Supplementary Information

Oximinotrifluoromethylation of Unactivated Alkenes under Ambient Conditions

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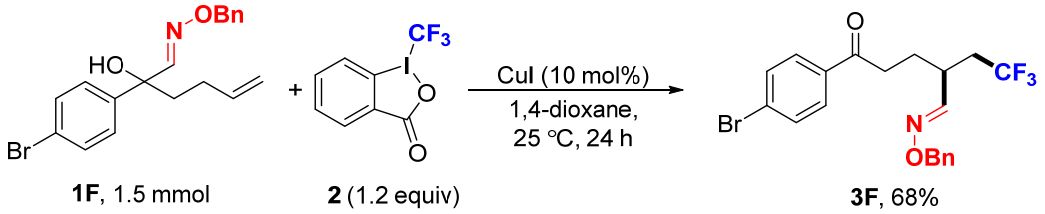
General information.

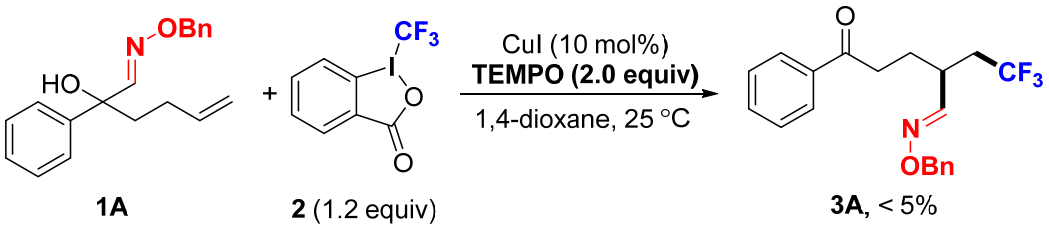
All reactions were carried out under argon using Schlenk techniques. Reagents were purchased at the commercial quality and used without further purification. Analytical thin layer chromatography (TLC) was performed on precoated silica gel 60 GF254 plates. Flash column chromatography was performed using Tsingdao silica gel (60, particle size 0.040-0.063 mm). Visualization on TLC was achieved by use of UV light (254 nm), $KMnO_4$ or iodine stain. NMR spectra were recorded on a Bruker DPX 400 spectrometer at 400/500 MHz for ^1H NMR, 100/125 MHz for ^{13}C NMR and 376 MHz for ^{19}F NMR in $CDCl_3$ with tetramethylsilane (TMS) as internal standard. The chemical shifts are expressed in ppm and coupling constants are given in Hz. Data for ^1H NMR are recorded as follows: chemical shift (ppm), multiplicity (s, singlet; d, doublet; t, triplet; q, quarter; m, multiplet), coupling constant (Hz), integration. Data for ^{13}C NMR are reported in terms of chemical shift (δ, ppm). ^{19}F NMR spectra were recorded on a Bruker DPX 400 MHz spectrometer ($CFCl_3$ as an external reference (0 ppm)). Mass spectrometric data were obtained using Bruker Apex IV RTMS.

Scheme S1 and Scheme S2



1F, 1.5 mmol **2** (1.2 equiv) **3F**, 68%

Scheme S1 Large-scale synthesis.

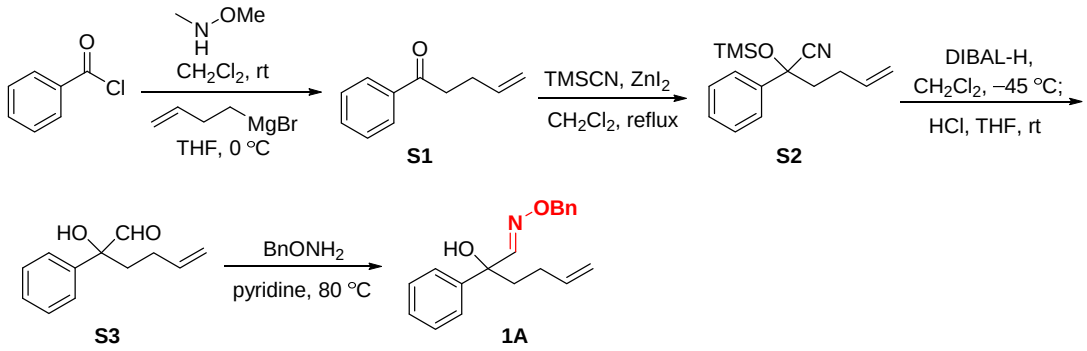


1A **2** (1.2 equiv) **3A**, < 5%

Scheme S2 Control experiment.

Experimental procedure for synthesis of substrates

Procedure for synthesis of linear substrates



To a solution of *N*,*O*-dimethylhydroxylamine hydrochloride (5.9 g, 60 mmol) in anhydrous CH_2Cl_2 (60 mL) were added Et_3N (16.8 mL, 120 mmol) and benzoyl chloride (7.0 mL, 30 mmol) at 0 °C. The reaction mixture was stirred at room temperature for 1 h and quenched with saturated $NaHCO_3$ (30 mL). Dichloromethane (3 × 60 mL) was added to extract the product from the aqueous layer. The combined organic layer was washed with HCl (1M, 30 mL) and brine (30 mL), dried over anhydrous Na_2SO_4, filtered and concentrated to afford the crude product (9.7 g). The crude product was dissolved in THF (15 mL) and added to a solution of prepared Grignard reagent (1M, 90 mL) in THF at 0 °C dropwisely. The reaction mixture was stirred at that temperature for 30 min and quenched with saturated NH_4Cl (30 mL). Diethyl ether was used to extract the product from the aqueous layer (3 × 60 mL). The combined organic layer was washed with brine (30 mL), dried over anhydrous Na_2SO_4, filtered and concentrated to afford the crude product **S1** (7.9 g, 80%), which was applied to the next step without further purification.

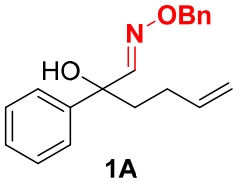
A solution of **S1** (7.9 g, 49 mmol), TMSCN (6.8 mL, 52 mmol) and ZnI_2 (0.80 g, 2.5 mmol) in anhydrous CH_2Cl_2 (60 mL) were heated to reflux for 12 h and cooled down to room temperature. The solvent was removed to afford the crude product, which was purified by flash column chromatography to afford the product **S2** as a colorless oil (9.5 g, 76%). The product **S2** was dissolved in anhydrous CH_2Cl_2 (50 mL). To this solution was added diisobutylaluminium hydride (DIBALH) (1M/hexane, 60 mL, 60 mmol) at –45 °C. The reaction mixture was stirred for 2 h and quenched with H_2O (2 mL) and potassium

sodium tartrate (1 M, 40 mL) with vigorously stirring. Dichloromethane was used to extract the product from the aqueous layer (3 × 50 mL). The combined organic layer was washed with brine (30 mL), dried over anhydrous Na_2SO_4, filtered and concentrated to afford the crude product (5.8 g, 78%), which was dissolved in THF (50 mL). To this solution was added HCl (3 M, 10 mL, 50 mmol) at room temperature and the reaction mixture was stirred for 1 h and quenched with H_2O (10 mL). EtOAc was used to extract the product from the aqueous layer (3 × 40 mL). The combined organic layer was washed with brine (30 mL), dried over anhydrous Na_2SO_4, filtered and concentrated to afford the crude product, which was purified by flash column chromatography to afford the product **S3** (4.0 g, 75% yield) as a colorless oil.

A solution of **S3** (0.95 g, 5.0 mmol) and *O*-benzylhydroxylamine (1.2 g, 10 mmol) in pyridine (5 mL) was heated at 80 °C for 2 h and then cooled down to room temperature. The solvent was evaporated under reduced pressure. EtOAc (30 mL) was added to dissolve the crude product, which was washed with HCl (1 M, 10 mL) and brine (10 mL) sequentially. The organic layer was dried over anhydrous Na_2SO_4, filtered and concentrated to afford the crude product, which was purified by flash column chromatography to afford the product **1A** (1.2 g, 80% yield, 36% overall yield) as a colorless oil.

The procedure for synthesis of **1B-1O** is similar to that reported for synthesis of **1A**.

(*E*)-2-hydroxy-2-phenylhex-5-enal O-benzyl oxime (1A)

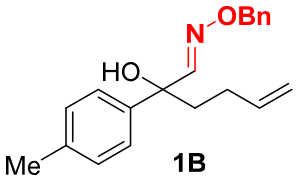


1A

1A: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 (s, 1H), 7.32 – 7.03 (m, 10H), 5.72 – 5.56 (m, 1H), 5.02 – 4.90 (m, 2H), 4.87 – 4.71 (m, 2H), 3.34 (s, 1H), 2.04 – 1.78 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.4, 143.3, 138.7, 137.9, 128.5, 128.4, 128.2, 128.0, 127.5,

126.2, 114.8, 78.0, 76.3, 36.7, 27.8. HRMS (ESI) m/z calcd. for $C_{19}H_{22}O_2N$ $[M+H]^+$ 296.1645, found 296.1641.

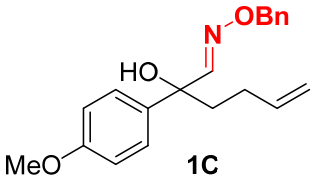
(*E*)-2-hydroxy-2-(p-tolyl)hex-5-enal O-benzyl oxime (1B)



1B

1B: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 (s, 1H), 7.33 – 7.24 (m, 7H), 7.12 (d, *J* = 8.1 Hz, 2H), 5.83 – 5.61 (m, 1H), 5.11 – 4.99 (m, 2H), 4.98 – 4.82 (m, 2H), 3.39 (s, 1H), 2.29 (s, 3H), 2.15 – 1.83 (m, 4H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.8, 140.3, 138.3, 137.2, 137.0, 129.2, 128.5, 128.4, 128.1, 125.2, 114.8, 76.3, 75.5, 40.0, 27.7, 21.0. HRMS (ESI) m/z calcd. for $C_{20}H_{24}O_2N$ $[M+H]^+$ 310.1802, found 310.1798.

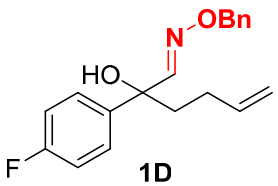
(*E*)-2-hydroxy-2-(4-methoxyphenyl)hex-5-enal O-benzyl oxime (1C)



1C

1C: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (s, 1H), 7.38 – 7.29 (m, 7H), 6.91 – 6.83 (m, 2H), 5.87 – 5.69 (m, 1H), 5.13 – 5.04 (m, 2H), 5.02 – 4.88 (m, 2H), 4.57 (s, 1H), 3.79 (s, 3H), 2.12 – 1.94 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.9, 153.8, 138.4, 137.2, 135.3, 128.6, 128.5, 128.2, 126.6, 114.8, 113.9, 76.5, 75.3, 55.4, 40.0, 27.8. HRMS (ESI) m/z calcd. for $C_{20}H_{24}O_3N$ $[M+H]^+$ 326.1751, found 326.1746.

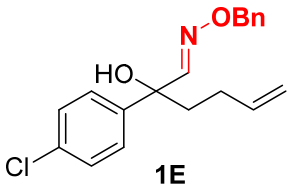
(*E*)-2-(4-fluorophenyl)-2-hydroxyhex-5-enal O-benzyl oxime (1D)



1D

1D: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 (s, 1H), 7.41 – 7.28 (m, 7H), 7.02 (t, *J* = 8.7 Hz, 2H), 5.83 – 5.70 (m, 1H), 5.14 – 5.04 (m, 2H), 5.00 – 4.90 (m, 2H), 3.41 (s, 1H), 2.12 – 1.91 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.1 (d, *J* = 245.8 Hz), 153.4, 139.01 (d, *J* = 3.0 Hz), 138.2, 137.1, 128.6, 128.5, 128.3, 127.13 (d, *J* = 8.1 Hz), 115.5, 115.16 (d, *J* = 22.7 Hz), 76.6, 75.4, 40.2, 27.7. ^{19}F NMR (376 MHz, $CDCl_3$) δ -115.4. HRMS (ESI) m/z calcd. for $C_{19}H_{21}O_2NF$ $[M+H]^+$ 314.1551, found 314.1548.

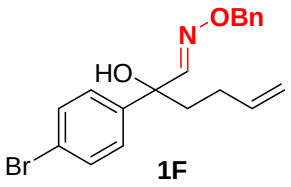
(*E*)-2-(4-chlorophenyl)-2-hydroxyhex-5-enal O-benzyl oxime (1E)



1E

1E: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 (s, 1H), 7.42 – 7.25 (m, 9H), 5.88 – 5.64 (m, 1H), 5.18 – 5.05 (m, 2H), 5.02 – 4.87 (m, 2H), 3.44 (s, 1H), 2.26 – 1.91 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.1, 141.8, 138.1, 137.0, 133.3, 128.7, 128.6, 128.5, 128.2, 126.8, 115.1, 76.6, 75.4, 40.1, 27.6. HRMS (ESI) m/z calcd. for $C_{19}H_{21}O_2NCl$ $[M+H]^+$ 330.1255, found 330.1251.

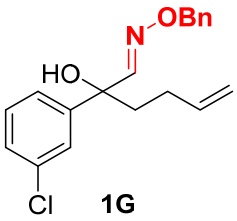
(*E*)-2-(4-bromophenyl)-2-hydroxyhex-5-enal O-benzyl oxime (1F)



1F

1F: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 (s, 1H), 7.51 – 7.24 (m, 9H), 5.83 – 5.67 (m, 1H), 5.17 – 5.04 (m, 2H), 5.00 – 4.87 (m, 2H), 3.43 (s, 1H), 2.15 – 1.91 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.1, 142.3, 138.0, 137.0, 131.6, 128.5(4), 128.5(2), 128.2, 127.2, 121.5, 115.0, 76.5, 75.4, 40.0, 27.6. HRMS (ESI) m/z calcd. for $C_{19}H_{21}O_2NBr$ $[M+H]^+$ 374.0750, found 374.0746.

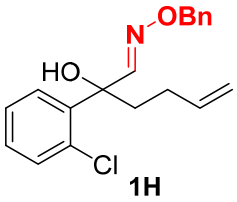
(*E*)-2-(3-chlorophenyl)-2-hydroxyhex-5-enal O-benzyl oxime (1G)



1G

1G: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (s, 1H), 7.48 – 7.43 (m, 1H), 7.37 – 7.29 (m, 5H), 7.29 – 7.19 (m, 3H), 5.86 – 5.64 (m, 1H), 5.14 – 5.04 (m, 2H), 5.01 – 4.89 (m, 2H), 3.45 (s, 1H), 2.18 – 1.87 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.9, 145.5, 138.0, 137.0, 134.7, 129.9, 128.6, 128.5, 128.3, 127.7, 125.7, 123.5, 115.1, 76.7, 75.4, 40.1, 27.6. HRMS (ESI) m/z calcd. for $C_{19}H_{21}O_2NCl$ $[M+H]^+$ 330.1255, found 330.1251.

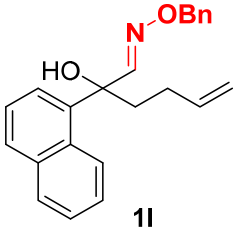
(*E*)-2-(2-chlorophenyl)-2-hydroxyhex-5-enal O-benzyl oxime (1H)



1H

1H: ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.34 – 8.22 (m, 1H), 7.90 – 7.83 (m, 1H), 7.43 – 7.25 (m, 7H), 7.25 – 7.18 (m, 1H), 5.86 – 5.70 (m, 1H), 5.14 – 5.02 (m, 2H), 5.01 – 4.86 (m, 2H), 3.74 (s, 1H), 2.44 – 2.30 (m, 1H), 2.26 – 2.01 (m, 2H), 2.01 – 1.83 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.9, 140.8, 138.3, 137.3, 131.2, 130.9, 129.2, 128.6, 128.6, 128.3, 127.3, 115.0, 76.6, 75.8, 37.7, 28.0. HRMS (ESI) m/z calcd. for $C_{19}H_{21}O_2NCl$ $[M+H]^+$ 330.1255, found 330.1253.

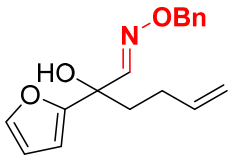
(*E*)-2-hydroxy-2-(naphthalen-1-yl)hex-5-enal O-benzyl oxime (1I)



1I

1I: ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.42 – 8.26 (m, 1H), 7.94 – 7.89 (m, 1H), 7.84 (d, *J* = 8.0 Hz, 1H), 7.78 (d, *J* = 8.0 Hz, 1H), 7.70 – 7.63 (m, 1H), 7.50 – 7.27 (m, 8H), 5.86 – 5.66 (m, 1H), 5.18 – 5.06 (m, 2H), 5.00 – 4.78 (m, 2H), 3.26 (brs, 1H), 2.58 – 2.45 (m, 1H), 2.40 – 2.22 (m, 1H), 2.20 – 1.94 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.3, 138.4, 138.2, 137.5, 134.8, 130.5, 129.3(3), 129.3(0), 128.6, 128.5, 128.1, 125.9, 125.8, 125.4, 125.0, 124.0, 114.9, 76.6, 76.5, 38.8, 28.1. HRMS (ESI) m/z calcd. for $C_{23}H_{24}O_2N$ $[M+H]^+$ 346.1801, found 346.1796.

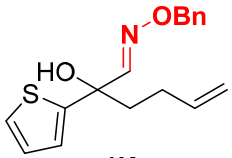
(*E*)-2-(furan-2-yl)-2-hydroxyhex-5-enal O-benzyl oxime (1J)



1J

1J: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 (s, 1H), 7.41 – 7.23 (m, 6H), 6.41 – 6.15 (m, 2H), 5.90 – 5.69 (m, 1H), 5.11 (s, 2H), 5.03 – 4.88 (m, 2H), 3.53 (s, 1H), 2.26 – 1.89 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.4, 151.0, 142.5, 138.0, 137.0, 128.5, 128.5, 128.2, 115.0, 110.4, 106.4, 76.6, 72.8, 37.5, 27.5. HRMS (ESI) m/z calcd. for $C_{17}H_{20}O_3N$ $[M+H]^+$ 286.1438, found 286.1437.

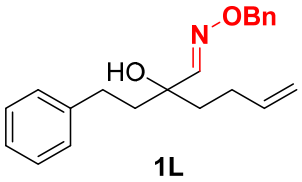
(*E*)-2-hydroxy-2-(thiophen-2-yl)hex-5-enal O-benzyl oxime (1K)



1K

1K: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (s, 1H), 7.46 – 7.31 (m, 5H), 7.28 (dd, *J* = 5.1, 1.2 Hz, 1H), 7.01 (dd, *J* = 5.0, 3.6 Hz, 1H), 6.94 (dd, *J* = 3.6, 1.1 Hz, 1H), 5.91 – 5.74 (m, 1H), 5.21 – 5.10 (m, 2H), 5.08 – 4.94 (m, 2H), 3.80 (s, 1H), 2.27 – 1.99 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.4, 148.6, 138.0, 137.0, 128.6, 128.5, 128.2, 127.2, 125.0, 123.3, 115.1, 76.7, 74.7, 40.8, 27.8. HRMS (ESI) m/z calcd. for $C_{17}H_{19}O_2NNaS$ $[M+Na]^+$ 324.1029, found 324.1024.

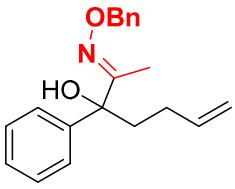
(*E*)-2-hydroxy-2-phenethylhex-5-enal O-benzyl oxime (1L)



1L

1L: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 (s, 1H), 7.39 – 7.28 (m, 5H), 7.26 (d, *J* = 7.3 Hz, 2H), 7.21 – 7.17 (m, 1H), 7.16 – 7.11 (m, 2H), 5.85 – 5.72 (m, 1H), 5.12 (s, 2H), 5.02 – 4.90 (m, 2H), 3.02 (s, 1H), 2.77 – 2.66 (m, 1H), 2.56 – 2.44 (m, 1H), 2.23 – 2.11 (m, 1H), 2.05 – 1.90 (m, 2H), 1.88 – 1.72 (m, 2H), 1.72 – 1.61 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.7, 142.1, 138.4, 137.3, 128.6(3), 128.6(0), 128.5, 128.2, 126.0, 115.0, 75.7, 74.3, 41.7, 39.1, 29.8, 27.8. HRMS (ESI) m/z calcd. for $C_{21}H_{26}O_2N$ $[M+H]^+$ 324.1958, found 324.1951.

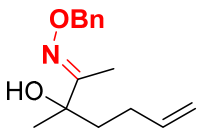
(*E*)-3-hydroxy-3-phenylhept-6-en-2-one O-benzyl oxime (1M)



1M

1M: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 (s, 1H), 7.33 – 7.24 (m, 7H), 7.12 (d, *J* = 8.1 Hz, 2H), 5.83 – 5.61 (m, 1H), 5.11 – 4.99 (m, 2H), 4.98 – 4.82 (m, 2H), 3.39 (s, 1H), 2.29 (s, 3H), 2.15 – 1.83 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.4, 143.3, 138.7, 137.9, 128.5, 128.4, 128.2, 128.0, 127.5, 126.2, 114.8, 78.0, 76.3, 36.7, 27.9, 11.7. HRMS (ESI) m/z calcd. for $C_{20}H_{24}O_2N$ $[M+H]^+$ 310.1802, found 310.1799.

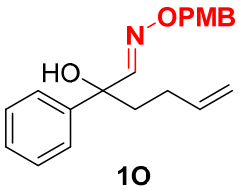
(*E*)-3-hydroxy-3-methylhept-6-en-2-one O-benzyl oxime (1N)



1N

1N: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 – 7.24 (m, 5H), 5.83 – 5.69 (m, 1H), 5.10 (s, 2H), 5.00 – 4.86 (m, 2H), 3.82 (s, 1H), 2.15 – 2.03 (m, 1H), 1.83 (s, 3H), 1.81 – 1.57 (m, 3H), 1.31 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.2, 138.5, 137.8, 128.4, 128.1, 127.9, 114.5, 76.1, 74.4, 39.1, 27.9, 27.0, 11.0. HRMS (ESI) m/z calcd. for $C_{15}H_{22}O_2N$ $[M+H]^+$ 248.1645, found 248.1643.

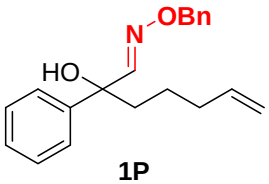
(*E*)-2-hydroxy-2-phenylhex-5-enal O-(4-methoxybenzyl) oxime (1O)



1O

1O: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 (s, 1H), 7.43 – 7.36 (m, 2H), 7.33 – 7.27 (m, 2H), 7.27 – 7.19 (m, 3H), 6.87 – 6.80 (m, 2H), 5.82 – 5.67 (m, 1H), 5.03 – 4.97 (m, 2H), 4.97 – 4.83 (m, 2H), 3.71 (s, 3H), 3.51 (s, 1H), 2.11 – 1.93 (m, 4H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.5, 153.4, 143.2, 130.2, 129.1, 128.4, 127.3, 125.2, 114.7, 113.8, 76.1, 75.5, 55.2, 40.0, 27.6. HRMS (ESI) m/z calcd. for $C_{20}H_{24}O_3N$ $[M+H]^+$ 326.1750, found 326.1750.

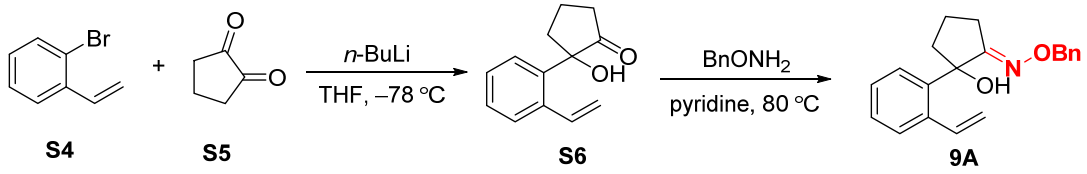
(*E*)-2-hydroxy-2-phenylhept-6-enal O-benzyl oxime (1P)



1P

1P: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (s, 1H), 7.41 – 7.36 (m, 2H), 7.33 – 7.15 (m, 8H), 5.80 – 5.61 (m, 1H), 5.12 – 5.01 (m, 2H), 4.99 – 4.85 (m, 2H), 3.40 (s, 1H), 2.05 – 1.82 (m, 4H), 1.37 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.7, 143.4, 138.4, 137.1, 128.4, 128.4, 128.3, 128.0, 127.2, 125.2, 114.8, 76.3, 75.6, 40.3, 33.7, 22.4. HRMS (ESI) m/z calcd. for $C_{20}H_{24}O_3N$ $[M+H]^+$ 310.1801, found 310.1798.

Procedure for synthesis of benzyl-protected cyclic oximes 9A and 9D



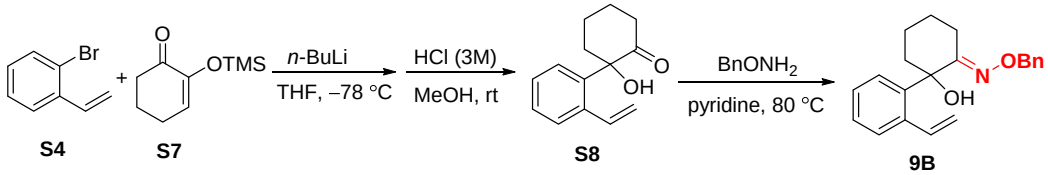
S4 S5 S6 9A

To a solution of **S4** (2.7 g, 15 mmol) in anhydrous THF (20 mL) was added *n*-BuLi (2.2 M/hexane, 7.0 mL, 15 mmol) at −78 °C. The reaction solution was stirred for 1 h, followed by addition of **S5** (0.75 g, 7.5 mmol). The reaction solution was warmed up to room temperature and stirred for 12 h and quenched with water (20 mL). EtOAc was used to extract the product from the aqueous layer (3 × 40 mL). The combined organic layer was washed with brine (20 mL), dried over anhydrous Na_2SO_4, filtered and concentrated to afford the crude product, which was purified by flash column chromatography to afford the product **S6** (0.38 g, 25%) as a colorless oil.

A solution of **S6** (0.38 g, 1.9 mmol) and *O*-benzylhydroxylamine (0.46 g, 3.8 mmol) in pyridine (3 mL) was heated at 80 °C for 2 h and then cooled down to room temperature. The solvent was evaporated under reduced pressure. EtOAc (20 mL) was added to dissolve the crude product, which was washed with HCl (1 M, 10 mL) and brine (10 mL) sequentially. The organic layer was dried over anhydrous Na_2SO_4, filtered and concentrated to afford the crude product, which was purified by flash column chromatography to afford the product **9A** (0.29 g, 50% yield) as a colorless oil.

The procedure for synthesis of **9D** is similar to that of **9A**.

Procedure for synthesis of benzyl-protected cyclic oximes 9B and 9C



S4 S7 S8 9B

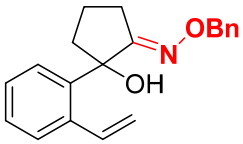
To a solution of **S4** (1.9 g, 10 mmol) in anhydrous THF (20 mL) was added *n*-BuLi (2.2 M/hexane, 4.5 mL, 10 mmol) at −78 °C. The reaction solution was stirred for 1 h, followed by addition of **S7** (1.8 g, 10 mmol). The reaction solution was warmed up to

room temperature and stirred for 2 h and quenched with water (20 mL). EtOAc was used to extract the product from the aqueous layer (3 × 20 mL). The combined organic layer was washed with brine (10 mL), dried over anhydrous Na_2SO_4, filtered and concentrated to afford the crude product, which was dissolved in MeOH (10 mL). 3M HCl (4 mL) was added to the reaction mixture. The mixture was stirred for 10 min and diluted with water (15 mL). Dichloromethane was used to extract the product from the aqueous layer (3 × 30 mL). The combined organic layer was washed with brine (10 mL), dried over anhydrous Na_2SO_4, filtered and concentrated to afford the crude product, which was purified by flash column chromatography to afford the product **S8** (0.95 g, 44%) as a colorless oil.

A solution of **S8** (0.95 g, 4.4 mmol) and *O*-benzylhydroxylamine (1.2 g, 10 mmol) in pyridine (5 mL) was heated at 80 °C for 2 h and then cooled down to room temperature. The solvent was evaporated under reduced pressure. EtOAc (30 mL) was added to dissolve the crude product, which was washed with HCl (1 M, 10 mL) and brine (10 mL) sequentially. The organic layer was dried over anhydrous Na_2SO_4, filtered and concentrated to afford the crude product, which was purified by flash column chromatography to afford the product **9B** (0.65 g, 45% yield) as a colorless oil.

The procedure for synthesis of **9C** is similar to that of **9B**.

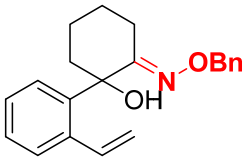
(*E*)-2-hydroxy-2-(2-vinylphenyl)cyclopentan-1-one O-benzyl oxime (9A)



9A

9A: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 – 7.46 (m, 1H), 7.34 – 7.10 (m, 9H), 5.52 (d, *J* = 17.4 Hz, 1H), 5.22 (d, *J* = 11.0 Hz, 1H), 5.09 (s, 2H), 2.91 – 2.72 (m, 2H), 2.58 – 2.44 (m, 1H), 2.38 – 2.27 (m, 1H), 2.08 – 1.97 (m, 1H), 1.93 – 1.80 (m, 1H), 1.64 – 1.49 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.0, 140.8, 138.1, 137.1(4), 137.1(2), 128.4, 128.3, 127.9, 127.9, 127.7, 127.2, 126.8, 115.4, 82.4, 76.3, 41.1, 27.5, 20.6. HRMS (ESI) m/z calcd. for $C_{20}H_{22}O_2N$ $[M+H]^+$ 308.1645, found 308.1640.

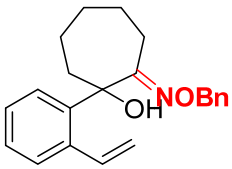
(*E*)-2-hydroxy-2-(2-vinylphenyl)cyclohexan-1-one O-benzyl oxime (9B)



9B

9B: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.34 (m, 2H), 7.32 – 7.07 (m, 8H), 5.35 (dd, *J* = 17.3, 1.5 Hz, 1H), 5.02 (s, 2H), 4.97 (dd, *J* = 10.9, 1.5 Hz, 1H), 3.93 (s, 1H), 3.01 – 2.87 (m, 1H), 2.78 – 2.65 (m, 1H), 2.07 (ddd, *J* = 14.5, 9.5, 5.1 Hz, 1H), 1.78 – 1.55 (m, 3H), 1.54 – 1.34 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.9, 139.4, 138.4, 137.9, 137.7, 128.4, 128.3, 128.2, 127.7, 127.2, 126.7, 114.9, 76.5, 75.9, 41.1, 25.5, 24.2, 22.2. HRMS (ESI) m/z calcd. for $C_{21}H_{24}O_2N$ $[M+H]^+$ 322.1802, found 322.1799.

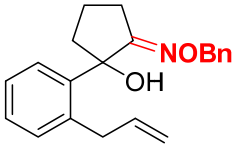
(*E*)-2-hydroxy-2-(2-vinylphenyl)cycloheptan-1-one O-benzyl oxime (9C)



9C

9C: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 – 7.73 (m, 1H), 7.56 (d, *J* = 7.6 Hz, 1H), 7.50 – 7.36 (m, 5H), 7.36 – 7.27 (m, 1H), 7.22 (t, *J* = 7.5 Hz, 1H), 6.98 (d, *J* = 7.7 Hz, 1H), 5.58 (dd, *J* = 17.5, 1.3 Hz, 1H), 5.29 (dd, *J* = 11.0, 1.4 Hz, 1H), 5.26 (s, 2H), 4.56 (s, 1H), 3.34 – 3.27 (m, 1H), 2.77 – 2.65 (m, 1H), 2.05 – 1.94 (m, 2H), 1.91 – 1.63 (m, 4H), 1.57 (dd, *J* = 23.7, 11.6 Hz, 1H), 1.45 – 1.30 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.3, 142.3, 138.7, 138.2, 137.8, 128.9, 128.4, 128.2, 127.9, 127.6, 127.0, 126.1, 114.9, 80.3, 76.3, 40.7, 30.2, 28.2, 26.1, 23.4. HRMS (ESI) m/z calcd. for $C_{22}H_{26}O_2N$ $[M+H]^+$ 336.1958, found 336.1953.

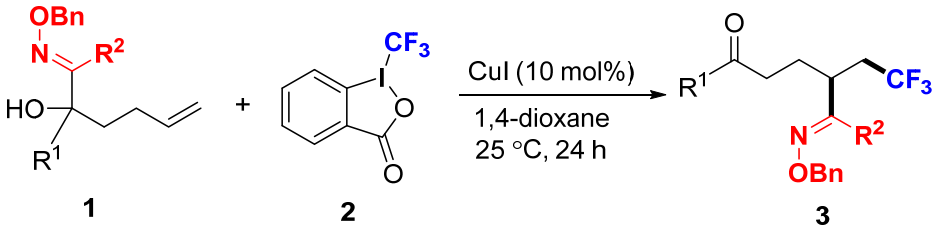
(*E*)-2-(2-allylphenyl)-2-hydroxycyclopentan-1-one O-benzyl oxime (9D)



9D

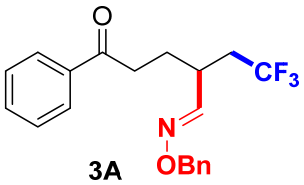
9D: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.15 (m, 8H), 7.12 – 7.05 (m, 1H), 6.03 – 5.86 (m, 1H), 5.09 (s, 2H), 5.06 – 4.93 (m, 2H), 3.51 – 3.45 (m, 2H), 2.88 – 2.75 (m, 1H), 2.63 – 2.47 (m, 1H), 2.27 – 2.16 (m, 1H), 2.11 – 1.99 (m, 1H), 1.98 – 1.84 (m, 1H), 1.68 – 1.50 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.3, 141.8, 138.5, 138.1, 138.1, 131.6, 128.5, 128.3, 127.9, 127.7, 127.0, 125.6, 115.8, 82.6, 76.3, 41.4, 37.9, 27.5, 20.6. HRMS (ESI) m/z calcd. for $C_{21}H_{24}O_2N$ $[M+H]^+$ 322.1802, found 322.1800.

General procedure for 1,2-trifluoromethyl-oximation of alkene 1



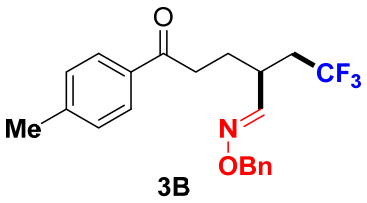
In an oven-dried 10 mL Schlenk tube were added **1** (0.20 mmol), CuI (4 mg, 0.02 mmol) and Togni's reagent **2** (75 mg, 0.24 mmol). The tube was vacuumed and back-filled with argon three times and then added with 1,4-dioxane (2 mL). The reaction mixture was stirred at 25 °C for 24 h. The solvent was removed under reduced pressure to afford the crude product, which was purified by flash column chromatography to afford the product **3**.

