Electronic Supplementary Material (ESI) for ChemComm.

Supporting Information

Ligand-Controlled Gold-Catalyzed Cycloisomerization of 1,n-Enyne Esters toward Synthesis of Dihydronaphthalene

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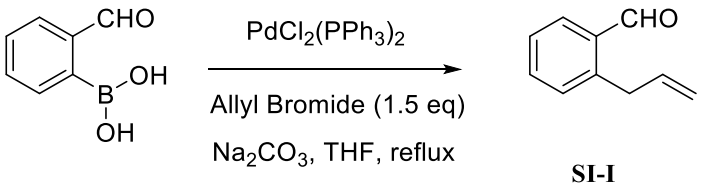
General Remarks

All of the reactions dealing with air and/or moisture-sensitive reactions were carried out under an atmosphere of nitrogen using oven/flame-dried glassware. Unless otherwise noted, all commercial reagents were obtained from the commercial provider and used without further purification. Anhydrous solvents were used after general distillation strategies. ^{1}HNMR, ^{13}CNMR spectra were recorded on 400 MHz spectrometers. Chemical shifts were reported relative to internal tetramethylsilane (δ 0.00 ppm) or $CDCl_3$ (δ 7.26 ppm) for ^{1}H and $CDCl_3$ (δ 77.0 ppm) for ^{13}C. Flash column chromatography was performed on 230-430 mesh silica gel. HRMS were recorded on LTQ-FTUHRA spectrometer.

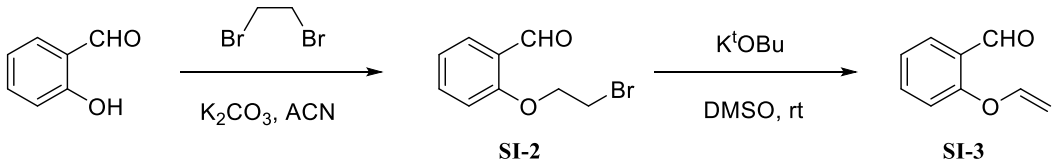
General procedure for the synthesis of 2-formyl styrene:



SI-I

To a solution of the 2-formylphenylboronic acid and corresponding allyl halide (1.5 equiv) in THF (0.2 M) in a round-bottom flask were added $PdCl_2(PPh_3)_2$ (2.5 mol %). The reaction mixture was heated to 50 ^oC, then aq Na_2CO_3 (1 M, 2 equiv) solution was added drop wise over a period of 1 h and the heating continued in reflux for 3-4 h. The reaction mixture was quenched with H_2O and extracted with CH_2Cl_2 (three times). The combined organic layer was washed with brine, dried over $MgSO_4$, and concentrated in vacuum. The residue was purified by column chromatography on silica gel (EtOAc/n-hexane = 1:50) to afford the desired yellow product (90% yield).

General procedure for the synthesis of:



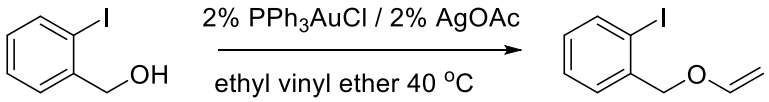
SI-2 **SI-3**

***O*-(2-Bromoethoxy)benzaldehyde (SI-2).** In a 250 ml two-necked flask equipped with a magnetic stirr bar and reflux condenser, salicylaldhyde (3.90 g, 32 mmol), 1,2-dibromoethane (60.1 g, 320 mmol) and anhydrous K_2CO_3 (8.83 g, 64.0 mmol) were mixed with anhydrous CH_3CN (200 ml). The mixture was refluxed for 30 h and then cooled to room temperature, filtered and the solid was washed with CH_3CN. The filtrate was evaporated to dryness. The crude

product was purified by column chromatography on silica gel using diethylether:Hexane (8:1) to give as a pale yellow solid (**SI-2**; 4.81 g, 66%).

***O*-(vinyl) benaldehyde** (**SI-3**) Compound **SI-2** (2.28 g, 10 mmol) dissolved in 10 ml DMSO at room temperature then potassium ter-butoxide added (1.34 g 1.2 mmol). The reaction stirred for 1 hr, monitored by TLC. After the completion of the reaction 1N HCl was added followed by 40 ml of water to saturate the DMSO and extracted with diethylether 3*50 ml. combined the organic layer and evaporated under vaccum at room temperature to afford the desired yellow product. (**SI-3**; 1.0 g, 67%)

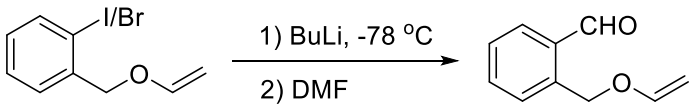
General procedure for:



SI-4

Typical procedure for Au-catalyzed transfer vinylation of alcohols: To a screw cap tube containing $AuClPPh_3$ (9.9 mg, 2 mol%) and silver salt (2 mol%), 1 ml of ethyl vinyl ether (10 equiv) was added under air. The mixture was stirred at room temperature for 10 mins. After the addition of alcohol (1 mmol), the mixture was stirred at 50 ^{o}C. The reaction was monitored by TLC, after the completion of the reaction, evaporate the solvent to dryness to afford the desired product.

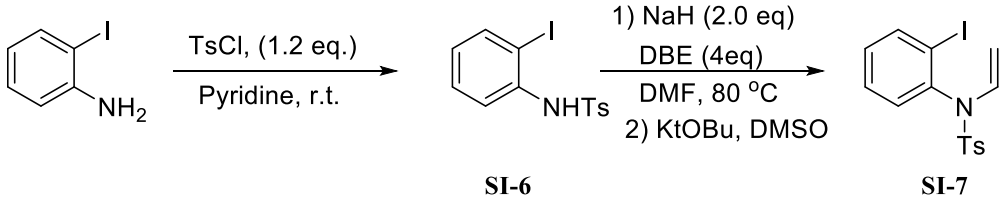
General procedure for:



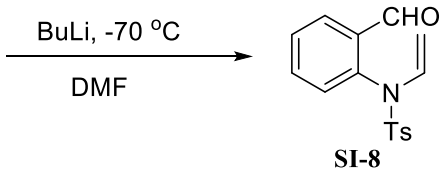
SI-5

Preparation of Aryl aldehydes: Under N_2, to a solution of 1-Bromo or Iodo aryl compound (2.34 g, 10.0 mmol) in anhydrous diethyl ether (40 mL) at -78 ^{0}C was slowly added *n*-BuLi (1.1 eq, 2.5 M in hexanes, 4.4 mL). The reaction was stirred at the same temperature for 40 min and DMF (2.31 mL, 3.0 mmol) was dropwise added. The reaction was allowed to warm to room temperature over 1 h before it was quenched by saturated aqueous NH_4Cl at 0 °C. The reaction mixture was diluted by Et_2O (30 mL), washed with saturated NH_4Cl (10 mL) and brine (10mL), dried over Na_2SO_4, and concentrated. The residue was purified by silica gel chromatography (eluent: EtOAc/hexanes = 1/5) to afford the pure product as a colorless oil in 77% yield.

General procedure for synthesis of:



SI-6 **SI-7**



SI-8

To a solution of (2.19 g 10.0 mmol, 1.0 equiv.) in pyridine (40 mL) was added TsCl (2.28 g, 1.2 equiv.) at room temperature. The mixture was stirred for 5 h and monitored the reaction by TLC.

Remove the pyridine under the vacuum. The product was extracted with EtOAc (50 mL x 3), and the combined organic extracts were washed with brine and dried over Na_2SO_4. After removal of the solvents under reduced pressure, the product was purified by column to give **SI-6**. Then to a solution of NaH (4.0 mmol, 2.0 equiv.) in DMF (30 mL), **SI-6** (2.0 mmol, 1.0 equiv.) in DMF (10.0 mL) was added dropwise. After stirred for 30 min, 1,2-dibromoethane (8.0 mmol, 4 equiv.) was added. The mixture was heated to 80 ^oC for 8 h. When **SI-6** was disappeared, quench the reaction with saturated NH_4Cl and extract with EA (50 mL x 3). The combined organic extracts were washed with brine and dried over Na_2SO_4. The E_2 elimination and aryl aldehyde procedure mentioned above and isolated the required product as a yellow syrup (SI-8; 42%.)

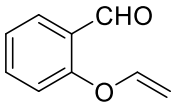
General procedure for Propargyl alcohol synthesis: To a solution of alkyne (1.1 eq) in diethyl ether 10.0 mL was added n-Butyl Lithium (1.1 mmol, 2.5 M in hexanes) at -78 ^oC. The reaction stirred at the same temperature for an hour. The aromatic aldehyde (1.0 eq 2.0 mmol) added slowly to the reaction mixture at the same temperature. The reaction was allowed to warm to room temperature over 1 h before it was quenched by saturated aqueous NH4Cl at 0 ^0C. The reaction mixture was diluted by Et_2O (30 mL), washed with saturated NH_4Cl (10 mL) and brine (10mL), dried over Na_2SO_4, and concentrated to afford required alcohol.

General procedure for Propargyl ester synthesis: To a solution of the Propargyl alcohol (2.0 mmol) in DCM 10 mL Triethylamine (2.0 eqs) and DMAP (0.1 eq) at 0 ^oC was added Trimethyl acetylchloride (1.2 eqs). The reaction stirred for 2 h at room temperature, monitored by TLC. After completion of the reaction, washed with 1 N HCl and sodium bicarbonate. The solvent dried over Na2SO4 and evaporated the solvent to get the propargyl ester compounds.

Procedure for gold transformations

For compounds **3a-3q**, **6a-6h**, **7a-7c**, **8a-8d**: To a solution of propargyl acetate (1.0 mmol) water (3.0 eq) in toluene or dichloromethane (0.2 M) was added the ditBuXPhosAuNTf$_2$ (2.0 mol%). The reaction stirred for 12 h, reactions were monitored by NMR spectroscopy. After the completion of the reaction, the residue was purified by silica gel chromatography (eluent: DCM/hexanes = 1/5) to afford the pure product.

Compound Characterization

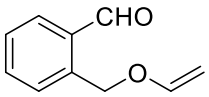


SI - 3

^{1}HNMR (CDCl$_3$, 400MHz): δ 10.45(s, 1H), 7.88-7.86(dd, *J* = 10.04 Hz, 1H), 7.57 (t, *J* = 6.28 Hz, 1H), 7.16 (t, *J* = 7.53 Hz 1H), 7.09-7.07 (d, *J* = 6.28 Hz 1H) 6.73-6.68 (dd, J_1 = 7.53, J_2 = 13.81 Hz, 1H), 4.87-4.84 (dd, J_1 = 13.87 Hz, 1H), 4.61-4.59(dd, J = 11.30 Hz, 1H)

^{13}CNMR (CDCl$_3$, 400MHz): δ 188.96, 158.77, 147.47, 135.71, 128.31, 125.89, 123.31, 116.82, 97.22

HRMS calculated for $C_9H_8O_2$ $[M+H]^+$: 149.0524, Found: 149.0524

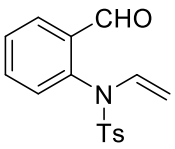


SI - 5

^{1}HNMR (CDCl$_3$, 400MHz): δ 7.96 (t, *J* = 1.9 Hz, 1H), 7.86-7.83 (m, 1H), 7.53-7.50 (m, 1H), 7.40-7.36 (m, 3H), 7.34-7.30 (m, 2H).

^{13}C-NMR (CDCl3, 400MHz, ppm) δ= 192.66, 151.06, 19.08, 133.69, 133.22, 132.80, 127.62, 127.49, 87.68, 67.28

HRMS calculated for $C_{10}H_{10}O_2$ $[M+H]^+$: 163.0680, Found: 163.0681

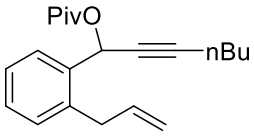


SI - 8

^{1}HNMR ($CDCl_3$, 400MHz): δ 9.89 (s, 1H), 8.05 (m, 1H), 7.59-7.53 (m, 4H), 7.35-7.29 (dd, 3H), 6.85-6.83 (m, 1H), 4.36-4.34 (dd, J_1 = 1.51, J_2 = 9.08 Hz, 1H), 3.79-3.75 (dd, J_1 = 1.57, J_2 = 15.13 Hz, 1H), 2.45 (s, 3H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 189.15, 144.72, 138.03, 135.32, 135.11, 135.10, 134.69, 130.91, 129.94, 129.87, 128.76, 127.50, 95.04, 21.64

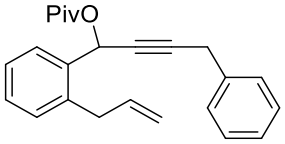
HRMS calculated for $C_{16}H_{15}O_3S$ $[M+H]^+$: 302.0772, Found: 302.0773



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.61(dd, J = 7.05 Hz, 1H), 7.27-7.18 (m, 3H), 6.54 (t, 1H), 5.96 (m, 1H), 5.06-5.02 (m, 2H), 3.53 (dd, J = 6 Hz, 2H), 2.21 (dt, J_1 = 1.85, J_2 = 7.05 Hz, 2H), 1.51-1.34 (m, 4H), 1.20 (s, 9H), 0.89 (t, 3H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 176.87, 137.57, 136.49, 135.94, 129.77, 128.49, 127.90, 126.42, 116.06, 87.56, 76.92, 63.48, 38.59, 36.43 30.32, 26.88, 21.70, 18.37, 13.39

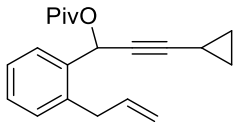
HRMS calculated for $C_{21}H_{28}O_2$ $[M+H]^+$: 313.2089, Found: 313.2089



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.64 (dd, 1H), 7.29-7.20 (m, 8H), 6.62 (t, J = 2.06 Hz 1H), 5.01 (m, 1H), 3.64 (d, 2H), 3.53 (dd, 2H), 1.21 (s, 9H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 177.01, 137.67, 136.52, 136.12, 135.76, 129.94, 128.72, 128.39, 128.06, 127.77, 126.61, 116.25, 84.92, 79.47, 63.48, 38.74, 36.58, 26.99, 25.10

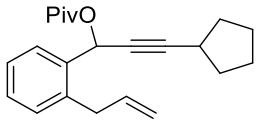
HRMS calculated for $C_{24}H_{26}O_2$ $[M+H]^+$: 347.1932, Found: 347.1933



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.56(dd, 1H), 7.28-7.17(m, 3H), 6.49(d, 1H), 5.95(m, 1H), 5.09-5.00(m, 2H), 3.50 (dt, 2H), 1.23 (m, 1H), 1.19 (s, 9H), 0.07-0.65(m, 4H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 177.02, 137.67, 136.61, 136.05, 129.93, 128.60, 127.99, 126.55, 116.20, 90.73, 72.22, 63.65, 38.72, 36.54, 27.01, 26.50, 8.32, -0.37.

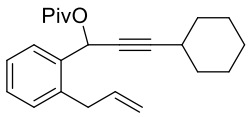
HRMS calculated for $C_{20}H_{24}O_2$ $[M+H]^+$: 297.1176, Found: 297.1175



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.60 (), 7.30 (dd, 1H), 7.18 (m, 3H), 6.54 (d, *J* = 2Hz, 1H), 6.02-5.92 (m, 1H), 5.09-5.02 (m, 2H), 3.52 (dt, 2H), 2.64 (dq, 1H), 1.91-1.85 (m, 8H), 1.71-1.51 (m, 8H), 1.20 (s, 9H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 177.02, 137.79, 136.65, 136.07, 129.89, 128.57, 128.10, 126.50, 116.15, 91.94, 76.57, 63.73, 38.71, 36.52, 33.60, 30.19, 26.99, 24.89.

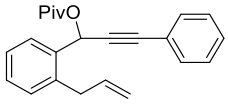
HRMS calculated for $C_{22}H_{28}O_2$ $[M+H]^+$: 325.2089, Found: 325.2089



^{1}HNMR ($CDCl_3$, 400MHz): δ 8.18 (dd, 1H), 7.62 (dd, 1H), 7.45 (dt, 1H), 7.34-7.18 (m,4H), 6.56 (d, 1H), 6.00 (m, 1H), 5.11 (m 1H), 3.81 (dt, 1H), 3.53 (dt, 2H), 2.65 (m, 1H), 2.43 (m, 1H), 1.91-1.28 (m, 16H), 1.20 (s, 9H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 204.08, 141.69, 136.05, 134019, 132.12, 129.79, 128.79, 128.43, 126.58, 44.49, 35.01, 29.89, 29.83, 25.96, 25.91, 25.84, 20.98, 17.94, -0.01.

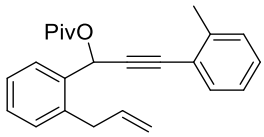
HRMS calculated for $C_{23}H_{30}O_2$ $[M+H]^+$: 339.2245, Found: 339.2246



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.70-7.68(dd, 1H), 7.43-7.41 (m, 2H), 7.31-7.21 (m, 6H), 6.79 (s, 1H), 6.04-5.96 (m, 1H), 5.12-5.05 (m, 2H), 3.59 (dt, 2H), 1.23 (s, 9H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 176.96, 137.80, 136.53, 135.53, 131.78, 130.07, 128.84, 128.20, 128.16, 126.68, 122.32, 116.34, 86.54, 86.02, 63.67, 38.78, 36.64, 27.01.

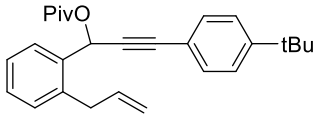
HRMS calculated for $C_{23}H_{24}O_2$ $[M+H]^+$: 333.1776, Found: 333.1777



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.70 (d, 1H), 7.33-7.22 (dd, 1H), 7.11 (m, 5H), 7.09 (d, 2H), 6.77 (s, 1H), 6.06-5.96 (m, 1H), 5.12-5.05 (m, 2H), 3.60 (dt, 2H), 2.34 (s, 3H), 1.23 (s, 9H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 177.04, 138.73, 137.85, 136.59, 135.67, 130.05, 128.94, 128.79, 128.22, 126.67, 119.29, 116.33, 86.72, 85.33, 63.79, 38.81, 36.64, 27.03, 21.46.

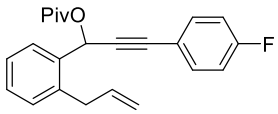
HRMS calculated for $C_{24}H_{26}O_2$ $[M+H]^+$: 347.1932, Found: 347.1933



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.70-7.68 (d, 1H) 7.37-7.21 (m, 5H), 6.77 (s, 1H), 6.04-5.96 (m, 1H), 5.12-5.05 (m, 2H), 3.60 (d, 2H), 1.29 (s, 9H), 1.23 (s, 9H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 177.02, 137.86, 136.60, 135.66, 131.58, 130.05, 126.66, 125.19, 119.35, 116.35, 86.71, 85.38, 63.81, 38.80, 36.65, 34.76, 31.12, 27.04

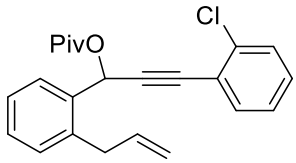
HRMS calculated for $C_{24}H_{26}O_2$ $[M+H]^+$: 389.5510, Found: 389.5511



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.67 (dd, 1H), 7.42-7.39 (m, 2H), 7.31-7.23 (m, 6H), 6.98 (t, 1H), 6.76 (s, 1H), 6.06-5.96 (m, 1H), 5.12-5.04 (m, 2H), 3.59 (dt, 2H), 1.23 (s, 9H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 177.01, 137.60, 136.53, 133.81, 133.73,, 130.13, 128.91, 128.16, 126.73, 118.43, 116.37, 115.61, 115.39, 85.79, 85.47, 63.60, 38.81, 36.65, 27.01

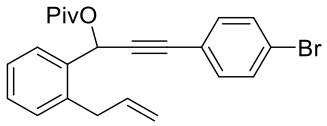
HRMS calculated for $C_{23}H_{23}FO_2$ $[M+H]^+$: 351.1682, Found: 351.1682



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.68-7.65 (dd, 1H), 7.41 (t, 1H), 7.34-7.19 (m, 6H), 6.76 (s, 1H), 6.05-5.95(m, 1H), 5.13-5.04 (m, 2H), 3.59 (d, *J* = 7.80 Hz, 1H), 1.23 (s, 9H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 176.97, 17.77, 136.48, 135.25, 134.05, 131.65, 130.16, 129.92, 129.43, 128.98, 128.88, 128.16, 126.77, 124.01, 116.40, 87.28, 85.05, 83.45, 38.80, 36.65, 27.01.

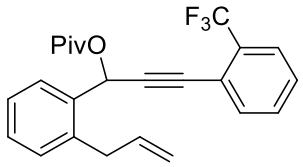
HRMS calculated for $C_{23}H_{23}ClO_2$ $[M+H]^+$: 367.1386, Found: 367.1387



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.65 (dd, 1H), 7.41-7.27 (m, 3H), 6.75 (d, 1H), 6.03 (m, 1H), 5.12 (m, 2H), 3.58 (dd, 1H), 1.22 (s, 8H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 177.00, 137.80, 136.52, 135.30, 133.24, 131.48, 130.16, 128.17, 126.75, 122.92, 121.28, 87.22, 85.44, 63.58, 63.55, 38.81, 36.65, 27.03, 27.01

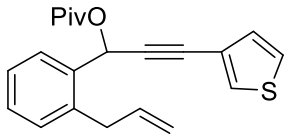
HRMS calculated for $C_{23}H_{23}BrO_2$ $[M+H]^+$: 411.0881, Found: 411.0881



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.10 (dd, 1H), 7.61-7.53 (dd, 2H), 7.45-7.36 (tt, 2H), 7.30-7.24 (m, 3H), 6.80 (s, 1H), 6.01 (m, 1H), 5.12-5.03 (m, 2H), 3.58 (t, 2H), 1.24 (s, 9H)

^{13}CNMR (CDCl3, 400MHz): δ 176.97, 137.83, 136.50, 134.94, 133.97, 131.28, 130.04, 129.03, 128.44, 128.31, 126.77, 125.76, 125.71, 122.01, 120.59, 116.38, 91.72, 82.42, 63.38, 38.81, 36.64, 26.98.

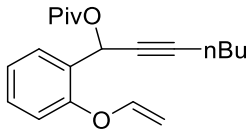
HRMS calculated for $C_{24}H_{23}F_3O_2$ $[M+H]^+$: 401.1650, Found: 401.1651



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.66 (dd, 1H), 7.44 (dd, 1H), 7.31-7.22 (m, 4H), 7.10 (dd, 1H), 6.76 (s, 1H), 6.02 (m, 1H), 5.09 (m, 2H), 3.60 (dd, 2H), 1.23 (s, 9H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 177.02, 137.80, 136.55, 135.54, 130.09, 129.93, 129.48, 128.85, 128.17, 126.70, 125.22, 121.38, 116.35, 85.63, 81.73, 63.71, 38.80, 36.64, 27.03

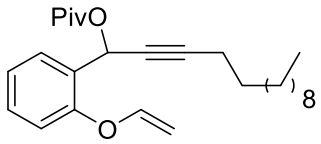
HRMS calculated for $C_{21}H_{22}O_2S$ $[M+H]^+$: 339.1340, Found: 339.1341



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.66-7.64 (dd, 1H), 7.32-7.28 (dt, 1H), 7.14 (dt, 1H), 7.10 (), 7.00-6.97 (dd, 1H), 6.66-6.61 (dd, 1H), 4.79-7.75 (dd, J_1=1.92 Hz, J2=13.92 Hz, 1Hz), 4.49-4.47 (dd, J_1=1.32 Hz, J_2=5.4 Hz, 1H), 2.29-2.24 (dt, 2H), 1.54-1.37 (m, 4H), 0.91(t, 3H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 153.90, 148.24, 131.14, 129.50, 128.19, 123.58, 116.68, 95.63, 87.30, 79.13, 60.47, 30.62, 21.92, 18.51, 13.56

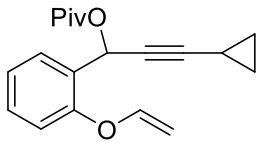
HRMS calculated for $C_{20}H_{26}O_3$ $[M+H]^+$: 315.1881, Found 315.1882



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.72 (dd, 1H), 7.33-7.29 (m, 1H), 7.13-7.10 (dt, 1H), 6.95 (d, 1H), 6.70 (t, 1H), 6.55 (m, 1H), 4.72-4.68 (dd, 1H), 4.42-4.40 (dd, 1H), 2.26 (dd, 2H), 1.55-1.26 (m, 18H), 1.19 (s, 9H), 0.87 (t, 3H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 176.80, 153.92, 148.14, 129.83, 128.93, 127.81, 123.22, 116.48, 95.27, 87.72, 76.47, 60.77, 38.61, 31.85, 29.46, 29.23, 29.07, 28.74, 28.43, 27.02, 22.62, 18.79, 14.06

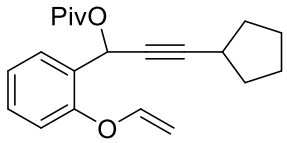
HRMS calculated for $C_{26}H_{28}O_3$ $[M+H]^+$: 399.2821, Found 399.2822



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.67 (dd, 1H), 7.31 (dt, 1H), 7.10 (t, 1H), 6.95 (d, 1H), 6.66 (d, 1H), 6.59 (dd, 1H), 4.68 (dd, 1H), 4.41 (dd, 1H), 1.29 (m, 1H), 1.18 (s, 9H), 0.76(m, 4H)

^{13}CNMR (CDCl3, 400MHz): δ 176.81, 153.86, 148.15, 129.83, 129.33, 128.86, 127.80, 123.25, 116.53, 95.32, 90.65, 71.58, 60.75, 38.61, 27.02, 8.35, -0.39,

HRMS calculated for $C_{19}H_{22}O_3$ $[M+H]^+$: 299.1568, Found 299.1569

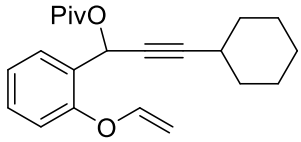


^{1}HNMR ($CDCl_3$, 400MHz): δ 7.70 (DD, 1H), 7.31 (dt, 1H), 7.12(dt, 1H), 6.96 (dd, 1H), 6.71 (d, 1H), 6.57(dd, 1H),

4.71-4.67 (dd, 1H), 4.42-4.40 (dd, 1H), 2.68 (dp, 1H), 1.89 (m, 2H), 1.72-1.52 (m, 8 H), 1.19 (s, 9H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 176.79, 153.98, 148.18, 129.84, 129.00, 127.85, 123.22, 116.52, 95.21, 91.94, 75.91, 60.82, 38.60, 33.66, 30.18, 27.01, 24.89.

HRMS calculated for $C_{21}H_{26}O_3$ $[M+H]^+$: 327.1881, Found 327.1882

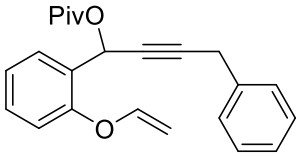


^{1}HNMR ($CDCl_3$, 400MHz): δ 7.74 (d, 1H), 7.32 (m, 1H), 7.12 (d, 1H), 6.98 (d, 1H), 6.72 (d,1H), 6.59 (dd, 1H), 4.71-4.67

(dd, 1H), 4.41 (dd, 1H), 2.46 (m, 2H), 1.76-1.67 (m, 4H), 1.47-1.30 (m, 4H), 1.20 (s, 9H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 176.76, 154.00, 148.17, 129.84, 129.04, 127.81, 123.21, 116.49, 95.21, 91.65, 76.51, 60.80, 38.60, 32.35, 28.95, 27.01, 25.84, 24.58

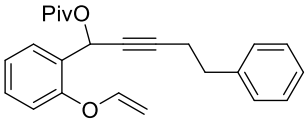
HRMS calculated for $C_{22}H_{28}O_3$ $[M+H]^+$: 341.2038, Found 341.2038



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.71 (d, 1H), 7.29 (m, 6H), 7.21 (dd, 1H), 7.11 (dt, 1H), 6.97 (d, 1H), 6.78 (t, 1H) ,6.58 (dd, 1H), 4.70 (dd, 1H), 4.43 (dd, 1H), 1.23 (s, 9H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 176.87, 153.92, 148.09, 136.19, 129.97, 129.34, 128.91, 128.40, 127.81, 127.49, 126.54, 123.28, 116.50, 95.44, 84.81, 78.91, 60.77, 38.69, 27.04

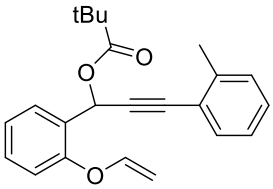
HRMS calculated for $C_{23}H_{24}O_3$ $[M+H]^+$: 349.1725, Found 349.1724



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.58-7.56 (dd, 1H), 7.33-7.19 (m, 6 H), 7.08 (dt, 1H), 6.97 (dd, 1H), 6.68 (t, 1H), 6.57 (dd, 1H), 4.71-4.67 (dd, 1H), 4.42-4.40 (dd, 1H), 2.83 (t, 2H), 2.56-2.52 (dt, 2H), 1.19 (s, 9H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 176.83, 153.86, 148.11, 140.43, 129.86, 128.96, 128.48, 128.29, 127.60, 126.20, 123.24, 116.44, 95.34, 86.74, 60.67, 38.63, 34.74, 27.04, 21.02

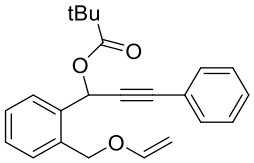
HRMS calculated for $C_{24}H_{26}O_3$ $[M+H]^+$: 363.1881, Found 363.1882



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.79-7.77 (dd, *J* = 8.0 Hz, 1H), 7.37-6.99 (m, 8H), 6.93 (s, 1H), 6.64-6.60 (dd, *J* = 3.2 Hz, 1H), 4.76-4.72 (dd, *J* = 13.37 1H), 4.45-4.44 (dd *J* = 1.07, 1Hz), 2.34 (s, 3H), 1.22 (s, 9H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 176.88, 153.97, 148.14, 138.71, 131.79, 130.06, 129.02, 128.94, 127.38, 123.35, 119.36, 116.57, 95.50, 86.64, 84.75, 60.93, 38.73, 27.07, 21.48

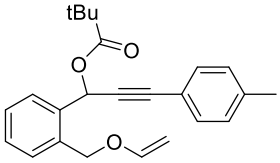
HRMS calculated for $C_{23}H_{24}O_3$ $[M+H]^+$: 349.1725, Found 349.1725



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.67 (d, 1H), 7.48-7.29 (m, 9H), 6.76 (s, 1H), 6.60-6.56 (dd, 1H), 5.05 (ddd, 2H), 4.36-4.34 (dd, 1H), 4.11 (dd, 1H), 1.23 (s, 3H),

^{13}CNMR ($CDCl_3$, 400MHz): δ 176.91, 151.43, 135.33, 134.99, 131.84, 129.18, 128.94, 128.87, 128.71, 128.36, 128.29, 128.22, 122.18, 87.66, 86.89, 85.48, 67.26, 63.87, 38.83, 27.02

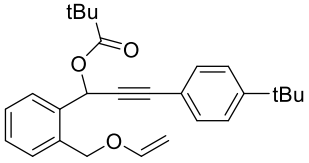
HRMS calculated for $C_{23}H_{24}O_3$ $[M+H]^+$: 349.1725, Found 349.1725



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.67 (dd, 1H), 7.48 (dd, 1H), 7.37-7.33 (m 4H), 7.10 (dd, 2H), 6.76 (s, 1H), 6.60 (dd, 1H), 5.05 (ddd, 2H), 4.36-4.34 (dd, 1H), 4.11-4.10 (dd, 1H), 2.33 (s, 3H), 1.23 (s, 9H),

^{13}CNMR ($CDCl_3$, 400MHz): δ 176.89, 151.43, 138.86, 135.39, 134.99, 131.73, 128.96, 128.62, 128.34, 128.22, 119.06, 87.63, 87.08, 84.77, 67.22, 63.96, 38.80, 27.00, 21.45

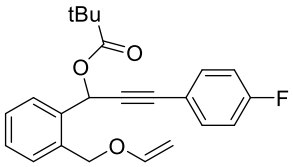
HRMS calculated for $C_{24}H_{26}O_3$ $[M+H]^+$: 363.1881, Found 363.1882



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.68 (m, 1H), 7.46-7.30 (m 6H), 6.77 (s,1H), 6.57 (dd, 1H), 5.05 (s, 2H), 4.36 (dd, 1H)4.11 (dd, 1H), 1.28 (s, 9H), -1.22 (s, 9H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 176.78, 151.98, 151.39, 135.33, 134.99, 131.55, 128.84, 128.58, 128.33, 128.17, 125.18, 119.12, 87.60, 87.03, 84.79, 67.17, 63.95, 38.76, 34.70, 31.07, 26.98

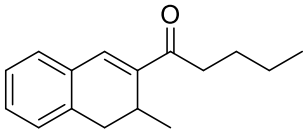
HRMS calculated for $C_{27}H_{32}O_3$ $[M+H]^+$: 405.2351, Found 405.2351



^{1}HNMR ($CDCl_3$, 400MHz): δ 7.65 (d, 1H), 7.47-7.36 (m, 5H), 6.79 (dt, 2H), 6.73 (s, 1H), 6.57 (m, 1H), 5.03 (ddd, 2H), 4.32 (dt, 1H), 4.10 (m, 1H), 1.22 (s, 9H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 176.90, 151.43, 135.32, 134.93, 133.85, 133.79, 128.98, 128.80, 128.35, 128.32, 118.27, 115.62, 115.48, 87.66, 85.80, 85.26, 67.27, 63.79, 38.83, 27.02

HRMS calculated for $C_{23}H_{23}O_3$ $[M+H]^+$: 367.1631, Found 367.1631

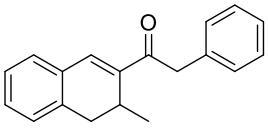


3a was obtained through general procedure in 12h and 86% isolated yields as colorless liquid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.34 (s, 1H), 7.29-7.17 (m, 4H), 3.19 (dp, J_1 = 2.02, J_2= 7.28 Hz 1H), 3.06-3.00 (dd, J_1 = 7.89, J_2= 16.8 Hz, 1H), 2.78 (dd, J = 6.88 Hz 2H), 2.68-2.63 (dd, J_1 = 2.43, J_2 = 15.87 Hz, 1H), 1.71-1.63 (m, 2H), 1.44-1.33 (m, 1H), 0.95 (t, J = Hz, J = 6.47 Hz, 3H), 0.89-0.87 (d, J = 5.46 Hz, 3H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 200.60, 142.63, 135.97, 134.83, 132.01, 129.81, 128.77, 128.38, 126.57, 37.05, 34.99, 27.13, 25.77, 22.52, 17.91, 13.94.

HRMS calculated for $C_{16}H_{20}O$ $[M+H]^+$: 229.1514, Found 229.1514

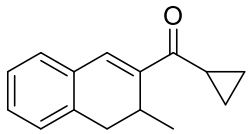


3b was obtained through general procedure in 12h and 64% isolated yields as colorless oil (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.45 (s, 1H), 7.32-7.17 (m, 8H), 4.11 (s, 2H), 3.19-3.12 (dp, *J1* = 2.02, J_2 = 7.28 Hz 1H), 3.06-3.00 (dd, J_1 = 16.78, J_2 = 6.79 Hz, 1H), 2.6-2.63 (d, *J* = 16.0 Hz, 1H), 0.87 (d, *J* = 7.0 Hz, 3H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 197.62, 142.35, 136.28, 136.08, 135.35, 131.87, 130.11, 129.26, 128.85, 128.59, 126.67, 44.29, 34.95, 25.95, 17.82

HRMS calculated for $C_{19}H_{18}O$ $[M+H]^+$: 263.1357, Found 263.1358

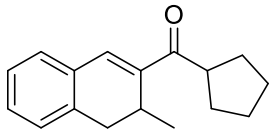


3c was obtained through general procedure in 12h and 64% isolated yields as pale yellow oil (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.37-7.33 (m, 1H), 7.30-7.23 (m, 4H), 7.22-7.20 (d, 1H), 7.19-7.15 (td, 1H), 7.08-7.06 (dd, 1H), 6.89 (s, 1H), 3.38-3.31 (dp, J_1 = 2.02, J_2 = 7.28 Hz, 1H), 3.18-3.12 (dd, J_1 = Hz, 1H), 2.75 (dd, *J* = 16.0 Hz, 1H), 2.32 (s, 3H), 1.04 (d, *J* = 6.85 Hz, 3H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 203.9, 142.5, 136.0, 134.8, 132.1, 129.7, 128.7, 128.3, 126.5, 45.0, 35.030.5, 30.4, 26.3, 26.2, 25.9, 17.9,

HRMS calculated for $C_{15}H_{16}O$ $[M+H]^+$: 213.1201, Found 213.1201

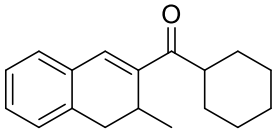


3d was obtained through general procedure in 12h and 79% isolated yields as colorless liquid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.34 (s, 1H), 7.30-7.18 (m, 4H), 3.63-3.55 (q, *J* = 8.5 Hz, 1H), 3.20-3.12 (dp, J_1 = 1.7 Hz, J_2 = 7.0 Hz, 1H), 3.07-3.02 (dd, J_1 = 7.0 Hz, J_2 = 15.0 Hz, 1H), 2.68-2.64 (dd, J_1 = 1.0 Hz, J_2 = 15.52 Hz, 1Hz), 1.91-1.59 (m, 8H), 0.89-0.87 (d, *J* = 7.90 Hz, 3H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 202.94, 142.55, 136.00, 134.83, 132.15, 129.75, 128.78, 128.39, 126.56, 45.04, 35.02, 30.50, 26.34, 26.26, 25.97, 17.92.

HRMS calculated for $C_{17}H_{20}O$ $[M+H]^+$: 241.1514, Found 241.1513.

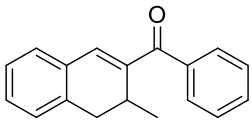


3e was obtained through general procedure in 12h and 70% isolated yields as colorless oil (Elution: dichloromethane/hexanes = 1/5).

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.34 (s, 1H), 7.30-7.18 (m, 4H), 3.63-3.55 (q, J = 8.5 Hz, 1H), 3.20-3.12 (dp, J_1 = 1.7 Hz, J_2 = 7.0 Hz, 1H), 3.07-3.02 (dd, J_1 = 7.0 Hz, J_2 = 15.0 Hz, 1H), 2.68-2.64 (dd, J_1 = 1.0 Hz, J_2 = 15.52 Hz, 1Hz), 1.91-1.59 (m, 10H), 0.89-0.87 (d, J = 7.90 Hz, 3H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 204.07, 141.68, 136.04, 134.06, 129.74, 128.67, 128.42, 126.57, 44.32, 35.00, 29.88, 29.82, 25.95, 25.90, 25.84, 17.93.

HRMS calculated for $C_{18}H_{22}O$ $[M+H]^+$: 255.1670, Found 255.1671

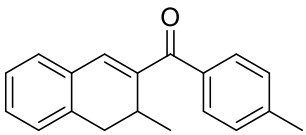


3f was obtained through general procedure in 12h and 84% isolated yields as pale yellow oil (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.72 (m, 1H), 7.57-7.53 (tt, 1H), 7.47(m, 1H), 7.31-7.12(m, 4H), 7.04 (s, 1H), 3.27 (dp, J_1=2.02, J_2= 7.28 Hz ,1H), 3.18 (dd, 1H), 2.74 (dd, 1H), 1.06 (d, 3H),

^{13}CNMR ($CDCl_3$, 400MHz): δ 197.2, 142.08, 139.0, 131.9, 131.5, 130.01, 129.1, 128.8, 128.5, 128.19, 126.6, 35.2, 27.3, 18.0,

HRMS calculated for $C_{18}H_{16}O$ $[M+H]^+$: 249.1201, Found 249.1201

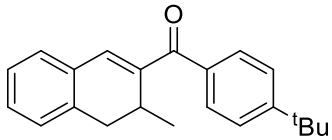


3g was obtained through general procedure in 12h and 81% isolated yields as colorless liquid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.35 (m, 1H), 7.30-7.15 (m, 6H), 7.08-7.06 (dd, 1H), 6.90 (s, 1H), 3.38-3.31 (dp, J_1 = 2.02, J_2 = 7.28 Hz, 1H), 3.18-3.12 (dd, J_1 = 16.78, J_2 = 6.79 Hz, 1H), 2.75 (dd, J = 16.0 Hz, 1H), 2.32 (s, 3H), 1.04 (d, J = 6.85 Hz, 3H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 199.08, 143.14, 140.49, 139.46, 136.12, 135.69, 130.65, 130.27, 129.37, 128.79, 127.49, 126.62, 125.10, 35.04, 25.79, 19.49, 17.99.

HRMS calculated for $C_{19}H_{18}O$ $[M+H]^+$: 263.1357, Found 263.1358

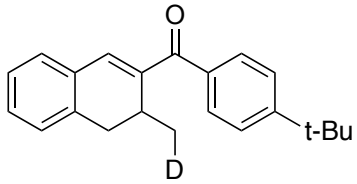


3h was obtained through general procedure in 12h and 88% isolated yields as color less oil (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.69 (d, 2H), 7.48 (d, 2H), 7.27-7.13 (m, 4H), 7.05 (s, 1H), 3.38-3.21 (dp, J_1 = 2.02, J_2 = 7.28 Hz, 1H), 3.20-3.14 (dd, J_1 = 16.78, J_2 = 6.79 Hz, 1H), 2.75 (dd, J = 16.0 Hz, 1H), 2.32 (s, 3H), 1.35 (s, 9H), 1.06 (d, J = 6.85 Hz, 3H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 197.05, 155.21, 142.17, 138.29, 135.98, 135.87, 132.08, 129.81, 129.18, 128.77, 128.44, 126.61, 125.14, 35.29, 35.00, 31.18, 27.47, 18.08.

HRMS calculated for $C_{22}H_{24}O$ $[M+H]^+$: 305.1827, Found 305.1827.

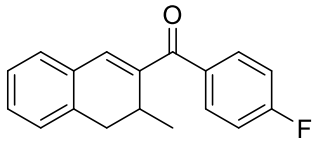


3h' was obtained through general procedure in 12h and 84% isolated yields as color less oil (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.69-7.68 (d, J=9.72 Hz, 2H), 7.49-7.47 (d, J=9.72 Hz, 2H), 7.28 (t, J=8.64 Hz, 1H), 7.22-7.19 (dd, J1=7.56 Hz, J2=6.48 Hz, 2H), 7.16-7.15 (d J=6.48 Hz, 1H), 7.06 (s, 1H), 3.26-3.23 (dq, J1=7.80 Hz, J2=2.24 Hz, 1H), 3.20-3.16 (dd, J1=16.00 Hz, J2= 6.90 Hz, 1H), 2.76-2.73 (d, J=15.15 Hz, 1H), 1.37 (s, 9H), 1.05-1.04 (td, J=7.35 Hz, 2H).

^{13}CNMR ($CDCl_3$, 400MHz): 197.07, 155.22, 142.19, 138.30, 136.00, 135.89, 132.09, 129.82, 129.19, 128.79, 128.45, 126.662, 125.16, 35.27, 35.01, 31.19, 27.42, 17.80 (t, J=19.0 Hz).

HRMS calculated for $C_{22}H_{23}DO$ $[M+H]^+$: 306.1827, Found 306.1827.

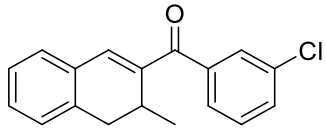


3i was obtained through general procedure in 12h and 75% isolated yields as pale yellow liquid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.75 (m, 1H), 7.31-7.13 (m, 6H), 7.01 (s, 1H), 3.28-3.14 (m, 1H), 2.77-2.73 (dd, *J* = 16.0 Hz, 1H), 1.07-1.04 (d, *J* = 6.85 Hz, 3H)

^{13}CNMR (CDCl3, 400MHz): δ 195.84, 141.98, 138.74, 135.88, 134.92, 131.81, 131.54, 130.09, 128.84, 128.56, 126.70, 115.40, 115.19, 35.22, 27.55, 18.04.

HRMS calculated for $C_{18}H_{15}OF$ $[M+H]^+$: 267.1106, Found 267.1107.

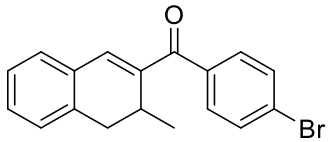


3j was obtained through general procedure in 12h and 68% isolated yields as colorless liquid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.68 (s, 1H), 7.58-7.50 (m, 2H), 7.42-7.38 (t, 1H), 7.32-7.14 (m, 4H), 7.04 (s, 1H), 3.28-3.21 (dp, J_1 = 2.02, J_2 = 7.28 Hz, 1H), 3.20-3.16 (dd, J_1 = 6.79, J_2 = 16.78 Hz, 1H), 2.76-2.73 (dd, *J* = 16.0 Hz, 1H), 1.04 (d, *J* = 6.85 Hz, 3H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 195.66, 141.69, 140.50, 139.72, 135.97, 134.38, 131.67, 131.39, 130.31, 129.51, 129.00, 128.86, 128.76, 127.11, 126.73, 35.12, 27.26, 17.99.

HRMS calculated for $C_{18}H_{15}OCl$ $[M+H]^+$: 283.0811, Found 283.0812.

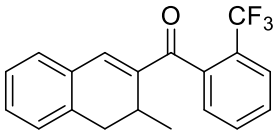


3k was obtained through general procedure in 12h and 73% isolated yields as a white solid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.60 (m, 4H), 7.31-7.13 (m, 4H), 7.01 (s, 1H), 3.24 (dp, J_1 = 2.02, J_2 = 7.28 Hz, 1H), 3.15 (dd, J_1 = 16.78, J_2 = 6.79 Hz, 1H), 2.74 (dd, J = 16.0 Hz, 1H), 1.06 (d, J = 6.85 Hz, 3H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 196.08, 141.98, 138.74, 137.5, 135.9, 131.7, 131.4, 130.6, 130.2, 128.85, 128.6, 126.7, 126.2, 35.22, 27.55, 18.04.

HRMS calculated for $C_{18}H_{15}OBr$ $[M+H]^+$: 327.0306, Found 327.0307.

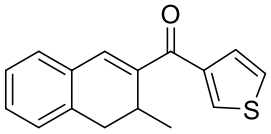


3l was obtained through general procedure in 12h and 48% isolated yields as pale yellow oil (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.75 (t, 1H), 7.61 (m, 2H), 7.39 (d, 1H), 7.17-7.07 (m, 4 H), 6.78 (s, 1H), 3.35 (dp, J_1 = 2.02, J_2 = 7.28 Hz, 1H), 3.18-3.13 (dd, J_1 = 16.78, J_2 = 6.79 Hz, 1H), 2.77 (dd, J = 16.0 Hz, 1H), 1.03 (d, J = 6.85 Hz, 3H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 195.69, 142.79, 141.75, 138.60, 136.29, 131.56, 131.28, 130.62, 129.32, 128.97, 128.22, 126.67, 126.54, 34.91, 25.88, 17.52.

HRMS calculated for $C_{19}H_{15}OF_3$ $[M+H]^+$: 317.1075, Found 317.1075

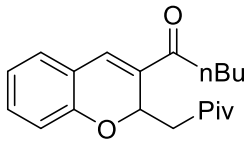


3m was obtained through general procedure in 12h and 56% isolated yields as colorless liquid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.88 (dd, 1H), 7.50 (dd, 1H), 7.37 (m, 1H), 7.30-7.17 (m, 6H), 3.25-3.13 (dp, J_1 = 2.02, J_2 = 7.28 Hz 1H), 3.15-3.13 (d, 1H), 2.74-2.71 (d, 1H), 1.06 (d, J= 8Hz, 3H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 187.61, 143.09, 141.63, 137.31, 135.87, 131.94, 131.33, 129.86, 128.78, 128.44, 128.34, 126.64, 125.96, 35.25, 27.71, 18.11.

HRMS calculated for $C_{16}H_{14}OS$ $[M+H]^+$: 255.0765, Found 255.0764

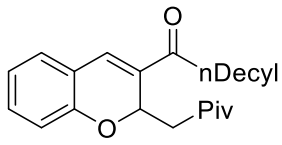


6a was obtained through general procedure in 12h and 90% isolated yields as colorless liquid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.34 (s,1H), 7.27-7.18 (m, 2H), 1.09 (t, 1H), 6.94 (dt, 1H), 66.81-6.79 (dd, 1H), 5.95-5.93 (dd, J= 8Hz, 1H), 3.20-3.13 (dd, 1H), 2.74 (dt, J= 8Hz,2H), 2.33-2.29 (dd, J=16Hz, 1H), 1.69 (m, 2H), 1.39 (m,2H), 1.07 (s, 9H), 0.95 (t, 3H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 210.95, 198.31, 153.26, 132.82, 132.53, 132.41, 128.96, 121.68, 120.19, 117.31, 70.12, 44.45, 39.52, 36.82, 26.67, 25.89, 22.43, 13.87

HRMS calculated for $C_{20}H_{26}O_3$ $[M+H]^+$: 315.1881, Found 315.1882

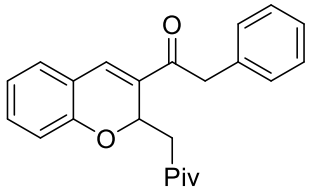


6b was obtained through general procedure in 12h and 86% isolated yields as colorless liquid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.34 (s,1H), 7.27-7.18 (m, 2H), 6.94 (dt, 1H), 6.79 (dd, 1H), 5.95 (dd, *J* = 8Hz, 1H), 3.20-3.13 (dd, 1H), 2.74 (dt, *J* = 8Hz ,2H), 2.30 (dd, *J* = 16Hz, 1H), 1.66 (m, 2H), 1.27 (m,12H), 1.07 (s, 9H), 0.88 (t, 3H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 210.91, 198.31, 153.26, 132.81, 132.51, 132.39, 128.95, 121.66, 120.19, 117.28, 70.11, 44.43, 39.50, 37.10, 31.81, 29.40, 29.30, 29.22, 25.87, 24.56, 22.50, 14.05.

HRMS calculated for $C_{25}H_{36}O_3$ $[M+H]^+$: 385.2664, Found 385.2665

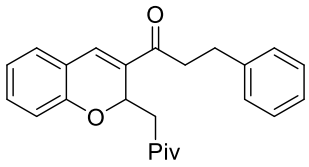


6c was obtained through general procedure in 12h and 78% isolated yields as yellow oil (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.46 (s, 1H) 7.33 (m, 2H), 7.27-7.18 (m, 4H), 6.94 (dt, 1H), 6.80 (dd, 1H), 5.96-5.93 (dd, *J* =12 Hz, 1H), 4.07 (s, 2H), 3.18-3.11 (dd, *J* = 16 Hz, 1H), 2.30-2.25 (dd, *J* = 16 Hz, 1H), 1.04 (s, 9H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 210.68, 195.35, 153.32, 134.39, 133.67, 132.84, 132.46, 129.24, 129.16, 128.69, 126.94, 121.74, 120.06, 117.36, 70.15, 44.42, 44.12, 39.39, 25.88

HRMS calculated for $C_{23}H_{24}O_3$ $[M+H]^+$: 349.1725, Found 349.1725

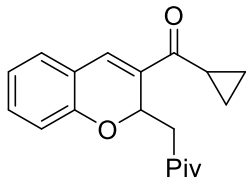


6d was obtained through general procedure in 12h and 82% isolated yields as colorless liquid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.31-7.12 (m, 8H), 6.93 (dt, *J* = 8 Hz, 1H), 6.79 (d, *J* = 8 Hz, 1H), 5.95 (dd, *J* = 8Hz, 1H), 3.17-2.96 (m, 5H), 2.27 (dd, *J* = 16Hz, 1H), 1.06 (s, 9H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 210.90, 196.95, 153.27, 140.98, 132.73, 132.68, 132.65, 129.0, 128.48, 128.36, 126.16, 121.70, 120.06, 117.30, 70.04, 44.4, 39.47, 38.86, 30.29, 25.87.

HRMS calculated for $C_{24}H_{26}O_3$ $[M+H]^+$: 363.1881, Found 363.1882

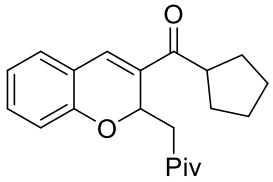


6e was obtained through general procedure in 12h and 84% isolated yields as yellow color oil (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.48 (s, 1H), 7.26-7.18 (m, 2H), 6.93 (t, *J* = 7.10 Hz, 1H), 6.80 (d, *J* = 7.78 Hz, 1H), 5.94-5.92 (dd, J_1 = 2.37 , J_2 = 10.14 Hz, 1H), 3.20-3.14 (dd, J_1 = 10.48 Hz, 1H), 2.46 (m, 1H), 2.34-2.29 (dd, J_1 = 13.0, J_2=17.8 Hz, 1H), 1.11 (m, 2H), 1.04 (s, 9H), 0.95 (m, 2H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 211.02, 197.34, 153.31, 133.54, 132.47, 132.31, 128.97, 121.68, 120.40, 117.35, 70.38, 44.47, 39.58, 25.91, 15.86, 11.13, 10.95

HRMS calculated for $C_{19}H_{22}O_3$ $[M+H]^+$: 299.1568, Found 299.1569

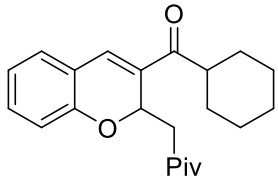


6f was obtained through general procedure in 12h and 86% isolated yields as colorless liquid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.35 (s, 1H), 7.26-7.18 (m 2H), 6.94 (t, 1H), 6.80 (d, 1H), 6.95 (dd, 1H), 3.52 (m, 1H), 3.20-3.14 (dd, 1H), 2.32 (dd, 1H), 1.87-1.62 (m, 8H), 1.07 (s, 9H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 210.93, 200.72, 153.23, 132.59, 132.47, 128.97, 121.65, 120.31, 17.29, 70.33, 44.96, 44.44, 39.50, 30.53, 29.98, 26.23, 25.89.

HRMS calculated for $C_{21}H_{26}O_3$ $[M+H]^+$: 327.1881, Found 327.1882

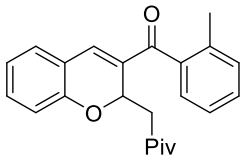


6g was obtained through general procedure in 12h and 87% isolated yields as colorless liquid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.33 (s, 1H), 7.26-7.17 (m, 2H), 6.93 (t, 1H), 6.80 (dd, 1H), 5.90(dd, 1H), 3.14 (dd, 1H), 3.06 (m, 1H), 2.30 (dd, 1H), 1.85-1.69 (m, 5H), 1.47-1.20 (m, 6H), 1.05 (s, 9H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 210.92, 210.66, 153.26, 132.50, 131.93, 131.69, 128.97, 121.65, 120.25, 117.29, 70.23, 44.44, 44.39, 39.52, 29.78, 29.38, 25.90, 25.77.

HRMS calculated for $C_{22}H_{28}O_3$ $[M+H]^+$: 341.2038, Found 341.2038

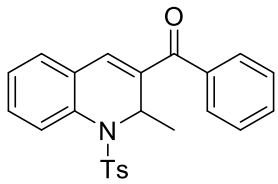


6h was obtained through general procedure in 12h and 80% isolated yields as pale yellow oil (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.41 (dt, J_1 = 2.04, J_2 = 7.39, 1H), 7.34-7.24 (m, 5H), 7.07-7.04 (dd, J_1 = 2.80, J_2 = 7.39, Hz, 1H), 6.93 (s,1H), 6.90 (dt, J = 6.90 Hz, 1H), 6.84-6.82 (d, J = 9.17 Hz, 1H), 6.15-6.11 (dd, J_1 = 2.80, J_2 = 9.97= Hz, 1H), 3.55-3.28 (dd, J = 16.0 Hz, 1H), 2.55-2.50 (dd, J_1 = 2.80, J_2 = 16.0 Hz, 1H), 2.34 (s, 3H), 1.11 (s, 9H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 211.07, 196.30, 153.35, 137.89, 137.64, 136.21, 133.22, 133.03, 130.96, 130.00, 129.32, 127.82, 125.19, 121.74, 120.19, 117.35, 70.38, 44.58, 39.54, 25.94, 19.61

HRMS calculated for $C_{23}H_{24}O_3$ $[M+H]^+$: 349.1725, Found 349.1725

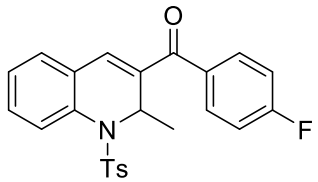


7a was obtained through general procedure in 12h and 72% isolated yields as colorless liquid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.79-7.77 (d, 1H), 7.46-7.38 (m, 2H), 7.32-6.98 (m, 11H), 6.52 (s, 1H), 5.53 (q, 1H), 2.25 (s, 3H), 1.20-1.18 (d, J = 11.82 Hz, 3H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 193.54, 143.50, 137.39, 137.21, 135.48, 131.80, 131.11, 129.34, 128.78, 128.71, 128.52, 128.14, 126.91, 126.74, 50.08, 21.43, 19.43.

HRMS calculated for $C_{24}H_{21}SNO_3$ $[M+H]^+$: 404.1242, Found 404.1242.

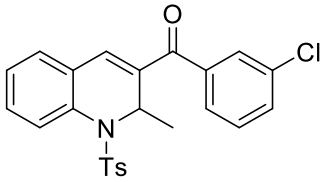


7b was obtained through general procedure in 12h and 87% isolated yields as yellow white solid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.86 (dd, 1H), 7.48 (dt,1H), 7.30-7.21 (m, 5H), 7.12-7.03 (m, 5H), 6.57 (s, 1H), 5.56 (q, 1H), 2.32 (s, 3H), 1.27-1.25 (d, J = 11.82 Hz, 3H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 192.04, 143.49, 137.07, 136.26, 135.24, 134.12, 133.48, 131.32, 131.22, 129.32, 128.73, 128.50, 126.92, 126.80, 115.42, 115.20, 50.19, 21.44, 19.44

HRMS calculated for $C_{24}H_{20}FNSO_3$ $[M+H]^+$: 422.1147, Found 422.1148

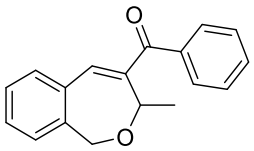


7c was obtained through general procedure in 12h and 77% isolated yields as colorless liquid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.85 (dd, 1H), 7.49 (dt, 2H), 7.33-7.26 (m, 4H), 7.12-7.06 (m, 5H), 6.59 (s, 1H), 5.58 (q, 1H), 2.35 (s, 3H), 1.26 (d, J = 11.82, 3H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 192.01, 139.05, 136.82, 136.21, 136.17, 134.28, 134.20, 131.70, 131.47, 129.66, 129.41, 128.93, 128.57, 126.92, 126.83, 126.80, 126.77, 49.99, 21.53, 19.37

HRMS calculated for $C_{24}H_{20}ClNSO_3$ $[M+H]^+$: 438.0852, Found 438.0852

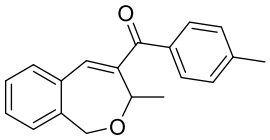


8a was obtained through general procedure in 12h and 68% isolated yields as colorless liquid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.12 (dd, 2H), 7.23-7.10 (m, 7H), 6.84 (d, J = 1.89 Hz, 1H), 5.36-5.33 (dq, J_1 = 1.89, J_2 = 6.57 Hz, 1H), 4.73-4.63 (dd, 2H), 1.33 (d, J = 8 Hz, 3H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 197.99, 147.02, 143.39, 140.95, 135.87, 134.87, 133.54, 132.49, 129.76, 129.08, 128.68, 127.80, 127.03, 79.27, 70.81, 19.98.

HRMS calculated for $C_{18}H_{16}O_2$ $[M+H]^+$: 265.1150, Found 265.1150

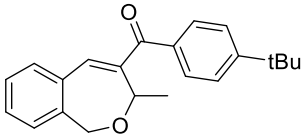


8b was obtained through general procedure in 12h and 66% isolated yields as colorless liquid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.71 (dd, 1H), 7.29-7.18 (m, 6H), 6.84 (d, J = 1.89 Hz, 1H), 5.33 (dq, J_1 = 1.89, J_2 = 6.57 Hz, 1H), 4.70-4.63 (q, 2H), 2.38 (s, 3H), 1.33 (d, J = 8 Hz, 3H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 198.09**,** 147.12, 143.49, 141.05, 135.97, 134.97, 133.64, 132.59, 129.86, 129.18, 128.78, 127.90, 127.13, 79.37, 70.91, 21.60, 20.08.

HRMS calculated for $C_{19}H_{18}O_2$ $[M+H]^+$: 279.1306, Found 279.1307

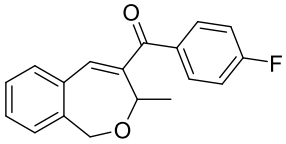


8c was obtained through general procedure in 12h and 52% isolated yields as colorless oil (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.3-7.81 (m, 2H), 7.52-7.50 (m, 2H), 7.29-7.18 (m, 4H), 6.95 (d, J = 1.89 Hz, 1H), 5.44-5.39 (dq, J_1 = 1.89, J_2 = 6.57 Hz, 1H), 4.81-4.71 (dd, J_1 = 14.10, J_2 = 15.09 Hz, 2H), 1.41 (d, J = 8 Hz, 3H), 1.38 (s, 9H).

^{13}CNMR ($CDCl_3$, 400MHz): δ 197.98, 156.42, 147.00, 140.97, 135.89, 134.78, 133.59, 132.57, 129.65, 128.72, 127.82, 127.06, 125.40, 79.35, 70.87, 31.07, 26.94, 20.01

HRMS calculated for $C_{22}H_{24}O_2$ $[M+H]^+$: 321.1776, Found 321.1775

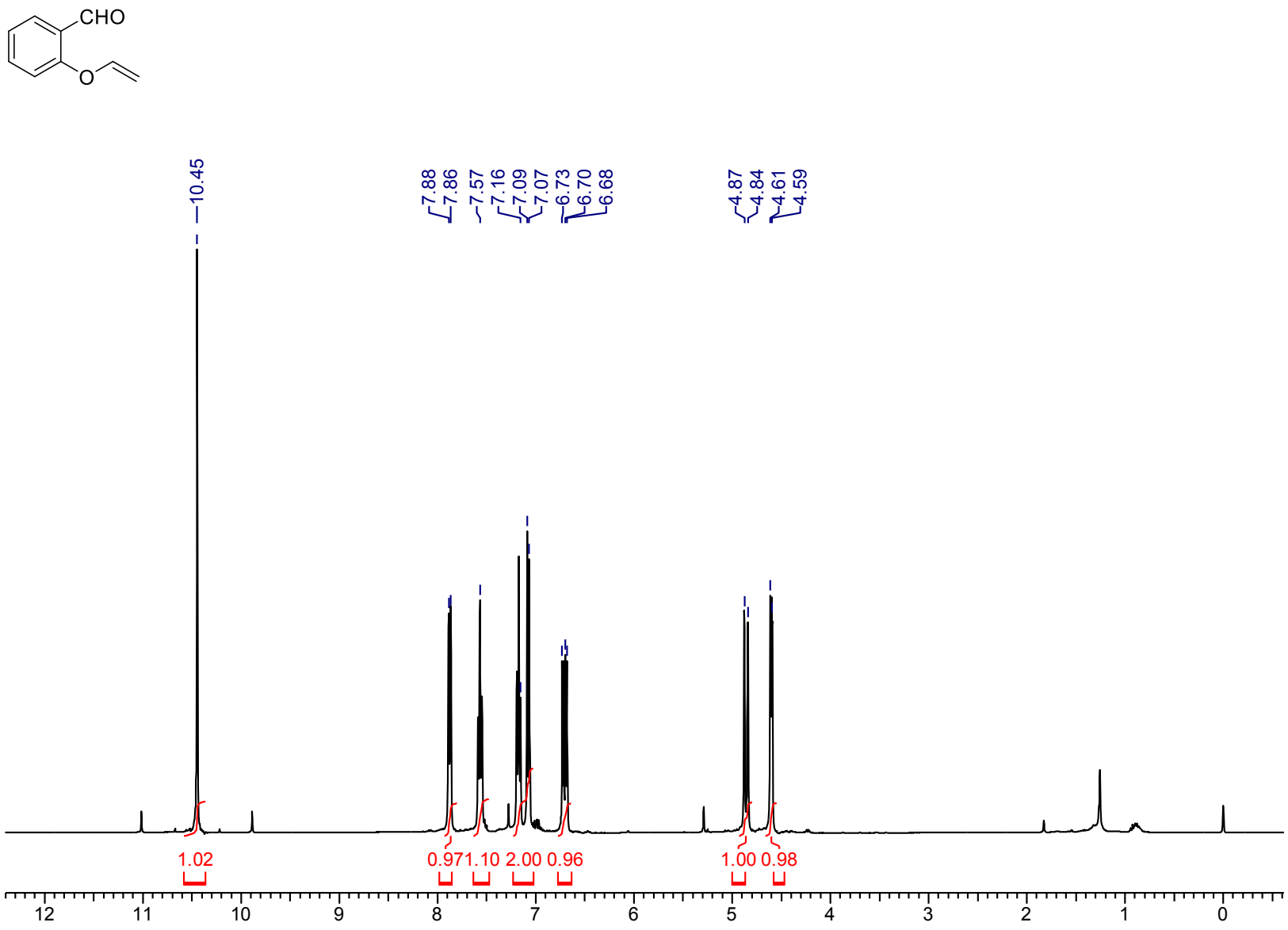


8d was obtained through general procedure in 12h and 70% isolated yields as colorless liquid (Elution: dichloromethane/hexanes = 1/5)

^{1}HNMR ($CDCl_3$, 400MHz): δ 7.86 (m, 1H), 7.26-7.14 (m, 6H), 6.89 (d, J = 1.89 Hz, 1H), 5.39 (dq, J_1 = 1.89, J_2 = 6.57 Hz, 1H), 4.76-4.69 (q, 2H), 1.38 (d, J = 8 Hz, 3H)

^{13}CNMR ($CDCl_3$, 400MHz): δ 196.84, 146.82, 141.13, 136.55, 133.36, 132.72, 132.24, 132.15, 129.04, 127.96, 127.19, 115.79, 115.57, 79.23, 70.89, 20.06.

