Supporting Information

Regioselective Intramolecular Markovnikov and Anti-Markovnikov Hydrofunctionalization of Alkenes via Photoredox Catalysis

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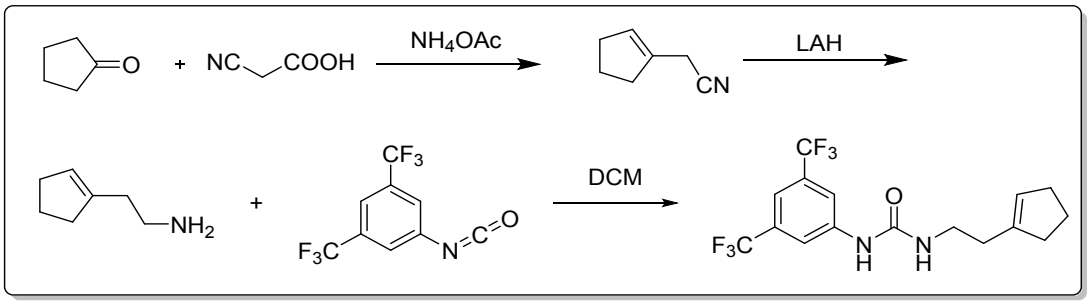
General Information

The commercial materials and photocatalyst were purchased from Adamas-beta®, Shanghai Energy® and Tianjin Heowns®. Solvents for conjugate addition reactions were treated by the standard methods. Reactions were powered by magnetic stirrers. Flash column chromatography was carried out on silica gel (300–400 mesh) using a forced flow of eluent. For TLC, silica gel plates were used and visualized by fluorescence quenching under UV light. All the NMR spectra were recorded on a Bruker NMR spectrometers. Chemical shifts (δ) for ^{1}H NMR (400 Hz), ^{13}C NMR (100 Hz) were given in ppm. ^{1}H NMR chemical shifts were recorded relative to $SiMe_4$ (δ 0.00). ^{13}C NMR chemical shifts were recorded relative to solvent resonance (CDCl3: δ 77.16, CD_3OD: δ 49.0, $(CD_3)_2CO$: δ 206.4, 29.7). Data were reported as follows: chemical shift, intergration, multiplicity (s = single, d = doublet, t = triplet, q = quartet, br = broad, m = multiplet) and coupling constants (Hz). High resolution mass spectra (HRMS) were recorded on a Bruker Daltonics maXis UHR-TOF MS. Melting points were determined on a SGW X-4 microscope melting point apparatus and were uncorrected. X-ray crystallography analysis was performed on a Bruker X8 APEX X-ray diffraction meter. High resolution mass spectra (HRMS) were recorded on a Bruker Daltonics maXis UHR-TOF MS. The blue light source (465nm) was provided by WATTECS WP-TEC-1020 parallel reactor.

Synthesis Procedure of Substrates

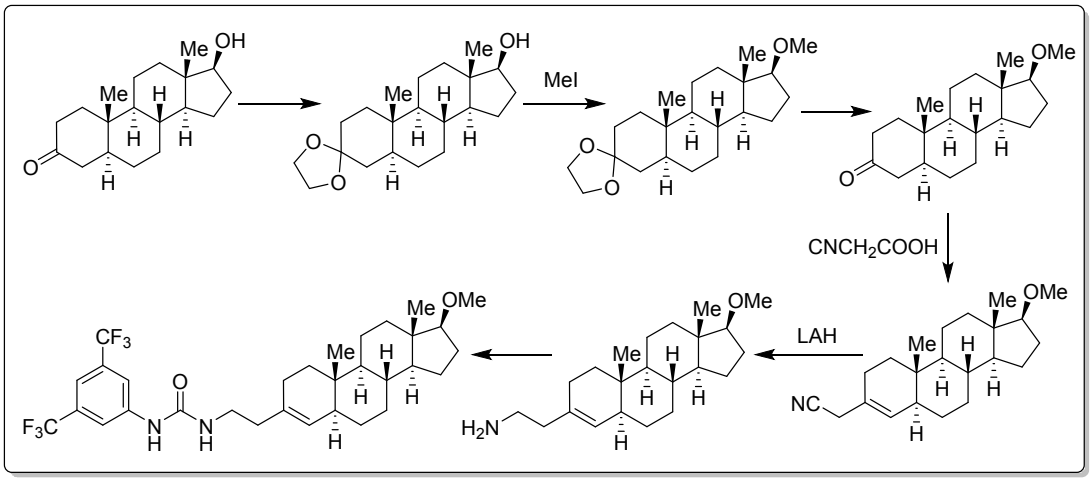
Typical Synthesis Procedure of Substrates (Procedure 1)



To a toluene solution of cyclopentanone (60 mmol), NH_4OAc (5 mmol) was added cyanoacetic acid (50 mmol). The mixture was heated under reflux for 16 h, incorporating a Dean-Stark Apparatus to remove water. Then the solvent was removed to give the crude nitrile, which was next purified in flash column chromatography on silica gel using ethyl acetate/petroleum ether (v/v, 1:10) as eluent to get nitrile. And the

nitrile was dissolved in THF and was added to a mixture of LAH (2 equiv.) in THF at 0 °C. The reaction mixture was stirred at room temperature for 2 h and quenched by slow addition of 1 M NaOH at 0 °C. The slurry was filtered through Celite and concentrated. To a solution of amine (1.1 mmol) in dichloromethane (15 mL), the 3,5-bis(trifluoromethyl)phenyl isocyanate (1 mmol) was added into the mixture at 0 °C, then the mixture was stirred for 10 min at room temperature. After that, the solvent was evaporated to dryness under reduced pressure and purified via flash column chromatography on silica gel using ethyl acetate/petroleum ether (v/v, 1:5) as eluent to obtained the corresponding compounds.

Synthesis Procedure of Substrates 1m (Procedure 2)

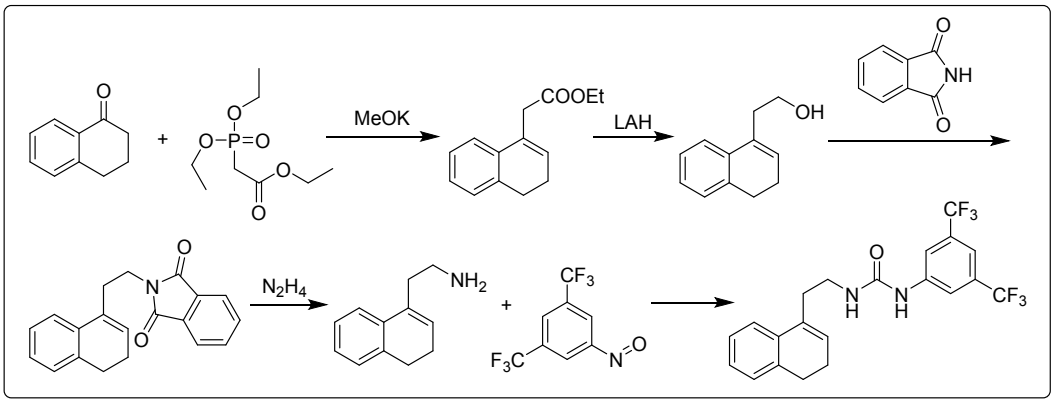


To a solution of Stanolone (1 equiv, 17.24 mmol) indry toluene (80 mL) were added ethylene glycol (120 equiv) and p-toluenesulfonic acid (0.05 equiv) under an argon atmosphere. The mixture was refluxed for 12 h using a Dean–Stark/water separator. The solution was quenched by the addition of saturated aqueous $NaHCO_3$ and concentrated under vacuum. The product was extracted with EA, washed with brine, dried over Na_2SO_4, and evaporated to dryness to obtained the corresponding ketal without further purification. The ketal were dissolved in anhydrouds THF (10 mL), and NaH (10 equiv) was added. The mixture was stirred at refluxing temperature for 0.5h then MeI (3 equiv) was added. The reaction mixture was stirred at refluxing temperature another 1h and then cooled to room temperature before addition of water and extraction with DCM. The organic phase was washed with brine, dried over Na_2SO_4. The solvent

was removed under reduced pressure and residue was dissolved in hydrochloric acid (30 mL, 2M). After stirred for 2 h at room temperature, $NaHCO_3$ was added and extracted with DCM. The organic phases were dried over Na_2SO_4 and solvent was evaporated under reduced pressure, the residue was purified via flash column chromatography on silica gel using ethyl acetate/petroleum ether (v/v, 1:10) as eluent to obtained the corresponding ketone.

To a toluene solution of ketone, NH_4OAc (0.1 equiv) was added cyanoacetic acid (1 equiv). The mixture was heated under reflux for 5 h, incorporating a Dean-Stark Apparatus to remove water. Then the solvent was removed to give the crude nitrile, which was next purified in flash column chromatography on silica gel using ethyl acetate/petroleum ether (v/v, 1:10) as eluent to get nitrile. And the nitrile was reduced to amine in the presence of $LiAlH_4$ (2 equiv). To a solution of amine (1.1 mmol) in dichloromethane (15 mL), the 3,5-bis(trifluoromethyl)phenyl isocyanate (1 mmol) was added into the mixture at 0 ^oC, then the mixture was stirred for 10 min at room temperature. After that, the solvent was evaporated to dryness under reduced pressure and purified via flash column chromatography on silica gel using ethyl acetate/petroleum ether (v/v, 1:5) as eluent to obtained the corresponding compounds.

Synthesis Procedure of Substrates (Procedure 3)



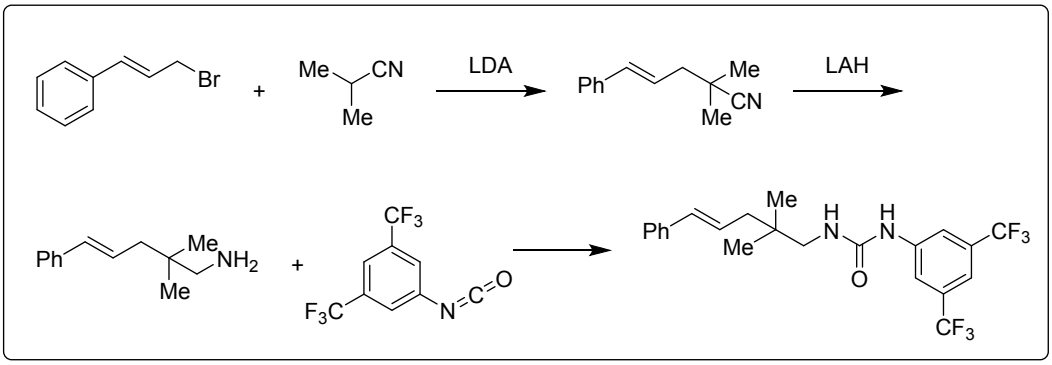
Potassium methoxide (68.0 mmol) was added to dryethanol (70 mL) under a nitrogen atmosphere. To the resulting solution was added triethyl phosphonoacetate (68.0mmol) in one portion. After stirring for 10 min α-tetralone (68.0mmol) was added within 5 min and the mixture was stirredfor 2.5 h at 80 °C. The reaction mixture was

cooled to roomtemperature, diluted with water (140 mL) and extracted with ethyl acetate. The organic phases were washed with water and dried over Na_2SO_4 and the solvent was evaporated under reduced pressure. The residue was purified via flash column chromatography on silica gel using ethyl acetate/petroleum ether (v/v, 1:5) as eluent to obtained the corresponding ester.

The ester was reduced to alcohol in the presence of $LiAlH_4$ (2 equiv). To a solution of alcohol (1 eq) in anhydrous THF under N_2 at 0 °C was added triphenylphosphine (1.3 eq) and phthalimide (1.5 eq). Then DEAD (1.3 eq) was added over 10 min at 0 °C. After one hour at 0 °C, the reaction mixture was warmed up to room temperature and stirred overnight. The resulting mixture was concentrated and the residue was purified by flash chromatography. The residue was dissolved in 20 mL EA and 20 mL KOH (1 M). The aqueous phase was extracted with EA (3 x 10 mL) and the combined organic layers were dried (Na_2SO_4). The solvent was removed under reduced pressure and a white powder was obtained. The white powder was dissolved in MeOH (40 mL) at room temperature and the hydrazine monohydrate (4 eq) was added. The mixture was stirred over-night and concentrated under reduced pressure. The mixture was washed with DCM (3 x 20 mL) and KOH (1 M, 20 mL), the combined organic layers were dried (Na_2SO_4). After removal of the solvent, amine was obtained as a pale yellow oil

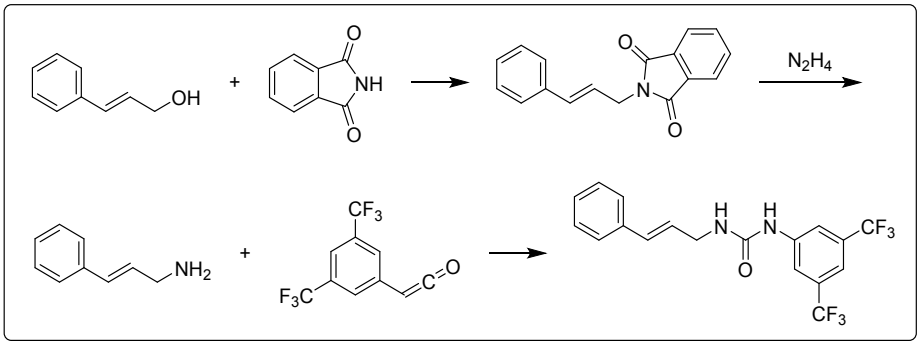
To a solution of amine (1.1 mmol) in dichloromethane (15 mL), the 3,5-bis(trifluoromethyl)phenyl isocyanate (1 mmol) was added into the mixture at 0 ^oC, then the mixture was stirred for 10 min at room temperature. After that, the solvent was evaporated to dryness under reduced pressure and purified via flash column chromatography on silica gel using ethyl acetate/petroleum ether (v/v, 1:5) as eluent to obtained the corresponding compounds.

Synthesis Procedure of Substrates (Procedure 4)



LDA (11 mmol, 1.1 equiv.) was added to the isobutyronitrile (10 mmol, 1 equiv.) at -78 °C in THF. The solution was stirred at 0 °C for 1 h, then the cinnamyl bromide (10 mmol, 1 equiv.) was added. The reaction mixture was then allowed to warm to room temperature and stirred for 2 h. The reaction was quenched with addition of water, extracted with EA, organic layers were dried (Na_2SO_4) and concentrated. The resultant oil was purified via flash column chromatography on silica gel to obtained the nitrile. And the nitrile was reduced to amine in the presence of $LiAlH_4$ (2 equiv). To a solution of amine (1.1 mmol) in dichloromethane (15 mL), the 3,5-bis(trifluoromethyl)phenyl isocyanate (1 mmol) was added into the mixture at 0 °C, then the mixture was stirred for 10 min at room temperature. After that, the solvent was evaporated to dryness under reduced pressure and purified via flash column chromatography on silica gel to obtained the corresponding compounds.

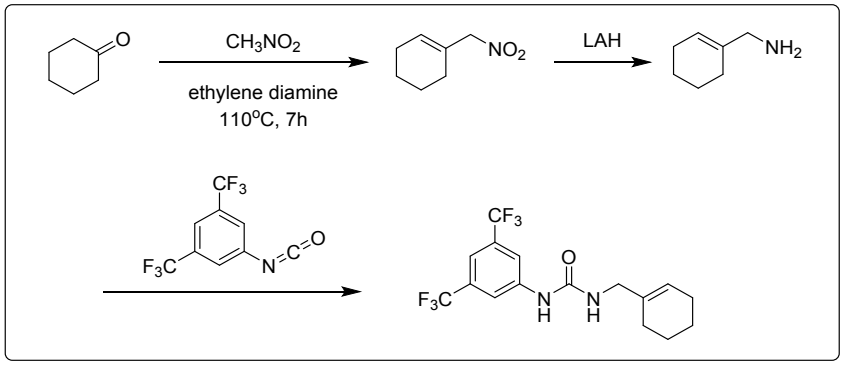
Synthesis Procedure of Substrates 1k (Procedure 5)



To a solution of cinnamyl alcohol (1 eq) in anhydrous THF under Ar at 0 °C was added triphenylphosphine (1.3 eq) and phthalimide (1.5 eq). Then DEAD (1.3 eq) was added over 10 min at 0 °C. After one hour at 0 °C, the reaction mixture was warmed up to room temperature and stirred overnight. The resulting mixture was concentrated and

the residue was purified by flash chromatography. The residue was dissolved in 20 mL EA and 20 mL KOH (1 M). The aqueous phase was extracted with EA (3 x 10 mL) and the combined organic layers were dried (Na_2SO_4). The solvent was removed under reduced pressure and a white powder was obtained. The white powder was dissolved in MeOH (40 mL) at room temperature and the hydrazine monohydrate (4 eq) was added. The mixture was stirred over-night and concentrated under reduced pressure. The mixture was washed with DCM (3 x 20 mL) and KOH (1 M, 20 mL), the combined organic layers were dried (Na_2SO_4). After removal of the solvent, amine was obtained as a pale yellow oil without further purification. To a solution of amine (1.1 mmol) in dichloromethane (15 mL), the 3,5-bis(trifluoromethyl)phenyl isocyanate (1 mmol) was added into the mixture at 0 °C, then the mixture was stirred for 10 min at room temperature. After that, the solvent was evaporated to dryness under reduced pressure and purified via flash column chromatography on silica gel using ethyl acetate/petroleum ether (v/v, 1:5) as eluent to obtained the corresponding compounds.

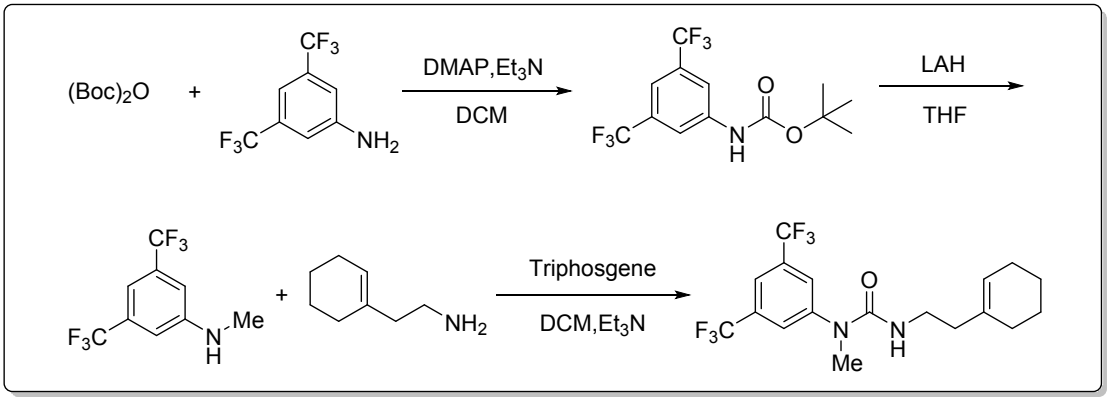
Synthesis Procedure of Substrates 1j (Procedure 6)



A solution of cyclohexanone (10 g, 1.0 equiv) and ethylene diamine (0.34 mL, 0.05 equiv) in nitromethane (70 mL) was heated to 110 °C for 10 h under N_2 atmosphere. After completion of reaction as monitored by TLC, the reaction mixture was cooled to room temperature and purified by column to afford nitro compound as a pale yellow oil. The nitro compound was reduced to amine in the presence of $LiAlH_4$ (2 equiv). To a solution of amine (1.1 mmol) in dichloromethane (15 mL), the isocyanate (1 mmol) was added into the mixture at 0 °C, then the mixture was stirred for 10 min at room temperature. After that, the solvent was evaporated to dryness under

reduced pressure and purified via flash column chromatography on silica gel to obtained the corresponding compounds.

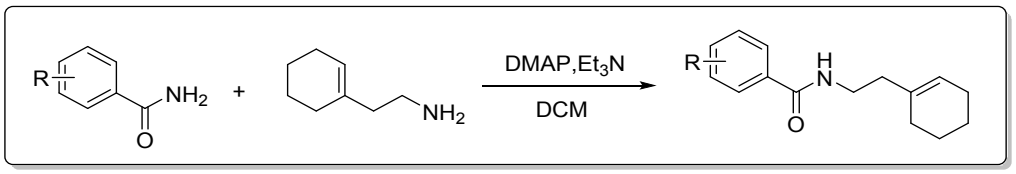
Synthesis Procedure of Substrates Protected by Methyl (Procedure 7)



To a solution of Di-tert-butyl dicarbonate (3.6 mmol) in toluene (20 mL) was added DMAP (0.3 mmol), then triethylamine (8.0 mmol) and amines (3.0 mmol) were sequentially added into the mixture. The mixture was stirred at 120 ^{o}C until the completion of the reaction determined by TLC analysis. The crude product was purified by flash chromatography on silica gel (eluent: PE/EtOAc from 5:1 to 2:1) affording to the corresponding compounds.

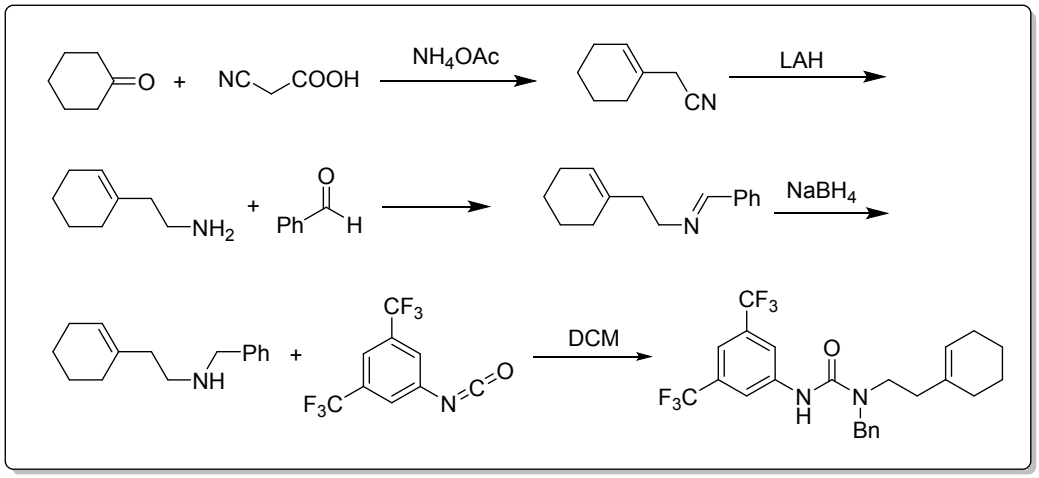
The compounds was dissolved in THF and was added to a mixture of LAH (2 equiv.) in THF at 0 °C. The reaction mixture was stirred at 70 ^{o}C for 2 h and quenched by slow addition of 1 M NaOH at 0 °C. The slurry was filtered through Celite and concentrated affording to the corresponding amine. To a solution of amine (0.85 mmol) in dichloromethane (15 mL), the triphosgene (0.285 mmol) were sequentially added into the mixture and stirred for 3 h. Then the 1-cyclohexene-1-ethanamine was added and stirred at room temperature for 10 h. After that, the solvent was evaporated to dryness under reduced pressure and purified via flash column chromatography on silica gel using ethyl acetate/petroleum ether (v/v, 2:1) as eluent to obtained the corresponding compounds.

Synthesis Procedure of Amide (Procedure 8)



To a solution of acylamide (1.1 mmol) in dichloromethane (15 mL) was added DMAP (0.1 mmol), then triethylamine (2.2 mmol) and amines (1.0 mmol) were sequentially added into the mixture. The mixture was stirred at room temperature until the completion of the reaction determined by TLC analysis. The crude product was purified by flash chromatography on silica gel (eluent: PE/EtOAc from 5:1 to 2:1) affording to the corresponding compounds.

Synthesis Procedure of Substrates Protected by Benzyl (Procedure 9)

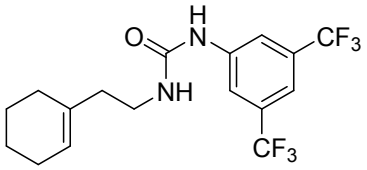


To a toluene solution of cyclopentanone (60 mmol), NH_4OAc (5 mmol) was added cyanoacetic acid (50 mmol). The mixture was heated under reflux for 16 h, incorporating a Dean-Stark Apparatus to remove water. Then the solvent was removed to give the crude nitrile, which was next purified in flash column chromatography on silica gel using ethyl acetate/petroleum ether (v/v, 1:10) as eluent to get nitrile. And the nitrile was reduced to amine in the presence of $LiAlH_4$ (2 equiv). To a solution of amine in methanol (30 mL), the benzaldehyde (1 equiv) was added into the mixture and stirred for 6 h at room temperature. The sodium borohydride (4 equiv) was added slowly and the mixture was heated at 60 °C until the imine was disappeared determined by TLC. The volatile materials were evaporated under vacuum and amine was purified by flash

column chromatography. To a solution of amine (1.1 mmol) in dichloromethane (15 mL), the 3,5-bis(trifluoromethyl)phenyl isocyanate (1 mmol) was added into the mixture at 0 °C, then the mixture was stirred for 10 min at room temperature. After that, the solvent was evaporated to dryness under reduced pressure and purified via flash column chromatography on silica gel using ethyl acetate/petroleum ether (v/v, 1:5) as eluent to obtained the corresponding compounds.

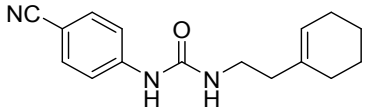
Characterization Data for The Substrates

1-(3,5-bis(trifluoromethyl)phenyl)-3-(2-(cyclohex-1-en-1-yl)ethyl)urea(1a)



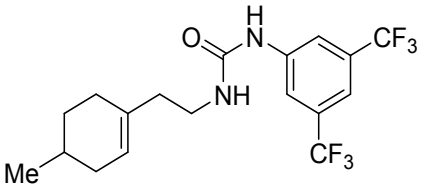
The compound was prepared according to the **Procedure 1**. White solid; 95% yield, 361 mg; m.p. 166-168 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (s, 2H), 7.48 (s, 1H), 6.91 (s, 1H), 5.49 (s, 1H), 4.86 (s, 1H), 3.38-3.34 (m, 2H), 2.20-2.16 (d, *J* = 8 Hz, 2H), 1.99-1.92 (m, 4H), 1.64-1.53 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.47, 140.46, 134.40, 132.73-131.73 (q, *J* = 33 Hz, CF_3), 127.21-119.07 (q, J = 271 Hz, CF_3), 126.48, 124.04, 118.58, 115.95, 37.98, 37.82, 27.78, 25.24, 22.75, 22.30; ^{19}F NMR (376 MHz, $CDCl_3$) δ 63.64; HRMS (ESI) *m/z* calcd for $C_{17}H_{18}F_6N_2NaO^+$ [$(M+Na)^+$]: 403.1216; found: 403.1230.

1-(4-cyanophenyl)-3-(2-(cyclohex-1-en-1-yl)ethyl)urea(1b)



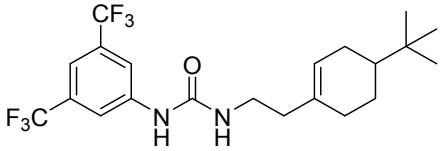
The compound was prepared according to the **Procedure 1**. White solid; 92% yield, 247 mg; m.p. 170-172 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.46 (s, 1H), 7.69-7.67 (d, *J* = 8 Hz, 2H), 7.62-7.60 (d, *J* = 8 Hz, 2H), 5.88 (s, 1H), 5.45 (s, 1H), 3.34-3.29 (q, *J* = 6Hz, 2H), 2.16-2.13 (t, *J* = 6 Hz, 2H), 1.96-1.95 (m, 4H), 1.64-1.58(m, 2H), 1.56-1.50(m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.51, 145.09, 134.93, 132.94, 122.58, 119.00, 117.71, 103.62, 38.19, 37.86, 27.75, 24.99, 22.73, 22.21; HRMS (ESI) *m/z* calcd for $C_{16}H_{19}N_3NaO^+$ [$(M+Na)^+$]: 292.1420; found: 292.1420.

1-(3,5-bis(trifluoromethyl)phenyl)-3-(2-(4-methylcyclohex-1-en-1-yl)ethyl)urea(1c)



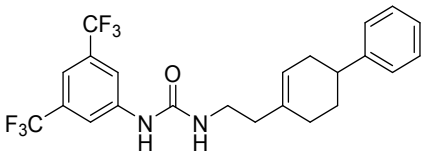
The compound was prepared according to the **Procedure 1**. White solid; 95% yield, 374 mg; m.p. 132-134 °C; ^{1}H NMR (400 MHz, $(CD_3)_2CO$) δ 8.64 (s, 1H), 8.15 (s, 2H), 7.52 (s, 1H), 5.98 (s, 1H), 5.44 (s, 1H), 3.36-3.31 (m, 2H), 2.19-2.16 (d, J = 6 Hz, 2H), 2.07-2.03 (m, 3H), 1.73-1.69 (m, 1H), 1.60-1.57 (m, 2H), 1.24-1.16 (m, 1H), 0.93-0.92 (d, J = 4 Hz, 3H); ^{13}C NMR (100 MHz, $(CD_3)_2CO$) δ154.67, 142.81, 134.58, 131.92-130.94 (q, *J* = 33 Hz, CF_3), 127.68-119.57 (q, J = 271 Hz, CF_3), 122.27, 122.20, 117.44, 113.75, 37.97, 37.84, 33.67, 31.01, 28.26, 27.86, 21.13; ^{19}F NMR (376 MHz, $(CD_3)_2CO$) δ 63.64; HRMS (ESI) *m/z* calcd for $C_{18}H_{20}F_6N_2NaO+$ $[(M+Na)^+]$: 417.1372; found: 417.1385.

1-(3,5-bis(trifluoromethyl)phenyl)-3-(2-(4-(tert-butyl)cyclohex-1-en-1-yl)ethyl)urea(1d)



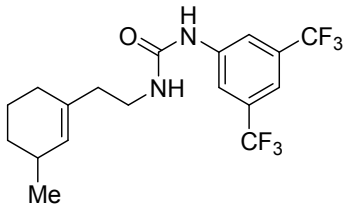
The compound was prepared according to the **Procedure 1**. White solid; 96% yield, 418 mg; m.p. 125-127 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.80 (s, 1H),8.12 (s, 2H), 7.48 (s, 1H), 6.14-6.11 (t, *J* = 6 Hz, 1H), 5.45 (m, 1H), 3.38-3.34 (q, *J* = 5 Hz, 2H), 2.20-2.17 (t, *J* = 6 Hz, 2H), 2.07-1.95 (m, 3H), 1.82-1.70 (m, 2H), 1.24-1.09 (m, 2H), 0.83 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.00, 142.61, 134.50, 131.99-131.01 (q, *J* = 33 Hz, CF_3), 127.62-119.51 (q, *J* = 271 Hz, CF_3), 122.95, 117.53, 113.79, 43.96, 38.07, 37.66, 31.73, 29.29, 26.65, 26.59, 24.10; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.61; HRMS (ESI) *m/z* calcd for $C_{21}H_{26}F_6N_2NaO^+$ $[(M+Na)^+]$: 459.1842; found: 459.1842.

1-(3,5-bis(trifluoromethyl)phenyl)-3-(2-(1,2,3,6-tetrahydro-[1,1'-biphenyl]-4-yl)ethyl)urea(1e)



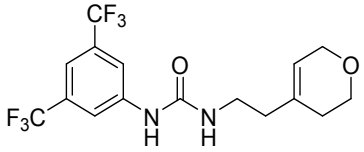
The compound was prepared according to the **Procedure 1**. White solid;96% yield, 438 mg; m.p. 166-168 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ7.86 (s, 2H), 7.49 (s, 1H), 7.32-7.28 (d, *J* = 12 Hz, 2H), 7.22-7.19 (m, 3H), 6.87 (s, 1H), 5.55 (s, 1H), 4.86-4.83 (t, *J* = 6 Hz, 1H), 3.43-3.38 (t, *J* = 10 Hz, 2H), 2.78-2.72 (m, 2H), 2.32-2.13 (m, 5H), 2.07-1.96 (m, 2H), 1.82-1.72 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ154.45, 146.62, 140.47, 134.42, 132.78-131.79 (q, *J* = 33 Hz, CF_3), 128.41, 127.21-119.08 (q, *J* = 271 Hz, CF_3), 126.81, 126.11, 123.58, 118.54, 116.02, 39.81, 38.15, 37.44, 33.33, 29.77, 28.44; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.09; HRMS (ESI) *m/z* calcd for $C_{23}H_{22}F_6N_2NaO^+$ $[(M+Na)^+]$: 479.1529; found: 479.1543.

1-(3,5-bis(trifluoromethyl)phenyl)-3-(2-(3-methylcyclohex-1-en-1-yl)ethyl)urea(1f)



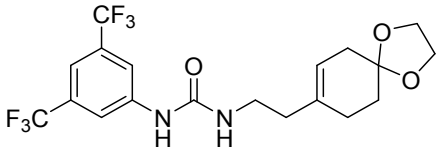
The compound was prepared according to the **Procedure 1**. White solid; 97% yield, 382 mg; m.p. 140-142 °C; ^{1}H NMR (400 MHz, $(CD_3)_2CO$) δ 8.73 (s, 1H), 8.14 (s, 2H), 7.50 (s, 1H), 6.06 (s, 1H), 5.44-5.32 (m, 1H), 3.37-3.32 (m, 2H), 2.19-2.15 (t, *J* = 8 Hz, 2H), 2.01-1.93 (m, 3H), 1.73-1.70 (m, 1H), 1.63-1.60 (m, 2H), 1.13-1.05 (m, 1H), 0.94-0.93 (t, *J* = 4 Hz, 3H); ^{13}C NMR (100 MHz, $(CD_3)_2CO$) δ154.86, 142.69, 134.39, 134.20, 131.96-130.98 (q, *J* = 33 Hz, CF_3), 129.15, 127.64-119.53 (q, *J* = 271 Hz, CF_3), 122.24, 117.48, 113.74, 38.08, 37.98, 37.94, 36.40, 31.00, 30.44, 30.18, 29.54, 28.72, 27.77, 25.06, 21.58, 21.35, 21.27; ^{19}F NMR (376 MHz, $(CD_3)_2CO$) δ -63.66; HRMS (ESI) *m/z* calcd for $C_{18}H_{20}F_6N_2NaO+$ [$(M+Na)^+$]: 417.1357; found: 417.1385.

1-(3,5-bis(trifluoromethyl)phenyl)-3-(2-(3,6-dihydro-2H-pyran-4-yl)ethyl)urea(1g)



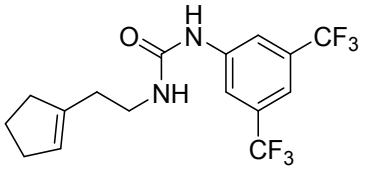
The compound was prepared according to the **Procedure 1**. White solid;96% yield, 367 mg; m.p. 130-132 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.42 (s, 1H),7.73 (s, 2H), 7.40 (s, 1H), 5.84 (d, *J* = 12 Hz, 2H), 5.46 (s, 1H), 4.08 (t, *J* = 6 Hz, 1H), 3.78-3.75 (t, *J* = 6 Hz, 2H), 3.40-3.35 (m, 2H), 2.22-2.19 (t, *J* = 6 Hz, 2H), 2.02 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.80, 140.61, 132.63-131.64 (q, *J* = 33 Hz, CF_3), 132.42, 127.15-119.02 (q, *J* = 271 Hz, CF_3), 122.09, 118.37, 115.71, 65.29, 64.16, 37.64, 37.05, 28.03; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.33; HRMS (ESI) *m/z* calcd for $C_{16}H_{16}F_6N_2NaO_2^+$ [$(M+Na)^+$]: 405.1008; found: 405.1008.

1-(2-(1,4-dioxaspiro[4.5]dec-7-en-8-yl)ethyl)-3-(3,5-bis(trifluoromethyl)phenyl) urea(1h)



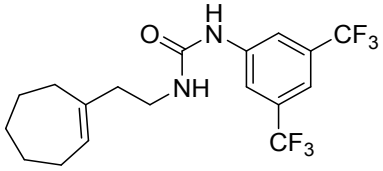
The compound was prepared according to the **Procedure 1**. White solid;96% yield, 438 mg; m.p. 117-119 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.70 (s, 1H),8.14 (s, 2H), 7.51 (s, 1H), 6.07-6.04 (t, *J* = 6 Hz, 1H), 5.67-5.35 (m, 1H), 3.90 (s, 3H), 3.39-3.33 (q, *J* = 8 Hz, 2H), 2.32-1.97 (m, 7H), 1.71-1.68 (t, *J* = 6 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ154.83, 142.67, 134.42, 131.94-130.96 (q, *J* = 33 Hz, CF_3), 127.65-119.54 (q, *J* = 271 Hz, CF_3), 120.53, 120.21, 117.51, 113.82, 107.37, 38.02, 37.22, 35.55, 30.96, 27.06, 26.47; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.64; HRMS (ESI) *m/z* calcd for $C_{19}H_{20}F_6N_2NaO_3^+$ [$(M+Na)^+$]: 461.1270; found: 461.1285.

1-(3,5-bis(trifluoromethyl)phenyl)-3-(2-(cyclopent-1-en-1-yl)ethyl)urea(1i)



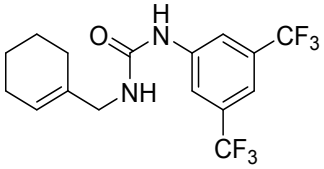
The compound was prepared according to the **Procedure 1**. White solid; 97% yield, 364 mg; m.p. 119-121 °C; ^{1}H NMR (400 MHz, $(CD_3)_2CO$) δ 8.69 (s, 1H), 8.15 (s, 2H), 7.51 (s, 1H), 6.10 (s, 1H), 5.42 (s, 1H), 3.41-3.36 (q, *J* = 6 Hz, 2H), 2.34-2.25 (m, 2H), 1.87-1.79 (m, 2H); ^{13}C NMR (100 MHz, $(CD_3)_2CO$) δ 154.78, 142.73, 141.72, 131.93-130.95 (q, *J* = 33 Hz, CF_3), 127.66-119.55 (q, *J* = 271 Hz, CF_3), 124.71, 117.48, 113.72, 38.08, 34.58, 32.15, 31.37, 23.06; ^{19}F NMR (376 MHz, $(CD_3)_2CO$) δ -63.67; HRMS (ESI) *m/z* calcd for $C_{16}H_{16}F_6N_2NaO^+$ [$(M+Na)^+$]: 389.1101; found: 389.1059.

1-(3,5-bis(trifluoromethyl)phenyl)-3-(2-(cyclopent-1-en-1-yl)ethyl)urea(1j)



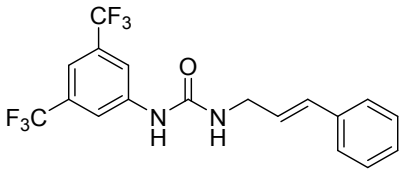
The compound was prepared according to the **Procedure 1**. White solid; 97% yield, 382 mg; m.p. 159-161 °C; ^{1}H NMR (400 MHz, $(CD_3)_2CO$) δ 8.66 (s, 1H), 8.15 (s, 2H), 7.52 (s, 1H), 5.96 (s, 1H), 5.65-5.61 (t, *J* = 8 Hz, 1H), 3.34-3.29 (q, *J* = 6 Hz, 1H), 2.22-2.19 (t, *J* = 6 Hz, 2H), 2.18-2.15 (m, 2H), 2.09-2.05 (m, 2H), 1.75-1.70 (m, 2H), 1.49-1.42 (m, 4H); ^{13}C NMR (100 MHz, $(CD_3)_2CO$) δ 154.65, 142.79, 141.82, 131.92-130.95 (q, *J* = 33 Hz, CF_3), 127.95, 127.67-119.57 (q, *J* = 271 Hz, CF_3), 117.40, 113.73, 40.33, 38.15, 32.45, 32.17, 28.27, 28.07, 27.06, 26.61, 26.17; ^{19}F NMR (376 MHz, $(CD_3)_2CO$) δ -63.65; HRMS (ESI) *m/z* calcd for $C_{18}H_{20}F_6N_2NaO$+ [$(M+Na)^+$]: 417.1362; found: 417.1385.

1-(3,5-bis(trifluoromethyl)phenyl)-3-(cyclohex-1-en-1-ylmethyl)urea(1k)



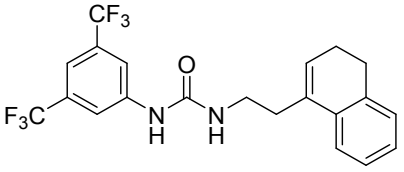
The compound was prepared according to the **Procedure 6**. White solid; 95% yield, 347 mg; m.p. 149-151 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.63 (s, 1H), 8.18 (s, 2H), 7.53 (s, 1H), 6.17 (s, 1H), 5.60 (s, 1H), 3.75-3.74 (d, *J* = 4 Hz, 2H), 1.99-1.96 (m, 4H), 1.64-1.52 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.73, 142.76, 135.33, 131.93-130.95 (q, *J* = 33 Hz, CF_3), 127.67-119.56 (q, *J* = 271 Hz, CF_3), 121.72, 117.48, 113.80, 45.39, 26.09, 24.65, 22.43, 22.24; ^{19}F NMR (376 MHz, $CDCl_3$) δ 63.65; HRMS (ESI) *m/z* calcd for $C_{16}H_{16}F_6N_2NaO^+$ [$(M+Na)^+$]: 389.1059; found: 389.1033.

1-(3,5-bis(trifluoromethyl)phenyl)-3-cinnamylurea(1l)



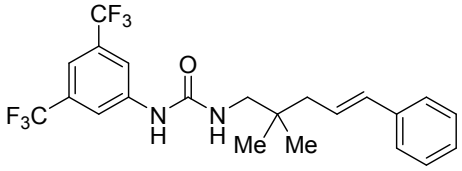
The compound was prepared according to the **Procedure 5**. White solid;96% yield, 372 mg; m.p. 185-187 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.35 (s, 1H),8.13 (s, 2H), 7.55 (m, 2H), 7.44-7.43 (d, *J* = 4 Hz, 2H), 7.35-7.31 (t, *J* = 8 Hz, 2H), 7.26-7.22 (t, *J* = 8 Hz, 2H), 6.79-6.76 (t, *J* = 6 Hz, 1H), 6.56-6.52 (d, *J* = 16 Hz, 1H), 6.37-6.34 (d, *J* = 6 Hz, 1H), 3.95-3.93 (t, *J* = 4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.15, 143.06, 137.03, 131.55-130.58 (q, *J* = 33 Hz, CF_3), 130.39, 129.06, 128.04, 127.89-119.77 (q, *J* = 271 Hz, CF_3), 127.84, 126.59, 117.77, 113.87, 41.60; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.84; HRMS (ESI) *m/z* calcd for $C_{18}H_{14}F_6N_2NaO^+$ [(M+Na)$^+$]: 411.0903; found: 411.0922.

1-(3,5-bis(trifluoromethyl)phenyl)-3-(2-(3,4-dihydronaphthalen-1-yl)ethyl)urea(1m)



The compound was prepared according to the **Procedure 3**. White solid;96% yield, 411 mg; m.p. 137-139 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.63 (s, 1H),8.17 (s, 2H), 7.53 (s, 1H), 7.42-7.40 (d, *J* = 8 Hz, 1H), 7.23-7.12 (m, 3H), 6.18-6.15 (t, *J* = 6 Hz, 1H), 5.98-5.96 (t, *J* = 4 Hz, 1H), 5.90-5.88 (t, *J* = 4 Hz, 1H), 3.47-3.41 (d, *J* = 8 Hz, 2H), 2.75-2.70 (m, 2H), 2.25-2.20 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ154.76, 142.78, 136.55, 134.32, 133.96, 131.94-130.97 (q, *J* = 33 Hz, CF_3), 127.69-119.58 (q, *J* = 271 Hz, CF_3), 127.52, 126.76, 126.39, 122.66, 117.50, 113.79, 39.08, 33.16, 27.99, 22.88; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.58; HRMS (ESI) *m/z* calcd for $C_{21}H_{18}F_6N_2NaO^+$ [(M+Na)$^+$]: 451.1216; found: 451.1234.

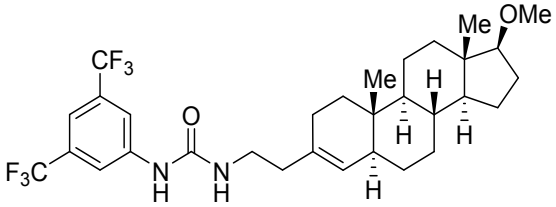
1-(3,5-bis(trifluoromethyl)phenyl)-3-(2,2-dimethyl-5-phenylpent-4-en-1-yl) urea(1n)



The compound was prepared according to the **Gp 4**. White solid;96% yield, 426 mg; m.p. 125-127 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.12 (s, 1H),7.66 (s, 2H), 7.37 (s, 1H), 7.28-7.22 (m, 4H), 7.18-7.12 (m, 2H), 6.34-6.30 (d, *J* = 16 Hz, 1H), 6.19-6.15 (t, *J* = 8 Hz, 1H), 5.90-5.88 (t, *J* = 4 Hz, 1H), 3.12-3.11 (d, *J* = 4 Hz, 2H), 2.09-2.07 (d, *J* = 8 Hz, 2H), 0.89 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.09, 140.31, 137.26, 132.96, 132.67-131.67 (q, *J* = 33 Hz, CF_3), 128.51, 127.22, 127.10-118.96 (q, *J* = 271 Hz, CF_3), 125.91, 118.55, 115.88, 50.15, 43.47, 35.37, 24.75; ^{19}F NMR (376 MHz, $CDCl_3$) δ -

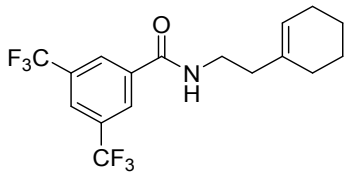
63.30; HRMS (ESI) *m/z* calcd for $C_{22}H_{22}F_6N_2NaO^+$ [$(M+Na)^+$]: 467.1529; found: 467.1545.

1-(3,5-bis(trifluoromethyl)phenyl)-3-(2-((5S,8R,9S,10R,13S,14S,17S)-17-methoxy-10,13-dimethyl-2,5,6,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1H-cyclopenta[a]phenanthren-3-yl)ethyl)urea(1o)



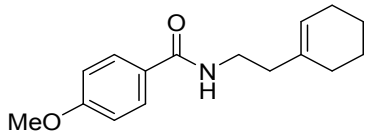
The compound was prepared according to the **Procedure 2**. White solid;93% yield, 544 mg; m.p. 170-172 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.31 (s, 1H),7.75 (s, 2H), 7.40 (s, 1H), 5.81-5.60 (br, 1H), 5.33-5.32 (d, *J* = 4 Hz, 1H), 3.36 (s, 3H), 3.27-3.23 (t, *J* = 8 Hz, 2H), 2.14-2.11 (t, *J* = 6 Hz, 1H), 2.03-1.98 (m, 1H), 1.91-1.88 (m, 2H), 1.75-1.53 (m, 5H), 1.47-1.40 (m, 3H), 1.37-1.10 (m, 8H), 0.97-0.83 (m, 3H), 0.74 (s, 3H), 0.66 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ155.65, 140.67, 132.87, 132.65-131.66 (q, *J* = 33 Hz, CF_3), 127.16-119.14 (q, *J* = 271 Hz, CF_3), 122.55, 118.97, 118.23, 115.62, 57.80, 54.08, 51.23, 42.85, 41.61, 39.97, 38.17, 37.27, 36.04, 35.33, 34.37, 32.75, 31.22, 28.43, 27.64, 26.92, 23.23, 20.69, 11.66, 11.55; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.25; HRMS (ESI) *m/z* calcd for $C_{31}H_{40}F_6N_2NaO_2^+$ [$(M+Na)^+$]: 609.2886; found: 609.2877.

N-(2-(cyclohex-1-en-1-yl)ethyl)-3,5-bis(trifluoromethyl)benzamide(1p)



The compound was prepared according to the **Procedure 8**. White solid; 90% yield, 985 mg; m.p. 145-147 °C; ^{1}H NMR (400 MHz, $(CD_3)_2CO$) δ 8.46 (s, 2H), 8.22 (s, 1H), 8.20 (s, 1H), 5.48 (s, 1H), 3.57-3.52 (q, *J* = 6.7 Hz, 2H), 2.29-2.25 (t, *J* = 8 Hz, 2H), 2.02-1.96 (m, 4H), 1.65-1.60 (m, 2H), 1.57-1.51 (m, 2H); ^{13}C NMR (100 MHz, $(CD_3)_2CO$) δ 163.58, 137.64, 134.89, 131.85-130.85 (q, *J* = 33 Hz, CF_3), 127.76, 127.40-119.29 (q, *J* = 271 Hz, CF_3), 124.70, 122.64, 38.41, 37.59, 27.81, 24.97, 22.73, 22.15; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.18; HRMS (ESI) *m/z* calcd for $C_{17}H_{18}F_6NO^+$ [$(M+H)^+$]: 366.1287; found: 366.1266.

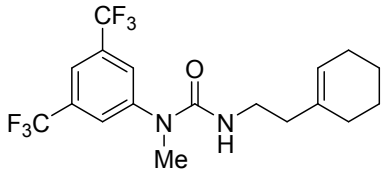
N-(2-(cyclohex-1-en-1-yl)ethyl)-4-methoxybenzamide(1q)



The compound was prepared according to the **Procedure 8**. White solid;98% yield, 450 mg; m.p. 134-136 °C; ^{1}H NMR (400 MHz, $(CD_3)_2CO$) δ 7.88-7.86 (d, *J* = 8 Hz, 2H), 7.61 (s, 1H), 6.97-6.95 (d, *J* = 8 Hz, 2H), 5.46 (s, 1H), 3.84 (s, 3H), 3.50-3.45 (q, *J* =

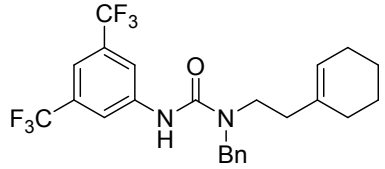
6.7 Hz, 2H), 2.25-2.21 (t, *J* = 8 Hz, 2H), 1.99-1.96 (m, 4H), 1.64-1.59 (m, 2H), 1.56-1.52 (m, 2H); ^{13}C NMR (100 MHz, $(CD_3)_2CO$) δ 166.02, 161.96, 135.25, 128.80, 127.64, 122.31, 113.36, 54.86, 38.09, 37.95, 27.94, 25.03, 22.80, 22.25; HRMS (ESI) *m/z* calcd for $C16H_{22}NO_2^+$ [$(M+H)^+$]: 260.1645; found: 260.1658.

1-(3,5-bis(trifluoromethyl)phenyl)-3-(2-(cyclohex-1-en-1-yl)ethyl)-1-methylurea



The compound was prepared according to the **Procedure 7**. White solid;95% yield, 107 mg; m.p. 157-159 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (s, 3H),5.31 (s, 1H), 4.42-4.40 (t, *J* = 4 Hz, 1H), 3.32-3.27 (m, 5H), 2.12-2.08 (t, *J* = 8 Hz, 2H), 1.86-1.85 (m, 4H), 1.57-1.53 (m, 2H), 1.49-1.45 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.08, 145.50, 134.77, 133.51-132.51 (q, *J* = 33 Hz, CF_3), 126.86-118.75 (q, *J* = 271 Hz, CF_3), 126.58, 123.81, 119.69, 38.32, 37.76, 36.89, 27.56, 25.01, 22.69, 22.21; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.06; HRMS (ESI) *m/z* calcd for $C_{18}H_{21}F_6N_2O^+$ [$(M+H)^+$]: 395.1553; found: 395.1577.

1-benzyl-3-(3,5-bis(trifluoromethyl)phenyl)-1-(2-(cyclohex-1-en-1-yl)ethyl)urea



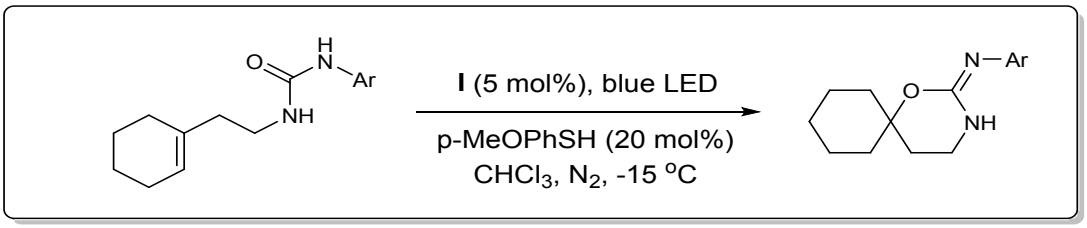
The product was prepared according to the **Procedure 9**. White solid;98% yield, 460 mg; m.p. 137-139 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.78 (s, 2H),7.48 (s, 1H), 7.41-7.38 (m, 2H), 7.35-7.31 (m, 3H), 6.70 (s, 1H), 5.56 (s, 1H), 4.59 (s, 2H), 3.50-3.46 (t, *J* = 8 Hz, 2H), 2.28-2.24 (t, *J* = 8 Hz, 2H), 2.02-1.98 (m, 2H), 1.65-1.60 (m, 2H), 1.57-1.53 (m, 2H), 0.90-0.83 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.75, 140.72, 136.86, 135.11, 132.58-131.58 (q, *J* = 33 Hz, CF_3), 129.14, 128.03, 127.26-119.04 (q, *J* = 271 Hz, CF_3), 127.12, 124.20, 115.98, 50.75, 47.19, 36.59, 28.81, 25.28, 22.83, 22.14; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.02; HRMS (ESI) *m/z* calcd for $C_{24}H_{24}F_6N_2NaO^+$ [$(M+Na)^+$]: 493.1685; found: 493.1673.

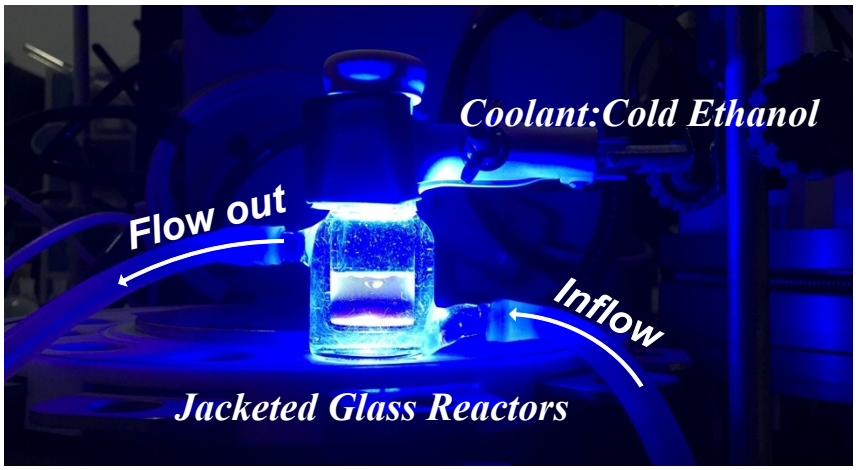
Procedure of Visible-Light Photoredox Catalysis

Synthesis Procedure of Photoredox Catalysis (PC 1)

To a 10 mL vial was added substrate (0.1 mmol) and chloroform (2 mL), then the catalyst (5 mol%) and 4-(trifluoromethylthio)phenol (20 mol%) was added into the mixture. The system was degassing by cyclic freezing/thawing method. Then the mixture was stirred at room temperature utilizing blue LED until the completion of the reaction determined by TLC analysis. The crude product was purified by flash chromatography on silica gel (eluent: PE/EtOAc from 10:1 to 5:1) affording to the compounds.

Synthesis Procedure B of Photoredox Catalysis (PC 2)

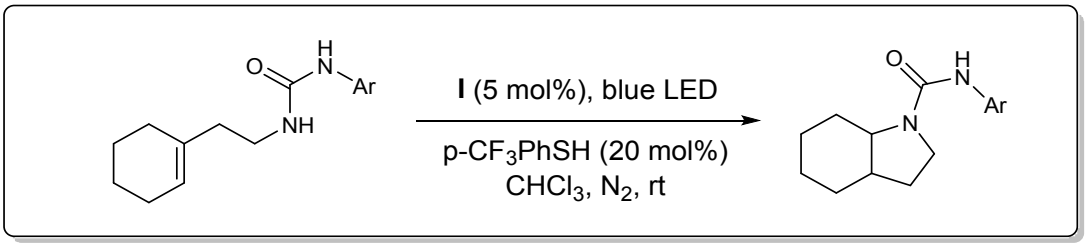


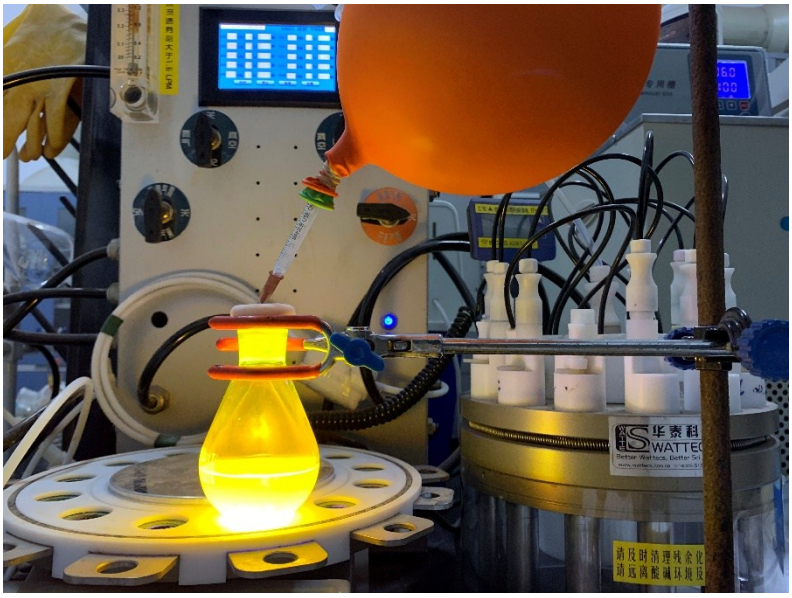


To a 10 mL glass reactor was added substrate (0.1 mmol) and chloroform (2 mL), then the catalyst (5 mol%) and 4-methoxybenzenethiol (20 mol%) was added into the mixture. The system was degassing by cyclic freezing/thawing method. Then the mixture was stirred at -15 °C utilizing blue LED until the completion of the reaction determined by TLC analysis. The crude product was purified by flash chromatography on silica gel (eluent: DCM/ methanol 20:1) affording to the compounds.