(*E*)-5-oxo-5-phenyl-2-(2,2,2-trifluoroethyl)pentanal O-benzyl oxime (3A)



3A: (81% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (d, *J* = 7.7 Hz, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.44 (t, *J* = 7.5 Hz, 2H), 7.35 – 7.22 (m, 6H), 5.06 – 5.01 (m, 2H), 3.00 – 2.85 (m, 2H), 2.79 – 2.68 (m, 1H), 2.46 – 2.19 (m, 2H), 2.08 – 1.97 (m, 1H), 1.97 – 1.83 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.4, 151.3, 137.7, 136.7, 133.3, 128.7, 128.4, 128.2, 128.1, 127.9, 126.3 (q, *J* = 277.3 Hz), 75.8, 37.0 (q, *J* = 28.1 Hz), 35.3, 34.0 (q, *J* = 2.4 Hz), 26.5. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.5. HRMS (ESI) m/z calcd. For $C_{20}H_{21}O_2NF_3$ $[M+H]^+$ 364.1519, found 364.1516.

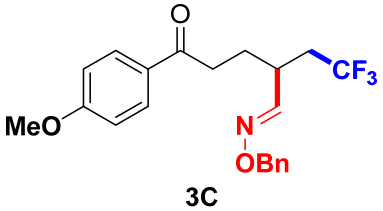
(*E*)-5-oxo-5-(*p*-tolyl)-2-(2,2,2-trifluoroethyl)pentanal O-benzyl oxime (3B)



3B

3B: (60% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.77 (d, *J* = 8.2 Hz, 2H), 7.36 – 7.21 (m, 7H), 5.06 – 5.04 (m, 2H), 3.01 – 2.82 (m, 2H), 2.79 – 2.68 (m, 1H), 2.41 (s, 3H), 2.40 – 2.20 (m, 2H), 2.07 – 1.97 (m, 1H), 1.95 – 1.84 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.7, 151.4, 144.1, 137.6, 134.3, 129.4, 128.5, 128.2(4), 128.2(3), 127.9, 126.3 (q, *J* = 277.3 Hz), 75.9, 37.1 (q, *J* = 28.1 Hz), 35.2, 34.1 (q, *J* = 2.4 Hz), 29.8, 26.6, 21.8. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.6. HRMS (ESI) m/z calcd. for $C_{21}H_{23}O_2NF_3$ [M+H]+ 378.1675, found 378.1672.

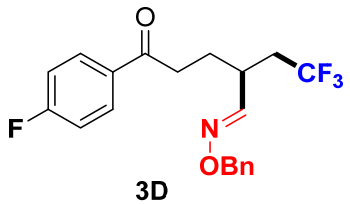
(*E*)-5-(4-methoxyphenyl)-5-oxo-2-(2,2,2-trifluoroethyl)pentanal O-benzyl oxime (3C)



3C

3C: (63% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.9 Hz, 2H), 7.37 – 7.19 (m, 6H), 6.91 (d, *J* = 8.9 Hz, 2H), 5.06 – 5.00 (m, 2H), 3.87 (s, 3H), 2.94 – 2.79 (m, 2H), 2.79 – 2.66 (m, 1H), 2.45 – 2.16 (m, 2H), 2.06 – 1.96 (m, 1H), 1.93 – 1.80 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.5, 163.6, 151.4, 137.7, 126.3 (q, *J* = 275.4 Hz), 130.4, 129.9, 128.5, 128.2, 127.9, 113.8, 75.9, 55.6, 37.1 (q, *J* = 28.1 Hz), 34.9 (q, *J* = 2.4 Hz), 26.8. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.5. HRMS (ESI) m/z calcd. for $C_{21}H_{23}O_3NF_3$ $[M+H]^+$ 394.1624, found 394.1620.

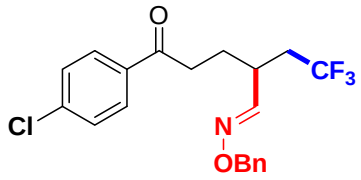
(*E*)-5-(4-fluorophenyl)-5-oxo-2-(2,2,2-trifluoroethyl)pentanal O-benzyl oxime (3D)



3D

3D: (70% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 – 7.86 (m, 2H), 7.41 – 7.29 (m, 6H), 7.14 (t, *J* = 8.6 Hz, 2H), 5.10 – 5.01 (m, 2H), 2.96 – 2.88 (m, 2H), 2.81 – 2.70 (m, 1H), 2.49 – 2.23 (m, 2H), 2.12 – 2.01 (m, 1H), 1.98 – 1.86 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.4, 165.9 (d, *J* = 254.8 Hz), 151.3, 137.7, 133.2 (d, *J* = 3.0 Hz), 130.8 (d, *J* = 9.2 Hz), 128.5, 128.2, 128.0, 126.3 (q, *J* = 277.4 Hz), 115.8 (d, *J* = 21.9 Hz), 75.9, 37.2 (q, *J* = 28.0 Hz), 35.3, 34.1 (q, *J* = 2.6 Hz), 26.5. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.6, -105.1. HRMS (ESI) m/z calcd. For $C_{20}H_{20}O_2NF_4$ $[M+H]^+$ 382.1424, found 382.1423.

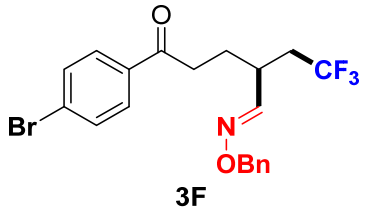
(*E*)-5-(4-chlorophenyl)-5-oxo-2-(2,2,2-trifluoroethyl)pentanal O-benzyl oxime (3E)



3E

3E: (71% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 – 7.73 (m, 2H), 7.43 – 7.39 (m, 2H), 7.34 – 7.24 (m, 6H), 5.08 – 4.99 (m, 2H), 2.91 – 2.84 (m, 2H), 2.79 – 2.68 (m, 1H), 2.44 – 2.20 (m, 2H), 2.07 – 1.96 (m, 1H), 1.93 – 1.81 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.7, 151.2, 139.7, 137.7, 135.1, 129.5, 129.0, 128.5, 128.2, 127.9, 126.3 (q, *J* = 274.6 Hz), 75.9, 37.1 (q, *J* = 28.3 Hz), 35.3, 34.0 (q, *J* = 2.5 Hz), 26.4. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.5. HRMS (ESI) m/z calcd. For $C_{20}H_{20}O_2NClF_3$ $[M+H]^+$ 398.1129, found 398.1129.

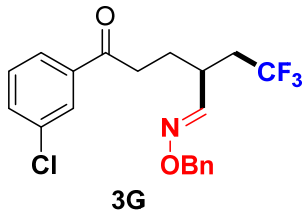
(*E*)-5-(4-bromophenyl)-5-oxo-2-(2,2,2-trifluoroethyl)pentanal O-benzyl oxime (3F)



3F

3F: (70% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 – 7.82 (m, 2H), 7.57 (t, *J* = 7.4 Hz, 1H), 7.45 (t, *J* = 7.7 Hz, 2H), 7.36 (dd, *J* = 7.2, 1.2 Hz, 1H), 7.33 – 7.24 (m, 5H), 5.07 – 4.99 (m, 2H), 2.98 – 2.91 (m, 2H), 2.91 – 2.82 (m, 1H), 2.48 – 2.14 (m, 2H), 2.11 – 2.00 (m, 1H), 2.00 – 1.88 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.0, 151.2, 137.7, 135.5, 132.0, 129.6, 128.5, 128.5, 128.3, 128.0, 126.3 (q, *J* = 275.6 Hz), 75.9, 37.2 (q, *J* = 28.2 Hz), 35.3, 34.1 (q, *J* = 2.3 Hz), 26.4. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.6. HRMS (ESI) m/z calcd. For $C_{20}H_{20}O_2NBrF_3$ $[M+H]^+$ 442.0624, found 442.0626.

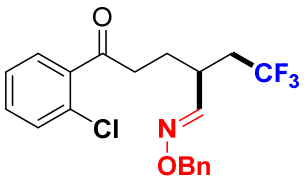
(*E*)-5-(3-chlorophenyl)-5-oxo-2-(2,2,2-trifluoroethyl)pentanal O-benzyl oxime (3G)



3G

3G: (84% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (s, 1H), 7.72 (d, *J* = 7.8 Hz, 1H), 7.55 (d, *J* = 8.0 Hz, 1H), 7.39 (t, *J* = 7.9 Hz, 1H), 7.36 – 7.21 (m, 6H), 5.10 – 4.98 (m, 2H), 2.96 – 2.81 (m, 2H), 2.79 – 2.66 (m, 1H), 2.46 – 2.18 (m, 2H), 2.09 – 1.97 (m, 1H), 1.96 – 1.83 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.7, 151.2, 138.3, 137.6, 135.1, 133.2, 130.1, 128.5, 128.3, 128.2, 128.0, 126.3 (q, *J* = 277.3 Hz), 126.2, 75.9, 37.2 (q, *J* = 28.3 Hz), 35.4, 34.0 (q, *J* = 2.5 Hz), 26.3. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.6. HRMS (ESI) m/z calcd. For $C_{20}H_{20}O_2NClF_3$ $[M+H]^+$ 398.1129, found 398.1130.

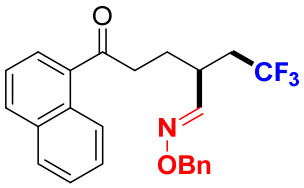
(*E*)-5-(2-chlorophenyl)-5-oxo-2-(2,2,2-trifluoroethyl)pentanal O-benzyl oxime (3H)



3H

3H: (71% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.35 (m, 3H), 7.35 – 7.19 (m, 7H), 5.09 – 4.99 (m, 2H), 2.91 (t, *J* = 7.4 Hz, 2H), 2.79 – 2.67 (m, 1H), 2.45 – 2.17 (m, 2H), 2.08 – 1.97 (m, 1H), 1.94 – 1.78 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 202.1, 151.1, 139.2, 137.5, 131.9, 131.0, 130.7, 129.0, 128.5, 128.3, 128.0, 127.1, 126.3 (q, *J* = 277.1 Hz), 76.0, 39.7, 37.0 (q, *J* = 28.3 Hz), 33.9 (q, *J* = 2.4 Hz), 26.6. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.5. HRMS (ESI) m/z calcd. For $C_{20}H_{20}O_2NClF_3$ [M+H]+ 398.1129, found 398.1127.

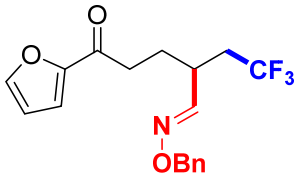
(*E*)-5-(naphthalen-1-yl)-5-oxo-2-(2,2,2-trifluoroethyl)pentanal O-benzyl oxime (3I)



3I

3I: (71% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.55 (d, *J* = 8.5 Hz, 1H), 7.98 (d, *J* = 8.2 Hz, 1H), 7.89 – 7.85 (m, 1H), 7.72 (dd, *J* = 7.2, 0.9 Hz, 1H), 7.60 – 7.50 (m, 2H), 7.46 (dd, *J* = 8.0, 7.4 Hz, 1H), 7.35 (d, *J* = 6.9 Hz, 1H), 7.30 – 7.17 (m, 5H), 5.06 – 4.97 (m, 2H), 3.01 (t, *J* = 7.3 Hz, 2H), 2.84 – 2.71 (m, 1H), 2.47 – 2.22 (m, 2H), 2.16 – 2.04 (m, 1H), 2.01 – 1.84 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 203.1, 151.3, 137.6, 135.7, 134.0, 132.9, 130.1, 128.5(4), 128.5(1), 128.2, 128.1, 127.9, 127.7, 126.6, 126.3 (q, *J* = 277.3 Hz), 125.8, 124.5, 75.9, 38.7, 37.1 (q, *J* = 28.1 Hz), 34.1 (q, *J* = 2.4 Hz), 26.9. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.5. HRMS (ESI) m/z calcd. for $C_{24}H_{23}O_2NF_3$ $[M+H]^+$ 414.1675, found 414.1673.

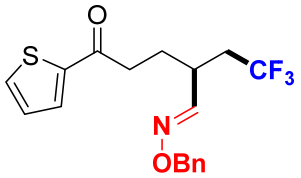
(*E*)-5-(furan-2-yl)-5-oxo-2-(2,2,2-trifluoroethyl)pentanal O-benzyl oxime (3J)



3J

3J: (70% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 (d, *J* = 1.0 Hz, 1H), 7.36 – 7.23 (m, 6H), 7.09 (d, *J* = 3.5 Hz, 1H), 6.52 (dd, *J* = 3.6, 1.7 Hz, 1H), 5.08 – 4.99 (m, 2H), 2.80 (t, *J* = 7.5 Hz, 2H), 2.78 – 2.66 (m, 1H), 2.45 – 2.17 (m, 2H), 2.05 – 1.95 (m, 1H), 1.88 (ddd, *J* = 16.6, 10.7, 4.7 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 188.2, 152.5, 151.2, 146.5, 137.6, 128.5, 128.3, 128.0, 126.3 (q, *J* = 279.9 Hz), 117.3, 112.38, 76.0, 36.9 (q, *J* = 28.3 Hz), 35.1, 34.0 (d, *J* = 2.3 Hz), 26.4. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.6. HRMS (ESI) m/z calcd. for $C_{18}H_{19}O_3NF_3$ $[M+H]^+$ 354.1311, found 354.1309.

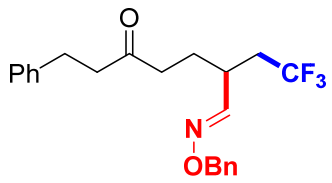
(*E*)-5-oxo-5-(thiophen-2-yl)-2-(2,2,2-trifluoroethyl)pentanal O-benzyl oxime (3K)



3K

3K: (69% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 (dd, *J* = 4.9, 0.9 Hz, 1H), 7.56 (dd, *J* = 3.8, 0.9 Hz, 1H), 7.35 – 7.22 (m, 6H), 7.10 (dd, *J* = 4.9, 3.9 Hz, 1H), 5.09 – 4.98 (m, 2H), 2.94 – 2.81 (m, 2H), 2.78 – 2.68 (m, 1H), 2.43 – 2.19 (m, 2H), 2.10 – 1.98 (m, 1H), 1.96 – 1.83 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 191.9, 151.2, 144.0, 137.7, 133.8, 132.1, 128.5, 128.3, 128.2, 128.0, 126.3 (q, *J* = 277.2 Hz), 75.9, 37.0 (q, *J* = 28.2 Hz), 36.0, 34.1 (q, *J* = 2.5 Hz), 26.7. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.5. HRMS (ESI) m/z calcd. for $C_{18}H_{19}O_2NF_3S$ $[M+H]^+$ 370.1083, found 370.1080.

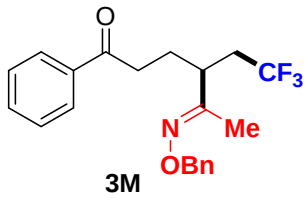
(*E*)-5-oxo-7-phenyl-2-(2,2,2-trifluoroethyl)heptanal O-benzyl oxime (3L)



3L

3L: (40% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 – 7.24 (m, 7H), 7.19 (t, *J* = 7.3 Hz, 1H), 7.13 (d, *J* = 7.3 Hz, 2H), 6.46 (d, *J* = 7.9 Hz, 1H), 5.08 (s, 2H), 3.48 – 3.33 (m, 1H), 2.83 (t, *J* = 7.6 Hz, 2H), 2.63 – 2.57 (m, 2H), 2.42 – 2.28 (m, 2H), 2.27 – 2.13 (m, 2H), 1.93 – 1.73 (m, 1H), 1.60 – 1.52 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 208.7, 152.1, 141.0, 137.7, 128.6(4), 128.6(3), 128.4, 128.2, 128.1, 126.3, 126.2 (q, *J* = 277.5 Hz), 76.3, 44.4, 40.0, 37.1 (q, *J* = 28.2 Hz), 29.8, 29.7 (q, *J* = 2.9 Hz), 26.0. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.6. HRMS (ESI) m/z calcd. for $C_{22}H_{25}O_2NF_3[M+H]^+$ 392.1832, found 392.1828.

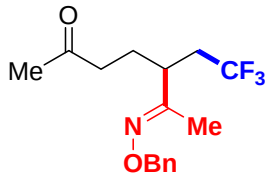
(*E*)-4-(1-((benzyloxy)imino)ethyl)-6,6,6-trifluoro-1-phenylhexan-1-one (3M)



3M

3M: (79% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 – 7.77 (m, 2H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.43 (t, *J* = 7.7 Hz, 2H), 7.34 – 7.20 (m, 5H), 5.08 – 4.90 (m, 2H), 2.87 – 2.77 (m, 2H), 2.76 – 2.67 (m, 1H), 2.48 – 2.35 (m, 1H), 2.30 – 2.17 (m, 1H), 2.02 – 1.88 (m, 2H), 1.84 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 199.1, 157.2, 138.4, 136.8, 133.2, 128.7, 128.4, 128.1, 127.9, 127.7, 126.4 (q, *J* = 277.1 Hz), 75.6, 38.9 (q, *J* = 2.3 Hz), 36.4 (q, *J* = 28.1 Hz), 35.3, 26.2, 11.9. ^{19}F NMR (376 MHz, $CDCl_3$) δ -64.2. HRMS (ESI) m/z calcd. For $C_{21}H_{23}O_2NF_3$ $[M+H]^+$ 378.1675, found 378.1674.

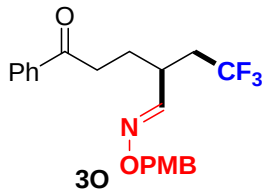
(*E*)-5-(1-((benzyloxy)imino)ethyl)-7,7,7-trifluoroheptan-2-one (3N)



3N

3N: (25% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.23 (m, 5H), 5.11 – 4.98 (m, 2H), 3.63 – 3.45 (m, 1H), 2.42 – 2.30 (m, 2H), 2.30 – 2.23 (m, 1H), 2.22 – 2.09 (m, 1H), 2.01 (s, 3H), 1.85 – 1.73 (m, 4H), 1.74 – 1.65 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 207.5, 157.2, 137.9, 128.4, 128.2, 127.9, 126.3 (q, *J* = 277.1 Hz), 75.8, 40.5, 36.1 (q, *J* = 28.3 Hz), 31.7 (q, *J* = 2.4 Hz), 29.9, 25.3, 16.3. ^{19}F NMR (376 MHz, $CDCl_3$) δ -64.7. HRMS (ESI) m/z calcd. For $C_{19}H_{20}ONF_2$ $[M+H]^+$ 316.1507, found 316.1517.

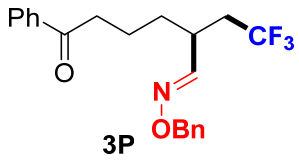
(*E*)-5-oxo-5-phenyl-2-(2,2,2-trifluoroethyl)pentanal O-(4-methoxybenzyl) oxime (3O)



3O

3O: (80% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (dd, *J* = 8.0, 1.5 Hz, 2H), 7.60 (t, *J* = 7.4 Hz, 1H), 7.49 (t, *J* = 7.6 Hz, 2H), 7.34 (d, *J* = 7.3 Hz, 1H), 7.29 (d, *J* = 8.5 Hz, 2H), 6.86 (d, *J* = 8.6 Hz, 2H), 5.00 (s, 2H), 3.77 (s, 3H), 2.97 (td, *J* = 7.5, 7.0, 2.9 Hz, 2H), 2.83 – 2.73 (m, 1H), 2.49 – 2.24 (m, 2H), 2.06 (ddt, *J* = 14.7, 7.7, 4.5 Hz, 1H), 2.01 – 1.85 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.9, 159.4, 151.0, 136.7, 133.2, 129.9, 129.6, 128.6, 128.0, ,126.3(q, *J* = 277.4 Hz), 113.8, 75.5, 55.2, 37.0 (q, *J* = 28.1 Hz), 35.2, 34.0 (q, *J* = 2.4 Hz), 26.5. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.5. HRMS (ESI) m/z calcd. For $C_{21}H_{23}O_3NF_3$ $[M+H]^+$ 394.1625, found 394.1623.

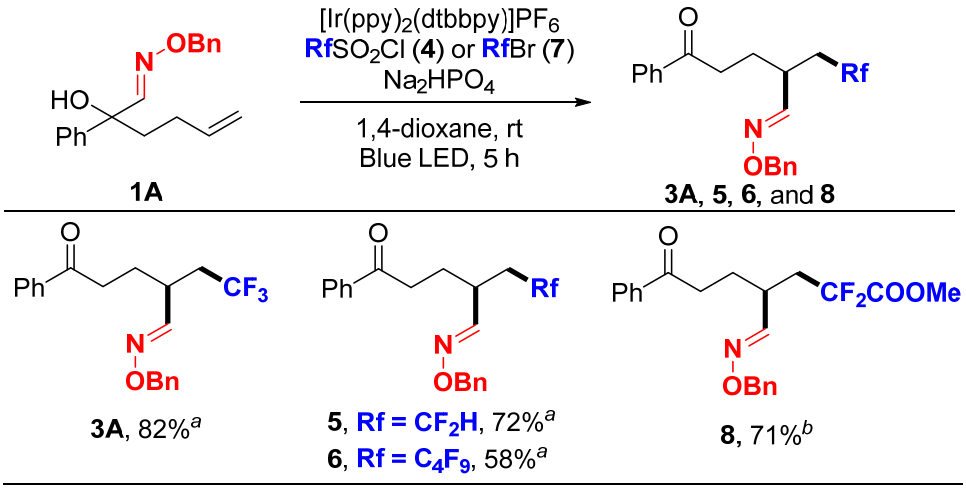
(*E*)-6-oxo-6-phenyl-2-(2,2,2-trifluoroethyl)hexanal O-benzyl oxime (3P)



3P

3P: (69% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 – 7.84 (m, 2H), 7.56 (t, *J* = 7.4 Hz, 1H), 7.46 (t, *J* = 7.6 Hz, 2H), 7.39 – 7.29 (m, 5H), 7.29 – 7.24 (m, 1H), 5.06 (s, 2H), 3.05 – 2.86 (m, 2H), 2.76 – 2.65 (m, 1H), 2.43 – 2.1 (m, 2H), 1.84 – 1.68 (m, 2H), 1.67 – 1.53 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 199.6, 151.6, 137.6, 136.9, 133.2, 128.8, 128.5, 128.3, 128.1, 128.0, 127.6 (q, *J* = 278.9 Hz), 76.0, 37.9, 36.5 (q, *J* = 28.1 Hz), 34.3, 32.2 (q, *J* = 2.7 Hz), 21.0. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.5. HRMS (ESI) m/z calcd. For $C_{21}H_{23}O_2NF_3$ $[M+H]^+$ 378.1675, found 378.1673.

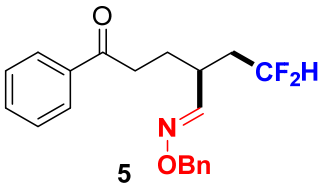
General Procedure for synthesis of fluoroalkylated oximes.



In an oven-dried 10 mL tube were added **1A** (44 mg, 0.2 mmol), sulfonyl chloride (**4**, 0.3 mmol), Na_2HPO_4 (144 mg, 0.4 mmol) and $[Ir(dtbbpy)(ppy)_2]PF_6$ (1.6 mg, 0.002 mmol) sequentially. The tube was vacuumed and back-filled with argon three times and then added with 1,4-dioxane (2 mL). The reaction mixture was irradiated with blue LED for 5 h at 25 °C. EtOAc (30 mL) was added and the organic layer was washed with water (5 mL) and brine (5 mL) sequentially, dried over anhydrous Na_2SO_4, filtered and concentrated to afford the crude product, which was purified by flash column chromatography to afford the product **3A** (82% yield), **5**, and **6**.

The procedure for synthesis of 8 is similar to that reported for synthesis of 3A.

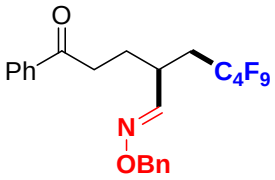
(*E*)-2-(2,2-difluoroethyl)-5-oxo-5-phenylpentanal O-benzyl oxime (5)



5

5: (72% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 7.4 Hz, 2H), 7.57 (t, *J* = 7.4 Hz, 1H), 7.45 (t, *J* = 7.7 Hz, 2H), 7.37 – 7.23 (m, 6H), 5.84 (tdd, *J* = 56.5, 5.5, 4.0 Hz, 1H), 5.08 – 4.99 (m, 2H), 2.94 (t, *J* = 7.4 Hz, 2H), 2.67 – 2.56 (m, 1H), 2.17 – 1.83 (m, 4H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 199.5, 152.1, 137.7, 136.8, 133.3, 128.7, 128.5, 128.3, 128.1, 128.0, 116.1 (t, *J* = 239.2 Hz), 75.9, 37.2 (t, *J* = 21.4 Hz), 35.5, 34.4 (q, *J* = 4.5 Hz), 26.8. ^{19}F NMR (376 MHz, $CDCl_3$) δ -115.2 (q, *J* = 284.5 Hz). HRMS (ESI) m/z calcd. For $C_{20}H_{22}O_2NF_2$ $[M+H]^+$ 346.1613, found 346.1610.

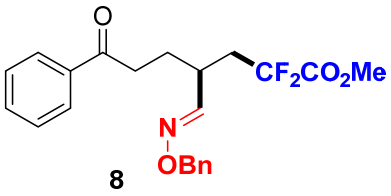
(*E*)-7,7,7,7,7,7,7,7,7-nonafluoro-2-(3-oxo-3-phenylpropyl)-7l12-hepta-4,6-diynal O-benzyl oxime (6)



6

6: (58% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 – 7.82 (m, 2H), 7.57 (t, *J* = 7.4 Hz, 1H), 7.45 (t, *J* = 7.7 Hz, 2H), 7.36 (dd, *J* = 7.2, 1.2 Hz, 1H), 7.33 – 7.24 (m, 5H), 5.07 – 4.99 (m, 2H), 2.98 – 2.91 (m, 2H), 2.91 – 2.82 (m, 1H), 2.48 – 2.14 (m, 2H), 2.11 – 2.00 (m, 1H), 2.00 – 1.88 (m, 1H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 199.0, 151.5, 137.7, 136.8, 133.3, 128.7, 128.5, 128.3, 128.1, 128.0, 120.1 – 104.0 (m), 75.9, 35.4, 33.8 (t, *J* = 21.2 Hz), 32.9, 27.2. ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.0 – -81.1 (m), -111.4 – -113.8 (m), -122.5 – -131.0 (m). HRMS (ESI) m/z calcd. For $C_{23}H_{21}O_2NF_9$ $[M+H]^+$ 514.1423, found 514.1422.

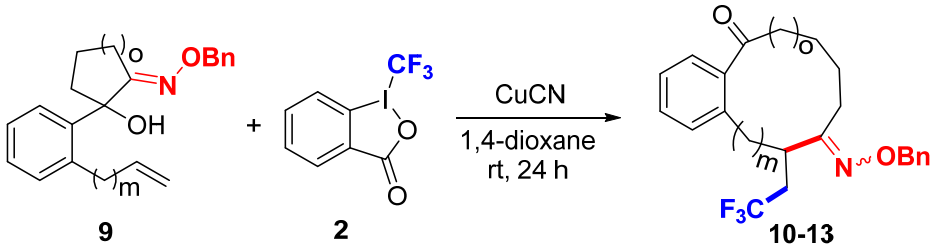
methyl (*E*)-4-(((benzyloxy)imino)methyl)-2,2-difluoro-7-oxo-7-phenylheptanoate (8)



8

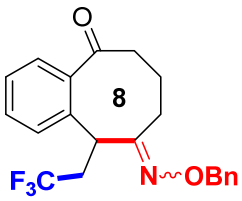
8: (71% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 – 7.83 (m, 2H), 7.57 (t, *J* = 7.4 Hz, 1H), 7.45 (t, *J* = 7.7 Hz, 2H), 7.34 – 7.22 (m, 6H), 5.02 (s, 2H), 3.84 (s, 3H), 3.04 – 2.86 (m, 2H), 2.78 – 2.65 (m, 1H), 2.49 – 2.35 (m, 1H), 2.34 – 2.17 (m, 1H), 2.05 – 1.85 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 199.1, 164.4 (t, *J* = 32.7 Hz), 151.9, 137.7, 136.8, 133.2, 128.7, 128.5, 128.3, 128.1, 127.9, 119.7 – 112.1 (m), 75.8, 53.6, 37.7 (t, *J* = 22.9 Hz), 35.4, 33.8 (t, *J* = 3.4 Hz), 27.1. ^{19}F NMR (376 MHz, $CDCl_3$) δ -103.4 (dd, *J* = 631.2, 264.3 Hz). HRMS (ESI) m/z calcd. For $C_{22}H_{24}O_4NF_2$ $[M+H]^+$ 404.1667, found 404.1664.

General procedure for ring expansion strategy for synthesis of medium-sized rings.



9 2 10-13

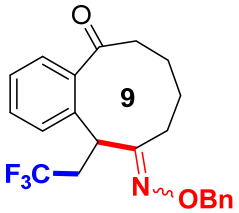
In an oven-dried 10 mL Schlenk tube were added **9** (0.20 mmol), CuCN (1.6 mg, 0.02 mmol) and Togni's reagent **2** (75 mg, 0.24 mmol). The tube was vacuumed and back-filled with argon three times and then added with 1,4-dioxane (2 mL). The reaction mixture was stirred at 25 °C for 24 h. The solvent was removed under reduced pressure to afford the crude product, which was purified by flash column chromatography to afford the product **10-13**.



10 (1.7:1)

10 (82% overall yield). (major isomer). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.26 (m, 8H), 7.13 – 7.07 (m, 1H), 5.09 (q, *J* = 12.2 Hz, 2H), 3.90 (t, *J* = 6.7 Hz, 1H), 3.31 – 3.16 (m, 2H), 2.80 – 2.62 (m, 2H), 2.55 – 2.44 (m, 1H), 2.16 – 2.03 (m, 1H), 1.79 – 1.62 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 209.8, 156.7, 140.6, 137.6, 136.0, 130.1, 128.6, 128.4, 128.3, 127.9, 127.8, 127.0 (q, *J* = 277.2 Hz), 125.8, 76.4, 43.9, 42.9 (q, *J* = 2.7 Hz), 37.0 (q, *J* = 27.6 Hz), 27.0, 20.9. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.6. HRMS (ESI) m/z calcd. For $C_{21}H_{21}O_2NF_3$ $[M+H]^+$ 376.1519, found 376.1518.

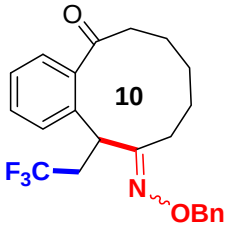
10 (minor isomer). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.22 (m, 7H), 7.12 – 7.01 (m, 2H), 4.95 (q, *J* = 11.9 Hz, 2H), 4.46 (dd, *J* = 9.7, 4.2 Hz, 1H), 3.23 – 3.07 (m, 1H), 3.00 – 2.89 (m, 1H), 2.83 – 2.68 (m, 2H), 2.69 – 2.59 (m, 1H), 2.55 – 2.44 (m, 1H), 2.18 – 2.05 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 209.2, 157.9, 140.5, 137.2, 135.4, 130.8, 128.3, 128.2, 127.9, 127.8, 127.6, 127.4, 126.4 (q, *J* = 277.7 Hz), 76.2, 43.3, 38.8 (q, *J* = 2.8 Hz), 35.7 (q, *J* = 28.3 Hz), 33.67, 24.7. ^{19}F NMR (376 MHz, $CDCl_3$) δ -64.6. HRMS (ESI) m/z calcd. For $C_{21}H_{21}O_2NF_3$ $[M+H]^+$ 376.1519, found 376.1517.



11 (7:1)

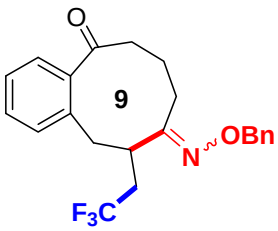
11: (76% yield, major isomer). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.26 (m, 8H), 7.13 – 7.07 (m, 1H), 5.09 (q, *J* = 12.2 Hz, 2H), 3.90 (t, *J* = 6.7 Hz, 1H), 3.31 – 3.16 (m, 1H), 2.80 – 2.62 (m, 3H), 2.55 – 2.44 (m, 1H), 2.16 – 2.03 (m, 1H), 1.79 – 1.66 (m, 1H), 1.64 – 1.49 (m, 2H), 1.46 – 1.33 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 211.6, 157.9, 140.9, 138.0, 136.1, 130.4, 129.8, 128.4, 128.3, 127.9, 127.4, 127.0 (q, *J* = 277.2 Hz), 124.8,

76.5, 45.1, 44.4 (q, J = 2.7 Hz), 37.4 (q, J = 27.6 Hz), 30.5, 24.8, 24.5. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.6. HRMS (ESI) m/z calcd. For $C_{22}H_{23}O_2NF_3$ $[M+H]^+$ 390.1675, found 390.1672.



12 (7:1)

12: (77% yield, major isomer).^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 (t, J = 7.4 Hz, 1H), 7.36 – 7.22 (m, 8H), 5.07 (s, 2H), 4.56 (dd, J = 8.4, 5.0 Hz, 1H), 3.24 – 3.09 (m, 2H), 2.74 – 2.48 (m, 3H), 1.87 – 1.64 (m, 2H), 1.56 – 1.30 (m, 5H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 209.8, 160.1, 141.1, 138.1, 137.5, 130.9, 128.4, 128.2, 128.0, 127.8, 127.0, 126.7 (q, J = 278.0 Hz), 126.2, 75.9, 44.0, 36.3 (q, J = 2.5 Hz), 34.8 (q, J = 28.3 Hz), 27.7, 23.3, 22.1, 22.0. ^{19}F NMR (376 MHz, CDCl3) δ -63.7. HRMS (ESI) m/z calcd. For $C_{23}H_{25}O_2NF_3$ $[M+H]^+$ 404.1832, found 404.1830.

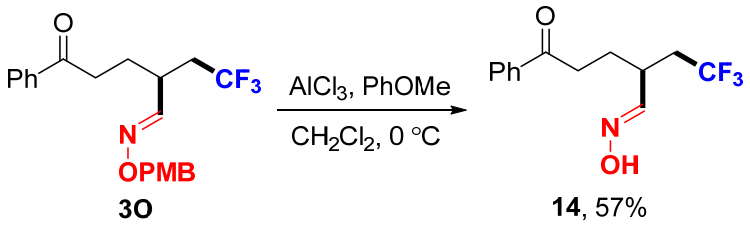


13

13: (67% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.22 (m, 7H), 7.17 – 7.11 (m, 2H), 5.05 – 4.83 (m, 2H), 3.53 – 3.14 (m, 1H), 2.98 – 2.47 (m, 5H), 2.44 – 2.11 (m, 3H), 2.07 – 1.72 (m, 2H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 210.8, 158.4, 141.0, 137.4, 136.5, 131.4, 129.6, 128.4, 128.1, 127.8, 126.6, 126.4 (q, J = 276.0 Hz), 124.2, 76.1, 43.3, 36.2 (q, J = 27.0 Hz), 35.5, 29.8 (q, J = 2.7 Hz, 27.2, 22.8.^{19}F NMR (376 MHz, $CDCl_3$) δ -64.7. HRMS (ESI) m/z calcd. For $C_{22}H_{23}O_2NF_3$ $[M+H]^+$ 390.1675, found 390.1673.

