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Supporting Information for

Gold/Lewis Acid Catalyzed Oxidative Cyclization Involving Activation of Nitriles

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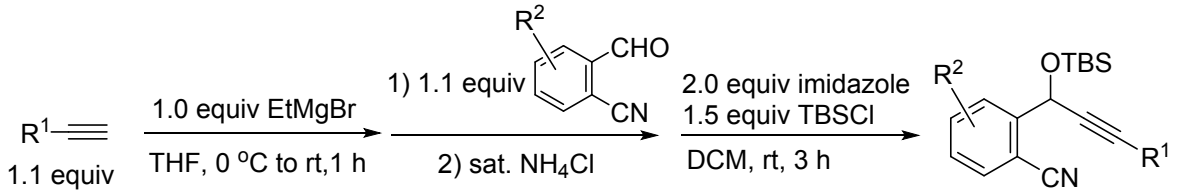
Contents:

General Methods. All reactions were carried out under Argon unless noted. DCM and DCE were distilled from CaH_2. Toluene was distilled from sodium and benzophenone. THF was distilled from sodium and benzophenone or purified using Innovative Technology Solvent Purifier (for the synthesis of substrates). MeCN was purified using Innovative Technology Solvent Purifier. 2-Cyanobenzaldehyde was purified by column chromatography before using.

Unless noted, all commercial reagents were used without further purification. (Acetonitrile)[(2-biphenyl)di-*tert*-butylphosphine]gold(I) hexafluoroantimonate (catalyst **A**) was purchased from Aldrich Chemical Company. $AgNTf_2$ was purchased from TCI Company. PPh_3AuNTf_2 was prepared by stirring the [Au(L)Cl] complex and $AgNTf_2$ in DCM at room temperature.[1] ^{t}BuXphosAu(MeCN)SbF_6 (catalyst **B**)[2] and $IPrAuNTf_2$[3] and $(ArO)_3PAuCl$ (Ar = 2,4-di-*tert*-butylphenyl)[4] were prepared according to the published methods. $AuBr_3$ was purchased from Alfa Aesar.

^1H and ^{13}C NMR spectra were recorded at room temperature in $CDCl_3$ (containing 0.03% TMS) or DMSO-d_6 (containing 0.03% TMS), on Varian XL-400 MHz spectrometer, Agilent 400 MHz NMR spectrometer or Bruker 400 MHz NMR spectrometer. ^1H NMR spectra was recorded at 400 MHz, ^{13}C NMR spectra was recorded at 100 MHz. ^1H NMR spectra was recorded with tetramethylsilane (δ = 0.00 ppm) or $CDCl_3$ (δ = 7.26 ppm) in $CDCl_3$ or DMSO-d_6 (δ = 2.50 ppm) as internal reference; ^{13}C NMR spectra was recorded with $CDCl_3$ (δ = 77.00 ppm) or DMSO-d_6 (δ = 39.51 ppm) as internal reference. High-resolution mass spectra were obtained by using Waters Micromass GTC, Agilent Technologies 6224 TOF LC/MS. IR spectra were obtained by using a Nicolet iS10 spectrometer. Melting points were measured using a SGW-4 microscopic melting point apparatus and were uncorrected. Single crystal X-ray diffraction data were collected at 293 K for (**3a**, **5a** and **7b**).

Typical procedure for the Synthesis and characterization of (*o*-cyano)phenylpropargyl ethers 1.[5]

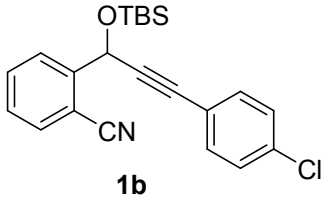


for **1a**, R^1 = Ph, R^2 = H

To a solution of 1-ethynylbenzene (33 mmol, 3.6 mL) in THF (60 mL) was added dropwise EtMgBr (30 mmol, 3.0 M solution in Et_2O, 10 mL) at 0 °C under argon. Then the mixture was warmed up to room temperature and stirred for 1 h. The mixture was cooled to 0 °C, and 2-cyanobenzaldehyde (30 mmol, 3.934 g) was added. Then the reaction mixture was

warmed up to room temperature and stirred until the reaction was complete as monitored by TLC (1.0 h). The resulting reaction mixture was quenched with saturated NH_4Cl solution, and extracted with ethyl acetate. The combined organic extracts were washed with water and brine, and dried over Na_2SO_4. The solvent was evaporated under the reduced pressure to afford the crude alcohol which was used directly without further purification for the next step.

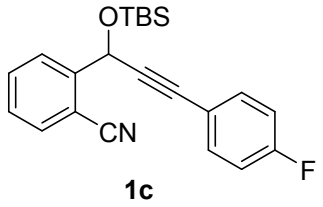
To a solution of the above crude alcohol in DCM (50 mL) were added imidazole (60 mmol, 4.09 g) and TBSCl (45 mmol, 6.78 g) under argon. The reaction mixture was then stirred at room temperature for 3 h. Then the resulting mixture was quenched with saturated ammonium chloride solution and extracted with ethyl acetate, washed with water and brine, dried over Na_2SO_4, and concentrated *in vacuo*. The residue was purified by column chromatography on silica gel (petroleum ether : ethyl acetate = 50:1) to afford **1a** in 79% overall yield (8.236 g) as a light-yellow sticky oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.35 (s, 3H), 0.41 (s, 3H), 1.08 (s, 9H), 6.12 (s, 1H), 7.36-7.38 (m, 3H), 7.42-7.46 (m, 1H), 7.53-7.55 (m, 2H), 7.67-7.72 (m, 2H), 7.98 (d, J = 8.0 Hz, 1H). ^{13}C NMR(100 MHz, $CDCl_3$) δ -5.1, -4.6, 18.0, 25.6, 63.3, 86.6, 88.0, 110.3, 117.0, 122.1, 127.0, 128.1, 128.4, 131.4, 132.7, 132.8, 145.0. The spectroscopic data are in agreement with that previously reported.[5]



1b

2-(1-((*tert*-Butyldimethylsilyl)oxy)-3-(4-chlorophenyl)prop-2-yn-1-yl)benzonitrile (1b). First step: 1-chloro-4-ethynylbenzene (5.5 mmol, 751.2 mg) in THF (8 mL) was added EtMgBr (5 mmol, 3.0 M solution in Et_2O, 1.67 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Cyanobenzaldehyde (5.0 mmol, 655.7 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (10 mL) were added imidazole (10.0 mmol, 680.8 mg) and TBSCl (7.5 mmol, 1.13 g), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 50:1 to 20:1) afforded the desired product in 82% overall yield (1.56 g) as a light-yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.22 (s, 3H), 0.27 (s,

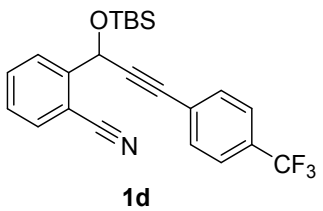
3H), 0.96 (s, 9H), 5.97 (s, 1H), 7.25-7.27 (m, 2H), 7.35-7.41 (m, 3H), 7.61-7.67 (m, 2H), 7.85 (d, J = 8.0 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.0, -4.5, 18.2, 25.7, 63.3, 85.4, 89.1, 110.3, 117.1, 120.7, 127.1, 128.2, 128.6, 132.8, 133.0, 133.1, 134.6, 145.0. The spectroscopic data are in agreement with that previously reported.[5]



1c

2-(1-((*tert*-butyldimethylsilyl)oxy)-3-(4-fluorophenyl)prop-2-yn-1-yl)benzonitrile (1c).

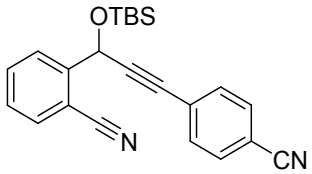
First step: 1-ethynyl-4-fluorobenzene (5.5 mmol, 660.7 mg) in THF (8 mL) was added EtMgBr (5 mmol, 3.0 M solution in Et_2O, 1.67 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Cyanobenzaldehyde (5.0 mmol, 655.7 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (10 mL) were added imidazole (10.0 mmol, 680.8 mg) and TBSCl (7.5 mmol, 1.13 g), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 20:1) afforded the desired product in 85% overall yield (1.556 g) as a light-yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.22 (s, 3H), 0.28 (s, 3H), 0.96 (s, 9H), 5.98 (s, 1H), 6.96-7.00 (m, 2H), 7.37-7.43 (m, 3H), 7.61-7.66 (m, 2H), 7.86 (d, J = 8.0 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.1, -4.5, 18.2, 25.7, 63.3, 85.5, 87.9 (d, $^4J_{C\text{-}F}$ = 1.5 Hz), 110.3, 115.5 (d, $^2J_{C\text{-}F}$ = 22.0 Hz), 117.1, 118.3 (d, $^4J_{C\text{-}F}$ = 3.8 Hz), 127.0, 128.2, 132.9, 133.0, 133.5 (d, $^3J_{C\text{-}F}$ = 8.3 Hz), 145.1, 162.6 (d, ^1J = 248.7 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -110.3 (m, 1F). The spectroscopic data is in agreement with that previously reported.[5]



1d

2-(1-((*tert*-butyldimethylsilyl)oxy)-3-(4-(trifluoromethyl)phenyl)prop-2-yn-1-

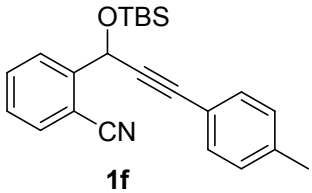
yl)benzonitrile (1d). First step: 1-ethynyl-4-(trifluoromethyl)benzene (3.3 mmol, 561.4 mg) in THF (5 mL) was added EtMgBr (3 mmol, 3.0 M solution in Et_2O, 1.0 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Cyanobenzaldehyde (3.0 mmol, 393.4 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (5 mL) were added imidazole (6.0 mmol, 408.5 mg) and TBSCl (4.5 mmol, 678.2 mg), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether to petroleum ether : ethyl acetate = 20:1) afforded the desired product in 82% overall yield (1.02 g) as a light yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.24 (s, 3H), 0.30 (s, 3H), 0.98 (s, 9H), 6.01 (s, 1H), 7.42 (t, *J* = 7.6 Hz, 1H), 7.56-7.58 (m, 4H), 7.64-7.70 (m, 2H), 7.88 (d, *J* = 7.6 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.0, -4.6, 18.2, 25.7, 63.3, 85.1, 90.6, 110.4, 117.1, 123.8 (q, *J* = 270.7 Hz), 125.2 (q, *J* = 3.6 Hz), 126.1 (d, *J* = 1.2 Hz), 127.1, 128.4, 130.3 (q, *J* = 32.2 Hz), 131.8, 133.0, 133.1, 144.8. ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.9 (s, 3F). The spectroscopic data is in agreement with that previously reported.[5]



1e

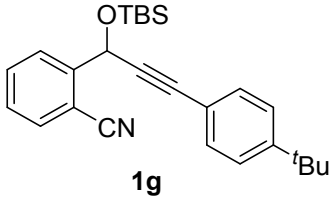
2-(1-((*tert*-butyldimethylsilyl)oxy)-3-(4-cyanophenyl)prop-2-yn-1-yl)benzonitrile (1e). First step: 1-ethynyl-4-(trifluoromethyl)benzene (3.3 mmol, 419.6 mg) in THF (5 mL) was added EtMgBr (3 mmol, 3.0 M solution in Et_2O, 1.0 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Cyanobenzaldehyde (3.0 mmol, 393.4 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (5 mL) were added imidazole (6.0 mmol, 408.5 mg) and TBSCl (4.5 mmol, 678.2 mg), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 100:1 to 40:1 to 20:1) afforded the desired product in 78% overall yield (876 mg) as a light yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.20 (s, 3H), 0.26 (s, 3H), 0.94 (s, 9H), 5.98 (s, 1H), 7.39-7.43 (m, 1H), 7.49-7.58 (m, 4H), 7.62-7.68 (m, 2H), 7.83 (d, *J* = 7.6 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$)

δ -5.1, -4.7, 18.1, 25.5, 63.2, 84.6, 92.4, 110.2, 111.8, 116.9, 118.1, 126.9, 127.0, 128.4, 131.8, 132.0, 133.0, 133.1, 144.4. IR (neat): 2956, 2930, 2856, 2231, 1605, 1501, 1471, 1449, 1333, 1251, 1052, 986, 837, 780, 759, 716 cm^{-1}. HRMS (ESI) calcd for $C_{23}H_{24}N_2ONaSi$ $[M+Na]^+$: 395.1550, found 395.1555.



1f

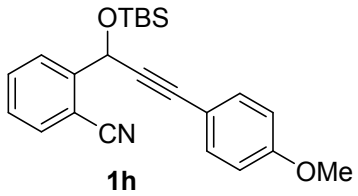
2-(1-((*tert*-Butyldimethylsilyl)oxy)-3-(*p*-tolyl)prop-2-yn-1-yl)benzonitrile (1f). First step: 1-ethynyl-4-methylbenzene (5.5 mmol, 697 μL) in THF (8 mL) was added EtMgBr (5 mmol, 3.0 M solution in Et_2O, 1.67 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Cyanobenzaldehyde (5.0 mmol, 655.7 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (10 mL) were added imidazole (10.0 mmol, 680.8 mg) and TBSCl (7.5 mmol, 1.13 g), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether to petroleum ether : ethyl acetate = 30:1) afforded the desired product in 82% overall yield (1.48 g) as a light-yellow oil. ^1H NMR (400 MHz, $CDCl_3$) δ 0.24 (s, 3H), 0.29 (s, 3H), 0.96 (s, 9H), 2.27 (s, 3H), 6.00 (s, 1H), 7.05 (d, J = 8.0 Hz, 2H), 7.29-7.33 (m, 3H), 7.54-7.58 (m, 2H), 7.85 (d, J = 8.0 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.1, -4.6, 18.0, 21.2, 25.6, 63.3, 86.8, 87.3, 110.3, 117.0, 119.0, 127.0, 128.0, 128.8, 131.3, 132.7, 132.8, 138.5, 145.1. The spectroscopic data is in agreement with that previously reported.[5]



1g

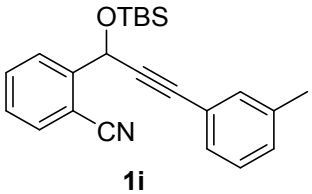
2-(3-(4-(*tert*-butyl)phenyl)-1-((tert-butyldimethylsilyl)oxy)prop-2-yn-1-yl)benzonitrile (1g). First step: 1-(*tert*-butyl)-4-ethynylbenzene (5.5 mmol, 870.3mg) in THF (8 mL) was added EtMgBr (5 mmol, 3.0 M solution in Et_2O, 1.67 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Cyanobenzaldehyde (5.0 mmol, 655.7 mg) was added at

0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (10 mL) were added imidazole (10.0 mmol, 680.8 mg) and TBSCl (7.5 mmol, 1.13 g), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether to petroleum ether : ethyl acetate = 50:1 to 20:1) afforded the desired product in 82% overall yield (1.66 g) as a yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.24 (s, 3H), 0.28 (s, 3H), 0.96 (s, 9H), 1.28 (s, 9H), 5.99 (s, 1H), 7.30-7.39 (m, 5H), 7.59-7.64 (m, 2H), 7.87 (d, J = 8.0 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.0, -4.4, 18.2, 25.7, 31.1, 34.7, 63.5, 86.9, 87.5, 110.5, 117.2, 119.3, 125.2, 127.2, 128.1, 131.3, 132.9, 133.0, 145.4, 151.8. IR (film): 2958, 2924, 2857, 2225, 1692, 1600, 1505, 1471, 1463, 1449, 1391, 1363, 1252, 1108, 1068, 986, 834, 778, 759, 672 cm^{-1}. HRMS (ESI) calcd for $C_{26}H_{33}NONaSi$ $[M+Na]^+$: 426.2224, found 426.2217.



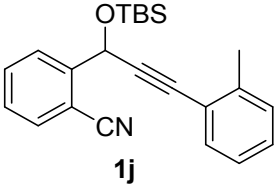
1h

2-(1-((*tert*-Butyldimethylsilyl)oxy)-3-(4-methoxyphenyl)prop-2-yn-1-yl)benzonitrile (1h). First step: 1-ethynyl-4-methoxybenzene (5.5 mmol, 713 μL) in THF (8 mL) was added EtMgBr (5 mmol, 3.0 M solution in Et_2O, 1.67 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Cyanobenzaldehyde (5.0 mmol, 655.7 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (10 mL) were added imidazole (10.0 mmol, 680.8 mg) and TBSCl (7.5 mmol, 1.13 g), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 100:1 to 20:1) afforded the desired product in 78% overall yield (1.48 g) as a yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.24 (s, 3H), 0.29 (s, 3H), 0.96 (s, 9H), 3.68 (s, 3H), 6.00 (s, 1H), 6.77-6.79 (m, 2H), 7.28-7.37 (m, 3H), 7.54-7.58 (m, 2H), 7.86 (d, J = 8.0 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.3, -4.7, 17.9, 25.5, 54.7, 63.3, 86.5, 86.6, 110.2, 113.6, 113.9, 116.8, 126.9, 127.9, 132.6, 132.7, 145.0, 159.5. One carbon is overlapped with other signals. The spectroscopic data is in agreement with that previously reported.[5]



1i

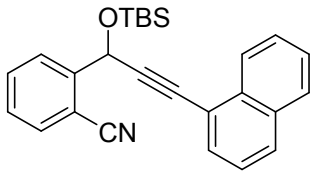
2-(1-((*tert*-butyldimethylsilyl)oxy)-3-(m-tolyl)prop-2-yn-1-yl)benzonitrile (1i). First step: 1-ethynyl-3-methylbenzene (5.5 mmol, 710 μL) in THF (8 mL) was added EtMgBr (5 mmol, 3.0 M solution in Et_2O, 1.67 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Cyanobenzaldehyde (5.0 mmol, 655.7 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (10 mL) were added imidazole (10.0 mmol, 680.8 mg) and TBSCl (7.5 mmol, 1.13 g), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 100:1 to 30:1) afforded the desired product in 89% overall yield (1.6 g) as a light-yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.24 (s, 3H), 0.30 (s, 3H), 0.97 (s, 9H), 2.25 (s, 3H), 6.00 (s, 1H), 7.05-7.07 (m, 1H), 7.13-7.16 (m, 1H), 7.23-7.24 (m, 2H), 7.30-7.33 (m, 1H), 7.55-7.59 (m, 2H), 7.86 (d, *J* = 7.6 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.2, -4.6, 18.0, 20.9, 25.6, 63.3, 86.8, 87.6, 110.3, 116.9, 121.9, 127.0, 127.97, 128.03, 128.5, 129.3, 131.8, 132.7, 132.8, 137.7, 145.0. IR (neat): 2954, 2928, 2885, 2857, 2226, 1697, 1601, 1485, 1472, 1449, 1362, 1252, 1207, 1175, 1111, 1067, 1005, 939, 838, 779, 761, 690, 670 cm^{-1}. HRMS (ESI) calcd for $C_{23}H_{27}NONaSi$ $[M+Na]^+$: 384.1754, found 384.1752.



1j

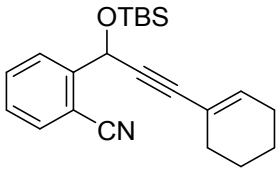
2-(1-(*tert*-Butyldimethylsilyloxy)-3-*o*-tolylprop-2-ynyl)benzonitrile (1j). First step: 1-ethynyl-2-methylbenzene (5.5 mmol, 693 μL) in THF (8 mL) was added EtMgBr (5 mmol, 3.0 M solution in Et_2O, 1.67 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Cyanobenzaldehyde (5.0 mmol, 655.7 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude

alcohol in DCM (10 mL) were added imidazole (10.0 mmol, 680.8 mg) and TBSCl (7.5 mmol, 1.13 g), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 100:1 to 30:1) afforded the desired product in 85% overall yield (1.54 g) as an orange oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.15 (s, 3H), 0.20 (s, 3H), 0.88 (s, 9H), 2.31 (s, 3H), 5.96 (s, 1H), 6.97-7.10 (m, 3H), 7.23-7.31 (m, 2H), 7.48-7.52 (m, 2H), 7.79 (d, *J* = 8.0 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.1, -4.6, 18.1, 20.5, 25.6, 63.4, 85.5, 92.0, 110.2, 117.0, 121.9, 125.3, 126.9, 128.0, 128.5, 129.3, 131.8, 132.7, 132.9, 140.1, 145.4. The spectroscopic data is in agreement with that previously reported.[5]



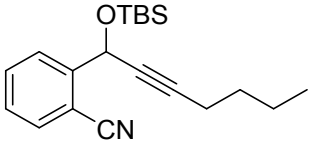
1k

2-(1-((*tert*-butyldimethylsilyl)oxy)-3-(naphthalen-1-yl)prop-2-yn-1-yl)benzonitri (1k). First step: 1-ethynylnaphthalene (2.75 mmol, 391 μL) in THF (8 mL) was added EtMgBr (2.5 mmol, 3.0 M solution in Et_2O, 0.83 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Cyanobenzaldehyde (2.5 mmol, 327.8 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (10 mL) were added imidazole (5.0 mmol, 340.4 mg) and TBSCl (3.75 mmol, 565.2 mg), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum to petroleum ether : ethyl acetate = 20:1) afforded the desired product in 43% overall yield (432 mg) as an orange oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.38 (s, 3H), 0.44 (s, 3H), 1.10 (s, 9H), 6.26 (s, 1H), 7.46-7.51 (m, 2H), 7.58-7.68 (m, 2H), 7.72-7.80 (m, 3H), 7.89-7.92 (m, 2H), 8.06 (d, *J* = 7.6 Hz, 1H), 8.42 (d, *J* = 8.0 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.0, -4.4, 18.2, 25.7, 63.6, 84.9, 93.0, 110.4, 117.2, 119.9, 125.0, 126.0, 126.4, 126.8, 127.2, 128.16, 128.22, 129.0, 130.6, 132.9, 133.0, 133.1, 133.2, 145.4. The spectroscopic data is in agreement with that previously reported.[5]



1l

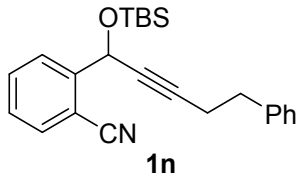
2-(1-((*tert*-Butyldimethylsilyl)oxy)-3-(cyclohex-1-en-1-yl)prop-2-yn-1-yl)benzonitrile (1l). First step: 1-ethynylcyclohex-1-ene (5.5 mmol, 647 μL) in THF (8 mL) was added EtMgBr (5 mmol, 3.0 M solution in Et_2O, 1.67 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Cyanobenzaldehyde (5.0 mmol, 655.7 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (10 mL) were added imidazole (10.0 mmol, 680.8 mg) and TBSCl (7.5 mmol, 1.13 g), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 50:1 to 30:1) afforded the desired product in 85% overall yield (1.5 g) as a light yellow oil.^{1}H NMR (400 MHz, $CDCl_3$) δ 0.20 (s, 3H), 0.24 (s, 3H), 0.93 (s, 9H), 1.53-1.61 (m, 4H), 2.05-2.11 (m, 4H), 5.88 (s, 1H), 6.09-6.11 (m, 1H), 7.34-7.37 (m, 1H), 7.57-7.62 (m, 2H), 7.80 (d, J = 8.0 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.1, -4.5, 18.0, 21.2, 22.0, 25.4, 25.6, 28.6, 63.3, 85.3, 88.5, 110.3, 117.0, 119.8, 127.0, 128.0, 132.7, 132.8, 135.3, 145.5. The spectroscopic data is in agreement with that previously reported.[5]



1m

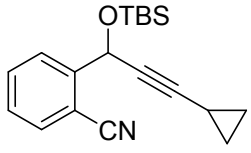
2-(1-(*tert*-Butyldimethylsilyloxy)hept-2-ynyl)benzonitrile (1m). First step: hex-1-yne (5.5 mmol, 632 μL) in THF (8 mL) was added EtMgBr (5 mmol, 3.0 M solution in Et_2O, 1.67 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Cyanobenzaldehyde (5.0 mmol, 655.7 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (10 mL) were added imidazole (10.0 mmol, 680.8 mg) and TBSCl (7.5 mmol, 1.13 g), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 50:1) afforded the desired product in 81% overall yield (1.333 g) as a colorless oil. ^{1}H NMR

(400 MHz, $CDCl_3$) δ 0.17 (s, 3H), 0.21 (s, 3H), 0.88 (t, *J* = 7.2 Hz, 3H), 0.92 (s, 9H), 1.34-1.52 (m, 4H), 2.19-2.22 (m, 2H), 5.75 (s, 1H), 7.33-7.37 (m, 1H), 7.57-7.62 (m, 2H), 7.79 (d, *J* = 7.6 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.1, -4.6, 13.5, 18.2, 18.4, 21.8, 25.7, 30.3, 63.1, 79.3, 87.7, 110.3, 117.1, 126.9, 127.9, 132.7, 132.9, 146.0. The spectroscopic data is in agreement with that previously reported.[5]



1n

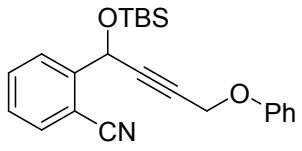
2-(1-(*tert*-Butyldimethylsilyloxy)-5-phenylpent-2-ynyl)benzonitrile (1n). but-3-yn-1-yl - benzene (5.5 mmol, 773 μL) in THF (8 mL) was added EtMgBr (5 mmol, 3.0 M solution in Et_2O, 1.67 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Cyanobenzaldehyde (5.0 mmol, 655.7 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (10 mL) were added imidazole (10.0 mmol, 680.8 mg) and TBSCl (7.5 mmol, 1.13 g), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum) afforded the desired product in 84% overall yield (1.57 g) as a light-yellow oil. ^1H NMR (400 MHz, $CDCl_3$) δ 0.12 (s, 3H), 0.15 (s, 3H), 0.89 (s, 9H), 2.47 (td, *J* = 7.2, 1.2 Hz, 2H), 2.75-2.79 (m, 2H), 5.71 (s, 1H), 7.12-7.16 (m, 3H), 7.19-7.22 (m, 2H), 7.28-7.31 (m, 1H), 7.50-7.56 (m, 2H), 7.69 (d, *J* = 8.0 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.2, -4.6, 18.1, 20.8, 25.6, 34.5, 63.0, 80.1, 86.7, 110.2, 117.1, 126.1, 127.0, 127.9, 128.2, 128.3, 132.6, 132.8, 140.2, 145.8. The spectroscopic data is in agreement with that previously reported.[5]



1o

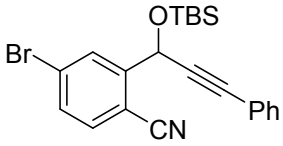
2-(1-(*tert*-Butyldimethylsilyloxy)-3-cyclopropylprop-2-ynyl)benzonitrile (1o). ethynyl - cyclopropane (5.5 mmol, 466 μL) in THF (8 mL) was added EtMgBr (5 mmol, 3.0 M solution in Et_2O, 1.67 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-

Cyanobenzaldehyde (5.0 mmol, 655.7 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (10 mL) were added imidazole (10.0 mmol, 680.8 mg) and TBSCl (7.5 mmol, 1.13 g), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 50:1) afforded the desired product in 79% overall yield (1.225 g) as a colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.15 (s, 3H), 0.20 (s, 3H), 0.65-0.76 (m, 4H), 0.90 (s, 9H), 1.21-1.25 (m, 1H), 5.70 (s, 1H), 7.32-7.36 (m, 1H), 7.56-7.60 (m, 2H), 7.76 (d, *J* = 8.0 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.1, -4.5, -0.6, 8.0, 18.1, 25.7, 63.1, 74.4, 90.6, 110.2, 117.1, 127.0, 127.9, 132.8, 132.9, 145.9. The spectroscopic data is in agreement with that previously reported.[5]



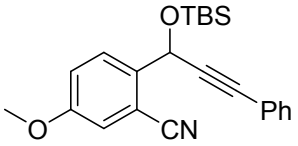
1p

2-(1-((*tert*-butyldimethylsilyl)oxy)-4-phenoxybut-2-yn-1-yl)benzonitrile (1p). (prop-2-yn-1-yloxy)benzene (5.5 mmol, 706 μL) in THF (8 mL) was added EtMgBr (5 mmol, 3.0 M solution in Et_2O, 1.67 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Cyanobenzaldehyde (5.0 mmol, 655.7 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (10 mL) were added imidazole (10.0 mmol, 680.8 mg) and TBSCl (7.5 mmol, 1.13 g), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether to petroleum ether : ethyl acetate = 30:1) afforded the desired product in 63% overall yield (1.19 g) as a light-yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.15 (s, 3H), 0.19 (s, 3H), 0.92 (s, 9H), 4.74 (s, 2H), 5.80 (s, 1H), 6.96-7.00 (m, 3H), 7.27-7.31 (m, 2H), 7.36-7.39 (m, 1H), 7.56-7.63 (m, 2H). 7.75 (d, *J* = 8.0 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.2, -4.7, 18.1, 25.6, 55.8, 62.8, 81.7, 86.2, 110.2, 114.9, 117.0, 121.3, 127.1, 128.2, 129.3, 132.8, 133.0, 144.7, 157.4. IR (neat): 2954, 2929, 2857, 2225, 1598, 1588, 1495, 1472, 1449, 1362, 1260, 1213, 1174, 1129, 1066, 1032, 1014, 837, 778, 752, 690, 671 cm^{-1}. HRMS (ESI) calcd for $C_{23}H_{27}NO_2NaSi$ $[M+Na]^+$: 400.1703, found 400.1703.



1q

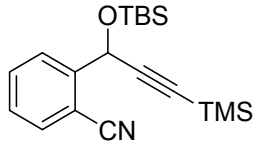
4-bromo-2-(1-((*tert*-butyldimethylsilyl)oxy)-3-phenylprop-2-yn-1-yl)benzonitrile (1q). ethynylbenzene (2.2 mmol, 242 μL) in THF (5 mL) was added EtMgBr (2 mmol, 3.0 M solution in Et_2O, 0.67 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 4-Bromo-2-formylbenzonitrile (2.0 mmol, 420 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (6 mL) were added imidazole (4.0 mmol, 272.3 mg) and TBSCl (3.0 mmol, 452.2 mg), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 20:1) afforded the desired product in 52% overall yield (443.6 mg) as an orange brown oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.24 (s, 3H), 0.29 (s, 3H), 0.97 (s, 9H), 5.93 (s, 1H), 7.31-7.32 (m, 3H), 7.43-7.46 (m, 2H), 7.50-7.56 (m, 2H), 8.01 (d, *J* = 1.2 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.0, -4.4, 18.2, 25.7, 63.0, 87.2, 87.4, 109.2, 116.5, 122.0, 128.2, 128.3, 128.8, 130.6, 131.58, 131.61, 134.1, 147.0. IR (neat): 2954, 2929, 2884, 2857, 2227, 1587, 1490, 1471, 1401, 1254, 1203, 1174, 1116, 1087, 1065, 1002, 983, 836, 794, 779, 755, 733, 689, 672 cm^{-1}. HRMS (ESI) calcd for $C_{22}H_{24}NONaSiBr$ $[M+Na]^+$: 448.0703, found 448.0692.



1r

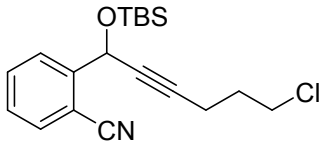
2-(1-((*tert*-butyldimethylsilyl)oxy)-3-phenylprop-2-yn-1-yl)-5-methoxybenzonitrile (1r). ethynylbenzene 3.3 mmol, 362 μL) in THF (6 mL) was added EtMgBr (3 mmol, 3.0 M solution in Et_2O, 1.0 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Formyl-5-methoxybenzonitrile (3.0 mmol, 483.5 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (8 mL) were added imidazole (6.0 mmol, 408.5 mg) and TBSCl (4.5 mmol,

678.2 mg), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 20:1) afforded the desired product in 69% overall yield (778 mg) as a light-yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.22 (s, 3H), 0.27 (s, 3H), 0.95 (s, 9H), 3.80 (s, 3H), 5.94 (s, 1H), 7.12-7.16 (m, 2H), 7.28-7.30 (m, 3H), 7.42-7.44 (m, 2H), 7.77 (d, *J* = 8.8 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.0, -4.5, 18.2, 25.7, 55.5, 63.0, 86.4, 88.5, 111.2, 117.1, 117.2, 119.4, 122.3, 128.2, 128.5, 128.8, 131.5, 137.5, 158.9. IR (neat): 2957, 2928, 2856, 2228, 1606, 1574, 1490, 1463, 1443, 1292, 1250, 1158, 1100, 1061, 1001, 982, 836, 778, 755, 690, 670 cm^{-1}. HRMS (ESI) calcd for $C_{23}H_{27}NO_2NaSi$ $[M+Na]^+$: 400.1703, found 400.1707.



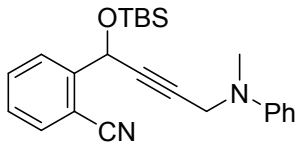
1s

2-(1-((*tert*-butyldimethylsilyl)oxy)-3-(trimethylsilyl)prop-2-yn-1-yl)benzonitrile (1s). ethynyltrimethylsilane (5.5 mmol, 777 μL) in THF (8 mL) was added EtMgBr (5 mmol, 3.0 M solution in Et_2O, 1.67 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Cyanobenzaldehyde (5.0 mmol, 655.7 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (10 mL) were added imidazole (10.0 mmol, 680.8 mg) and TBSCl (7.5 mmol, 1.13g), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether to petroleum ether : ethyl acetate = 40:1) afforded the desired product in 40% overall yield (680 mg) as a colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.17 (s, 9H), 0.20 (s, 3H), 0.24 (s, 3H), 0.93 (s, 9H), 5.75 (s, 1H), 7.36-7.40 (m, 1H), 7.59-7.63 (m, 2H), 7.81 (d, *J* = 7.6 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.0, -4.5, -0.4, 18.2, 25.7, 63.4, 92.0, 104.1, 110.7, 117.0, 127.3, 128.2, 132.8, 132.9, 144.9. IR (neat): 2957, 2930, 2857, 2227, 1472, 1362, 1250, 1209, 1113, 1073, 1006, 837, 778, 759, 701, 676 cm^{-1}. HRMS (ESI) calcd for $C_{19}H_{29}NONaSi_2$ $[M+Na]^+$: 366.1680, found 366.1678.



1t

2-(1-((*tert*-butyldimethylsilyl)oxy)-6-chlorohex-2-yn-1-yl)benzonitrile (1t). 5-chloropent-1-yne (5.5 mmol, 583 μL) in THF (8 mL) was added EtMgBr (5 mmol, 3.0 M solution in Et_2O, 1.67 mL) in THF (8 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Cyanobenzaldehyde (5.0 mmol, 655.7 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (8 mL) were added imidazole (10.0 mmol, 680.8 mg) and TBSCl (7.5 mmol, 1.13g), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether to petroleum ether : ethyl acetate = 30:1) afforded the desired product in 72% overall yield (1.26 g) as a colorless oil.^{1}H NMR (400 MHz, $CDCl_3$) δ 0.15 (s, 3H), 0.20 (s, 3H), 0.91 (s, 9H), 1.90-1.97 (m, 2H), 2.38-2.41 (m, 2H), 3.60 (t, *J* = 6.4 Hz, 2H), 5.72 (s, 1H), 7.34-7.38 (m, 1H), 7.57-7.62 (m, 2H), 7.76 (d, *J* = 7.6 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.2, -4.7, 16.0, 18.1, 25.6, 30.9, 43.4, 62.9, 80.3, 85.4, 110.1, 117.0, 126.7, 128.0, 132.7, 132.9, 145.6. The spectroscopic data is in agreement with that previously reported.[5]



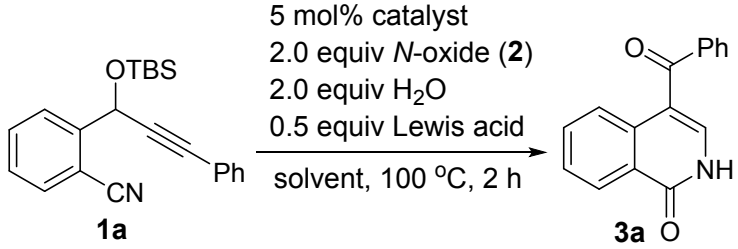
1u

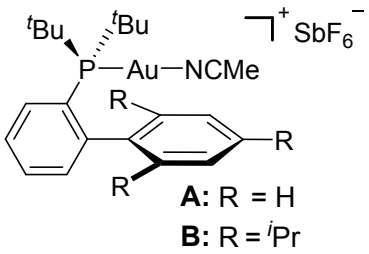
2-(1-((*tert*-butyldimethylsilyl)oxy)-4-(methyl(phenyl)amino)but-2-yn-1-yl)benzonitrile (1u). *N,N*-dimethylprop-2-yn-1-amine (3.3 mmol, 479.2 mg) in THF (6 mL) was added EtMgBr (3 mmol, 3.0 M solution in Et_2O, 1.0 mL) at 0 °C. Then the mixture was stirred at room temperature for 1 h. 2-Cyanobenzaldehyde (3.0 mmol, 393.4 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (8 mL) were added imidazole (6.0 mmol, 408.5 mg) and TBSCl (4.5 mmol, 678.2 mg), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 30:1) afforded the desired product in 78% overall yield (915 mg) as a light-yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.10 (s, 3H), 0.11 (s, 3H),

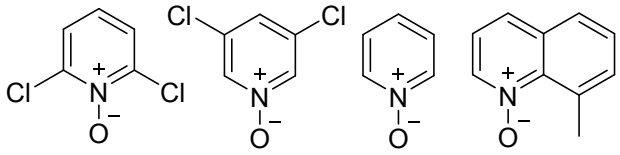
0.87 (s, 9H), 2.92 (s, 3H), 4.06 (s, 2H), 5.71 (s, 1H), 6.76-6.82 (m, 3H), 7.20-7.24 (m, 2H), 7.29-7.33 (m, 1H), 7.49-7.53 (m, 1H), 7.56 (d, J = 7.6 Hz, 1H), 7.66 (d, J = 8.0 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.2, -4.7, 18.1, 25.6, 38.6, 42.7, 62.8, 82.7, 83.0, 110.2, 114.3, 117.0, 118.1, 127.0, 128.0, 128.9, 132.7, 132.9, 145.2, 149.0. The spectroscopic data is in agreement with that previously reported.[5]

Optimization studies.

Table S1. Optimization of the Reaction Conditions





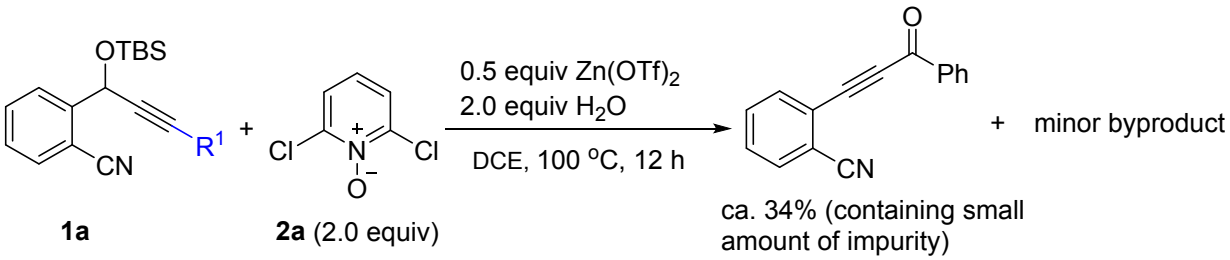


2a **2b** **2c** **2d**

entry	catalyst	solvent	*N*-oxide	Lewis acid	yield (%)[a]
1	PPh_3AuNTf_2	DCE	**2a**	-	-[b]
2	**A**	DCE	**2a**	$Zn(OTf)_2$	32
3	**B**	DCE	**2a**	$Zn(OTf)_2$	-(22)
4	$IPrAuNTf_2$	DCE	**2a**	$Zn(OTf)_2$	57
5	**PPh_3AuNTf_2**	**DCE**	**2a**	**$Zn(OTf)_2$**	**88**
6	PPh_3AuCl	DCE	**2a**	$Zn(OTf)_2$	77
7	PPh_3AuOTf	DCE	**2a**	$Zn(OTf)_2$	83
8	$AuBr_3$	DCE	**2a**	$Zn(OTf)_2$	-
9	PPh_3AuNTf_2	DCE	**2a**	$ZnCl_2$	12(67)
10	PPh_3AuNTf_2	DCE	**2a**	$Al(OTf)_3$	31
11	PPh_3AuNTf_2	DCE	**2a**	$Sc(OTf)_3$	46
12	PPh_3AuNTf_2	DCE	**2b**	$Zn(OTf)_2$	67
13	PPh_3AuNTf_2	DCE	**2c**	$Zn(OTf)_2$	58
14	PPh_3AuNTf_2	DCE	**2d**	$Zn(OTf)_2$	68
15	PPh_3AuNTf_2	toluene	**2a**	$Zn(OTf)_2$	72
16	PPh_3AuNTf_2	MeCN	**2a**	$Zn(OTf)_2$	71
17	PPh_3AuNTf_2	DCE	**2a**	$Zn(OTf)_2$	73[c]
18	PPh_3AuNTf_2	DCE	**2a**	$Zn(OTf)_2$[d]	77
19	$AgNTf_2$	DCE	**2a**	$Zn(OTf)_2$	-(24)
20	$HNTf_2$	DCE	**2a**	$Zn(OTf)_2$	-
21	-	DCE	**2a**	$Zn(OTf)_2$	-[e]

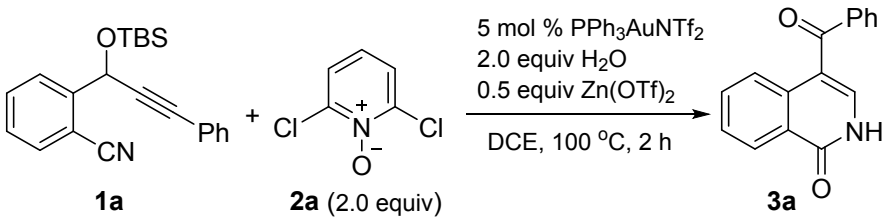
[a]The yields were determined by ^{1}H NMR using 1,3,5-trimethoxybenzene as an internal standard. The yields of the unreacted **1a** are shown in parentheses. [b]6 h. [c]5.0 equiv of H_2O was used. [d]0.25 equiv of $Zn(OTf)_2$ was used. [e]12 h. 2-(3-Oxo-3-phenylprop-1-yn-1-yl)benzonitrile was formed in ca. 34% yield.

The results of Table S1, entry 21.



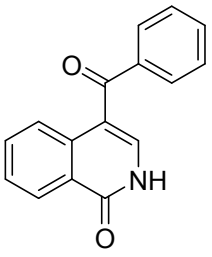
To a sealable tube were added *o*-(cyano)phenyl propargyl ether **1a** (0.5 mmol, 173.8 mg), DCE (5 mL), 2,6-dichloropyridine *N*-oxide **2a** (1 mmol, 164 mg), H_2O (1 mmol, 18 μL) and $Zn(OTf)_2$ (0.25 mmol, 90.9 mg) under Argon. Then the tube was sealed. After the reaction mixture was stirred at 100 °C for 12 h as monitored by thin-layer chromatography, the mixture was filtered through a pad of silica gel and washed with ethyl acetate. The solvent was evaporated under the reduced pressure and the residue was purified by column chromatography on silica gel (eluent: petroleum ether: ethyl acetate = 30:1 to 25:1 to 20:1) to afford 2-(3-oxo-3-phenylprop-1-yn-1-yl)benzonitrile in ca. 34% yield (39 mg) as a light yellow solid (containing small amount of impurity), along with a minor byproduct (11 mg), the structure of which was not defined yet. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52-7.61 (m, 3H), 7.63-7.68 (m, 2H), 7.75-7.82 (m, 2H), 8.33 (d, J = 7.6 Hz, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 86.9, 91.1, 116.2, 117.1, 124.0, 128.8, 129.9, 130.8, 132.7, 132.9, 134.3, 134.6, 136.3, 177.4. The spectroscopic data is in agreement with that previously reported.[6]

Typical procedures for the synthesis of 4-benzoylisoquinolin-1(*2H*)-one (3a).



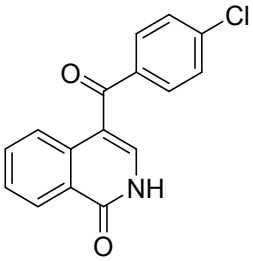
To a sealable tube were added *o*-(cyano)phenyl propargyl ether **1a** (0.3 mmol, 104.3 mg), DCE (3 mL), 2,6-dichloropyridine *N*-oxide **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) under Argon. Then the tube was sealed. After the reaction mixture was stirred at 100 °C for 2 h as monitored by thin-layer chromatography, the reaction mixture was filtered through a pad of silica gel and washed with ethyl acetate. The solvent was evaporated under the reduced

pressure and the residue was purified by column chromatography on silica gel (wet loading, eluent: petroleum ether: acetone = 5:2) to afford **3a** in 80% yield (59.6 mg) as a light yellow solid.



3a

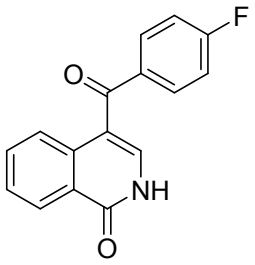
4-Benzoylisoquinolin-1(*2H*)-one (3a). M.p. 192-194 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.48-7.55 (m, 3H), 7.57-7.66 (m, 2H), 7.75-7.81 (m, 3H), 8.30 (d, J = 8.0 Hz, 1H), 8.47 (d, J = 8.0 Hz, 1H), 11.82 (d, J = 4.0 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 113.5, 125.2, 125.6, 127.1, 127.3, 128.6, 129.5, 132.3, 133.2, 135.1, 139.0, 139.3, 161.5, 193.6. IR (neat): 3181, 3053, 2869, 1668, 1631, 1617, 1596, 1511, 1473, 1443, 1333, 1316, 1284, 1240, 1145, 1063, 927, 874, 795, 790, 763, 746, 711, 694, 684 cm^{-1}. HRMS (ESI) calcd for $C_{16}H_{12}NO_2$ $[M+H]^+$: 250.0863, found 250.0863.



3b

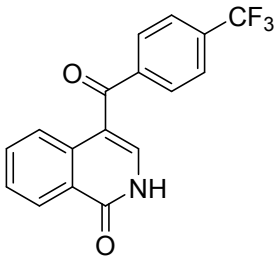
4-(4-Chlorobenzoyl)isoquinolin-1(*2H*)-one (3b). Following the typical procedure, 0.3 mmol scale, **1b** (0.3 mmol,114.6 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) were stirred at 100 °C for 2 h. Column chromatography on silica gel (eluent: petroleum ether : acetone = 4:1 to 5:2) afforded the title product as a yellow solid in 73% (62 mg) isolated yield. M.p. 248-251 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.53-7.59 (m, 4H), 7.77-7.81 (m, 3H), 8.29 (d, J = 8.0 Hz, 1H), 8.44 (d, J = 8.4 Hz, 1H), 11.86 (s, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 113.2,

125.12, 125.51, 127.1, 127.3, 128.6, 131.3, 133.1, 135.0, 137.2, 137.7, 139.5, 161.5, 192.3. IR (neat): 3291, 3184, 3050, 1670, 1637, 1617, 1474, 1334, 1296, 1286, 1260, 1242, 1087, 1012, 885, 876, 840, 799, 790, 772, 757, 747, 692, 684, 665 cm^{-1}. HRMS (ESI) calcd for $C_{16}H_{11}NO_2Cl$ $[M+H]^+$: 284.0473, found 284.0474.



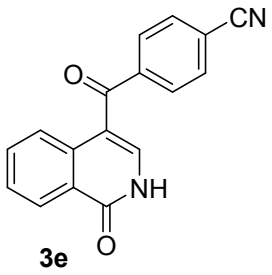
3c

4-(4-Fluorobenzoyl)isoquinolin-1(*2H*)-one (3c). Following the typical procedure, 0.3 mmol scale, **1c** (0.3 mmol, 109.7 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) were stirred at 100 °C for 2 h. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 10:1 to 5:1 to 3:1) afforded the title product as a yellow solid in 83% (66.7 mg) isolated yield. M.p. 210-212 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.33-7.37 (m, 2H), 7.51 (d, J = 6.4 Hz, 1H), 7.56-7.60 (m, 1H), 7.76-7.87 (m, 3H), 8.29 (dd, J = 8.0 Hz, 0.8 Hz, 1H), 8.39 (d, J = 8.0 Hz, 1H), 11.82 (d, J = 4.8 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 113.5, 115.5, 115.7, 125.1, 125.6, 127.2 (d, $^2J_{C\text{-}F}$ = 23.8 Hz), 132.4 (d, $^3J_{C\text{-}F}$ = 9.7 Hz), 133.2, 135.1, 135.5 (d, $^4J_{C\text{-}F}$ = 3.0 Hz), 139.0, 161.6, 164.6 (d, $^1J_{C\text{-}F}$ = 249.1 Hz), 192.2. ^{19}F NMR (376 MHz, DMSO-d_6) δ -102.4 (m, 1F). IR (neat): 3181, 3053, 1669, 1634, 1618, 1597, 1474, 1334, 1301, 1284, 1239, 1226, 1153, 1145, 1063, 868, 847, 775, 754, 738, 698, 684 cm^{-1}. HRMS (ESI) calcd for $C_{16}H_{11}NO_2F$ $[M+H]^+$: 268.0768, found 268.0770.



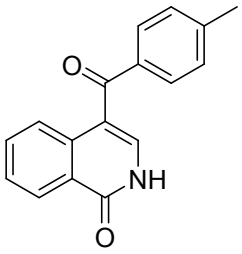
3d

4-(4-(trifluoromethyl)benzoyl)isoquinolin-1(2*H*)-one (3d). Following the typical procedure, 0.3 mmol scale, **1d** (0.3 mmol, 124.7 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) were stirred at 100 °C for 1.5 h. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 5:1 to 4:1 to 3:1) afforded the title product as a white solid in 66% (63.2 mg) isolated yield. M.p. 255-256 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.54-7.62 (m, 2H), 7.79-7.95 (m, 5H), 8.29 (dd, J = 7.8 Hz, 0.8 Hz, 1H), 8.58 (d, J = 8.4 Hz, 1H), 11.89 (d, J = 6.0 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 112.9, 123.9 (q, J = 271.4 Hz), 125.2, 125.5 (q, J = 4.4 Hz), 127.1, 127.4, 130.0, 131.6 (q, J = 31.3 Hz), 133.3, 134.8, 140.8, 142.8, 161.6, 192.6. ^{19}F NMR (376 MHz, DMSO-d_6) δ -62.2 (s, 3F). IR (neat): 3183, 3050, 2876, 1669, 1642, 1619, 1510, 1474, 1323, 1309, 1162, 1142, 1109, 1067, 1058, 889, 877, 853, 778, 759, 740, 709, 685, 656 cm^{-1}. HRMS (ESI) calcd for $C_{17}H_{11}NO_2F_3$ $[M+H]^+$: 318.0736, found 318.0735.



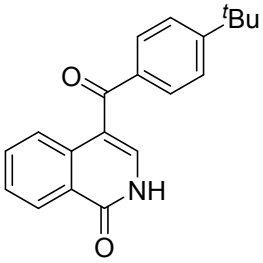
3e

4-(1-oxo-1,2-dihydroisoquinoline-4-carbonyl)benzonitrile (3e). Following the typical procedure, 0.3 mmol scale, **1e** (0.3 mmol, 111.8 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) were stirred at 100 °C for 4 h. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 4:1 to 2:1 to 1:1) for three times to afford the title product (containing some amount of impurity) in 26% isolated yield. In another experiment, the yield of **3e** was determined by ^{1}H NMR of the crude reaction mixture (67%). ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.61-7.64 (m, 1H), 7.82-7.91 (m, 3H), 8.01-8.03 (m, 2H), 8.30 (dd, J = 8.0 Hz, 0.8 Hz, 1H), 8.60 (d, J = 8.4 Hz, 1H), 11.91 (d, J = 6.0 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 112.7, 114.1, 118.3, 125.2, 125.4, 127.1, 127.5, 129.9, 132.6, 133.4, 134.7, 141.1, 143.0, 161.5, 192.5. HRMS (ESI) calcd for $C_{17}H_{11}N_2O_2$ $[M+H]^+$: 275.0815, found 275.0812.



3f

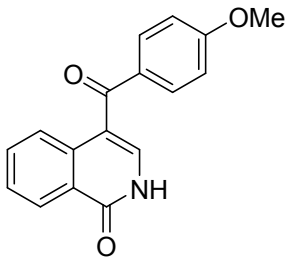
4-(4-Methylbenzoyl)isoquinolin-1(*2H*)-one (3f). Following the typical procedure, 0.3 mmol scale, **1d** (0.3 mmol, 108.5 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) were stirred at 100 °C for 2 h. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate : acetone = 8:1:1 to 5:1:1) afforded the title product as a light yellow solid in 84% (66.1 mg) isolated yield. M.p. 215-217 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 2.40 (s, 3H), 7.34-7.36 (m, 2H), 7.47 (d, J = 6.0 Hz, 1H), 7.57-7.61 (m, 1H), 7.67-7.69 (m, 2H), 7.77-7.81 (m, 1H), 8.29 (d, J = 6.8 Hz, 1H), 8.37 (d, J = 8.4 Hz, 1H), 11.77 (d, J = 4.8 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 21.1, 113.7, 125.1, 125.5, 127.0, 127.2, 129.1, 129.6, 133.1, 135.2, 136.2, 138.3, 142.7, 161.5, 193.2. IR (neat): 3296, 3176, 3034, 2922, 2862, 1683, 1637, 1618, 1605, 1473, 1444, 1337, 1312, 1289, 1239, 1181, 1162, 1066, 891, 835, 771, 746, 739, 685 cm^{-1}. HRMS (ESI) calcd for $C_{17}H_{14}NO_2$ $[M+H]^+$: 264.1019, found 264.1019.



3g

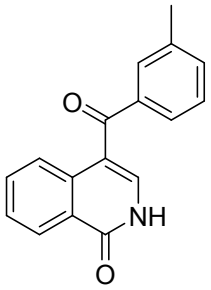
(4-(*tert*-Butyl)benzoyl)isoquinolin-1(*2H*)-one (3g). Following the typical procedure, 0.3 mmol scale, **1e** (0.3 mmol, 121.1 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) were stirred at 100 °C for 3 h. Column chromatography on silica gel (eluent: petroleum ether : acetone = 6:1 to 4:1) afforded the part product as a white solid in 63% (57.4 mg) isolated yield. Another part of product was separated by preparative TLC on silica gel in 7% (6.8 mg) yield. The combined yield of **3e** was 70%. M.p. 228-231 °C. ^{1}H NMR (400 MHz, DMSO-d_6)

δ 1.30 (s, 9H), 7.49-7.60 (m, 4H), 7.70-7.72 (m, 2H), 7.77-7.80 (m, 1H), 8.30 (d, J = 8.0 Hz, 1H), 8.43 (d, J = 8.0 Hz, 1H), 11.77 (s, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 30.9, 34.8, 113.6, 125.1, 125.4, 125.6, 127.1, 127.2, 129.5, 133.1, 135.2, 136.2, 138.7, 155.4, 161.5, 193.1. IR (neat): 3184, 3042, 2965, 2869, 2744, 1669, 1631, 1617, 1603, 1473, 1335, 1313, 1284, 1239, 1187, 1145, 1109, 1063, 888, 847, 779, 762, 754, 707, 687, 665 cm^{-1}. HRMS (ESI) calcd for $C_{20}H_{20}NO_2$ $[M+H]^+$: 306.1489, found 306.1478.



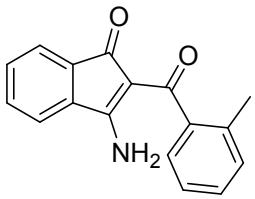
3h

(4-Methoxybenzoyl)isoquinolin-1(*2H*)-one (3h). Following the typical procedure, 0.3 mmol scale, **1h** (0.3 mmol, 113.4 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) were stirred at 100 ^{o}C for 2 h. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 10:1 to 4:1 to 2:1) afforded the title product as a light yellow solid in 60% (50 mg) isolated yield. M.p. 190-192 ^{o}C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 3.85 (s, 3H), 7.06-7.08 (m, 2H), 7.46 (d, J = 6.8 Hz, 1H), 7.56-7.60 (m, 1H), 7.75-7.80 (m, 3H), 8.24 (d, J = 8.4 Hz, 1H), 8.29 (d, J = 8.0 Hz, 1H), 11.75 (d, J = 5.2 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 55.6, 113.9, 114.1, 125.1, 125.6, 127.0, 127.2, 131.2, 131.9, 132.9, 135.3, 137.1, 161.5, 162.8, 192.1. IR (neat): 3312, 3181, 3063, 2917, 2835, 1681, 1618, 1598, 1571, 1501, 1471, 1456, 1329, 1289, 1247, 1234, 1175, 1157, 1140, 1023, 888, 841, 780, 759, 699, 686 cm^{-1}. HRMS (ESI) calcd for $C_{17}H_{14}NO_3$ $[M+H]^+$: 280.0968, found 280.0971.



3i

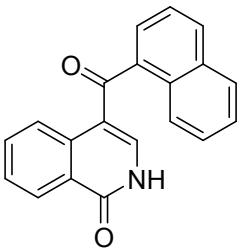
4-(3-Methylbenzoyl)isoquinolin-1(*2H*)-one (3i). Following the typical procedure, 0.3 mmol scale, **1g** (0.3 mmol, 108.5 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) were stirred at 100 °C for 2 h. Column chromatography on silica gel (eluent: petroleum ether : acetone = 4:1 to 5:2) afforded the title product as a yellow solid in 64% (50.8 mg) isolated yield. M.p. 184-187 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 2.37 (s, 3H), 7.39-7.61 (m, 6H), 7.78-7.81 (m, 1H), 8.29 (d, J = 8.0 Hz, 1H), 8.44 (d, J = 8.4 Hz, 1H), 11.77 (s, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 20.9, 113.6, 125.2, 125.6, 126.7, 127.1, 127.3, 128.4, 129.8, 133.0, 133.1, 135.1, 138.0, 139.0, 139.1, 161.6, 193.7. IR (neat): 3312, 3173, 3045, 1636, 1625, 1586, 1474, 1444, 1338, 1311, 1171, 886, 774, 734, 709, 686 cm^{-1}. HRMS (ESI) calcd for $C_{17}H_{13}NO_2Na$ $[M+Na]^+$: 286.0839, found 286.0847.



4

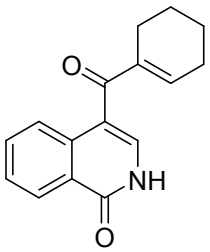
3-Amino-2-(2-methylbenzoyl)-*1H*-inden-1-one (4). Following the typical procedure, 0.3 mmol scale, **1h** (0.3 mmol, 108.5 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) were stirred at 100 °C for 4 h. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate : acetone = 12:1:1 to 8:1:1) afforded the title product as a yellow solid in 17% (13.5 mg) isolated yield. M.p. 252-254 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 2.20 (s, 3H), 7.12-7.20 (m, 3H), 7.26-7.29 (m, 1H), 7.43-7.45 (m, 1H), 7.63-7.65 (m, 2H), 8.08-8.10 (m, 1H), 10.17 (s, 1H), 10.24 (s, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 19.0, 104.0, 121.3, 121.8,

124.8, 126.9, 128.3, 129.6, 132.5, 133.6, 133.9, 135.1, 135.7, 141.6, 171.5, 186.7, 192.0. IR (neat): 3306, 3166, 1675, 1629, 1612, 1588, 1474, 1448, 1310, 1264, 1231, 1173, 1160, 1129, 1114, 978, 866, 776, 763, 735, 699, 663 cm^{-1}. HRMS (ESI) calcd for $C_{17}H_{14}NO_2Na$ $[M+Na]^+$: 286.0839, found 286.0840.



3k

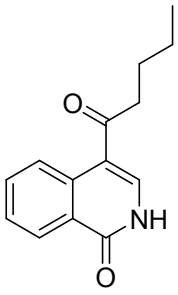
(2-Naphthoyl)isoquinolin-1(*2H*)-one (3k). Following the typical procedure, 0.3 mmol scale, **1i** (0.3 mmol, 119.3 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) were stirred at 100 °C for 2 h. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate : acetone = 12:1:1 to 6:1:1) afforded the title product as a pink solid in 43% (38.4 mg) isolated yield. M.p. 232-234 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.40 (d, J = 6.4 Hz, 1H), 7.54-7.69 (m, 5H), 7.88-7.97 (m, 2H), 8.05 (d, J = 7.2 Hz, 1H), 8.21 (d, J = 8.0 Hz, 1H), 8.32 (d, J = 7.6 Hz, 1H), 9.01 (d, J = 8.0 Hz, 1H), 11.76 (d, J = 4.8 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 114.4, 124.9, 125.1, 125.3, 125.5, 126.6, 126.9, 127.2, 127.4, 127.6, 128.5, 130.3, 130.6, 133.3, 133.6, 134.8, 137.3, 142.2, 161.6, 195.1. IR (neat): 3189, 3053, 2848, 2759, 1677, 1637, 1622, 1474, 1335, 1289, 1256, 1247, 1173, 1140, 1111, 890, 773, 749, 741, 726, 688, 681 cm^{-1}. HRMS (ESI) calcd for $C_{20}H_{14}NO_2$ $[M+H]^+$: 300.1019, found 300.1015.



3l

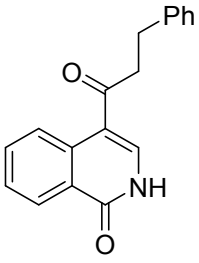
2-(Cyclohex-1-ene-1-carbonyl)isoquinolin-1(*2H*)-one (3l). Following the typical procedure, 0.3 mmol scale, **1j** (0.3 mmol, 105.5 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6

mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) were stirred at 100 °C for 1.5 h. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate : acetone = 12:1:1 to 6:1:1) afforded the title product as a white solid in 60% (45.5 mg) isolated yield. M.p. 169-171 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.70-1.77 (m, 4H), 2.28 (w, 2H), 2.47 (w, 2H), 6.70 (s, 1H), 7.55-7.61 (m, 2H), 7.73-7.77 (m, 1H), 8.21 (d, J = 8.4 Hz, 1H), 8.45 (d, J = 8.0 Hz, 1H), 12.43 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 21.6, 21.9, 23.9, 26.1, 116.9, 125.4, 125.5, 127.2, 127.4, 133.3, 133.4, 135.9, 140.4, 143.3, 164.6, 195.2. IR (neat): 3309, 3181, 3034, 2926, 2865, 1670 ,1622, 1475, 1387, 1339, 1283, 1267, 1237, 1178, 1138, 1058, 930, 885, 829, 791, 772, 732, 684, 662 cm^{-1}. HRMS (ESI) calcd for $C_{16}H_{16}NO_2$ $[M+H]^+$: 254.1176, found 254.1177.



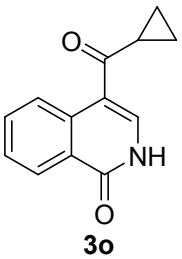
3m

4-Pentanoylisoquinolin-1(*2H*)-one (3m). Following the typical procedure, 0.3 mmol scale, **1k** (0.3 mmol, 98.3 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) were stirred at 100 °C for 1 h. Column chromatography on silica gel (eluent: petroleum ether : acetone = 5:2 to petroleum : ethyl acetate : acetone = 4:1:1) afforded the title product as a light yellow solid in 62% (42.3 mg) isolated yield. M.p. 180-183 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 0.88-0.92 (t, 3H), 1.29-1.38 (m, 2H), 1.55-1.62 (m, 2H), 2.90-2.93 (t, 3H), 7.53-7.57 (m, 1H), 7.75-7.79 (m, 1H), 8.18 (d, J = 6.4 Hz, 1H), 8.24 (d, J = 8.0 Hz, 1H), 8.82 (d, J = 8.4 Hz, 1H), 11.92 (s, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 13.9, 21.8, 26.7, 38.5, 113.3, 125.3, 125.5, 126.9, 127.0, 133.2, 134.8, 138.1, 161.8, 199.0. IR (neat): 3309, 3178, 3042, 2912, 2862, 1691, 1646, 1619, 1467, 1437, 1335, 1268, 1245, 1164, 1141, 1076, 1032, 881, 789, 770, 744, 687 cm^{-1}. HRMS (ESI) calcd for $C_{14}H_{16}NO_2$ $[M+H]^+$: 230.1176, found 230.1178.



3n

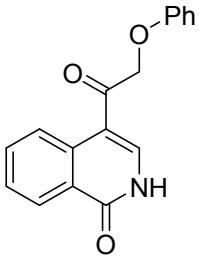
4-(3-Phenylpropanoyl)isoquinolin-1(*2H*)-one (3n). Following the typical procedure, 0.3 mmol scale, **1l** (0.3 mmol, 112.7 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) were stirred at 100 °C for 2 h. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate : acetone = 8:1:1 to 6:1:1 to 4:1:1) afforded the title product as a white solid in 62% (51.2 mg) isolated yield. M.p. 193-195 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 2.92-2.95 (t, 3H), 3.26-3.30 (t, 3H), 7.15-7.18 (m, 1H), 7.24-7.28 (m, 4H), 7.53-7.56 (m, 1H), 7.75-7.79 (m, 1H), 8.21-8.25 (m, 2H), 8.84 (d, J = 8.4 Hz, 1H), 11.94 (d, J = 4.8 Hz, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 30.1, 40.1, 113.2, 125.3, 125.5, 125.8, 126.9, 127.0, 128.2, 128.5, 133.2, 134.7, 138.4, 141.3, 161.8, 197.9. IR (neat): 3184, 3013, 2924, 2867, 1674, 1646, 1620, 1474, 1341, 1296, 1261, 1244, 1138, 1113, 932, 880, 784, 765, 751, 694, 683 cm^{-1}. HRMS (ESI) calcd for $C_{18}H_{16}NO_2$ $[M+H]^+$: 278.1176, found 278.1176.



3o

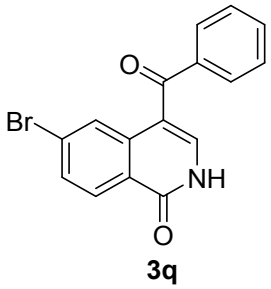
4-(Cyclopropanecarbonyl)isoquinolin-1(*2H*)-one (3o). Following the typical procedure, 0.3 mmol scale, **1m** (0.3 mmol, 93.5 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) were stirred at 100 °C for 1 h. Column chromatography on silica gel (eluent: petroleum ether : acetone = 5:2 to petroleum ether : ethyl acetate : acetone = 4:1:1) afforded the title product as a white solid in 53% (33.8 mg) isolated yield. M.p. 260-263 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 0.94-1.01 (m, 4H), 2.66-2.70 (m, 1H), 7.53-7.56 (m, 1H), 7.73-7.77 (m, 1H), 8.25 (d, J =

7.6 Hz, 1H), 8.30 (s, 1H), 8.71 (d, J = 8.0 Hz, 1H), 11.98 (s, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 10.6, 17.8, 114.5, 125.3, 125.5, 126.9, 127.1, 133.1, 134.5, 137.9, 161.8, 197.8. IR (neat): 3369, 3181, 3040, 2859, 1686, 1637, 1618, 1471, 1404, 1334, 1268, 1168, 1142, 1117, 1081, 1032, 945, 892, 873, 859, 778, 753, 686 cm^{-1}. HRMS (ESI) calcd for $C_{13}H_{12}NO_2$ $[M+H]^+$: 214.0863, found 214.0862.



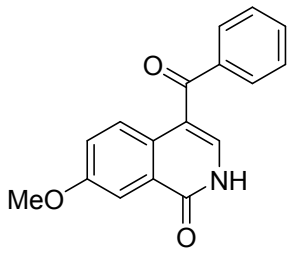
3p

4-(2-Phenoxyacetyl)isoquinolin-1(*2H*)-one (3p). Following the typical procedure, 0.3 mmol scale, **1n** (0.3 mmol, 113.3 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) were stirred at 100 °C for 2 h. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 15:1 to 8:1 to 5:1 to 3:1) afforded the title product as a white solid in 34% (28.5 mg) isolated yield. M.p. 226-228 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 5.40 (s, 2H), 6.91-6.98 (m, 3H), 7.26-7.30 (m, 2H), 7.55-7.59 (m, 1H), 7.77-7.81 (m, 1H), 8.26 (d, J = 7.6 Hz, 1H), 8.36 (s, 1H), 8.79 (d, J = 8.0 Hz, 1H), 12.12 (s, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 69.8, 110.7, 114.6, 120.8, 125.0, 125.4, 126.9, 127.2, 129.4, 133.4, 134.5, 138.7, 158.0, 161.7, 193.2. IR (neat): 3312, 3178, 3047, 2922, 2881, 2754, 1659, 1625, 1599, 1489, 1474, 1337, 1217, 1171, 1141, 1064, 915, 785, 772, 758, 737, 691 cm^{-1}. HRMS (ESI) calcd for $C_{17}H_{14}NO_3$ $[M+H]^+$: 280.0968, found 280.0968.



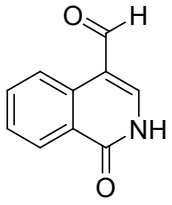
3q

4-Benzoyl-6-bromoisoquinolin-1(*2H*)-one (3q). Following the typical procedure, 0.3 mmol scale, **1o** (0.3 mmol, 127.9 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) were stirred at 100 °C for 2 h. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 10:1 to 5:1 to 3:1) afforded the title product as a white solid in 74% (72.8 mg) isolated yield. M.p. 223-225 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.52-7.56 (m, 3H), 7.63-7.67 (m, 1H), 7.74-7.76 (m, 3H), 8.18 (d, J = 8.8 Hz, 1H), 8.72 (d, J = 2.0 Hz, 1H), 11.92 (s, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 112.1, 124.4, 127.5, 127.7, 128.5, 129.3, 129.4, 130.2, 132.3, 136.5, 138.7, 141.1, 161.0, 193.4. IR (neat): 3291, 3173, 3053, 2919, 1679, 1631, 1617, 1591, 1446, 1424, 1316, 1286, 1231, 1172, 1059, 888, 827, 802, 781, 750, 722, 689, 681, 653 cm^{-1}. HRMS (ESI) calcd for $C_{16}H_{11}NO_2Br$ $[M+H]^+$: 327.9968, found 327.9971.