The Gram Scale Reaction

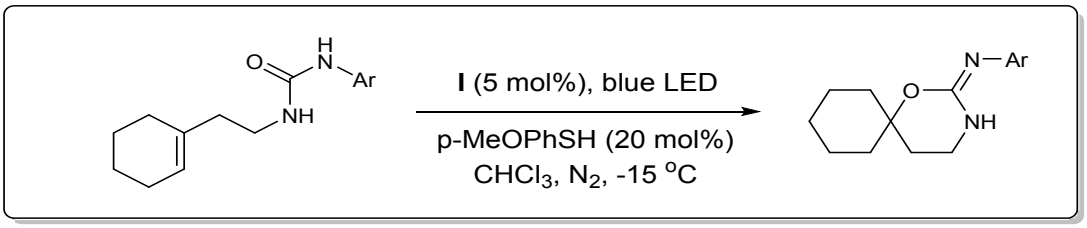
Synthesis Procedure of Photoredox Catalysis (PC 1)

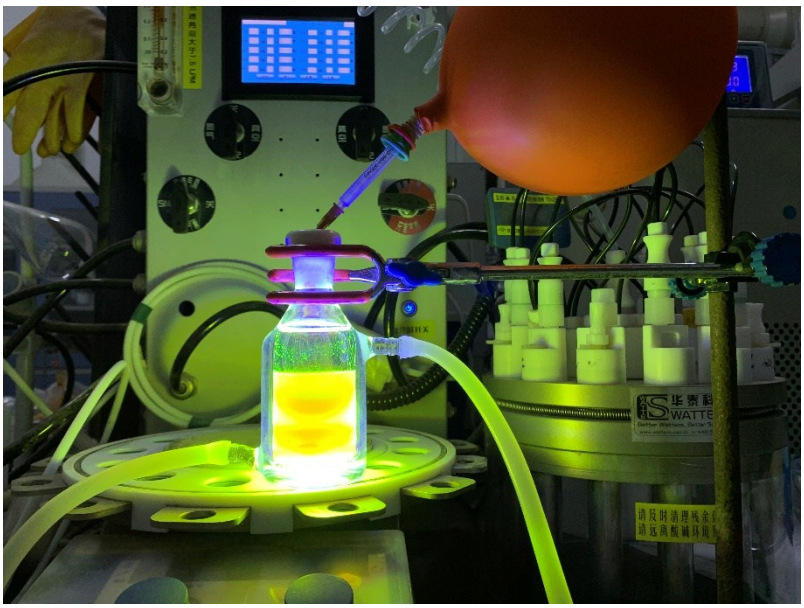




To a 100 mL flask was added substrate (3.0 mmol, 1.14g) and chloroform (40 mL), then the catalyst (5 mol%) and 4-(trifluoromethylthio)phenol (20 mol%) was added into the mixture. The system was degassing by cyclic freezing/thawing method. Then the mixture was equipped with a N_2 balloon and stirred at room temperature utilizing blue LED until the completion of the reaction determined by TLC analysis. The crude product was purified by flash chromatography on silica gel (eluent: PE/EtOAc from 10:1 to 5:1) affording to the compounds.

Synthesis Procedure B of Photoredox Catalysis (PC 2)

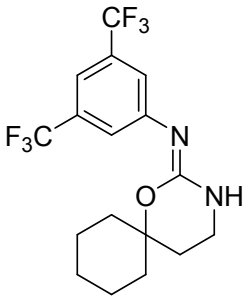




To a 50 mL glass reactor was added substrate (3.0 mmol, 1.14g) and chloroform (40 mL), then the catalyst (5 mol%) and 4-methoxybenzenethiol (20 mol%) was added into the mixture. The system was degassing by cyclic freezing/thawing method. Then the mixture was equipped with a N_2 balloon and stirred at -15 ^oC utilizing blue LED until the completion of the reaction determined by TLC analysis. The crude product was purified by flash chromatography on silica gel (eluent: DCM/ methanol 20:1) affording to the compounds.

Characterization Data for The Products

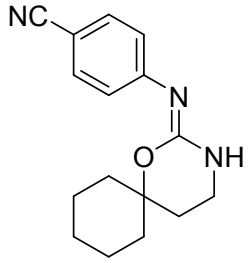
(E)-N-(3,5-bis(trifluoromethyl)phenyl)-1-oxa-3-azaspiro[5.5]undecan-2-imine(2a)



The product was prepared according to the **PC 2**. White solid; 84% yield, 31.9 mg; m.p. 137-139 ^oC; ^1H NMR (400 MHz, $CDCl_3$) δ 7.57 (s, 2H), 7.37 (s, 1H), 6.51-5.86 (br, 1H), 3.42-3.39 (t, J = 8 Hz, 2H), 1.92-1.83 (m, 4H), 1.64-1.44 (m, 6H), 1.30-1.26 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.01, 147.52, 131.92-130.95 (q, J = 32 Hz, CF_3),

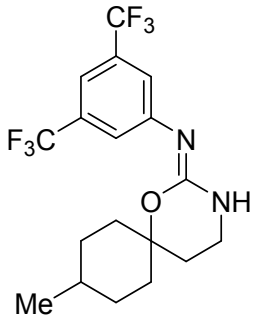
127.75-119.62 (q, J = 271 Hz, CF_3), 122.50, 113.90, 79.55, 36.29, 35.55, 31.59, 25.30, 21.38; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.97; HRMS (ESI) *m/z* calcd for $C_{17}H_{19}F_6N_2O^+$ [$(M+H)^+$]: 381.1396; found: 381.1387.

(E)-4-((1-oxa-3-azaspiro[5.5]undecan-2-ylidene)amino)benzonitrile (2b)



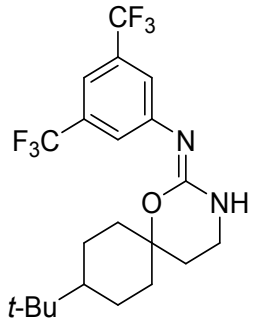
The product was prepared according to the **PC 2**. White solid; 88% yield, 23.7 mg; m.p. 154-156 °C; ^1H NMR (400 MHz, $CDCl_3$) δ 8.21-7.92 (br, 1H), 7.55-7.53 (d, J = 8 Hz, 2H), 7.37-7.35 (d, J = 8 Hz, 2H), 3.51-3.48 (m, 2H), 1.91-1.88 (m, 4H), 1.68-1.51 (m, 6H), 1.40-1.25 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.77, 145.14, 133.07, 120.86, 119.41, 105.12, 81.46, 36.86, 35.52, 30.95, 25.21, 21.65; HRMS (ESI) *m/z* calcd for $C_{16}H_{19}N_3NaO^+$ [$(M+Na)^+$]: 292.1420; found: 292.1445.

(E)-N-(3,5-bis(trifluoromethyl)phenyl)-9-methyl-1-oxa-3-azaspiro[5.5]undecan-2-imine(2c)



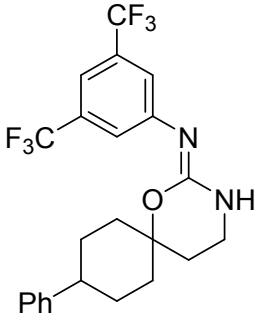
The product was prepared according to the **PC 2**. White solid; 80% yield, 31.5 mg; m.p. 143-145 °C; ^1H NMR (400 MHz, $CDCl_3$) δ 7.61 (s, 2H), 7.40 (s, 1H), 5.98-5.36 (br, 1H), 3.46-3.42 (t, J = 8 Hz, 2H), 2.03-2.00 (d, J = 12 Hz, 2H), 1.85-1.81 (t, J = 8 Hz, 2H), 1.60-1.57 (d, J = 12 Hz, 2H), 1.48-1.36 (m, 3H), 1.31-1.21 (m, 3H), 0.93-0.91 (d, J = 8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.66, 147.27, 131.97-131.00 (q, J = 32 Hz, CF_3), 129.89, 127.73-119.60 (q, J = 271 Hz, CF_3), 122.31, 114.09, 78.87, 36.47, 35.43, 32.52, 32.00, 29.50, 21.75; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.77; HRMS (ESI) *m/z* calcd for $C_{18}H_{21}F_6N_2O^+$ [$(M+H)^+$]: 395.1553; found: 395.1567.

(E)-N-(3,5-bis(trifluoromethyl)phenyl)-9-(tert-butyl)-1-oxa-3-azaspiro[5.5]undecan-2-imine(2d)



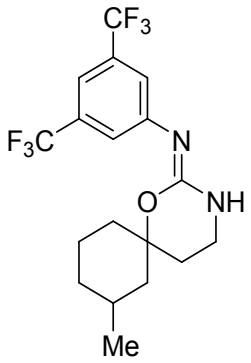
The product was prepared according to the **PC 2**. White solid; 75% yield, 31.5 mg; m.p. 167-169 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86-7.64 (br, 1H), 7.56 (s, 2H), 7.38 (s, 1H), 3.44-3.40 (t, *J* = 8 Hz, 2H), 2.06-1.97 (m, 2H), 1.85-1.81 (t, *J* = 8 Hz, 2H), 1.60-1.57 (d, *J* = 12 Hz, 2H), 1.41-1.33 (m, 2H), 1.26-1.11 (m, 2H), 0.99-0.93 (m, 1H), 0.87-0.83 (m, 2H), 0.72 (s, 7H); ^{13}C NMR (100 MHz, $CDCl_3$) δ152.03, 146.78, 132.02-131.05 (q, *J* = 32 Hz, CF_3), 127.64-119.51 (q, *J* = 271 Hz, CF_3), 122.60, 114.63, 79.15, 47.46, 36.31, 35.87, 32.21, 27.20, 21.81; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.85; HRMS (ESI) *m/z* calcd for $C_{21}H_{27}F_6N_2O^+$ [(M+Na)$^+$]: 437.2022; found: 437.2033.

(E)-N-(3,5-bis(trifluoromethyl)phenyl)-9-phenyl-1-oxa-3-azaspiro[5.5]undecan-2-imine(2e)



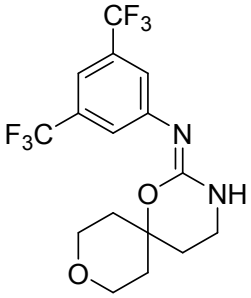
The product was prepared according to the **PC 2**. White solid; 84% yield, 38.3 mg; m.p. 160-162 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 (s, 2H), 7.44 (s, 1H), 7.25-7.22 (m, 2H), 7.18-7.15 (t, *J* = 6 Hz, 1H), 7.00-6.99 (d, *J* = 4 Hz, 2H), 6.91-6.13 (br, 1H), 3.46-3.43 (t, *J* = 6 Hz, 2H), 2.54-2.46 (m, 1H), 2.14-2.11 (d, *J* = 12 Hz, 2H), 1.90-1.86 (t, *J* = 8 Hz, 2H), 1.75-1.65 (m, 4H), 1.59-1.52 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ151.46, 147.70, 146.09, 132.15-131.17 (q, *J* = 33 Hz, CF_3), 128.35, 127.73-119.60 (q, *J* = 271 Hz, CF_3), 126.66, 126.21, 122.59, 114.25, 78.16, 53.43, 43.60, 36.45, 35.71, 32.43, 28.55; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.78; HRMS (ESI) *m/z* calcd for $C_{23}H_{22}F_6N_2NaO^+$ [(M+Na)$^+$]: 479.1529; found: 479.1577.

(E)-N-(3,5-bis(trifluoromethyl)phenyl)-8-methyl-1-oxa-3-azaspiro[5.5]undecan-2-imine(2f)



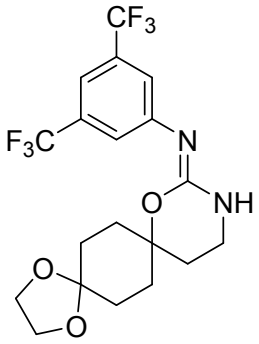
The product was prepared according to the **PC 2**. White solid; 69% yield, 27.2 mg; m.p. 132-134 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 (s, 2H), 7.37 (s, 1H), 5.36-5.44 (br, 1H), 3.47-3.44 (t, *J* = 8 Hz, 2H), 2.07-1.91 (m, 2H), 1.83-1.81 (t, *J* = 4 Hz, 2H), 1.75-1.72 (d, *J* = 12 Hz, 2H), 1.65-1.53 (m, 2H), 1.32-1.26 (m, 5H), 1.04-0.98 (t, *J* = 12 Hz, 1H), 0.90-0.88 (d, *J* = 8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.04, 146.93, 131.91-130.93 (q, *J* = 33 Hz, CF_3), 130.00, 127.70-119.57 (q, *J* = 271 Hz, CF_3), 122.13, 114.04, 79.69, 43.96, 36.58, 34.96, 34.12, 32.72, 27.27, 22.25, 20.92, 14.14; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.96; HRMS (ESI) *m/z* calcd for $C_{18}H_{21}F_6N_2O^+$ [$(M+H)^+$]: 395.1553; found: 395.1571.

(E)-N-(3,5-bis(trifluoromethyl)phenyl)-1,9-dioxa-3-azaspiro[5.5]undecan-2-imine(2g)



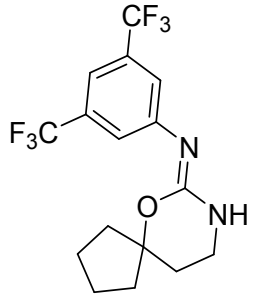
The product was prepared according to the **PC 2**. White solid; 89% yield, 34.0 mg; m.p. 121-123 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92-7.65 (br, 1H), 7.58 (s, 2H), 7.42 (s, 1H), 3.82-3.80 (d, *J* = 8 Hz, 2H), 3.69-3.63 (t, *J* = 12 Hz, 2H), 3.46-3.44 (t, *J* = 8 Hz, 2H), 1.92-1.76 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.17, 146.48, 132.15-131.17 (q, *J* = 33 Hz, CF_3), 127.61-119.48 (q, *J* = 271 Hz, CF_3), 122.18, 122.15, 114.51, 76.70, 63.00, 35.98, 35.64, 31.85; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.98; HRMS (ESI) *m/z* calcd for $C_{16}H_{16}F_6N_2NaO_2^+$ [$(M+Na)^+$]: 405.1008; found: 405.1002.

(E)-N-(3,5-bis(trifluoromethyl)phenyl)-1,4,9-trioxa-11-azadispiro[4.2.5^8.2^5] pentadecan-10-imine (2h)



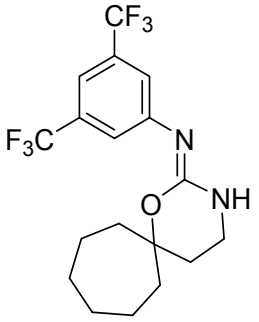
The product was prepared according to the **PC 2**. White solid; 85% yield, 37.2 mg; m.p. 118-120 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 (s, 2H), 7.38 (s, 1H), 3.98-3.90 (m, 4H), 3.45-3.41 (t, *J* = 8 Hz, 2H), 2.02-1.98 (m, 2H), 1.88-1.77 (m, 6H), 1.65-1.62 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ151.05, 146.46, 132.09-131.12 (q, *J* = 32 Hz, CF_3), 127.64-119.51 (q, *J* = 271 Hz, CF_3), 121.79, 114.38, 107.94, 78.09, 64.48, 64.28, 36.85, 33.11, 31.34, 29.91; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.92; HRMS (ESI) *m/z* calcd for $C_{19}H_{20}F_6N_2NaO_3^+$ [$(M+Na)^+$]: 461.1270; found: 461.1276.

(E)-N-(3,5-bis(trifluoromethyl)phenyl)-6-oxa-8-azaspiro[4.5]decan-7-imine (2i)



The product was prepared according to the **PC 2**. White solid; 78% yield, 28.5 mg; m.p. 129-131 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 (s, 2H), 7.38 (s, 1H), 6.57-5.88 (br, 1H), 3.49-3.45 (t, *J* = 8 Hz, 2H), 2.07-1.92 (m, 4H), 1.92-1.84 (m, 2H), 1.83-1.75 (m, 2H), 1.72-1.65 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.03, 147.32, 131.98-131.01 (q, *J* = 32 Hz, CF_3), 127.71-119.58(q, *J* = 271 Hz, CF_3), 122.15, 114.06, 38.09, 37.85; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.01; HRMS (ESI) *m/z* calcd for $C_{16}H_{16}F_6N_2NaO^+$ [$(M+Na)^+$]: 389.1059; found: 389.1063.

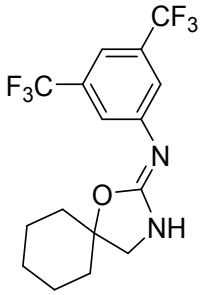
(E)-N-(3,5-bis(trifluoromethyl)phenyl)-1-oxa-3-azaspiro[5.6]dodecan-2-imine (2j)



The product was prepared according to the **PC 2**. White solid; 29.6% yield, 438 mg; m.p. 140-142 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 (s, 2H), 7.38 (s, 1H), 6.22-5.29 (br, 1H), 3.44-3.40 (t, *J* = 8 Hz, 2H), 2.00-1.94 (m, 2H), 1.88-1.85 (m, 2H), 1.79-1.75

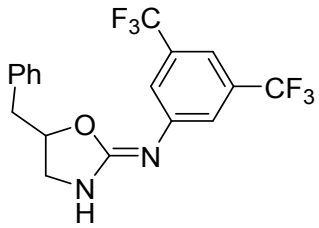
(m, 2H), 1.73-1.61 (m, 5H), 1.57-1.51 (m, 2H), 1.47-1.40 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ151.53, 131.99-131.01(q, J = 32 Hz, CF_3), 127.69-119.57(q, J = 271 Hz, CF_3), 121.96, 114.18, 99.99, 83.88, 39.01, 36.90, 32.12, 29.58, 21.82; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.96; HRMS (ESI) *m/z* calcd for $C_{18}H_{20}F_6N_2NaO^+$ [$(M+Na)^+$]: 417.1372; found: 417.1385.

(E)-N-(3,5-bis(trifluoromethyl)phenyl)-1-oxa-3-azaspiro[4.5]decan-2-imine (2k)



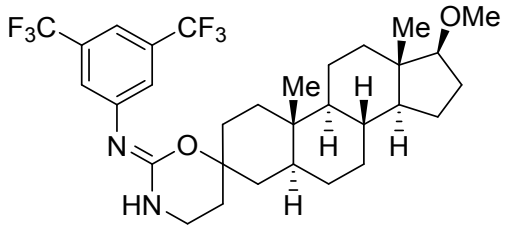
The product was prepared according to the **PC 2**. White solid; 79% yield, 28.9 mg; m.p. 150-152 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 (s, 2H), 7.42 (s, 1H), 3.42 (s, 2H), 1.96-1.93 (m, 2H), 1.93-1.64 (m, 4H), 1.574 (br, 3H), 1.43-1.33 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ157.31, 132.21-131.23(q, J = 32 Hz, CF_3), 127.64-119.51(q, J = 271 Hz, CF_3), 122.36, 114.75, 87.23, 53.41, 36.06, 24.74, 22.71.; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.03; HRMS (ESI) *m/z* calcd for $C_{16}H_{16}F_6N_2NaO^+$ [$(M+Na)^+$]: 389.1059; found: 389.1071.

(E)-5-benzyl-N-(3,5-bis(trifluoromethyl)phenyl)oxazolidin-2-imine (2l)



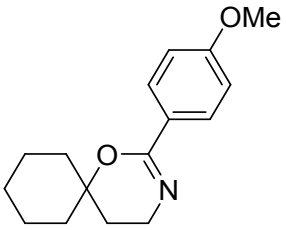
The product was prepared according to the **PC 2**. White solid; 80% yield, 31.0 mg; m.p. 122-124 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (s, 2H), 7.44 (s, 1H), 7.35-7.31 (m, 2H), 7.29-7.27 (m, 3H), 5.01-4.94 (m, 1H), 3.76-3.72 (t, J = 8 Hz, 1H), 3.48-3.44 (m, 1H), 3.17-3.11 (m, 1H), 3.03-2.98 (m, 1H), 1.35-1.16 (br, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ δ 157.18, 135.57, 132.35-131.37(q, J = 32 Hz, CF_3), 129.24, 128.81, 127.55-119.42(q, J = 271 Hz, CF_3), 127.22, 122.13, 115.26, 48.14, 40.44, 29.72; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.94; HRMS (ESI) *m/z* calcd for $C_{18}H_{15}F_6N_2O^+$ [$(M+H)^+$]: 389.1083; found: 389.1099.

(5S,8R,9S,10S,13S,14S,17S,E)-N-(3,5-bis(trifluoromethyl)phenyl)-17-methoxy-10,13-dimethylhexadecahydrospiro[cyclopenta[a]phenanthrene-3,6'-[1,3]oxazinan]-2'-imine (2o)



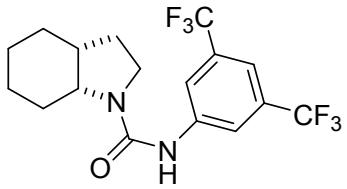
The product was prepared according to the **PC 2**. White solid; 75% yield, 43.9 mg; m.p. 161-163 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 (s, 2H), 7.42 (s, 1H), 5.95-5.71 (br, 1H), 3.46-3.43 (t, *J* = 6 Hz, 2H), 3.35 (s, 3H), 3.27-3.23 (t, *J* = 8 Hz, 1H), 2.05-1.98 (m, 2H), 1.90-1.87 (m, 2H), 1.85-1.82 (t, *J* = 6 Hz, 2H), 1.67-1.54 (m, 6H), 1.47-1.36 (m, 5H), 1.31-1.15 (m, 7H), 0.79 (s, 3H), 0.74 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ152.26, 146.31, 132.11-131.13(q, J = 33 Hz, CF_3), 130.01, 127.64-119.54(q, J = 271 Hz, CF_3), 122.25, 114.62, 90.76, 80.72, 57.85, 53.52, 51.00, 42.90, 40.46, 38.25, 37.87, 36.25, 35.69, 35.17, 33.24, 32.56, 31.48, 31.02, 29.33, 28.04, 27.67, 23.28, 20.59, 11.63, 11.39; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.58; HRMS (ESI) *m/z* calcd for $C_{31}H_{40}F_6N_2NaO_2^+$ [$(M+Na)^+$]: 609.2886; found: 609.2866.

2-(4-methoxyphenyl)-1-oxa-3-azaspiro[5.5]undec-2-ene (2q)



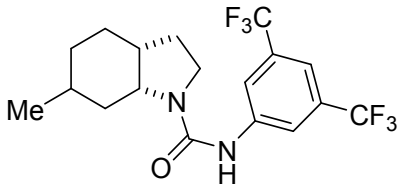
The product was prepared according to the **PC 2**. White solid; 24% yield, 6.8 mg; m.p. 135-137 °C; ^{1}H NMR (400 MHz, CD_3OD) δ 7.83-7.81 (d, *J* = 8 Hz, 2H), 6.96-6.94 (d, *J* = 8 Hz, 2H), 3.83 (s, 3H), 3.56-3.53 (t, *J* = 6 Hz, 2H), 1.91-1.81 (m, 4H), 1.79-1.71 (m, 2H), 1.65-1.53 (m, 4H), 1.48-1.37 (m, 1H), 1.34-1.27 (m, 1H); ^{13}C NMR (100 MHz, CD_3OD) δ 162.26, 158.16, 128.52, 125.53, 113.24, 76.83, 54.52, 39.18, 35.57, 30.95, 25.29, 21.36.; HRMS (ESI) *m/z* calcd for $C_{16}H_{22}NO_2^+$ [$(M+H)^+$]: 260.1645; found: 260.1673.

N-(3,5-bis(trifluoromethyl)phenyl)octahydro-1H-indole-1-carboxamide (3a)



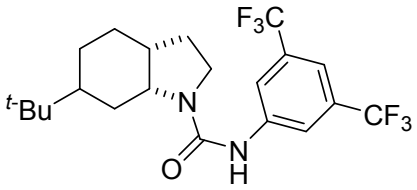
The product was prepared according to the **PC 1**. White solid; 81% yield, 30.8 mg; m.p. 128-130 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (s, 2H), 7.48 (s, 1H), 6.47 (s, 1H), 3.60 (br, 1H), 3.60-3.56 (t, *J* = 8 Hz, 1H), 3.50 -3.43 (m, 1H), 2.37-2.31 (br, 1H), 2.14-2.06 (m, 2H), 1.92-1.85 (m, 1H), 1.77-1.51 (m, 4H), 1.36-1.22 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.71, 140.78, 132.50-131.51(q, J = 33 Hz, CF_3), 130.96, 128.84, 127.32-119.19 (q, J = 271 Hz, CF_3), 118.87, 115.71, 56.78, 45.01, 37.23, 27.85, 26.82, 26.05, 23.61, 20.74; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.13; HRMS (ESI) *m/z* calcd for $C_{17}H_{18}F_6N_2NaO^+$ [$(M+Na)^+$]: 403.1216; found: 403.1211.

N-(3,5-bis(trifluoromethyl)phenyl)-6-methyloctahydro-1H-indole-1-carboxamide (3c)



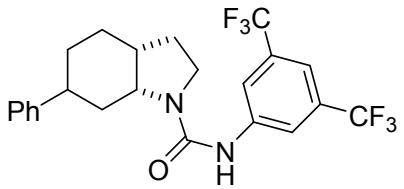
The product was prepared according to the **PC 1**. White solid; 68% yield, 26.8 mg; m.p. 135-137 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (s, 2H), 7.48 (s, 1H), 6.47 (s, 1H), 4.04-4.00 (m, 1H), 3.61-3.48 (m, 2H), 2.23-2.21 (m, 2H), 1.95-1.77 (m, 3H), 1.68-1.60 (m, 2H), 1.50-1.43 (m, 1H), 1.40-1.33 (m, 1H), 1.13-1.04 (m, 1H), 0.95-0.93 (d, *J* = 8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.93, 140.73, 132.55-131.55(q, J = 33 Hz, CF_3), 127.31-119.18(q, J = 271 Hz, CF_3), 118.86, 115.76, 56.36, 45.93, 37.21, 34.23, 30.20, 29.07, 26.81, 24.78, 20.02; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.98; HRMS (ESI) *m/z* calcd for $C_{18}H_{21}F_6N_2O^+$ [$(M+H)^+$]: 395.1553; found: 395.1541.

N-(3,5-bis(trifluoromethyl)phenyl)-6-(tert-butyl)octahydro-1H-indole-1-carboxamide (3d)



The product was prepared according to the **PC 1**. White solid; 57% yield, 23.6 mg; m.p. 155-157 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (s, 2H), 7.46 (s, 1H), 6.64 (s, 1H), 4.04-4.00 (m, 1H), 3.61-3.52 (m, 2H), 2.66-2.62 (d, *J* = 16 Hz, 1H), 2.23-2.17 (m, 1H), 1.99-1.90 (m, 1H), 1.81-1.72 (m, 2H), 1.66-1.62 (m, 1H), 1.32-1.15 (m, 2H), 1.13-1.01 (m, 1H), 0.89-0.86 (m, 1H), 0.83 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.64, 140.79, 132.49-131.50(q, J = 33 Hz, CF_3), 127.31-119.18(q, J = 271 Hz, CF_3), 118.90, 115.64, 58.73, 46.75, 41.70, 37.75, 32.23, 30.44, 28.10, 28.01, 27.41, 25.41; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.01; HRMS (ESI) *m/z* calcd for $C_{21}H_{27}F_6N_2O^+$ [$(M+Na)^+$]: 437.2022; found: 437.2056.

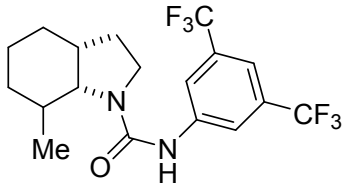
N-(3,5-bis(trifluoromethyl)phenyl)-6-phenyloctahydro-1H-indole-1-carboxamide (3e)



The product was prepared according to the **PC 1**. White solid; 58% yield, 26.5 mg; m.p. 145-147 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (s, 2H), 7.47 (s, 1H), 7.28-7.14 (m, 5H), 6.63 (s, 1H), 4.10-4.09 (m, 1H), 3.71-3.58 (m, 2H), 2.75-2.72 (d, *J* = 12 Hz, 1H), 2.66-2.60 (t, *J* = 12 Hz, 1H), 2.26 (br, 1H), 2.04-1.97 (m, 1H), 1.92-1.85 (m, 1H), 1.80-1.76 (m, 1H), 1.65-1.53 (m, 1H), 1.48-1.37 (m, 1H), 0.97-0.86 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.65, 145.64, 140.57, 132.60-131.61(q, J = 33 Hz, CF_3), 128.39,

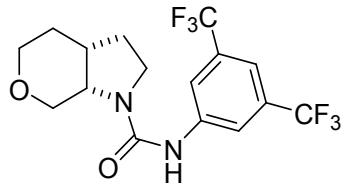
127.27-119.14(q, J = 271 Hz, CF_3),126.87, 126.06, 118.99, 115.90, 57.86, 46.57, 37.58, 37.36, 33.81, 30.99, 30.03, 27.00; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.03; HRMS (ESI) *m/z* calcd for $C_{23}H_{23}F_6N_2O^+$ [$(M+H)^+$]: 457.1709; found: 457.1734.

N-(3,5-bis(trifluoromethyl)phenyl)-7-methyloctahydro-1H-indole-1-carboxamide (3f)



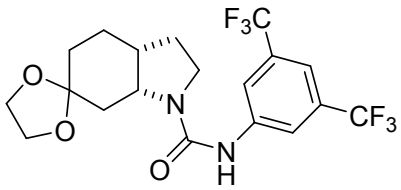
The product was prepared according to the **PC 1**. White solid; 50% yield, 19.7 mg; m.p. 143-145 °C; ^1H NMR (400 MHz, $CDCl_3$) δ 7.93 (s, 2H), 7.49 (s, 1H), 6.61 (s, 1H), 3.91-3.88 (m, 1H), 3.65-3.54 (m, 2H), 2.62-2.57 (m, 1H), 2.34-2.27 (m, 1H), 2.03-1.90 (m, 1H), 1.69-1.55 (m, 3H), 1.50-1.42 (m, 2H), 1.05-1.04 (m, 1H), 0.93-0.83 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.65, 140.73, 132.52-131.53 (q, J = 33 Hz, CF_3), 127.31-119.09 (q, J = 271 Hz, CF_3), 118.87, 115.71, 57.24, 46.57, 45.06, 38.23, 36.03, 34.44, 33.00, 30.57, 30.37, 28.88, 26.33, 26.04, 22.52, 20.63, 20.43; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.01; HRMS (ESI) *m/z* calcd for $C_{18}H_{21}F_6N_2O^+$ [$(M+H)^+$]: 395.1553; found: 395.1549.

N-(3,5-bis(trifluoromethyl)phenyl)hexahydropyrano[3,4-b]pyrrole-1(2H)-carboxamide (3g)



The product was prepared according to the **PC 1**. White solid; 47% yield, 18.0 mg; m.p. 118-120 °C; ^1H NMR (400 MHz, $CDCl_3$) δ 8.10 (s, 1H), 7.90 (s, 2H), 7.49 (s, 1H), 5.36 (s, 1H), 4.18-4.13 (dd, *J* = 12 Hz, *J* = 8 Hz, 1H), 4.06-4.00 (t, *J* = 12 Hz, 1H), 3.75-3.70 (dd, *J* = 12 Hz, *J* = 8 Hz, 1H), 2.97-2.89 (td, *J* = 12 Hz, *J* = 4 Hz, 1H), 2.36-2.28 (m, 1H), 2.22-2.14 (m, 1H), 2.05-1.95 (m, 3H), 1.78-1.70 (m, 1H), 1.40-1.36 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 155.74, 140.76, 132.55-131.56 (q, J = 33 Hz, CF_3), 130.93, 128.83, 127.31-119.18 (q, J = 271 Hz, CF_3), 118.82, 115.79, 79.25, 56.13, 36.12, 33.17, 28.99, 26.50, 19.82; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.98; HRMS (ESI) *m/z* calcd for $C_{16}H_{16}F_6N_2NaO_2^+$ [$(M+Na)^+$]: 405.1008; found: 405.1015.

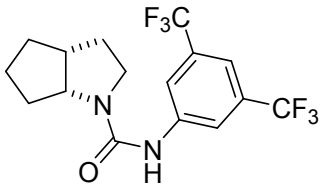
N-(3,5-bis(trifluoromethyl)phenyl)hexahydropyrano[3,4-b]pyrrole-1(2H)-carboxamide (3h)



The product was prepared according to the **PC 1**. White solid; 55% yield, 24.1 mg; m.p. 130-132 °C; ^1H NMR (400 MHz, $CDCl_3$) δ 7.92 (s, 2H), 7.49 (s, 1H), 6.63 (br, 1H),

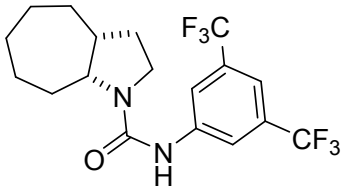
4.22-4.16 (m, 1H), 4.00-3.91 (m, 4H), 3.62-3.58 (t, *J* = 8 Hz, 1H), 3.51-3.45 (q, *J* = 8 Hz, 1H), 2.36-2.32 (m, 1H), 2.25-2.21 (m, 1H), 2.12-1.90 (m, 3H), 1.82-1.78 (m, 1H), 1.70-1.57 (m, 2H), 1.51-1.43 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.60, 152.58, 140.65, 132.46-131.47(q, J = 33 Hz, CF_3), 127.29-119.16 (q, J = 271 Hz, CF_3), 119.08, 115.86, 108.17, 64.49, 64.24, 56.27, 45.09, 35.87, 29.50, 26.87, 22.63; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.01; HRMS (ESI) *m/z* calcd for $C_{19}H_{20}F_6N_2NaO_3^+$ [$(M+Na)^+$]: 461.1270; found: 461.1283.

N-(3,5-bis(trifluoromethyl)phenyl)hexahydrocyclopenta[b]pyrrole-1(2H)-carboxamide (3i)



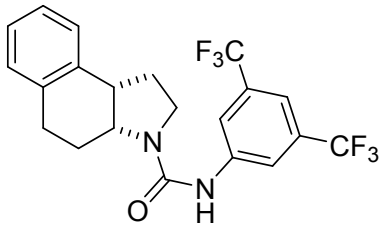
The product was prepared according to the **PC 1**. White solid; 67% yield, 24.5 mg; m.p. 156-158 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (s, 2H), 7.48 (s, 1H), 6.60-6.58 (d, *J* = 8 Hz, 1H), 4.25-4.20 (br, 1H), 3.67-3.61 (m, 1H), 3.51-3.44 (m, 1H), 2.84-2.80 (m, 1H), 2.26-2.21 (m, 1H), 2.09-1.96 (m, 2H), 1.87-1.63 (m, 4H), 1.52-1.44 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 152.89, 140.65, 132.56-131.56 (q, J = 33 Hz, CF_3), 127.28-119.15 (q, J = 271 Hz, CF_3), 125.66, 118.96, 115.85, 62.79, 46.50, 43.60, 34.08, 31.66, 30.53, 25.48; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.02; HRMS (ESI) *m/z* calcd for $C_{16}H_{17}F_6N_2HO^+$ [$(M+H)^+$]: 367.1240; found: 367.1240.

N-(3,5-bis(trifluoromethyl)phenyl)octahydrocyclohepta[b]pyrrole-1(2H)-carboxamide (3j)



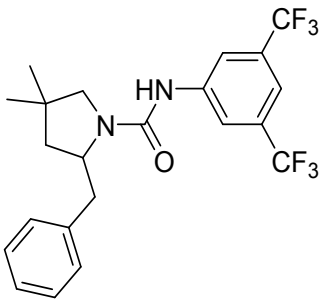
The product was prepared according to the **PC 1**. White solid; 84% yield, 33.0 mg; m.p. 130-132 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (s, 2H), 7.42 (s, 1H), 6.95 (s, 1H), 4.01-3.97 (t, *J* = 8 Hz, 1H), 3.60-3.56 (t, *J* = 8 Hz, 1H), 3.38-3.31 (m, 1H), 2.42-.2.34 (br, 1H), 2.09-1.99 (m, 2H), 1.91-1.71 (m, 5H), 1.55-1.46 (q, *J* = 12 Hz, 1H), 1.27-1.16 (m, 3H), 0.89-0.82 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.37, 140.87, 132.67, 132.23-131.24 (q, J = 33 Hz, CF_3), 127.30-119.17 (q, J = 271 Hz, CF_3), 119.22, 115.62, 114.59, 62.99, 45.82, 42.17, 31.84, 31.47, 31.22, 29.81, 27.72, 26.21; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.11; HRMS (ESI) *m/z* calcd for $C_{18}H_{20}F_6N_2NaO^+$ [$(M+Na)^+$]: 417.1372; found: 417.1388.

N-(3,5-bis(trifluoromethyl)phenyl)-1,2,3a,4,5,9b-hexahydro-3H-benzo[e]indole-3-carboxamide (3m)



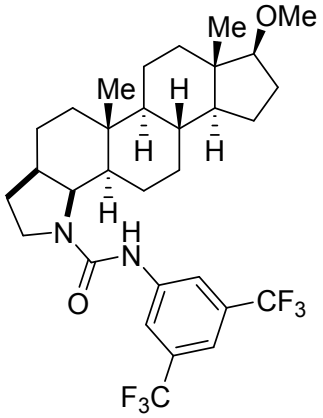
The product was prepared according to the **PC 1**. White solid; 55% yield, 23.5 mg; m.p. 153-155 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (s, 2H), 7.52 (s, 1H), 7.20-7.13 (m, 4H), 6.57 (s, 1H), 4.33-4.27 (br, 1H), 3.64-3.54 (m, 2H), 3.50-3.43 (m, 1H), 2.86-2.76 (m, 2H), 2.54-2.47 (m, 1H), 2.36-2.32 (m, 1H), 2.18-2.08 (m, 1H), 1.72-1.62 (m, 1H), 0.89-0.79 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.06, 140.49, 136.65, 136.21, 132.61-131.62 (q, J = 33 Hz, CF_3), 128.86, 128.81, 127.29-118.84 (q, J = 272 Hz, CF_3), 126.43, 126.32, 119.12, 116.07, 56.93, 45.41, 40.97, 33.10, 28.06, 25.60; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.98; HRMS (ESI) *m/z* calcd for $C_{21}H_{18}F_6N_2NaO^+$ [$(M+Na)^+$]: 451.1216; found: 451.1232.

2-benzyl-N-(3,5-bis(trifluoromethyl)phenyl)-4,4-dimethylpyrrolidine-1-carboxamide (3n)



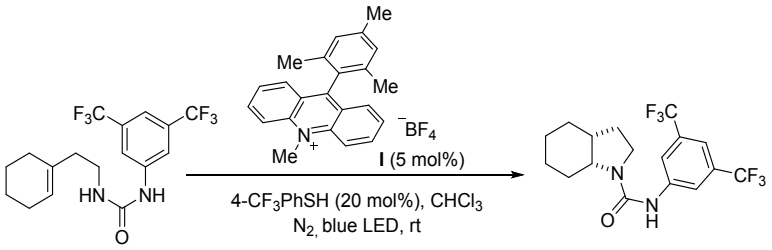
The product was prepared according to the **PC 1**. White solid; 70% yield, 31.1 mg; m.p. 164-166 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (br, 1H), 7.44 (s, 1H), 7.35-7.32 (m, 2H), 7.28-7.25 (m, 3H), 6.22 (br, 1H), 4.26-4.22 (m, 1H), 3.52-3.50 (d, *J* = 8 Hz, 1H), 3.22-3.20 (d, *J* = 8 Hz, 1H), 3.05-3.03 (d, *J* = 8 Hz, 1H), 2.80-2.77 (m, 1H), 1.92-1.87 (m, 1H), 1.62-1.56 (m, 1H), 1.12 (s, 3H), 1.01 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.01, 140.64, 138.56, 132.40-131.41 (q, J = 33 Hz, CF_3), 129.56, 128.88, 127.32-119.19 (q, J = 271 Hz, CF_3), 126.97, 118.80, 115.61, 59.57, 59.31, 37.81, 26.55, 26.09; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.98; HRMS (ESI) *m/z* calcd for $C_{22}H_{23}F_6N_2O^+$ [$(M+H)^+$]: 445.1709; found: 445.1723.

(5aR,5bS,7aS,8S,10aS,10bR,12aR)-N-(3,5-bis(trifluoromethyl)phenyl)-8-methoxy-5a,7a-dimethyloctadecahydrocyclopenta[5,6]naphtho[1,2-g]indole-1(2H)-carboxamide (3o)



The product was prepared according to the **PC 1**. White solid;63% yield, 36.9 mg; m.p. 176-178 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.37 (s, 1H),7.73 (s, 2H), 7.40 (s, 1H), 5.87 (s, 1H), 3.35 (s, 3H), 3.27-3.21 (t, *J* = 8 Hz, 3H), 2.05-1.96 (m, 1H), 1.90-1.87 (d, *J* = 12 Hz, 1H), 1.65-1.44 (m, 6H), 1.38-1.32 (m, 2H), 1.29-1.10 (m, 7H), 1.06-0.86 (m, 4H), 0.84-0.79 (m, 1H), 0.74 (s, 3H), 0.71 (s, 3H), 0.60-0.56 (t, *J* = 8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ155.93, 140.68, 132.65-131.66 (q, J = 33 Hz, CF_3), 127.16-119.02 (q, J = 271 Hz, CF_3), 118.30, 115.53, 91.04, 57.81, 54.72, 51.33, 46.49, 42.97, 40.49, 38.40, 38.16, 37.30, 36.47, 36.05, 35.75, 35.49, 35.28, 31.58, 28.69, 27.69, 23.26, 20.66, 12.19, 11.67; ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.25; HRMS (ESI) *m/z* calcd for $C_{31}H_{40}F_6N_2NaO_2^+$ [$(M+Na)^+$]: 609.2888; found: 609.2877.

Table S1. Optimization of Experiment Conditions for 3a.*



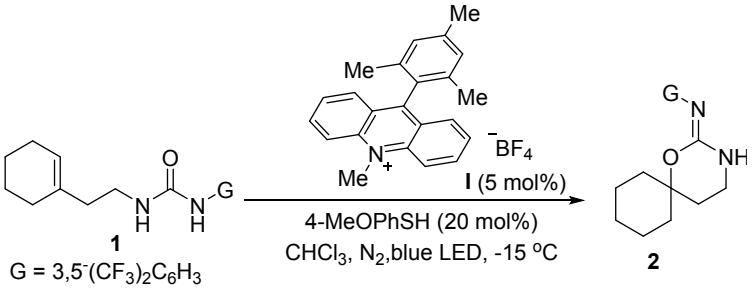
1a **3a**

Entry	Variations from standard conditions	Yield (**2a**)
1	None	81%
2	No light	NR
3	No photocatalyst	NR
4	No 4-$CF_3C_6H_4SH$	NR
5	CH_2Cl_2, instead of $CHCl_3$	47%
6	$ClCH_2CH_2Cl$, instead of $CHCl_3$	60%
7	DMF, instead of $CHCl_3$	NR
8	CH_3CN, instead of $CHCl_3$	65%

9	4-EtC_6H_4SH, instead of 4-$CF_3C_6H_4SH$	48%
10	4-$MeOC_6H_4SH$, instead of 4-$CF_3C_6H_4SH$	50%
11	2,4,6-^{i}-PrC_6H_2SH, instead of 4-$CF_3C_6H_4SH$	75%
12	$[Ru(bpy)_3Cl_2]6H_2O$, instead of **I**	NR
13	$[Ir(ppy)_2(dtbbpy)]PF_6$, instead of **I**	NR
14	0 ^{o}C, instead of r.t.	31%

*The reactions were carried out with **1a** (0.1 mmol) in the presence of a catalyst (5 mol%) in solvent (2 mL). Yield of **3a** are isolated yields. NR: no reaction

Table S2. Optimization of Substituents on the Urea.*

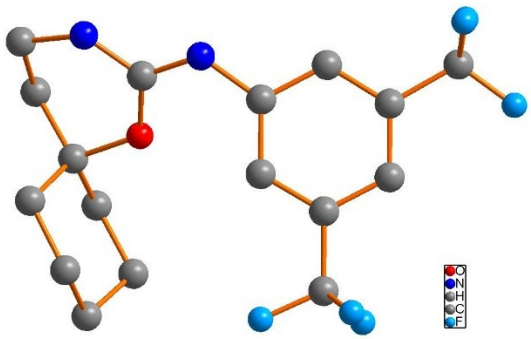


Entry	G	Yield (**2a**)
1	3,5-dimethylphenyl	NR
2	4-methoxyphenyl	NR
3	4-bromophenyl	trace
4	4-nitrophenyl	complex
5	4-(trifluoromethyl)phenyl	39%

*The reactions were carried out with **1** (0.1 mmol) in the presence of a catalyst (5 mol%), 4-MeOPhSH (20 mol%) in chloroform (2 mL). Yield of **2** are isolated yields. NR: no reaction.

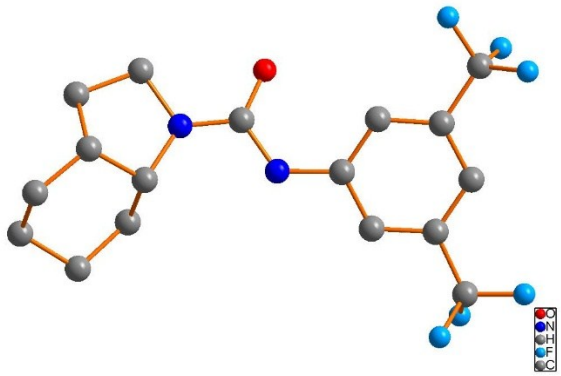
Crystal Data and Structure Refinement

Crystal data and structure refinement of **2a**



Empirical formula	$C_{17}H_{18}F_6N_2O$
Formula weight	380.33
Temperature	173(2) K
Wavelength	1.54184 A
Crystal system, space group	triclinic
Unit cell dimensions	a = 8.7596(10) Å alpha = 89.020(15) deg. b = 9.7743(19) Å beta = 76.945(12) deg. c = 11.1698(19) Å gamma = 68.226(15) deg.
Volume	862.8(3)
Z, Calculated density	2, 1.464 Mg/m^3
Absorption coefficient	1.200 mm^-1
F(000)	392
Theta range for data collection	7.6920 to 68.9300 deg.
Limiting indices	-10<=h<=7, -11<=k<=11, -13<=l<=13
Reflections collected / unique	5482 / 3221
Completeness to theta = 67.684	99.4 %
Absorption correction	multi-scan
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	3223 / 0 / 235
Goodness-of-fit on F^2	1.038
Final R indices [I>2 sigma(I)]	R1 = 0.0858, wR2 = 0.2326
R indices (all data)	R1 = 0.1104, wR2 = 0.2588
Largest diff. peak and hole	0.731 and -0.513 e.A^-3

Crystal data and structure refinement of **3a**



Empirical formula	$C_{17}H_{18}F_6N_2O$
Formula weight	380.33
Temperature	173(2) K
Wavelength	1.54184 A
Crystal system, space group	monoclinic
Unit cell dimensions	a = 9.8103(4) Å alpha = 90 deg. b = 21.4003 (5) Å beta = 115.226(17) deg. c = 9.3414(10) Å gamma = 90 deg.
Volume	1774.1(5)
Z, Calculated density	4, 1.424 Mg/m^3
Absorption coefficient	1.167 mm^-1
F (000)	784
Theta range for data collection	4.132 to 70.582 deg.
Limiting indices	-8<=h<=11, -25<=k<=25, -11<=l<=11
Reflections collected / unique	6485 / 3343
Completeness to theta = 67.684	99.9 %
Absorption correction	multi-scan
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	6641 / 0 / 235
Goodness-of-fit on F^2	1.042
Final R indices [I>2 sigma(I)]	R1 = 0.0656, wR2 = 0.1826
R indices (all data)	R1 = 0.0943, wR2 = 0.2148
Largest diff. peak and hole	0.339 and -0.330 e.A^-

References

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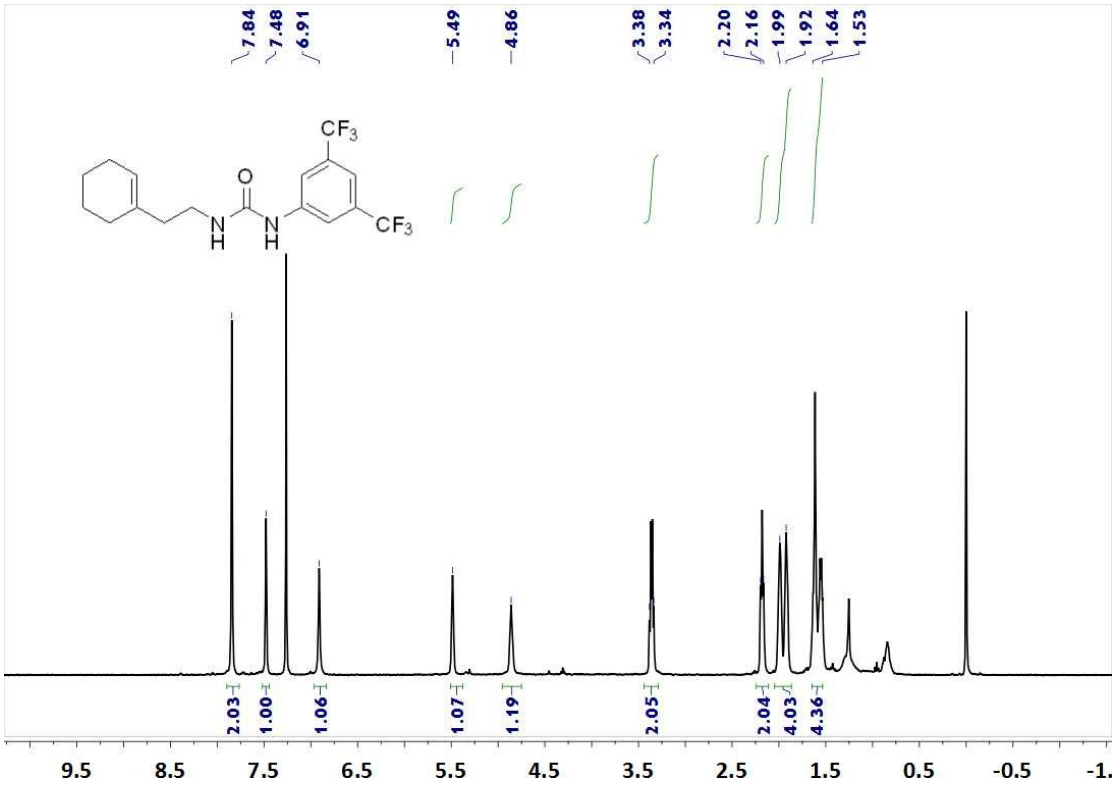
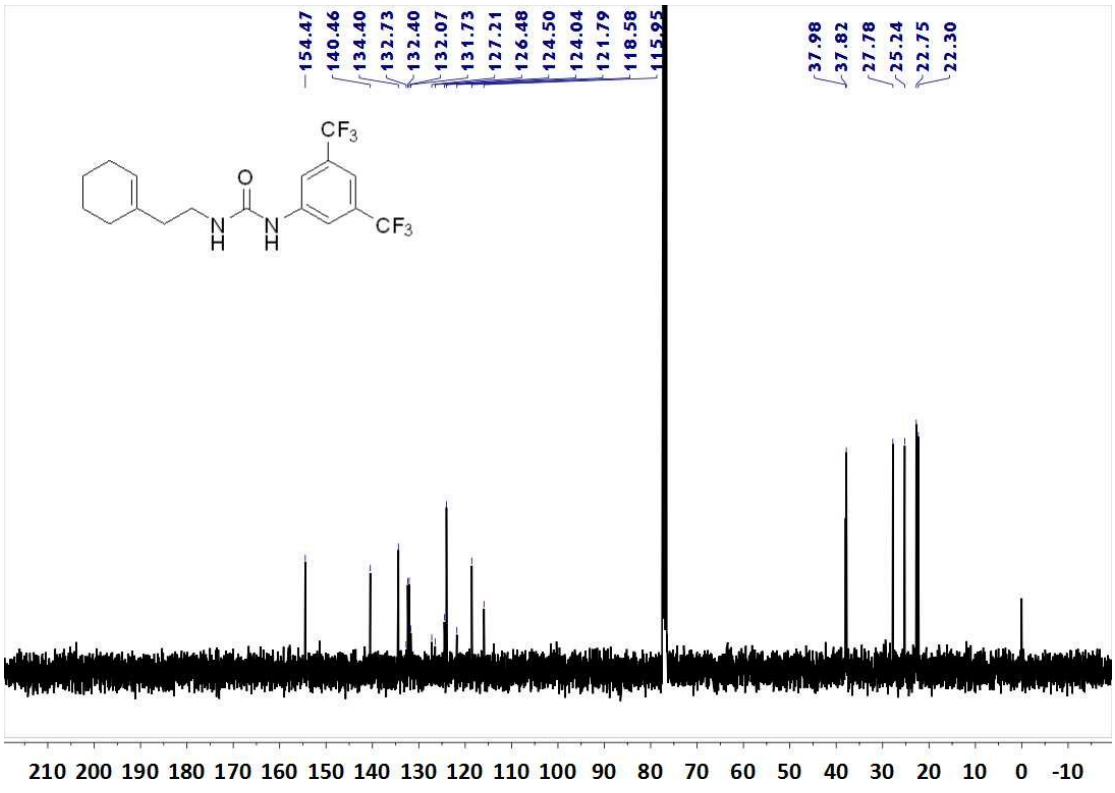
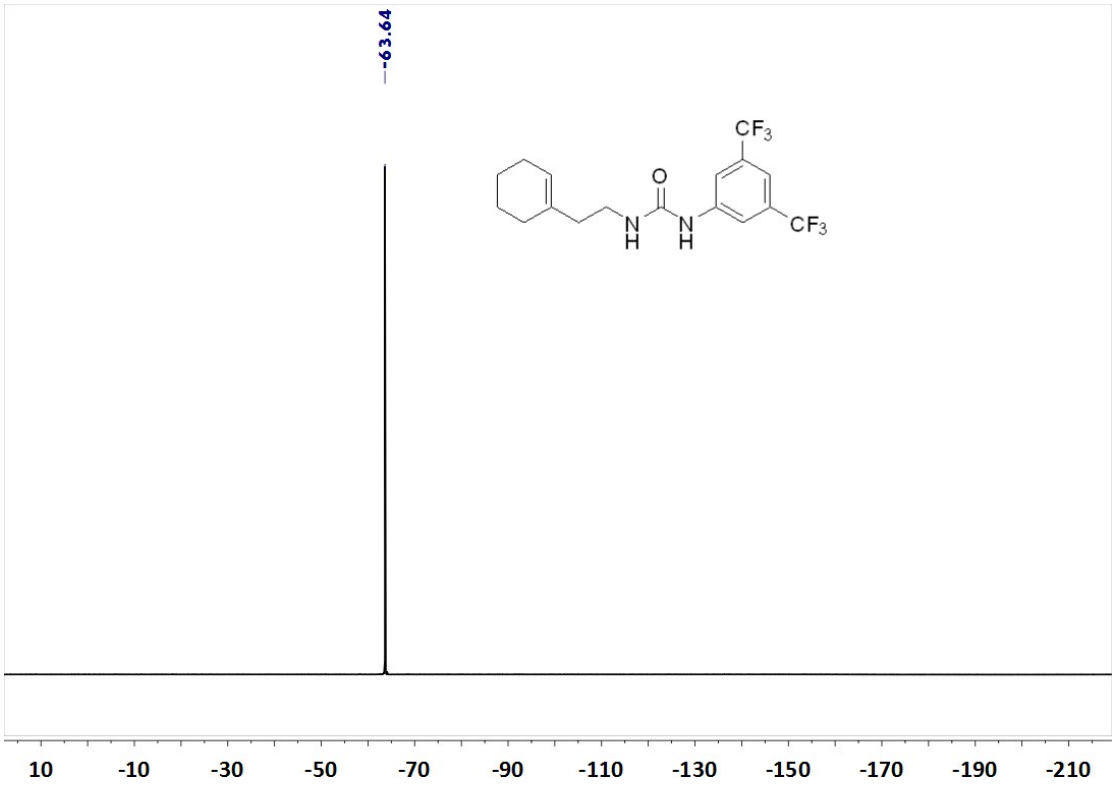
^{1}H, ^{13}C and ^{19}F-NMR Spectra