Synthetic transformations

Removal of PMB group of 3O

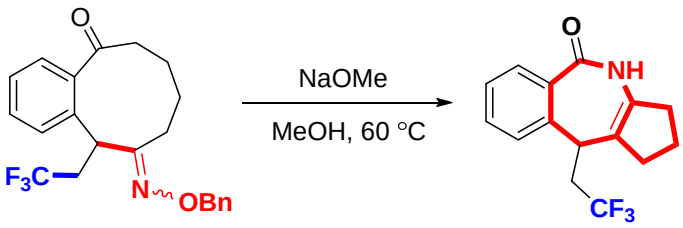


3O **14**, 57%

To a solution of **3O** (158 mg, 0.4 mmol) in anhydrous CH_2Cl_2 (16 mL) were added anisole (172 mg, 1.6 mmol) and $AlCl_3$ (210 mg, 1.6 mmol) sequentially at 0 °C. The reaction mixture was stirred at that temperature for 30 min and quenched with ice water (10 mL). Dichloromethane was used to extract the product from the aqueous layer (3 × 10 mL). The combined organic layer was washed with brine (5 mL), dried over anhydrous Na_2SO_4, filtered and concentrated to afford the crude product, which was purified by flash column chromatography to afford the product **14** (62 mg, 57%) as a colorless oil.

14: (57% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (dd, *J* = 8.2, 1.4 Hz, 2H), 7.71 (brs, 1H), 7.62 – 7.56 (m, 1H), 7.48 (t, *J* = 7.6 Hz, 2H), 7.35 (d, *J* = 7.4 Hz, 1H), 3.14 – 2.97 (m, 2H), 2.85 – 2.73 (m, 1H), 2.50 – 2.26 (m, 2H), 2.14 – 2.03 (m, 1H), 2.02 – 1.90 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 199.1, 152.4, 136.8, 133.4, 128.8, 128.1, 126.3 (q, *J* = 277.1 Hz), 37.1 (q, *J* = 28.3 Hz), 35.4, 34.0 (q, *J* = 2.5 Hz), 26.7. ^{19}F NMR (376 MHz, CDCl3) δ -63.6. HRMS (ESI) m/z calcd. For $C_{13}H_{15}O_2NF_3$ $[M+H]^+$ 274.1049, found 274.1049.

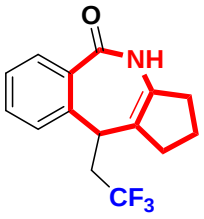
Transformation of medium-sized oxime 11 to lactam 15



11 **15**, 40%

To a solution of **11** (39 mg, 0.10 mmol) in methanol (2 mL) was added NaOMe (23 mg, 0.40 mmol) at room temperature. The reaction mixture was heated up to 60 °C for 2 h, cooled down to room temperature and quenched with H_2O (3 mL). EtOAc (10 mL) was added and the organic layer was washed with brine (5 mL), dried over anhydrous Na_2SO_4, filtered and concentrated to afford the crude product, which was purified by flash column chromatography to afford the product **15** (12 mg, 40%).

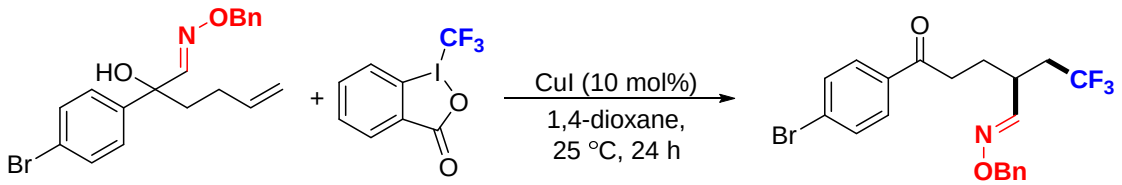
10-(2,2,2-trifluoroethyl)-2,3,4,10-tetrahydrobenzo[e]cyclopenta[b]azepin-5(1H)-one (15)



15

15: (40% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 (dd, *J* = 7.8, 1.2 Hz, 1H), 7.91 (brs, 1H), 7.49 (td, *J* = 7.5, 1.4 Hz, 1H), 7.39 (td, *J* = 7.6, 1.2 Hz, 1H), 7.14 (d, *J* = 7.2 Hz, 1H), 3.59 (dd, *J* = 8.7, 6.2 Hz, 1H), 2.72 – 2.32 (m, 6H), 2.01 – 1.88 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 168.9, 142.5, 132.9, 132.5, 131.7, 131.5, 127.8, 127.4, 124.7, 39.2 (q, *J* = 2.8 Hz), 36.2 (q, *J* = 27.1 Hz), 34.9, 33.9, 21.3. ^{19}F NMR (376 MHz, $CDCl_3$) δ -64.54. HRMS (ESI) m/z calcd. For $C_{15}H_{15}ONF_3$ $[M+H]^+$ 282.1100, found 282.1100.

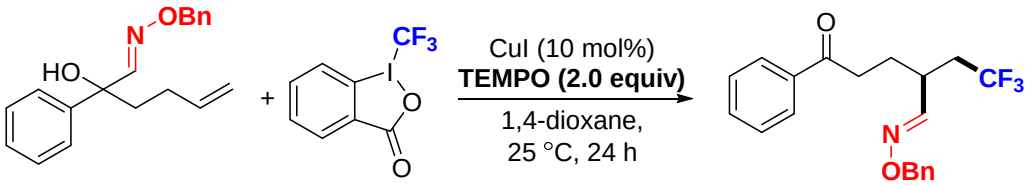
Large-scale synthesis



1F, 1.5 mmol **2** (1.2 equiv) **3F**, 68%

The procedure for large-scale synthesis is similar to that for synthesis of **3A**.

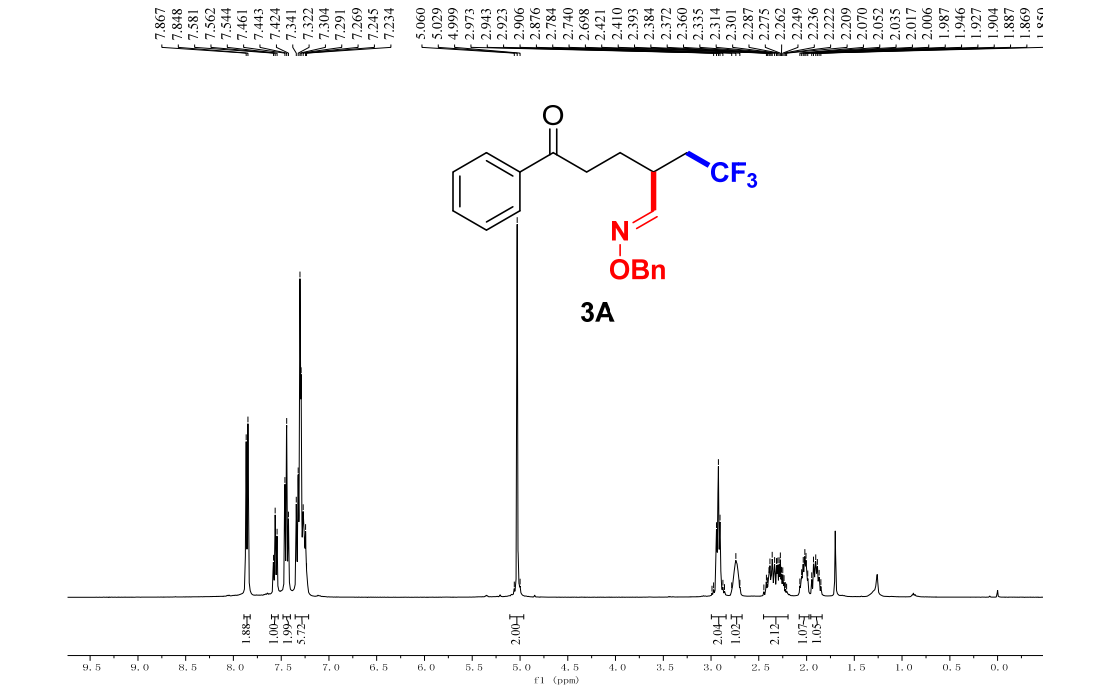
Control experiment with TEMPO as radical scavenger

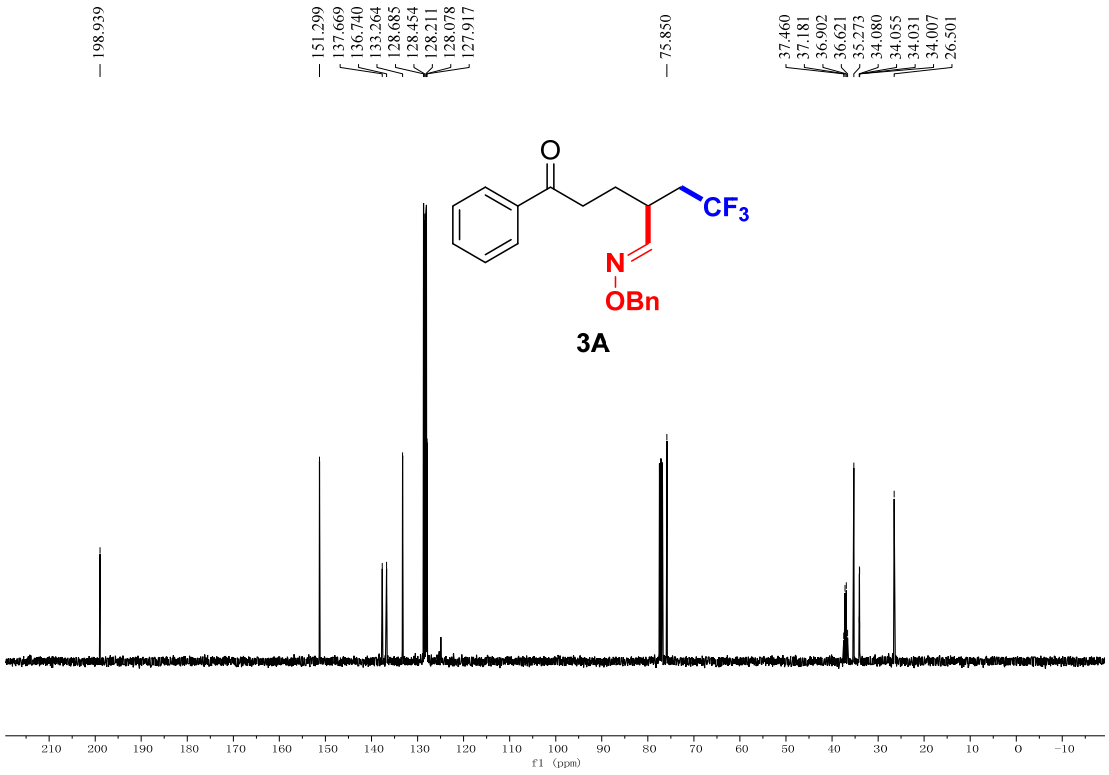


1A **2** (1.2 equiv) **3A**, < 5%

In an oven-dried 10 mL Schlenk tube were added **1A** (0.20 mmol), CuI (4 mg, 0.02 mmol), Togni's reagent **2** (75 mg, 0.24 mmol) and TEMPO (60 mg, 0.4 mmol). The tube was vacuumed and back-filled with argon three times and then added with 1,4-dioxane (2 mL). The reaction mixture was stirred at 25 °C for 24 h. NMR showed most of **1A** existed and trace amount of **3A** was detected.

NMR Spectra


7.867
7.848
7.581
7.562
7.544
7.461
7.443
7.424
7.341
7.322
7.304
7.291
7.269
7.245
7.234
5.060
5.029
4.999
2.973
2.943
2.923
2.906
2.876
2.784
2.740
2.698
2.421
2.410
2.393
2.384
2.372
2.360
2.335
2.314
2.301
2.287
2.275
2.262
2.249
2.236
2.222
2.209
2.070
2.052
2.035
2.017
2.006
1.987
1.946
1.927
1.904
1.887
1.869
O
CF3
N
OBn
3A
1.88
1.00
1.99
5.72
2.00
2.04
1.02
2.12
1.07
1.05
f1 (ppm)


198.939
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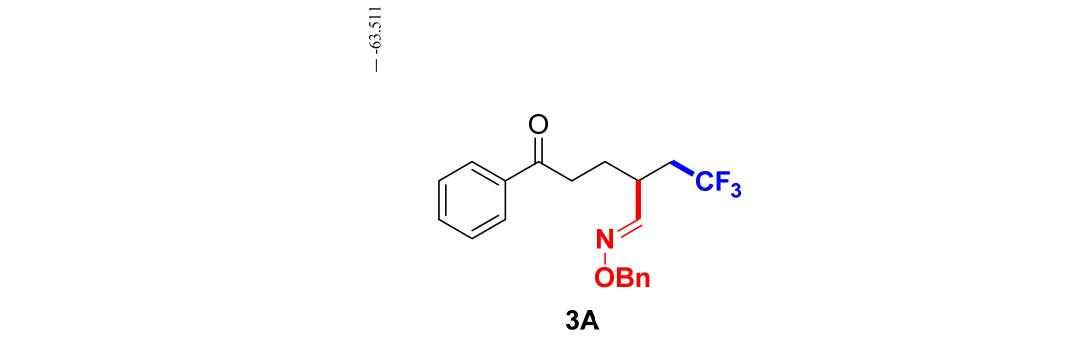
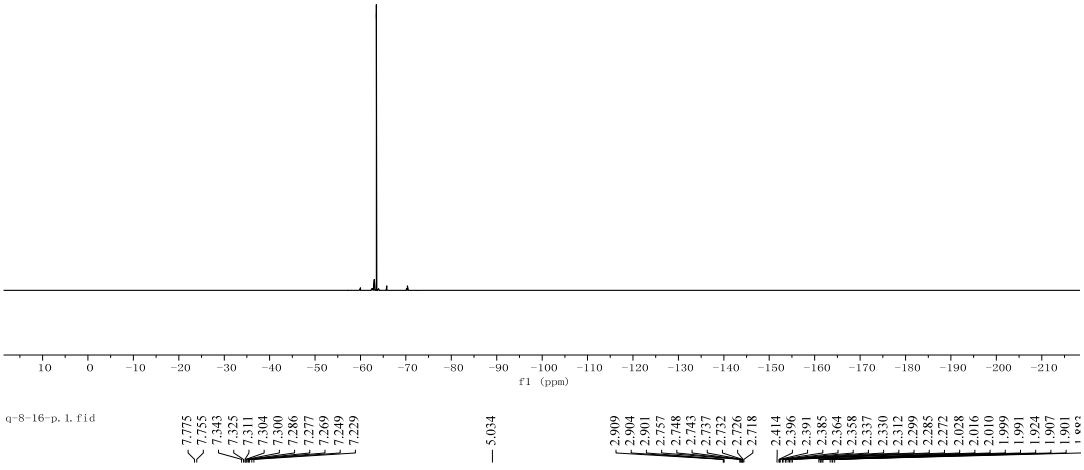
137.669
136.740
133.264
128.685
128.454
128.211
128.078
127.917
75.850
37.460
37.181
36.902
36.621
35.273
34.080
34.055
34.031
34.007
26.501
O
CF3
N
OBn
3A
f1 (ppm)


-63.511
O
CF3
N
OBn

3A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7.304
7.300
7.286
7.277
7.269
7.249
7.229
5.034
2.909
2.904
2.901
2.757
2.748
2.743
2.737
2.732
2.726
2.718
2.414
2.396
2.391
2.385
2.364
2.358
2.337
2.330
2.312
2.299
2.285
2.272
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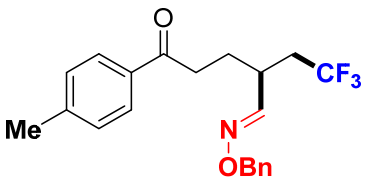
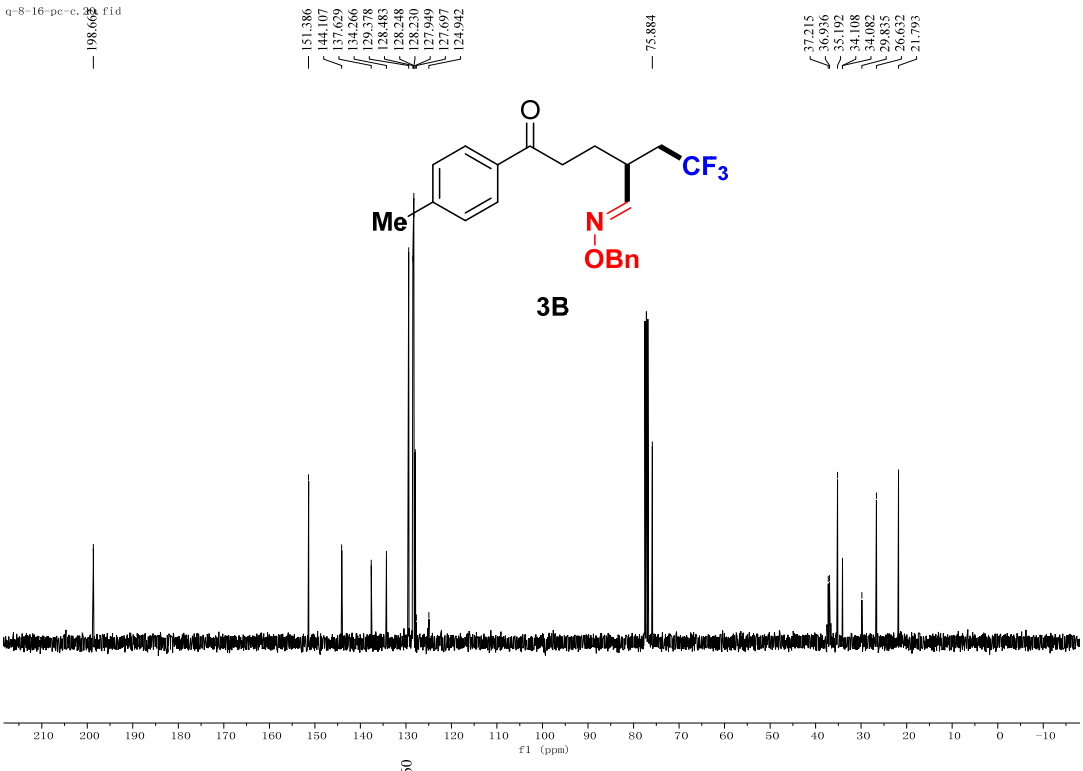
2.016
2.010
1.999
1.991
1.924
1.907
1.901


O
CF3
Me
N
OBn

3B

1.97
8.26
2.00
2.05
1.05
2.98
2.33
1.23
1.08
f1 (ppm)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144.107
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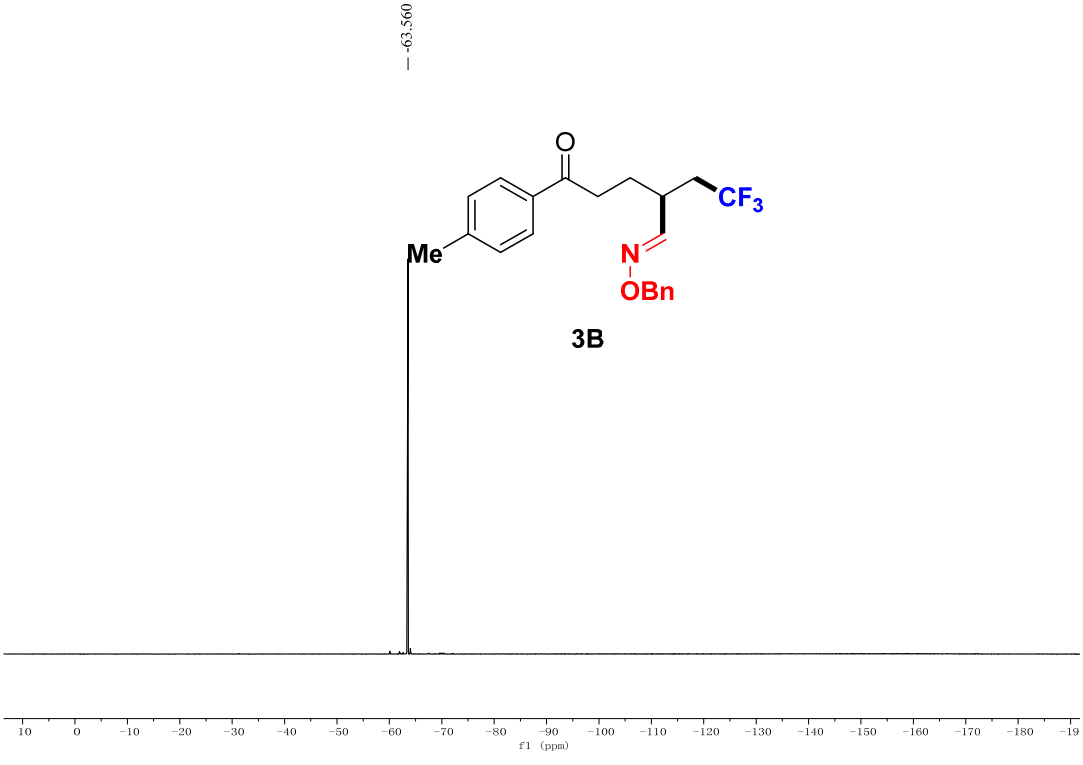
134.266
129.378
128.483
128.248
128.230
127.949
127.697
124.942
75.884
37.215
36.936
35.192
34.108
34.082
29.835
26.632
21.793
O
CF3
Me
N
OBn
3B
f1 (ppm)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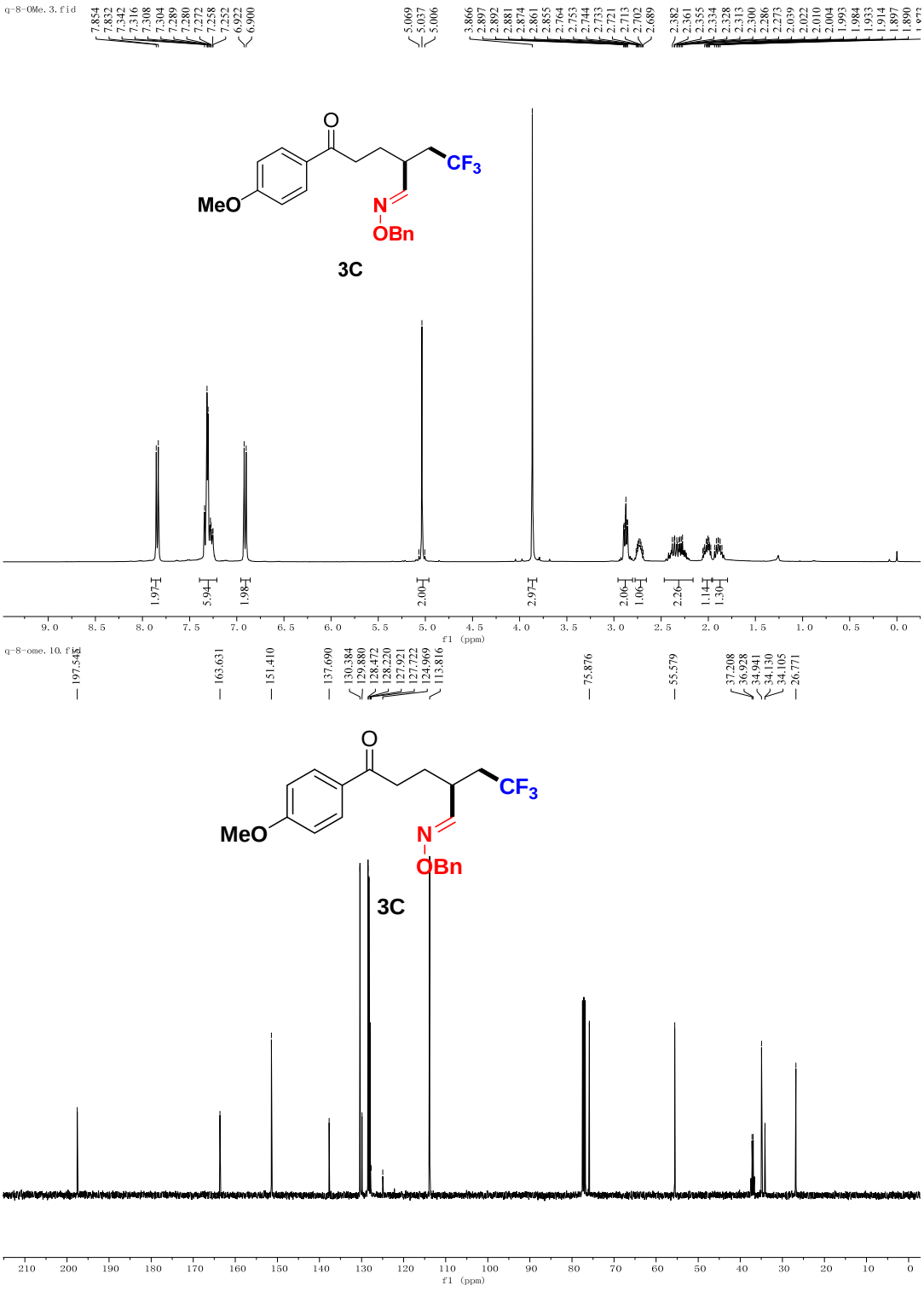
N
OBn
3B
f1 (ppm)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7.280
7.272
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7.252
6.922
6.900
5.069
5.037
5.006
3.866
2.897
2.892
2.881
2.874
2.861
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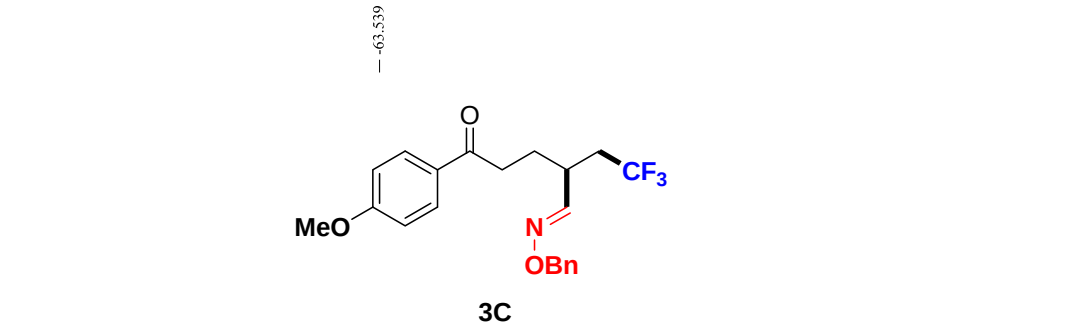
2.753
2.744
2.733
2.721
2.713
2.702
2.689
2.382
2.361
2.355
2.334
2.328
2.313
2.300
2.286
2.273
2.039
2.022
2.010
2.004
1.993
1.984
1.933
1.914
1.897
1.890
O
CF3
MeO
N
OBn
3C
1.97
5.94
1.98
2.00
2.97
2.06
1.06
2.26
1.14
1.30
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)
q-8-ome.10.fid
197.545
163.631
151.410
137.690
130.384
129.880
128.472
128.220
127.921
127.722
124.969
113.816
75.876
55.579
37.208
36.928
34.941
34.130
34.105
26.771
O
CF3
MeO
N
OBn
3C
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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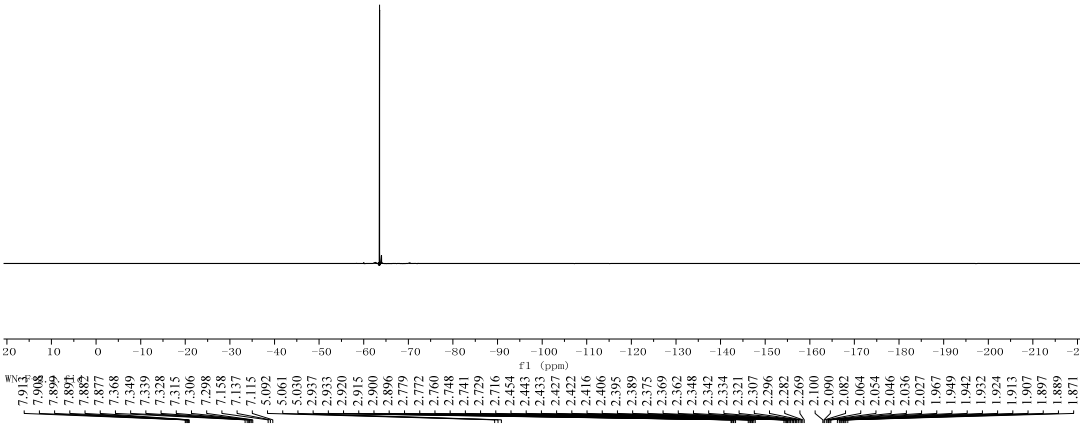
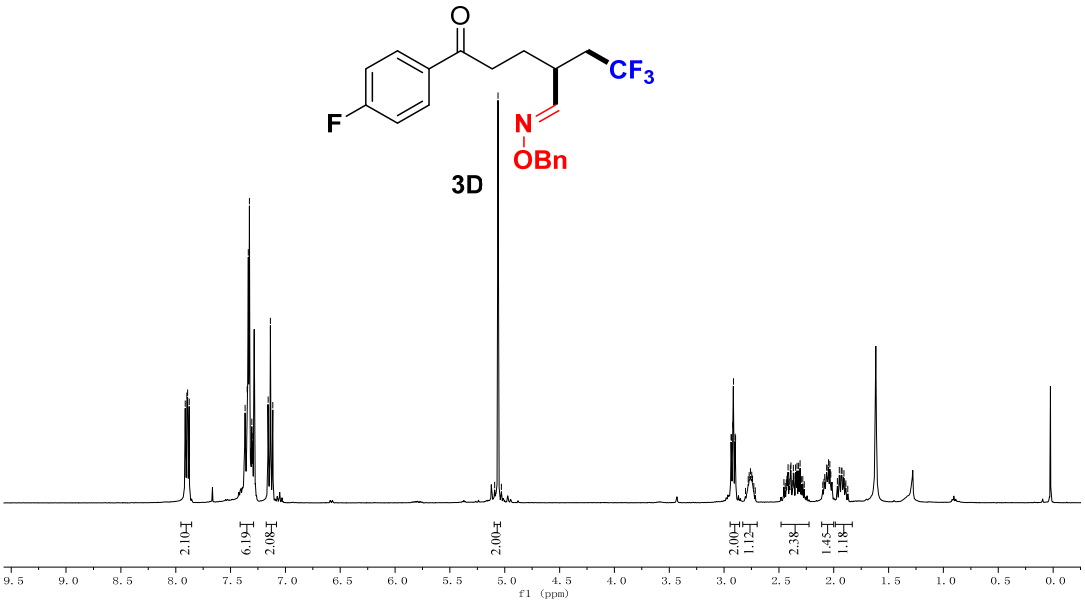
O
CF3
MeO
N
OBn

3C


f1 (ppm)


O
CF3
F
N
OBn
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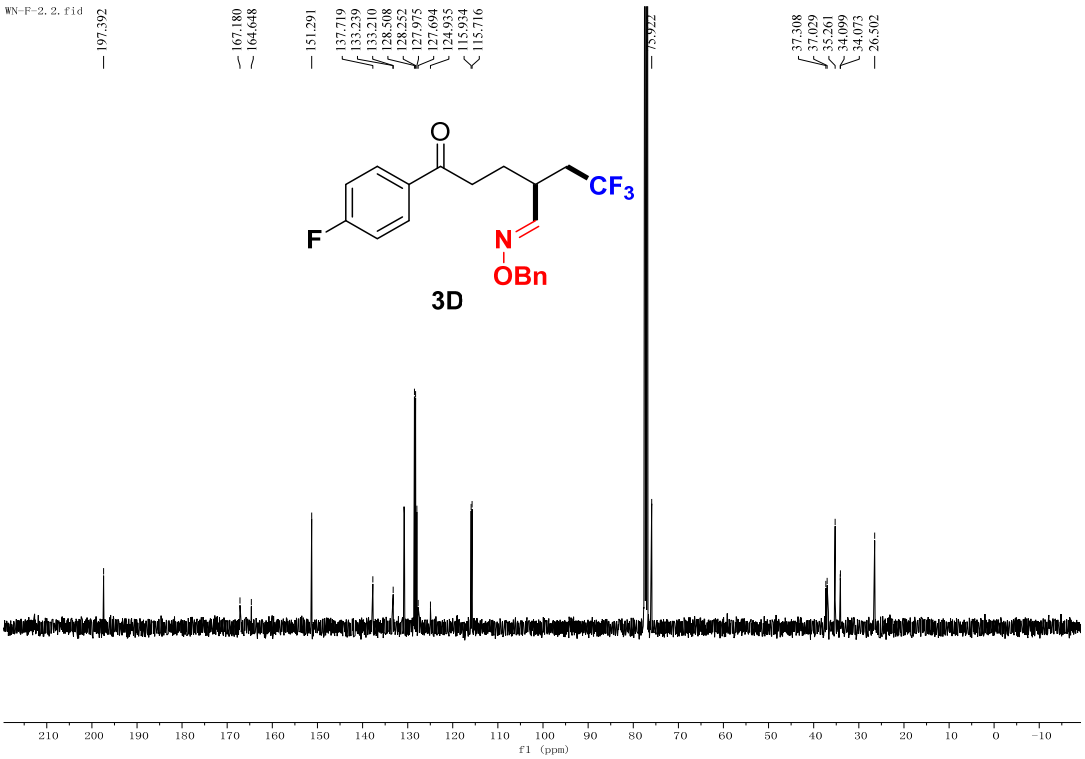
2.00
1.12
2.38
1.45
1.18
f1 (ppm)

