Supporting Information for

Multiheterocyclic Motifs via Three-Component Reactions of Benzynes, Cyclic Amines, and Protic–Nucleophiles

Sean P. Ross and Thomas R. Hoye*

Department of Chemistry
University of Minnesota
207 Pleasant St. SE
Minneapolis, MN 55455

*Correspondence to: hoye@umn.edu

Table of Contents

page #

I. General Experimental Protocols

NMR spectra (^{1}H and ^{13}C) were recorded on and HD-500 or AV-500 (500 MHz) spectrometer. ^{1}H chemical shifts in $CDCl_3$ solutions are referenced to TMS (δ 0.00 ppm). When encountered, non-first order multiplets in the ^{1}H NMR spectra are noted as 'nfom'. The following format is used to report resonances: chemical shift (ppm) [multiplicity, coupling constant(s) (Hz), integral (to the nearest integer), and assignment]. Assignments are indicated by the structural environment, e.g., R^{1}C*Ha*Hb; for diastereotopic geminal protons, the more downfield resonance is, arbitrarily, labeled as H_a. Coupling constants were analyzed using methods we have reported elsewhere.[1,2] Most ^{13}C NMR chemical shifts were determined by analysis of the HMBC and phase sensitive HSQC spectra using Mnova software package. Otherwise the carbon NMR spectrum shifts are measured from "1-D" spectra, labeled as such in the line listings. In some instances, particularly so in the case of NMR spectra of complex structures, the shifts of protons were determined from cross peaks in the HSQC spectra. In cases of severely overlapping peaks, the integration of individual contributing peaks are assumed to be the expected value. For example, if four individual CH's (as evidenced by the HSQC spectrum) are overlapped between 1.4 and 1.2 ppm and the integral value over that range equals 4, it is assumed that each resonance corresponds to one ("1H") proton.

Infrared spectra were measured on a Midac Corporation (Prospect 4000) FT-IR spectrometer. Only the more intense and/or diagnostic peaks are reported; spectra were collected as neat thin films on a germanium window in the attenuated total reflectance (ATR) mode.

High-resolution **mass spectrometry** (HRMS) measurements were obtained on a Bruker BioTOF II (ESI-TOF) instrument using electrospray ionization mode (ESI) using poly(ethylene glycol) (PEG) or poly(propylene glycol) (PPG) as the standard/calibrant. Samples were introduced as methanol solutions, doped with either sodium formate or ammonium acetate. HRMS data were collected as approximately ten separate data sets and then averaged to obtain the reported "found" value.

Medium pressure liquid **chromatography** (MPLC) was done on hand-packed columns of silica gel (25-200 psi, 20-40 μm, 60 Å pore size, Teledyne RediSep Rf Gold® normal-phase silica). The unit was outfitted with a Waters HPLC pump (M6000), a Waters (R401) differential refractive index detector, and a Gilson (112 UV) detector. Flash chromatography columns were packed with E. Merck silica gel (230-400 mesh). Thin layer chromatography (TLC, silica gel) was performed on glass-backed plates that were visualized by UV detection and/or by dipping into a solution of potassium permanganate or ceric ammonium molybdate (CAM) and heating.

Reactions performed under anhydrous conditions were done in oven-dried glassware under an atmosphere of nitrogen. Anhydrous THF was obtained from a column of activated alumina, immediately prior to use. Reaction temperatures refer to the temperature of the external cooling or heating bath unless otherwise noted. HDDA reactions, including those performed at temperatures above the boiling point of the reaction solvent, were performed in a screw-capped vial or culture tube capped with an inert, Teflon®-lined closure." DABCO was dried by azeotropic removal of water from a refluxing solution of toluene; when the concentration reached ca. 1 M, the solution was cooled and the DABCO crystallized as a white powder, which was collected by filtration and pumped to remove residual PhMe.

II. Methods for assigning the structure to two isomeric compounds arising from the trapping of the benzynes arising from 6a and 6b.

Competitive attack by the amine nucleophile at the two different benzyne carbons in the benzynes arising from HDDA precursors **6a** and **6b** led to major and minor isomers, as summarized below in Figure S1. The structures were assigned by analysis of the ^{1}H and ^{13}C NMR spectra—more specifically, trends in significant chemical shifts between each pair—and/or selective NOE correlations for at least one compound in each structural class of product, as summarized in Figure S1. The preference for isomer formation is consistent with previous reports of amine trapping with these types of benzyne.

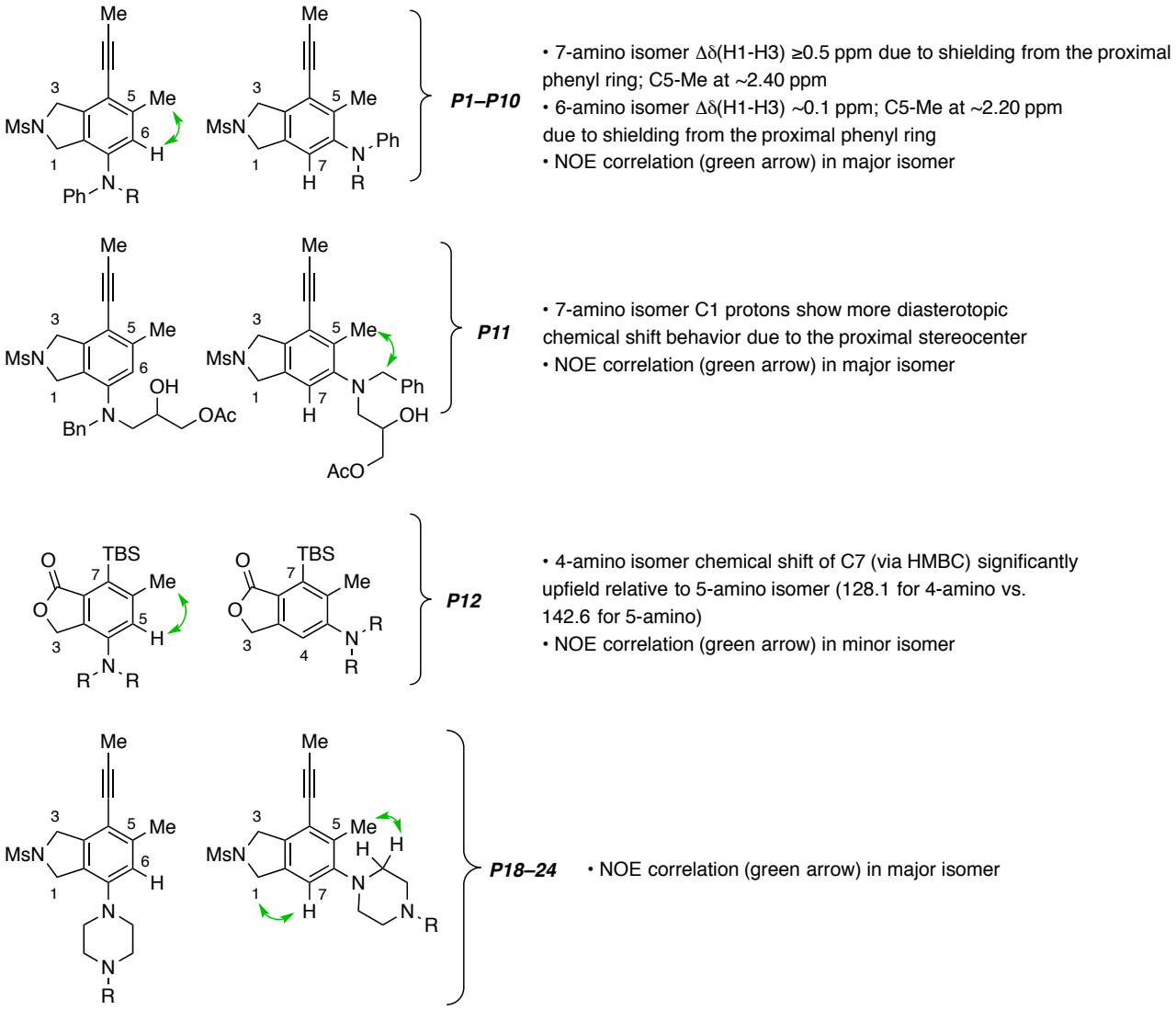
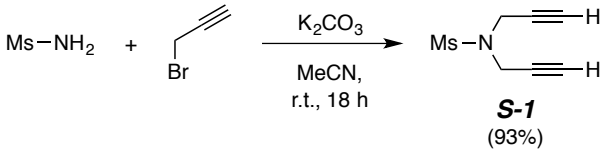


Figure S1. Summary of methods used for assignment of structure to the isomeric pairs shown.

III. Preparation procedures and characterization data for all new compounds

N,*N*-Di(prop-2-yn-1-yl)methanesulfonamide (S-1)



Methane sulfonamide (5.01 g, 52.6 mmol) and potassium carbonate (36.0 g, 263 mmol, 5 equiv) were placed in a 500 mL RBF equipped with a stir bar. Acetonitrile (175 mL, 0.3 M) was added and the contents were protected from light by wrapping the flask in aluminum foil. Propargyl bromide (80 % w/w in toluene, 16 mL, 131.4 mmol, 2.5 equiv) was added, and the resulting suspension was allowed to stir overnight. The mixture was filtered through Celite^{TM} and the filtrate was concentrated under reduced pressure. The crude product was purified by flash chromatography (2:1 hexane: EtOAc) to give **S-1** (8.37 g, 48.9 mmol, 93 %) as an off-white solid. If preferred, this solid can be recrystallized in a mixture of hexanes and EtOAc (ca. 5:1 vol ratio).

^{1}H NMR (500 MHz, $CDCl_3$): δ 4.17 (d, J = 2.5 Hz, 4H, NCH_2), 2.97 (s, 3H, NSO_2CH_3), and 2.39 (t, J = 2.5 Hz, 2H, C≡CH).

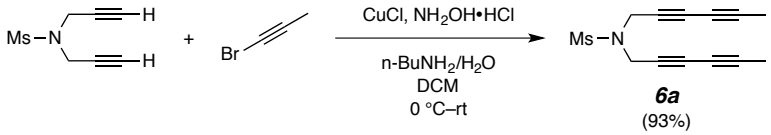
^{13}C NMR (125 MHz, $CDCl_3$): 76.1, 74.7, 38.7, and 36.6.

IR (neat): 3284, 2120, 1434, 1343, 1327, 1152, 1081, 951, 891, and 784 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_7H_9NNaO_2S^+$ [M+Na$^+$] requires 194.0246; found 194.0249.

mp: 54.5-56.5 °C.

***N,N*-Di(hexa-2,4-diyn-1-yl) methanesulfonamide (6a)**



Copper (I) chloride (115 mg, 1.17 mmol) and hydroxylamine hydrochloride (409 mg, 5.84 mmol) were added to a 250 mL 3-neck RBF equipped with a magnetic stir bar, and two addition funnels. The reaction vessel was placed under a nitrogen atmosphere and 40 % (v/v) aqueous butylamine was added and the mixture was cooled to 0 °C. *N,N*-Dipropargyl methanesulfonamide (2.0 g, 11.7 mmol) in DCM (59 mL) was placed into one addition funnel, and bromopropyne in hexane (1.4 M, 33.4 mL, 46.7 mmol) into the other. The solution of diyne was added dropwise, after approximately 10 % had been added (~6 mL), bromopropyne addition was begun; it was added at approximately the same rate as the diyne until addition of both reactants was complete. The mixture was allowed to warm to room temperature. After 40 minutes the reaction was judged to be complete by TLC (3:1 Hexane:EtOAc). The mixture was quenched by the addition of saturated aqueous NH_4Cl (50 mL) and extracted with DCM (50 mL). The combined organic layers were washed with NH_4Cl (50 mL, 1x) and brine (50 mL, 1x), dried ($MgSO_4$), and concentrated to give crude **6a** as an off-white solid. The crude product was purified by column chromatography (3:1 Hex:EtOAc to 2:1 Hex:EtOAc) to yield **6a** as a white crystalline solid (2.69 g, 10.9 mmol, 93%).

^{1}H-NMR (500 MHz, $CDCl_3$): 4.21 [s, 4H, MsN(CH_2)$_2$], 2.96 (s, 3H, NSO_2CH_3), and 1.94 (s, 6H, C≡CCH_3).

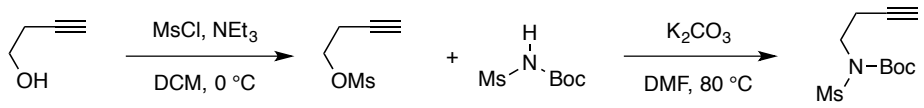
^{13}C-NMR (125 MHz, $CDCl_3$): 77.3, 71.6, 67.8, 63.6, 38.8, 37.6, and 4.4.

IR (neat): 2260, 1430, 1345, 1329, 1154, 1073, 965, 948, 893, and 781 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{13}H_{13}NNaO_2S^+$ [M+Na^+] requires 270.0559; found 270.0553.

mp: 99-101 °C.

***tert*-Butyl But-3-yn-1-yl(methylsulfonyl)carbamate (S-2)**



S-2
(83%)

3-Butynol (5 g, 71.3 mmol) and triethylamine (15 mL, 107.0 mmol, 1.5 equiv) were added to a 500 mL round-bottom flask, dissolved in DCM (237 mL), placed under nitrogen, and cooled to 0 °C. Methanesulfonyl chloride (6.9 mL, 89.2 mmol, 1.25 equiv) was diluted to 20 mL with DCM and added dropwise over 30 minutes. The mixture was stirred at 0 °C for 45 min, quenched with water (75 mL), and extracted with additional DCM (2 x 25 mL). The combined organic layers were washed with brine (75 mL), dried ($MgSO_4$), filtered, and concentrated (~20 °C, 20 torr). The resulting residue was distilled under vacuum (bp ~50 °C, ca. 1 torr) to give but-3-yn-1-yl methanesulfonate as a colorless liquid (10.6 g, 71.2 mmol, 99.8%). But-3-yn-1-yl methanesulfonate and *N*-Boc-methanesulfonamide (16.7 g, 85.4 mmol, 1.2 equiv) were dissolved in DMF (237 mL). K_2CO_3 (14.76 g, 107 mmol, 1.5 equiv) was added, and the suspension was stirred at 85 °C overnight. The mixture was cooled to room temperature, filtered through Celite™, and concentrated (~0.1 torr, 25-30 °C). The resulting residue was dissolved in EtOAc (200 mL) and washed with 1 M HCl (50 mL x 3), $NaHCO_3$ (50 mL), and brine (50 mL). The organic layer was dried ($MgSO_4$), filtered, and concentrated to give **S-2** as a white solid (14.6 g, 59 mmol, 83 %).

^{1}H-NMR (500 MHz, $CDCl_3$): δ 3.89 (t, J = 6.9 Hz, 2H, MsNBocCH_2CH$_2$), 3.34 (s, 3H, NSO_2CH_3), 2.67 (td, J = 6.7, 2.7 Hz, 2H, BocMsNCH$_2$CH_2), 2.02 (t, J = 2.7 Hz, 1H, C≡CH), and 1.56 [s, 9H, COOC(CH_3)$_3$].

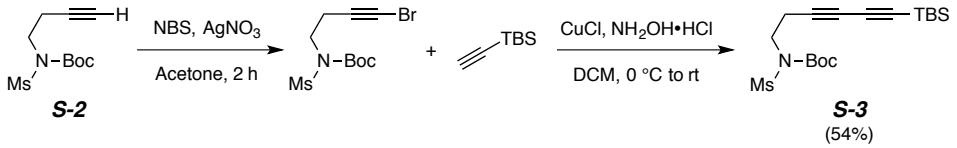
^{13}C-NMR (125 MHz, $CDCl_3$,1-D): δ 151.4, 85.0, 80.7, 70.7, 44.4, 42.6, 28.1, and 19.5.

IR (neat): 3282, 2978, 2936, 2121, 1726, 1351, 1140, 966, and 775 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{10}H_{17}NNaO_4S^+$ $[M+Na]^+$ requires 270.0770; found 270.0770.

mp: 60-63 °C.

***tert*-Butyl (6-(*tert*-Butyldimethylsilyl)hexa-3,5-diyn-1-yl)(methylsulfonyl)carbamate (S-3)**



Alkyne **S-2** (2.04 g, 8.25 mmol) was placed in a 100 mL round-bottom flask, dissolved in acetone (41 mL) and wrapped in foil. Silver nitrate (140 mg, 0.82 mmol, 0.1 equiv) and NBS (1.84 g, 10.3 mmol, 1.25 equiv) were added and the mixture was stirred at room temperature for 2 h. The mixture was then filtered and concentrated. The resulting residue was passed through a plug of silica (3:1 Hex:EtOAc) to give crude bromoalkyne (2.73 g).

Copper chloride (82 mg, 0.83 mmol, 0.1 equiv) and hydroxylamine hydrochloride (143 mg, 2.06 mmol, 0.25 equiv) were added to a 250 mL, 3-neck round-bottom flask, equipped with an addition funnel and 2 septa and placed under N_2. A solution of 40% (v/v) butylamine:water (24 mL) was added and the colorless solution was cooled to 0 °C. TBS-acetylene (1.74 g, 12.4 mmol, 1.5 equiv) was dissolved in DCM (60 mL) and 6 mL of this solution was added dropwise via syringe over 10 minutes. The crude bromoalkyne in DCM (60 mL) was added to the remainder of the TBS-acetylene solution, and the resulting solution was added dropwise via addition funnel over 60 minutes. The cooling bath was removed and the heterogeneous mixture was stirred for an additional 3 h at room temperature. The mixture was quenched by the addition of saturated NH_4Cl (75 mL) and extracted with additional DCM (2 x 100 mL). The organic layers were combined, washed with brine (75 mL), dried ($MgSO_4$), and concentrated. The resulting residue was purified by column chromatography (SiO_2, 6:1 Hex:EtOAc) to give **S-3** as a white solid (1.71 g, 4.44 mmol, 54%).

^{1}H-NMR (500 MHz, $CDCl_3$): δ 3.90 (t, J = 6.8 Hz, 2H, MsBocNCH_2CH$_2$), 3.34 (s, 3H, NSO_2CH_3), 2.64 (t, J = 6.7 Hz, 2H, MsBocNCH$_2$CH_2), 1.56 [s, 9H, $NCO_2C(CH_3)_3$], 0.93 [s, 9H, $SiC(CH_3)_3$], and 0.11 [s, 6H, $Si(CH_3)_2$].

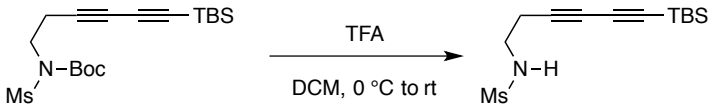
^{13}C-NMR (125 MHz, $CDCl_3$): δ 151.2, 88.4, 85.1, 83.2, 75.0, 67.7, 43.9, 42.5, 28.1, 26.1, 20.3, and -4.9.

IR (neat): 2957, 2934, 2896, 2861, 2229, 2107, 1731, 1353, 1141, 966, and 775 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{18}H_{35}N_2O_4SSi^+$ $[M+NH_4]^+$ requires 403.2081; found 403.2098.

mp: 103-104 °C.

***N*-(6-(*tert*-Butyldimethylsilyl)hexa-3,5-diyn-1-yl)methanesulfonamide (S-4)**



S-3 ***S-4*** (98%)

N-Boc-Sulfonamide **S-3** (1.67 g, 4.34 mmol) was added to a 100 mL round-bottom flask, dissolved in DCM (65 mL), and cooled to 0 °C under N_2. Trifluoroacetic acid (TFA, 6.4 mL, 82.5 mmol, 19 equiv) was added dropwise over 15 min at 0 °C. The cooling bath was removed and the mixture was stirred at room temperature for 6 h. The reaction was quenched by the careful addition of aq. $NaHCO_3$ and extracted with DCM (50 mL x 3). The combined organic layers were washed with brine (50 mL), dried ($MgSO_4$), filtered, and concentrated to give sulfonamide **S-4** (1.21 g, 4.24 mmol, 98%)

^{1}H-NMR (500 MHz, $CDCl_3$): δ 4.59 (br t, J = 5.6 Hz, 1H, MsN*H*), 3.32 (dt, J = 6.4, 6.4 Hz, 2H, MsNCH_2CH$_2$), 3.00 (s, 3H, NSO_2CH_3), 2.59 (t, J = 6.3 Hz, 2H, MsNCH$_2$CH_2), 0.95 [s, 9H, SiC(CH_3)$_3$], and 0.14 [s, 6H, Si(CH_3)$_2$].

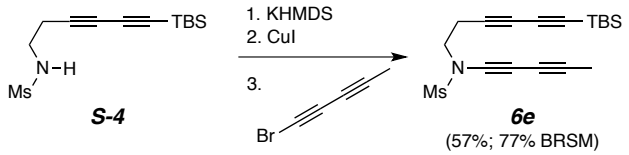
^{13}C-NMR (125 MHz, $CDCl_3$): δ 88.2, 83.6, 74.8, 68.1, 41.6, 41.1, 26.0, 21.4, 16.7, and -4.9.

IR (neat): 3245, 2950, 2929, 2885, 2857, 2228, 2105, 1303, 1142, 826, and 777 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{13}H_{23}NNaO_2SSi^+$ $[M+Na]^+$ requires 308.1111; found 308.1106.

mp: 100-104 °C.

_N_-(6-(_tert_-Butyldimethylsilyl)hexa-3,5-diyn-1-yl)-_N_-(penta-1,3-diyn-1-yl)methanesulfonamide (6e)



Sulfonamide **S-4** (1.21 g, 4.24 mmol) was added to a 250 mL round-bottom flask, dissolved in anhydrous THF (16 mL) and pyridine (9 mL), cooled to 0 °C, and purged with Ar. KHMDS (930 mg, 4.66 mmol, 1.1 equiv) in THF (6 mL) was added dropwise over 15 minutes at 0 °C. The cooling bath was removed and the solution was stirred for 15 min. CuI (890 mg, 4.66 mmol, 1.1 equiv) was added by quickly removing and replacing the septum, and the suspension was stirred under Ar at room temperature for 2.5 h. 1-Bromopentadiyne (prepared starting from 7.60 mmol of 2-methylhex-3,5-diyn-2-ol)[3] in toluene (~100 mL) was added dropwise via addition funnel over 45 minutes, and the reaction mixture was stirred overnight (~20 h). Reaction was quenched by the addition of 3:1 mixture of brine:NH_4OH (conc.) (80 mL). This mixture was extracted with Et_2O (150 mL). The organic layer was washed with additional 3:1 brine:NH_4OH (40 mL x 3) until the aq. layer was colorless. The combined aq. layers were combined and extracted with Et_2O (100 mL x 2). The combined organic layers were washed with 1M HCl (100 mL x 2), $NaHCO_3$ (50 mL x 2), and brine (50 mL), dried ($MgSO_4$), filtered, and concentrated. The resulting residue was purified by column chromatography (SiO_2, 30:1 to 6:1 to 1:1 Hex:EtOAc) to afford the tetrayne **6e** (0.837 g, 2.41 mmol, 57%). the solvent polarity was increased to 1:1 Hex:EtOAc, which allowed recovery of the starting sulfonamide **S-4** (0.321 g, 1.12 mmol). The yield of **6e** based on recovered starting material was 77%.

^{1}H-NMR (500 MHz, $CDCl_3$): δ 3.66 (t, J = 7.0 Hz, 2H, MsNCH_2CH$_2$), 3.17 (s, 3H, NSO_2CH_3), 2.72 (t, J = 6.9 Hz, 2H, MsNCH$_2$CH_2), 1.98 (s, 3H, C≡CCH_3), 0.94 [s, 9H, SiC(CH_3)$_3$], and 0.12 [s, 6H, Si(CH_3)$_2$].

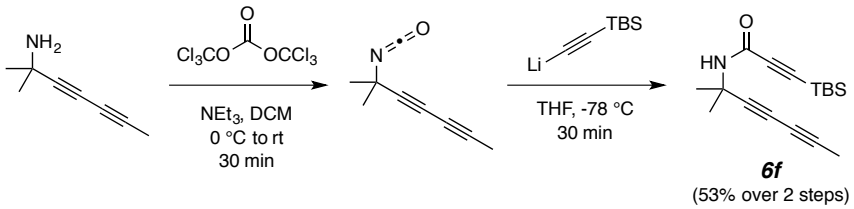
^{13}C-NMR (125 MHz, $CDCl_3$): δ 88.1, 83.8, 80.8, 74.2, 68.2, 64.8, 63.4, 60.2, 49.5, 39.5, 26.0, 19.5, 16.7, 4.5, and -4.9.

IR (neat): 2953, 2931, 2858, 2258, 2229, 2169, 2108, 1364, 1166, 956, and 776 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{18}H_{25}NNaO_2SSi^+$ $[M+Na]^+$ requires 370.1267; found 370.1270.

mp: 60-63 °C

3-(*tert*-Butyldimethylsilyl)-*N*-(2-methylhepta-3,5-diyn-2-yl)propiolamide (6f)



2-Methylhepta-3,5-diyn-2-amine[4] (250 mg, 2.06 mmol) and triethylamine (0.86 mL, 6.2 mmol, 3 equiv) were dissolved in DCM (5 mL), placed under nitrogen, and cooled to 0 °C. To this solution triphosgene (306 mg, 1.03 mmol, 1.5 equiv phosgene) in DCM (5 mL) was added dropwise over 5 min, the ice bath was removed, and the solution was stirred for 30 min. The crude reaction mixture was filtered through Celite™, concentrated, and the resulting residue was passed through a plug of silica (Et_2O) to give the crude isocyanate, which was used immediately for the following step.

tert-Butyldimethylsilylacetylene (438 mg, 3.12 mmol, 1.51 equiv) was added to a 10 mL RBF, dissolved in THF (5 mL), placed under nitrogen, and cooled to 0 °C. To this solution, *n*-BuLi (1.24 mL, 2.5 M, 3.09 mmol, 1.50 equiv) was added dropwise over 10 min, and the resulting solution was stirred at 0 °C for 30 min, followed by cooling to -78 °C. The crude isocyanate from the previous step in THF (5 mL) was added dropwise to this lithium acetylide solution over 5 min. This mixture was stirred for 30 min at -78 °C, at which time TLC (10:1 Hex:EtOAc) indicated complete consumption of the isocyanate. The reaction was quenched with acetic acid (0.5 mL) and warmed to room temperature. The reaction mixture was transferred to separatory funnel with Et_2O (20 mL) and the organic layer was washed with sat. $NaHCO_3$ (10 mL x 2). The combined aq layers were combined and extracted with Et_2O (20 mL x 2), and the combined organic layers were washed with brine (20 mL), dried ($MgSO_4$), filtered, concentrated, and the resulting residue was passed through a plug of silica (3:1 Hex:EtOAc). Concentration to a volume of ~5 mL resulted in a white solid, which was washed with hexanes to give **6f** (168 mg, 0.58 mmol, 28%) as a crystalline white solid. The mother liquor was purified by MPLC (15:1 Hex:EtOAc) to give additional **6f** (148 mg, 0.51 mmol, 25%), also as a crystalline white solid.

^{1}H-NMR (500 MHz, $CDCl_3$): δ 5.85 (br s, 1H, N*H*), 1.92 (s, 3H, C≡CCH_3), 1.65 [s, 6H, C≡CC(CH_3)$_2$], 0.96 [s, 9H, SiC(CH_3)$_3$], and 0.16 [s, 6H, Si(CH_3)$_2$].

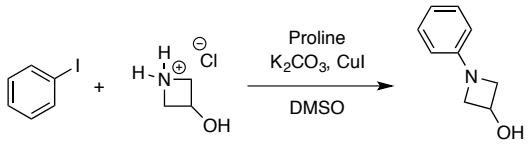
^{13}C-NMR (125 MHz, $CDCl_3$): δ 151.5, 98.8, 89.2, 77.3, 77.2, 67.2, 63.8, 49.2, 28.7, 26.1, 16.7, 4.4, and -4.9.

IR (neat): 3236, 3030, 2954, 2934, 2858, 2258, 2163, 1638, 1538, 1288, 1251, and 830 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{17}H_{25}NNaOSi^+$ $[M+Na]^+$ requires 310.1598; found 310.1588.

mp: 158–159 °C

1-Phenylazetidin-3-ol (8f)



8f
(59%)

Iodobenzene (1.02 g, 5 mmol), 3-hydroxyazetidine hydrochloride (1.64 g, 15 mmol, 3 equiv), and proline (115 mg, 1 mmol, 0.2 equiv) were placed in a culture tube equipped with a stir bar and then dissolved in DMSO (10 mL). Potassium carbonate (3.45 g, 25 mmol 5 equiv) and cupric iodide (95 mg, 0.5 mmol, 0.1 equiv) were added, and the culture tube was sealed with a Teflon-lined cap. The solution was heated for 40 h in an oil bath at 90 °C. The mixture was cooled, transferred to a separatory funnel with water (50 mL), and extracted with EtOAc (5 x 25 mL). The combined organic layers were washed with brine (25 mL), dried (Na_2SO_4), filtered, and concentrated. The resulting residue was purified by flash column chromatography (1:1 Hex:EtOAc) to give **8f** (439 mg, 2.94 mmol, 59%) as a white solid.

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.22 (dd, J = 8.6, 7.4 Hz, 2H, NArH_m), 6.76 (tt, J = 7.4, 0.9 Hz, 1H, NArH_p), 6.48 (dd, J = 8.6, 1.1 Hz, 2H, NArH_o), 4.74 (br app pent, J = 6.3 Hz, 1H, CHOH), 4.17 (nfom, 2H, N(CH_aH$_b$)$_2$), 3.66 (nfom, 2H, N(CH$_a$$H_b$)$_2$), and 2.14 (br s, 1H, CHOH).

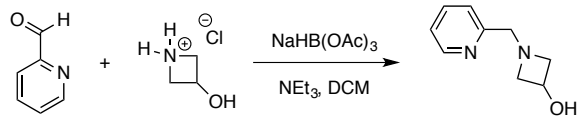
^{13}C-NMR (125 MHz, $CDCl_3$): δ 151.6, 129.0, 117.8, 111.9, 62.8, and 62.0.

IR (neat): 3324, 3036, 2944, 2849, 1600, 1503, 1474, 1347, 1125, and 754 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_9H_{12}NO^+$ [M+H$^+$] requires 150.0913; found 150.0917.

mp: 63-65 °C.

1-(Pyridin-2-ylmethyl)azetidin-3-ol (8g)



8g
(69%)

2-Pyridinecarboxaldehyde (1 g, 9.34 mmol), 3-hydroxyazetidine hydrochloride (1.23 g, 11.2 mmol, 1.2 equiv), and triethylamine (1.6 mL, 11.2 mmol, 1.2 equiv) were added to a 50 mL round bottom flask and dissolved in DCM (25 mL). Sodium triacetoxyborohydride (3.94 g, 18.6 mmol, 2 equiv) was added slowly over 20 min, and the resulting mixture was stirred at room temperature overnight. The reaction was quenched by the addition of sat. aq. K_2CO_3 (10 mL), transferred to a separatory funnel, diluted with water (10 mL), and extracted with DCM (5 x 20 mL). The combined organic layers were dried ($MgSO_4$), filtered, and concentrated. The resulting residue was purified by flash column chromatography (95:5:0.5 to 80:10:1 $CHCl_3$:MeOH:NH_4OH) to give **8g** (1.05 g, 6.41 mmol, 69%) as a brown oil.

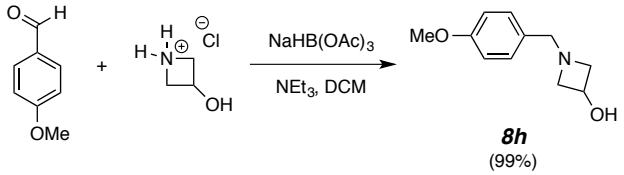
^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.53 (ddd, *J* = 5.0, 2.2, 1.1 Hz, 1H, py*H*6), 7.65 (ddd, *J* = 7.7, 7.7, 1.7 Hz, 1H, py*H*4), 7.30 (ddd, *J* = 7.9, 1.2, 1.2 Hz, 1H, py*H*3), 7.16 (ddd, *J* = 7.6, 4.8, 1.3 Hz, 1H, py*H*5), 4.48 (app pent, *J* = 5.9 Hz, 1H, C*H*OH), 3.78 (s, 2H, PyCH_2N), 3.71 [nfom, 2H, N(C_aH_2)$_2$], and 3.06 [nfom, 2H, N(C_bH_2)$_2$].

^{13}C-NMR (125 MHz, $CDCl_3$): δ 158.1, 149.2, 136.7, 122.5, 122.1, 65.1, 64.5, and 62.9.

IR (neat): 3240 (br), 2946, 2838, 1476, 1433, 1361, 1188, 1081, and 758 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_9H_{13}N_2O^+$ [M+H^+] requires 165.1022; found 165.1027.

1-(4-Methoxybenzyl)azetidin-3-ol (8h)



p-Anisaldehyde (1 g, 7.34 mmol), 3-hydroxyazetidine hydrochloride (0.97 g, 8.85 mmol, 1.16 equiv), and triethylamine (0.64 mL, 4.6 mmol, 0.6 equiv) were added to a 50 mL round bottom flask and dissolved in DCM (30 mL). Sodium triacetoxyborohydride (3.11 g, 14.6 mmol, 2 equiv) was added slowly over 20 min, and the resulting mixture was stirred at room temperature overnight. The reaction was quenched by the addition of sat. aq. K_2CO_3 (10 mL), transferred to a separatory funnel, diluted with water (10 mL), and extracted with DCM (5 x 20 mL). The combined organic layers were dried ($MgSO_4$), filtered, and concentrated. The resulting residue was purified by flash column chromatography (2:1 Hex:EtOAc +1% NEt_3) to give **8h** (1.40 g, 7.25 mmol, 99%) as a white solid.

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.17 (d, J = 8.6 Hz, 2H, MeOArH_m), 6.85 (d, J = 8.7 Hz, 2H, MeOArH_o), 4.42 (app pent, J = 5.8 Hz, 1H, CHOH), 3.79 (s, 3H, OCH_3), 3.59 [nfom, 2H, N(CH_aH$_b$)$_2$], 3.55 (s, 2H, MeOArCH_2N), and 2.92 [nfom, 2H, N(CH$_a$$H_b$)$_2$].

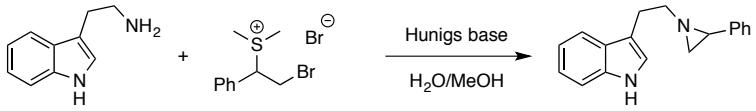
^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 158.9, 130.0, 129.9, 113.9, 64.0, 63.2, 62.9, and 55.4.

IR (neat): 3347 (br), 2948, 2834, 1612, 1513, 1361, 1245, 1175, and 1033 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{11}H_{16}NO_2^+$ [M+H$^+$] requires 194.1176; found 194.1182.

mp: 47–49 °C.

3-(2-(2-Phenylaziridin-1-yl)ethyl)-1H-indole (8j)



8j
(98%)

(2-Bromo-1-phenylethyl)dimethylsulfonium bromide[5] (3.49 g, 10.7 mmol) and Hünigs base (3.73 mL, 21.4 mmol, 2 equiv) were added to a 250 mL Erlenmeyer flask equipped with a stir bar and dissolved in water (52 mL). Tryptamine (3.43 g, 21.4 mmol, 2 equiv) in MeOH (18 mL) was added drop wise over 30 min, the flask was sealed, and the mixture was stirred overnight. The reaction was quenched by the addition of sat. aq. K_2CO_3 (20 mL), transferred to a separatory funnel, and extracted with DCM (5 x 50 mL). The combined organic layers were dried ($MgSO_4$), filtered, and concentrated. The resulting residue was purified by flash column chromatography (2:1 Hex:EtOAc +1% NEt_3) to give **8j** (2.76 g, 10.5 mmol, 98%) as a viscous orange oil.

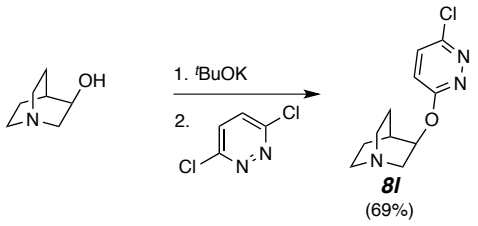
^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.96 (br s, 1H, N*H*), 7.59 (dddd, *J* = 7.9, 0.9, 0.9, 0.9 Hz, 1H, Ind*H*4), 7.33 (ddd, *J* = 8.1, 1.0, 1.0 Hz, 1H, Ind*H*7), 7.30-7.27 (m, 2H, PhH_o), 7.23-7.16 (m, 4H, PhH_m, PhH_p, Ind*H*6), 7.10 (ddd, *J* = 8.0, 7.0, 1.1 Hz, 1H, Ind*H*5), 6.94 (d, *J* = 2.4 Hz, 1H, Ind*H*2), 3.09 (nfom, 2H, IndCH_2CH_2N), 2.85 (nfom, 1H, IndCH_2CH_aH$_b$), 2.67 (nfom, 1H, IndCH_2C$H_a$$H_b$), 2.30 (dd, *J* = 6.6, 3.4 Hz, 1H, NC*H*Ph), 1.93 (d, *J* = 3.4 Hz, 1H, NCH_aH$_b$CHPh), and 1.69 (d, *J* = 6.6 Hz, 1H, NCH_aH$_b$CHPh).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 140.5, 136.2, 128.3, 128.2, 127.4, 126.4, 121.9, 121.8, 119.2, 118.8, 114.0, 111.1, 62.2, 41.4, 38.1, and 25.8.

IR (neat): 3415, 3172, 3052, 2922, 2844, 1457, 1341, 1090, and 1010 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{18}H_{19}N_2^+$ [M+H$^+$] requires 263.1543; found 262.1539.

(±)-3-((6-Chloropyridazin-3-yl)oxy)quinuclidine (8l)



The following procedure is reported in a patent.[6] Potassium *tert*-butoxide (508 mg, 4 mmol) was added to a 100 mL round-bottom flask equipped with a stir bar and septum and placed under N_2. THF (20 mL) was added. (±)-Quinuclidinol (448 mg, 4 mmol) was added in one portion by quickly removing and replacing the septum, and this mixture was stirred at room temperature for 1 h. 3,6-Dichloropyridazine (740 mg, 5 mmol) was added and the mixture was stirred at room temperature overnight (~14 h). The THF was removed under reduced pressure (~20 torr, 20 °C) and the resulting residue was partitioned between 9:1 $CHCl_3$:^{i}PrOH (50 mL) and brine (10 mL). The organic layer was dried over $MgSO_4$, filtered, and concentrated. The resulting residue was purified by flash chromatography (90:10:1, $CHCl_3$:MeOH:NH_4OH) to give **8l** as a crystalline white solid (665 mg, 2.77 mmol, 69%)

^{1}H-NMR (500 MHz, CD_3OD): δ 7.66 (d, *J* = 9.2 Hz, 1H, Pyz*H*5), 7.23 (d, *J* = 9.2 Hz, 1H, Pyz*H*4), 5.22 (dddd, *J* = 8.3, 3.5, 3.5, 1.3 Hz, 1H, C*H*OPyz), 3.41 (ddd, *J* = 14.7, 8.1, 2.2 Hz, 1H, NCH_aH$_b$CHOPyz), 2.96–2.88 (m, 2H, CH($CH_2C_aH_2$)$_2$N), 2.88–2.77 (m, 2H, CH($CH_2C_bH_2$)$_2$N), 2.82 (ddd, *J* = 14.7, 2.5, 2.5 Hz, 1H, NCHa*H*bCHOPyz), 2.26 (nfom, 1H, C*H*(CH_2CH_2)$_2$N), 2.01 (nfom, 1H, CH($C_aH_2CH_2$)$_2$N), 1.82 (nfom, 1H, CH($C_bH_2CH_2$)$_2$N), 1.72 (nfom, 1H, CH($C_bH_2CH_2$)$_2$N), and 1.54 (nfom, 1H, CH($C_aH_2CH_2$)$_2$N).

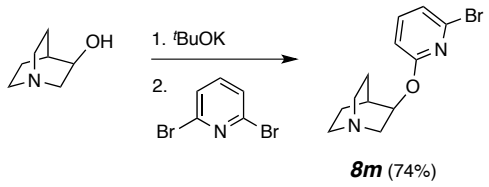
^{13}C-NMR (125 MHz, CD_3OD): δ 164.6, 150.8, 131.4, 121.1, 73.7, 54.7, 46.5, 45.7, 24.8, 23.4, and 18.5.

IR (neat): 3059, 2944, 2870, 1584, 1420, 1302, 1135, and 1015 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{11}H_{15}ClN_3O^+$ $[M+H]^+$ requires 240.0898; found 240.0894.

mp: 135-137 °C.

(±)-3-((6-Bromopyridin-2-yl)oxy)quinuclidine (**8m**)



8m (74%)

The following procedure is reported in a patent.[6] Potassium *tert*-butoxide (448 mg, 4 mmol) was added to a 100 mL round-bottom flask equipped with a stir bar and septum and placed under N_2. THF (20 mL) was added. Quinuclidinol (508 mg, 4 mmol) was added in one portion by quickly removing and replacing the septum and this mixture was stirred at room temperature for 1 h. 2,6-Dibromopyridine (1.18 g, 5 mmol) was added and the mixture was stirred at room temperature overnight (~14 h). The THF was removed under reduced pressure (~20 torr, 20 °C) and the resulting residue was partitioned between 9:1 $CHCl_3$:^{i}PrOH (50 mL) and brine (10 mL). The organic layer was dried over $MgSO_4$, filtered, and concentrated. The resulting residue was purified by flash chromatography (90:10:1, $CHCl_3$:MeOH:NH_4OH) to give **8m** as a crystalline white solid (839 mg, 2.96 mmol, 74%).

^{1}H-NMR (500 MHz, CD_3OD): δ 7.55 (dd, *J* = 7.7, 7.7 Hz, 1H, Py*H*4), 7.12 (d, *J* = 7.4 Hz, 1H, Py*H*3), 6.77 (d, *J* = 8.2 Hz, 1H, Py*H*5), 5.02 (dddd, *J* = 8.3, 3.5, 3.5, 1.5 Hz, 1H, C*H*OPy), 3.36 (ddd, *J* = 14.6, 8.2, 2.2 Hz, 1H, NC$H_a$$H_b$CHOPy), 2.95–2.86 (m, 2H, CH($CH_2C_aH_2$)$_2$N), 2.85–2.75 (m, 2H, CH($CH_2C_bH_2$)$_2$N), 2.73 (ddd, *J* = 14.5, 3.0, 3.0 Hz, 1H, NC$H_a$$H_b$CHOPy), 2.17 (nfom, 1H, C*H*(CH_2CH_2)$_2$N), 2.03–1.96 (nfom, 1H, C*H*($C_aH_2CH_2$)$_2$N), 1.84–1.77 (nfom, 1H, C*H*($C_bH_2CH_2$)$_2$N), 1.74–1.67 (nfom, 1H, C*H*($C_bH_2CH_2$)$_2$N), and 1.54–1.48 (nfom, 1H, C*H*($C_aH_2CH_2$)$_2$N).

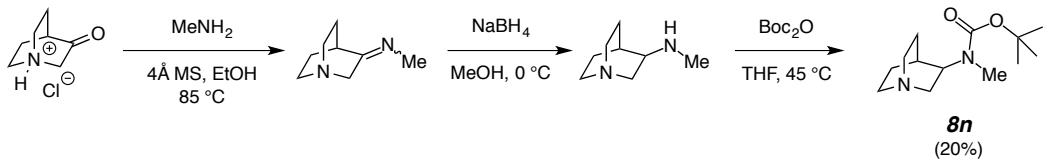
^{13}C-NMR (125 MHz, CD_3OD): δ 162.8, 141.2, 138.0, 120.1, 109.5, 72.2, 55.0, 46.6, 45.8, 24.8, 23.5, and 18.7.

IR (neat): 2951, 2870, 1588, 1551, 1437, 1295, 1156, 1019, 980, and 786 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{12}H_{16}BrN_2O^+$ $[M+H]^+$ requires 283.0441; found 283.0464.

mp: 81–82 °C.

(±)-*tert*-Butyl *N*-methyl *N*-quinuclidin-3-yl carbamate (8n)



3-Quinuclidone hydrochloride (1 g, 6.19 mmol) and 4 Å MS (500 mg) were placed into a culture tube, suspended in a solution of $MeNH_2$ in EtOH (33 wt%, 3 mL), and heated to 80 °C for 2 h. The mixture was cooled, filtered, and washed with MeOH (10 mL). The combined filtrate was cooled to 0 °C, and sodium borohydride (700 mg, 18.5 mmol, 3 equiv) was added slowly over 10 min. The mixture was stirred at 0 °C for 1 h, warmed to room temperature, and quenched with $NaHCO_3$ (10 mL) and water (10 mL). The mixture was transferred to a separatory funnel and extracted with EtOAc (3 x 15 mL). The combined organic layers were dried (Na_2SO_4), filtered, and concentrated. The crude amine was then dissolved in THF (25 mL). Boc_2O (1.7 g, 7.8 mmol, 1.3 equiv) was added and the mixture was heated to 50 °C for 1.5 h, cooled, and concentrated. The resulting residue was dissolved in EtOAc (20 mL), washed with sat. aq $NaHCO_3$ (10 mL) and brine (10 mL), dried (Na_2SO_4), filtered, concentrated, and passed through a plug of SiO_2 (80:20 EtOAc:*i*-PrOH + 2% NEt_3). The resulting residue was purified by MPLC (90:10 EtOAc:*i*-PrOH + 2% NEt_3) to give **8n** (291 mg, 1.21 mmol, 20%) as an off-white, low-melting, waxy solid.

^{1}H-NMR (500 MHz, $CDCl_3$): δ 4.06 (br m, 1H, C*H*NMeBoc), 3.20 (ddd, *J* = 14.1, 10.2, 2.4 Hz, 1H, NCH_aH$_b$CHNMeBoc), 3.00–2.93 (m, 1H, CH(CH$_2$C$_a$$H_aH_b$)$_2$N), 2.95 (s, 3H, NC$H_3$), 2.89–2.84 (m, 1H, NCH$_a$$H_b$CHNMeBoc), 2.88–2.73 (m, 3H, CH(CH$_2$C$_a$$H_a$$H_b$)$_2$N, CH(CH$_2C_b$$H_2$)$_2$N), 1.92 (nfom, 1H, C*H*(CH$_2$CH$_2$)$_2$N), 1.83–1.75 (nfom, 1H, CH(C$_a$$H_aH_bCH_2$)$_2$N), 1.70–1.58 (m, 2H, CH(C$_b$$H_2CH_2$)$_2$N), 1.51–1.43 (m, 1H, CH(C$_a$H$_a$$H_bCH_2$)$_2$N), and 1.47 (s, 9H, NCOOC(CH_3)$_3$).

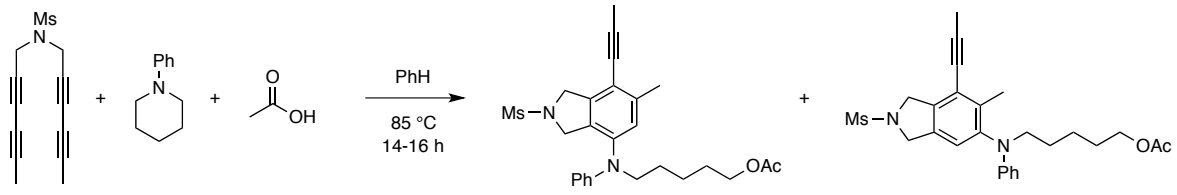
^{13}C-NMR (125 MHz, $CDCl_3$): δ 156.4, 79.6, 52.3, 51.8, 47.5, 46.8, 30.9, 28.4, 28.2, 26.5, and 21.7.

IR (neat): 2940, 2870, 1686, 1363, and 1148 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{13}H_{25}N_2O_2^+$ $[M+H]^+$ requires 241.1911; found 241.1916.

mp: ~30 °C.

5-((6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-4-yl)(phenyl)amino)pentyl acetate (P1-maj) and **5-((6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-5-yl)(phenyl)amino)pentyl acetate (P1-min)**



Tetrayne **6a** (75 mg, 0.303 mmol), acetic acid (**9a**, 19 μL, 0.333 mmol, 1.1 equiv), and *N*-phenylpiperidine (**8a**, 100 μL, 0.606 mmol, 2 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL, 0.04 M), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (10:1 to 1:1 Hex:EtOAc). The resulting residue was purified by MPLC (3:1 Hex:EtOAc) to give, in order of elution, **P1-maj** (107 mg, 0.228 mmol, 75 % yield) as a white solid and **P1-min** (8 mg, 0.017 mmol, 6 % yield) as a pale yellow oil.

P1-maj

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.19 (dd, *J* = 8.5, 7.5 Hz, 2H, NArH_m), 6.93 (s, 1H, CH_2NCH_2ArH), 6.85 (t, *J* = 7.2 Hz, 1H, NArH_p), 6.67 (d, *J* = 8.4 Hz, 2H, NArH_o), 4.68 (s, 2H, N(CaH_2)$_2$), 4.13 [s, 2H, N(C$_b$$H_2$)$_2$], 4.05 (t, *J* = 6.6 Hz, 2H, CH_2OAc), 3.65 (br t, *J* = 7.6 Hz, 2H, ArNCH_2), 2.75 (s, 3H, NSO_2CH_3), 2.41 (s, 3H, ArCH_3), 2.12 (s, 3H, ArC≡CCH_3), 2.04 (s, 3H, OCOCH_3), 1.69–1.62 (m, 4H, N(CH_2)$_5$O), and 1.42–1.36 (br pent, *J* = 7.5 Hz, 2H, $NCH_2CH_2CH_2$).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 171.2 147.2, 141.7, 141.2, 140.7, 129.4, 129.2, 125.0, 120.3, 117.5, 114.5, 94.0, 75.3, 64.2, 54.5, 53.6, 52.4, 34.5, 28.1 (x2), 23.4, 21.0, 20.5, and 4.6.

IR (neat): 2939, 2861, 2232, 1734, 1594, 1488, 1339, 1240, 1155, 1072, and 754 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{26}H_{32}N_2NaO_4S^+$ [M+Na$^+$] requires 491.1975; found 491.1993.

mp: 58-61 °C.

P1-min

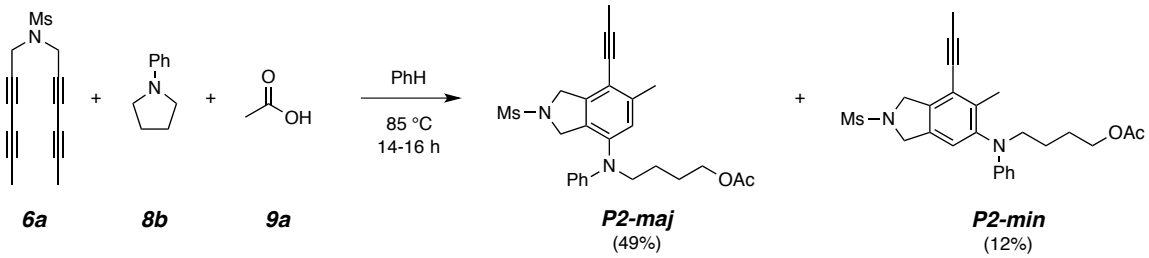
^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.15 (dd, *J* = 8.4, 7.4 Hz, 2H, NArH_m), 6.97 (s, 1H, CH_2NCH_2ArH), 6.70 (t, *J* = 7.2 Hz, 1H, NArH_p), 6.45 (d, *J* = 7.9 Hz, 2H, NArH_o), 4.75 [s, 2H, N(C$_a$$H_2$)$_2$], 4.69 [s, 2H, N(C$_b$$H_2$)$_2$], 4.04 (t, *J* = 6.7 Hz, 2H, CH_2OAc), 3.54 (br t, *J* = 7.9 Hz, 2H, ArNCH_2), 2.92 (s, 3H, NSO_2CH_3), 2.19 (s, 3H, ArCH_3), 2.13 (s, 3H, ArC≡CCH_3), 2.04 (s, 3H, COCH_3), 1.71-1.62 (m, 4H, N(CH_2)$_5$O), and 1.43-1.35 (br pent, *J* = 7.5 Hz, 2H, $NCH_2CH_2CH_2$).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 171.1, 148.3, 145.3, 139.1, 137.3, 134.4, 129.2, 123.1, 121.0, 117.1, 112.9, 95.5, 75.5, 64.4, 52.0, 54.22, 54.17, 35.0, 28.4, 27.4, 23.6, 21.1, 16.1, and 4.6.

IR (neat): 2936, 2861, 2229, 1734, 1595, 1499, 1337, 1240, 1156, 1075, and 753 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{26}H_{32}N_2NaO_4S^+$ [M+Na$^+$] requires 491.1975; found 491.1986.

4-((6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-4-yl)(phenyl)amino)butyl acetate (P2-maj) and **4-((6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-5-yl)(phenyl)amino)butyl acetate(P2-min)**



Tetrayne **6a** (75 mg, 0.303 mmol), acetic acid (**9a**, 19 μL, 0.333 mmol, 1.1 equiv), and *N*-phenylpyrrolidine (**8b**, 56 mg, 0.379 mmol, 1.25 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL, 0.04 M), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (10:1 to 1:1 Hex:EtOAc). The resulting residue was purified by MPLC (3:1 Hex:EtOAc) to give, in order of elution, **P2-maj** (67 mg, 0.147 mmol, 49 % yield) and **P2-min** (15 mg, 0.033 mmol, 12 % yield), each as a pale yellow oil.

P2-maj

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.20 (dd, *J* = 8.6, 7.5 Hz, 2H, NArH_m), 6.93 [s, 1H, Ph(R)NC=C*H*], 6.86 (tt, *J* = 7.4, 1.1 Hz, 1H, NArH_p), 6.69 (dd, *J* = 8.7, 0.9 Hz ,2H, NArH_o), 4.68 [br s, 2H, MsN(C_aH_2)$_2$], 4.14 [br s, 2H, MsN(C_bH_2)$_2$], 4.07 (br t, *J* = 6.1 Hz, 2H, AcOCH_2), 3.68 (br t, *J* = 7.0 Hz, 2H, ArNCH_2), 2.75 (s, 3H, NSO_2CH_3), 2.42 (s, 3H, ArCH_3), 2.12 (s, 3H, ArC≡CCH_3), 2.04 (s, 3H, CH_3CO), and 1.70–1.66 (m, 4H, $NCH_2CH_2CH_2CH_2O$).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 171.1, 147.0, 141.6, 141.1, 141.0, 129.3, 129.2, 124.8, 120.3, 117.5, 114.3, 94.1, 75.2, 63.9, 54.5, 53.6, 52.2, 34.5, 26.1, 24.4, 21.0, 20.4, and 4.6.

IR (neat): 2957, 2919, 2861, 2232, 1734, 1594, 1488, 1338, 1242, 1155, 1073, 1035, and 754 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{25}H_{30}N_2NaO_4S^+$ [M+Na^+] requires 477.1818; found 477.1837.

P2-min

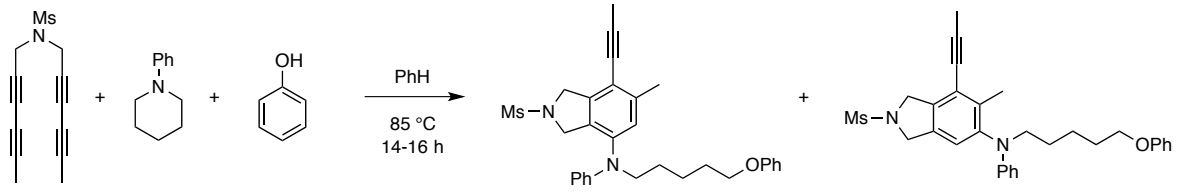
^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.15 (dd, *J* = 8.4, 7.5 Hz, 2H, NArH_m), 6.97 [s, 1H, MsN(CH_2)$_2$Ar*H*], 6.71 (t, *J* = 7.3 Hz, 1H, NArH_p), 6.45 (d, *J* = 8.6 Hz, 2H, NArH_o), 4.75 [s, 2H, MsN(C_aH_2)$_2$], 4.69 [s, 2H, MsN(C_bH_2)$_2$], 4.07 (br t, *J* = 6.5 Hz, 2H, AcOCH_2), 3.68 (br t, *J* = 6.9 Hz, 2H, ArNCH_2), 2.92 (s, 3H, NSO_2CH_3), 2.19 (s, 3H, ArCH_3), 2.13 (s, 3H, ArC≡CCH_3), 2.04 (s, 3H, CH_3CO), and 1.75–1.63 (m, 4H, $NCH_2CH_2CH_2CH_2O$).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 171.1, 148.3, 145.3, 139.1, 137.3, 134.7, 129.3, 123.1, 121.1, 117.3, 113.0, 95.5, 76.0, 64.1, 54.23, 54.20, 51.7, 35.0, 26.2, 24.2, 21.0, 16.1, and 4.6.

IR (neat): 2954, 2863, 2229, 1735, 1595, 1499, 1337, 1243, 1156, 1075, and 1044 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{25}H_{30}N_2NaO_4S^+$ [M+Na^+] requires 477.1818; found 477.1824.

6-Methyl-2-(methylsulfonyl)-*N*-(5-phenoxypentyl)-*N*-phenyl-7-(prop-1-yn-1-yl)isoindolin-4-amine (P3-maj) and **6-Methyl-2-(methylsulfonyl)-*N*-(5-phenoxypentyl)-*N*-phenyl-7-(prop-1-yn-1-yl)isoindolin-5-amine (P3-min)**



6a ***8a*** ***9b*** ***P3-maj*** (78%) ***P3-min*** (8%)

Tetrayne **6a** (75 mg, 0.303 mmol), phenol (**9b**, 31 mg, 0.333 mmol, 1.1 equiv), and *N*-phenylpiperidine (**8a**, 62 μL, 0.379 mmol, 1.25 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL, 0.04 M), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (10:1 to 1:1 Hex:EtOAc). The resulting residue was purified by MPLC (6:1 Hex:EtOAc) to give, in order of elution, **P3-maj** (119 mg, 0.237 mmol, 78 % yield) as a yellow solid and **P3-min** (12 mg, 0.024 mmol, 8 % yield) as a yellow oil.

P3-maj

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.27 (dd, *J* = 8.6, 7.2 Hz, 2H, OArH_m), 7.19 (dd, *J* = 8.5, 7.4 Hz, 2H, NArH_m), 6.94 (s, 1H, CH_2NCH_2ArH), 6.93 (t, *J* = 7.3 Hz, 1H, OArH_p), 6.87 (d, *J* = 8.3 Hz, 2H, OArH_o), 6.84 (t, *J* = 7.4 Hz, 1H, NArH_p), 6.69 (d, *J* = 8.3 Hz, 2H, NArH_o), 4.68 (s, 2H, NC_aH_2), 4.14 (s, 2H, NC_bH_2), 3.94 (t, *J* = 6.2 Hz, 2H, CH_2OAr), 3.67 (br t, *J* = 7.7 Hz, 2H, ArNCH_2), 2.73 (s, 3H, NSO_2CH_3), 2.41 (s, 3H, ArCH_3), 2.12 (s, 3H, ArC≡CCH_3), 1.83–1.77 [br pent, *J* = 7.0 Hz, 2H, $N(CH_2)_3CH_2CH_2O$], 1.70 [br pent, *J* = 7.5 Hz, 2H, $NCH_2CH_2(CH_2)_3O$], and 1.52 [br pent, *J* = 7.5 Hz, 2H, $N(CH_2)_2CH_2$].

^{13}C-NMR (125 MHz, $CDCl_3$): δ 158.9, 147.4, 141.2, 141.7, 140.7, 129.5, 129.3, 129.2, 124.9, 120.6, 120.1, 117.4, 114.4 (x2), 94.0, 75.3, 67.5, 54.5, 53.7, 52.7, 34.4, 29.1, 27.7, 23.7, 20.4, and 4.6.

IR (neat): 3061, 3035, 2942, 2864, 2229, 1596, 1496, 1339, 1243, 1156, and 755 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{30}H_{34}N_2NaO_3S^+$ [$M+Na^+$] requires 525.2182; found 525.2195.

mp: 51-54 °C.

P3-min

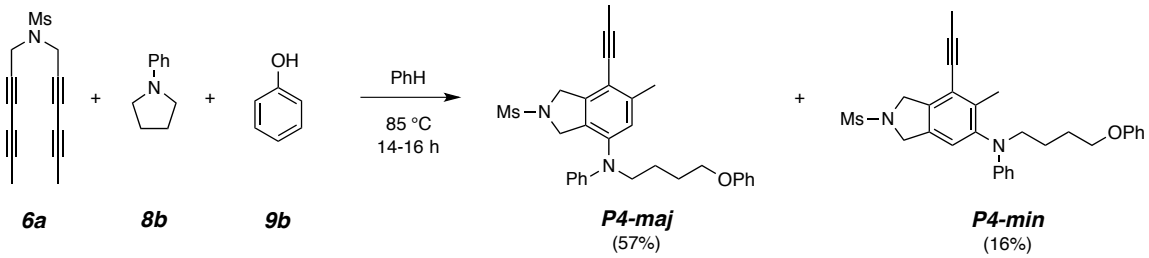
^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.27 (dd, *J* = 8.3, 7.6 Hz, 2H, OArH_m), 7.14 (dd, *J* = 8.3, 7.4 Hz, 2H, NArH_m), 6.97 (s, 1H, $N(CH_2)_2ArH$), 6.93 (dd, *J* = 7.4, 7.4 Hz, 1H, OArH_p), 6.87 (d, *J* = 8.2 Hz, 2H, OArH_o), 6.70 (dd, *J* = 7.3, 7.3 Hz, 1H, NArH_p), 6.46 (d, *J* = 8.6 Hz, 2H, NArH_o), 4.74 (s, 2H, $N(CaH_2)_2$), 4.67 (s, 2H, $N(CbH_2)_2$), 3.94 (t, *J* = 6.3 Hz, 2H, CH_2OAr), 3.56 (br t, *J* = 7.9 Hz, 2H, ArNCH_2), 2.90 (s, 3H, NSO_2CH_3), 2.19 (s, 3H, ArCH_3), 2.13 (s, 3H, ArC≡CCH_3), 1.80 (br pent, *J* = 7.0 Hz, 2H, $N(CH_2)_3CH_2CH_2O$), 1.72 [br pent, *J* = 7.5 Hz, 2H, $NCH_2CH_2(CH_2)_3O$], and 1.51 [br pent, *J* = 7.5 Hz, 2H, $N(CH_2)_2CH_2$].

^{13}C-NMR (125 MHz, $CDCl_3$): δ 158.9, 148.4, 145.4, 139.2, 137.2, 134.5, 129.5, 129.2, 123.1, 121.1, 120.8, 117.1, 114.4, 112.9, 95.5, 75.5, 67.6, 54.23, 54.16, 51.9, 35.0, 29.2, 27.4, 23.8, 16.1, and 4.6.

IR (neat): 2934, 2865, 2229, 1734, 1596, 1498, 1338, 1243, 1156, and 754 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{30}H_{34}N_2NaO_3S^+$ [$M+Na^+$] requires 525.2182; found 525.2187.

6-Methyl-2-(methylsulfonyl)-*N*-(4-phenoxybutyl)-*N*-phenyl-7-(prop-1-yn-1-yl)isoindolin-4-amine (P4-maj) and **6-Methyl-2-(methylsulfonyl)-*N*-(4-phenoxybutyl)-*N*-phenyl-7-(prop-1-yn-1-yl)isoindolin-5-amine (P4-min)**



Tetrayne **6a** (75 mg, 0.303 mmol), phenol (**9b**, 31 mg, 0.333 mmol, 1.1 equiv), and *N*-phenylpyrrolidine (**8b**, 56 mg, 0.379 mmol, 1.25 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL, 0.04 M), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (10:1 to 1:1 Hex:EtOAc). The resulting residue was purified by MPLC (6:1 Hex:EtOAc) to give, in order of elution, **P4-maj** (85 mg, 0.174 mmol, 57 % yield) and **P4-min** (24 mg, 0.049 mmol, 16 % yield), each as a pale yellow oil.

P4-maj

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.27 (dd, *J* = 7.5, 8.3 Hz, 2H, OArH_m), 7.19 (dd, *J* = 7.5, 8.3 Hz, 2H, NArH_m), 6.95 [s, 1H, MsN$(CH_2)_2$Ar*H*], 6.94 (t, *J* = 7.2 Hz, 1H, OArH_p), 6.86 (d, *J* = 8.5 Hz, 2H, OArH_o), 6.85 (t, *J* = 7.5 Hz, 1H, NArH_p), 6.71 (d, *J* = 8.3 Hz, 2H, NArH_o), 4.68 (s, 2H, $MsNC_aH_2$), 4.14 (s, 2H, $MsNC_bH_2$), 3.97 (br t, *J* = 5.6 Hz, 2H, ArOCH_2), 3.74 (br t, *J* = 7.0 Hz, 2H, ArNCH_2), 2.73 (s, 3H, NSO_2CH_3), 2.40 (s, 3H, NArCH_3), 2.12 (s, 3H, ArC≡CCH_3), and 1.86–1.78 (m, 4H, $NCH_2CH_2CH_2CH_2O$).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 159.0, 147.3, 141.7, 141.2, 140.7, 129.5, 129.3, 129.1, 124.8, 120.7, 120.2, 117.6, 114.4 (x2), 94.0, 75.3, 67.3, 54.5, 53.6, 52.3, 34.4, 26.7, 24.8, 20.3, and 4.5.

IR (neat): 3066, 3099, 2949, 2917, 2869, 1595, 1495, 1338, 1243, 1154, and 753 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{29}H_{33}N_2O_3S^+$ $[M+H^+]$ requires 489.2206; found 489.2210.

P4-min

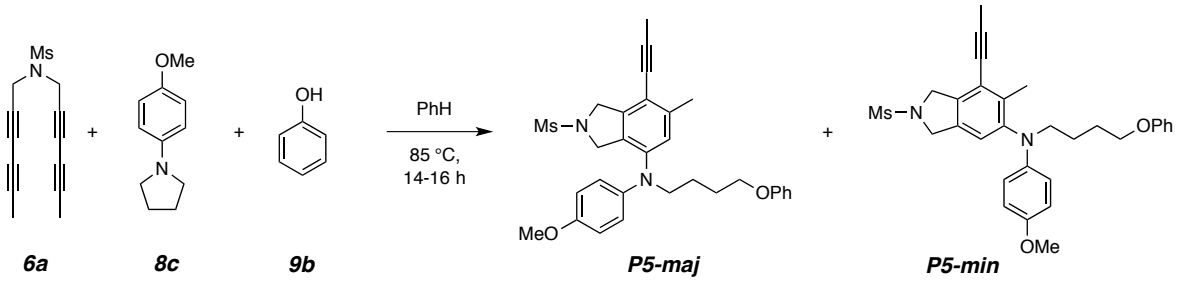
^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.27 (dd, *J* = 7.5, 8.5 Hz, 2H, OArH_m), 7.14 (dd, *J* = 7.4, 8.6 Hz, 2H, NArH_m), 6.98 [s, 1H, MsN$(CH_2)_2$Ar*H*], 6.94 (t, *J* = 7.6 Hz, 1H, OArH_p), 6.87 (d, *J* = 8.2 Hz, 2H, OArH_o), 6.70 (t, *J* = 7.2 Hz, 1H, NArH_p), 6.48 (d, *J* = 8.2 Hz, 2H, NArH_o), 4.74 (s, 2H, $MsNC_aH_2$), 4.67 (s, 2H, $MsNC_bH_2$), 3.97 (t, *J* = 5.8 Hz, 2H, ArOCH_2), 3.62 (br t, *J* = 6.9 Hz, 2H, ArNCH_2), 2.89 (s, 3H, NSO_2CH_3), 2.20 (s, 3H, ArCH_3), 2.12 (s, 3H, ArC≡CCH_3), and 1.87–1.78 (m, 4H. $NCH_2CH_2CH_2CH_2O$).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 158.8, 148.3, 145.3, 137.3, 139.2, 134.5, 129.4, 129.1, 123.1, 121.1, 120.6, 117.0, 114.4, 112.9, 95.5, 75.5, 67.3, 54.1, 54.1, 51.7, 34.8, 26.8, 24.3, 16.0, and 4.5.

IR (neat): 2935, 2873, 2229, 1597, 1498, 1337, 1243, 1155, and 754 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{29}H_{33}N_2O_3S^+$ $[M+H^+]$ requires 489.2206; found 489.2216.

***N*-(4-Methoxyphenyl)-6-methyl-2-(methylsulfonyl)-N-(4-phenoxybutyl)-7-(prop-1-yn-1-yl)isoindolin-4-amine (P5-maj)** and ***N*-(4-Methoxyphenyl)-6-methyl-2-(methylsulfonyl)-N-(4-phenoxybutyl)-7-(prop-1-yn-1-yl)isoindolin-5-amine (P5-min)**



Tetrayne **6a** (75 mg, 0.303 mmol), phenol (**9b**, 31 mg, 0.333 mmol, 1.1 equiv), and *N*-(*p*-methoxyphenyl)pyrrolidine (**8c**, 67 mg, 0.379 mmol, 1.25 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL, 0.04 M), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (1:1 Hex:EtOAc). The resulting residue was purified by MPLC (3:1 Hex:EtOAc) to give a coeluting mixture of a 2.6:1 ratio of **P5-maj** and **P5-min** (151 mg, 0.291 mmol, 96 % yield) as an off-white amorphous solid that took on a brown color over a period of ~1 week, even under storage in the dark at -10 °C. The ^{1}H NMR spectrum of this sample suggested that most of the material remained intact as **P5-maj** and **P5-min**.

Data for P5-maj in the 2.6:1 mixture of P5-maj:P5-min

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.27 (m, 2H, OArH_m), 6.93 (m, 1H, OArH_p), 6.86 (m, 2H, OArH_o), 6.83 (s, 1H, MsN$(CH_2)_2$ArH), 6.82 (d, J = 9.0 Hz, 2H, NArH_o), 6.78 (d, J = 9.0 Hz, 2H, NArH_m), 4.62 (br t, J = 2.0 Hz, 2H, N$(C_aH_2)_2$), 3.96 (t, J = 5.8 Hz, 2H, CH_2OPh), 3.94 (s, 2H, N$(C_bH_2)_2$), 3.78 (s, 3H, OCH_3), 3.68 (t, J = 7.5 Hz, 2H, Ar_2NCH_2), 2.68 (s, 3H, NSO_2CH_3), 2.38 (s, 3H, ArCH_3), 2.10 (s, 3H, ArC≡CCH_3), and 1.85–1.75 (m, 4H, $Ar_2NCH_2CH_2CH_2CH_2OPh$).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 158.8, 155.4, 155.3, 141.2, 140.8, 129.5, 126.1, 120.6, 123.4, 120.6, 120.5, 114.7, 114.5, 111.7, 93.1, 75.5, 67.4, 55.5, 54.4, 53.9, 53.3, 34.3, 26.8, 24.6, 20.5, and 4.6.

Data for P5-min in the 2.6:1 mixture of P5-maj:P5-min

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.27 (m, 2H, OArH_m), 6.97 (s, 1H, MsN$(CH_2)_2$ArH), 6.93 (m, 1H, OArH_p), 6.86 (m, 2H, OArH_o), 6.74 (d, J = 9.1 Hz, 2H, NArH_o), 6.48 (d, J = 9.1 Hz, 2H, NArH_m), 4.73 (br t, J = 1.8 Hz, 2H, MsN$(C_aH_2)_2$), 4.66 (s, 2H, MsN$(C_bH_2)_2$), 3.96 (t, J = 5.8 Hz, CH_2OPh), 3.73 (s, 3H, OCH_3), 3.59 (t, J = 7.5 Hz, 2H, Ar_2NCH_2), 2.89 (s, 3H, NSO_2CH_3), 2.18 (s, 3H, ArCH_3), 2.12 (s, 3H, ArC≡CCH_3), and 1.85–1.75 (m, 4H, $Ar_2NCH_2CH_2CH_2CH_2OPh$).

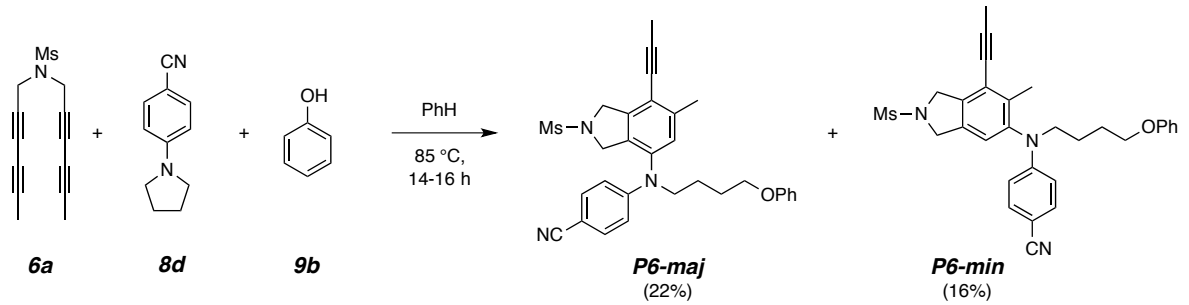
^{13}C-NMR (125 MHz, $CDCl_3$): δ 158.8, 152.2, 152.1, 146.4, 135.8, 135.0, 138.7, 129.5, 122.0, 120.6, 120.8, 114.7, 114.5, 115.4, 95.2, 75.5, 67.4, 55.7, 54.2 (x2), 52.4, 35.2, 26.8, 24.6, 16.2, and 4.6.

Data for P5-maj:P5-min

IR (neat): 3056, 3038, 2934, 2916, 2867, 2232, 1600, 1585, 1507, 1337, 1242, 1155, 1035, and 826 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{30}H_{35}N_2O_4S^+$ [M+Na$^+$] requires 519.2312; found 519.2327.

4-((6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-4-yl)(4-phenoxybutyl)amino)benzonitrile (P6-maj) and **4-((6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-5-yl)(4-phenoxybutyl)amino)benzonitrile (P6-min)**



Tetrayne **6a** (75 mg, 0.303 mmol), phenol (**9b**, 36 mg, 0.379 mmol, 1.25 equiv), and *N*-(*p*-cyanophenyl)pyrrolidine (**8d**, 398 mg, 1.52 mmol, 5 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL, 0.04 M), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (5:1 to 1:3 Hex:EtOAc). The resulting residue was purified by MPLC (3:1 Hex:EtOAc) to give, in order of elution, **P6-maj** (34 mg, 0.066 mmol, 22 % yield) and **P6-min** (25 mg, 0.049 mmol, 16%) each as a yellow oil.

P6-maj

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.40 (d, J = 9.0 Hz, NArH_m), 7.28 (dd, J = 8.8, 7.5 Hz, 2H, OArH_m), 6.98 (s, 1H, N$(CH_2)_2$ArH), 6.96 (tt, J = 7.3, 1.0 Hz, 1H, OArH_p), 6.86 (dd, J = 8.8, 1.0 Hz, 2H, OArH_o), 6.54 (d, J = 8.9 Hz, 2H, NArH_o), 4.74 [s, 2H, N$(C_aH_2)_2$], 4.34 [s, 2H, N$(C_bH_2)_2$], 3.99 (t, J = 5.8 Hz, 2H, CH_2OPh), 3.71 (br t, J = 7 Hz, 2H, ArAr'NCH_2), 2.82 (s, 3H, NSO_2CH_3), 2.42 (s, 3H, NArCH_3), 2.14 (s, 3H ArC≡CCH_3), and 1.88-1.79 (m, 4H, $Ar_2NCH_2CH_2CH_2CH_2OPh$).

^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 158.8, 150.1, 142.7, 141.4, 138.5, 133.8, 131.4, 129.7, 128.4, 121.1, 120.1, 118.1, 114.5, 113.4, 100.1, 95.8, 75.0, 67.2, 54.6, 53.3, 52.0, 35.3, 26.6, 24.7, 20.5, and 4.8.

IR (neat): 3041, 2934, 2919, 2867, 2214, 1598, 1510, 1484, 1337, 1243, 1155, 1079, and 825 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{30}H_{32}N_3O_3S^+$ [M+H$^+$] requires 514.2159; found 514.2146.

P6-min

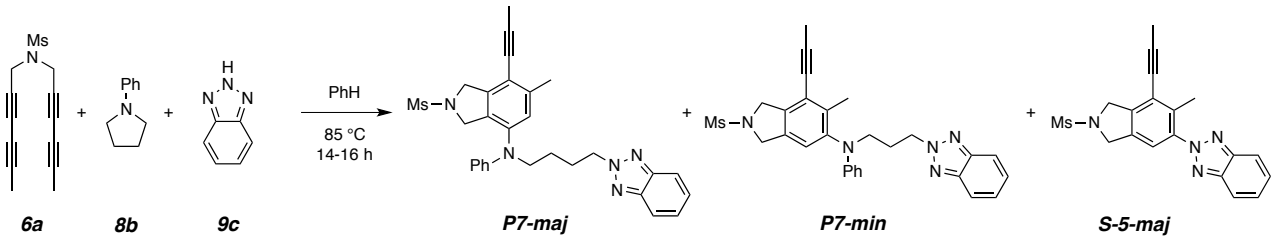
^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.38 (d, J = 9.1 Hz, 2H, NArH_m), 7.29 (dd, J = 8.7, 7.4 Hz, 2H, OArH_m), 6.96 (tt, J = 7.3, 1.0 Hz, 1H, OArH_p), 6.95 (s, 1H, N$(CH_2)_2$ArH), 6.87 (dd, J = 8.8, 1.0 Hz, 2H, OArH_o), 6.43 (d, J = 9.1 Hz, 2H, NArH_o), 4.75 [s, 2H, N$(C_aH_2)_2$], 4.70 [s, 2H, N$(C_bH_2)_2$], 3.99 (t, J = 5.9 Hz, 2H, CH_2OPh), 3.87-3.43 (br m, 2H, ArAr'NCH_2), 2.92 (s, 3H, NSO_2CH_3), 2.16 (s, 3H, NArCH_3), 2.14 (s, 3H ArC≡CCH_3), and 1.90-1.79 (m, 4H, $Ar_2NCH_2CH_2CH_2CH_2OPh$).

^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 158.8, 150.9, 143.6, 138.7, 138.6, 135.3, 133.8, 129.7, 123.0, 121.8, 121.1, 120.4, 114.5, 112.3, 98.9, 96.4, 75.2, 67.2, 54.3, 54.2, 51.8, 35.3, 26.7, 24.2, 16.0, and 4.8.

IR (neat): 3038, 2920, 2867, 2213, 1600, 1511, 1459, 1336, 1244, 1155, 1078, and 824 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{30}H_{32}N_3O_3S^+$ [M+H$^+$] requires 514.2159; found 514.2163.

***N*-(4-(2*H*-Benzo[*d*][1,2,3]triazol-2-yl)butyl)-6-methyl-2-(methylsulfonyl)-*N*-phenyl-7-(prop-1-yn-1-yl)isoindolin-4-amine (P7-maj)** and ***N*-(4-(2*H*-Benzo[*d*][1,2,3]triazol-2-yl)butyl)-6-methyl-2-(methylsulfonyl)-*N*-phenyl-7-(prop-1-yn-1-yl)isoindolin-5-amine (P7-min)**



Tetrayne **6a** (75 mg, 0.303 mmol), benzotriazole (**9c**, 40 mg, 0.333 mmol, 1.1 equiv), and *N*-phenylpyrrolidine (**8b**, 56 mg, 0.379 mmol, 1.25 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL, 0.04 M), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (10:1 to 1:1 Hex:EtOAc). The resulting residue was purified by MPLC (3:1 Hex:EtOAc) to give, in order of elution, **P7-maj** (81 mg, 0.158 mmol, 52 % yield) and **P7-min** (28 mg (97 wt%; 3 wt% EtOAc), 0.053 mmol, 17 % yield), each as a pale yellow oil. The sample of **P7-maj** coeluted with ca. 8% of a second component that was shown to be **S-5-maj** the product of competitive direct trapping of the intermediate benzyne with benzotriazole.

P7-maj

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.85 (nfom, 2H, N-N-NArH_o), 7.39 (nfom, 2H, N-N-NArH_m), 7.16 (dd, J = 8.6, 7.4 Hz, 2H, NArH_m), 6.87 (s, 1H, N$(CH_2)_2$ArH), 6.84 (t, J = 7.4 Hz, 1H, NArH_p), 6.66 (d, J = 8.2 Hz, 2H, NArH_o), 4.74 [t, J = 7.0 Hz, 2H, CH_2NN'(N')], 4.66 (s, 2H, MsNC$_a H_2$), 4.08 (s, 2H, MsNC$_b H_2$), 3.69 (br t, J = 7.4 Hz, 2H, ArNCH_2), 2.72 (s, 3H, NSO_2CH_3), 2.37 (s, 3H, ArCH_3), 2.18 [pent, J = 7.0 Hz, 2H, $NCH_2CH_2CH_2CH_2$NN'(N')], 2.12 (s, 3H, C≡CCH_3), and 1.68 [m, 2H, $NCH_2CH_2CH_2CH_2$NN'(N')].

^{13}C-NMR (125 MHz, $CDCl_3$): δ 147.1, 144.2, 141.7, 141.0, 140.8, 129.4, 129.0, 126.2, 124.5, 120.5, 117.88, 117.85, 114.4, 94.0, 75.3, 56.0, 54.4, 53.6, 51.9, 34.4, 27.3, 24.9, 20.5, and 4.6.

IR (neat): 3053, 2951, 2919, 2855, 2241, 1594, 1496, 1337, and 1156 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{29}H_{31}N_5NaO_2S^+$ [M+Na$^+$] requires 536.2091; found 536.2107.

P7-min

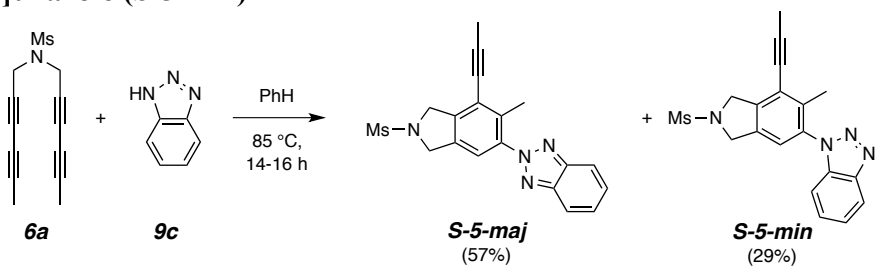
^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.85 (nfom, 2H, N-N-NArH_o), 7.40 (nfom 2H, N-N-NArH_m), 7.11 (dd, J = 8.4, 7.5 Hz, 2H, NArH_m), 6.88 (s, 1H, N$(CH_2)_2$ArH), 6.69 (t, J = 7.3 Hz, 1H, NArH_p), 6.47 (d, J = 8.4 Hz, 2H, NArH_o), 4.75 [t, J = 6.9 Hz, 2H, CH_2NN'(N')], 4.72 (s, 2H, MsNC$_a H_2$), 4.61 (s, 2H, MsNC$_b H_2$), 3.57 (br t, J = 7.6 Hz, 2H, ArNCH_2), 2.89 (s, 3H, SO_2CH_3), 2.17 [pent, J = 7.3 Hz, 2H, $NCH_2CH_2CH_2CH_2$-NN'(N')], 2.14 (s, 3H, ArCH_3), 2.12 (s, 3H, ≡CCH_3), and 1.72-1.66 [m, 2H, $NCH_2CH_2CH_2$-CH_2-NN'(N')].

^{13}C-NMR (125 MHz, $CDCl_3$): δ 148.0, 145.1, 144.3, 139.0, 137.3, 134.4, 129.2, 126.5, 123.0, 121.1,117.9, 117.4, 113.0, 95.5, 75.4, 56.1, 54.2, 54.1, 51.1, 27.5, 24.6, 16.0, and 4.7.

IR (neat): 2956, 2925, 2866, 2232, 1595, 1499, 1336, and 1155 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{29}H_{31}N_5NaO_2S^+$ [M+Na$^+$] requires 536.2091; found 536.2101.

2-(6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-5-yl)-2H-benzo[d][1,2,3]triazole (S-5-maj) and **1-(6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-5-yl)-1H-benzo[d][1,2,3]triazole (S-5-min)**



Tetrayne **6a** (75 mg, 0.303 mmol) and benzotriazole (**9c**, 100 mg, 0.839 mmol, 2.8 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL, 0.04 M), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (1:1 $CHCl_3$:EtOAc). The resulting residue was purified by MPLC (9:1 $CHCl_3$:EtOAc) to give, in order of elution, **S-5-maj** (63 mg, 0.172 mmol, 57 % yield) as an off-white solid and **S-5-min** (32 mg, 0.087 mmol, 29 % yield) as a white solid.

S-5-maj

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.96 (nfom, 2H, NArH_o), 7.47 (nfom, 2H, NArH_m), 7.46 (s, 1H, $N(CH_2)_2$ArH), 4.82 (s, 2H, $MsNC_aH_2$), 4.78 (s, 2H, $MsNC_bH_2$), 2.92 (s, 3H, NSO_2CH_3), 2.41 (s, 3H, ArCH_3), and 2.16 (s, 3H, Ar$C{\equiv}CCH_3$).

^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 145.0, 140.6, 135.7, 134.1, 127.3, 121.5, 119.9, 118.5, 96.8, 75.0, 54.4, 54.2, 35.3, 16.7, and 4.8.

IR (neat): 2929, 2872, 2235, 1325, 1144, 1090, and 830 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{19}H_{19}N_4O_2S^+$ [M+H$^+$] requires 367.1223; found 367.1223.

mp: 262-264 °C (decomp)

S-5-min

^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.16 (ddd, J = 8.4, 1.0, 1.0 Hz, 1H, NArH4), 7.52 (ddd, J = 8.2, 6.9, 1.1 Hz, 1H, NArH5 or 6), 7.45 (ddd, J = 8.2, 7.0, 1.1 Hz, 1H, NArH5 or 6), 7.29 (ddd, J = 8.3, 1.0, 1.0 Hz, 1H, NArH7), 7.22 (s, 1H, $N(CH_2)_2$ArH), 4.85 (br t, J = 1.8 Hz, 2H, $MsNC_aH_2$), 4.79 (s, 2H, $MsNC_bH_2$), 2.95 (s, 3H, NSO_2CH_3), 2.16 (s, 3H, Ar$C{\equiv}CCH_3$), and 2.14 (s, 3H, ArCH_3).

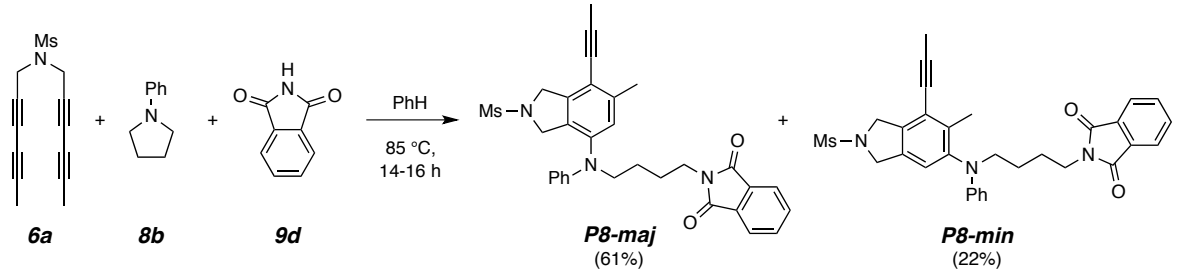
^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 145.7, 141.1, 137.3, 135.4, 134.6, 134.0, 128.5, 124.5, 121.6, 120.8, 120.4, 110.0, 97.1, 74.8, 54.4, 54.2, 35.5, 16.1, and 4.8.

IR (neat): 2954, 2917, 2873, 2227, 1456, 1147, 1087, and 827 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{19}H_{19}N_4O_2S^+$ [M+H$^+$] requires 367.1223; found 367.1221.

mp: 248-250 °C (decomp)

2-(4-((6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-4-yl)(phenyl)amino)butyl)isoindoline-1,3-dione (P8-maj) and **2-(4-((6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-5-yl)(phenyl)amino)butyl)isoindoline-1,3-dione (P8-min)**



6a ***8b*** ***9d*** ***P8-maj*** (61%) ***P8-min*** (22%)

Tetrayne **6a** (75 mg, 0.303 mmol), phthalimide (**9d**, 49 mg, 0.333 mmol, 1.1 equiv), and *N*-phenylpyrrolidine (**8b**, 56 mg, 0.379 mmol, 1.25 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL, 0.04 M), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (10:1 to 1:1 Hex:EtOAc). The resulting residue was purified by MPLC (3:1 Hex:EtOAc) to give, in order of elution, **P8-maj** (100 mg, 0.185 mmol, 61 % yield) and **P8-min** (36 mg, 0.066 mmol, 22 % yield), each as a pale yellow oil.

P8-maj

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.82 (nfom, 2H, $N(CO)_2Ar\mathit{H}_o$), 7.72 (nfom, 2H, $N(CO)_2Ar\mathit{H}_m$), 7.17 (dd, J = 8.0, 8.0 Hz, 2H, $NAr\mathit{H}_m$), 6.91 (s, 1H, $N(CH_2)_2Ar\mathit{H}$), 6.83 (t, J = 7.3 Hz, 1H, $NAr\mathit{H}_p$), 6.69 (d, J = 8.7 Hz, 2H, $NAr\mathit{H}_o$), 4.67 (s, 2H, $MsNC_a\mathit{H}_2$), 4.10 (s, 2H, $MsNC_b\mathit{H}_2$), 3.69 (t, J = 8.1 Hz, 2H, $ArNC\mathit{H}_2$), 3.68 [t, J = 7.4 Hz, 2H, $(CO)_2NC\mathit{H}_2$], 2.78 (s, 3H, $NSO_2C\mathit{H}_3$), 2.38 (s, 3H, $ArC\mathit{H}_3$), 2.12 (s, 3H, $ArC{\equiv}CC\mathit{H}_3$), 1.77–1.71 (m, 2H, $NCH_2C\mathit{H}_2C\mathit{H}_2CH_2O$), and 1.69–1.64 (m, 2H, $NCH_2C\mathit{H}_2C\mathit{H}_2CH_2O$).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 168.4, 147.3, 141.6, 140.9, 140.7, 134.0, 132.3, 129.4, 129.2, 124.7, 123.2, 120.4, 118.0, 114.4, 93.9, 75.3, 54.7, 53.6, 52.0, 37.5, 34.4, 26.0, 25.3, 20.3, and 4.56.

IR (neat): 2919, 2861, 2255, 1770, 1709, 1594, 1496, 1488, 1397, 1337, 1155, and 754 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{31}H_{31}N_3NaO_4S^+$ [$M+Na^+$] requires 564.1927; found 564.1933.

P8-min

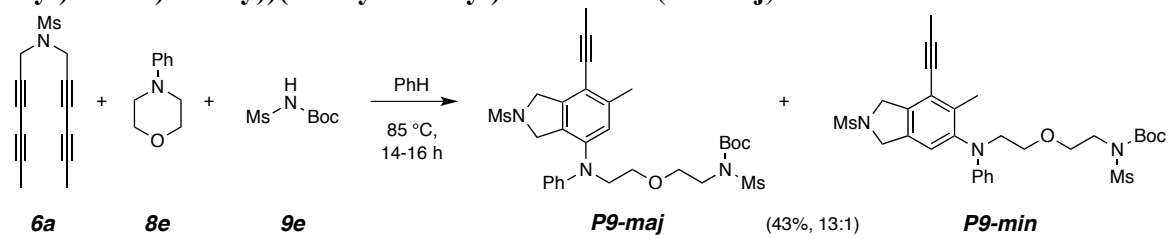
^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.84 (nfom, 2H, $N(CO)_2Ar\mathit{H}_o$), 7.72 [nfom, 2H, $N(CO)_2Ar\mathit{H}_m$], 7.13 (dd, J = 8.5, 7.6 Hz, 2H, $NAr\mathit{H}_m$), 6.96 [s, 1H, $N(CH_2)_2Ar\mathit{H}$], 6.70 (t, J = 7.2 Hz, 1H, $NAr\mathit{H}_p$), 6.45 (d, J = 8.4 Hz, 2H, $NAr\mathit{H}_o$), 4.73 (s, 2H, $MsNC_a\mathit{H}_2$), 4.67 (s, 2H, $MsNC_b\mathit{H}_2$), 3.68 [br t, J = 6.6 Hz, 2H, $(CO)_2NC\mathit{H}_2$], 3.57 (br t, J = 7.4 Hz, 2H, $ArNC\mathit{H}_2$), 2.91 (s, 3H, $NSO_2C\mathit{H}_3$), 2.16 (s, 3H, $ArC\mathit{H}_3$), 2.12 (s, 3H, $Ar{\equiv}CC\mathit{H}_3$), and 1.75–1.66 (m, 4H, $NCH_2(C\mathit{H}_2)_2CH_2O$).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 168.4, 148.1, 145.3, 139.1, 137.3, 134.4, 134.2, 134.1, 129.2, 123.2, 123.1, 121.1, 117.2, 113.0, 95.4, 75.5, 54.2, 54.1, 51.3, 37.6, 34.9, 25.8, 25.3, 16.0, and 4.6.

IR (neat): 2933, 2863, 2255, 1770, 1710, 1596, 1499, 1337, 1156, and 752 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{31}H_{31}N_3NaO_4S^+$ [$M+Na^+$] requires 564.1927; found 564.1931.

***tert*-Butyl (2-(2-((6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-4-yl)-(phenyl)amino)ethoxy))(methylsulfonyl)carbamate (P9-maj)**



6a ***8e*** ***9e*** ***P9-maj*** (43%, 13:1) ***P9-min***

Tetrayne **6a** (51 mg, 0.202 mmol), *tert*-butyl (methylsulfonyl)carbamate (**9e**, 47 mg, 0.242 mmol, 1.2 equiv), and *N*-phenylmorpholine (**8e**, 49 mg, 0.303 mmol, 1.5 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (1:1 Hex:EtOAc). The resulting residue was purified by MPLC (3:1 Hex:EtOAc) to give a coeluting mixture of a 13:1 ratio of **P9-maj** and **P9-min** (52 mg, 0.086 mmol, 43% yield).

P9-maj

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.19 (dd, *J* = 8.6, 7.3 Hz, 2H, NArH_m), 7.01 (s, 1H, Ar*H*), 6.85 (tt, *J* = 7.4, 1.0 Hz, 1H, NArH_p), 6.70 (dd, *J* = 8.8, 1.1 Hz, 2H, NArH_o), 4.68 (s, 2H, MsNCH_2C$_{alkyne}$), 4.15 (s, 2H, MsNCH_2C$_{NPh}$), 3.88 (t, *J* = 5.6 Hz, 2H, CH_2NBocMs), 3.87 (t, *J* = 6.2 Hz, 2H, CH_2NPh), 3.64 (t, *J* = 6.0 Hz, 2H, NPhCH$_2$CH_2O), 3.56 (t, *J* = 5.5 Hz, 2H, OCH_2CH$_2$NBocMs), 3.18 (s, 3H, BocNSO$_2$CH_3), 2.77 (s, 3H, NSO$_2$CH_3), 2.41 (s, 3H, ArCH_3), 2.12 (s, 3H, ArC≡CCH_3), and 1.52 (s, 9H, OC(CH_3)$_3$).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 151.2, 147.0, 141.9, 140.8, 129.7, 129.4, 125.4 (x2), 120.3, 117.1, 114.9, 94.2, 84.7, 75.3, 69.0, 68.3, 54.4, 53.6, 52.0, 45.0, 41.6, 34.6, 28.0, 20.4, and 4.6.

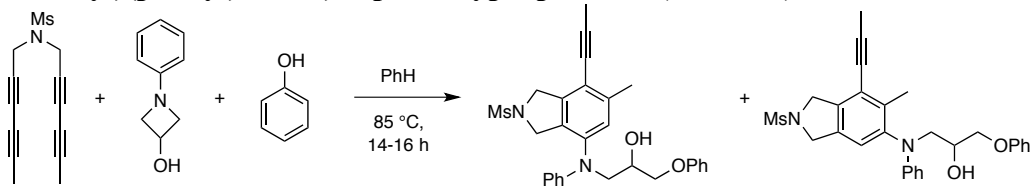
IR (neat): 3056, 2975, 2917, 2867, 2320, 1727, 1594, 1488, 1347, 1152, and 965 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{29}H_{40}N_3O_7S_2^+$ $[M+H]^+$ requires 606.2302; found 606.2314.

P9-min (NMR data for the minor isomer extracted from the spectrum of the 13:1 mixture)

^{1}H-NMR (500 MHz, $CDCl_3$; not all resonances could be identified, likely due to superposition with resonances for the major isomer for some of the protons most remote from the differences in structure): δ 7.14 (dd, *J* = 8.7, 7.4 Hz, 2H, NArH_m), 7.05 (s, 1H, Ar*H*), 6.49 (d, *J* = 8.6 Hz, NArH_o), 4.74 (s, 2H, MsNC$_a$H$_2$), 4.70 (s, 2H, MsNC$_b$H$_2$), 3.77 (br t, *J* = 6.6 Hz, 2H, CH_2NPh), 3.66 (t, *J* = 6.1 Hz, 2H, NPhCH$_2$CH_2O), 3.19 (s, 3H, BocNSO$_2$CH_3), 2.91 (s, 3H, ArCH$_2$NSO$_2$CH_3), and 2.16 (s, 3H, ArCH_3).

1-((6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-4-yl)(phenyl)amino)-3-phenoxypropan-2-ol (**P10-maj**), and **1-((6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-5-yl)(phenyl)amino)-3-phenoxypropan-2-ol** (**P10-min**)



6a ***8f*** ***9b*** ***P10-maj*** (56%) ***P10-min*** (34%)

Tetrayne **6a** (75 mg, 0.303 mmol), phenol (**9b**, 31 mg, 0.333 mmol, 1.1 equiv), and **8f** (57 mg, 0.379 mmol, 1.5 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (1:3 Hex:EtOAc). The resulting residue was purified by MPLC (3:1 Hex:EtOAc) to give, in order of elution, **P10-maj** (84 mg, 0.171 mmol, 56%) and **P10-min** (51 mg, 0.104 mmol, 34%), each as an off-white solid.

P10-maj

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.28 (dd, *J* = 8.8, 7.4 Hz, 2H, OArH_m), 7.20 (dd, *J* = 8.6, 7.4 Hz, 2H, NArH_m), 7.05 (s, 1H, MsN(CH_2)$_2$Ar*H*), 6.98 (tt, *J* = 7.4, 1.0 Hz, 1H, OArH_p), 6.88 (tt, *J* = 7.2, 1.1 Hz, 1H, NArH_p), 6.87 (dd, *J* = 8.9, 1.1 Hz, 2H, OArH_o), 6.78 (dd, *J* = 8.7, 1.1 Hz, 2H, NArH_o), 4.66 (s, 2H, NC_aH_2), 4.27 (dddd, *J* = 7.4, 5.4, 5.4, 3.9 Hz, 1H, C*H*OH), 4.15 (s, 2H, NC_bH_2), 4.03 (dd, *J* = 9.5, 4.0 Hz, 1H, CHCH_aH$_b$OPh), 4.00 (dd, *J* = 14.9, 5.3 Hz, 1H, Ar$_2$NCH_aH$_b$CH), 3.98 (dd, *J* = 9.5, 5.4 Hz, 1H, CHCH$_a$$H_b$OPh), 3.87 (dd, *J* = 15.0, 7.3 Hz, 1H, Ar$_2$NCH$_a$$H_b$CH), 2.71 (s, 3H, NSO_2CH_3), 2.37 (s, 3H, ArCH_3), and 2.11 (s, 3H, ArC≡CCH_3).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 158.3, 147.4, 141.4, 140.8, 129.5, 129.4, 129.3, 124.9 (x2), 121.4, 120.8, 117.8, 114.8, 114.4, 94.2, 75.2, 69.4, 68.3, 55.3, 54.4, 53.6, 34.5, 20.4, and 4.6.

IR (neat): 3495 (br), 3062, 3038, 2918, 2854, 2235, 1596, 1491, 1335, 1242, 1153, and 1078 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{28}H_{31}N_2O_4S^+$ [M+H$^+$] requires 491.1999; found 491.2012.

mp: 126-129 °C.

P10-min

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.28 (dd, *J* = 8.7, 7.5 Hz, 2H, OArH_m), 7.15 (dd, *J* = 8.8, 7.4 Hz, 2H, NArH_m), 7.07 (s, 1H, MsN(CH_2)$_2$Ar*H*), 6.98 (tt, *J* = 7.4, 0.9 Hz, 1H, OArH_p), 6.86 (dd, *J* = 8.8, 0.9 Hz, 2H, OArH_o), 6.75 (tt, *J* = 7.3, 0.9 Hz, 1H, NArH_p), 6.57 (dd, *J* = 8.8, 0.8 Hz, 2H, NArH_o), 4.71 (t, *J* = 2.2 Hz, 2H, $MsNC_aH_2$), 4.64 (br d, *J* = 13.8 Hz, 1H, $MsNC_bH_aH_b$), 4.59 (br d, *J* = 13.5 Hz, 1H, $MsNC_bH_aH_b$), 4.31 (dddd, *J* = 7.4, 5.5, 5.5, 3.9 Hz, 1H, C*H*OH), 4.05 (dd, *J* = 9.5, 3.9 Hz, 1H, CHCH_aH$_b$OPh), 3.99 (dd, *J* = 9.5, 5.4 Hz, 1H, CHCH$_a$$H_b$OPh), 3.90 (dd, *J* = 14.8, 5.5 Hz, 1H, ArAr'NCH_aH$_b$), 3.83 (dd, *J* = 14.8, 7.1 Hz, 1H, ArAr'NCH$_a$$H_b$), 2.89 (s, 3H, NSO_2CH_3), 2.18 (s, 3H, ArCH_3), and 2.12 (s, 3H, ArC≡CCH_3).

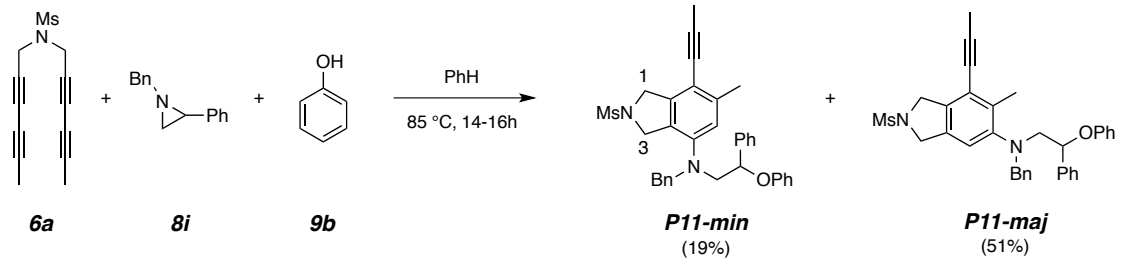
^{13}C-NMR (125 MHz, $CDCl_3$): δ 158.3, 148.5, 145.4, 138.6, 137.4, 134.3, 129.6, 129.3, 122.9, 121.5, 121.4, 118.1, 114.5, 113.7, 95.6, 75.4, 69.6, 68.5, 55.0, 54.2, 54.1, 34.9, 16.0, and 4.4

IR (neat): 3507 (br), 3060, 3038, 2919, 2854, 2230, 1596, 1498, 1334, 1154, and 1079 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{28}H_{31}N_2O_4S^+$ [M+H$^+$] requires 491.1999; found 491.2008.

mp: 166-169 °C.

_N_-Benzyl-6-methyl-2-(methylsulfonyl)-_N_-(2-phenoxy-2-phenylethyl)-7-(prop-1-yn-1-yl)isoindolin-4-amine (P11-min), and **_N_-Benzyl-6-methyl-2-(methylsulfonyl)-_N_-(2-phenoxy-2-phenylethyl)-7-(prop-1-yn-1-yl)isoindolin-5-amine (P11-maj)**



6a ***8i*** ***9b*** ***P11-min*** (19%) ***P11-maj*** (51%)

Tetrayne **6a** (75 mg, 0.303 mmol), phenol (**9b**, 31 mg, 0.333 mmol, 1.1 equiv), and **8i** (79 mg, 0.379 mmol, 1.5 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (2:1 Hex:EtOAc). The resulting residue was purified by MPLC (5:1 Hex:EtOAc) to give, in order of elution, **P11-min** (32 mg, 0.058 mmol, 19%) and **P11-maj** (84 mg, 0.153 mmol, 51%), each as a pale yellow foam.

P11-min

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.29–7.20 (m, 8H, $CH_2Ph\mathit{H}_m\mathit{H}_p$; $CHPh\mathit{H}_m\mathit{H}_p$; $OPh\mathit{H}_m$), 7.16–7.14 (m, 4H, $CH_2Ph\mathit{H}_o$; $CHPh\mathit{H}_o$), 6.91 (s, 1H, $MsN(CH_2)_2Ar\mathit{H}$), 6.86 (t, J = 7.3 Hz, 1H, $OPh\mathit{H}_p$), 6.67 (d, J = 8.1 Hz, 2H, $OPh\mathit{H}_o$), 5.07 (dd, J = 8.5, 4.0 Hz, 1H, $NCH_2C\mathit{H}PhOPh$), 4.68 (s, 2H, $C1\mathit{H}2$), 4.56 (d, J = 13.1 Hz, 1H, $C3\mathit{H}_aH_b$), 4.50 (d, J = 12.9 Hz, 1H, $C3H_a\mathit{H}_b$), 4.30 (d, J = 14.2 Hz, 1H, $PhC\mathit{H}_aH_bN$), 4.24 (d, J = 14.2 Hz, 1H, $PhCH_a\mathit{H}_bN$), 3.47 (dd, J = 14.5, 8.4 Hz, 1H, $NC\mathit{H}_aH_bCHPhOPh$), 3.24 (dd, J = 14.4, 4.0 Hz, 1H, $NCH_a\mathit{H}_bCHPhOPh$), 2.85 (s, 3H, $NSO_2C\mathit{H}_3$), 2.38 (s, 3H, $NArC\mathit{H}_3$), and 2.13 (s, 3H, $ArC{\equiv}CC\mathit{H}_3$).

^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 157.9, 145.5, 141.0, 140.8, 139.6, 138.2, 129.5, 128.9, 128.7, 128.2, 128.1, 127.5, 126.1, 125.6, 121.1, 120.6, 115.8, 112.0, 93.1, 78.4, 75.6, 58.4, 57.5, 54.5, 54.4, 34.5, 20.6, and 4.7.

IR (neat): 3065, 3030, 2919, 2852, 1601, 1492, 1339, 1235, 1155, 1077, 961, and 754 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{34}H_{34}N_2NaO_3S^+$ [$M+Na^+$] requires 573.2182; found 573.2187.

P11-maj

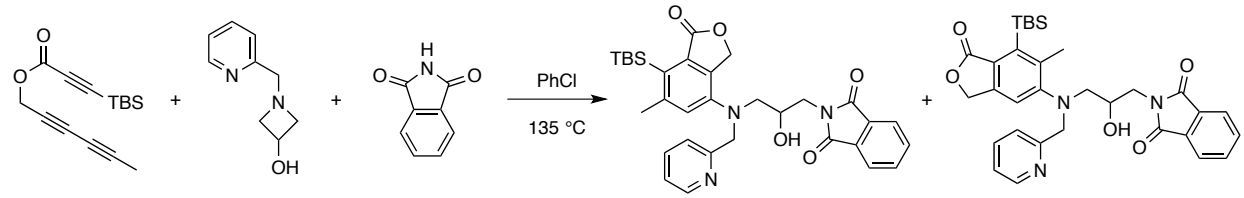
^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.30–7.24 (m, 6H, $CH_2Ph\mathit{H}_m\mathit{H}_p$; $CHPh\mathit{H}_m\mathit{H}_p$), 7.22–7.18 (m, 4H, $CH_2Ph\mathit{H}_o$; $CHPh\mathit{H}_o$), 7.14 (dd, J = 8.6, 7.3 Hz, 2H, $OPh\mathit{H}_m$), 6.86 (tt, J = 7.3, 1.1 Hz, 1H, $OPh\mathit{H}_p$), 6.79 (s, 1H, $MsN(CH_2)_2Ar\mathit{H}$), 5.16 (dd, J = 8.4, 4.0 Hz, 1H, $NCH_2C\mathit{H}PhOPh$), 4.67 [m, 2H, $MsN(C_aH_2)_2$], 4.58 [s, 2H, $MsN(C_bH_2)_2$], 4.41 (d, J = 14.7 Hz, 1H, $PhNC\mathit{H}_aH_bN$), 4.30 (d, J = 14.8 Hz, 1H, $PhNCH_a\mathit{H}_bN$), 3.59 (dd, J = 14.9, 8.4 Hz, 1H, $NC\mathit{H}_aH_bCHPhOPh$), 3.34 (dd, J = 14.9, 4.0 Hz, 1H, $NCH_a\mathit{H}_bCHPhOPh$), 2.69 (s, 3H, $NSO_2C\mathit{H}_3$), 2.34 (s, 3H, $NArC\mathit{H}_3$), and 2.11 (s, 3H, $ArC{\equiv}CC\mathit{H}_3$).

^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 157.8, 150.1, 140.0, 138.5, 136.0, 134.1, 133.4, 129.4, 128.8, 128.7, 128.4, 127.8, 127.3, 126.1, 120.9, 120.4, 116.9, 115.6, 94.7, 78.2, 76.1, 59.2, 59.1, 54.42, 54.37, 34.8, 16.4, and 4.7.

IR (neat): 3062, 3028, 2916, 2851, 2227, 1598, 1586, 1493, 1453, 1338, 1237, 1155, and 753 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{34}H_{34}N_2NaO_3S^+$ [$M+Na^+$] requires 573.2182; found 573.2189.

2-(3-((7-(*tert*-Butyldimethylsilyl)-6-methyl-1-oxo-1,3-dihydroisobenzofuran-4-yl)(pyridin-2-ylmethyl)amino)-2-hydroxypropyl)isoindoline-1,3-dione (**P12-min**) and **2-(3-((7-(*tert*-Butyldimethylsilyl)-6-methyl-1-oxo-1,3-dihydroisobenzofuran-5-yl)(pyridin-2-ylmethyl)amino)-2-hydroxypropyl)isoindoline-1,3-dione** (**P12-maj**)



6b ***8g*** ***9d*** ***P12-min*** (19%) ***P12-maj*** (48%)

Triyne **6b** (50 mg, 0.192 mmol), phthalimide (**9d**, 31 mg, 0.211 mmol, 1.10 equiv), and **8g** (42 mg, 0.240 mmol, 1.25 equiv) were combined in a culture tube, dissolved in chlorobenzene (7 mL), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 135 °C, cooled, concentrated, and passed through a plug of silica (99:1 EtOAc:IPA + 1% NEt_3). The resulting residue was purified by MPLC (2:3 Hex:EtOAc +1% NEt_3) to give, in order of elution, **P12-min** (21 mg, 0.037 mmol, 19% yield) as a dark yellow oil and **P12-maj** (53 mg, 0.093 mmol, 48%) as an off-white solid.

P12-min

^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.50 (ddd, *J* = 5.0, 1.8, 0.9 Hz, 1H, Py*H*6), 7.87 (nfom, 2H, PhthH_o), 7.73 (nfom, 2H, PhthH_m), 7.71 (ddd, *J* = 7.6, 7.6, 1.8 Hz, 1H, Py*H*4), 7.25 (ddd, *J* = 7.7, 1.0, 1.0 Hz, 1H, Py*H*3), 7.22 (ddd, *J* = 7.7, 4.9, 1.3 Hz, 1H, Py*H*5), 6.78 (s, 1H, COAr*H*), 5.13 (d, *J* = 14.8 Hz, 1H, COOC*H*aHb), 5.09 (d, *J* = 14.9 Hz, 1H, COOCHa*H*b), 4.64 (d, *J* = 17.4 Hz, 1H, PyC*H*aHbN), 4.53 (d, *J* = 17.4 Hz, 1H, PyCHa*H*bN), 4.23 (dddd, *J* =9.8, 6.7, 5.1, 2.7 Hz, 1H, C*H*OH), 3.89 [dd, *J* = 13.9, 6.8 Hz, 1H, CHC*H*aHbN(CO)$_2$], 3.80 [dd, *J* = 13.9, 5.1 Hz, 1H, CHCHa*H*bN(CO)$_2$], 3.63 (dd, *J* = 14.5, 2.7 Hz, 1H, COArNC*H*aHbCH), 3.37 (dd, *J* = 14.5, 10.0 Hz, 1H, COArNC*H*aHbCH), 2.39 (s, 3H, ArCH_3), 0.98 [s, 9H, SiC(CH_3)$_3$], 0.37 (s, 3H, Si$C_a$$H_3$$C_b$$H_3$), and 0.36 (s, 3H, Si$C_a$$H_3$$C_b$$H_3$).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 171.1, 168.9, 158.0, 149.2, 147.9, 145.1, 137.4, 134.1, 133.6, 132.3, 128.1, 128.0, 123.3, 123.0, 122.6, 122.1, 68.4, 67.1, 57.9, 58.1, 41.4, 28.4, 25.9, 19.6 and 1.4.

IR (neat): 3500 (br), 3064, 2929, 2855, 1767, 1712, 1586, 1396, 1089, and 1024 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{32}H_{38}N_3O_5Si^+$ [M+H$^+$] requires 572.2575; found 572.2581.

P12-maj

^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.55 (ddd, *J* = 4.9, 1.9, 0.9 Hz, 1H, Py*H*6), 7.84 (nfom, 2H, PhthH_o), 7.72 (nfom, 2H, PhthH_m), 7.64 (ddd, *J* = 7.7, 7.7, 1.9 Hz, 1H, Py*H*4), 7.20 (ddd, *J* = 7.6, 4.9, 1.2 Hz, 1H, Py*H*5), 7.17 (s, 1H, COArH), 7.11 (ddd, *J* = 7.8, 1.1, 1.1 Hz, 1H, Py*H*3), 5.09 (d, *J* = 14.9 Hz, 1H, COOC*H*aHb), 5.05 (d, *J* = 14.9 Hz, 1H, COOCHa*H*b), 4.40 (d, *J* = 16.4 Hz, 1H, PyC*H*aHbN), 4.37 (d, *J* = 16.7 Hz, 1H, PyCHa*H*bN), 4.10 (dddd, *J* = 9.2, 6.9, 4.9, 3.0 Hz, 1H, C*H*OH), 3.78 (dd, *J* = 13.9, 6.9 Hz, 1H, CHC*H*aHbN(CO)$_2$], 3.72 [dd, *J* = 13.9, 4.9 Hz, 1H, CHCHa*H*bN(CO)$_2$], 3.50 (dd, *J* = 14.0, 3.0 Hz, 1H, COArNC*H*aHbCH), 3.16 (dd, *J* = 13.9, 9.2 Hz, 1H, COArNC*H*aHbCH), 2.44 (s, 3H, ArCH_3), 1.03 [s, 9H, SiC(CH_3)$_3$], 0.41 (s, 3H, Si$C_a$$H_3$$C_b$$H_3$), and 0.39 (s, 3H, Si$C_a$$H_3$$C_b$$H_3$).

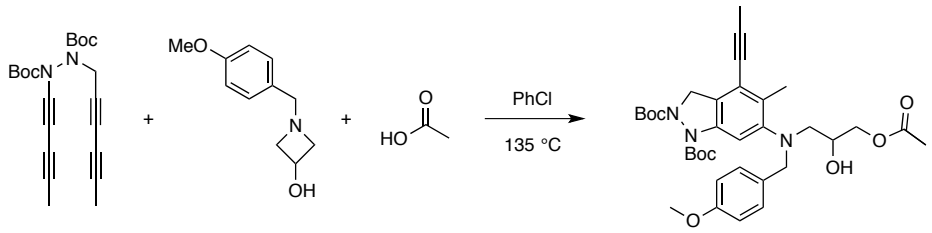
^{13}C-NMR (125 MHz, $CDCl_3$): δ 170.8, 168.6, 157.8, 155.2, 154.9, 146.1, 148.9, 142.6, 137.0, 134.1, 132.1, 126.1, 123.3, 122.6, 122.5, 116.0, 67.7, 67.6, 59.8, 57.6, 42.0, 28.4, 22.0, 19.4, and 1.5.

IR (neat): 3500 (br), 2932, 2855, 1760, 1713, 1588, 1394, 1245, and 1032 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{32}H_{38}N_3O_5Si^+$ [M+H$^+$] requires 572.2575; found 572.2596.

mp: 104-106 °C.

di-*tert*-Butyl 6-((3-Acetoxy-2-hydroxypropyl)(4-methoxybenzyl)amino)-5-methyl-4-(prop-1-yn-1-yl)-1*H*-indazole-1,2(3*H*)-dicarboxylate (P13)



6c ***8h*** ***9a*** ***P13*** (42%)

Tetrayne **6c** (77 mg, 0.207 mmol), acetic acid (**9a**, 15 μL, 0.259 mmol, 1.25 equiv), and **8h** (60 mg, 0.311 mmol, 1.5 equiv) were combined in a culture tube, dissolved in chlorobenzene (7.5 mL), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 135 °C, cooled, concentrated, and passed through a plug of silica (5:1 to 1:3 Hex:EtOAc). The resulting residue was purified by MPLC (2:1 Hex:EtOAc) to give **P13** (54 mg, 0.087 mmol, 42%) as a yellow oil.

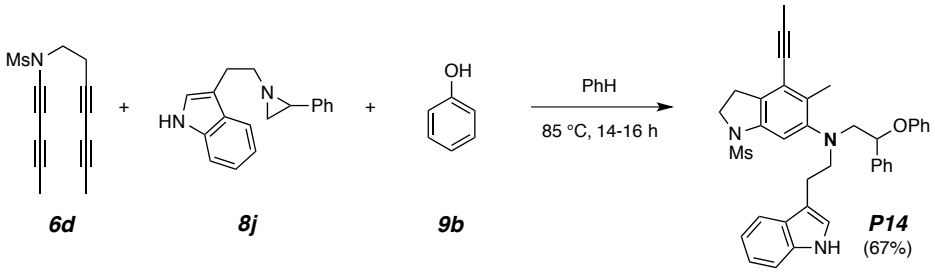
^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.26 (br s, 1H, NArH), 7.12 (d, *J* = 8.5 Hz, 2H, MeOArH_m), 6.83 (d, *J* = 8.7 Hz, 2H, MeOArH_o), 5.064 (d, *J* = 14.9 Hz, 0.5H, CH_aH$_b$NBoc), 5.057 (d, *J* = 14.9 Hz, 0.5H, CH_aH$_b$NBoc), 4.599 (d, *J* = 14.9 Hz, 0.5H CH$_a$$H_b$NBoc), 4.595 (d, *J* = 14.9 Hz, 0.5H CH$_a$$H_b$NBoc), 4.076 (dd, *J* = 11.5, 2.6 Hz, 0.5H, CH_aH$_b$OAc), 4.071 (dd, *J* = 11.5, 2.6 Hz, 0.5H, CH_aH$_b$OAc), 3.97–3.93 (m, 1H, 1H, CH$_a$$H_b$OAc), 3.94 (d, *J* = 13.9 Hz, 1H, MeOArCH_aH$_b$N), 3.93 (d, *J* = 13.9 Hz, 1H, MeOArCH$_a$$H_b$N), 3.82–3.74 (m, 1H, CHOH), 3.79 (s, 3H, CH_3OAr), 3.060 (dd, *J* = 12.9, 3.8 Hz, 0.5H, ArNCH_aH$_b$CH), 3.053 (dd, *J* = 12.9, 4.5 Hz, 0.5H, ArNCH_aH$_b$CH), 2.92 (dd, *J* = 13.0, 8.6 Hz, 1H, ArNCH$_a$$H_b$CH), 2.41 (s, 3H, ArC$H_3$), 2.13 (s, 3H, OCOC$H_3$), 2.02 (s, 3H, ArC≡CC$H_3$), 1.53 [s, 9H, COOC(C$H_3$)$_3$], and 1.52 [s, 9H, COOC(CH_3)$_3$]. [This compound is a mixture of two diastereomeric entities (wrt the fixed stereogenic center and a non-planar, Boc-containing nitrogen atom*), which interconvert slowly on the NMR time scale. These are populated in a ratio of ca. 1:1, evident in the doubling of a number of resonances in the ^{13}C spectrum as well. *See the inequivalent nature of the methylene protons of the indazoline ring in the related bis-Boc compound **P28.**]

^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 171.2, 159.1, 156.4, 152.9, 149.1, 138.4, 132.7, 130.5, 129.4, 127.4, 119.6, 114.0, 111.1, 94.6, 82.63, 82.57, 82.3, 75.7, 66.8, 66.6, 60.4, 60.2, 55.4, 54.7, 54.6, 52.1, 28.3, 21.0, 15.9, and 4.8.

IR (neat): 3480 (br), 2977, 2933, 2836, 2232, 1736, 1707, 1610, 1598, 1457, 1368, 1248, 1149, 1037, and 848 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{34}H_{46}N_3O_8^+$ [M+H$^+$] requires 624.3279; found 624.3275.

_N_-(2-(1_H_-Indol-3-yl)ethyl)-5-methyl-1-(methylsulfonyl)-_N_-(2-phenoxy-2-phenylethyl)-4-(prop-1-yn-1-yl)indolin-6-amine (P14)



Tetrayne **6d** (50 mg, 0.202 mmol), phenol (**9b**, 29 mg, 0.303 mmol, 1.5 equiv), and **8j** (82 mg, 0.312 mmol, 1.6 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (1:3 Hex:EtOAc). The resulting residue was purified by MPLC (3:1 Hex:EtOAc +1%NEt_3) to give **P14** (84 mg, 0.171 mmol, 56%) as a colorless foam.

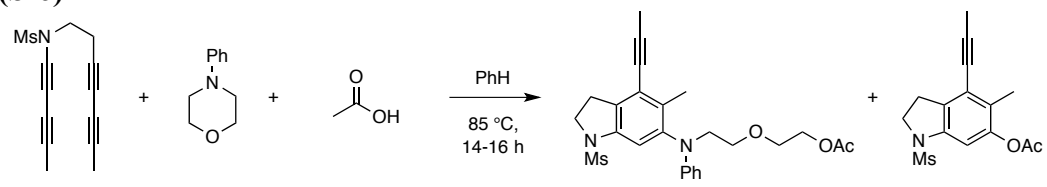
^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.89 (br s, 1H, IndN*H*), 7.50 (dddd, *J* = 7.9, 0.9, 0.9, 0.9 Hz, 1H, Ind*H*4), 7.32 (ddd, *J* = 8.1, 0.9, 0.9 Hz, 1H, Ind*H*7), 7.30-7.21 (m, 6H, NMsAr*H*, CHC_6H_5), 7.16 (ddd, *J* = 7.0, 7.0, 1.2 Hz, 1H, Ind*H*6), 7.12 (dd, *J* = 8.4, 7.5 Hz, 2H, OPhH_m), 7.07 (ddd, *J* = 7.0, 7.0, 1.0 Hz, 1H, Ind*H*5), 6.91 (d, *J* = 2.4 Hz, 1H, Ind*H*2), 6.83 (tt, *J* = 7.4, 1.1 Hz, 1H, OPhH_p), 6.71 (dd, *J* = 8.8, 1.2 Hz, 2H, OPhH_o), 5.07 (dd, *J* = 8.5, 3.7 Hz, 1H, PhC*H*OPh), 3.97 (nfom, 1H, MsNC$H_a$$H_b$$CH_2$), 3.90 (nfom, 1H, MsNC$H_a$$H_b$$CH_2$), 3.58 (dd, *J* = 14.3, 8.6 Hz, C$H_a$$H_b$CHPhOPh), 3.52 (dd, *J* = 13.3, 5.4 Hz, 1H, IndCH_2C$H_a$$H_b$N), 3.46 (dd, *J* = 13.3, 7.5 Hz, IndCH_2C$H_a$$H_b$N), 3.36 (dd, *J* = 14.3, 3.7 Hz, 1H, C$H_a$$H_b$CHPhOPh), 3.14 (t, *J* =8.4 Hz, 2H, MsNCH_2CH_2), 2.85 (t, *J* = 7.7 Hz, 2H, IndCH_2CH_2N), 2.55 (s, 3H, NSO_2CH_3), 2.26 (s, 3H, ArCH_3), and 2.12 (s, 3H, ArC≡CCH_3).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 158.0, 149.1, 140.2, 139.7, 136.2, 132.3, 129.3, 129.1, 128.6, 127.6, 127.5, 126.0, 122.2, 121.8, 121.7, 120.7, 119.2, 118.8, 115.8, 114.0, 111.1, 109.0, 93.8, 78.8, 76.5, 61.4, 55.4, 50.5, 33.7, 28.0, 23.7, 16.1, and 4.6.

IR (neat): 3422, 3062, 2951, 2917, 2852, 2232, 1588, 1494, 1455, 1345, 1235, 1158, 971, and 910 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{37}H_{38}N_3O_3S^+$ [M+H^+] requires 604.2628; found 604.2636.

2-(2-((5-Methyl-1-(methylsulfonyl)-4-(prop-1-yn-1-yl)indolin-6 yl)(phenyl)amino)-ethoxy)ethyl acetate (P15) and **5-methyl-1-(methylsulfonyl)-4-(prop-1-yn-1-yl)indolin-6-yl acetate (S-6)**



6d ***8e*** ***9a*** ***P15*** (54%) ***S-6*** (27%)

Tetrayne **6d** (50 mg, 0.202 mmol), acetic acid (**9a**, 15 µl, 0.253 mmol, 1.25 equiv), and *N*-phenylmorpholine (**8e**, 82 mg, 0.505 mmol, 2.5 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (1:1 Hex:EtOAc). The resulting residue was purified by MPLC (2:1 Hex:EtOAc) to give, in order of elution, **S-6** (17 mg, 0.55 mmol, 27%) and **P15** (54 mg, 0.115 mmol, 57% yield).

S-6

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.01 (s, 1H, Ar*H*), 3.98 (t, *J* = 8.3 Hz, 2H, MsNCH_2CH$_2$), 3.16 (t, *J* = 8.4 Hz, 2H, MsNCH$_2$CH_2), 2.85 (s, 3H, NSO$_2$CH_3), 2.30 (s, 3H, OCOCH_3), 2.17 (s, 3H, ArCH_3), and 2.12 (s, 3H, ArC≡CCH_3).

^{13}C-NMR (125 MHz, $CDCl_3$): δ169.1, 148.8, 140.0, 131.6, 127.2, 122.5, 107.6, 94.9, 75.4, 50.6, 35.1, 28.0, 20.7, 13.9, and 4.4.

IR (neat): 3098, 3015, 2921, 2853, 2225, 1760, 1605, 1453, 1346, 1202, 1158, 1089, and 969 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{15}H_{18}NO_4S^+$ [M+H$^+$] requires 308.0951; found 308.0976.

P15

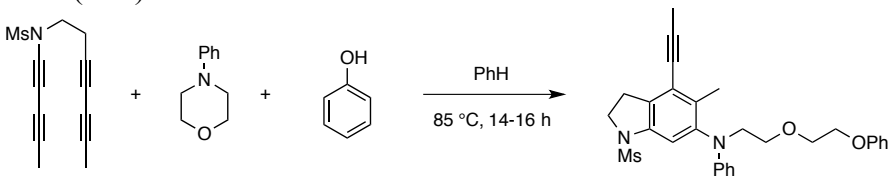
^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.19 (s, 1H, Ar*H*), 7.13 (dd, *J* = 8.8, 7.3 Hz, 2H, NArH_m), 6.69 (tt, *J* = 7.3, 0.9 Hz, 1H, NArH_p), 6.49 (dd, *J* = 8.8, 0.9 Hz, 2H, NArH_o), 4.19 (br t, *J* = 4.8 Hz, 2H, OCH$_2$CH_2OAc), 4.00 (t, *J* = 8.5 Hz, 2H, MsNCH_2CH$_2$), 3.81 (t, *J* = 6.4 Hz, 2H, ArNCH_2CH$_2$O), 3.68 (t, *J* = 6.2 Hz, 2H, ArNCH$_2$CH_2O), 3.63 (br t, *J* = 4.9 Hz, 2H, OCH_2CH$_2$OAc), 3.20 (t, *J* = 8.5 Hz, 2H, MsNCH$_2$CH_2), 2.83 (s, 3H, NSO$_2$CH_3), 2.13 (s, 3H, ArC≡CCH_3), 2.12 (s, 3H, ArCH_3), and 2.04 (s, 3H, OCOCH_3).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 171.1, 148.1, 144.6, 140.8, 134.5, 132.3, 129.1, 122.9, 117.1, 114.5, 112.8, 94.7, 75.9, 69.1, 68.5, 63.5, 51.3, 50.4, 34.3, 28.1, 20.9, 15.6, and 4.6.

IR (neat): 2943, 2919, 2869, 2223, 1751, 1434, 1343, 1214, and 1166 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{25}H_{31}N_2O_5S^+$ [M+H$^+$] requires 471.1948; found 471.1966.

5-Methyl-1-(methylsulfonyl)-*N*-(2-(2-phenoxyethoxy)ethyl)-*N*-phenyl-4-(prop-1-yn-1-yl)indolin-6-amine (P16)



6d ***8e*** ***9b*** ***P16*** (76%)

Tetrayne **6d** (50 mg, 0.202 mmol), phenol (**9b**, 24 mg, 0.253 mmol, 1.25 equiv), and *N*-phenylmorpholine (**8e**, 82 mg, 0.505 mmol, 2.5 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (1:1 Hex:EtOAc). The resulting residue was purified by MPLC (4:1 Hex:EtOAc) to give **P16** (77 mg, 0.153 mmol, 76% yield) as a yellow oil.

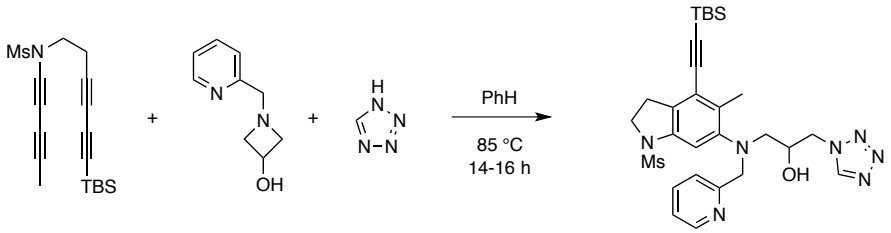
^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.26 (dd, *J* = 8.6, 7.3 Hz, 2H, OArH_m), 7.21 (s, 1H, Ar*H*), 7.13 (dd, *J* = 8.8, 7.3 Hz, 2H, NArH_m), 6.93 (tt, *J* = 7.4, 1.0 Hz, 1H, OArH_p), 6.89 (dd, *J* = 8.8, 1.0 Hz, 2H, OArH_o), 6.69 (tt, *J* = 7.3, 1.0 Hz, 1H, NArH_p), 6.49 (dd, *J* = 8.8, 0.9 Hz, 2H, NArH_o), 4.09 (br t, *J* = 4.8 Hz, 2H, OCH_2CH_2OPh), 3.97 (t, *J* = 8.5 Hz, 2H, $MsNCH_2CH_2$), 3.82 (t, *J* = 6.5 Hz, 2H, $ArNCH_2CH_2O$), 3.78 (t, *J* = 4.9 Hz, 2H, OCH_2CH_2OPh), 3.76 (t, *J* = 6.2 Hz, 2H, $ArNCH_2CH_2O$), 3.18 (t, *J* = 8.5 Hz, 2H, $MsNCH_2CH_2$), 2.77 (s, 3H, NSO_2CH_3), 2.120 (s, 3H, $ArC{\equiv}CCH_3$), and 2.116 (s, 3H, $ArCH_3$).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 158.8, 148.0, 144.7, 140.8, 134.7, 132.5, 129.3, 129.2, 122.9, 120.9, 117.1, 114.73, 114.72, 112.8, 94.7, 76.0, 69.8, 68.7, 67.4, 51.4, 50.5, 34.2, 28.1, 15.7, and 4.6.

IR (neat): 3061, 3036, 2917, 2873, 2228, 1596, 1588, 1497, 1347, 1244, and 1160 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{29}H_{33}N_2O_4S^+$ [$M+H^+$] requires 505.2156; found 505.2172.

1-((4-((*tert*-Butyldimethylsilyl)ethynyl)-5-methyl-1-(methylsulfonyl)indolin-6-yl)(pyridin-2-ylmethyl)amino)-3-(1*H*-tetrazol-1-yl)propan-2-ol (P17)



6e ***8g*** ***9f*** ***P17*** (37%)

Tetrayne **6e** (75 mg, 0.216 mmol), tetrazine (**9f**, 0.53 mL, ~0.45M in MeCN, 0.24 mmol, 1.10 equiv), and **8g** (93 mg, 0.54 mmol, 2.5 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (99:1 EtOAc:IPA + 1% NEt_3). The resulting residue was purified by MPLC (2:3 Hex:EtOAc +1% NEt_3) to give, **P17** (46 mg, 0.079 mmol, 37%) as a brown oil.

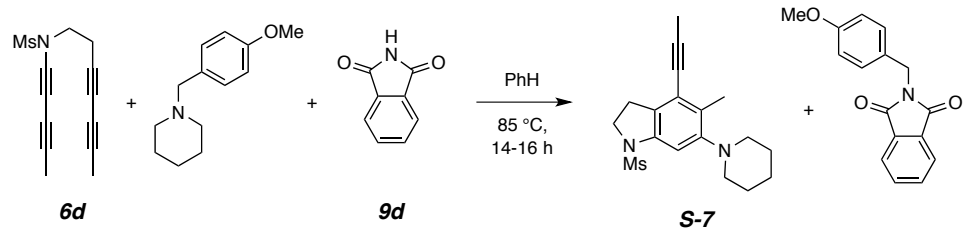
^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.57 (ddd, *J* = 5.0, 1.8, 1.0 Hz, 1H, Py*H*6), 8.48 (s, 1H, Tet*H*), 7.63 (ddd, *J* = 7.7, 7.7, 1.8 Hz, 1H, Py*H*4), 7.22 (ddd, *J* = 7.6, 4.9, 1.2 Hz, 1H, Py*H*5), 7.19 (s, 1H, NAr*H*), 7.05 (ddd, *J* = 7.8, 1.1, 1.1 Hz, 1H, Py*H*3), 4.68 (dd, *J* = 13.6, 6.9 Hz, 1H, CHC$H_a$$H_b$Tet), 4.30 (d, *J* = 16.1 Hz, 1H, PyC$H_a$$H_b$N), 4.24 (m, 1H, C*H*OH), 4.23 (d, *J* = 16.1 Hz, 1H, PyC$H_a$$H_b$N), 4.00 (dd, *J* = 10.6, 8.7 Hz, 1H, MsNC$H_a$$H_b$), 3.95 (dd, *J* = 10.7, 8.5 Hz, 1H, MsNC$H_a$$H_b$), 3.47 (dd, *J* = 13.8, 3.0 Hz, 1H, ArNC$H_a$$H_b$CH), 3.16 (t, *J* = 8.6 Hz, 2H, MsNCH_2CH_2), 3.11 (dd, *J* = 13.8, 8.9 Hz, 1H, ArNC$H_a$$H_b$CH), 2.79 (s, 3H, NSO_2CH_3), 2.32 (s, 3H, NArCH_3), 0.98 (s, 9H, SiC(CH_3)$_3$), and 0.17 [s, 6H, Si(CH_3)$_2$].

^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 158.1, 153.0, 149.8, 149.1, 140.3, 137.1, 133.0, 131.0, 122.8, 122.7, 122.1, 110.4, 101.71, 101.66, 68.3, 60.8, 57.6, 56.7, 50.6, 34.4, 28.2, 26.2, 16.7, 16.3, and -4.40.

IR (neat): 3500 (br), 2953, 2929, 2857, 2151, 1590, 1471, 1347, 1160, and 1088 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{28}H_{40}N_7O_3SSi^+$ [M+H^+] requires 582.2677; found 582.2682.

5-Methyl-1-(methylsulfonyl)-6-(piperidin-1-yl)-4-(prop-1-yn-1-yl)indoline (S-7)



6d *9d* *S-7*

Tetrayne **6d** (50 mg, 0.202 mmol), *N*-(4-methoxybenzyl)piperidine (104 mg, 0.505 mmol, 2.5 equiv), and phthalimide (**9d**, 37 mg, 0.253 mmol, 1.25 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (1:3 Hex:EtOAc). The resulting residue was purified by MPLC (10:1 Hex:EtOAc) to give a coeluting mixture (~1:1 molar ratio) of **S-7** [93 mg, (55 wt%, 52 mg), 0.156 mmol, 77% yield] and N-(4-methoxybenzyl)phthalimide (45 wt%, 0.156 mmol, 77%).

Data for S-7 extracted from the mixture of S-7 and *N*-(4-methoxybenzyl)-phthalimide

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.08 (s, 1H, ArH), 3.97 (t, J = 8.2 Hz, 2H, MsNCH_2CH$_2$), 3.11 (t, J = 8.5 Hz, 2H, MsNCH$_2$CH_2), 2.81 (s, 3H, NSO$_2$CH_3), 2.78 (br t, J = 5.3 Hz, 4H, N(CH_2CH$_2$)$_2$CH$_2$), 2.32 (s, 3H, ArCH_3), 2.12 (s, 3H, ArC≡CCH_3), 1.69 (br pent, J = 6.0 Hz, 4H, N(CH$_2$CH_2)$_2$CH$_2$), and 1.55 (m, 2H, N(CH$_2$CH$_2$)$_2$CH_2).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 153.2, 139.8, 130.3, 127.8, 121.8, 105.3, 93.0, 76.5, 53.6, 50.5, 34.0, 27.9, 26.5, 24.2, 15.6, and 4.5.

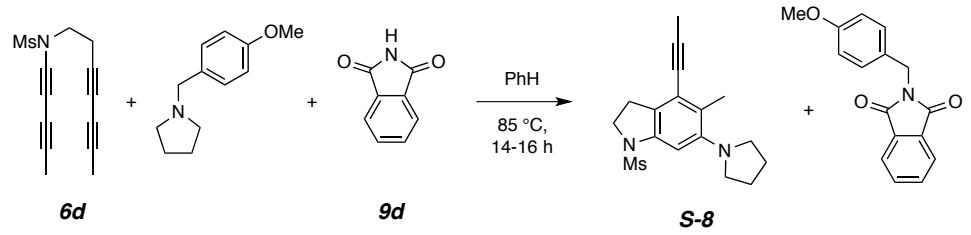
Data for the mixture of S-7 and *N*-(4-methoxybenzyl)-phthalimide

IR (neat): 2933, 2849, 2794, 2235, 1767, 1712, 1588, 1513, 1392, 1346, 1247, 1159, and 1101 cm^{-1}.

Data for S-7 from the mixture of S-7 and *N*-(4-methoxybenzyl)-phthalimide

HRMS (ESI-TOF): Calcd for $C_{18}H_{25}N_2O_2S^+$ [M+H$^+$] requires 333.1631; found 333.1631.

5-Methyl-1-(methylsulfonyl)-4-(prop-1-yn-1-yl)-6-(pyrrolidin-1-yl)indoline (S-8)



6d ***9d*** ***S-8***

Tetrayne **6d** (50 mg, 0.202 mmol), *N*-(4-methoxybenzyl)pyrrolidine (104 mg, 0.505 mmol, 2.5 equiv), and phthalimide (**9d**, 37 mg, 0.253 mmol, 1.25 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and passed through a plug of silica (1:3 Hex:EtOAc). The resulting residue was purified by MPLC (10:1 Hex:EtOAc) to give, in order of elution, *N*-(4-methoxybenzyl)phthalimide (32 mg, 0.12 mmol) and **S-8** (41 mg, 0.129 mmol, 64%) as a pale yellow oil.

S-8

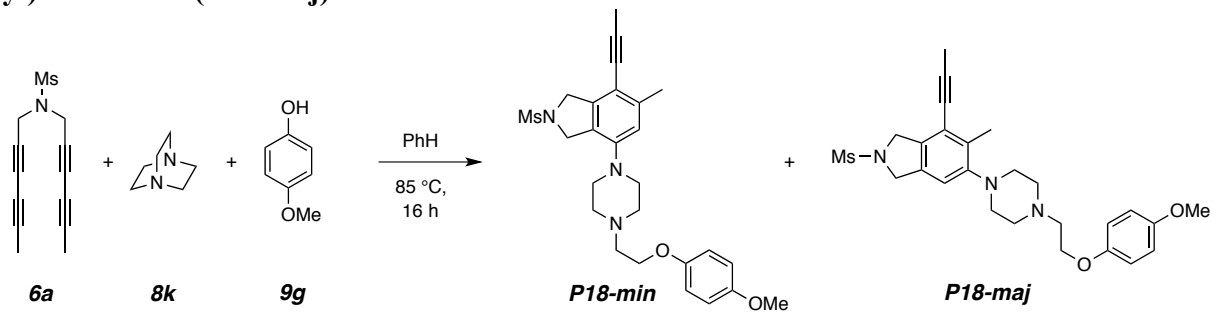
^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.03 (s, 1H, ArH), 3.95 (t, J = 8.4 Hz, 2H, MsNCH_2CH$_2$), 3.13-3.09 (m, 6H, MsNCH$_2$CH_2, N(CH_2CH$_2$)$_2$), 2.82 (s, 3H, NSO$_2$CH_3), 2.34 (s, 3H, ArCH_3), 2.12 (s, 3H, ArC≡CCH_3), and 1.91 (m, 4H, N(CH$_2$CH_2)$_2$).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 149.9, 139.8, 127.1, 125.9, 122.2, 102.7, 93.4, 76.7, 51.5, 50.7, 34.1, 28.0, 24.8, 17.5, and 4.6.

IR (neat): 2955, 2916, 2873, 2812, 2230, 1589, 1462, 1346, 1158, and 970 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{17}H_{23}N_2O_2S^+$ [M+H$^+$] requires 319.1475; found 319.1493.

7-(4-(2-(4-Methoxyphenoxy)piperazin-1-yl)-5-methyl-2-(methylsulfonyl)-4-(prop-1-yn-1-yl)isoindoline (P18-min) and
6-(4-(2-(4-methoxyphenoxy)ethyl)piperazin-1-yl)-5-methyl-2-(methylsulfonyl)-4-(prop-1-yn-1-yl)isoindoline (P18-maj)



6a ***8k*** ***9g*** ***P18-min*** ***P18-maj***

Tetrayne **6a** (50 mg, 0.202 mmol), 4-methoxyphenol (**9g**, 38 mg, 0.303 mmol, 1.5 equiv), and DABCO (**8k**, 34 mg, 0.303 mmol, 1.5 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, and passed through a plug of silica (1:3+1% Hex:EtOAc+NEt_3). The resulting residue was purified by MPLC (2:1+1% Hex:EtOAc+NEt_3) to give a 1:1.3 mixture of **P18-min** and **P18-maj** (72 mg, 0.149 mmol, 74 %). A different sample of the crude product mixture was separated by MPLC using 2:3 Hex:EtOAc as eluant, to give, in order of elution, **P18-min** and **P18-maj**, each as an off-white solid.

P18-min

^{1}H-NMR (500 MHz, $CDCl_3$): δ 6.89 (d, *J* = 9.1 Hz, 2H, MeOAr*Ho or m*), 6.85 (d, *J* = 9.3 Hz, 2H, MeOAr*Ho or m*), 6.67 (s, 1H, NAr*H*), 4.68 (s, 2H, $MsNC_aH_2$), 4.64 (s, 2H, $MsNC_bH_2$), 4.09 (t, *J* = 5.6 Hz, 2H, $ArOCH_2$), 3.77 (s, 3H, $OArOCH_3$), 3.02 [br t, *J* = 4.6 Hz, 4H, $ArN(CH_2CH_2)_2N$], 2.86 (s, 3H, NSO_2CH_3), 2.85 (t, *J* = 5.8 Hz, 2H, $ArOCH_2CH_2N$), 2.71 [br t, J = 4.5 Hz, 4H, $ArN(CH_2CH_2)_2N$], 2.38 (s, 3H, $ArCH_3$), and 2.09 (s, 3H, $ArC{\equiv}CCH_3$).

^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 153.9, 152.9, 146.9, 141.2, 140.3, 125.4, 117.8, 115.6, 114.6, 112.3, 93.0, 75.4, 66.5, 57.3, 55.7, 54.4, 53.7 (x2), 50.4, 34.7, 20.5, and 4.6.

IR (neat): 2948, 2916, 2830, 1604, 1508, 1335, 1229, 1154, 1038, and 829 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{26}H_{33}N_3NaO_4S^+$ [$M+Na^+$] requires 506.2084; found 506.2104.

mp: 147-150 °C.

P18-maj

1H-NMR (500 MHz, $CDCl_3$): δ 6.89 (d, *J* = 9.1 Hz, 2H, MeOAr*Ho or m*), 6.87 (s, 1H, NAr*H*), 6.85 (d, *J* = 9.3 Hz, 2H, MeOAr*Ho or m*), 4.67 [s, 4H, $MsN(CH_2)_2$], 4.10 (t, *J* = 5.8 Hz, 2H, $ArOCH_2CH_2N$), 3.77 (s, 3H, $ArOCH_3$), 2.90 [br t, *J* = 4.5 Hz, 4H, $ArN(CH_2CH_2)_2N$], 2.87 (t, *J* = 5.6 Hz, 2H, OCH_2CH_2N), 2.85 (s, 3H, CH_3SO_2), 2.75 [br m, 4H, $ArN(CH_2CH_2)_2N$], 2.37 (s, 3H, $ArCH_3$), and 2.11 (s, 3H, $ArC{\equiv}CCH_3$).

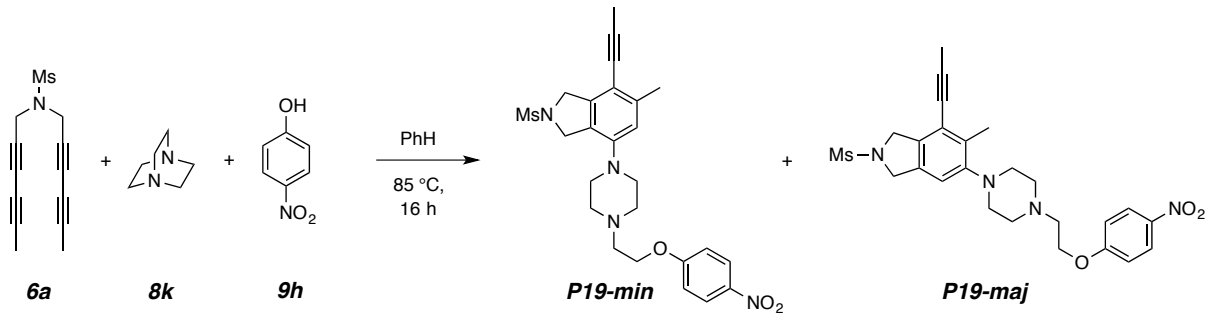
^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 154.0, 153.0, 152.0, 134.6, 133.6, 133.4, 120.3, 115.7, 114.7, 112.8, 94.6, 76.0, 66.7, 57.5, 55.8, 54.6, 54.3, 54.1, 52.0, 34.6, 16.0, and 4.7.

IR (neat): 2945, 2916, 2829, 2229, 1592, 1508, 1463, 1665, 1229, 1153, and 826 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{26}H_{34}N_3O_4S^+$ [$M+H^+$] requires 484.2265; found 484.2279.

mp: 152-156 °C.

5-Methyl-2-(methylsulfonyl)-7-(4-(2-(4-nitrophenoxy)ethyl)piperazin-1-yl)-4-(prop-1-yn-1-yl)isoindoline (P19-min) and
5-Methyl-2-(methylsulfonyl)-6-(4-(2-(4-nitrophenoxy)ethyl)piperazin-1-yl)-4-(prop-1-yn-1-yl)isoindoline (P19-maj)



Tetrayne **6a** (50 mg, 0.202 mmol), 4-nitrophenol (**9h**, 42 mg, 0.303 mmol, 1.5 equiv), and DABCO (**8k**, 34 mg, 0.303 mmol, 1.5 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, and passed through a plug of silica (1:9+1% Hex:EtOAc+NEt_3). The resulting residue was purified by MPLC (1:3+1% Hex:EtOAc+NEt_3) to give a 1:2.4 mixture of **P19-min** and **P19-maj** (36 mg, 0.072 mmol, 36 %). These were separated by MPLC using 2:3 Hex:EtOAc as the elution solvent to give, in order of elution, **P19-min** and **P19-maj**, each as an off-white solid.

P19-min

^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.21 (nfod, *J* = 9.2 Hz, 2H, NO_2ArH_o), 6.99 (nfod, *J* = 9.2 Hz, 2H, NO_2ArH_m), 6.67 (s, 2H, $NArH$), 4.68 (s, 2H, $MsNC_aH_2$), 4.64 (s, 2H, $MsNC_bH_2$), 4.23 (t, *J* = 5.6 Hz, 2H, $ArOCH_2CH_2N$), 3.02 (br t, *J* = 4.4 Hz, 4H, $[ArN(CH_2CH_2)_2N]$, 2.92 (t, *J* = 5.5 Hz, 2H, OCH_2CH_2N), 2.87 (s, 3H, NSO_2CH_3), 2.72 [br t, J = 4.7 Hz, 4H, $ArN(CH_2CH_2)_2$], 2.38 (s, 3H, $NArCH_3$), and 2.09 (s, 3H, $ArC{\equiv}CCH_3$).

^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 163.7, 146.7, 141.6, 141.3, 140.4, 125.9, 125.5, 117.9, 114.6, 112.5, 93.1, 75.32, 66.8, 56.8, 54.4, 53.8, 53.7, 50.4, 34.8, 20.5, and 4.6.

IR (neat): 2948, 2919, 2826, 1593, 1509, 1336, 1260, 1155, and 844 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{25}H_{30}N_4NaO_5S^+$ $[M+Na^+]$ requires 521.1829; found 521.1842.

mp: 223-225 °C.

P19-maj

1H-NMR (500 MHz, $CDCl_3$): δ 8.20 (nfod, *J* = 9.2 Hz, 2H, NO_2ArH_o), 6.99 (nfod, *J* = 9.2 Hz, 2H, NO_2ArH_m), 6.85 (s, 1H, $NArH$), 4.67 (s, 4H, $MsN(CH_2)$), 4.25 (t, *J* = 5.7 Hz, 2H, $ArOCH_2CH_2N$), 2.94 (t, *J* = 5.8 Hz, 2H, $ArOCH_2CH_2N$), 2.91 [br t, *J* = 4.6 Hz, 4H, $ArN(CH_2CH_2)_2N$], 2.86 (s, 3H, CH_3SO_2), 2.77 [br s, 4H, $ArN(CH_2CH_2)_2N$], 2.37 (s, 3H, $NArCH_3$), and 2.12 (s, 3H, $ArC{\equiv}CCH_3$).

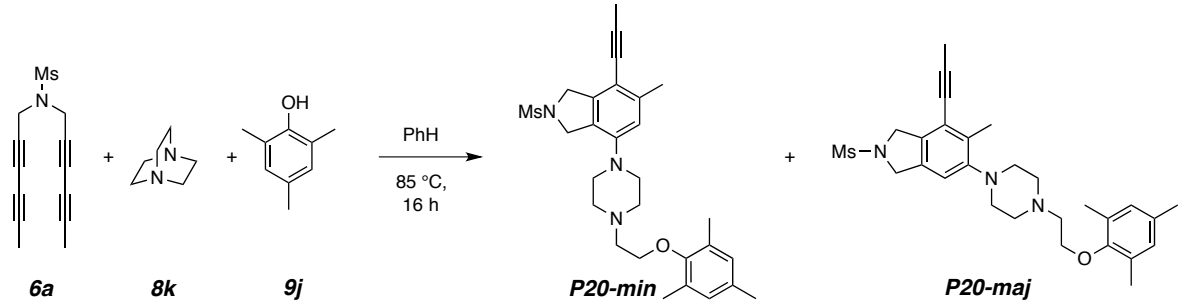
^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 163.7, 151.8, 141.6, 134.5, 133.53, 133.46, 125.9, 120.2, 114.6, 112.7, 94.6, 75.8, 66.8, 56.9, 54.5, 54.2, 54.0, 51.84, 34.60, 15.9, and 4.6.

IR (neat): 2951, 2922, 2820, 2229, 1592, 1509, 1336, 1260, and 1154 cm-1.

HRMS (ESI-TOF): Calcd for $C_{25}H_{30}N_4NaO_5S^+$ $[M+Na^+]$ requires 521.1829; found 521.1852.

mp: 80-84 °C.

7-(4-(2-(Mesityloxy)ethyl)piperazin-1-yl)-5-methyl-2-(methylsulfonyl)-4-(prop-1-yn-1-yl)isoindoline (P20-min) and
6-(4-(2-(Mesityloxy)ethyl)piperazin-1-yl)-5-methyl-2-(methylsulfonyl)-4-(prop-1-yn-1-yl)isoindoline (P20-maj)



Tetrayne **6a** (50 mg, 0.202 mmol), 2,4,6-trimethylphenol (41 mg, 0.303 mmol, 1.5 equiv), and DABCO (**8k**, 34 mg, 0.303 mmol, 1.5 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, and passed through a plug of silica (1:3+1% Hex:EtOAc+NEt_3). The resulting residue was purified by MPLC (3:2+1% Hex:EtOAc+NEt_3) to give, in order of elution, **P20-min** (35 mg, 0.070 mmol, 35 %) and **P20-maj** (44 mg, 0.089 mmol, 44 %).

The reaction could also be performed on a 1 mmol scale. Namely, heating a mixture of tetrayne **6a** (247 mg, 1 mmol), 2,4,6-trimethylphenol (204 mg, 1.5 mmol, 1.5 equiv), and DABCO (**8k**, 169 mg, 1.5 mmol, 1.5 equiv) in benzene (40 mL) overnight at 85 °C resulted in the isolation of **P20-min** (164 mg, 0.33 mmol, 33 %) and **P20-maj** (230 mg, 0.46 mmol, 46 %), using the purification conditions described above.

P20-min

^{1}H-NMR (500 MHz, $CDCl_3$): δ 6.82 (s, 2H, OArH_m), 6.68 (s, 1H, NArH), 4.68 (s, 2H, MsNC$_a$$H_2$), 4.65 (s, 2H, MsNC$_b$$H_2$), 3.89 (t, J = 5.7 Hz, 2H, ArOCH_2), 3.05 (br t, J = 4.8 Hz, 4H, ArN(CH_2CH$_2$)$_2$N), 2.86 (s, 3H, CH_3SO$_2$N), 2.85 (t, J = 5.9 Hz, 2H, ArOCH$_2$CH_2N), 2.72 (br t, J = 4.2 Hz, 4H, ArN(CH$_2$CH_2)$_2$N), 2.38 (s, 3H, NArCH_3), 2.26 (s, 6H, OAr2,6-CH_3), 2.23 (s, 3H, OAr4-CH_3) and 2.09 (s, 3H, ArC≡CCH_3).

^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 153.7, 146.9, 141.2, 140.3, 133.1 130.4, 129.4, 125.4, 117.8, 112.2, 93.0, 75.4, 69.5, 58.3, 54.4, 53.84, 53.75, 50.4, 34.7, 20.7, 20.5, 16.2, and 4.6.

IR (neat): 2948, 2922, 2823, 1604, 1487, 1337, 1214, and 1154 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{28}H_{37}N_3NaO_3S^+$ $[M+Na]^+$ requires 518.2448; found 518.2453.

mp: 168-170 °C.

P20-maj

^{1}H-NMR (500 MHz, $CDCl_3$): δ 6.86 (s, 1H, NArH), 6.81 (s, 2H, OArH_m), 4.67 [s, 4H, MsN(CH_2)$_2$], 3.91 (t, J = 5.8 Hz, 2H, ArOCH_2), 2.93 (br t, J = 4.6 Hz, 4H, ArN(CH_2CH$_2$)$_2$N), 2.87 (t, J = 5.9 Hz, 2H, ArOCH$_2$CH_2N), 2.85 (s, 3H, CH_3SO$_2$N), 2.77 (br s, 4H, ArN(CH$_2$CH_2)$_2$N), 2.38 (s, 3H, NArCH_3), 2.26 (s, 6H, OAr2,6-CH_3), 2.23 (s, 3H, OAr4-CH_3), and 2.11 (s, 3H, ArC≡CCH_3).

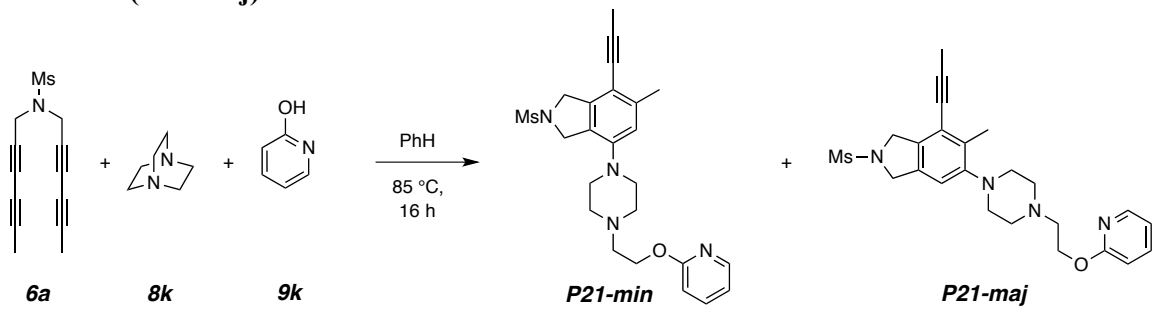
^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 153.7, 152.0, 135.5, 133.5, 133.3, 133.1, 130.4, 129.4, 120.2, 112.7, 94.5, 75.9, 69.6, 58.3, 54.5, 54.2, 54.1, 51.9, 34.5, 20.7, 16.2, 15.9, and 4.6.

IR (neat): 2951, 2919, 2816, 2227, 1595, 1463, 1337, 1215, and 1153 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{28}H_{37}N_3NaO_3S^+$ $[M+Na]^+$ requires 518.2448; found 518.2458.

mp: 69–73 °C.

5-Methyl-2-(methylsulfonyl)-4-(prop-1-yn-1-yl)-7-(4-(2-(pyridin-2-yloxy)ethyl)piperazin-1-yl)isoindoline (P21-min) and
5-Methyl-2-(methylsulfonyl)-4-(prop-1-yn-1-yl)-6-(4-(2-(pyridin-2-yloxy)ethyl)piperazin-1-yl)isoindoline (P21-maj)



Tetrayne **6a** (50 mg, 0.202 mmol), 2-pyridone (**9k**, 29 mg, 0.303 mmol, 1.5 equiv), and DABCO (**8k**, 34 mg, 0.303 mmol, 1.5 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL, 0.03 M), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, and passed through a plug of silica (1% IPA/EtOAc+1% NEt_3). The resulting residue was purified by MPLC (1:3 Hex:EtOAc +1% NEt_3) to give a coeluting, 1:1.25 mixture of **P21-min** and **P21-maj** (43 mg, 0.094 mmol, 47%), which were separated by MPLC (EtOAc) to give, in order of elution, samples of **P21-min** and **P21-maj** that were used to obtain the characterization.

P21-min

^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.15 (ddd, *J* = 5.0, 2.0, 0.8 Hz, 1H, *H6*), 7.57 (ddd, *J* = 8.4, 7.0, 2.0 Hz, 1H, *H4*), 6.87 (ddd, *J* = 7.0, 5.1, 0.9 Hz, 1H, *H5*), 6.78 (ddd, *J* = 8.4, 0.9, 0.9 Hz, 1H, *H3*), 6.66 (s, 1H, NAr*H*), 4.68 (s, 2H, $MsNC_aH_2$), 4.64 (s, 2H, $MsNC_bH_2$), 4.48 (t, *J* = 5.8 Hz, 2H, $ArOCH_2$), 3.02 (br t, *J* = 4.5 Hz, 4H, $ArN(CH_2CH_2)_2N$), 2.87 (t, *J* = 6 Hz, 2H, $ArOCH_2CH_2N$), 2.86 (s, 3H, CH_3SO_2N), 2.71 (br t, *J* = 4.8 Hz, 4H, $ArN(CH_2CH_2)_2N$), 2.38 (s, 3H, $ArCH_3$), and 2.09 (s, 3H, $ArC{\equiv}CCH_3$).

^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 163.7, 147.0, 146.9, 141.3, 140.5, 138.7, 125.5, 117.9, 116.9, 112.4, 111.4, 93.1, 75.5, 63.4, 57.3, 54.5, 53.9, 53.8, 50.5, 34.8, 20.6, and 4.7.

IR (neat): 2951, 2919, 2823, 1597, 1570, 1445, 1433, 1336, 1286, 1154, 1017, and 782 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{24}H_{30}N_4O_3NaS^+$ $[M+Na]^+$ requires 477.1931; found 477.1910.

mp: 179-180 °C.

P21-maj

^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.15 (ddd, *J* = 5.1, 2.0, 0.8 Hz, 1H, *H6*), 7.57 (ddd, *J* = 8.4, 7.1, 2.0 Hz, 1H, *H4*), 6.87 (ddd, *J* = 7.1, 5.0, 0.9 Hz, 1H, *H5*), 6.85 (s, 1H, NAr*H*), 6.77 (ddd, *J* = 8.3, 0.8, 0.8 Hz, 1H, *H3*), 4.67 (br s, 4H, $MsN(CH_2)_2$), 4.49 (t, *J* = 5.7 Hz, 2H, $ArOCH_2$), 2.90 (br t, *J* = 4.8 Hz, 4H, $ArN(CH_2CH_2)_2N$), 2.89 (t, *J* = 5.9 Hz, 2H, $ArOCH_2CH_2N$), 2.85 (s, 3H, CH_3SO_2), 2.75 (br s, 4H $ArN(CH_2CH_2)_2N$), 2.37 (s, 3H, $NArCH_3$), and 2.11 (s, 3H, $ArC{\equiv}CCH_3$).