3r

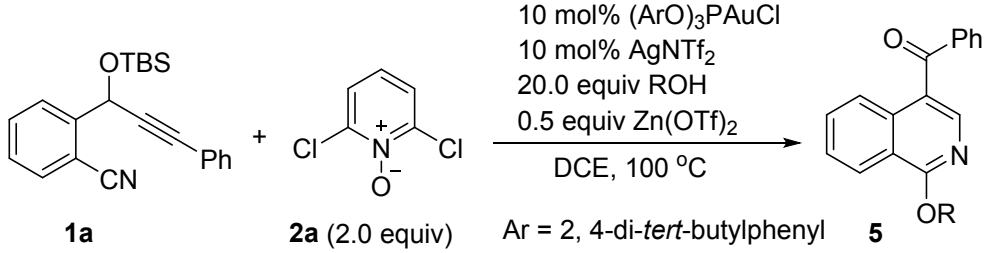
5-Benzoyl-7-methoxyisoquinolin-1(*2H*)-one (3r). Following the typical procedure, 0.16 mmol scale, **1p** (0.16 mmol, 60.4 mg), DCE (1.6 mL), **2a** (0.32 mmol, 52.5 mg), H_2O (0.32 mmol, 5.8 μL), $Zn(OTf)_2$ (0.08 mmol, 29.1 mg) and PPh_3AuNTf_2 (0.008 mmol, 5.9 mg) were stirred at 100 °C for 2 h. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate = 10:1 to 8:1 to 5:1 to 3:1) afforded the title product as a white solid in 40% (17.8 mg) isolated yield. M.p. 249-251 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 3.90 (s, 3H), 7.37 (s, 1H), 7.43-7.46 (m, 1H), 7.52-7.56 (m, 2H), 7.63-7.76 (m, 4H), 8.45 (d, J = 9.2 Hz, 1H), 11.76 (s, 1H).^{13}C NMR (100 MHz, DMSO-d_6) δ 55.4, 107.7, 113.5, 122.4, 127.0, 127.1, 128.5, 128.7, 129.3, 132.2, 137.2, 139.0, 158.3, 161.1, 193.6. IR (neat): 3178, 3060, 3032, 2940, 2917, 2848, 1660, 1630, 1613, 1597, 1512, 1490, 1451, 1345, 1285, 1266, 1241, 1213, 1178, 1068, 1027, 889, 876, 841, 785, 752, 707, 687 cm^{-1}. HRMS (ESI) calcd for $C_{17}H_{14}NO_3$ $[M+H]^+$: 280.0968, found 280.0967.



3s

1-Oxo-1,2-dihydroisoquinoline-4-carbaldehyde (3s). Following the typical procedure, 0.3 mmol scale, **1q** (0.3 mmol, 103.1 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) were stirred at 100 °C for 1 h. Column chromatography on silica gel (eluent: petroleum ether : ethyl acetate : acetone = 12:1:1 to 6:1:1) afforded the title product as a brown solid in 23% (11.8 mg) isolated yield. M.p. 225-228 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.59-7.62 (m, 1H), 7.82-7.85 (m, 1H), 8.15 (d, J = 6.4 Hz, 1H), 8.24 (d, J = 8.0 Hz, 1H), 8.95 (d, J = 8.0 Hz, 1H), 9.76 (s, 1H), 12.23 (br s, 1H).^{13}C NMR (100 MHz, DMSO-d_6) δ 113.7, 124.2, 124.7, 127.0, 127.6, 133.4, 133.7, 146.9, 161.7, 189.9. IR (neat): 3176, 3053, 2931, 2858, 2736, 1652, 1625, 1511, 1479, 1446, 1386, 1329, 1270, 1230, 1139, 1071, 839, 814, 764, 709, 689, 654 cm^{-1}. HRMS (ESI) calcd for $C_{10}H_7NO_2$ $[M]^+$: 173.0471, found 173.0468. The spectroscopic data is in agreement with that previously reported.[7]

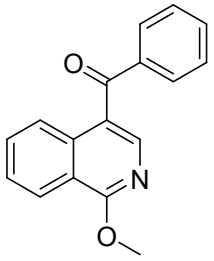
Typical procedures for the synthesis of (1-methoxyisoquinolin-4-yl)(phenyl)methanone (5a).



1a **2a** (2.0 equiv) Ar = 2, 4-di-*tert*-butylphenyl **5**

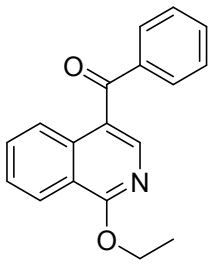
To a sealable tube were added *o*-(cyano)phenyl propargyl ether **1a** (0.3 mmol, 104.3 mg), DCE (3 mL), 2,6-dichloropyridine *N*-oxide **2a** (0.6 mmol, 98.4 mg), MeOH (6 mmol, 243μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg), $(ArO)_3PAuCl$ (Ar = 2,4-di-*tert*-butylphenyl) (0.03 mmol, 26.4 mg) and $AgNTf_2$ (0.03 mmol, 11.6 mg) under Argon. Then the tube was sealed. After the reaction mixture was stirred at 100 °C for 2 h as monitored by thin-layer

chromatography, the reaction mixture was filtered through a pad of silica gel and washed with ethyl acetate. The solvent was evaporated under the reduced pressure and the residue was purified by column chromatography on silica gel (eluent: petroleum ether: ethyl acetate = 25:1) to afford **5a** in 70% yield (55.4 mg) as a white solid.



5a

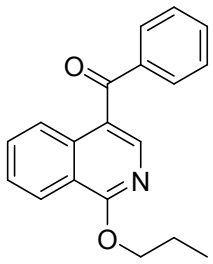
(1-methoxyisoquinolin-4-yl)(phenyl)methanone (5a). M.p. 96-98 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.20 (s, 3H), 7.46-7.50 (m, 2H), 7.58-7.63 (m, 2H), 7.73-7.76 (m, 1H), 7.87-7.89 (m, 2H), 8.25 (s, 1H), 8.34 (d, *J* = 8.4 Hz, 1H), 8.41 (d, *J* = 8.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 54.3, 119.4, 123.6, 124.4, 125.0, 127.3, 128.4, 130.2, 131.8, 132.8, 135.9, 138.9, 145.5, 163.0, 196.0. IR (neat): 2982, 2945, 2919, 1644, 1597, 1577, 1561, 1502, 1465, 1444, 1373, 1323, 1316, 1308, 1252, 1203, 1167, 1101, 1066, 1025, 980, 923, 871, 764, 746, 717, 698, 678, 655 cm^{-1}. HRMS (ESI) calcd for $C_{17}H_{14}NO_2$ $[M+H]^+$: 264.1019, found 264.1020.



5b

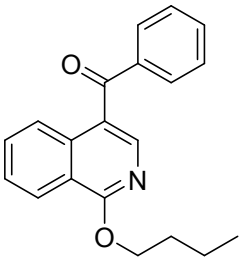
(1-Ethoxyisoquinolin-4-yl)(phenyl)methanone (5b). Following the typical procedure, 0.3 mmol scale, **1a** (0.3 mmol, 104.3 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), EtOH (6 mmol, 0.35 mL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg), $(ArO)_3PAuCl$ (Ar = 2,4-di-*tert*-butylphenyl) (0.03 mmol, 26.4 mg) and $AgNTf_2$ (0.03 mmol, 11.6 mg) were stirred at 100 ^{o}C for 2 h. Column chromatography on silica gel (eluent: petroleum ether to : petroleum ether : ethyl acetate = 30:1) afforded the title product as a white waxy solid in 65% (54 mg) isolated yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 1.52-1.55 (t, *J* = 6.8 Hz, 3H), 4.61-4.67 (q, *J* = 7.2 Hz, 2H), 7.46-7.50 (m, 2H), 7.58-7.62 (m, 2H), 7.72-7.76 (m, 1H), 7.86-7.88 (m, 2H), 8.24 (s, 1H), 8.36 (d, *J* = 8.4 Hz, 1H), 8.42 (d, *J* = 8.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 14.5, 62.8, 119.5, 123.3, 124.4, 125.0, 127.2, 128.3, 130.2, 131.8, 132.7, 135.9, 138.9, 145.8, 162.7, 196.1. IR (neat): 3053, 2977, 2927, 1647, 1579, 1563, 1500, 1446, 1413, 1378, 1345, 1312, 1246, 1161, 1091, 1065, 1026, 858, 767, 717, 698, 678, 657 cm^{-1}. HRMS (ESI) calcd for $C_{18}H_{16}NO_2$ $[M+H]^+$: 278.1176, found 278.1174.



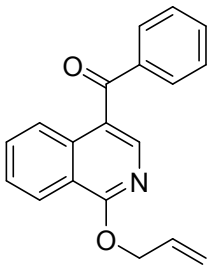
5c

Phenyl(1-propoxyisoquinolin-4-yl)methanone (5c). Following the typical procedure, 0.3 mmol scale, **1a** (0.3 mmol, 104.3 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), ^{n}PrOH (6 mmol, 449 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg), $(ArO)_3PAuCl$ (Ar = 2,4-di-*tert*-butylphenyl) (0.03 mmol, 26.4 mg) and $AgNTf_2$ (0.03 mmol, 11.6 mg) were stirred at 100 ^{o}C for 3 h. Column chromatography on silica gel (eluent: petroleum ether to : petroleum ether : ethyl acetate = 40:1 to 25:1) afforded the title product as a white waxy solid in 56% (49 mg) isolated yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.10-1.14 (t, *J* = 7.6 Hz, 3H), 1.90-1.99 (m, 2H), 4.52-4.55 (t, *J* = 6.4 Hz, 2H), 7.46-7.50 (m, 2H), 7.57-7.62 (m, 2H), 7.72-7.76 (m, 1H), 7.86-7.88 (m, 2H), 8.24 (s, 1H), 8.37 (d, *J* = 7.6 Hz, 1H), 8.42 (d, *J* = 8.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 10.6, 22.2, 68.5, 119.5, 123.3, 124.4, 125.0, 127.2, 128.3, 130.2, 131.7, 132.7, 135.9, 138.9, 145.8, 162.9, 196.0. IR (neat): 3055, 2966, 2932, 2872, 1649, 1579, 1563, 1500, 1446, 1413, 1359, 1335, 1314, 1251, 1161, 1091, 1065, 946, 879, 804, 767, 716, 698, 678, 657 cm^{-1}. HRMS (ESI) calcd for $C_{19}H_{18}NO_2$ $[M+H]^+$: 292.1332, found 292.1336.



5d

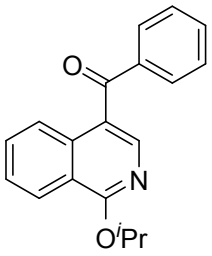
(1-Butoxyisoquinolin-4-yl)(phenyl)methanone (5d). Following the typical procedure, 0.3 mmol scale, **1a** (0.3 mmol, 104.3 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), ^{n}BuOH (6 mmol, 550 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg), $(ArO)_3PAuCl$ (Ar = 2,4-di-*tert*-butylphenyl) (0.03 mmol, 26.4 mg) and $AgNTf_2$ (0.03 mmol, 11.6 mg) were stirred at 100 ^{o}C for 4 h. Column chromatography on silica gel (eluent: petroleum ether to : petroleum ether : ethyl acetate = 50:1) afforded the title product as a light yellow oil in 66% (60.8 mg) isolated yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.01-1.05 (t, *J* = 7.6 Hz, 3H), 1.54-1.61 (m, 2H), 1.87-1.94 (m, 2H), 4.56-4.60 (t, *J* = 6.4 Hz, 2H), 7.46-7.50 (m, 2H), 7.58-7.62 (m, 2H), 7.72-7.76 (m, 1H), 7.86-7.88 (m, 2H), 8.24 (s, 1H), 8.36 (d, *J* = 8.0 Hz, 1H), 8.42 (d, *J* = 8.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 13.9, 19.4, 30.9, 66.8, 119.5, 123.3, 124.4, 125.0, 127.2, 128.3, 130.2, 131.8, 132.7, 135.9, 138.9, 145.8, 162.9, 196.0. IR (neat): 3050, 2957, 2927, 2867, 1650, 1579, 1563, 1500, 1446, 1412, 1364, 1349, 1313, 1248, 1161, 1092, 1064, 1026, 878, 804, 767, 716, 698, 678, 658 cm^{-1}. HRMS (ESI) calcd for $C_{20}H_{20}NO_2$ $[M+H]^+$: 306.1489, found 306.1482.



5e

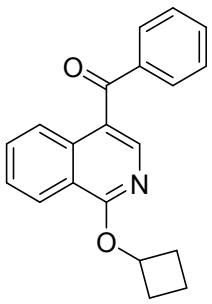
(1-(Allyloxy)isoquinolin-4-yl)(phenyl)methanone (4e). Following the typical procedure, 0.3 mmol scale, **1a** (0.3 mmol, 104.3 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), CH_2=$CHCH_2OH$ (6 mmol, 410 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg), $(ArO)_3PAuCl$ (Ar = 2,4-di-*tert*-butylphenyl) (0.03 mmol, 26.4 mg) and $AgNTf_2$ (0.03 mmol, 11.6 mg) were

stirred at 100 °C for 4 h. Column chromatography on silica gel (eluent: petroleum ether to : petroleum ether : ethyl acetate = 30:1 to 10:1) afforded the title product as a light yellow oil in 45% (39 mg) isolated yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.64 (d, *J* = 5.6 Hz, 2H), 5.19 (d, *J* = 16.8 Hz, 1H), 5.27 (d, *J* = 10.4 Hz, 1H), 5.91-6.01 (m, 1H), 7.48-7.51 (m, 3H), 7.55-7.63 (m, 2H), 7.71-7.75 (m, 1H), 7.79-7.81 (m, 2H), 8.38 (d, *J* = 8.0 Hz, 1H), 8.50 (d, *J* = 8.0 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 51.1, 115.8, 118.8, 125.4, 125.5, 127.7, 128.1, 128.5, 129.8, 132.0, 132.7, 133.1, 134.5, 138.8, 139.9, 161.6, 193.8. IR (neat): 3055, 2922, 1728, 1664, 1637, 1597, 1577, 1484, 1446, 1395, 1380, 1318, 1250, 974, 870, 785, 765, 719, 697, 660 cm^{-1}. HRMS (ESI) calcd for $C_{19}H_{16}NO_2$ $[M+H]^+$: 290.1176, found 290.1180.



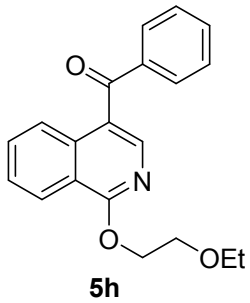
5f

(1-Isopropoxyisoquinolin-4-yl)(phenyl)methanone (5f). Following the typical procedure, 0.3 mmol scale, **1a** (0.3 mmol, 104.3 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), ^{i}PrOH (6 mmol, 459 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg), 3Å MS (30 mg), $(ArO)_3PAuCl$ (Ar = 2,4-di-*tert*-butylphenyl) (0.03 mmol, 26.4 mg) and $AgNTf_2$ (0.03 mmol, 11.6 mg) were stirred at 100 °C for 3.5 h. Column chromatography on silica gel (eluent: petroleum ether to : petroleum ether : ethyl acetate = 30:1) afforded the title product as a white waxy solid in 44% (38.2 mg) isolated yield. M.p. 88-90 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 1.48-1.50 (d, *J* = 6.4 Hz, 6H), 5.60-5.69 (m, 1H), 7.46-7.50 (m, 2H), 7.58-7.61 (m, 2H), 7.71-7.76 (m, 1H), 7.86-7.88 (m, 2H), 8.25 (s, 1H), 8.35-8.37 (m, 1H), 8.43 (d, *J* = 7.6 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 22.0, 69.6, 119.8, 123.0, 124.5, 125.0, 127.0, 128.3, 130.2, 131.7, 132.6, 136.0, 139.1, 146.0, 162.4, 196.1. IR (neat): 3079, 3045, 2974, 2917, 1647, 1578, 1560, 1498, 1411, 1396, 1372, 1316, 1306, 1260, 1108, 1086, 1065, 930, 921, 883, 824, 790, 766, 715, 695, 679, 657 cm^{-1}. HRMS (ESI) calcd for $C_{16}H_{12}NO_2$ $[M+H-C_3H_7]^+$: 250.0863, found 250.0863.



5g

(1-Cyclobutoxyisoquinolin-4-yl)(phenyl)methanone (5g). Following the typical procedure, 0.3 mmol scale, **1a** (0.3 mmol, 104.3 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), cyclobutanol (6 mmol, 470 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg), 3Å MS (30 mg), $(ArO)_3PAuCl$ (Ar = 2,4-di-*tert*-butylphenyl) (0.03 mmol, 26.4 mg) and $AgNTf_2$ (0.03 mmol, 11.6 mg) were stirred at 100 ^oC for 3.5 h. Column chromatography on silica gel (eluent: petroleum ether to : petroleum ether : ethyl acetate = 40:1) afforded the title product as a white solid in 57% (51.6 mg) isolated yield. ^1H NMR (400 MHz, $CDCl_3$) δ 1.71-1.79 (m, 1H), 1.88-1.96 (m, 1H), 2.25-2.35 (m, 2H), 2.54-2.61 (m, 2H), 5.45-5.52 (m, 1H), 7.46-7.50 (m, 2H), 7.58-7.63 (m, 2H), 7.72-7.76 (m, 1H), 7.86-7.88 (m, 2H), 8.22 (s, 1H), 8.37 (d, *J* = 8.4 Hz, 1H), 8.41 (d, *J* = 8.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 13.7, 30.8, 71.0, 119.4, 123.4, 124.5, 125.0, 127.2, 128.4, 130.2, 131.7, 132.7, 136.0, 139.0, 145.9, 162.0, 196.1. IR (neat): 2992, 2940, 2922, 1646, 1578, 1561, 1499, 1413, 1396, 1336, 1314, 1260, 1162, 1098, 938, 876, 805, 771, 723, 703, 678 cm^{-1}. HRMS (ESI) calcd for $C_{20}H_{18}NO_2$ $[M+H]^+$: 304.1332, found 304.1330.

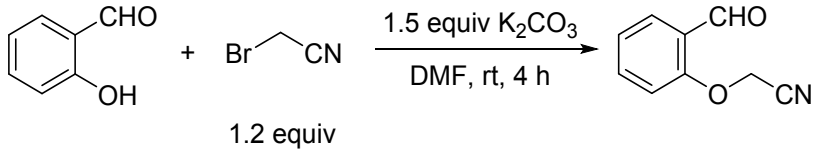


5h

(1-(2-Ethoxyethoxy)isoquinolin-4-yl)(phenyl)methanone (5h). Following the typical procedure, 0.3 mmol scale, **1a** (0.3 mmol, 104.3 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), $HOCH_2CH_2OEt$ (6 mmol, 580 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg), 3Å MS (30 mg),

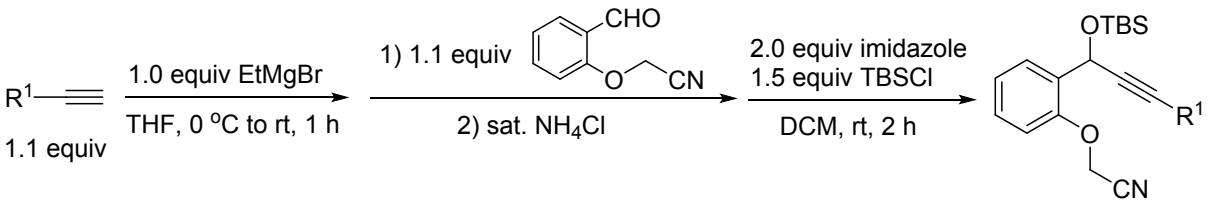
$(ArO)_3PAuCl$ (Ar = 2,4-di-*tert*-butylphenyl) (0.03 mmol, 26.4 mg) and $AgNTf_2$ (0.03 mmol, 11.6 mg) were stirred at 100 ^oC for 2.5 h. Column chromatography on silica gel (eluent: petroleum ether to : petroleum ether : ethyl acetate = 40:1 to 20:1) afforded the title product as a light yellow sticky oil in 62% (59.7 mg) isolated yield. ^1H NMR (400 MHz, $CDCl_3$) δ 1.24-1.27 (t, *J* = 6.8 Hz, 3H), 3.62-3.67 (q, *J* = 6.8 Hz, 2H), 3.91-3.93 (t, *J* = 4.8 Hz, 3H), 4.73-4.75 (t, *J* = 4.4 Hz, 3H), 7.45-7.49 (m, 2H), 7.57-7.62 (m, 2H), 7.71-7.75 (m, 1H), 7.85-7.87 (m, 2H), 8.22 (s, 1H), 8.38-8.40 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 15.2, 66.2, 66.7, 68.6, 119.4, 123.6, 124.5, 124.9, 127.2, 128.3, 130.1, 131.8, 132.8, 135.9, 138.8, 145.3, 162.5, 196.0. IR (neat): 3053, 2969, 2862, 1744, 1651, 1579, 1564, 1500, 1446, 1399, 1340, 1314, 1250, 1122, 1092, 1026, 860, 768, 717, 698, 678, 658 cm^{-1}. HRMS (ESI) calcd for $C_{20}H_{20}NO_3$ $[M+H]^+$: 322.1438, found 322.1437.

Synthesis and characterization of 2-(2-formylphenoxy)acetonitrile



To a Schlenk tube were added salicylaldehyde (30 mmol, 3.664 g), DMF (20 mL), K_2CO_3 (45 mmol, 6.219 g) under Argon. Yellow Precipitate was observed after the reaction mixture was stirred at rt for 15 min, then $BrCH_2CN$ (36 mmol, 4.318 g) was added drop by drop at rt and stirred for another 4 h. The resulting reaction mixture was diluted with a large amount of ethyl acetate and quenched with water, then extracted with ethyl acetate for 3 times. The combined organic extracts were washed with water and brine, and dried over Na_2SO_4. The residue was purified by column chromatography on silica gel (petroleum ether : ethyl acetate = 2:1 to 1:1) to afford 2-(2-formylphenoxy)acetonitrile in 99% (4.8 g) overall yield. ^1H NMR (400 MHz, $CDCl_3$) δ 4.94 (s, 2H), 7.08-7.10 (m, 1H), 7.19-7.23 (m, 1H), 7.62-7.66 (m, 1H), 7.89-7.91 (m, 1H), 10.43 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 53.7, 112.6, 114.4, 123.2, 125.6, 129.4, 136.0, 158.2, 188.6. The spectroscopic data is in agreement with that previously reported.[8]

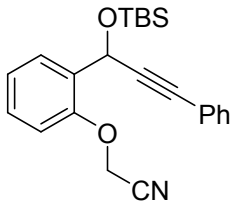
Synthesis and characterization of (*o*-phenoxyacetonitrile)propargyl ethers 6.



6a (R^1 = Ph)

First step: 1-ethynylbenzene (3.3 mmol, 362 μL) in THF (6 mL) was added dropwise EtMgBr (3 mmol, 3.0 M solution in Et_2O, 1 mL) at 0 °C under argon. Then the reaction mixture was warmed up to room temperature and stirred for 1 h. 2-(2-Formylphenoxy) acetonitrile (3.0 mmol, 483.5 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. The resulting reaction mixture was quenched with saturated NH_4Cl solution, and extracted with ethyl acetate. The combined organic extracts were washed with water and brine, and dried over Na_2SO_4. The solvent was evaporated under the reduced pressure to afford the crude alcohol which was used directly without further purification for the next step.

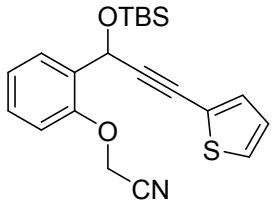
To a solution of the above crude alcohol in DCM (6 mL) were added imidazole (6.0 mmol, 408.5 mg) and TBSCl (4.5 mmol, 678.2 mg). The reaction mixture was then stirred at room temperature for 2 h. Then the resulting mixture was quenched with saturated ammonium chloride solution and extracted with dichloromethane, washed with water and brine, dried over Na_2SO_4, and concentrated *in vacuo*. The residue was purified by column chromatography on silica gel (eluent: petroleum ether to petroleum ether : ethyl acetate = 50:1 to 30:1) afforded the desired product in 75% overall yield (847.2 mg) as a light-yellow oil.



6a

2-(2-(1-((*tert*-Butyldimethylsilyl)oxy)-3-phenylprop-2-yn-1-yl)phenoxy)acetonitrile (6a). ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.26 (s, 3H), 0.31 (s, 3H), 1.03 (s, 9H), 4.82 (s, 2H), 6.05 (s, 1H), 6.98 (d, *J* = 8.0 Hz, 1H), 7.18-7.22 (m, 1H), 7.32-7.39 (m, 4H), 7.47 (b, 2H), 7.85 (d, *J* =

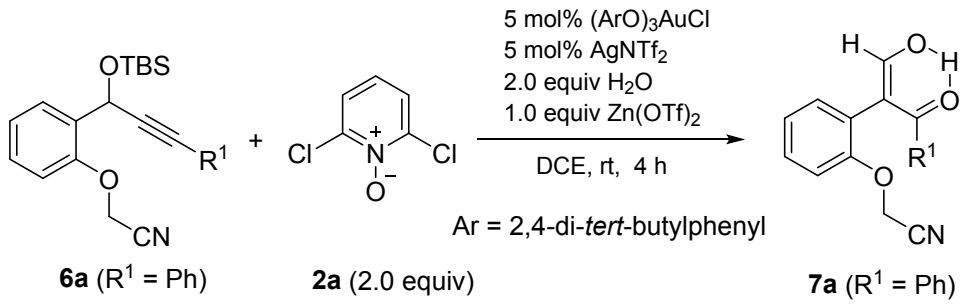
7.6 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -4.9, -4.5, 18.2, 25.8, 53.7, 59.6, 84.6, 89.7, 112.0, 115.1, 122.7, 123.2, 128.0, 128.17, 128.21, 129.0, 131.3, 131.5, 152.9. IR (neat): 2954, 2929, 2884, 2856, 1591, 1489, 1471, 1456, 1252, 1218, 1180, 1112, 1055, 1001, 980, 939, 834, 777, 752, 690, 670 cm^{-1}. HRMS (ESI) calcd for $C_{23}H_{27}NO_2NaSi$ $[M+Na]^+$: 400.1703, found 400.1699.



6b

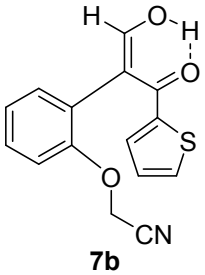
2-(2-(1-((*tert*-Butyldimethylsilyl)oxy)-3-(thiophen-2-yl)prop-2-yn-1-yl)phenoxy)acetonitrile (6b). First step: 2-ethynylthiophene (3.3 mmol, 330 μL) in THF (6 mL) was added EtMgBr (3 mmol, 3.0 M solution in Et_2O, 1 mL) at 0 °C. Then the reaction mixture was stirred at room temperature for 1 h. 2-(2-Formylphenoxy) acetonitrile (3.0 mmol, 483.5 mg) was added at 0 °C and the reaction mixture was stirred at room temperature for 1 h. Second step: To a solution of the above crude alcohol in DCM (6 mL) were added imidazole (6.0 mmol, 408.5 mg) and TBSCl (4.5 mmol, 678.2 mg), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether to petroleum ether : ethyl acetate = 50:1 to 30:1) afforded the desired product in 54% overall yield (621.2 mg) as a yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.19 (s, 3H), 0.23 (s, 3H), 0.95 (s, 9H), 4.84 (d, J = 4.0 Hz, 2H), 5.98 (s, 1H), 6.94-6.99 (m, 2H), 7.15-7.18 (m, 2H), 7.22-7.24 (m, 1H), 7.33-7.36 (m, 1H), 7.76 (d, J = 7.2 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -4.9, -4.5, 18.3, 25.8, 54.0, 59.8, 78.0, 93.5, 112.1, 115.1, 122.8, 123.4, 126.9, 127.0, 128.0, 129.1, 131.2, 132.0, 153.0. IR (neat): 2952, 2930, 2883, 2854, 1600, 1590, 1488, 1456, 1289, 1258, 1218, 1177, 1117, 1064, 1036, 858, 840, 826, 776, 751, 699, 677, 668 cm^{-1}. HRMS (ESI) calcd for $C_{21}H_{25}NO_2SNaSi$ $[M+Na]^+$: 406.1268, found 406.1262.

Transformation of various alkyne-nitriles.



6a (R^1 = Ph) **2a** (2.0 equiv) **7a** (R^1 = Ph)

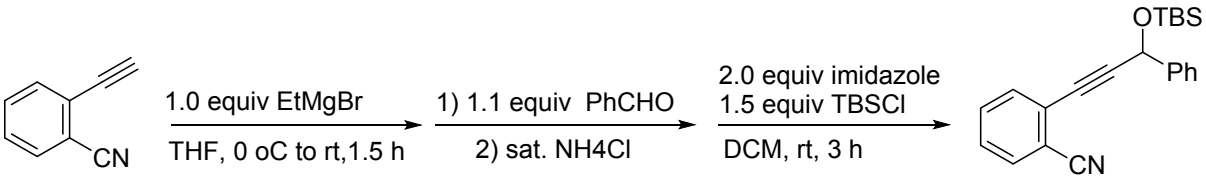
(*Z*)-2-(2-(1-Hydroxy-3-oxo-3-phenylprop-1-en-2-yl)phenoxy)acetonitrile (7a). To a Schlenk tube were added (*o*-phenoxyacetonitrile)propargyl ether **6a** (0.3 mmol, 113.3 mg), DCE (3 mL), 2,6-dichloropyridine *N*-oxide **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.3 mmol, 109 mg), $(ArO)_3AuCl$ (Ar = 2,4-di-*tert*-butylphenyl) (0.015 mmol, 13.2 mg) and $AgNTf_2$ (0.015 mmol, 5.8 mg) under Argon. After the reaction mixture was stirred at room temperature for 4 h as monitored by thin-layer chromatography, it was diluted with ethyl acetate. Then the saturated NaOH solution was added. After shaking, the water phase was separated. The addition of saturated NaOH solution and washing with ethyl acetate were repeated by another two times. The water phase were combined. Then 3M HCl solution was added to the water phase until the pH = 7, and the resulting mixture was extracted with dichloromethane for several times. The mixture was dried over anhydrous Na_2SO_4. The solvent was evaporated under the reduced pressure and the residue was purified by preparative TLC on silica gel (eluent: petroleum ether: ethyl acetate = 10:1) to afford **7a** in 66% yield (55.2 mg) yield (containing trace amount of aldehyde form) as a light brown oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.30 (s, 2H), 6.84 (d, *J* = 8.0 Hz, 1H), 7.09-7.12 (m, 1H), 7.21-7.26 (m, 3H), 7.31-7.38 (m, 4H), 8.41 (s, 1H), 15.77 (s, 1H)**.** ^{13}C NMR (100 MHz, $CDCl_3$) δ 53.0, 111.0, 112.2, 114.6, 123.5, 125.8, 127.86, 127.94, 129.5, 131.4, 132.1, 136.3, 154.0, 182.2, 187.4. IR (neat): 3060, 2927, 2851, 1727, 1621, 1601, 1491, 1448, 1374, 1276, 1211, 1179, 1122, 1058, 1034, 1018, 897, 753, 705, 692 cm^{-1}. HRMS (ESI) calcd for $C_{17}H_{13}NO_3$ $[M]^+$: 279.0890, found 279.0885.



7b

(*Z*)-2-(2-(1-Hydroxy-3-oxo-3-(thiophen-2-yl)prop-1-en-2-yl)phenoxy)acetonitrile (7b). Following the above typical procedure, 0.3 mmol scale, **6b** (0.3 mmol, 115.1 mg), DCE (3 mL), **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.3 mmol, 109 mg), $(ArO)_3AuCl$ (Ar = 2,4-di-*tert*-butylphenyl) (0.015 mmol, 13.2 mg) and $AgNTf_2$ (0.015 mmol, 5.8 mg) were stirred at rt for 4 h. Purification of the crude product by preparative TLC on silica gel (eluent: petroleum ether : ethyl acetate = 5:1) afforded the title product as a brown solid in 62% (53.1 mg) yield (containing trace amount of aldehyde form). M.p. 97-99 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 4.62 (s, 2H), 6.90-6.92 (m, 1H), 7.03-7.07 (m, 2H), 7.18-7.21 (m, 1H), 7.33-7.34 (m, 1H), 7.47-7.51 (m, 2H), 8.13 (s, 1H), 15.72 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 53.3, 109.6, 112.5, 114.6, 123.7, 124.9, 127.7, 130.5, 132.4, 133.2, 133.4, 139.9, 155.2, 179.2, 180.2. IR (neat): 3097, 3084, 2972, 2937, 1611, 1596, 1491, 1455, 1414, 1375, 1268, 1210, 1192, 1122, 1059, 1034, 989, 912, 896, 912, 896, 853, 786, 753, 725, 685 cm^{-1}. HRMS (ESI) calcd for $C_{15}H_{11}NO_3S$ $[M]^+$: 285.0454, found 285.0461.

Synthesis and characterization of (*o*-cyano)phenylpropargyl ether 8.

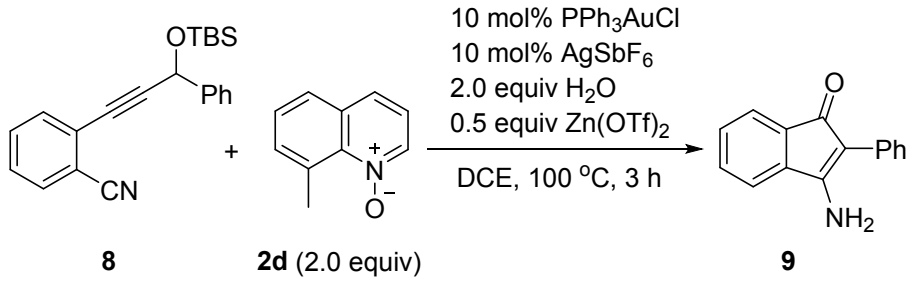


8

2-(3-((*tert*-Butyldimethylsilyl)oxy)-3-phenylprop-1-yn-1-yl)benzonitrile (8). First step: 2-ethynylbenzonitrile (16.5 mmol, 2.098 g) in THF (20 mL) was added EtMgBr (15 mmol, 3.0 M solution in Et_2O, 5.0 mL) at 0 °C. Then the reaction mixture was stirred at room temperature for 1 h. Benzaldehyde (15.0 mmol, 1.52 mL) was added at 0 °C and the reaction mixture was stirred at room temperature for 1.5 h. Second step: To a solution of the above crude alcohol in DCM (20 mL) were added imidazole (30.0 mmol, 2.042 g) and TBSCl (22.5

mmol, 3.391 g), and stirred at room temperature. Column chromatography on silica gel (eluent: petroleum ether to petroleum ether : ethyl acetate = 40:1) afforded the desired product in 42% overall yield (2.2 g) as a light-yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 0.26 (s, 3H), 0.29 (s, 3H), 1.02 (s, 9H), 5.85 (s, 1H), 7.32-7.44 (m, 4H), 7.51-7.54 (m, 2H), 7.62-7.66 (m, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ -5.0, -4.5, 18.2, 25.7, 65.0, 81.5, 96.5, 115.1, 117.3, 126.1, 126.5, 127.8, 128.3, 128.4, 132.2, 132.4, 132.5, 140.8. IR (neat): 2954, 2928, 2856, 2226, 1733, 1563, 1482, 1472, 1463, 1451, 1252, 1090, 1065, 1028, 842, 776, 762, 735, 703, 671 cm^{-1}. HRMS (ESI) calcd for $C_{22}H_{25}NONaSi$ $[M+Na]^+$: 370.1598, found 370.1602.

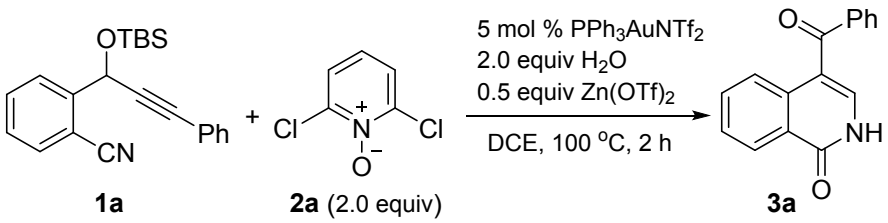
Formation of indanone compound 9.



8 **2d** (2.0 equiv) **9**

3-Amino-2-phenyl-*1H*-inden-1-one (9). To a sealable tube were added *o*-(cyano)phenyl propargyl ether **8** (0.3 mmol, 104.3 mg), DCE (3 mL), 8-methylquinoline *N*-oxide **2d** (0.6 mmol, 95.5 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg), PPh_3AuCl (0.03 mmol, 14.8 mg) and $AgSbF_6$ (0.03 mmol, 10.3 mg) under Argon. After the reaction mixture was stirred at 100 °C for 3 h as monitored by thin-layer chromatography, the mixture was filtered through a pad of silica gel and washed with ethyl acetate. The solvent was evaporated under the reduced pressure and the residue was purified by column chromatography on silica gel (eluent: petroleum ether: ethyl acetate = 20:1 to 5:1 to 2:1) to afford **9** in 51% yield (34 mg) as a brown solid. ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.17 (t, J = 7.6 Hz, 1H), 7.31-7.52 (m, 7H), 7.73 (d, J = 6.8 Hz, 1H), 8.09 (broad, 2H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 103.2, 118.9, 119.5, 124.9, 128.1, 128.2, 130.4, 131.1, 133.0, 135.1, 138.3, 161.9, 189.8. HRMS (ESI) calcd for $C_{15}H_{12}NO$ $[M+H]^+$: 222.0913, found 222.0908. The spectroscopic data are in agreement with that previously reported.[9]

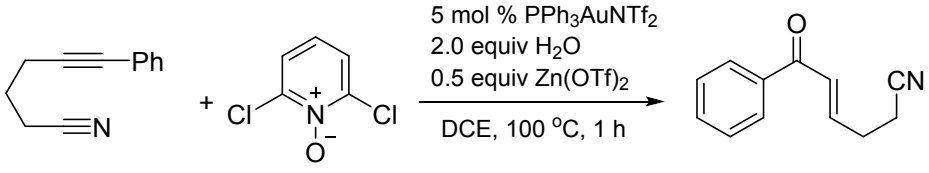
Gram scale reaction.



1a **2a** (2.0 equiv) **3a**

To a sealable tube were added *o*-(cyano)phenyl propargyl ether **1a** (6.0 mmol, 2.09 g), DCE (60 mL), 2,6-dichloropyridine *N*-oxide **2a** (12.0 mmol, 1.97 g), H_2O (12.0 mmol, 216 μL), $Zn(OTf)_2$ (3.0 mmol, 1.09 g) and PPh_3AuNTf_2 (0.3 mmol, 221.8 mg) under Argon. Then the tube was sealed. After the reaction mixture was stirred at 100 °C for 2 h as monitored by thin-layer chromatography, the reaction mixture was filtered through a pad of silica gel and washed with ethyl acetate. The solvent was evaporated under the reduced pressure and the residue was purified by column chromatography on silica gel (eluent: petroleum ether: ethyl acetate = 10:1 to 8:1 to 5:1 to 3:1) to afford **3a** in 72% yield (1.08 g) as a light yellow solid.

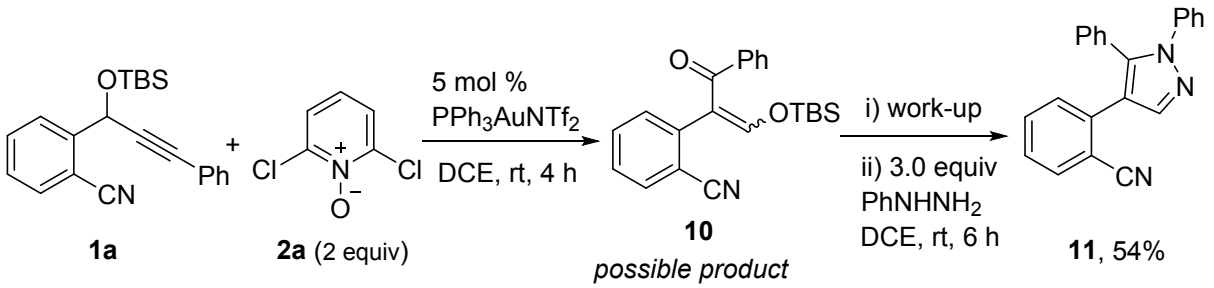
Oxidative reaction of 6-phenylhex-5-ynenitrile.



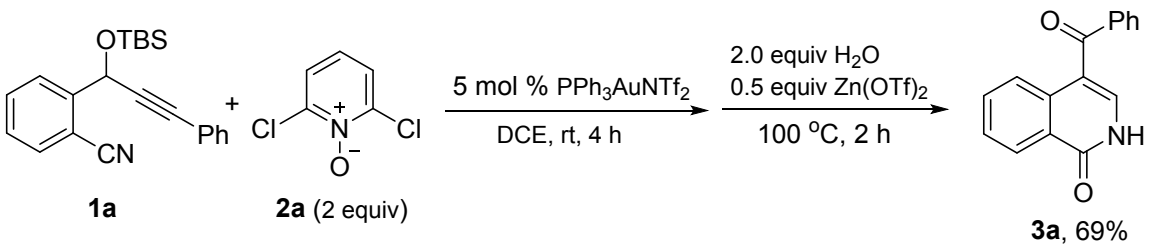
1.0 equiv **2a** (2.0 equiv)

To a sealable tube were added 6-phenylhex-5-ynenitrile (0.3 mmol, 50.8 mg), DCE (3 mL), 2,6-dichloropyridine *N*-oxide **2a** (0.6 mmol, 98.4 mg), H_2O (0.6 mmol, 10.8 μL), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) under Argon. Then the tube was sealed. After the reaction mixture was stirred at 100 °C for 1 h as monitored by thin-layer chromatography, the reaction mixture was filtered through a pad of silica gel and washed with ethyl acetate. The solvent was evaporated under the reduced pressure and the residue was purified by column chromatography on silica gel (eluent: petroleum ether: ethyl acetate = 15:1 to 10:1 to 5:1) to afford (*E*)-6-oxo-6-phenylhex-4-enenitrile in 83% yield (46 mg) as a colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 2.55-2.59 (m, 2H), 2.63-2.68 (m, 2H), 6.91-7.04 (m, 2H), 7.45-7.48 (m, 2H), 7.54-7.58 (m, 1H), 7.92-7.94 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 16.2, 28.2, 118.5, 127.9, 128.5, 128.6, 133.0, 137.2, 143.0, 189.8. The spectroscopic data is in agreement with that previously reported.[10]

Mechanistic studies

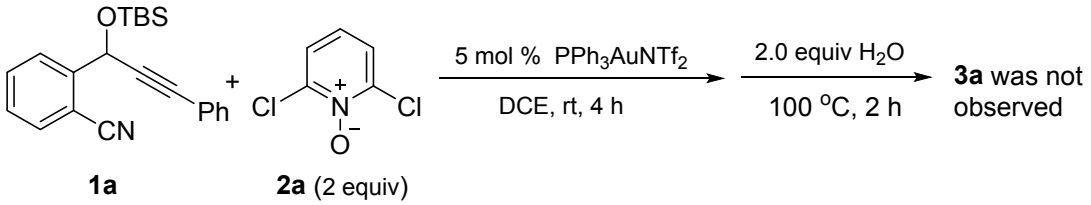


To a Schlenk tube were added **1a** (0.6 mmol, 208.5 mg), DCE (6 mL), **2a** (1.2 mmol, 196.8 mg), PPh_3AuNTf_2 (0.03 mmol, 22.2 mg) at room temperature for 4 h under argon. After the reaction was complete as monitored by thin-layer chromatography, 0.5 M NaOH aqueous solution was added. After shaking, the water phase was separated. Repeating this procedure until the product were disappeared in organic phase according to TLC analysis. The water phase was washed with DCM by three times. Then 1M HCl solution was added to the water phase until the pH = 2-3, and the resulting mixture was extracted with dichloromethane for three times. The organic phase was combined and washed with H_2O and brine, the mixture was dried over anhydrous Na_2SO_4. Then the solution is gently concentrated (ca. 6 mL). $PhNHNH_2$ (1.8 mmol, 194.7 mg) was added and the mixture was stirred at room temperature for 6 h. The solvent was evaporated and the residue was purified by column chromatography on silica gel (eluent: petroleum ether to petroleum ether : ethyl acetate = 20:1 to 10:1) to afford the product **11** in 54% overall yield (104.6 mg, containing small amount of impurity). ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.04-7.07 (m, 2H), 7.15 (dd, J = 7.8 Hz, 0.4 Hz, 1H), 7.19-7.32 (m, 9H), 7.40 (td, J = 7.2 Hz, 1.6 Hz, 1H), 7.64 (dd, J = 7.6 Hz, 0.8 Hz, 1H), 8.02 (s, 1 H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 112.2, 118.3, 118.9, 125.1, 127.1, 127.5, 128.5, 128.6, 128.7, 129.0, 130.1, 130.9, 132.3, 133.3, 136.6, 139.4, 140.1, 140.7. IR (neat): 3110, 2922, 2217, 1595, 1569, 1554, 1494, 1444, 1382, 1072, 956, 916, 877, 787, 771, 759, 693, 660 cm^{-1}. HRMS (ESI) calcd for $C_{22}H_{16}N_3$ $[M+H]^+$: 322.1339, found 322.1337.



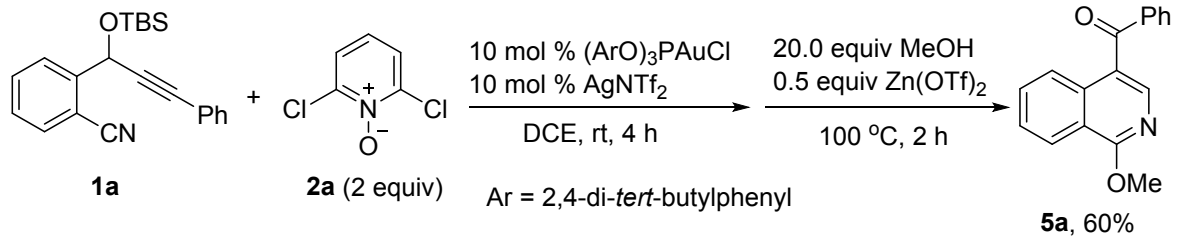
1a **2a** (2 equiv) **3a**, 69%

To a sealable tube were added *o*-(cyano)phenyl propargyl ether **1a** (0.2 mmol, 69.5 mg), DCE (2 mL), 2,6-dichloropyridine *N*-oxide **2a** (0.4 mmol, 65.6 mg) and PPh_3AuNTf_2 (0.01 mmol, 7.4 mg) under Argon. Then the tube was sealed. After the reaction mixture was stirred at room temperature for 4 h, H_2O (0.4 mmol, 7.2 μL) and $Zn(OTf)_2$ (0.1 mmol, 36.4 mg) were added to the reaction mixture. Then the tube was put in an oil bath preheated at 100 °C and the mixture was stirred for 2 h. The reaction mixture was filtered through a pad of silica gel and washed with ethyl acetate. The solvent was evaporated under the reduced pressure and the residue was purified by column chromatography on silica gel (eluent: petroleum ether: ethyl acetate = 10:1 to 8:1 to 5:1 to 3:1) to afford **3a** in 69% yield (34.6 mg) as a light yellow solid.



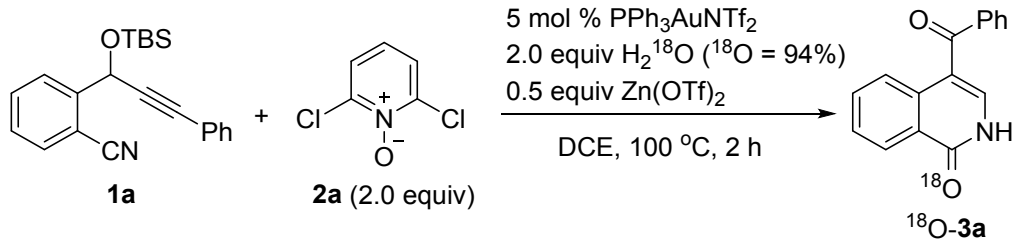
1a **2a** (2 equiv)

To a sealable tube were added *o*-(cyano)phenyl propargyl ether **1a** (0.2 mmol, 69.5 mg), DCE (2 mL), 2,6-dichloropyridine *N*-oxide **2a** (0.4 mmol, 65.6 mg) and PPh_3AuNTf_2 (0.01 mmol, 7.4 mg) under Argon. Then the tube was sealed. After the reaction mixture was stirred at room temperature for 4 h as monitored by thin-layer chromatography, H_2O (0.4 mmol, 7.2 μL) was added to the reaction mixture. Then the tube was put in an oil bath preheated at 100 °C and the mixture was stirred for 2 h. The product **3a** was not observed by TLC. This result indicated that without a Lewis acid, no cyclization occurred.



To a sealable tube were added *o*-(cyano)phenyl propargyl ether **1a** (0.2 mmol, 69.5 mg), DCE (2 mL), 2,6-dichloropyridine *N*-oxide **2a** (0.4 mmol, 65.6 mg), $(ArO)_3PAuCl$ (0.02 mmol, 17.6 mg) and $AgNTf_2$ (0.02 mmol, 7.8 mg) under Argon. Then the tube was sealed. After the reaction mixture was stirred at room temperature for 4 h, MeOH (4 mmol, 162 μL) and $Zn(OTf)_2$ (0.1 mmol, 36.4 mg) were added to the reaction mixture. Then the tube was put in an oil bath preheated at 100 °C and the mixture was stirred for 2 h. The reaction mixture was filtered through a pad of silica gel and washed with ethyl acetate. The solvent was evaporated under the reduced pressure and the residue was purified by column chromatography on silica gel (eluent: petroleum ether: ethyl acetate = 20:1 to afford **5a** in 60% yield (31.6 mg) as a white solid.

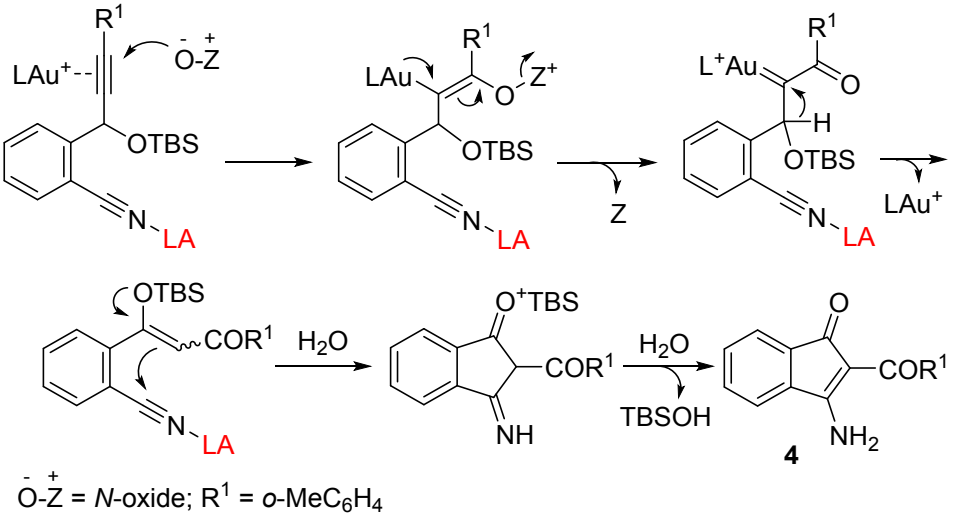
Synthesis of 4-benzoylisoquinolin-1(*2H*)-one-^{18}O (^{18}O-3a).



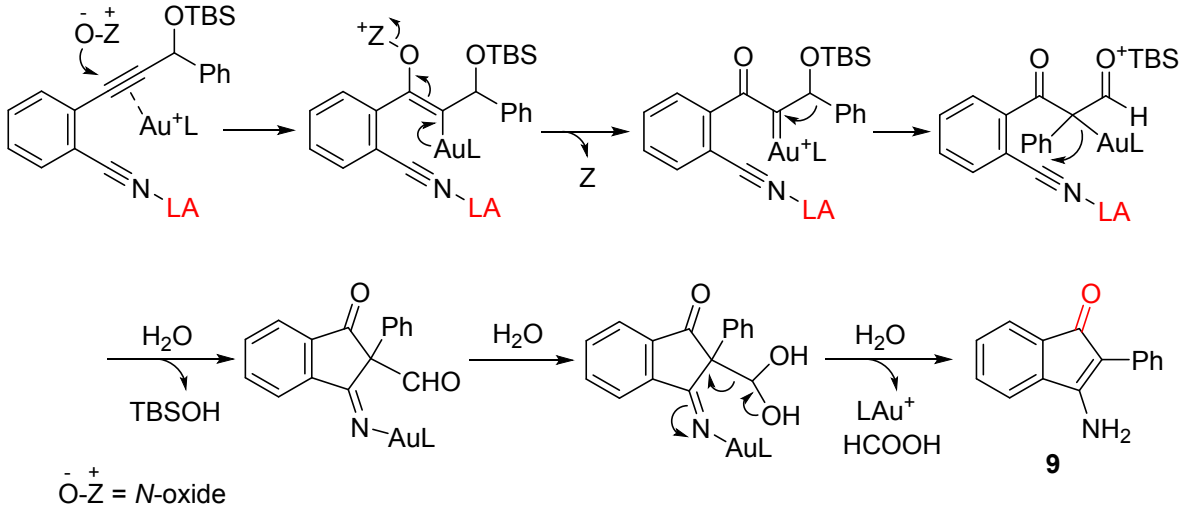
To a sealed tube were added *o*-(cyano)phenyl propargyl ether **1a** (0.3 mmol, 104.3 mg), DCE (3 mL), 2,6-dichloropyridine *N*-oxide **2a** (0.6 mmol, 98.4 mg), $H_2{}^{18}O$ (0.6 mmol, 10.8 μL, ^{18}O = 94%, determined by GC-MS), $Zn(OTf)_2$ (0.15 mmol, 54.5 mg) and PPh_3AuNTf_2 (0.015 mmol, 11.1 mg) under Argon. After the reaction mixture was stirred at 100 °C for 2 h as monitored by thin-layer chromatography, the mixture was filtered through a pad of silica gel and washed with ethyl acetate. The solvent was evaporated under the reduced pressure and the residue was purified by column chromatography on silica gel (eluent: petroleum ether: ethyl acetate = 15:1 to 10:1 to 5:1) to afford ^{18}O-**3a** in 79% yield (59.7 mg) as a light yellow solid and the ^{18}O content of ^{18}O-**3a** was 66% as determined by HRMS (ESI).

^{1}H NMR (400 MHz, DMSO-d_6) δ 7.49-7.66 (m, 5H), 7.75-7.82 (m, 3H), 8.30 (d, J = 8.0 Hz, 1H), 8.47 (d, J = 8.0 Hz, 1H), 11.80 (s, 1H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 113.5, 125.2, 125.5, 127.1, 127.3, 128.5, 129.4, 132.3, 133.1, 135.1, 139.0, 139.2, 161.5, 161.5, 193.6. In ^{13}C NMR, two peaks were observed for the carbon attached with carbonyl group of the amide moiety (161.48, 161.51 ppm), the upfield one being due to the carbon substituted with ^{18}O. IR (neat): 3291, 3184, 3050, 2922, 2848, 1668, 1630, 1617, 1596, 1473, 1443, 1333, 1316, 1284, 1235, 1145, 1063, 927, 874, 790, 763, 711, 694, 684. HRMS (ESI) calcd for $C_{16}H_{12}NO^{18}O$ $[M+H]^+$: 252.0905, found 252.0904.

Possible reaction mechanism for the formation of 4.



Scheme S1. Possible reaction mechanism for the formation of **4**



Scheme S2. Possible reaction mechanism for the formation of **9**

References:

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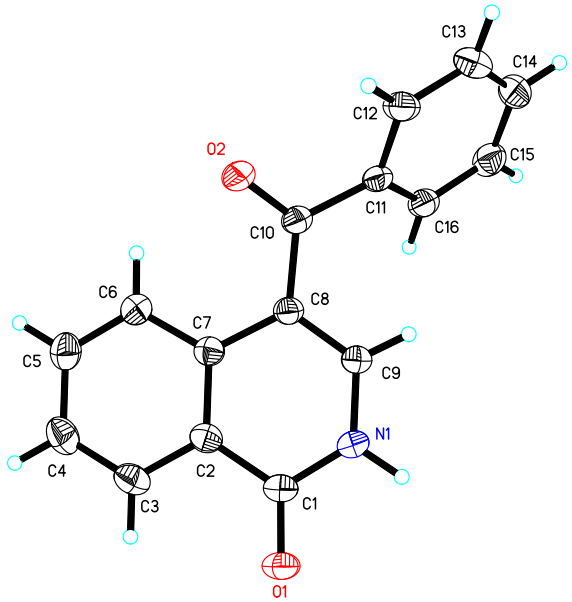


Figure S1. X-ray crystal structure of compound **3a**

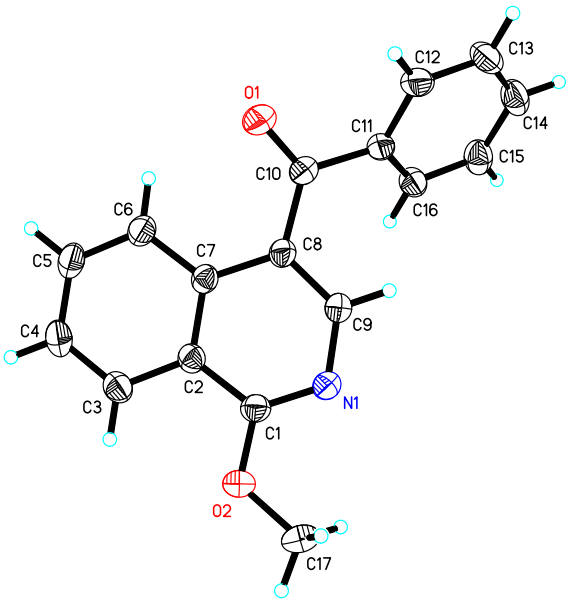


Figure S2. X-ray crystal structure of compound **5a**

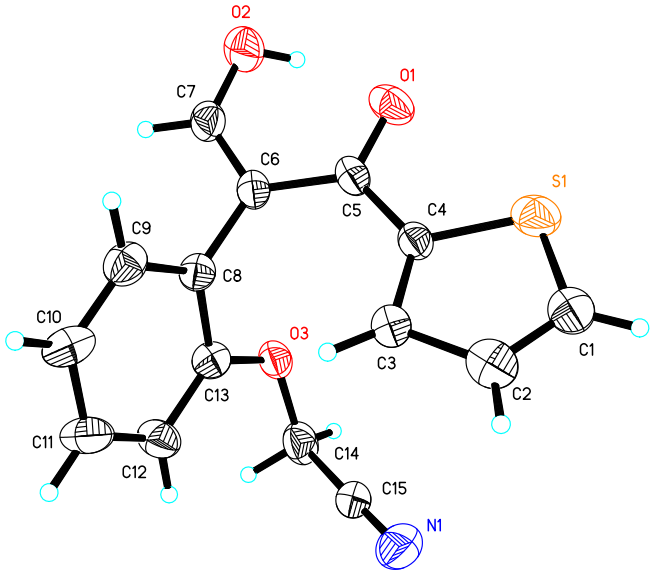
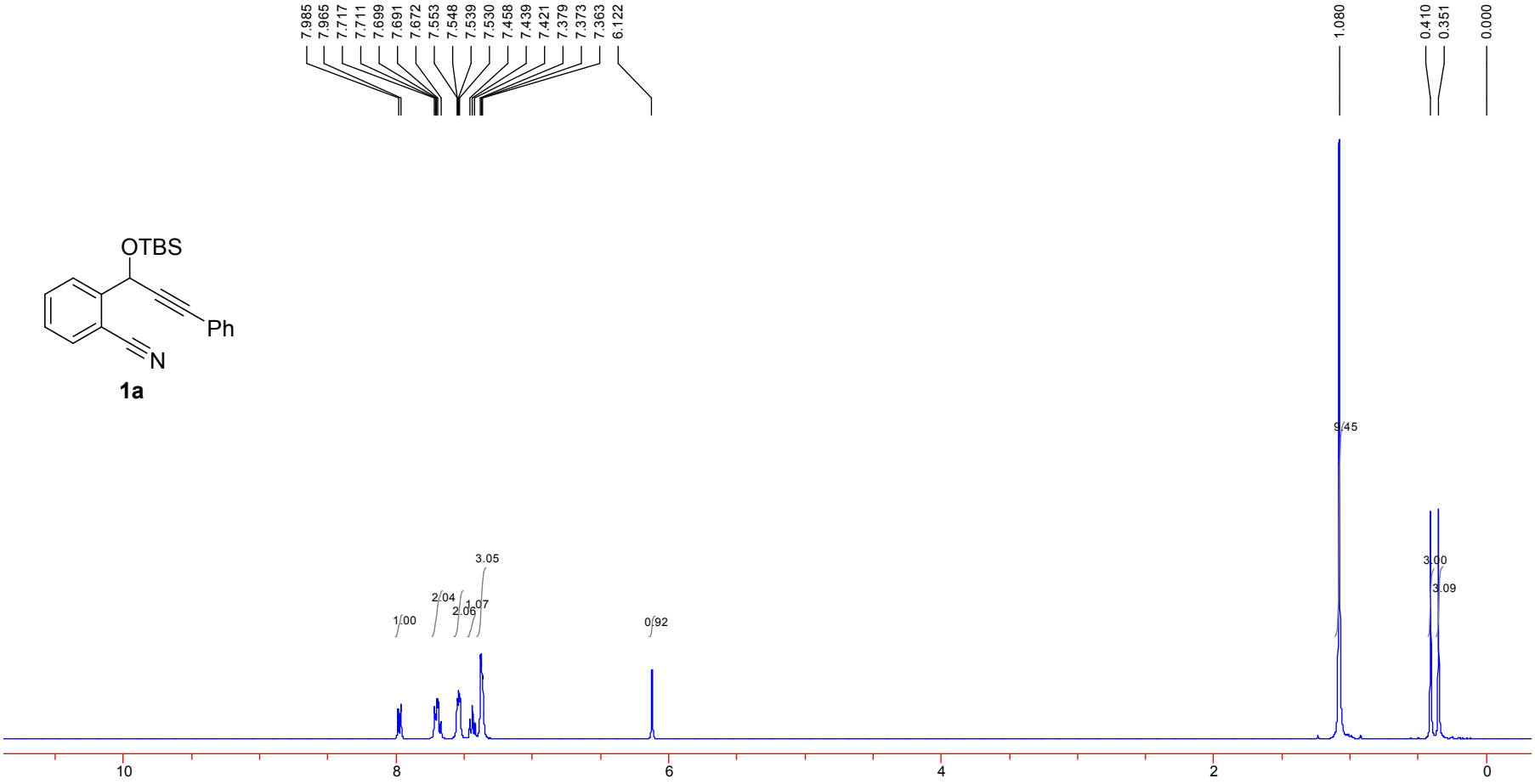
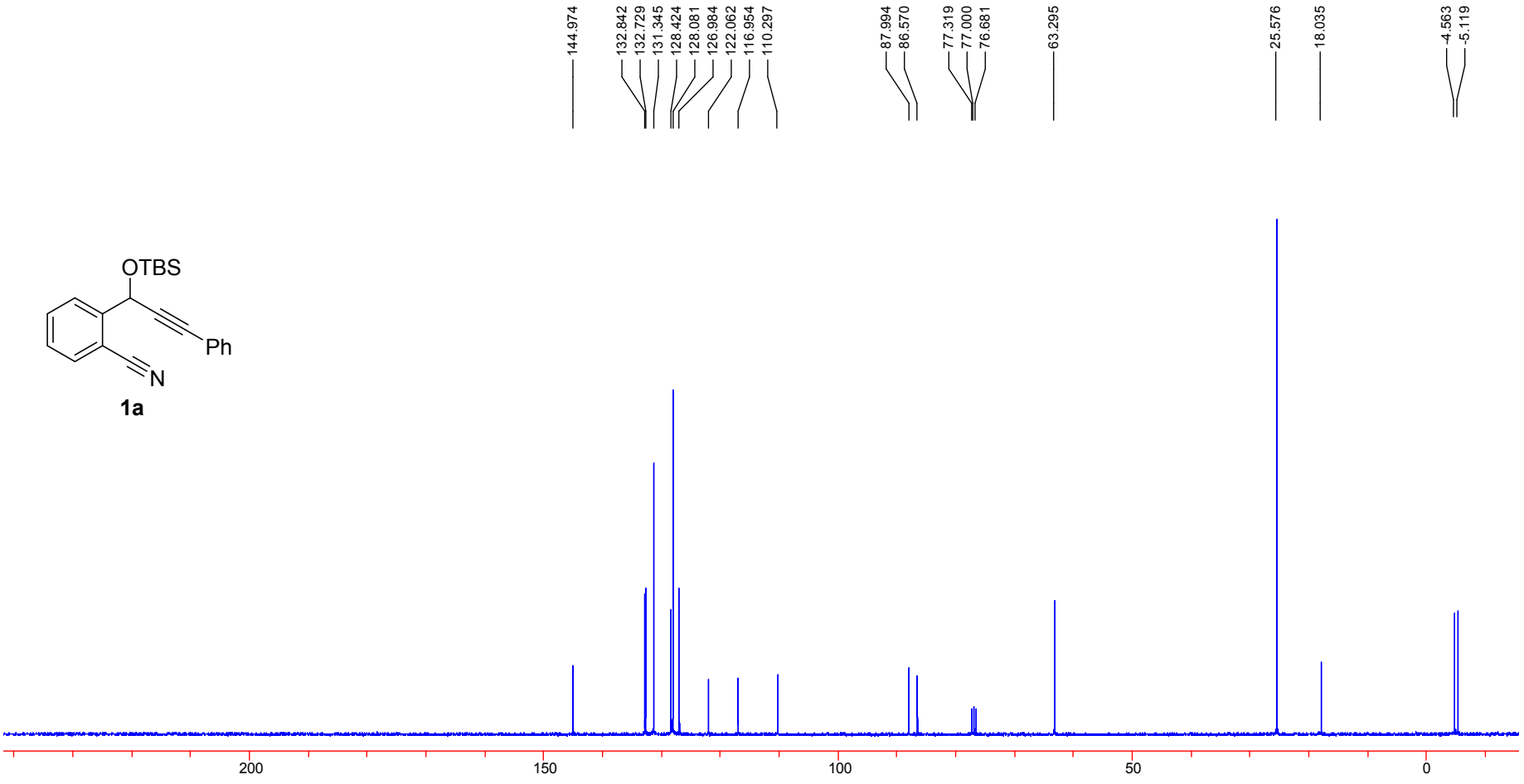


Figure S3. X-ray crystal structure of compound **7b**

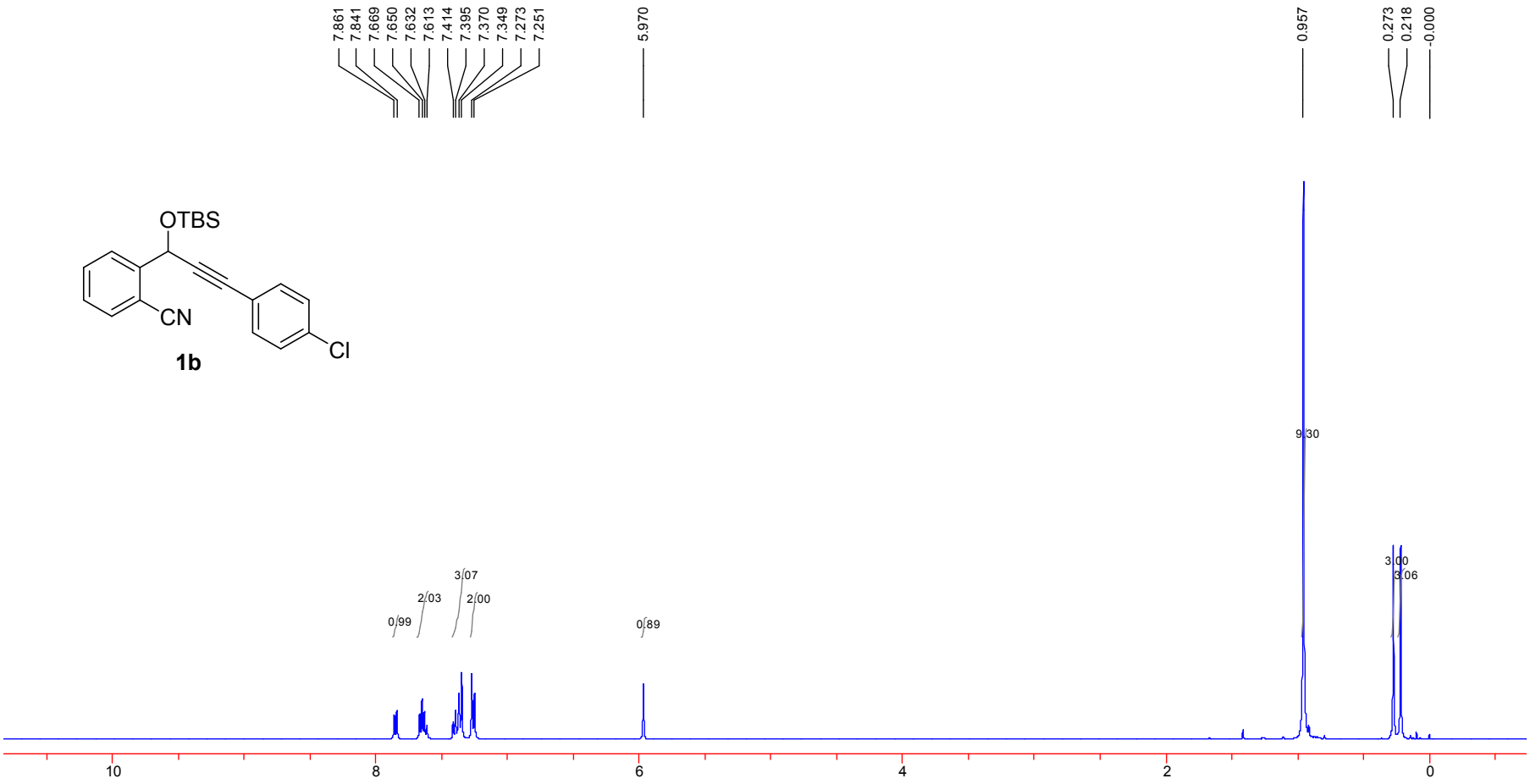
^{1}H NMR (400 MHz, $CDCl_3$)