3D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133.239
133.210
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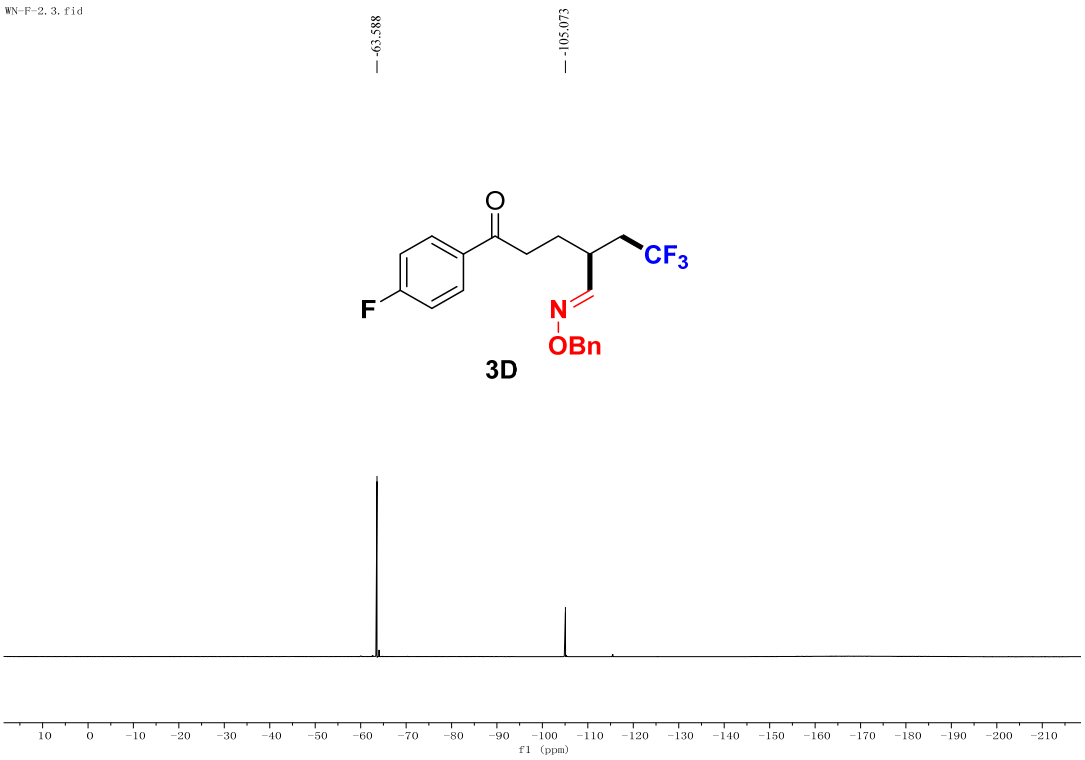
128.252
127.975
127.694
124.935
115.934
115.716
78.922
37.308
37.029
35.261
34.099
34.073
26.502
O
CF3
F
N
OBn
3D
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)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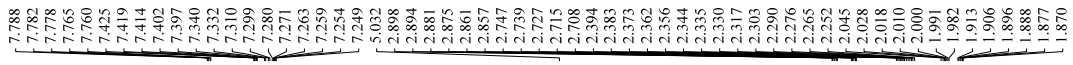
-105.073
O
CF3
F
N
OBn
3D
10 0 −10 −20 −30 −40 −50 −60 −70 −80 −90 −100 −110 −120 −130 −140 −150 −160 −170 −180 −190 −200 −210
f1 (ppm)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7.760
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7.402
7.397
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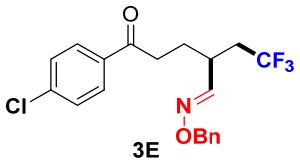
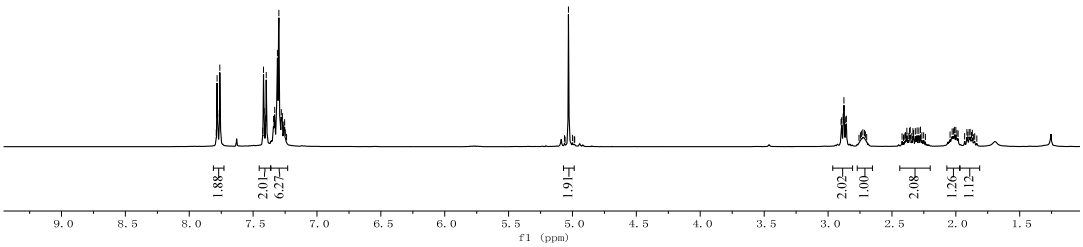
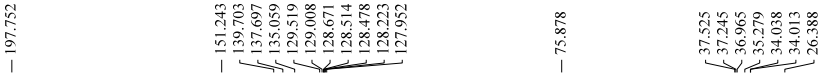
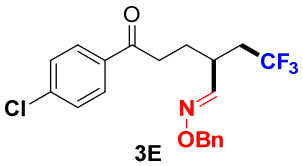
7.332
7.310
7.299
7.280
7.271
7.263
7.259
7.254
7.249
5.032
2.898
2.894
2.881
2.875
2.861
2.857
2.747
2.739
2.727
2.715
2.708
2.394
2.383
2.373
2.362
2.356
2.344
2.335
2.330
2.317
2.303
2.290
2.276
2.265
2.252
2.045
2.028
2.018
2.010
2.000
1.991
1.982
1.913
1.906
1.896
1.888
1.877
1.870


O
CF3
Cl
N
OBn

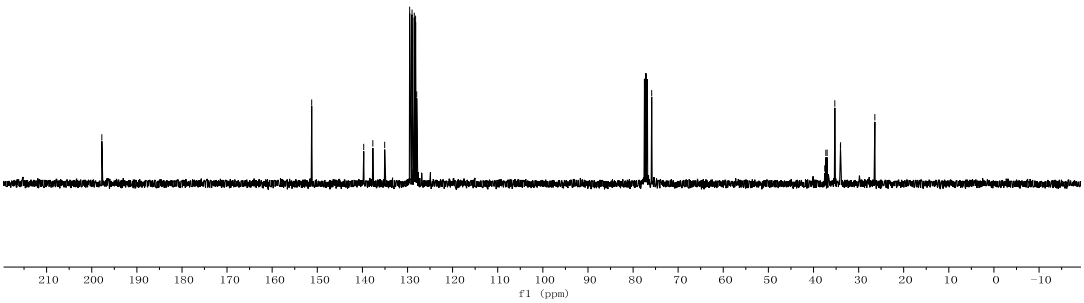
3E

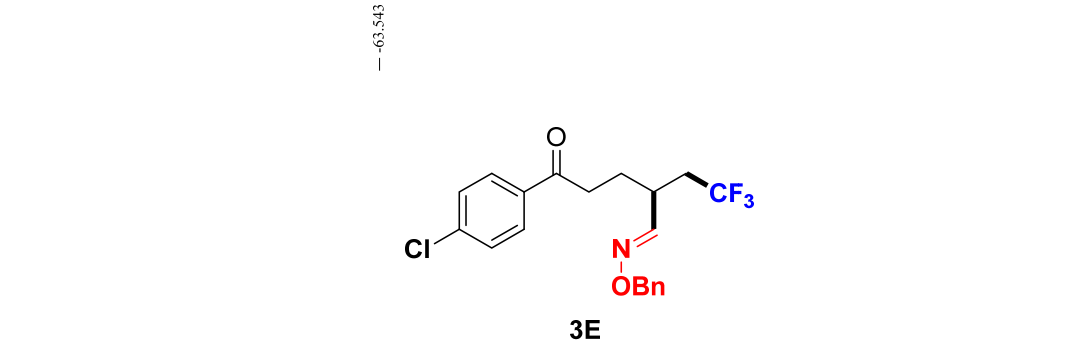

1.88
2.01
6.27
1.91
2.02
1.00
2.08
1.26
1.12
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
f1 (ppm)


197.752
151.243
139.703
137.697
135.059
129.519
129.008
128.671
128.514
128.478
128.223
127.952
75.878
37.525
37.245
36.965
35.279
34.038
34.013
26.388

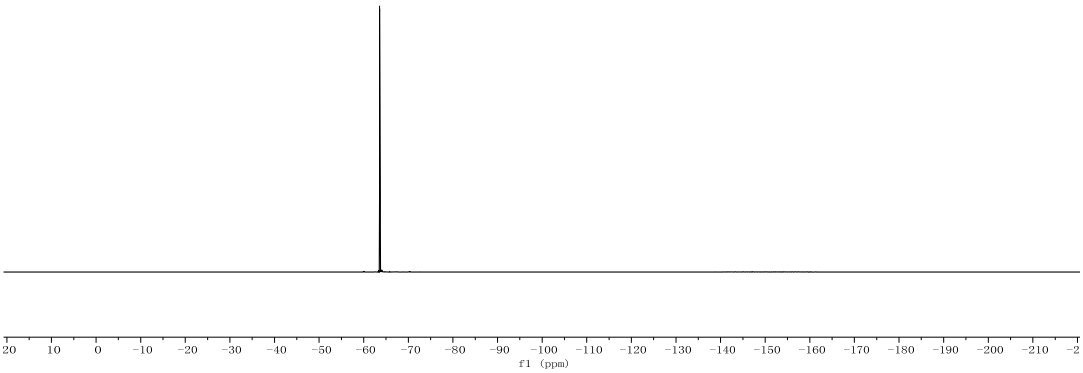

O
CF3
Cl
N
OBn

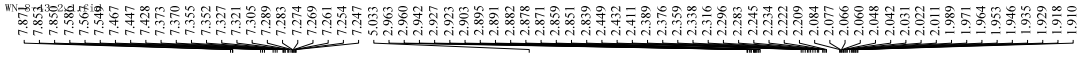
3E

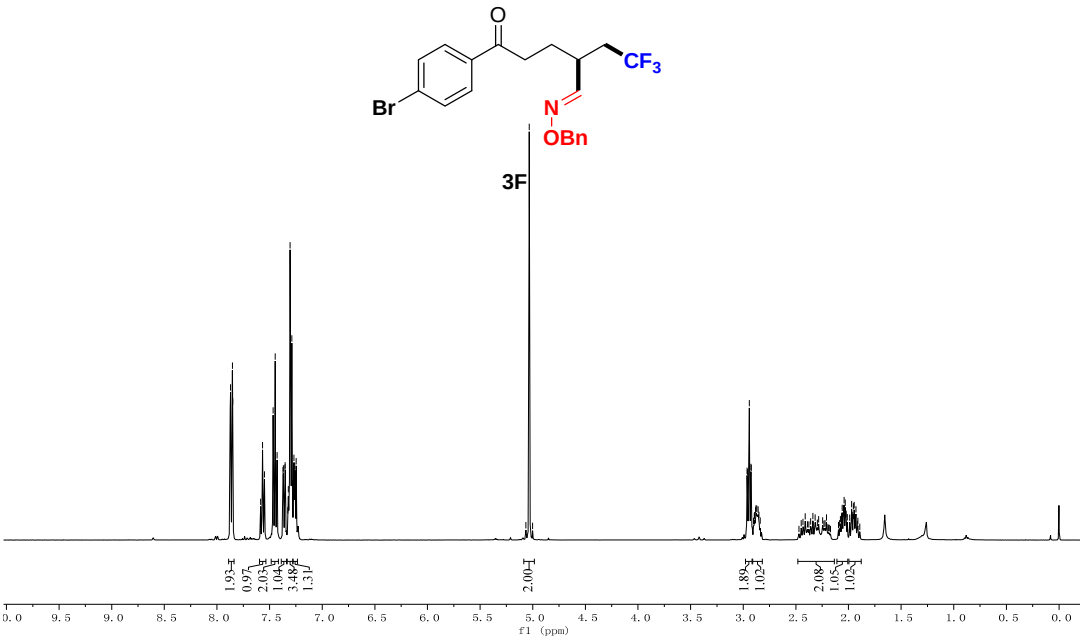

210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)


-63.543
O
CF3
Cl
N
OBn

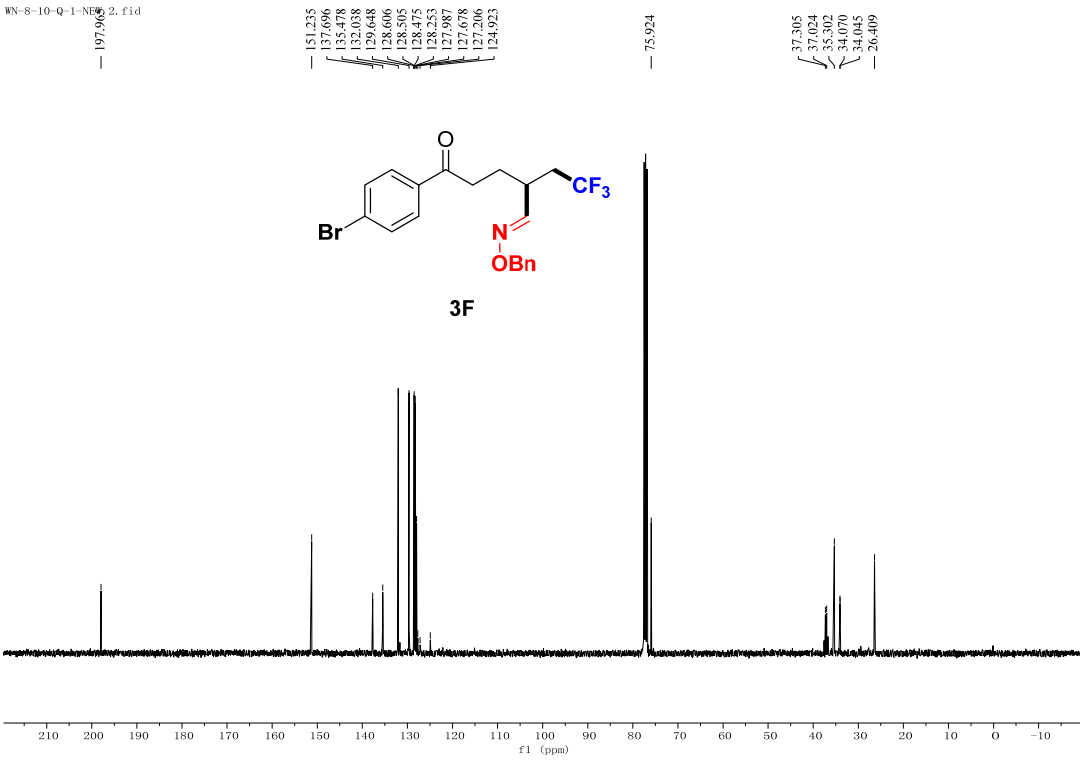
3E

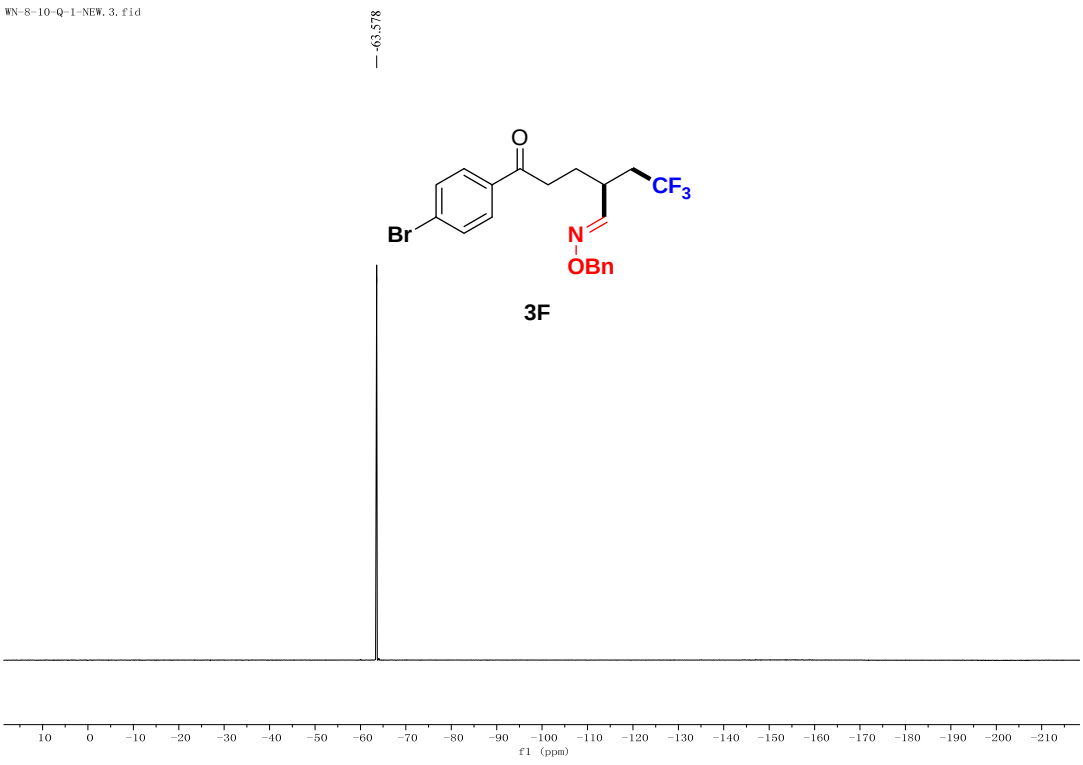

f1 (ppm)

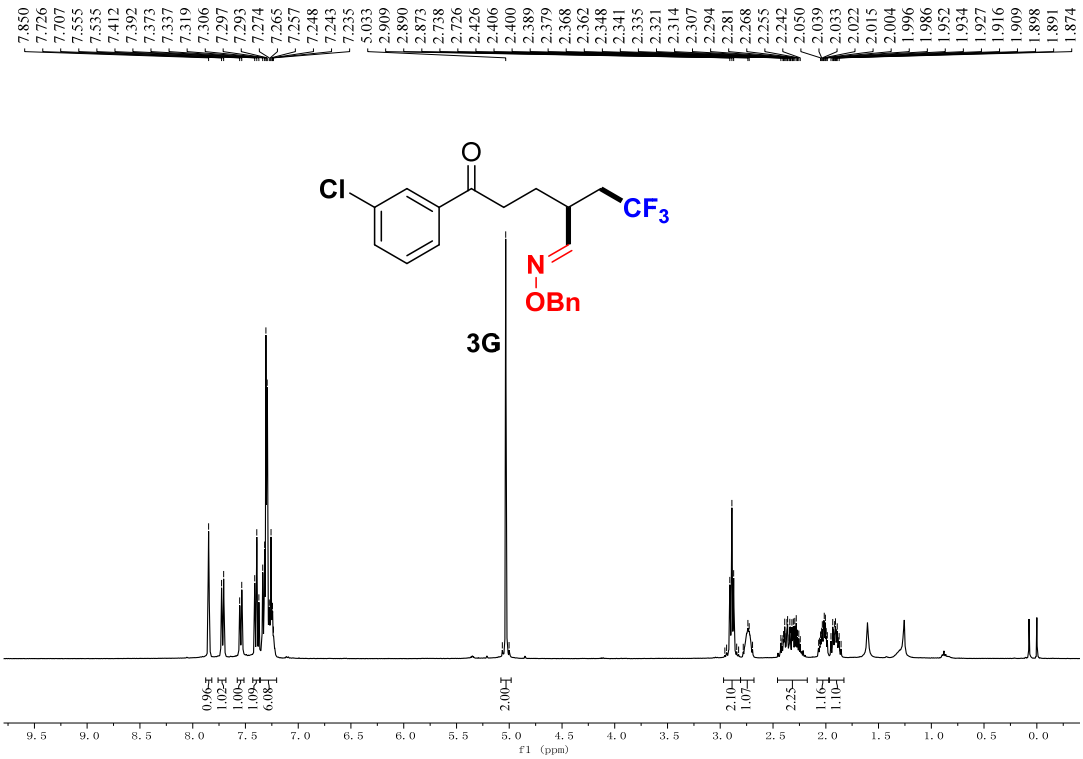


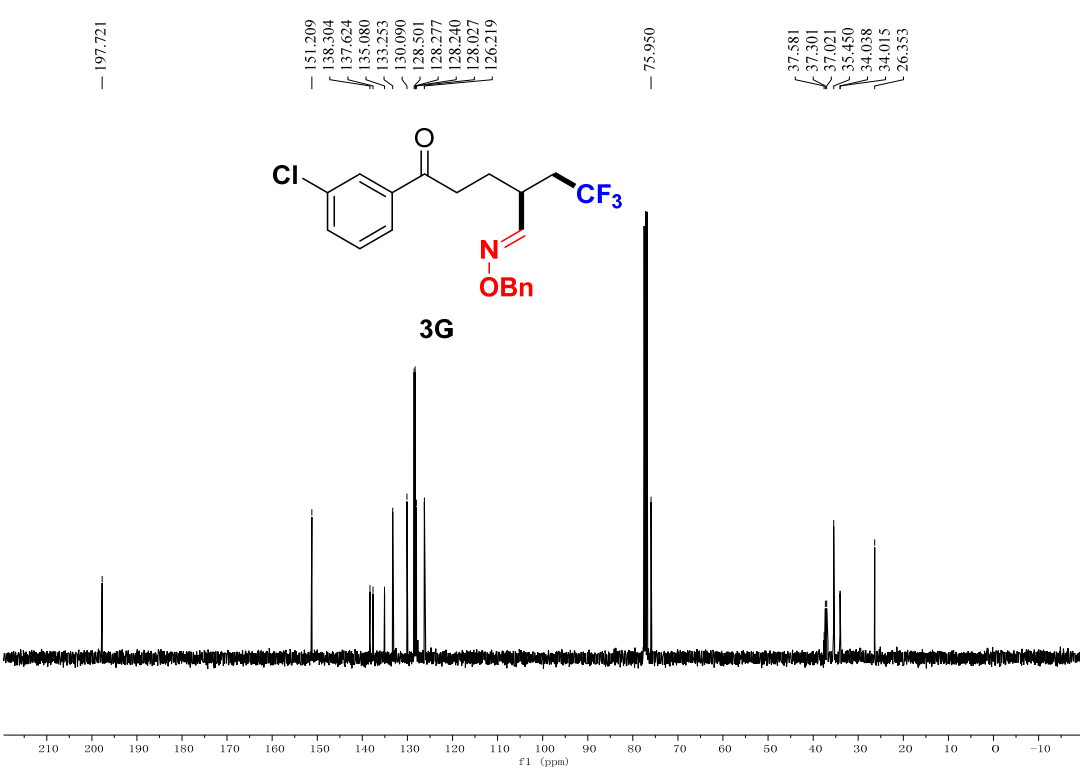

O
CF3
Br
N
OBn
1.93
0.97
2.03
1.04
3.48
1.31
2.00
1.89
1.02
2.08
1.05
1.02
f1 (ppm)

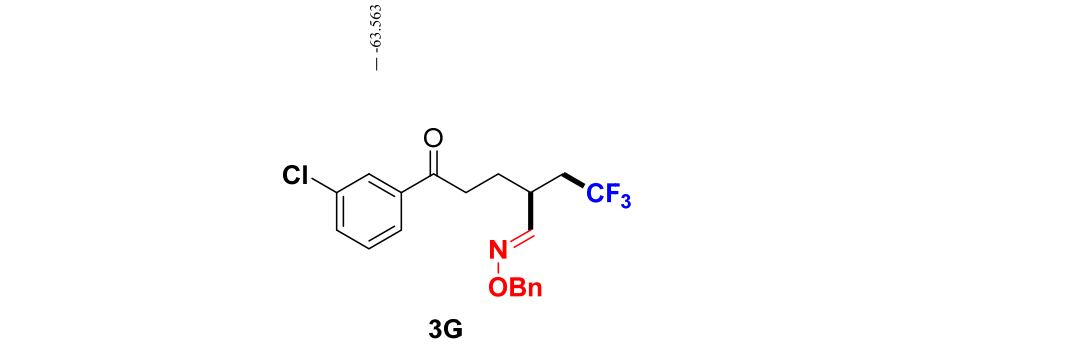
3F


WN-8-10-Q-1-NEW.2.fid
197.960
151.235
137.696
135.478
132.038
129.648
128.606
128.505
128.475
128.253
127.987
127.678
127.206
124.923
75.924
37.305
37.024
35.302
34.070
34.045
26.409
O
CF3
Br
N
OBn
3F
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

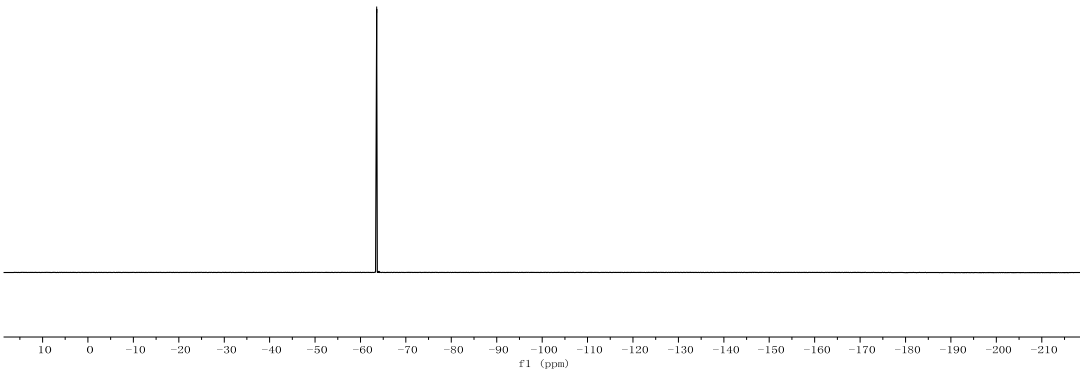

WN-8-10-Q-1-NEW.3.fid
-63.578
O
CF3
Br
N
OBn
3F
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

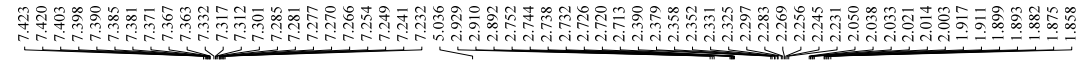

7.850
7.726
7.707
7.555
7.535
7.412
7.392
7.373
7.337
7.319
7.306
7.297
7.293
7.274
7.265
7.257
7.248
7.243
7.235
5.033
2.909
2.890
2.873
2.738
2.726
2.426
2.406
2.400
2.389
2.379
2.368
2.362
2.348
2.341
2.335
2.321
2.314
2.307
2.294
2.281
2.268
2.255
2.242
2.050
2.039
2.033
2.022
2.015
2.004
1.996
1.986
1.952
1.934
1.927
1.916
1.909
1.898
1.891
1.874
Cl
O
CF3
N
OBn
3G
0.96
1.02
1.00
1.09
6.08
2.00
2.10
1.07
2.25
1.16
1.10
f1 (ppm)

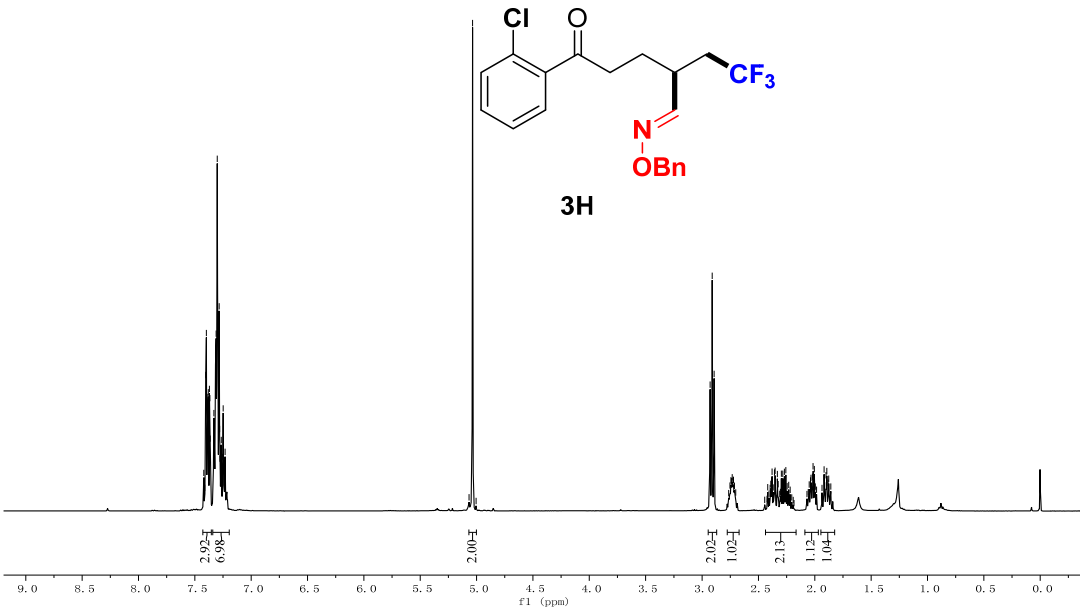

197.721
151.209
138.304
137.624
135.080
133.253
130.090
128.501
128.277
128.240
128.027
126.219
75.950
37.581
37.301
37.021
35.450
34.038
34.015
26.353
Cl
O
CF3
N
OBn
3G
f1 (ppm)


-63.563
Cl
O
CF3
N
OBn

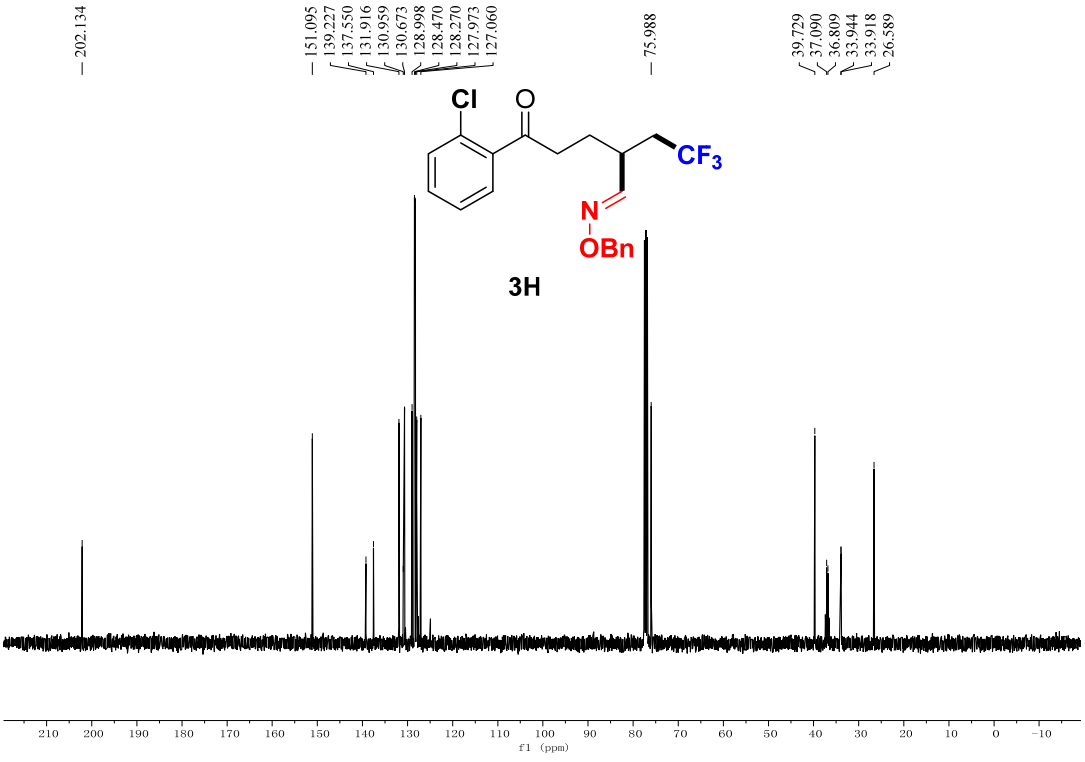
3G

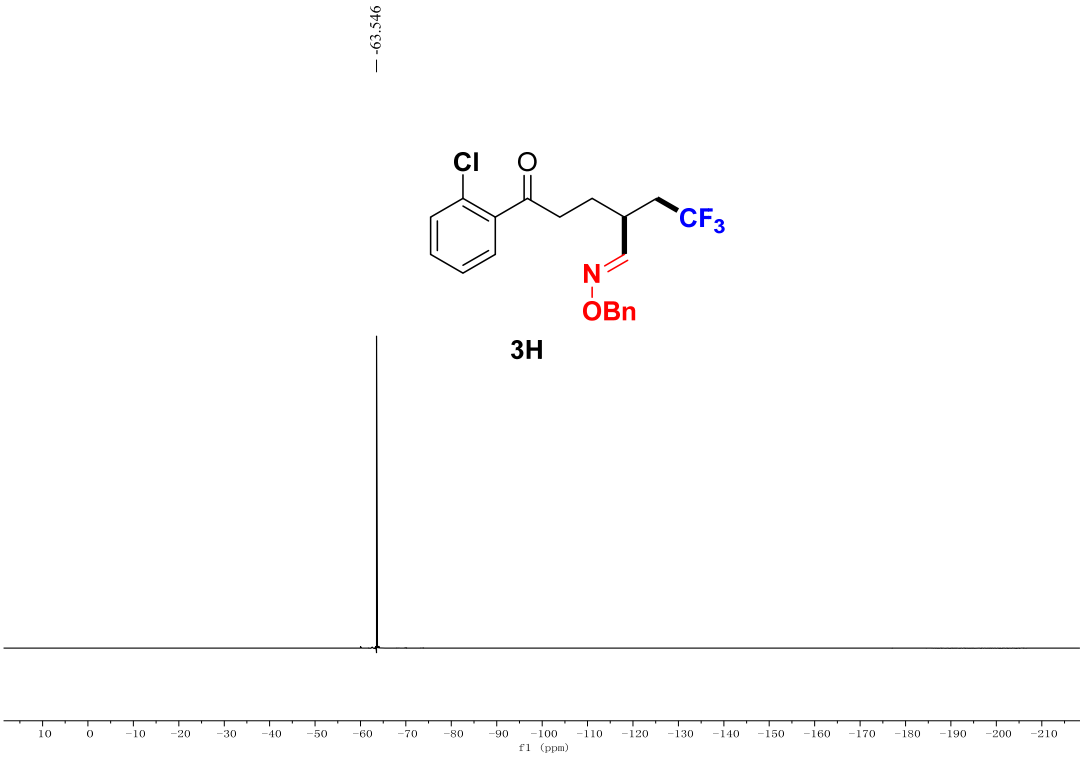

10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

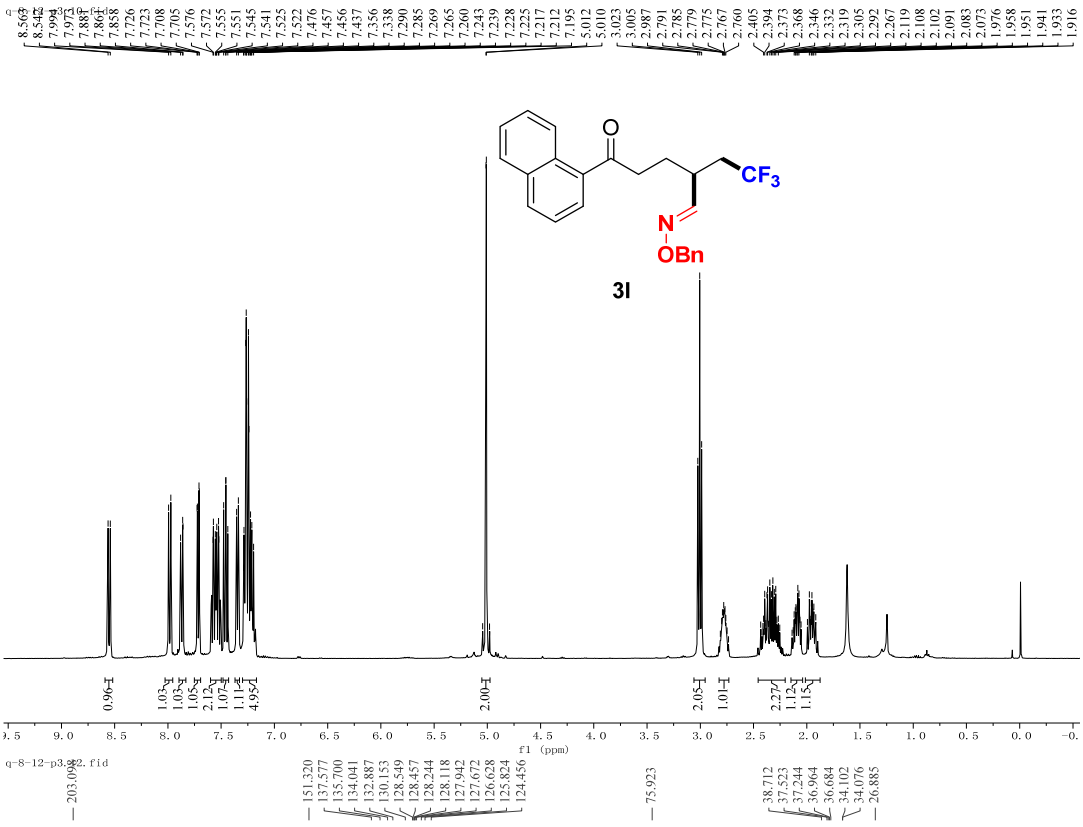

7.423 7.420 7.403 7.398 7.390 7.385 7.381 7.371 7.367 7.363 7.332 7.317 7.312 7.301 7.285 7.281 7.277 7.270 7.266 7.254 7.249 7.241 7.232
5.036 2.929 2.910 2.892 2.752 2.744 2.738 2.732 2.726 2.720 2.713 2.390 2.379 2.358 2.352 2.331 2.325 2.297 2.283 2.269 2.256 2.245 2.231 2.050 2.038 2.033 2.021 2.014 2.003 1.917 1.911 1.899 1.893 1.882 1.875 1.858