HRMS calculated for $C_{18}H_{15}O_2$ $[M+H]^+$: 283.1056, Found 283.1056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7.09
7.07
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6.70
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4.61
4.59
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1.10
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1.00
0.98
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7
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3
2
1
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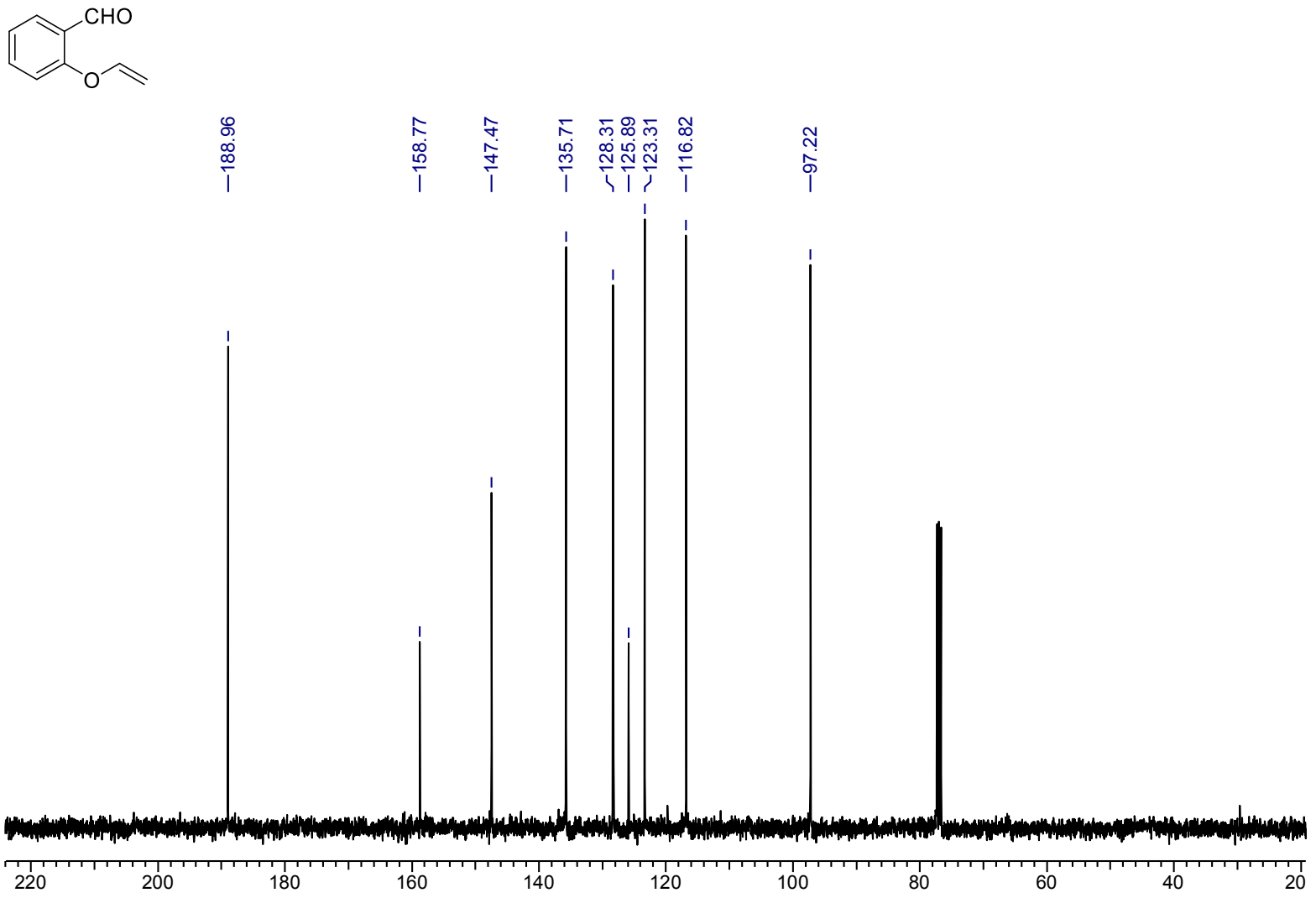
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123.31
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140
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100
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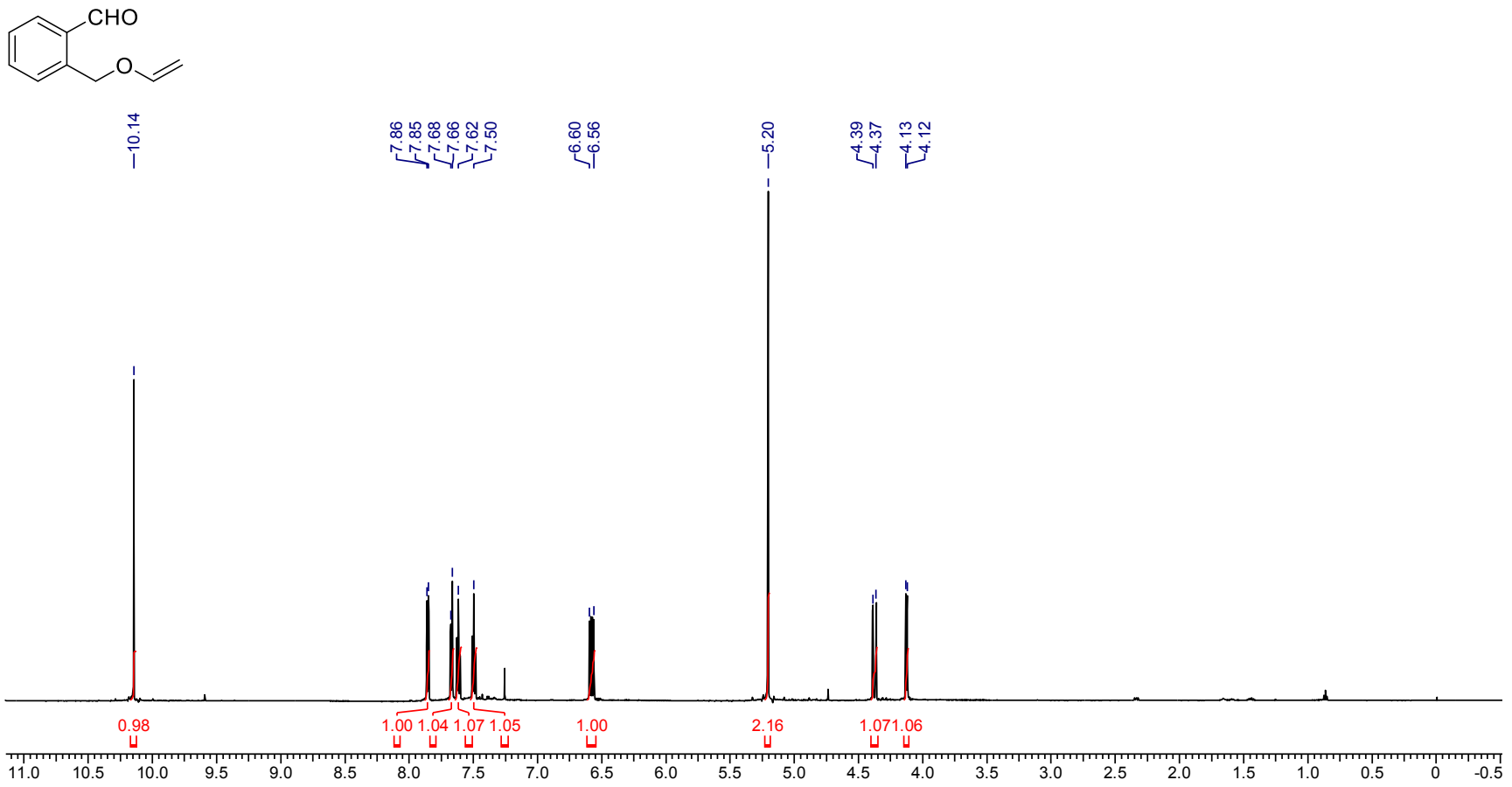
20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4.13
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1.07
1.05
1.00
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1.06
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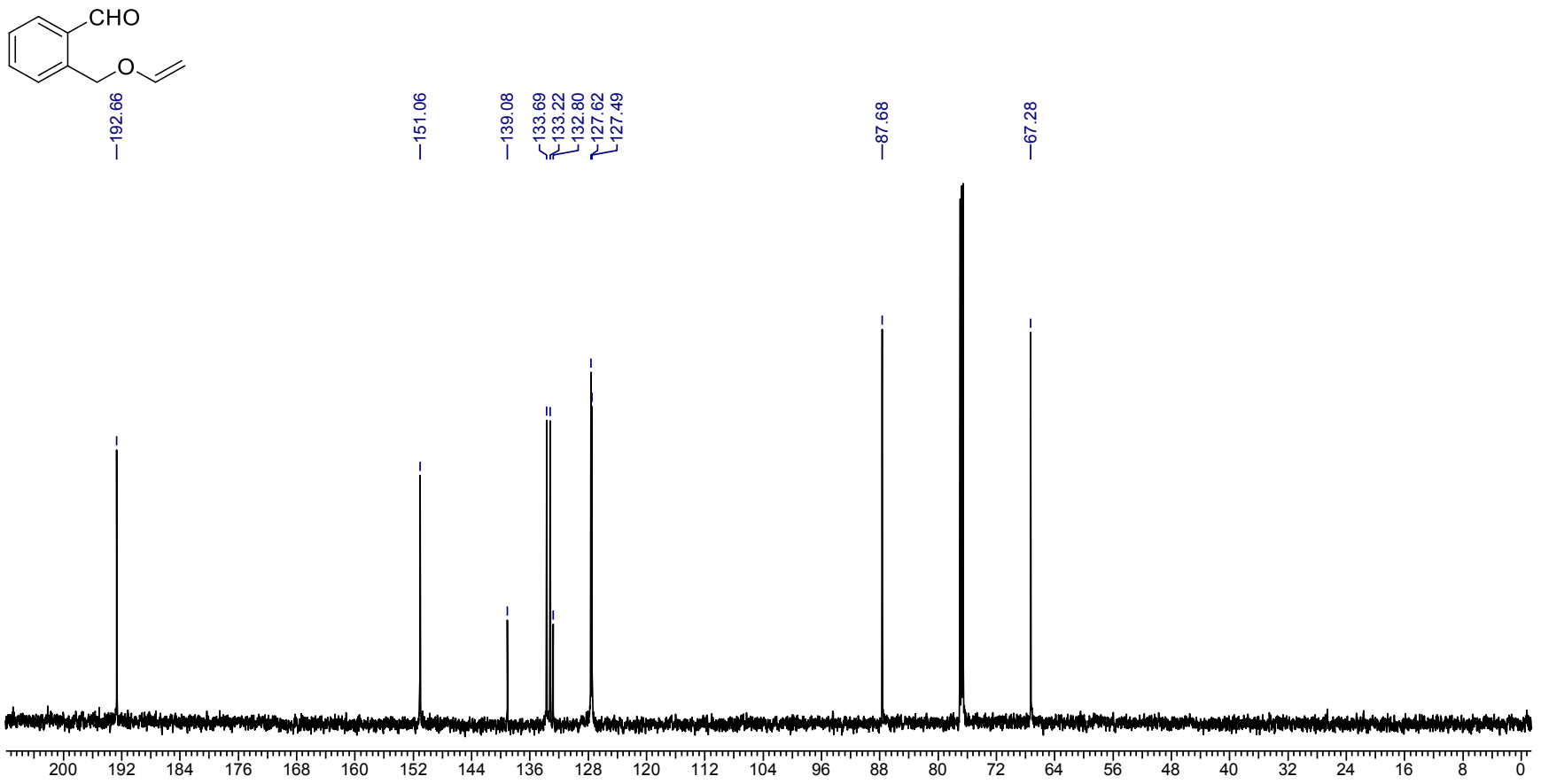
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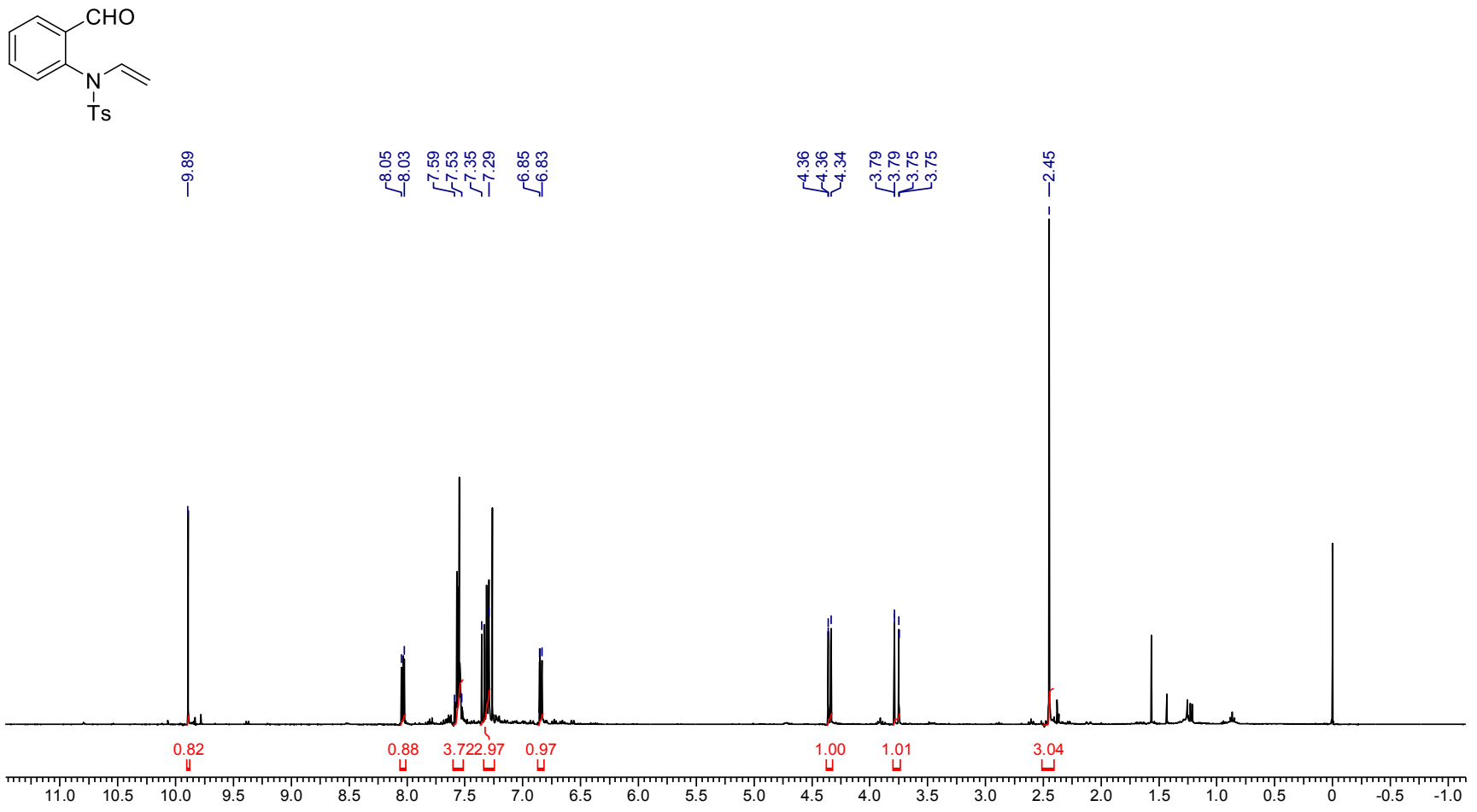
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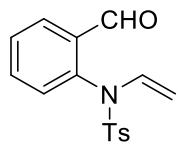
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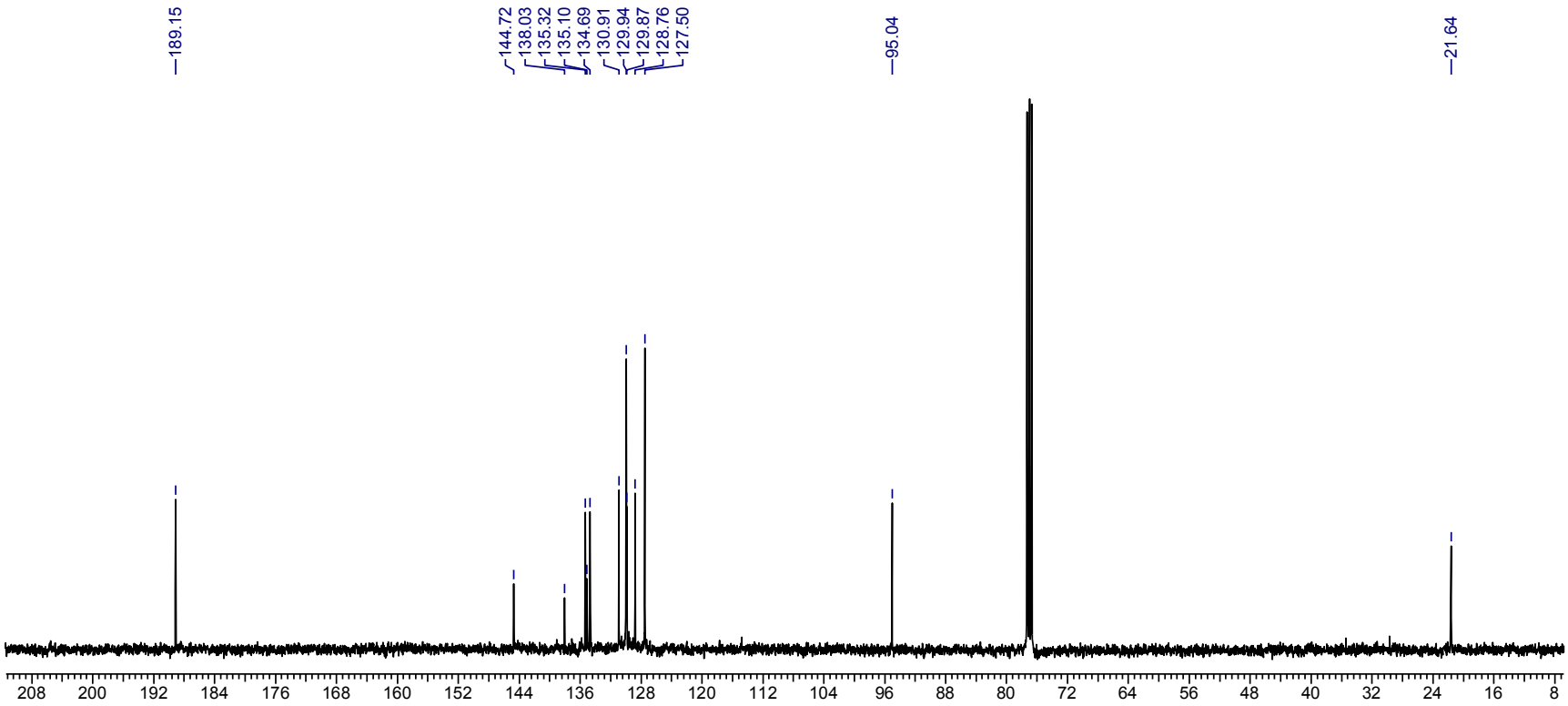
N
Ts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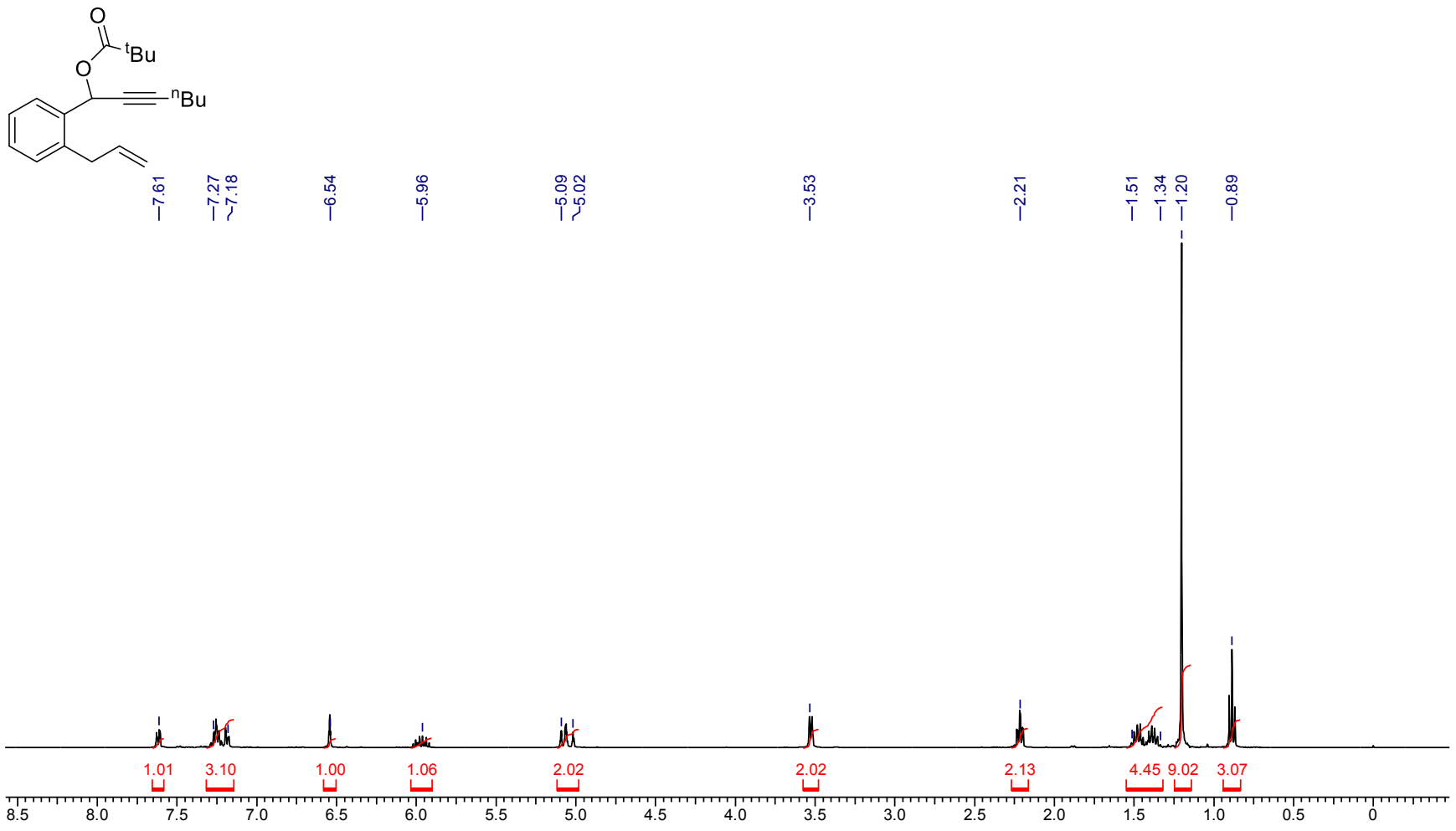
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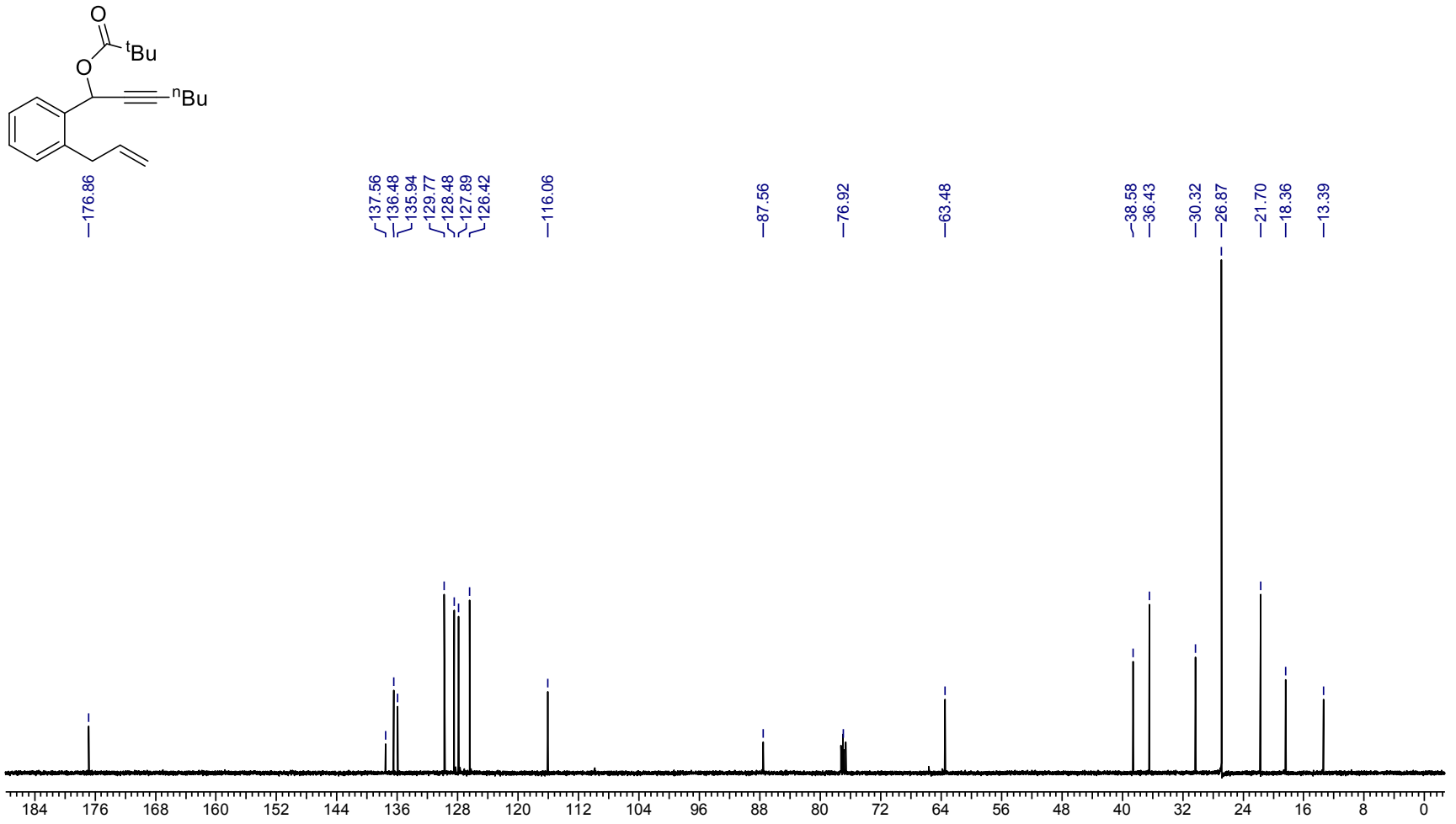
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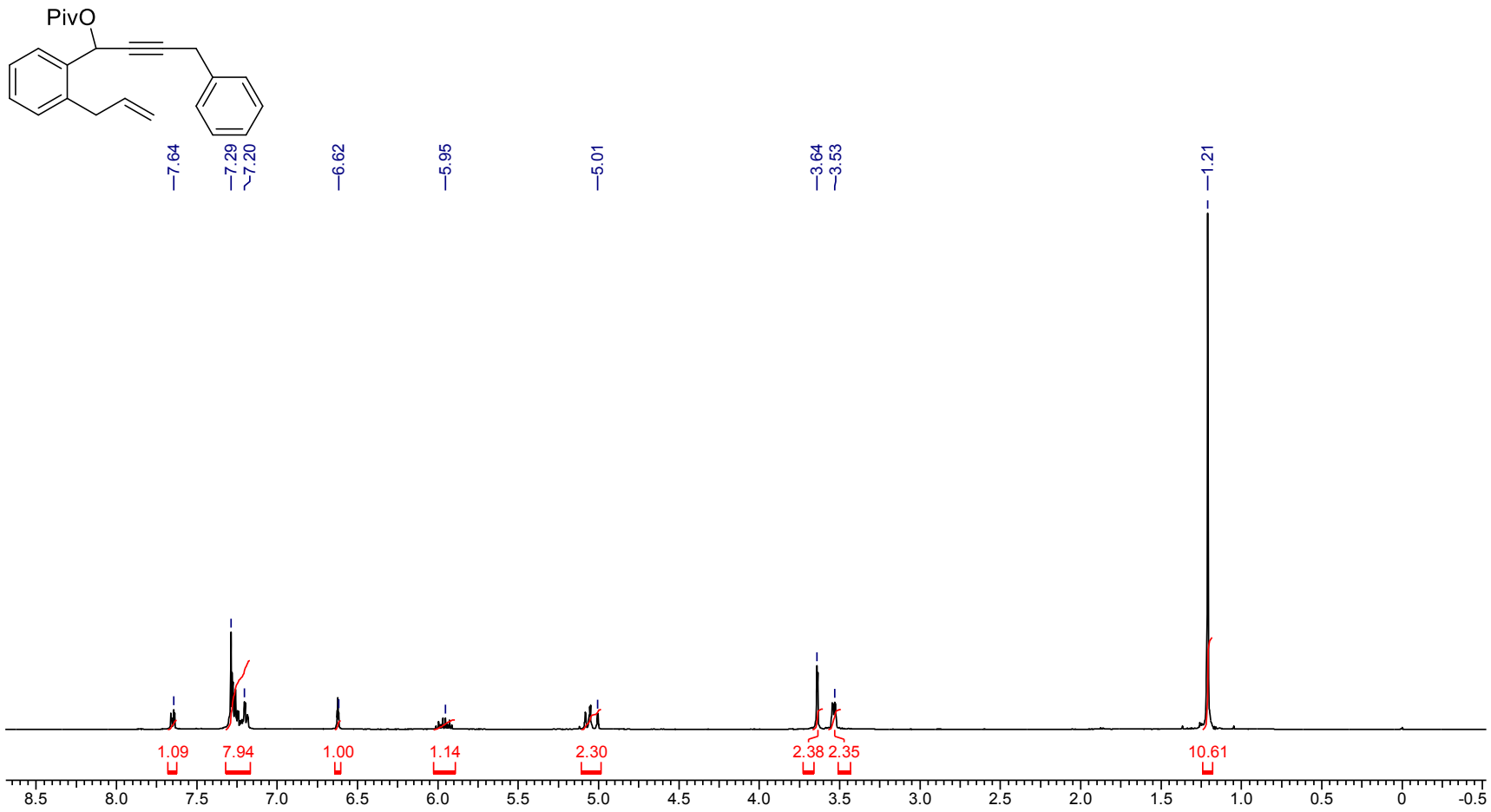
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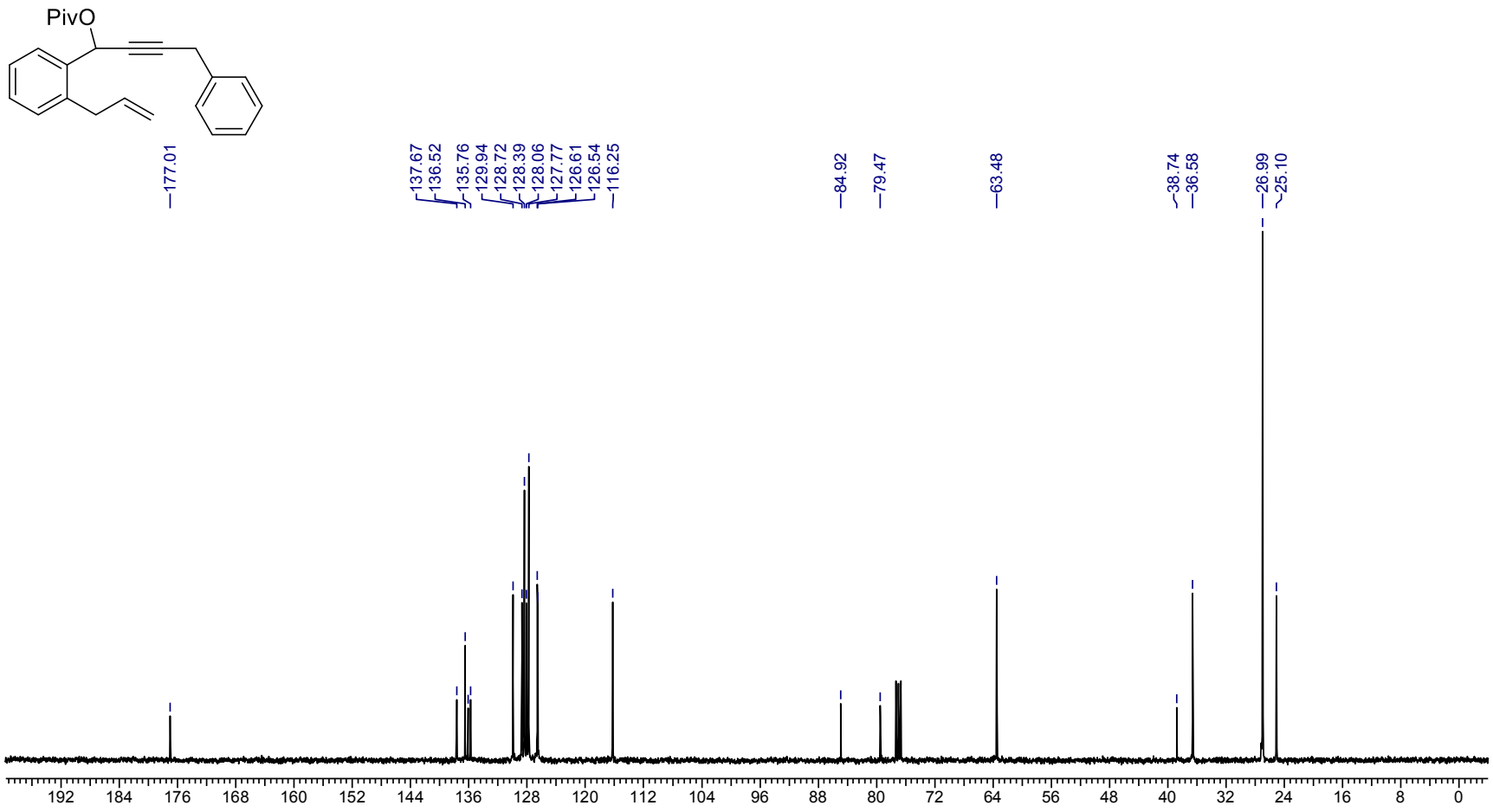
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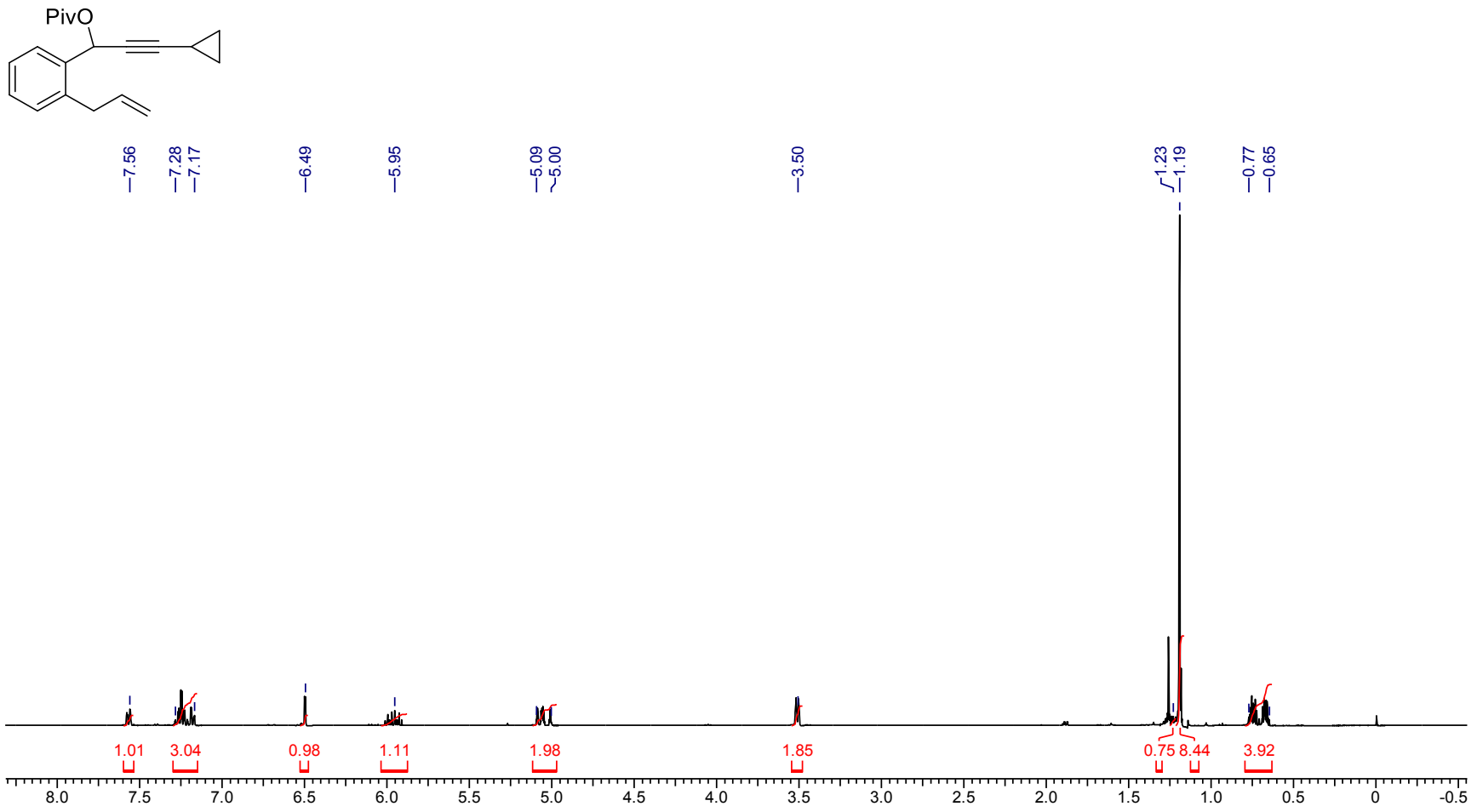
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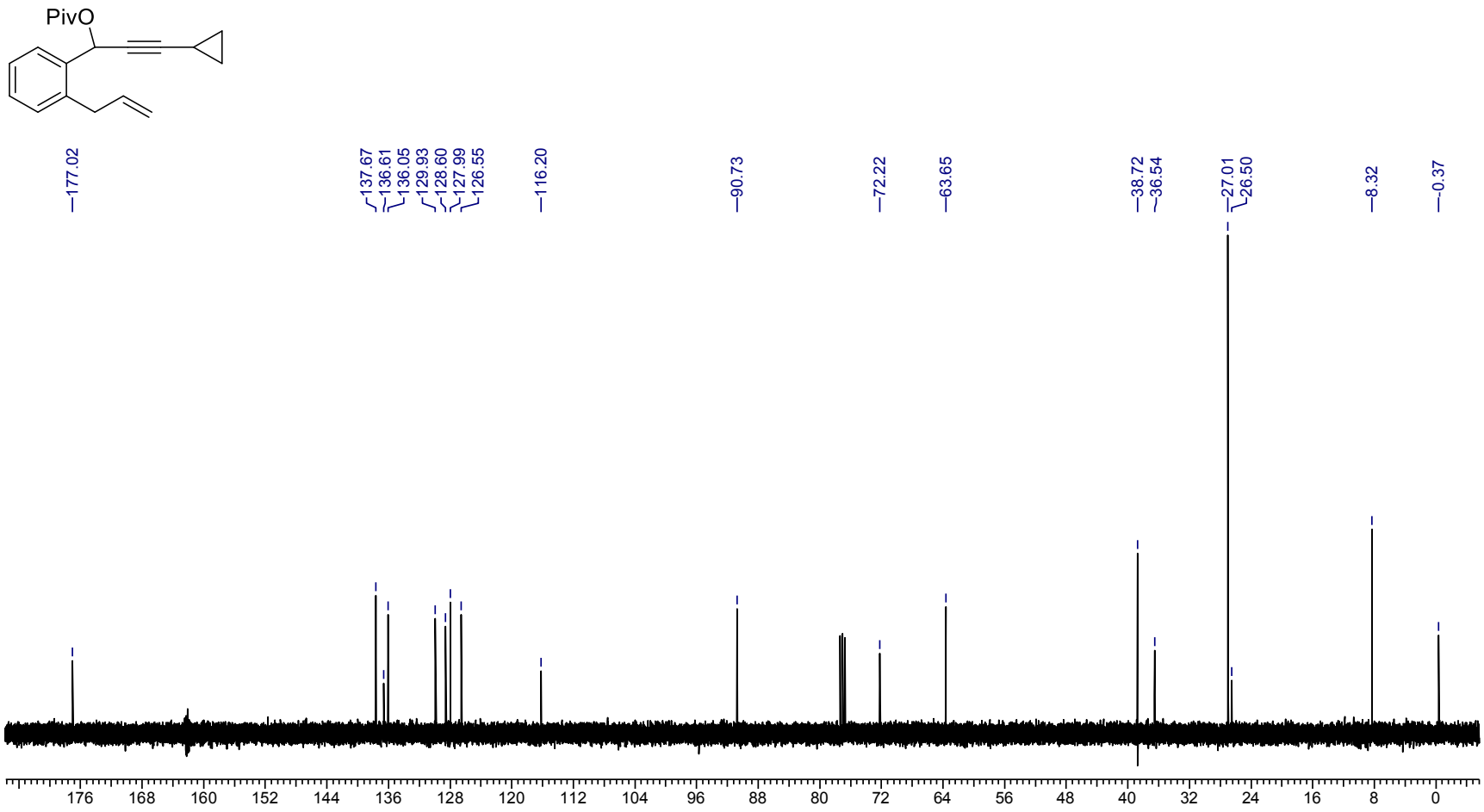
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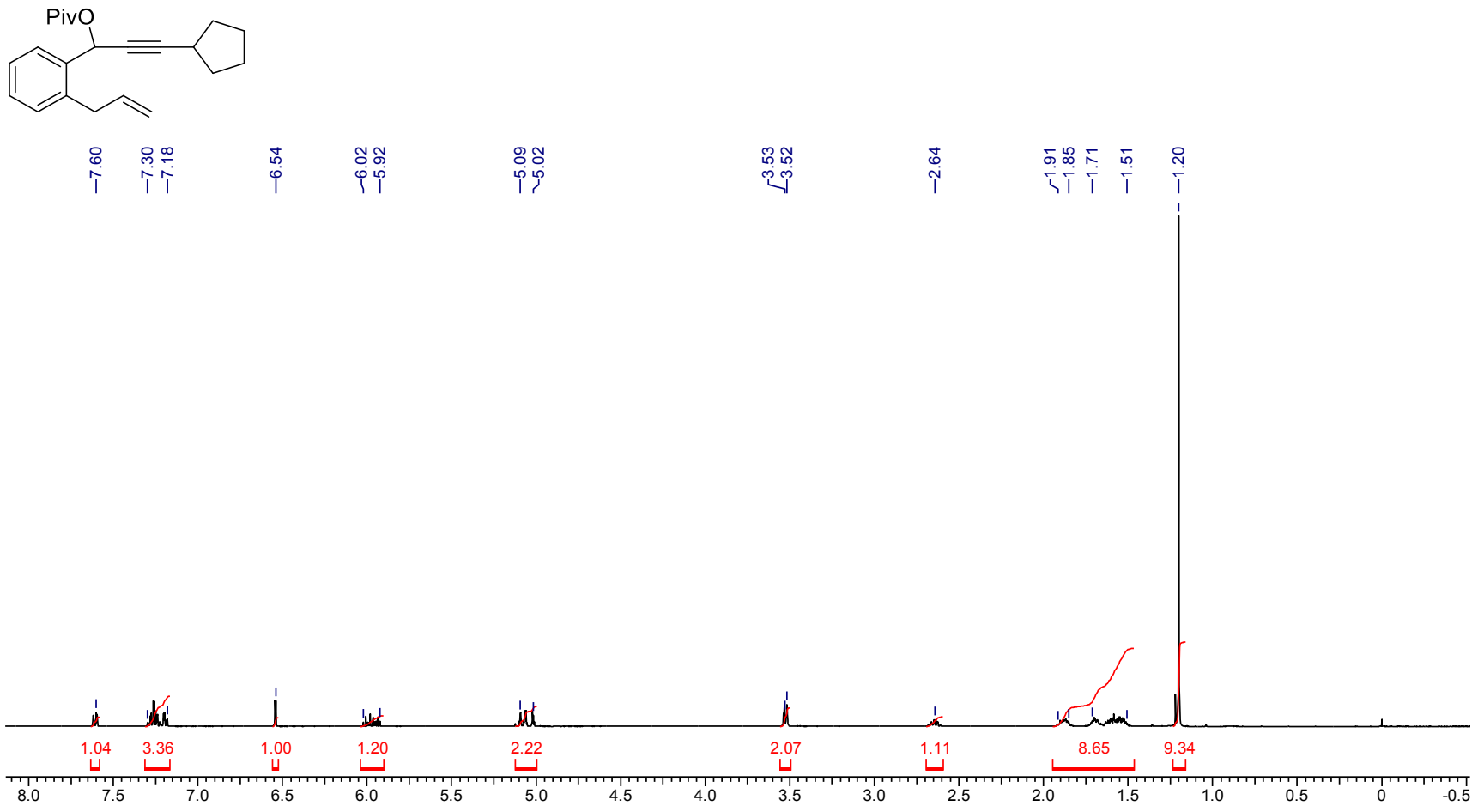
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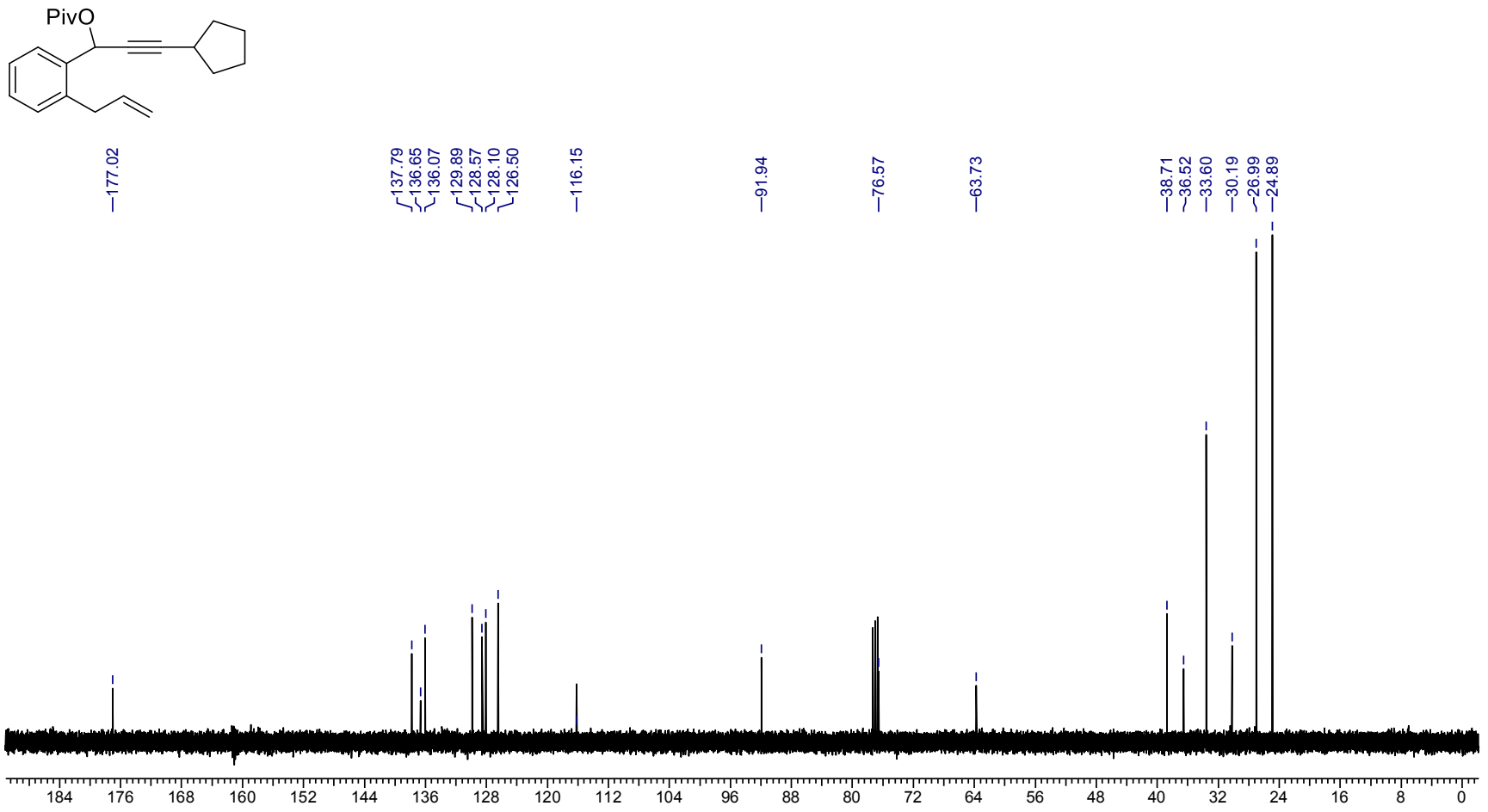
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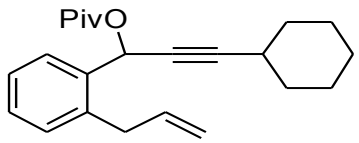
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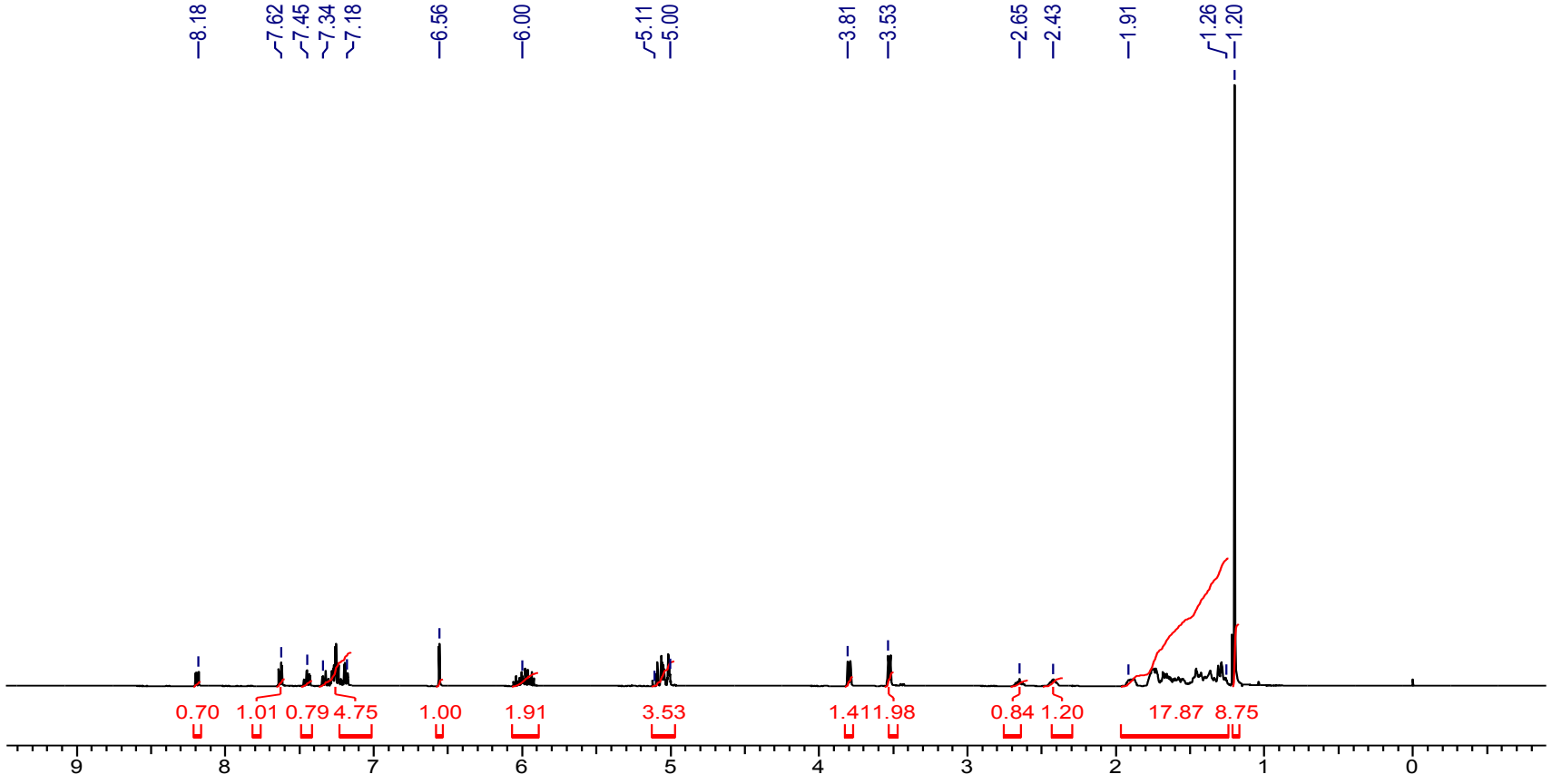
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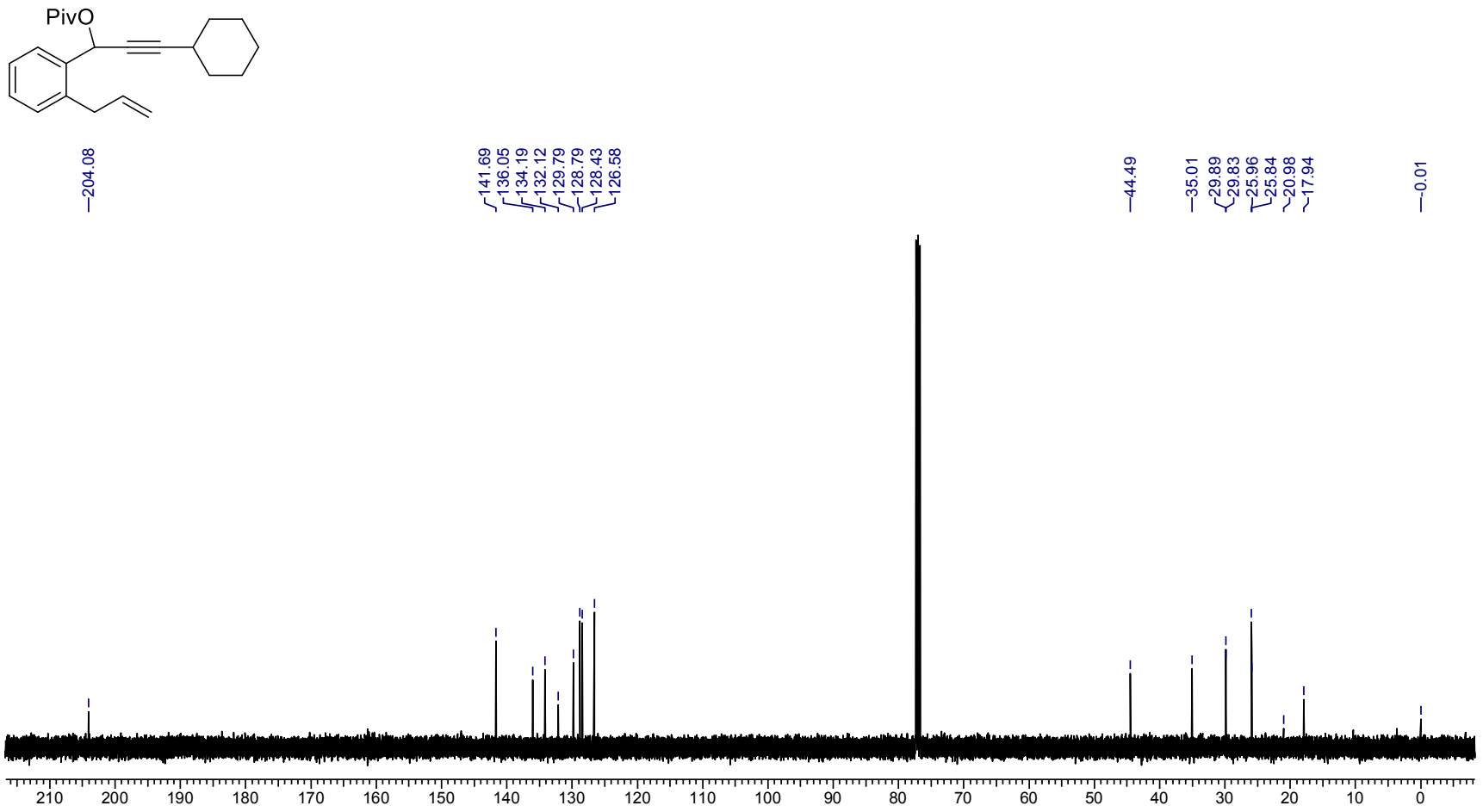