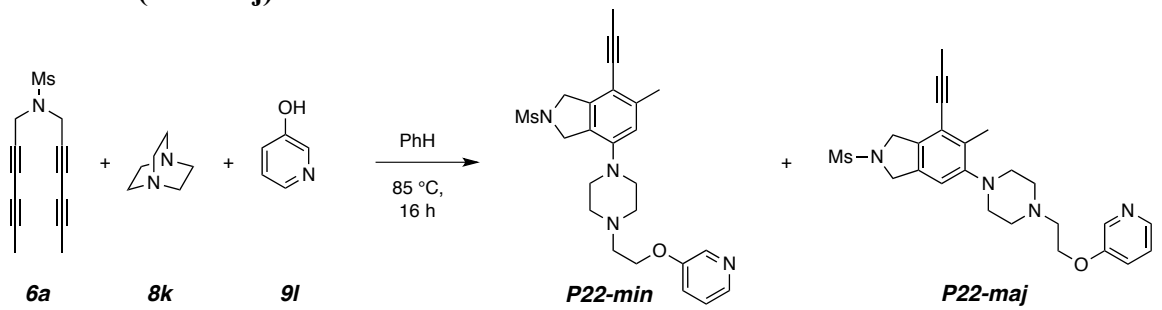
^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 163.8, 152.1 147.0, 138.7, 134.7, 133.6, 133.4, 120.3, 116.9, 112.8, 111.4, 94.6, 76.0, 63.4, 57.3, 54.6, 54.3, 54.0, 52.0, 34.7, 16.0, and 4.7.

IR (neat): 2951, 2919, 2818, 2227, 1596, 1570, 1466, 1433, 1336, 1286, 1154, 1079, 1021, 958, 781, and 757 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{24}H_{31}N_4O_3S^+$ $[M+H]^+$ requires 455.2111; found 455.2114.

mp: 176-180 °C.

5-Methyl-2-(methylsulfonyl)-4-(prop-1-yn-1-yl)-7-(4-(2-(pyridin-3-yloxy)ethyl)piperazin-1-yl)isoindoline (P22-min) and
5-Methyl-2-(methylsulfonyl)-4-(prop-1-yn-1-yl)-6-(4-(2-(pyridin-3-yloxy)ethyl)piperazin-1-yl)isoindoline (P22-maj)



6a *8k* *9l* *P22-min* *P22-maj*

Tetrayne **6a** (50 mg, 0.202 mmol), 3-hydroxypyridine (**9l**, 29 mg, 0.303 mmol, 1.5 equiv), and DABCO (**8k**, 34 mg, 0.303 mmol, 1.5 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL, 0.03 M), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, and passed through a plug of silica (10% IPA/EtOAc+2% NEt_3). The resulting residue was purified by MPLC (5% IPA/EtOAc+1% NEt_3) to give a 1:1 mixture of **P22-min** and **P22-maj** (51 mg, 0.112 mmol, 56%), which was then separated by MPLC (EtOAc) to give, in order of elution, **P22-min** and **P22-maj**.

P22-min

^{1}H-NMR (500 MHz, $CDCl_3$, 1-D): δ 8.35 (br t, *J* = 1.8 Hz, 1H, *H*2), 8.23 (nfom, 1H, *H*6), 7.23 (m, 2H, *H4, H5*), 6.67 (s, 1H, NAr*H*), 4.68 (s, 2H, $MsNC_aH_2$), 4.64 (s, 2H, $MsNC_bH_2$), 4.18 (t, *J* = 5.6 Hz, 2H, $ArOCH_2CH_2N$), 3.02 (br t, *J* = 4.5 Hz, 4H, $ArN(CH_2CH_2)_2N$), 2.89 (t, *J* = 5.5 Hz, 2H, $ArOCH_2CH_2N$), 2.87 (s, 3H, CH_3SO_2N), 2.72 (br t, J = 4.7 Hz, 4H, $ArN(CH_2CH_2)_2N$), 2.38 (s, 3H, $NArCH_3$), and 2.09 (s, 3H, $ArC{\equiv}CCH_3$).

^{13}C-NMR (125 MHz, $CDCl_3$,1-D): δ 155.0, 146.9, 142.4, 141.4, 140.5, 138.2, 125.6, 124.0, 121.4, 118.0, 112.5, 93.2, 75.5, 66.4, 57.2, 54.5, 53.9, 53.8, 50.5, 34.8, 20.6, and 4.7.

IR (neat): 2945, 2919, 2824, 1604, 1545, 1488, 1427,1334, 1262, and 1154 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{24}H_{30}N_4NaO_3S^+$ $[M+Na]^+$ requires 477.1931; found 477.1936.

mp: 180-184 °C.

P22-maj

1H-NMR (500 MHz, $CDCl_3$): δ 8.34 (br t, *J* = 1.9 Hz, 1H, *H*2), 8.23 (nfom, 1H, *H*6), 7.23 (m, 2H, *H*4*, H*5), 6.85 (s, 1H, NAr*H*), 4.67 (s, 4H, $MsN(CH_2)_2$), 4.20 (t, *J* = 5.7 Hz, 2H, $ArOCH_2$), 2.91 (br t, *J* = 4.82 Hz, 6H, $ArN(CH_2CH_2)_2N$, $ArOCH_2CH_2N$), 2.86 (s, 3H, CH_3SO_2N), 2.76 (br m, 4H, $ArN(CH_2CH_2)_2N$), 2.37 (s, 3H, $NArCH_3$), and 2.12 (s, 3H, $Ar{\equiv}CCH_3$).

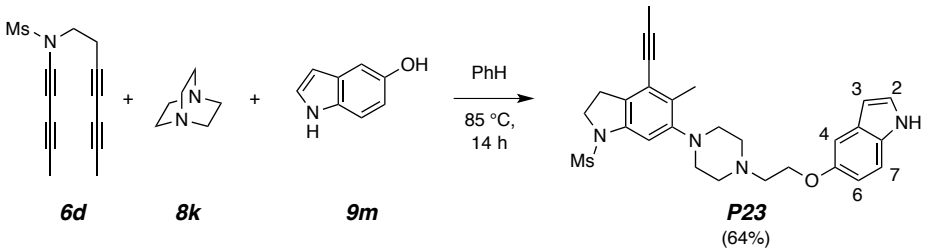
^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): δ 155.0, 151.9, 142.3, 138.2, 134.6, 133.6, 133.5, 123.9, 121.4, 120.3, 112.8, 94.6, 77.2, 75.9, 66.4, 57.2, 54.6, 54.3, 54.1, 52.0, 34.7, 16.0, and 4.7.

IR (neat): 2945, 2818, 2366, 2232, 1575, 144, 1427, 1334, 1267, and 1153 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{24}H_{30}N_4NaO_3S^+$ $[M+Na]^+$ requires 477.1931; found 477.1935.

mp: 77-80 °C.

6-(2-(4-(5-Methyl-1-(methylsulfonyl)-4-(prop-1-yn-1-yl)indolin-6-yl)piperazin-1-yl)ethoxy)-1*H*-indole (P23)



Tetrayne **6d** (50 mg, 0.202 mmol), DABCO (**8k**, 34 mg, 0.303 mmol, 1.5 equiv), and 5-hydroxyindole (**9m**, 34 mg, 0.253 mmol, 1.25 equiv) were combined in a culture tube, dissolved in chlorobenzene (7.5 mL, 0.03 M), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, and passed through a plug of silica (3:1 Hex:EtOAc +1% NEt_3 to1:3 Hex:EtOAc +1% NEt_3). The resulting residue was purified by MPLC (3:2 Hex:EtOAc +1% NEt_3) to give **P23** (64 mg, 0.130 mmol, 64%) as an off-white amorphous solid.

^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.07 (br s, 1H, N*H*), 7.29 (ddd, *J* = 8.6, 0.9, 0.6 Hz, 1H, *H*7), 7.19 (ddd, *J* = 3.0, 2.5, 0.4 Hz, 1H, *H*2), 7.13 (br d, *J* = 2 Hz, 1H, *H*4), 7.13 (s, 1H, NAr*H*), 6.89 (ddd, *J* = 8.8, 2.4, 0.4 Hz, 1H, *H*6), 6.48 (ddd, *J* = 3.1, 2.0, 0.9 Hz, 1H, *H*3), 4.19 (t, *J* = 5.9 Hz, 2H, NCH_2CH_2O), 3.95 (t, *J* = 8.5 Hz, 2H, $MsNCH_2CH_2$), 3.12 (t, *J* = 8.5 Hz, $MsNCH_2CH_2$), 2.93 (br t, *J* = 4.8 Hz, 4H, $ArN(CH_2CH_2)_2N$), 2.91 (t, *J* = 5.9 Hz, 2H, NCH_2CH_2O), 2.80 (s, 3H, NSO_2CH_3), 2.76 (br s, 4H, $ArN(CH_2CH_2)_2N$), 2.33 (s, 3H, $NArCH_3$), and 2.12 (s, 3H, $ArC{\equiv}CCH_3$).

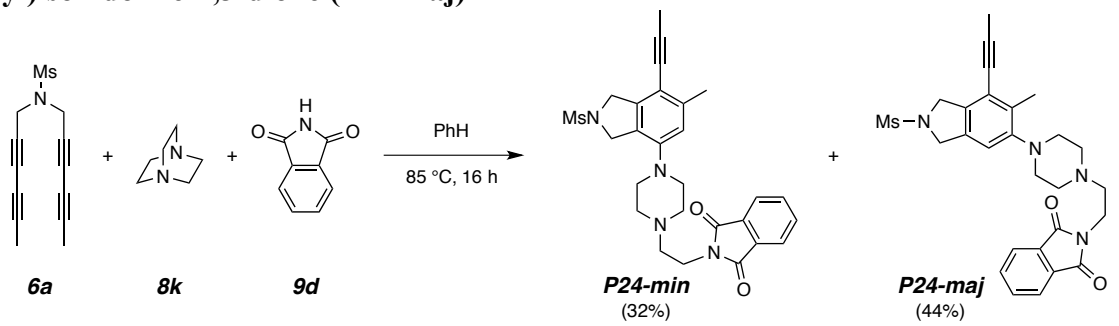
^{13}C-NMR (125 MHz, $CDCl_3$): δ 153.3, 152.3, 151.8, 140.0, 131.1, 130.1, 128.5, 124.9, 122.1, 113.1, 111.7, 105.3, 103.8, 102.4, 93.8, 76.3, 66.8, 57.5, 54.0, 52.0, 50.5, 34.1, 27.9, 15.7, and 4.6.

IR (neat): 3402, 2930, 2878, 2818, 2229, 1588, 1456, 1345, 1158, and 969 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{27}H_{33}N_4O_3S^+$ $[M+H]^+$ requires 493.2268; found 493.2273.

2-(2-(4-(6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-4-yl)piperazin-1-yl)ethyl)isoindoline-1,3-dione (P24-min) and

2-(2-(4-(6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-5-yl)piperazin-1-yl)ethyl)isoindoline-1,3-dione (P24-maj)



Tetrayne **6a** (75 mg, 0.303 mmol), phthalimide (**9d**, 49 mg, 0.333 mmol, 1.1 equiv), and DABCO (**8k**, 41 mg, 0.379 mmol, 1.25 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL, 0.04 M), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, and passed through a plug of silica (98:1:1 DCM:NEt_3:IPA). The resulting residue was purified by MPLC (2.5:1:0.03 DCM:Hex:NEt_3) to give, in order of elution, **P24-min** (49 mg, 0.10 mmol, 32 %) and **P24-maj** (67 mg, 0.13 mmol, 44 %), each as a white solid.

P24-min

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.86 (nfom, 2H, COAr*Ho*), 7.72 (nfom, 2H, COAr*Hm*), 6.63 (s, 1H, NAr*H*), 4.67 (s, 2H, $MsNC_aH_2$), 4.61 (s, 2H, $MsNC_bH_2$), 3.85 (t, J = 6.3 Hz, 2H, PhthNCH_2), 2.92 [br t, J = 4.6 Hz, 4H, ArN(CH_2CH_2)$_2$], 2.85 (s, 3H, NSO_2CH_3), 2.70 (t, J = 6.4 Hz, 2H, PhthNCH_2CH_2N), 2.64 [br t, J = 4.7 Hz, 4H, ArN(CH_2CH_2)$_2$], 2.36 (s, 3H, NArCH_3), and 2.09 (s, 3H, ArC≡CCH_3).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 168.4, 146.9, 141.2, 140.2, 133.9, 133.8, 125.4, 123.1, 117.8, 112.1, 92.9, 75.4, 55.7, 54.3, 53.7, 53.1, 50.41, 35.2, 34.6, 20.4, and 4.6.

IR (neat): 2951, 2916, 2820, 1773, 1711, 1394, 1333, and 1153 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{27}H_{31}N_4O_4S^+$ [M+H$^+$] requires 507.2061; found 507.2072.

mp: 212–215 °C (decomp).

P24-maj (containing ca. 6% of **P24-min**)

1H-NMR (500 MHz, $CDCl_3$): δ 7.86 (nfom, 2H, COAr*Ho*), 7.72 (nfom, 2H, COAr*Hm*), 6.81 (s, 2H, NAr*H*), 4.66 (s, 2H, $MsNC_aH_2$), 4.64 (s, 2H, $MsNC_bH_2$), 3.86 (t, J = 6.5 Hz, 2H, PhthNCH_2), 2.85 (s, 3H, NSO_2CH_3), 2.81 [br t, J = 4.9 Hz, 4H, ArN(CH_2CH_2)$_2$N], 2.71 (t, J = 6.6 Hz, 2H, PhthNCH_2CH_2N), 2.68 [br m, 4H, ArN(CH_2CH_2)$_2$N], 2.35 (s, 3H, NArCH_3), and 2.11 (s, 3H, ArC≡CCH_3).

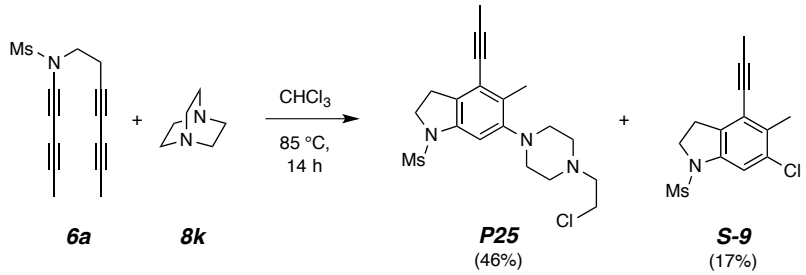
^{13}C-NMR (125 MHz, $CDCl_3$): δ 168.4, 152.1, 133.9, 133.8, 133.3 (x2), 132.2, 123.1, 120.1, 112.6, 94.4, 75.9, 55.7, 54.4, 54.2, 53.3, 52.0, 35.2, 34.5, 15.8, and 4.4.

IR (neat): 2948, 2816, 2256, 1771, 1709, 1397, 1335, 1154, and 1012 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{27}H_{31}N_4O_4S^+$ [M+H$^+$] requires 507.2064; found 507.2064.

mp: 251–253 °C (decomp).

6-(4-(2-Chloroethyl)piperazin-1-yl)-5-methyl-1-(methylsulfonyl)-4-(prop-1-yn-1-yl)indoline (P25) and **6-Chloro-5-methyl-1-(methylsulfonyl)-4-(prop-1-yn-1-yl)indoline (S-9)**



Tetrayne **6d** (50 mg, 0.202 mmol) and DABCO (**8k**, 27 mg, 0.242 mmol, 1.2 equiv) were combined in a culture tube, dissolved in chloroform (7.5 mL, amylene stabilized), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, and passed through a plug of silica (1:3 Hex:EtOAc +1% NEt_3). The resulting residue was purified by MPLC (3:1 Hex:EtOAc +1% NEt_3) to give, in order of elution, **S-9** (10 mg, 0.035 mmol, 17%) as a white solid and **P25** (37 mg, 0.093 mmol, 46%) as a tan amorphous solid.

S-9

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.35 (s, 1H, NArH), 3.97 (t, J = 8.5 Hz, 2H, MsNCH_2CH$_2$), 3.14 (t, J = 8.5 Hz, 2H, MsNCH$_2$CH_2), 2.86 (s, 3H, NSO_2CH_3), 2.41 (s, 3H, NArCH_3), and 2.13 (s, 3H, NArC≡CCH_3).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 140.0, 135.0, 132.7, 131.9, 122.8, 113.7, 95.0, 75.6, 50.4, 34.6, 28.0, 17.7, and 4.5.

IR (neat): 3108, 3024, 2995, 2916, 2849, 2235, 1583, 1449, 1333, 1156, and 969 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{13}H_{15}ClNO_2S^+$ $[M+H]^+$ requires 284.0507; found 284.0557.

mp: 156-158 °C.

P25

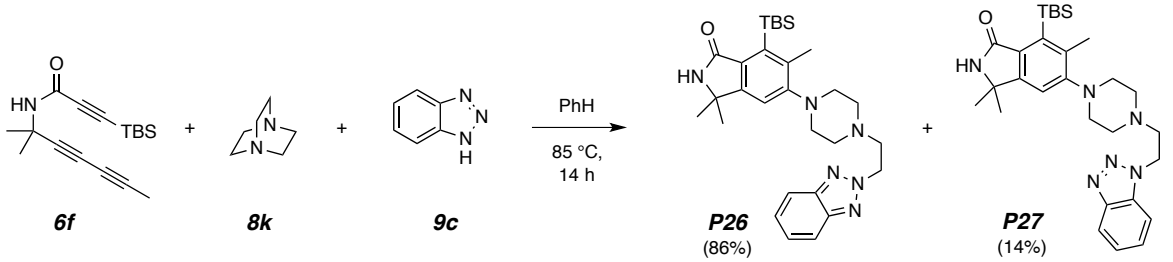
^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.11 (s, 1H, NArH), 3.95 (t, J = 8.6 Hz, 2H, MsNCH_2CH$_2$), 3.62 (t, J = 7.1 Hz, 2H, NCH$_2$CH_2Cl), 3.12 (t, J = 8.5 Hz, 2H, MsNCH$_2$CH_2), 2.90 (bt, J = 4.5 Hz, 4H, ArN(CH_2CH$_2$)$_2$N), 2.81 (s, 3H, NSO_2CH_3), 2.80 (t, J = 6.9 Hz, 2H, NCH_2CH$_2$Cl), 2.68 (br m, 4H), 2.32 (s, 3H, NArCH_3), and 2.12 (s, 3H, ≡CCH_3).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 151.6, 140.0, 130.0, 128.5, 122.2, 105.3, 93.9, 76.3, 59.8, 51.8, 53.5, 50.5, 41.0, 34.1, 27.9, 15.6, and 4.5.

IR (neat): 3009, 2944, 2917, 2879, 2816, 2230, 1590, 1448, 1345, 1158, and 969 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{19}H_{27}ClN_3O_2S^+$ $[M+H]^+$ requires 396.1507; found 396.1524.

5-(4-(2-(2*H*-Benzo[*d*][1,2,3]triazol-2-yl)ethyl)piperazin-1-yl)-7-(*tert*-butyldimethylsilyl)-3,3,6-trimethylisoindolin-1-one (**P26**) and
5-(4-(2-(1*H*-Benzo[*d*][1,2,3]triazol-1-yl)ethyl)piperazin-1-yl)-7-(*tert*-butyldimethylsilyl)-3,3,6-trimethylisoindolin-1-one (**P27**)



Amide **6f** (59 mg, 0.202 mmol), DABCO (**8k**, 34 mg, 0.303 mmol, 1.5 equiv), and benzotriazole (**9c**, 36 mg, 0.303 mmol, 1.5 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL), and sealed with a Teflon-lined cap. The solution was heated overnight (14–16 h) in an oil bath at 85 °C, cooled, and passed through a plug of silica (1:6 Hex:EtOAc +1% NEt_3). The resulting residue was purified by MPLC (1:1 Hex:EtOAc +1% NEt_3) to give, in order of elution, **P26** (90 mg, 0.173 mmol, 86%) and **P27** (15 mg, 0.029 mmol, 14%), each as a white solid.

P26

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.88 (nfom, 2H, NNNArH_o), 7.40 (nfom, 2H, NNNArH_m), 6.96 (s, 1H, NHCOAr*H*), 6.05 (s, 1H, N*H*CO), 4.91 (t, *J* = 6.7 Hz, 2H, NCH_2CH_2NNNAr), 3.22 (t, *J* = 6.7 Hz, 2H, NCH_2CH_2NNNAr), 2.95 (br t, *J* = 4.5 Hz, 4H, ArN(CH_2CH_2)$_2$N), 2.73 (br m, 4H, ArN(CH_2CH_2)$_2$N), 2.48 (s, 3H, NHCOArCH_3), 1.46 [s, 6H, NHC(CH_3)$_2$], 1.07 [s, 9H, SiC(CH_3)$_3$], and 0.44 [s, 6H, Si(CH_3)$_2$].

^{13}C-NMR (125 MHz, $CDCl_3$): δ 179.0, 154.7, 152.8, 144.4, 140.1, 140.0, 130.7, 126.3, 118.0, 111.8, 57.4, 56.6, 54.1, 53.4, 51.8, 28.8, 28.5, 20.9,19.3, and 1.8.

IR (neat): 3190, 3074, 2927, 2820, 1694, 1335, 1012, and 831 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{29}H_{43}N_6OSi^+$ $[M+H]^+$ requires 519.3262; found 519.3265.

mp: 236-238 °C (decomp).

P27

^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.08 (ddd, *J* = 8.4, 1.0 Hz, 1H, NNNAr*H*4), 7.60 (ddd, *J* = 8.4, 0.9 Hz, 1H, NNNAr*H*7), 7.51 (ddd, *J* = 8.0, 6.9, 1.0 Hz, 1H, NNNAr*H*5or6), 7.39 (ddd, *J* = 8.2, 6.9, 1.0 Hz, 1H, NNNAr*H*5or6), 6.95 (s, 1H, NHCOAr*H*), 5.91 (s, 1H, N*H*CO), 4.82 (t, *J* = 6.7 Hz, 2H, NCH_2CH_2NNNAr), 3.06 (t, *J* = 6.8 Hz, 2H, NCH_2CH_2NNNAr), 2.93 [br t, *J* = 4.5 Hz, 4H, ArN(CH_2CH_2)$_2$N], 2.72 [s, 4H, ArN(CH_2CH_2)$_2$N], 2.47 (s, 3H, NHCOArCH_3), 1.47 (s, 6H, NHC(CH_3)$_2$), 1.07 [s, 9H, SiC(CH_3)$_3$], and 0.44 [s, 6H, Si(CH_3)$_2$].

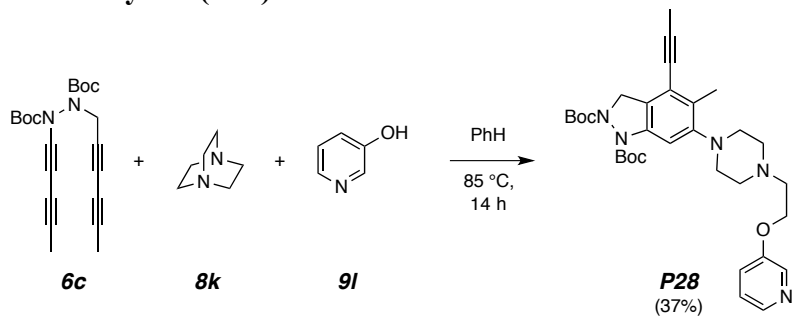
^{13}C-NMR (125 MHz, $CDCl_3$): δ 169.9, 154.6, 152.8, 146.1, 140.1, 139.9, 133.2, 130.7, 127.4, 123.9, 120.2, 111.9, 109.5, 57.3, 56.5, 53.6, 51.8, 46.1, 28.8, 28.5, 20.8, 19.3, and 1.8.

IR (neat): 3196, 3073, 2928, 2852, 2820, 1697, 1589, 1455, 1012, and 831 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{29}H_{43}N_6OSi^+$ $[M+H]^+$ requires 519.3262; found 519.3263.

mp: 235-240 °C (decomp).

di-*tert*-Butyl 5-methyl-4-(prop-1-yn-1-yl)-6-(4-(2-(pyridin-3-yloxy)ethyl)piperazin-1-yl)-1*H*-indazole-1,2(3*H*)-dicarboxylate (P28)



Tetrayne **6c** (77 mg, 0.207 mmol), DABCO (**8k**, 35 mg, 0.311 mmol, 1.5 equiv), and 3-hydroxypyridine (**9l**, 30 mg, 0.311 mmol, 1.5 equiv) were combined in a culture tube, dissolved in chlorobenzene (7.5 mL), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, and passed through a plug of silica (1:1 Hex:EtOAc +1% NEt_3 to 10% IPA/EtOAc +2% NEt_3). The resulting residue was purified by MPLC (1:3 Hex:EtOAc +1% NEt_3) to give **P28** (44 mg, 0.076 mmol, 37%) as a yellow oil.

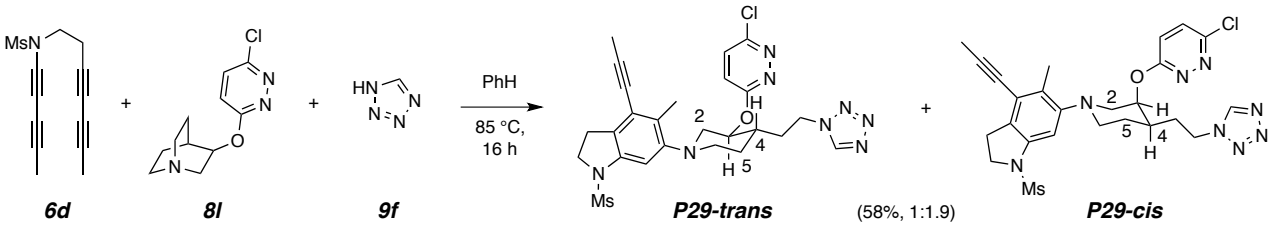
^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.35 (dd, J = 2.1, 2.1 Hz, 1H, Pyr*H*2), 8.23 (dd, J = 3.7, 2.7 Hz, 1H, Pyr*H*6), 7.23–7.22 (m, 2H, 1H, Pyr*H*4,5), 7.19 (br s, 1H, NBocAr*H*), 5.04 (d, J = 14.5 Hz, 1H, BocNBocNCH_aH$_b$), 4.57 (d, J =14.5 Hz, 1H, BocNBocNCH$_a$$H_b$), 4.20 (t, J = 5.7 Hz, 2H, NCH_2CH_2OPy), 2.94 (m, 4H, ArN(CH_2CH_2)N), 2.91 (t, J = 5.8 Hz, 1H, NCH_2CH_2OPy), 2.75 [br s, $W_{1/2h}$ = 18 Hz, 4H, ArN(CH_2CH_2)N], 2.34 (s, 3H, ArCH_3), 2.12 (s, 3H, ArC≡CCH_3), 1.56 [s, 9H, NCOOC(CH_3)$_3$], and 1.51 [s, 9H, NCOOC(CH_3)$_3$].

^{13}C-NMR (125 MHz, $CDCl_3$, 1-D): 156.5, 155.1, 152.9, 151.4, 142.4, 138.4, 138.2, 130.6, 125.3, 124.0, 121.4, 119.3, 107.7, 94.0, 82.5, 82.1, 75.9, 66.5, 57.3, 54.2, 51.9 (2x), 28.4, 28.3, 15.7, and 4.8.

IR (neat): 3059, 2977, 2934, 2817, 2232, 1738, 1706, 1596, 1471, 1368, 1149, 1013, and 853 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{32}H_{44}N_5O_5^+$ $[M+H]^+$ requires 578.3337; found 578.3352.

(±)-6-((3*S*,4*R*)-4-(2-(1*H*-Tetrazol-1-yl)ethyl)-3-((6-chloropyridazin-3-yl)oxy)piperidin-1-yl)-5-methyl-1-(methylsulfonyl)-4-(prop-1-yn-1-yl)indoline (**P29-cis**) and **(±)-6-((3*S*,4*S*)-4-(2-(1*H*-Tetrazol-1-yl)ethyl)-3-((6-chloropyridazin-3-yl)oxy)piperidin-1-yl)-5-methyl-1-(methylsulfonyl)-4-(prop-1-yn-1-yl)indoline** (**P29-trans**)



6d ***8l*** ***9f*** ***P29-trans*** ***P29-cis***

Tetrayne **6d** (50 mg, 0.202 mmol) and the quinuclidine derivative **8l** (121 mg, 0.505 mmol, 2.5 equiv) were combined in a culture tube and dissolved in benzene (7.5 mL). Tetrazole (**9f**, ~.45 M in MeCN, 0.5 mL, 0.222 mmol, 1.1 equiv) was added resulting in a suspension. The culture tube was sealed with a Teflon-lined cap and heated overnight (14-16 h, homogenous after ~5 min) in an oil bath at 85 °C, cooled, and passed through a plug of silica (1:3 Hex:EtOAc +1% NEt_3). The resulting residue was purified by MPLC (2:1 Hex:EtOAc +1% NEt_3) to give a coeluting 1:1.9 mixture of **P29-trans** and **P29-cis** (65 mg, 0.117 mmol, 58%) as a colorless foam.

Data for **P29-cis** (major isomer)

^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.49 (s, 1H, $Ar_{tetrazole}H$), 7.40 (d, J = 9.2 Hz, 1H, $OAr H_m$), 7.06 (s, 1H, $Ar_{indoline}H$), 7.03 (d, J = 9.2 Hz, 1H, $OAr H_o$), 5.58 (dd, J = 4.1, 3.2 Hz, 1H, C3*H*), 4.83-4.70 (m, 2H, $C4CH_2CH_2Ar_{tetrazole}$), 3.99–3.87 (m, 2H, $MsNCH_2CH_2$), 3.54 (ddd, J = 13.2, 3.4, 1.8 Hz, 1H, C2*Ha*), 3.09 (t, J = 8.7 Hz, 2H, $MsCH_2CH_2$), 3.11–3.04 (m, 1H, C6*H*a), 2.81 (ddd, J = 11.4, 11.4, 2.6 Hz, 1H, C6Hb), 2.81 (s, 3H, NSO_2CH_3), 2.78 (m, 1H, C2*H*b), 2.27 (dddd, J = 14, 7, 7, 7 Hz, 1H, $C4CHaHbCH_2Ar_{tetrazole}$), 2.15 (ddd, J = 14, 7, 7, 7 Hz, 1H, $C4CHaHbCH_2Ar_{tetrazole}$), 2.08 (s, 3H, $ArCH_3$), 2.08 (s, 3H, $ArC{\equiv}CCH_3$), 2.04 (m, 1H, C5*H*a), 1.86–1.80 (m, 1H, C4*H*), and 1.80–1.75 (m, 1H, C5*H*b).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 164.0, 152.8, 151.4, 151.0, 140.0, 131.3, 130.1, 128.8, 122.2, 120.5, 105.8, 93.9, 76.2, 72.6, 54.4, 51.5, 50.7, 50.5, 36.2, 34.1, 31.3, 27.9, 27.2, 15.1, and 4.5.

Data for **P29-trans** (minor isomer)

^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.51 (s, 1H, $Ar_{tetrazole}H$), 7.39 (d, J = 9.2 Hz, 1H, $OAr H_m$), 7.02 (s, 1H, $Ar_{indoline}H$), 6.96 (d, J = 9.2 Hz, 1H, $OAr H_o$), 5.31 (ddd, J = 9.5, 9.5, 4.4 Hz, 1H, C3*H*), 4.83–4.70 (m, 2H, $C4CH_2CH_2Ar_{tetrazole}$), 3.99–3.87 (m, 2H, $MsNCH_2CH_2$), 3.61 [ddd, J = 10.6, 4.5, 1.9 Hz, 1H, C_2Ha(eq)], 3.11 (t, J = 8.5 Hz, 2H, $MsNCH_2CH_2$), 3.11–3.04 (m, 1H, C_6Ha), 2.78 (s, 3H, NSO_2CH_3), 2.67 (ddd, J = 11.7, 11.7, 2.5 Hz, 1H, C_6Hb), 2.53 [dd, J = 10.7, 9.5 Hz, 1H, C_2Hb(ax)], 2.46 (dddd, J = 14.0, 7.9, 7.9, 4.4 Hz, 1H, $C_4CHaHbCH_2Ar_{tetrazole}$), 2.38 (s, 3H, $ArCH_3$), 2.12 (s, 3H, $ArC{\equiv}CCH_3$), 2.04 (m, 1H, C5*H*a), 2.01 (m, 1H, $C_4CHaHbCH_2Ar_{tetrazole}$), 1.78–1.74 (m, 1H, C4*H*), and 1.67 (dddd, J = 12.0, 12.0, 12.0, 4.2 Hz, 1H, C5*H*b).

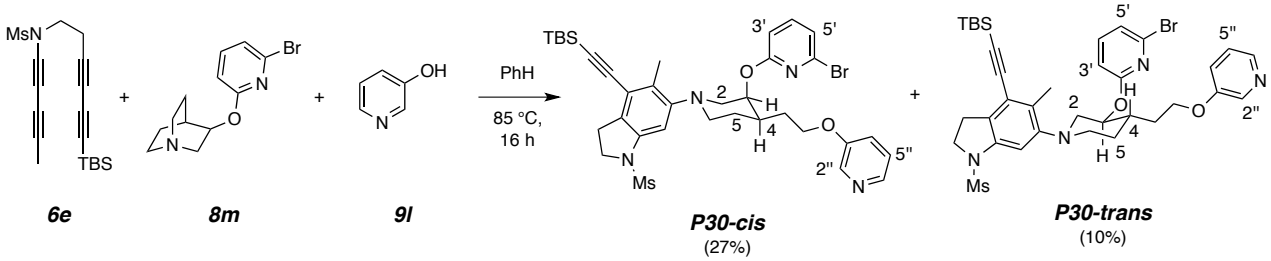
^{13}C-NMR (125 MHz, $CDCl_3$): δ 164.0, 152.8, 151.3, 151.0, 140.0, 131.2, 130.7, 128.8, 122.3, 120.5, 105.6, 93.9, 76.5, 76.2, 55.2, 51.8, 50.7, 50.5, 38.1, 34.1, 32.2, 30.1, 27.9, 15.6, and 4.5.

Data for mixture of **P29-cis** and **P29-trans**

IR (neat): 2948, 2925, 2809, 2232, 1587, 1420, 1346, 1159, and 970 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{25}H_{30}ClN_8O_3S^+$ $[M+H]^+$ requires 557.1845; found 557.1852.

(±)-6-((3S,4R)-3-((6-bromopyridin-2-yl)oxy)-4-(2-(pyridin-3-yloxy)ethyl)piperidin-1-yl)-4-((tert-butyldimethylsilyl)ethynyl)-5-methyl-1-(methylsulfonyl)indoline (P30-cis) and **(±)-6-((3S,4S)-3-((6-bromopyridin-2-yl)oxy)-4-(2-(pyridin-3-yloxy)ethyl)piperidin-1-yl)-4-((tert-butyldimethylsilyl)ethynyl)-5-methyl-1-(methylsulfonyl)indoline** (**P30-trans**)



Tetrayne **6e** (70 mg, 0.202 mmol), the quinuclidine derivative **8m** (86 mg, 0.303 mmol, 1.5 equiv), and 3-hydroxypyridine (**9l**, 29 mg, 0.303 mmol, 1.5 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL), sealed with a Teflon-lined cap, and heated overnight (14-16 h) in an oil bath at 85 °C. The mixture was cooled and passed through a plug of silica (1:3 Hex:EtOAc +1% NEt_3). The resulting residue was purified by MPLC (2:1 Hex:EtOAc +1% NEt_3) to give, in order of elution, **P30-cis** [39 mg, 0.050 mmol, 25%; containing 12 mol% (7 wt%) of a 1:1 adduct of tetrayne **6e** and 3-hydroxypyridine (**9l**)] and **P30-trans** (14 mg, 0.019 mmol, 10%) each as a yellow oil.

P30-cis

^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.27 (dd, *J* = 2.9, 0.7 Hz, 1H, C2``*H*), 8.20 (dd, *J* = 4.6, 1.4 Hz, 1H, C6``*H*), 7.42 (dd, *J* = 8.2, 7.5 Hz, 1H, C4`*H*), 7.20 (ddd, *J* = 8.5, 4.5, 0.8 Hz, 1H, C5``*H*), 7.16 (ddd, *J* = 8.4, 3.0, 1.4 Hz, 1H, C4``*H*), 7.14 (s, 1H, NAr*H*), 7.04 (dd, *J* = 7.5, 0.7 Hz, 1H, C5`*H* or C3'*H*), 6.74 (dd, *J* = 8.2, 0.7 Hz, 1H, C5`*H* or C3'*H*), 5.38 (ddd, *J* = 2.7, 2.7, 1.7 Hz, 1H, C3*H*), 4.17–4.13 (nfom, 1H, MsNC*H*aHbCH$_2$), 4.09-4.05 (nfom, 1H, MsNCHa*H*bCH$_2$), 3.98 (ddd, *J* = 10.5, 8.1, 8.1 Hz, 1H, C4CH$_2$C*H*aHbOAr), 3.93 (ddd, *J* = 10.7, 8.1, 8.1 Hz, 1H, C4CH$_2$CHa*H*bOAr), 3.41 (br d, *J* = 13 Hz, 1H, C2*H*a), 3.12 (t, *J* = 8.4 Hz, 2H, MsNCH$_2$C*H*$_2$), 3.11 (m, 1H, C6*H*a), 2.85 (ddd, *J* = 11.3, 11.3, 2.5 Hz, 1H, C6*H*b), 2.81 (s, 3H, NSO$_2$C*H*$_3$), 2.80 (dd that includes *J* = 1.3 Hz, 1H, C2*H*b), 2.19 (s, 3H, NArC*H*$_3$), 2.09–1.99 (m, 3H, C5*H*a, C4C*H*aHbCH$_2$OAr, C4*H*), 1.90–1.83 (nfom, 1H, C4CHa*H*bCH$_2$OAr), 1.75 (nfom, 1H, C5*H*b), 0.97 [s, 9H, SiC(C*H*$_3$)$_3$], and 0.17 [s, 6H, Si(C*H*$_3$)$_2$].

^{13}C-NMR (125 MHz, $CDCl_3$): δ 163.3, 155.1, 152.0, 142.0, 140.7, 140.0, 138.4, 137.8, 131.1, 128.9, 123.8, 121.5, 121.2, 120.2, 110.0, 107.0, 106.7, 100.8, 71.3, 65.9, 55.2, 51.8, 50.5, 35.9, 34.2, 30.9, 29.6, 27.8, 26.1, 16.6, 15.3, and -4.5.

IR (neat): 2951, 2929, 2856, 2806, 2149, 1587, 1438, and 1159 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{35}H_{46}N_4O_4SSi^+$ $[M+H]^+$ requires 725.2187; found 725.2198.

P30-trans

^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.29 (dd, *J* = 2.9, 0.7 Hz, 1H, C2``*H*), 8.21 (dd, *J* = 4.5, 1.5 Hz, 1H, C6``*H*), 7.39 (dd, *J* = 8.1, 7.5 Hz, 1H, C4`*H*), 7.21 (ddd, *J* = 8.4, 4.4, 0.9 Hz, 1H, C5``*H*), 7.18 (ddd, *J* = 8.4, 2.9, 1.6 Hz, 1H, C4``*H*), 7.10 (s, 1H, NAr*H*), 7.04 (dd, *J* = 7.5, 0.7 Hz, 1H, C5`*H* or C3'*H*), 6.62 (dd, *J* = 8.2, 0.8 Hz, 1H, C5`*H* or C3'*H*), 5.06 (ddd, *J* = 9.6, 9.6, 4.4 Hz, 1H, C3*H*), 4.13 (t, *J* = 6.5 Hz, 2H, C4CH$_2$C*H*$_2$OAr), 3.96 (t, *J* = 8.5 Hz, 2H, MsNC*H*$_2$CH$_2$), 3.57 (ddd, *J* = 10.9, 4.5, 1.9 Hz, 1H, C2*H*a), 3.15 (br t, *J* = 8 Hz, 2H, MsCH$_2$C*H*$_2$), 3.07 (dddd, *J* = 11.6, 4.5, 2.9, 2.3 Hz, 1H, C6*H*a), 2.80 (s, 3H, NSO$_2$C*H*$_3$), 2.78 (ddd, *J* = 11.7, 11.7, 2.4 Hz, 1H, C6*H*b), 2.50 (s,

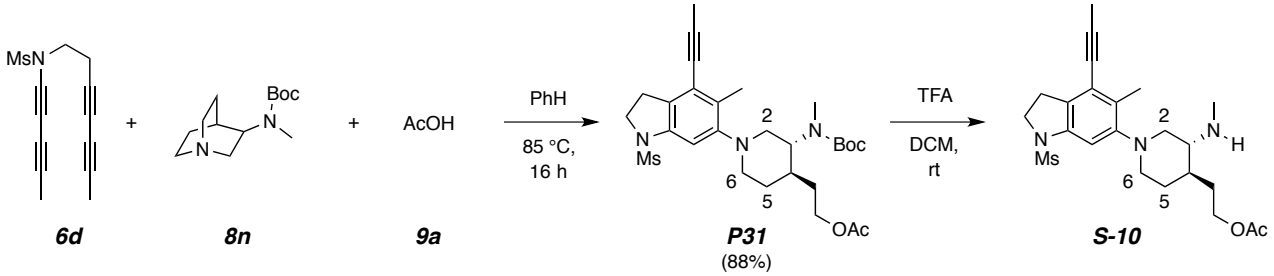
3H, NArC*H*$_3$), 2.43 (dd, *J* = 10.9, 9.8 Hz, 1H, C2*H*b), 2.21 (dddd, *J* = 13.9, 6.9, 6.9, 4.9 Hz, 1H, C4C*H*aHbCH$_2$OAr), 2.04 (m, 1H, C5*H*a), 2.00-1.94 (m, 1H, C4*H*), 1.81 (dddd, *J* = 14.0, 7.6, 6.3, 6.3 Hz, 1H, C4CHa*H*bCH$_2$OAr), 1.67 (dddd, *J* = 11.9, 11.9, 11.9, 4.4 Hz, 1H, C5Hb), 1.00 (s, 9H, SiC(C*H*$_3$)$_3$), and 0.19 (s, 6H, Si(CH$_3$)$_2$)

^{13}C-NMR (125 MHz, $CDCl_3$): δ 162.9, 155.1, 151.5, 142.0, 140.8, 137.8, 131.2, 139.9, 138.5, 128.7, 123.8, 121.7, 121.3, 120.6, 109.8, 106.3, 101.9, 101.0, 75.4, 66.2, 56.2, 51.5, 50.5, 37.9, 34.1, 31.9, 30.5, 28.1, 26.1, 16.6, 16.1, and -4.4.

IR (neat): 2950, 2928, 2855, 2809, 2150, 1584, 1435, 1349, and 1159 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{35}H_{46}N_4O_4SSi^+$ $[M+H]^+$ requires 725.2187; found 725.2195.

(±)-2-((3*R*,4*R*)-1-(methylsulfonyl)-4-(prop-1-yn-1-yl)indolin-6-yl)-3-(methylamino)piperidin-4-yl)ethyl acetate (S-10) via
(±)-(3*R*,4*R*)-2-(3-((tert-Butoxycarbonyl)(methyl)amino)-1-(5-methyl-1-(methylsulfonyl)-4-(prop-1-yn-1-yl)indolin-6-yl)piperidin-4-yl)ethyl acetate (P31)



Tetrayne **6d** (50 mg, 0.202 mmol), quinuclidine **8n** (68 mg, 0.253 mmol, 1.25 equiv) and acetic acid (**9a**, 13 μL, 0.22 mmol, 1.1 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL), sealed with a Teflon-lined cap, and heated overnight (14-16 h) in an oil bath at 85 °C. The solution was cooled and directly passed through a plug of silica (1:1 Hex:EtOAc elution). The resulting residue was purified by MPLC (3:1 Hex:EtOAc) to give **P31** (97 mg, 0.177 mmol, 88%) as a pale yellow foam. NMR analysis of this material revealed a pair of slowly interconverting *N*-Boc rotamers.

Data for P31

The NMR spectra are very broad and not are line listed here (see copies).

IR (neat): 2974, 2931, 2852, 2232, 1736, 1686, 1458, 1347, 1241, 1159, and 970 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{28}H_{42}N_3O_6S^+$ $[M+H]^+$ requires 548.2789; found 548.2816.

A small portion of **P31** (15 mg) was dissolved in DCM (1 mL) and TFA (150 μL) and stirred at room temperature for 2 h. The reaction mixture was quenched with satd. aq. K_2CO_3 (5 mL) and extracted with DCM to give the *N*-Boc deprotected amine **S-10**, which was used for ^1H and ^{13}C NMR analysis.

Data for S-10

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.08 (s, 1H, Ar*H*), 4.18 (nfom, 2H, C*H*$_2$OAc), 3.96 (t, *J* = 8.4 Hz, 2H, MsNC*H*$_2$CH$_2$), 3.33 (ddd, *J* = 11.3, 3.4, 1.4 Hz, 1H, C2*H*a), 3.13 (t, *J* = 8.5 Hz, 2H, MsNCH$_2$C*H*$_2$), 2.95 (br m including a d, *J* = ~11 Hz, 1H, C6*H*a), 2.82 (s, 3H, NSO$_2$C*H*$_3$), 2.64 (ddd, *J* = 10.6, 10.6, 2.8 Hz, 1H, C6*H*b), 2.53 (br m, 1H, C3*H*), 2.49 (s, 3H, NC*H*$_3$), 2.41 (br m, 1H, C2*H*b), 2.33 (s, 3H, ArC*H*$_3$), 2.15 (m, 1H, C*H*aH$_b$CH$_2$OAc), 2.12 (s, 3H, ArC≡CC*H*$_3$), 2.07 (s, 3H, OCOC*H*$_3$), 1.96 (m, 1H, C5*H*a), 1.59 (m, 1H, CHa*H*$_b$CH$_2$OAc), and 1.50 (m, 2H, C5*H*b, C4*H*).

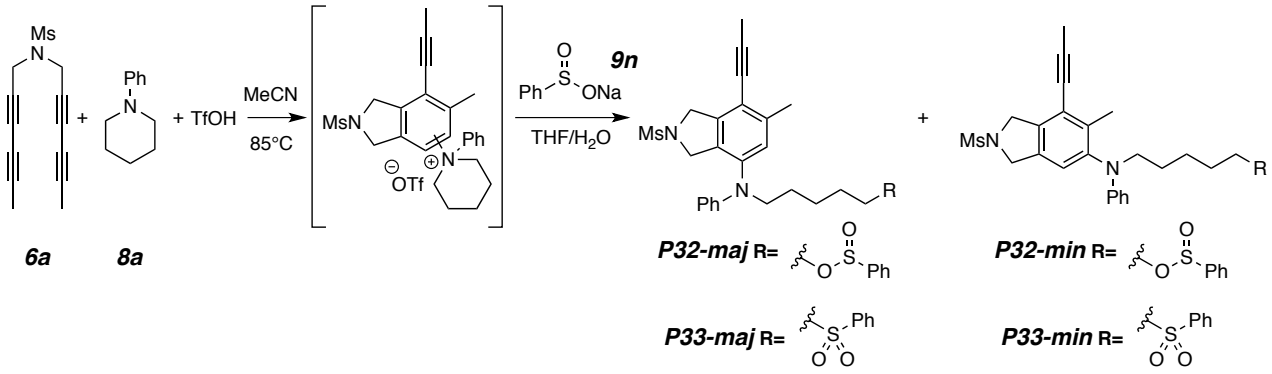
^{13}C-NMR (125 MHz, $CDCl_3$): δ 171.2, 151.8, 139.9, 128.6, 130.3, 122.3, 105.4, 93.7, 76.3, 62.3, 60.5, 51.9, 50.5, 34.1, 33.3, 30.8, 30.1, 27.9, 21.0, 15.6, and 4.5 (could not detect C2 and C4)

5-((6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-4-yl)(phenyl)amino)pentyl benzenesulfinate (**P32-maj**),

5-((6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-5-yl)(phenyl)amino)pentyl benzenesulfinate (**P32-min**),

6-Methyl-2-(methylsulfonyl)-*N*-phenyl-*N*-(5-(phenylsulfonyl)pentyl)-7-(prop-1-yn-1-yl)isoindolin-4-amine (P33-maj), and

6-Methyl-2-(methylsulfonyl)-*N*-phenyl-*N*-(5-(phenylsulfonyl)pentyl)-7-(prop-1-yn-1-yl)isoindolin-5-amine (P33-min).



Tetrayne **6a** (75 mg, 0.303 mmol), *N*-phenylpiperidine (110 μL, 0.667 mmol, 2.2 equiv), and triflic acid (0.29 mL of 1.1 M in MeCN, 0.333 mmol, 1.1 equiv) were combined in a culture tube, dissolved in acetonitrile (7 mL), sealed with a Teflon-lined cap, heated overnight (14-16 h) in an oil bath at 85 °C, cooled, concentrated, and dissolved in THF:H_2O (1:1, 3.5 mL). Sodium benzenesulfinate (150 mg, 0.909 mmol, 3 equiv) was added and the culture tube was sealed with a Teflon-lined cap and heated for 6 h in an oil bath at 90 °C (resulting in a biphasic mixture). This mixture was cooled (whereupon it reverted to a single phase), transferred to a separatory funnel, and extracted with EtOAc (3 x 5 mL). The combined organic layers were washed with brine (5 mL), dried ($MgSO_4$), filtered, concentrated, and passed through a plug of silica (1:3 Hex:EtOAc elution). The resulting residue was purified by MPLC (3:1 Hex:EtOAc) to give, in order of elution, **P32-maj** (39 mg, 0.071 mmol, 23%), **P32-min** (13 mg, 0.024 mmol, 8%), **P33-maj** (31 mg, 0.058 mmol, 19%), and **P33-min** (13 mg, 0.024 mmol, 8%), each as a pale yellow oil.

P32-maj

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.69 (dd, J = 7.5, 1.2 Hz, 2H, SArH_o), 7.57–7.51 (m, 3H, SArH_m, SArH_p), 7.18 (dd, J = 8.7, 7.4 Hz, 2H, NArH_m), 6.91 (s, 1H, MsNCH$_2$ArH), 6.84 (t, J = 7.3 Hz, NArH_p), 6.67 (d, J = 8.6 Hz, NArH_o), 4.68 [s, 2H, MsN(C$_a$H$_2$)], 4.11 [s, 2H, MsN(C$_b$H$_2$)], 4.02 (ddd, J = 10.0, 6.4, 6.4 Hz, 1H, CH_aH$_b$OSOAr), 3.61 (br t, J = 7.6 Hz, 2H, ArPhNCH_2), 3.57 (ddd, J = 10.1, 6.3, 6.3 Hz, 1H, CH$_a$$H_b$OSOAr), 2.74 (s, 3H, NSO$_2CH_3$), 2.41 (s, 3H, ArC$H_3$), 2.12 (s, 3H, ArC≡CC$H_3$), 1.67–1.57 (m, 4H of Ar$_2$NCH$_2$(CH_2)$_3$CH$_2$OSOAr), and 1.41–1.34 (m, 2H of Ar$_2$NCH$_2$(CH_2)$_3$CH$_2$OSOAr).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 147.2, 144.6, 141.2, 140.8, 132.2, 129.4, 129.2, 129.1, 125.3, 124.9 (x2), 120.2, 117.5, 114.4, 94.1, 75.2, 64.1, 54.5, 53.7, 52.5, 34.5, 29.5, 27.5, 23.6, 20.4, and 4.6.

IR (neat): 3054, 2935, 2860, 2234, 1594, 1488, 1338, 1154, 1130, and 753 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{30}H_{34}N_2NaO_4S_2^+$ [M+Na]$^+$ requires 573.1852; found 573.1857.

P32-min

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.69 (dd, *J* = 8.0, 2.1 Hz, 2H, SArH_o), 7.57–7.51 (m, 3H, SArH_m, SArH_p), 7.14 (dd, *J* = 8.3, 7.3 Hz, 2H, NArH_m), 6.95 (s, 1H, MsNCH$_2$Ar*H*), 6.70 (t, *J* = 7.2 Hz, 1H, NArH_p), 6.43 (d, *J* = 8.6 Hz, 2H, NArH_o), 4.74 [s, 2H, MsN(C_aH_2)], 4.68 [s, 2H, MsN(C_bH_2)], 4.02 (ddd, *J* = 10.0, 6.4, 6.4 Hz, 1H, CH_aH$_b$OSOAr), 3.58 (ddd, *J* = 9.9, 6.3, 6.3 Hz, 1H CH$_a$$H_b$OSOAr), 3.50 (br t, *J* = 7.4 Hz, 2H, ArPhNCH_2), 2.91 (s, 3H, NSO$_2$CH_3), 2.16 (s, 3H, ArCH_3), 2.13 (s, 3H, ArC≡CCH_3), 1.69–1.59 (m, 4H of Ar$_2$NCH$_2$(CH_2)$_3$CH$_2$OSOAr), and 1.41–1.34 (m, 2H of Ar$_2$NCH$_2$(CH_2)$_3$CH$_2$-OSOAr).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 148.5, 145.3, 144.7, 139.2, 137.5, 134.5, 132.2, 129.2, 129.1, 125.3, 123.2, 121.0, 117.1, 112.9, 95.4, 75.5, 64.4, 54.2, 54.1, 51.7, 34.9, 29.5, 27.0, 23.4, 16.0, and 4.6.

IR (neat): 2924, 2854, 2224, 1595, 1499, 1337, 1155, 1130, 1079, 958, and 753 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{30}H_{34}N_2NaO_4S_2^+$ $[M+Na]^+$ requires 573.1852; found 573.1859.

P33-maj

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.89 (dd, *J* = 8.1, 1.7 Hz, 2H, SArH_o), 7.66 (ddd, *J* = 7.4, 7.4, 1.2 Hz, 1H, SArH_p), 7.57 (dd, *J* = 7.7, 7.7 Hz, 2H, SArH_m), 7.18 (dd, *J* = 8.6, 7.5 Hz, 2H, NPhH_m), 6.89 (s, 1H, MsNCH$_2$Ar*H*), 6.85 (tt, *J* = 7.4, 1.3 Hz, 1H, NPhH_p), 6.65 (d, *J* = 7.8 Hz, 2H, NPhH_o), 4.67 [s, 2H, MsN(C_aH_2)], 4.10 [s, 2H, MsN(C_bH_2)], 3.61 (t, *J* = 7.5 Hz, 2H, ArPhNCH_2), 3.06 (br t , *J* = 8 Hz, 2H, CH_2SO$_2$Ph), 2.75 (s, 3H, NSO$_2$CH_3), 2.41 (s, 3H, ArCH_3), 2.12 (s, 3H, ArC≡CCH_3), 1.74 (br pent, *J* = 8 Hz, 2H, CH_2CH$_2$SO$_2$Ph), 1.64-1.57 (br pent, *J* = 8 Hz, 2H, ArPhNCH$_2$CH_2), and 1.46-1.40 (br pent, *J* = 8 Hz, 2H, ArPhN(CH$_2$)$_2$CH_2(CH$_2$)$_2$SO$_2$Ph).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 147.1, 141.0, 140.8, 139.1, 133.8, 129.41, 129.35, 129.1, 128.1, 124.74, 124.67, 120.4, 117.6, 115.0, 94.0, 75.2, 56.1, 54.4, 53.6, 52.2, 34.6, 27.5, 25.9, 22.5, 20.5, and 4.6.

IR (neat): 3050, 2929, 2858, 2170, 1594, 1488, 1336, 1150, and 753 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{30}H_{34}N_2NaO_4S_2^+$ $[M+Na]^+$ requires 573.1852; found 573.1862.

P33-min

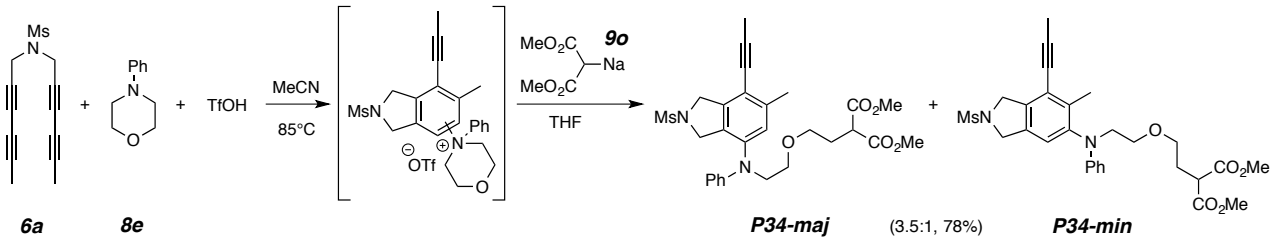
^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.89 (d, *J* = 7.5 Hz, 2H, SArH_o), 7.67 (dd, *J* = 7.7 Hz, 1H, SArH_p), 7.57 (dd, *J* = 7.7, 7.7 Hz, 2H, SArH_m), 7.14 (dd, *J* = 8.5, 7.5 Hz, 2H, NPhH_m), 6.94 (s, 1H, MsNCH$_2$Ar*H*), 6.70 (t, *J* = 7.2 Hz, 1H, NPhH_p), 6.42 (d, *J* = 8.6 Hz, 2H, NPhH_o), 4.75 [s, 2H, MsN(C_aH_2)], 4.69 [s, 2H, MsN(C_bH_2)], 3.50 (t, *J* = 7.7 Hz, 2H, ArPhNCH_2), 3.06 (br t, *J* = 8.0 Hz, 2H, CH_2SO$_2$Ph), 2.92 (s, 3H, NSO$_2$CH_3), 2.16 (s, 3H, ArCH_3), 2.13 (s, 3H, ArC≡CCH_3), 1.75 (br pent, *J* = 8 Hz, 2H, CH$_2$CH$_2$SO$_2$Ph), 1.66–1.60 (br pent, *J* = 8 Hz, 2H, ArPhNCH$_2$CH_2), and 1.45–1.39 (br pent, *J* = 8 Hz, 2H, ArPhN(CH$_2$)$_2$CH_2(CH$_2$)$_2$SO$_2$Ph).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 148.3, 145.1, 139.2, 139.0, 137.4, 133.8, 133.5, 129.3, 129.2, 128.1, 123.0, 121.1, 117.3, 112.9, 95.5, 75.4, 56.1, 54.22, 54.16, 51.5, 35.0, 27.1, 25.9, 22.5, 16.1, and 4.8.

IR (neat): 2925, 2855, 2024, 1595, 1499, 1336, 1151, and 751 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{30}H_{34}N_2NaO_4S_2^+$ $[M+Na]^+$ requires 573.1852; found 573.1859.

Dimethyl 2-(2-(2-((6-methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-4-yl)(phenyl)amino)ethoxy)ethyl)malonate (P34)



A solution of triflic acid (0.24 mmol, 1.2 equiv) and *N*-phenylmorpholine (**8e**, 0.62 mmol, 3 equiv) in acetonitrile (1.1 mL) was added to a culture tube containing a solution of tetrayne **6a** (50 mg, 0.202 mmol) in acetonitrile (9 mL). The tube was sealed with a Teflon-lined cap, and heated overnight (14-16 h) in an oil bath at 85 °C. The contents were cooled and concentrated. In a separate vial NaH (36 mg, 60% in mineral oil, 0.91 mmol, 4.5 equiv) in THF (5 mL) was placed under N_2, and dimethyl malonate (120 μL, 1.01 mmol, 5 equiv) was added dropwise, and the mixture was stirred for 30 min. This solution was added to the crude ammonium triflate and the resulting solution was stirred in a capped culture tube at 85-90 °C for 3 h. The mixture was then concentrated and the residue was passed through a plug of silica (1:3 Hex:EtOAc). The resulting residue was purified by MPLC (2:1 Hex:EtOAc) to give a 3.5:1 coeluting mixture of **P34-maj** and **P34-min** (86 mg, 0.158 mmol, 78%) as a pale yellow oil.

Data for **P34-maj** extracted from the 3.5:1 mixture of **P34-maj** and **P34-min**

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.19 (dd, J = 8.6, 7.4 Hz, 2H, NPhH_m), 7.03 (s, 1H, ArH), 6.85 (tt, J = 7.3, 1.0 Hz, 1H, NPhH_p), 6.72 (dd, J = 8.8, 1.1 Hz, 2H, NPhH_o), 4.68 [s, 2H, MsN(C_aH_2)], 4.13 [s, 2H, MsN(C_bH_2)], 3.85 (t, J = 6.1 Hz, 2H, ArPhNCH_2), 3.71 (s, 6H, C(CO_2CH_3)$_2$), 3.56 (t, J = 5.9 Hz, 2H, $Ar_2NCH_2CH_2O$), 3.49 (t, J = 7.3 Hz, 2H, HC(CO_2CH_3)$_2$), 3.43 (t, J = 6.0 Hz, 2H, OCH_2CH_2CH), 2.76 (s, 3H, NSO_2CH_3), 2.41 (s, 3H, ArCH_3), 2.13 (m, 2H, OCH_2CH_2CH), and 2.12 (s, 3H, ArC≡CCH_3).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 169.7, 146.9, 141.2, 140.6, 129.4, 129.2, 125.3, 125.2, 120.3, 117.4, 114.5, 94.1, 75.4, 68.3, 68.2, 54.5, 53.6, 52.5, 52.0, 48.5, 34.5, 28.9, 20.4, and 4.6.

Data for **P34-min** extracted from the 3.5:1 mixture of **P34-maj** and **P34-min**

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.14 (dd, J = 8.8, 7.3 Hz, 2H, NPhH_m), 7.05 (s, 1H, ArH), 6.70 (obscured m, 1H, NPhH_p), 6.48 (dd, J = 8.9, 1.0 Hz, 2H, NPhH_o), 4.74 [s, 2H, MsN(C_aH_2)], 4.70 [s, 2H, MsN(C_bH_2)], 3.75 (t, J = 6.4 Hz, 2H, ArPhNCH_2), 3.71 (s, 6H, C(CO_2CH_3)$_2$), 3.59 (t, J = 6.1 Hz, 2H, $Ar_2NCH_2CH_2O$), 3.51 (t, J = 7.3 Hz, 2H, HC(CO_2CH_3)$_2$), 3.44 (t, J = 6.0 Hz, 2H, OCH_2CH_2CH), 2.91 (s, 3H, NSO_2CH_3), 2.15 (s, 3H, ArCH_3), 2.13 (m, 2H, OCH_2CH_2CH), and 2.12 (s, 3H, ArC≡CCH_3).

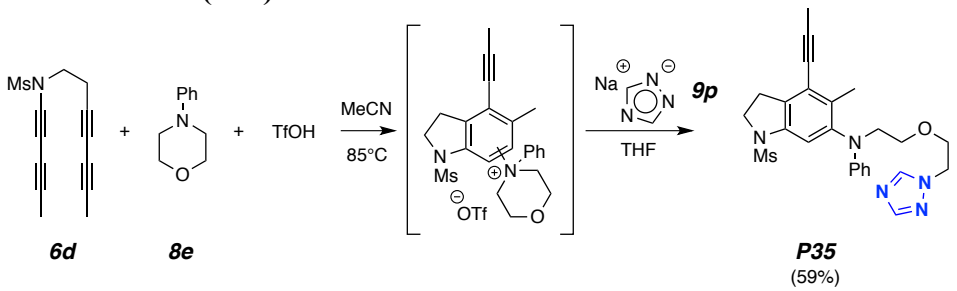
^{13}C-NMR (125 MHz, $CDCl_3$): δ 169.7, 148.2, 145.1, 139.0, 137.3, 134.5, 129.5, 129.2, 123.5, 120.9, 113.0, 94.1, 75.4, 68.3, 68.2, 54.2 (x2), 52.5, 51.3, 48.5, 34.9, 28.9, 15.9, and 4.6.

Data for the mixture of **P34-maj** and **P34-min**

IR (neat): 3065, 3027, 2953, 2867, 2235, 1748, 1735, 1595, 1496, 1491, 1338, and 1155 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{28}H_{35}N_2O_7S^+$ $[M+H]^+$ requires 543.2159; found 543.2174.

_N_-(2-(2-(1_H_-1,2,4-Triazol-1-yl)ethoxy)ethyl)-5-methyl-1-(methylsulfonyl)-_N_-phenyl-4-(prop-1-yn-1-yl)indolin-6-amine (P35)



A solution of triflic acid (0.24 mmol, 1.2 equiv) and *N*-phenylmorpholine (**8e**, 0.62 mmol, 3 equiv) in acetonitrile (1.1 mL) was added to a culture tube containing a solution of tetrayne **6d** (50 mg, 0.202 mmol) in acetonitrile (9 mL). The tube was sealed with a Teflon-lined cap, and heated overnight (14-16 h) in an oil bath at 85 °C. The reaction solution was cooled and concentrated, and the crude ammonium triflate intermediate was dissolved in THF (5 mL) in a culture tube. 1,2,4-Triazole sodium salt (**9p**, 92 mg, 1.01 mmol, 5 equiv) was added, the culture tube was sealed with a Teflon-lined cap, and the contents heated for 4 h in an oil bath at 90 °C. The resulting solution was cooled and concentrated. The residue was dissolved in DCM and washed with $NaHCO_3$ (10 mL). The aq. layer was extracted with additional DCM (4 x 6 mL), and the combined organic layers were dried ($MgSO_4$), filtered, concentrated, and passed through a plug of silica (99:1 EtOAc:*i*-PrOH +1% NEt_3). The resulting residue was purified by MPLC (1:3 Hex:EtOAc +1% NEt_3) to give **P35** (57 mg, 0.120 mmol, 59%) as a pale yellow oil.

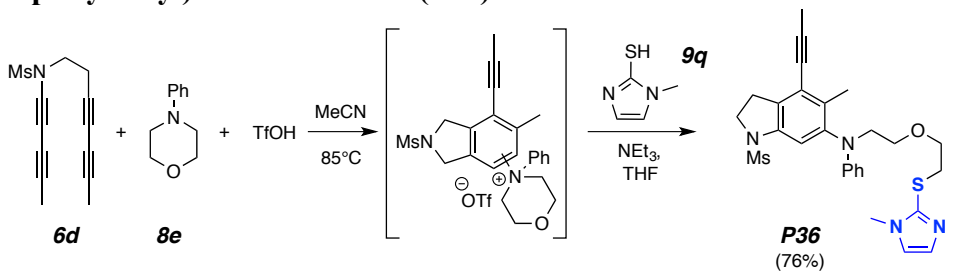
^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.03 (s, 1H, triazole*H*5), 7.89 (s, 1H, triazole*H*3), 7.25 (s, 1H, Ar*H*), 7.14 (dd, *J* = 8.8, 7.3 Hz, 2H, NPhH_m), 6.70 (tt, *J* = 7.3, 1.0, Hz, 1H, NPhH_p), 6.44 (dd, *J* = 8.8, 1.0 Hz, 2H, NPhH_o), 4.34 (t, *J* = 5.0 Hz, 2H, OCH_2CH_2triazole), 4.01 (t, *J* = 8.5 Hz, 2H, $MsNCH_2CH_2$), 3.74 (t, *J* = 5.1 Hz, 2H, $ArPhNCH_2CH_2O$), 3.74 (t, *J* = 5.5 Hz, 2H, OCH_2CH_2triazole or $ArPhNCH_2CH_2O$), 3.61 (t, *J* = 5.5 Hz, 2H, OCH_2CH_2triazole or $ArPhNCH_2CH_2O$), 2.83 (s, 3H, NSO_2CH_3), 2.13 (s, 3H, ArC≡CCH_3), and 2.05 (s, 3H, ArCH_3).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 151.7, 147.8, 144.6, 143.9, 140.7, 135.5, 132.4, 129.2, 122.9, 117.2, 114.8, 112.8, 94.8, 75.9, 68.8, 68.7, 50.9, 50.5, 49.7, 34.2, 28.1, 15.5, and 4.5.

IR (neat): 3123, 3006, 2960, 2925, 2870, 2235, 1589, 1500, 1345, 1158, 1121, 969, and 753 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{25}H_{30}N_5O_3S^+$ $[M+H]^+$ requires 480.2064; found 480.2074.

5-Methyl-*N*-(2-(2-((1-methyl-1*H*-imidazol-2-yl)thio)ethoxy)ethyl)-1-(methylsulfonyl)-*N*-phenyl-4-(prop-1-yn-1-yl)indolin-6-amine (P36)



A solution of triflic acid (0.24 mmol, 1.2 equiv) and *N*-phenylmorpholine (**8e**, 0.62 mmol, 3 equiv) in acetonitrile (1.1 mL) was added to a culture tube containing a solution of tetrayne **6d** (50 mg, 0.202 mmol) in acetonitrile (9 mL). The tube was sealed with a Teflon-lined cap, and heated overnight (14-16 h) in an oil bath at 85 °C. The reaction solution was cooled and concentrated, and the crude ammonium triflate intermediate was dissolved in THF (5 mL) in a culture tube. 2-Mecapto-1-methylimidazole (**9q**, 138 mg, 1.21 mmol, 6 equiv) and triethylamine (0.28 mL, 2.00 mmol, 10 equiv) were added and the culture tube was sealed with a Teflon-lined cap. The contents heated for 4 h in an oil bath at 90 °C. The resulting solution was cooled and concentrated. The residue was dissolved in DCM and washed with $NaHCO_3$ (10 mL). The aq. layer was extracted with additional DCM (4 x 6 mL), and the combined organic layers were dried ($MgSO_4$), filtered, concentrated, and passed through a plug of silica (1:9 Hex:EtOAc +1% NEt_3). The resulting residue was purified by MPLC (2:3 Hex:EtOAc +1% NEt_3) to give, in order of elution, **P36**, and a coeluting mixture of **P36** and 2-mecapto-1-methylimidazole. The latter was further purified by MPLC (1:1 Hex:EtOAc +1% NEt) to give a total combined yield of pure **P36** (63 mg, 0.120 mmol, 59%), again accompanied by a portion of **P36** and **9q**. The total chemical yield of **P36** was judged to be 76%.

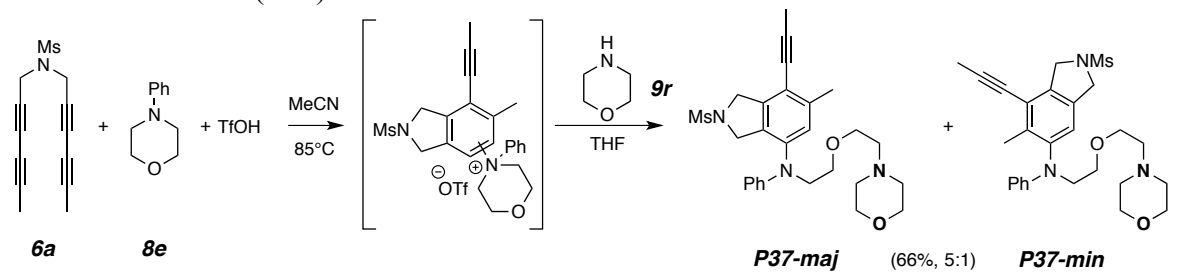
^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.19 (s, 1H, Ar*H*), 7.12 (dd, *J* = 8.7, 7.3 Hz, 2H, NPhH_m), 7.02 (d, *J* = 1.3 Hz, 1H, SAr*H*5), 6.90 (d, *J* = 1.3 Hz, 1H, SAr*H*4), 6.68 (tt, *J* = 7.3, 1.0 Hz, 1H, NPhH_p), 6.47 (dd, *J* = 8.8, 1.0 Hz, 2H, NPhH_o), 4.00 (t, *J* = 8.4 Hz, 2H, MsNCH_2CH$_2$), 3.76 (t, *J* = 6.4 Hz, 2H, ArPhNCH$_2$), 3.65 (t, *J* = 6.4 Hz, 2H, ArPhNCH$_2$CH_2O or OCH_2CH$_2$SAr), 3.63 (t, *J* = 6.4 Hz, 2H, ArPhNCH$_2$CH_2O or OCH_2CH$_2$SAr), 3.59 (s, 3H, NCH_3), 3.20 (t, *J* = 8.5 Hz, MsNCH$_2$CH_2), 3.19 (t, *J* = 6.3 Hz, 2H, OCH$_2$CH_2SAr), 2.83 (s, 3H, NSO$_2$CH_3), 2.13 (s, 3H, ArC≡CCH_3), and 2.10 (s, 3H, ArCH_3).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 148.1, 144.6, 141.3, 140.7, 134.6, 132.3, 129.1, 129.0, 122.9, 122.1, 117.1, 114.6, 112.8, 94.7, 75.9, 70.1, 68.1, 51.3, 50.4, 34.2, 33.5, 33.2, 28.2, 15.7, and 4.7.

IR (neat): 3003, 2920, 2232, 1590, 1499, 1463, 1345, 1159, 1115, and 969 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{27}H_{32}N_4NaO_3S_2^+$ [M+Na]$^+$ requires 547.1808; found 547.1820.

6-Methyl-2-(methylsulfonyl)-*N*-(2-(2-morpholinoethoxy)ethyl)-*N*-phenyl-7-(prop-1-yn-1-yl)isoindolin-4-amine (P37)



Tetrayne **6a** (50 mg, 0.202 mmol), *N*-phenylmorpholine (**8e**, 82 mg, 0.505 mmol, 2.5 equiv) and triflic acid (0.22 mL of a1.1 M solution in MeCN, 0.242 mmol, 1.2 equiv) were combined in a culture tube, dissolved in acetonitrile (7 mL), sealed with a Teflon-lined cap, and heated overnight (14–16 h) in an oil bath at 85 °C. The solution of the ammonium triflate intermediate was cooled, concentrated, and dissolved in THF (3.5 mL). Morpholine (**9r**, 100 μL, 1.14 mmol, 5.6 equiv) was added and the culture tube was sealed with a Teflon-lined cap and heated for 2 h in an oil bath at 90 °C. The resulting solution was cooled, concentrated, and passed directly through a plug of silica (95:5 EtOAc:*i*-PrOH +1% NEt_3 elution). The resulting residue was purified by MPLC (99:1 EtOAc:*i*-PrOH +1% NEt_3) to give a 5:1 coeluting mixture of **P37-maj** and **P37-min** (66 mg, 0.133 mmol, 66%) as a pale yellow oil.

Data for P37-maj extracted from the 5:1 mixture of P37-maj and P37-min

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.19 (dd, J = 8.7, 7.4 Hz, 2H, NPhH_m), 7.04 (s, 1H, MsNCH$_2$ArH), 6.84 (tt, J = 7.3, 1.0 Hz, 1H, NPhH_p), 6.72 (dd, J = 8.7, 0.9 Hz, 2H, NPhH_o), 4.68 [s, 2H, MsN(C$_a$$H_2$)$_2$], 4.14 [s, 2H, MsN(C$_b$$H_2$)$_2$], 3.89 (t, J = 6.0 Hz, 2H, Ar$_2$NCH_2CH$_2$O), 3.68 (br t, J = 4.6 Hz, 4H, N(CH$_2$CH_2)$_2$O), 3.61 (t, J = 5.8 Hz, 2H, ArPhNCH$_2$CH$_2$OCH_2, 3.54 (t, J = 5.8 Hz, 2H, ArPhNCH$_2$CH_2O), 2.75 (s, 3H, NSO_2CH_3), 2.53 (t, J = 5.7 Hz, 2H, OCH$_2$CH_2N(CH$_2$CH_2)$_2$O), 2.45 (m, 4H, N(CH_2CH$_2$)$_2$O), 2.41 (s, 3H, ArCH_3), and 2.12 (ArC≡CCH_3).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 146.9, 141.1, 140.6, 129.4, 129.3, 125.5, 125.4, 120.2, 117.3, 114.9, 94.1, 75.3, 69.1, 68.5, 66.8, 58.3, 54.5, 54.1, 53.6, 52.0, 34.6, 20.4, and 4.6.

Data for P37-min extracted from the 5:1 mixture of P37-maj and P37-min

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.14 (dd, J = 8.9, 7.4 Hz, 2H, NPhH_m), 7.04 (s, 1H, MsNCH$_2$ArH), 6.70 (m, 1H, NPhH_p), 6.49 (dd, J = 8.7, 0.8 Hz, 2H, NPhH_o), 4.74 [br t, J = 1.8 Hz, 2H, MsN(C$_a$$H_2$)$_2$], 4.69 [m, 2H, MsN(C$_b$$H_2$)$_2$], 3.79 (t, J = 6.4 Hz, 2H, ArPhNCH_2CH$_2$O), 3.68 (br t, J = 4.6 Hz, 4H, N(CH$_2$CH_2)$_2$O), 3.61 (t, J = 5.8 Hz, 2H, ArPhNCH$_2$CH$_2$OCH_2), 3.54 (t, J = 5.8 Hz, 2H, ArPhNCH$_2$CH_2O), 2.91 (s, 3H, NSO_2CH_3), 2.54 (t, J = 5.7 Hz, 2H, OCH$_2$CH_2N(CH$_2$CH$_2$)$_2$O), 2.45 (m, 4H, N(CH_2CH$_2$)$_2$O), 2.17 (s, 3H, ArCH_3), and 2.12 (ArC≡CCH_3).

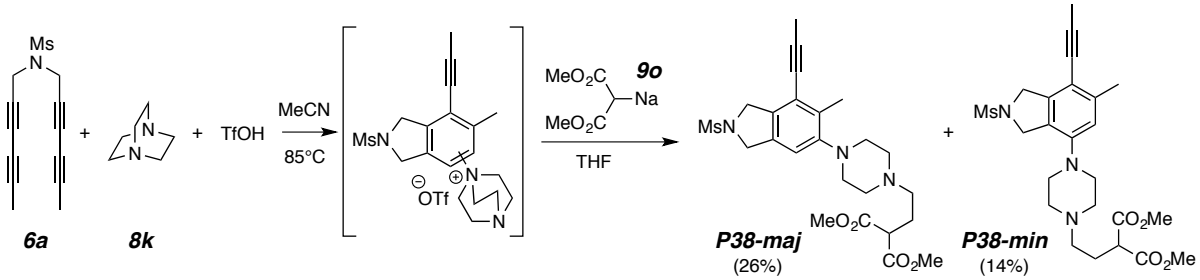
^{13}C-NMR (125 MHz, $CDCl_3$): δ 148.2, 145.2, 139.2, 137.7, 134.6, 129.4, 129.2, 123.3, 120.9, 113.0, 94.1, 75.3, 69.1, 68.5, 66.8, 58.3, 54.2 (x2), 54.1, 51.4, 35.0, 15.7, and 4.6.

Data for the 5:1 mixture of P37-maj and P37-min

IR (neat): 3030, 2954, 2916, 2855, 2235, 1594, 1498, 1337, 1154, and 1116 cm^{-1}.
HRMS (ESI-TOF): Calcd for $C_{27}H_{36}N_3O_4S^+$ $[M+H]^+$ requires 498.2421; found 498.2429.

3-(4-(6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-5-yl)piperazin-1-yl)propanenitrile (P38-min) and

3-(4-(6-Methyl-2-(methylsulfonyl)-7-(prop-1-yn-1-yl)isoindolin-4-yl)piperazin-1-yl)propanenitrile (P38-maj)



A stock solution of equimolar amounts of DABCO and triflic acid in acetonitrile (final concentration of 1.13 M) was prepared and stored in sealed culture tube. Tetrayne **6a** (50 mg, 0.202 mmol) in MeCN (10 mL) in a culture tube was treated with an aliquot of the above stock solution (0.36 mL, 0.404 mmol, 2 equiv), and the tube was sealed with a Teflon-lined cap. This solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, and concentrated. In a separate vial NaH (33 mg, 60% in mineral oil, 0.808 mmol, 4 equiv) in THF (5 mL) was placed under N_2 and dimethyl malonate (120 μL, 1.01 mmol, 5 equiv) was added dropwise and stirred for 30 min. This solution was added to the crude ammonium triflate. The resulting solution was stirred at 85-90 °C for 3 h. The mixture was concentrated, and the residue passed through a plug of silica (1:3 Hex:EtOAc +1% NEt_3). The resulting residue was purified by MPLC (1:1 Hex:EtOAc +1% NEt_3) to give, in order of elution, **P38-min** (14 mg, 0.028 mmol, 14%), and **P38-maj** (26 mg, 0.099 mmol, 26%) each as a white solid.

P38-min

^{1}H-NMR (500 MHz, $CDCl_3$): δ 6.66 (s, 1H, Ar*H*), 4.68 [m, 2H, MsN(C_aH_2)], 4.62 [m, 2H, MsN(C_bH_2)], 3.75 (s, 6H, CH(CO_2CH_3)$_2$), 3.52 (t, *J* = 7.3 Hz, 1H, C*H*(CO_2CH_3)$_2$), 2.95 (br t, *J* = 4.8 Hz, 4H, ArN(CH_2CH_2)$_2$N), 2.86 (s, 3H, NSO_2CH_3), 2.54 (br t, *J* = 4.5 Hz, 4H, ArN(CH_2CH_2)$_2$N), 2.44 (t, *J* = 6.6 Hz, 2H, $NCH_2CH_2CH(CO_2Me)_2$), 2.38 (s, 3H, $ArCH_3$), 2.13 (dt, *J* = 6.9, 6.9 Hz, 2H, $NCH_2CH_2CH(CO_2Me)_2$), and 2.09 (s, 3H, $ArC{\equiv}CCH_3$).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 169.9, 146.9, 140.3, 125.5, 117.9, 117.8, 112.2, 93.0, 75.4, 55.8, 54.3, 53.7, 53.2, 52.5, 50.4, 50.0, 34.7, 26.0, 20.4, and 4.5.

IR (neat): 2950, 2917, 2818, 1747, 1733, 1604, 1336, and, 1154 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{24}H_{34}N_3O_6S^+$ $[M+H]^+$ requires 492.2163; found 492.2178.

mp: 73–76 °C

P38-maj

^{1}H-NMR (500 MHz, $CDCl_3$): δ 6.83 (s, 1H, Ar*H*), 4.67 (br s, 4H, MsN(CH_2)$_2$), 3.75 (s, 6H, CH(CO_2CH_3)$_2$), 3.53 (t, *J* = 7.2 Hz, 1H, C*H*(CO_2CH_3)$_2$), 2.86 (s, 3H, NSO_2CH_3), 2.84 (br t, *J* = 4.6 Hz, 4H, ArN(CH_2CH_2)$_2$N), 2.59 (br s, 4H, ArN(CH_2CH_2)$_2$N), 2.46 (t, *J* = 6.9 Hz, 2H, $NCH_2CH_2CH(CO_2Me)_2$), 2.35 (s, 3H, $NArCH_3$), 2.14 (dt, *J* = 6.9, 6.9 Hz, 2H, $NCH_2CH_2CH(CO_2Me)_2$), and 2.11 (s, 3H, $ArC{\equiv}CCH_3$).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 170.0, 152.0, 134.5, 133.4 (x2), 120.2, 112.6, 94.5, 75.8, 55.8, 54.4 (2x), 53.4, 52.5, 52.0, 49.9, 34.5, 26.01, 15.9, and 4.5.

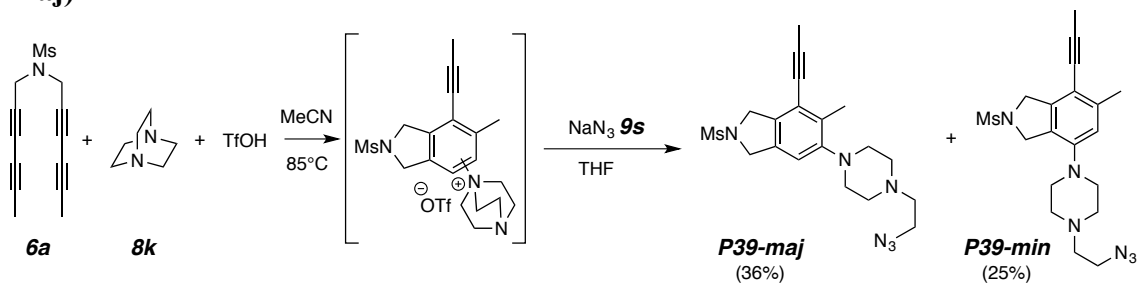
IR (neat): 2950, 2815, 2229, 1748, 1733, 1463, 1336, and 1152 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{24}H_{34}N_3O_6S^+$ $[M+H]^+$ requires 492.2163; found 492.2179.

mp: 144–146 °C

7-(4-(2-Azidoethyl)piperazin-1-yl)-5-methyl-2-(methylsulfonyl)-4-(prop-1-yn-1-yl)isoindoline (P39-min) and

6-(4-(2-Azidoethyl)piperazin-1-yl)-5-methyl-2-(methylsulfonyl)-4-(prop-1-yn-1-yl)isoindoline (P39-maj)



A stock solution of equimolar amounts of DABCO and triflic acid in acetonitrile (final concentration of 1.13 M) was prepared and stored in sealed culture tube. Tetrayne **6a** (100 mg, 0.404 mmol) in MeCN (18 mL) in a culture tube was treated with an aliquot of the above stock solution (0.72 mL, 0.808 mmol, 2 equiv), and the tube was sealed with a Teflon-lined cap. This solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, and concentrated. The resulting residue was dissolved in 9:1 dioxane:H_2O (9 mL) and sodium azide (**9s**, 265 mg, 4.04 mmol, 10 equiv) and tetrabutylammonium hydrogensulfate (137 mg, 1 equiv) were added. The resulting solution was stirred at 85-90 °C for 8 h. The mixture was transferred to a separatory funnel with EtOAc (25 mL) and washed with $NaHCO_3$ (3 x 10 mL). The combined aqueous layers were extracted with EtOAc (3 x 10 mL) and the combined organic layers were dried (Na_2SO_4), filtered, and concentrated. The residue was passed through a plug of silica (1:3 Hex:EtOAc +1% NEt_3). The resulting residue was purified by MPLC (3:1 Hex:EtOAc +1% NEt_3) to give, in order of elution, **P39-min** (40 mg, 0.099 mmol, 25%) and **P39-maj** (59 mg, 0.147 mmol, 36%), each as a white solid.

P39-min

^{1}H-NMR (500 MHz, $CDCl_3$): δ 6.67 (s, 1H, Ar*H*), 4.68 [(br s, 2H, MsN(C_aH_2)], 4.63 [br s, 2H, MsN(C_bH_2)], 3.38 (br t, *J* = 6 Hz, 2H, $NCH_2CH_2N_3$), 3.01 (br t, *J* = 4.9 Hz, 4H, ArN(CH_2CH_2)$_2$N), 2.86 (s, 3H, NSO_2CH_3), 2.67 (br t, *J* = 6 Hz, 2H, $NCH_2CH_2N_3$), 2.63 (br t, *J* = 4.8 Hz, ArN(CH_2CH_2)$_2$N), 2.38 (s, 3H, ArCH_3), and 2.09 (s, 3H, ArC≡CCH_3).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 146.7, 140.3, 125.5, 118.0, 117.9, 112.4, 93.1, 75.3, 57.1, 54.3, 53.7, 53.4, 50.4, 48.1, 34.7, 20.5, and 4.6.

IR (neat): 2945, 2916, 2819, 2221 (w), 2100 (s), 1604, 1489, 1453, 1334, and 1153 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{19}H_{27}N_6O_2S^+$ $[M+H]^+$ requires 403.1911; found 403.1918.

mp: 108–114 °C (decomp)

P39-maj

^{1}H-NMR (500 MHz, $CDCl_3$): δ 6.85 (s, 1H, Ar*H*), 4.67 (br s, 4H, MsN(CH_2)$_2$), 3.39 (t, *J* = 6.0 Hz, 2H, $NCH_2CH_2N_3$), 2.89 (br t, *J* = 4.6 Hz, 4H, ArN(CH_2CH_2)$_2$N), 2.86 (s, 3H, NSO_2CH_3), 2.69-2.62 (m, 4H, ArN(CH_2CH_2)$_2$N), 2.68 (br t, *J* = 6.3 Hz, 2H, $NCH_2CH_2N_3$), 2.36 (s, 3H, NArCH_3), and 2.12 (s, 3H, ArC≡CCH_3).

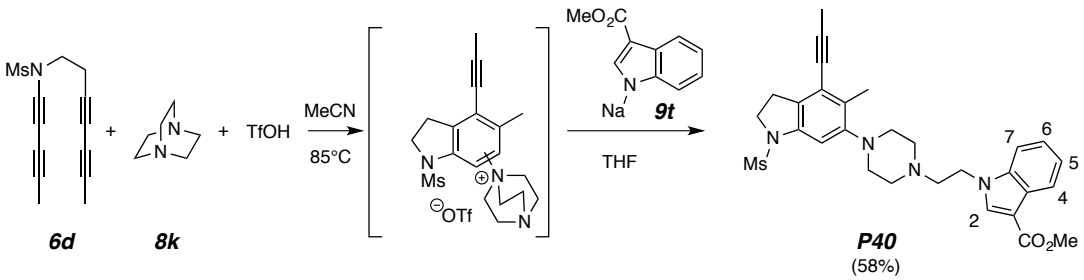
^{13}C-NMR (125 MHz, $CDCl_3$): δ 151.9, 133.5, 134.6, 120.2, 112.8, 112.7, 94.4, 75.8, 57.3, 54.3 (2x), 53.6, 52.0, 48.2, 34.6, 15.9, and 4.5.

IR (neat): 2942, 2916, 2816, 2225 (w), 2100 (s), 1601, 1463, 1334, and 1152 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{19}H_{27}N_6O_2S^+$ $[M+H]^+$ requires 403.1911; found 403.1930.

mp: 179–185 °C (decomp)

Methyl 1-(2-(4-(5-methyl-1-(methylsulfonyl)-4-(prop-1-yn-1-yl)indolin-6-yl)piperazin-1-yl)ethyl)-1*H*-indole-3-carboxylate (P40)



A stock solution of equimolar amounts of DABCO and triflic acid in acetonitrile (final concentration of 1.13 M) was prepared and stored in sealed culture tube. Tetrayne **6d** (50 mg, 0.202 mmol) in MeCN (10 mL) in a culture tube was treated with an aliquot of the above stock solution (0.36 mL, 0.404 mmol, 2 equiv), and the tube was sealed with a Teflon-lined cap. This solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, and concentrated. In a separate vial NaH (36 mg, 60% in mineral oil, 0.91 mmol, 4.5 equiv) in THF (4 mL) was placed under N_2 and methyl 1H-indole-3-carboxylate (177 mg, 1.01 mmol, 5 equiv) was added. The mixture was stirred for 30 min and the resulting solution was added to the crude ammonium triflate. The resulting solution was stirred at 85-90 °C for 3 h. The resulting mixture was concentrated and passed through a plug of silica (1:3 Hex:EtOAc +1% NEt_3). The resulting residue was purified by MPLC (1:1 Hex:EtOAc +1% NEt_3) to give **P40** (62 mg, 0.116 mmol, 58%) as an orange solid.

^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.19 (nfom, 1H, *H*7), 7.90 (s, 1H, *H*2), 7.40 (nfom, 1H, *H*4), 7.31–7.27 (m, 2H, *H*5, *H*6), 7.10 (s, 1H, NAr*H*), 4.29 (t, *J* = 6.9 Hz, 2H, $NCH_2CH_2N_{indole}$), 3.95 (t, *J* = 8.4 Hz, 2H, $MsNCH_2CH_2$), 3.92 (s, 3H, CO_2CH_3), 3.12 (t, *J* = 8.6 Hz, 2H, $MsNCH_2CH_2$), 2.88 (br t, *J* = 4.8 Hz, 4H, $ArN(CH_2CH_2)_2N$), 2.85 (t, *J* = 6.9 Hz, 2H, $NCH_2CH_2N_{indole}$), 2.82 (s, 3H, NSO_2CH_3), 2.65 (br s, 4H, $ArN(CH_2CH_2)_2N$), 2.30 (s, 3H, NAr*H*), and 2.12 (s, 3H, $ArC{\equiv}CCH_3$).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 165.5, 151.5, 139.9, 136.5, 134.6, 130.0, 128.5, 126.8, 123.0, 122.3, 121.89, 121.85, 109.8, 107.2, 105.3, 93.9, 76.3, 57.5, 53.9, 51.9, 51.0, 50.5, 44.8, 34.2, 27.9, 15.7, and 4.5.

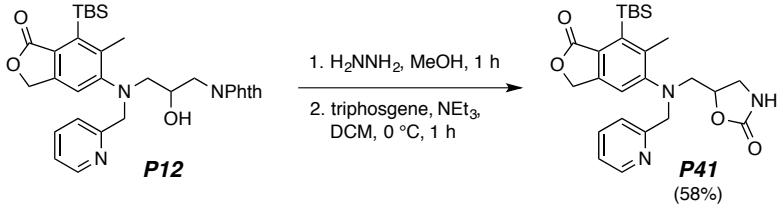
IR (neat): 3123, 3062, 2951, 2817, 2229, 1698, 1592, 1535, 1467, 1345, 1158, 969, and 777 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{29}H_{35}N_4O_4S^+$ $[M+H]^+$ requires 535.2374; found 535.2384.

mp: 174-179 °C

This reaction could also be performed in a one-pot sequence (cf. Table 2 in the manuscript), although the two-stage triflate procedure described above was more efficient. For example, tetrayne **6e** (50 mg, 0.202 mmol), DABCO (34 mg, 0.303 mmol, 1.5 equiv), and methyl 1H-indole-3-carboxylate (44 mg, 0.253 mmol, 1.25 equiv) were combined in a culture tube, dissolved in benzene (7.5 mL, ~0.03 M), and sealed with a Teflon-lined cap. The solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, and passed through a plug of silica (1:3 Hex:EtOAc +1% NEt_3). The resulting residue was purified by MPLC (1:1 Hex:EtOAc +1% NEt_3) to give, **P40** (40 mg, 0.075 mmol, 37%) as an orange solid.

5-(((7-(*tert*-Butyldimethylsilyl)-6-methyl-1-oxo-1,3-dihydroisobenzofuran-5-yl)(pyridin-2-ylmethyl)amino)methyl)oxazolidin-2-one (P41)



Phthalimide **P12** (32 mg, 0.056 mmol) was dissolved in MeOH (3 mL), hydrazine hydrate (0.28 mL, 5.6 mmol, 10 equiv) was added, and the solution was stirred for 1 h at ambient temperature. The reaction mixture was concentrated and the resulting residue was suspended in NH_4OH/H_2O (1:1; 10 mL). This mixture was extracted with EtOAc (3 x 10 mL). The combined organic layers were dried (Na_2SO_4), filtered, and concentrated. The crude amino alcohol was dissolved in DCM (5 mL) and cooled to 0 °C under N_2. Triethylamine (84 μL, 0.6 mmol, 10 equiv) and triphosgene (27 mg, 0.06 mmol, 1 equiv) in DCM (2 mL) were added, and the mixture was stirred at 0 °C for 45 min. Water (5 mL) was added and the mixture was extracted with DCM (3 x 5 mL). The combined organic layers were washed with brine (10 mL), dried ($MgSO_4$), filtered, and concentrated. The residue was passed through a plug of SiO_2 (1:3 EtOAc:*i*-PrOH +2% NEt_3). The resulting residue was purified by MPLC (1:1 EtOAc:*i*-PrOH +2% NEt_3) to give an impure material that was further purified by flash column [95:5:0.5 to 90:10:1 $CHCl_3$:MeOH:NH_4OH (CMA)] to give **P41** (15 mg, 0.033 mmol, 58%) as a yellow oil.

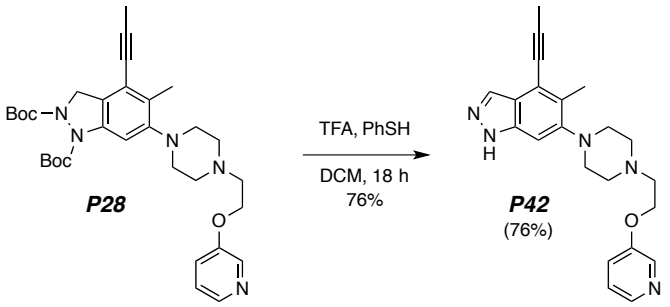
^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.55 (ddd, *J* = 4.9, 1.8, 1.1 Hz, 1H, Pyr*H*6), 7.64 (ddd, *J* = 7.7, 7.7, 1.8 Hz, 1H, Pyr*H*4), 7.27 (ddd, *J* = 7.9, 1.1, 1.1 Hz, 1H, Pyr*H*3), 7.22 (s, 1H, COAr*H*), 7.20 (ddd, *J* = 7.5, 4.9, 1.2 Hz, 1H, Pyr*H*5), 5.37 (br m, 1H, OCON*H*), 5.13 (s, 2H, CH_2OCO), 4.71 (dddd, *J* = 8.5, 6.8, 6.8, 5.4 Hz, 1H, ArNCH$_2$C*H*OCONH), 4.40 (d, *J* = 14.8 Hz, 1H, PyrCH_aH$_b$N), 4.35 (d, *J* = 14.9 Hz, PyrCH$_a$$H_b$N), 3.57 (ddd, *J* = 8.6, 8.6, 0.8 Hz, 1H, OCH_aH$_b$NH), 3.50 (dd, *J* = 14.3, 7.0 Hz, 1H, ArNCH_aH$_b$CHO), 3.31 (dd, *J* = 14.2, 5.5 Hz, 1H, ArNCH$_a$$H_b$CHO), 3.27 (ddd, *J* = 8.8, 6.6, 0.8 Hz, 1H, CHOCH$_a$$H_b$NH), 2.59 (s, 3H, ArC$H_3$), 1.05 [s, 9H, SiC(C$H_3$)$_3$], 0.46 (s, 3H, SiC$_a$$H_3$), and 0.45 (s, 3H, SiC$_b$$H_3$).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 170.7, 159.1, 157.5, 154.1, 149.4, 146.1, 142.9, 142.7, 136.8, 127.0, 122.9, 122.5, 116.3, 74.2, 67.7, 60.9, 55.7, 44.0, 28.4, 21.4, 19.4, and 1.3.

IR (neat): 3297, 2890, 2851, 1754, 1587, 1244, and 1085 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{25}H_{34}N_3O_4Si^+$ $[M+H]^+$ requires 468.2313; found 468.2316.

5-Methyl-4-(prop-1-yn-1-yl)-6-(4-(2-(pyridin-3-yloxy)ethyl)piperazin-1-yl)-1*H*-indazole (P42)



N-Boc-Indazolidine **P28** (41 mg, 0.070 mmol) in DCM (2 mL) was cooled to 0 °C under N_2. Thiophenol (0.14 mL, 1.41 mmol, 20 equiv) and trifluoroacetic acid (0.27 mL, 3.52 mmol, 50 equiv) were added, the cooling bath was removed, and the solution was stirred for 20 h. The reaction was quenched by the addition of saturated $NaHCO_3$ (4 mL) and 6 M NaOH (1 mL), and the resulting mixture was extracted with DCM (4 x 6 mL). The combined organic layers were dried (Na_2SO_4), filtered, and concentrated. The resulting residue was purified by flash column [95:5:0.5 to 90:10:1 $CHCl_3$, MeOH, NH_4OH (CMA)] to give **P42** (20 mg, 0.053 mmol, 76%) as a white solid.

^{1}H-NMR (500 MHz, $CDCl_3$): δ 10.40 (br s, 1H, N*H*), 8.36 (dd, *J* = 2.2, 1.2 Hz, 1H, Pyr*H*2), 8.24 (dd, *J* = 3.8, 2.3 Hz, 1H, Pyr*H*6), 8.04 (d, *J* = 1.0 Hz, 1H,HNNC*H*), 7.23-7.22 (m, 2H, Pyr*H*4, Pyr*H*5), 7.07 (s, 1H, Ar*H*), 4.24 (t, *J* = 5.6 Hz, 2H, NCH_2CH_2OPyr), 2.99 (br t, *J* = 4.6 Hz, 4H, $ArN(CH_2CH_2)N$), 2.96 (t, *J* = 5.7 Hz, NCH_2CH_2OPyr), 2.81 (br m, 4H, $ArN(CH_2CH_2)N$), 2.47 (s, 3H, $NArCH_3$), and 2.22 (s, 3H, $ArC{\equiv}CCH_3$).

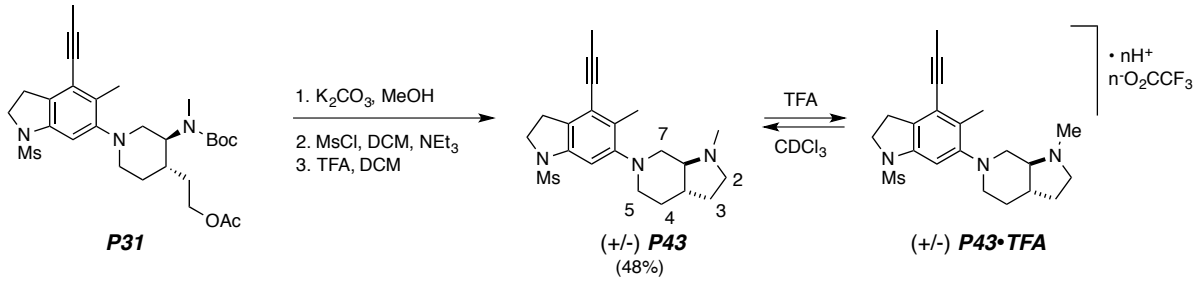
^{13}C-NMR (125 MHz, $CDCl_3$): δ 154.9, 151.9, 142.3, 139.2, 138.1, 134.3, 130.1, 123.9, 121.4, 121.3, 116.4, 99.3, 93.7, 77.6, 66.2, 57.2, 54.1, 52.2, 16.0, and 4.6.

IR (neat): 3149 (br), 2887, 2796, 2227, 1613, 1575, 1428, 1270, 1230, 1163, and 950 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{22}H_{26}N_5O^+$ $[M+H]^+$ requires 376.2132; found 376.2136.

mp: 219-222 °C

1-Methyl-6-(5-methyl-1-(methylsulfonyl)-4-(prop-1-yn-1-yl)indolin-6-yl)octahydro-1H-pyrrolo[2,3-c]pyridine (P43)



The *N*-Boc acetate **P31** (88 mg, 0.161 mmol) and K_2CO_3 (23 mg, 0.16 mmol, 1 equiv) were dissolved in MeOH (4 mL) and stirred at room temperature for 1.5 h. The resulting mixture was diluted with water (10 mL) and extracted with DCM (3 x 10 mL). The combined organic layers were dried ($MgSO_4$), filtered, and concentrated to give the crude primary alcohol, which was used for the following step without further purification. This alcohol and triethylamine (110 μL, 0.8 mmol, ~5 equiv) were dissolved in DCM (5 mL) and cooled to 0 °C under N_2. To this solution methanesulfonyl chloride (16 μL, 0.2 mmol, 1.25 equiv) was added, and the resulting solution was stirred at 0 °C for 15 min, quenched with water (5 mL), and extracted with DCM (5 mL x 3). The combined organic layers were dried ($MgSO_4$), filtered, and concentrated, and the resulting residue was passed through a plug of silica (1:1 Hex:EtOAc) to give a crude mesylated, which was used directly for the following step. This mesylate was dissolved in DCM (2 mL) and TFA (1 mL) and the solution was stirred at room temperature for 3 h. The resulting mixture was concentrated, dissolved in DCM (10 mL), and washed with sat aq. K_2CO_3 (3 mL x 3). The organic layer was dried ($MgSO_4$), filtered, and concentrated, and the resulting residue was passed through a plug of silica (90:10 EtOAc:i-PrOH +1% NEt_3). This residue was purified by MPLC (99:1+1 % EtOAc:*i*-PrOH+NEt_3) to give **P43** (30 mg, 0.77 mmol, 48% over the three steps).

Data for P43

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.13 (s, 1H, Ar*H*), 3.95 (t, *J* = 8.4 Hz, 2H, MsNCH_2CH$_2$), 3.30 (ddd, *J* = 9.9, 8.6, 6.1 Hz, 1H, C2H_a), 3.26 (ddd, *J* = 10.4, 3.7, 1.5 Hz, 1H, C7H_a), 3.12 (t, *J* = 8.6 Hz, 2H, MsNCH_2CH_2), 3.06 (dddd, *J* = 11.8, 4.0, 2.3, 1.6 Hz, 1H, C5H_a), 2.82 (s, 3H, NSO_2CH_3), 2.67 (ddd, *J* = 11.7, 11.7, 2.8 Hz, 1H, C5H_b), 2.49 (dd, *J* = 10.1, 10.1 Hz, 1H, C7H_b), 2.33 (ddd, *J* = 11.1, 9.8, 4.3 Hz, 1H, C2H_b), 2.32 (s, 3H, NCH_3), 2.31 (s, 3H, ArCH_3), 2.12 (s, 3H, NArC≡CCH_3), 1.98 (m, 1H, C7a*H*), 1.97 (m, 1H, C3H_a), 1.89 (dddd, *J* = 11.5, 2.3, 2.3, 2.3 Hz, 1H, C4H_a), 1.61 (m, 1H, C3a*H*), 1.54 (m, 1H, C4H_b), and 1.49 (m, 1H, C3H_b)

^{13}C-NMR (125 MHz, $CDCl_3$): δ 152.3, 139.9, 130.2, 128.2, 122.0, 106.2, 93.7, 76.4, 69.6, 56.5, 55.5, 52.5, 50.6, 44.1, 40.6, 34.2, 30.4, 28.0, 27.9, 15.5, and 4.5.

IR (neat): 2945, 2931, 2852, 2797, 2232, 1589, 1458, 1346, 1159, 1096, and 969 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{21}H_{30}N_3O_2S^+$ $[M+H]^+$ requires 388.2053; found 388.2050.

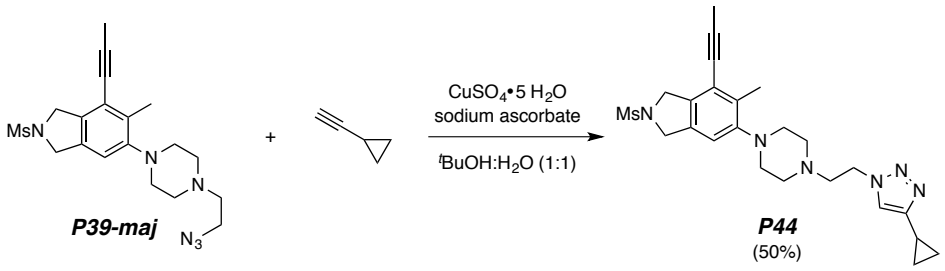
Trifluoroacetic acid (ca. 20 uL) was added to NMR sample of **P43** in $CDCl_3$ and the following data were collected:

Data for P43·TFA

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.40 (s, 1H, Ar*H*), 4.21 (t, *J* = 11.4 Hz, 1H, C7H_a), 4.10 (m, 1H, C2H_a), 4.09 (m, 1H, C7H_b), 4.07 (m, 1H, MsNC$H_a$$H_b$$CH_2$), 4.00 (m, 1H, MsNC$H_a$$H_b$$CH_2$), 3.81 (ddd, *J* = 11.7, 11.7, 3.6 Hz, 1H, C7a*H*), 3.71 (br dd, *J* = 12.6, 5.8 Hz, 1H, C5H_a), 3.64 (ddd, *J* = 12.7, 12.7, 3.4 Hz, 1H, C5H_b), 3.35 (dddd, *J* = 12.1, 11.5, 4.9, 2.9 Hz, 1H, C2H_b), 3.21 (t, *J* = 9.1 Hz, 2H, MsNCH_2CH_2), 3.01 (d, *J* = 4.4 Hz, 3H, $HN^+C$$H_3$), 2.94 (s, 3H, $NSO_2C$$H_3$), 2.52 (ddddd, *J* = 11.9, 11.9, 11.9, 6.7, 3.8 Hz, 1H, C3a*H*), 2.47 (s, 3H, NArCH_3), 2.39 (m, 1H, C3H_a), 2.35 (m, 1H, C4H_a), 2.20 (m, 1H, C3H_a), 2.15 (s, 3H, ArC≡CCH_3), and 1.98 (dddd, *J* = 12.5, 11.2, 11.2, 8.4 Hz, 1H, C3H_b).

^{13}C-NMR (125 MHz, $CDCl_3$): δ 141.3, 139.6, 136.2, 127.5, 124.8, 103.7, 98.1, 74.4, 65.6, 56.8, 55.9, 54.1, 50.1, 39.8, 39.2, 35.6, 28.1, 26.7 (x2), 15.2, and 4.6.

6-(4-(2-(4-Cyclopropyl-1*H*-1,2,3-triazol-1-yl)ethyl)piperazin-1-yl)-5-methyl-2-(methylsulfonyl)-4-(prop-1-yn-1-yl)isoindoline (P44)



Azide **P39-maj** (42 mg, 0.104 mmol) and cyclopropylacetylene (14 μL, 0.156 mmol, 1.5 equiv) were dissolved in *t*-BuOH (4 mL) and water (2 mL). An aqueous solution of copper sulfate pentahydrate (26 mg, 0.104 mmol, 1 equiv) and sodium ascorbate (41 mg, 0.208 mmol, 2 equiv) in water (2 mL) was added in one portion, and the resulting heterogeneous mixture was stirred at room temperature for 24 h. The reaction mixture was quenched by the addition of 3:1 brine:NH_4OH (8 mL) and extracted with DCM (3 x 10 mL). The combined organic layers were dried (Na_2SO_4), filtered, concentrated, and passed through a plug of silica (1% ^{i}PrOH/EtOAc +1% NEt_3). The resulting residue was purified by MPLC (1:9 Hex:EtOAc +1% NEt_3) to give **P44** (24 mg, 0.052 mmol, 50%) as a white solid.

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.38 (s, 1H, triazole*H*), 6.85 (s, 1H, NAr*H*), 4.67 [s, 4H, MsN(CH_2)$_2$], 4.44 (t, J = 6.4 Hz, 2H, CH_2CH_2N-N-NAr), 2.89–2.85 (m, 9H, CH_2CH_2triazole, ArN(CH_2CH_2)N, NSO_2CH_3), 2.66 (br s, 4H, ArN(CH_2CH_2)N), 2.36 (s, 3H, NArCH_3), 2.12 (s, 3H, ArC≡CCH_3), 1.96 [tt, J = 8.1, 5.0 Hz, 1H, CH(CH_2)$_2$], 0.95 [nfom, 2H, CH(CH_aH$_b$)$_2$], 0.85 (nfom, 2H, CH(CH_aH_b)$_2$,).

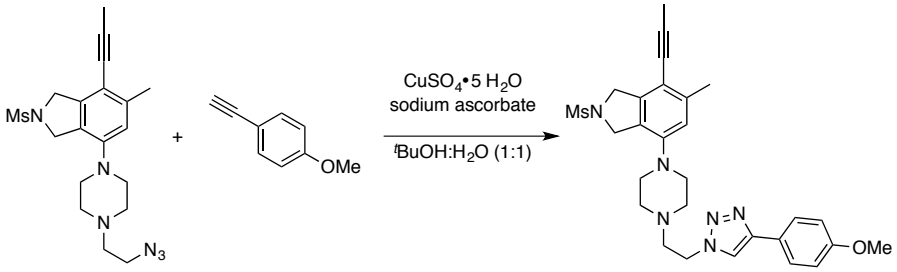
^{13}C-NMR (125 MHz, $CDCl_3$): δ 151.6, 150.1, 134.6, 133.5, 133.1, 120.3, 120.2, 112.7, 94.6, 75.8, 57.7, 54.3 (x2), 53.5, 52.0, 47.6, 34.6, 15.9, 7.9, 6.4, and 4.5.

IR (neat): 3146, 3085, 3003, 2946, 2820, 2229, 1602, 1464, 1333, and 1153 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{24}H_{33}N_6O_2S^+$ $[M+H]^+$ requires 469.2380; found 469.2398.

mp: 195-198 °C

7-(4-(2-(4-(4-Methoxyphenyl)-1*H*-1,2,3-triazol-1-yl)ethyl)piperazin-1-yl)-5-methyl-2-(methylsulfonyl)-4-(prop-1-yn-1-yl)isoindoline (P45)



P39-min ***P45*** (54%)

Azide **P39-min** (30 mg, 0.075 mmol) and *p*-methoxyphenylacetylene (15 μL, 0.113 mmol, 1.5 equiv) were dissolved in *t*-BuOH (3 mL) and water (1.5 mL). A solution of copper sulfate pentahydrate (18 mg, 0.075 mmol, 1 equiv) and sodium ascorbate (30 mg, 0.149 mmol, 2 equiv) in water (1.5 mL) was added in one portion, and the resulting heterogeneous mixture was stirred at room temperature for 24 h. Brine:satd. NH_4OH (3:1, 8 mL) was added and the mixture was extracted with DCM (3 x 10 mL). The combined organic layers were dried (Na_2SO_4), filtered, concentrated, and passed through a plug of silica (1% ^{i}PrOH/EtOAc +1% NEt_3). The resulting residue was purified by MPLC (1:3 Hex:EtOAc +1% NEt_3) to give **P45** (21 mg, 0.040 mmol, 54%) as a white solid.

^{1}H-NMR (500 MHz, $CDCl_3$): δ 7.83 (s, 1H, triazoleC*H*), 7.76 (d, *J* = 8.8 Hz, 2H, MeOArH_m), 6.97 (d, *J* = 8.8 Hz, 2H, MeOArH_o), 6.67 (s, 1H, NAr*H*), 4.68 (s, 2H, MsN(C_aH_2)), 4.63 (s, 2H, MsN(C_bH_2)), 4.53 (t, *J* = 6.2 Hz, 2H, NCH_2CH_2triazole), 3.85 (s, 3H, ArOCH_3), 2.98 (bt, *J* = 4.6 Hz, 4H, ArN(CH_2CH_2)N), 2.94 (t, *J* = 6.3 Hz, 2H, NCH_2CH_2triazole), 2.87 (s, 3H, NSO_2CH_3), 2.65 (bt, *J* = 4.5 Hz, 4H, ArN(CH_2CH_2)N), 2.38 (s, 3H, ArCH_3), and 2.09 (s, 3H, ArC≡CCH_3).

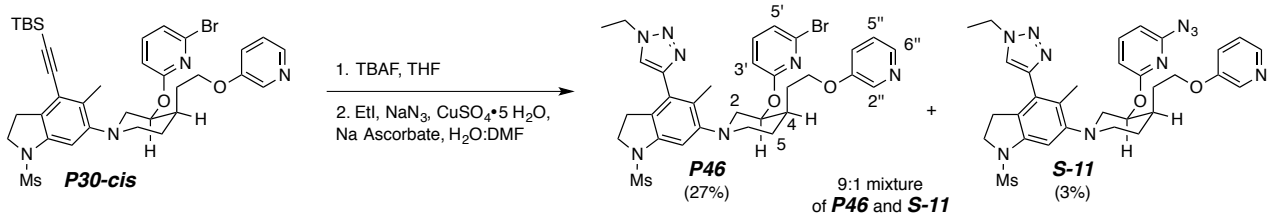
^{13}C-NMR (125 MHz, $CDCl_3$): δ 159.6, 147.6, 141.3, 140.3, 127.0, 125.6, 123.5, 119.3, 118.0, 117.7, 114.3, 112.7, 93.2, 75.3, 57.5, 55.3, 54.3, 53.7, 53.3, 50.5, 47.7, 34.8, 20.5, and 4.5.

IR (neat): 3088, 3073, 2952, 2822, 2043, 1604, 1498, 1449, 1336, 1244, 1151, and 832 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{28}H_{35}N_6O_3S^+$ $[M+H]^+$ requires 535.2486; found 535.2486.

mp: 222-228 °C

(±)-6-((3*S*,4*S*)3-((6-Bromopyridin-2-yl)oxy)-4-(2-(pyridin-3-yloxy)ethyl)piperidin-1-yl)-4-(1-ethyl-1*H*-1,2,3-triazol-4-yl)-5-methyl-1-(methylsulfonyl)indoline (**P46**) and **(±)-6-((3*S*,4*R*)-3-((6-azidopyridin-2-yl)oxy)-4-(2-(pyridin-3-yloxy)ethyl)piperidin-1-yl)-4-(1-ethyl-1*H*-1,2,3-triazol-4-yl)-5-methyl-1-(methylsulfonyl)indoline**



The TBS-alkyne **P30-cis** (32 mg, 0.059 mmol) was dissolved in THF (3 mL) and 1 M tetrabutylammonium fluoride (0.1 mL, 0.1 mmol, 1.7 equiv) was added. The solution was stirred for 10 min. The mixture was quenched with satd. aq. $NaHCO_3$ (8 mL) and extracted with EtOAc (2 x 10 mL). The combined extracts were dried (Na_2SO_4), filtered, and concentrated, and the resulting residue was passed through a plug of SiO_2 (1:3 Hex:EtOAc +1% NEt_3) to provide the sample of desilylated alkyne that was used directly in the next reaction. Sodium azide (19 mg, 0.295 mmol, 5 equiv) was dissolved in DMF:H_2O (1:1, 4 mL) in a culture tube and ethyl iodide (9 μL, 0.113 mmol, 1.9 equiv) was added. The tube was capped and the solution was stirred for 30 min. The crude terminal alkyne in DMF:H_2O (1:1, 2 mL), sodium ascorbate (12 mg, 0.059 mmol, 1 equiv), and cupric sulfate (29 mg, 0.118 mmol, 2.0 equiv) were added sequentially, the tube was recapped, and the resulting yellow-brown suspension was stirred overnight at 60 °C. The reaction was quenched by the addition of NH_4OH/brine (1:3; 10 mL), and the mixture was extracted with EtOAc (4 x 10 mL). The combined organic layers were dried ($MgSO_4$), filtered, and concentrated, and the residue was passed through a plug of SiO_2 (99:1 EtOAc:*i*-PrOH +1% NEt_3). The resulting residue was purified by MPLC (1:6 Hex:EtOAc +1% NEt_3) to give a 9:1 coeluting mixture of **P46** and **S-11** (12 mg, 0.016 mmol, 91% by mass **P46**, corrected yield of 27%) as a yellow oil.

Data for **P46** extracted from the 9:1 mixture of **P46** and **S-11**

^{1}H-NMR (500 MHz, $CDCl_3$): δ 8.27 (d, *J* = 2.8 Hz, 1H, *H*2''), 8.21 (dd, *J* = 4.4, 1.1 Hz, 1H, *H*6''), 7.48 (s, 1H, Triazole*H*), 7.39 (dd, *J* = 8.1, 7.5 Hz, 0.8 H, *H*4'), 7.23 (s, 1H, NMsAr*H*), 7.20 (ddd, *J* = 8.6, 4.4, 0.5 Hz, 1H, *H*5''), 7.16 (ddd, *J* = 8.4, 2.9, 1.4 Hz, 1H, *H*4''), 7.02 (dd, *J* = 7.5, 0.6 Hz, 1H, H5'), 6.71 (dd, *J* = 8.2, 0.5 Hz, 1H, H3'), 5.39 (m, 1H, C3*H*), 4.47 (q, *J* = 7.4 Hz, 2H, triazoleNCH_2CH$_3$), 4.17-4.12 (nfom, 1H, C4CH$_2$CH_aH$_b$O), 4.11-4.06 (nfom, 1H, C4CH$_2$CH$_a$$H_b$O), 3.95 (ddd, *J* = 10.5, 10.1, 6.7 Hz, 1H, MsNCH_aH$_b$CH$_2$), 3.91 (ddd, *J* = 10.3, 9.6, 7.2 Hz, 1H, MsNCH$_a$$H_bCH_2$), 3.48 (m, 1H, C2$H_aH_b$), 3.17 (m, 1H, C6$H_aH_b$), 3.12 (ddd, *J* = 16.9, 9.8, 7.4 Hz, 1H, MsNCH$_2$CH_aH$_b$), 3.01 (ddd, *J* = 16.4, 9.6, 6.8 Hz, 1H, MsNCH$_2$CH$_a$$H_b$), 2.93 (m, 1H, C6H$_a$$H_b$), 2.85 (s, 3H, NSO$_2CH_3$), 2.83 (m, 1H, C2H$_a$$H_b$), 2.08 (m, 1H, C4*H*), 2.08 (m, 1H, C5H_aH$_b$), 2.03 (m, 1H, C4CH_aH$_b$CH$_2$O), 2.01 (s, 3H, ArCH_3), 1.88 (m, 1H, C4CH$_a$$H_bCH_2$O), 1.78 (m, 1H, C5H$_a$$H_b$), and 1.61 (t, *J* = 7.4 Hz, 3H, triazoleNCH$_2$CH_3).

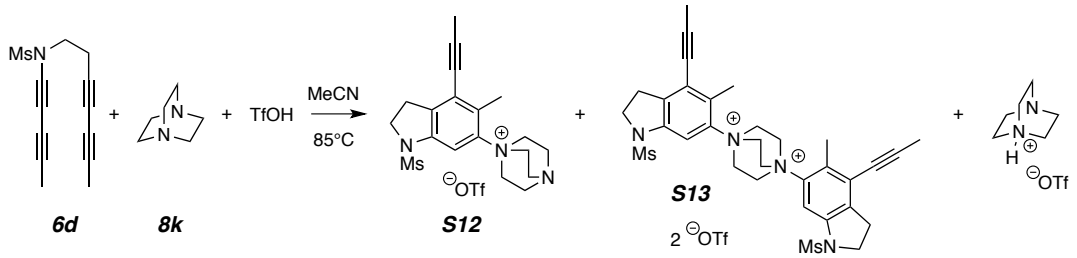
^{13}C-NMR (125 MHz, $CDCl_3$): δ 163.2, 155.0, 152.5, 144.7, 142.0, 140.5, 140.3, 138.4, 137.8, 129.3, 128.0, 125.9, 123.8, 121.7, 121.1, 120.2, 110.0, 106.4, 71.4, 66.0, 55.4, 52.0, 50.7, 45.3, 35.8, 34.1, 31.0, 28.1, 28.0, 15.4, and 14.9.

IR (neat): 3001, 2926, 2800, 2122 (N_3), 1588, 1552, 1438, 1344, 1293, 1158, and 792 cm^{-1}.

HRMS (ESI-TOF): Calcd for $C_{31}H_{27}BrN_7O_4S^+$ $[M+H]^+$ requires 682.1806; found 682.1800.

IV. Isolation of Ammonium triflate leading to P40 (S12)

1-(5-Methyl-1-(methylsulfonyl)-4-(prop-1-yn-1-yl)indolin-6-yl)-1,4-diazabicyclo[2.2.2]octan-1-ium trifluoromethanesulfonate (S12)



A stock solution of equimolar amounts of DABCO and triflic acid in acetonitrile (final concentration of 1.13 M) was prepared and stored in a sealed culture tube. Tetrayne **6d** (25 mg, 0.101 mmol) in MeCN (5 mL) in a culture tube was treated with an aliquot of the above stock solution (0.18 mL, 0.202 mmol, 2 molar equiv), and the tube was sealed with a Teflon-lined cap. This solution was heated overnight (14-16 h) in an oil bath at 85 °C, cooled, and concentrated to dryness. The crude material was redissolved in MeCN (2 mL) and Et_2O (6 mL) was added, resulting in a cloudy suspension that was cooled to 0 °C for 1 h. The resulting suspension was filtered, washed with Et_2O, and dried to give a 12:1 molar ratio of **S12** and what we judged to be the bis-dabconium triflate **S13** as a tan solid (33 mg, 85% by mass **S12**, 0.055 mmol, 55%).

Data for **S12** extracted from the mixture of **S12** and **S13**, which contained ca. 8 wt% of residual dabconium triflate

^{1}H-NMR (500 MHz, CD_3CN): δ 7.53 (s, 1H, Ar*H*), 4.04 (t, *J* = 8.5 Hz, 2H, $MsNCH_2CH_2$), 3.83 (br t, *J* = 7 Hz, 6H, $ArN^+(CH_2CH_2)_3N$), 3.29 (br t, *J* = 7 Hz, 6H, $ArN^+(CH_2CH_2)_3N$), 3.21 (t, *J* = 8.7 Hz, 2H, $MsNCH_2CH_2$), 2.96 (s, 3H, NSO_2CH_3), 2.71 (s, 3H, $ArCH_3$), and 2.15 (s, 3H, $ArC{\equiv}CCH_3$).

^{13}C-NMR (125 MHz, CD_3CN): δ 143.2, 142.1, 141.3, 137.2, 126.9, 105.7, 99.0, 74.5, 55.3, 50.1, 45.4, 34.7, 27.7, 20.3, and 3.5. (Triflate carbon not observed in the HSQC or HMBC spectrum.)

HRMS (ESI-TOF): Calcd for $C_{19}H_{26}N_3O_2S^+$ $[M]^+$ requires 360.1740; found 370.1734.

Several additional resonances in the ^{1}H, HSQC, and HMBC spectra and ESI-MS suggest the presence of a small amount of the diarylated DABCO salt **S13**.

V. References for Supplementary Information

1 Hoye, T. R., Hanson, P. R.; Vyvyan, J. R. A practical guide to first-order multiplet analysis in ^{1}H NMR spectroscopy. *J. Org. Chem*. **1994**, *59*, 4096–4103.

2 Hoye, T. R.; Zhao, H. A method for easily determining coupling constant values: an addendum to "a practical guide to first-order multiplet analysis in ^{1}H NMR spectroscopy". *J. Org. Chem*. **2002**, *67*, 4014–4016.

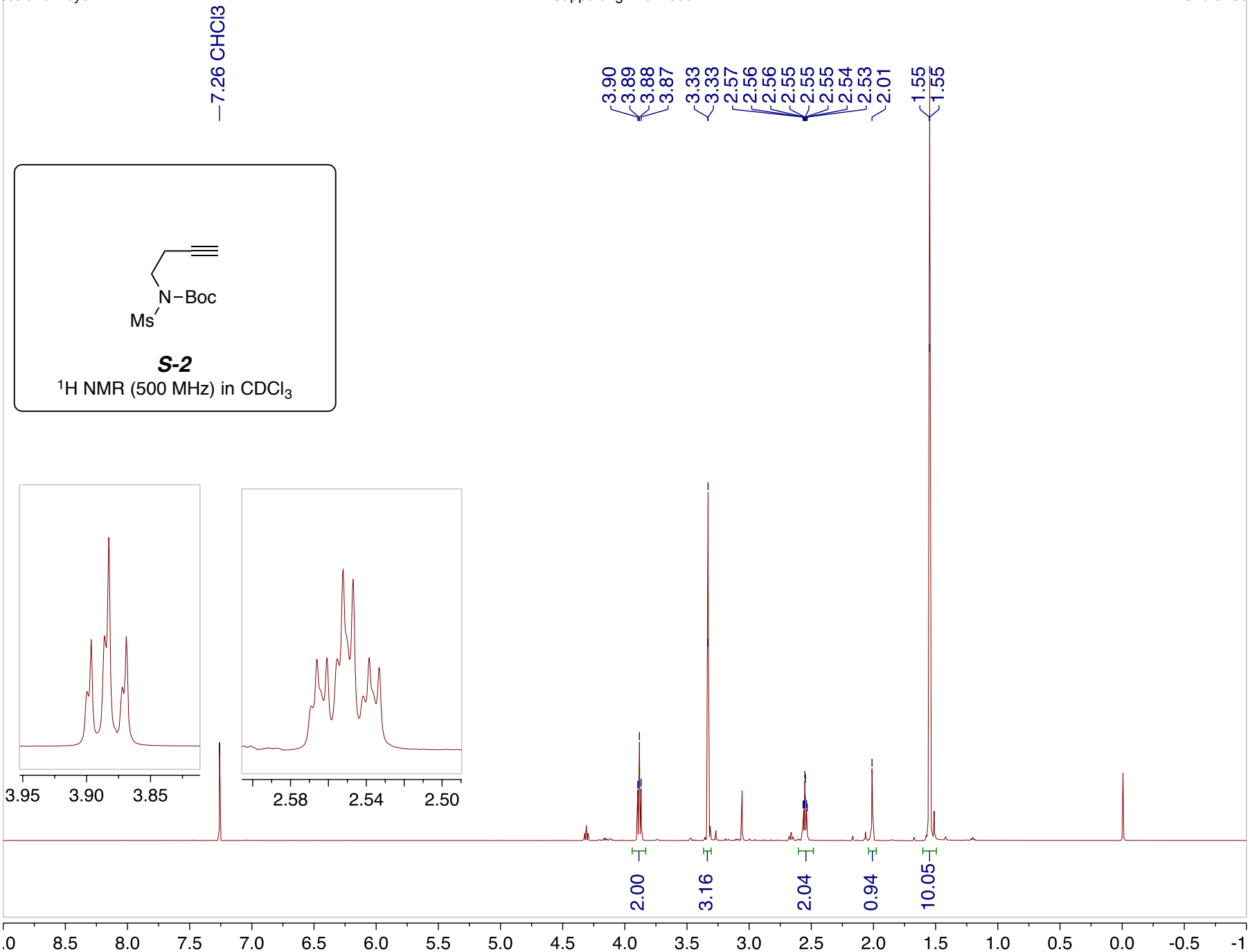
3 Ross, S. P.; Hoye, T. R. Reactions of hexadehydro-Diels-Alder benzynes with structurally complex multifunctional natural products. *Nature Chemistry* **2017**, *9*, 523–530.

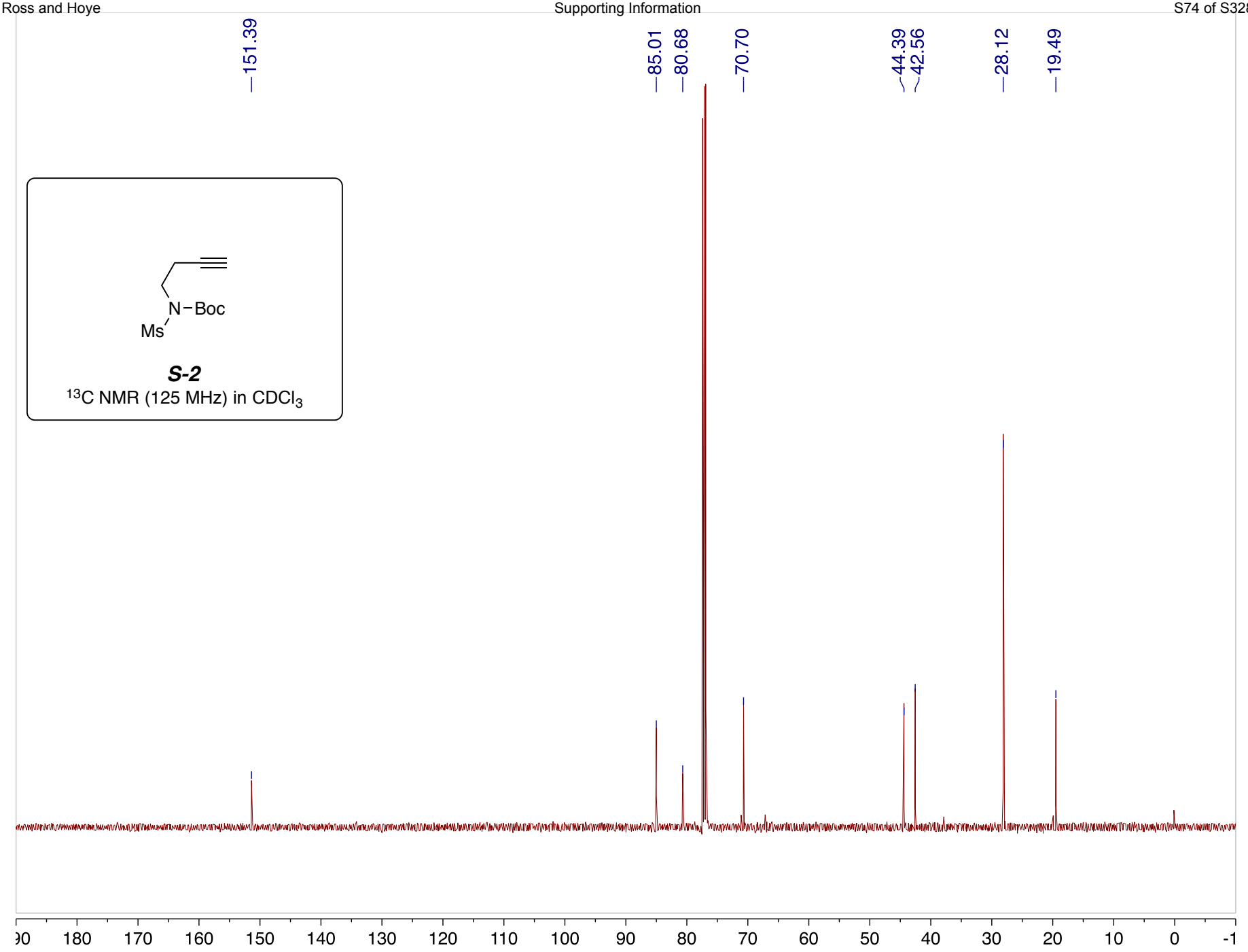
4 Chen, J.; Palani, V.; Hoye, T. R. Reactions of HDDA-Derived Benzynes with Sulfides: Mechanism, Modes, and Three-Component Reactions. *J. Am. Chem. Soc.* **2016**, *138*, 4318–4321.

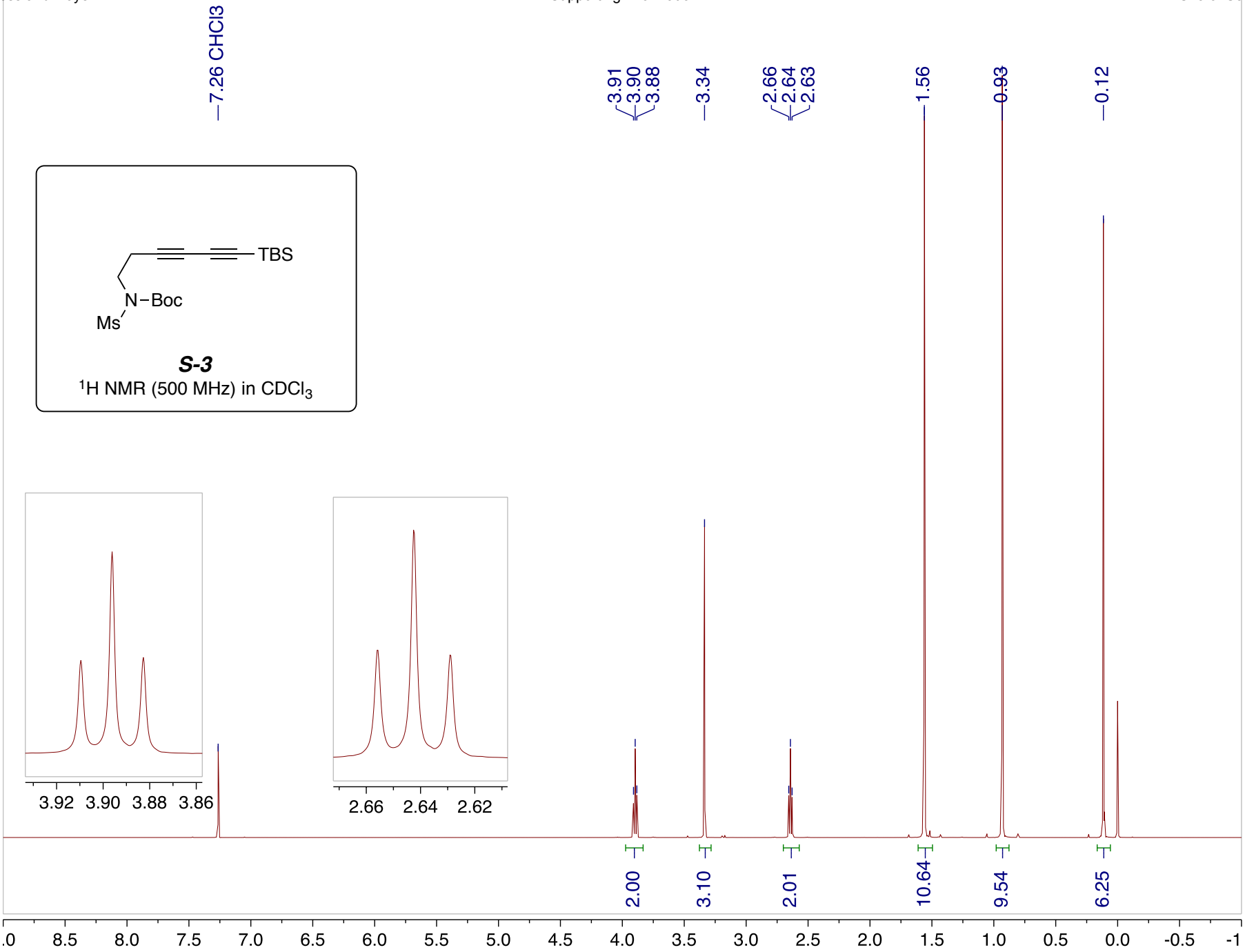
5 Stephens, D.; Zhang, Y.; Cormier, M.; Chavez, G.; Arman, H.; Larionov, O. V. Three-component reaction of small-ring cyclic amines with arynes and acetonitrile *Chem. Commun.* **2013**, *49*, 6558–6560.

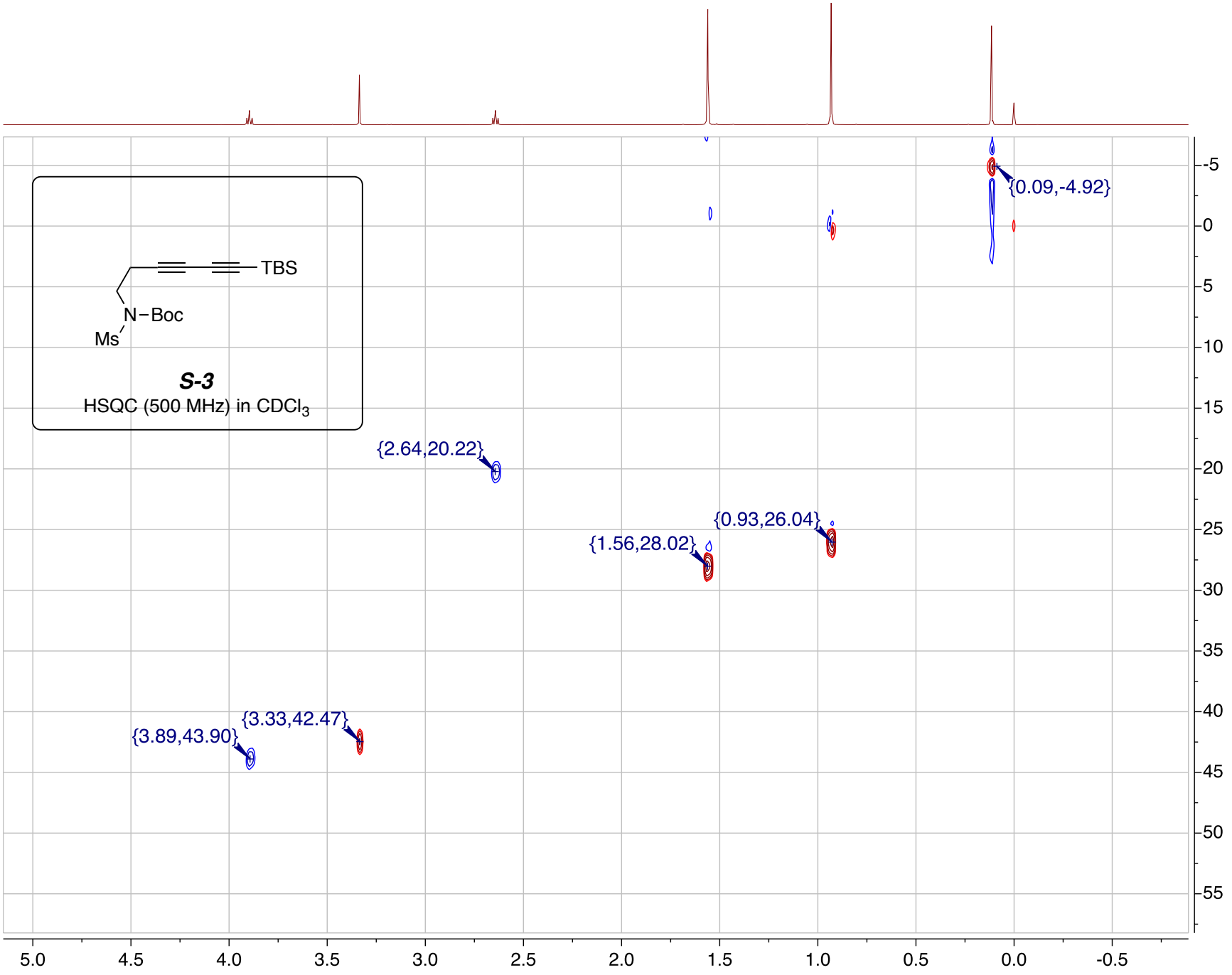
6 Ji, J.; Li, T.; Mortell, K.; Schimpf, M.; Nersesian, D.; Pan. L. Fused bicycloheterocycle substituted quinuclidine derivatives U.S. Patent 2005137204 A1, Jun 23, 2005.