Cl
O
CF3
N
OBn
2.92
6.98
2.00
2.02
1.02
2.13
1.12
1.04
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

3H

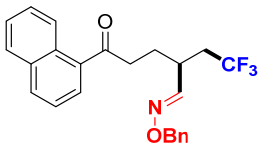

202.134
151.095
139.227
137.550
131.916
130.959
130.673
128.998
128.470
128.270
127.973
127.060
75.988
39.729
37.090
36.809
33.944
33.918
26.589
Cl
O
CF3
N
OBn
3H
f1 (ppm)


-63.546
Cl
O
CF3
N
OBn
3H
f1 (ppm)

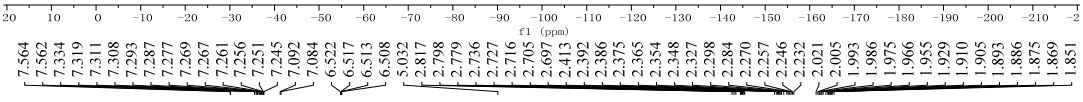

8.563
8.542
7.994
7.973
7.881
7.858
7.861
7.726
7.723
7.708
7.705
7.576
7.572
7.555
7.551
7.545
7.541
7.525
7.522
7.476
7.457
7.456
7.437
7.356
7.338
7.290
7.285
7.269
7.265
7.260
7.243
7.239
7.228
7.225
7.217
7.212
7.195
5.012
5.010
3.023
3.005
2.987
2.791
2.785
2.779
2.775
2.767
2.760
2.405
2.394
2.373
2.368
2.346
2.332
2.319
2.305
2.292
2.267
2.119
2.108
2.102
2.091
2.083
2.073
1.976
1.958
1.951
1.941
1.933
1.916
O
CF3
N
OBn
3l
0.96
1.03
1.03
1.05
2.12
1.07
1.11
4.95
2.00
2.05
1.01
2.27
1.12
1.15
f1 (ppm)
q-8-12-p3.42.fid
203.098
151.320
137.577
135.700
134.041
132.887
130.153
128.549
128.457
128.244
128.118
127.942
127.672
126.628
125.824
124.456
75.923
38.712
37.523
37.244
36.964
36.684
34.102
34.076
26.885
O
CF3
N
OBn
3l
f1 (ppm)

q-8-12-p3.11.fid

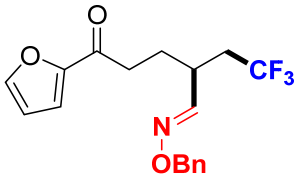
-63.507



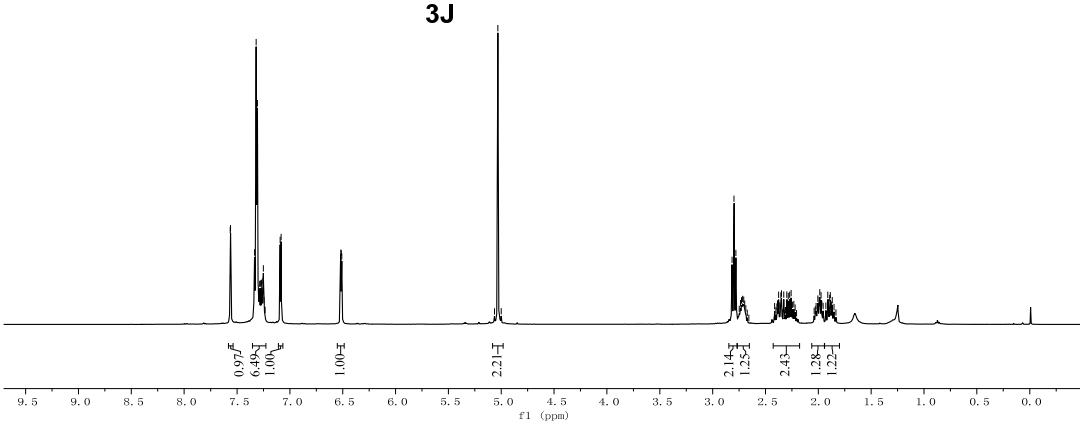
3l

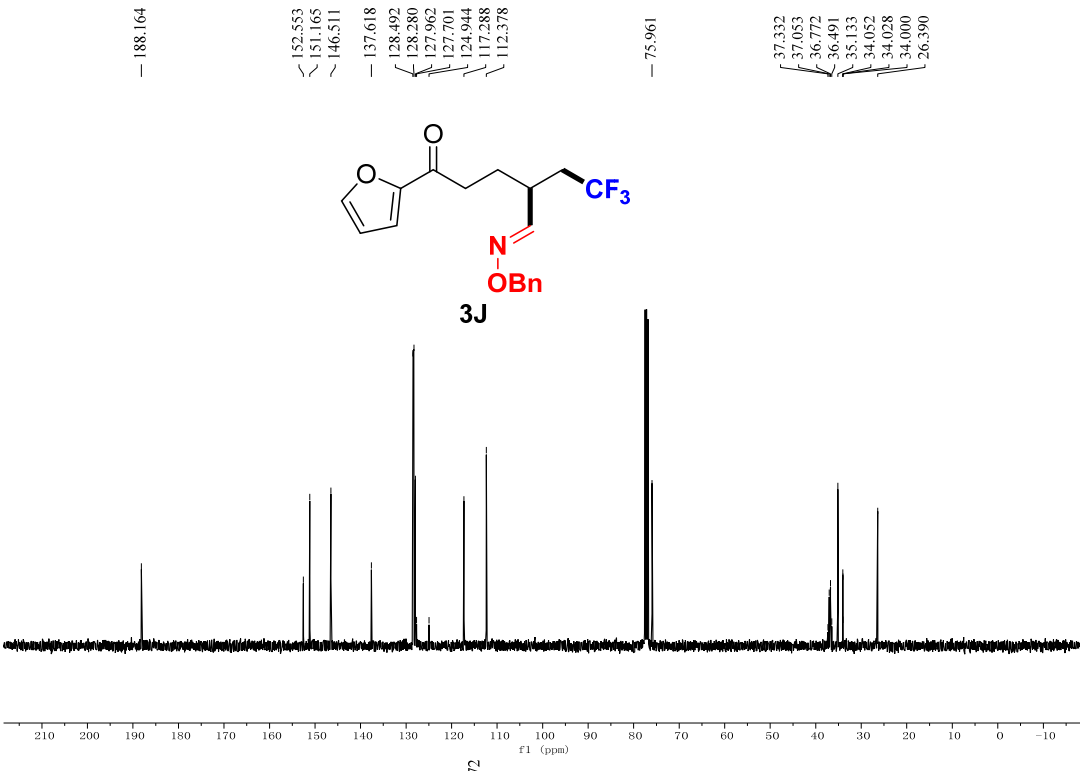


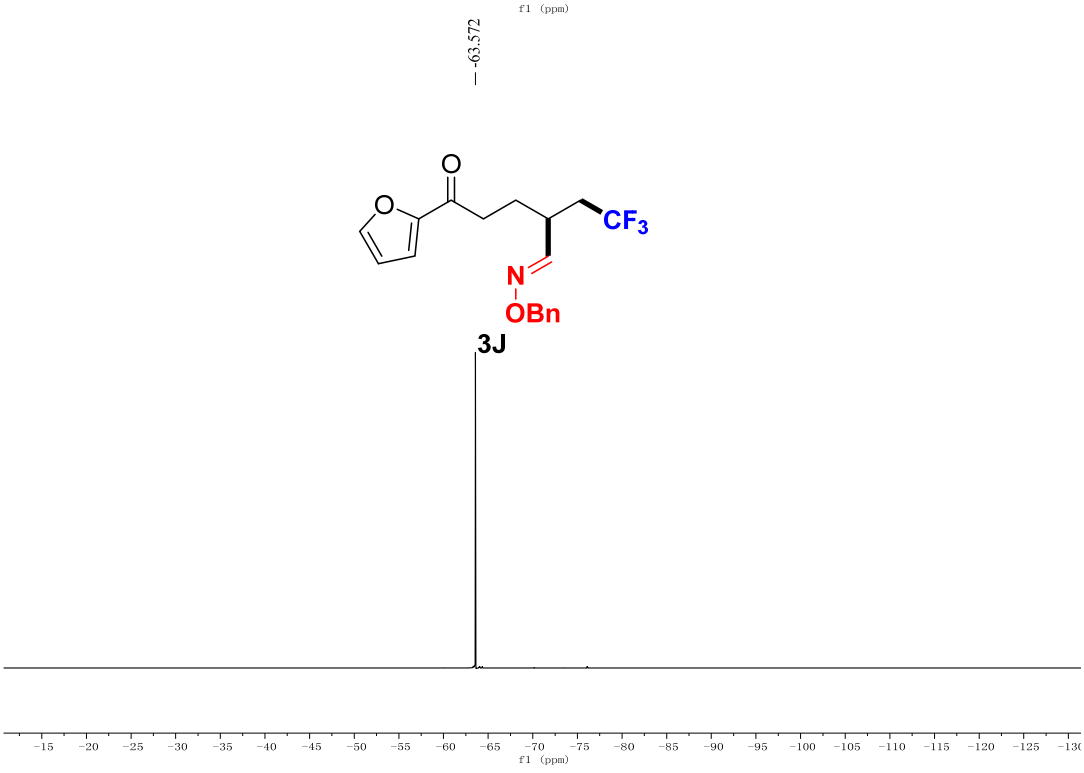
7.564 7.562 7.334 7.319 7.311 7.308 7.293 7.287 7.277 7.269 7.267 7.261 7.256 7.251 7.245 7.092 7.084 6.522 6.517 6.513 6.508 5.032 2.817 2.798 2.779 2.736 2.727 2.716 2.705 2.697 2.413 2.392 2.386 2.375 2.365 2.354 2.348 2.327 2.298 2.284 2.270 2.257 2.246 2.232 2.021 2.005 1.993 1.986 1.975 1.966 1.955 1.929 1.910 1.905 1.893 1.886 1.875 1.869 1.851

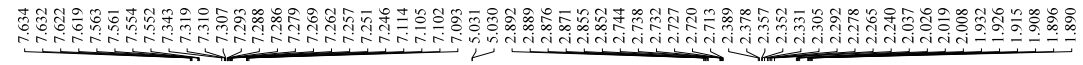


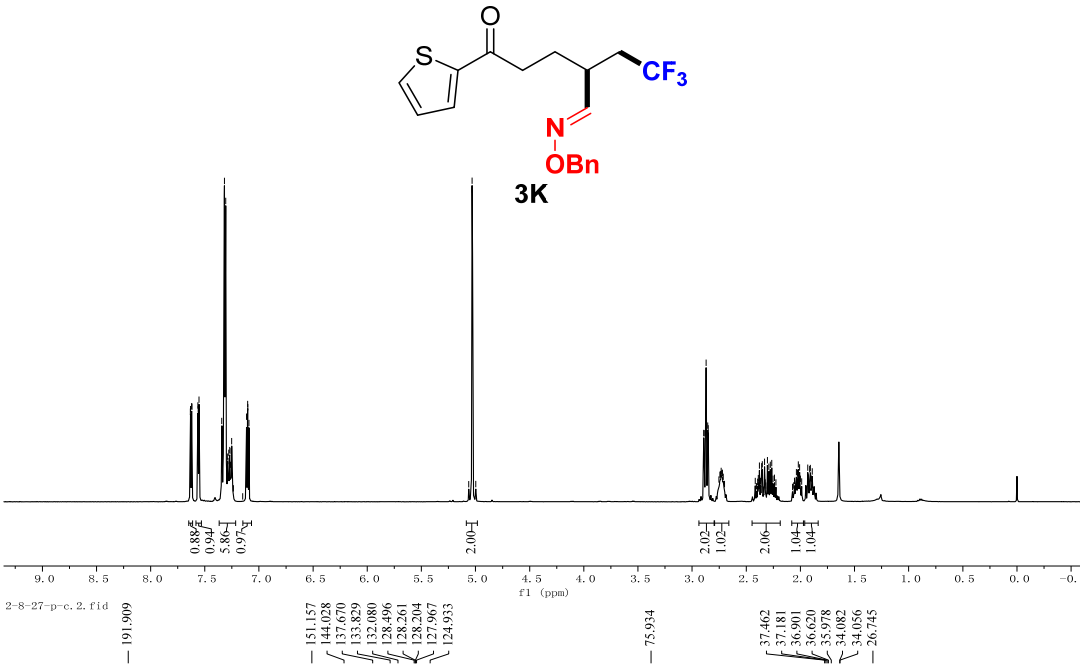
3J



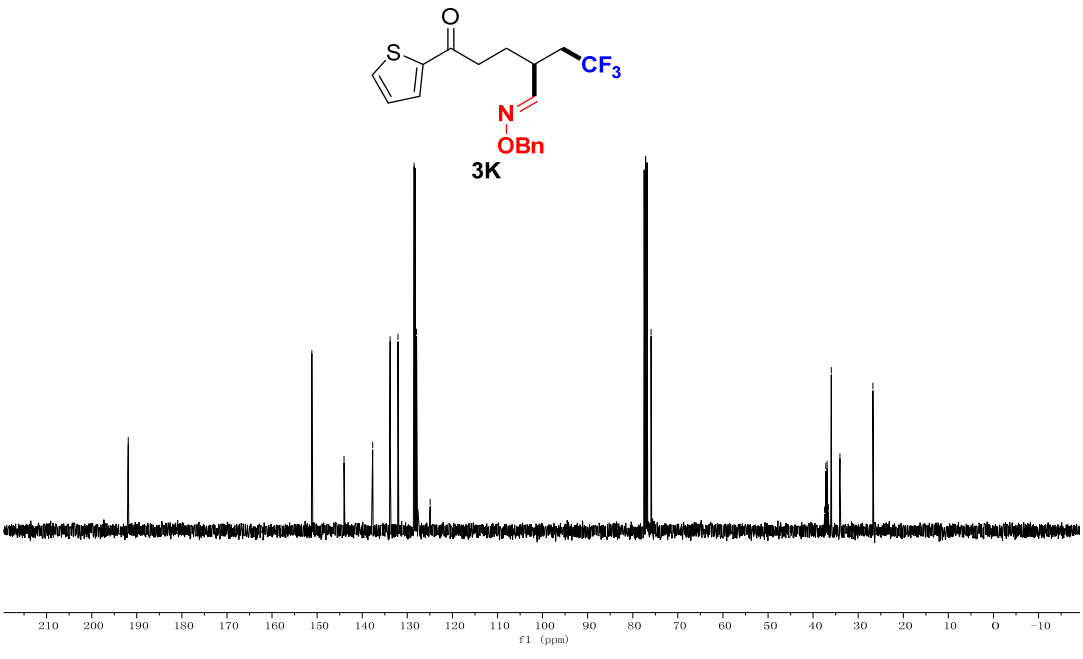

188.164
152.553
151.165
146.511
137.618
128.492
128.280
127.962
127.701
124.944
117.288
112.378
75.961
37.332
37.053
36.772
36.491
35.133
34.052
34.028
34.000
26.390
O
O
CF3
N
OBn
3J
f1 (ppm)

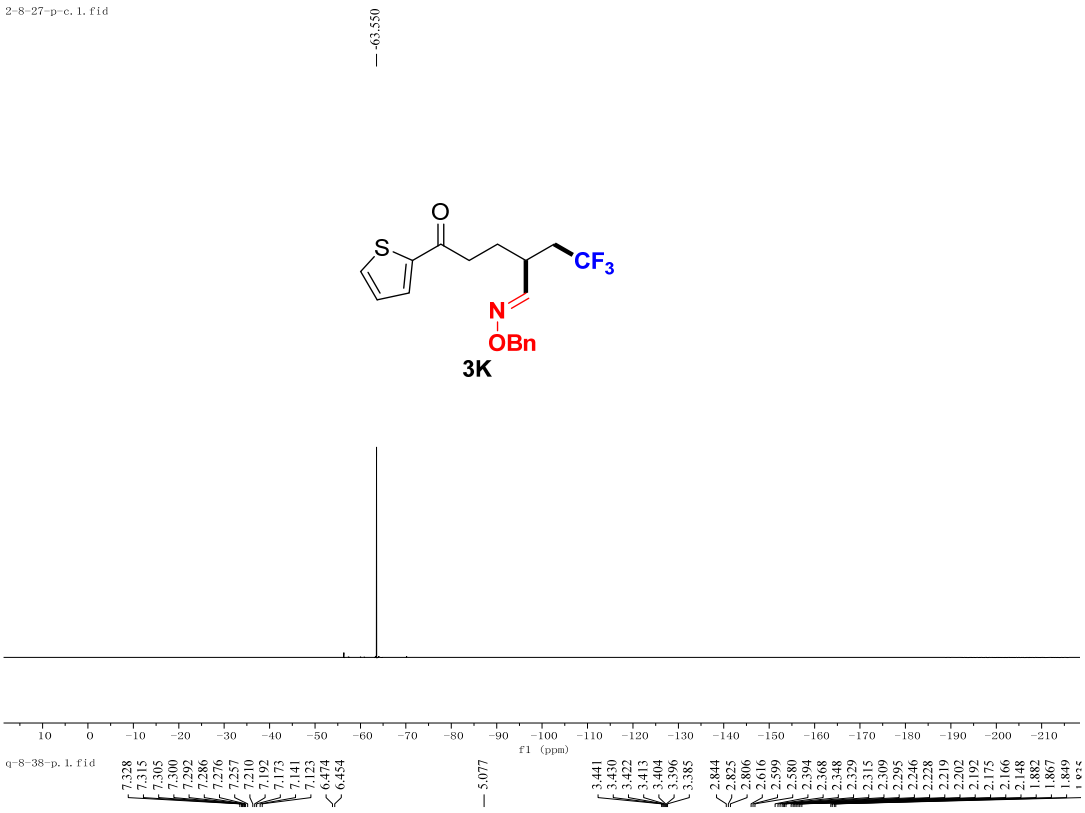

-63.572
O
O
CF3
N
OBn
3J
f1 (ppm)

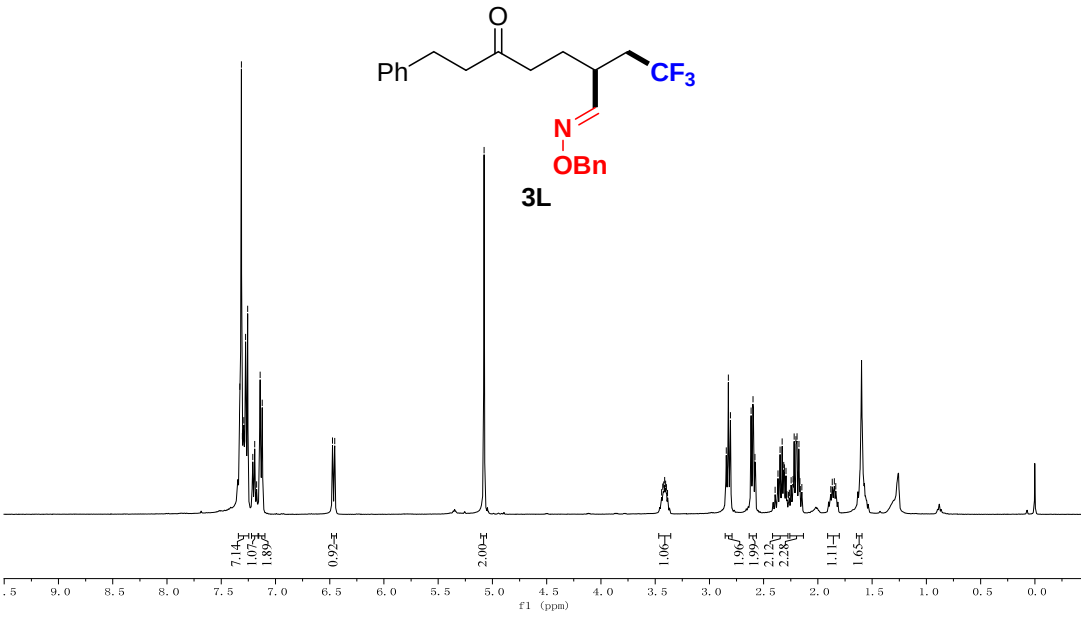

7.634
7.632
7.622
7.619
7.563
7.561
7.554
7.552
7.343
7.319
7.310
7.307
7.293
7.288
7.286
7.279
7.269
7.262
7.257
7.251
7.246
7.114
7.105
7.102
7.093
5.031
5.030
2.892
2.889
2.876
2.871
2.855
2.852
2.744
2.738
2.732
2.727
2.720
2.713
2.389
2.378
2.357
2.352
2.331
2.305
2.292
2.278
2.265
2.240
2.037
2.026
2.019
2.008
1.932
1.926
1.915
1.908
1.896
1.890

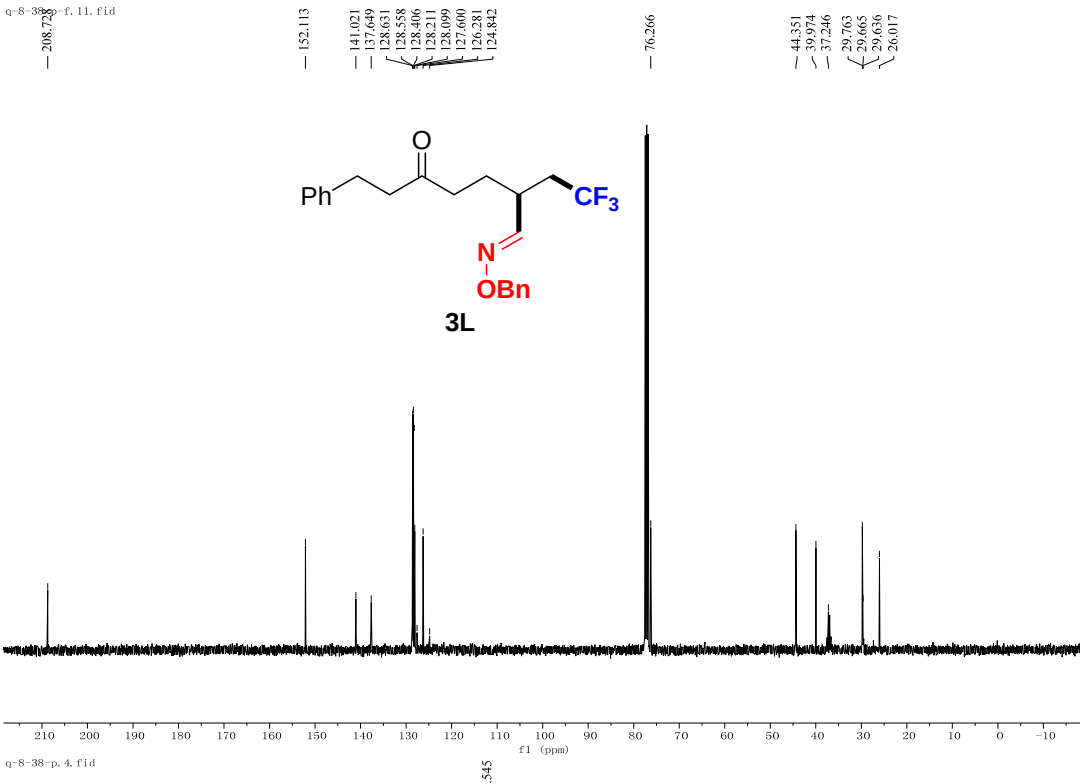

O
S
CF3
N
OBn
3K
0.89
0.94
5.86
0.97
2.00
2.02
1.02
2.06
1.04
1.04
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.
f1 (ppm)

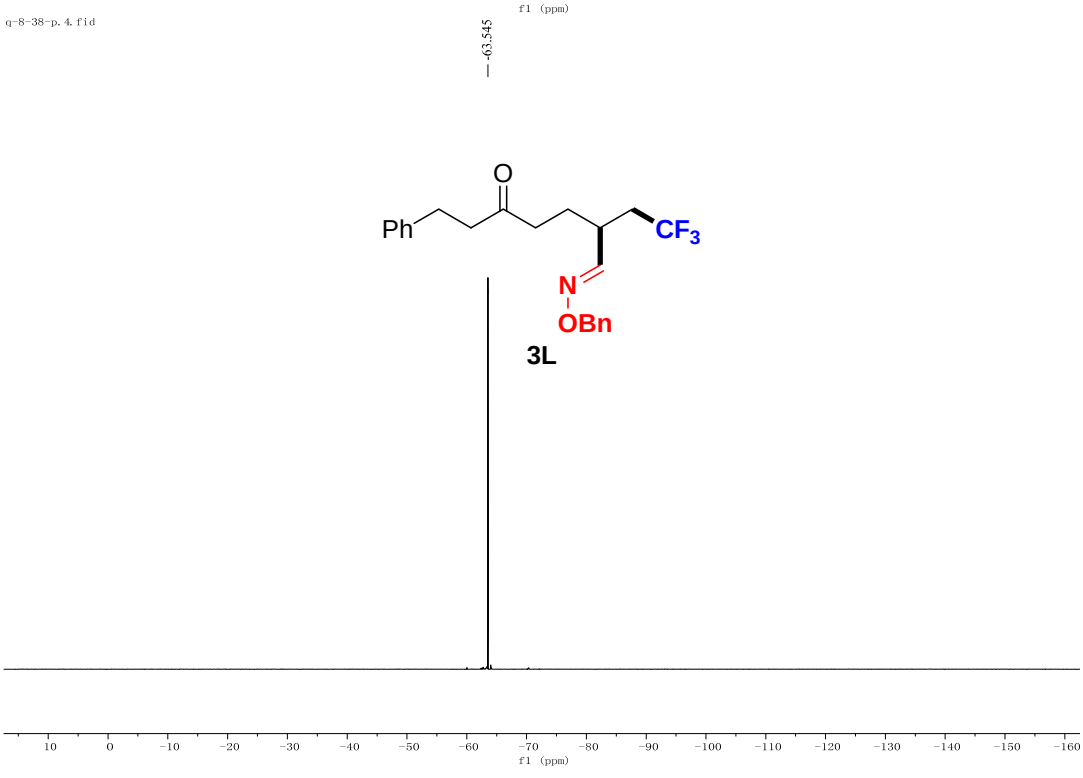
2-8-27-p-c.2.fid
191.909
151.157
144.028
137.670
133.829
132.080
128.496
128.261
128.204
127.967
124.933
75.934
37.462
37.181
36.901
36.620
35.978
34.082
34.056
26.745

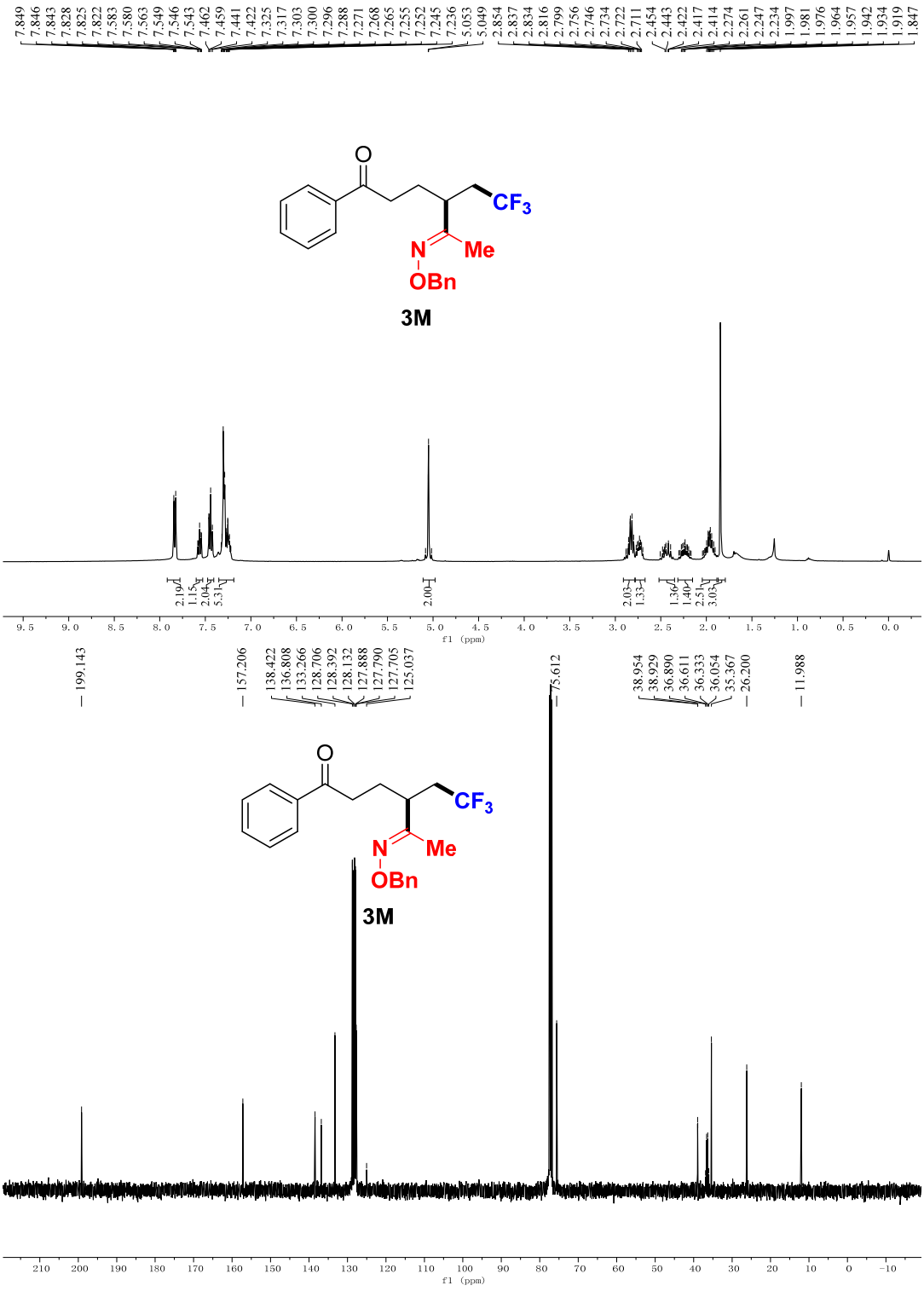

O
S
CF3
N
OBn
3K
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

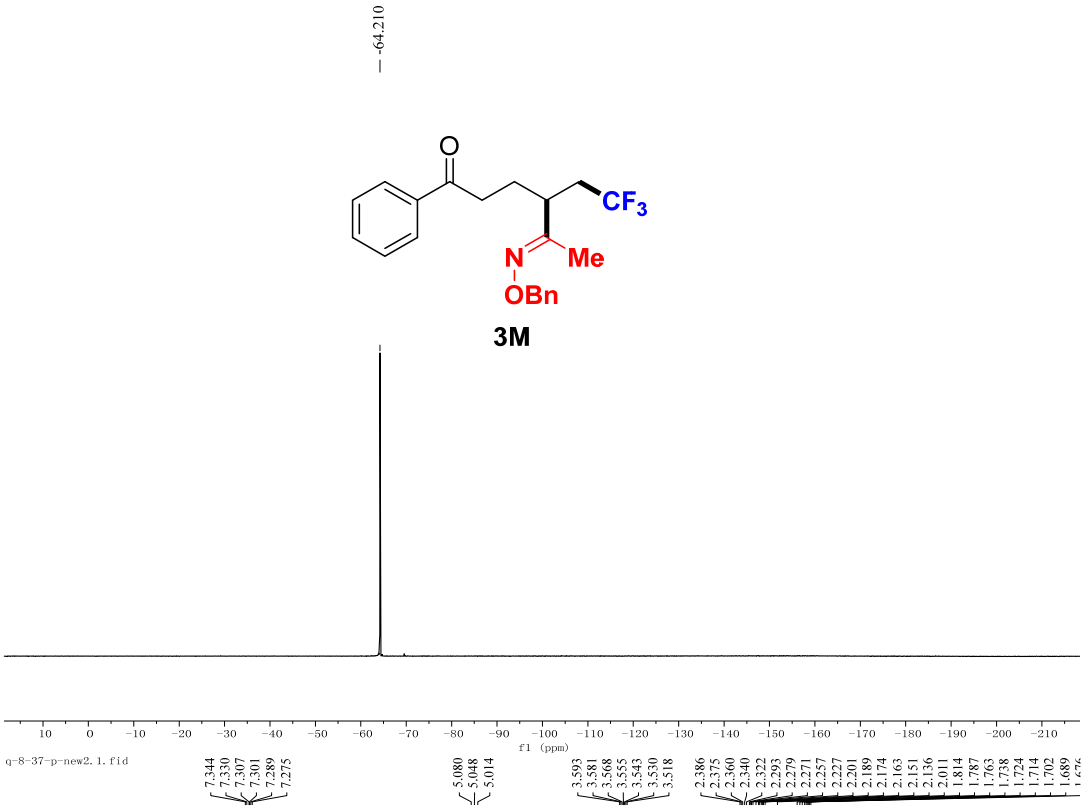

2-8-27-p-c. 1. fid
— -63.550
O
S
CF3
N
OBn
3K
10 0 −10 −20 −30 −40 −50 −60 −70 −80 −90 −100 −110 −120 −130 −140 −150 −160 −170 −180 −190 −200 −210
f1 (ppm)
q-8-38-p. 1. fid
7.328
7.315
7.305
7.300
7.292
7.286
7.276
7.257
7.210
7.192
7.173
7.141
7.123
6.474
6.454
— 5.077
3.441
3.430
3.422
3.413
3.404
3.396
3.385
2.844
2.825
2.806
2.616
2.599
2.580
2.394
2.368
2.348
2.329
2.315
2.309
2.295
2.246
2.228
2.219
2.202
2.192
2.175
2.166
2.148
1.882
1.867
1.849

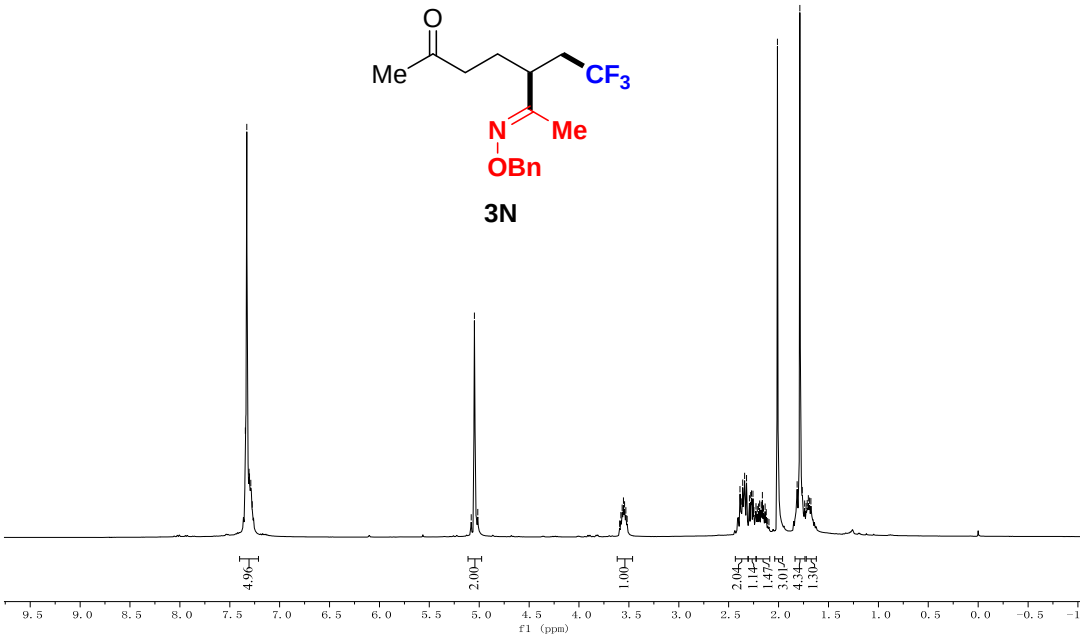

O
Ph
CF3
N
OBn
3L
7.14
1.07
1.89
0.92
2.00
1.06
1.90
1.99
2.12
2.28
1.11
1.65
.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


q-8-38-p-f. 11. fid
208.723
152.113
141.021
137.649
128.631
128.558
128.406
128.211
128.099
127.600
126.281
124.842
76.266
44.351
39.974
37.246
29.763
29.665
29.636
26.017
O
Ph
CF3
N
OBn
3L
f1 (ppm)


q-8-38-p. 4. fid
-63.545
O
Ph
CF3
N
OBn
3L
f1 (ppm)

