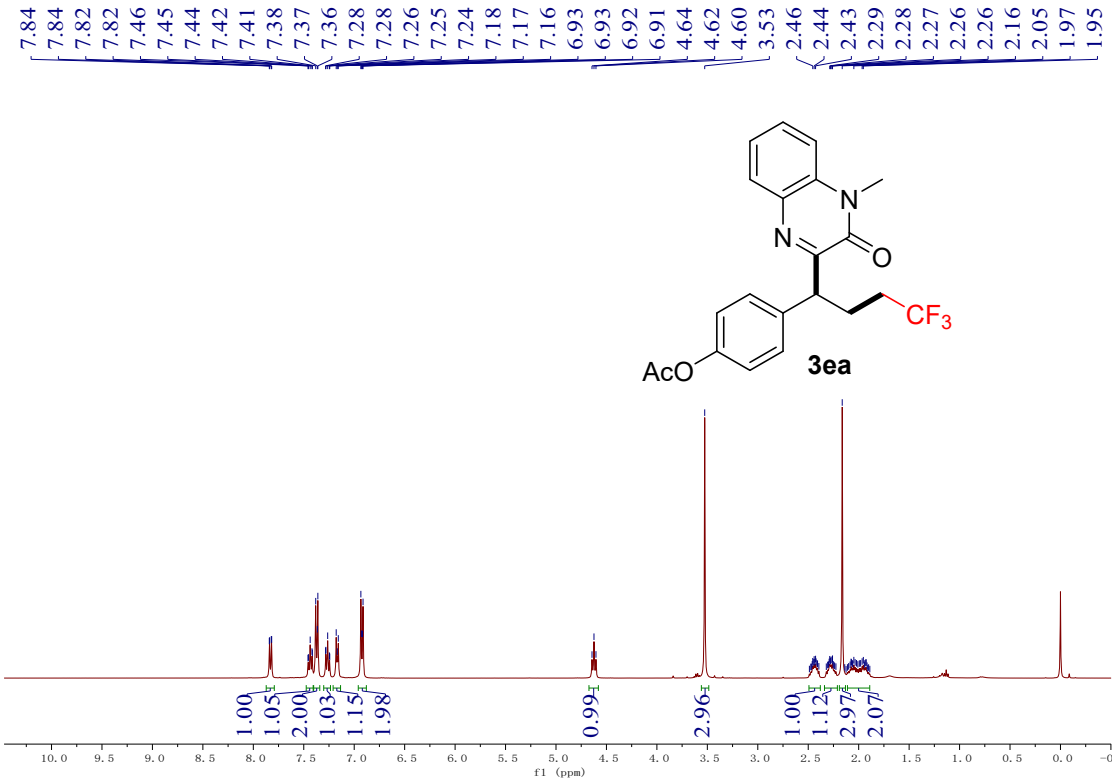
^{13}C NMR (101 MHz, $CDCl_3$)



^{19}F NMR (377 MHz, $CDCl_3$)



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



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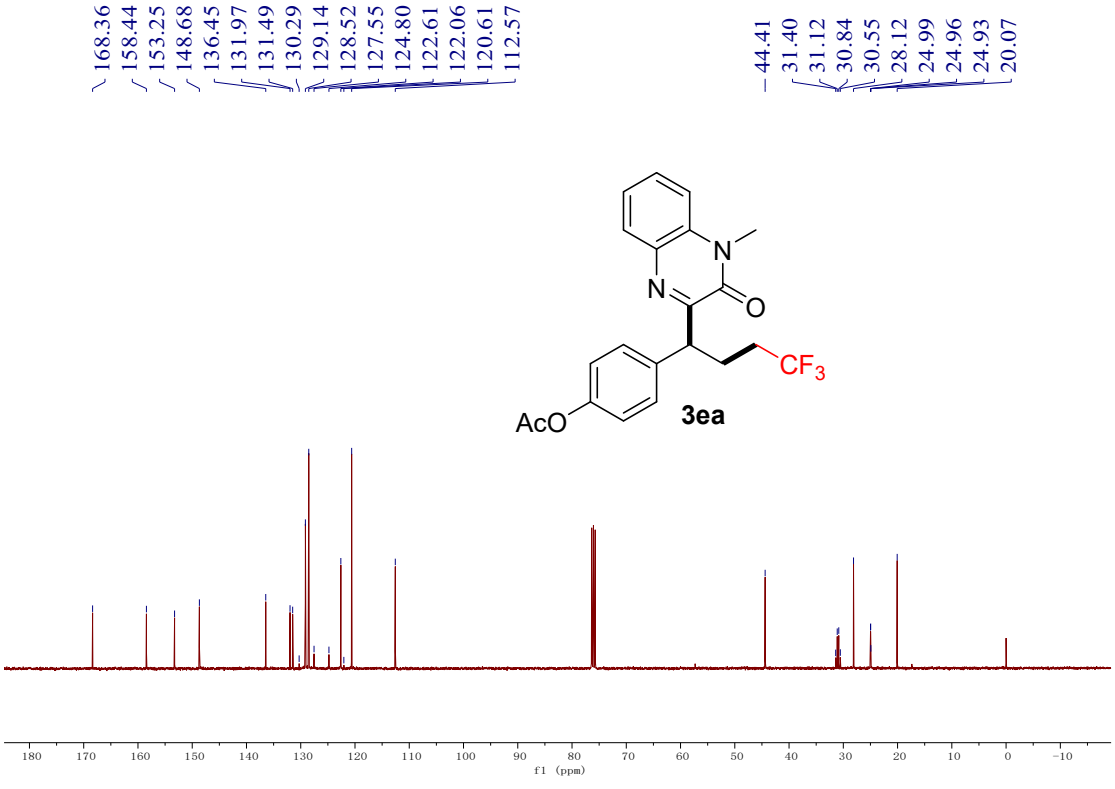
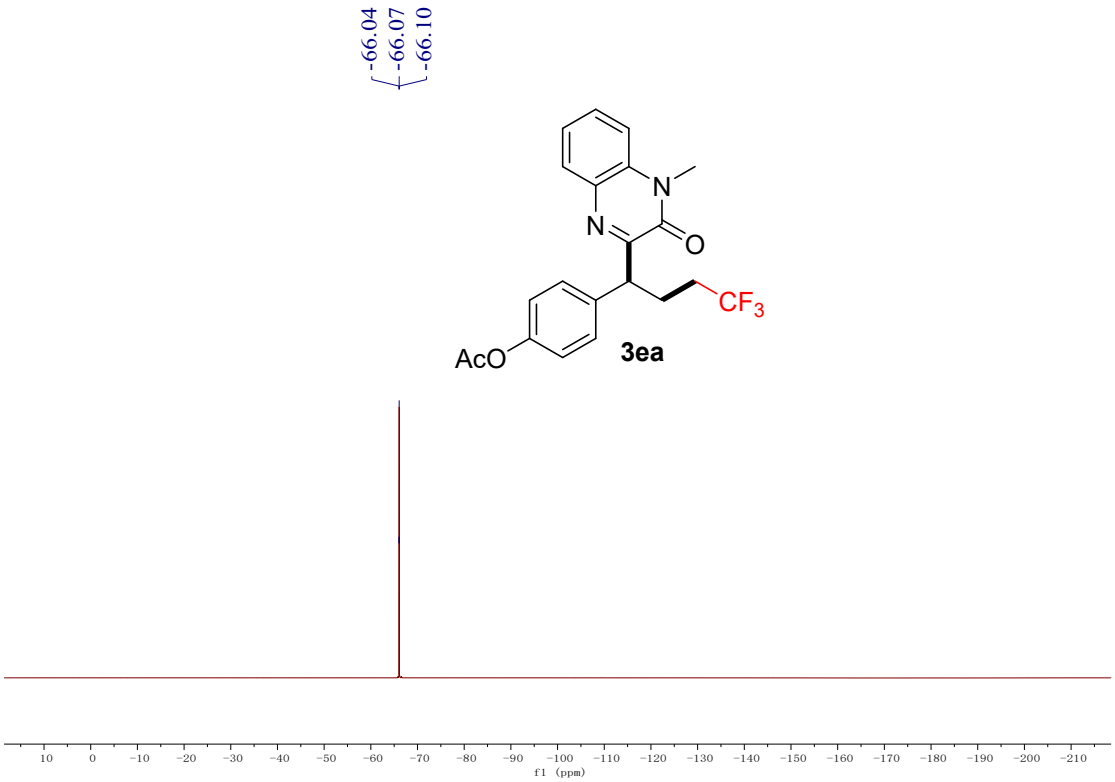
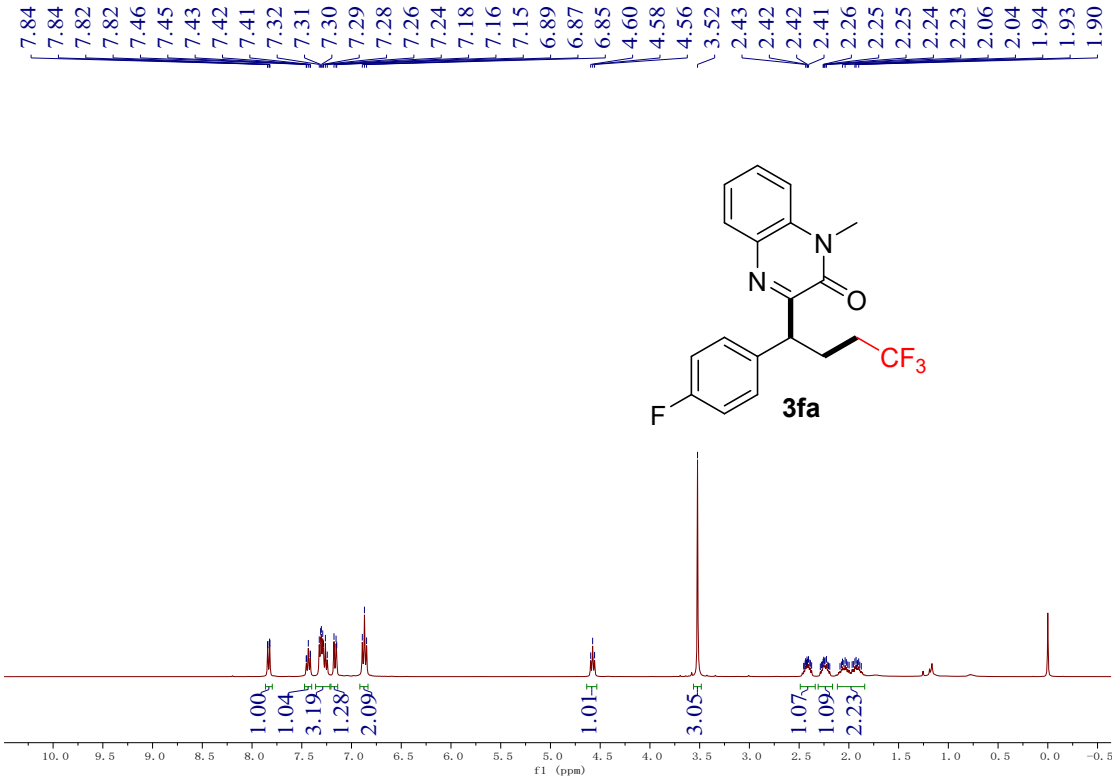


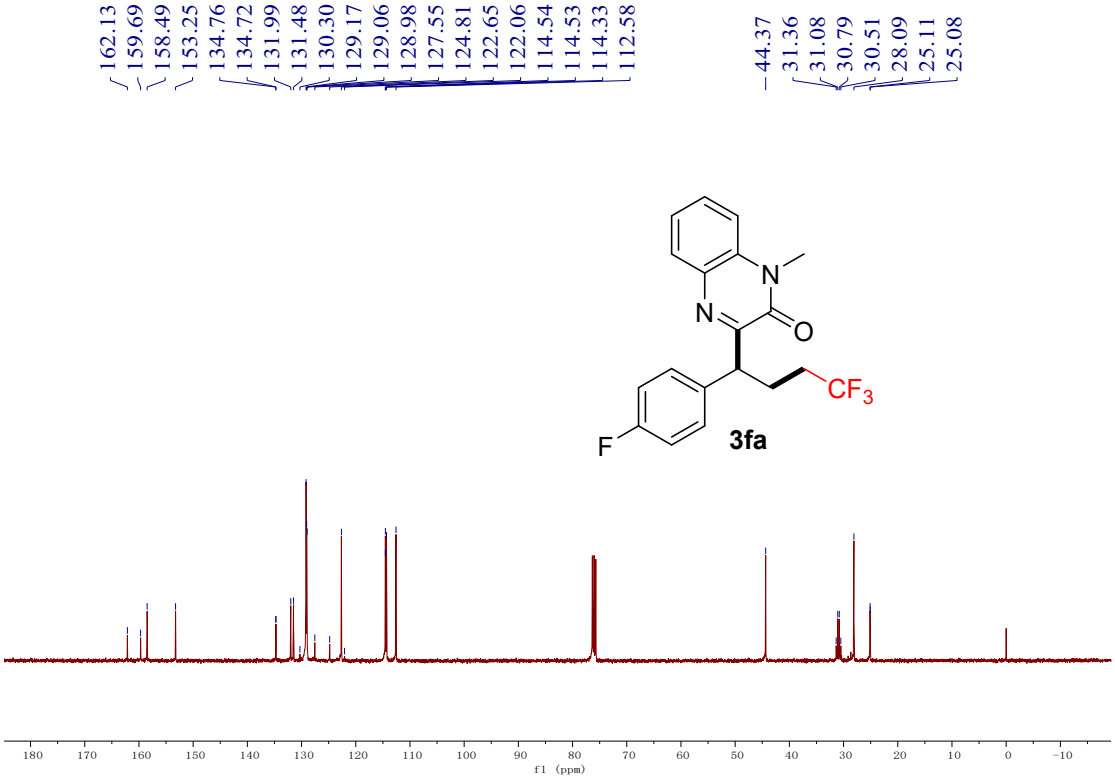
^{19}F NMR (377 MHz, $CDCl_3$)



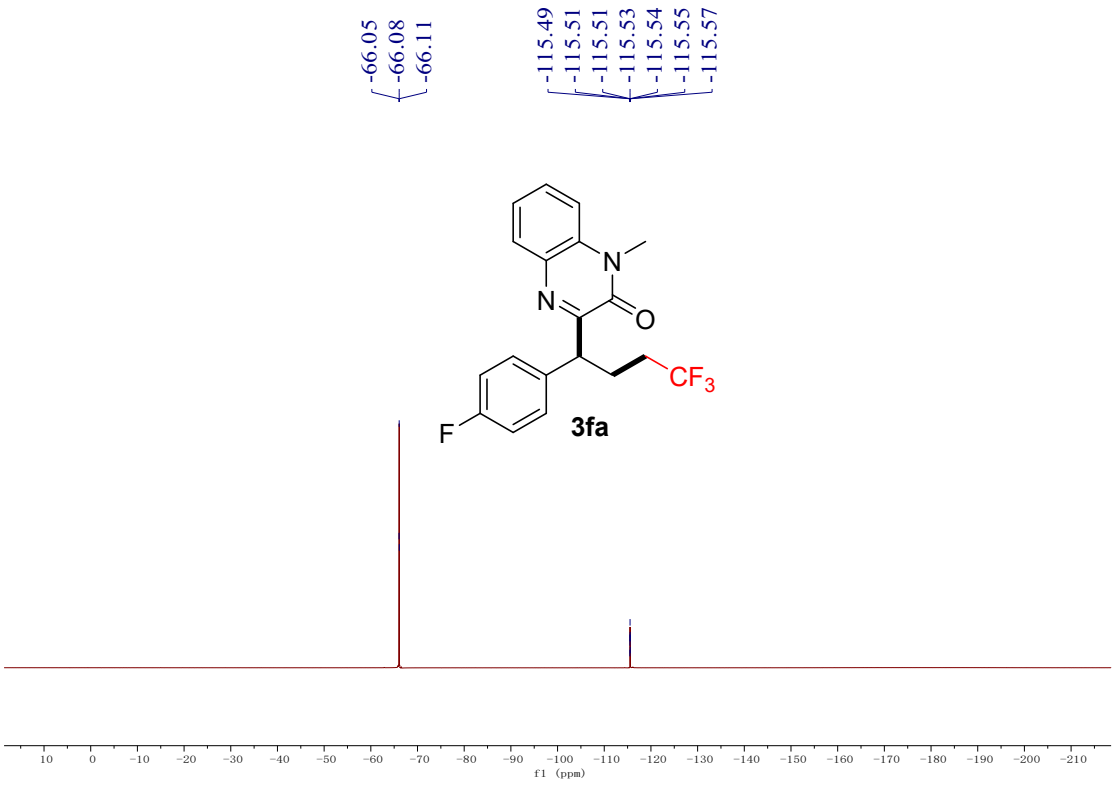
^{1}H NMR (400 MHz, $CDCl_3$)



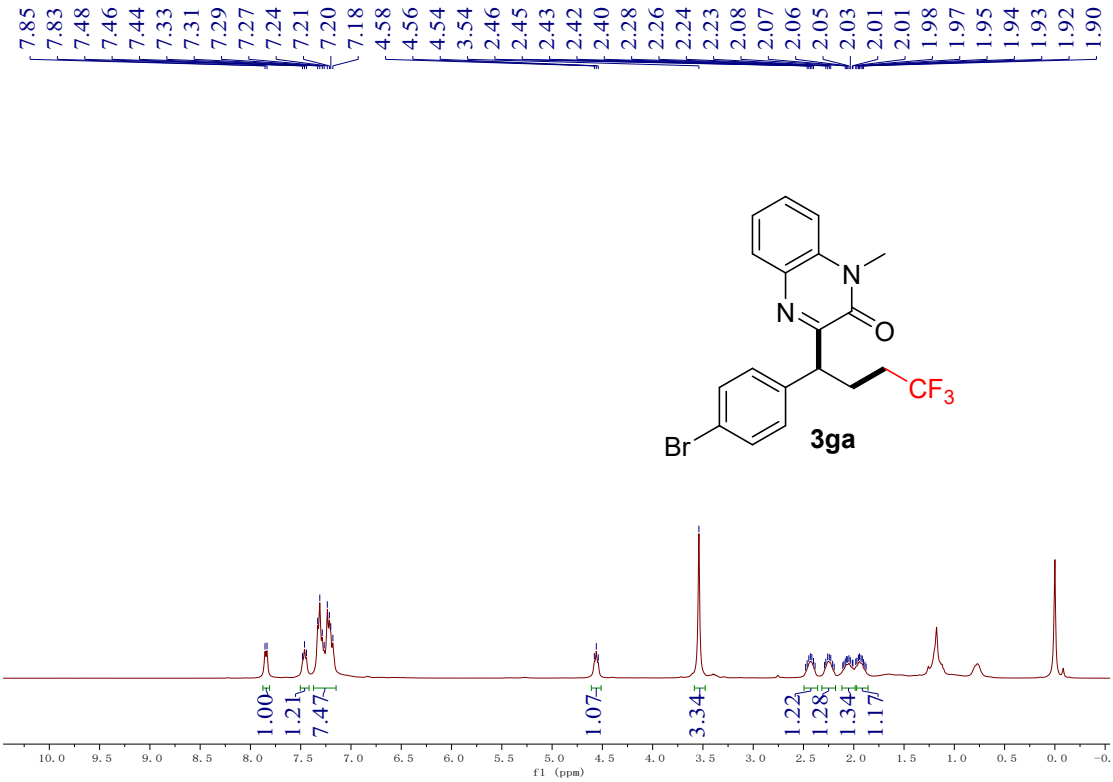
^{13}C NMR (101 MHz, $CDCl_3$)



^{19}F NMR (377 MHz, CDCl3)



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



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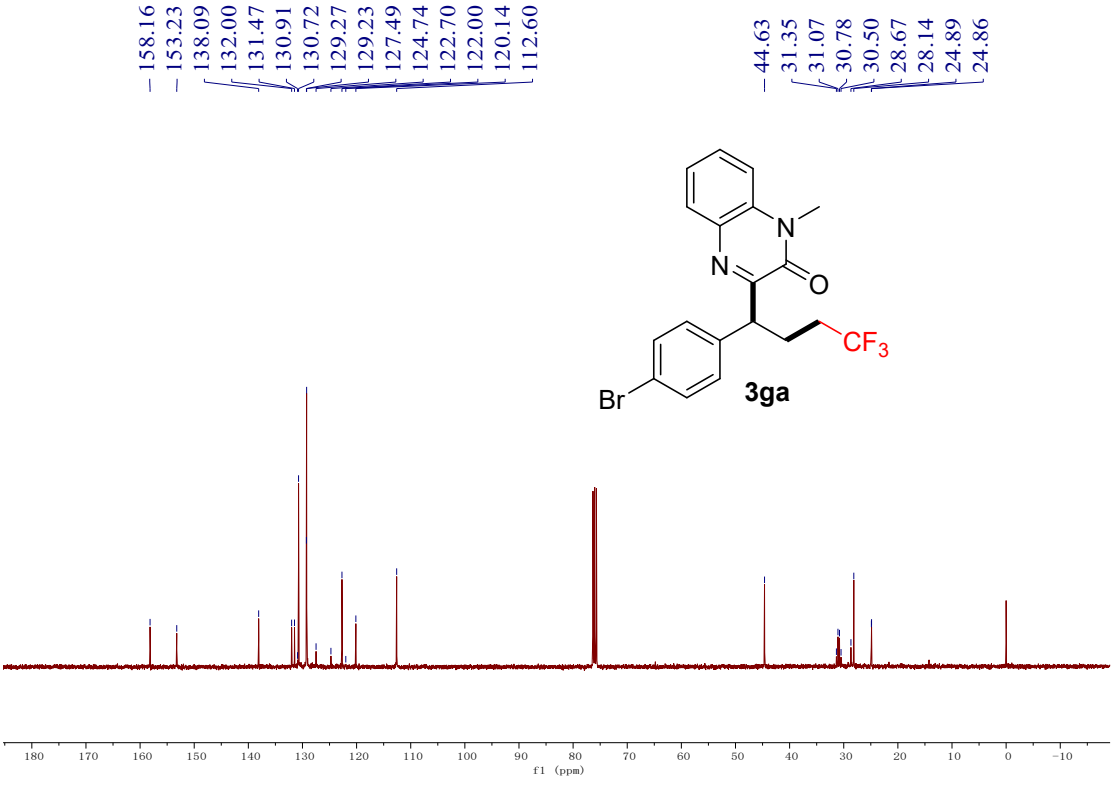

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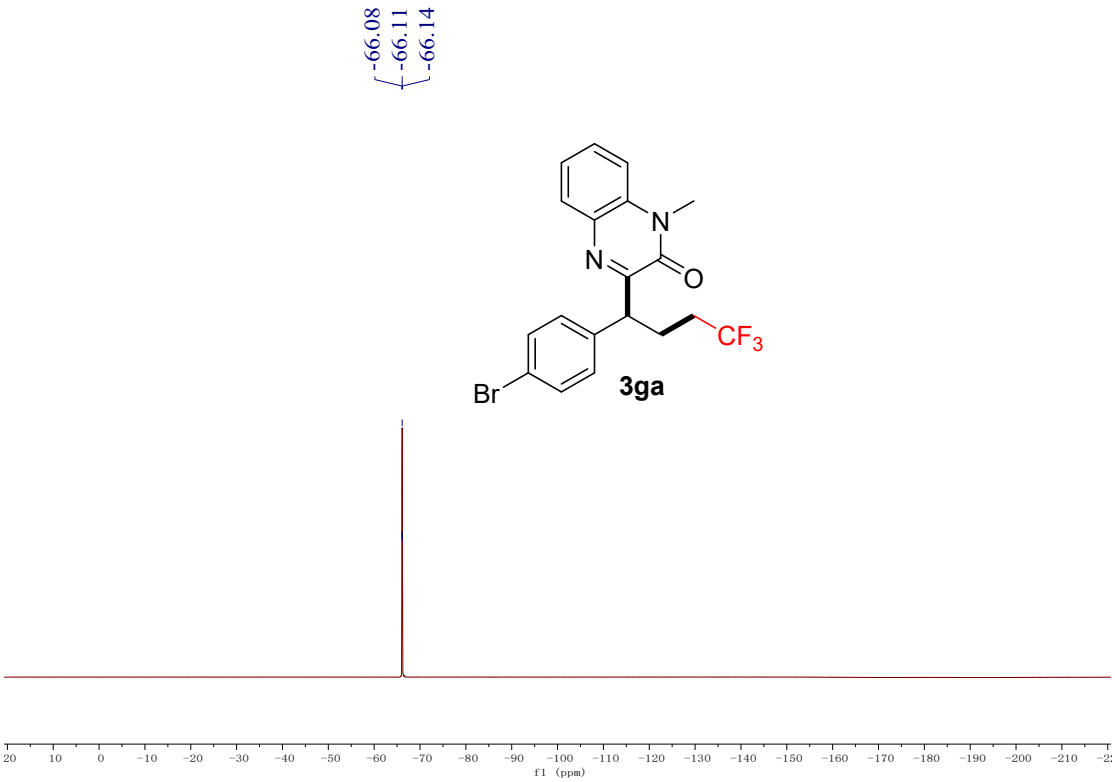

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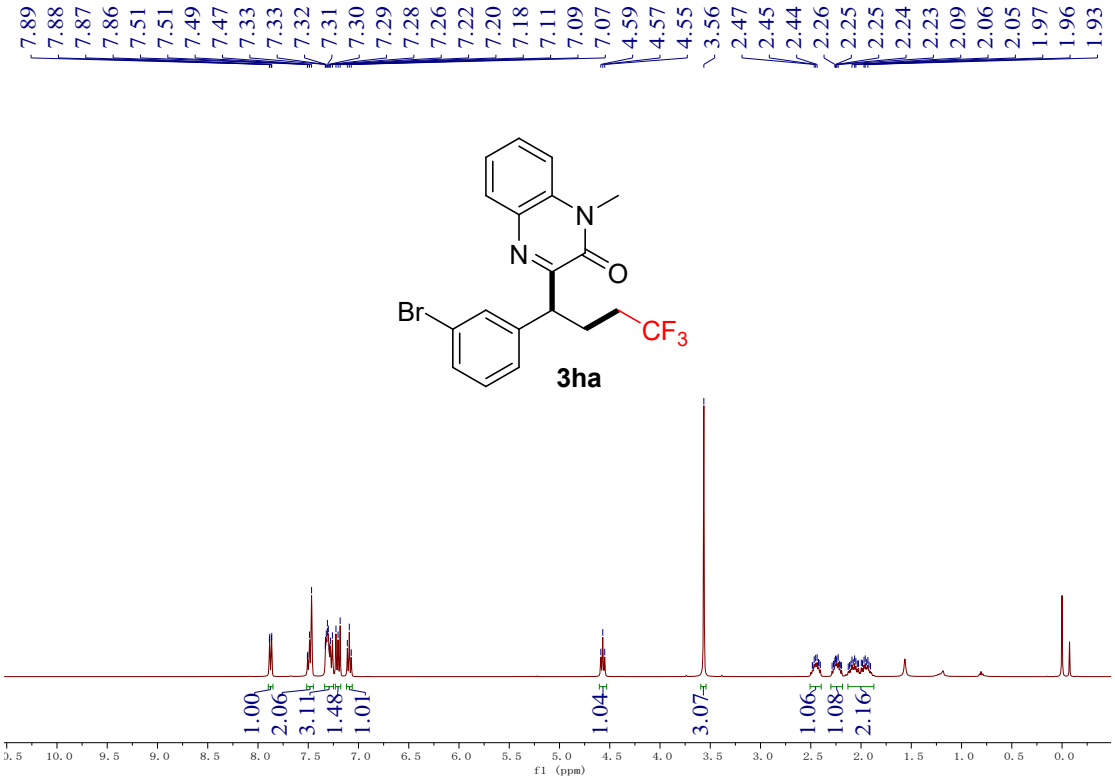

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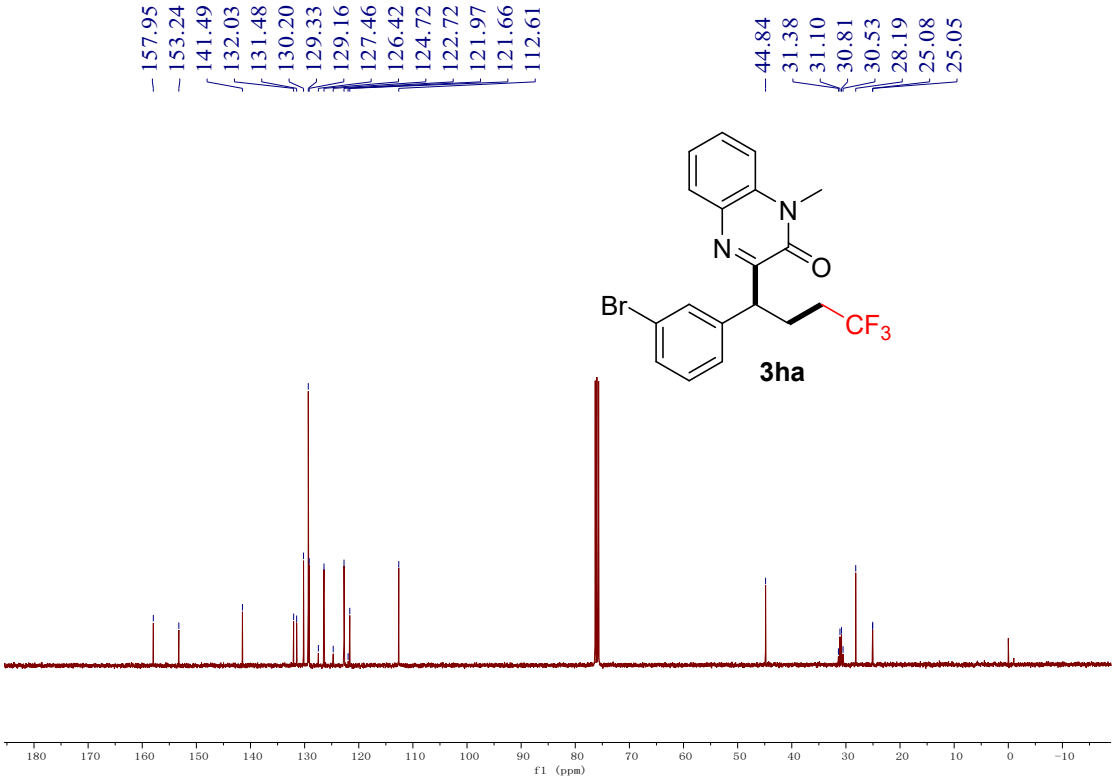
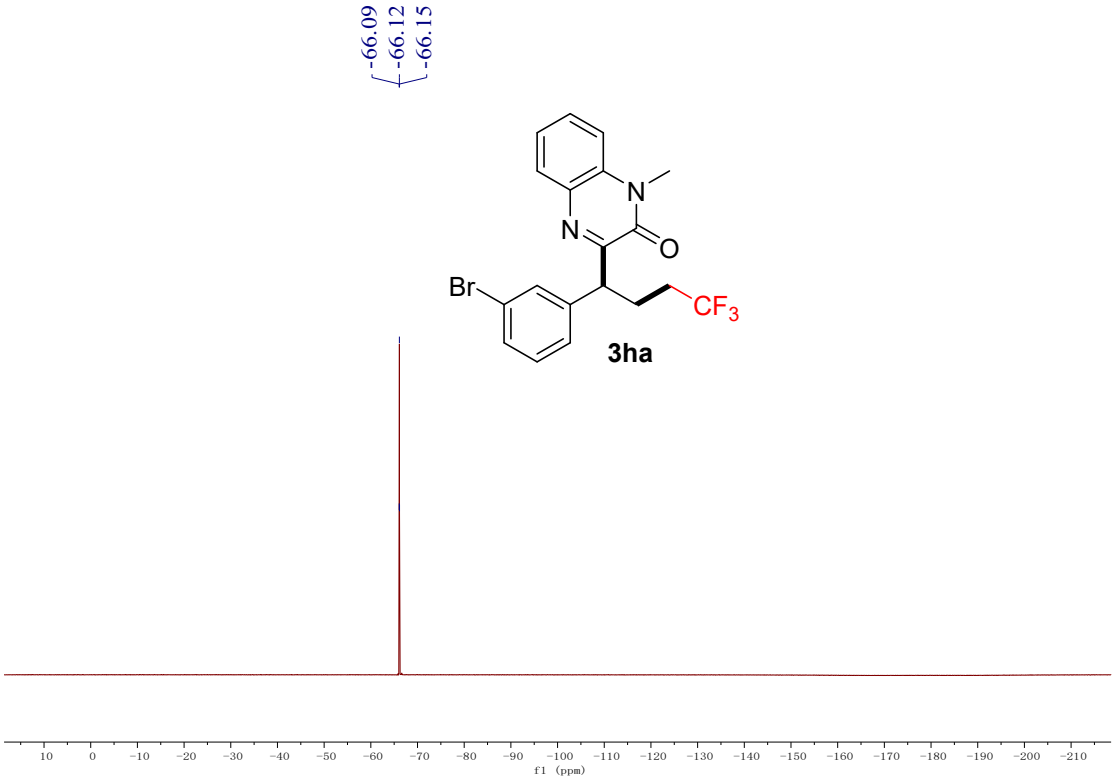


^{19}F NMR (377 MHz, $CDCl_3$)