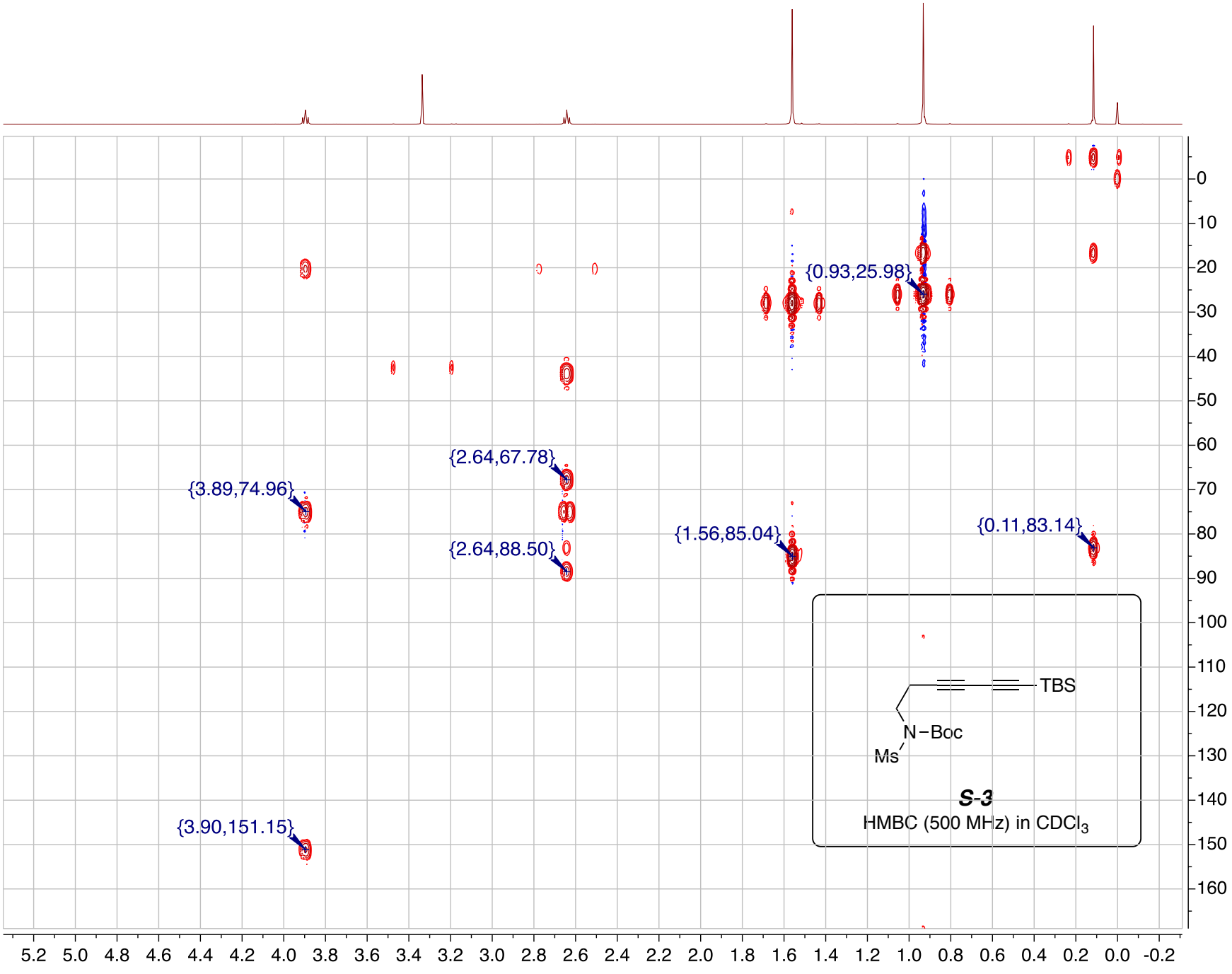
VI. Copies of NMR spectra

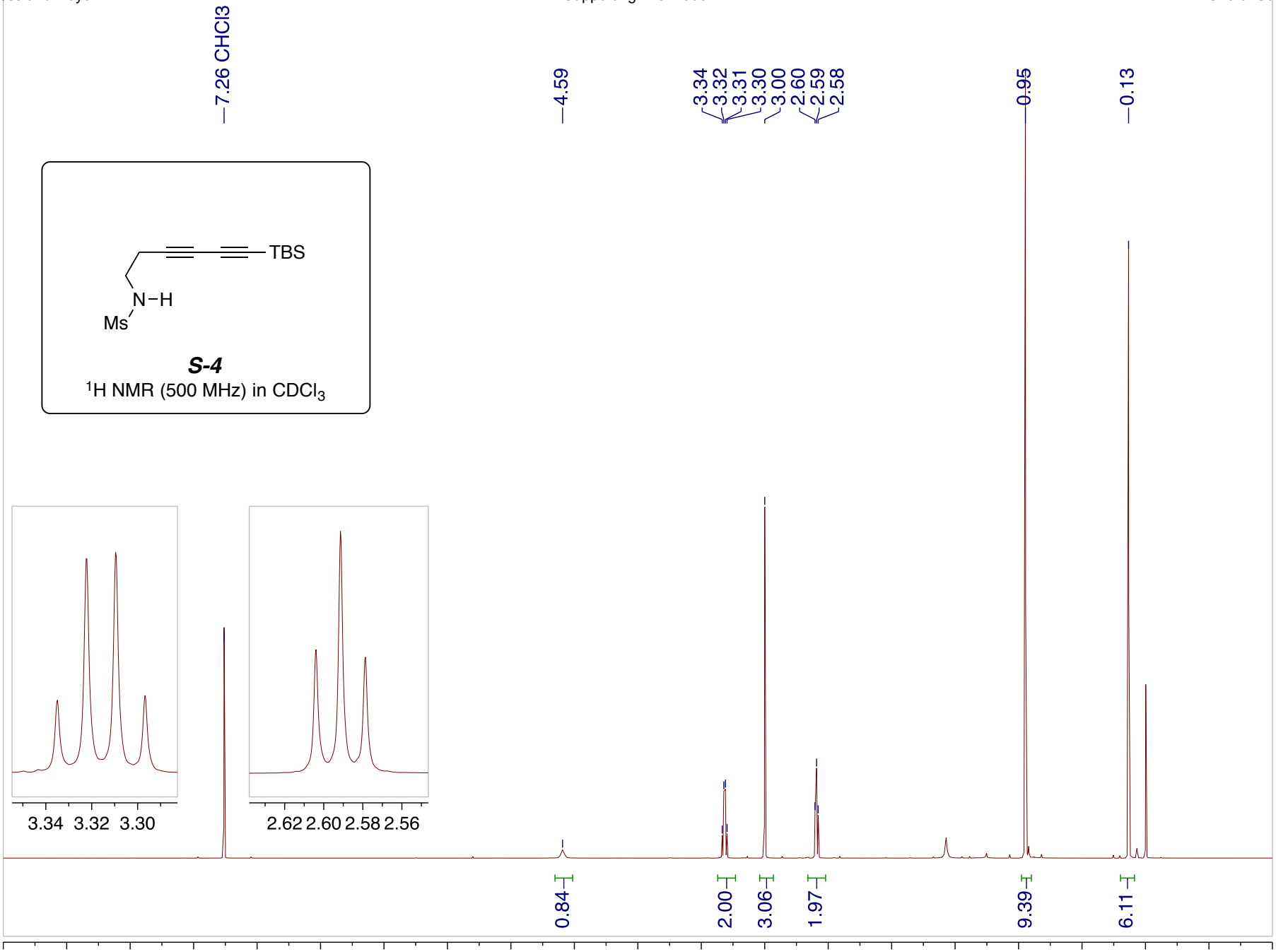

7.26 CHCl3
3.90
3.89
3.88
3.87
3.33
3.33
2.57
2.56
2.56
2.55
2.55
2.55
2.54
2.53
2.01
1.55
1.55
N−Boc
Ms
S-2
1H NMR (500 MHz) in CDCl3
3.95
3.90
3.85
2.58
2.54
2.50
2.00
3.16
2.04
0.94
10.05

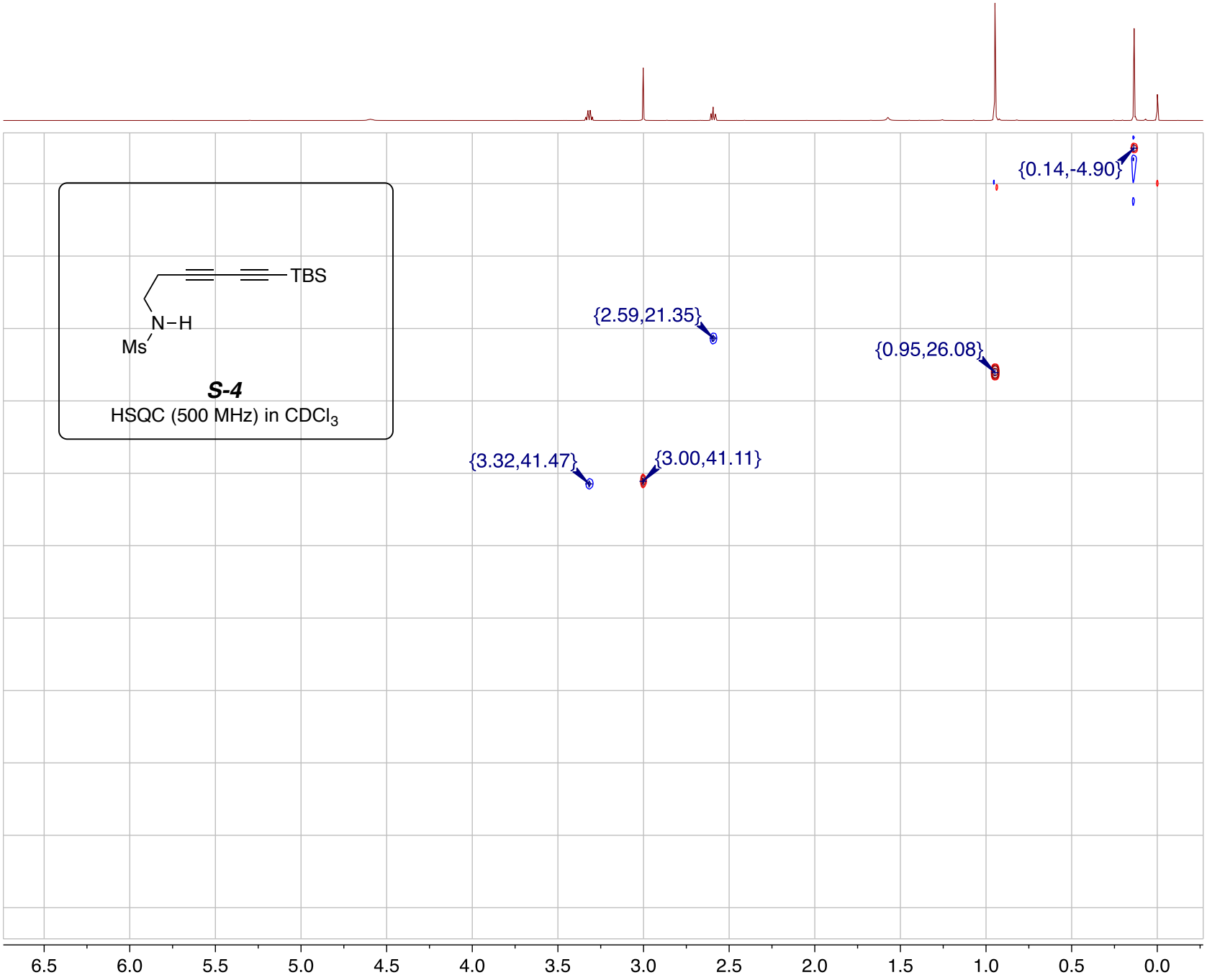

151.39
85.01
80.68
70.70
44.39
42.56
28.12
19.49
N−Boc
Ms
S-2
13C NMR (125 MHz) in CDCl3
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1

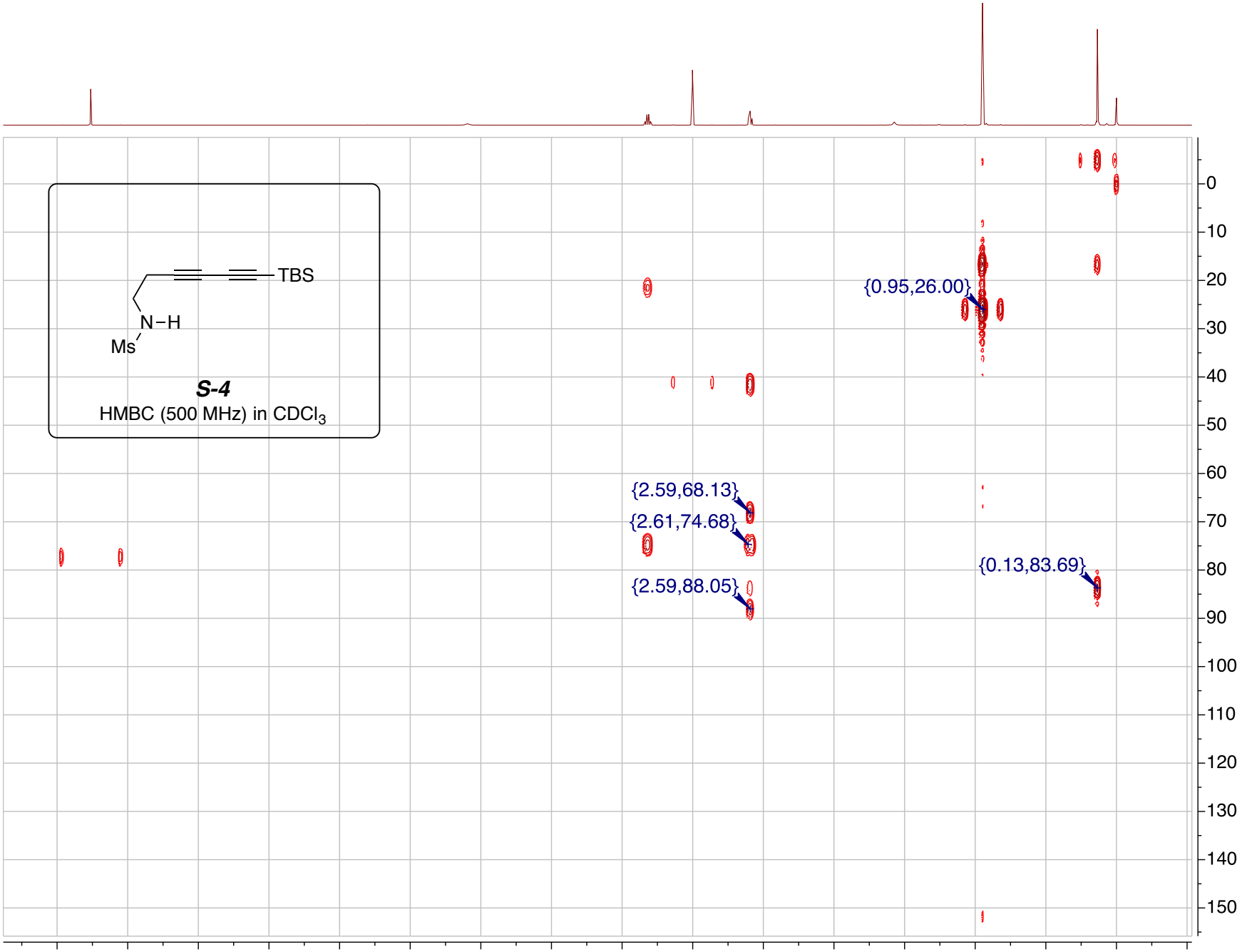

7.26 CHCl3
3.91
3.90
3.88
3.34
2.66
2.64
2.63
1.56
0.93
0.12
TBS
N−Boc
Ms
S-3
1H NMR (500 MHz) in CDCl3
3.92 3.90 3.88 3.86
2.66 2.64 2.62
2.00
3.10
2.01
10.64
9.54
6.25
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

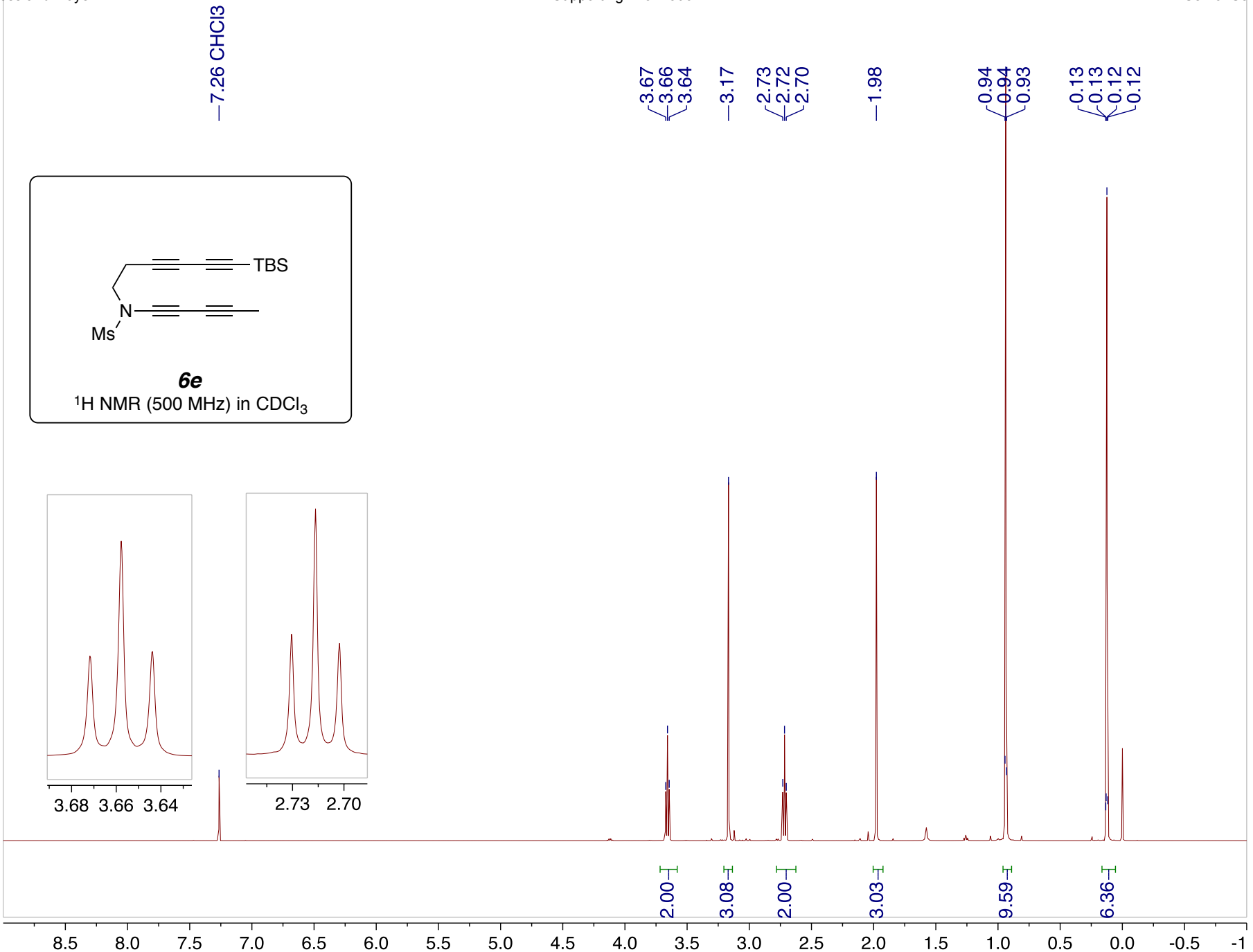

TBS
N−Boc
Ms
S-3
HSQC (500 MHz) in CDCl3
{0.09,-4.92}
{2.64,20.22}
{0.93,26.04}
{1.56,28.02}
{3.33,42.47}
{3.89,43.90}
-5
0
5
10
15
20
25
30
35
40
45
50
55
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

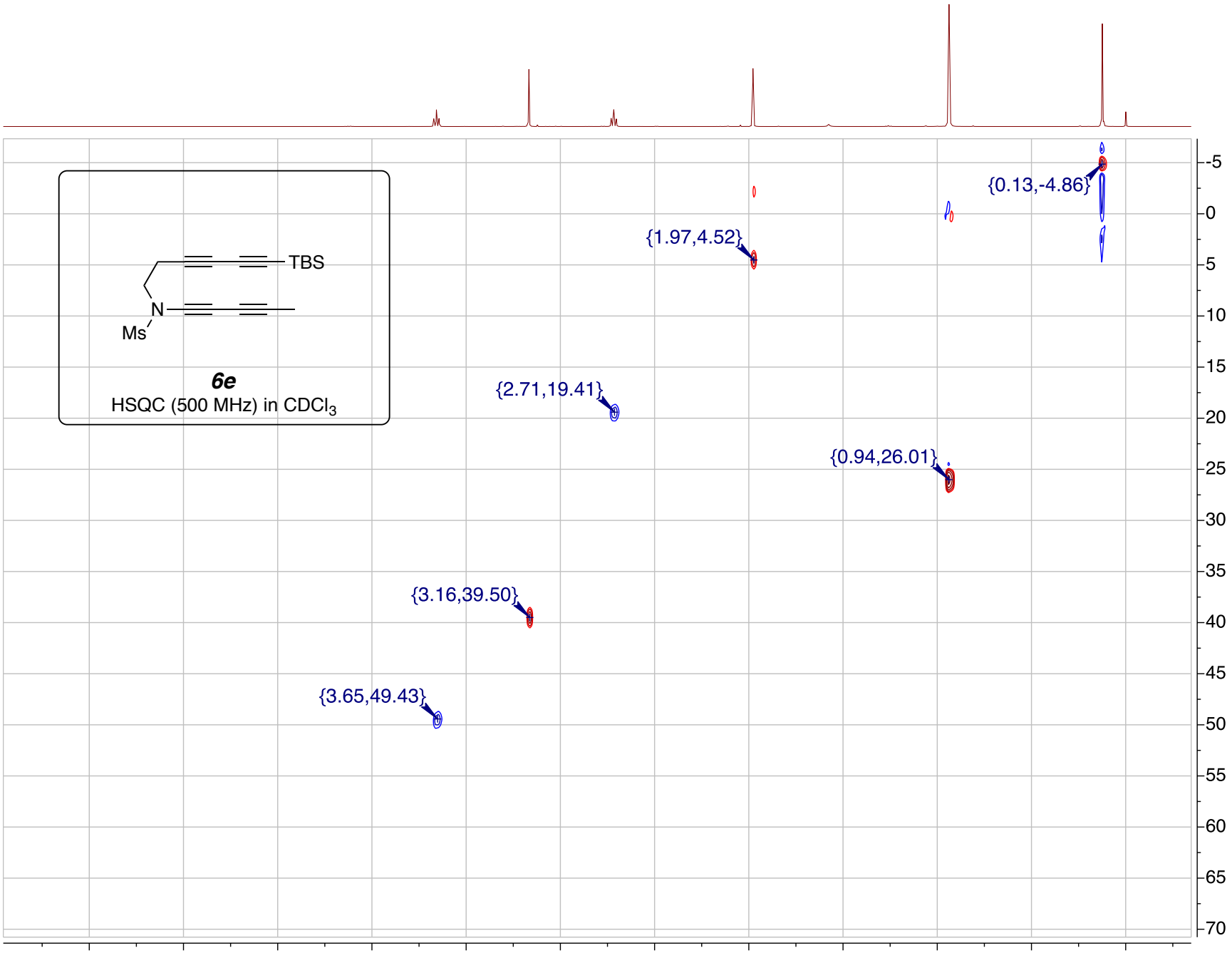

{0.93,25.98}
{2.64,67.78}
{3.89,74.96}
{2.64,88.50}
{1.56,85.04}
{0.11,83.14}
{3.90,151.15}
TBS
N−Boc
Ms
S-3
HMBC (500 MHz) in CDCl3


7.26 CHCl3
4.59
3.34
3.32
3.31
3.30
3.00
2.60
2.59
2.58
0.95
0.13
TBS
N−H
Ms
S-4
1H NMR (500 MHz) in CDCl3
3.34 3.32 3.30
2.62 2.60 2.58 2.56
0.84
2.00
3.06
1.97
9.39
6.11
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

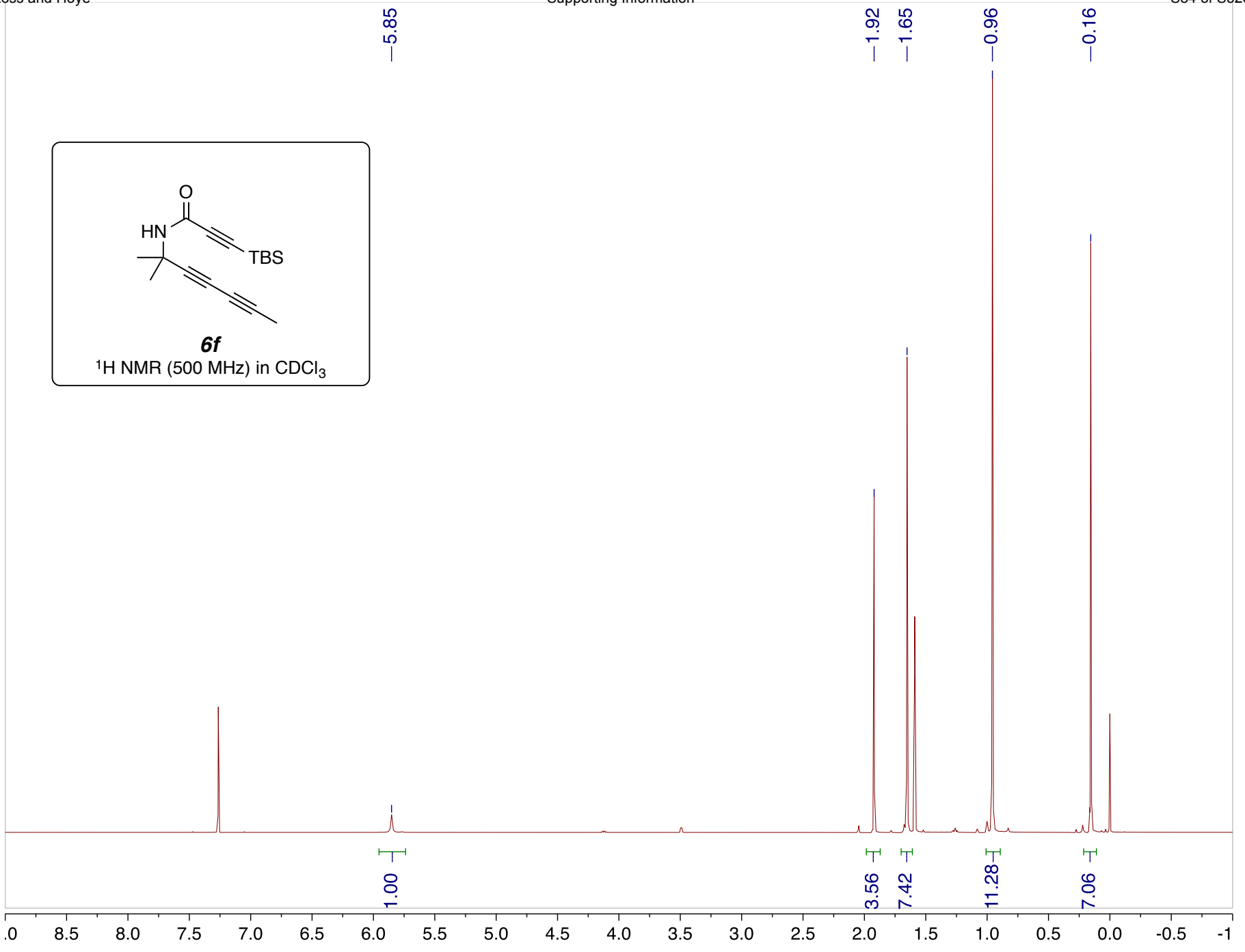

TBS
N−H
Ms
S-4
HSQC (500 MHz) in CDCl3
{0.14,-4.90}
{2.59,21.35}
{0.95,26.08}
{3.32,41.47}
{3.00,41.11}
0
10
20
30
40
50
60
70
80
90
100
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

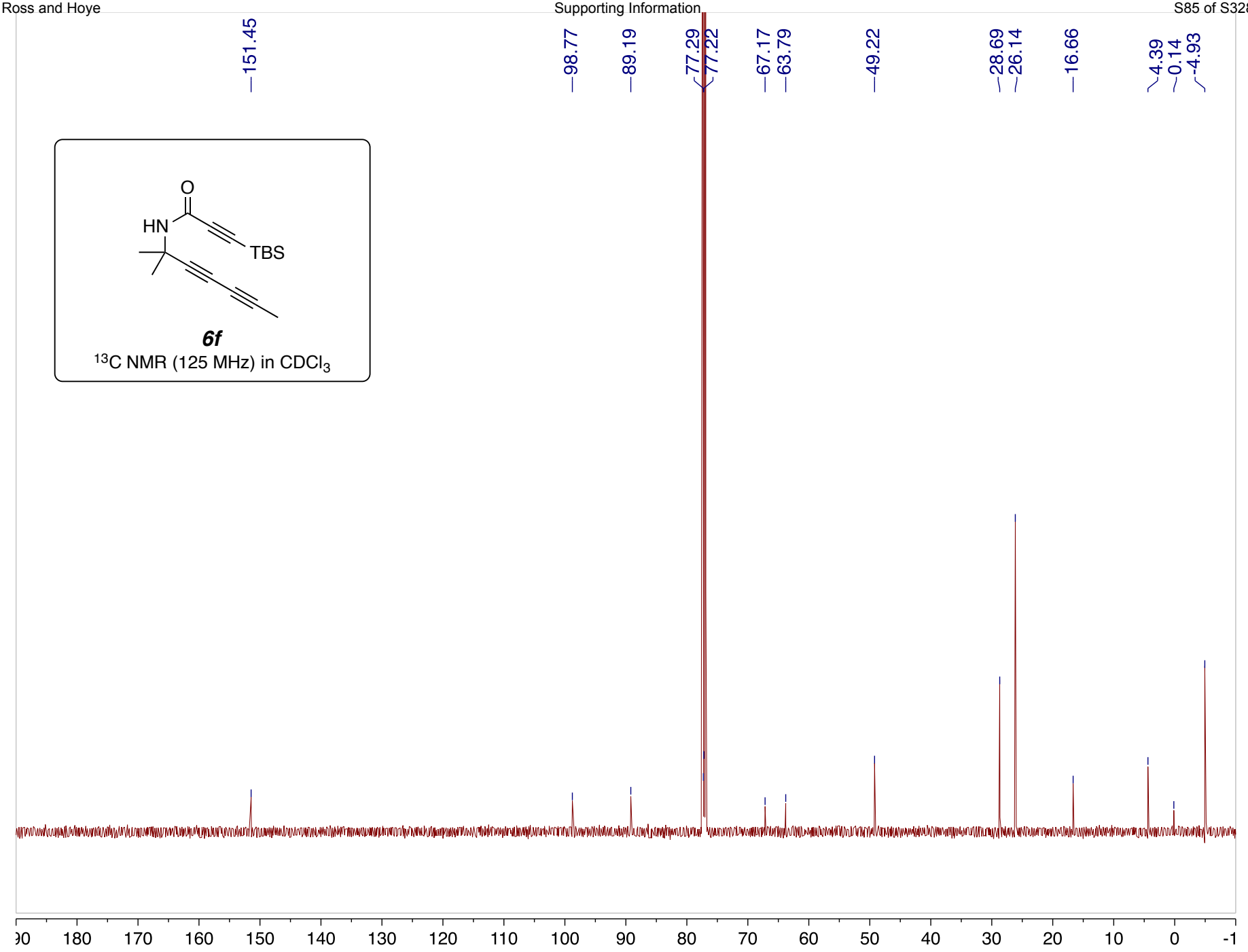

TBS
N–H
Ms
S-4
HMBC (500 MHz) in CDCl3
{0.95,26.00}
{2.59,68.13}
{2.61,74.68}
{2.59,88.05}
{0.13,83.69}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

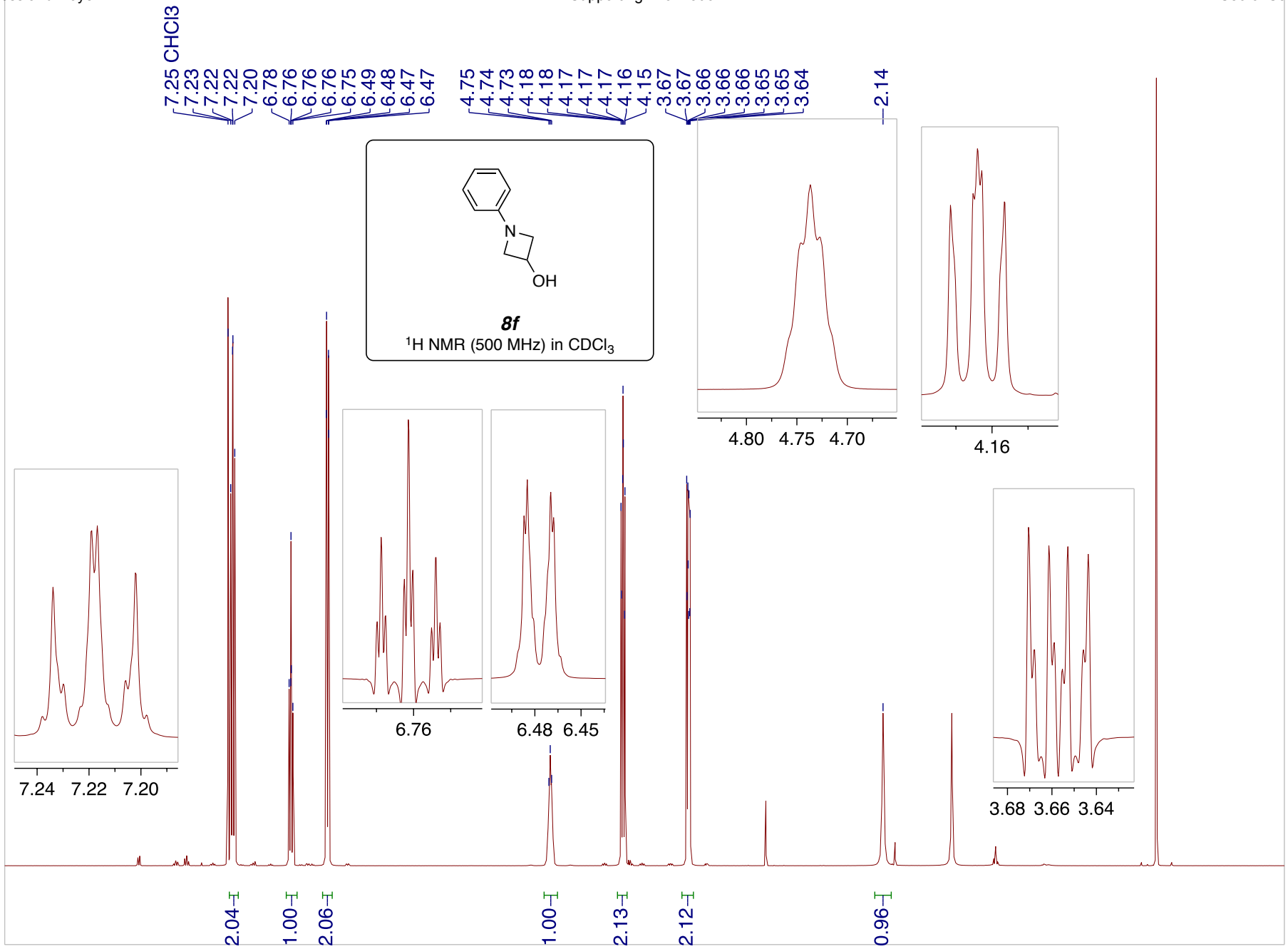

7.26 CHCl3
3.67
3.66
3.64
3.17
2.73
2.72
2.70
1.98
0.94
0.94
0.93
0.13
0.13
0.12
0.12
TBS
N
Ms
6e
1H NMR (500 MHz) in CDCl3
3.68 3.66 3.64
2.73 2.70
2.00
3.08
2.00
3.03
9.59
6.36
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1


TBS
N
Ms
6e
HSQC (500 MHz) in CDCl3
{0.13,-4.86}
{1.97,4.52}
{2.71,19.41}
{0.94,26.01}
{3.16,39.50}
{3.65,49.43}
-5
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

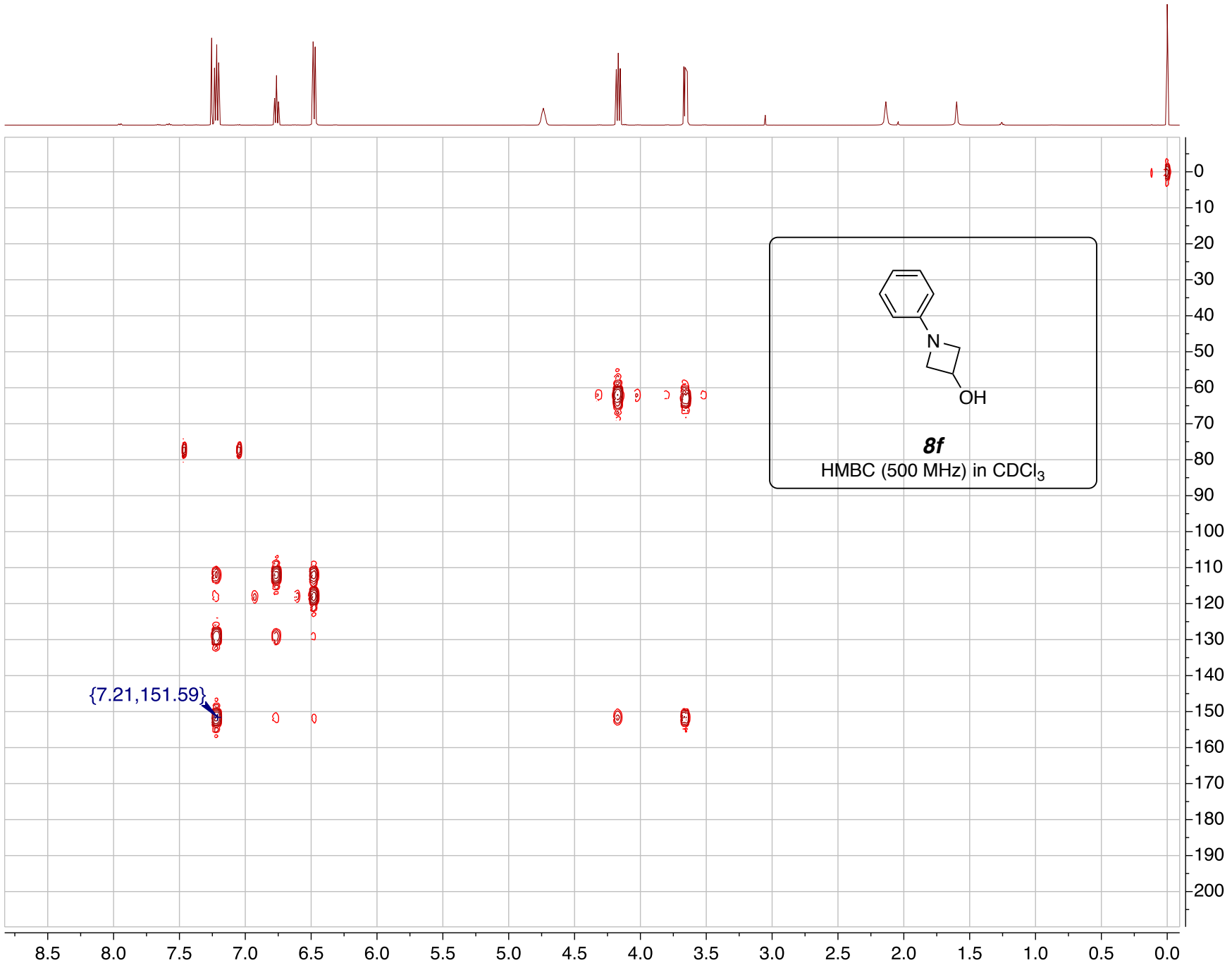

TBS
N
Ms
6e
HMBC (500 MHz) in CDCl3
{0.94,25.97}
{1.98,59.69}
{1.98,63.26}
{3.66,64.79}
{2.72,68.13}
{2.70,74.14}
{1.97,80.71}
{0.12,83.75}
{2.72,88.19}
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130

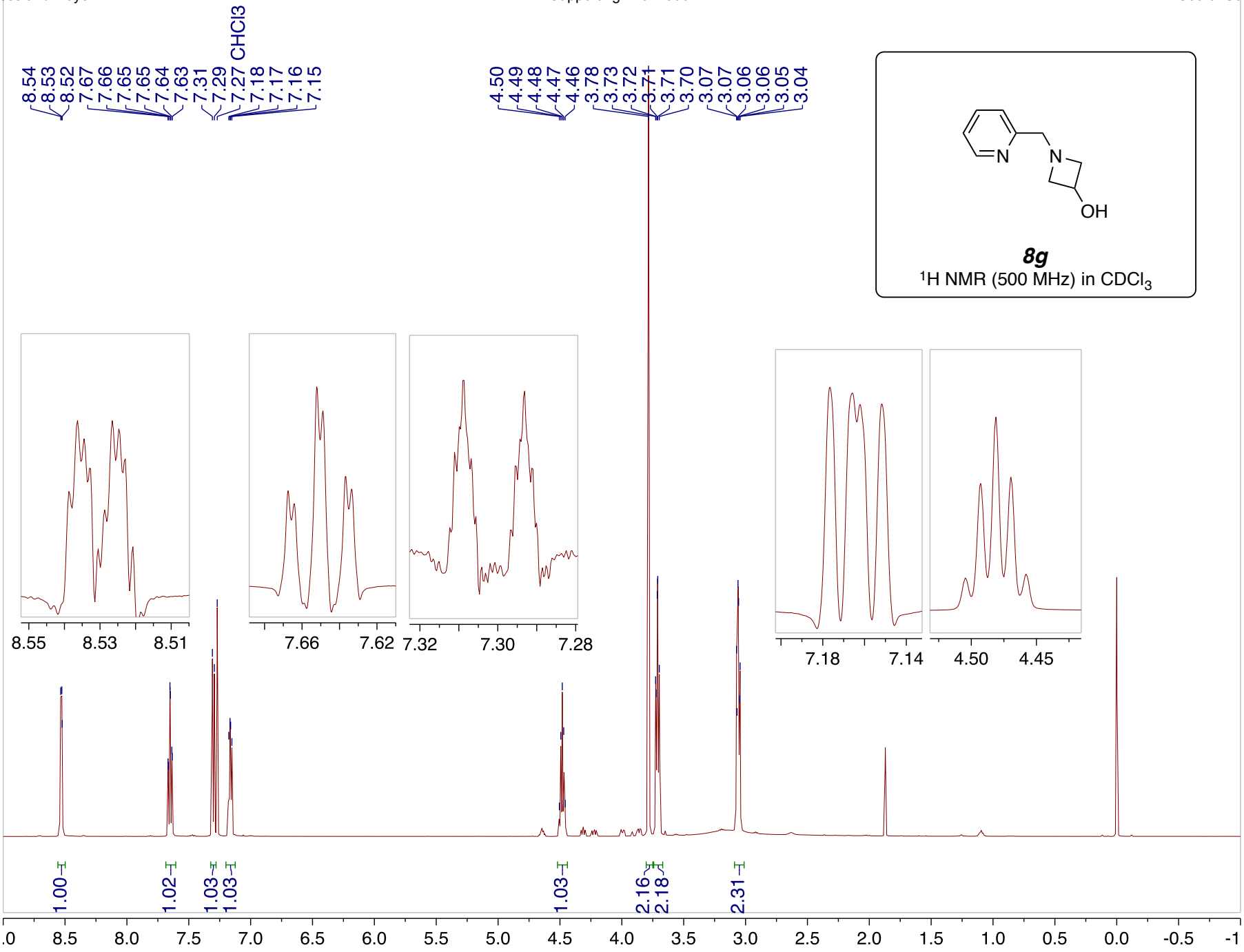

5.85
1.92
1.65
0.96
0.16
O
HN
TBS
6f
1H NMR (500 MHz) in CDCl3
1.00
3.56
7.42
11.28
7.06
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1


151.45
98.77
89.19
77.29
77.22
67.17
63.79
49.22
28.69
26.14
16.66
4.39
0.14
-4.93
O
HN
TBS
6f
13C NMR (125 MHz) in CDCl3
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1

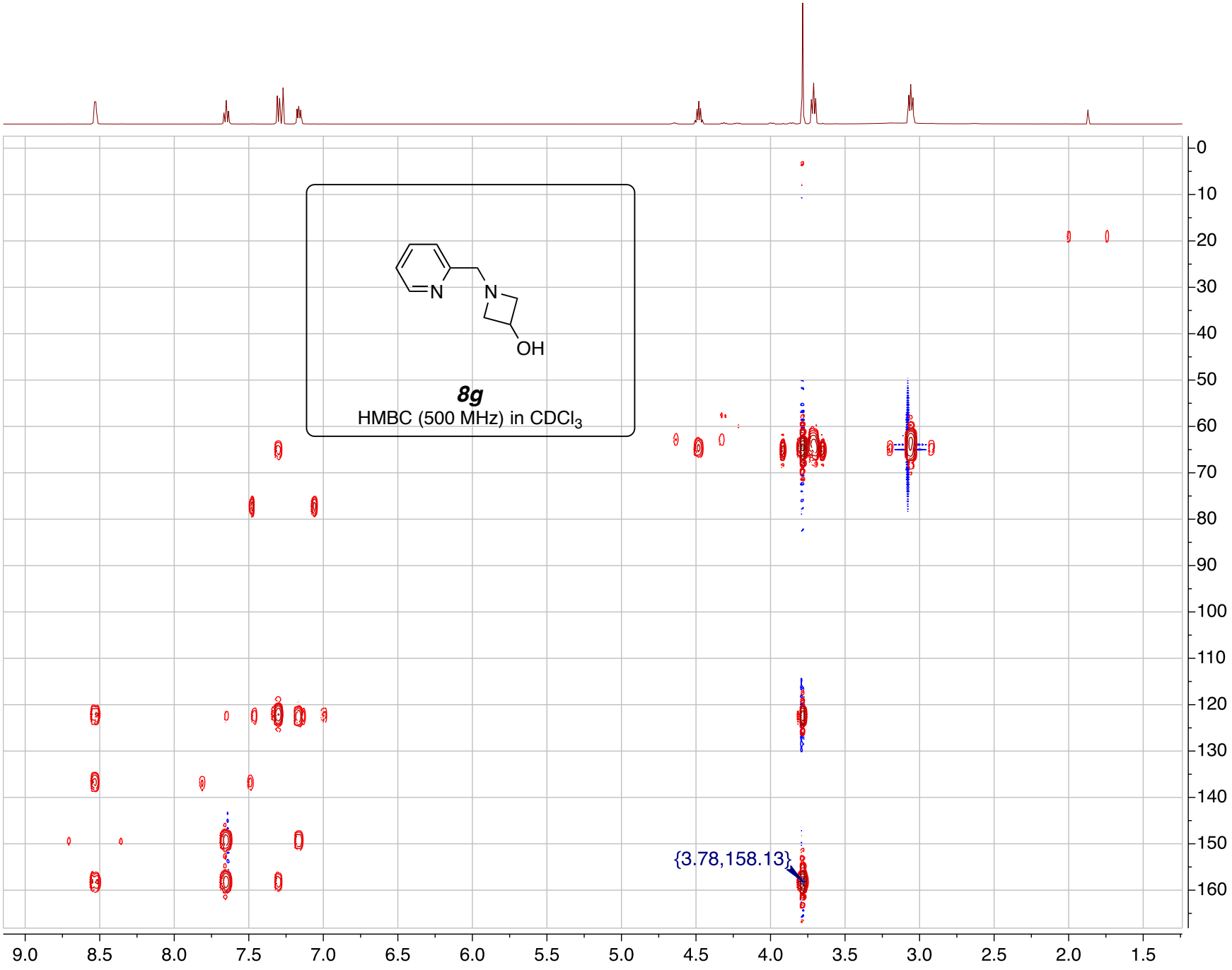

7.25 CHCl3
7.23
7.22
7.22
7.20
6.78
6.76
6.76
6.76
6.75
6.49
6.48
6.47
6.47
4.75
4.74
4.73
4.18
4.18
4.17
4.17
4.17
4.16
4.15
3.67
3.67
3.66
3.66
3.66
3.65
3.65
3.64
2.14
N
OH
8f
1H NMR (500 MHz) in CDCl3
4.80 4.75 4.70
4.16
7.24 7.22 7.20
6.76
6.48 6.45
3.68 3.66 3.64
2.04
1.00
2.06
1.00
2.13
2.12
0.96
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

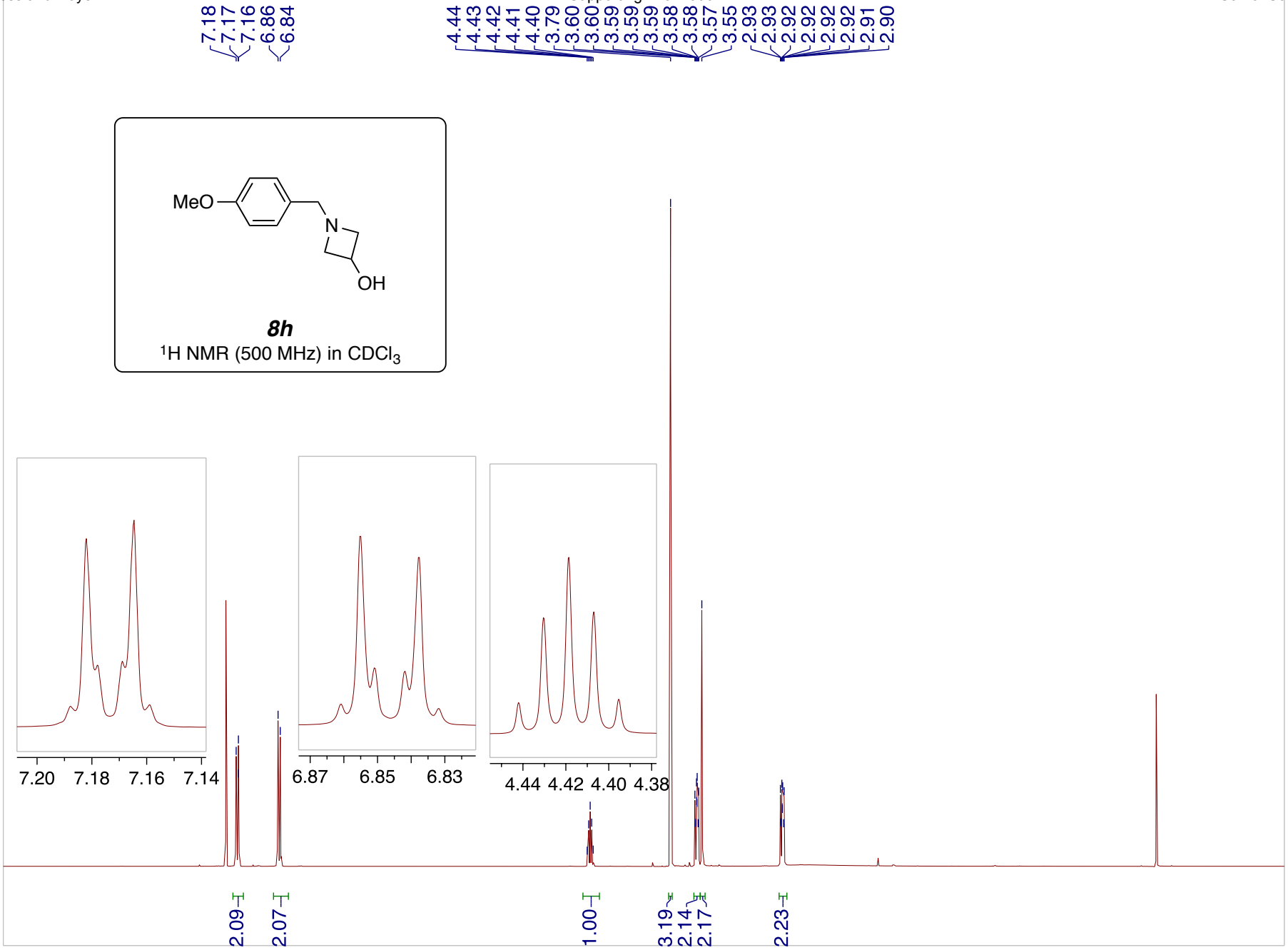

N
OH
8f
HSQC (500 MHz) in CDCl3
{4.74,62.84}
{4.17,61.92}
{6.48,111.95}
{6.76,117.88}
{7.22,128.99}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

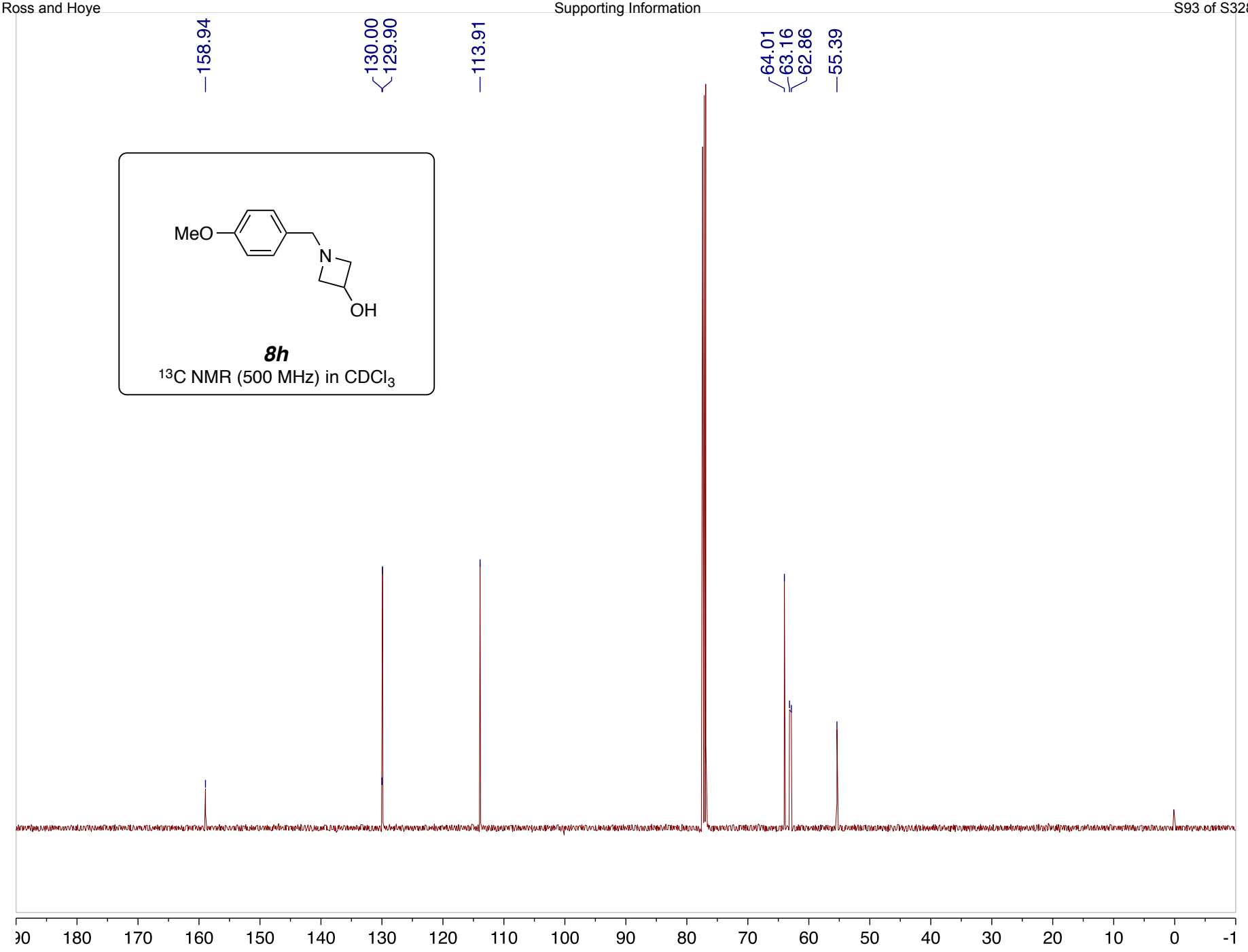

N
OH
8f
HMBC (500 MHz) in CDCl3
{7.21,151.59}
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200

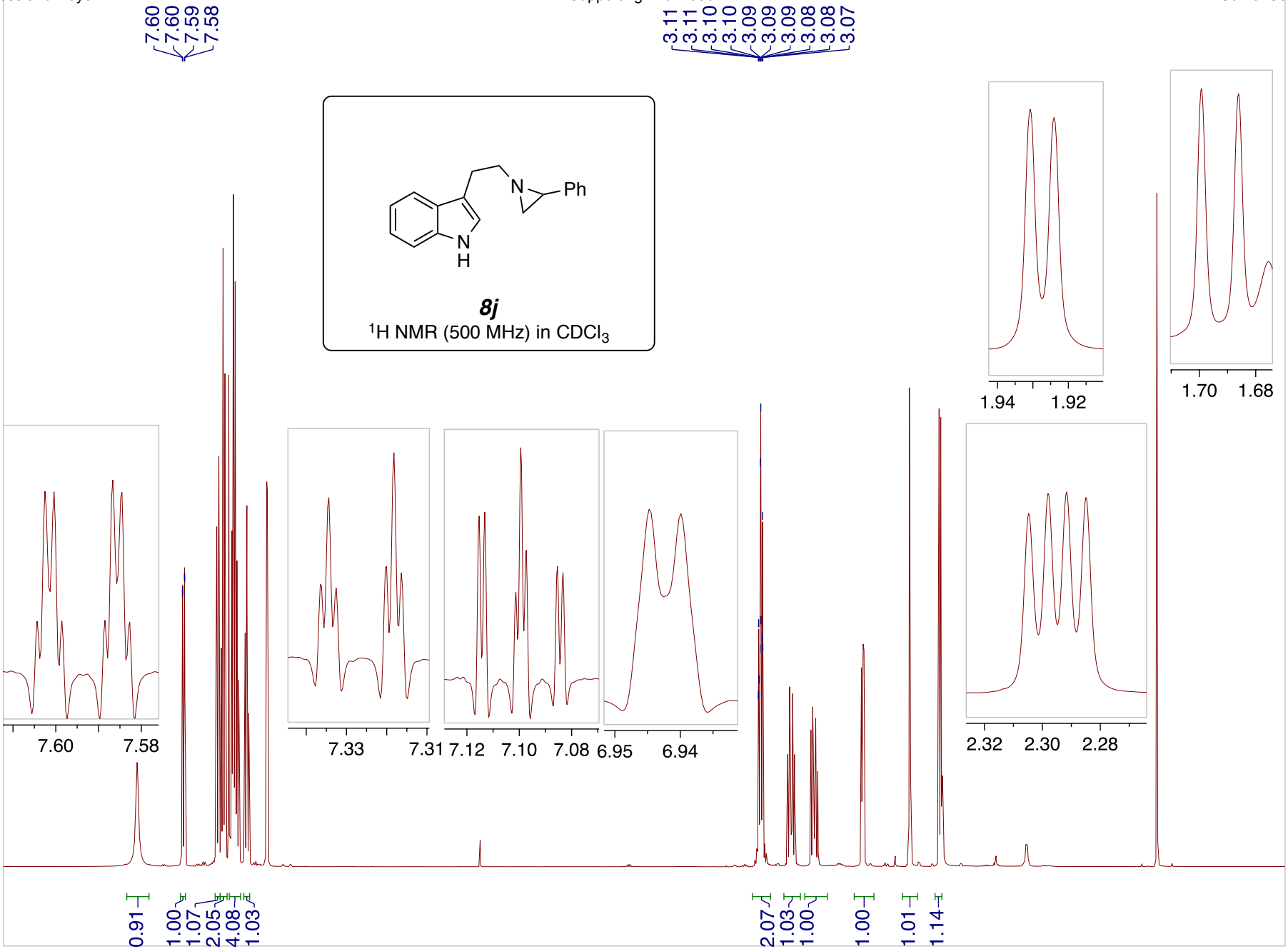

8.54
8.53
8.52
7.67
7.66
7.65
7.65
7.64
7.63
7.31
7.29
CHCl3
7.27
7.18
7.17
7.16
7.15
4.50
4.49
4.48
4.47
4.46
3.78
3.73
3.72
3.71
3.71
3.70
3.07
3.07
3.06
3.06
3.05
3.04
N
N
OH
8g
1H NMR (500 MHz) in CDCl3
8.55
8.53
8.51
7.66
7.62
7.32
7.30
7.28
7.18
7.14
4.50
4.45
1.00
1.02
1.03
1.03
1.03
2.16
2.18
2.31
.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1

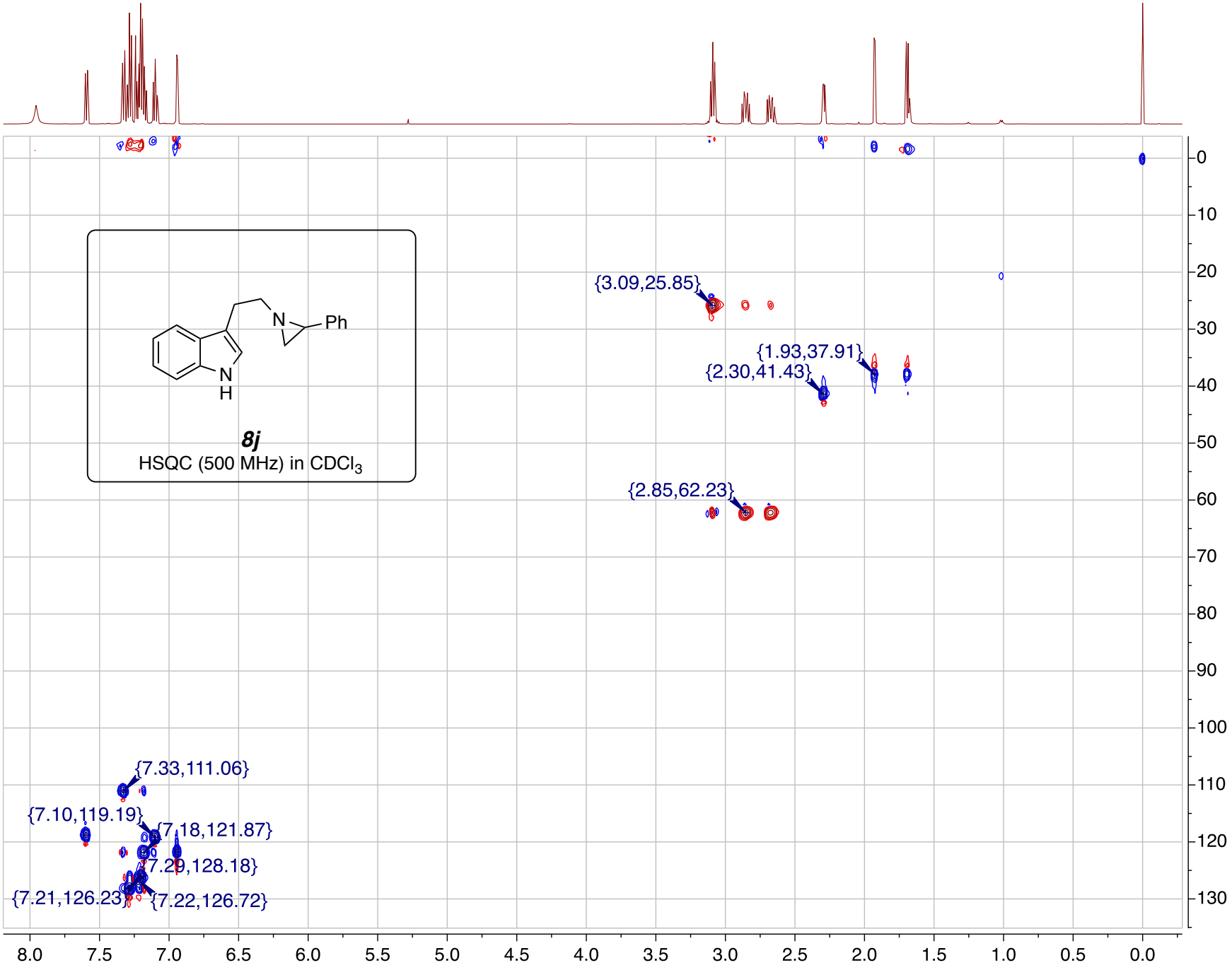

N
N
OH
8g
HSQC (500 MHz) in CDCl3
{3.78,65.06}
{4.48,63.21}
{3.06,64.57}
{7.30,122.42}
{7.16,122.05}
{7.65,136.68}
{8.53,149.19}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

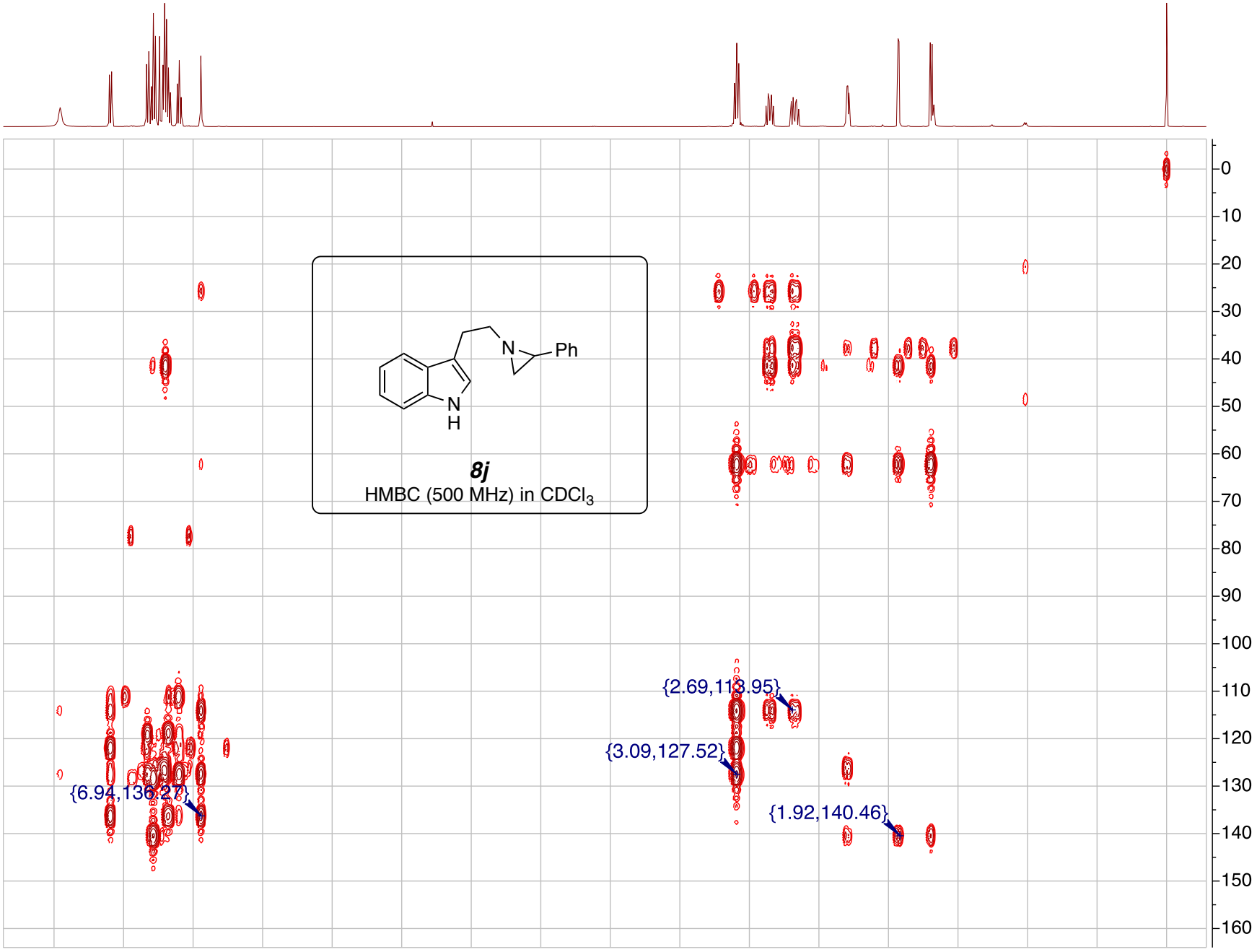

N
N
OH
8g
HMBC (500 MHz) in CDCl3
{3.78,158.13}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5

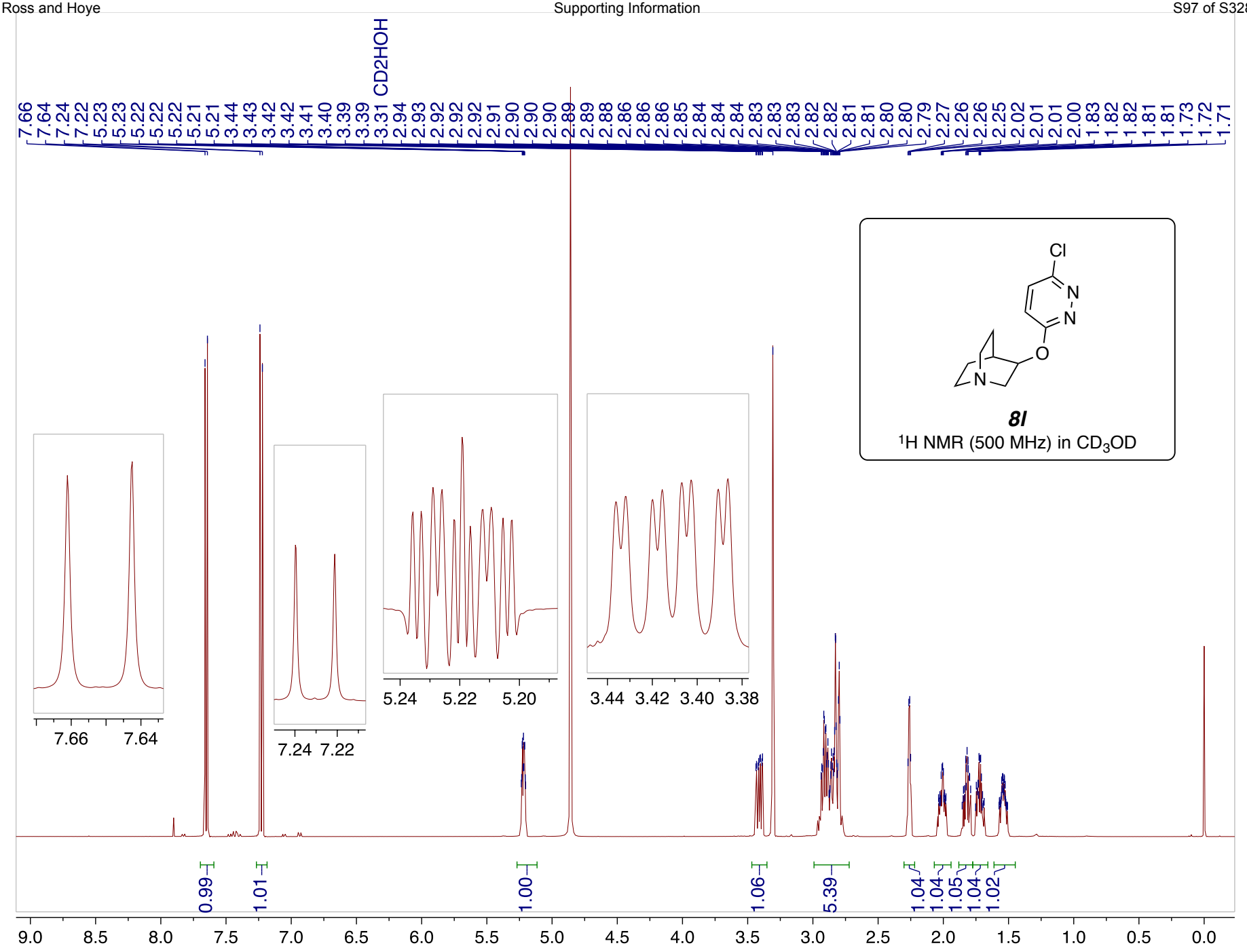

7.18
7.17
7.16
6.86
6.84
4.44
4.43
4.42
4.41
4.40
3.79
3.60
3.60
3.59
3.59
3.59
3.58
3.58
3.57
3.55
2.93
2.93
2.92
2.92
2.92
2.92
2.91
2.90
MeO
N
OH
8h
1H NMR (500 MHz) in CDCl3
7.20 7.18 7.16 7.14
6.87 6.85 6.83
4.44 4.42 4.40 4.38
2.09
2.07
1.00
3.19
2.14
2.17
2.23
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

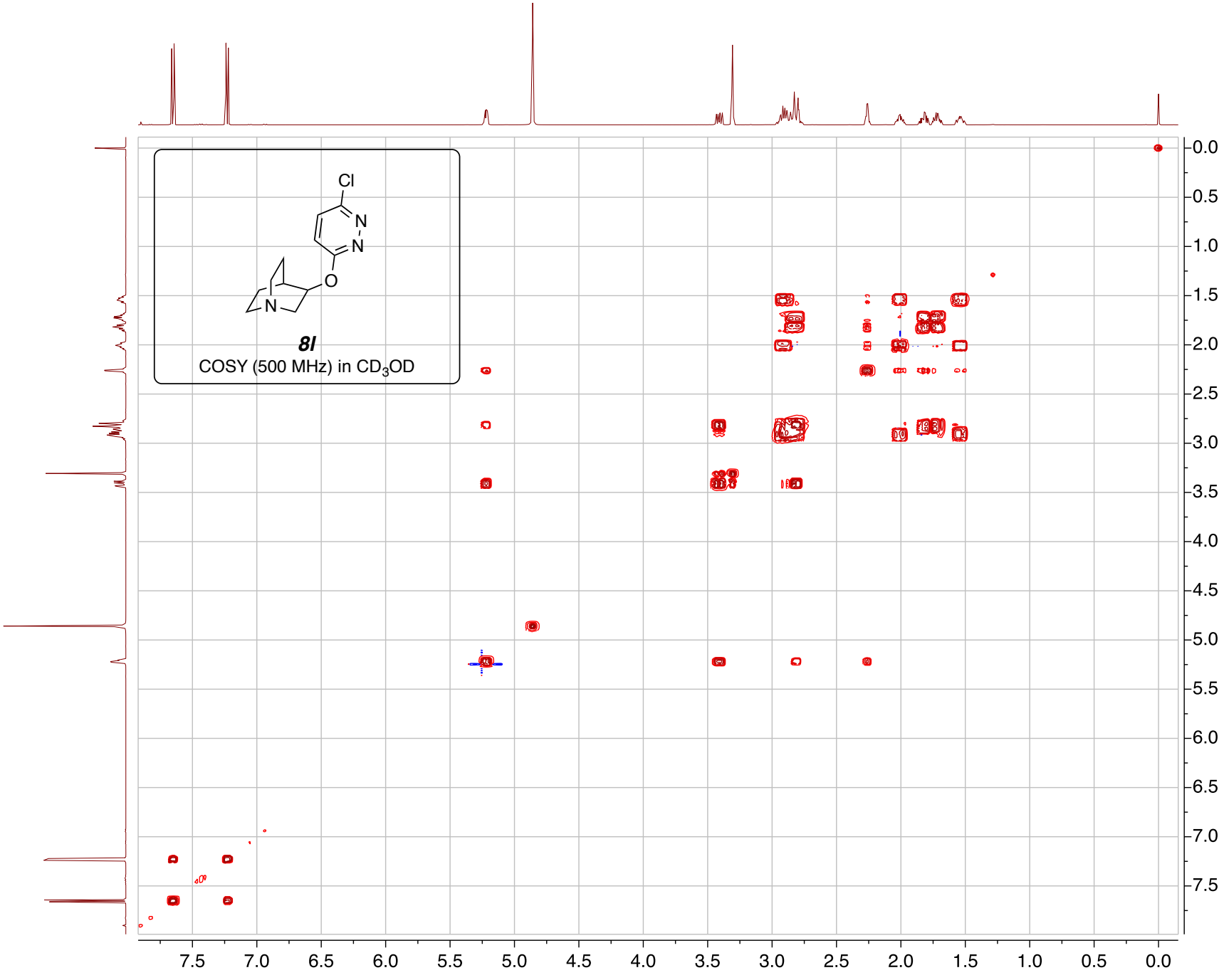

158.94
130.00
129.90
113.91
64.01
63.16
62.86
55.39
MeO
N
OH
8h
13C NMR (500 MHz) in CDCl3
90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1

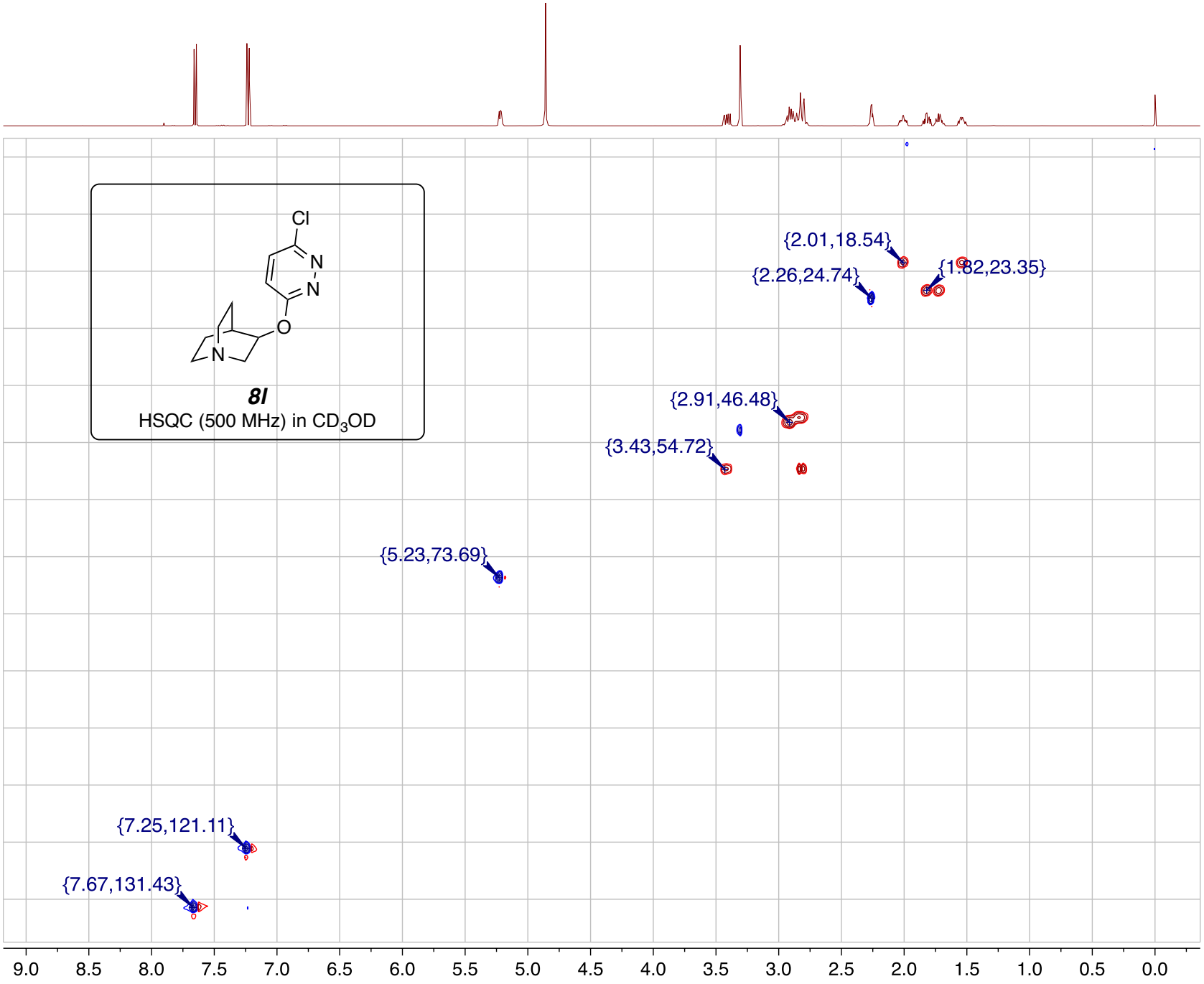

7.60
7.60
7.59
7.58
3.11
3.11
3.10
3.10
3.09
3.09
3.09
3.08
3.08
3.07
N
Ph
N
H
8j
1H NMR (500 MHz) in CDCl3
1.94
1.92
1.70
1.68
7.60
7.58
7.33
7.31
7.12
7.10
7.08
6.95
6.94
2.32
2.30
2.28
0.91
1.00
1.07
2.05
4.08
1.03
2.07
1.03
1.00
1.00
1.01
1.14
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1

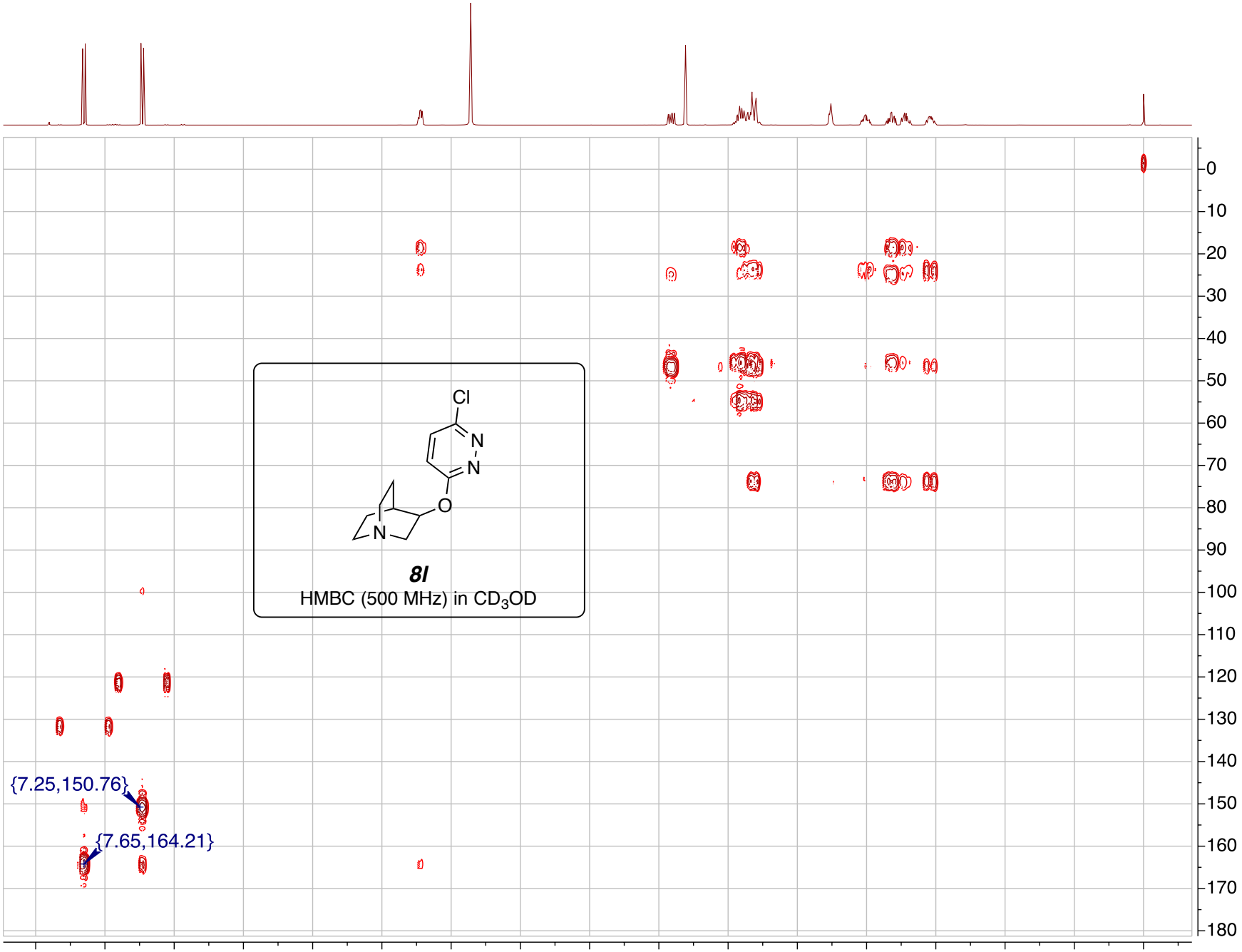

N
Ph
N
H
8j
HSQC (500 MHz) in CDCl3
{3.09,25.85}
{1.93,37.91}
{2.30,41.43}
{2.85,62.23}
{7.33,111.06}
{7.10,119.19}
{7.18,121.87}
{7.29,128.18}
{7.21,126.23}
{7.22,126.72}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

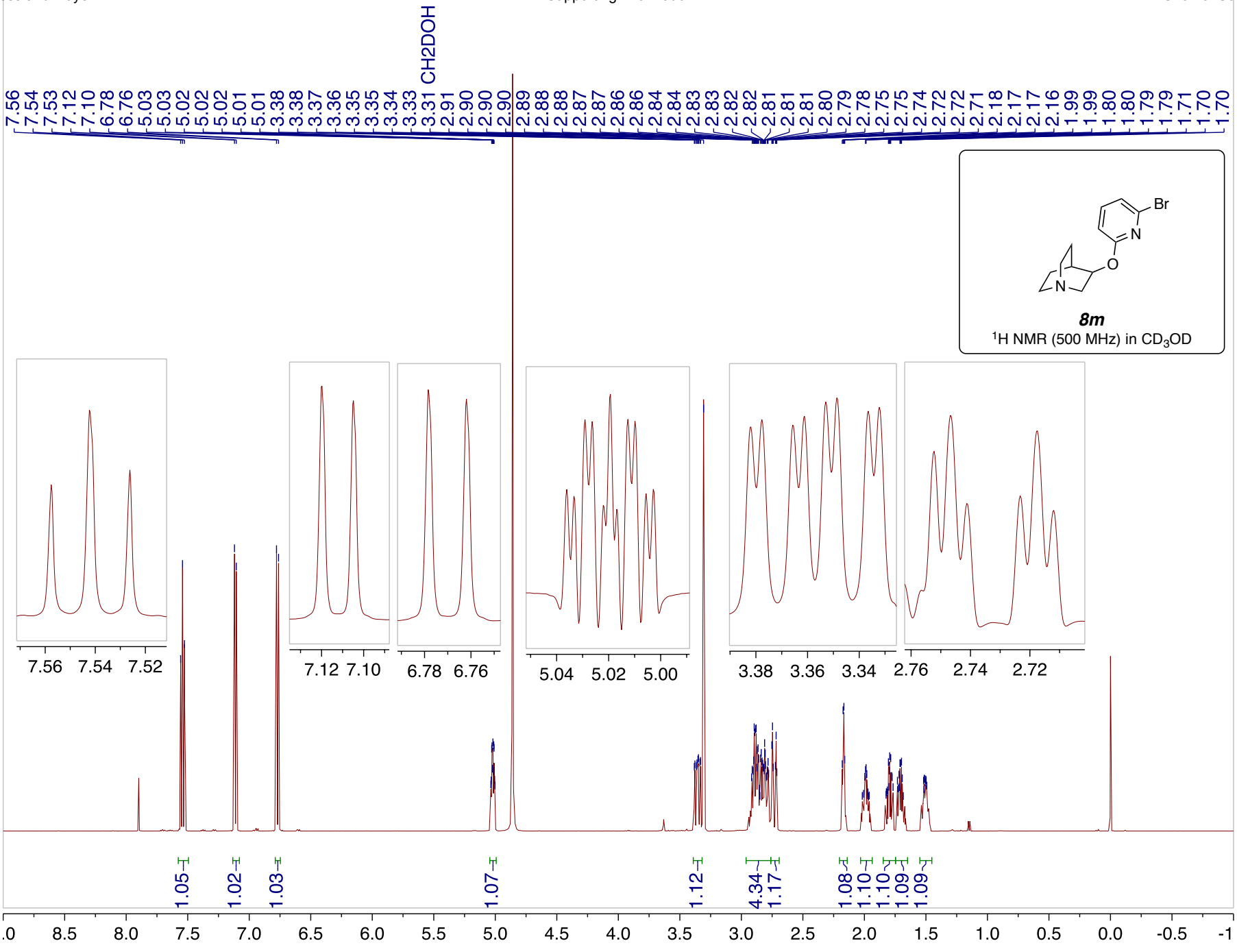

N
Ph
N
H
8j
HMBC (500 MHz) in CDCl3
{6.94,136.27}
{2.69,113.95}
{3.09,127.52}
{1.92,140.46}
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160

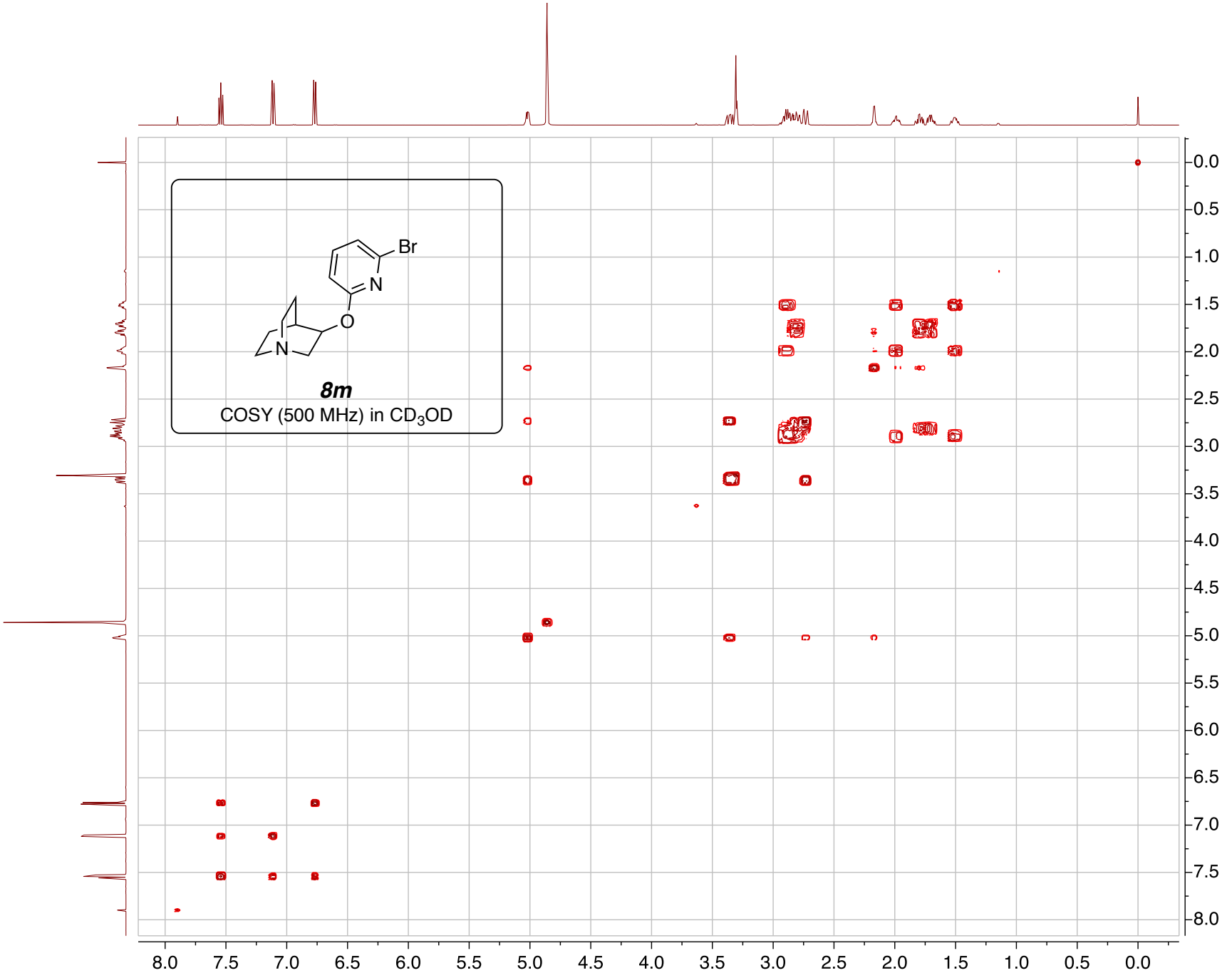

CD2HOH
7.66 7.64 7.24 7.22 5.23 5.23 5.22 5.22 5.22 5.21 5.21 3.44 3.43 3.42 3.42 3.41 3.40 3.39 3.39 3.31 2.94 2.93 2.92 2.92 2.92 2.91 2.90 2.90 2.90 2.89 2.89 2.88 2.86 2.86 2.86 2.85 2.84 2.84 2.84 2.83 2.83 2.83 2.82 2.82 2.81 2.81 2.80 2.80 2.79 2.27 2.26 2.26 2.25 2.02 2.01 2.01 2.00 1.83 1.82 1.82 1.81 1.81 1.73 1.72 1.71
Cl
N
N
O
N
8l
1H NMR (500 MHz) in CD3OD
7.66 7.64
7.24 7.22
5.24 5.22 5.20
3.44 3.42 3.40 3.38
0.99 1.01 1.00 1.06 5.39 1.04 1.04 1.05 1.04 1.02
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0


Cl
N
N
O
N
8l
COSY (500 MHz) in CD3OD
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

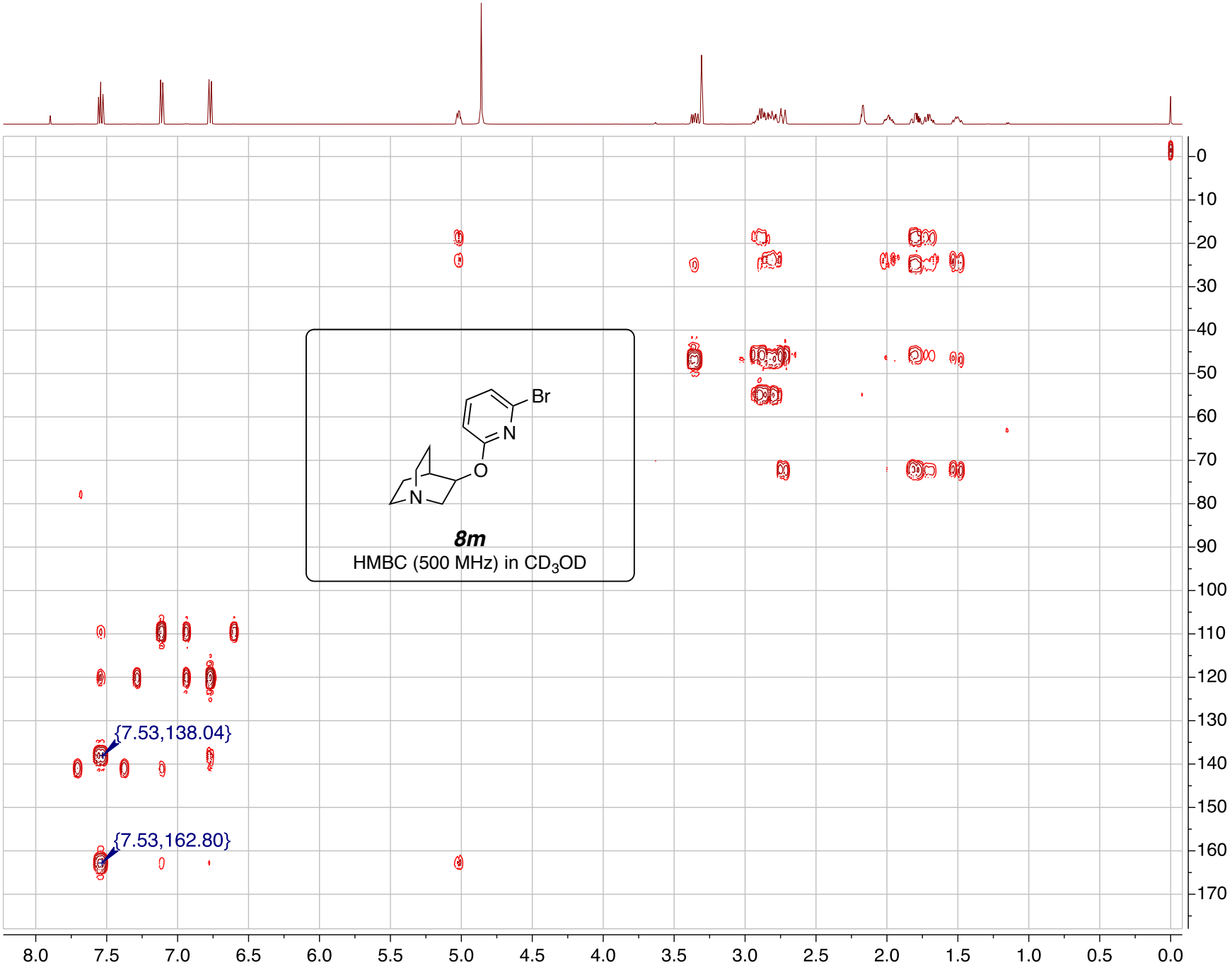

Cl
N
N
O
N
8l
HSQC (500 MHz) in CD3OD
{2.01,18.54}
{2.26,24.74}
{1.82,23.35}
{2.91,46.48}
{3.43,54.72}
{5.23,73.69}
{7.25,121.11}
{7.67,131.43}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

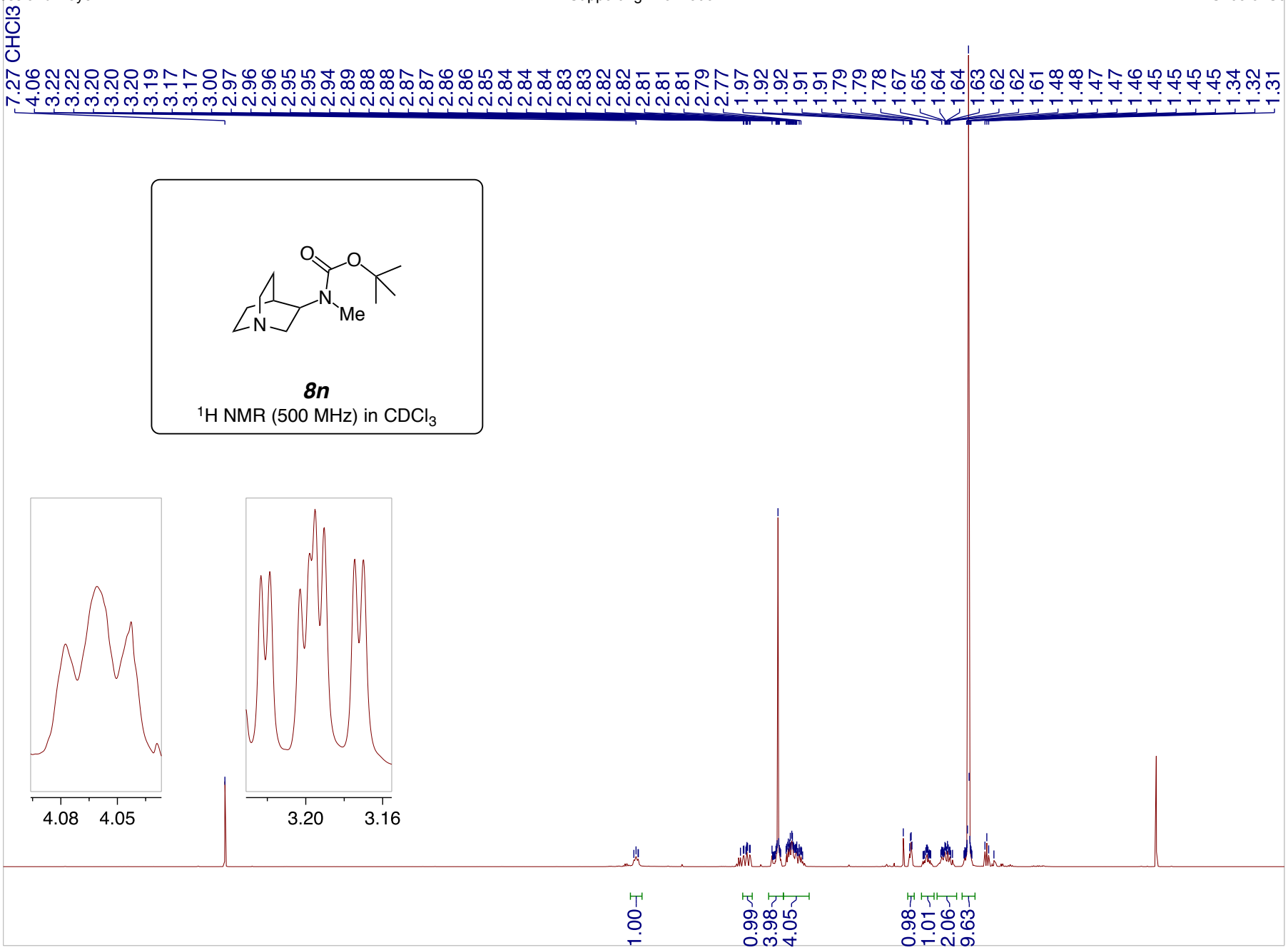

Cl
N
N
O
N
8l
HMBC (500 MHz) in CD3OD
{7.25,150.76}
{7.65,164.21}
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180

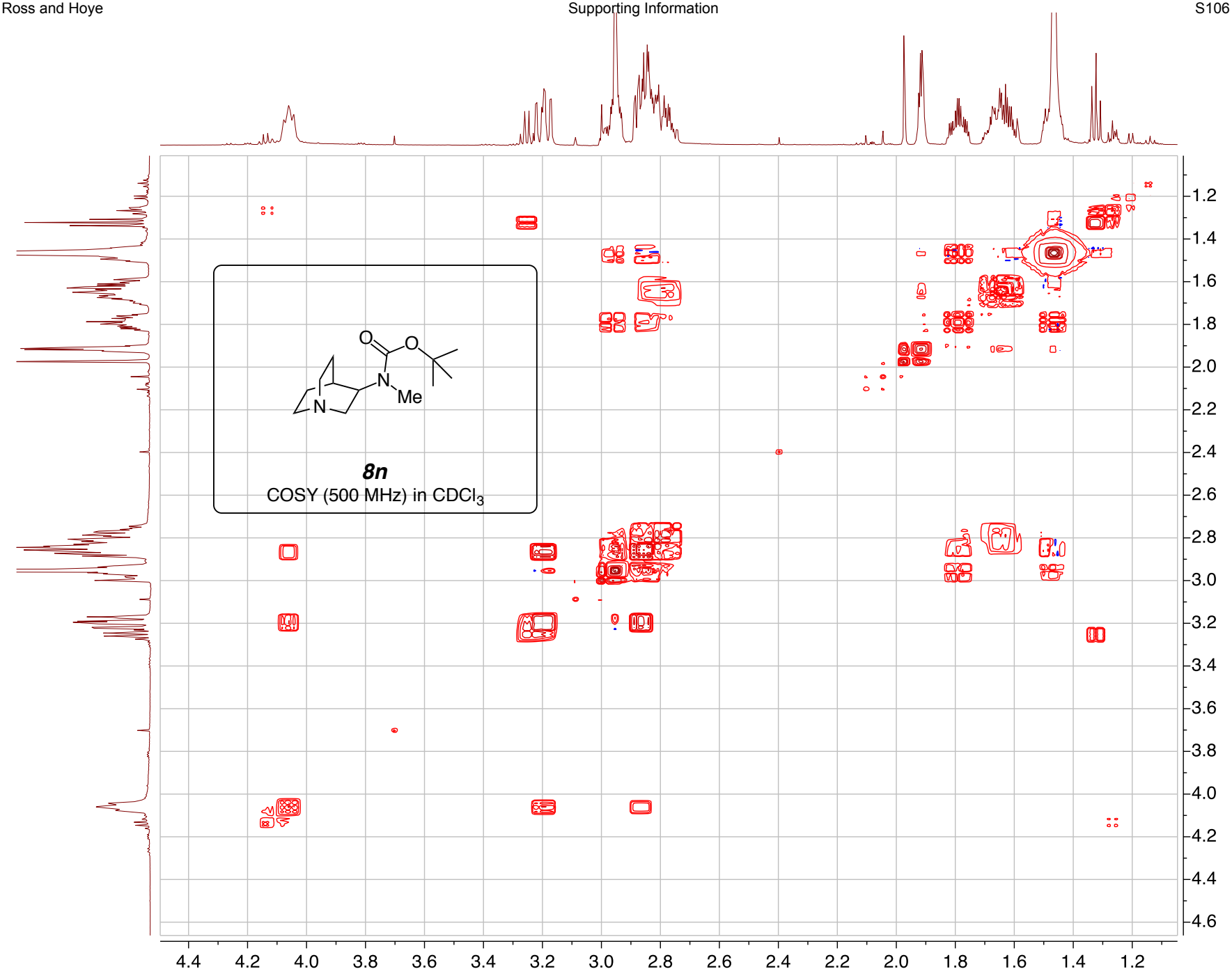

CH2DOH
7.56 7.54 7.53 7.12 7.10 6.78 6.76 5.03 5.03 5.02 5.02 5.02 5.01 5.01 3.38 3.38 3.37 3.36 3.35 3.35 3.34 3.33 3.31 2.91 2.90 2.90 2.90 2.89 2.88 2.88 2.87 2.87 2.86 2.86 2.84 2.84 2.83 2.83 2.82 2.82 2.81 2.81 2.81 2.80 2.79 2.78 2.75 2.75 2.74 2.72 2.72 2.71 2.18 2.17 2.17 2.16 1.99 1.99 1.80 1.80 1.79 1.79 1.71 1.70 1.70
Br
N
O
N
8m
1H NMR (500 MHz) in CD3OD
7.56 7.54 7.52
7.12 7.10
6.78 6.76
5.04 5.02 5.00
3.38 3.36 3.34
2.76 2.74 2.72
1.05 1.02 1.03 1.07 1.12 4.34 1.17 1.08 1.10 1.10 1.09 1.09
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

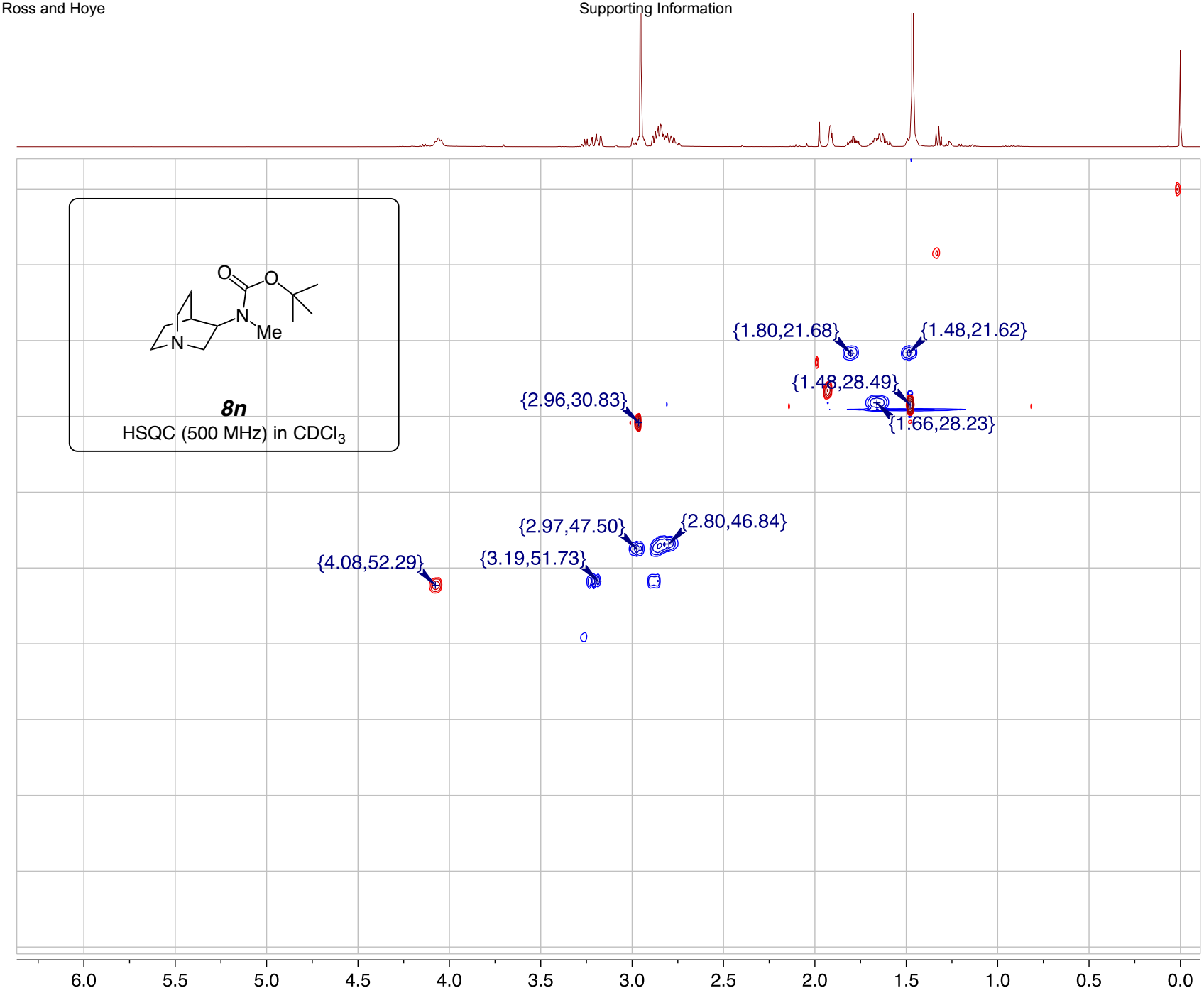

Br
N
O
N
8m
COSY (500 MHz) in CD3OD
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

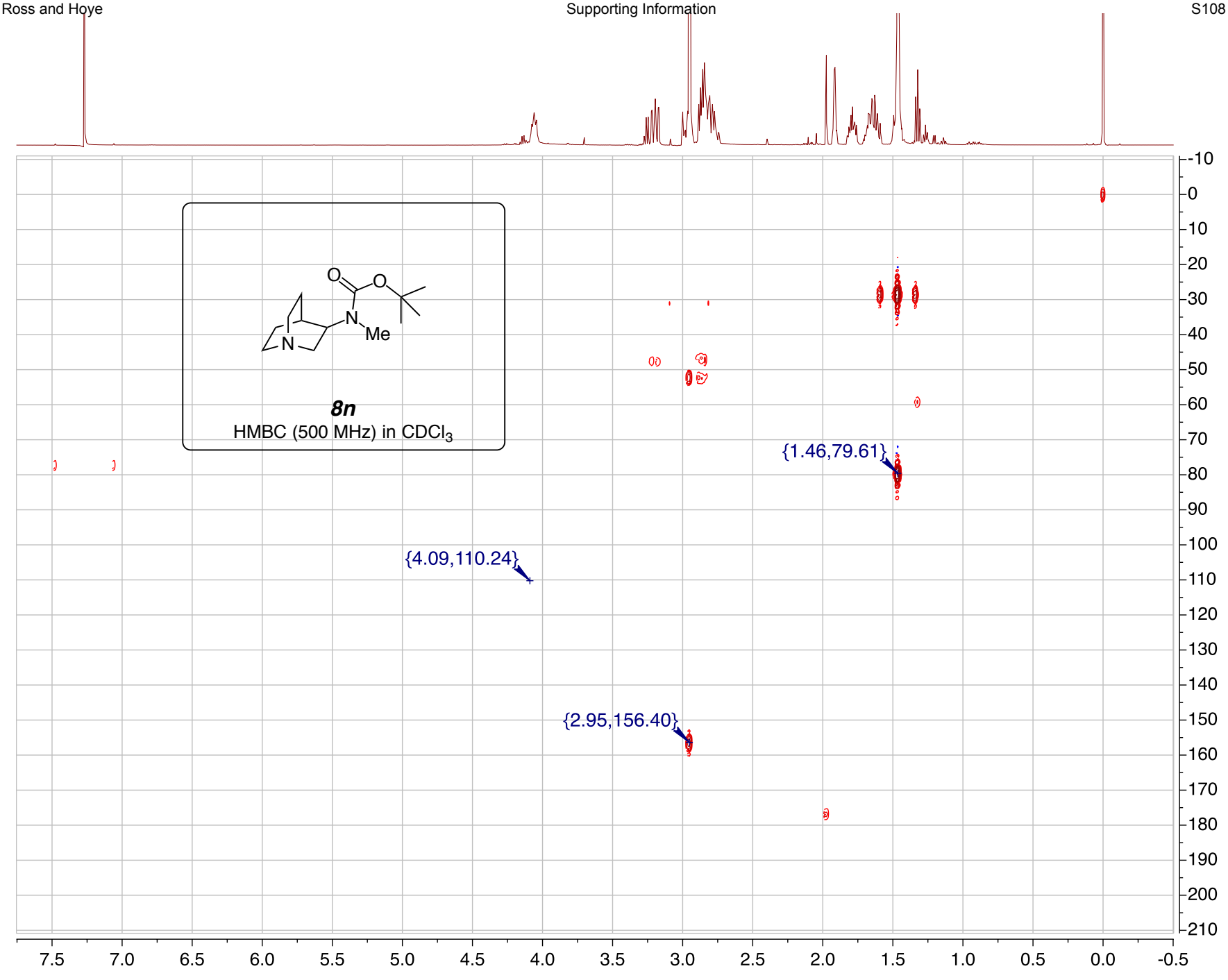

Br
N
O
N
8m
HSQC (500 MHz) in CD3OD
{1.99,18.54}
{1.79,23.45}
{2.89,46.54}
{2.81,45.75}
{3.37,54.97}
{5.02,72.25}
{6.77,109.48}
{7.11,120.11}
{7.54,141.01}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

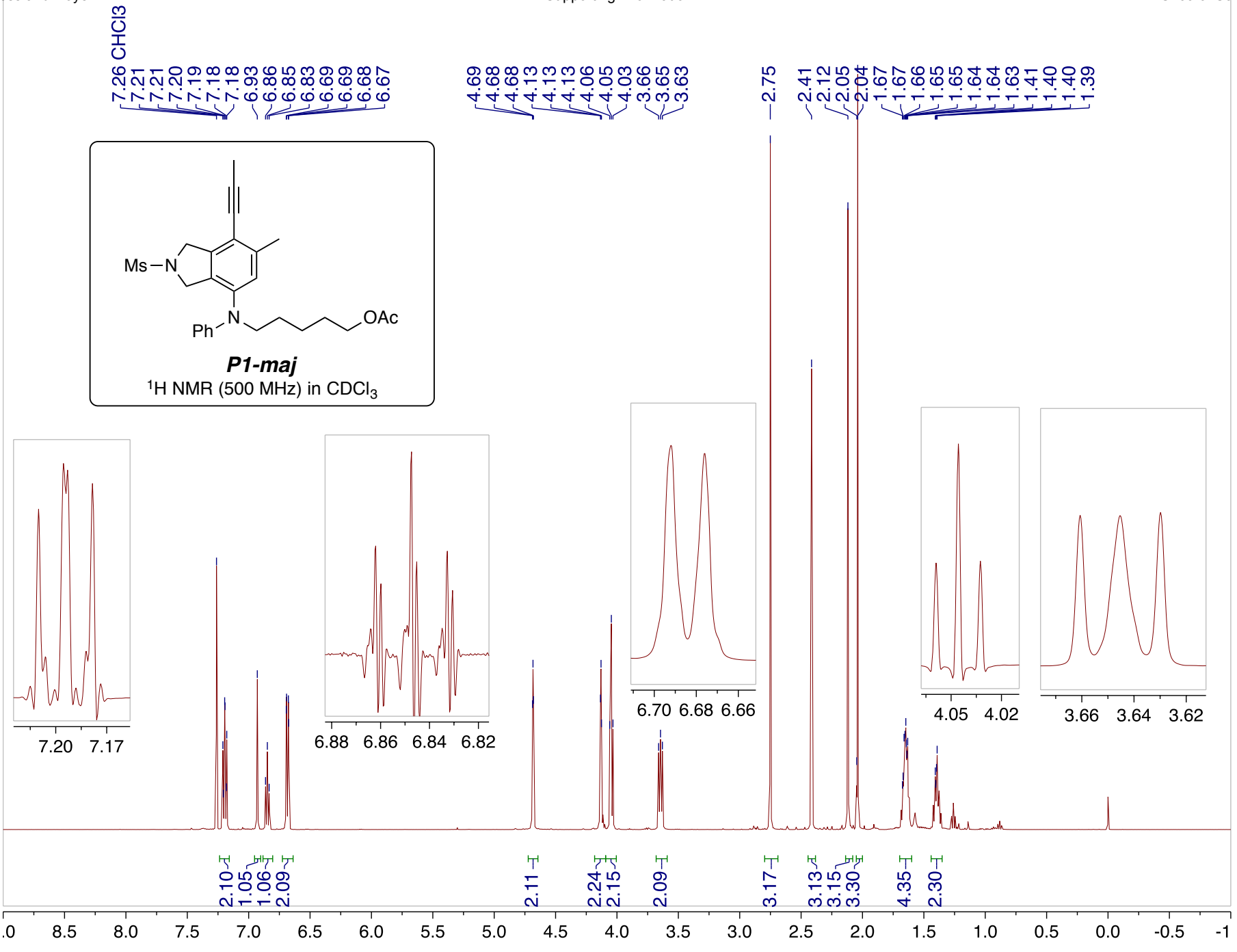

Br
N
O
N
8m
HMBC (500 MHz) in CD3OD
{7.53,138.04}
{7.53,162.80}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

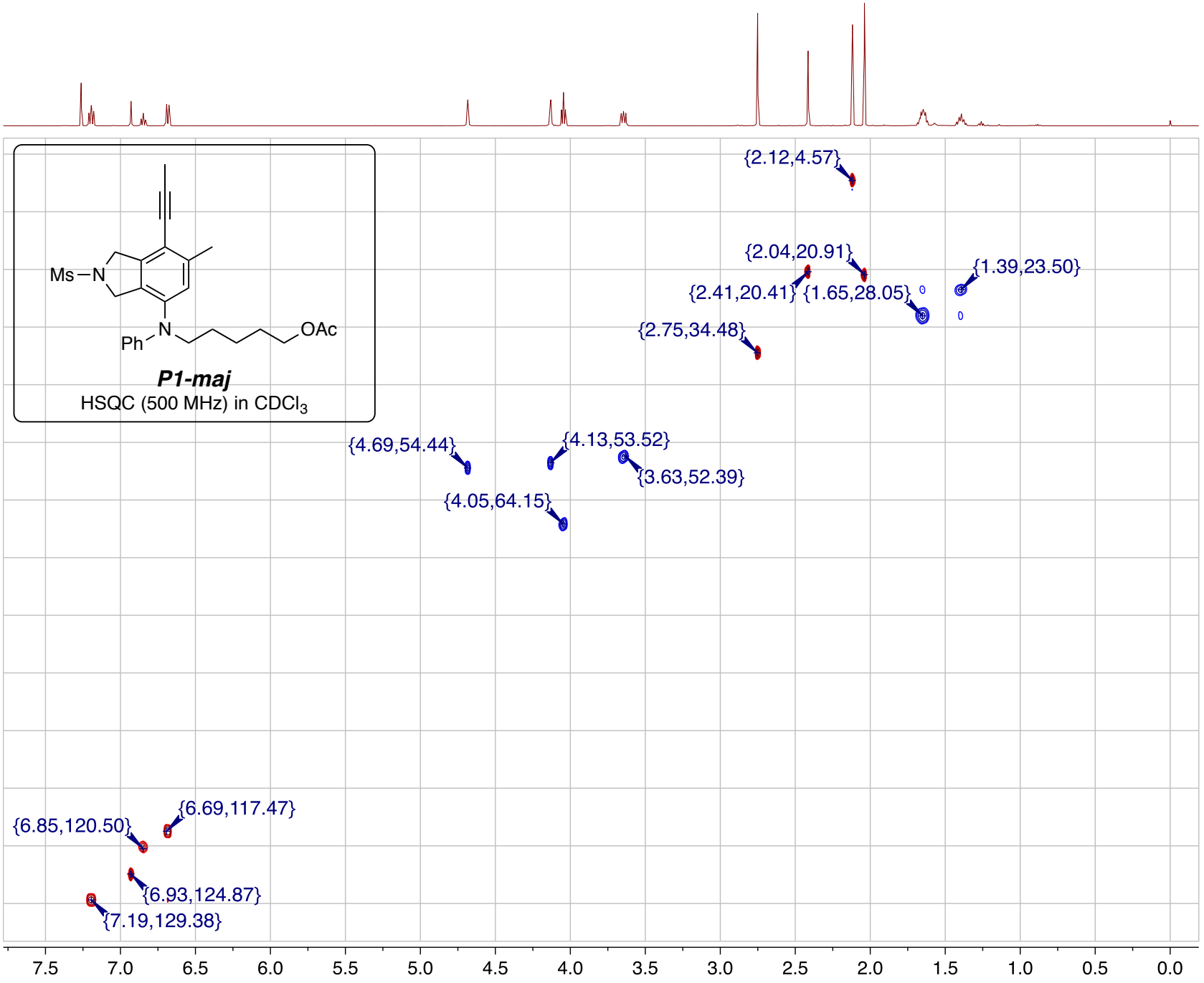

7.27 CHCl3
4.06 3.22 3.22 3.20 3.20 3.20 3.19 3.17 3.17 3.00 2.97 2.96 2.96 2.95 2.95 2.94 2.89 2.88 2.88 2.87 2.87 2.86 2.86 2.85 2.84 2.84 2.84 2.83 2.83 2.82 2.82 2.81 2.81 2.81 2.79 2.77 1.97 1.92 1.92 1.91 1.91 1.79 1.79 1.78 1.67 1.65 1.64 1.64 1.63 1.62 1.62 1.61 1.48 1.48 1.47 1.47 1.46 1.45 1.45 1.45 1.45 1.34 1.32 1.31
O
O
N
Me
N
8n
1H NMR (500 MHz) in CDCl3
4.08 4.05
3.20 3.16
1.00 0.99 3.98 4.05 0.98 1.01 2.06 9.63
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

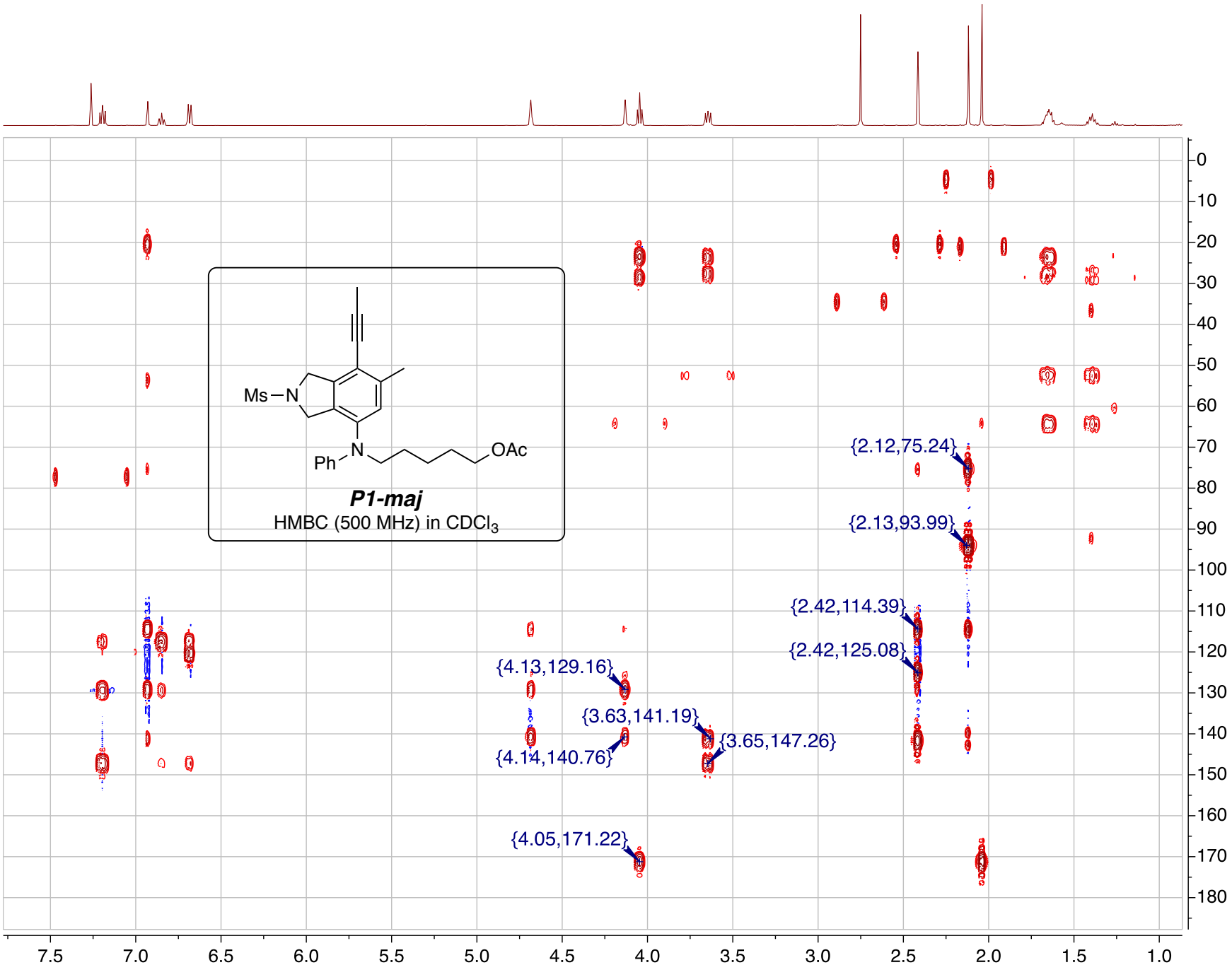

O
O
N
Me
N
8n
COSY (500 MHz) in CDCl3
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.8
4.0
4.2
4.4
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2

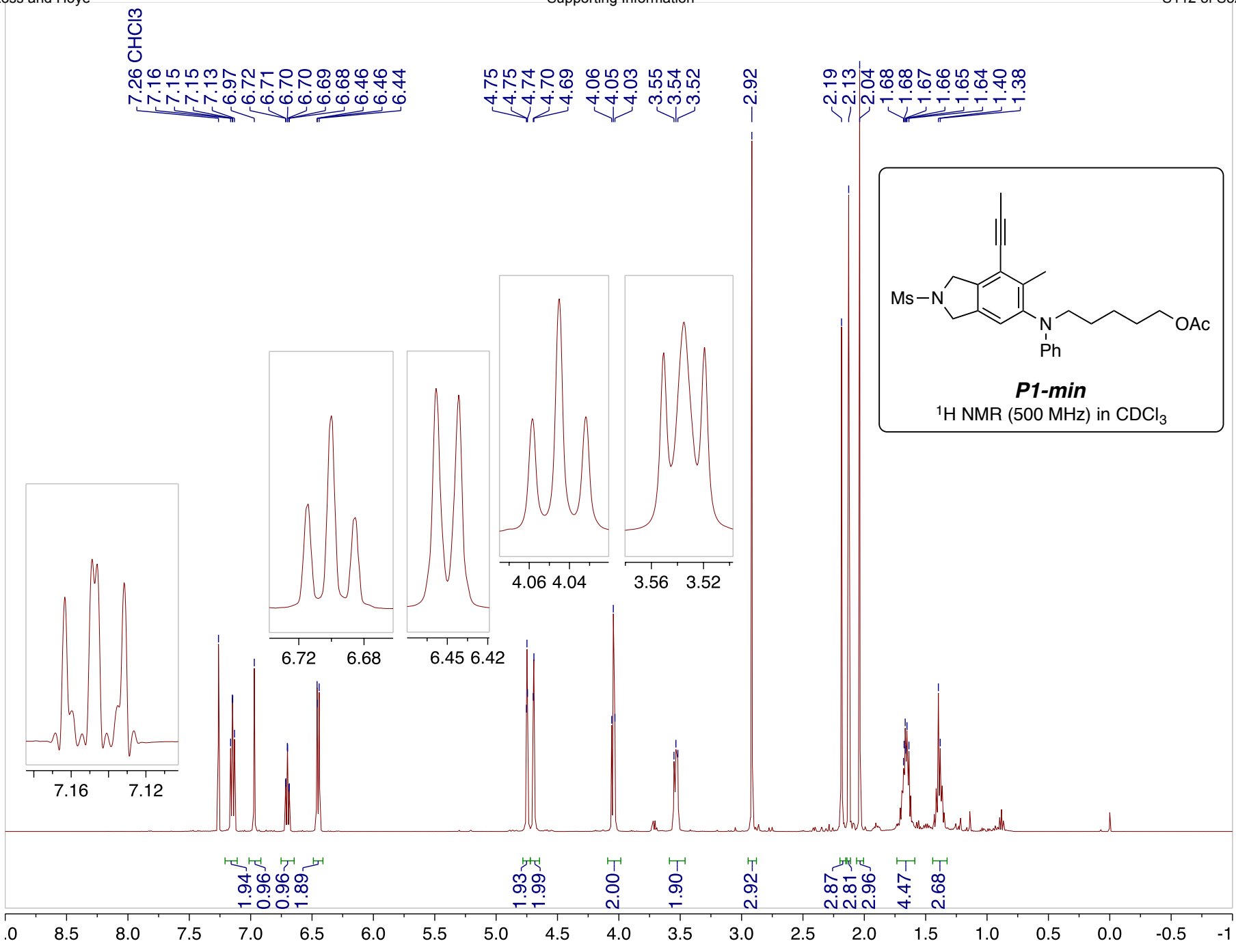

O
O
N
Me
N
8n
HSQC (500 MHz) in CDCl3
{1.80,21.68}
{1.48,21.62}
{1.48,28.49}
{2.96,30.83}
{1.66,28.23}
{2.97,47.50}
{2.80,46.84}
{4.08,52.29}
{3.19,51.73}
0
10
20
30
40
50
60
70
80
90
100
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0


O
O
N
Me
N
8n
HMBC (500 MHz) in CDCl3
{1.46,79.61}
{4.09,110.24}
{2.95,156.40}
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

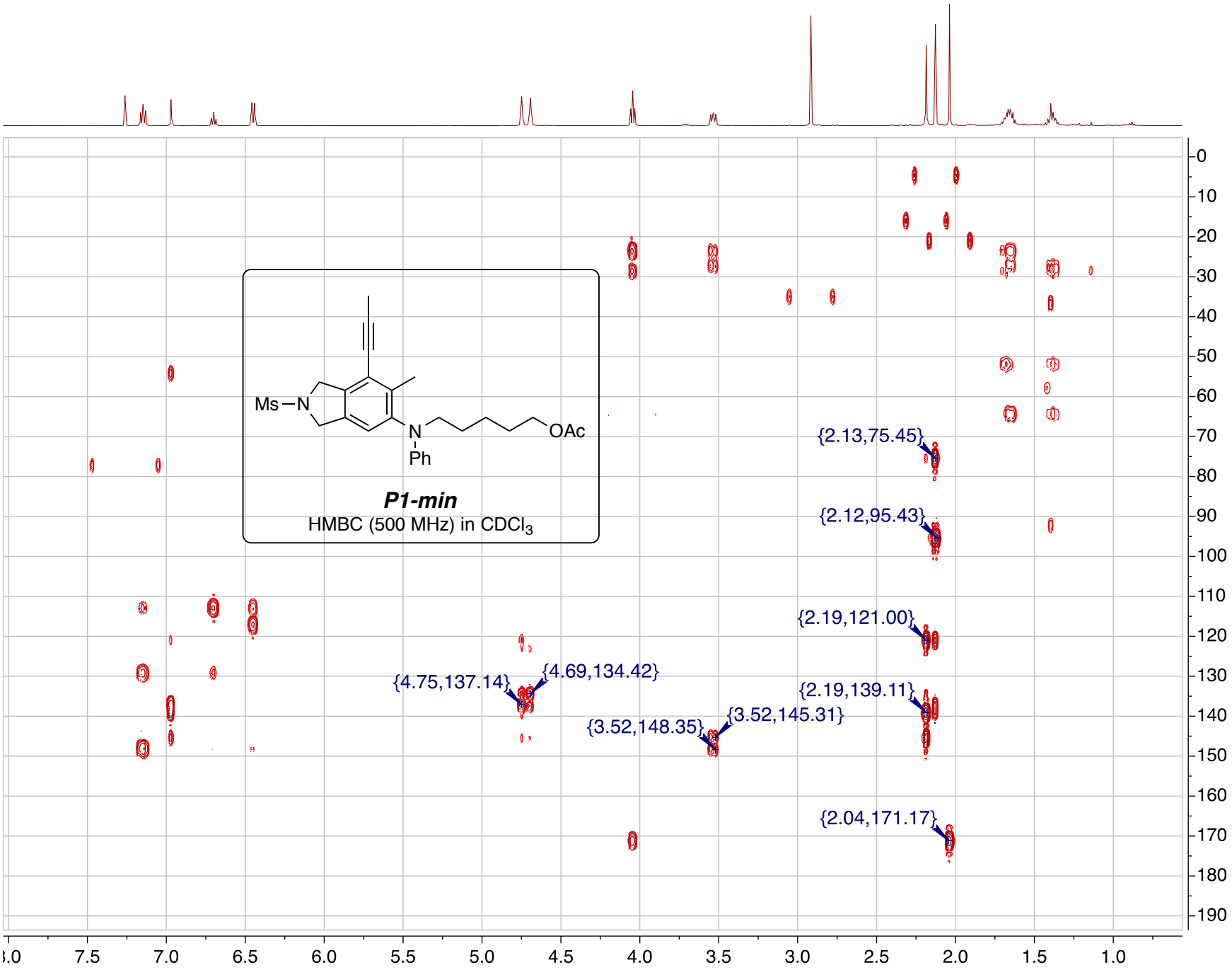

7.26 CHCl3
7.21 7.21 7.20 7.19 7.18 7.18 6.93 6.86 6.85 6.83 6.69 6.69 6.68 6.67
4.69 4.68 4.68 4.13 4.13 4.13 4.06 4.05 4.03 3.66 3.65 3.63
2.75 2.41 2.12 2.05 2.04
1.67 1.67 1.66 1.65 1.65 1.64 1.64 1.63 1.41 1.40 1.40 1.39
Ms
N
Ph
N
OAc
P1-maj
1H NMR (500 MHz) in CDCl3
7.20 7.17
6.88 6.86 6.84 6.82
6.70 6.68 6.66
4.05 4.02
3.66 3.64 3.62
2.10 1.05 1.06 2.09 2.11 2.24 2.15 2.09 3.17 3.13 3.15 3.30 4.35 2.30
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

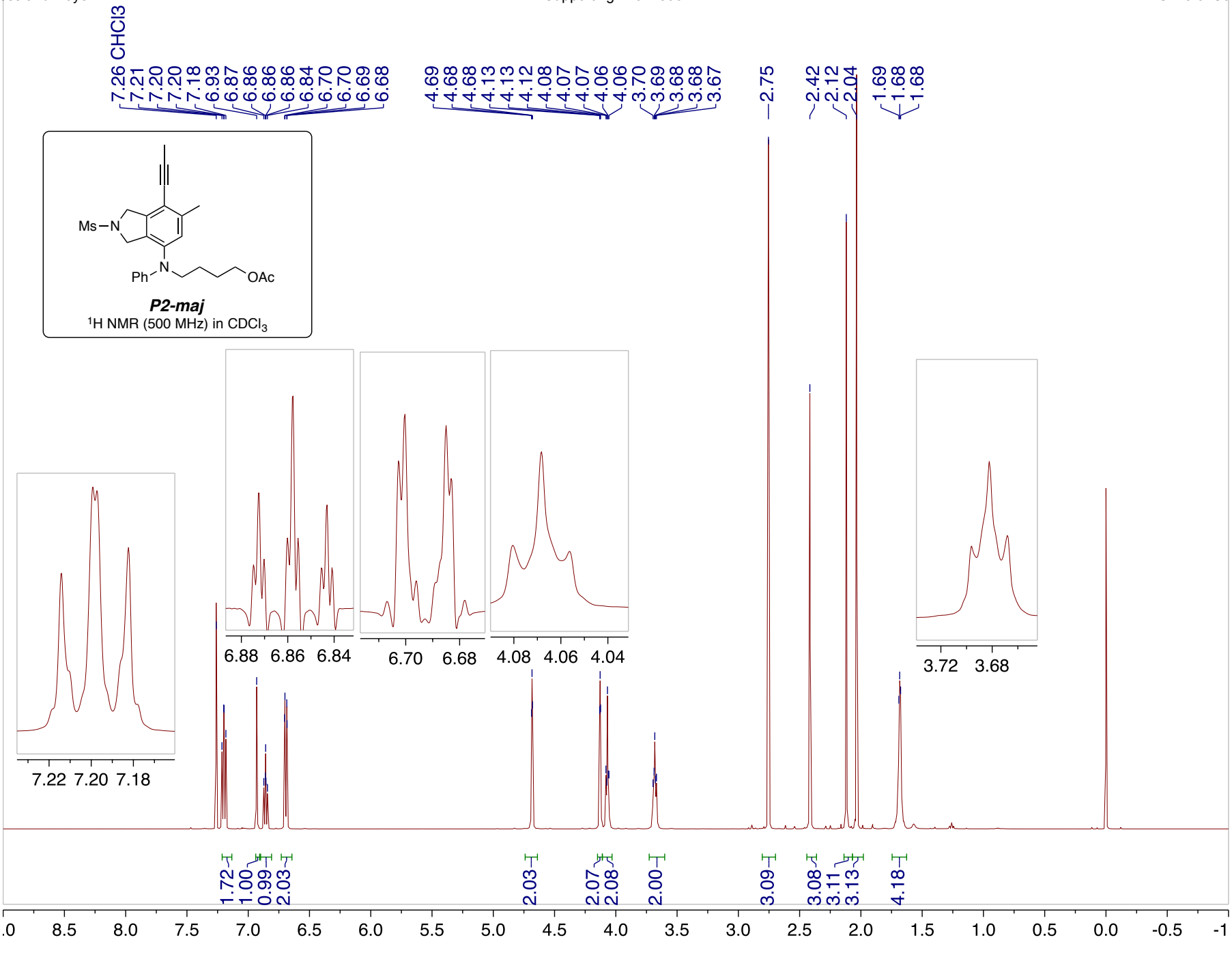

Ms—N
N
Ph
OAc
P1-maj
HSQC (500 MHz) in CDCl3
{2.12,4.57}
{2.04,20.91}
{1.39,23.50}
{2.41,20.41}
{1.65,28.05}
{2.75,34.48}
{4.69,54.44}
{4.13,53.52}
{3.63,52.39}
{4.05,64.15}
{6.69,117.47}
{6.85,120.50}
{6.93,124.87}
{7.19,129.38}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

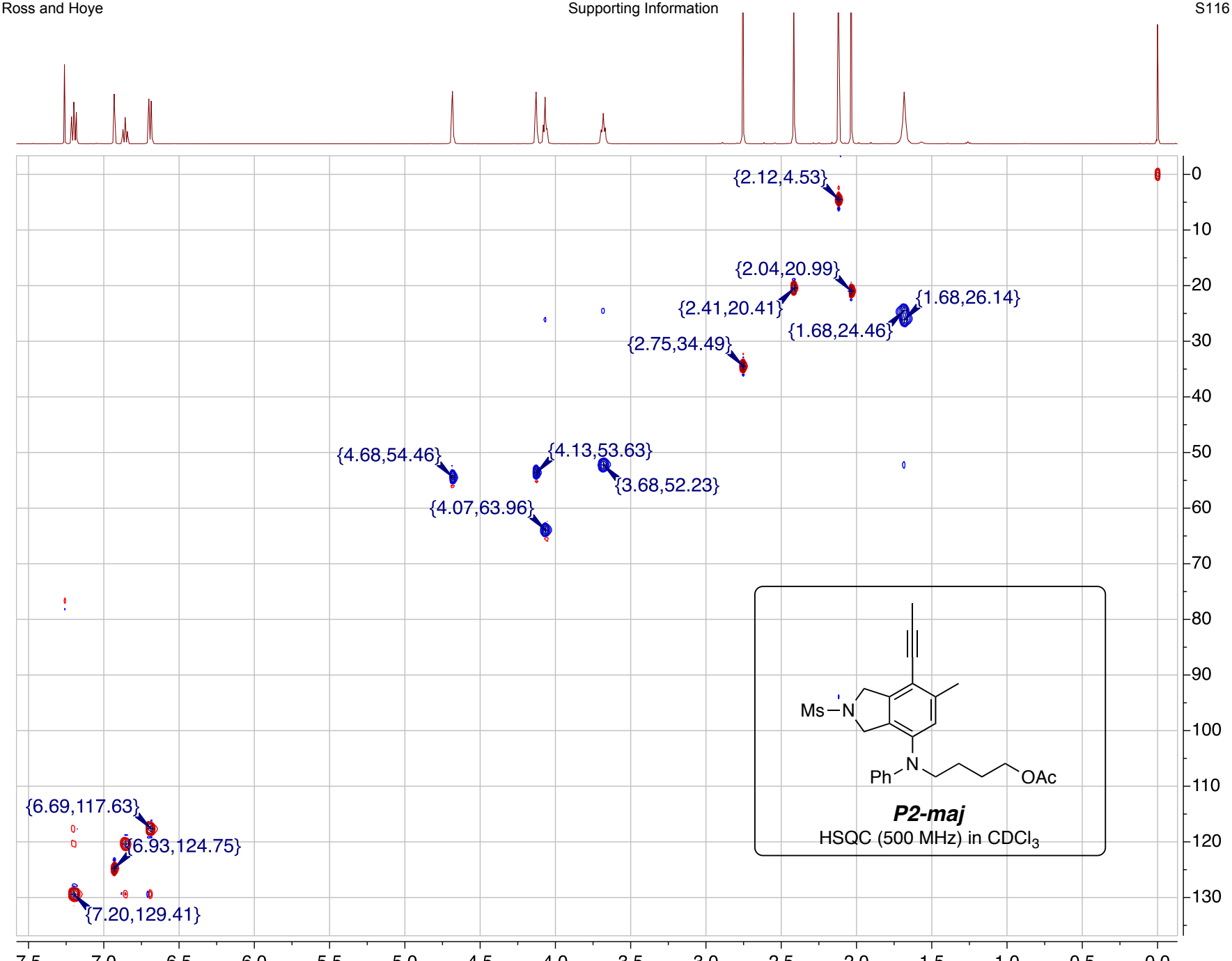

Ms—N
N
Ph
OAc
P1-maj
HMBC (500 MHz) in CDCl3
{2.12,75.24}
{2.13,93.99}
{2.42,114.39}
{2.42,125.08}
{4.13,129.16}
{3.63,141.19}
{3.65,147.26}
{4.14,140.76}
{4.05,171.22}
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180

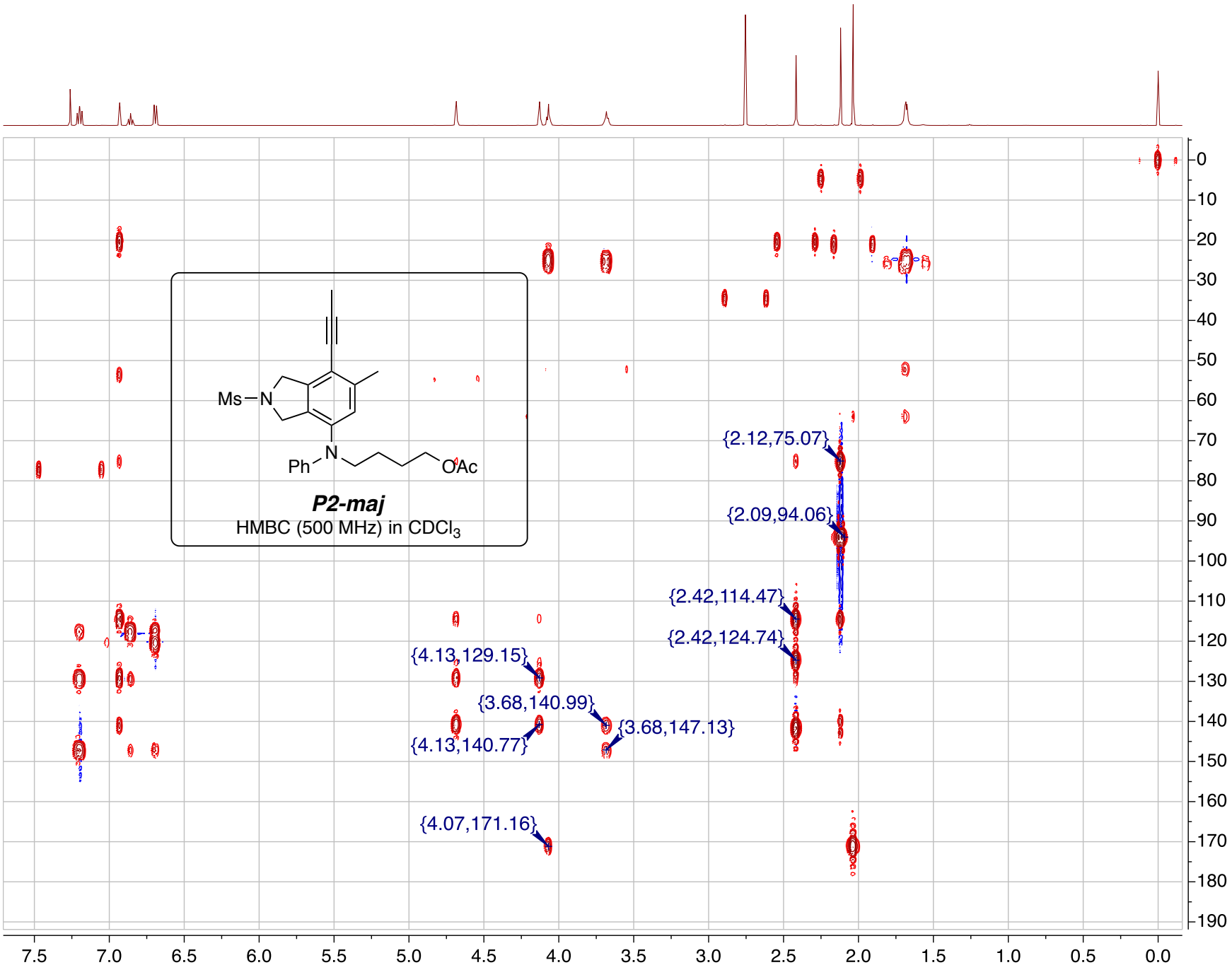

7.26 CHCl3
7.16
7.15
7.15
7.13
6.97
6.72
6.71
6.70
6.70
6.69
6.68
6.46
6.46
6.44
4.75
4.75
4.74
4.70
4.69
4.06
4.05
4.03
3.55
3.54
3.52
2.92
2.19
2.13
2.04
1.68
1.68
1.67
1.66
1.65
1.64
1.40
1.38
Ms
N
N
Ph
OAc
P1-min
1H NMR (500 MHz) in CDCl3
7.16 7.12
6.72 6.68
6.45 6.42
4.06 4.04
3.56 3.52
1.94
0.96
0.96
1.89
1.93
1.99
2.00
1.90
2.92
2.87
2.81
2.96
4.47
2.68
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

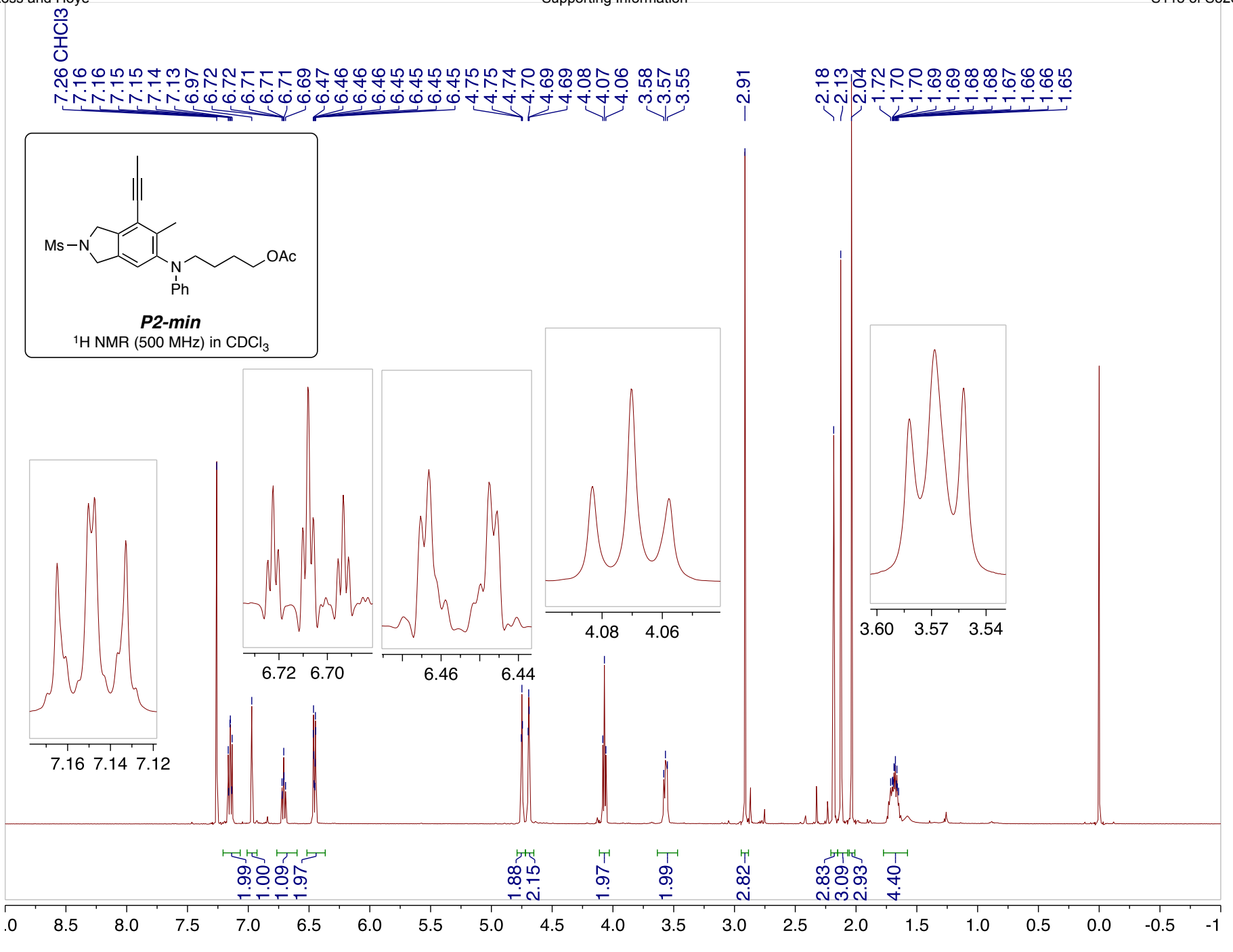

{2.13,4.59}
{2.19,16.03}
{1.38,23.55}
{1.65,28.25}
{1.67,27.33}
{2.92,34.96}
{3.54,51.83}
{4.75,54.22}
{4.69,54.14}
{4.04,64.24}
{6.45,112.96}
{6.69,117.11}
{6.96,123.07}
{7.14,129.22}
Ms—N
N
Ph
OAc
P1-min
HSQC (500 MHz) in CDCl3

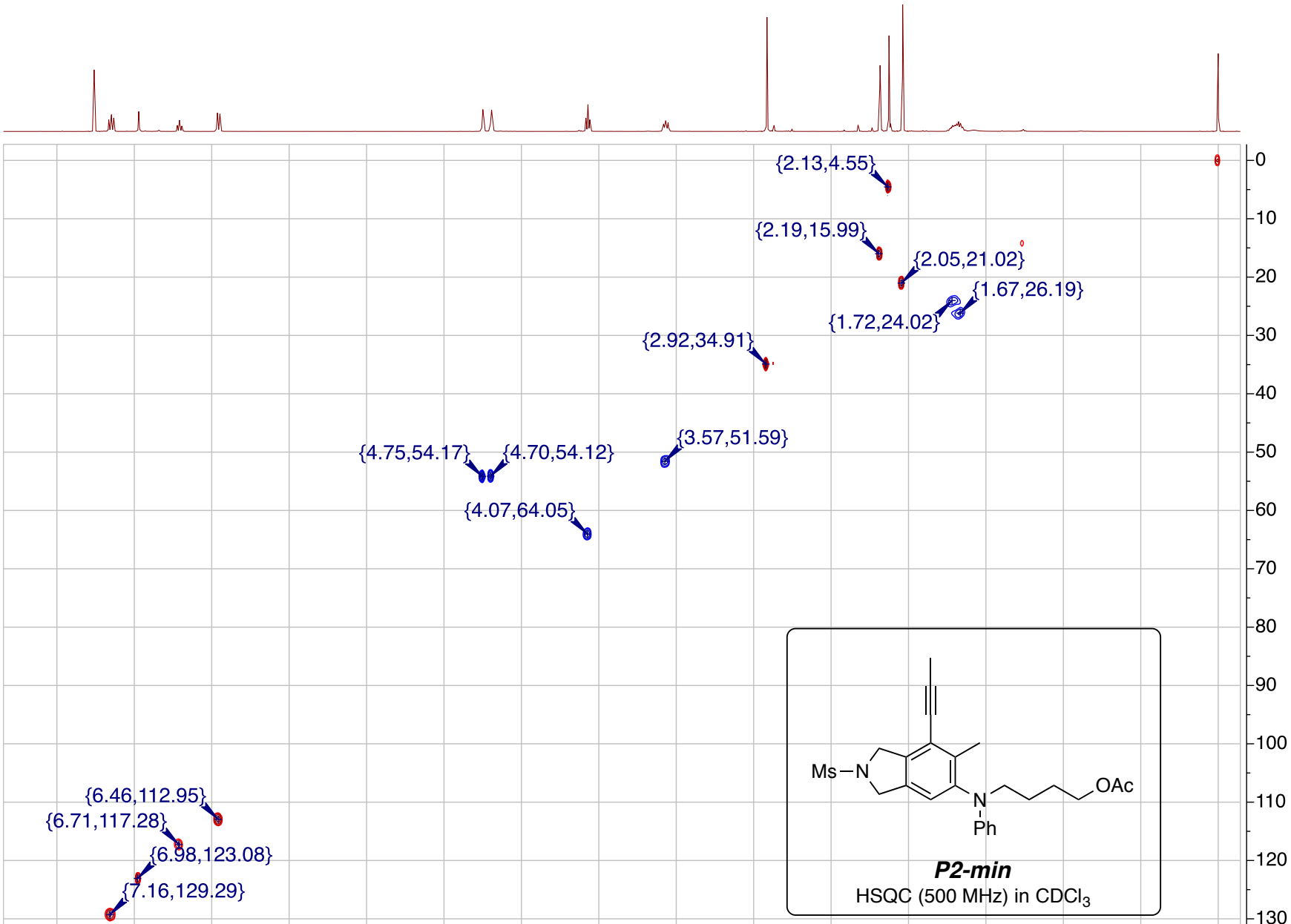

Ms—N
N
Ph
OAc
P1-min
HMBC (500 MHz) in CDCl3
{2.13,75.45}
{2.12,95.43}
{2.19,121.00}
{4.75,137.14}
{4.69,134.42}
{2.19,139.11}
{3.52,148.35}
{3.52,145.31}
{2.04,171.17}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0

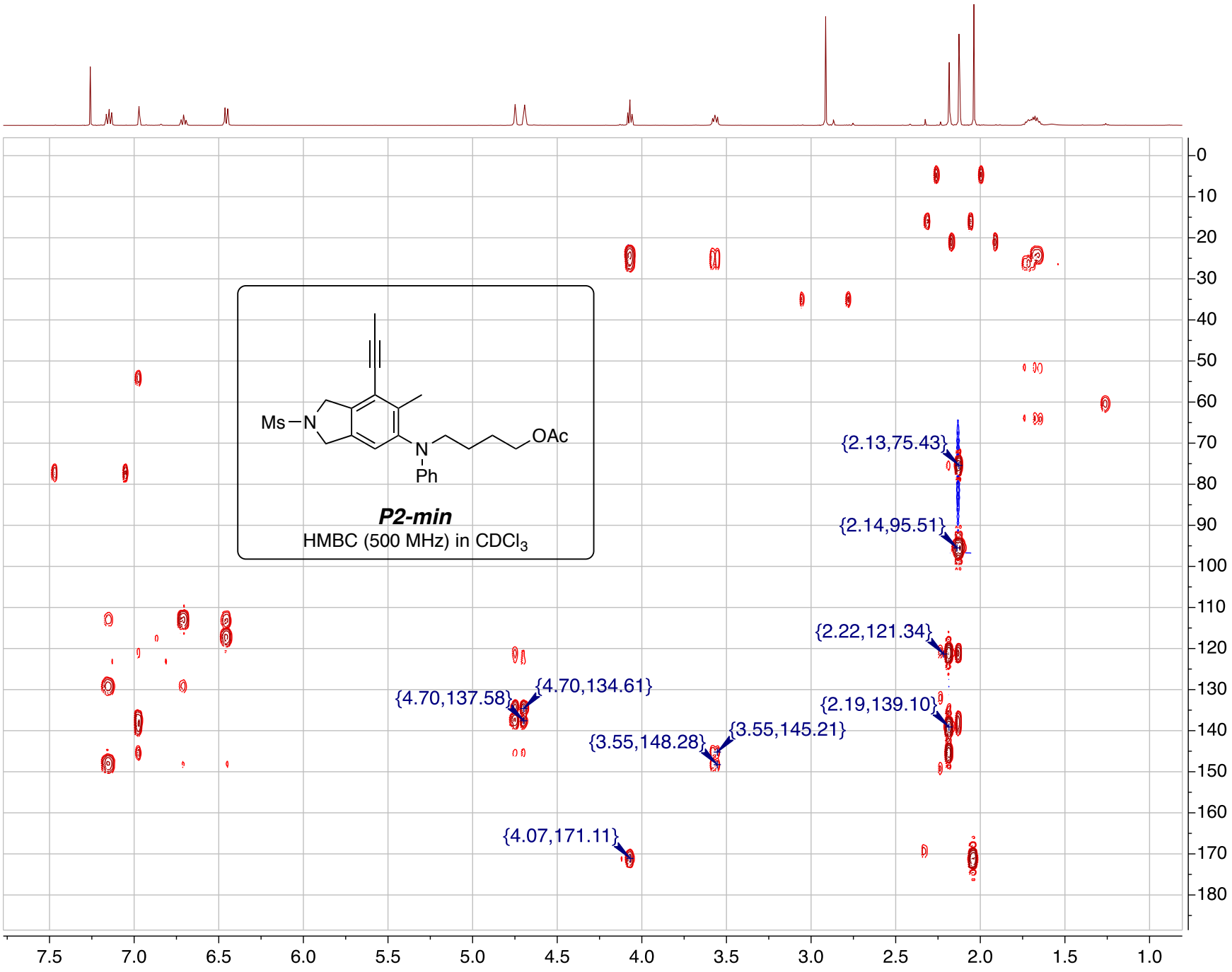

7.26 CHCl3
7.21
7.20
7.20
7.18
6.93
6.87
6.86
6.86
6.86
6.84
6.70
6.70
6.69
6.68
4.69
4.68
4.68
4.13
4.13
4.12
4.08
4.07
4.07
4.06
4.06
3.70
3.69
3.68
3.68
3.67
2.75
2.42
2.12
2.04
1.69
1.68
1.68
Ms
N
Ph
N
OAc
P2-maj
1H NMR (500 MHz) in CDCl3
7.22 7.20 7.18
6.88 6.86 6.84
6.70 6.68
4.08 4.06 4.04
3.72 3.68
1.72
1.00
0.99
2.03
2.03
2.07
2.08
2.00
3.09
3.08
3.11
3.13
4.18
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

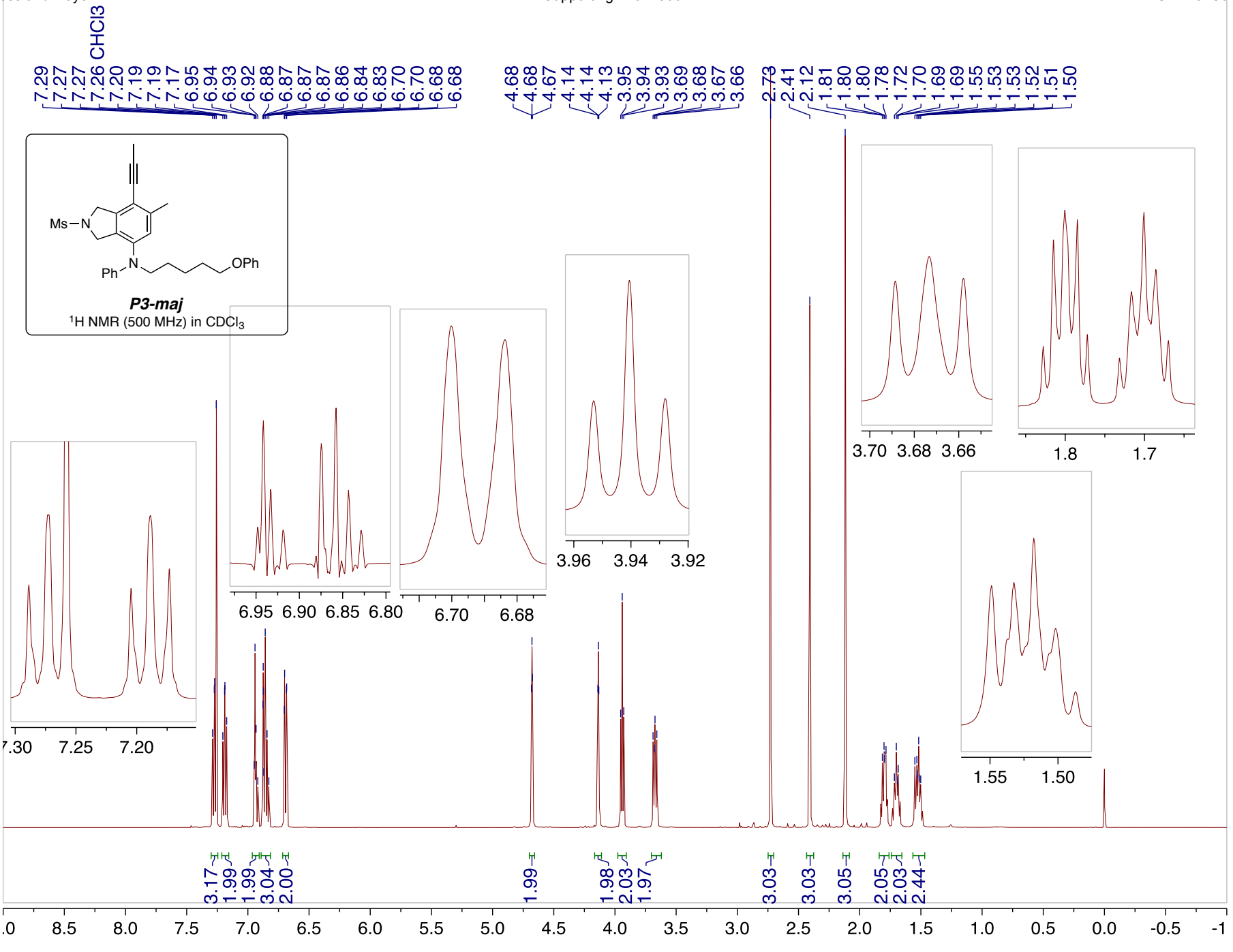

{2.12,4.53}
{2.04,20.99}
{2.41,20.41}
{1.68,26.14}
{1.68,24.46}
{2.75,34.49}
{4.68,54.46}
{4.13,53.63}
{3.68,52.23}
{4.07,63.96}
{6.69,117.63}
{6.93,124.75}
{7.20,129.41}
Ms
N
Ph
N
OAc
P2-maj
HSQC (500 MHz) in CDCl3

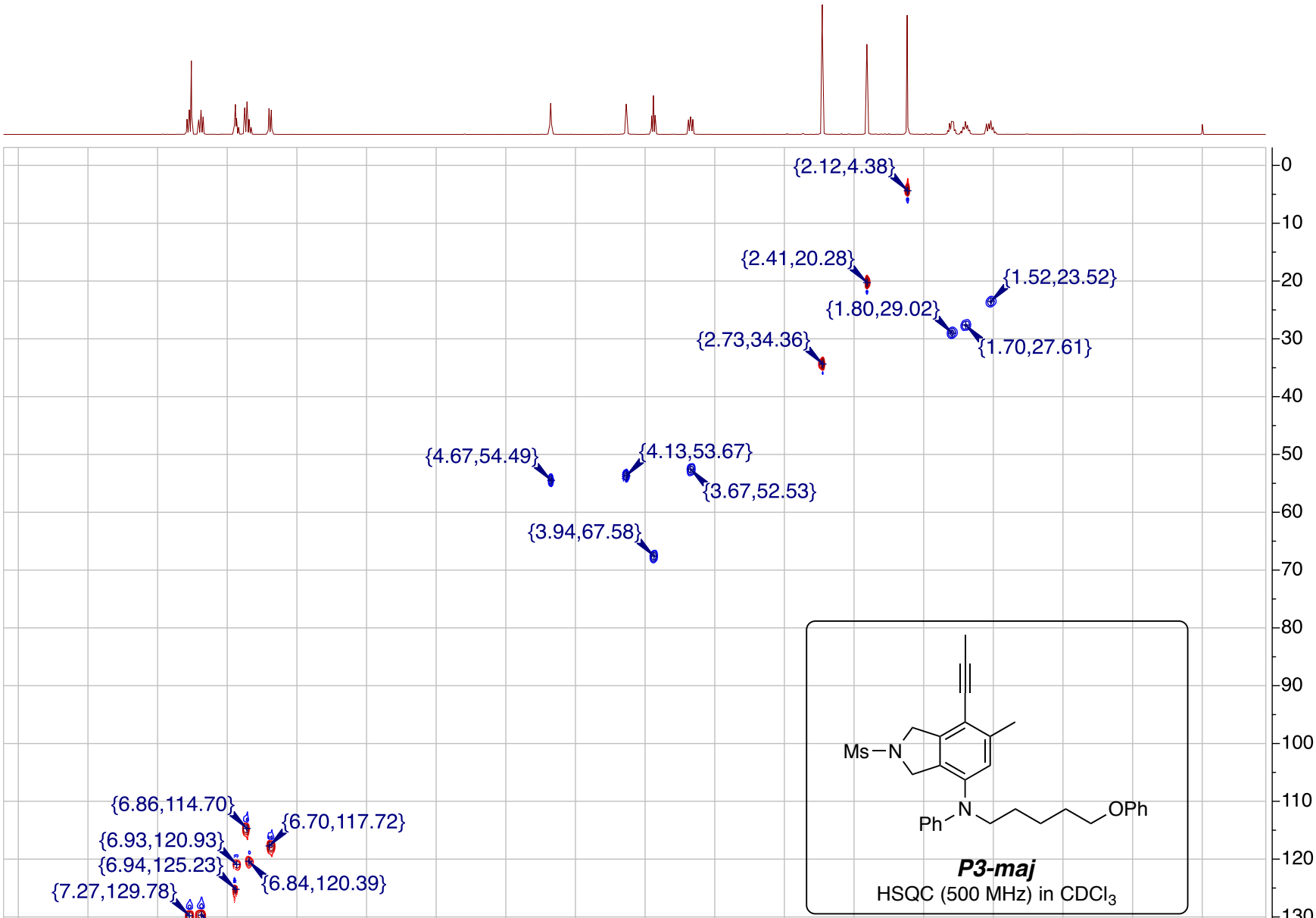

Ms
N
Ph
N
OAc
P2-maj
HMBC (500 MHz) in CDCl3
{2.12,75.07}
{2.09,94.06}
{2.42,114.47}
{2.42,124.74}
{4.13,129.15}
{3.68,140.99}
{3.68,147.13}
{4.13,140.77}
{4.07,171.16}
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190

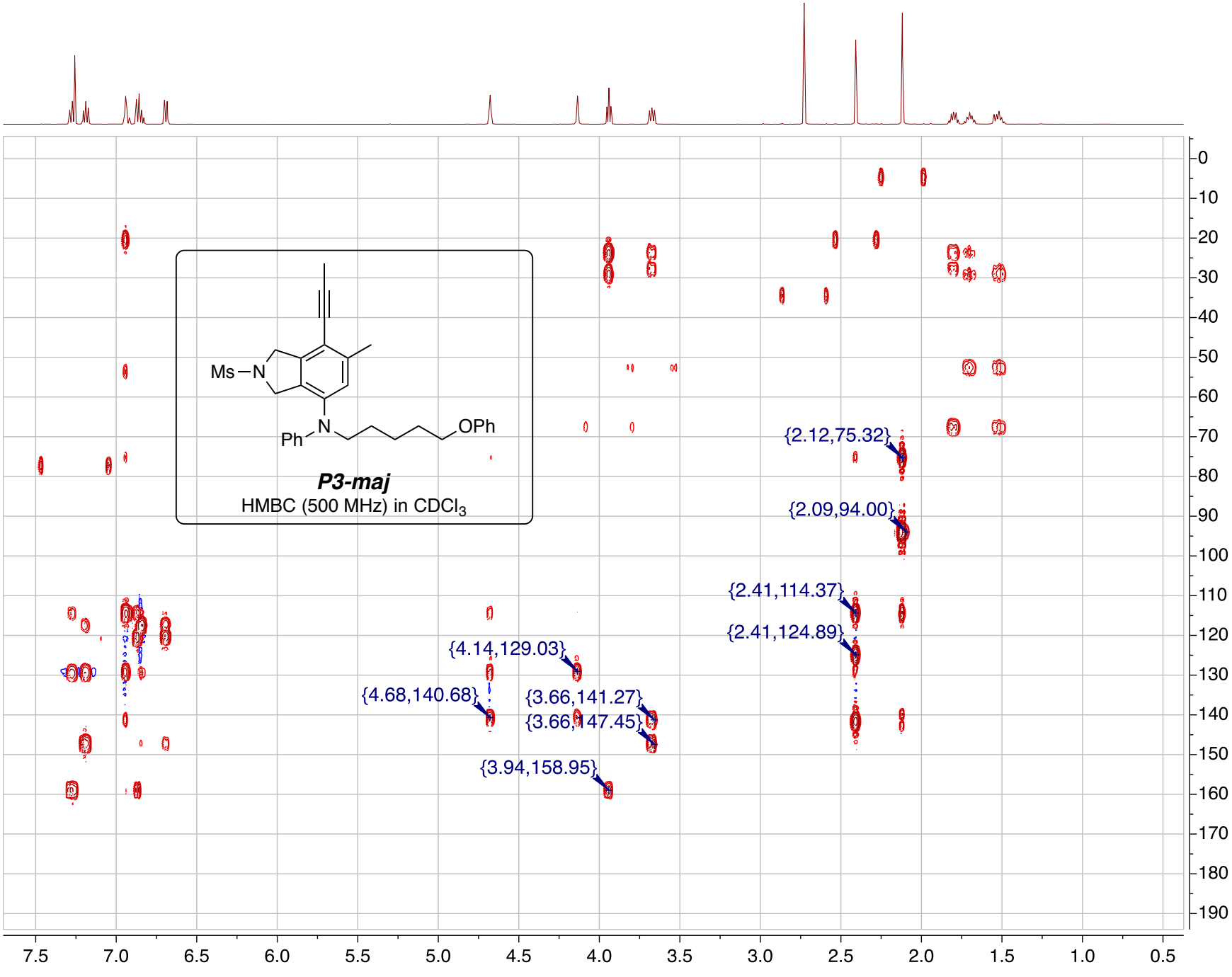

CHCl3
7.26 7.16 7.16 7.15 7.15 7.14 7.13 6.97 6.72 6.72 6.71 6.71 6.71 6.69 6.47 6.46 6.46 6.46 6.45 6.45 6.45 6.45 4.75 4.75 4.74 4.70 4.69 4.69 4.08 4.07 4.06 3.58 3.57 3.55 2.91 2.18 2.13 2.04 1.72 1.70 1.70 1.69 1.69 1.68 1.68 1.67 1.66 1.66 1.65
Ms
N
N
Ph
OAc
P2-min
1H NMR (500 MHz) in CDCl3
7.16 7.14 7.12
6.72 6.70
6.46 6.44
4.08 4.06
3.60 3.57 3.54
1.99 1.00 1.09 1.97 1.88 2.15 1.97 1.99 2.82 2.83 3.09 2.93 4.40
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

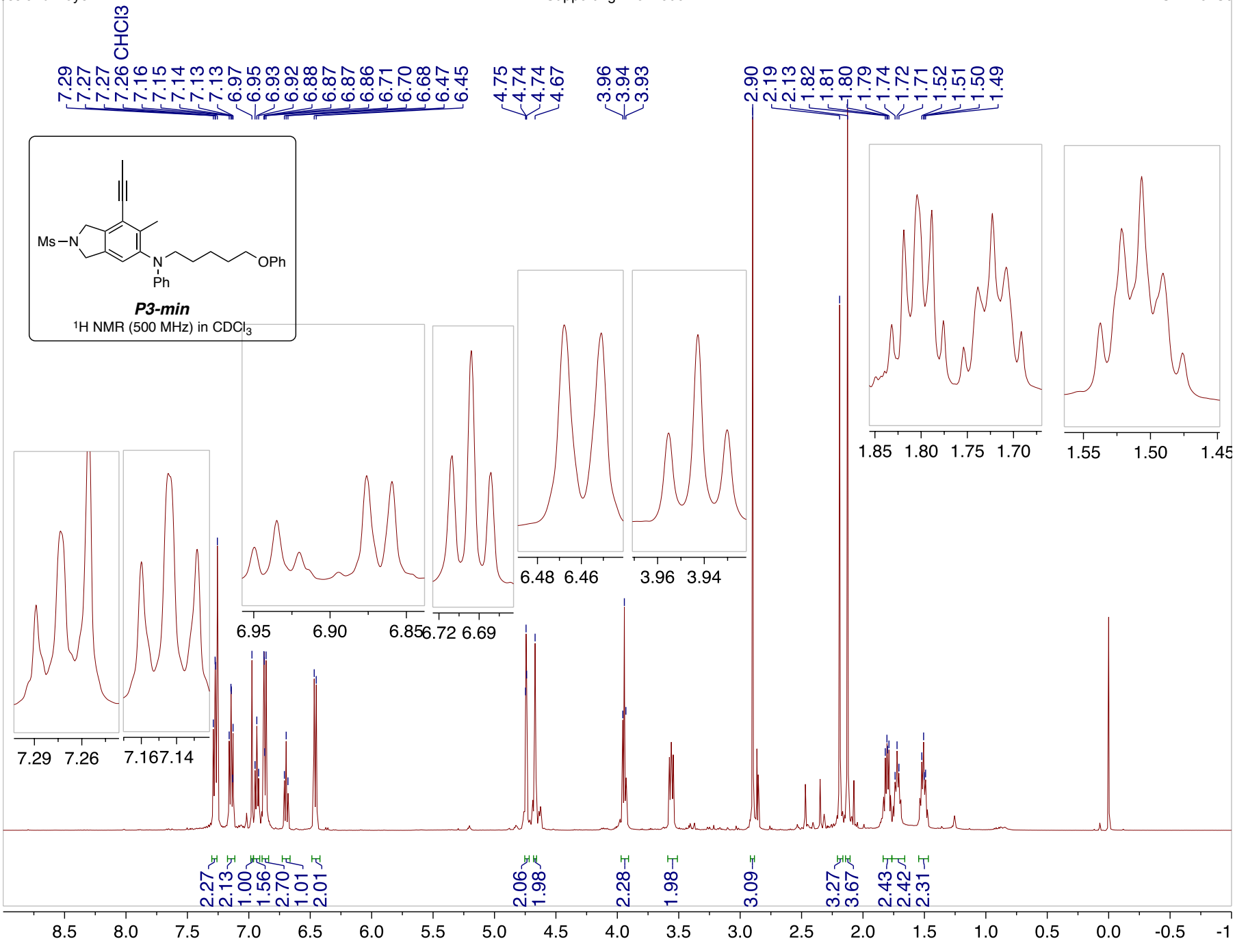

{2.13,4.55}
{2.19,15.99}
{2.05,21.02}
{1.67,26.19}
{1.72,24.02}
{2.92,34.91}
{3.57,51.59}
{4.75,54.17}
{4.70,54.12}
{4.07,64.05}
{6.46,112.95}
{6.71,117.28}
{6.98,123.08}
{7.16,129.29}
Ms—N
N
Ph
OAc
P2-min
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

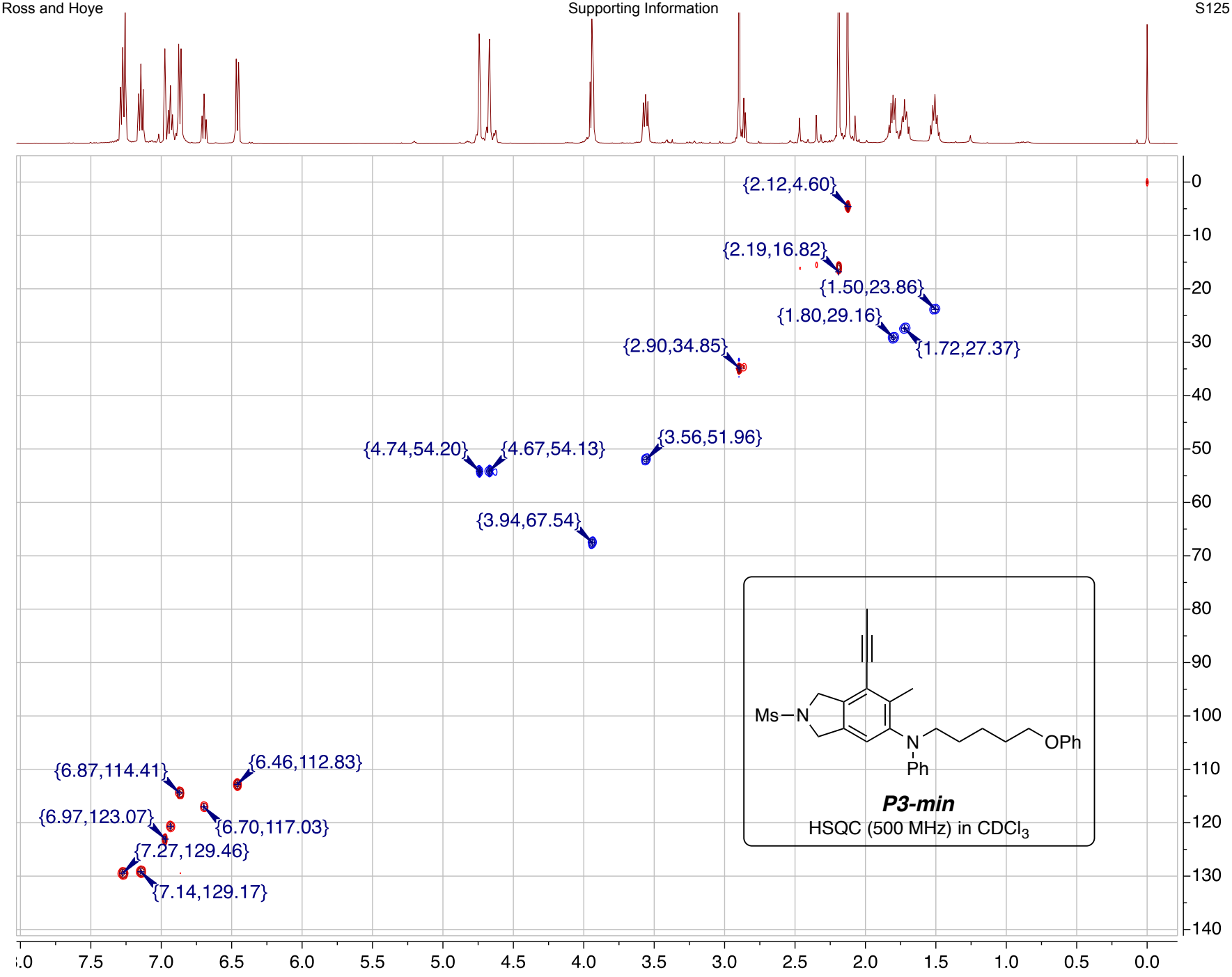

Ms—N
N
Ph
OAc
P2-min
HMBC (500 MHz) in CDCl3
{2.13,75.43}
{2.14,95.51}
{2.22,121.34}
{4.70,137.58}
{4.70,134.61}
{2.19,139.10}
{3.55,148.28}
{3.55,145.21}
{4.07,171.11}
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180

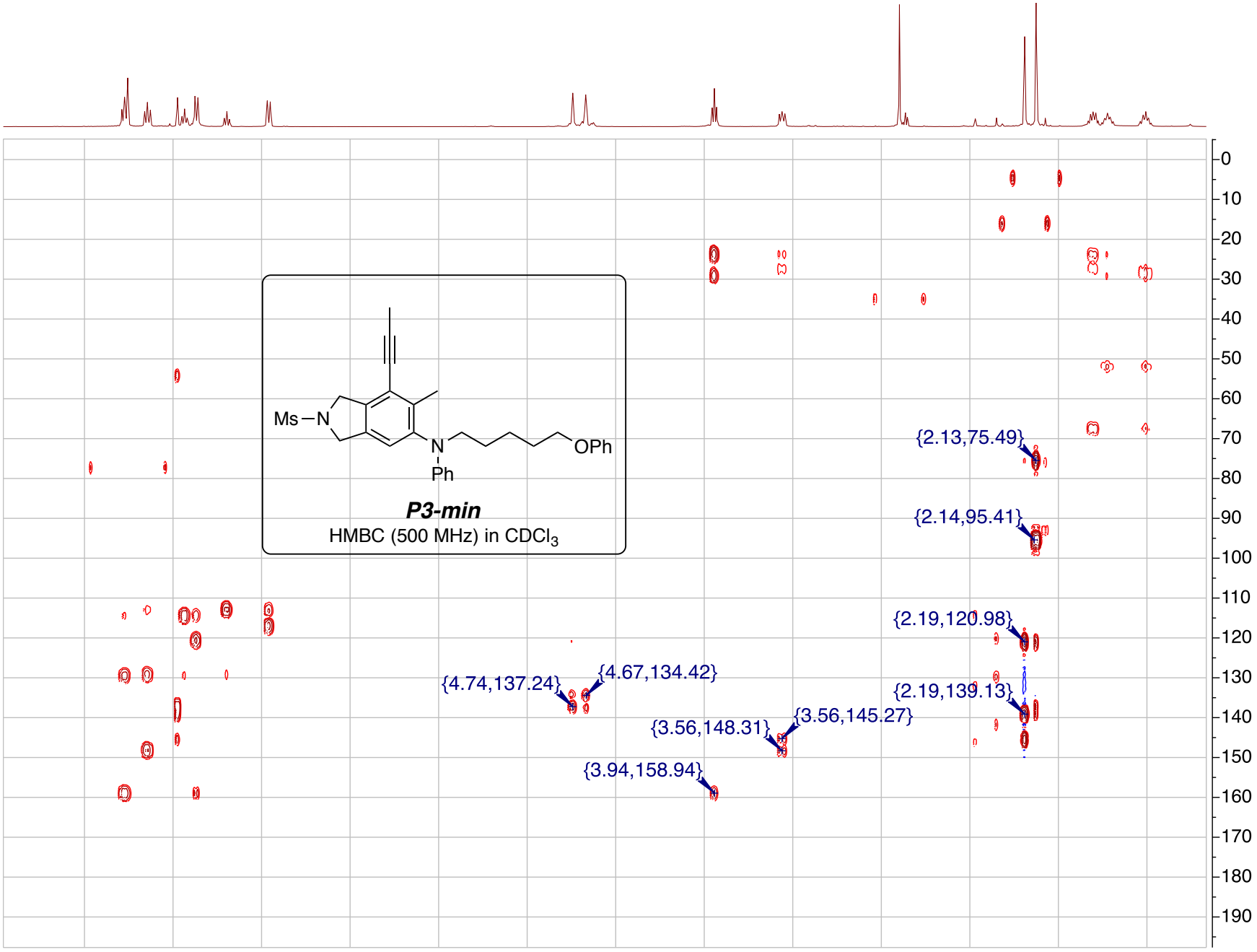

CHCl3
7.29 7.27 7.27 7.26 7.20 7.19 7.19 7.17 6.95 6.94 6.93 6.92 6.88 6.87 6.87 6.87 6.86 6.84 6.83 6.70 6.70 6.68 6.68
4.68 4.68 4.67 4.14 4.14 4.13 3.95 3.94 3.93 3.69 3.68 3.67 3.66
2.73 2.41 2.12 1.81 1.80 1.80 1.78 1.72 1.70 1.69 1.69 1.55 1.53 1.53 1.52 1.51 1.50
Ms
N
Ph
N
OPh
P3-maj
1H NMR (500 MHz) in CDCl3
7.30 7.25 7.20
6.95 6.90 6.85 6.80
6.70 6.68
3.96 3.94 3.92
3.70 3.68 3.66
1.8 1.7
1.55 1.50
3.17 1.99 1.99 3.04 2.00
1.99
1.98 2.03 1.97
3.03 3.03 3.05 2.05 2.03 2.44
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