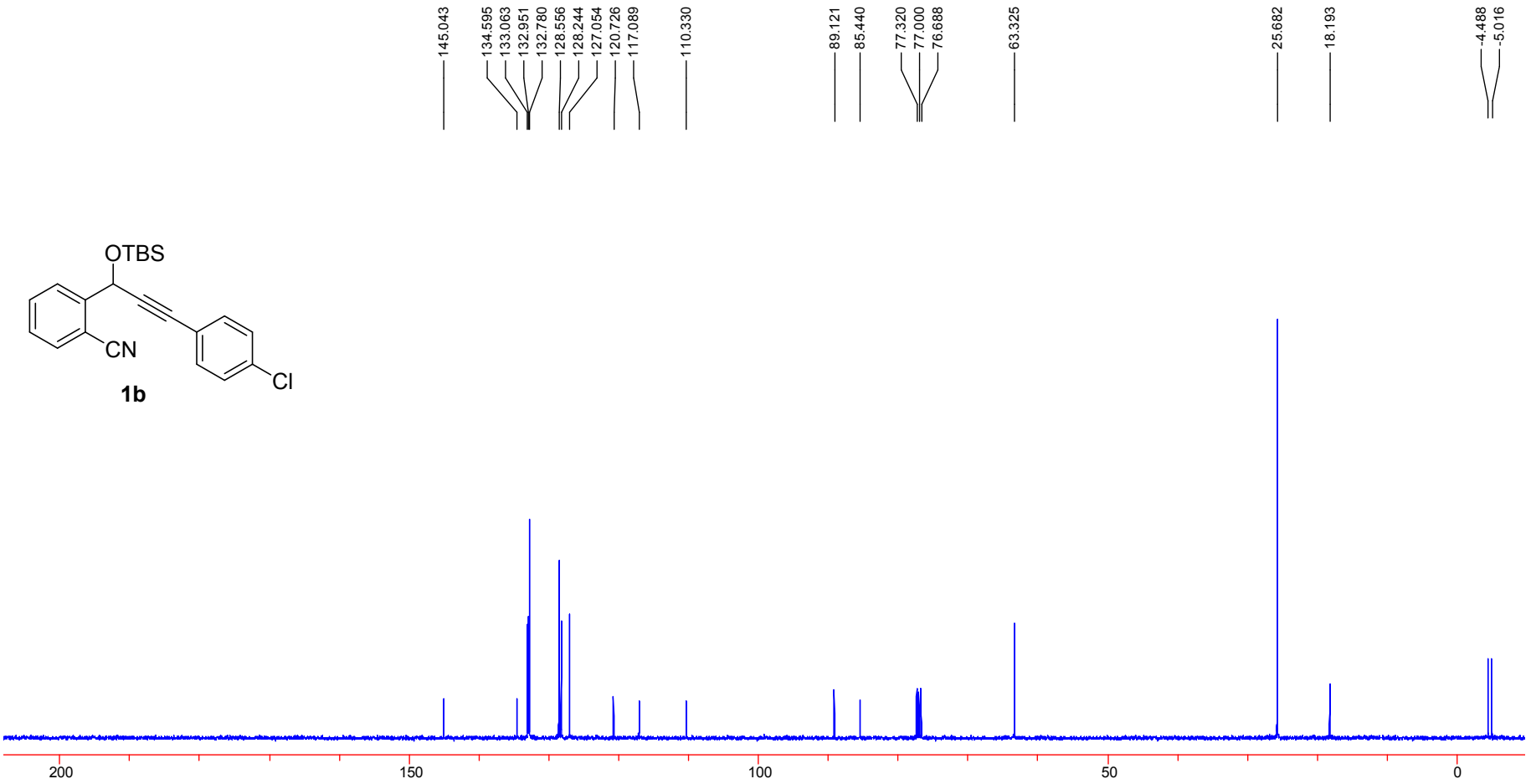
^{13}C NMR (100 MHz, $CDCl_3$)



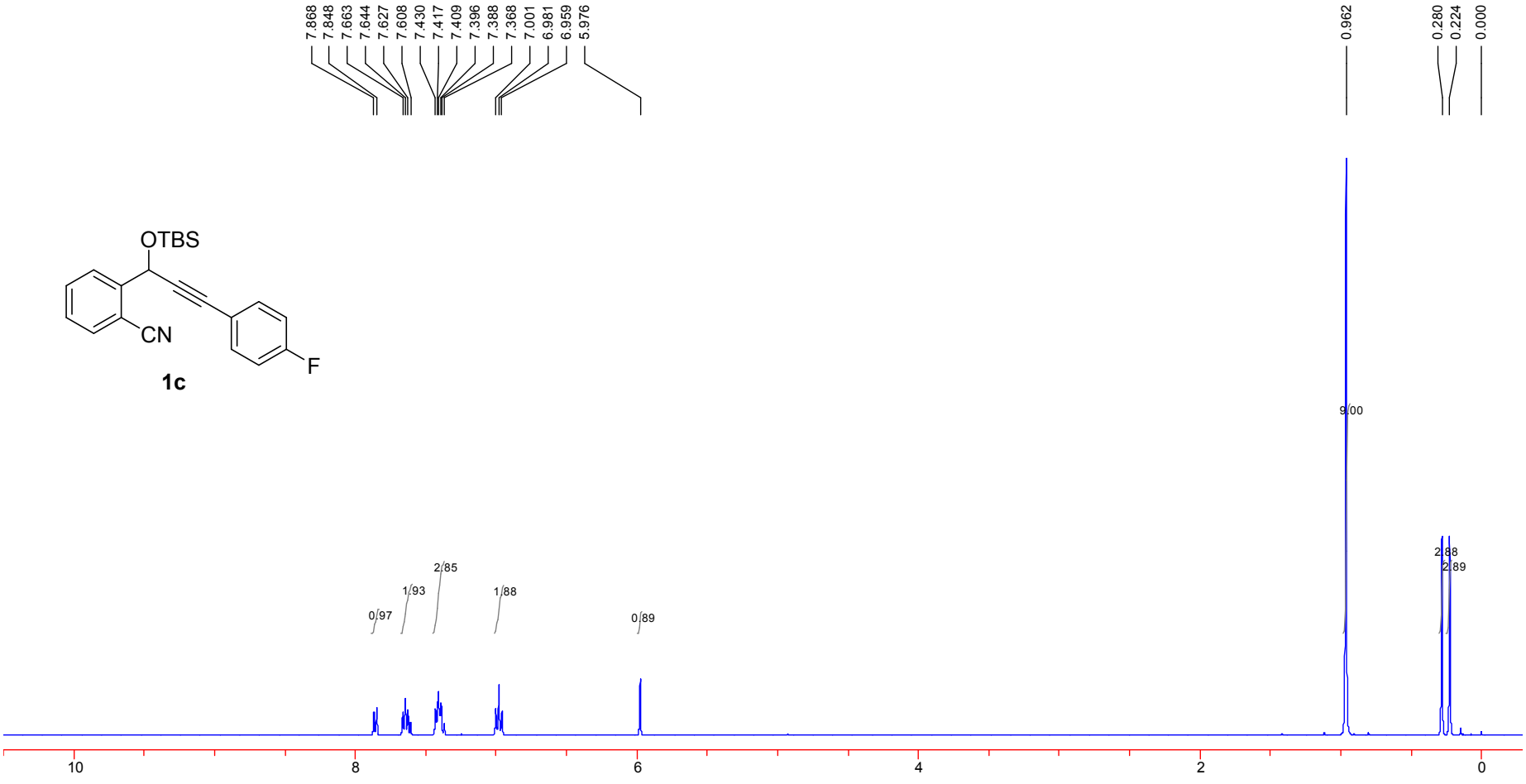
^{1}H NMR (400 MHz, $CDCl_3$)



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



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



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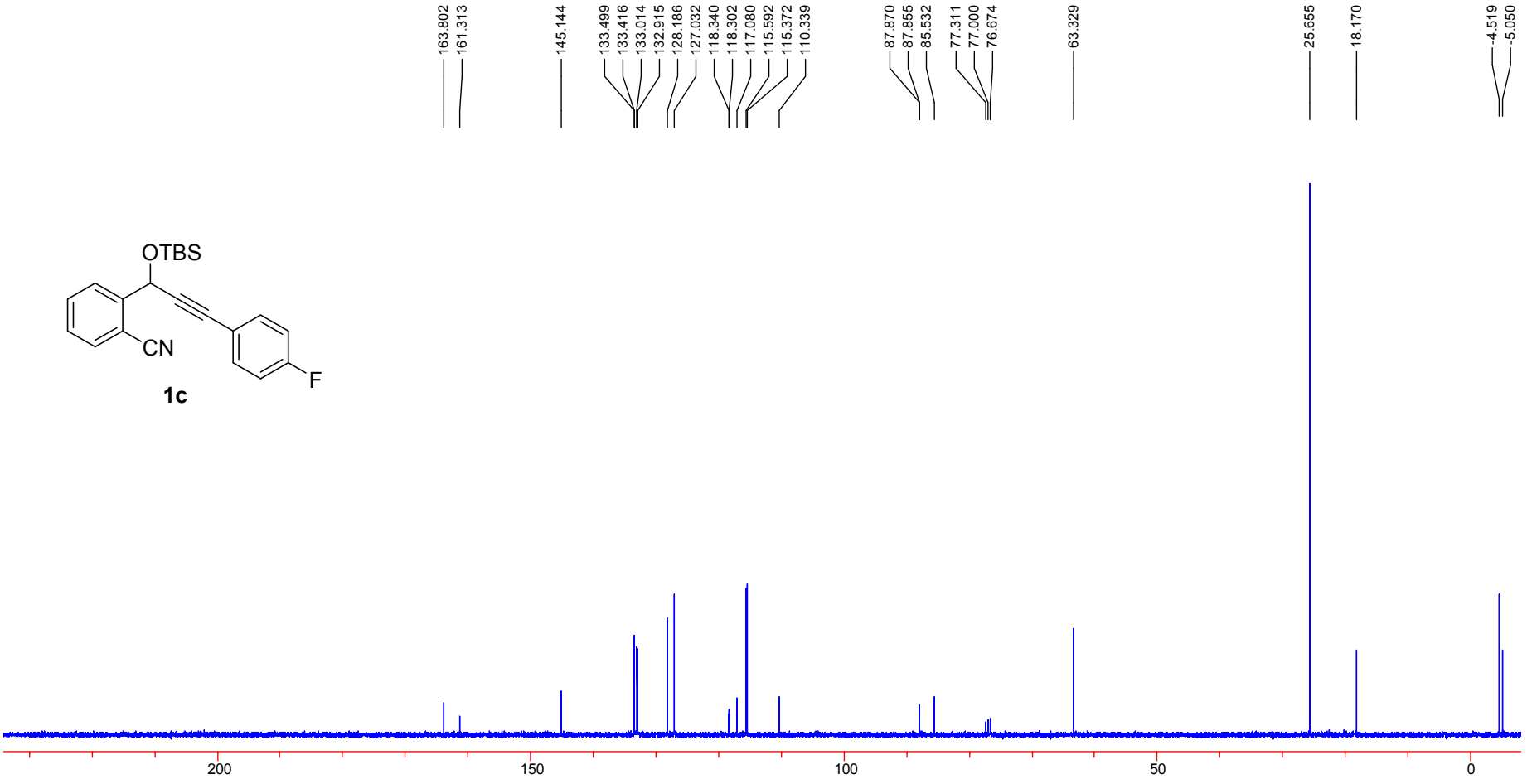
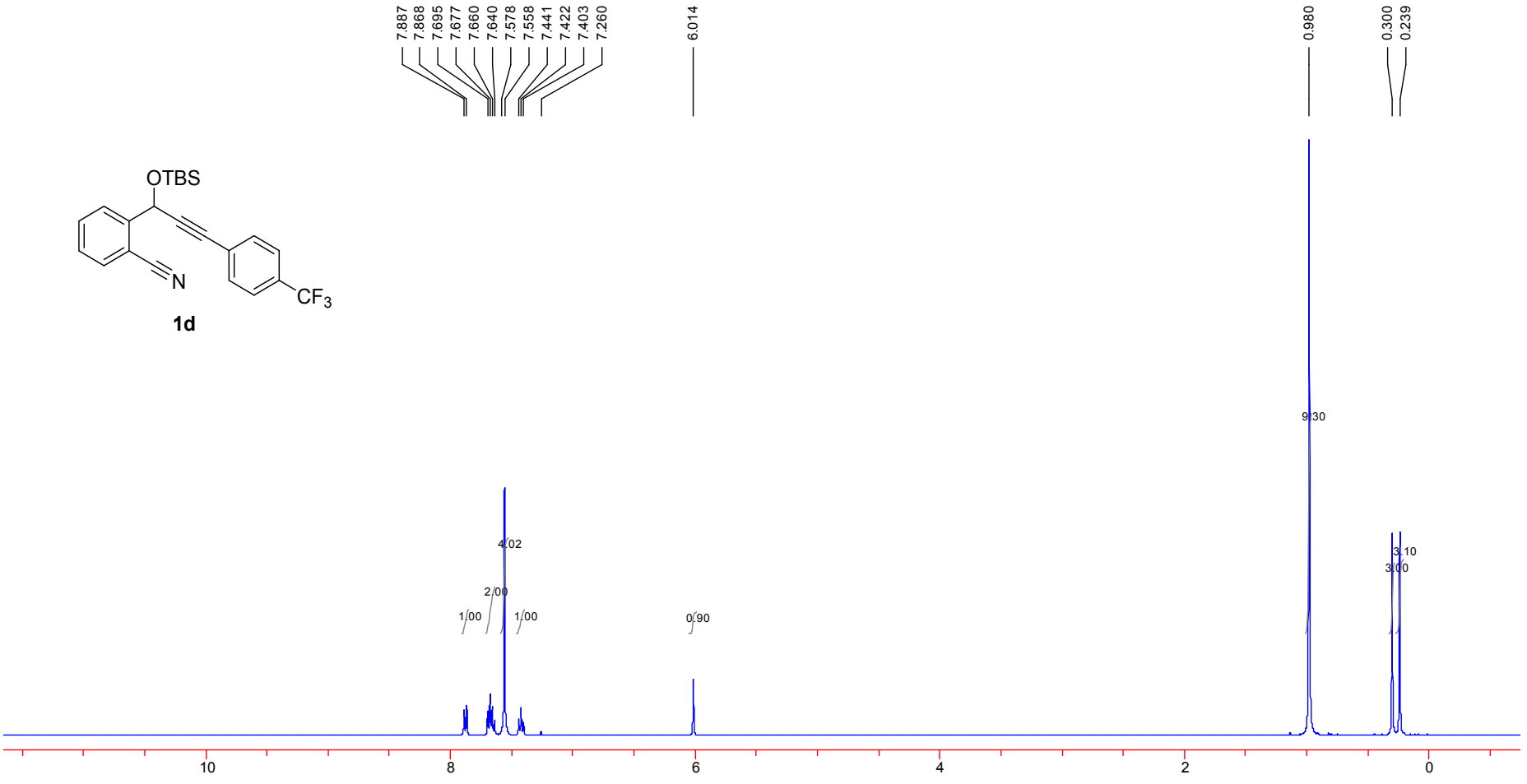
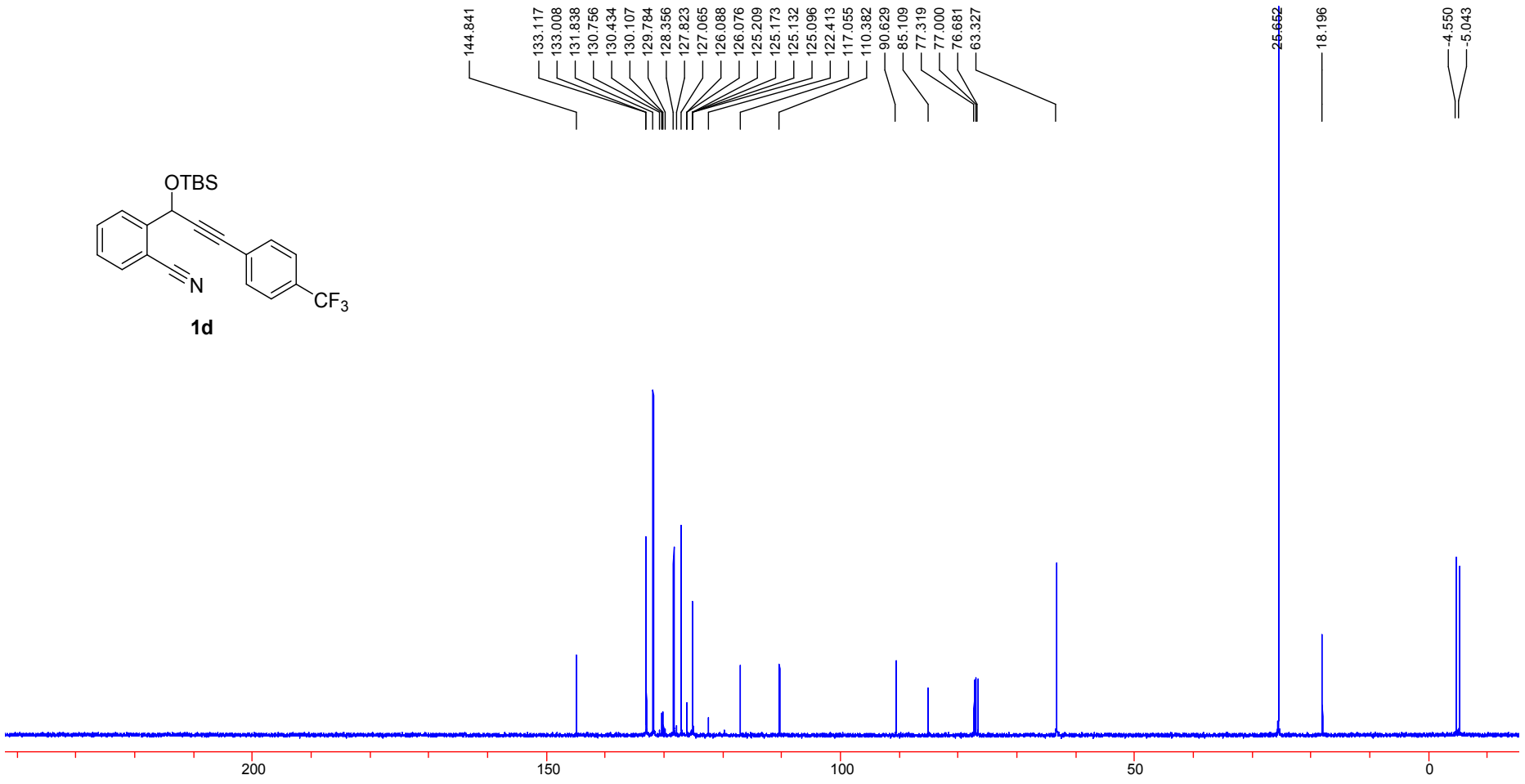


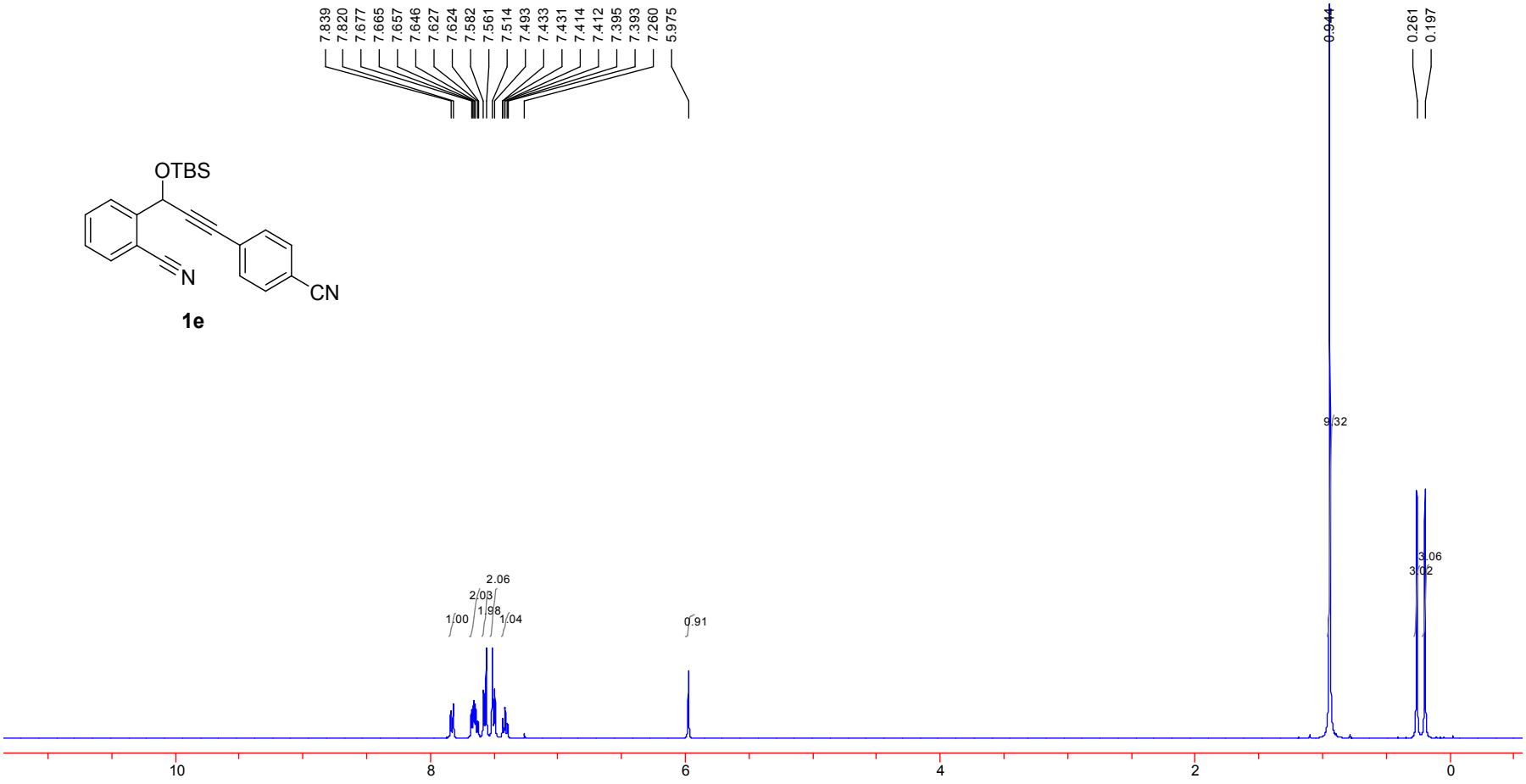
^{1}H NMR (400 MHz, $CDCl_3$)



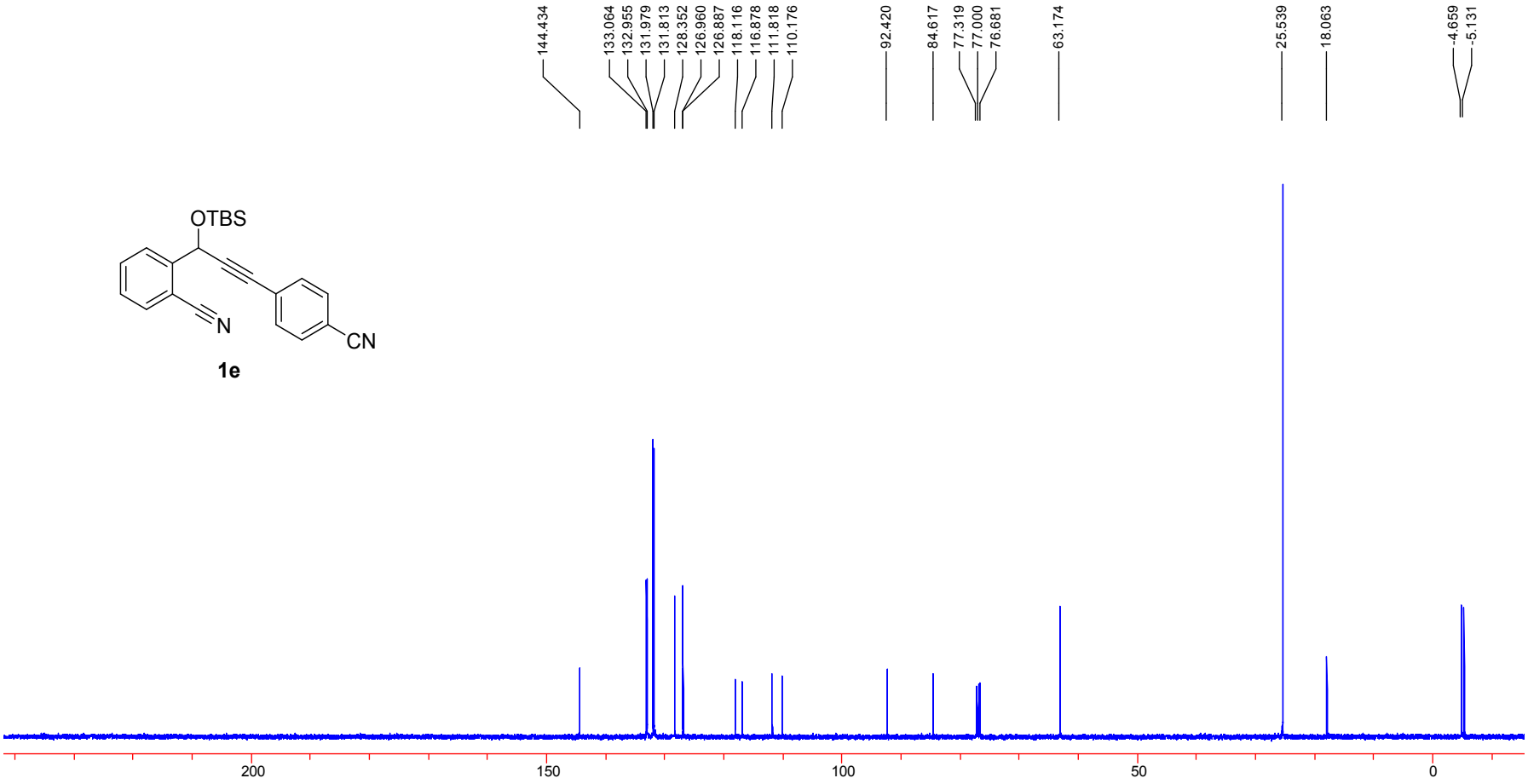
^{13}C NMR (100 MHz, $CDCl_3$)



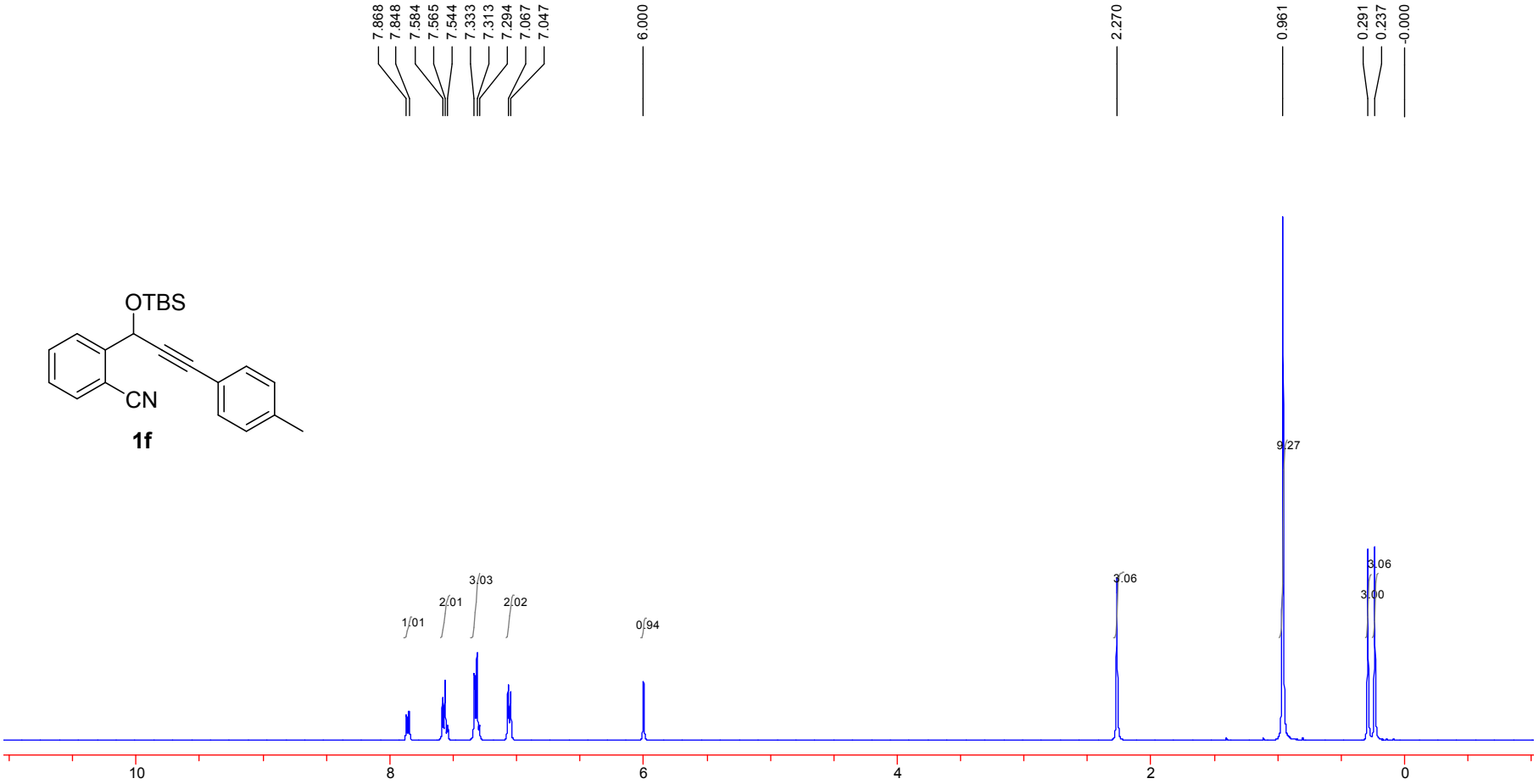
^{1}H NMR (400 MHz, $CDCl_3$)



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



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



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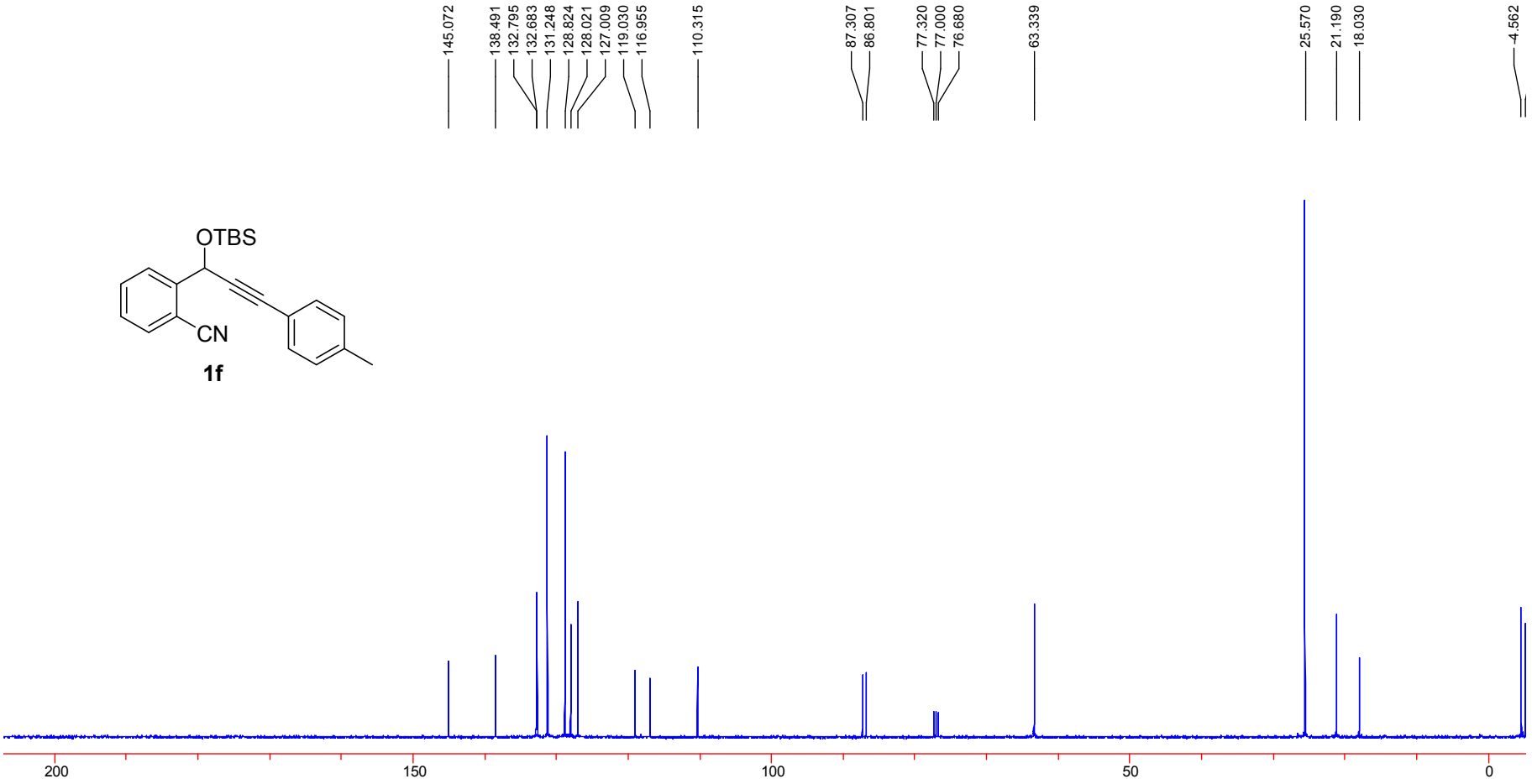

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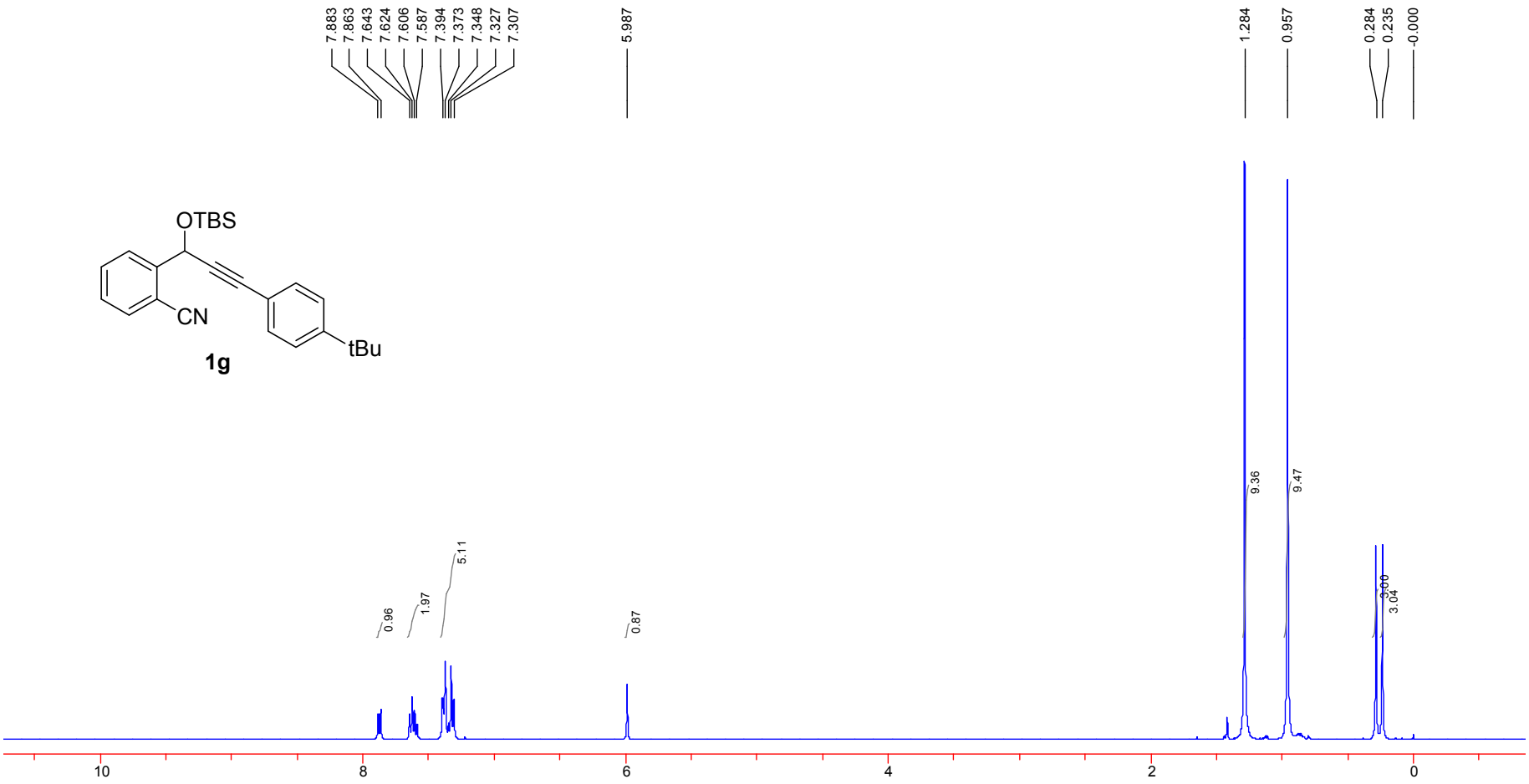

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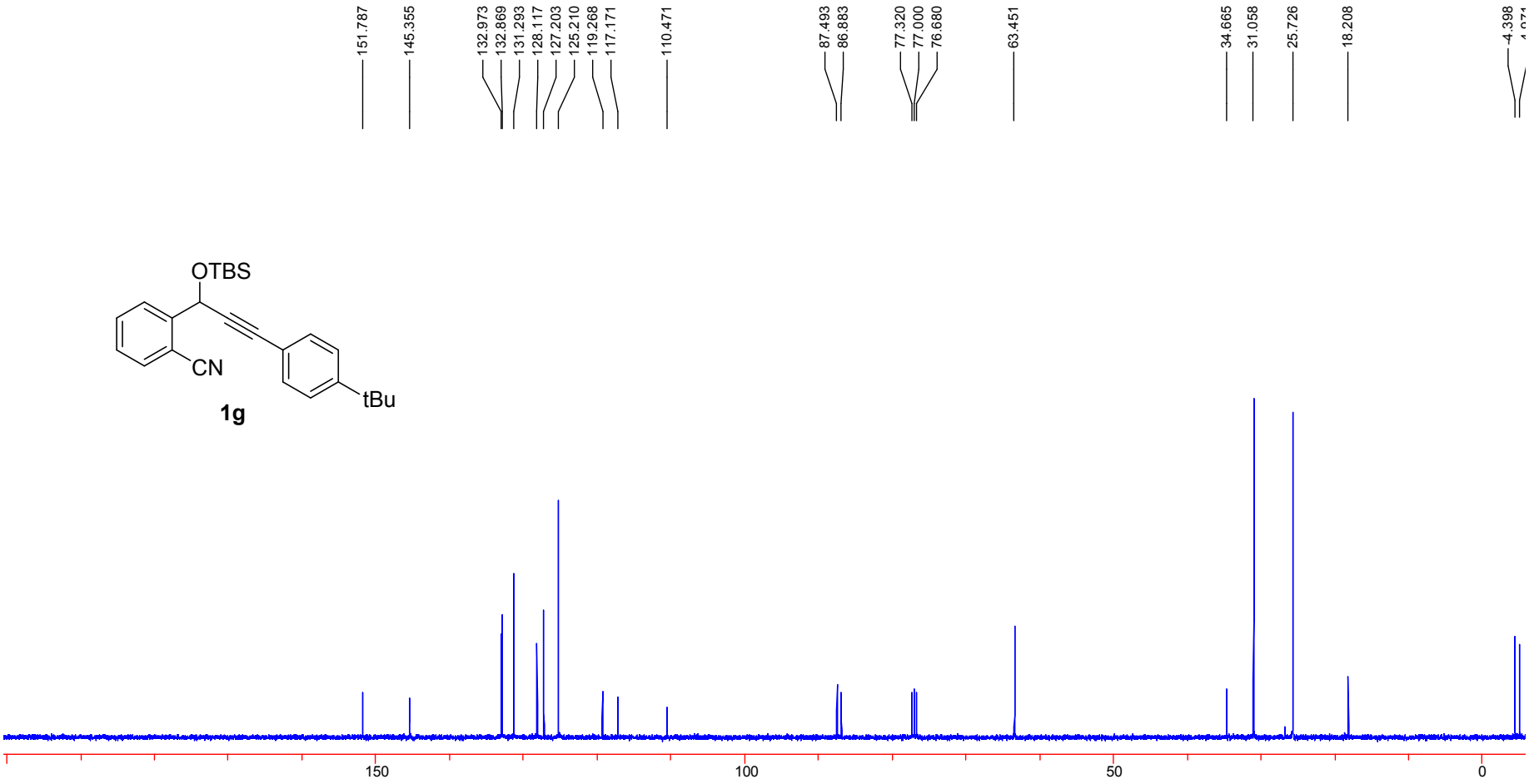

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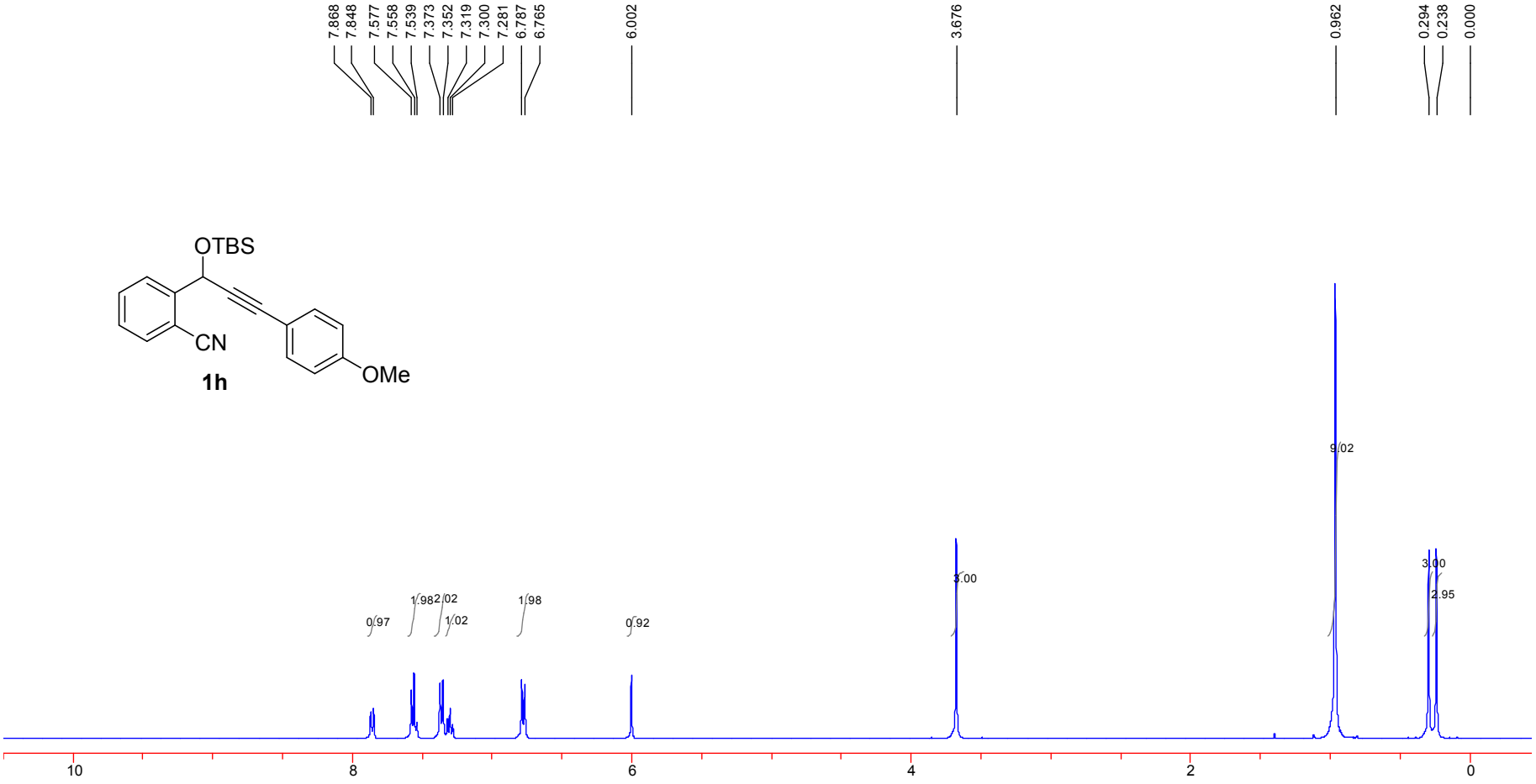

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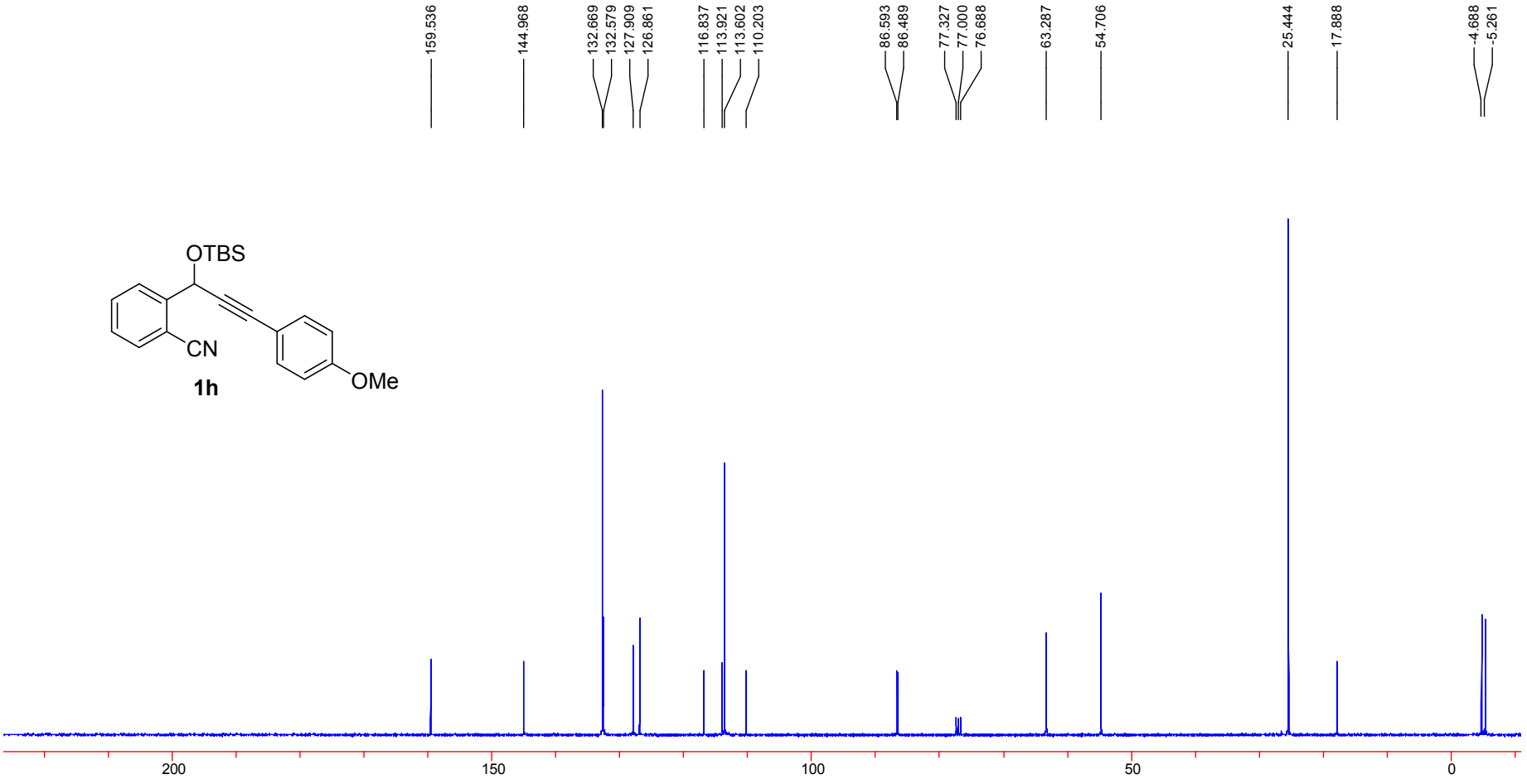

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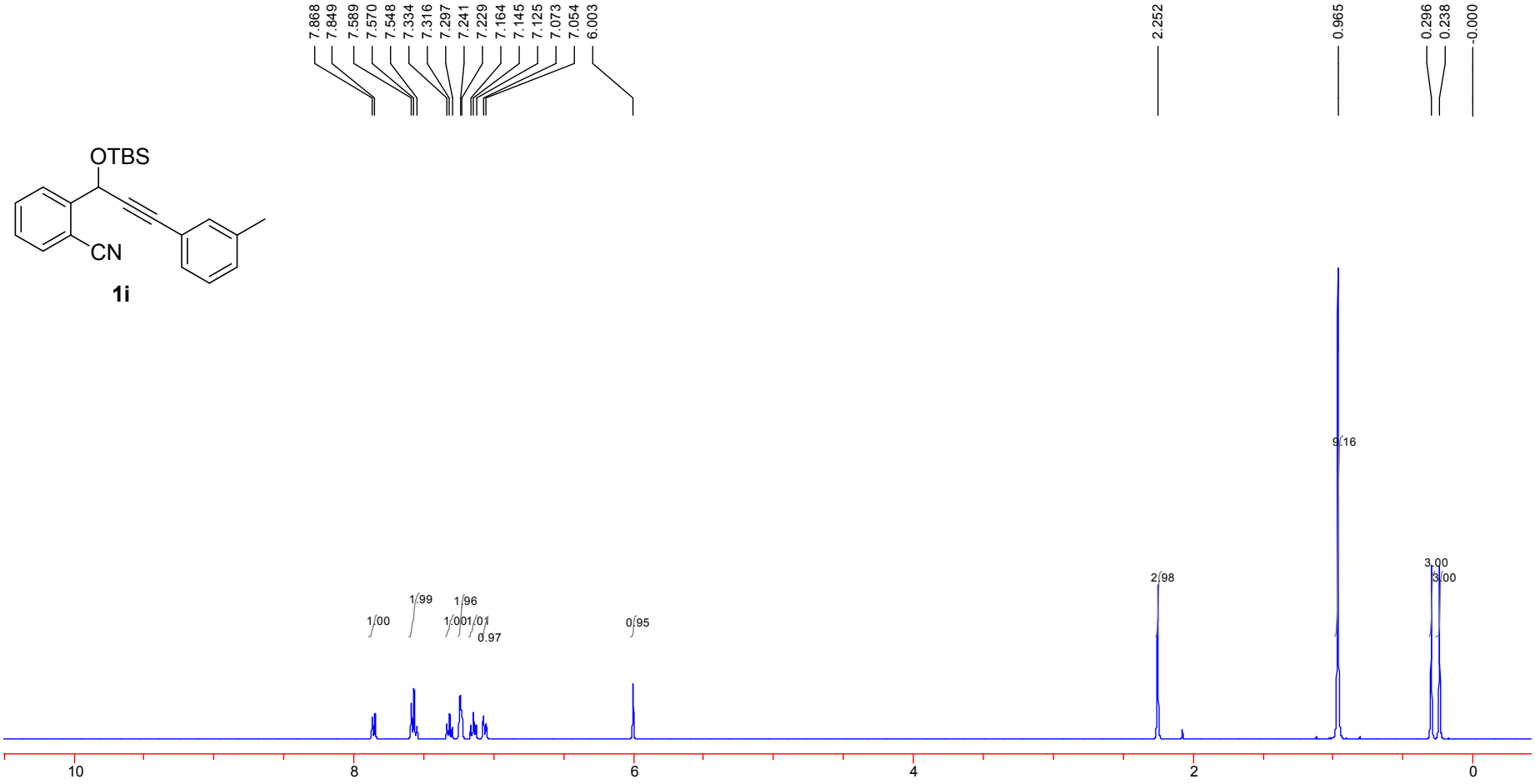

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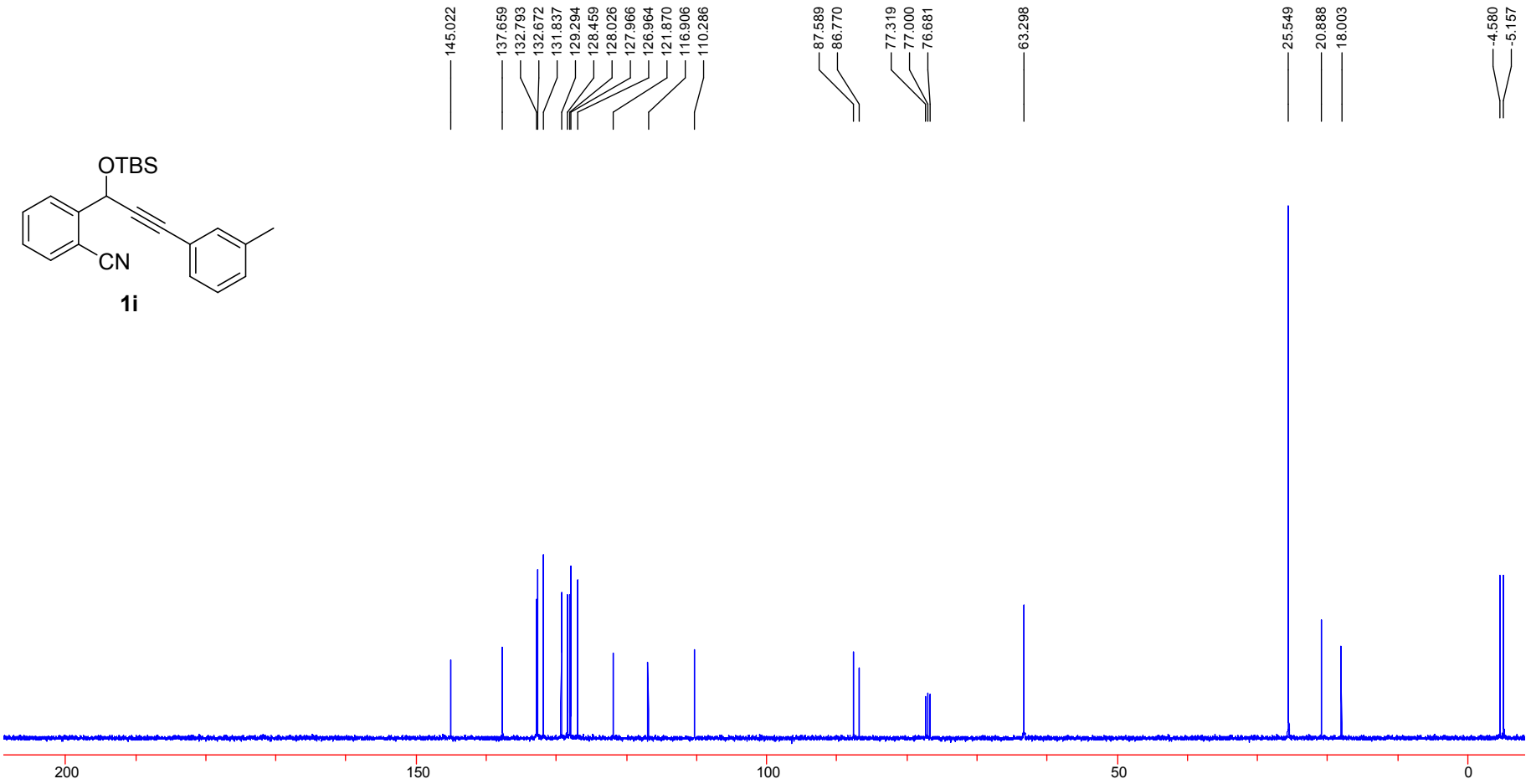

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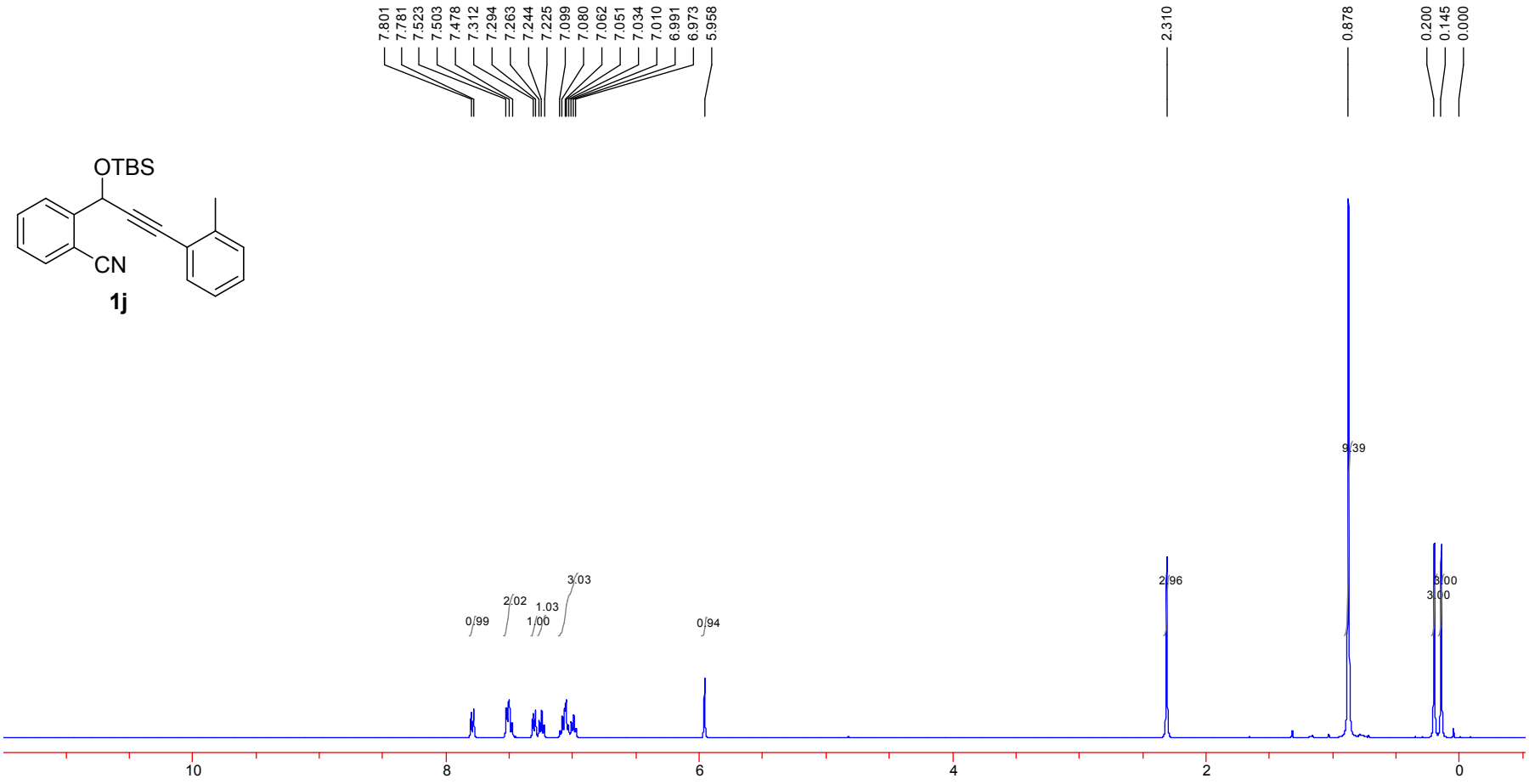

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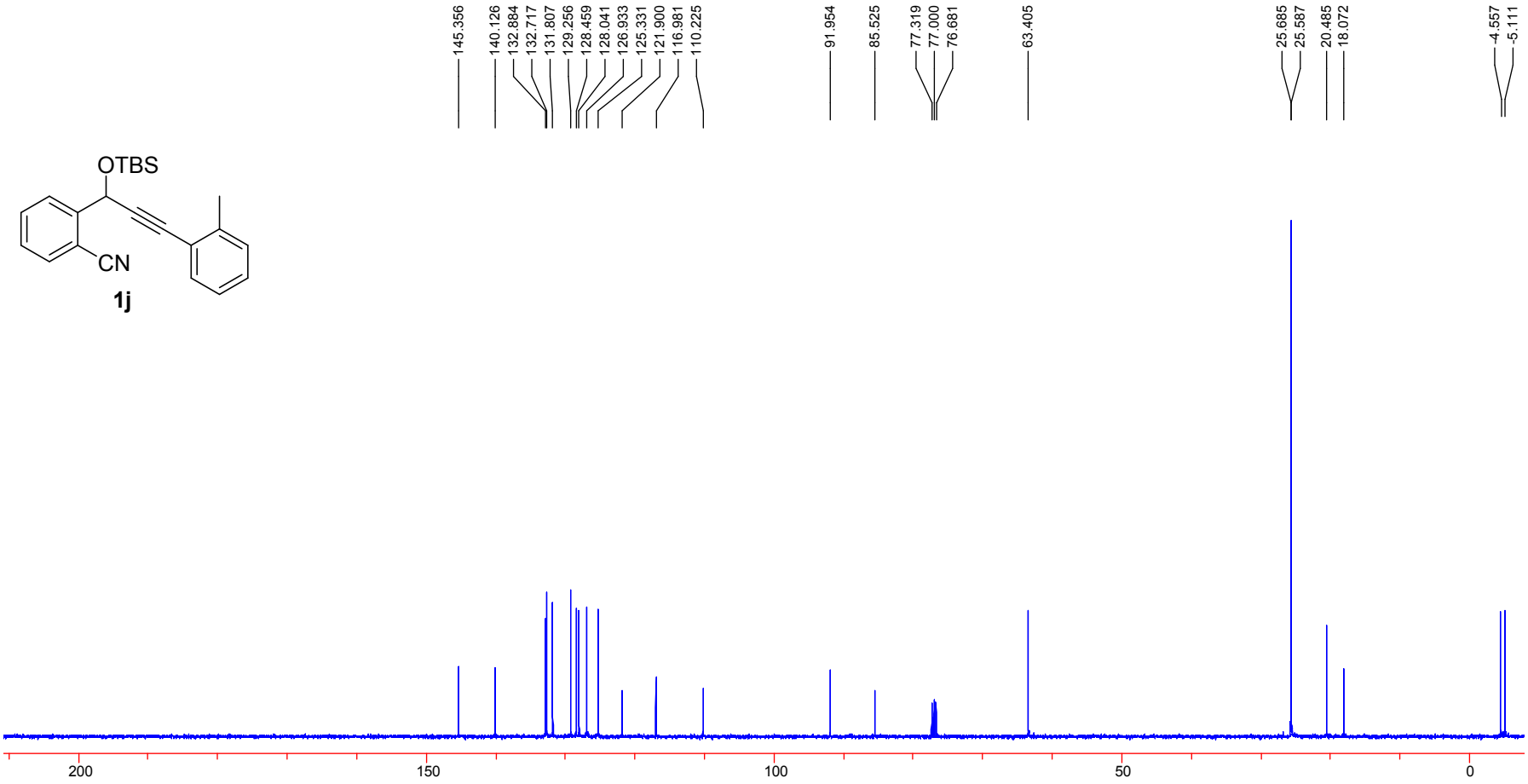

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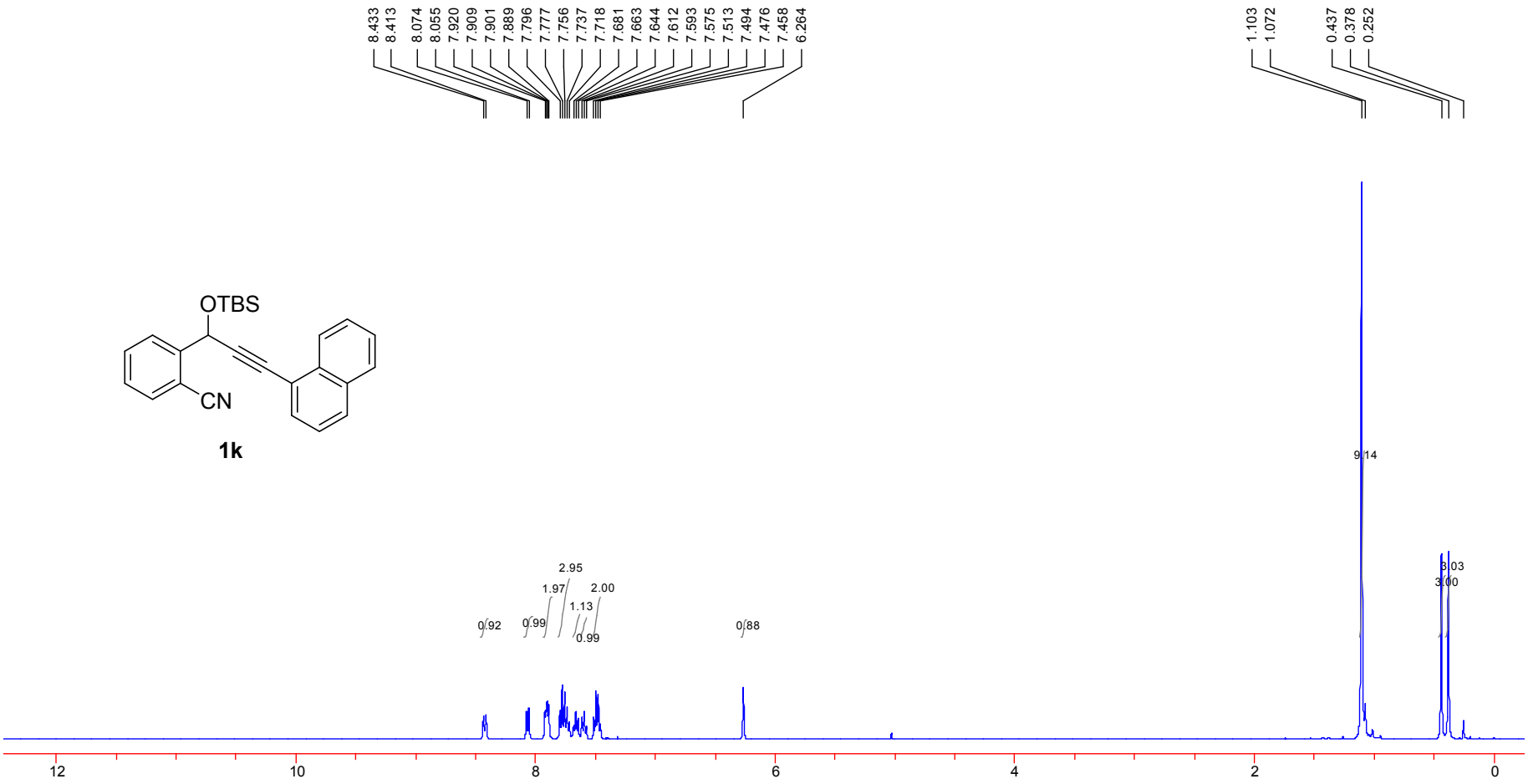