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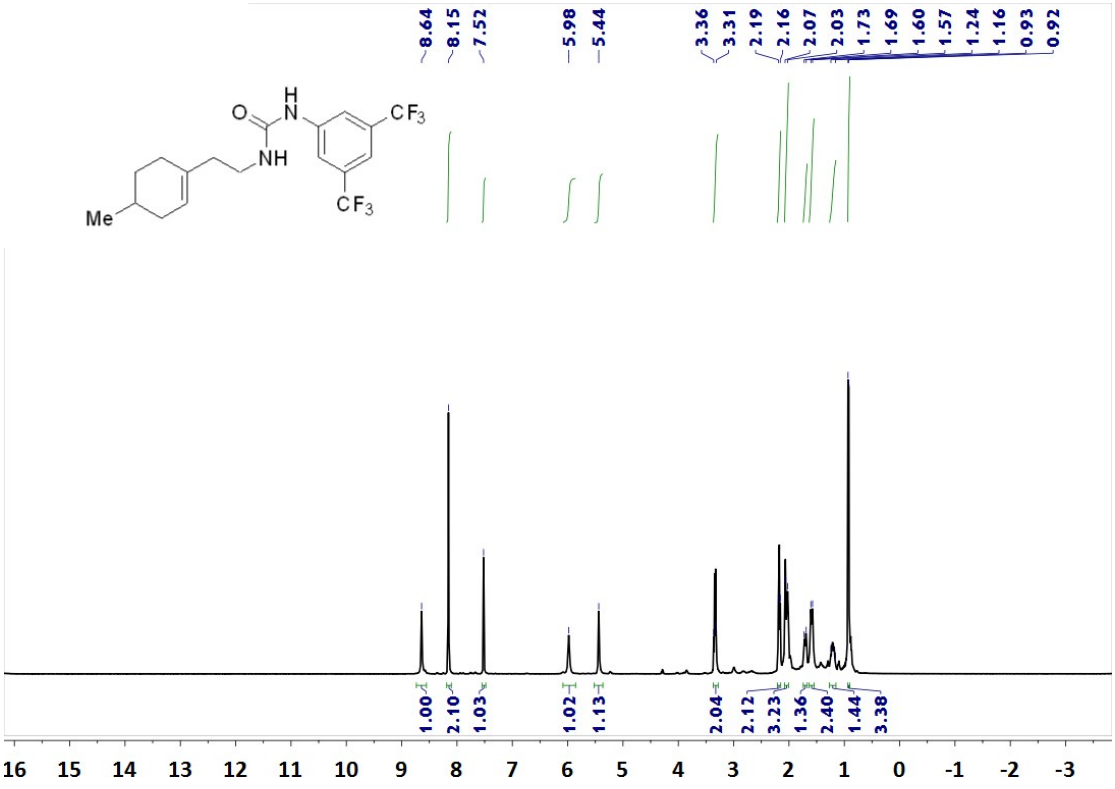
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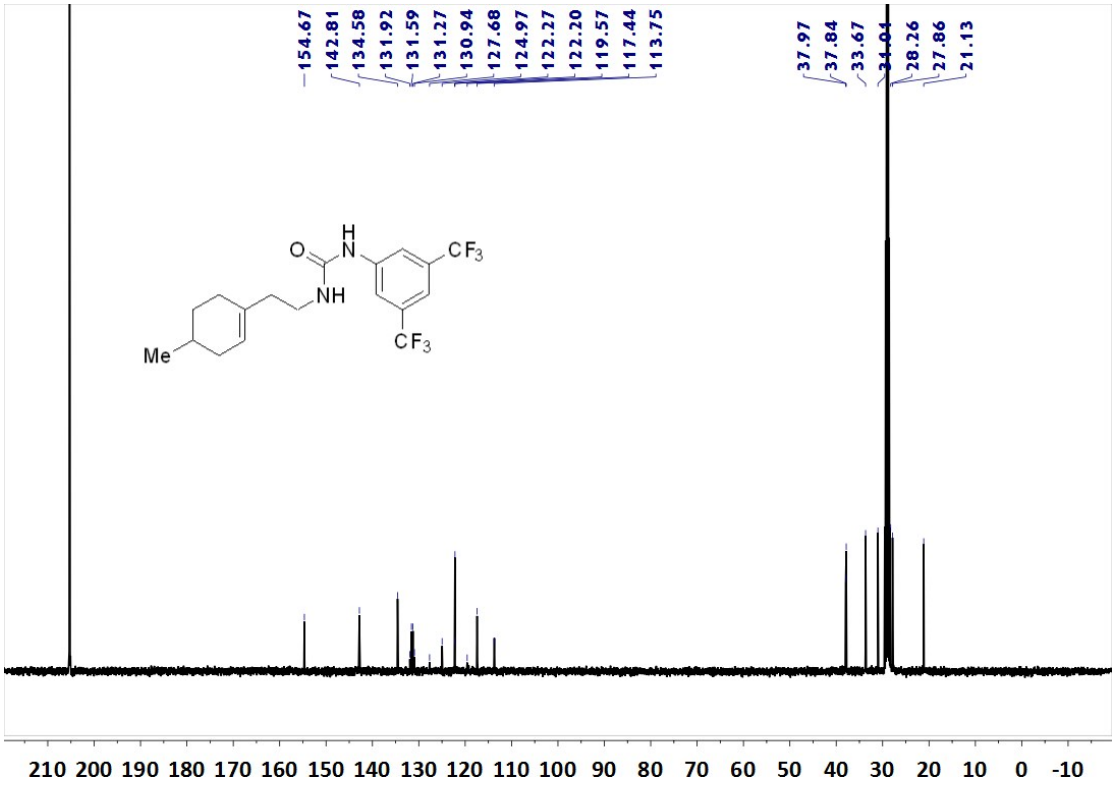
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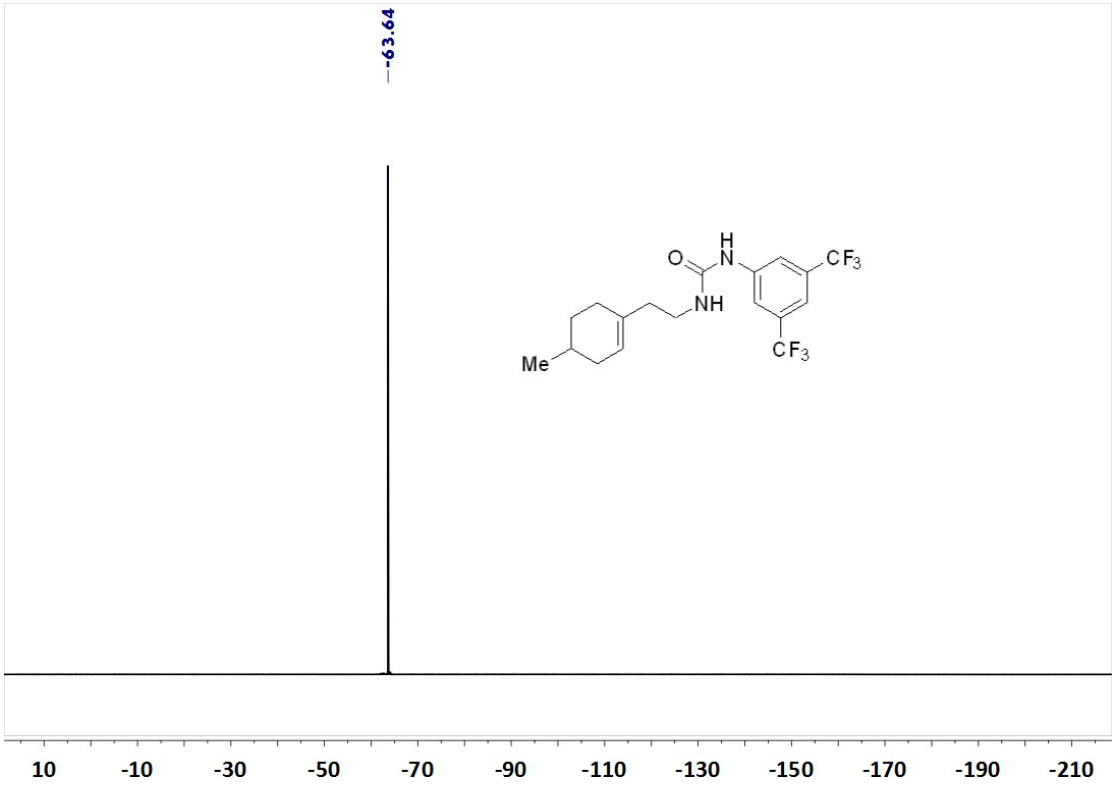
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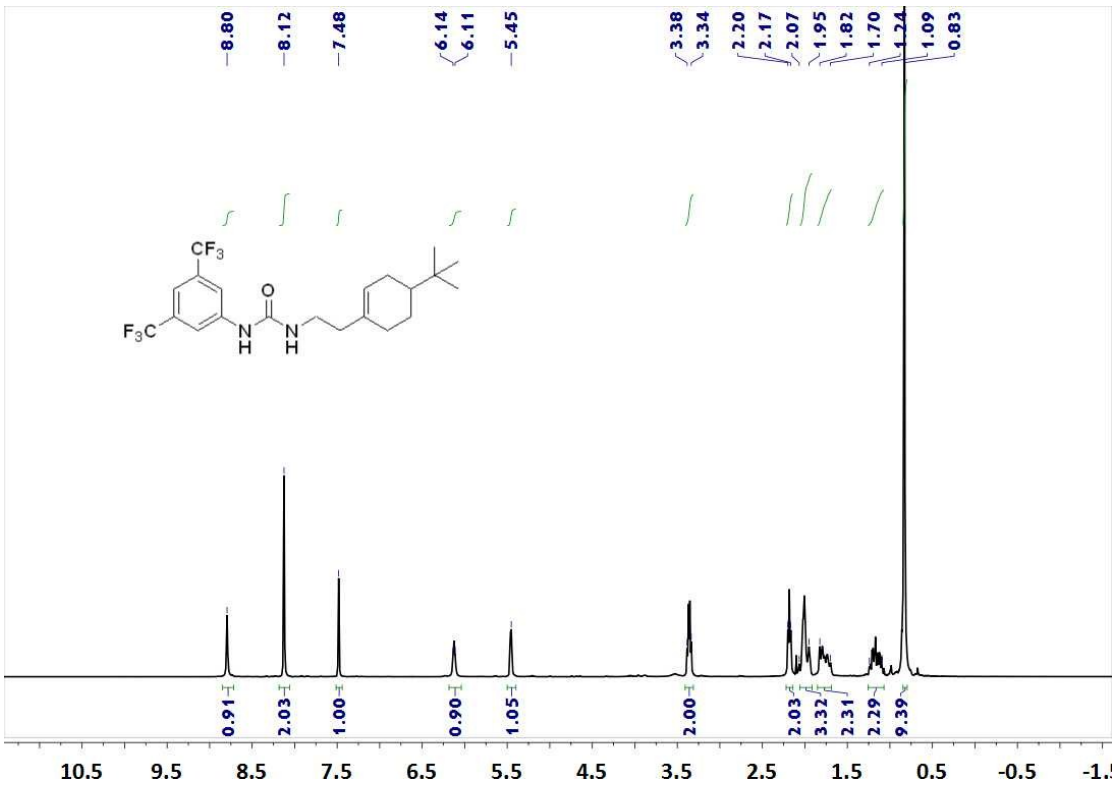
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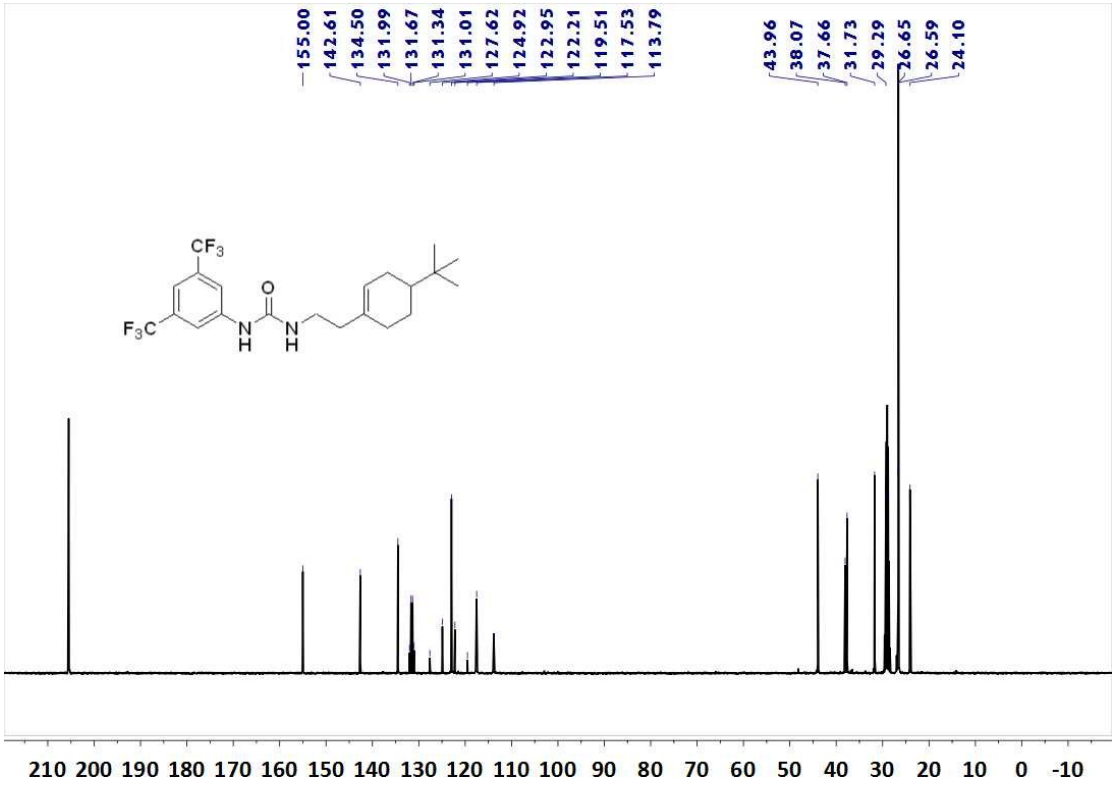
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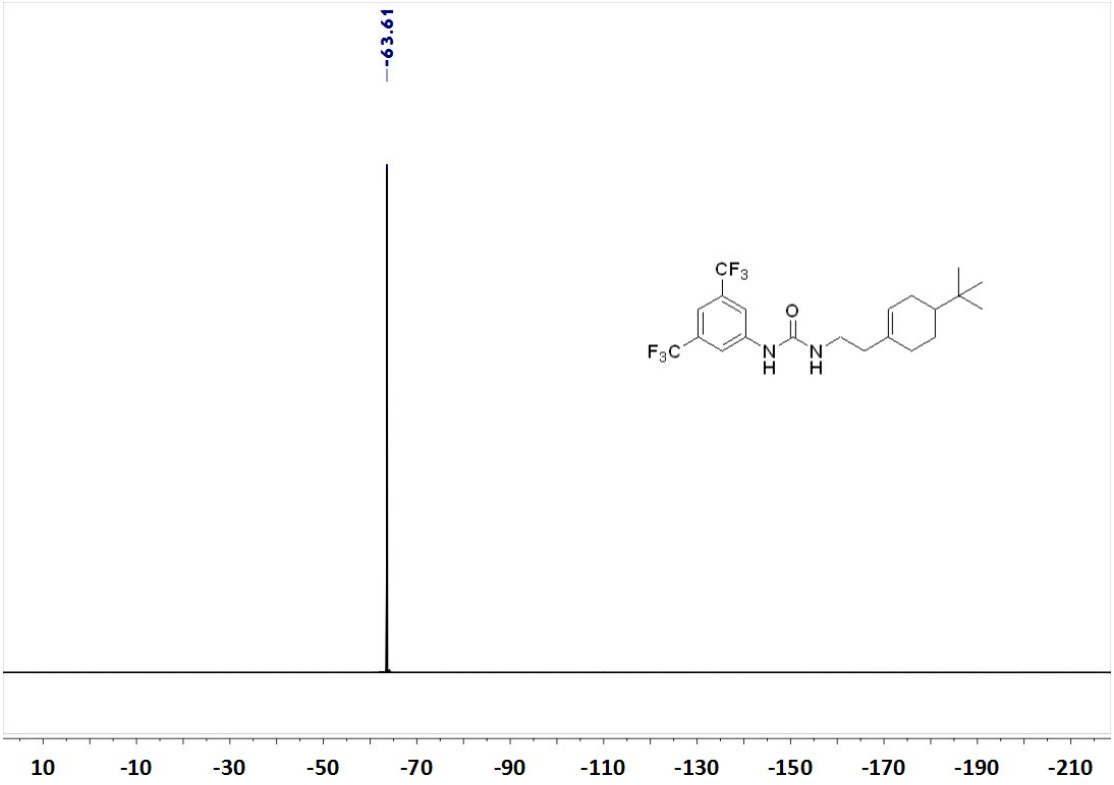
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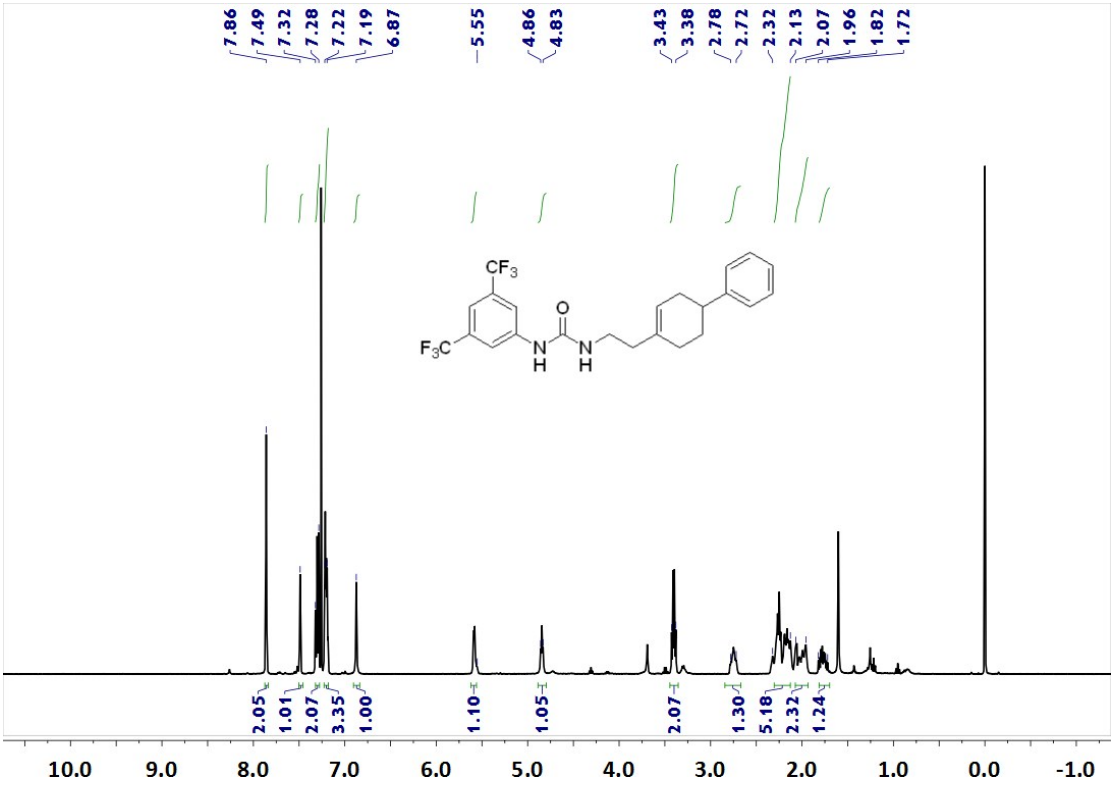
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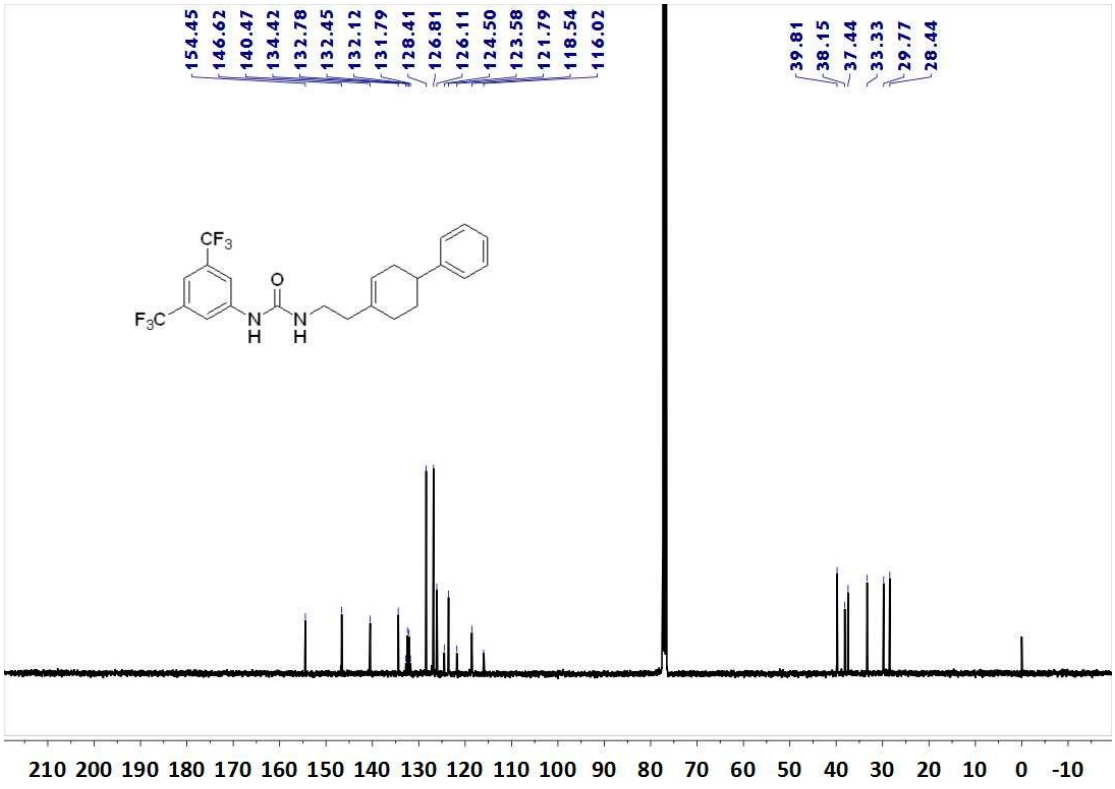
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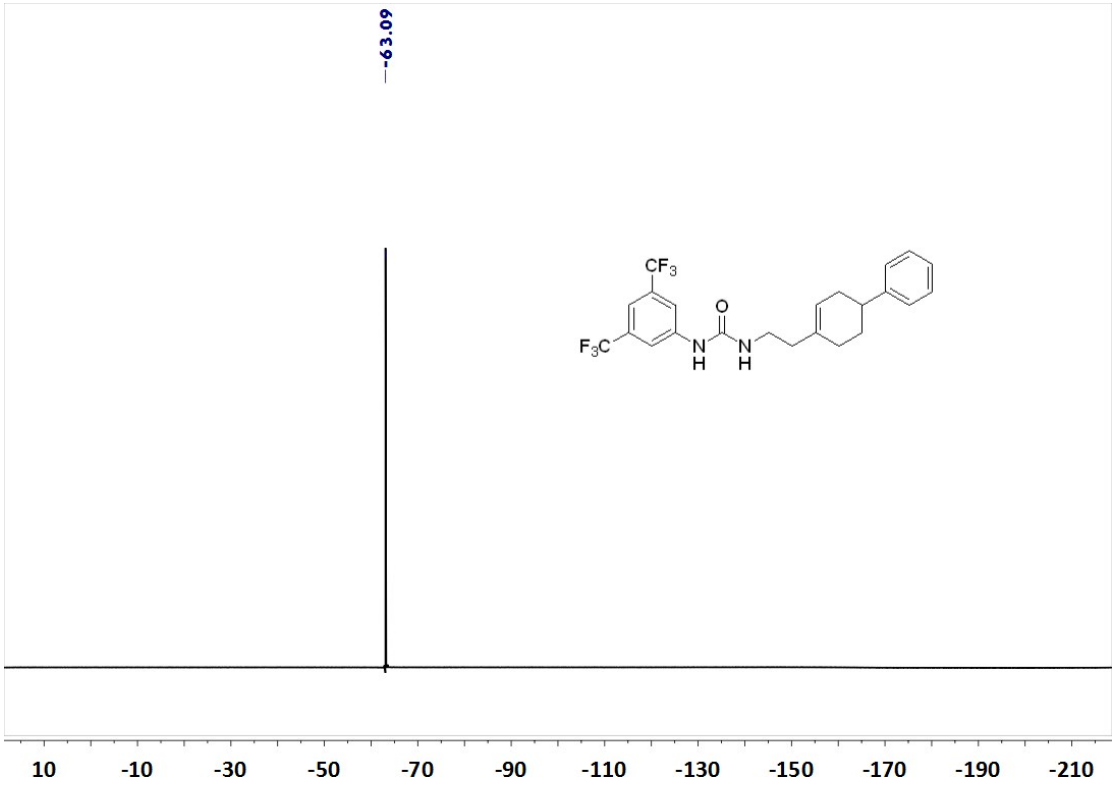
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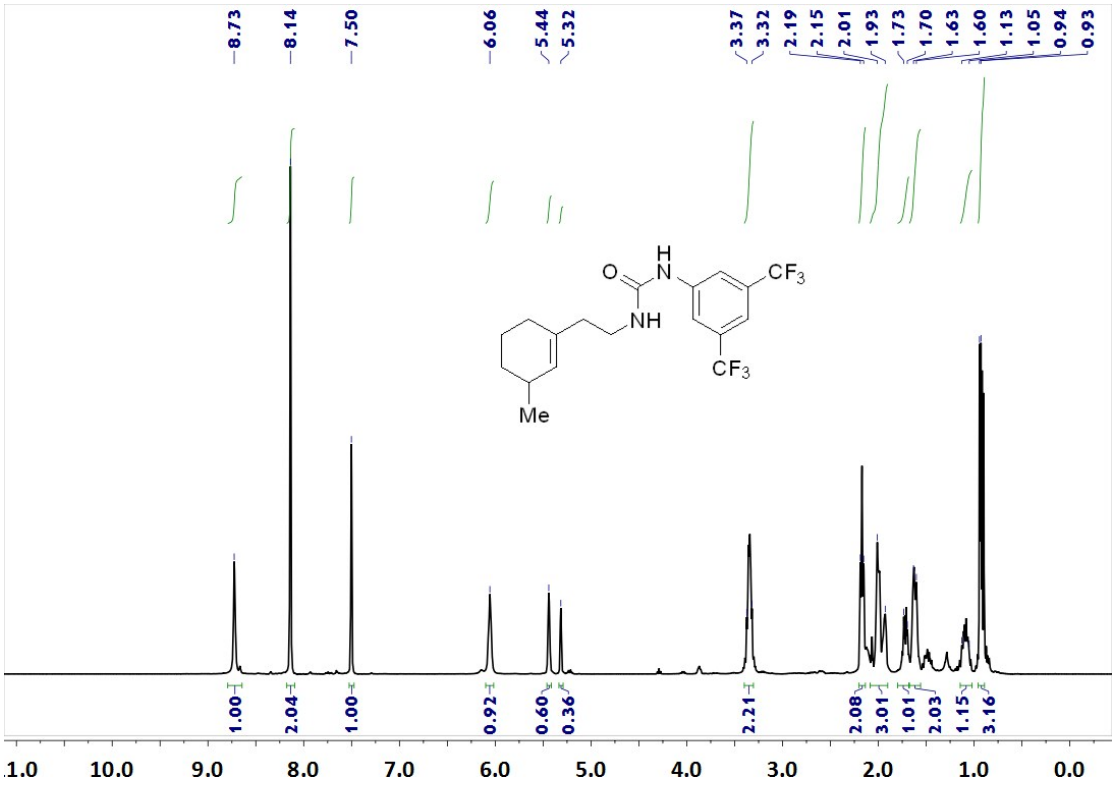
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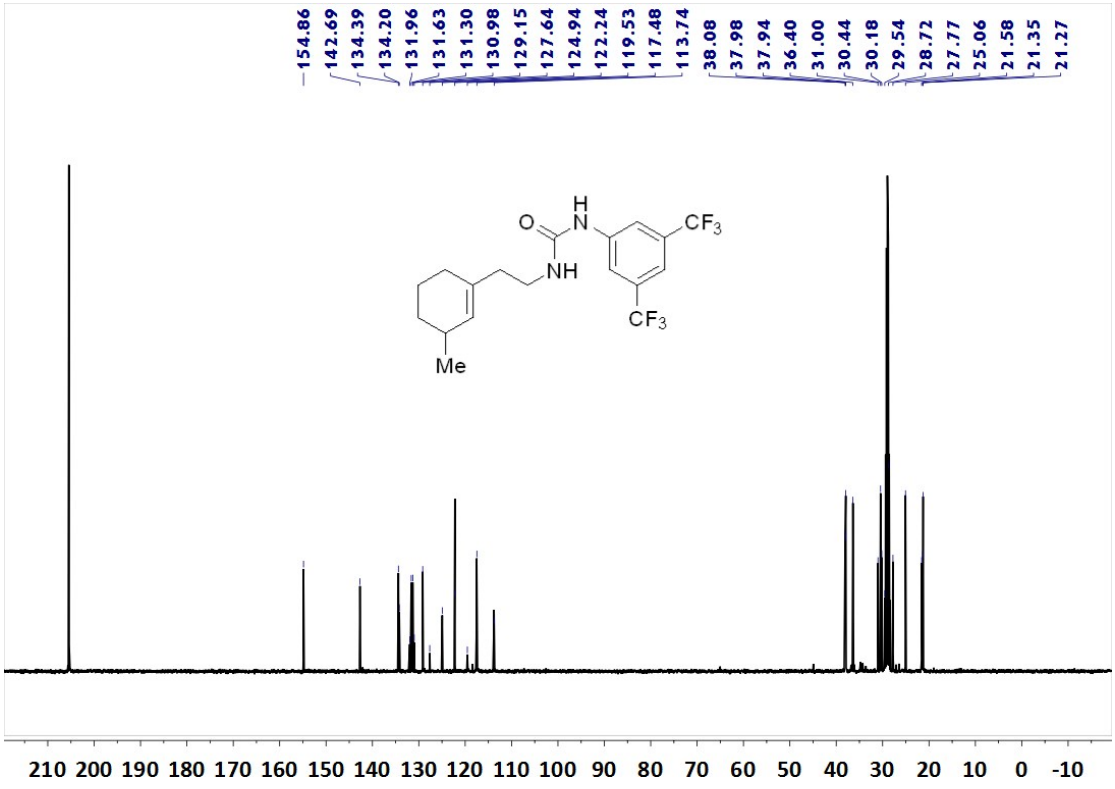
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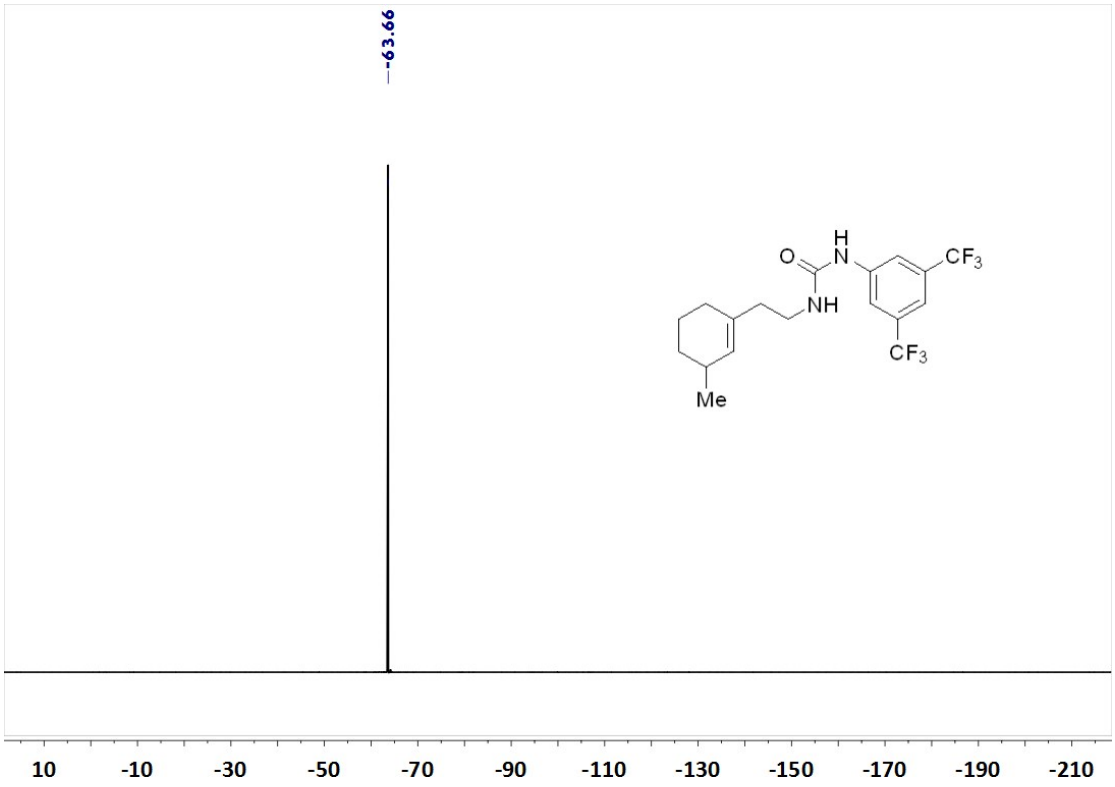
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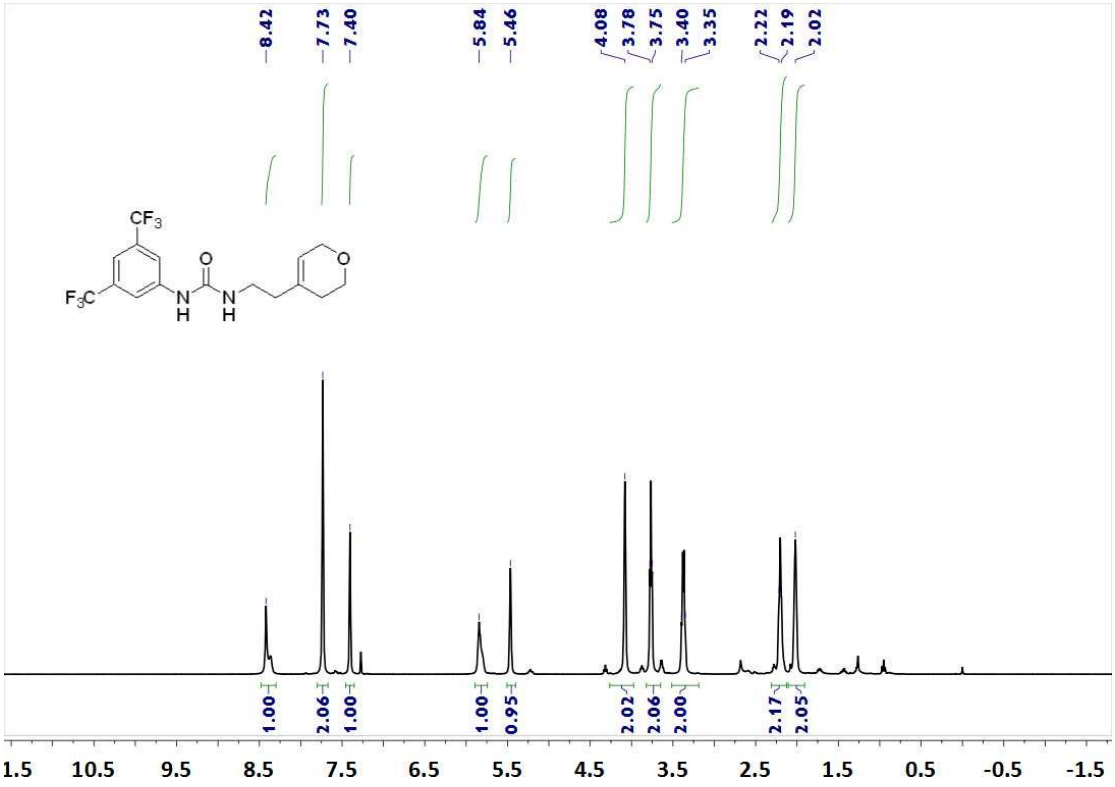
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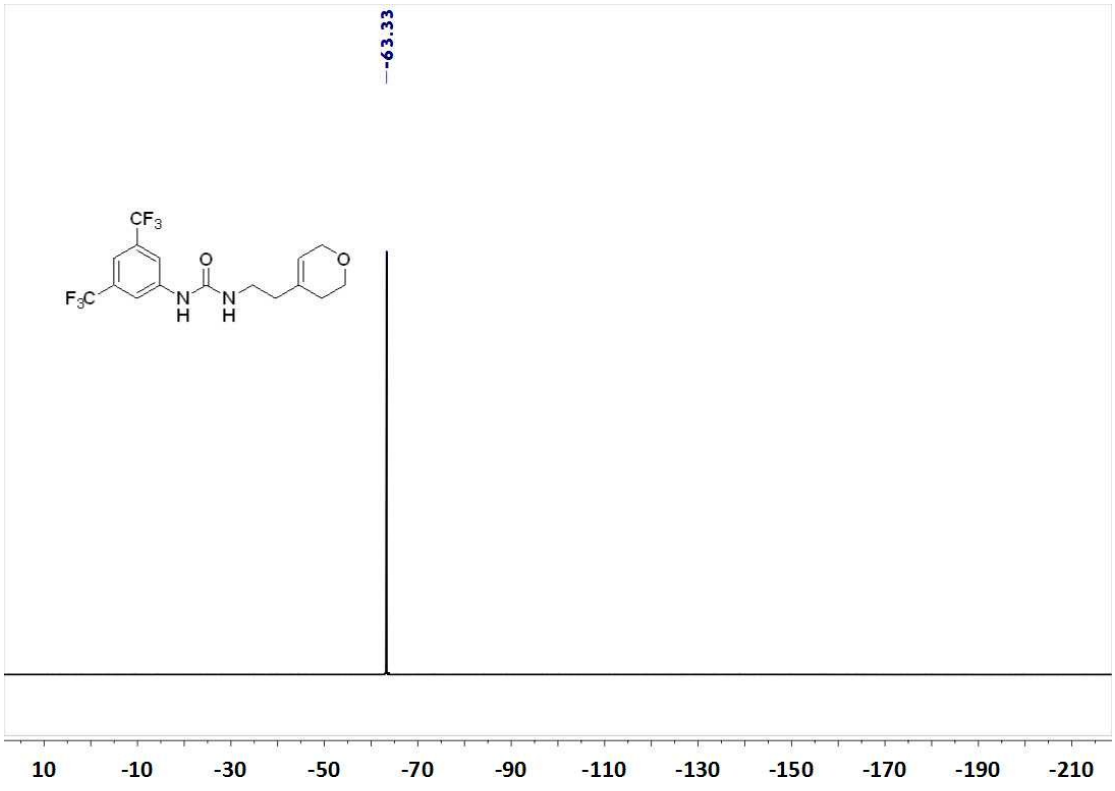
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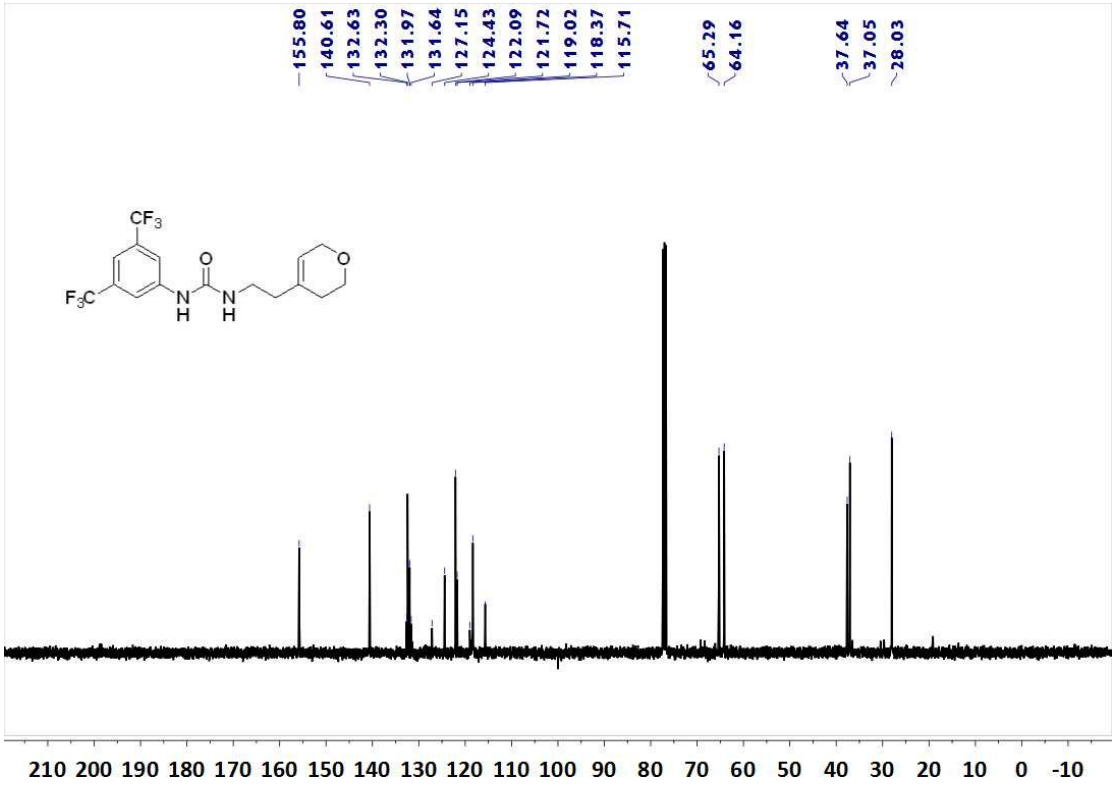
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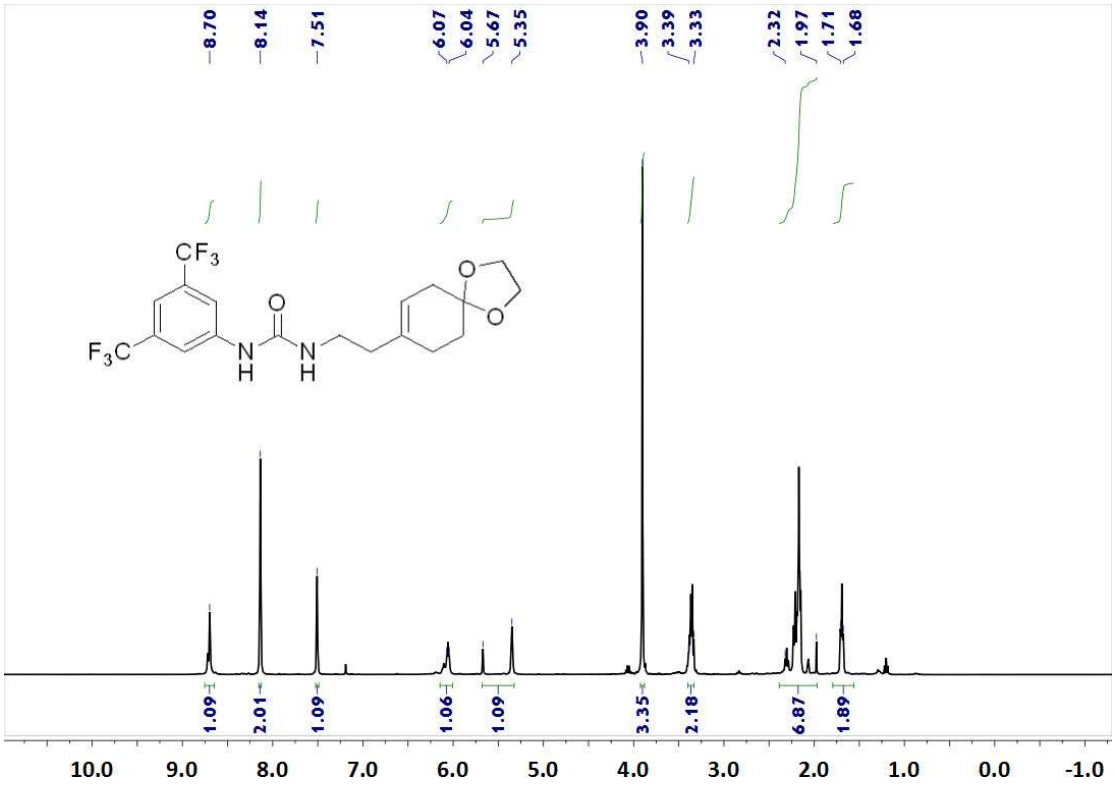
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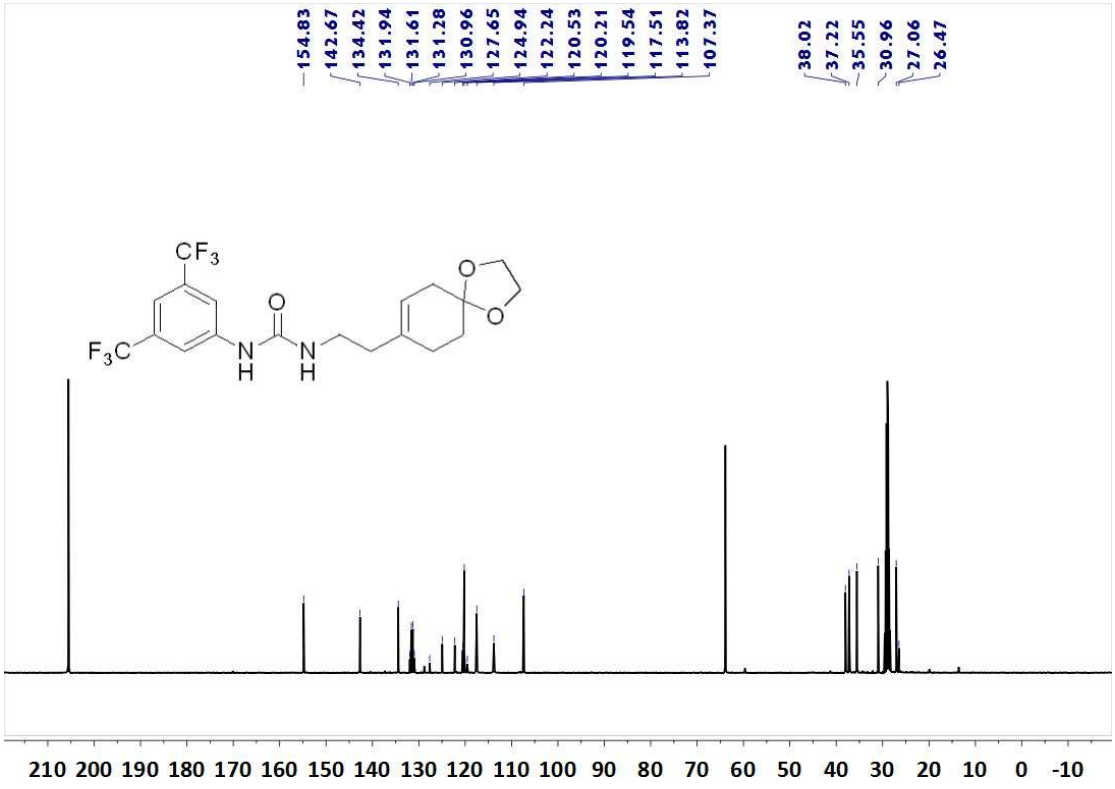
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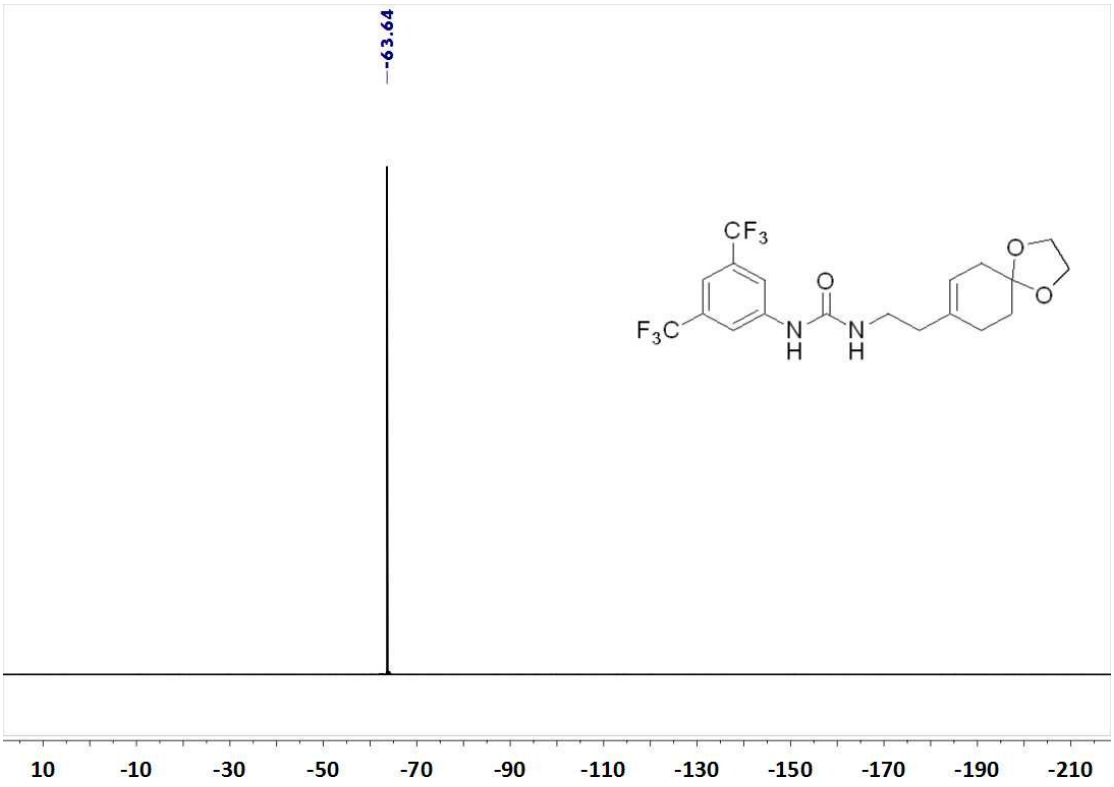
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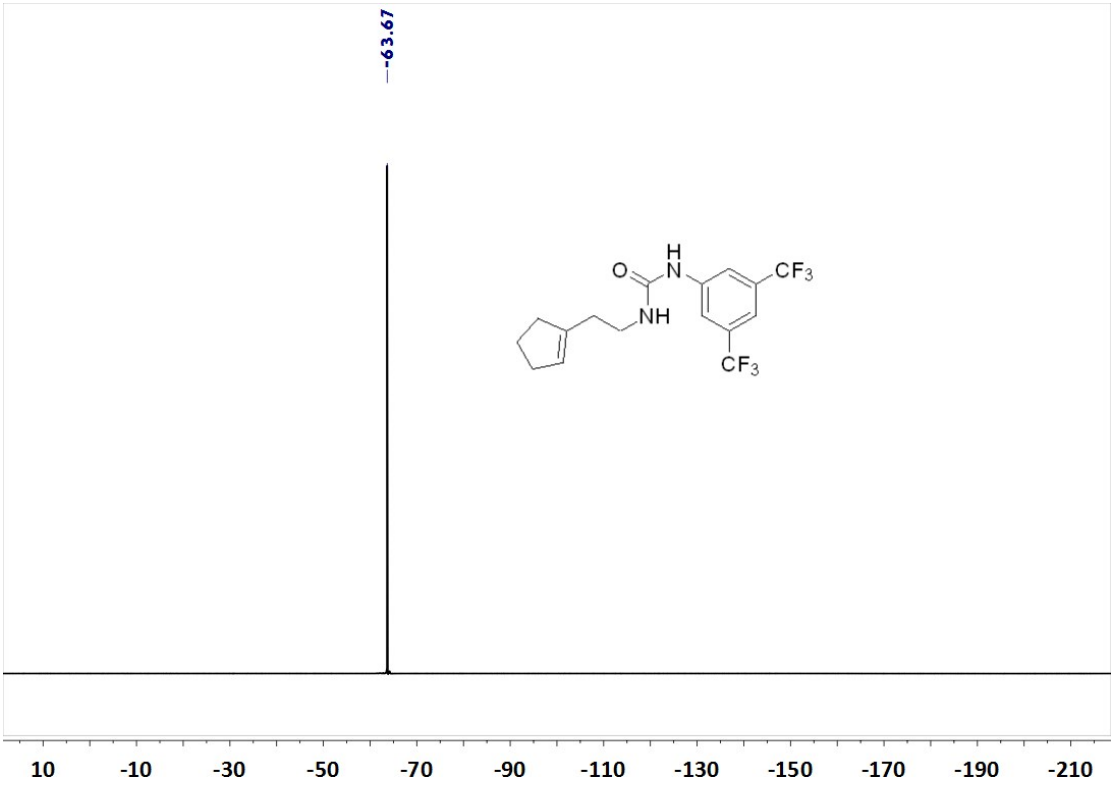
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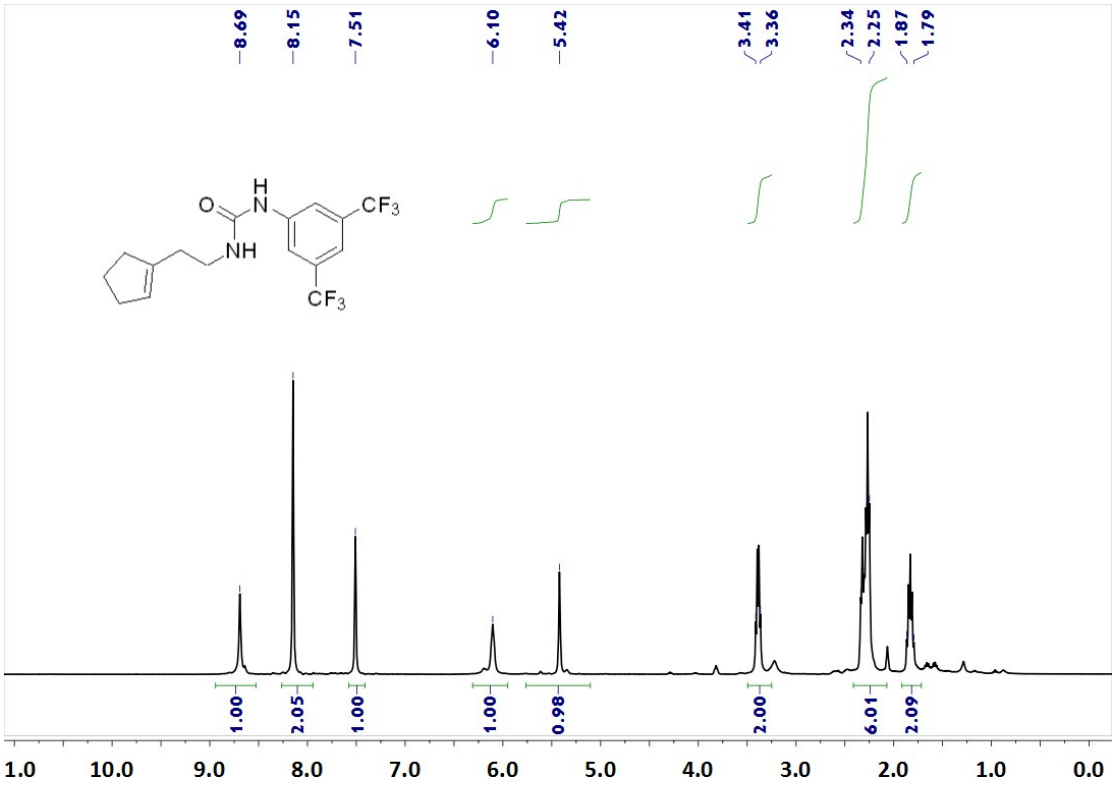
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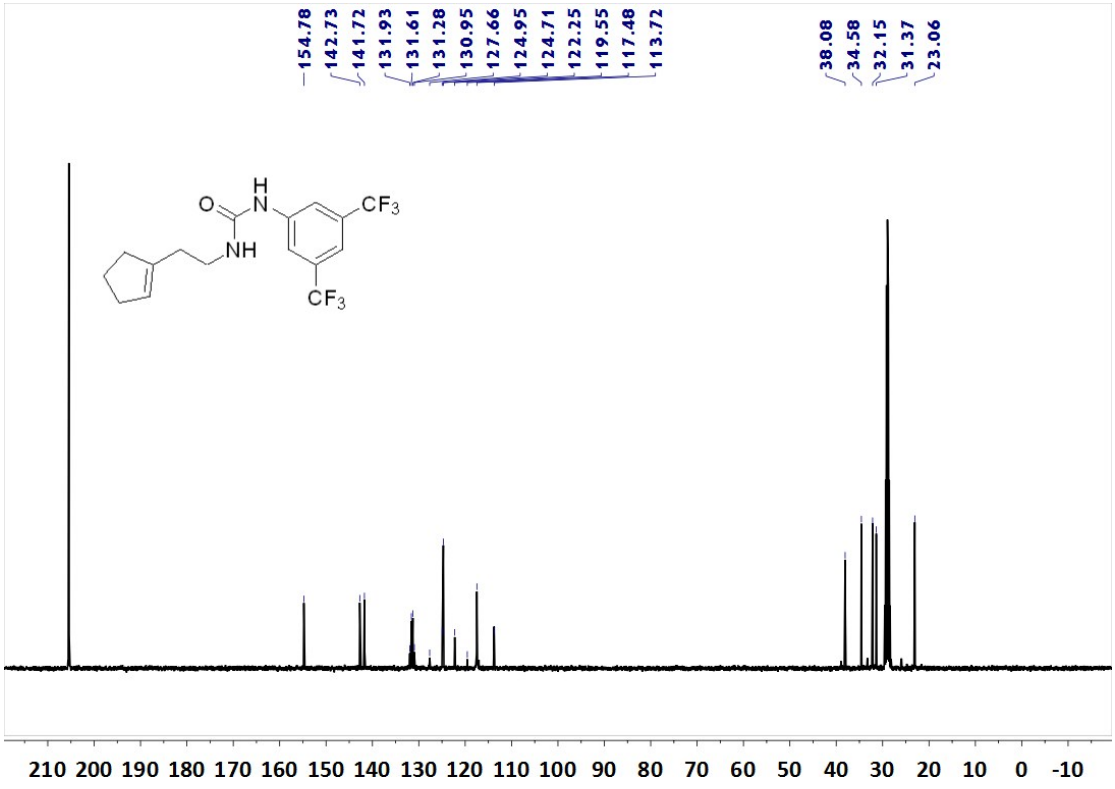
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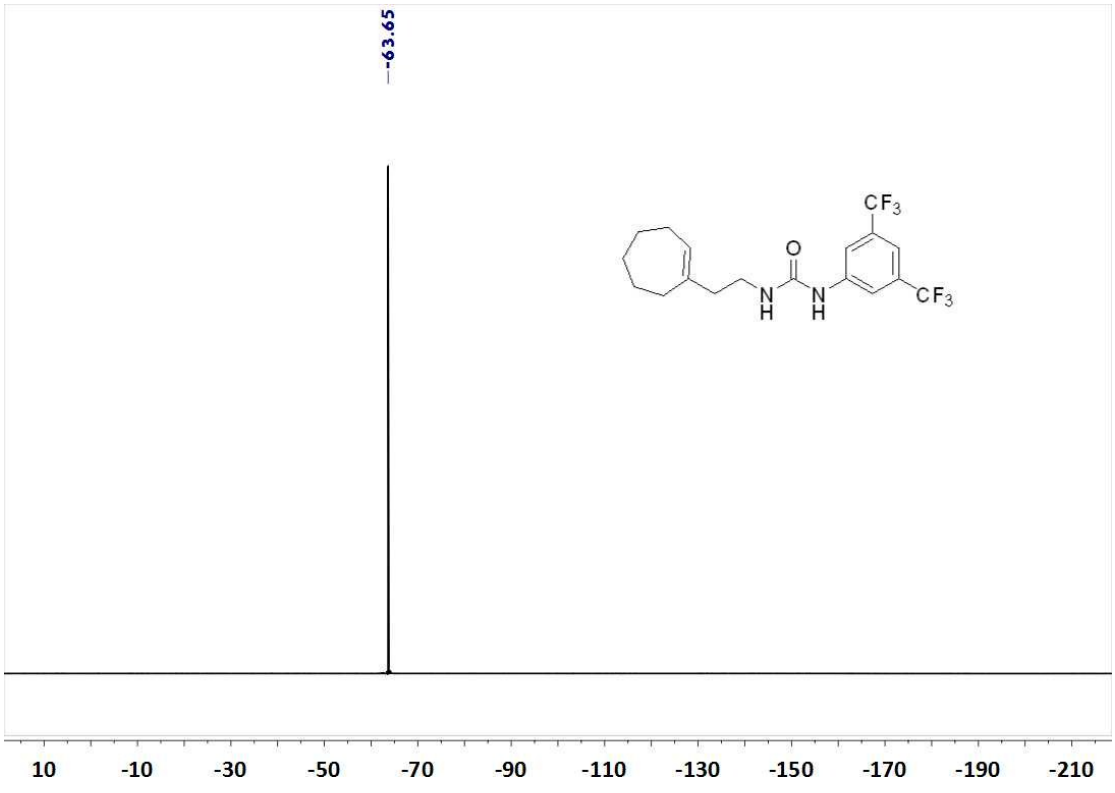
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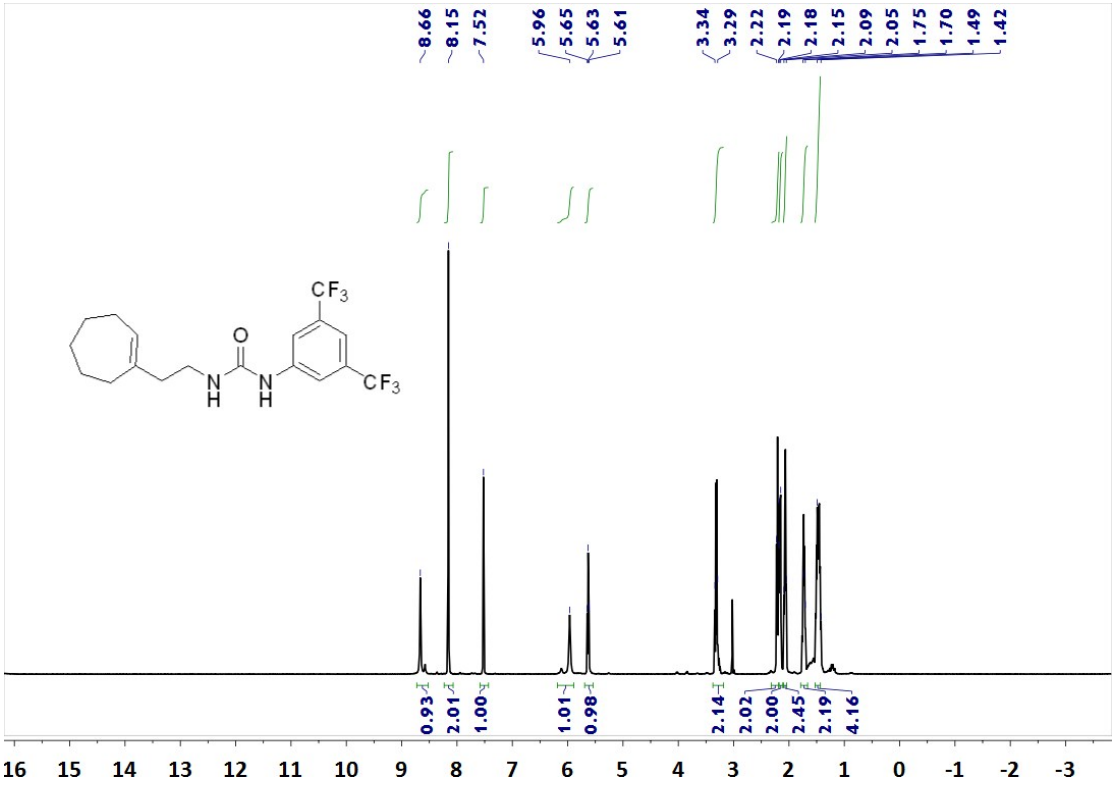
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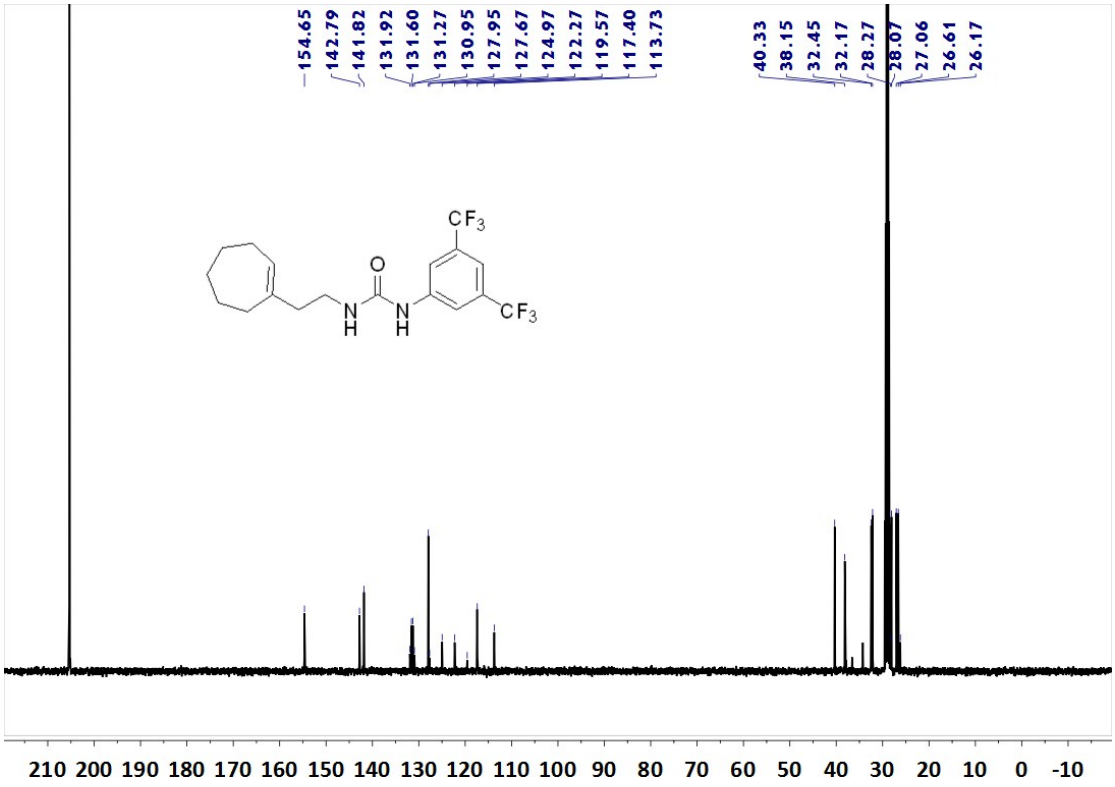
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27.06
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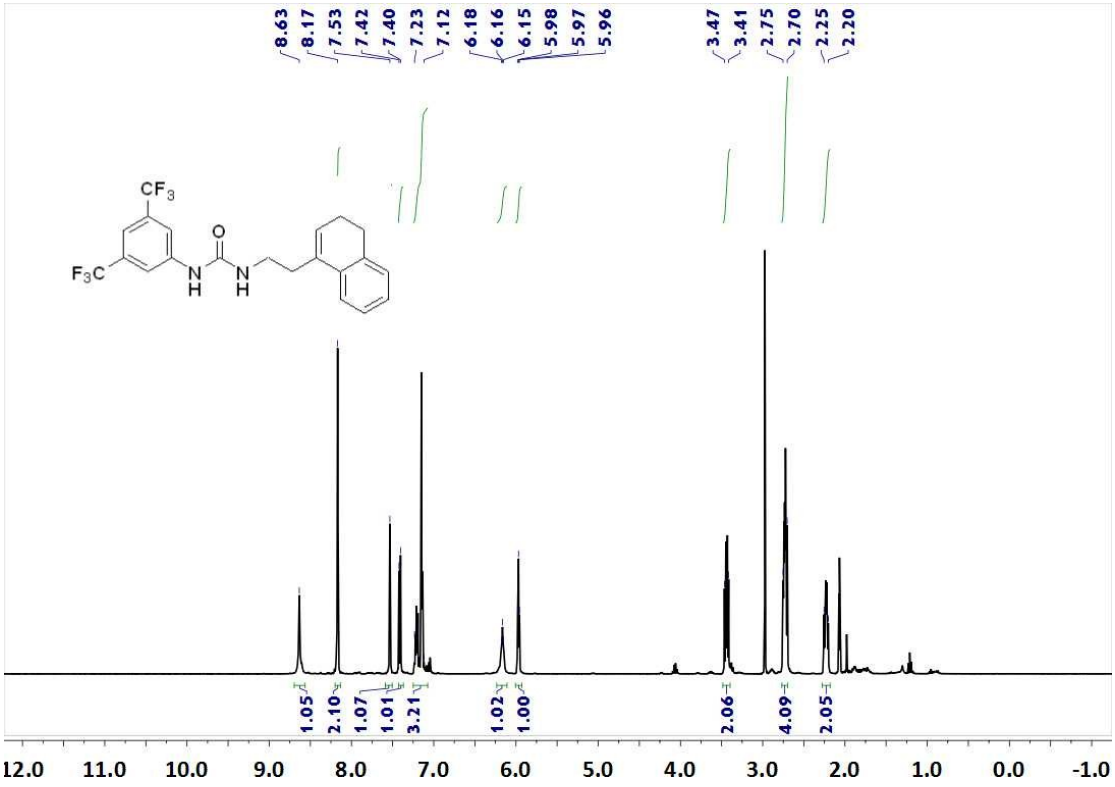
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N
H
N
H