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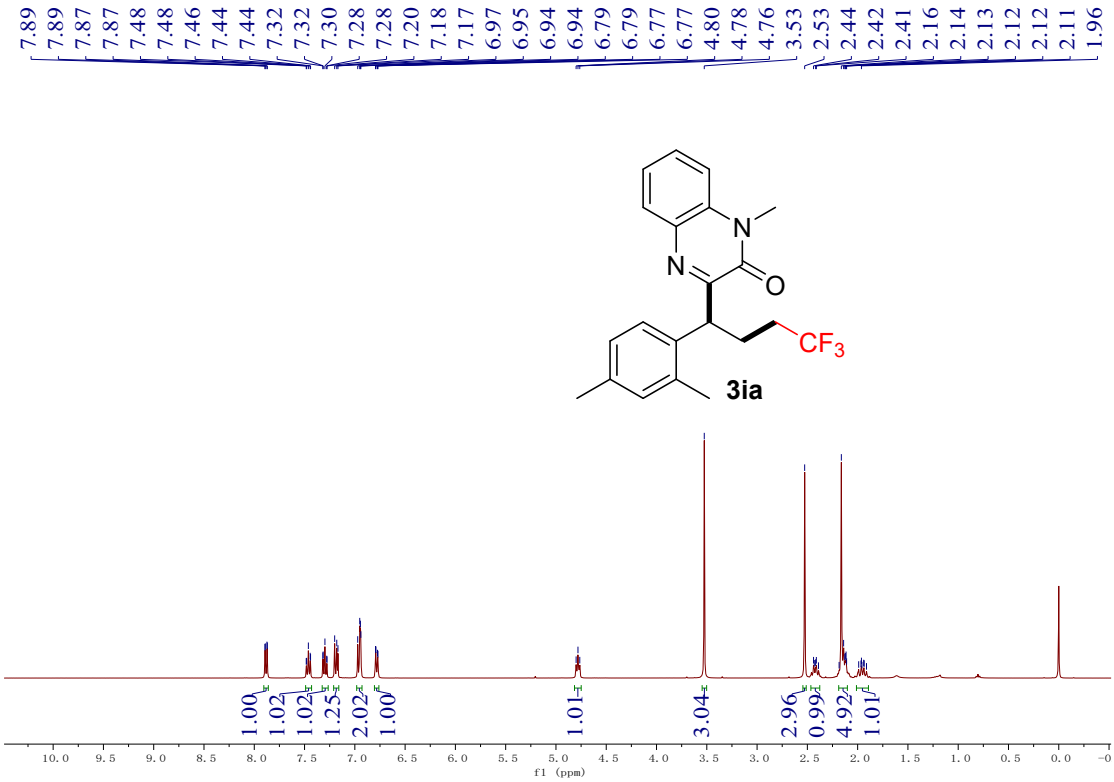

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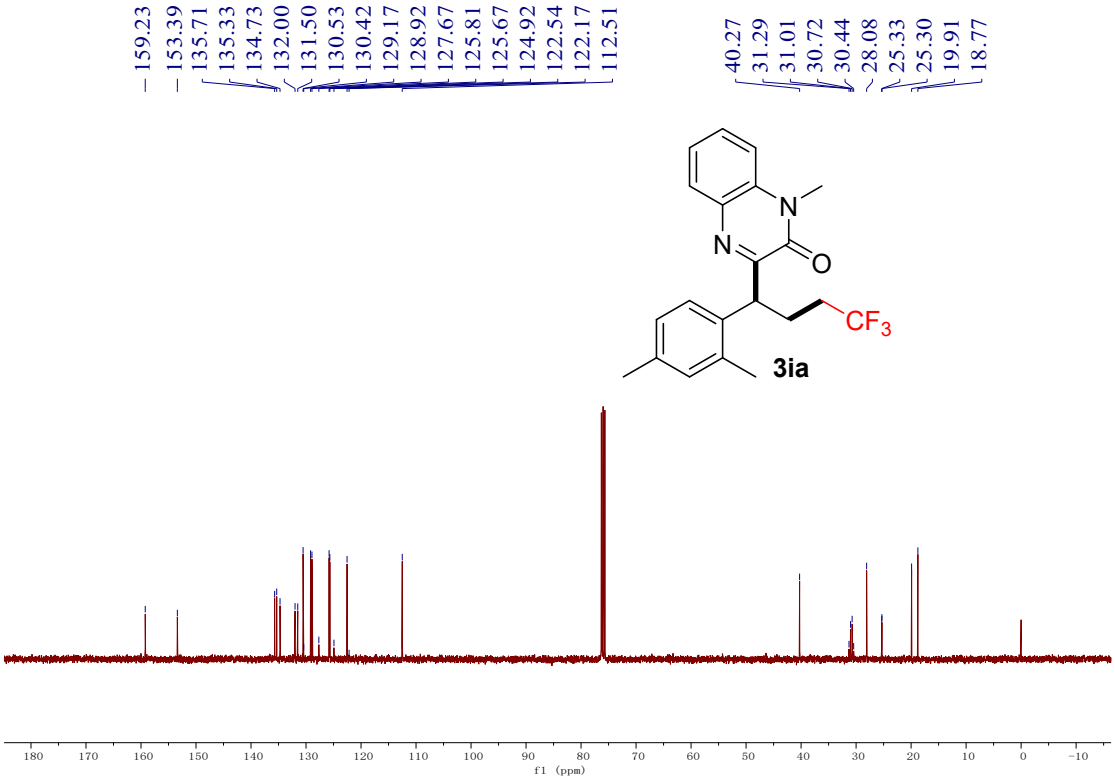

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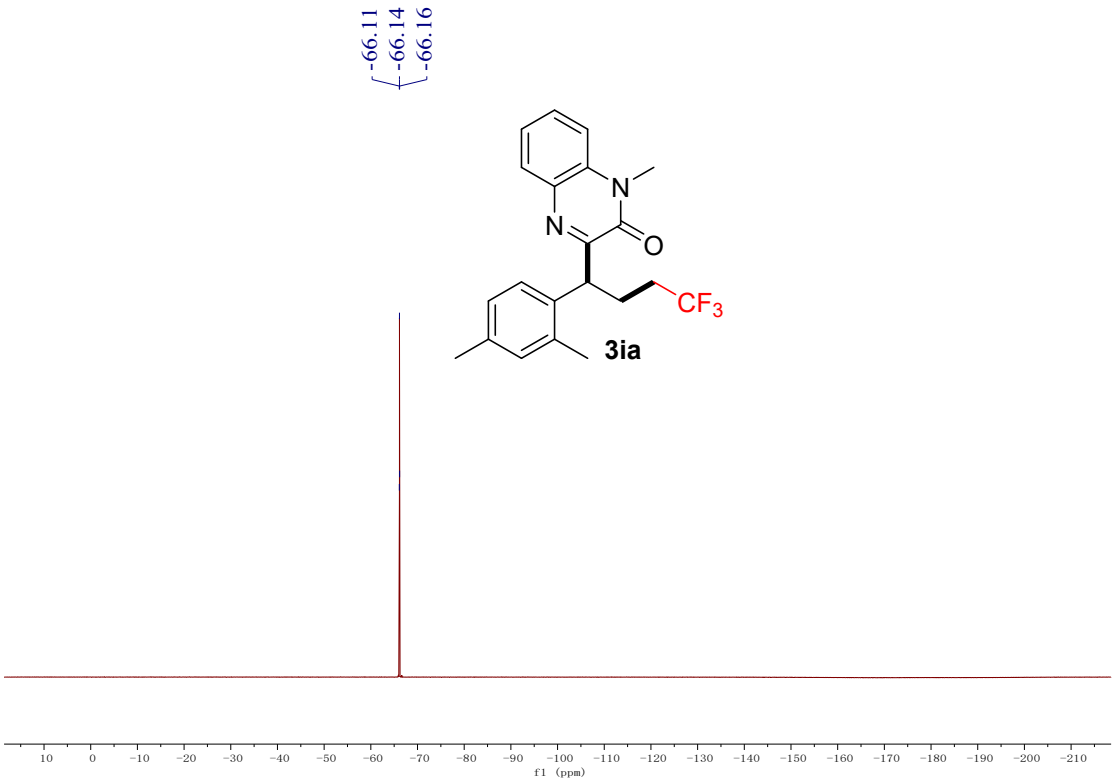

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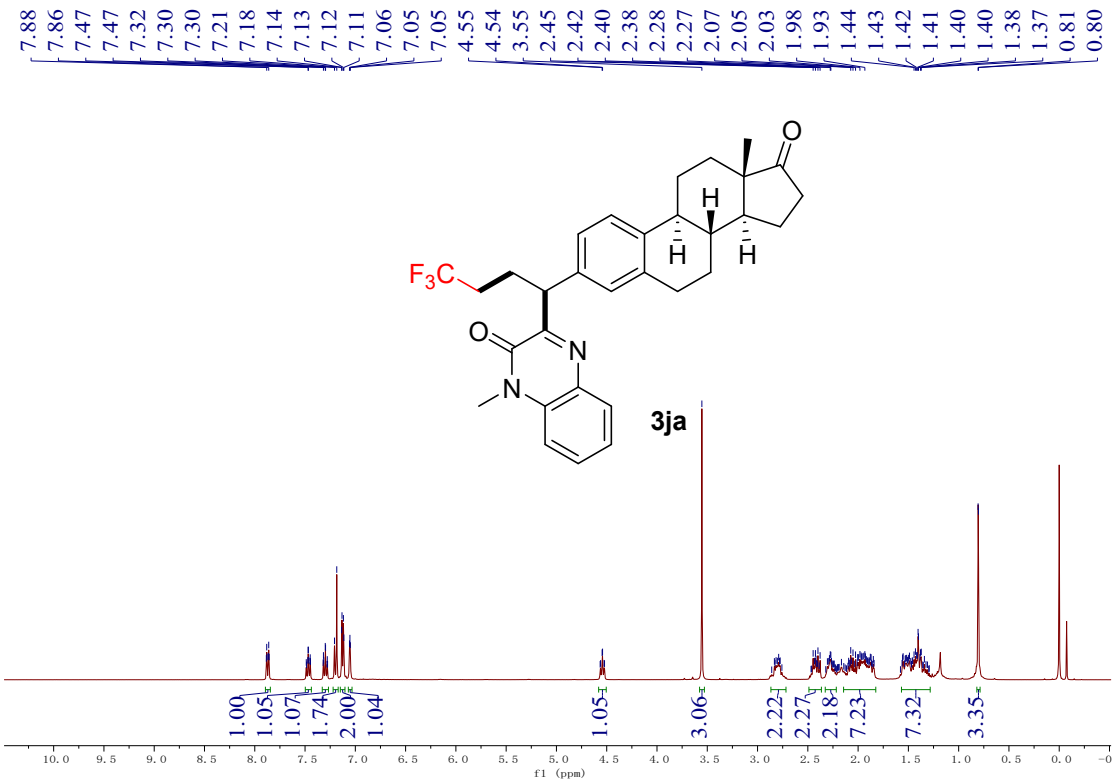

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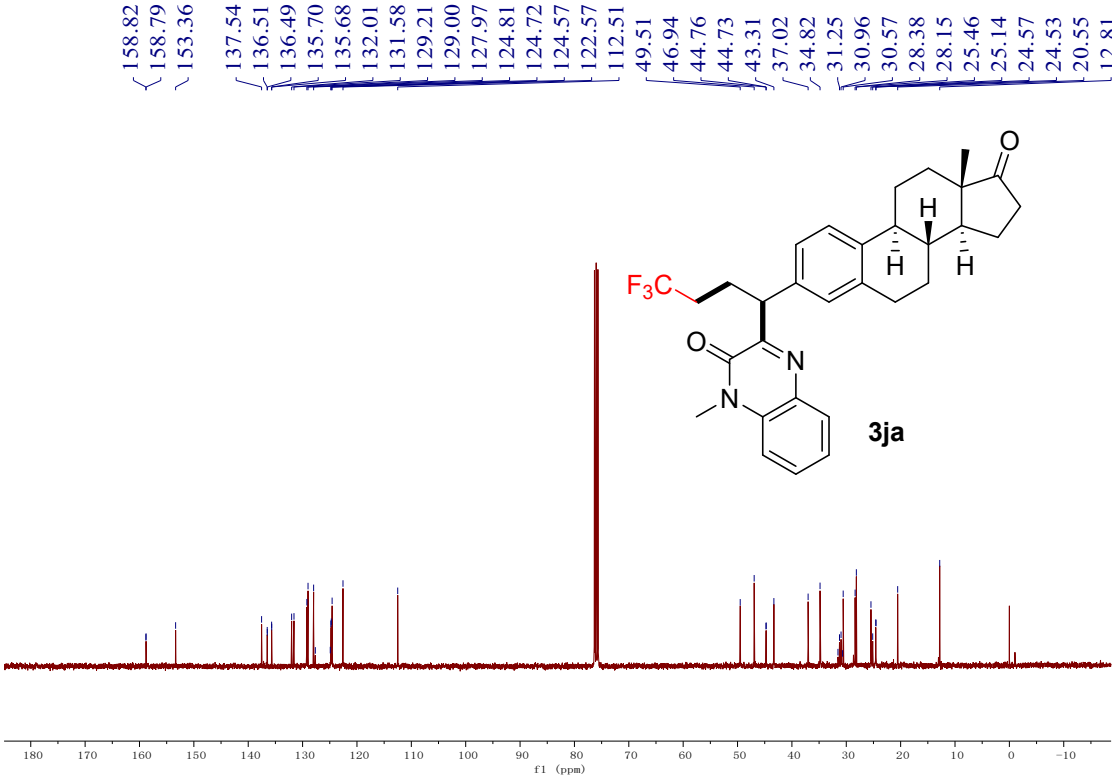

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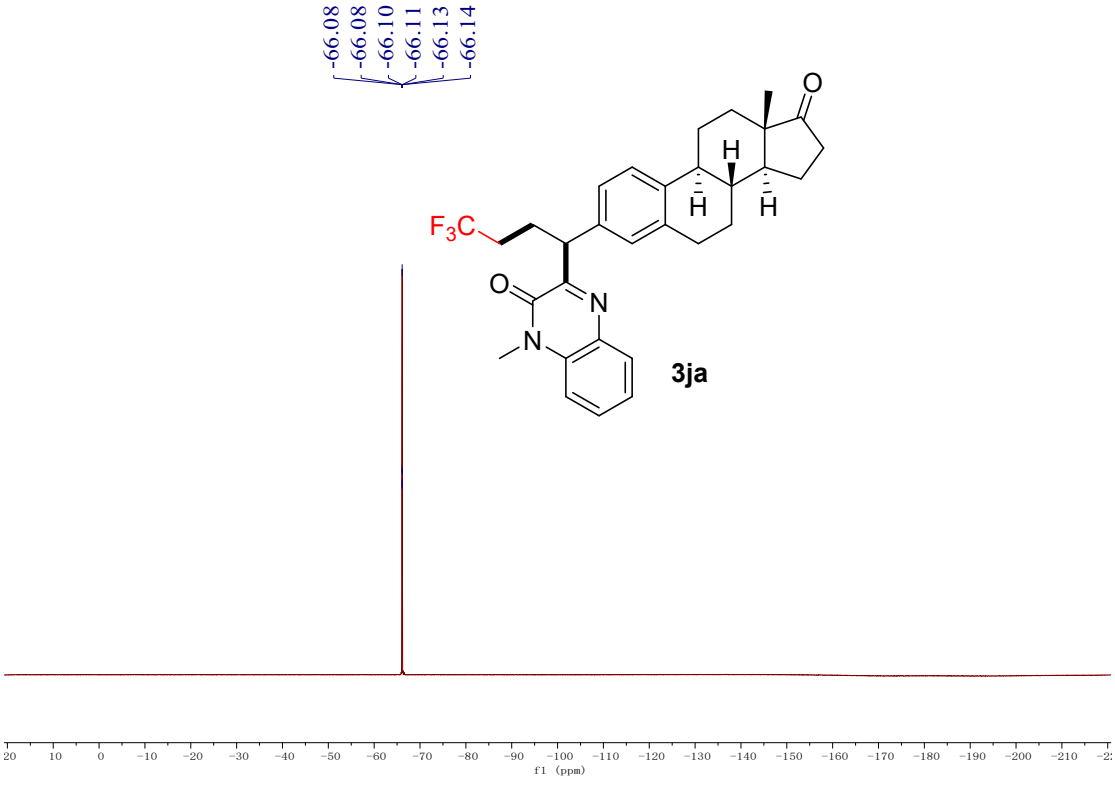

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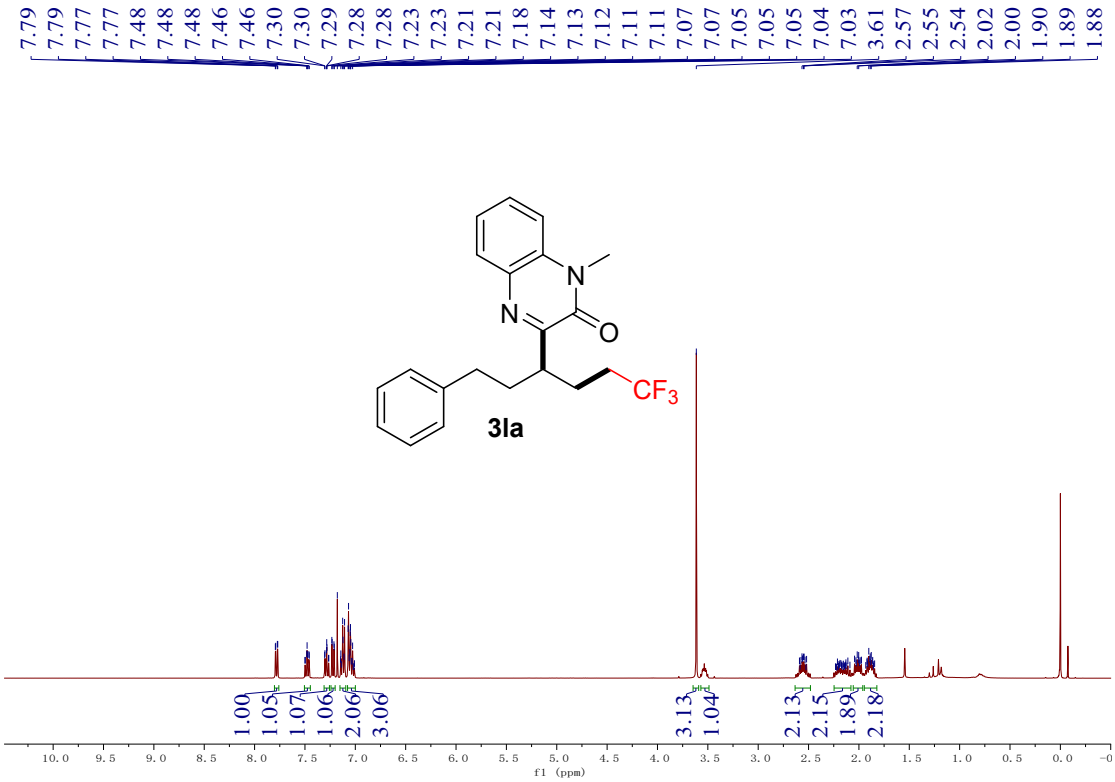

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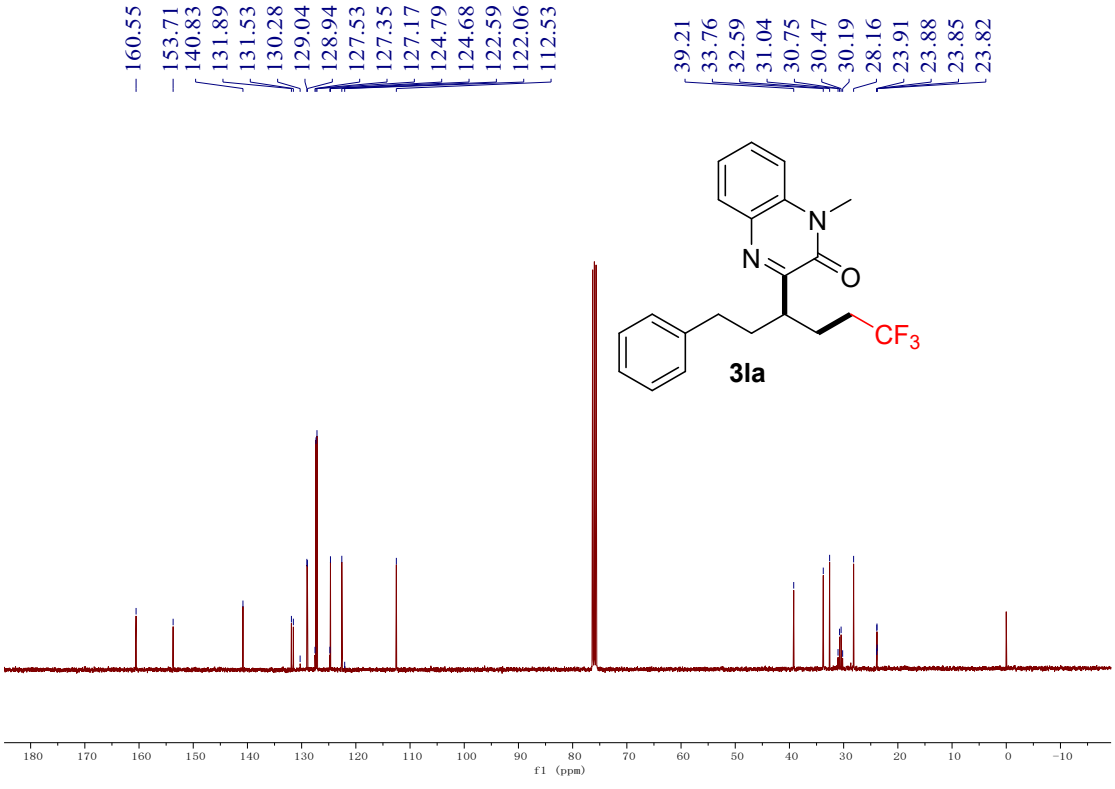

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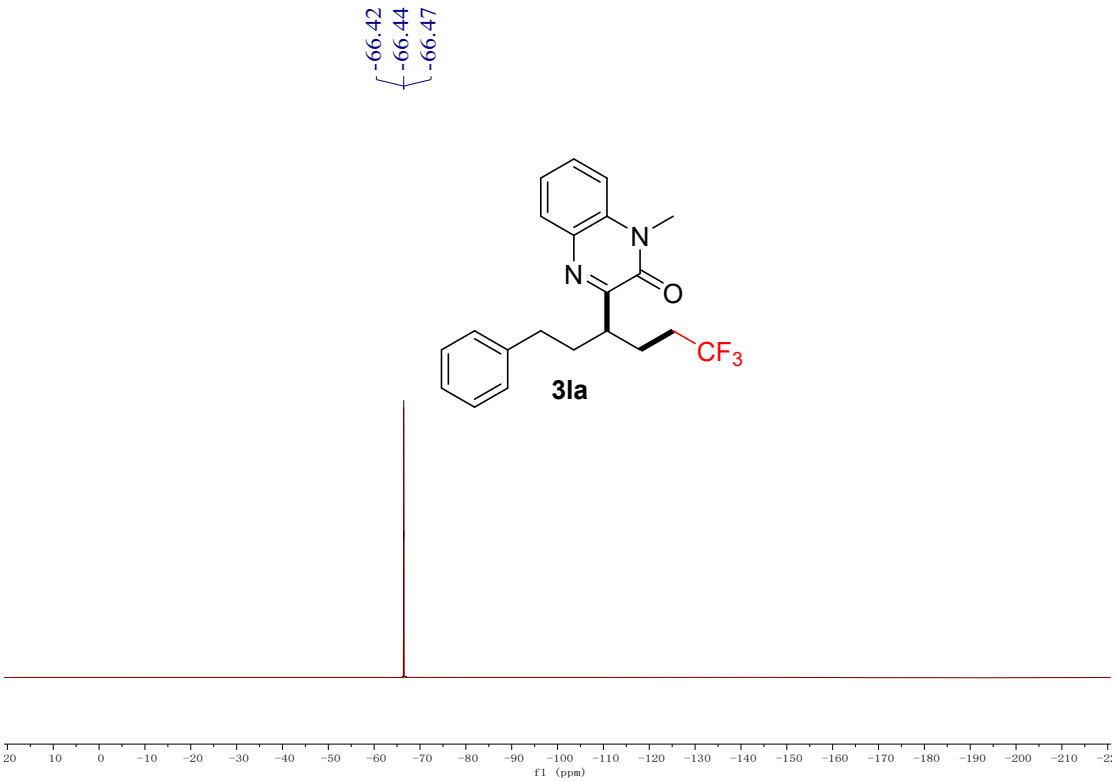

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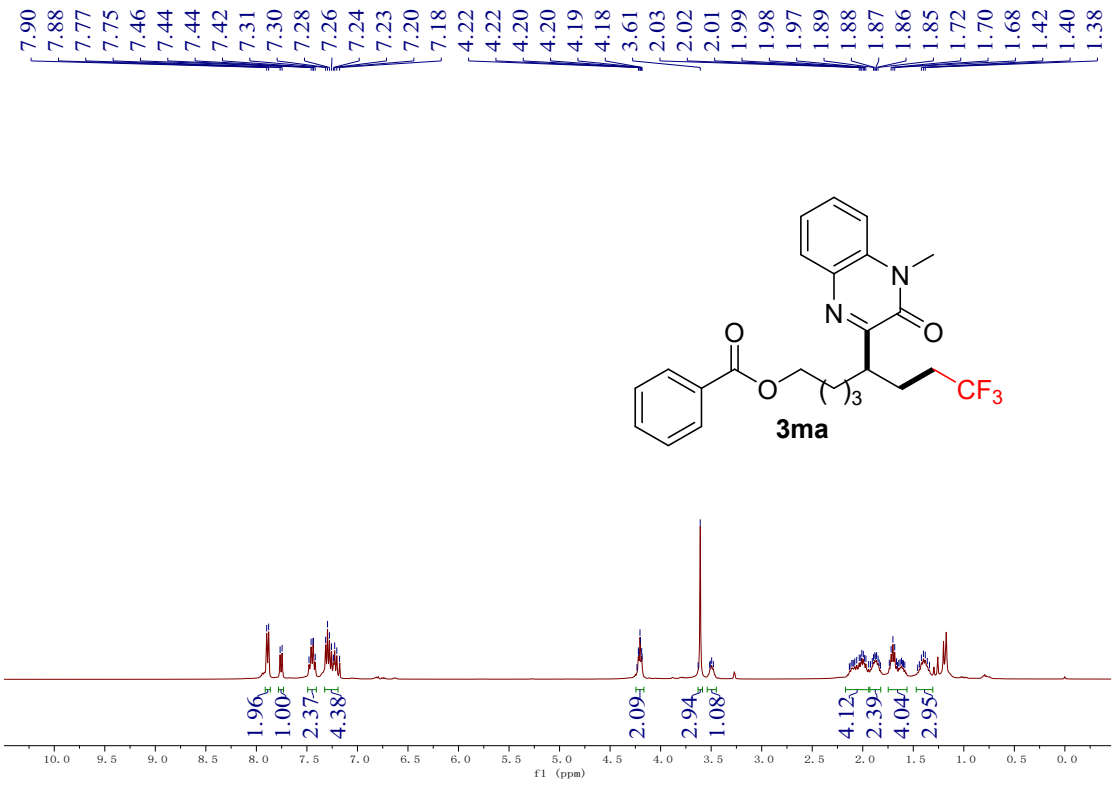

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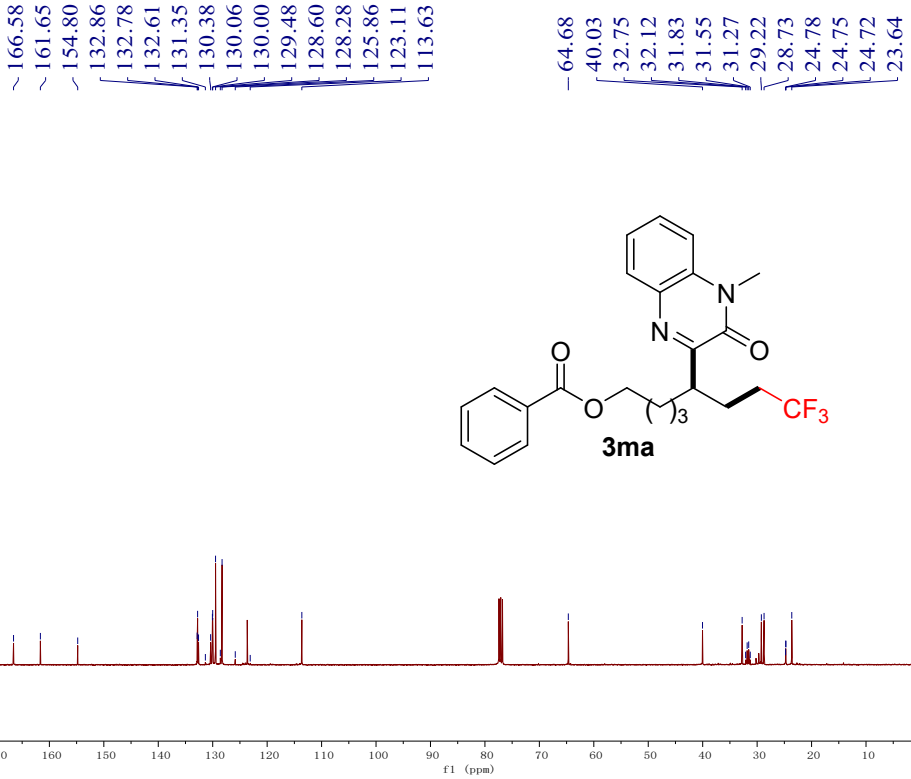

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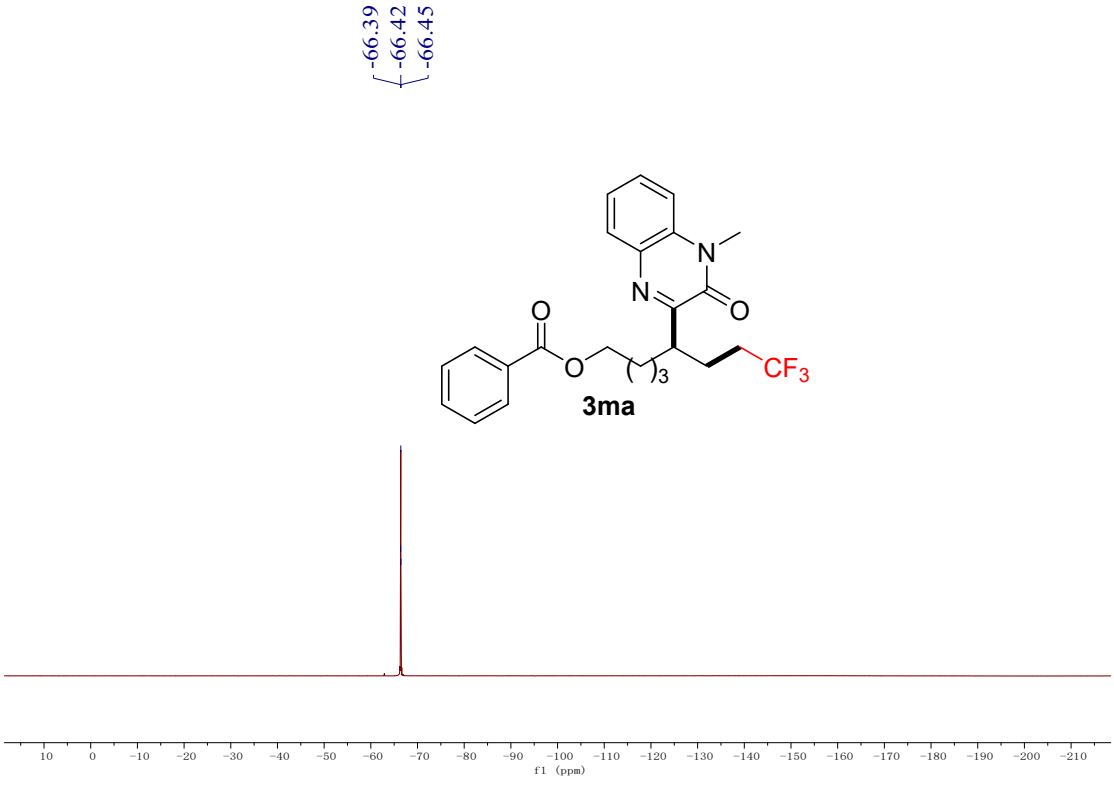

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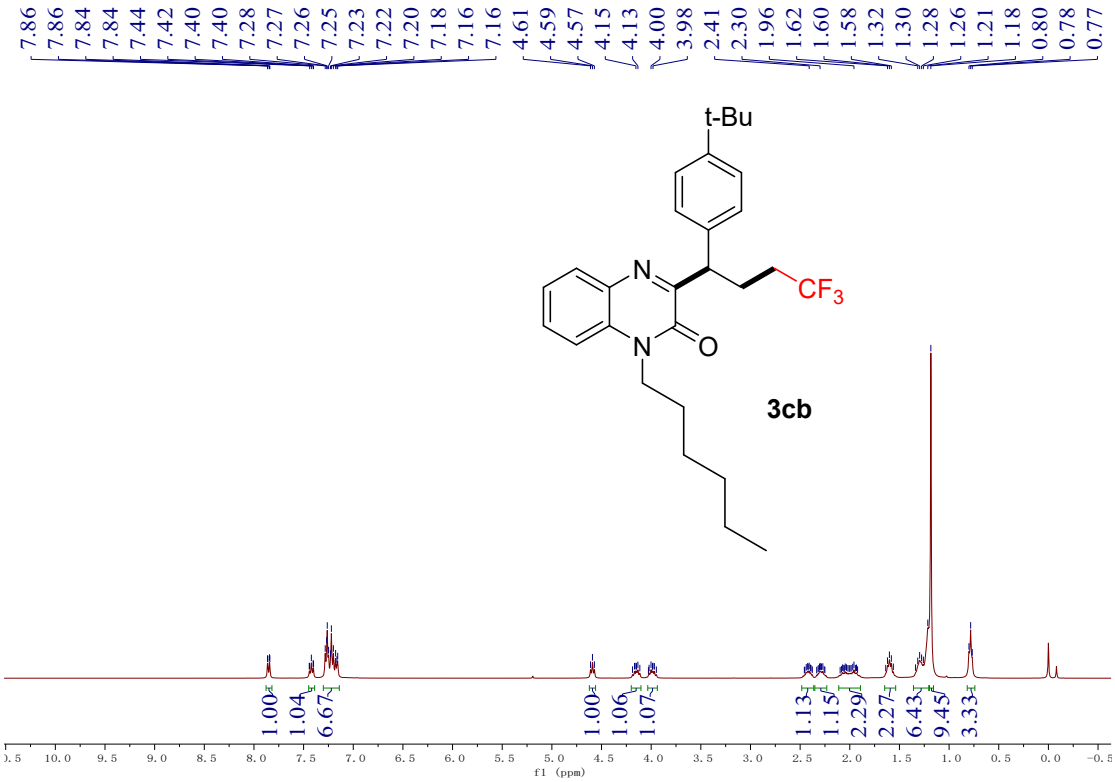