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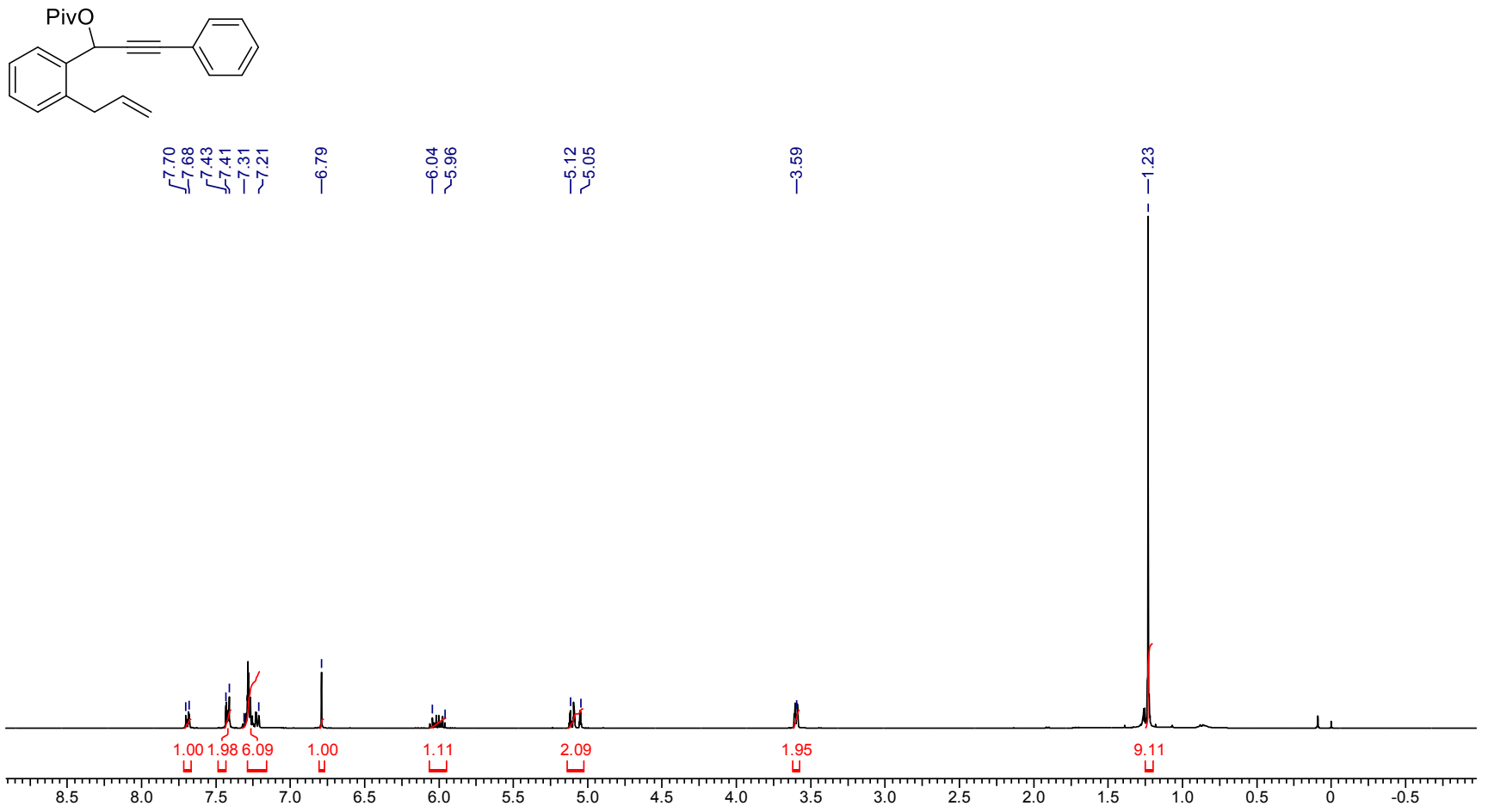
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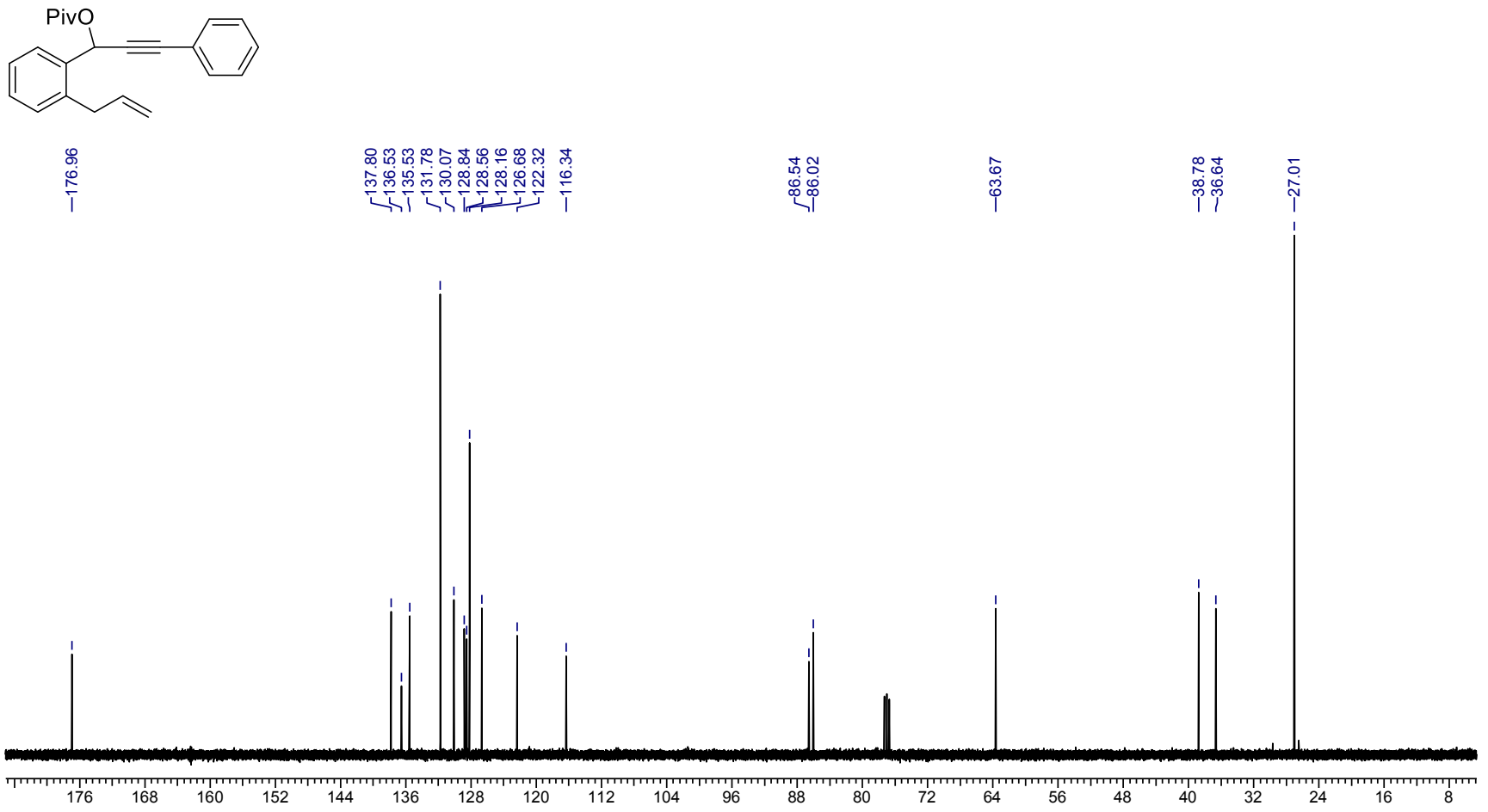
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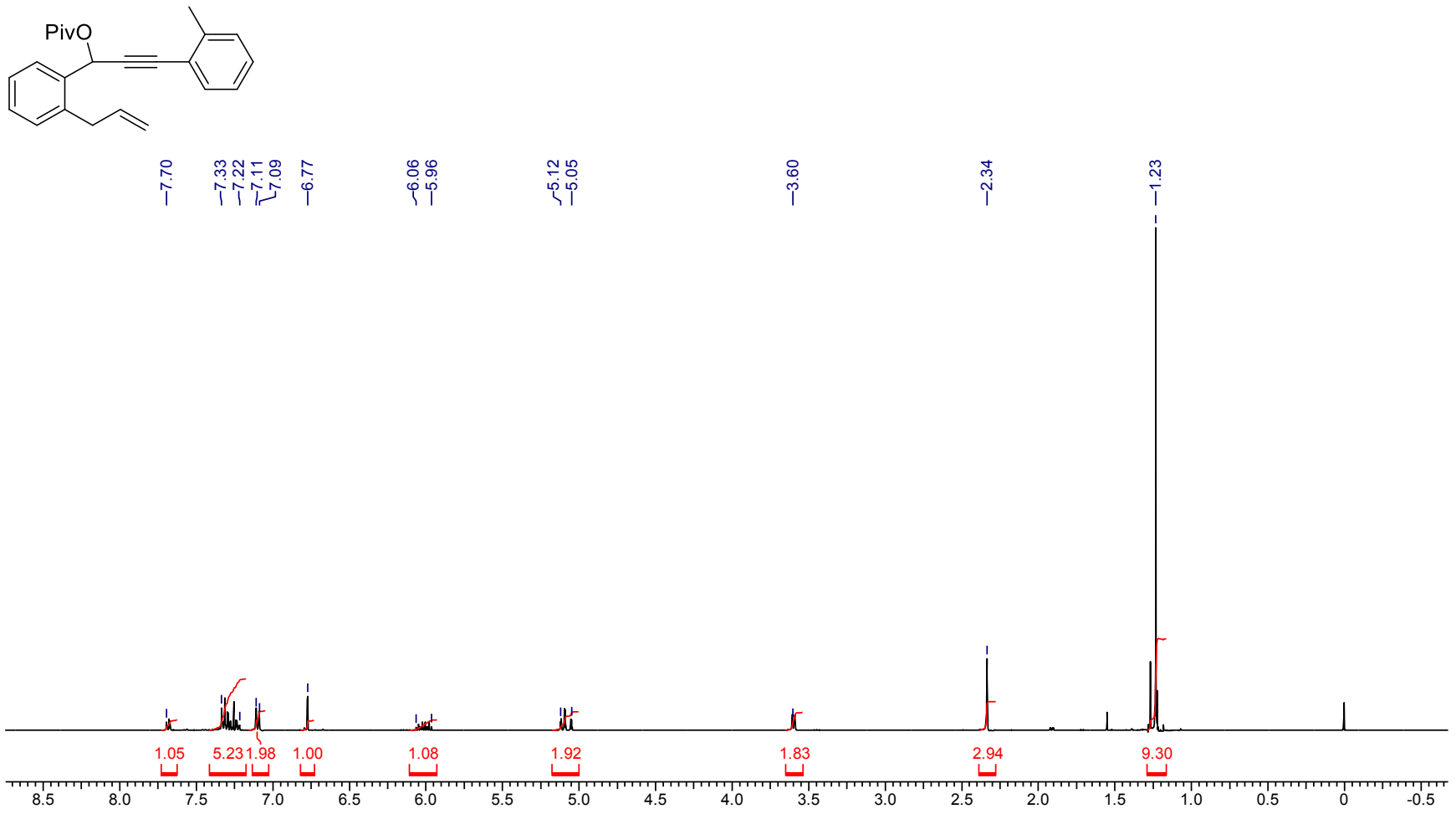
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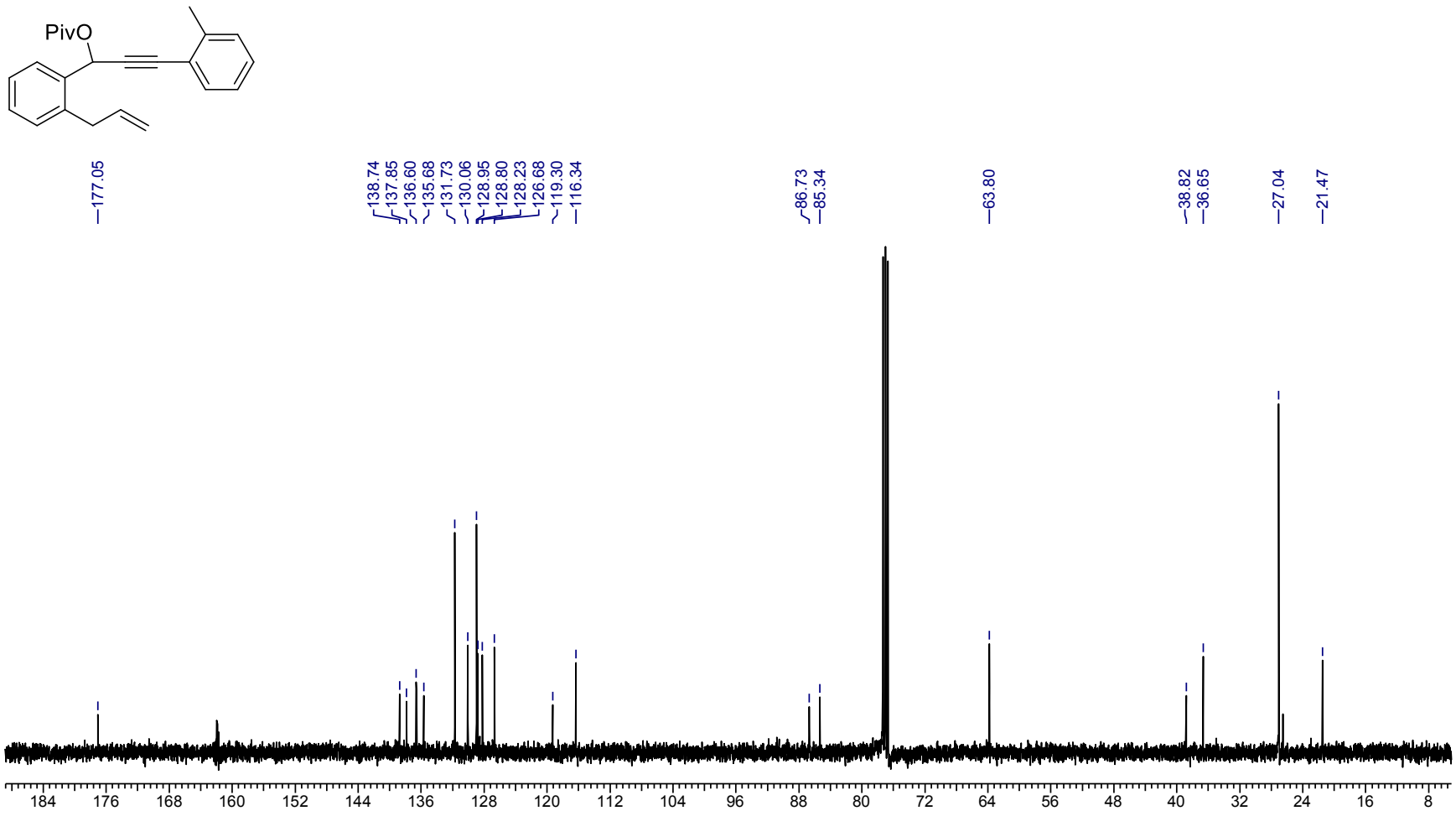
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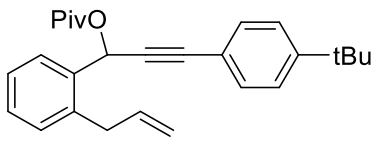
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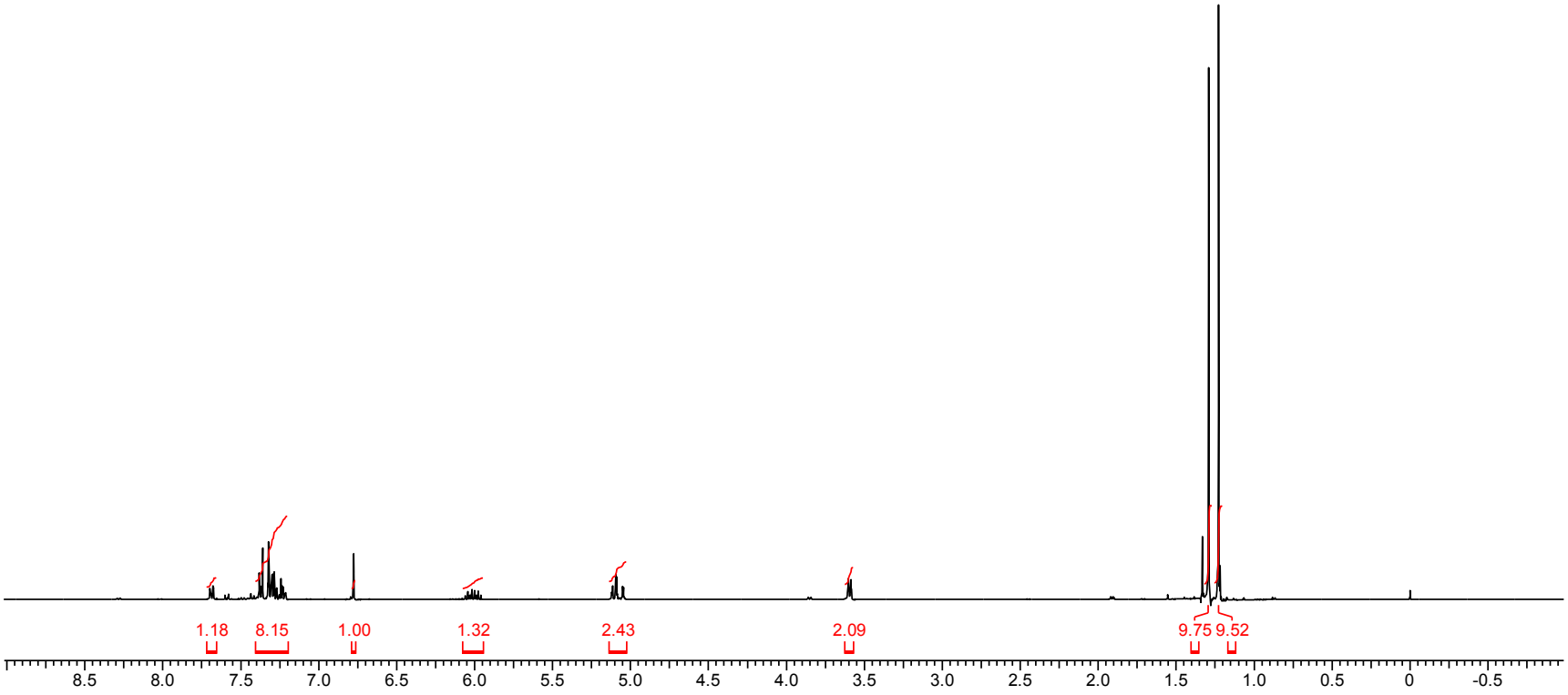
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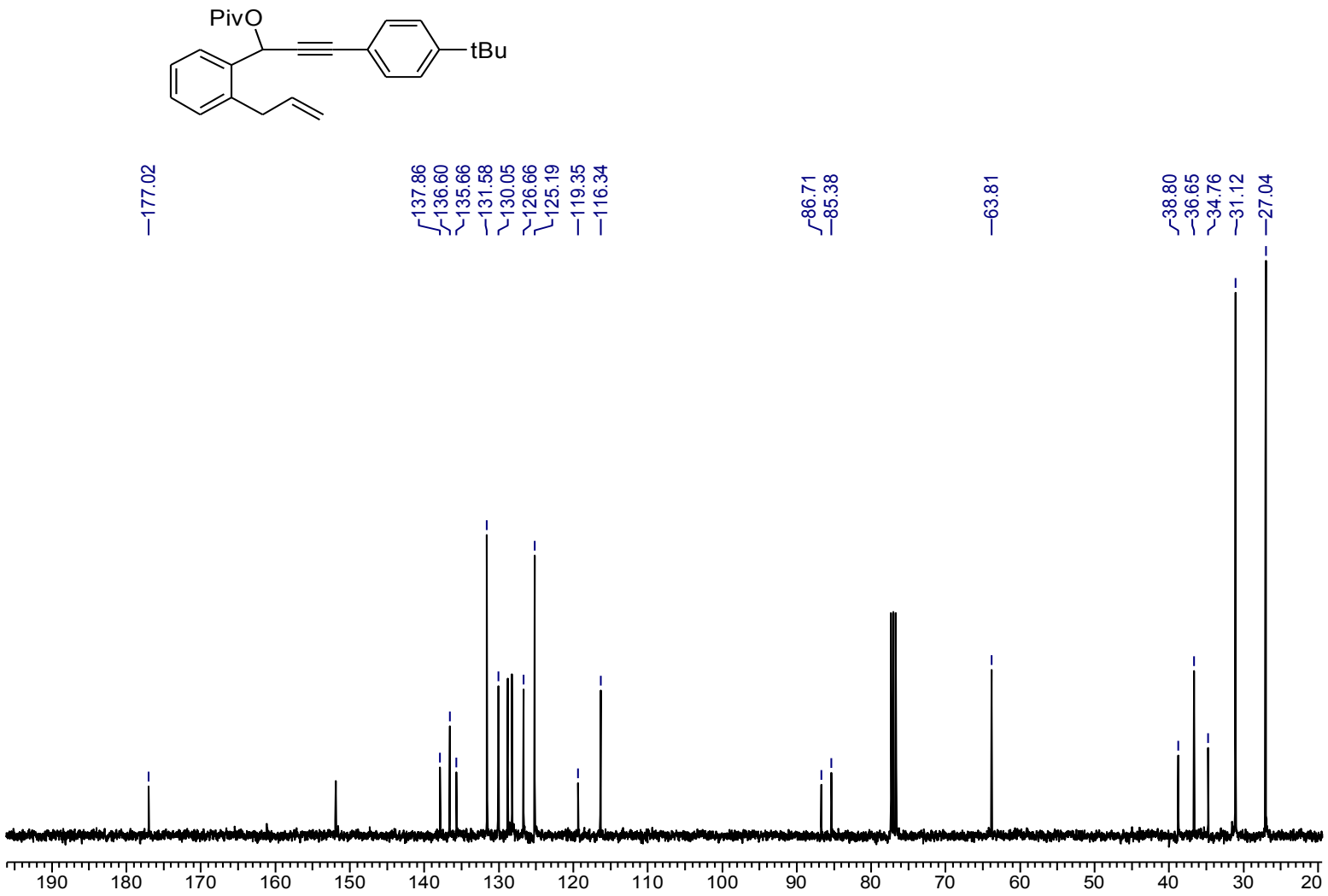
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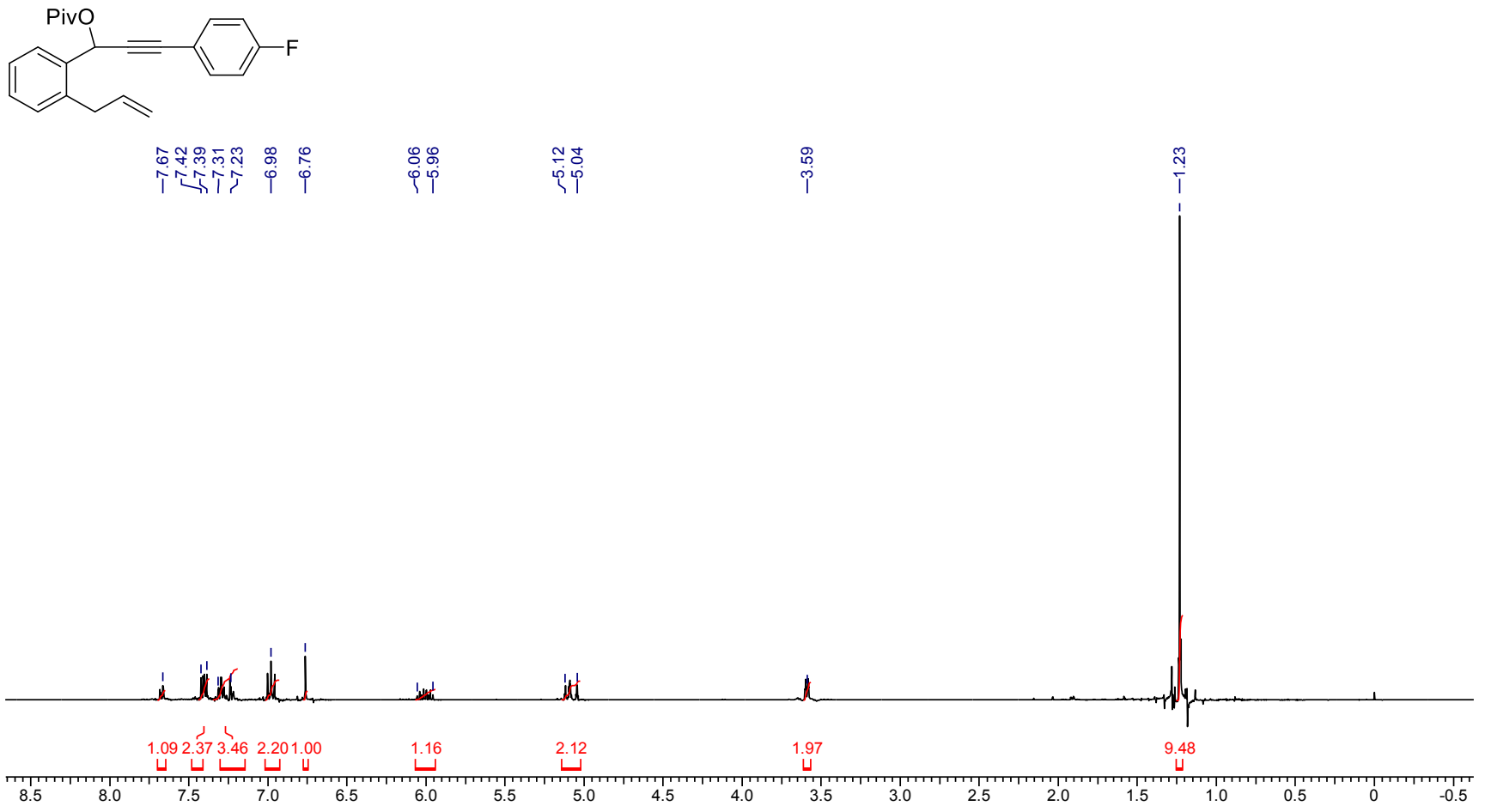
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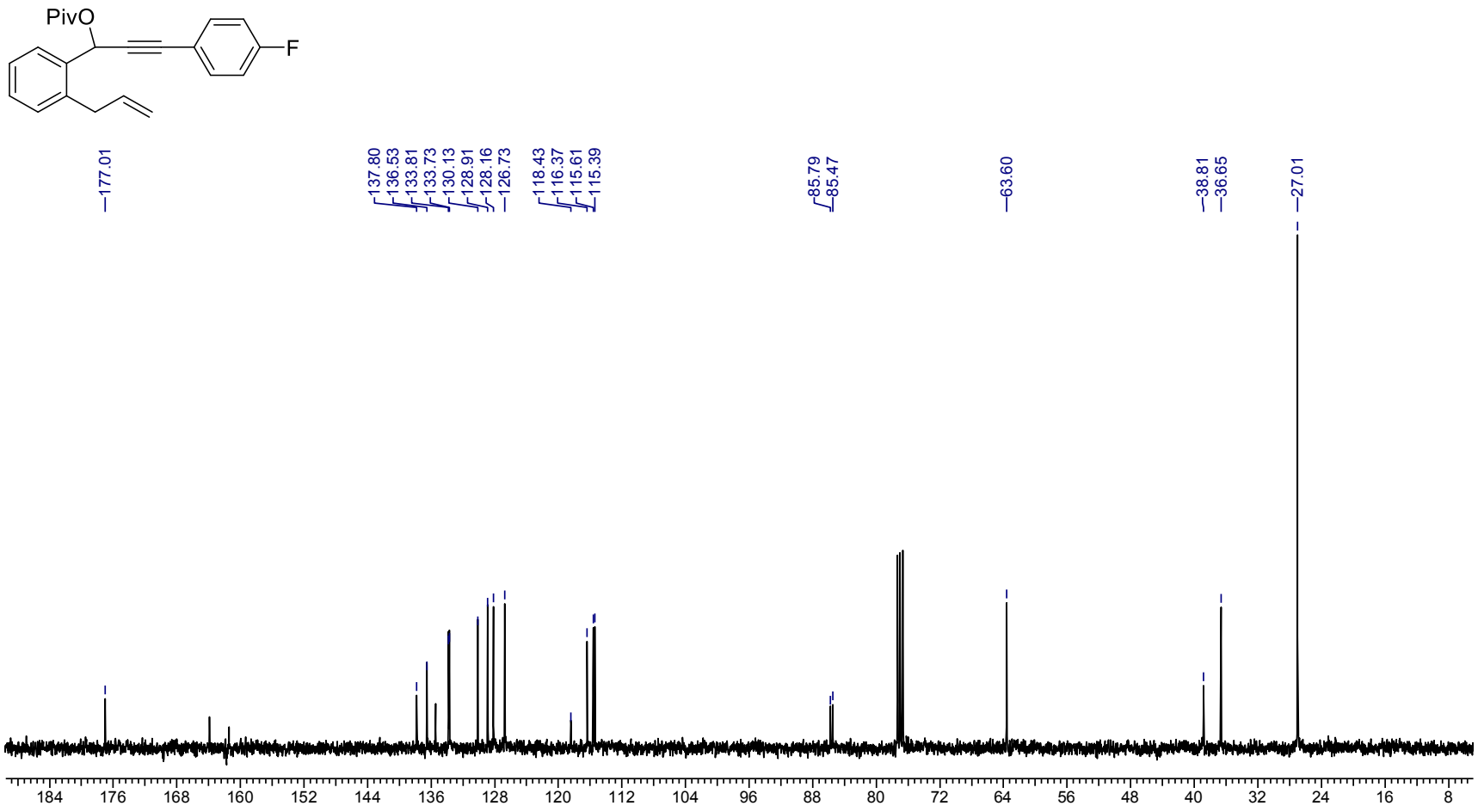
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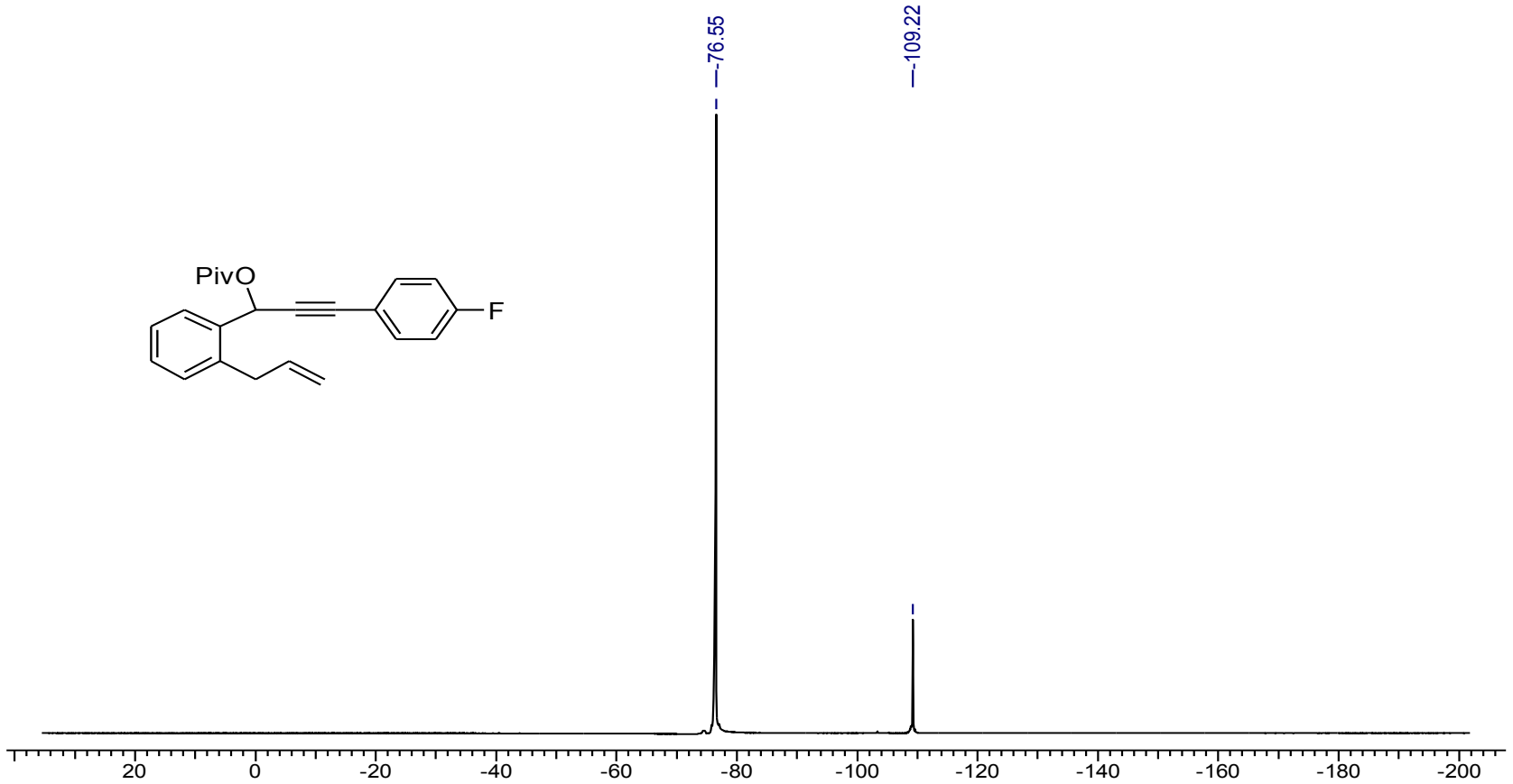
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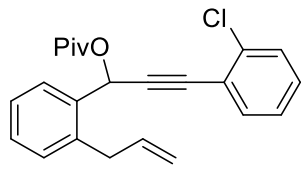
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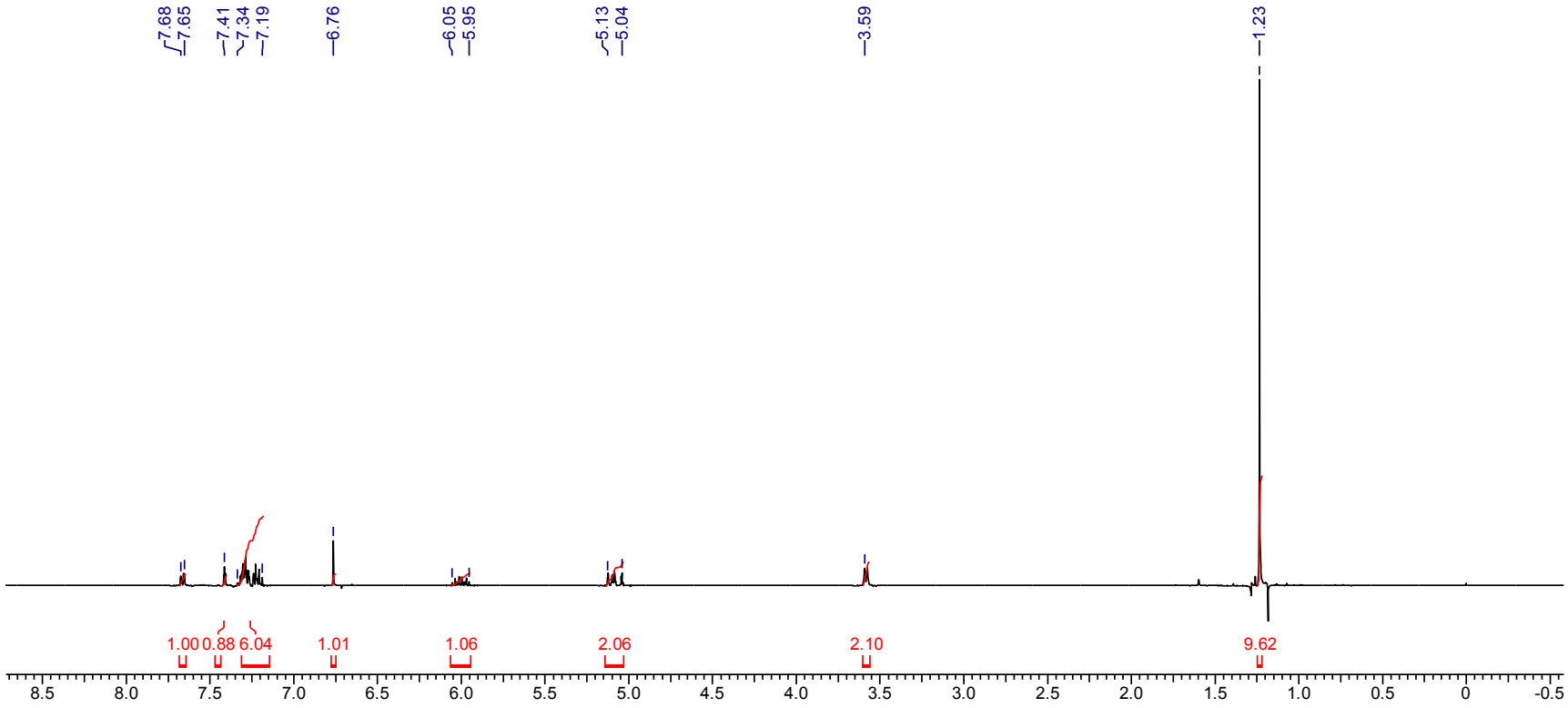
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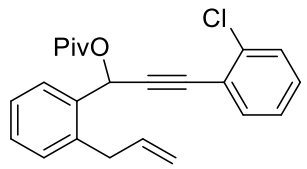
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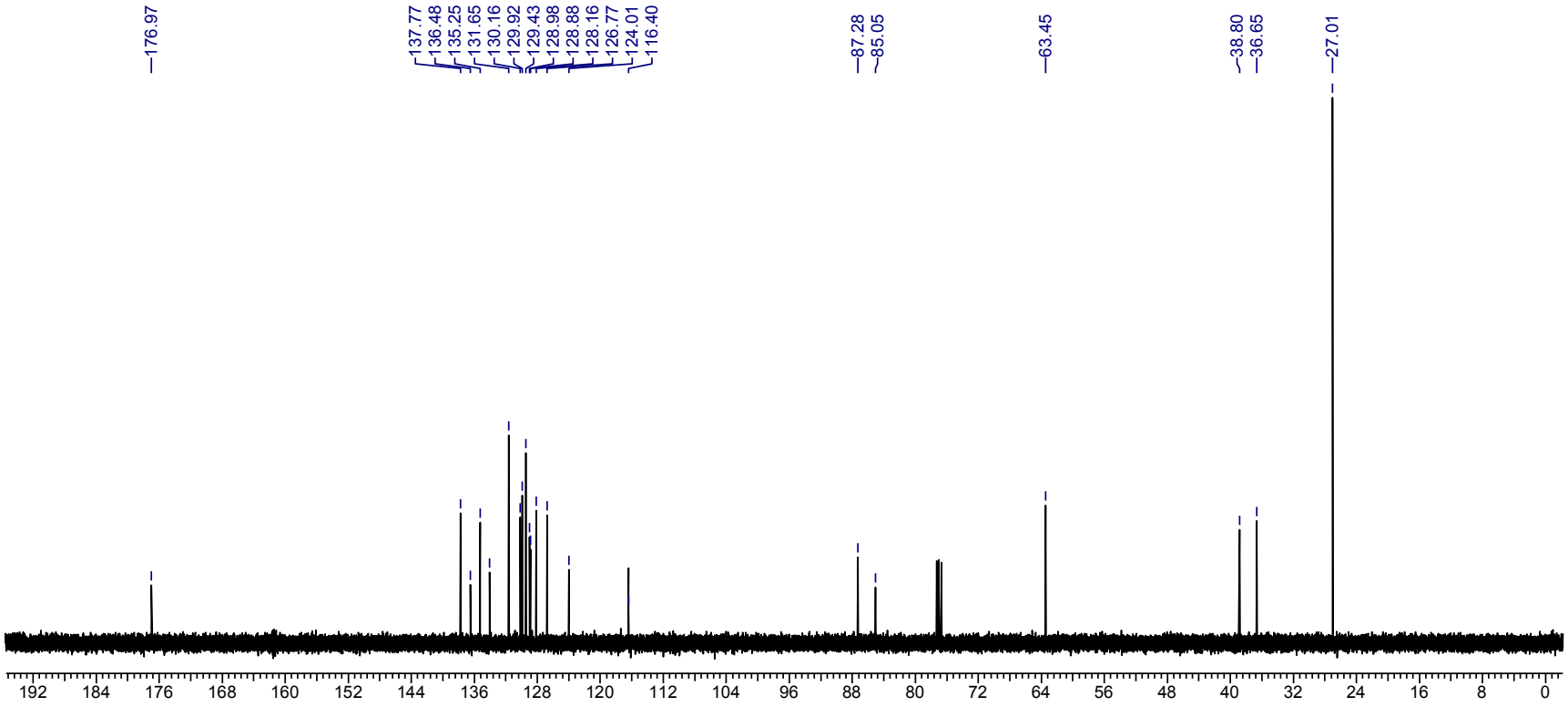
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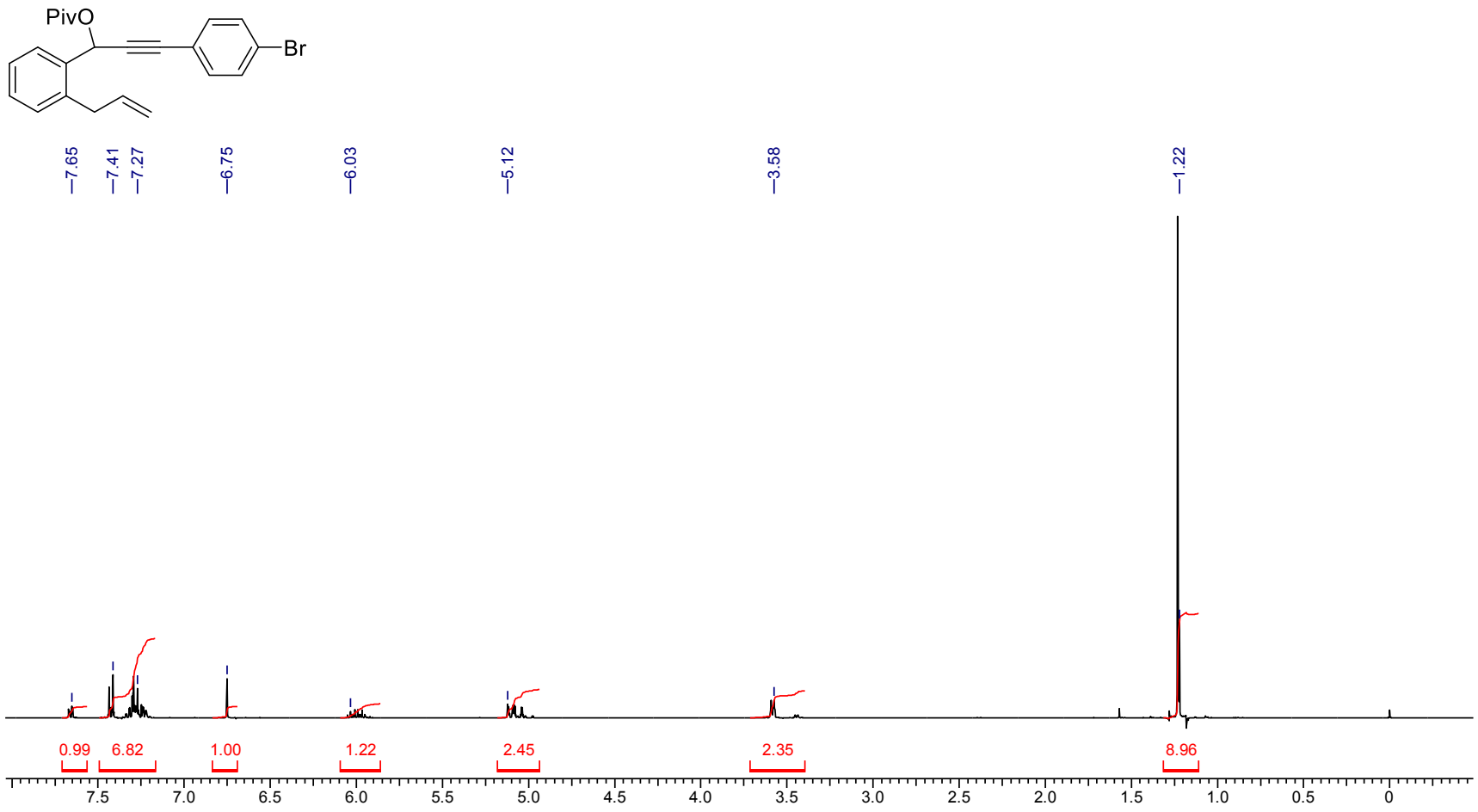
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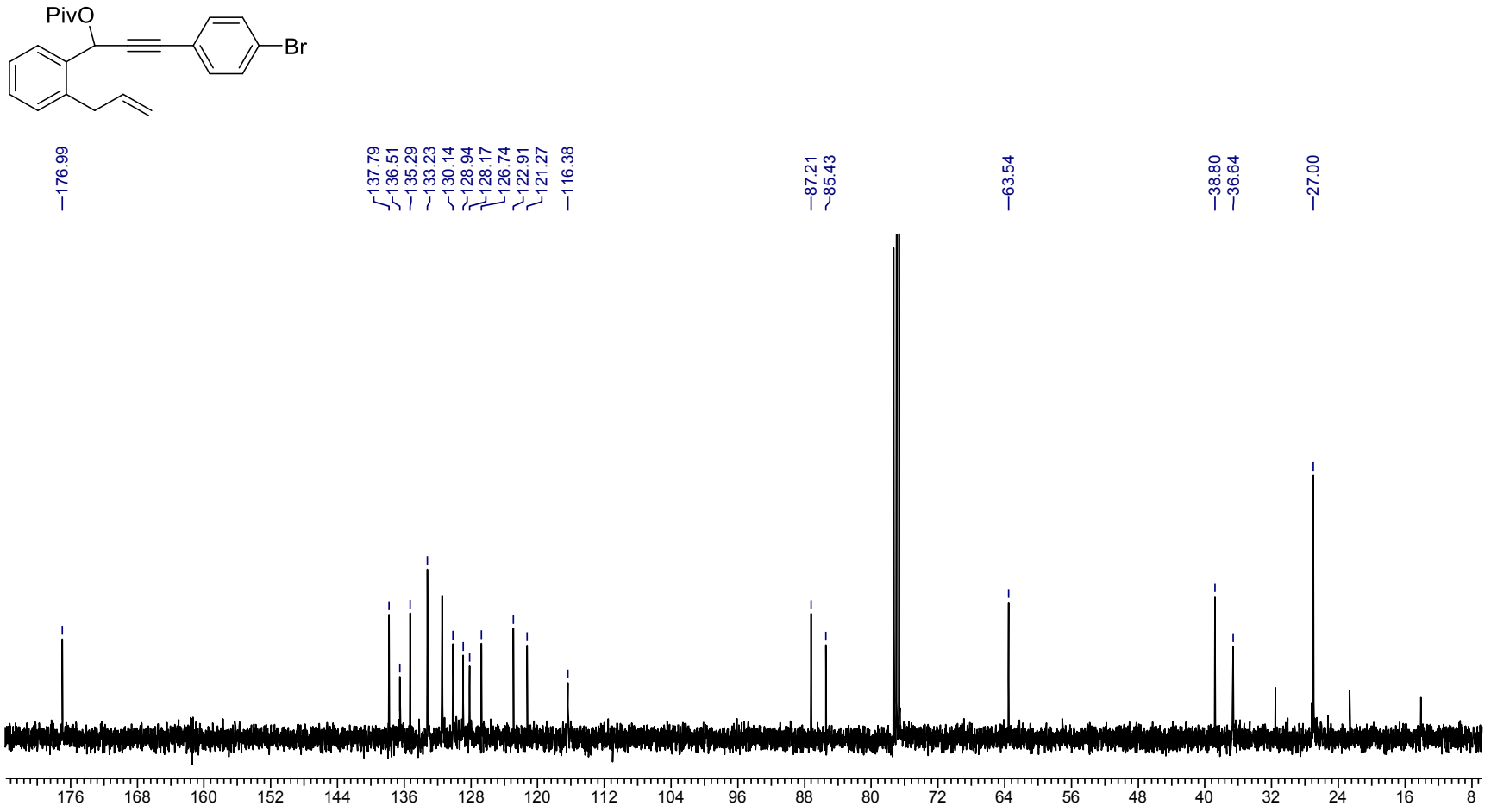
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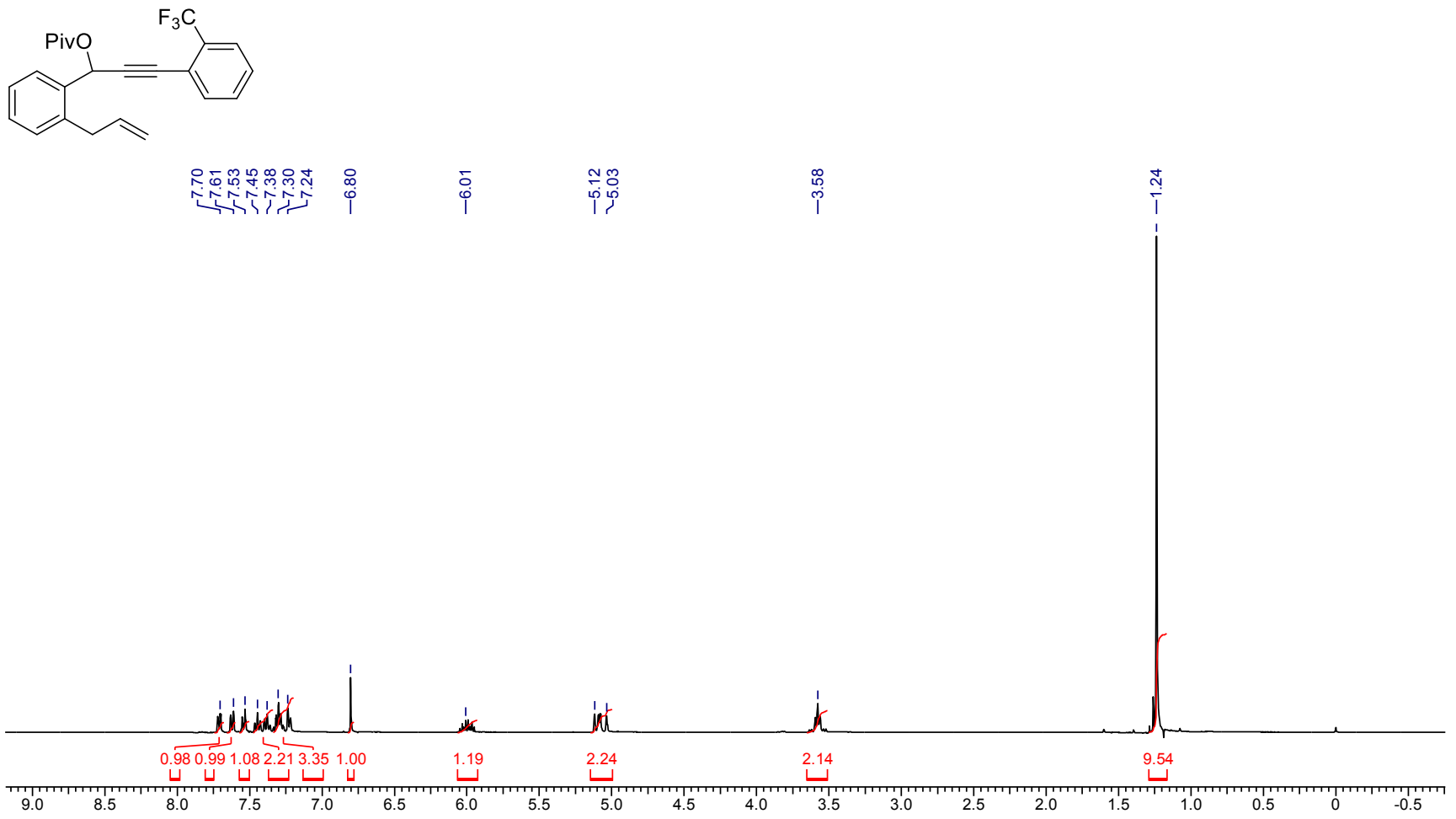
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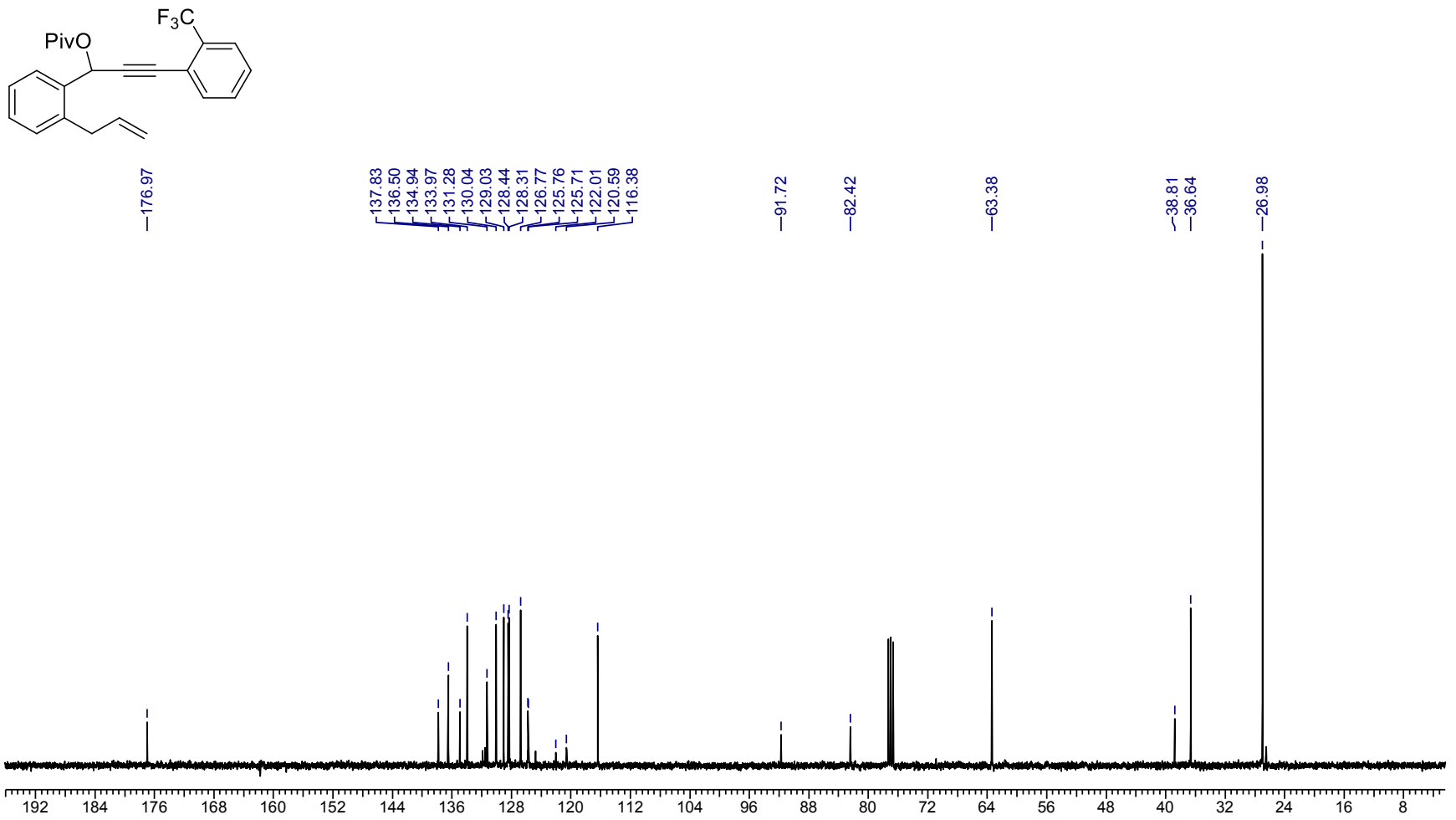
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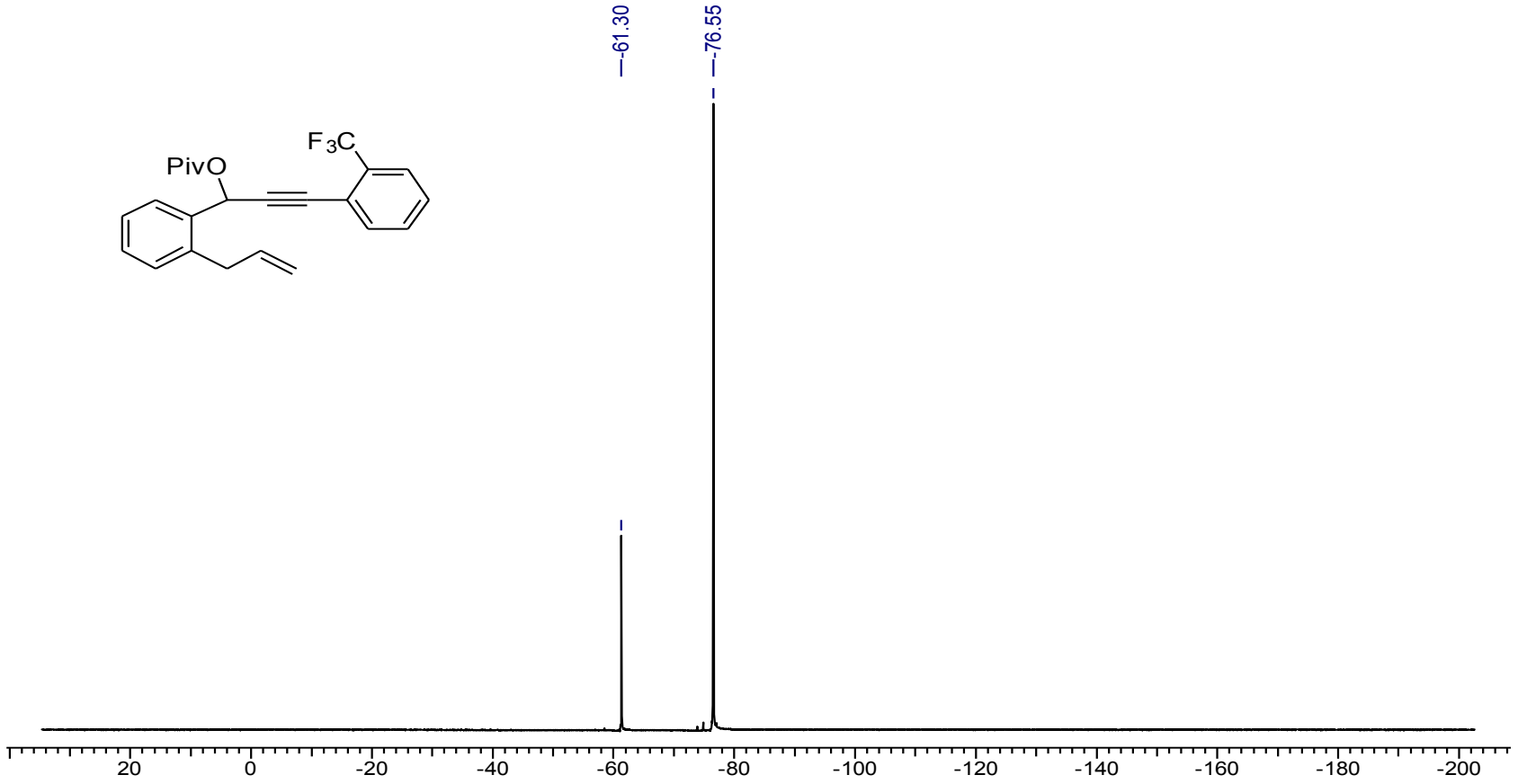
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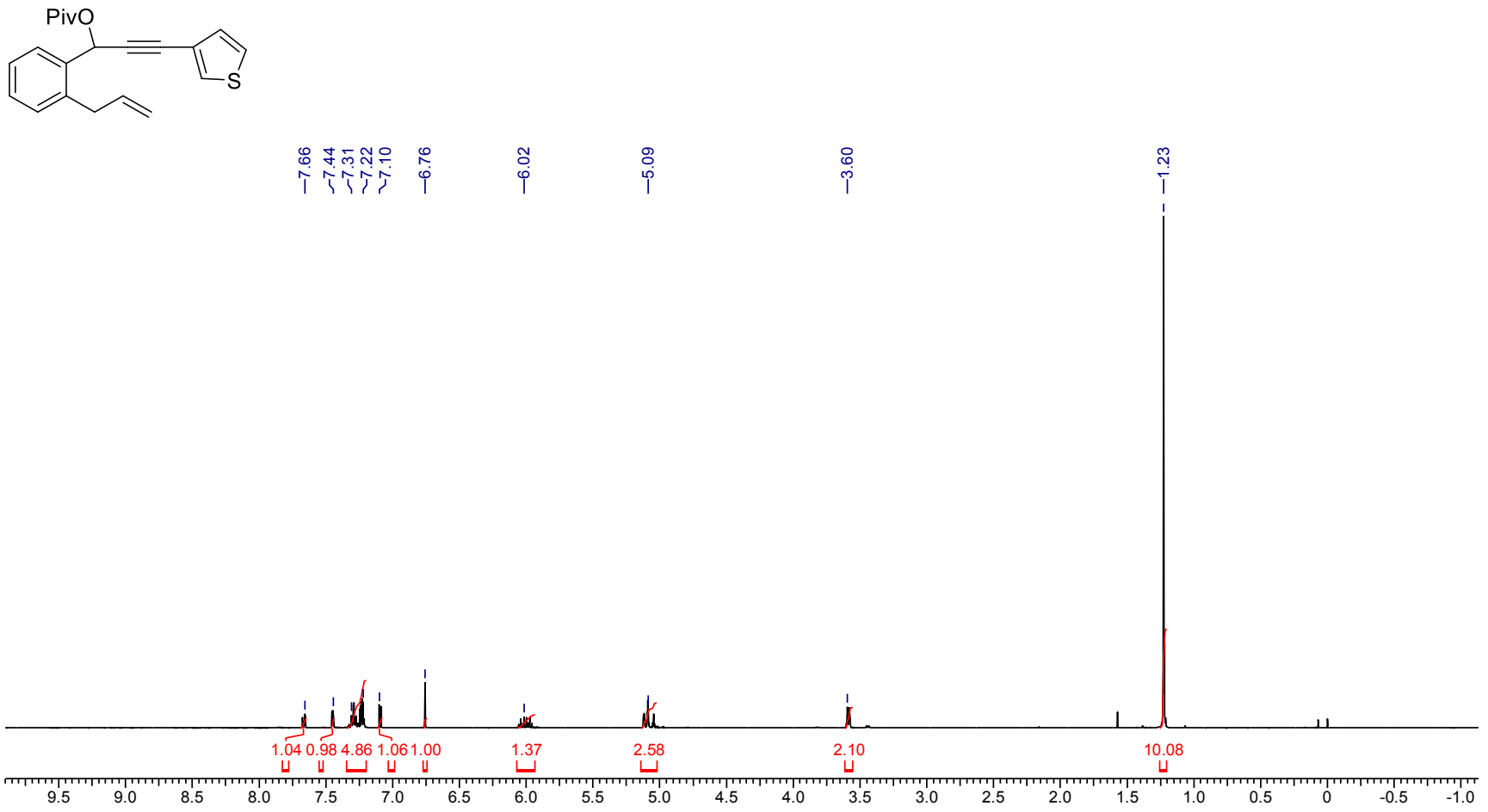
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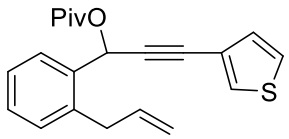
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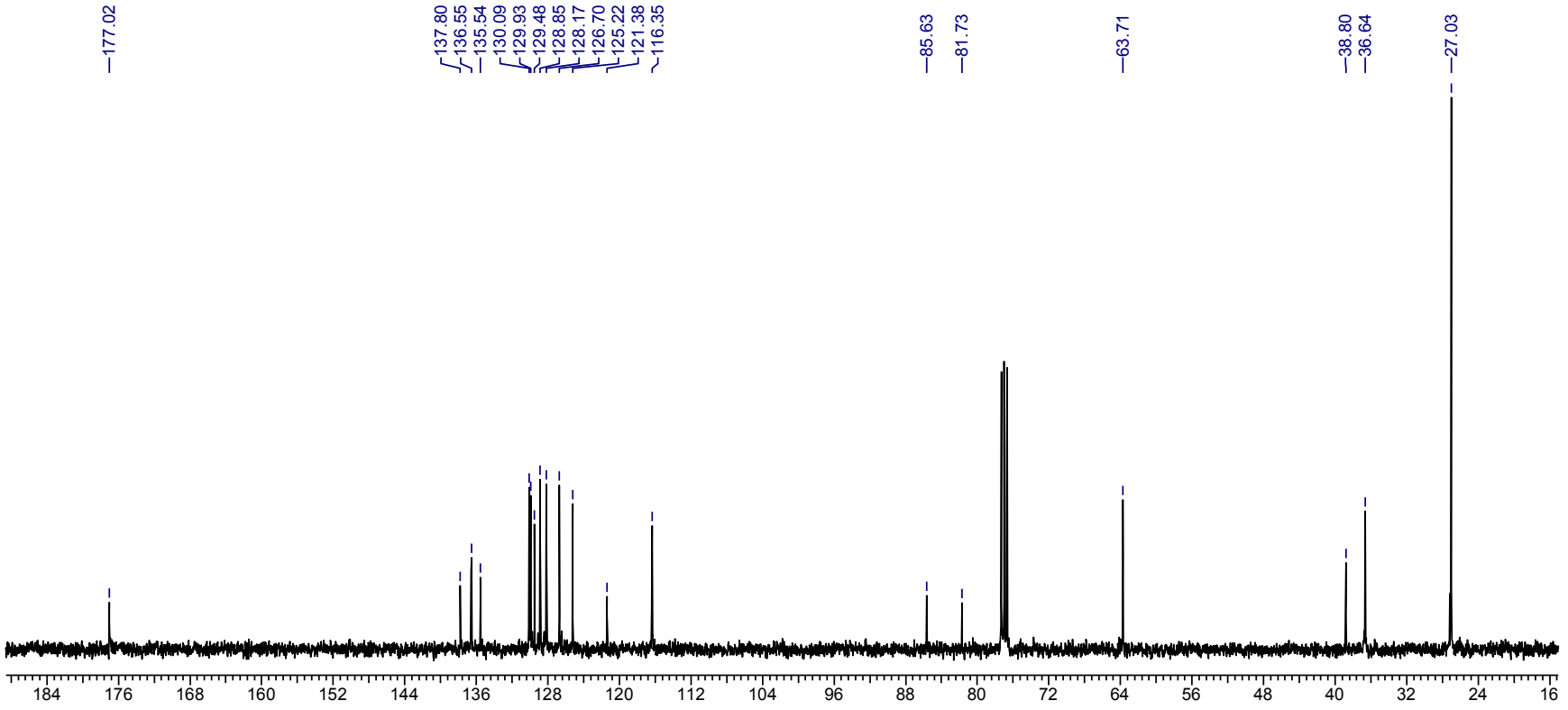
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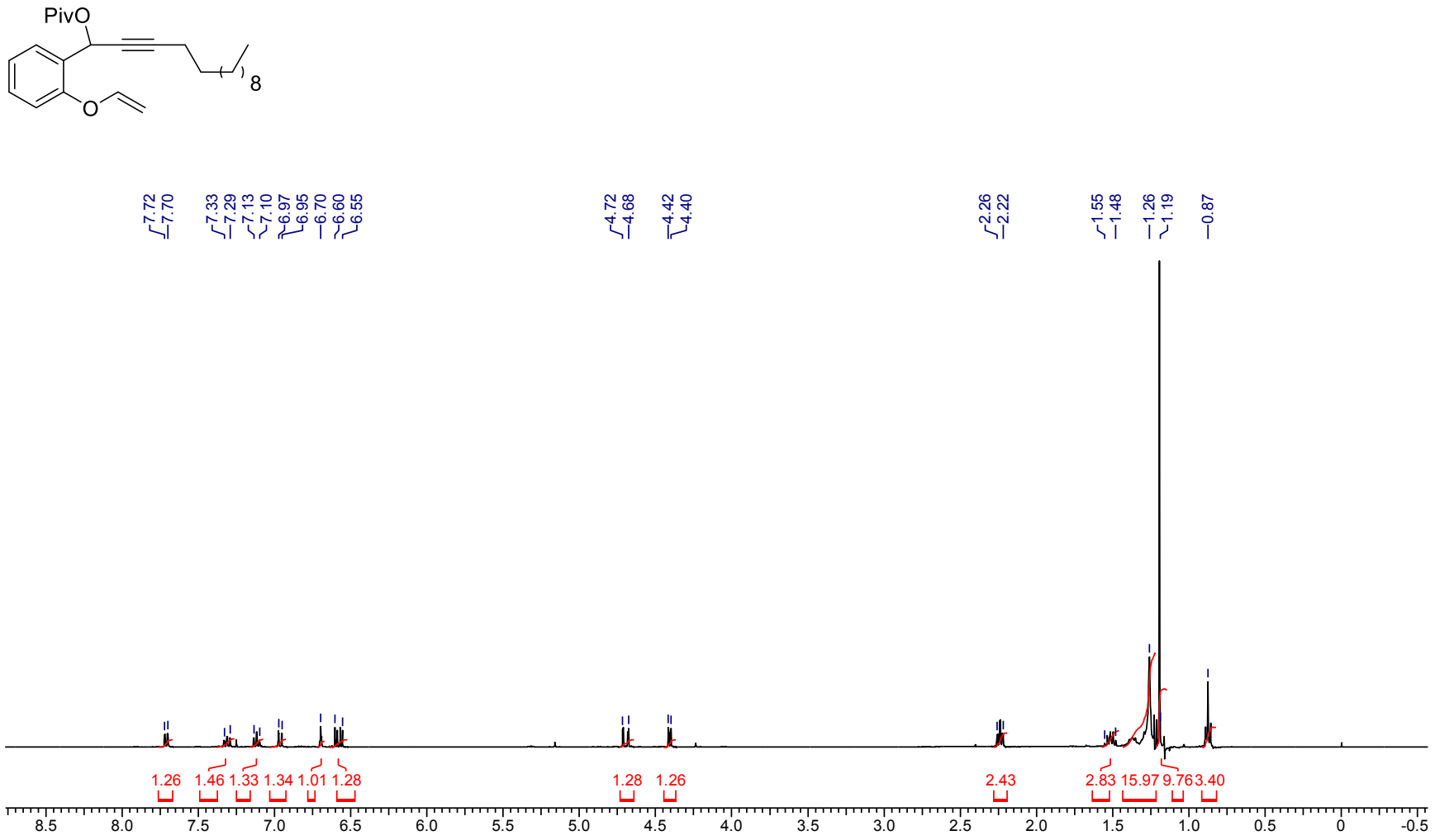
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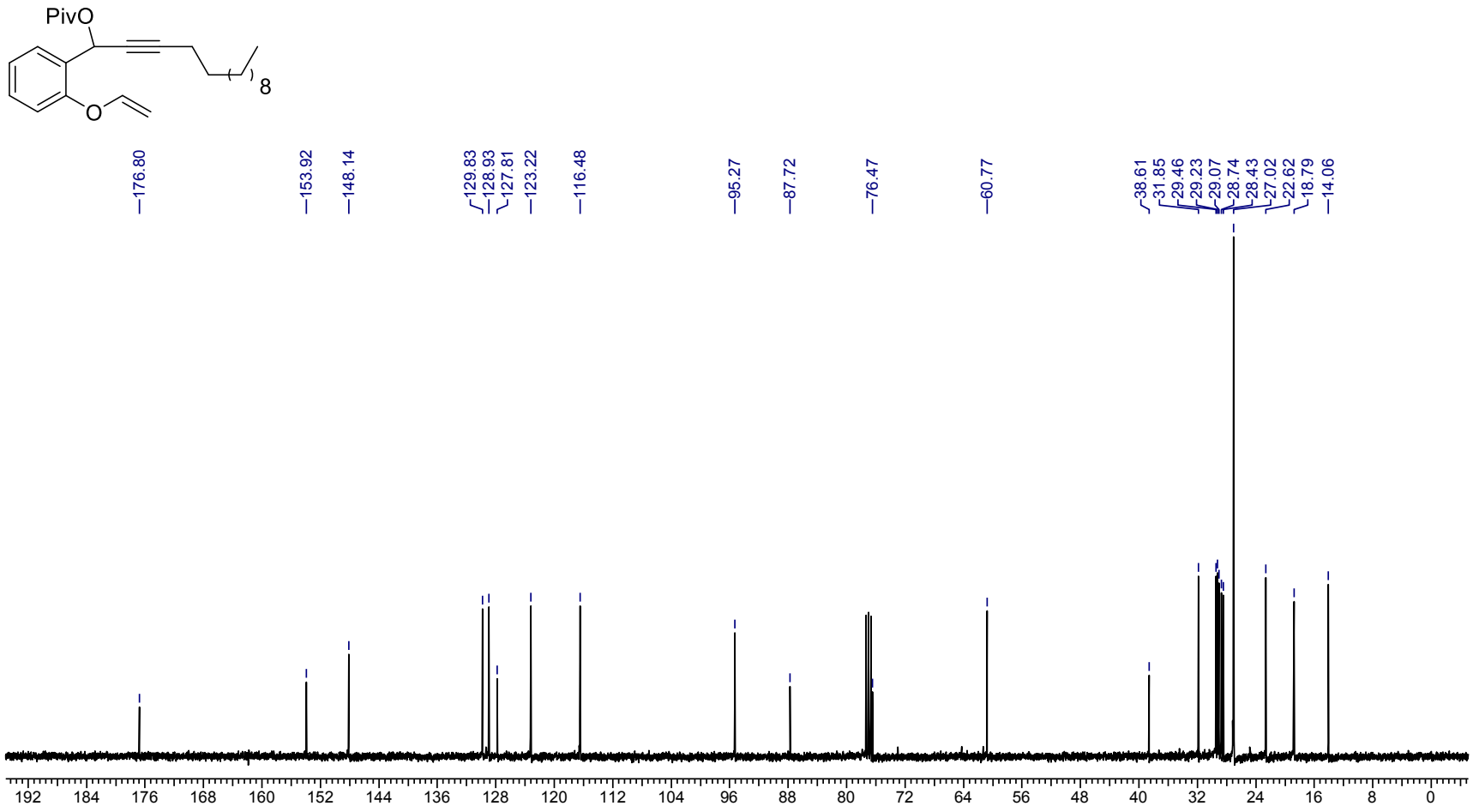
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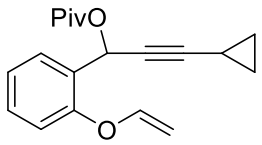