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2.10
1.07
1.01
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1.02
1.00
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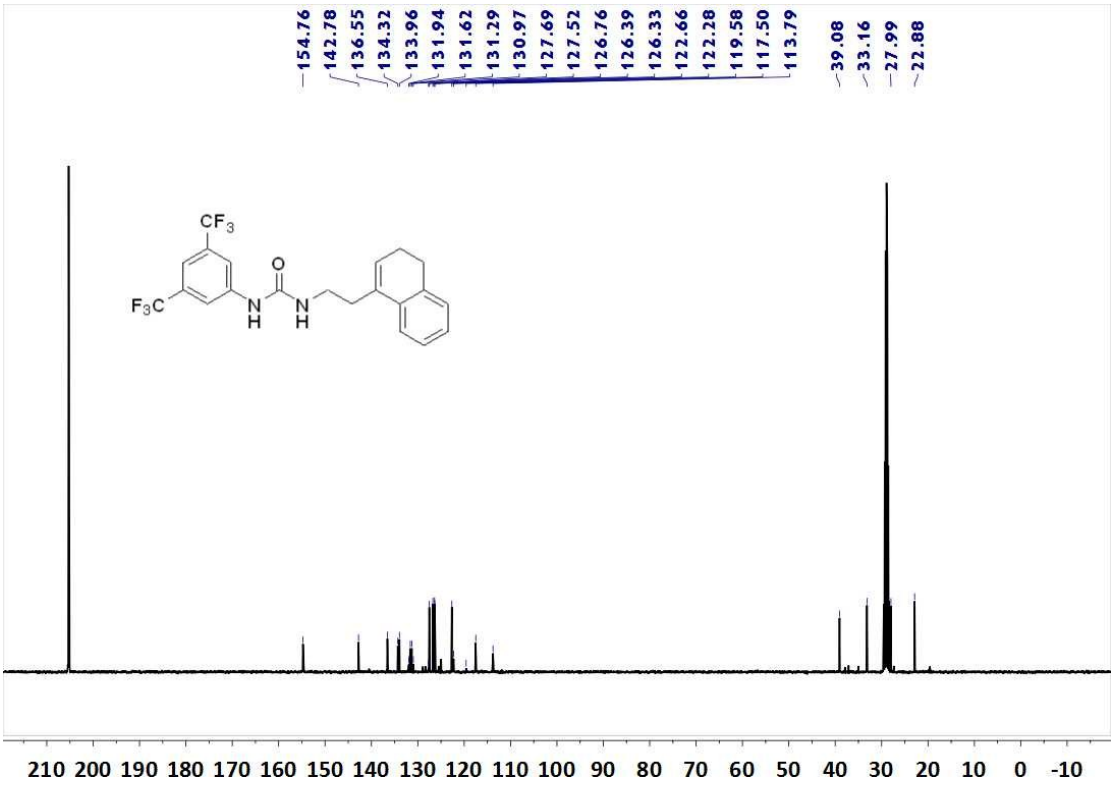
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33.16
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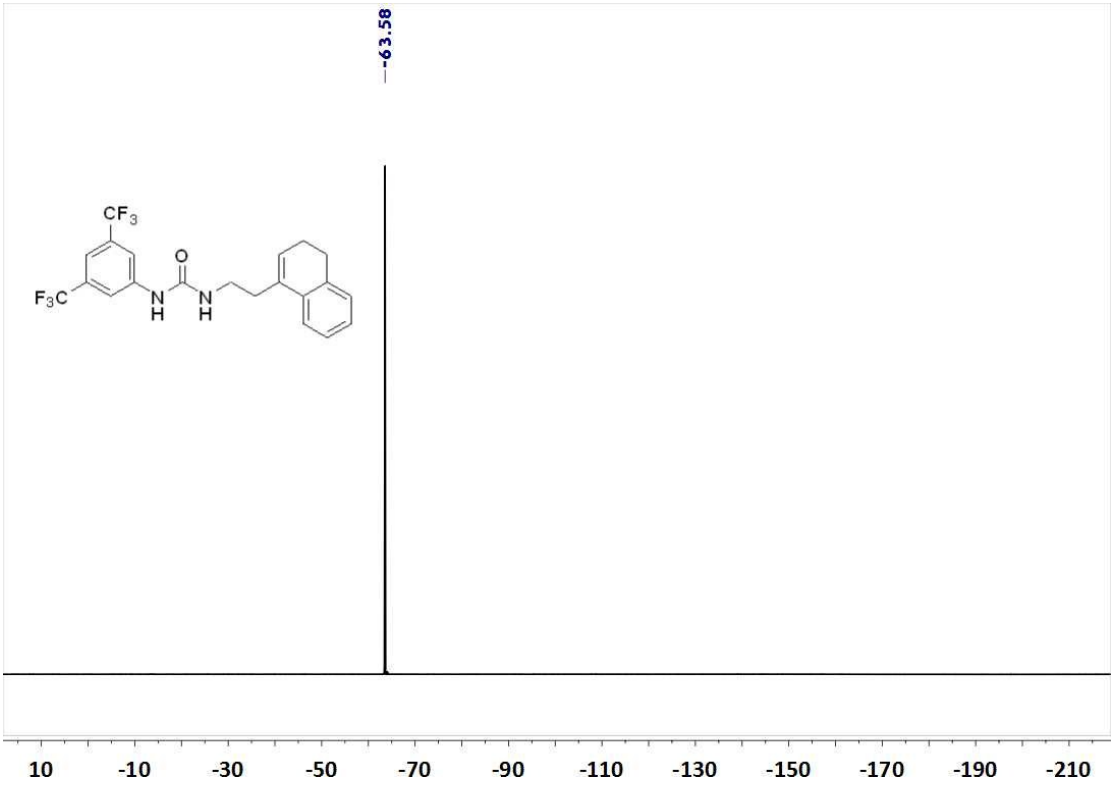
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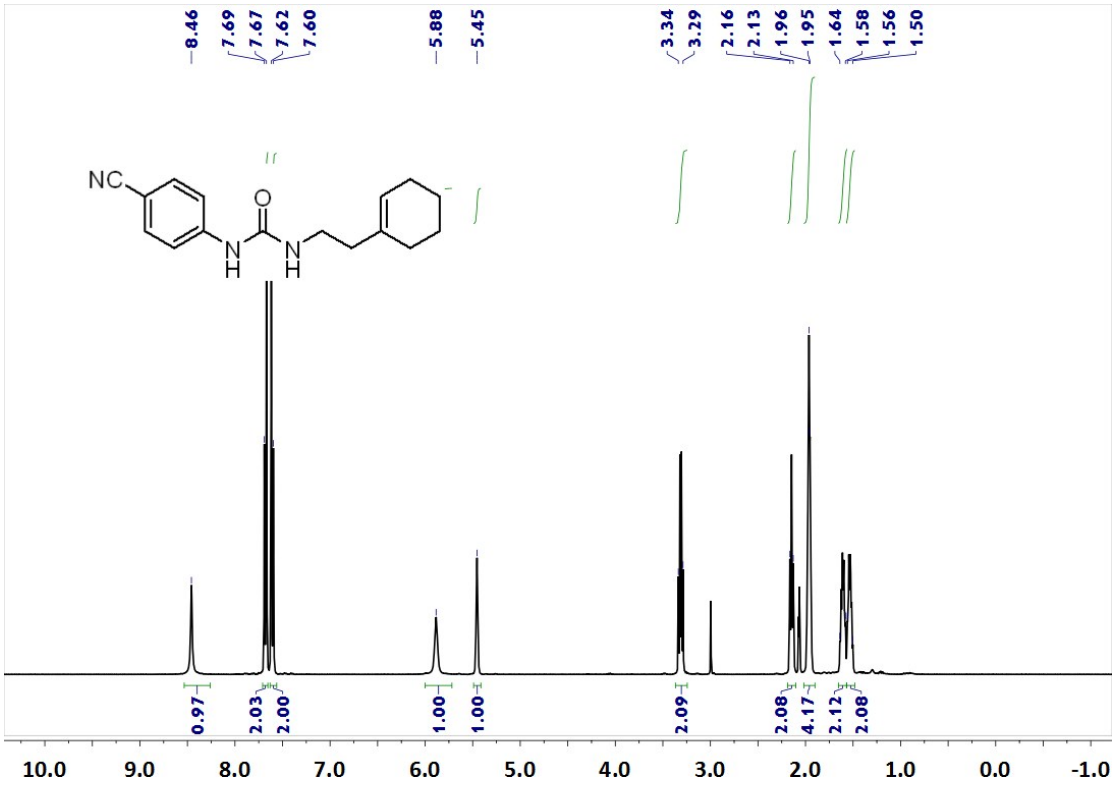
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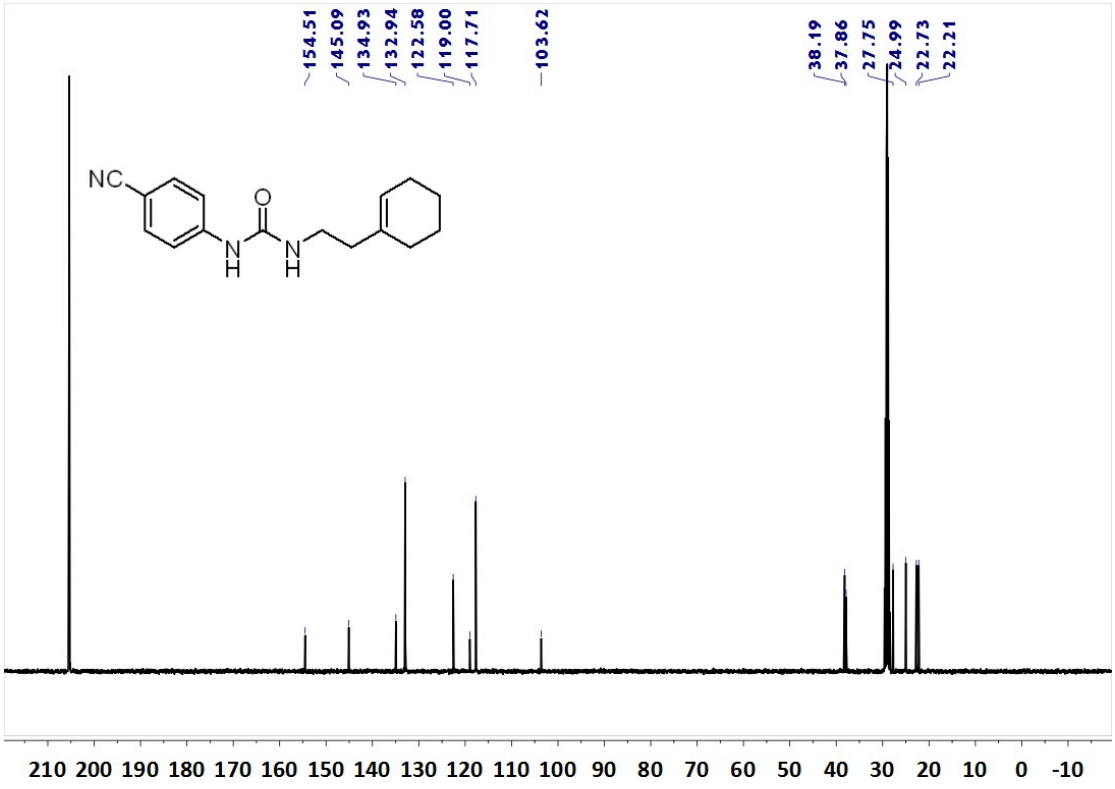
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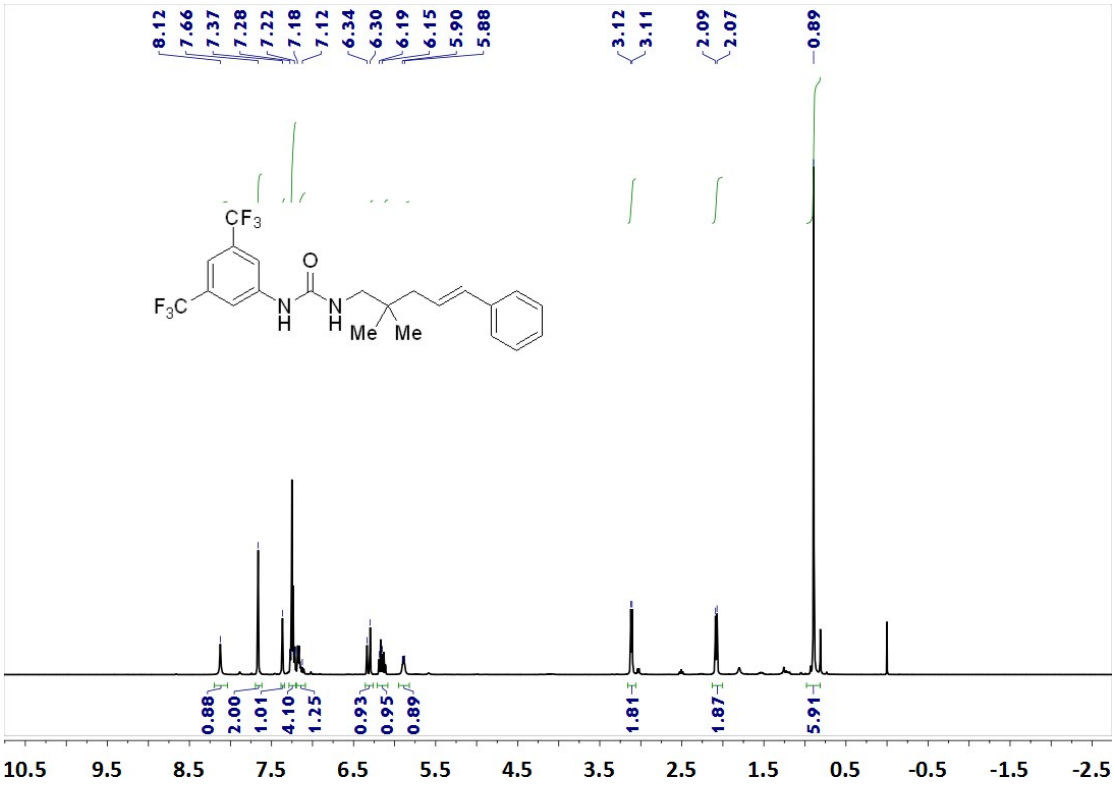
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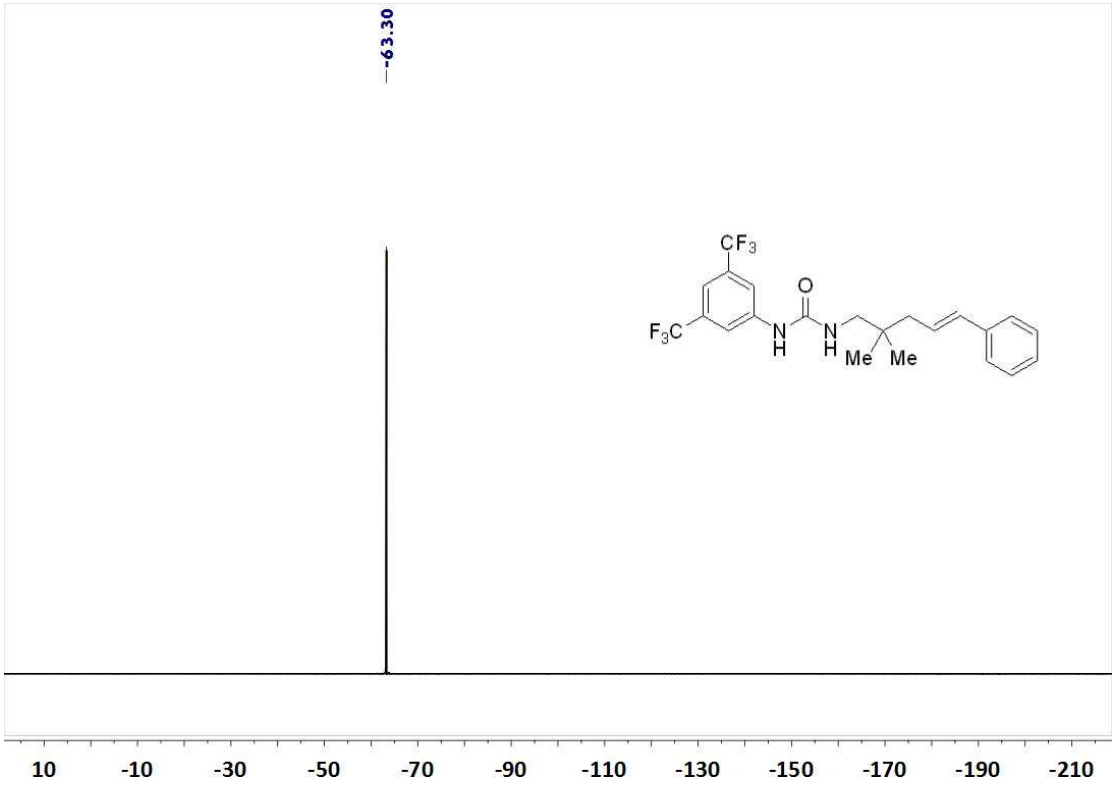
-2.5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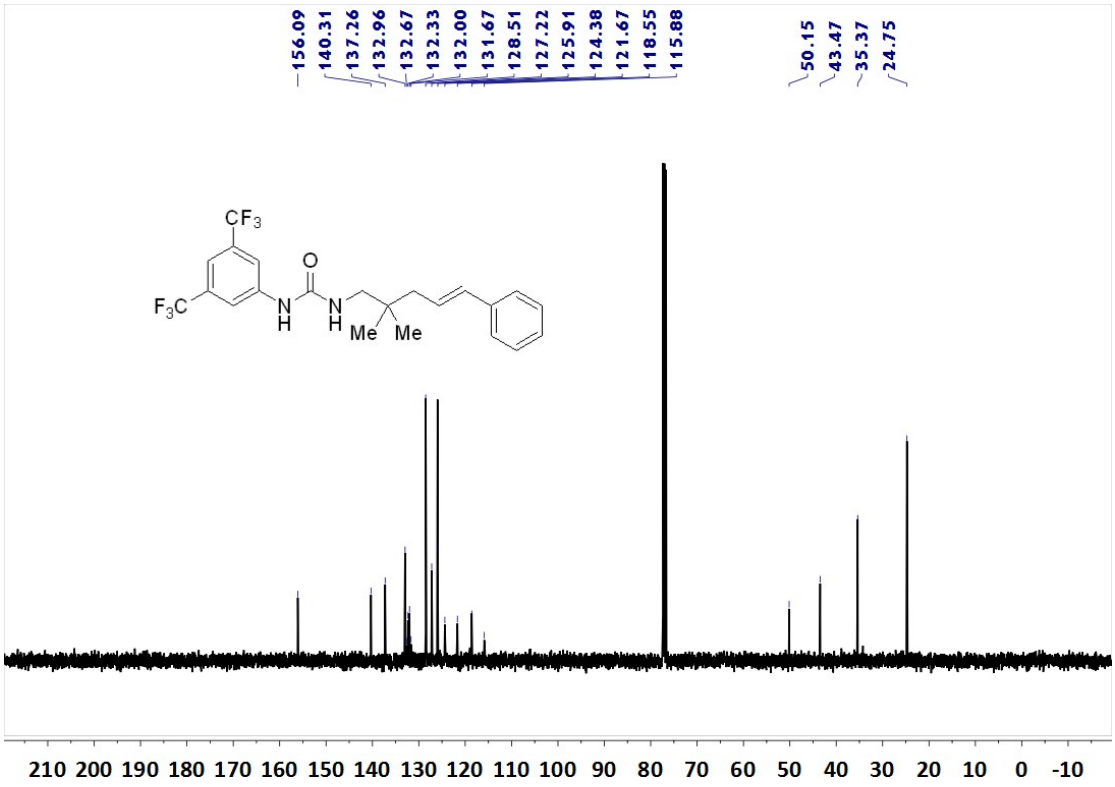
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Me
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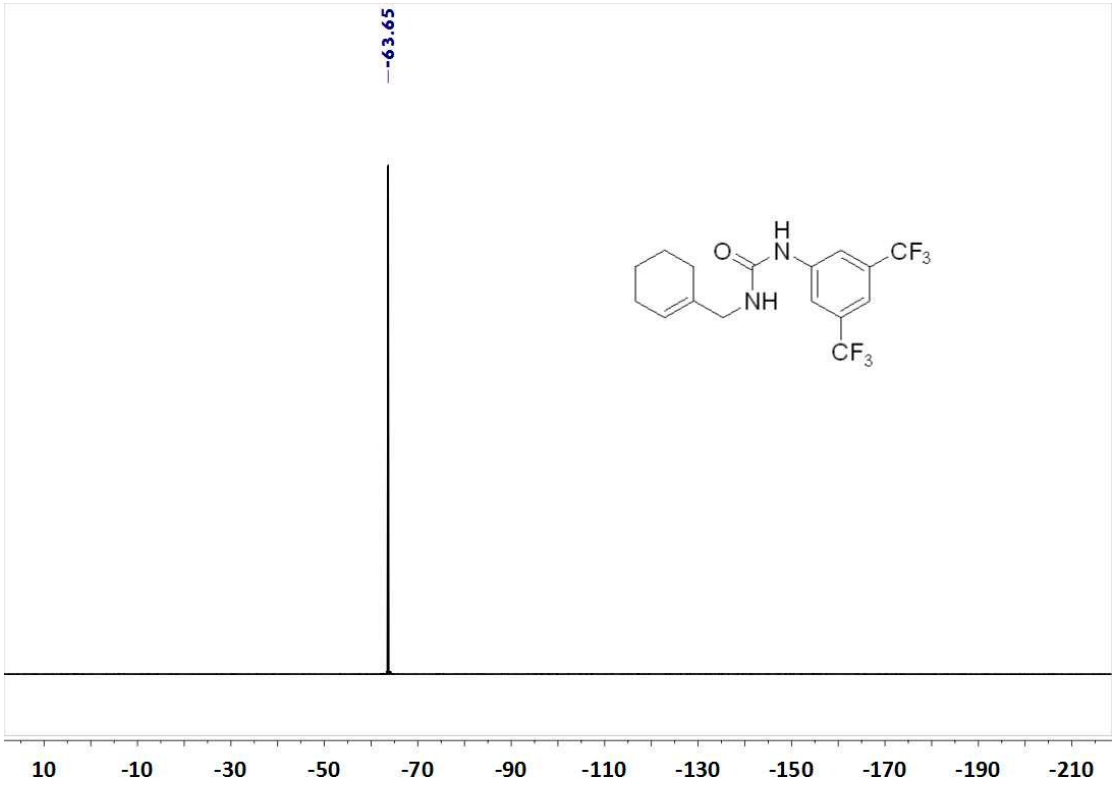
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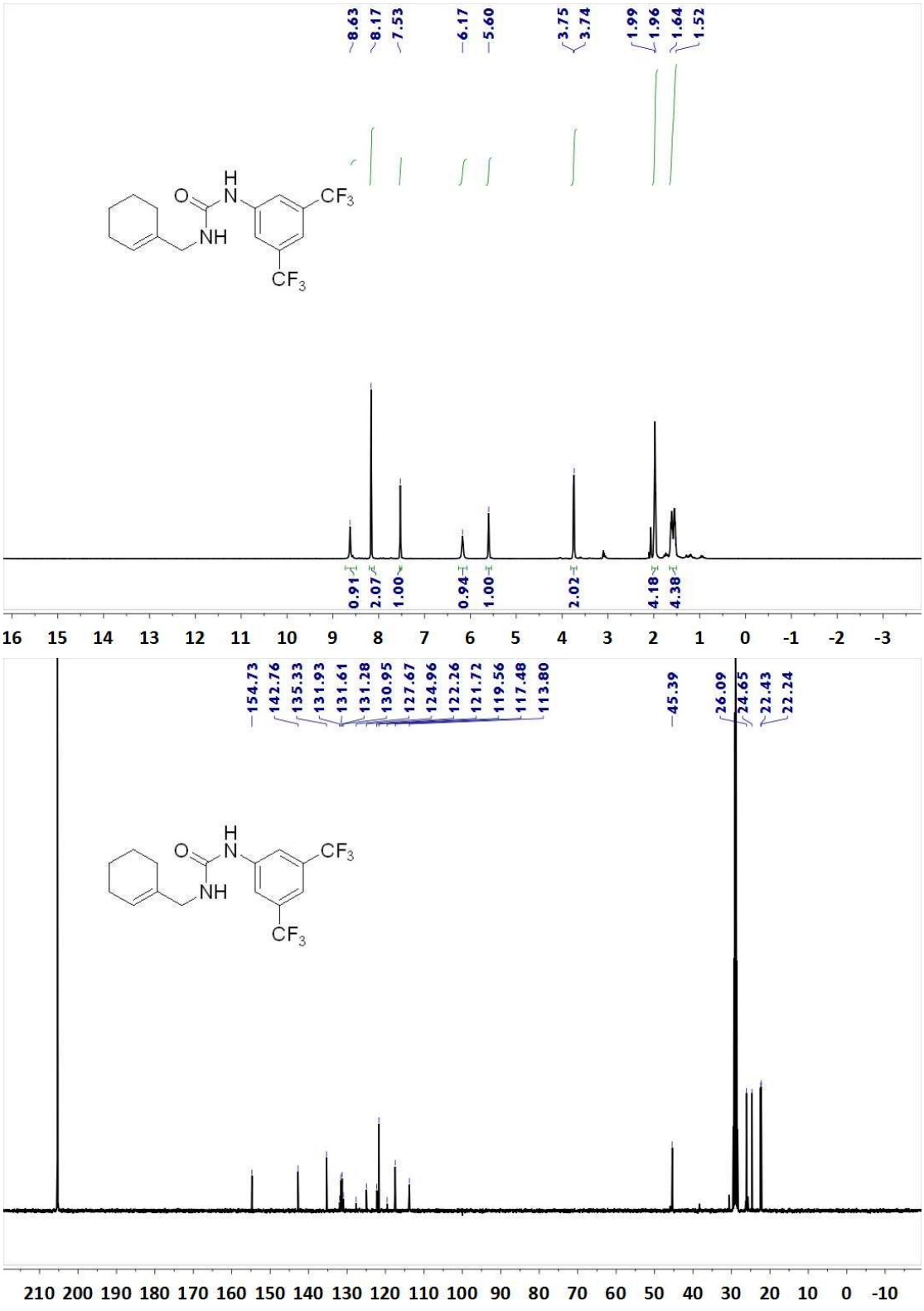
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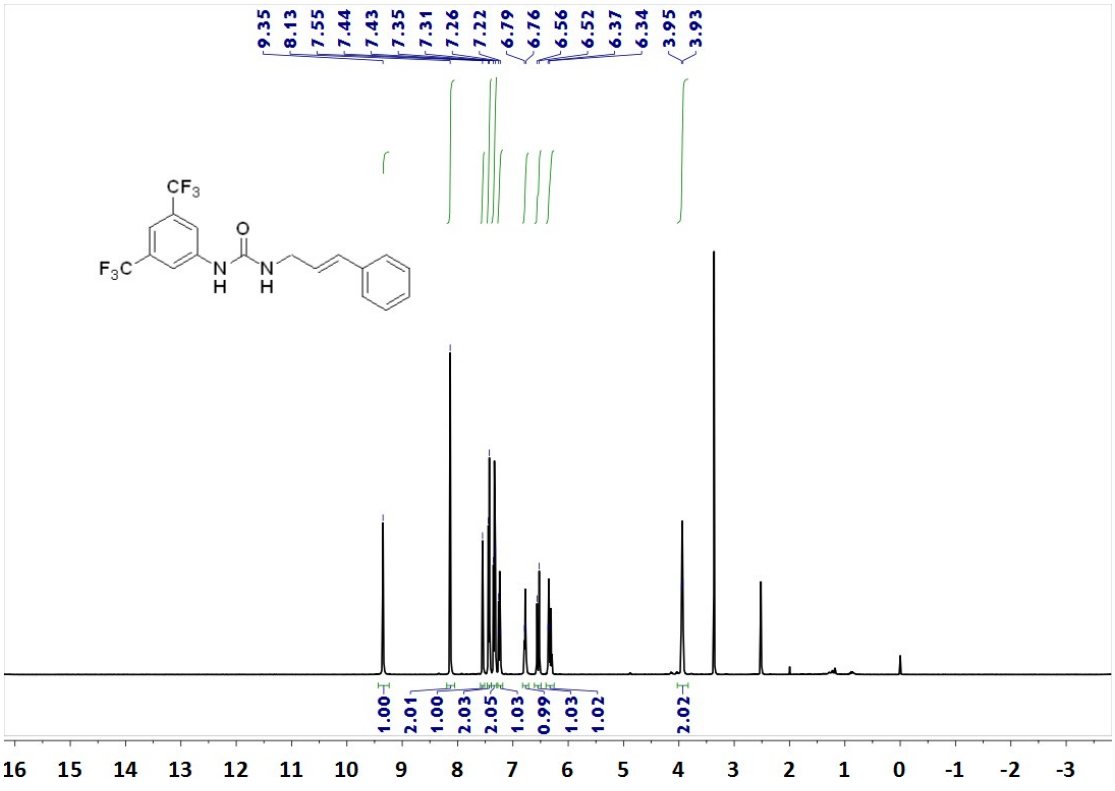
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6.37
6.34
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3.93
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F3C
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H
N
H
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1.00
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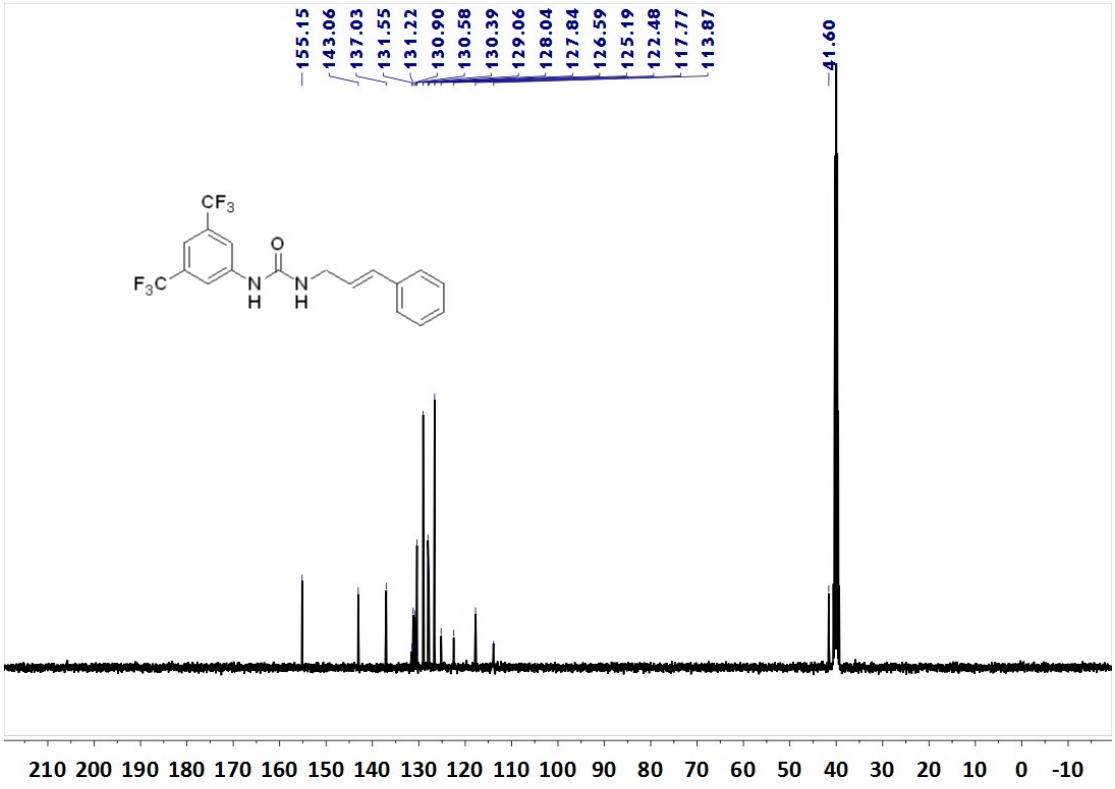
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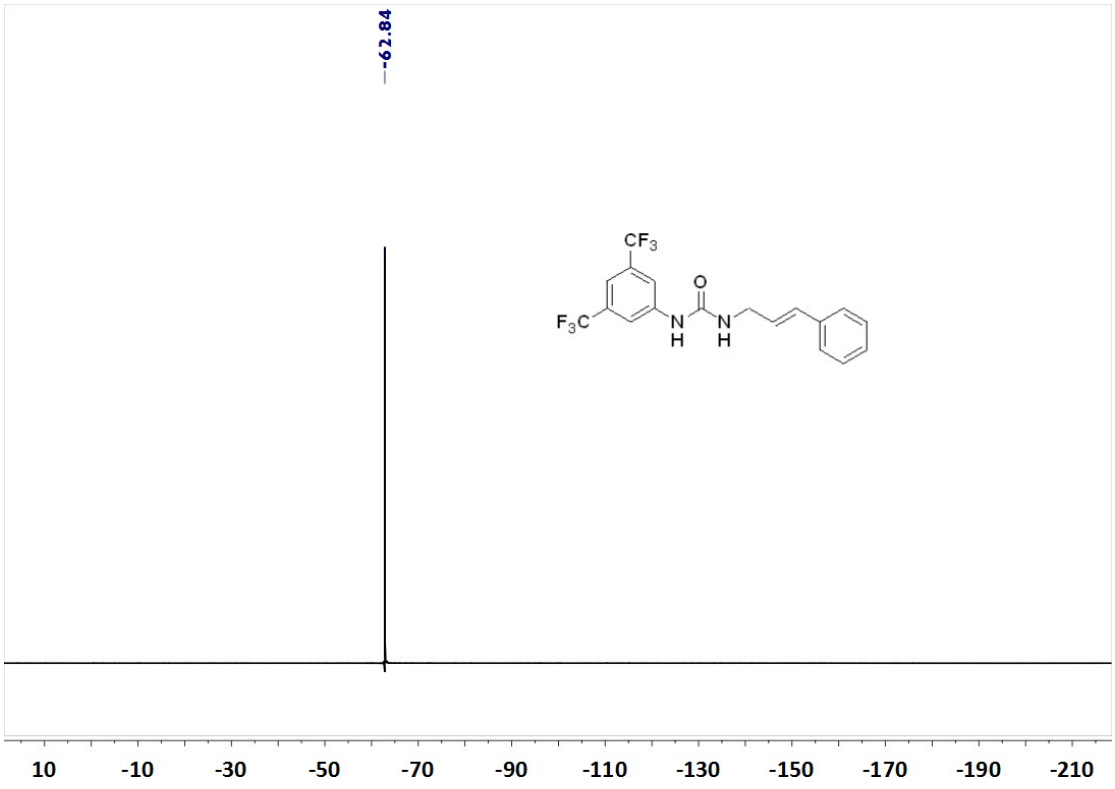
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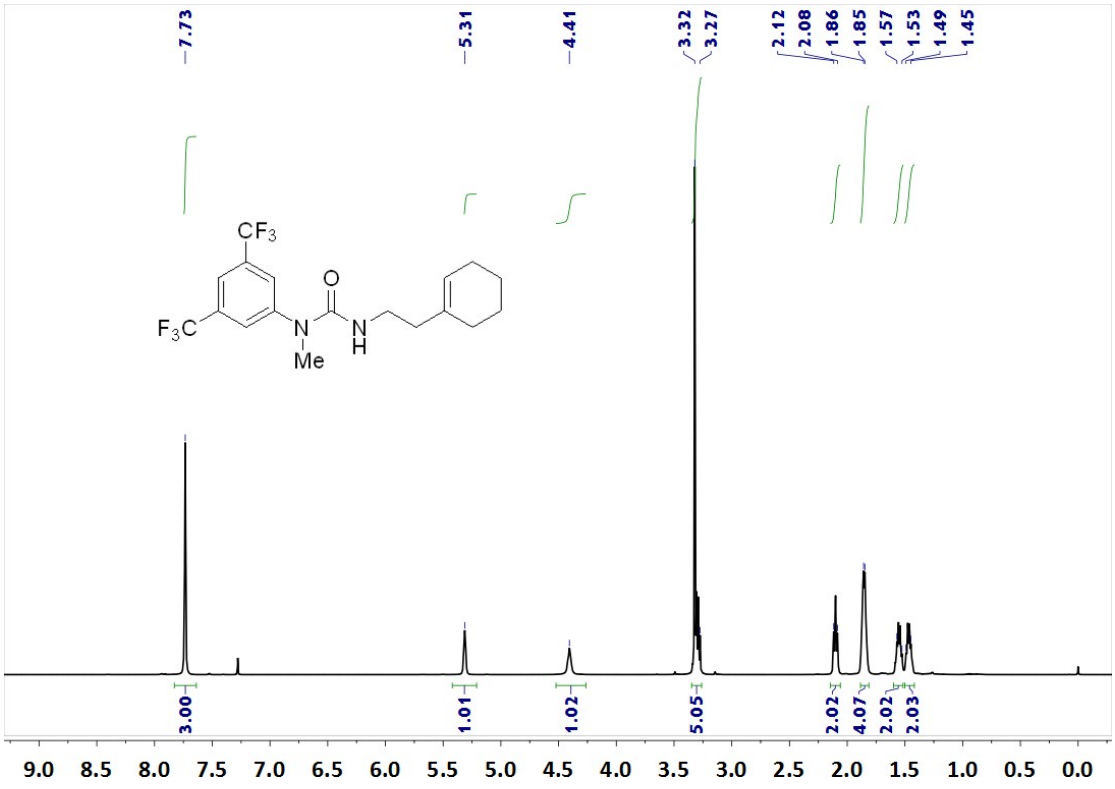
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F3C
N
Me
O
N
H
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1.01
1.02
5.05
2.02
4.07
2.02
2.03
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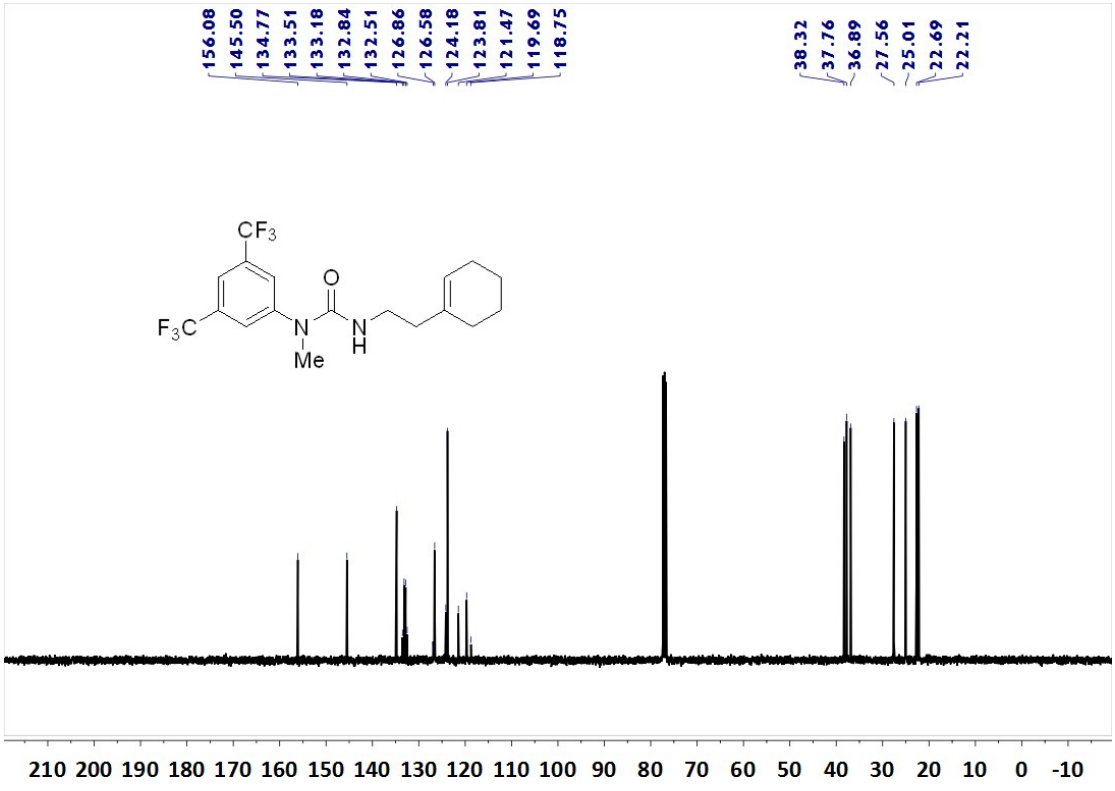
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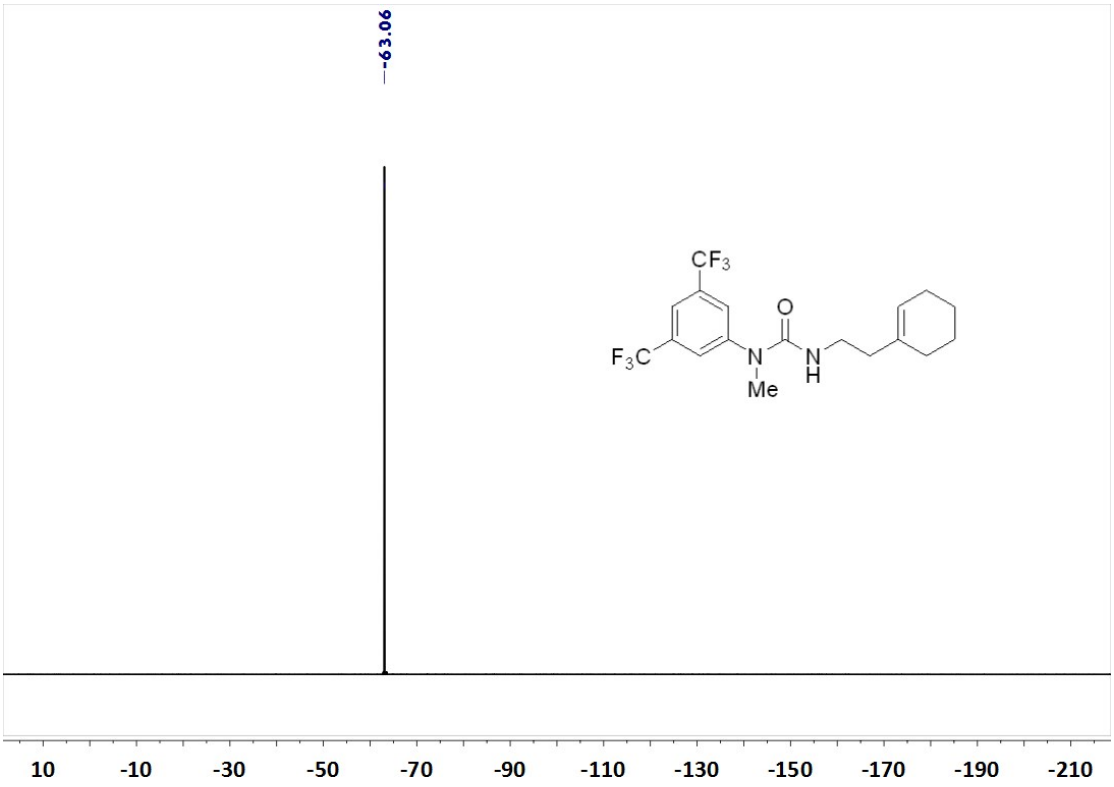
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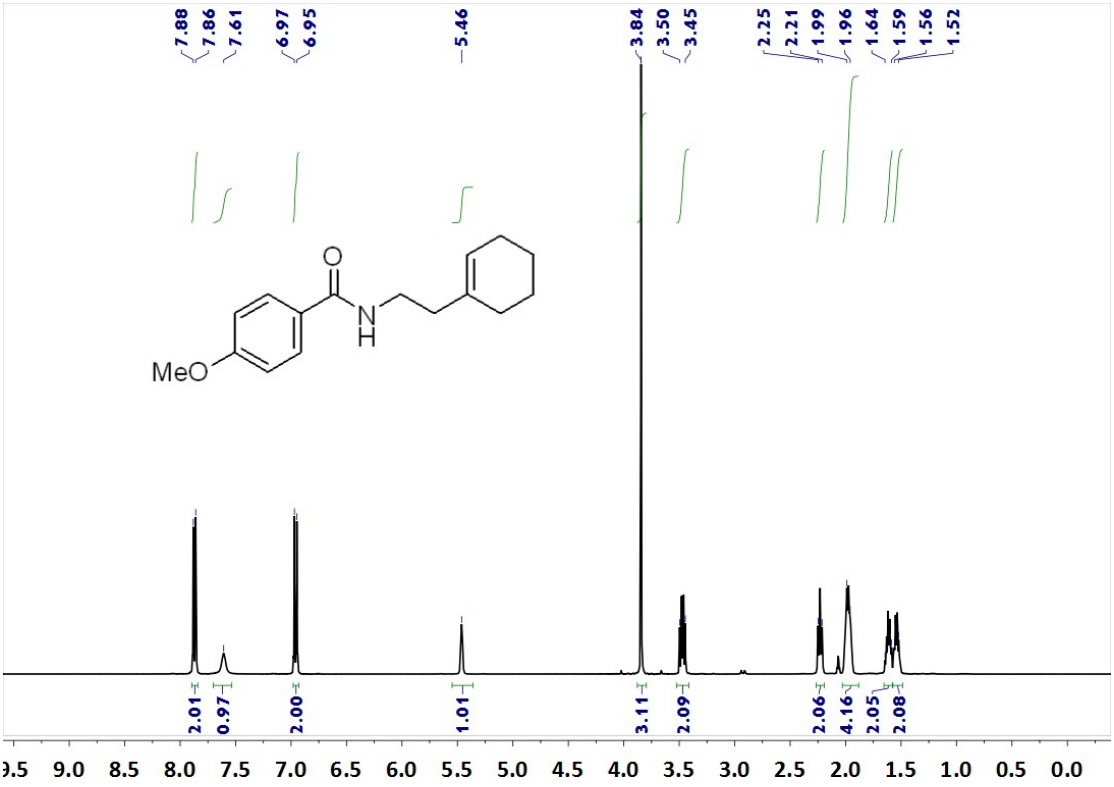
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1.56
1.52
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O
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1.01
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2.06
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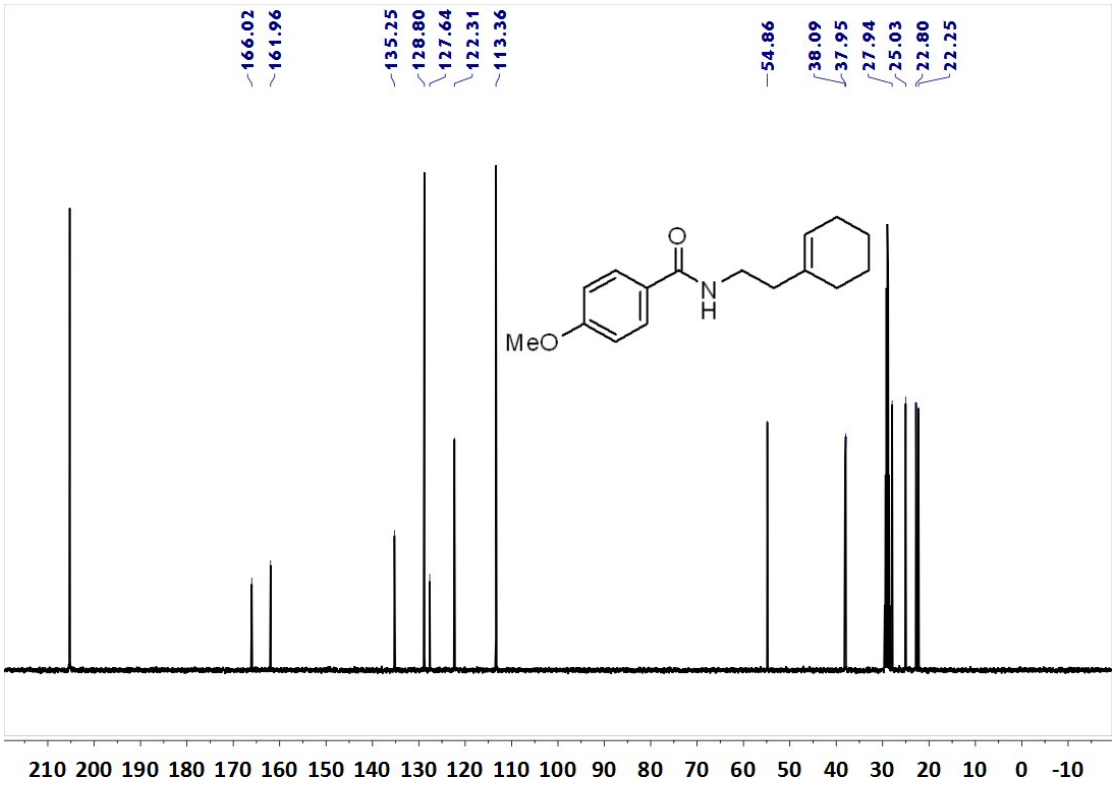