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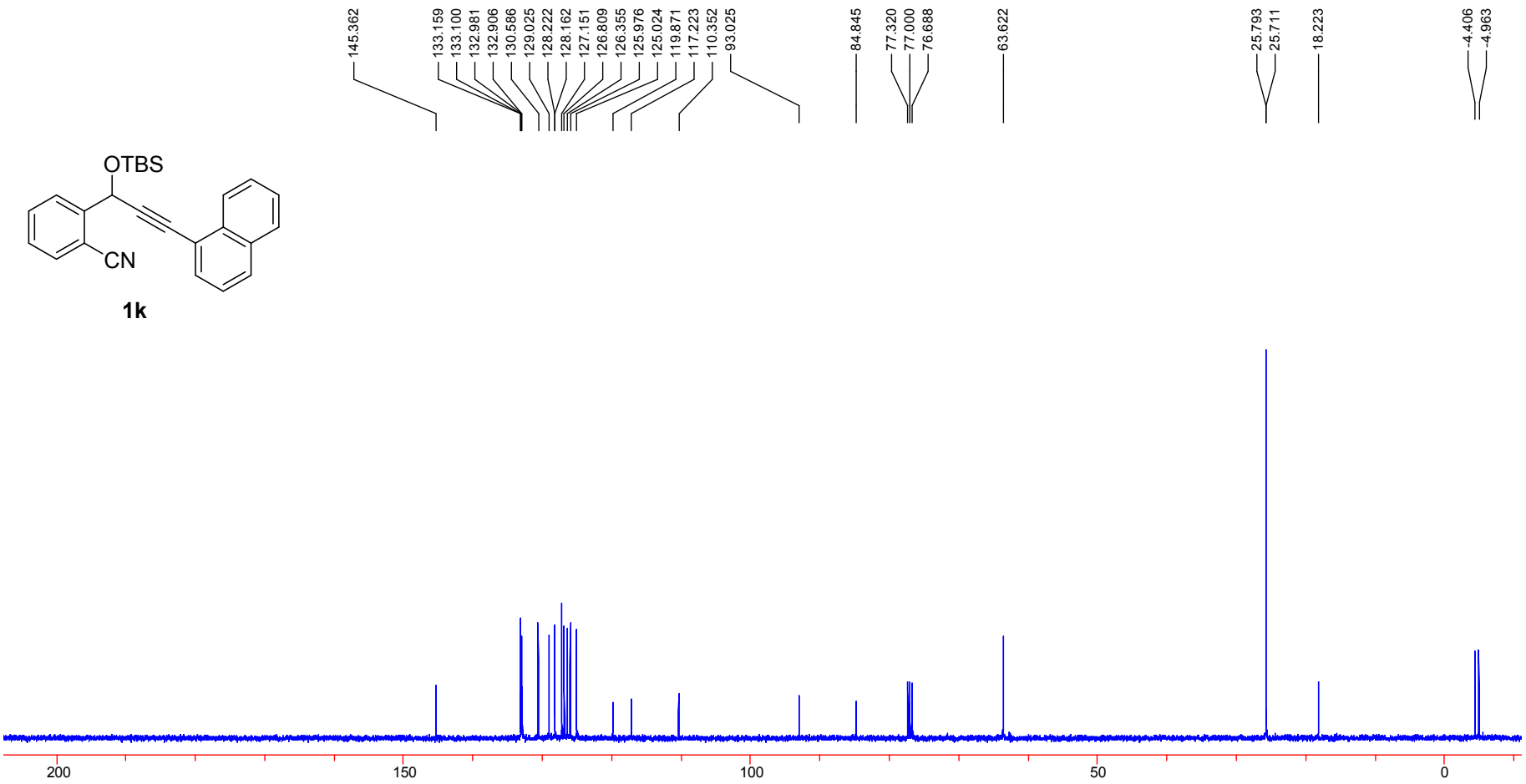
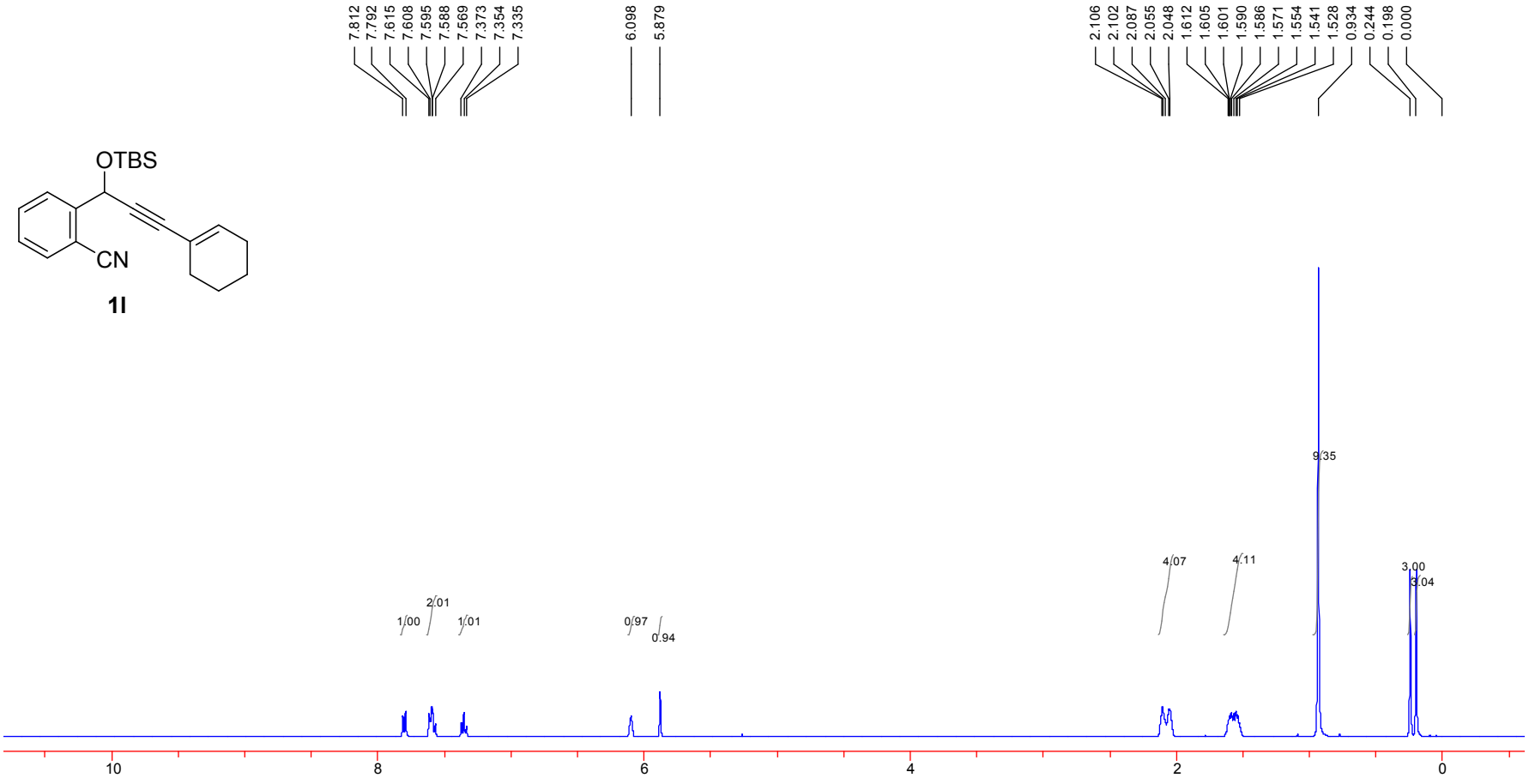
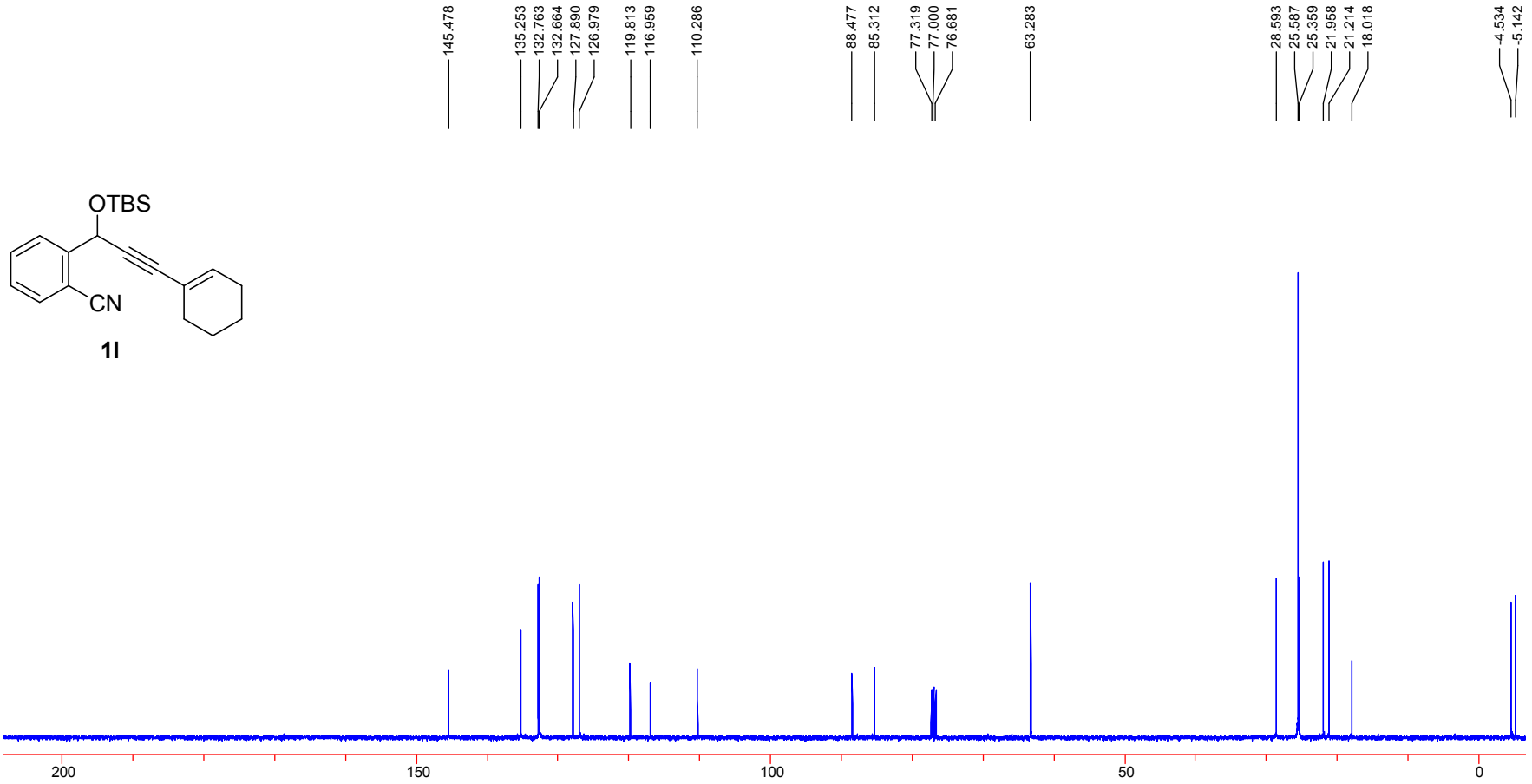


1k

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



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



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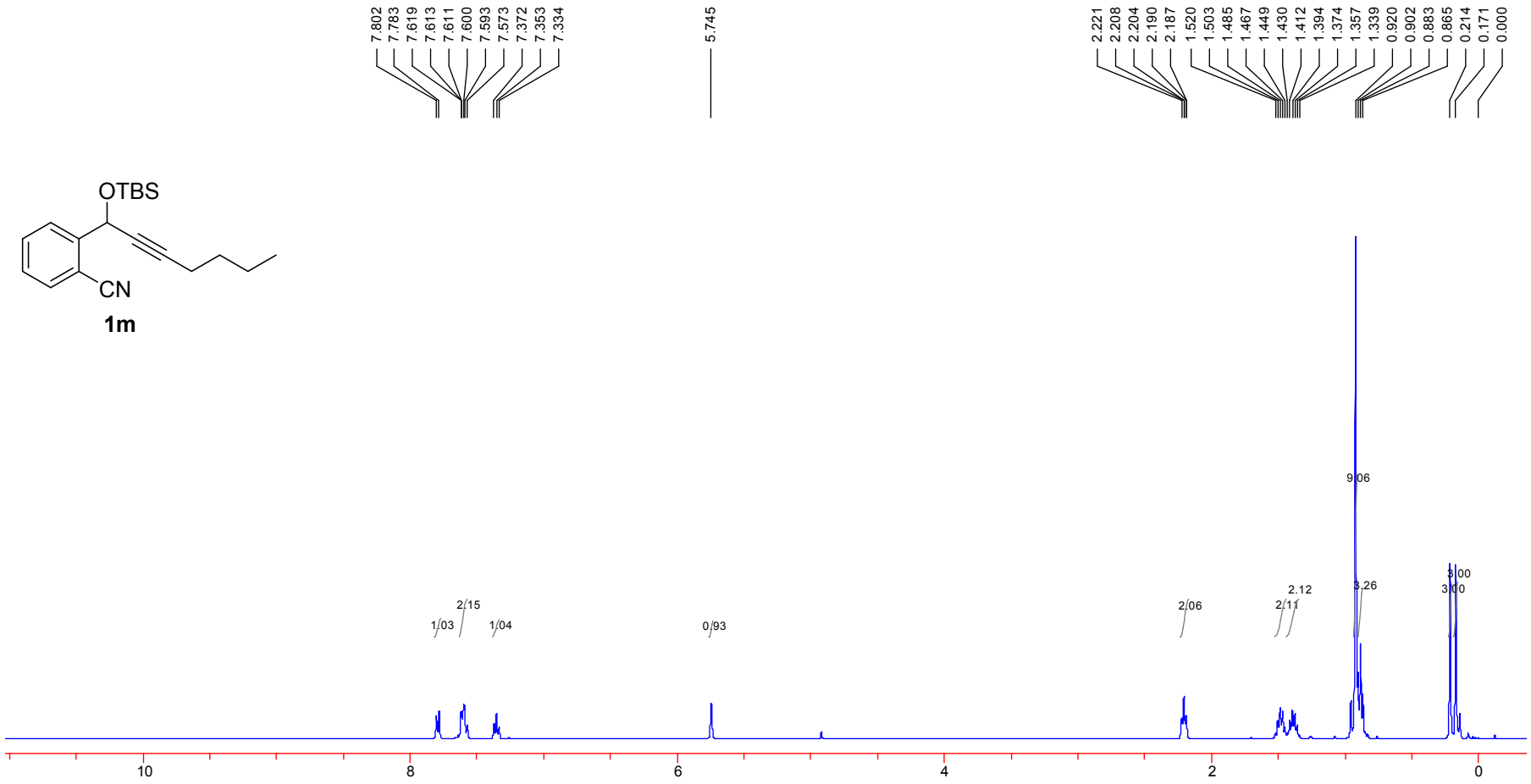
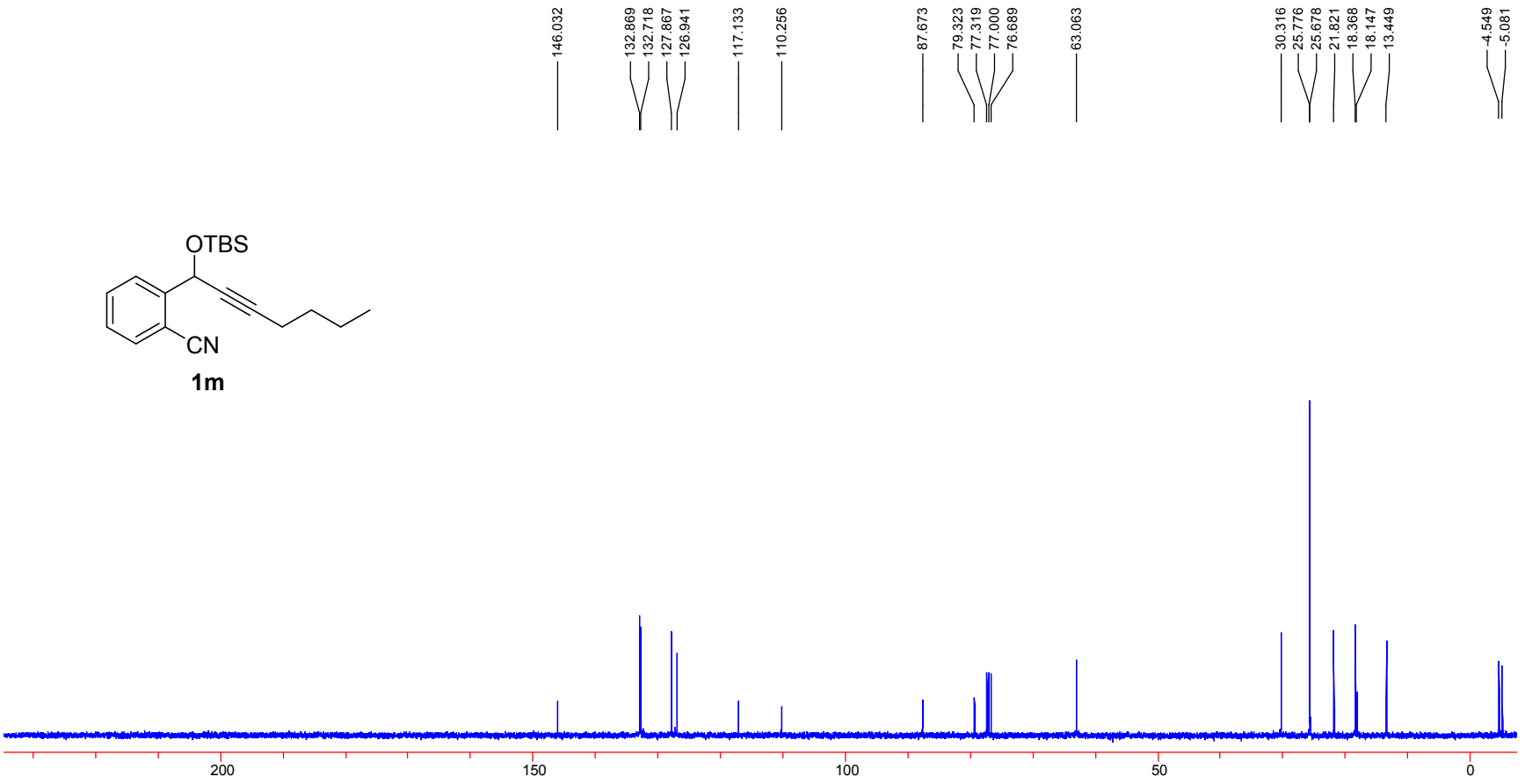
^{1}H NMR (400 MHz, $CDCl_3$)



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



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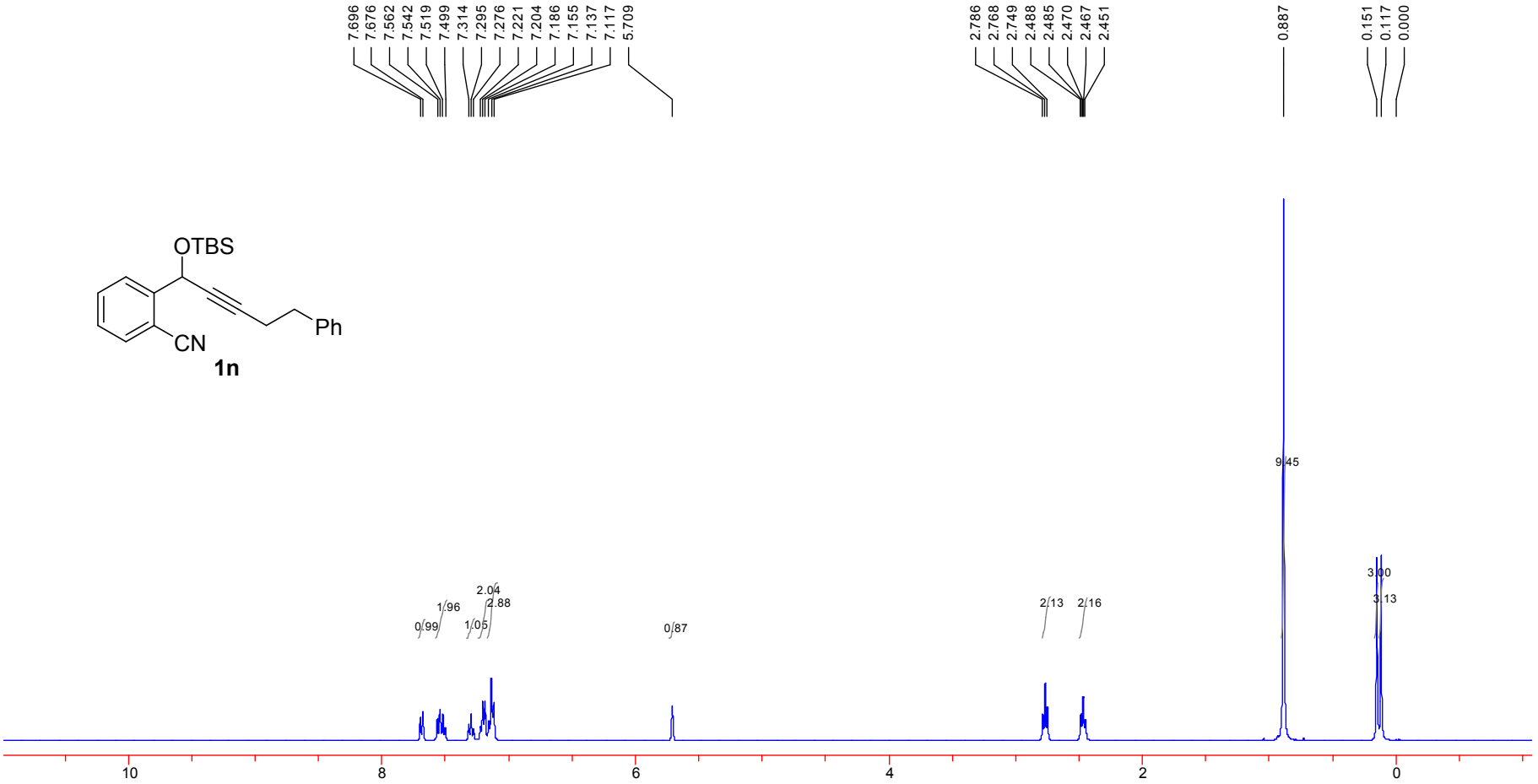
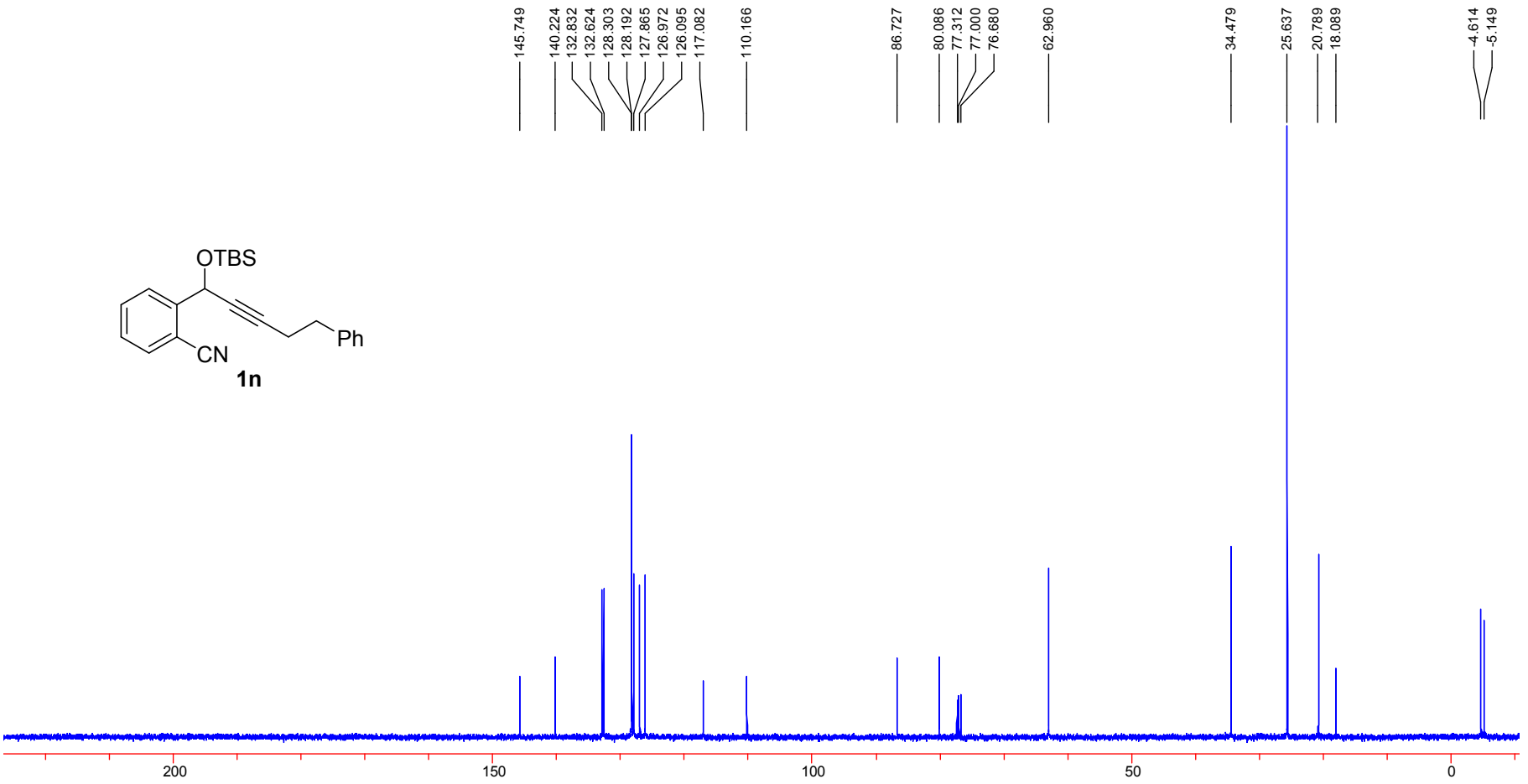
^{1}H NMR (400 MHz, $CDCl_3$)



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



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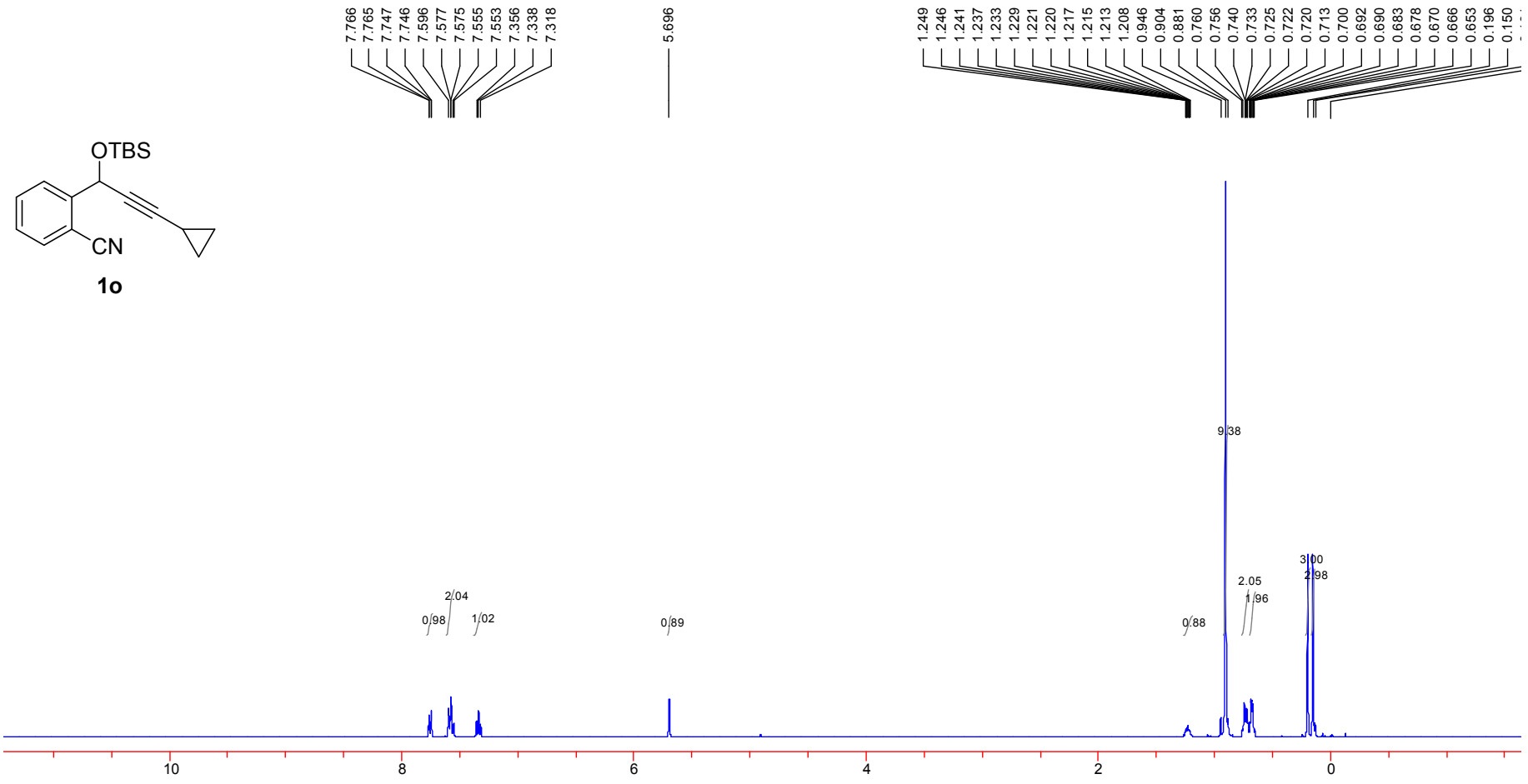
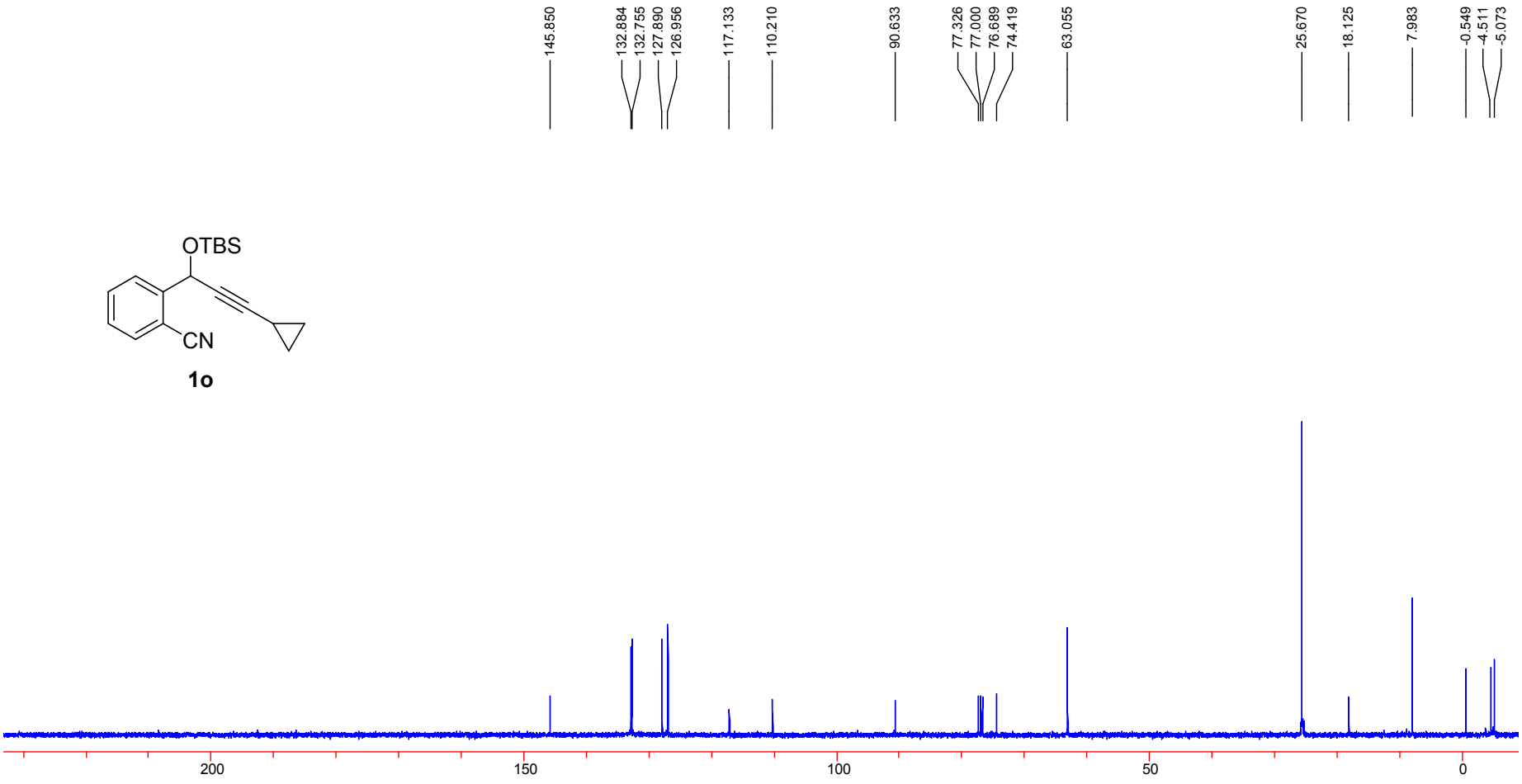


^{13}C NMR (100 MHz, $CDCl_3$)



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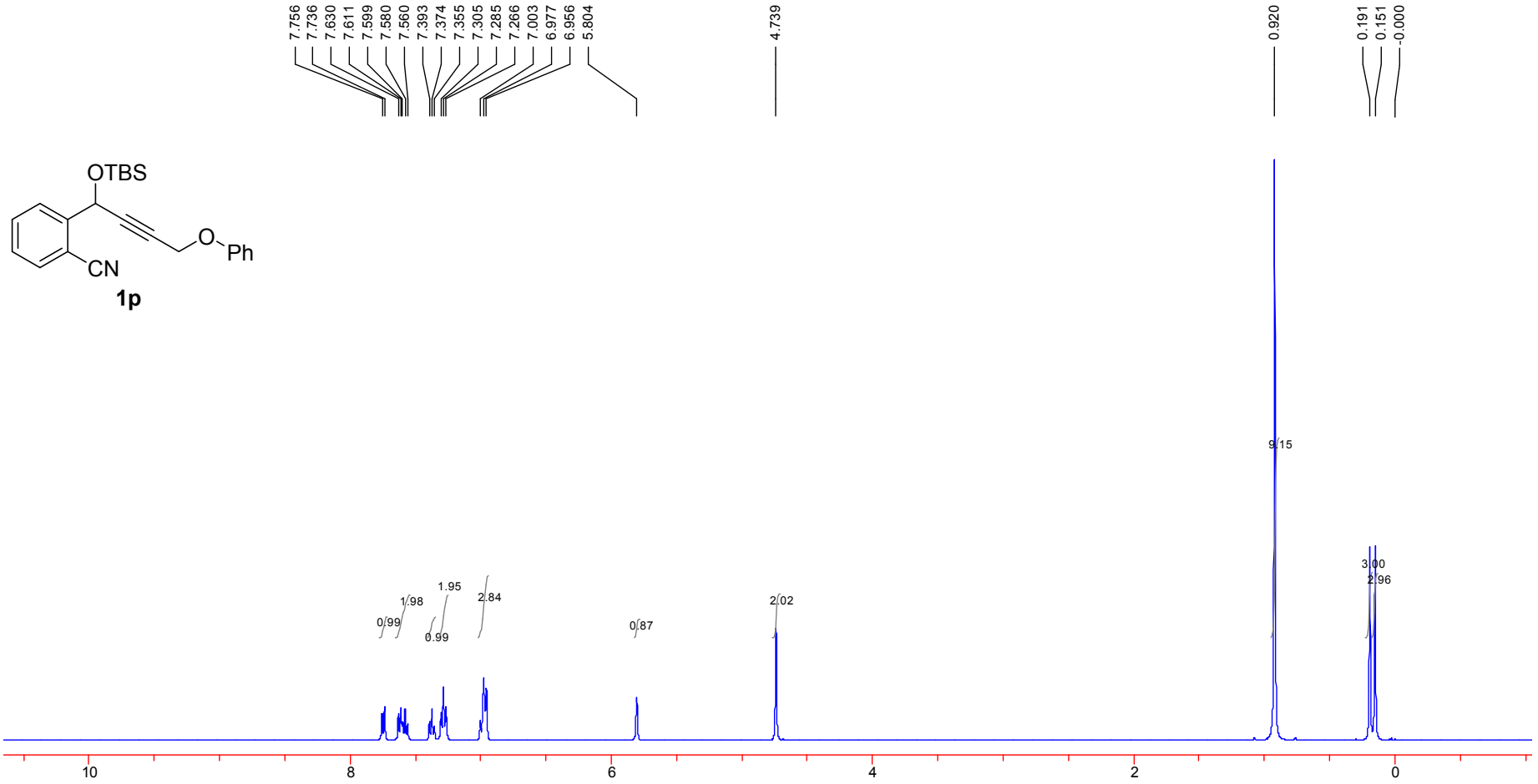
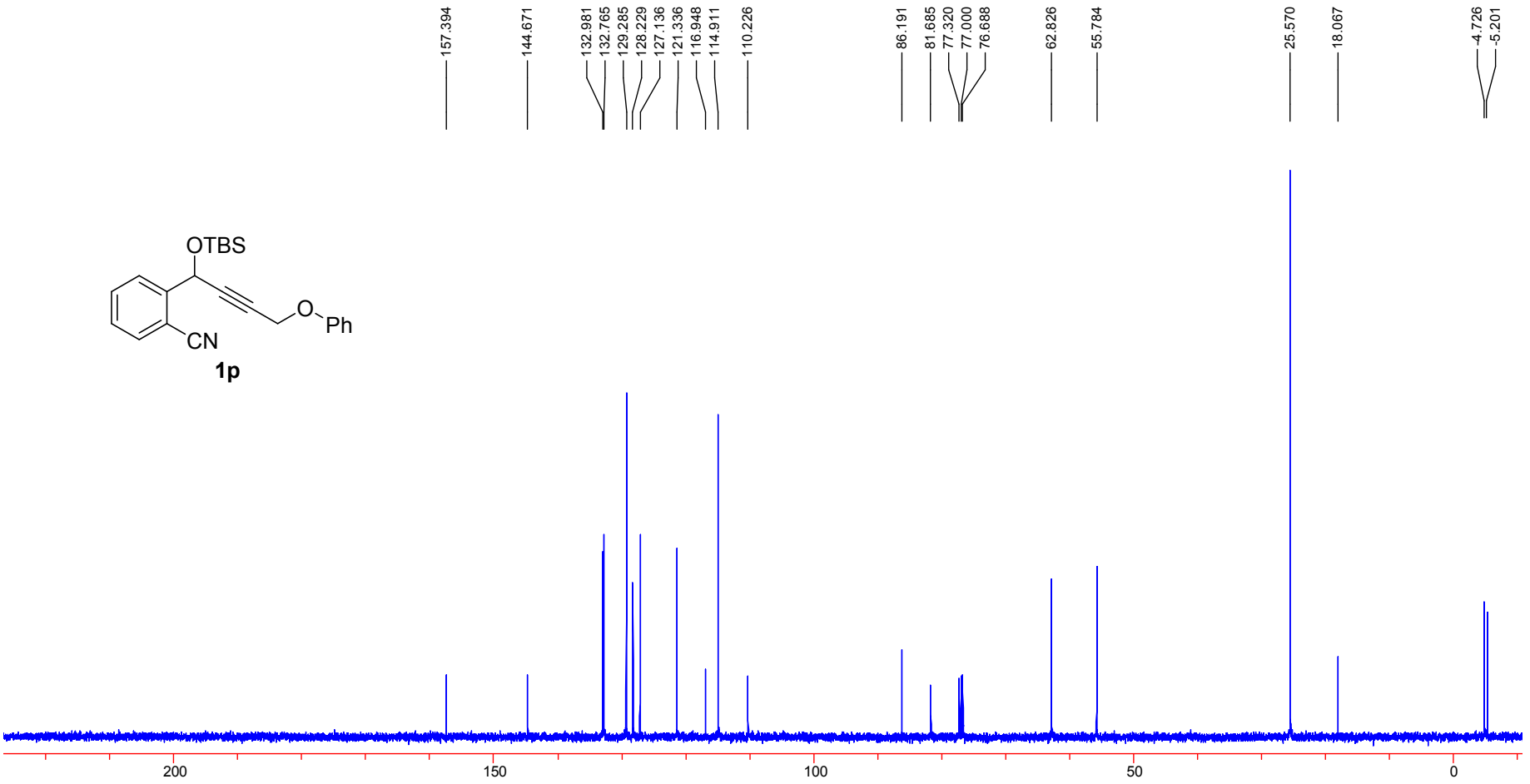
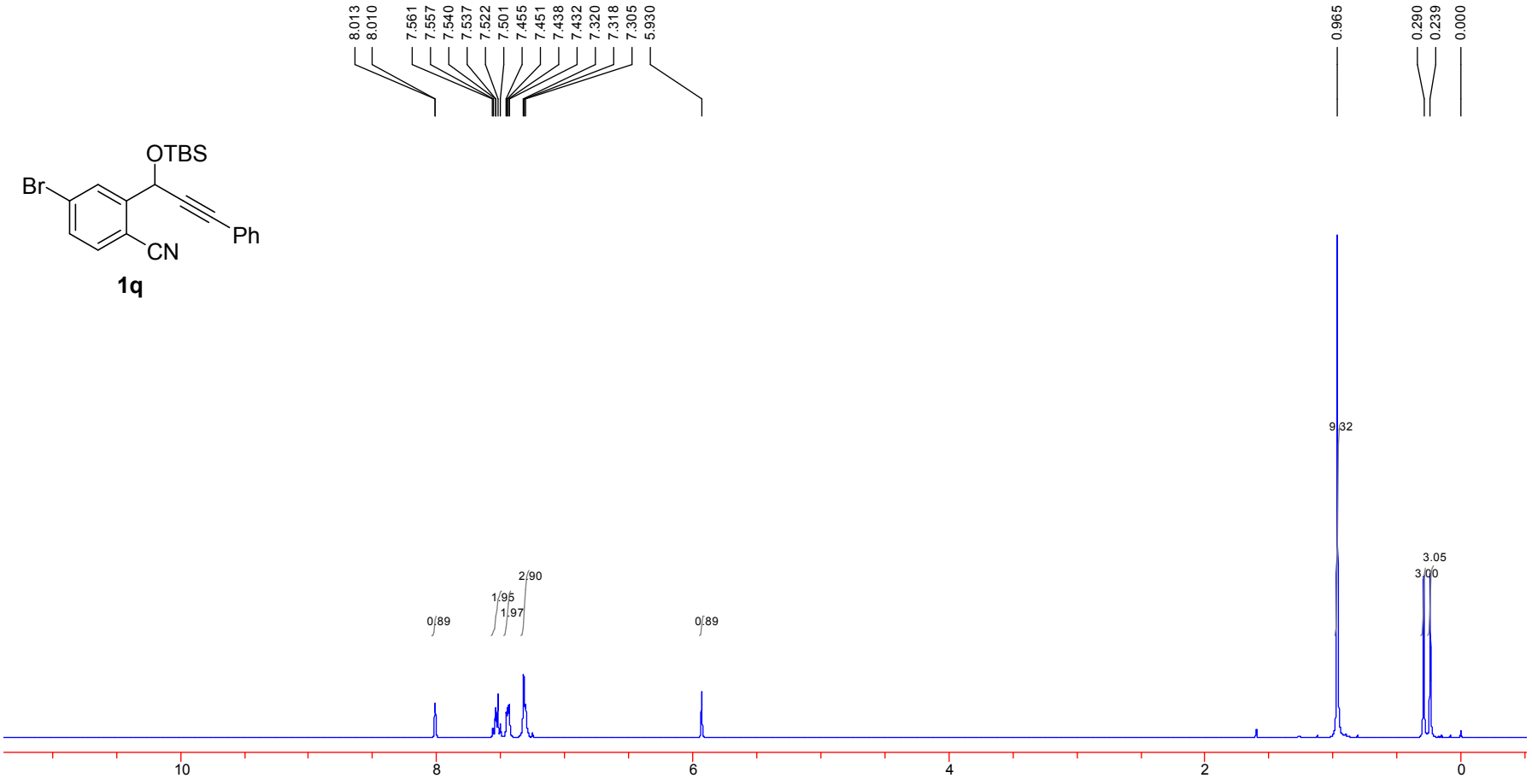
^{1}H NMR (400 MHz, $CDCl_3$)



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



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



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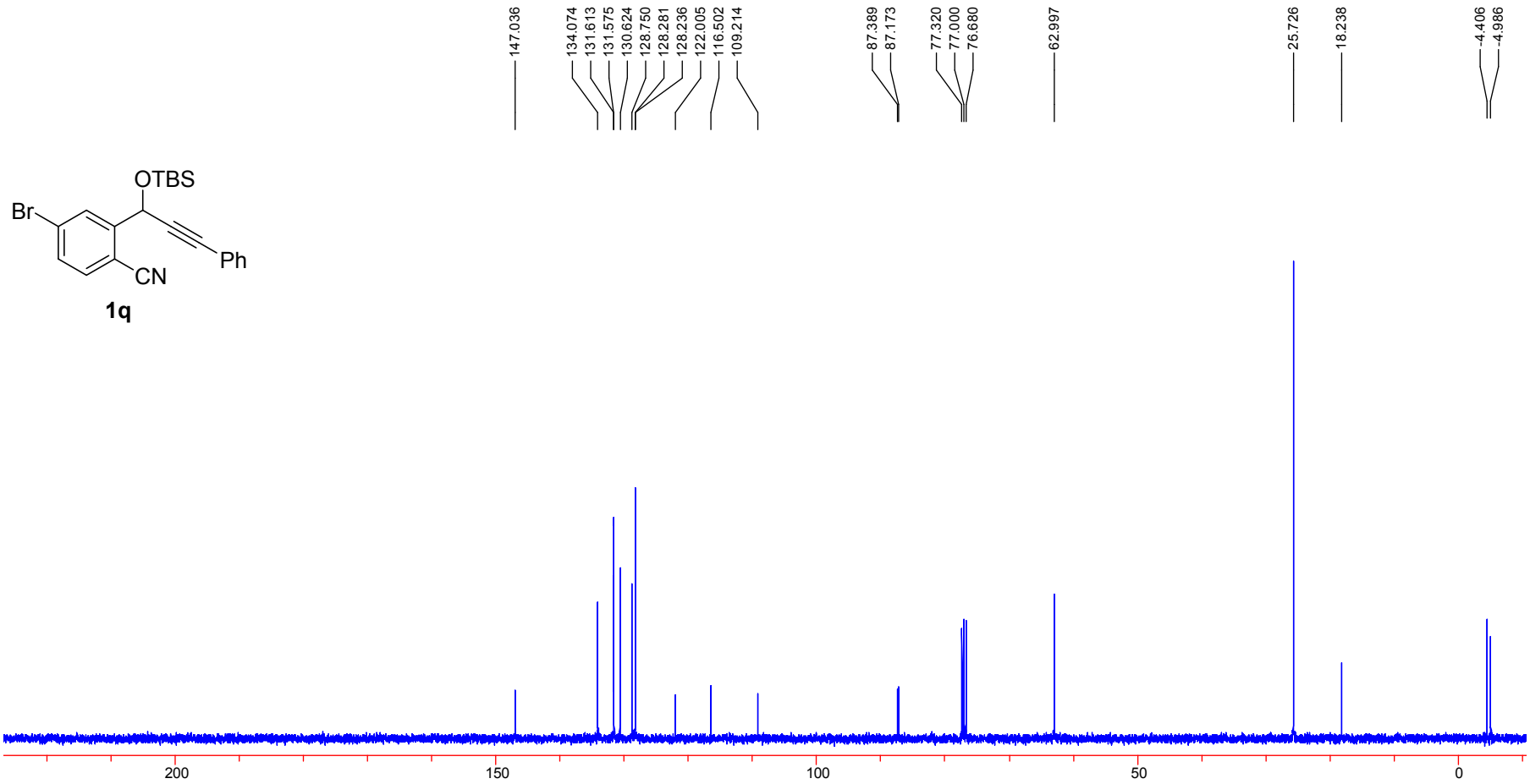

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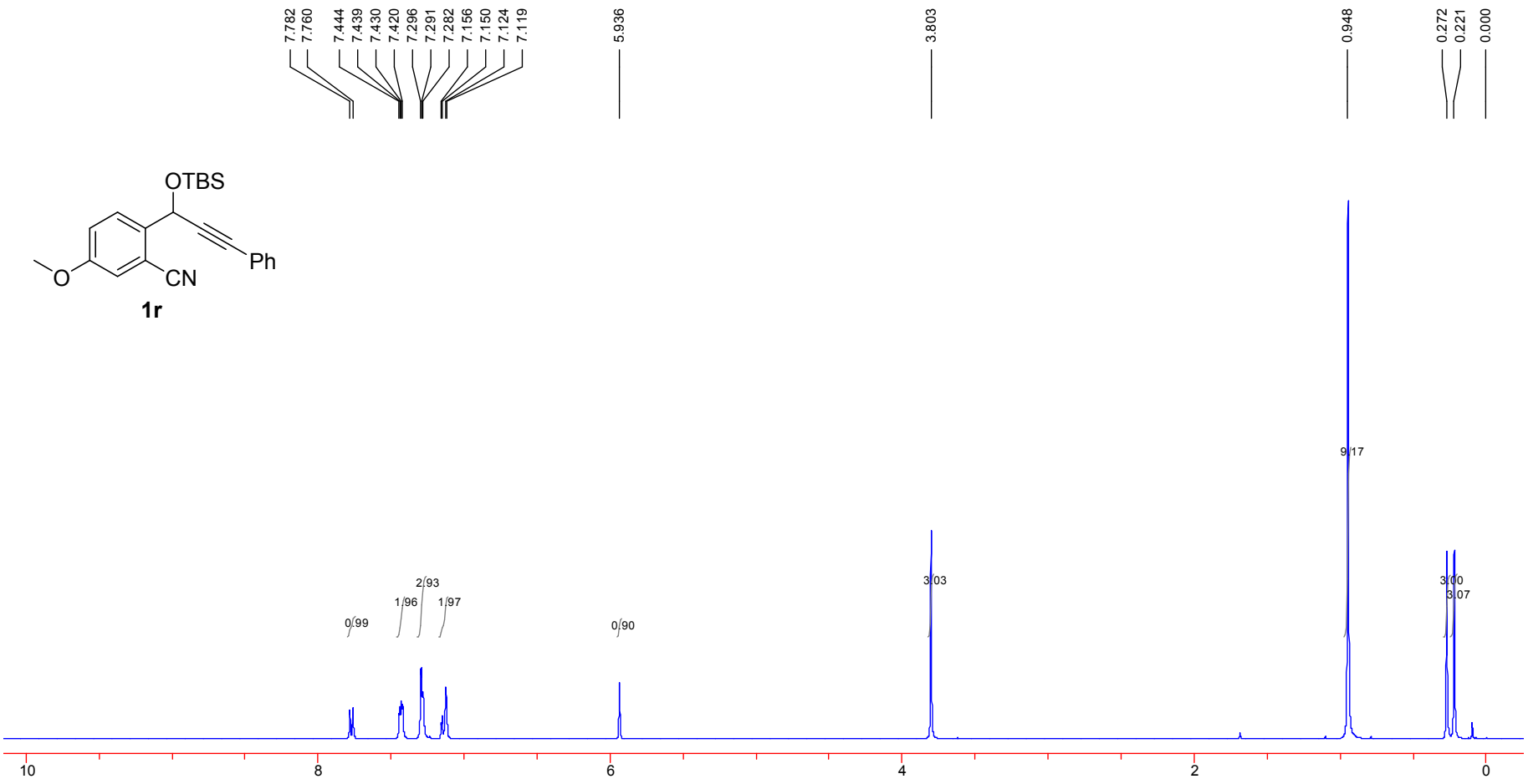

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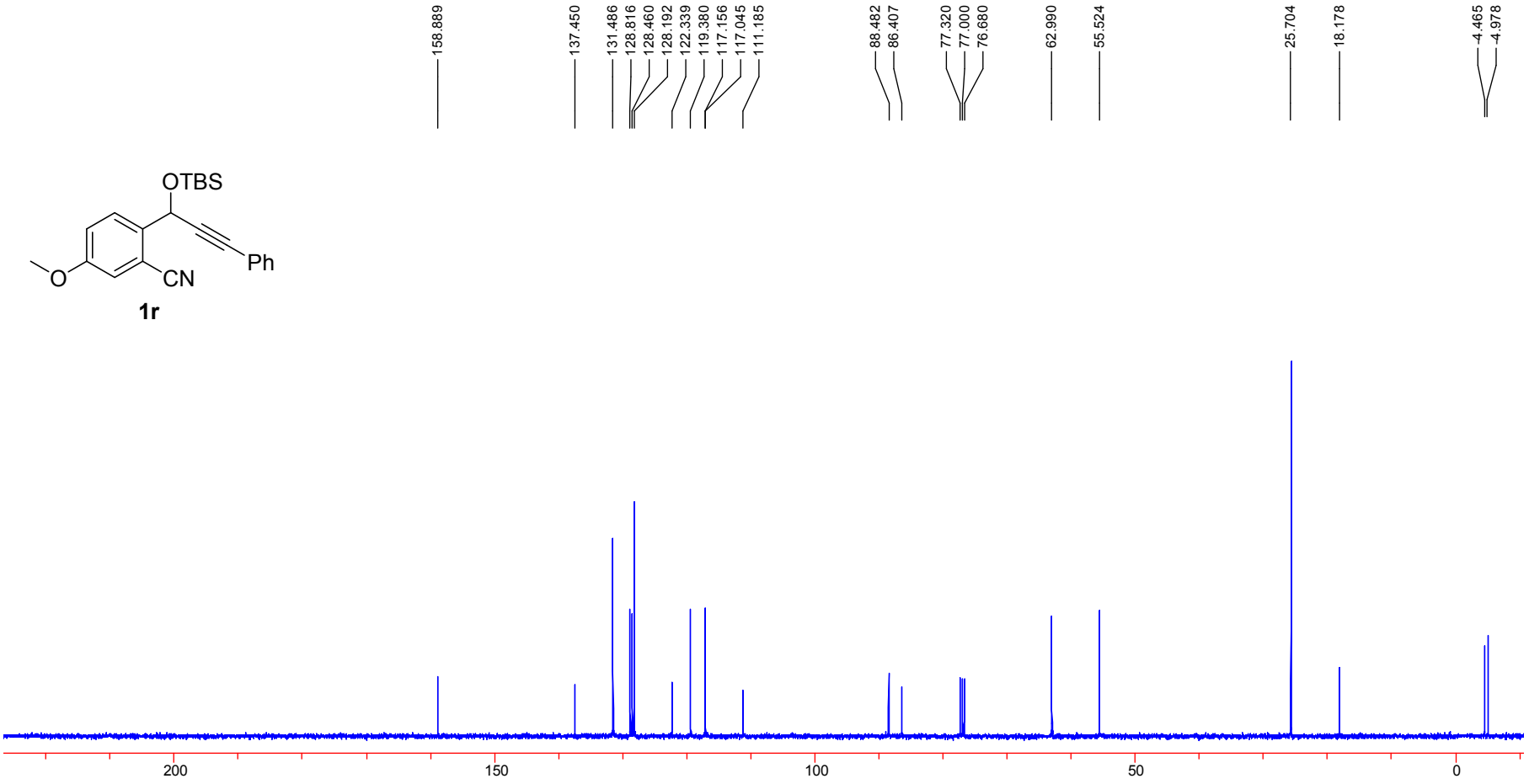

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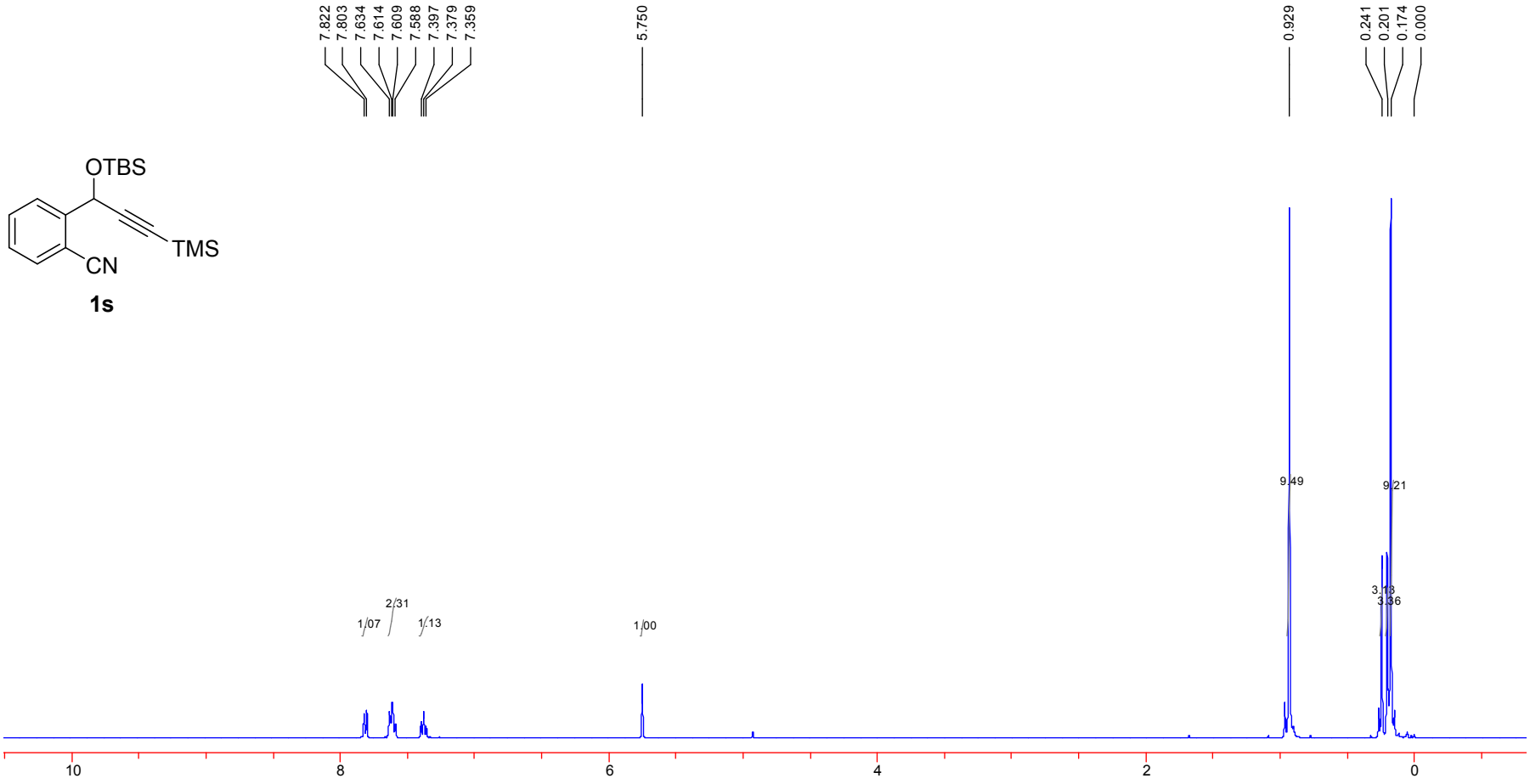
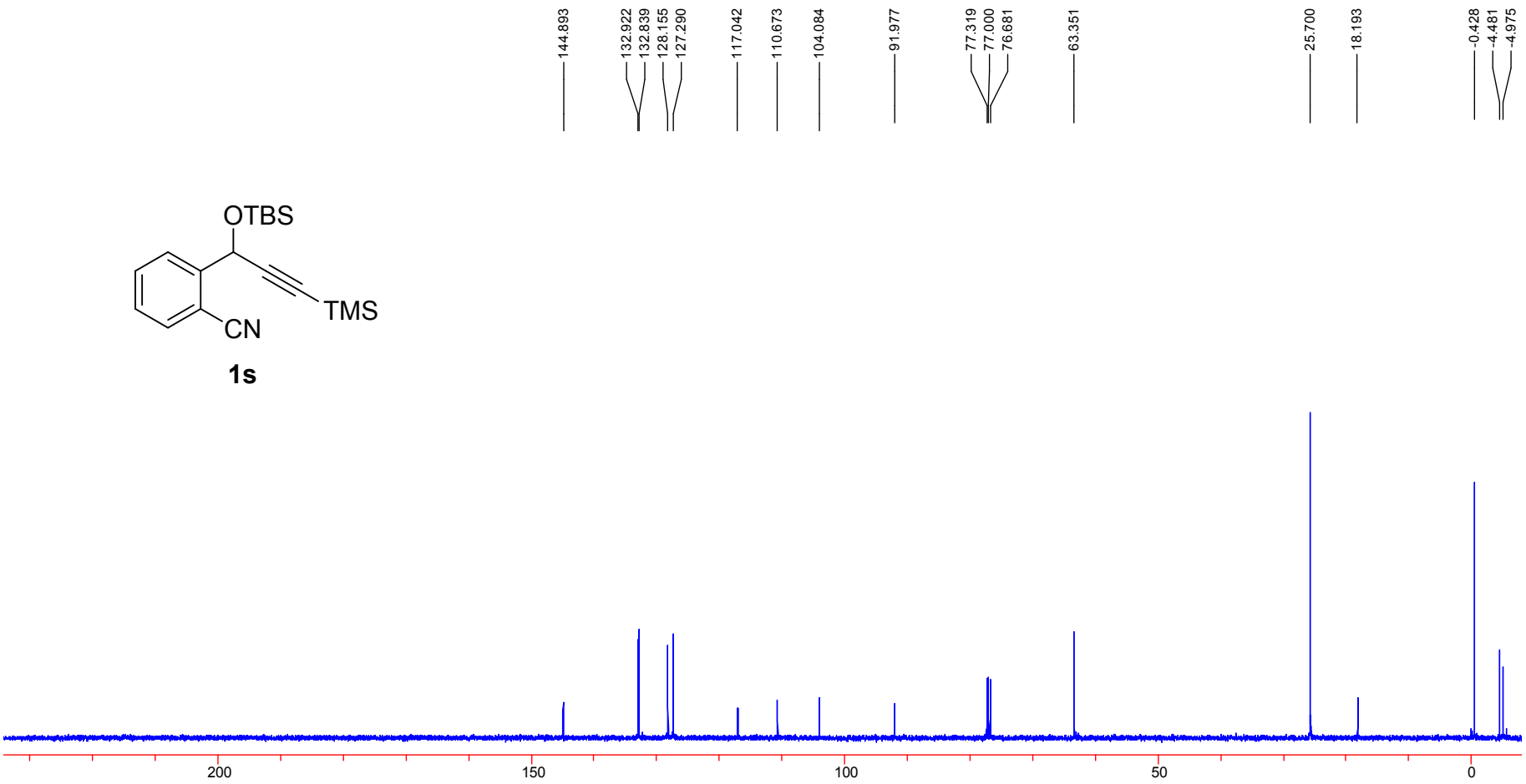


^{13}C NMR (100 MHz, $CDCl_3$)



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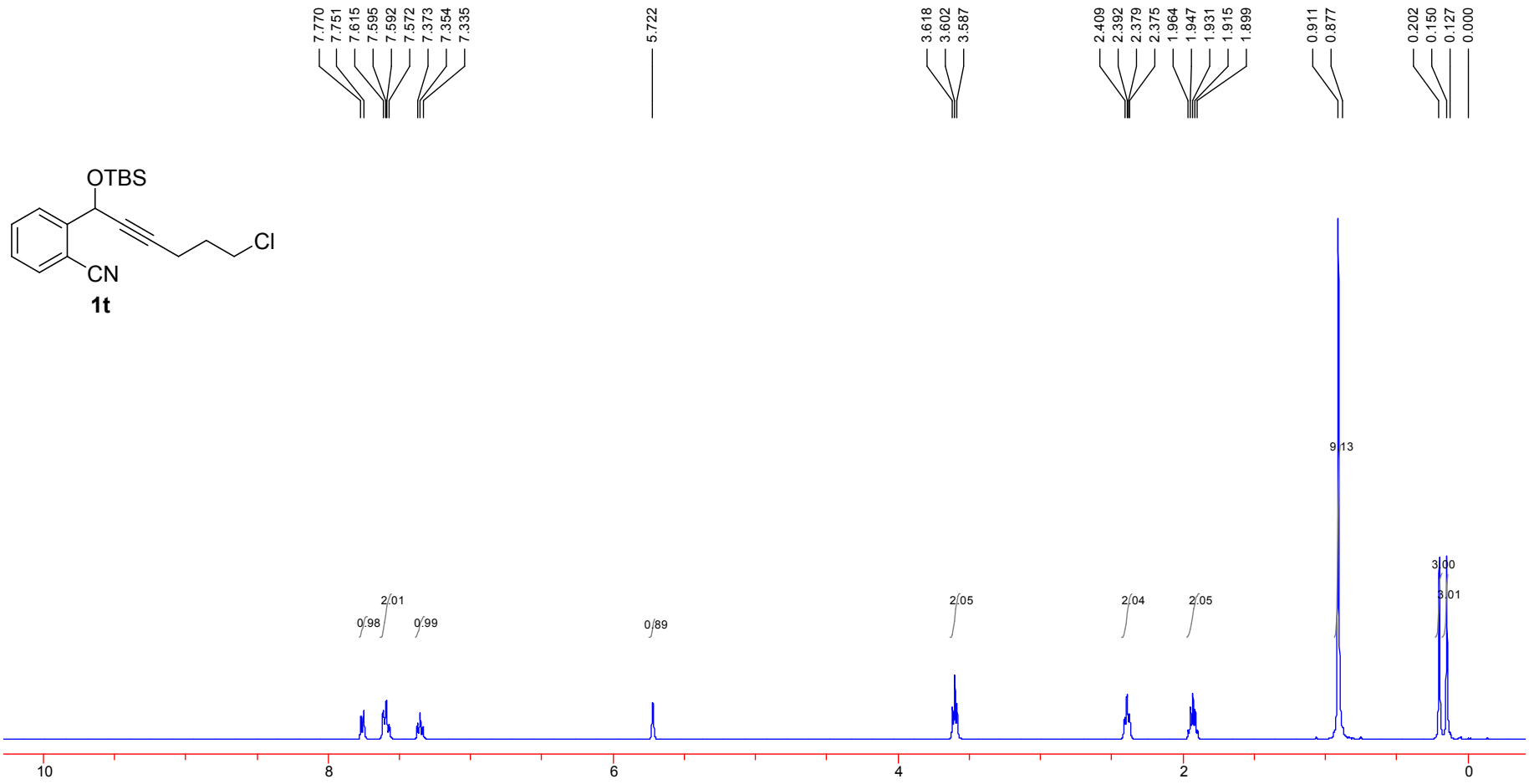
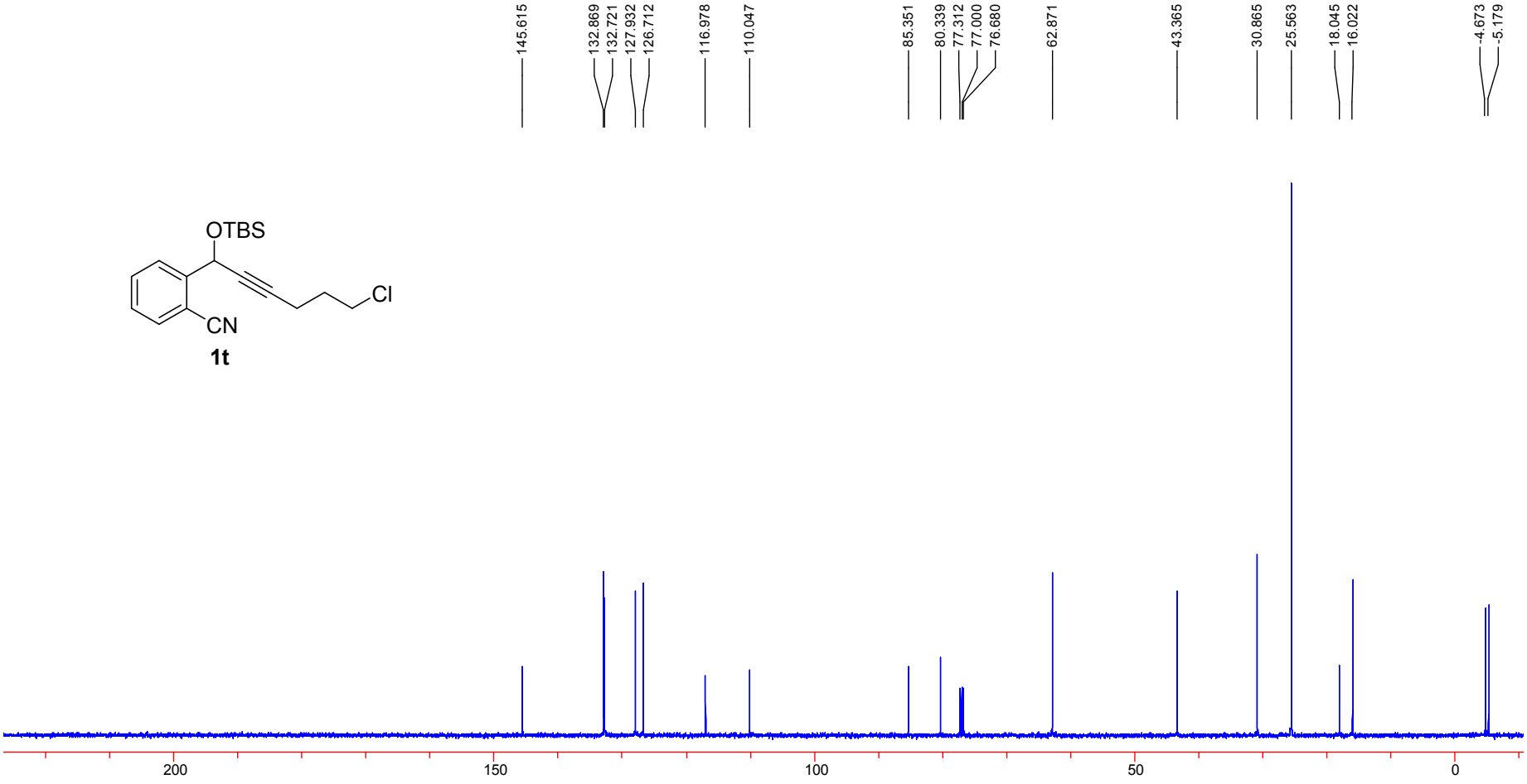
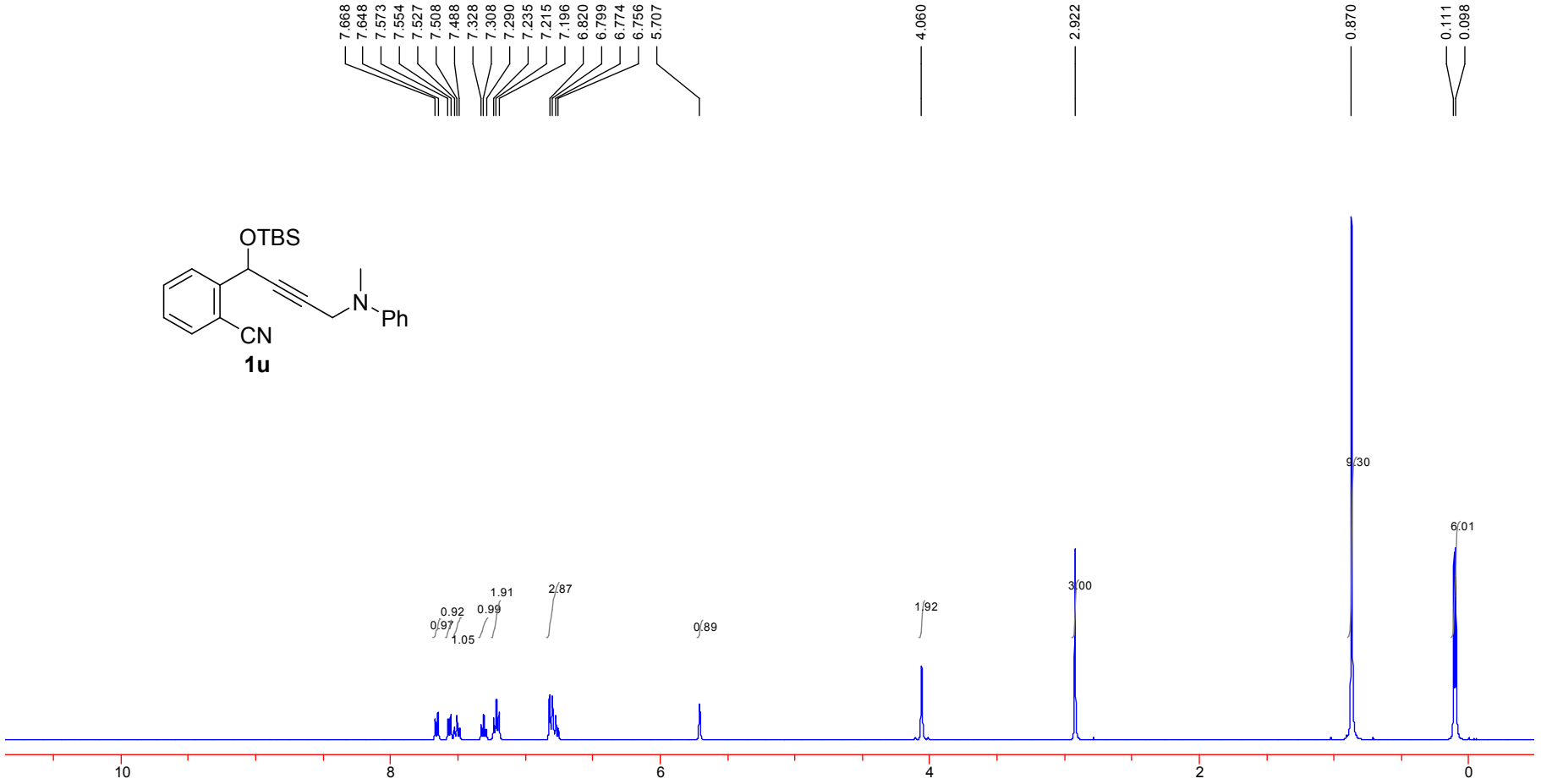