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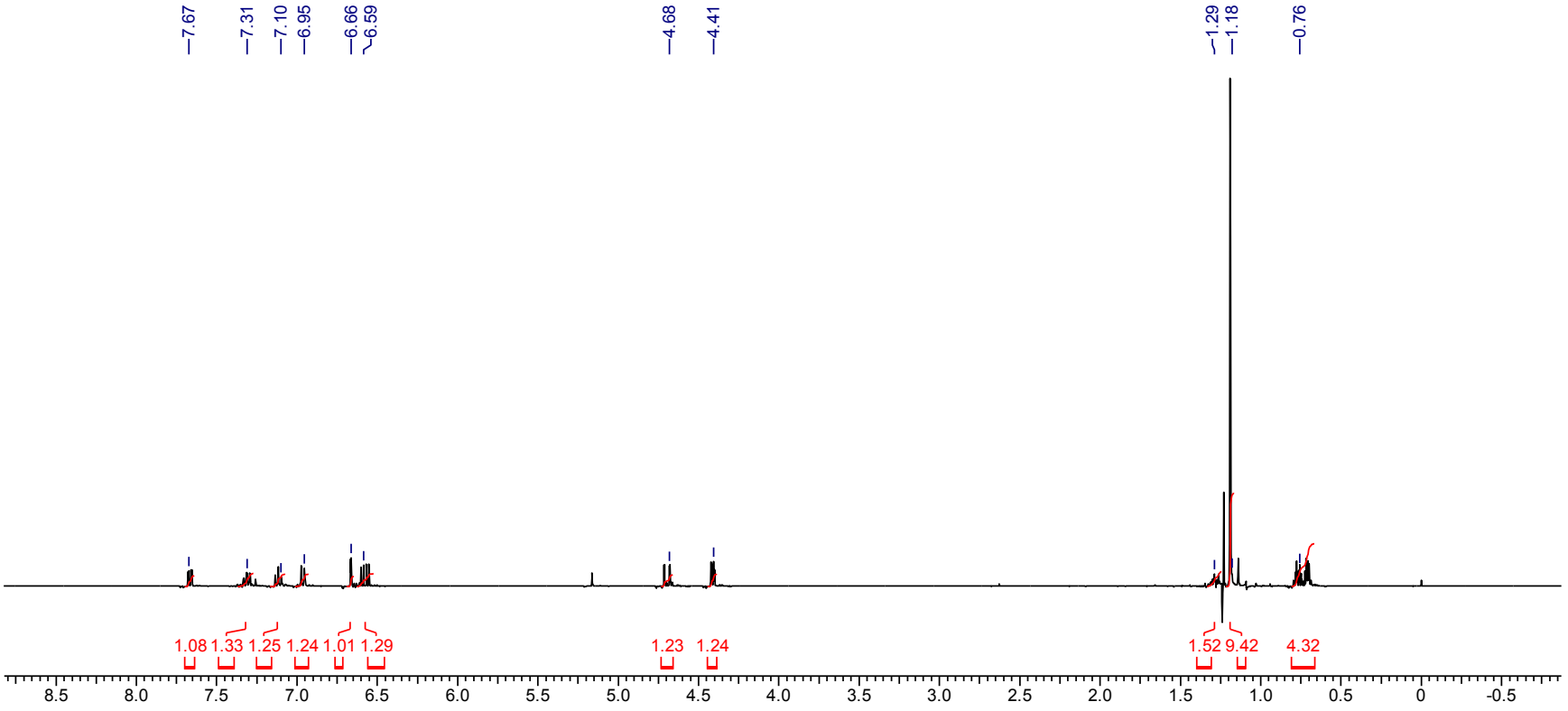
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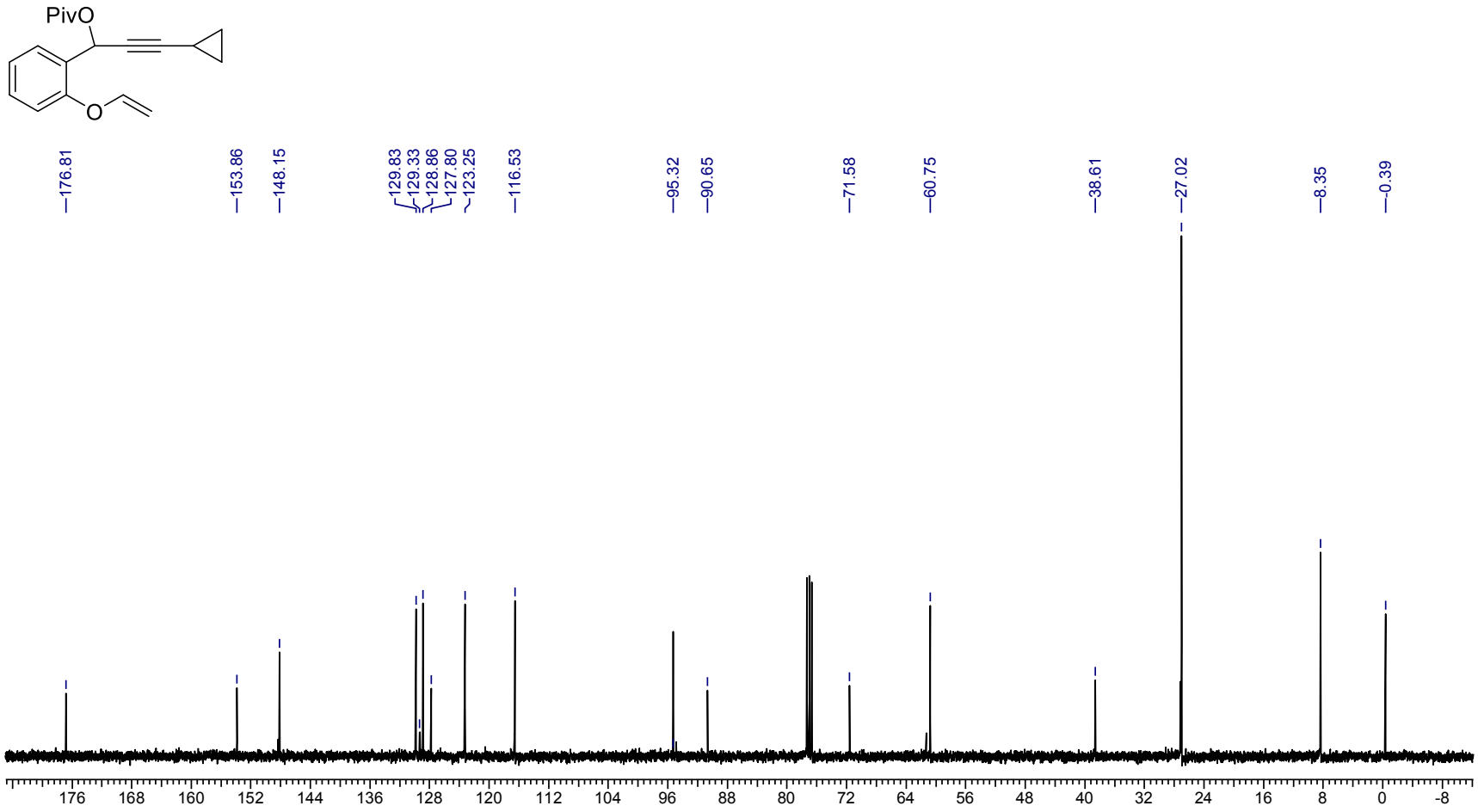
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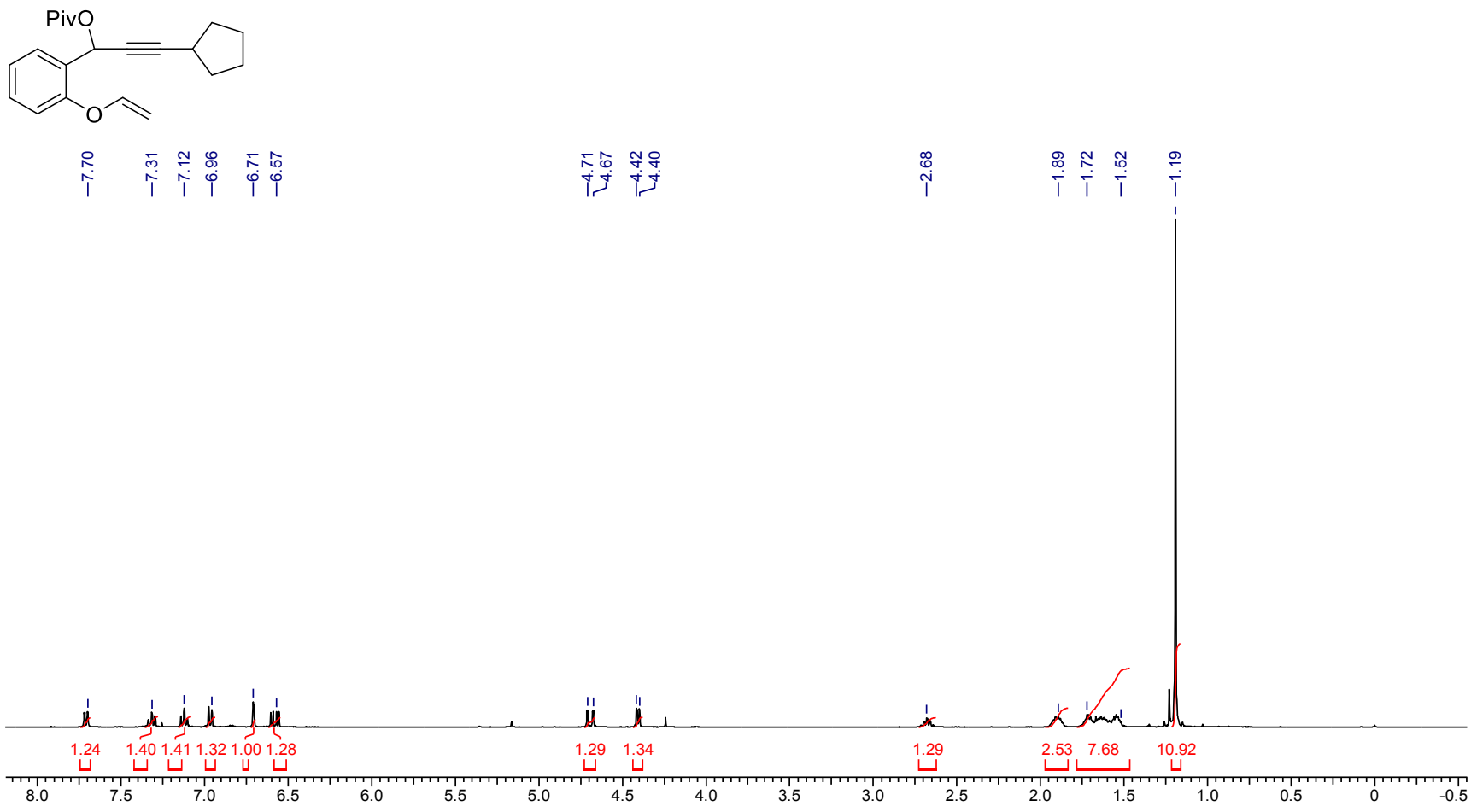
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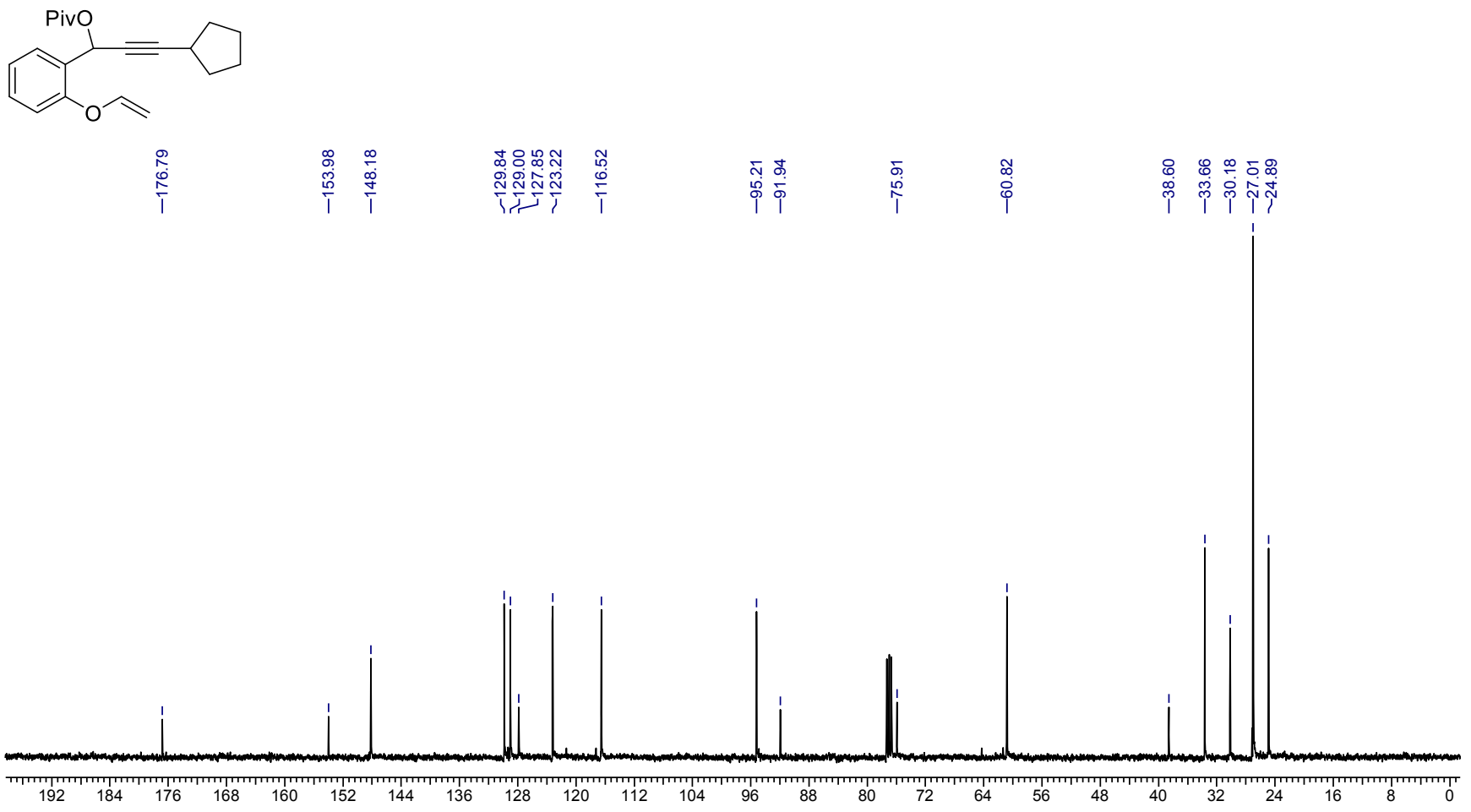
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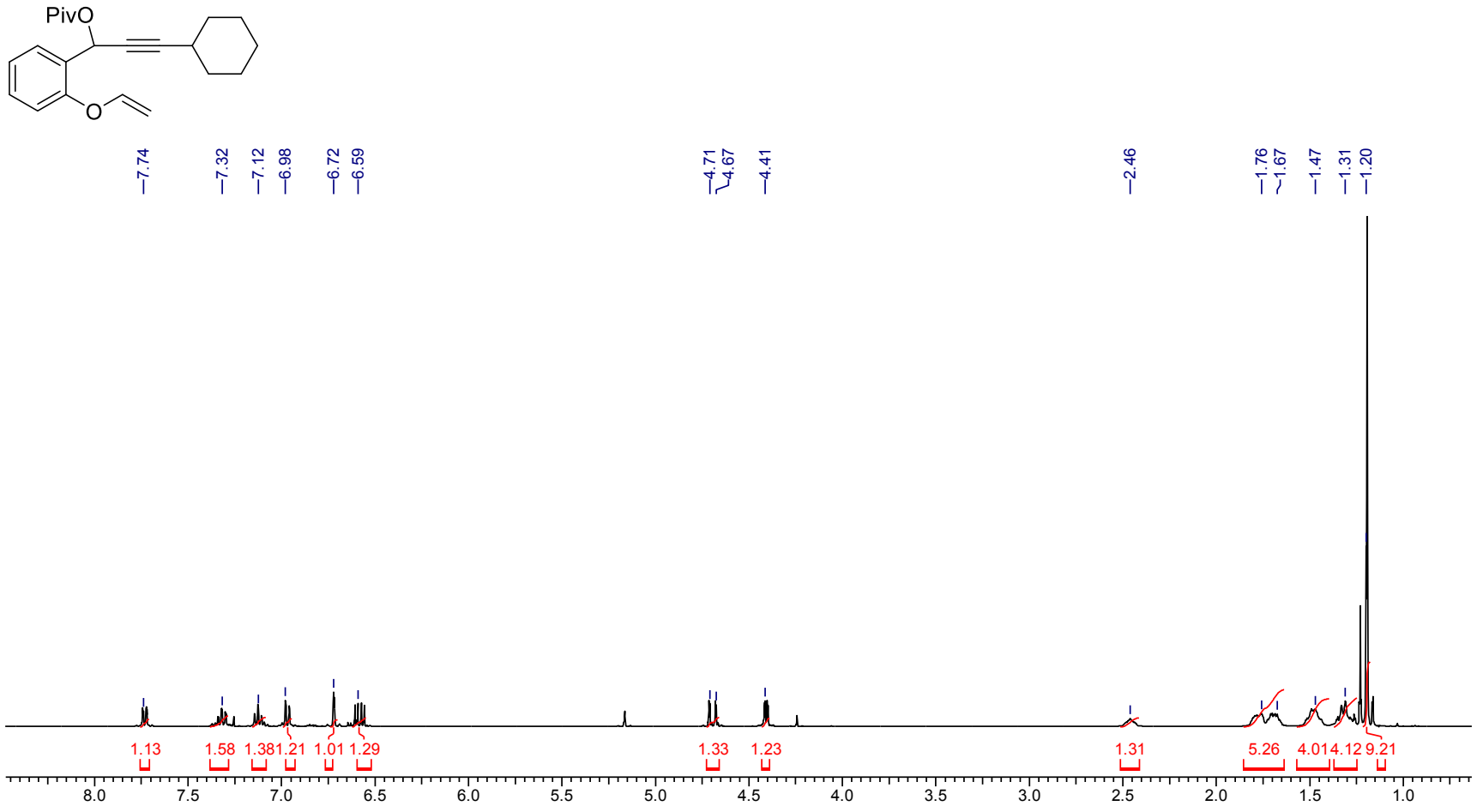
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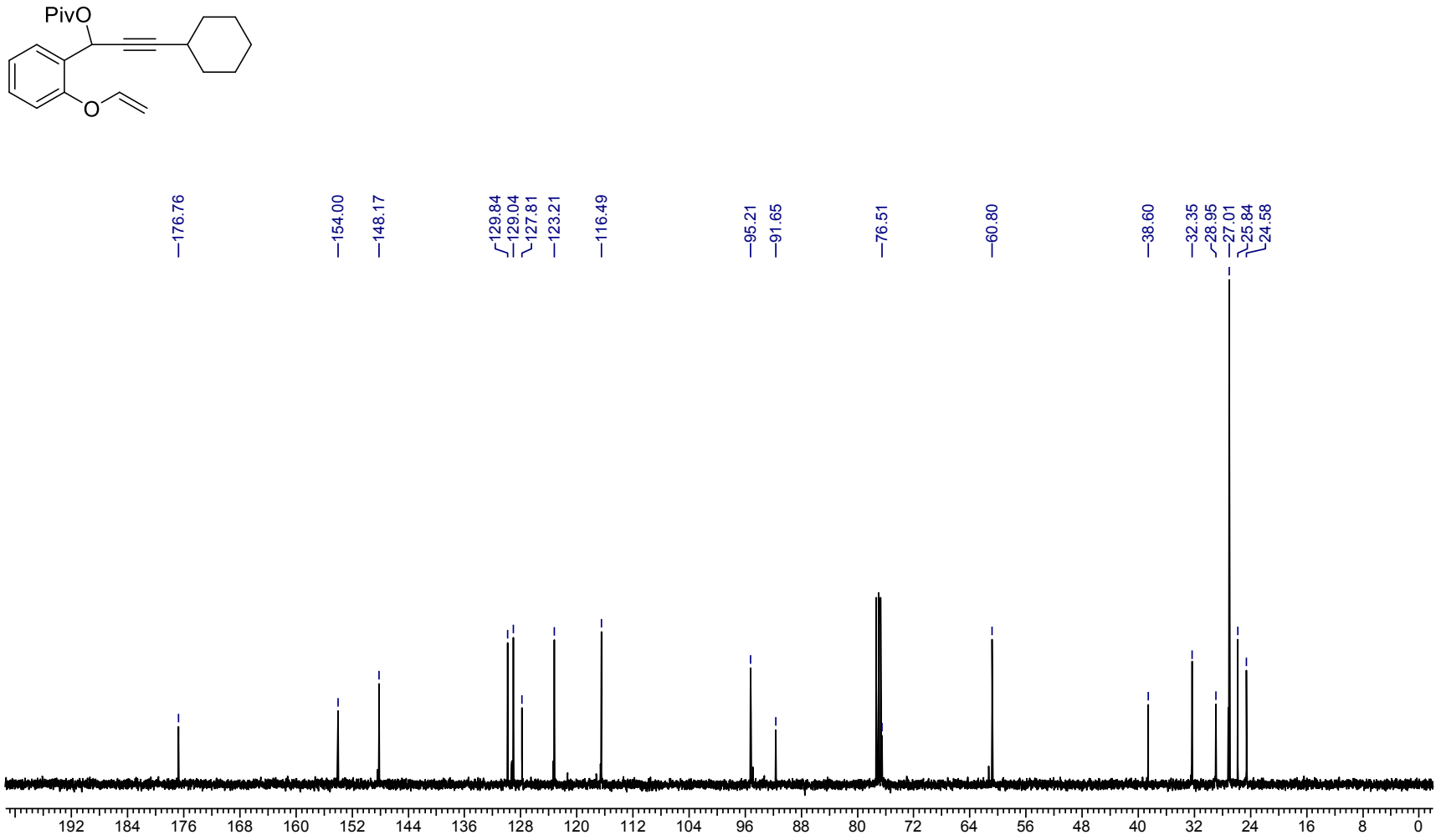
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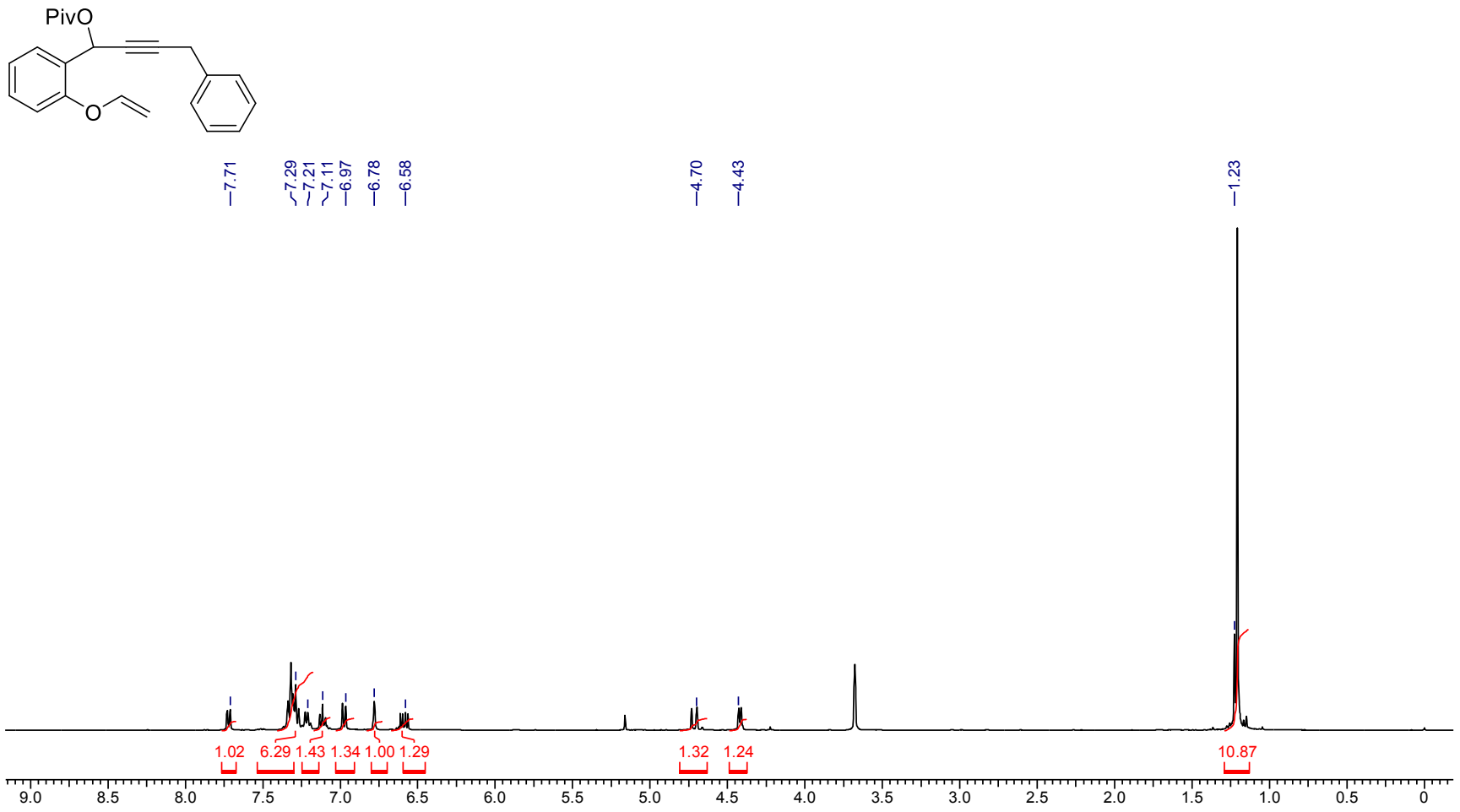
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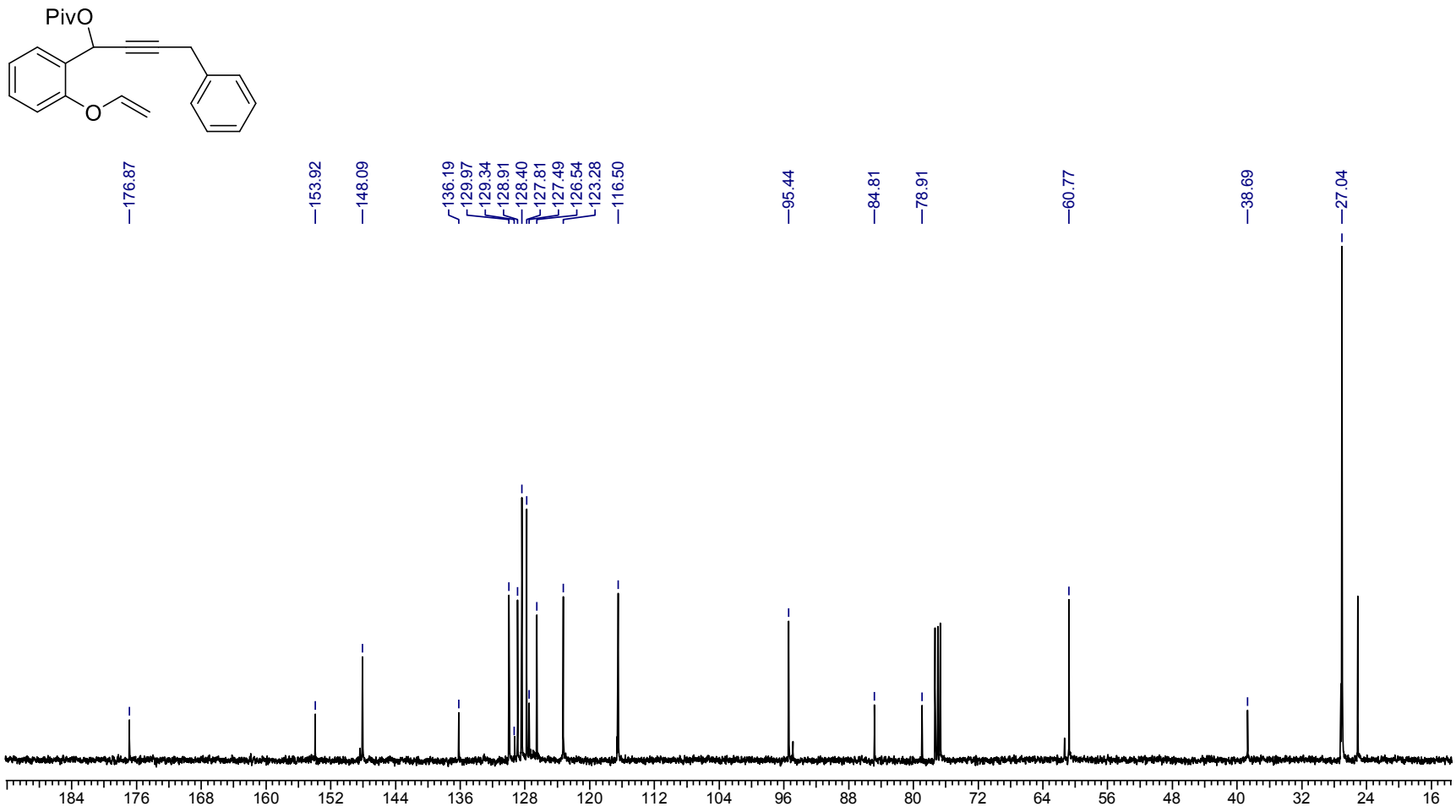
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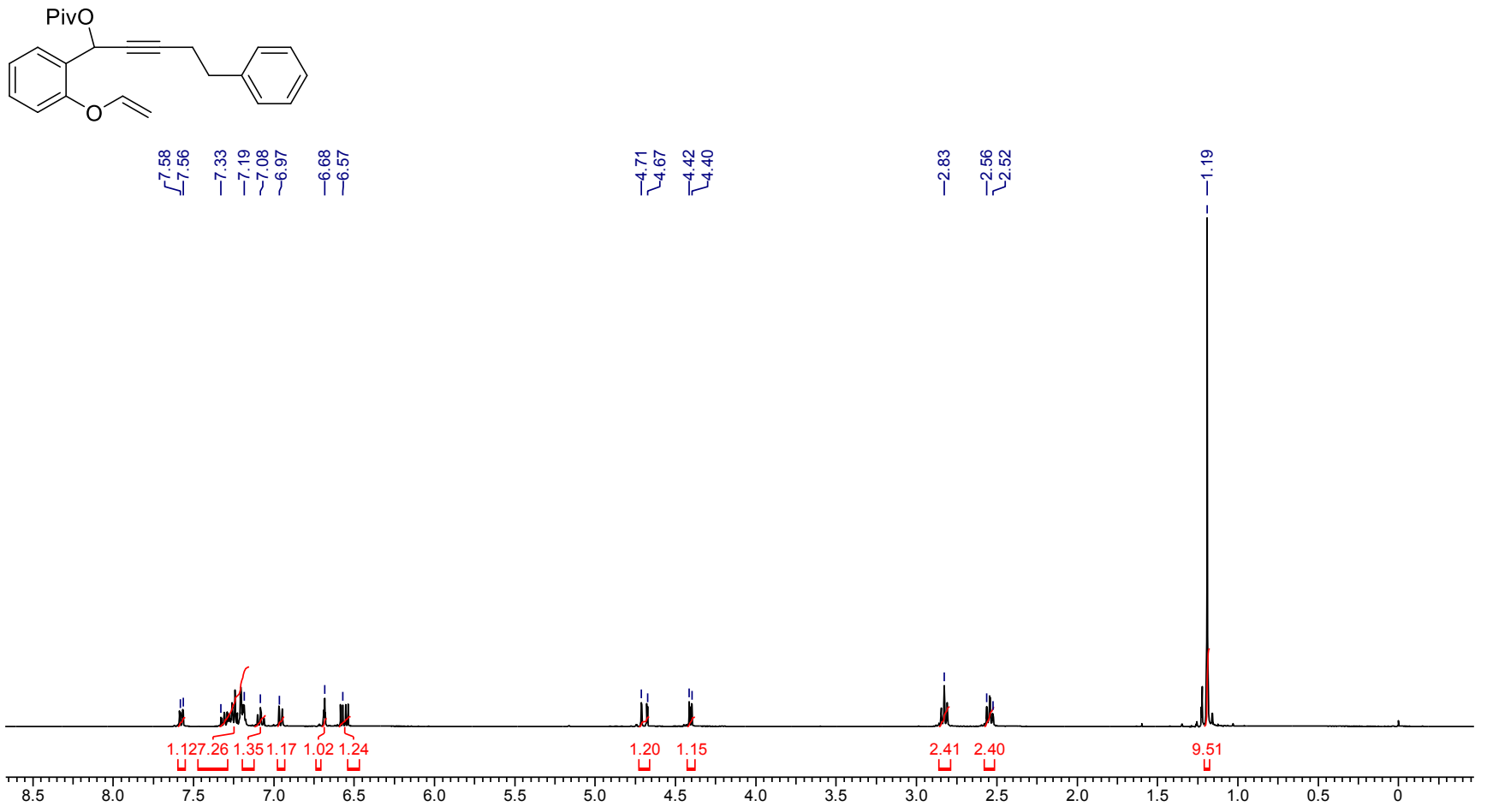
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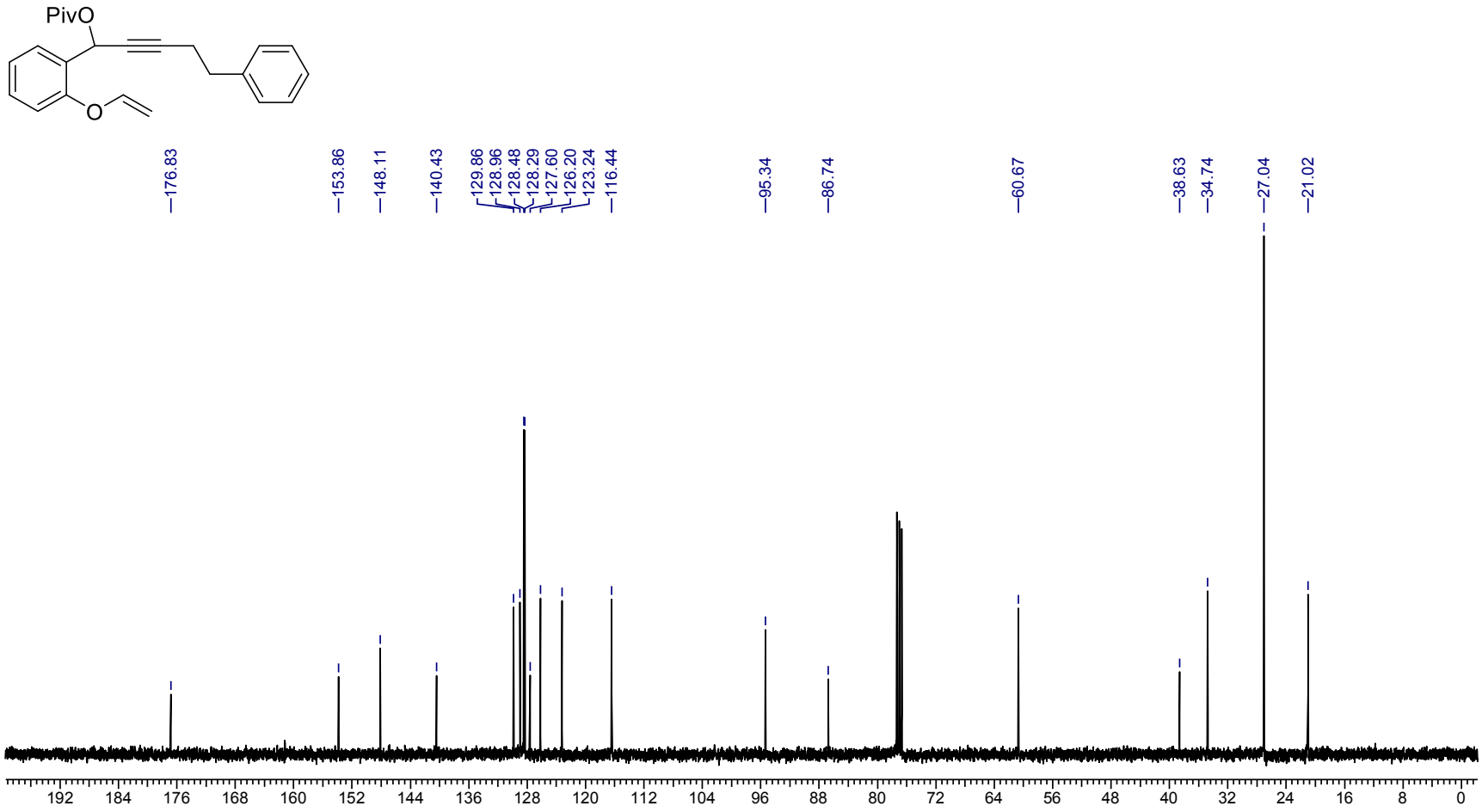
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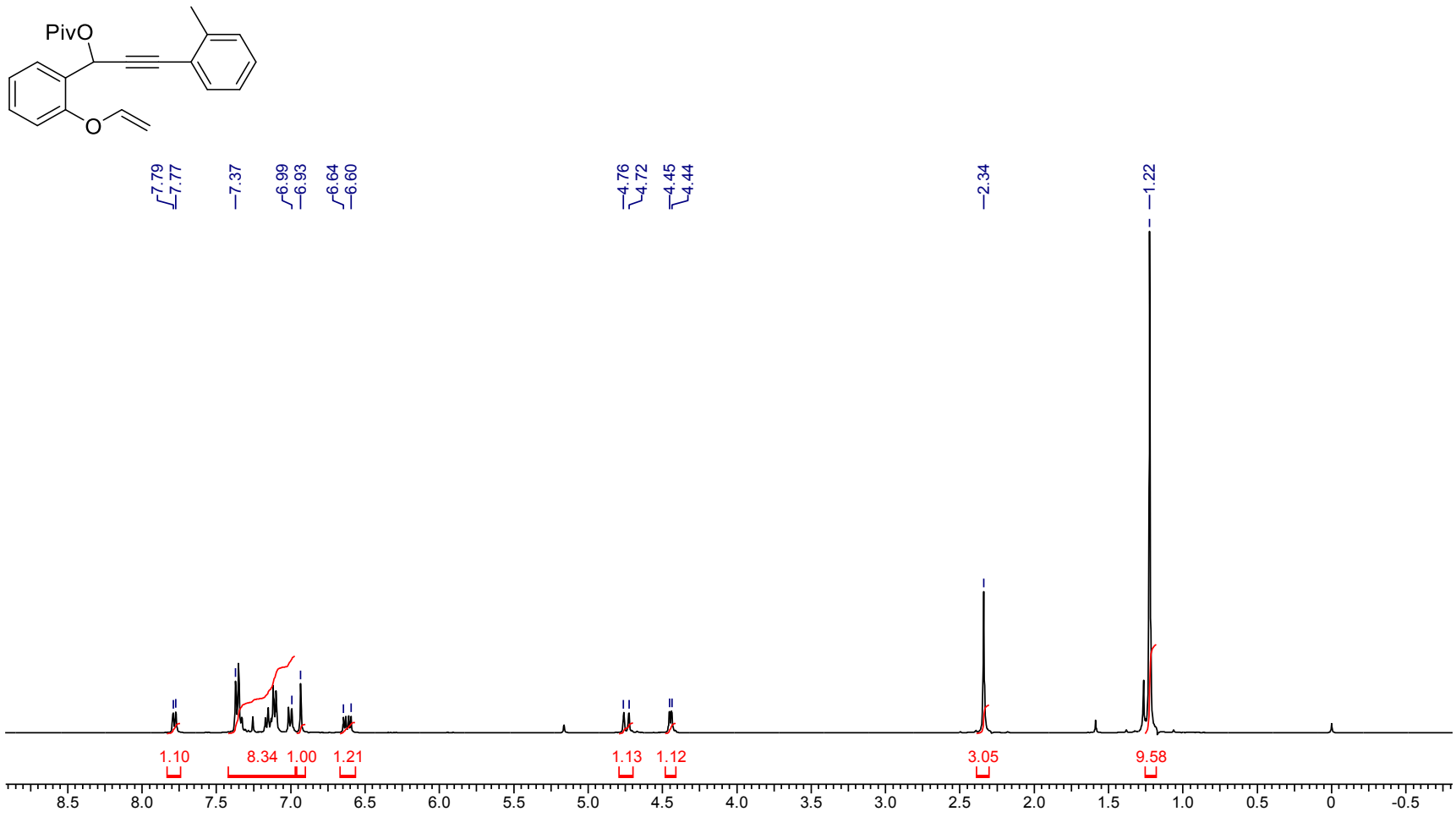
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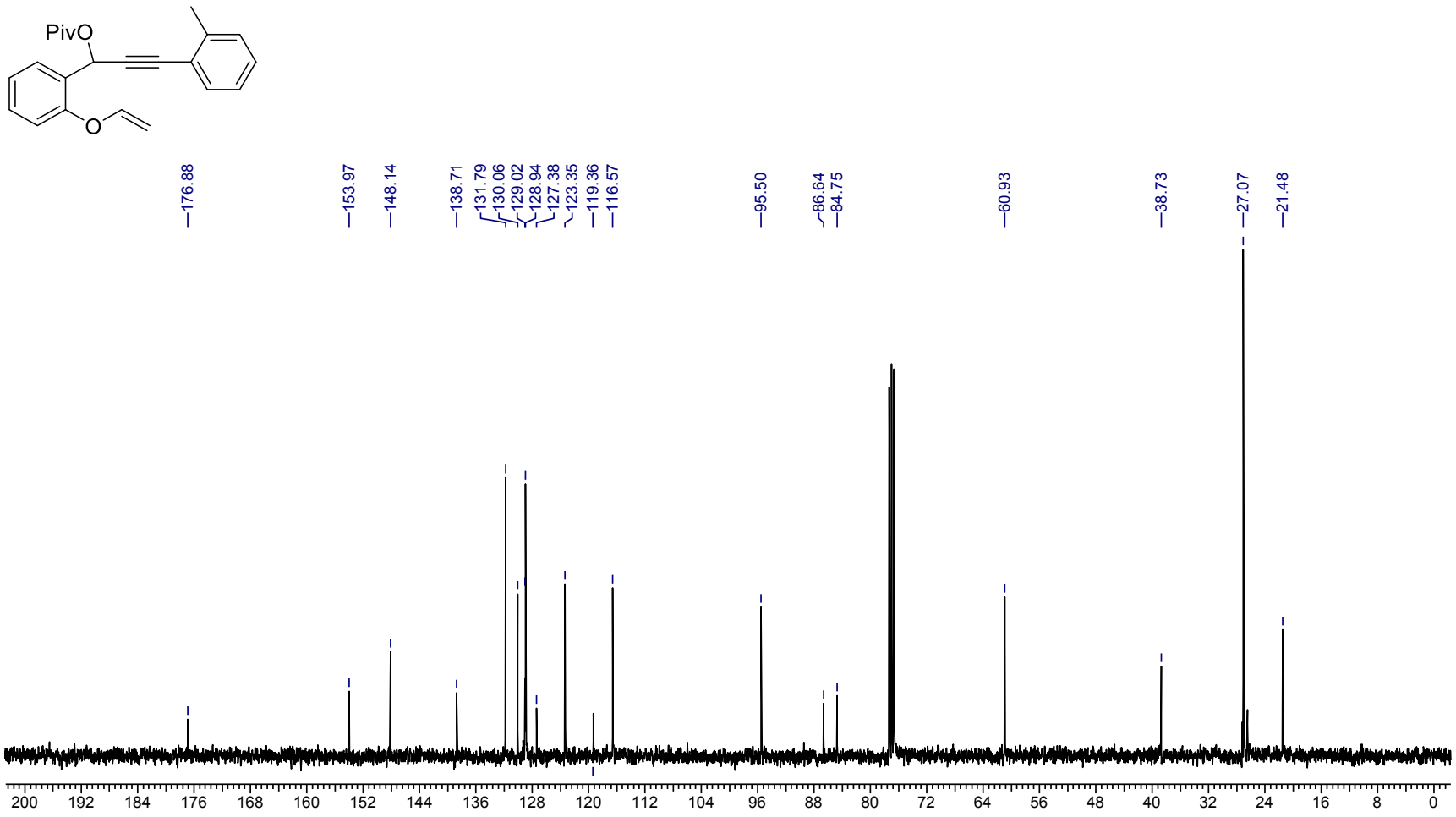
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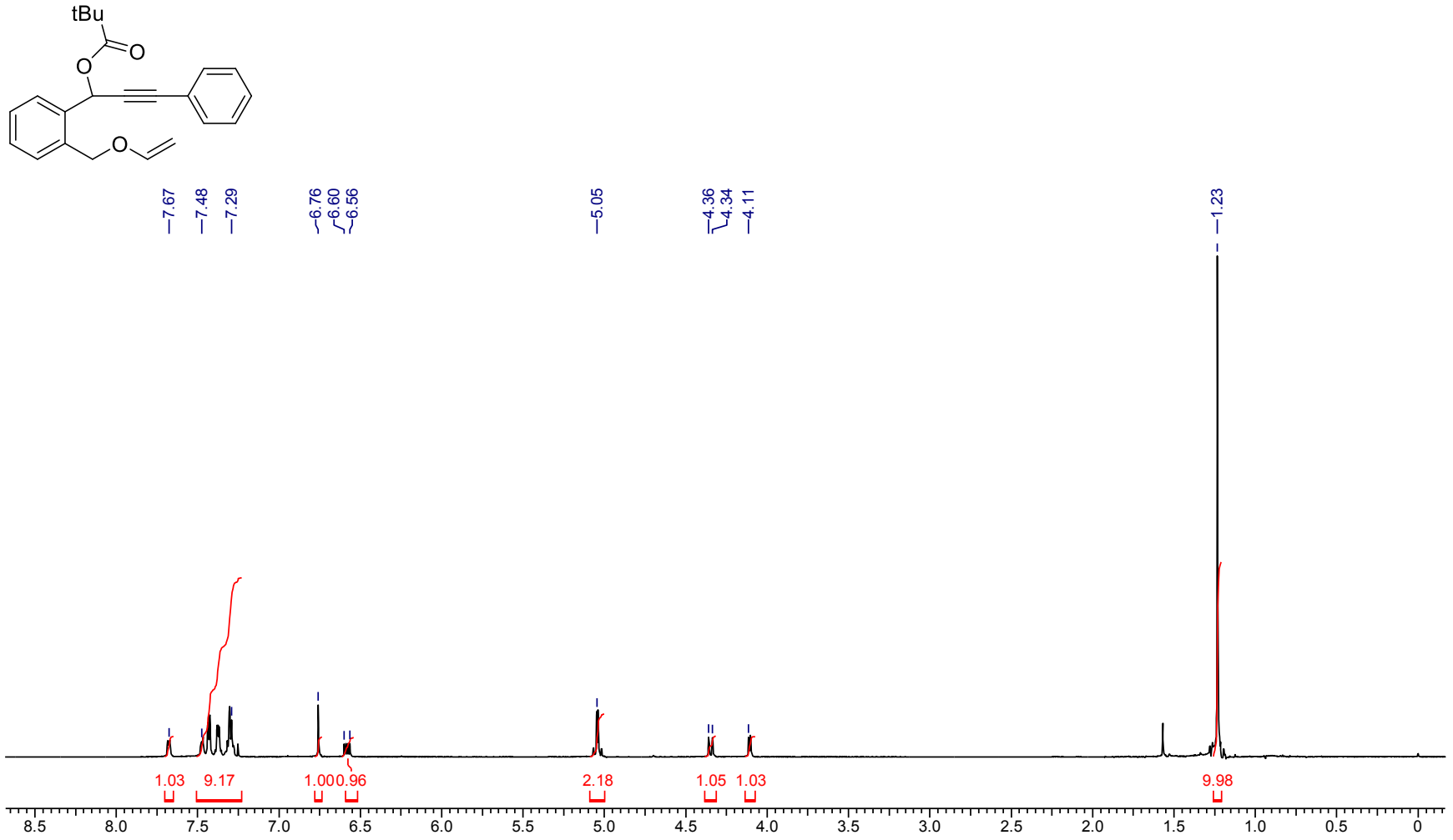
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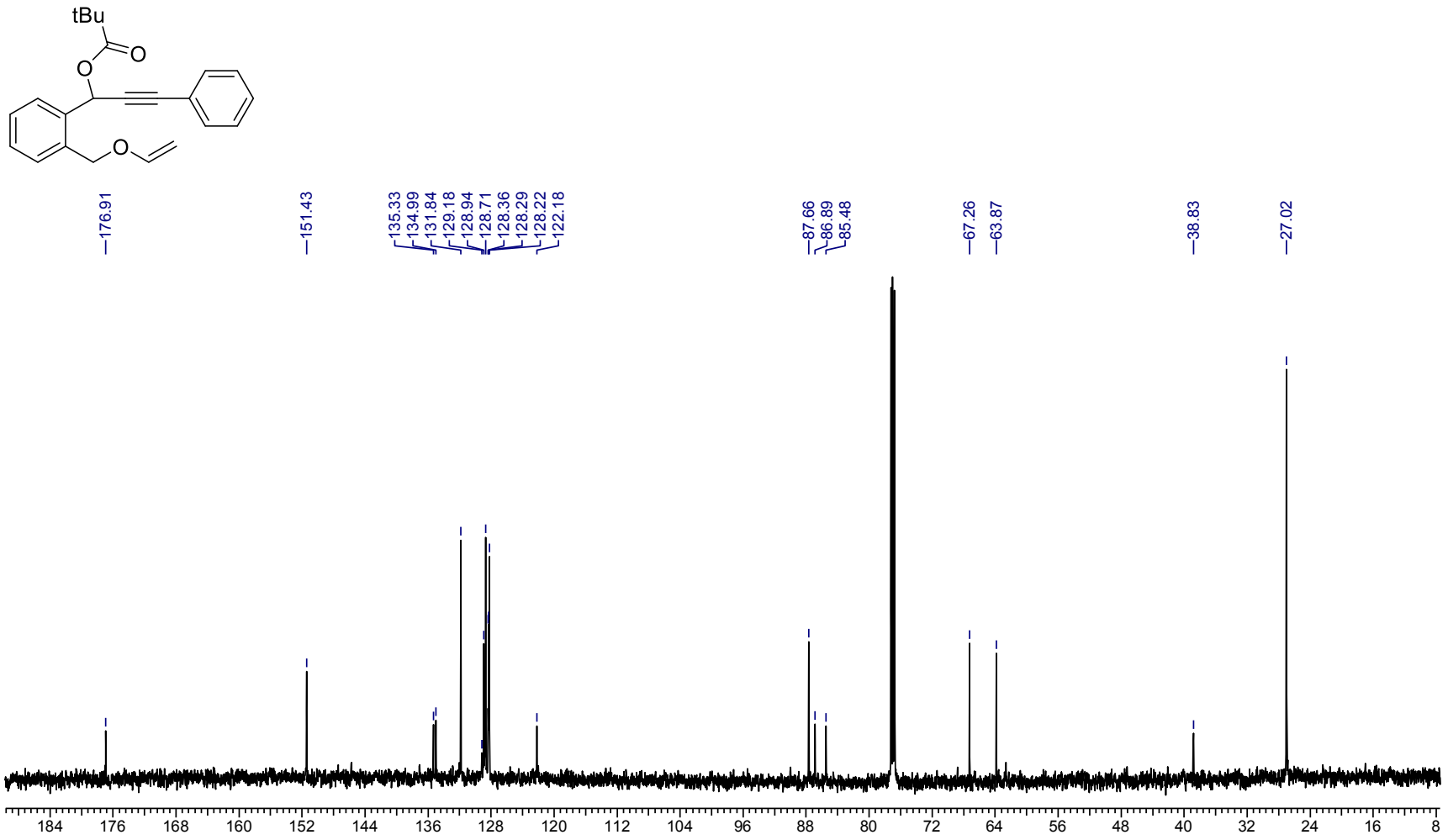
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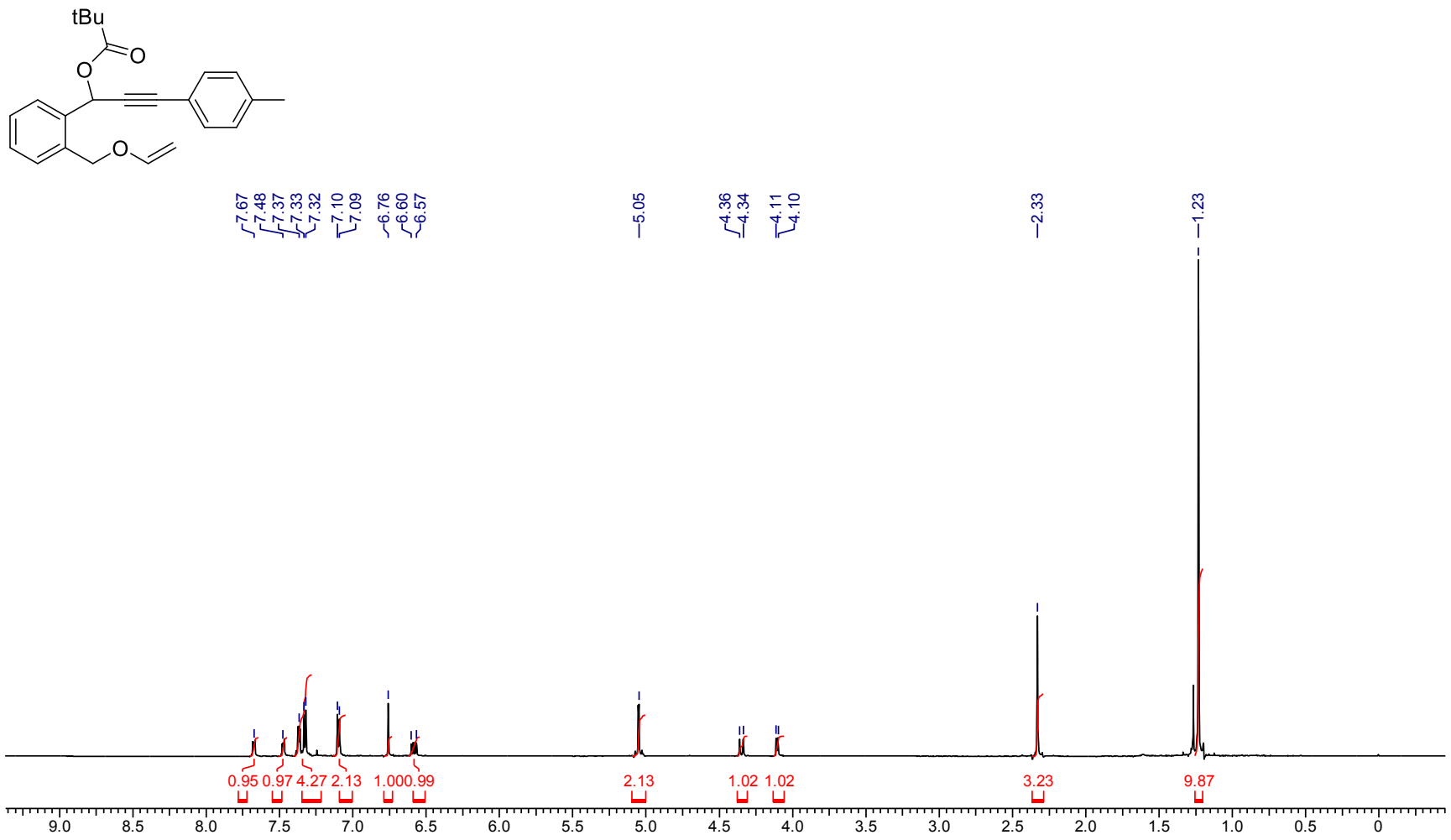
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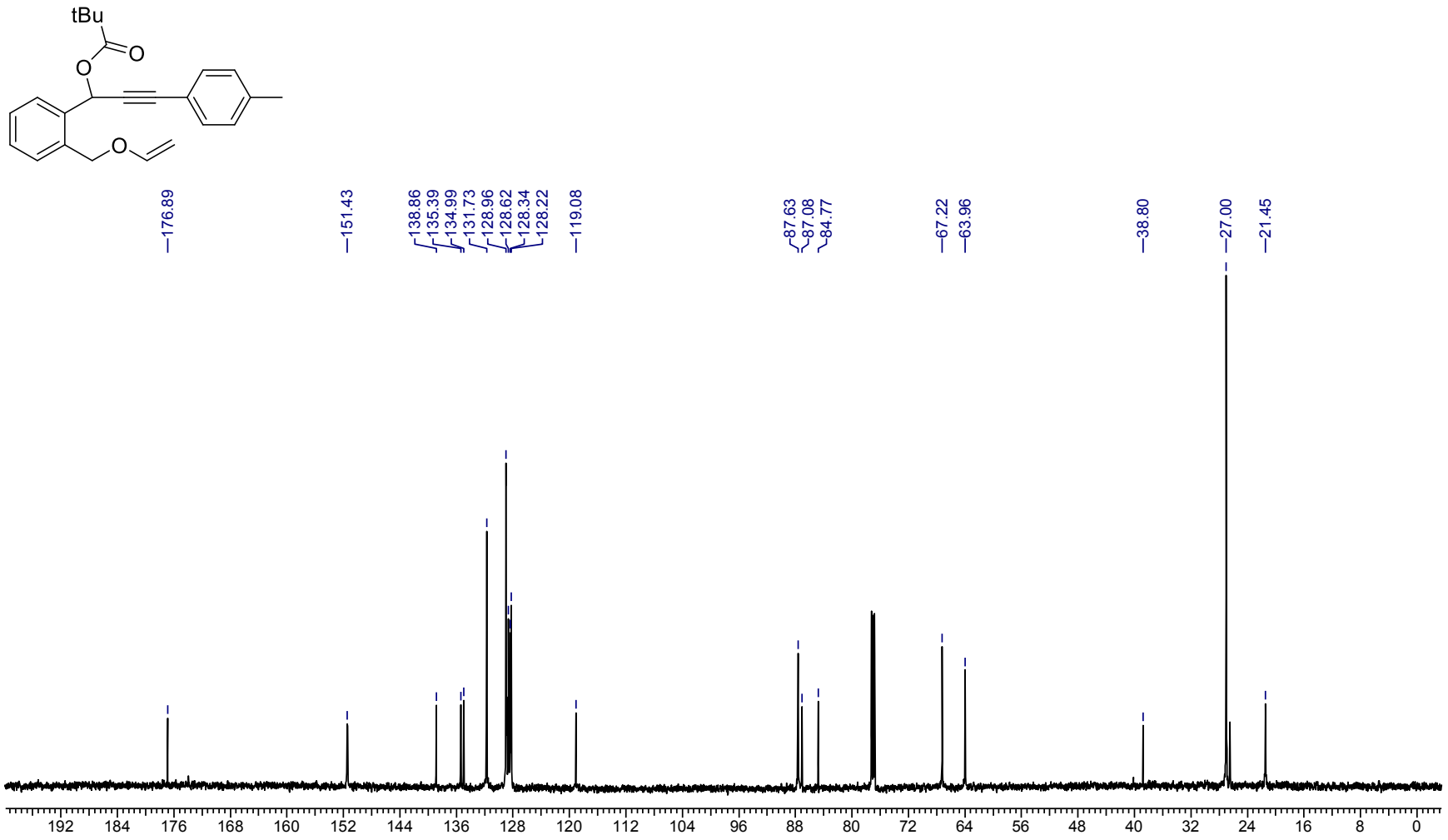
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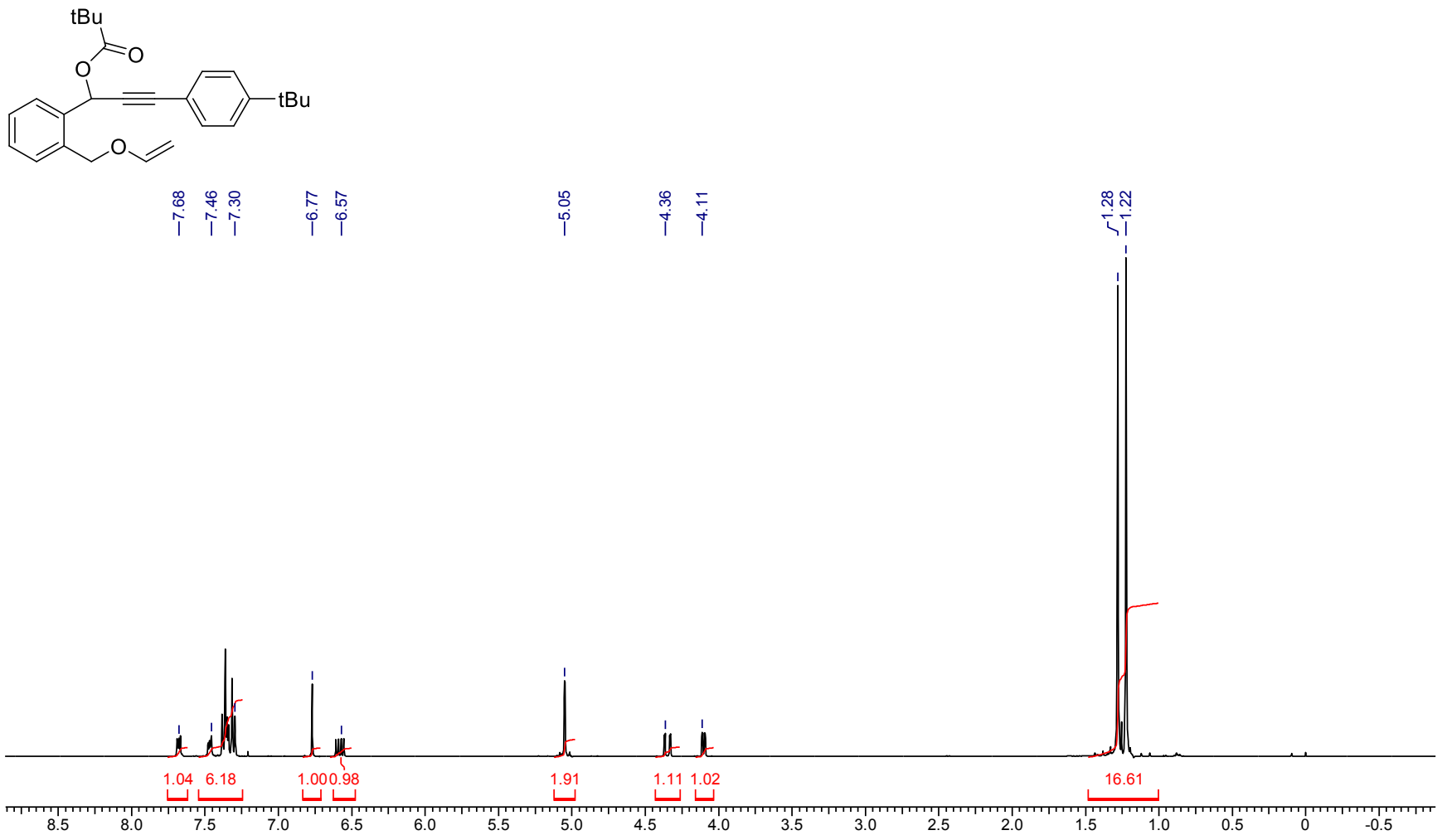
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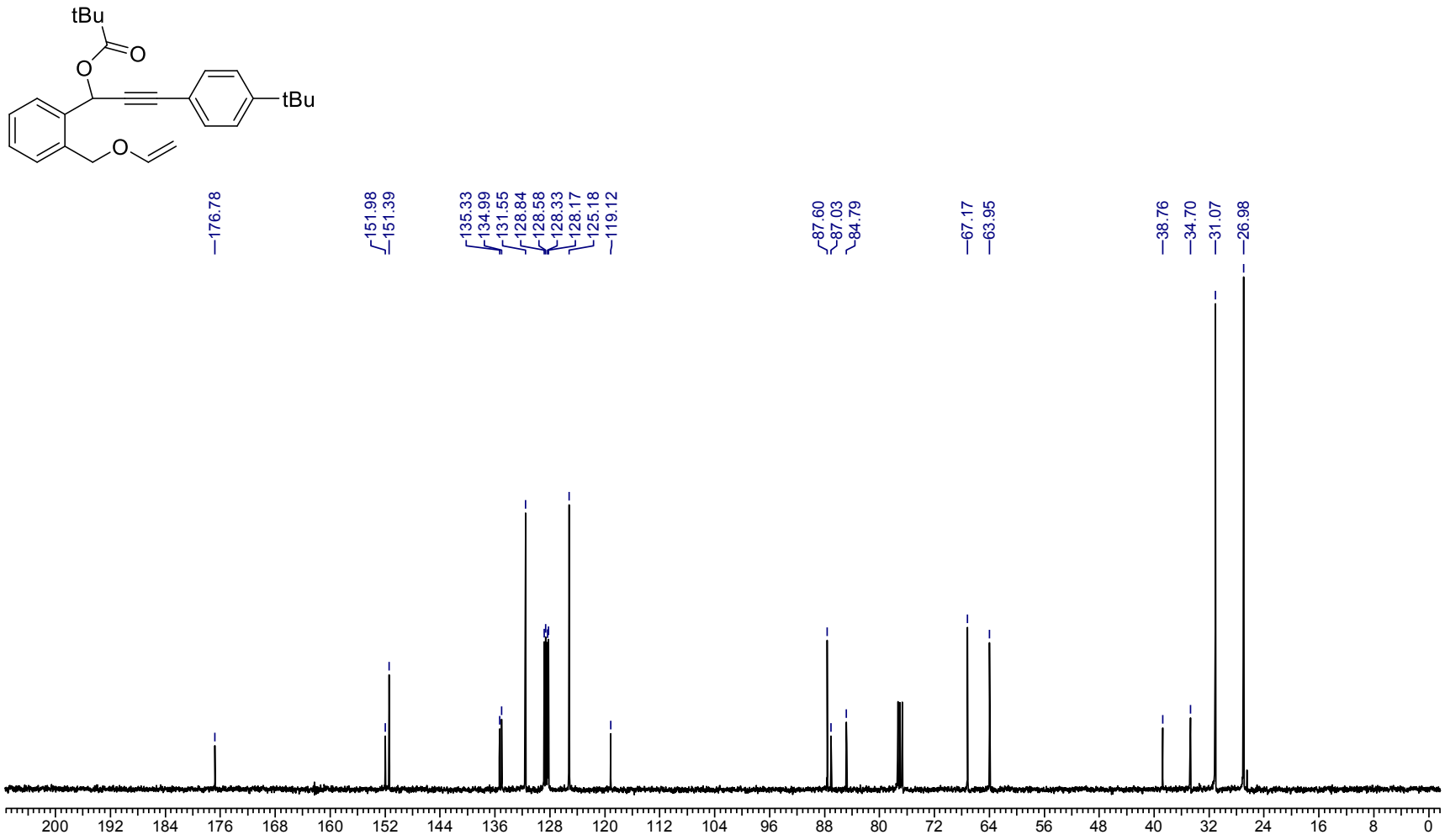
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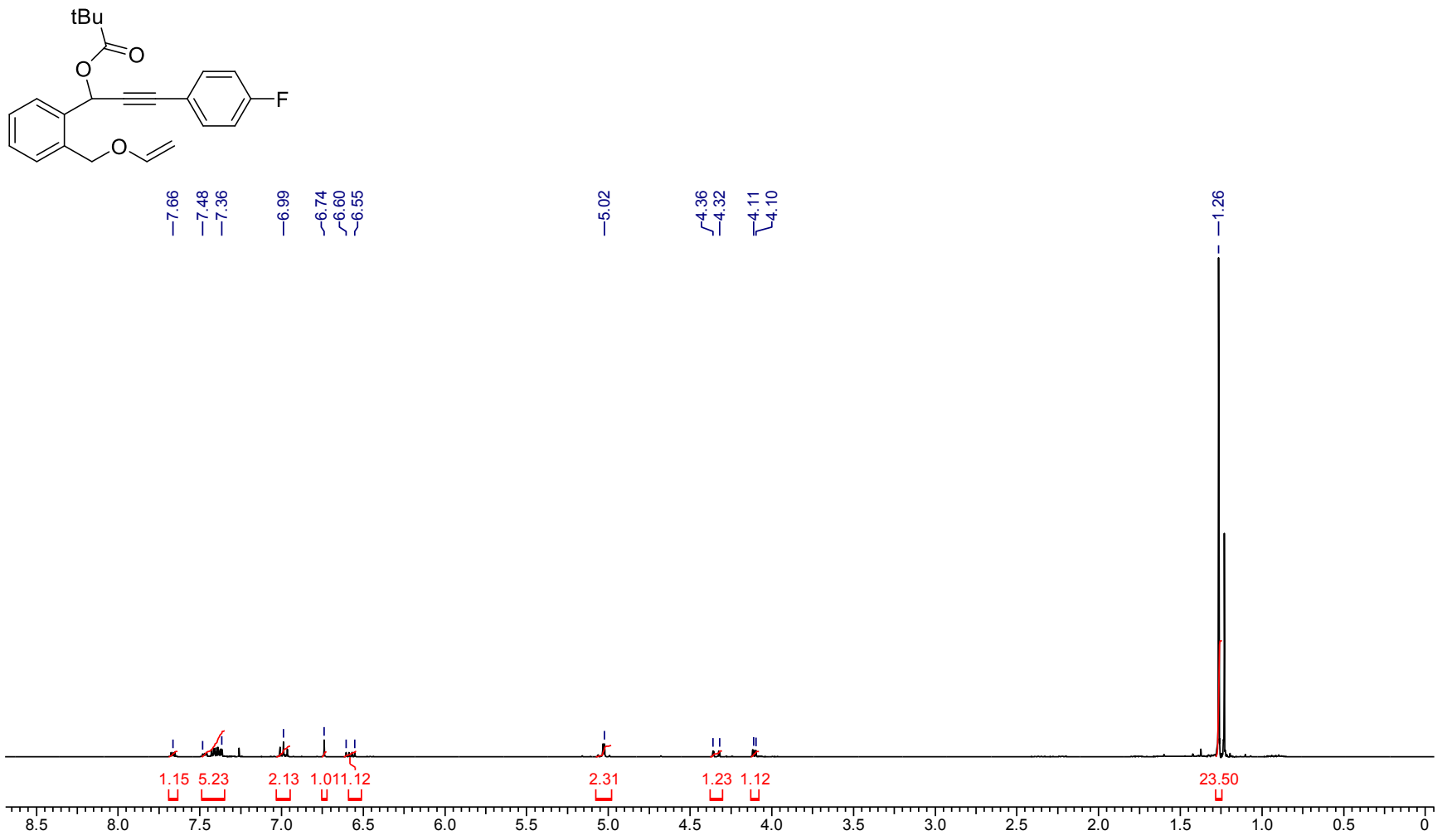
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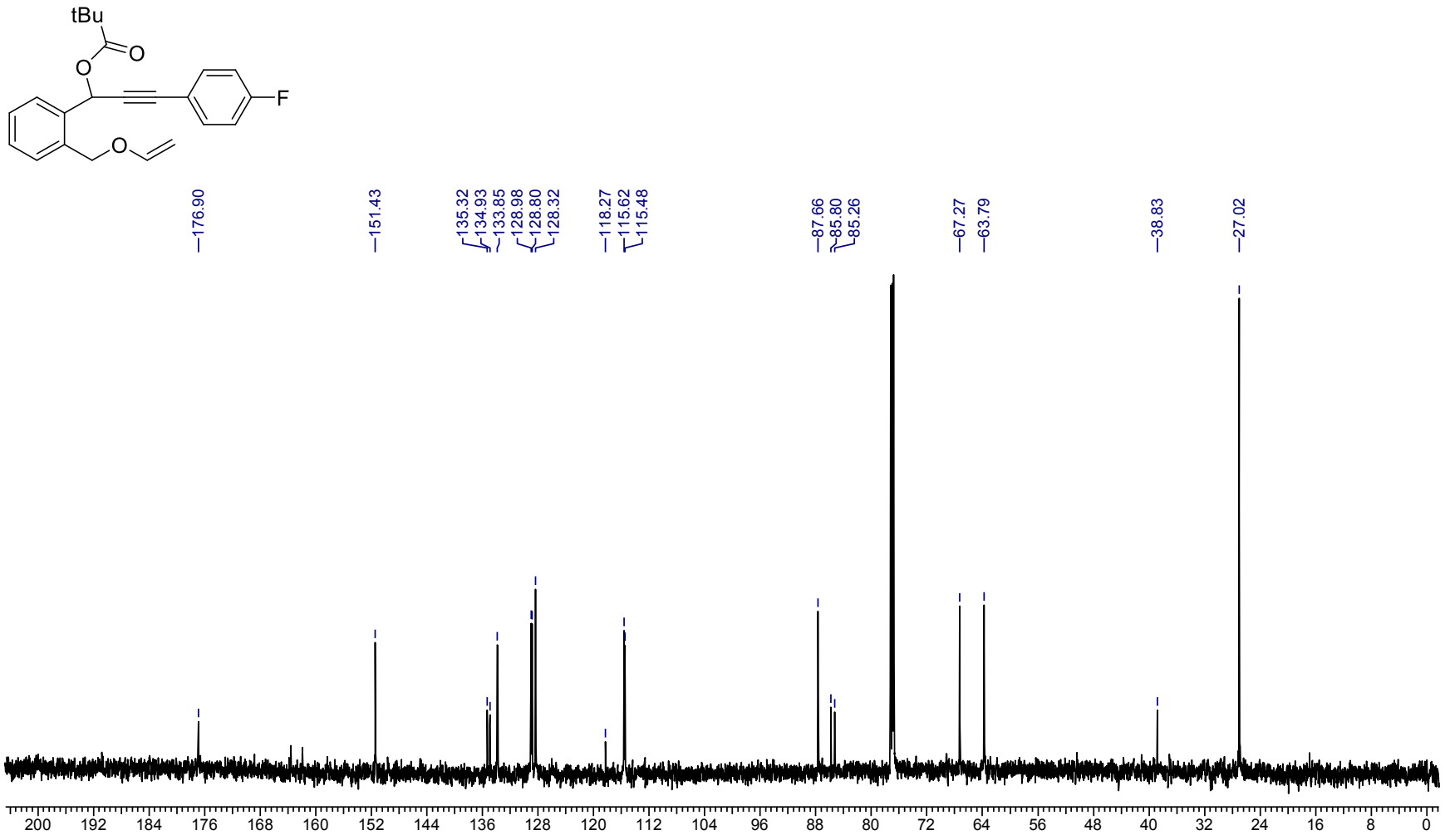
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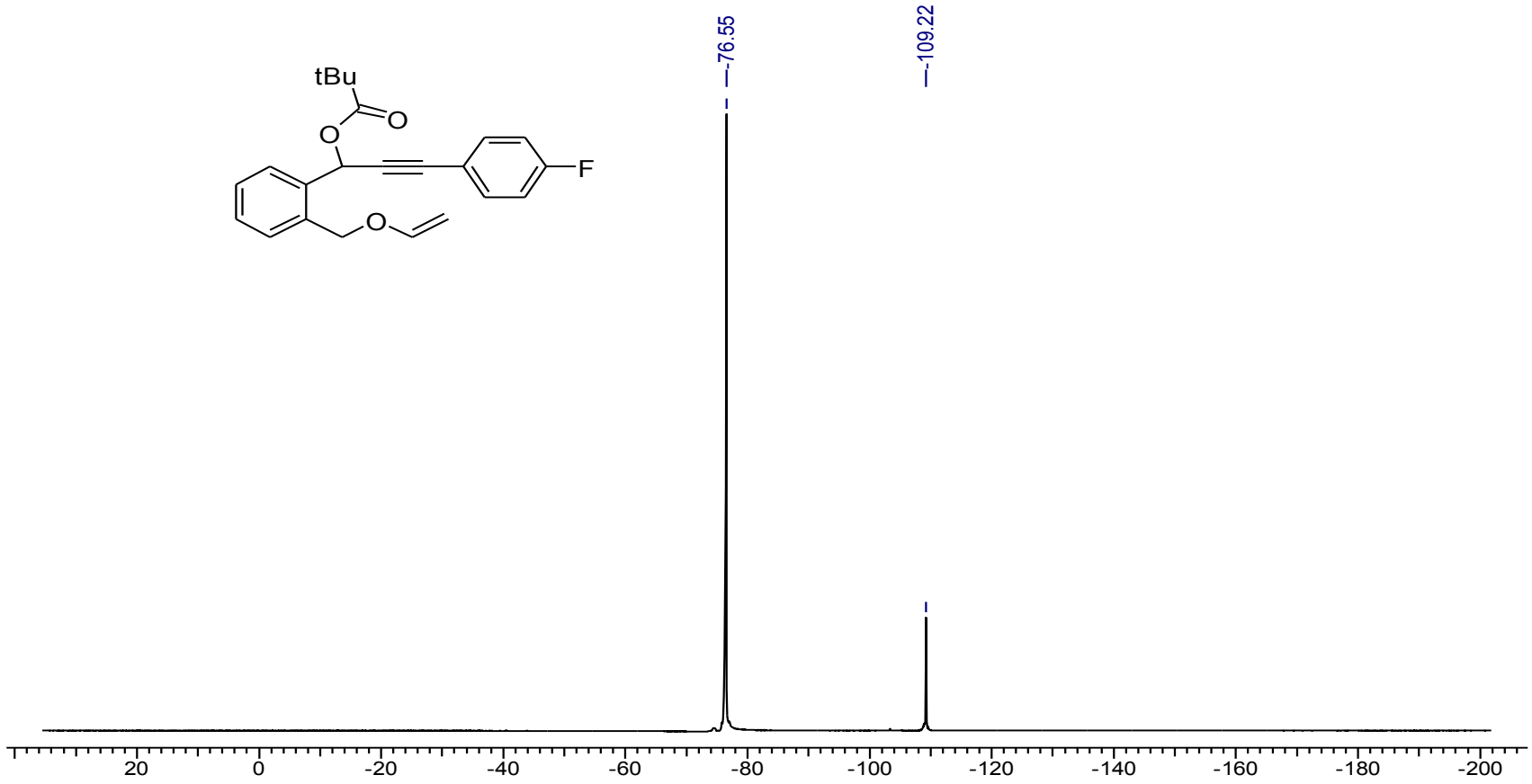
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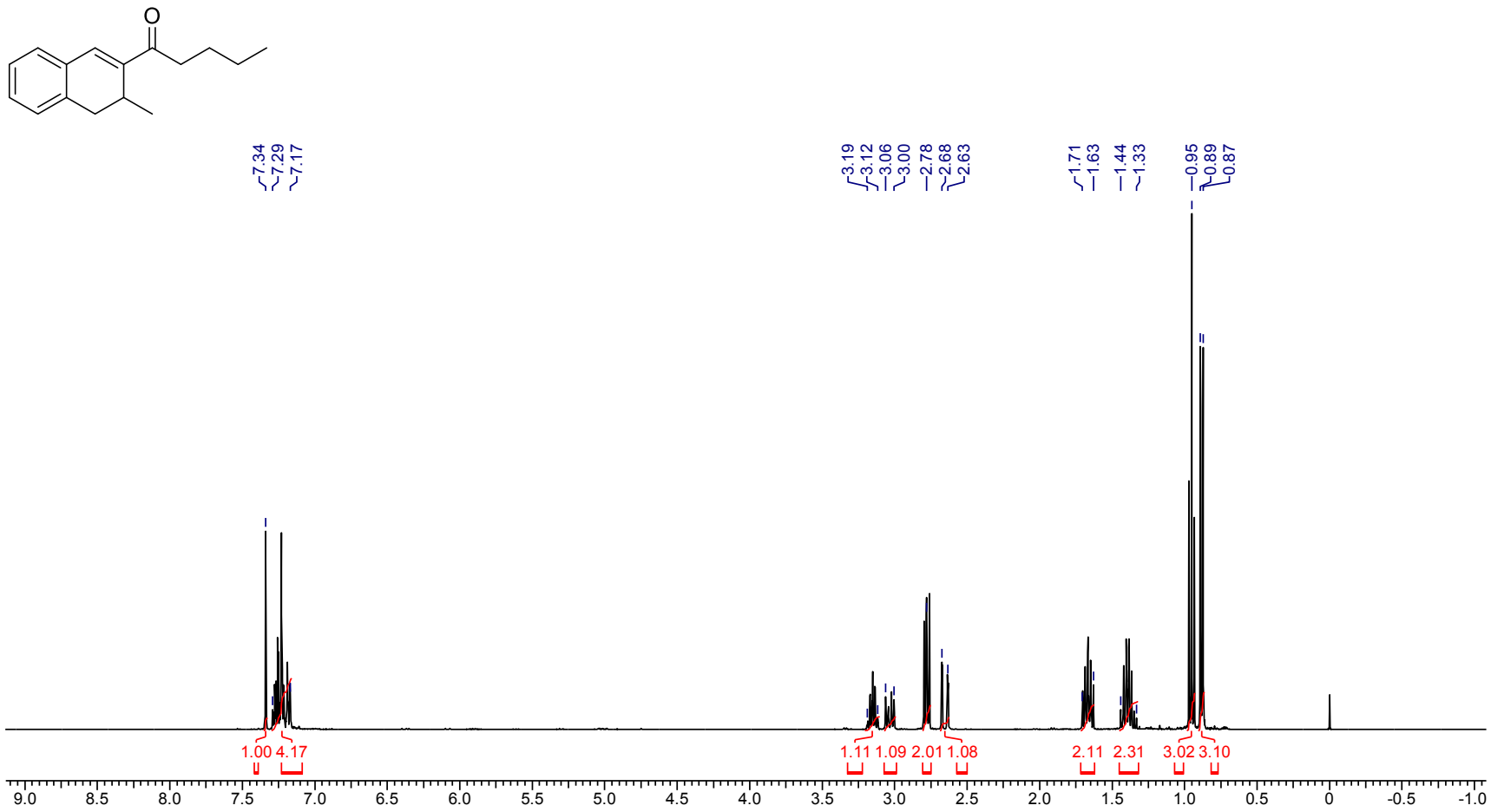
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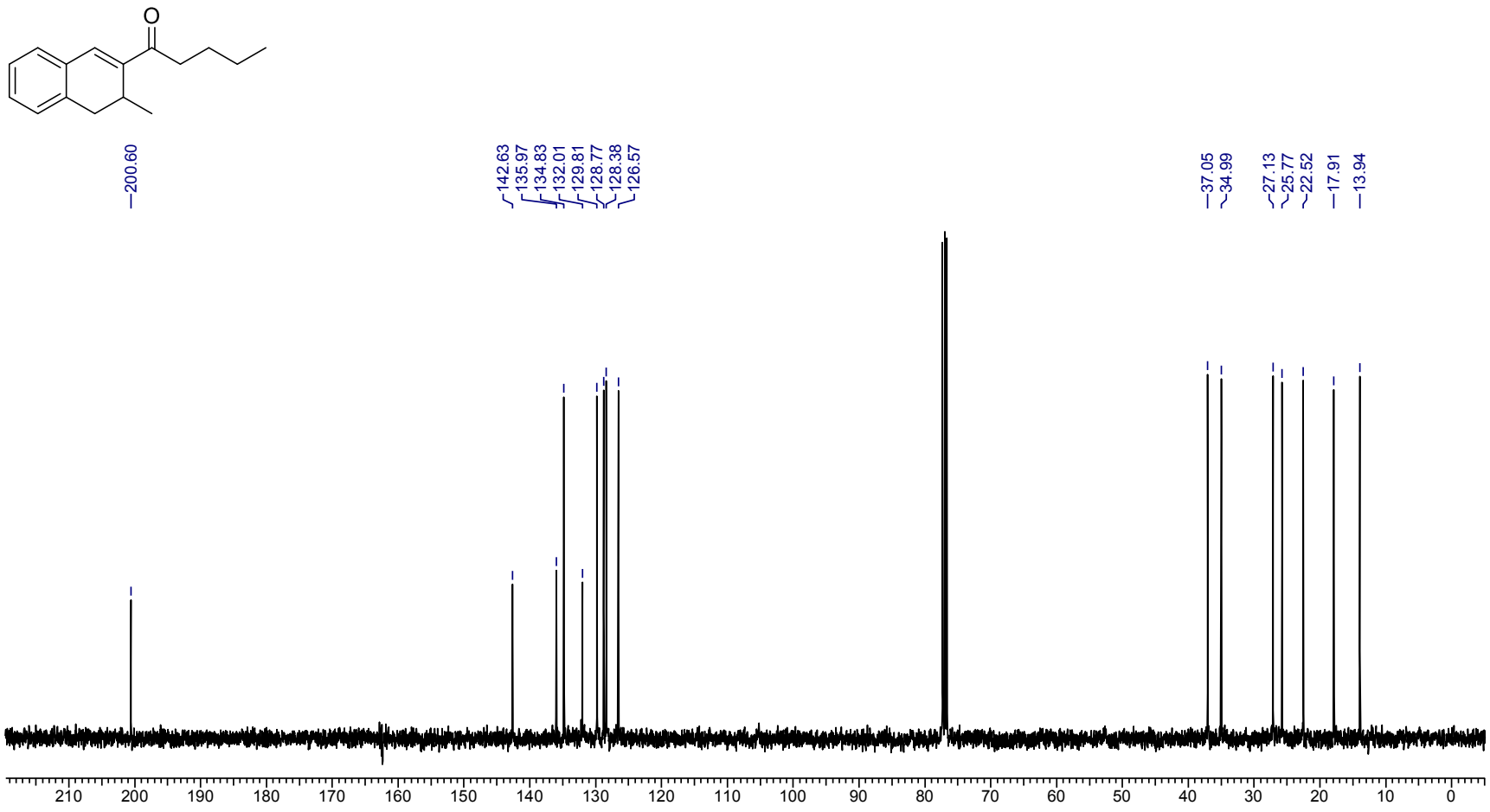
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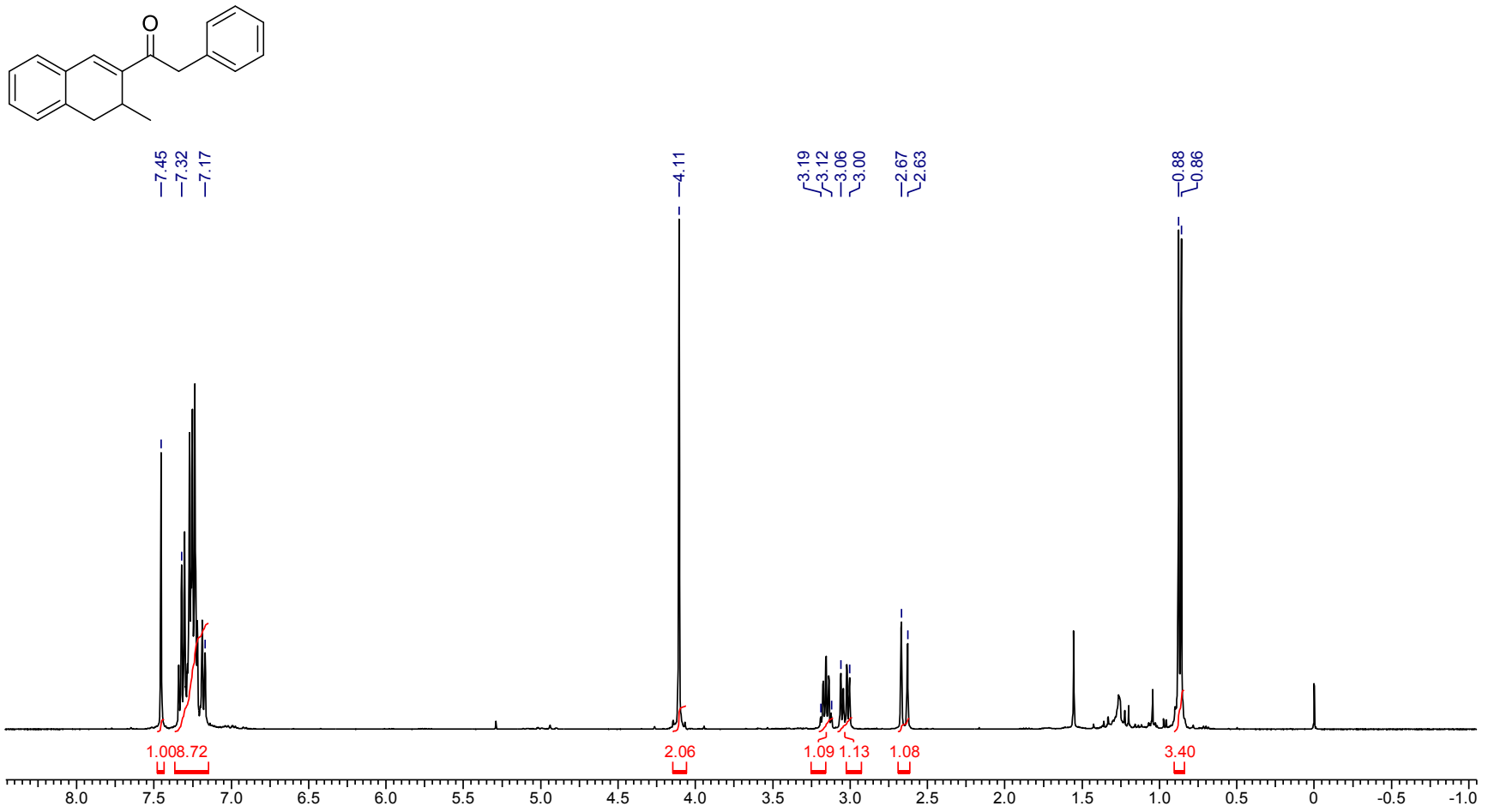
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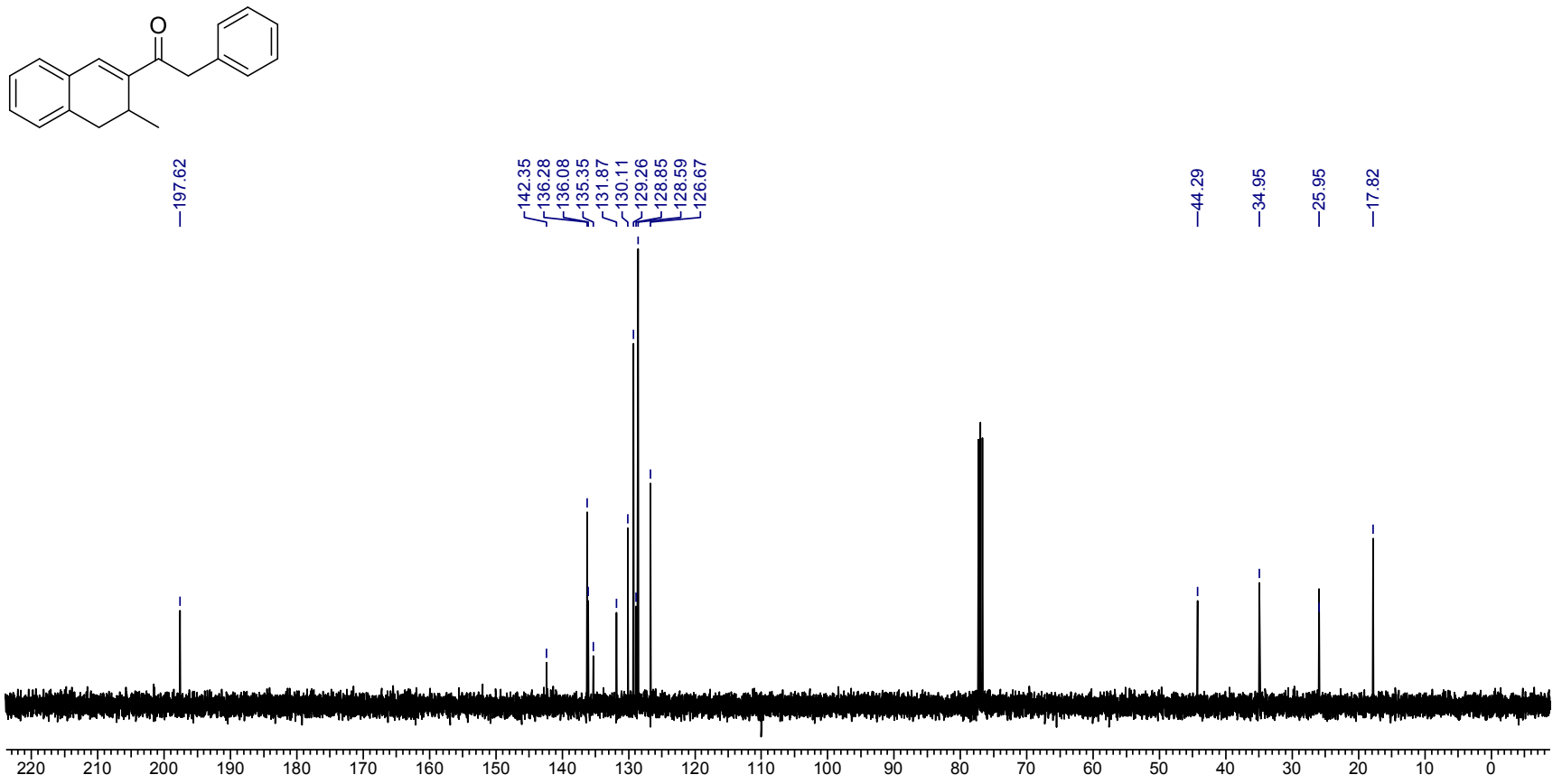
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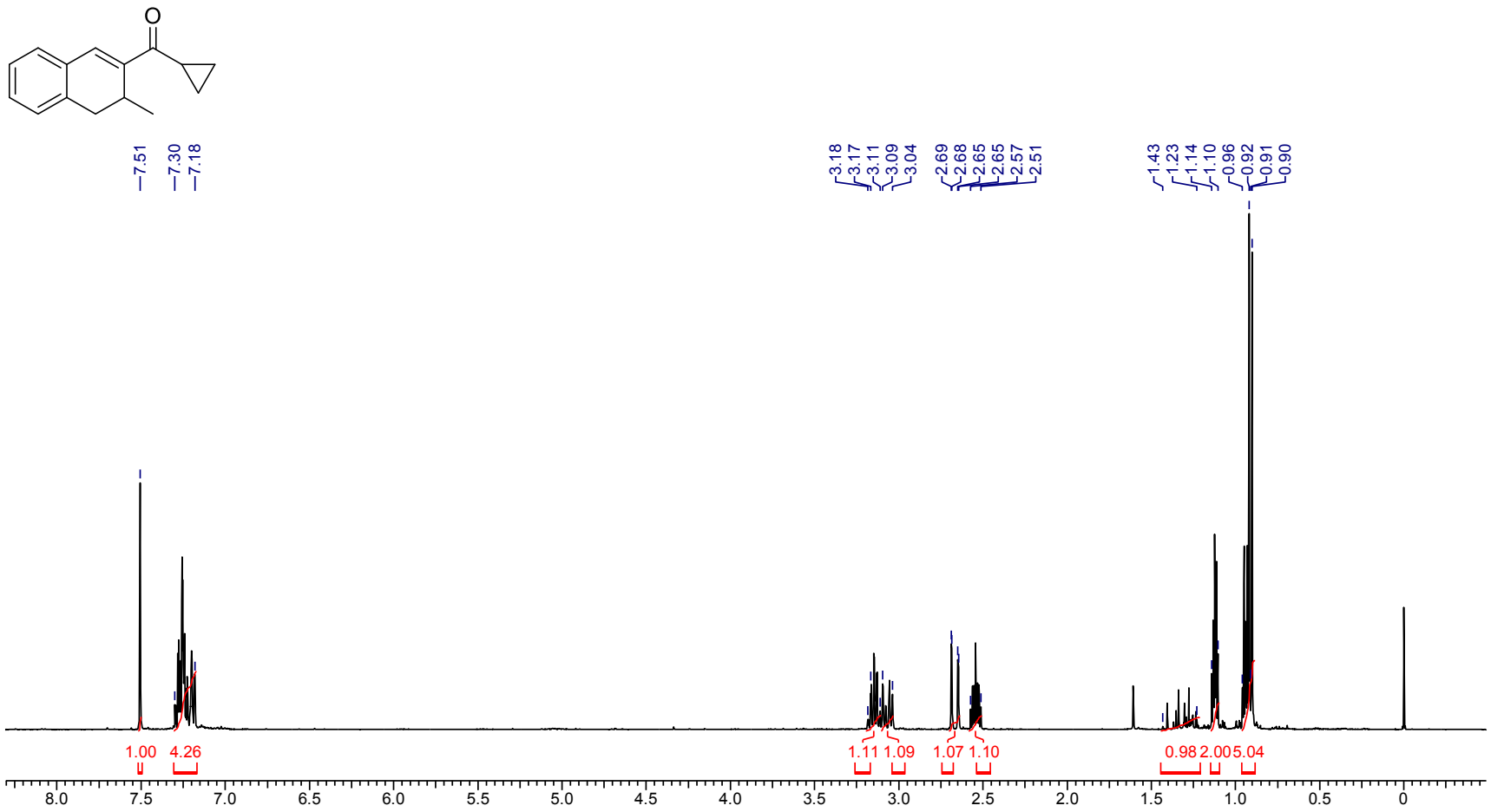