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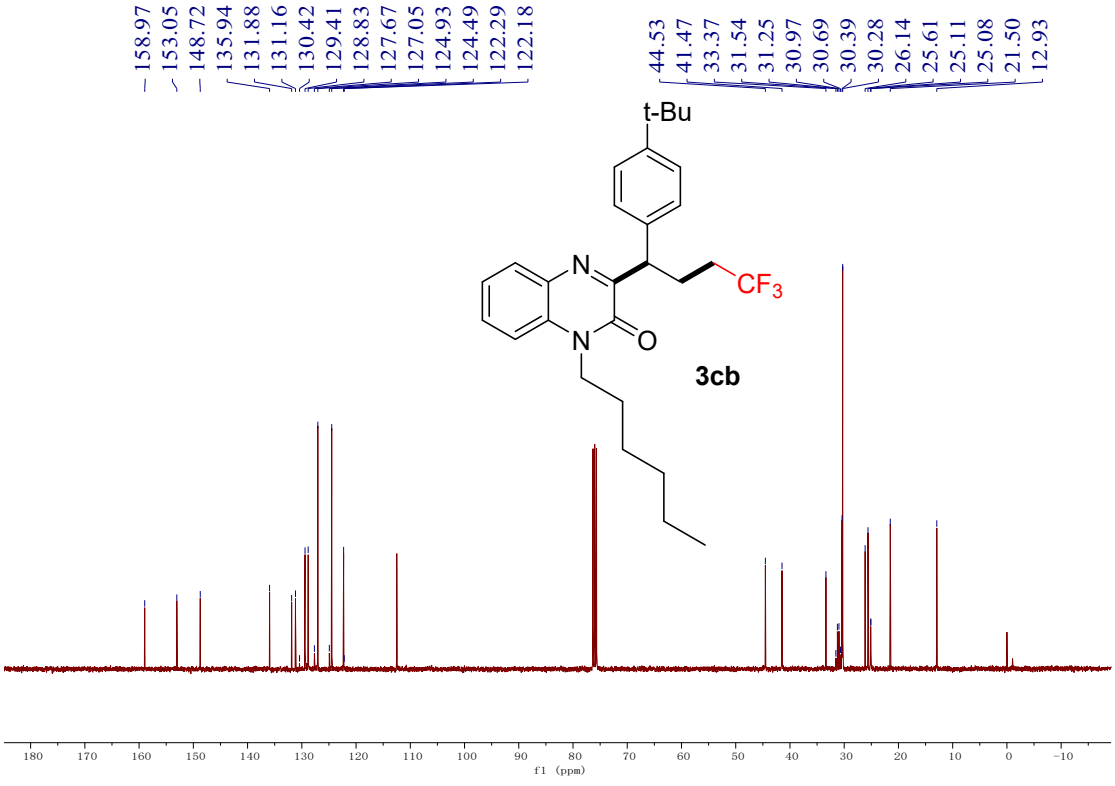

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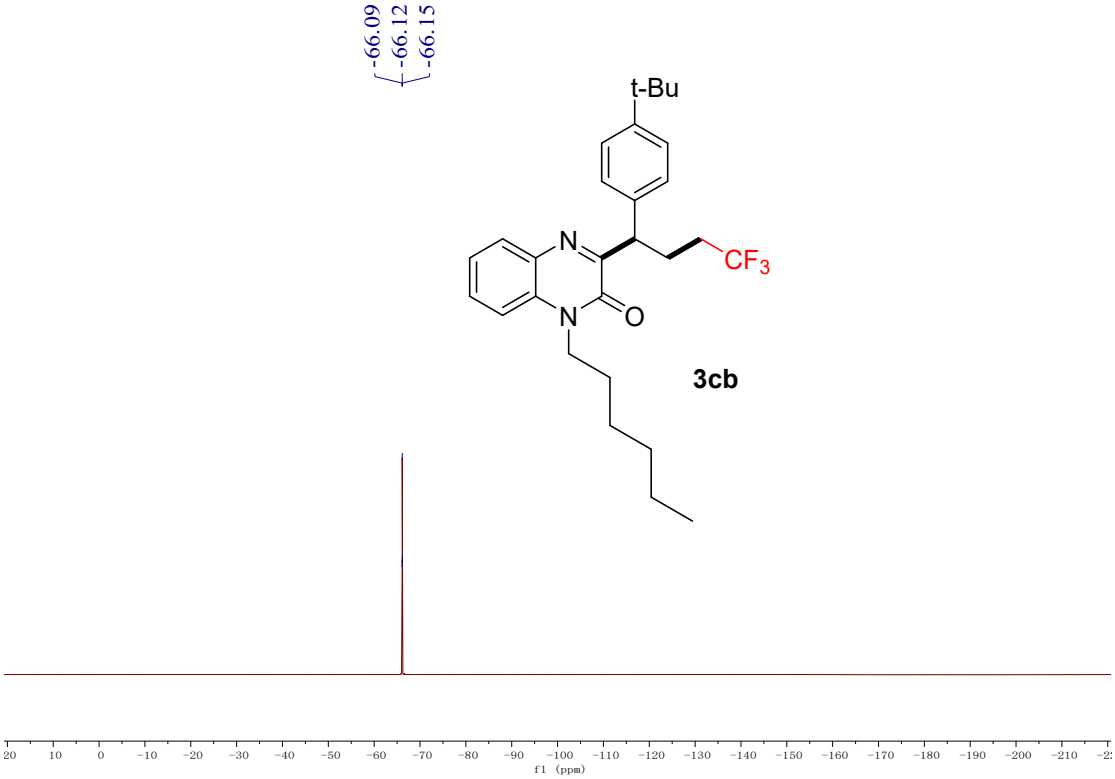

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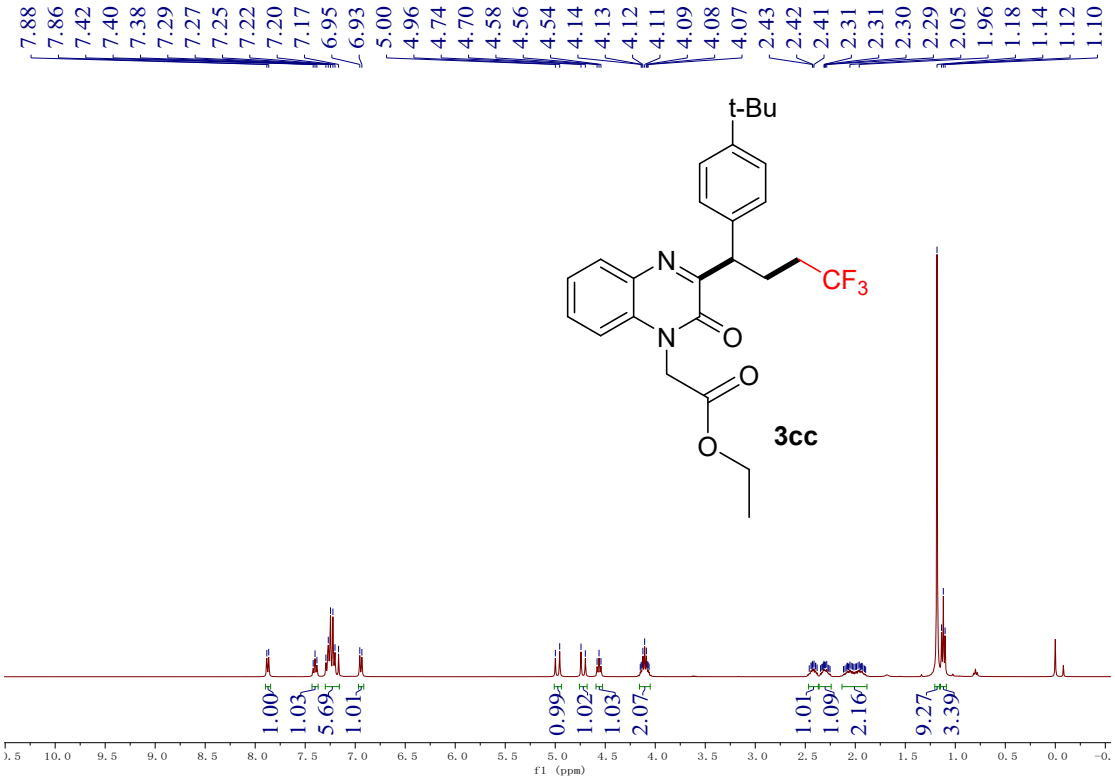

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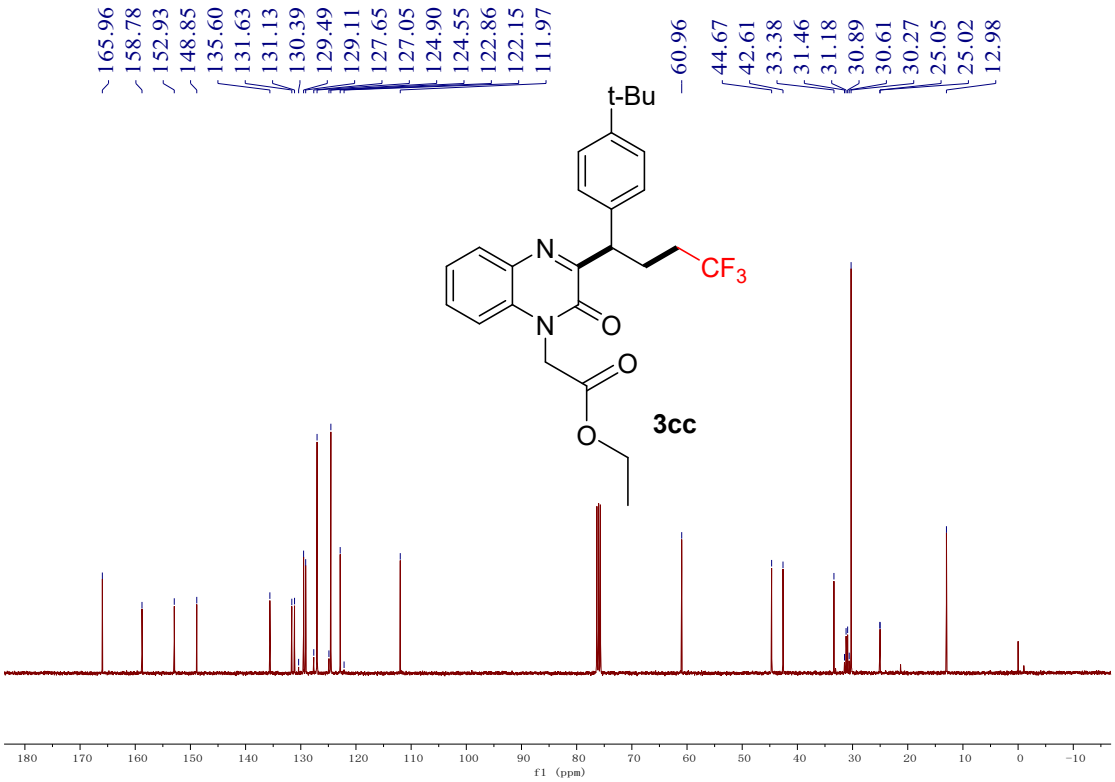

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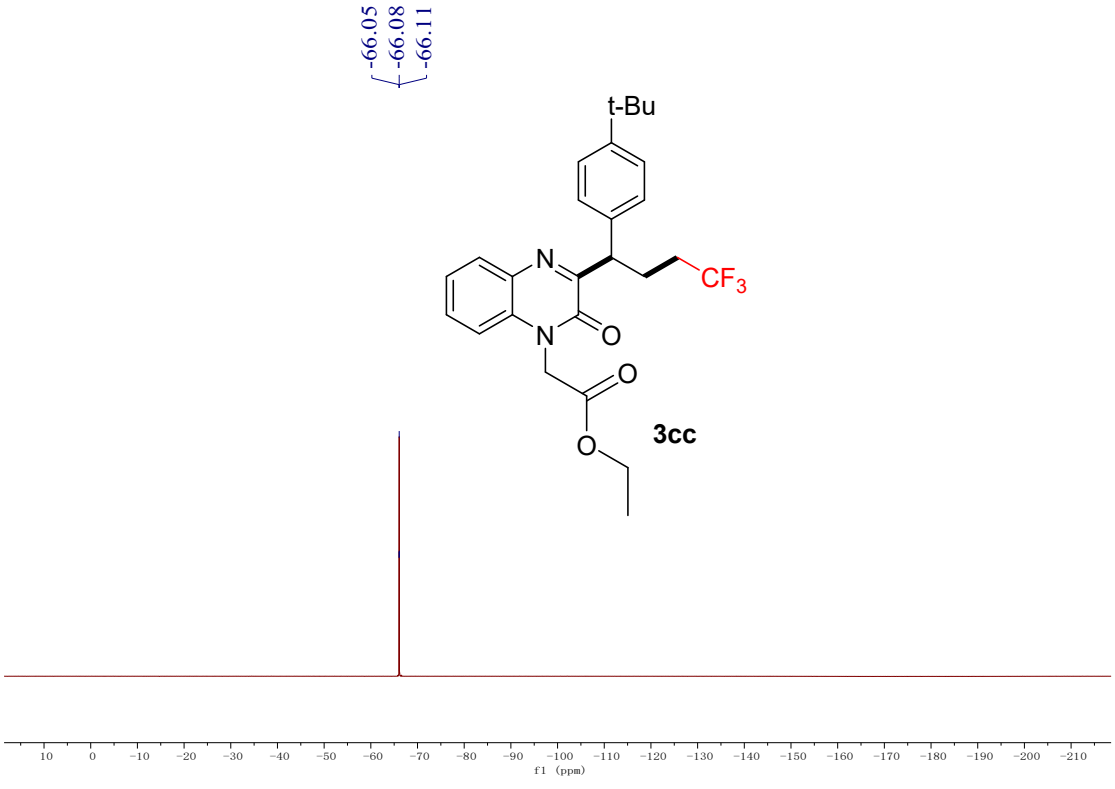

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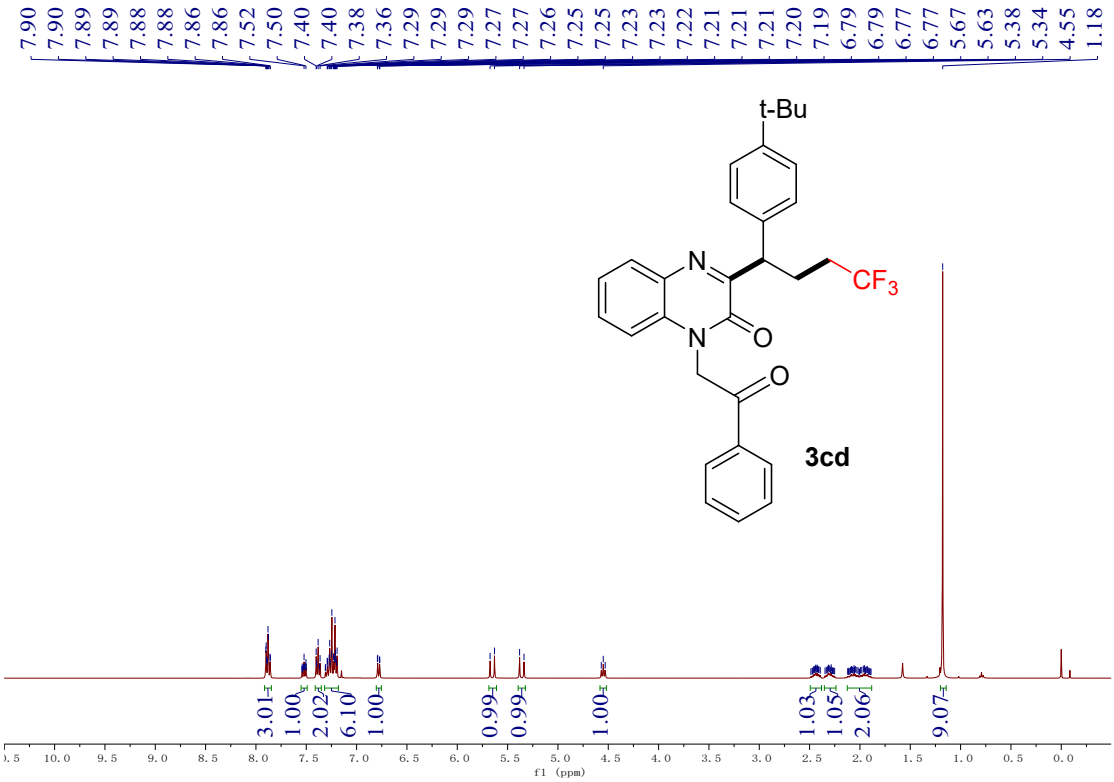

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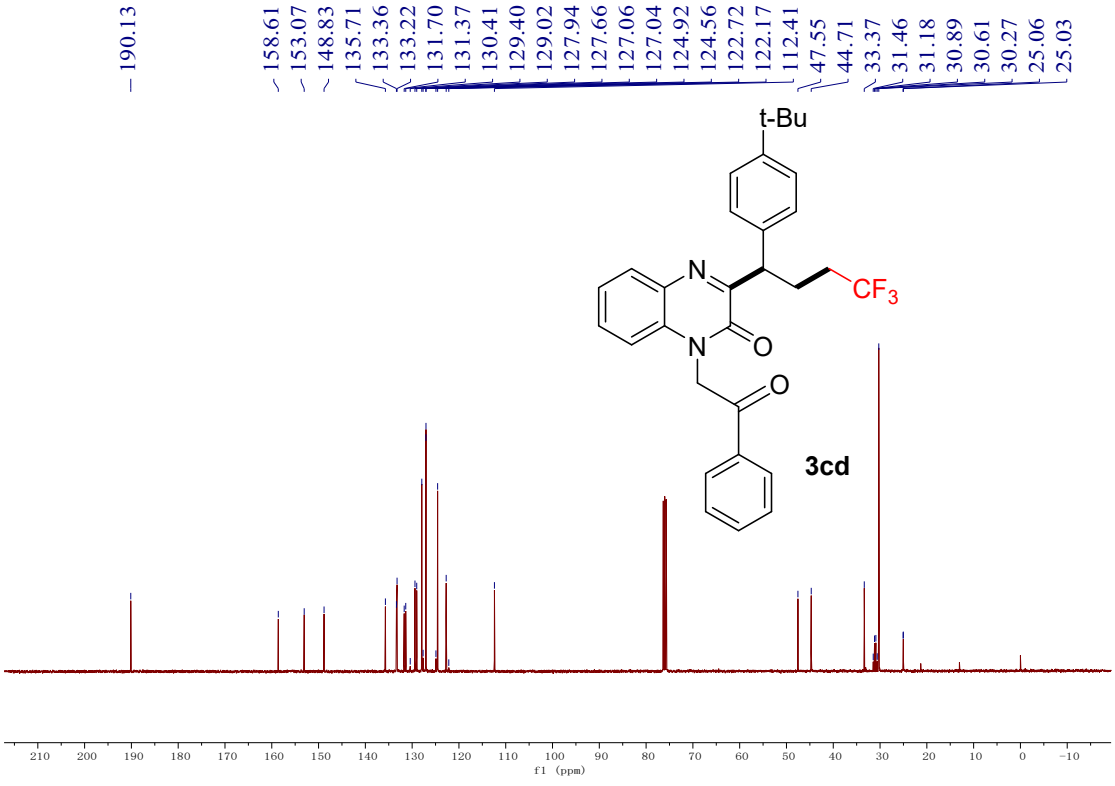

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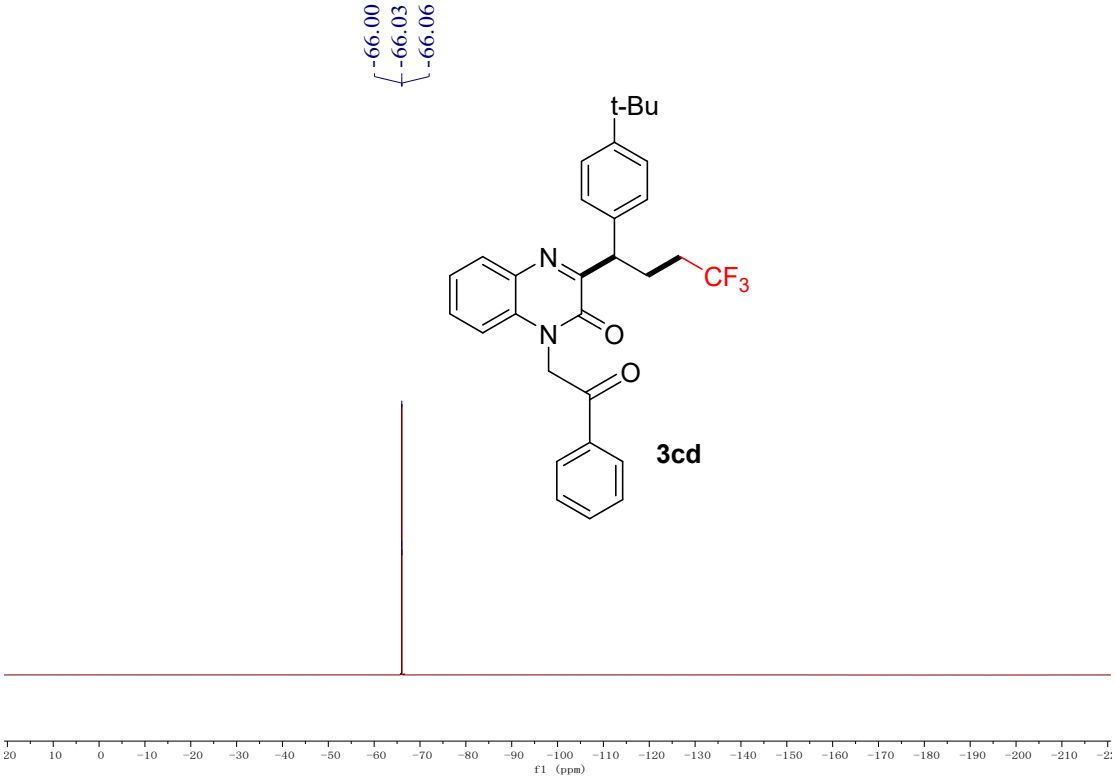

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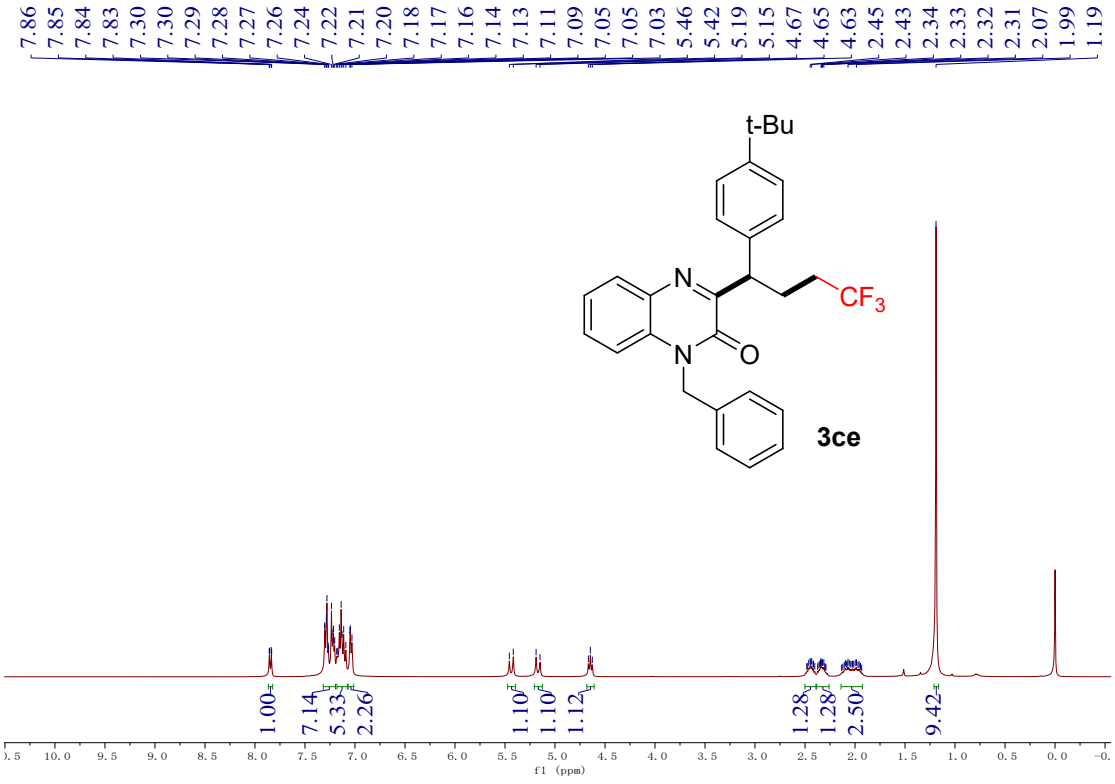

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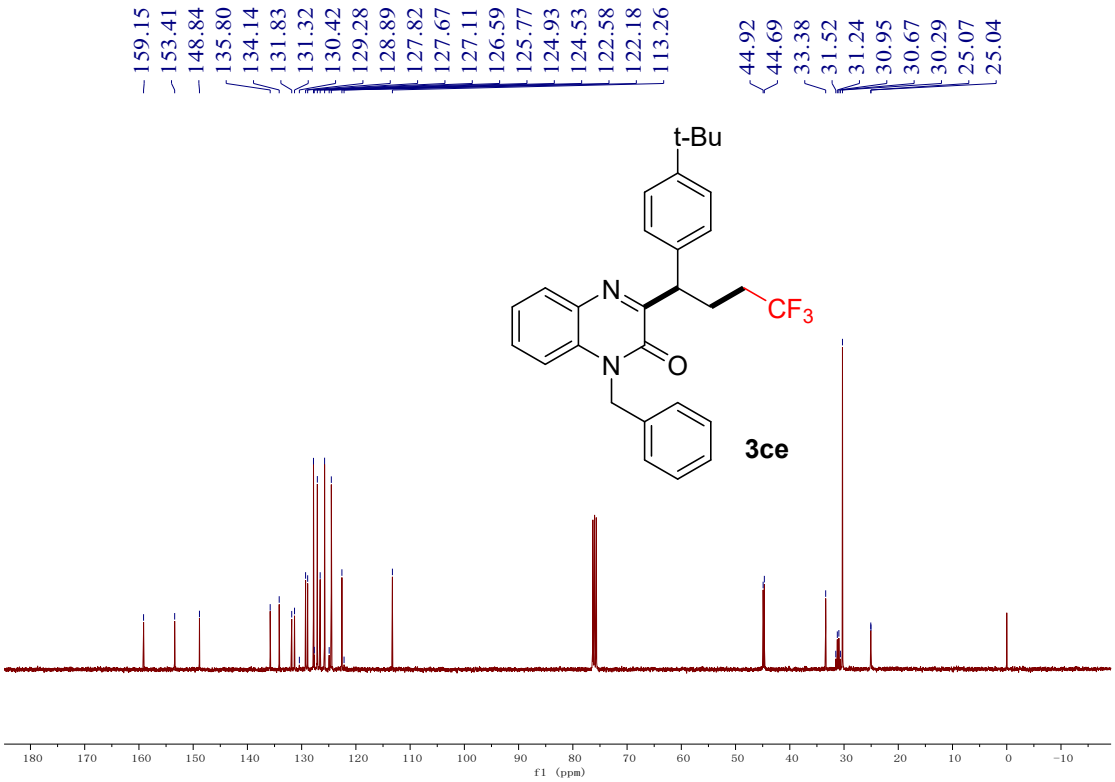

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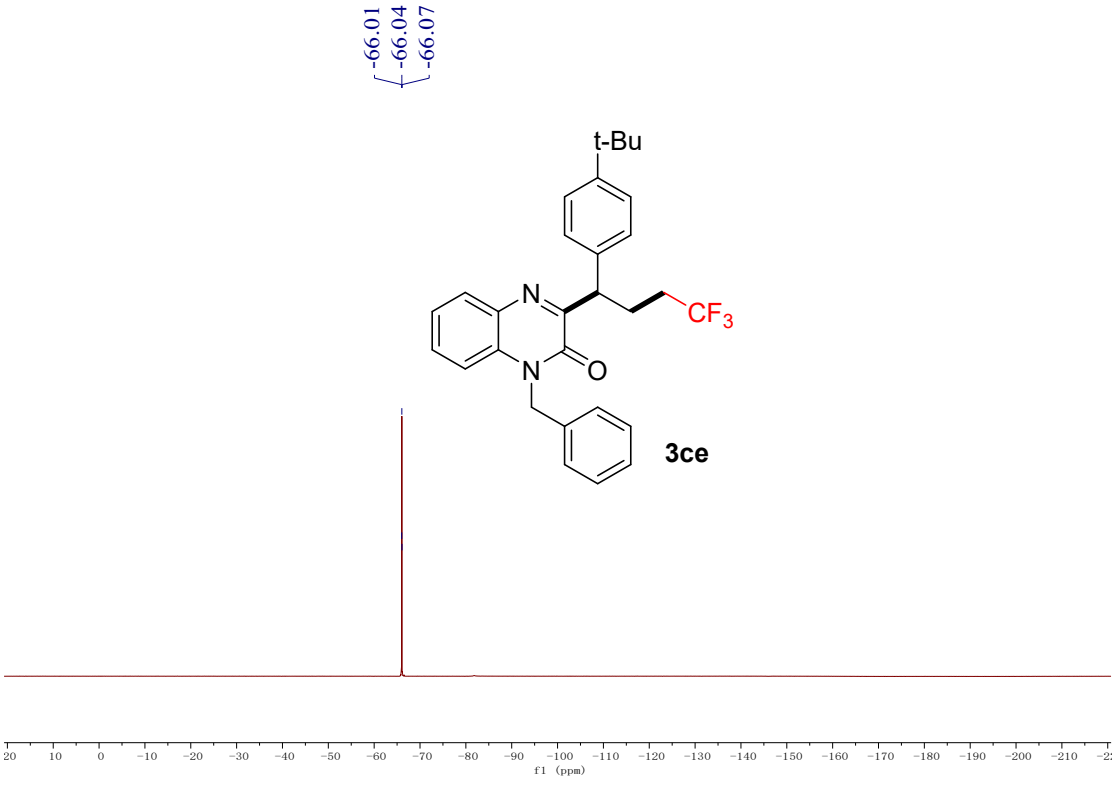

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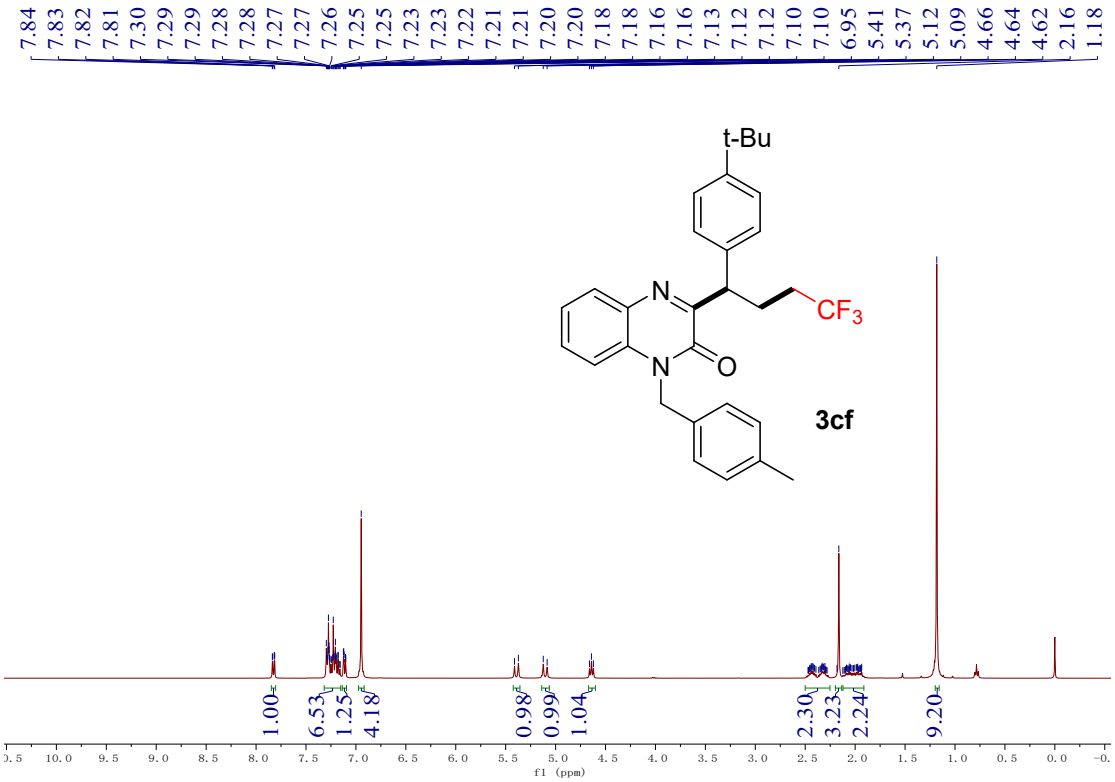

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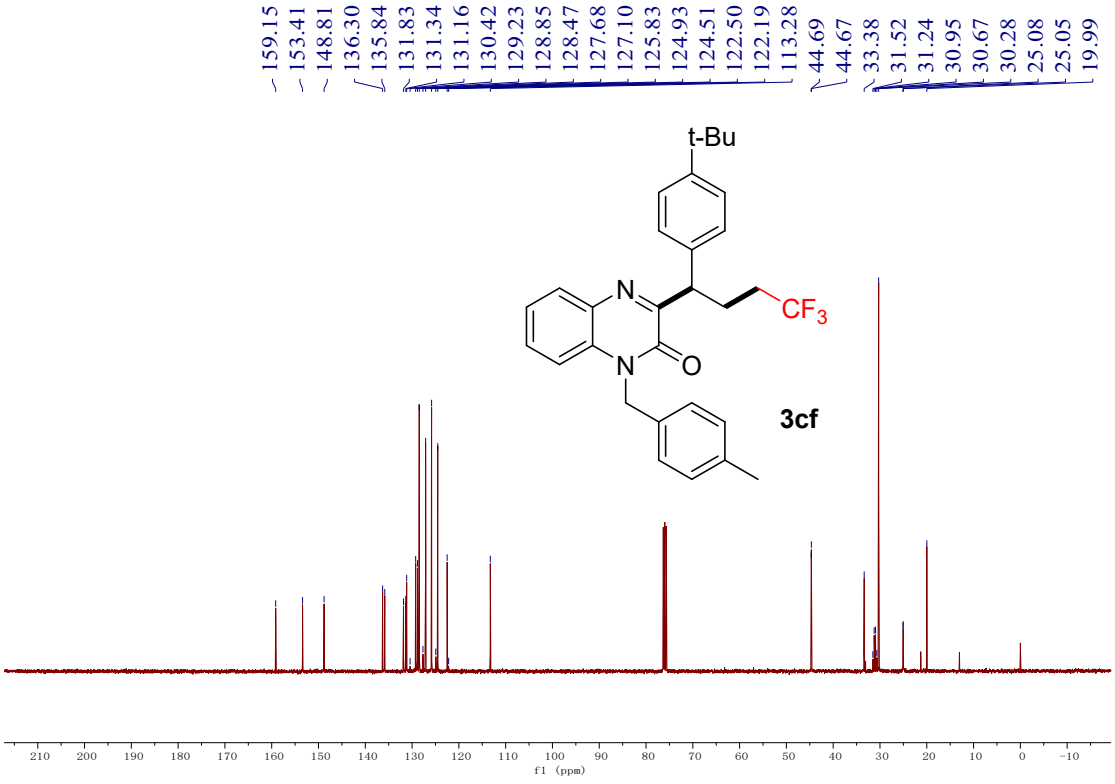