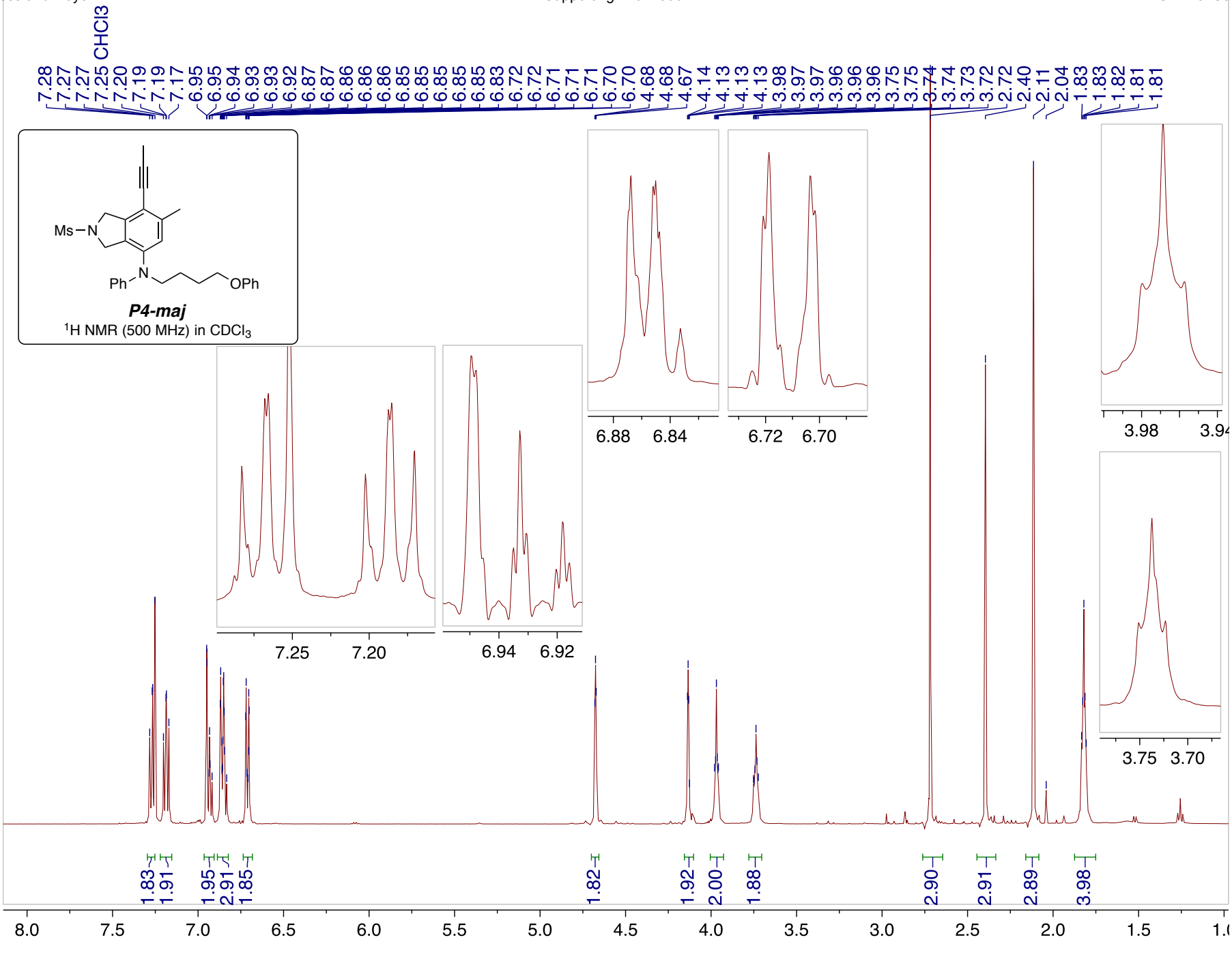

{2.12,4.38}
{2.41,20.28}
{1.52,23.52}
{1.80,29.02}
{2.73,34.36}
{1.70,27.61}
{4.67,54.49}
{4.13,53.67}
{3.67,52.53}
{3.94,67.58}
{6.86,114.70}
{6.70,117.72}
{6.93,120.93}
{6.94,125.23}
{6.84,120.39}
{7.27,129.78}
{7.18,129.69}
Ms—N
N
Ph
OPh
P3-maj
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

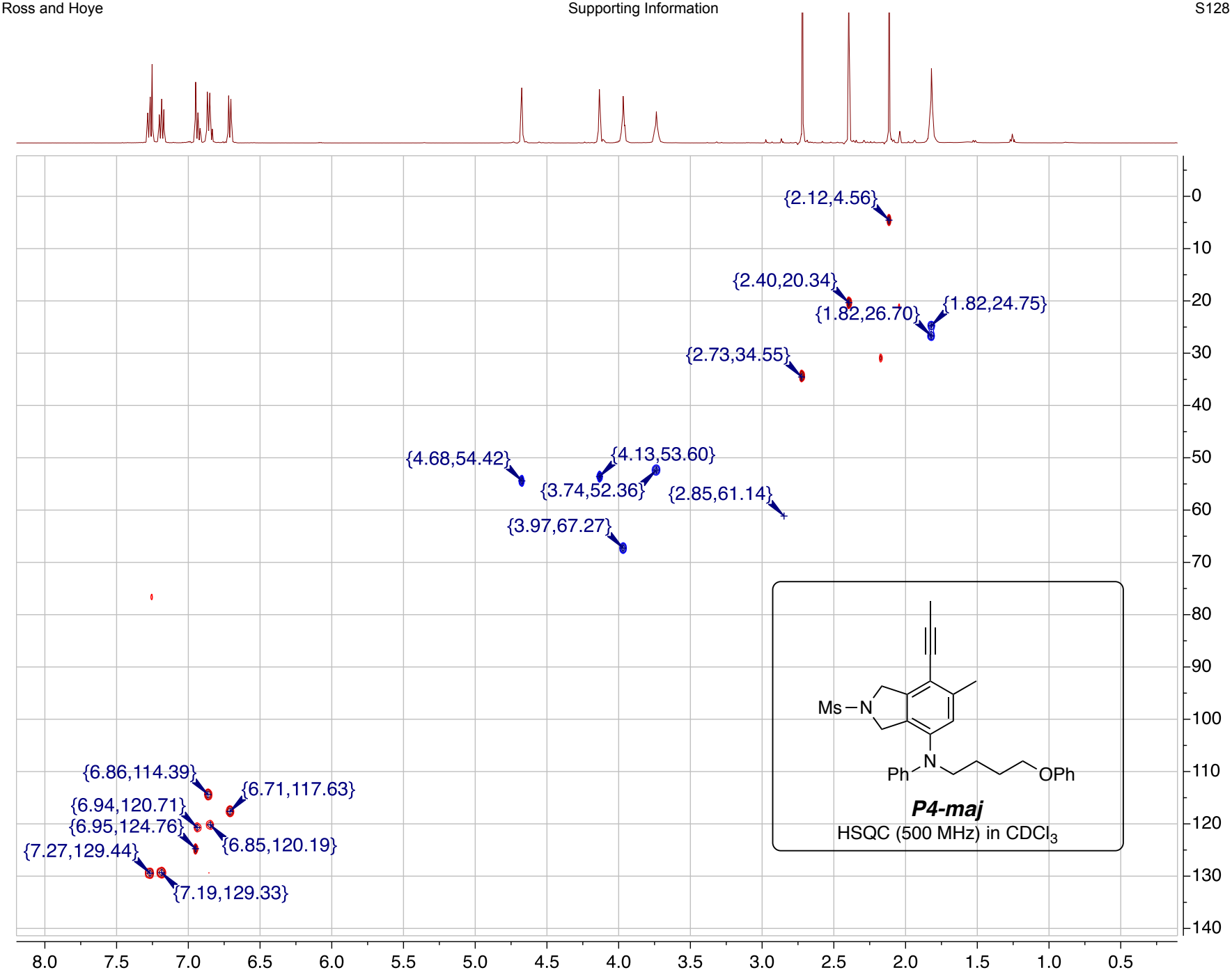

Ms—N
N
Ph
OPh
P3-maj
HMBC (500 MHz) in CDCl3
{2.12,75.32}
{2.09,94.00}
{2.41,114.37}
{2.41,124.89}
{4.14,129.03}
{4.68,140.68}
{3.66,141.27}
{3.66,147.45}
{3.94,158.95}
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190


CHCl3
7.29 7.27 7.27 7.26 7.16 7.15 7.14 7.13 7.13 6.97 6.95 6.93 6.92 6.88 6.87 6.87 6.86 6.71 6.70 6.68 6.47 6.45
4.75 4.74 4.74 4.67
3.96 3.94 3.93
2.90 2.19 2.13 1.82 1.81 1.80 1.79 1.74 1.72 1.71 1.52 1.51 1.50 1.49
Ms–N
N
Ph
OPh
P3-min
1H NMR (500 MHz) in CDCl3
7.29 7.26
7.16 7.14
6.95 6.90 6.85
6.72 6.69
6.48 6.46
3.96 3.94
1.85 1.80 1.75 1.70
1.55 1.50 1.45
2.27 2.13 1.00 1.56 2.70 1.01 2.01
2.06 1.98
2.28
1.98
3.09
3.27 3.67
2.43 2.42 2.31
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

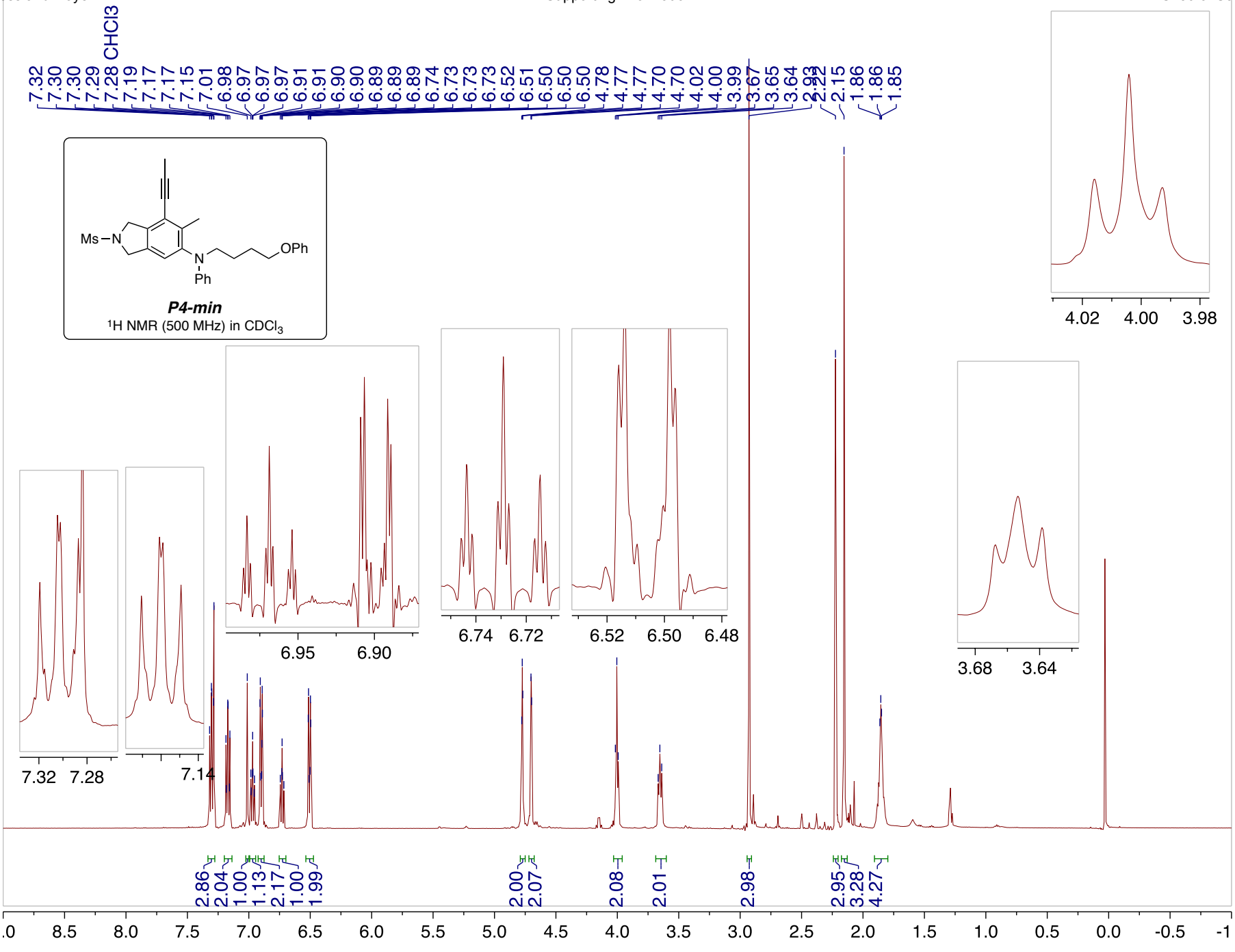

{2.12,4.60}
{2.19,16.82}
{1.50,23.86}
{1.80,29.16}
{1.72,27.37}
{2.90,34.85}
{4.74,54.20}
{4.67,54.13}
{3.56,51.96}
{3.94,67.54}
{6.87,114.41}
{6.46,112.83}
{6.97,123.07}
{6.70,117.03}
{7.27,129.46}
{7.14,129.17}
Ms
N
N
Ph
OPh
P3-min
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0


Ms—N
N
Ph
OPh
P3-min
HMBC (500 MHz) in CDCl3
{2.13,75.49}
{2.14,95.41}
{2.19,120.98}
{2.19,139.13}
{4.74,137.24}
{4.67,134.42}
{3.56,148.31}
{3.56,145.27}
{3.94,158.94}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5

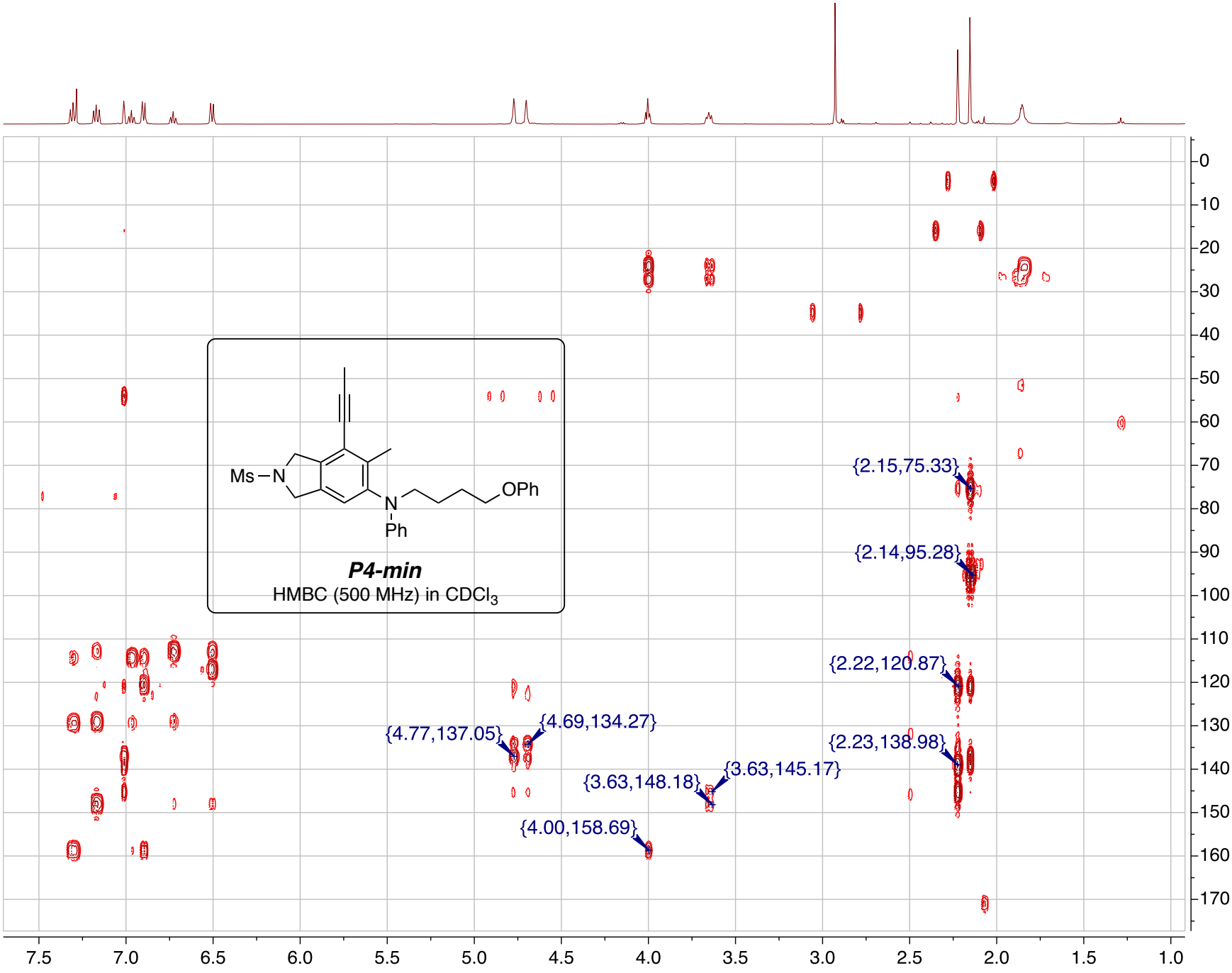

CHCl3
7.28 7.27 7.27 7.25 7.20 7.19 7.19 7.17
6.95 6.94 6.93 6.93 6.92 6.87 6.87 6.86 6.86 6.86 6.85 6.85 6.85 6.85 6.83 6.72 6.72 6.71 6.71 6.71 6.70 6.70 4.68 4.68 4.67
4.14 4.13 4.13 4.13 3.98 3.97 3.97 3.96 3.96 3.96 3.75 3.75 3.74 3.74 3.73 3.72 2.72 2.40 2.11 2.04 1.83 1.83 1.82 1.81 1.81
Ms
N
Ph
N
OPh
P4-maj
1H NMR (500 MHz) in CDCl3
6.88 6.84
6.72 6.70
3.98 3.94
7.25 7.20
6.94 6.92
3.75 3.70
1.83 1.91 1.95 2.91 1.85 1.82 1.92 2.00 1.88 2.90 2.91 2.89 3.98
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5

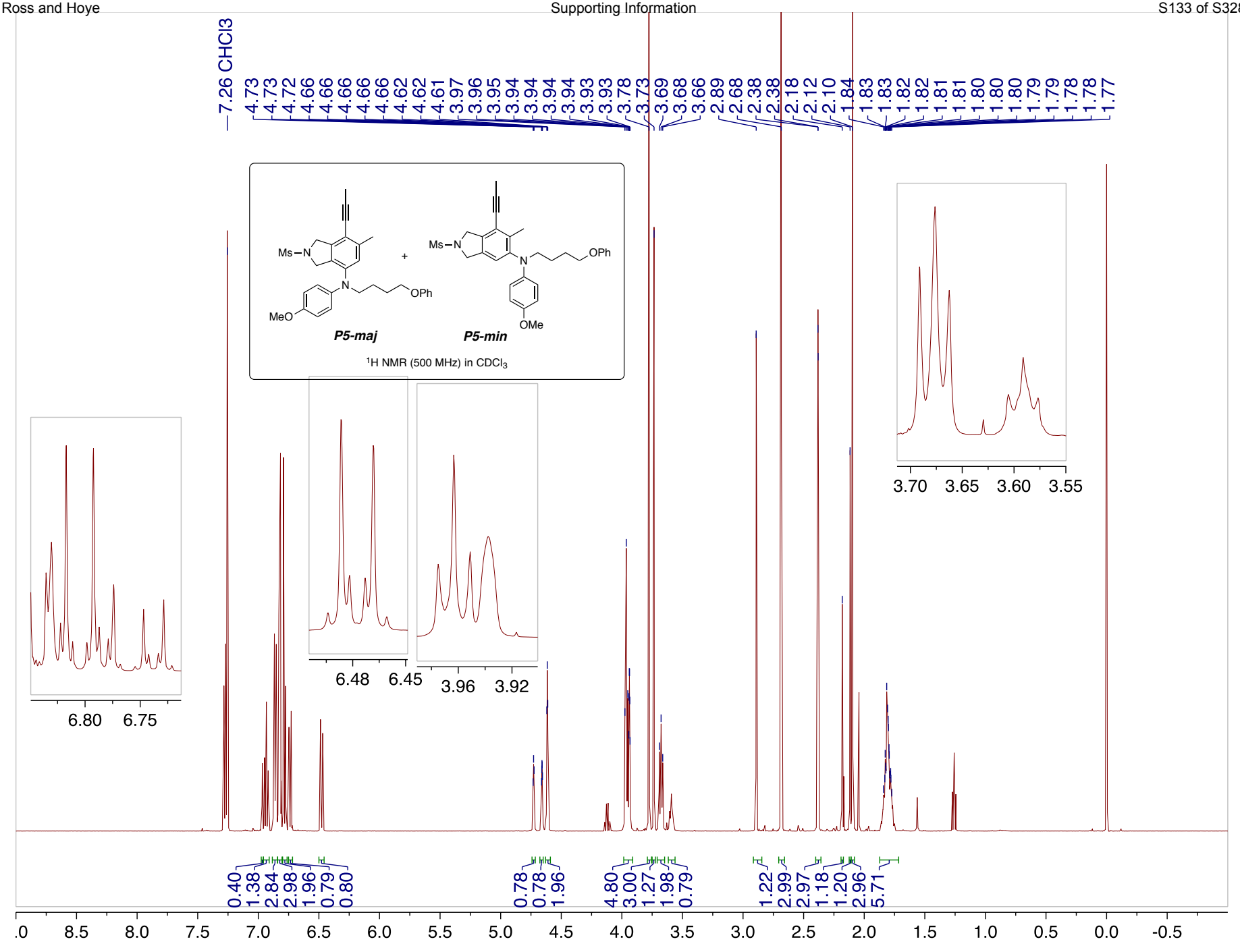

{2.12,4.56}
{2.40,20.34}
{1.82,24.75}
{1.82,26.70}
{2.73,34.55}
{4.68,54.42}
{4.13,53.60}
{3.74,52.36}
{2.85,61.14}
{3.97,67.27}
{6.86,114.39}
{6.71,117.63}
{6.94,120.71}
{6.95,124.76}
{6.85,120.19}
{7.27,129.44}
{7.19,129.33}
Ms
N
Ph
N
OPh
P4-maj
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5

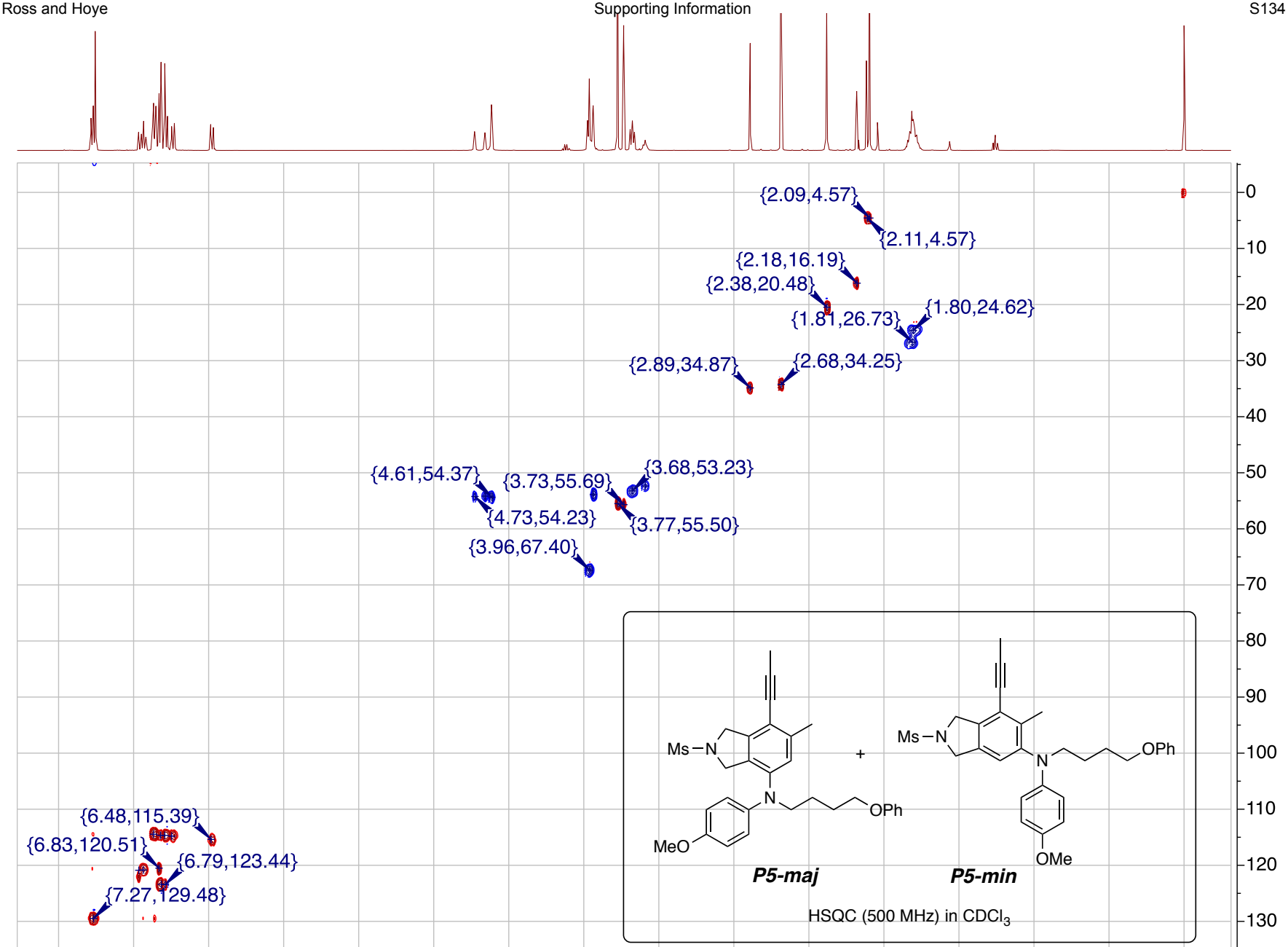

Ms–N
N
Ph
OPh
P4-maj
HMBC (500 MHz) in CDCl3
{2.12,75.23}
{2.11,93.93}
{2.40,114.34}
{2.40,124.77}
{4.14,129.31}
{4.68,140.71}
{3.74,141.12}
{3.74,147.32}
{3.97,158.77}
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210

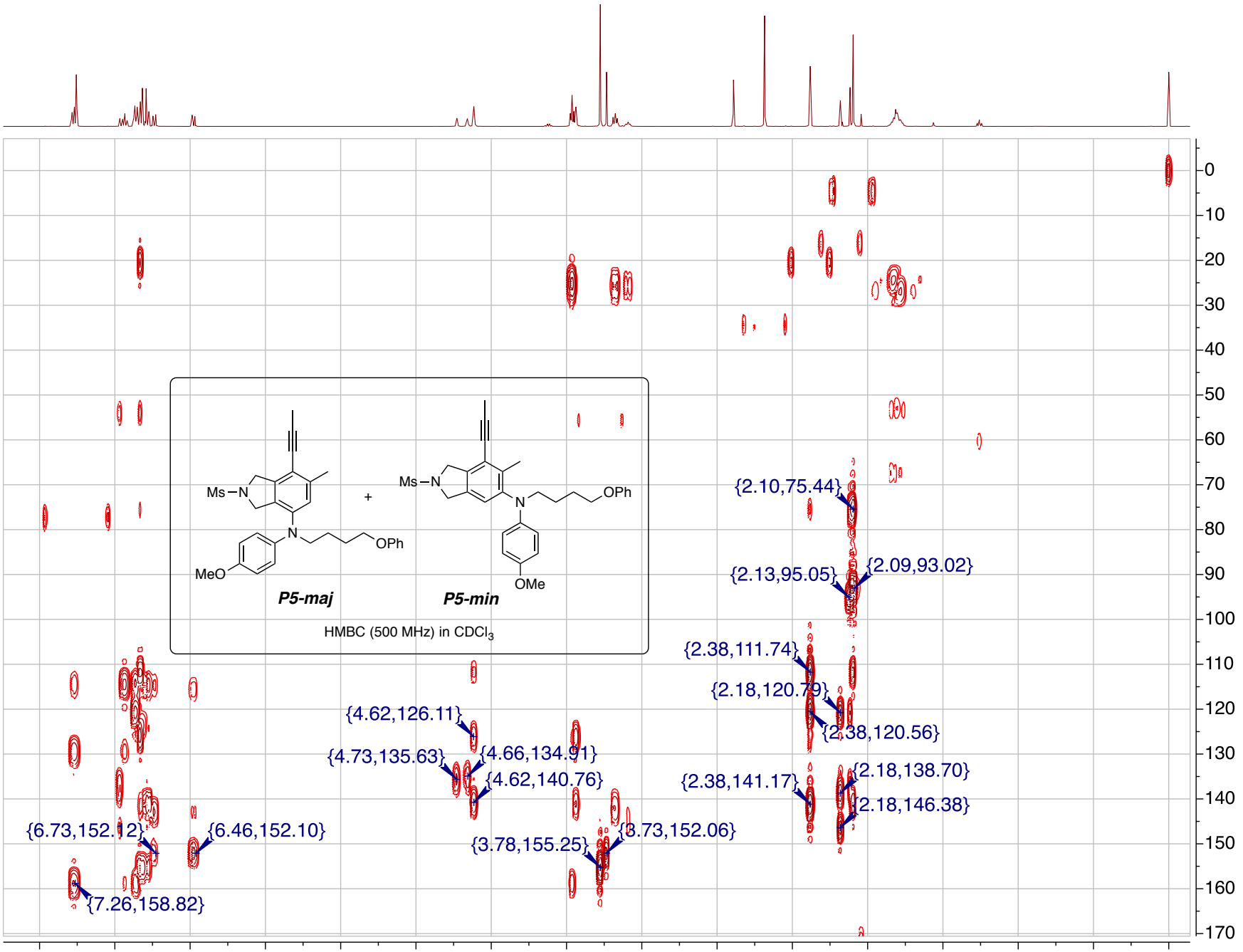

CHCl3
7.32 7.30 7.30 7.29 7.28 7.19 7.17 7.17 7.15 7.01 6.98 6.97 6.97 6.97 6.91 6.91 6.90 6.90 6.89 6.89 6.89 6.74 6.73 6.73 6.73 6.52 6.51 6.50 6.50 6.50 4.78 4.77 4.77 4.70 4.70 4.02 4.00 3.99 3.67 3.65 3.64 2.93 2.22 2.15 1.86 1.86 1.85
Ms–N
N
Ph
OPh
P4-min
1H NMR (500 MHz) in CDCl3
4.02 4.00 3.98
6.95 6.90
6.74 6.72
6.52 6.50 6.48
3.68 3.64
7.32 7.28
7.14
2.86 2.04 1.00 1.13 2.17 1.00 1.99
2.00 2.07
2.08
2.01
2.98
2.95 3.28 4.27
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

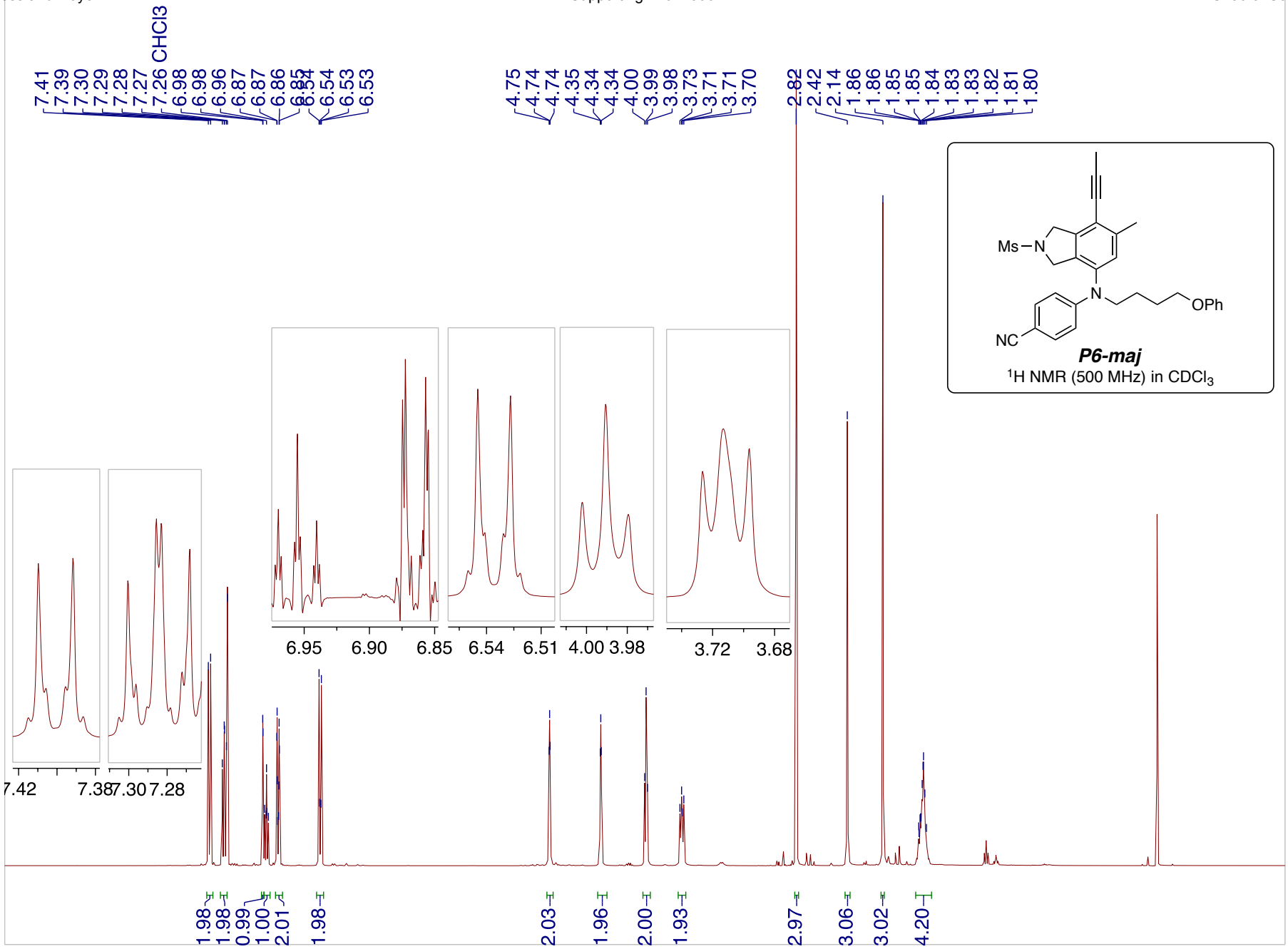

{2.16,4.39}
{2.23,15.93}
{1.86,26.65}
{1.86,24.59}
{2.93,34.76}
{4.78,54.10}
{4.71,54.02}
{3.66,51.61}
{4.01,67.23}
{6.90,114.33}
{6.51,112.84}
{7.02,123.02}
{6.73,117.01}
{7.31,129.35}
{7.18,129.05}
Ms
N
N
Ph
OPh
P4-min
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

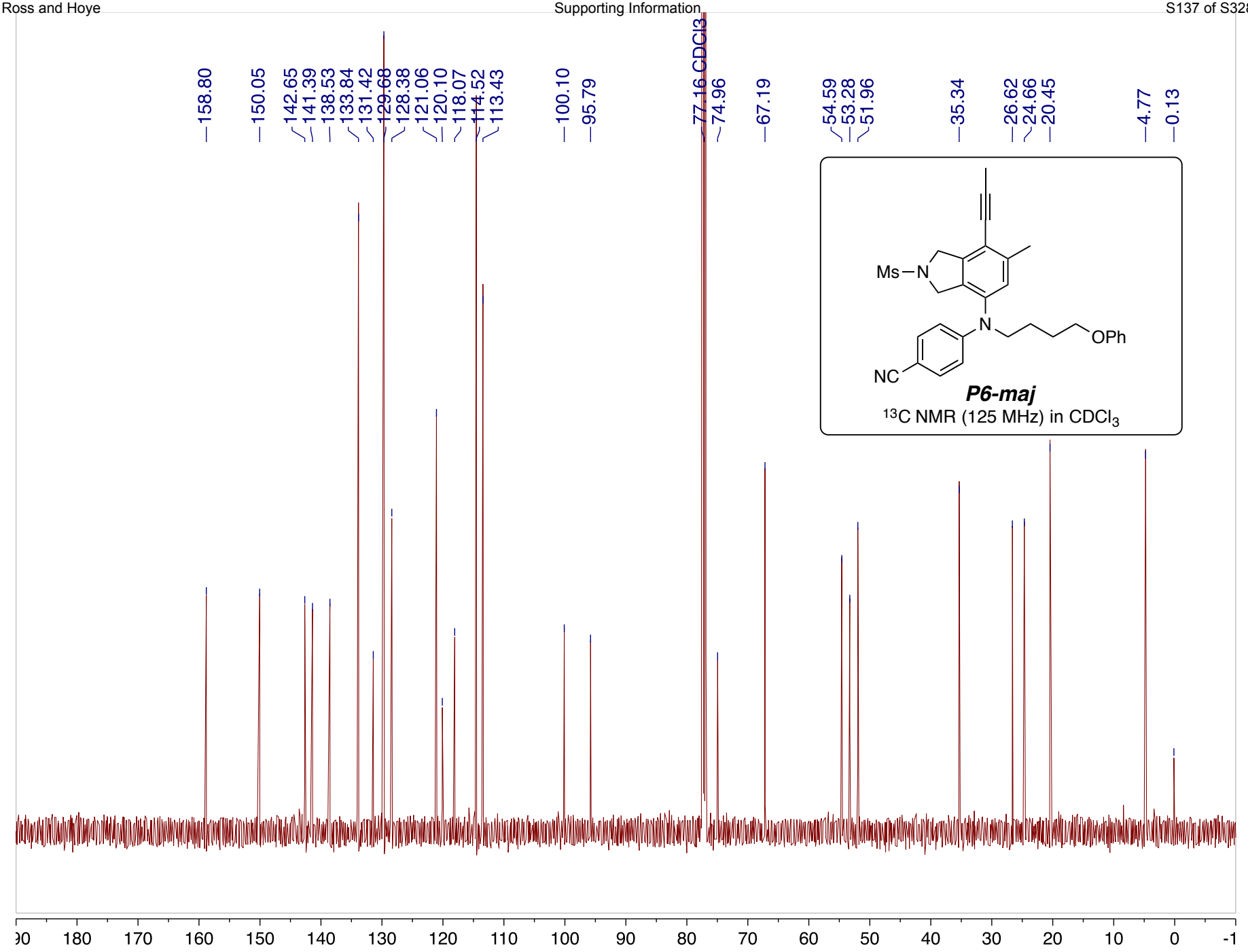

Ms–N
N
Ph
OPh
P4-min
HMBC (500 MHz) in CDCl3
{2.15,75.33}
{2.14,95.28}
{2.22,120.87}
{2.23,138.98}
{4.77,137.05}
{4.69,134.27}
{3.63,145.17}
{3.63,148.18}
{4.00,158.69}
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170

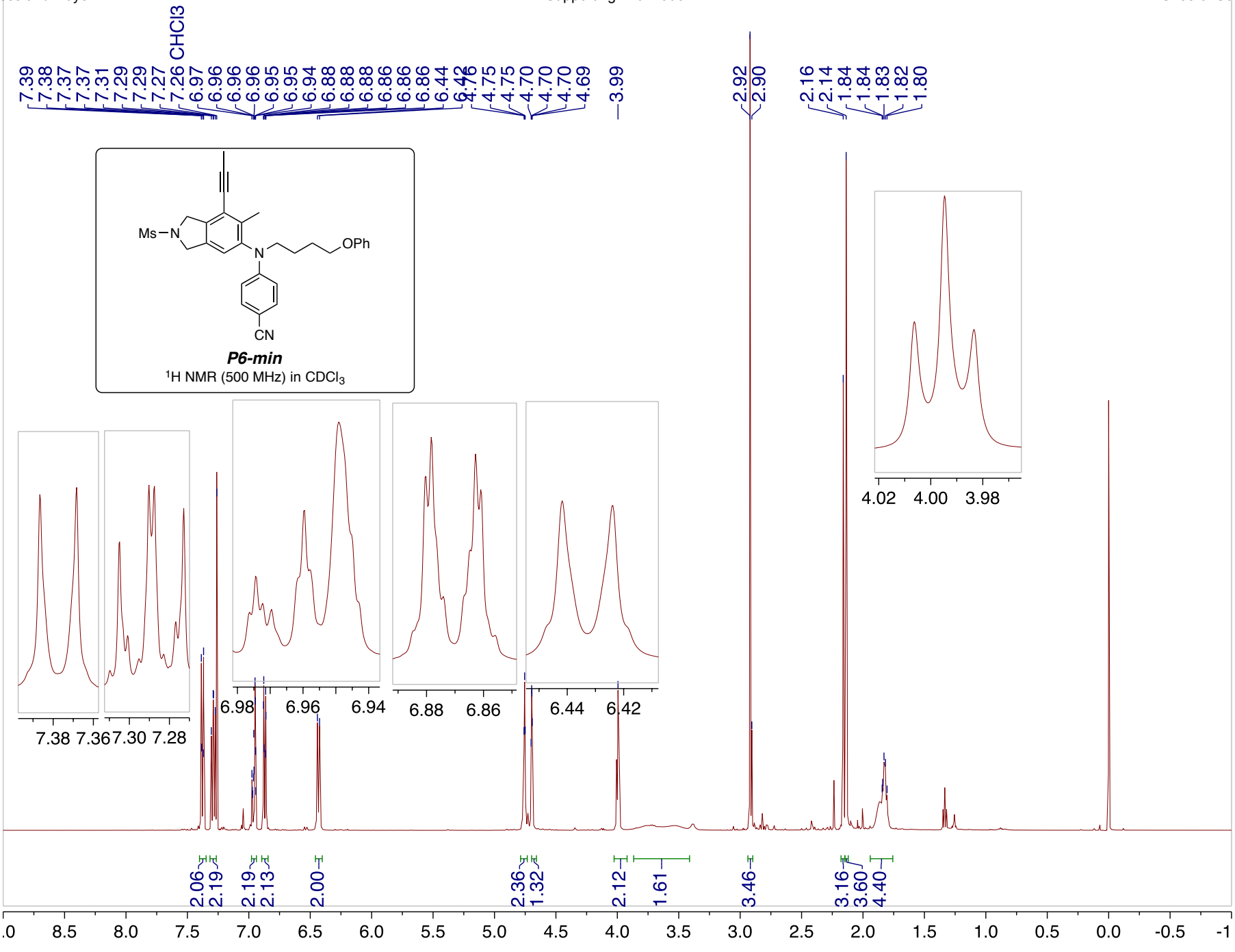

7.26 CHCl3
4.73 4.73 4.72 4.66 4.66 4.66 4.66 4.62 4.62 4.61 3.97 3.96 3.95 3.94 3.94 3.94 3.94 3.93 3.93 3.78 3.73 3.69 3.68 3.66 2.89 2.68 2.38 2.38 2.18 2.12 2.10 1.84 1.83 1.83 1.82 1.82 1.81 1.81 1.80 1.80 1.80 1.79 1.79 1.78 1.78 1.77
Ms–N
N
OPh
MeO
P5-maj
P5-min
OMe
1H NMR (500 MHz) in CDCl3
6.80 6.75
6.48 6.45
3.96 3.92
3.70 3.65 3.60 3.55
0.40 1.38 2.84 2.98 1.96 0.79 0.80
0.78 0.78 1.96
4.80 3.00 1.27 1.98 0.79
1.22 2.99 2.97 1.18 1.20 2.96 5.71
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5

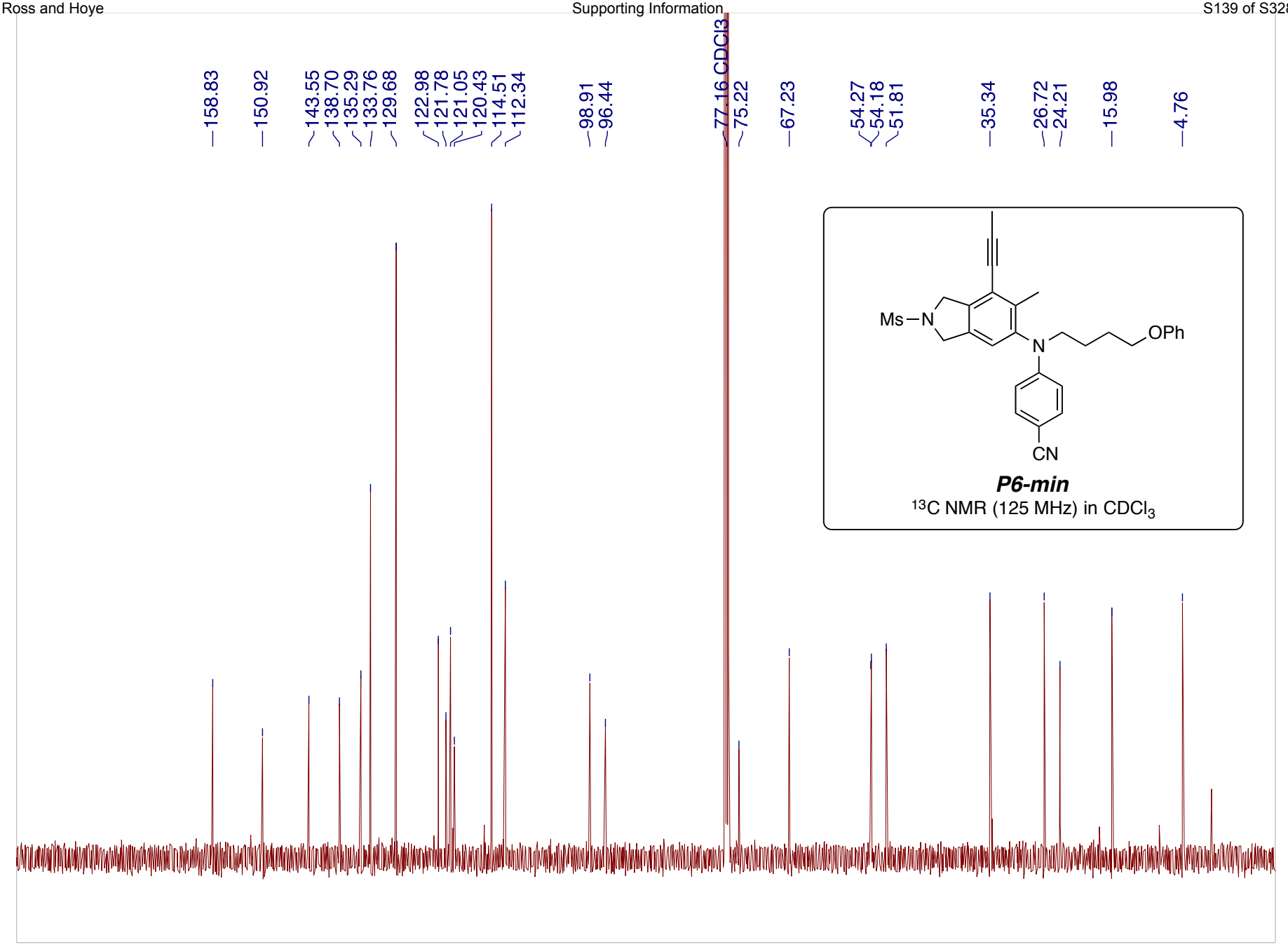

{2.09,4.57}
{2.11,4.57}
{2.18,16.19}
{2.38,20.48}
{1.81,26.73}
{1.80,24.62}
{2.89,34.87}
{2.68,34.25}
{4.61,54.37}
{3.73,55.69}
{3.68,53.23}
{4.73,54.23}
{3.77,55.50}
{3.96,67.40}
{6.48,115.39}
{6.83,120.51}
{6.79,123.44}
{7.27,129.48}
Ms–N
N
OPh
MeO
+
Ms–N
N
OPh
OMe
P5-maj
P5-min
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

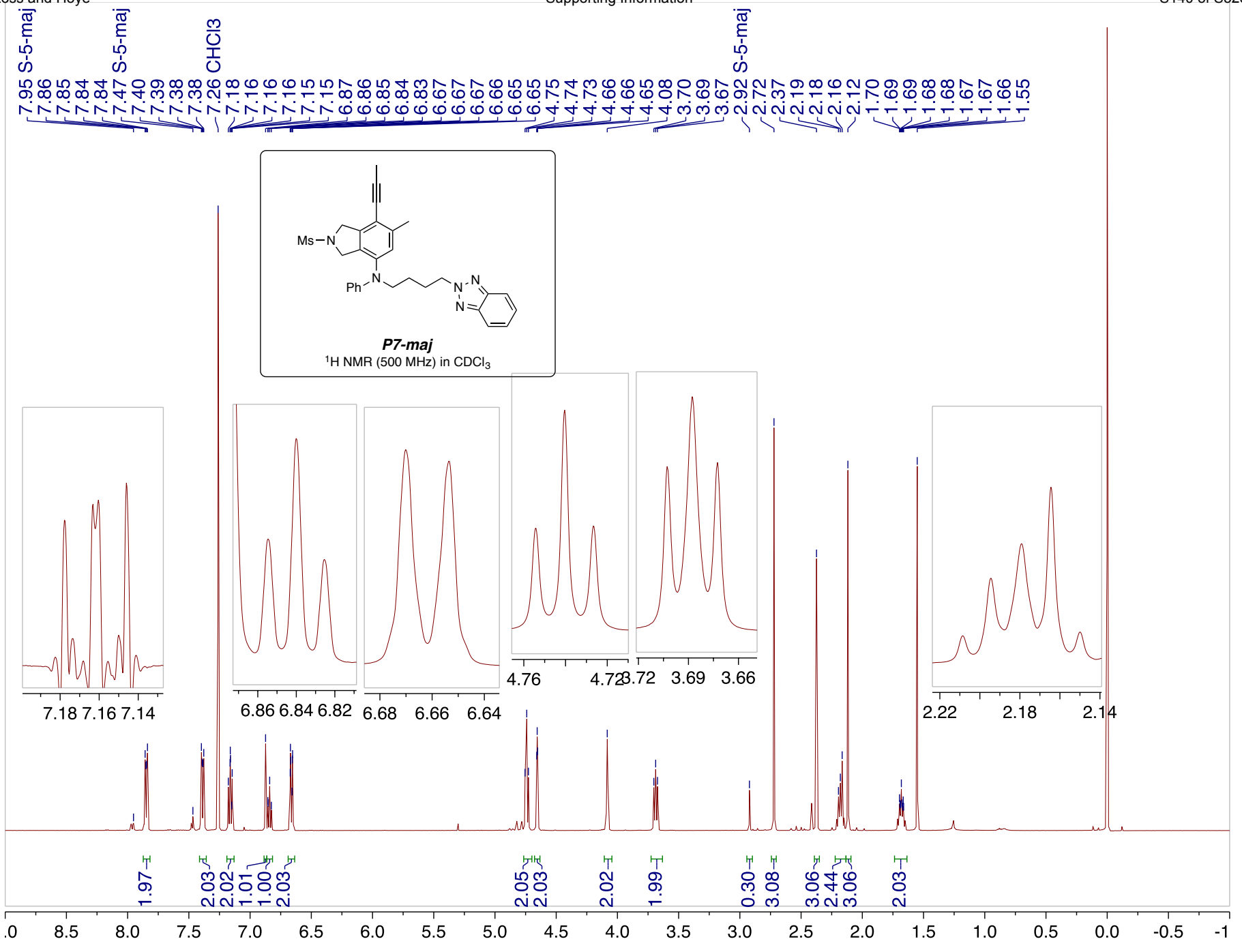

Ms–N
N
OPh
MeO
P5-maj
+
Ms–N
N
OPh
OMe
P5-min
HMBC (500 MHz) in CDCl3
{2.10,75.44}
{2.13,95.05}
{2.09,93.02}
{2.38,111.74}
{2.18,120.79}
{2.38,120.56}
{4.62,126.11}
{4.73,135.63}
{4.66,134.91}
{4.62,140.76}
{2.38,141.17}
{2.18,138.70}
{2.18,146.38}
{6.73,152.12}
{6.46,152.10}
{3.78,155.25}
{3.73,152.06}
{7.26,158.82}
7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170

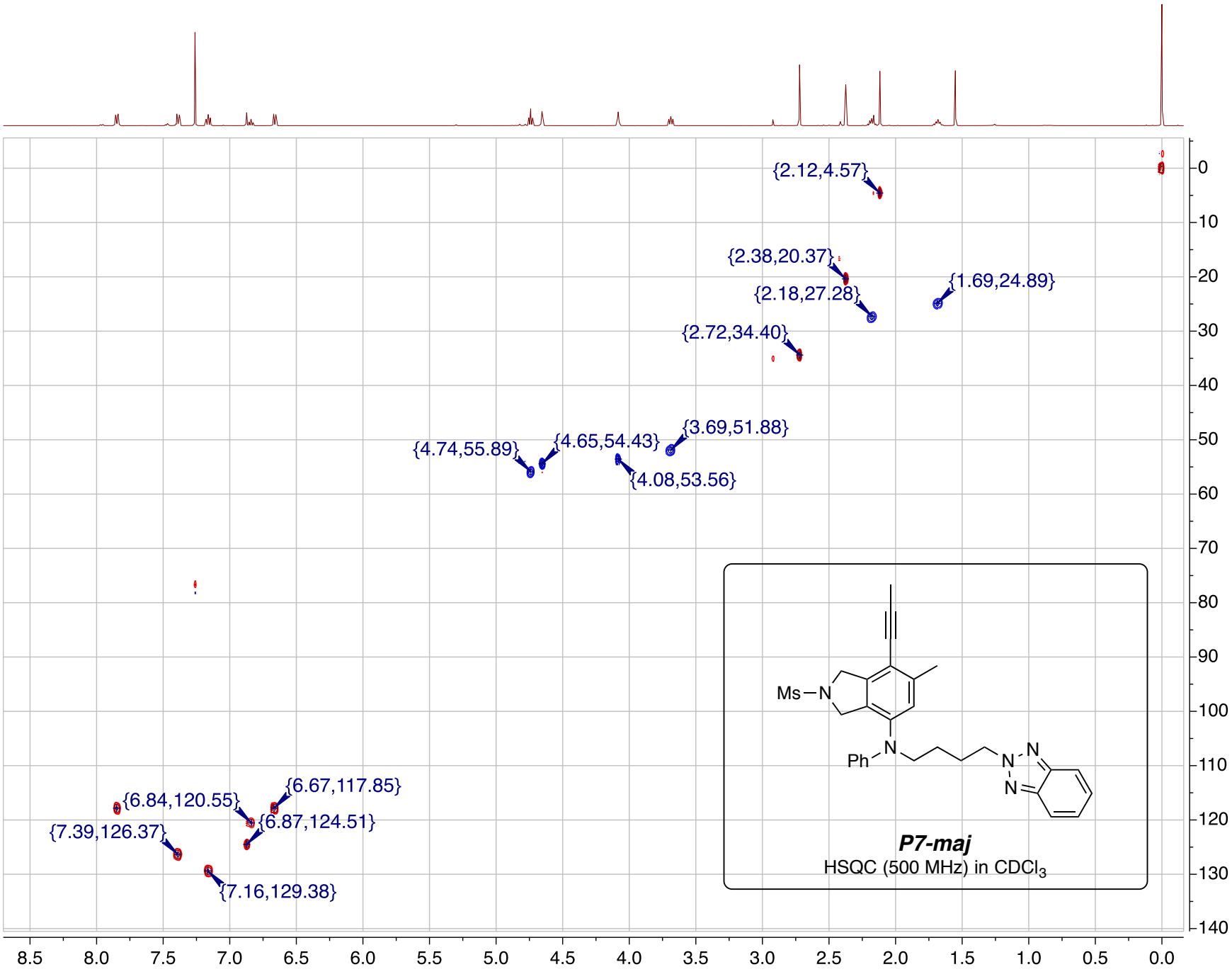

CHCl3
7.41 7.39 7.30 7.29 7.28 7.27 7.26 6.98 6.98 6.96 6.87 6.87 6.86 6.85 6.54 6.54 6.53 6.53
4.75 4.74 4.74 4.35 4.34 4.34 4.00 3.99 3.98 3.73 3.71 3.71 3.70
2.82 2.42 2.14 1.86 1.86 1.85 1.85 1.84 1.83 1.83 1.82 1.81 1.80
Ms–N
N
OPh
NC
P6-maj
1H NMR (500 MHz) in CDCl3
6.95 6.90 6.85 6.54 6.51 4.00 3.98 3.72 3.68
7.42 7.38 7.30 7.28
1.98 1.98 0.99 1.00 2.01 1.98 2.03 1.96 2.00 1.93 2.97 3.06 3.02 4.20
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

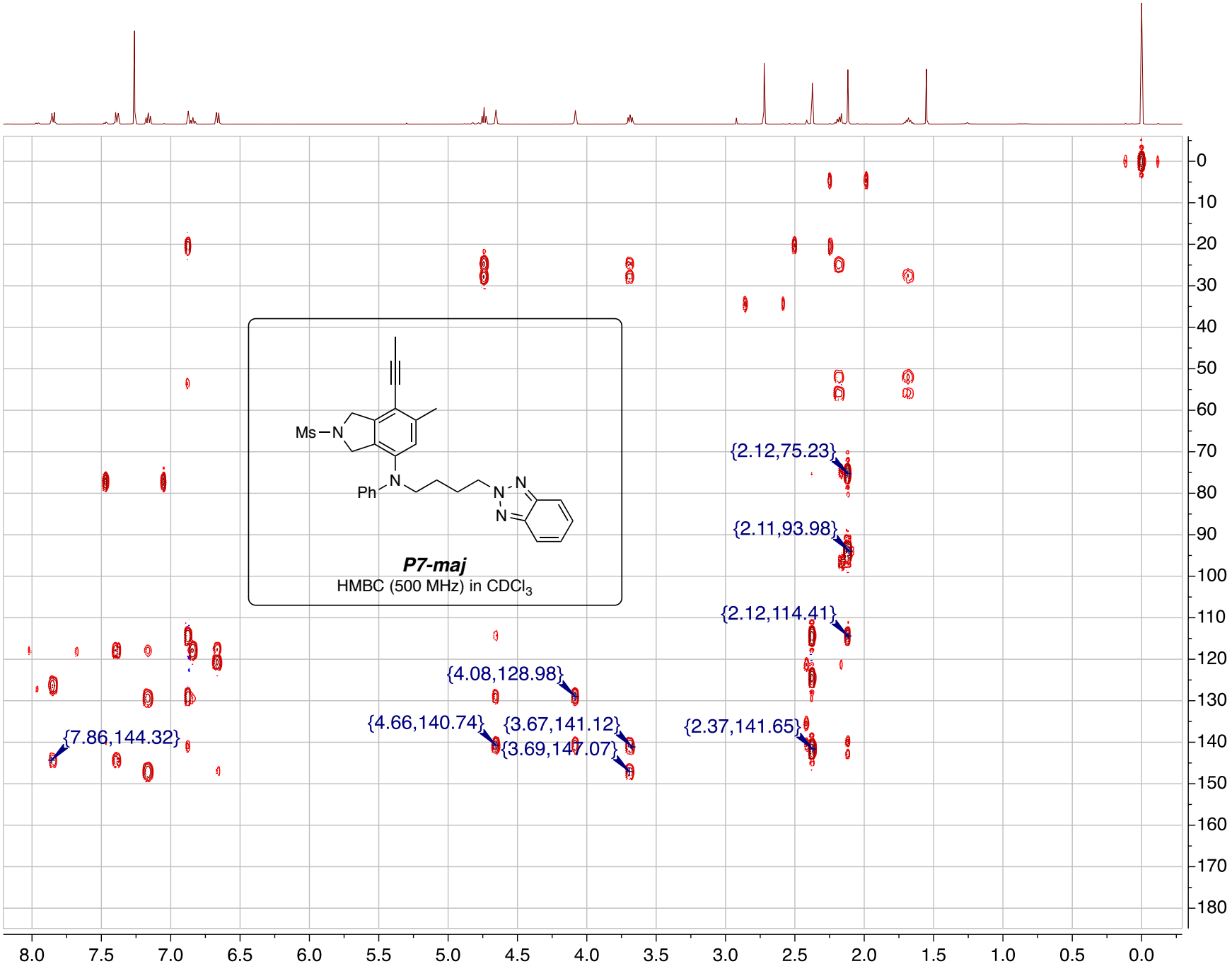

158.80
150.05
142.65
141.39
138.53
133.84
131.42
129.68
128.38
121.06
120.10
118.07
114.52
113.43
100.10
95.79
77.16 CDCl3
74.96
67.19
54.59
53.28
51.96
35.34
26.62
24.66
20.45
4.77
0.13
Ms
N
N
OPh
NC
P6-maj
13C NMR (125 MHz) in CDCl3
90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1

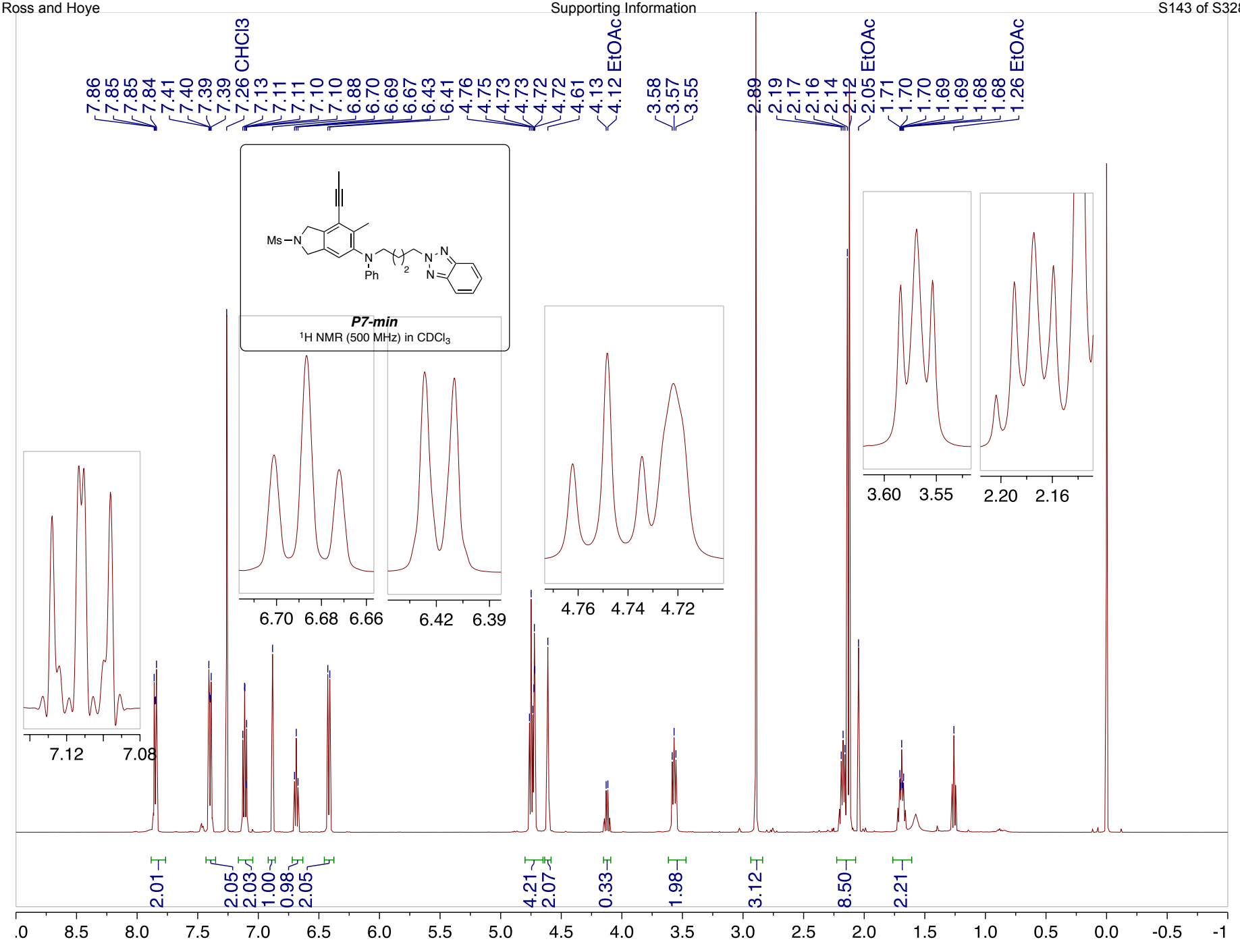

CHCl3
7.39 7.38 7.37 7.37 7.31 7.29 7.29 7.27 7.26 6.97 6.96 6.96 6.96 6.95 6.95 6.94 6.88 6.88 6.88 6.86 6.86 6.86 6.44 6.42 4.76 4.75 4.75 4.70 4.70 4.70 4.69 3.99 2.92 2.90 2.16 2.14 1.84 1.84 1.83 1.82 1.80
Ms
N
OPh
CN
P6-min
1H NMR (500 MHz) in CDCl3
7.38 7.36 7.30 7.28
6.98 6.96 6.94
6.88 6.86
6.44 6.42
4.02 4.00 3.98
2.06 2.19 2.19 2.13 2.00 2.36 1.32 2.12 1.61 3.46 3.16 3.60 4.40
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

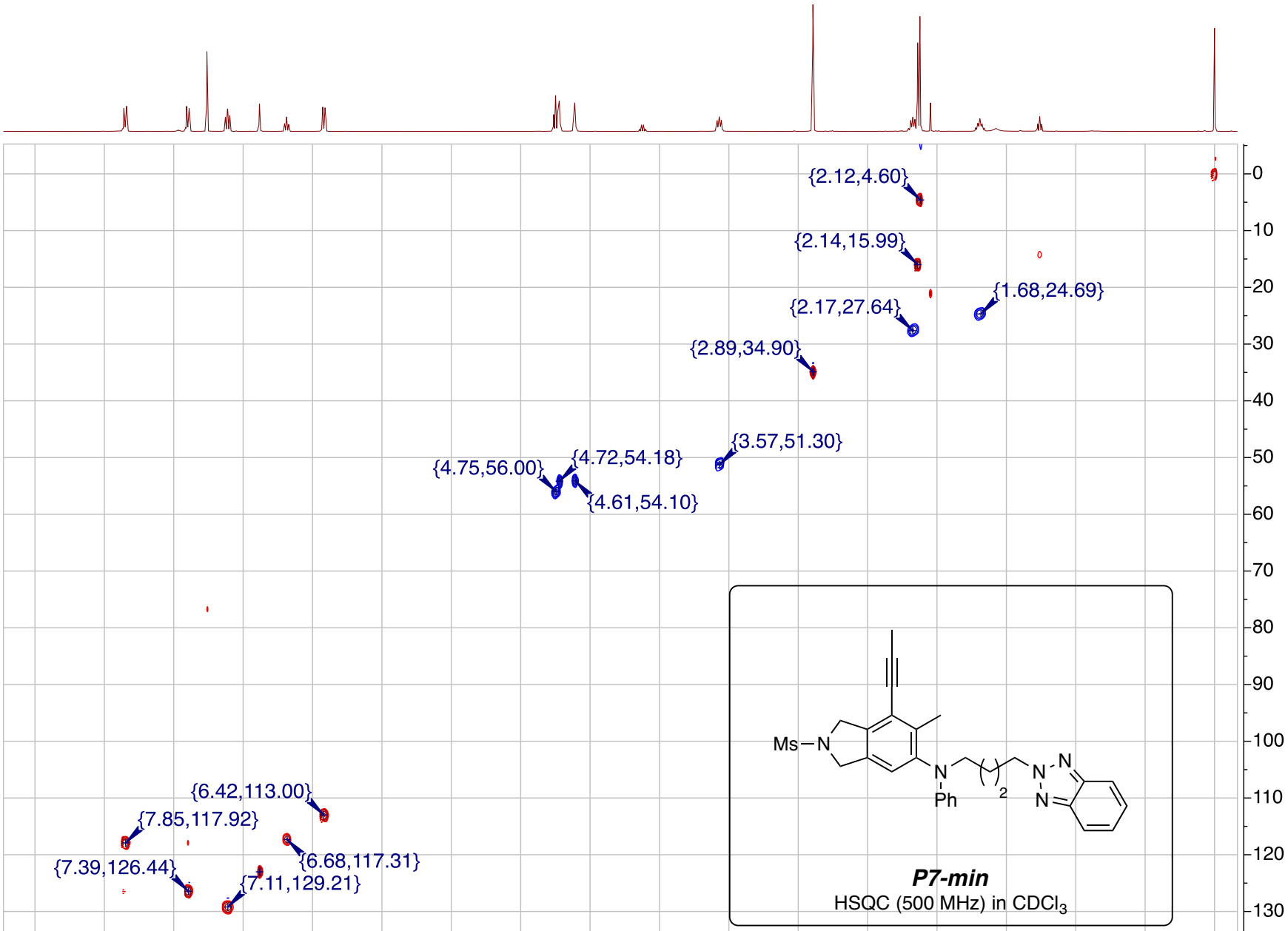

158.83
150.92
143.55
138.70
135.29
133.76
129.68
122.98
121.78
121.05
120.43
114.51
112.34
98.91
96.44
77.16 CDCl3
75.22
67.23
54.27
54.18
51.81
35.34
26.72
24.21
15.98
4.76
Ms—N
N
OPh
CN
P6-min
13C NMR (125 MHz) in CDCl3
90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1

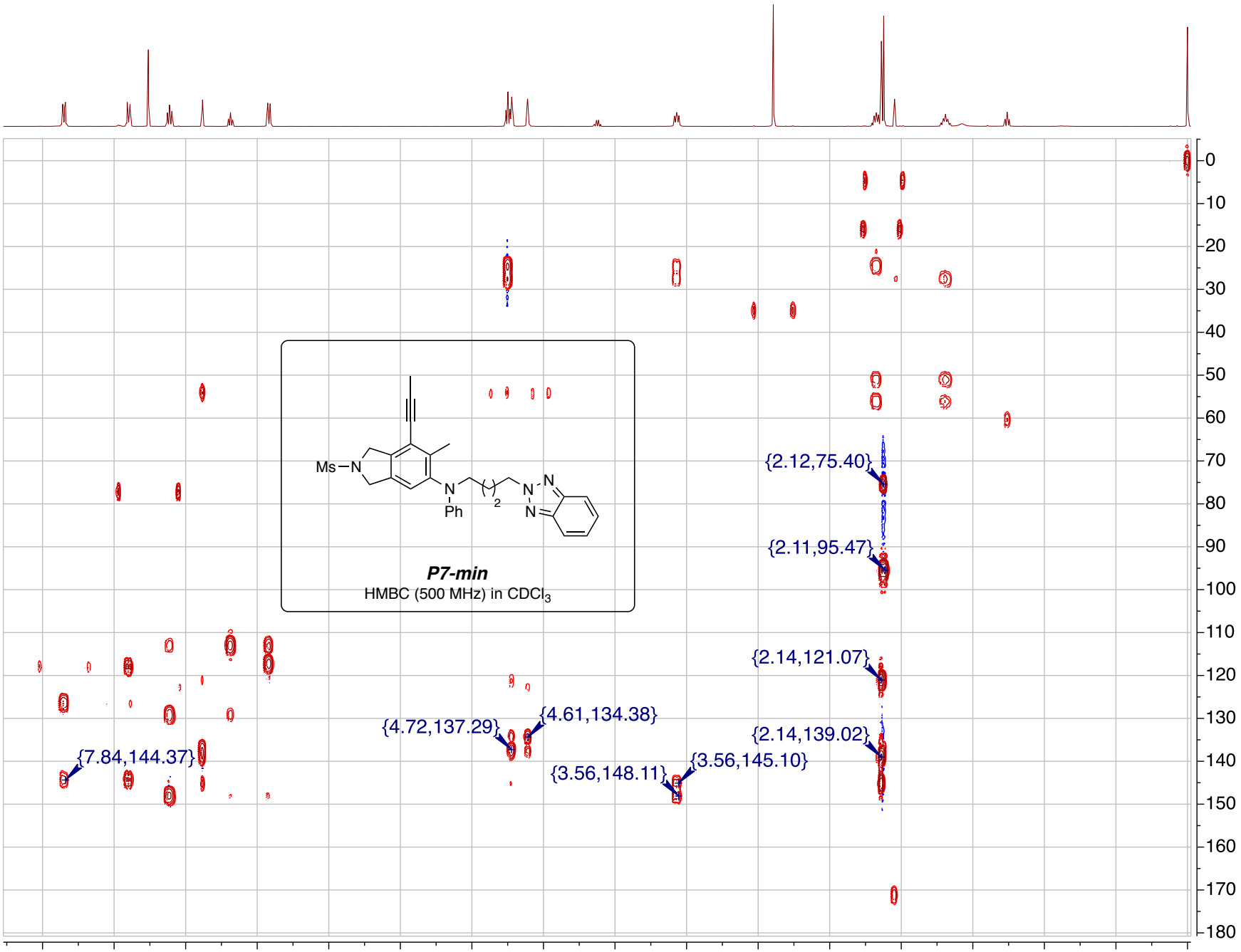

S-5-maj
S-5-maj
CHCl3
S-5-maj
7.95 7.86 7.85 7.84 7.84 7.47 7.40 7.39 7.38 7.38 7.26 7.18 7.16 7.16 7.16 7.15 7.15 6.87 6.86 6.85 6.84 6.83 6.67 6.67 6.67 6.66 6.65 6.65 4.75 4.74 4.73 4.66 4.66 4.65 4.08 3.70 3.69 3.67 2.92 2.72 2.37 2.19 2.18 2.16 2.12 1.70 1.69 1.69 1.68 1.68 1.67 1.67 1.66 1.55
Ms
N
Ph
N
N
N
P7-maj
1H NMR (500 MHz) in CDCl3
7.18 7.16 7.14
6.86 6.84 6.82
6.68 6.66 6.64
4.76 4.72
3.72 3.69 3.66
2.22 2.18 2.14
1.97 2.03 2.02 1.01 1.00 2.03 2.05 2.03 2.02 1.99 0.30 3.08 3.06 2.44 3.06 2.03
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

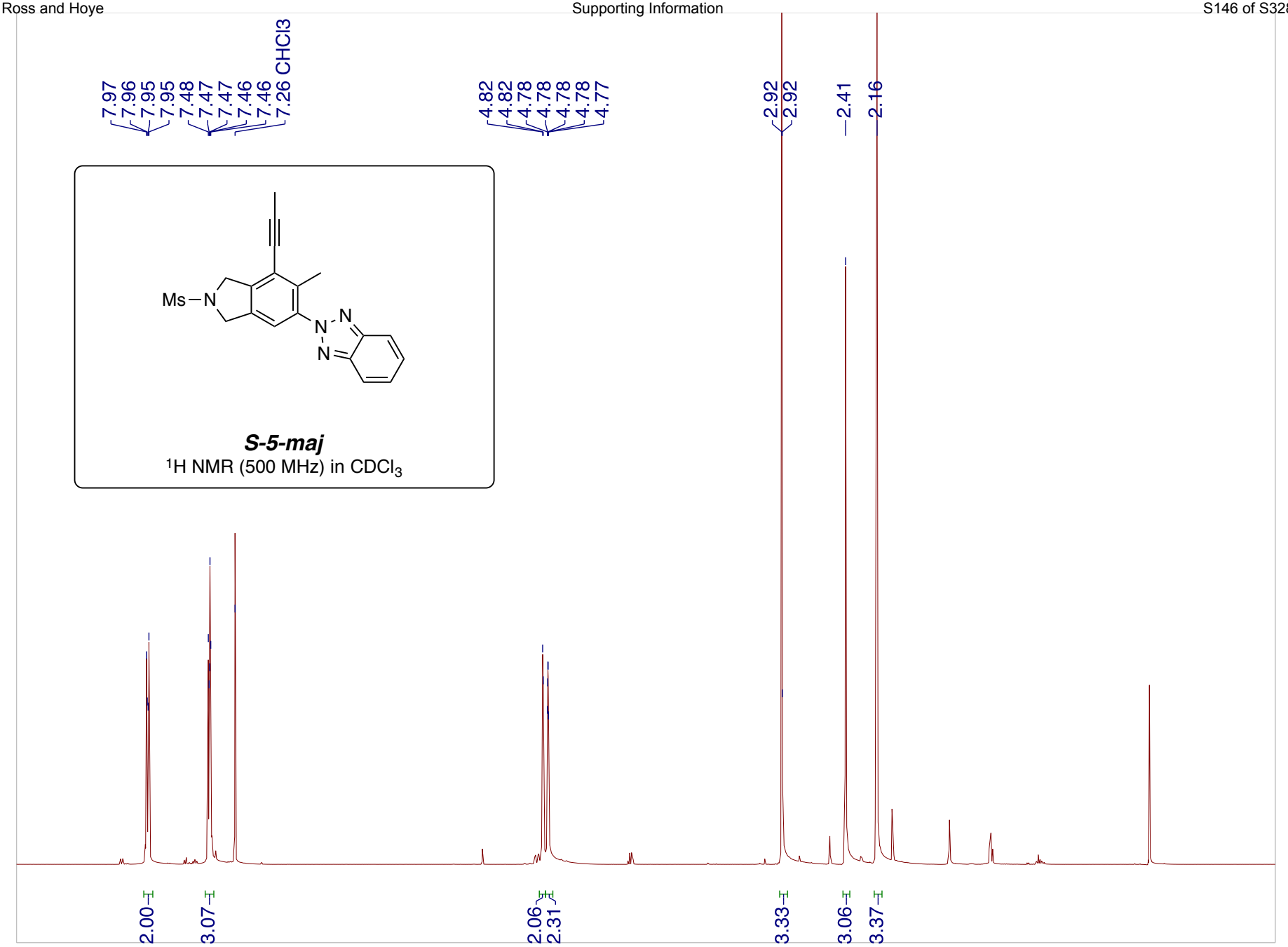

{2.12,4.57}
{2.38,20.37}
{2.18,27.28}
{1.69,24.89}
{2.72,34.40}
{3.69,51.88}
{4.74,55.89}
{4.65,54.43}
{4.08,53.56}
{6.67,117.85}
{6.84,120.55}
{6.87,124.51}
{7.39,126.37}
{7.16,129.38}
Ms—N
Ph
N
N
N
P7-maj
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

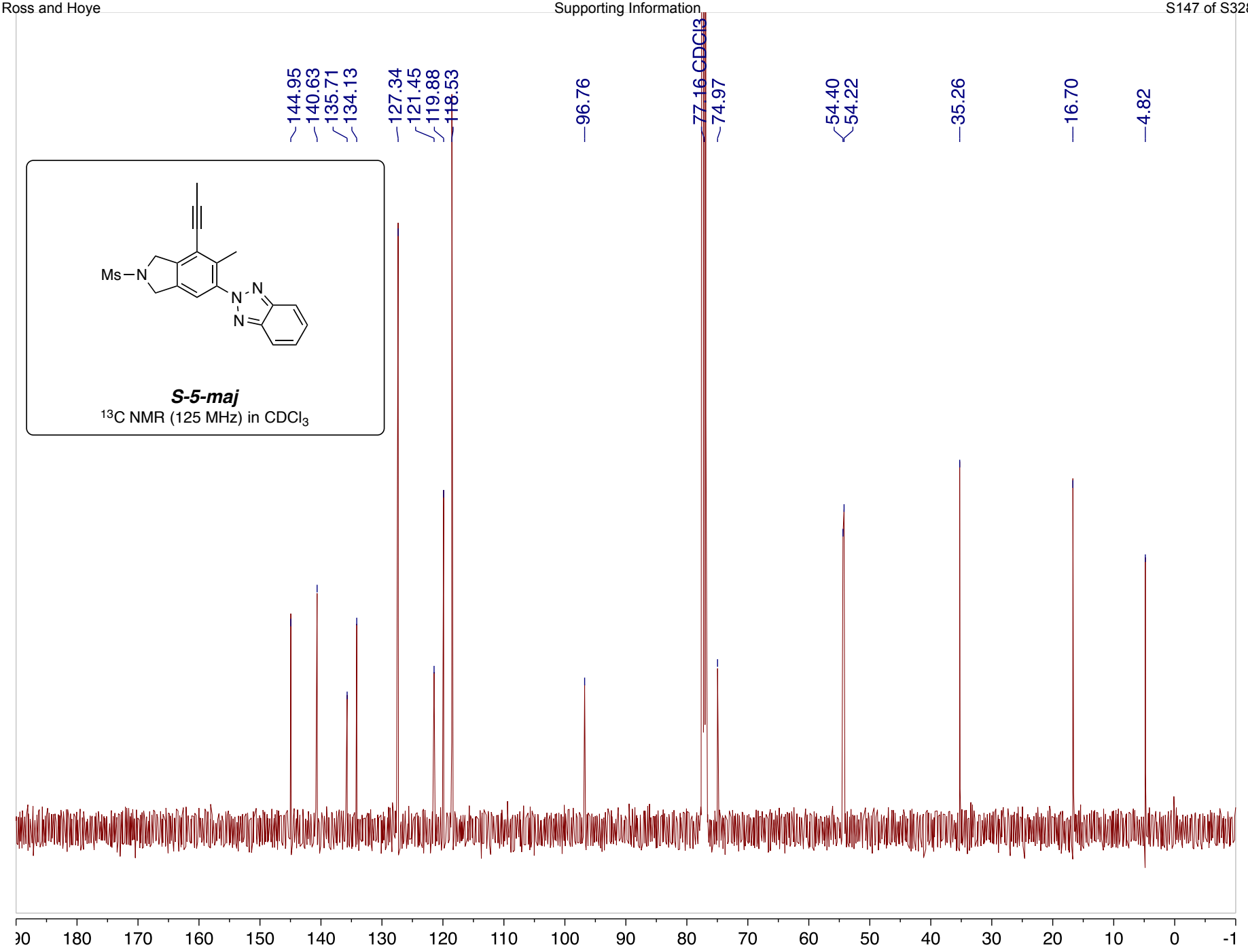

Ms—N
N
Ph
N
N
N
P7-maj
HMBC (500 MHz) in CDCl3
{2.12,75.23}
{2.11,93.98}
{2.12,114.41}
{4.08,128.98}
{4.66,140.74}
{3.67,141.12}
{3.69,147.07}
{2.37,141.65}
{7.86,144.32}
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180

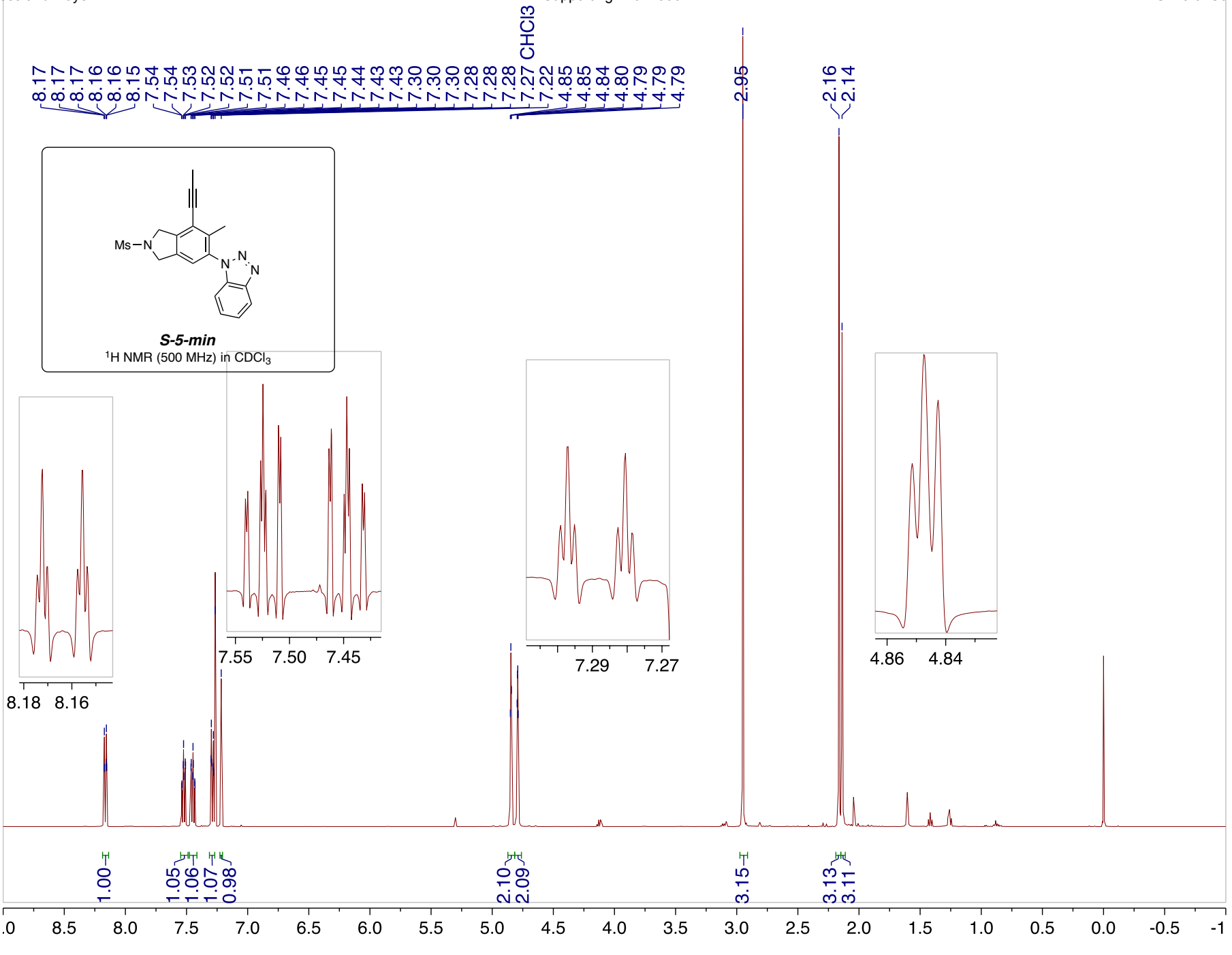

CHCl3
EtOAc
EtOAc
EtOAc
7.86 7.85 7.85 7.84 7.41 7.40 7.39 7.39 7.26 7.13 7.11 7.11 7.10 7.10 6.88 6.70 6.69 6.67 6.43 6.41 4.76 4.75 4.73 4.73 4.72 4.72 4.61 4.13 4.12 3.58 3.57 3.55 2.89 2.19 2.17 2.16 2.14 2.12 2.05 1.71 1.70 1.70 1.69 1.69 1.68 1.68 1.26
Ms–N
N
Ph
N
N
N
P7-min
1H NMR (500 MHz) in CDCl3
7.12 7.08
6.70 6.68 6.66
6.42 6.39
4.76 4.74 4.72
3.60 3.55
2.20 2.16
2.01 2.05 2.03 1.00 0.98 2.05 4.21 2.07 0.33 1.98 3.12 8.50 2.21
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

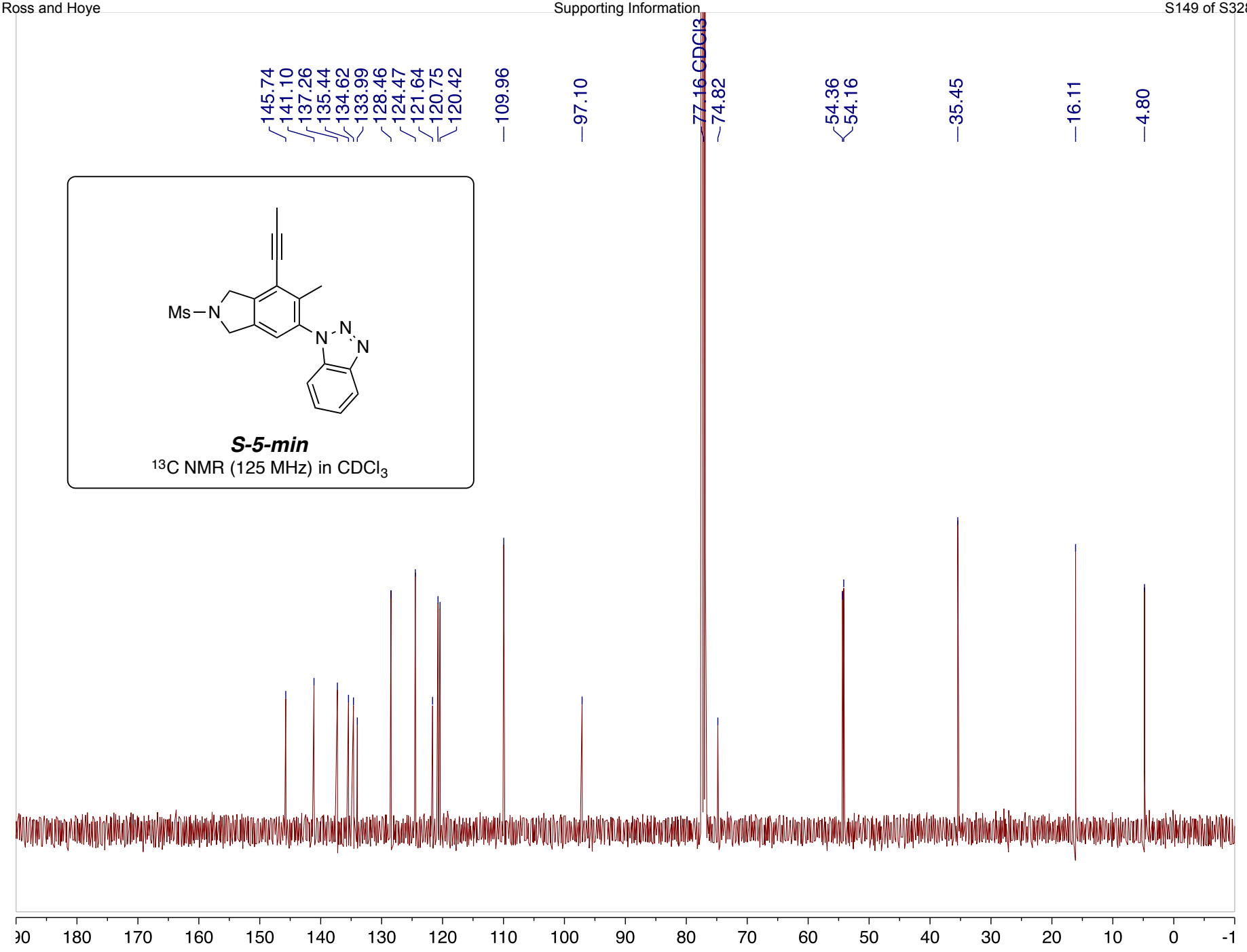

{2.12,4.60}
{2.14,15.99}
{1.68,24.69}
{2.17,27.64}
{2.89,34.90}
{3.57,51.30}
{4.72,54.18}
{4.75,56.00}
{4.61,54.10}
{6.42,113.00}
{7.85,117.92}
{6.68,117.31}
{7.39,126.44}
{7.11,129.21}
Ms—N
N
Ph
2
N
N
N
P7-min
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

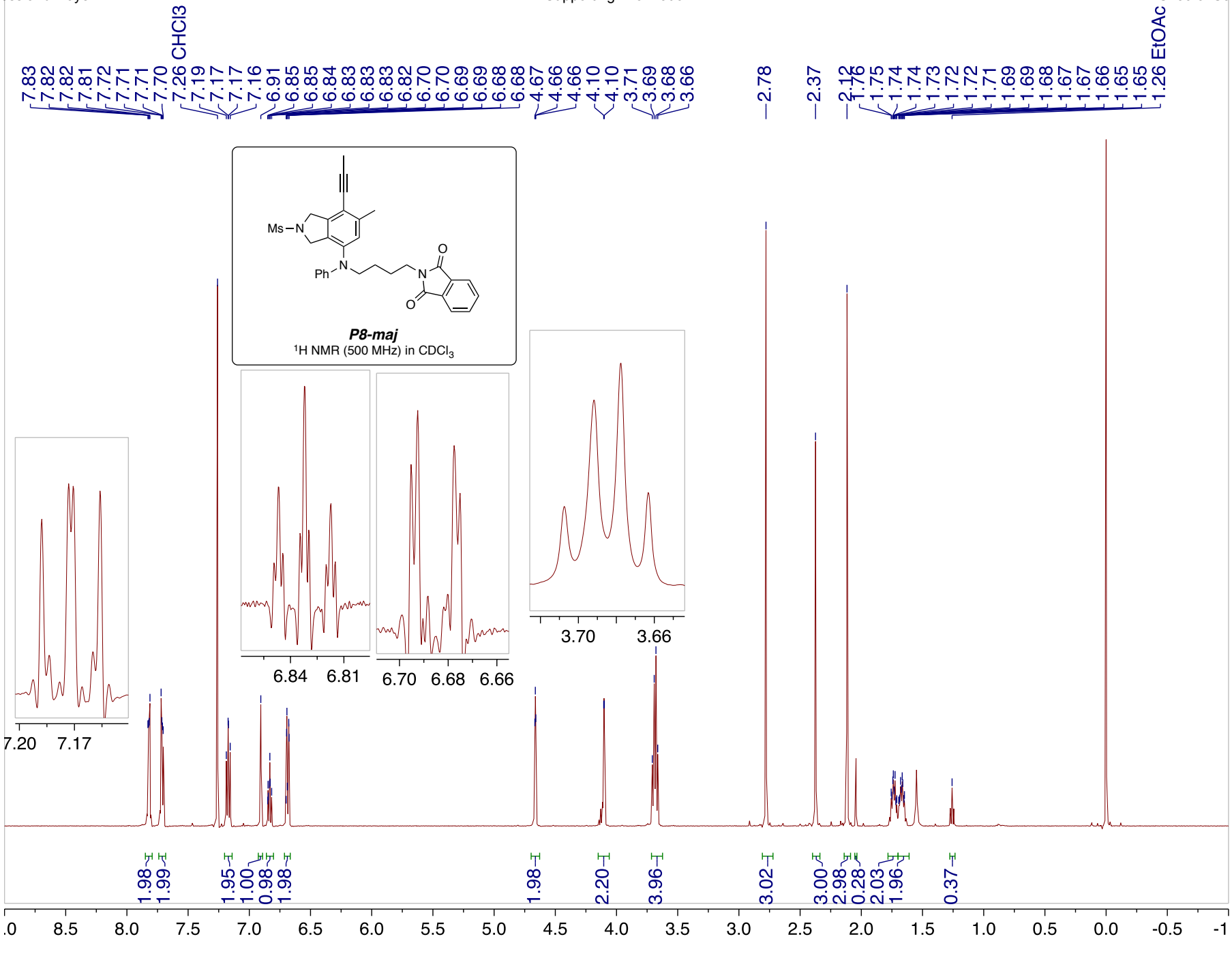

Ms–N
N
Ph
2
N
N
N
P7-min
HMBC (500 MHz) in CDCl3
{2.12,75.40}
{2.11,95.47}
{2.14,121.07}
{2.14,139.02}
{4.72,137.29}
{4.61,134.38}
{3.56,148.11}
{3.56,145.10}
{7.84,144.37}
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180

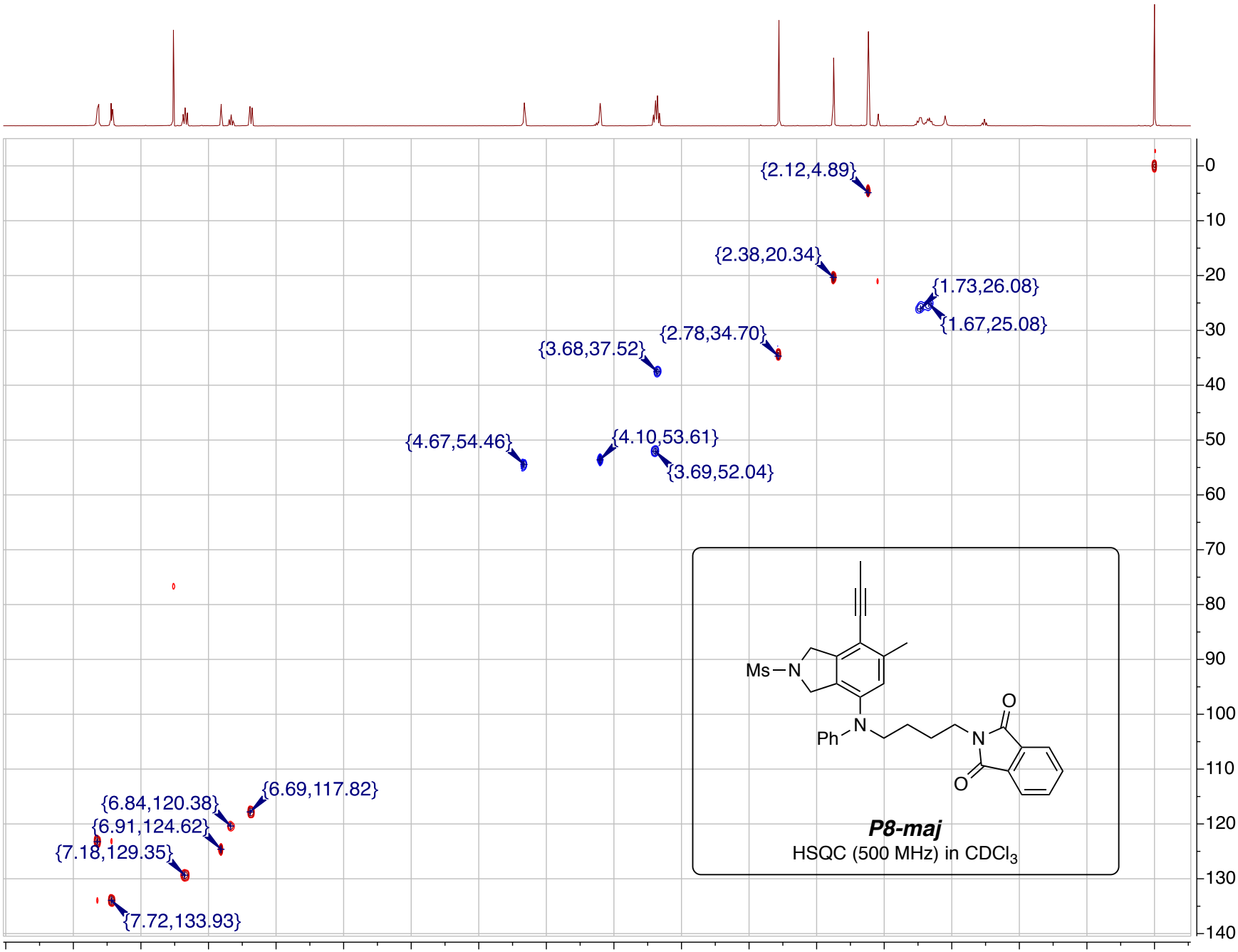

7.97
7.96
7.95
7.95
7.48
7.47
7.47
7.46
7.46
7.26 CHCl3
4.82
4.82
4.78
4.78
4.78
4.78
4.77
2.92
2.92
2.41
2.16
Ms—N
N
N
N
S-5-maj
1H NMR (500 MHz) in CDCl3
2.00
3.07
2.06
2.31
3.33
3.06
3.37
.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1

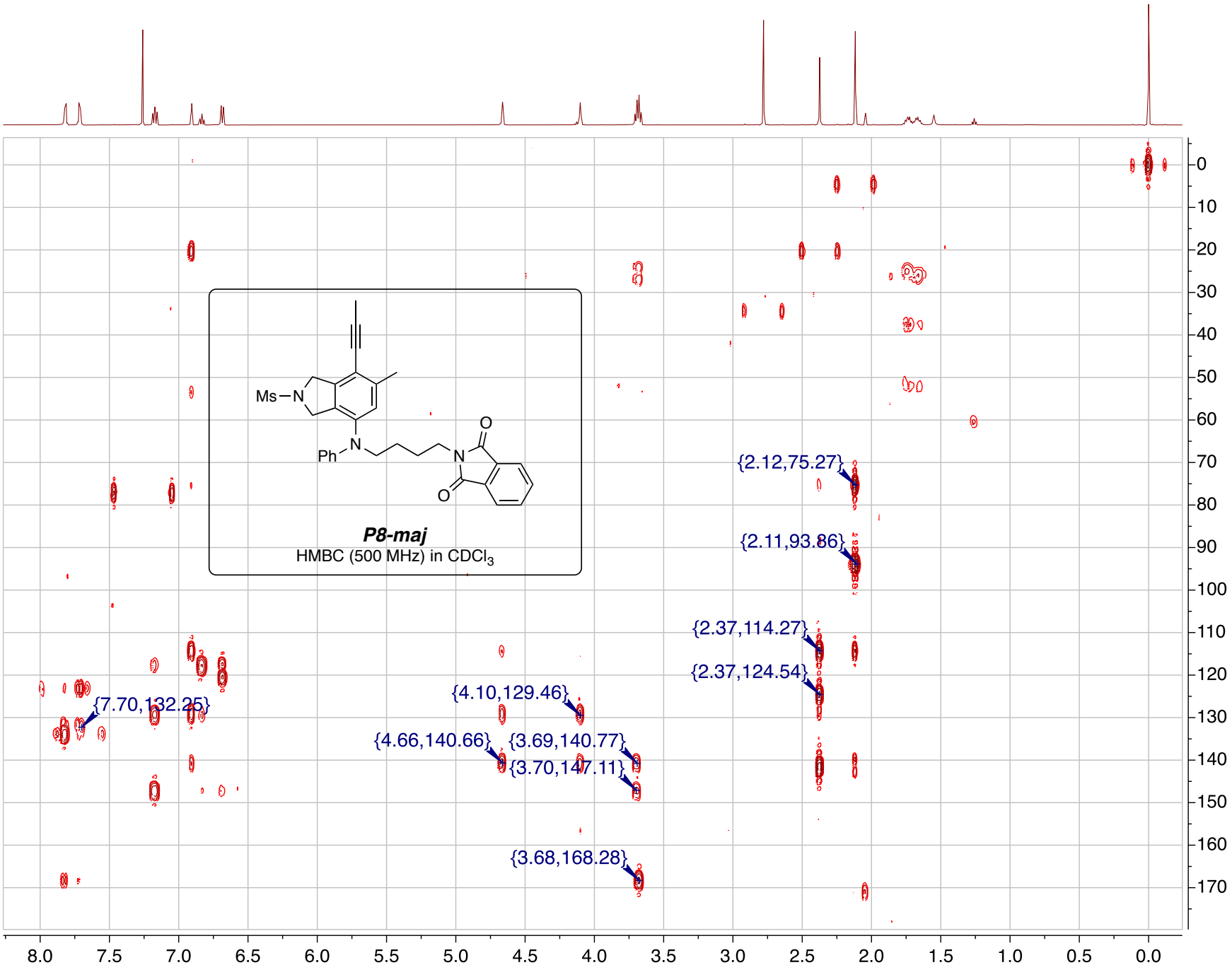

144.95
140.63
135.71
134.13
127.34
121.45
119.88
118.53
96.76
77.16 CDCl3
74.97
54.40
54.22
35.26
16.70
4.82
Ms—N
N
N
N
S-5-maj
13C NMR (125 MHz) in CDCl3
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10

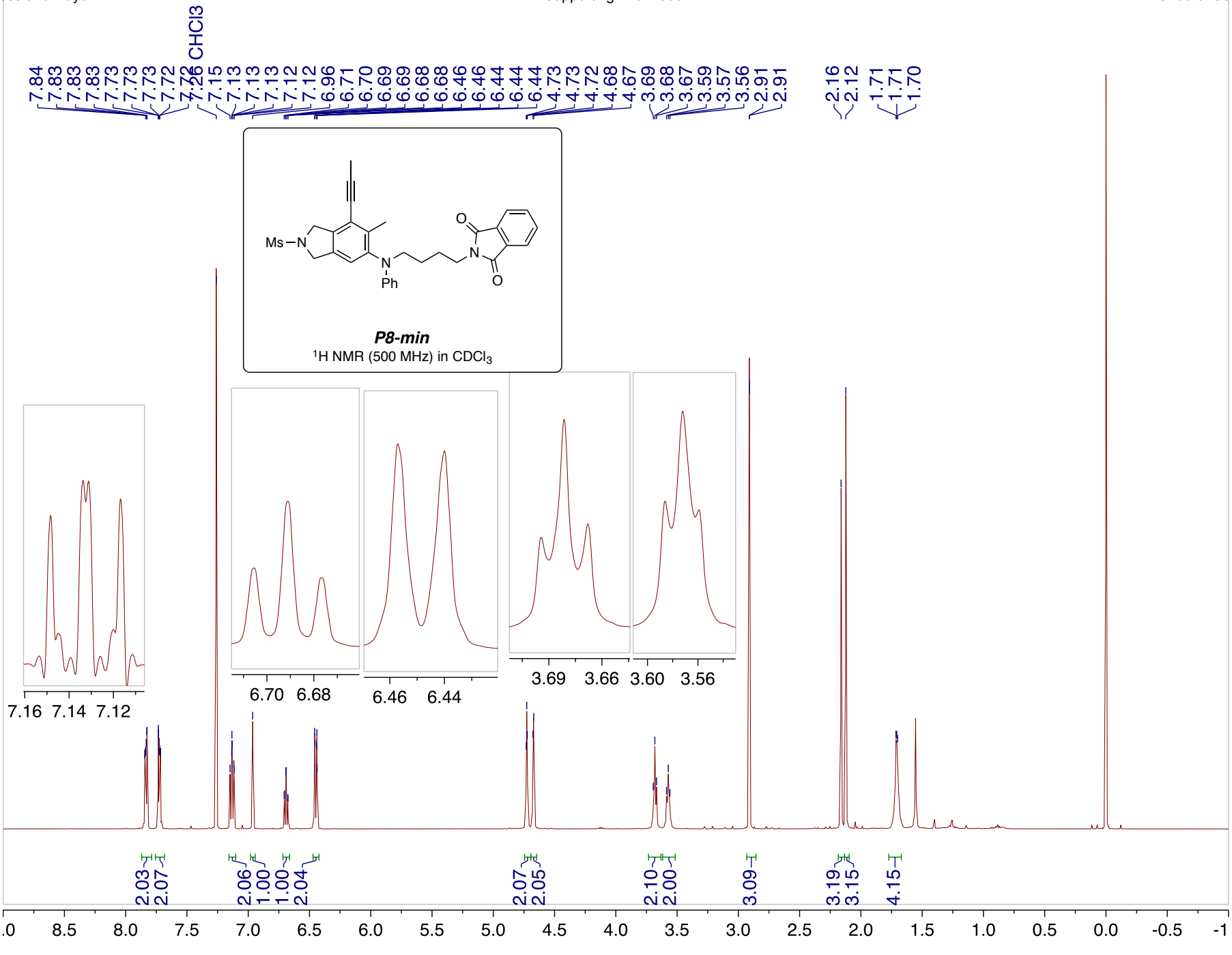

CHCl3
8.17 8.17 8.17 8.16 8.16 8.15
7.54 7.54 7.53 7.52 7.52 7.51 7.51 7.46 7.46 7.45 7.45 7.44 7.43 7.43 7.30 7.30 7.30 7.28 7.28 7.28 7.27
7.22
4.85 4.85 4.84 4.80 4.79 4.79 4.79
2.95
2.16 2.14
Ms
N
N
N
N
S-5-min
1H NMR (500 MHz) in CDCl3
8.18 8.16
7.55 7.50 7.45
7.29 7.27
4.86 4.84
1.00
1.05 1.06 1.07 0.98
2.10 2.09
3.15
3.13 3.11
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

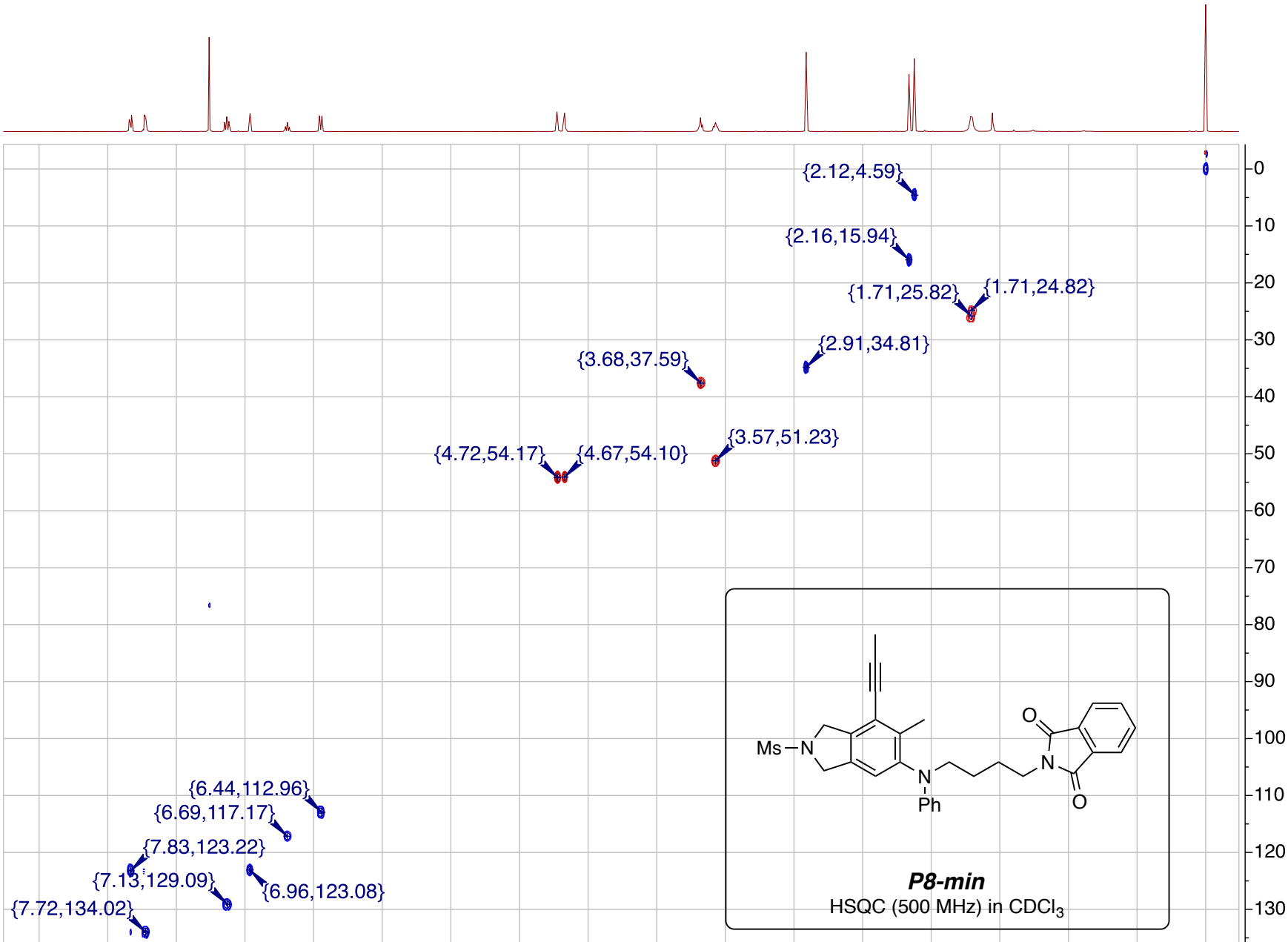

145.74
141.10
137.26
135.44
134.62
133.99
128.46
124.47
121.64
120.75
120.42
109.96
97.10
77.16 CDCl3
74.82
54.36
54.16
35.45
16.11
4.80
Ms—N
N
N
N
S-5-min
13C NMR (125 MHz) in CDCl3
90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1

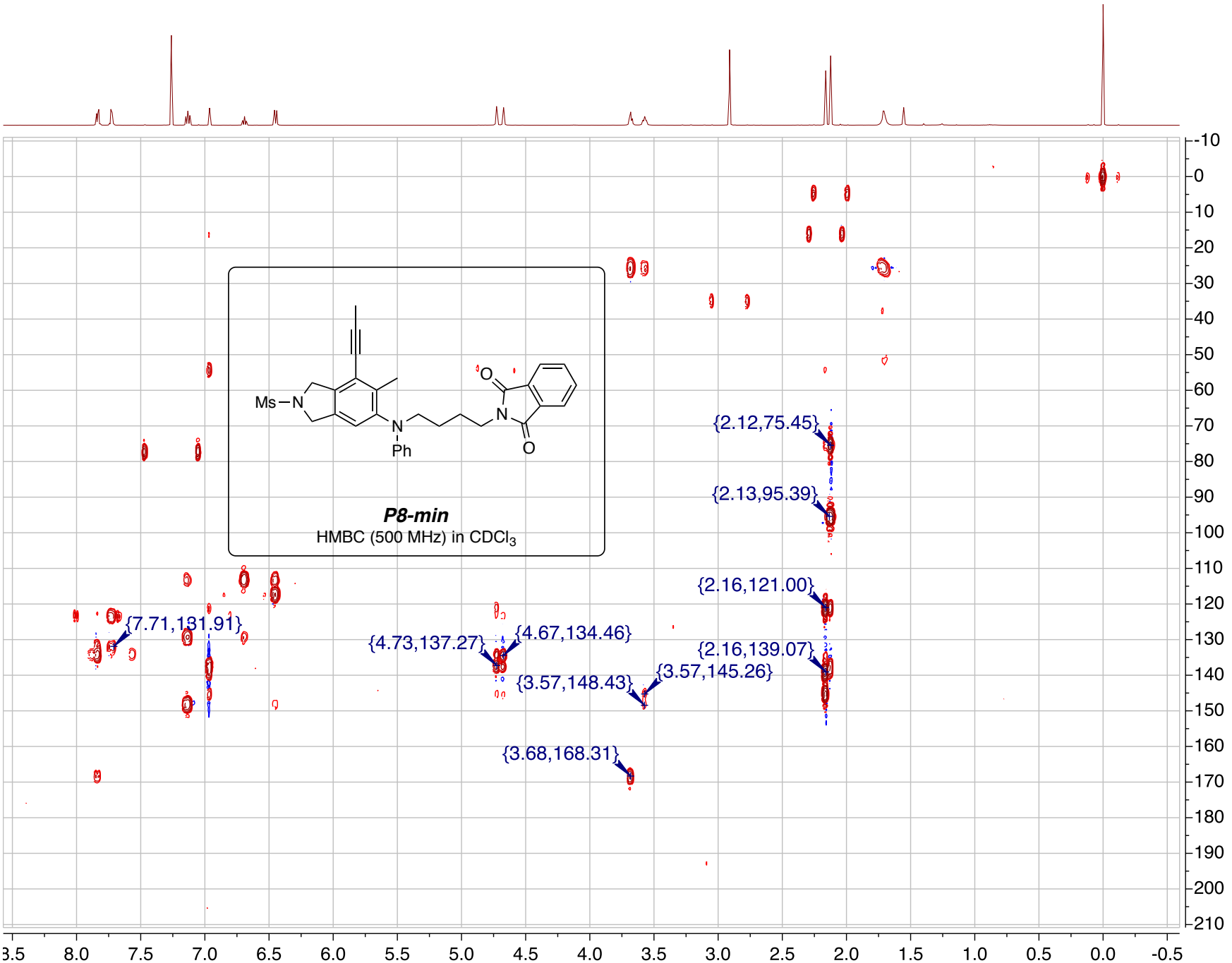

7.83 7.82 7.82 7.81 7.72 7.71 7.71 7.70
CHCl3 7.26
7.19 7.17 7.17 7.16
6.91 6.85 6.84 6.83 6.83 6.83 6.82 6.70 6.70 6.69 6.69 6.68 6.68
4.67 4.66 4.66 4.10 4.10
3.71 3.69 3.68 3.66
2.78
2.37
2.12 1.76 1.75 1.74 1.74 1.73 1.72 1.72 1.71 1.69 1.69 1.68 1.67 1.67 1.66 1.65 1.65
EtOAc 1.26
Ms
N
Ph
O
P8-maj
1H NMR (500 MHz) in CDCl3
7.20 7.17
6.84 6.81
6.70 6.68 6.66
3.70 3.66
1.98 1.99 1.95 1.00 0.98 1.98 1.98 2.20 3.96 3.02 3.00 2.98 0.28 2.03 1.96 0.37
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

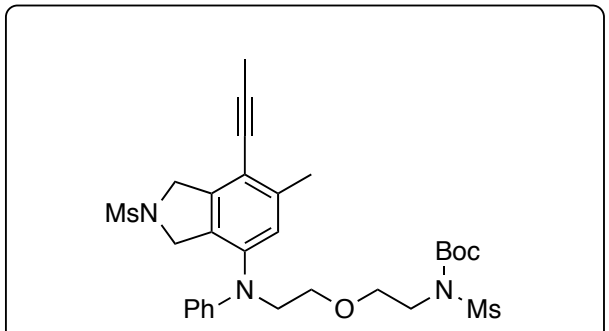

{2.12,4.89}
{2.38,20.34}
{1.73,26.08}
{1.67,25.08}
{2.78,34.70}
{3.68,37.52}
{4.67,54.46}
{4.10,53.61}
{3.69,52.04}
{6.69,117.82}
{6.84,120.38}
{6.91,124.62}
{7.18,129.35}
{7.72,133.93}
Ms
N
Ph
O
P8-maj
HSQC (500 MHz) in CDCl3


Ms—N
N
Ph
N
O
O
P8-maj
HMBC (500 MHz) in CDCl3
{2.12,75.27}
{2.11,93.86}
{2.37,114.27}
{2.37,124.54}
{4.10,129.46}
{7.70,132.25}
{4.66,140.66}
{3.69,140.77}
{3.70,147.11}
{3.68,168.28}
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170


CHCl3
7.84 7.83 7.83 7.83 7.73 7.73 7.73 7.72 7.72 7.26 7.15 7.13 7.13 7.13 7.12 7.12 6.96 6.71 6.70 6.69 6.69 6.68 6.68 6.46 6.46 6.44 6.44 6.44 4.73 4.73 4.72 4.68 4.67 3.69 3.68 3.67 3.59 3.57 3.56 2.91 2.91 2.16 2.12 1.71 1.71 1.70
Ms
N
N
Ph
O
O
O
P8-min
1H NMR (500 MHz) in CDCl3
7.16 7.14 7.12
6.70 6.68
6.46 6.44
3.69 3.66 3.60 3.56
2.03 2.07 2.06 1.00 1.00 2.04 2.07 2.05 2.10 2.00 3.09 3.19 3.15 4.15
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

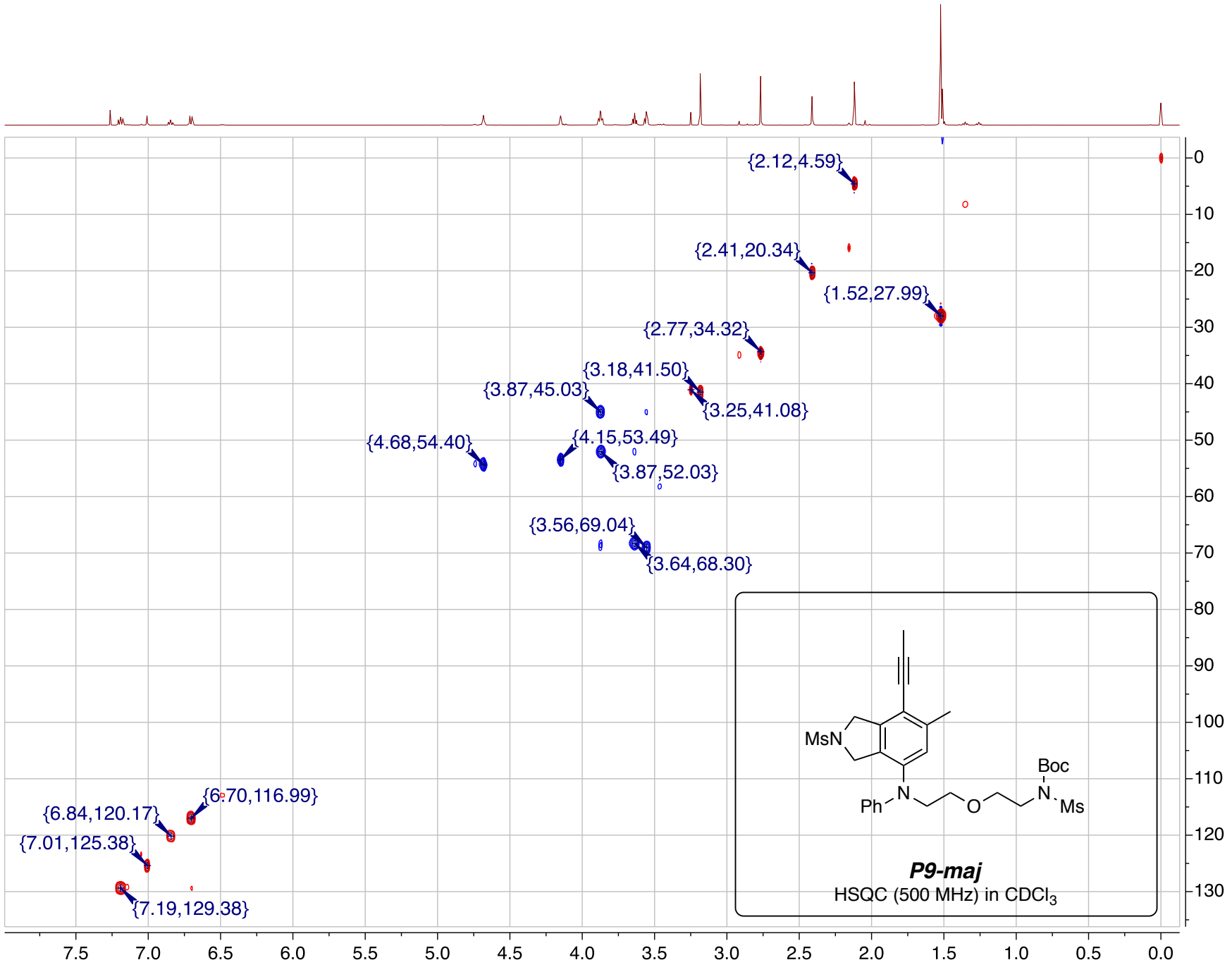

{2.12,4.59}
{2.16,15.94}
{1.71,25.82}
{1.71,24.82}
{2.91,34.81}
{3.68,37.59}
{3.57,51.23}
{4.72,54.17}
{4.67,54.10}
{6.44,112.96}
{6.69,117.17}
{7.83,123.22}
{7.13,129.09}
{6.96,123.08}
{7.72,134.02}
Ms
N
N
Ph
O
N
O
P8-min
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

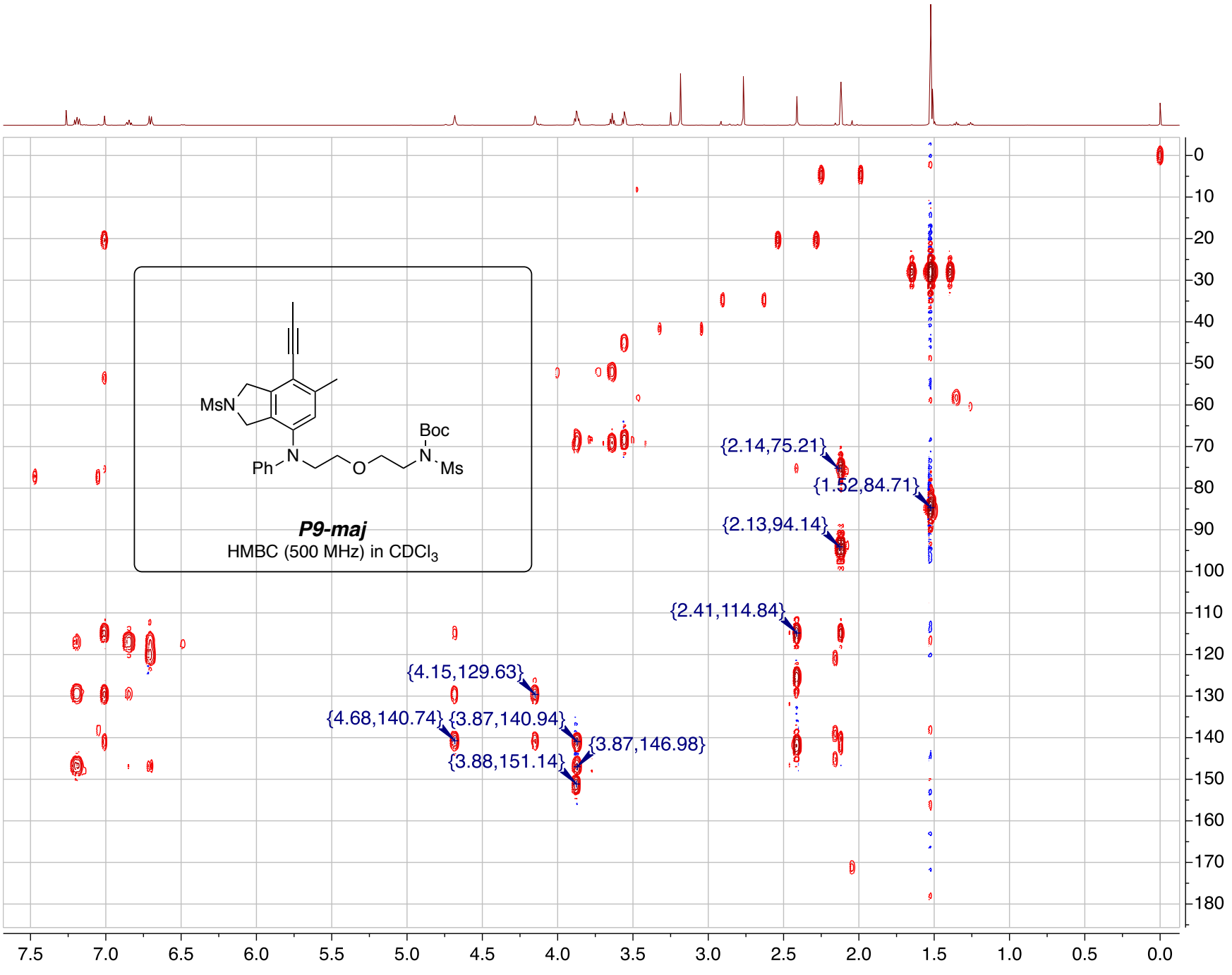

Ms–N
N
Ph
N
O
O
P8-min
HMBC (500 MHz) in CDCl3
{2.12,75.45}
{2.13,95.39}
{2.16,121.00}
{2.16,139.07}
{7.71,131.91}
{4.73,137.27}
{4.67,134.46}
{3.57,148.43}
{3.57,145.26}
{3.68,168.31}

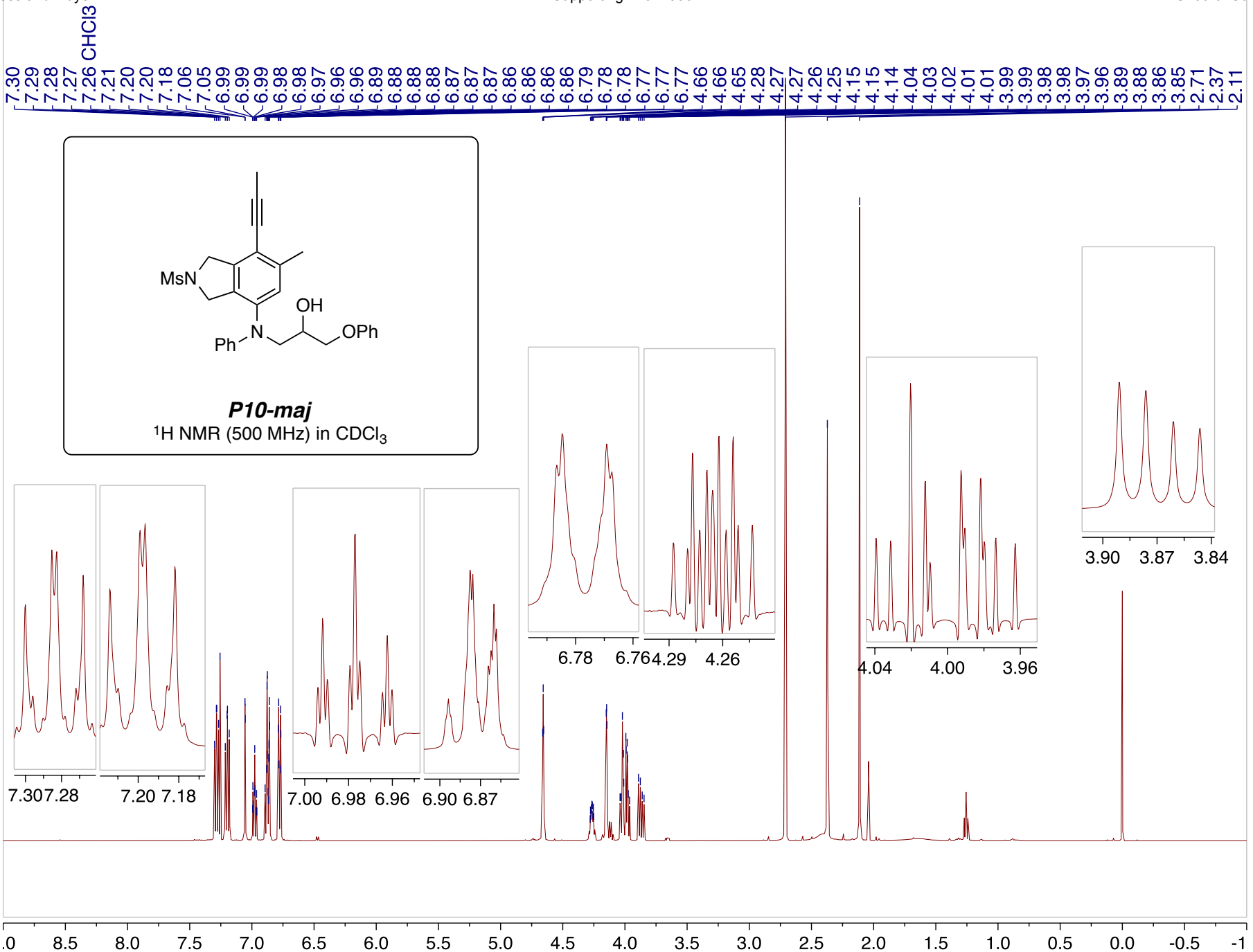


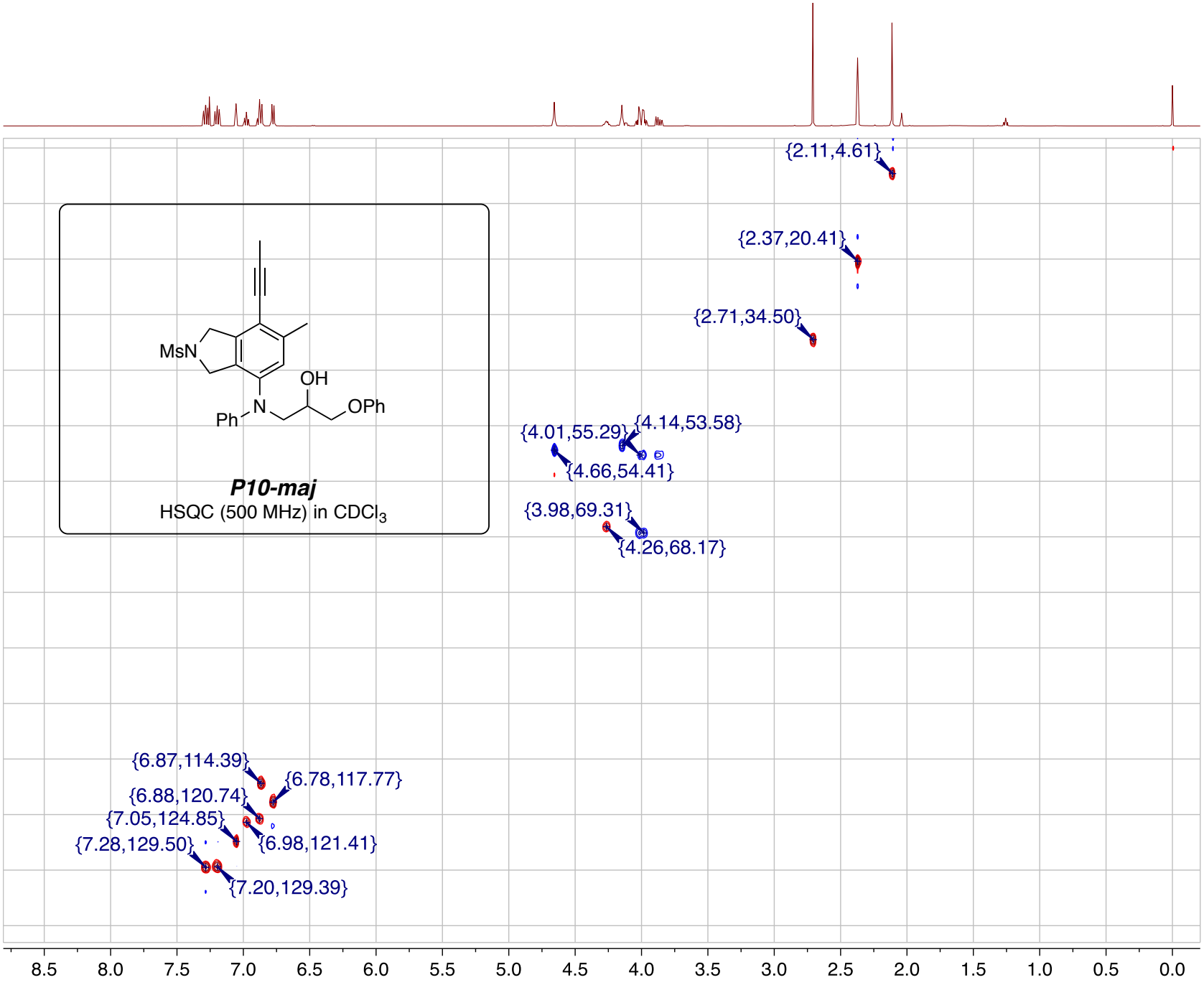
P9-maj

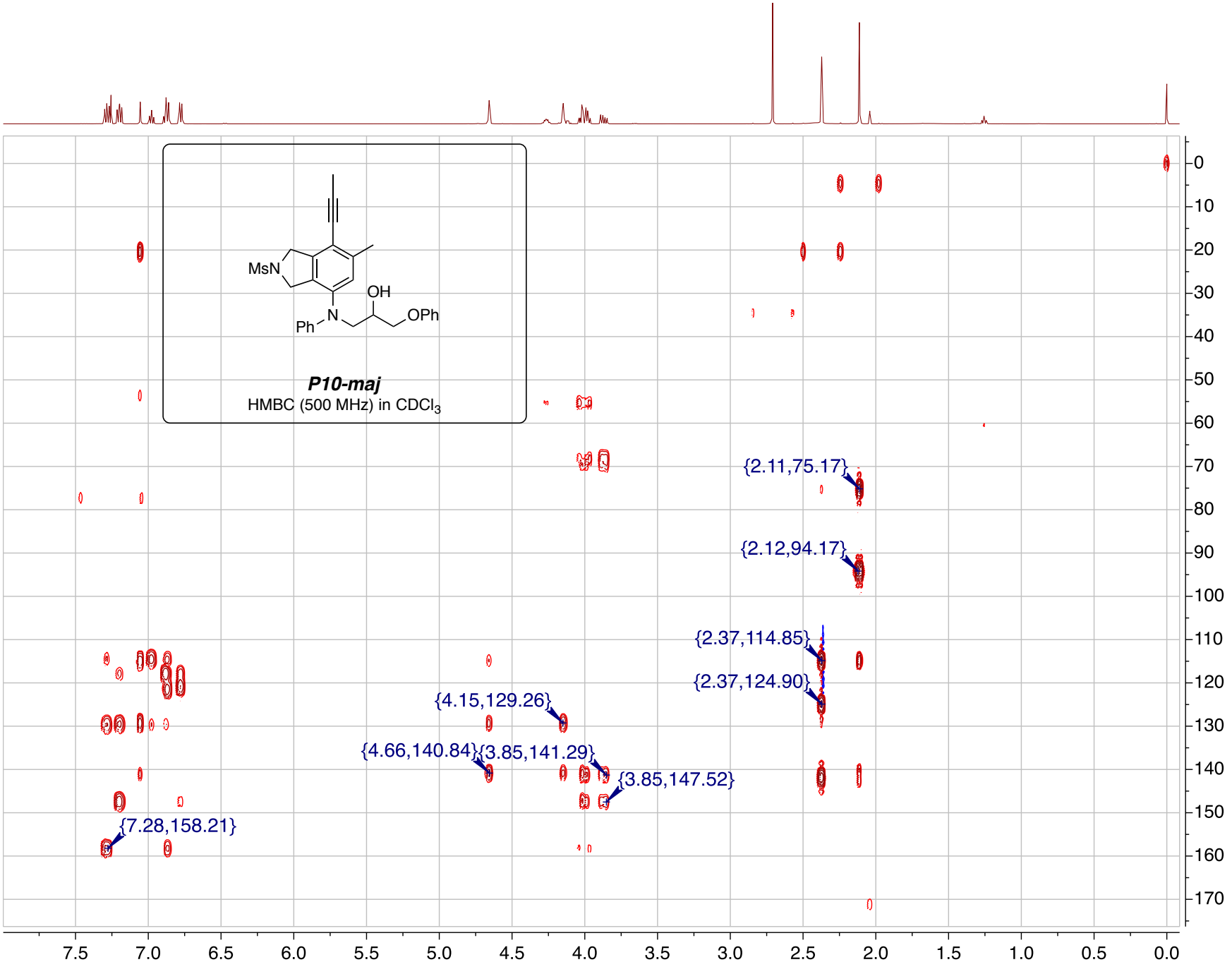
^{1}H NMR (500 MHz) in $CDCl_3$

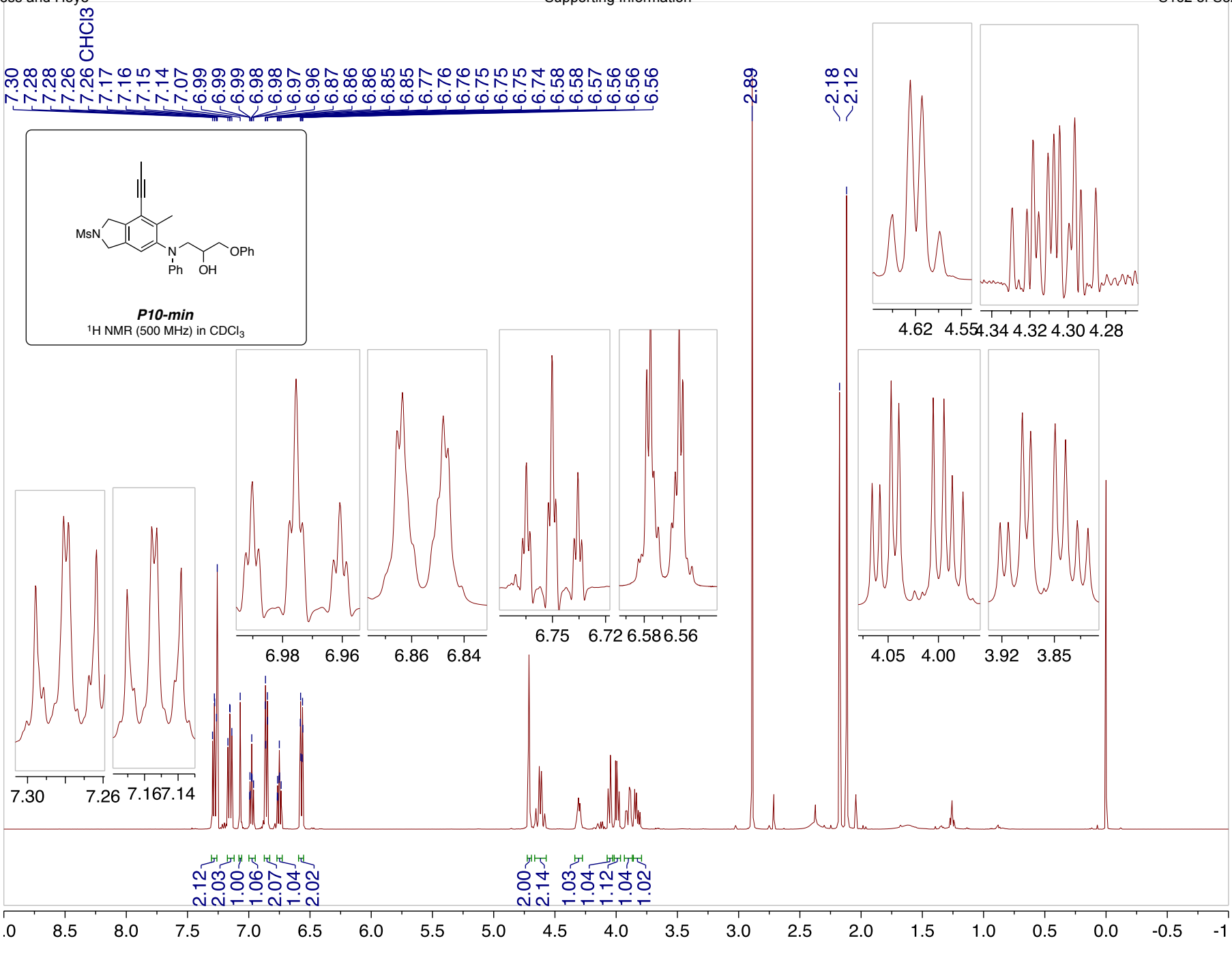

{2.12,4.59}
{2.41,20.34}
{1.52,27.99}
{2.77,34.32}
{3.18,41.50}
{3.87,45.03}
{3.25,41.08}
{4.68,54.40}
{4.15,53.49}
{3.87,52.03}
{3.56,69.04}
{3.64,68.30}
{6.84,120.17}
{7.01,125.38}
{7.19,129.38}
MsN
Boc
Ph
N
O
N
Ms
P9-maj
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

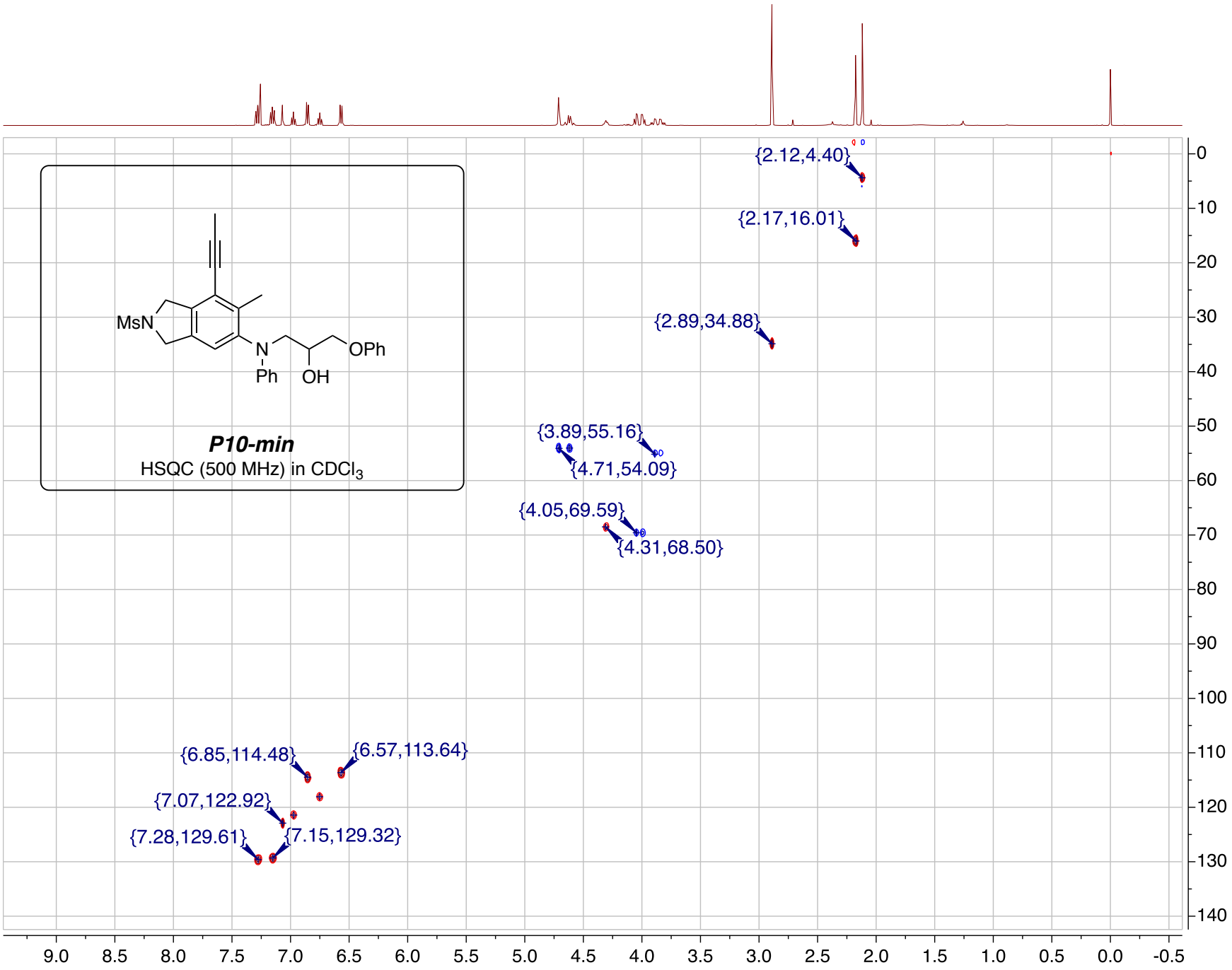

MsN
Boc
N
Ph
N
O
N
Ms
P9-maj
HMBC (500 MHz) in CDCl3
{2.14,75.21}
{1.52,84.71}
{2.13,94.14}
{2.41,114.84}
{4.15,129.63}
{4.68,140.74}
{3.87,140.94}
{3.87,146.98}
{3.88,151.14}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

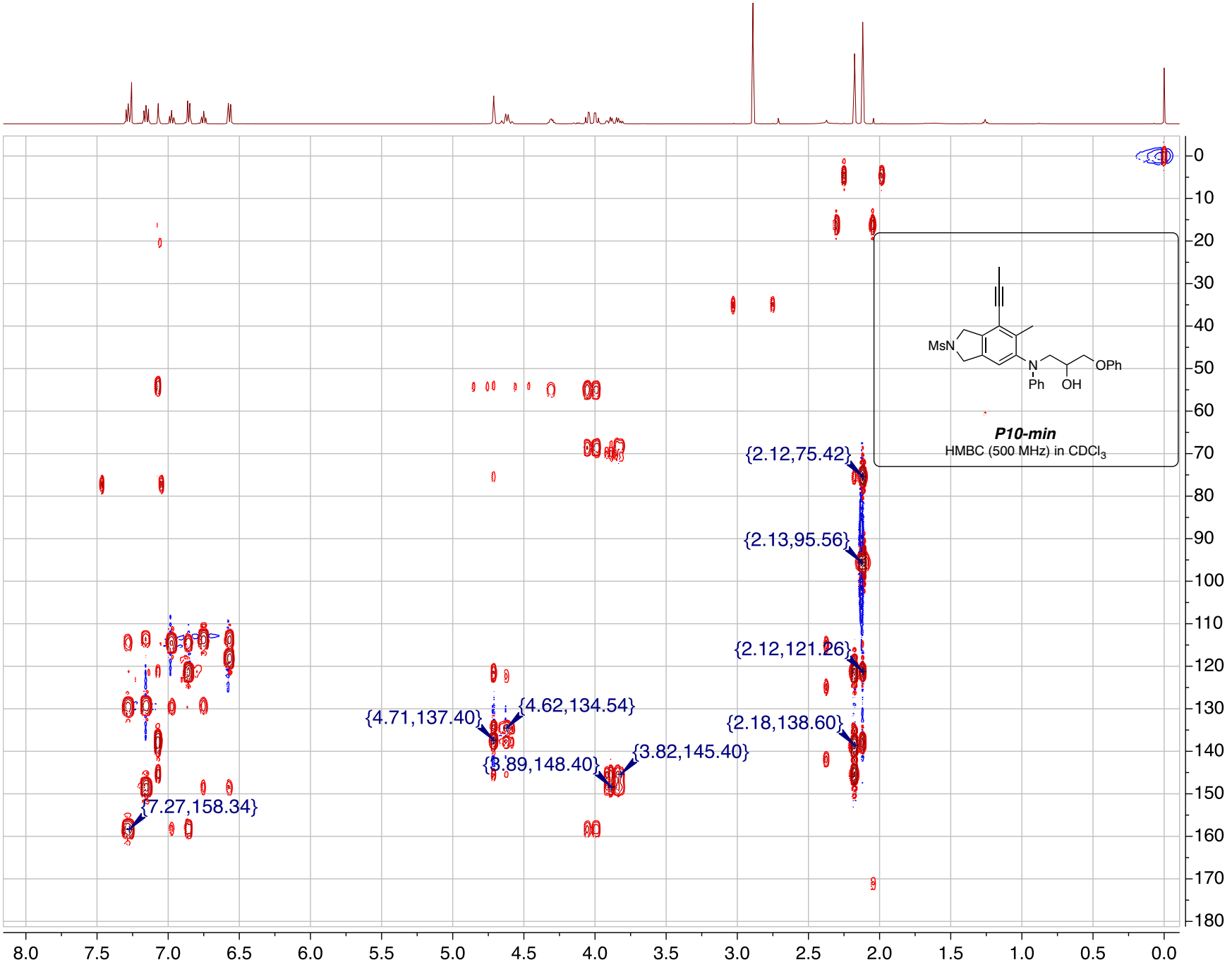

CHCl3
7.30 7.29 7.28 7.27 7.26 7.21 7.20 7.20 7.18 7.06 7.05 6.99 6.99 6.99 6.98 6.98 6.97 6.96 6.96 6.89 6.88 6.88 6.88 6.87 6.87 6.87 6.86 6.86 6.86 6.86 6.79 6.78 6.78 6.77 6.77 6.77 4.66 4.66 4.65 4.28 4.27 4.27 4.26 4.25 4.15 4.15 4.14 4.04 4.03 4.02 4.01 4.01 3.99 3.99 3.98 3.98 3.97 3.96 3.89 3.88 3.86 3.85 2.71 2.37 2.11
MsN
OH
OPh
Ph
N
P10-maj
1H NMR (500 MHz) in CDCl3
7.30 7.28
7.20 7.18
7.00 6.98 6.96
6.90 6.87
6.78 6.76
4.29 4.26
4.04 4.00 3.96
3.90 3.87 3.84
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

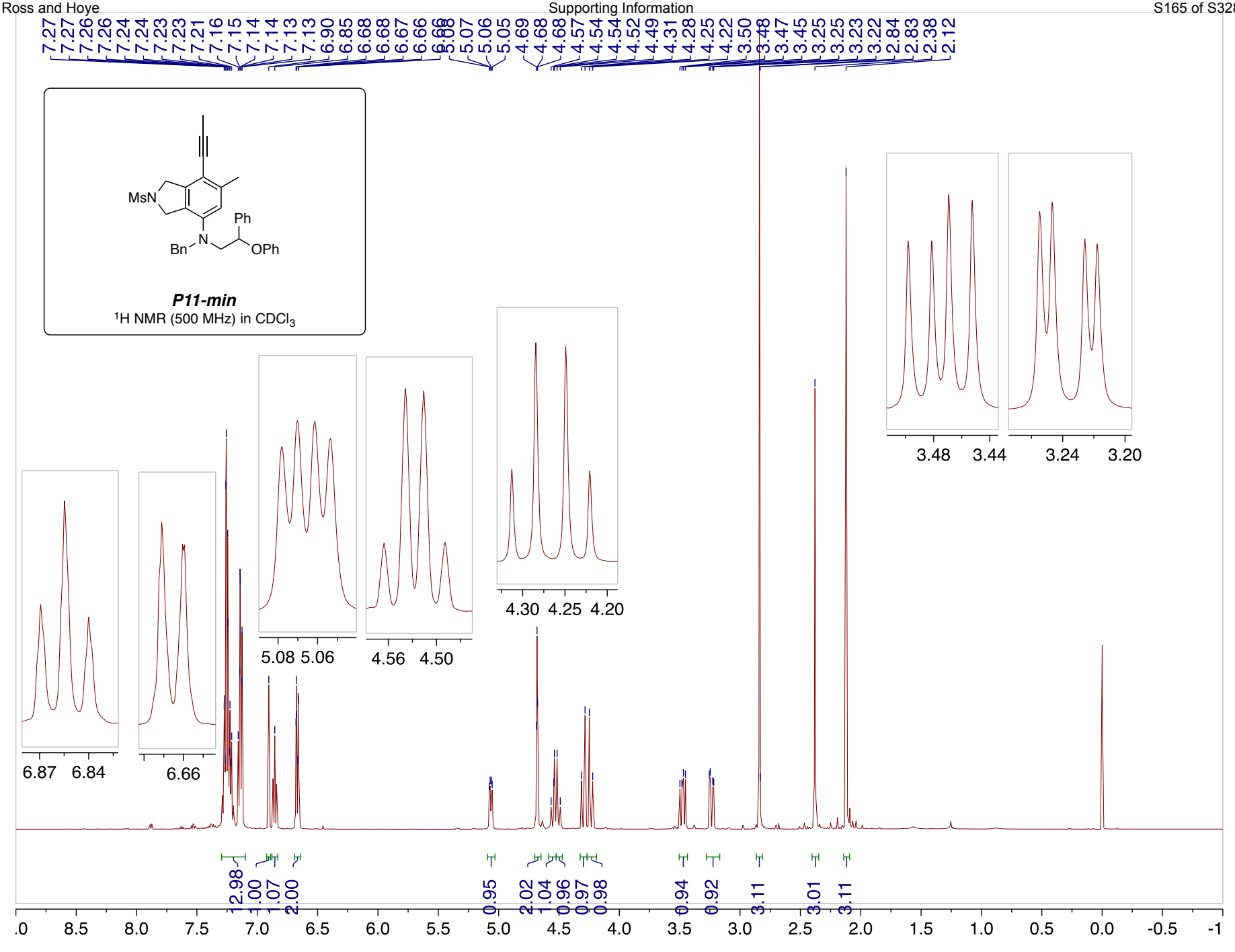

MsN
OH
N
Ph
OPh
P10-maj
HSQC (500 MHz) in CDCl3
{2.11,4.61}
{2.37,20.41}
{2.71,34.50}
{4.01,55.29}
{4.14,53.58}
{4.66,54.41}
{3.98,69.31}
{4.26,68.17}
{6.87,114.39}
{6.78,117.77}
{6.88,120.74}
{7.05,124.85}
{6.98,121.41}
{7.28,129.50}
{7.20,129.39}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

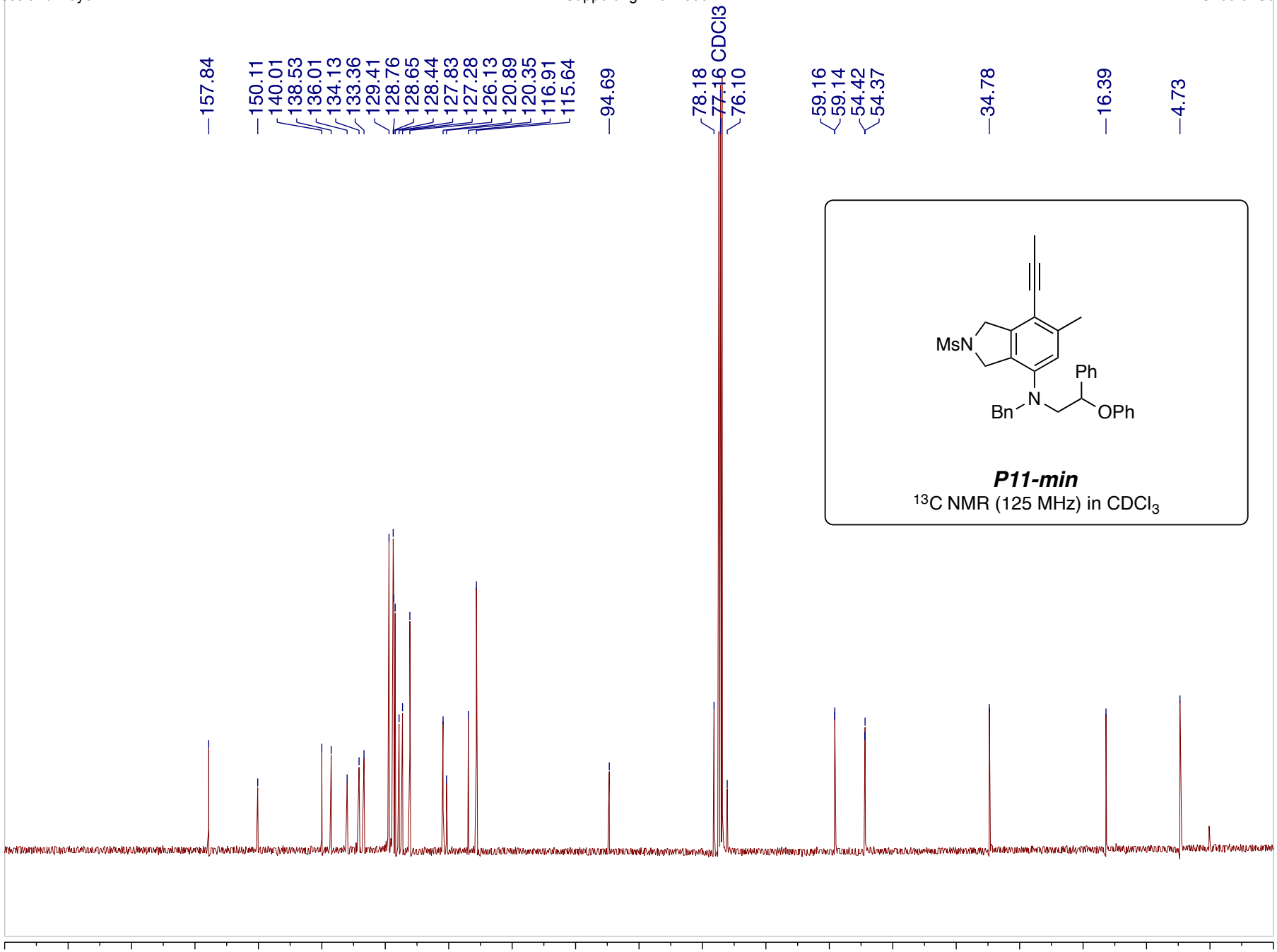

MsN
OH
N
Ph
OPh
P10-maj
HMBC (500 MHz) in CDCl3
{2.11,75.17}
{2.12,94.17}
{2.37,114.85}
{2.37,124.90}
{4.15,129.26}
{4.66,140.84}
{3.85,141.29}
{3.85,147.52}
{7.28,158.21}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

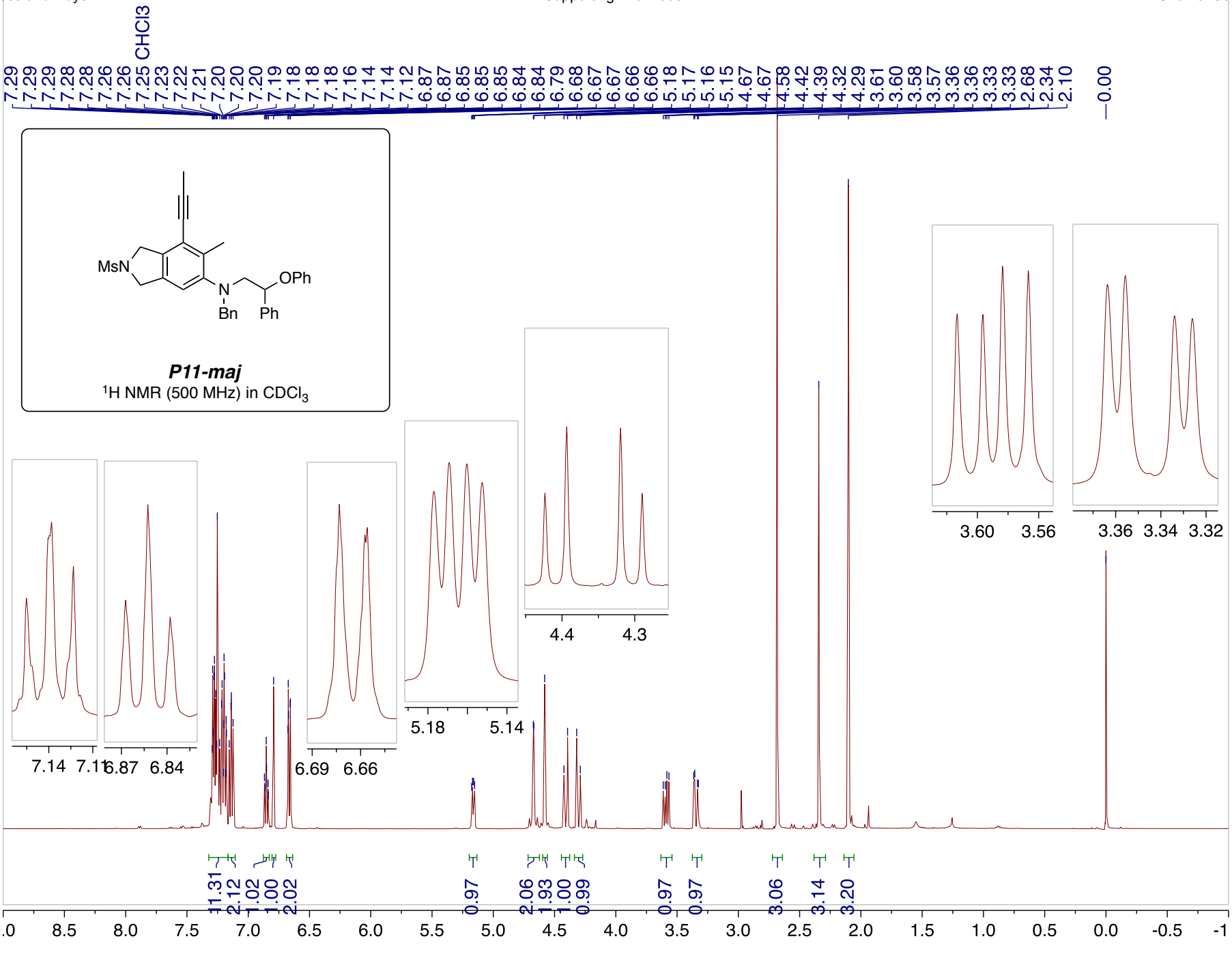

CHCl3
7.30 7.28 7.28 7.26 7.26 7.17 7.16 7.15 7.14 7.07 6.99 6.99 6.99 6.98 6.98 6.97 6.96 6.87 6.86 6.86 6.85 6.77 6.76 6.76 6.75 6.75 6.75 6.74 6.58 6.58 6.57 6.56 6.56 6.56
2.89
2.18 2.12
MsN
N
Ph
OH
OPh
P10-min
1H NMR (500 MHz) in CDCl3
4.62 4.55 4.34 4.32 4.30 4.28
6.98 6.96 6.86 6.84 6.75 6.72 6.58 6.56
4.05 4.00 3.92 3.85
7.30 7.26 7.16 7.14
2.12 2.03 1.00 1.06 2.07 1.04 2.02
2.00 2.14 1.03 1.04 1.12 1.04 1.02
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