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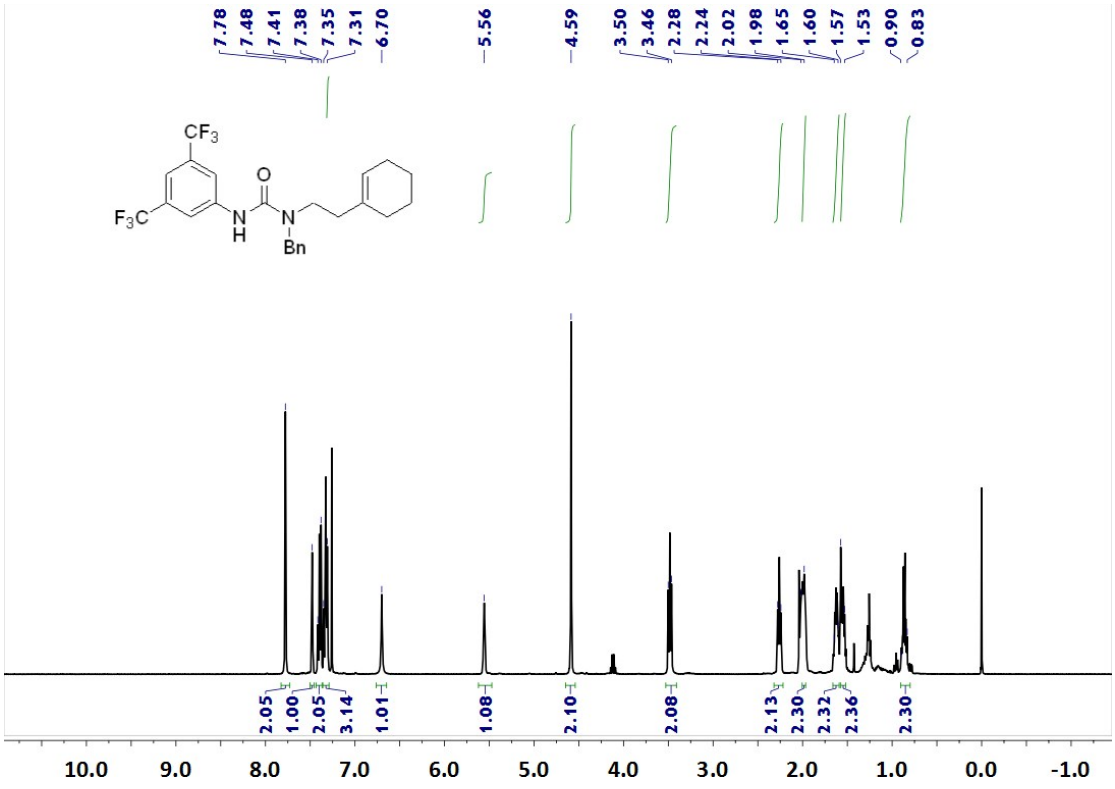
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0.83
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N
Bn
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2.08
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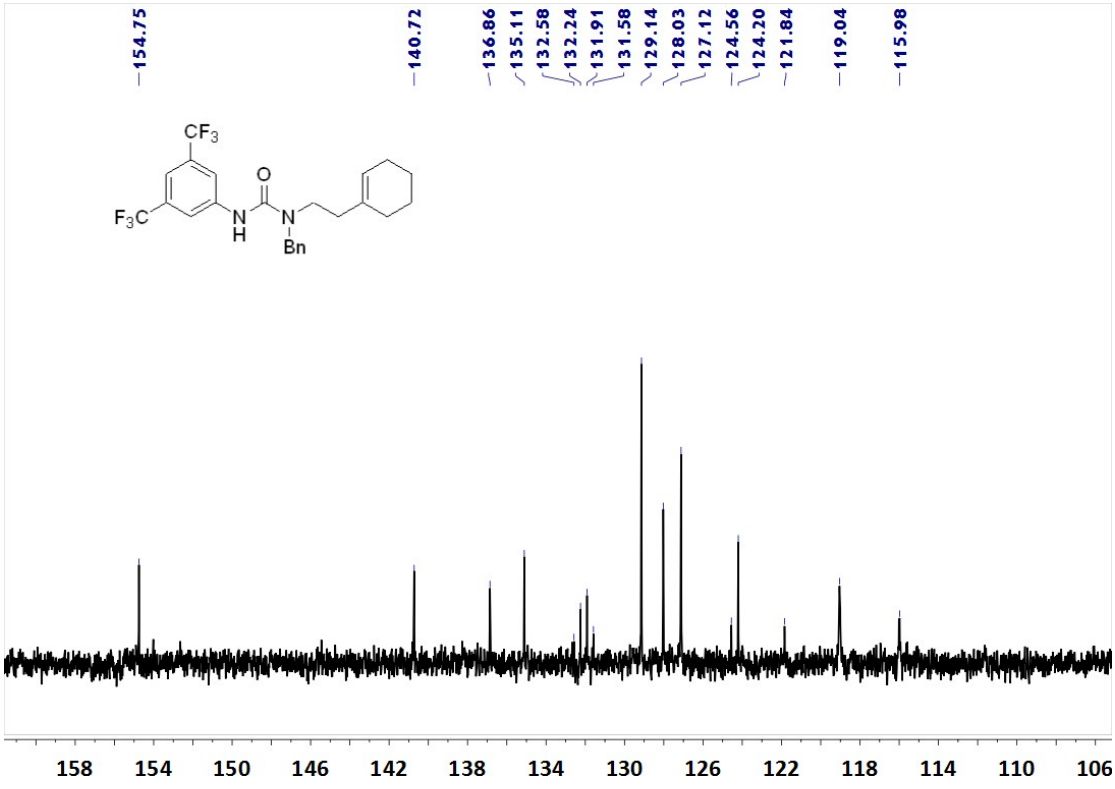
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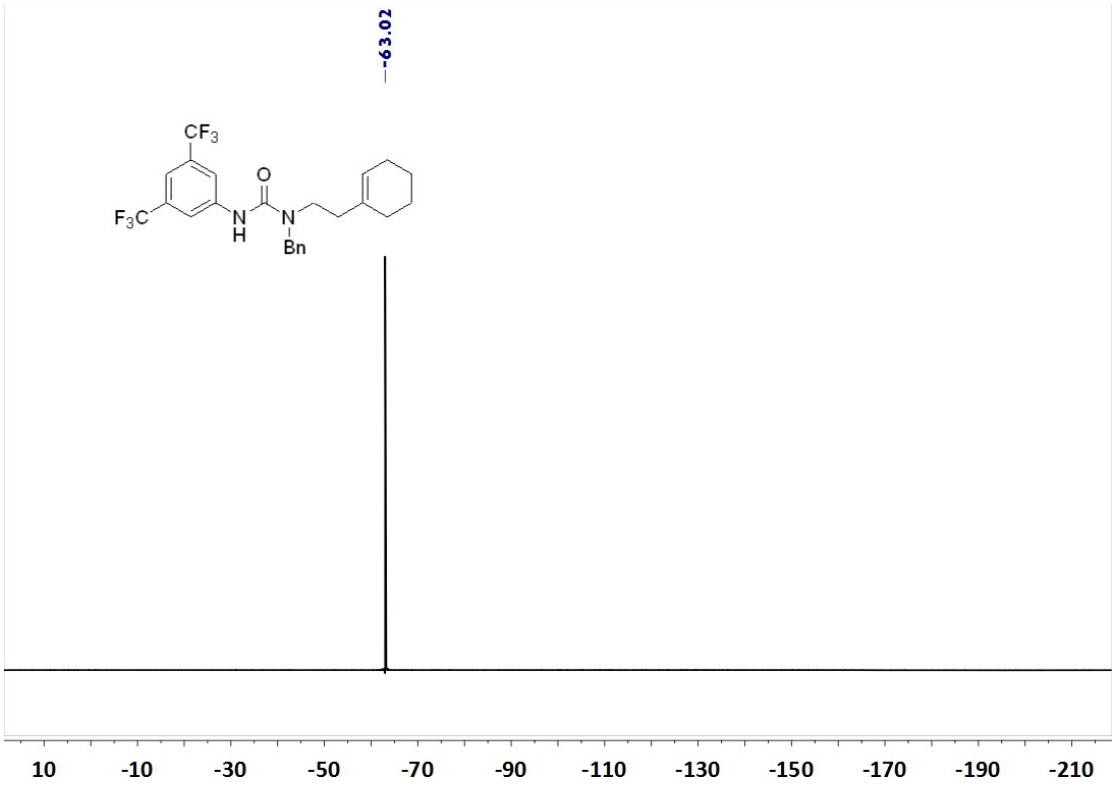
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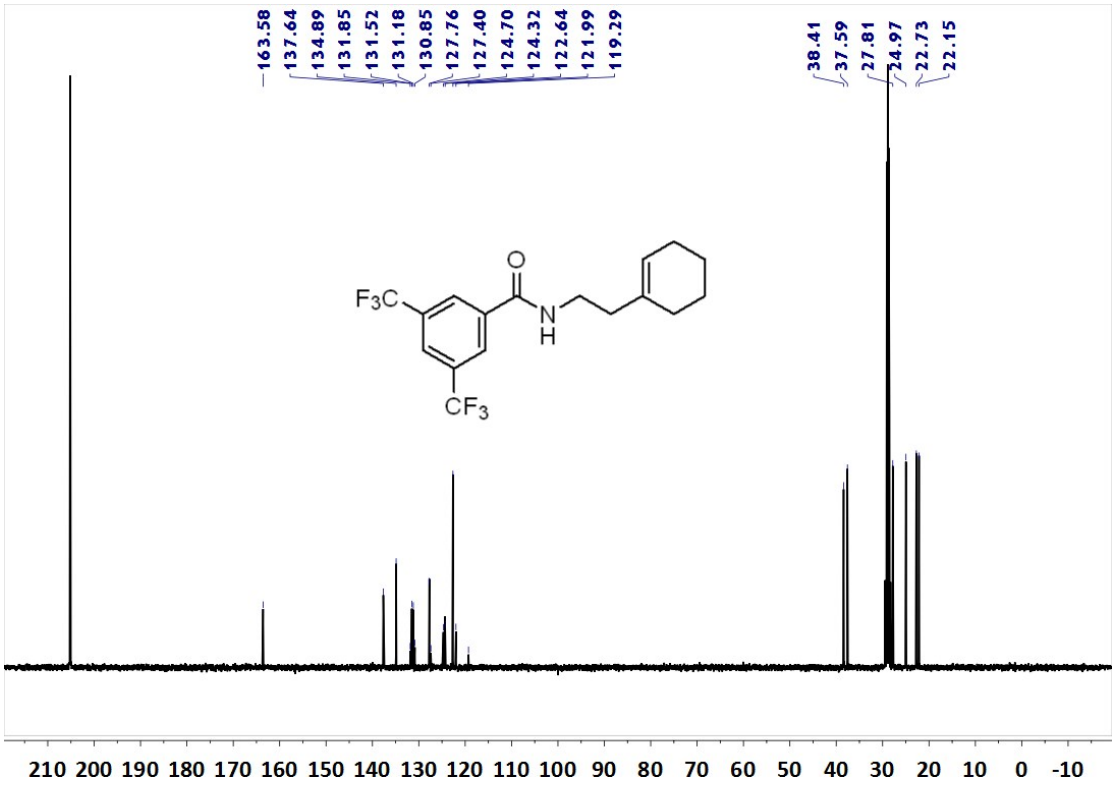
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CF3
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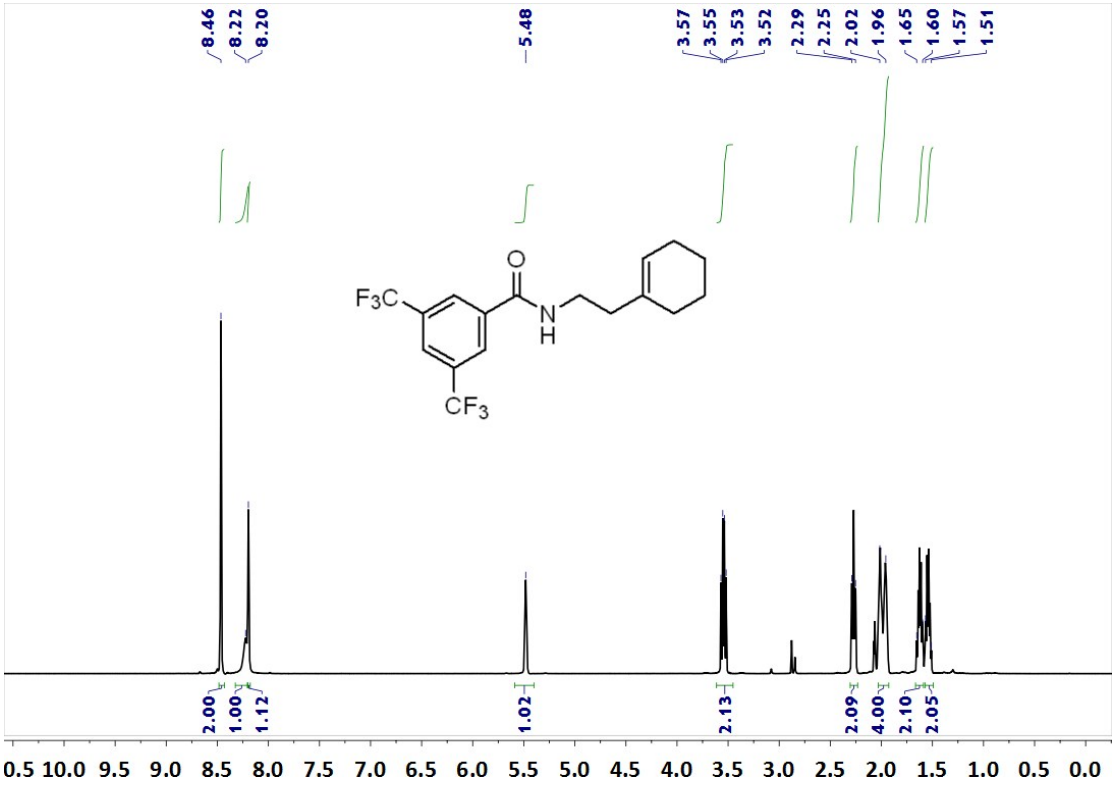
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CF3
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1.00
1.12
1.02
2.13
2.09
4.00
2.10
2.05
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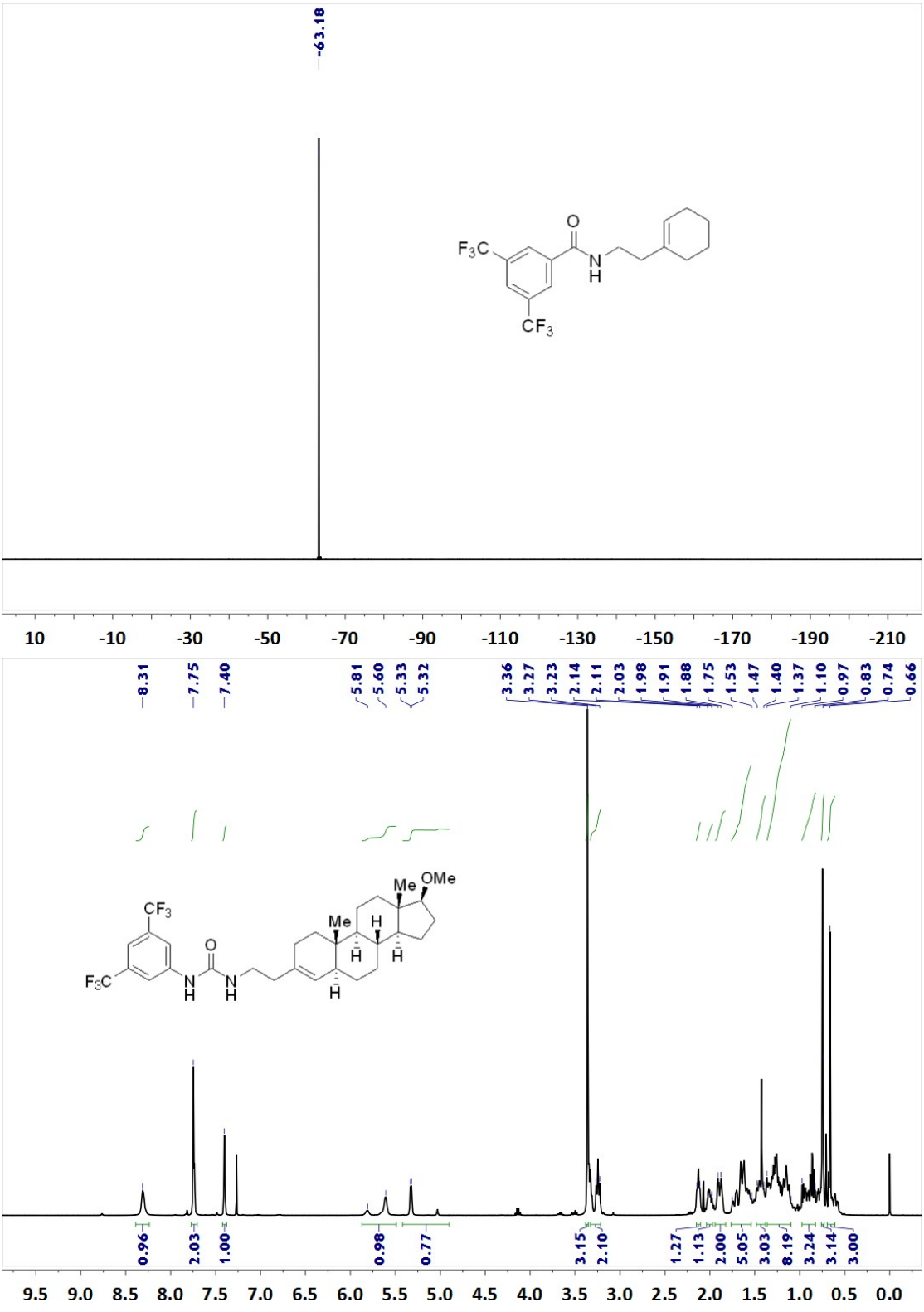
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CF3
F3C
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H
N
H
Me
OMe
H
H
H
0.96 2.03 1.00 0.98 0.77 3.15 2.10 1.27 1.13 2.00 5.05 3.03 8.19 3.24 3.14 3.00
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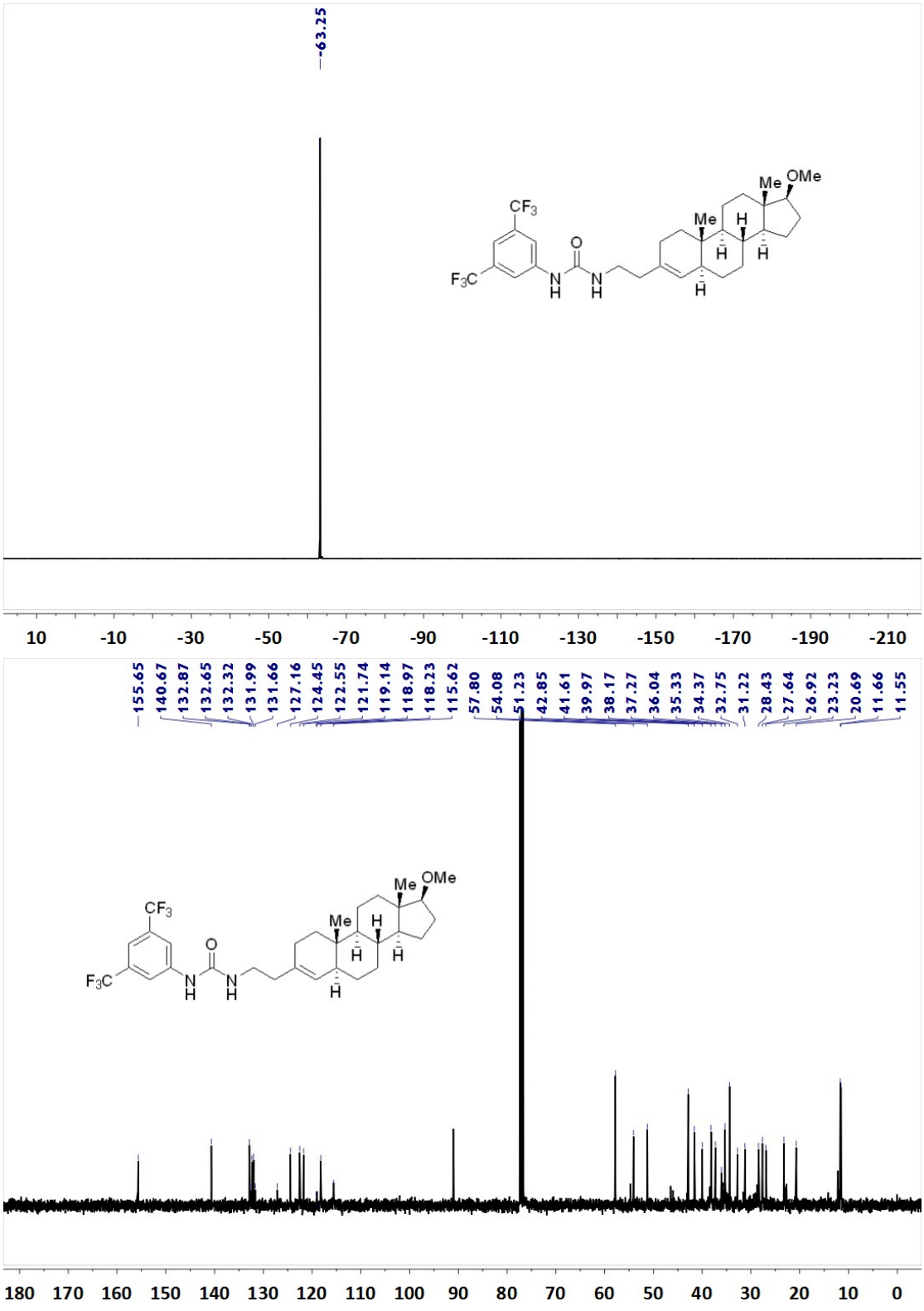
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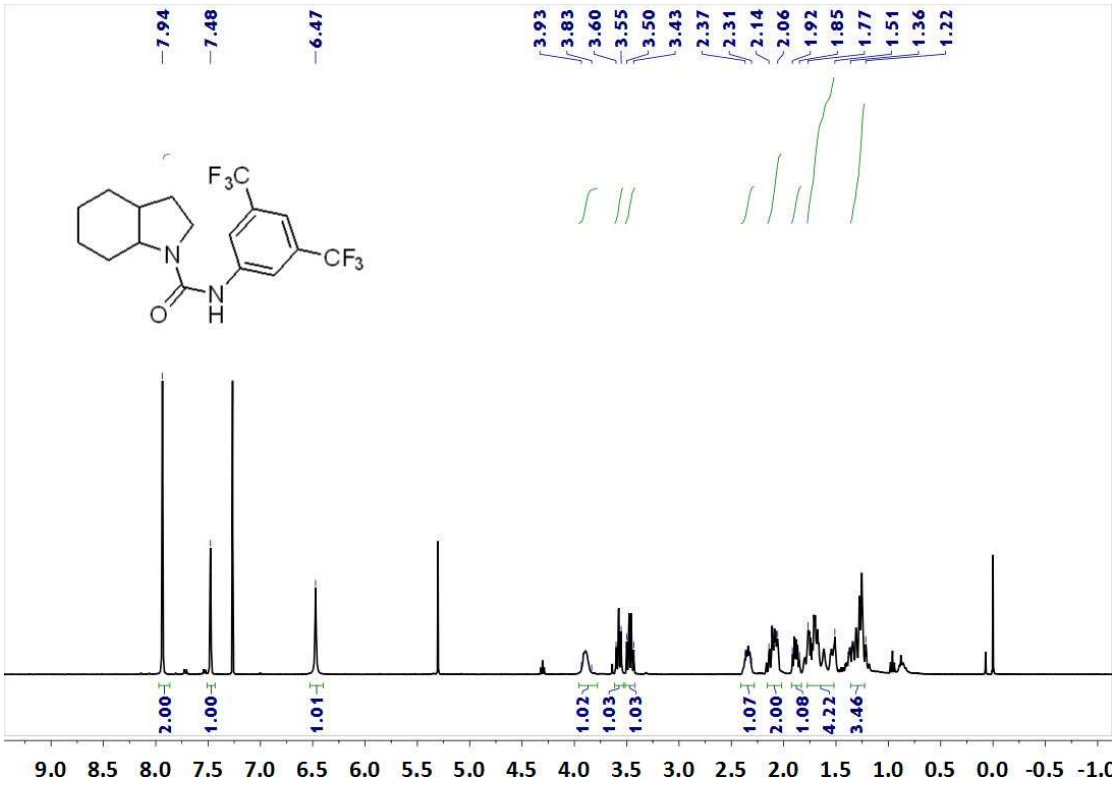
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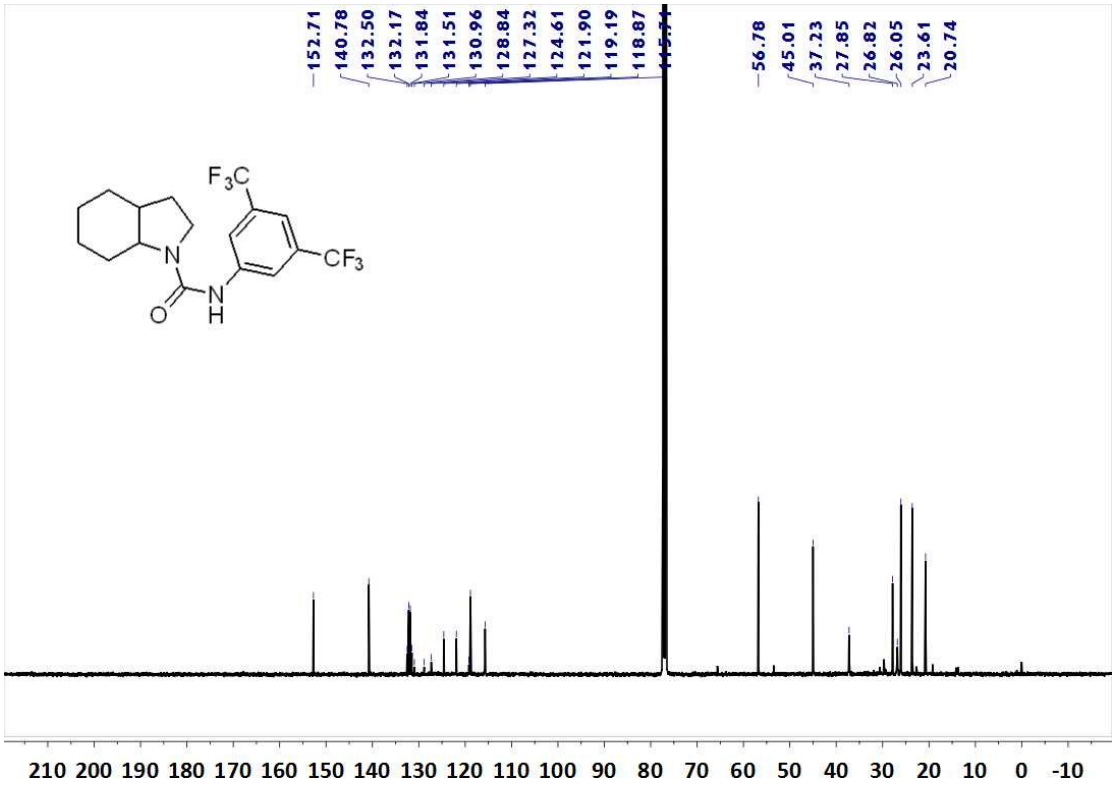
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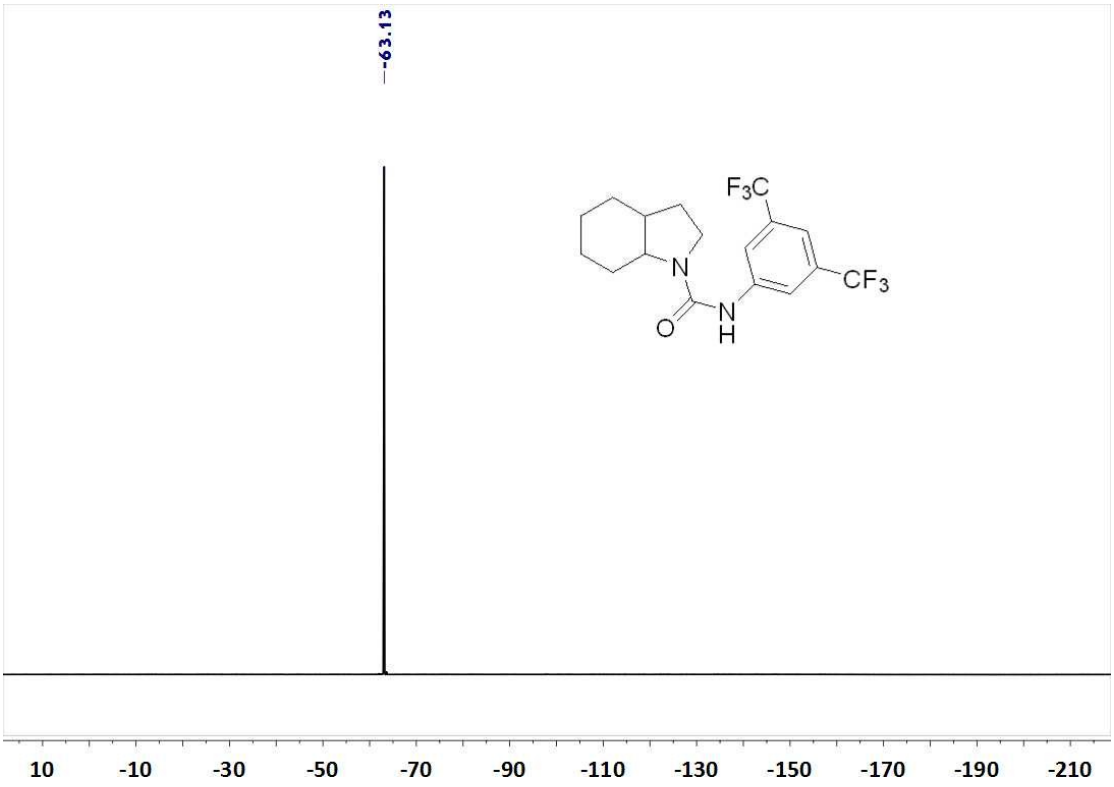
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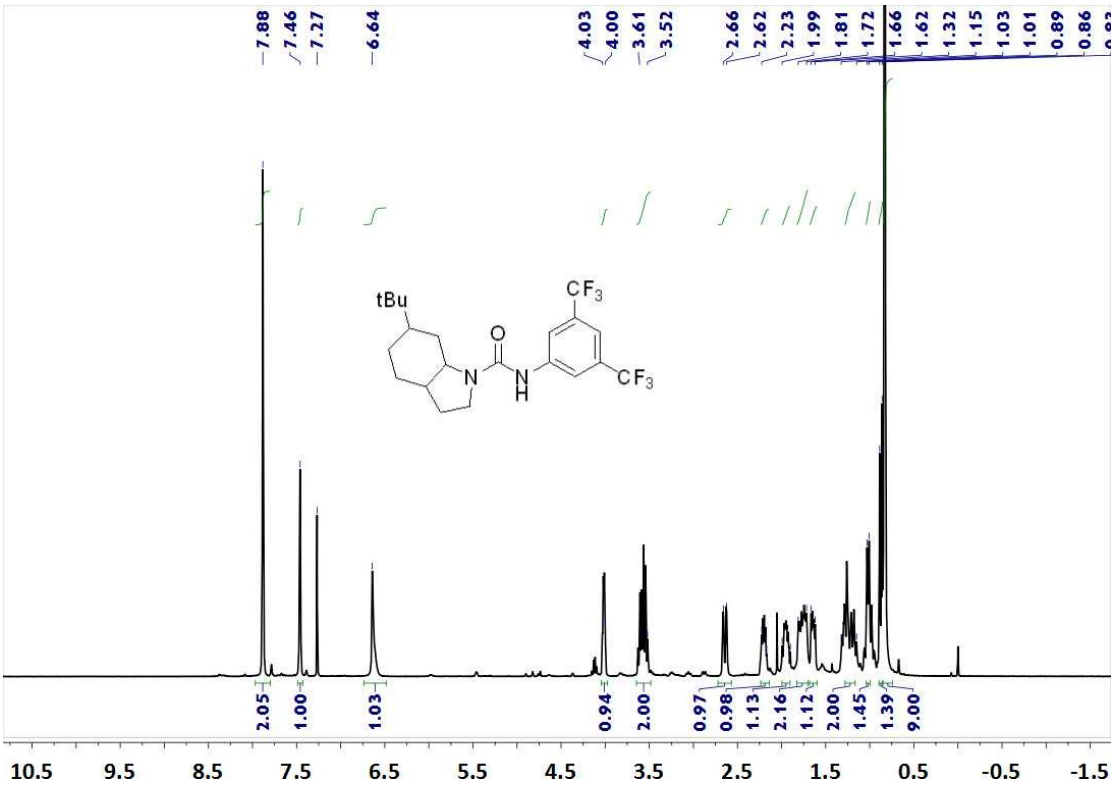
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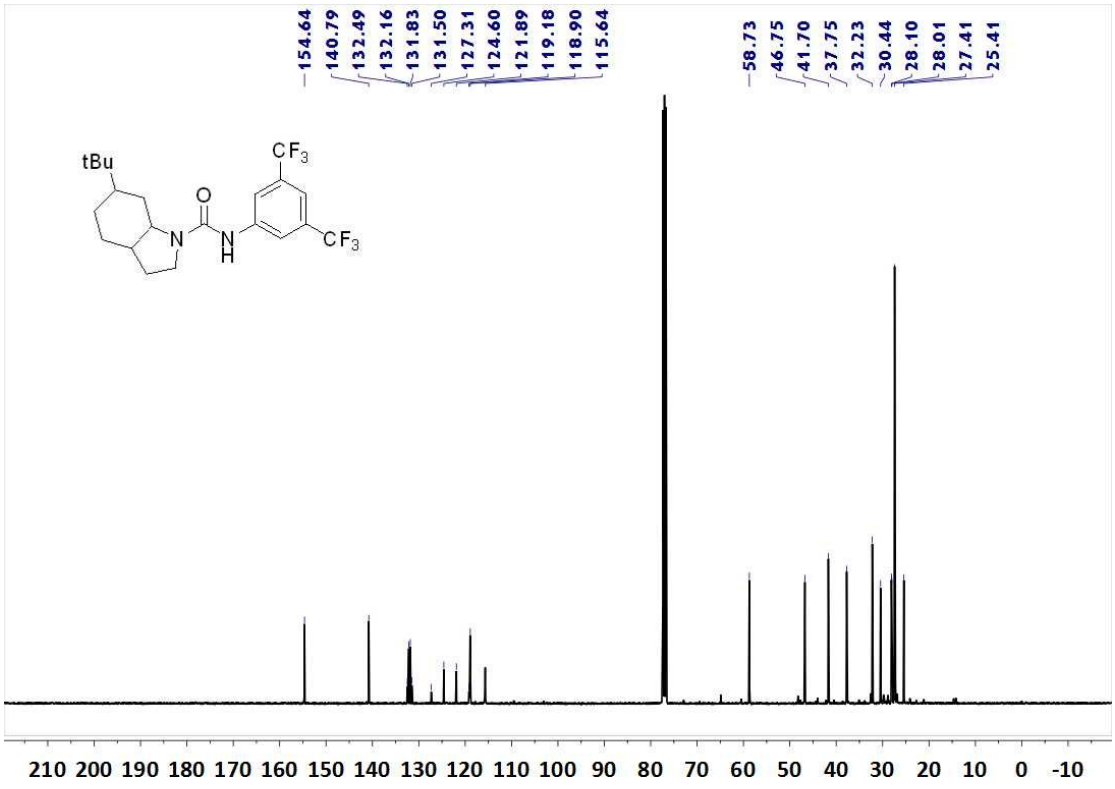
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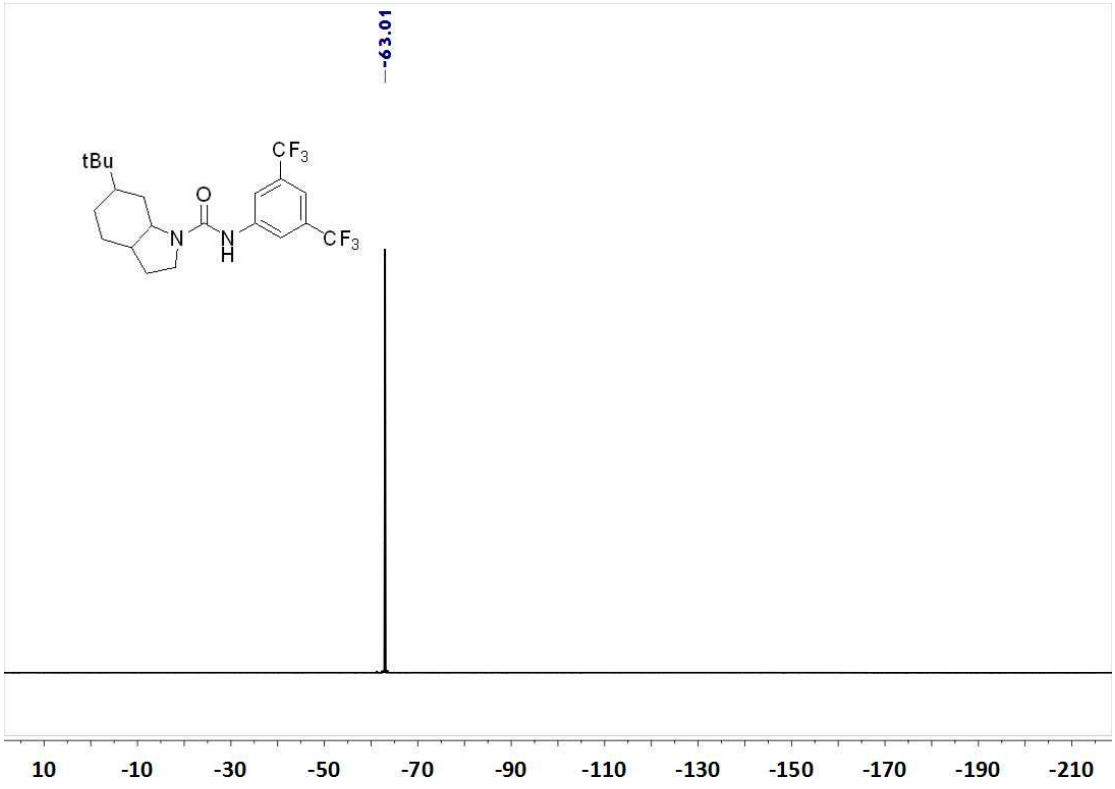
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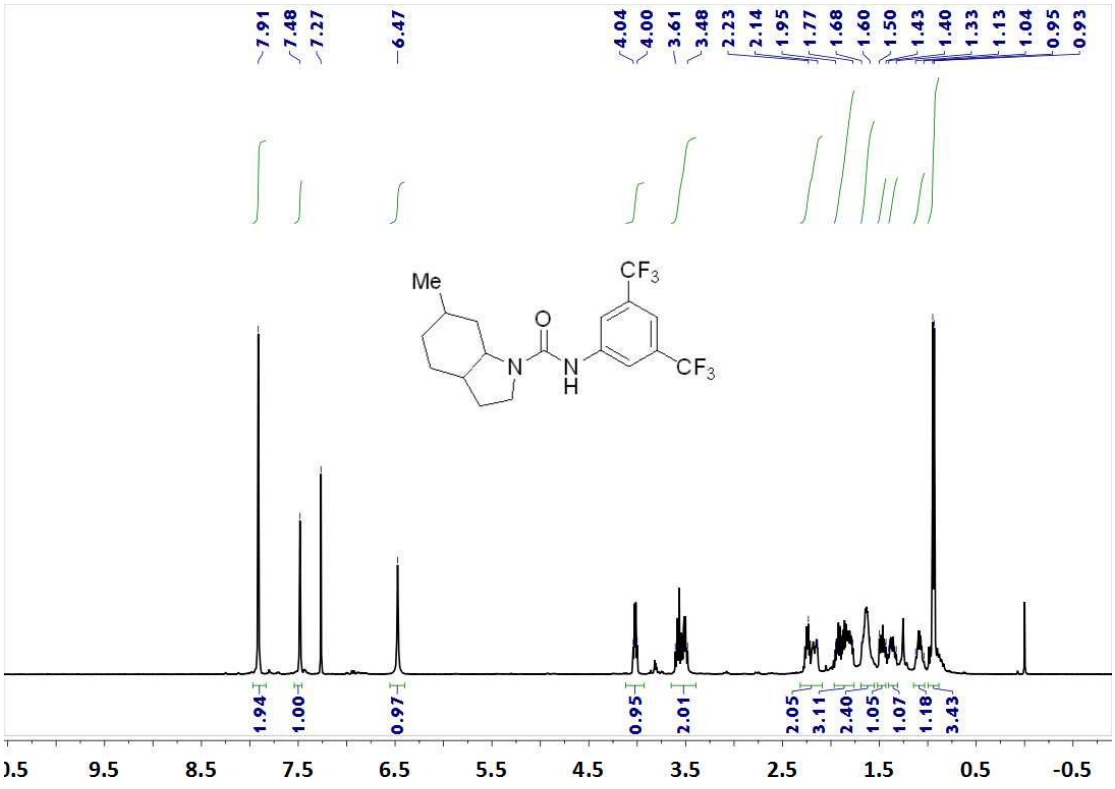
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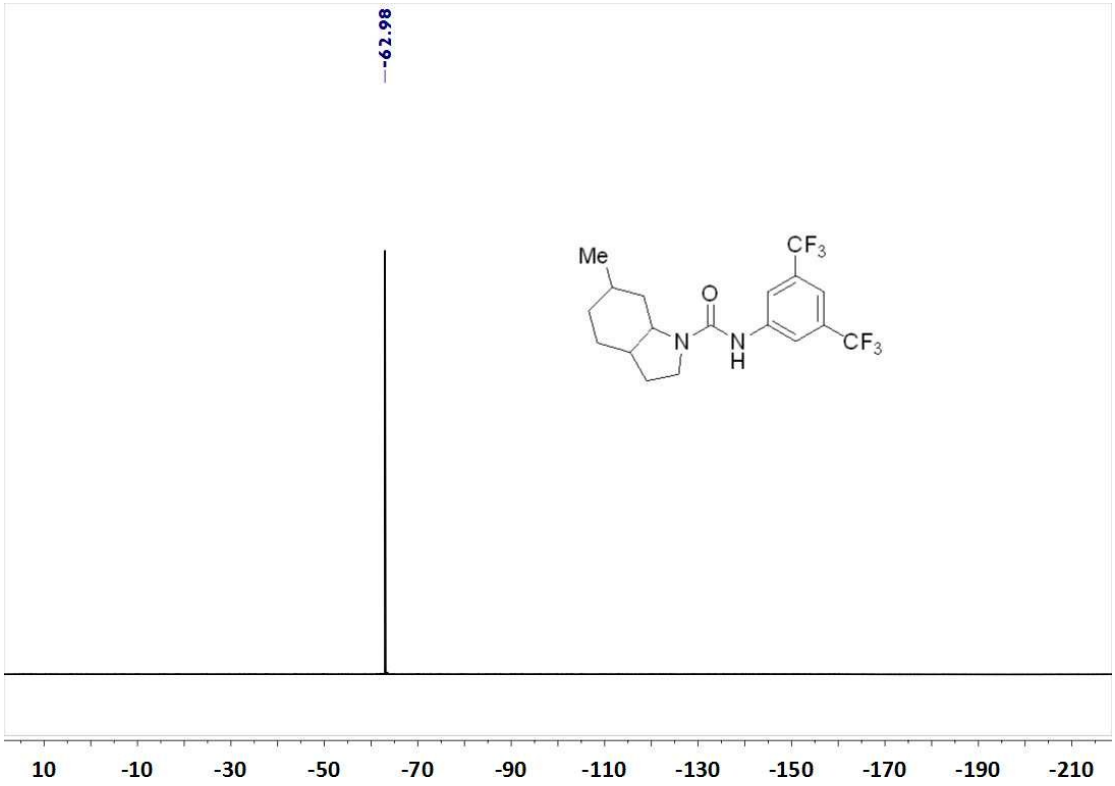
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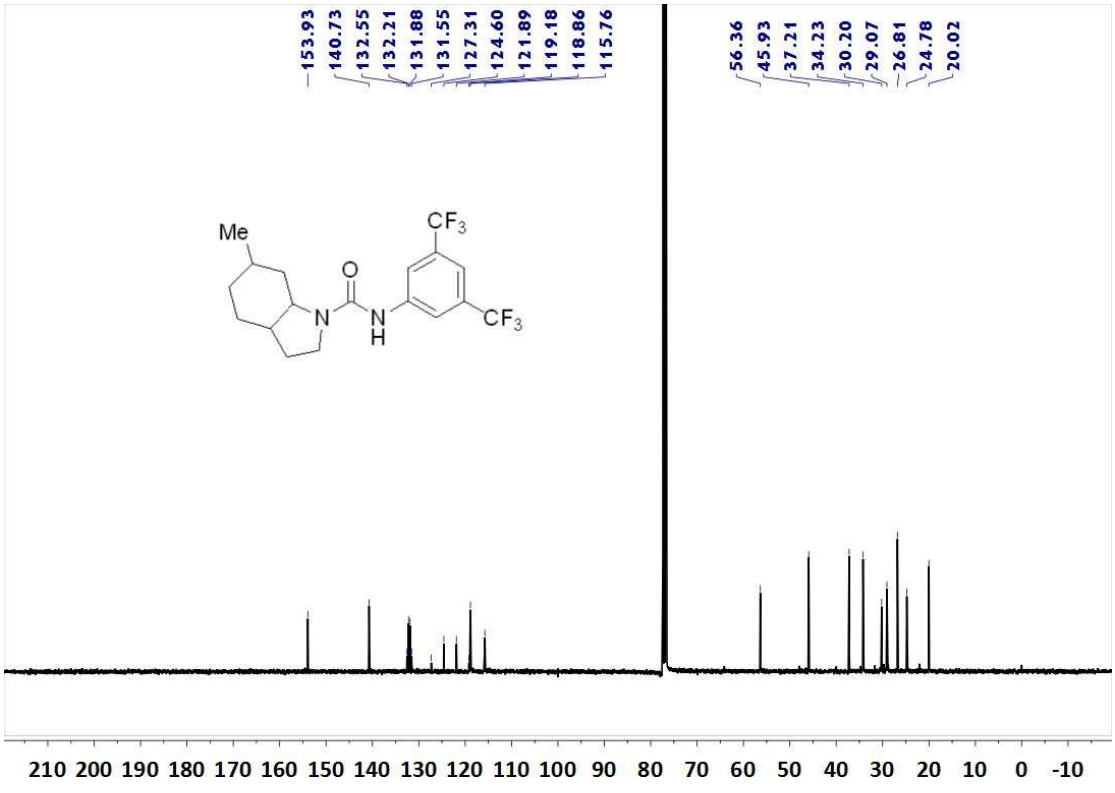
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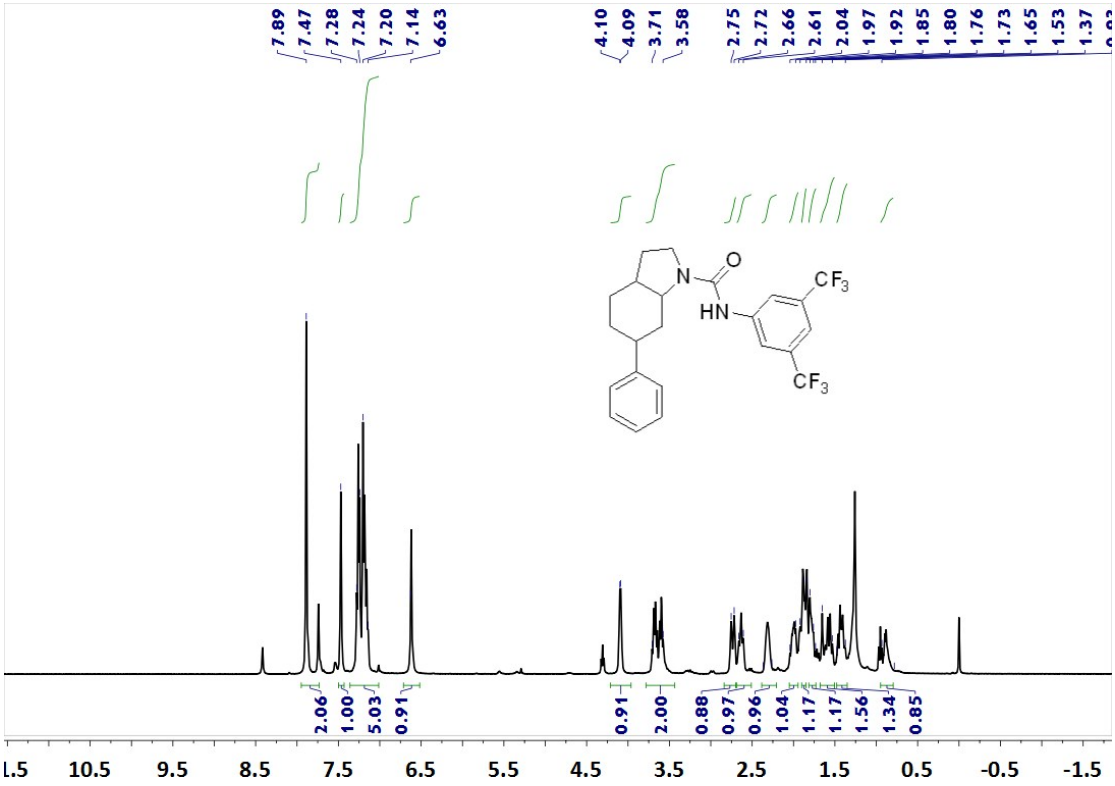
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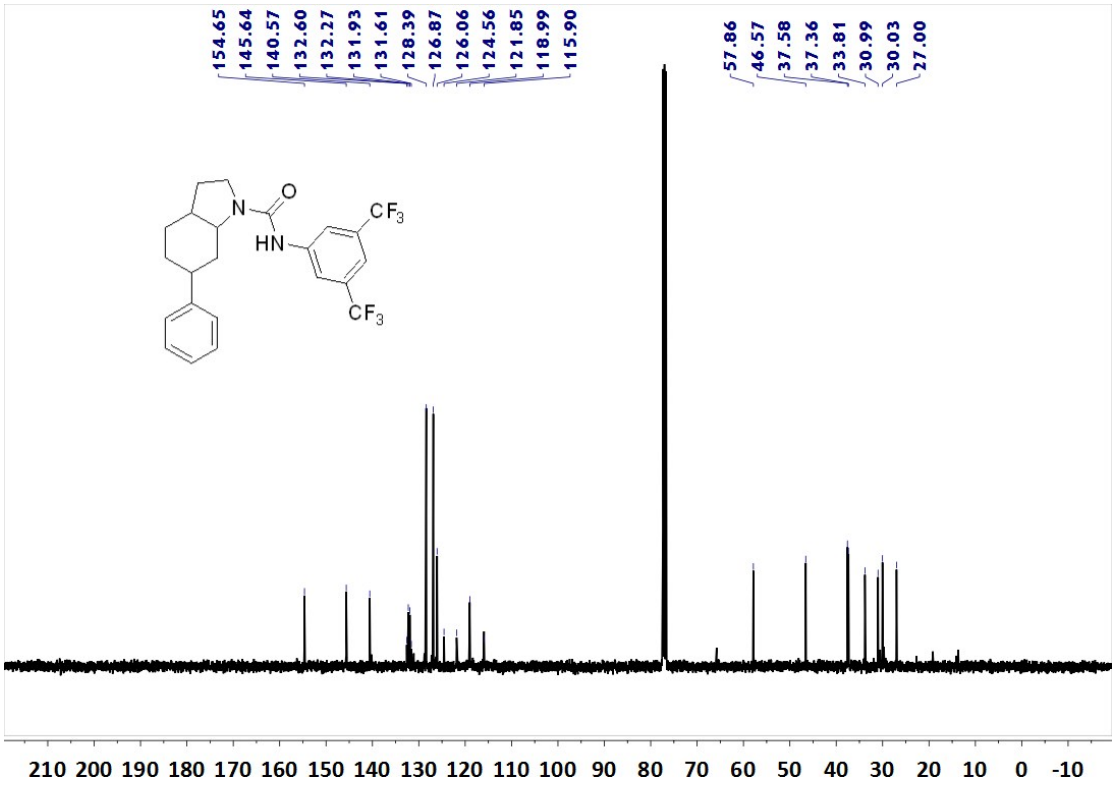
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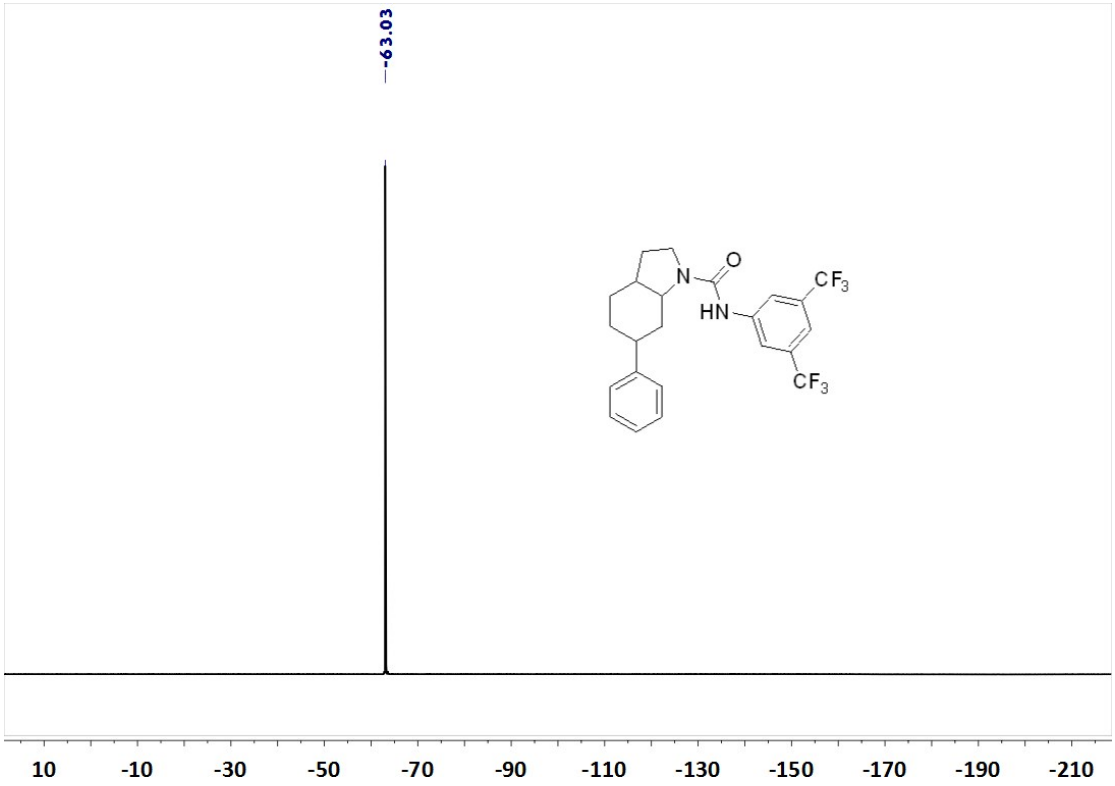
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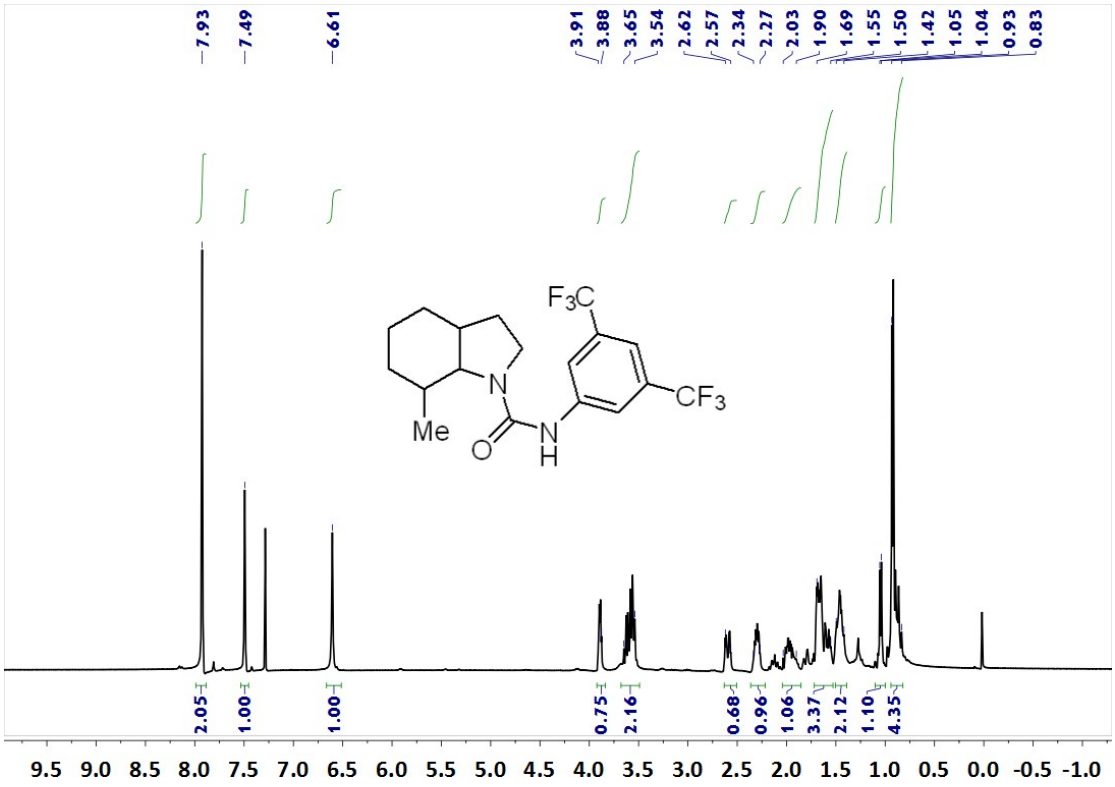