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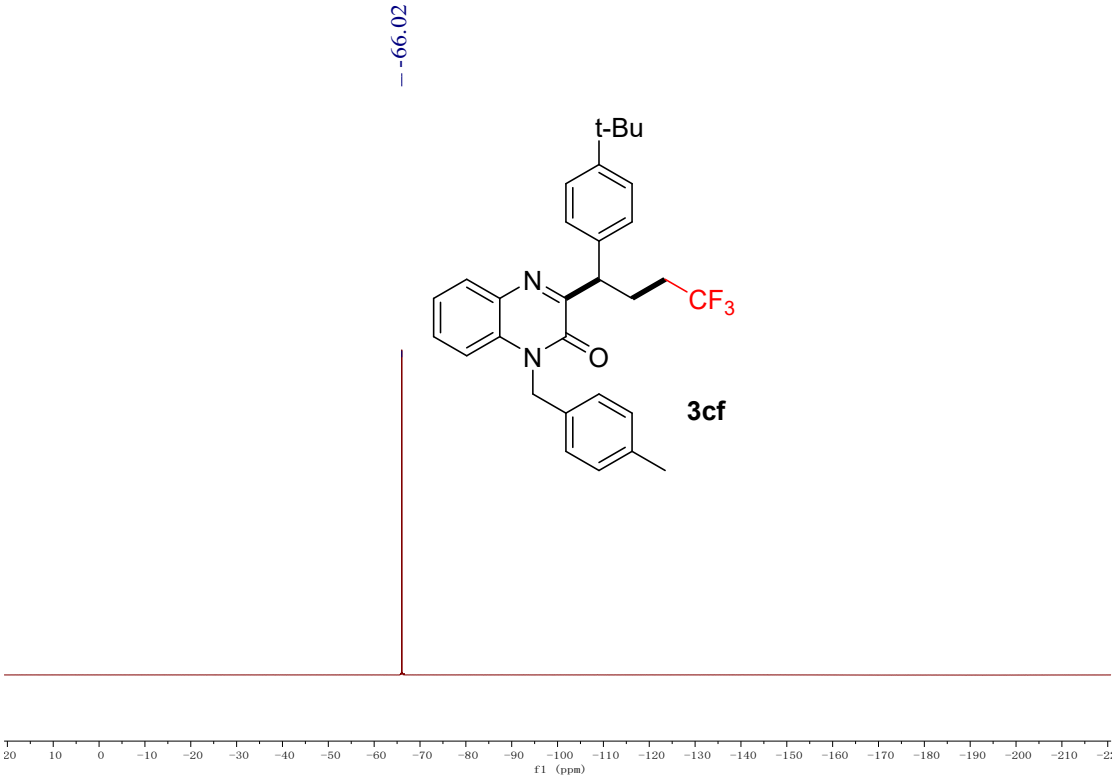

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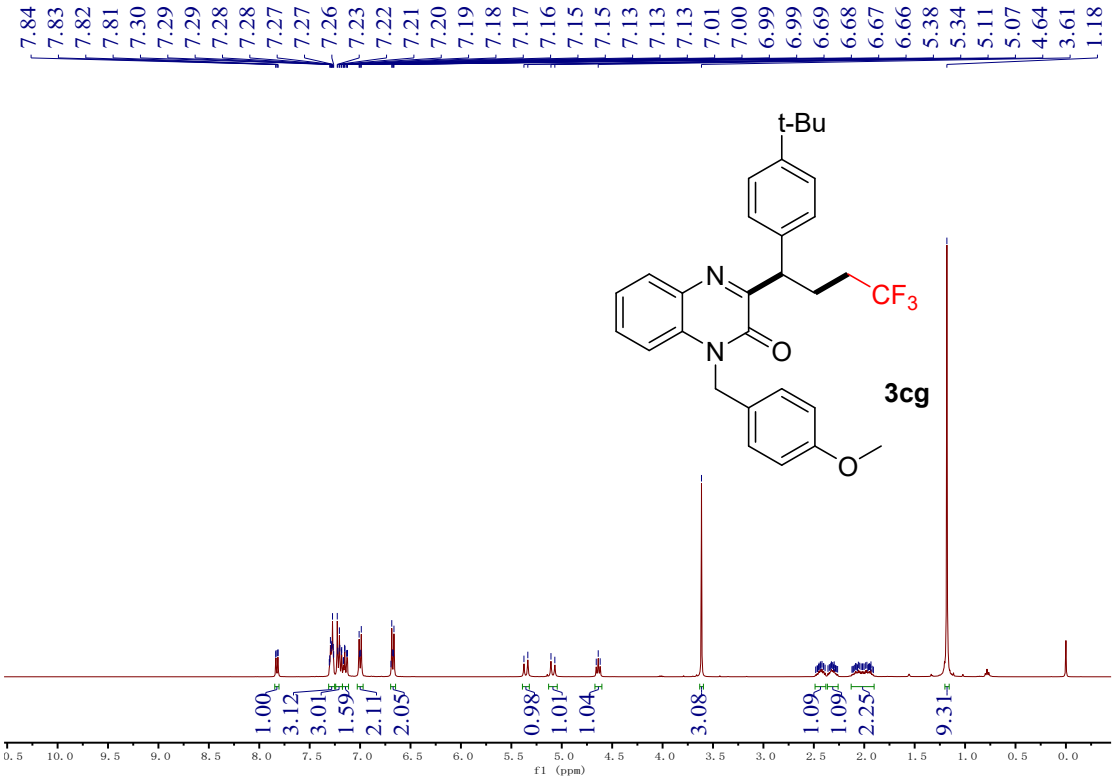

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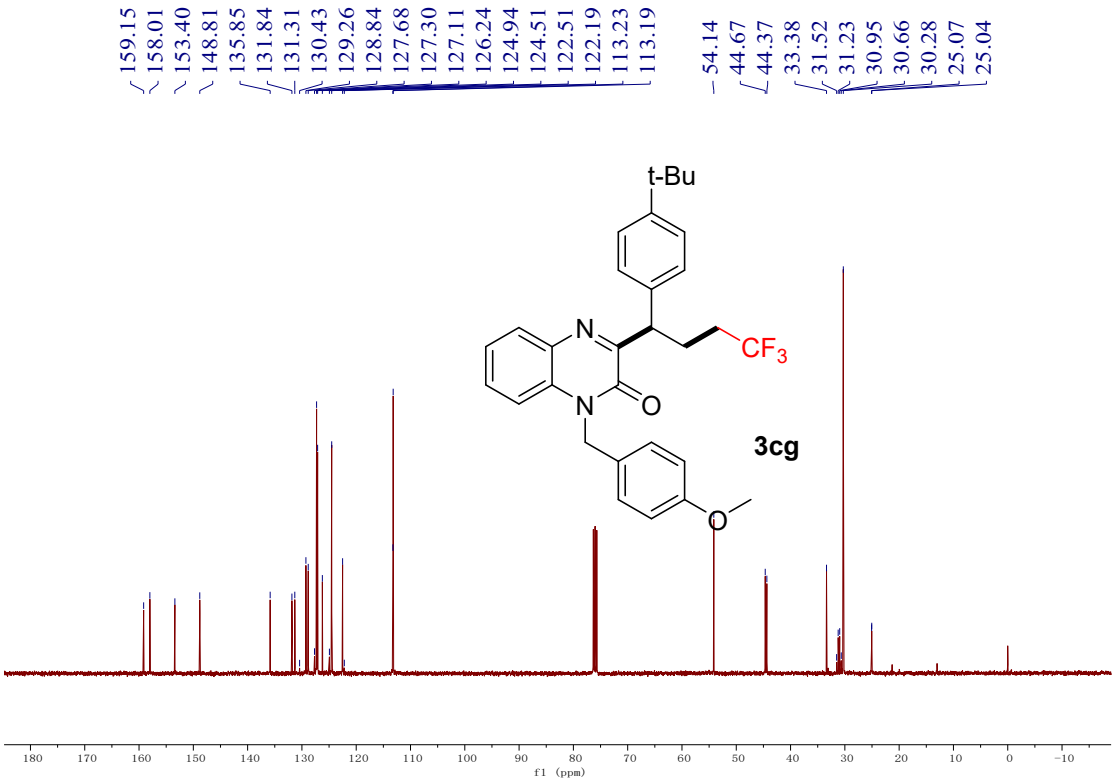
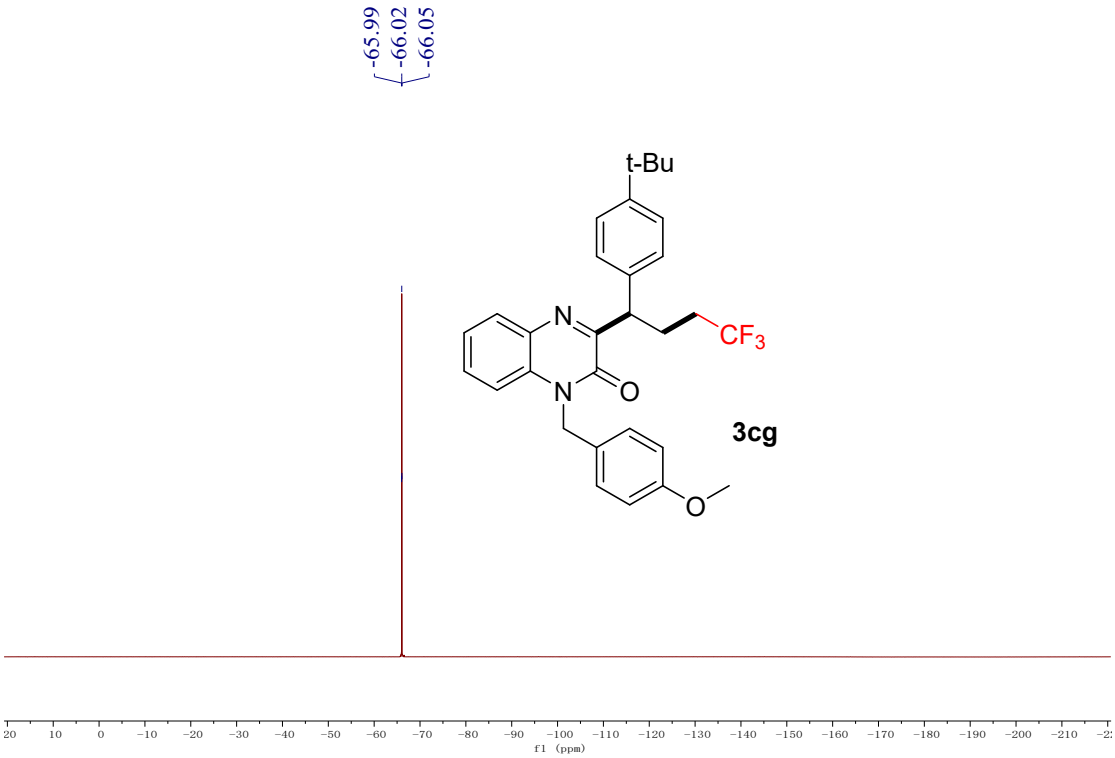
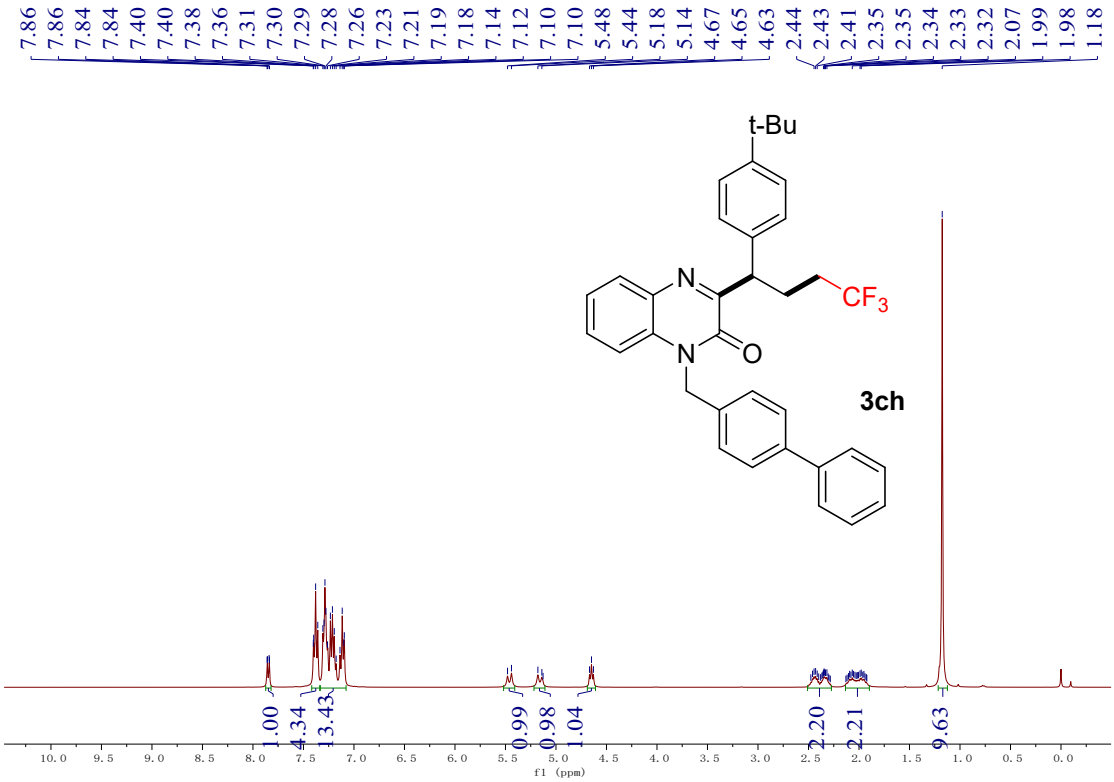


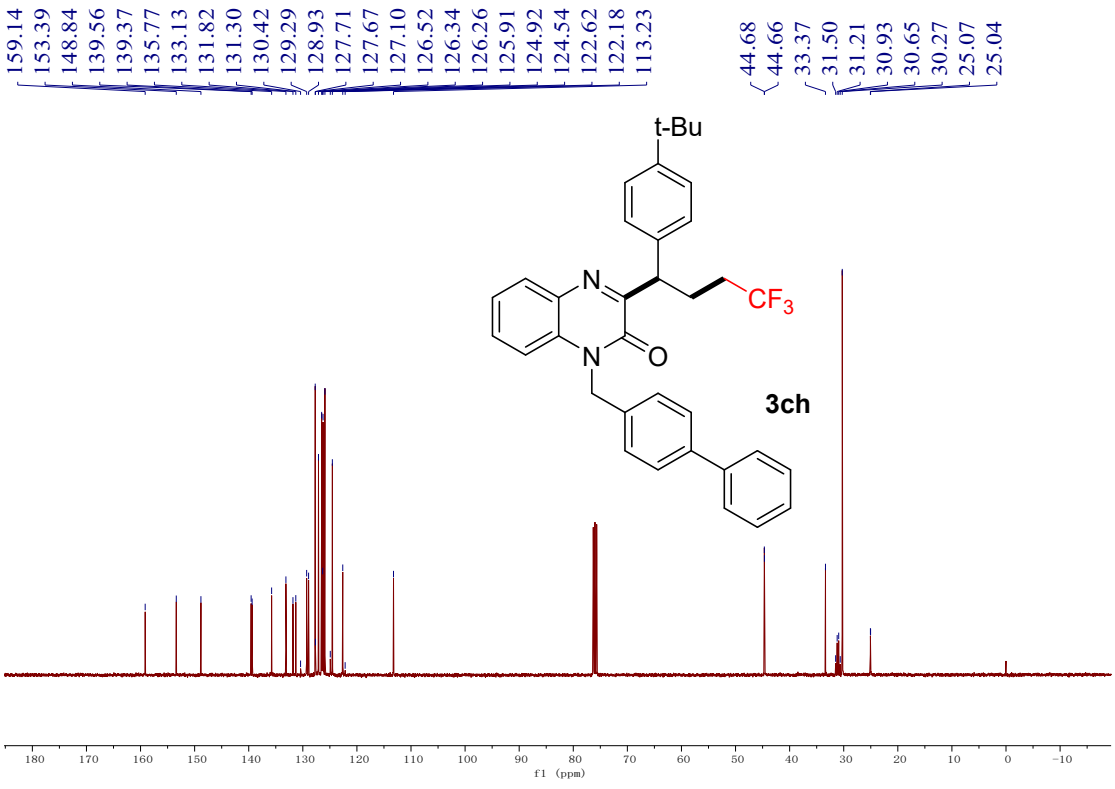
^{19}F NMR (377 MHz, $CDCl_3$)



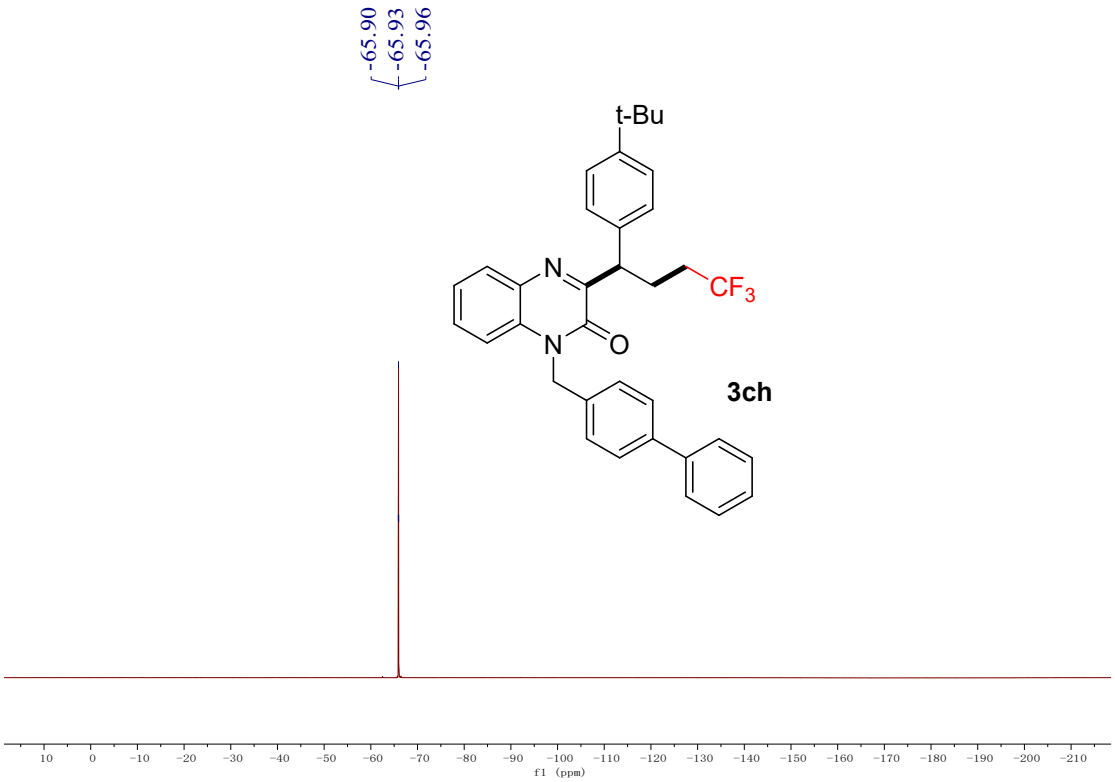
^{1}H NMR (400 MHz, $CDCl_3$)



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



^{19}F NMR (377 MHz, $CDCl_3$)



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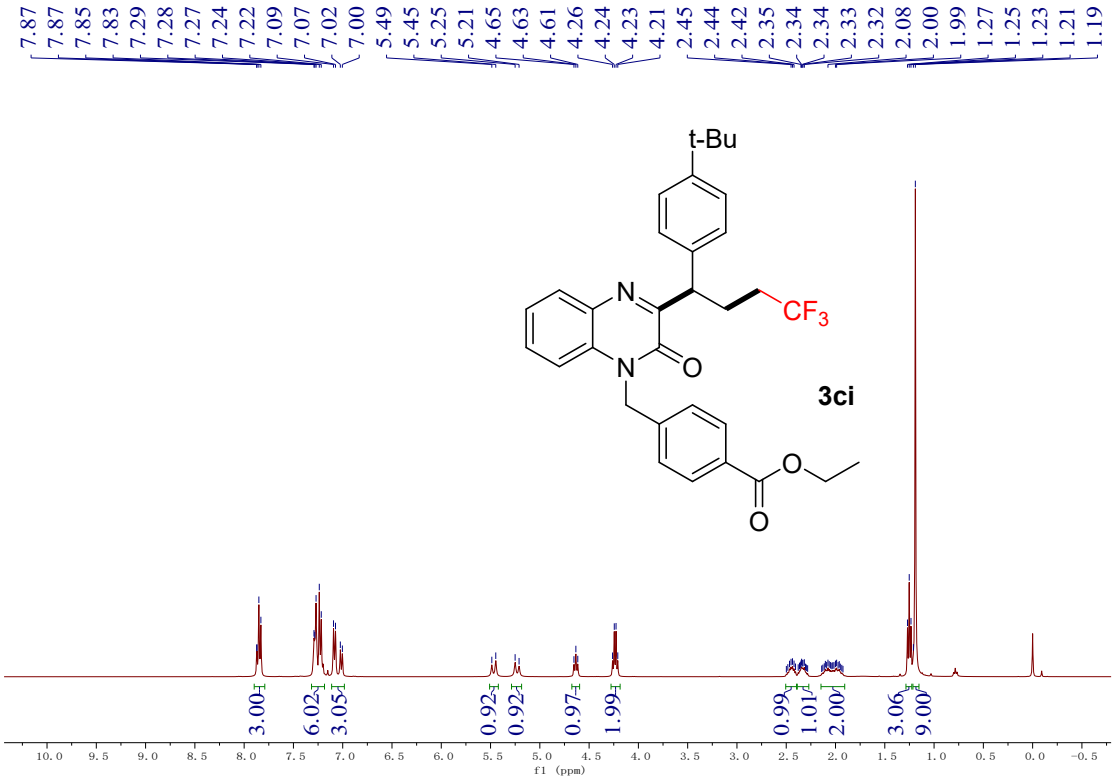

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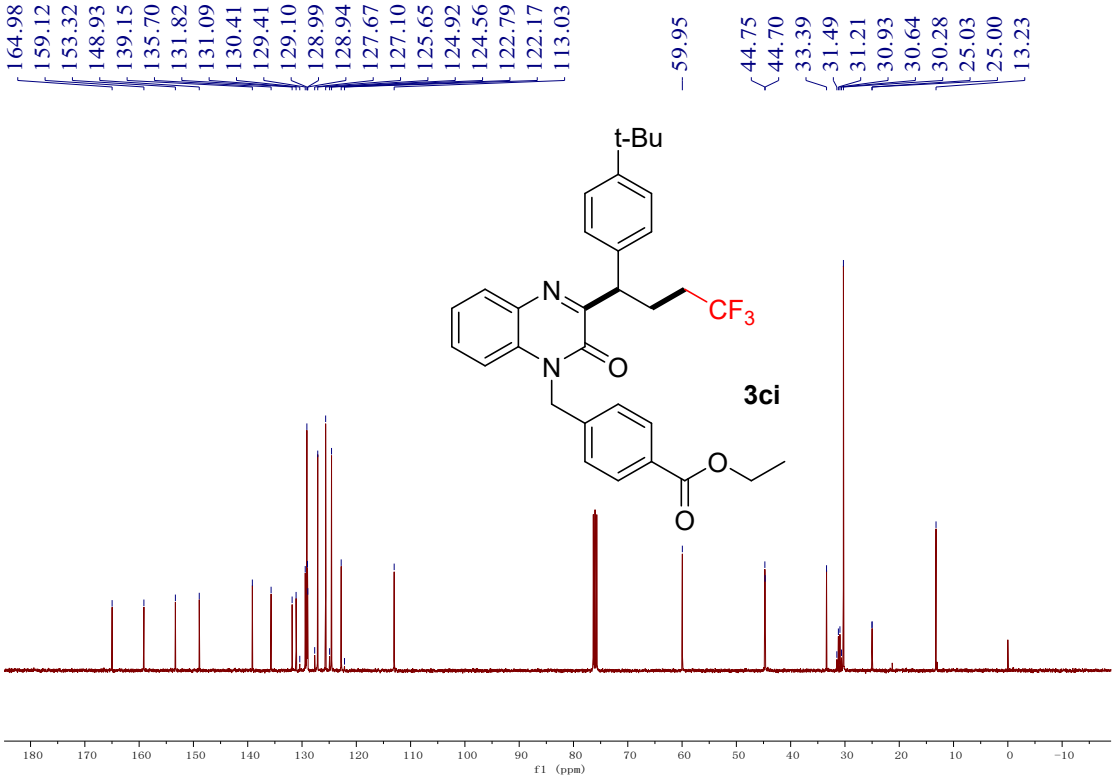

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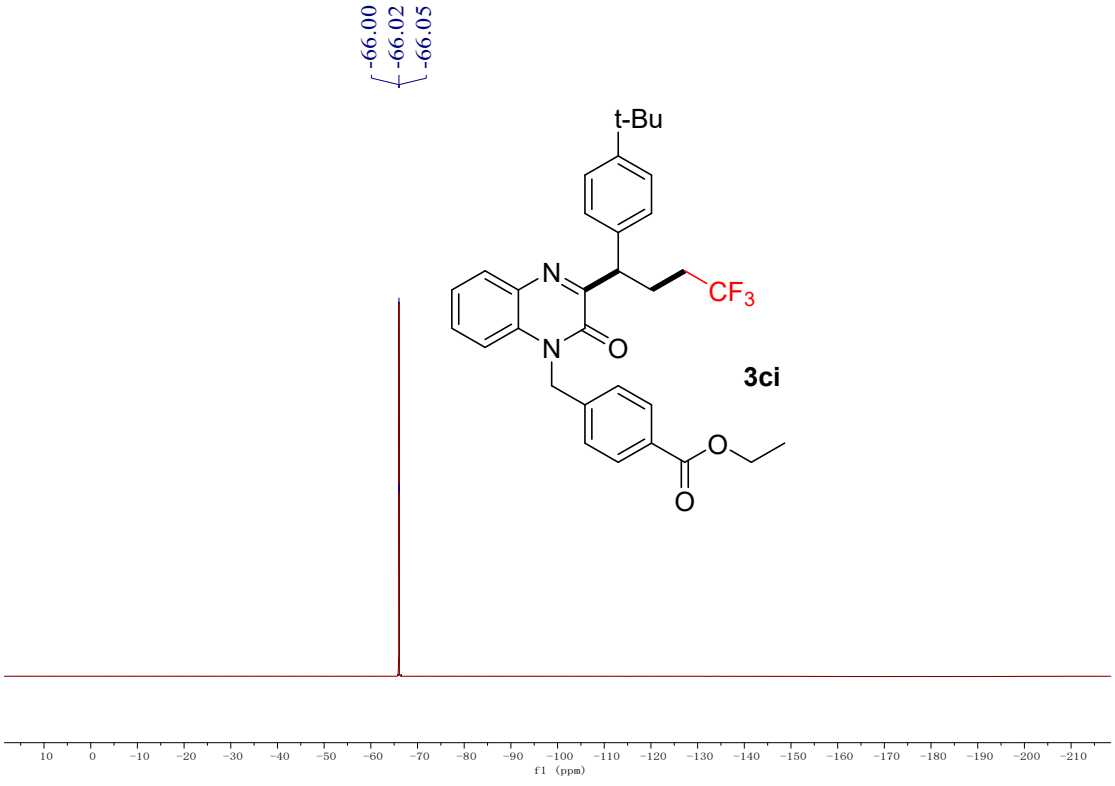

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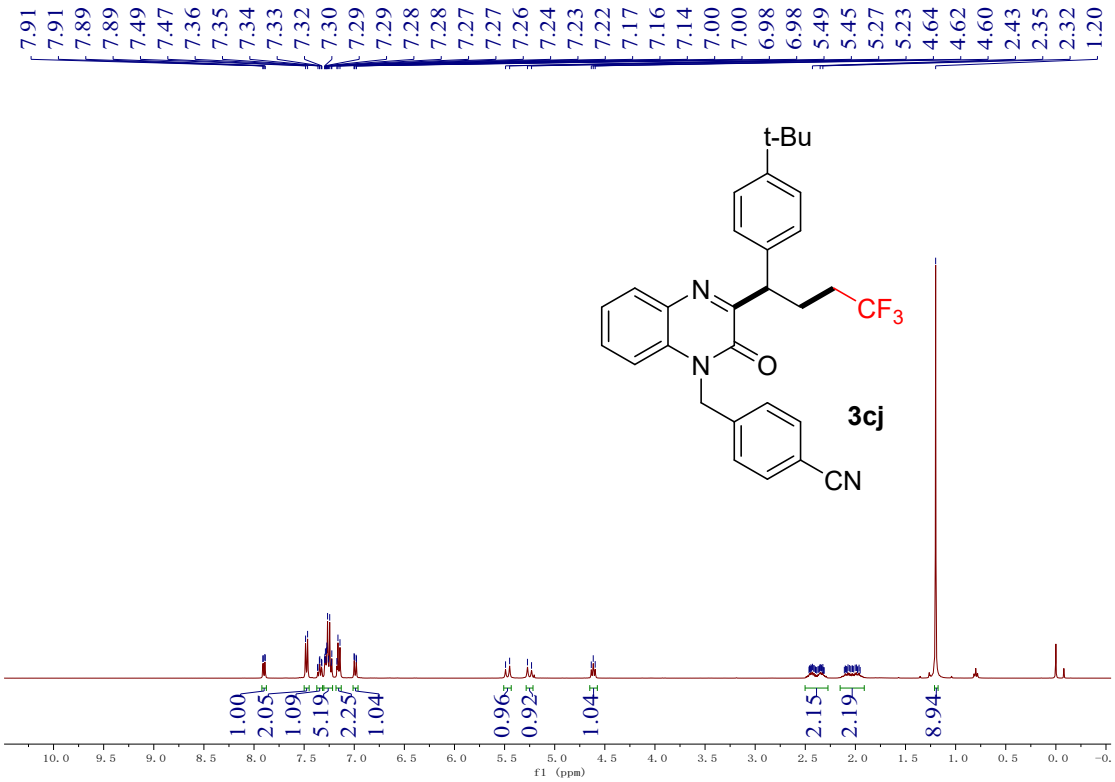

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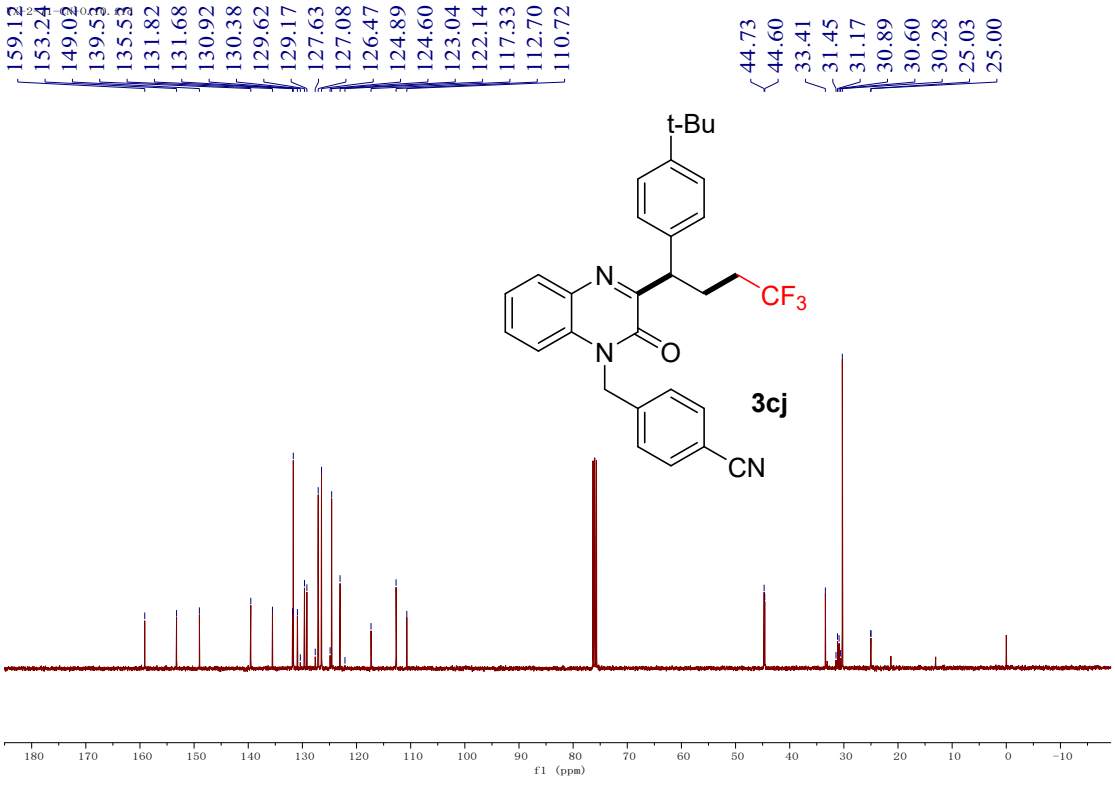