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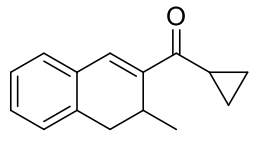
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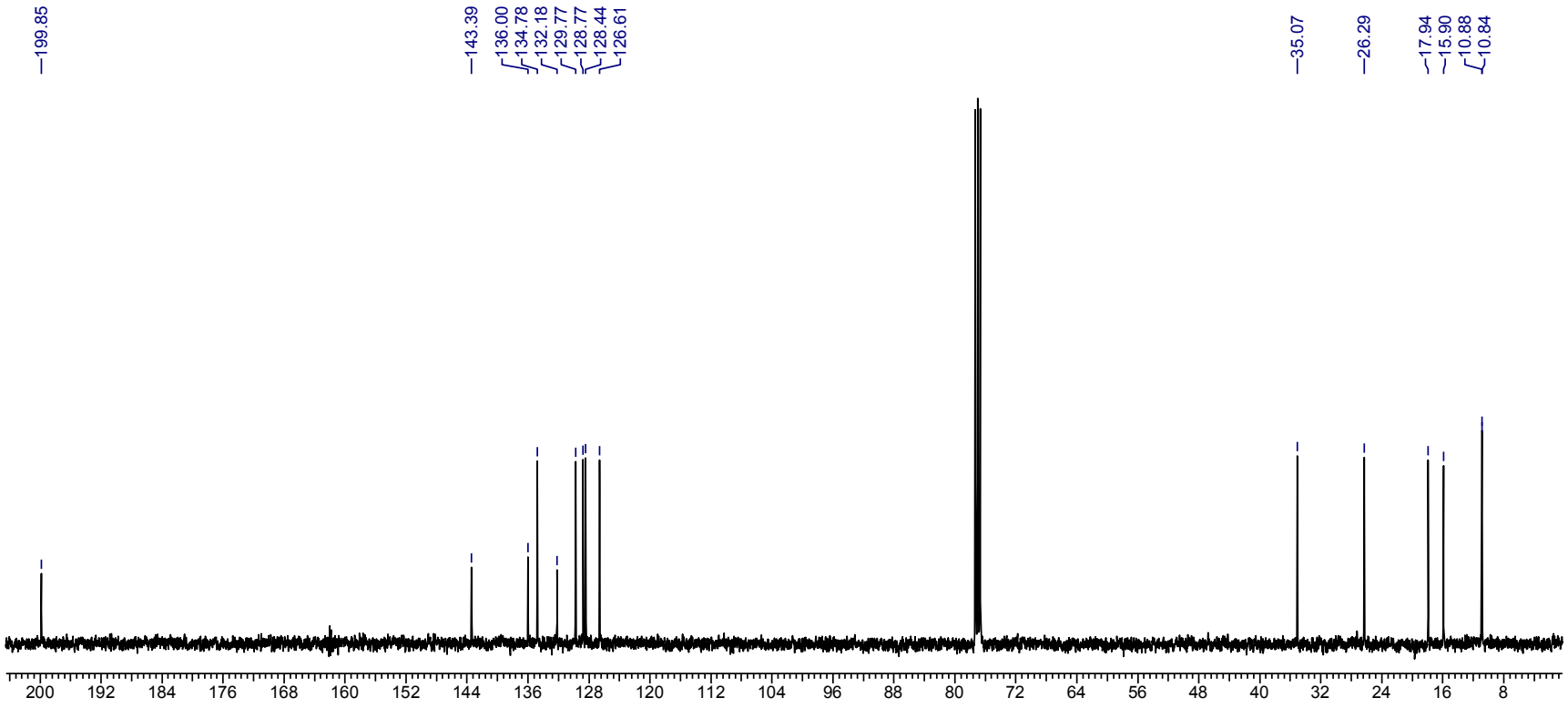
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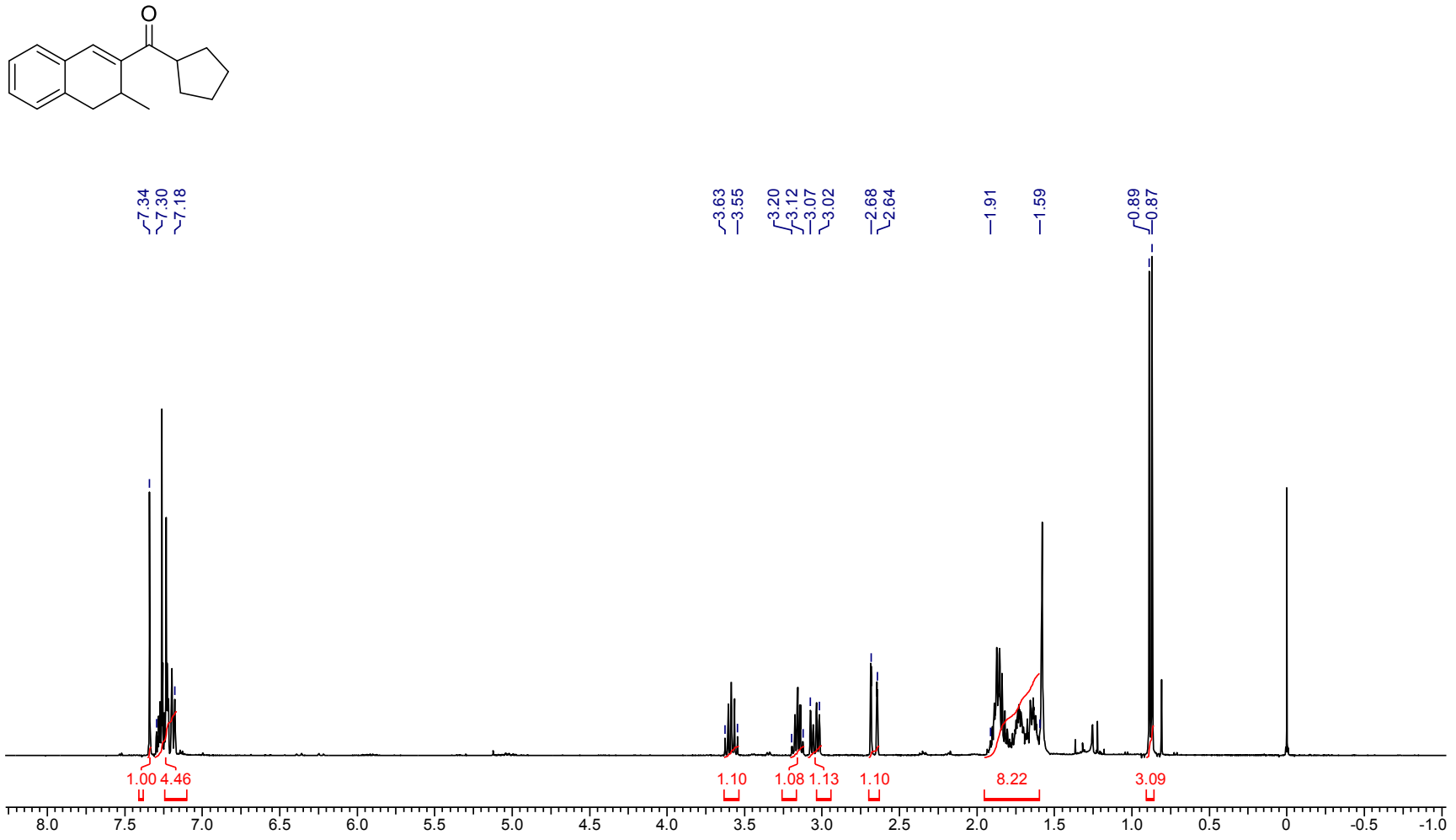
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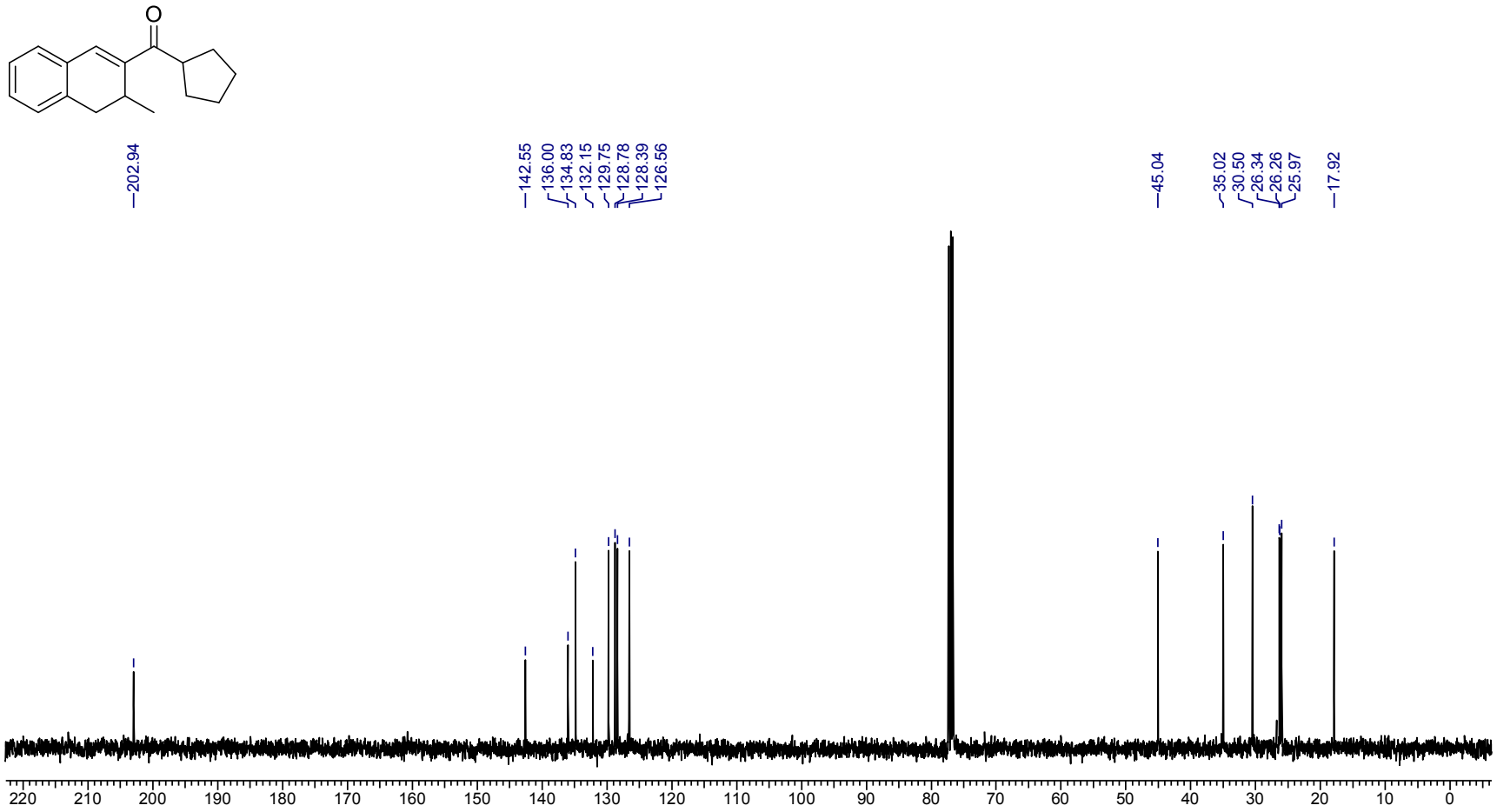
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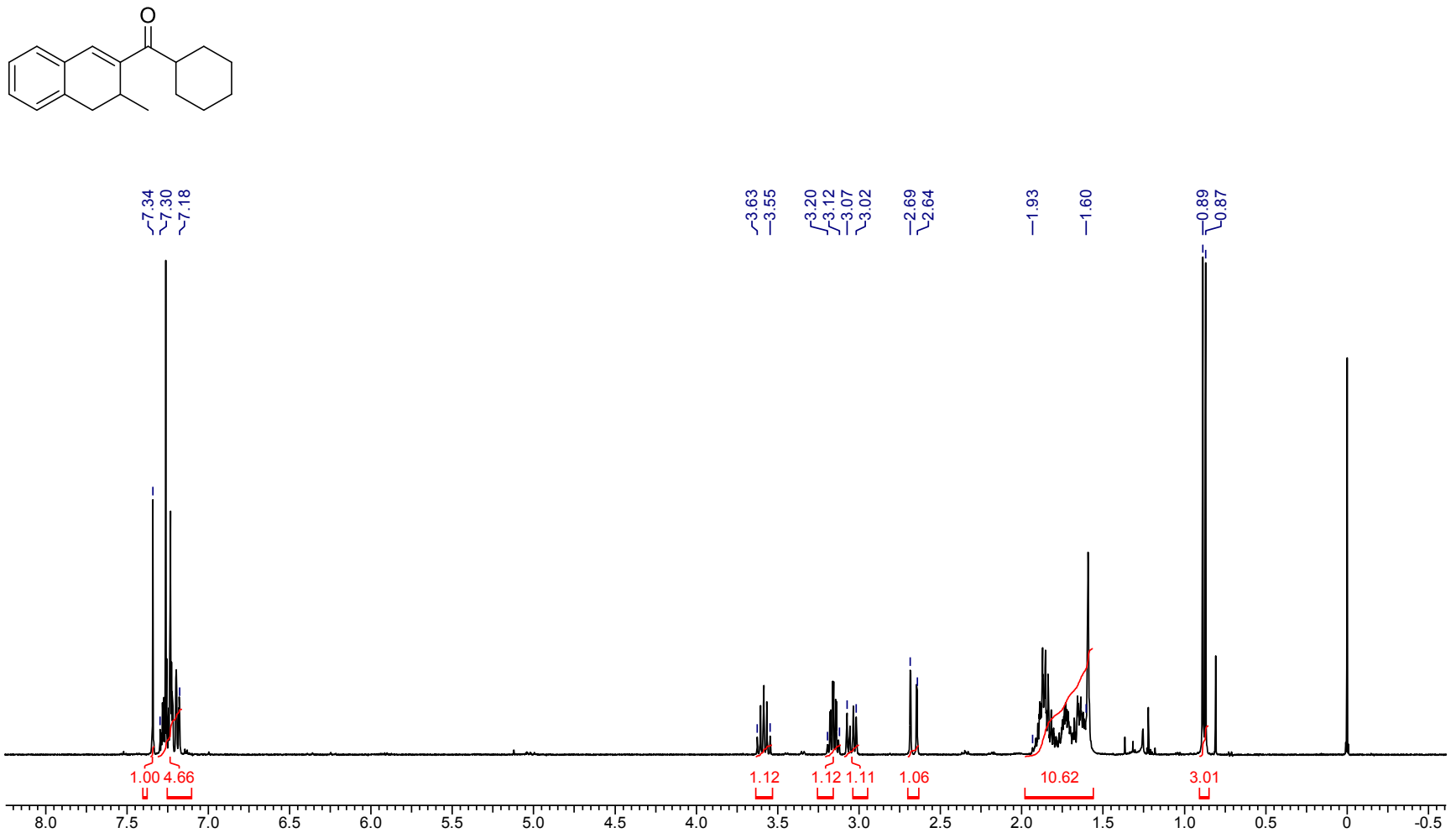
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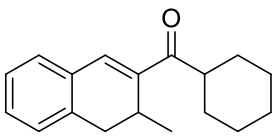
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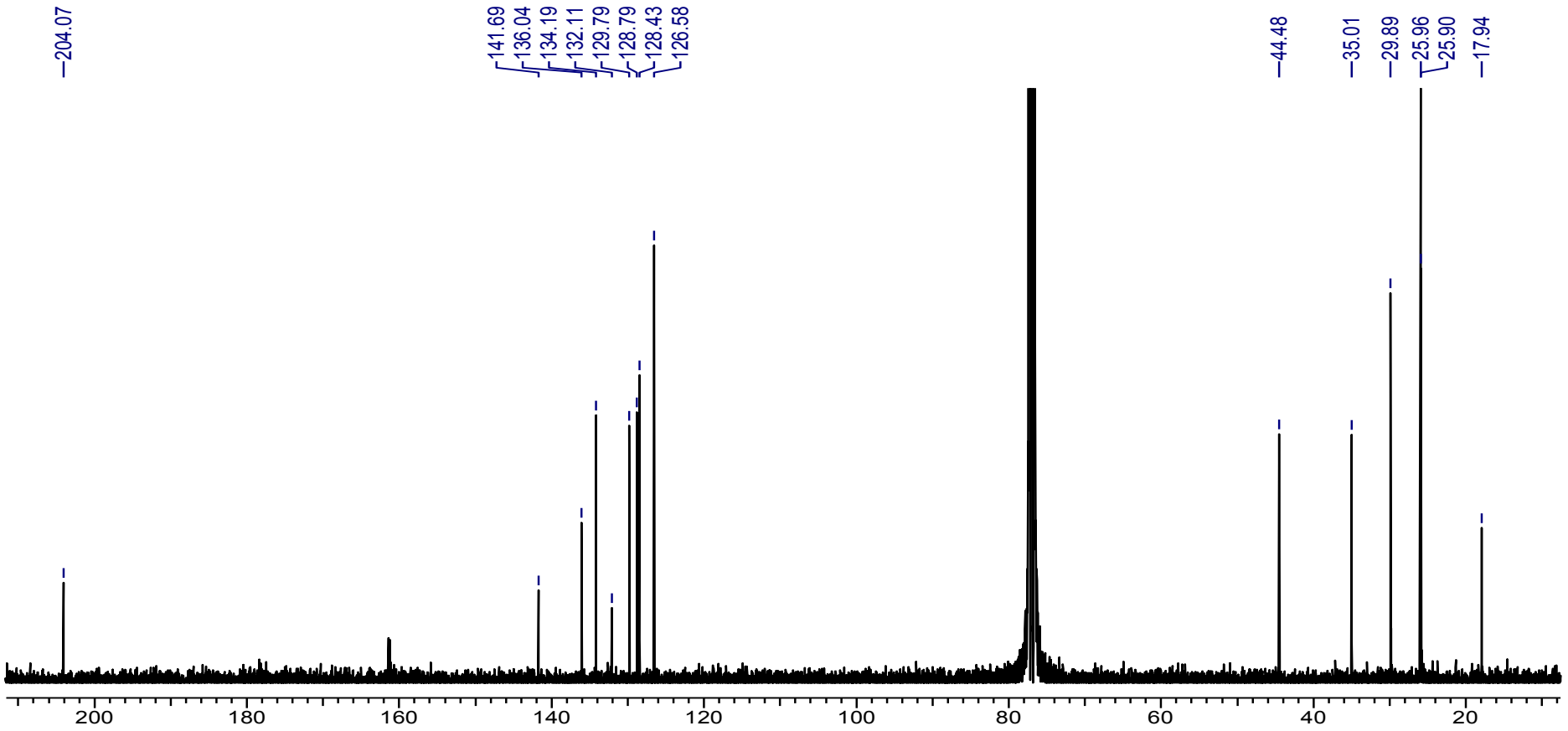
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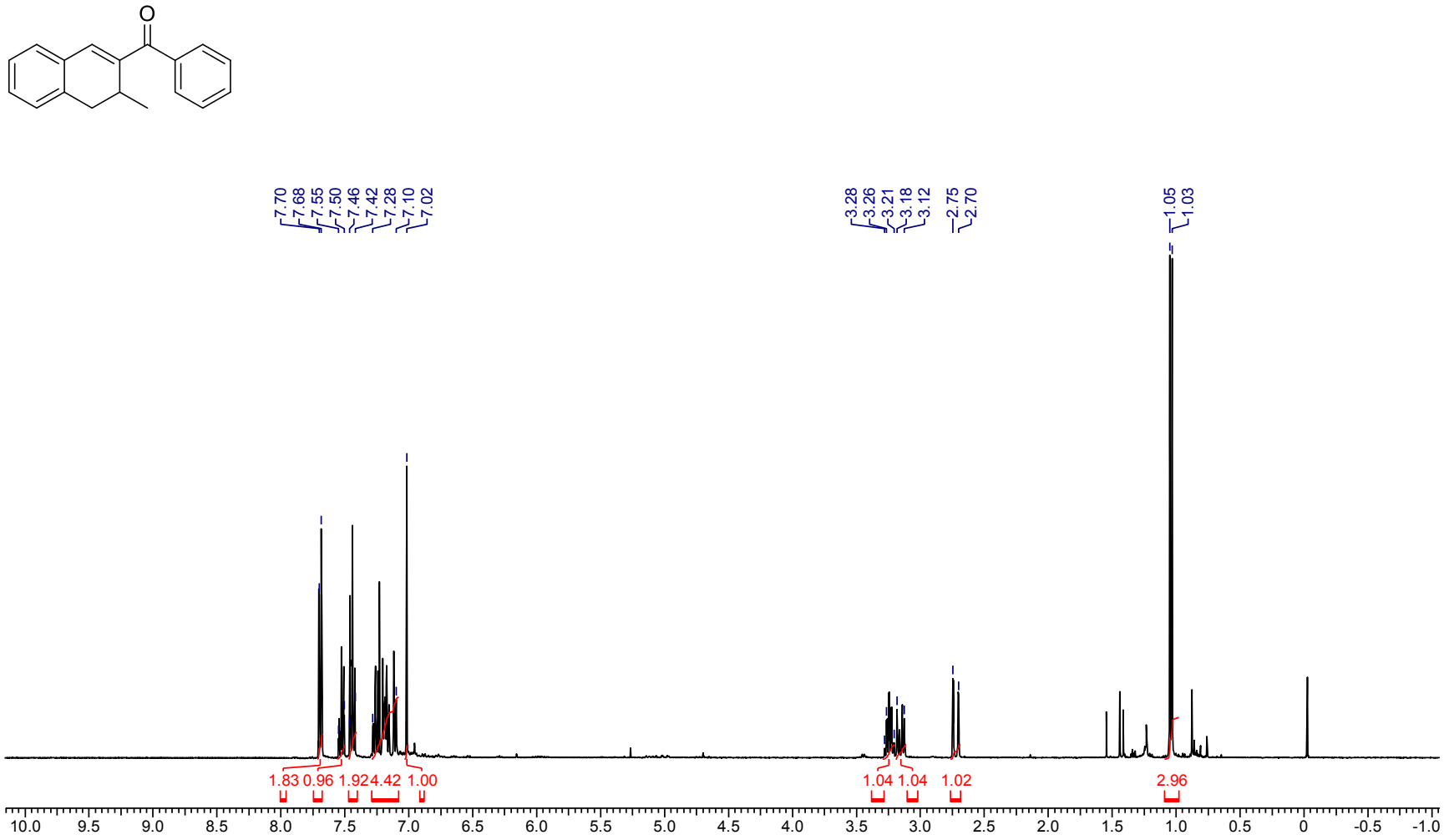
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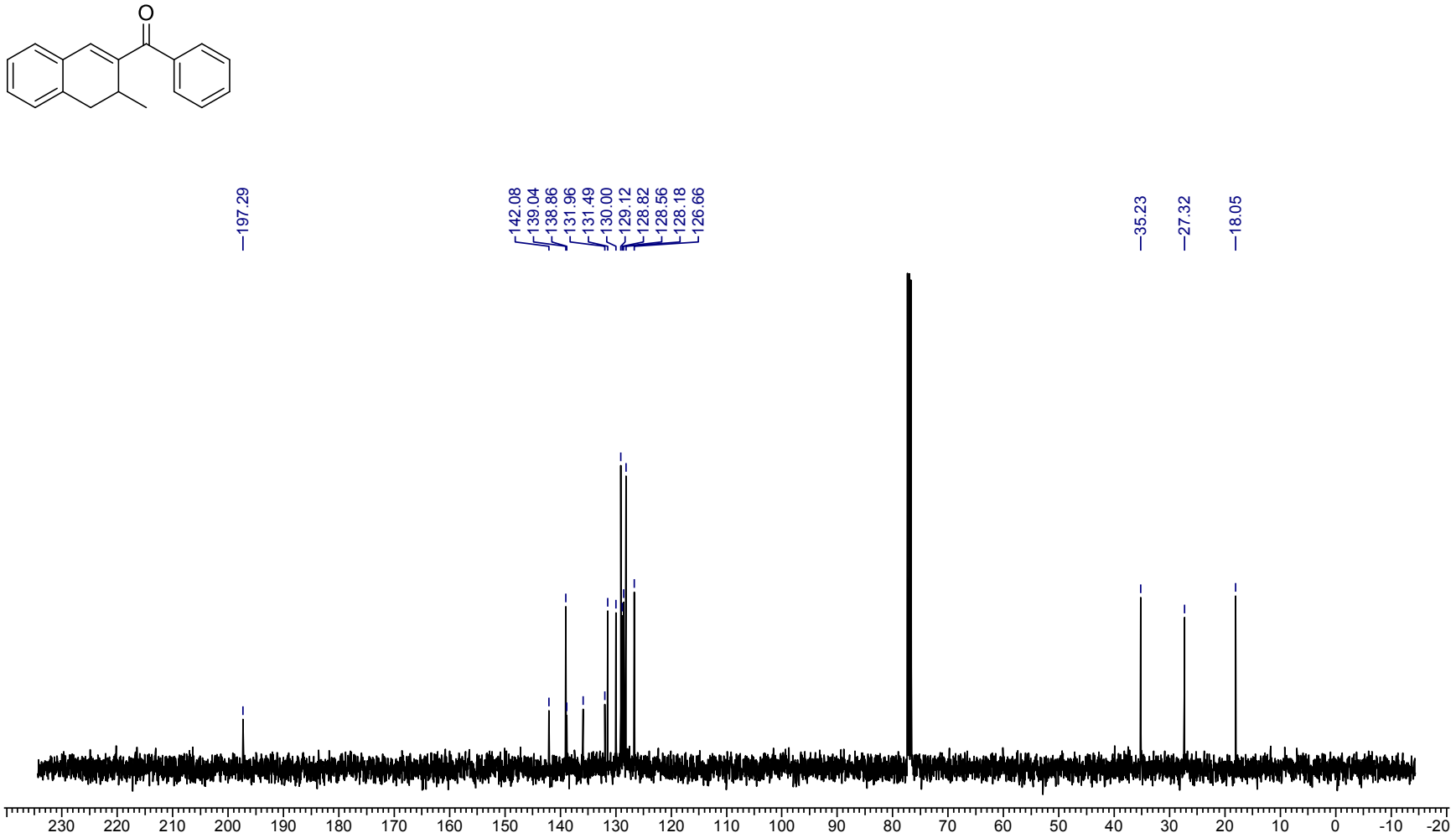
1.04 1.04 1.02
2.96
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0 -0.5 -1.0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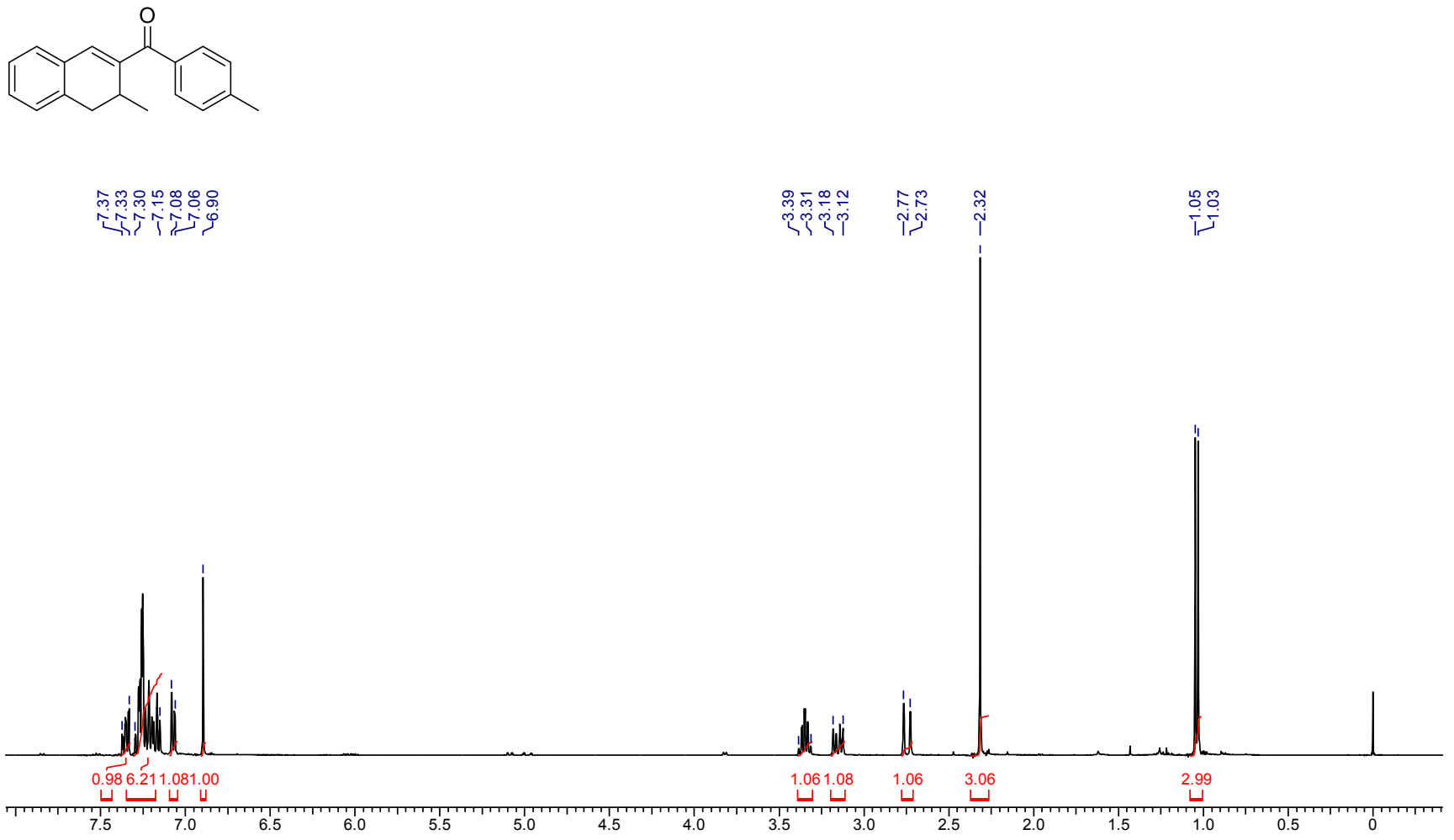
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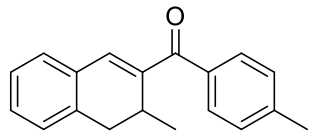
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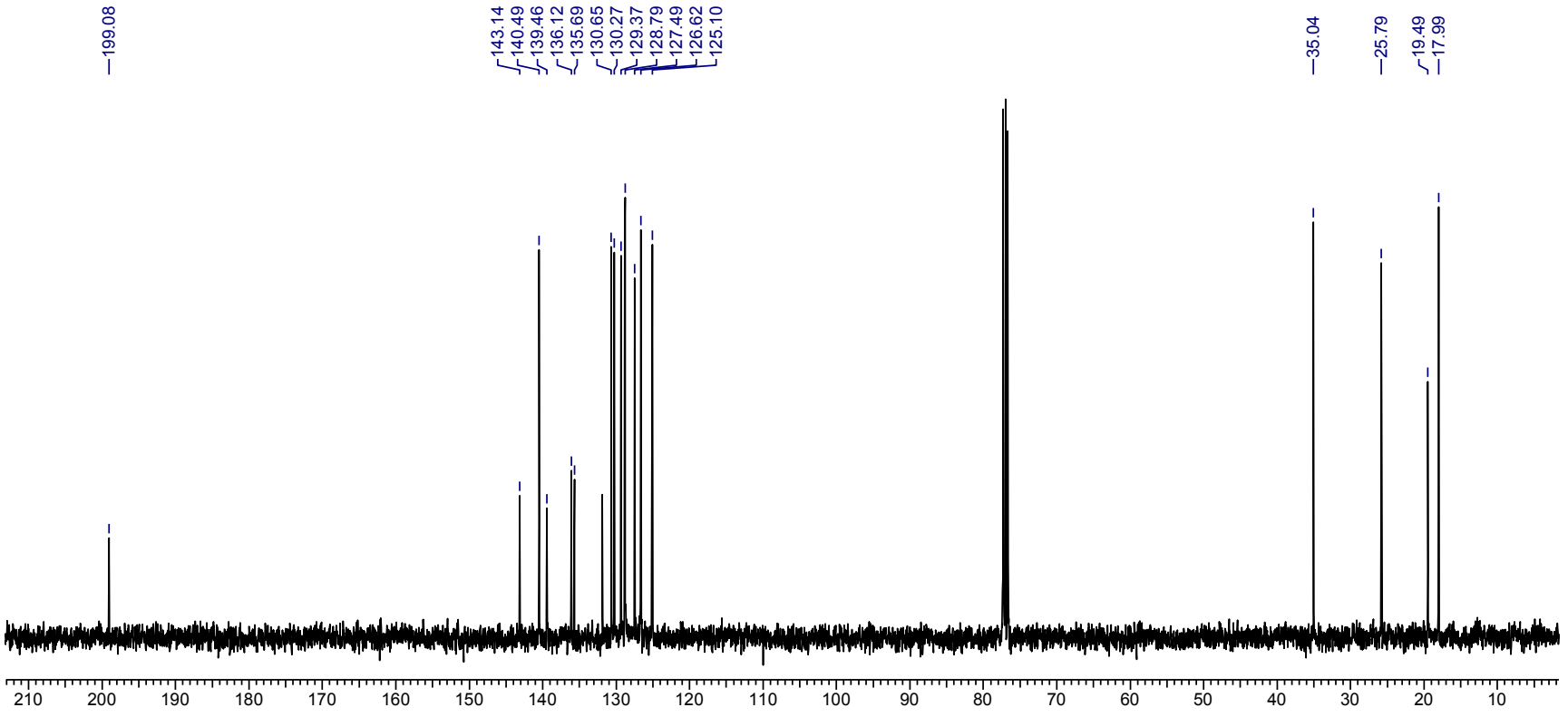
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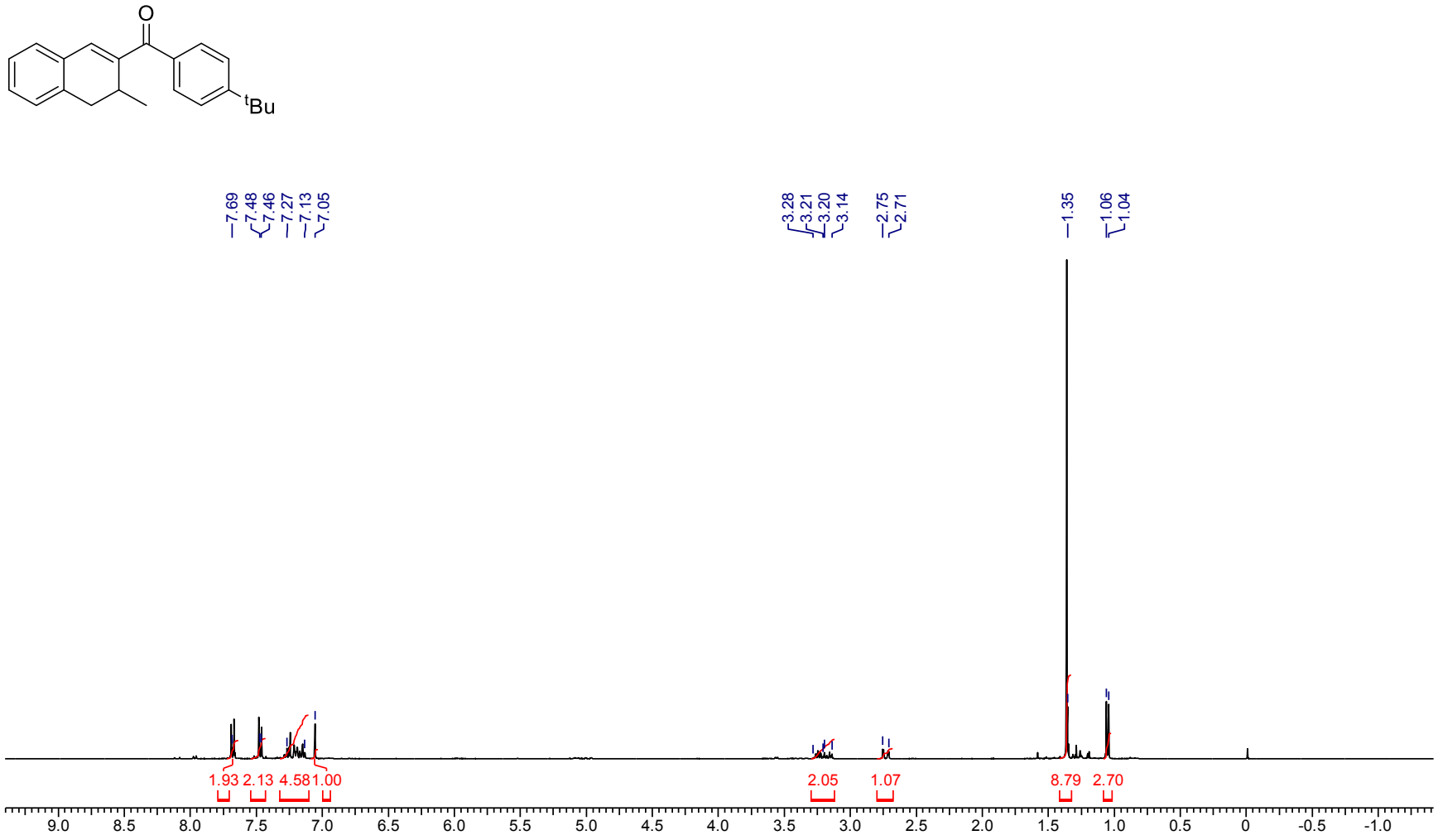
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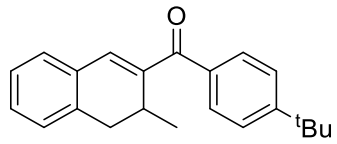
1.06
1.04
1.93 2.13 4.58 1.00
2.05 1.07
8.79 2.70
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0 -0.5 -1.0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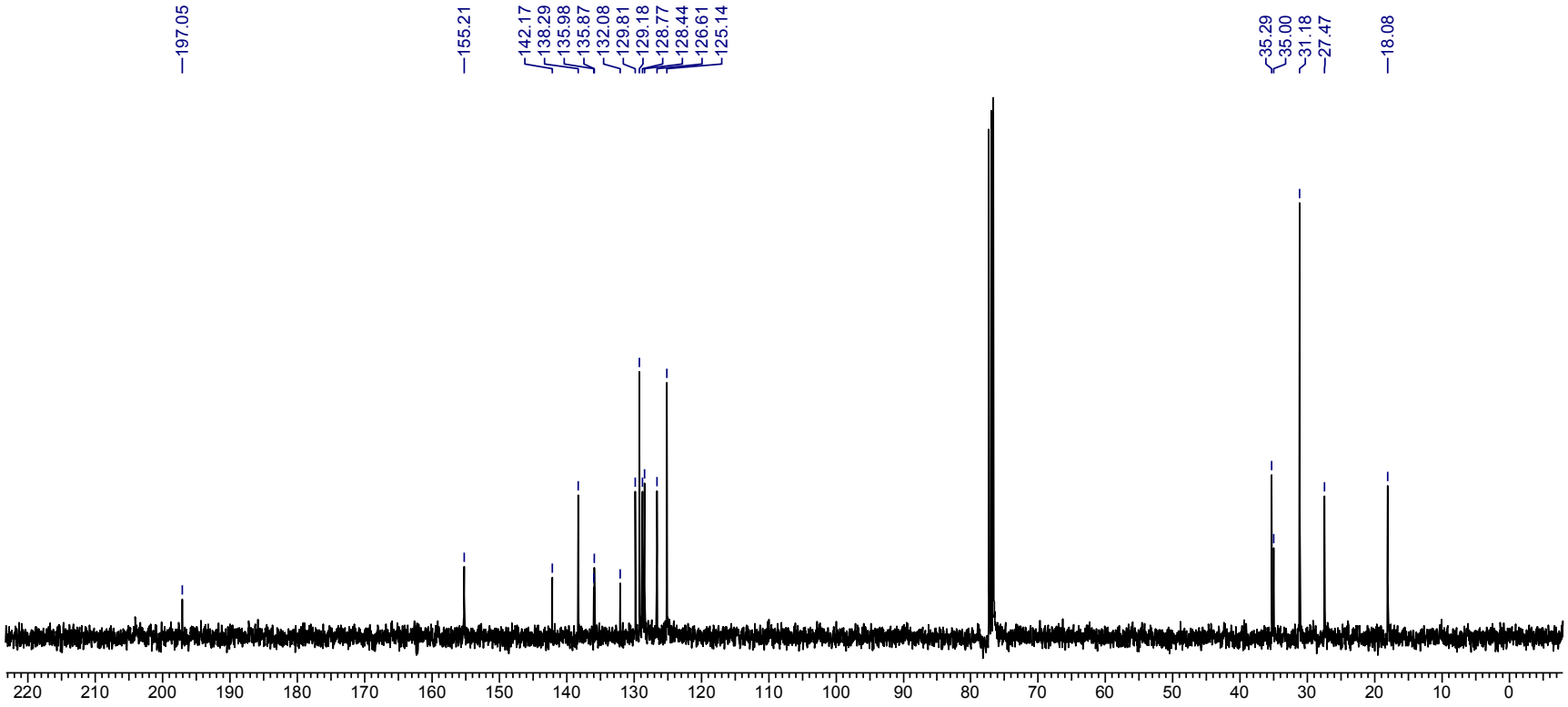
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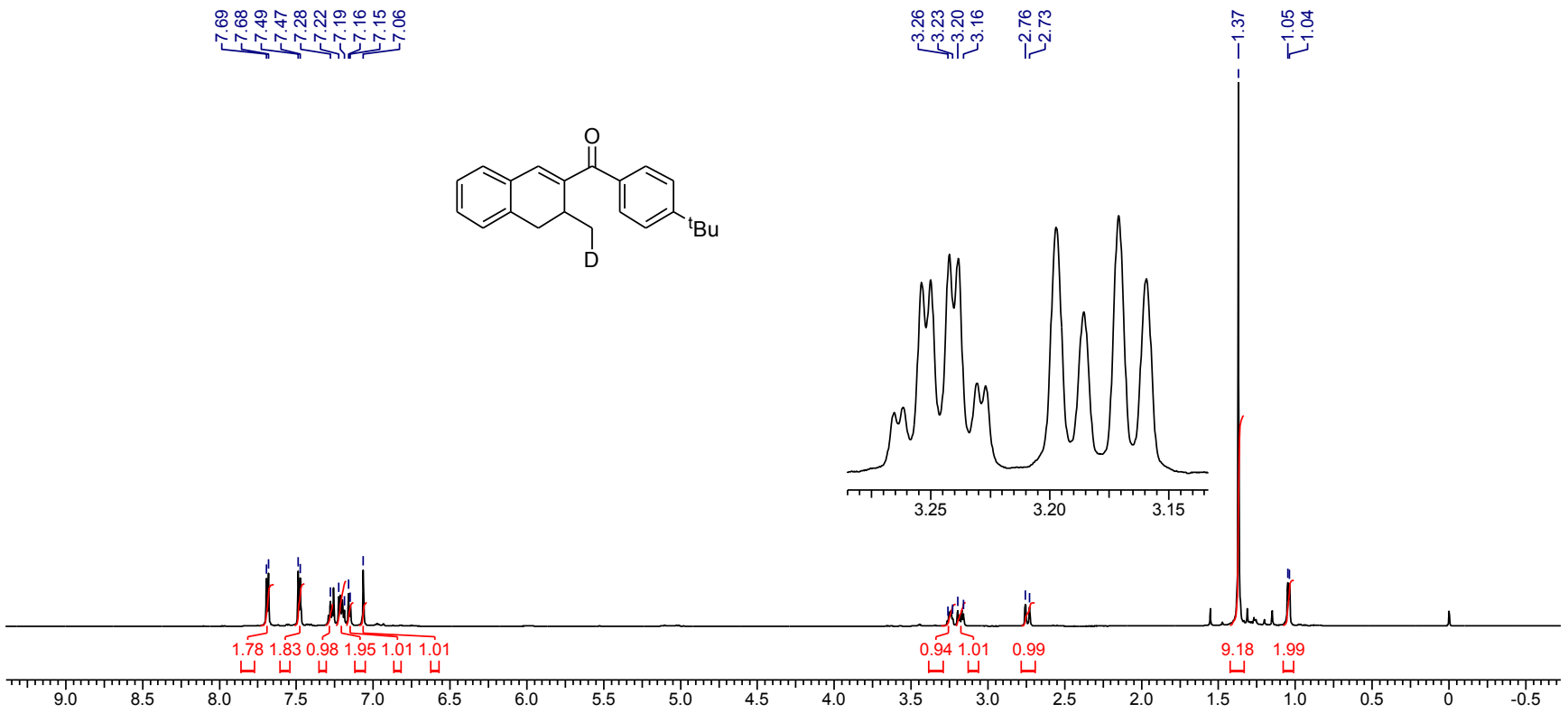
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2.76
2.73
1.37
1.05
1.04
O
tBu
D
3.25
3.20
3.15
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0.94 1.01 0.99
9.18 1.99
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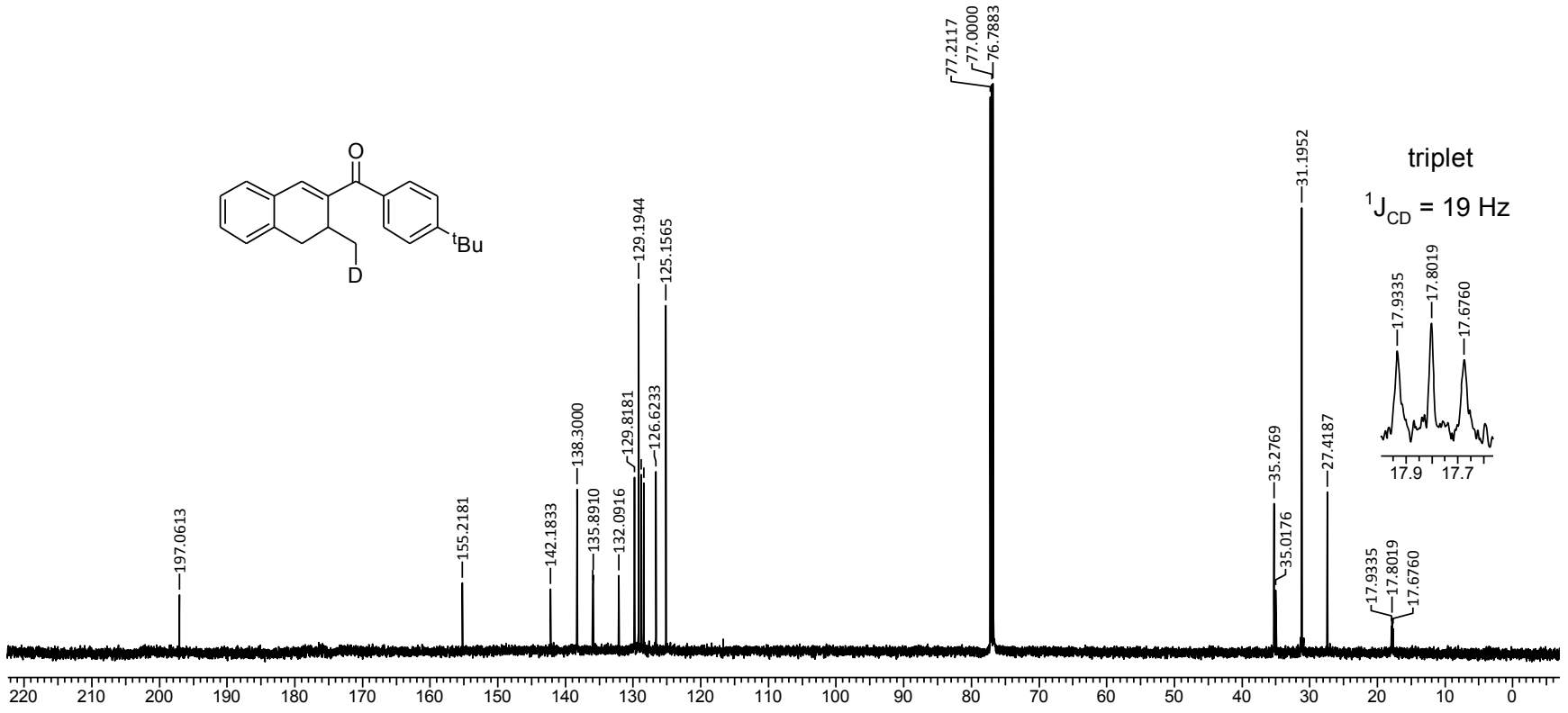
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129.1944
126.6233
125.1565
77.2117
77.0000
76.7883
35.2769
35.0176
31.1952
27.4187
17.9335
17.8019
17.6760
triplet
1JCD = 19 Hz
17.9335
17.8019
17.6760
17.9
17.7
220
210
200
190
180
170
160
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20
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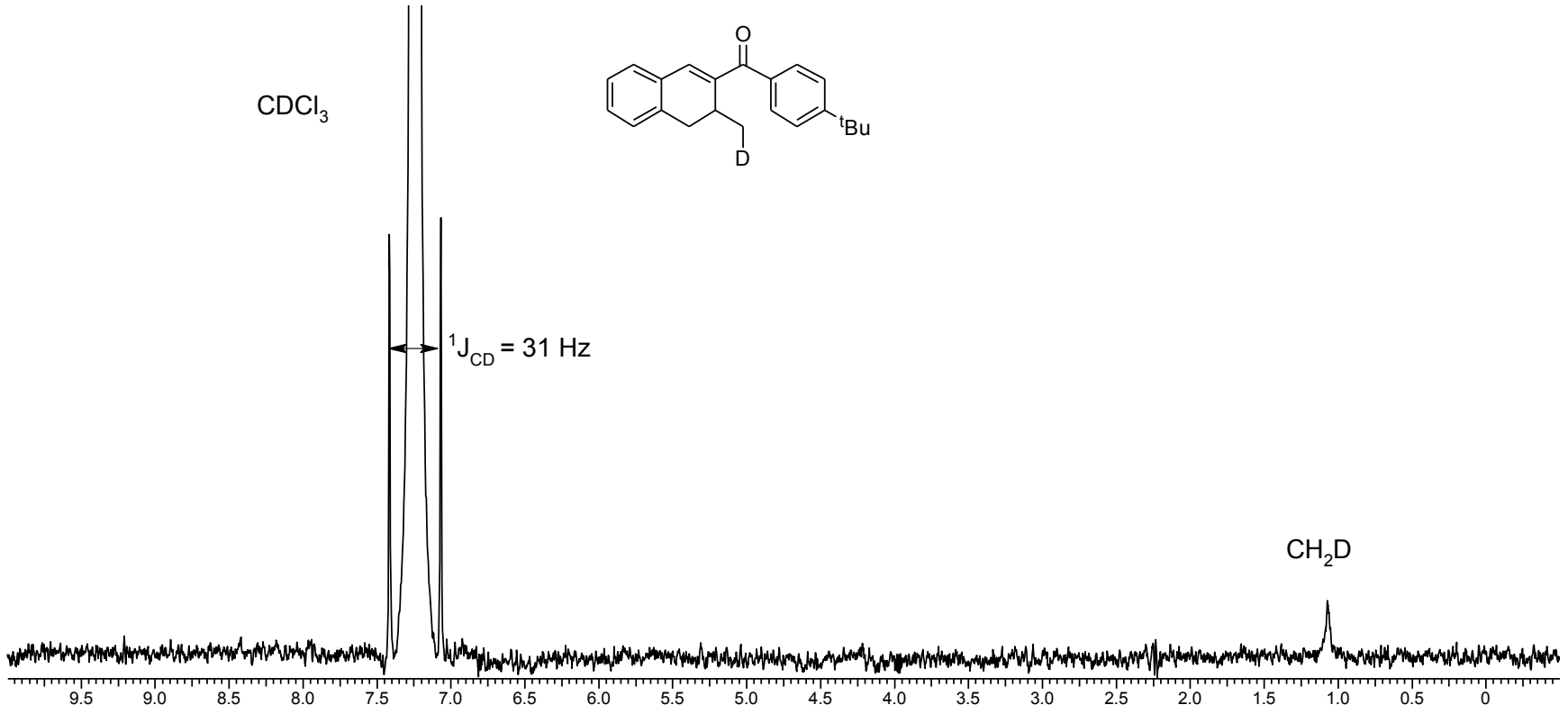
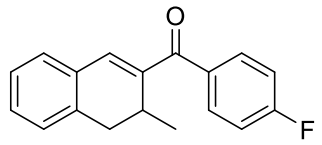
0