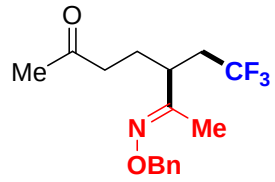

7.849
7.846
7.843
7.828
7.825
7.822
7.583
7.580
7.563
7.549
7.546
7.543
7.462
7.459
7.441
7.422
7.325
7.317
7.303
7.300
7.296
7.288
7.271
7.268
7.265
7.255
7.252
7.245
7.236
5.053
5.049
2.854
2.837
2.834
2.816
2.799
2.756
2.746
2.734
2.722
2.711
2.454
2.443
2.422
2.417
2.414
2.274
2.261
2.247
2.234
1.997
1.981
1.976
1.964
1.957
1.942
1.934
1.919
1.847
O
CF3
N
Me
OBn
3M
2.19
1.15
2.04
5.31
2.00
2.03
1.33
1.36
1.40
2.51
3.03
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)
199.143
157.206
138.422
136.808
133.266
128.706
128.392
128.132
127.888
127.790
127.705
125.037
75.612
38.954
38.929
36.890
36.611
36.333
36.054
35.367
26.200
11.988
O
CF3
N
Me
OBn
3M
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


-64.210
O
CF3
N
Me
OBn
3M
f1 (ppm)
q-8-37-p-new2.1.fid

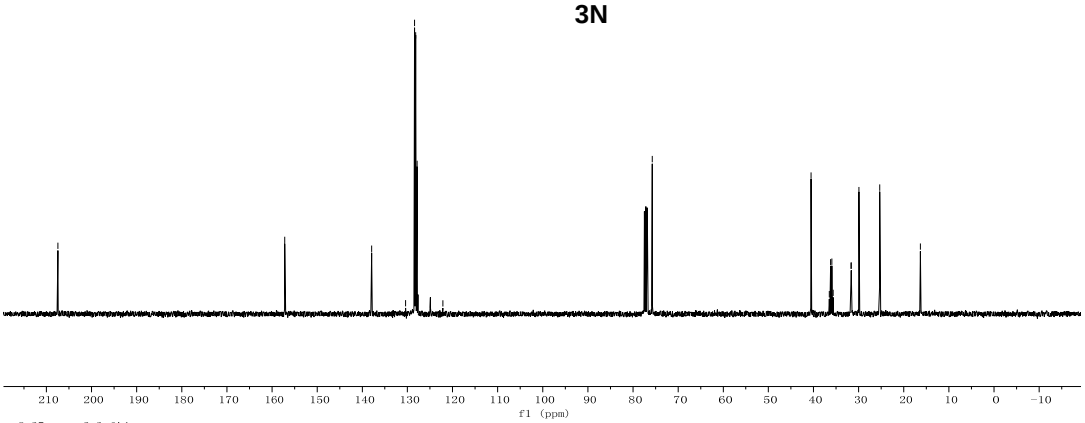

O
Me
CF3
N
Me
OBn
3N
4.96
2.00
1.00
2.04
1.14
1.47
3.01
4.34
1.30
f1 (ppm)

q-8-37-new2.4.fid

207.477 157.177 137.913 130.411 128.408 128.159 127.858 122.149 75.752 40.532 36.507 36.225 35.944 35.663 31.666 31.649 29.941 25.333 16.313

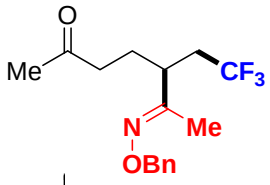


3N

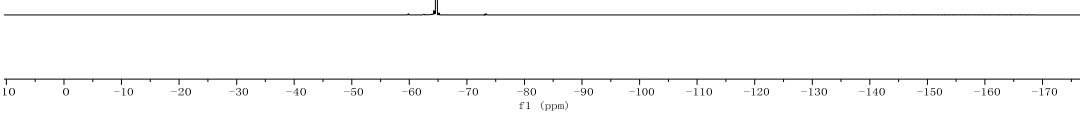


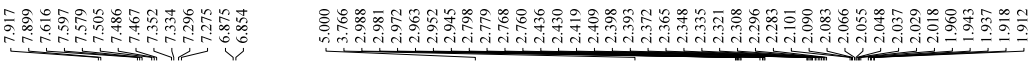
q-8-37-p-new2.3.fid

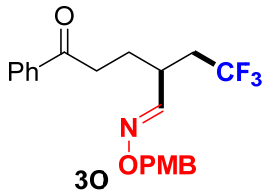
-64.701



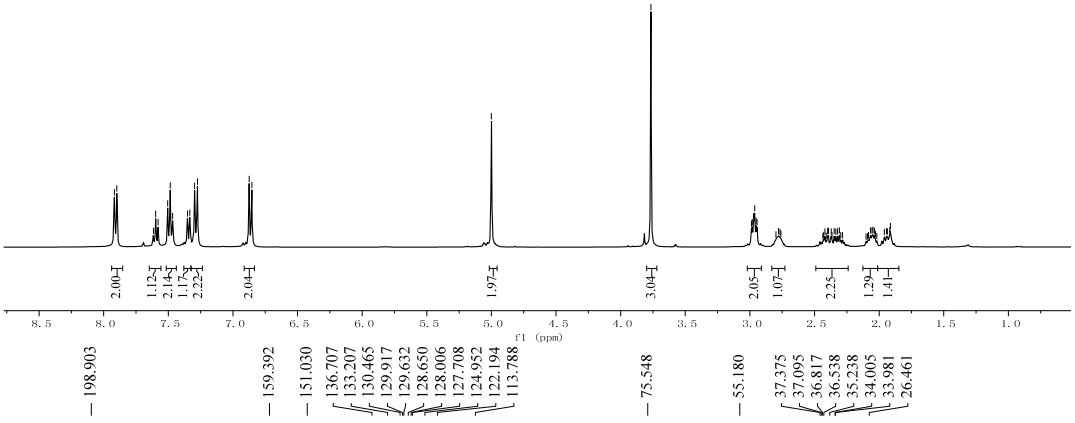
3N



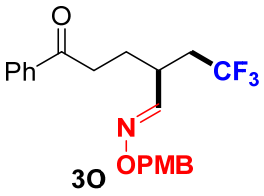

7.917
7.899
7.616
7.597
7.579
7.505
7.486
7.467
7.352
7.334
7.296
7.275
6.875
6.854
5.000
3.766
2.988
2.981
2.972
2.963
2.952
2.945
2.798
2.779
2.768
2.760
2.436
2.430
2.419
2.409
2.398
2.393
2.372
2.365
2.348
2.335
2.321
2.308
2.296
2.283
2.101
2.090
2.083
2.066
2.055
2.048
2.037
2.029
2.018
1.960
1.943
1.937
1.918
1.912


O
Ph
CF3
N
OPMB

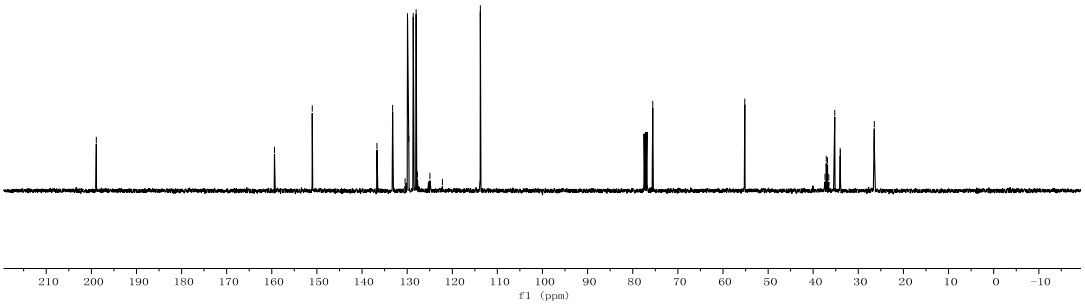
3O

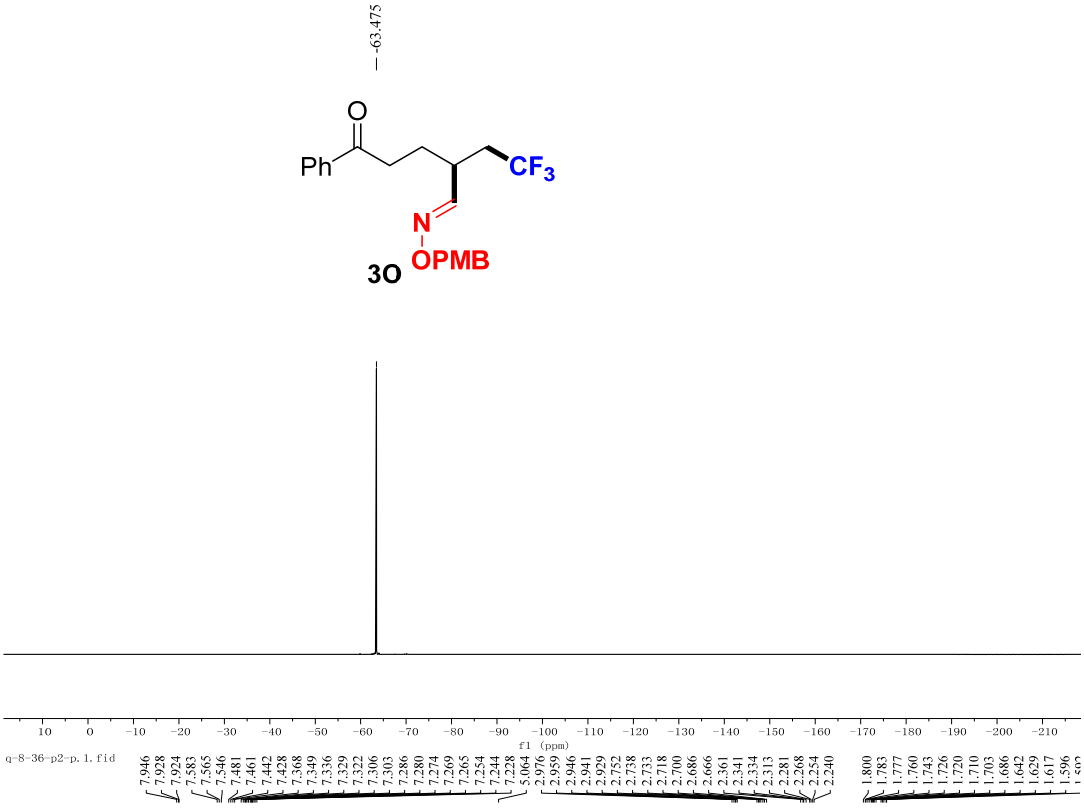

2.00
1.12
2.14
1.17
2.22
2.04
1.97
3.04
2.05
1.07
2.25
1.29
1.41
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
f1 (ppm)

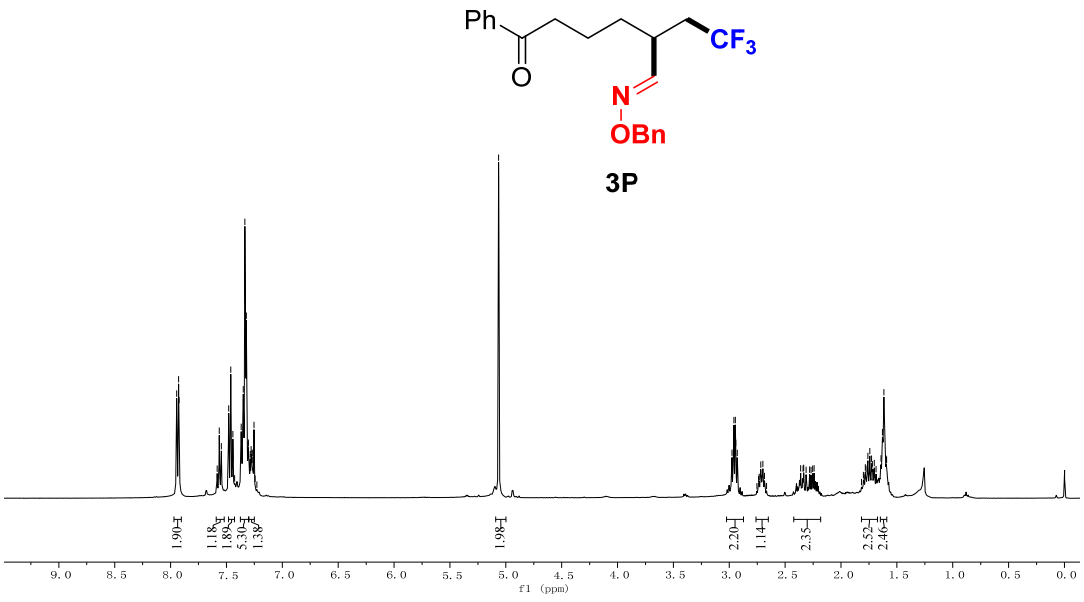
198.903
159.392
151.030
136.707
133.207
130.465
129.917
129.632
128.650
128.006
127.708
124.952
122.194
113.788
75.548
55.180
37.375
37.095
36.817
36.538
35.238
34.005
33.981
26.461

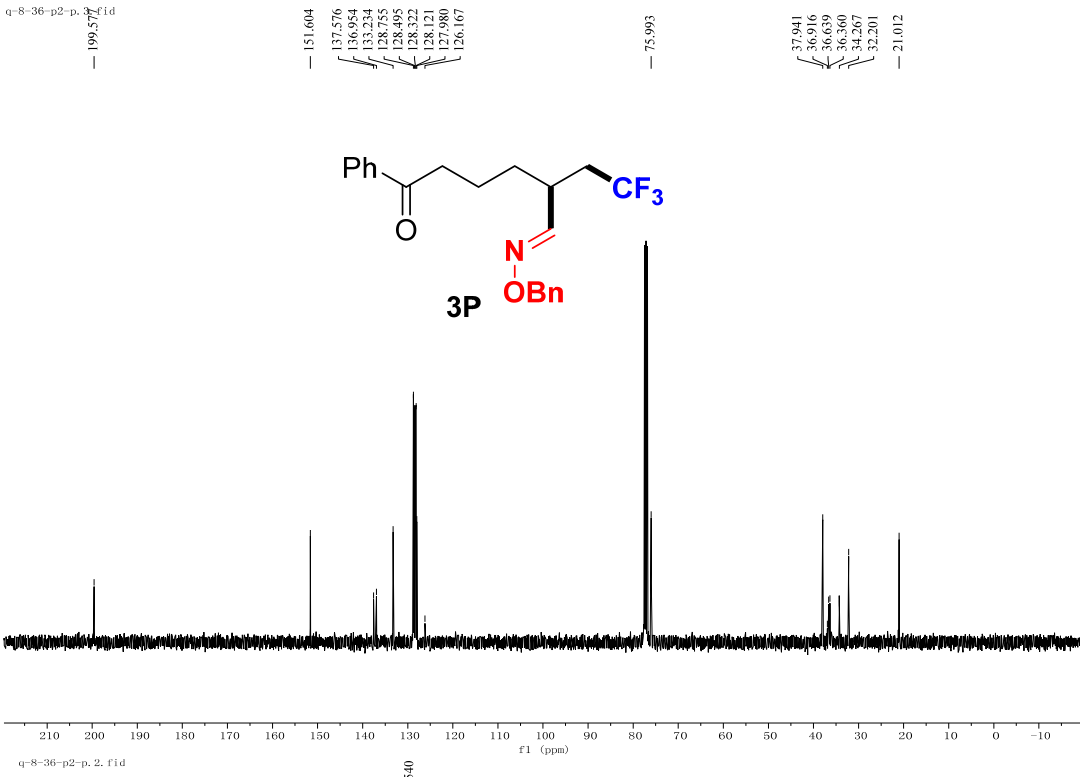

O
Ph
CF3
N
OPMB

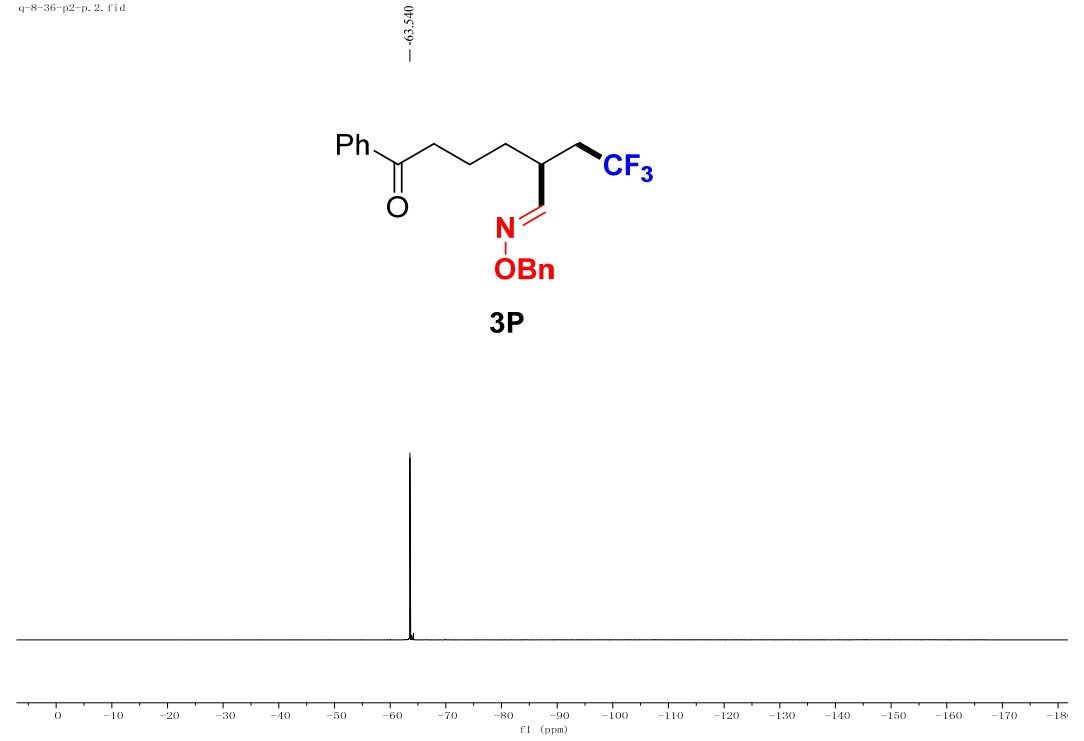
3O

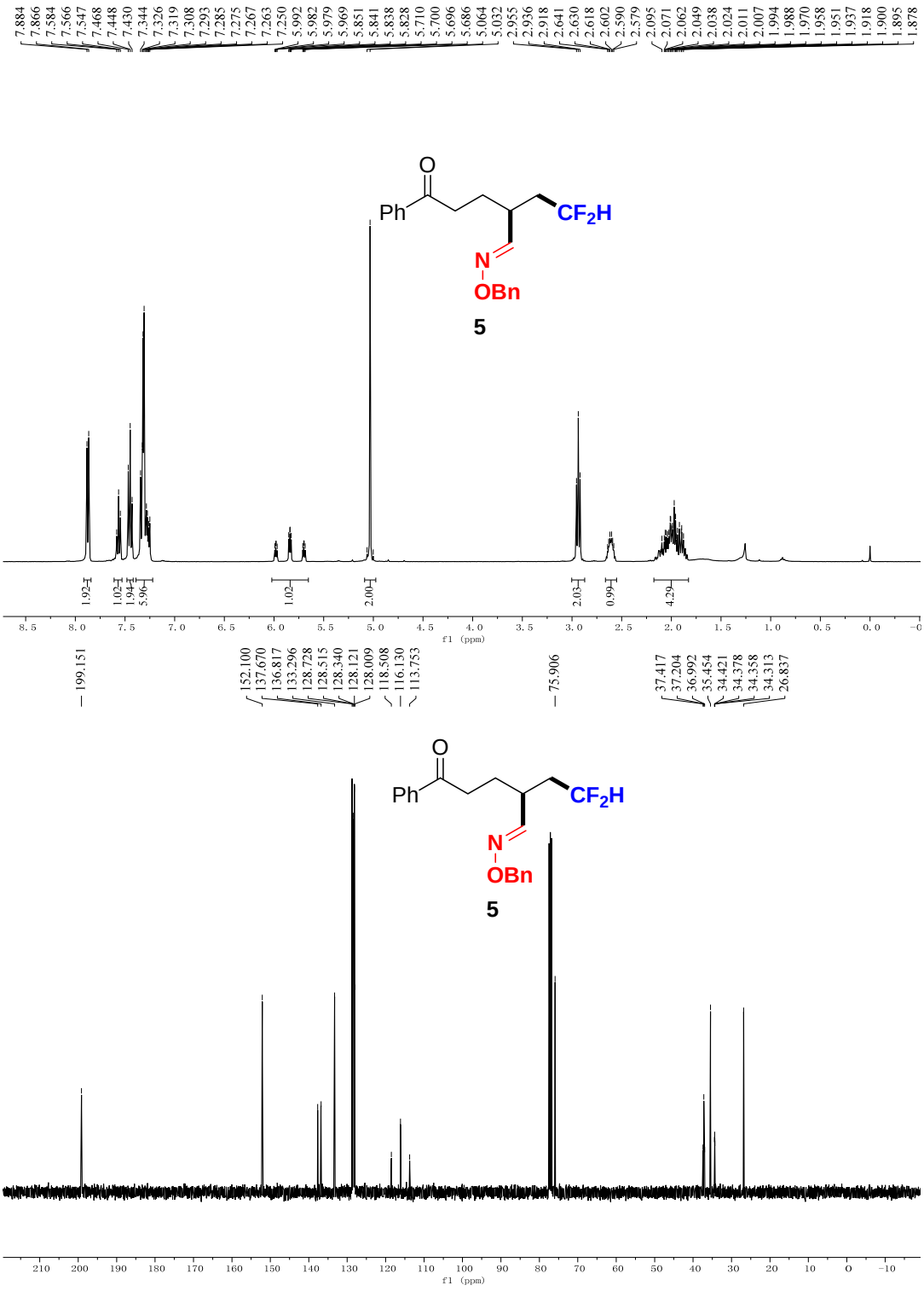

210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

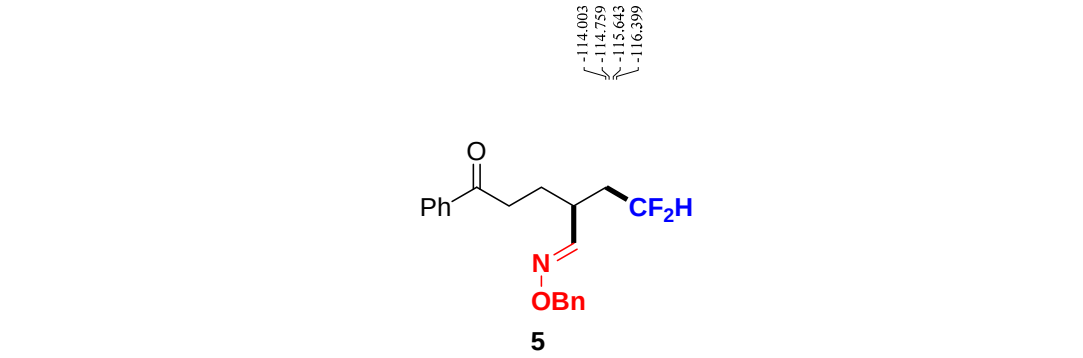

-63.475
O
Ph
CF3
N
OPMB
3O
f1 (ppm)
q-8-36-p2-p.1.fid


Ph
O
CF3
N
OBn
3P
1.90
1.18
1.89
5.30
1.38
1.98
2.20
1.14
2.35
2.52
2.46
f1 (ppm)

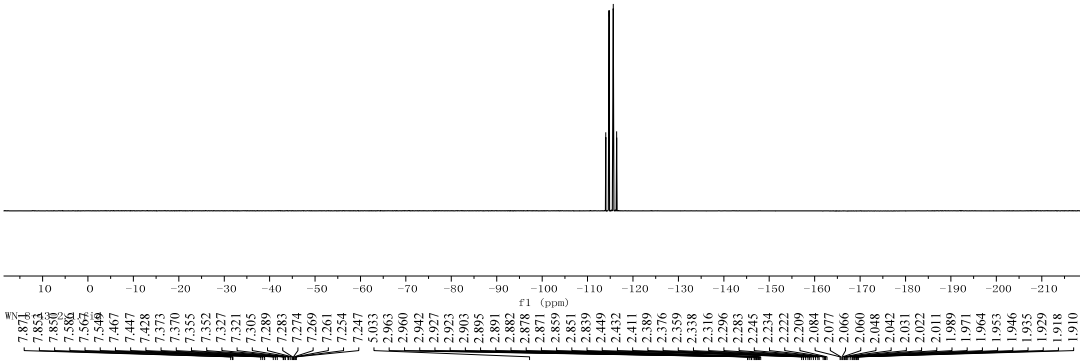

q-8-36-p2-p.2.fid
199.577
151.604
137.576
136.954
133.234
128.755
128.495
128.322
128.121
127.980
126.167
75.993
37.941
36.916
36.639
36.360
34.267
32.201
21.012
Ph
O
CF3
N
OBn
3P
f1 (ppm)

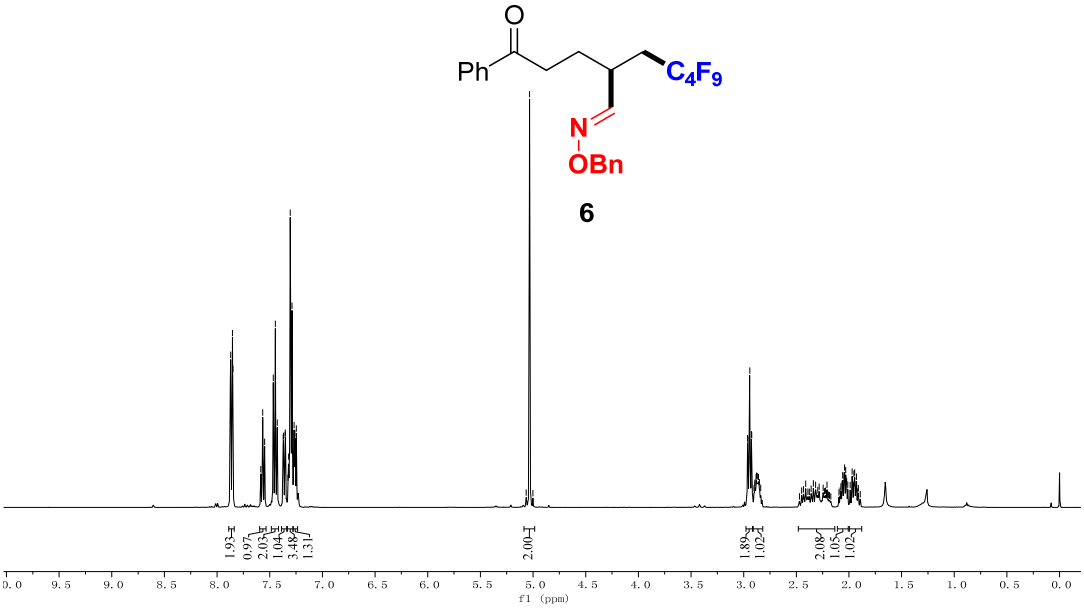

q-8-36-p2-p.2.fid
-63.540
Ph
O
CF3
N
OBn
3P
f1 (ppm)


7.884 7.866 7.584 7.566 7.547 7.468 7.448 7.430 7.344 7.326 7.319 7.308 7.293 7.285 7.275 7.267 7.263 7.250 5.992 5.982 5.979 5.969 5.851 5.841 5.838 5.828 5.710 5.700 5.696 5.686 5.064 5.032 2.955 2.936 2.918 2.641 2.630 2.618 2.602 2.590 2.579 2.095 2.071 2.062 2.049 2.038 2.024 2.011 2.007 1.994 1.988 1.970 1.958 1.951 1.937 1.918 1.900 1.895 1.878
O
Ph
CF2H
N
OBn
5
1.92 1.02 1.94 5.96 1.02 2.00 2.03 0.99 4.29
f1 (ppm)
199.151
152.100 137.670 136.817 133.296 128.728 128.515 128.340 128.121 128.009 118.508 116.130 113.753
75.906
37.417 37.204 36.992 35.454 34.421 34.378 34.358 34.313 26.837
O
Ph
CF2H
N
OBn
5
f1 (ppm)