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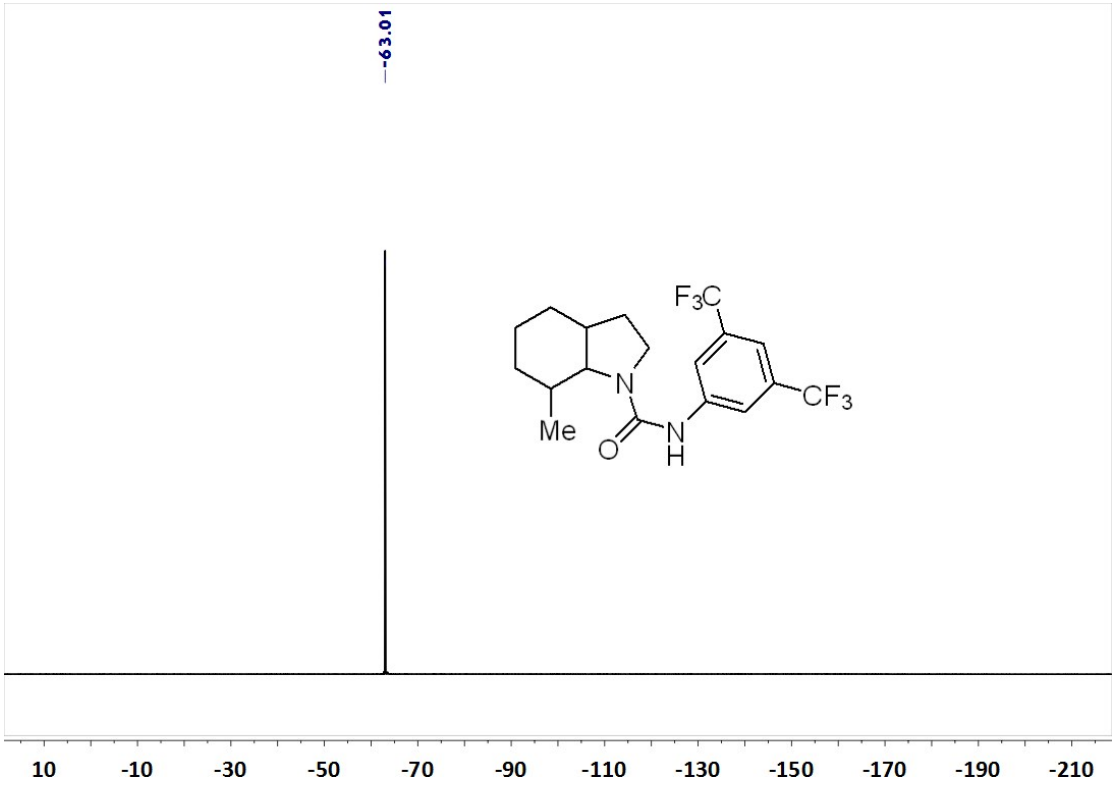
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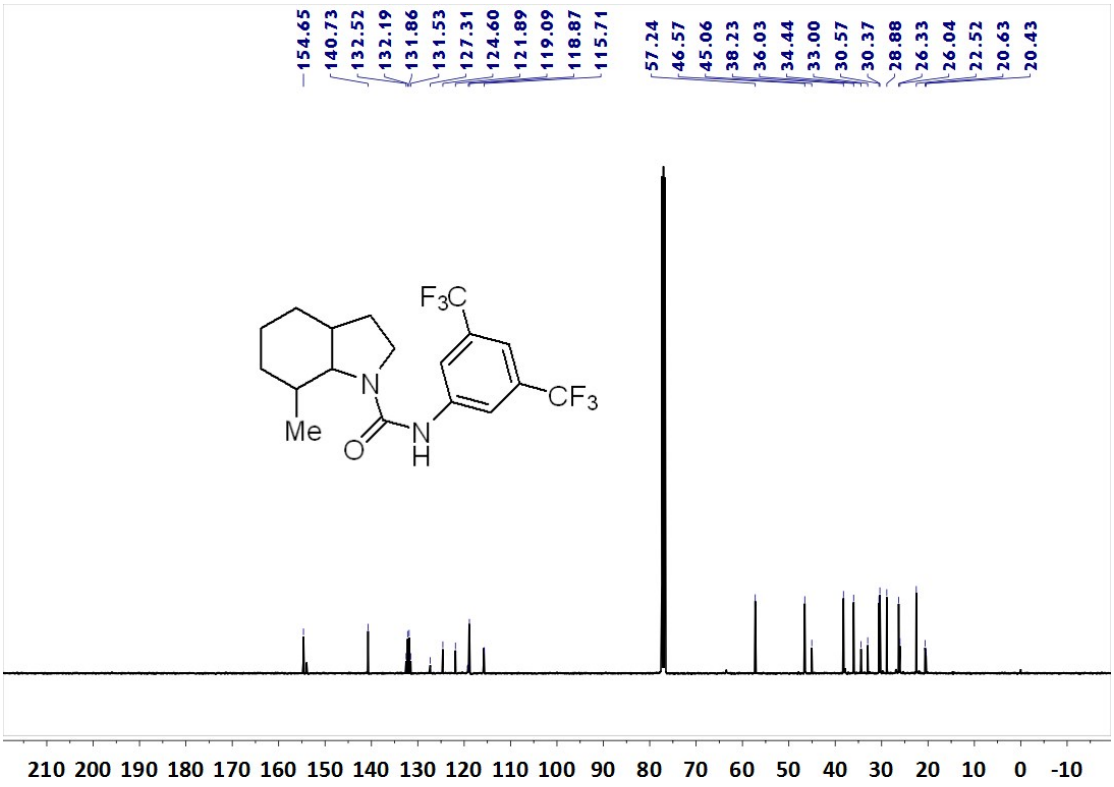
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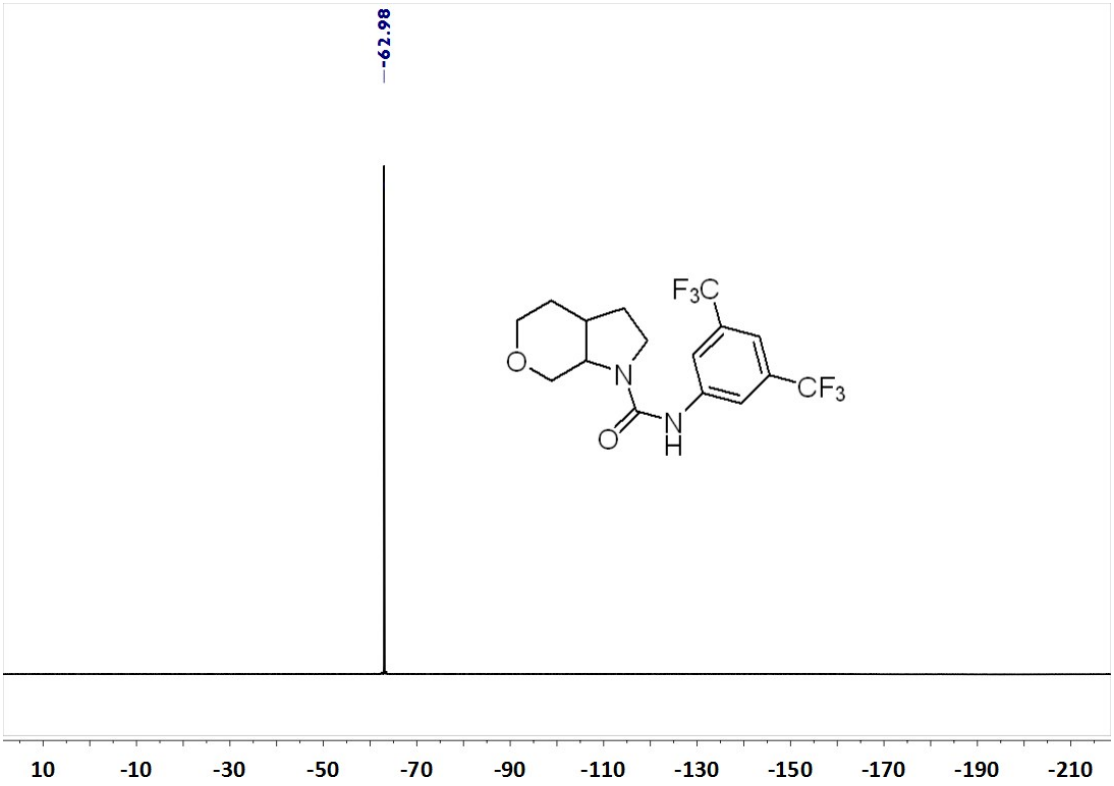
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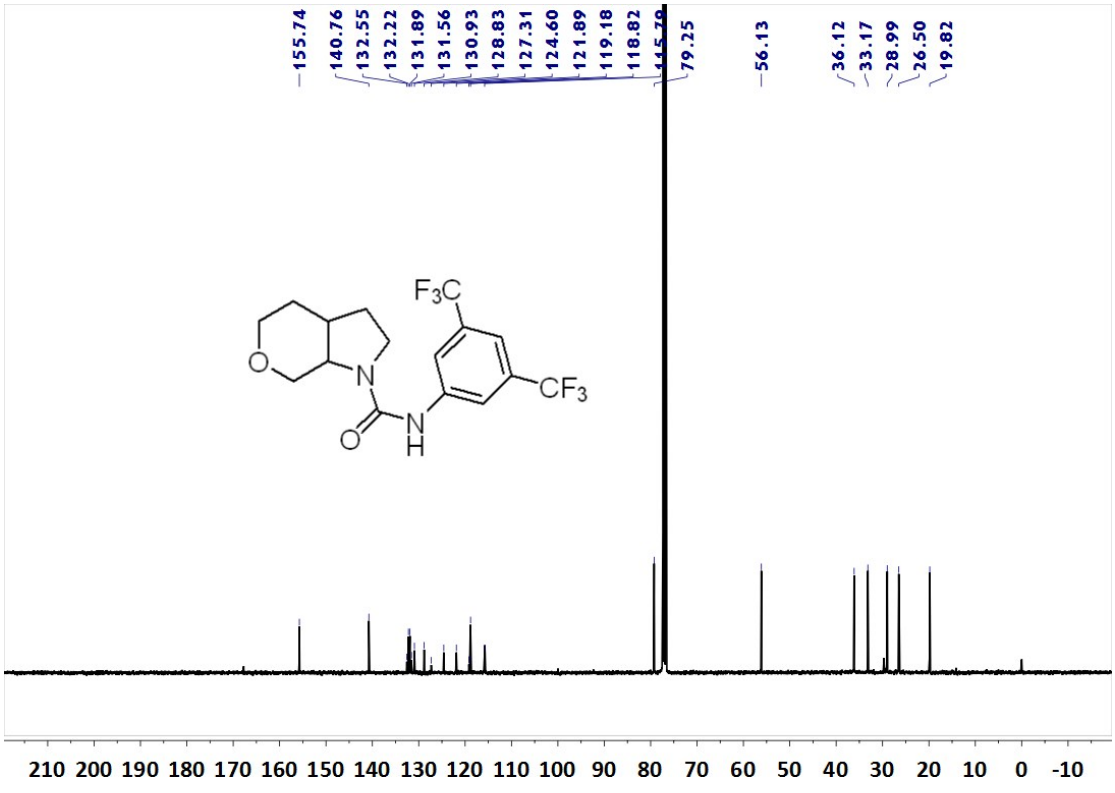
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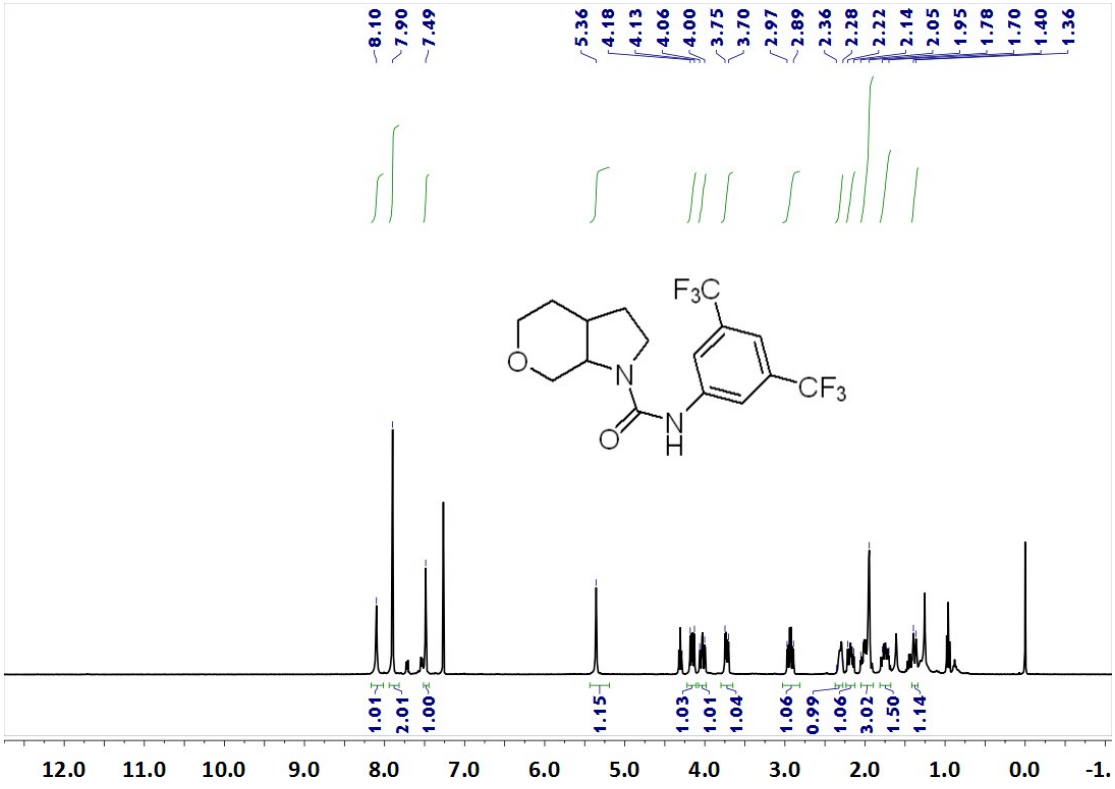
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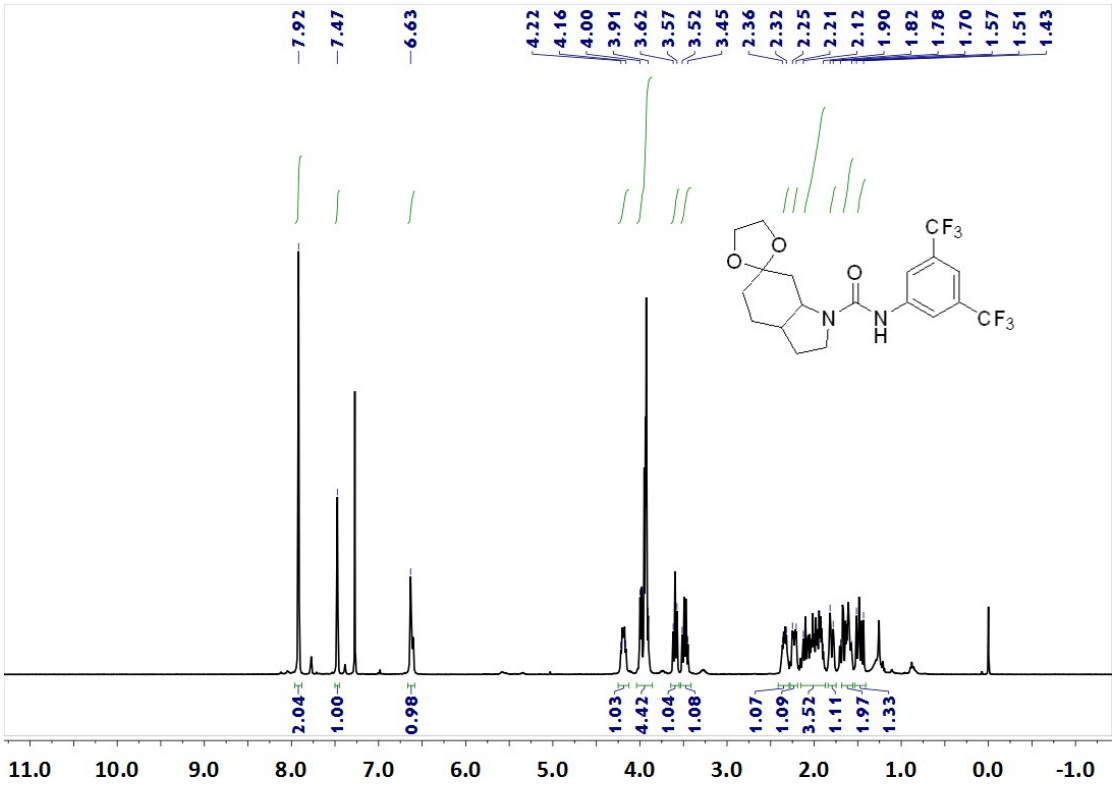
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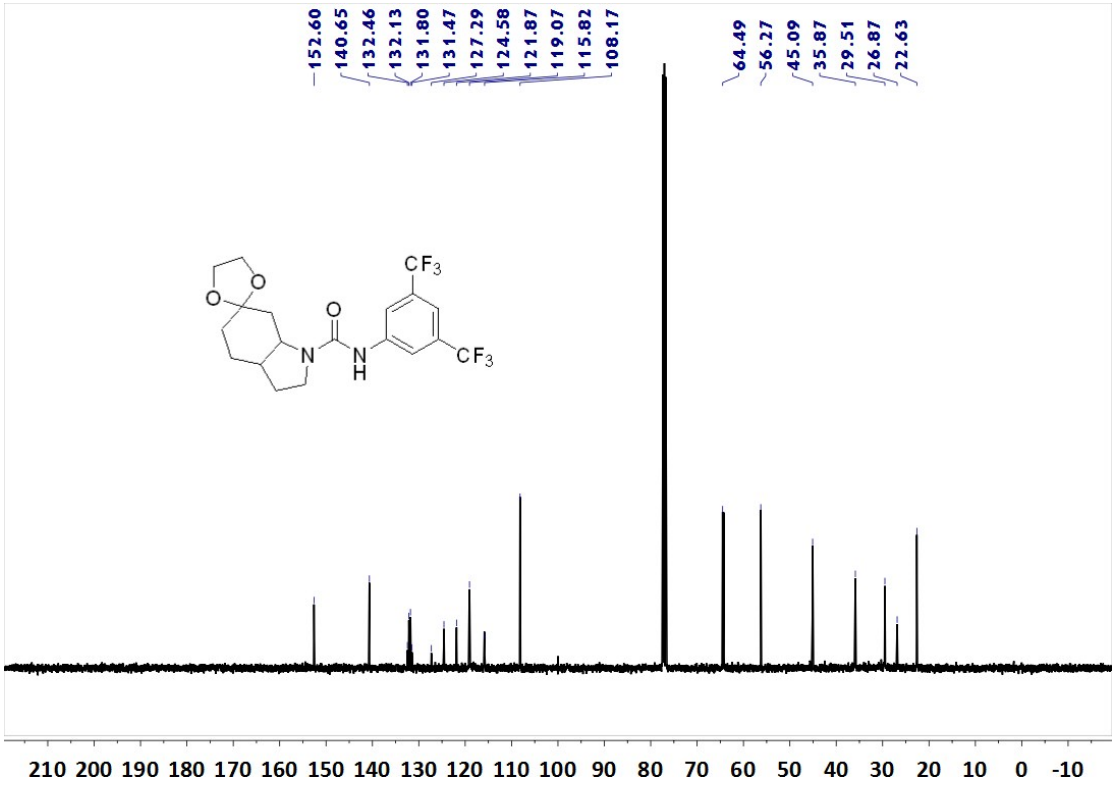
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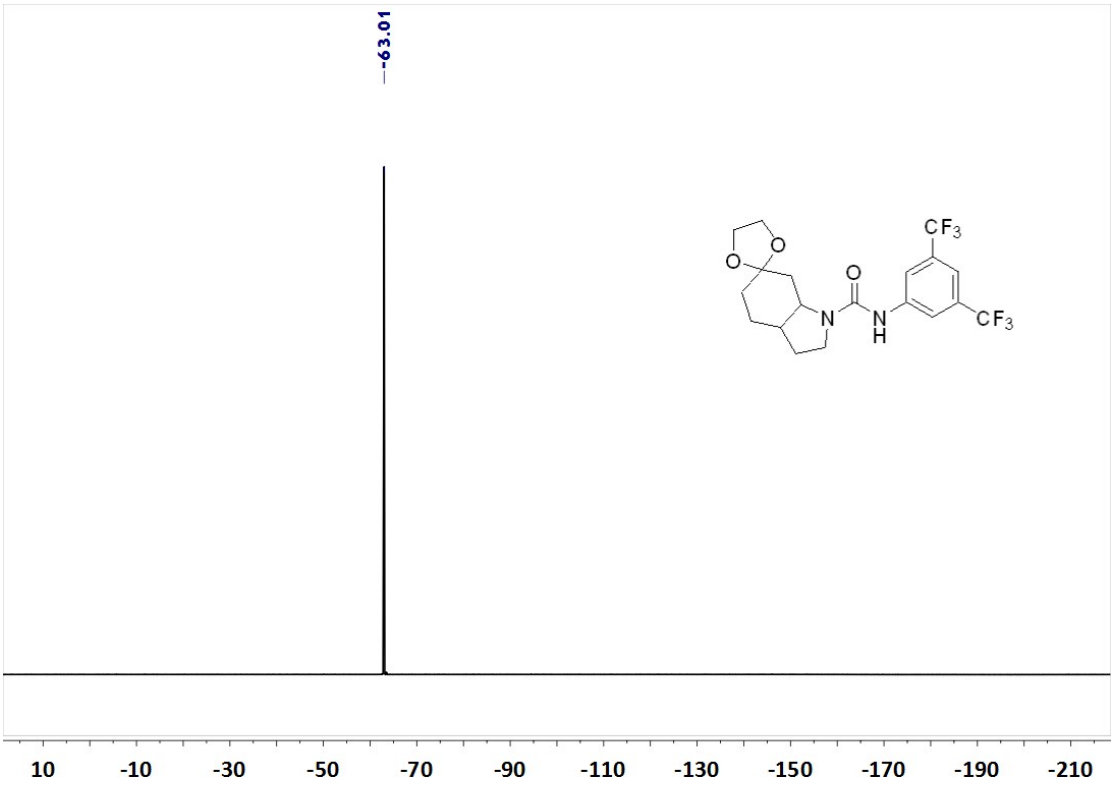
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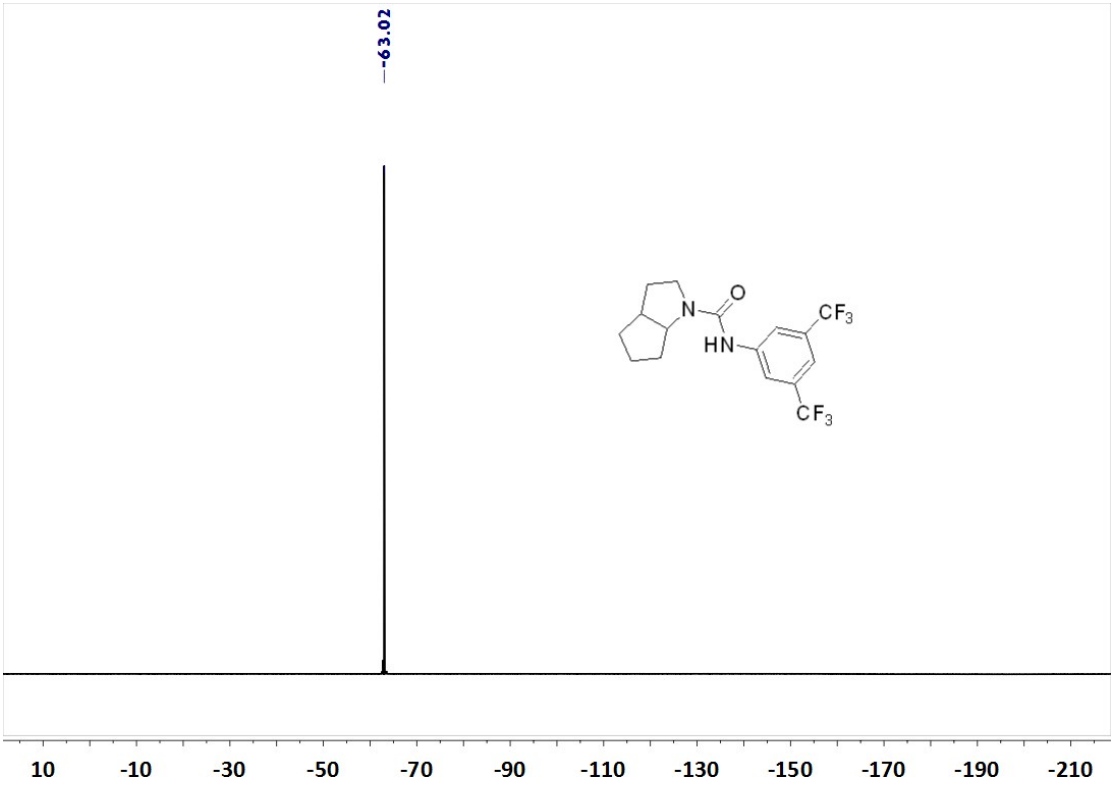
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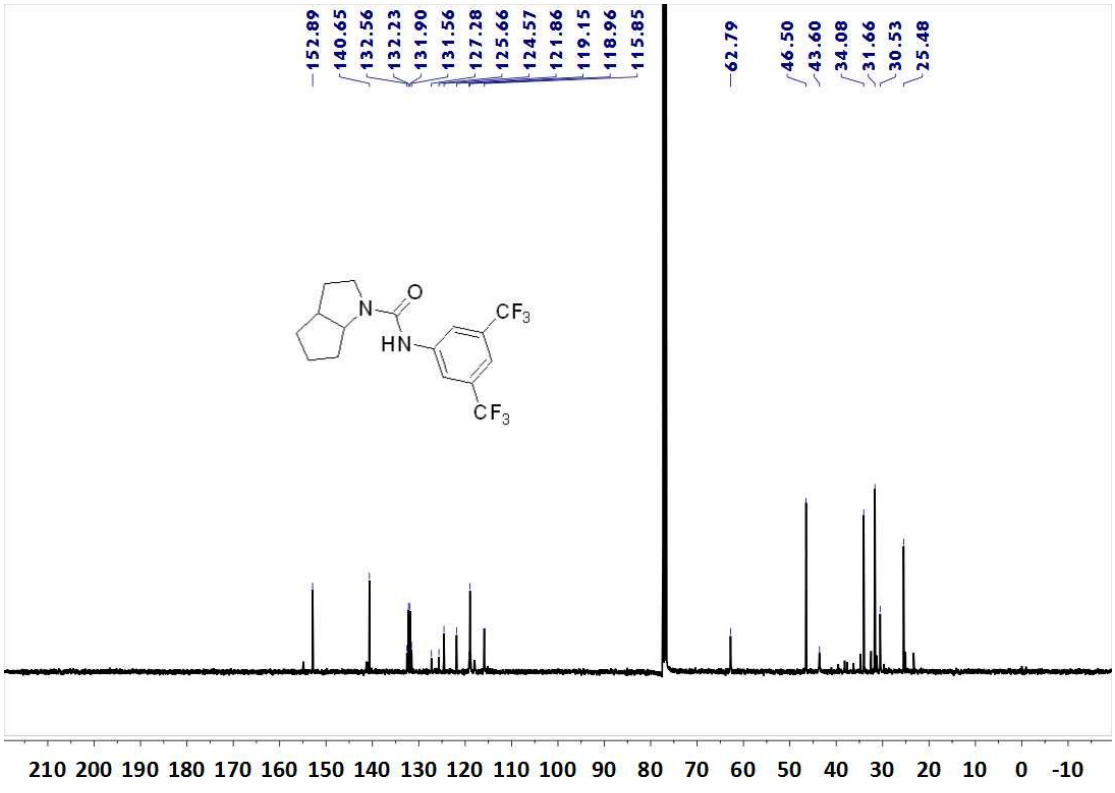
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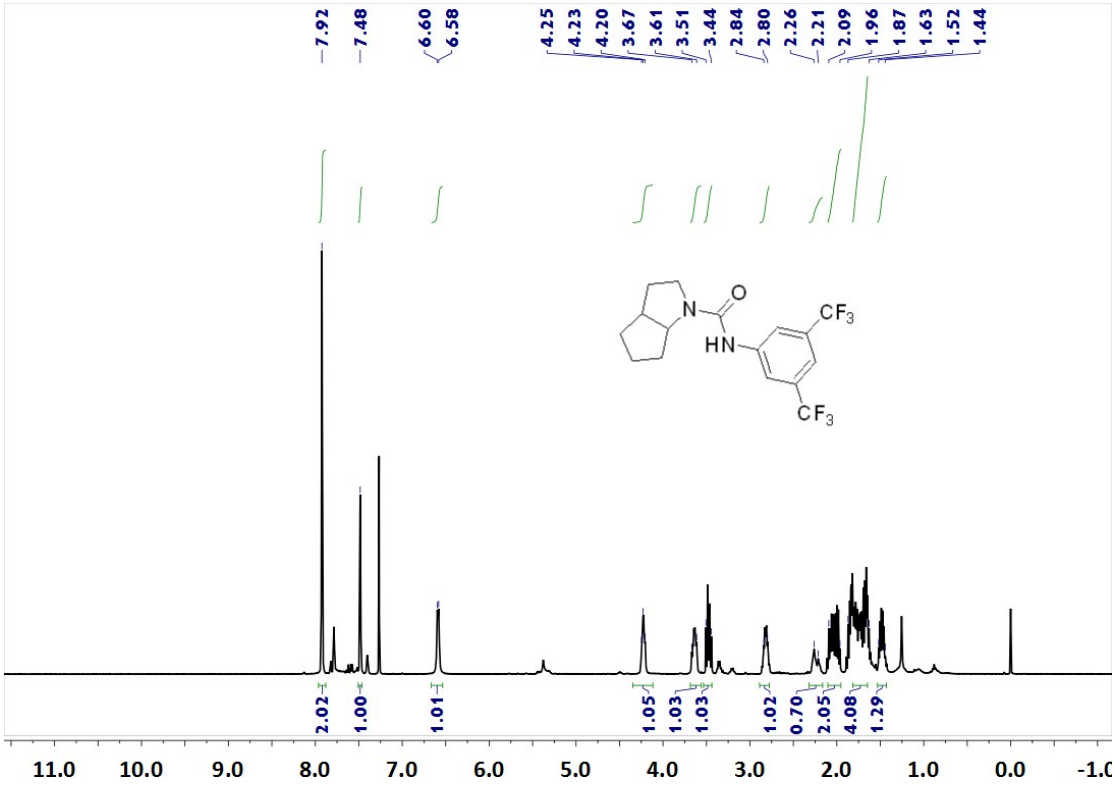
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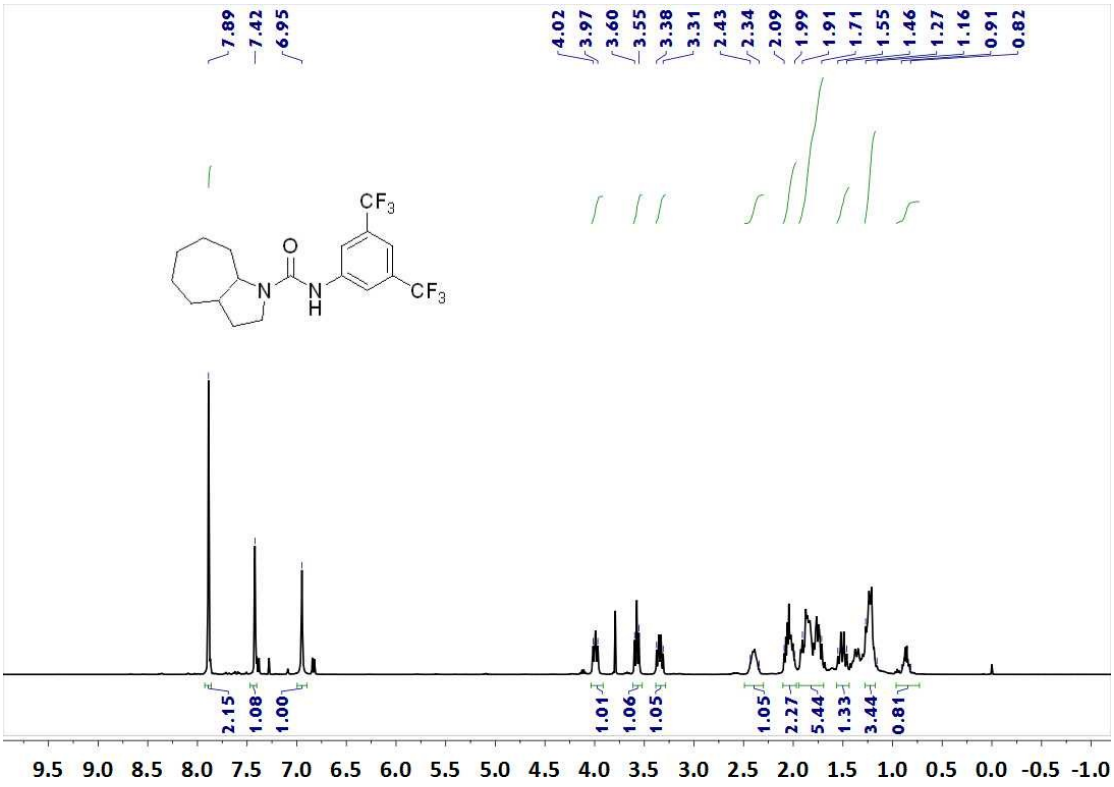
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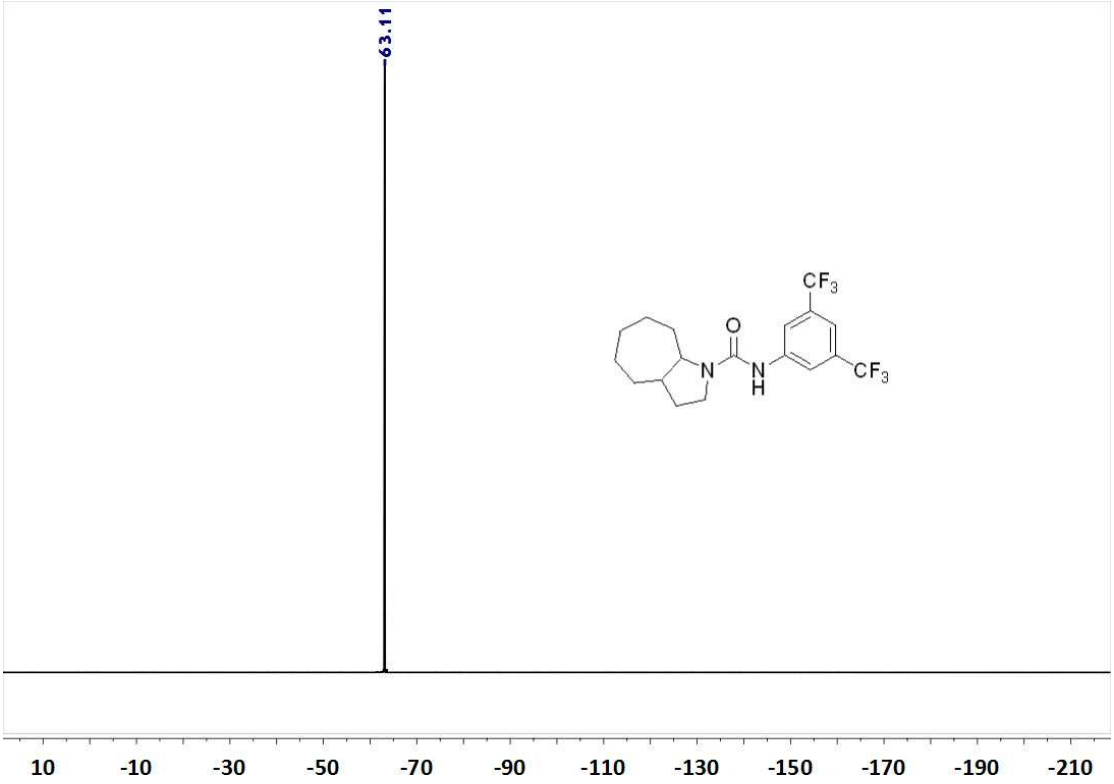
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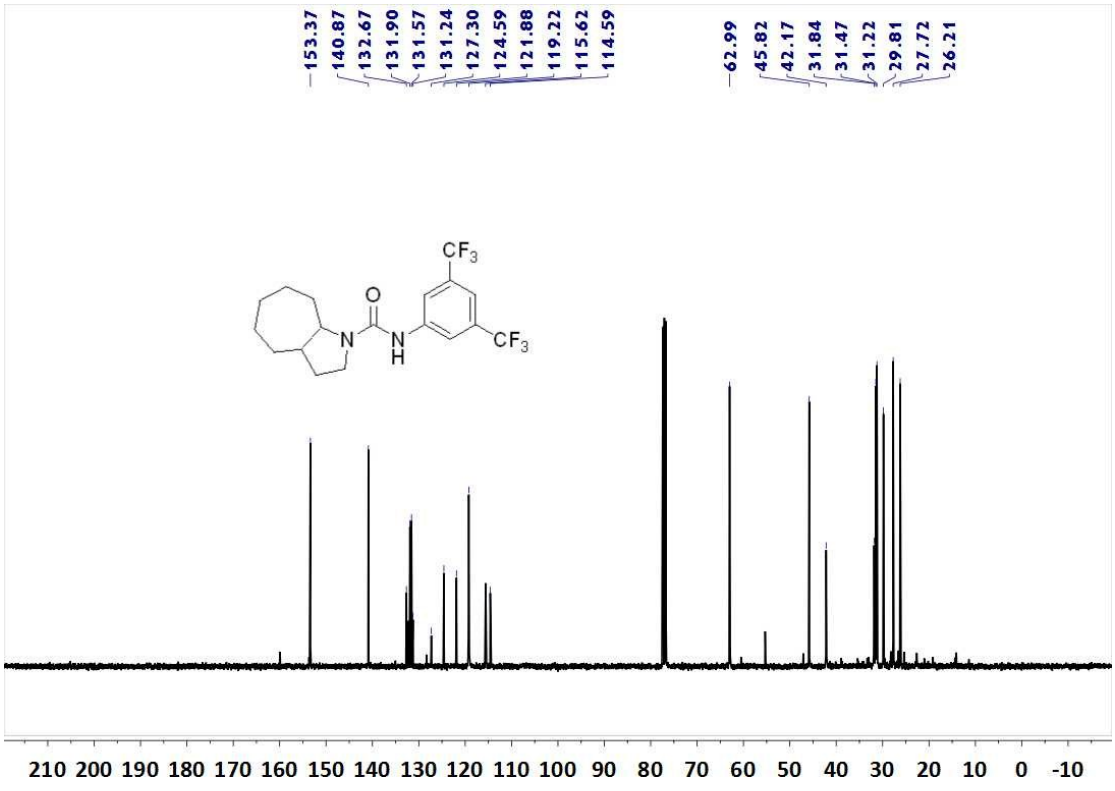
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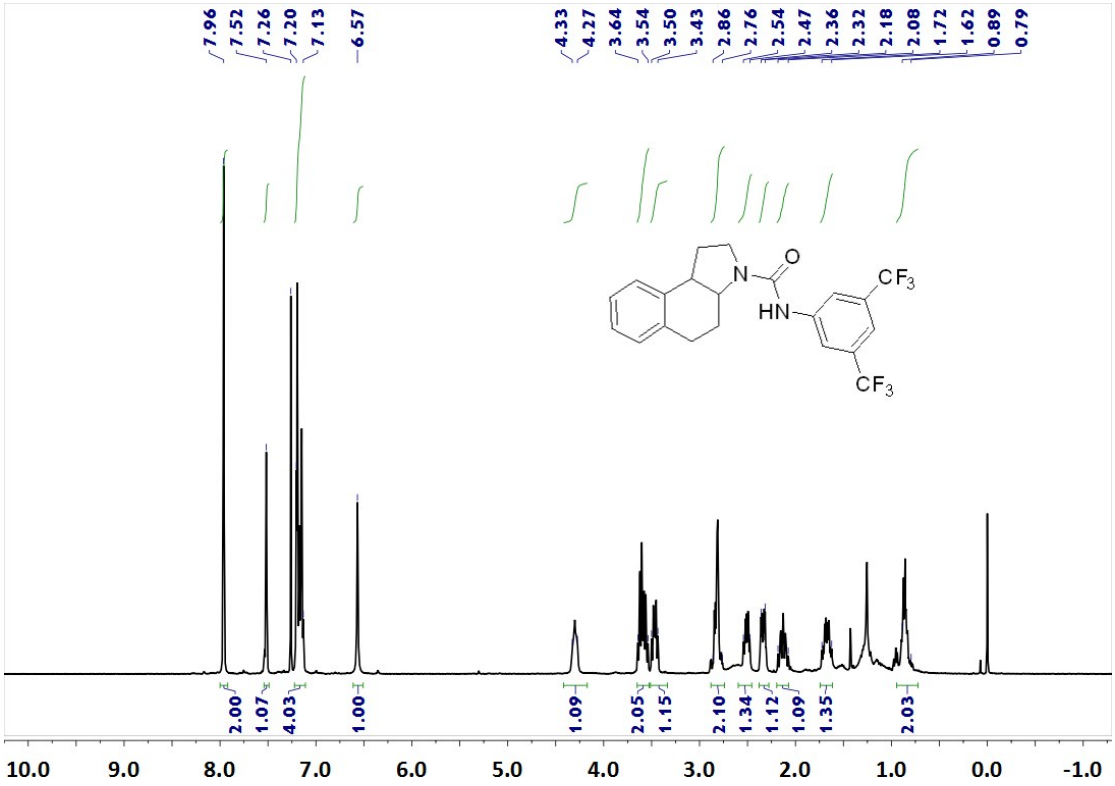
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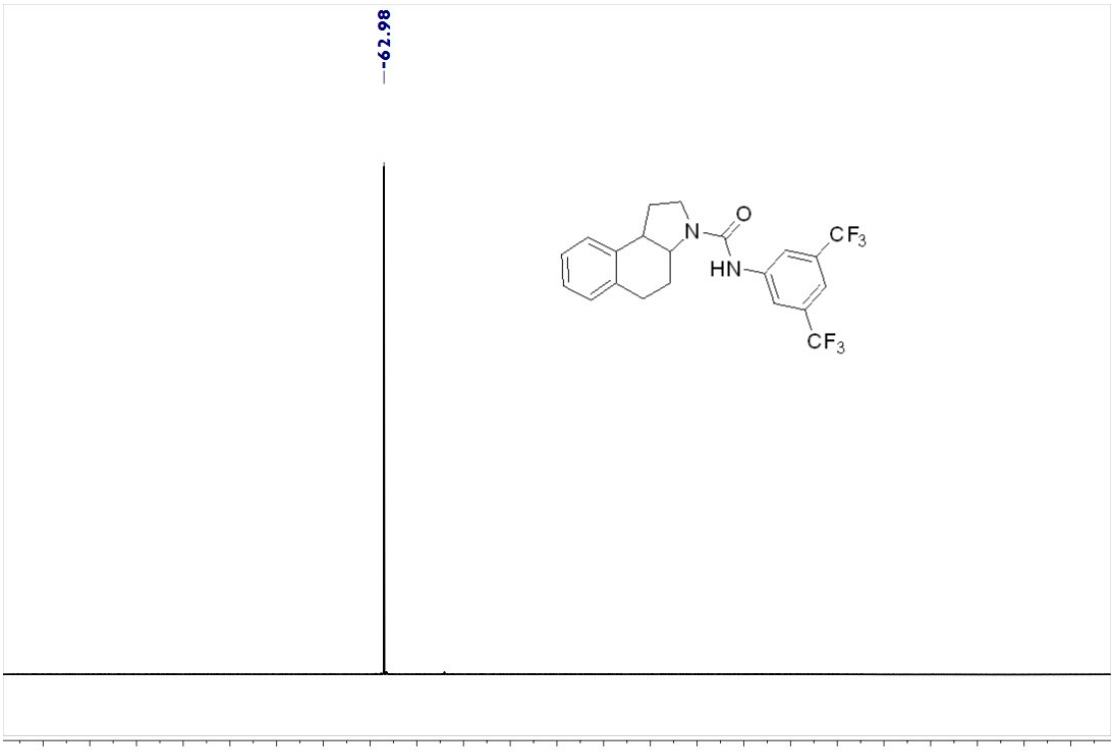
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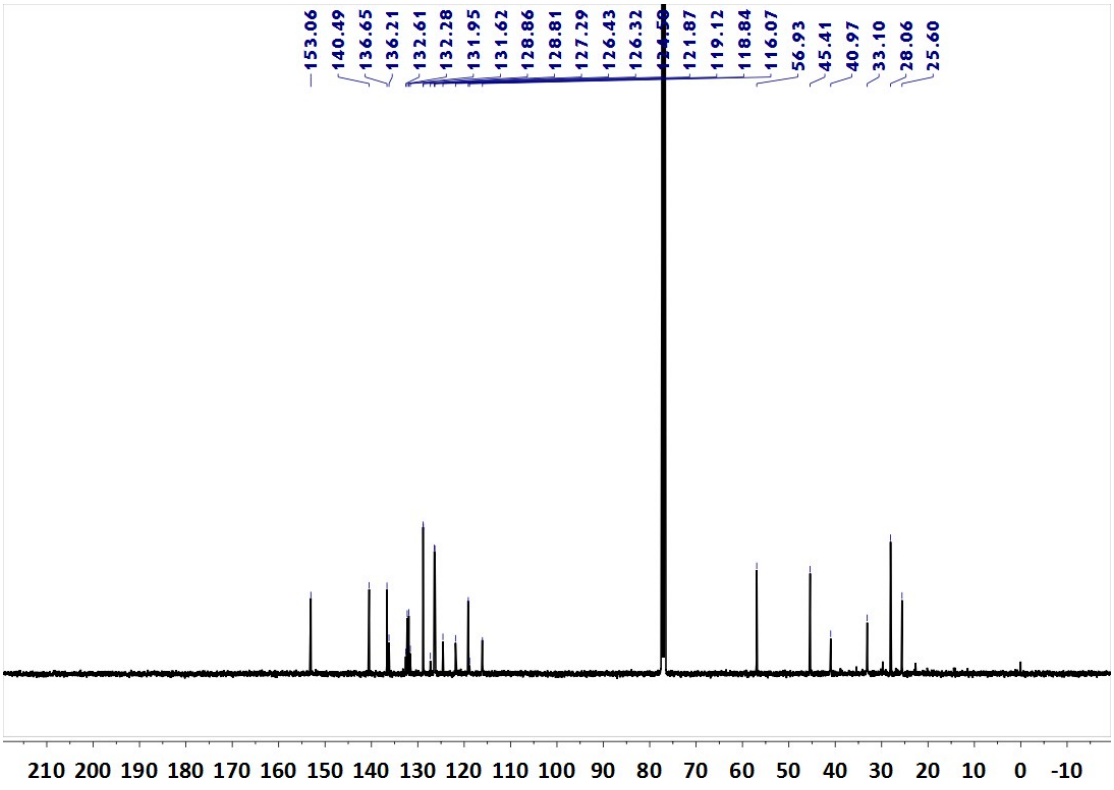
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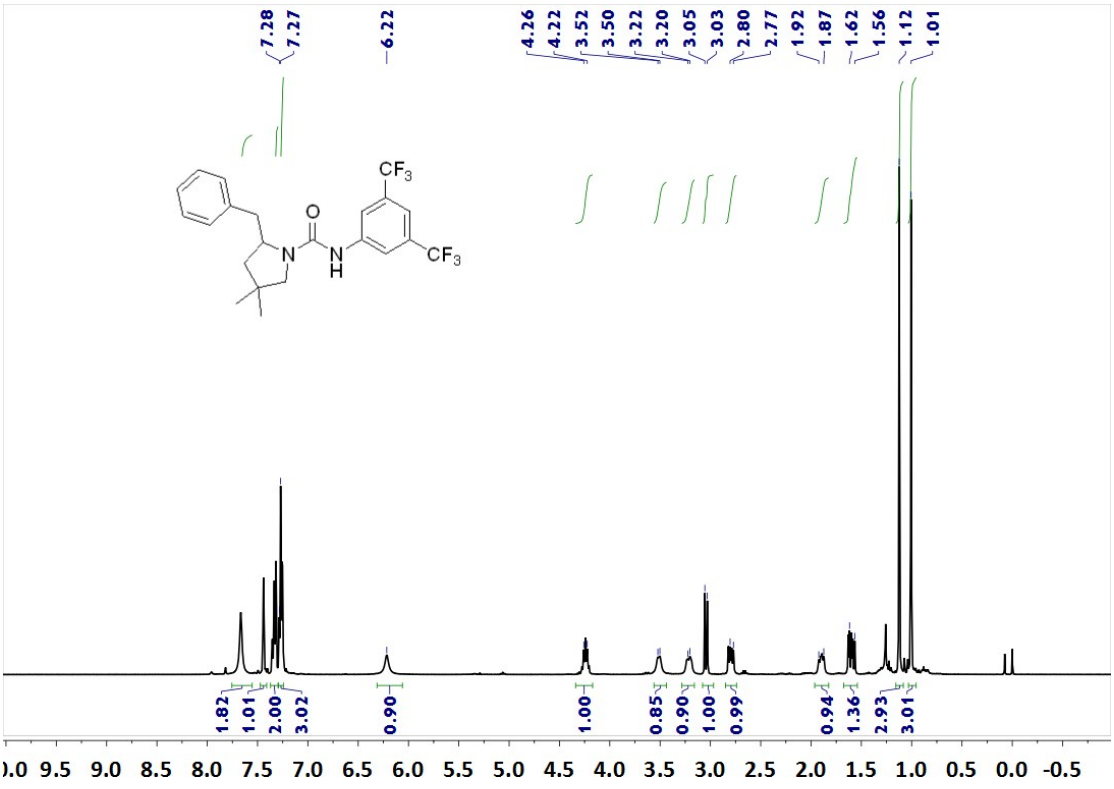
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CF3
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H
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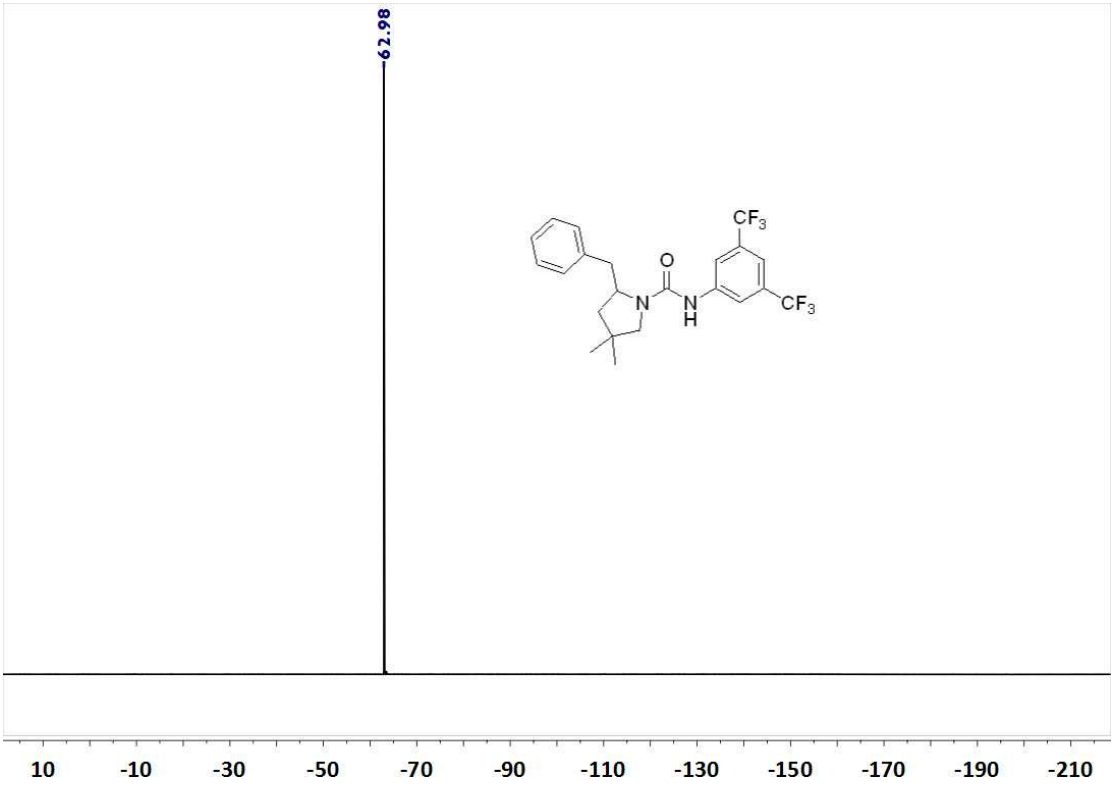
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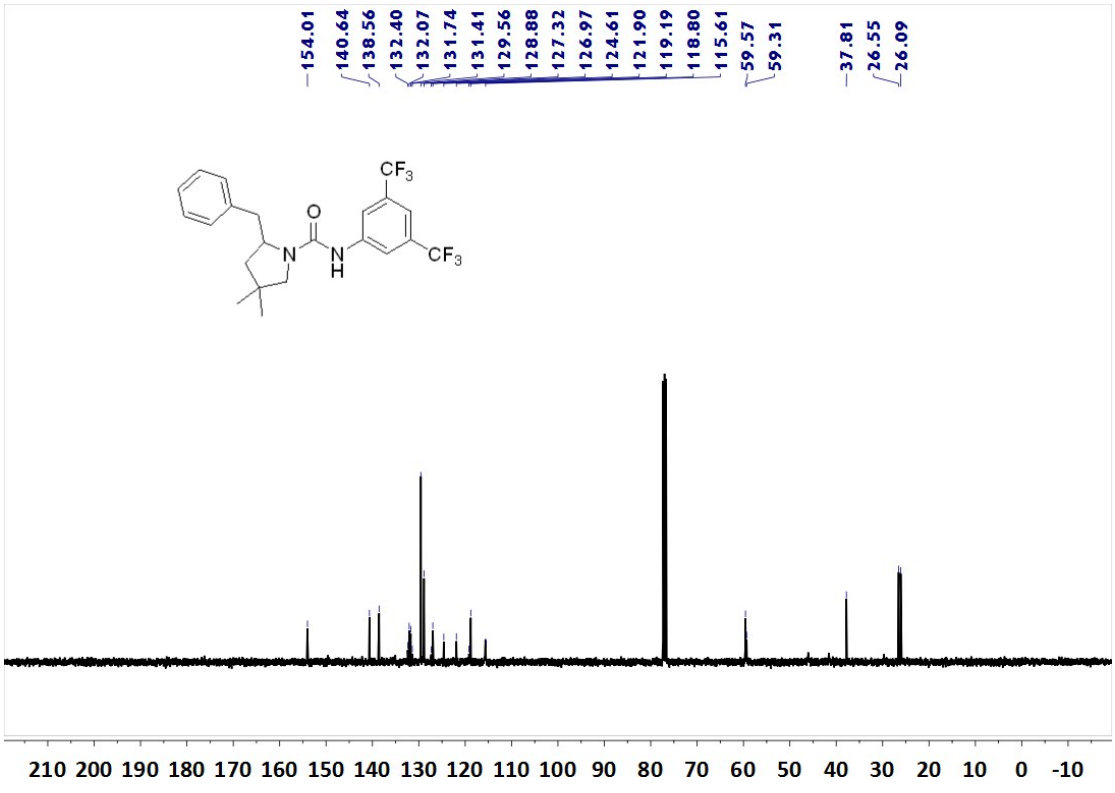
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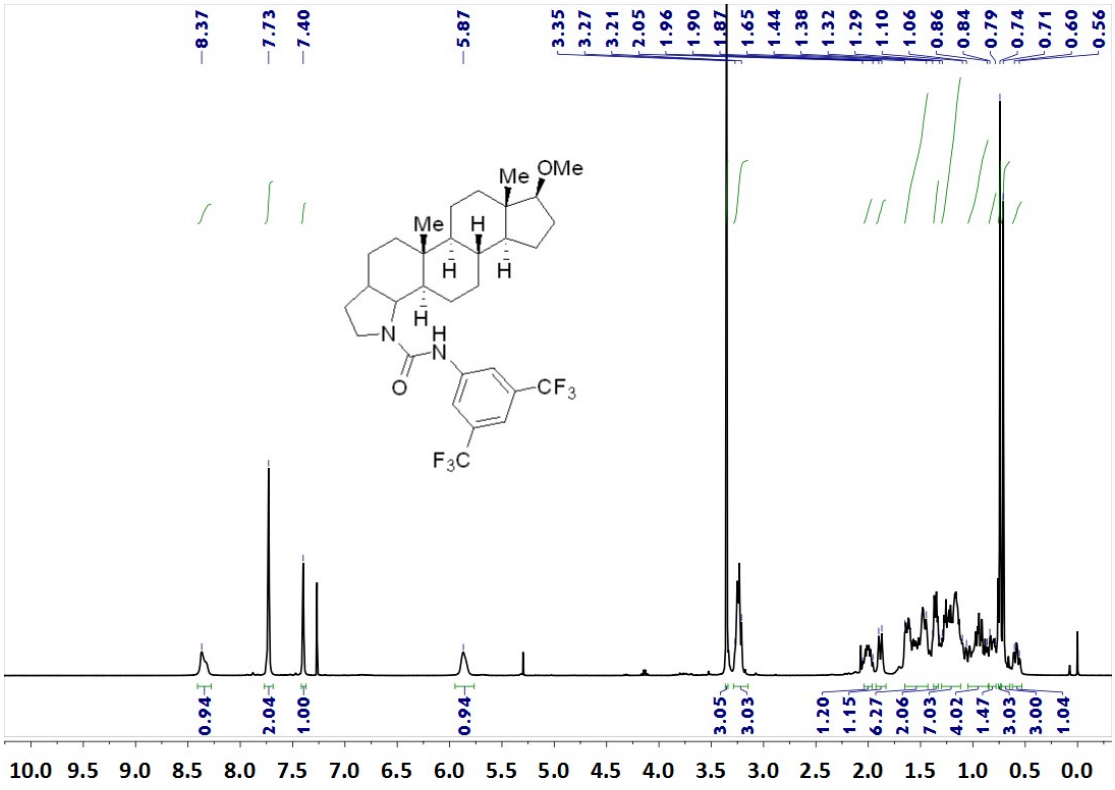
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Me
H
H
H
H
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H
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O
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3.03
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3.00
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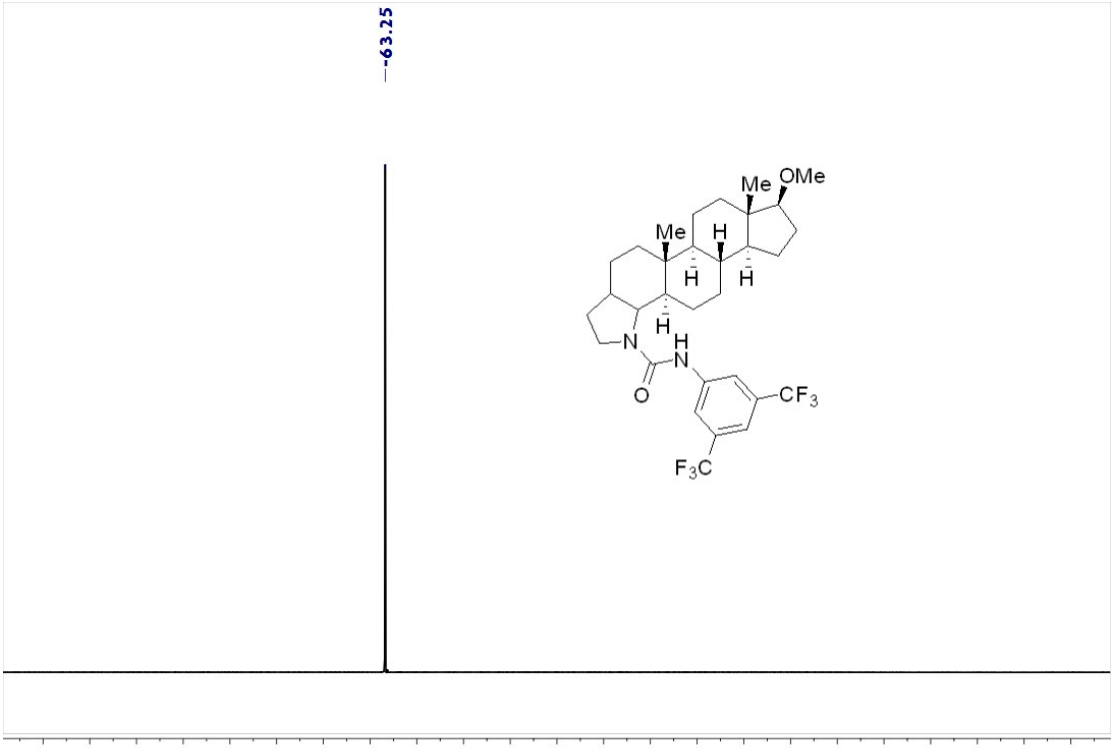