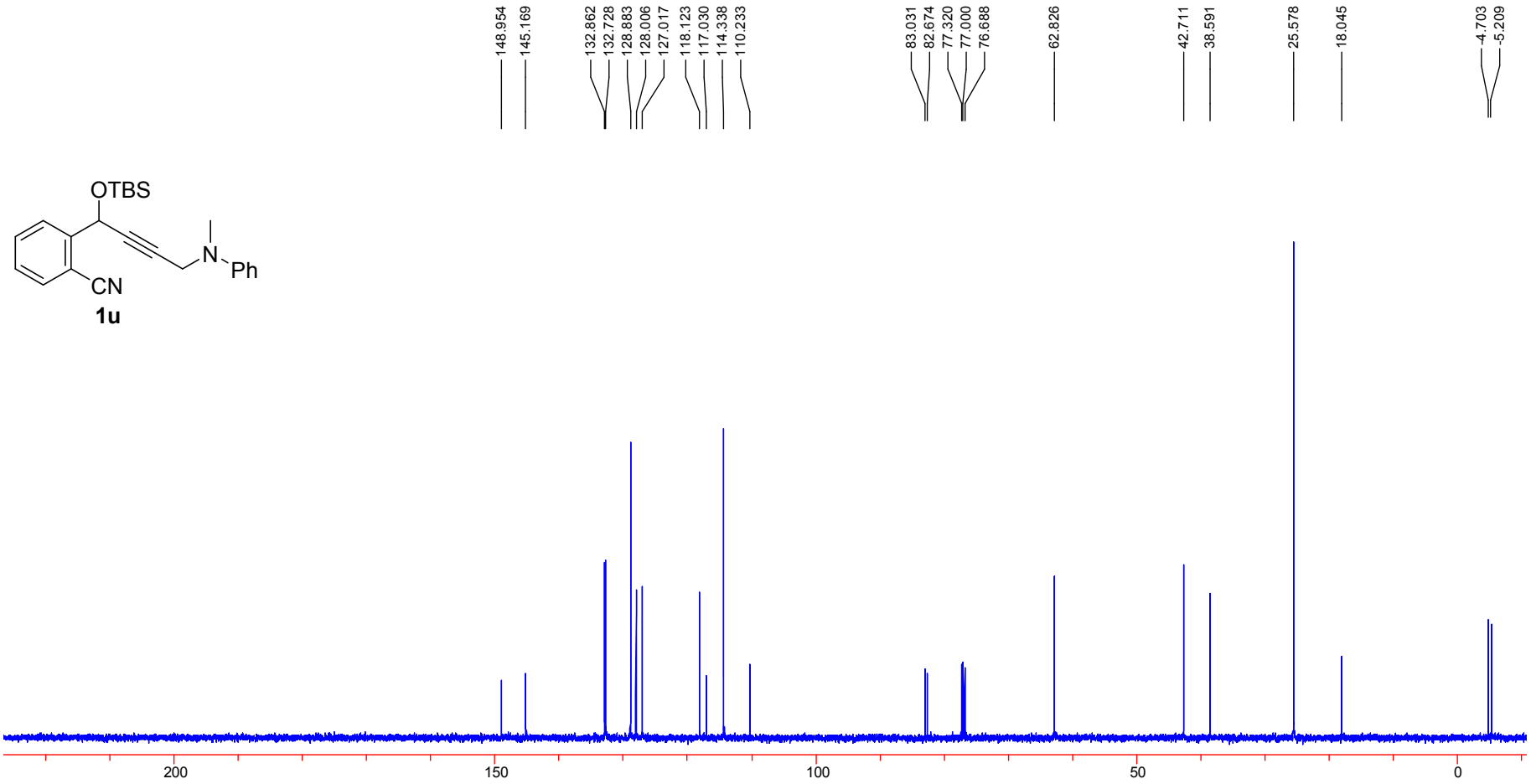
^{13}C NMR (100 MHz, $CDCl_3$)



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



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



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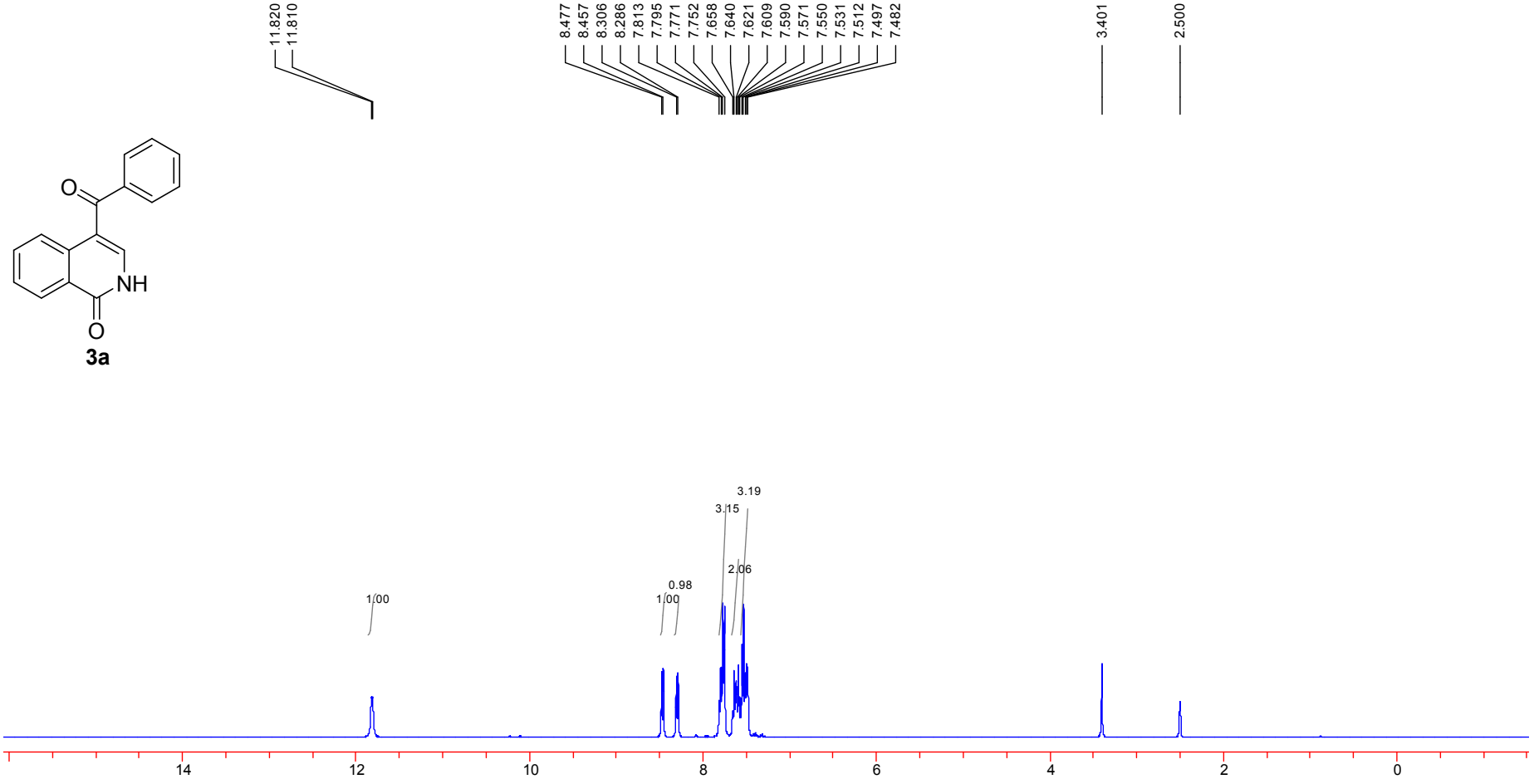
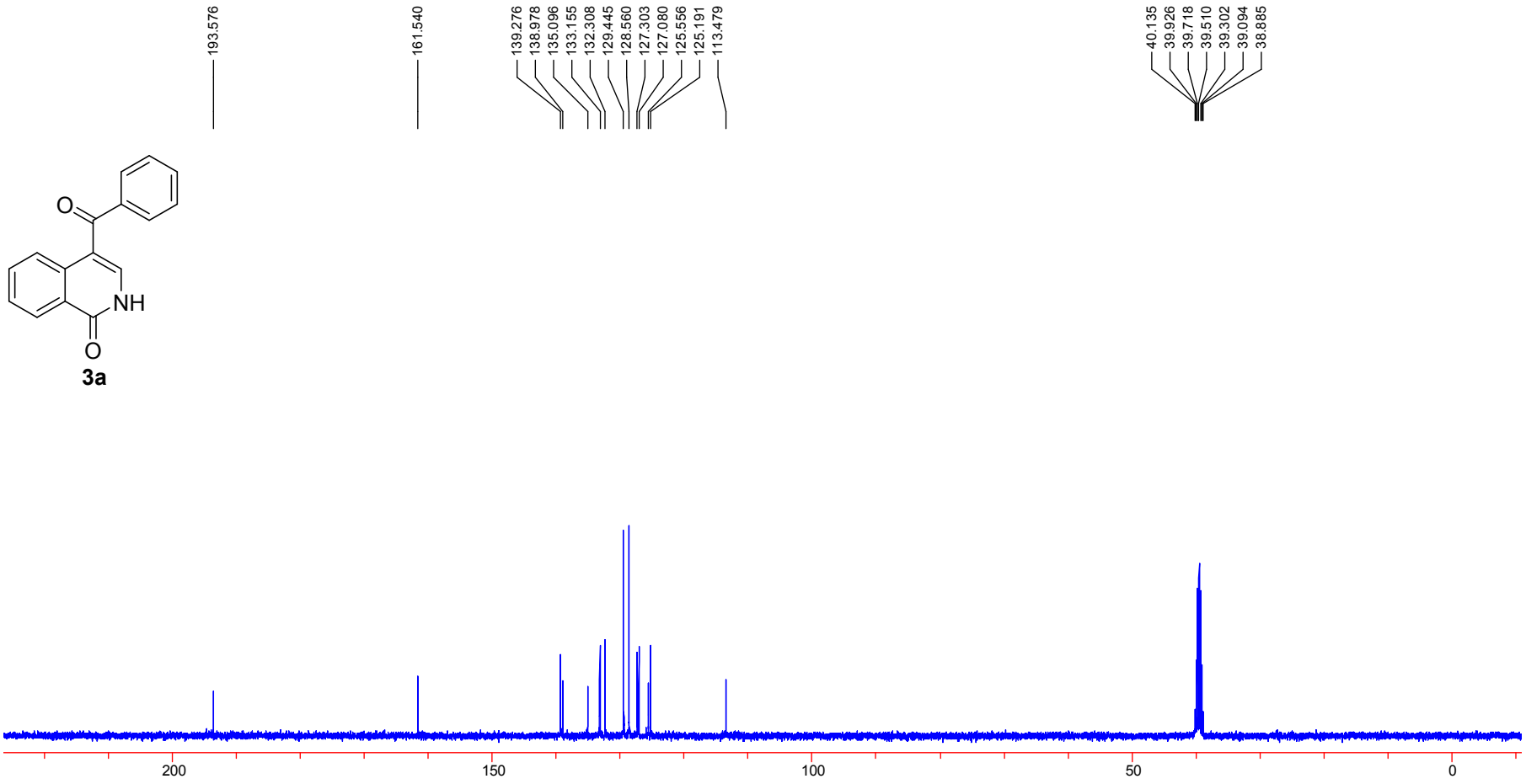
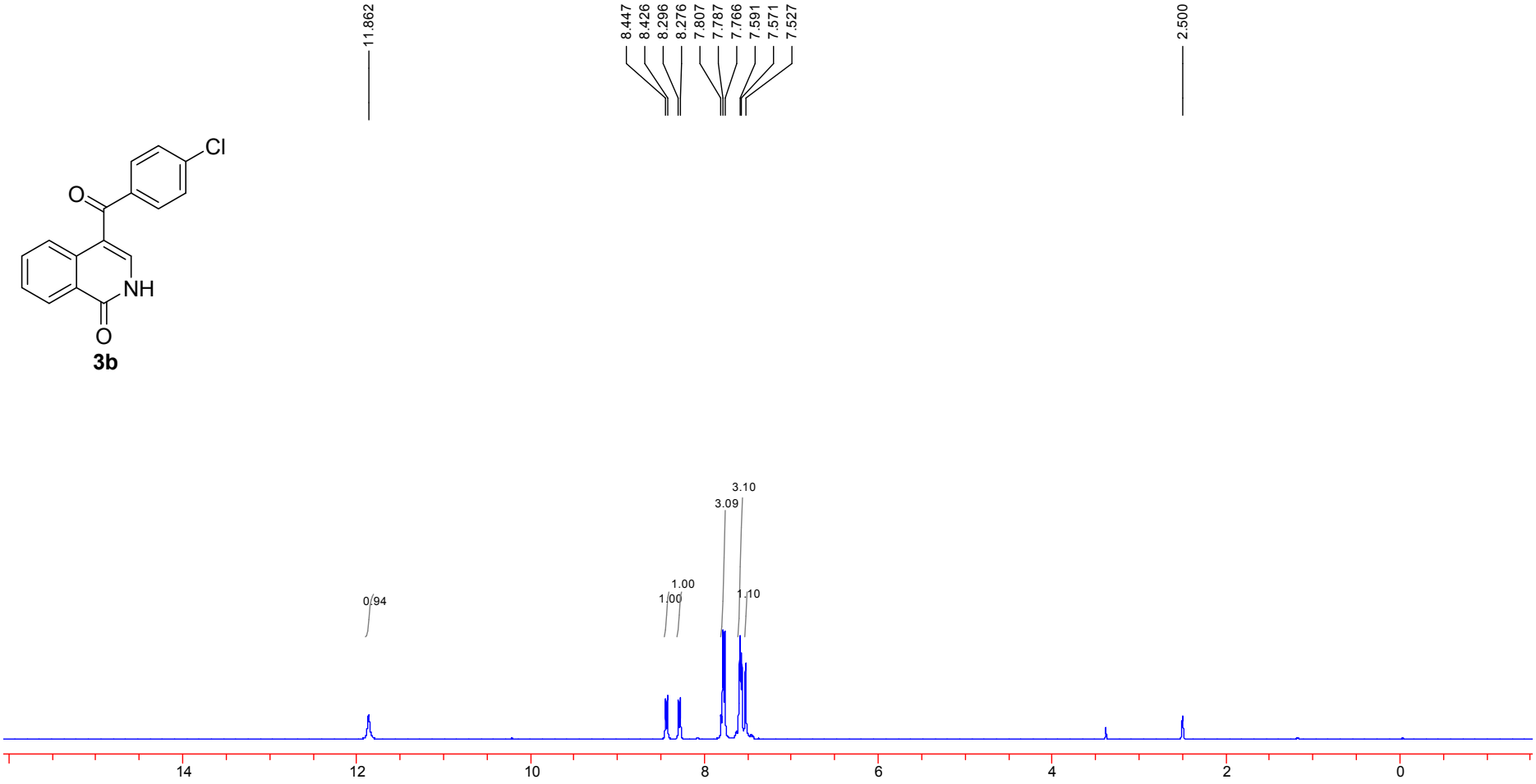


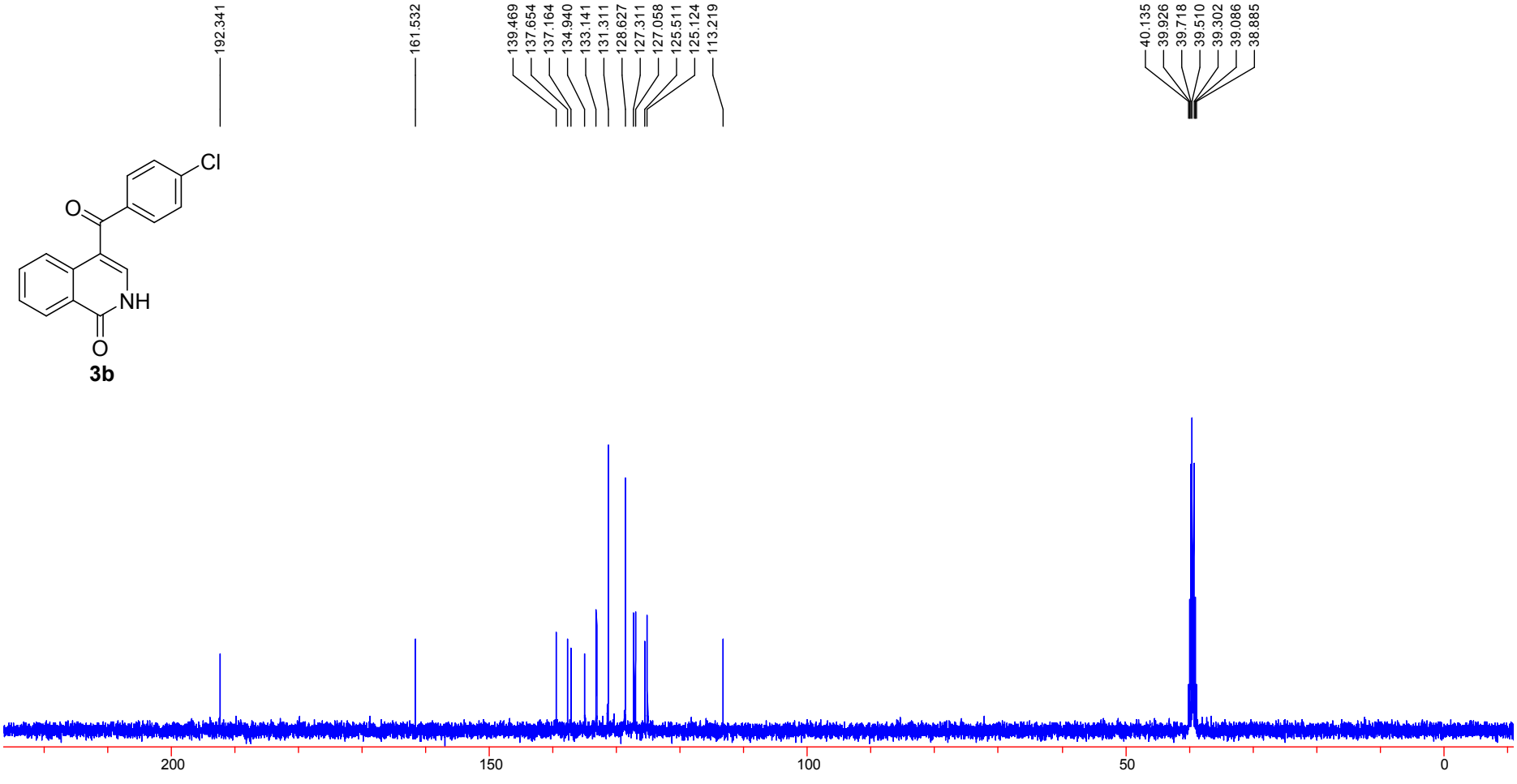
^{13}C NMR (100 MHz, DMSO-d_6)



^{1}H NMR (400 MHz, DMSO-d_6)



^{13}C NMR (100 MHz, DMSO-d_6)



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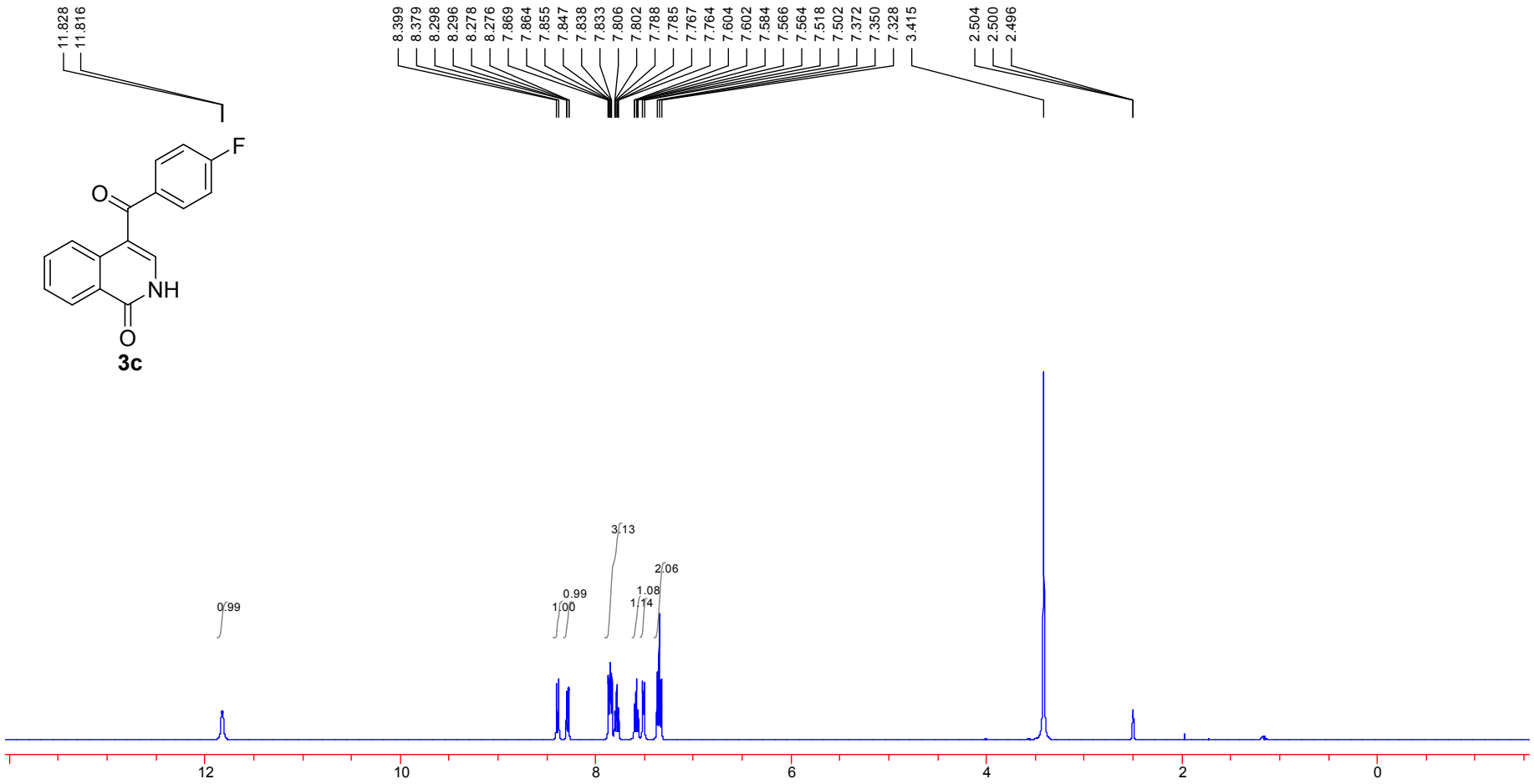

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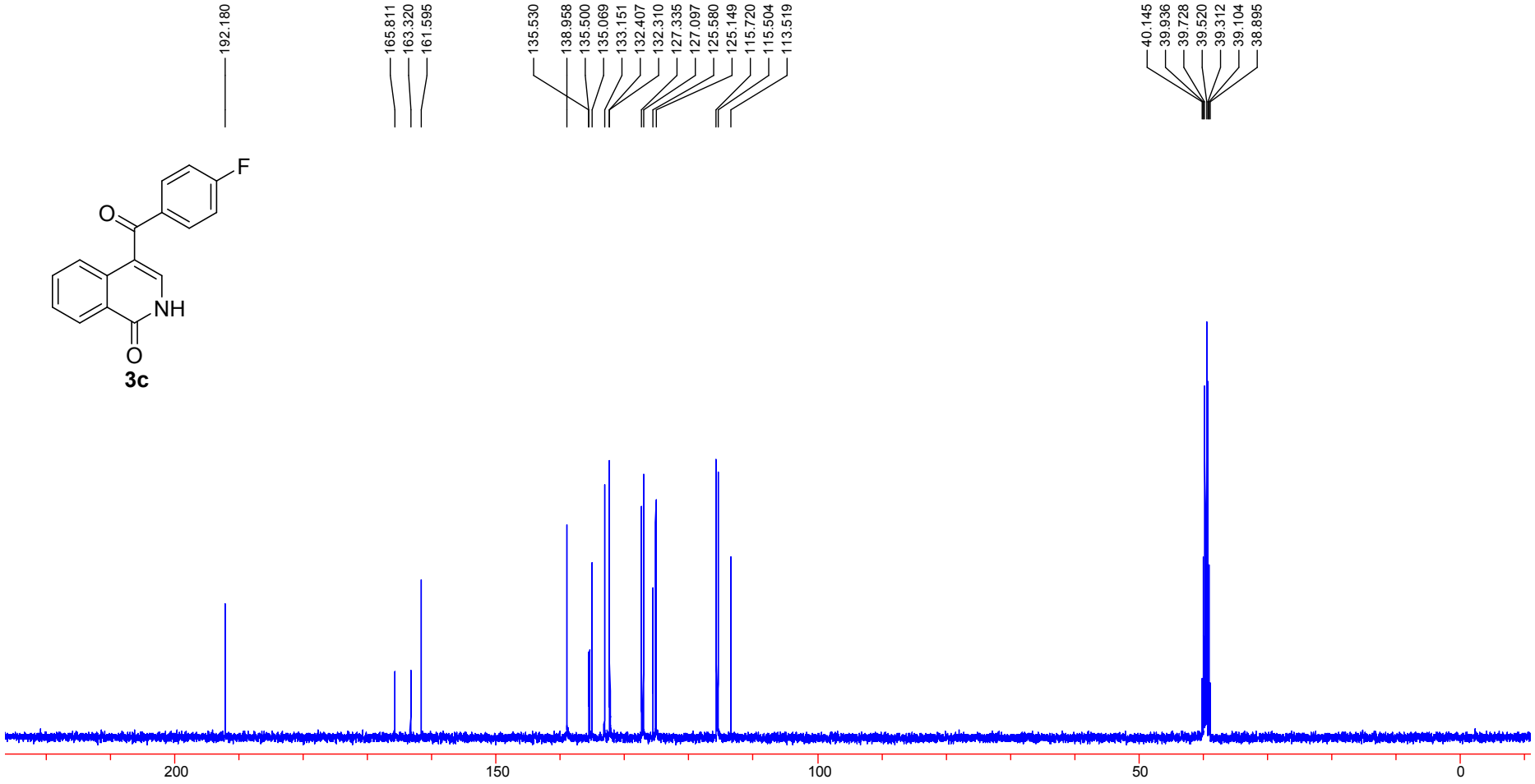
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125.149
115.720
115.504
113.519
40.145
39.936
39.728
39.520
39.312
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F
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3c
200
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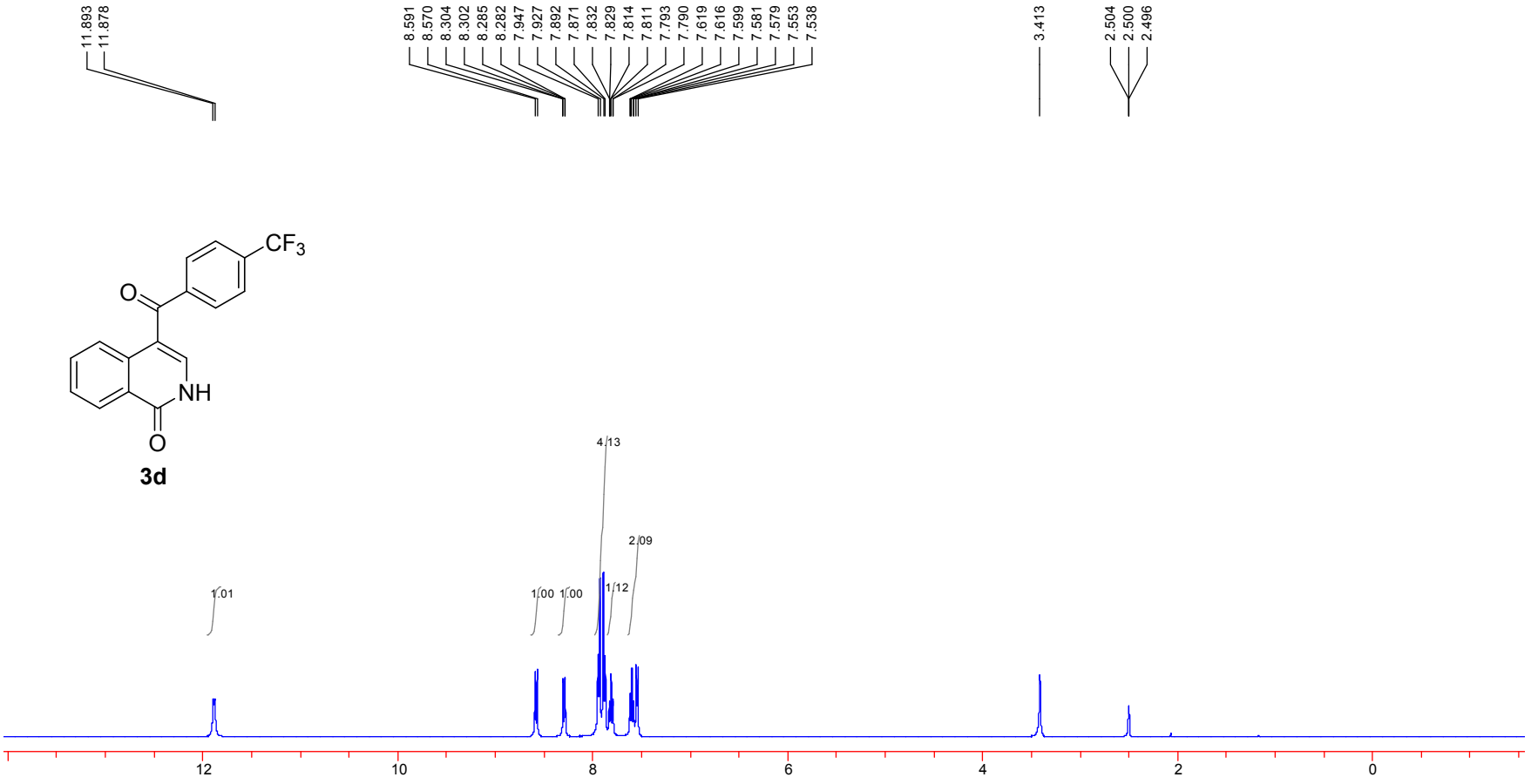
50
0

^{1}H NMR (400 MHz, DMSO-d_6)



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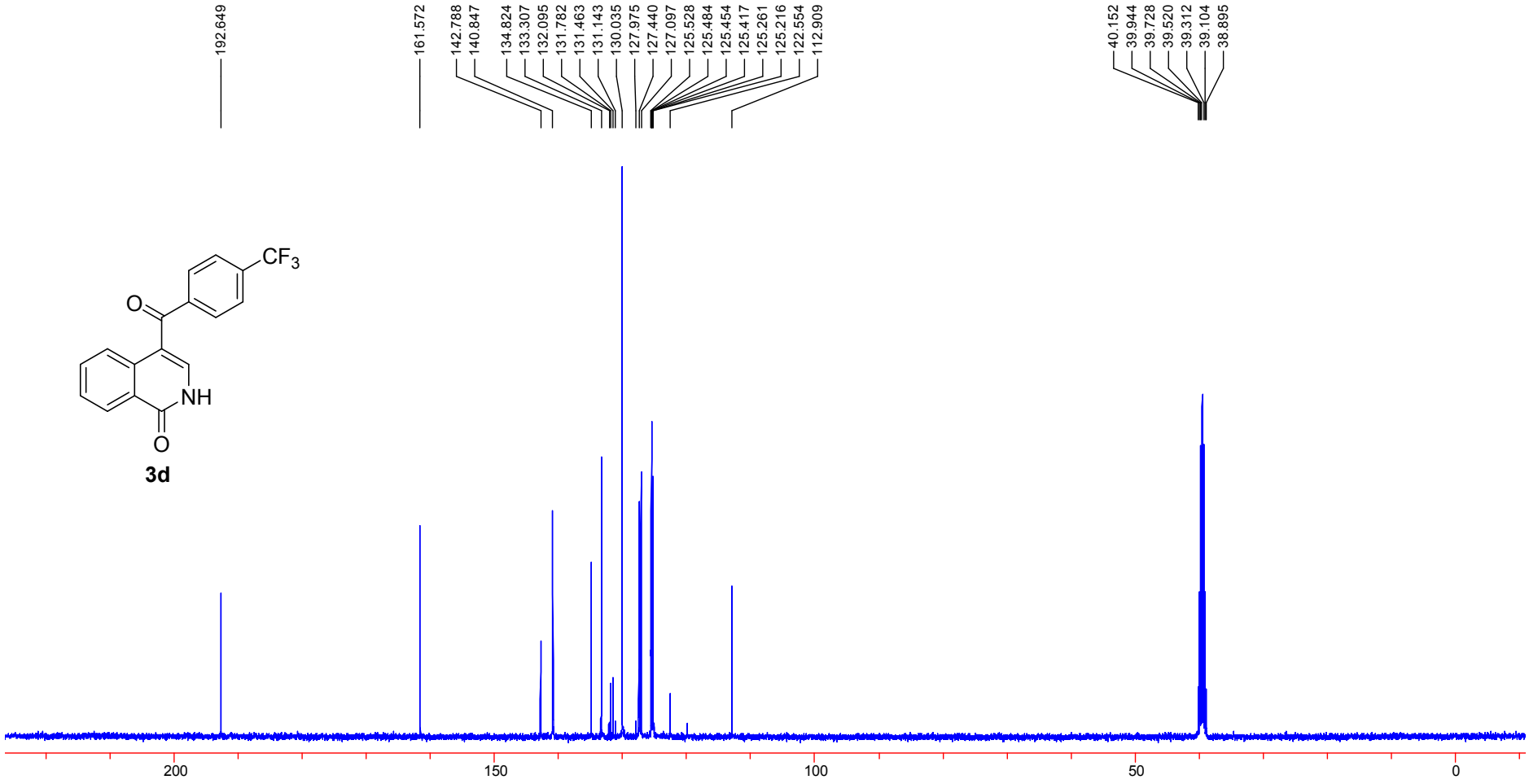

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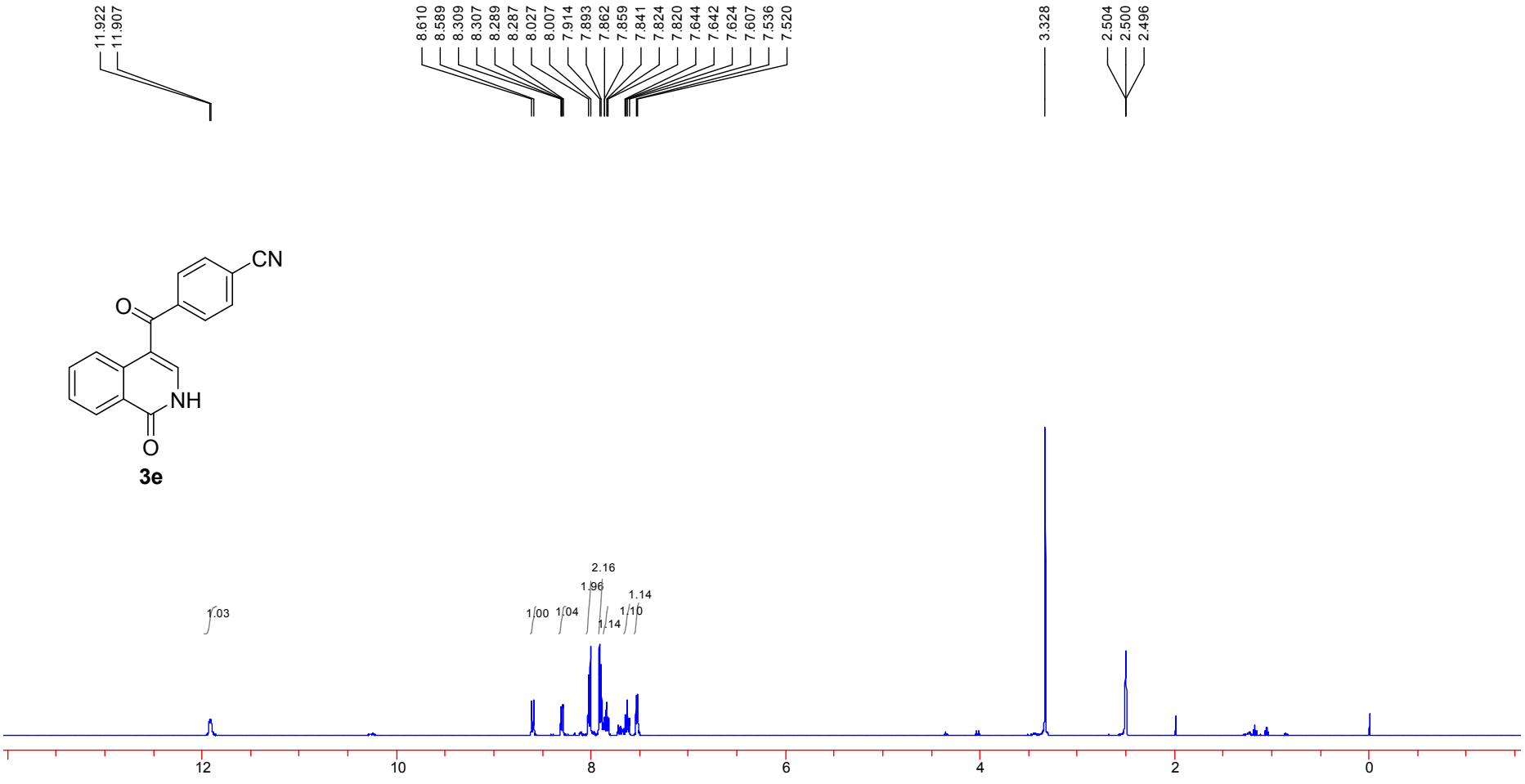

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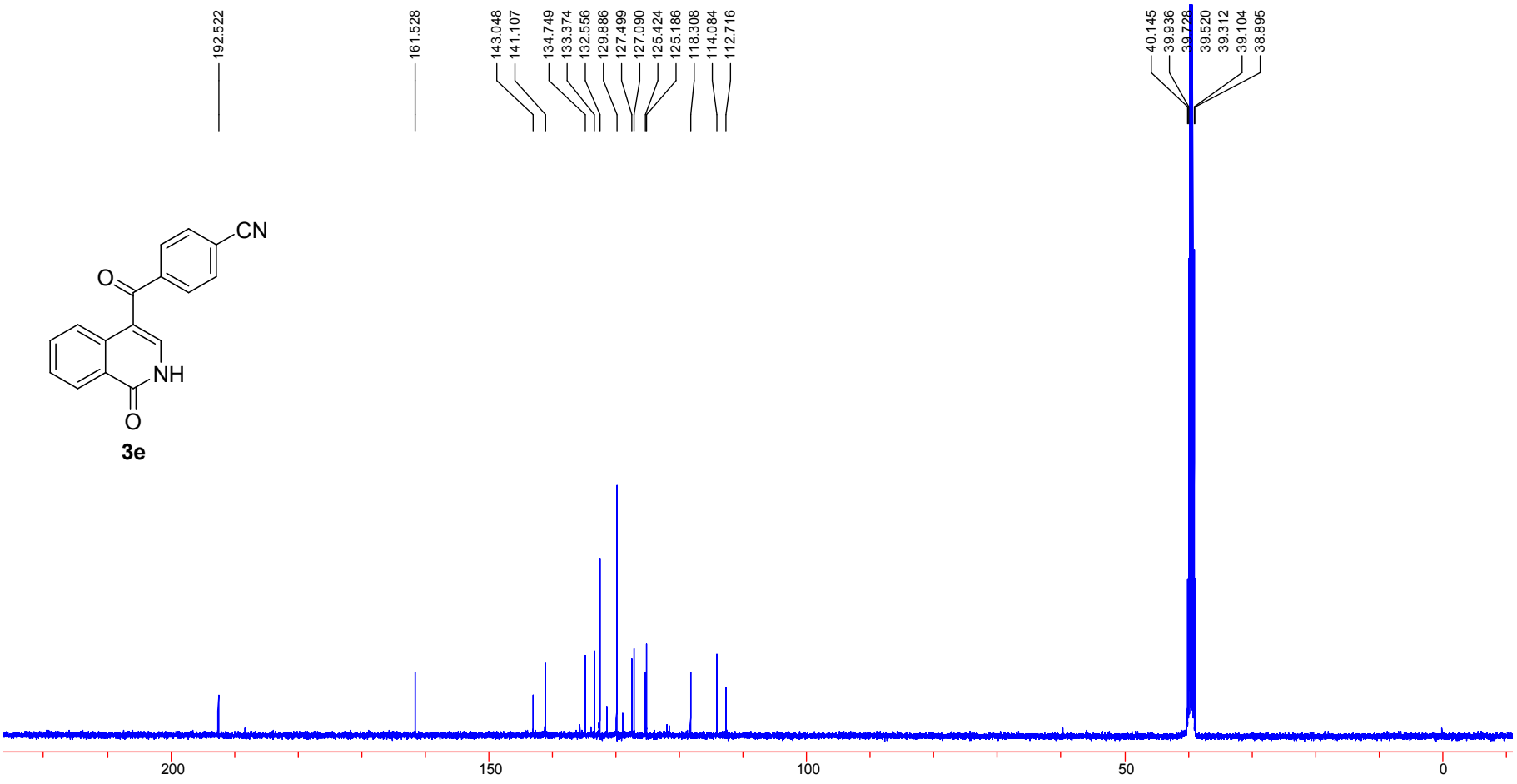

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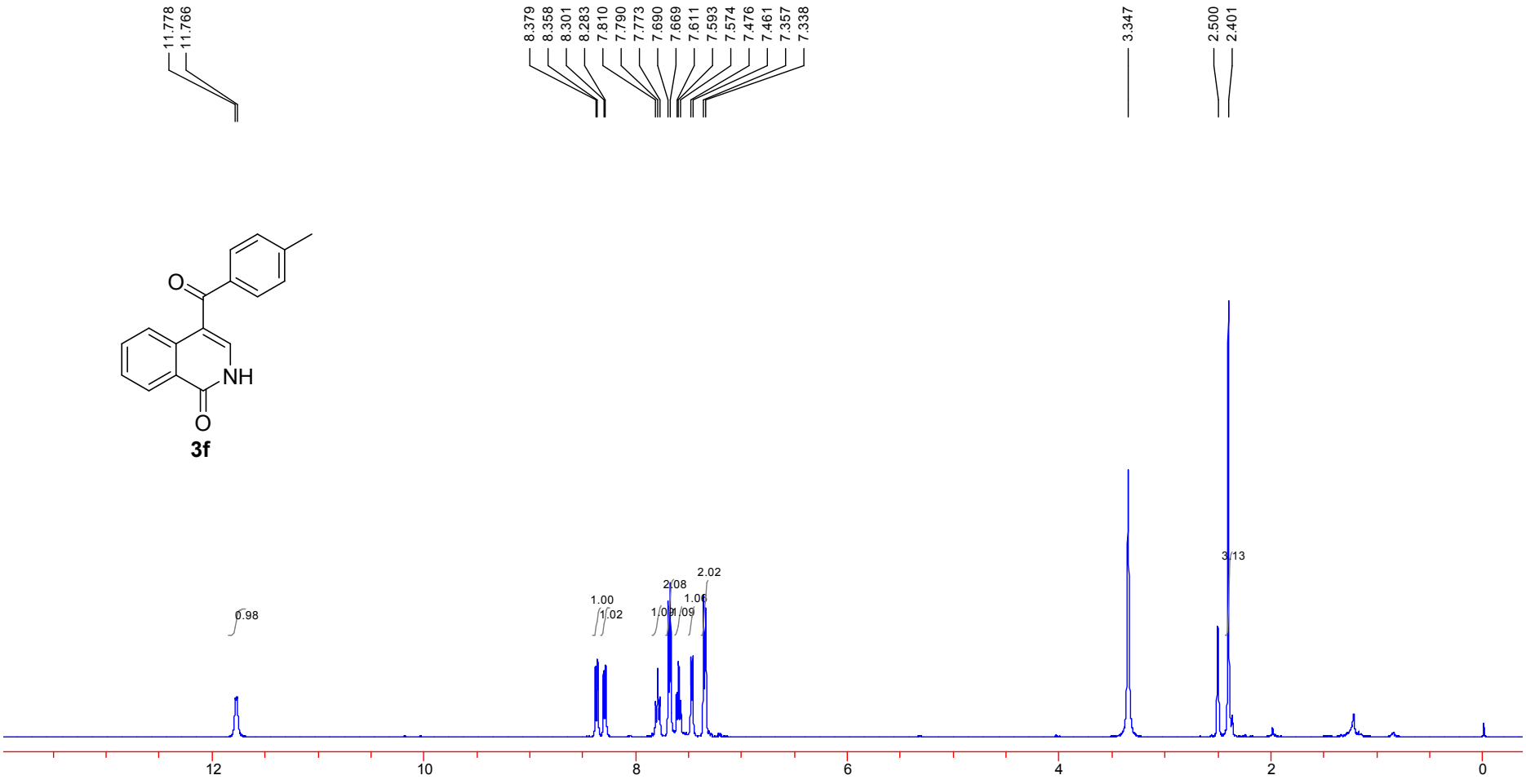

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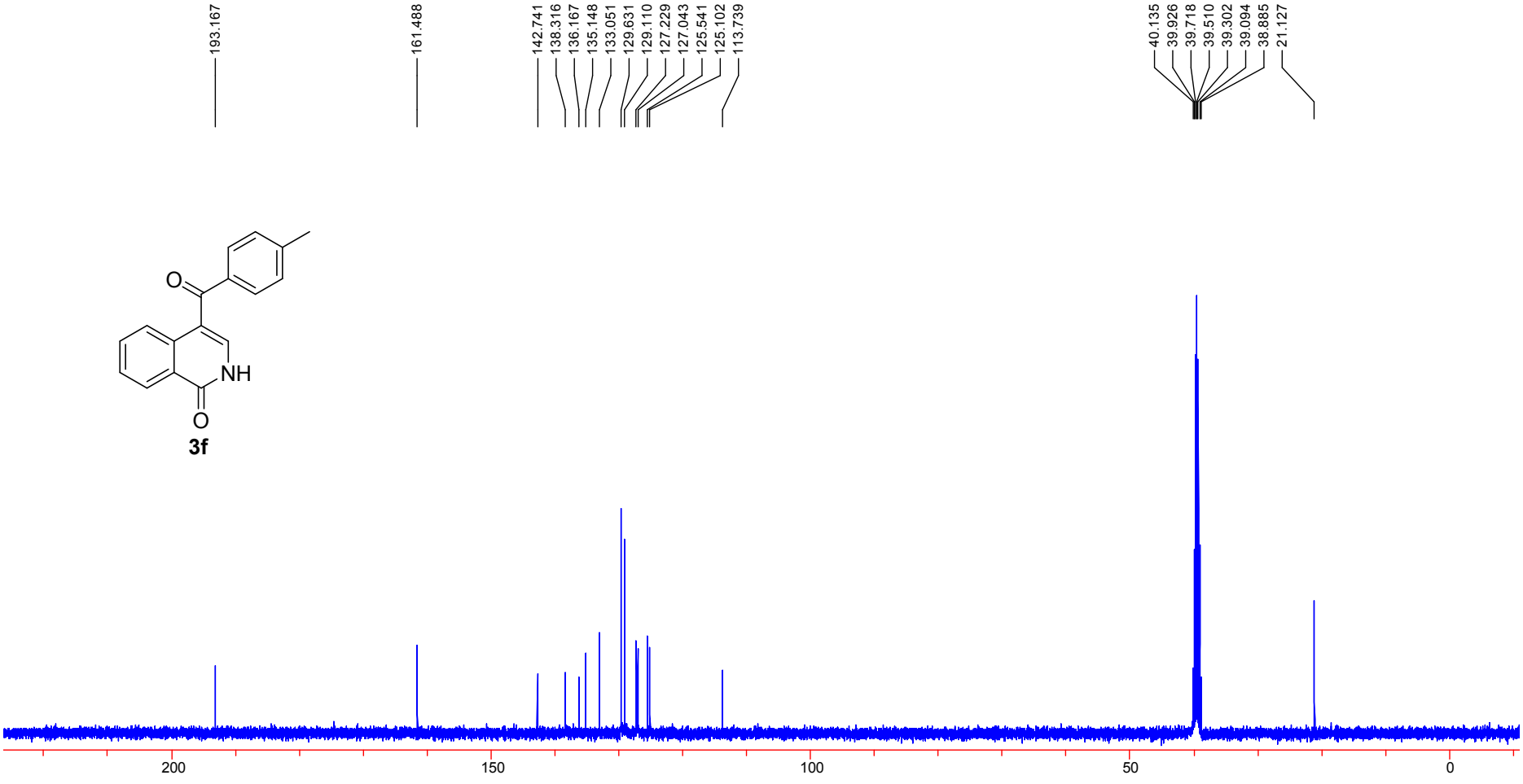

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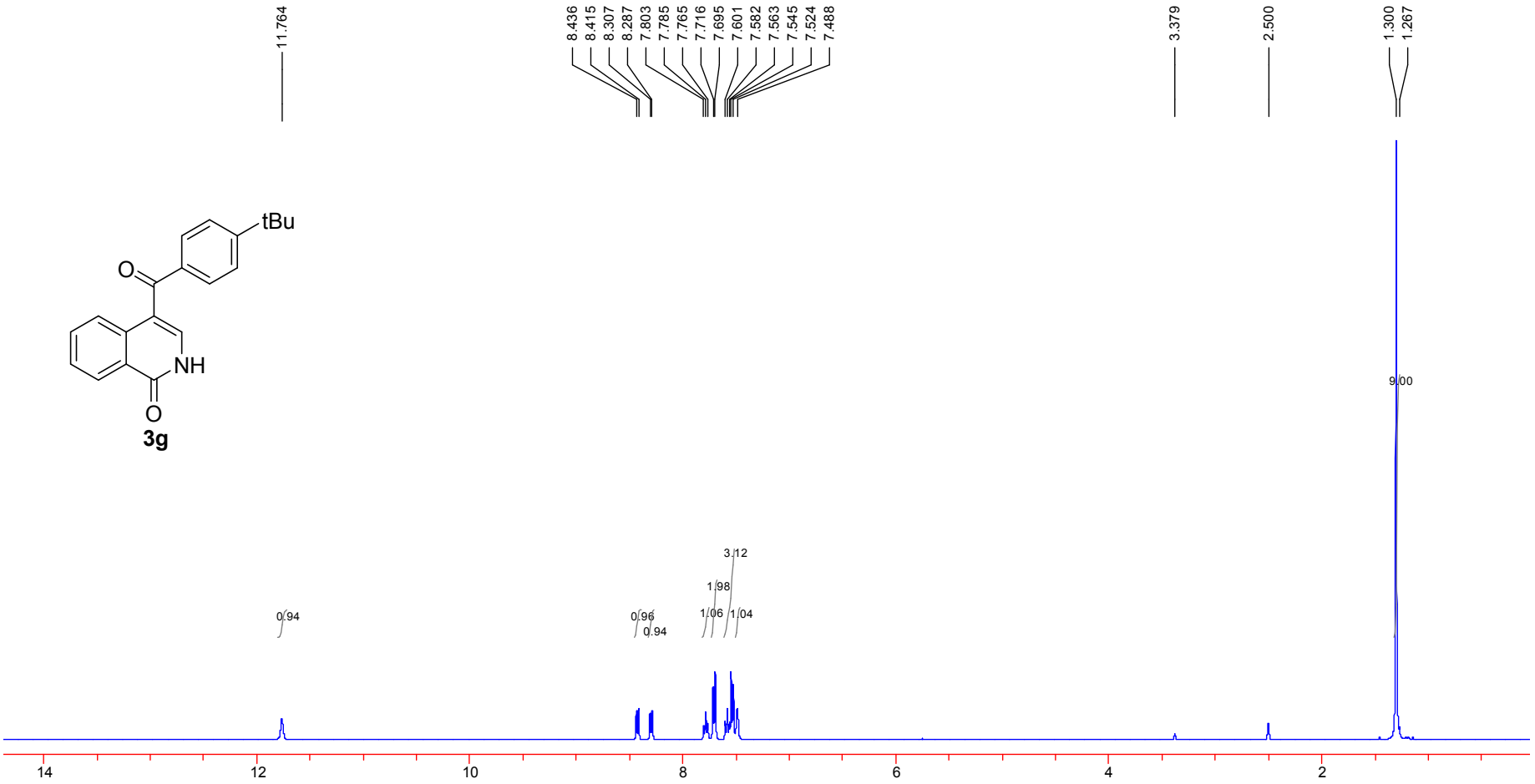
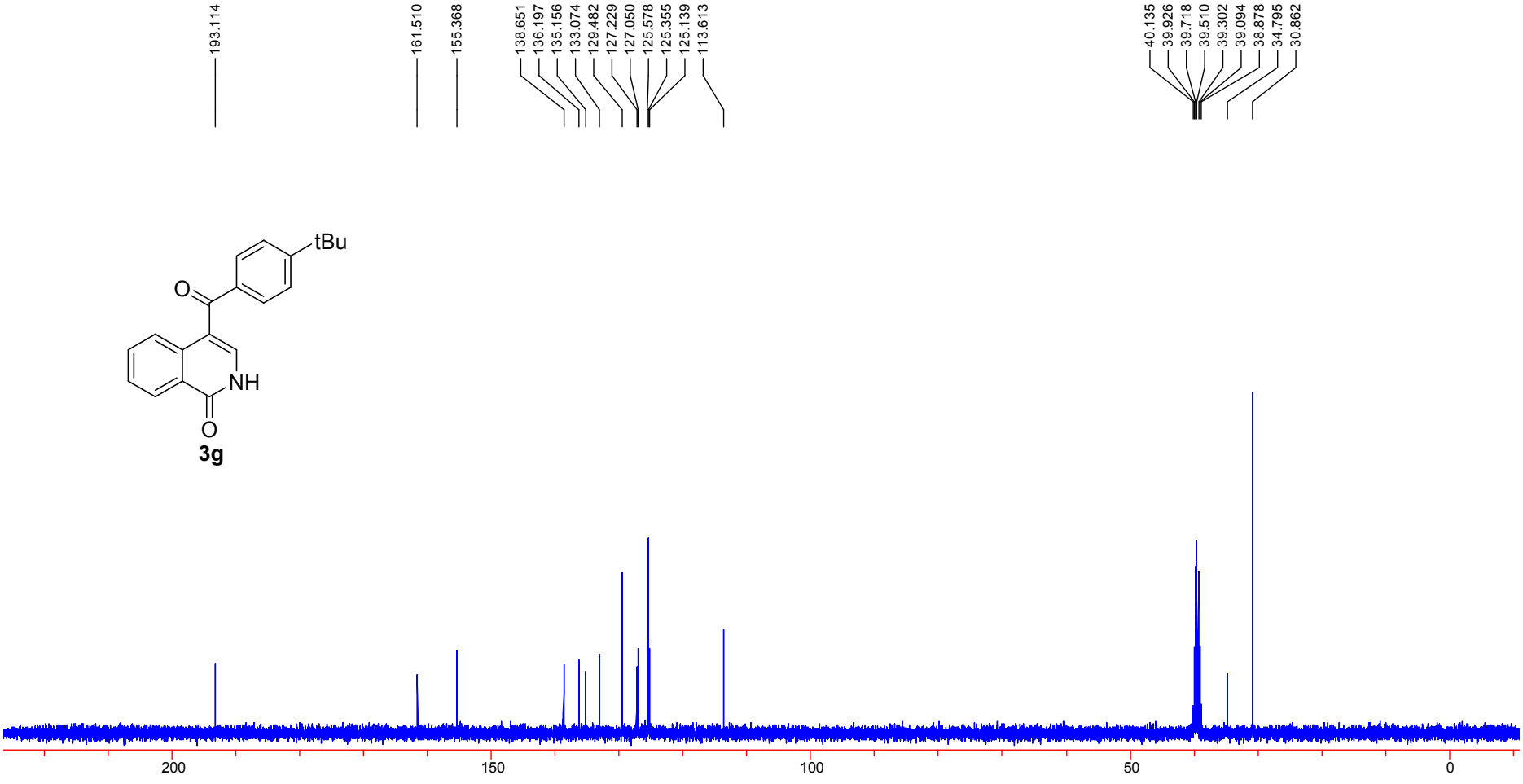


^{13}C NMR (100 MHz, DMSO-d_6)



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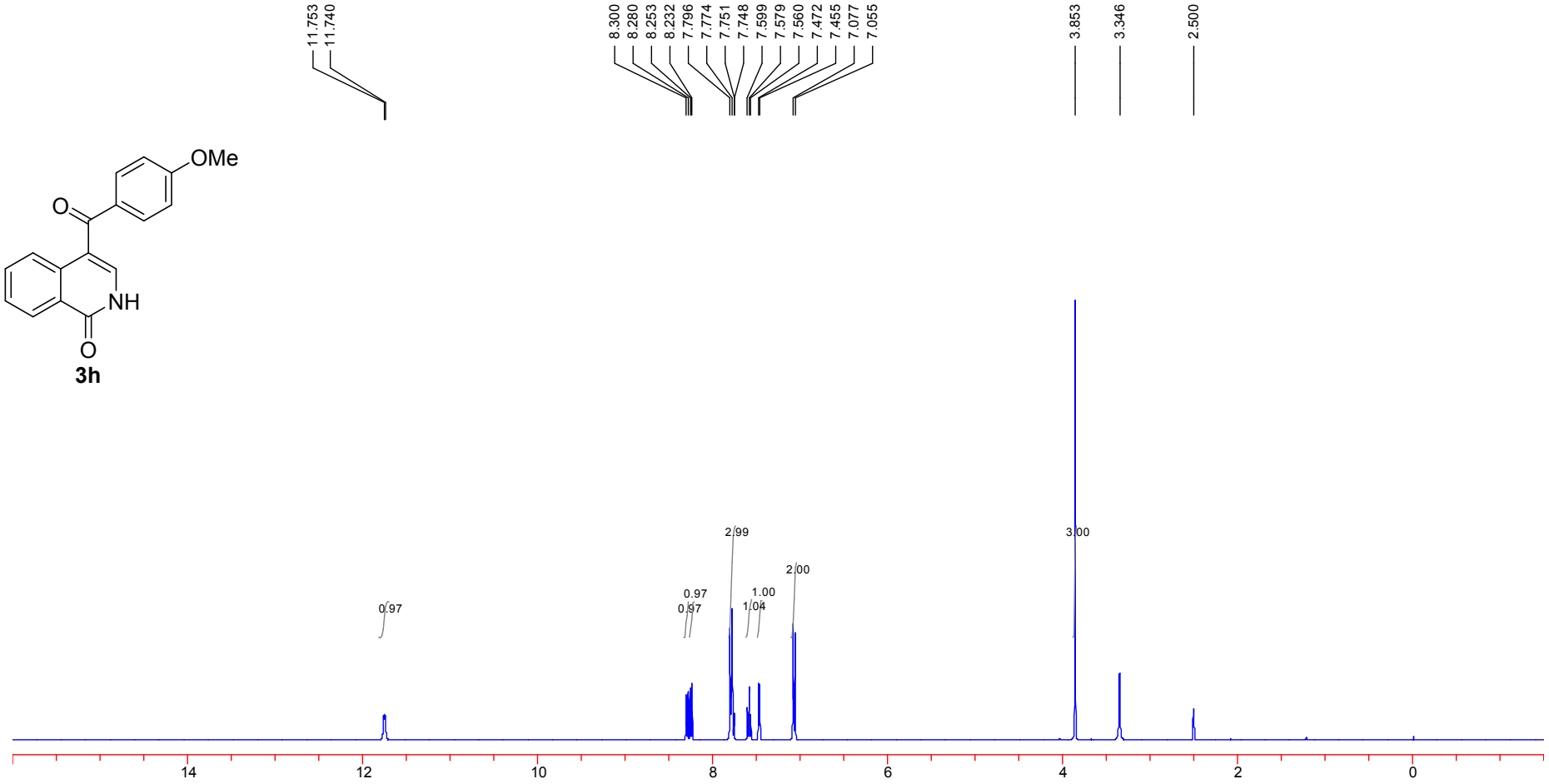

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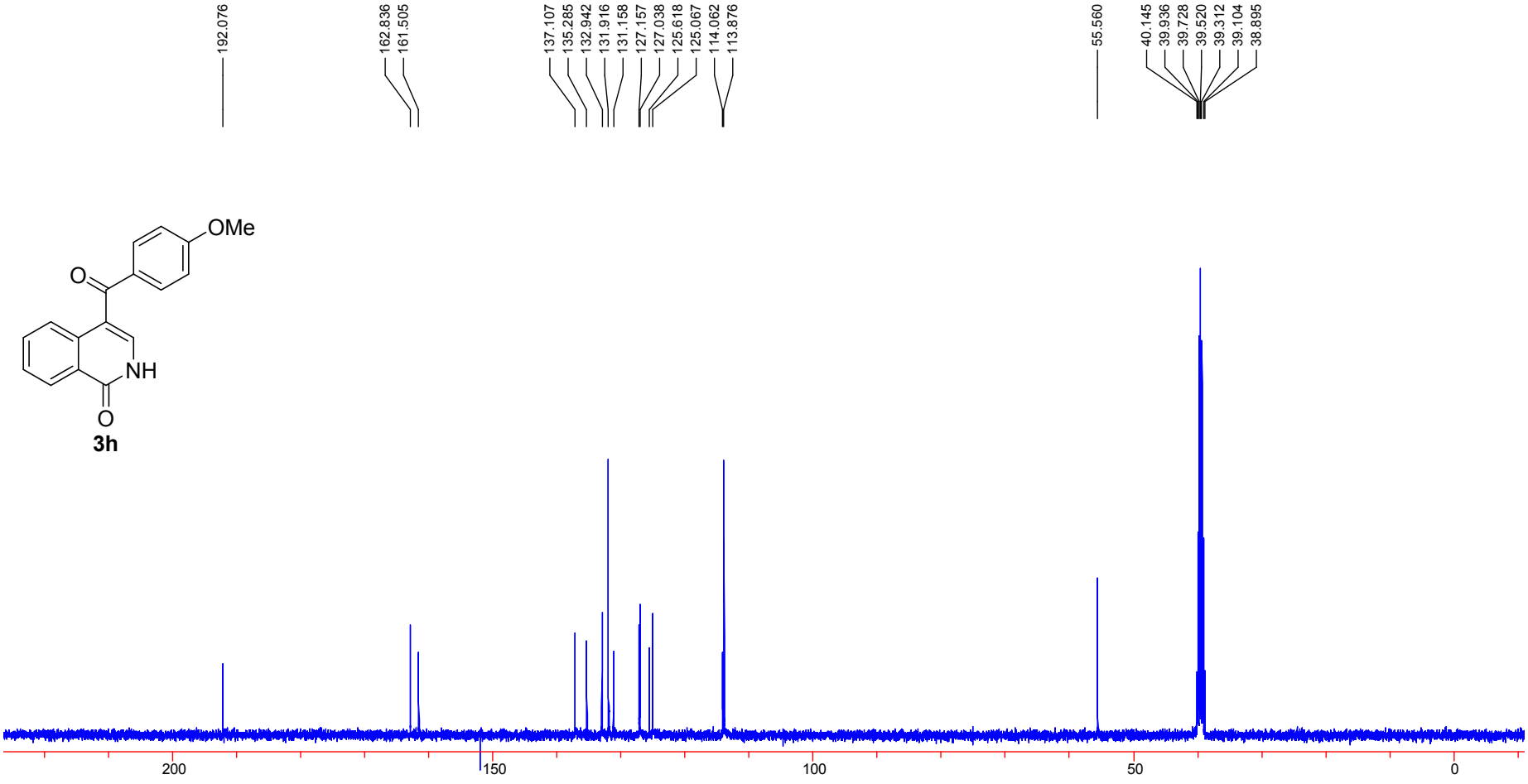

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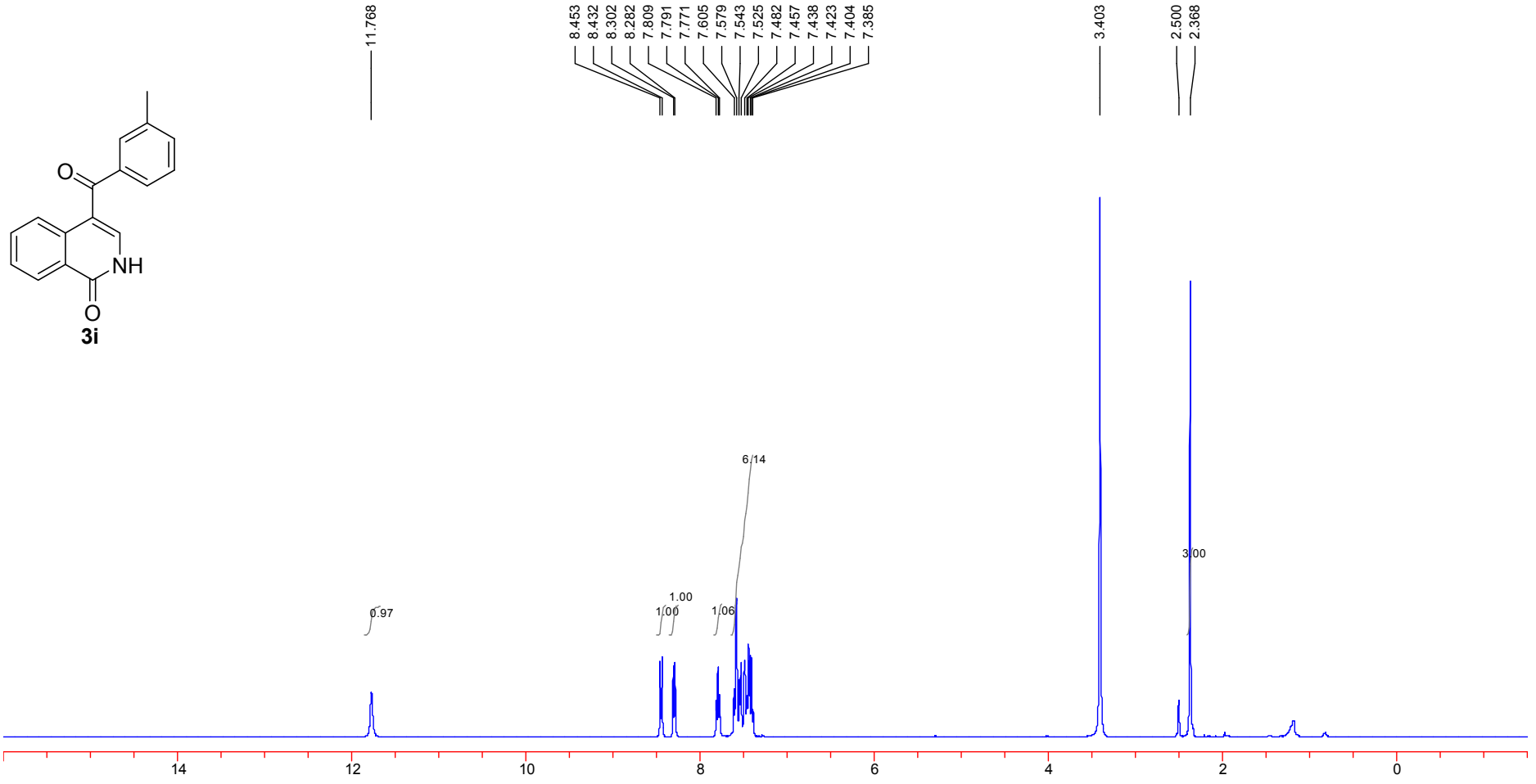