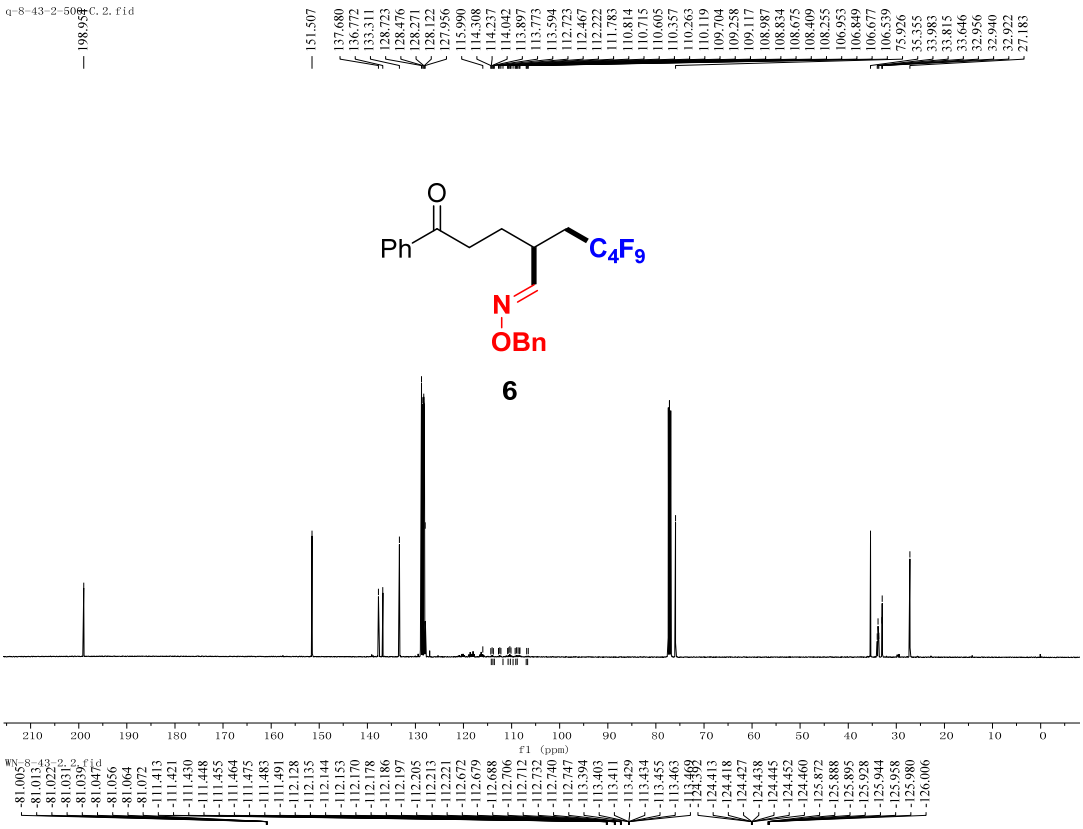


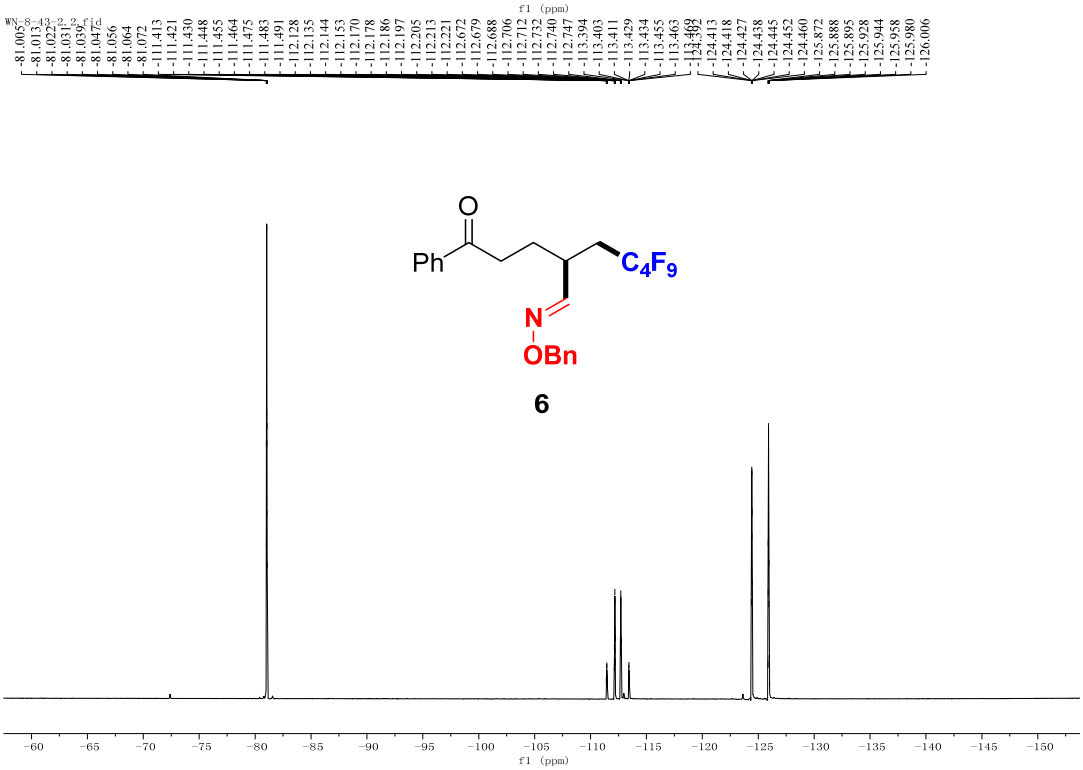
5

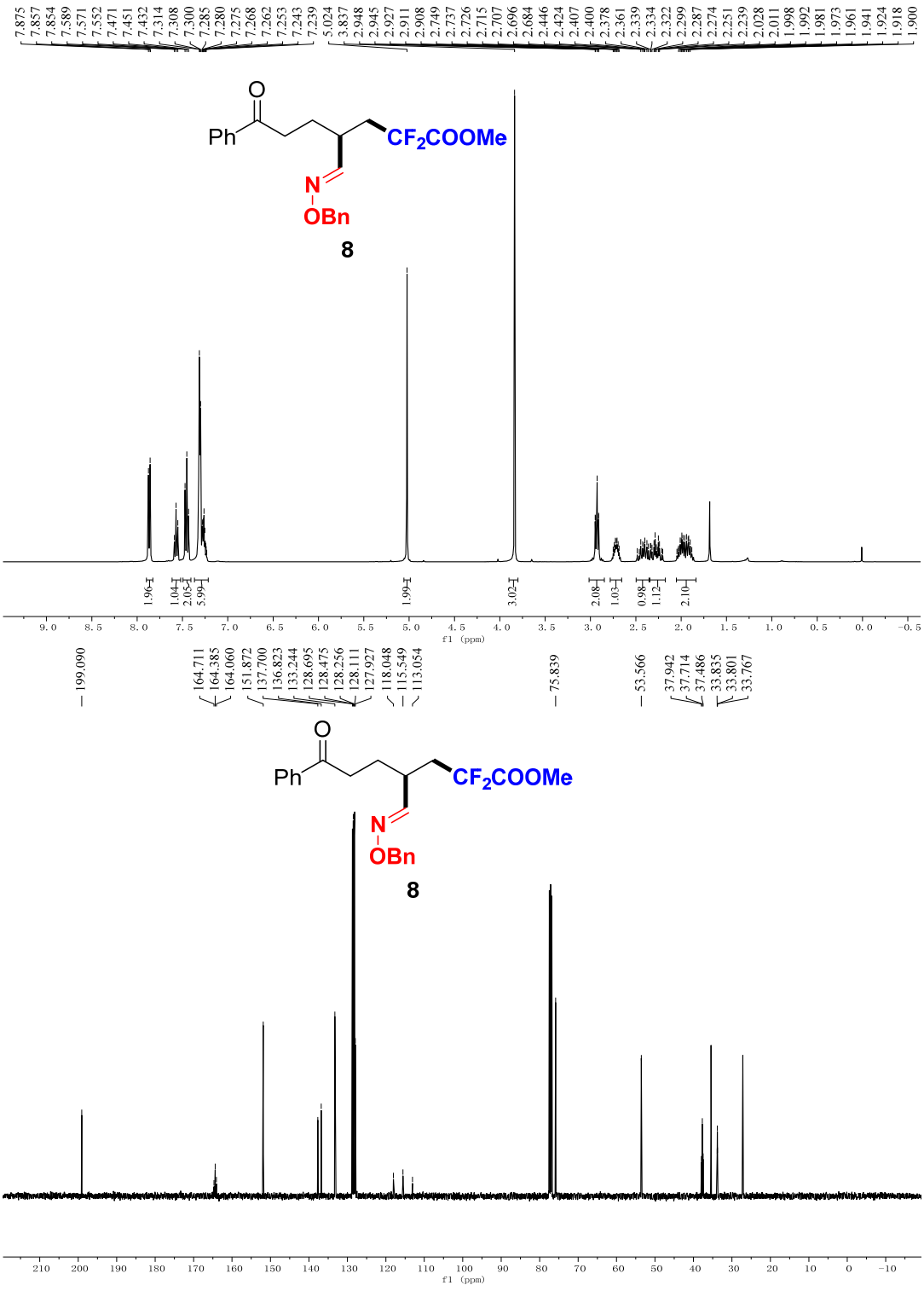


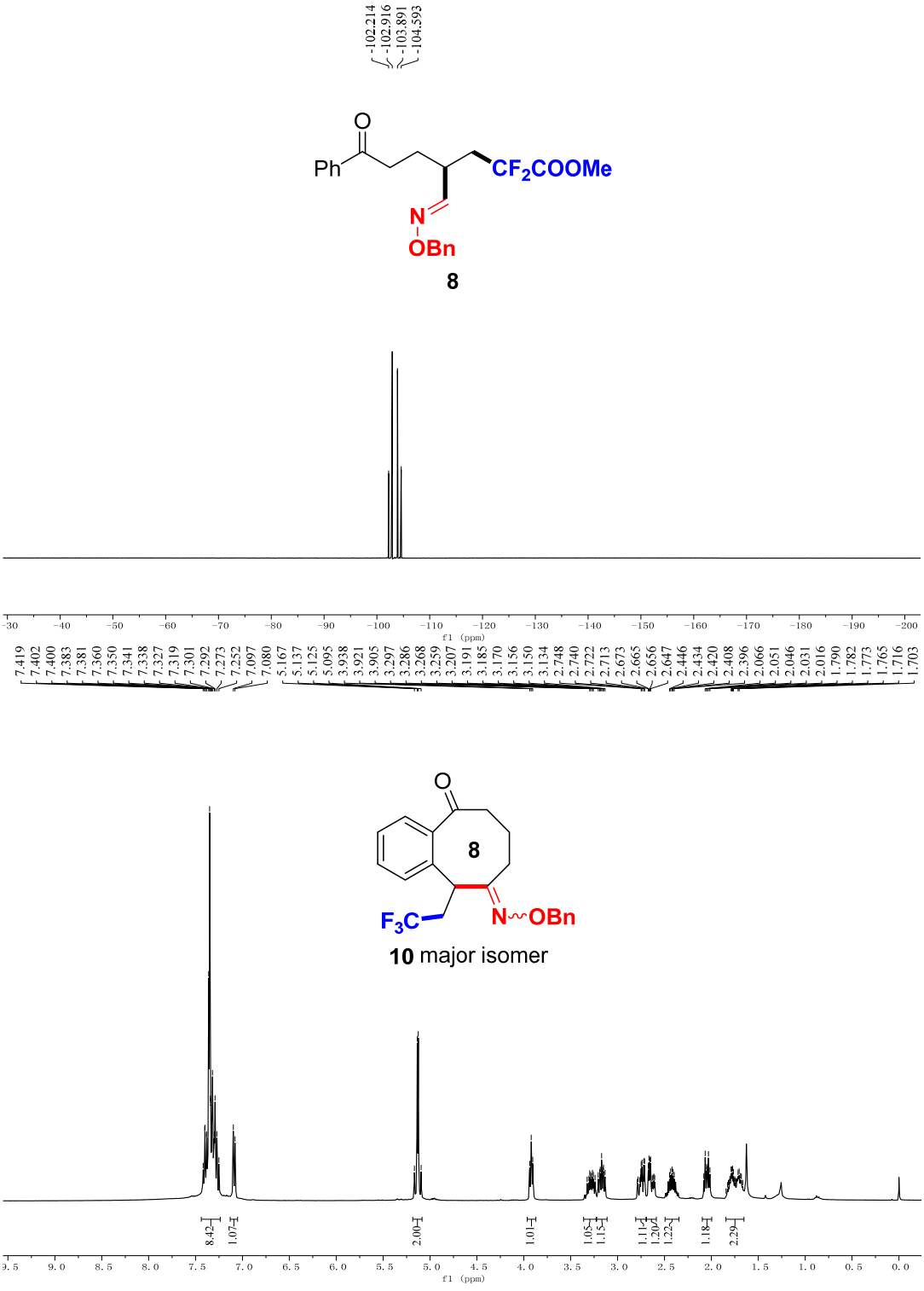


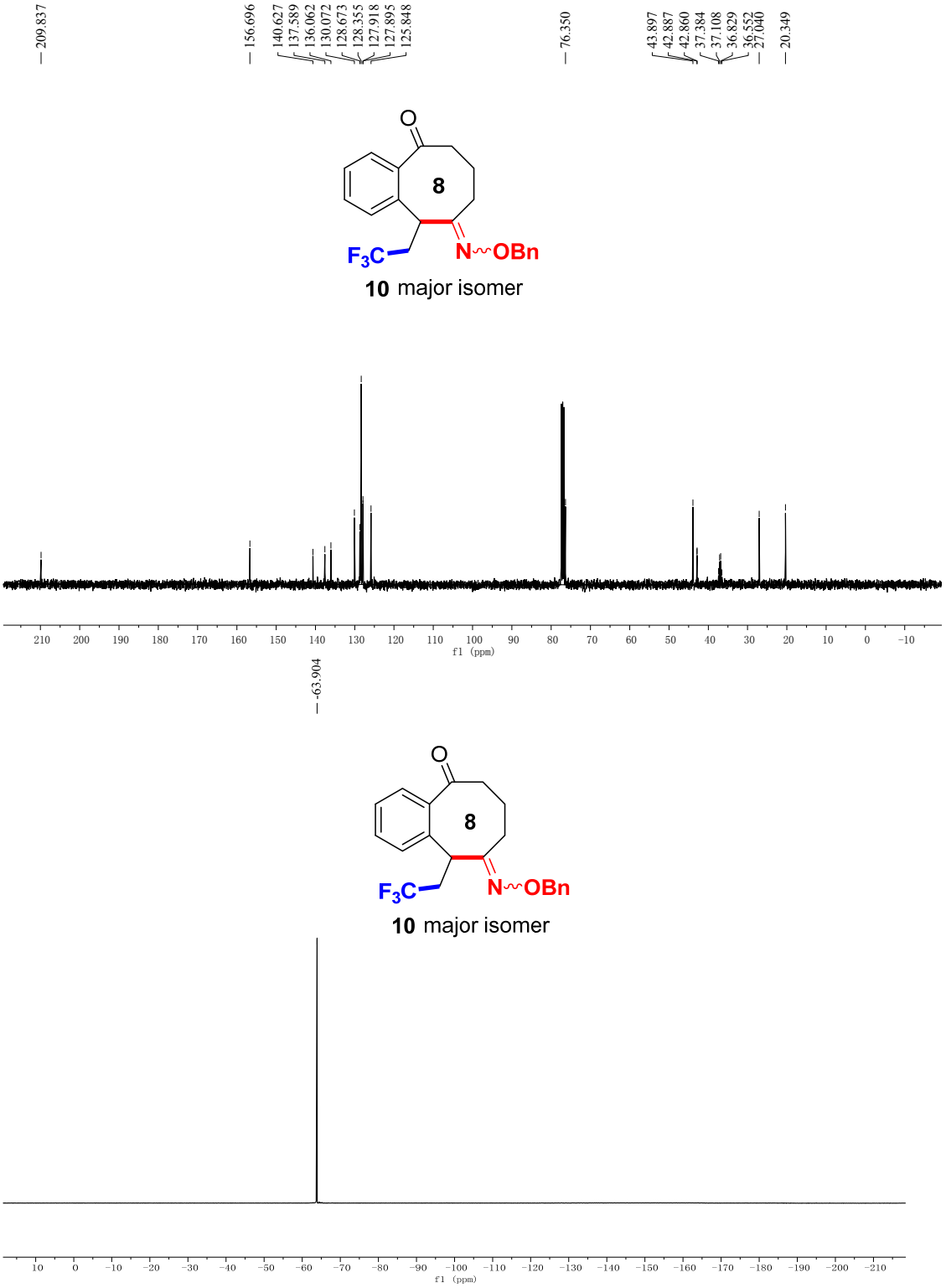
6

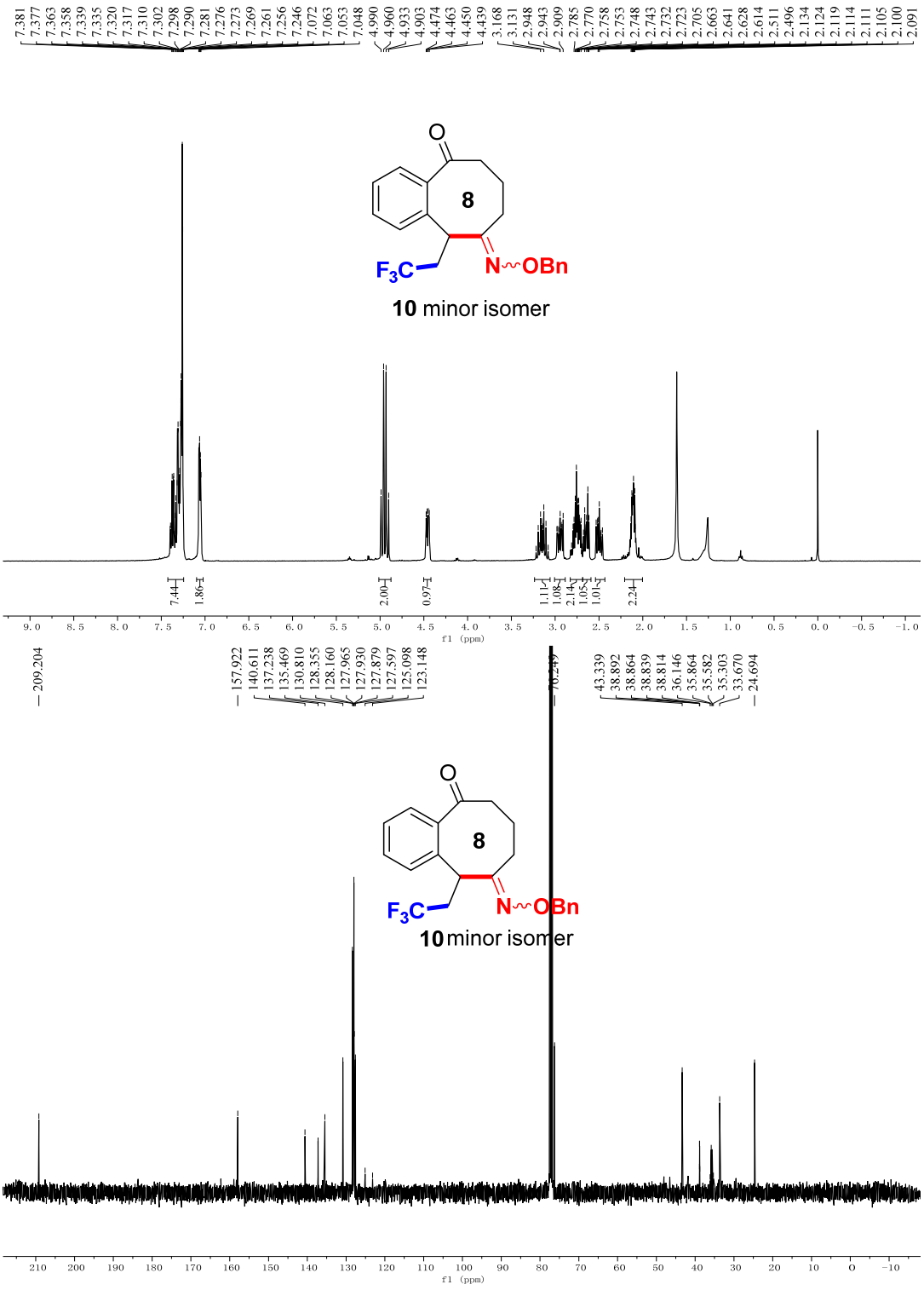

q-8-43-2-500mC.2.fid
198.958
151.507
137.680
136.772
133.311
128.723
128.476
128.271
128.122
127.956
115.990
114.308
114.237
114.042
113.897
113.773
113.594
112.723
112.467
112.222
111.783
110.814
110.715
110.605
110.357
110.263
110.119
109.704
109.258
109.117
108.987
108.834
108.675
108.409
108.255
106.953
106.849
106.677
106.539
75.926
35.355
33.983
33.815
33.646
32.956
32.940
32.922
27.183
O
Ph
C4F9
N
OBn
6
f1 (ppm)

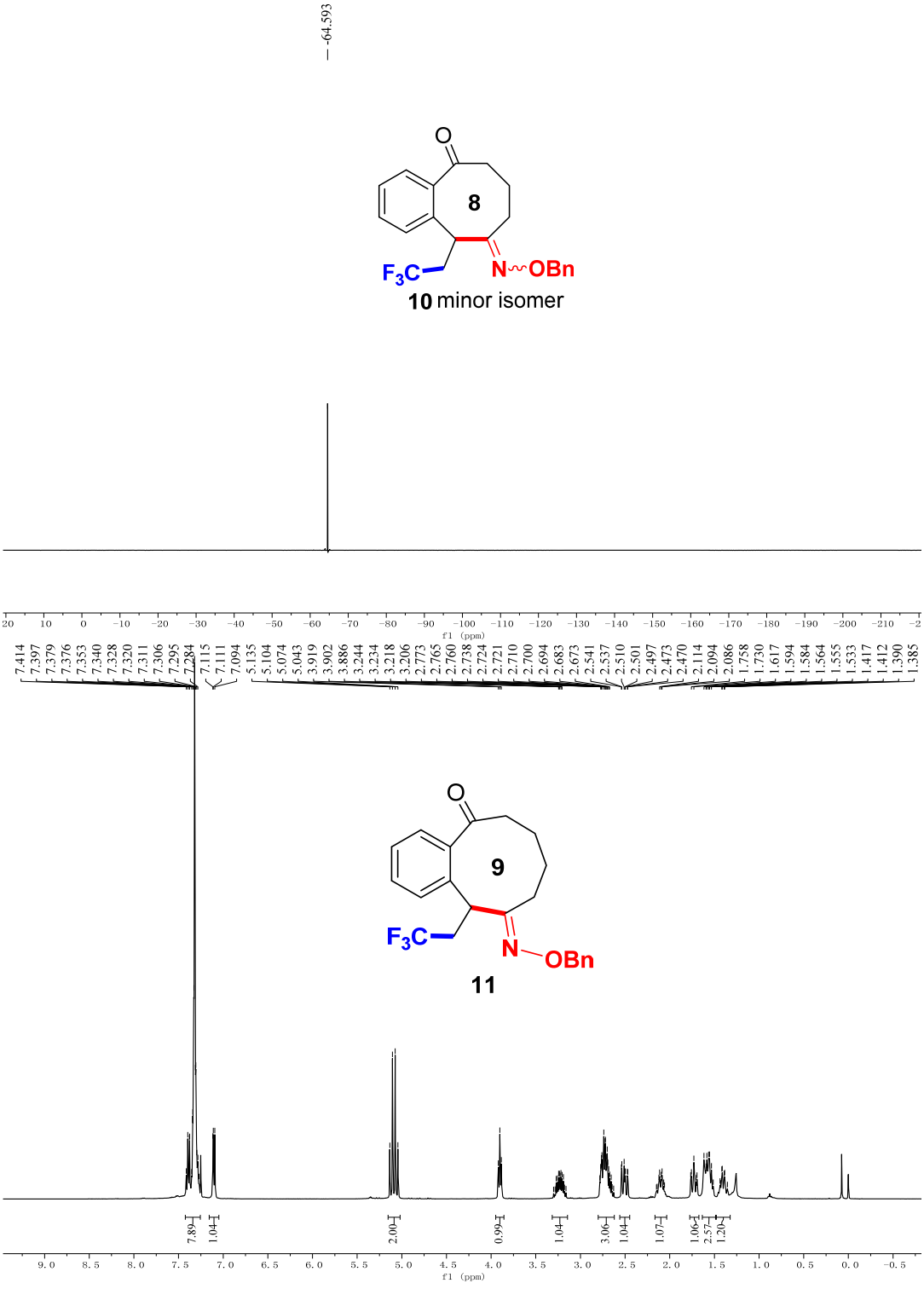

WY-8-43-2-19F.fid
-81.005
-81.013
-81.022
-81.031
-81.039
-81.047
-81.056
-81.064
-81.072
-111.413
-111.421
-111.430
-111.448
-111.455
-111.464
-111.475
-111.483
-111.491
-112.128
-112.135
-112.144
-112.153
-112.170
-112.178
-112.186
-112.197
-112.205
-112.213
-112.221
-112.672
-112.679
-112.688
-112.706
-112.712
-112.732
-112.740
-112.747
-113.394
-113.403
-113.411
-113.429
-113.434
-113.455
-113.463
-113.469
-124.392
-124.413
-124.418
-124.427
-124.438
-124.445
-124.452
-124.460
-125.872
-125.888
-125.895
-125.928
-125.944
-125.958
-125.980
-126.006
O
Ph
C4F9
N
OBn
6
f1 (ppm)

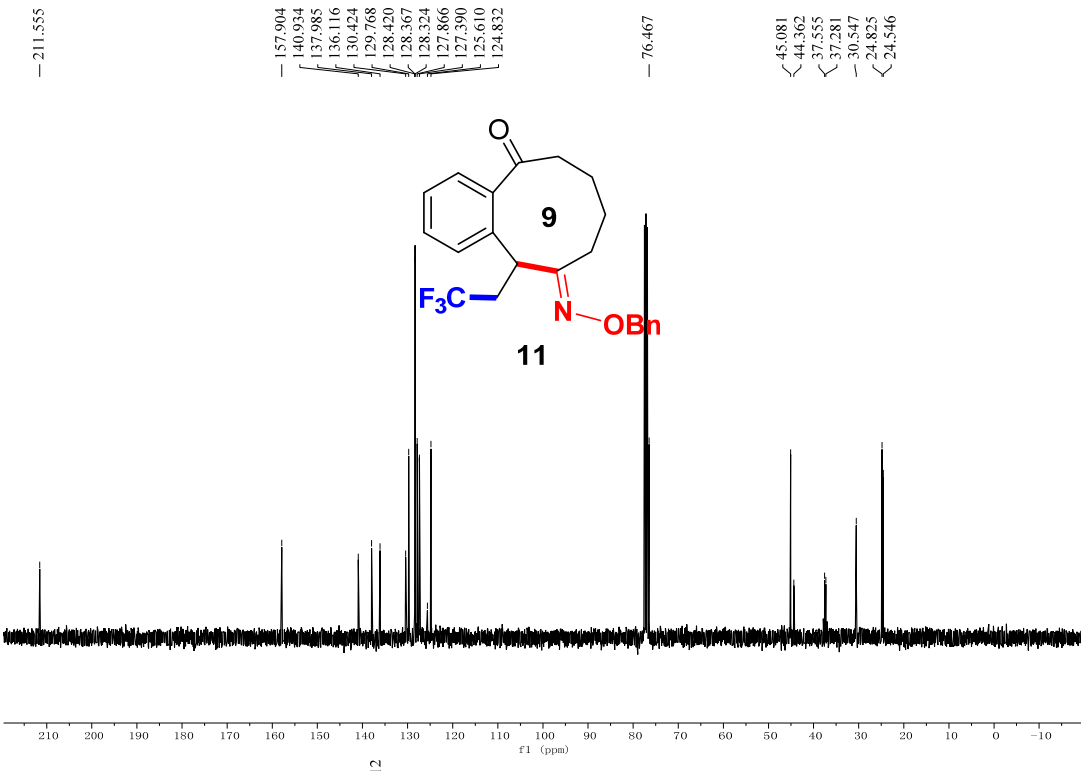

7.875
7.857
7.854
7.589
7.571
7.552
7.471
7.451
7.432
7.314
7.308
7.300
7.285
7.280
7.275
7.268
7.262
7.253
7.243
7.239
5.024
3.837
2.948
2.945
2.927
2.911
2.908
2.749
2.737
2.726
2.715
2.707
2.696
2.684
2.446
2.424
2.407
2.400
2.378
2.361
2.339
2.334
2.322
2.299
2.287
2.274
2.251
2.239
2.028
2.011
1.998
1.992
1.981
1.973
1.961
1.941
1.924
1.918
1.900
O
Ph
CF2COOMe
N
OBn
8
1.96
1.04
2.05
5.99
1.99
3.02
2.08
1.03
0.98
1.12
2.10
f1 (ppm)
199.090
164.711
164.385
164.060
151.872
137.700
136.823
133.244
128.695
128.475
128.256
128.111
127.927
118.048
115.549
113.054
75.839
53.566
37.942
37.714
37.486
33.835
33.801
33.767
O
Ph
CF2COOMe
N
OBn
8
f1 (ppm)

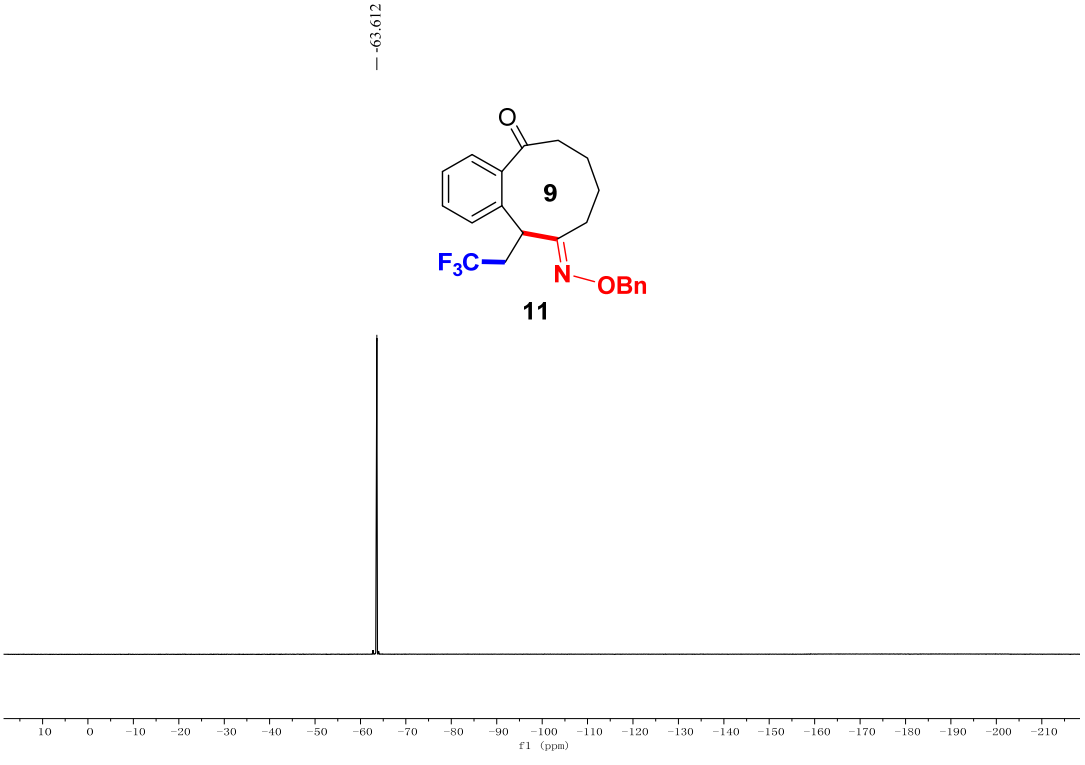

-102.214
-102.916
-103.891
-104.593
O
Ph
CF2COOMe
N
OBn
8
f1 (ppm)
7.419
7.402
7.400
7.383
7.381
7.360
7.350
7.341
7.338
7.327
7.319
7.301
7.292
7.273
7.252
7.097
7.080
5.167
5.137
5.125
5.095
3.938
3.921
3.905
3.297
3.286
3.268
3.259
3.207
3.191
3.185
3.170
3.156
3.150
3.134
2.748
2.740
2.722
2.713
2.673
2.665
2.656
2.647
2.446
2.434
2.420
2.408
2.396
2.066
2.051
2.046
2.031
2.016
1.790
1.782
1.773
1.765
1.716
1.703
O
8
F3C
N~OBn
10 major isomer
8.42
1.07
2.00
1.01
1.05
1.15
1.11
1.20
1.22
1.18
2.29
f1 (ppm)

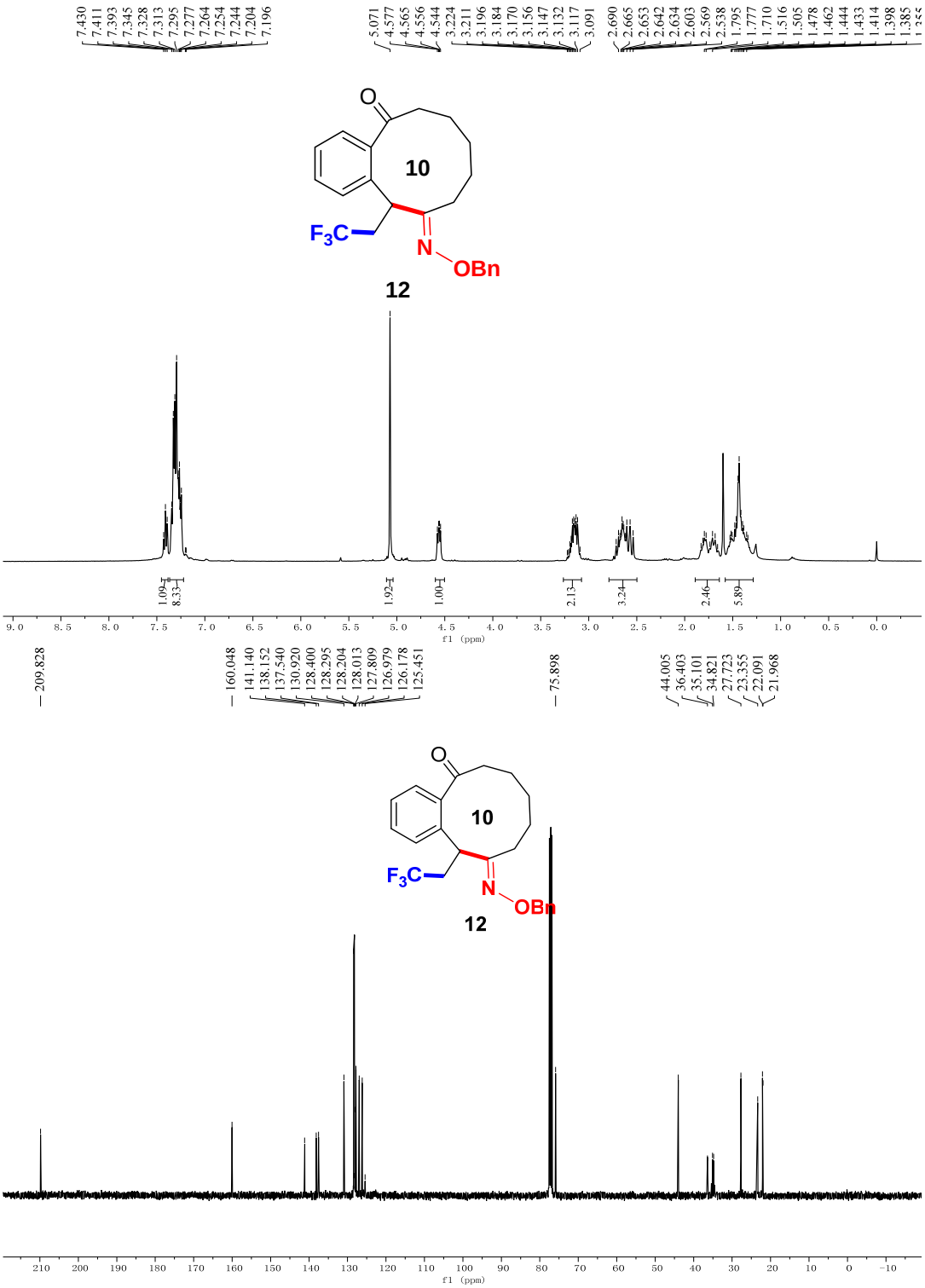

209.837
156.696
140.627
137.589
136.062
130.072
128.673
128.355
127.918
127.895
125.848
76.350
43.897
42.887
42.860
37.384
37.108
36.829
36.552
27.040
20.349
O
8
F3C
N
OBn
10 major isomer
f1 (ppm)
-63.904
O
8
F3C
N
OBn
10 major isomer
f1 (ppm)

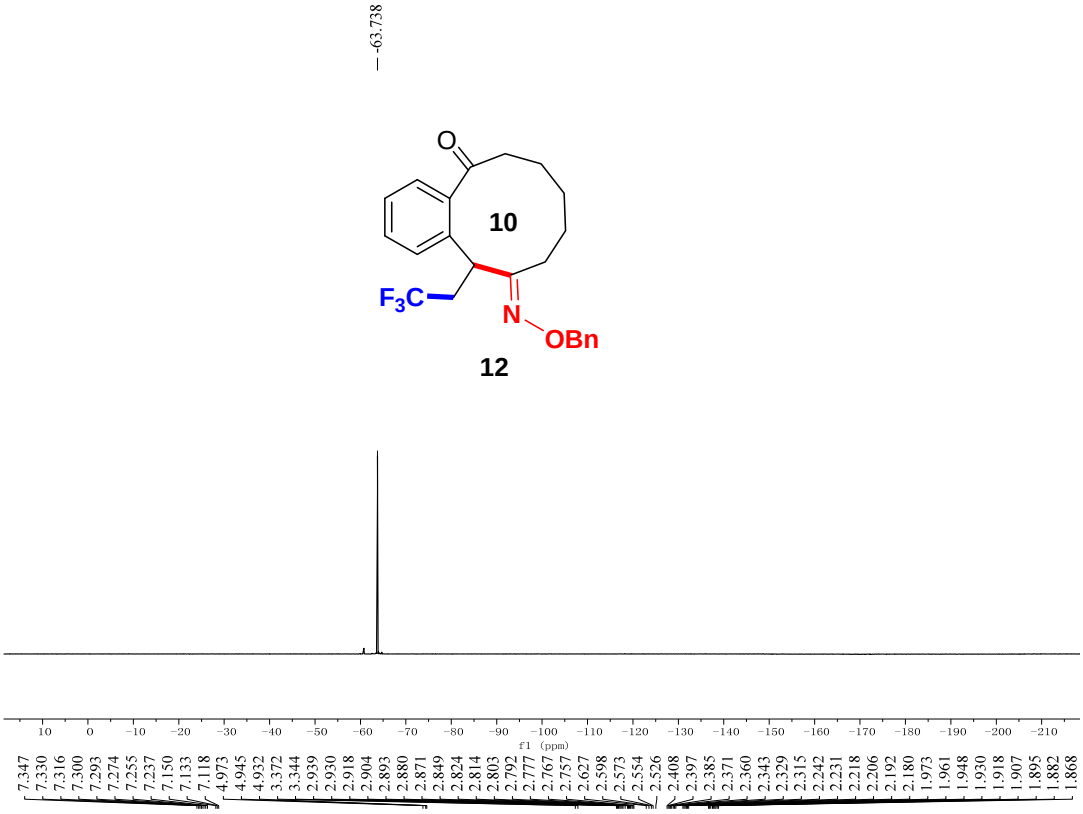

7.381
7.377
7.363
7.358
7.339
7.335
7.320
7.317
7.310
7.302
7.298
7.290
7.281
7.276
7.273
7.269
7.261
7.256
7.246
7.072
7.063
7.053
7.048
4.990
4.960
4.933
4.903
4.474
4.463
4.450
4.439
3.168
3.131
2.948
2.943
2.909
2.785
2.770
2.758
2.753
2.748
2.743
2.732
2.723
2.705
2.663
2.641
2.628
2.614
2.511
2.496
2.134
2.124
2.119
2.114
2.111
2.105
2.100
2.091
O
8
F3C
N~OBn
10 minor isomer
7.44
1.86
2.00
0.97
1.11
1.08
2.14
1.05
1.01
2.24
f1 (ppm)
209.204
157.922
140.611
137.238
135.469
130.810
128.355
128.160
127.965
127.930
127.879
127.597
125.098
123.148
70.249
43.339
38.892
38.864
38.839
38.814
36.146
35.864
35.582
35.303
33.670
24.694
O
8
F3C
N~OBn
10 minor isomer
f1 (ppm)