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0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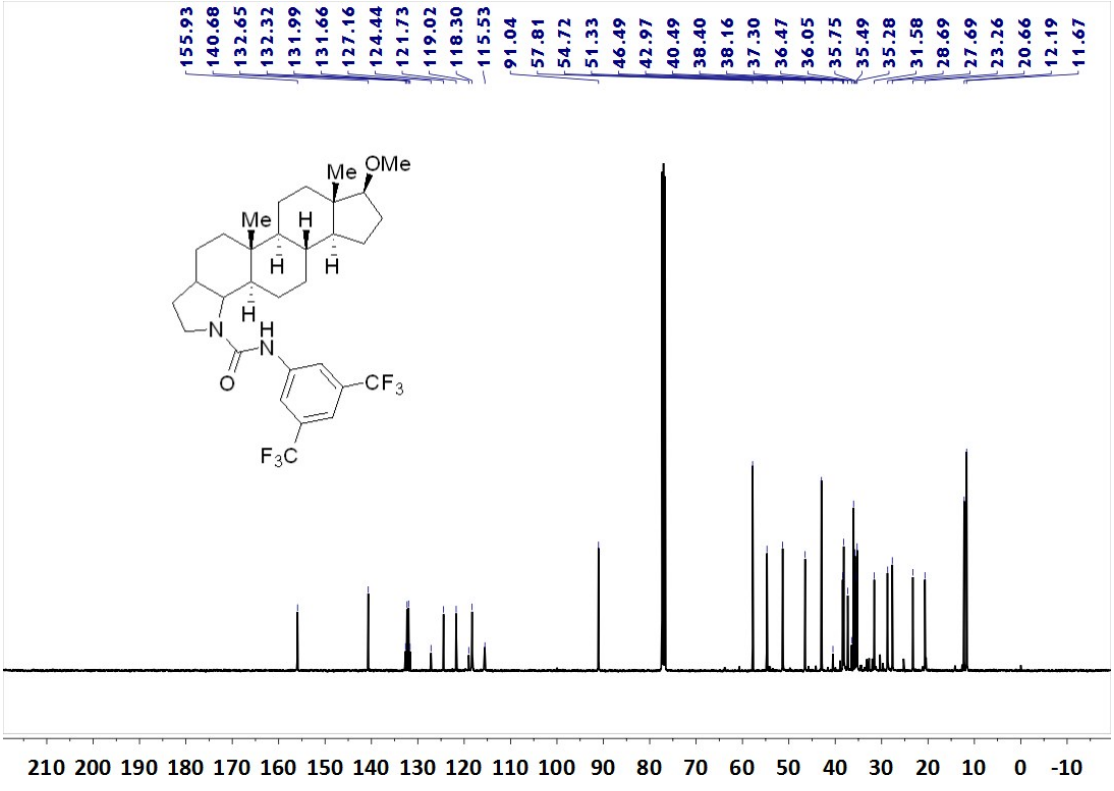
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OMe
Me
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O
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F3C
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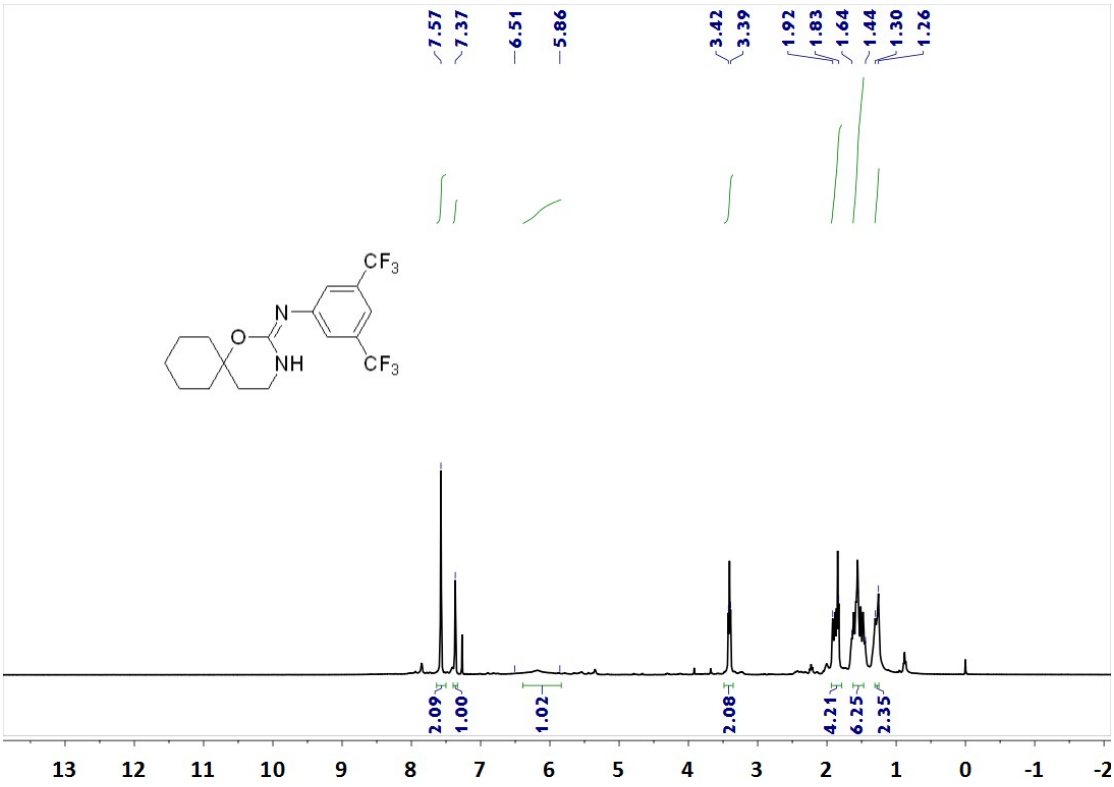
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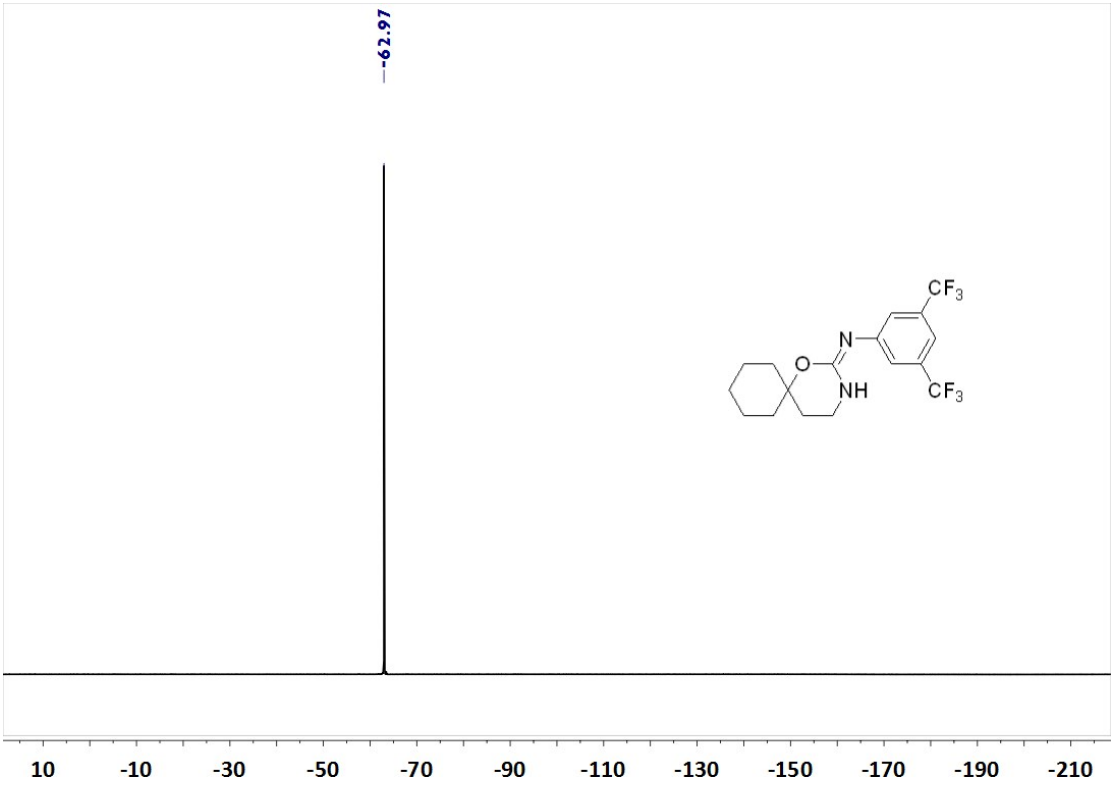
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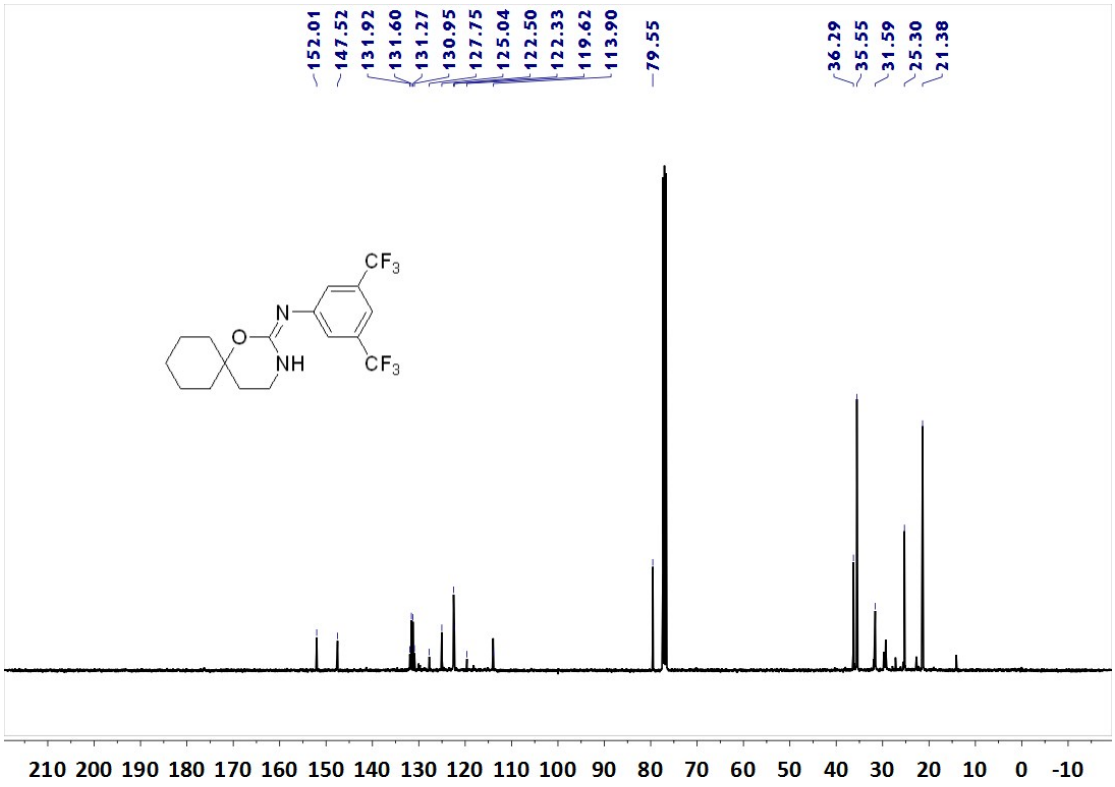
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CF3
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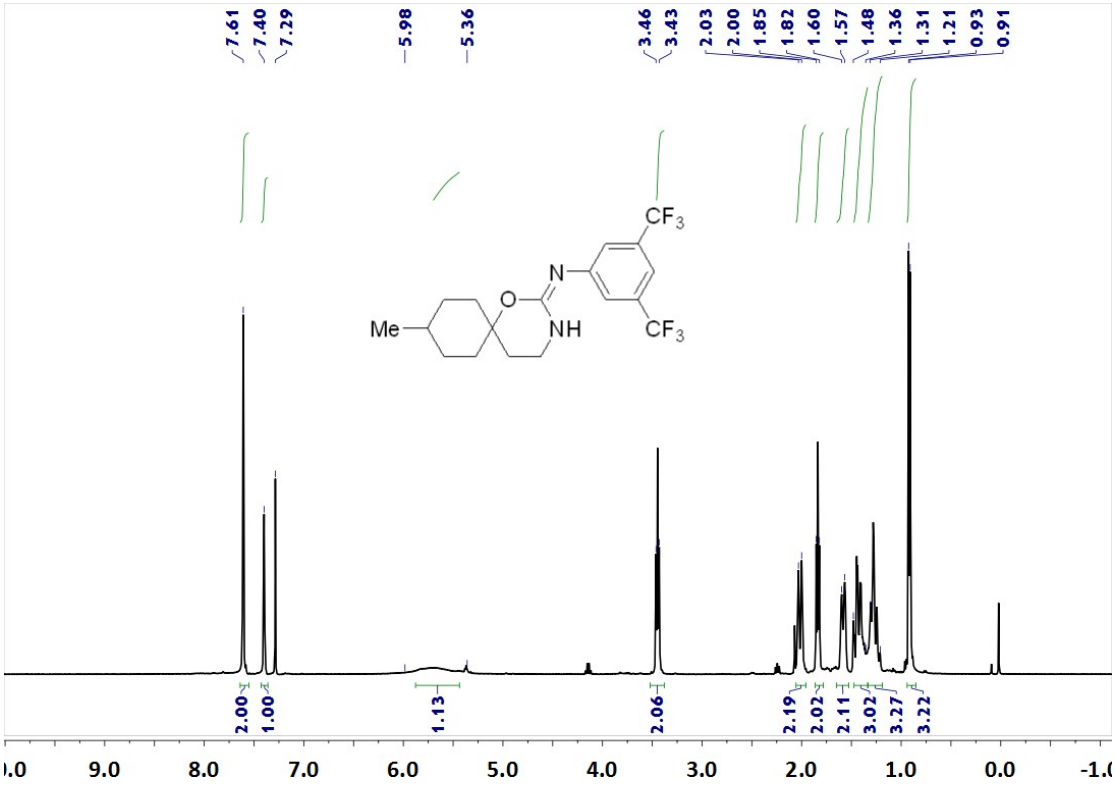
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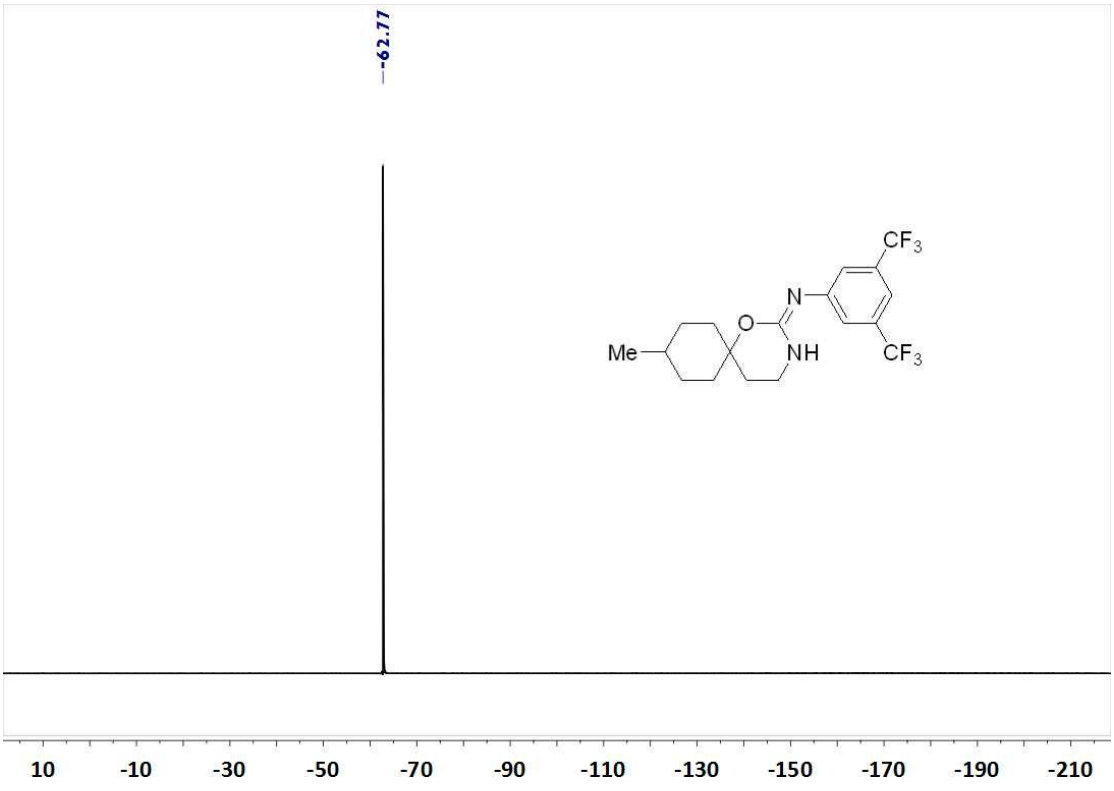
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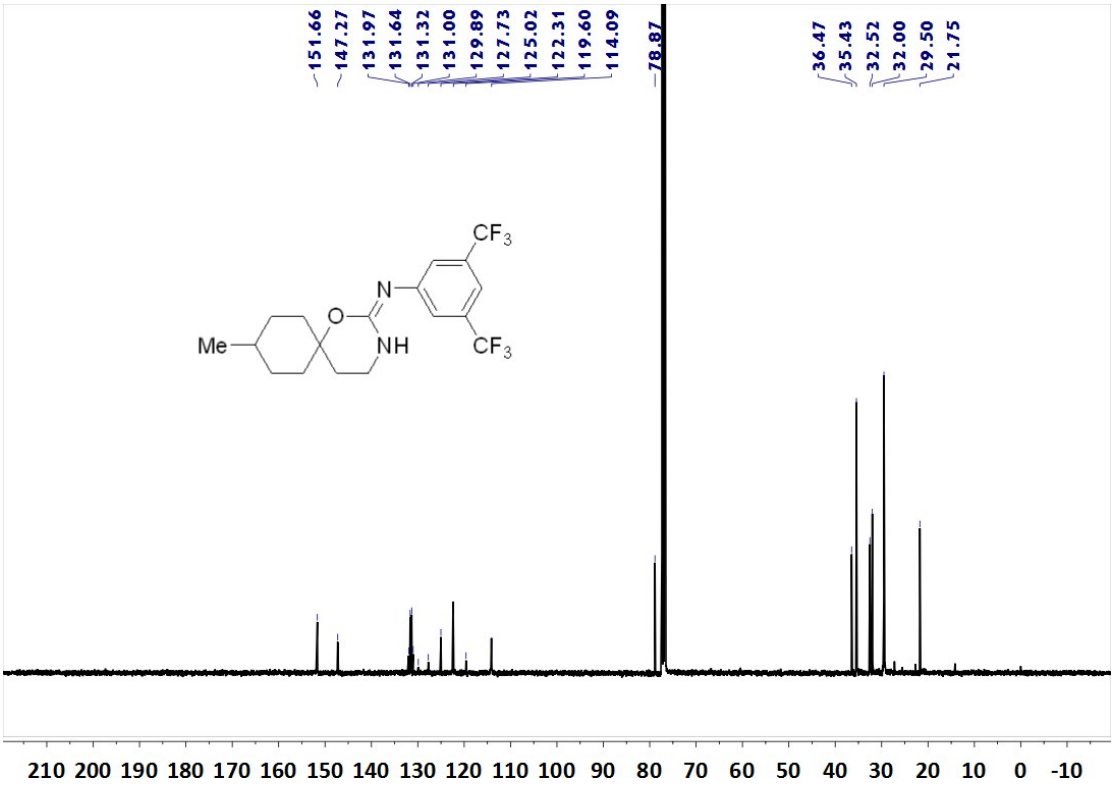
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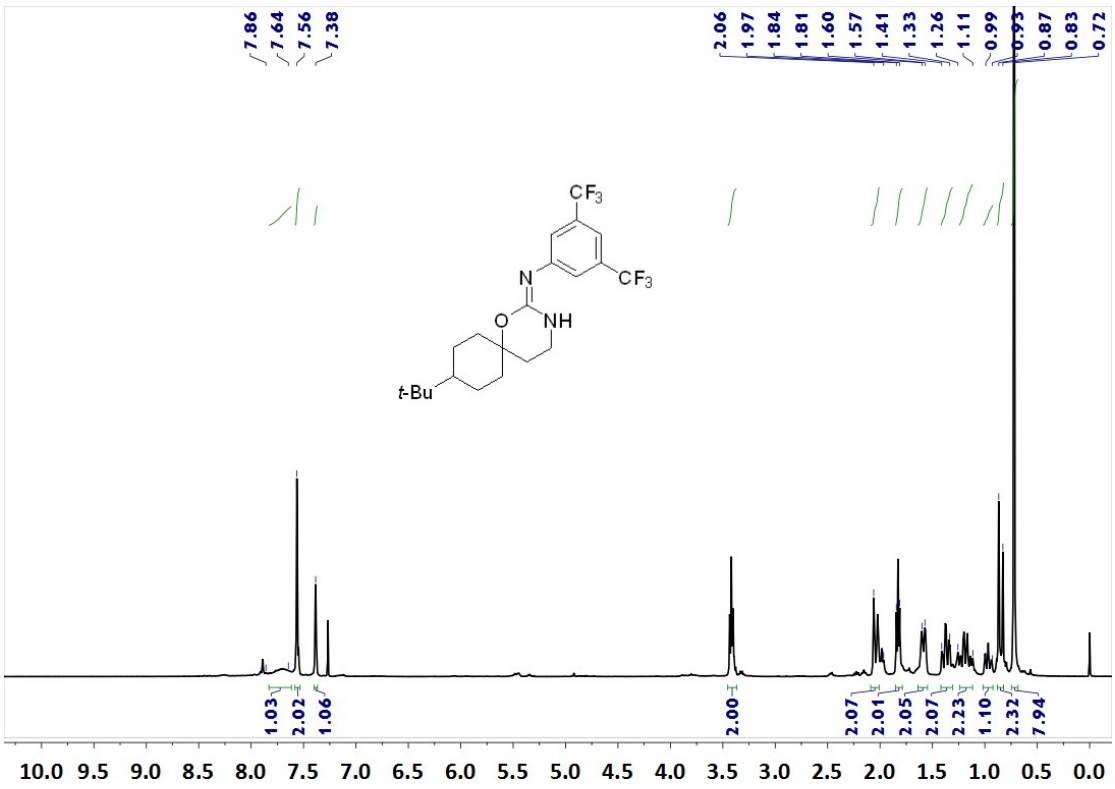
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NH
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1.06
2.00
2.07
2.01
2.05
2.07
2.23
1.10
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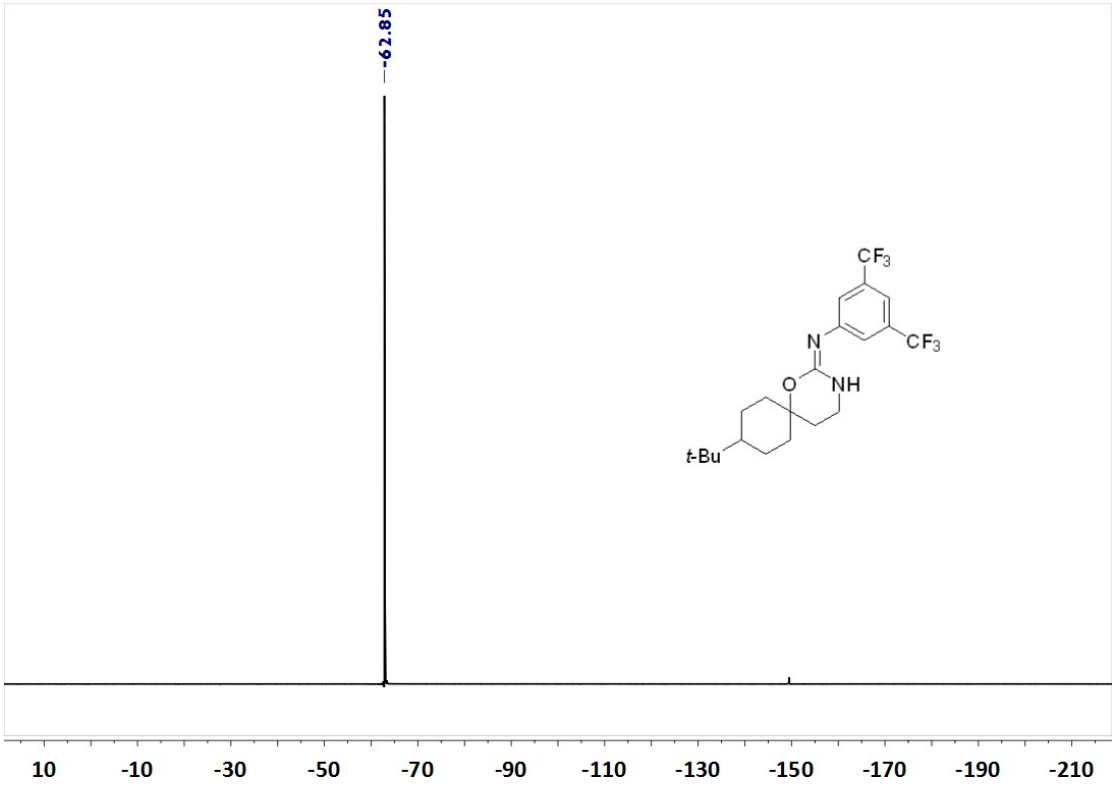
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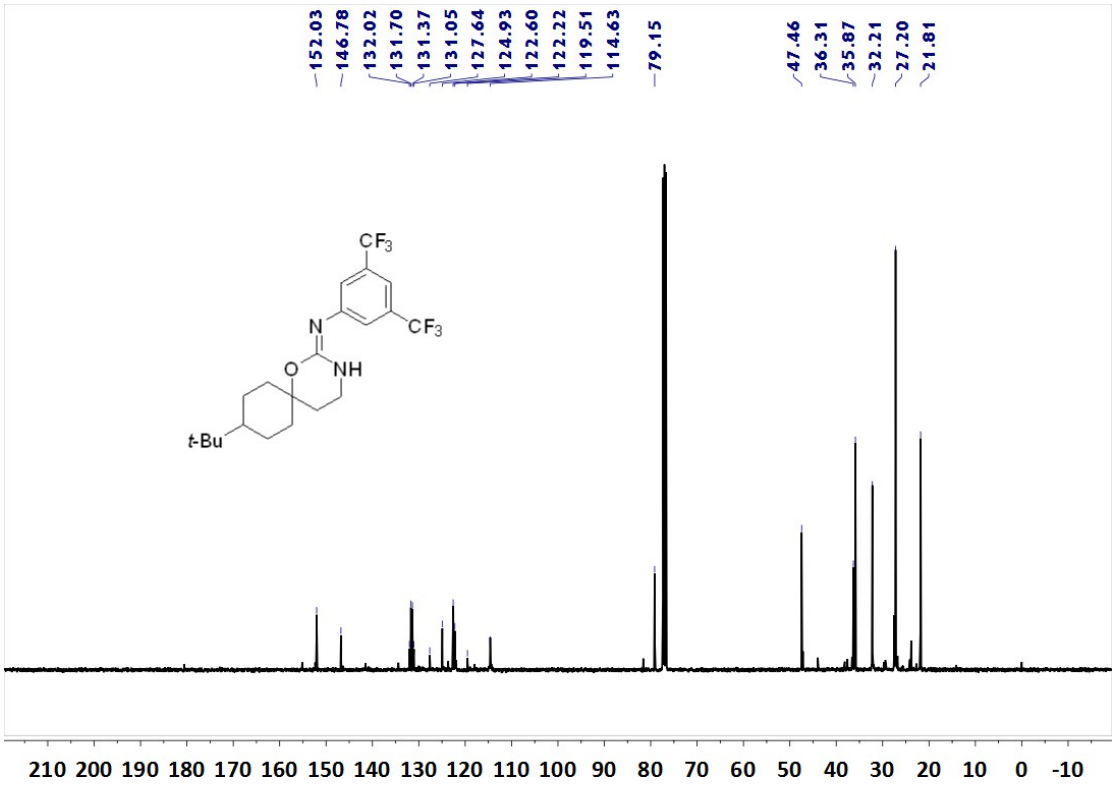
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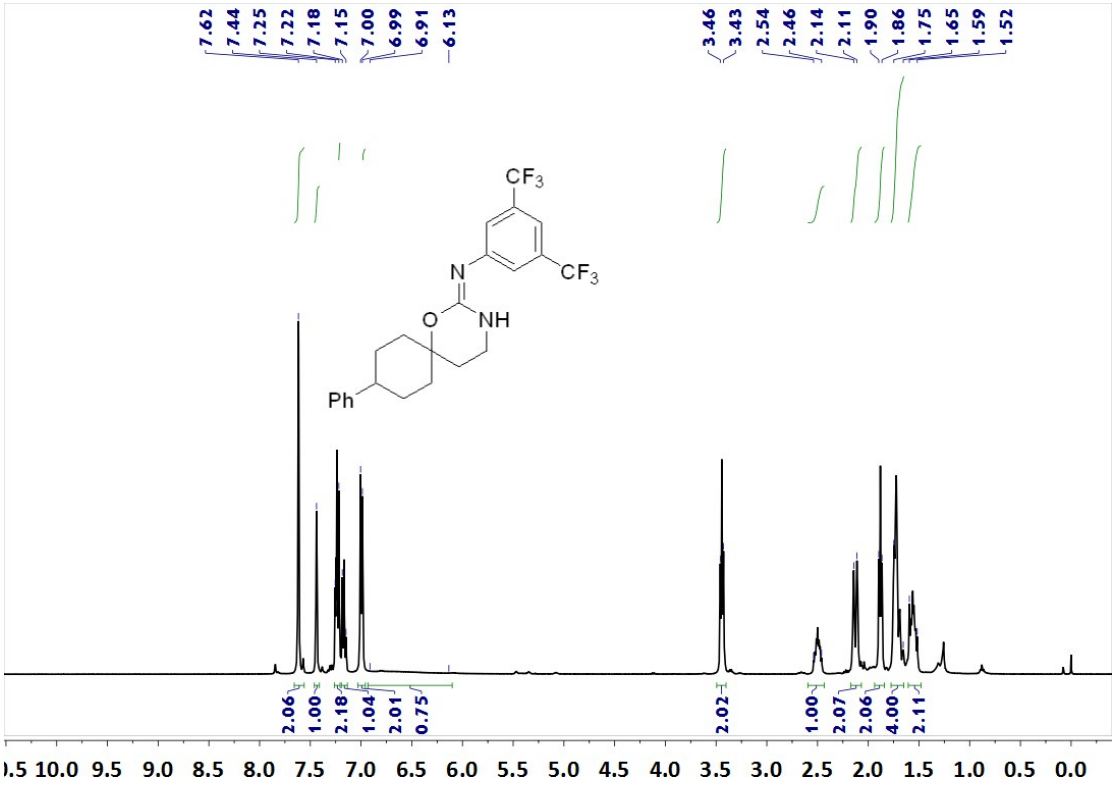
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1.00
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2.11
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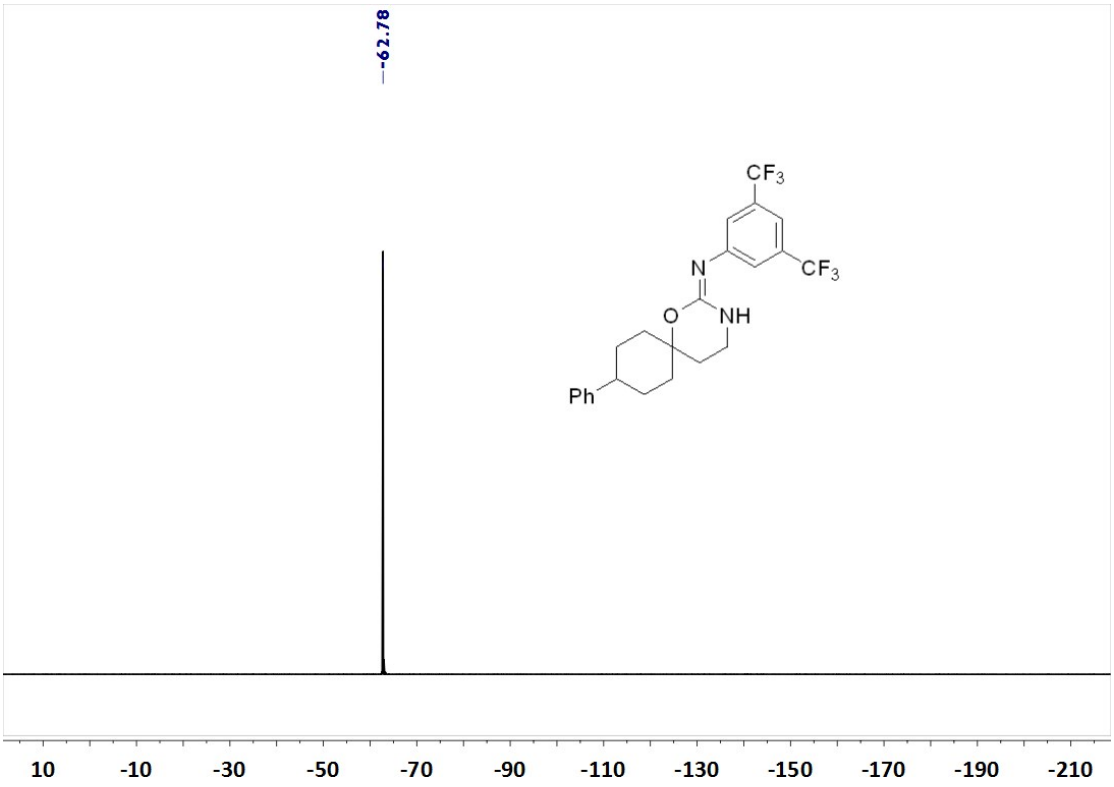
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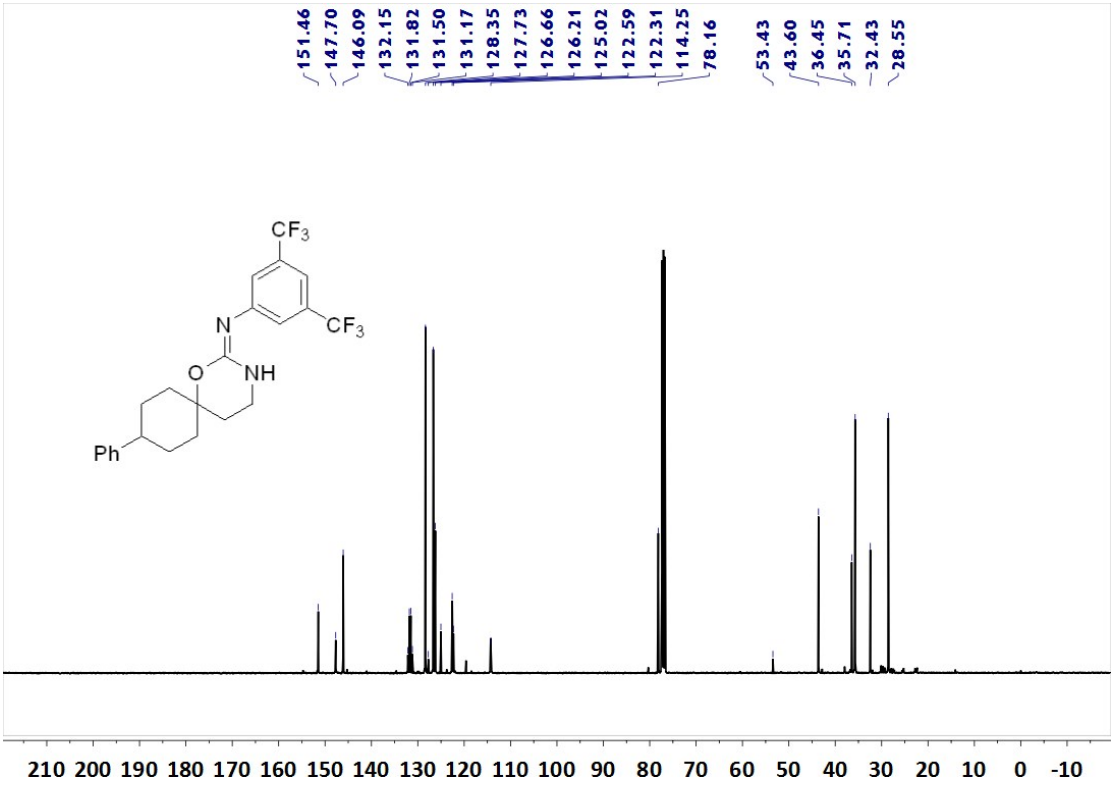
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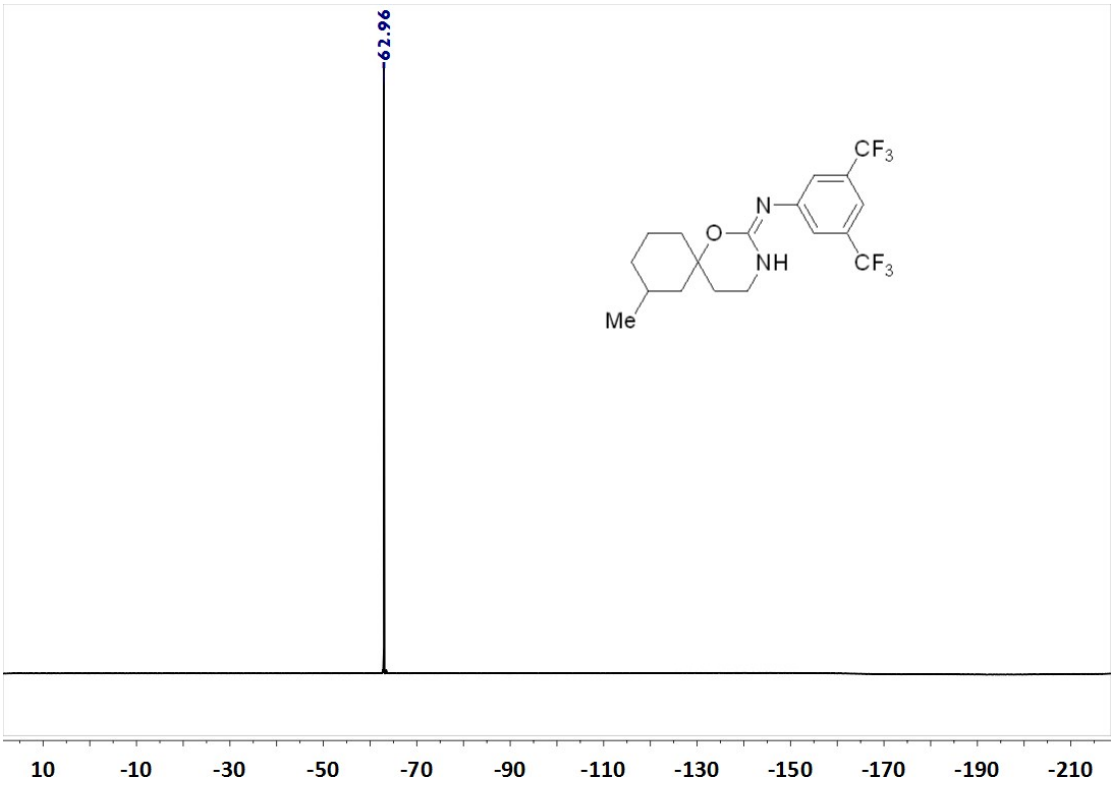
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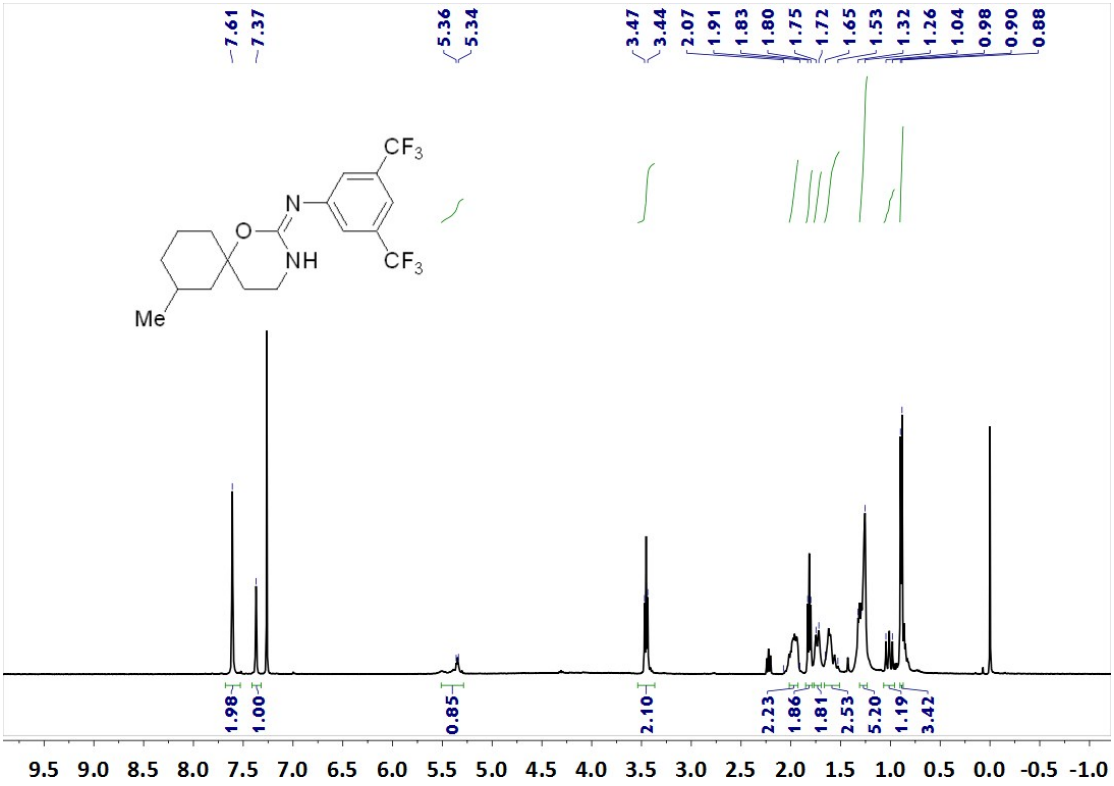
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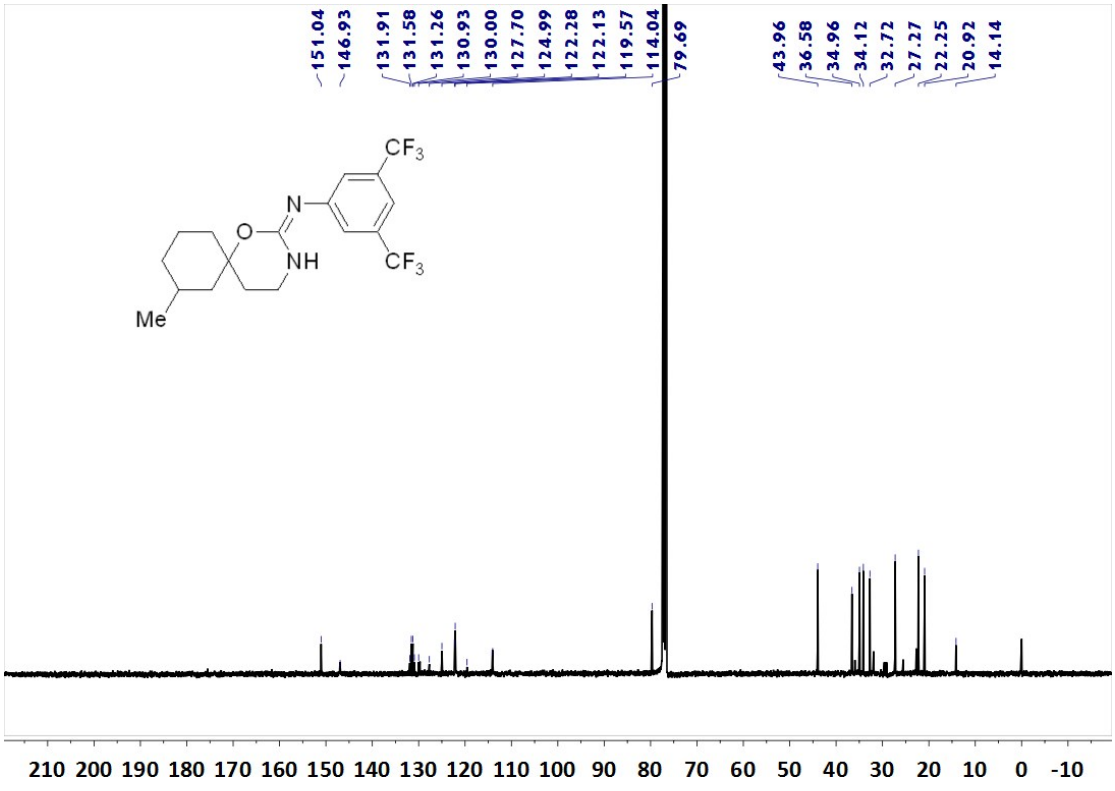
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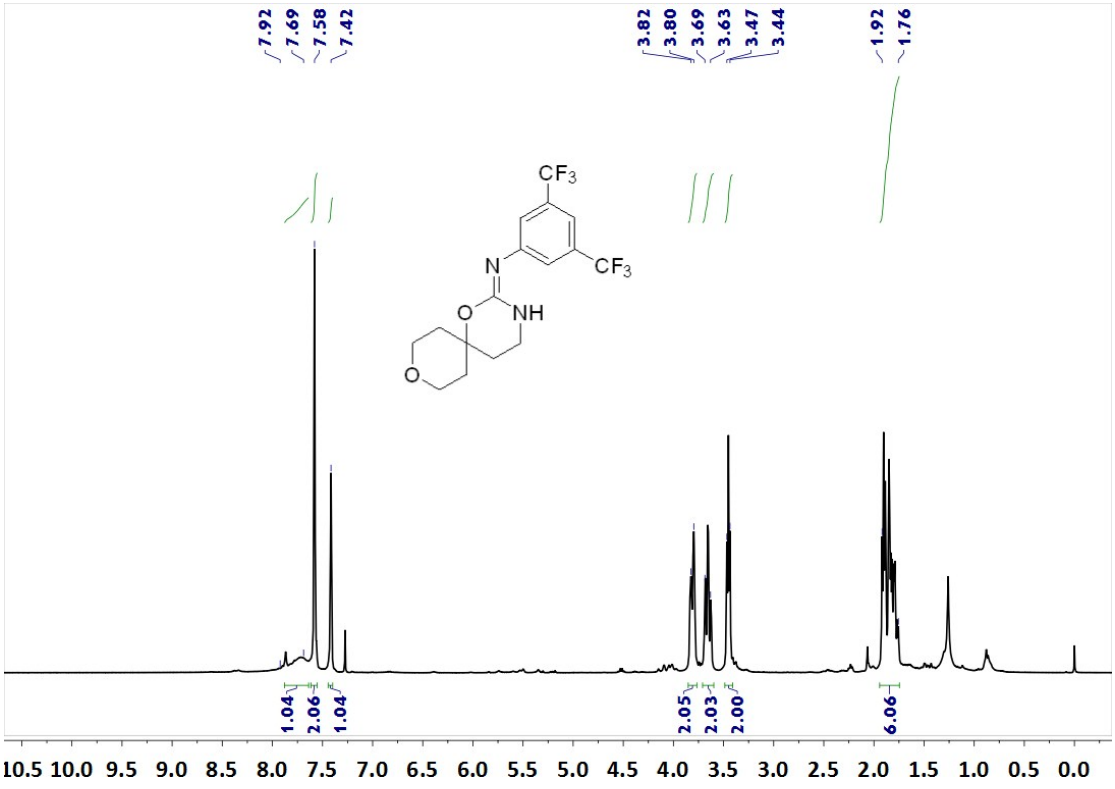
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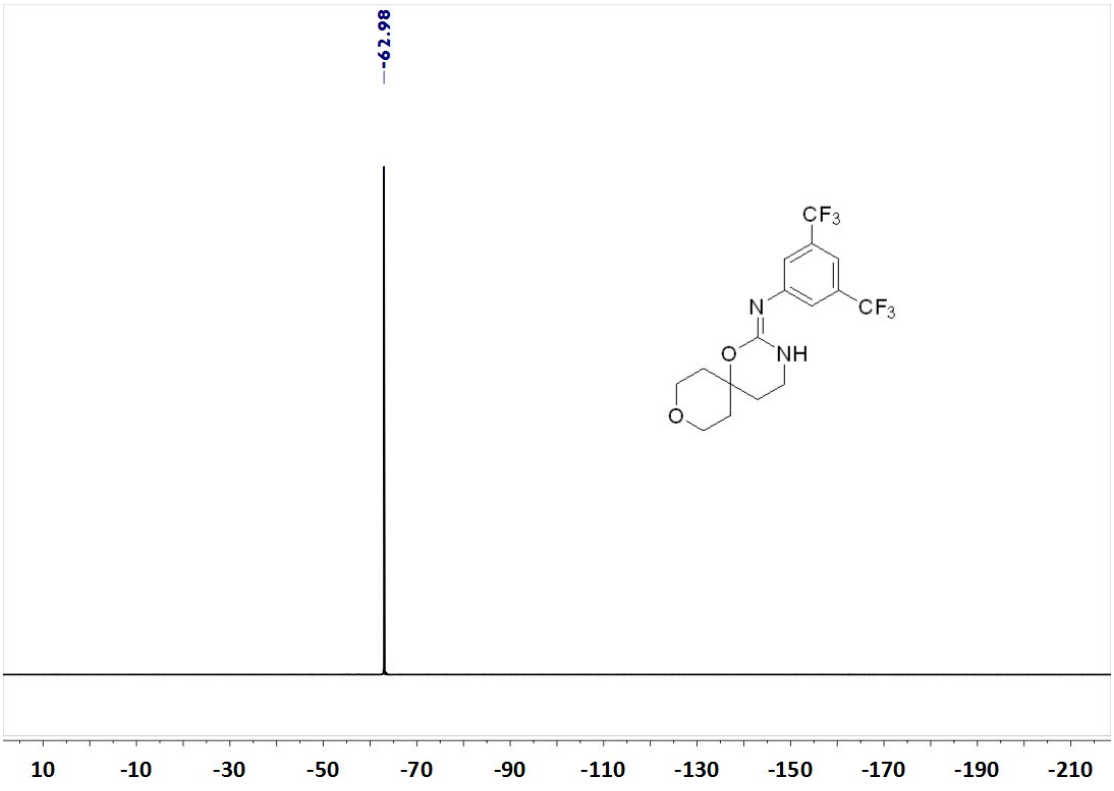
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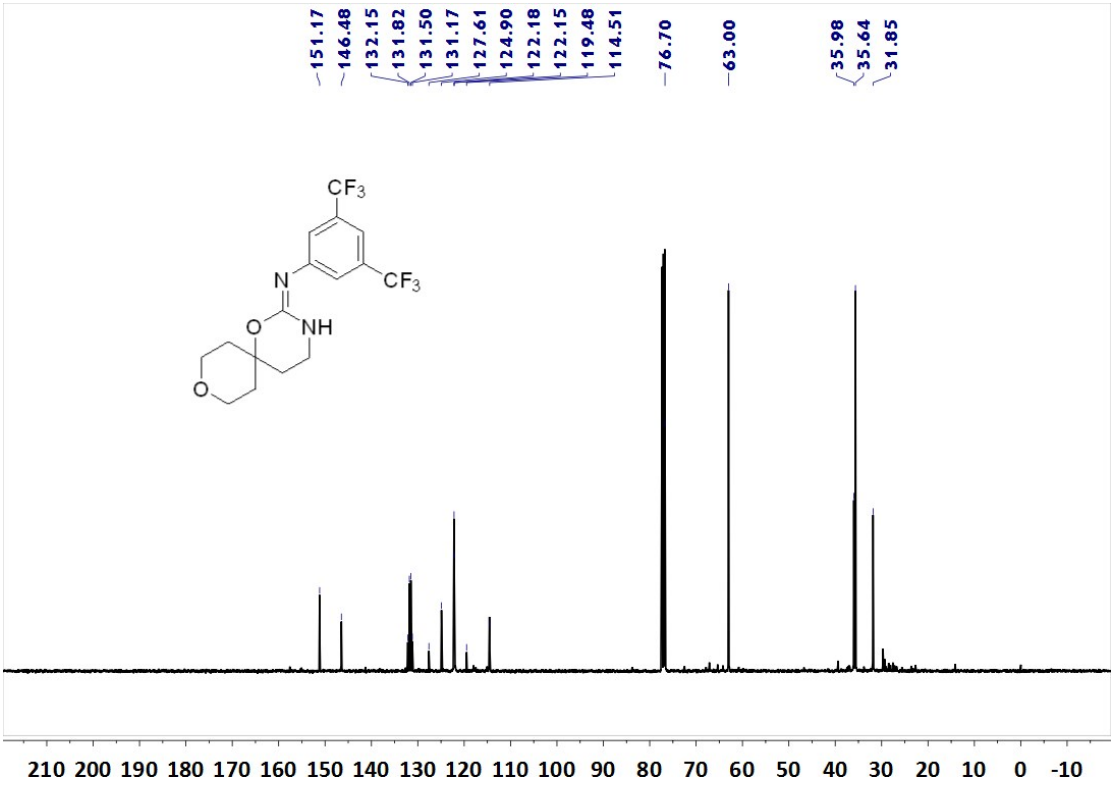
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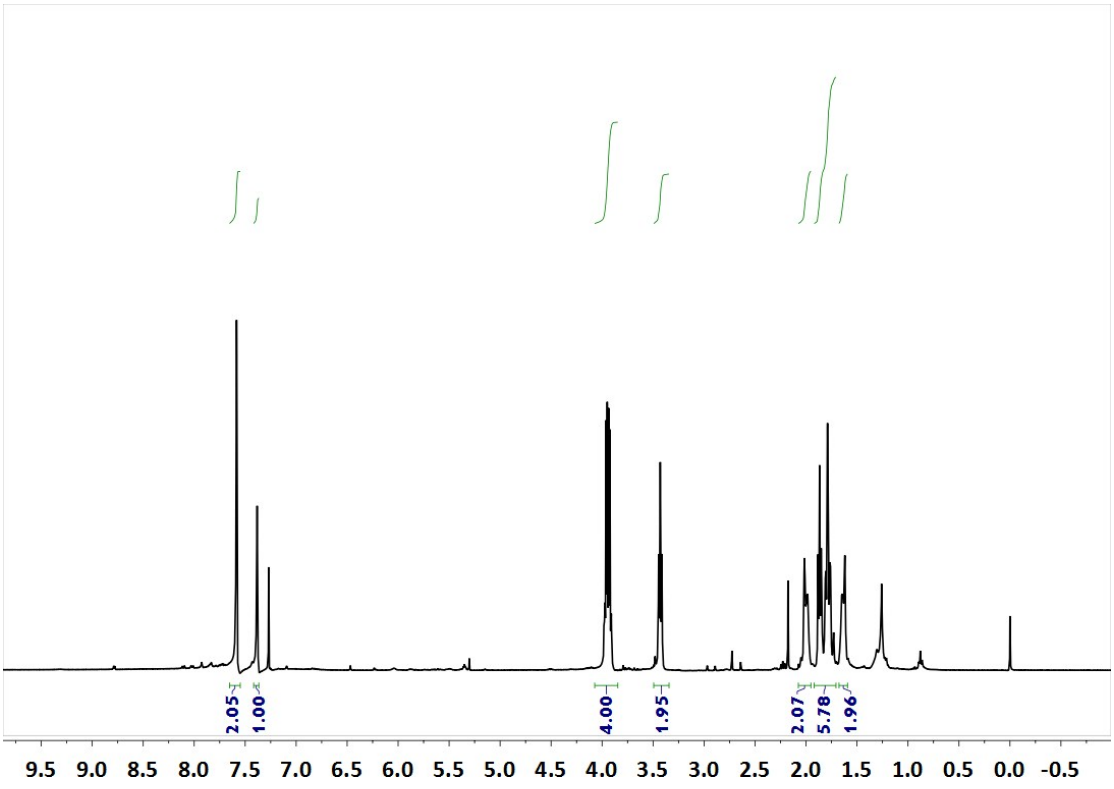