^{2}H NMR spectrum in $CDCl_3$

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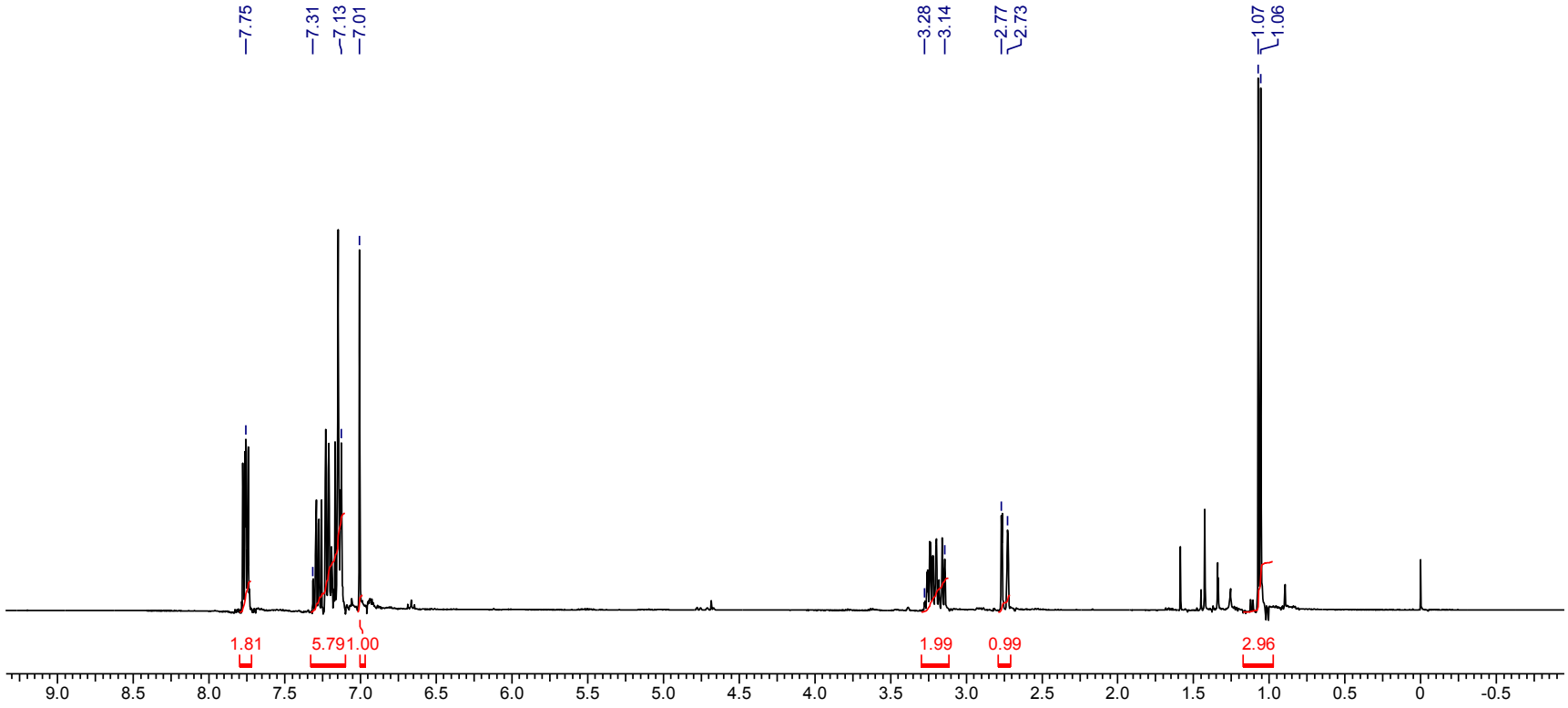
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1.99
0.99
2.96
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8.5
8.0
7.5
7.0
6.5
6.0
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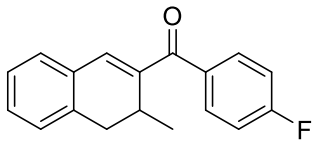
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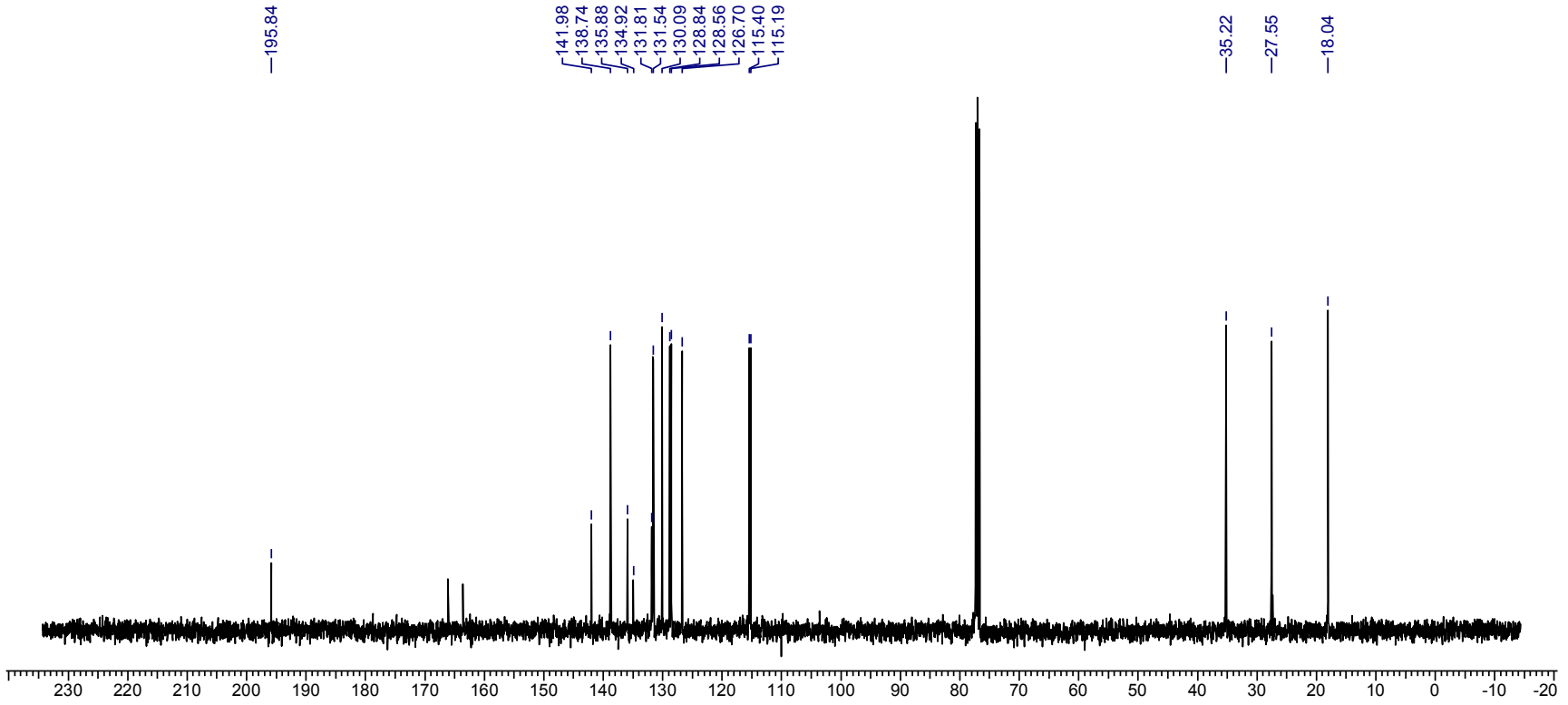
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27.55
18.04
230
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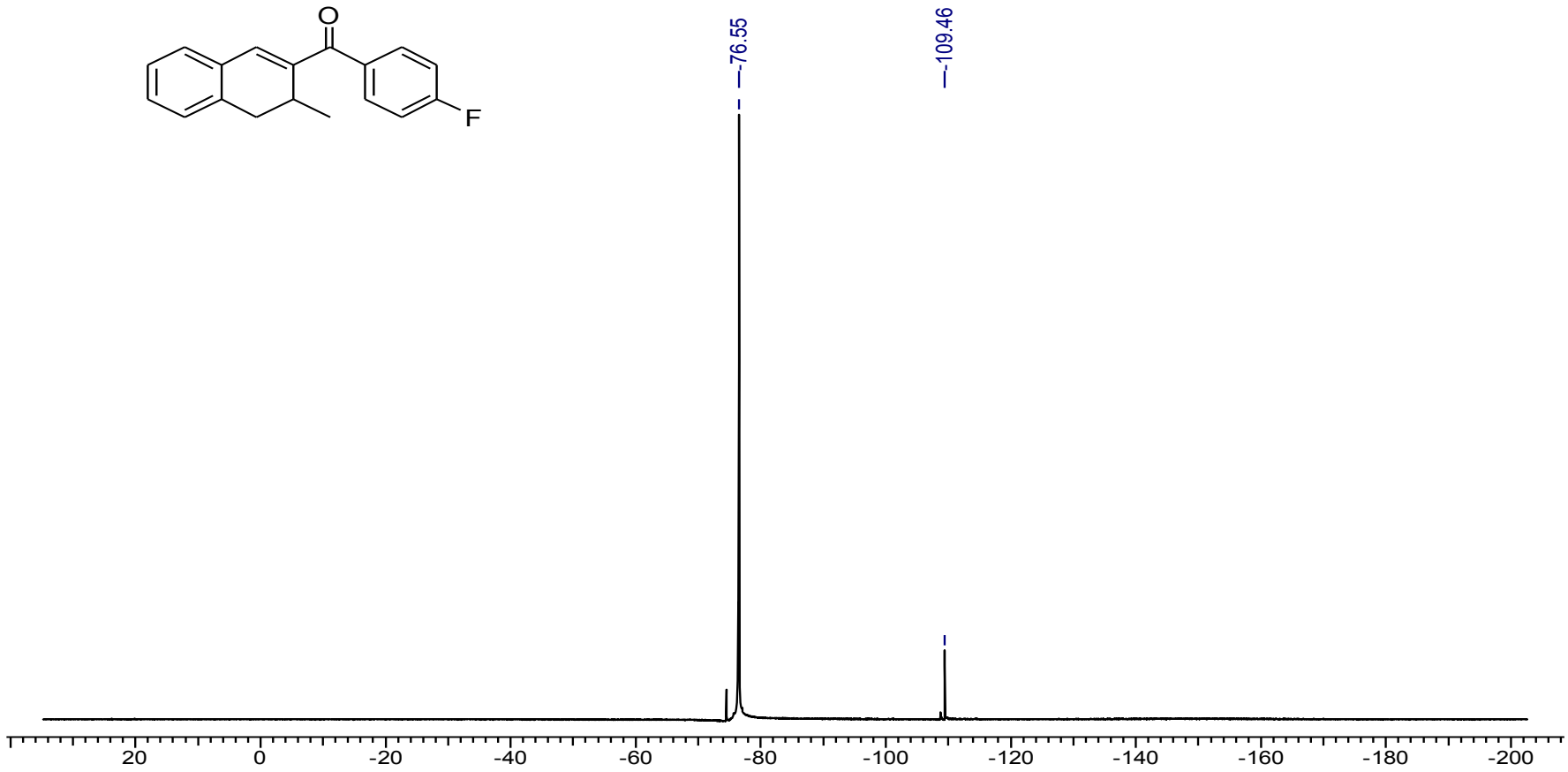
-20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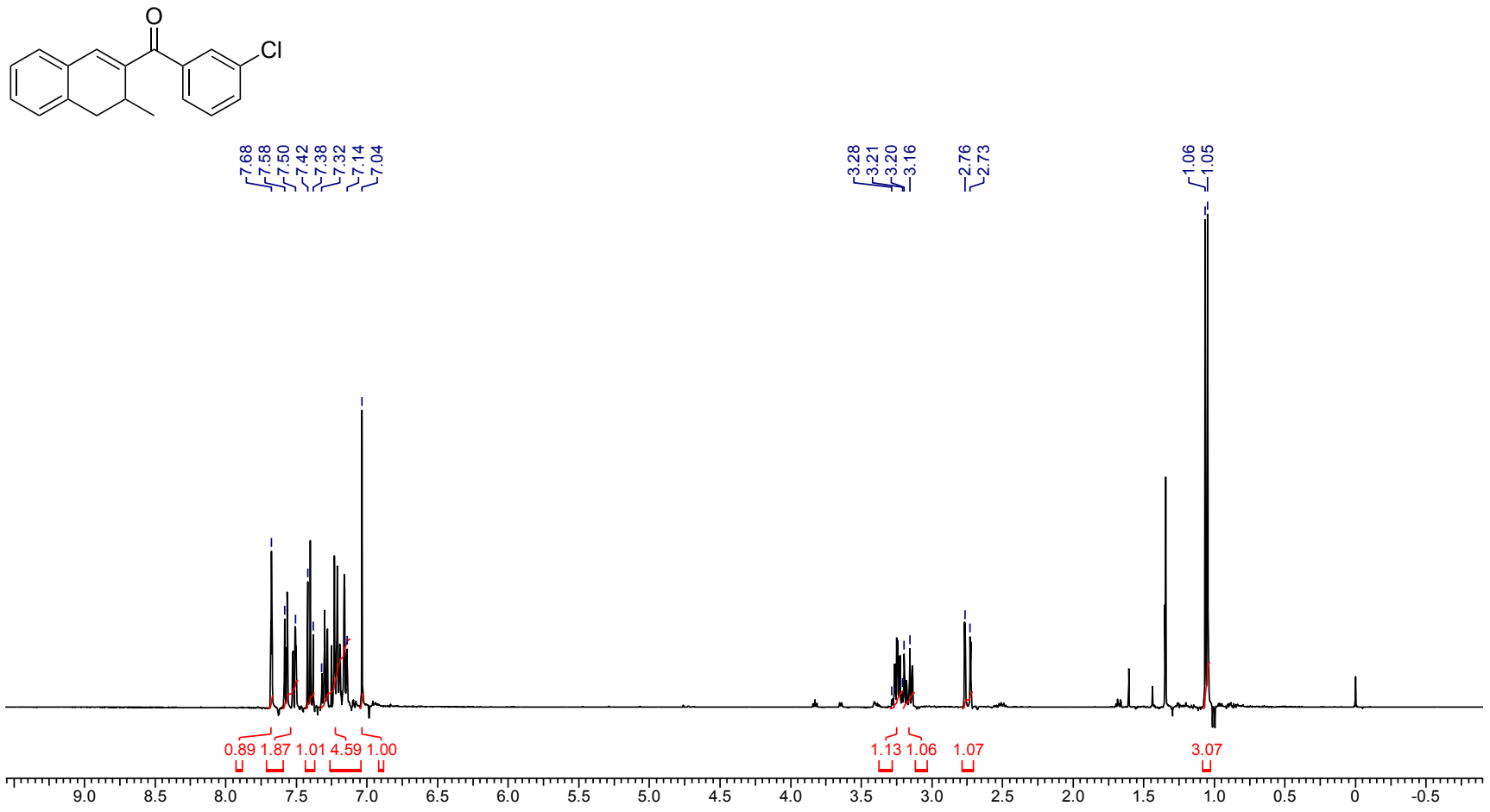
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3.16
2.76
2.73
1.06
1.05
0.89 1.87 1.01 4.59 1.00
1.13 1.06 1.07
3.07
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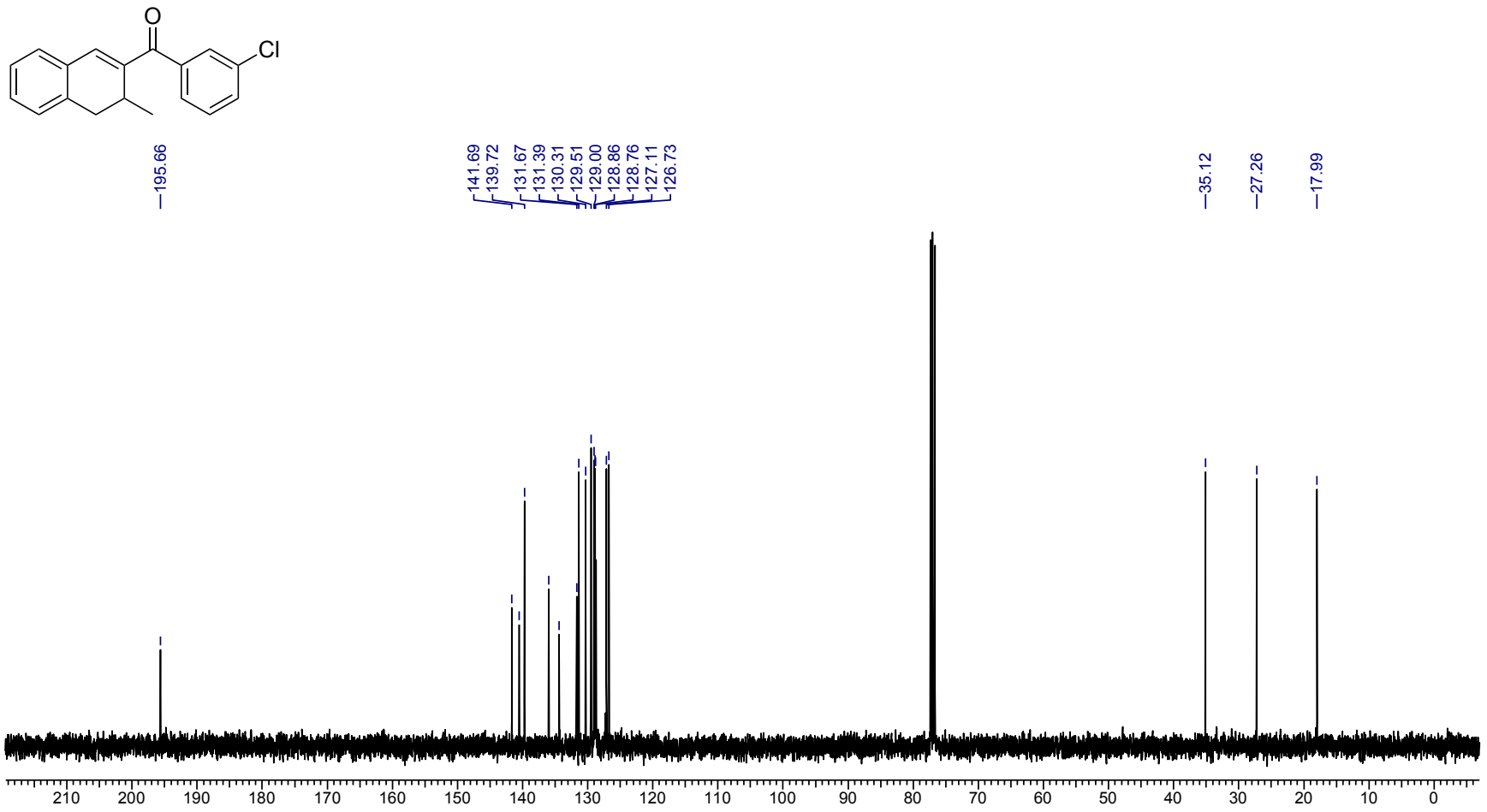
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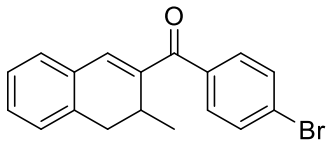
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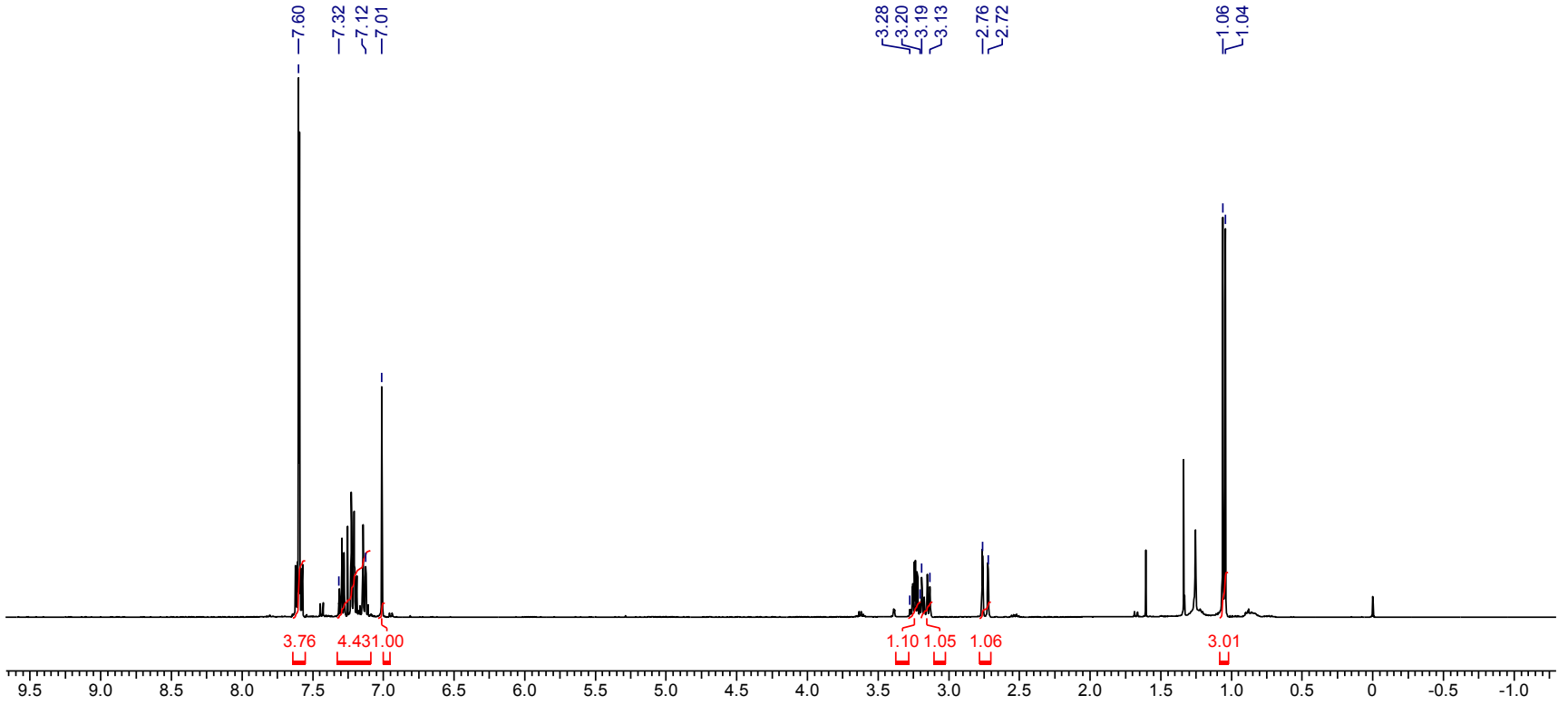
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1.00
1.10
1.05
1.06
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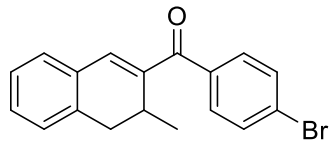
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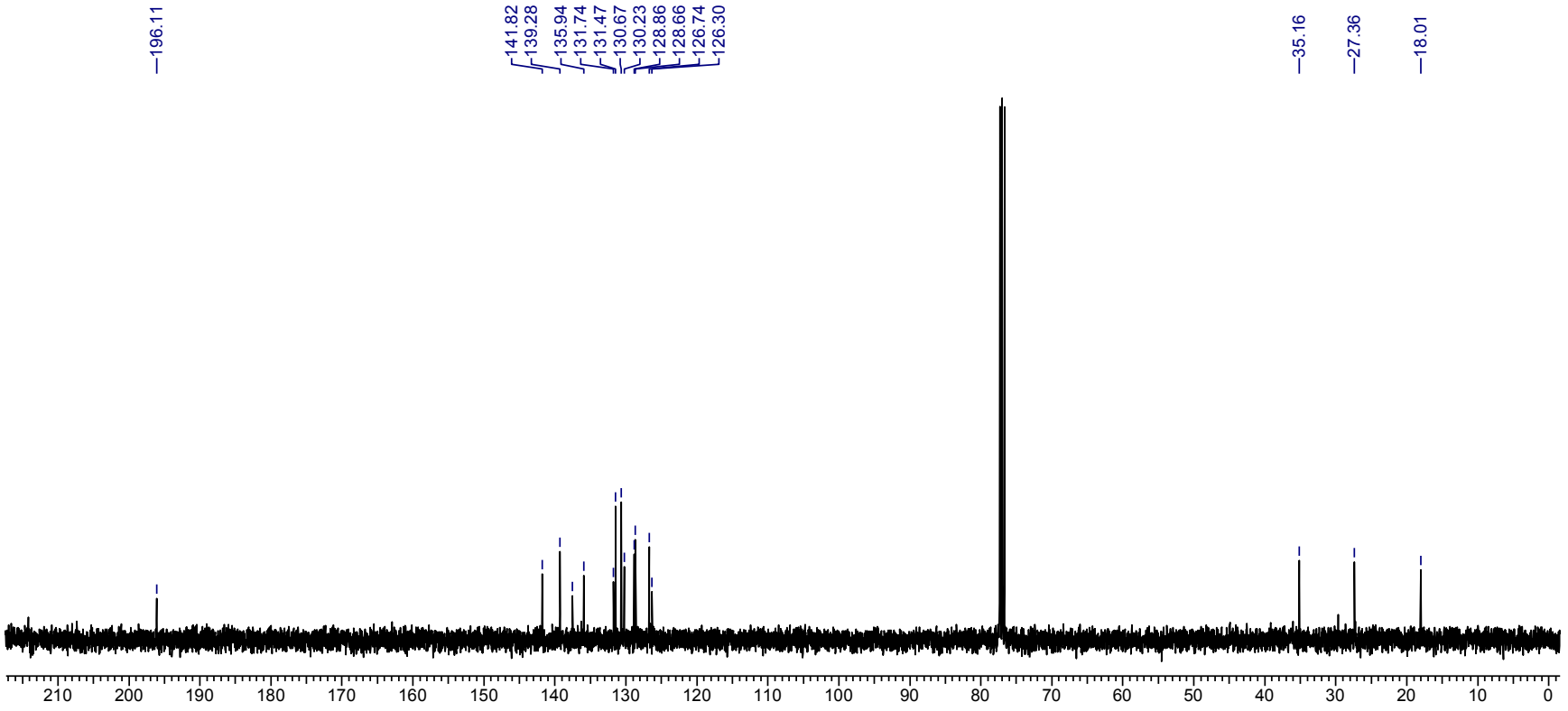
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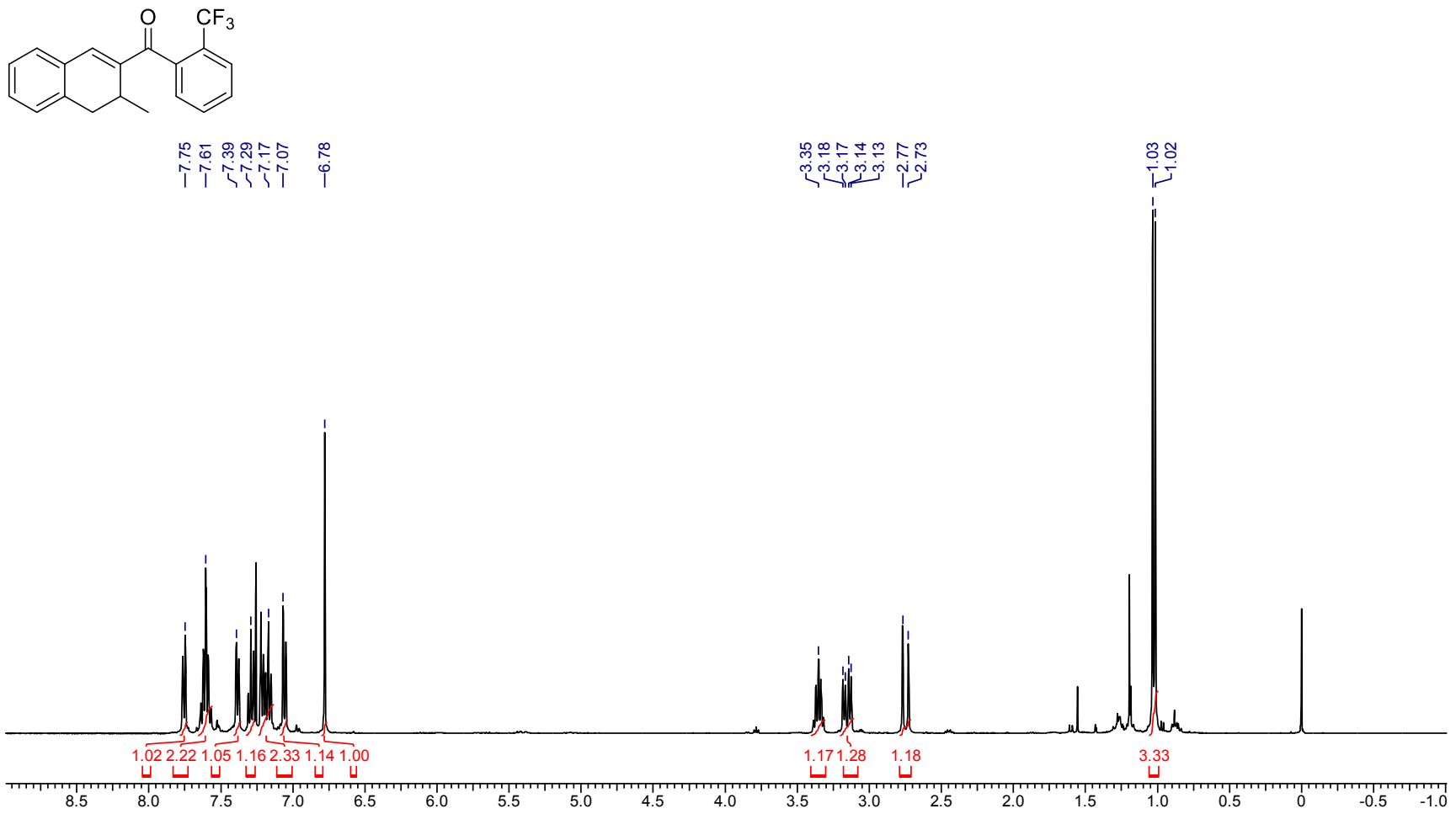
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3.13
2.77
2.73
1.03
1.02
1.02 2.22 1.05 1.16 2.33 1.14 1.00
1.17 1.28
1.18
3.33
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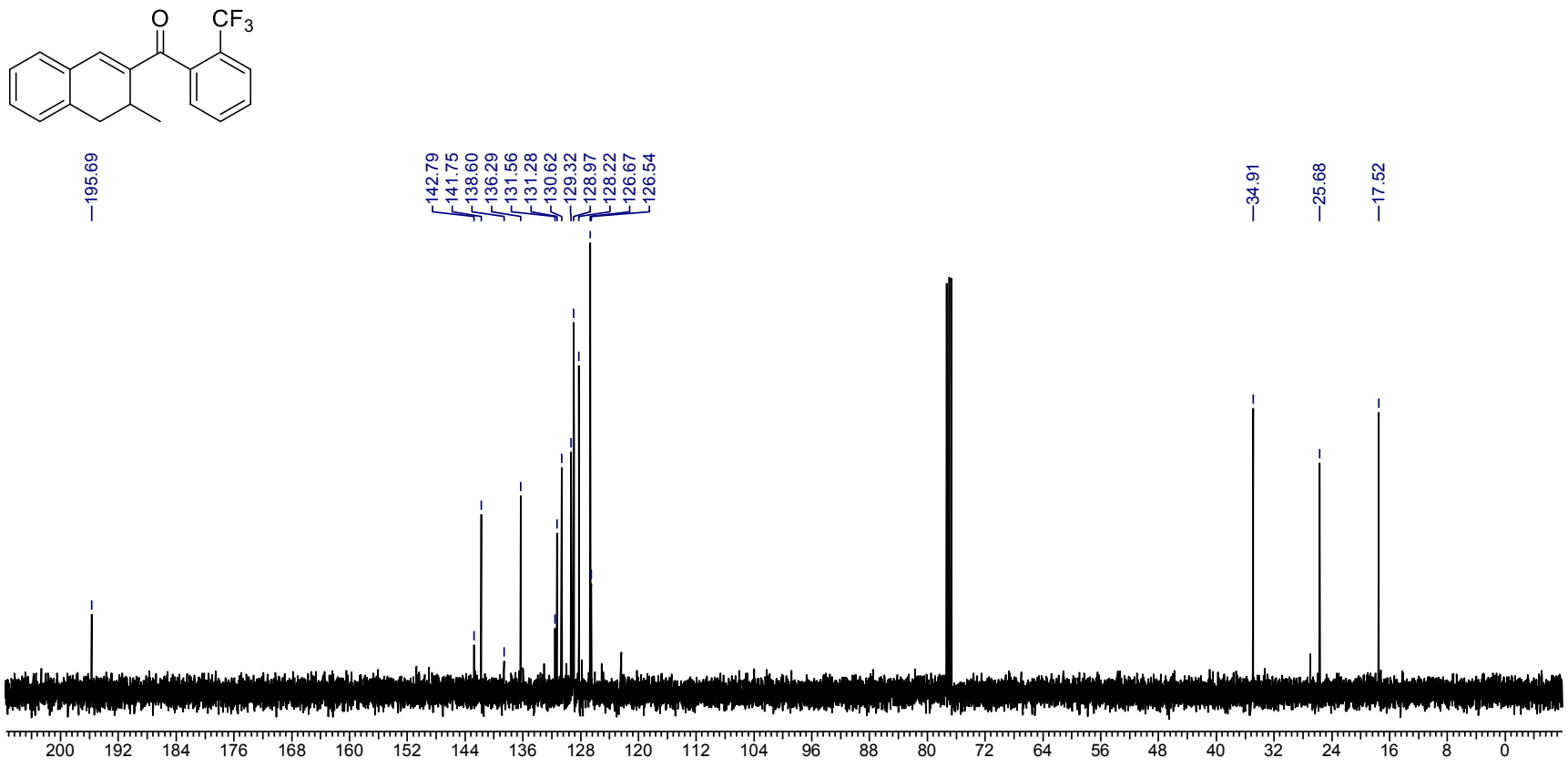
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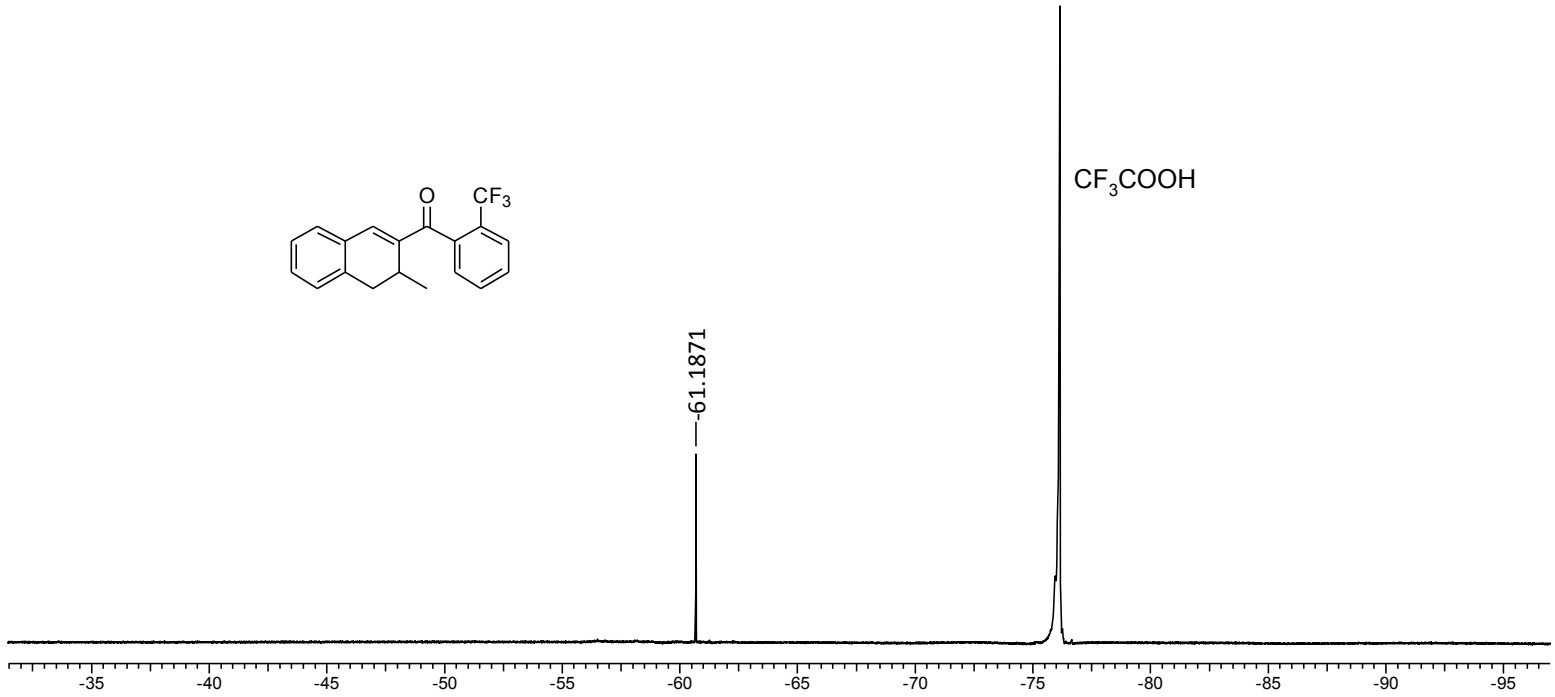
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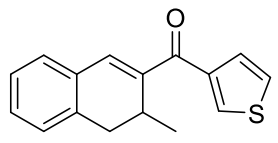
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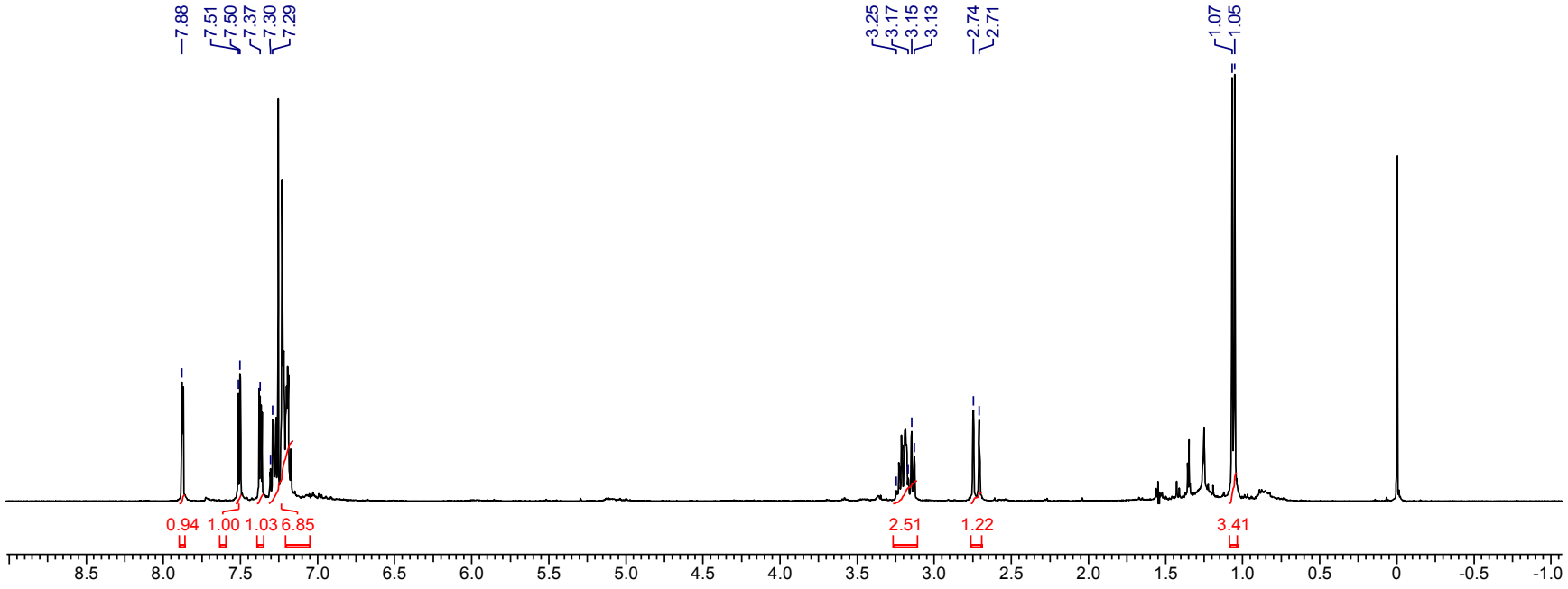