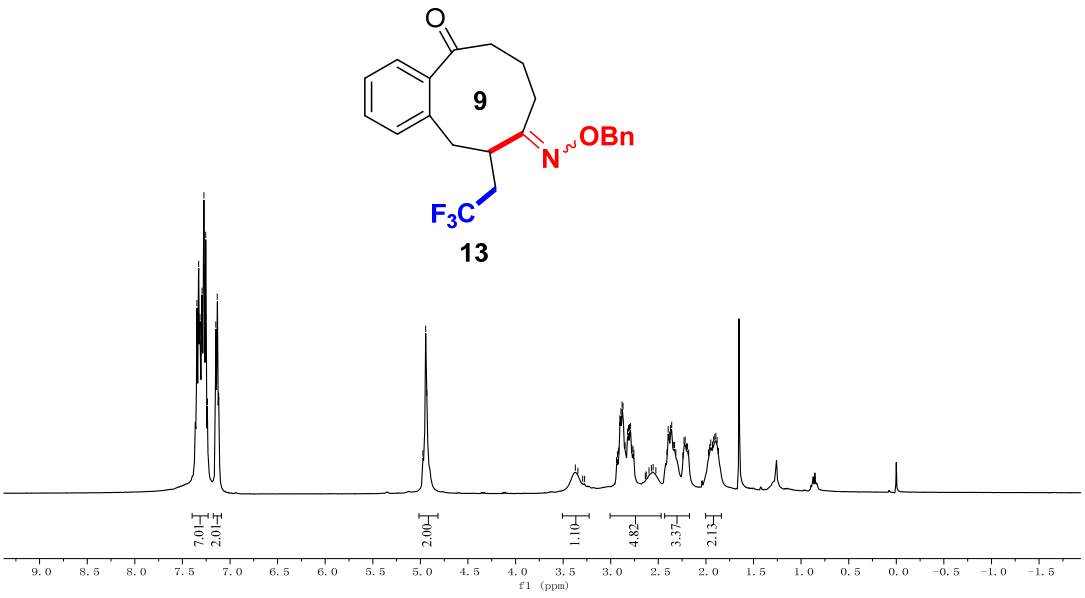

-64.593
O
8
F3C
N~OBn
10 minor isomer
f1 (ppm)
7.414
7.397
7.379
7.376
7.353
7.340
7.328
7.320
7.311
7.306
7.295
7.284
7.115
7.111
7.094
5.135
5.104
5.074
5.043
3.919
3.902
3.886
3.244
3.234
3.218
3.206
2.773
2.765
2.760
2.738
2.724
2.721
2.710
2.700
2.694
2.683
2.673
2.541
2.537
2.510
2.501
2.497
2.473
2.470
2.114
2.094
2.086
1.758
1.730
1.617
1.594
1.584
1.564
1.555
1.533
1.417
1.412
1.390
1.385
O
9
F3C
N
OBn
11
7.89
1.04
2.00
0.99
1.04
3.06
1.04
1.07
1.06
2.57
1.20
f1 (ppm)

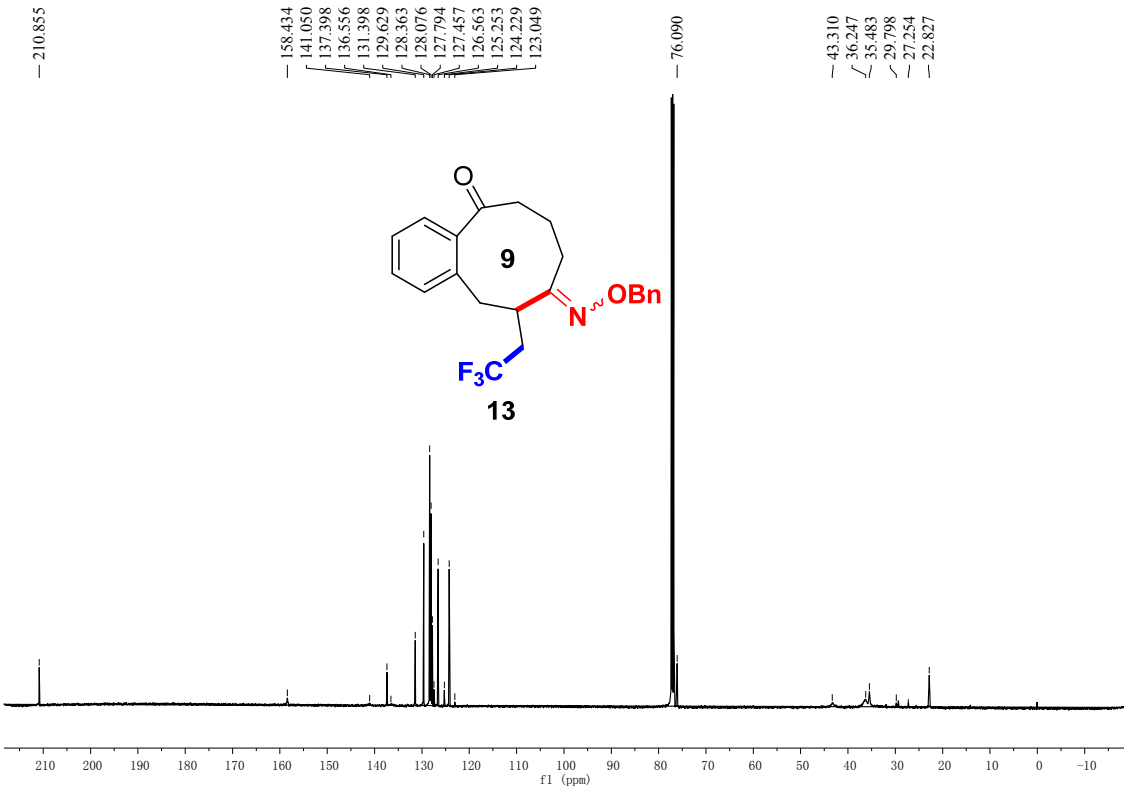

211.555
157.904
140.934
137.985
136.116
130.424
129.768
128.420
128.367
128.324
127.866
127.390
125.610
124.832
76.467
45.081
44.362
37.555
37.281
30.547
24.825
24.546
O
9
F3C
N
OBn
11
f1 (ppm)

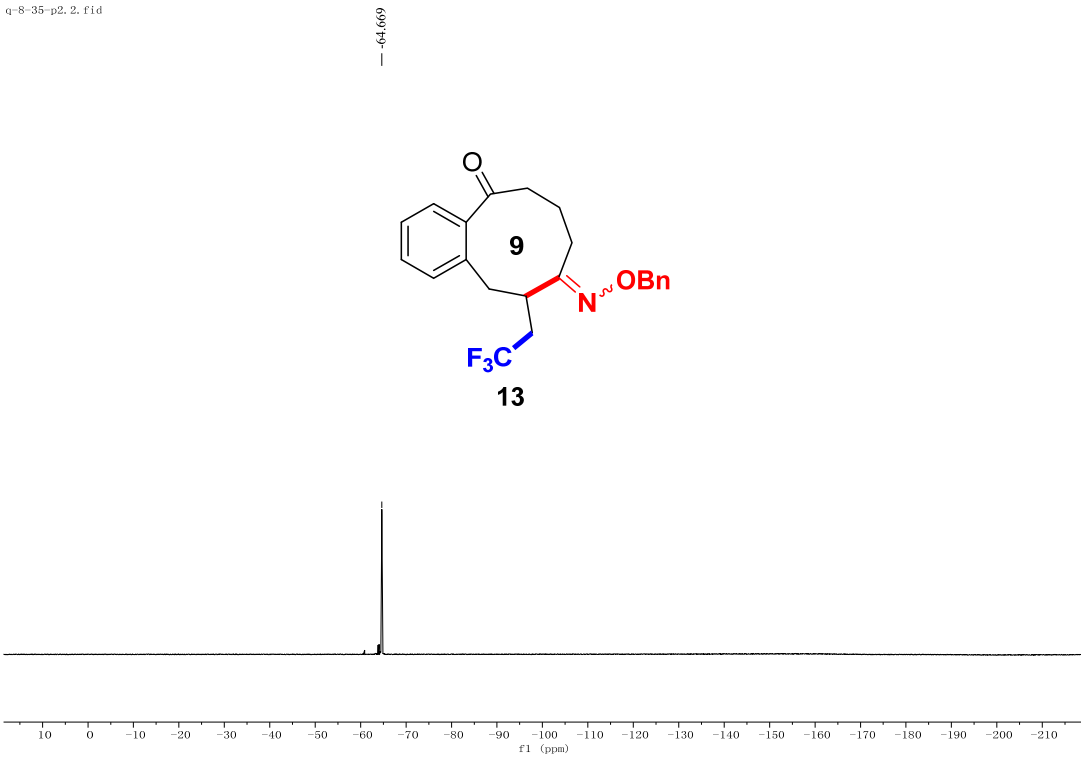

-63.612
O
9
F3C
N
OBn
11
f1 (ppm)

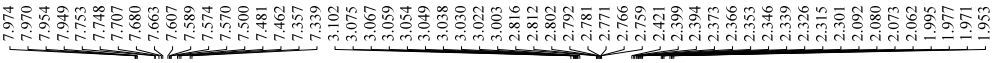

7.430
7.411
7.393
7.345
7.328
7.313
7.295
7.277
7.264
7.254
7.244
7.204
7.196
5.071
4.577
4.565
4.556
4.544
3.224
3.211
3.196
3.184
3.170
3.156
3.147
3.132
3.117
3.091
2.690
2.665
2.653
2.642
2.634
2.603
2.569
2.538
1.795
1.777
1.710
1.516
1.505
1.478
1.462
1.444
1.433
1.414
1.398
1.385
O
10
F3C
N
OBn
12
1.09
8.33
1.92
1.00
2.13
3.24
2.46
5.89
f1 (ppm)
209.828
160.048
141.140
138.152
137.540
130.920
128.400
128.295
128.204
128.013
127.809
126.979
126.178
125.451
75.898
44.005
36.403
35.101
34.821
27.723
23.355
22.091
21.968
f1 (ppm)

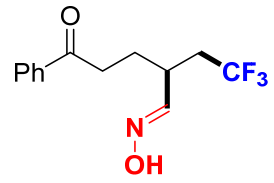

−63.738
O
10
F3C
N
OBn
12
10 0 −10 −20 −30 −40 −50 −60 −70 −80 −90 −100 −110 −120 −130 −140 −150 −160 −170 −180 −190 −200 −210
f1 (ppm)
7.347 7.330 7.316 7.300 7.293 7.274 7.255 7.237 7.150 7.133 7.118 4.973 4.945 4.932 3.372 3.344 2.939 2.930 2.918 2.904 2.893 2.880 2.871 2.849 2.824 2.814 2.803 2.792 2.777 2.767 2.757 2.627 2.598 2.573 2.554 2.526 2.408 2.397 2.385 2.371 2.360 2.343 2.329 2.315 2.242 2.231 2.218 2.206 2.192 2.180 1.973 1.961 1.948 1.930 1.918 1.907 1.895 1.882 1.868


O
9
N
OBn
F3C
13
7.01
2.01
2.00
1.10
4.82
3.37
2.13
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 −0.5 −1.0 −1.5
f1 (ppm)

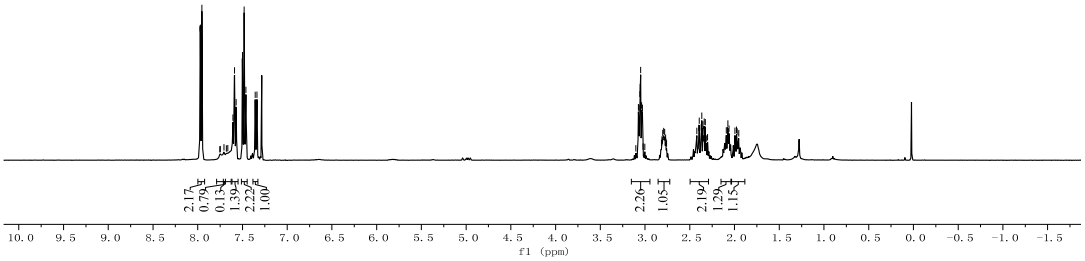

210.855
158.434
141.050
137.398
136.556
131.398
129.629
128.363
128.076
127.794
127.457
126.563
125.253
124.229
123.049
76.090
43.310
36.247
35.483
29.798
27.254
22.827
O
9
N
OBn
F3C
13
f1 (ppm)

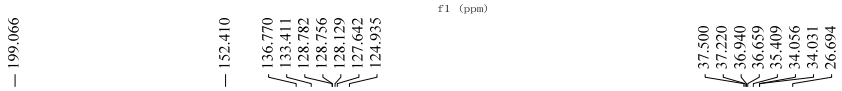

q-8-35-p2.2.fid
-64.669
O
9
N
OBn
F3C
13
f1 (ppm)

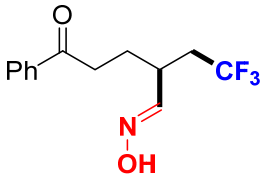

7.974
7.970
7.954
7.949
7.753
7.748
7.707
7.680
7.663
7.607
7.589
7.574
7.570
7.500
7.481
7.462
7.357
7.339
3.102
3.075
3.067
3.059
3.054
3.049
3.038
3.030
3.022
3.003
2.816
2.812
2.802
2.792
2.781
2.771
2.766
2.759
2.421
2.399
2.394
2.373
2.366
2.353
2.346
2.339
2.326
2.315
2.301
2.092
2.080
2.073
2.062
1.995
1.977
1.971
1.953


O
Ph
CF3
N
OH

14

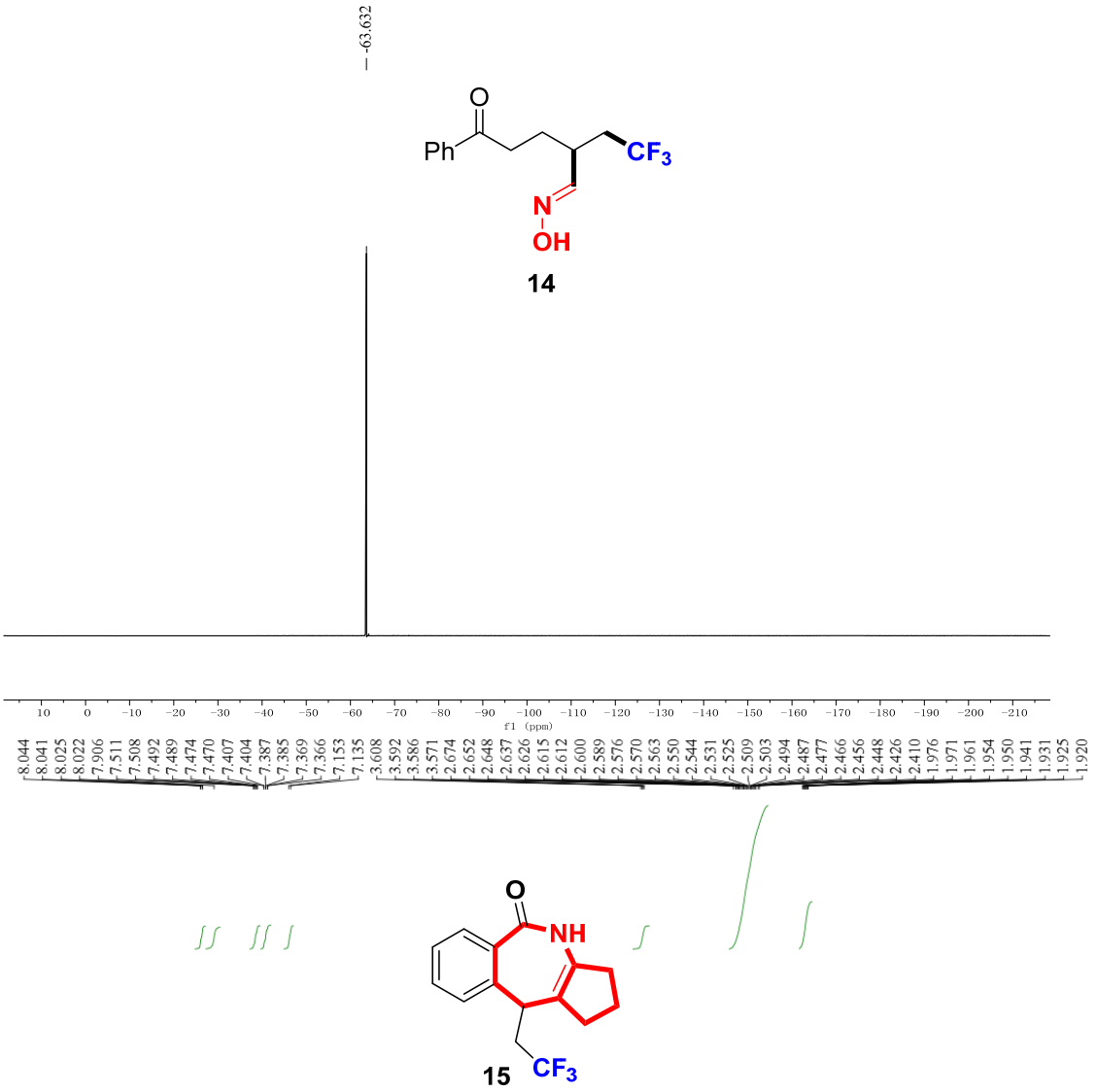

2.17
0.79
0.13
1.39
2.22
1.00
2.26
1.05
2.19
1.29
1.15
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 −0.5 −1.0 −1.5
f1 (ppm)

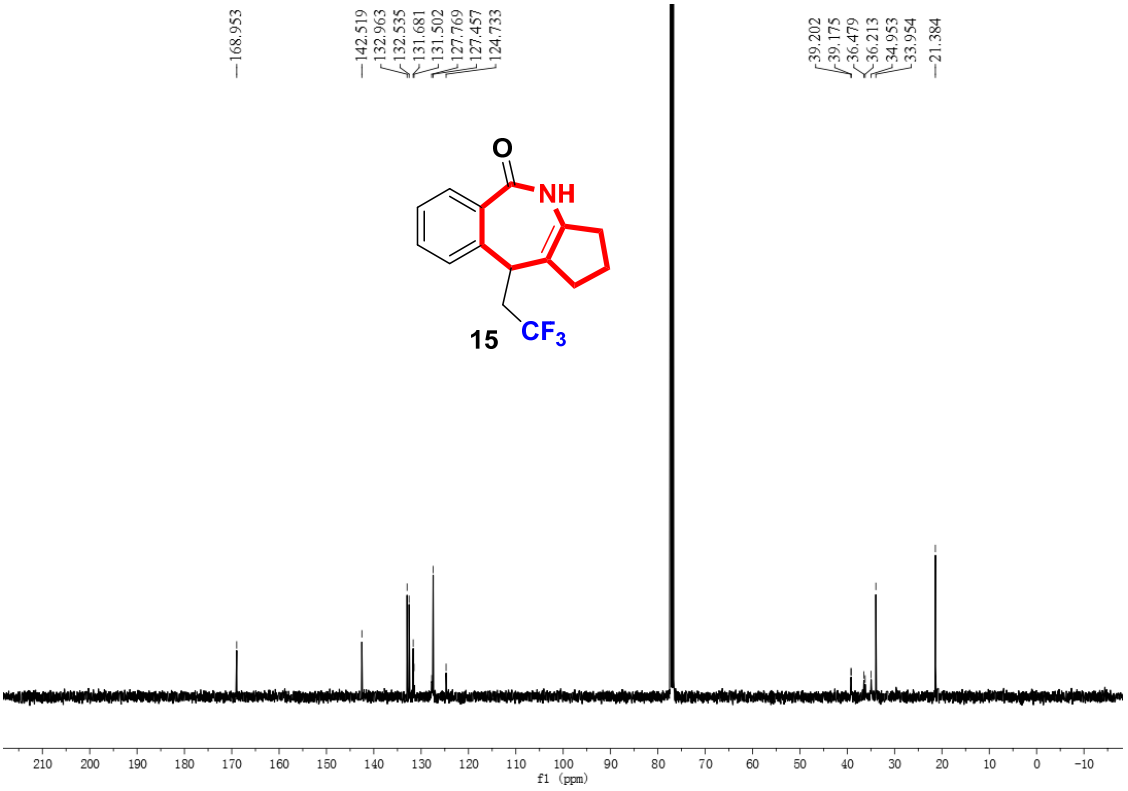

199.066
152.410
136.770
133.411
128.782
128.756
128.129
127.642
124.935
37.500
37.220
36.940
36.659
35.409
34.056
34.031
26.694

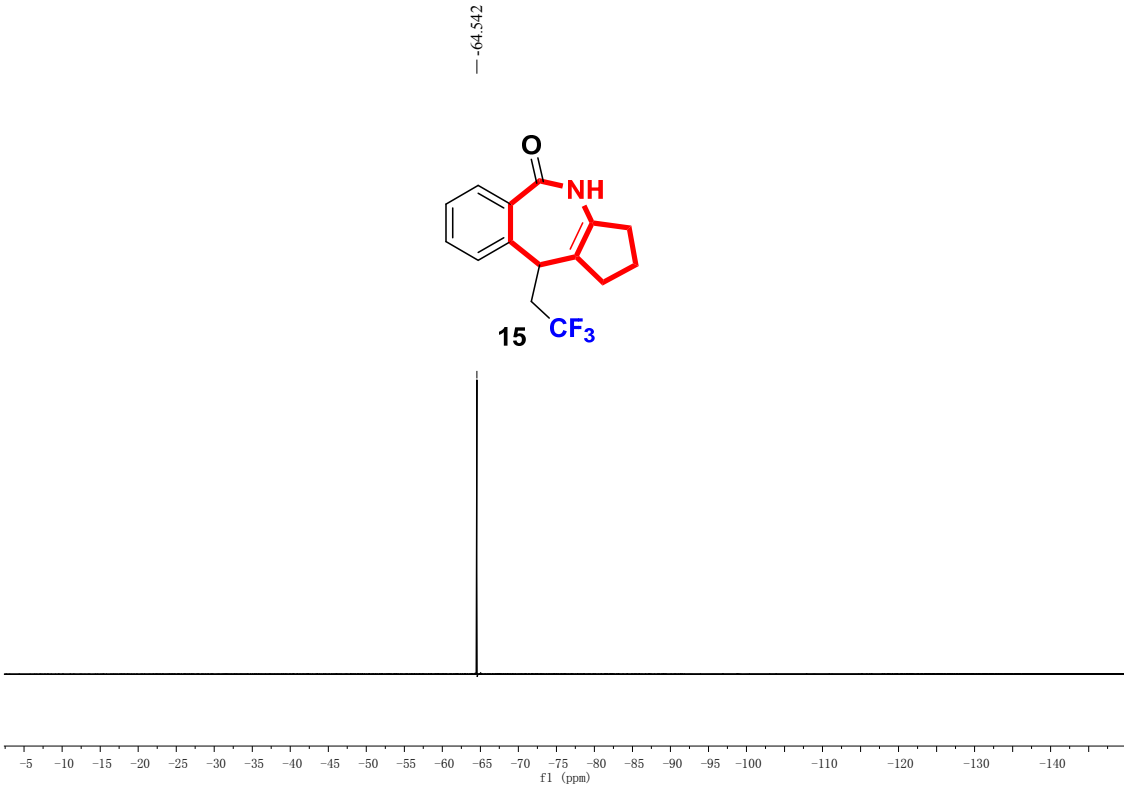

O
Ph
CF3
N
OH

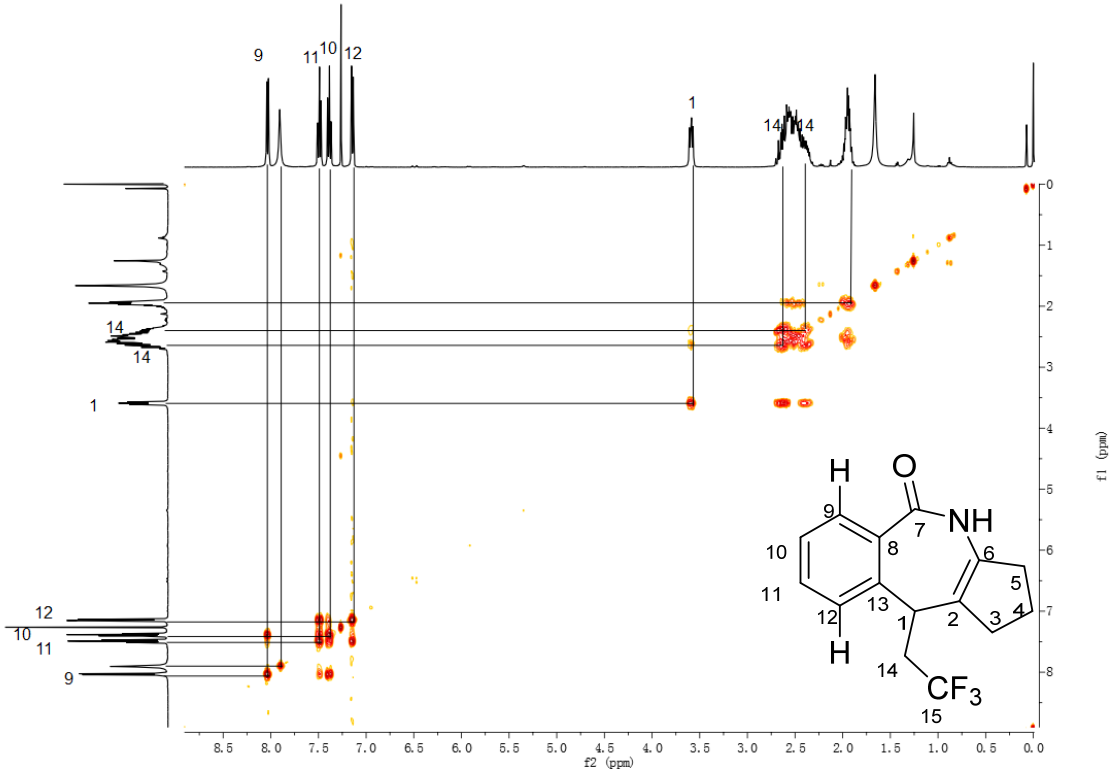
14

210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)

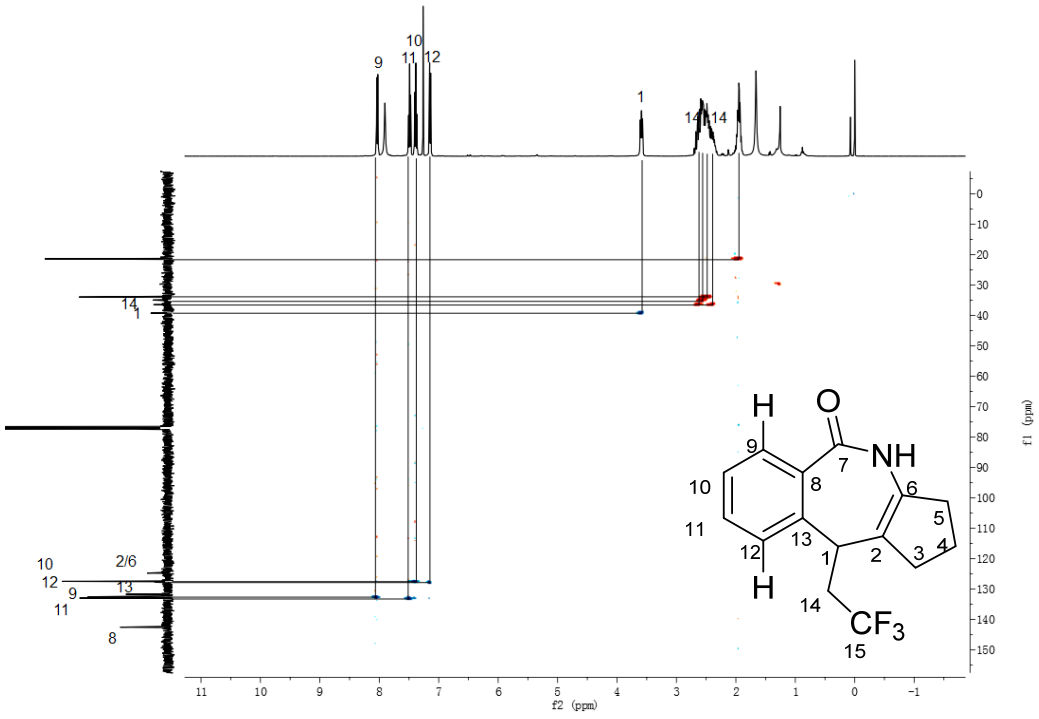

-63.632
O
Ph
CF3
N
OH
14
f1 (ppm)
8.044
8.041
8.025
8.022
7.906
7.511
7.508
7.492
7.489
7.474
7.470
7.407
7.404
7.387
7.385
7.369
7.366
7.153
7.135
3.608
3.592
3.586
3.571
2.674
2.652
2.648
2.637
2.626
2.615
2.612
2.600
2.589
2.576
2.570
2.563
2.550
2.544
2.531
2.525
2.509
2.503
2.494
2.487
2.477
2.466
2.456
2.448
2.426
2.410
1.976
1.971
1.961
1.954
1.950
1.941
1.931
1.925
1.920
O
NH
15
CF3
0.99
0.94
1.01
1.03
1.01
1.00
6.19
2.05
f1 (ppm)


168.953
142.519
132.963
132.535
131.681
131.502
127.769
127.457
124.733
39.202
39.175
36.479
36.213
34.953
33.954
21.384
O
NH
15
CF3
f1 (ppm)

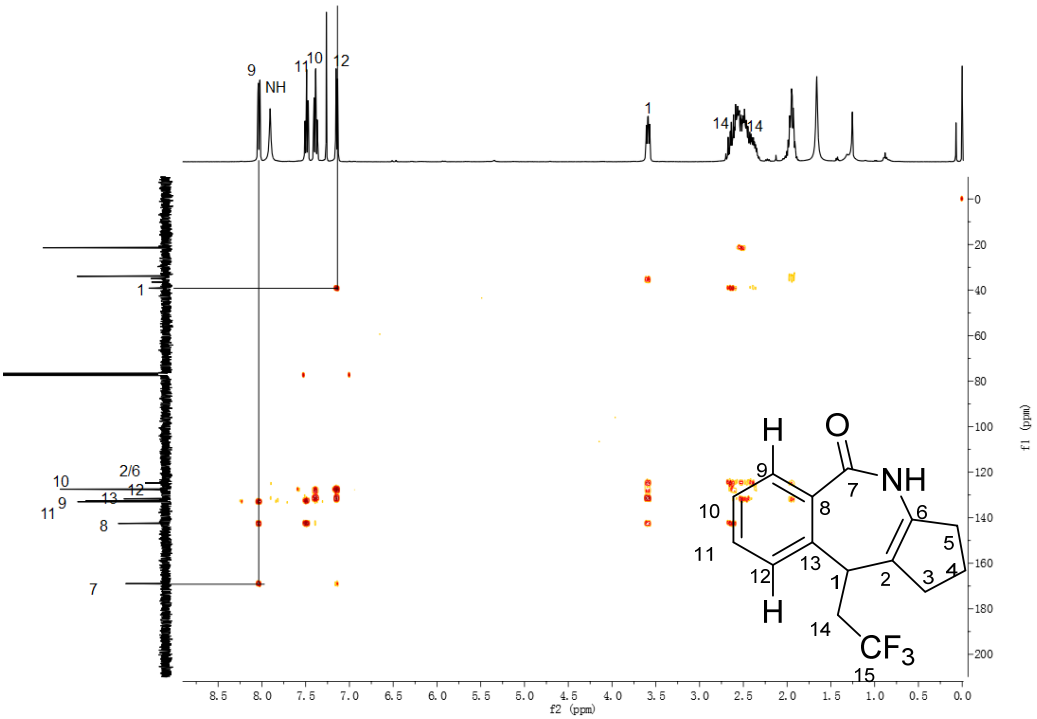

-64.542
O
NH
15
CF3
f1 (ppm)



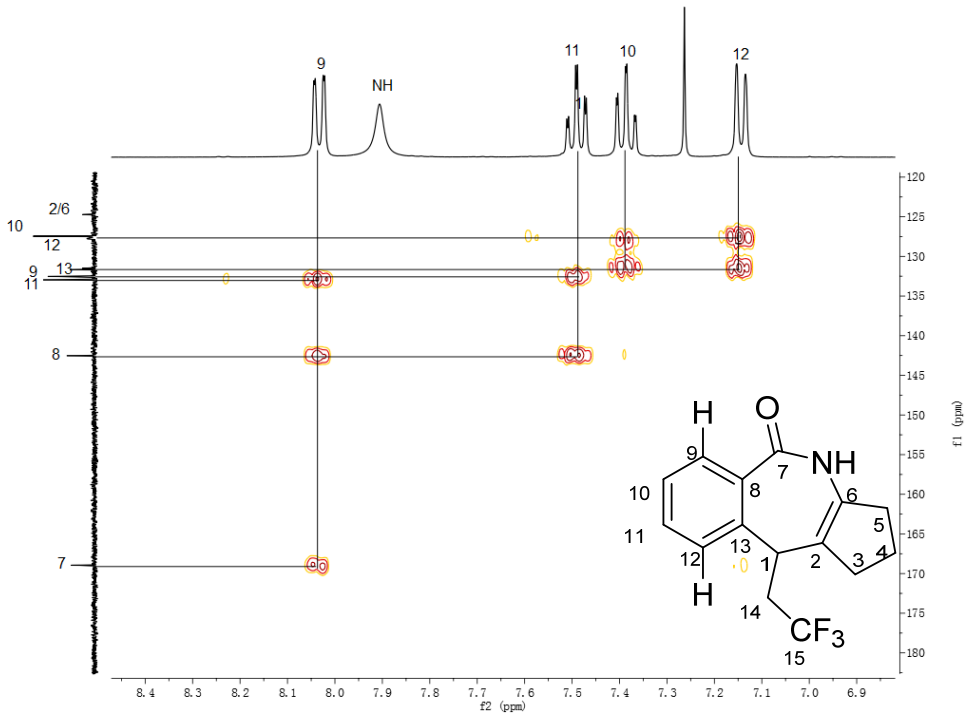
COSY of compound 15



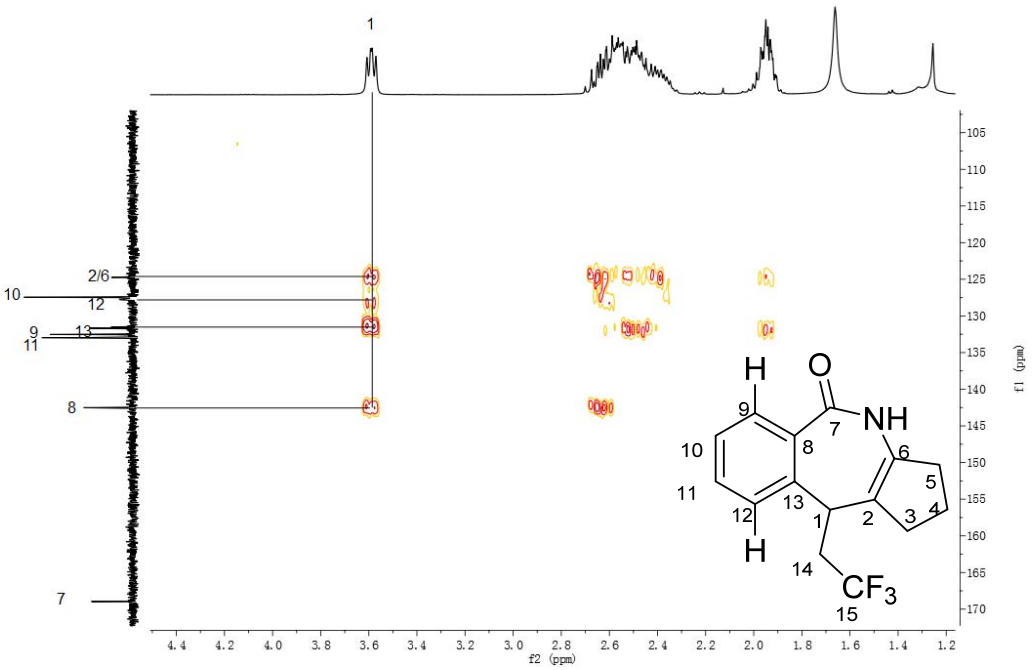
HSQC of compound 15



HMBC of compound 15



HMBC of compound 15



HMBC of compound 15