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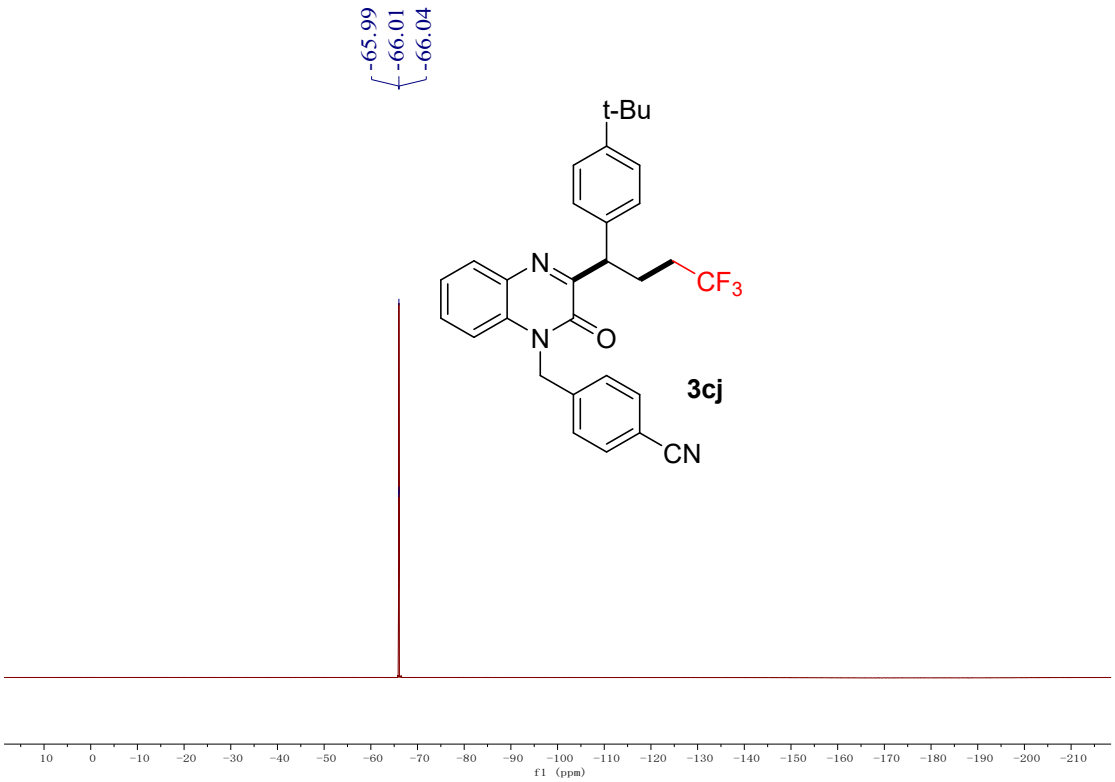

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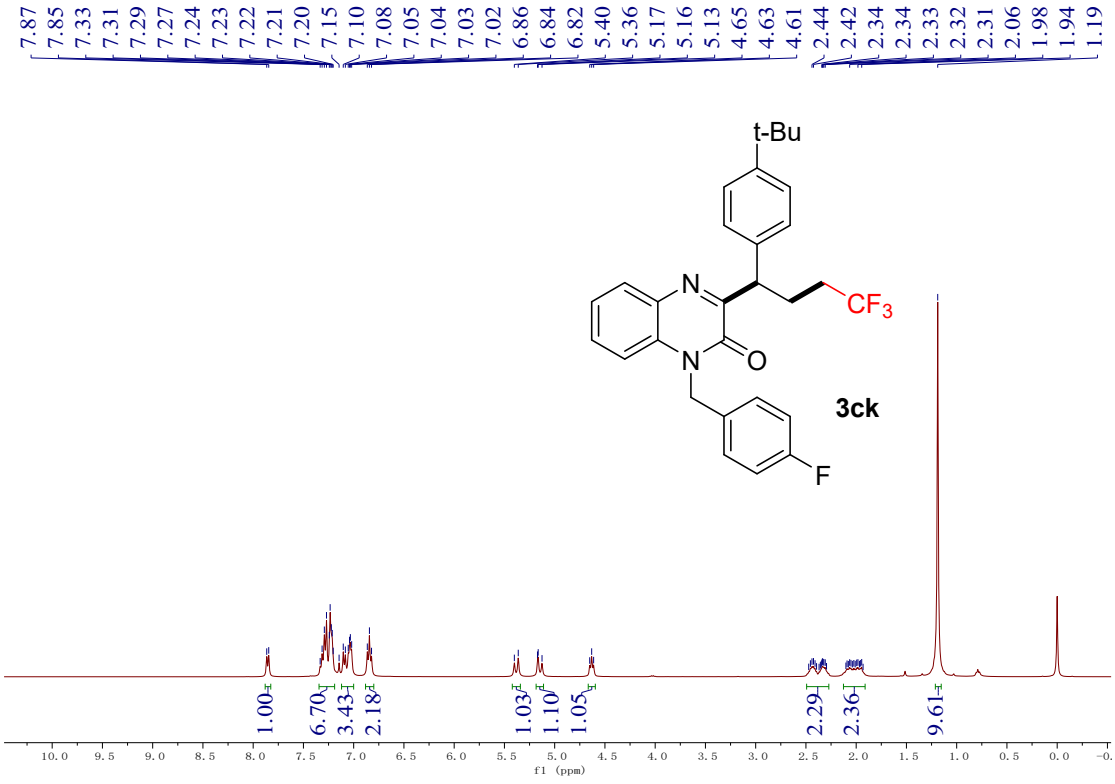

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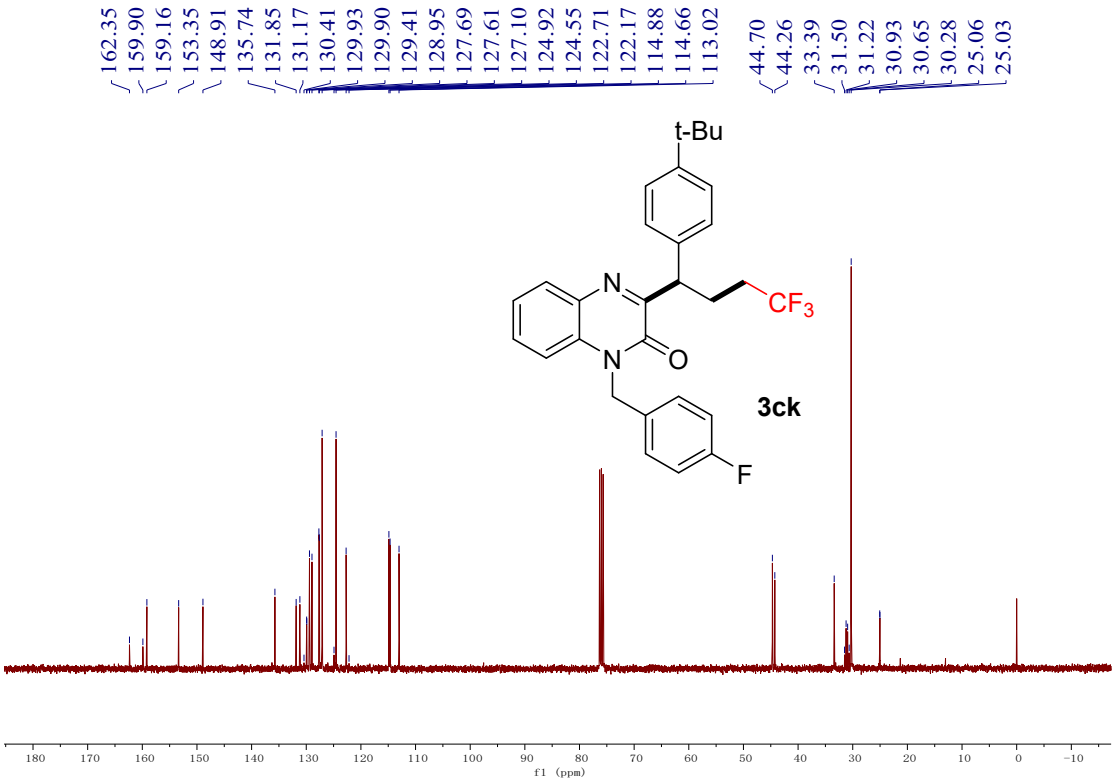

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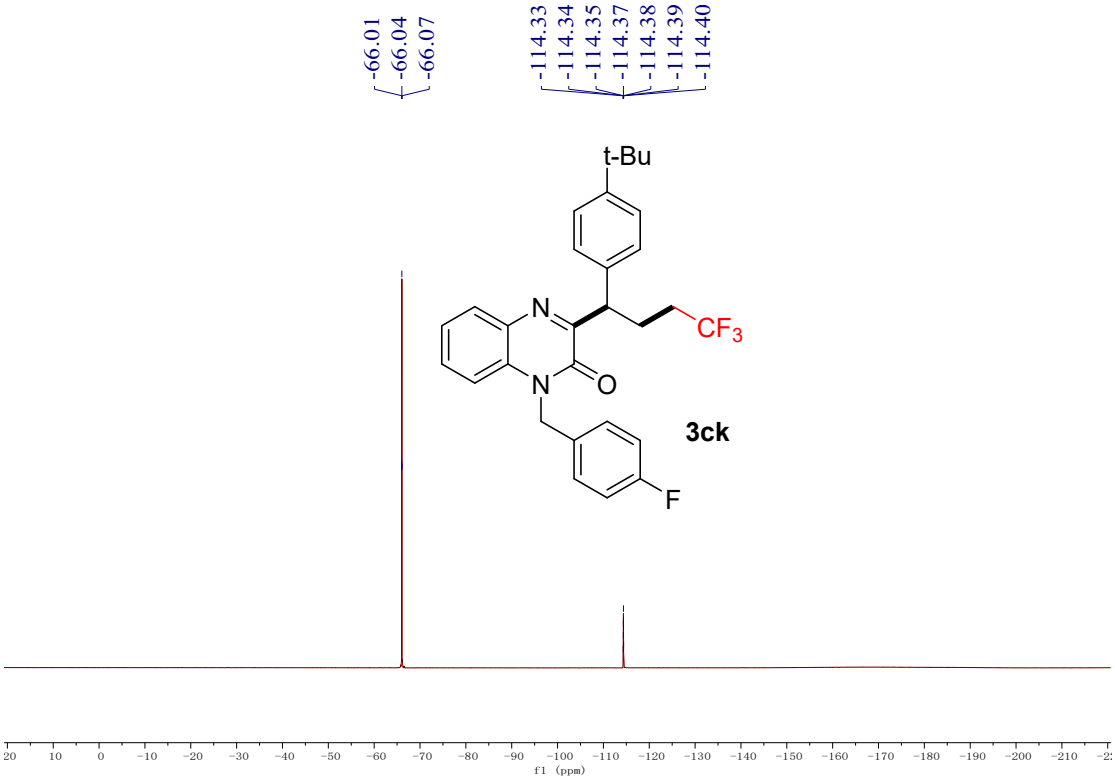

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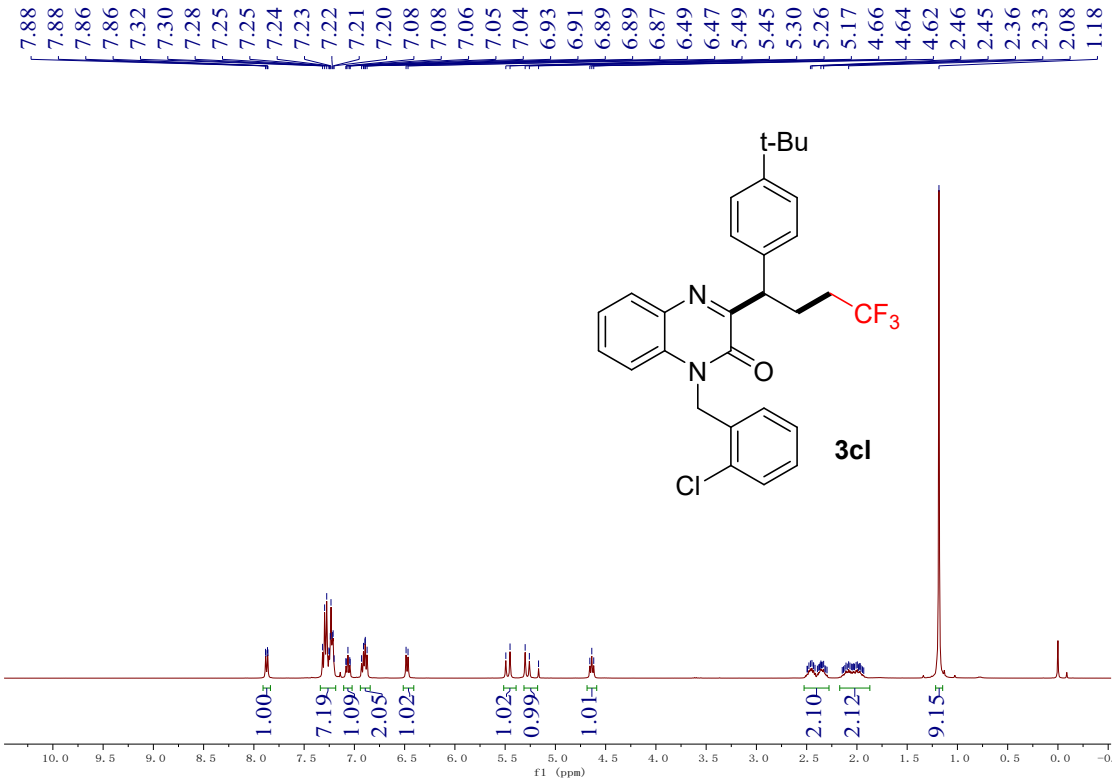

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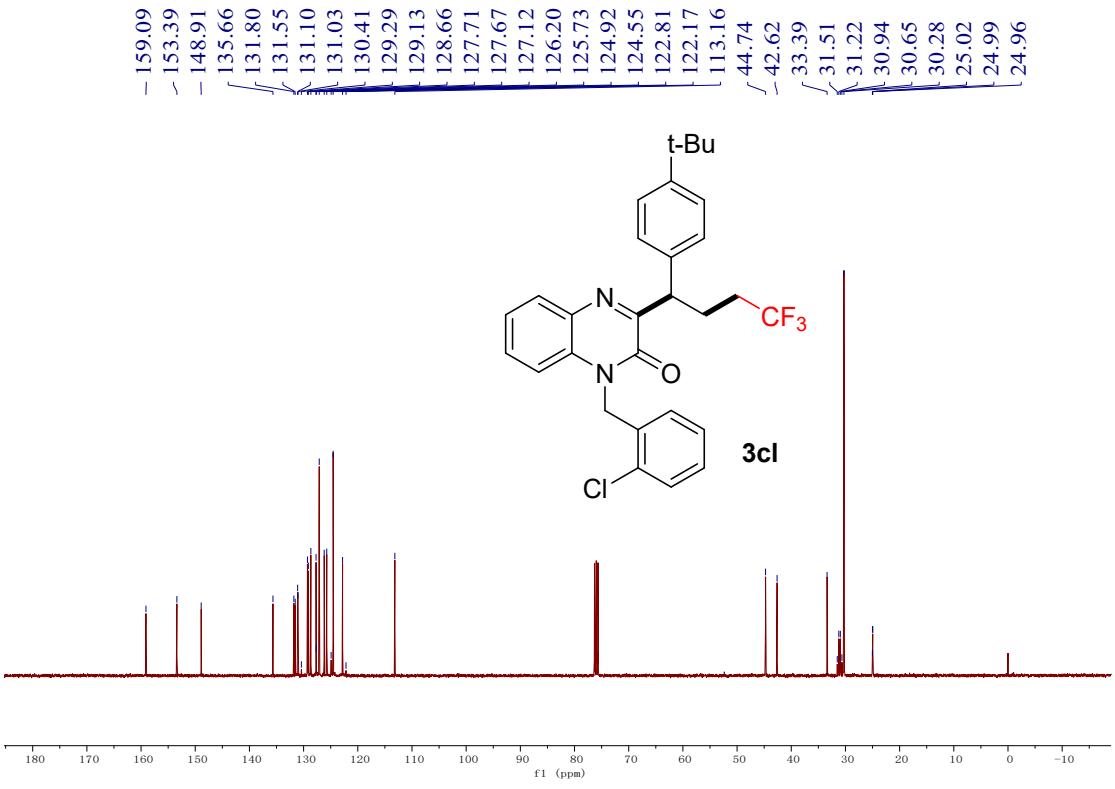

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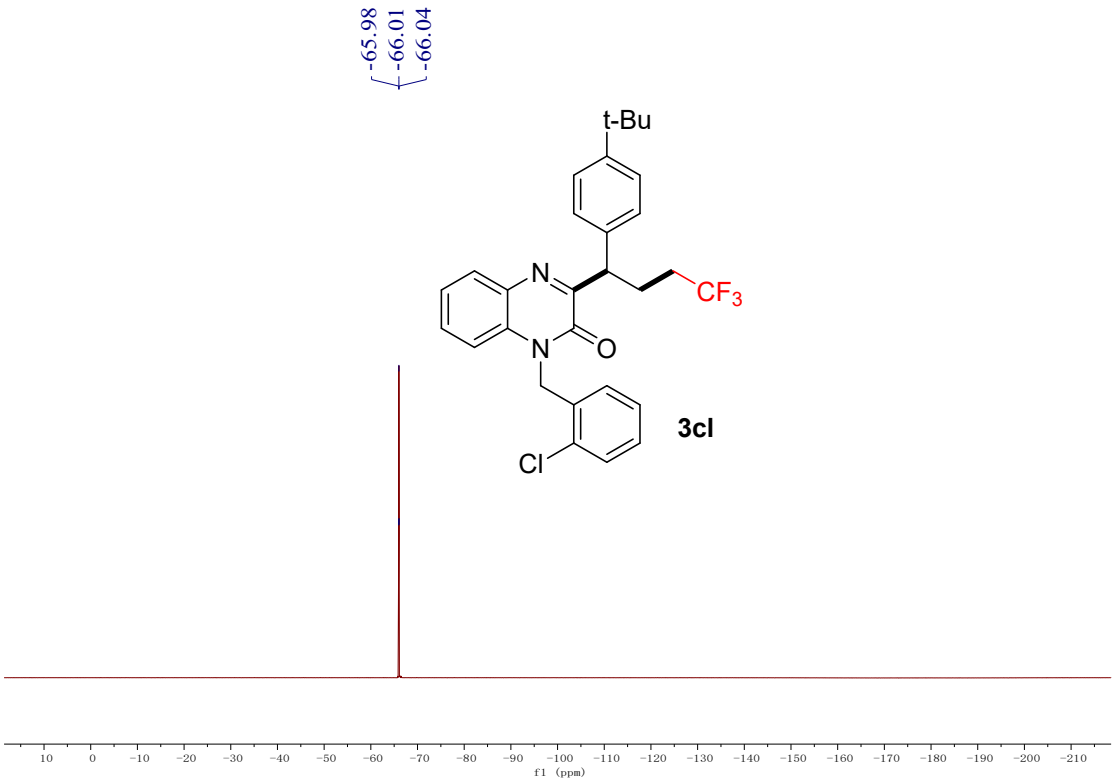

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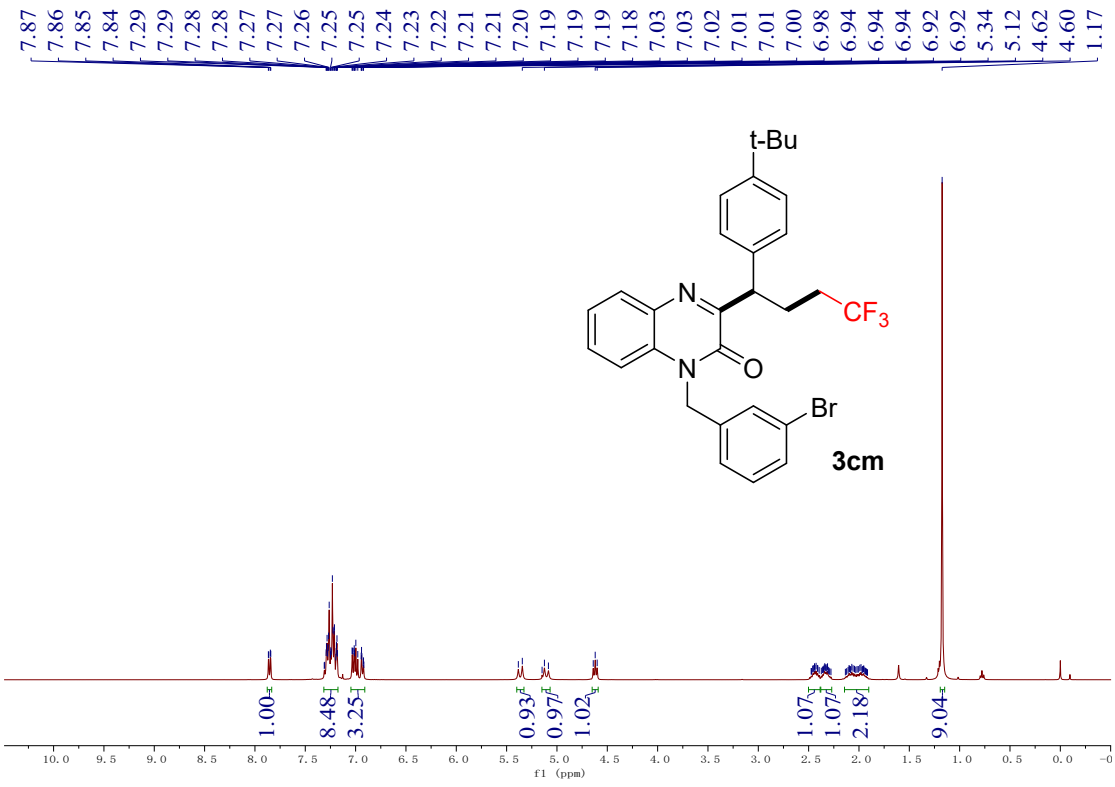

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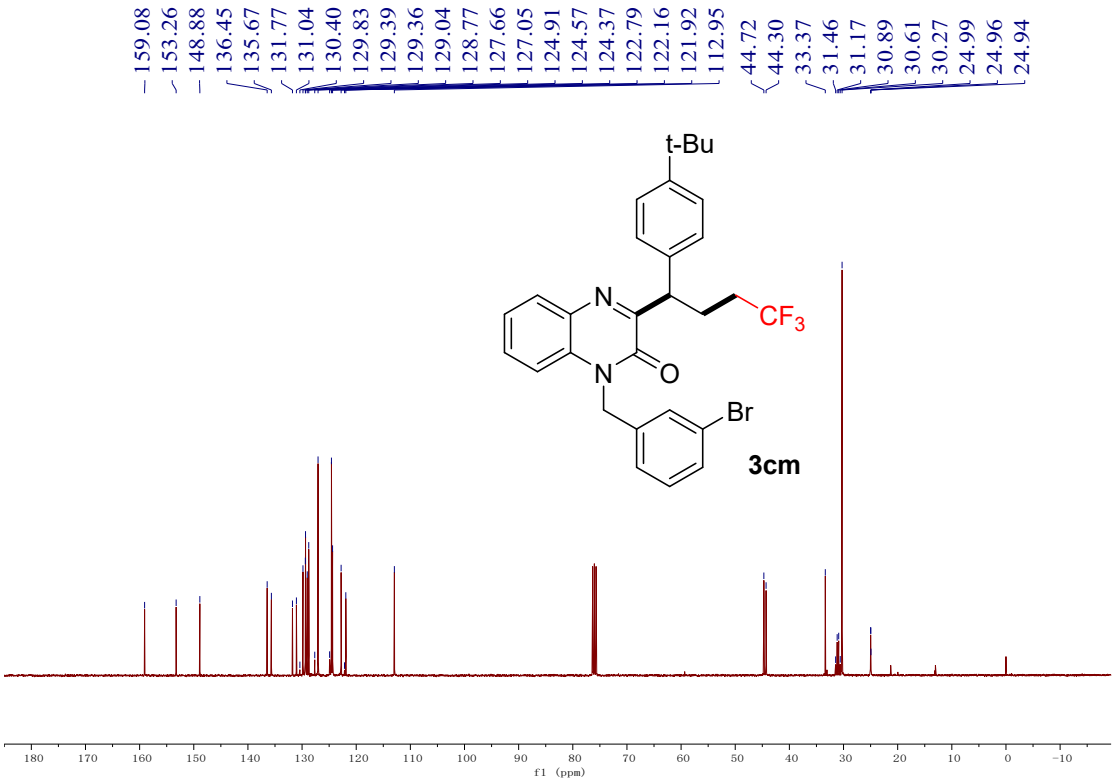

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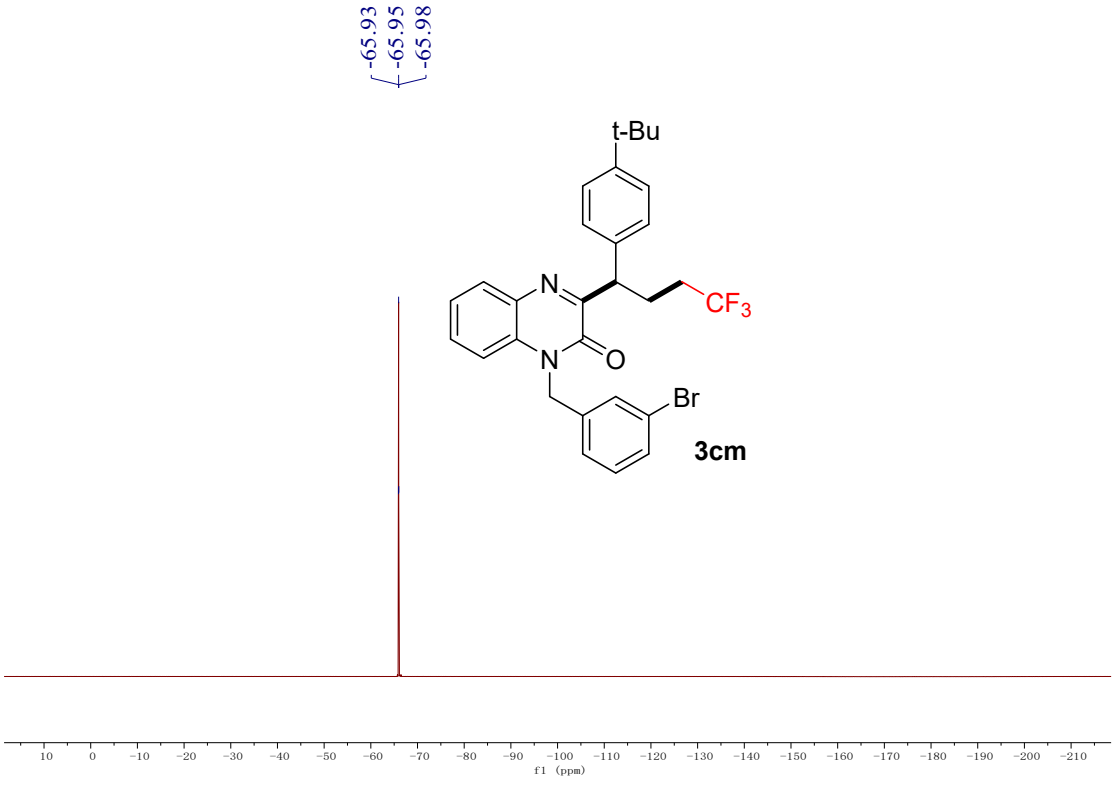

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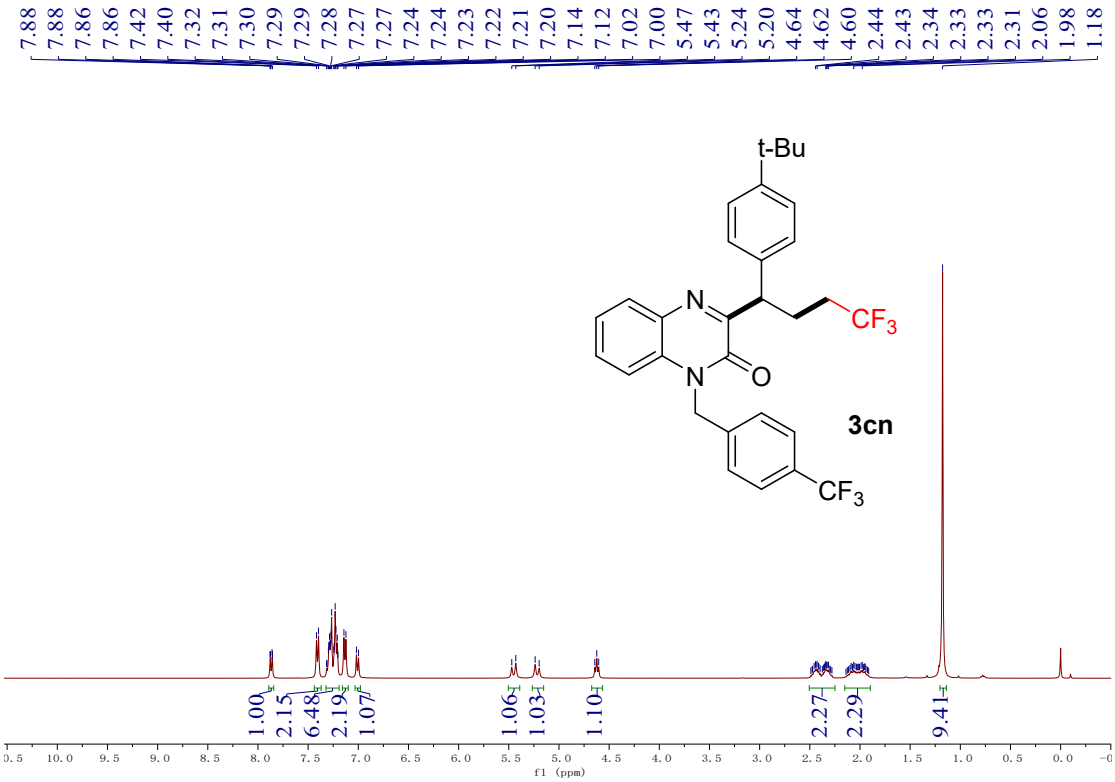

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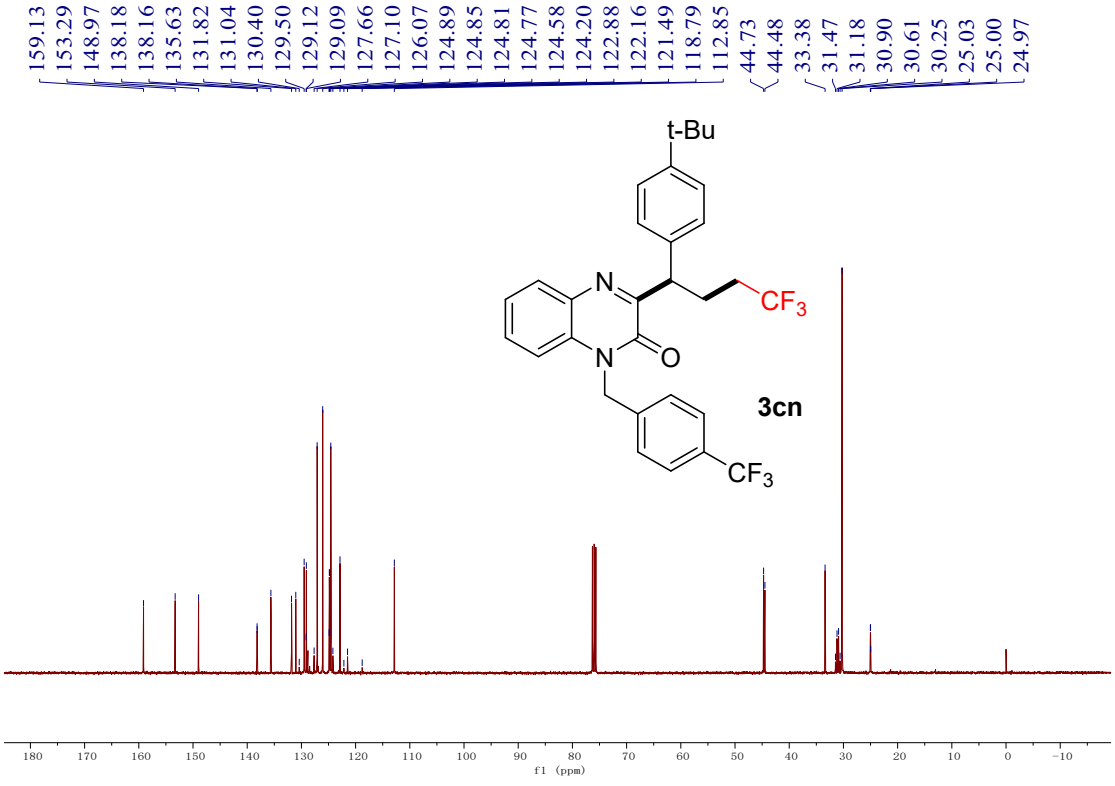

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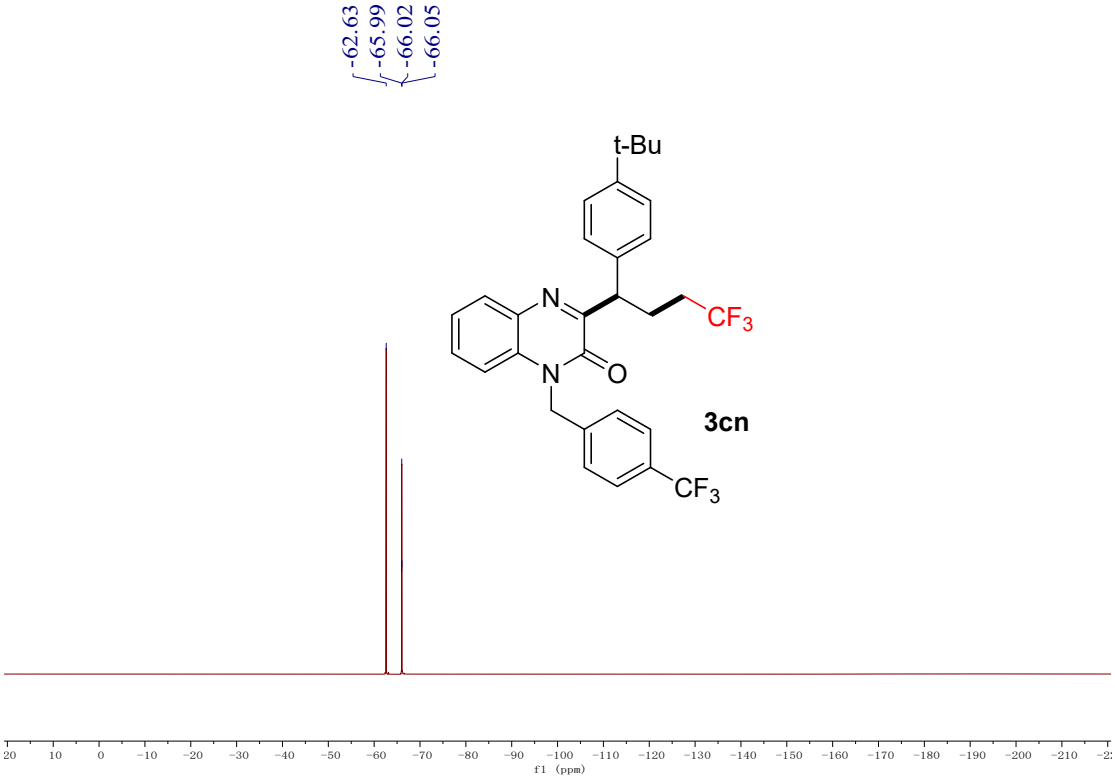