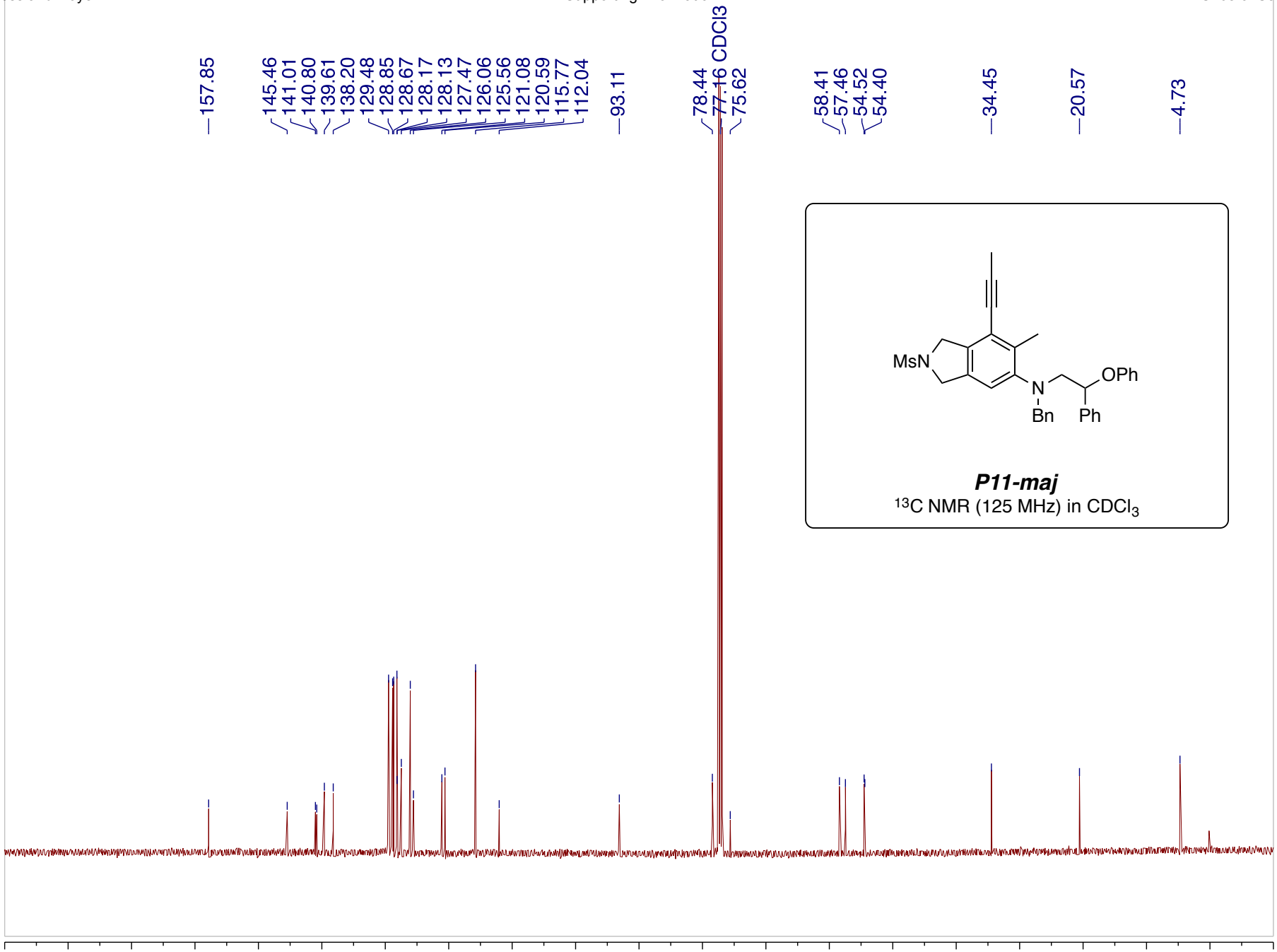

MsN
N
Ph
OH
OPh
P10-min
HSQC (500 MHz) in CDCl3
{2.12,4.40}
{2.17,16.01}
{2.89,34.88}
{3.89,55.16}
{4.71,54.09}
{4.05,69.59}
{4.31,68.50}
{6.85,114.48}
{6.57,113.64}
{7.07,122.92}
{7.28,129.61}
{7.15,129.32}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

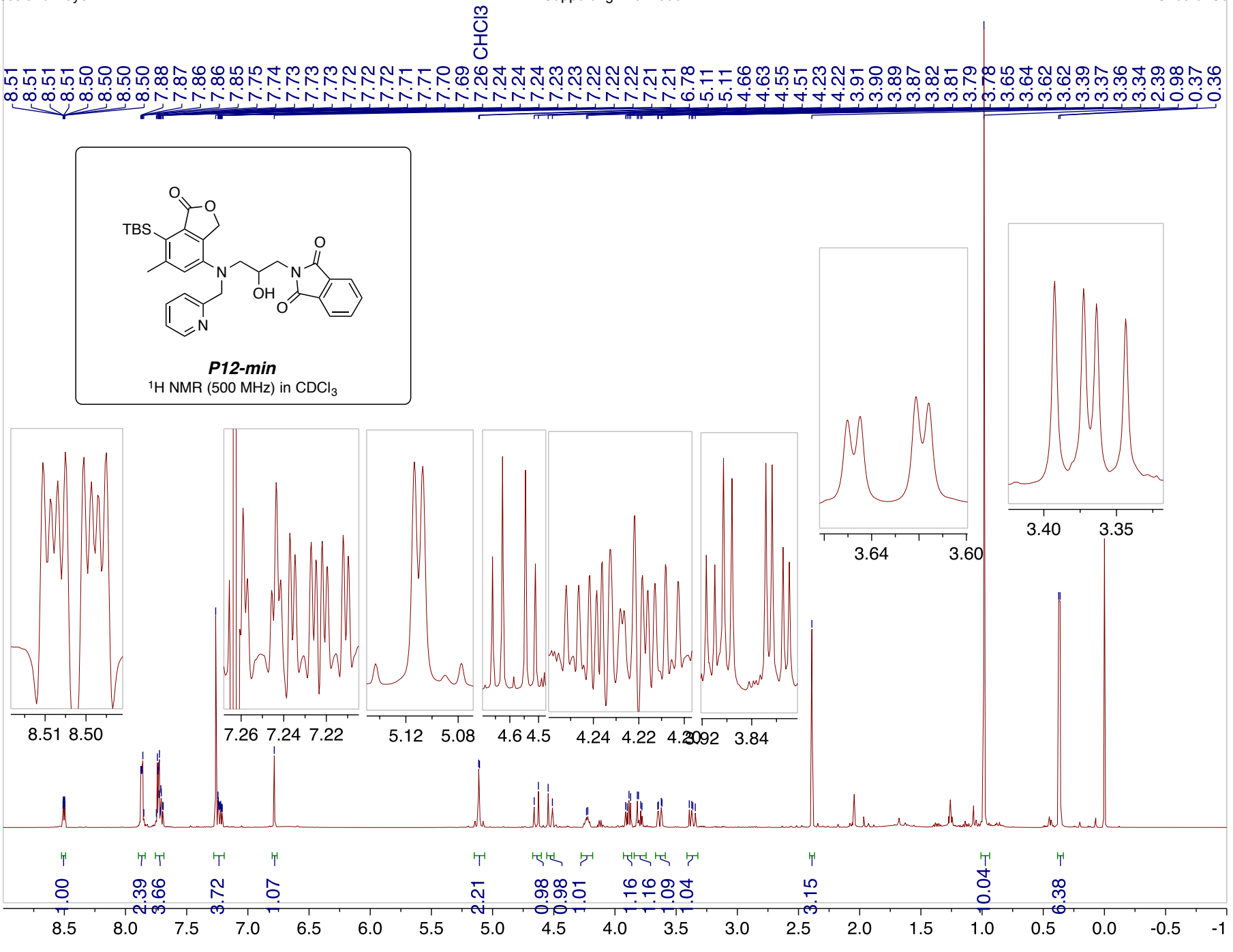

MsN
N
Ph
OH
OPh
P10-min
HMBC (500 MHz) in CDCl3
{2.12,75.42}
{2.13,95.56}
{2.12,121.26}
{2.18,138.60}
{4.71,137.40}
{4.62,134.54}
{3.89,148.40}
{3.82,145.40}
{7.27,158.34}
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180

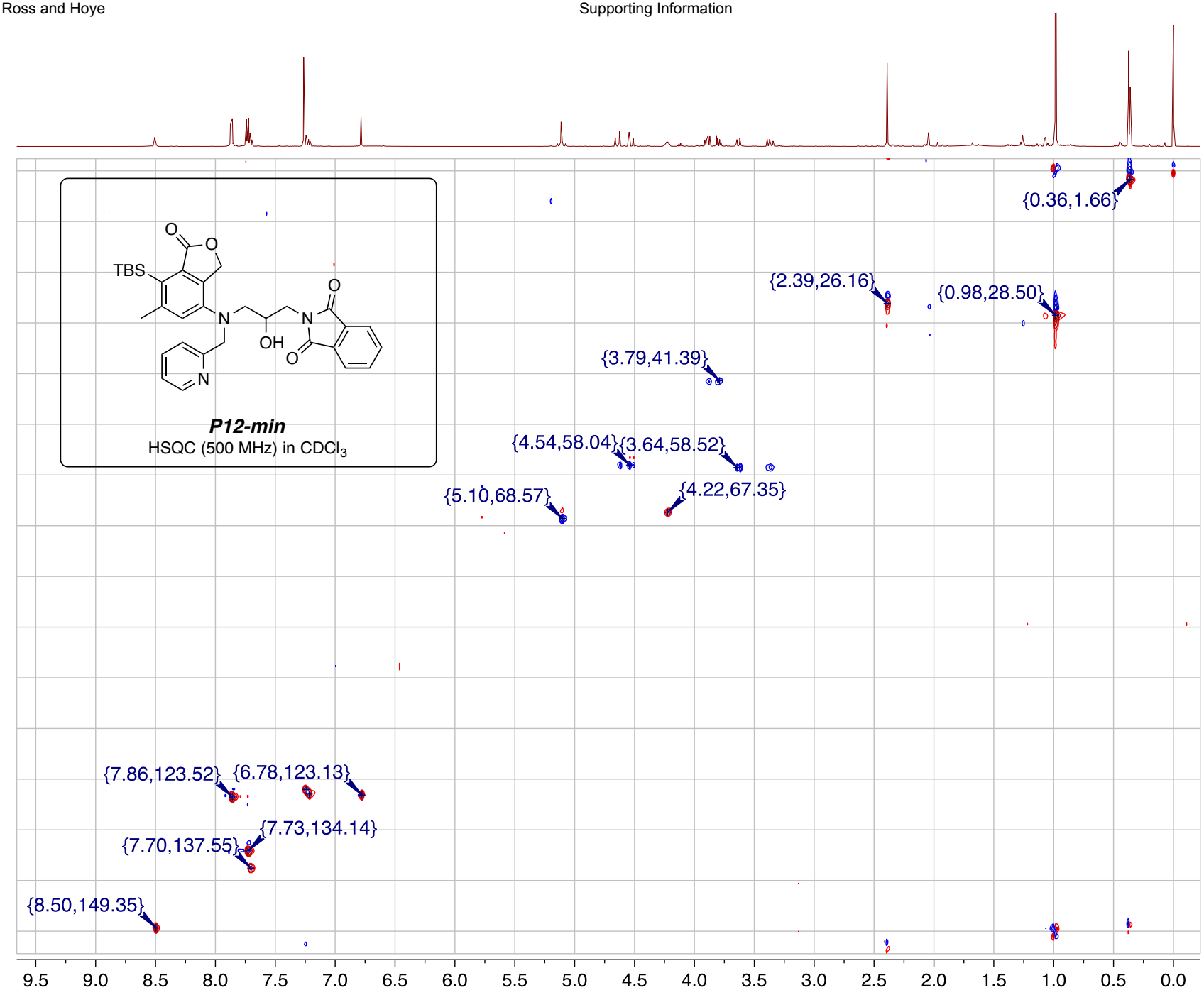

7.27 7.27 7.26 7.26 7.24 7.24 7.23 7.23 7.21 7.16 7.15 7.14 7.14 7.13 7.13 6.90 6.85 6.68 6.68 6.67 6.66 6.66 5.08 5.07 5.06 5.05 4.69 4.68 4.68 4.57 4.54 4.54 4.52 4.49 4.31 4.28 4.25 4.22 3.50 3.48 3.47 3.45 3.25 3.25 3.23 3.22 2.84 2.83 2.38 2.12
MsN
Ph
Bn
N
OPh
P11-min
1H NMR (500 MHz) in CDCl3
6.87 6.84
6.66
5.08 5.06
4.56 4.50
4.30 4.25 4.20
3.48 3.44
3.24 3.20
12.98 1.00 1.07 2.00 0.95 2.02 1.04 0.96 0.97 0.98 0.94 0.92 3.11 3.01 3.11
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

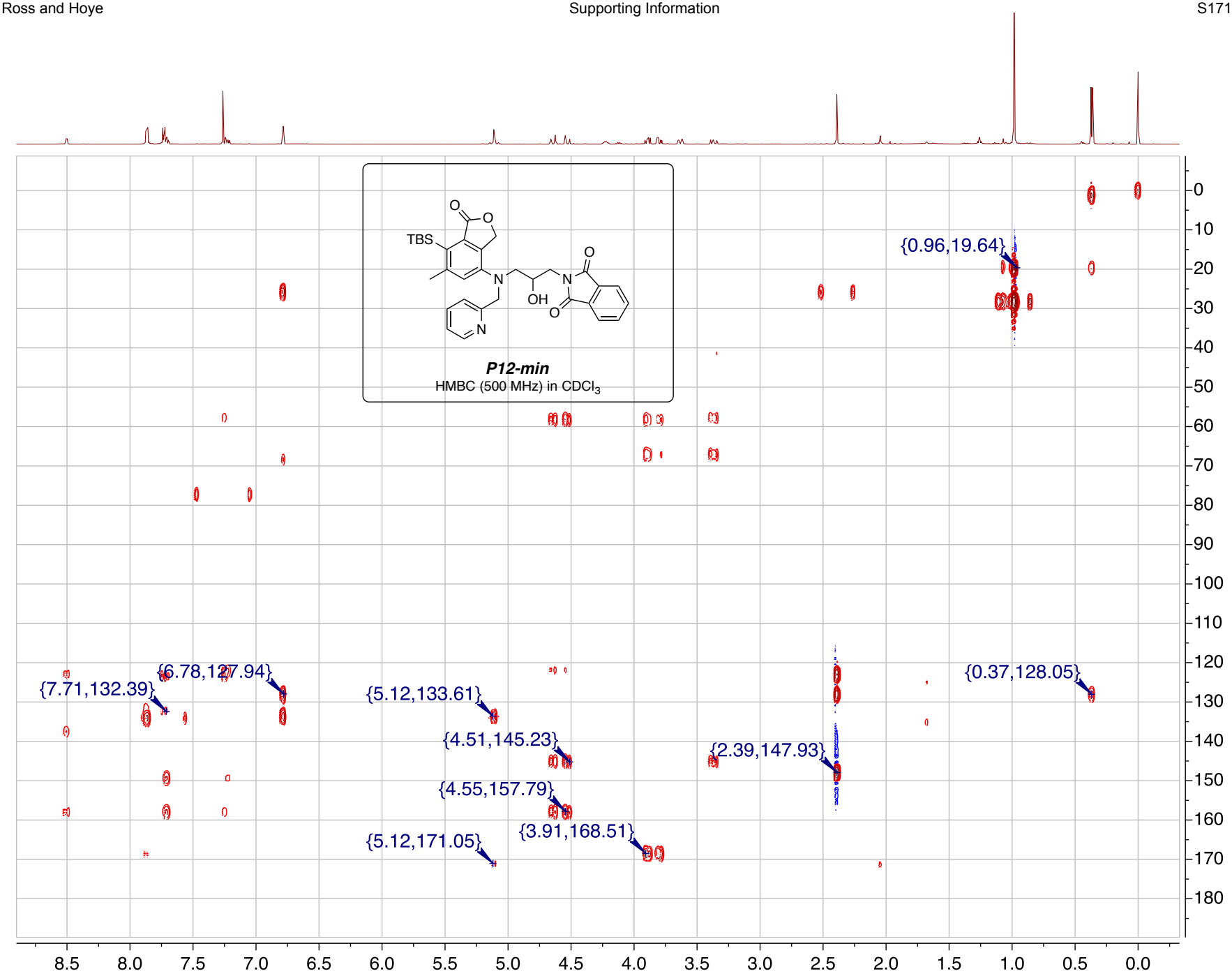

157.84
150.11
140.01
138.53
136.01
134.13
133.36
129.41
128.76
128.65
128.44
127.83
127.28
126.13
120.89
120.35
116.91
115.64
94.69
78.18
77.16 CDCl3
76.10
59.16
59.14
54.42
54.37
34.78
16.39
4.73
MsN
N
Bn
Ph
OPh
P11-min
13C NMR (125 MHz) in CDCl3
90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1

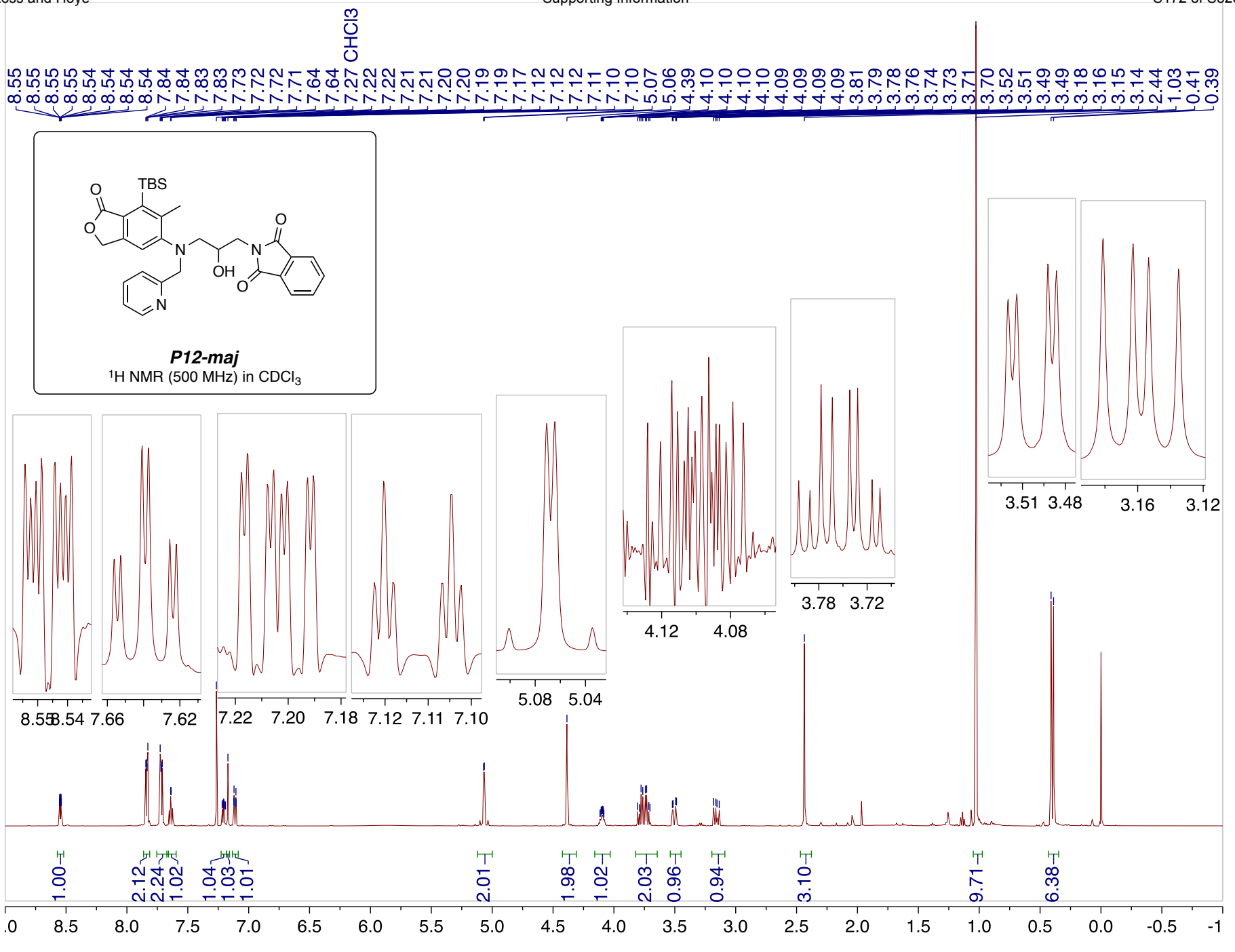

CHCl3
7.29 7.29 7.29 7.28 7.28 7.26 7.26 7.25 7.23 7.22 7.21 7.20 7.20 7.20 7.19 7.18 7.18 7.18 7.16 7.14 7.14 7.12 6.87 6.85 6.85 6.85 6.84 6.84 6.79 6.68 6.67 6.67 6.66 6.66 5.18 5.17 5.16 5.15 4.67 4.67 4.58 4.42 4.39 4.32 4.29 3.61 3.60 3.58 3.57 3.36 3.36 3.33 3.33 2.68 2.34 2.10 0.00
MsN
N
Bn
Ph
OPh
P11-maj
1H NMR (500 MHz) in CDCl3
7.14 7.11
6.87 6.84
6.69 6.66
5.18 5.14
4.4 4.3
3.60 3.56
3.36 3.34 3.32
11.31 2.12 1.02 1.00 2.02 0.97 2.06 1.93 1.00 0.99 0.97 0.97 3.06 3.14 3.20
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

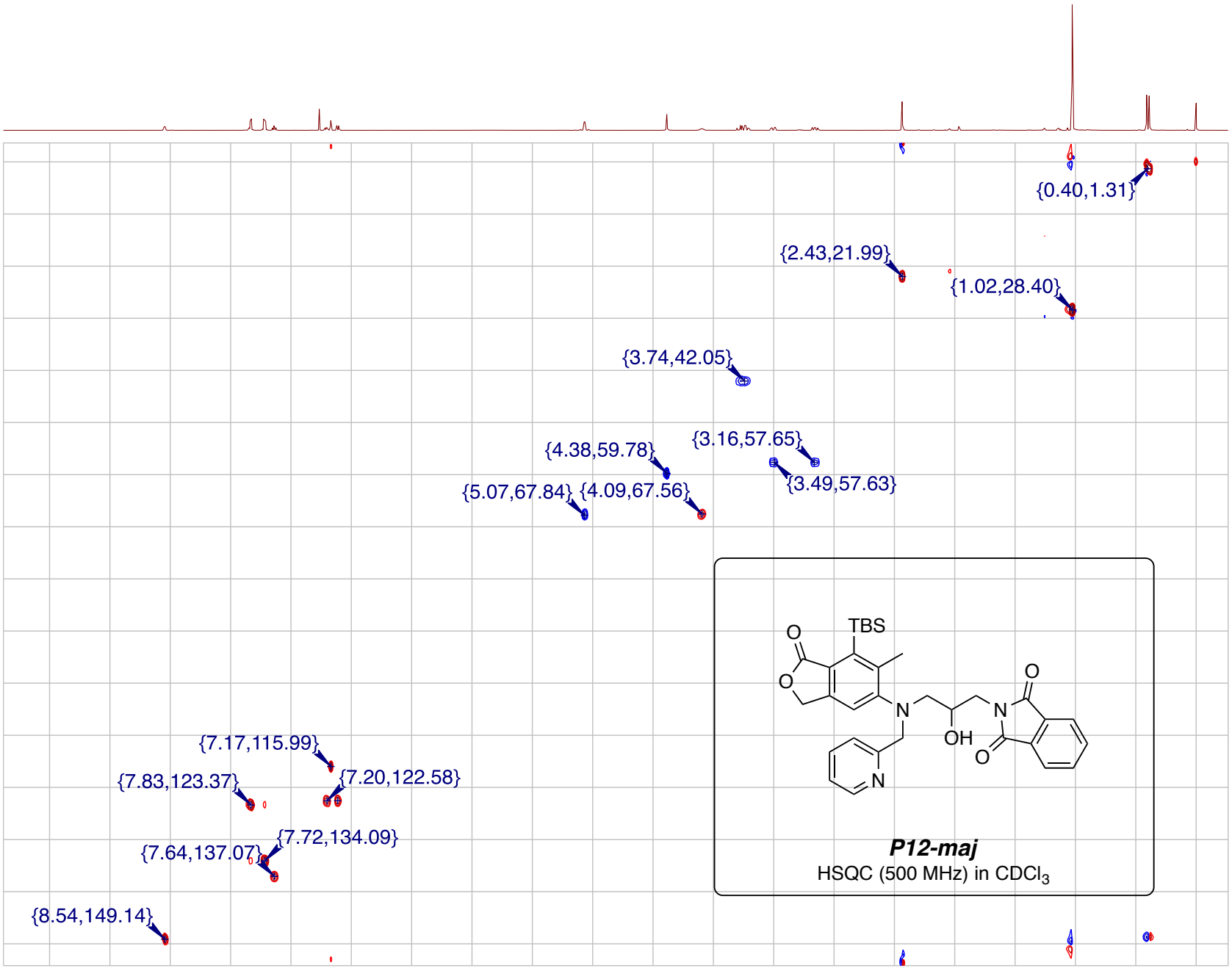

157.85
145.46
141.01
140.80
139.61
138.20
129.48
128.85
128.67
128.17
128.13
127.47
126.06
125.56
121.08
120.59
115.77
112.04
93.11
78.44
77.16 CDCl3
75.62
58.41
57.46
54.52
54.40
34.45
20.57
4.73
MsN
N
Bn
OPh
Ph
P11-maj
13C NMR (125 MHz) in CDCl3
90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1

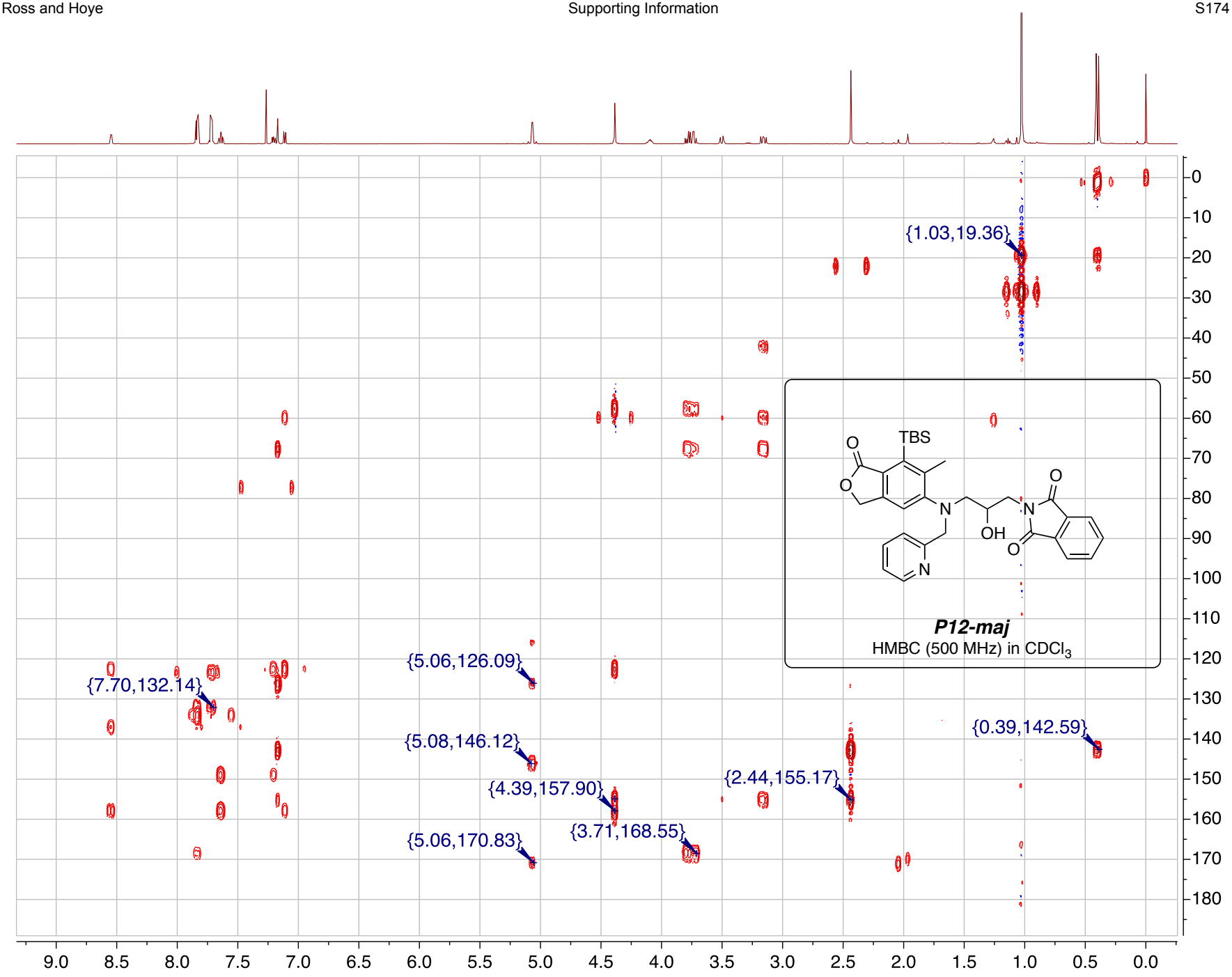

CHCl3
TBS
O
O
N
OH
N
O
O
N
P12-min
1H NMR (500 MHz) in CDCl3
8.51 8.50
7.26 7.24 7.22
5.12 5.08
4.6 4.5
4.24 4.22 4.20
3.92 3.84
3.64 3.60
3.40 3.35
1.00
2.39
3.66
3.72
1.07
2.21
0.98
0.98
1.01
1.16
1.16
1.09
1.04
3.15
10.04
6.38
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

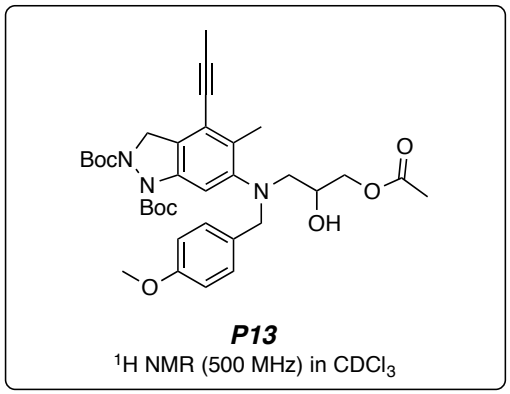

TBS
O
O
N
OH
O
N
O
N
P12-min
HSQC (500 MHz) in CDCl3
{0.36,1.66}
{2.39,26.16}
{0.98,28.50}
{3.79,41.39}
{4.54,58.04}
{3.64,58.52}
{4.22,67.35}
{5.10,68.57}
{7.86,123.52}
{6.78,123.13}
{7.73,134.14}
{7.70,137.55}
{8.50,149.35}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0


TBS
O
O
N
N
OH
O
O
N
P12-min
HMBC (500 MHz) in CDCl3
{0.96,19.64}
{7.71,132.39}
{6.78,127.94}
{5.12,133.61}
{4.51,145.23}
{4.55,157.79}
{5.12,171.05}
{3.91,168.51}
{2.39,147.93}
{0.37,128.05}
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180


CHCl3
TBS
O
O
N
OH
N
O
O
N
P12-maj
1H NMR (500 MHz) in CDCl3
8.55 8.54 7.66 7.62
7.22 7.20 7.18 7.12 7.11 7.10
5.08 5.04
4.12 4.08
3.78 3.72
3.51 3.48
3.16 3.12
1.00 2.12 2.24 1.02 1.04 1.03 1.01 2.01 1.98 1.02 2.03 0.96 0.94 3.10 9.71 6.38
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

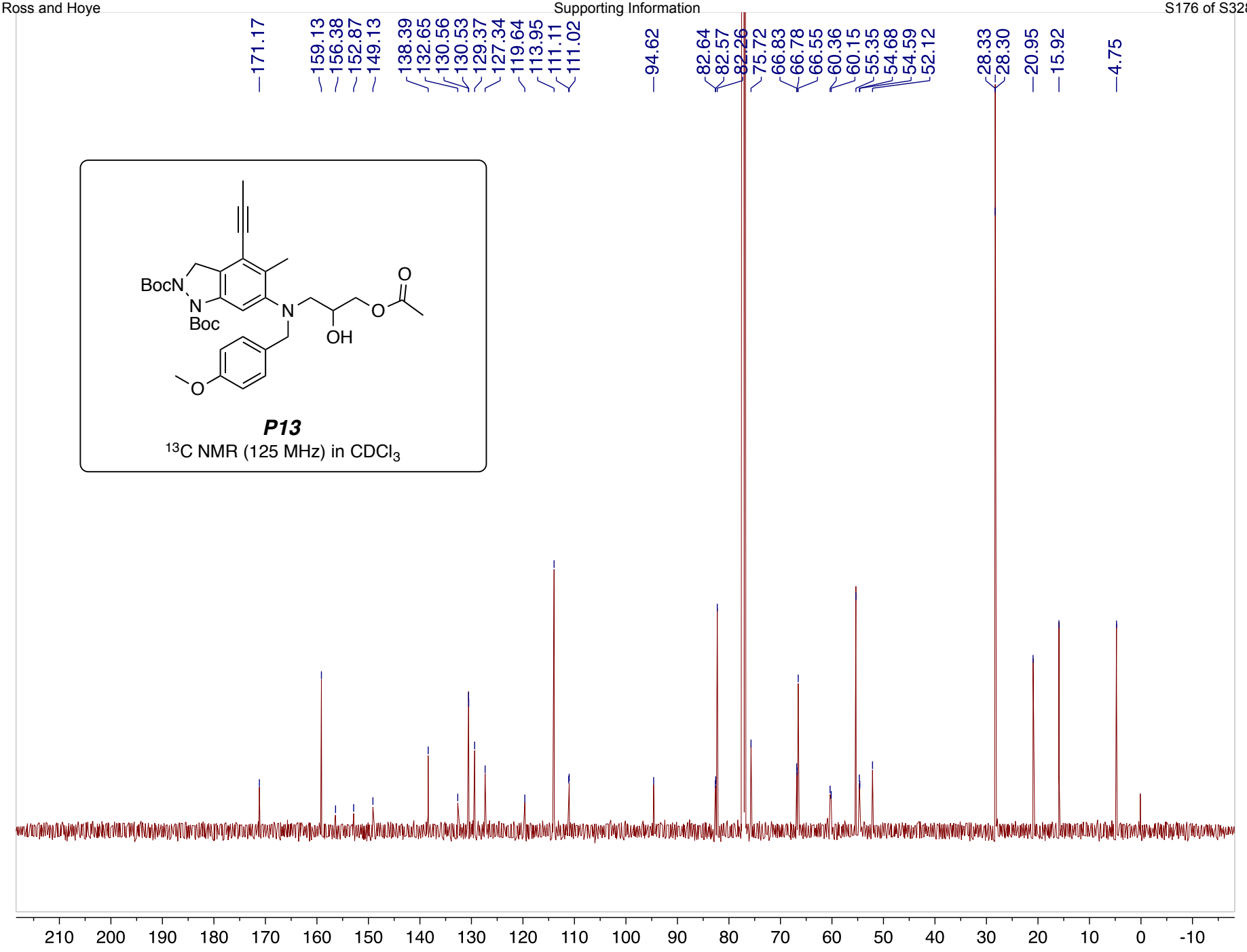

{0.40,1.31}
{2.43,21.99}
{1.02,28.40}
{3.74,42.05}
{3.16,57.65}
{4.38,59.78}
{3.49,57.63}
{5.07,67.84}
{4.09,67.56}
{7.17,115.99}
{7.83,123.37}
{7.20,122.58}
{7.72,134.09}
{7.64,137.07}
{8.54,149.14}
TBS
O
O
N
OH
N
O
O
N
P12-maj
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

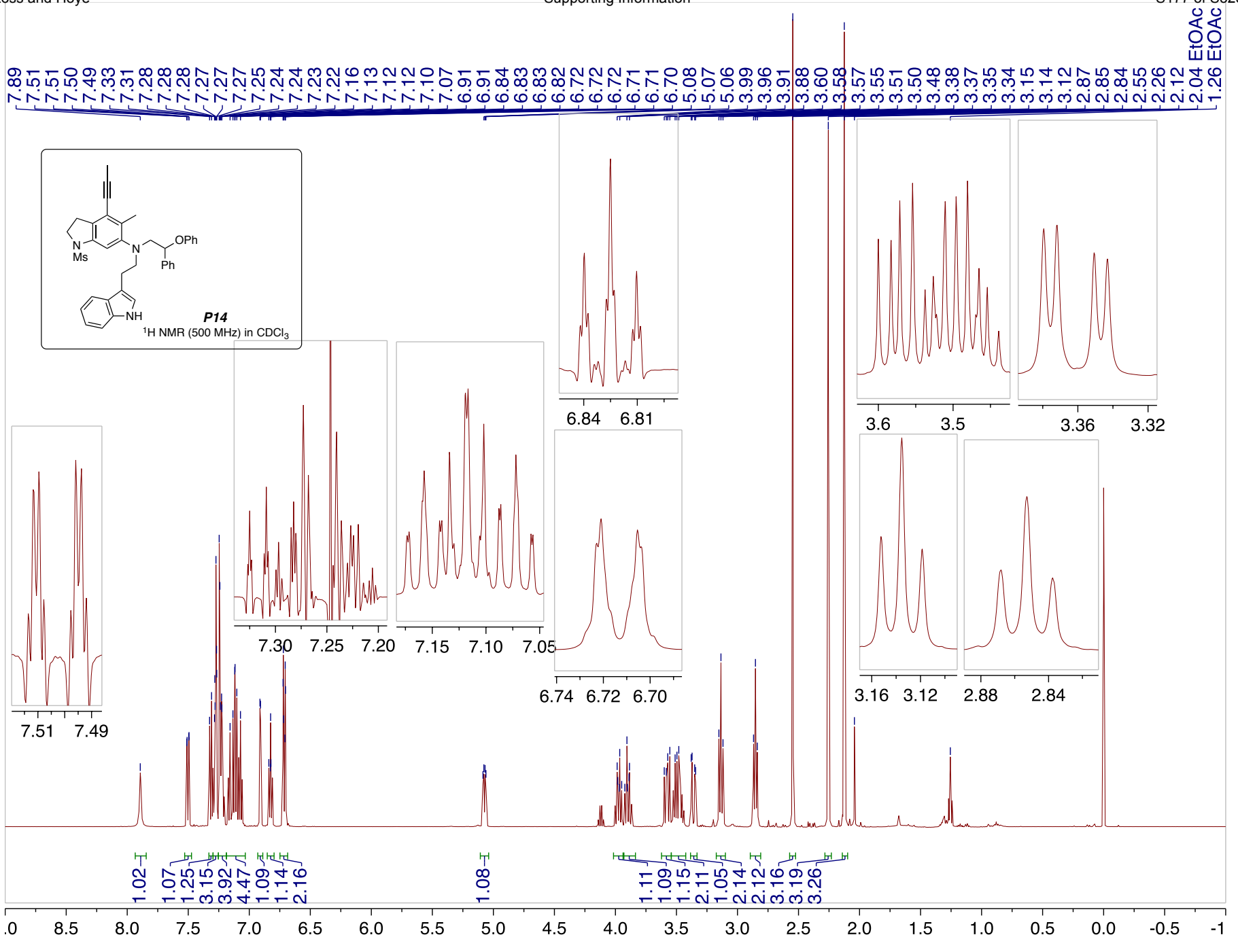

{1.03,19.36}
{7.70,132.14}
{5.06,126.09}
{5.08,146.12}
{4.39,157.90}
{5.06,170.83}
{3.71,168.55}
{2.44,155.17}
{0.39,142.59}
TBS
O
O
N
OH
N
O
O
N
P12-maj
HMBC (500 MHz) in CDCl3
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180

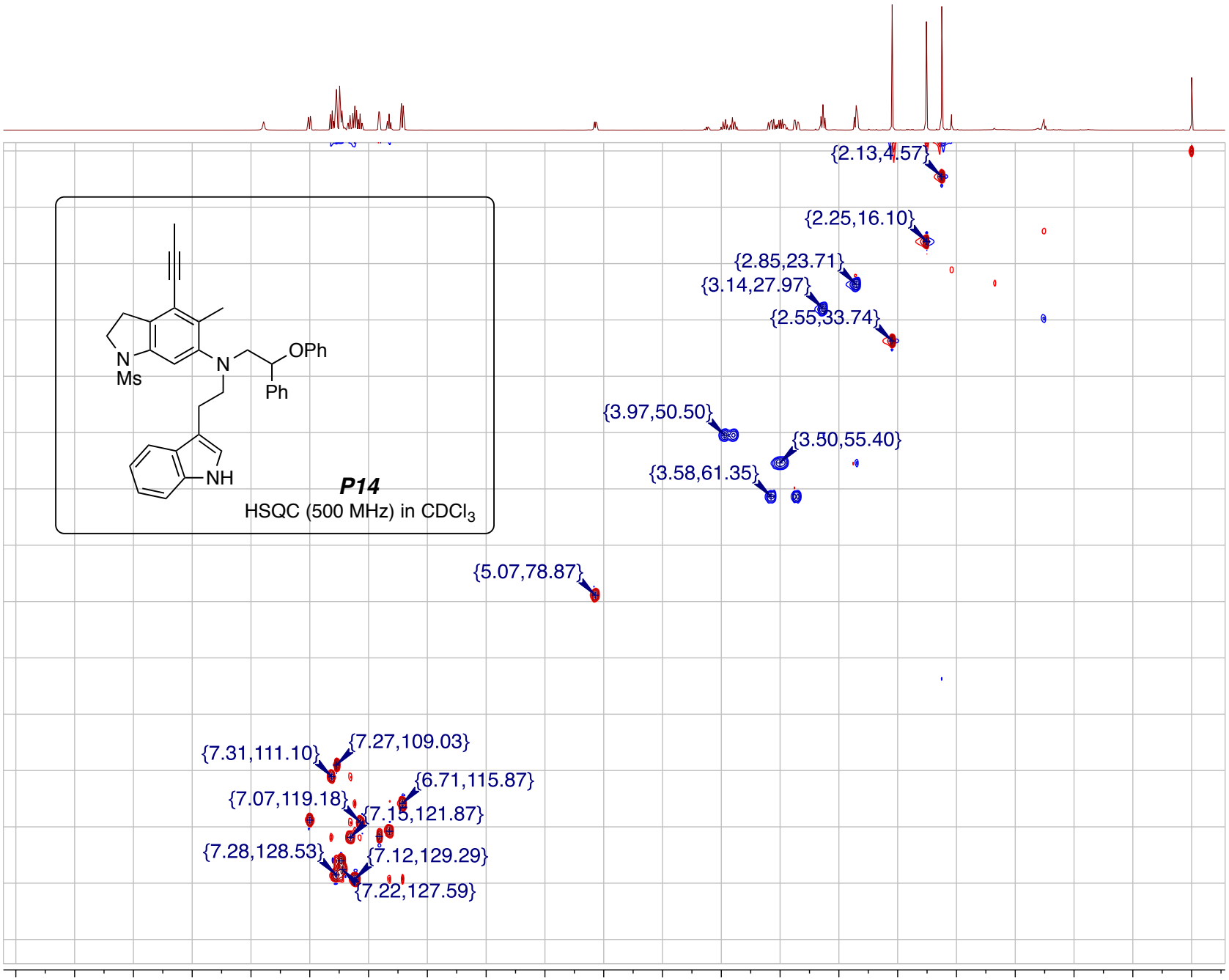


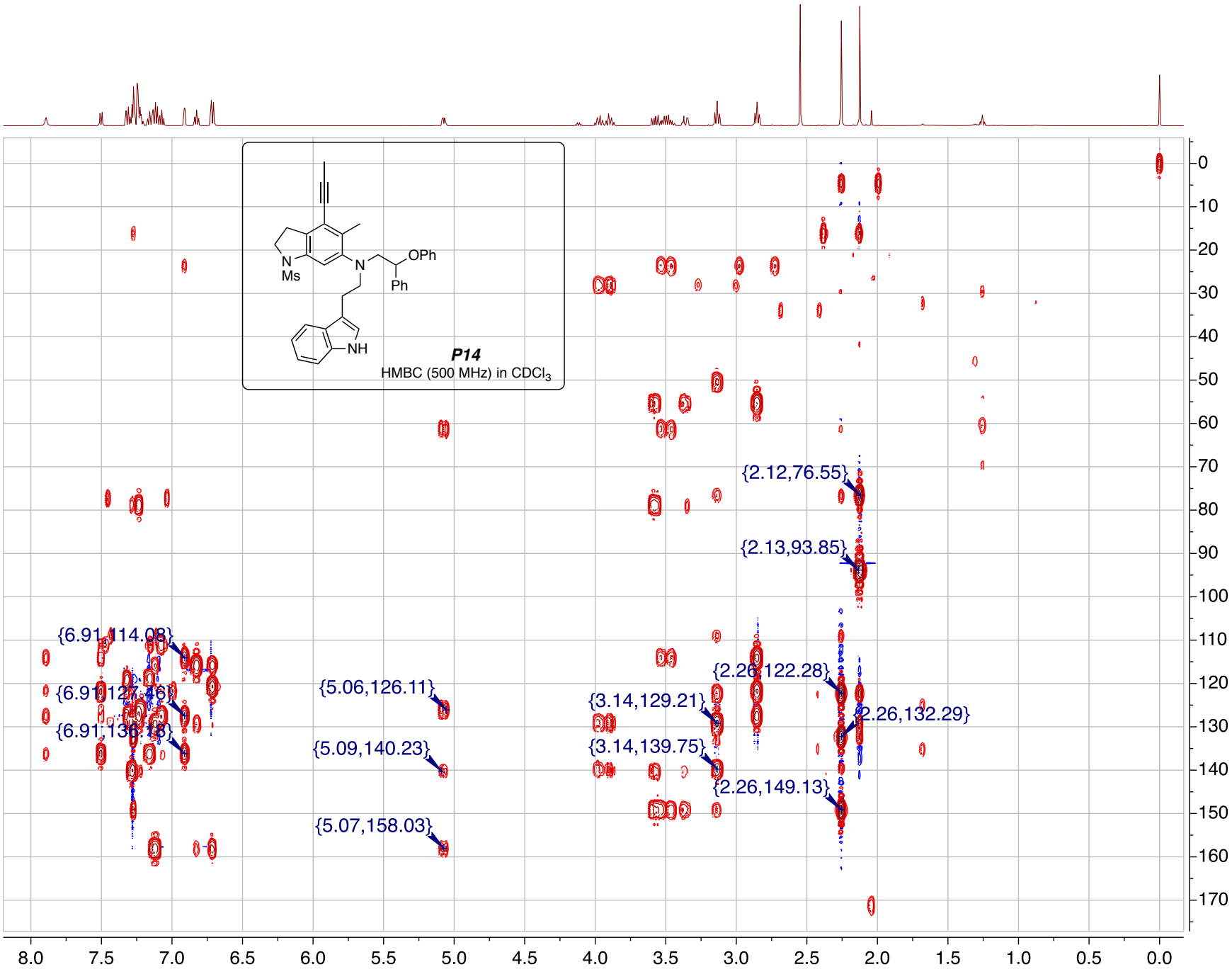
P13

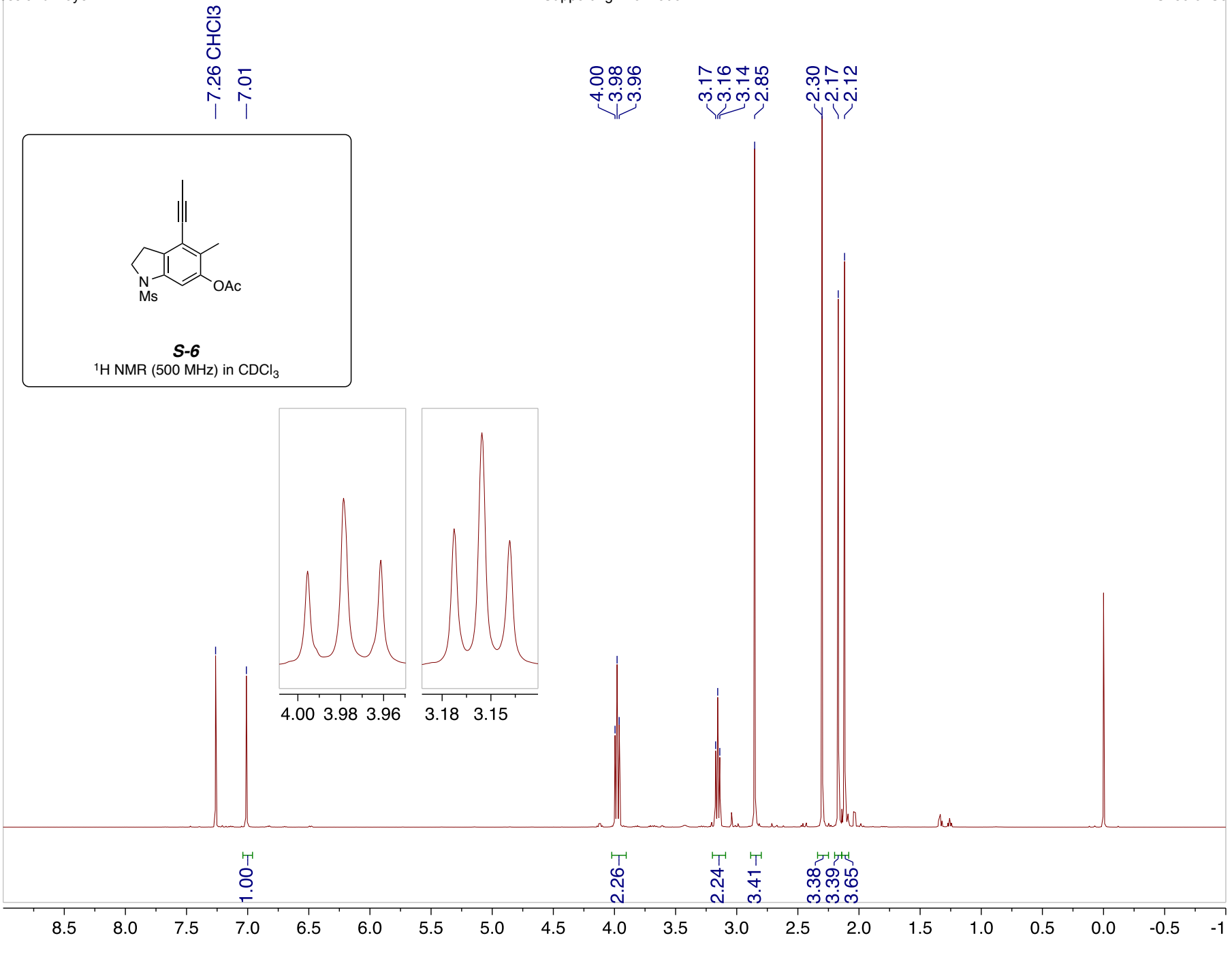
^{1}H NMR (500 MHz) in $CDCl_3$

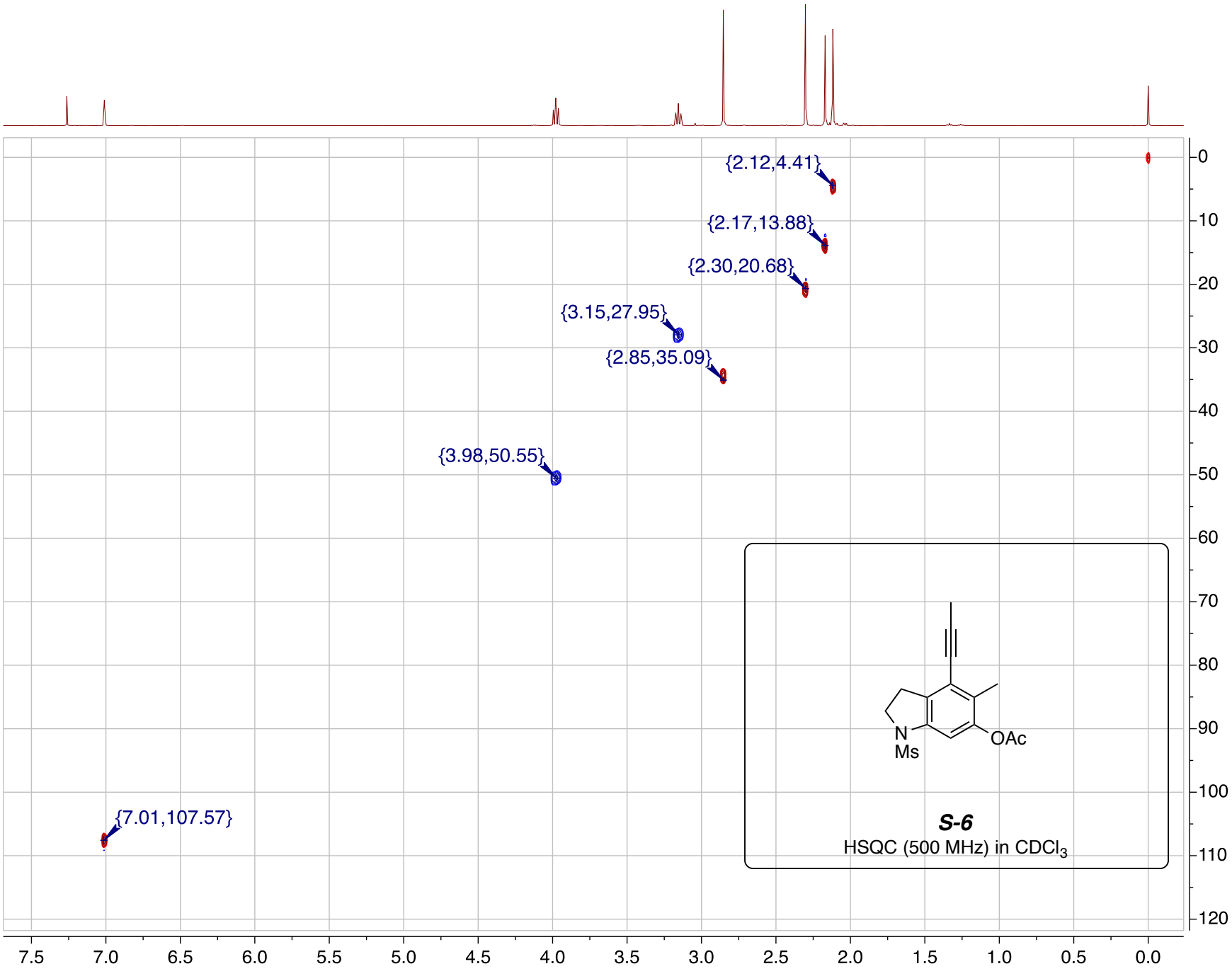

171.17
159.13
156.38
152.87
149.13
138.39
132.65
130.56
130.53
129.37
127.34
119.64
113.95
111.11
111.02
94.62
82.64
82.57
82.26
75.72
66.83
66.78
66.55
60.36
60.15
55.35
54.68
54.59
52.12
28.33
28.30
20.95
15.92
4.75
BocN
N
Boc
N
O
O
OH
O
P13
13C NMR (125 MHz) in CDCl3
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10

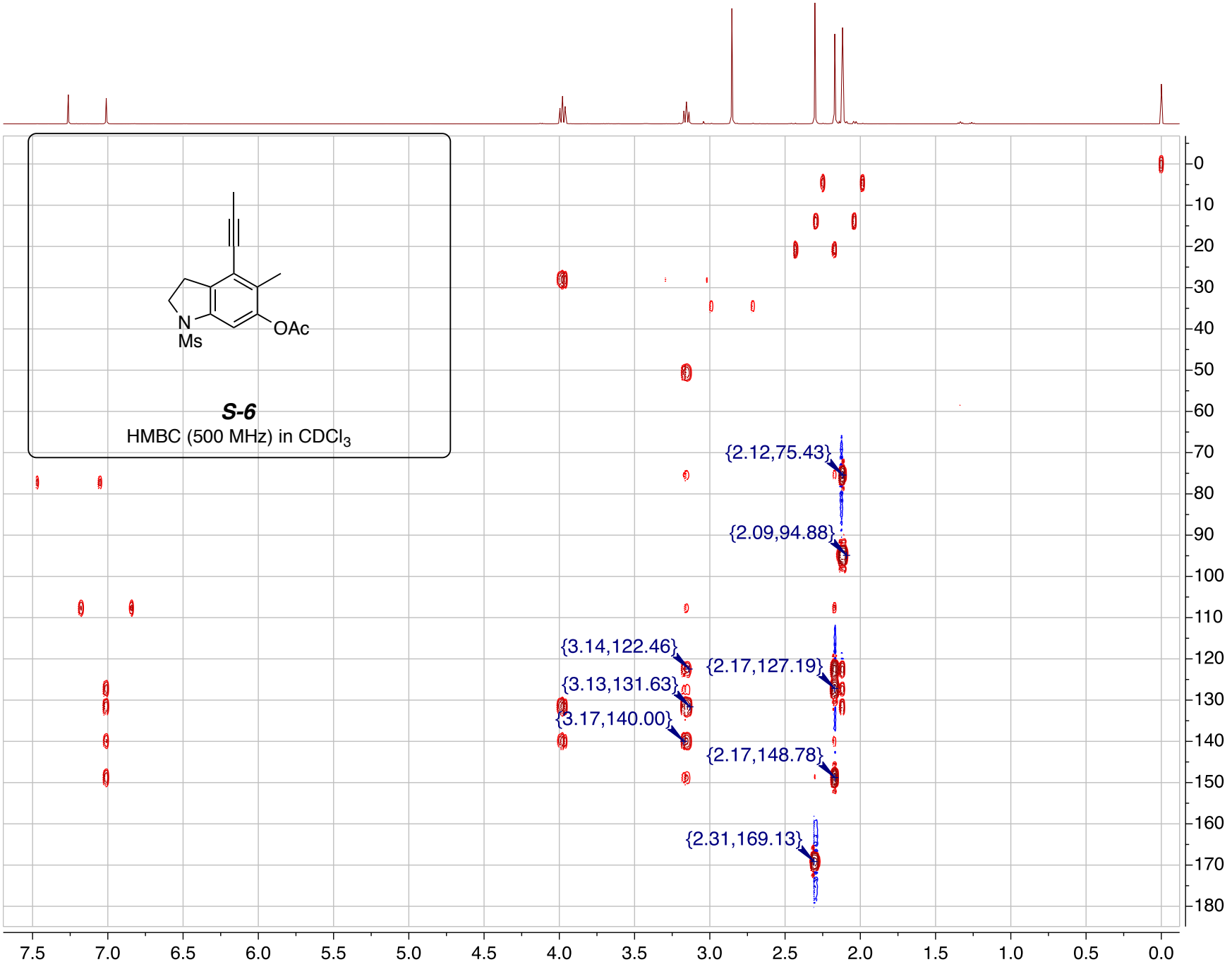

7.89 7.51 7.51 7.50 7.49 7.33 7.31 7.28 7.28 7.28 7.27 7.27 7.27 7.25 7.24 7.24 7.23 7.22 7.16 7.13 7.12 7.12 7.10 7.07 6.91 6.91 6.84 6.83 6.83 6.82 6.72 6.72 6.72 6.71 6.71 6.70 5.08 5.07 5.06 3.99 3.96 3.91 3.88 3.60 3.58 3.57 3.55 3.51 3.50 3.48 3.38 3.37 3.35 3.34 3.15 3.14 3.12 2.87 2.85 2.84 2.55 2.26 2.12 2.04 EtOAc 1.26 EtOAc
N Ms
N
OPh
Ph
NH
P14
1H NMR (500 MHz) in CDCl3
7.51 7.49
7.30 7.25 7.20
7.15 7.10 7.05
6.84 6.81
6.74 6.72 6.70
3.6 3.5
3.36 3.32
3.16 3.12
2.88 2.84
1.02 1.07 1.25 3.15 3.92 4.47 1.09 1.14 2.16
1.08
1.11 1.09 1.15 2.11 1.05 2.14 2.12 3.16 3.19 3.26
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

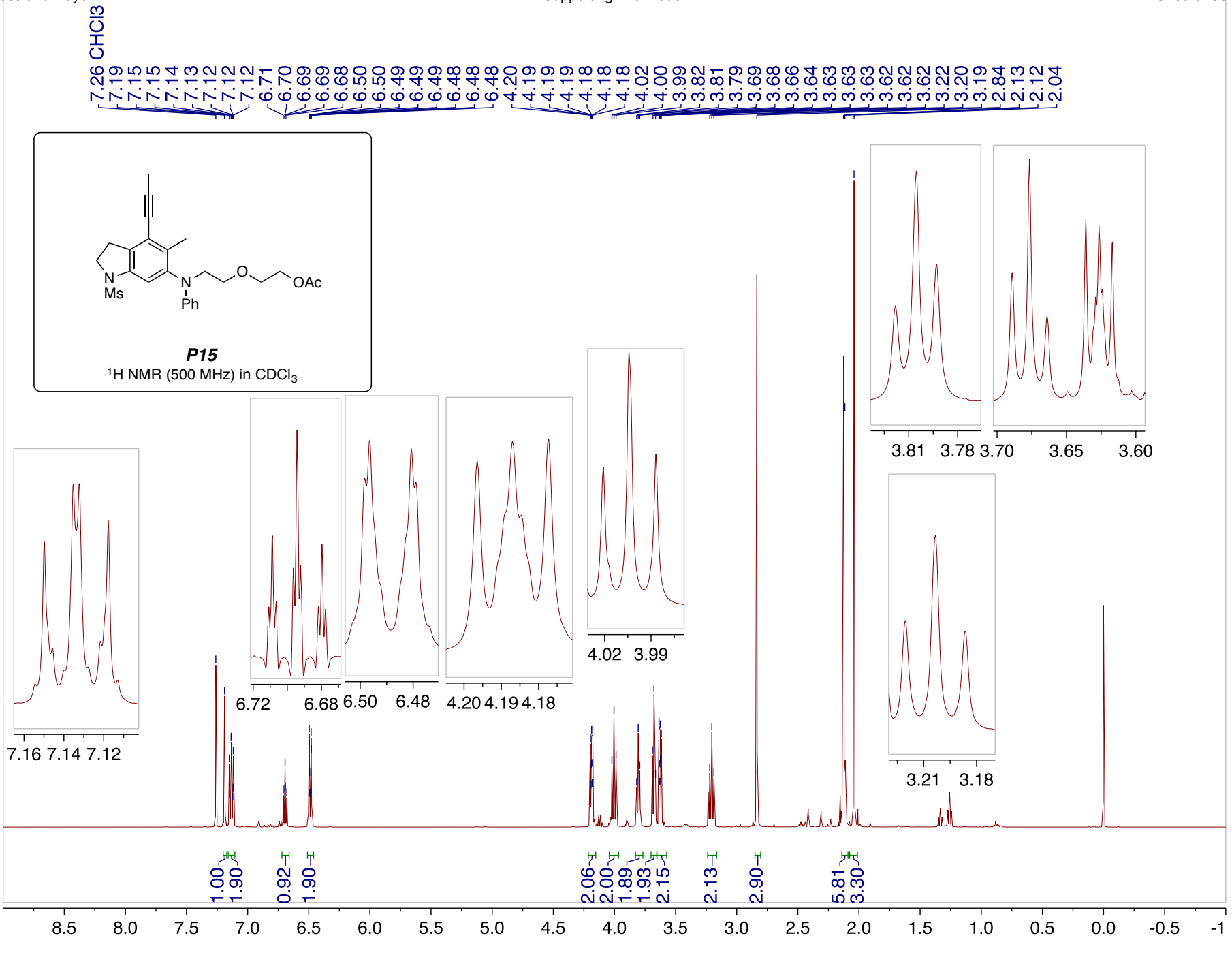

{2.13,4.57}
{2.25,16.10}
{2.85,23.71}
{3.14,27.97}
{2.55,33.74}
{3.97,50.50}
{3.50,55.40}
{3.58,61.35}
{5.07,78.87}
{7.31,111.10}
{7.27,109.03}
{6.71,115.87}
{7.07,119.18}
{7.15,121.87}
{7.28,128.53}
{7.12,129.29}
{7.22,127.59}
N
Ms
N
OPh
Ph
NH
P14
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

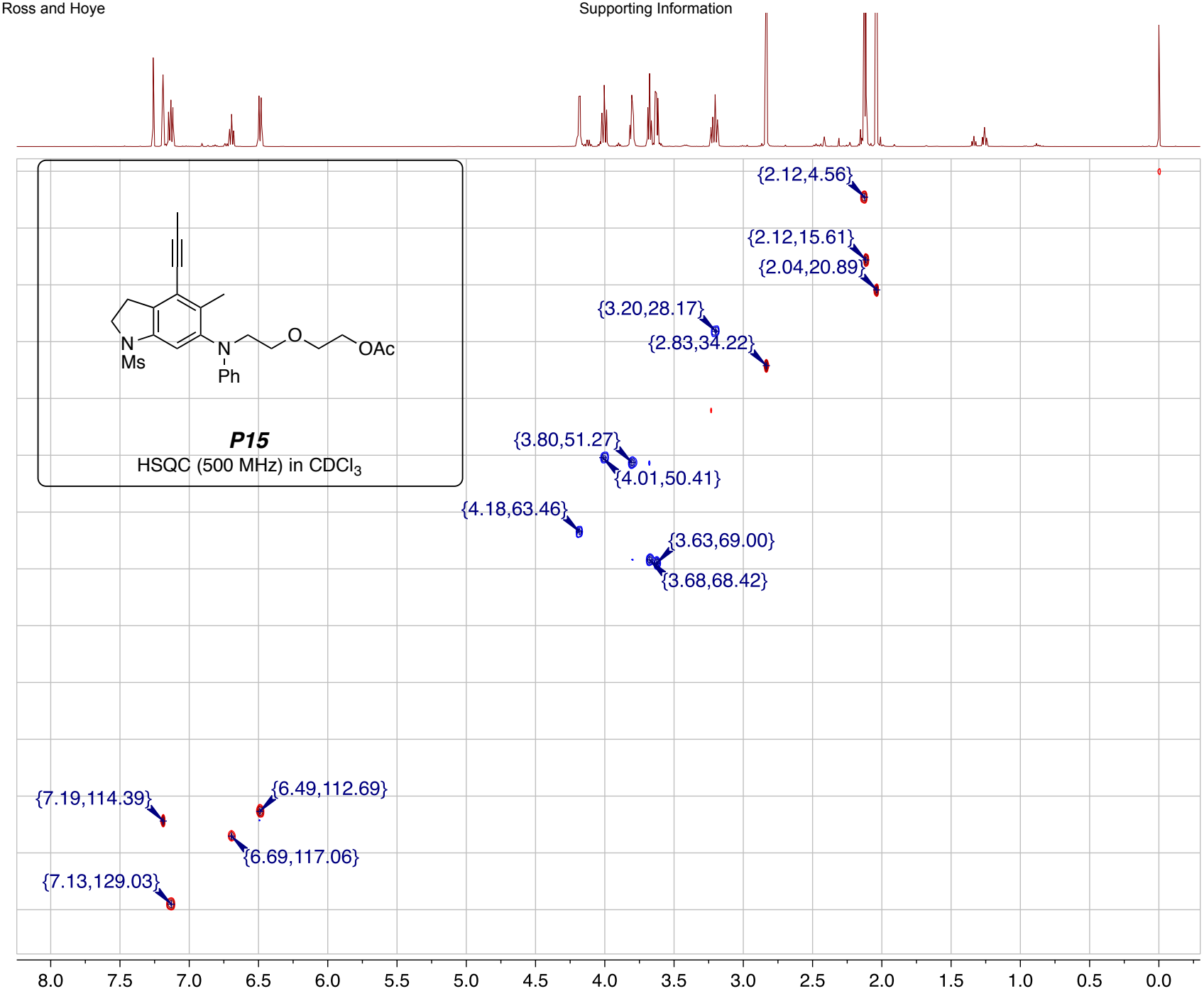

N
Ms
N
OPh
Ph
NH
P14
HMBC (500 MHz) in CDCl3
{2.12,76.55}
{2.13,93.85}
{6.91,114.08}
{6.91,127.16}
{6.91,136.18}
{5.06,126.11}
{5.09,140.23}
{5.07,158.03}
{3.14,129.21}
{3.14,139.75}
{2.26,122.28}
{2.26,132.29}
{2.26,149.13}
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170

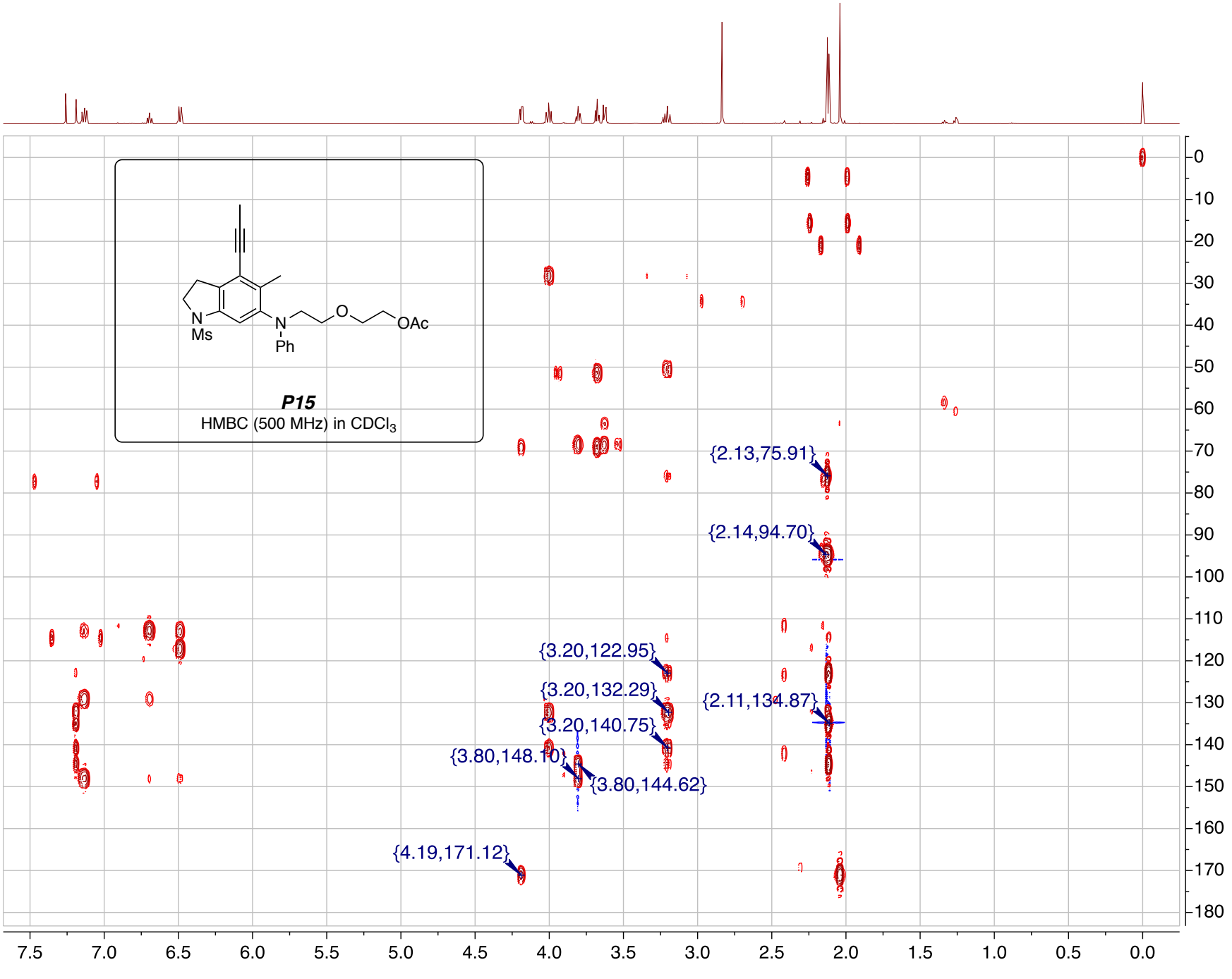

7.26 CHCl3
7.01
4.00
3.98
3.96
3.17
3.16
3.14
2.85
2.30
2.17
2.12
N
Ms
OAc
S-6
1H NMR (500 MHz) in CDCl3
4.00 3.98 3.96
3.18 3.15
1.00
2.26
2.24
3.41
3.38
3.39
3.65
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

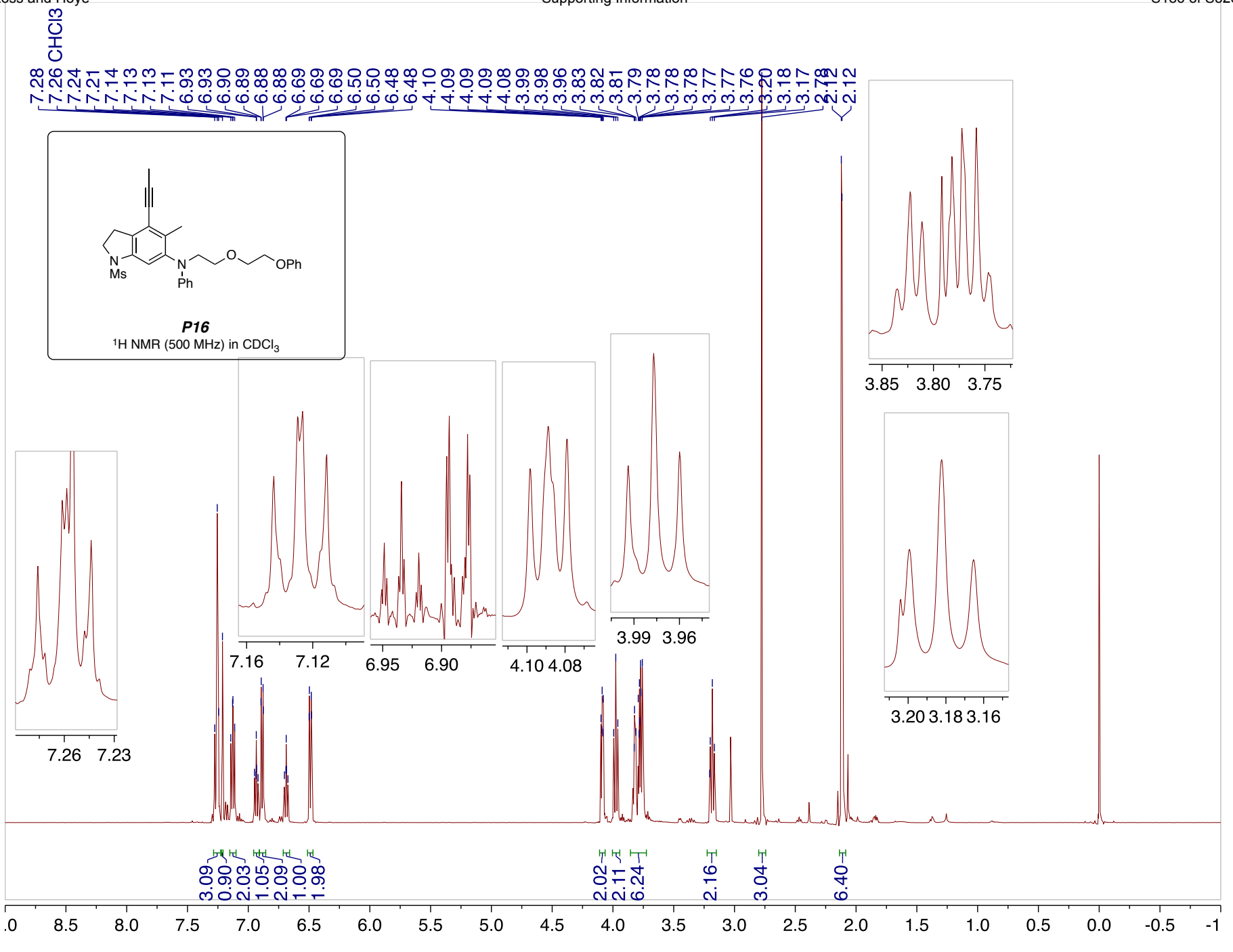

{2.12,4.41}
{2.17,13.88}
{2.30,20.68}
{3.15,27.95}
{2.85,35.09}
{3.98,50.55}
{7.01,107.57}
N
Ms
OAc
S-6
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

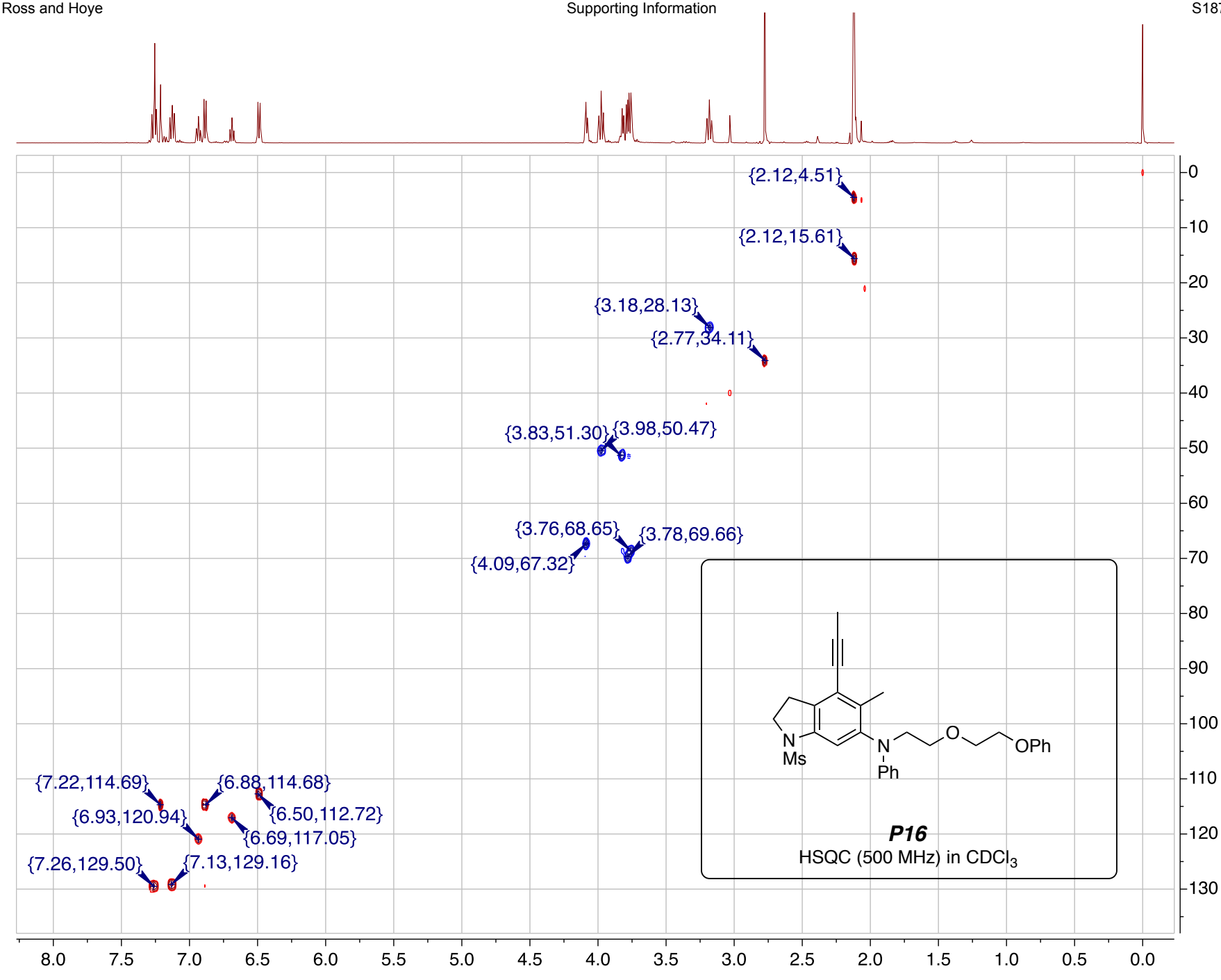

N
Ms
OAc
S-6
HMBC (500 MHz) in CDCl3
{2.12,75.43}
{2.09,94.88}
{3.14,122.46}
{2.17,127.19}
{3.13,131.63}
{3.17,140.00}
{2.17,148.78}
{2.31,169.13}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

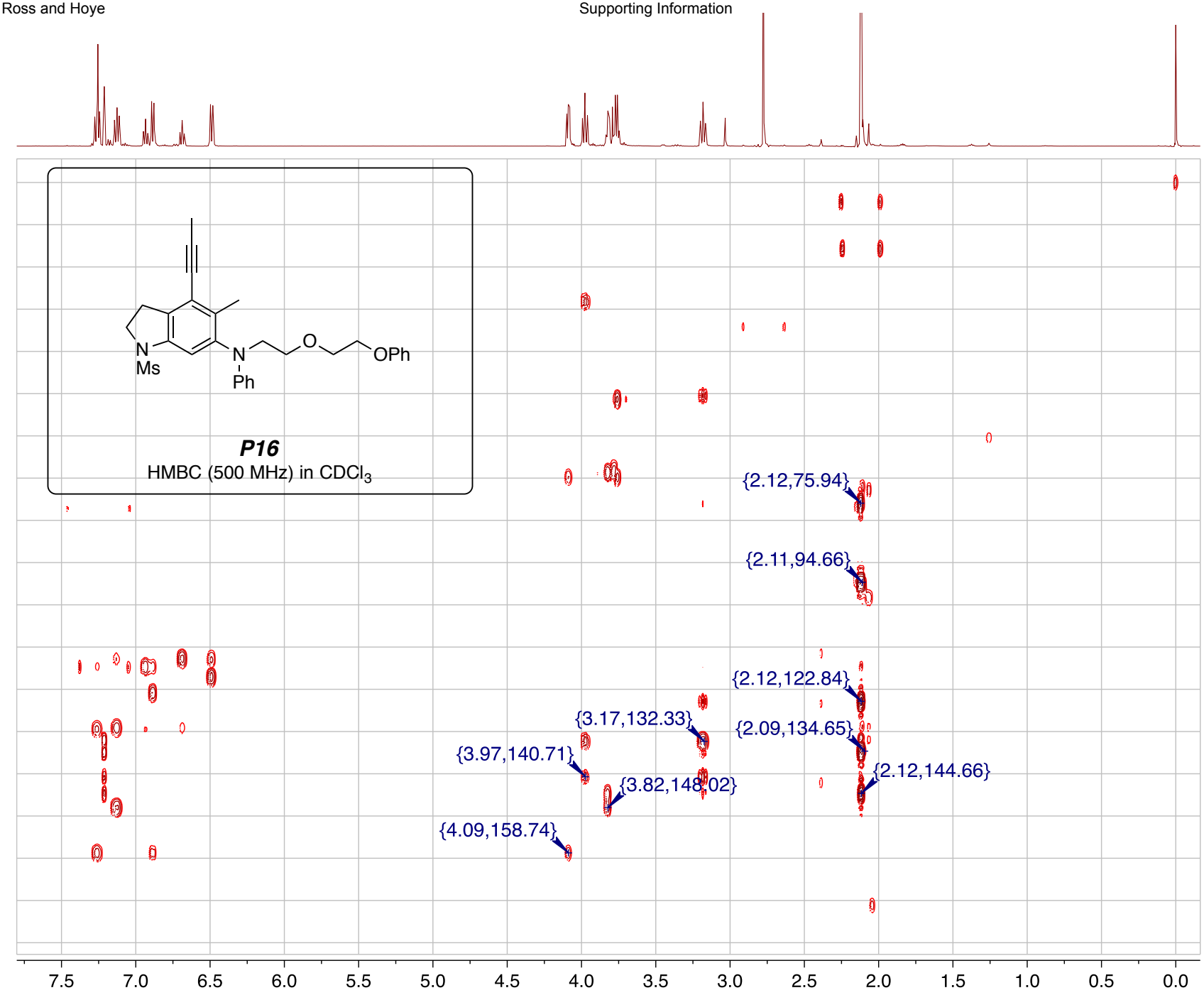

7.26 CHCl3
7.19 7.15 7.15 7.14 7.13 7.12 7.12 7.12
6.71 6.70 6.69 6.69 6.68 6.50 6.50 6.49 6.49 6.49 6.48 6.48 6.48
4.20 4.19 4.19 4.19 4.18 4.18 4.18 4.02 4.00 3.99 3.82 3.81 3.79 3.69 3.68 3.66 3.64 3.63 3.63 3.63 3.62 3.62 3.62 3.22 3.20 3.19 2.84 2.13 2.12 2.04
N
Ms
N
Ph
O
OAc
P15
1H NMR (500 MHz) in CDCl3
7.16 7.14 7.12
6.72 6.68
6.50 6.48
4.20 4.19 4.18
4.02 3.99
3.81 3.78
3.70 3.65 3.60
3.21 3.18
1.00 1.90 0.92 1.90 2.06 2.00 1.89 1.93 2.15 2.13 2.90 5.81 3.30
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

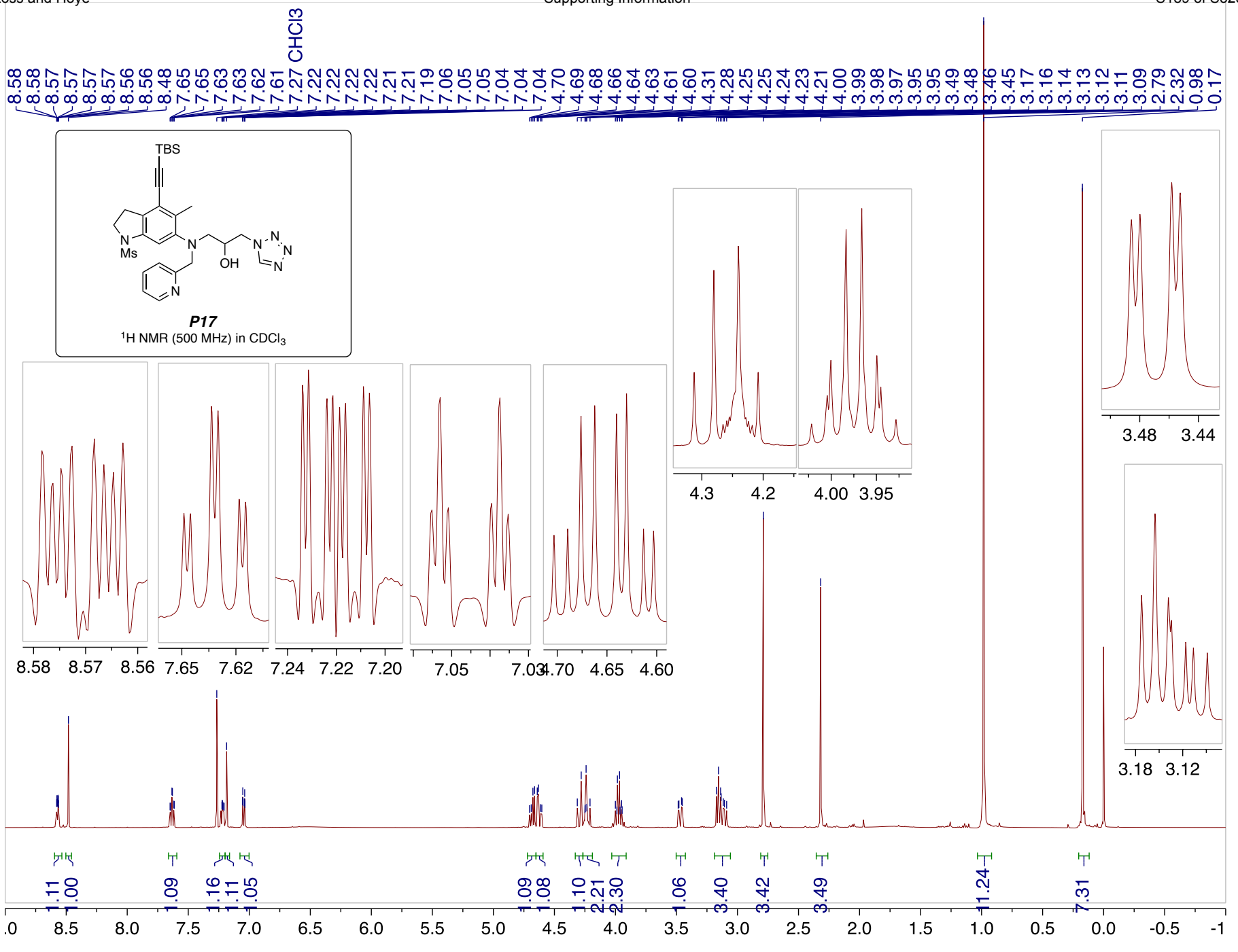

N
Ms
N
Ph
O
OAc
P15
HSQC (500 MHz) in CDCl3
{2.12,4.56}
{2.12,15.61}
{2.04,20.89}
{3.20,28.17}
{2.83,34.22}
{3.80,51.27}
{4.01,50.41}
{4.18,63.46}
{3.63,69.00}
{3.68,68.42}
{7.19,114.39}
{6.49,112.69}
{6.69,117.06}
{7.13,129.03}
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130

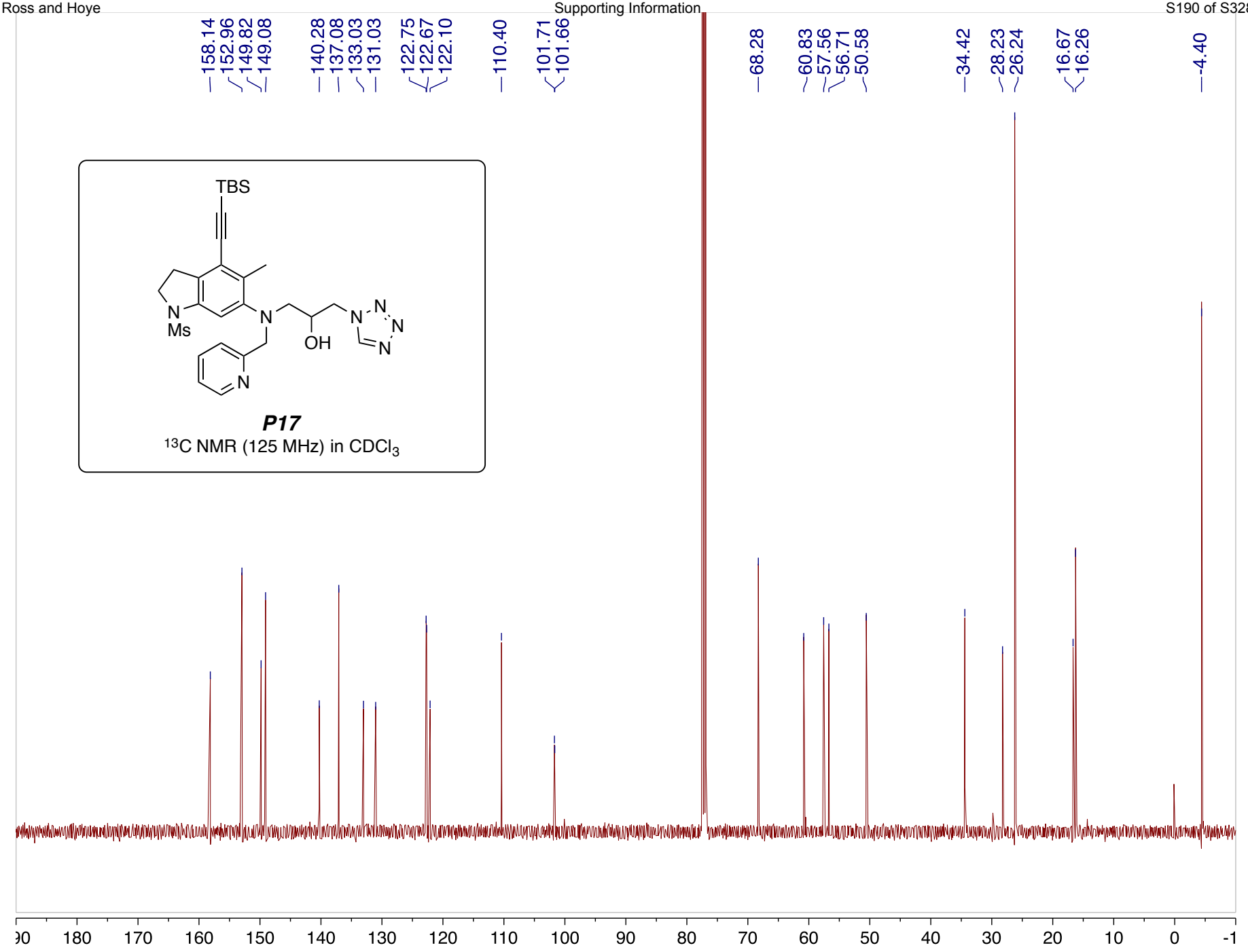

N
Ms
N
Ph
O
OAc
P15
HMBC (500 MHz) in CDCl3
{2.13,75.91}
{2.14,94.70}
{3.20,122.95}
{3.20,132.29}
{3.20,140.75}
{2.11,134.87}
{3.80,148.10}
{3.80,144.62}
{4.19,171.12}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

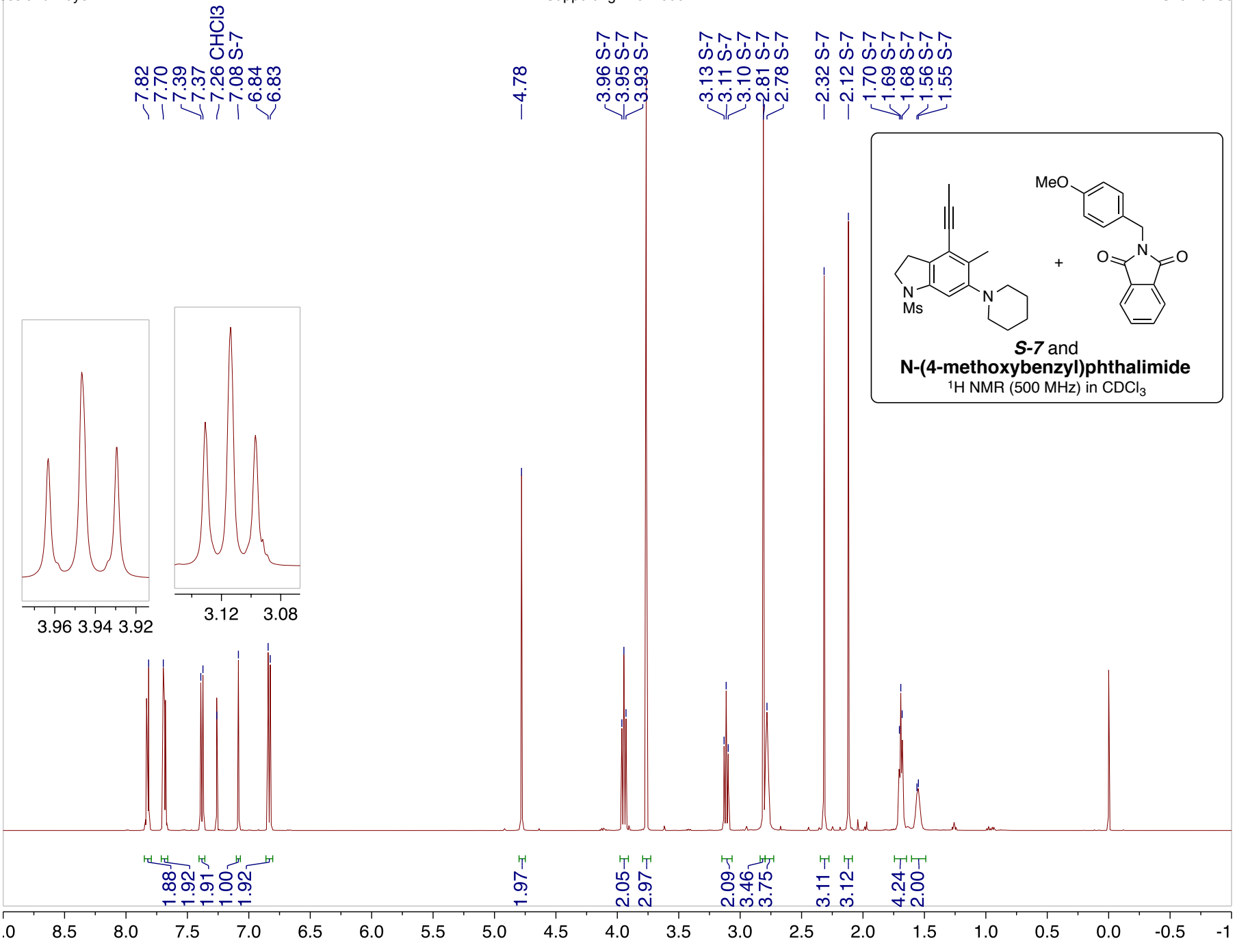

CHCl3
7.28 7.26 7.24 7.21 7.14 7.13 7.13 7.11 6.93 6.93 6.90 6.89 6.88 6.88 6.69 6.69 6.69 6.50 6.50 6.48 6.48 4.10 4.09 4.09 4.09 4.08 3.99 3.98 3.96 3.83 3.82 3.81 3.79 3.78 3.78 3.78 3.77 3.77 3.76 3.20 3.18 3.17 2.78 2.12 2.12
N Ms
N Ph
O
OPh
P16
1H NMR (500 MHz) in CDCl3
7.26 7.23
7.16 7.12
6.95 6.90
4.10 4.08
3.99 3.96
3.85 3.80 3.75
3.20 3.18 3.16
3.09 0.90 2.03 1.05 2.09 1.00 1.98
2.02 2.11 6.24 2.16 3.04 6.40
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

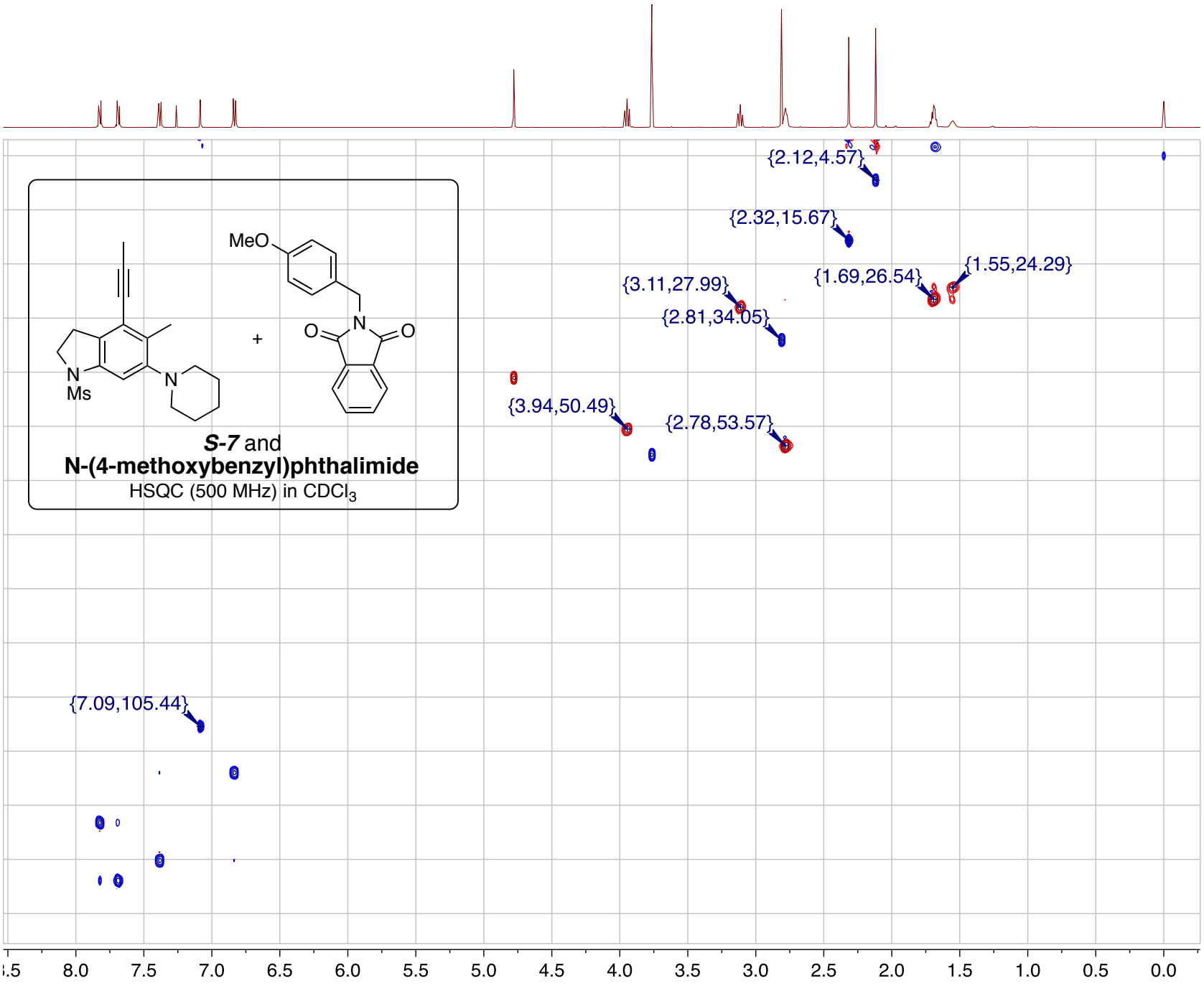

{2.12,4.51}
{2.12,15.61}
{3.18,28.13}
{2.77,34.11}
{3.83,51.30}
{3.98,50.47}
{3.76,68.65}
{3.78,69.66}
{4.09,67.32}
{7.22,114.69}
{6.88,114.68}
{6.93,120.94}
{6.50,112.72}
{6.69,117.05}
{7.26,129.50}
{7.13,129.16}
N
Ms
N
Ph
O
OPh
P16
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

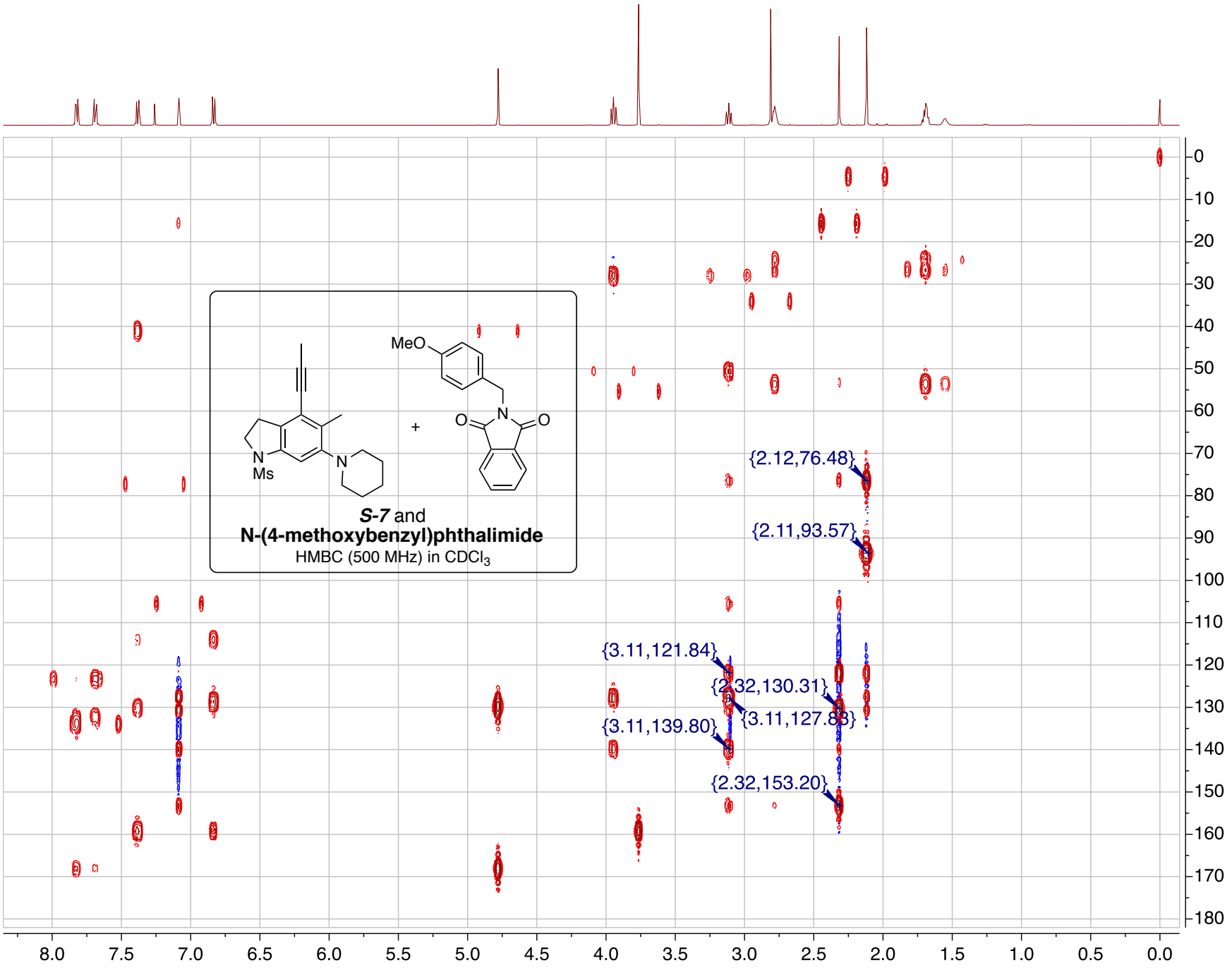

N
Ms
N
Ph
O
OPh
P16
HMBC (500 MHz) in CDCl3
{2.12,75.94}
{2.11,94.66}
{2.12,122.84}
{3.17,132.33}
{2.09,134.65}
{3.97,140.71}
{2.12,144.66}
{3.82,148.02}
{4.09,158.74}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

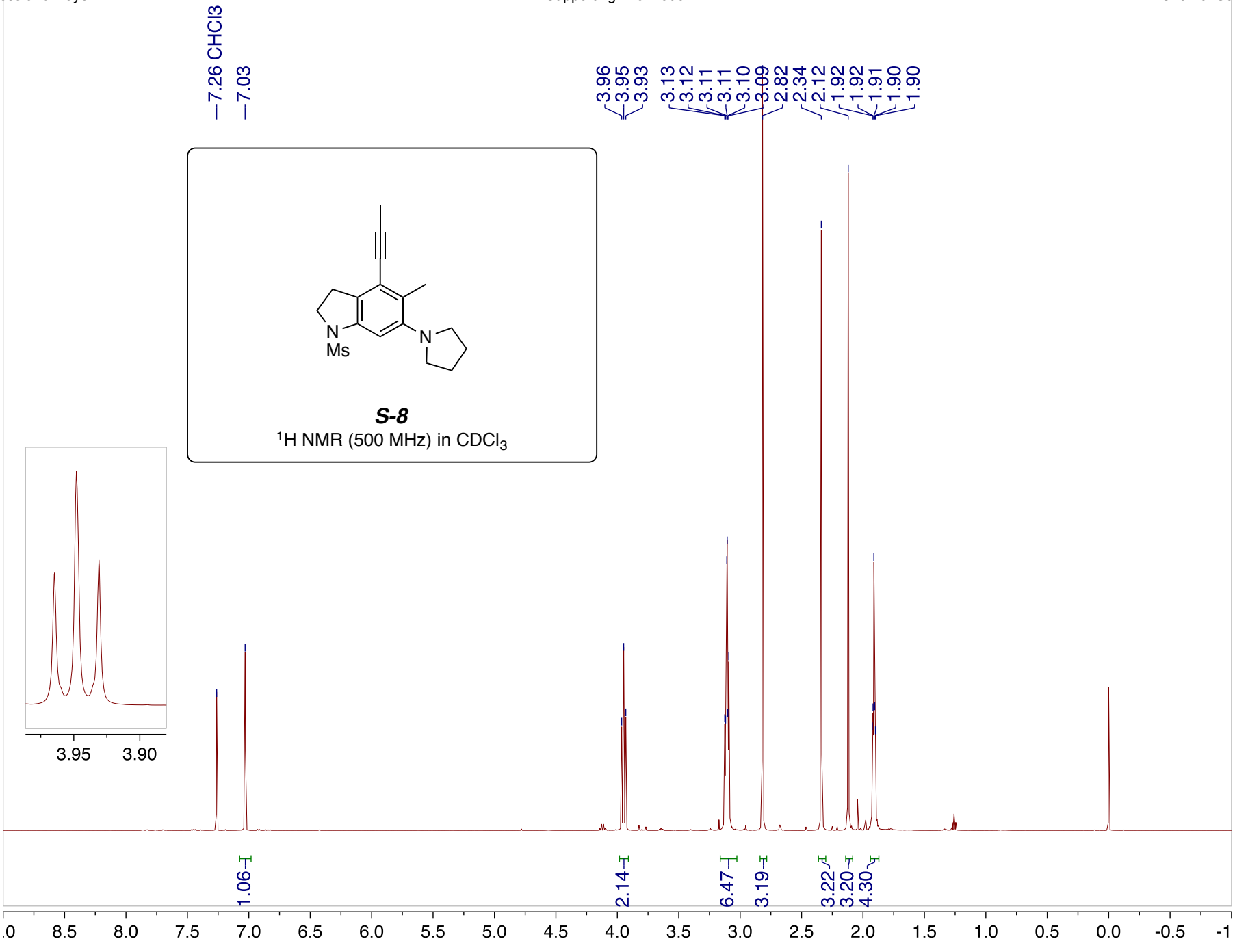

CHCl3
8.58 8.58 8.57 8.57 8.57 8.57 8.56 8.56 8.48 7.65 7.65 7.63 7.63 7.62 7.61 7.27 7.22 7.22 7.22 7.21 7.21 7.19 7.06 7.05 7.05 7.04 7.04 4.70 4.69 4.68 4.66 4.64 4.63 4.61 4.60 4.31 4.28 4.25 4.25 4.24 4.23 4.21 4.00 3.99 3.98 3.97 3.95 3.95 3.49 3.48 3.46 3.45 3.17 3.16 3.14 3.13 3.12 3.11 3.09 2.79 2.32 0.98 0.17
TBS
N
Ms
N
OH
N
N
N
N
P17
1H NMR (500 MHz) in CDCl3
8.58 8.57 8.56
7.65 7.62
7.24 7.22 7.20
7.05 7.03
4.70 4.65 4.60
4.3 4.2
4.00 3.95
3.48 3.44
3.18 3.12
1.11 1.00 1.09 1.16 1.11 1.05 1.09 1.08 1.10 2.21 2.30 1.06 3.40 3.42 3.49 11.24 7.31
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1


158.14
152.96
149.82
149.08
140.28
137.08
133.03
131.03
122.75
122.67
122.10
110.40
101.71
101.66
68.28
60.83
57.56
56.71
50.58
34.42
28.23
26.24
16.67
16.26
-4.40
TBS
N
Ms
N
OH
N
N
N
N
N
P17
13C NMR (125 MHz) in CDCl3
90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1

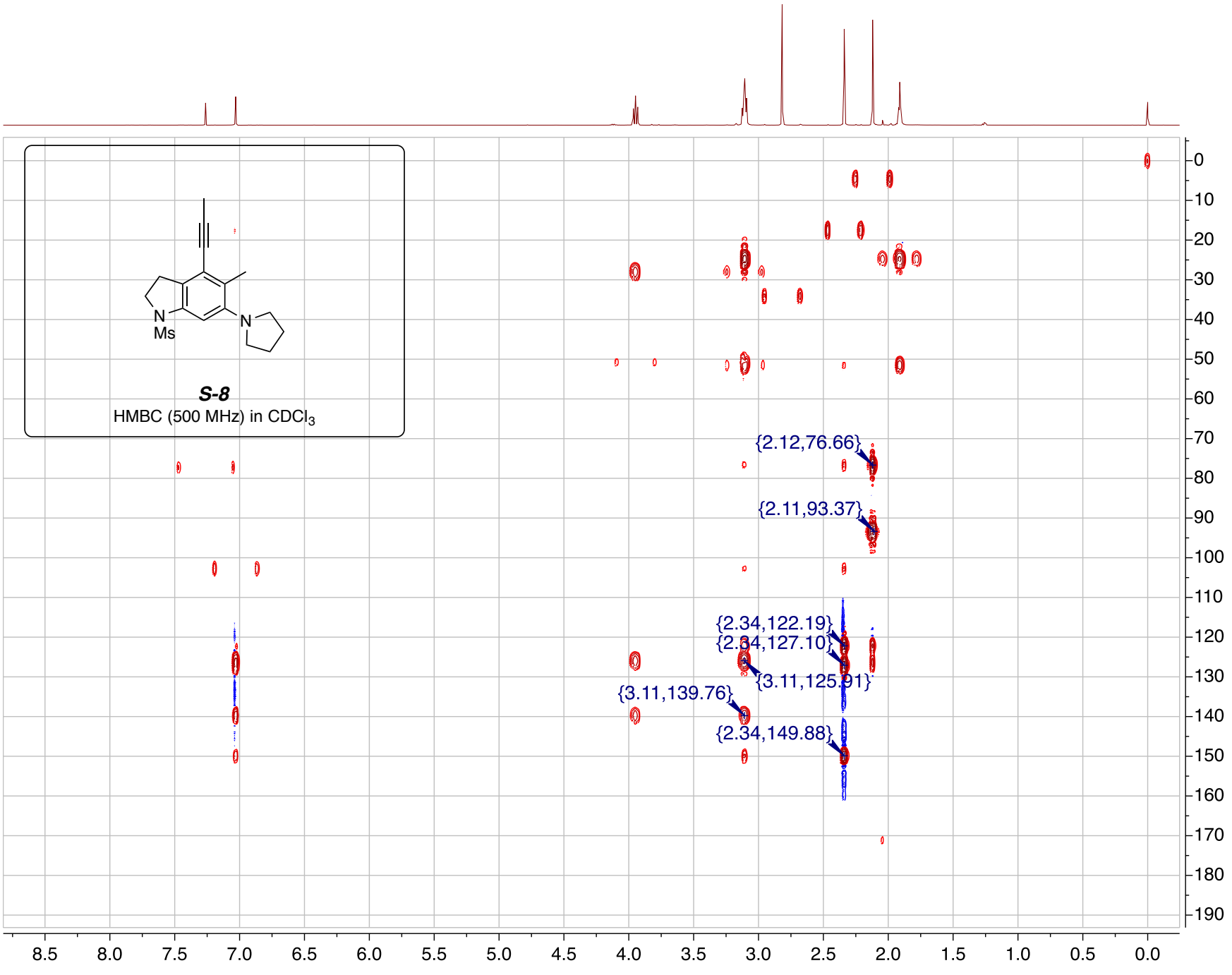

7.82
7.70
7.39
7.37
7.26 CHCl3
7.08 S-7
6.84
6.83
4.78
3.96 S-7
3.95 S-7
3.93 S-7
3.13 S-7
3.11 S-7
3.10 S-7
2.81 S-7
2.78 S-7
2.32 S-7
2.12 S-7
1.70 S-7
1.69 S-7
1.68 S-7
1.56 S-7
1.55 S-7
3.96 3.94 3.92
3.12 3.08
1.88
1.92
1.91
1.00
1.92
1.97
2.05
2.97
2.09
3.46
3.75
3.11
3.12
4.24
2.00
MeO
N
Ms
N
O
N
O
+
S-7 and
N-(4-methoxybenzyl)phthalimide
1H NMR (500 MHz) in CDCl3

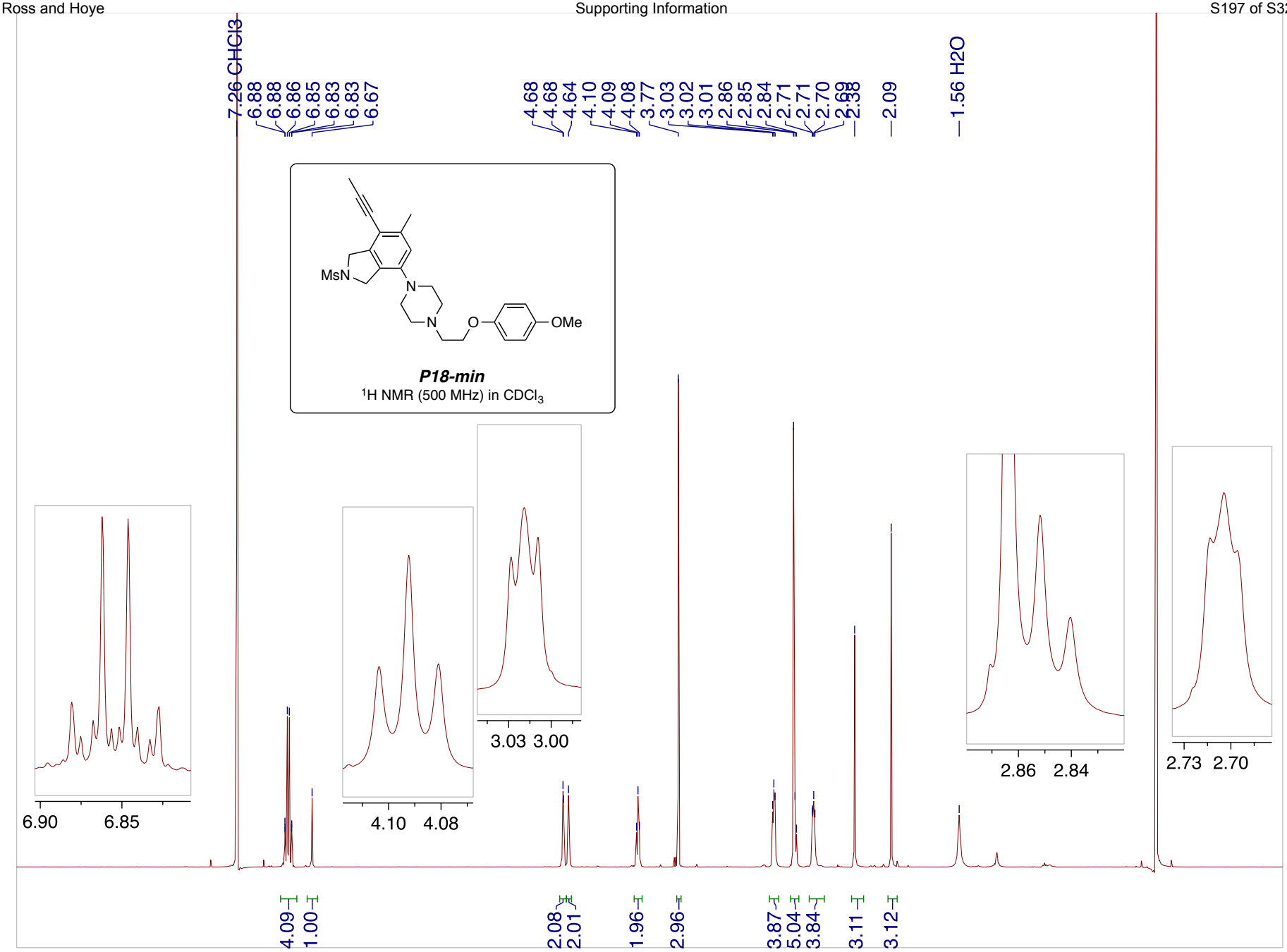

{2.12,4.57}
{2.32,15.67}
{1.69,26.54}
{1.55,24.29}
{3.11,27.99}
{2.81,34.05}
{3.94,50.49}
{2.78,53.57}
{7.09,105.44}
MeO
N
O
O
N
Ms
N
+
S-7 and
N-(4-methoxybenzyl)phthalimide
HSQC (500 MHz) in $CDCl_3$

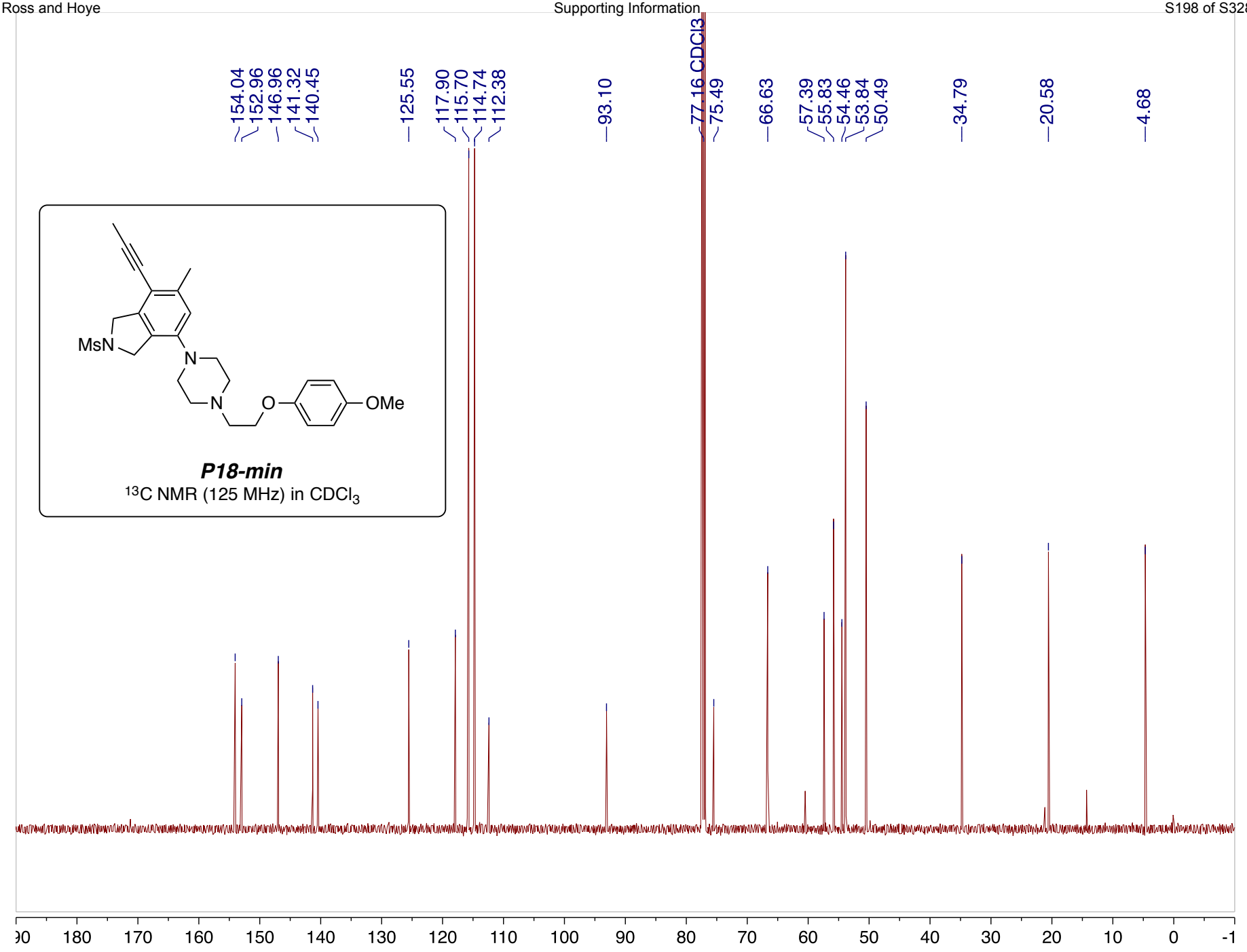

MeO
N
O
O
+
N
Ms
S-7 and
N-(4-methoxybenzyl)phthalimide
HMBC (500 MHz) in $CDCl_3$
{2.12,76.48}
{2.11,93.57}
{3.11,121.84}
{2.32,130.31}
{3.11,127.83}
{3.11,139.80}
{2.32,153.20}
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180

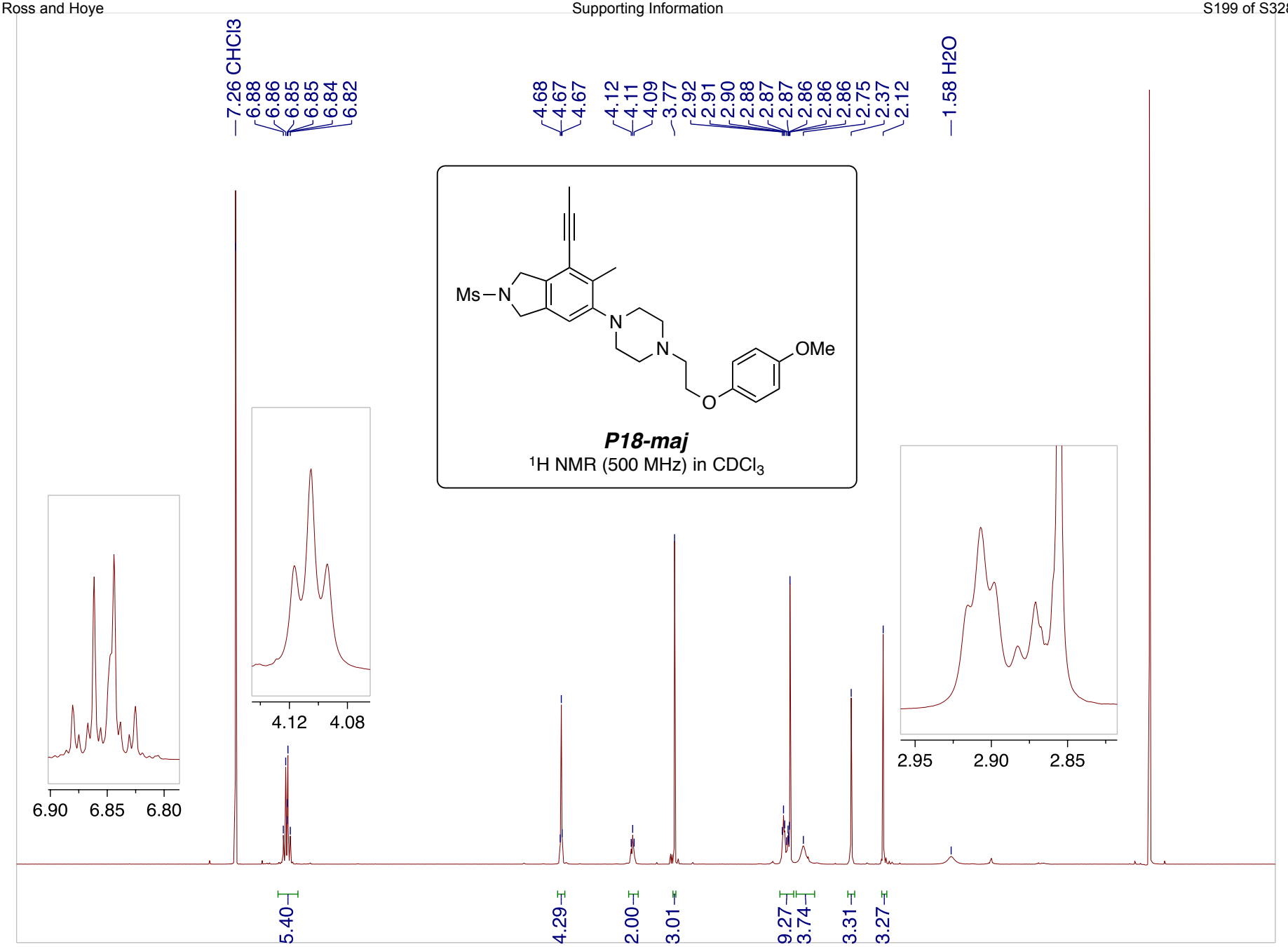

7.26 CHCl3
7.03
3.96
3.95
3.93
3.13
3.12
3.11
3.11
3.10
3.09
2.82
2.34
2.12
1.92
1.92
1.91
1.90
1.90
N
Ms
N
S-8
1H NMR (500 MHz) in CDCl3
3.95
3.90
1.06
2.14
6.47
3.19
3.22
3.20
4.30
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1

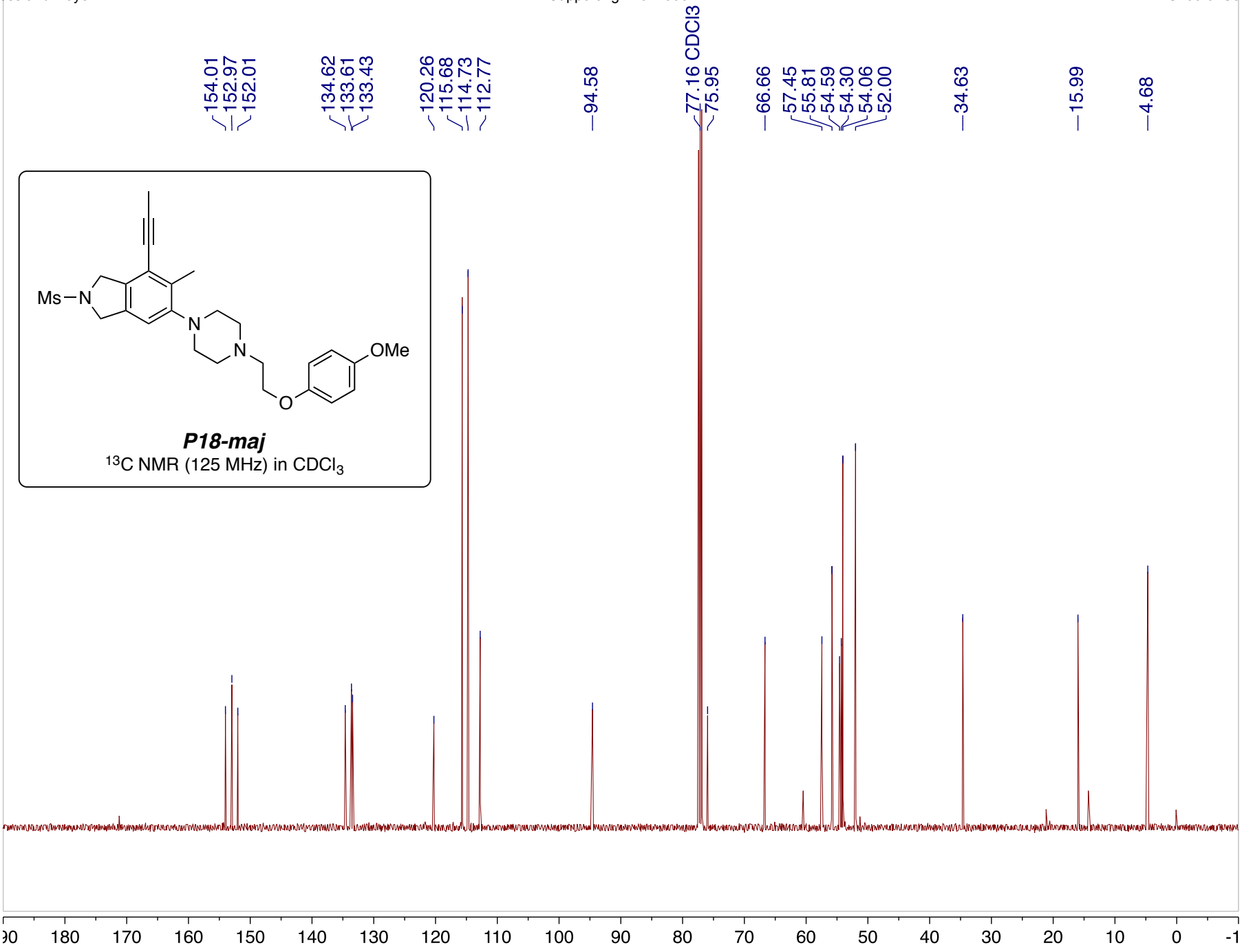

{2.12,4.55}
{2.34,17.52}
{1.91,24.76}
{3.11,27.97}
{2.82,34.05}
{3.95,50.74}
{3.10,51.49}
{7.03,102.66}
N
Ms
N
S-8
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

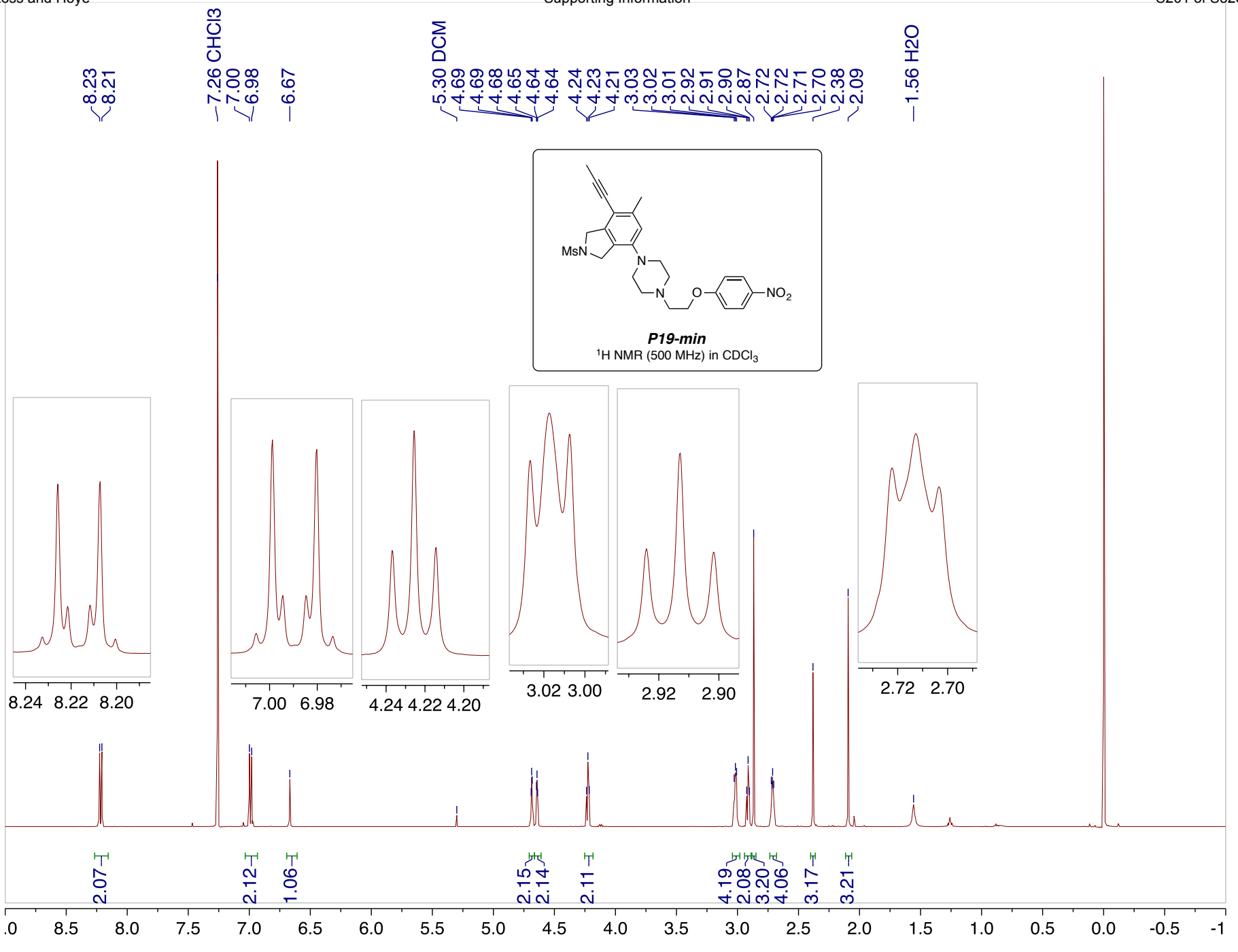

N
Ms
N
S-8
HMBC (500 MHz) in CDCl3
{2.12,76.66}
{2.11,93.37}
{2.34,122.19}
{2.34,127.10}
{3.11,125.91}
{3.11,139.76}
{2.34,149.88}
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190

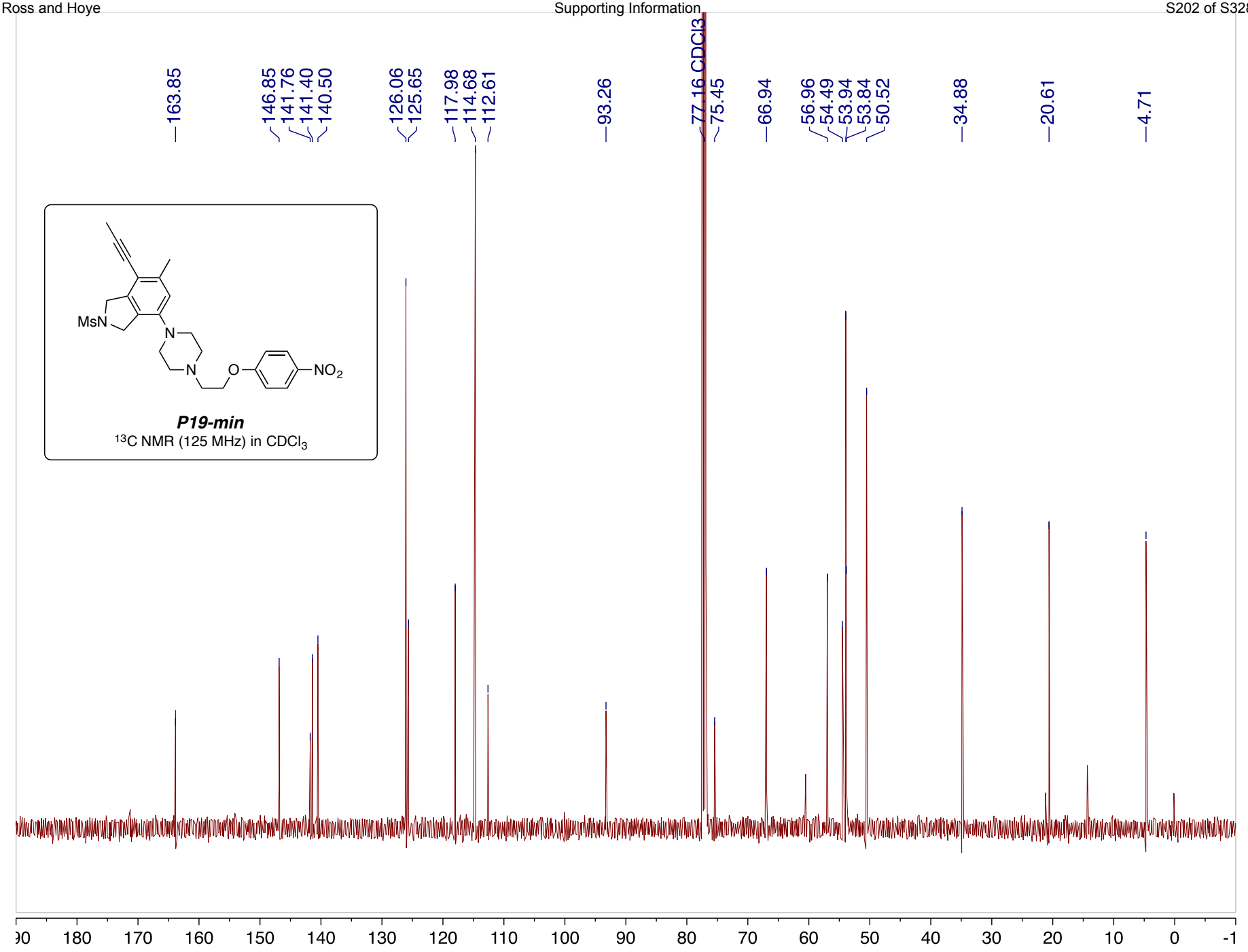

7.26 CHCl3
6.88
6.88
6.86
6.85
6.83
6.83
6.67
4.68
4.68
4.64
4.10
4.09
4.08
3.77
3.03
3.02
3.01
2.86
2.85
2.84
2.71
2.71
2.70
2.69
2.38
2.09
1.56 H2O
MsN
N
N
O
OMe
P18-min
1H NMR (500 MHz) in CDCl3
6.90
6.85
4.10
4.08
3.03
3.00
2.86
2.84
2.73
2.70
4.09
1.00
2.08
2.01
1.96
2.96
3.87
5.04
3.84
3.11
3.12
.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1

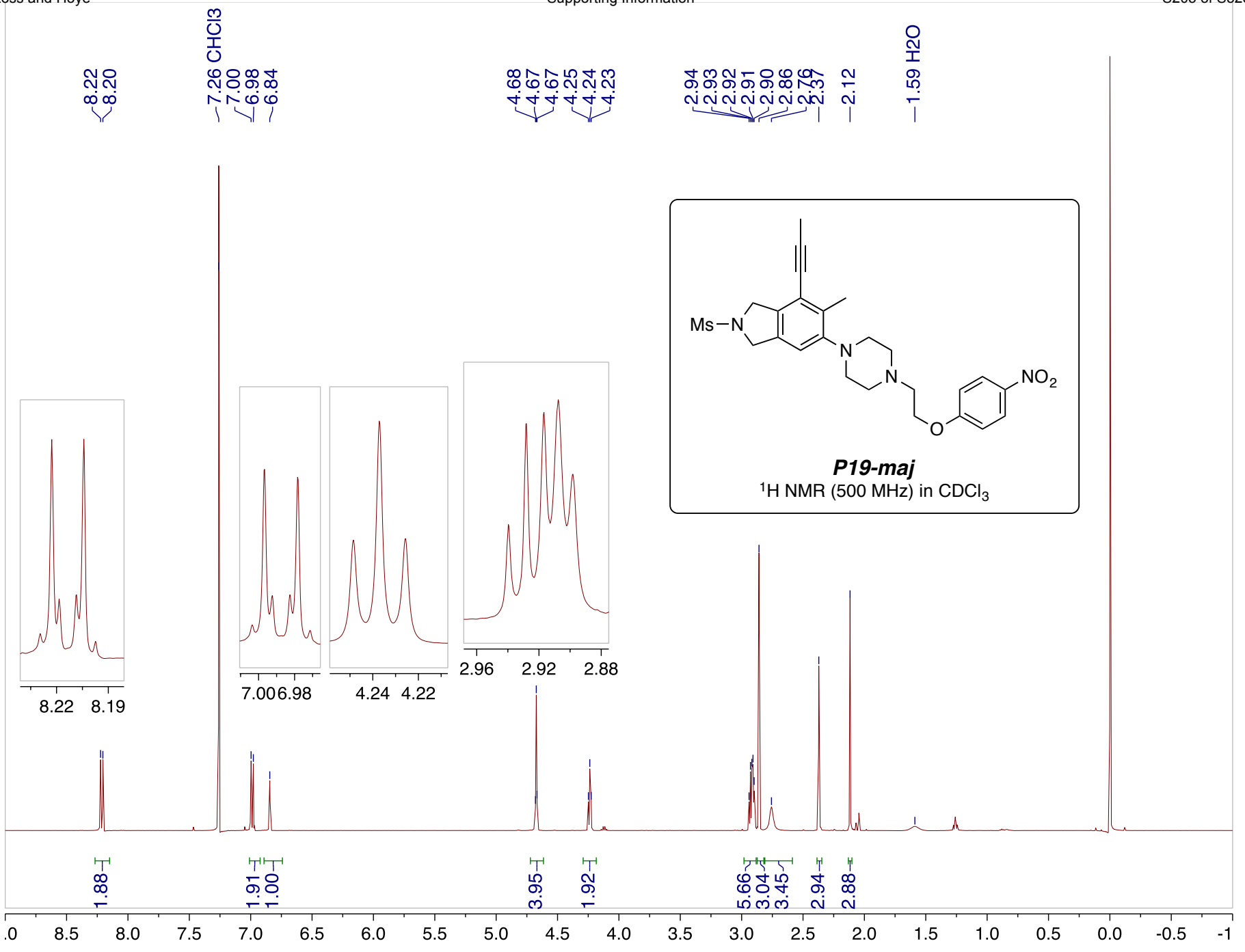

154.04
152.96
146.96
141.32
140.45
125.55
117.90
115.70
114.74
112.38
93.10
77.16 CDCl3
75.49
66.63
57.39
55.83
54.46
53.84
50.49
34.79
20.58
4.68
MsN
N
N
O
OMe
P18-min
13C NMR (125 MHz) in CDCl3
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1

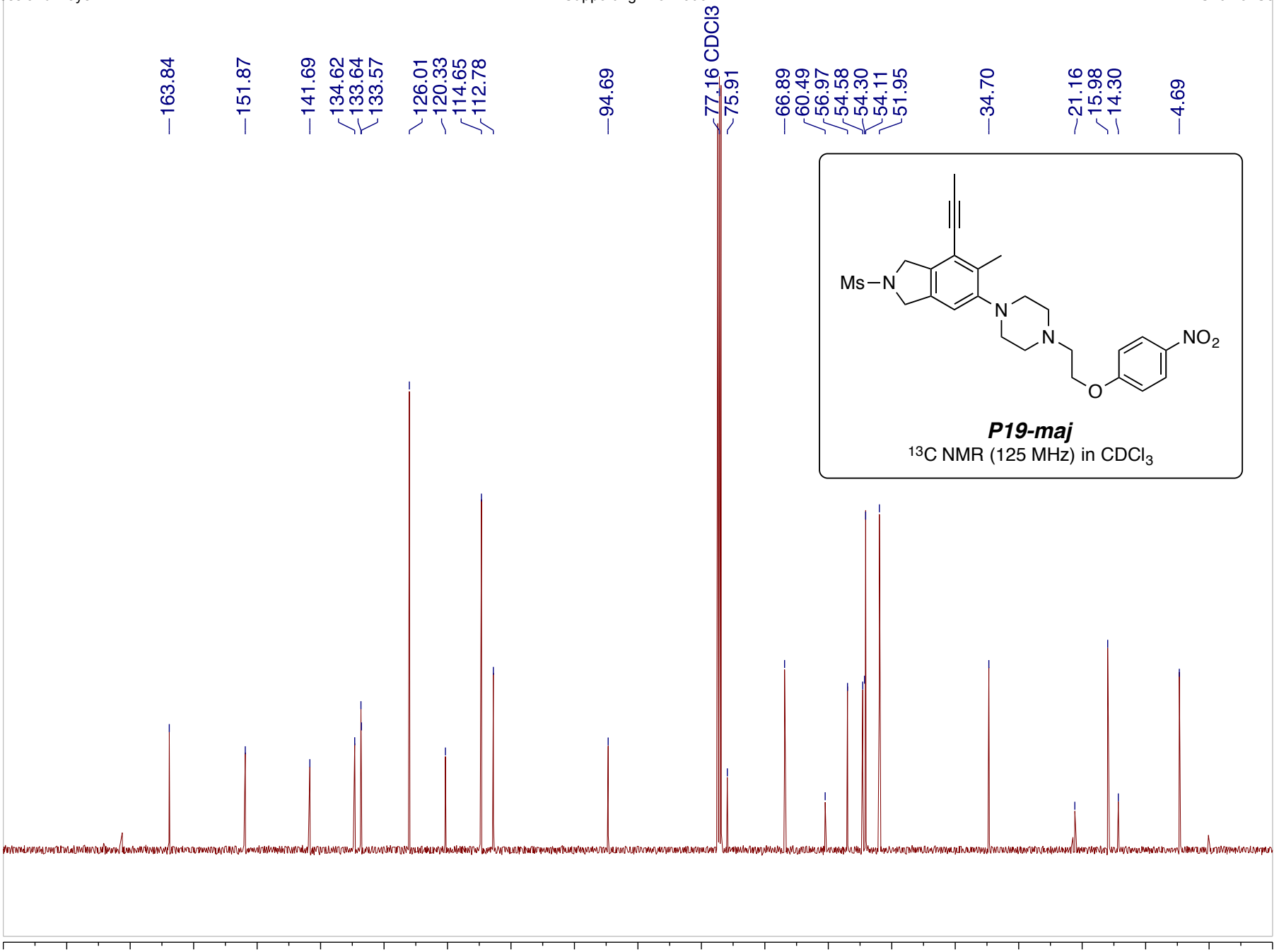

7.26 CHCl3
6.88
6.86
6.85
6.85
6.84
6.82
4.68
4.67
4.67
4.12
4.11
4.09
3.77
2.92
2.91
2.90
2.88
2.87
2.87
2.86
2.86
2.86
2.75
2.37
2.12
1.58 H2O
Ms
N
N
N
O
OMe
P18-maj
1H NMR (500 MHz) in CDCl3
6.90
6.85
6.80
4.12
4.08
2.95
2.90
2.85
5.40
4.29
2.00
3.01
9.27
3.74
3.31
3.27
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1

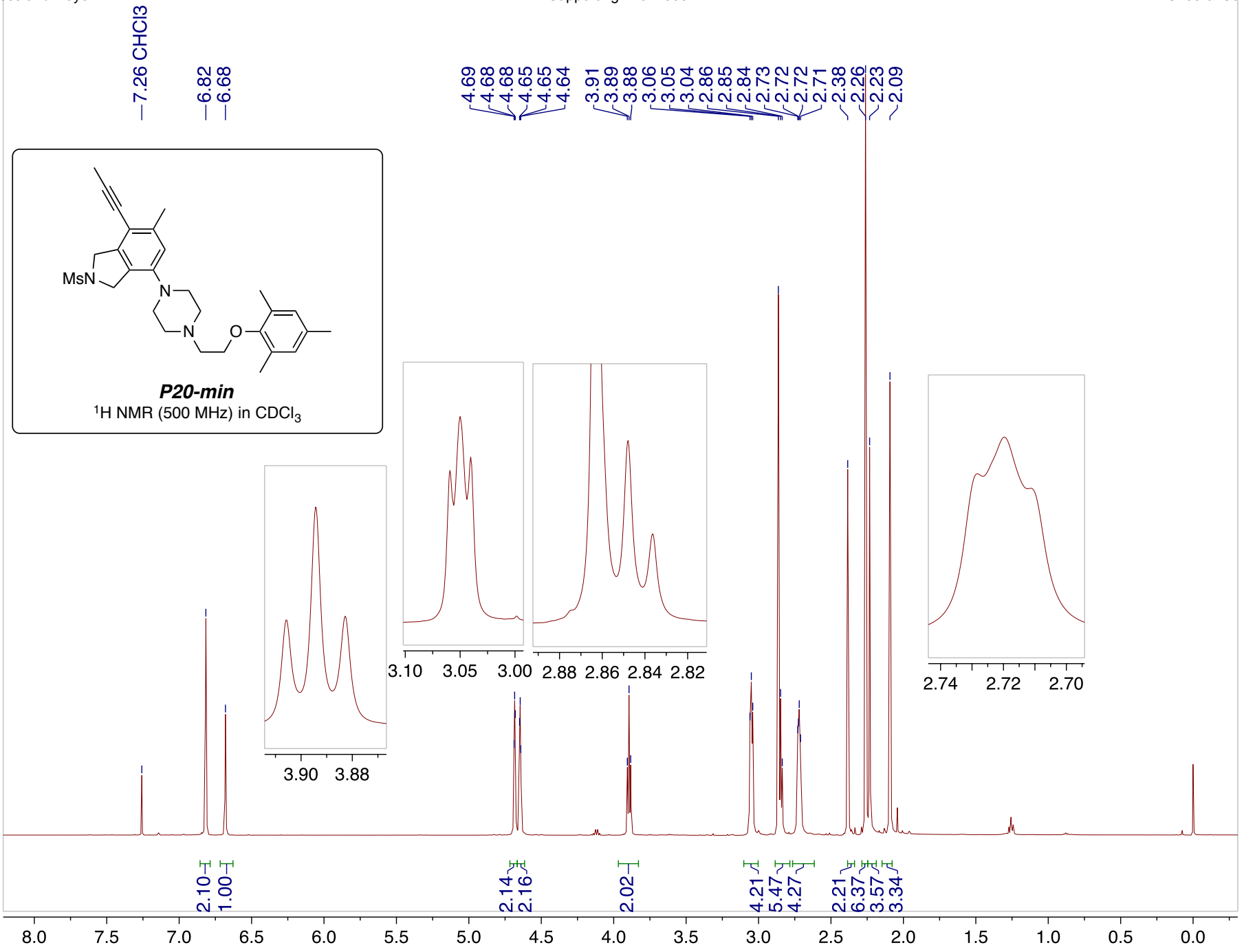

154.01
152.97
152.01
134.62
133.61
133.43
120.26
115.68
114.73
112.77
94.58
77.16 CDCl3
75.95
66.66
57.45
55.81
54.59
54.30
54.06
52.00
34.63
15.99
4.68
Ms
N
N
N
O
OMe
P18-maj
13C NMR (125 MHz) in CDCl3
90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1

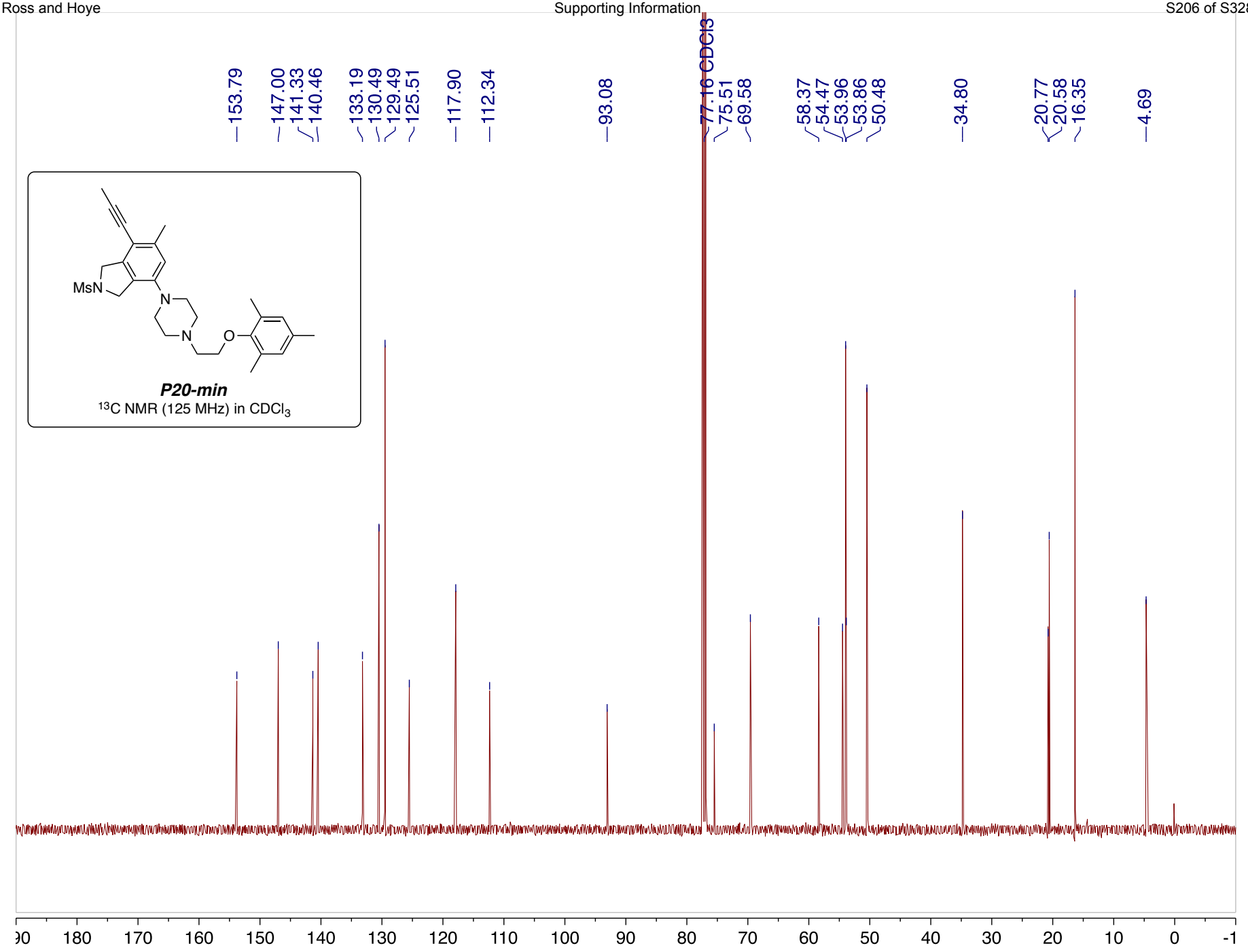

8.23
8.21
7.26 CHCl3
7.00
6.98
6.67
5.30 DCM
4.69
4.69
4.68
4.65
4.64
4.64
4.24
4.23
4.21
3.03
3.02
3.01
2.92
2.91
2.90
2.87
2.72
2.72
2.71
2.70
2.38
2.09
1.56 H2O
MsN
N
N
O
NO2
P19-min
1H NMR (500 MHz) in CDCl3
8.24 8.22 8.20
7.00 6.98
4.24 4.22 4.20
3.02 3.00
2.92 2.90
2.72 2.70
2.07
2.12
1.06
2.15
2.14
2.11
4.19
2.08
3.20
4.06
3.17
3.21
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

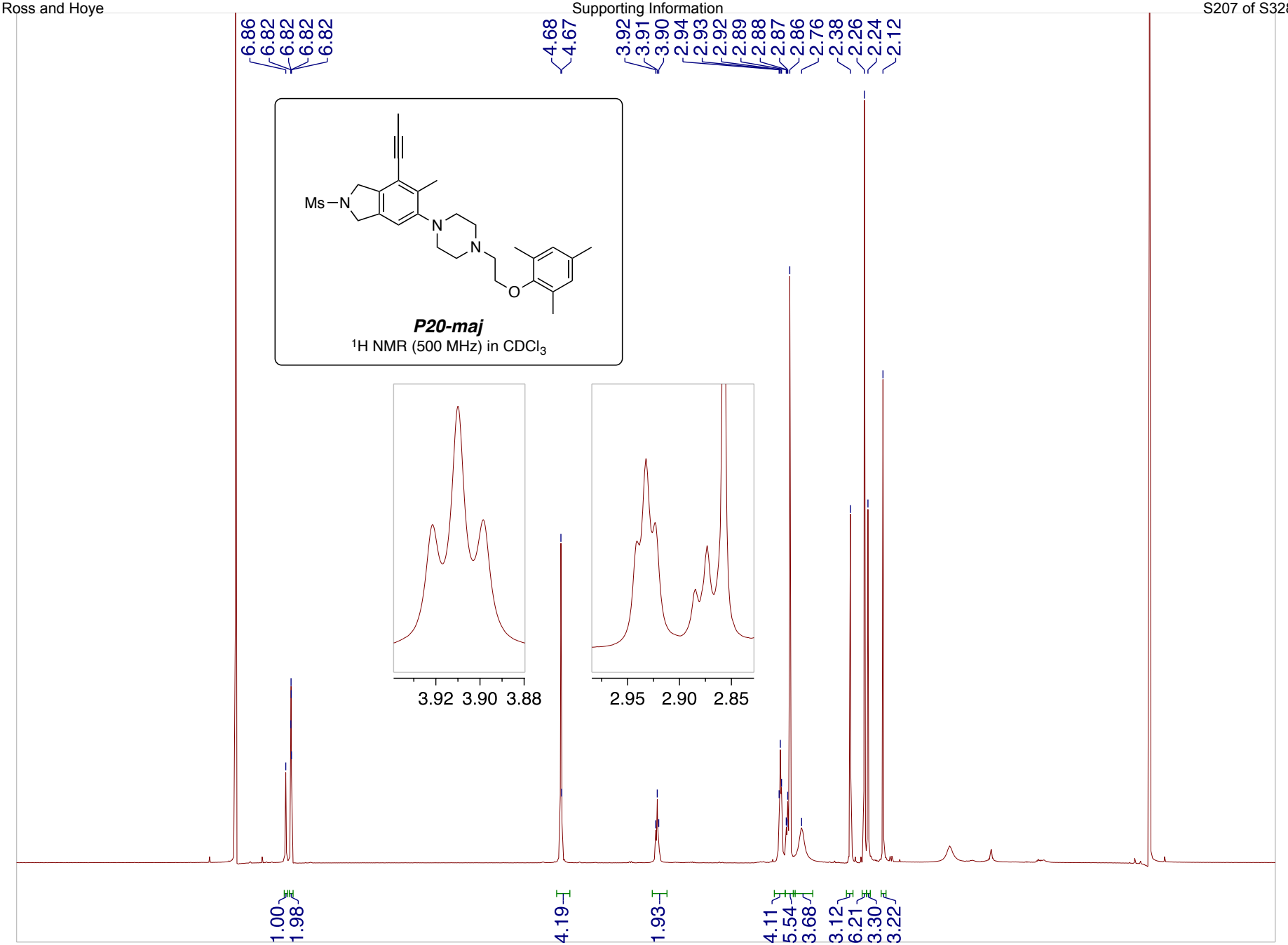

163.85
146.85
141.76
141.40
140.50
126.06
125.65
117.98
114.68
112.61
93.26
77.16 CDCl3
75.45
66.94
56.96
54.49
53.94
53.84
50.52
34.88
20.61
4.71
MsN
N
N
O
NO2
P19-min
13C NMR (125 MHz) in CDCl3
90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1