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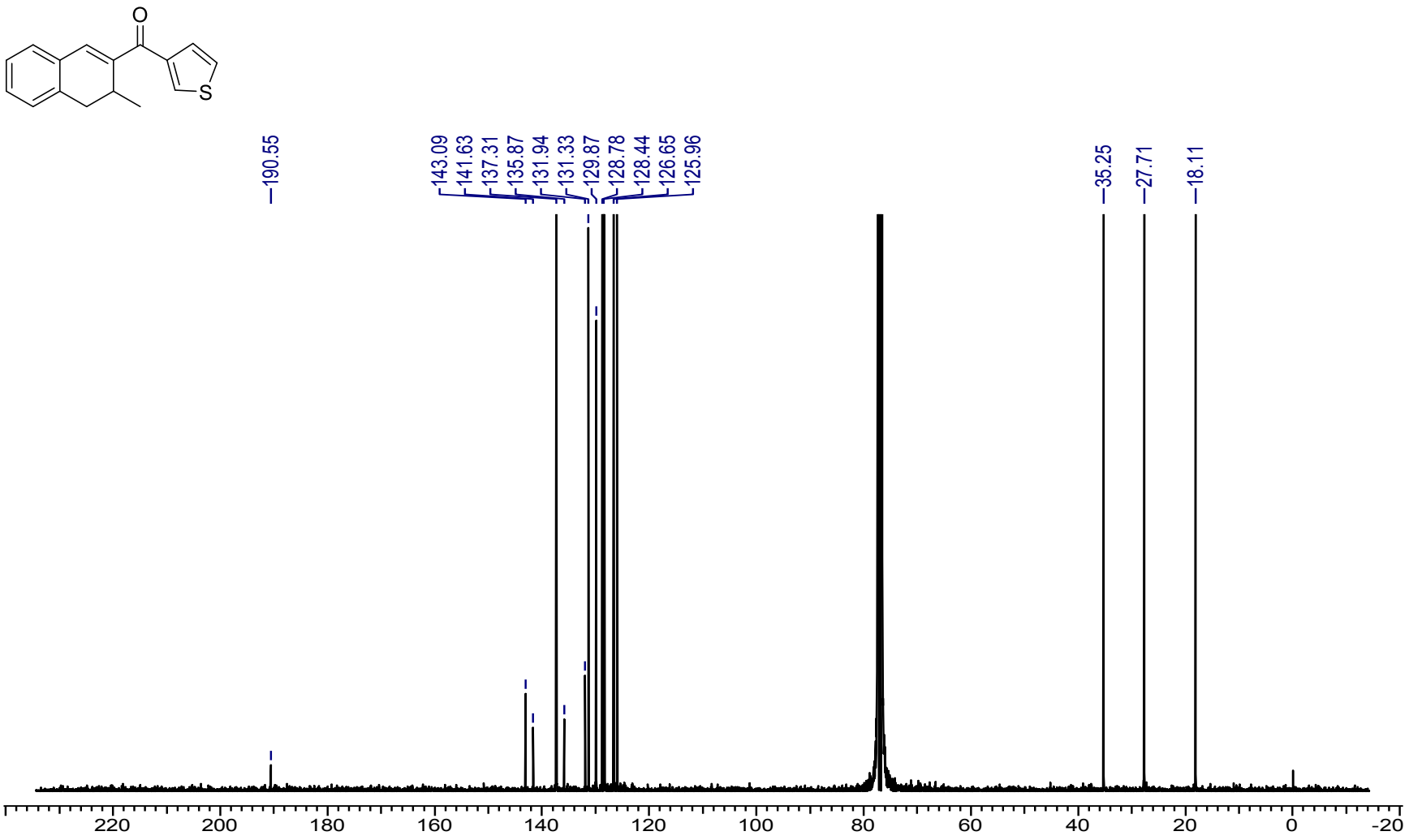
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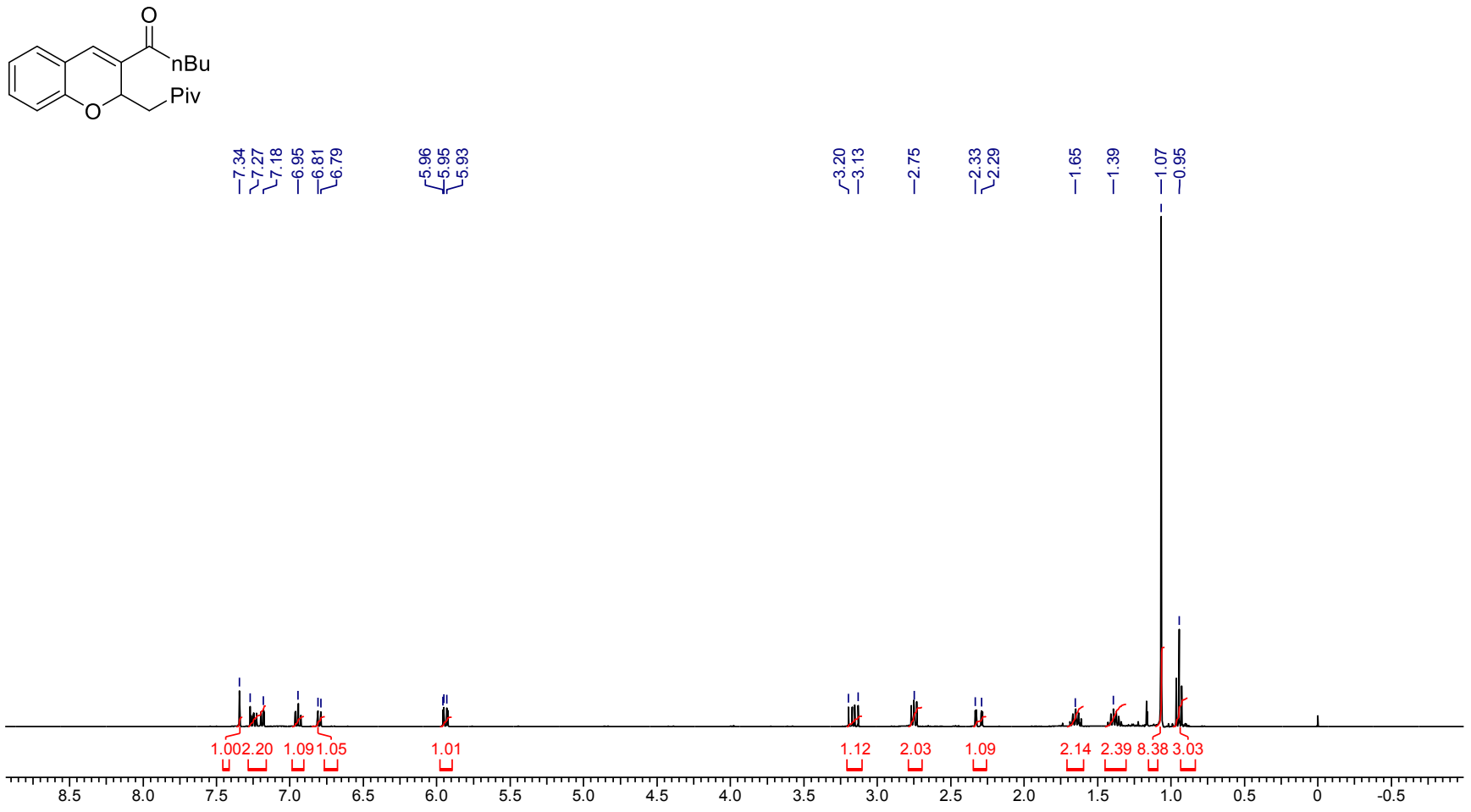
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1.39
1.07
0.95
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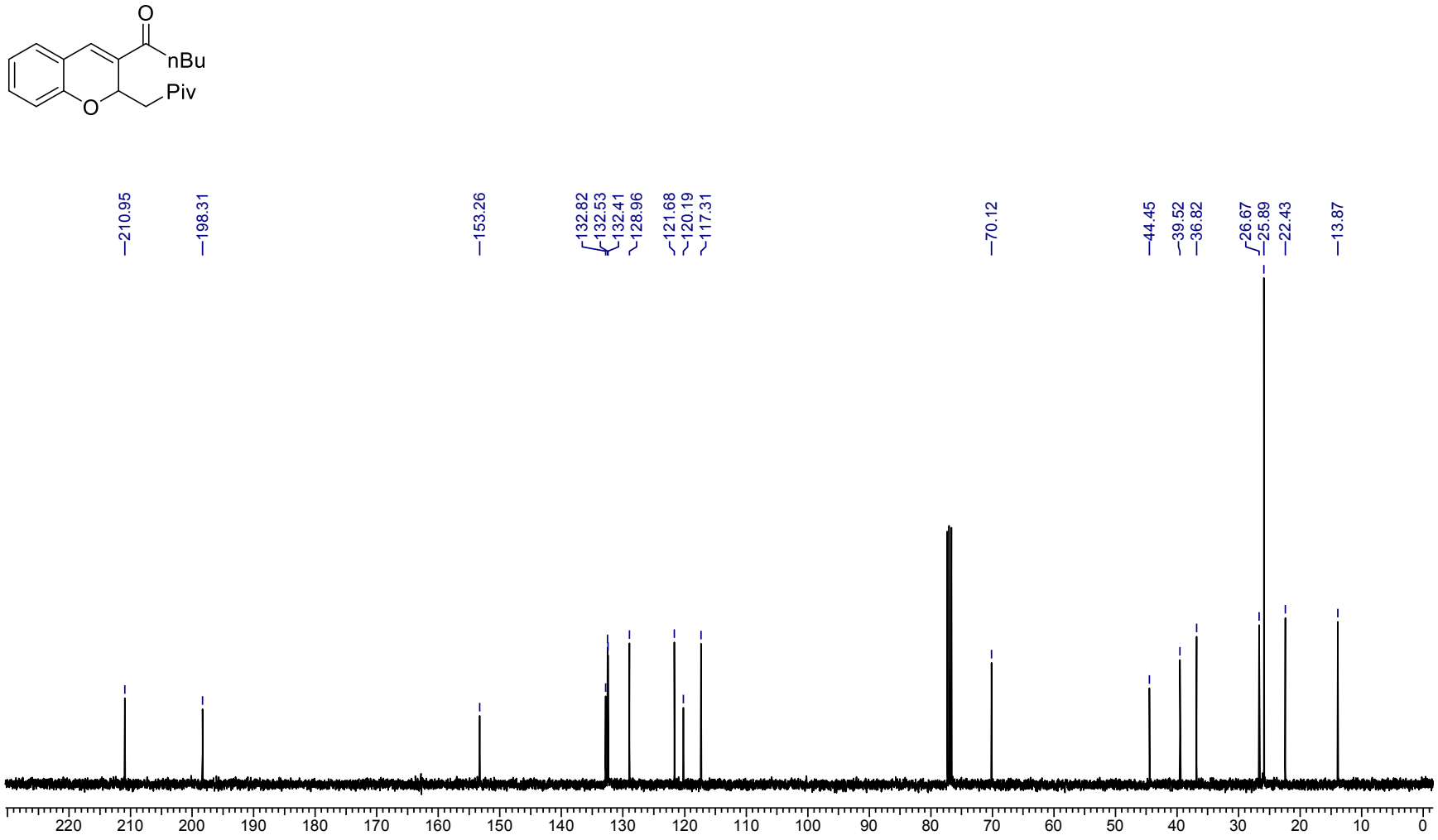
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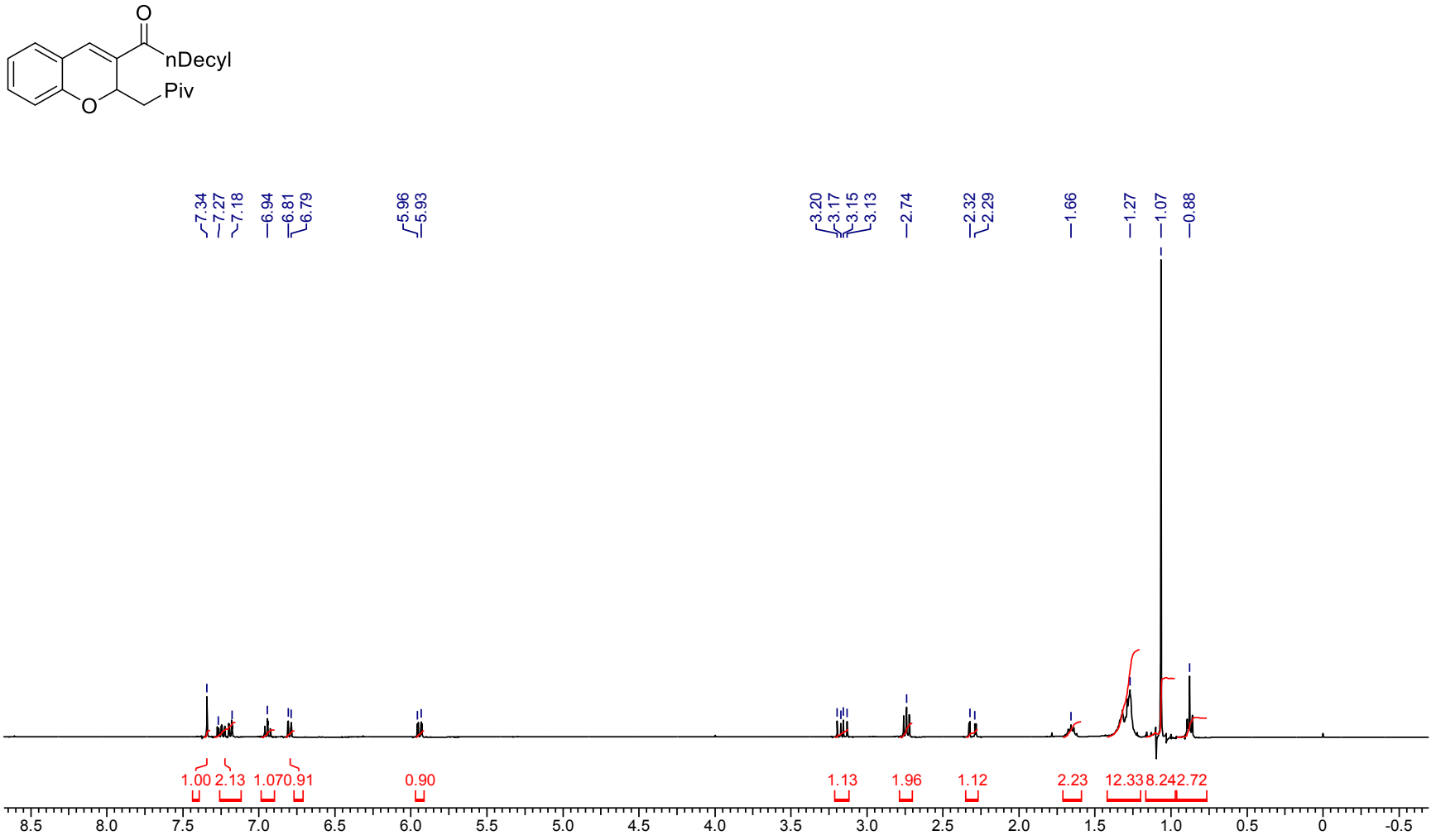
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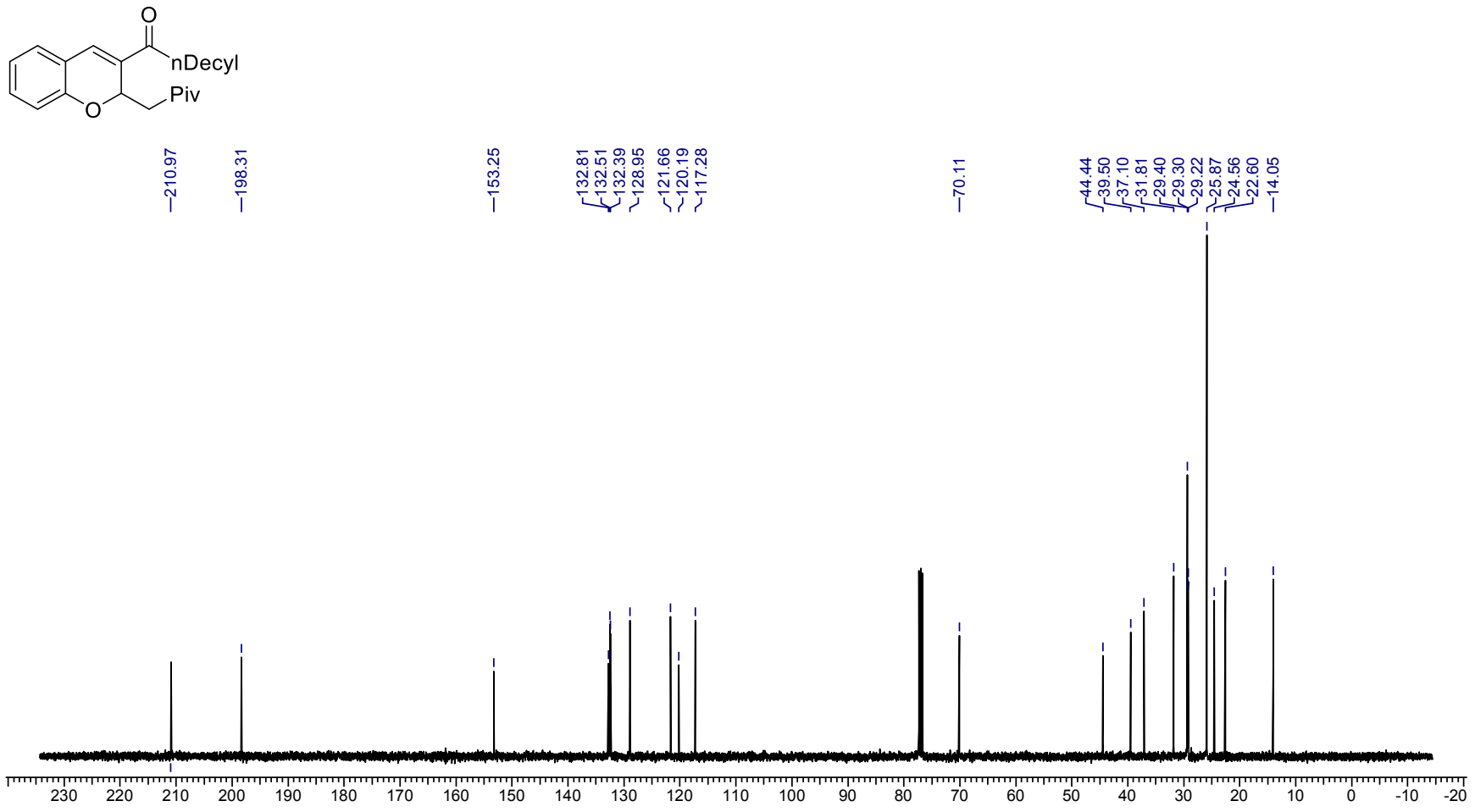
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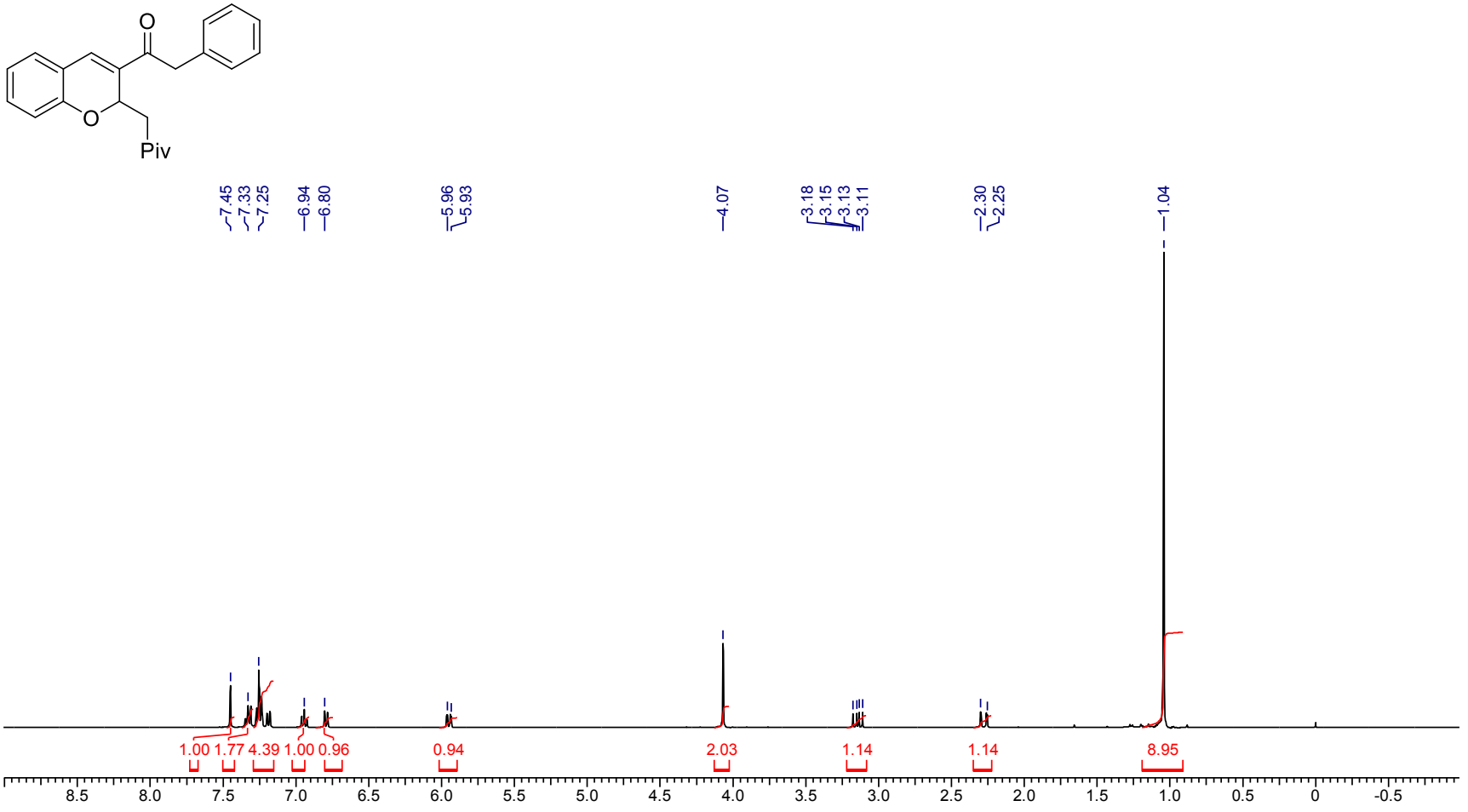
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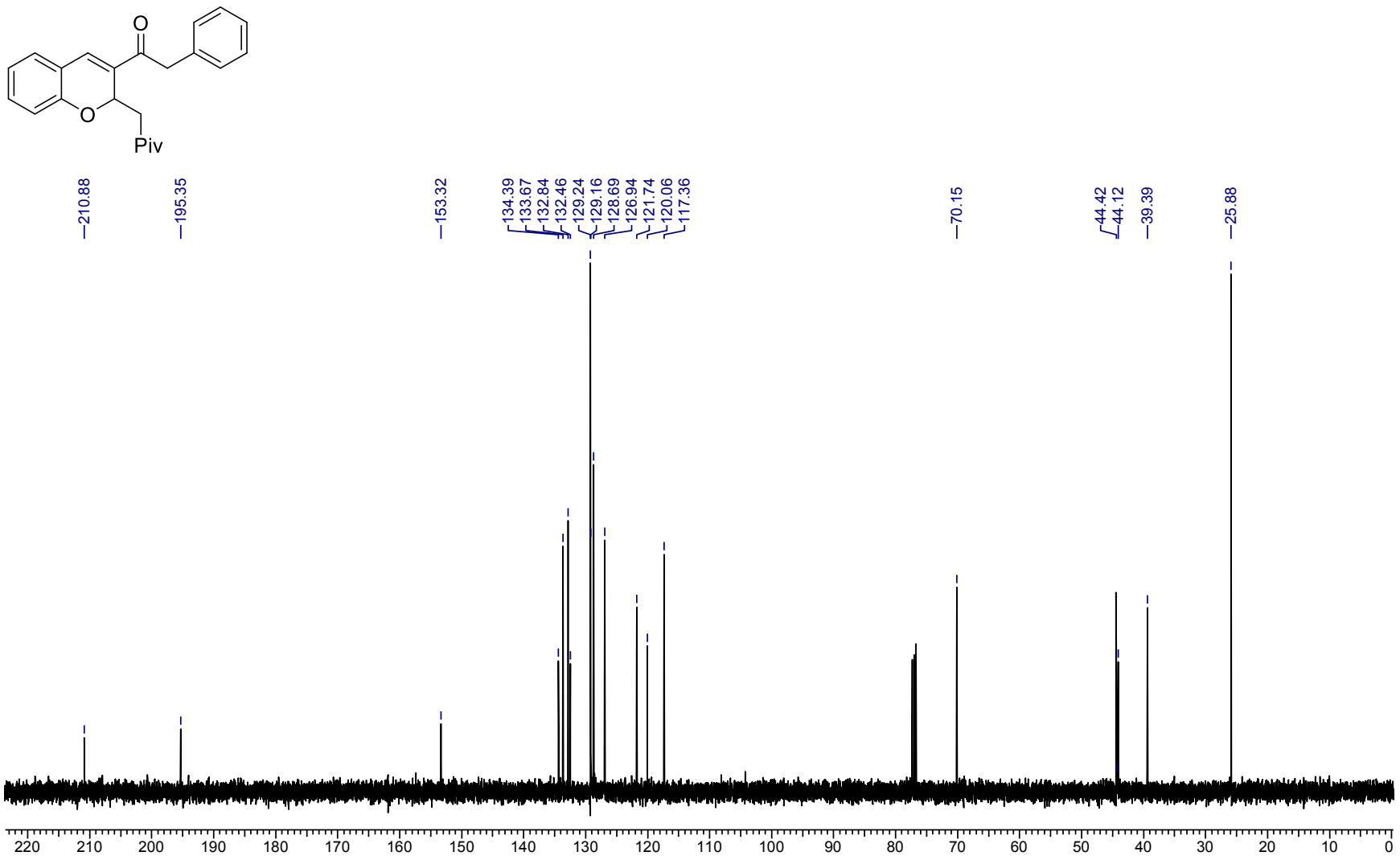
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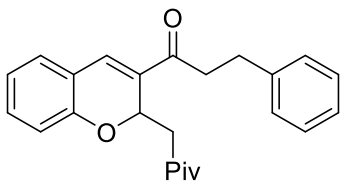
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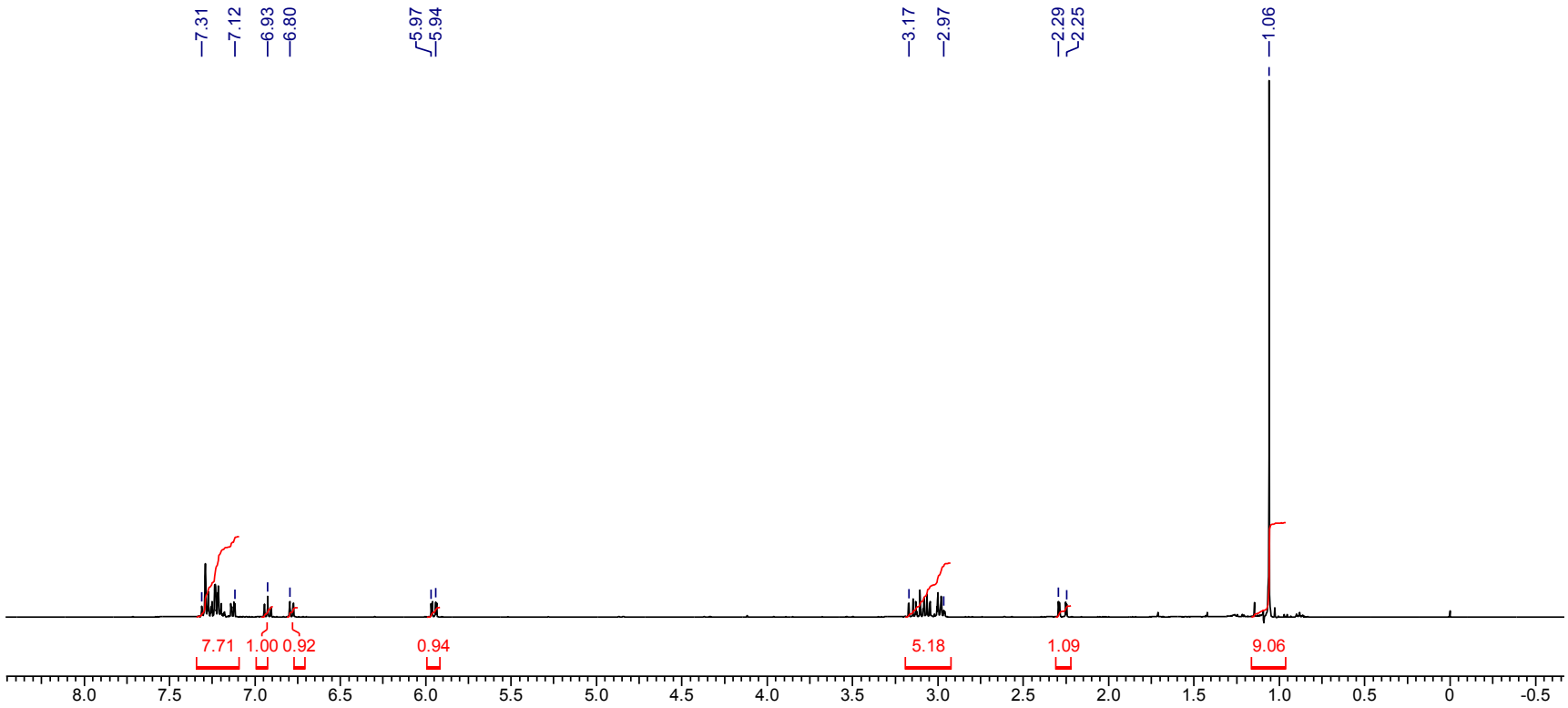
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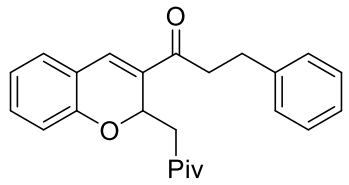
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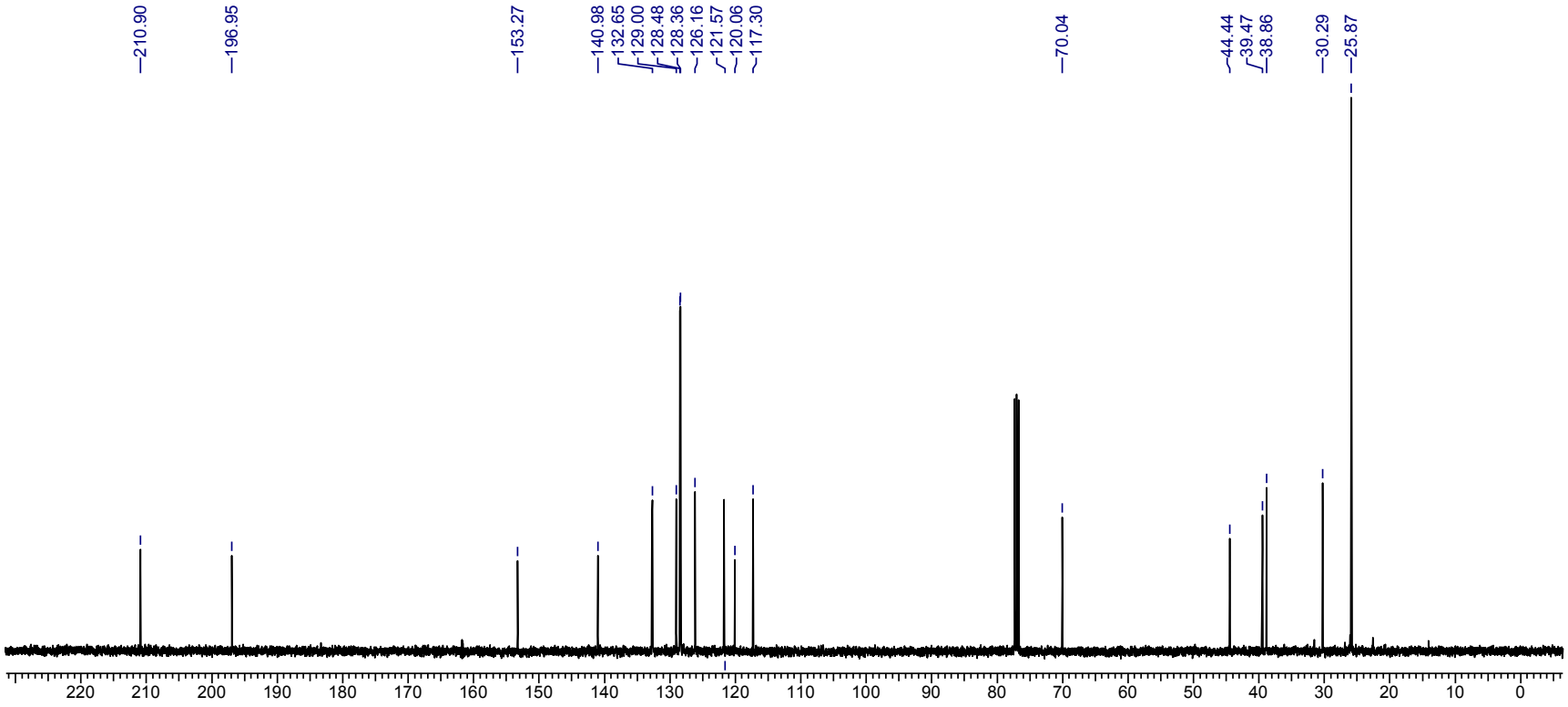
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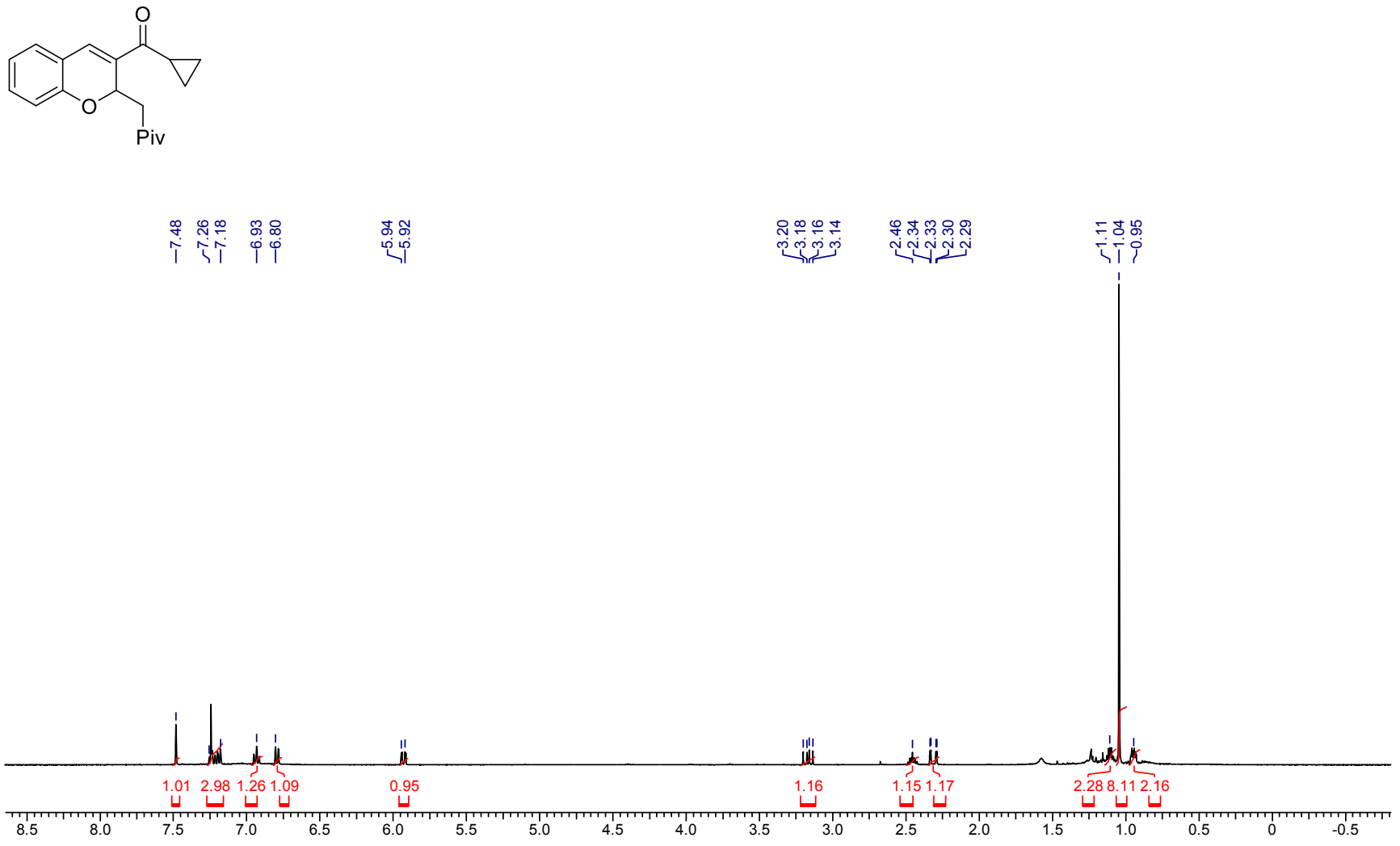
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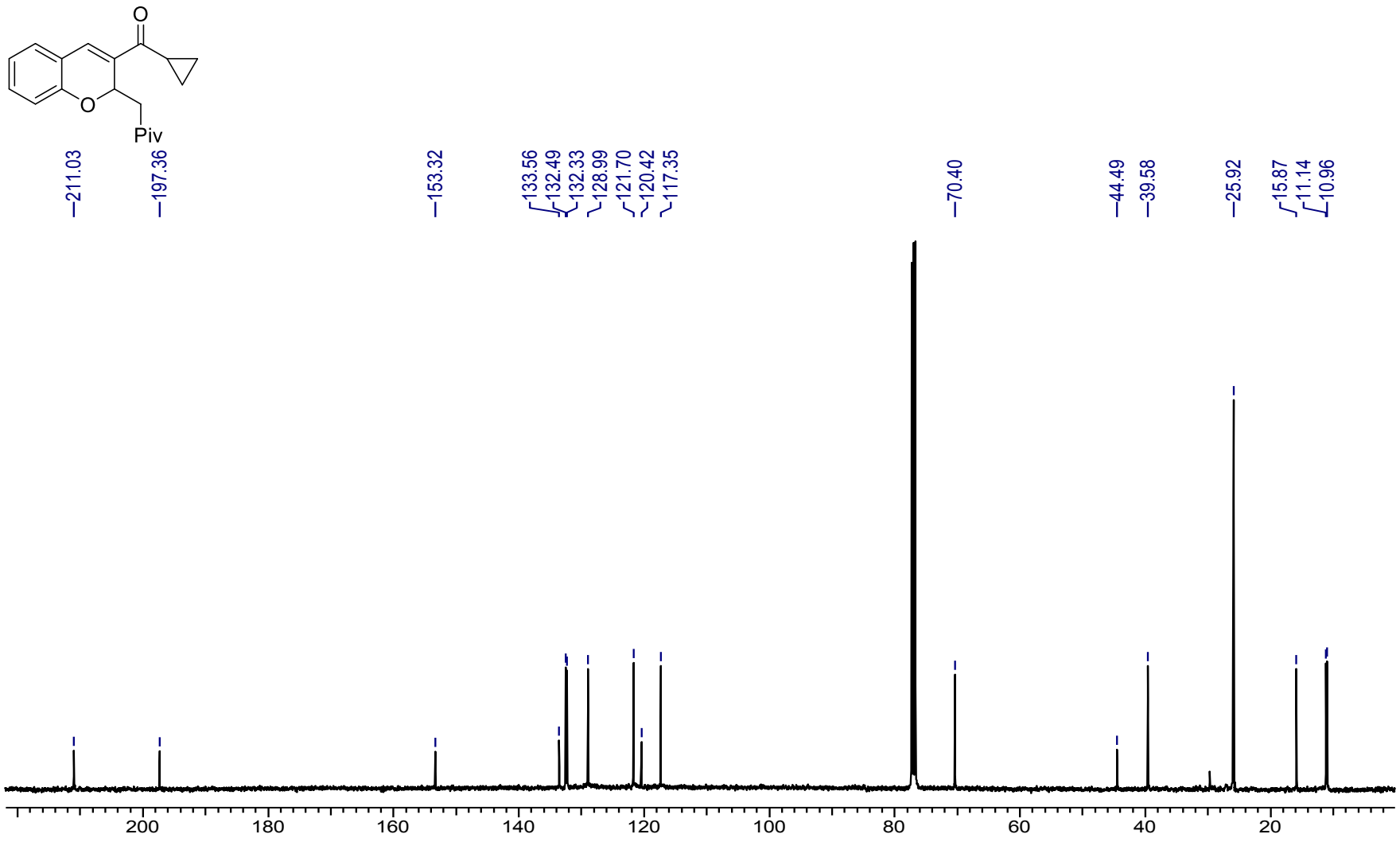
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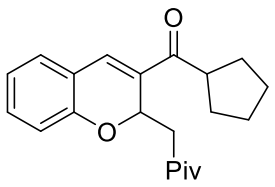
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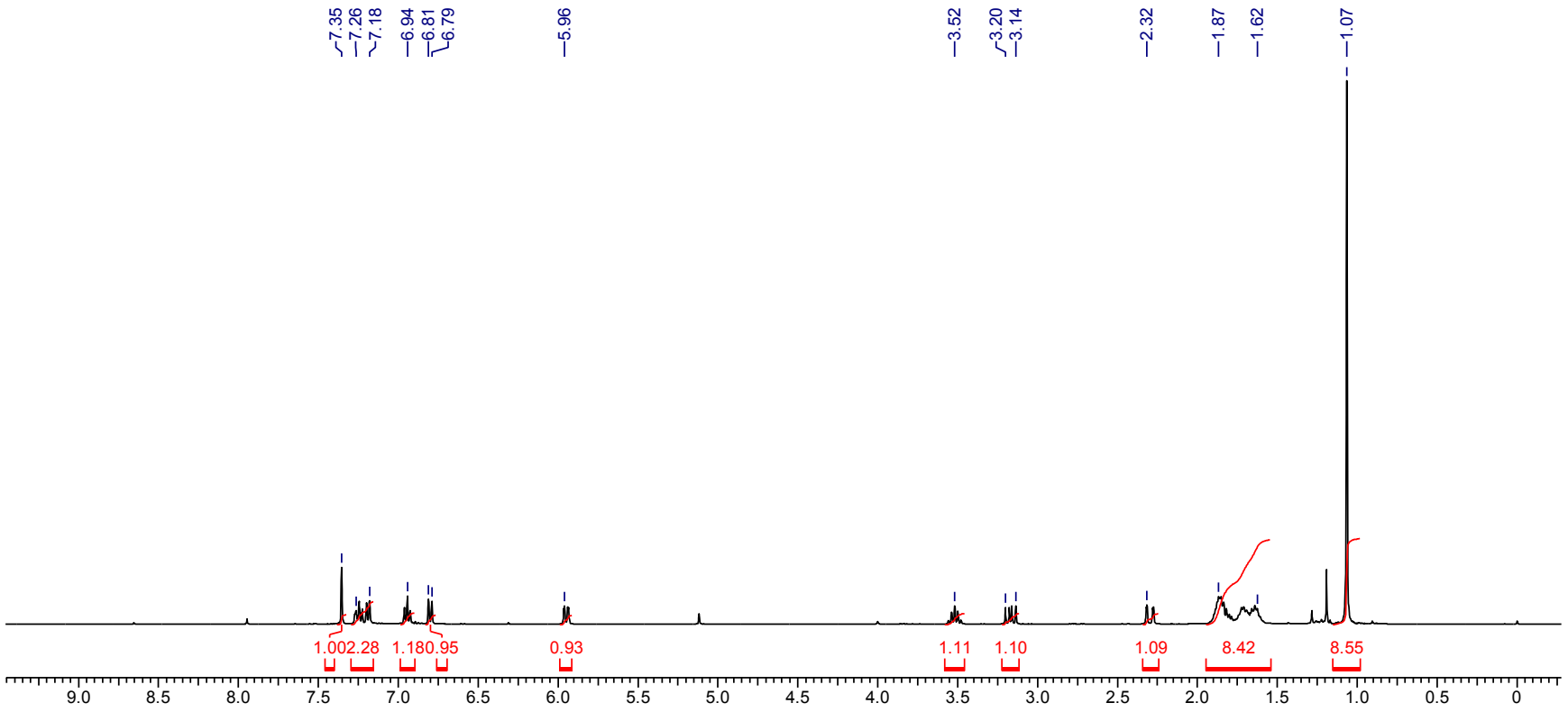
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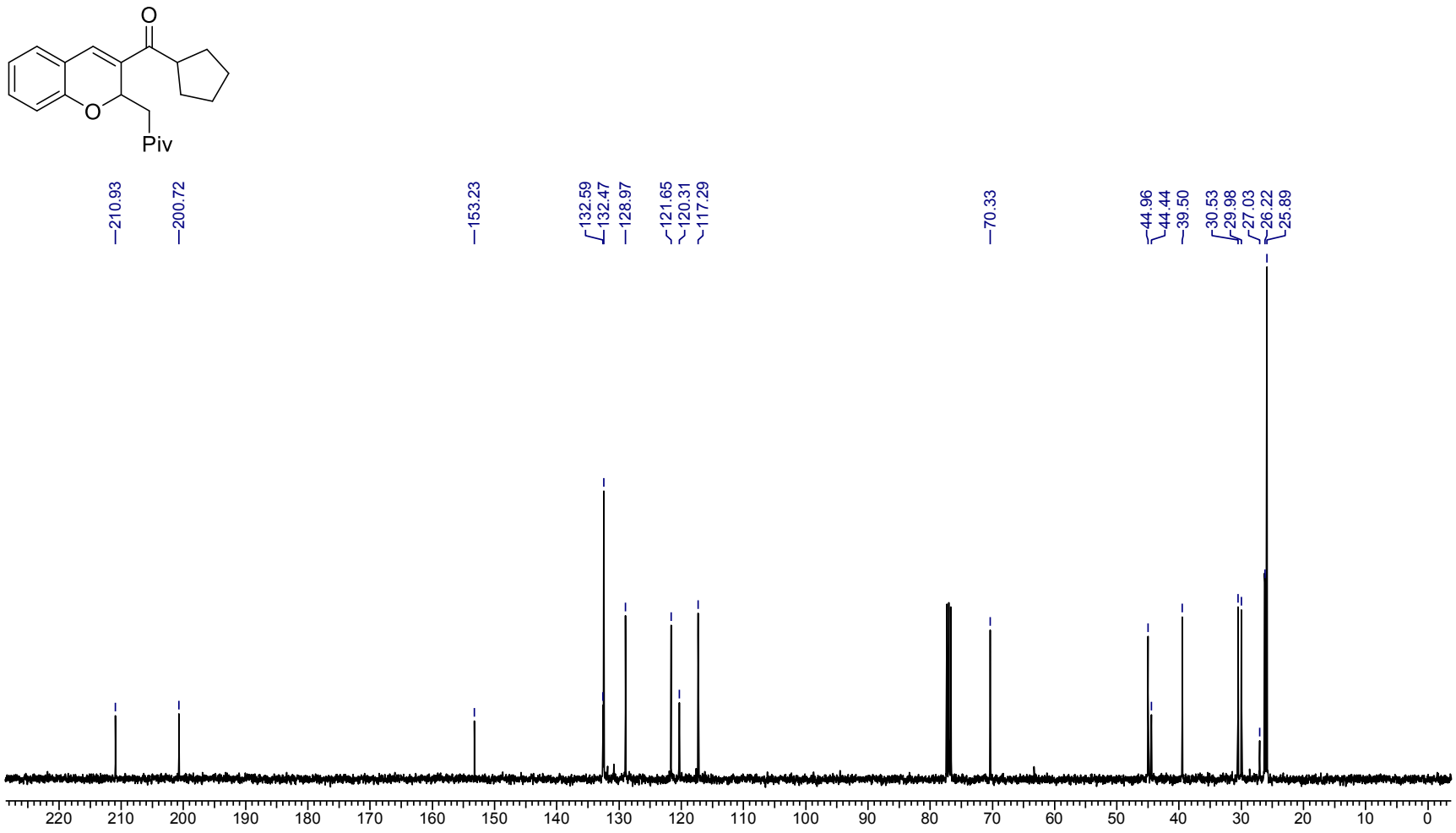
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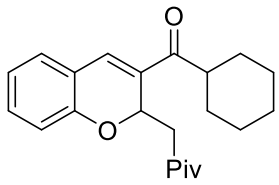
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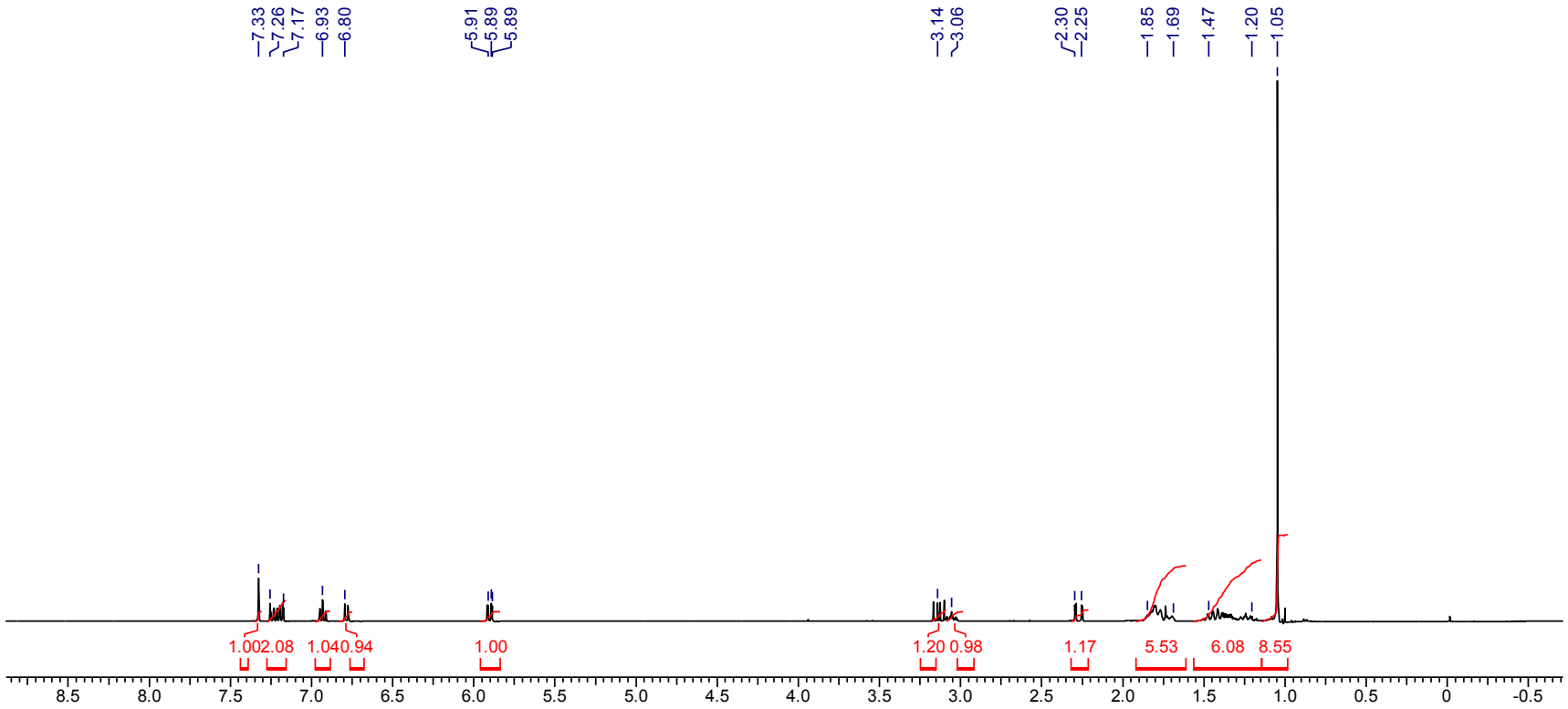
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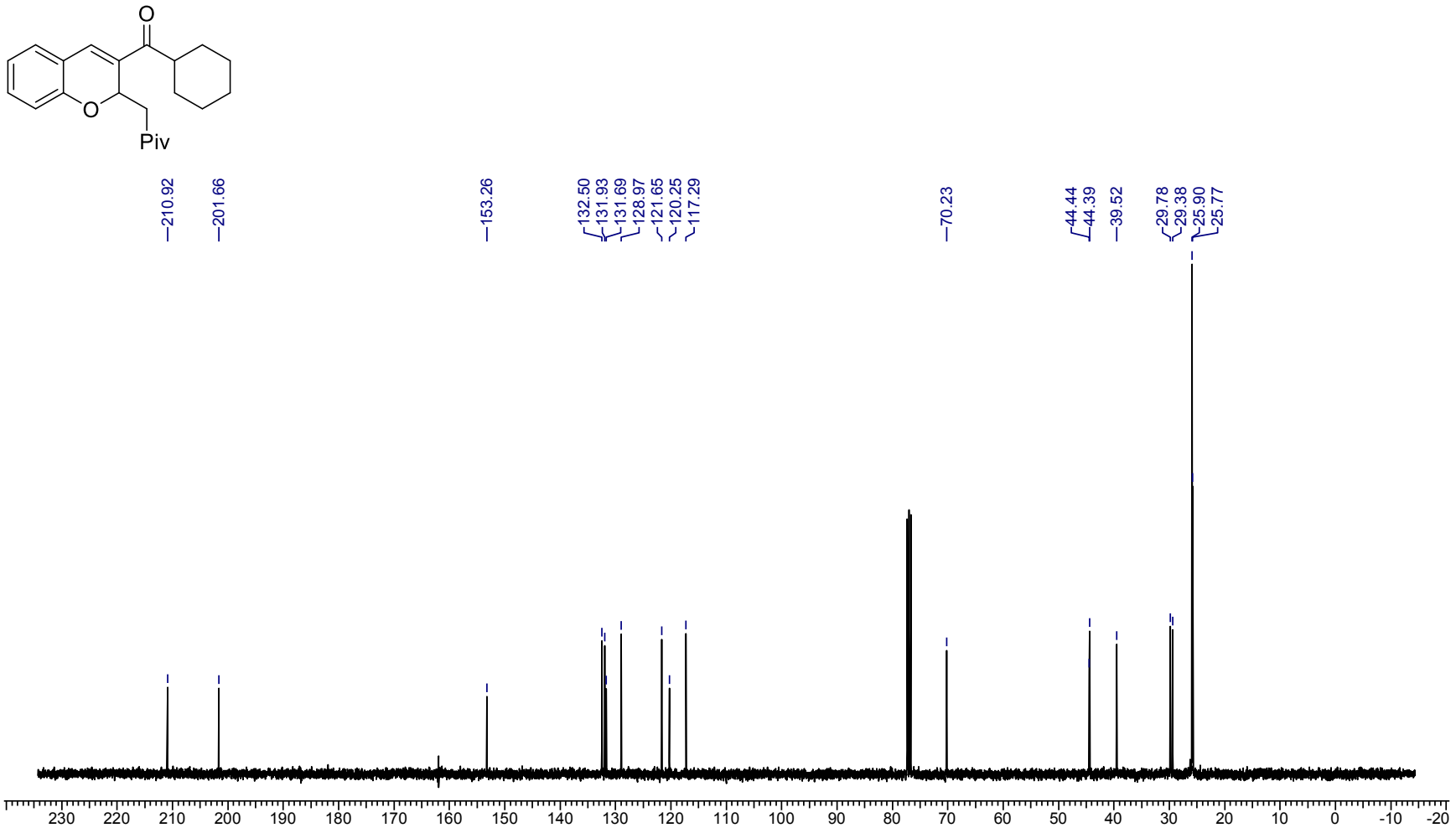
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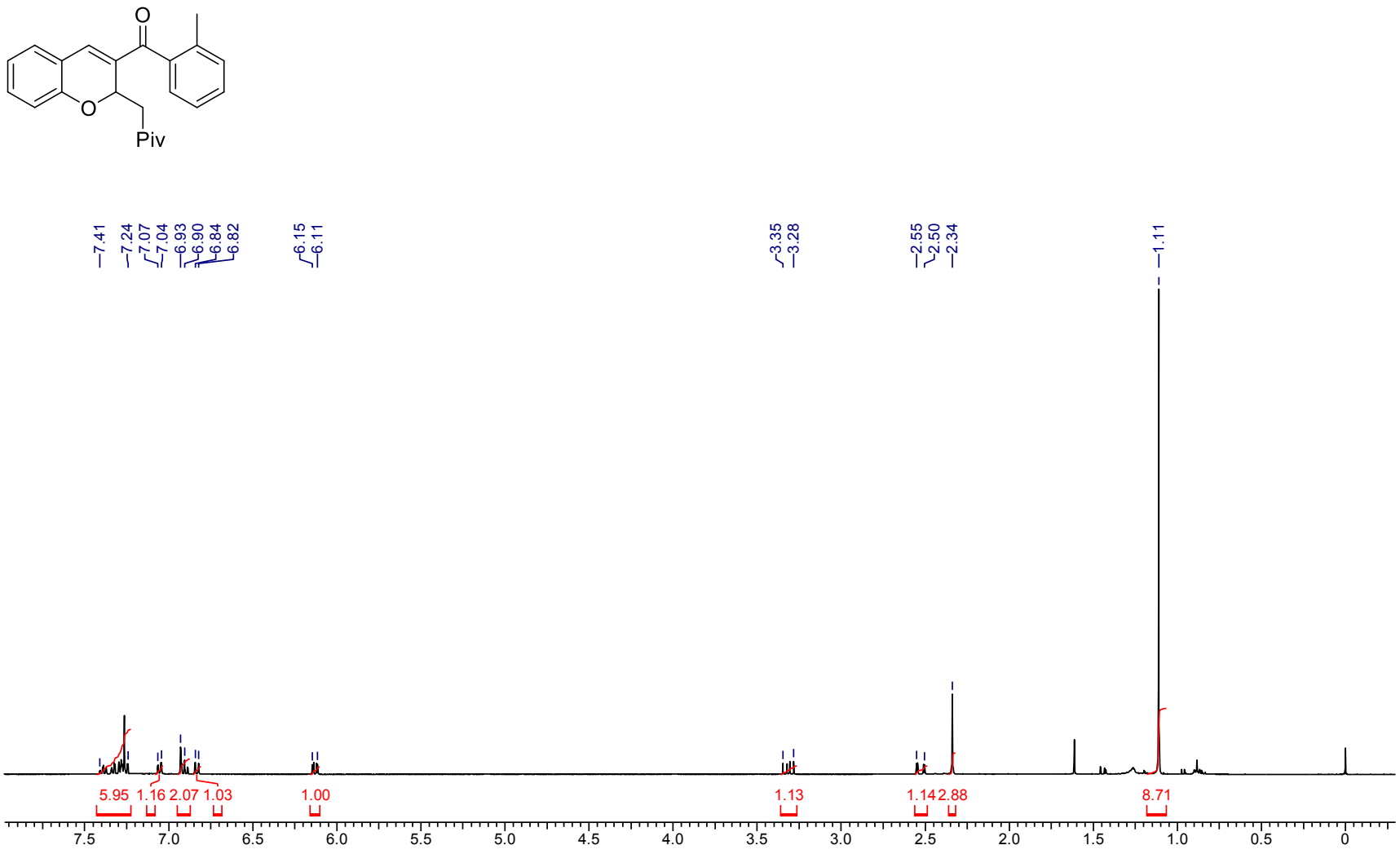