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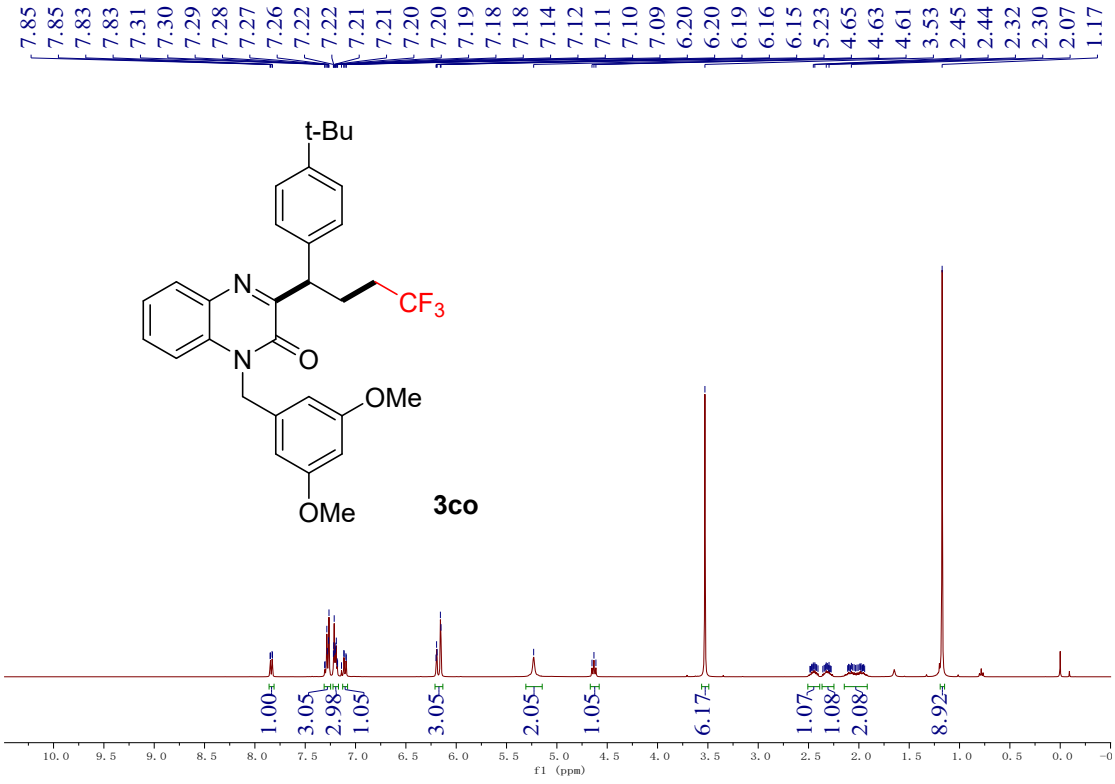

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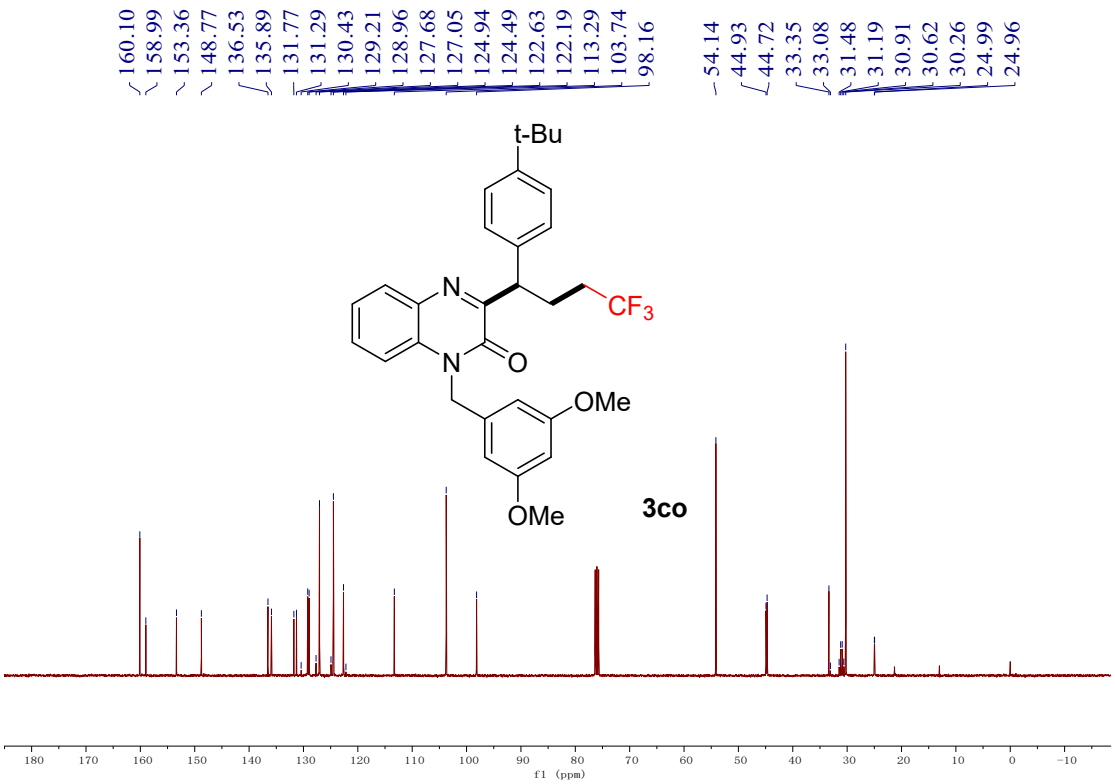

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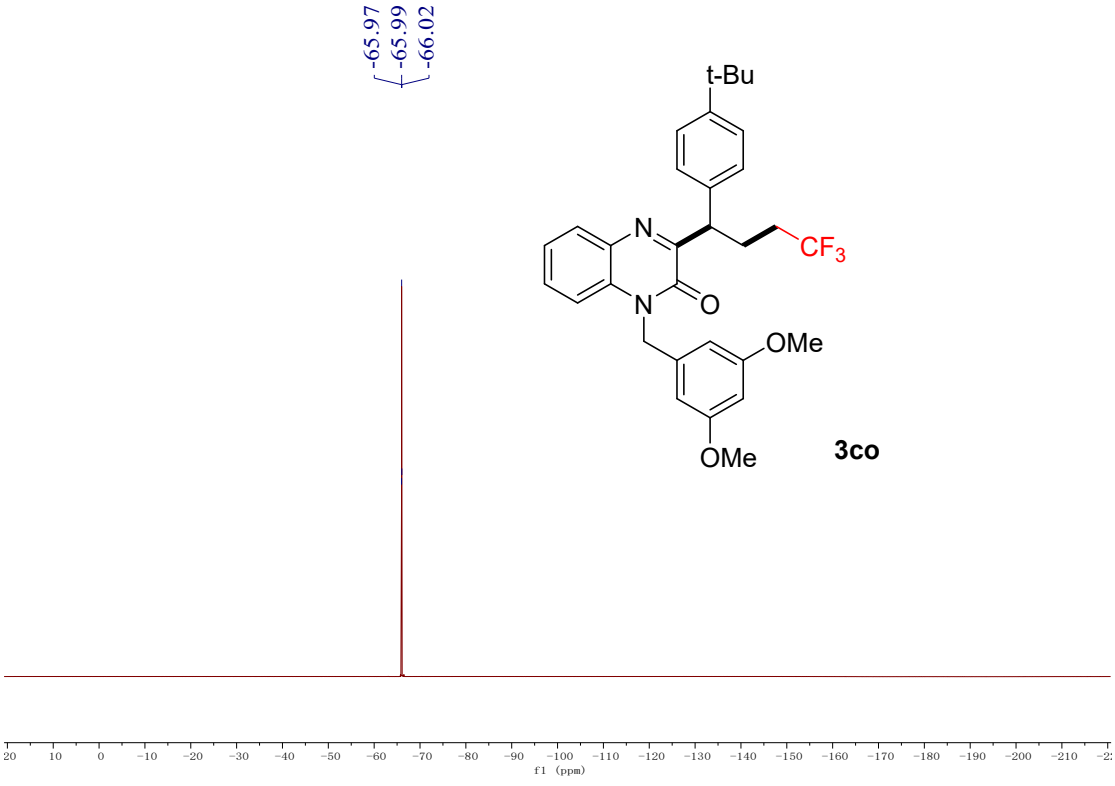

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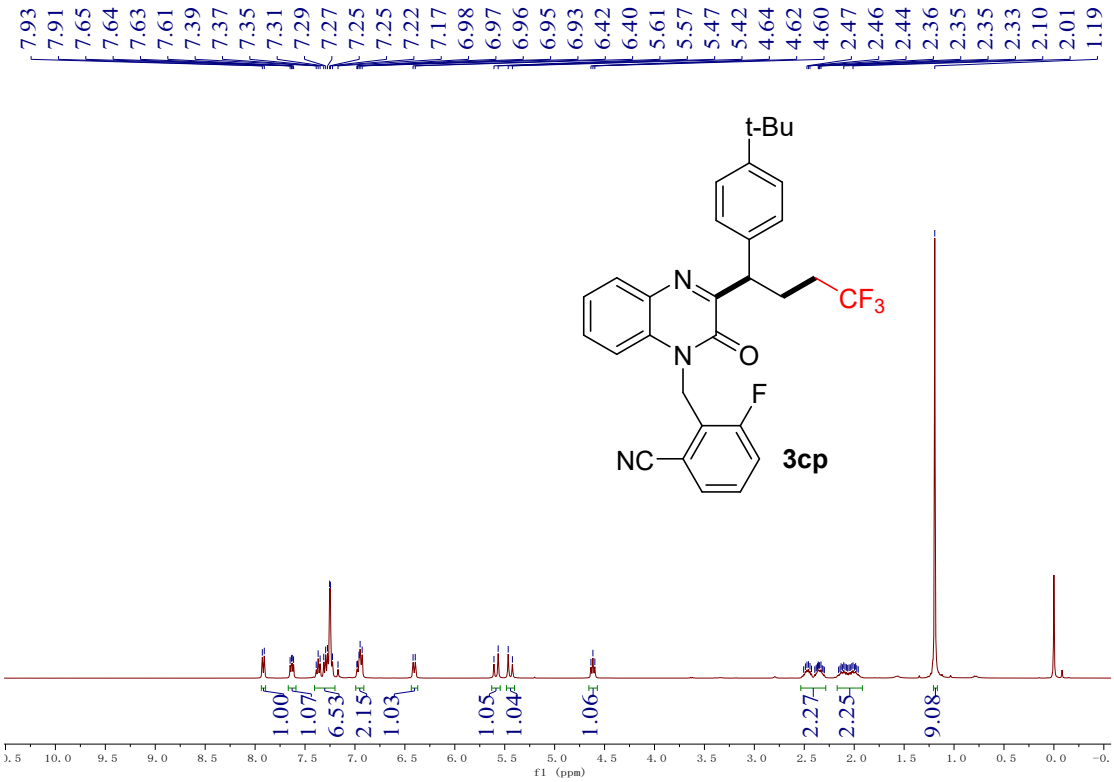

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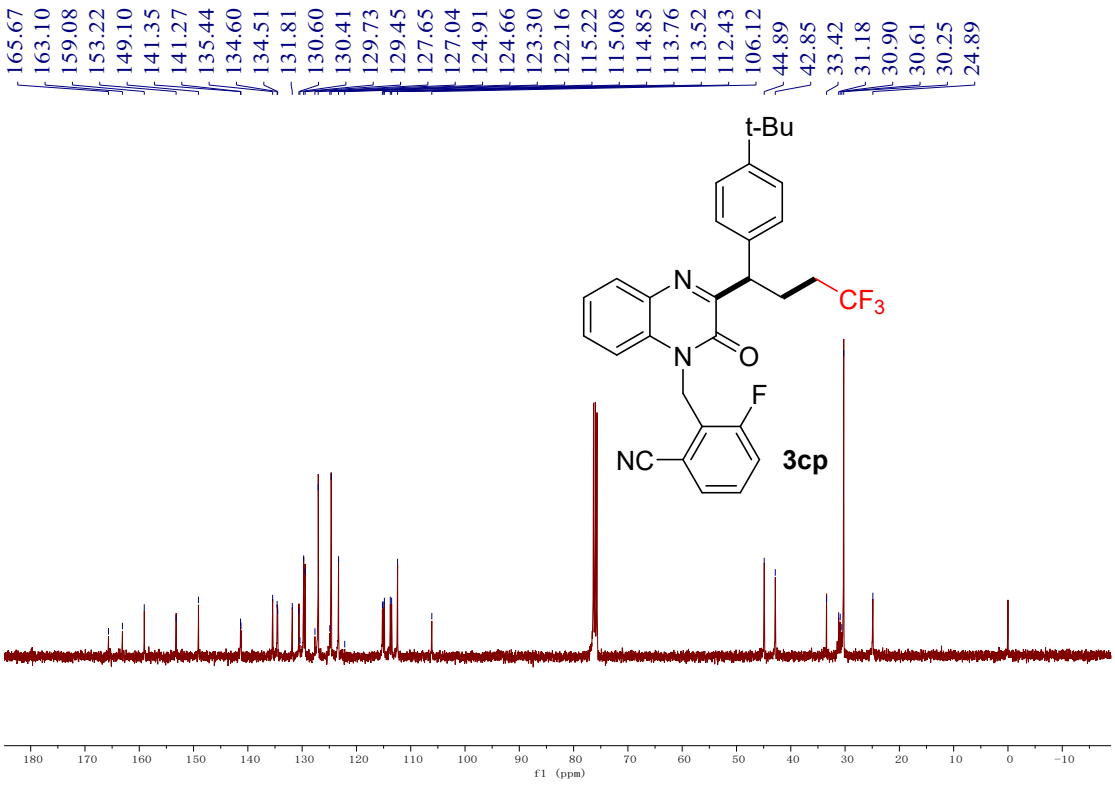

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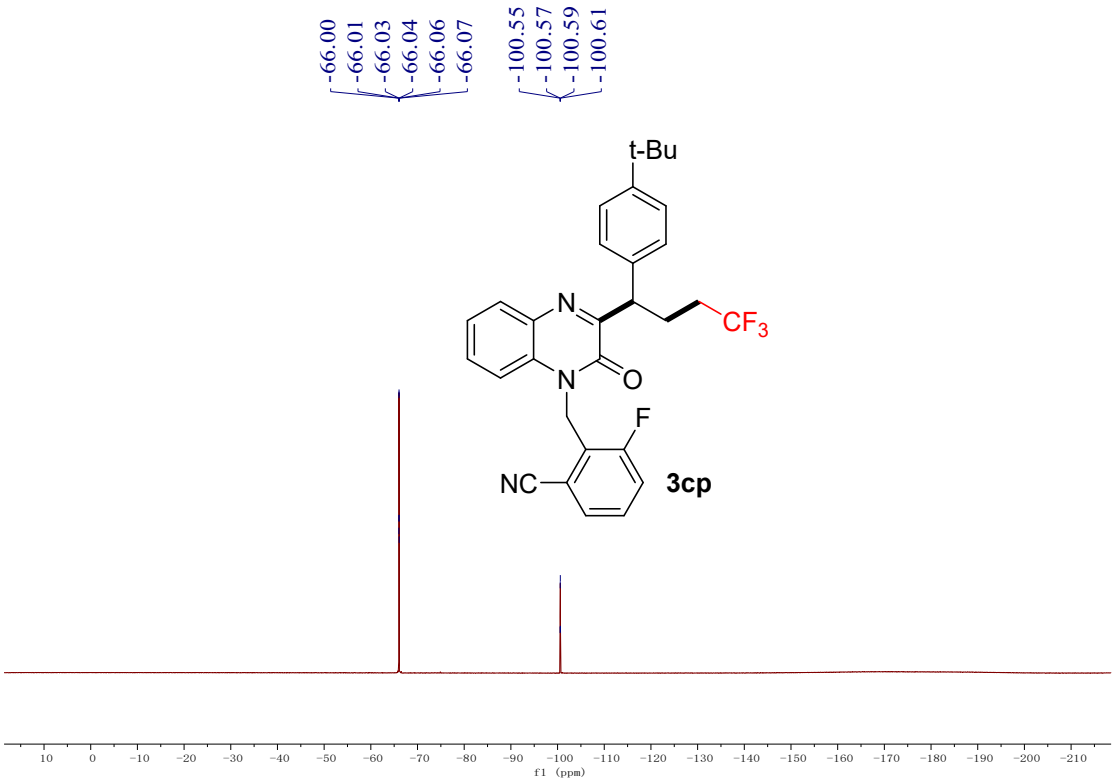

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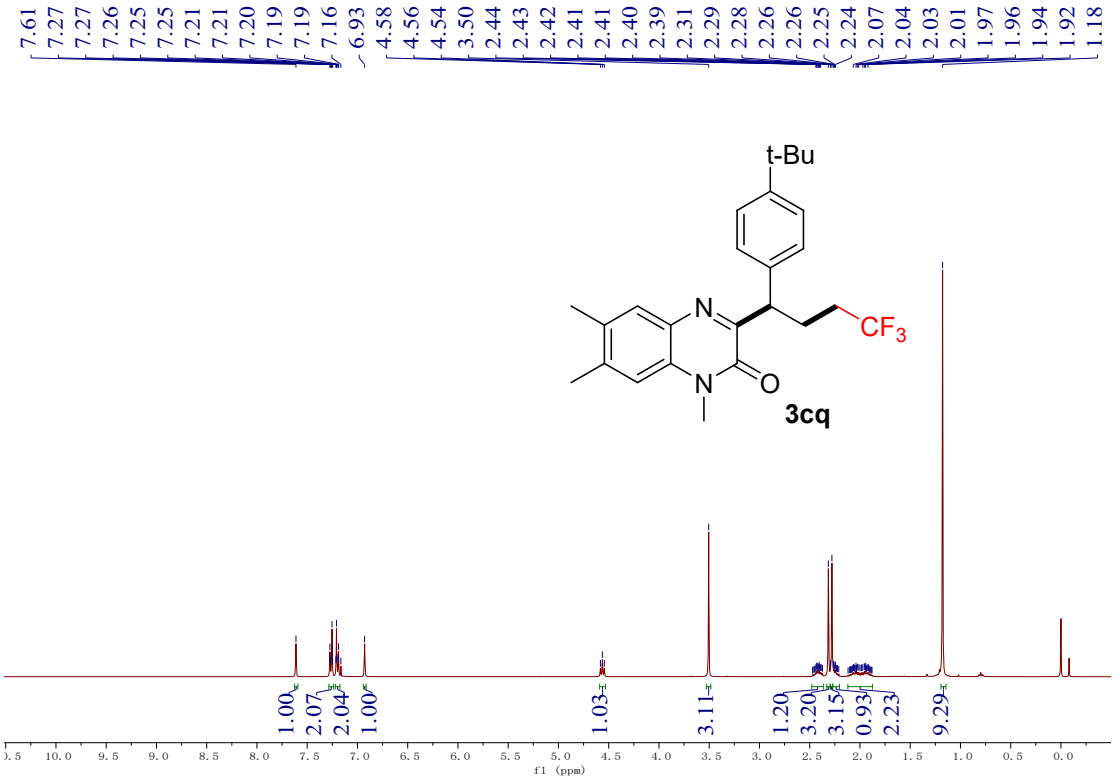

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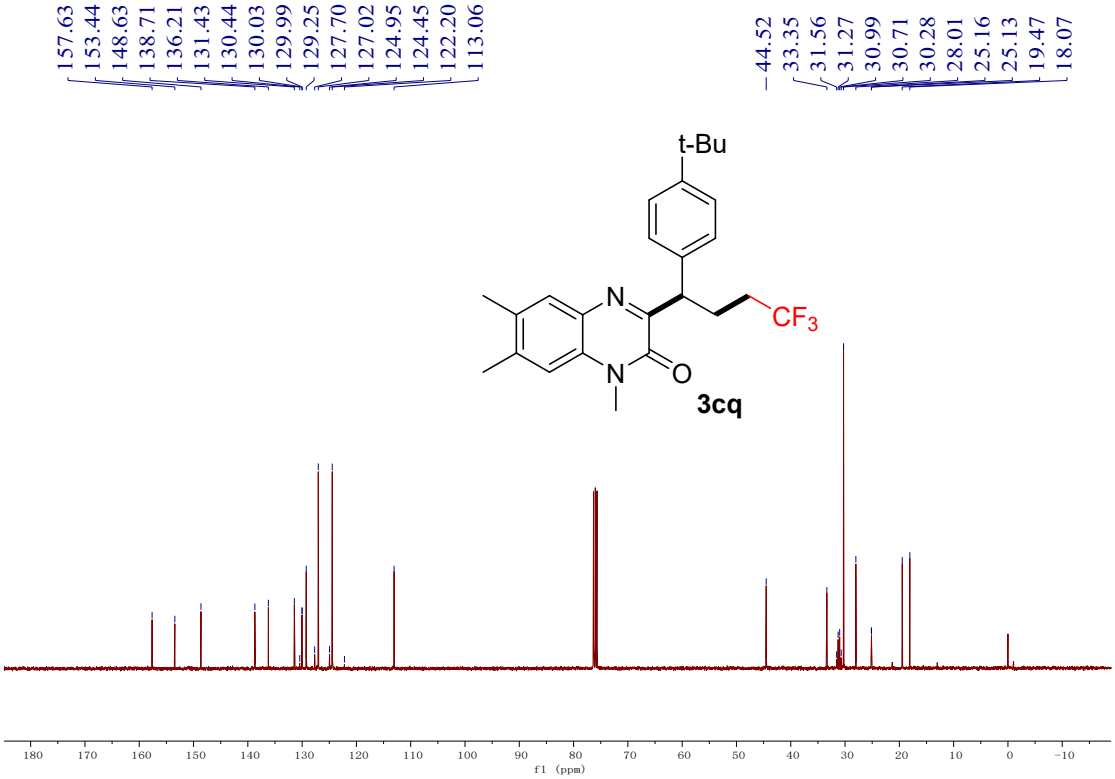

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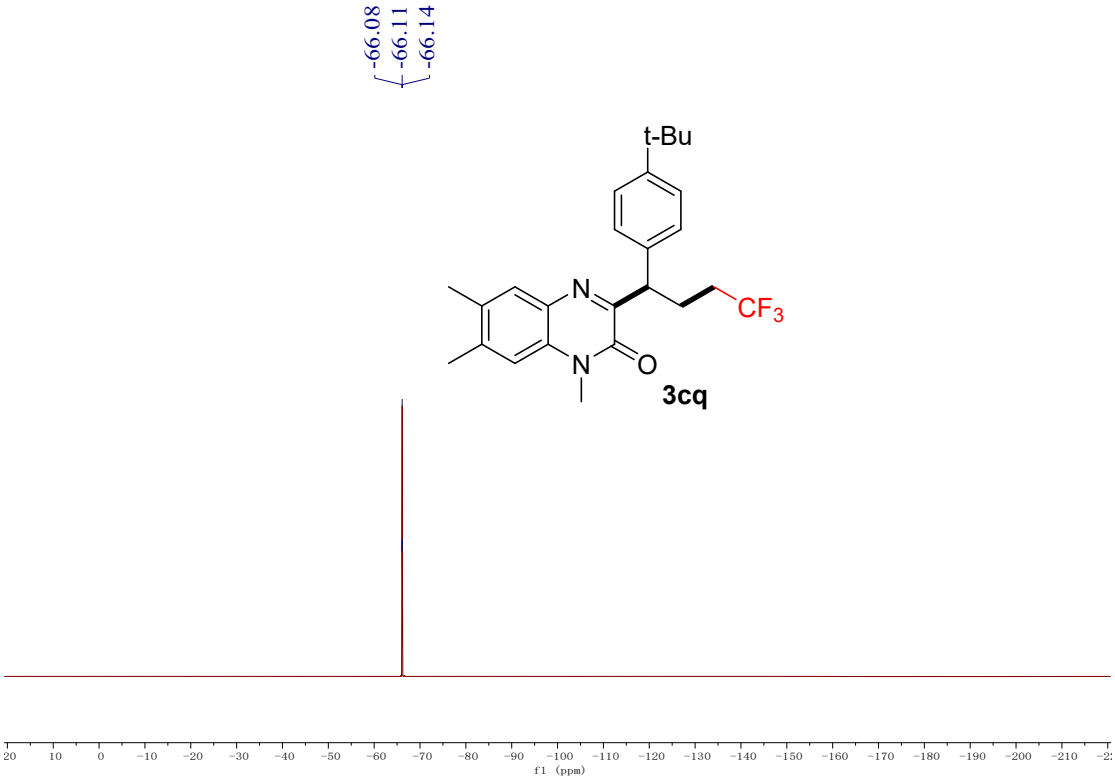

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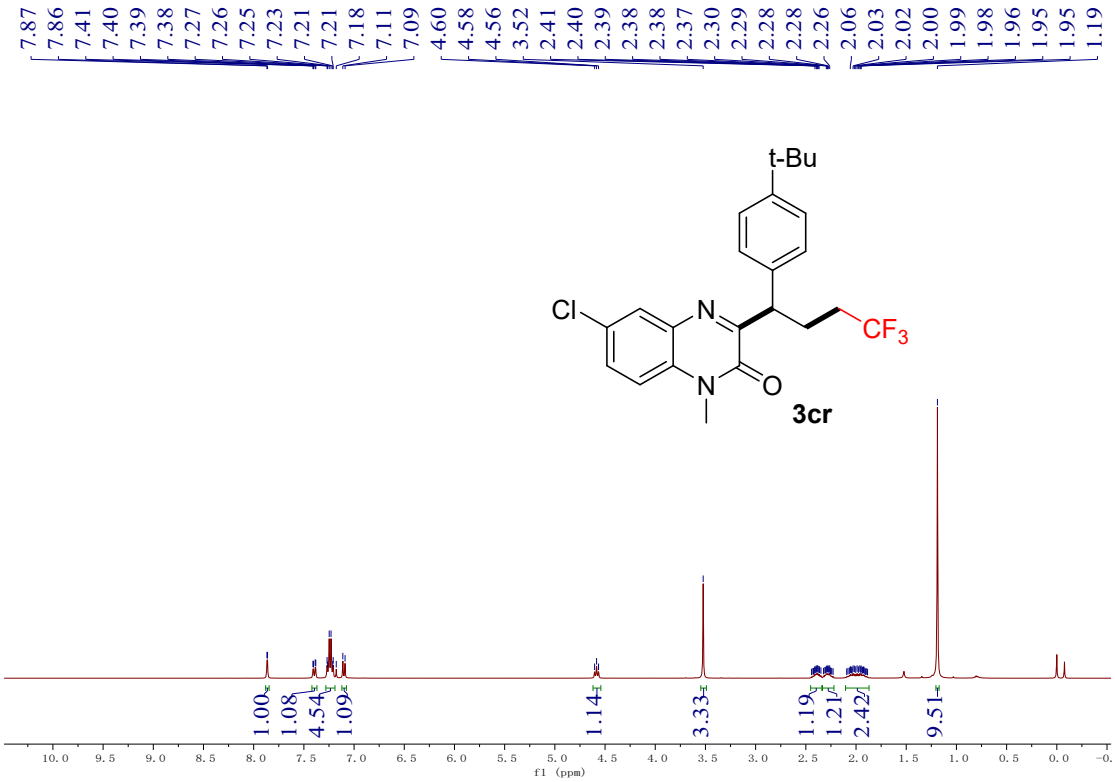

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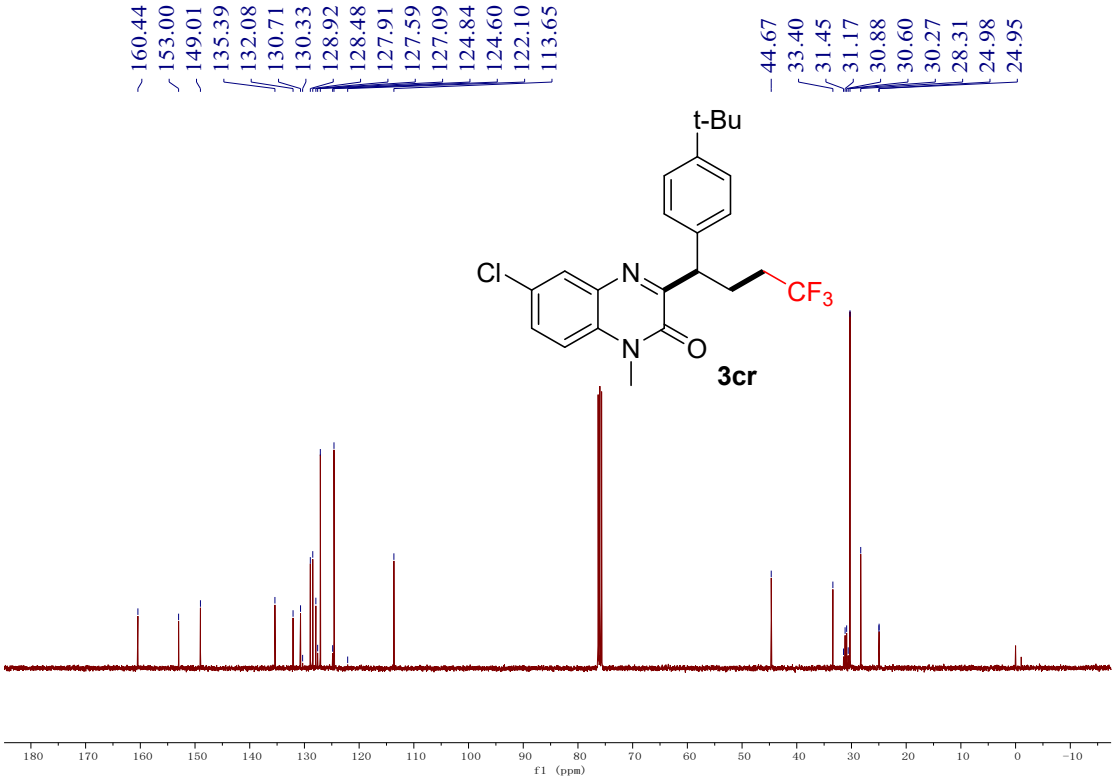

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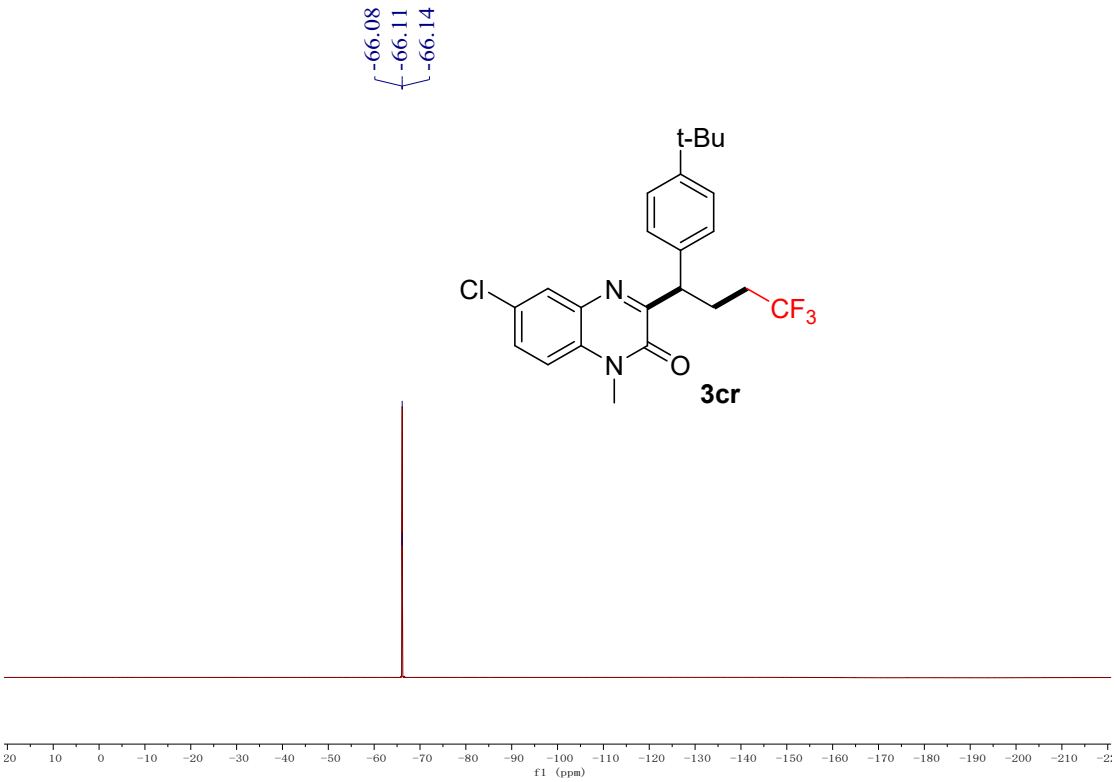

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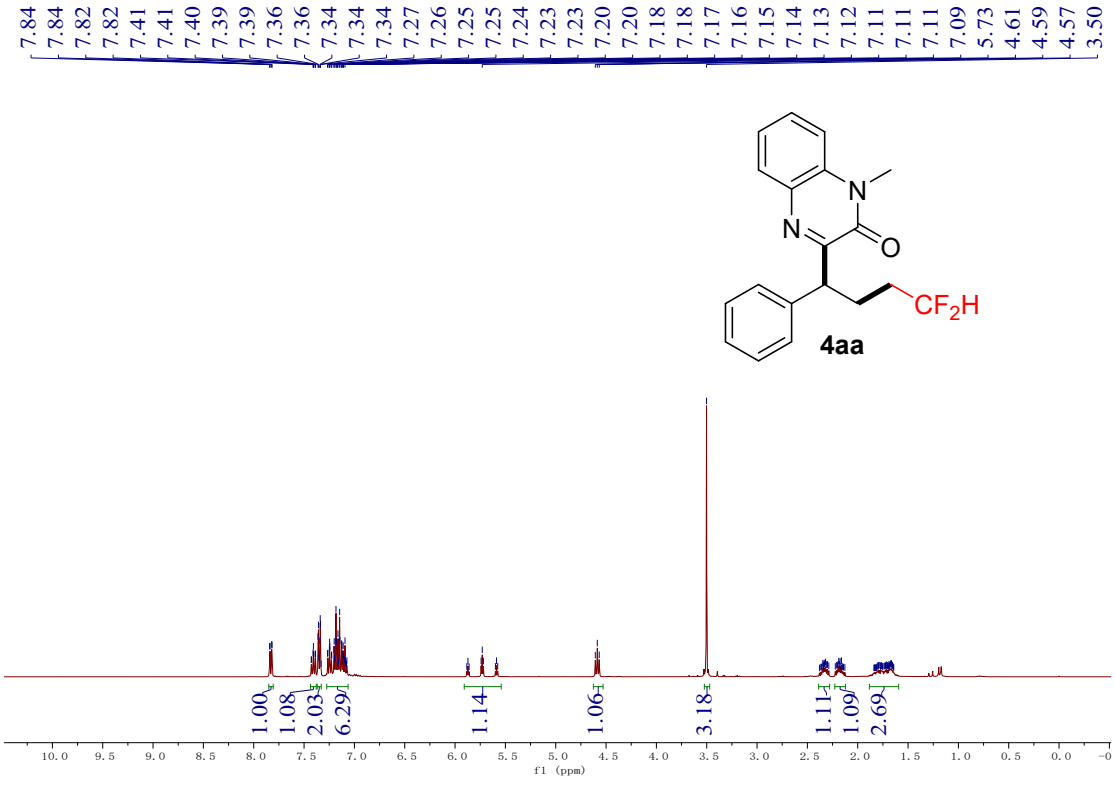