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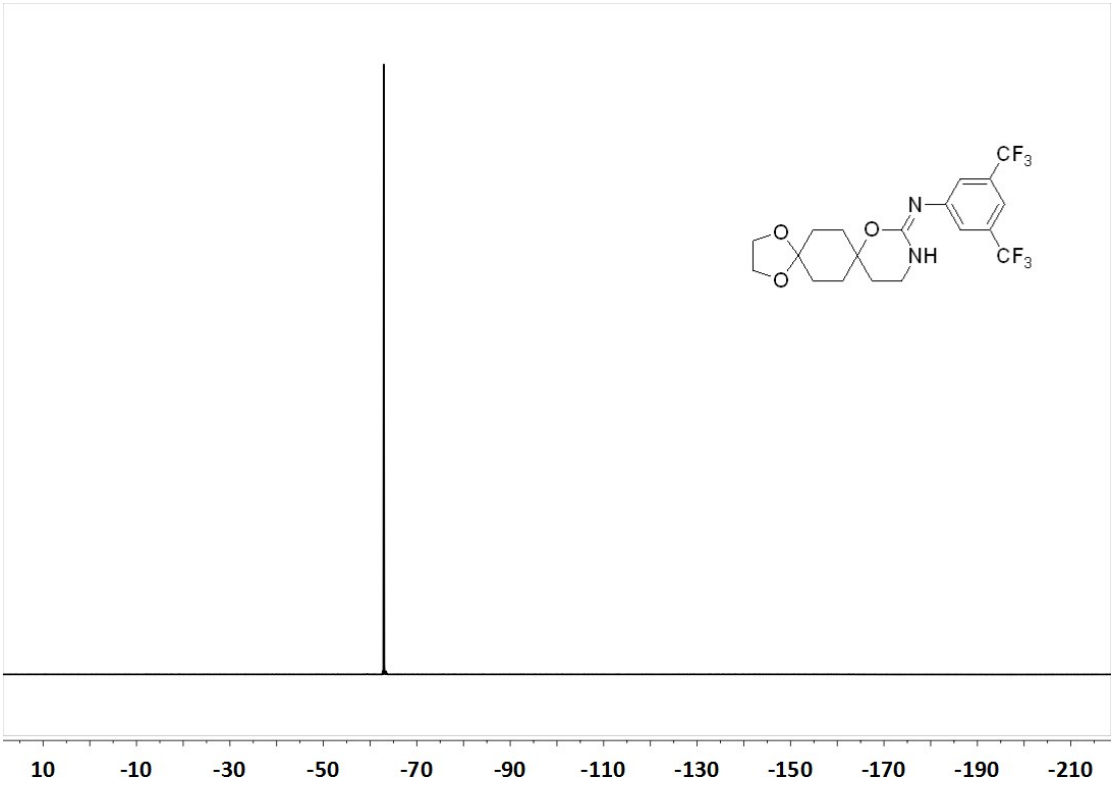
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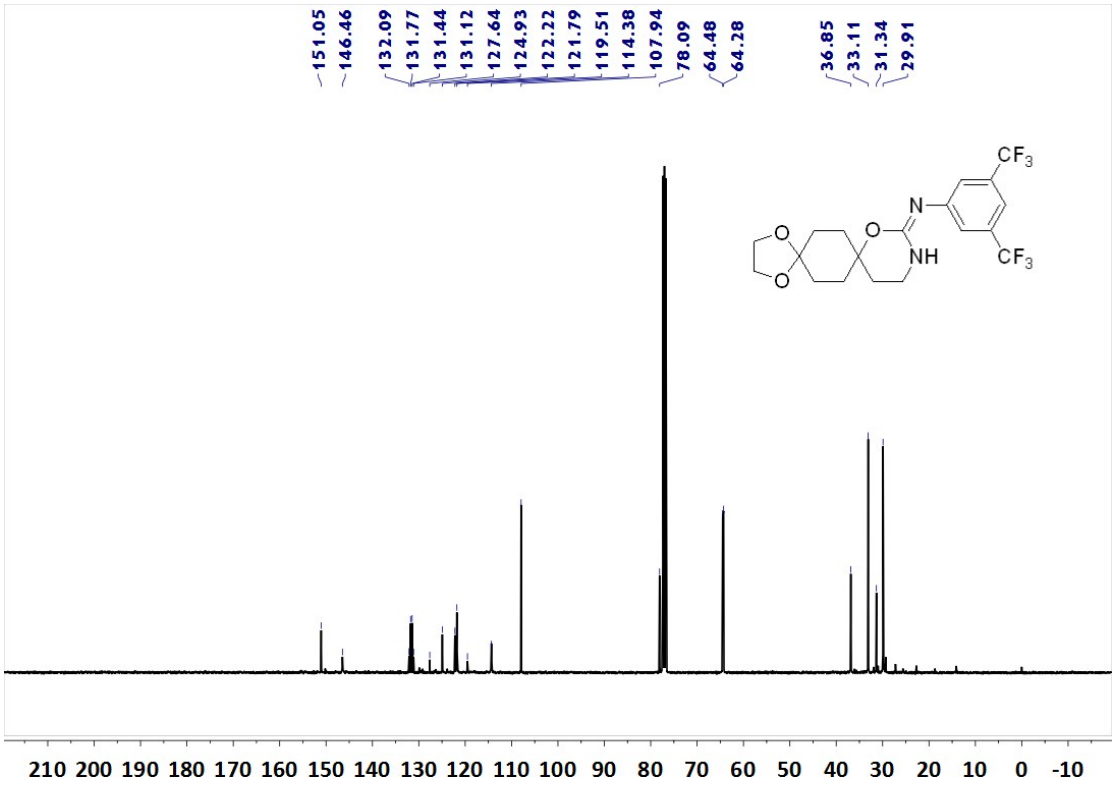
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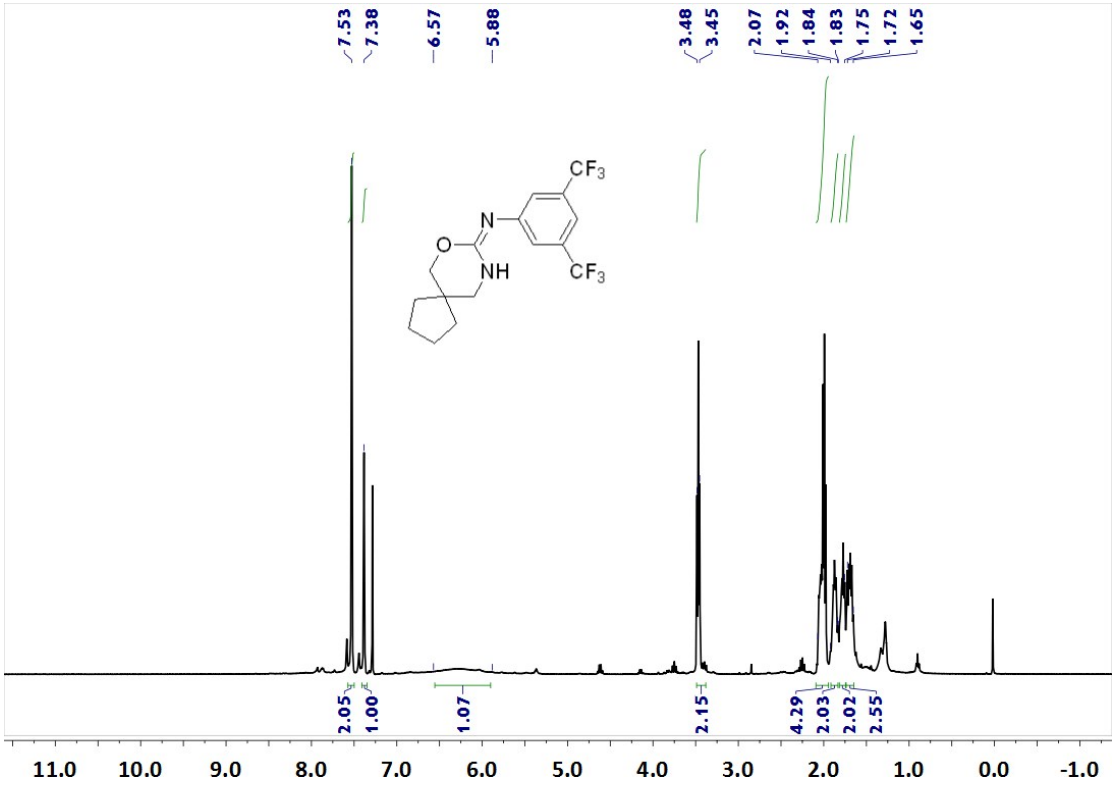
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O
NH
CF3
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1.07
2.15
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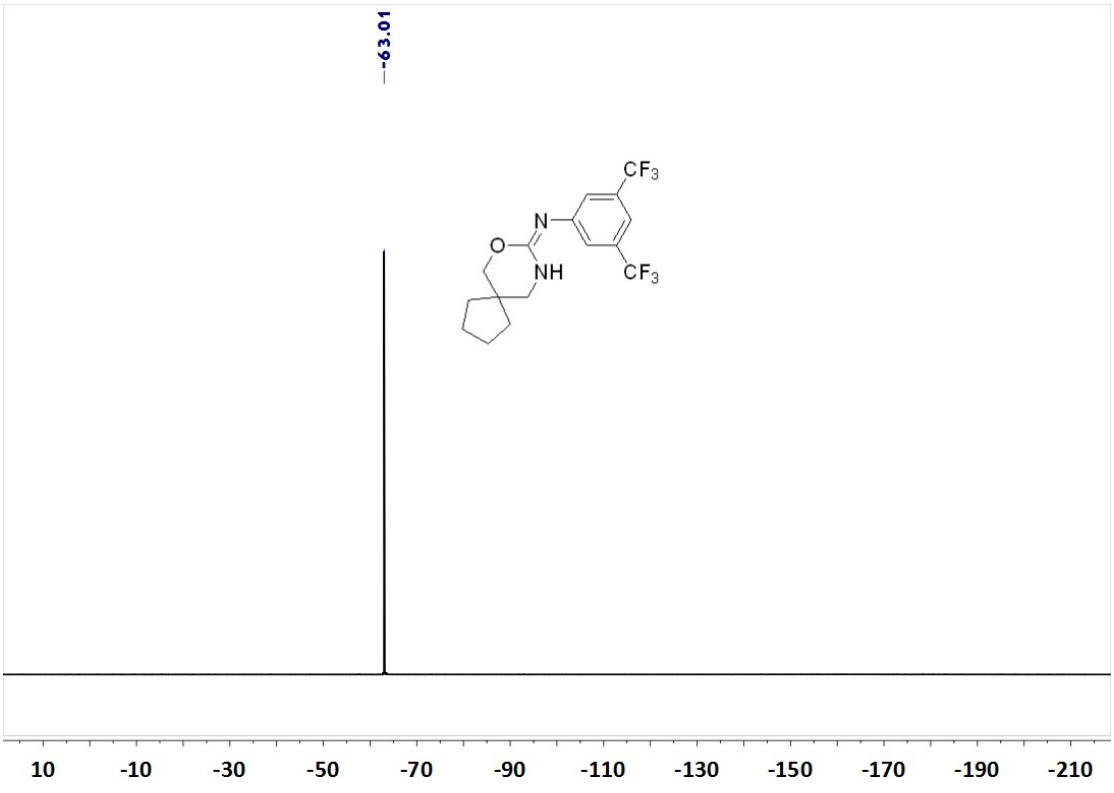
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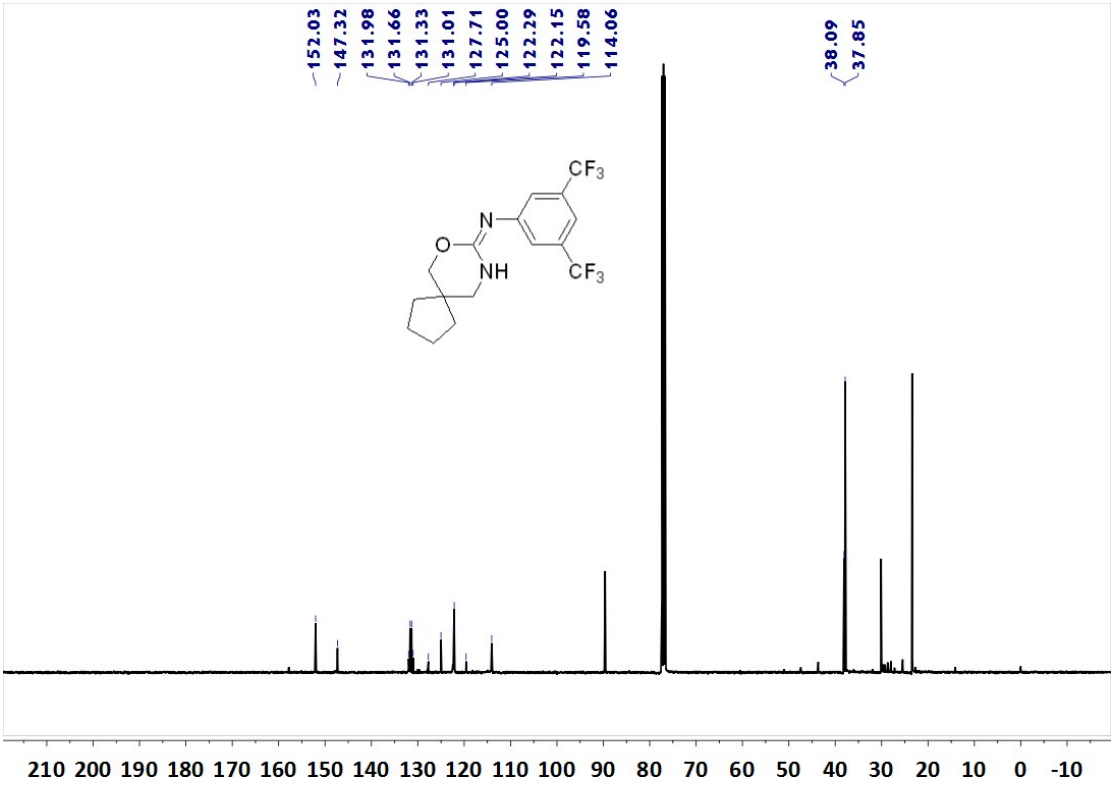
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CF3
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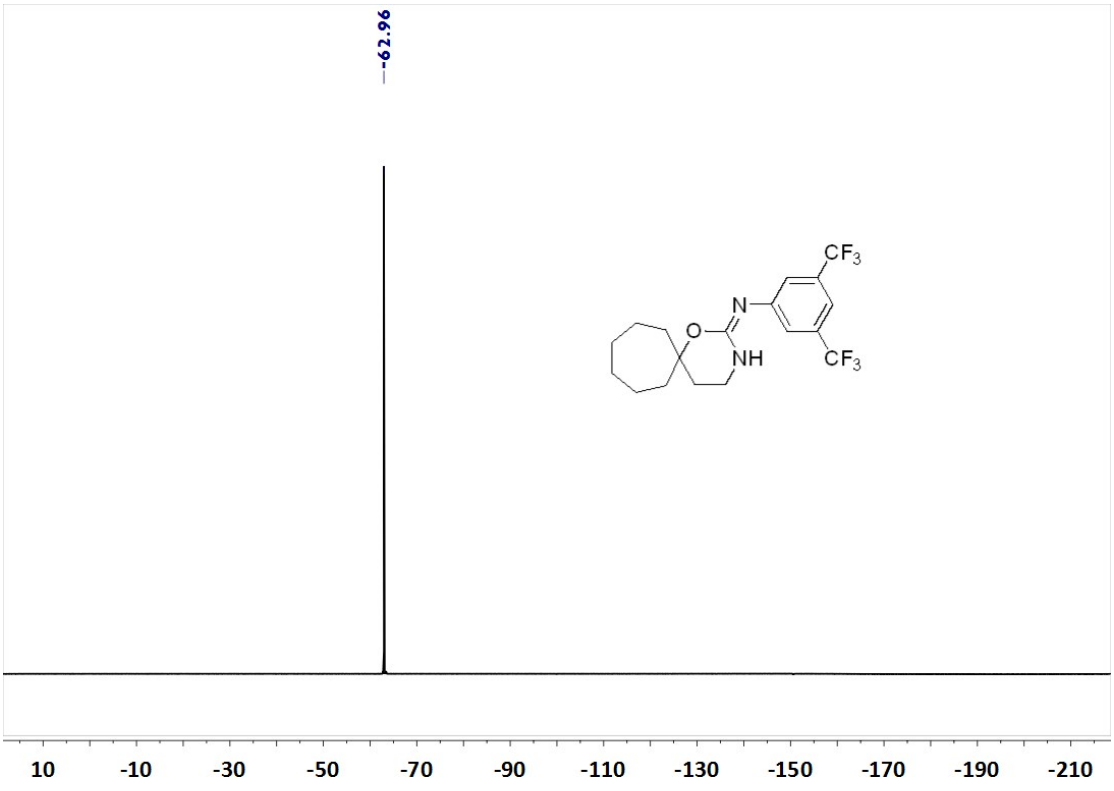
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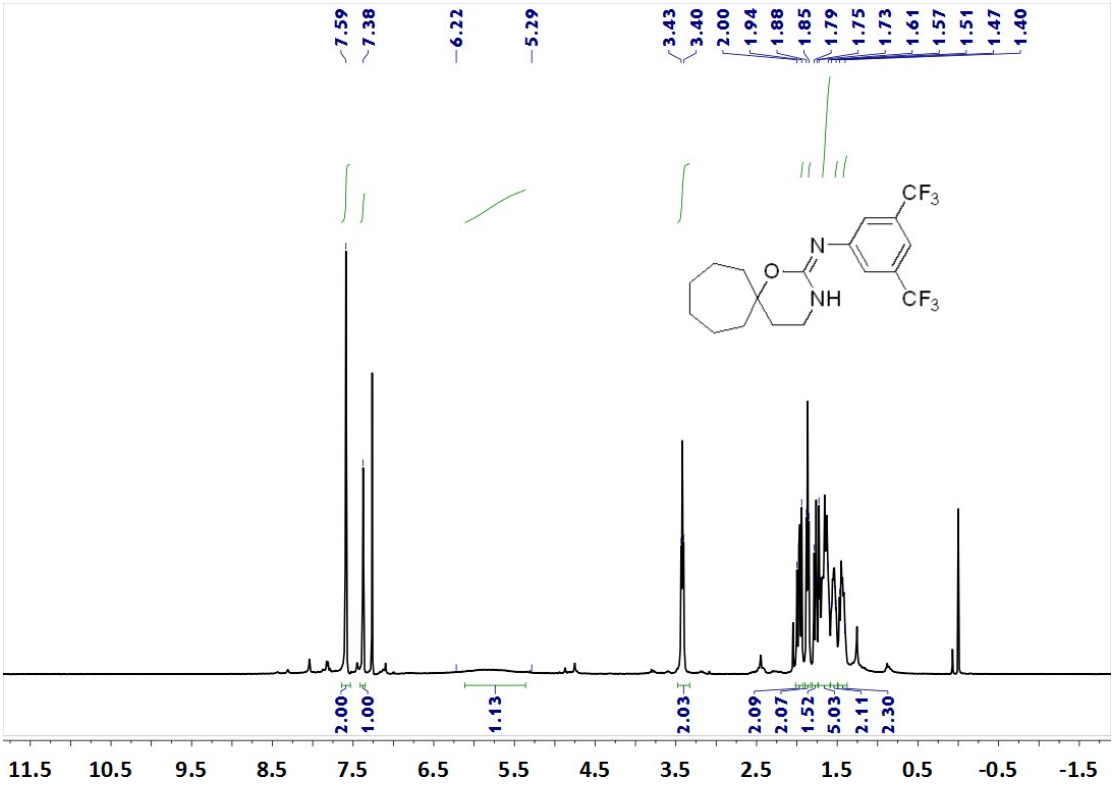
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NH
CF3
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1.00
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2.09
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5.03
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11.5
10.5
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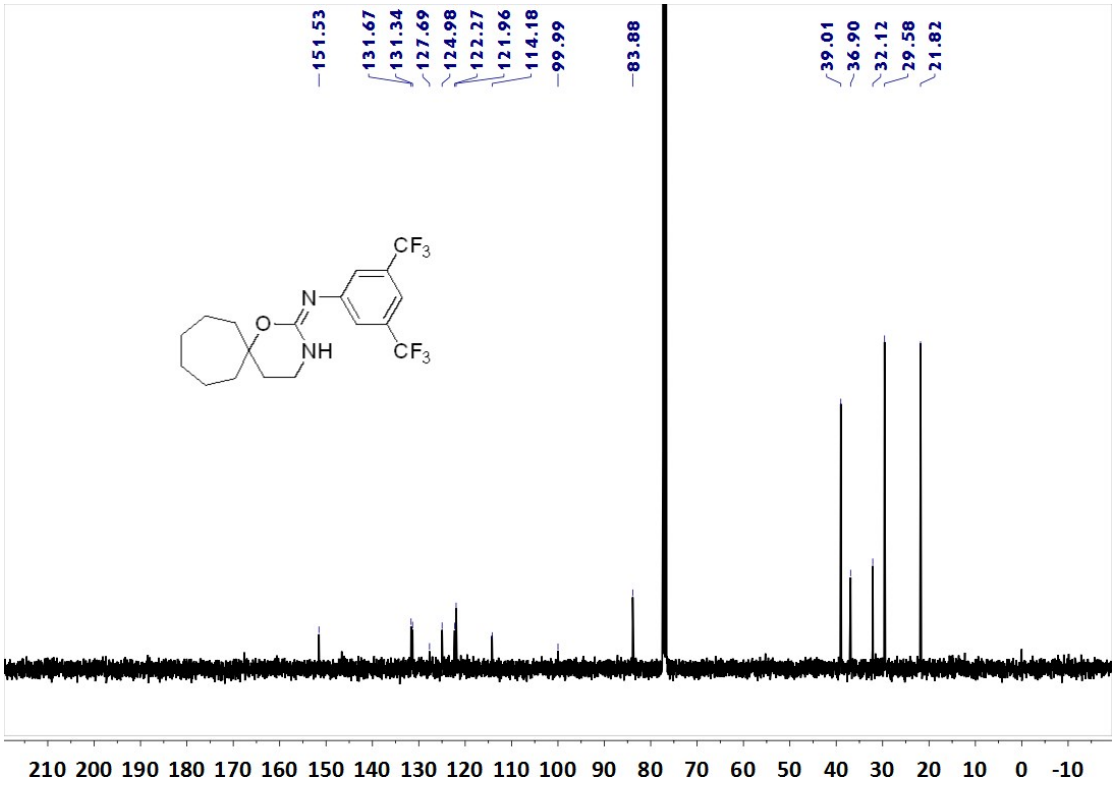
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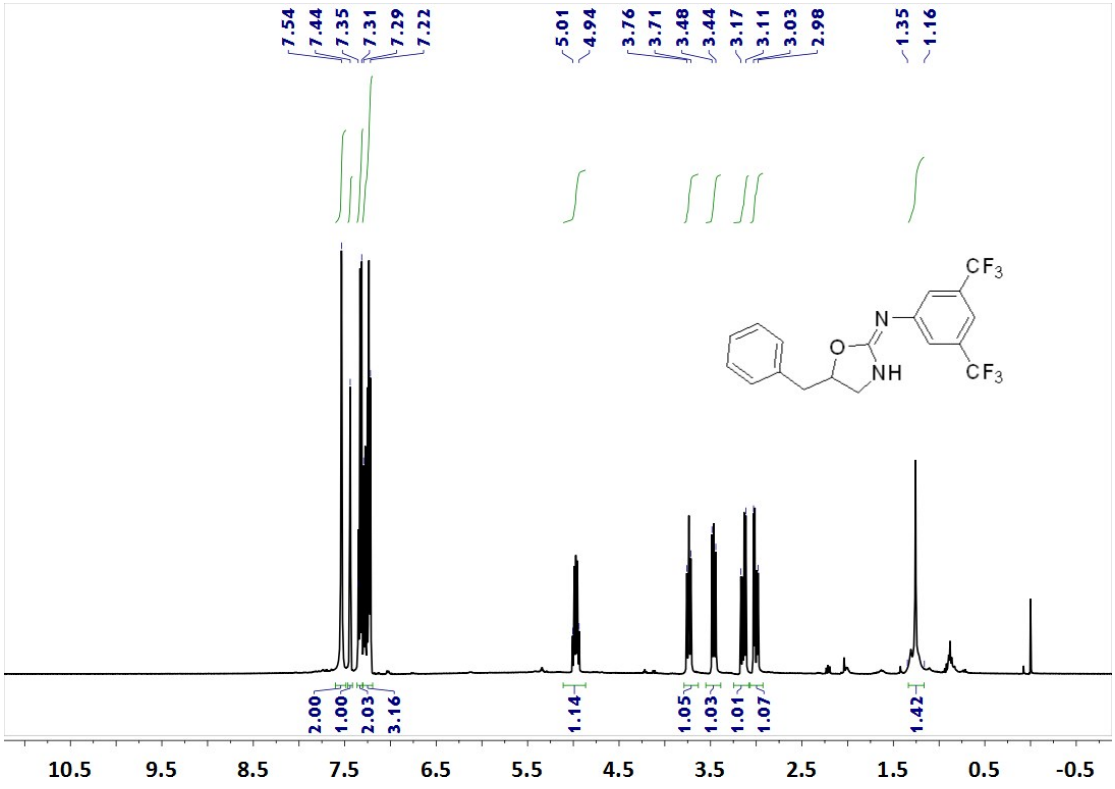
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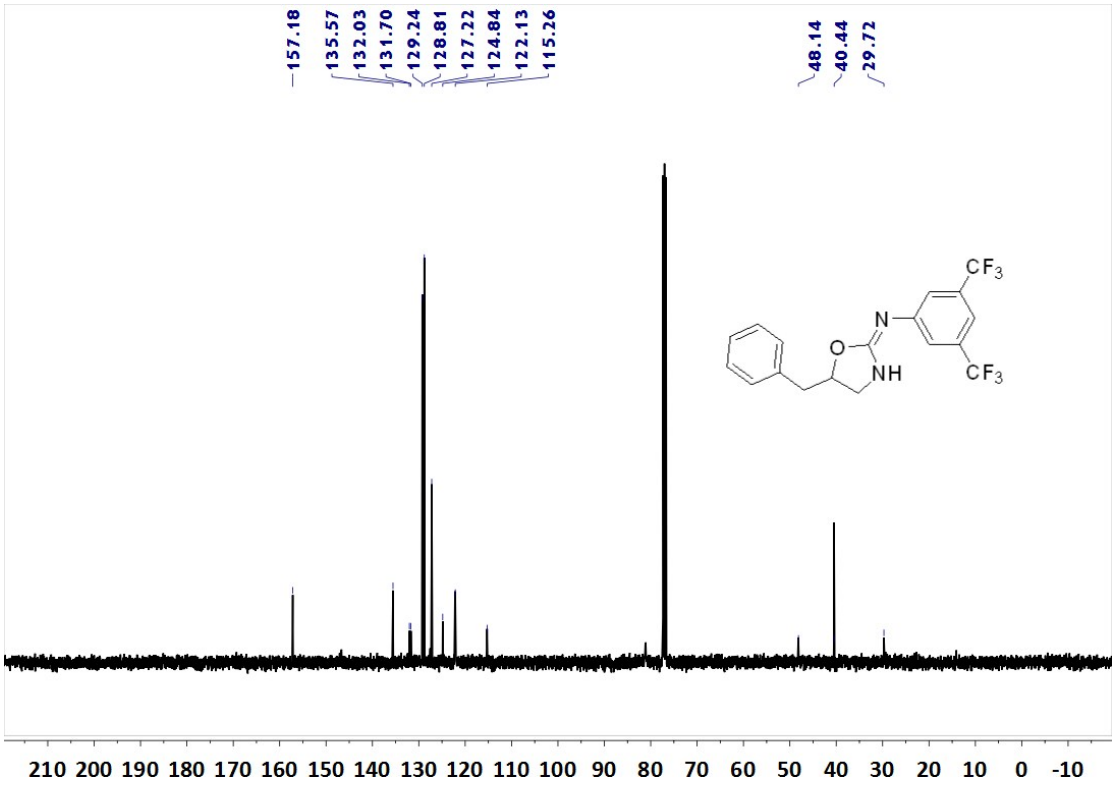
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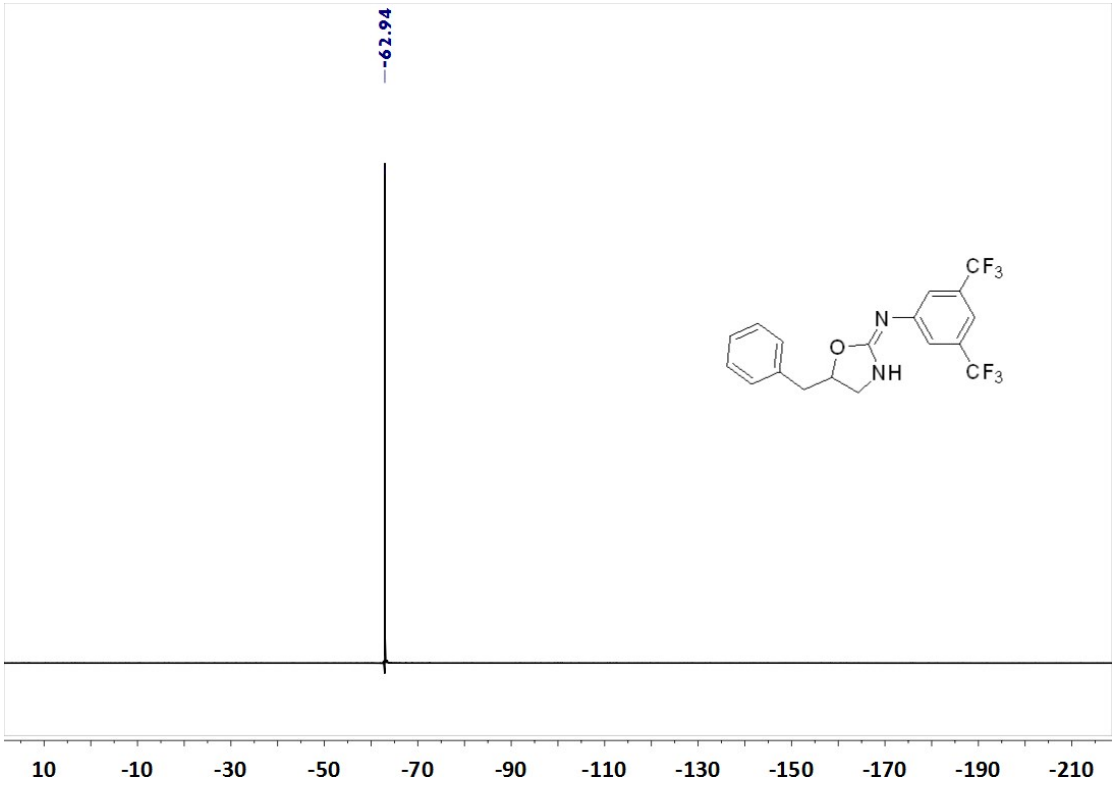
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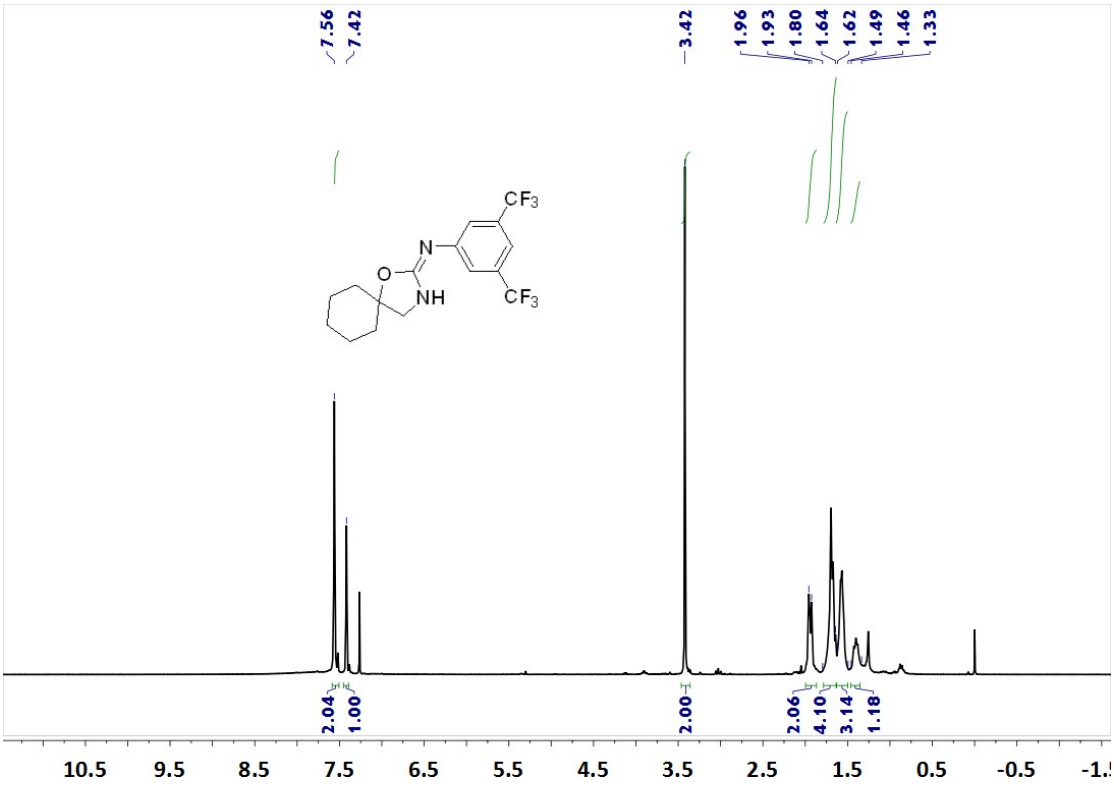
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NH
CF3
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2.00
2.06
4.10
3.14
1.18
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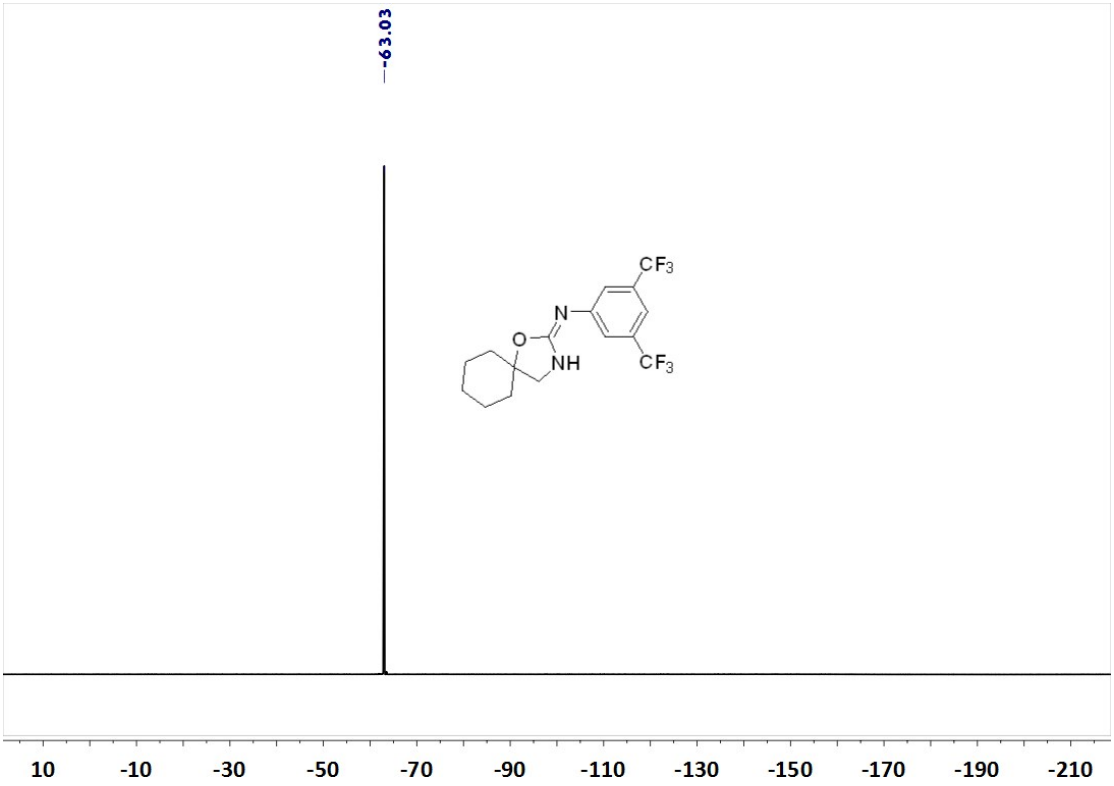
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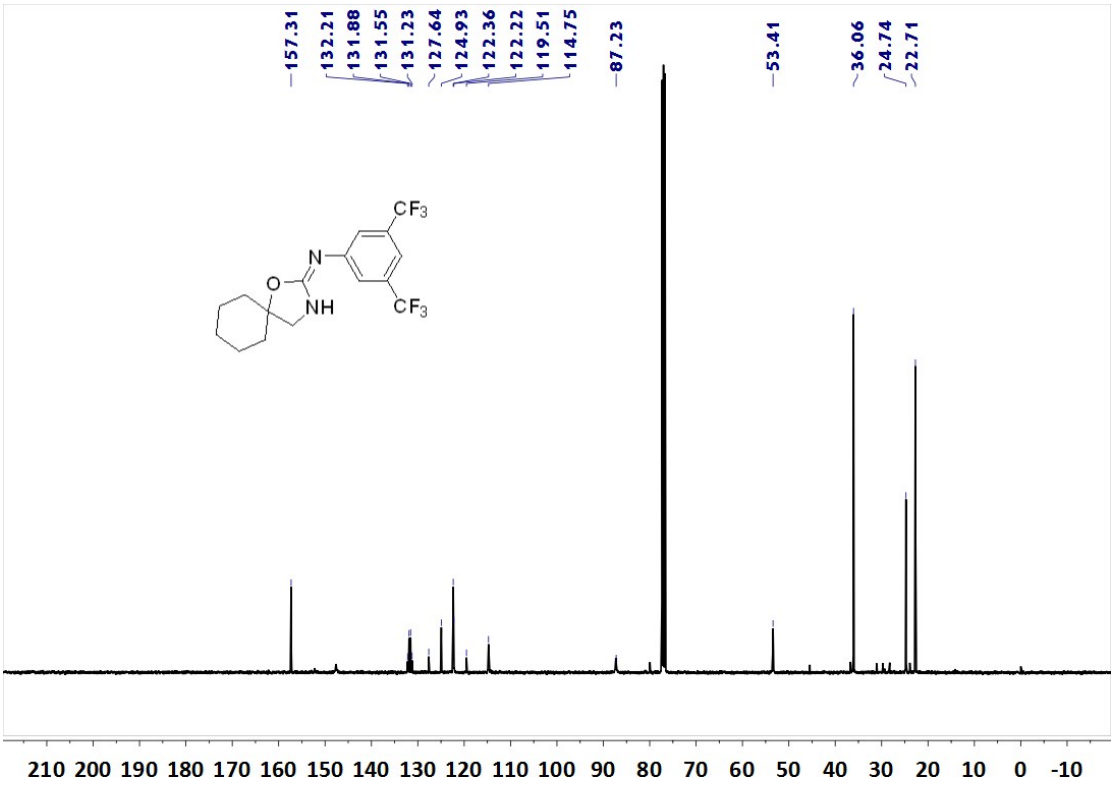
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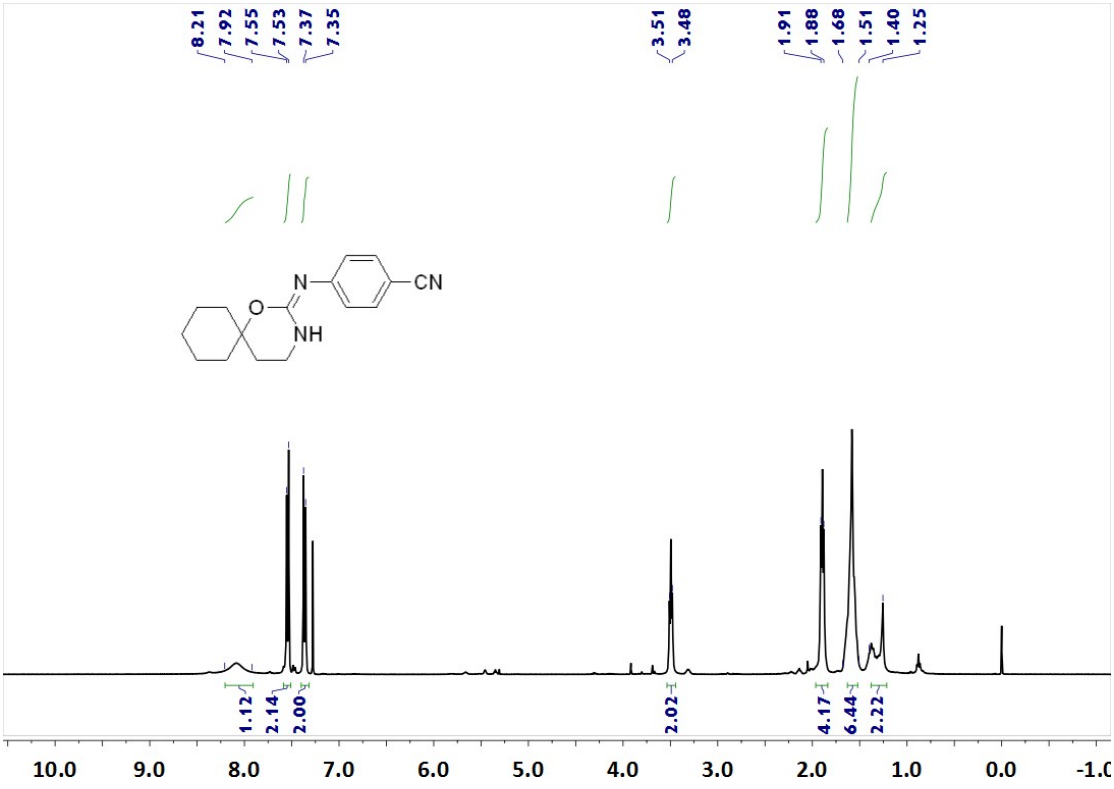
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2.22
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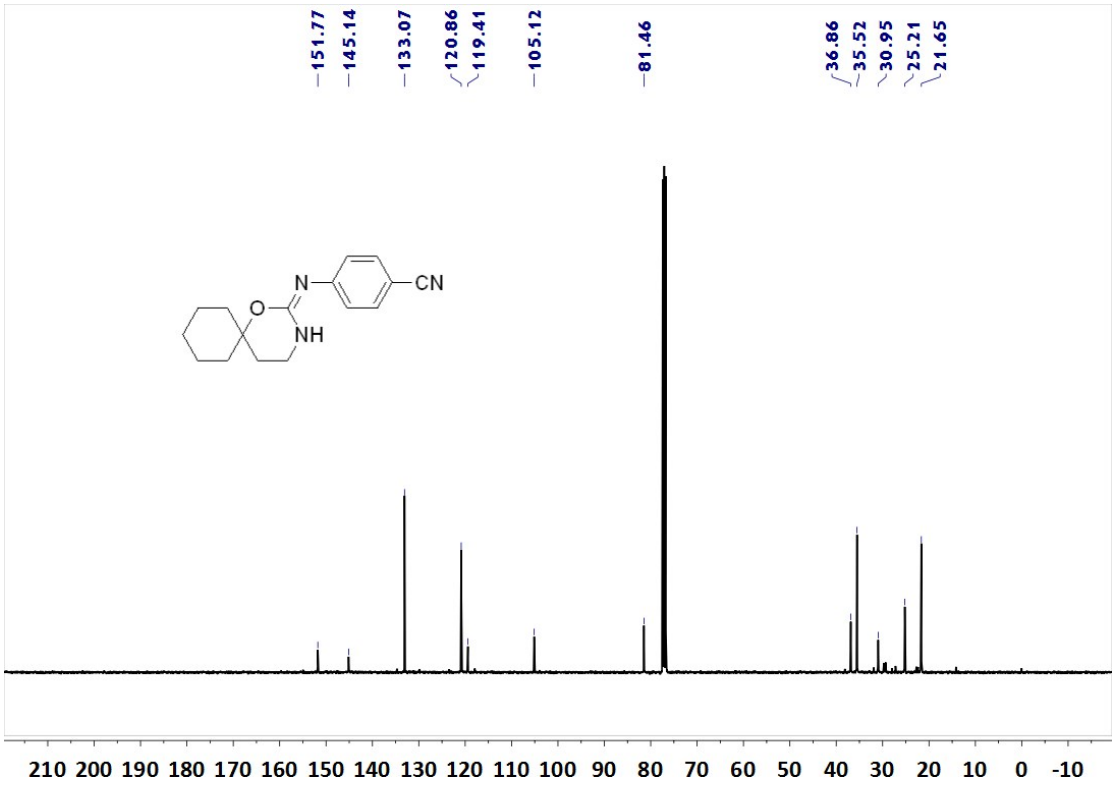
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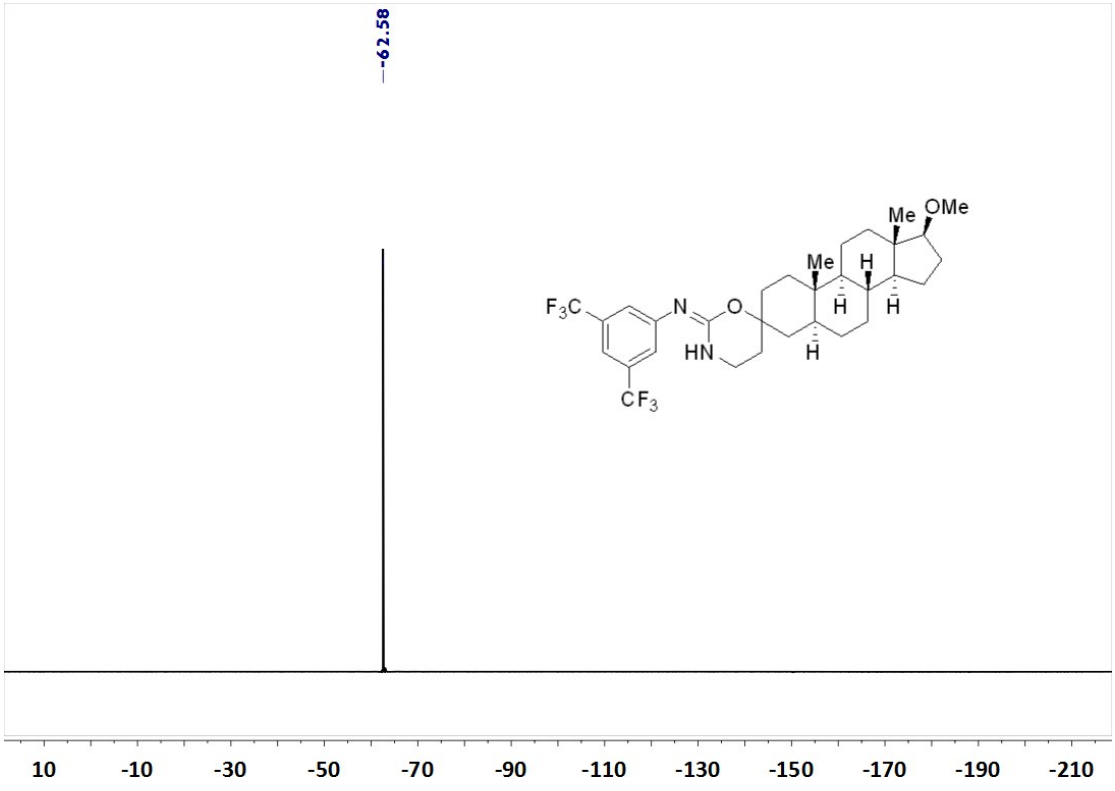
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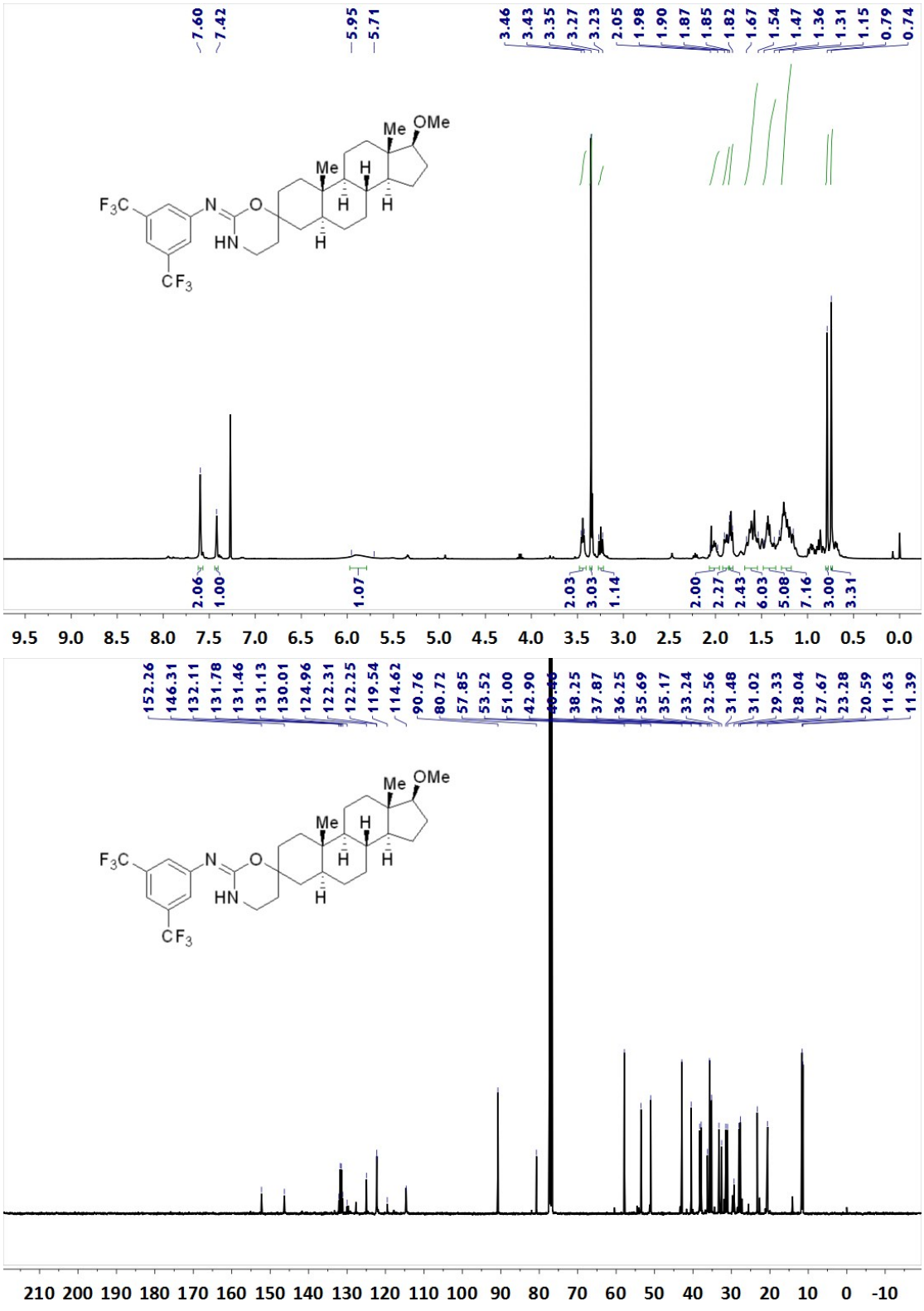
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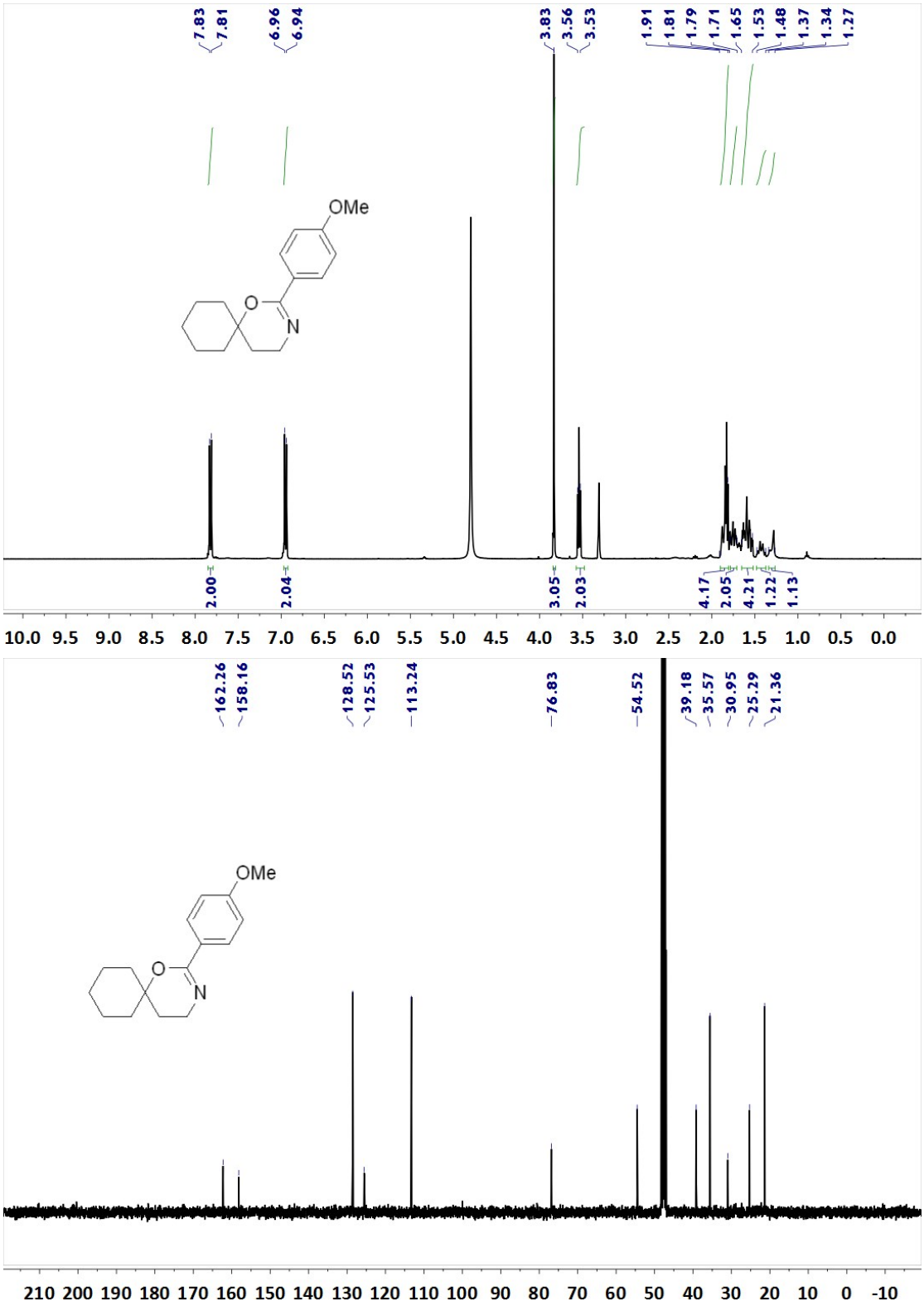
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