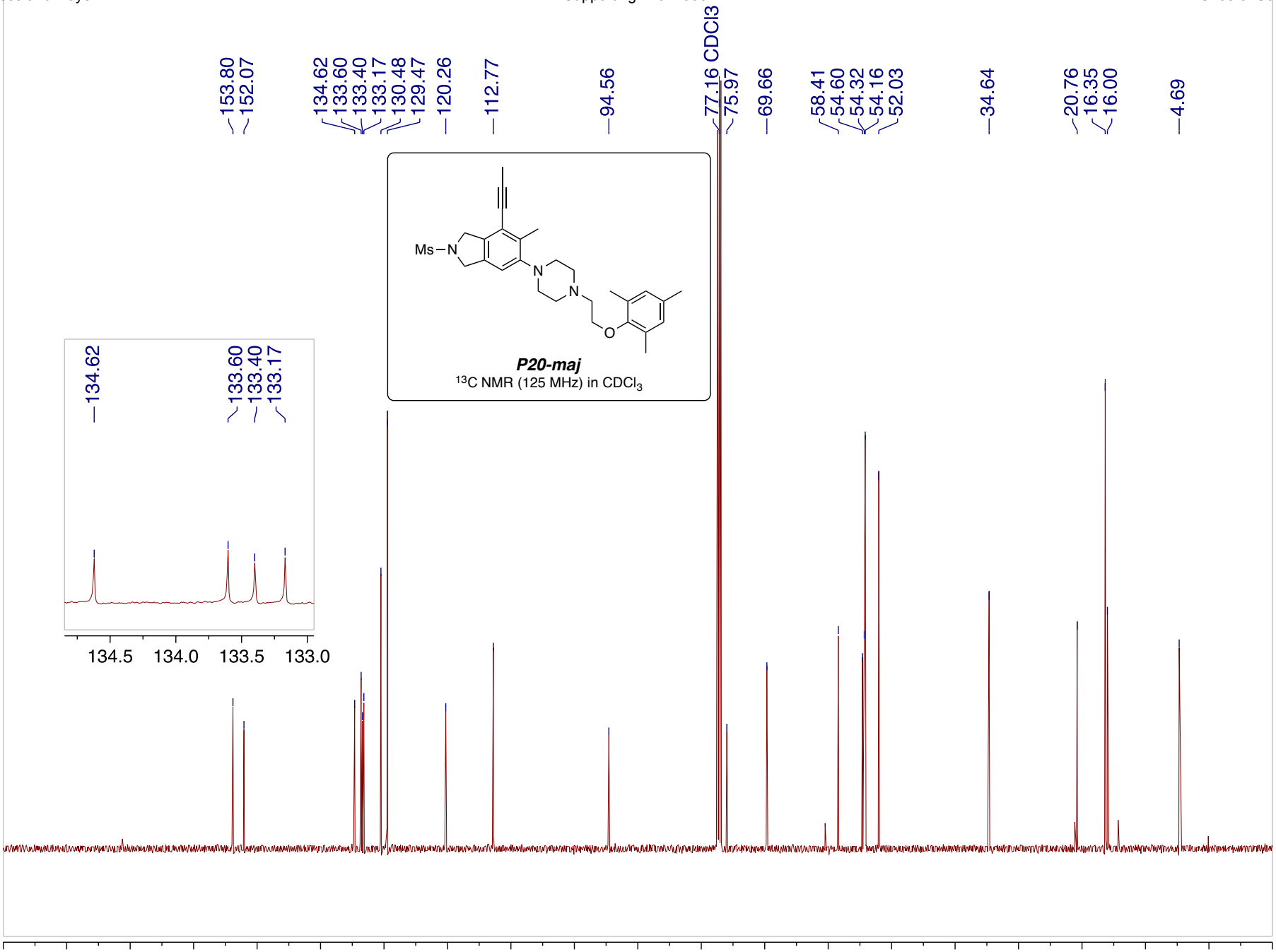

8.22
8.20
7.26 CHCl3
7.00
6.98
6.84
4.68
4.67
4.67
4.25
4.24
4.23
2.94
2.93
2.92
2.91
2.90
2.86
2.76
2.37
2.12
1.59 H2O
Ms—N
N
N
NO2
O
P19-maj
1H NMR (500 MHz) in CDCl3
8.22 8.19
7.00 6.98
4.24 4.22
2.96 2.92 2.88
1.88
1.91
1.00
3.95
1.92
5.66
3.04
3.45
2.94
2.88
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

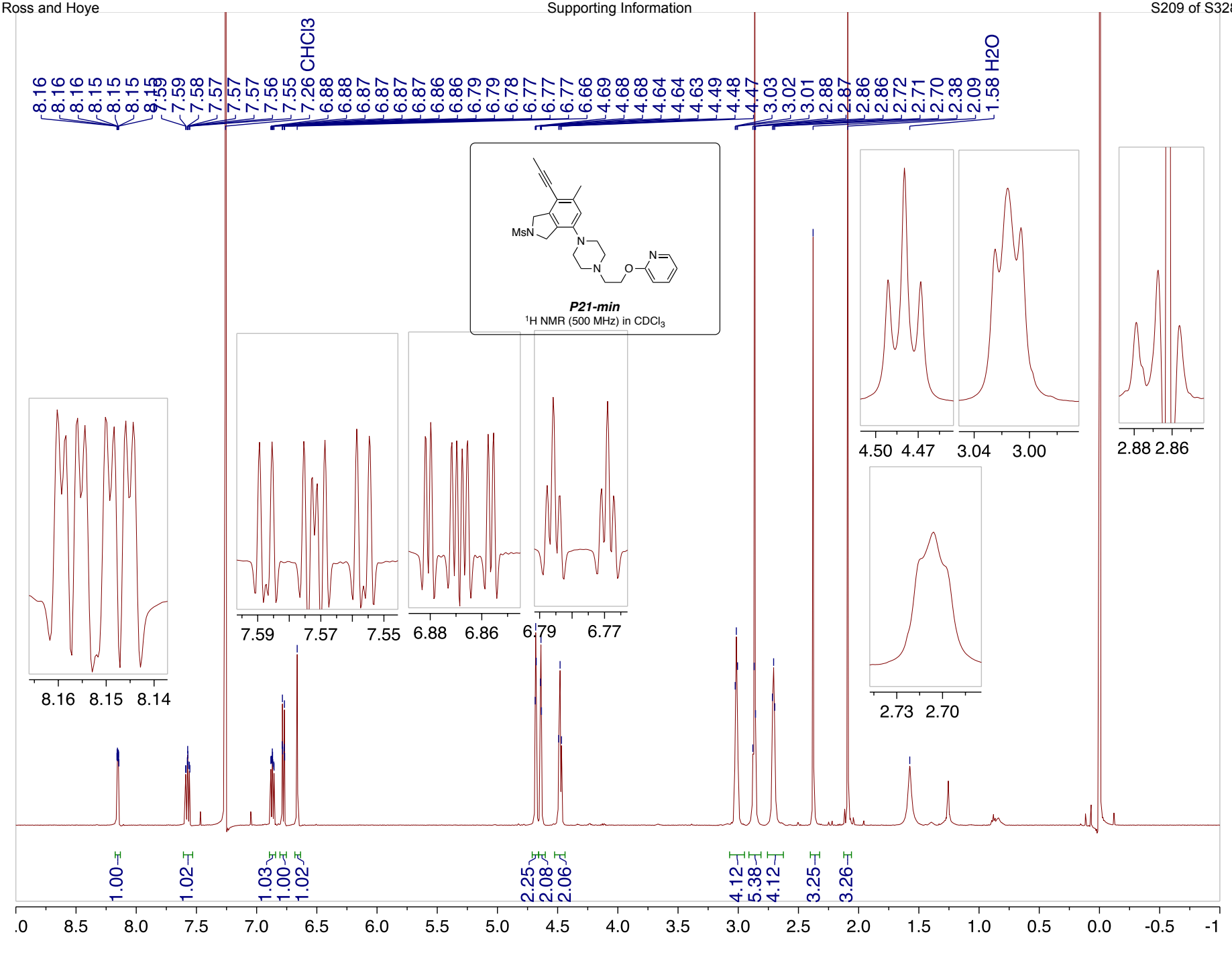

163.84
151.87
141.69
134.62
133.64
133.57
126.01
120.33
114.65
112.78
94.69
77.16 CDCl3
75.91
66.89
60.49
56.97
54.58
54.30
54.11
51.95
34.70
21.16
15.98
14.30
4.69
Ms—N
N
N
O
NO2
P19-maj
13C NMR (125 MHz) in CDCl3
90 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1

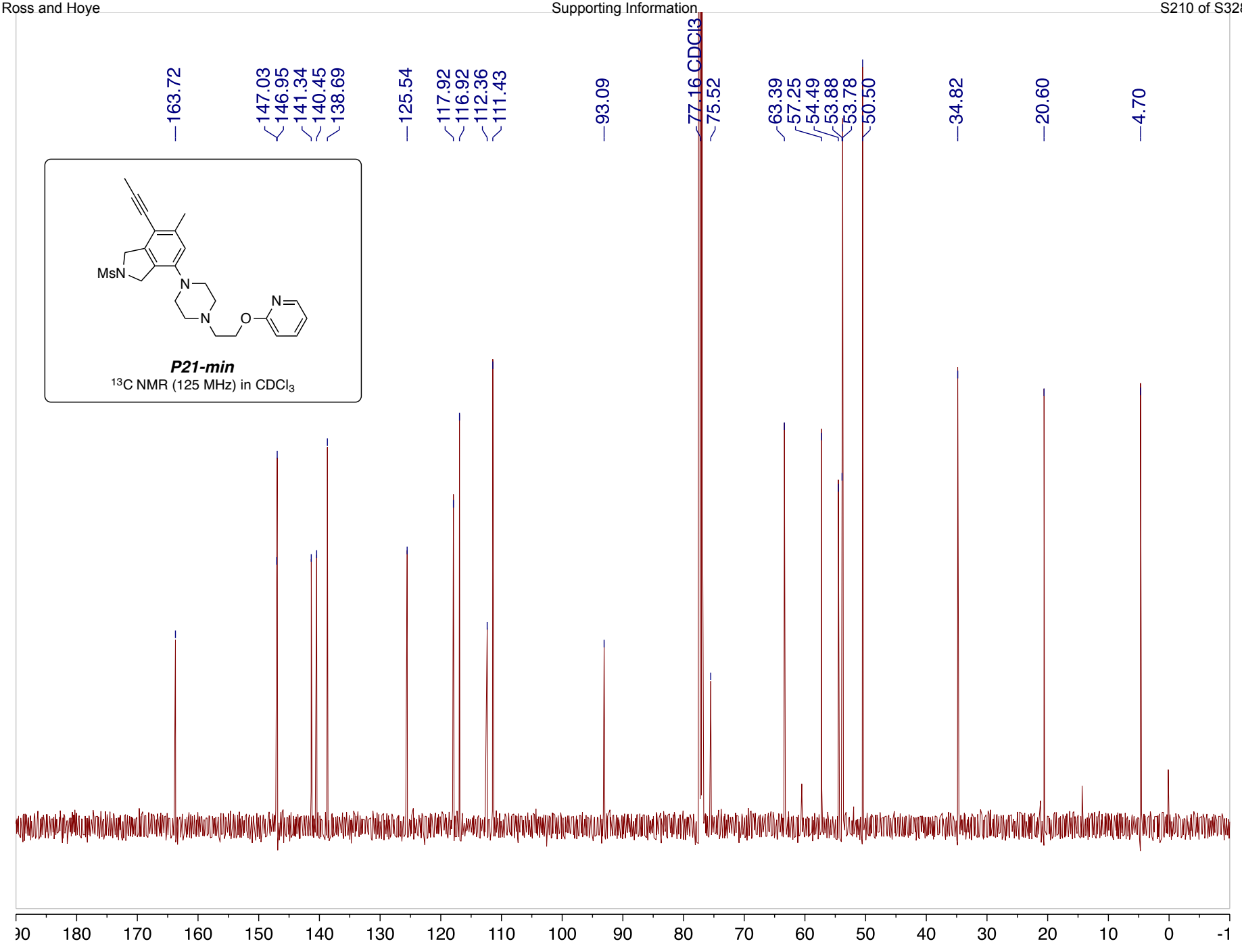

7.26 CHCl3
6.82
6.68
4.69
4.68
4.68
4.65
4.65
4.64
3.91
3.89
3.88
3.06
3.05
3.04
2.86
2.85
2.84
2.73
2.72
2.72
2.71
2.38
2.26
2.23
2.09
MsN
N
N
O
P20-min
1H NMR (500 MHz) in CDCl3
3.90 3.88
3.10 3.05 3.00
2.88 2.86 2.84 2.82
2.74 2.72 2.70
2.10
1.00
2.14
2.16
2.02
4.21
5.47
4.27
2.21
6.37
3.57
3.34
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

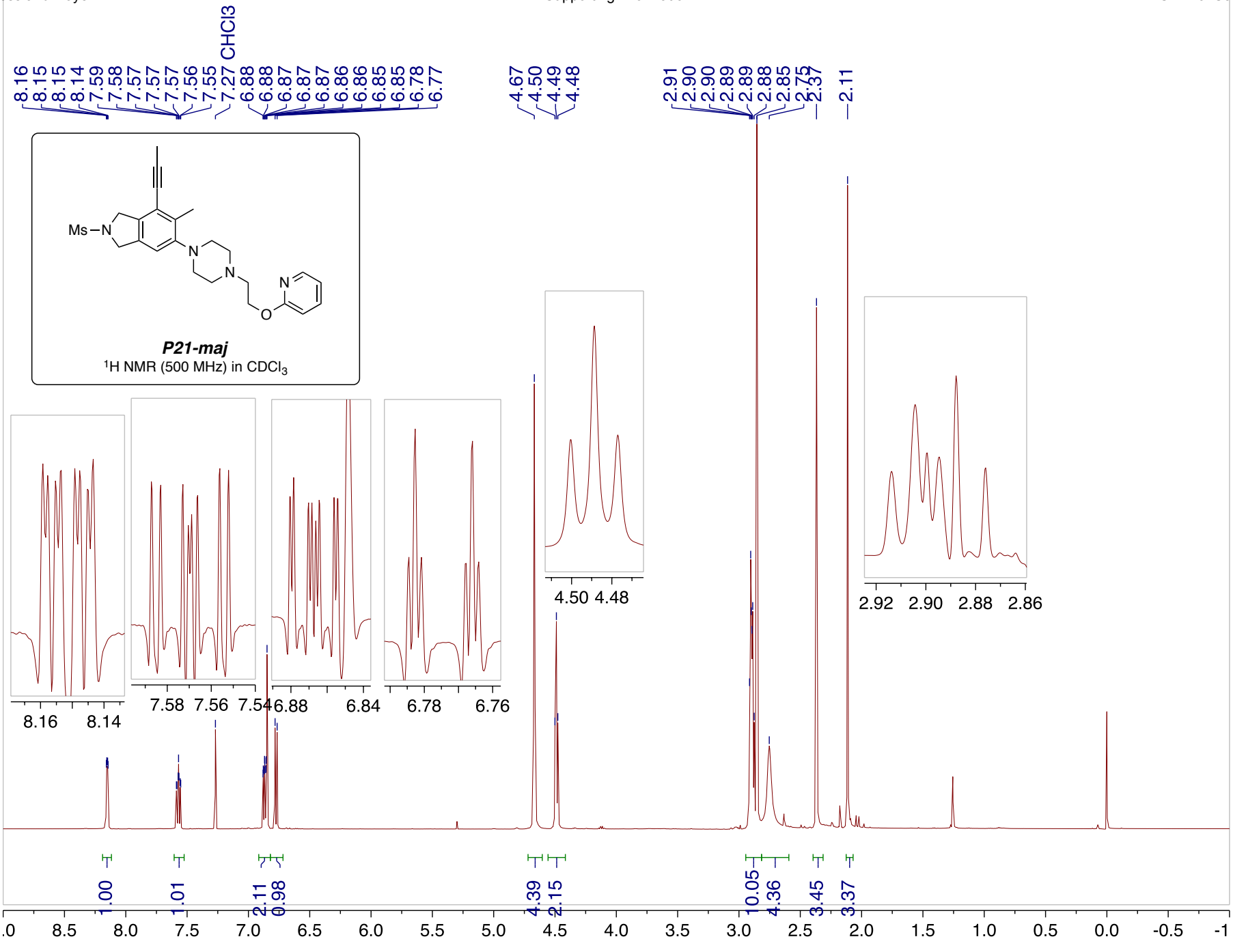

153.79
147.00
141.33
140.46
133.19
130.49
129.49
125.51
117.90
112.34
93.08
77.16 CDCl3
75.51
69.58
58.37
54.47
53.96
53.86
50.48
34.80
20.77
20.58
16.35
4.69
MsN
N
N
O
P20-min
13C NMR (125 MHz) in CDCl3
90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1

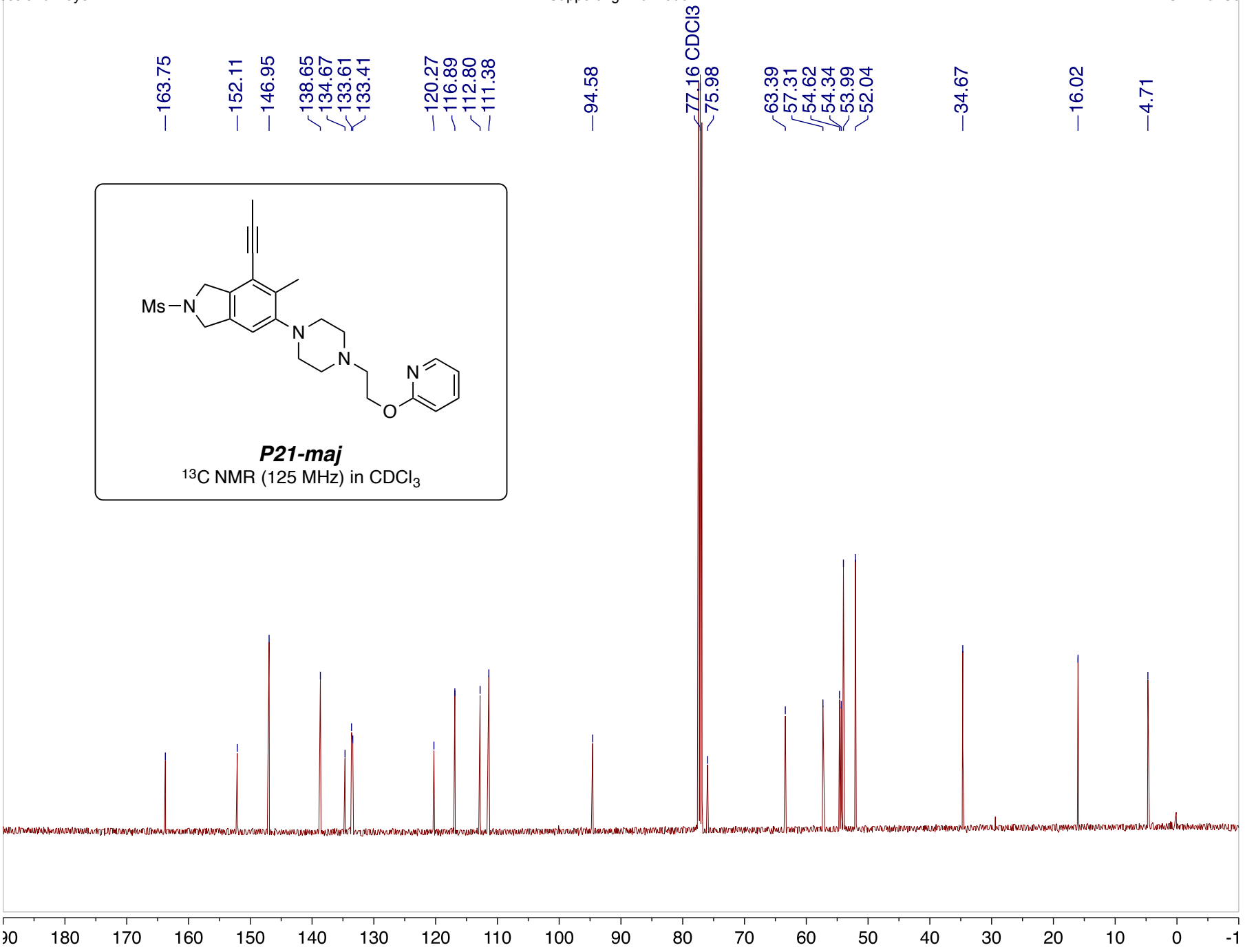

6.86
6.82
6.82
6.82
6.82
4.68
4.67
3.92
3.91
3.90
2.94
2.93
2.92
2.89
2.88
2.87
2.86
2.76
2.38
2.26
2.24
2.12
Ms
N
N
N
O
P20-maj
1H NMR (500 MHz) in CDCl3
3.92 3.90 3.88
2.95 2.90 2.85
1.00
1.98
4.19
1.93
4.11
5.54
3.68
3.12
6.21
3.30
3.22
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1

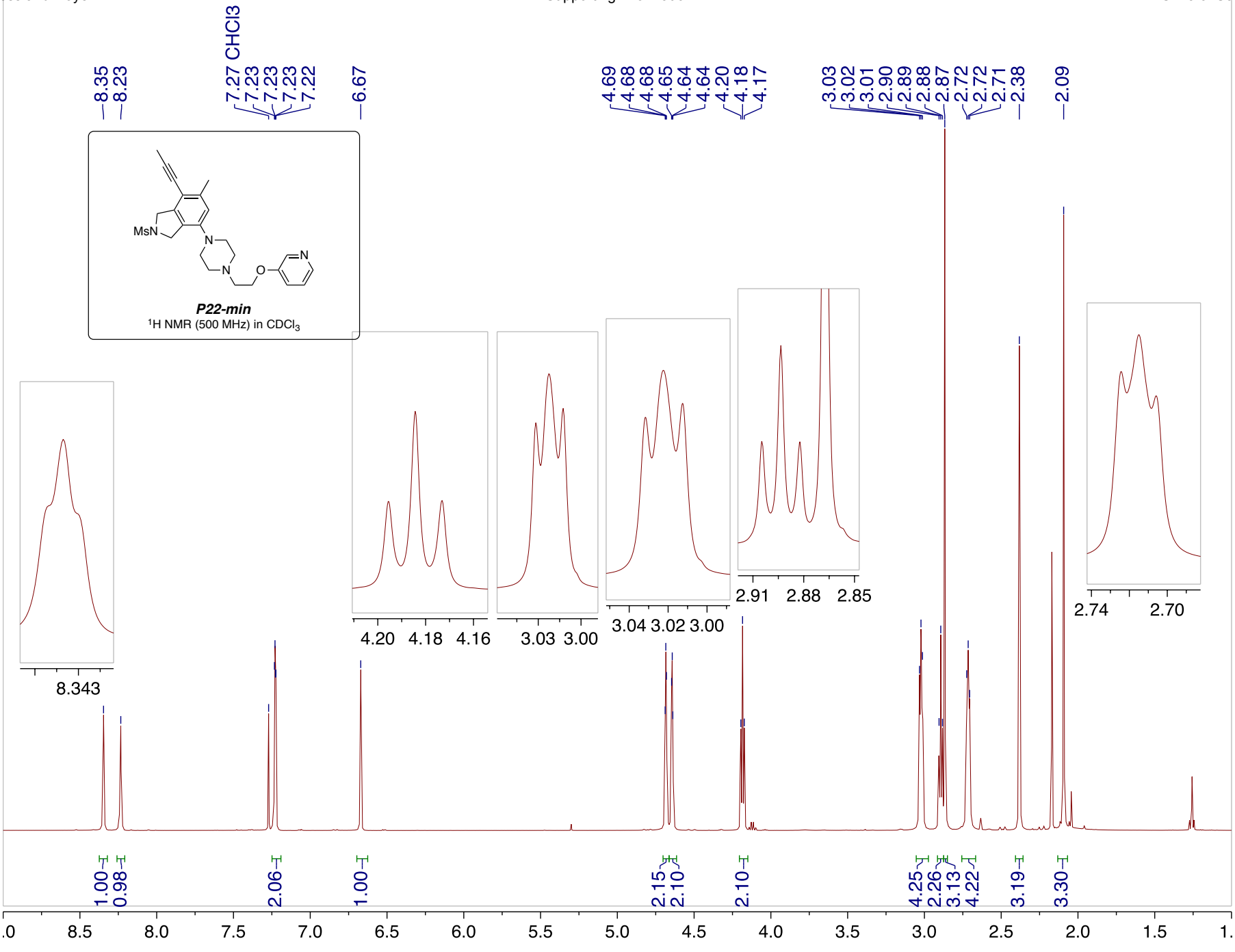

153.80
152.07
134.62
133.60
133.40
133.17
130.48
129.47
120.26
112.77
94.56
77.16 CDCl3
75.97
69.66
58.41
54.60
54.32
54.16
52.03
34.64
20.76
16.35
16.00
4.69
Ms
N
N
N
O
P20-maj
13C NMR (125 MHz) in CDCl3
134.62
133.60
133.40
133.17
134.5
134.0
133.5
133.0
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10

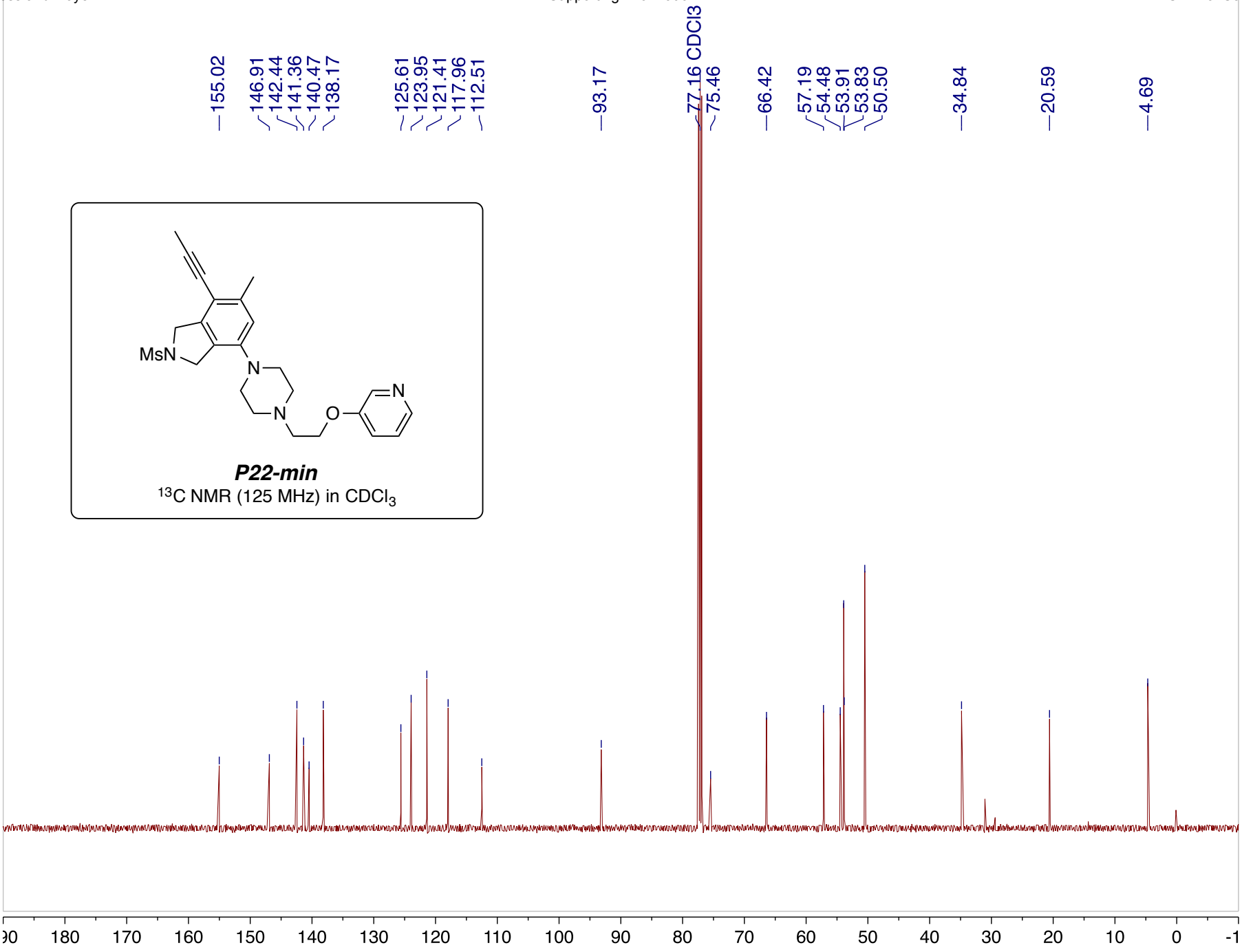

CHCl3
H2O
8.16 8.16 8.16 8.15 8.15 8.15 8.15 7.59 7.59 7.58 7.57 7.57 7.57 7.56 7.55 7.26 6.88 6.88 6.87 6.87 6.87 6.87 6.86 6.86 6.79 6.79 6.78 6.77 6.77 6.77 6.66 4.69 4.68 4.68 4.64 4.64 4.63 4.49 4.48 4.47 3.03 3.02 3.01 2.88 2.87 2.86 2.86 2.72 2.71 2.70 2.38 2.09 1.58
MsN
N
N
O
N
P21-min
1H NMR (500 MHz) in CDCl3
8.16 8.15 8.14
7.59 7.57 7.55
6.88 6.86
6.79 6.77
4.50 4.47
3.04 3.00
2.88 2.86
2.73 2.70
1.00 1.02 1.03 1.00 1.02 2.25 2.08 2.06 4.12 5.38 4.12 3.25 3.26
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

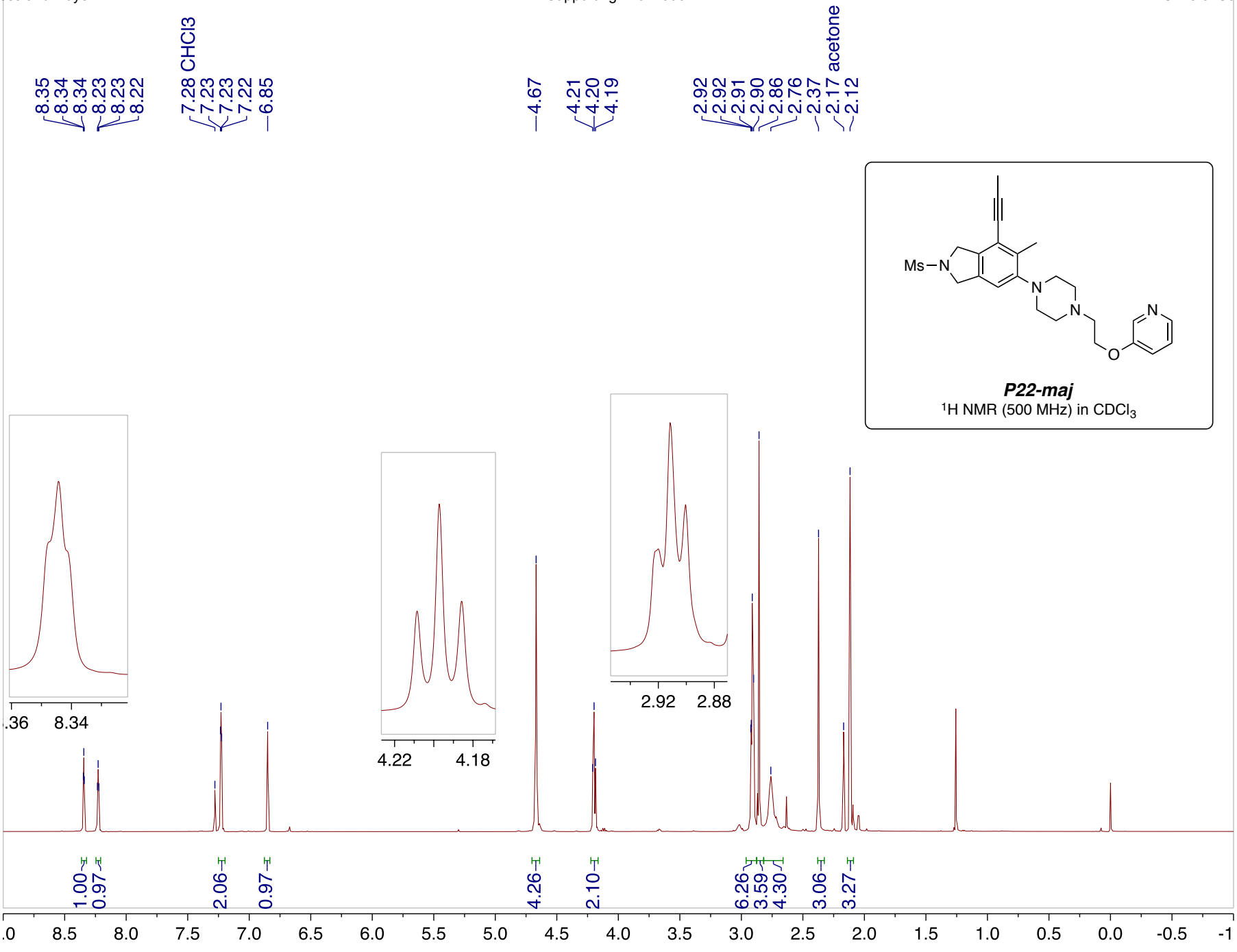

163.72
147.03
146.95
141.34
140.45
138.69
125.54
117.92
116.92
112.36
111.43
93.09
77.16 CDCl3
75.52
63.39
57.25
54.49
53.88
53.78
50.50
34.82
20.60
4.70
MsN
N
N
O
N
P21-min
13C NMR (125 MHz) in CDCl3
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10

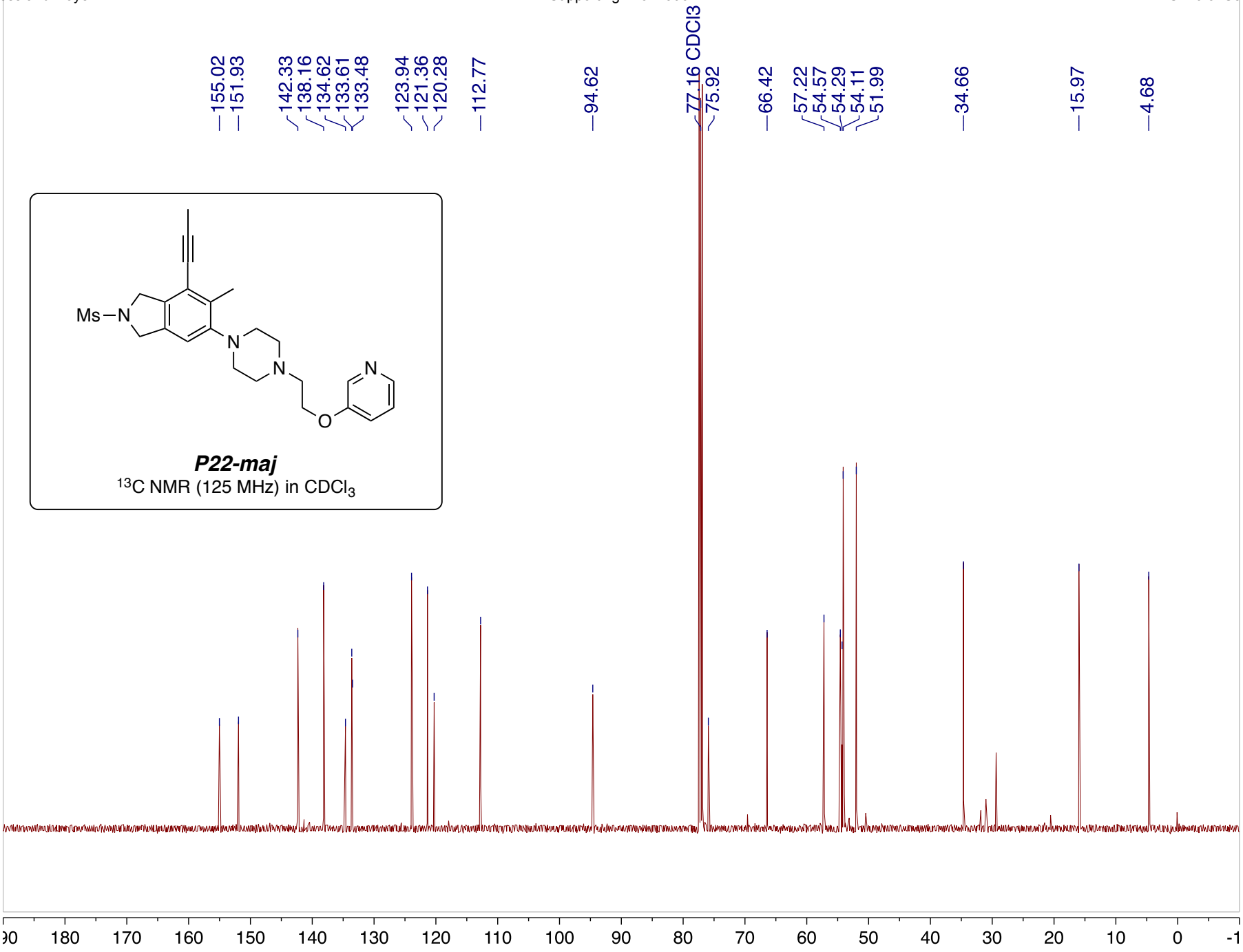

CHCl3
8.16 8.15 8.15 8.14 7.59 7.58 7.57 7.57 7.57 7.56 7.55 7.27 6.88 6.88 6.87 6.87 6.87 6.86 6.86 6.85 6.85 6.78 6.77
4.67 4.50 4.49 4.48
2.91 2.90 2.90 2.89 2.89 2.88 2.85 2.75 2.37 2.11
Ms
N
N
N
O
N
P21-maj
1H NMR (500 MHz) in CDCl3
8.16 8.14
7.58 7.56 7.54
6.88 6.84
6.78 6.76
4.50 4.48
2.92 2.90 2.88 2.86
1.00 1.01 2.11 0.98 4.39 2.15 10.05 4.36 3.45 3.37
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

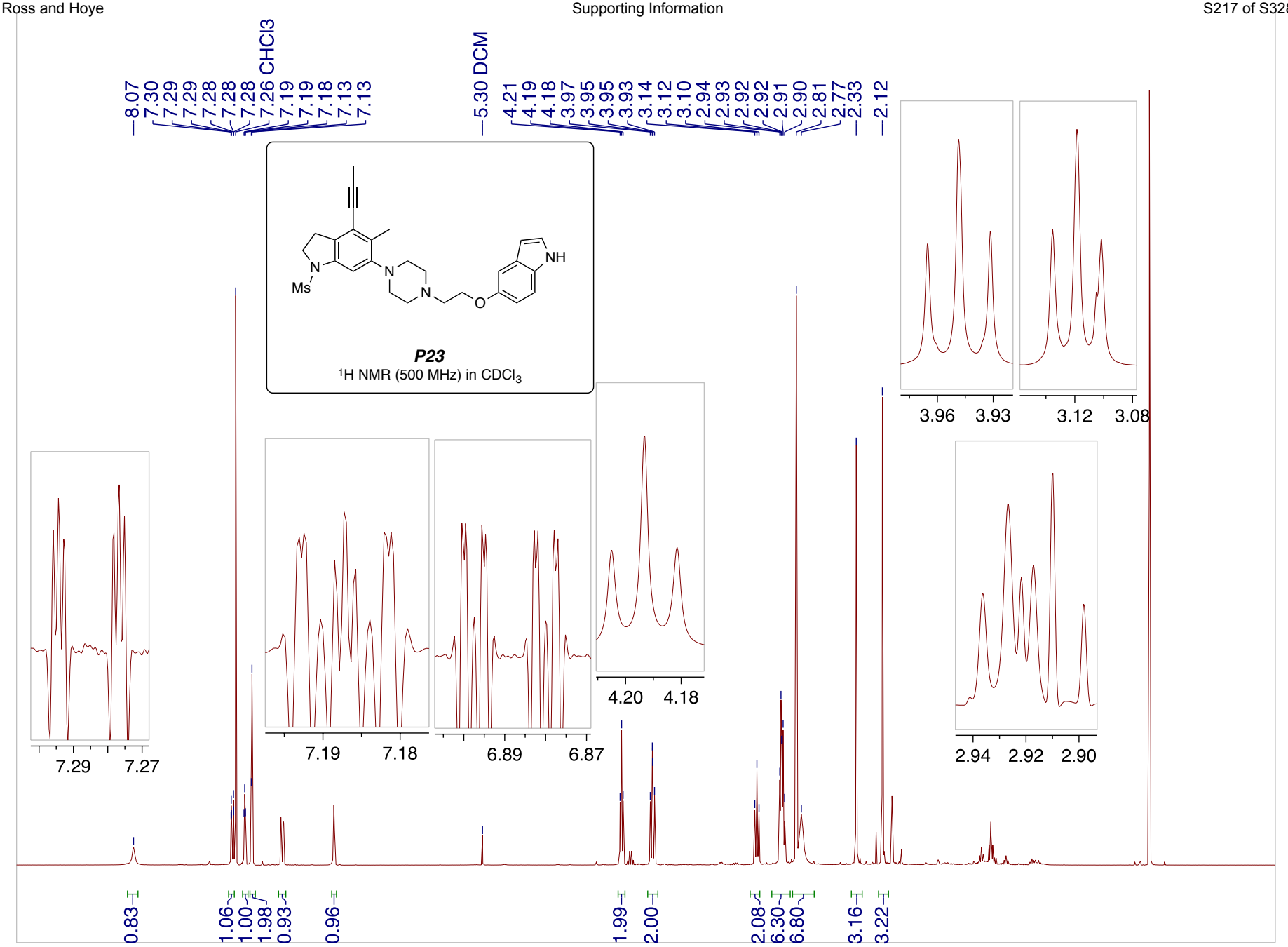

163.75
152.11
146.95
138.65
134.67
133.61
133.41
120.27
116.89
112.80
111.38
94.58
77.16 CDCl3
75.98
63.39
57.31
54.62
54.34
53.99
52.04
34.67
16.02
4.71
Ms
N
N
N
N
O
P21-maj
13C NMR (125 MHz) in CDCl3
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1

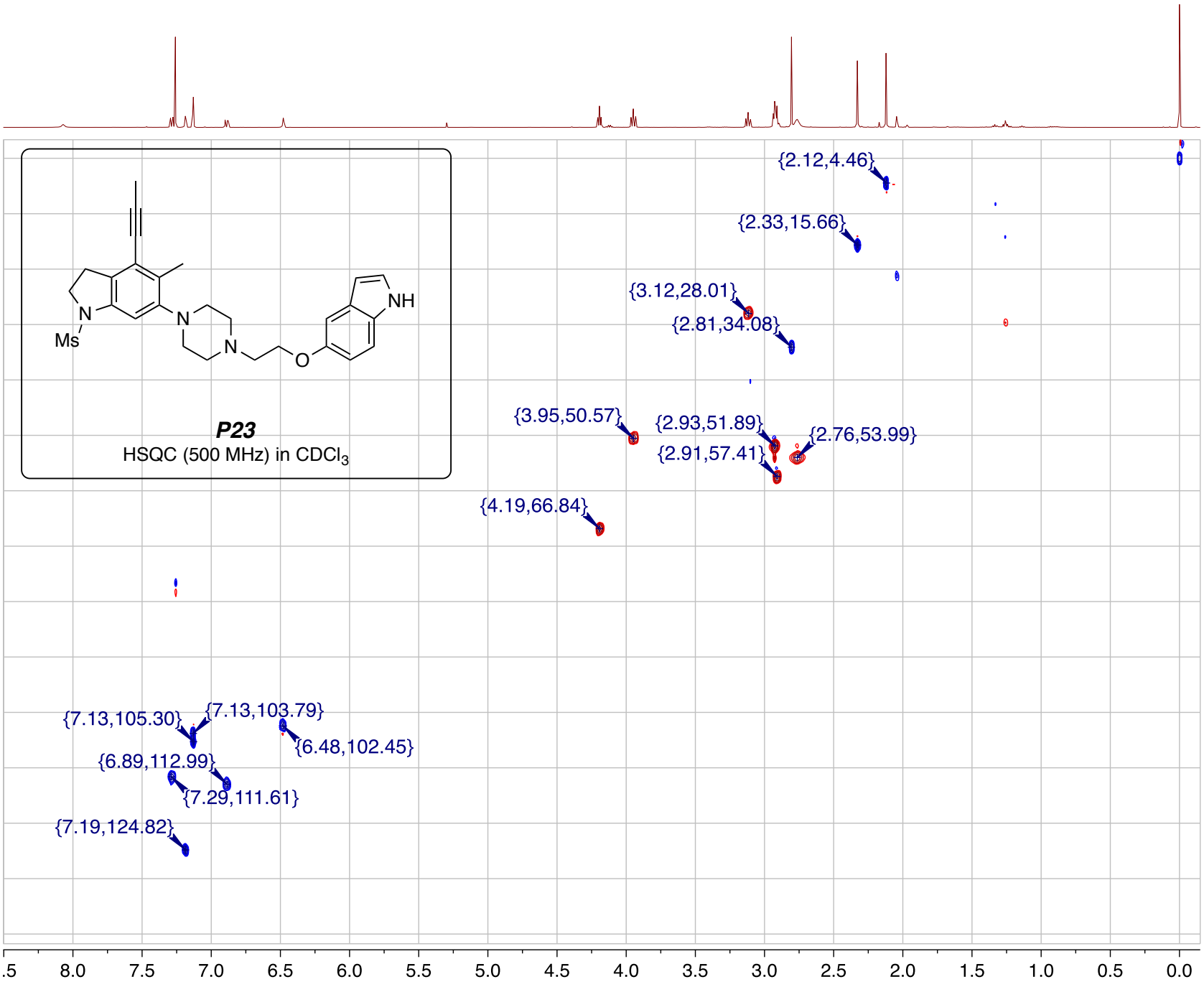

8.35
8.23
7.27 CHCl3
7.23
7.23
7.23
7.22
6.67
4.69
4.68
4.68
4.65
4.64
4.64
4.20
4.18
4.17
3.03
3.02
3.01
2.90
2.89
2.88
2.87
2.72
2.72
2.71
2.38
2.09
MsN
N
N
O
N
P22-min
1H NMR (500 MHz) in CDCl3
8.343
4.20 4.18 4.16
3.03 3.00
3.04 3.02 3.00
2.91 2.88 2.85
2.74 2.70
1.00
0.98
2.06
1.00
2.15
2.10
2.10
4.25
2.26
3.13
4.22
3.19
3.30
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5

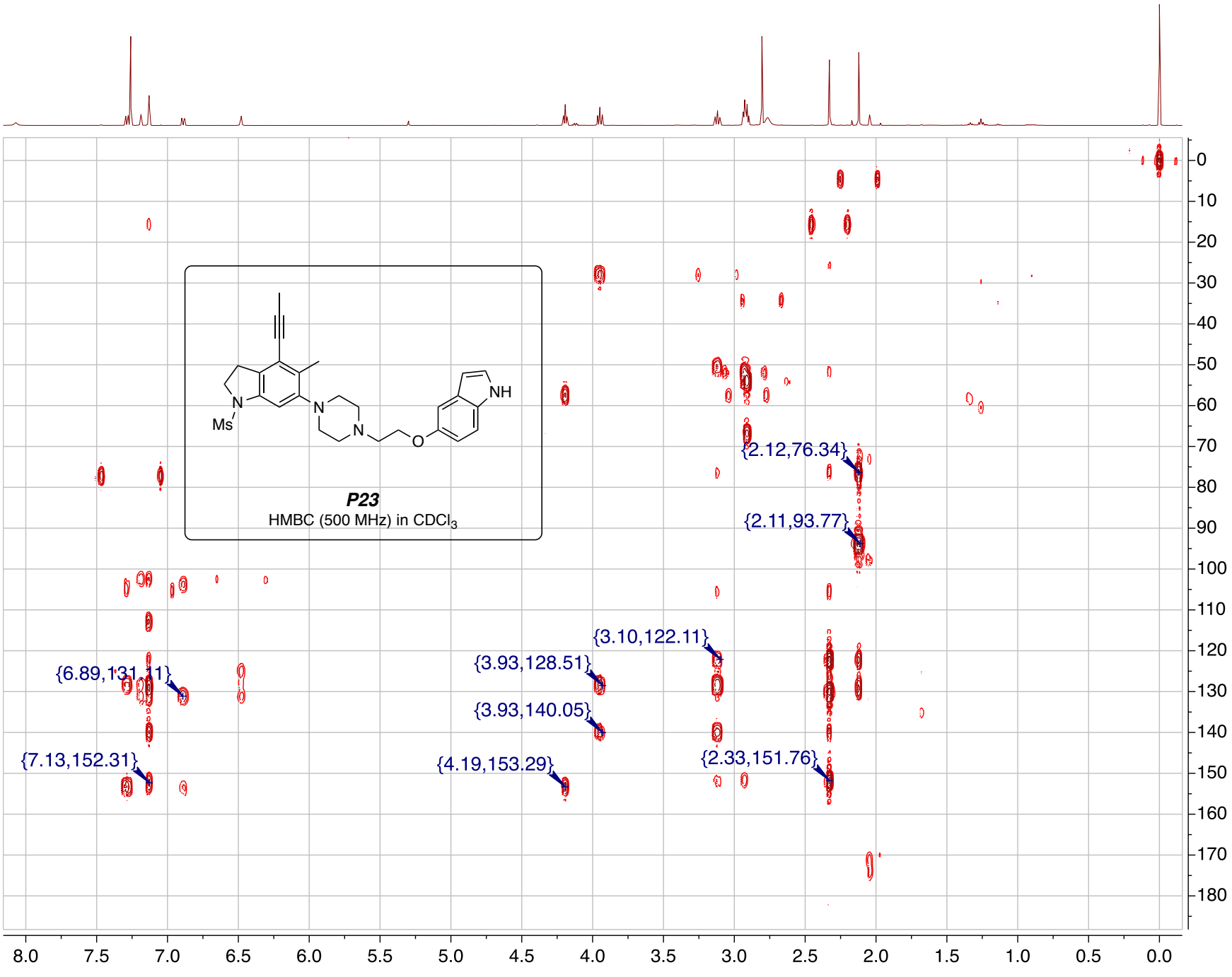

155.02
146.91
142.44
141.36
140.47
138.17
125.61
123.95
121.41
117.96
112.51
93.17
77.16 CDCl3
75.46
66.42
57.19
54.48
53.91
53.83
50.50
34.84
20.59
4.69
MsN
N
N
O
N
P22-min
13C NMR (125 MHz) in CDCl3
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1

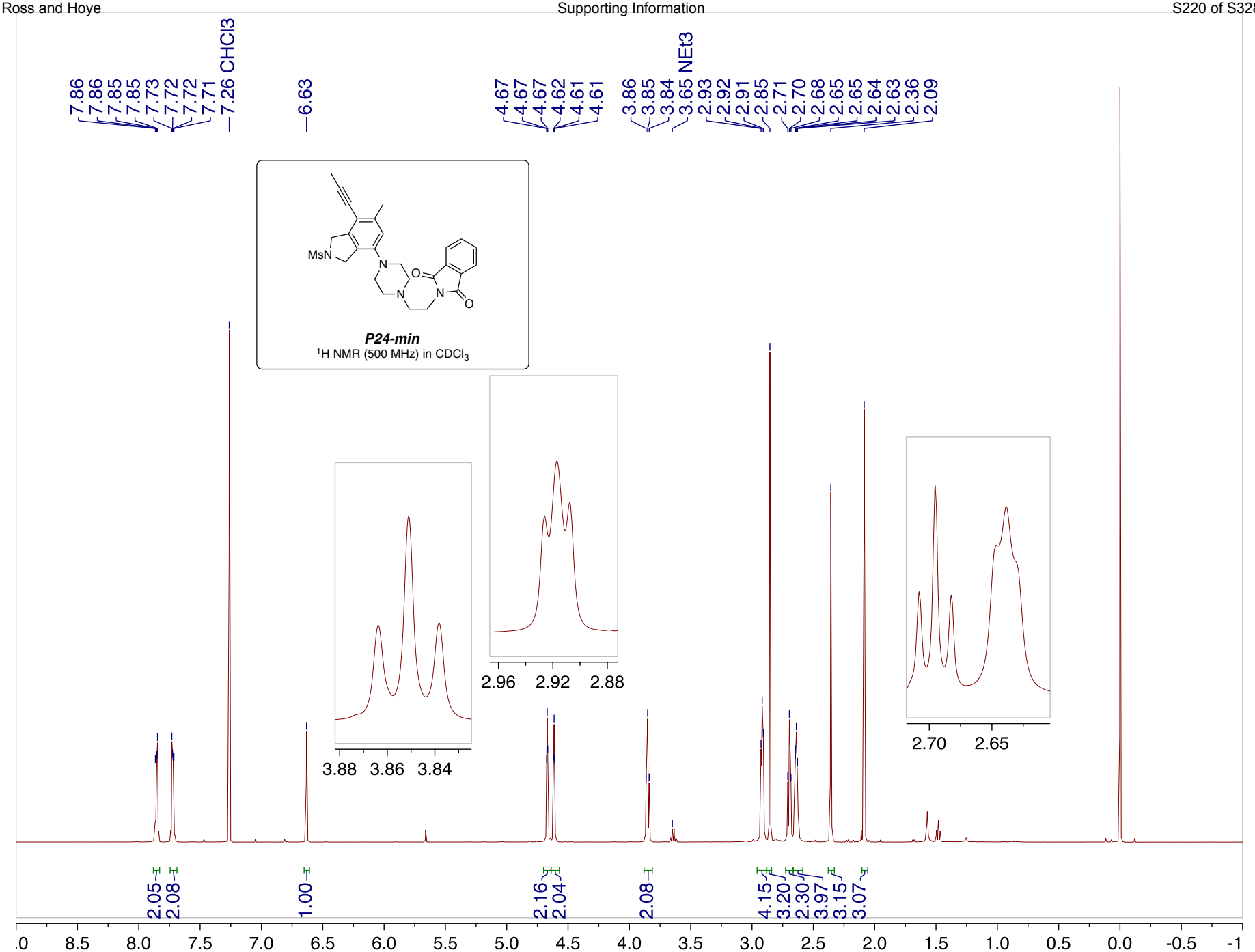

8.35
8.34
8.34
8.23
8.23
8.22
7.28 CHCl3
7.23
7.23
7.22
6.85
4.67
4.21
4.20
4.19
2.92
2.92
2.91
2.90
2.86
2.76
2.37
2.17 acetone
2.12
Ms
N
N
N
N
O
P22-maj
1H NMR (500 MHz) in CDCl3
8.36
8.34
4.22
4.18
2.92
2.88
1.00
0.97
2.06
0.97
4.26
2.10
6.26
3.59
4.30
3.06
3.27
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5

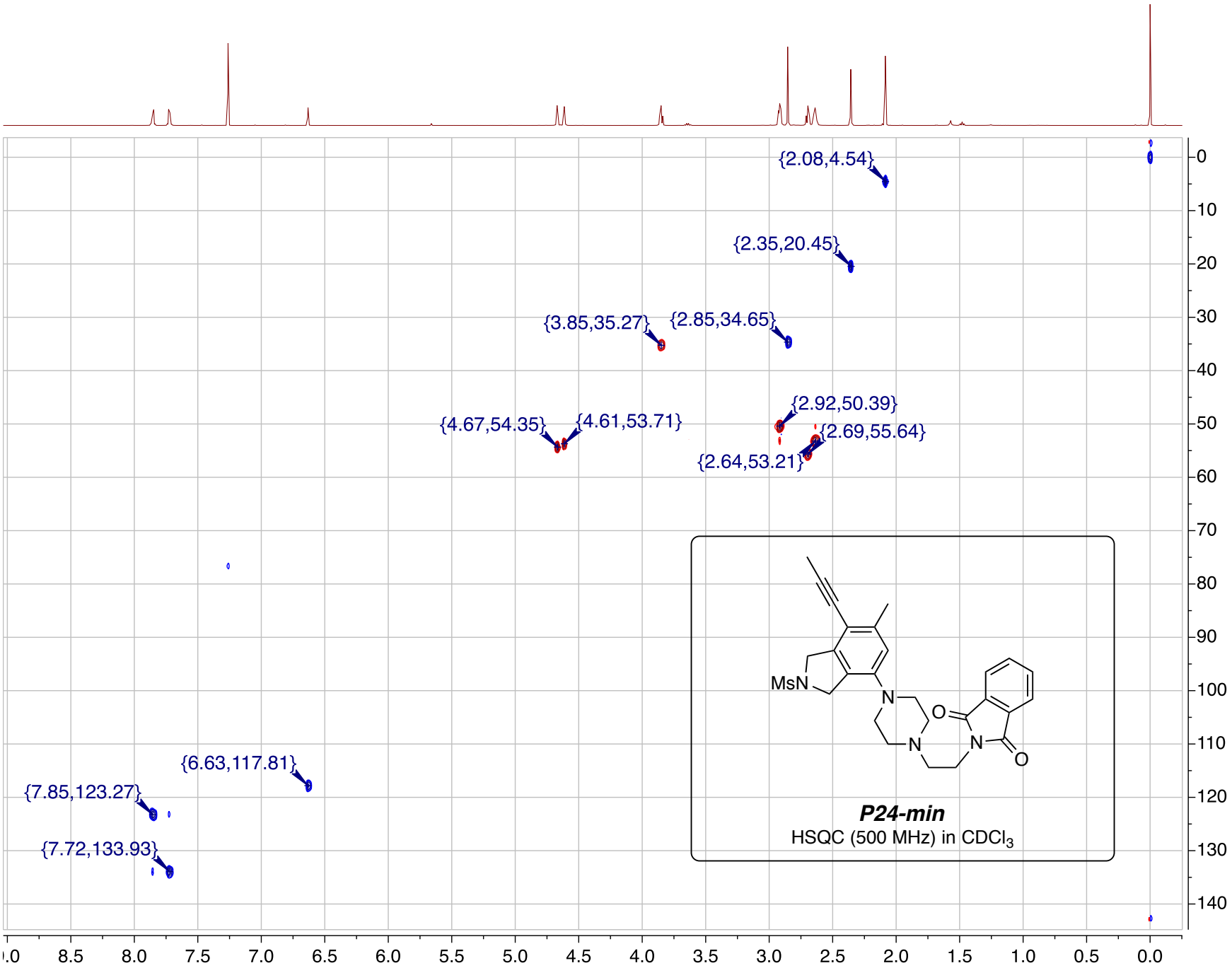

155.02
151.93
142.33
138.16
134.62
133.61
133.48
123.94
121.36
120.28
112.77
94.62
77.16 CDCl3
75.92
66.42
57.22
54.57
54.29
54.11
51.99
34.66
15.97
4.68
Ms
N
N
N
N
O
P22-maj
13C NMR (125 MHz) in CDCl3
90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-1

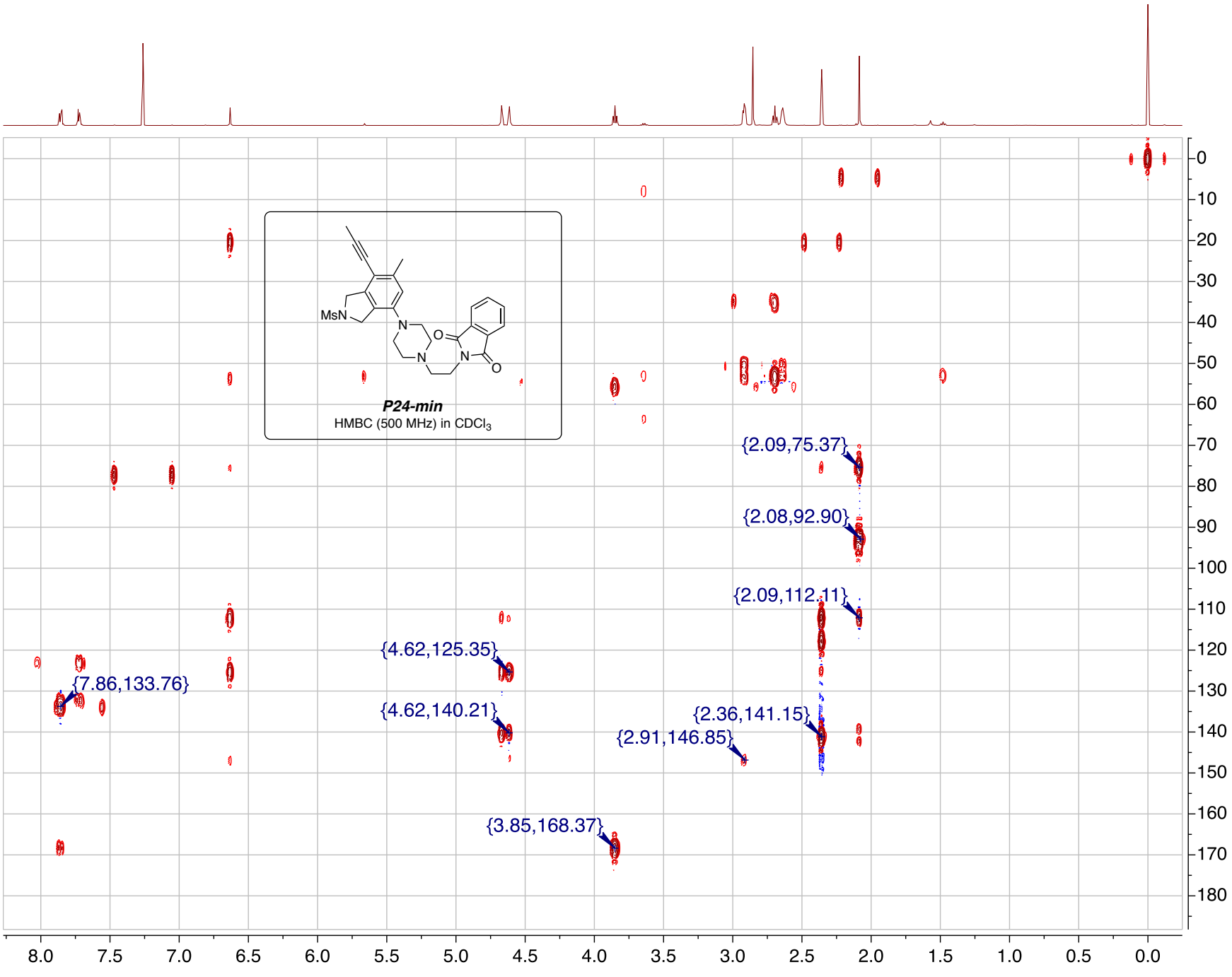

8.07
7.30
7.29
7.29
7.28
7.28
7.28
CHCl3
7.26
7.19
7.19
7.18
7.13
7.13
5.30 DCM
4.21
4.19
4.18
3.97
3.95
3.95
3.93
3.14
3.12
3.10
2.94
2.93
2.92
2.92
2.91
2.90
2.81
2.77
2.33
2.12
N
Ms
N
N
O
NH
P23
1H NMR (500 MHz) in CDCl3
3.96
3.93
3.12
3.08
7.29
7.27
7.19
7.18
6.89
6.87
4.20
4.18
2.94
2.92
2.90
0.83
1.06
1.00
1.98
0.93
0.96
1.99
2.00
2.08
6.30
6.80
3.16
3.22
.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1

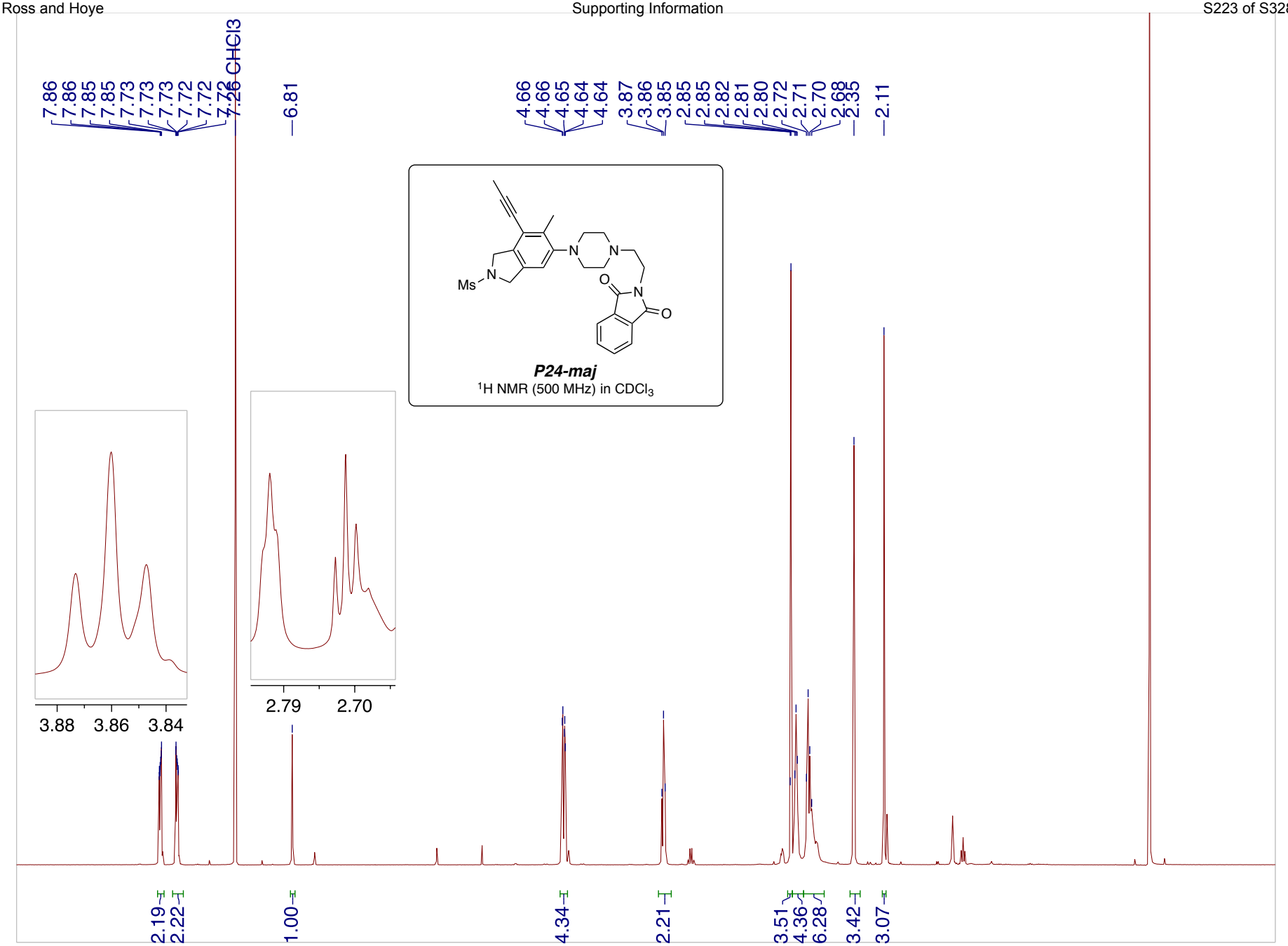

Ms
N
N
N
O
NH
P23
HSQC (500 MHz) in CDCl3
{2.12,4.46}
{2.33,15.66}
{3.12,28.01}
{2.81,34.08}
{3.95,50.57}
{2.93,51.89}
{2.91,57.41}
{2.76,53.99}
{4.19,66.84}
{7.13,105.30}
{7.13,103.79}
{6.48,102.45}
{6.89,112.99}
{7.29,111.61}
{7.19,124.82}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

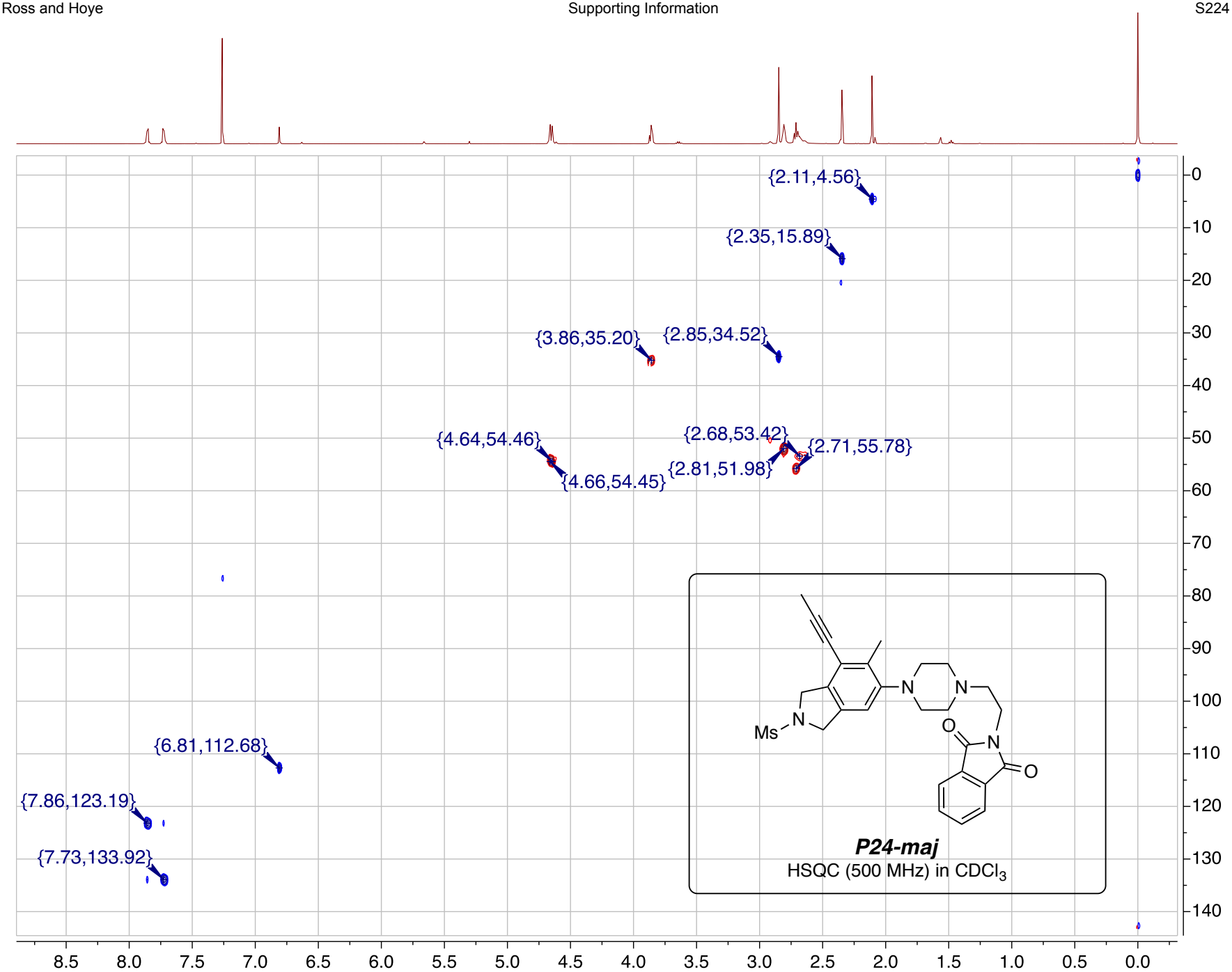

Ms
N
N
N
O
NH
P23
HMBC (500 MHz) in CDCl3
{2.12,76.34}
{2.11,93.77}
{3.10,122.11}
{3.93,128.51}
{3.93,140.05}
{4.19,153.29}
{2.33,151.76}
{6.89,131.11}
{7.13,152.31}
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180

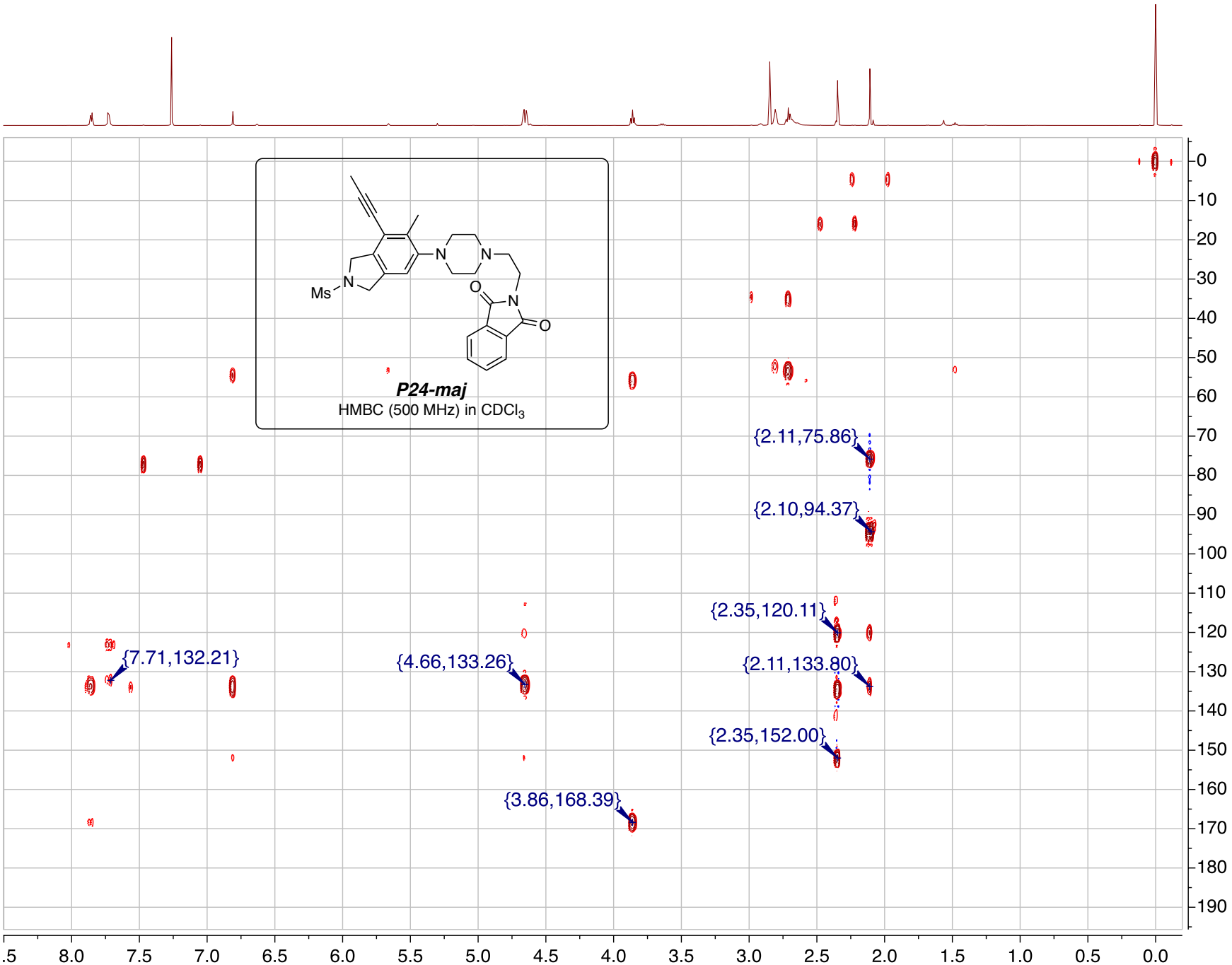

7.86
7.86
7.85
7.85
7.73
7.72
7.72
7.71
7.26 CHCl3
6.63
4.67
4.67
4.67
4.62
4.61
4.61
3.86
3.85
3.84
3.65 NEt3
2.93
2.92
2.91
2.85
2.71
2.70
2.68
2.65
2.65
2.64
2.63
2.36
2.09
MsN
N
O
N
N
O
P24-min
1H NMR (500 MHz) in CDCl3
3.88 3.86 3.84
2.96 2.92 2.88
2.70 2.65
2.05
2.08
1.00
2.16
2.04
2.08
4.15
3.20
2.30
3.97
3.15
3.07
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

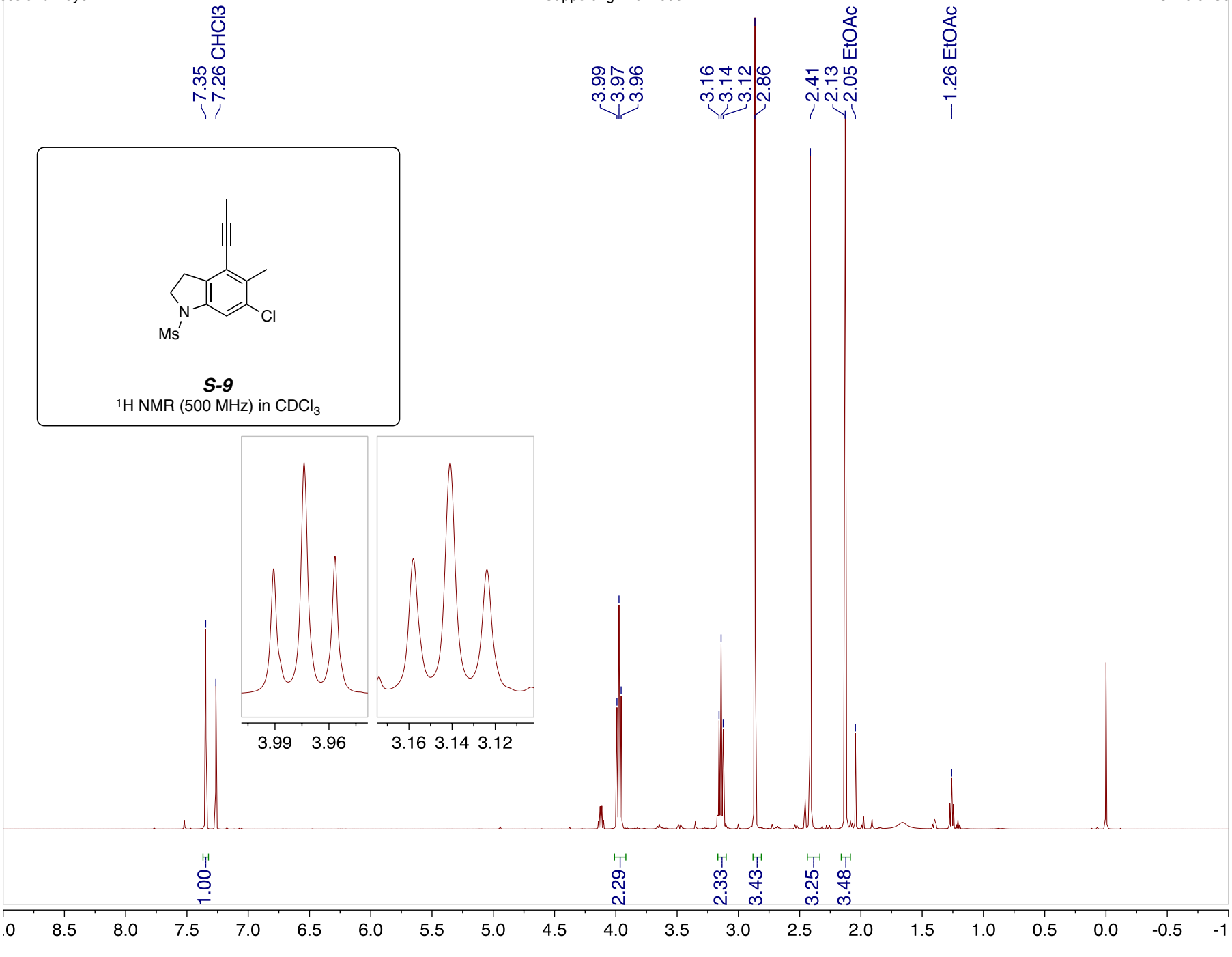

{2.08,4.54}
{2.35,20.45}
{3.85,35.27}
{2.85,34.65}
{2.92,50.39}
{4.67,54.35}
{4.61,53.71}
{2.69,55.64}
{2.64,53.21}
{6.63,117.81}
{7.85,123.27}
{7.72,133.93}
MsN
N
O
N
N
O
P24-min
HSQC (500 MHz) in CDCl3

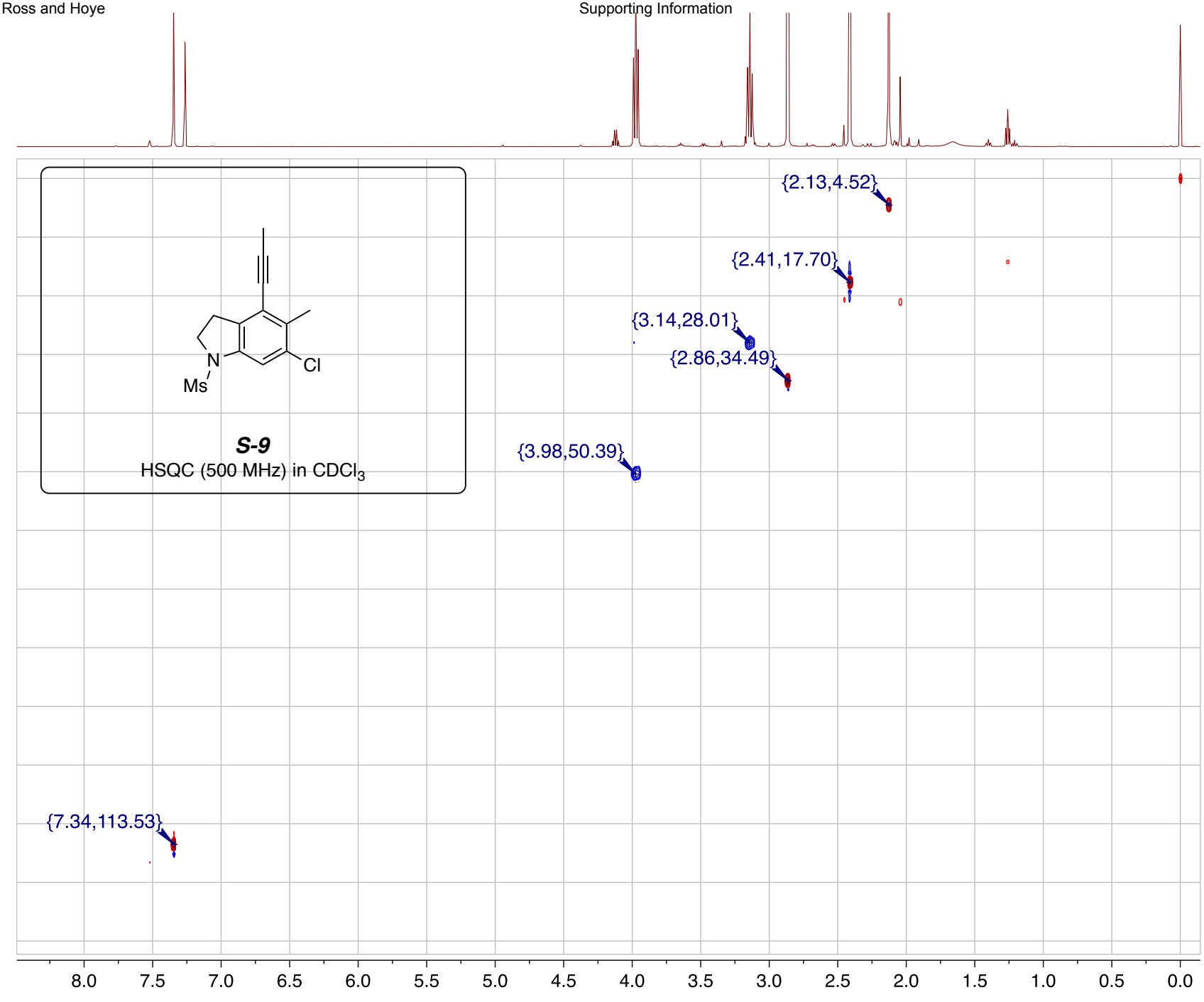

MsN
N
O
N
N
O
P24-min
HMBC (500 MHz) in CDCl3
{2.09,75.37}
{2.08,92.90}
{2.09,112.11}
{4.62,125.35}
{7.86,133.76}
{4.62,140.21}
{2.36,141.15}
{2.91,146.85}
{3.85,168.37}
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180

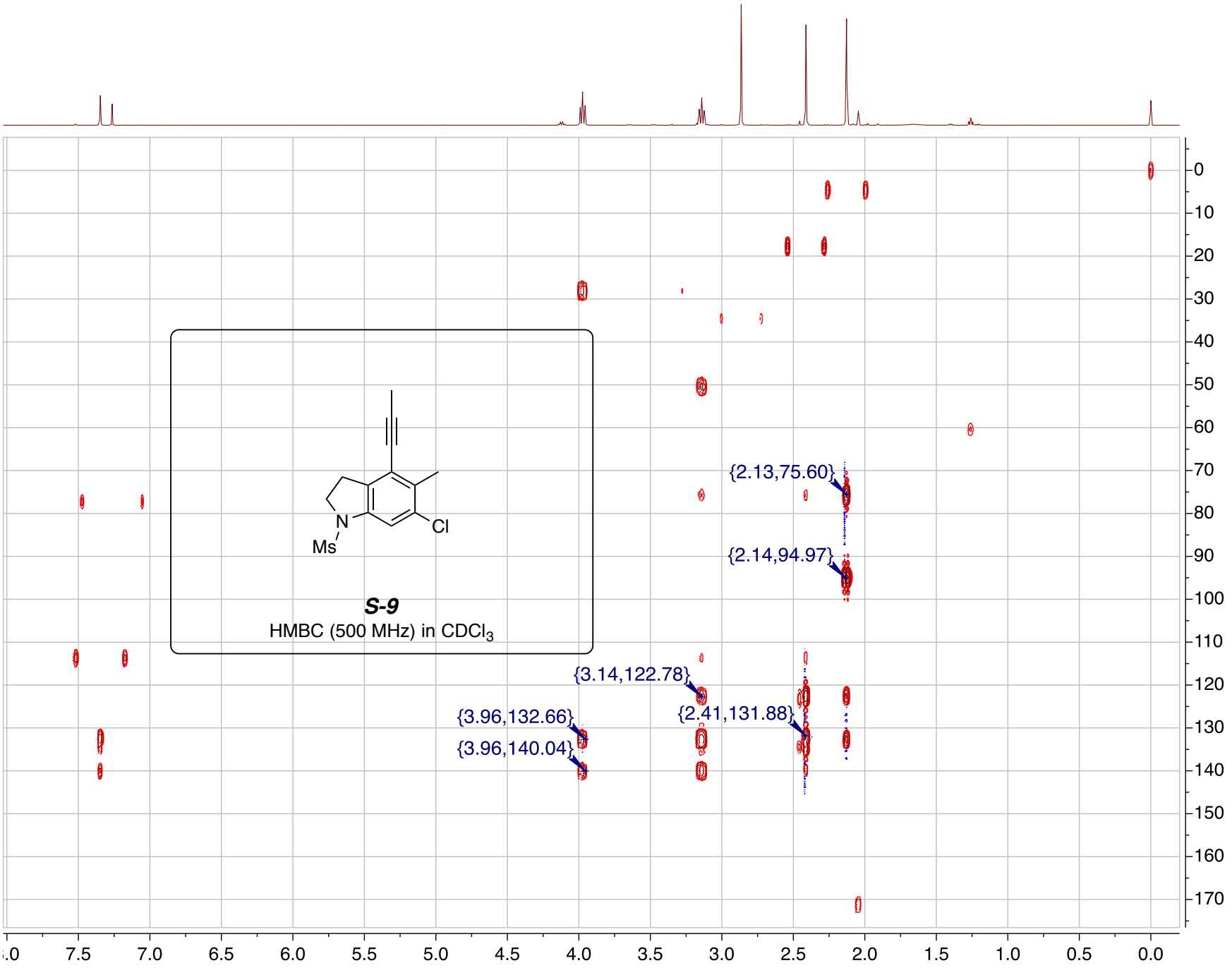

7.86
7.86
7.85
7.85
7.73
7.73
7.73
7.72
7.72
7.72
7.26 CHCl3
6.81
4.66
4.66
4.65
4.64
4.64
3.87
3.86
3.85
2.85
2.85
2.82
2.81
2.80
2.72
2.71
2.70
2.68
2.35
2.11
Ms
N
N
N
O
N
O
P24-maj
1H NMR (500 MHz) in CDCl3
3.88
3.86
3.84
2.79
2.70
2.19
2.22
1.00
4.34
2.21
3.51
4.36
6.28
3.42
3.07
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1

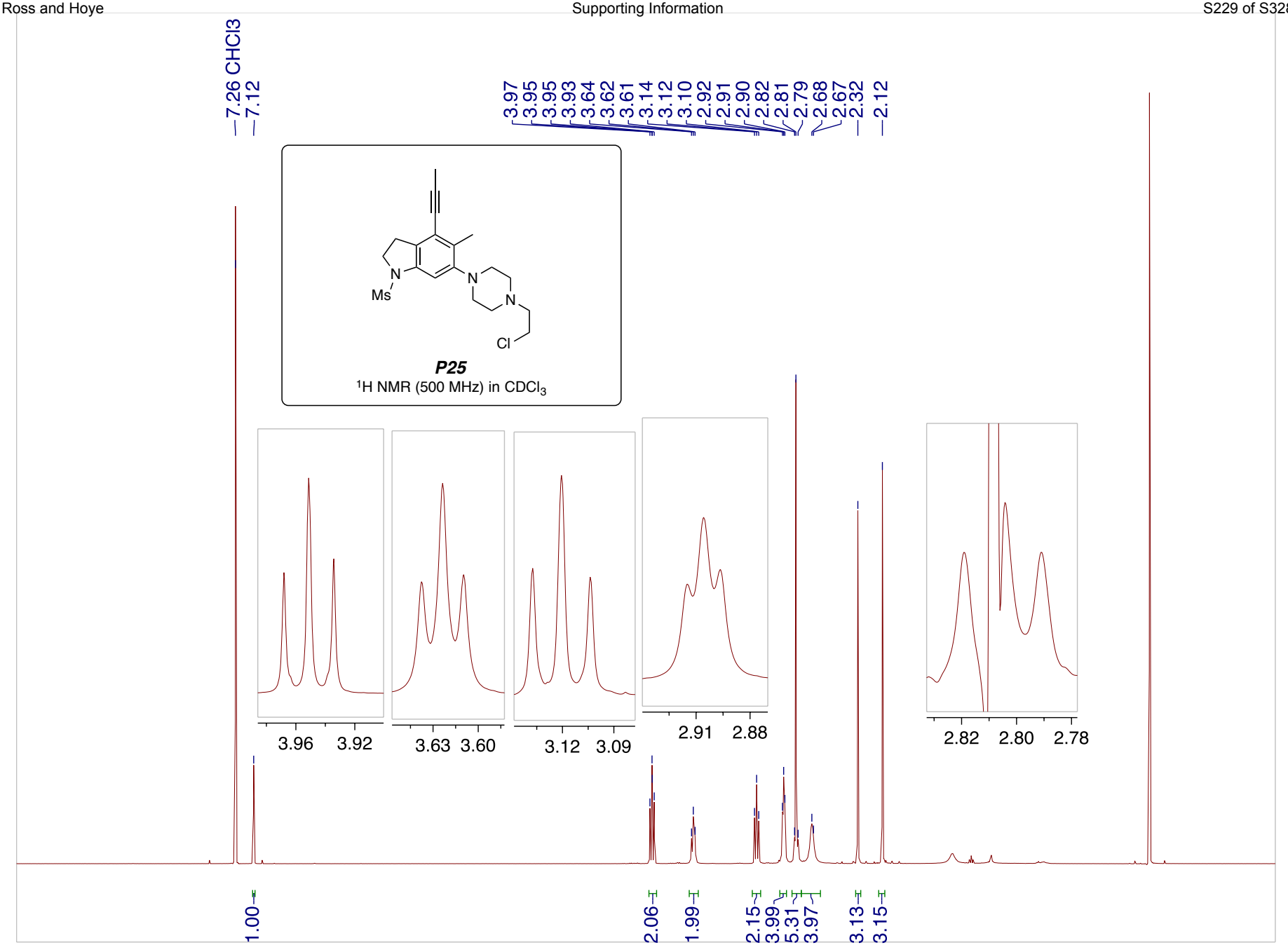

{2.11,4.56}
{2.35,15.89}
{3.86,35.20}
{2.85,34.52}
{4.64,54.46}
{4.66,54.45}
{2.68,53.42}
{2.71,55.78}
{2.81,51.98}
{6.81,112.68}
{7.86,123.19}
{7.73,133.92}
Ms
N
O
P24-maj
HSQC (500 MHz) in CDCl3

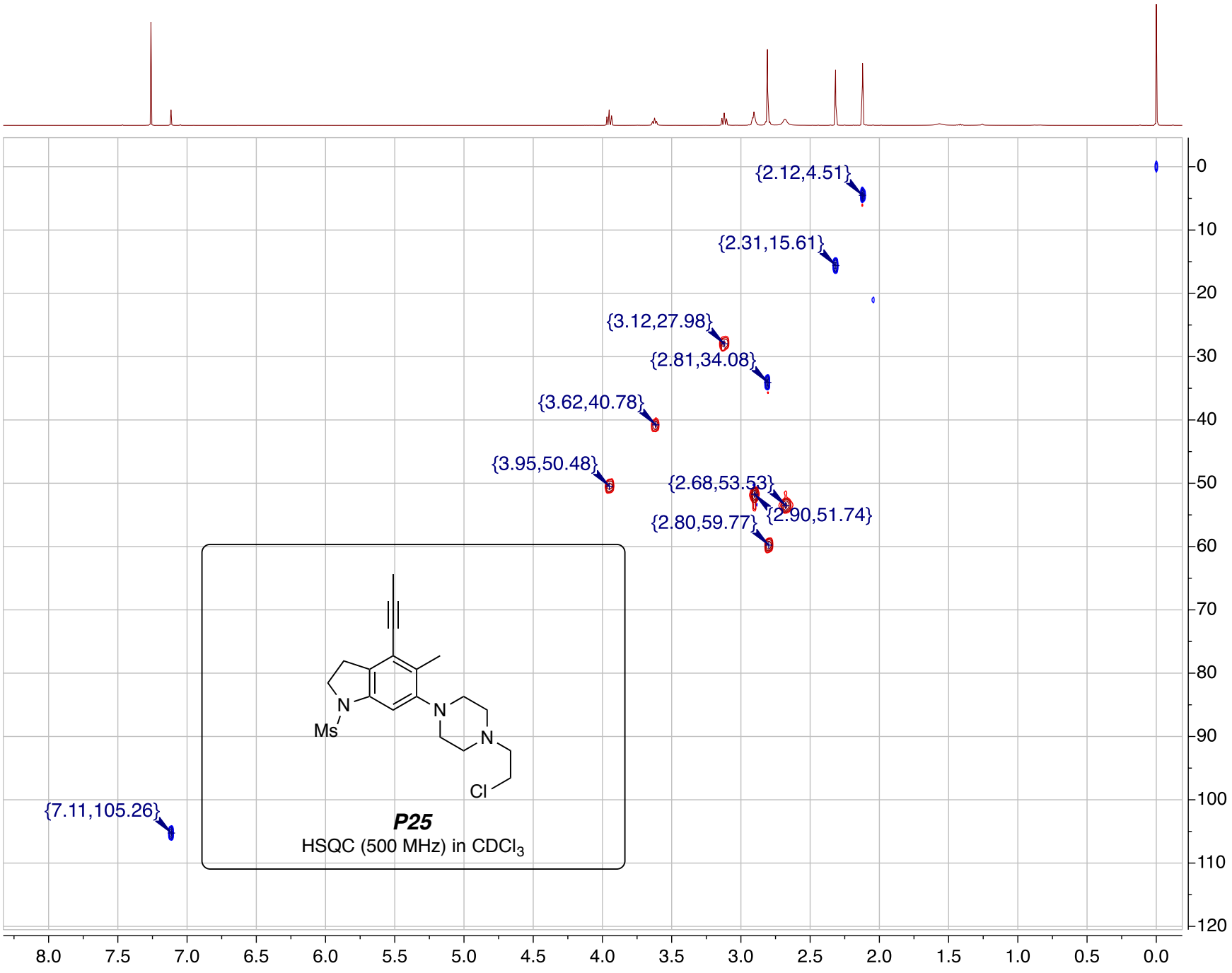

Ms
N
N
N
O
N
O
P24-maj
HMBC (500 MHz) in CDCl3
{2.11,75.86}
{2.10,94.37}
{2.35,120.11}
{7.71,132.21}
{4.66,133.26}
{2.11,133.80}
{2.35,152.00}
{3.86,168.39}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

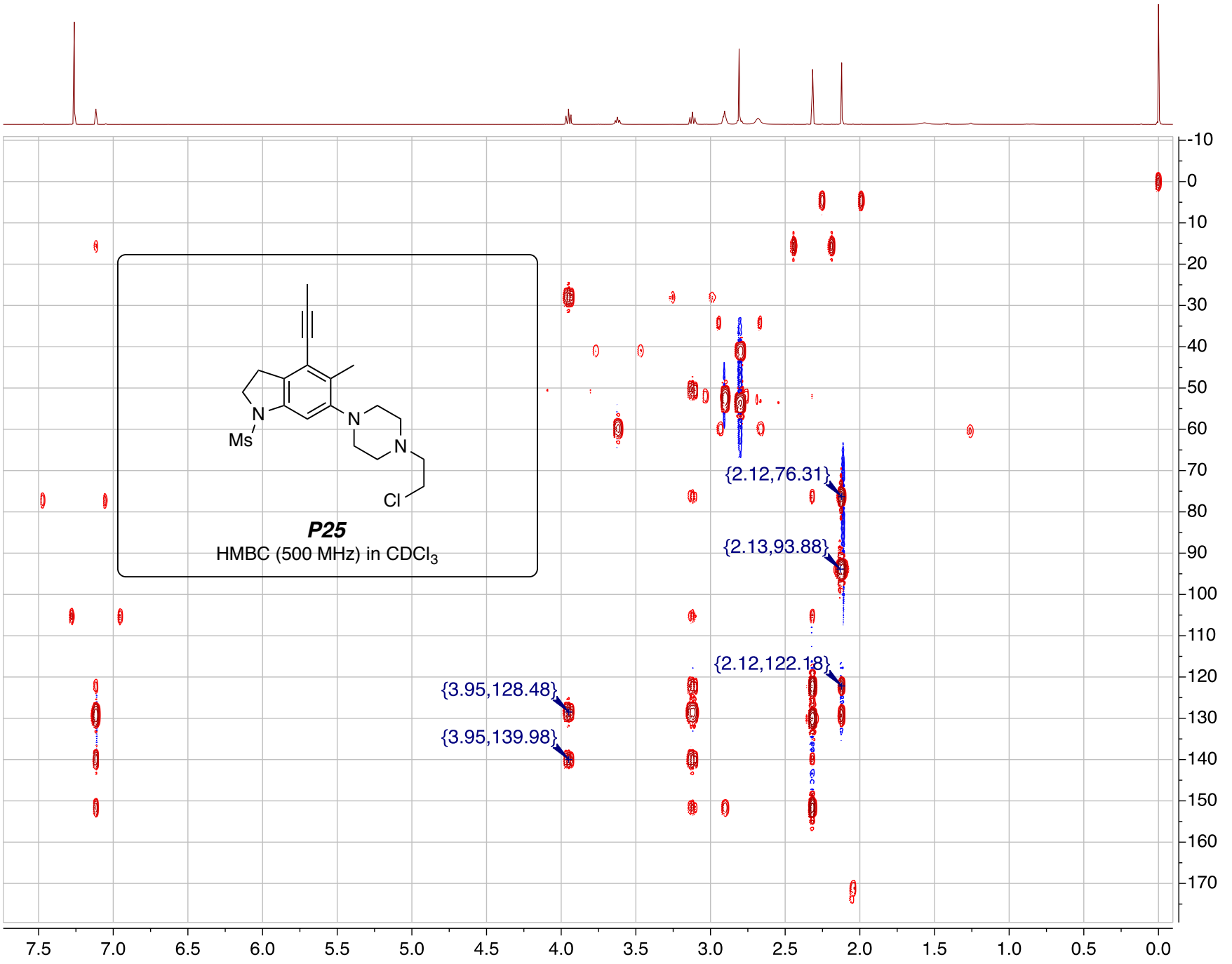

7.35
7.26 CHCl3
3.99
3.97
3.96
3.16
3.14
3.12
2.86
2.41
2.13
2.05 EtOAc
1.26 EtOAc
N
Ms
Cl
S-9
1H NMR (500 MHz) in CDCl3
3.99 3.96
3.16 3.14 3.12
1.00
2.29
2.33
3.43
3.25
3.48
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

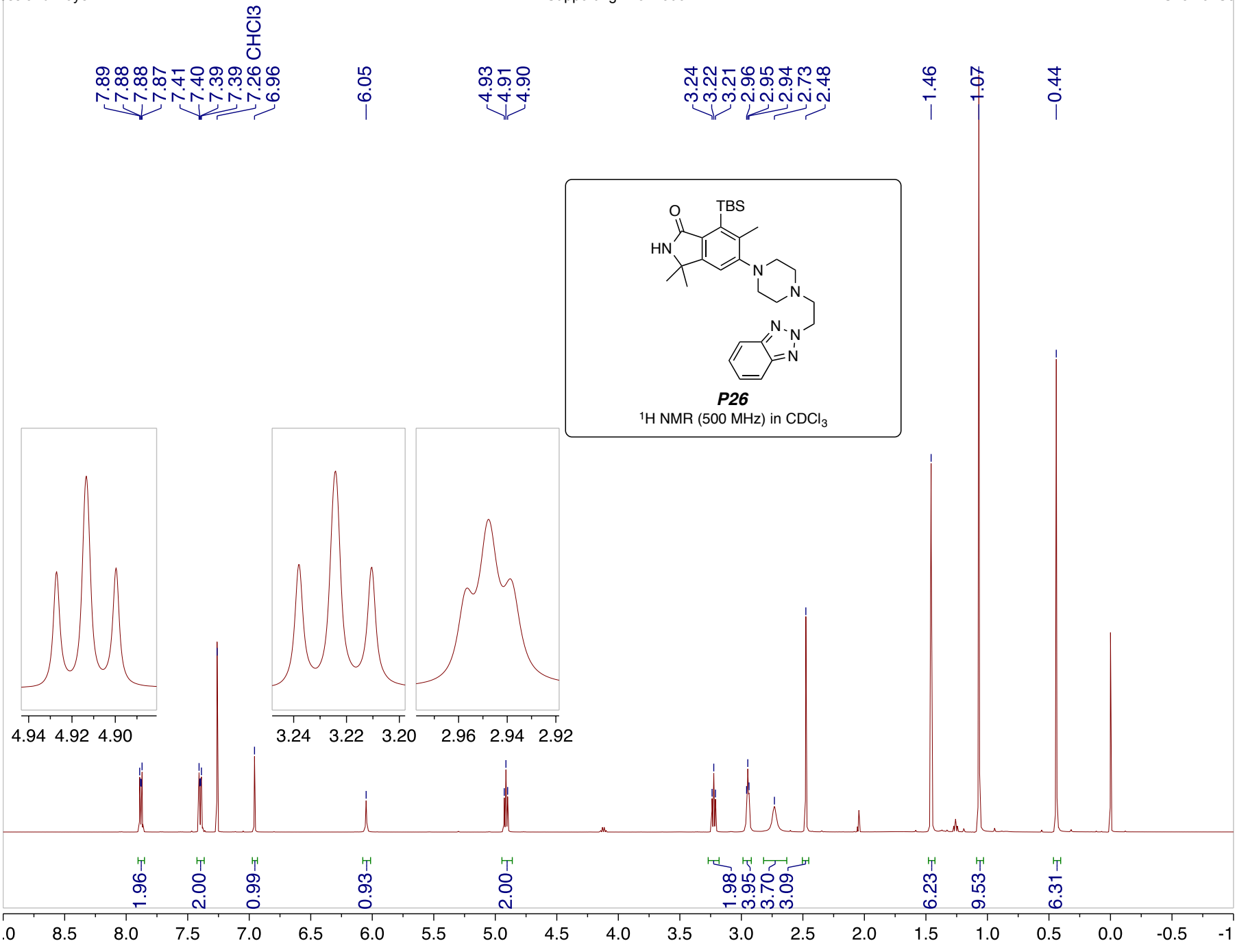

{2.13,4.52}
{2.41,17.70}
{3.14,28.01}
{2.86,34.49}
{3.98,50.39}
{7.34,113.53}
N
Ms
Cl
S-9
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

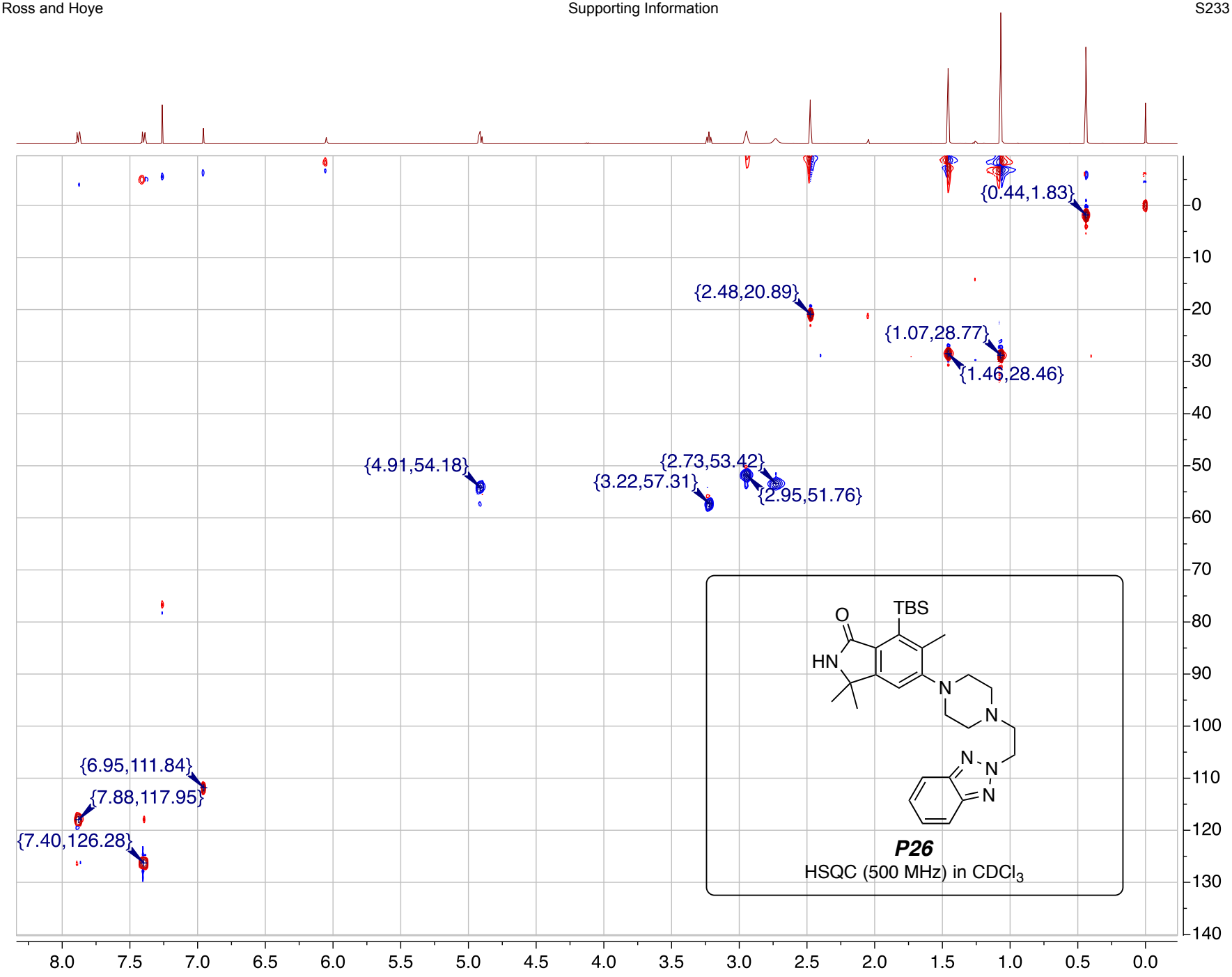

{2.13,75.60}
{2.14,94.97}
{3.14,122.78}
{2.41,131.88}
{3.96,132.66}
{3.96,140.04}
N
Ms
Cl
S-9
HMBC (500 MHz) in CDCl3


7.26 CHCl3
7.12
3.97
3.95
3.95
3.93
3.64
3.62
3.61
3.14
3.12
3.10
2.92
2.91
2.90
2.82
2.81
2.79
2.68
2.67
2.32
2.12
N
Ms
N
N
Cl
P25
1H NMR (500 MHz) in CDCl3
3.96 3.92
3.63 3.60
3.12 3.09
2.91 2.88
2.82 2.80 2.78
1.00
2.06
1.99
2.15
3.99
5.31
3.97
3.13
3.15
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1


{2.12,4.51}
{2.31,15.61}
{3.12,27.98}
{2.81,34.08}
{3.62,40.78}
{3.95,50.48}
{2.68,53.53}
{2.90,51.74}
{2.80,59.77}
{7.11,105.26}
Ms
N
N
N
Cl
P25
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

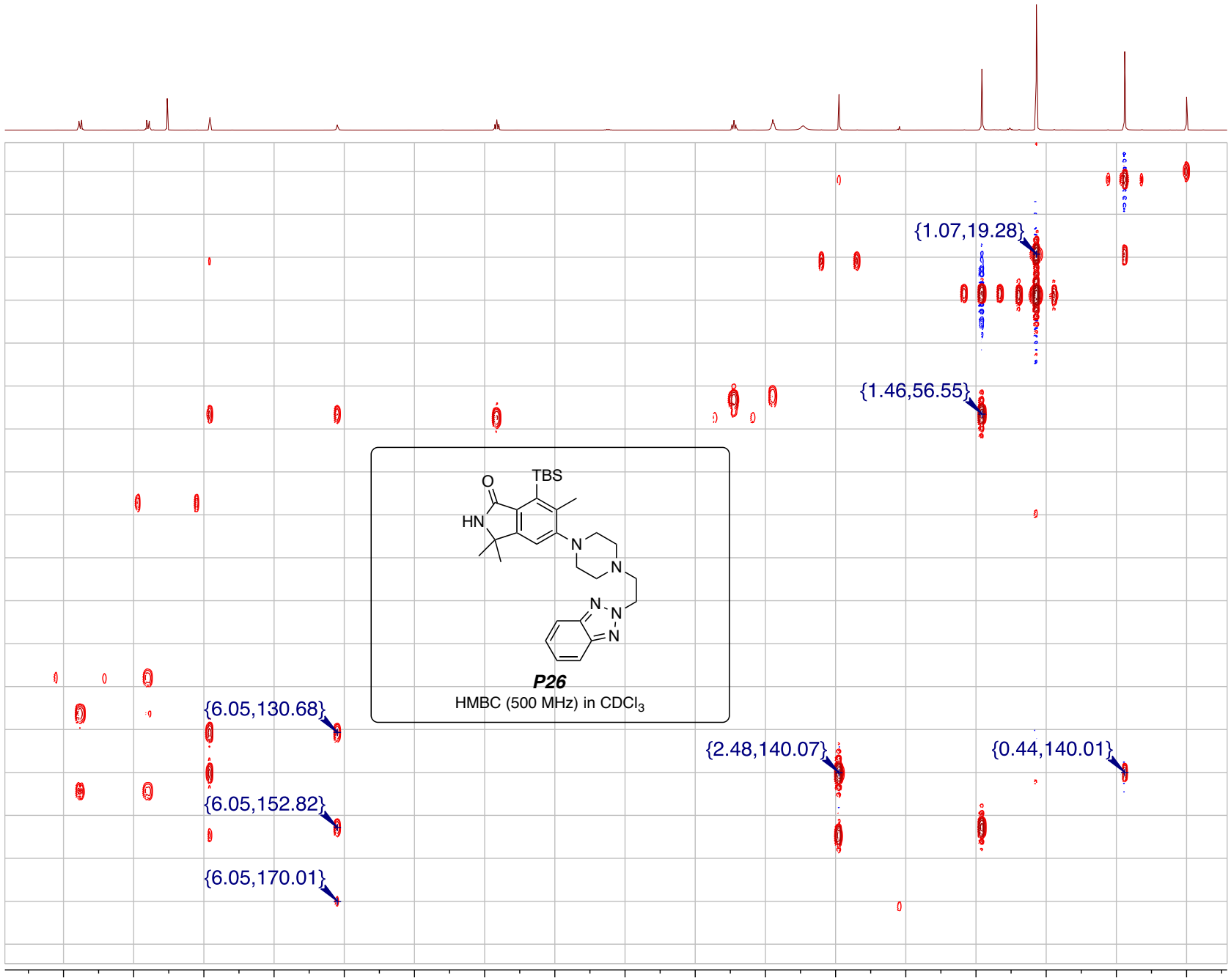

N
Ms
N
N
Cl
P25
HMBC (500 MHz) in CDCl3
{2.12,76.31}
{2.13,93.88}
{2.12,122.18}
{3.95,128.48}
{3.95,139.98}
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

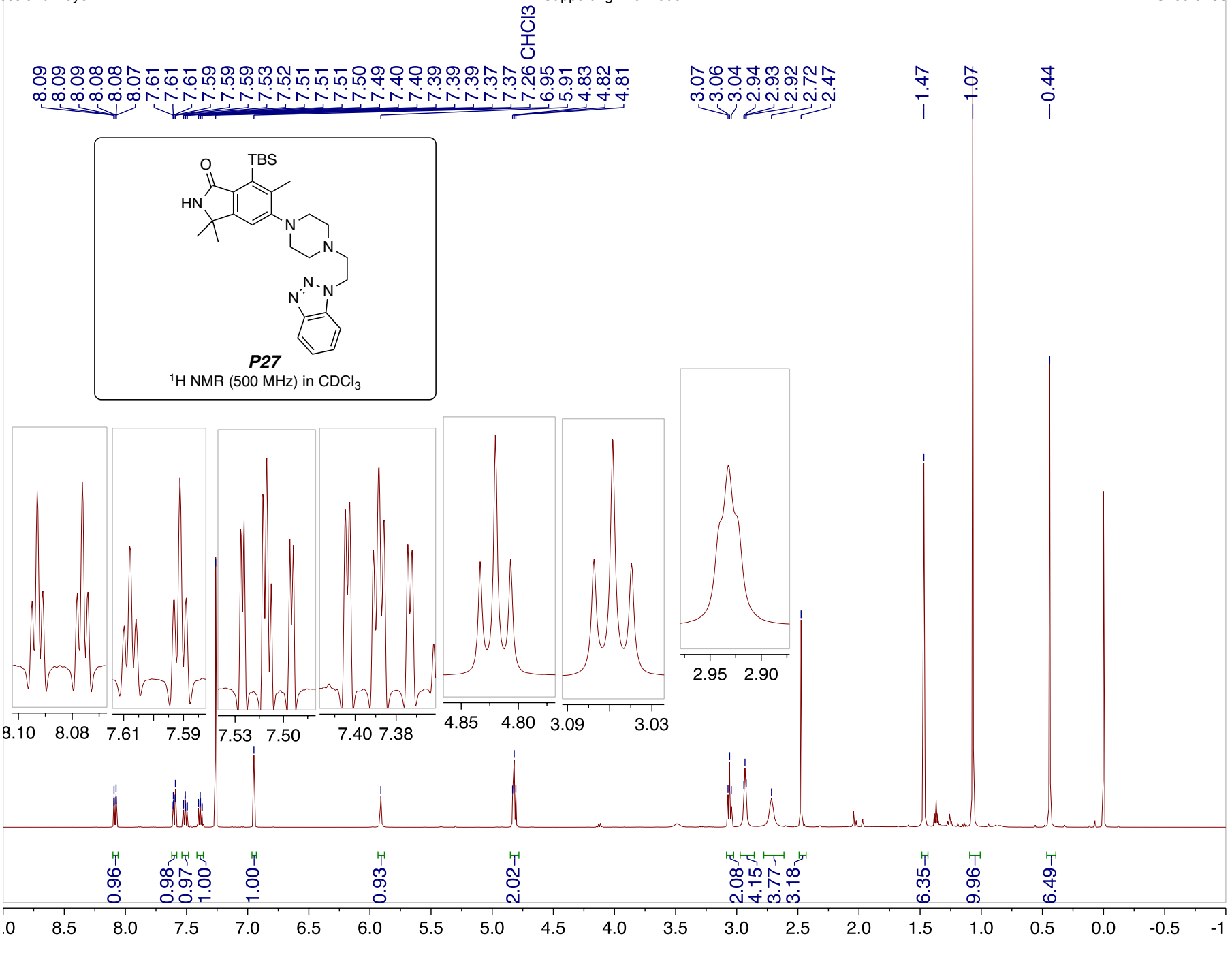

7.89
7.88
7.88
7.87
7.41
7.40
7.39
7.39
CHCl3
7.26
6.96
6.05
4.93
4.91
4.90
3.24
3.22
3.21
2.96
2.95
2.94
2.73
2.48
1.46
1.07
0.44
TBS
O
HN
N
N
N
N
N
P26
1H NMR (500 MHz) in CDCl3
4.94 4.92 4.90
3.24 3.22 3.20
2.96 2.94 2.92
1.96
2.00
0.99
0.93
2.00
1.98
3.95
3.70
3.09
6.23
9.53
6.31
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

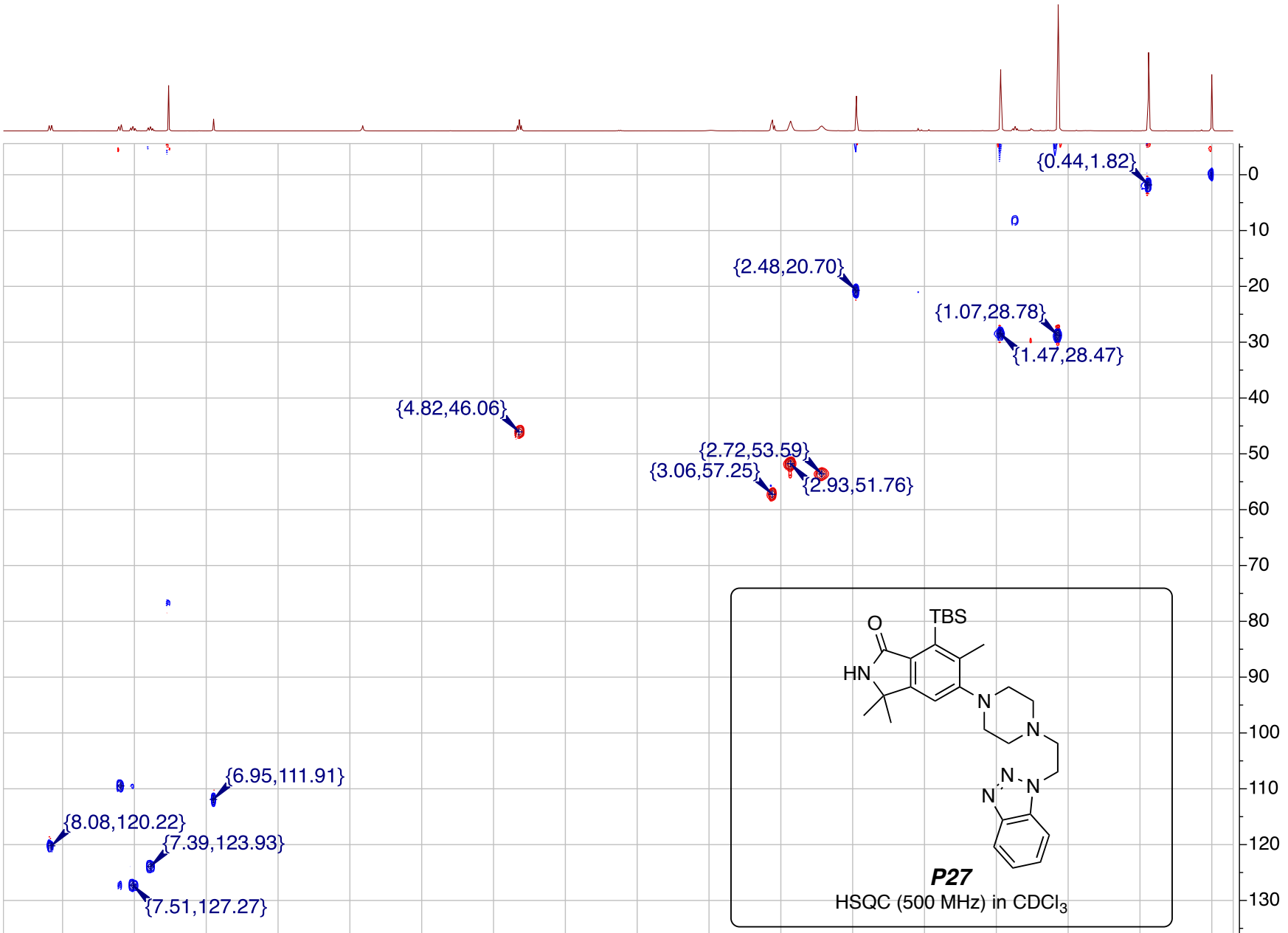


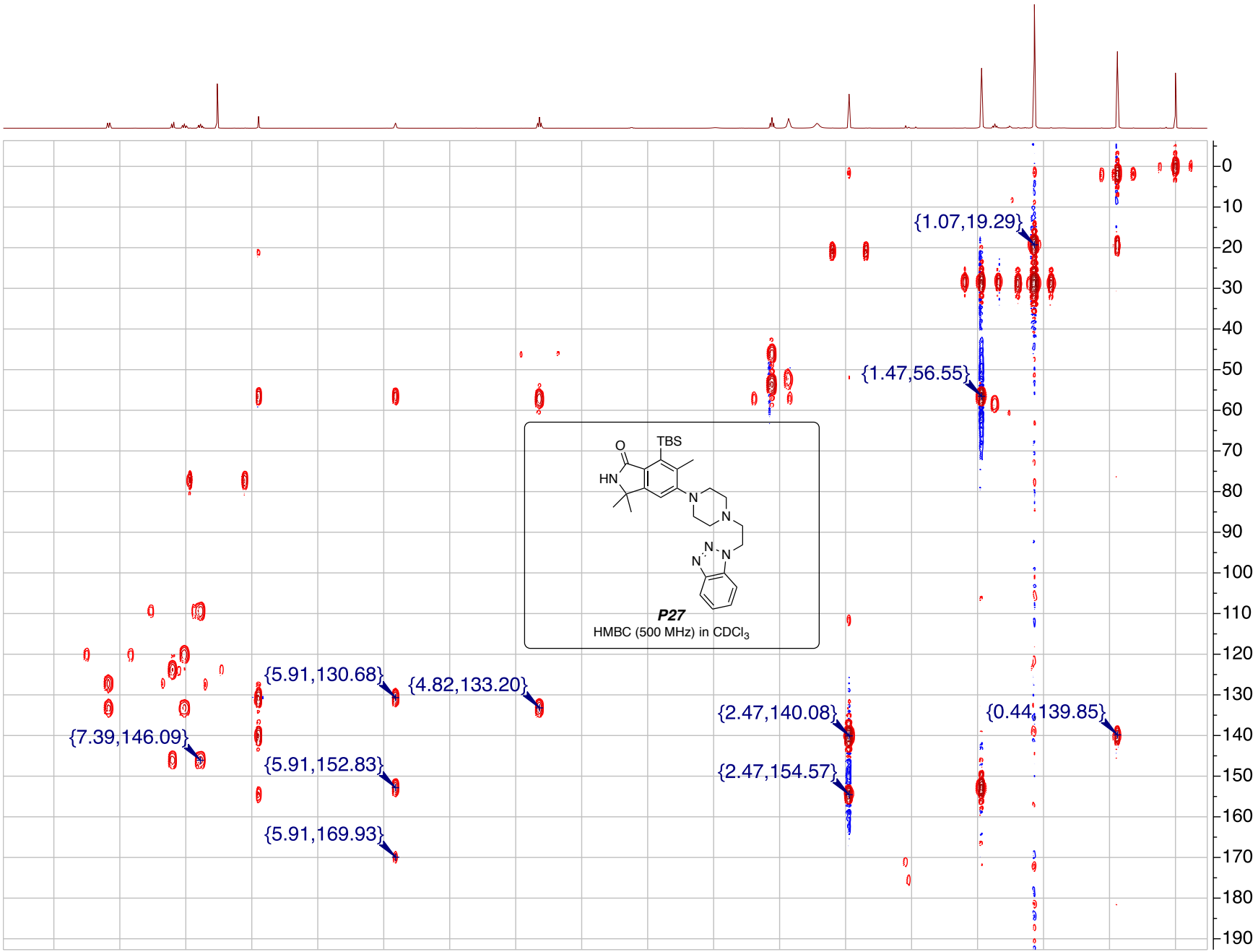
P26

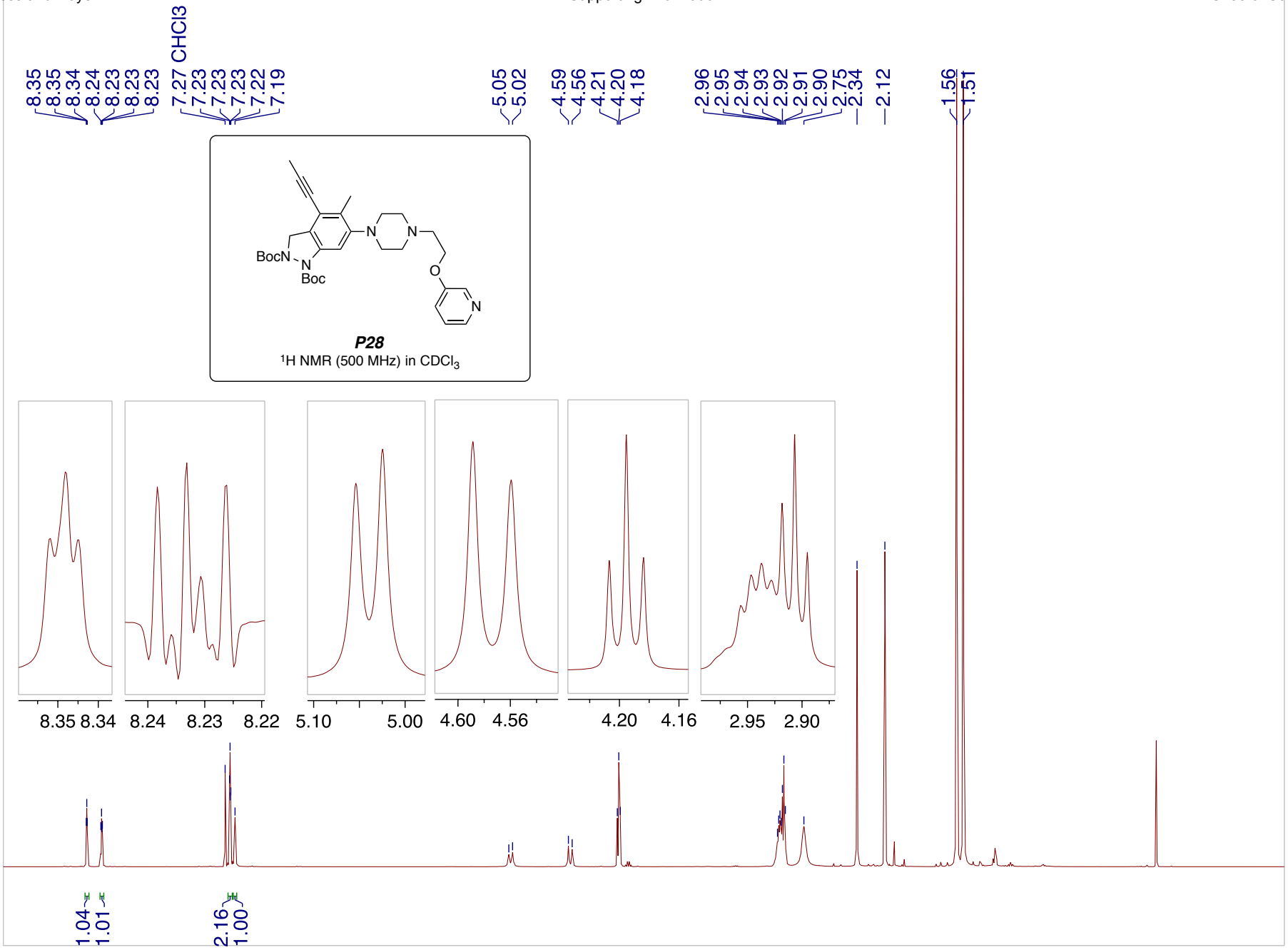
HSQC (500 MHz) in $CDCl_3$

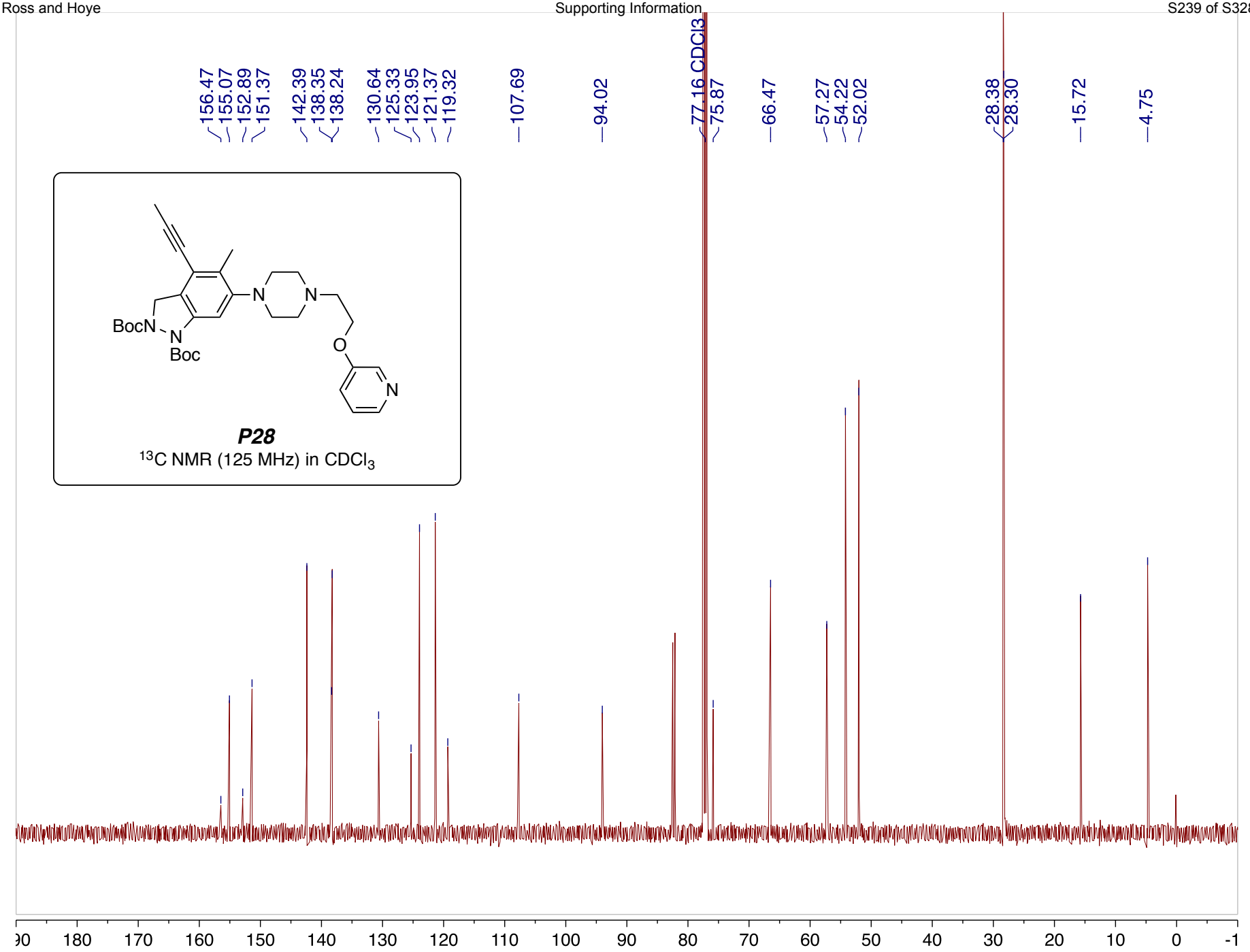

{1.07,19.28}
{1.46,56.55}
{6.05,130.68}
{6.05,152.82}
{6.05,170.01}
{2.48,140.07}
{0.44,140.01}
TBS
O
HN
N
N
N
N
N
P26
HMBC (500 MHz) in CDCl3

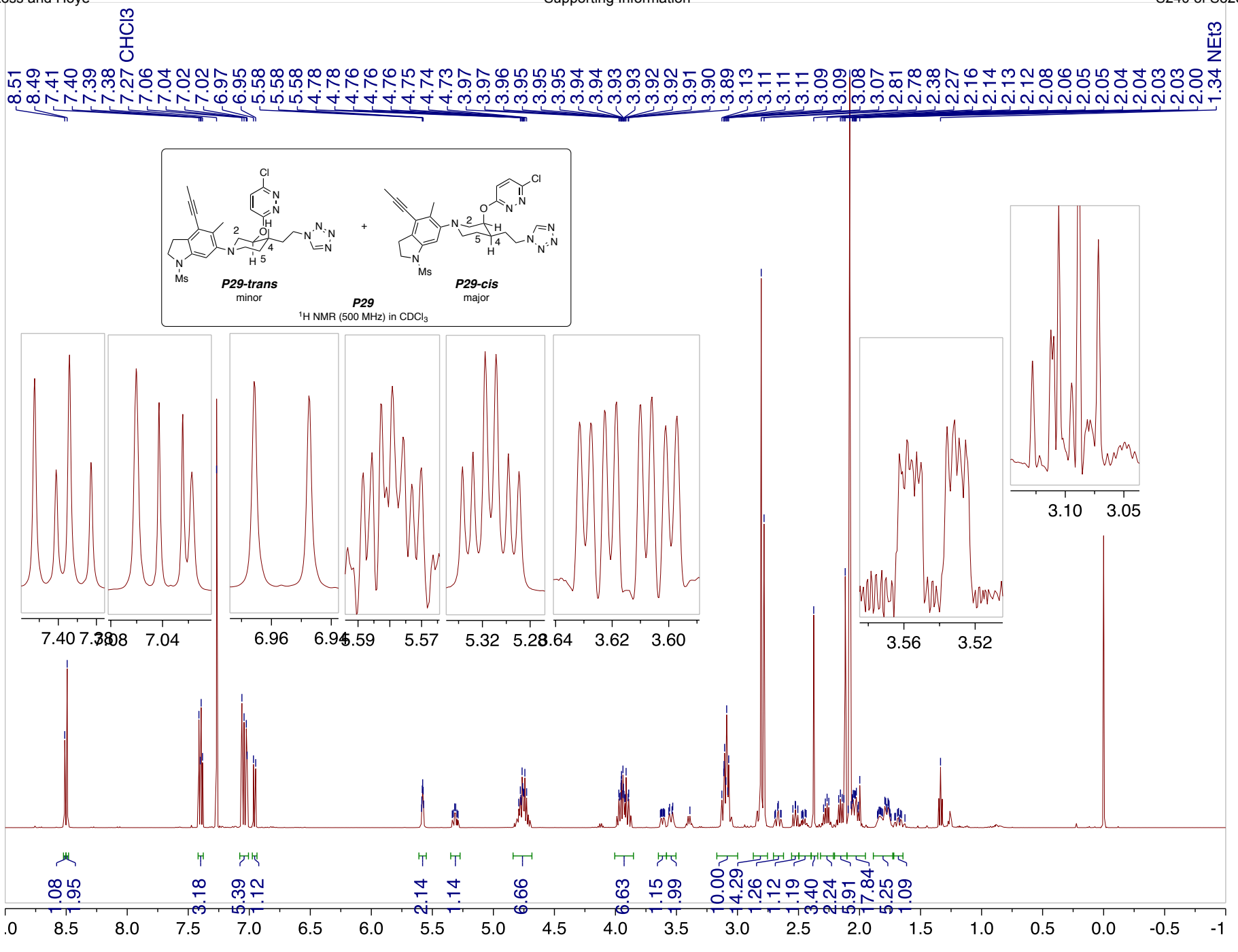

CHCl3
8.09 8.09 8.09 8.08 8.08 8.07 7.61 7.61 7.61 7.59 7.59 7.59 7.53 7.52 7.51 7.51 7.51 7.50 7.49 7.40 7.40 7.39 7.39 7.39 7.37 7.37 7.26 6.95 5.91 4.83 4.82 4.81
3.07 3.06 3.04 2.94 2.93 2.92 2.72 2.47
1.47
1.07
0.44
O
TBS
HN
N
N
N
N
N
P27
1H NMR (500 MHz) in CDCl3
8.10 8.08 7.61 7.59 7.53 7.50 7.40 7.38 4.85 4.80 3.09 3.03 2.95 2.90
0.96 0.98 0.97 1.00 1.00 0.93 2.02 2.08 4.15 3.77 3.18 6.35 9.96 6.49
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

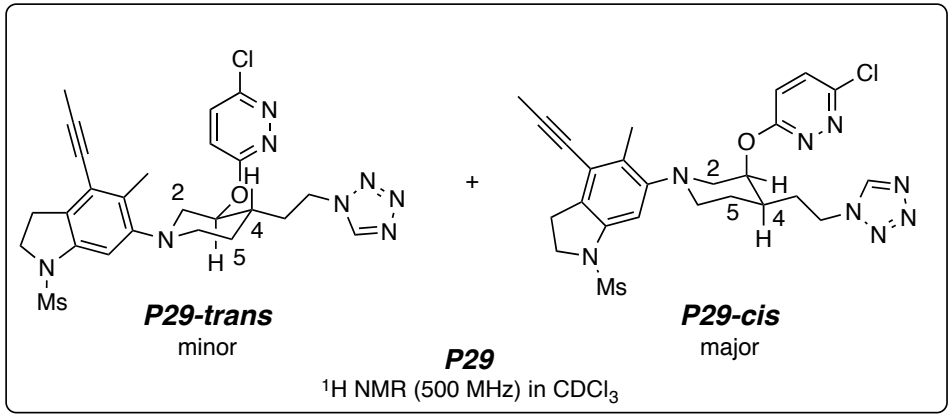

{0.44,1.82}
{2.48,20.70}
{1.07,28.78}
{1.47,28.47}
{4.82,46.06}
{2.72,53.59}
{3.06,57.25}
{2.93,51.76}
{6.95,111.91}
{8.08,120.22}
{7.39,123.93}
{7.51,127.27}
TBS
O
HN
N
N
N
N
N
P27
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0


{1.07,19.29}
{1.47,56.55}
{5.91,130.68}
{4.82,133.20}
{7.39,146.09}
{5.91,152.83}
{5.91,169.93}
{2.47,140.08}
{2.47,154.57}
{0.44,139.85}
TBS
O
HN
N
N
N
N
P27
HMBC (500 MHz) in CDCl3
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190


8.35
8.35
8.34
8.24
8.23
8.23
8.23
7.27 CHCl3
7.23
7.23
7.23
7.22
7.19
5.05
5.02
4.59
4.56
4.21
4.20
4.18
2.96
2.95
2.94
2.93
2.92
2.91
2.90
2.75
2.34
2.12
1.56
1.51
BocN
N
Boc
N
N
O
N
P28
1H NMR (500 MHz) in CDCl3
8.35 8.34
8.24
8.23
8.22
5.10
5.00
4.60
4.56
4.20
4.16
2.95
2.90
1.04
1.01
2.16
1.00
.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1


156.47
155.07
152.89
151.37
142.39
138.35
138.24
130.64
125.33
123.95
121.37
119.32
107.69
94.02
77.16 CDCl3
75.87
66.47
57.27
54.22
52.02
28.38
28.30
15.72
4.75
BocN
N
Boc
N
N
O
N
P28
13C NMR (125 MHz) in CDCl3
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

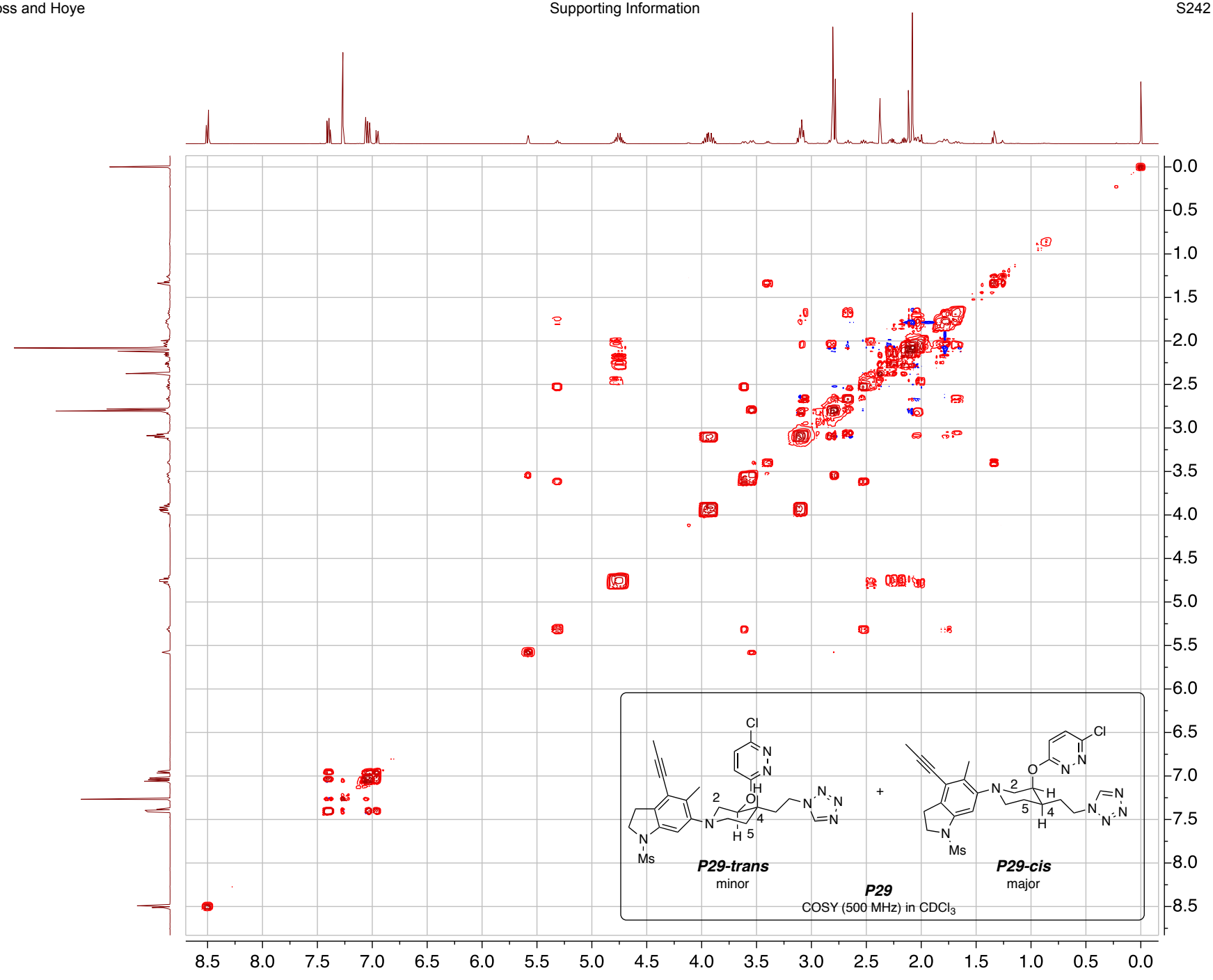

CHCl3
NEt3
8.51 8.49 7.41 7.40 7.39 7.38 7.27 7.06 7.04 7.02 7.02 6.97 6.95 5.58 5.58 5.58 4.78 4.78 4.76 4.76 4.76 4.75 4.74 4.73 3.97 3.97 3.96 3.95 3.95 3.95 3.94 3.94 3.93 3.93 3.92 3.92 3.91 3.90 3.89 3.13 3.11 3.11 3.11 3.09 3.09 3.08 3.07 2.81 2.78 2.38 2.27 2.16 2.14 2.13 2.12 2.08 2.06 2.05 2.05 2.04 2.04 2.03 2.03 2.00 1.34
P29-trans
minor
P29
P29-cis
major
1H NMR (500 MHz) in CDCl3
7.40 7.38 7.08 7.04
6.96 6.94
5.59 5.57
5.32 5.28
3.64 3.62 3.60
3.56 3.52
3.10 3.05
1.08 1.95 3.18 5.39 1.12 2.14 1.14 6.66 6.63 1.15 1.99 10.00 14.29 1.26 1.12 1.19 3.40 2.24 5.91 17.84 5.25 1.09
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

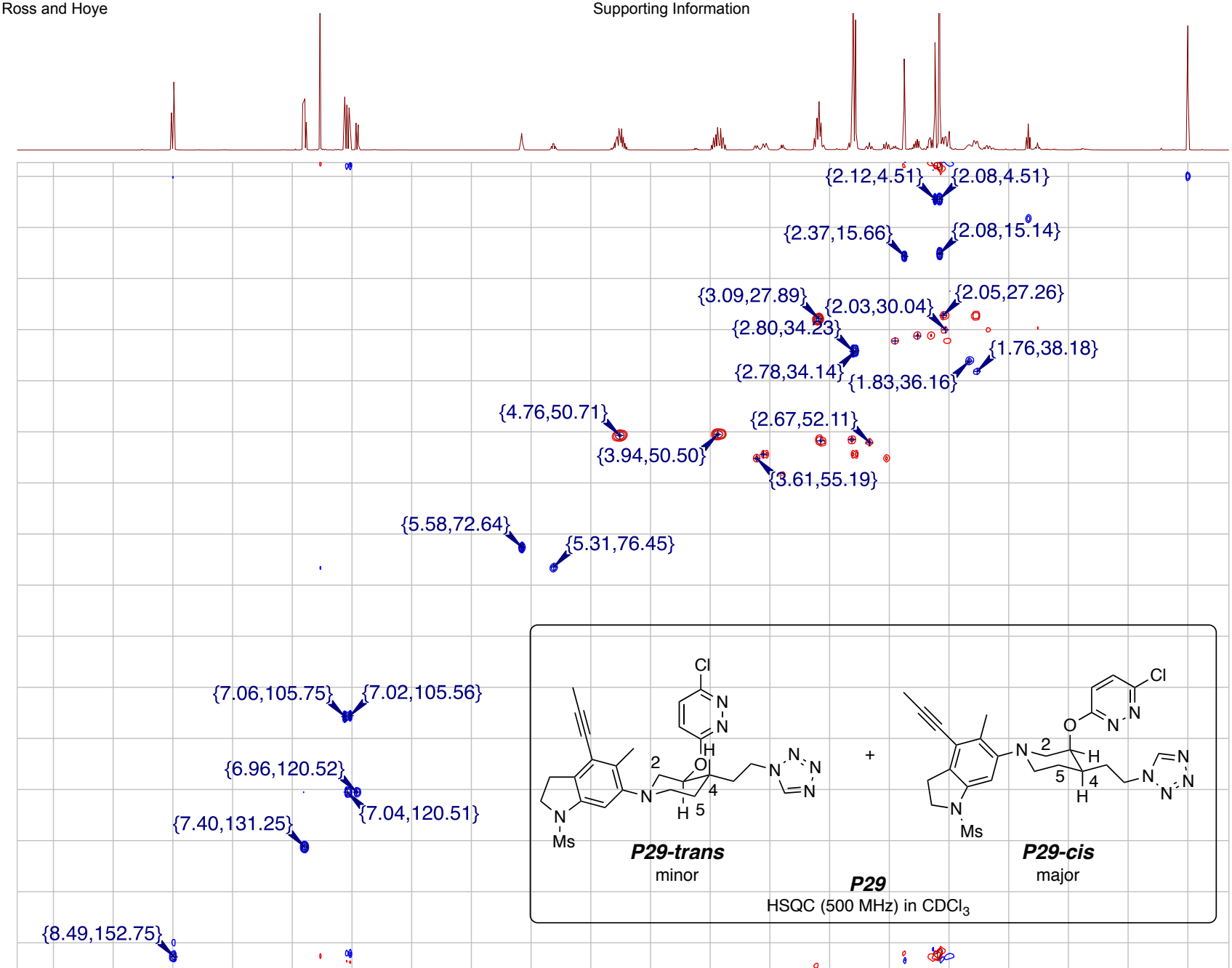


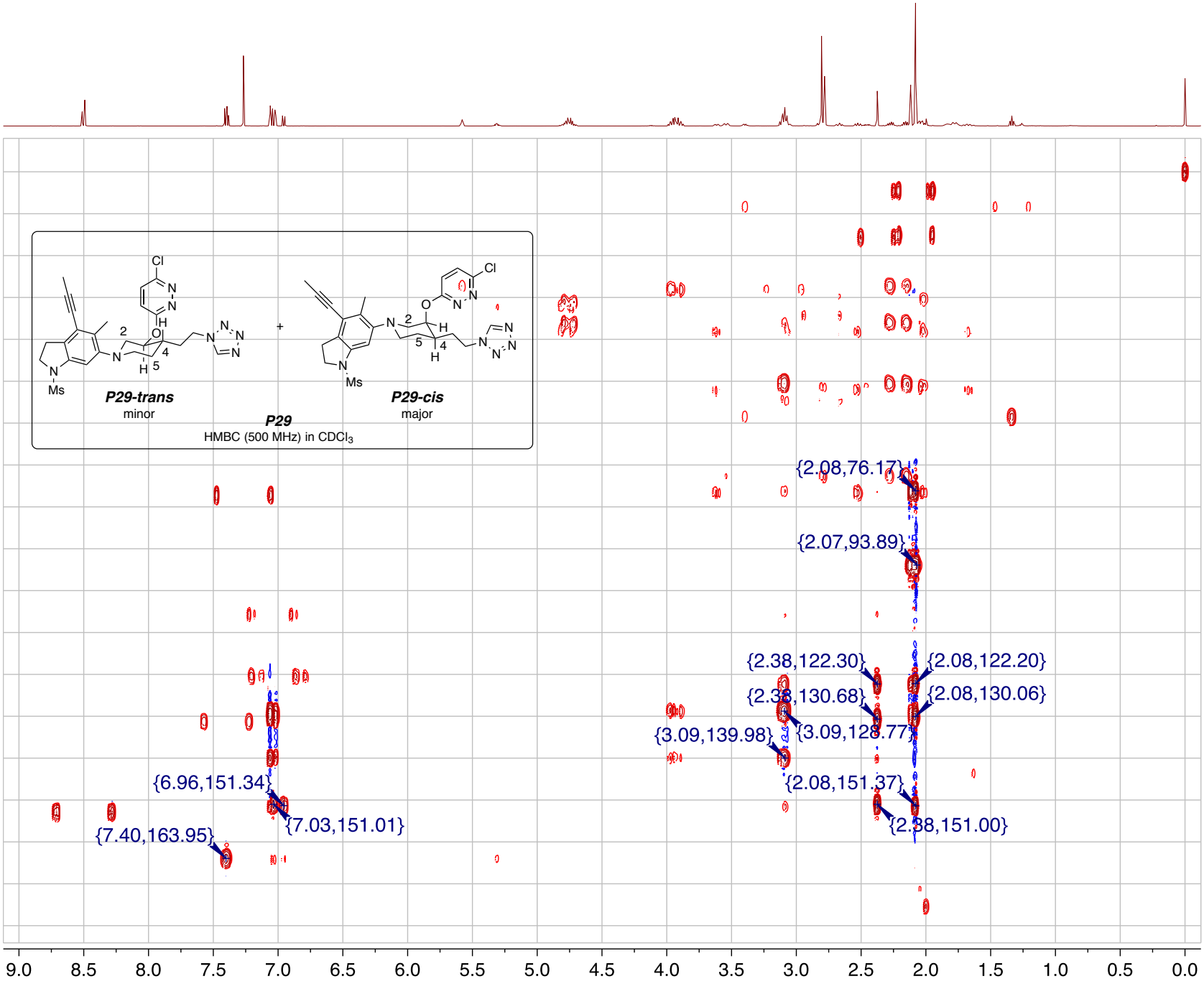
P29-trans
minor

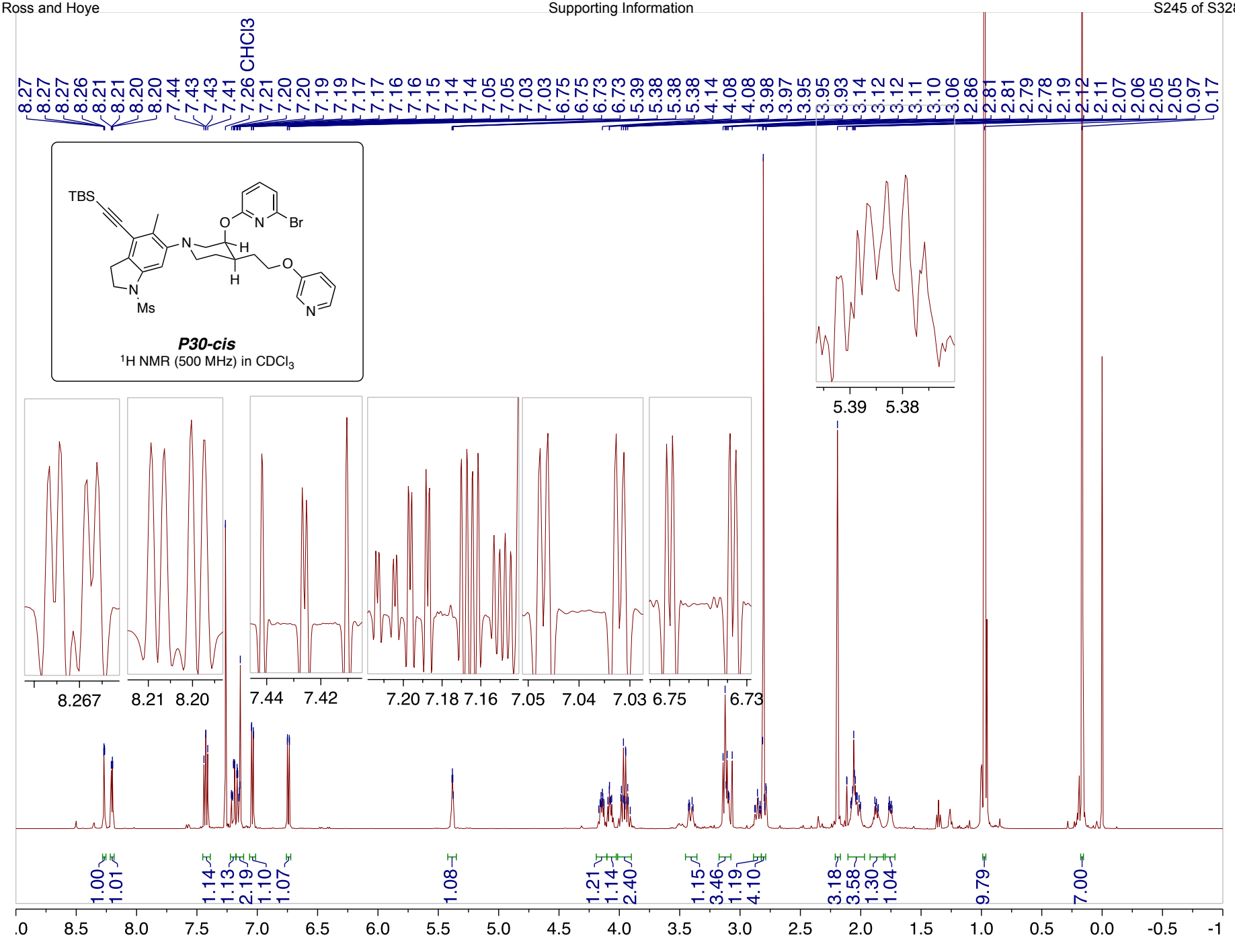
P29-cis
major

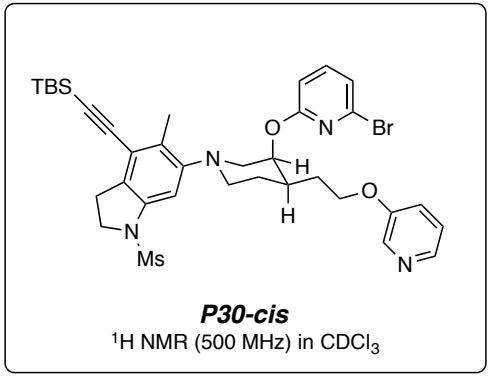
P29
^{1}H NMR (500 MHz) in $CDCl_3$


P29-trans
minor
P29
COSY (500 MHz) in CDCl3
P29-cis
major


{2.12,4.51}
{2.08,4.51}
{2.37,15.66}
{2.08,15.14}
{3.09,27.89}
{2.03,30.04}
{2.05,27.26}
{2.80,34.23}
{1.76,38.18}
{2.78,34.14}
{1.83,36.16}
{4.76,50.71}
{2.67,52.11}
{3.94,50.50}
{3.61,55.19}
{5.58,72.64}
{5.31,76.45}
{7.06,105.75}
{7.02,105.56}
{6.96,120.52}
{7.04,120.51}
{7.40,131.25}
{8.49,152.75}
P29-trans
minor
P29-cis
major
P29
HSQC (500 MHz) in CDCl3

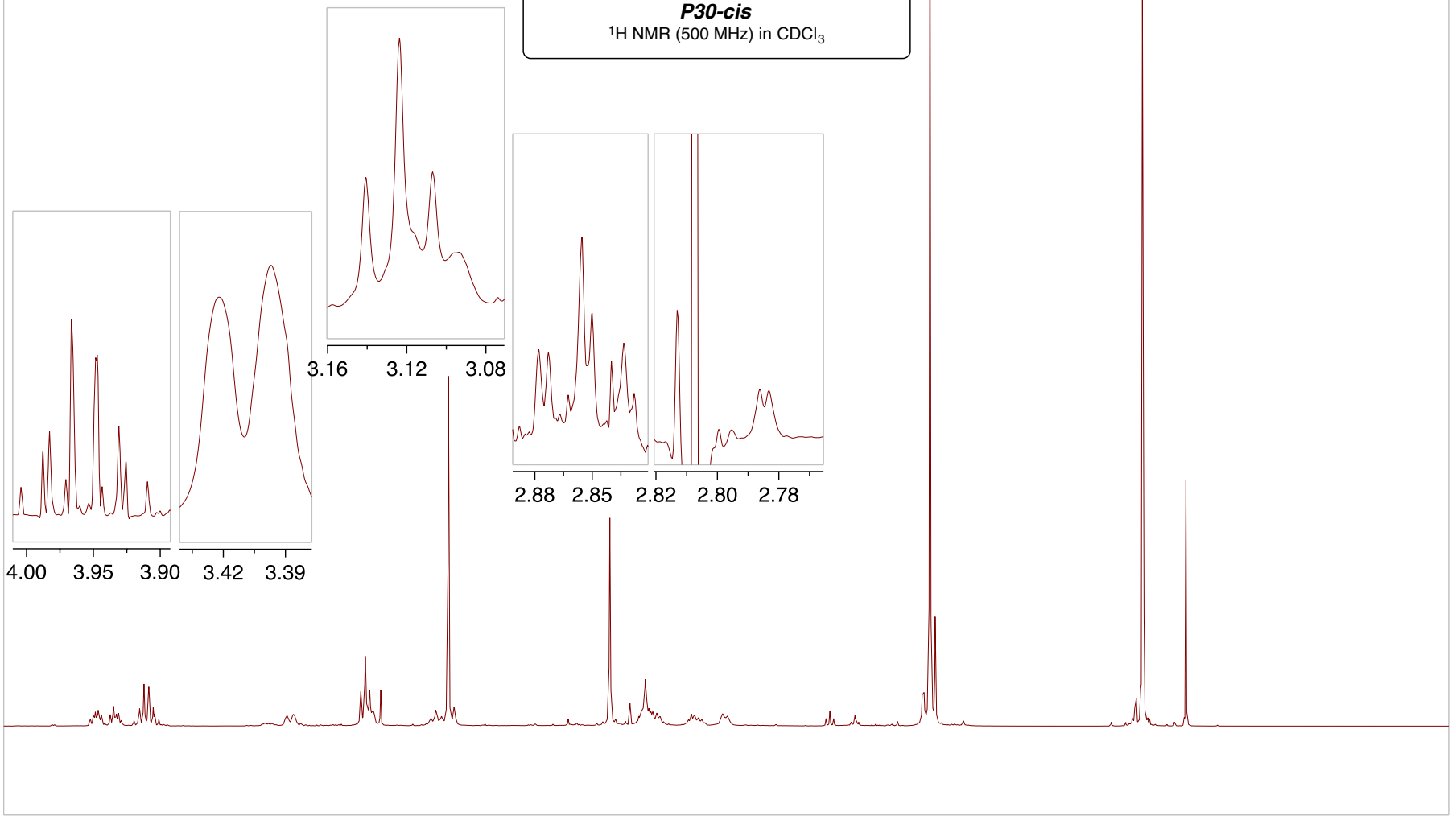

P29-trans
minor
P29
HMBC (500 MHz) in CDCl3
P29-cis
major
{2.08,76.17}
{2.07,93.89}
{2.38,122.30}
{2.08,122.20}
{2.38,130.68}
{2.08,130.06}
{3.09,139.98}
{3.09,128.77}
{2.08,151.37}
{2.38,151.00}
{6.96,151.34}
{7.03,151.01}
{7.40,163.95}