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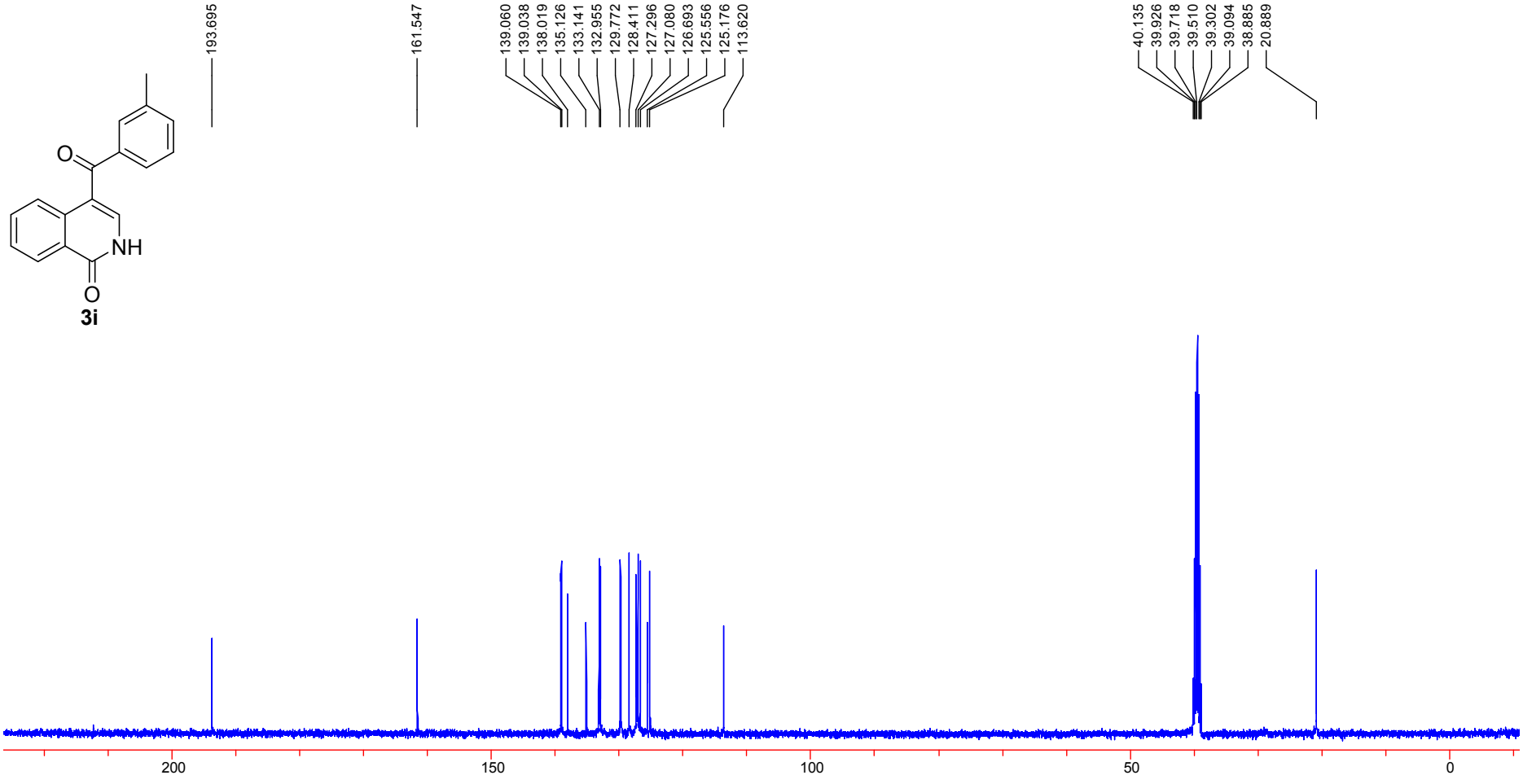

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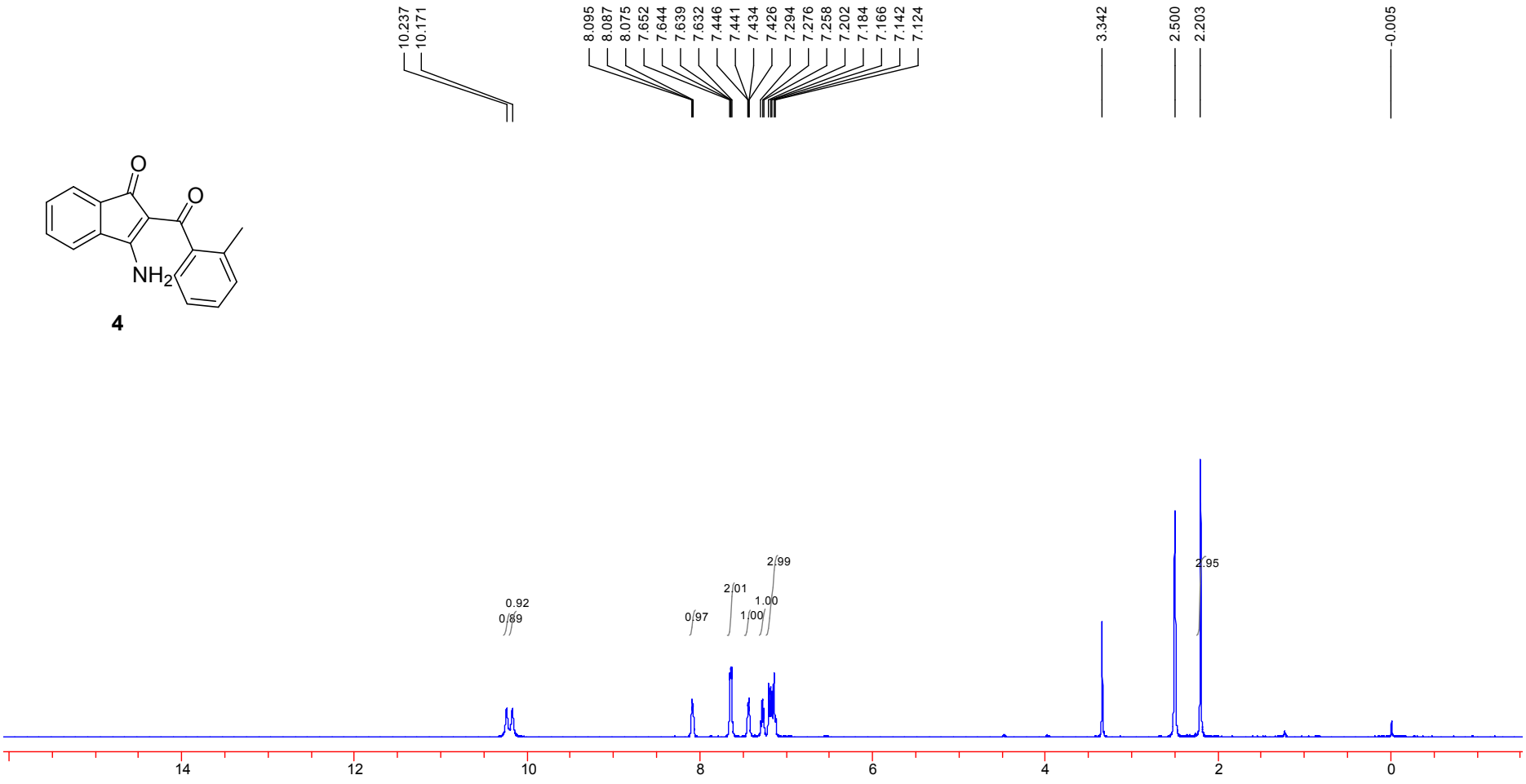
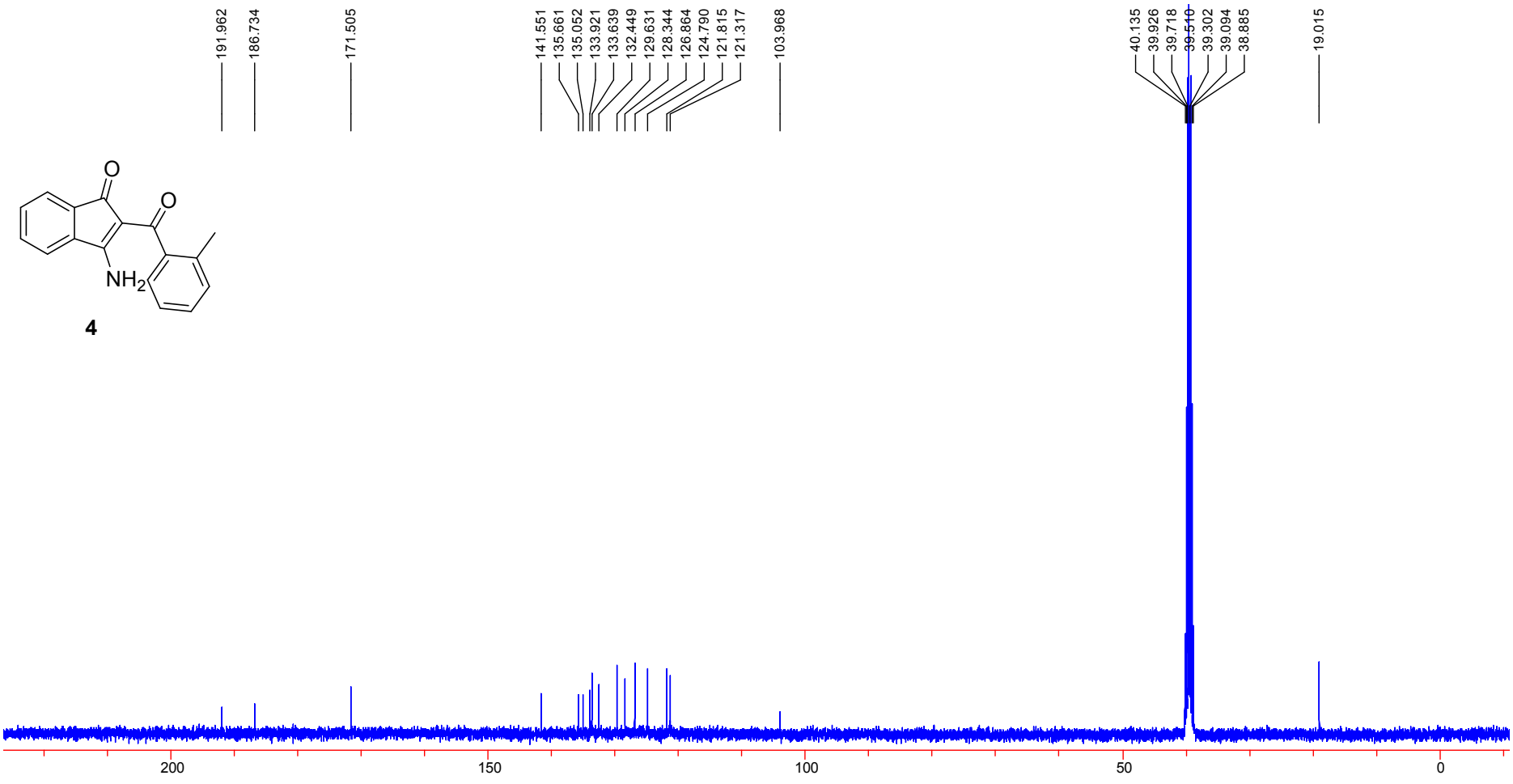
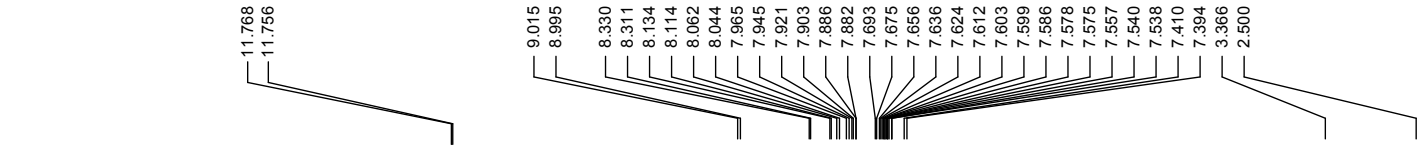


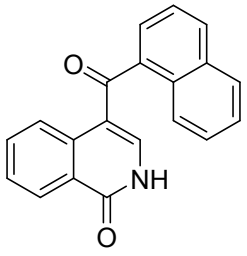
^{13}C NMR (100 MHz, DMSO-d_6)



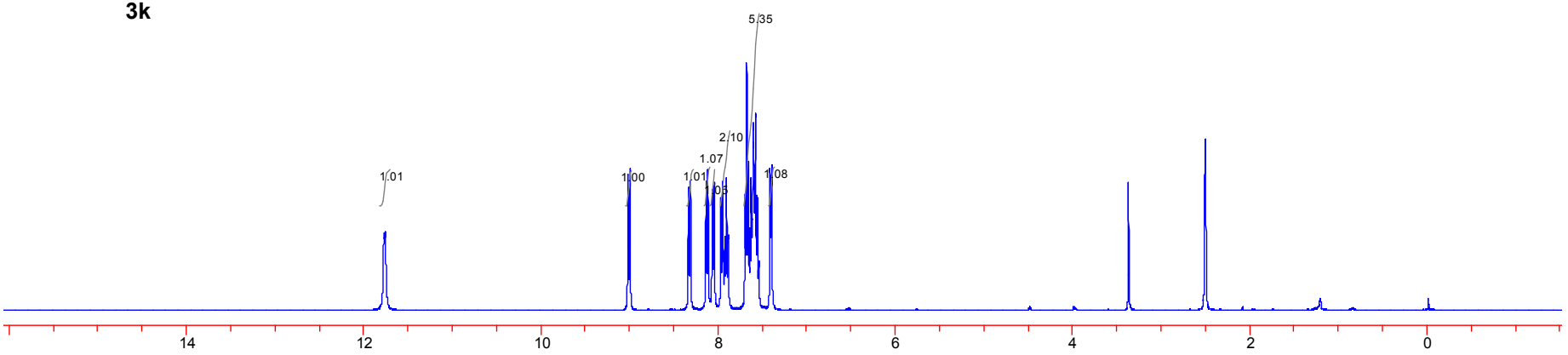
4

^{1}H NMR (400 MHz, DMSO-d_6)

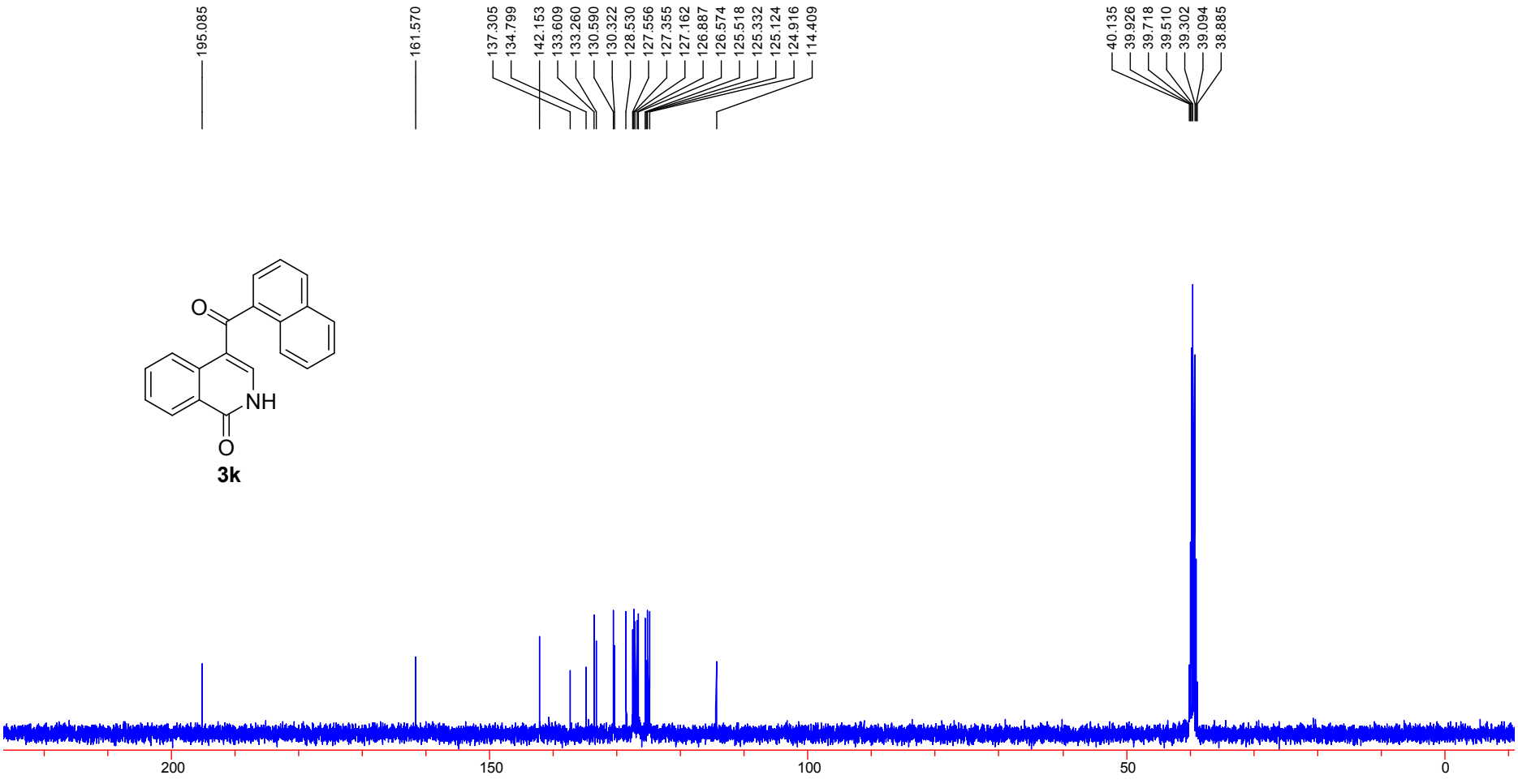




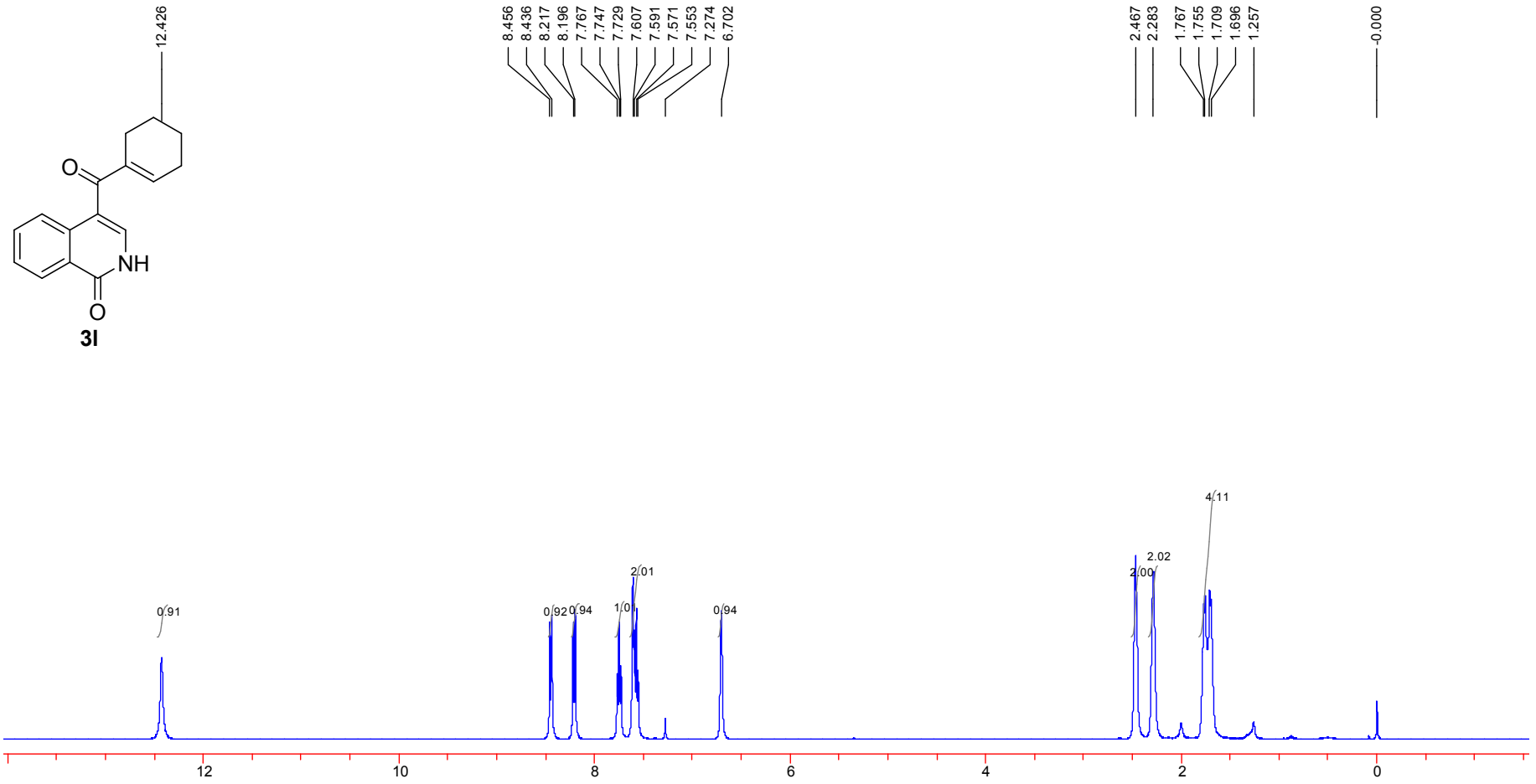
3k



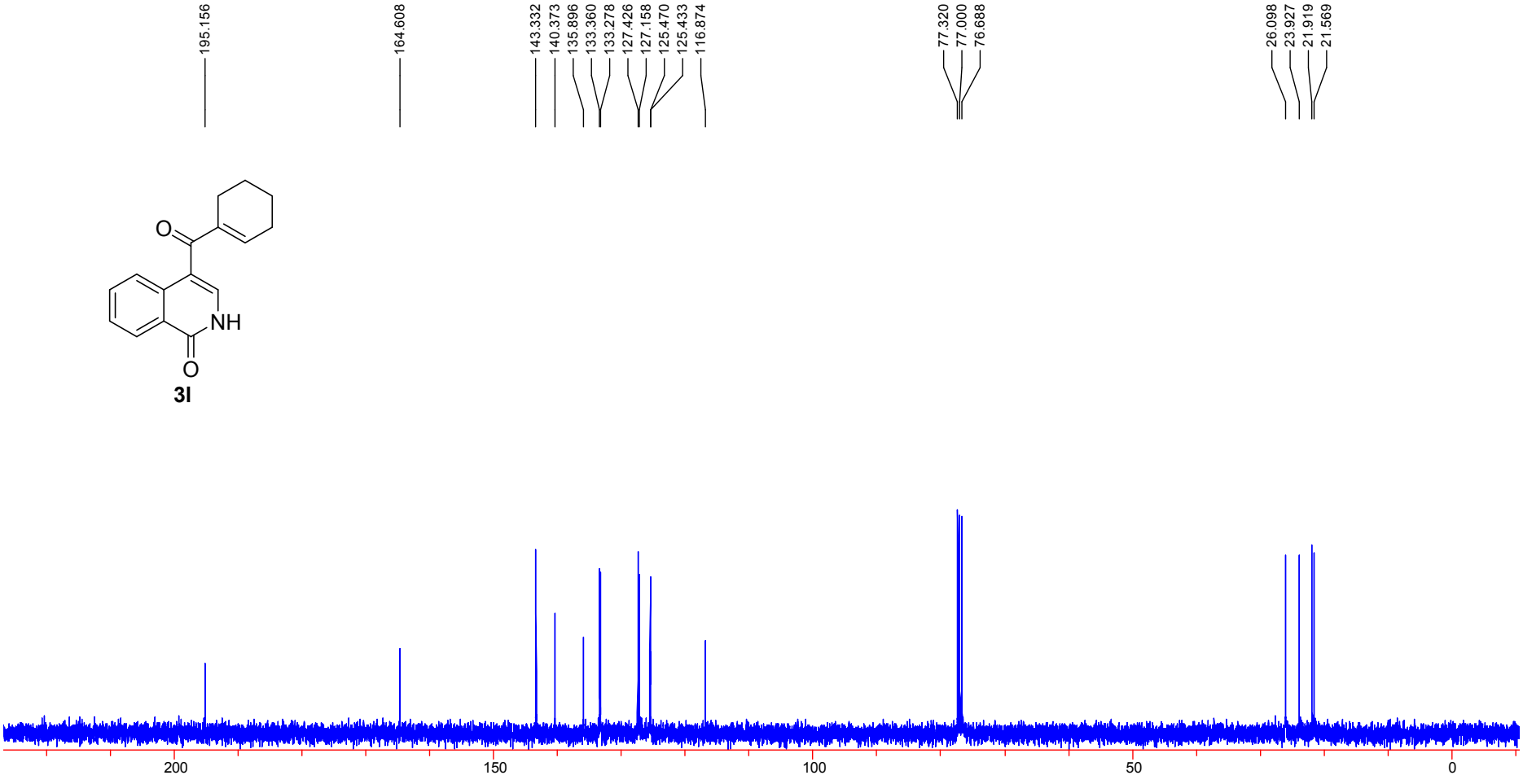
^{13}C NMR (100MHz, DMSO-d_6)



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



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



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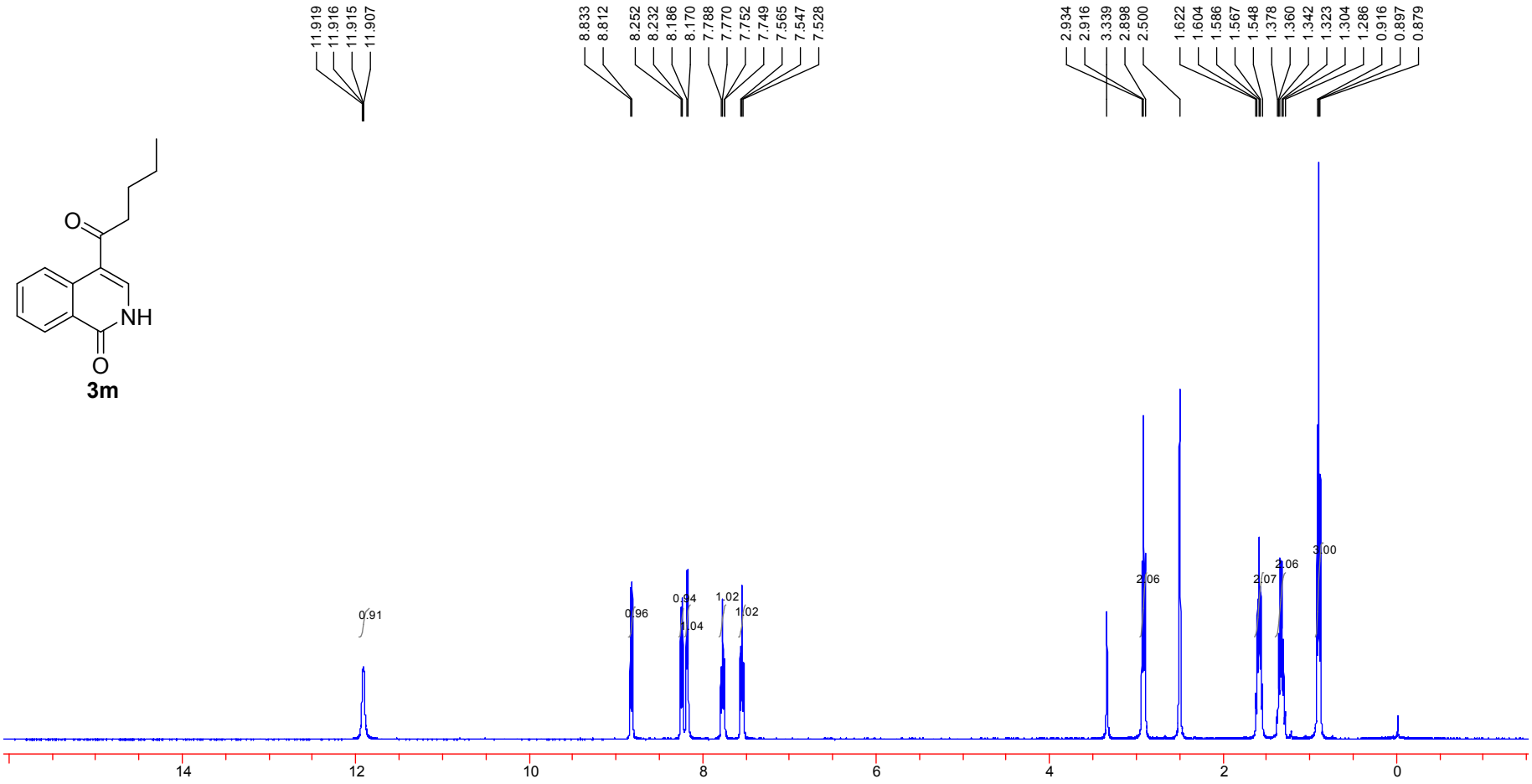
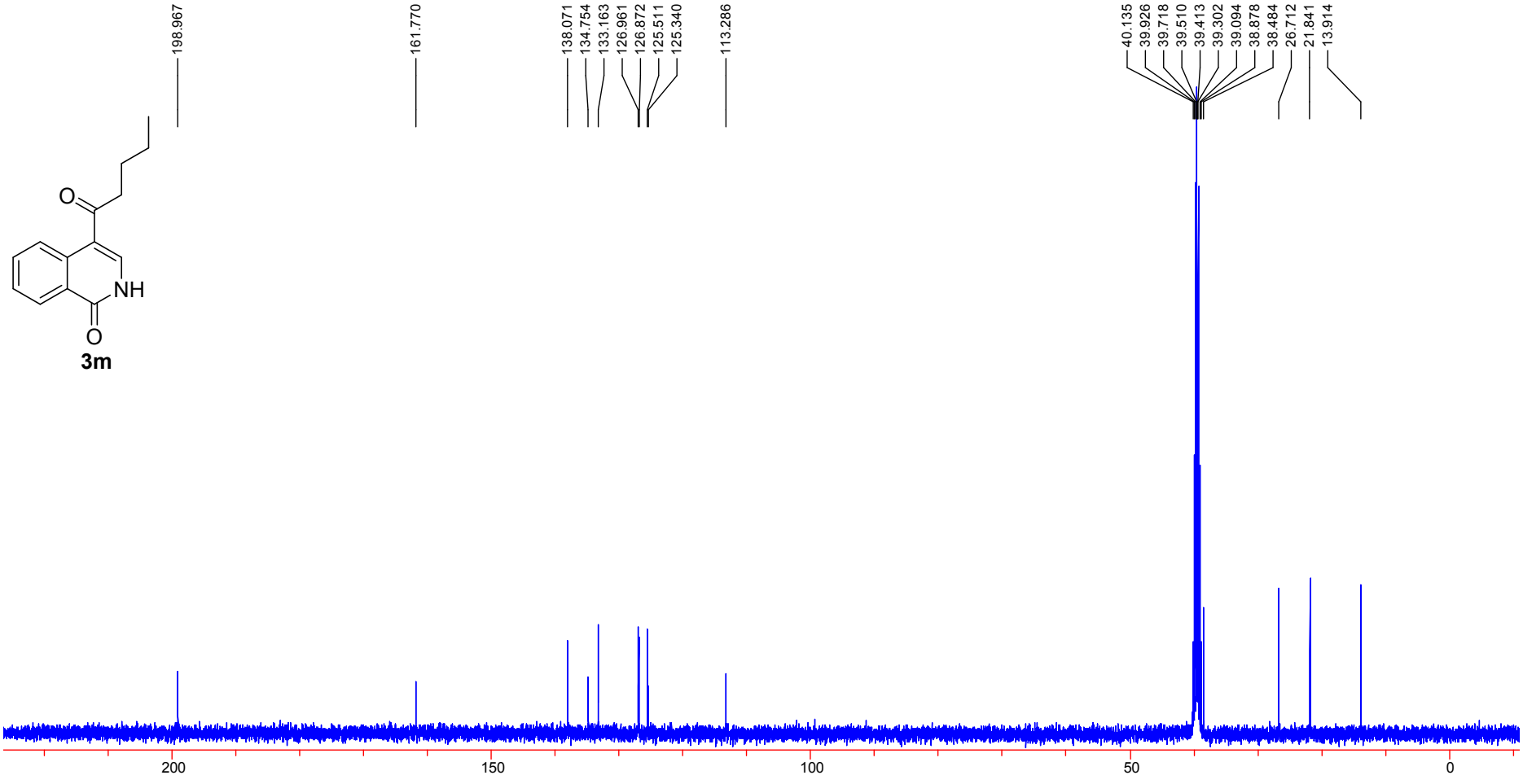
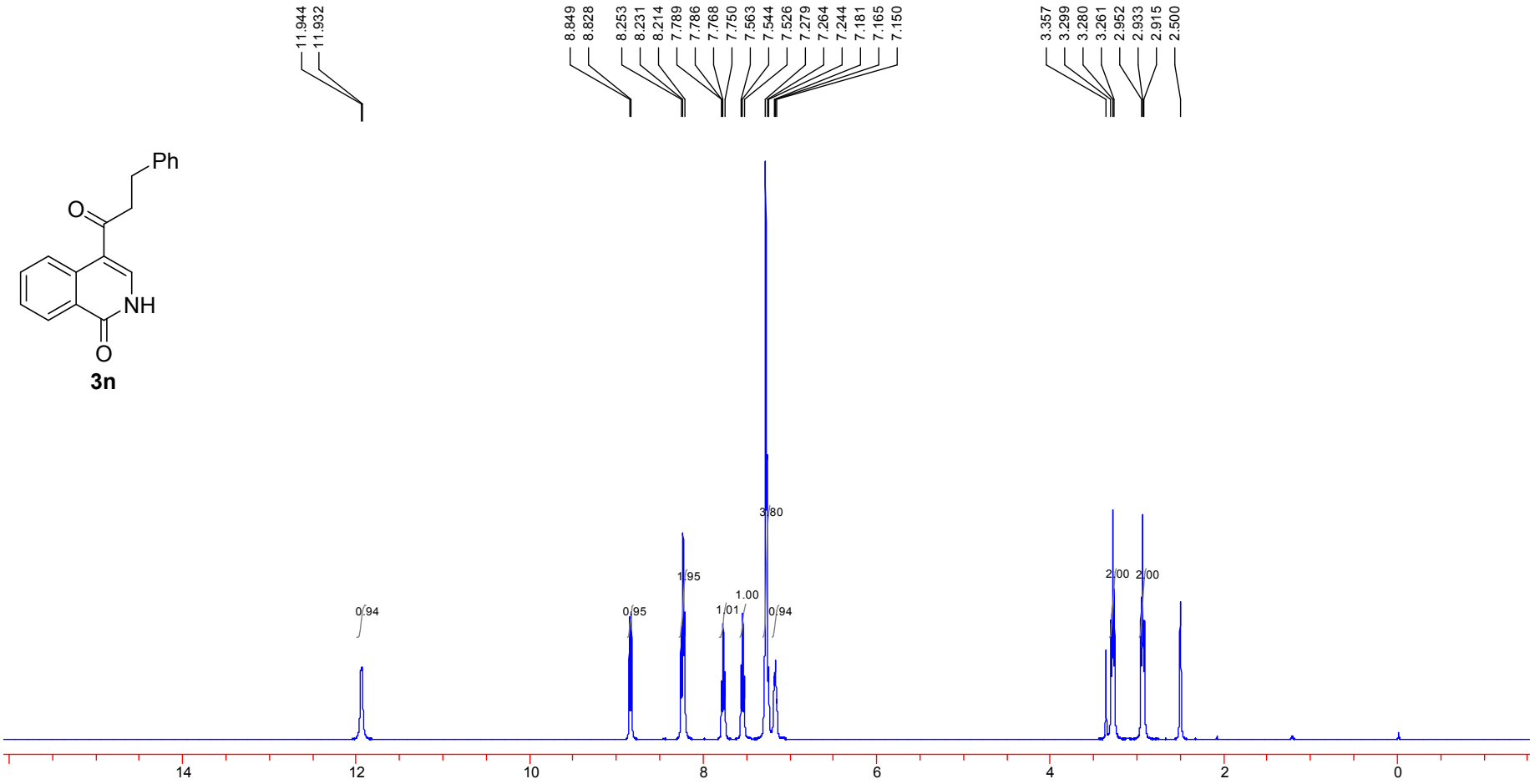
^{1}H NMR (400 MHz, DMSO-d_6)



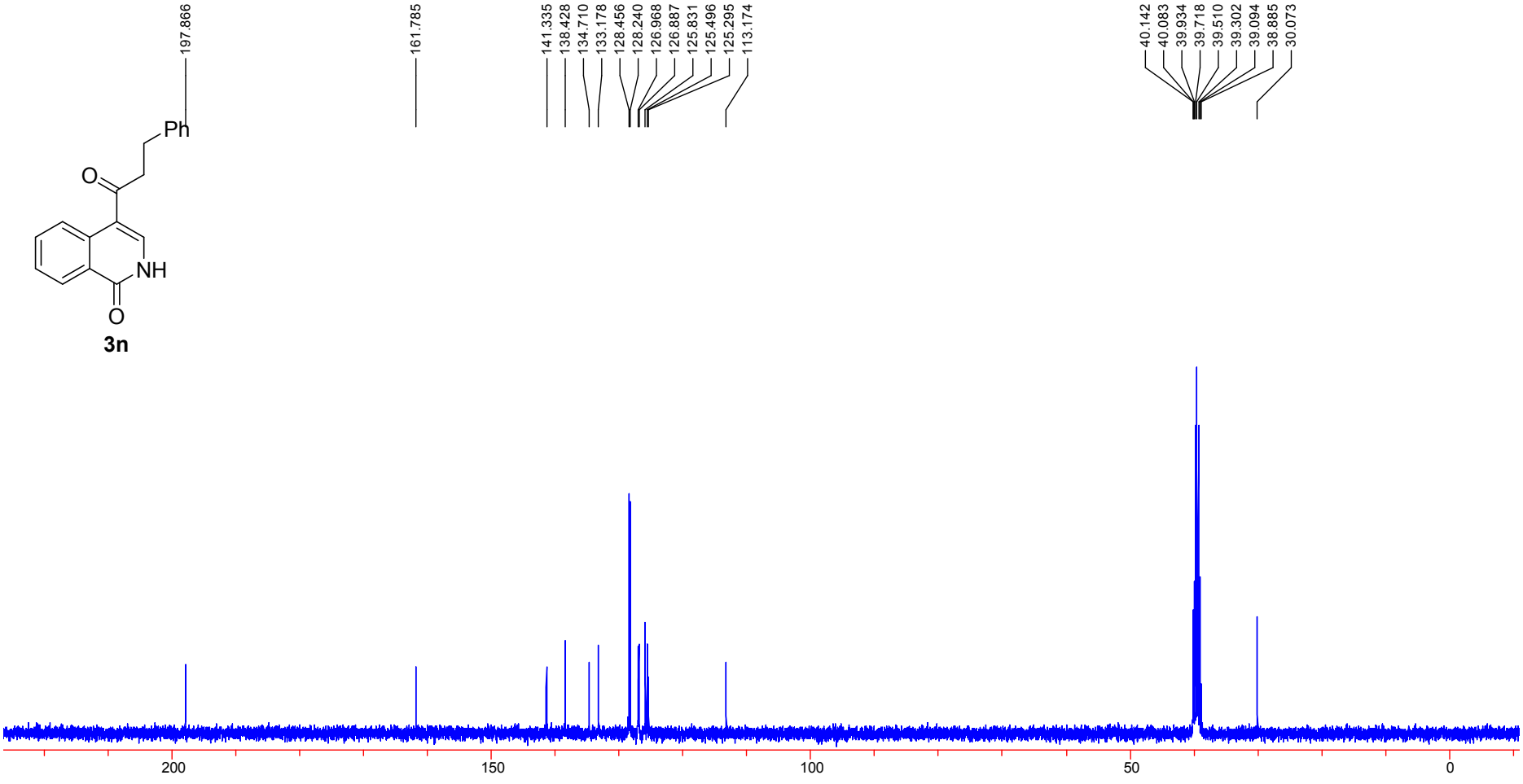
^{13}C NMR (100 MHz, DMSO-d_6)



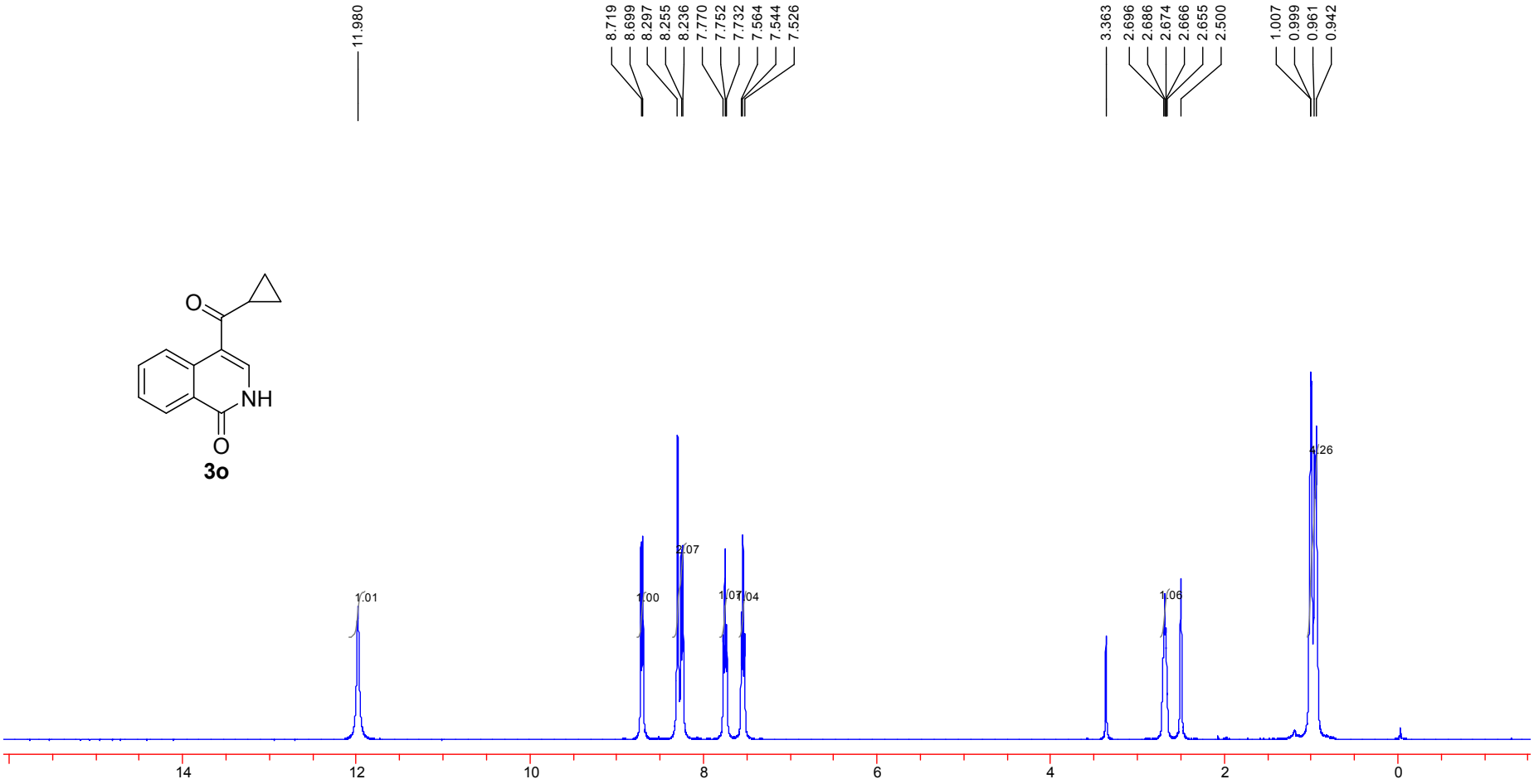
^{1}H NMR (400 MHz, DMSO-d_6)



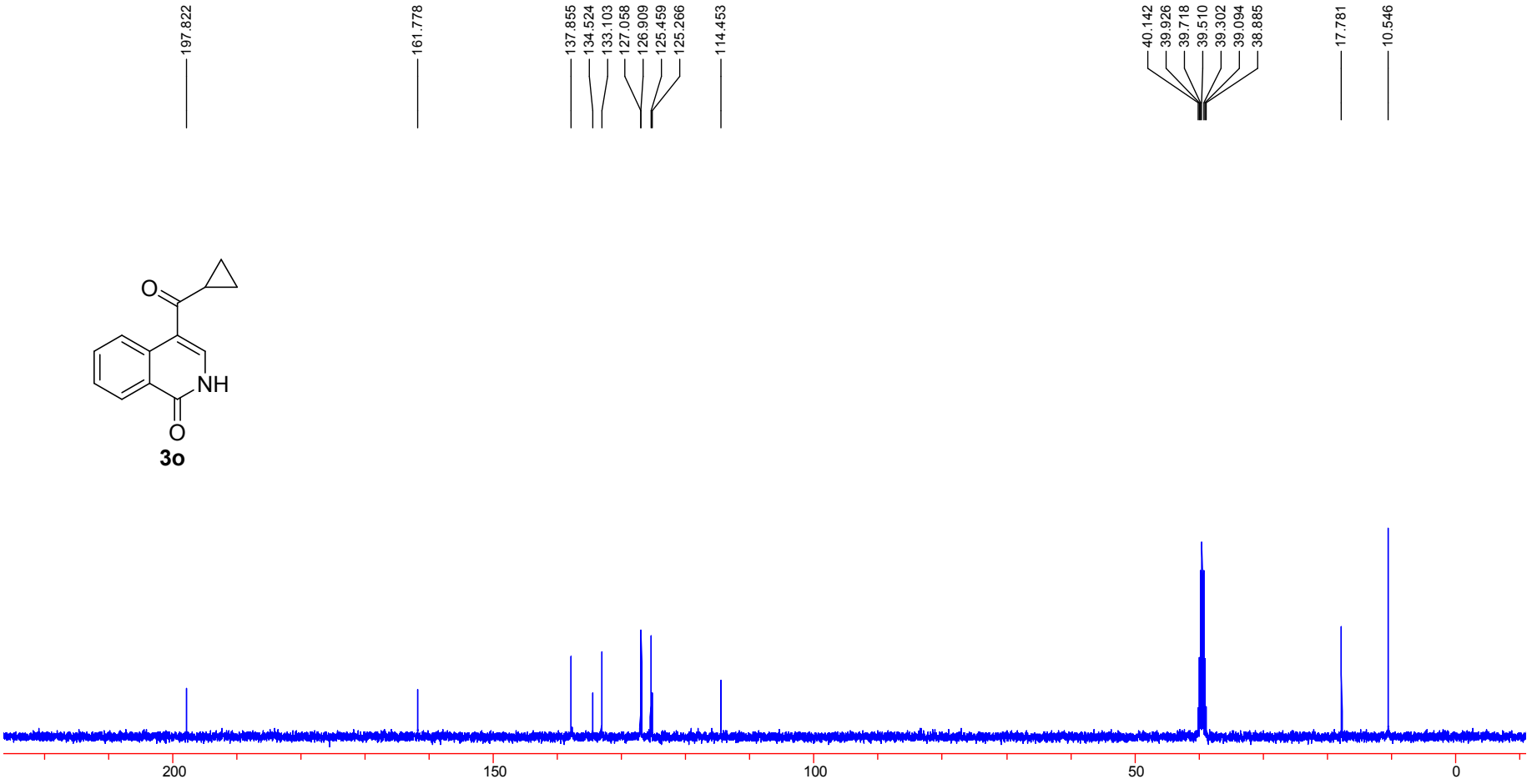
^{13}C NMR (100 MHz, DMSO-d_6)



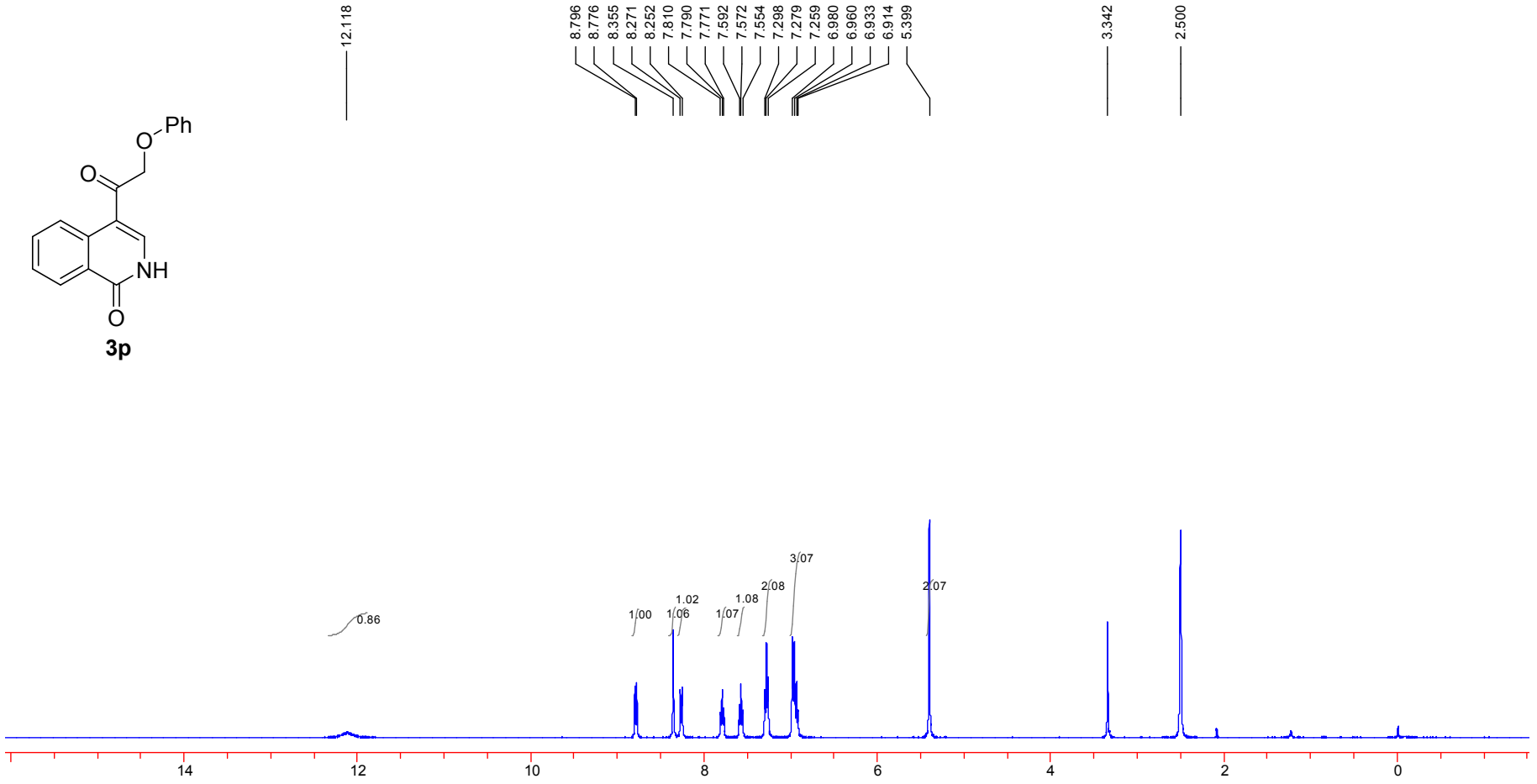
^{1}H NMR (400 MHz, DMSO-d_6)



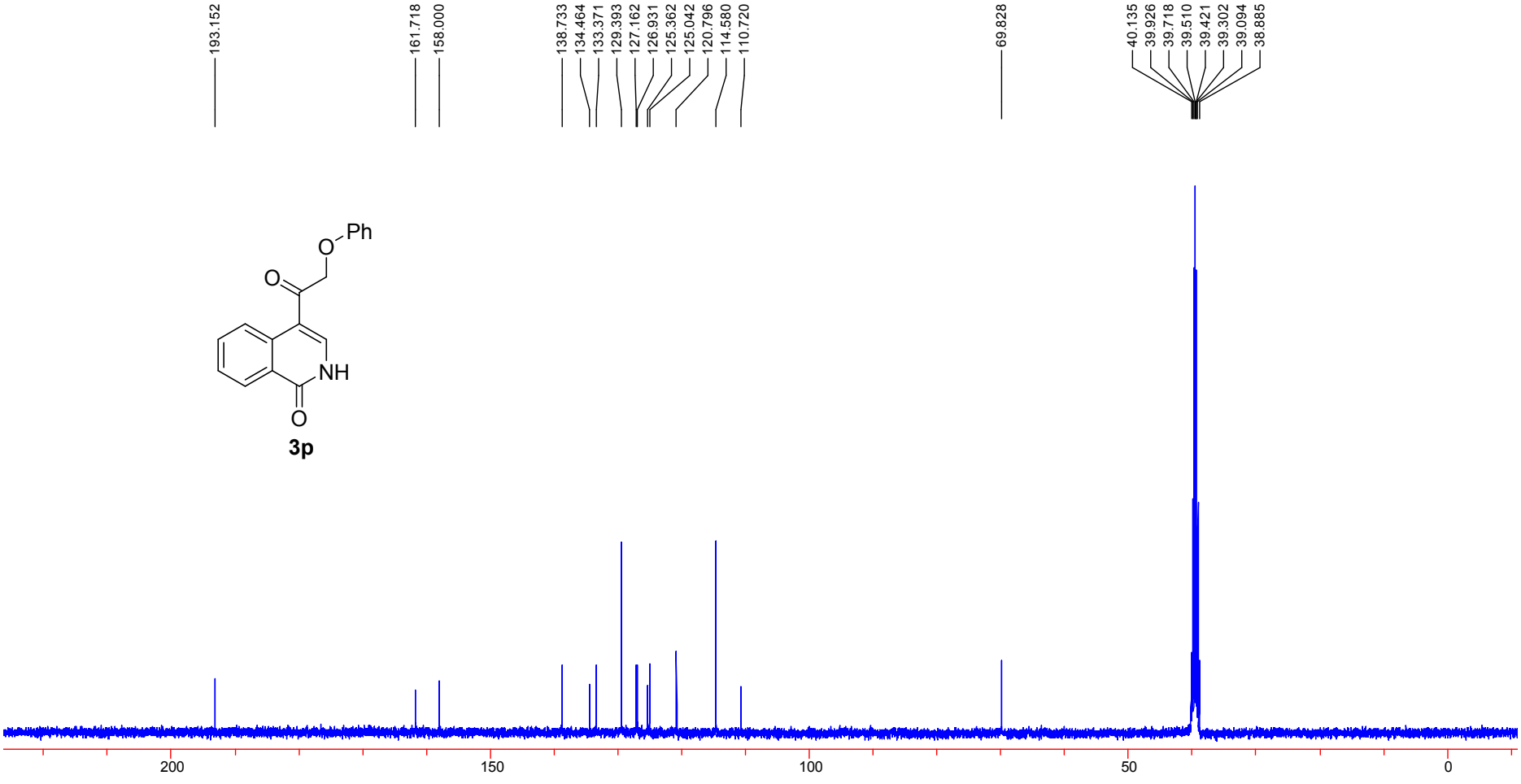
^{13}C NMR (100 MHz, DMSO-d_6)



^{1}H NMR (400 MHz, DMSO-d_6)

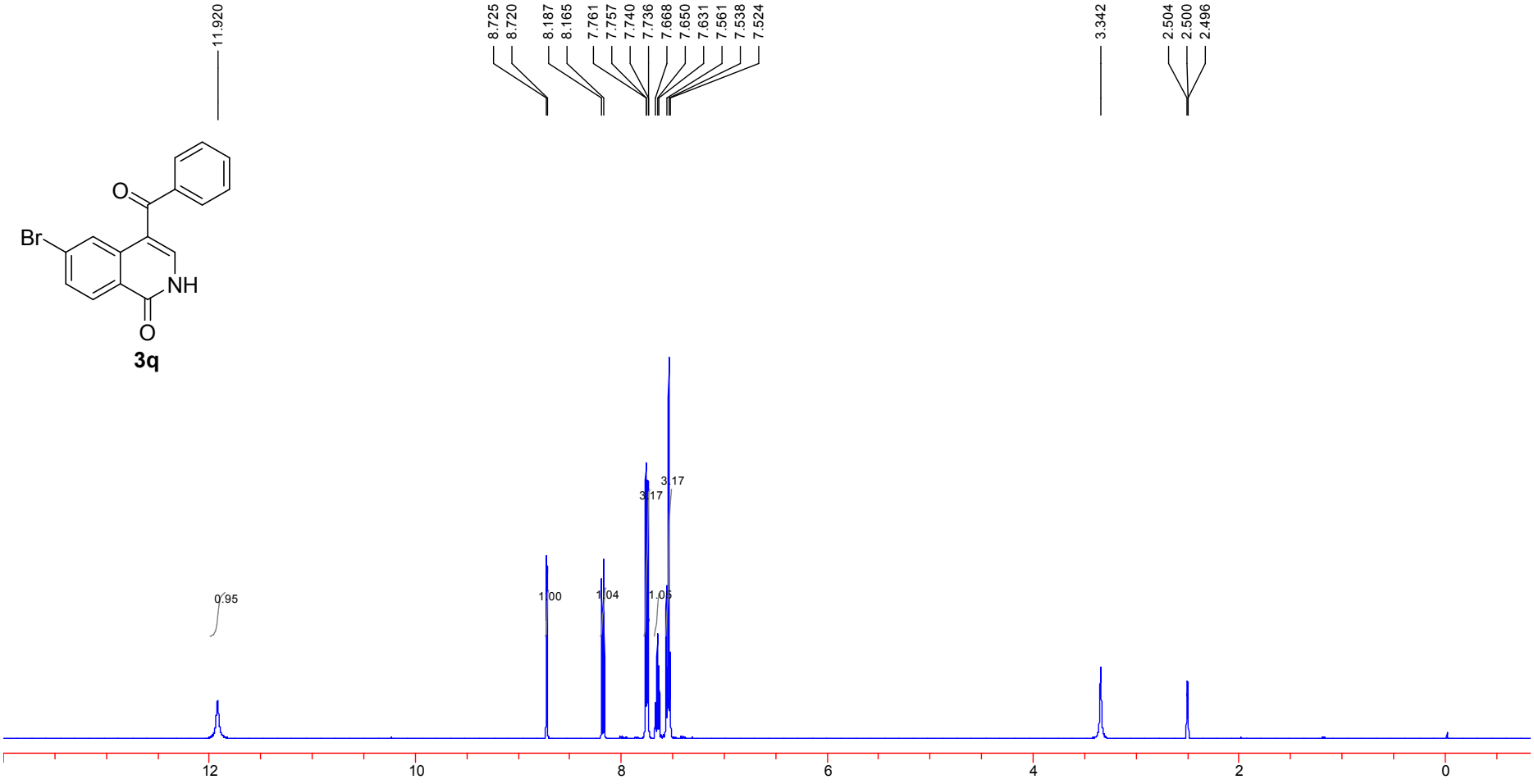


^{13}C NMR (100 MHz, DMSO-d_6)

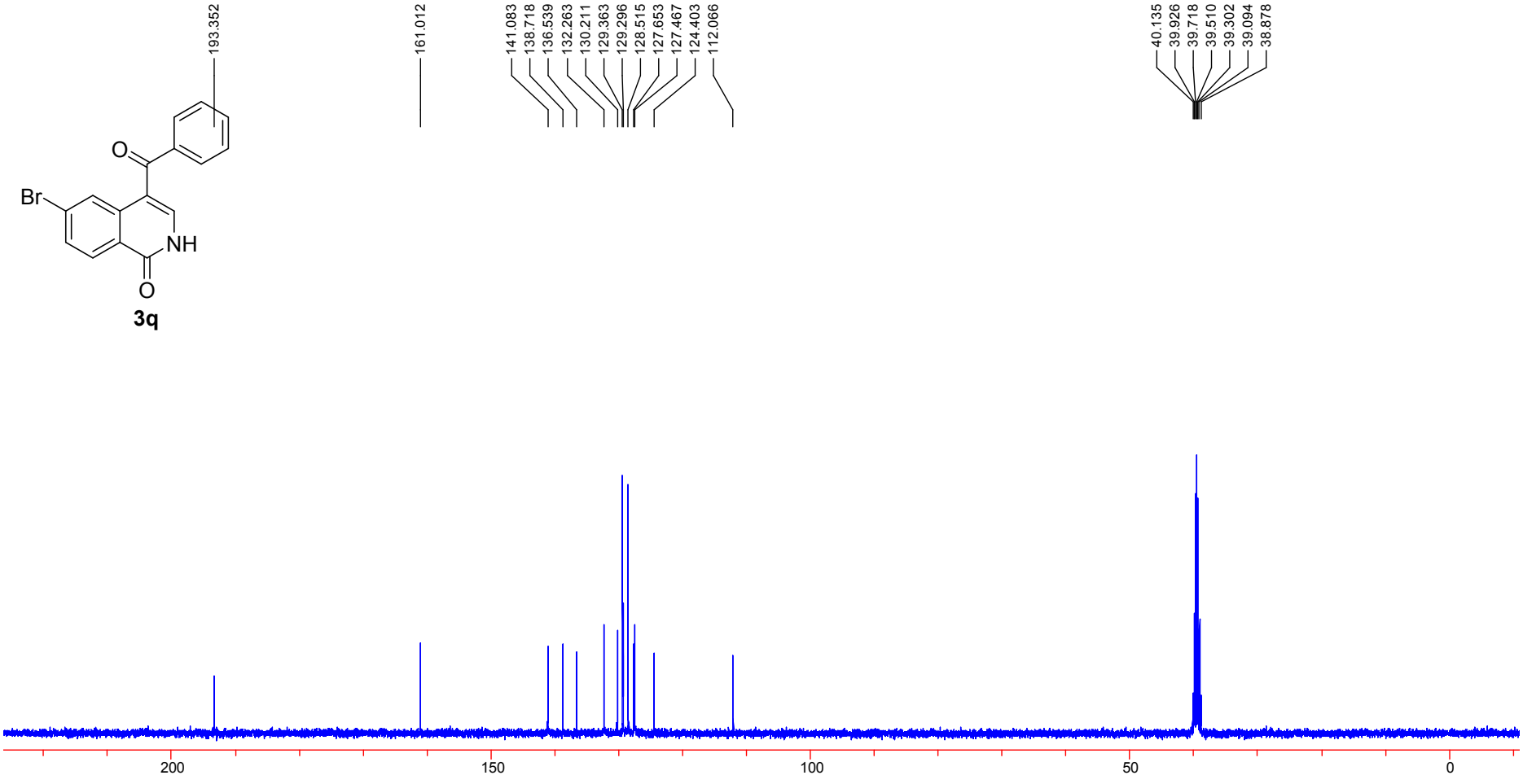


3p

^{1}H NMR (400 MHz, DMSO-d_6)

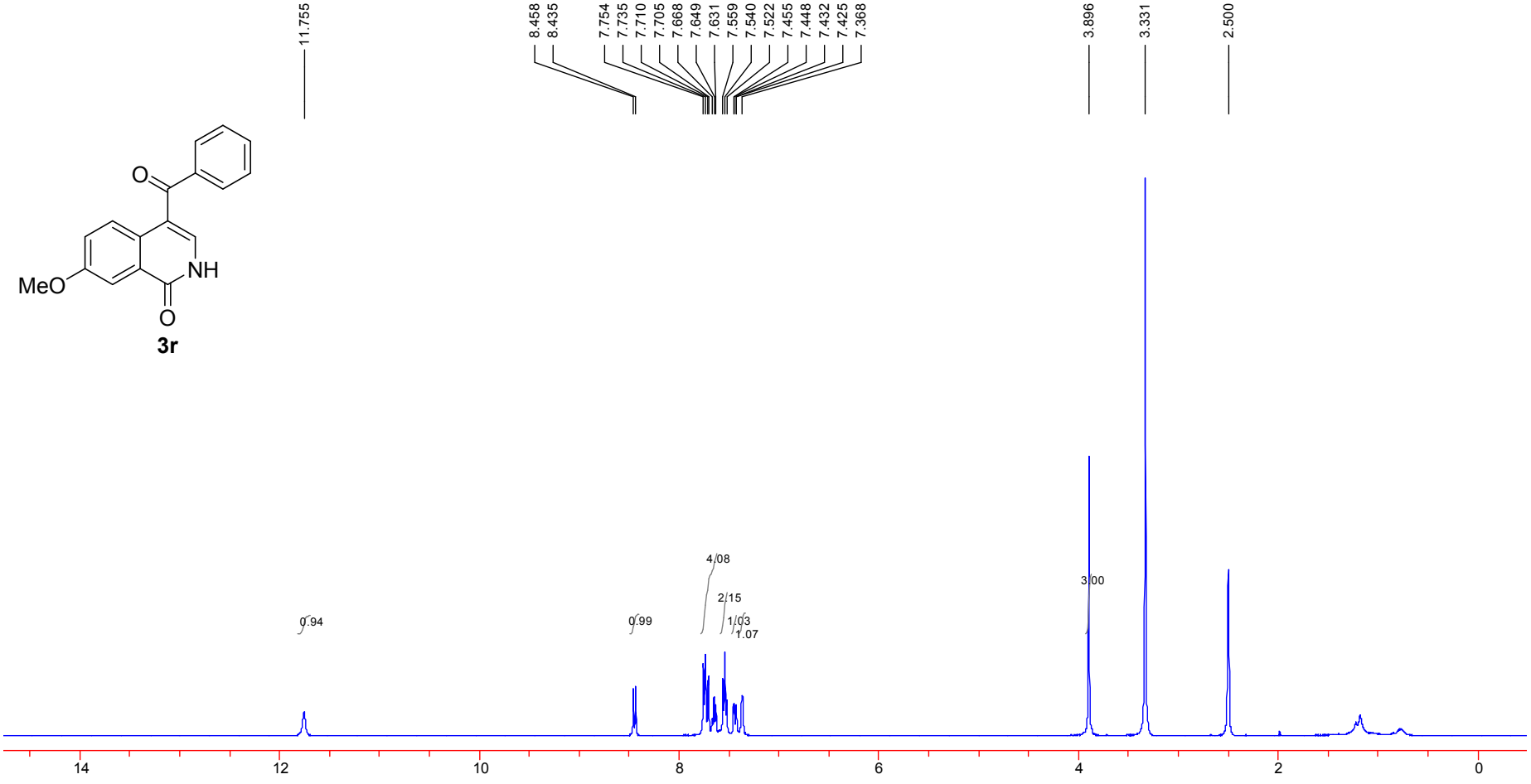


^{13}C NMR (100 MHz, DMSO-d_6)