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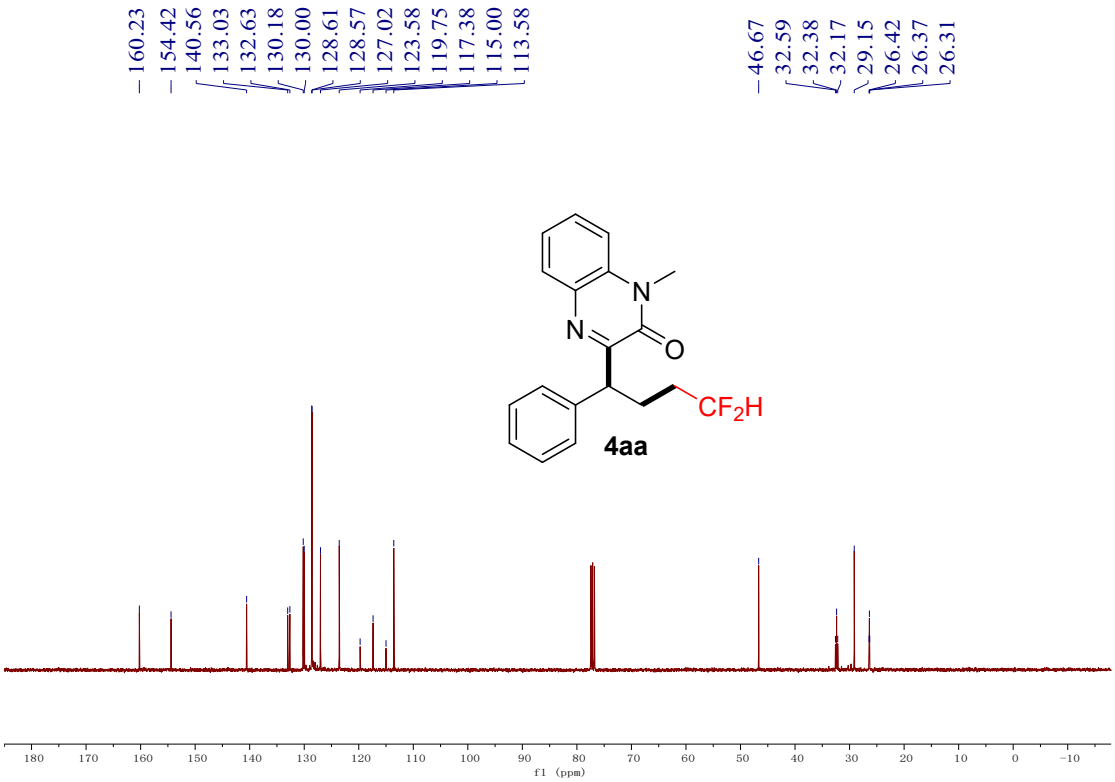

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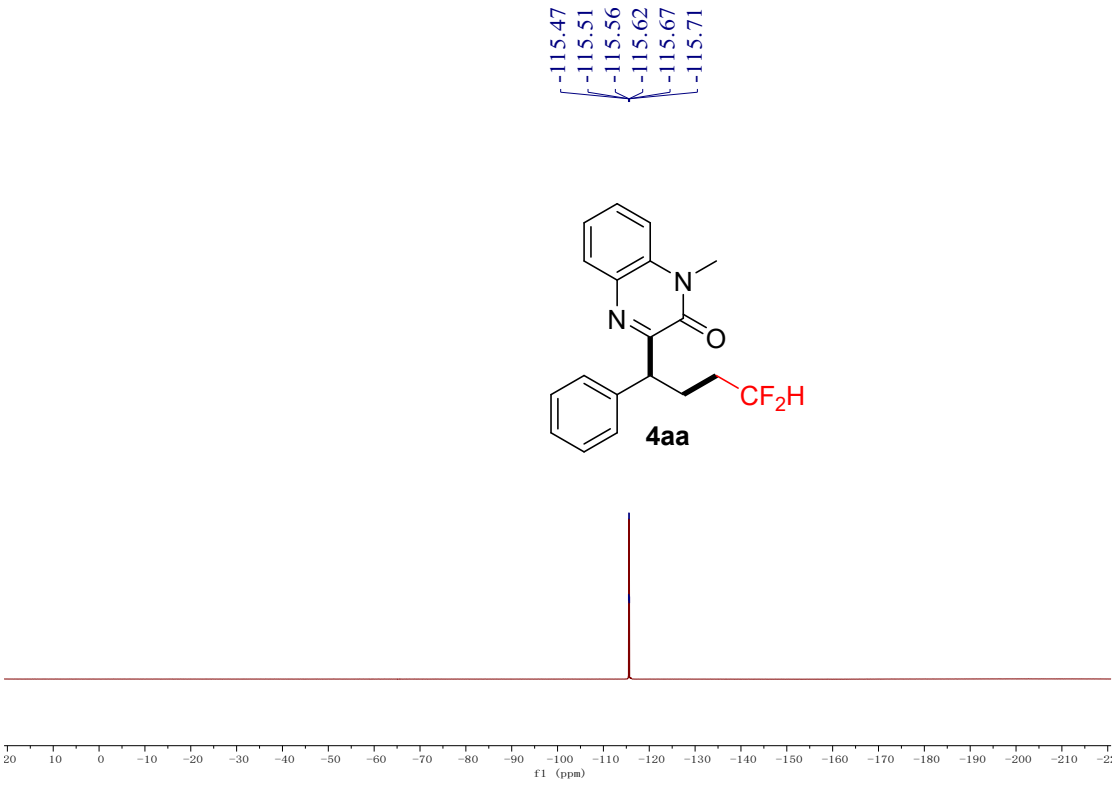

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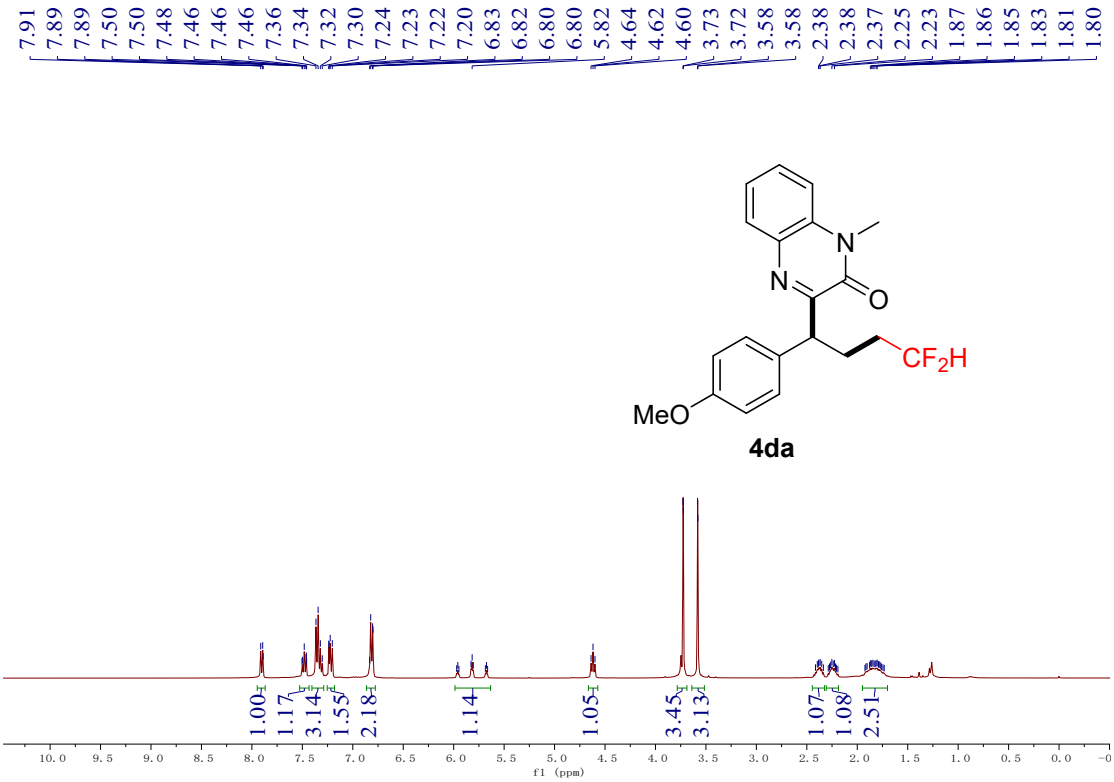

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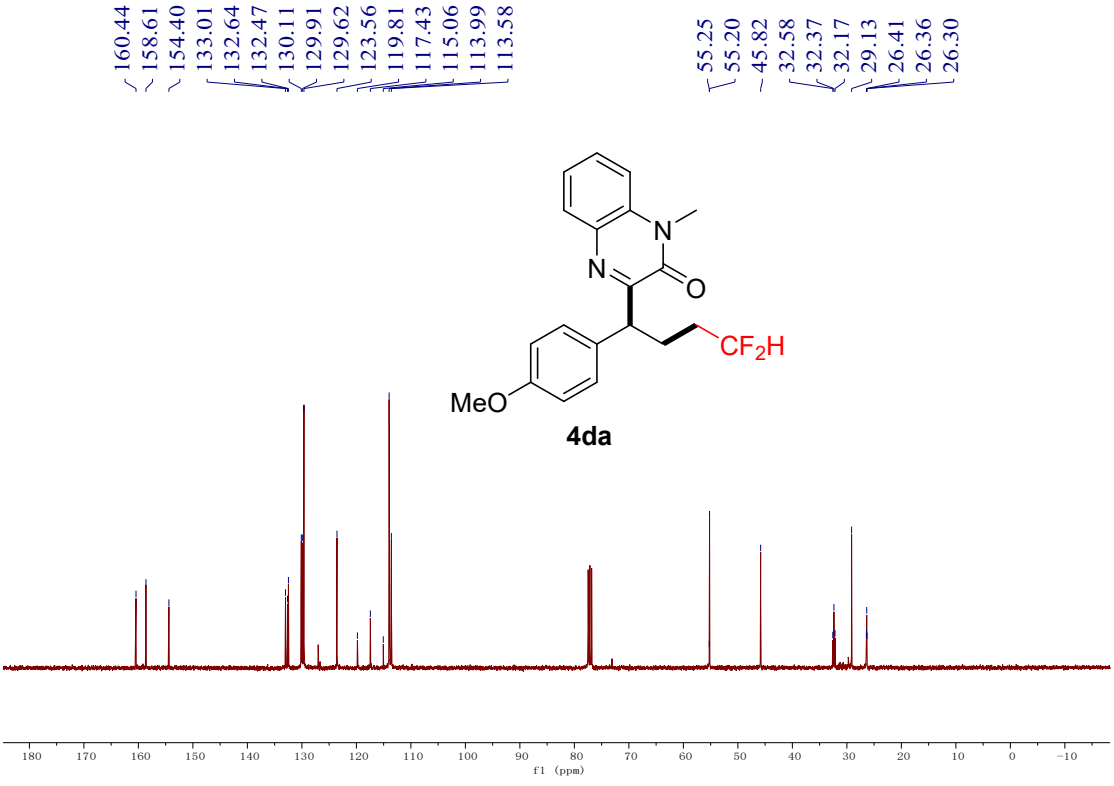

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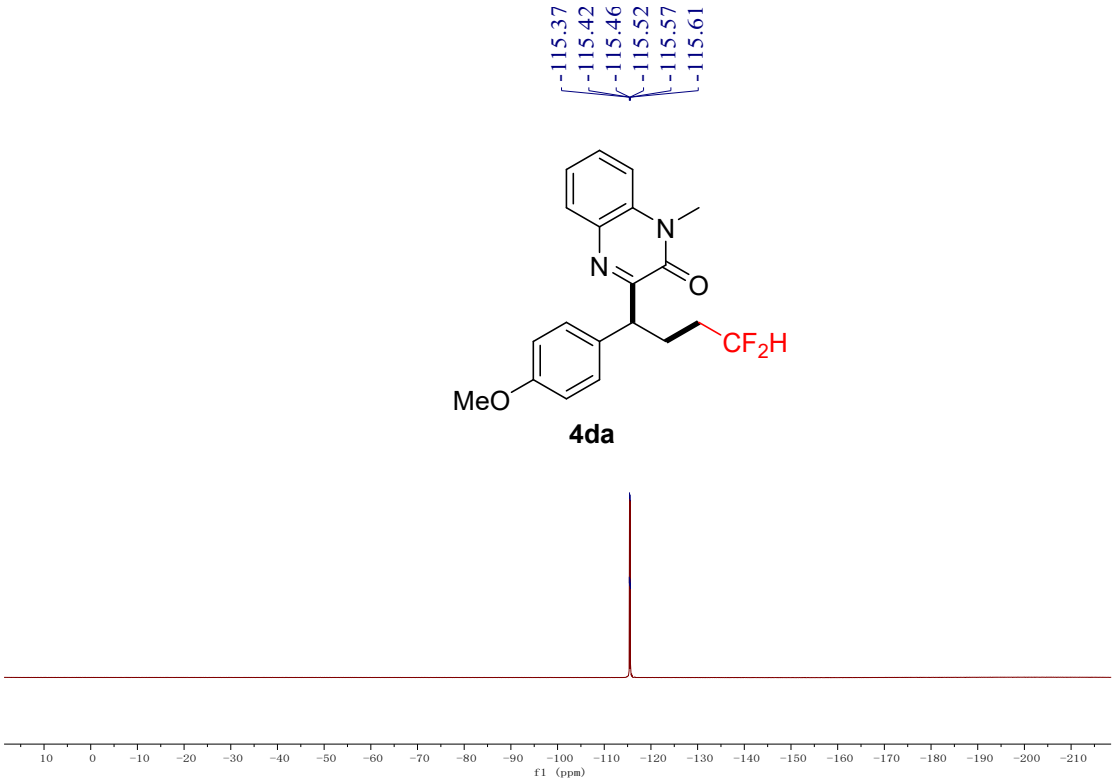

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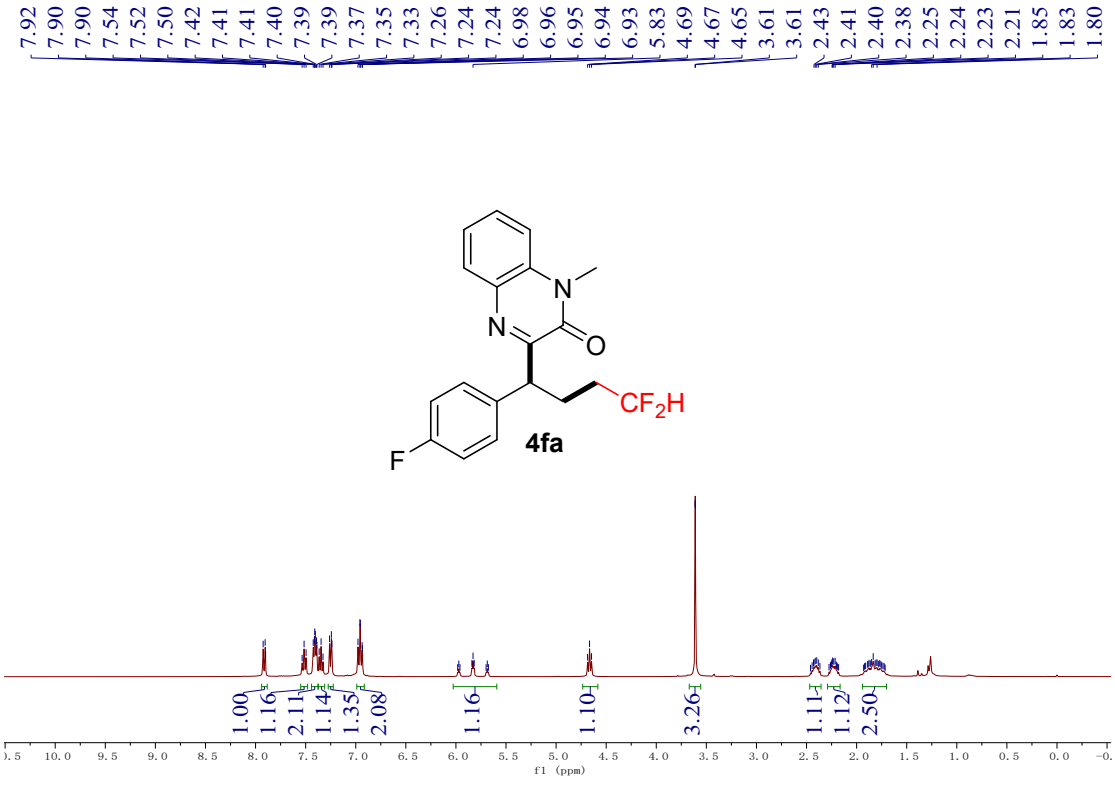

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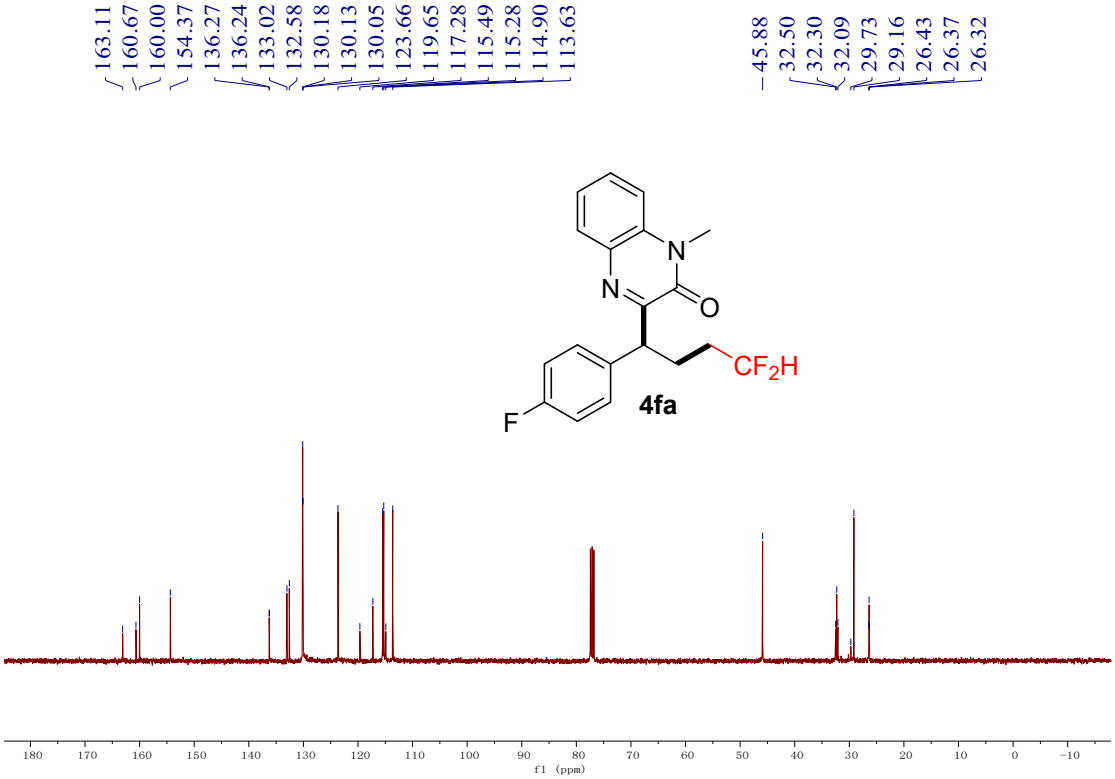

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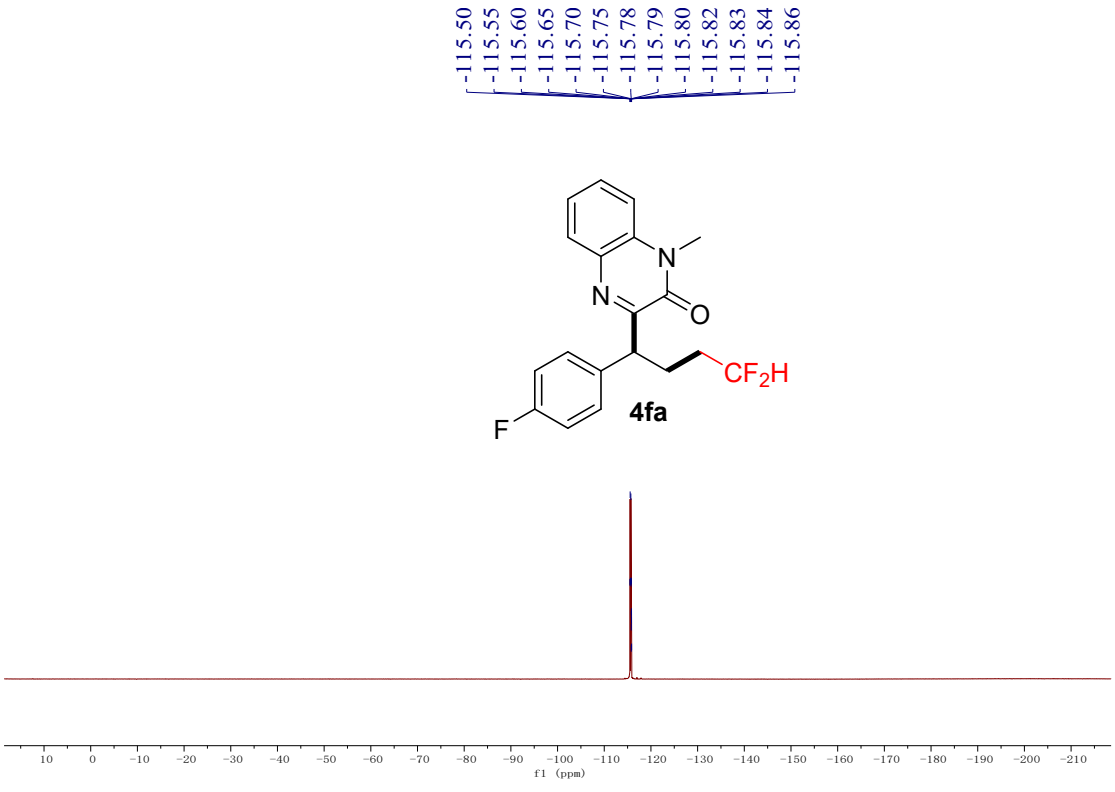

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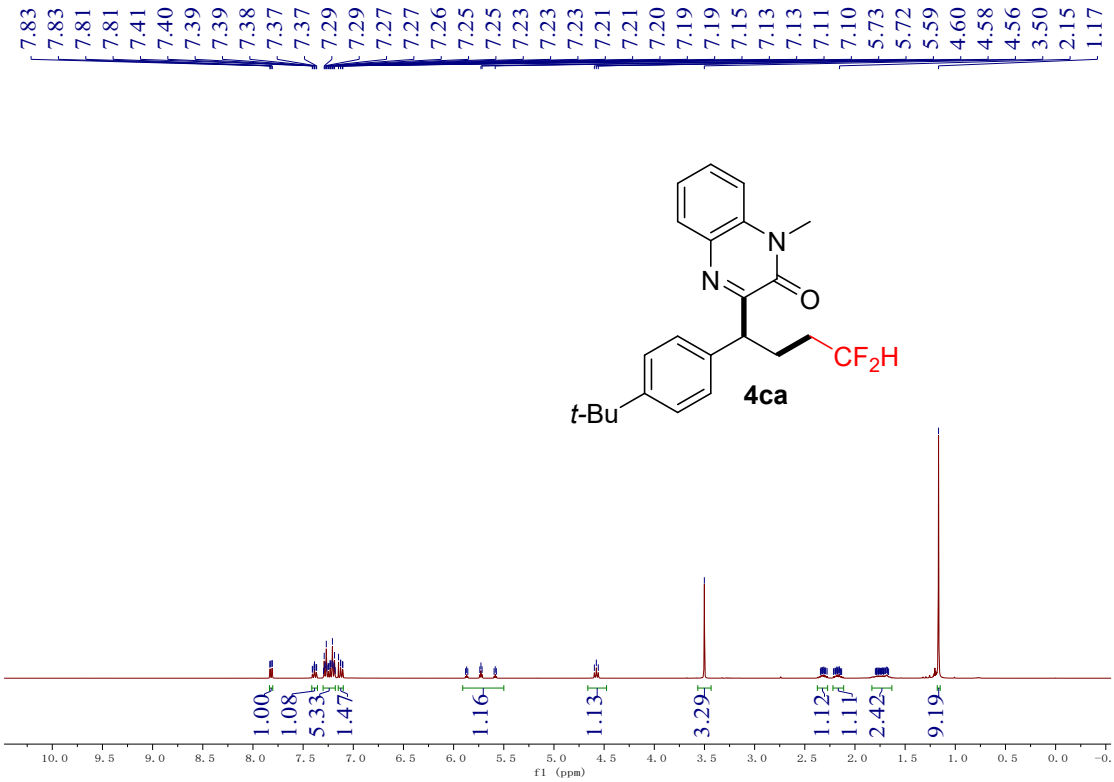

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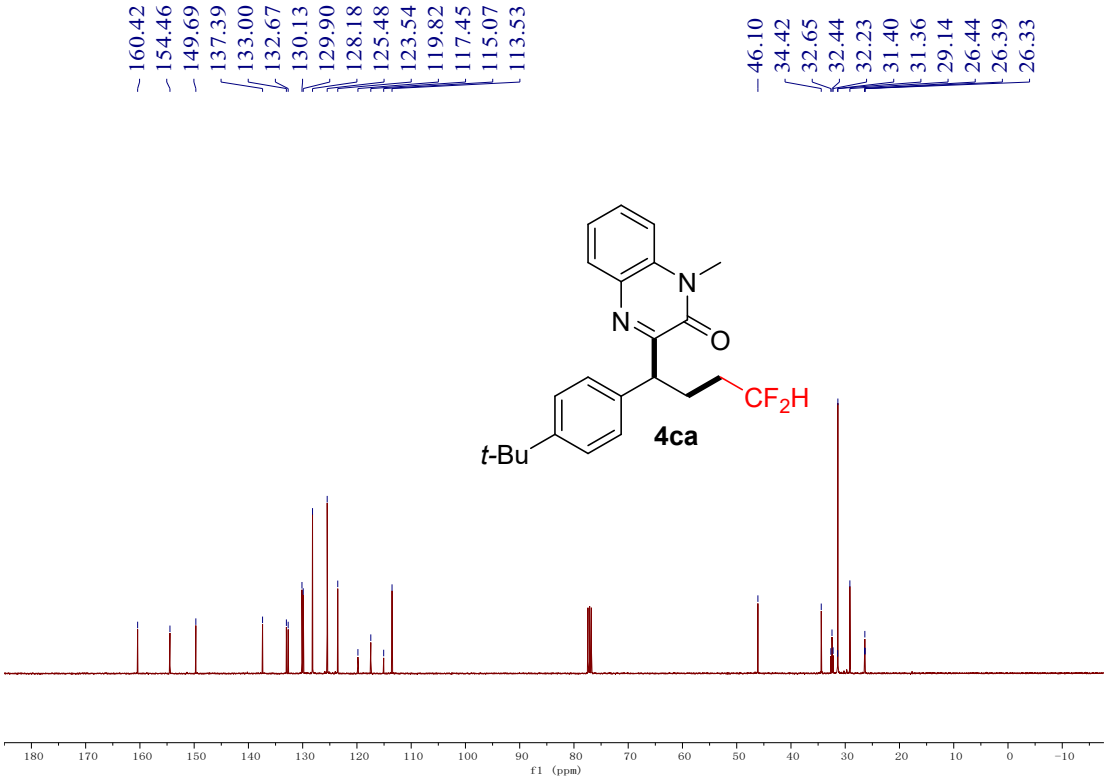

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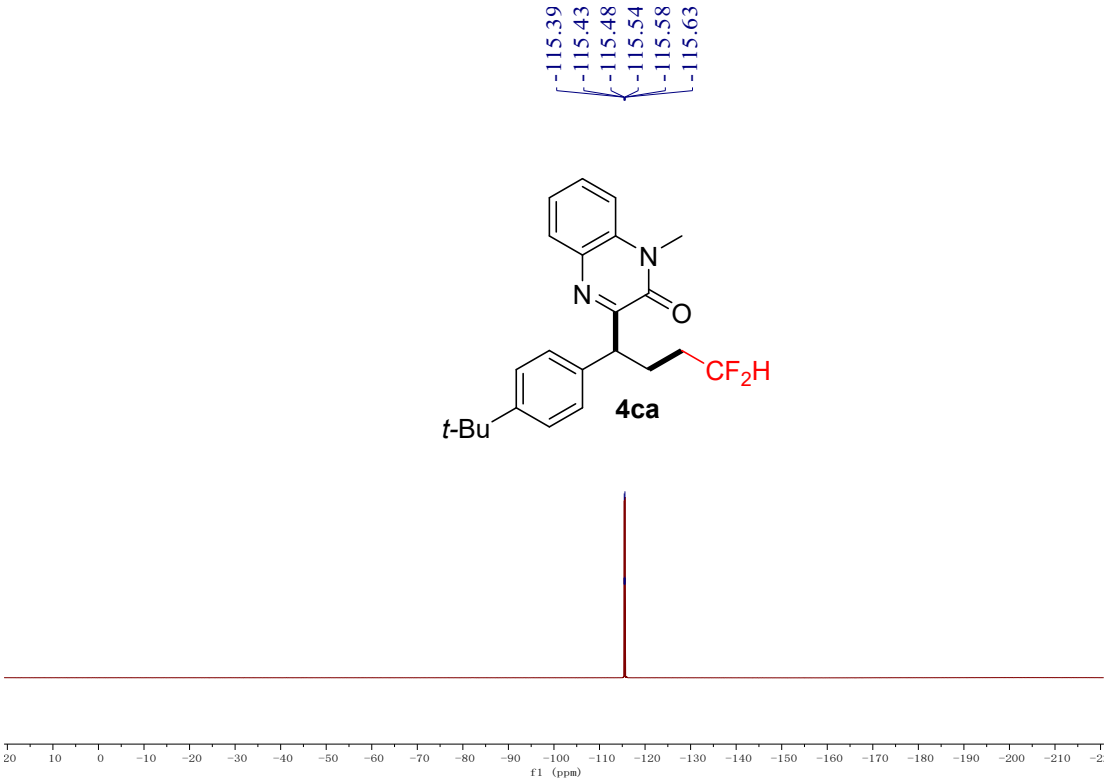

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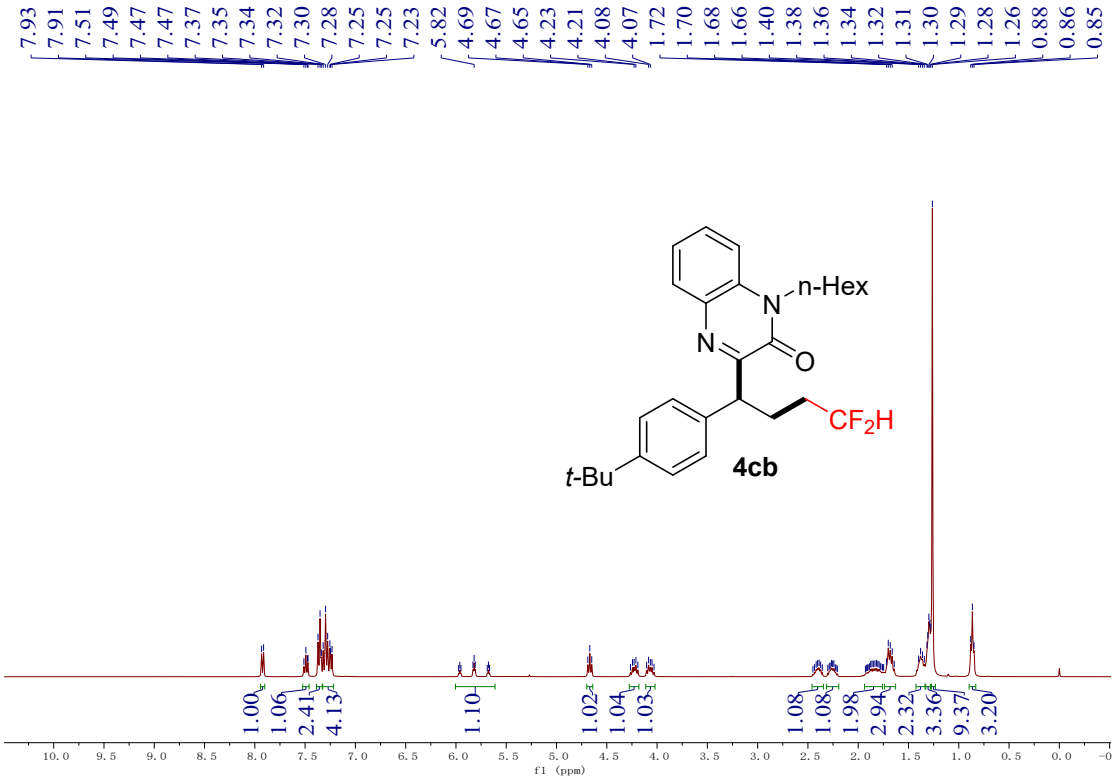