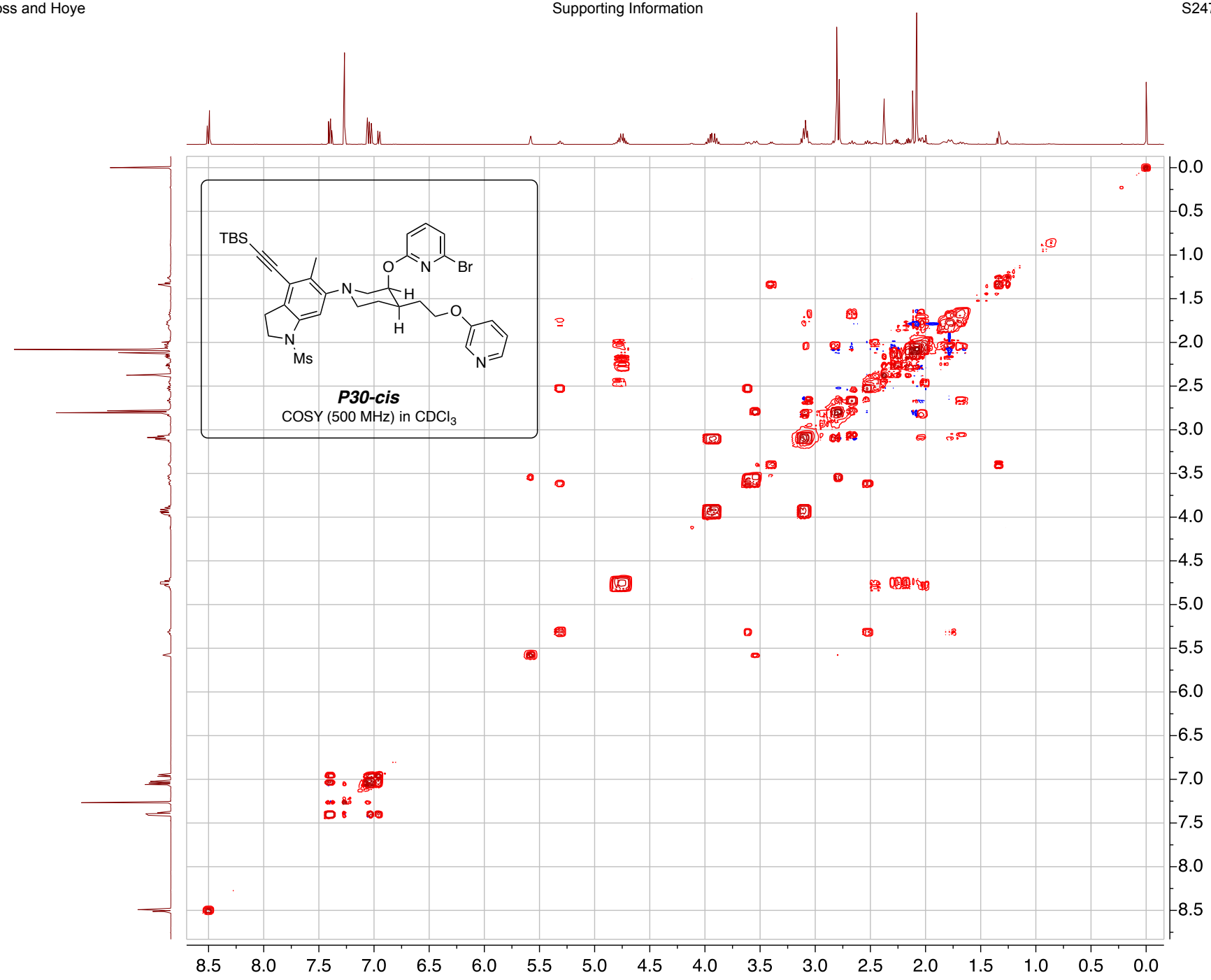

CHCl3
TBS
O
N
Br
N
H
O
H
N
Ms
N
P30-cis
1H NMR (500 MHz) in CDCl3
5.39 5.38
8.267
8.21 8.20
7.44 7.42
7.20 7.18 7.16
7.05 7.04 7.03
6.75 6.73

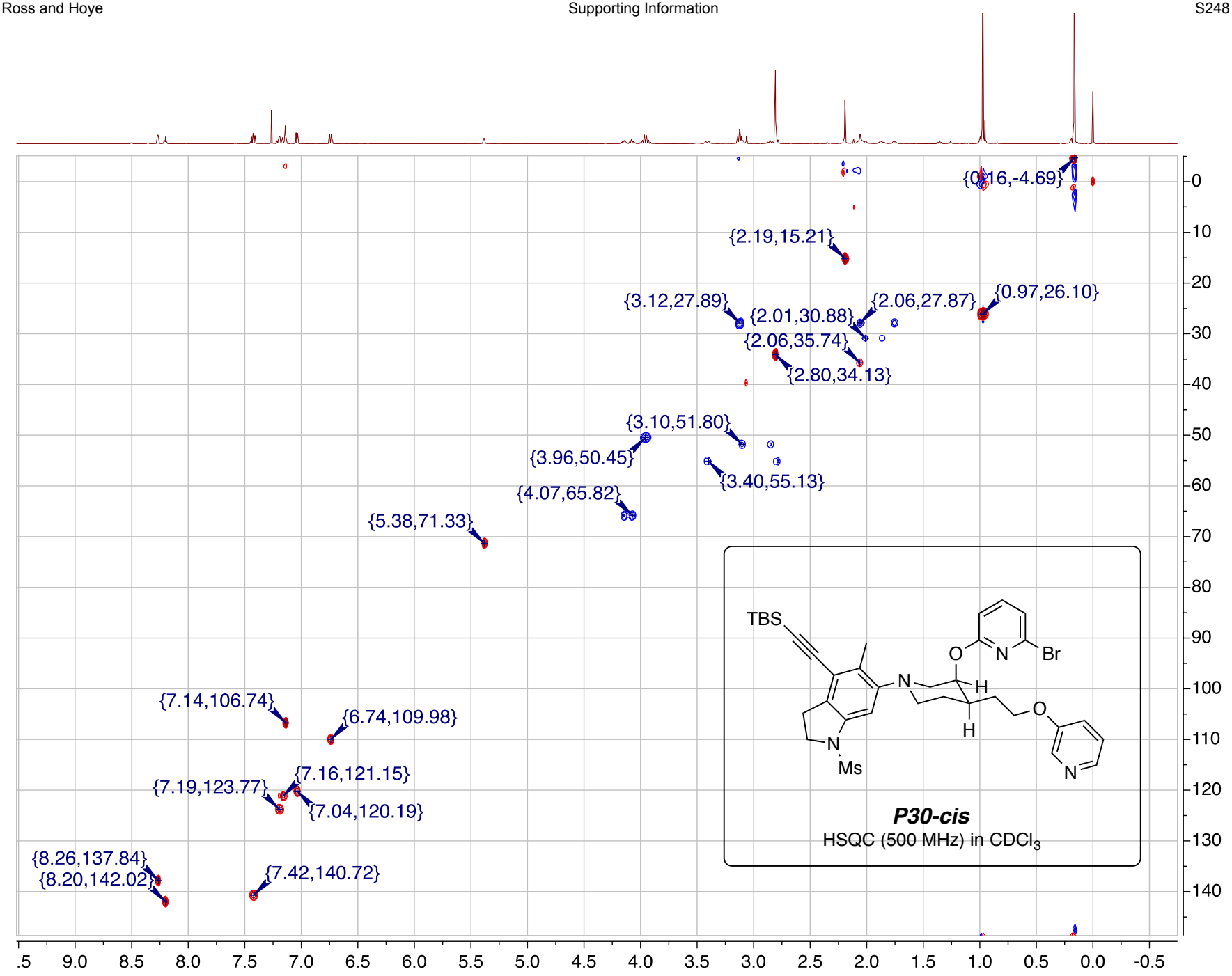


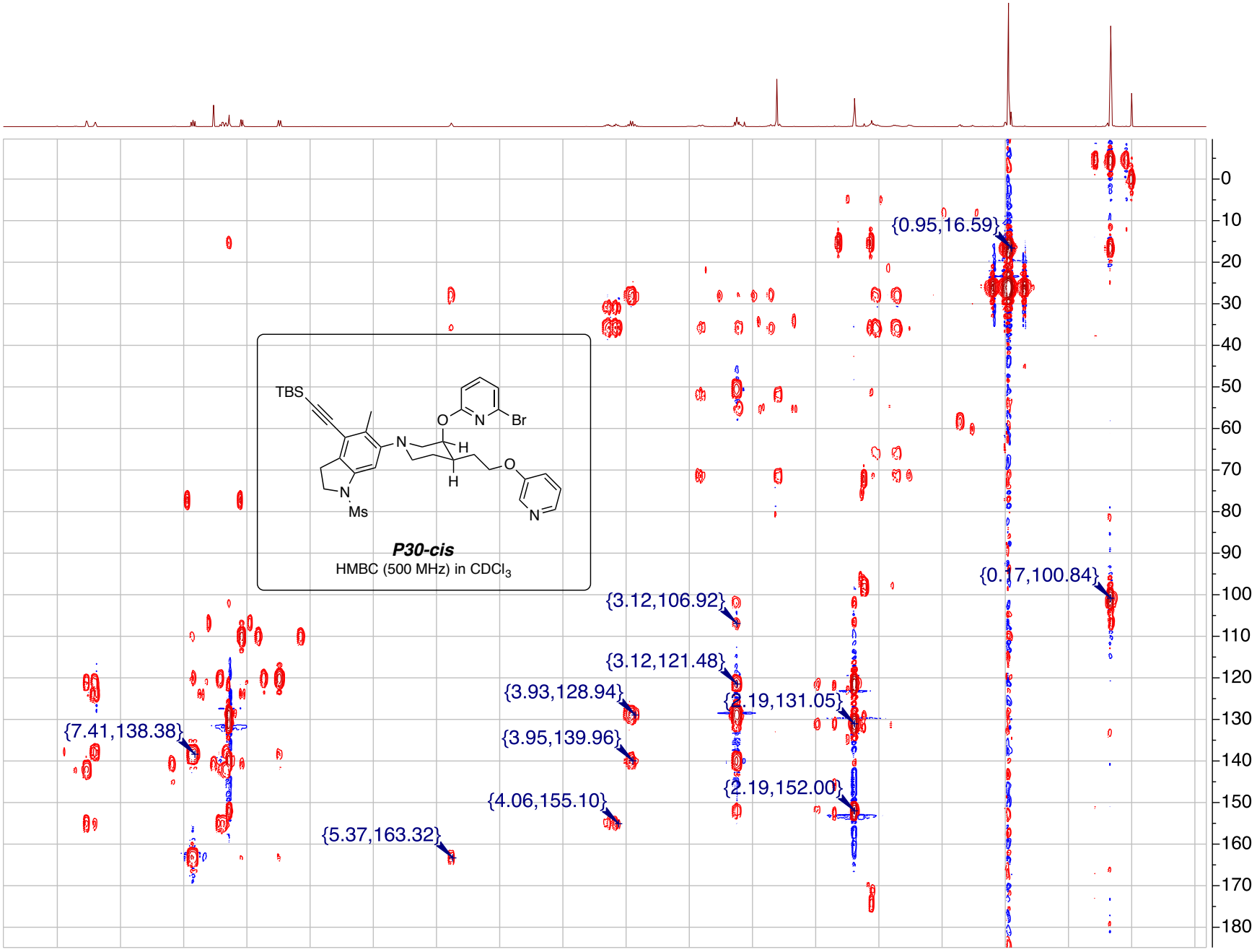
P30-cis

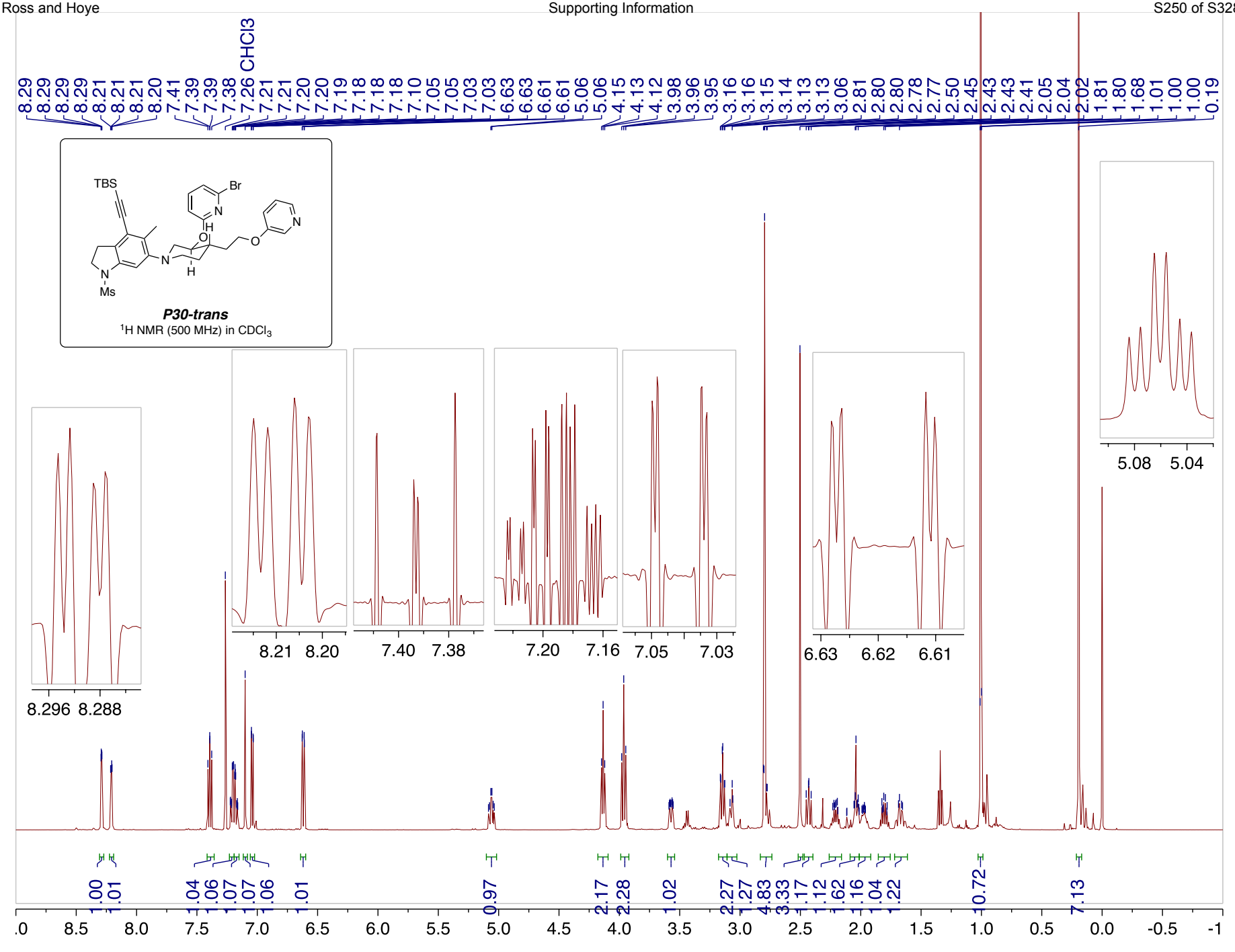
^{1}H NMR (500 MHz) in $CDCl_3$

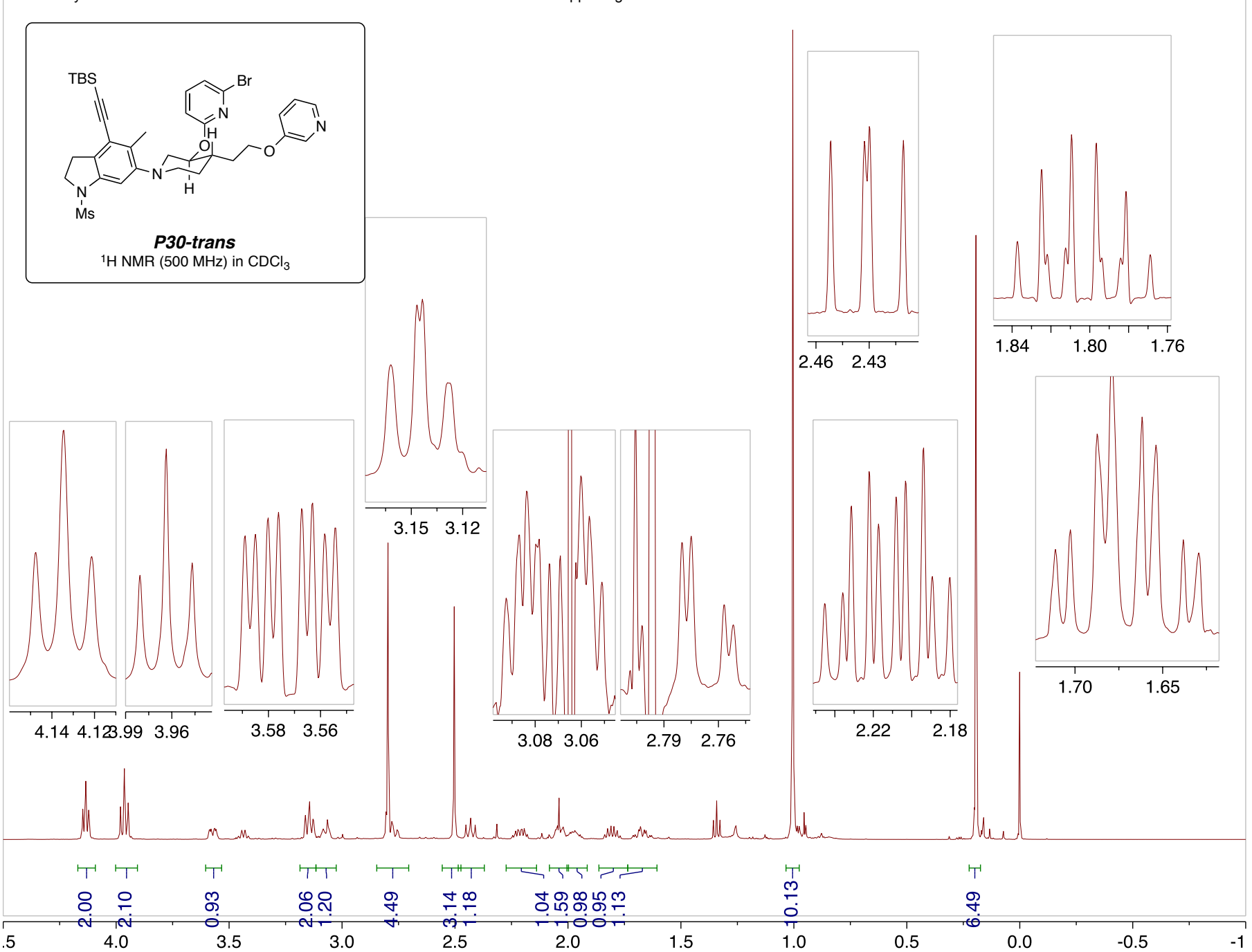


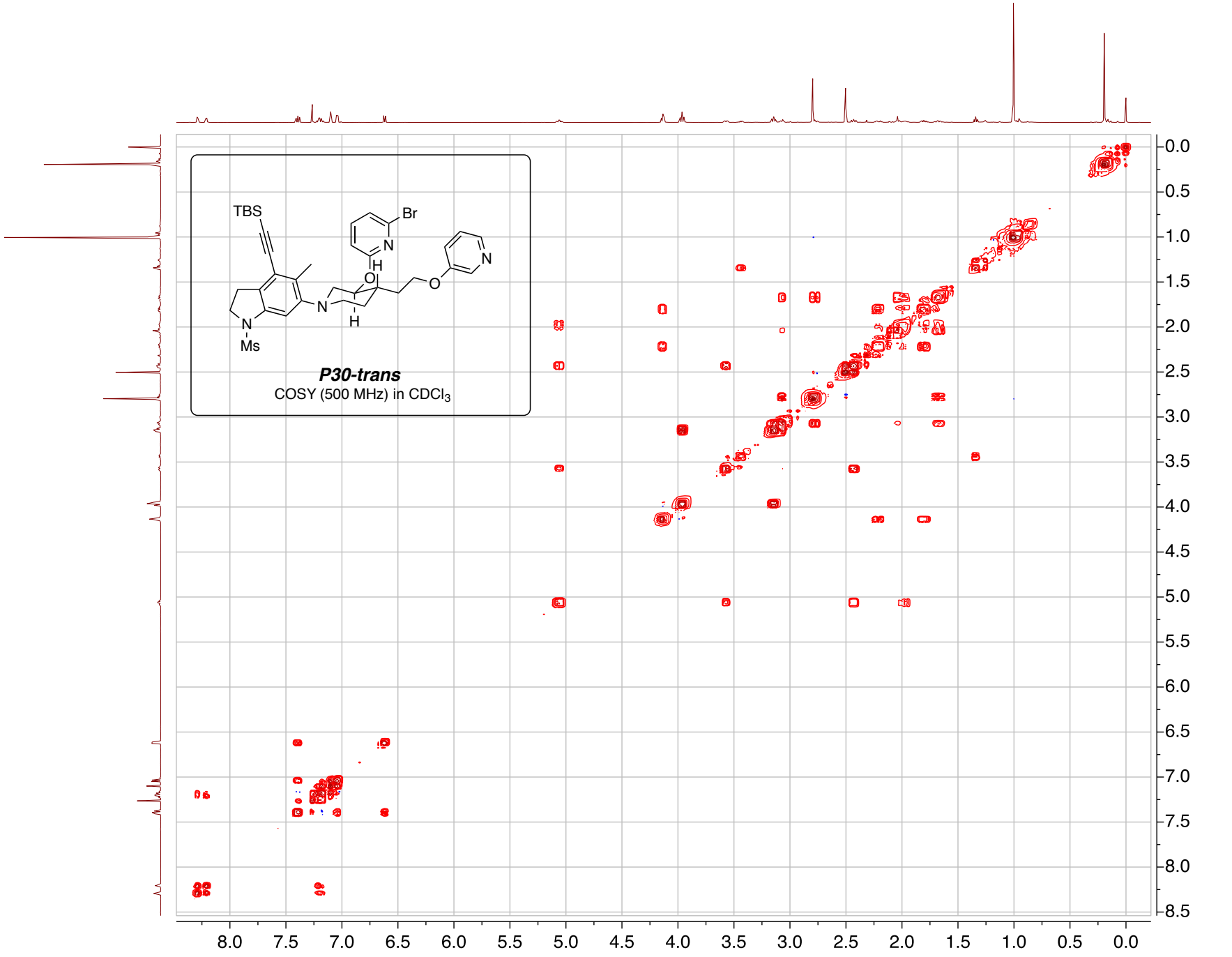

TBS
O
N
Br
N
H
O
H
N
Ms
N
P30-cis
COSY (500 MHz) in CDCl3
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

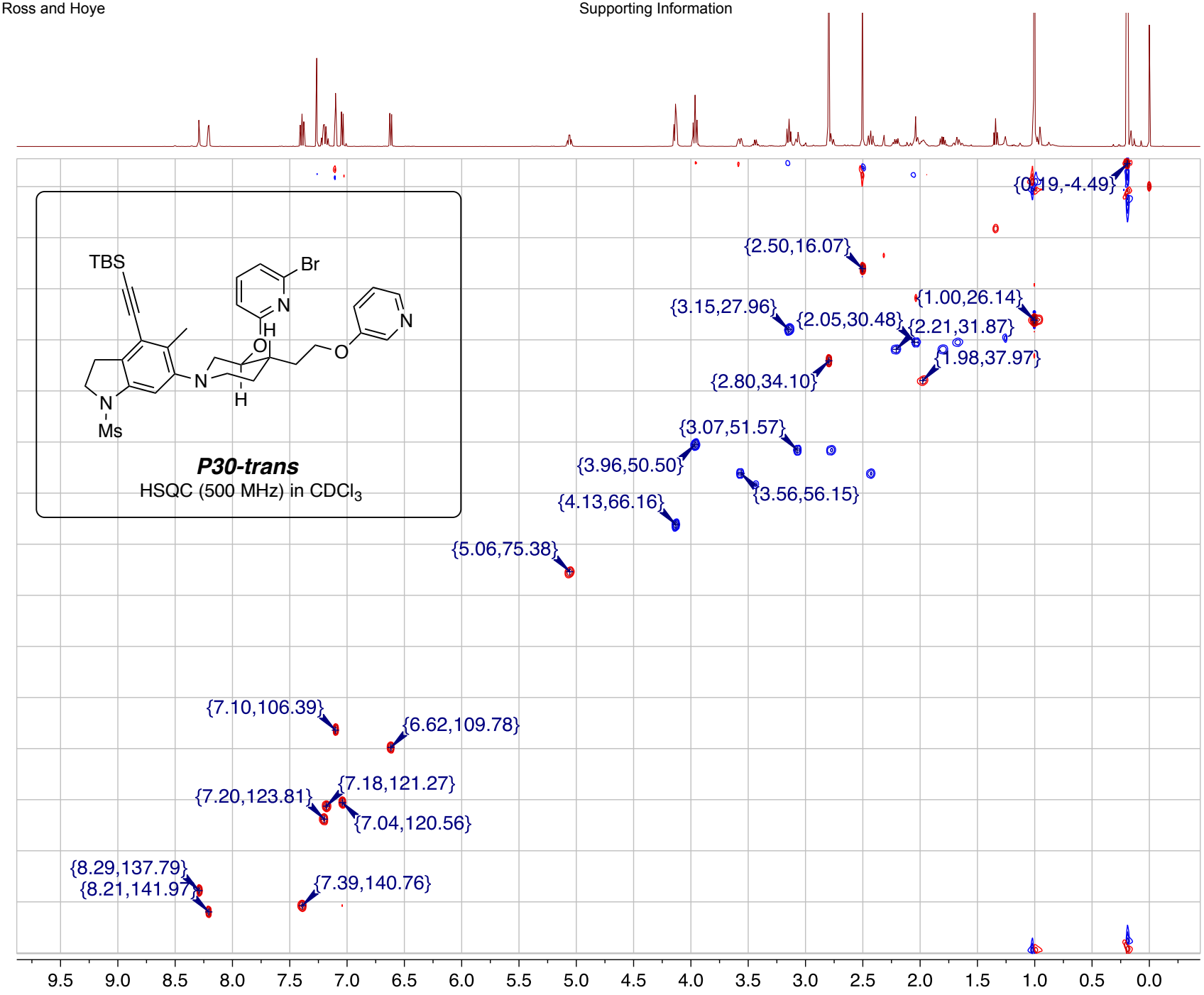

{0.16,-4.69}
{2.19,15.21}
{3.12,27.89}
{2.01,30.88}
{2.06,27.87}
{0.97,26.10}
{2.06,35.74}
{2.80,34.13}
{3.10,51.80}
{3.96,50.45}
{3.40,55.13}
{4.07,65.82}
{5.38,71.33}
{7.14,106.74}
{6.74,109.98}
{7.16,121.15}
{7.19,123.77}
{7.04,120.19}
{8.26,137.84}
{8.20,142.02}
{7.42,140.72}
TBS
N
O
N
Br
H
O
H
N
Ms
N
P30-cis
HSQC (500 MHz) in CDCl3

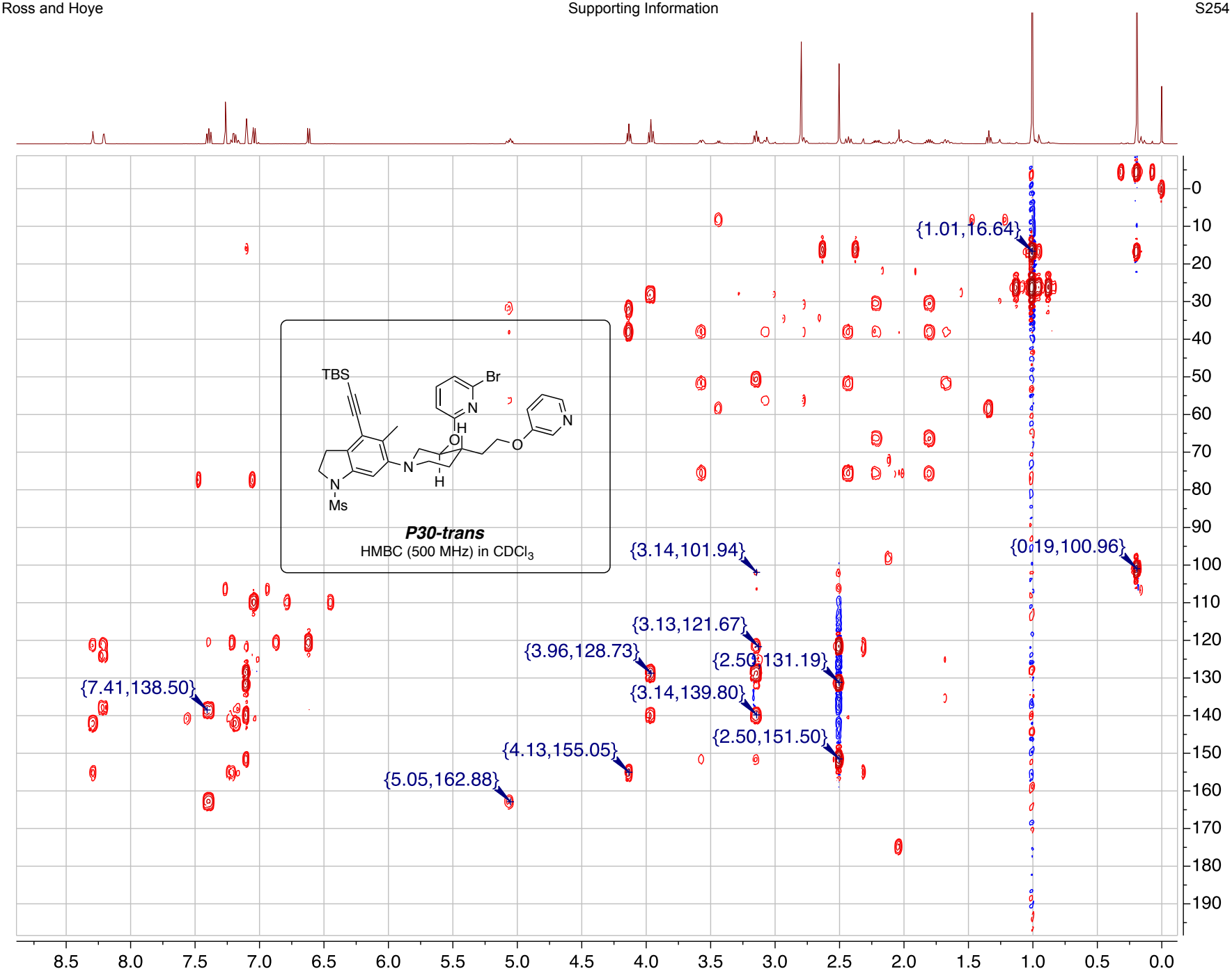

TBS
N
O
N
Br
H
H
O
N
N
Ms
P30-cis
HMBC (500 MHz) in CDCl3
{0.95,16.59}
{0.17,100.84}
{3.12,106.92}
{3.12,121.48}
{3.93,128.94}
{2.19,131.05}
{3.95,139.96}
{7.41,138.38}
{2.19,152.00}
{4.06,155.10}
{5.37,163.32}
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180

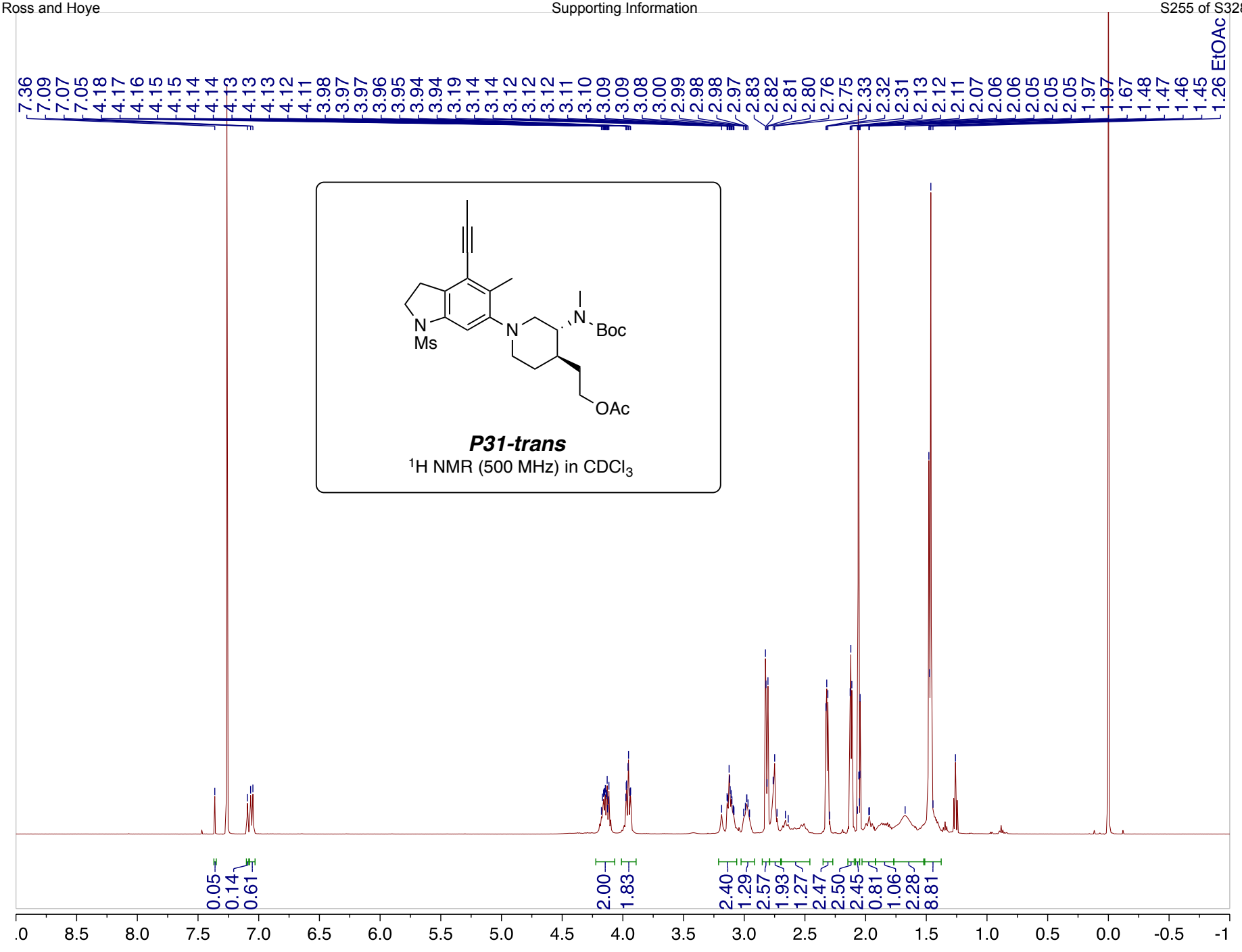

CHCl3
TBS
Br
N
H
O
N
O
N
H
N
Ms
P30-trans
1H NMR (500 MHz) in CDCl3
8.296 8.288
8.21 8.20
7.40 7.38
7.20 7.16
7.05 7.03
6.63 6.62 6.61
5.08 5.04
1.00 1.01 1.04 1.06 1.07 1.07 1.06 1.01 0.97 2.17 2.28 1.02 2.27 1.27 4.83 3.33 1.17 1.12 1.62 1.16 1.04 1.22 10.72 7.13

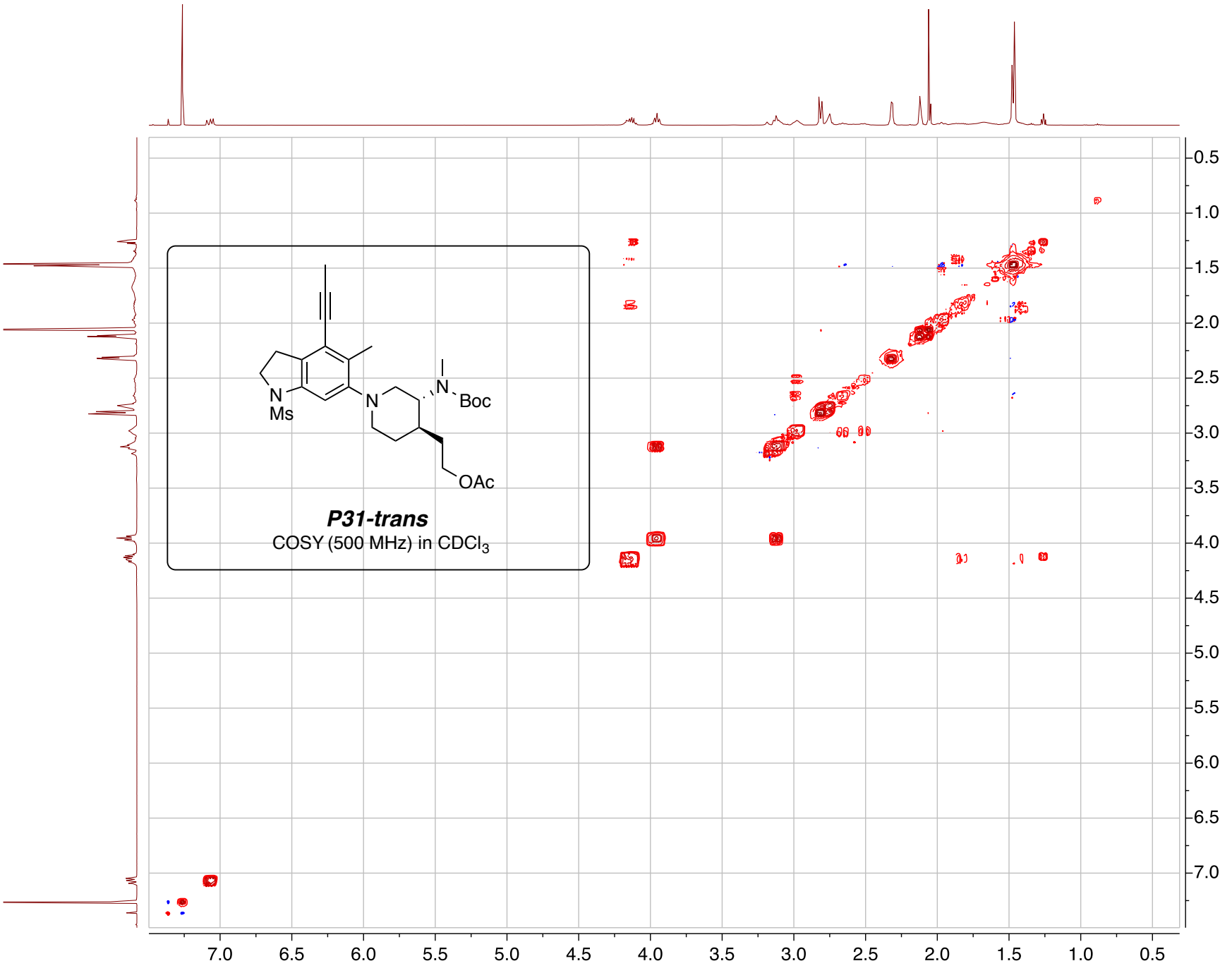

TBS
Br
N
H
O
O
N
N
H
N
Ms
P30-trans
1H NMR (500 MHz) in CDCl3
2.46 2.43
1.84 1.80 1.76
3.15 3.12
1.70 1.65
4.14 4.12 3.99 3.96
3.58 3.56
3.08 3.06 2.79 2.76
2.22 2.18
2.00 2.10 0.93 2.06 1.20 4.49 3.14 1.18 1.04 1.59 0.98 0.95 1.13 10.13 6.49
.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

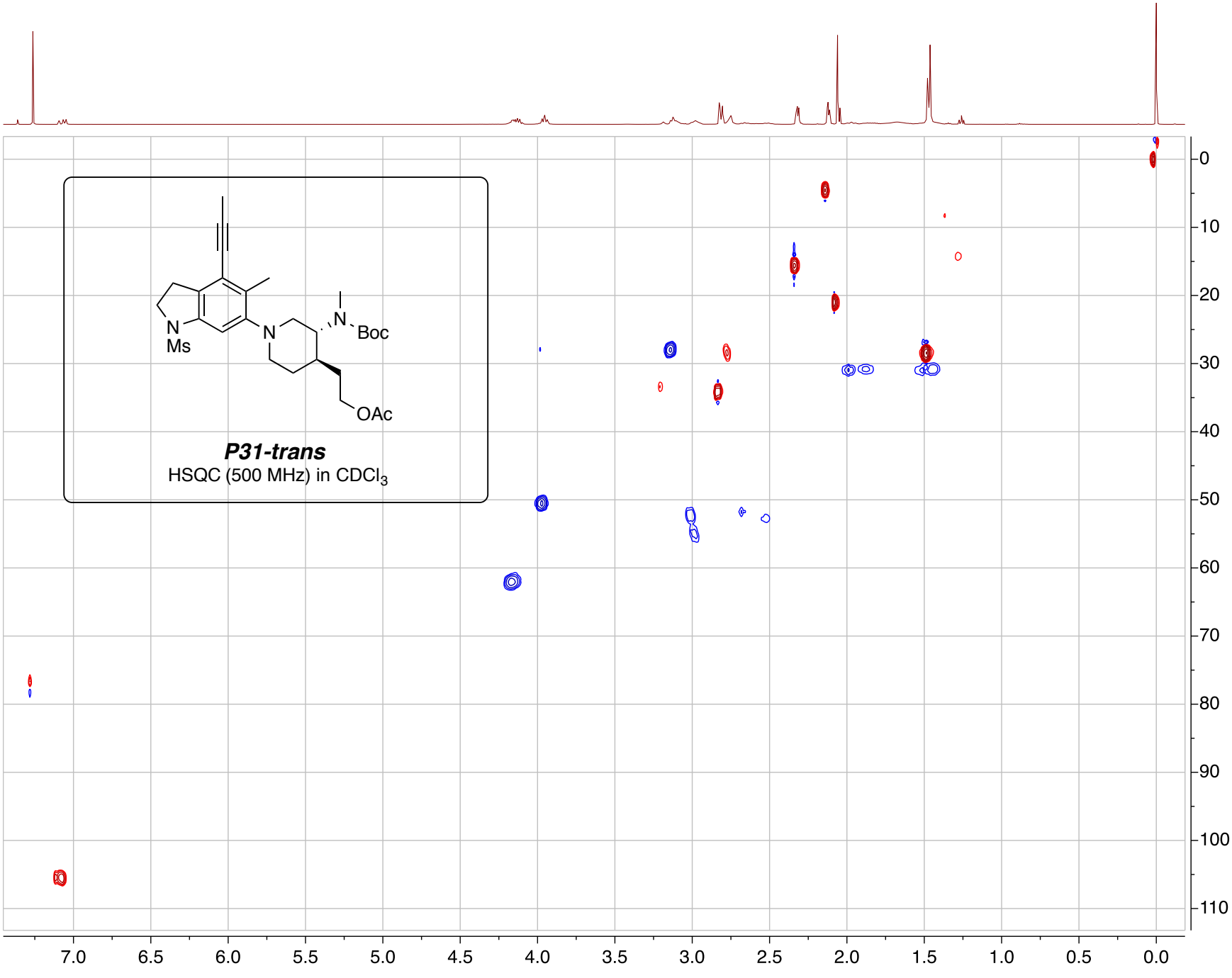

TBS
Br
N
H
O
O
N
N
N
H
Ms
P30-trans
COSY (500 MHz) in CDCl3
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5

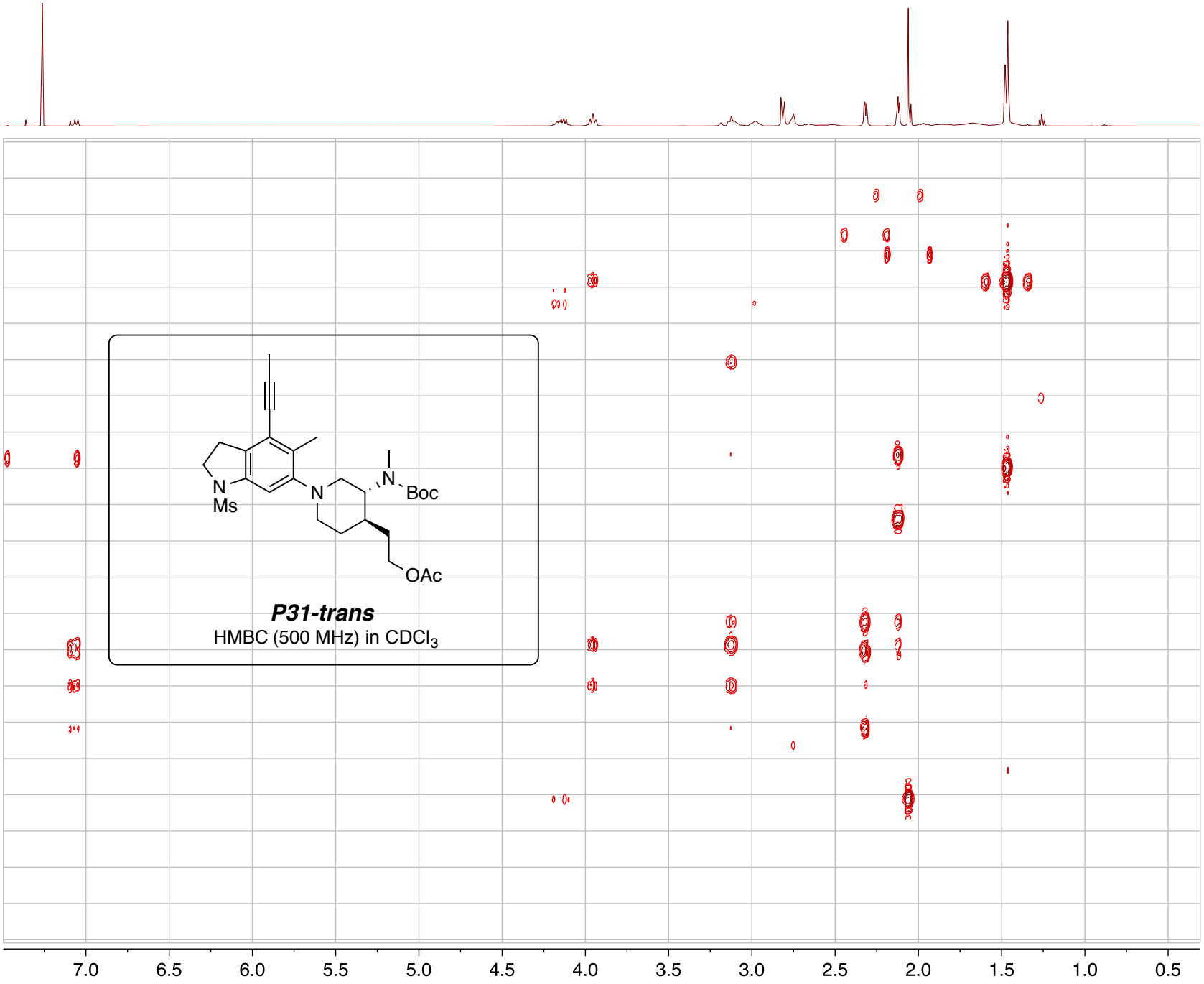

TBS
Br
N
H
O
O
N
N
N
H
N
Ms
P30-trans
HSQC (500 MHz) in CDCl3
{0.19,-4.49}
{2.50,16.07}
{1.00,26.14}
{3.15,27.96}
{2.05,30.48}
{2.21,31.87}
{1.98,37.97}
{2.80,34.10}
{3.07,51.57}
{3.96,50.50}
{3.56,56.15}
{4.13,66.16}
{5.06,75.38}
{7.10,106.39}
{6.62,109.78}
{7.18,121.27}
{7.20,123.81}
{7.04,120.56}
{8.29,137.79}
{8.21,141.97}
{7.39,140.76}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

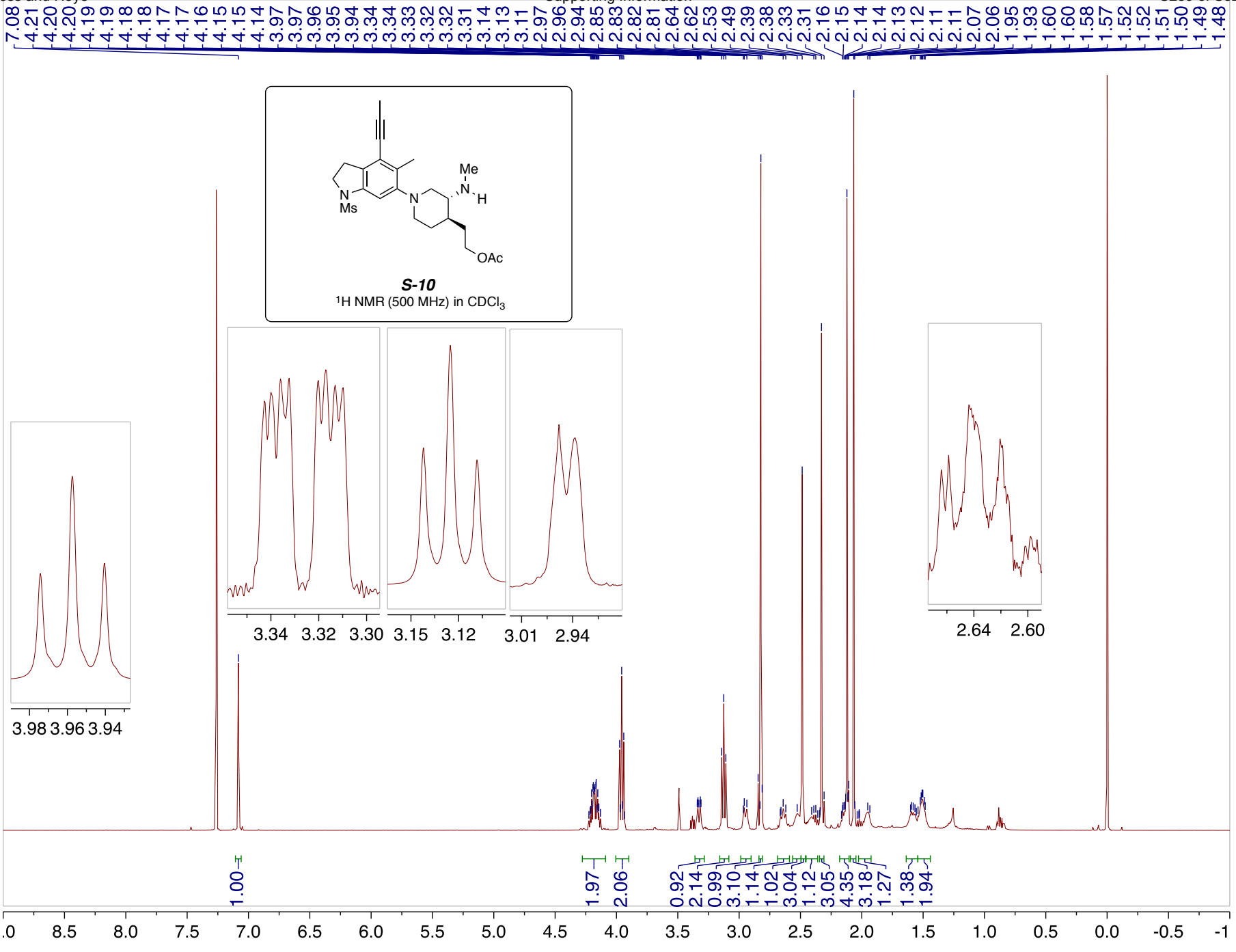

TBS
Br
N
H
O
O
N
N
H
N
Ms
P30-trans
HMBC (500 MHz) in CDCl3
{1.01,16.64}
{3.14,101.94}
{0.19,100.96}
{3.13,121.67}
{3.96,128.73}
{2.50,131.19}
{7.41,138.50}
{3.14,139.80}
{2.50,151.50}
{4.13,155.05}
{5.05,162.88}
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190

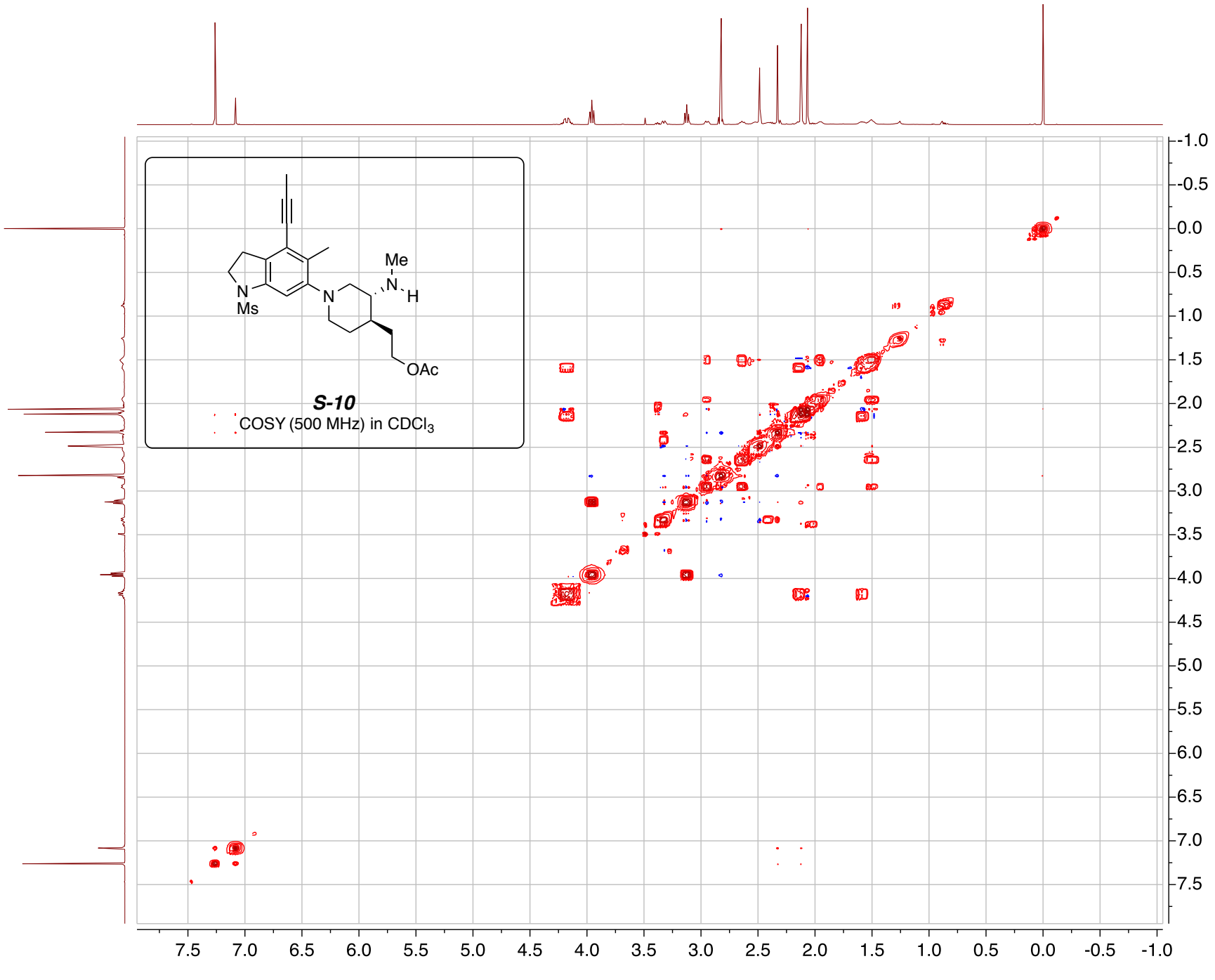

7.36 7.09 7.07 7.05 4.18 4.17 4.16 4.15 4.15 4.14 4.14 4.13 4.13 4.13 4.12 4.11 3.98 3.97 3.97 3.96 3.95 3.94 3.94 3.19 3.14 3.14 3.12 3.12 3.12 3.11 3.10 3.09 3.09 3.08 3.00 2.99 2.98 2.98 2.97 2.83 2.82 2.81 2.80 2.76 2.75 2.33 2.32 2.31 2.13 2.12 2.11 2.07 2.06 2.06 2.05 2.05 2.05 1.97 1.97 1.67 1.48 1.47 1.46 1.45 1.26 EtOAc
N
Ms
N
N
Boc
OAc
P31-trans
1H NMR (500 MHz) in CDCl3
0.05 0.14 0.61 2.00 1.83 2.40 1.29 2.57 1.93 1.27 2.47 2.50 2.45 0.81 1.06 2.28 8.81
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

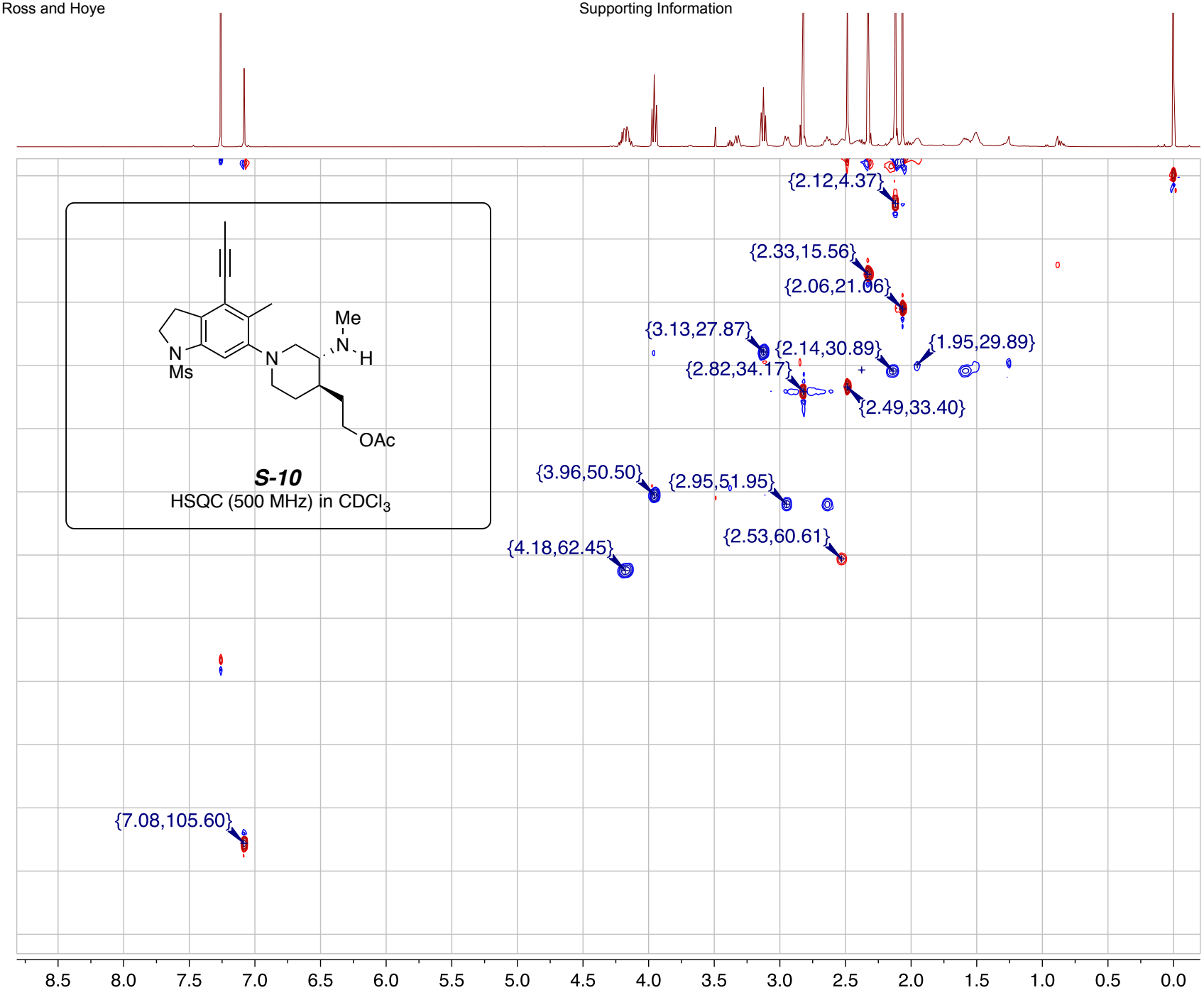

N
Ms
N
N
Boc
OAc
P31-trans
COSY (500 MHz) in CDCl3
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5

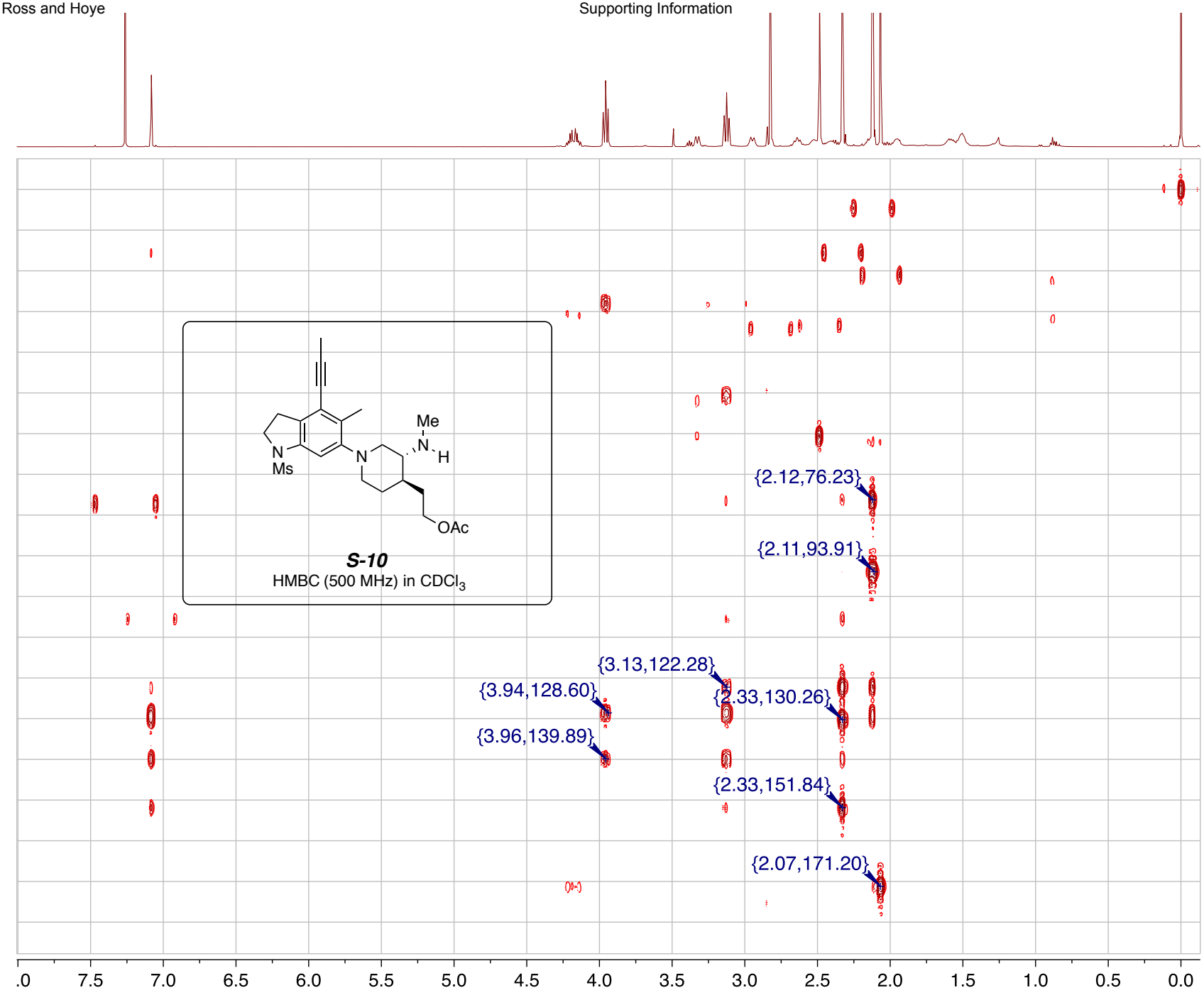

N
Ms
N
N
Boc
OAc
P31-trans
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

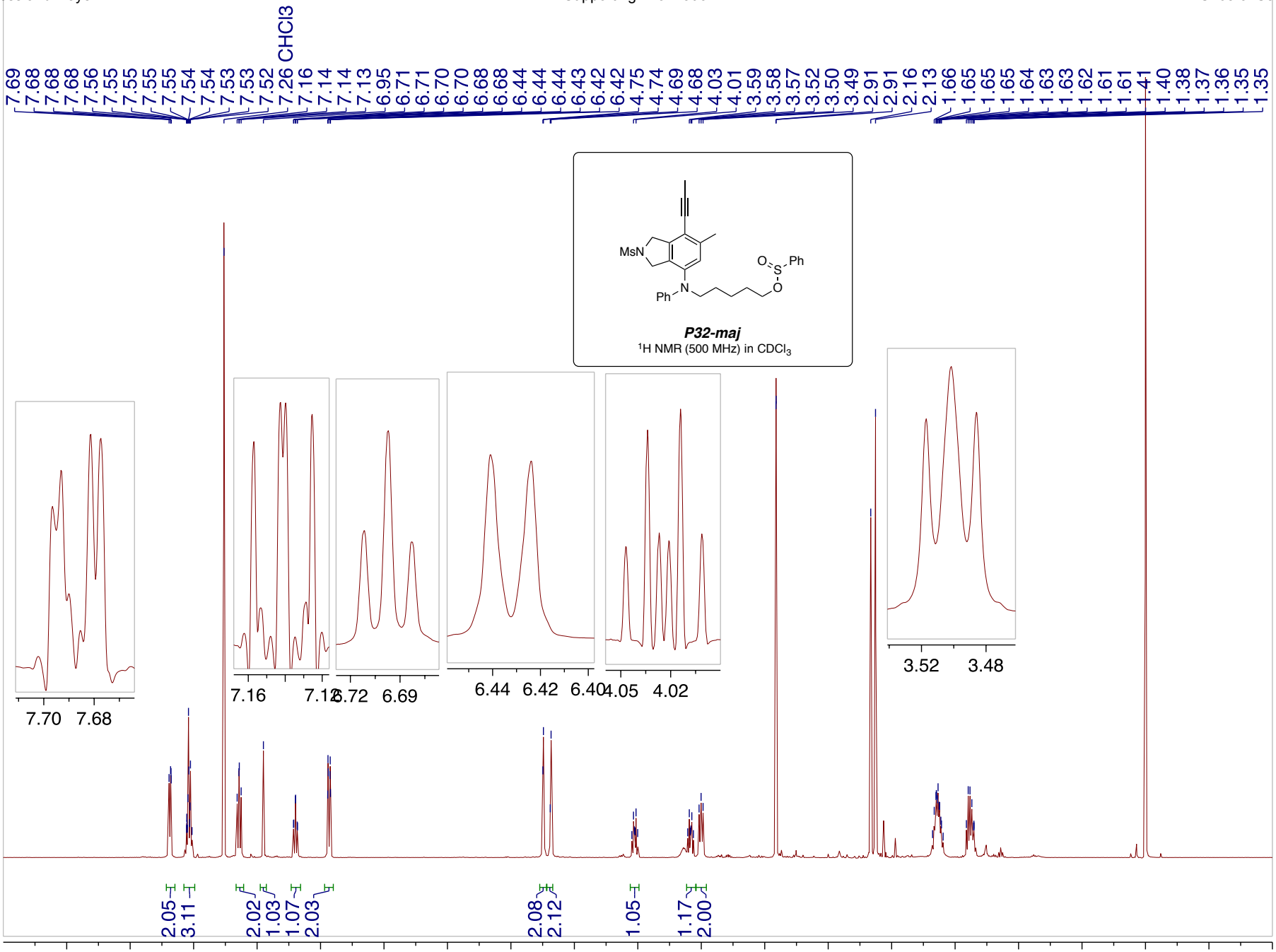

N
Ms
N
N
Boc
OAc
P31-trans
HMBC (500 MHz) in CDCl3
-10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5

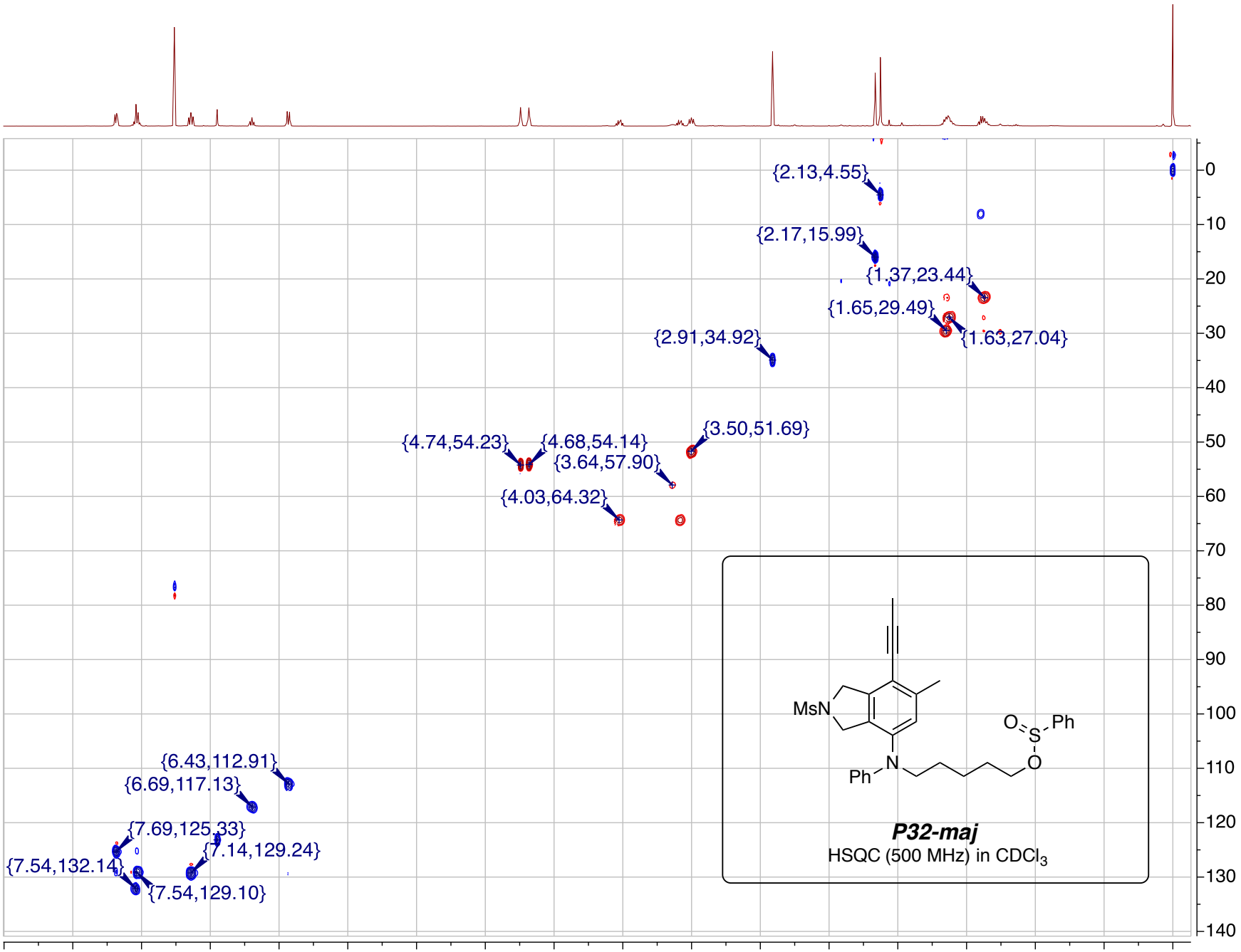

7.08 4.21 4.20 4.20 4.19 4.19 4.18 4.18 4.17 4.17 4.16 4.15 4.15 4.14 3.97 3.97 3.96 3.95 3.94 3.34 3.34 3.33 3.32 3.32 3.31 3.14 3.13 3.11 2.97 2.96 2.94 2.85 2.83 2.82 2.81 2.64 2.62 2.53 2.49 2.39 2.38 2.33 2.31 2.16 2.15 2.14 2.14 2.13 2.12 2.11 2.11 2.07 2.06 1.95 1.93 1.60 1.60 1.58 1.57 1.52 1.52 1.51 1.50 1.49 1.48
Me
N
H
N
N
Ms
OAc
S-10
1H NMR (500 MHz) in CDCl3
3.98 3.96 3.94
3.34 3.32 3.30 3.15 3.12 3.01 2.94
2.64 2.60
1.00 1.97 2.06 0.92 2.14 0.99 3.10 1.14 1.02 3.04 1.12 3.05 4.35 3.18 1.27 1.38 1.94
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

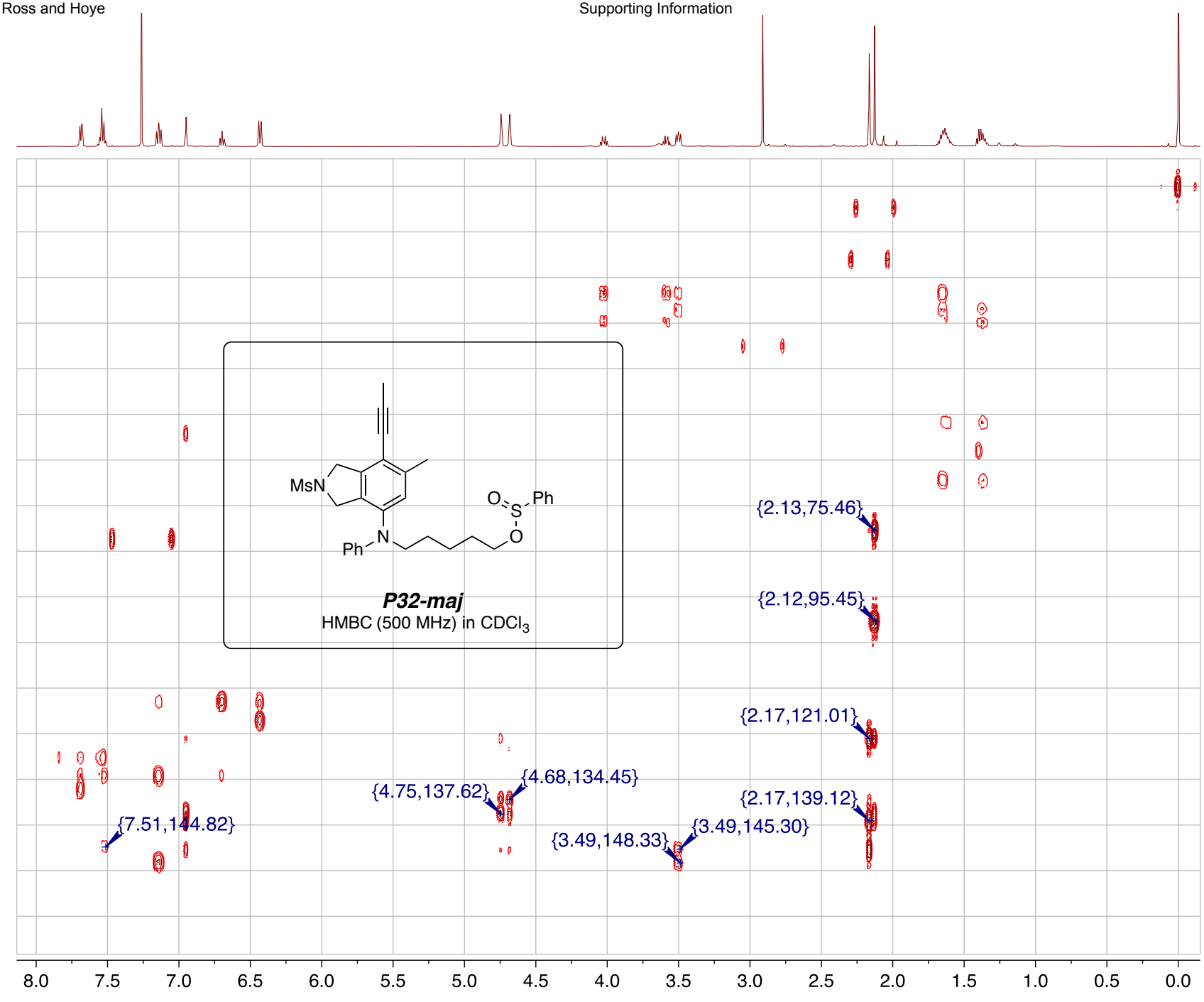

Me
N
H
N
N
Ms
OAc
S-10
COSY (500 MHz) in CDCl3
7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
-1.0 -0.5 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5

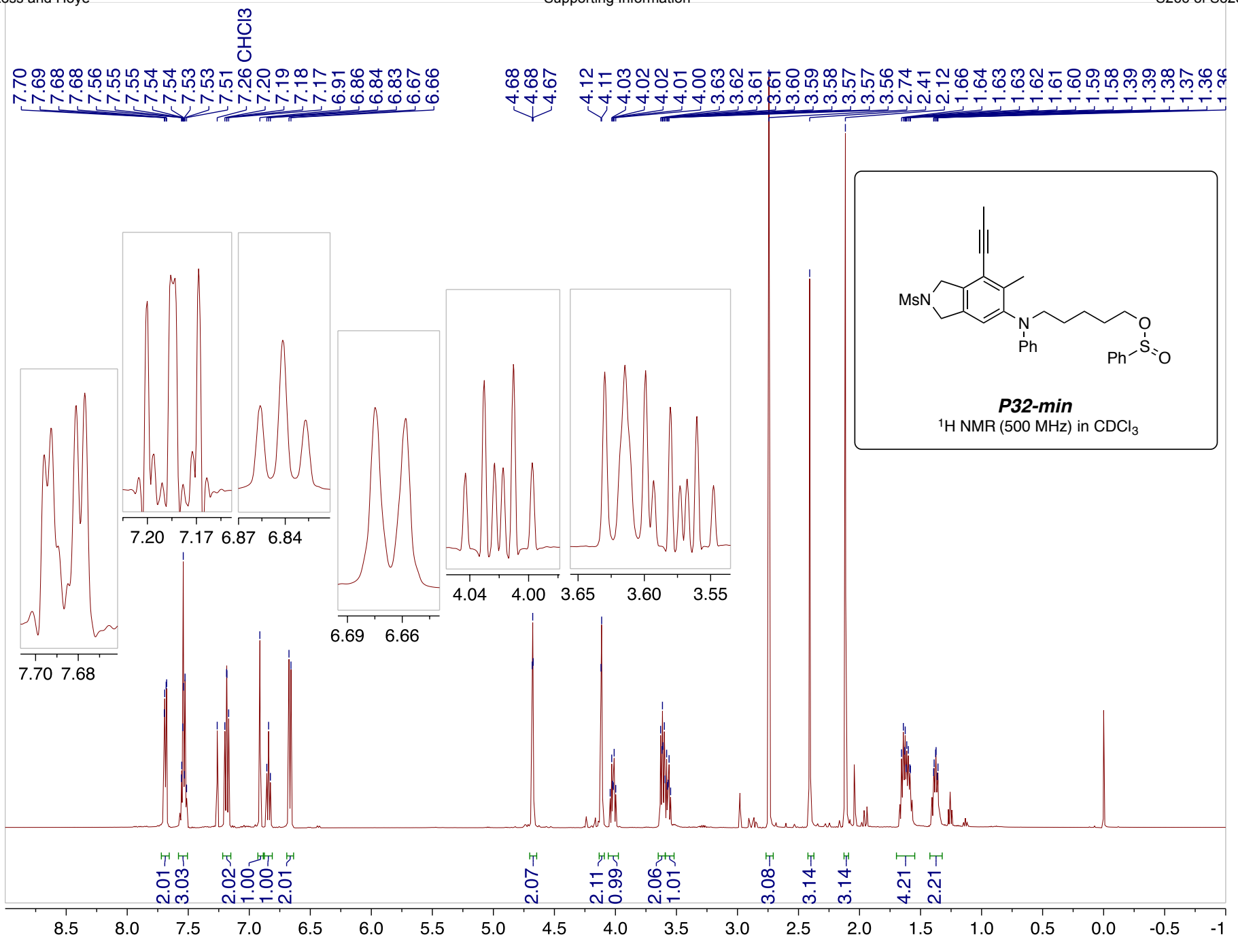

{2.12,4.37}
{2.33,15.56}
{2.06,21.06}
{3.13,27.87}
{2.14,30.89}
{1.95,29.89}
{2.82,34.17}
{2.49,33.40}
{3.96,50.50}
{2.95,51.95}
{2.53,60.61}
{4.18,62.45}
{7.08,105.60}
Me
N
H
N
N
Ms
OAc
S-10
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

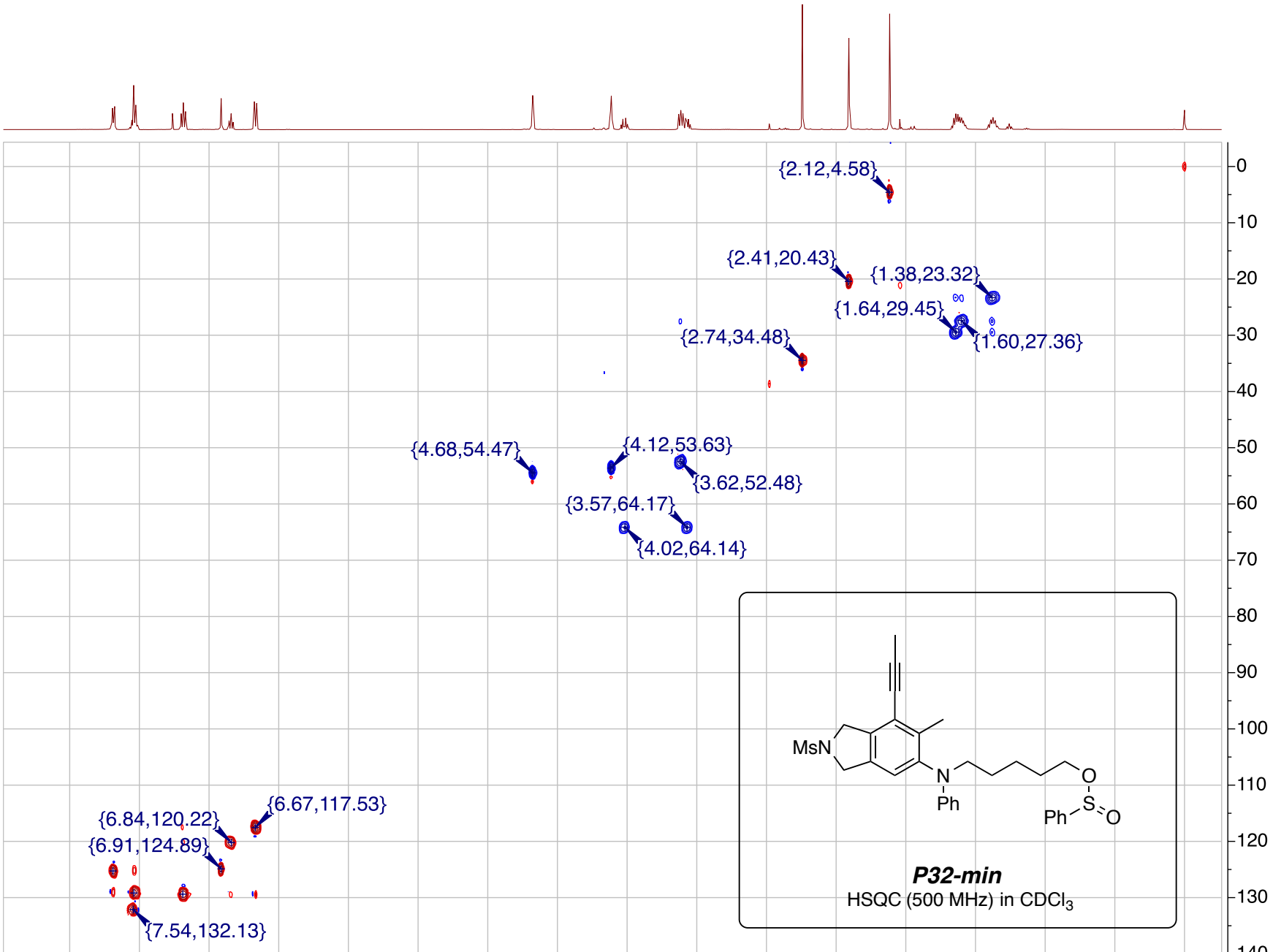

Me
N
H
N
N
Ms
OAc
S-10
HMBC (500 MHz) in CDCl3
{2.12,76.23}
{2.11,93.91}
{3.13,122.28}
{3.94,128.60}
{2.33,130.26}
{3.96,139.89}
{2.33,151.84}
{2.07,171.20}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

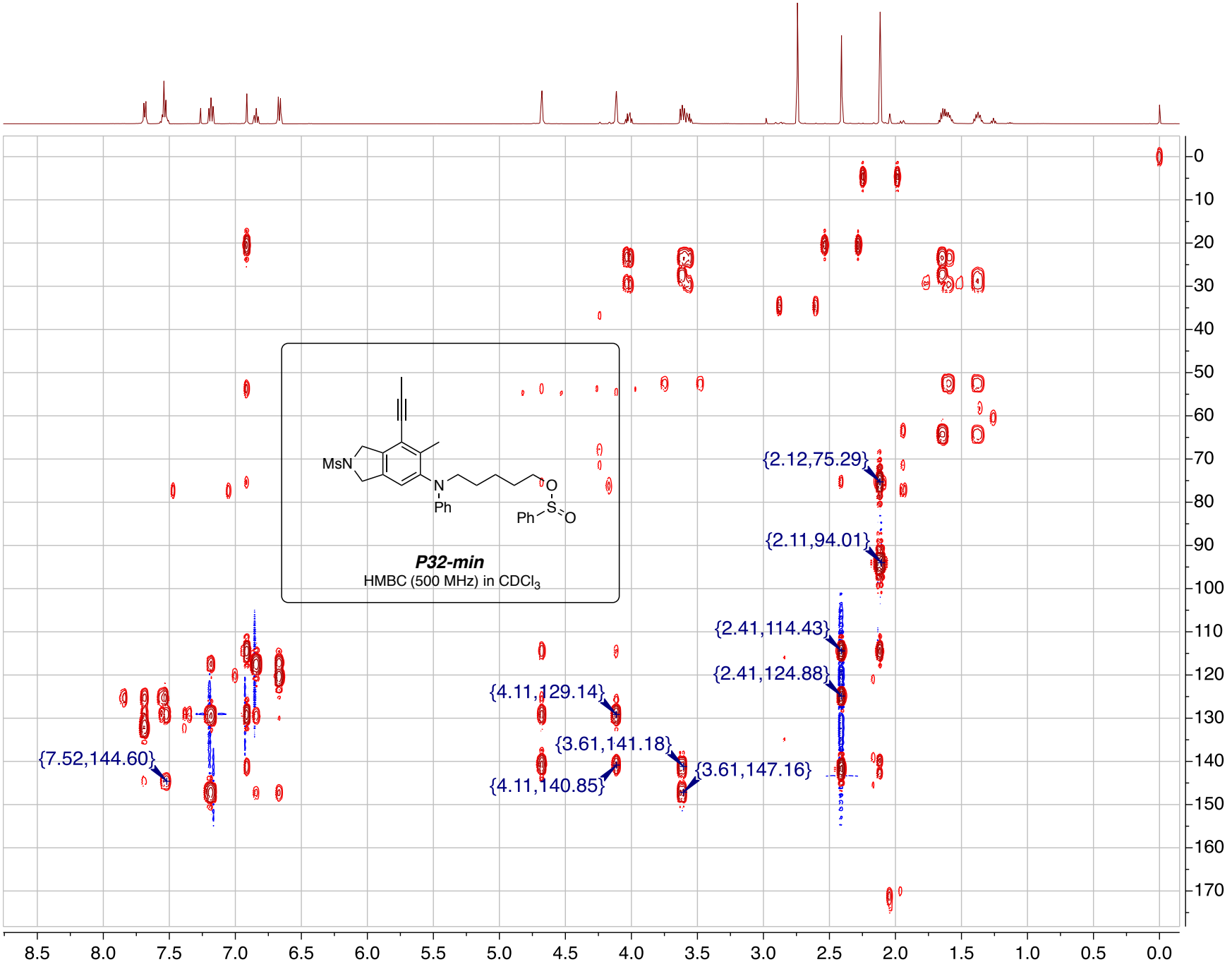

CHCl3
7.69 7.68 7.68 7.68 7.56 7.55 7.55 7.55 7.55 7.54 7.54 7.53 7.53 7.52 7.26 7.16 7.14 7.14 7.13 6.95 6.71 6.71 6.70 6.70 6.68 6.68 6.44 6.44 6.44 6.43 6.42 6.42 4.75 4.74 4.69 4.68 4.03 4.01 3.59 3.58 3.57 3.52 3.50 3.49 2.91 2.91 2.16 2.13 1.66 1.65 1.65 1.65 1.64 1.63 1.63 1.62 1.61 1.61 1.41 1.40 1.38 1.37 1.36 1.35 1.35
MsN
O
S
Ph
O
N
Ph
P32-maj
1H NMR (500 MHz) in CDCl3
7.70 7.68
7.16 7.12
6.72 6.69
6.44 6.42 6.40
4.05 4.02
3.52 3.48
2.05 3.11 2.02 1.03 1.07 2.03 2.08 2.12 1.05 1.17 2.00
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

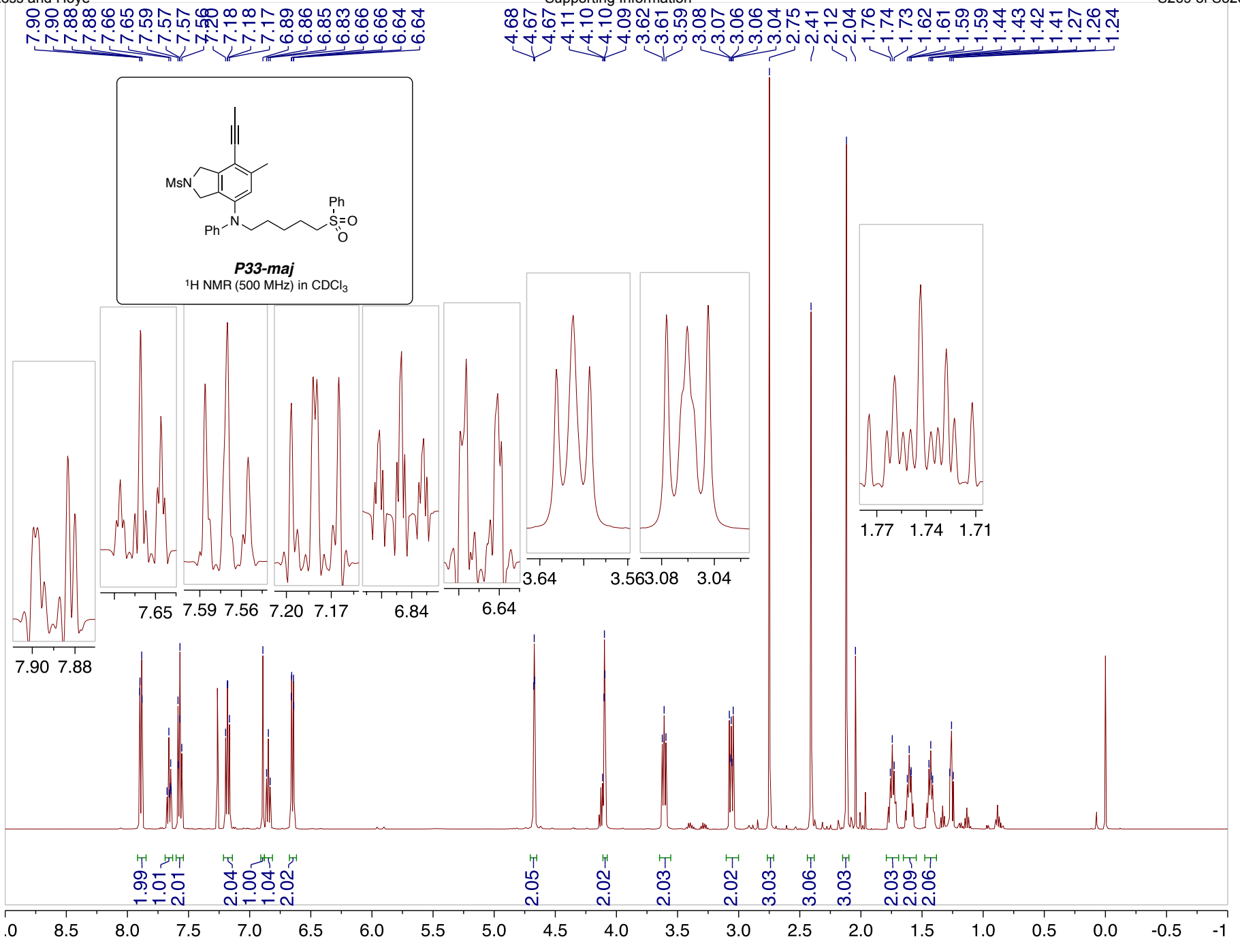

{2.13,4.55}
{2.17,15.99}
{1.37,23.44}
{1.65,29.49}
{1.63,27.04}
{2.91,34.92}
{3.50,51.69}
{4.74,54.23}
{4.68,54.14}
{3.64,57.90}
{4.03,64.32}
{6.43,112.91}
{6.69,117.13}
{7.69,125.33}
{7.14,129.24}
{7.54,132.14}
{7.54,129.10}
MsN
N
Ph
O
S
O
Ph
P32-maj
HSQC (500 MHz) in CDCl3

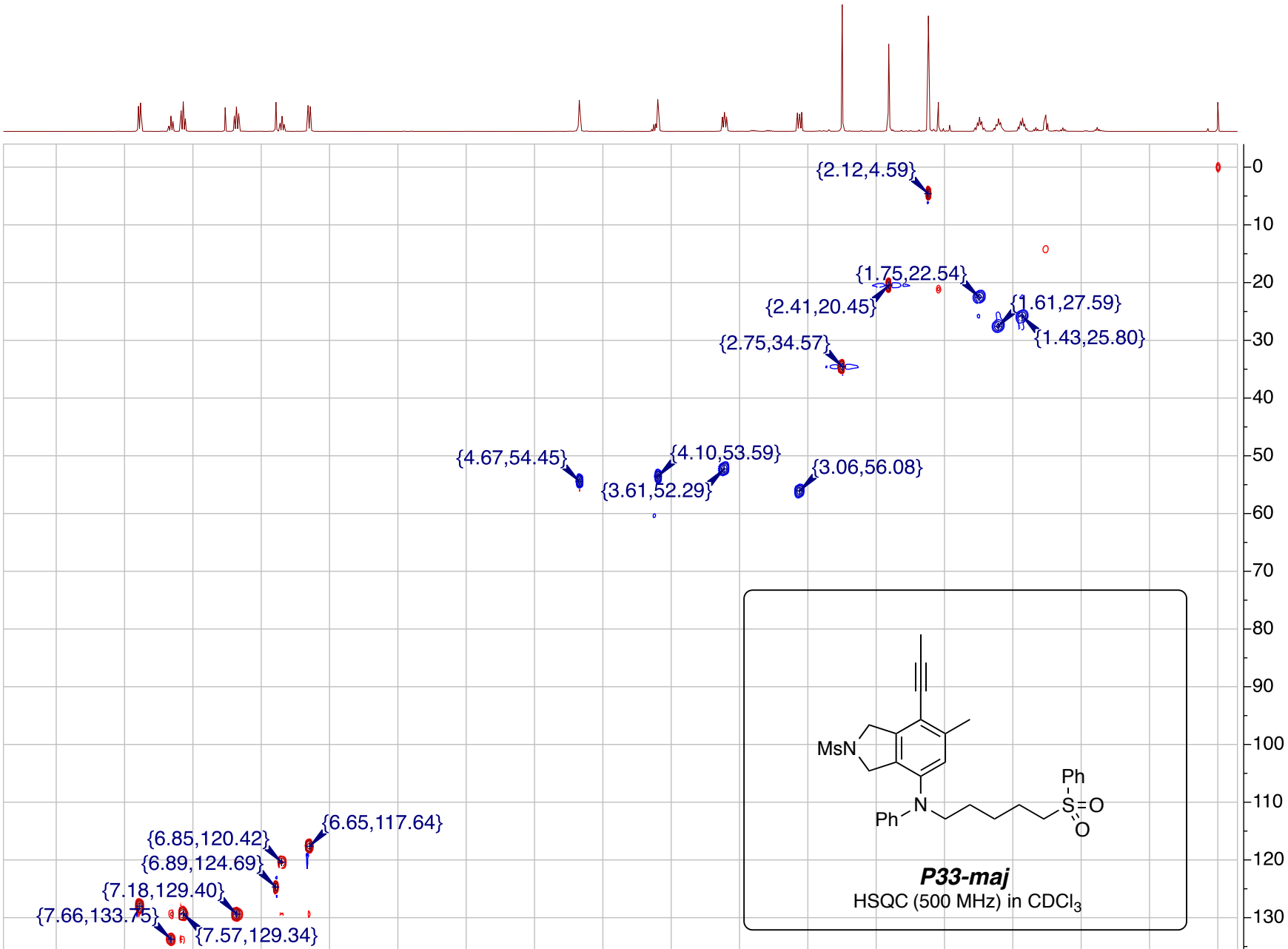

MsN
Ph
N
O
S
Ph
O
P32-maj
HMBC (500 MHz) in CDCl3
{2.13,75.46}
{2.12,95.45}
{2.17,121.01}
{4.68,134.45}
{4.75,137.62}
{2.17,139.12}
{7.51,144.82}
{3.49,145.30}
{3.49,148.33}
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160

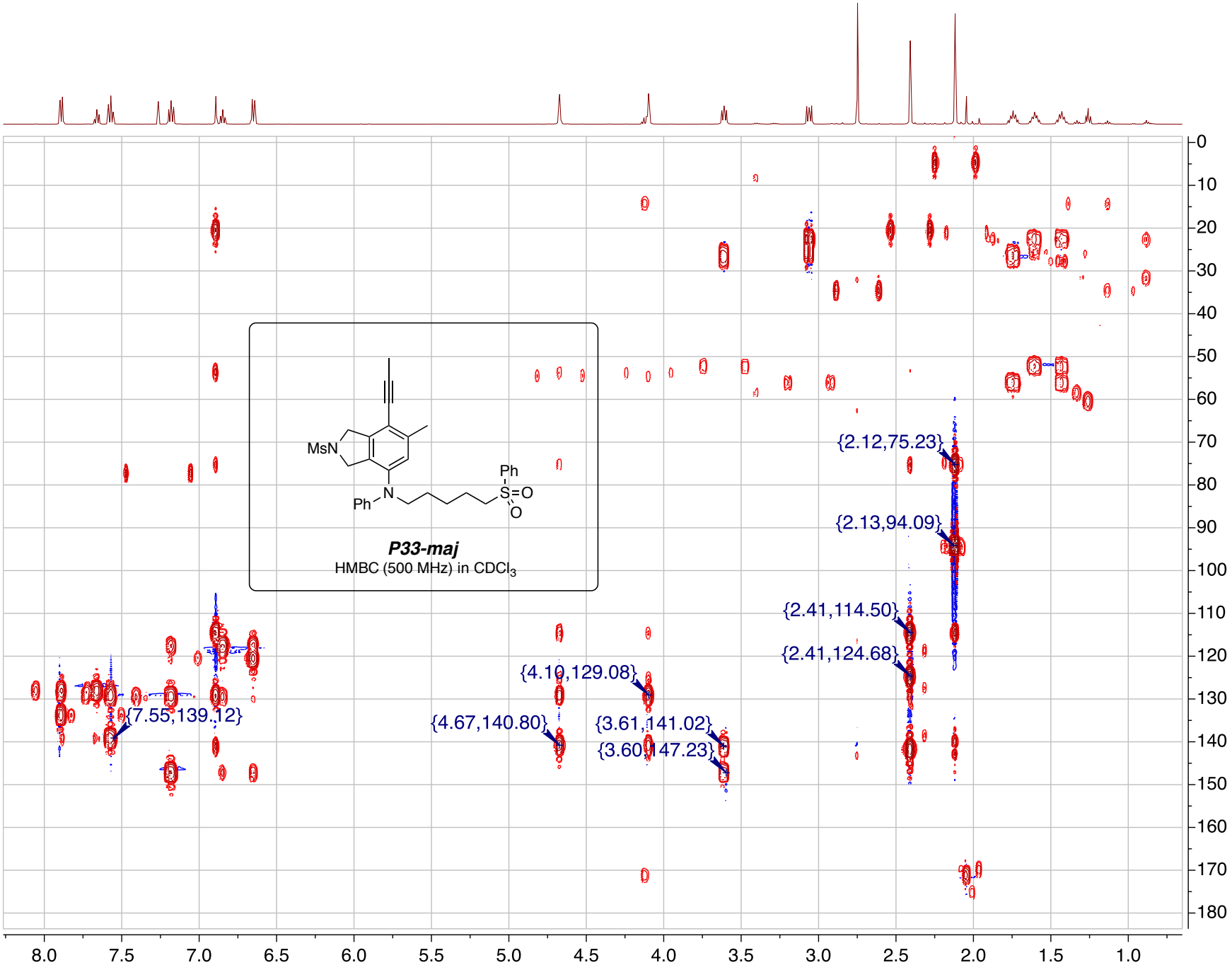

CHCl3
7.70 7.69 7.68 7.68 7.56 7.55 7.55 7.54 7.54 7.53 7.53 7.51 7.26 7.20 7.19 7.18 7.17 6.91 6.86 6.84 6.83 6.67 6.66
4.68 4.68 4.67
4.12 4.11 4.03 4.02 4.02 4.01 4.00 3.63 3.62 3.61 3.61 3.60 3.59 3.58 3.57 3.57 3.56 2.74 2.41 2.12 1.66 1.64 1.63 1.63 1.62 1.61 1.60 1.59 1.58 1.39 1.39 1.38 1.37 1.36
7.70 7.68
7.20 7.17 6.87 6.84
6.69 6.66
4.04 4.00 3.65 3.60 3.55
MsN
N
Ph
O
Ph
S
O
P32-min
1H NMR (500 MHz) in CDCl3
2.01 3.03 2.02 1.00 1.00 2.01 2.07 2.11 0.99 2.06 1.01 3.08 3.14 3.14 4.21 2.21
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

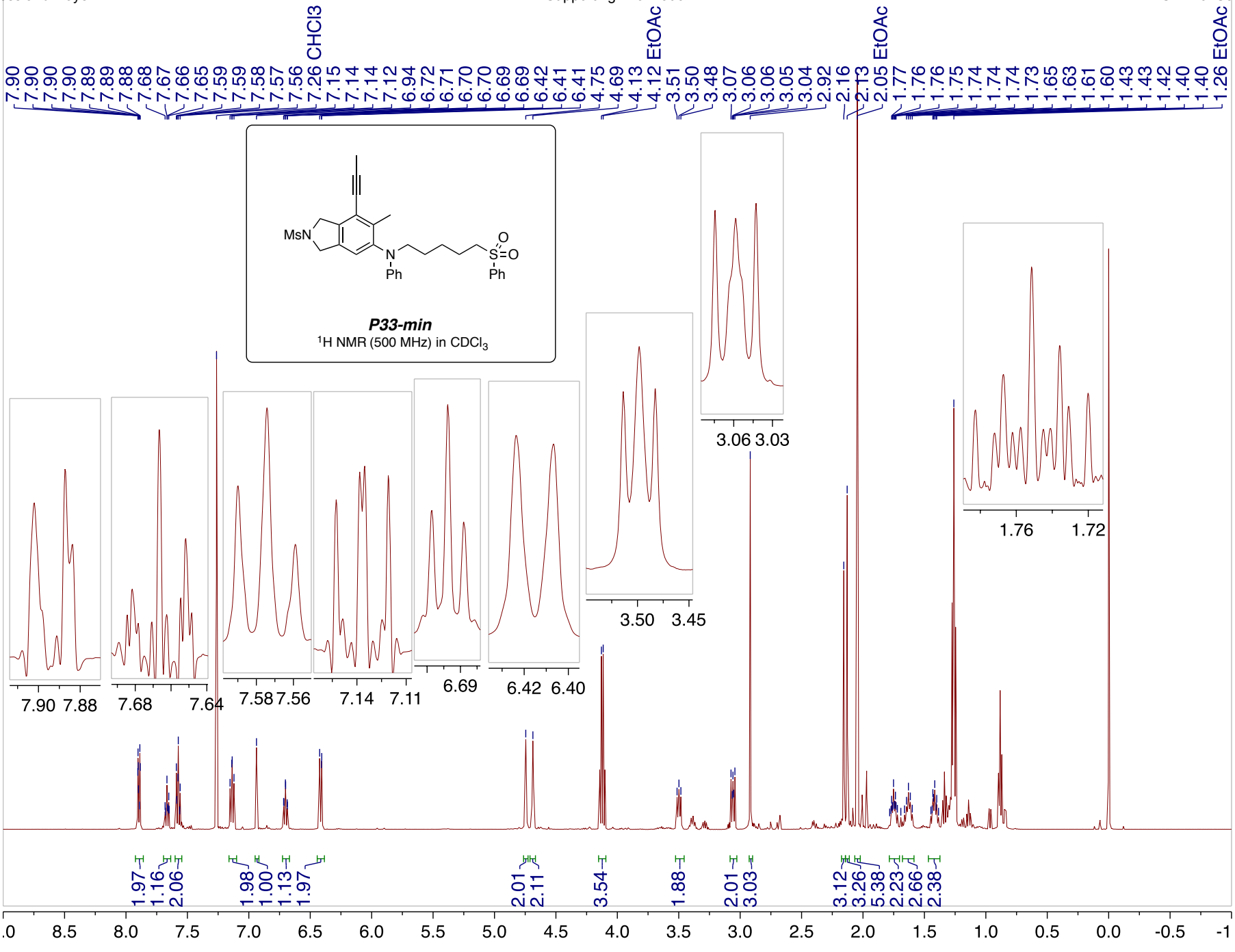

{2.12,4.58}
{2.41,20.43}
{1.38,23.32}
{1.64,29.45}
{1.60,27.36}
{2.74,34.48}
{4.68,54.47}
{4.12,53.63}
{3.62,52.48}
{3.57,64.17}
{4.02,64.14}
{6.84,120.22}
{6.67,117.53}
{6.91,124.89}
{7.54,132.13}
MsN
N
Ph
O
S
O
Ph
P32-min
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

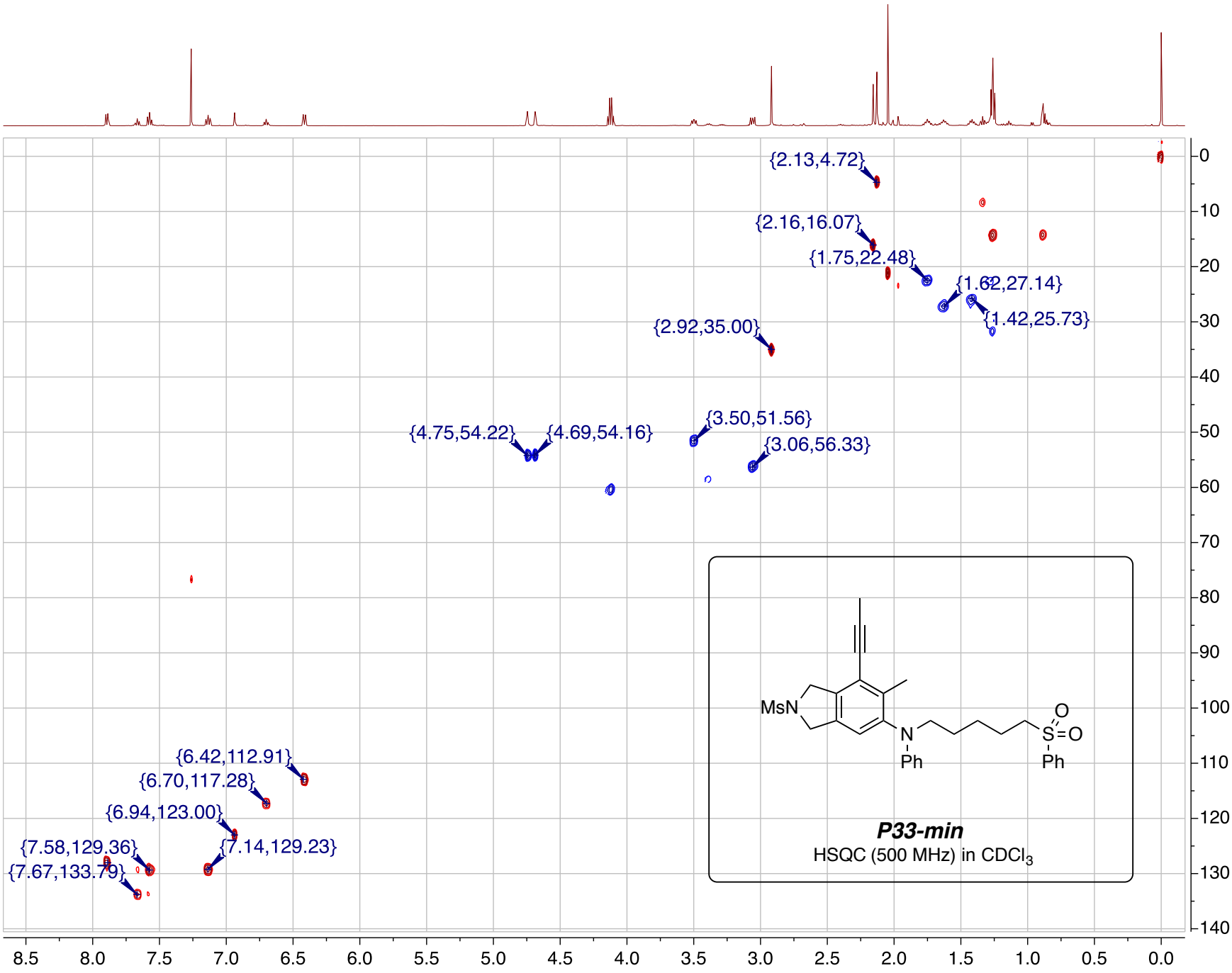

MsN
N
Ph
O
S
O
Ph
P32-min
HMBC (500 MHz) in CDCl3
{2.12,75.29}
{2.11,94.01}
{2.41,114.43}
{2.41,124.88}
{4.11,129.14}
{3.61,141.18}
{3.61,147.16}
{4.11,140.85}
{7.52,144.60}
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170

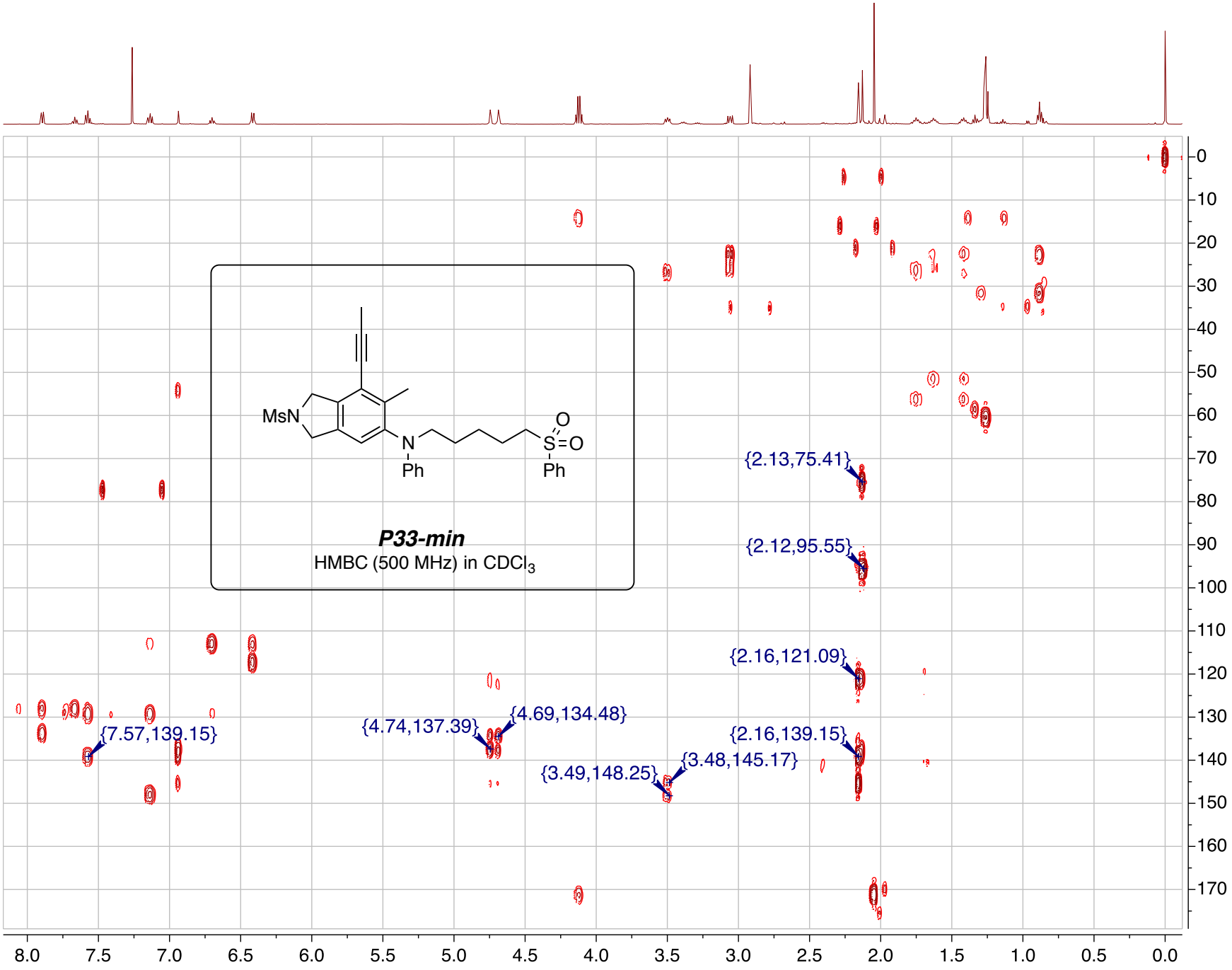

MsN
Ph
N
Ph
S=O
O
P33-maj
1H NMR (500 MHz) in CDCl3

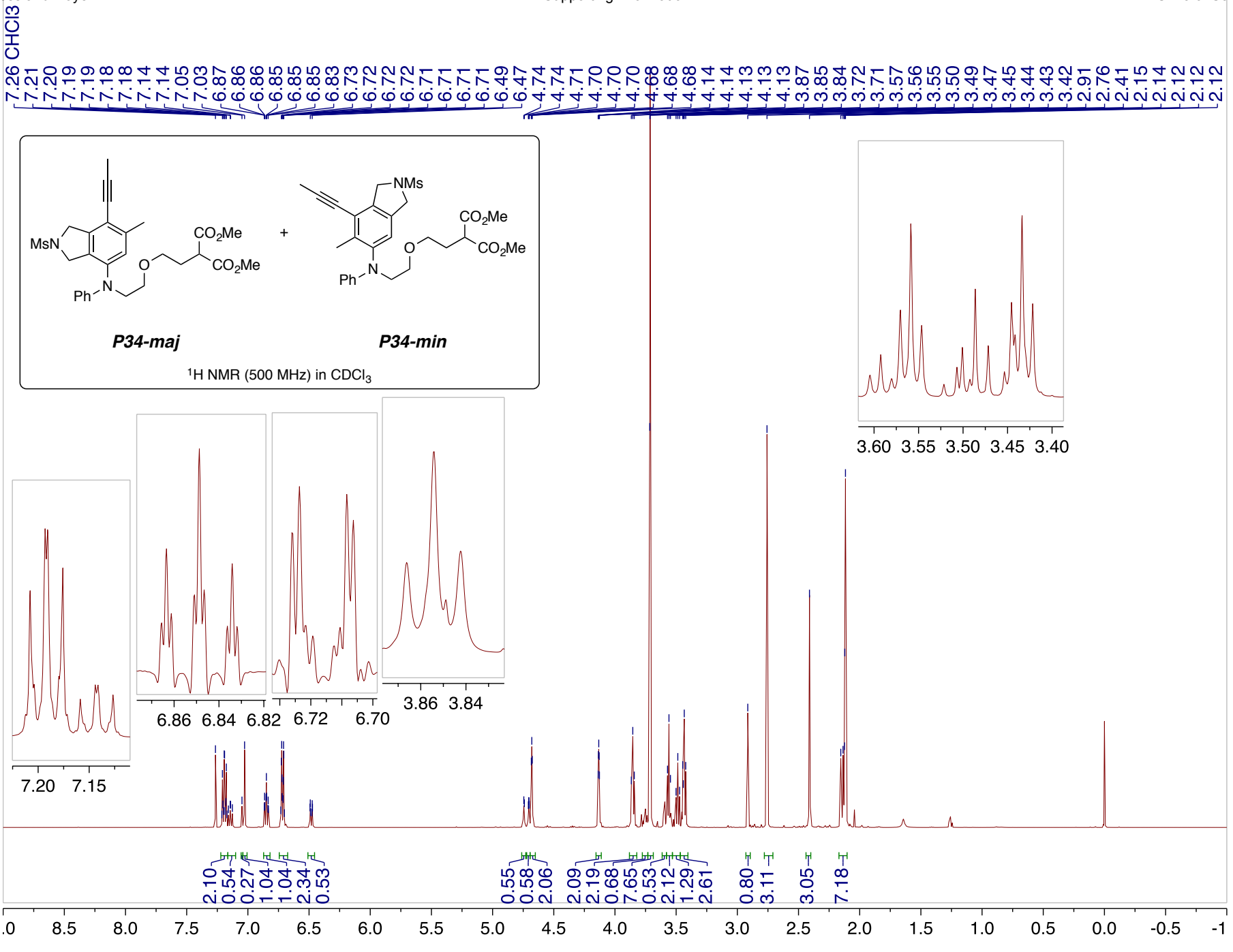

{2.12,4.59}
{1.75,22.54}
{2.41,20.45}
{1.61,27.59}
{1.43,25.80}
{2.75,34.57}
{4.67,54.45}
{4.10,53.59}
{3.61,52.29}
{3.06,56.08}
{6.65,117.64}
{6.85,120.42}
{6.89,124.69}
{7.18,129.40}
{7.66,133.75}
{7.57,129.34}
MsN
Ph
N
Ph
S=O
O
P33-maj
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

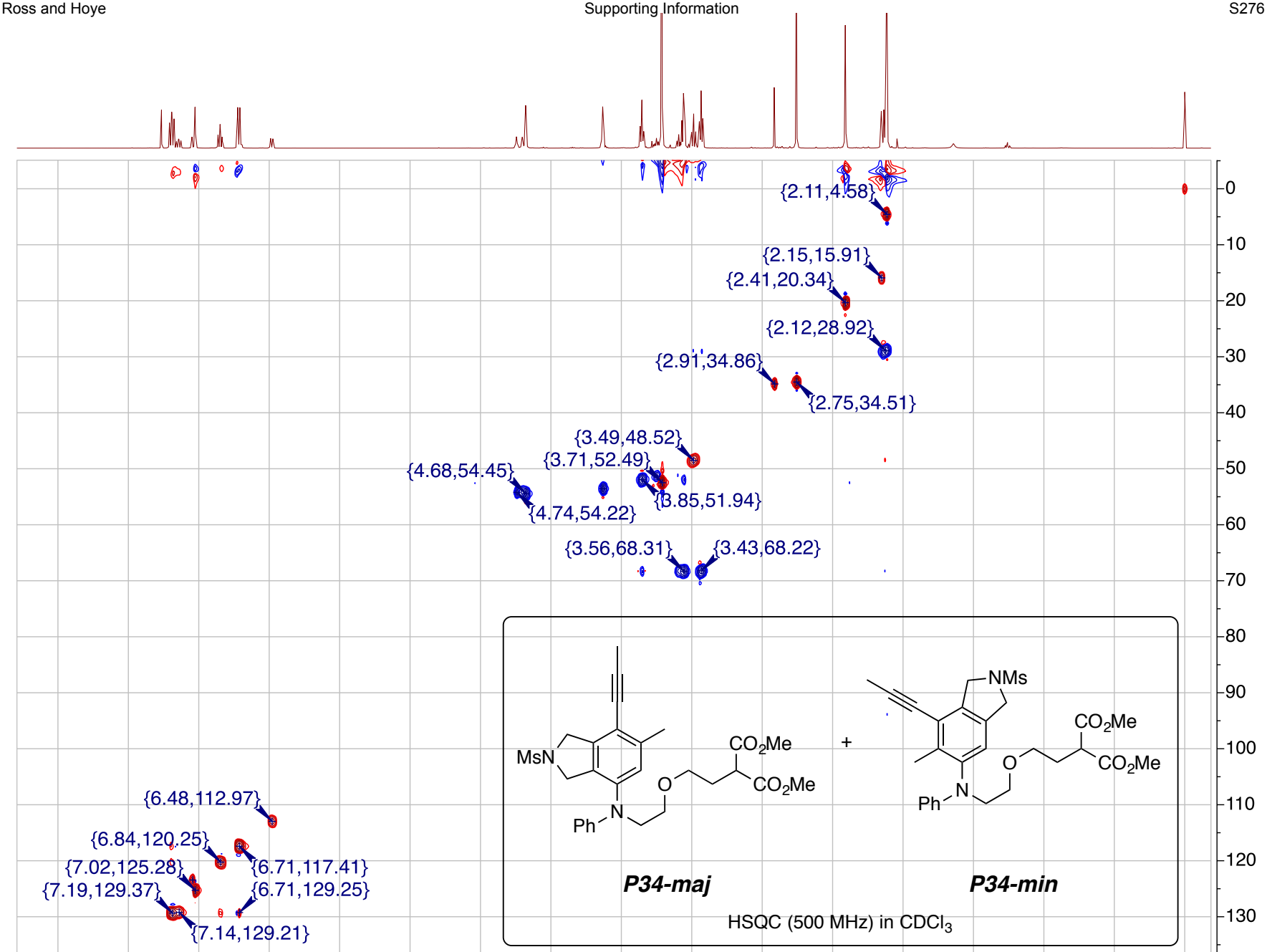

MsN
Ph
N
Ph
S=O
O
P33-maj
HMBC (500 MHz) in CDCl3
{2.12,75.23}
{2.13,94.09}
{2.41,114.50}
{2.41,124.68}
{4.10,129.08}
{7.55,139.12}
{4.67,140.80}
{3.61,141.02}
{3.60,147.23}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0

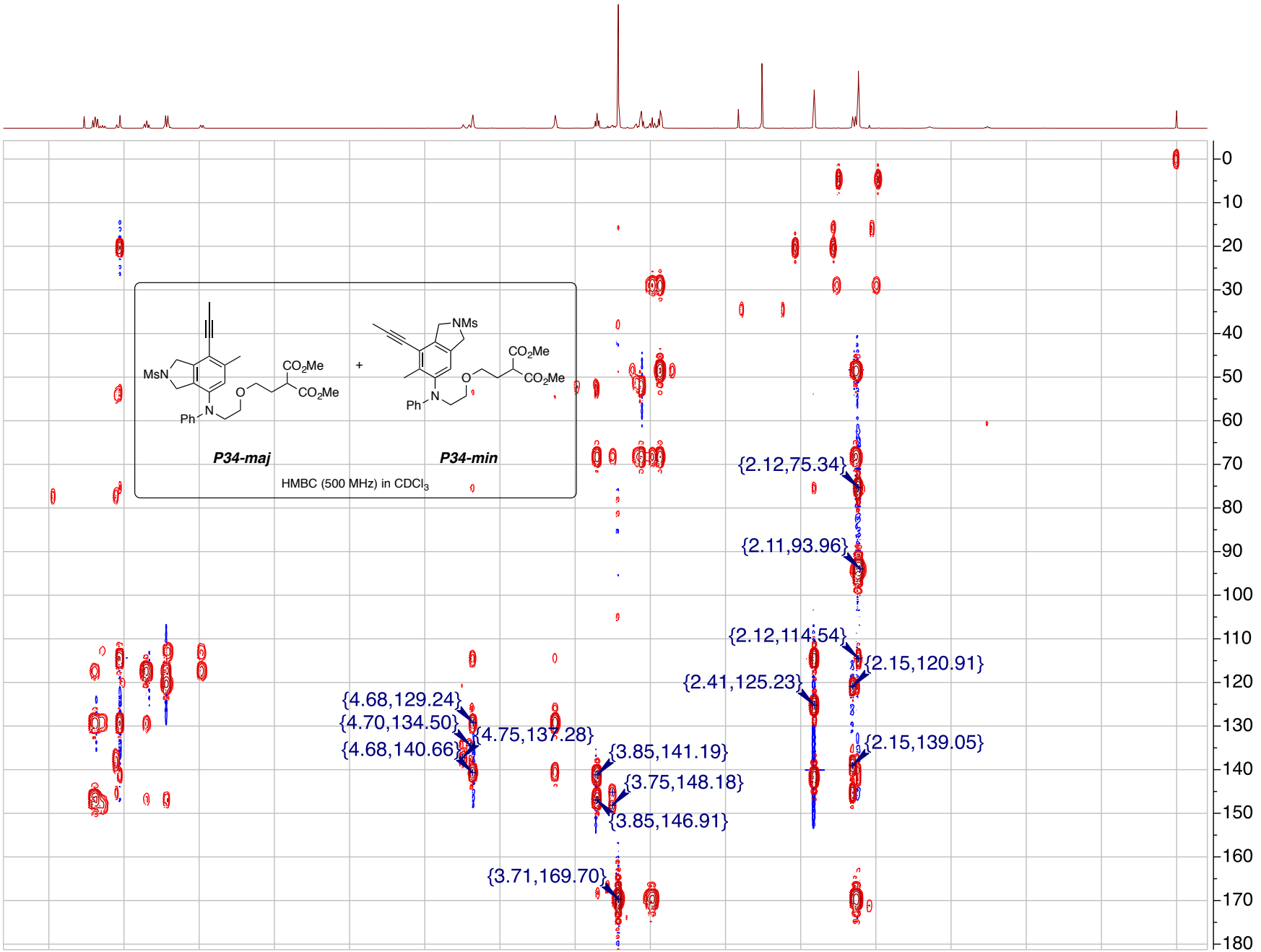

CHCl3
EtOAc
EtOAc
EtOAc
MsN
N
Ph
O
S
O
Ph
P33-min
1H NMR (500 MHz) in CDCl3
7.90 7.88
7.68 7.64
7.58 7.56
7.14 7.11
6.69
6.42 6.40
3.50 3.45
3.06 3.03
1.76 1.72
1.97 1.16 2.06 1.98 1.00 1.13 1.97 2.01 2.11 3.54 1.88 2.01 3.03 3.12 3.26 5.38 2.23 2.66 2.38
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

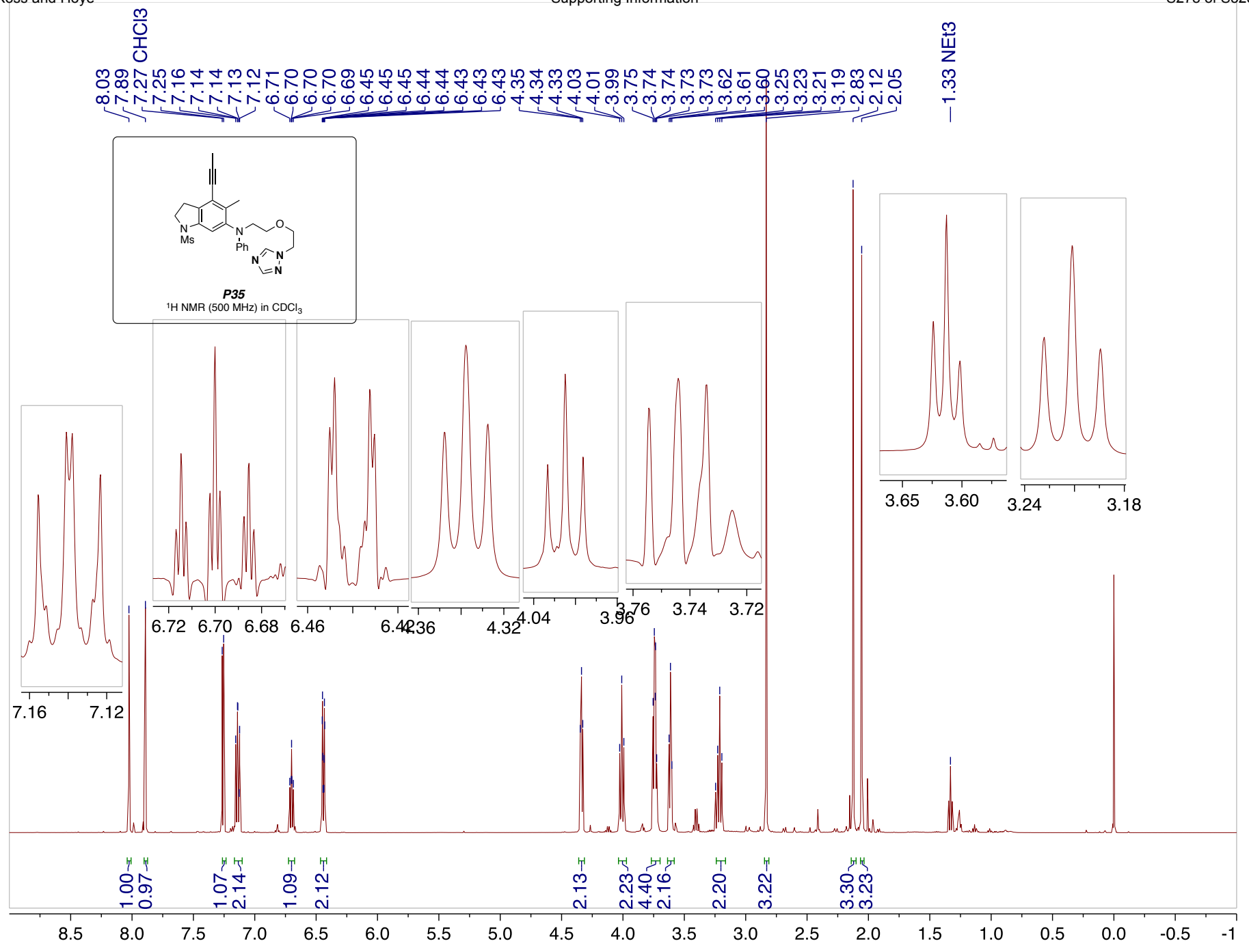

{2.13,4.72}
{2.16,16.07}
{1.75,22.48}
{1.62,27.14}
{1.42,25.73}
{2.92,35.00}
{4.75,54.22}
{4.69,54.16}
{3.50,51.56}
{3.06,56.33}
{6.42,112.91}
{6.70,117.28}
{6.94,123.00}
{7.58,129.36}
{7.14,129.23}
{7.67,133.79}
MsN
N
Ph
O
S=O
Ph
P33-min
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

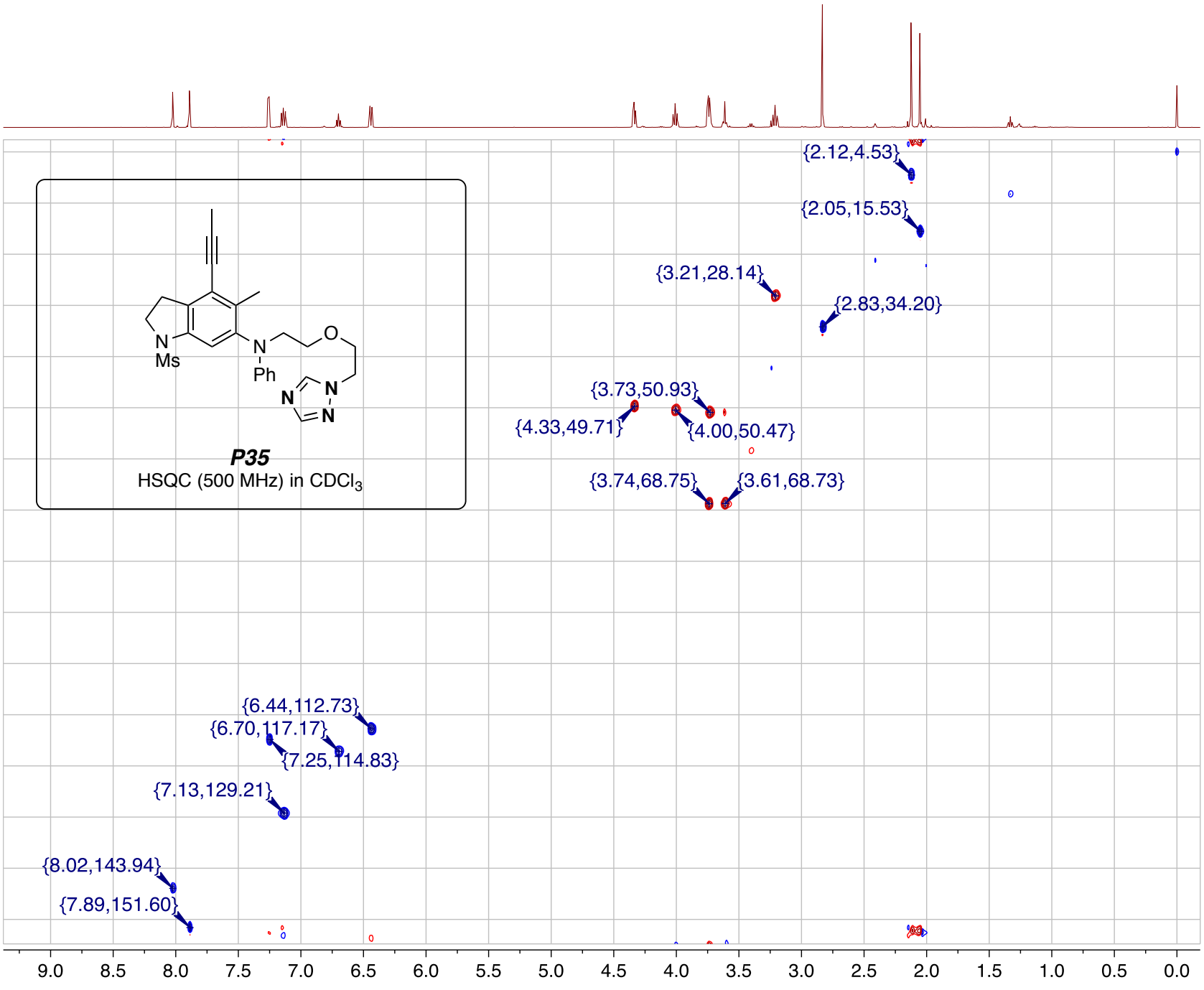

MsN
N
Ph
O
S=O
Ph
P33-min
HMBC (500 MHz) in CDCl3
{2.13,75.41}
{2.12,95.55}
{2.16,121.09}
{2.16,139.15}
{4.74,137.39}
{4.69,134.48}
{3.49,148.25}
{3.48,145.17}
{7.57,139.15}
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170

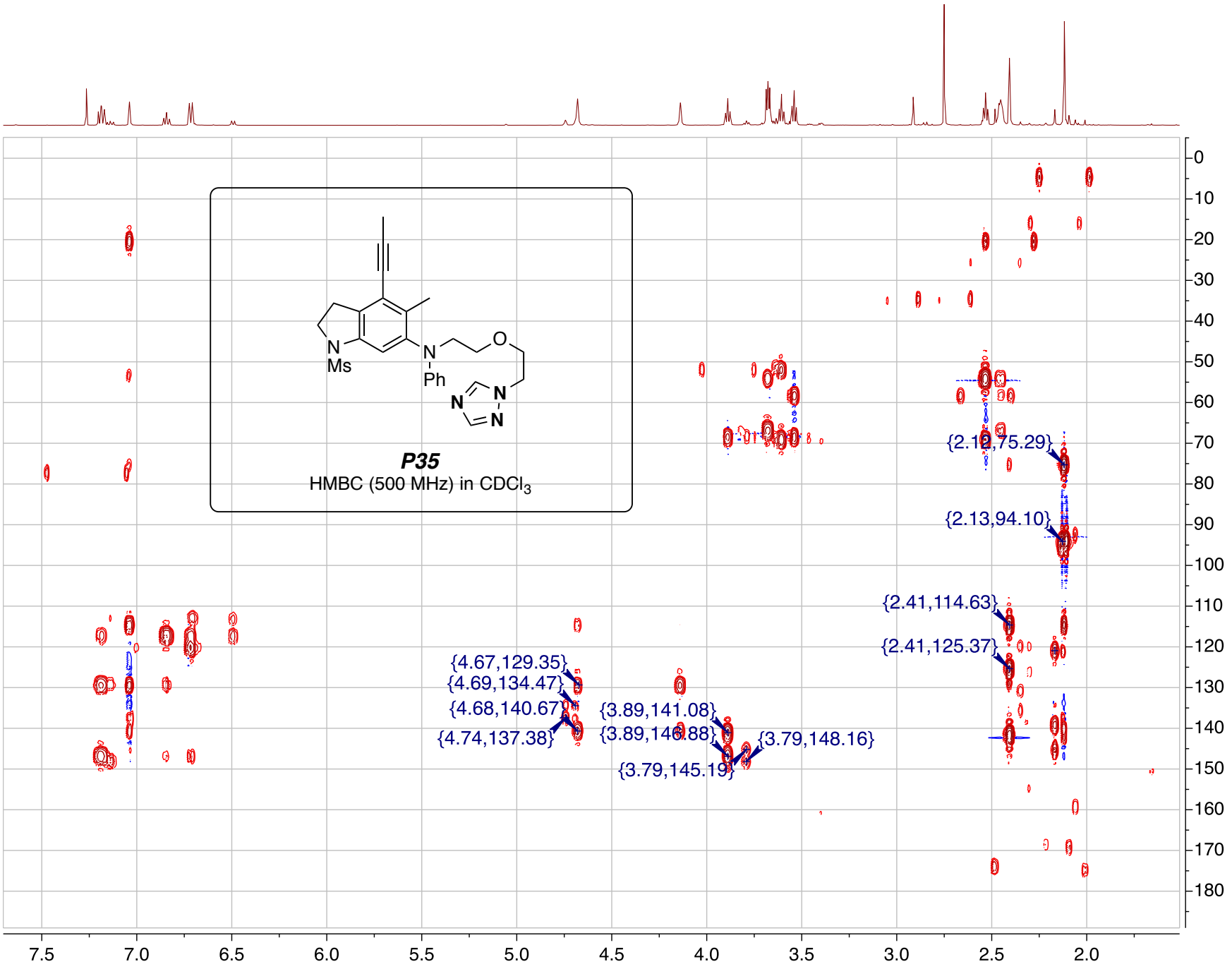

CHCl3
7.26 7.21 7.20 7.19 7.19 7.18 7.18 7.14 7.14 7.05 7.03 6.87 6.86 6.86 6.85 6.85 6.85 6.83 6.73 6.72 6.72 6.72 6.71 6.71 6.71 6.49 6.47 4.74 4.74 4.71 4.70 4.70 4.70 4.68 4.68 4.68 4.14 4.14 4.13 4.13 4.13 3.87 3.85 3.84 3.72 3.71 3.57 3.56 3.55 3.50 3.49 3.47 3.45 3.44 3.43 3.42 2.91 2.76 2.41 2.15 2.14 2.12 2.12 2.12
MsN
CO2Me
CO2Me
O
Ph
N
+
NMs
CO2Me
CO2Me
O
Ph
N
P34-maj
P34-min
1H NMR (500 MHz) in CDCl3
7.20 7.15
6.86 6.84 6.82 6.72 6.70
3.86 3.84
3.60 3.55 3.50 3.45 3.40
2.10 0.54 0.27 1.04 1.04 2.34 0.53
0.55 0.58 2.06 2.09 2.19 0.68 7.65 0.53 2.12 1.29 2.61 0.80 3.11 3.05 7.18
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

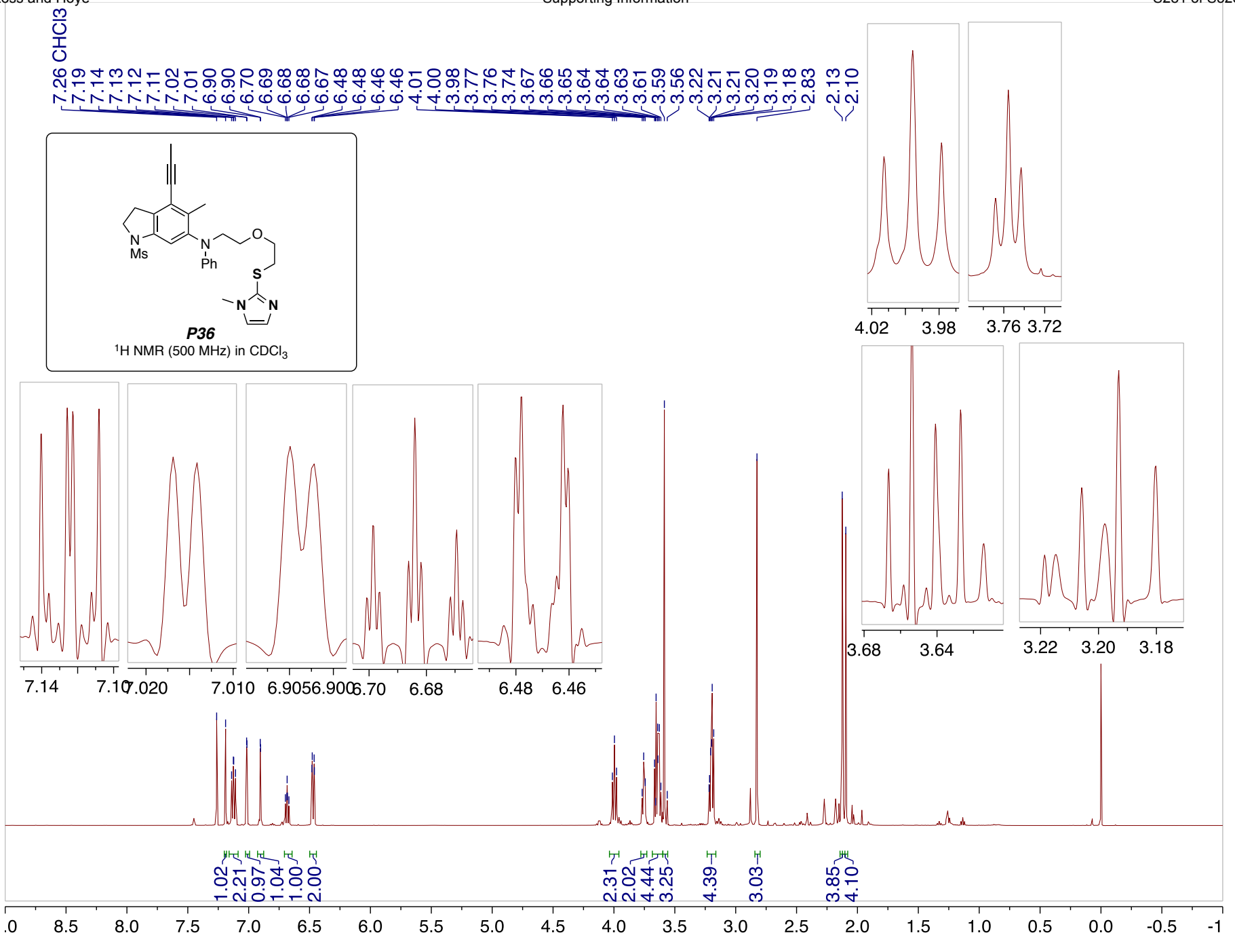

{2.11,4.58}
{2.15,15.91}
{2.41,20.34}
{2.12,28.92}
{2.91,34.86}
{2.75,34.51}
{3.49,48.52}
{3.71,52.49}
{4.68,54.45}
{3.85,51.94}
{4.74,54.22}
{3.56,68.31}
{3.43,68.22}
{6.48,112.97}
{6.84,120.25}
{7.02,125.28}
{6.71,117.41}
{7.19,129.37}
{6.71,129.25}
{7.14,129.21}
MsN
CO2Me
CO2Me
O
N
Ph
+
NMs
CO2Me
CO2Me
O
N
Ph
P34-maj
P34-min
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

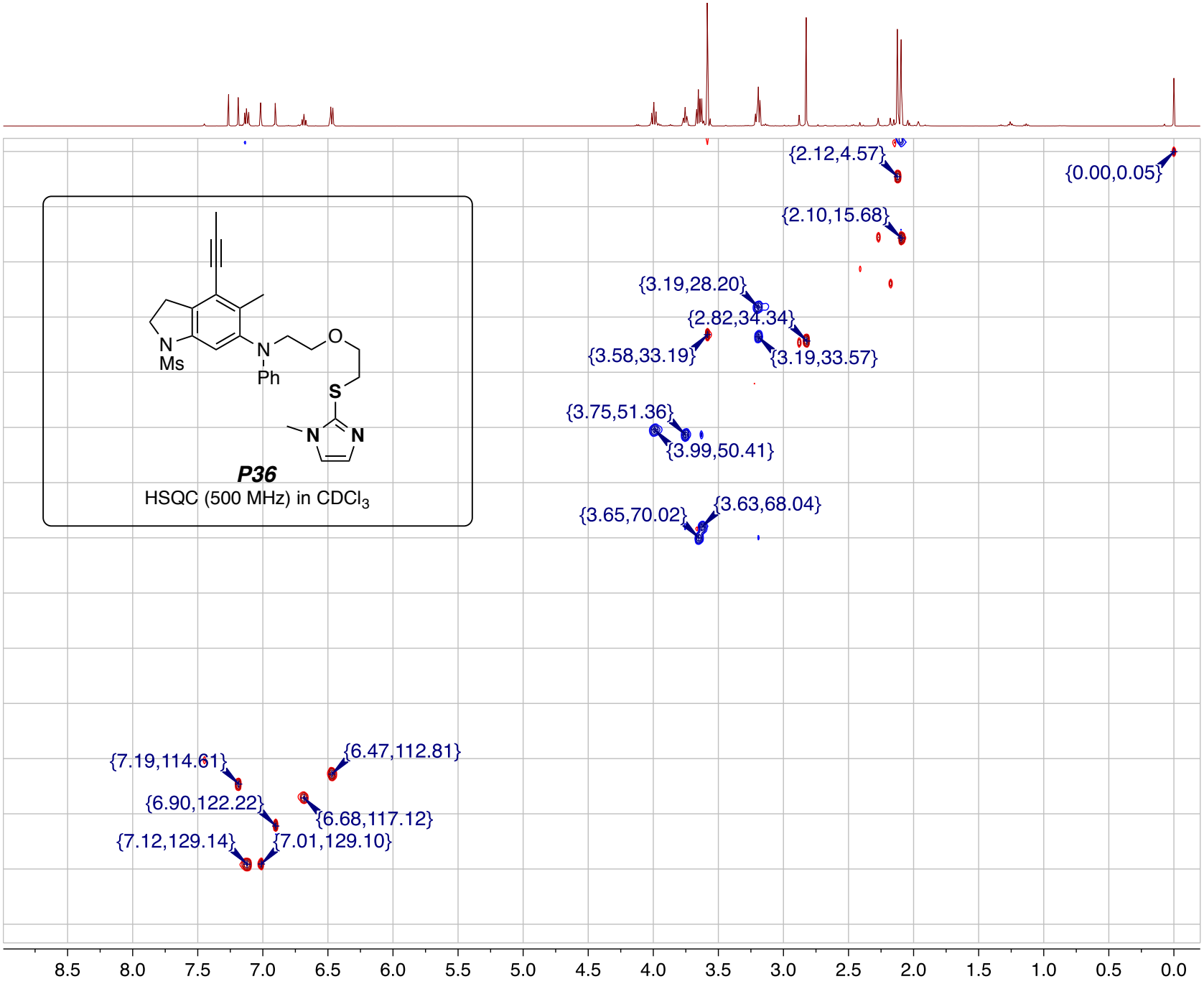

MsN
CO2Me
CO2Me
O
N
Ph
+
NMs
CO2Me
CO2Me
O
N
Ph
P34-maj
P34-min
HMBC (500 MHz) in CDCl3
{2.12,75.34}
{2.11,93.96}
{2.12,114.54}
{2.15,120.91}
{2.41,125.23}
{4.68,129.24}
{4.70,134.50}
{4.75,137.28}
{4.68,140.66}
{3.85,141.19}
{2.15,139.05}
{3.75,148.18}
{3.85,146.91}
{3.71,169.70}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

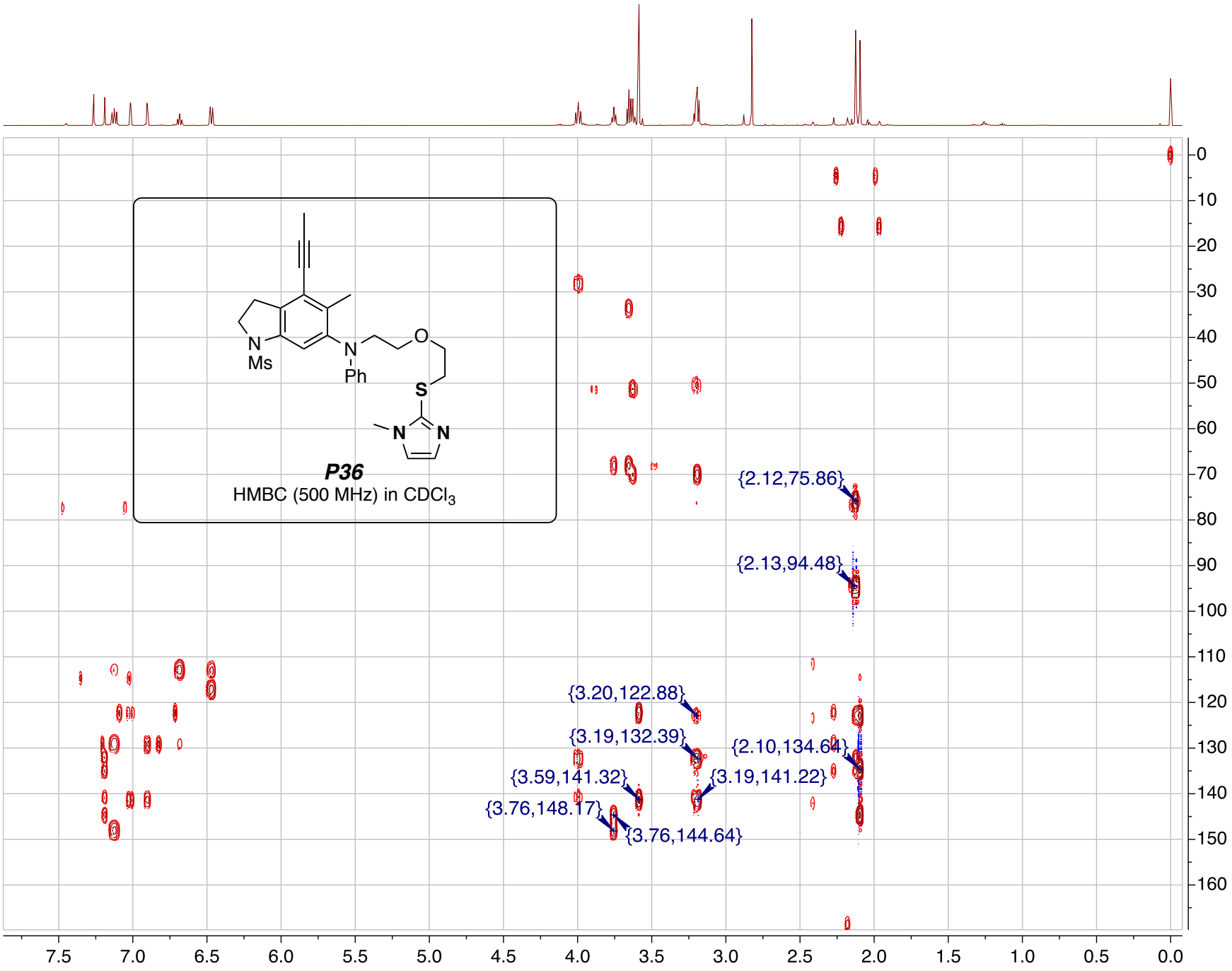

8.03
7.89
7.27 CHCl3
7.25
7.16
7.14
7.14
7.13
7.12
6.71
6.70
6.70
6.70
6.69
6.45
6.45
6.45
6.44
6.44
6.43
6.43
6.43
4.35
4.34
4.33
4.03
4.01
3.99
3.75
3.74
3.74
3.73
3.73
3.62
3.61
3.60
3.25
3.23
3.21
3.19
2.83
2.12
2.05
1.33 NEt3
Ms
N
Ph
N
O
N
N
P35
1H NMR (500 MHz) in CDCl3
7.16
7.12
6.72
6.70
6.68
6.46
6.42
4.36
4.32
4.04
3.96
3.76
3.74
3.72
3.65
3.60
3.24
3.18
1.00
0.97
1.07
2.14
1.09
2.12
2.13
2.23
4.40
2.16
2.20
3.22
3.30
3.23
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1

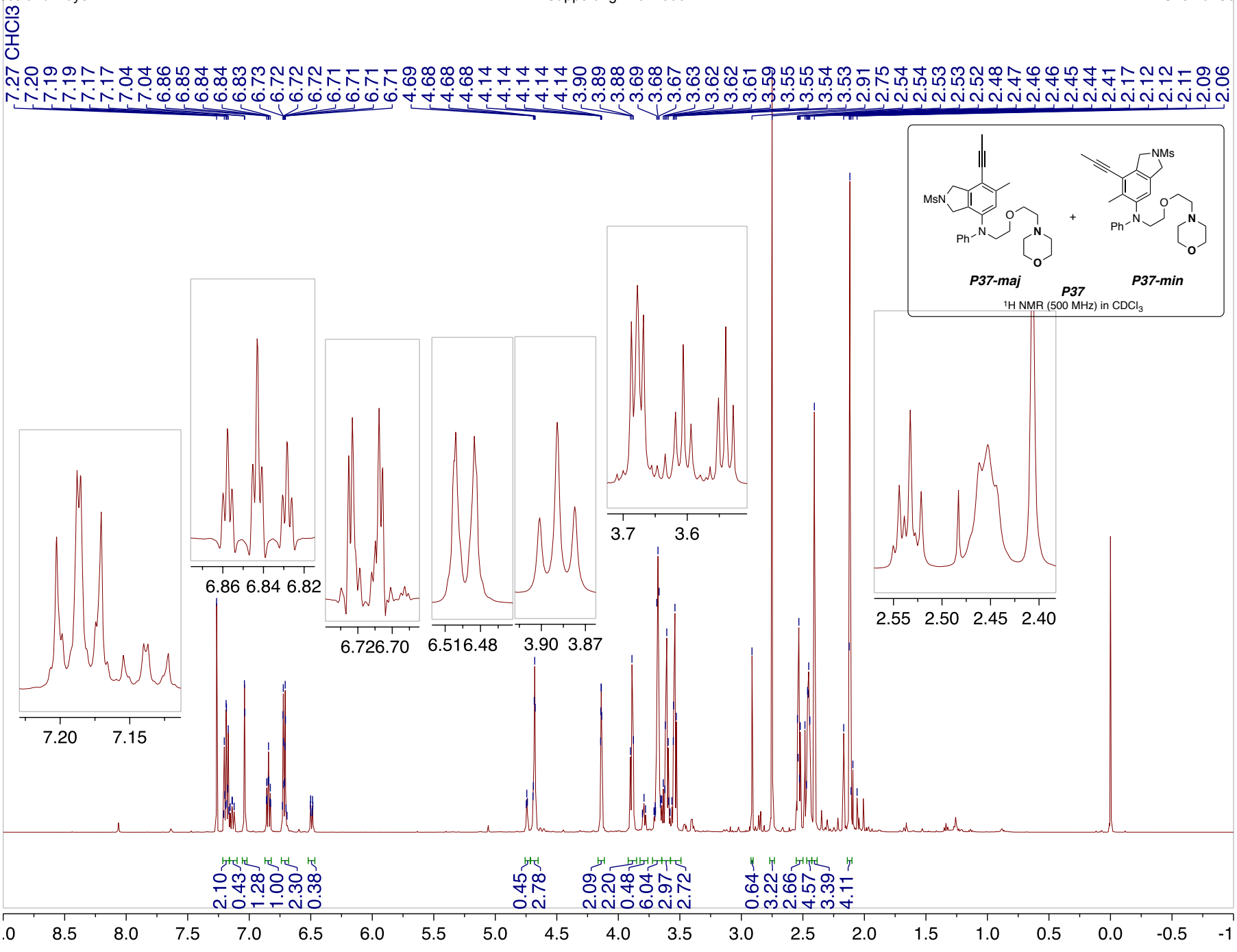

{2.12,4.53}
{2.05,15.53}
{3.21,28.14}
{2.83,34.20}
{3.73,50.93}
{4.33,49.71}
{4.00,50.47}
{3.74,68.75}
{3.61,68.73}
{6.44,112.73}
{6.70,117.17}
{7.25,114.83}
{7.13,129.21}
{8.02,143.94}
{7.89,151.60}
N
Ms
N
Ph
O
N
N
P35
HSQC (500 MHz) in CDCl3

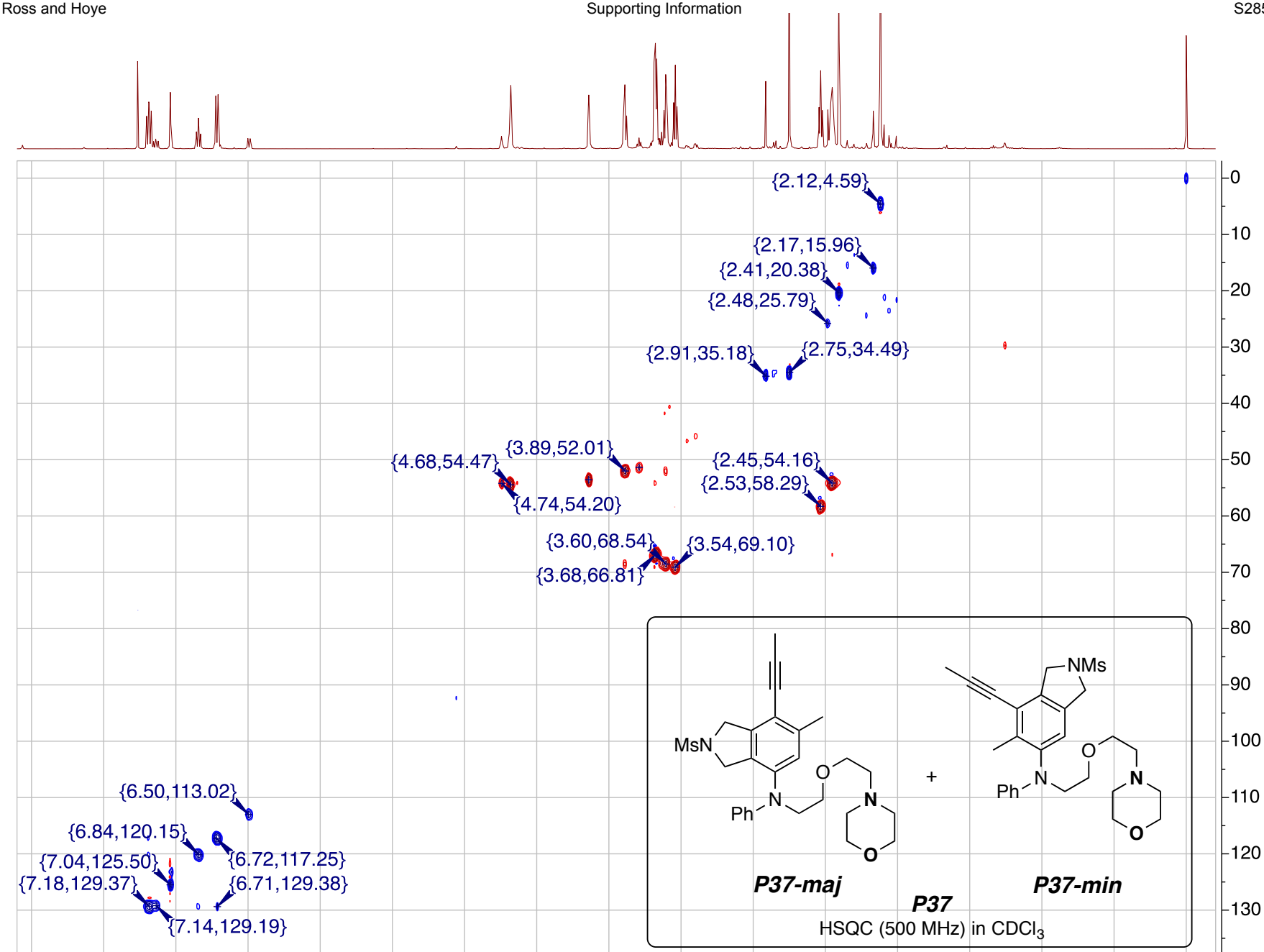

N
Ms
N
Ph
O
N
N
N
P35
HMBC (500 MHz) in CDCl3
{2.12,75.29}
{2.13,94.10}
{2.41,114.63}
{2.41,125.37}
{4.67,129.35}
{4.69,134.47}
{4.68,140.67}
{4.74,137.38}
{3.89,141.08}
{3.89,146.88}
{3.79,145.19}
{3.79,148.16}
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180