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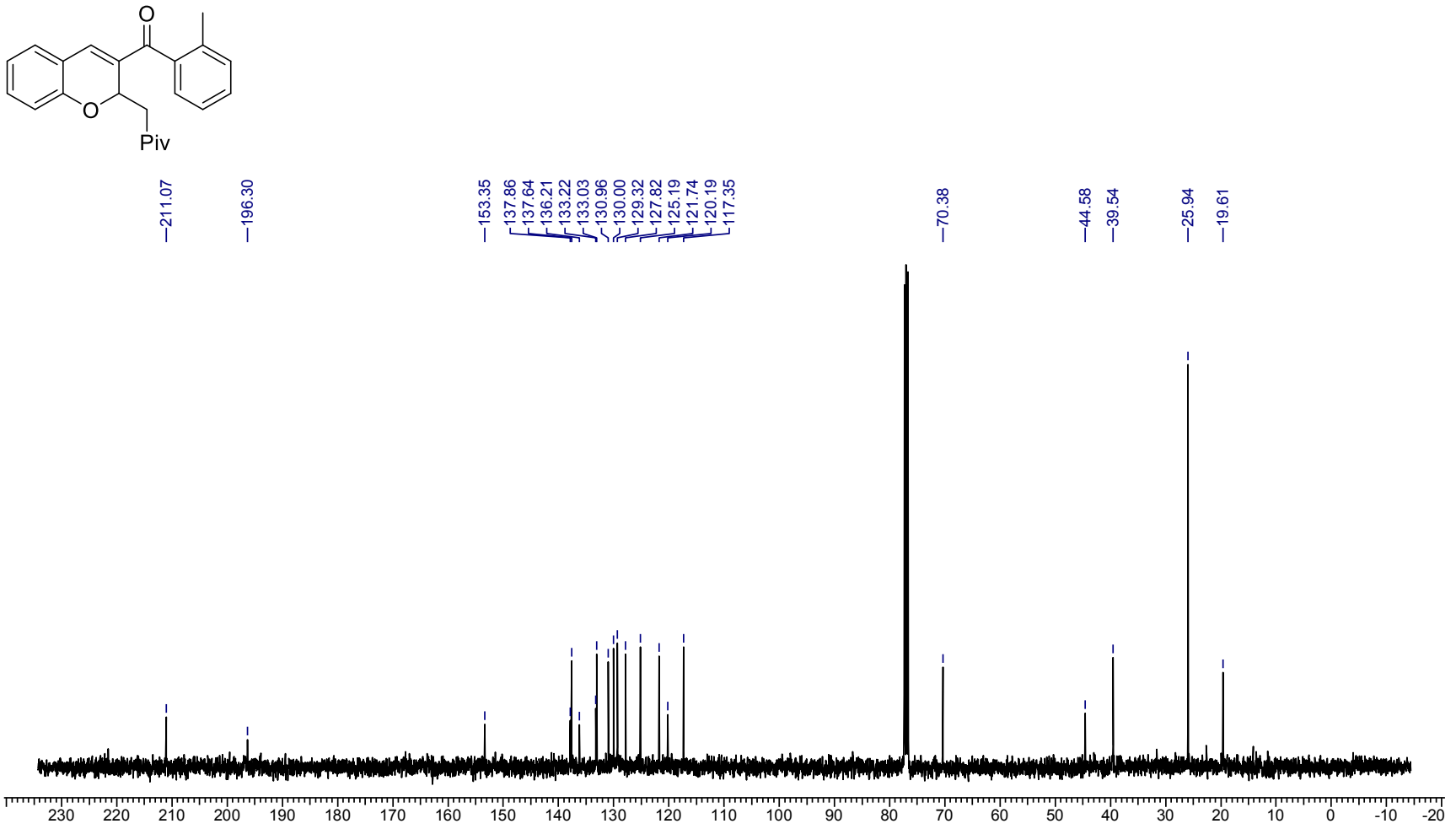
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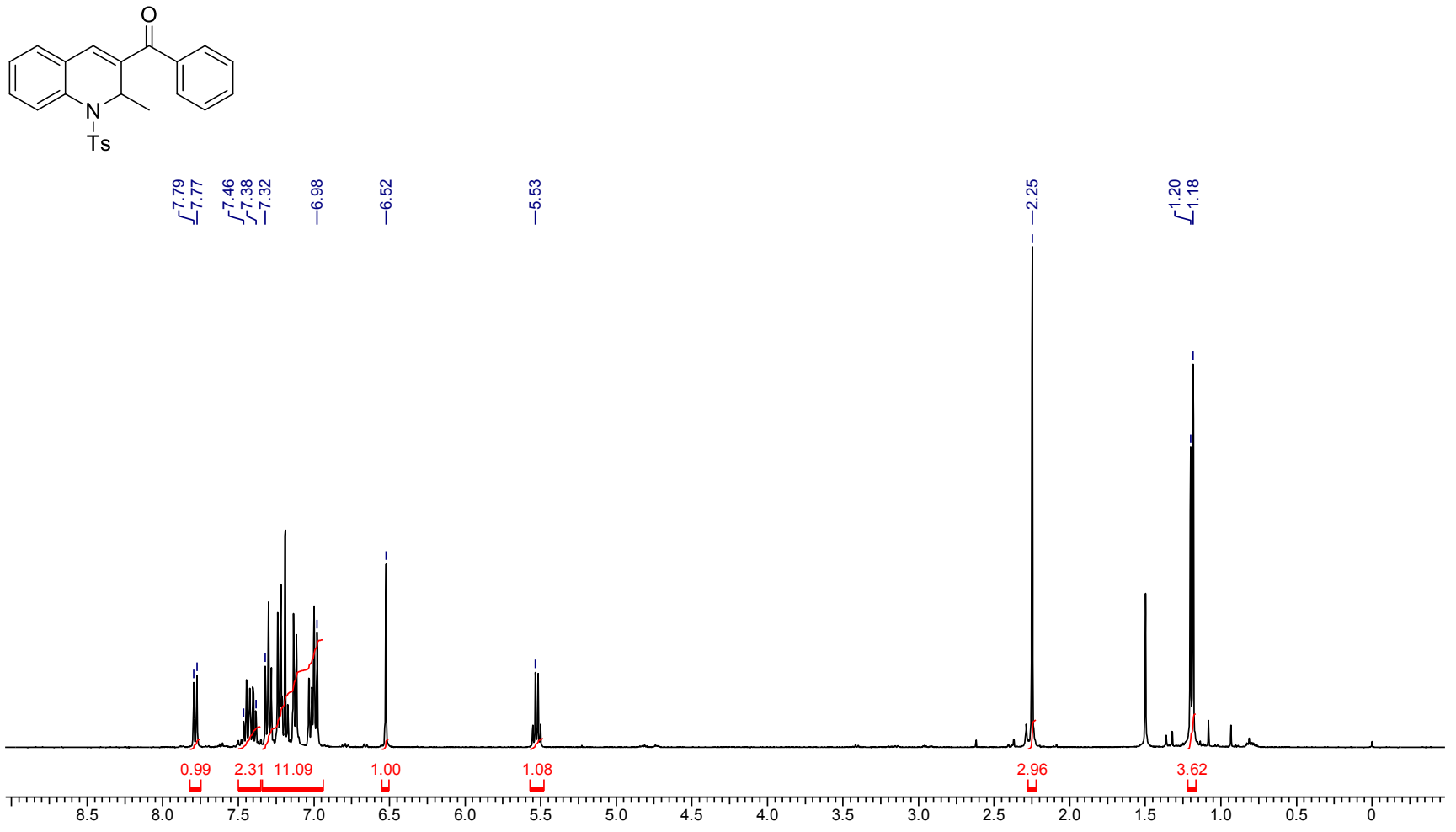
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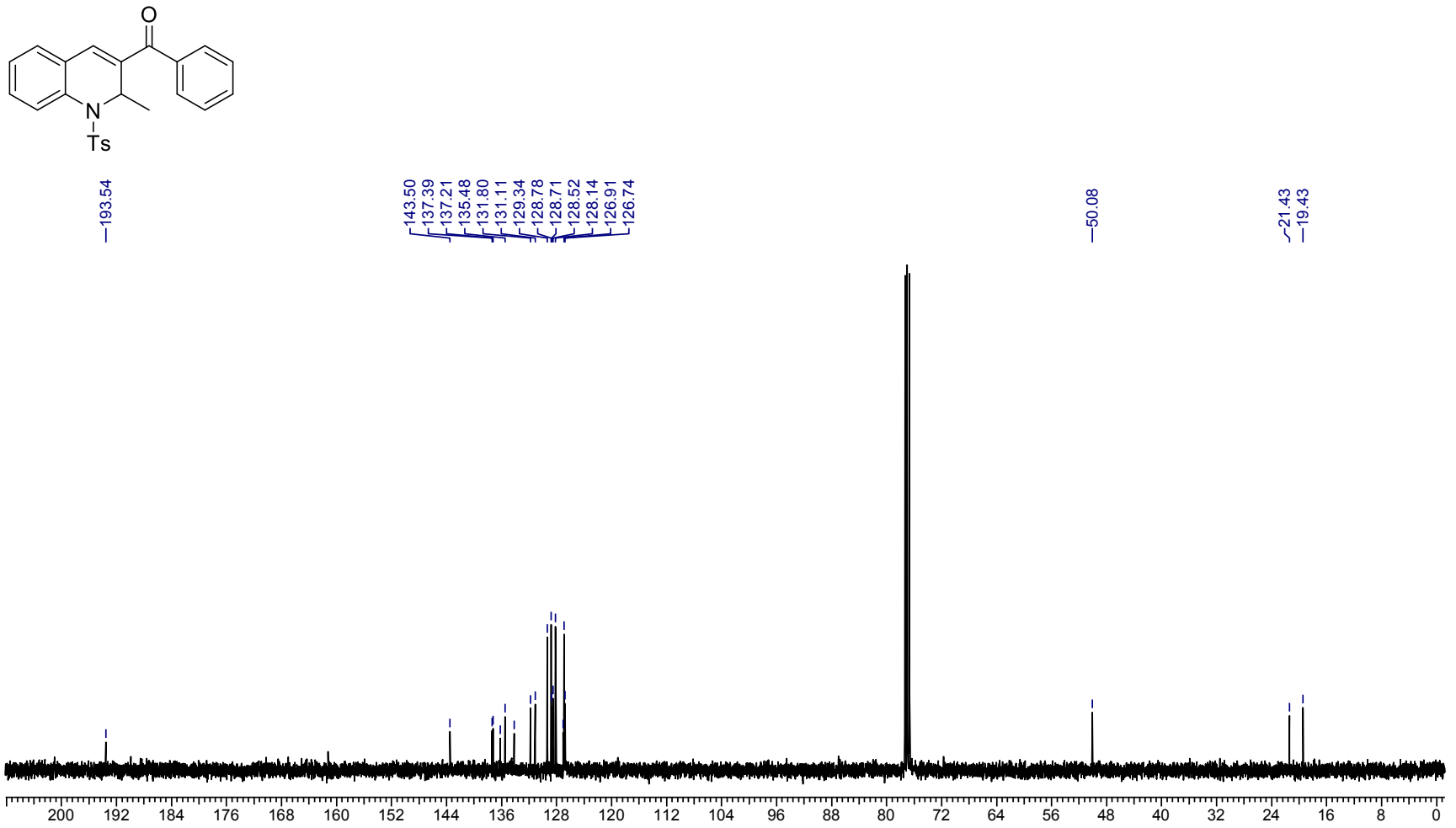
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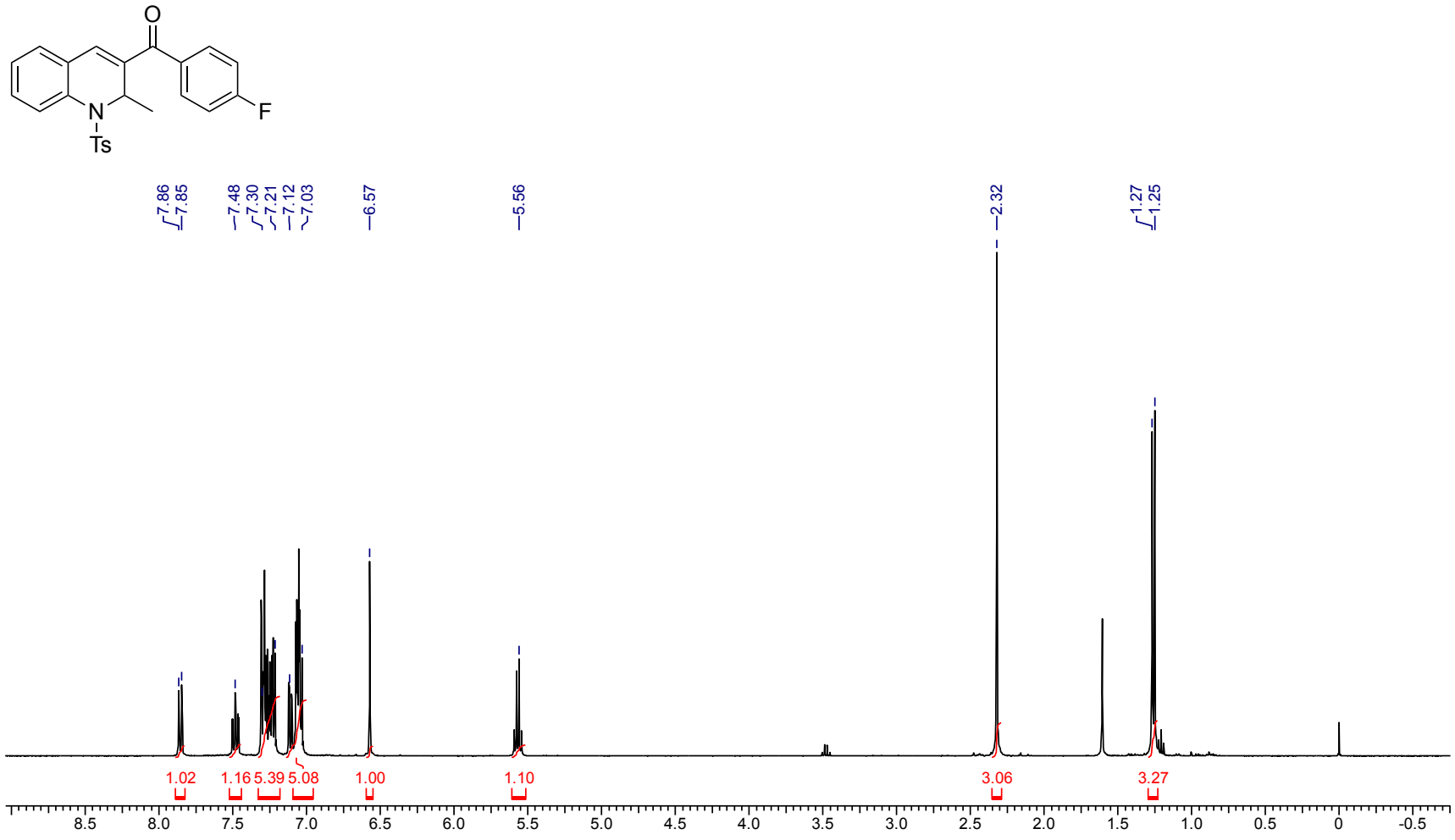
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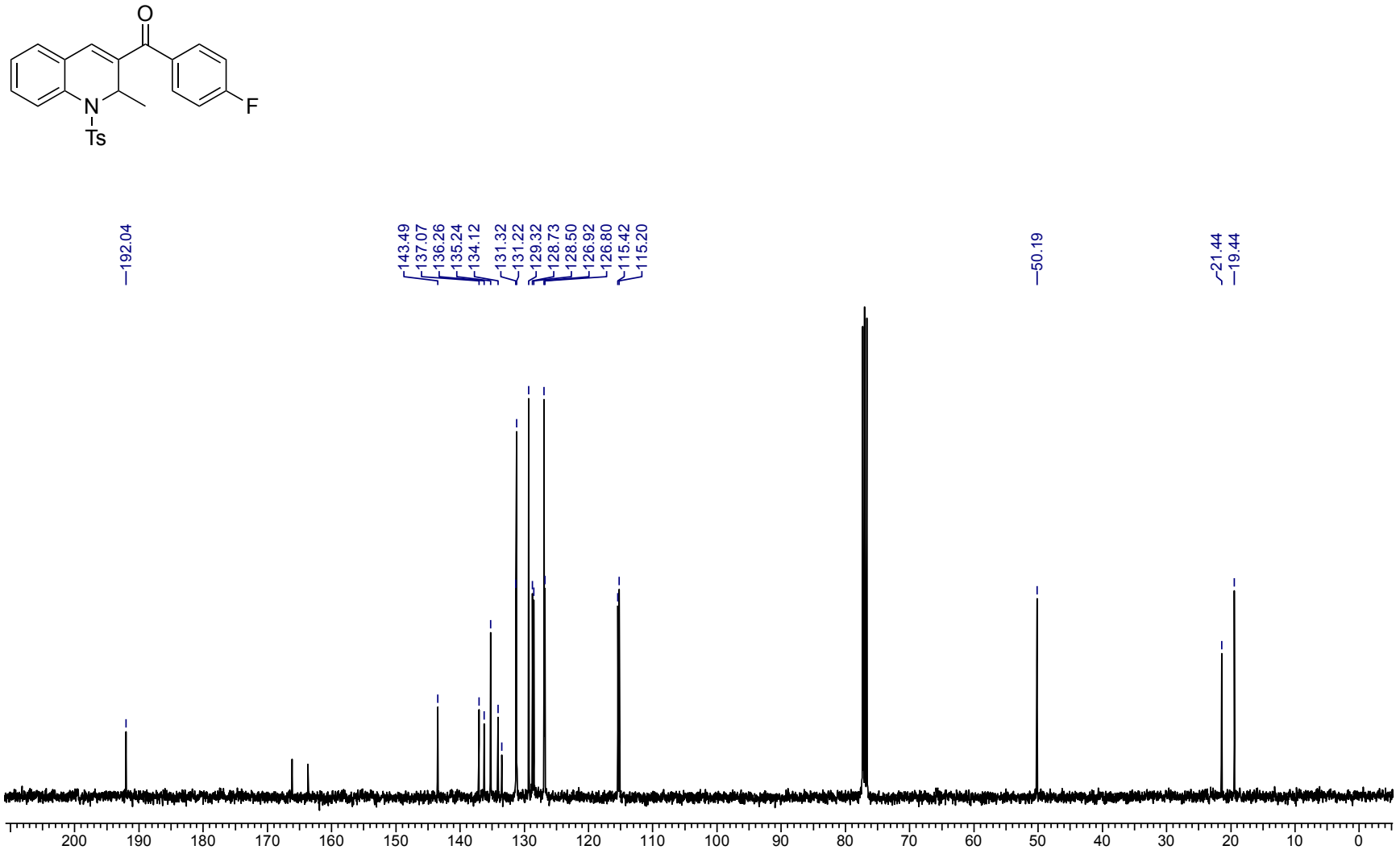
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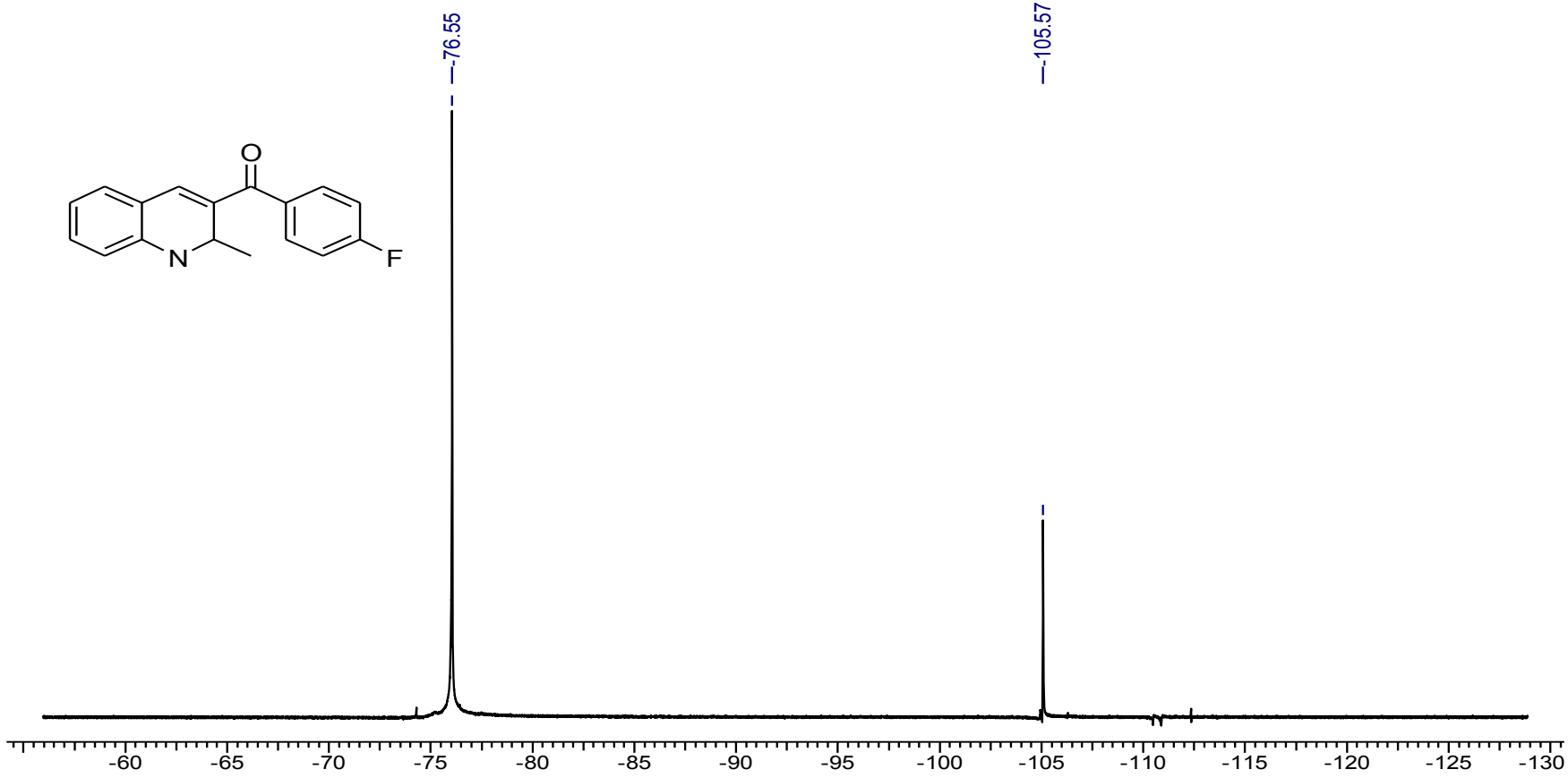
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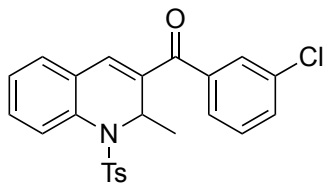
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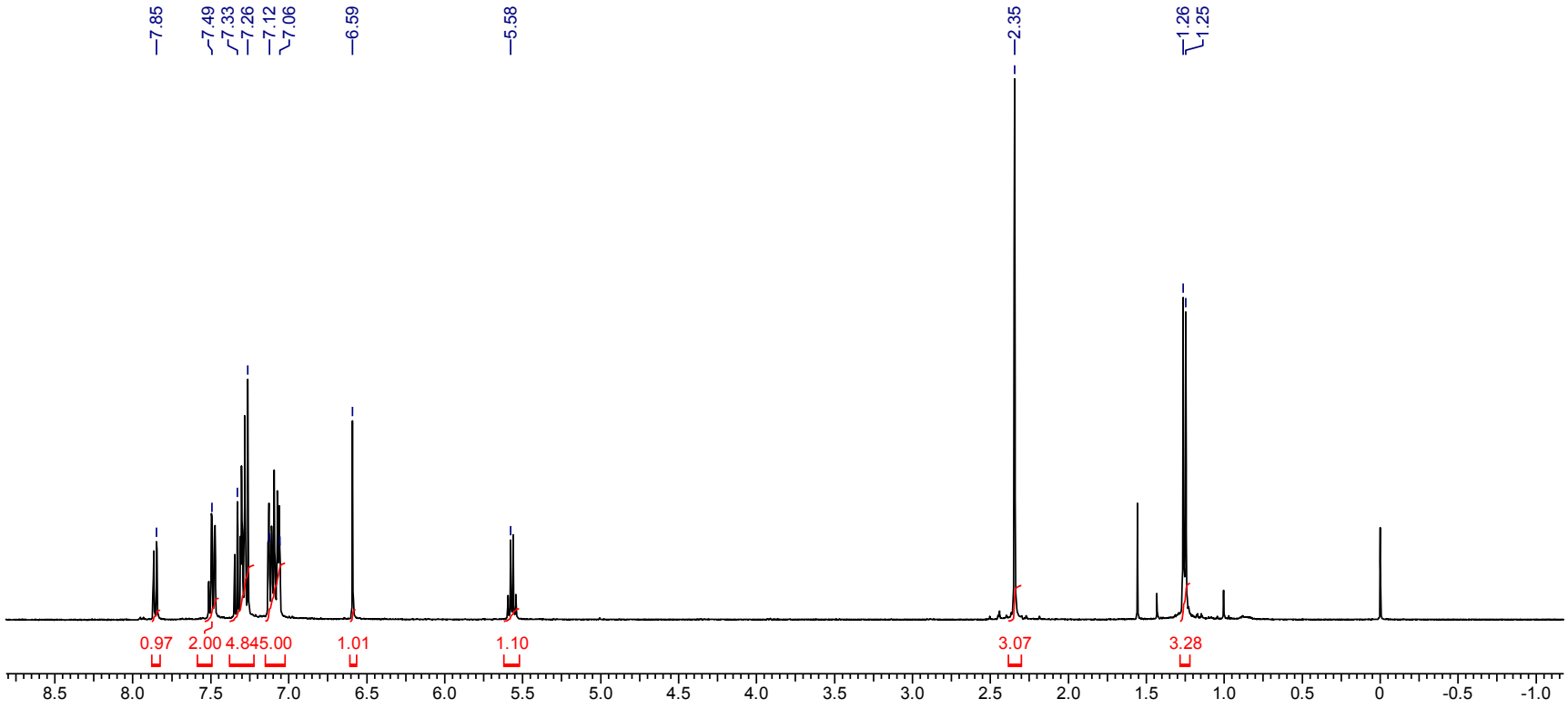
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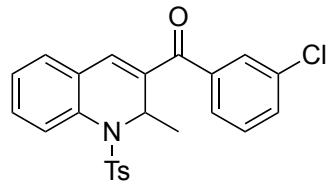
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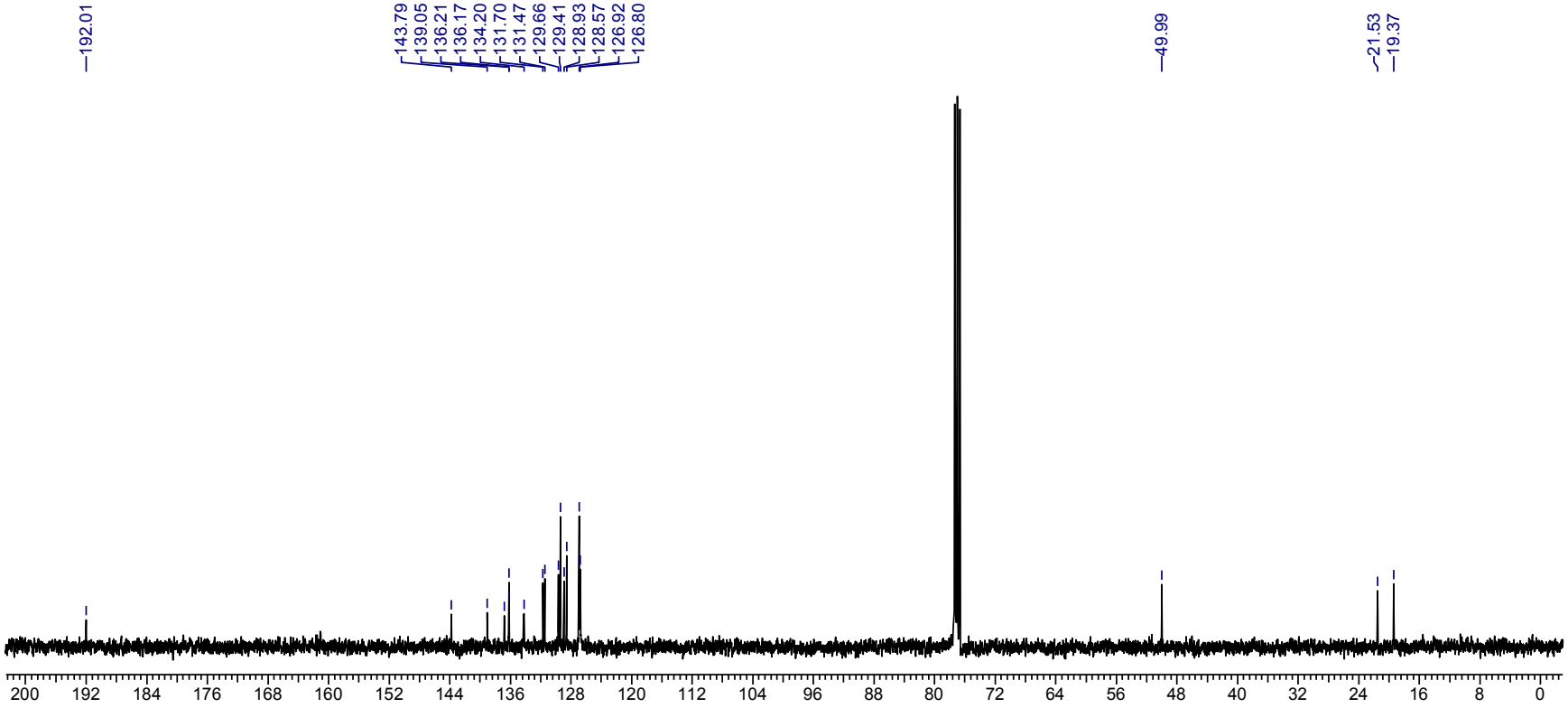
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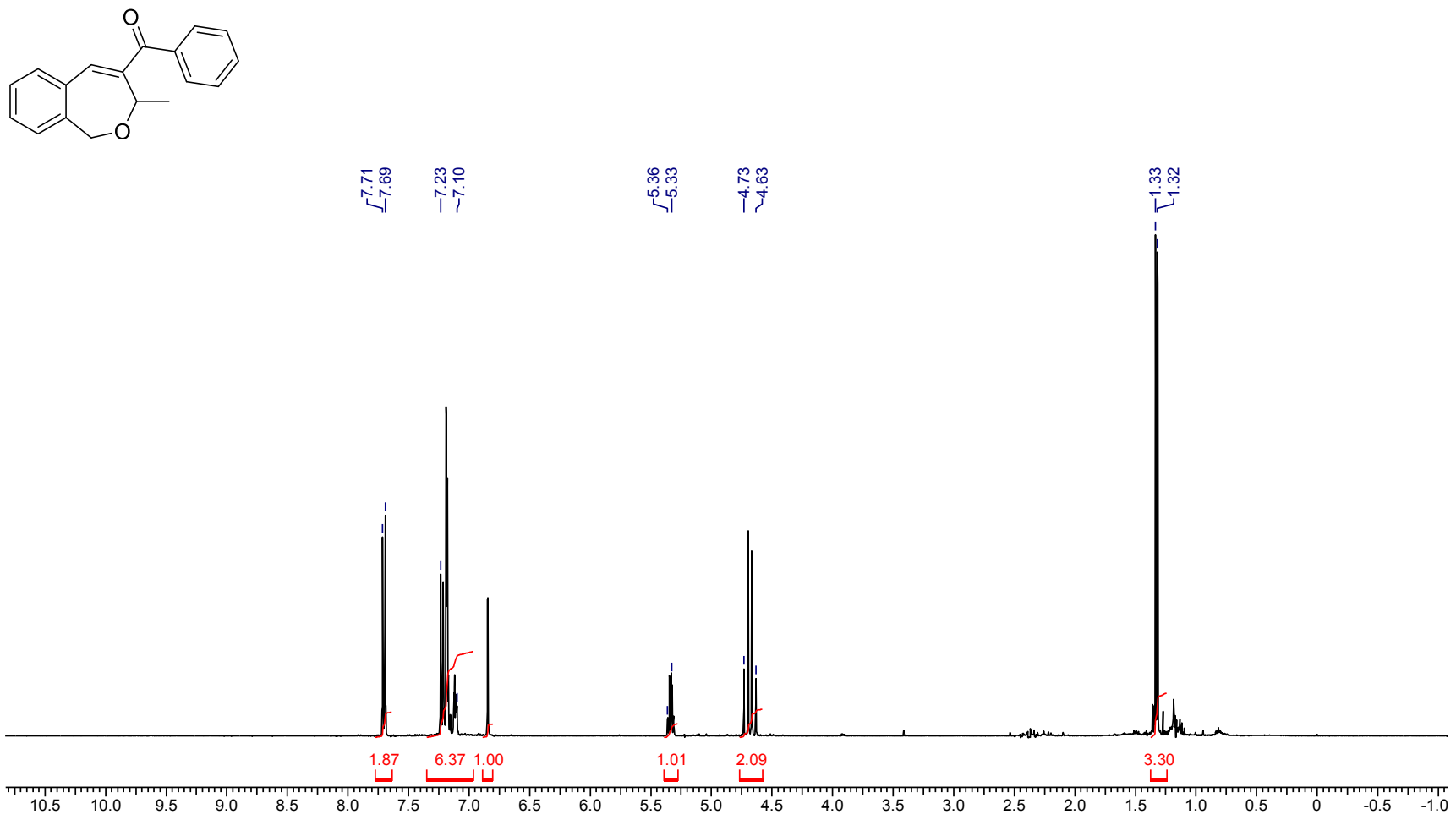
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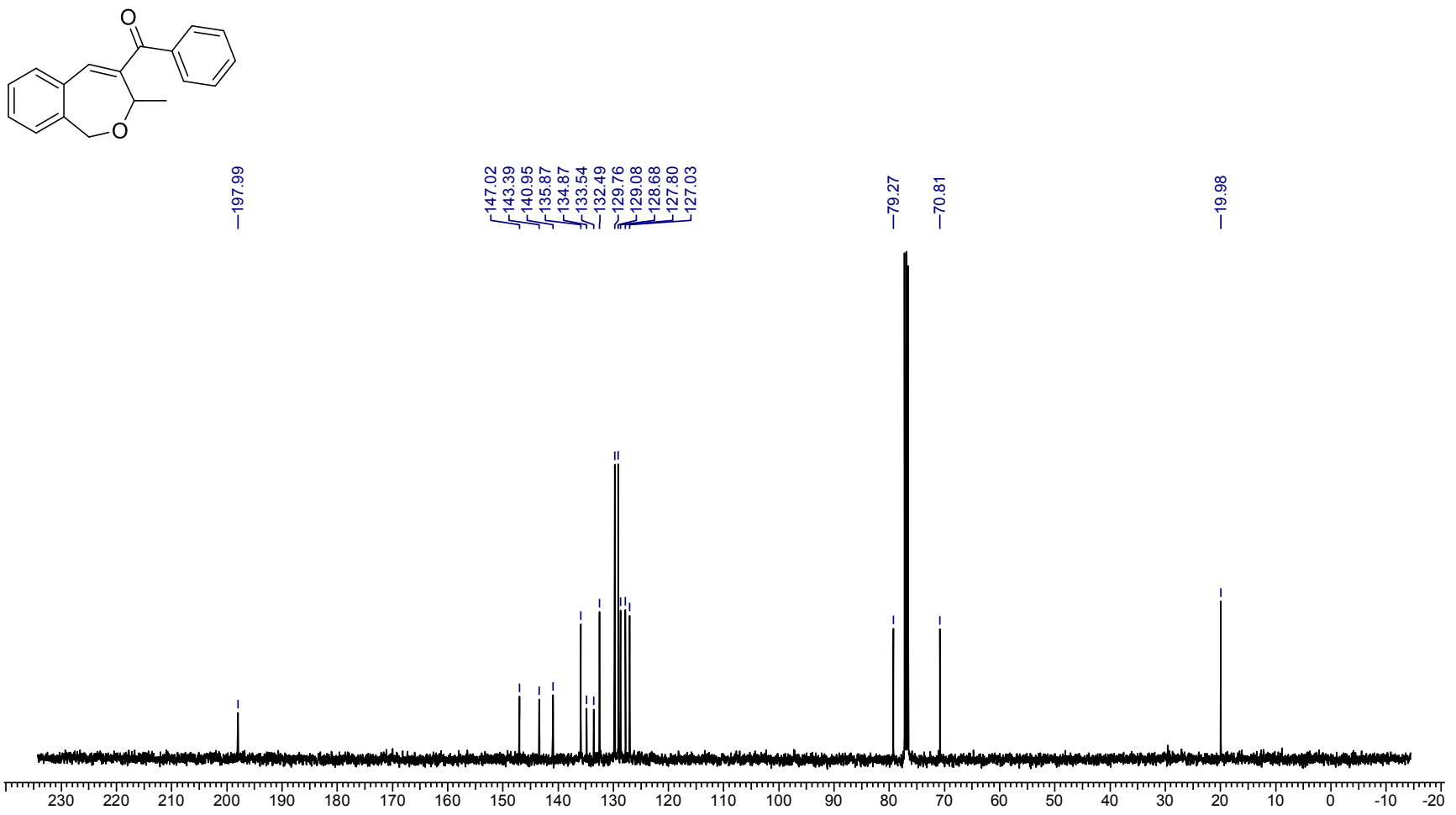
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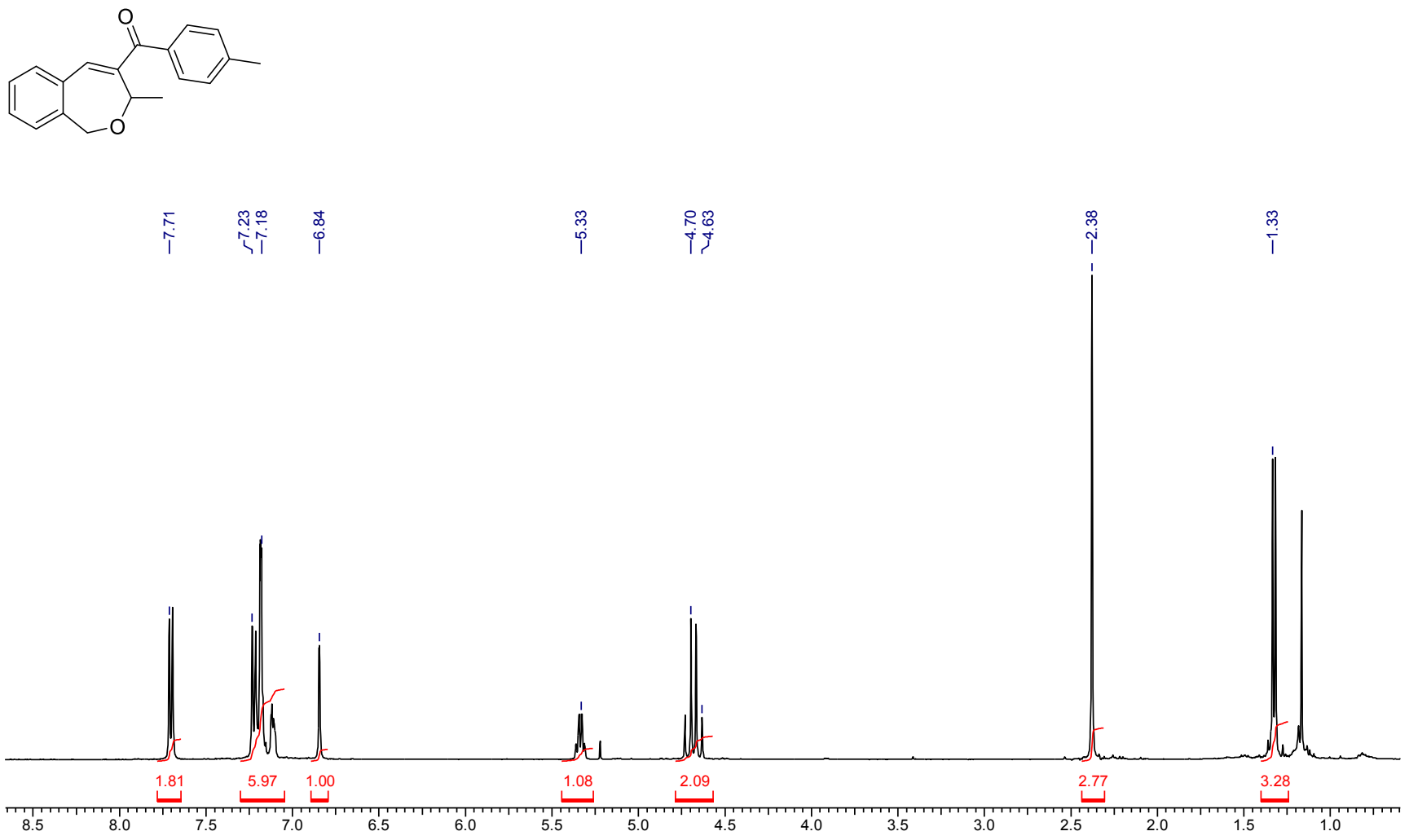
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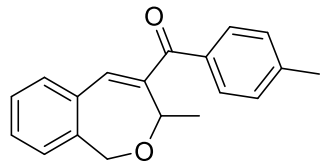
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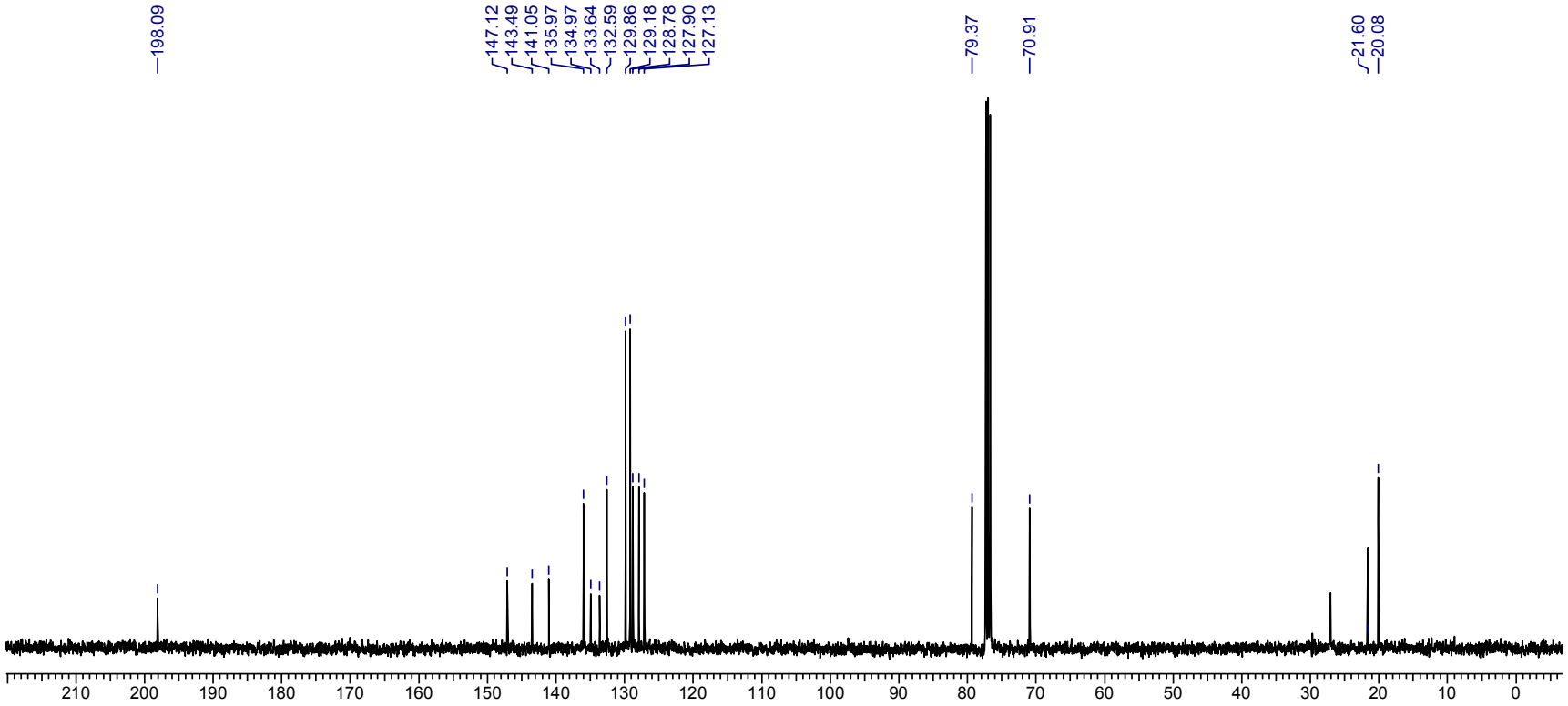
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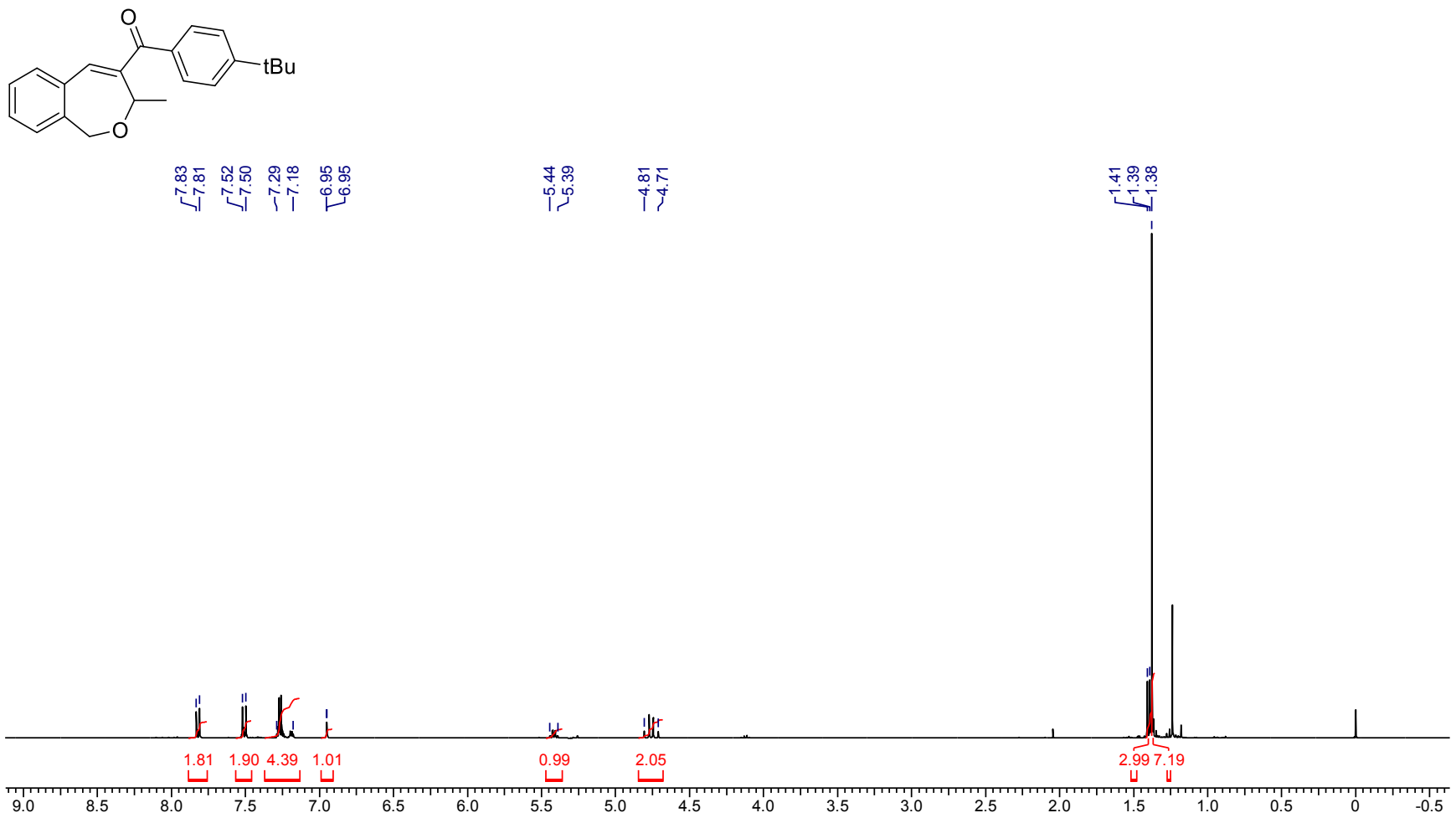
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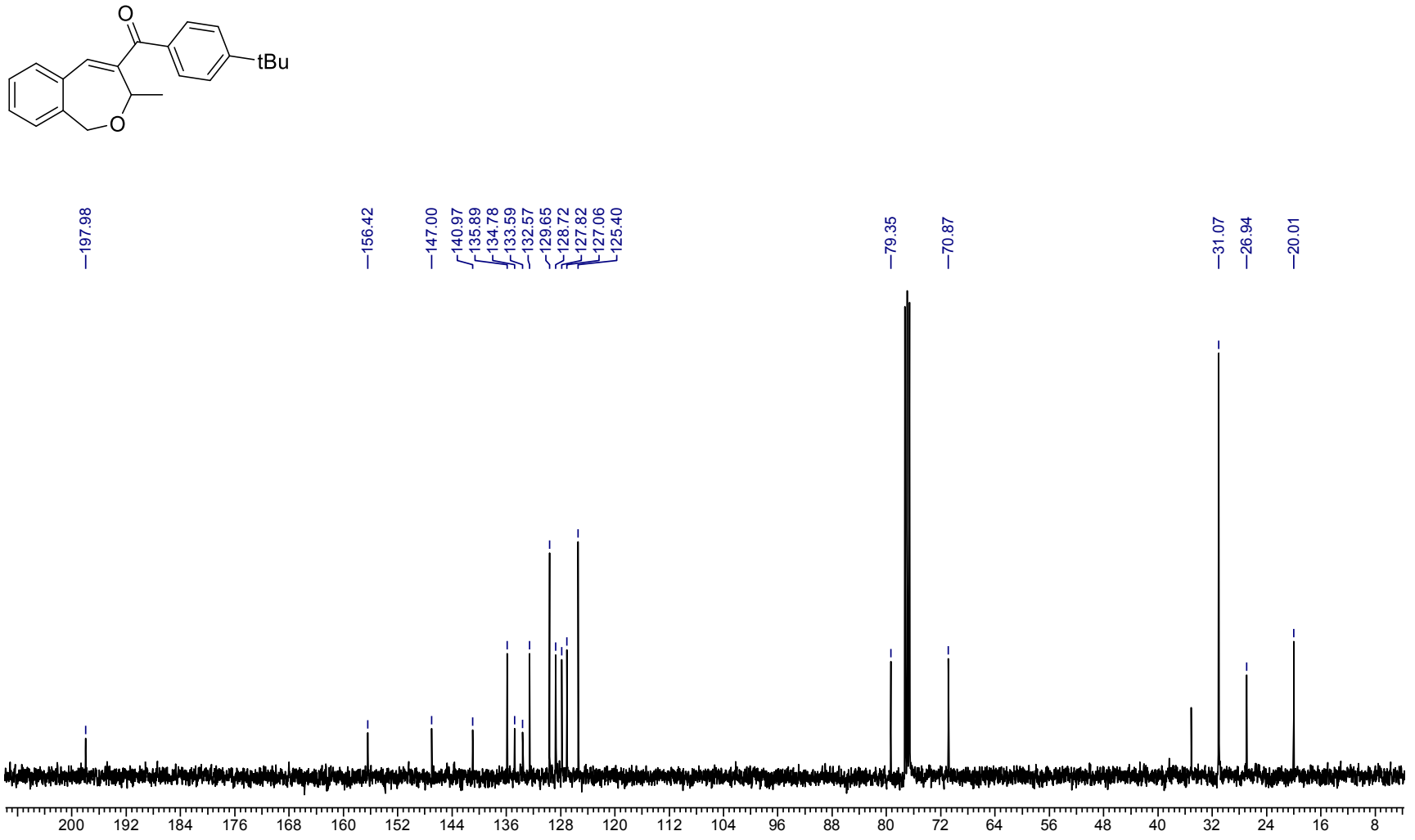
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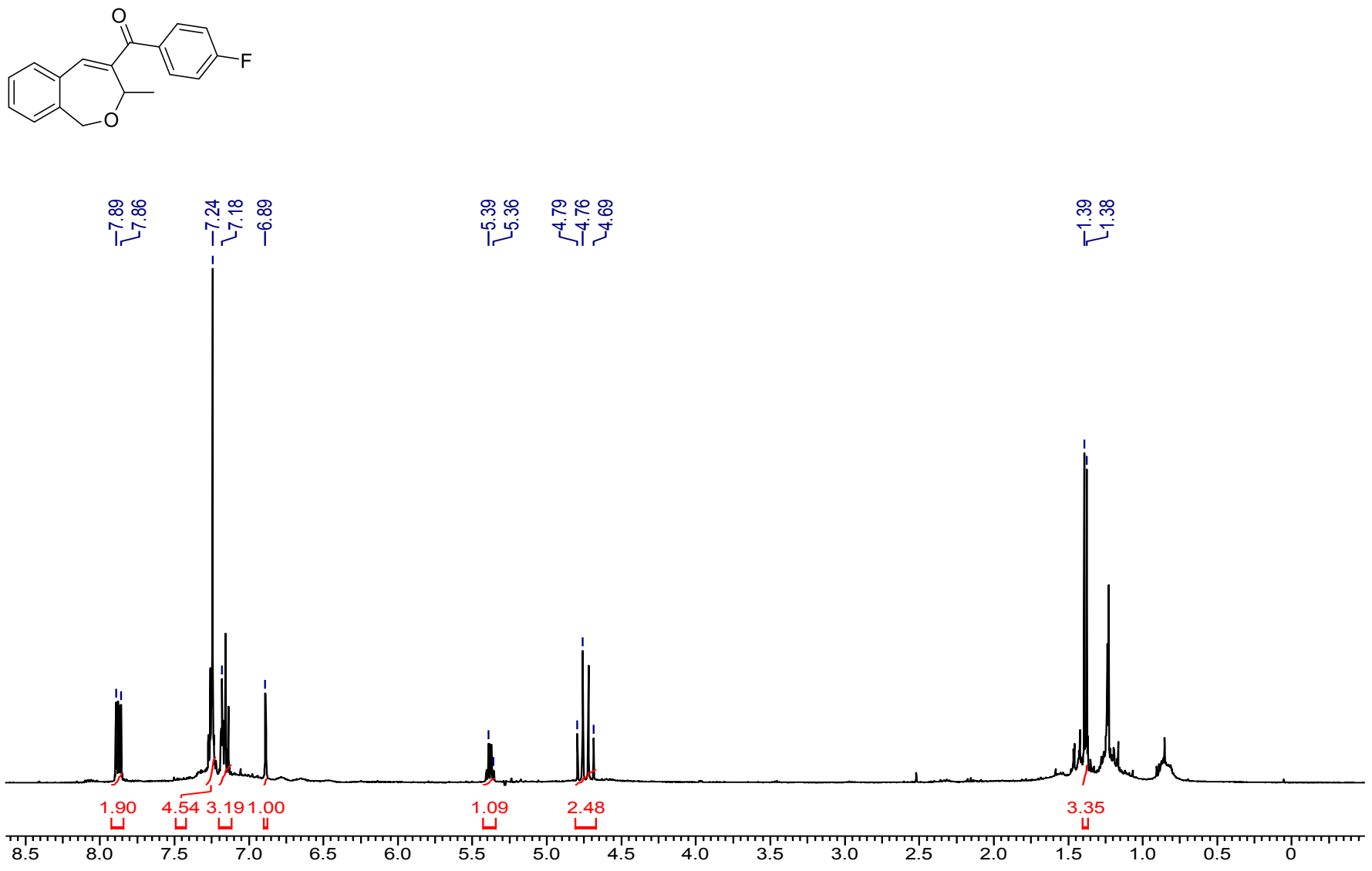
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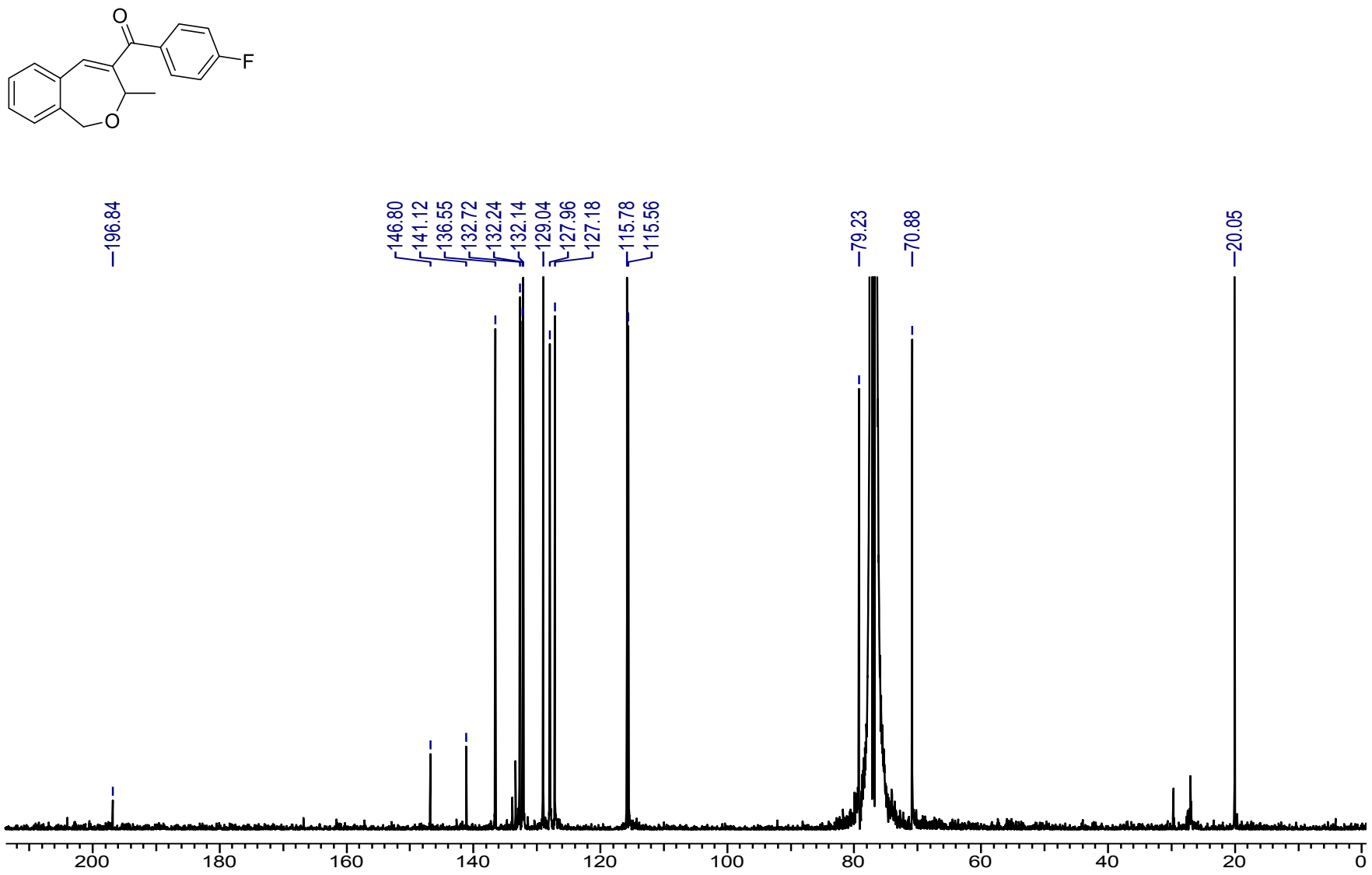
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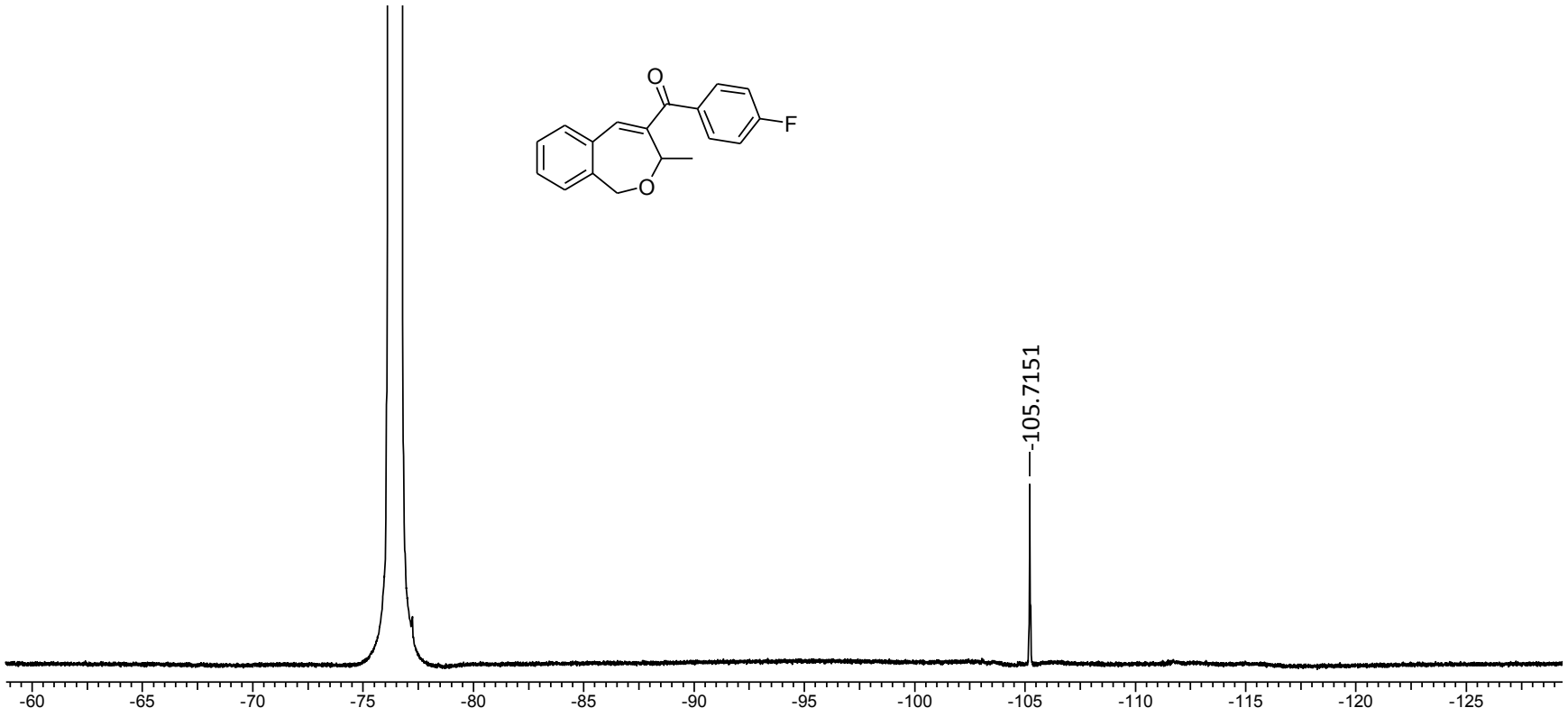
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