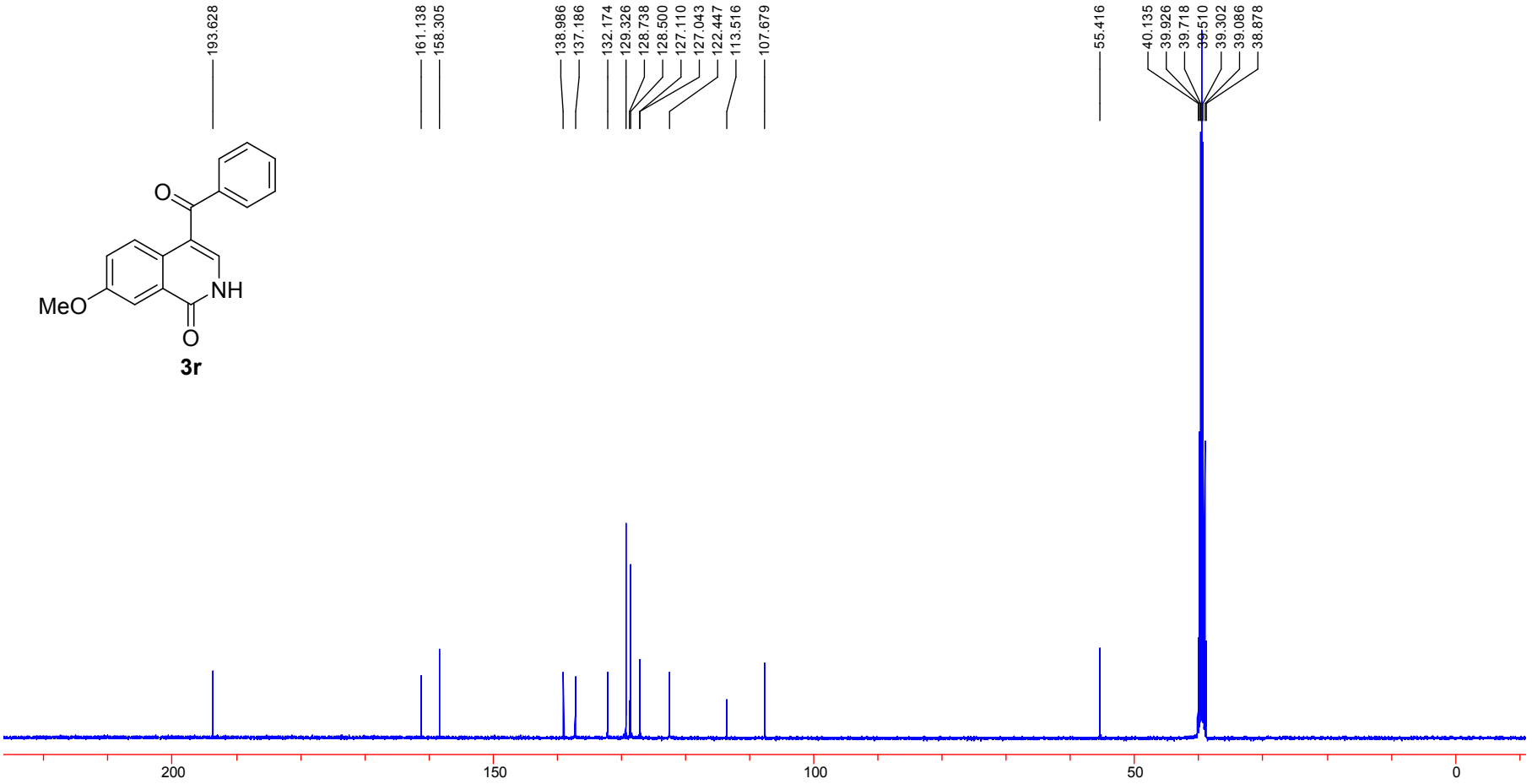


3q

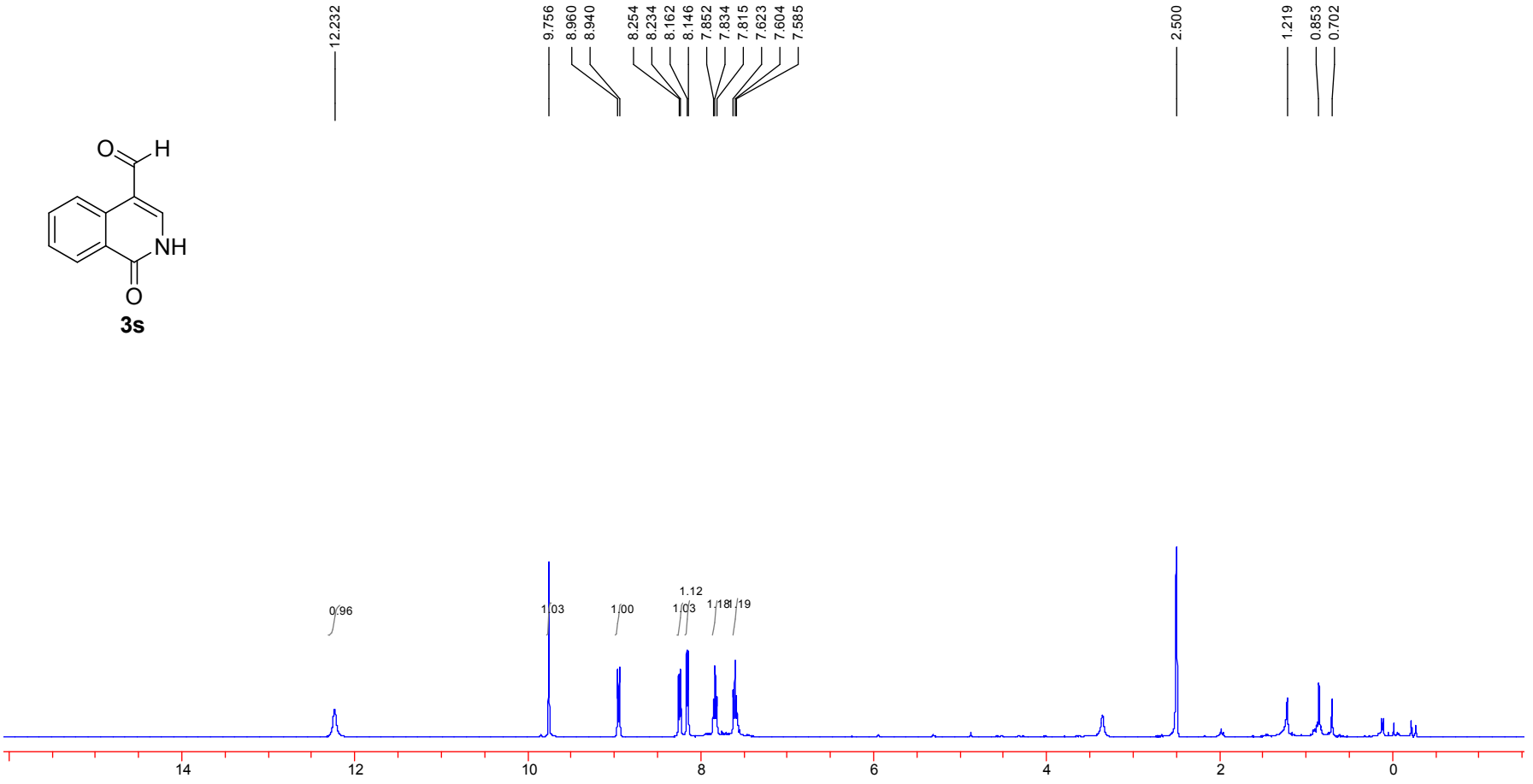
^{1}H NMR (400 MHz, DMSO-d_6)



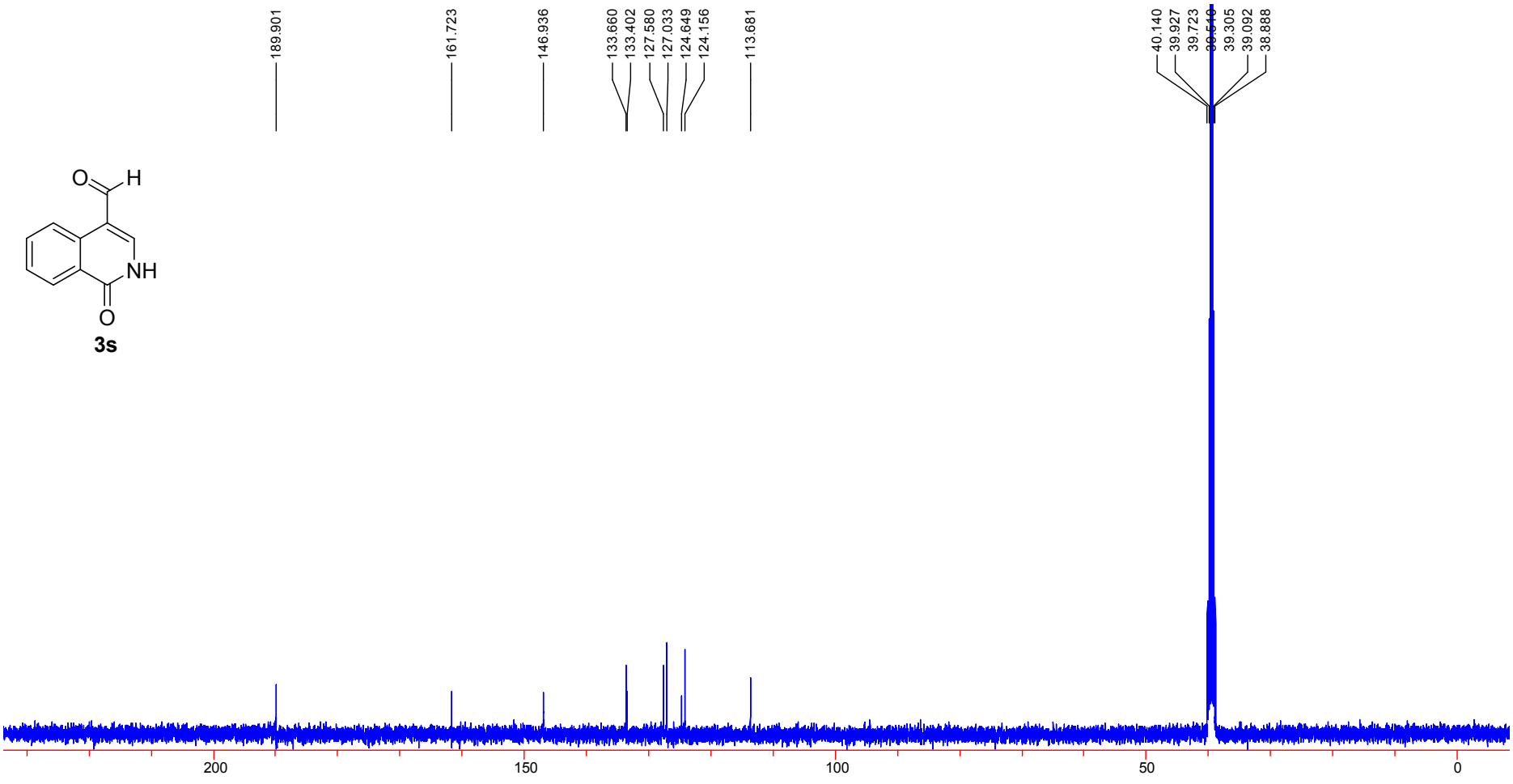
^{13}C NMR (100 MHz, DMSO-d_6)



^{1}H NMR (400 MHz, DMSO-d_6)

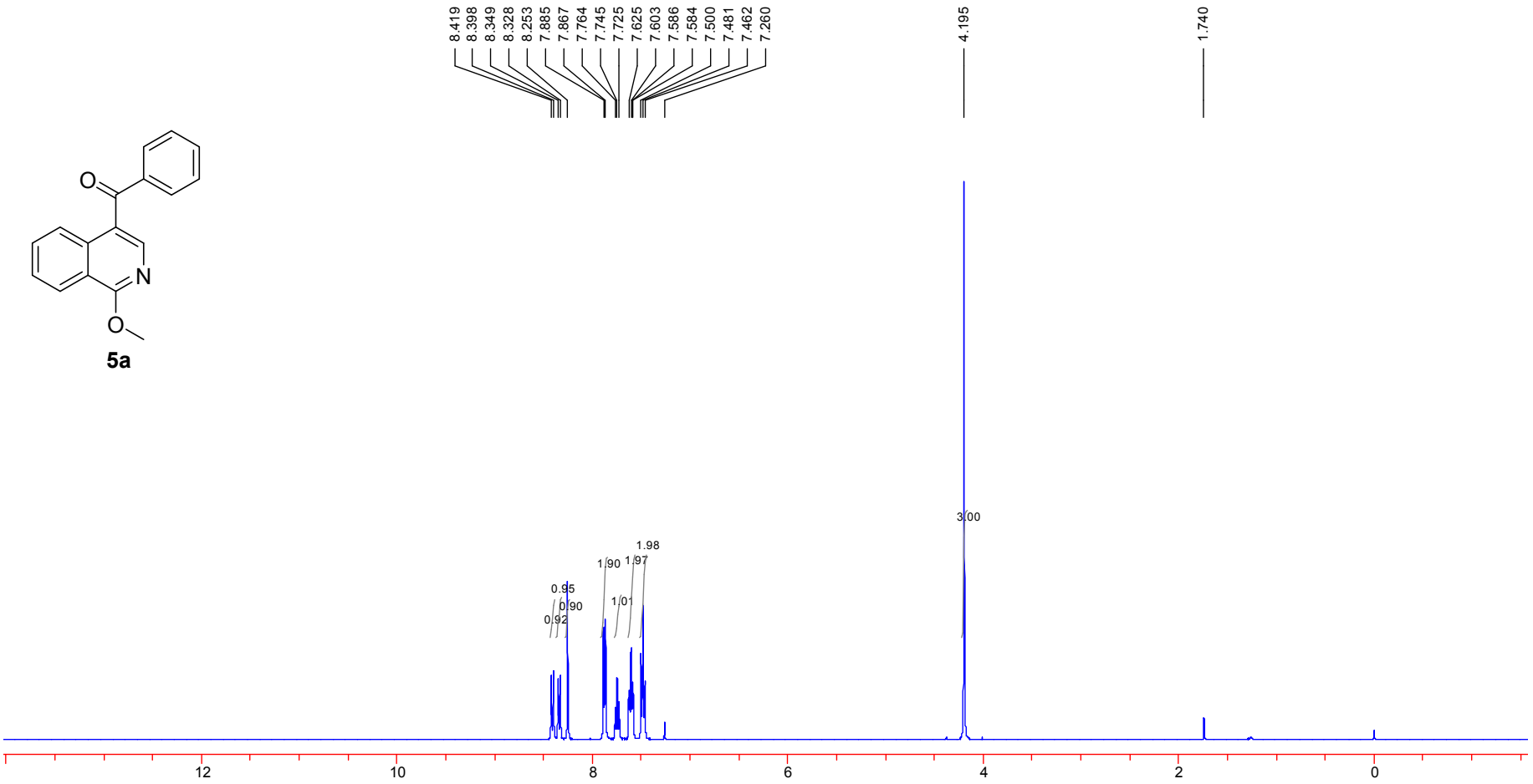


^{13}C NMR (100 MHz, DMSO-d_6)

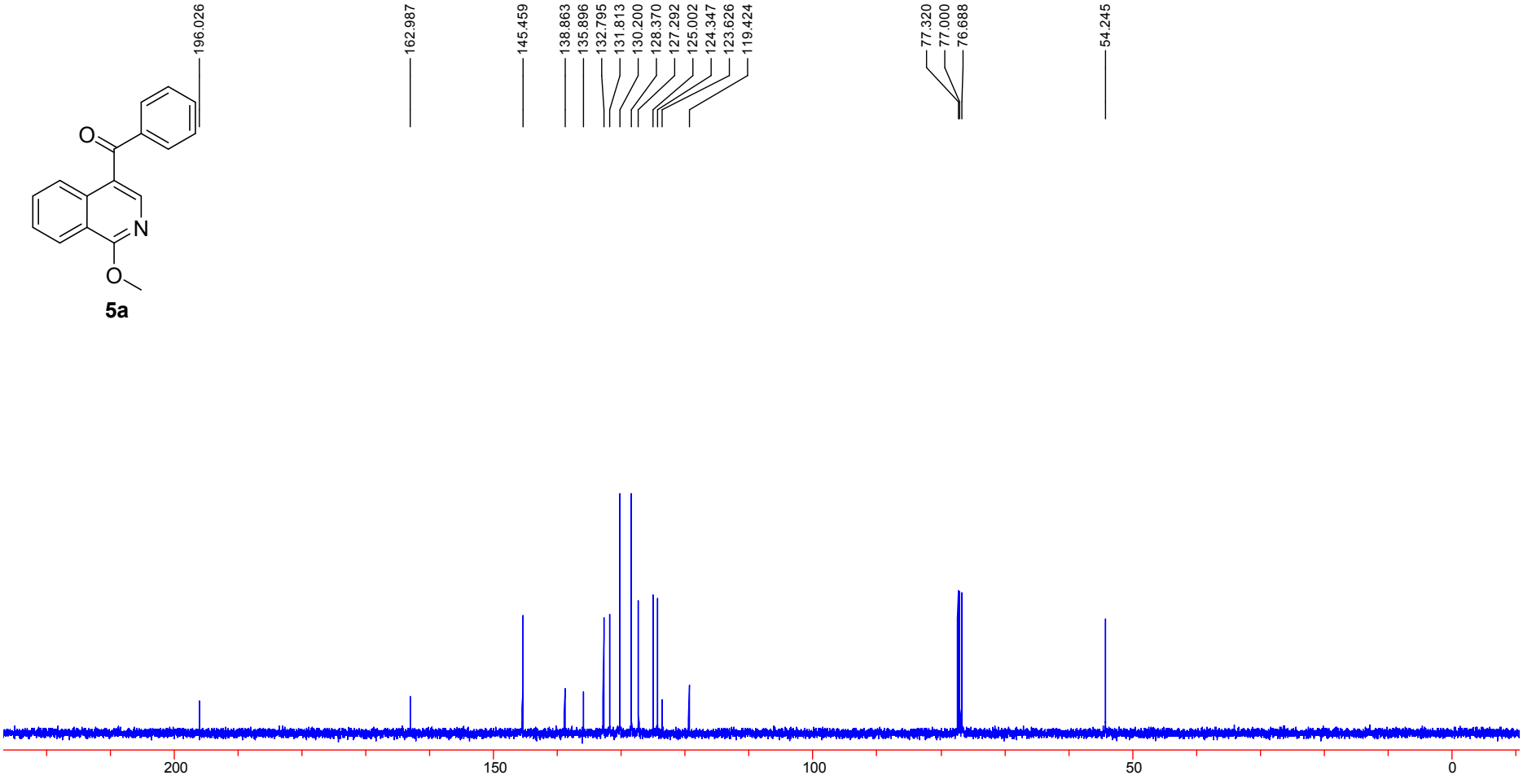


3s

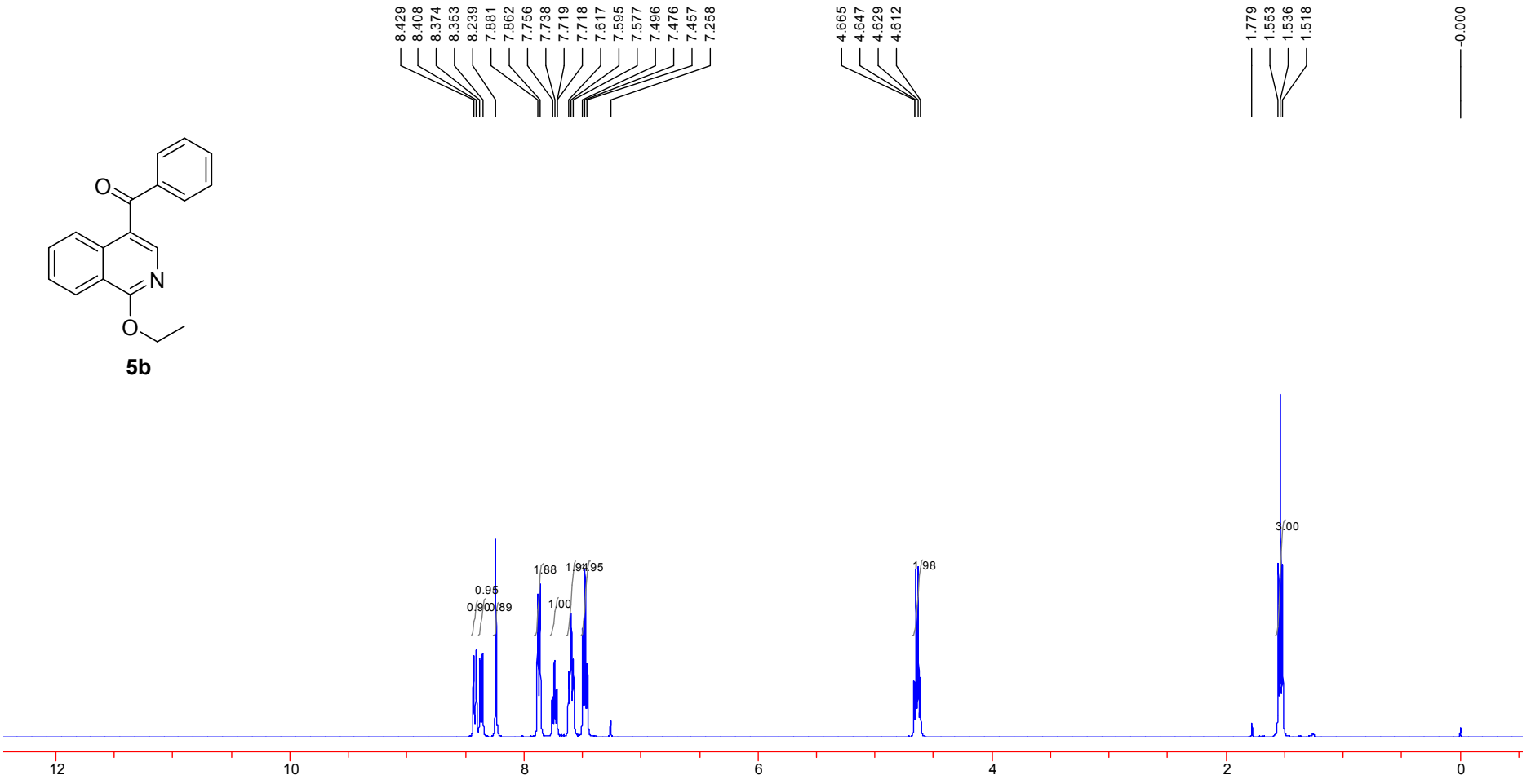
^{1}H NMR (400 MHz, $CDCl_3$)



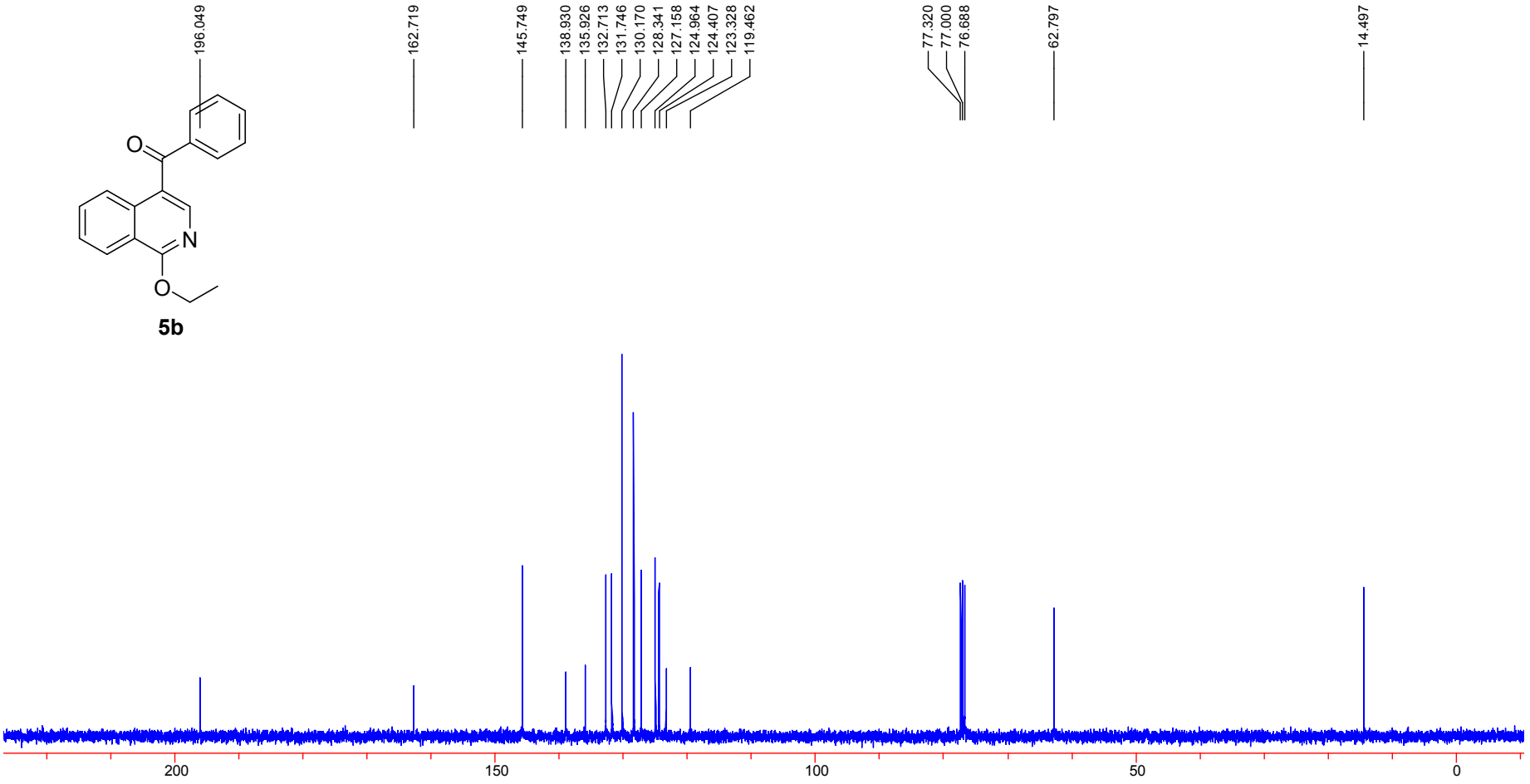
^{13}C NMR (100 MHz, $CDCl_3$)



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

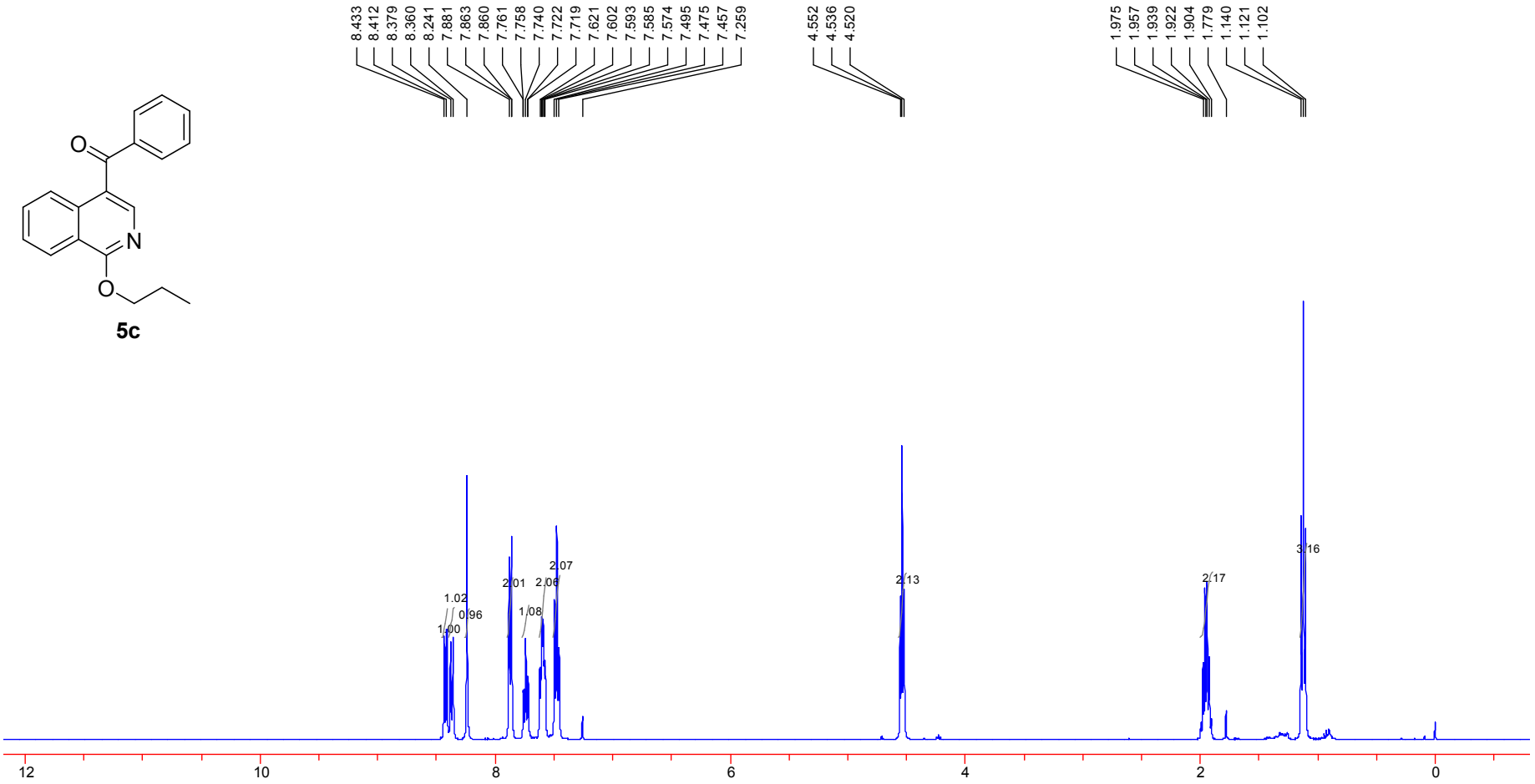


^{13}C NMR (100 MHz, $CDCl_3$)

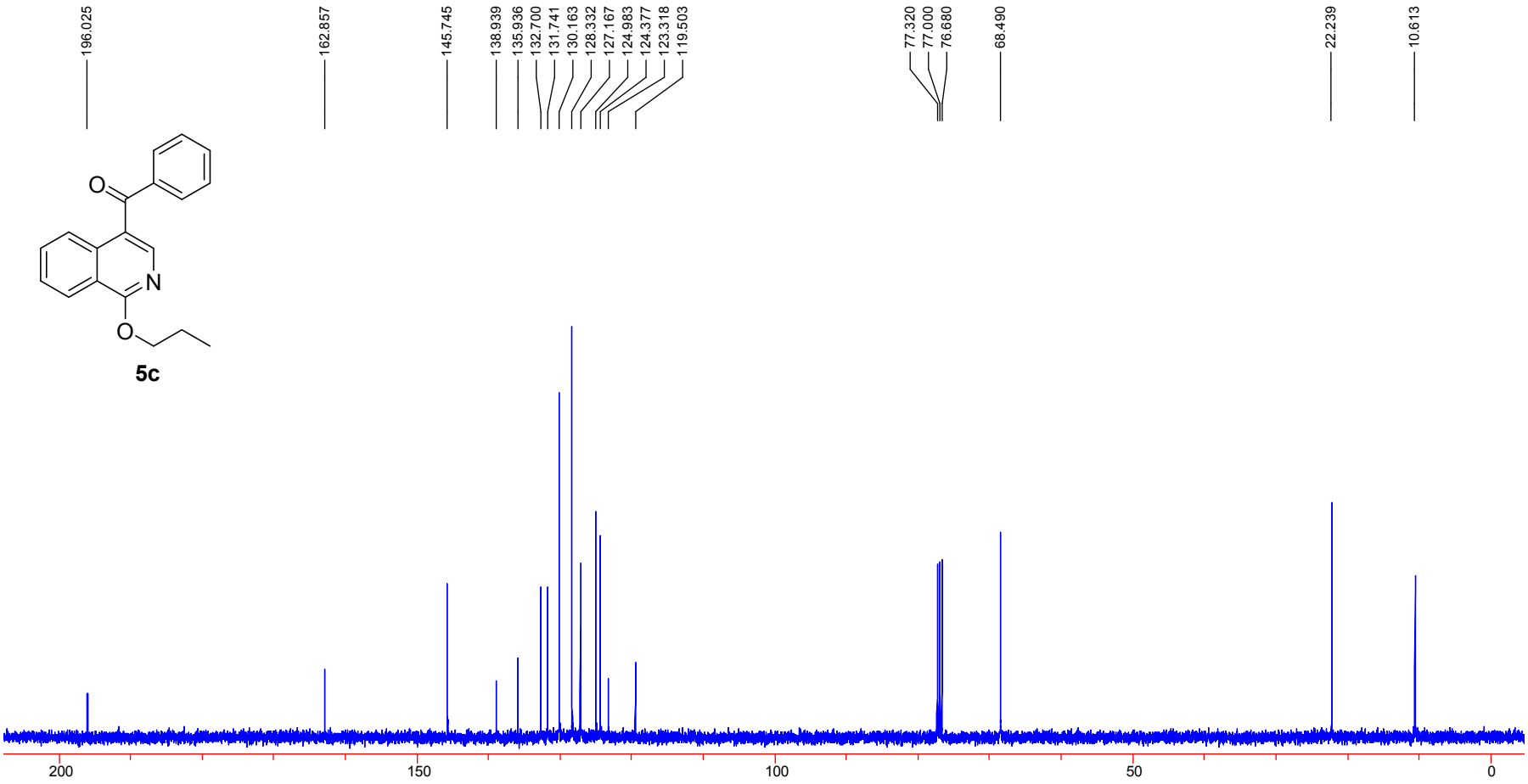


5b

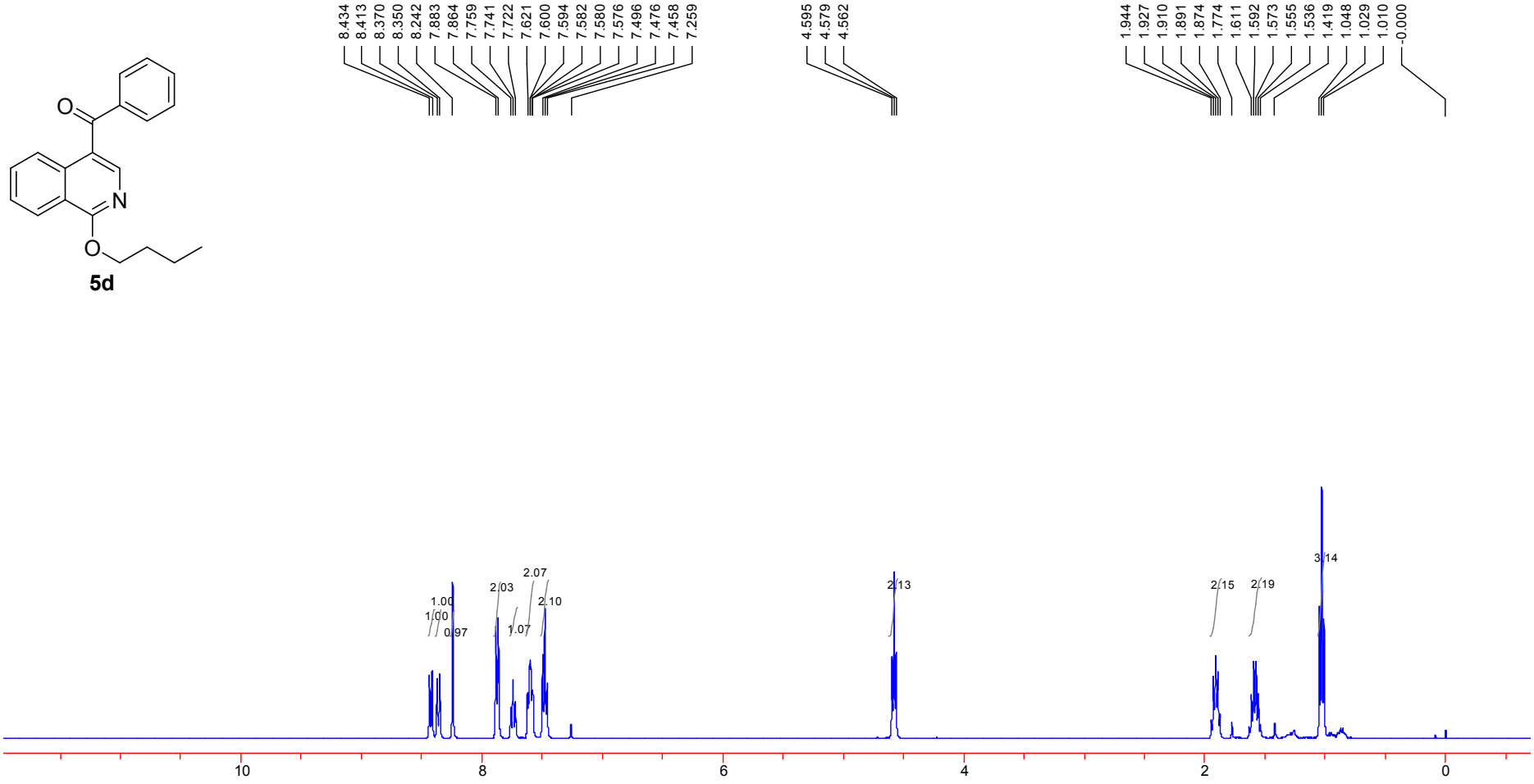
^{1}H NMR (400 MHz, $CDCl_3$)



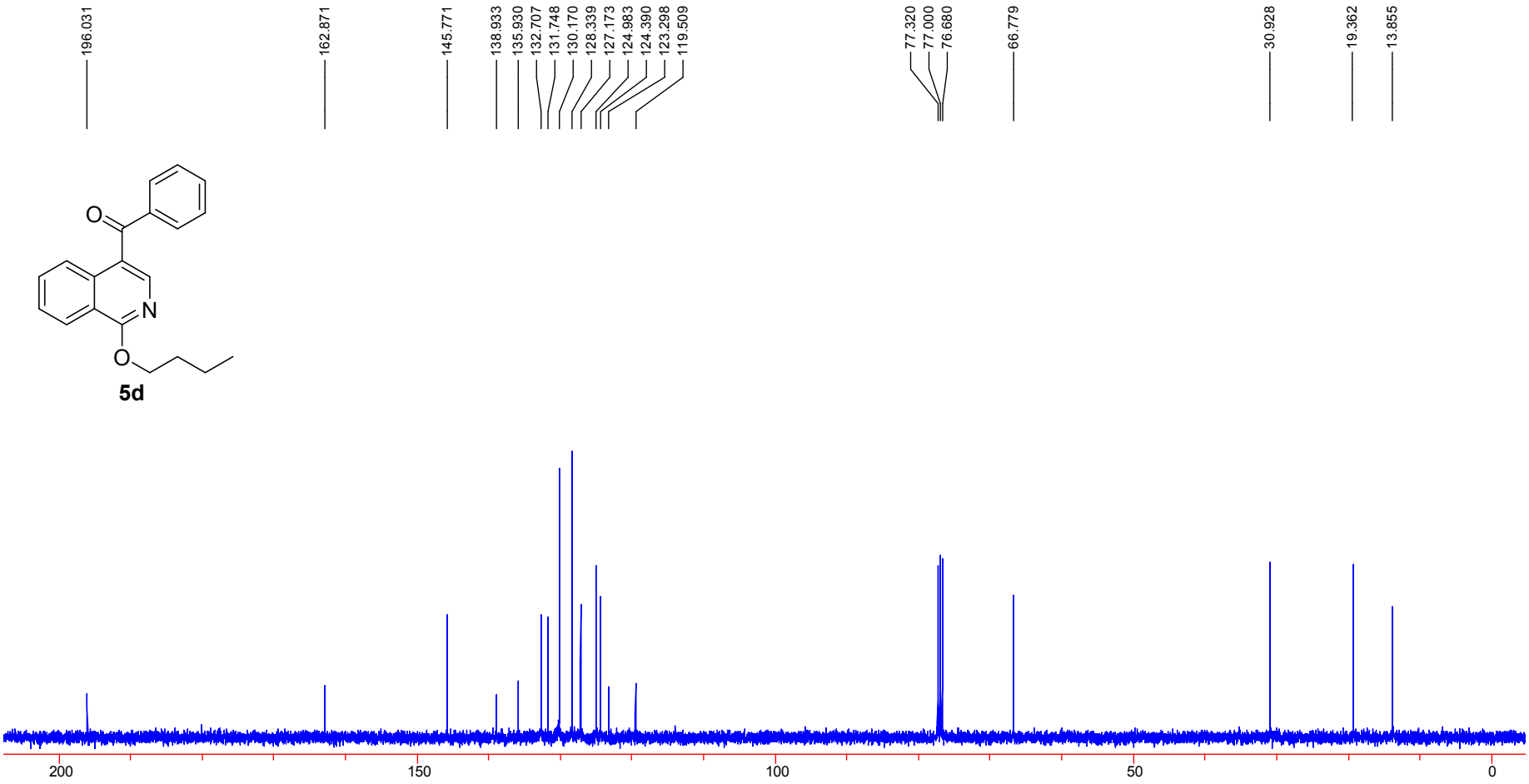
^{13}C NMR (100 MHz, $CDCl_3$)



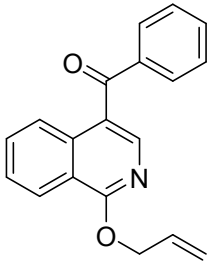
^{1}H NMR (400 MHz, $CDCl_3$)



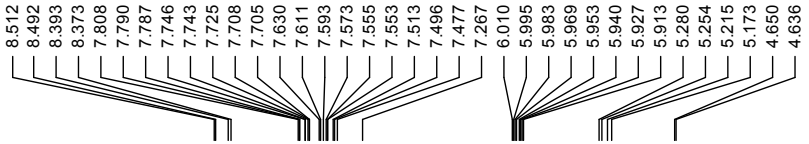
^{13}C NMR (100 MHz, $CDCl_3$)

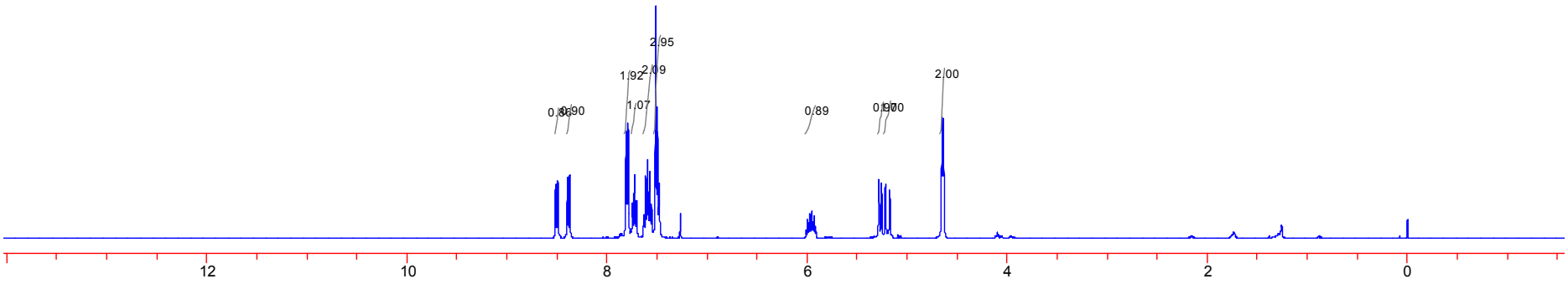


^{1}H NMR (400 MHz, $CDCl_3$)

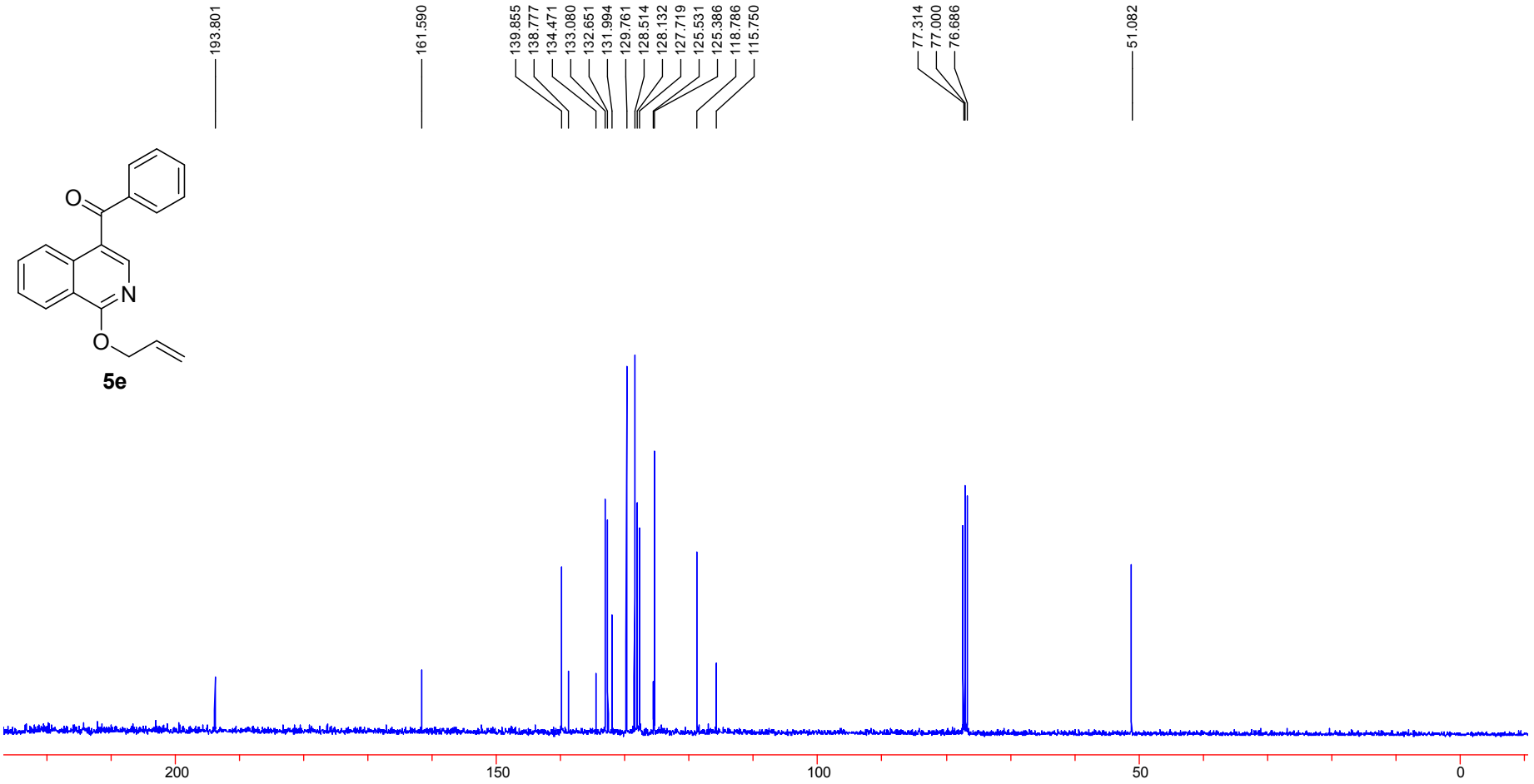


5e

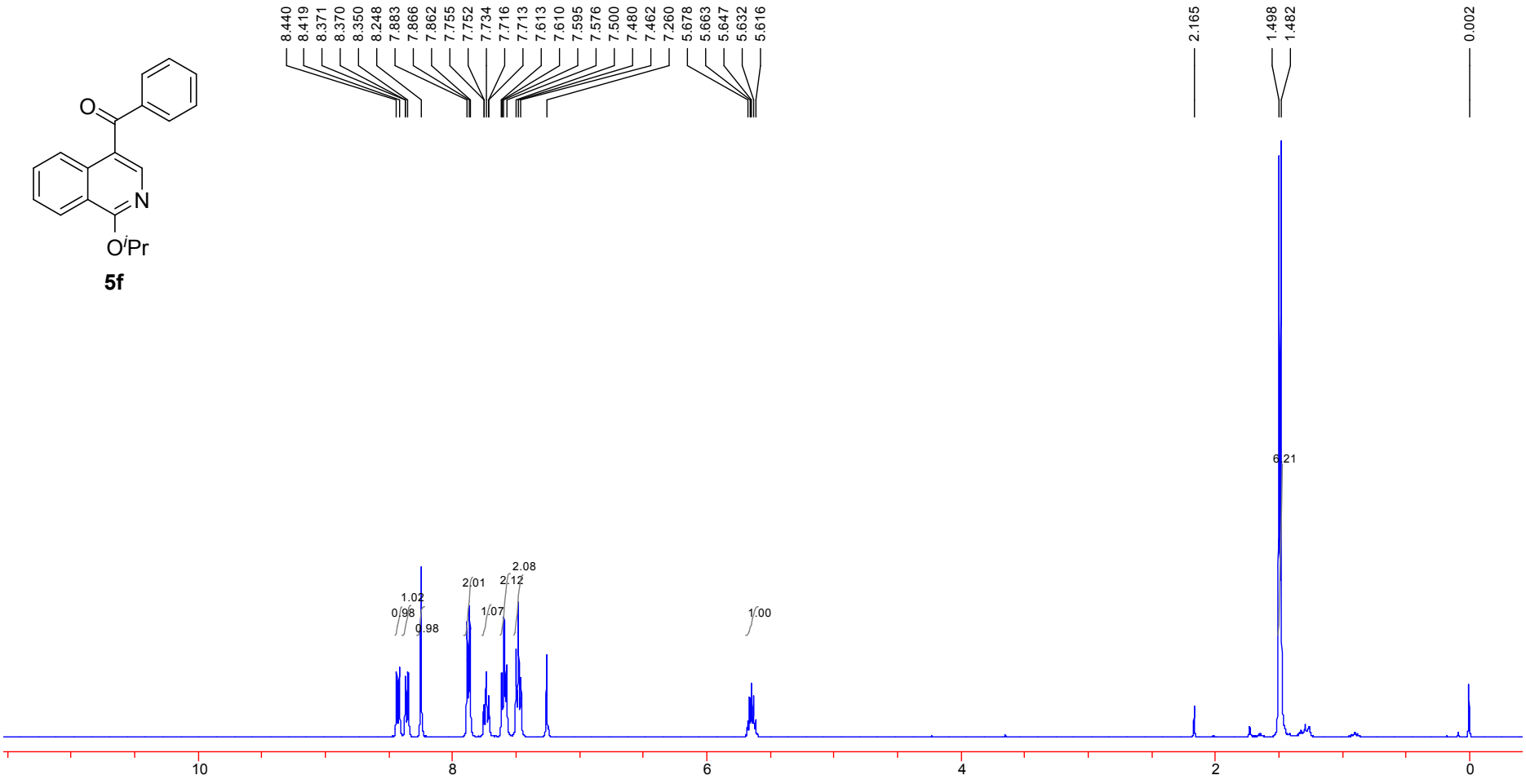




^{13}C NMR (100 MHz, $CDCl_3$)

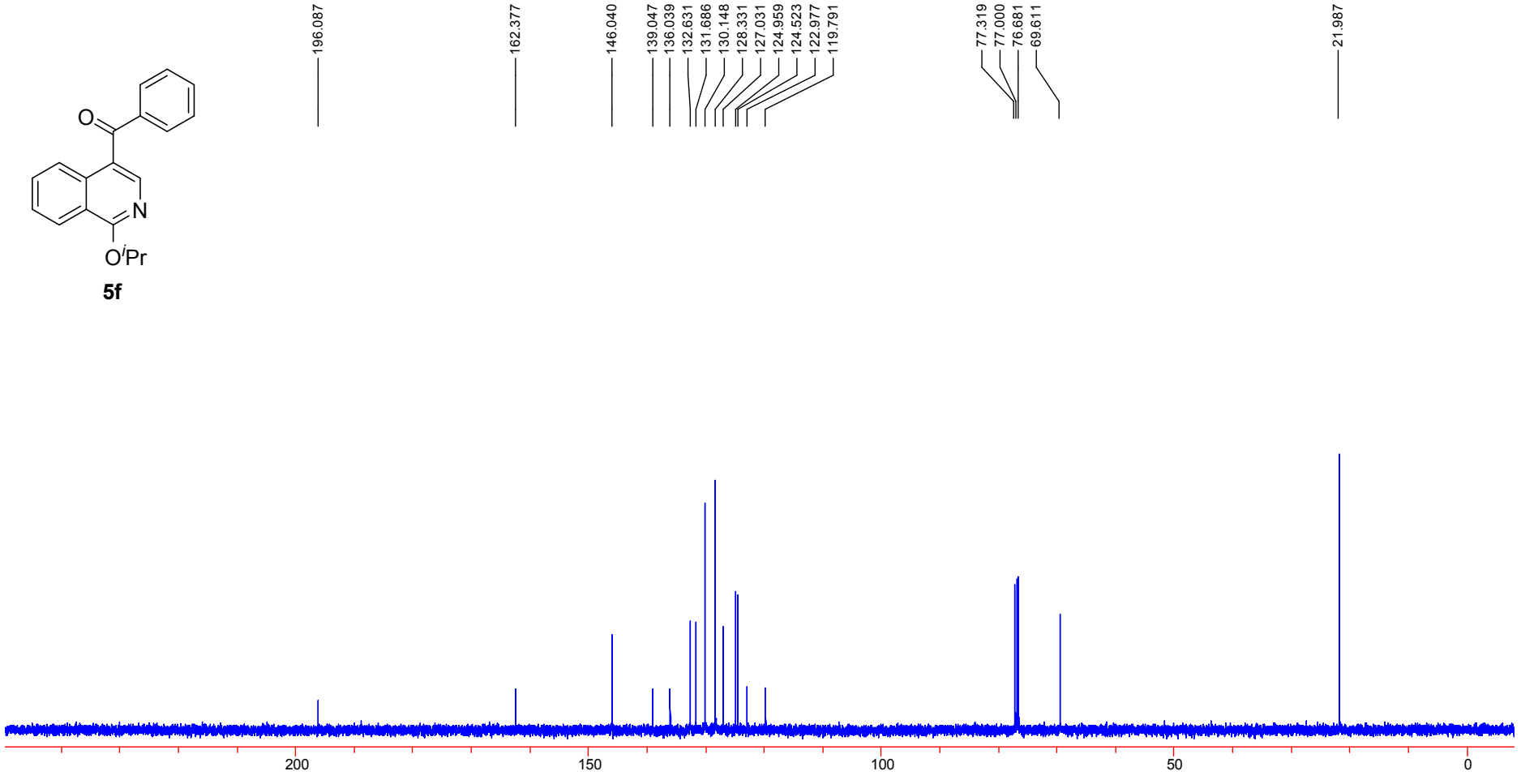


^{1}H NMR (400 MHz, $CDCl_3$)



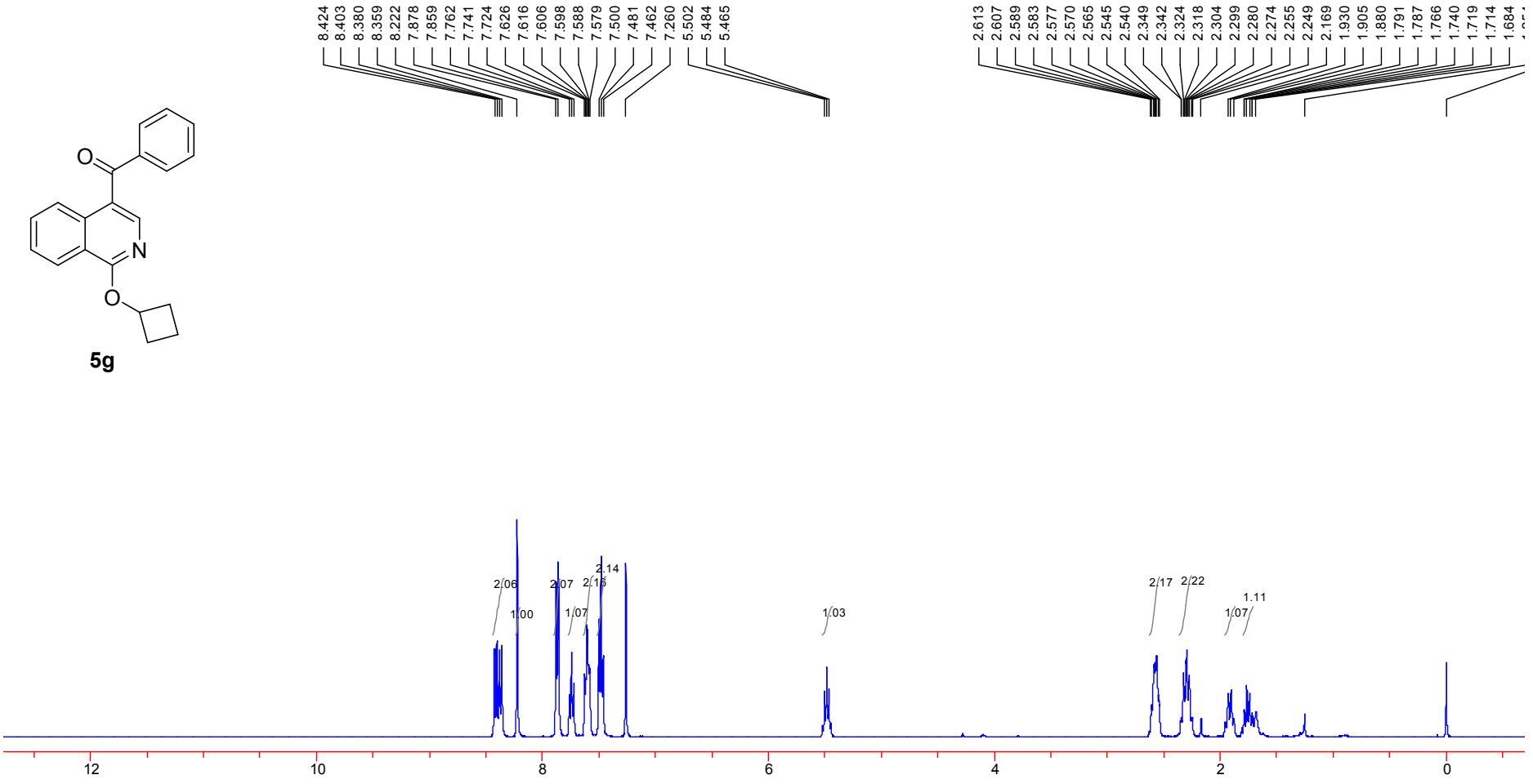
5f

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

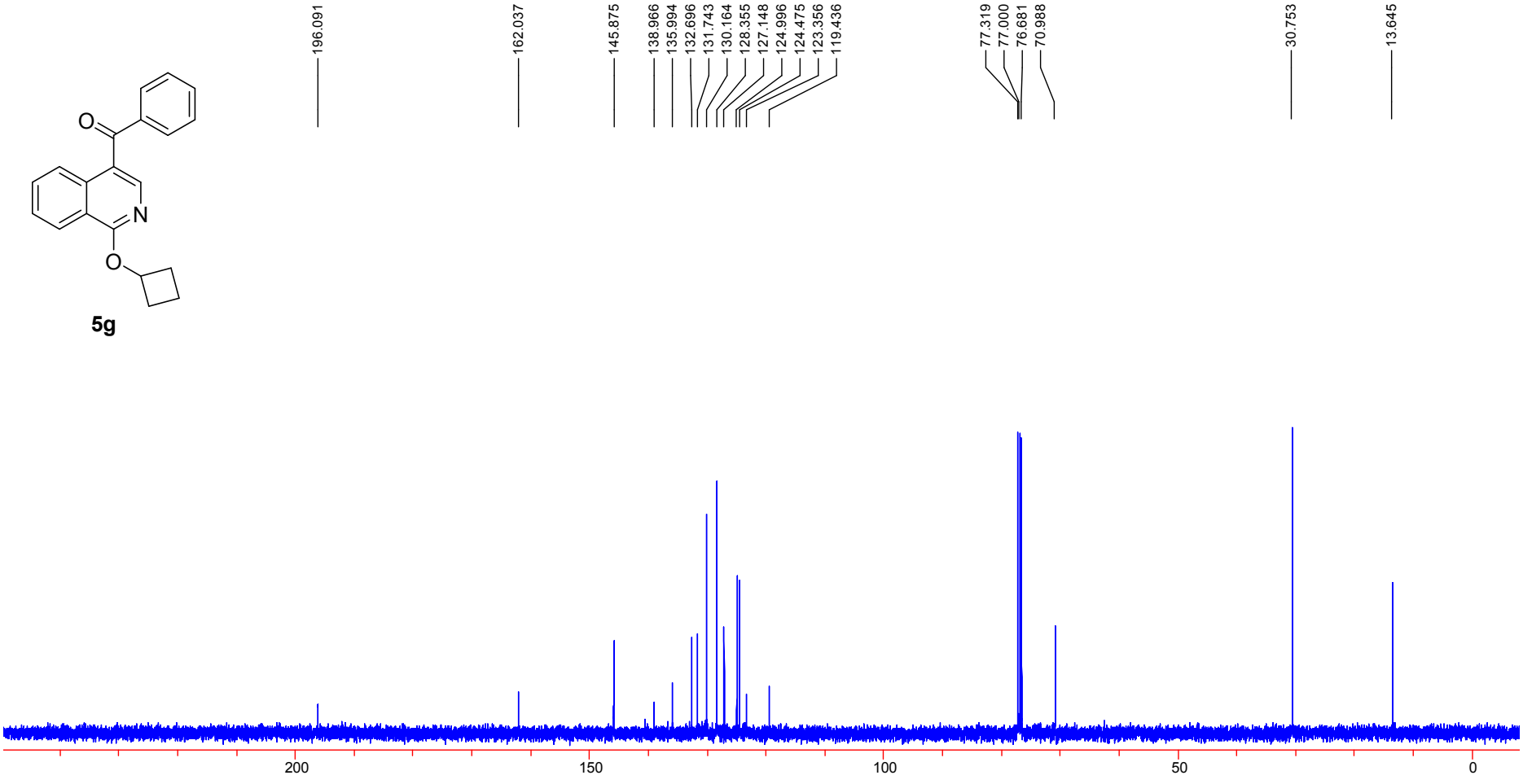


5f

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

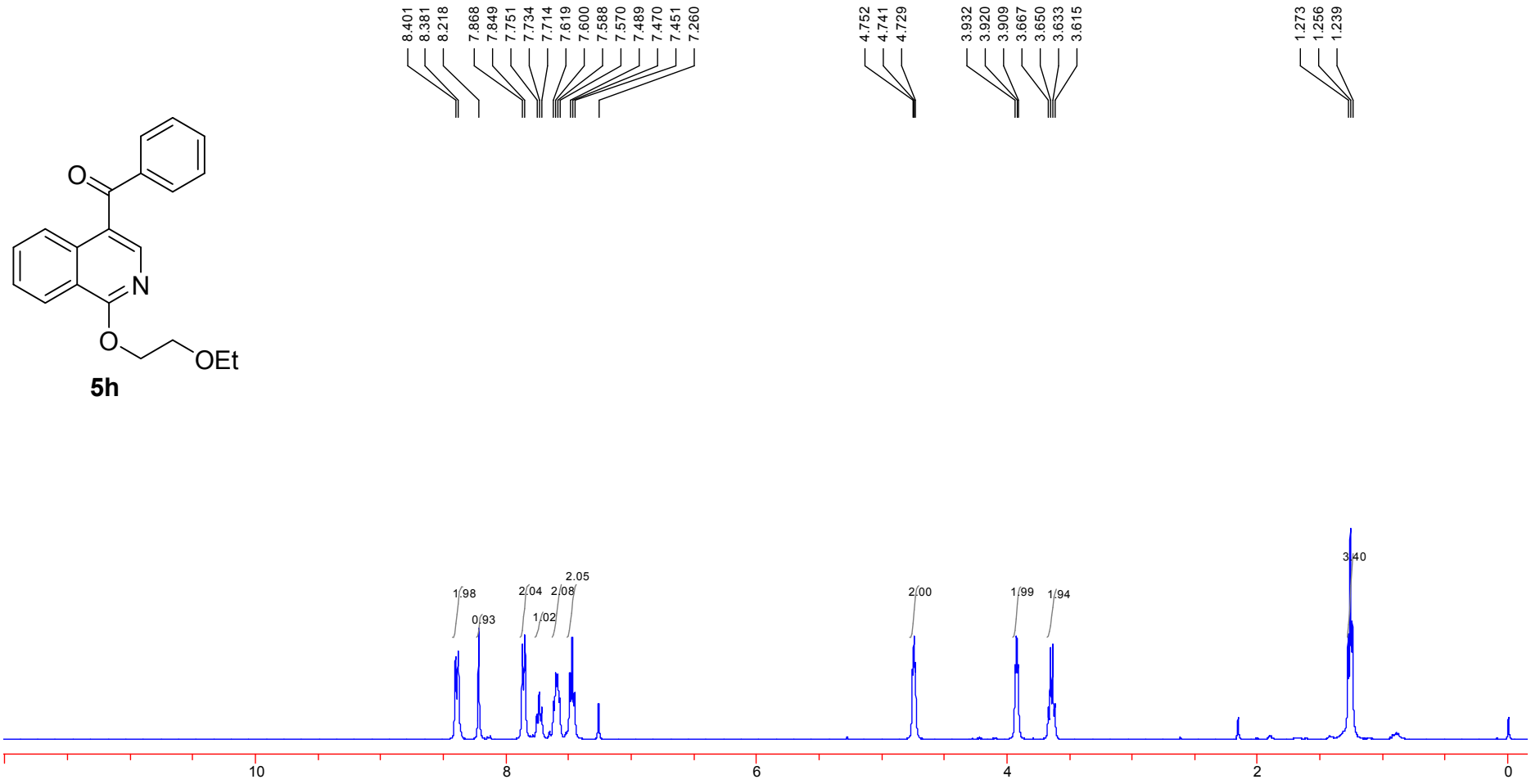


^{13}C NMR (100 MHz, $CDCl_3$)

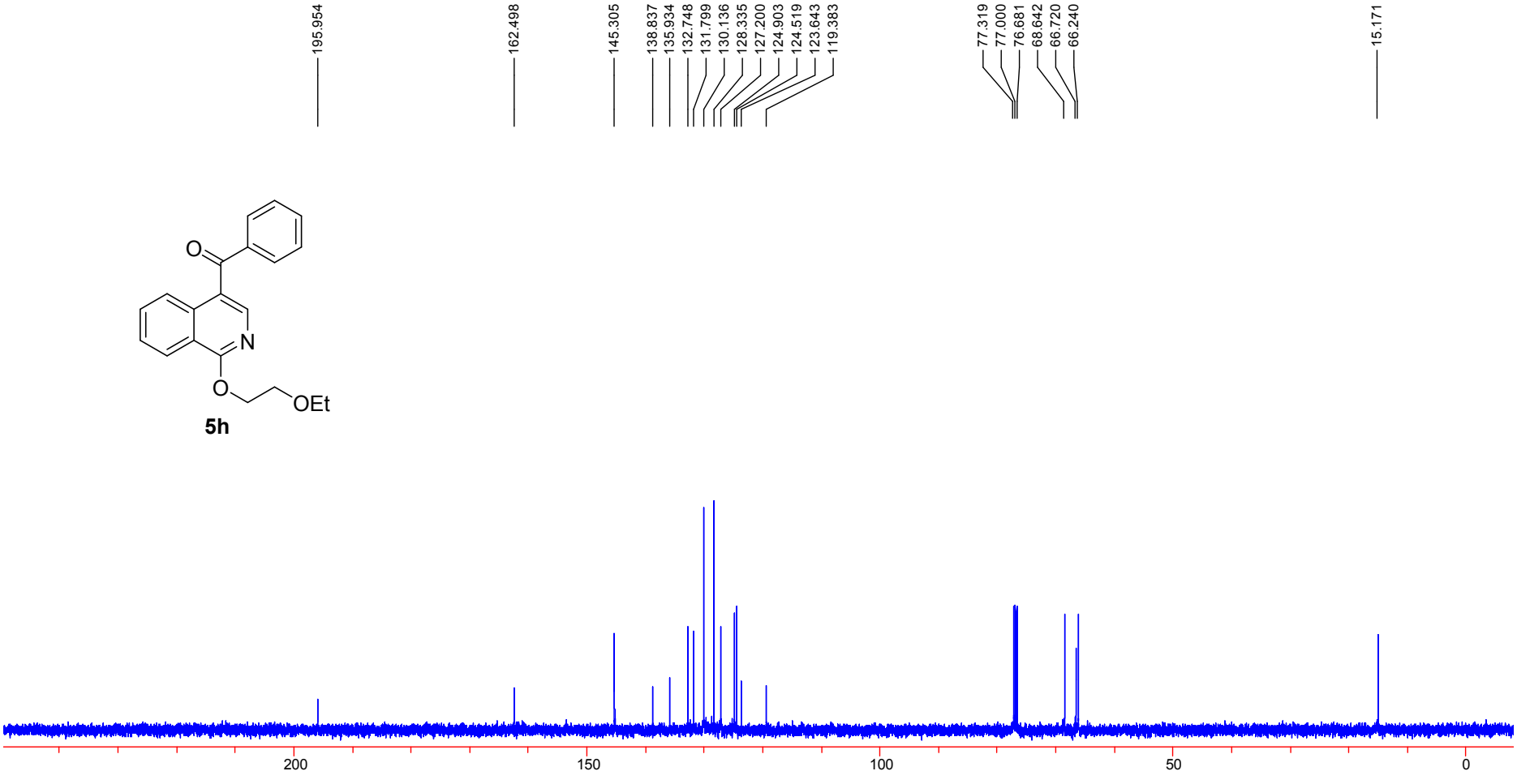


5g

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

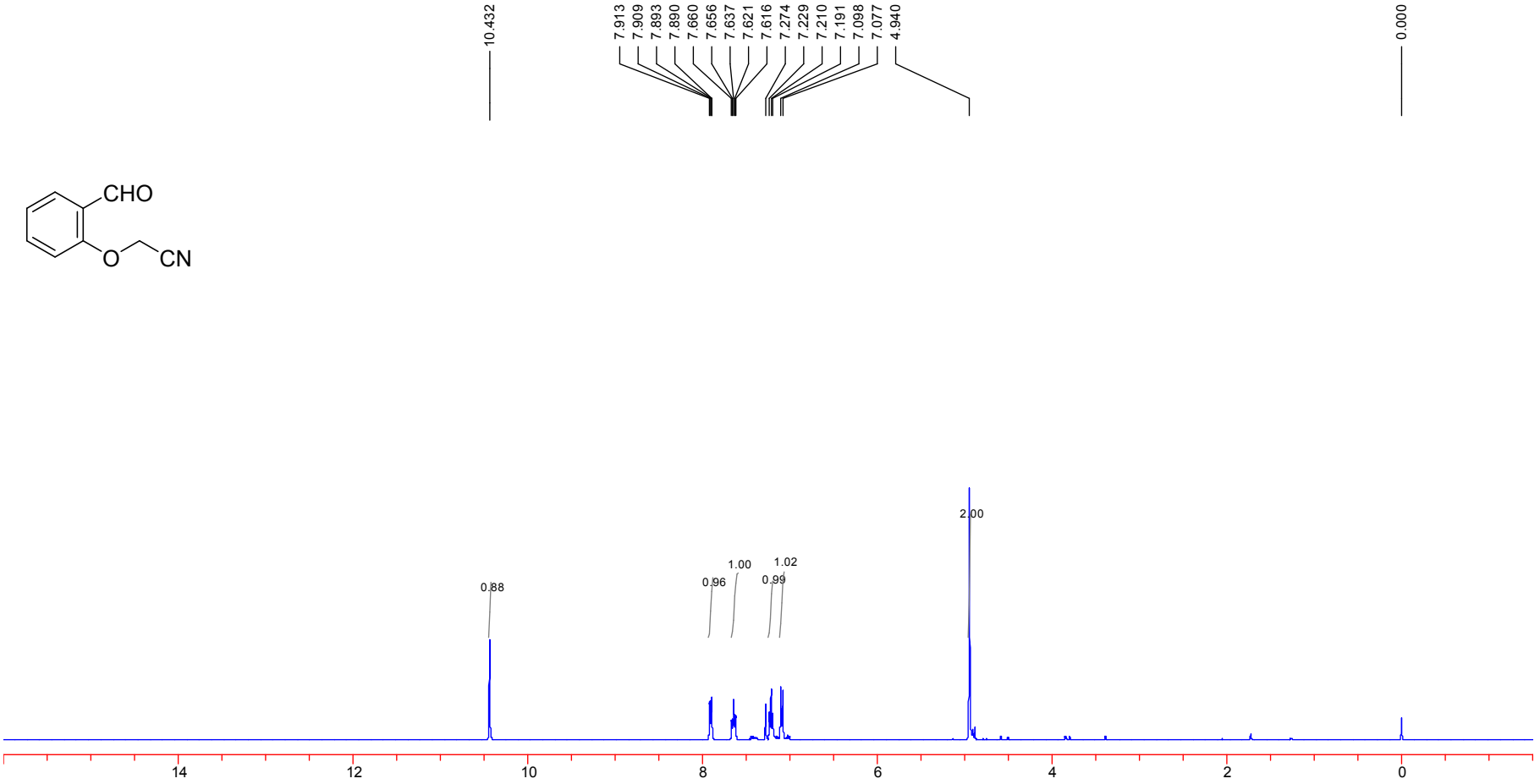


^{13}C NMR (100 MHz, $CDCl_3$)