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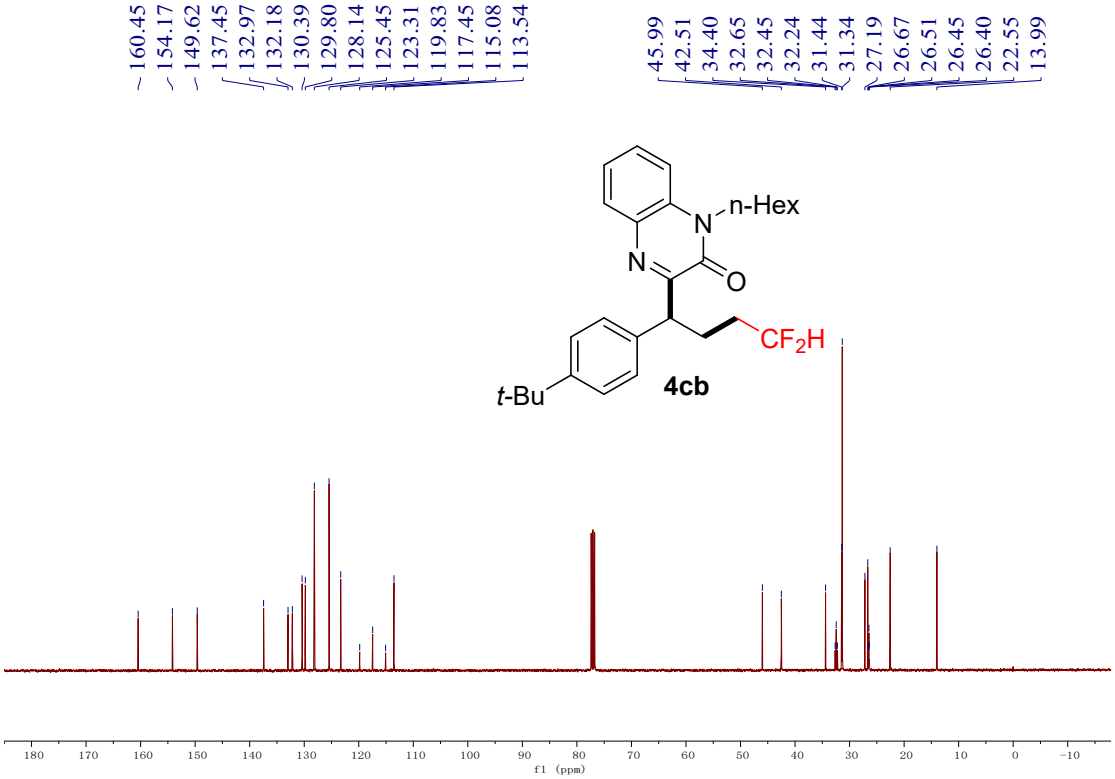

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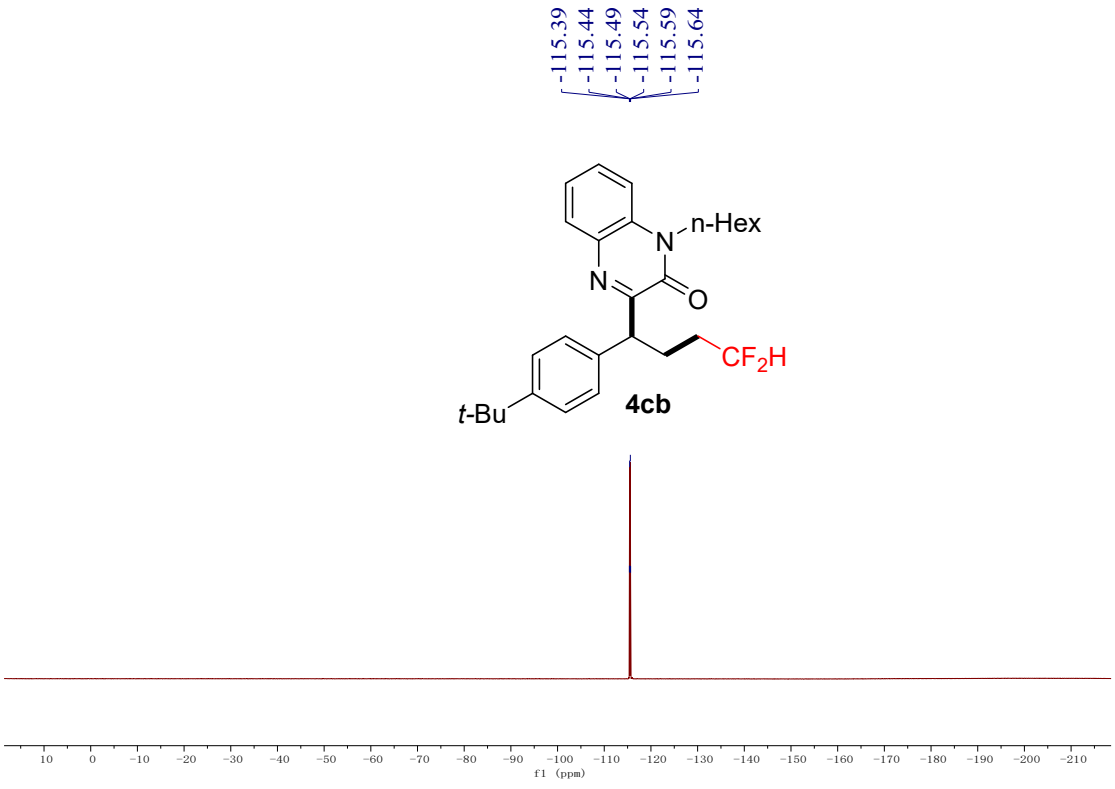

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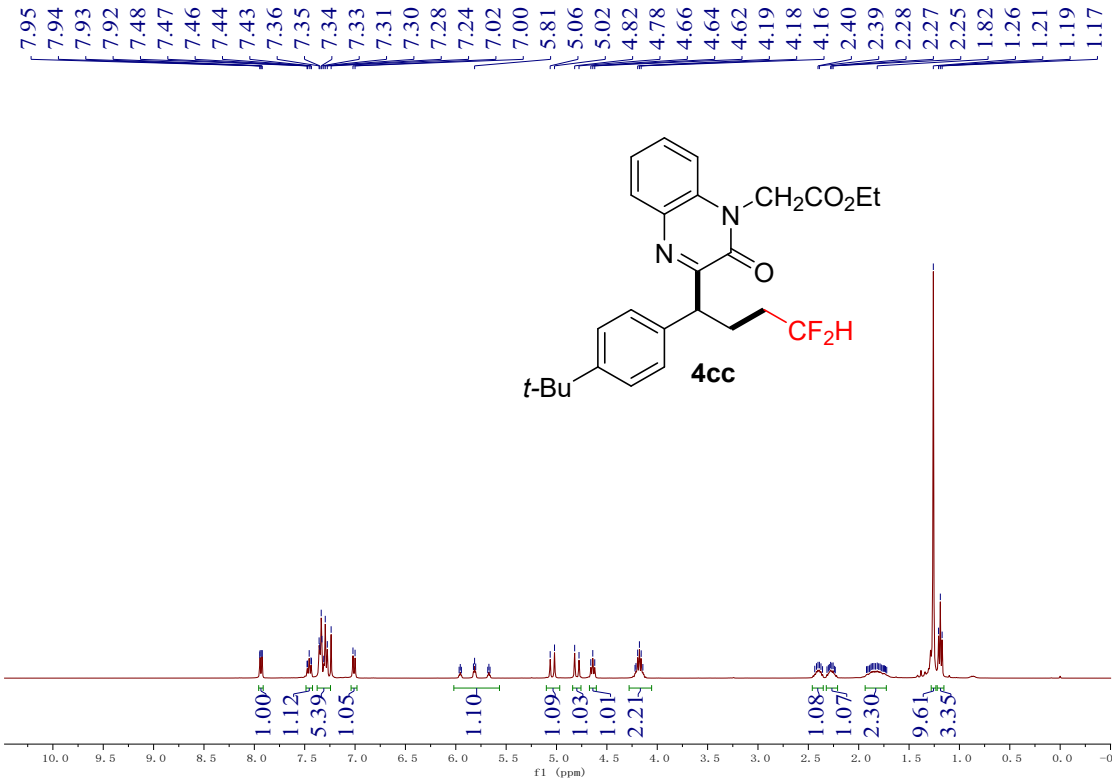

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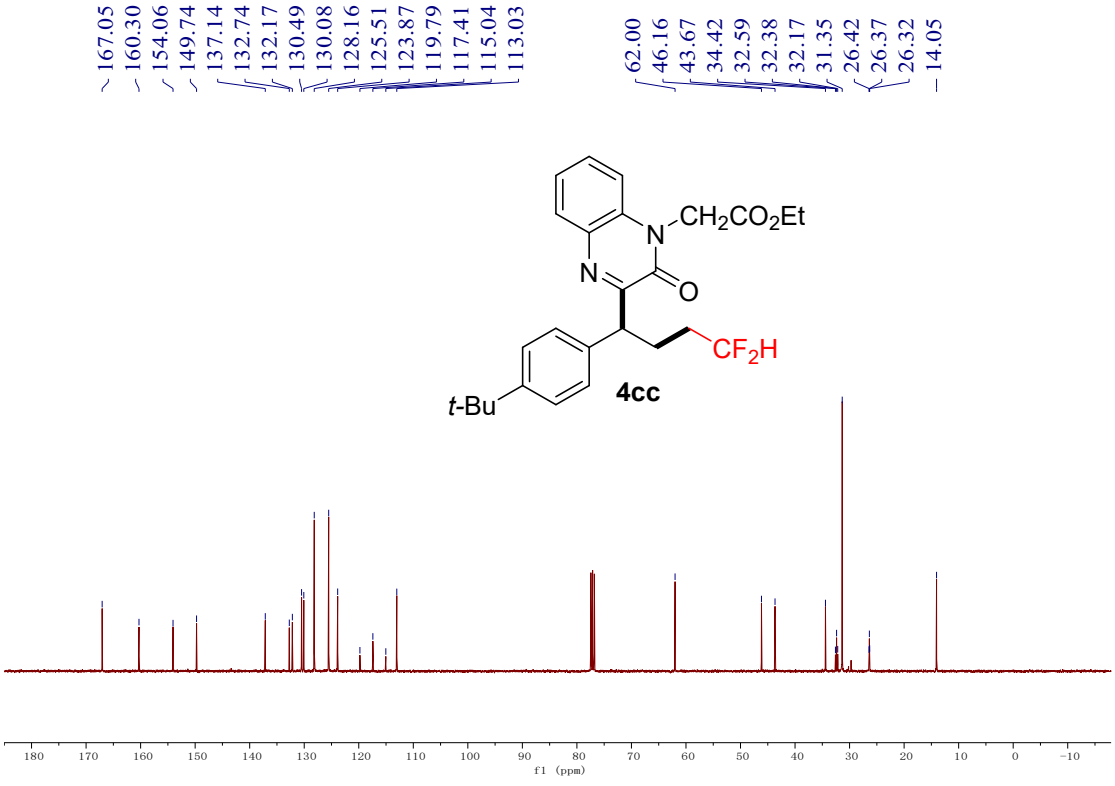

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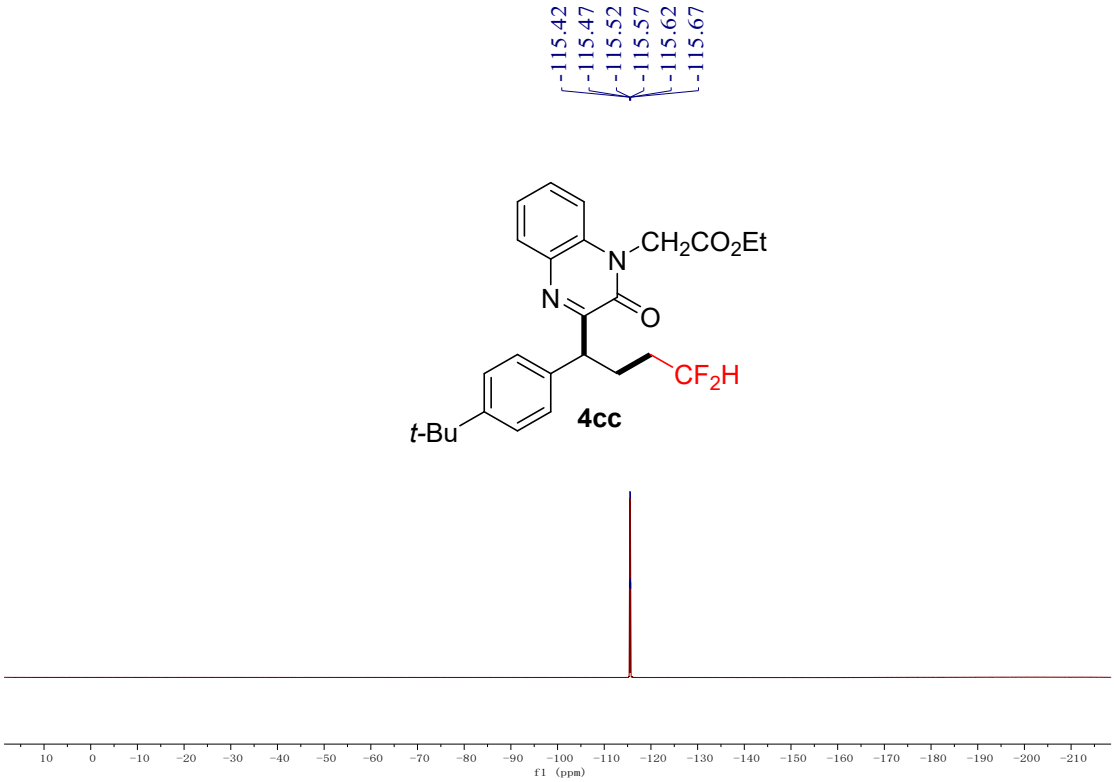

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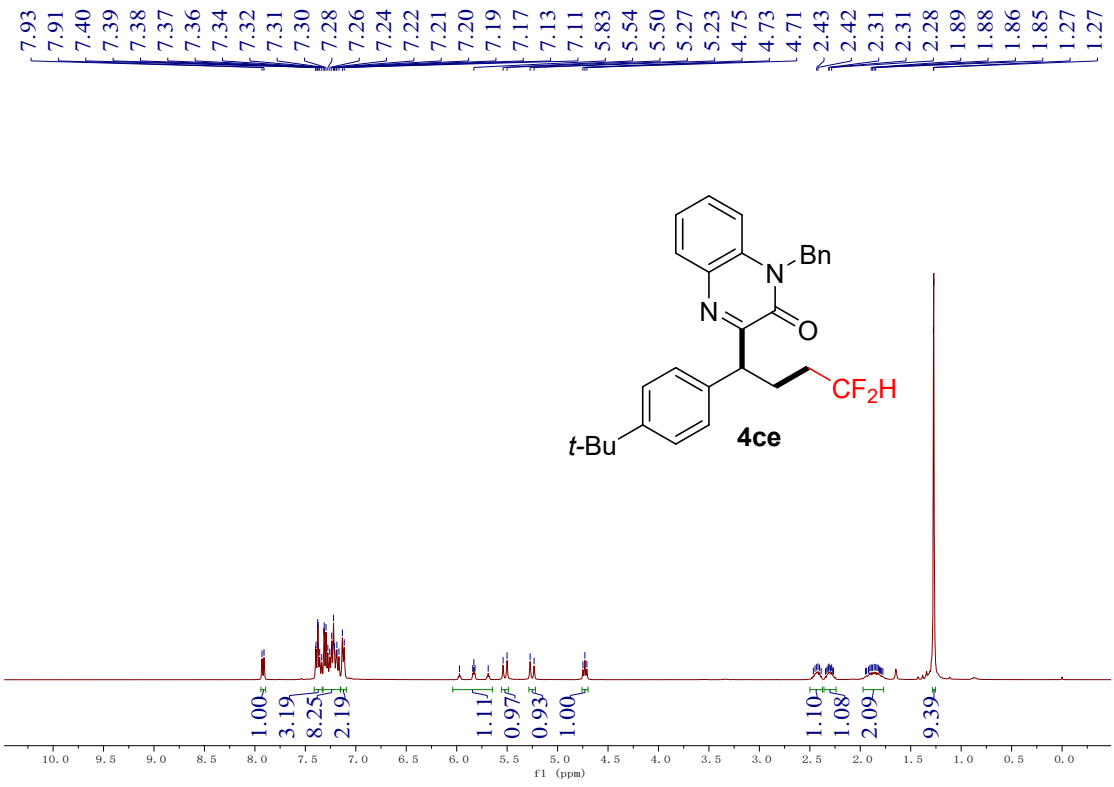

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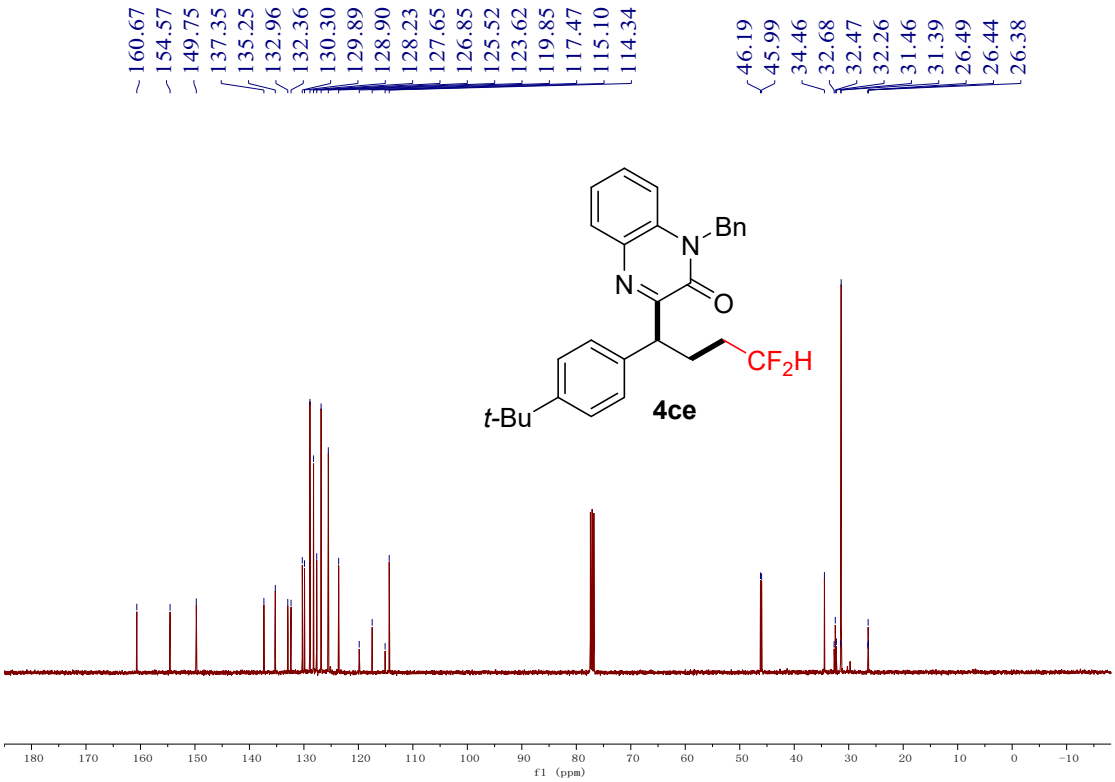
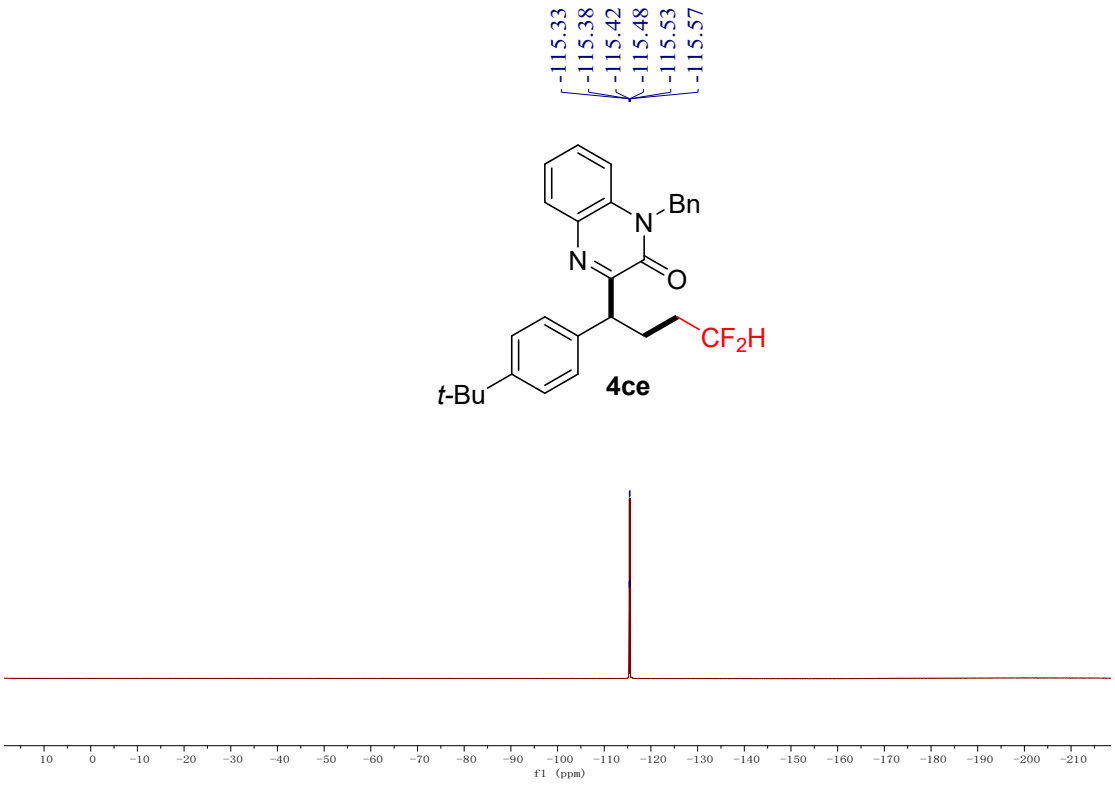
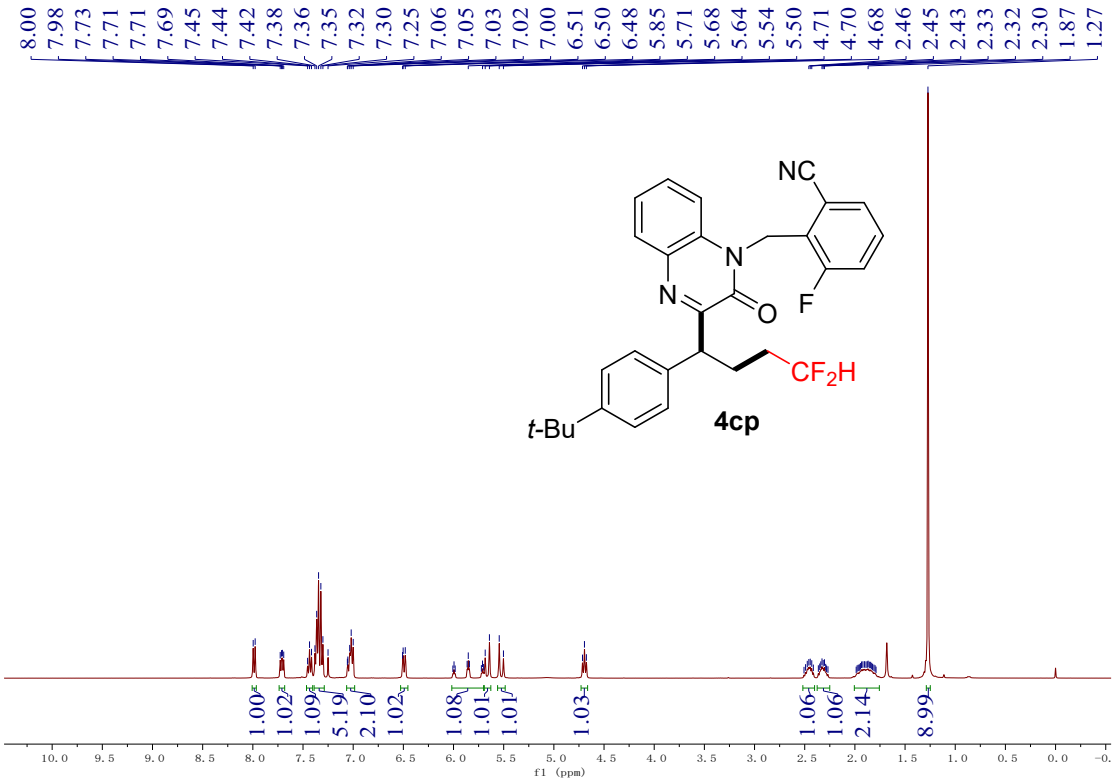


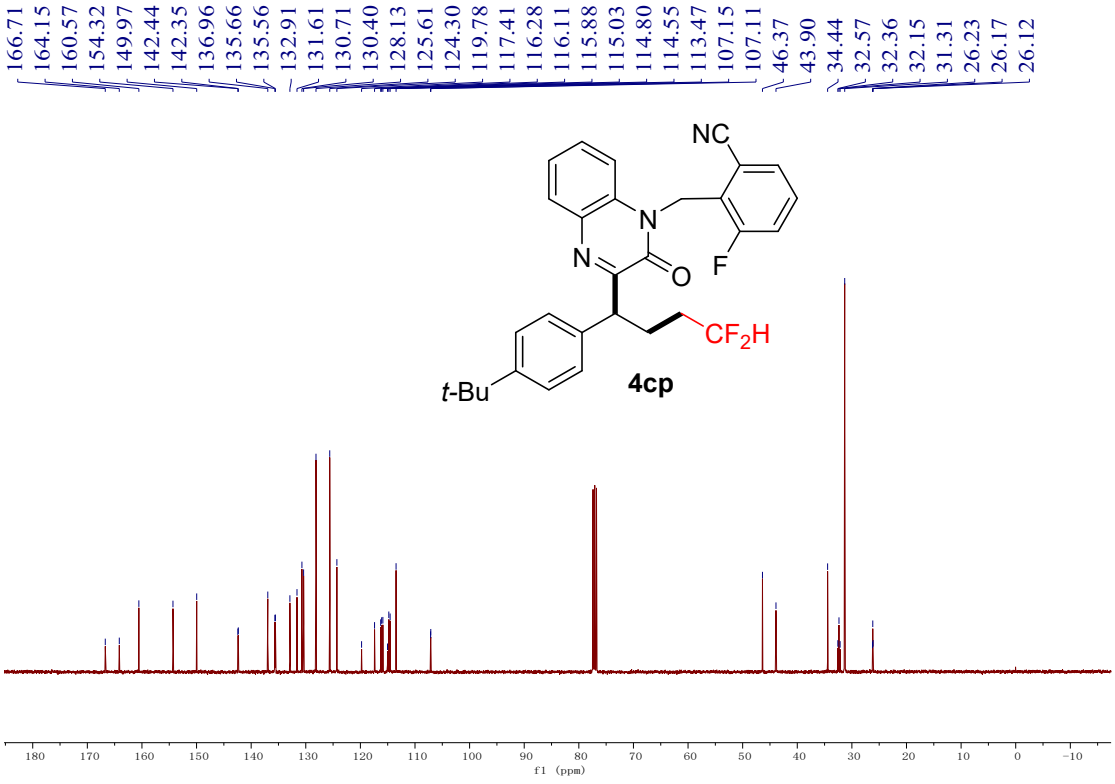
^{19}F NMR (377 MHz, $CDCl_3$)



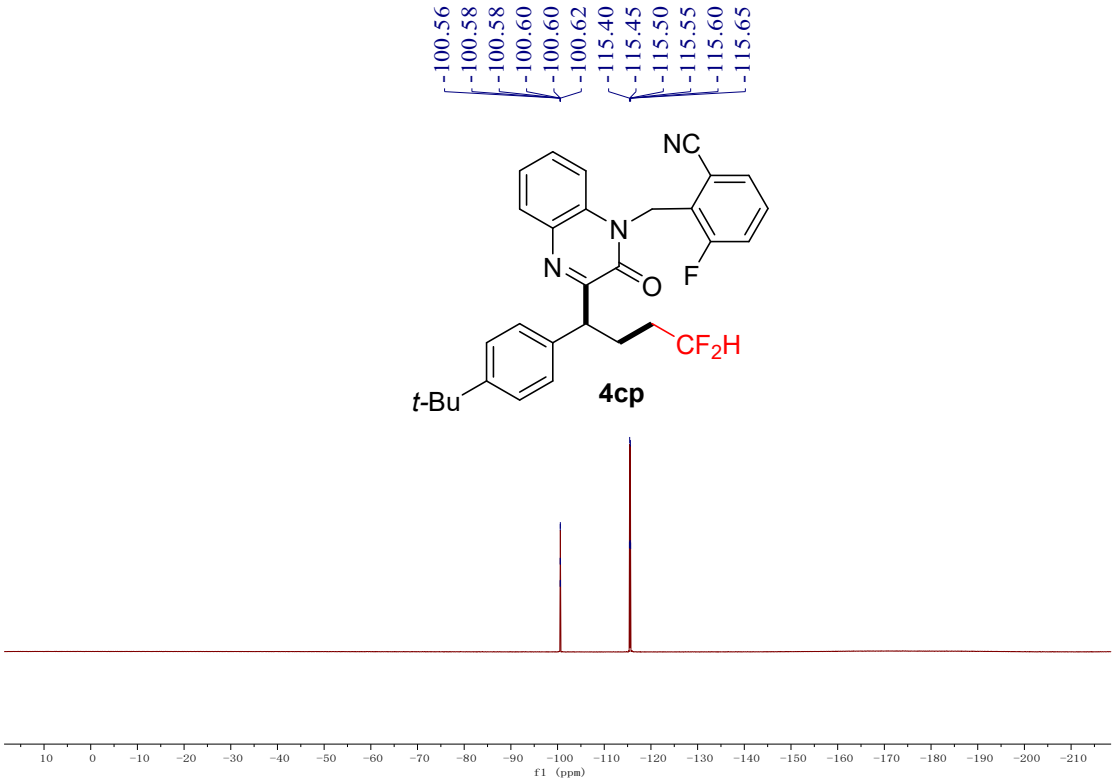
[1]H NMR (400 MHz, $CDCl_3$)



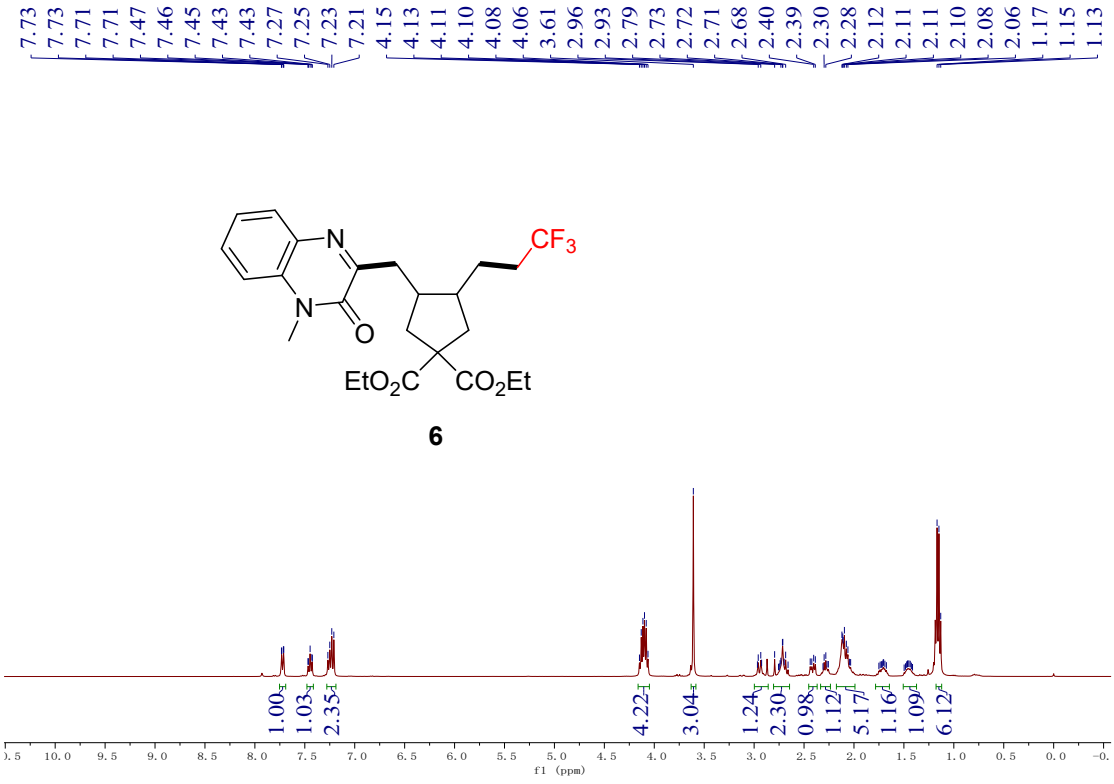
[13]C NMR (101 MHz, $CDCl_3$)



^{19}F NMR (377 MHz, $CDCl_3$)

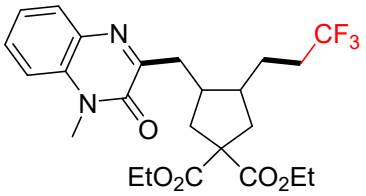


^{1}H NMR (400 MHz, $CDCl_3$)



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

172.59
172.49
159.37
154.78
133.02
132.60
129.75
128.54
125.80
123.53
123.05
113.59
61.55
61.47
58.66
41.30
38.96
38.37
38.08
33.39
32.90
32.61
32.33
32.05
29.03
21.55
21.53
13.99



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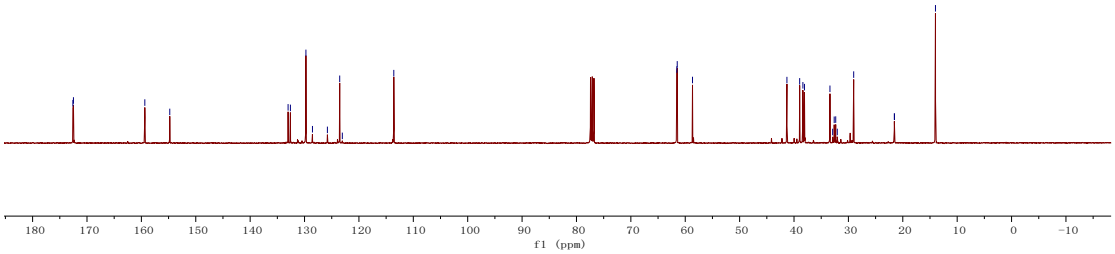
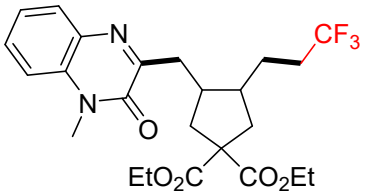


^{19}F NMR (377 MHz, $CDCl_3$)

-62.93
-62.96
-62.99
-66.31
-66.34
-66.37
-66.49
-66.52
-66.55



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