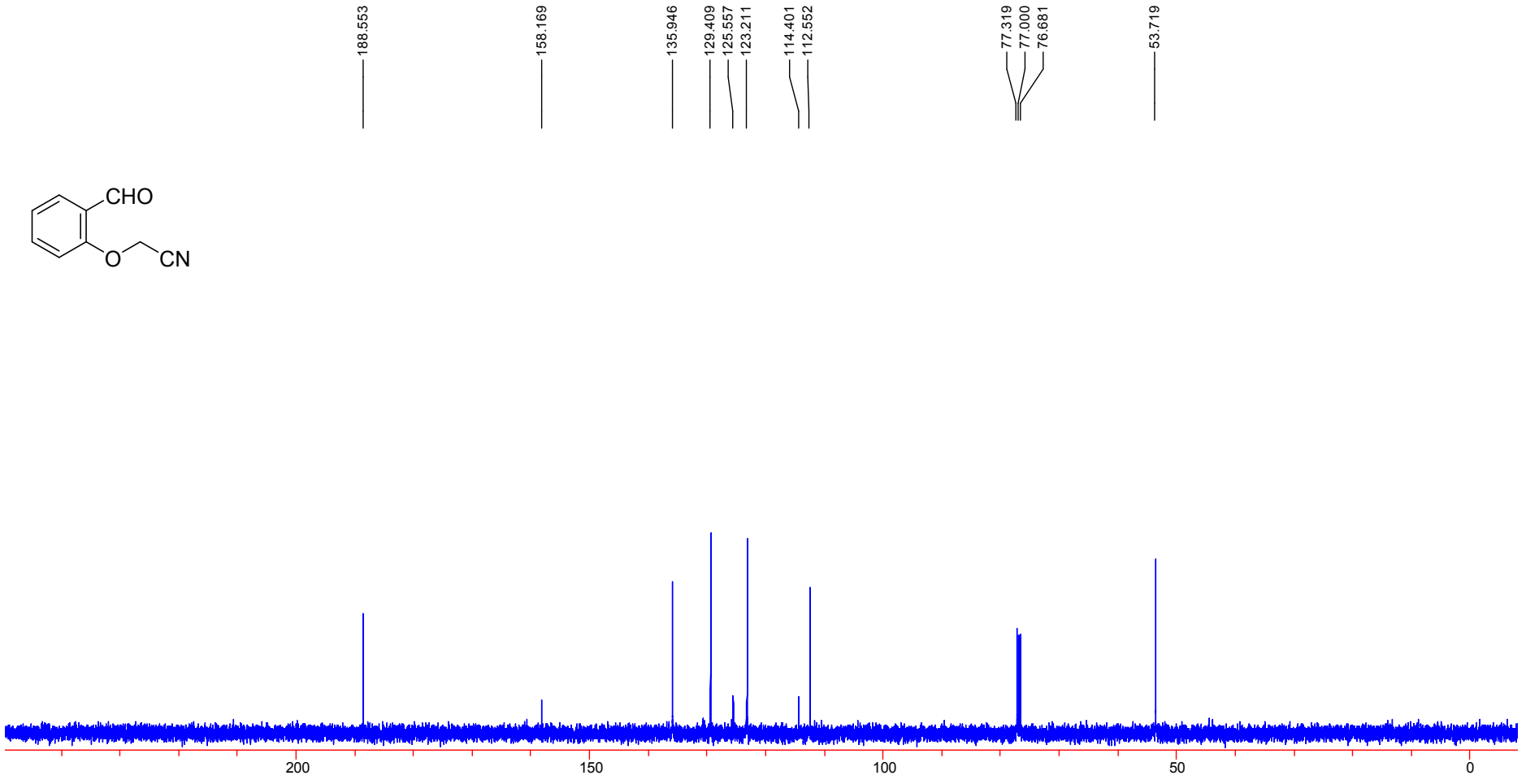


5h

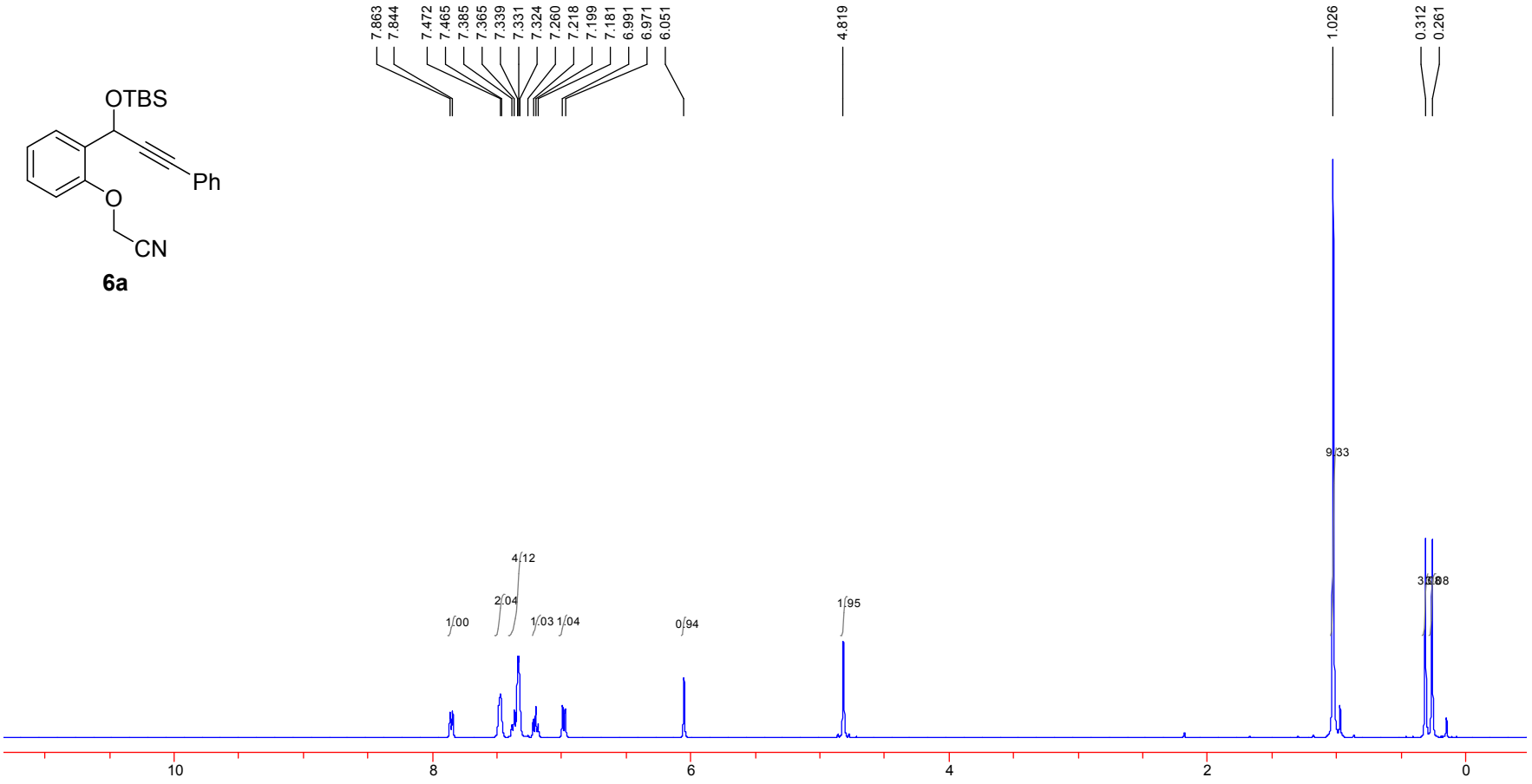
^{1}H NMR (400 MHz, $CDCl_3$)



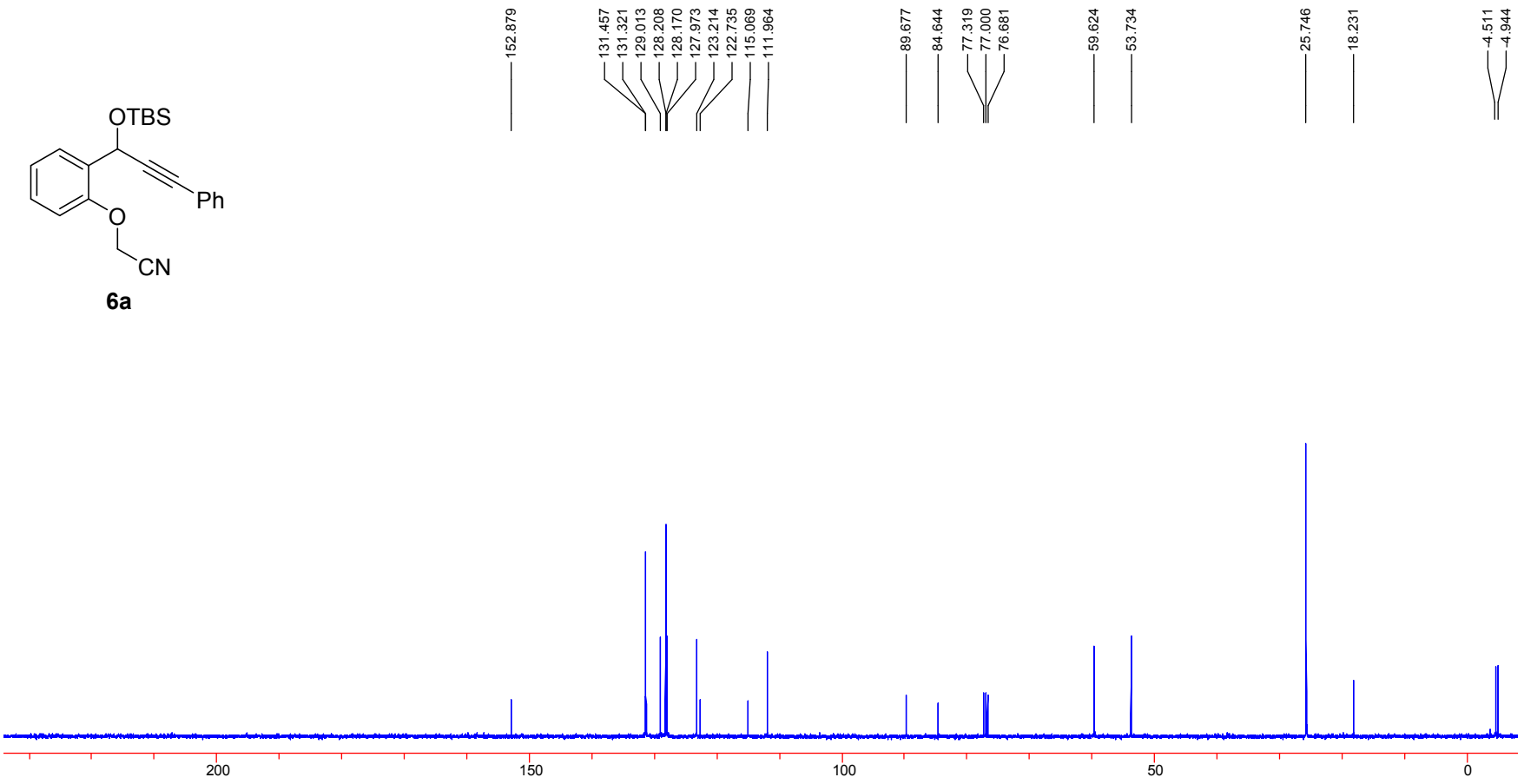
^{13}C NMR (100 MHz, $CDCl_3$)



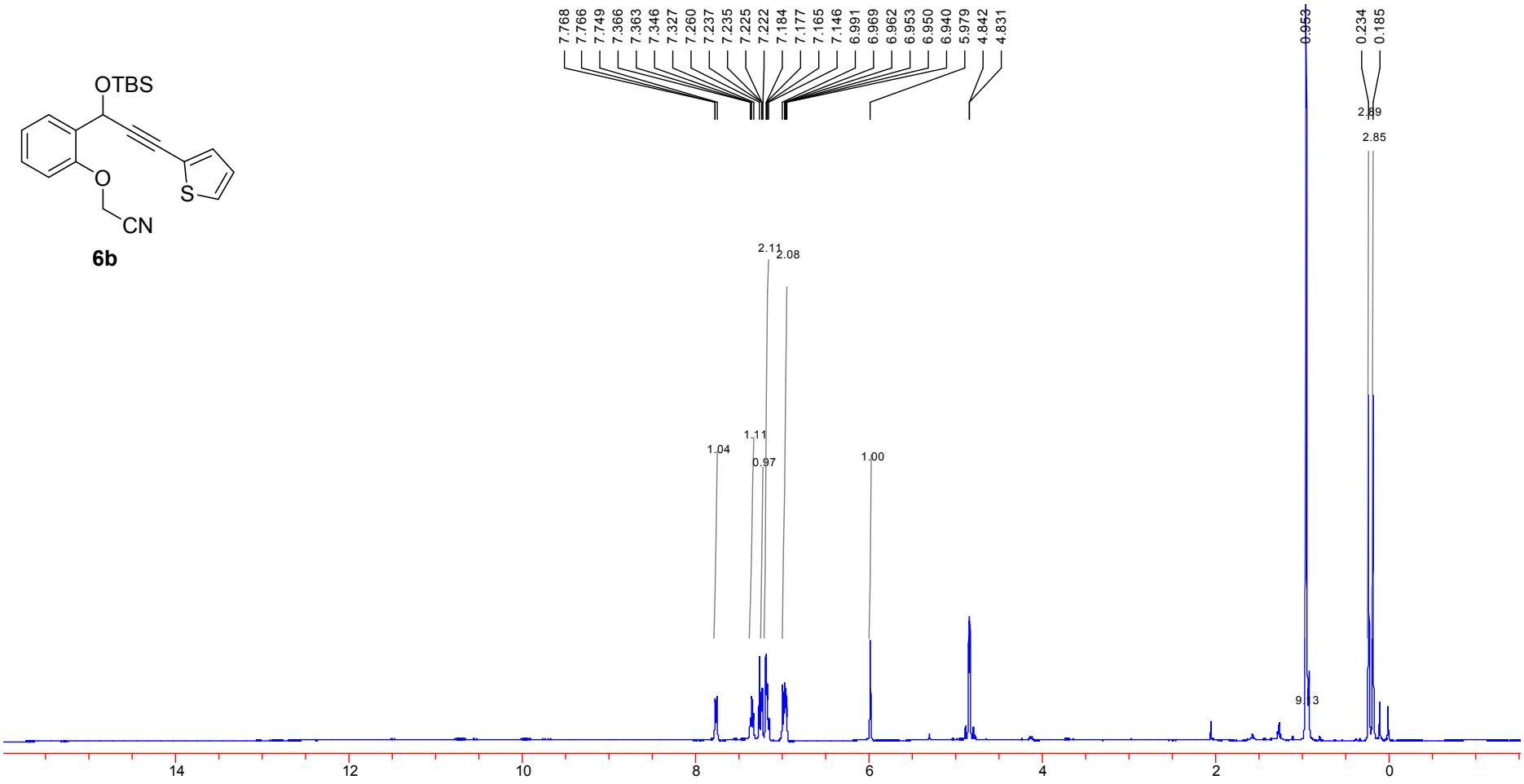
^{1}H NMR (400 MHz, $CDCl_3$)



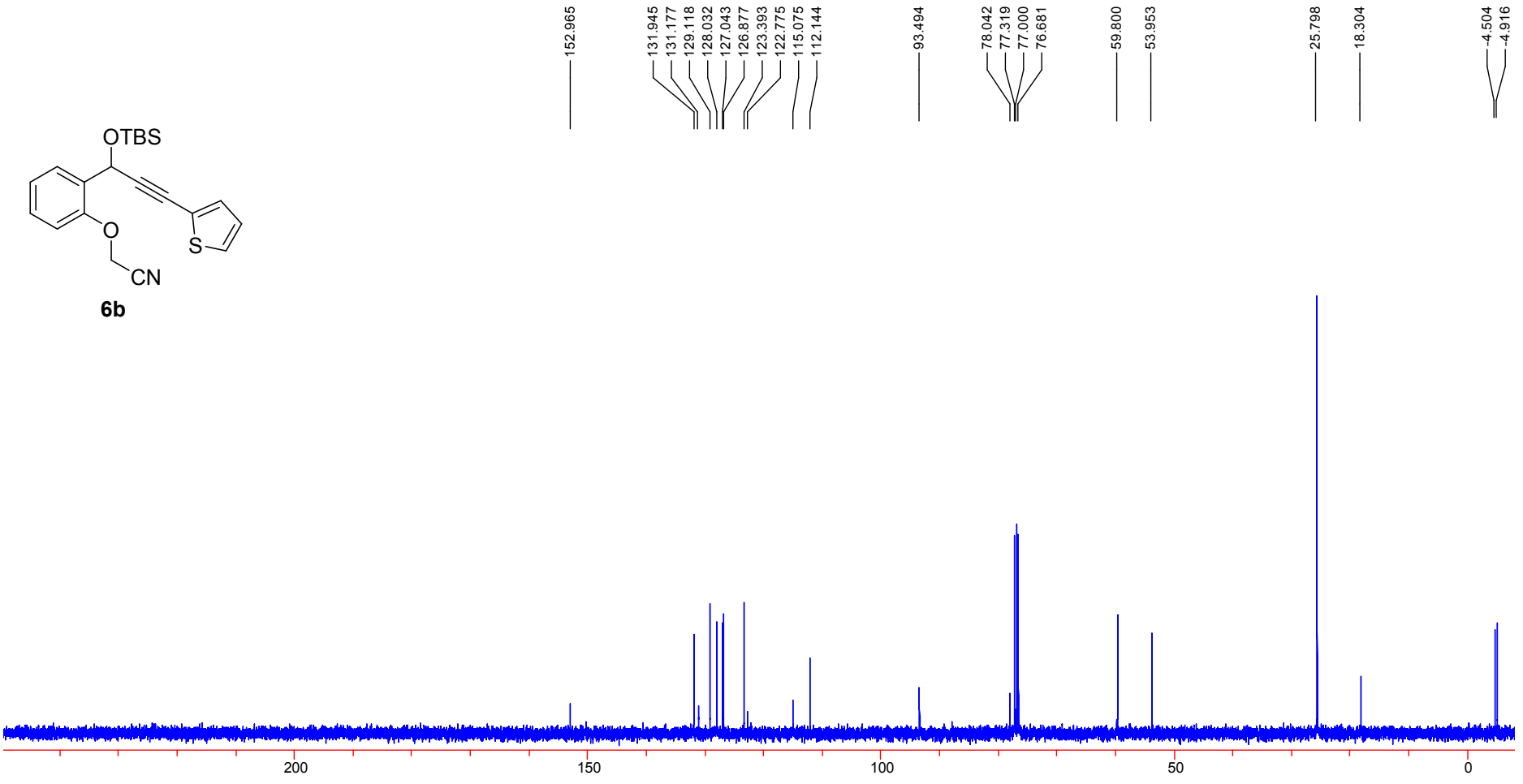
^{13}C NMR (100 MHz, $CDCl_3$)



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

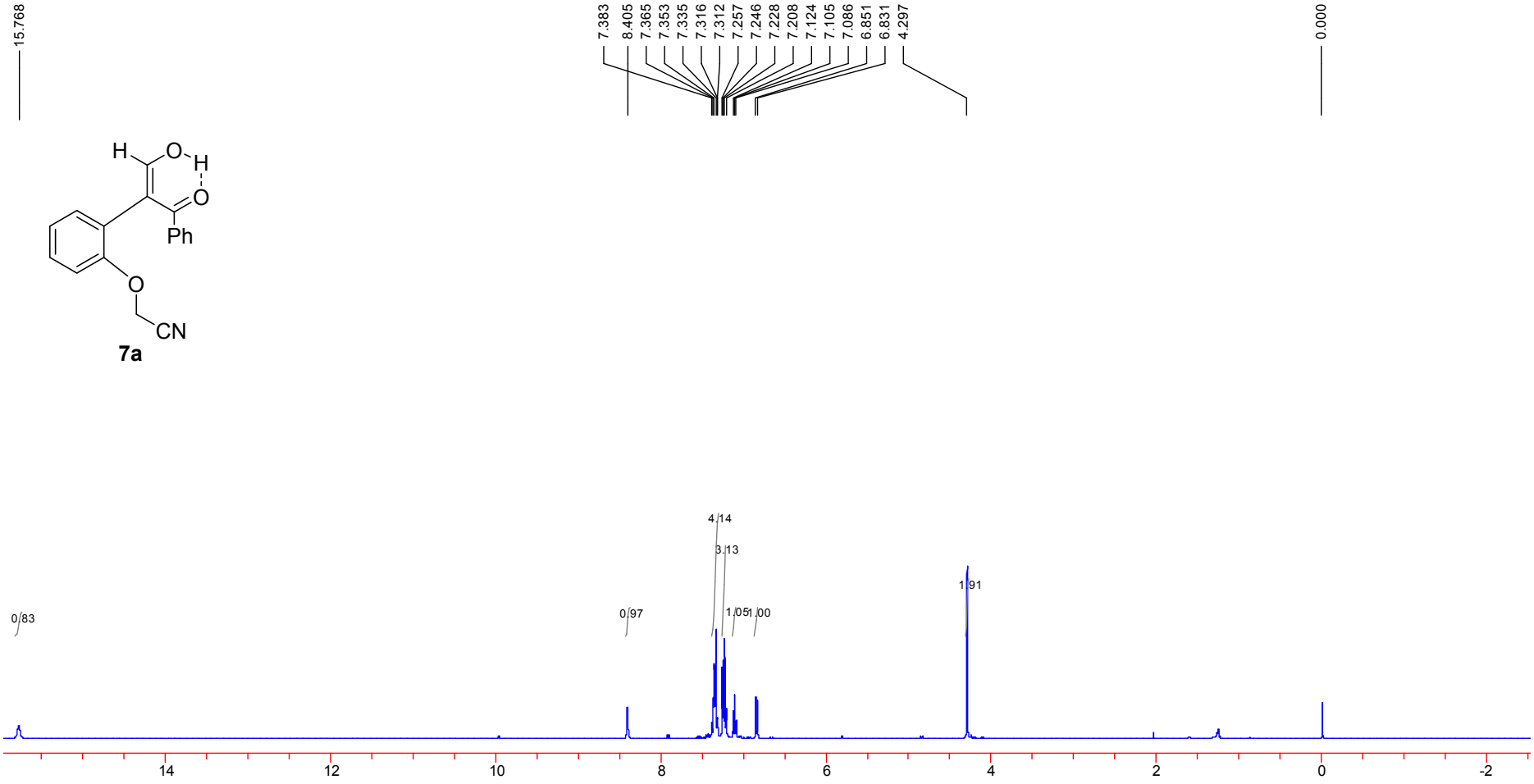


^{13}C NMR (100 MHz, $CDCl_3$)

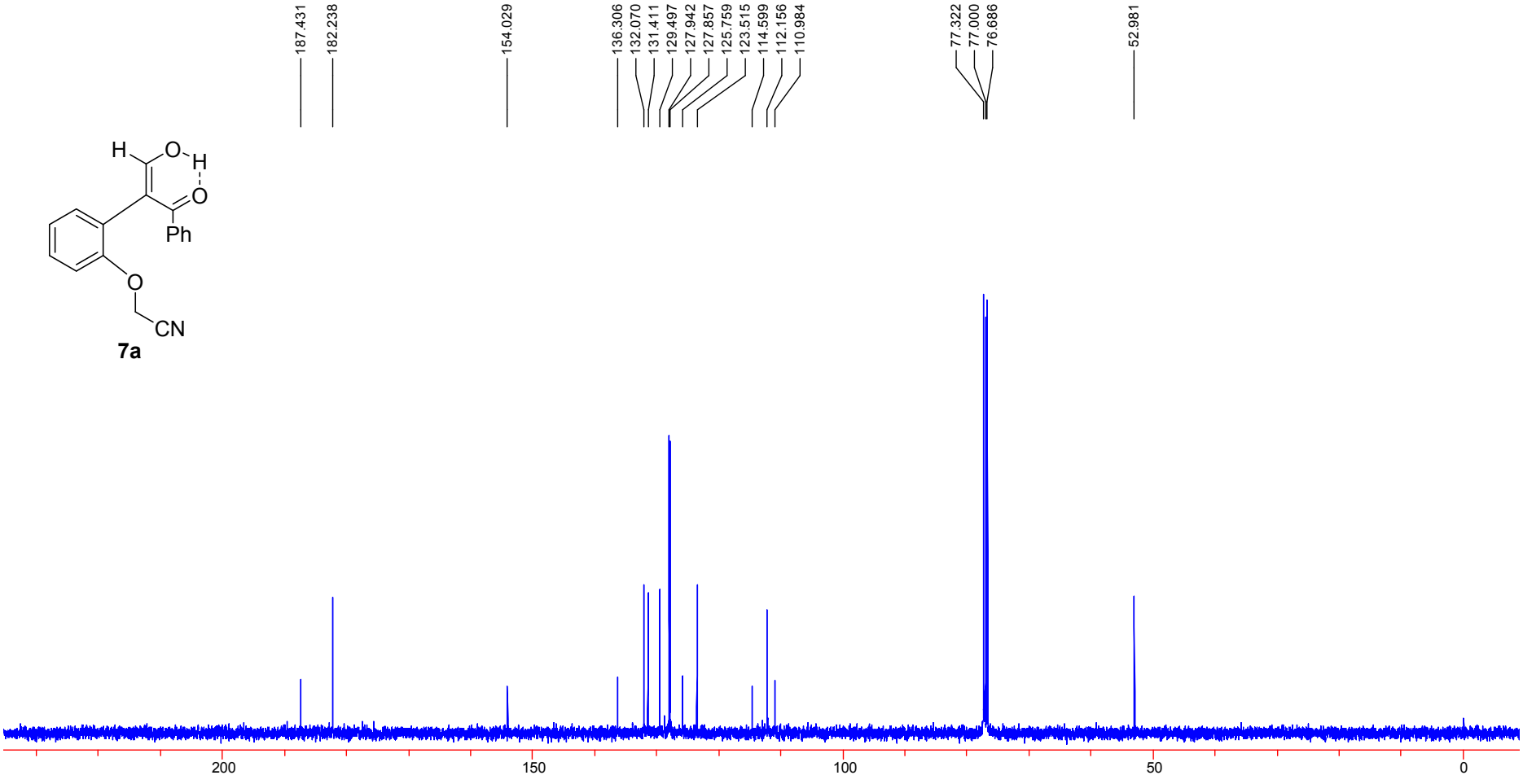


6b

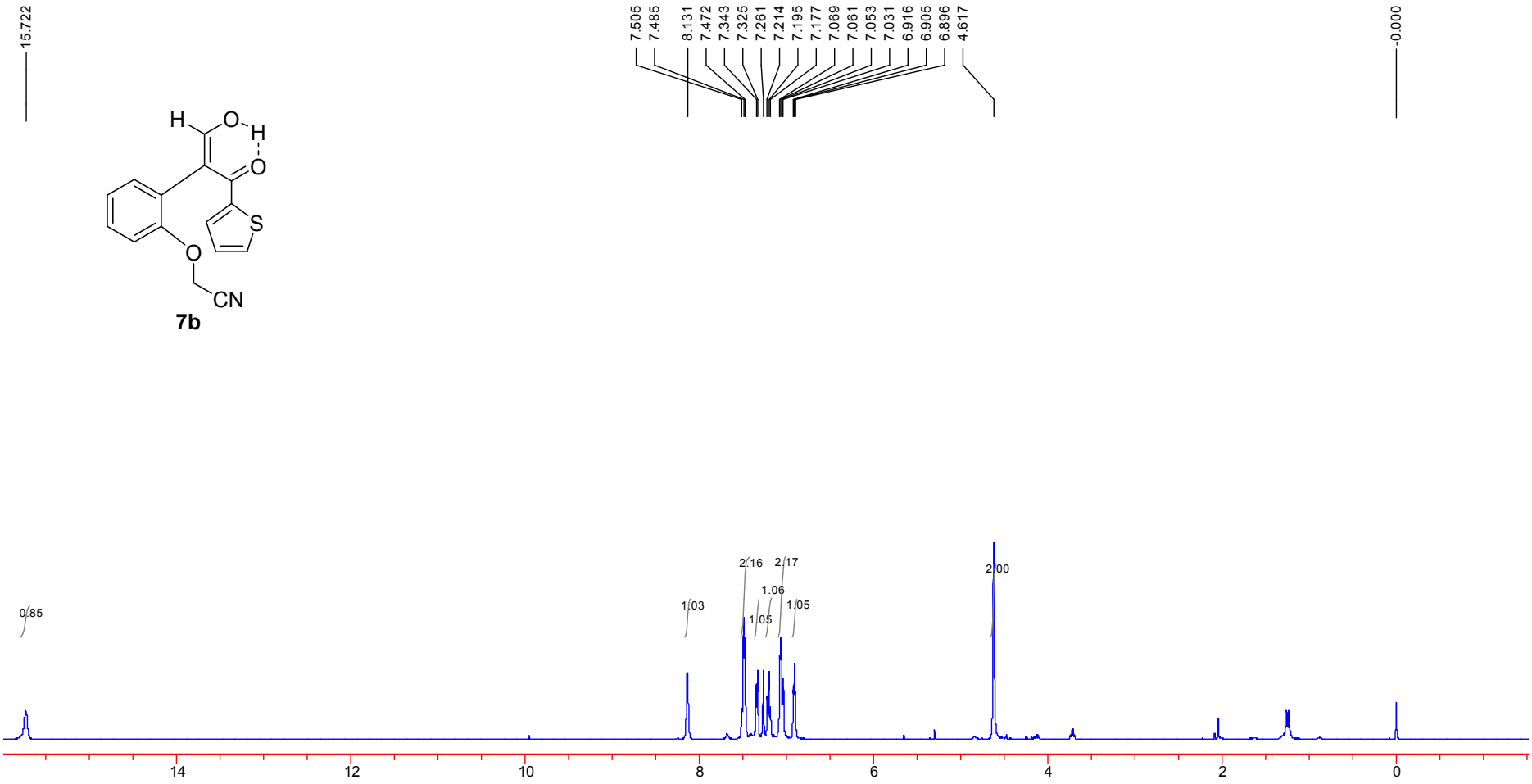
^{1}H NMR (400 MHz, $CDCl_3$)



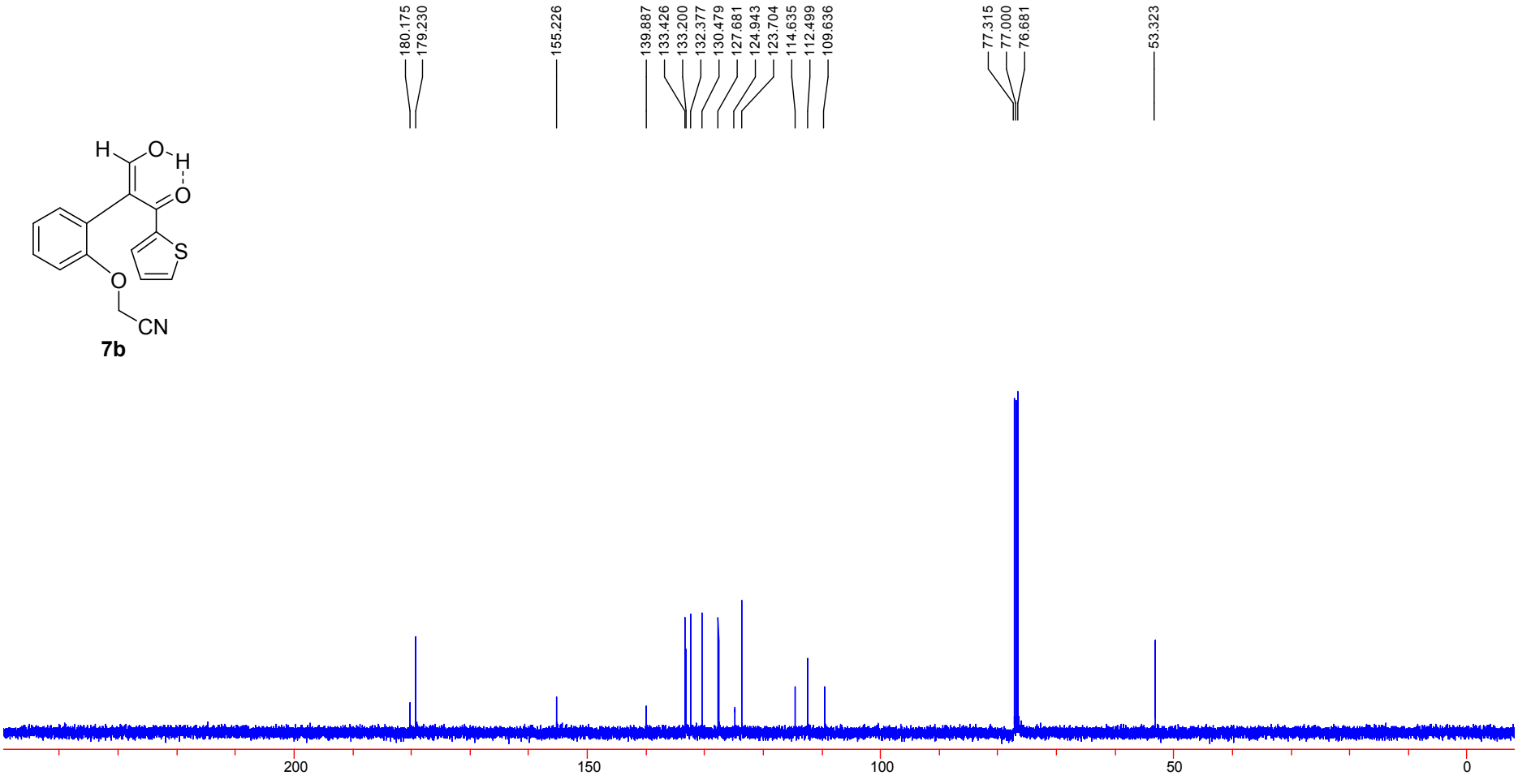
^{13}C NMR (100 MHz, $CDCl_3$)



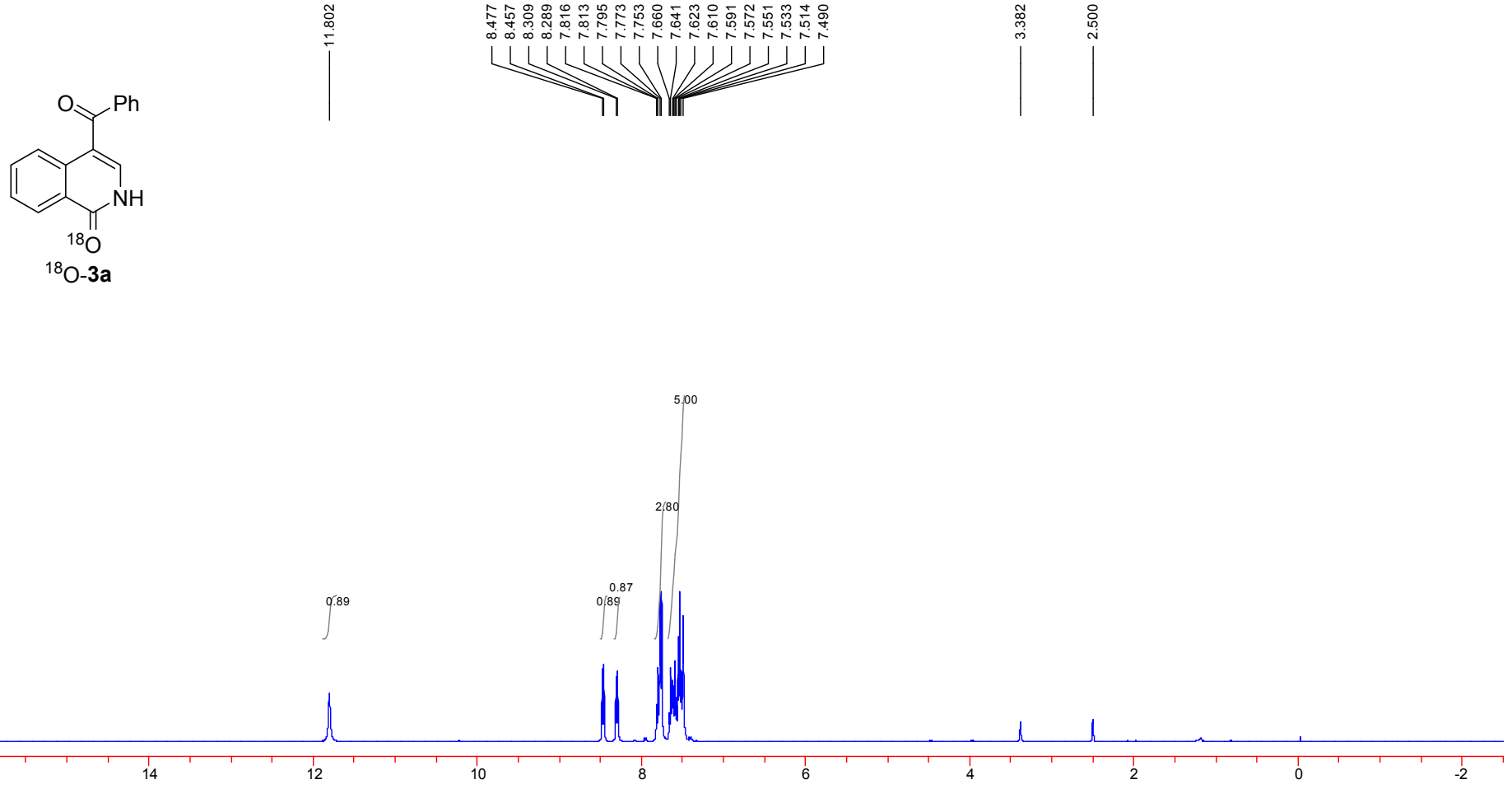
^{1}H NMR (400 MHz, $CDCl_3$)



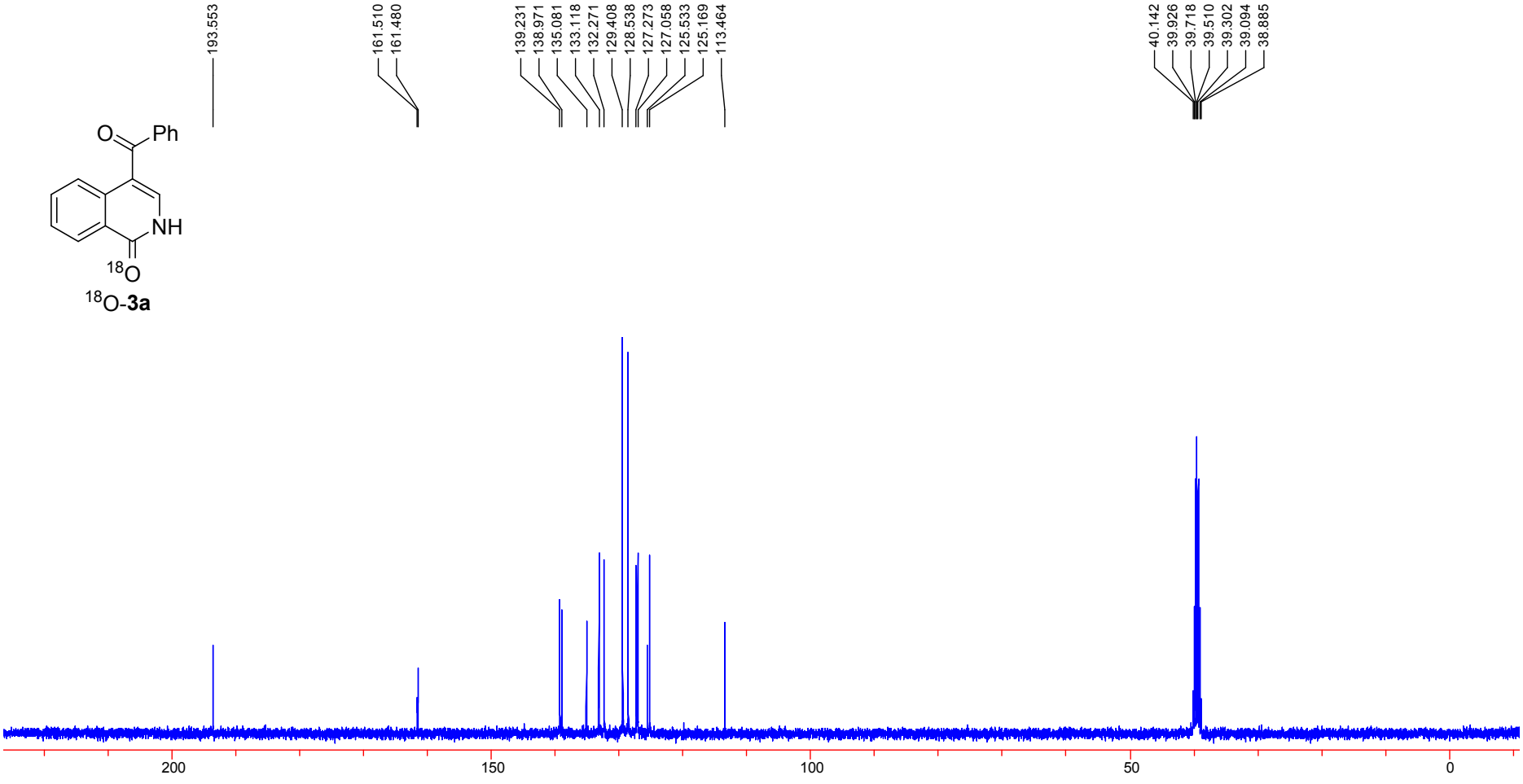
^{13}C NMR (100 MHz, $CDCl_3$)



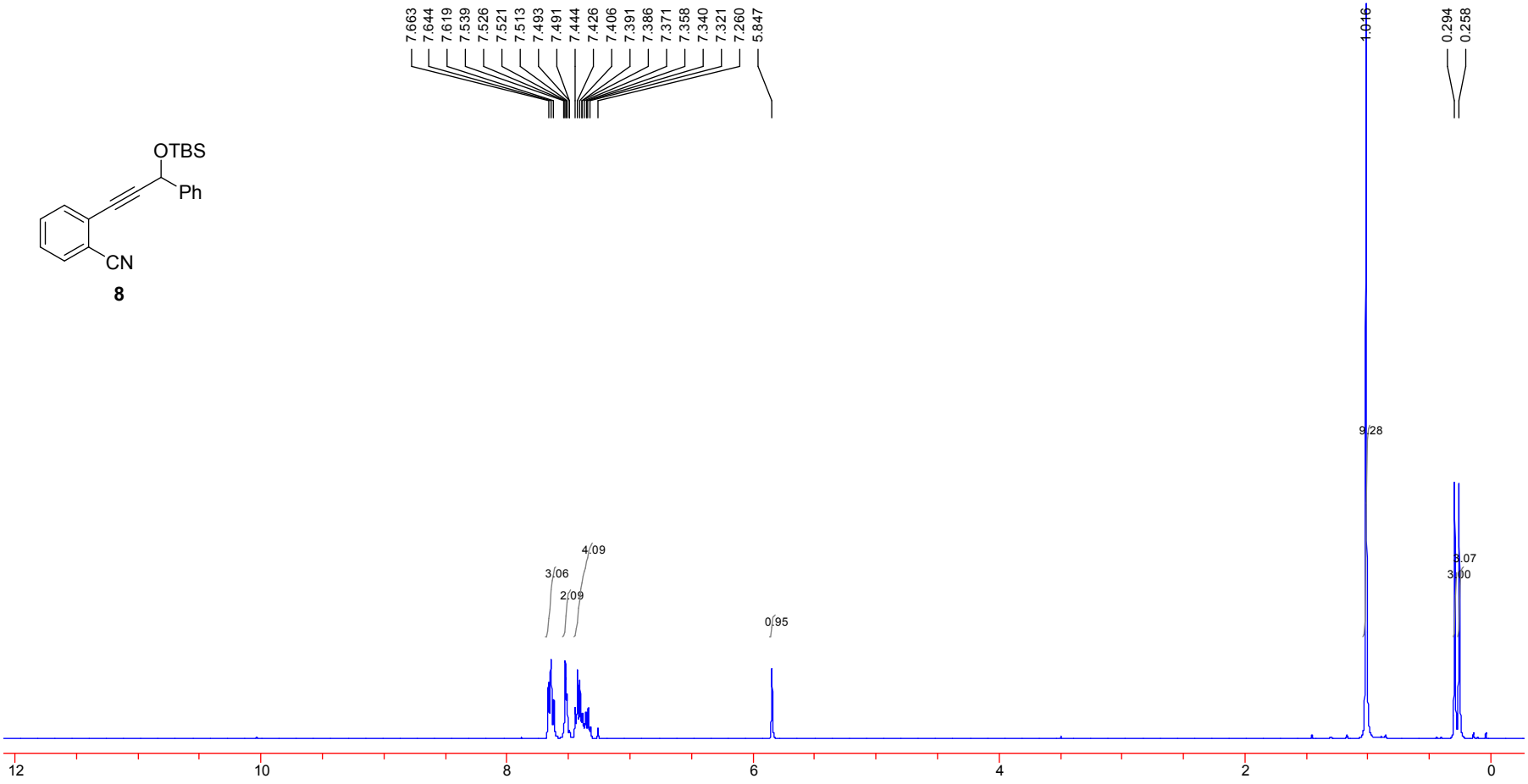
^{1}H NMR (400 MHz, DMSO-d_6)



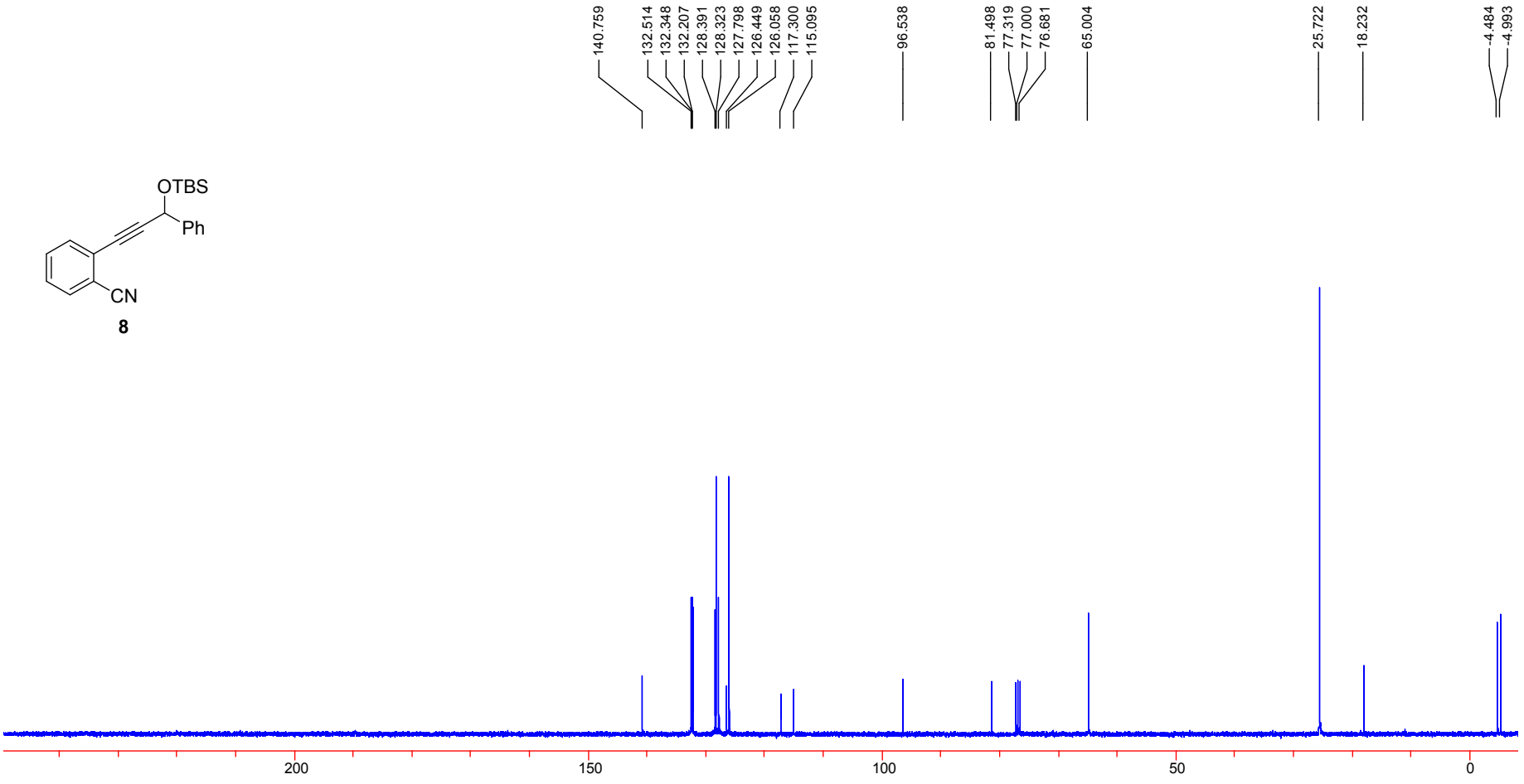
^{13}C NMR (100 MHz, DMSO-d_6)



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

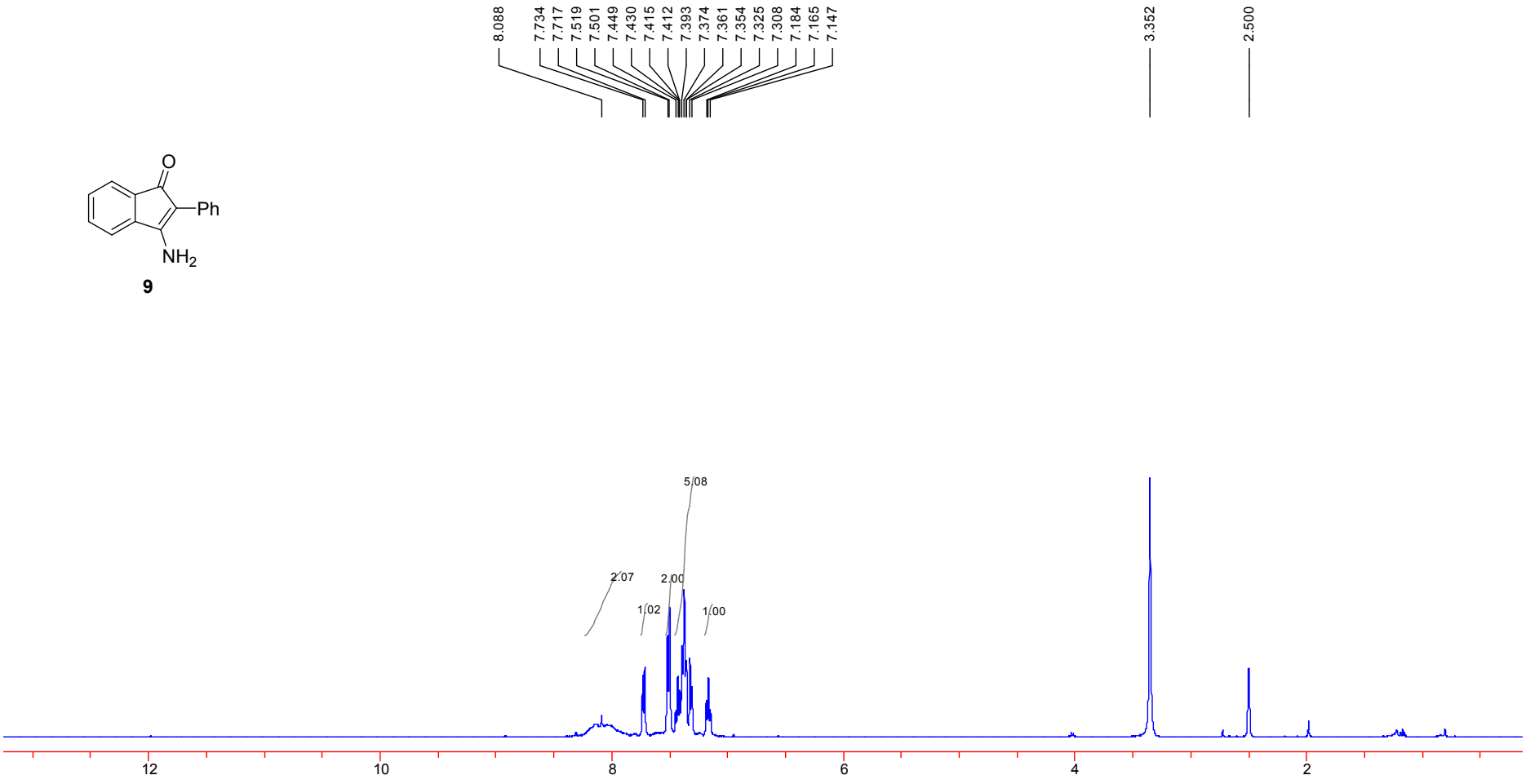


^{13}C NMR (100 MHz, $CDCl_3$)

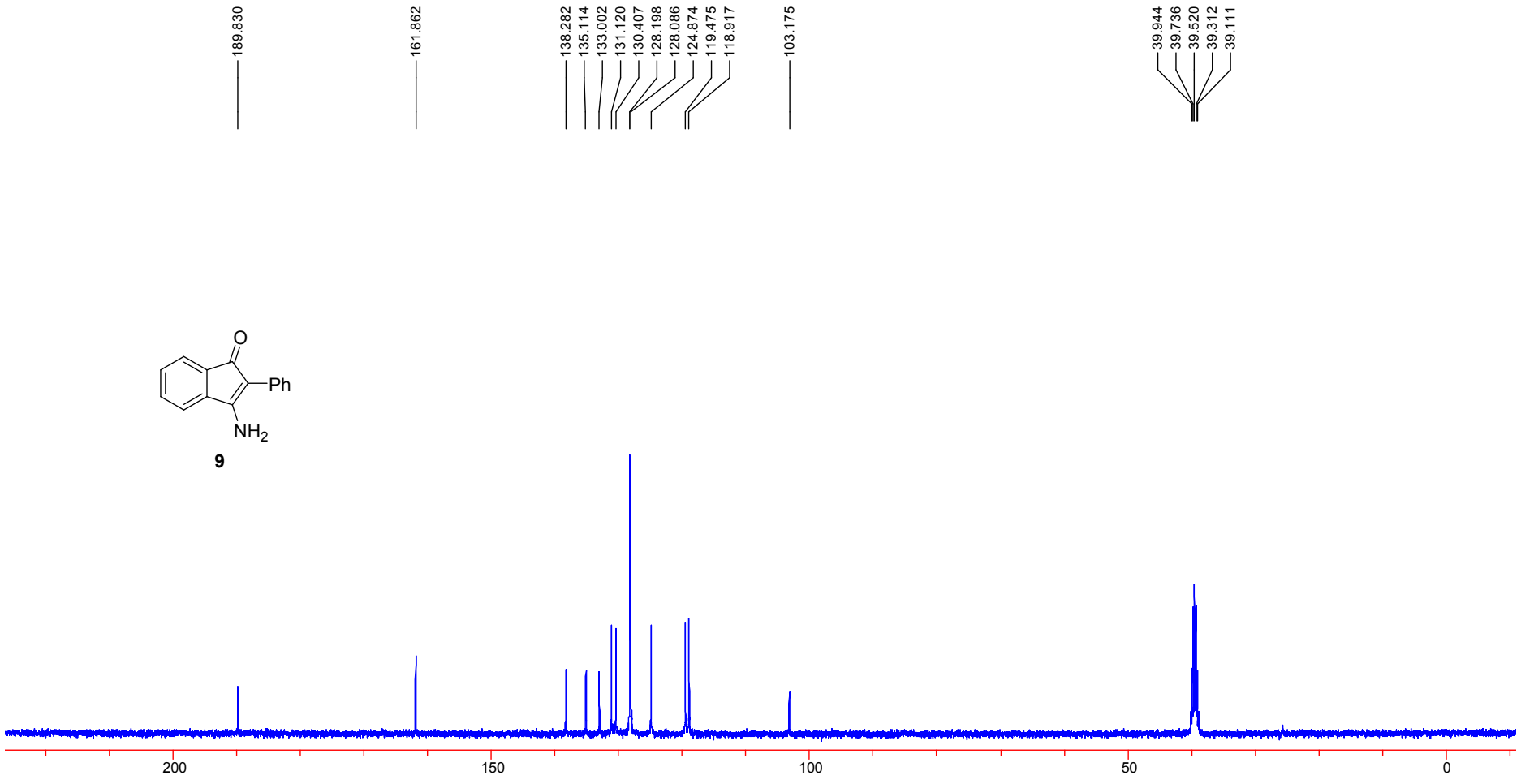


8

^{1}H NMR (400 MHz, DMSO-*d6*)



^{13}C NMR (100 MHz, DMSO-*d6*)



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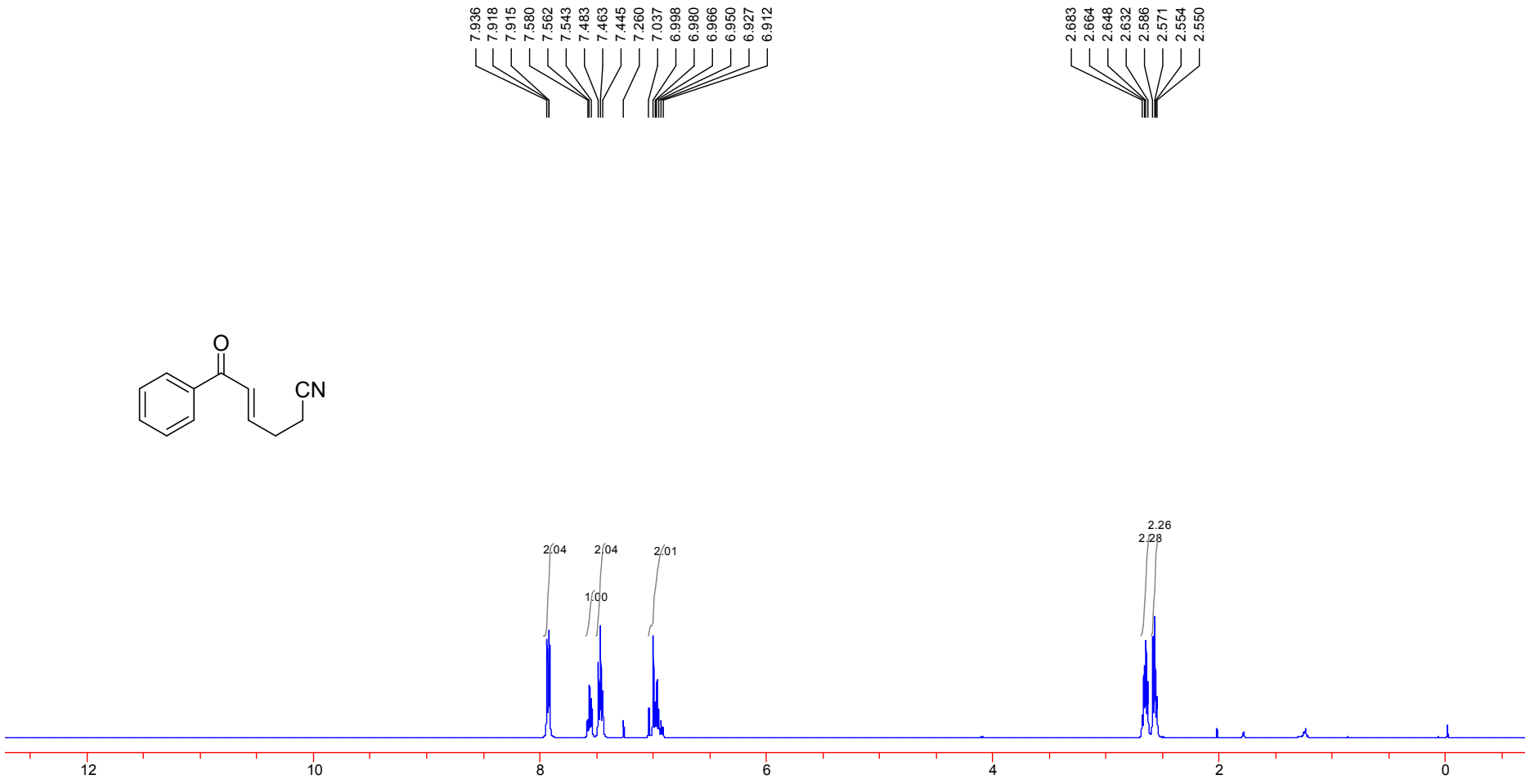
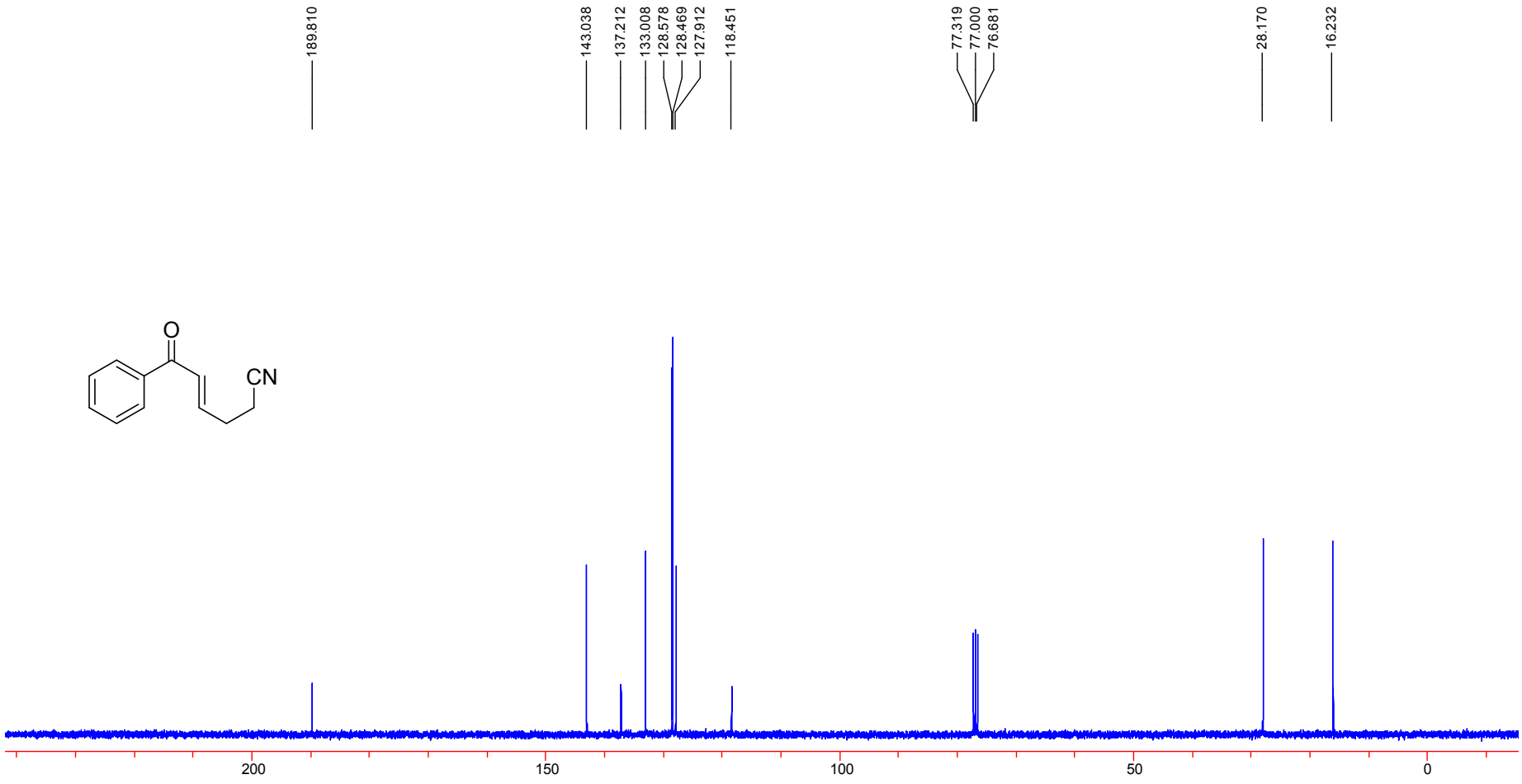
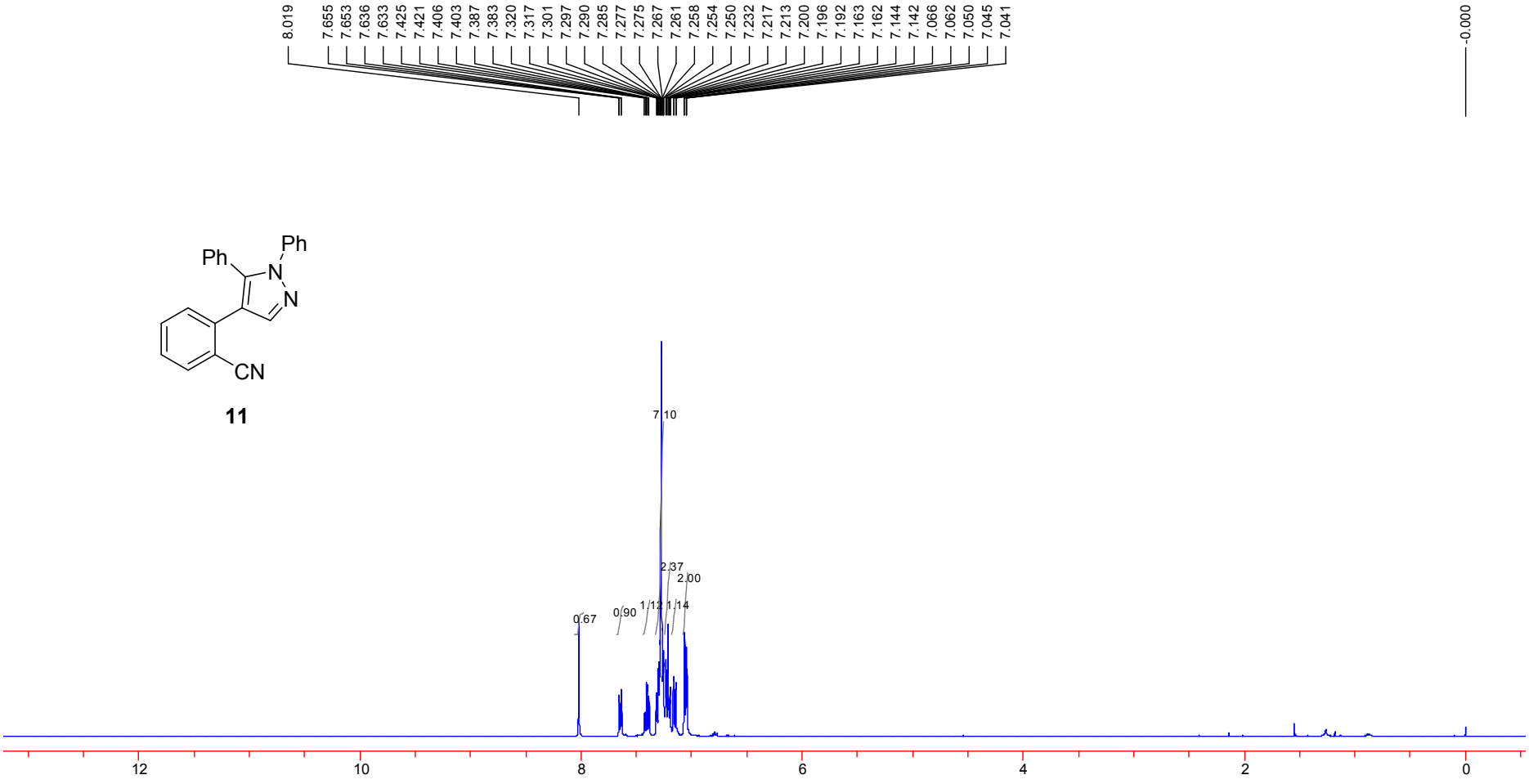
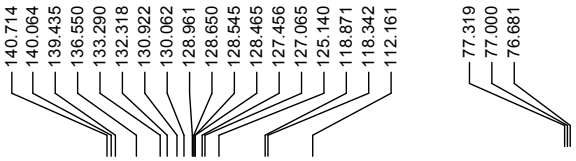

7.936
7.918
7.915
7.580
7.562
7.543
7.483
7.463
7.445
7.260
7.037
6.998
6.980
6.966
6.950
6.927
6.912
2.683
2.664
2.648
2.632
2.586
2.571
2.554
2.550
O
CN
2.04
2.04
2.01
1.00
2.26
2.28
12
10
8
6
4
2
0

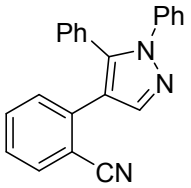

189.810
143.038
137.212
133.008
128.578
128.469
127.912
118.451
77.319
77.000
76.681
28.170
16.232
O
CN
200
150
100
50
0

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



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





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