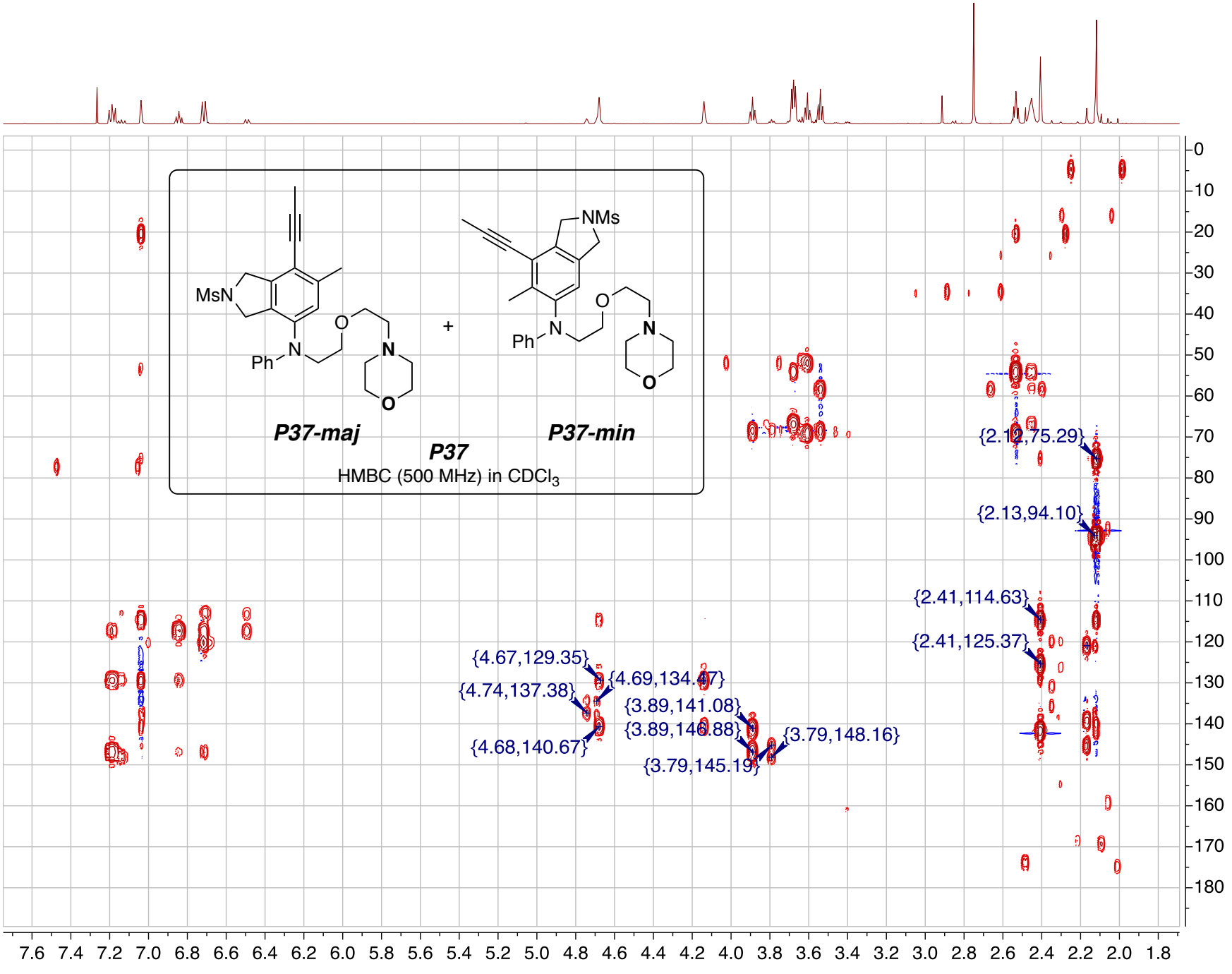

CHCl3
7.26 7.19 7.14 7.13 7.12 7.11 7.02 7.01 6.90 6.90 6.70 6.69 6.68 6.68 6.67 6.48 6.48 6.46 6.46 4.01 4.00 3.98 3.77 3.76 3.74 3.67 3.66 3.65 3.64 3.64 3.63 3.61 3.59 3.56 3.22 3.21 3.21 3.20 3.19 3.18 2.83 2.13 2.10
N
Ms
N
Ph
O
S
N
N
P36
1H NMR (500 MHz) in CDCl3
4.02 3.98 3.76 3.72
7.14 7.10 7.020 7.010 6.905 6.900 6.70 6.68 6.48 6.46
3.68 3.64 3.22 3.20 3.18
1.02 2.21 0.97 1.04 1.00 2.00 2.31 2.02 4.44 3.25 4.39 3.03 3.85 4.10
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

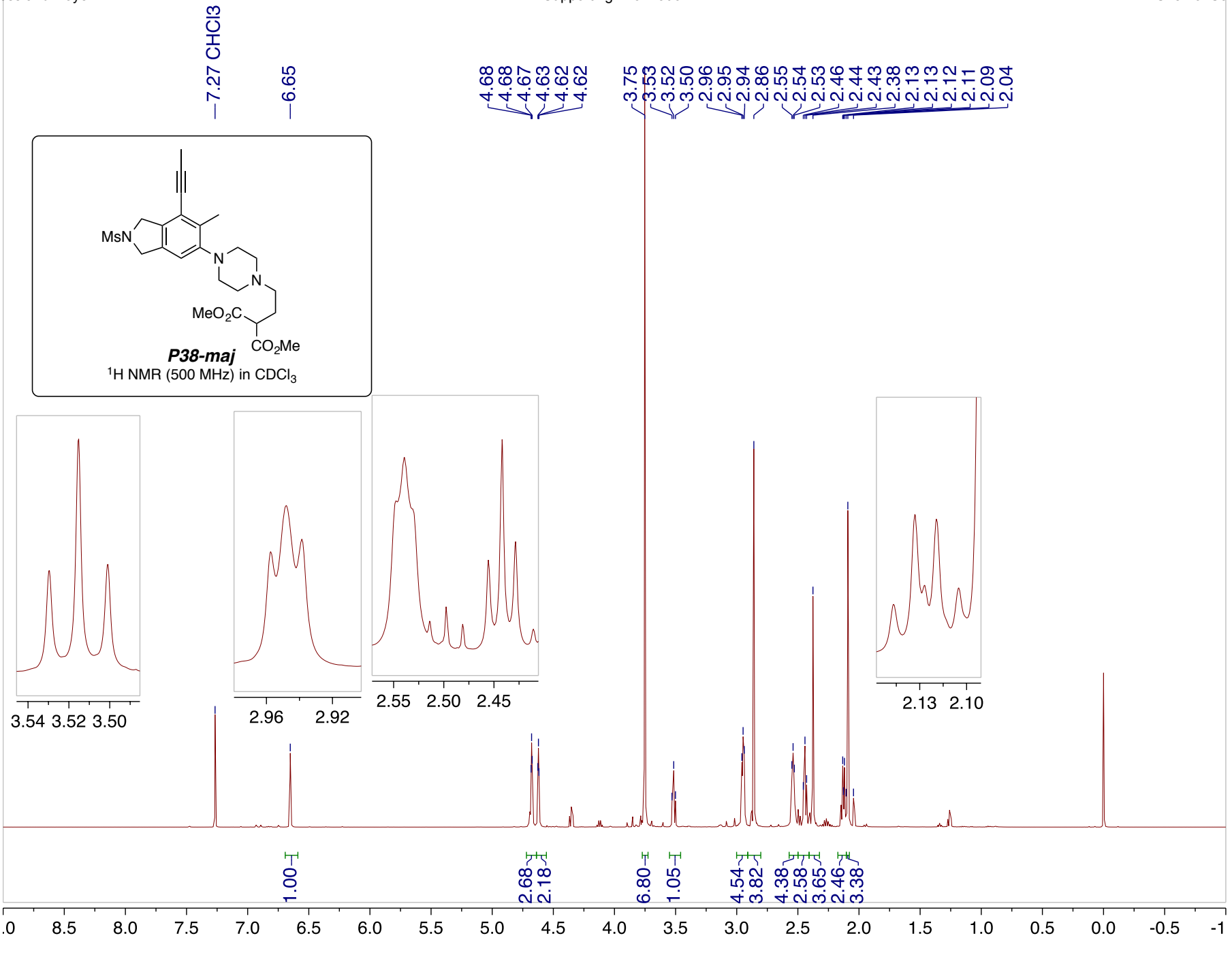

{2.12,4.57}
{0.00,0.05}
{2.10,15.68}
{3.19,28.20}
{2.82,34.34}
{3.58,33.19}
{3.19,33.57}
{3.75,51.36}
{3.99,50.41}
{3.65,70.02}
{3.63,68.04}
{7.19,114.61}
{6.47,112.81}
{6.90,122.22}
{6.68,117.12}
{7.12,129.14}
{7.01,129.10}
N
Ms
N
Ph
O
S
N
N
P36
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

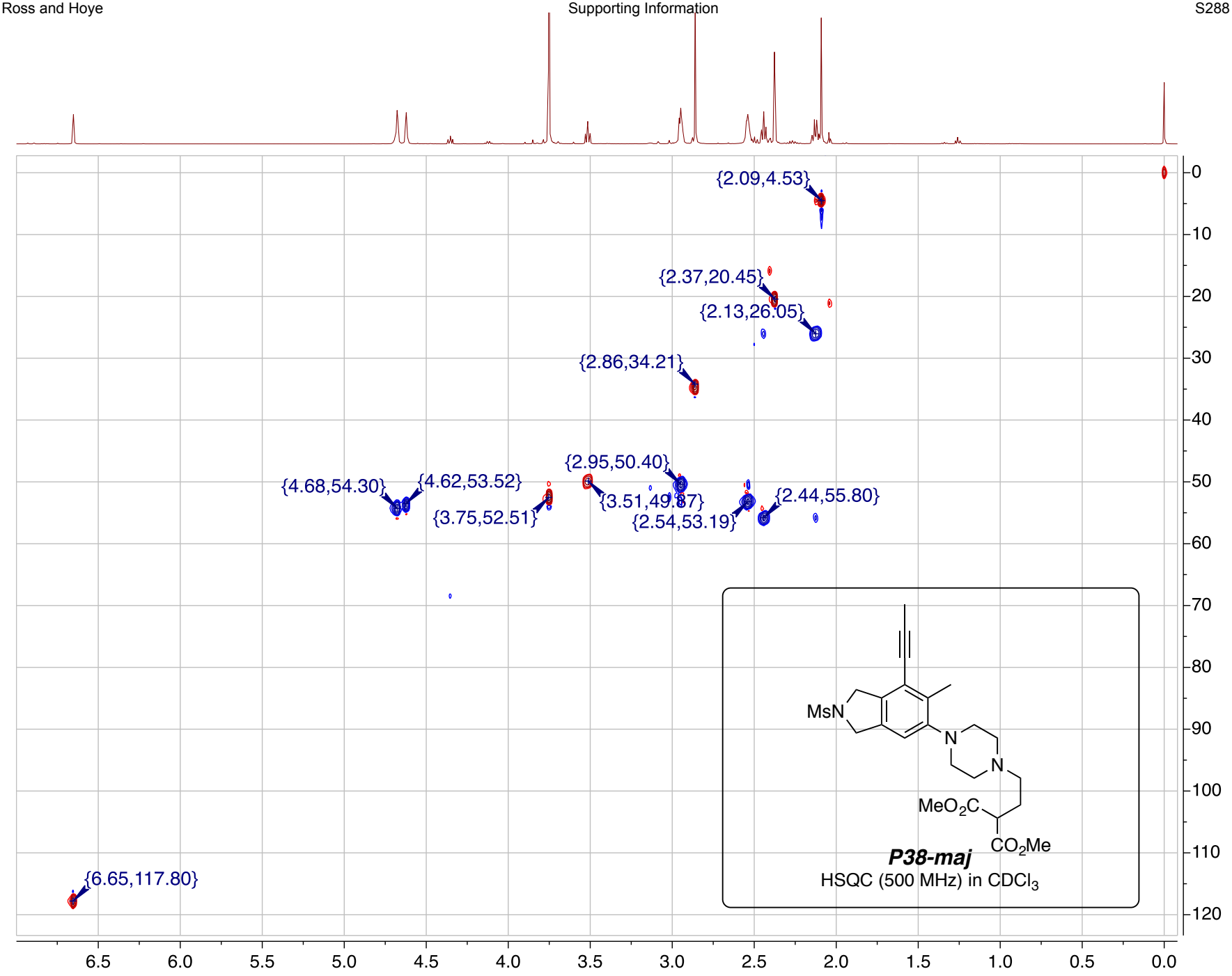

N
Ms
N
Ph
O
S
N
N
P36
HMBC (500 MHz) in CDCl3
{2.12,75.86}
{2.13,94.48}
{3.20,122.88}
{3.19,132.39}
{2.10,134.64}
{3.59,141.32}
{3.19,141.22}
{3.76,148.17}
{3.76,144.64}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

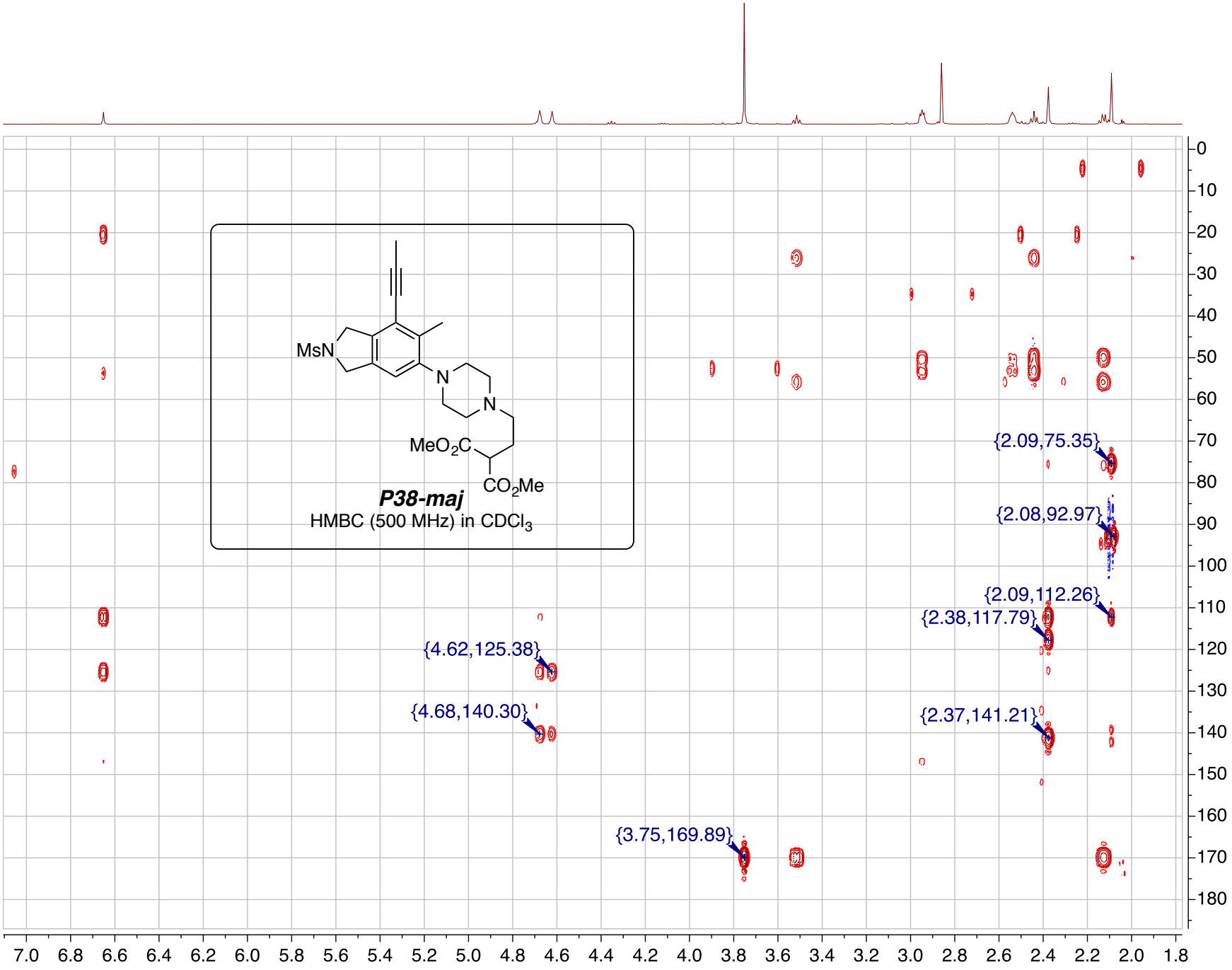

CHCl3
7.27 7.20 7.19 7.19 7.17 7.17 7.04 7.04 6.86 6.85 6.84 6.84 6.83 6.73 6.72 6.72 6.72 6.71 6.71 6.71
4.69 4.68 4.68 4.68 4.14 4.14 4.14 4.14 3.90 3.89 3.88 3.69 3.68 3.67 3.63 3.62 3.62 3.61 3.59 3.55 3.55 3.54 3.53 2.91 2.75 2.54 2.54 2.53 2.53 2.52 2.48 2.47 2.46 2.46 2.45 2.44 2.41 2.17 2.12 2.12 2.11 2.09 2.06
MsN
Ph
N
O
N
O
+
NMs
Ph
N
O
N
O
P37-maj
P37-min
P37
1H NMR (500 MHz) in CDCl3
7.20 7.15
6.86 6.84 6.82
6.726.70
6.516.48
3.90 3.87
3.7 3.6
2.55 2.50 2.45 2.40
2.10 0.43 1.28 1.00 2.30 0.38
0.45 2.78
2.09 2.20 0.48 6.04 2.97 2.72
0.64 3.22 2.66 4.57 3.39 4.11
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

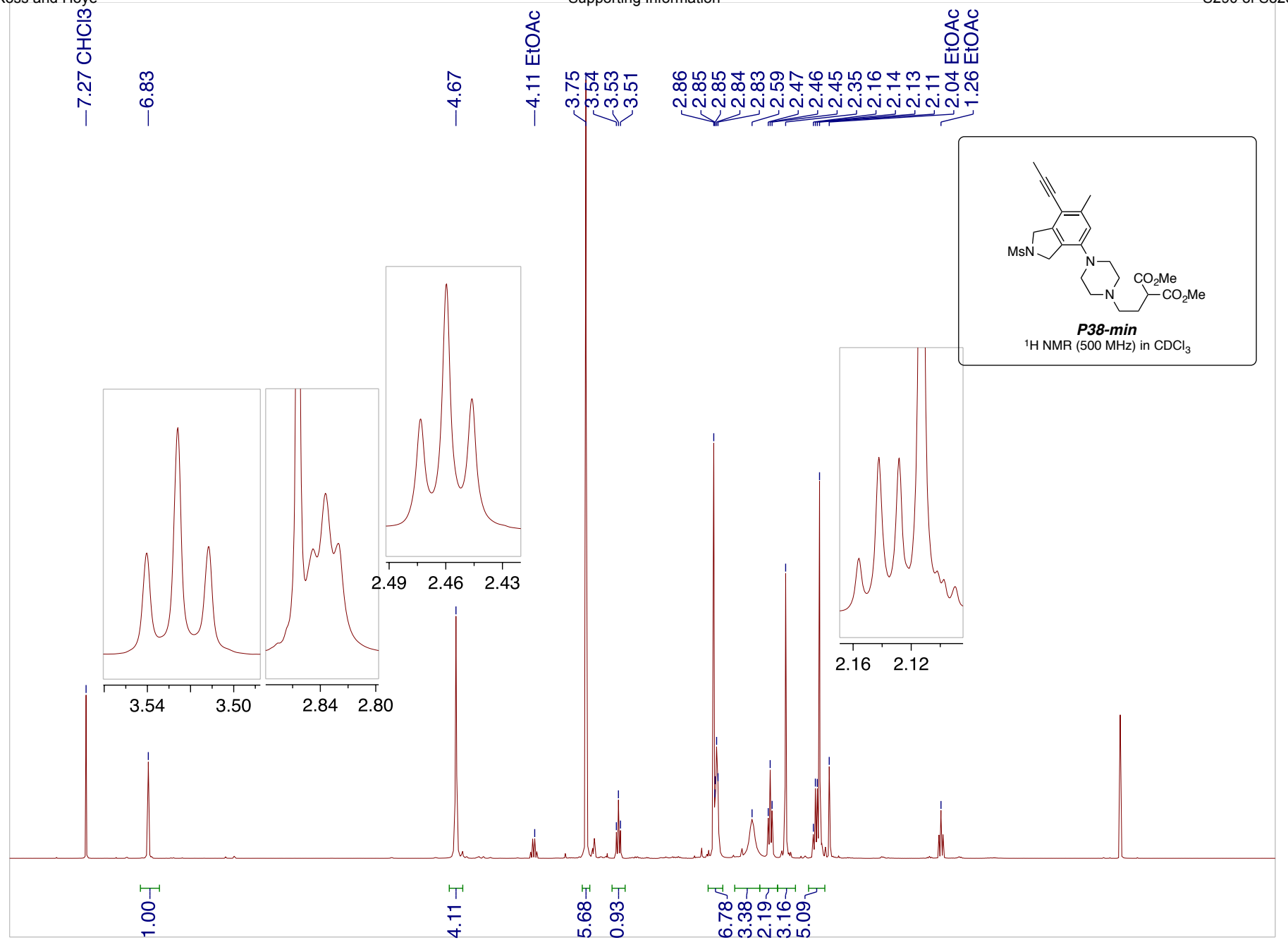

{2.12,4.59}
{2.17,15.96}
{2.41,20.38}
{2.48,25.79}
{2.91,35.18}
{2.75,34.49}
{4.68,54.47}
{3.89,52.01}
{2.45,54.16}
{2.53,58.29}
{4.74,54.20}
{3.60,68.54}
{3.54,69.10}
{3.68,66.81}
{6.50,113.02}
{6.84,120.15}
{6.72,117.25}
{7.04,125.50}
{7.18,129.37}
{6.71,129.38}
{7.14,129.19}
MsN
N
Ph
O
N
O
+
NMs
N
Ph
O
N
O
P37-maj
P37-min
P37
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

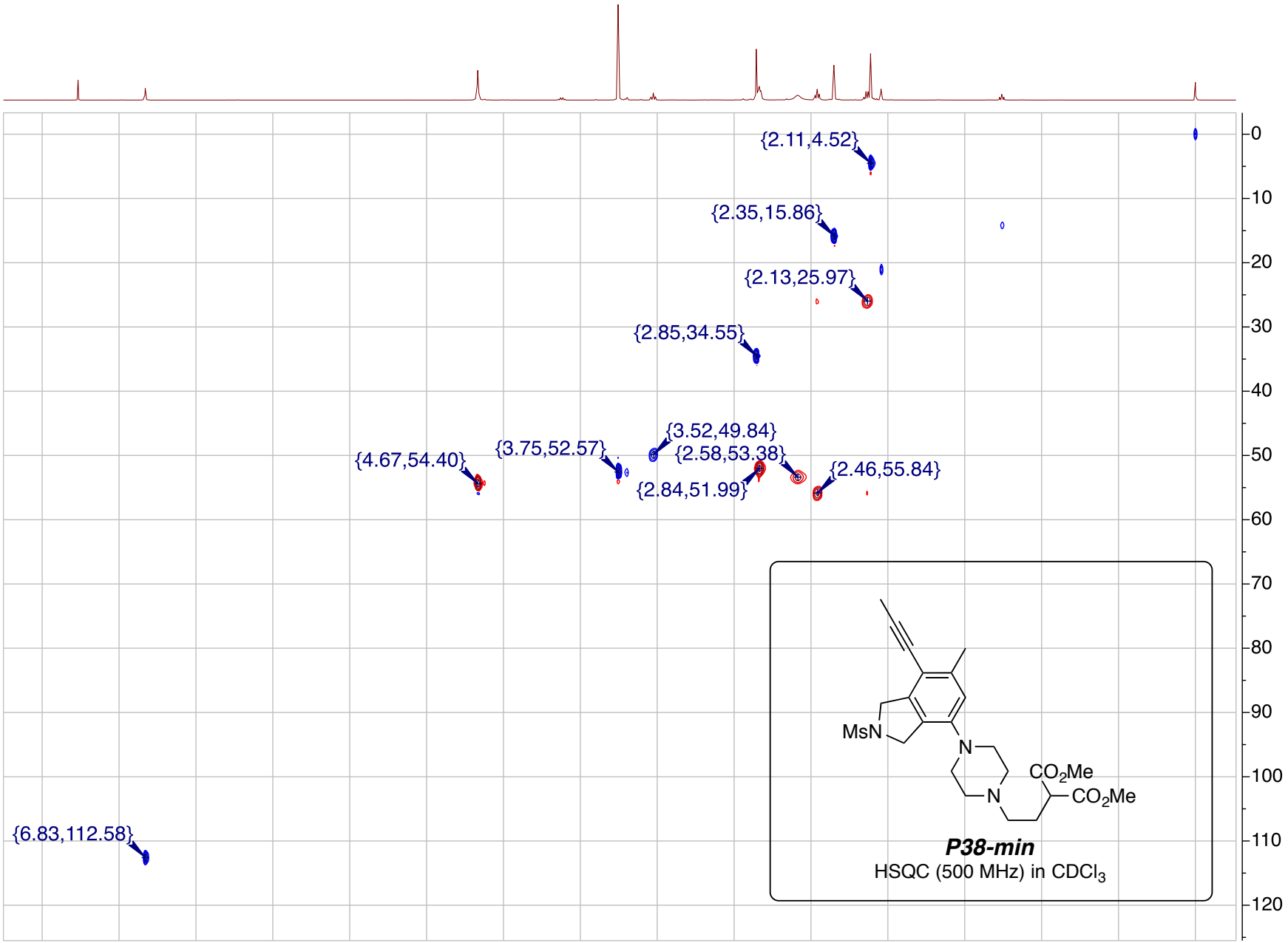

MsN
Ph
N
O
N
O
+
NMs
Ph
N
O
N
O
P37-maj
P37-min
P37
HMBC (500 MHz) in CDCl3
{2.12,75.29}
{2.13,94.10}
{2.41,114.63}
{2.41,125.37}
{4.67,129.35}
{4.74,137.38}
{4.69,134.47}
{3.89,141.08}
{3.89,146.88}
{4.68,140.67}
{3.79,148.16}
{3.79,145.19}
7.6 7.4 7.2 7.0 6.8 6.6 6.4 6.2 6.0 5.8 5.6 5.4 5.2 5.0 4.8 4.6 4.4 4.2 4.0 3.8 3.6 3.4 3.2 3.0 2.8 2.6 2.4 2.2 2.0 1.8
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180

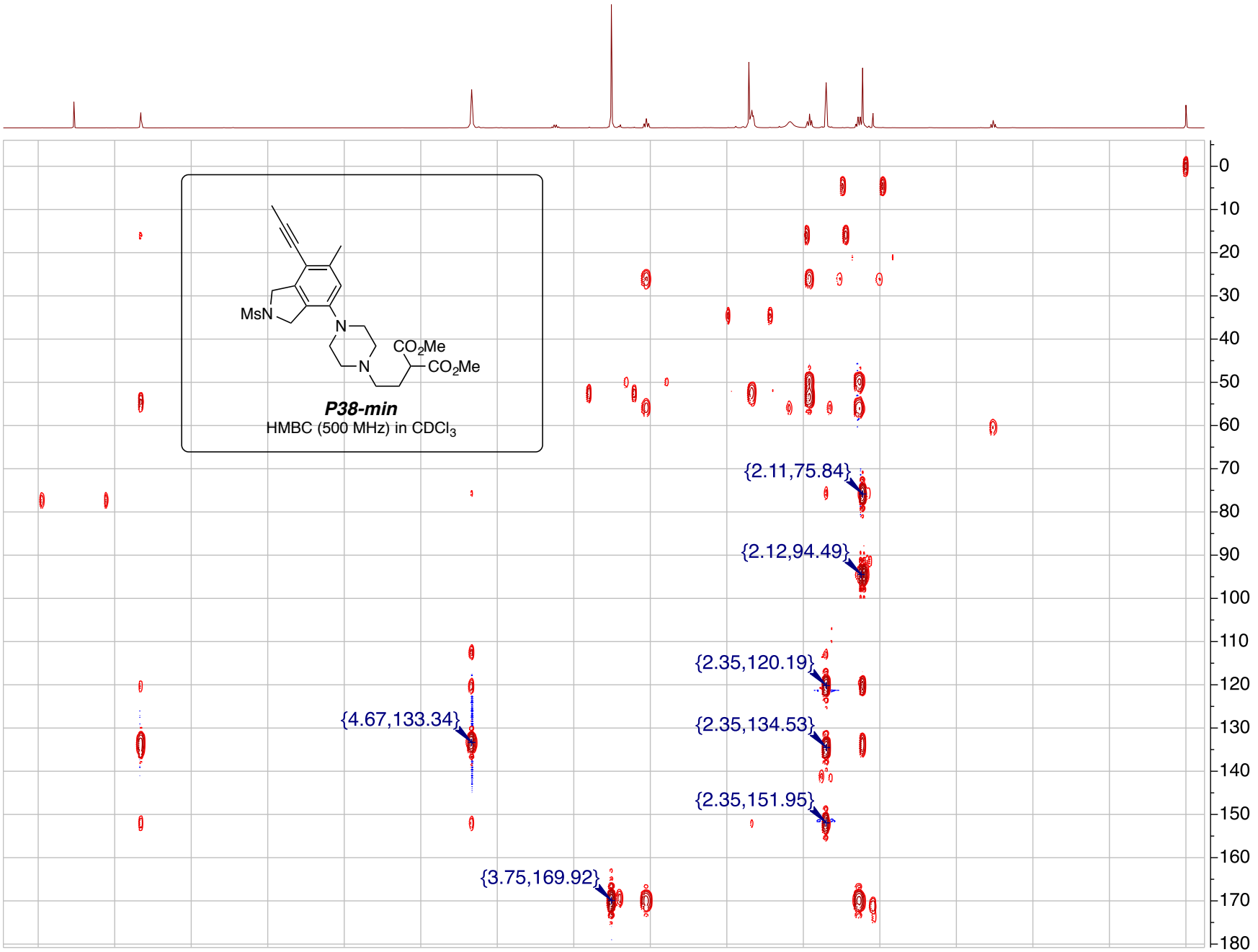

7.27 CHCl3
6.65
4.68
4.68
4.67
4.63
4.62
4.62
3.75
3.53
3.52
3.50
2.96
2.95
2.94
2.86
2.55
2.54
2.53
2.46
2.44
2.43
2.38
2.13
2.13
2.12
2.11
2.09
2.04
MsN
N
N
MeO2C
CO2Me
P38-maj
1H NMR (500 MHz) in CDCl3
3.54 3.52 3.50
2.96 2.92
2.55 2.50 2.45
2.13 2.10
1.00
2.68
2.18
6.80
1.05
4.54
3.82
4.38
2.58
3.65
2.46
3.38

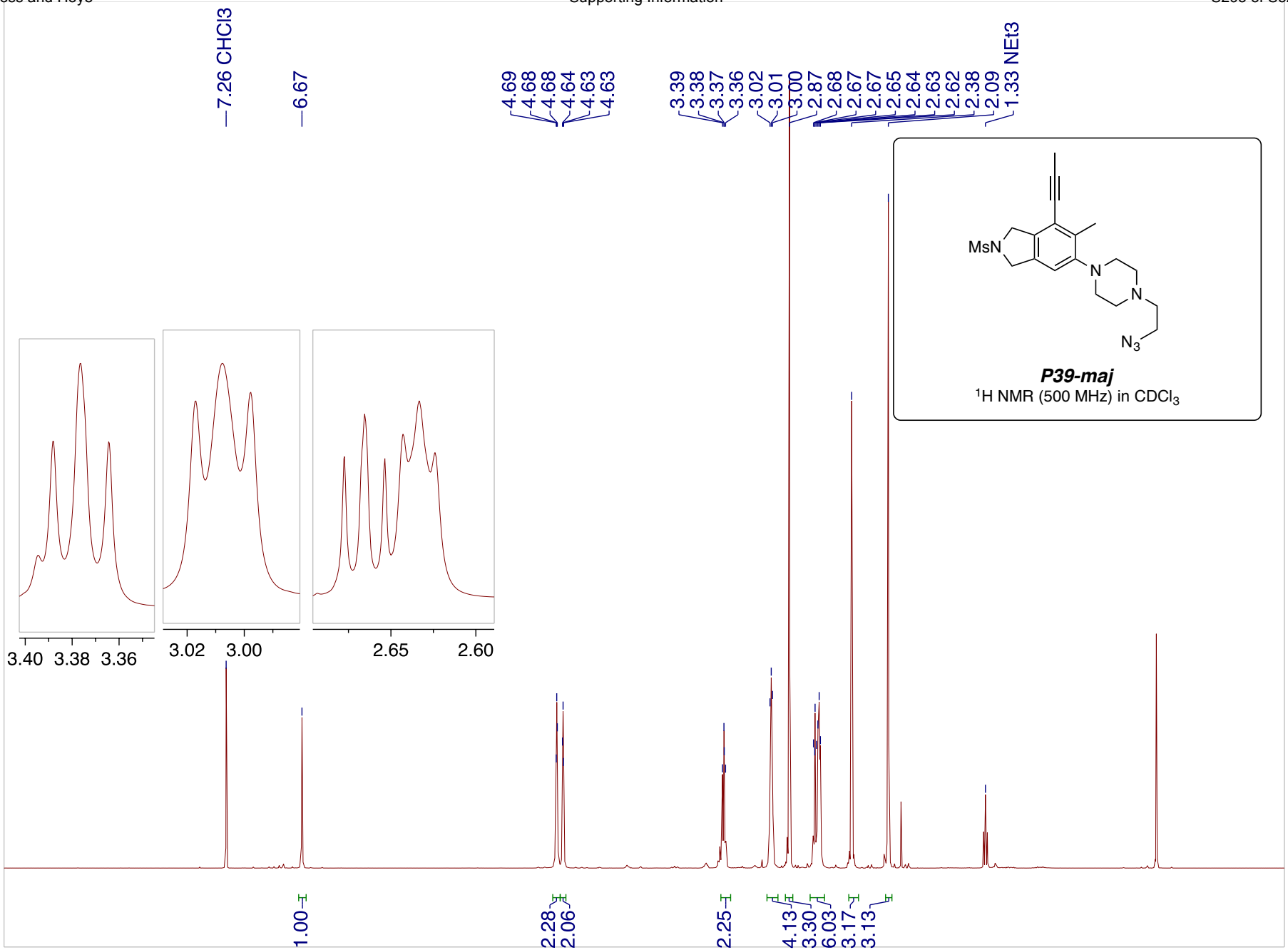

{2.09,4.53}
{2.37,20.45}
{2.13,26.05}
{2.86,34.21}
{2.95,50.40}
{4.68,54.30}
{4.62,53.52}
{3.75,52.51}
{3.51,49.87}
{2.54,53.19}
{2.44,55.80}
{6.65,117.80}
MsN
N
N
MeO2C
CO2Me
P38-maj
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

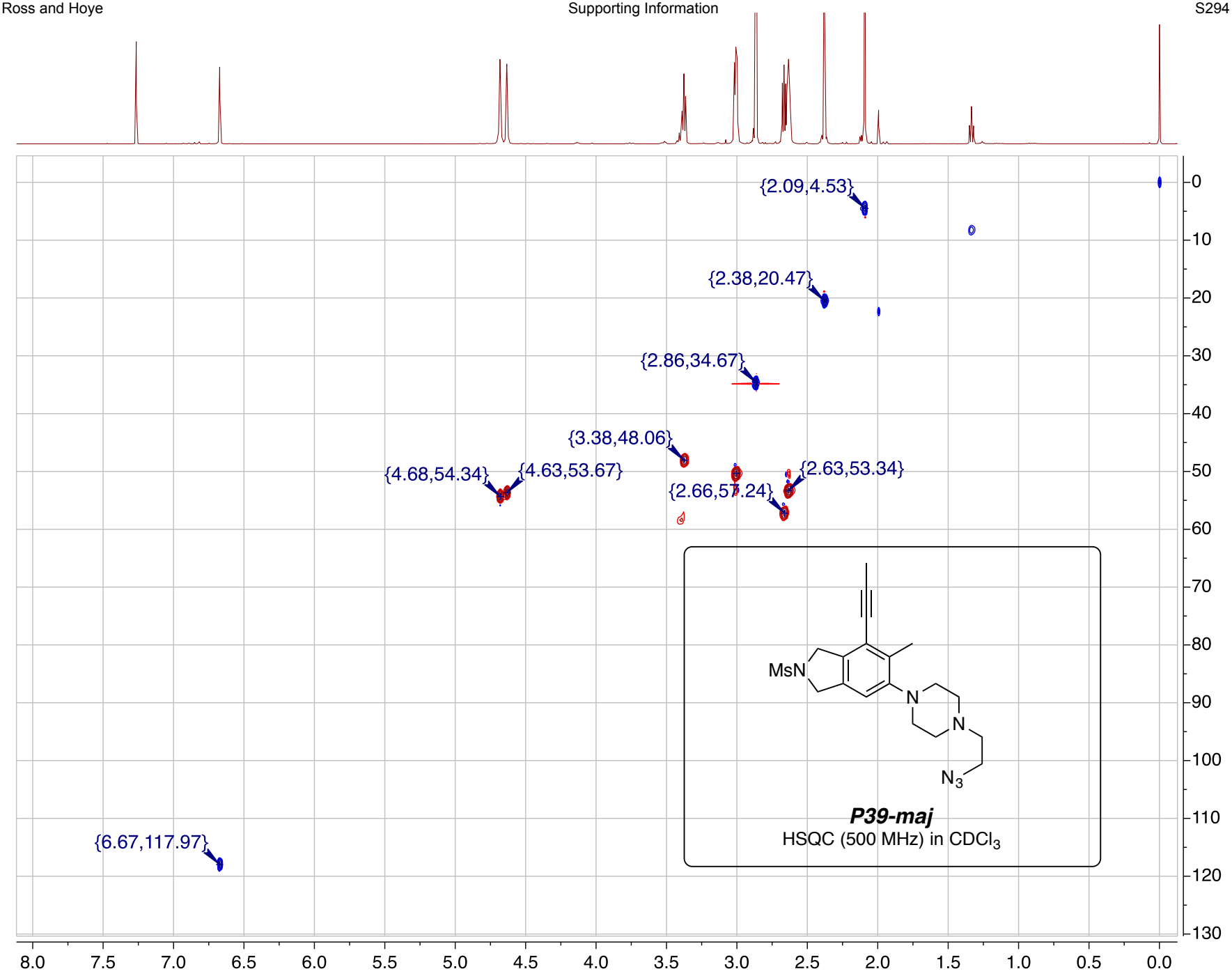

MsN
N
N
MeO2C
CO2Me
P38-maj
HMBC (500 MHz) in CDCl3
{2.09,75.35}
{2.08,92.97}
{2.09,112.26}
{2.38,117.79}
{4.62,125.38}
{4.68,140.30}
{2.37,141.21}
{3.75,169.89}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
7.0
6.8
6.6
6.4
6.2
6.0
5.8
5.6
5.4
5.2
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8

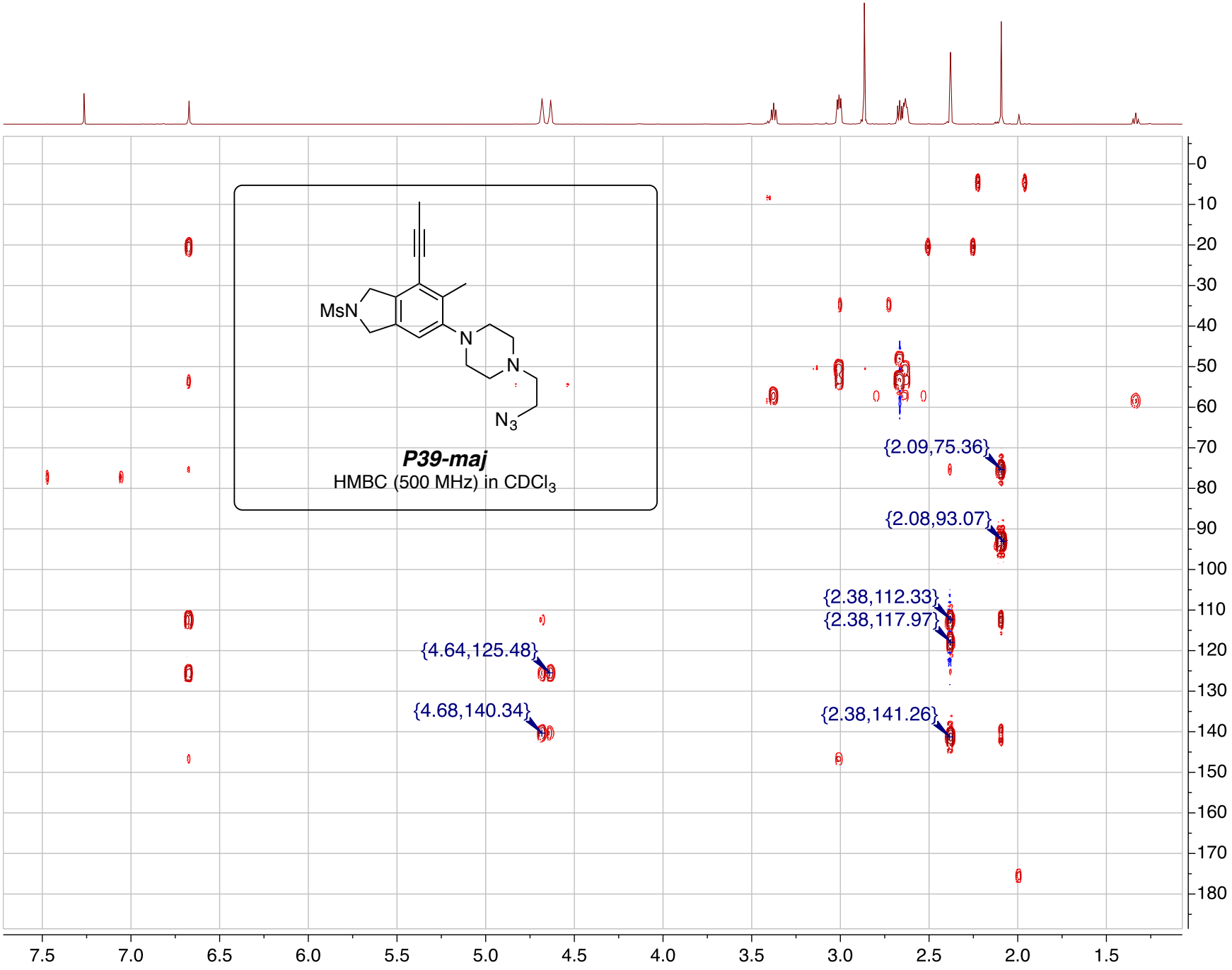

7.27 CHCl3
6.83
4.67
4.11 EtOAc
3.75
3.54
3.53
3.51
2.86
2.85
2.85
2.84
2.83
2.59
2.47
2.46
2.45
2.35
2.16
2.14
2.13
2.11
2.04 EtOAc
1.26 EtOAc
MsN
N
N
CO2Me
CO2Me
P38-min
1H NMR (500 MHz) in CDCl3
3.54 3.50
2.84 2.80
2.49 2.46 2.43
2.16 2.12
1.00
4.11
5.68
0.93
6.78
3.38
2.19
3.16
5.09
7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0

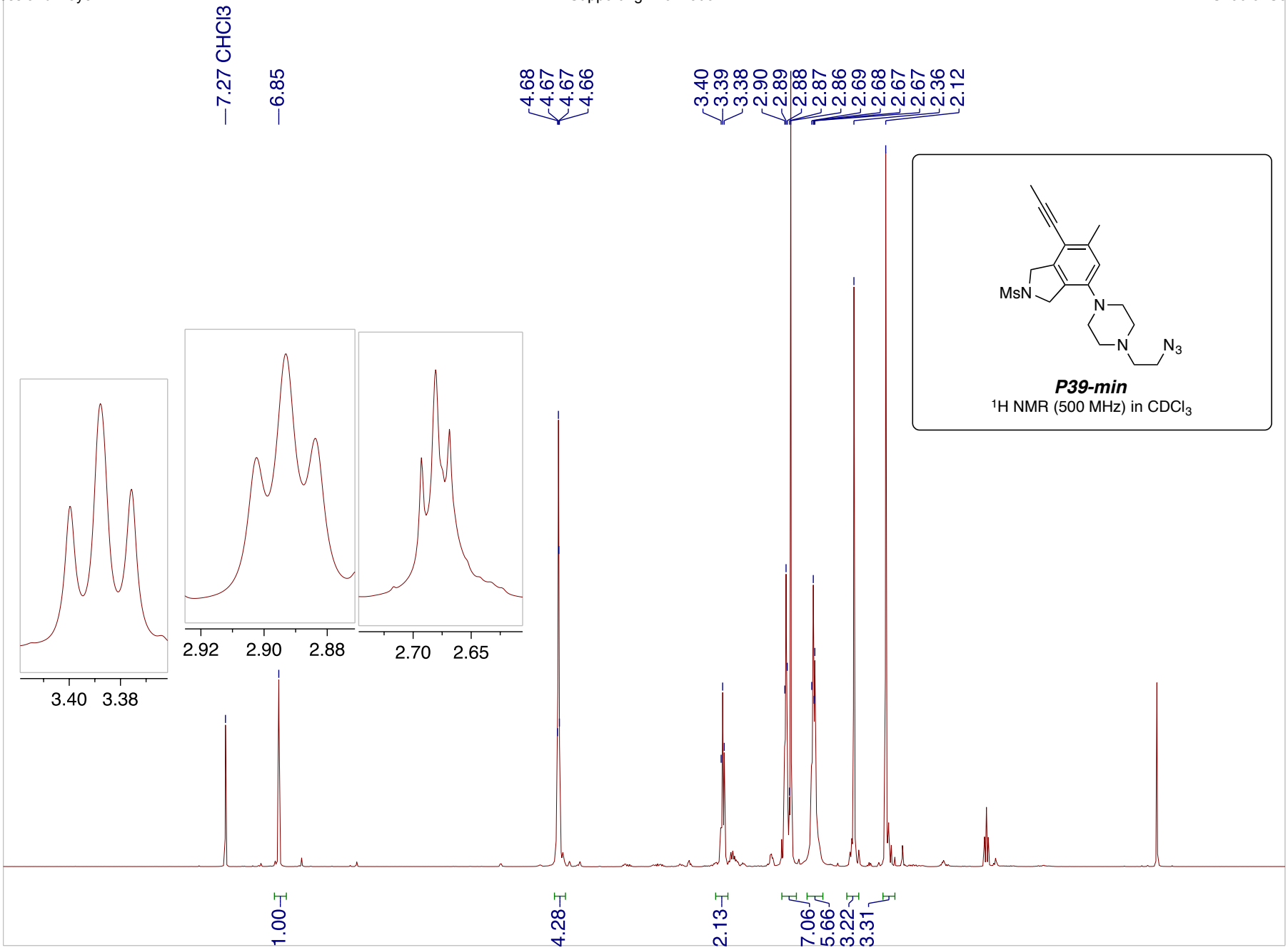

{2.11,4.52}
{2.35,15.86}
{2.13,25.97}
{2.85,34.55}
{3.52,49.84}
{3.75,52.57}
{2.58,53.38}
{4.67,54.40}
{2.46,55.84}
{2.84,51.99}
{6.83,112.58}
MsN
N
N
CO2Me
CO2Me
P38-min
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

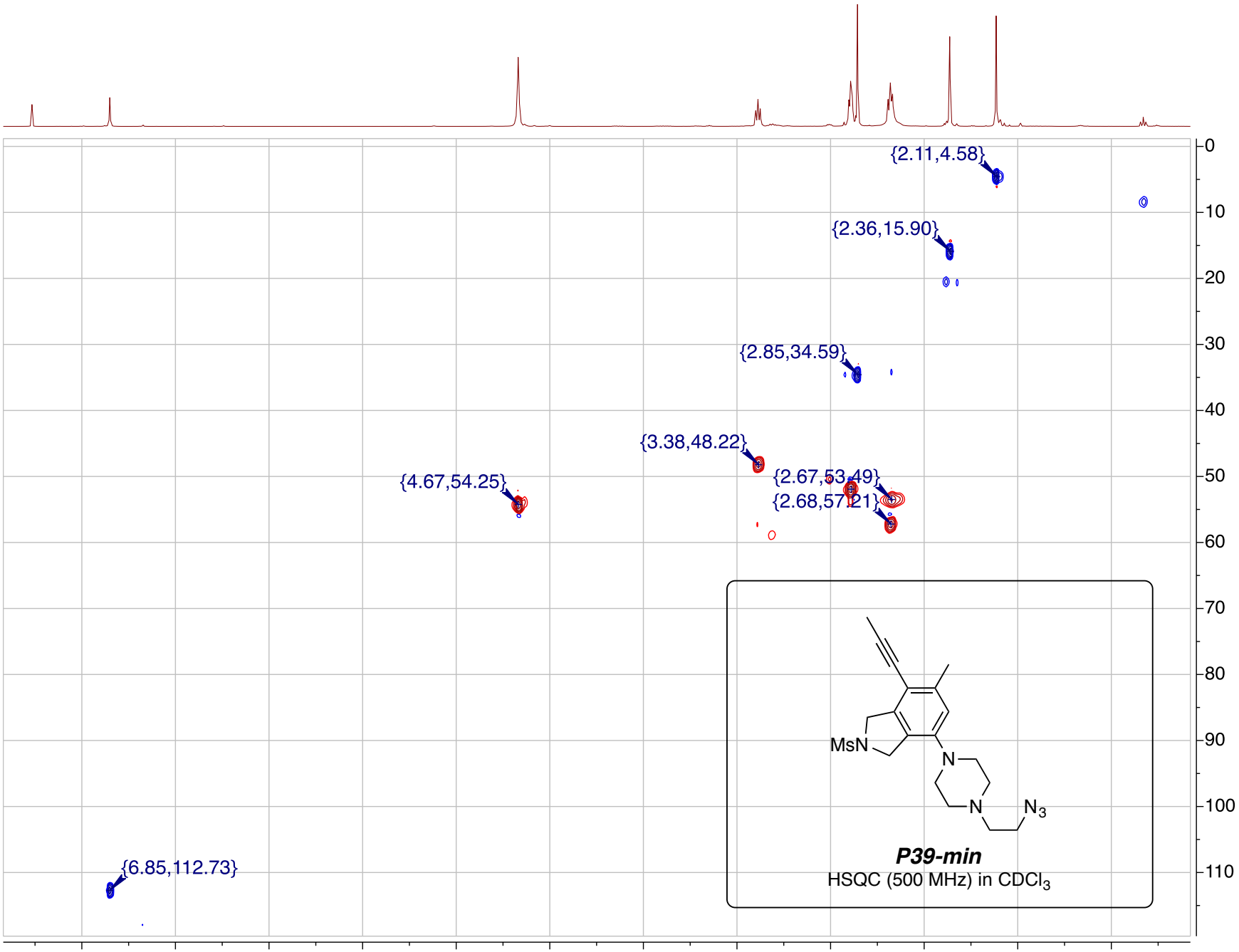

MsN
N
N
CO2Me
CO2Me
P38-min
HMBC (500 MHz) in CDCl3
{2.11,75.84}
{2.12,94.49}
{2.35,120.19}
{4.67,133.34}
{2.35,134.53}
{2.35,151.95}
{3.75,169.92}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

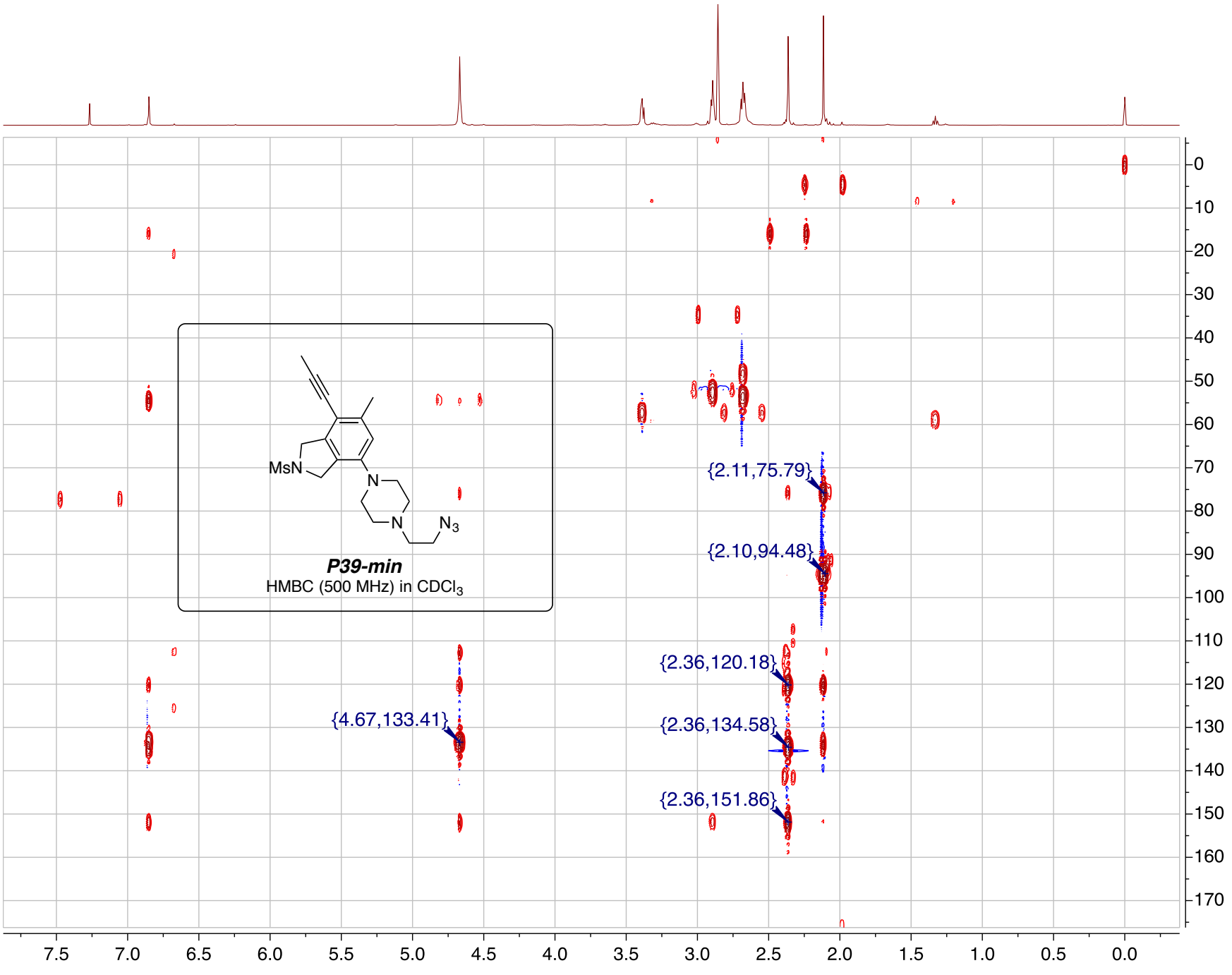

7.26 CHCl3
6.67
4.69
4.68
4.68
4.64
4.63
4.63
3.39
3.38
3.37
3.36
3.02
3.01
3.00
2.87
2.68
2.67
2.67
2.65
2.64
2.63
2.62
2.38
2.09
1.33 NEt3
MsN
N
N
N3
P39-maj
1H NMR (500 MHz) in CDCl3
3.40 3.38 3.36
3.02 3.00
2.65 2.60
1.00
2.28
2.06
2.25
4.13
3.30
6.03
3.17
3.13
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

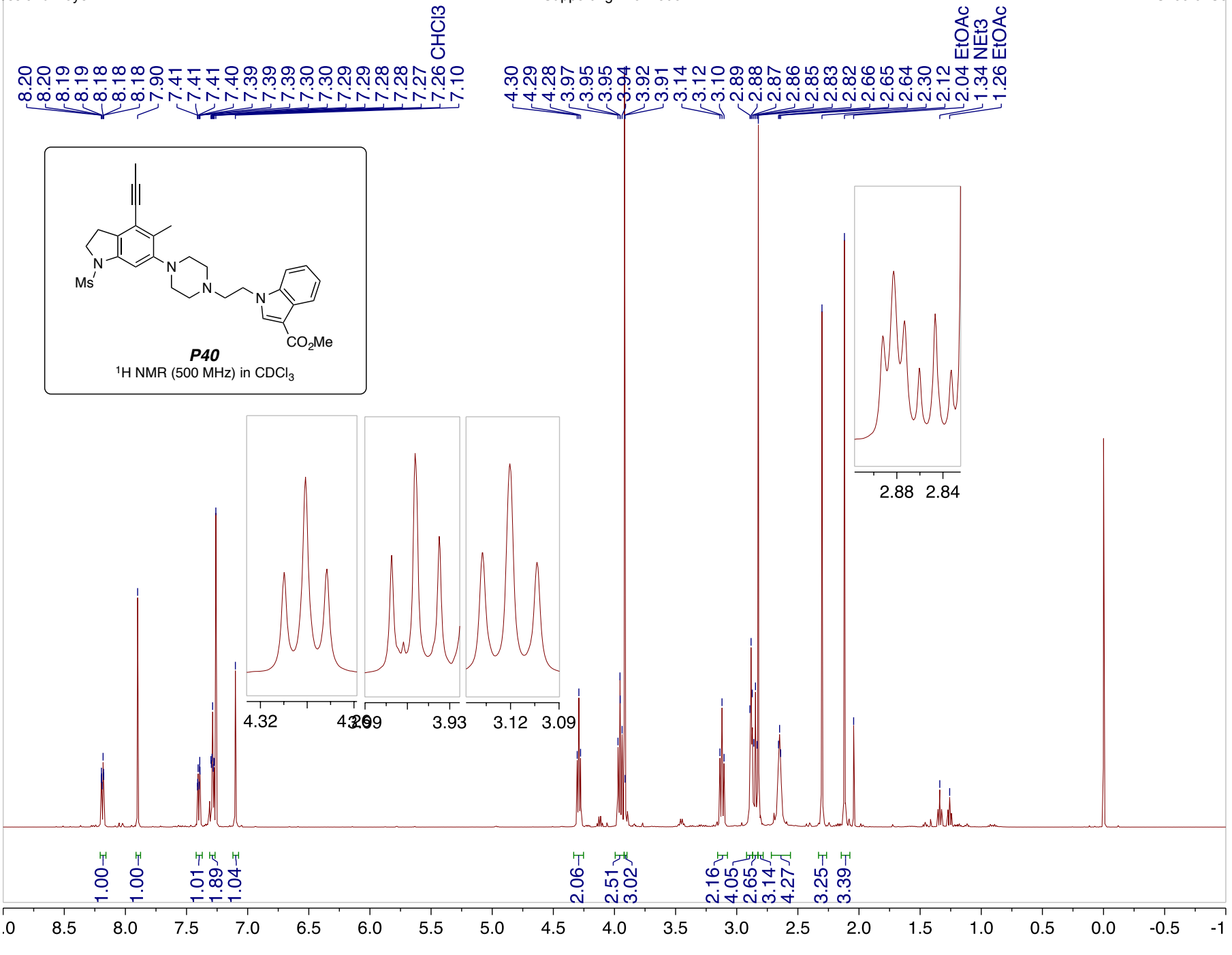

{2.09,4.53}
{2.38,20.47}
{2.86,34.67}
{3.38,48.06}
{4.68,54.34}
{4.63,53.67}
{2.66,57.24}
{2.63,53.34}
{6.67,117.97}
MsN
N
N
N3
P39-maj
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

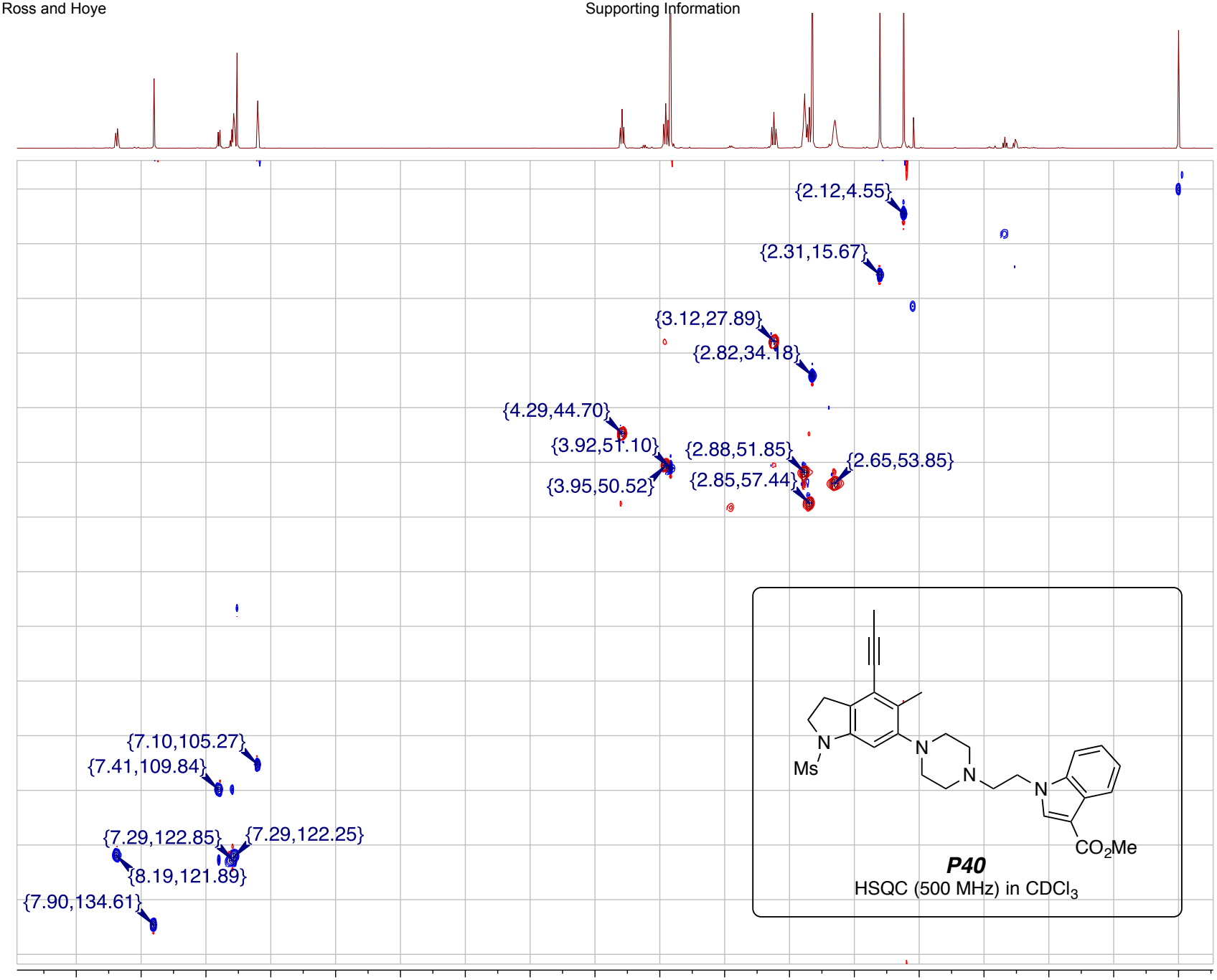

MsN
N
N
N3
P39-maj
HMBC (500 MHz) in CDCl3
{2.09,75.36}
{2.08,93.07}
{2.38,112.33}
{2.38,117.97}
{4.64,125.48}
{4.68,140.34}
{2.38,141.26}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5

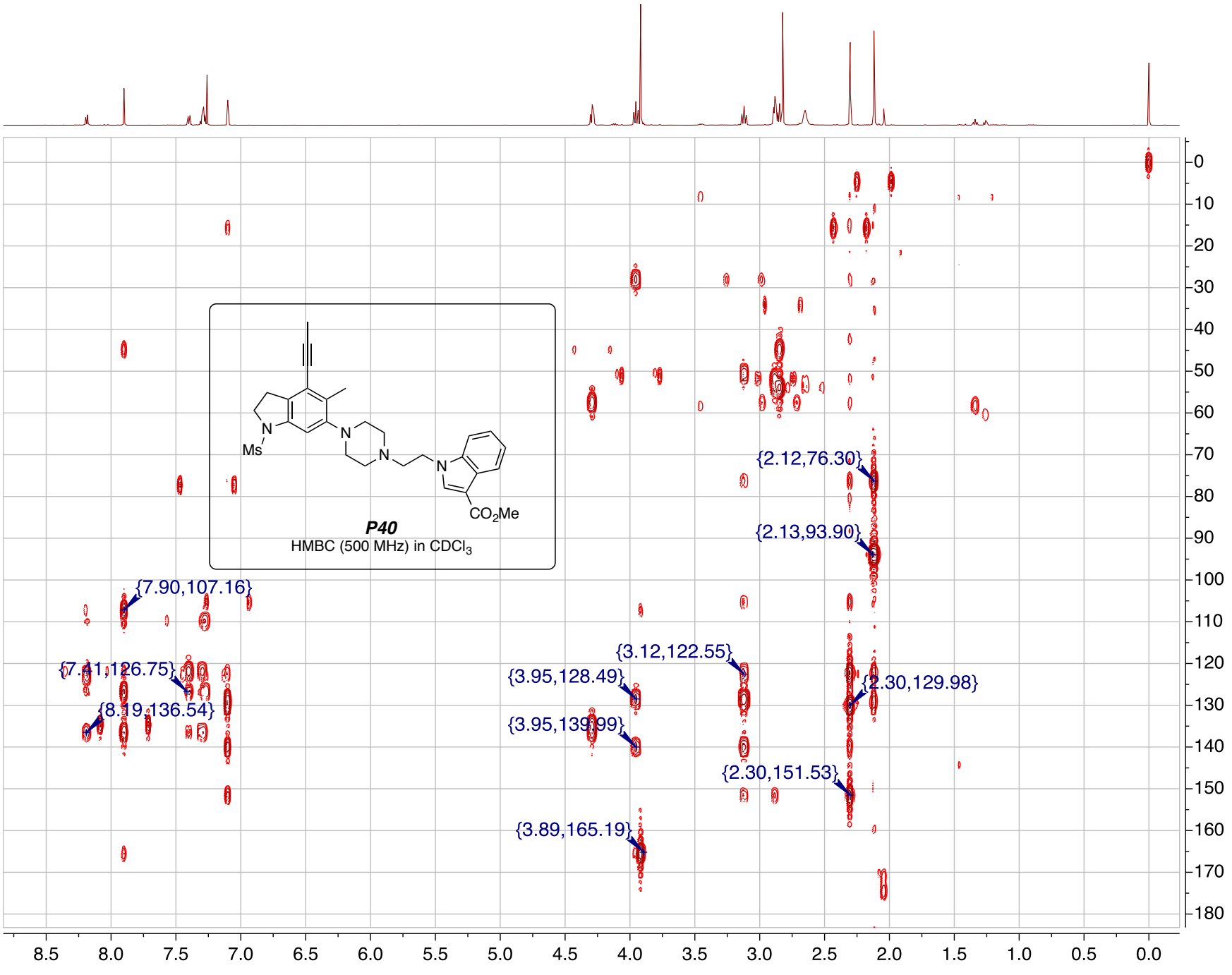

7.27 CHCl3
6.85
4.68
4.67
4.67
4.66
3.40
3.39
3.38
2.90
2.89
2.88
2.87
2.86
2.69
2.68
2.67
2.67
2.36
2.12
MsN
N
N
N3
P39-min
1H NMR (500 MHz) in CDCl3
3.40 3.38
2.92 2.90 2.88
2.70 2.65
1.00
4.28
2.13
7.06
5.66
3.22
3.31

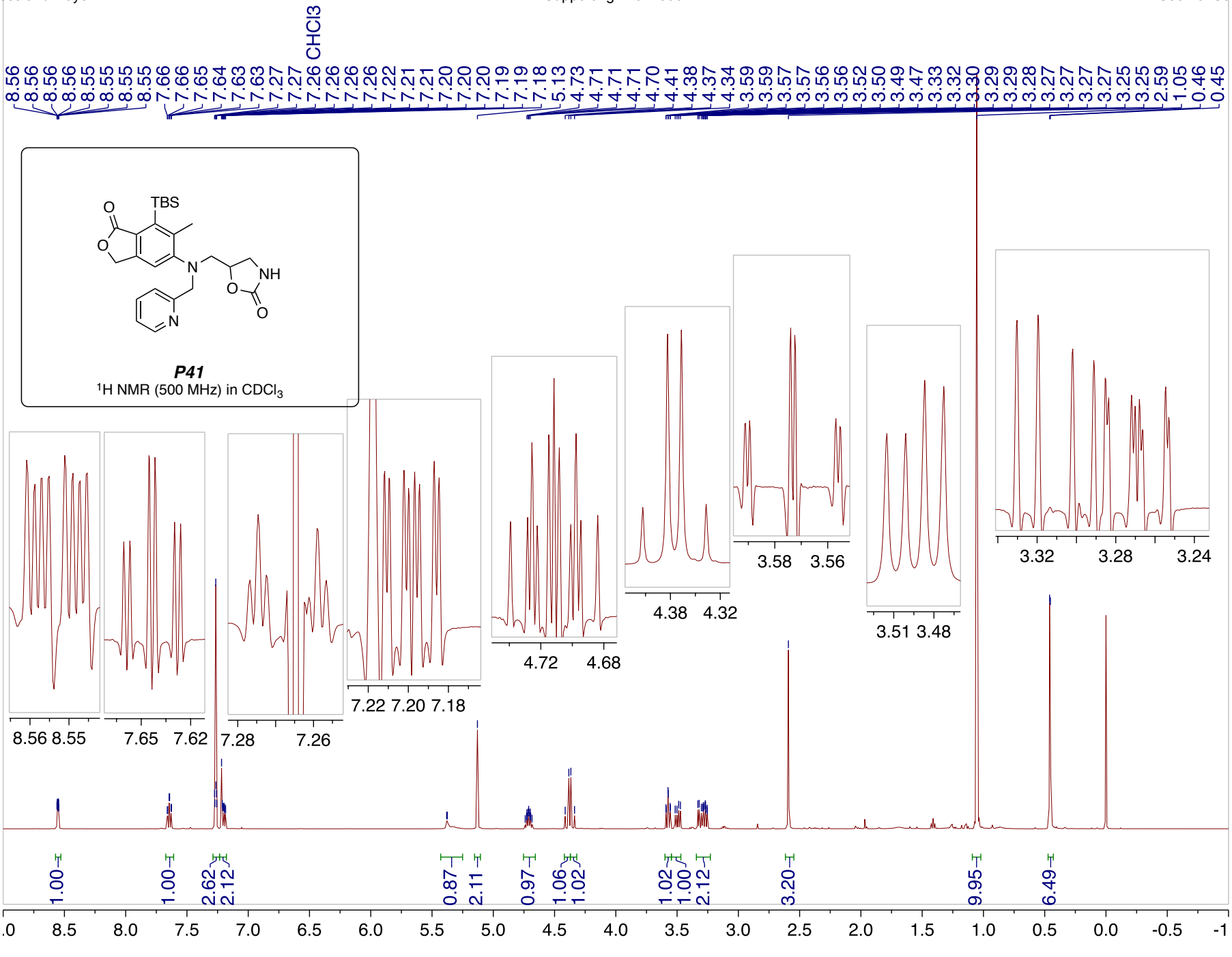

{2.11,4.58}
{2.36,15.90}
{2.85,34.59}
{3.38,48.22}
{4.67,54.25}
{2.67,53.49}
{2.68,57.21}
{6.85,112.73}
MsN
N
N
N3
P39-min
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5

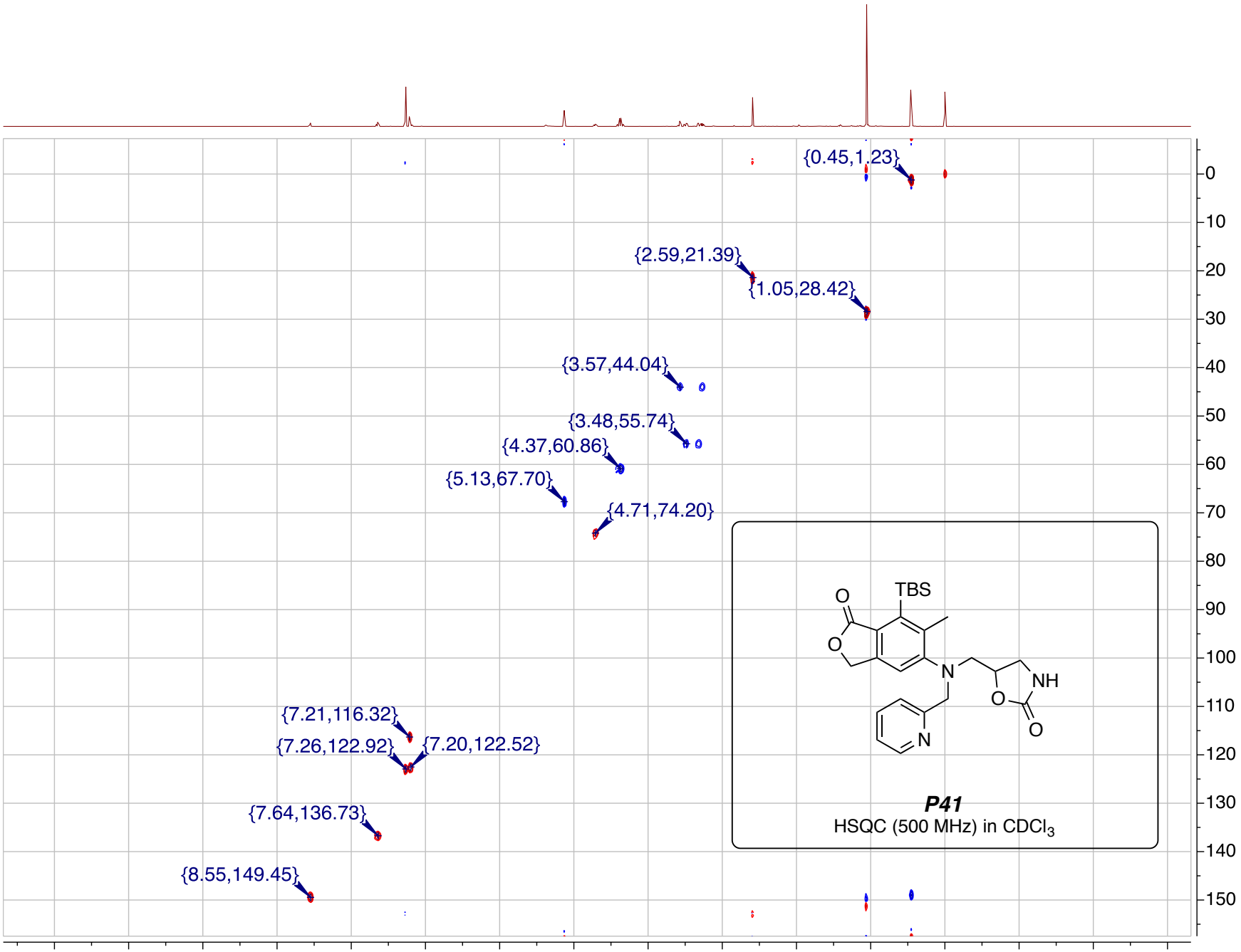

MsN
N
N
N3
P39-min
HMBC (500 MHz) in CDCl3
{2.11,75.79}
{2.10,94.48}
{2.36,120.18}
{2.36,134.58}
{2.36,151.86}
{4.67,133.41}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

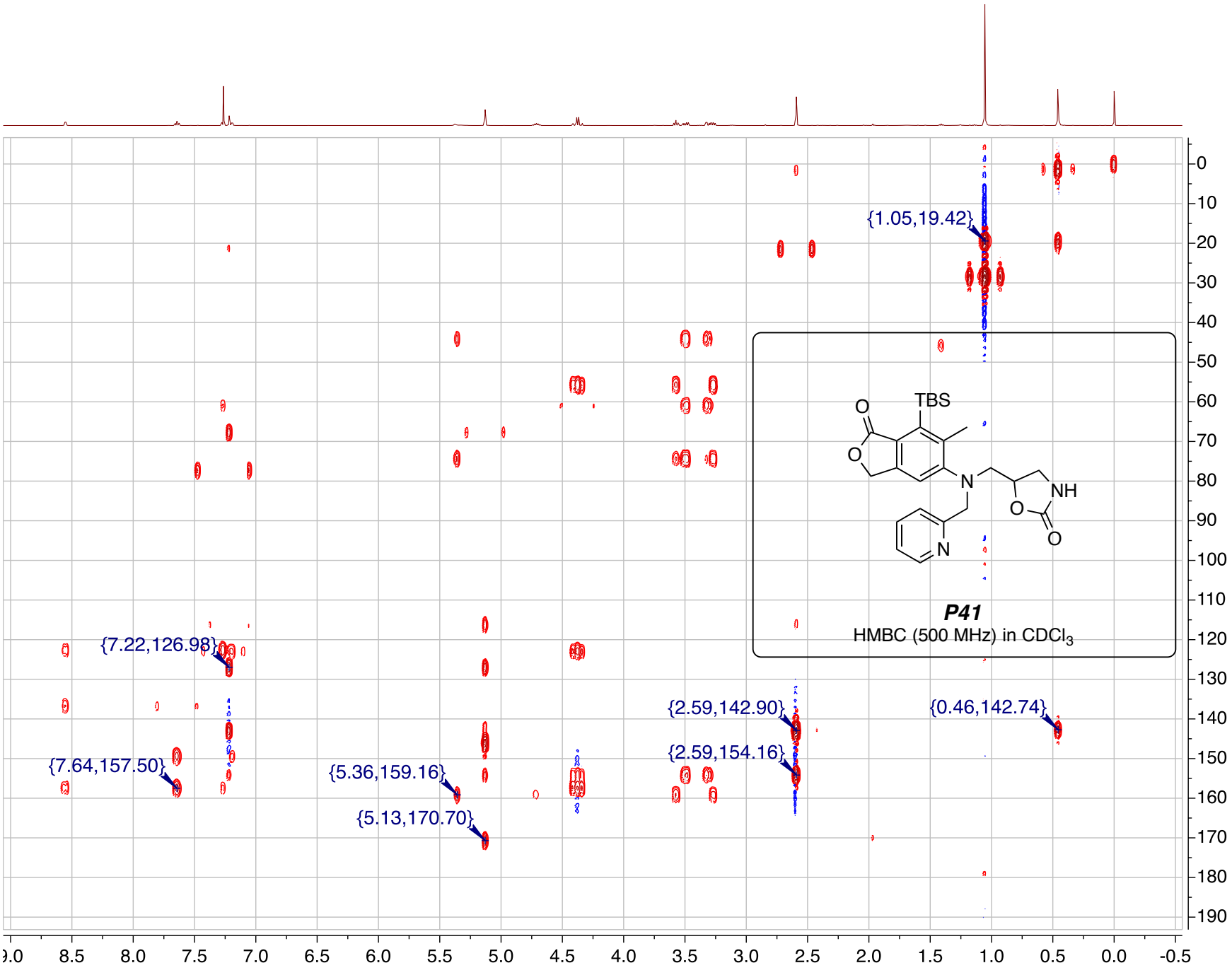

8.20 8.20 8.19 8.19 8.18 8.18 8.18 7.90 7.41 7.41 7.41 7.40 7.39 7.39 7.39 7.30 7.30 7.29 7.29 7.28 7.28 7.27 CHCl3 7.26 7.10
4.30 4.29 4.28 3.97 3.95 3.95 3.94 3.92 3.91 3.14 3.12 3.10 2.89 2.88 2.87 2.86 2.85 2.83 2.82 2.66 2.65 2.64 2.30 2.12 EtOAc 2.04 NEt3 1.34 EtOAc 1.26
Ms
CO2Me
P40
1H NMR (500 MHz) in CDCl3
4.32 4.29 3.99 3.93 3.12 3.09
2.88 2.84
1.00 1.00 1.01 1.89 1.04 2.06 2.51 3.02 2.16 4.05 2.65 3.14 4.27 3.25 3.39
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

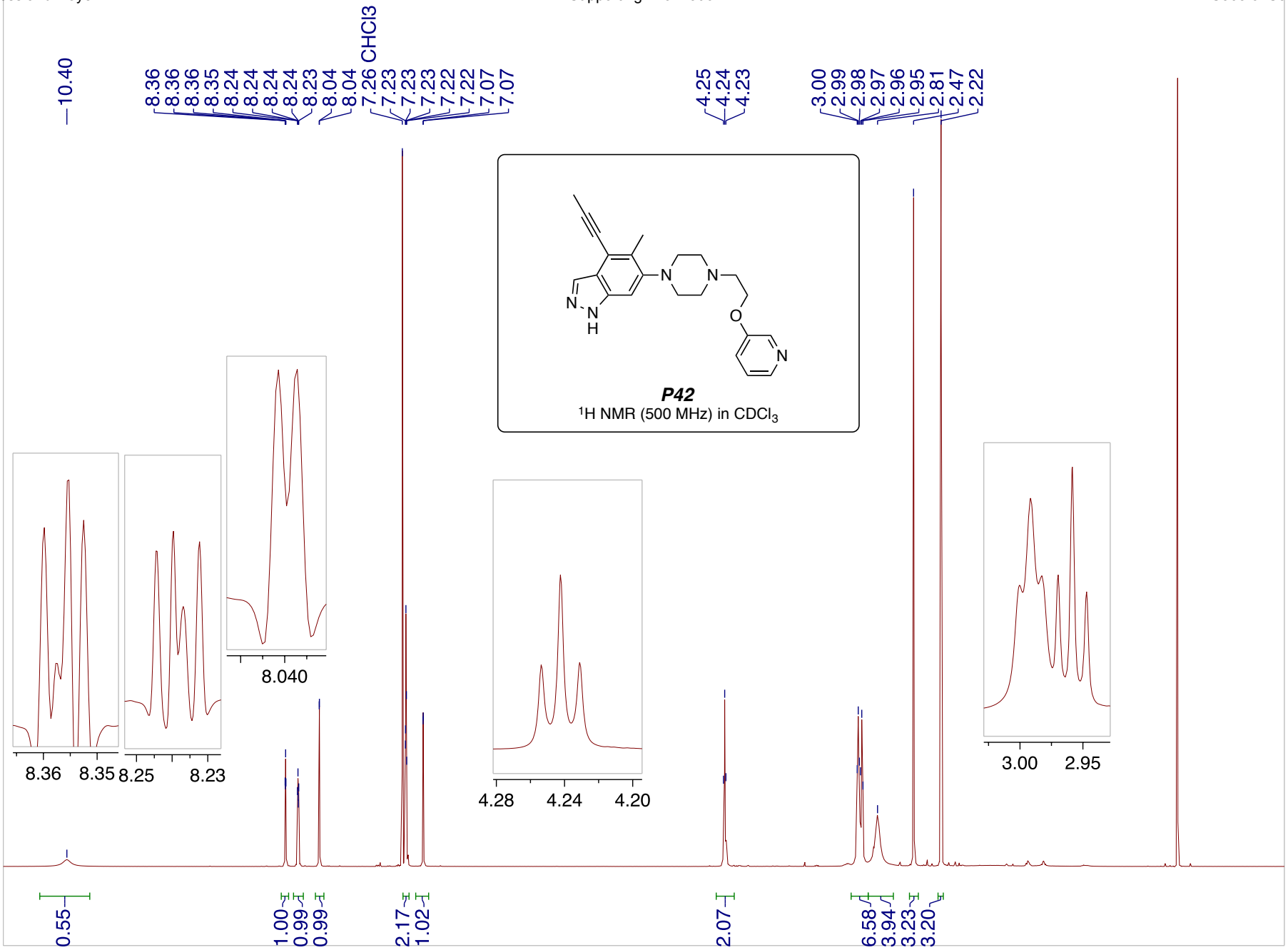

{2.12,4.55}
{2.31,15.67}
{3.12,27.89}
{2.82,34.18}
{4.29,44.70}
{3.92,51.10}
{2.88,51.85}
{2.65,53.85}
{3.95,50.52}
{2.85,57.44}
{7.10,105.27}
{7.41,109.84}
{7.29,122.85}
{7.29,122.25}
{8.19,121.89}
{7.90,134.61}
Ms
N
N
N
N
CO2Me
P40
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

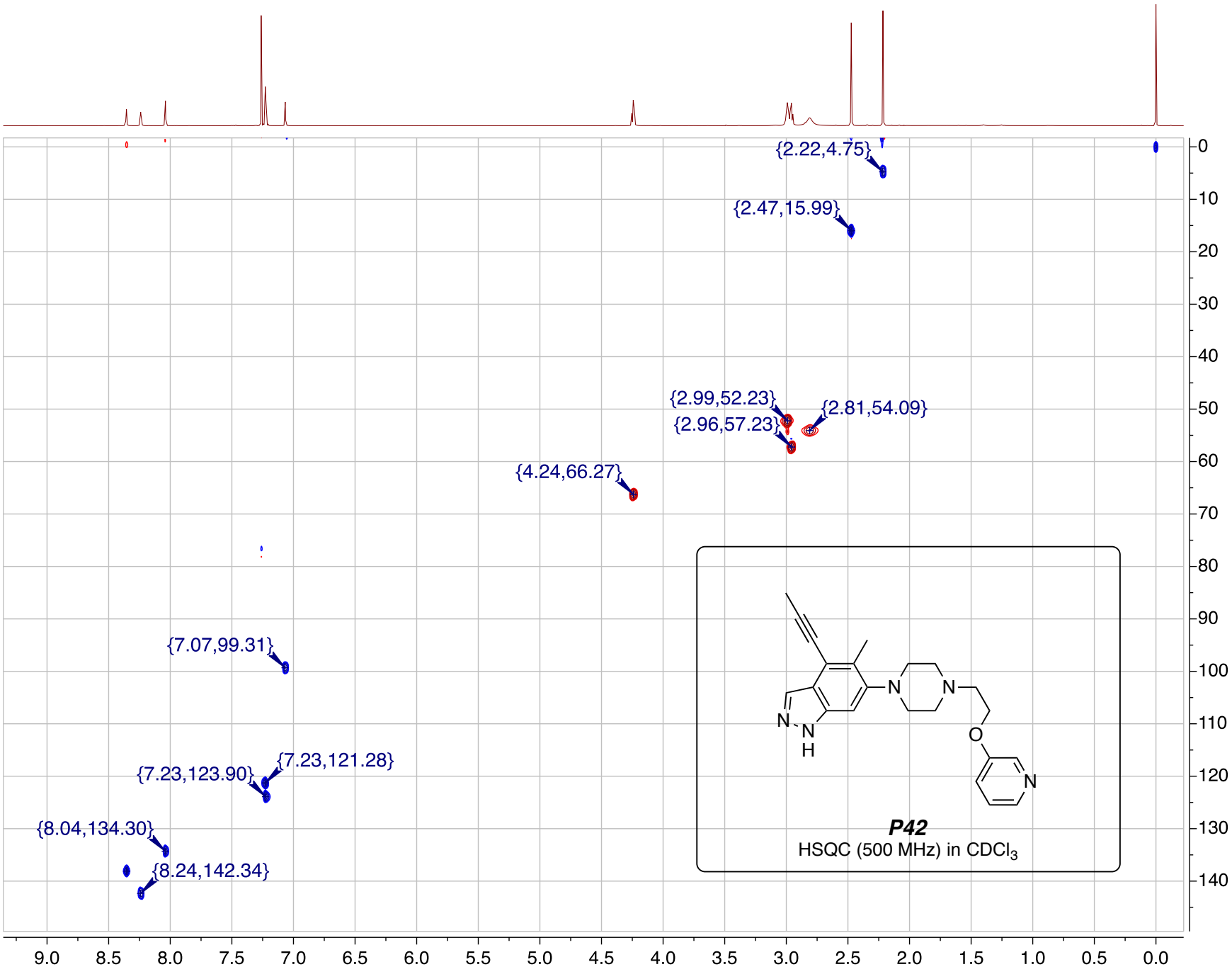

Ms
N
N
N
N
CO2Me
P40
HMBC (500 MHz) in CDCl3
{7.90,107.16}
{7.41,126.75}
{8.19,136.54}
{3.12,122.55}
{3.95,128.49}
{3.95,139.99}
{2.12,76.30}
{2.13,93.90}
{2.30,129.98}
{2.30,151.53}
{3.89,165.19}
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180


CHCl3
8.56 8.56 8.56 8.56 8.55 8.55 8.55 8.55 7.66 7.66 7.65 7.64 7.63 7.63 7.27 7.27 7.26 7.26 7.26 7.26 7.22 7.21 7.21 7.20 7.20 7.20 7.19 7.19 7.18 5.13 4.73 4.71 4.71 4.71 4.70 4.41 4.38 4.37 4.34 3.59 3.59 3.57 3.57 3.56 3.56 3.52 3.50 3.49 3.47 3.33 3.32 3.30 3.29 3.29 3.28 3.27 3.27 3.27 3.27 3.25 3.25 2.59 1.05 0.46 0.45
TBS
O
O
N
NH
O
O
N
P41
1H NMR (500 MHz) in CDCl3
8.56 8.55
7.65 7.62
7.28 7.26
7.22 7.20 7.18
4.72 4.68
4.38 4.32
3.58 3.56
3.51 3.48
3.32 3.28 3.24
1.00 1.00 2.62 2.12 0.87 2.11 0.97 1.06 1.02 1.02 1.00 2.12 3.20 9.95 6.49
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

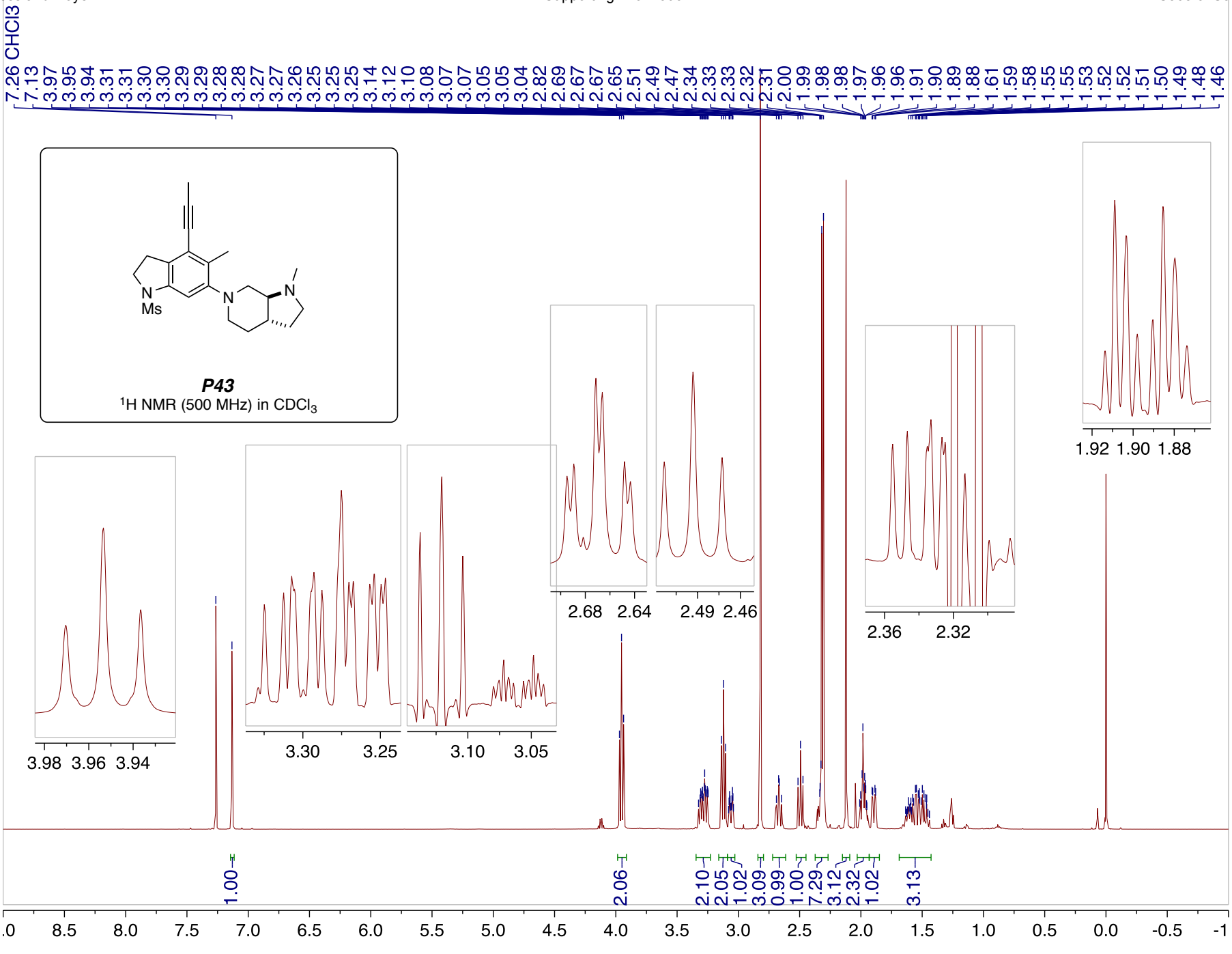

{0.45,1.23}
{2.59,21.39}
{1.05,28.42}
{3.57,44.04}
{3.48,55.74}
{4.37,60.86}
{5.13,67.70}
{4.71,74.20}
{7.21,116.32}
{7.26,122.92}
{7.20,122.52}
{7.64,136.73}
{8.55,149.45}
TBS
O
O
N
NH
O
O
N
P41
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3

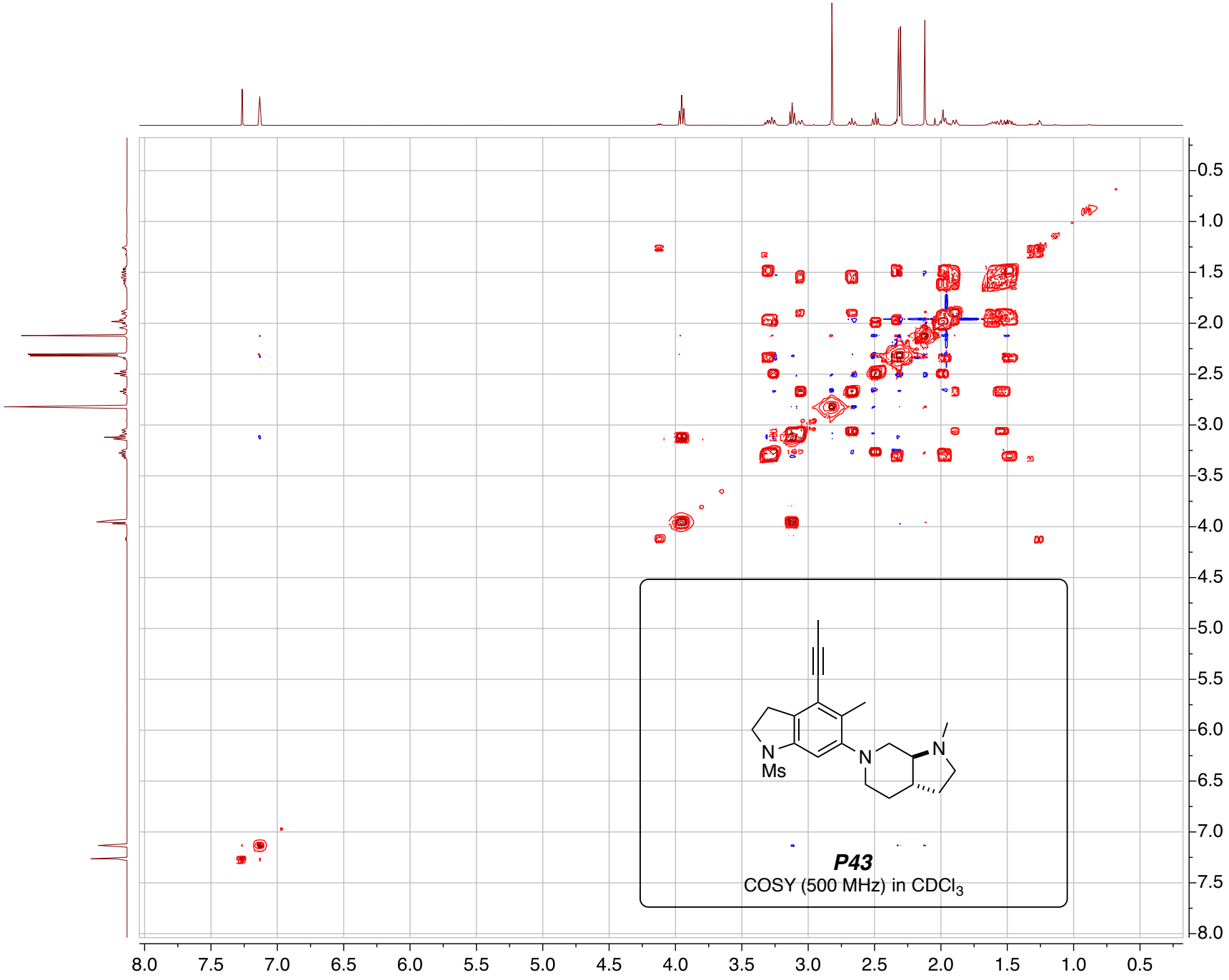

{1.05,19.42}
{7.22,126.98}
{7.64,157.50}
{5.36,159.16}
{5.13,170.70}
{2.59,142.90}
{2.59,154.16}
{0.46,142.74}
TBS
O
O
N
NH
O
O
N
P41
HMBC (500 MHz) in CDCl3

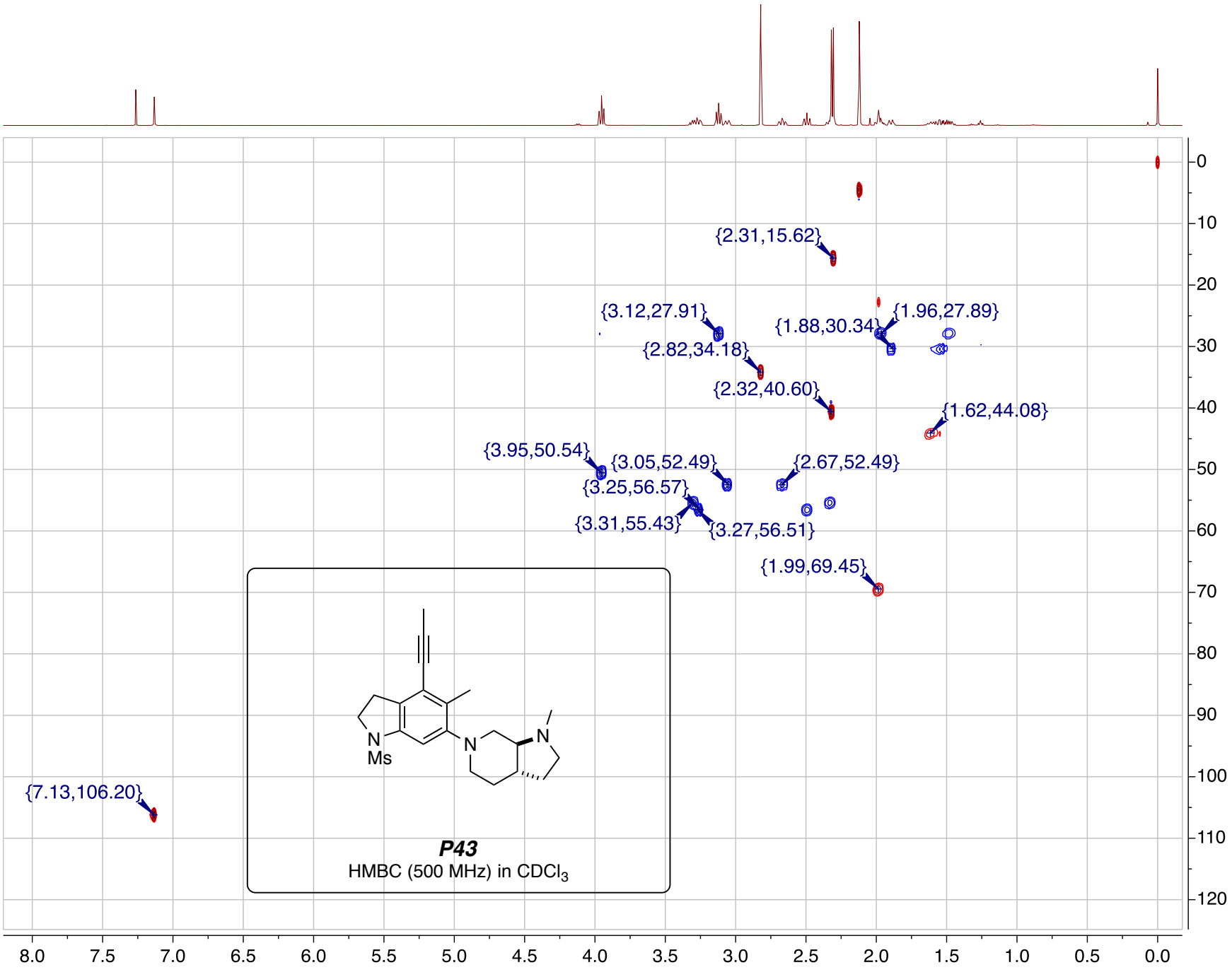

10.40
8.36
8.36
8.36
8.35
8.24
8.24
8.24
8.24
8.23
8.04
8.04
CHCl3
7.26
7.23
7.23
7.23
7.22
7.22
7.07
7.07
4.25
4.24
4.23
3.00
2.99
2.98
2.97
2.96
2.95
2.81
2.47
2.22
N
N
N
N
H
O
N
P42
1H NMR (500 MHz) in CDCl3
8.040
8.36
8.35
8.25
8.23
4.28
4.24
4.20
3.00
2.95
0.55
1.00
0.99
0.99
2.17
1.02
2.07
6.58
3.94
3.23
3.20
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1

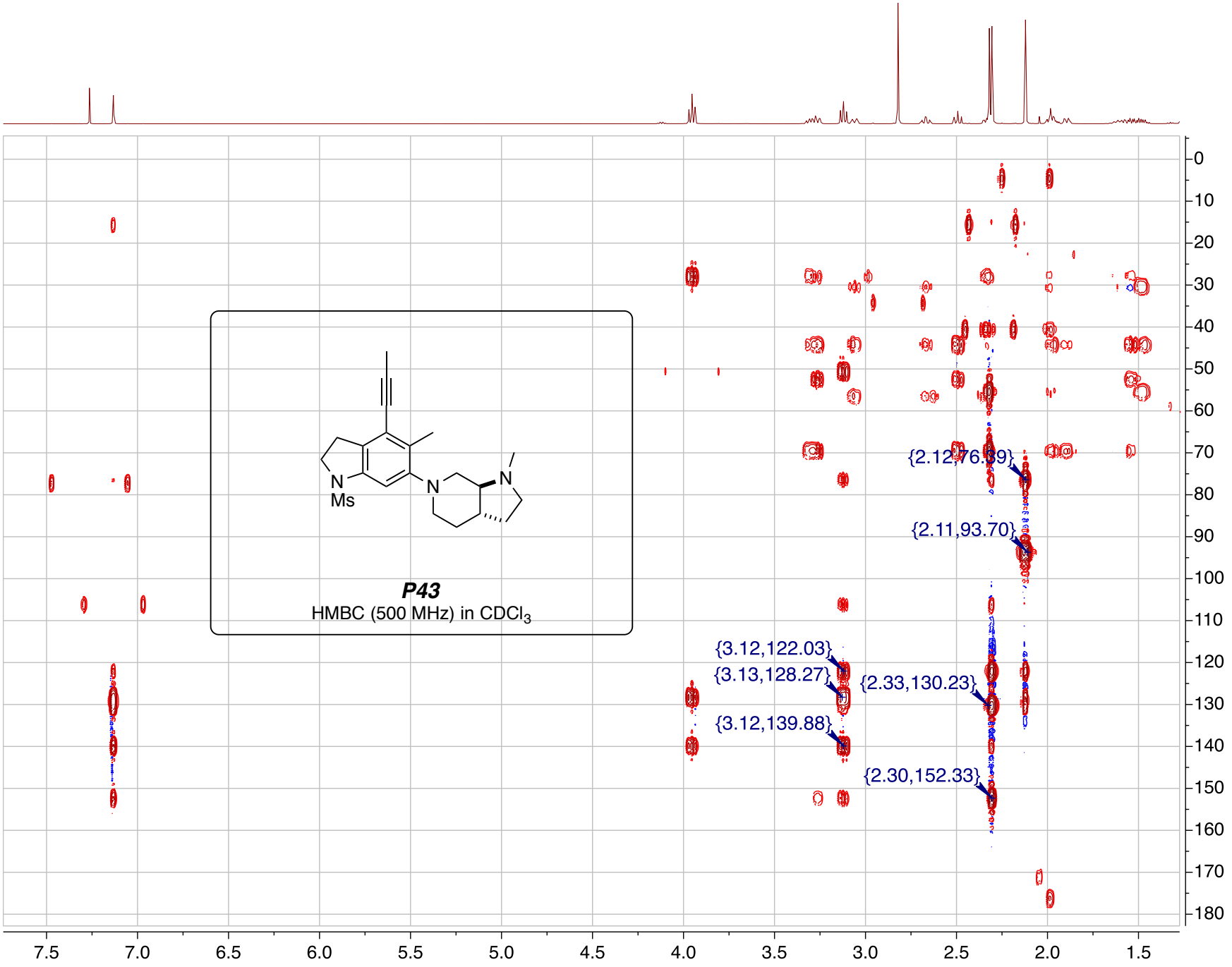

{2.22,4.75}
{2.47,15.99}
{2.99,52.23}
{2.96,57.23}
{2.81,54.09}
{4.24,66.27}
{7.07,99.31}
{7.23,123.90}
{7.23,121.28}
{8.04,134.30}
{8.24,142.34}
P42
HSQC (500 MHz) in CDCl3

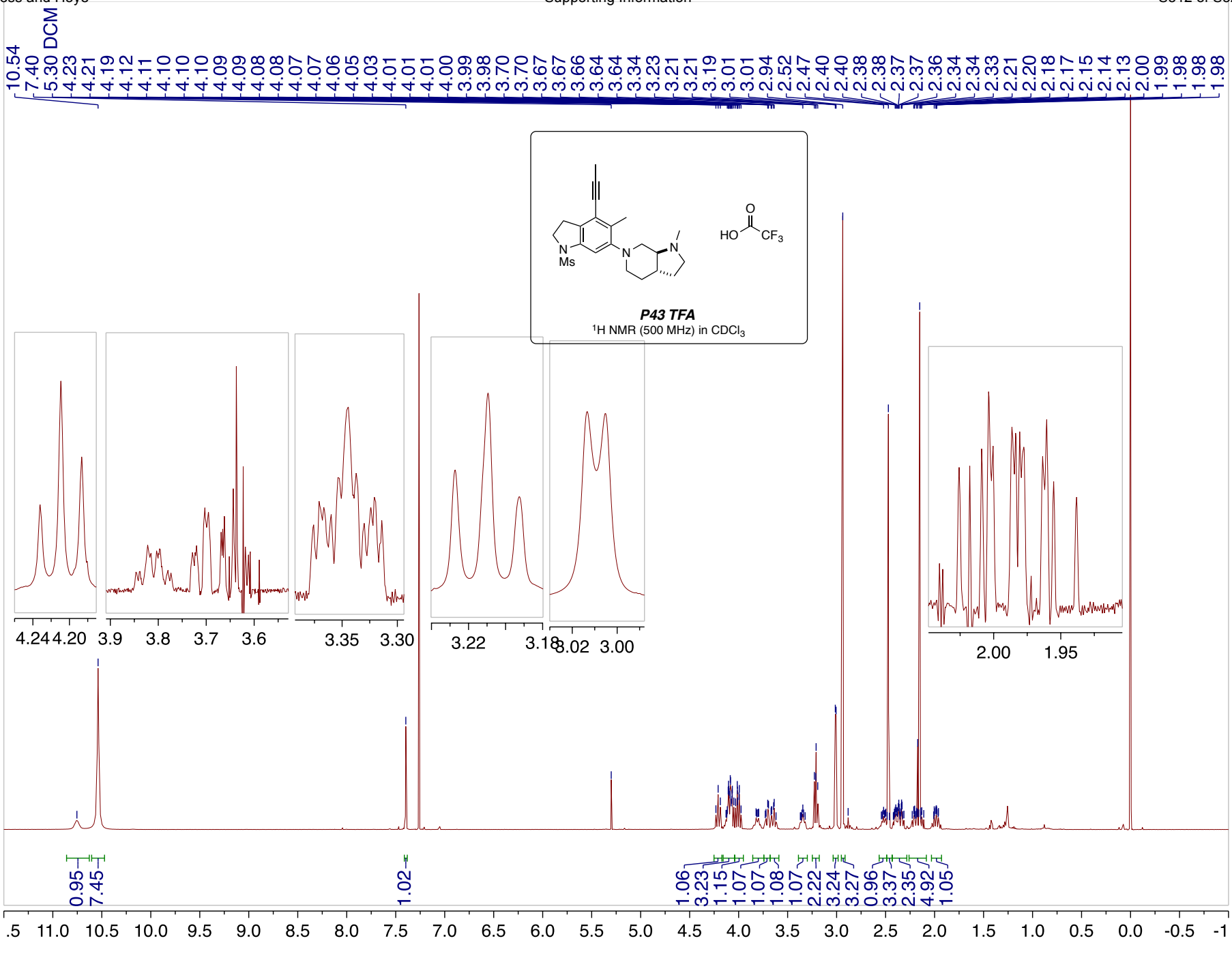

P42
HMBC (500 MHz) in CDCl3
{2.22,76.55}
{2.22,93.67}
{2.47,116.43}
{2.22,121.47}
{2.47,130.04}
{8.04,139.15}
{4.24,154.99}
{2.47,151.91}

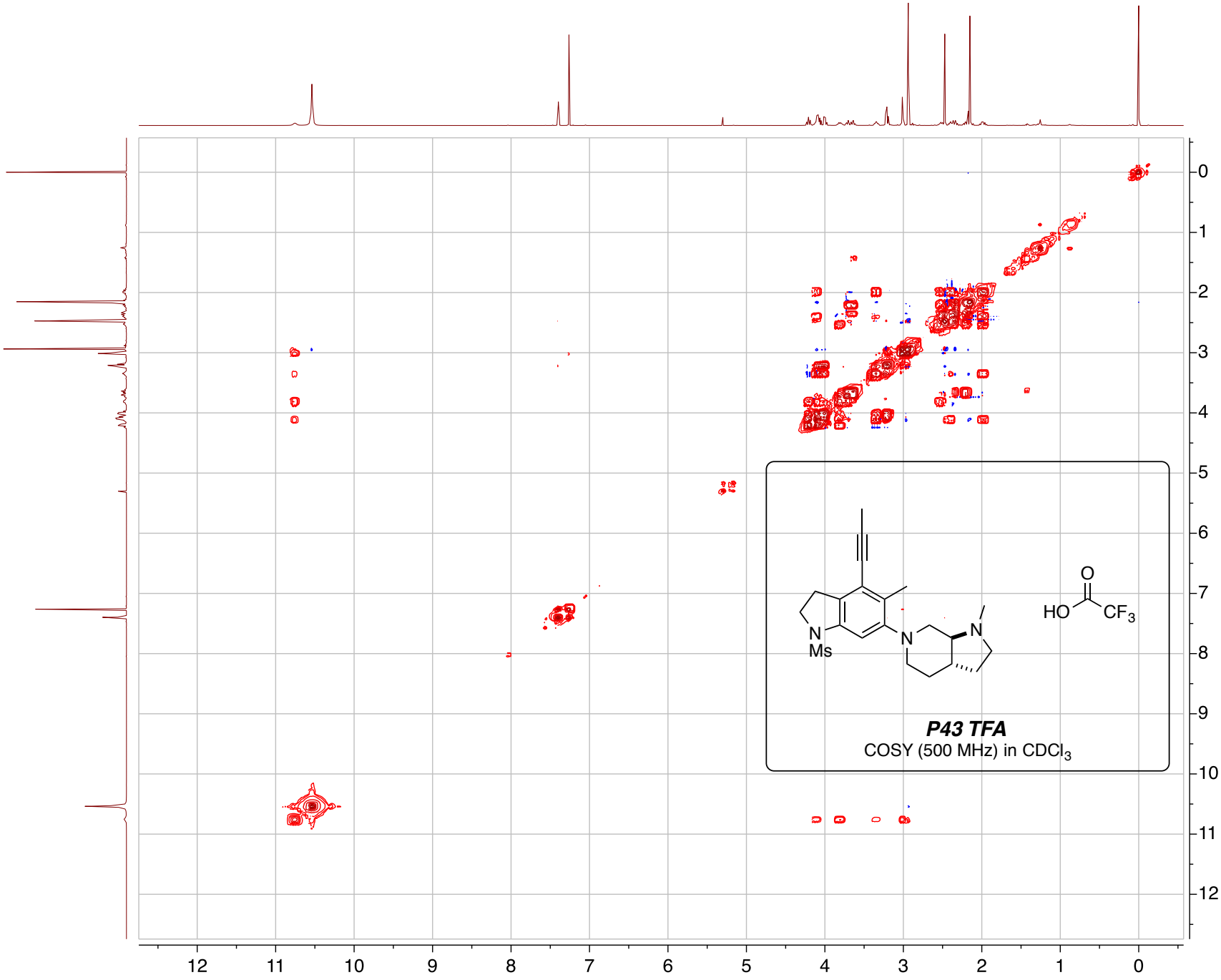

CHCl3
7.26 7.13 3.97 3.95 3.94 3.31 3.31 3.30 3.30 3.29 3.29 3.28 3.28 3.27 3.27 3.26 3.25 3.25 3.25 3.14 3.12 3.10 3.08 3.07 3.07 3.05 3.05 3.04 2.82 2.69 2.67 2.67 2.65 2.51 2.49 2.47 2.34 2.33 2.33 2.32 2.31 2.00 1.99 1.98 1.98 1.97 1.96 1.96 1.91 1.90 1.89 1.88 1.61 1.59 1.58 1.55 1.55 1.53 1.52 1.52 1.51 1.50 1.49 1.48 1.46
N
Ms
N
N
P43
1H NMR (500 MHz) in CDCl3
3.98 3.96 3.94
3.30 3.25
3.10 3.05
2.68 2.64
2.49 2.46
2.36 2.32
1.92 1.90 1.88
1.00
2.06
2.10
2.05
1.02
3.09
0.99
1.00
7.29
3.12
2.32
1.02
3.13
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

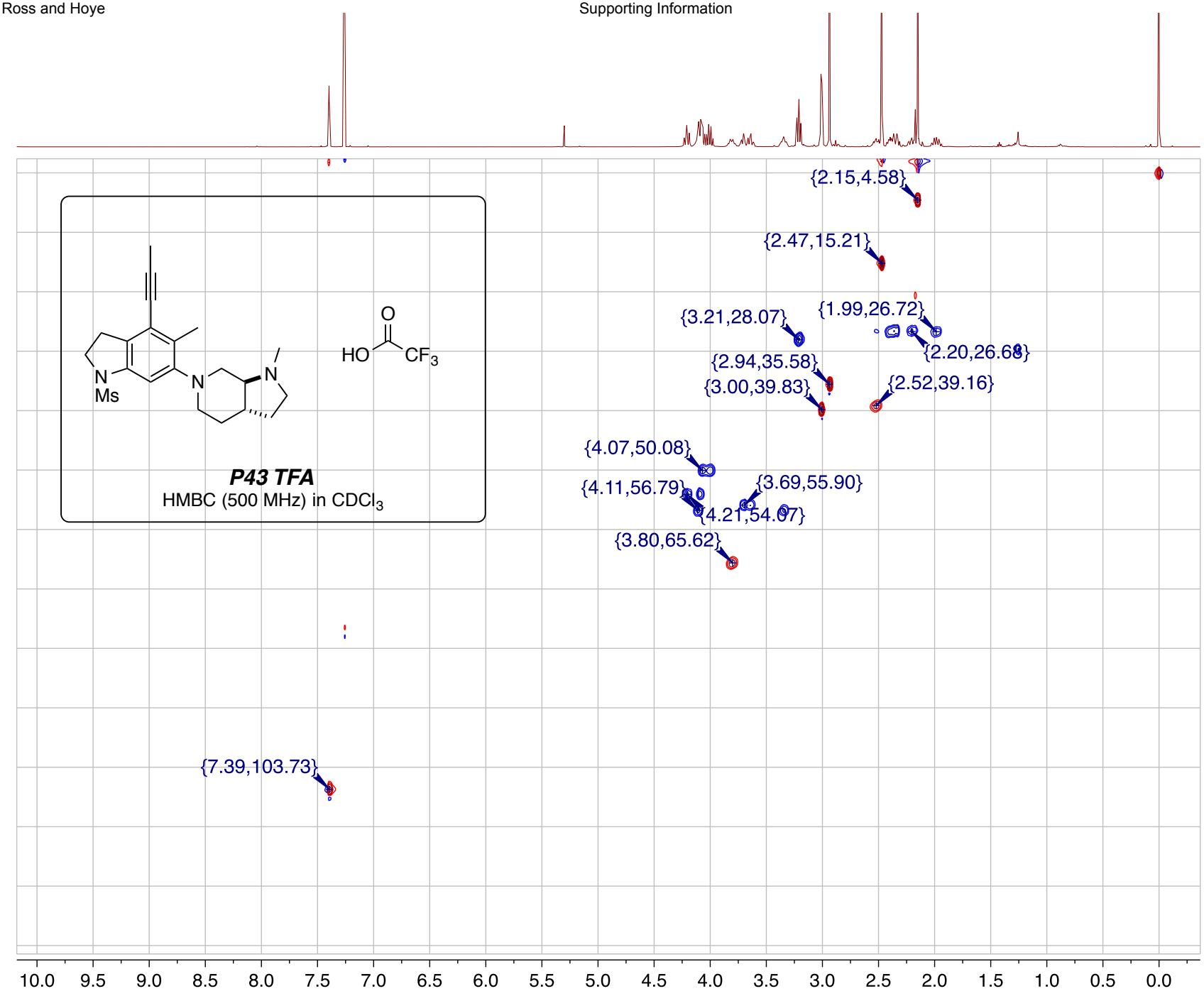

N
Ms
N
N
P43
COSY (500 MHz) in CDCl3
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5

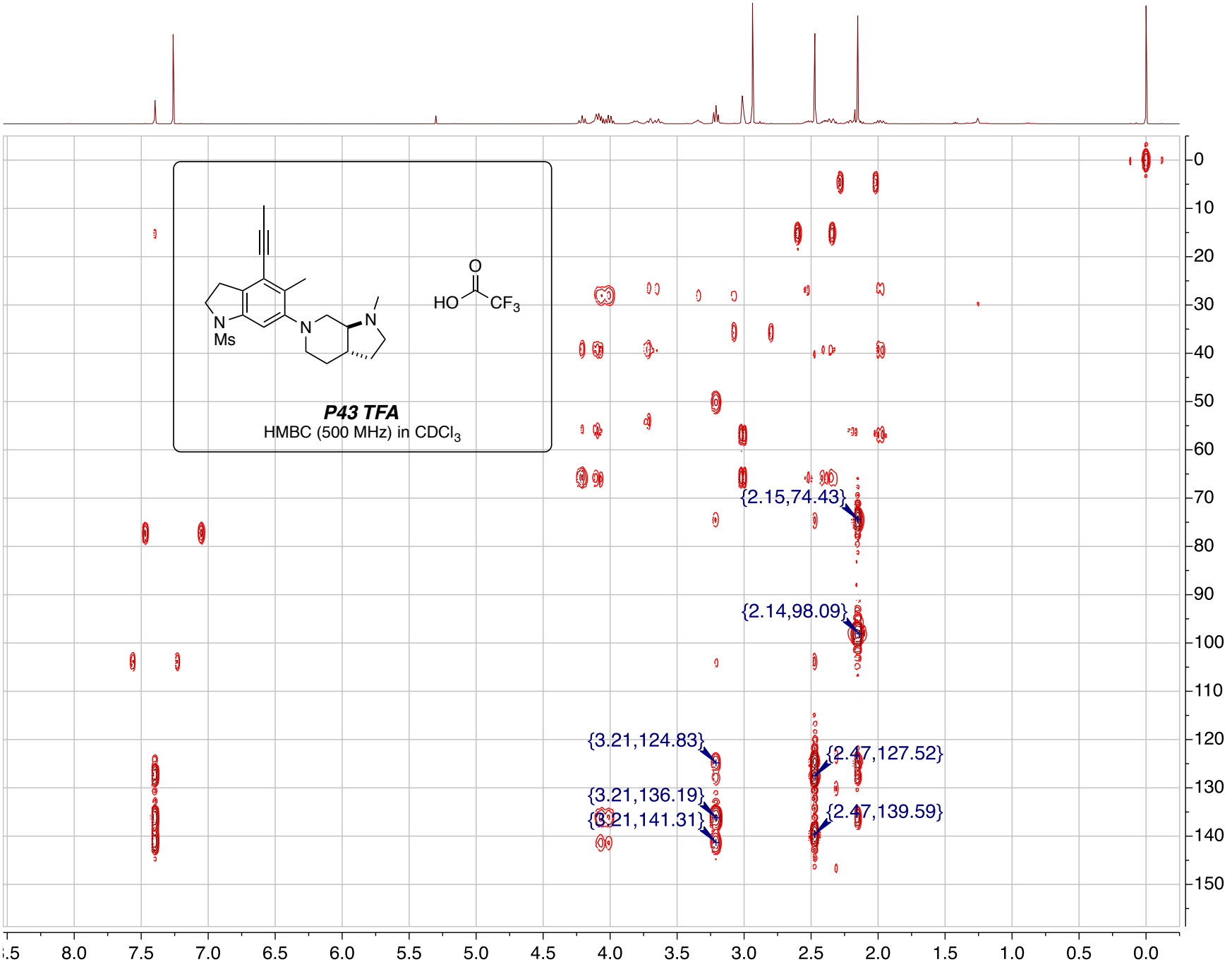

{2.31,15.62}
{3.12,27.91}
{1.96,27.89}
{1.88,30.34}
{2.82,34.18}
{2.32,40.60}
{1.62,44.08}
{3.95,50.54}
{3.05,52.49}
{2.67,52.49}
{3.25,56.57}
{3.31,55.43}
{3.27,56.51}
{1.99,69.45}
{7.13,106.20}
N
Ms
N
N
P43
HMBC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

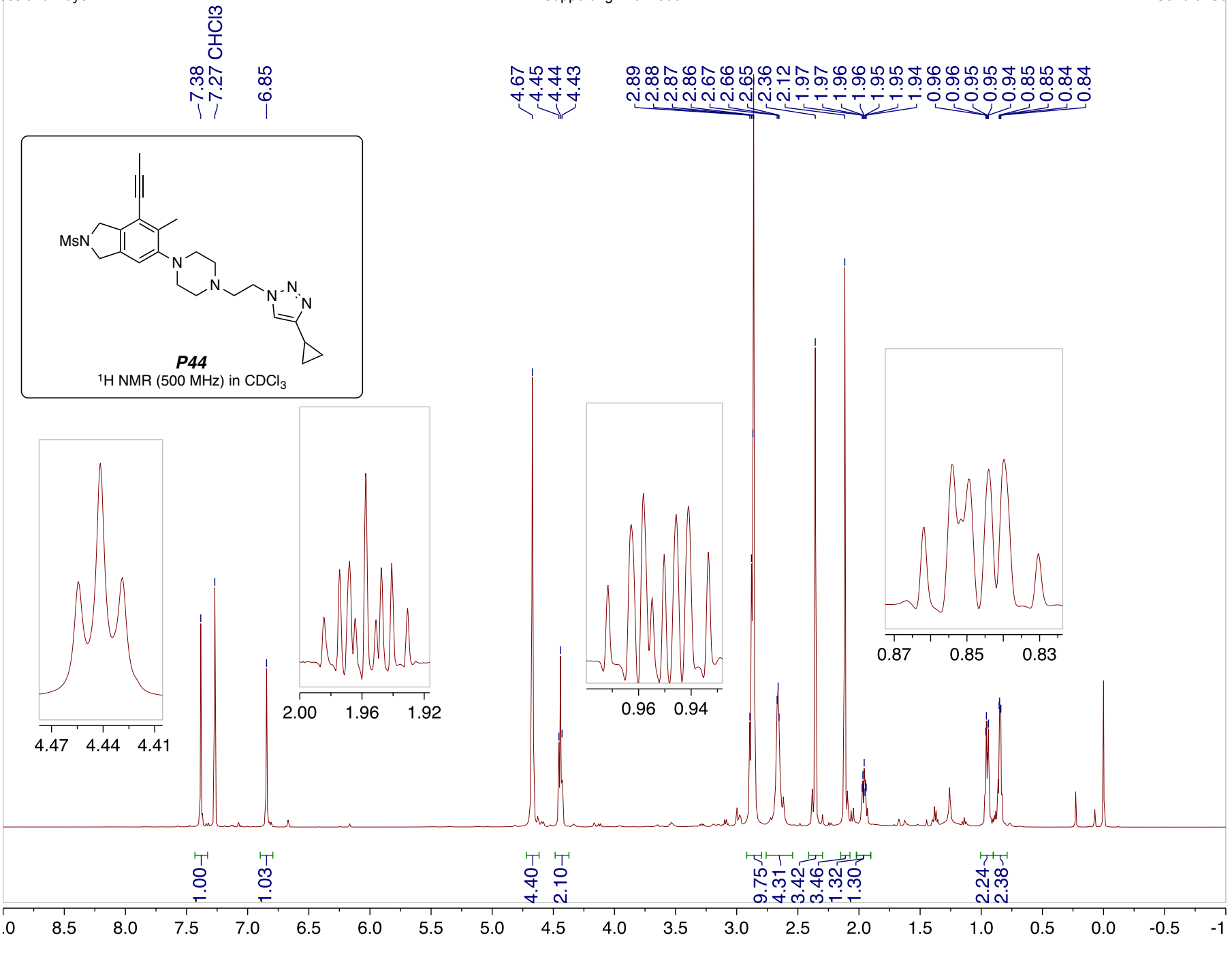

N
Ms
N
N
P43
HMBC (500 MHz) in CDCl3
{2.12,76.39}
{2.11,93.70}
{3.12,122.03}
{3.13,128.27}
{2.33,130.23}
{3.12,139.88}
{2.30,152.33}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5

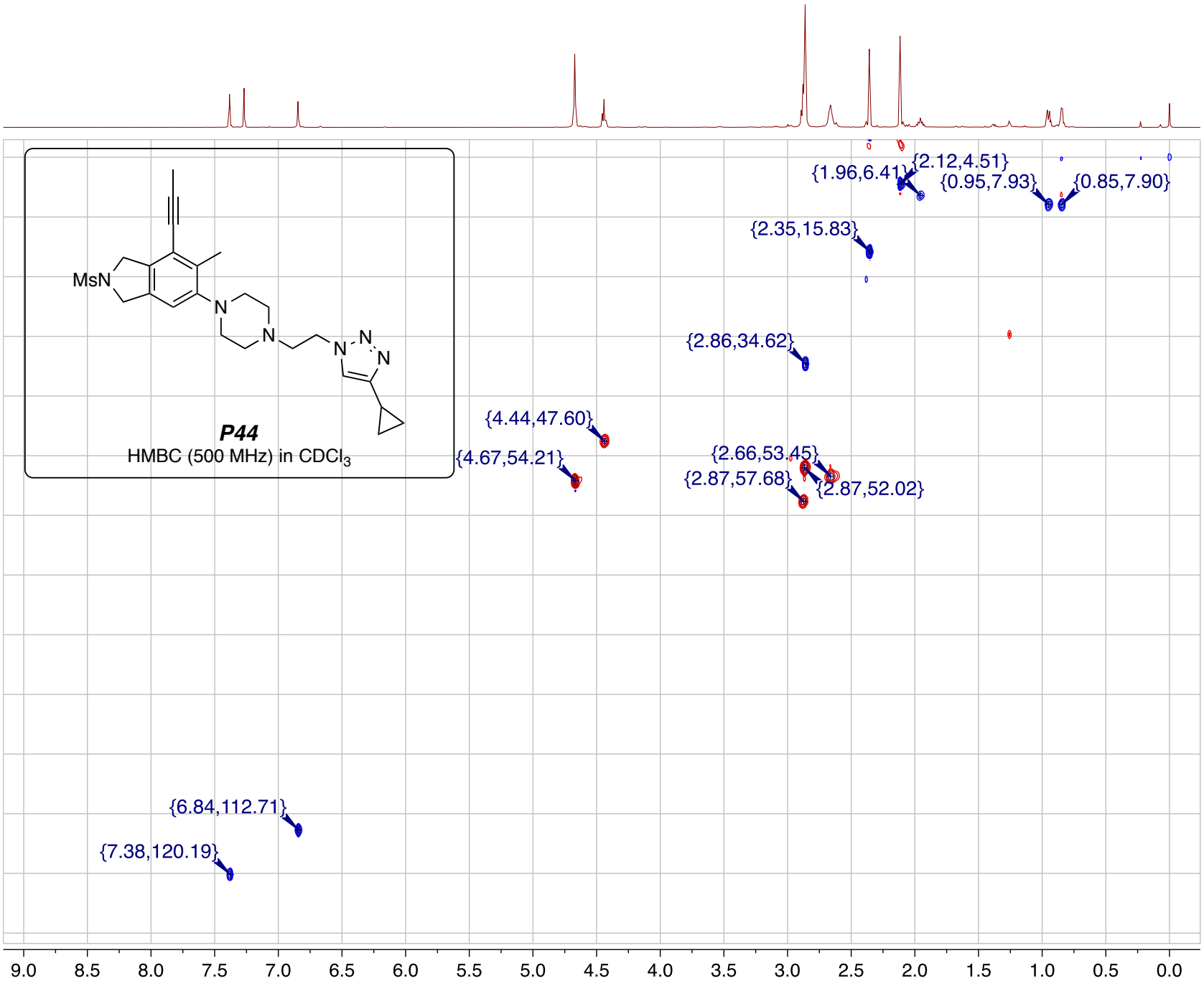

10.54
7.40
5.30 DCM
4.23
4.21
4.19
4.12
4.11
4.10
4.10
4.10
4.09
4.09
4.08
4.08
4.07
4.07
4.06
4.05
4.03
4.01
4.01
4.01
4.00
3.99
3.98
3.70
3.70
3.67
3.67
3.66
3.64
3.64
3.34
3.23
3.21
3.21
3.19
3.01
3.01
2.94
2.52
2.47
2.40
2.40
2.38
2.38
2.37
2.37
2.36
2.34
2.34
2.33
2.21
2.20
2.18
2.17
2.15
2.14
2.13
2.00
1.99
1.98
1.98
1.98
N
Ms
N
N
HO
O
CF3
P43 TFA
1H NMR (500 MHz) in CDCl3
4.24 4.20
3.9
3.8
3.7
3.6
3.35
3.30
3.22
3.18
8.02
3.00
2.00
1.95
0.95
7.45
1.02
1.06
3.23
1.15
1.07
1.07
1.08
1.07
2.22
3.24
3.27
0.96
3.37
2.35
4.92
1.05
.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1

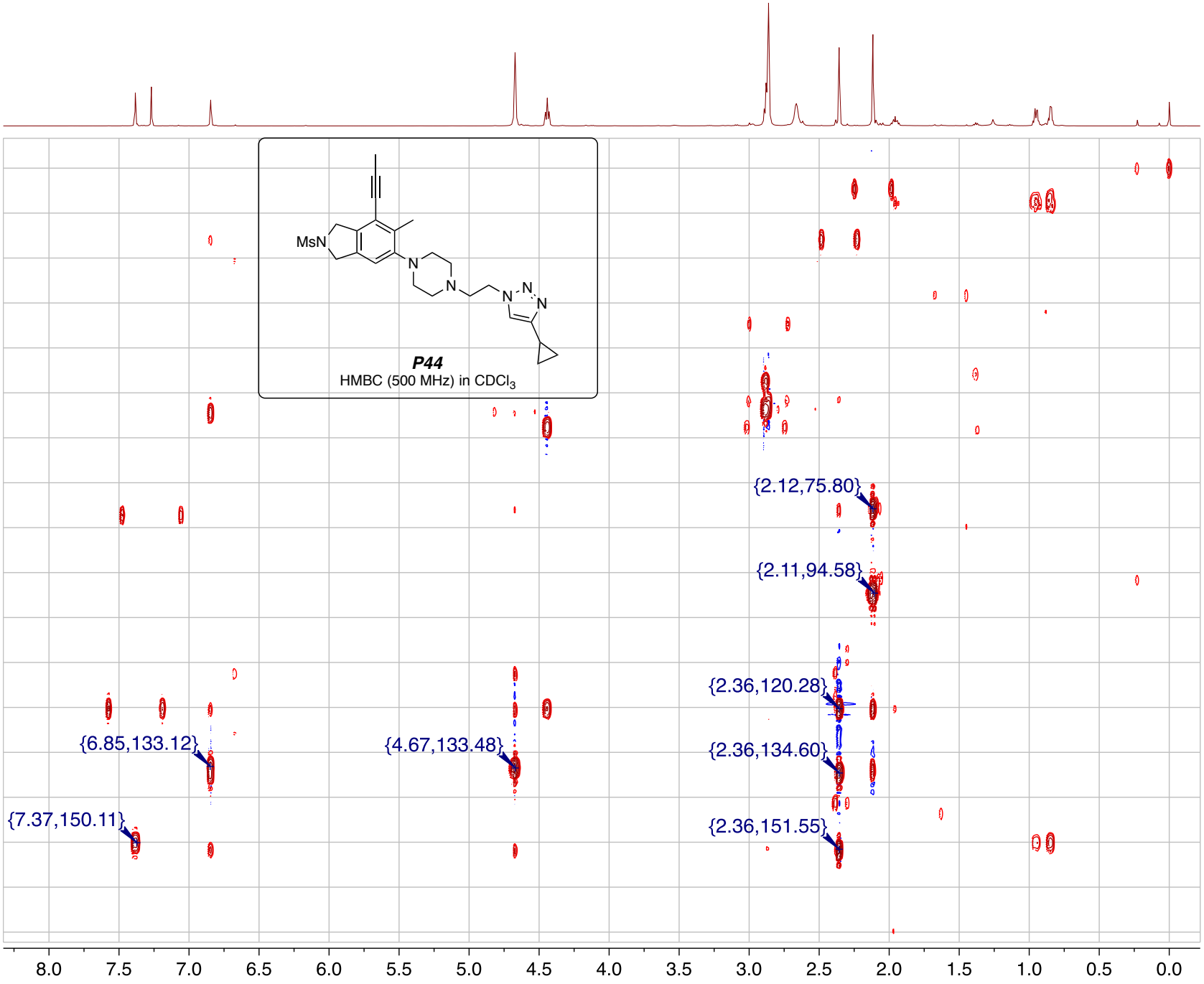

N
Ms
N
N
HO
O
CF3
P43 TFA
COSY (500 MHz) in CDCl3
0
1
2
3
4
5
6
7
8
9
10
11
12
12
11
10
9
8
7
6
5
4
3
2
1
0

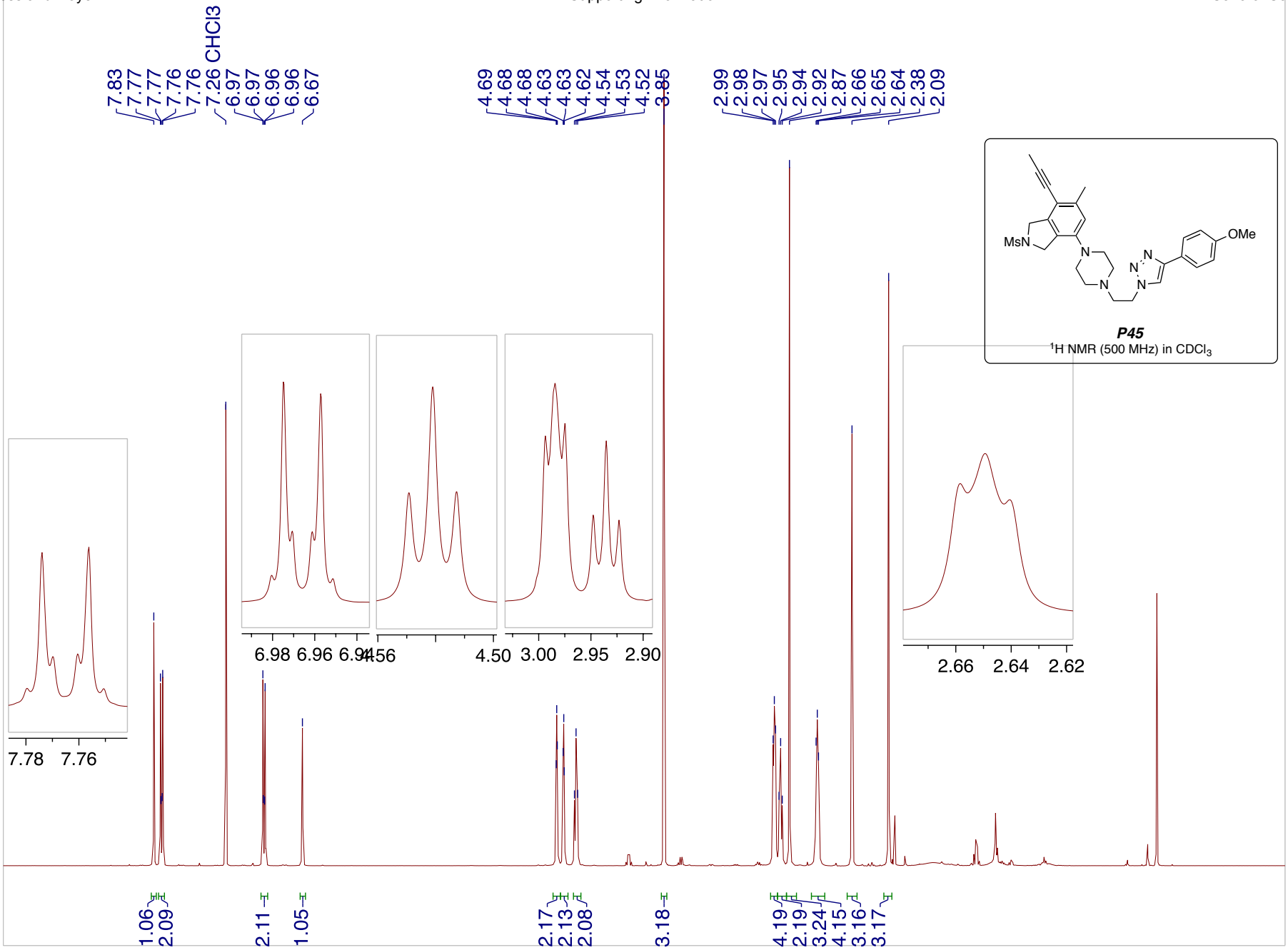

{2.15,4.58}
{2.47,15.21}
{1.99,26.72}
{3.21,28.07}
{2.20,26.68}
{2.94,35.58}
{3.00,39.83}
{2.52,39.16}
{4.07,50.08}
{4.11,56.79}
{3.69,55.90}
{4.21,54.07}
{3.80,65.62}
{7.39,103.73}
N
Ms
N
N
O
HO
CF3
P43 TFA
HMBC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

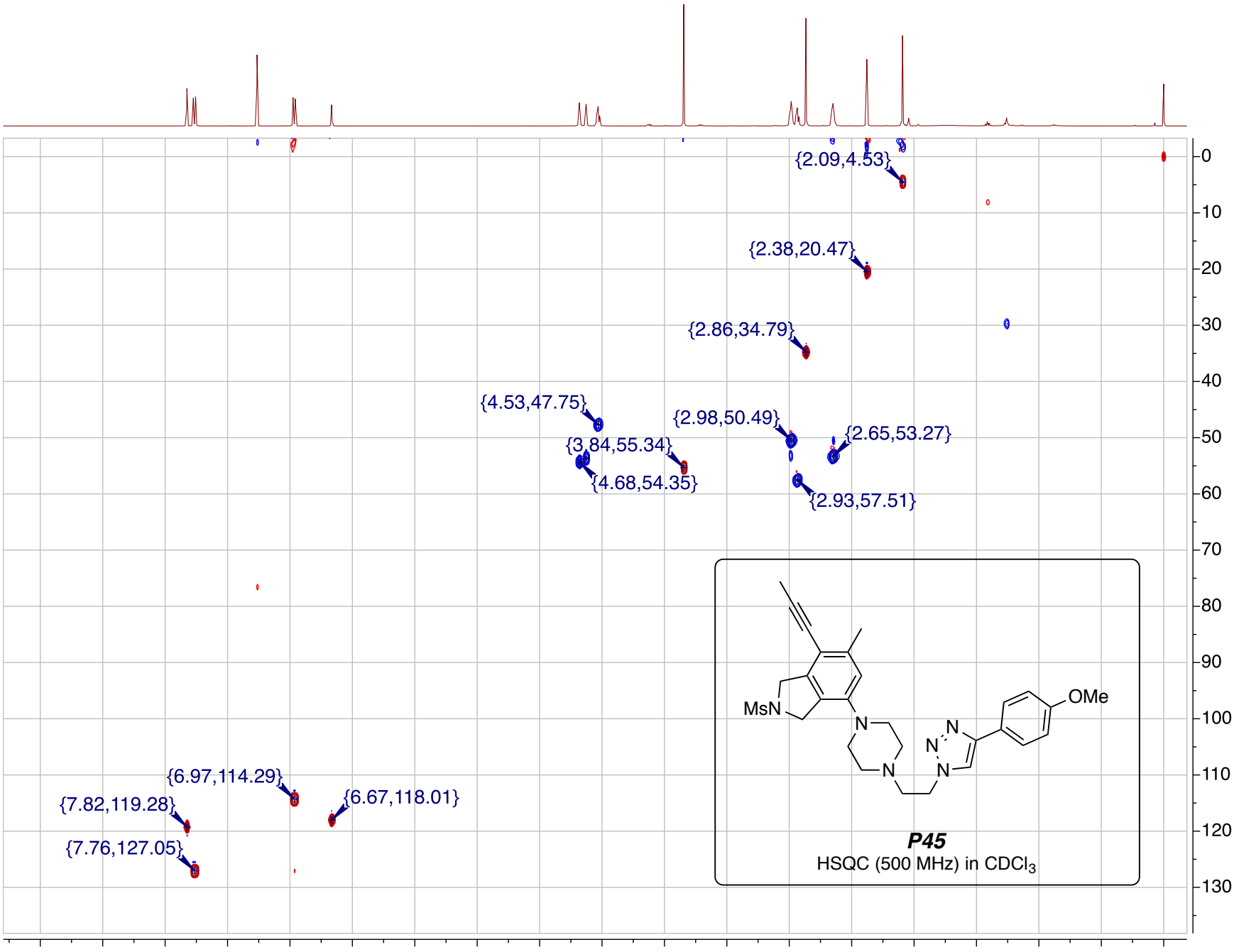

N
Ms
N
N
HO
O
CF3
P43 TFA
HMBC (500 MHz) in CDCl3
{2.15,74.43}
{2.14,98.09}
{3.21,124.83}
{2.47,127.52}
{3.21,136.19}
{3.21,141.31}
{2.47,139.59}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

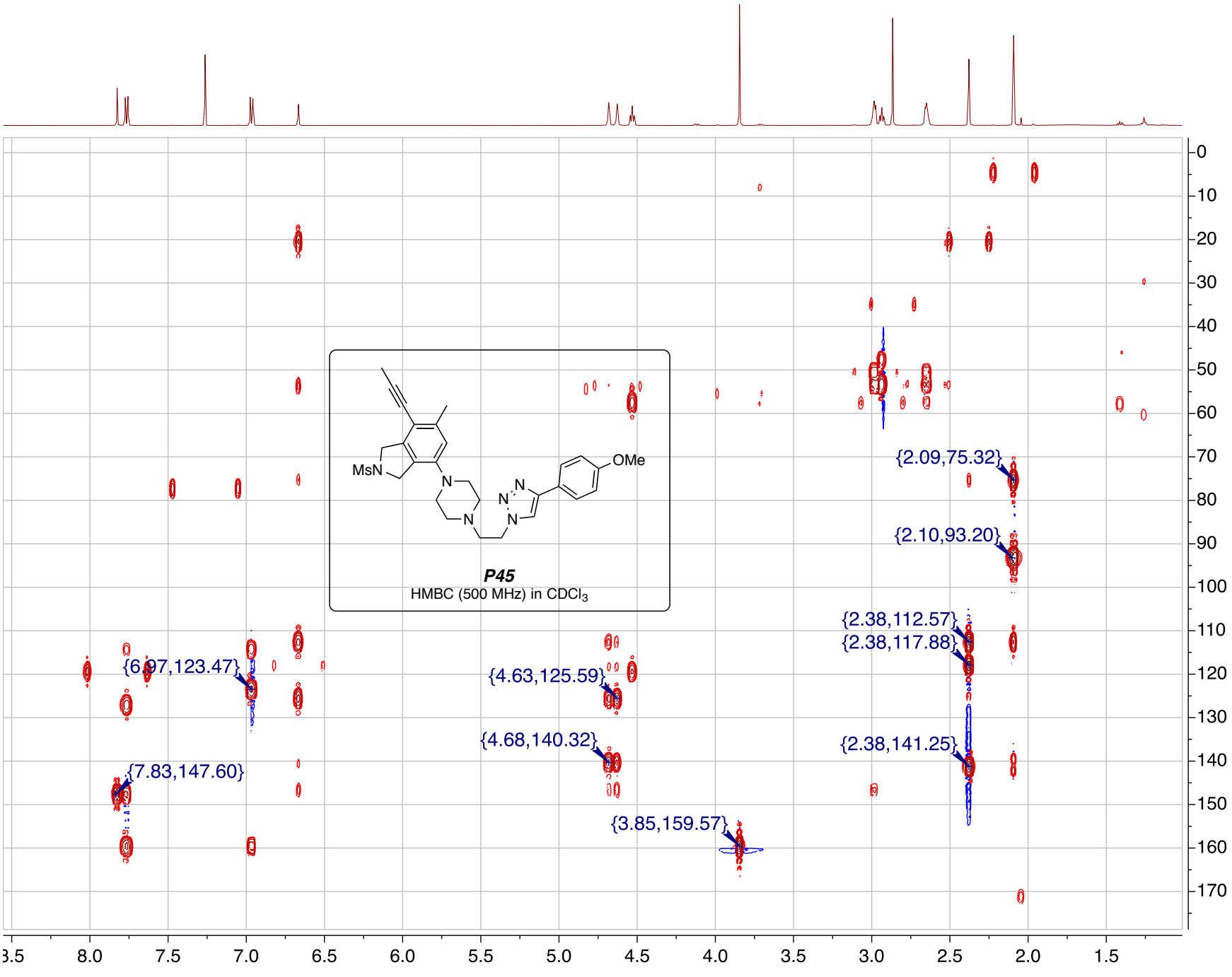

7.38
7.27 CHCl3
6.85
4.67
4.45
4.44
4.43
2.89
2.88
2.87
2.86
2.67
2.66
2.65
2.36
2.12
1.97
1.97
1.96
1.96
1.95
1.95
1.94
0.96
0.96
0.95
0.95
0.94
0.85
0.85
0.84
0.84
MsN
N
N
N
N
N
P44
1H NMR (500 MHz) in CDCl3
4.47 4.44 4.41
2.00 1.96 1.92
0.96 0.94
0.87 0.85 0.83
1.00
1.03
4.40
2.10
9.75
4.31
3.42
3.46
1.32
1.30
2.24
2.38
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

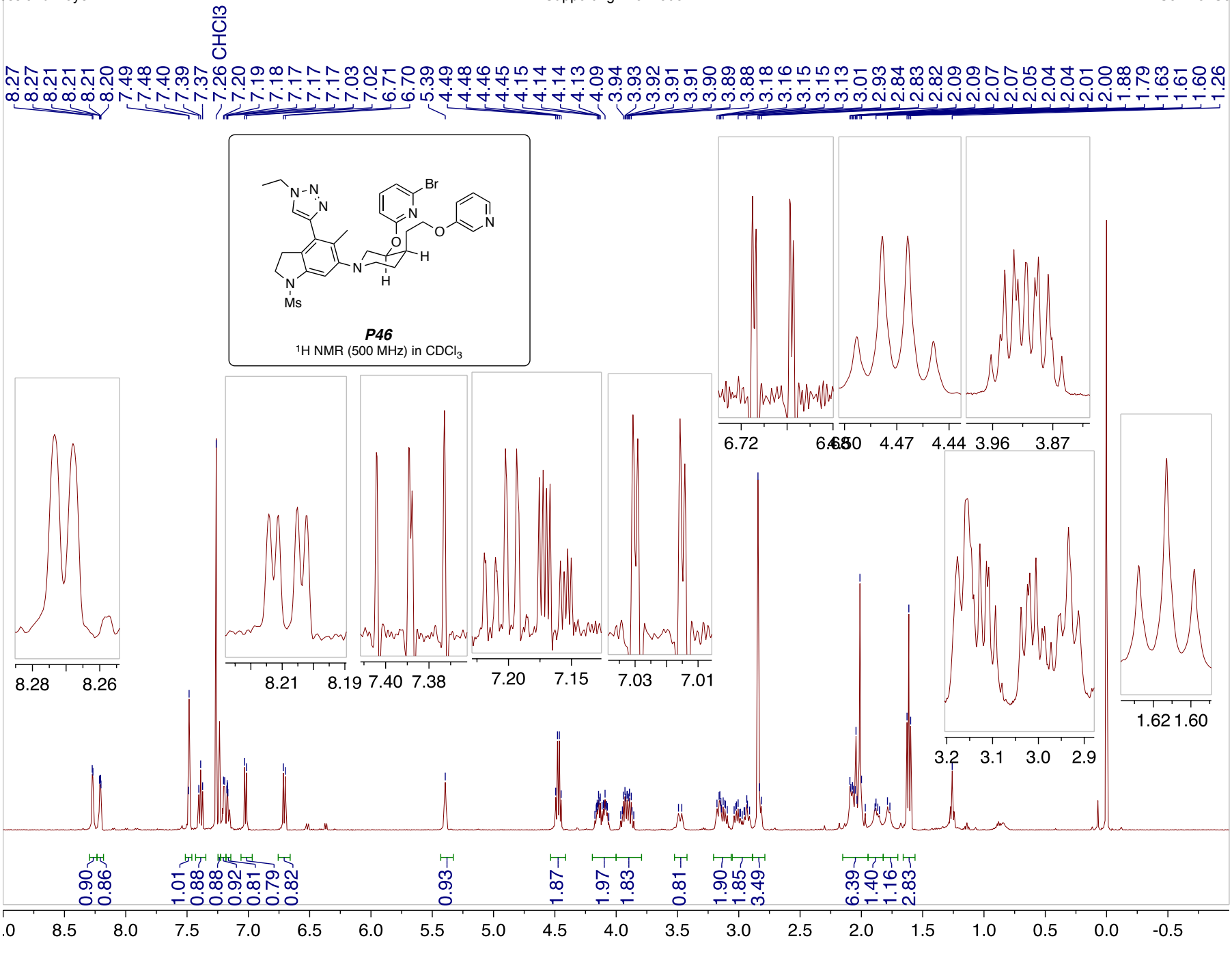

MsN
N
N
N
N
N
P44
HMBC (500 MHz) in CDCl3
{1.96,6.41}
{2.12,4.51}
{0.95,7.93}
{0.85,7.90}
{2.35,15.83}
{2.86,34.62}
{4.44,47.60}
{4.67,54.21}
{2.66,53.45}
{2.87,57.68}
{2.87,52.02}
{6.84,112.71}
{7.38,120.19}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

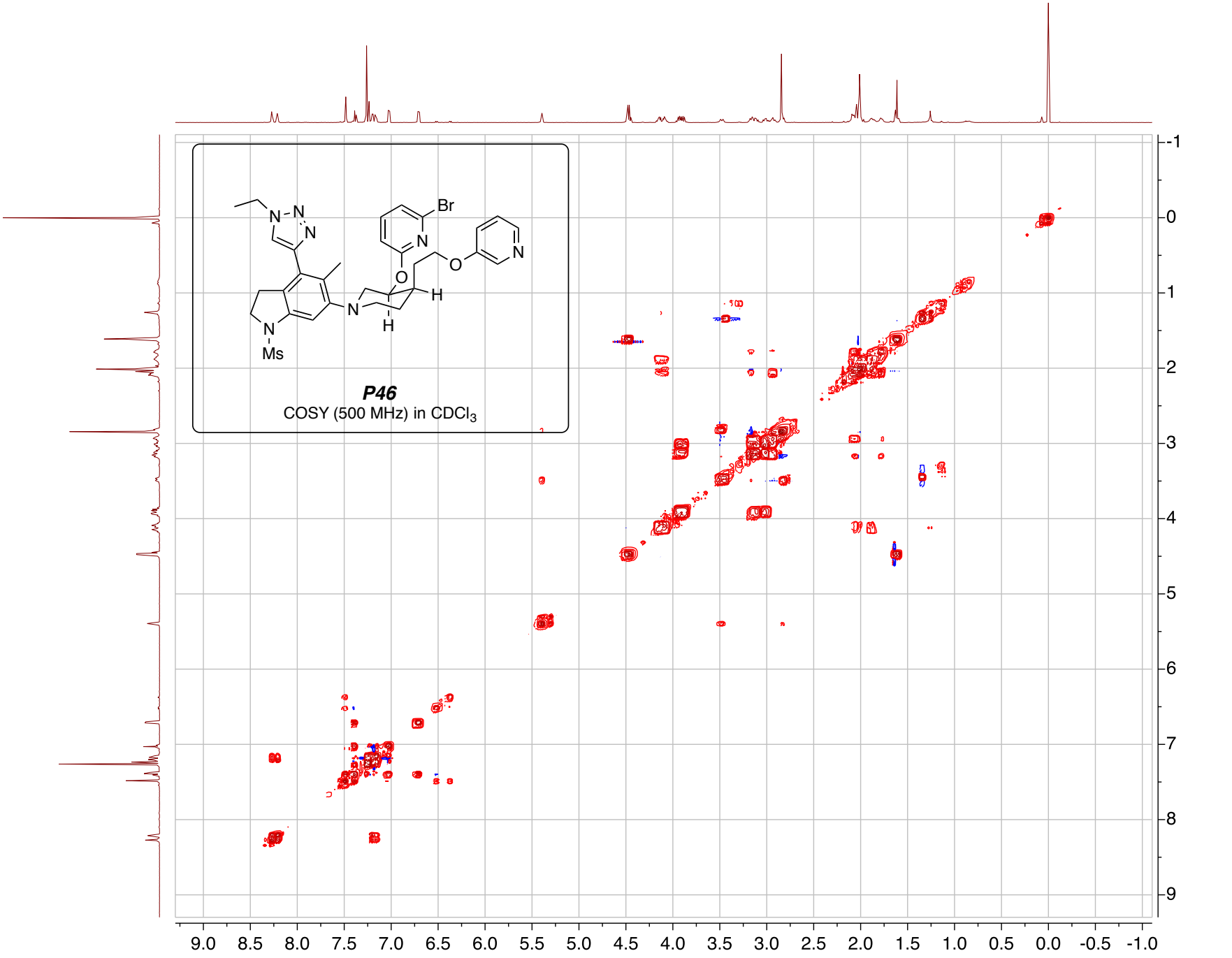

MsN
N
N
N
N
N
P44
HMBC (500 MHz) in CDCl3
{2.12,75.80}
{2.11,94.58}
{2.36,120.28}
{2.36,134.60}
{2.36,151.55}
{6.85,133.12}
{4.67,133.48}
{7.37,150.11}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

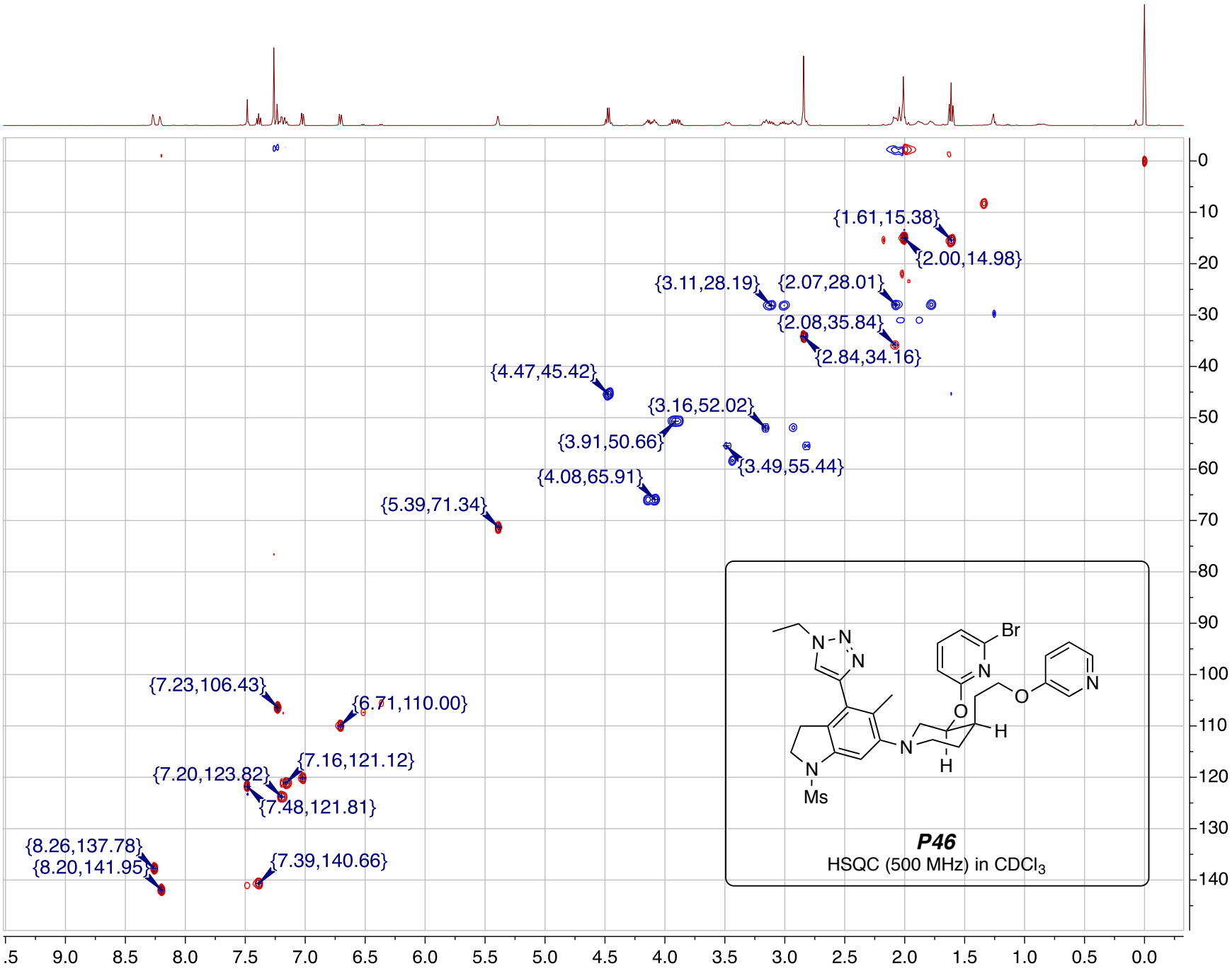

7.83
7.77
7.77
7.76
7.76
7.26 CHCl3
6.97
6.97
6.96
6.96
6.67
4.69
4.68
4.68
4.63
4.63
4.62
4.54
4.53
4.52
3.85
2.99
2.98
2.97
2.95
2.94
2.92
2.87
2.66
2.65
2.64
2.38
2.09
MsN
N
N
N
N
N
OMe
P45
1H NMR (500 MHz) in CDCl3
7.78 7.76
6.98 6.96 6.94
4.56
4.50 3.00 2.95 2.90
2.66 2.64 2.62
1.06
2.09
2.11
1.05
2.17
2.13
2.08
3.18
4.19
2.19
3.24
4.15
3.16
3.17
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1

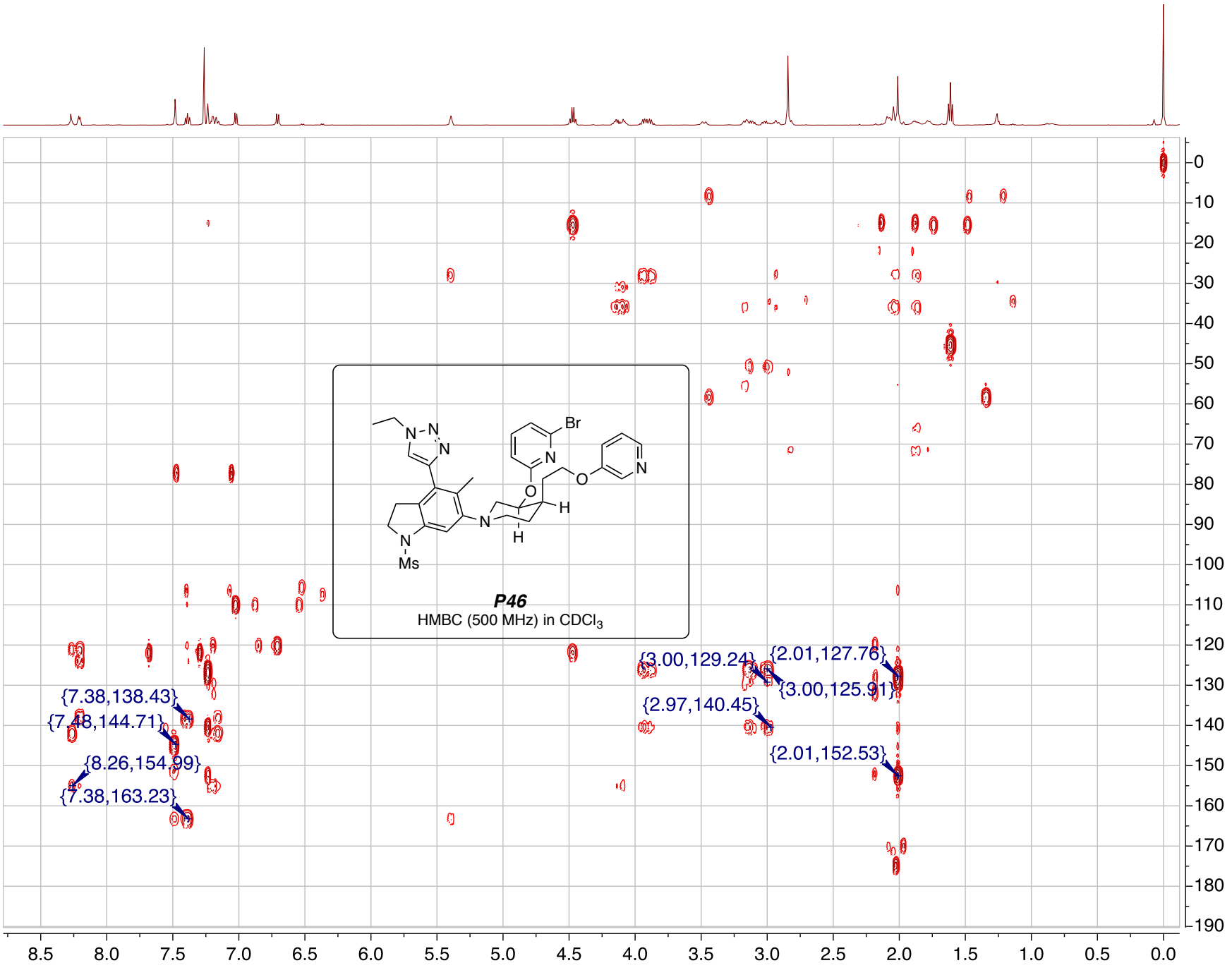

{2.09,4.53}
{2.38,20.47}
{2.86,34.79}
{4.53,47.75}
{2.98,50.49}
{2.65,53.27}
{3.84,55.34}
{4.68,54.35}
{2.93,57.51}
{6.97,114.29}
{6.67,118.01}
{7.82,119.28}
{7.76,127.05}
MsN
N
N
N
N
OMe
P45
HSQC (500 MHz) in CDCl3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

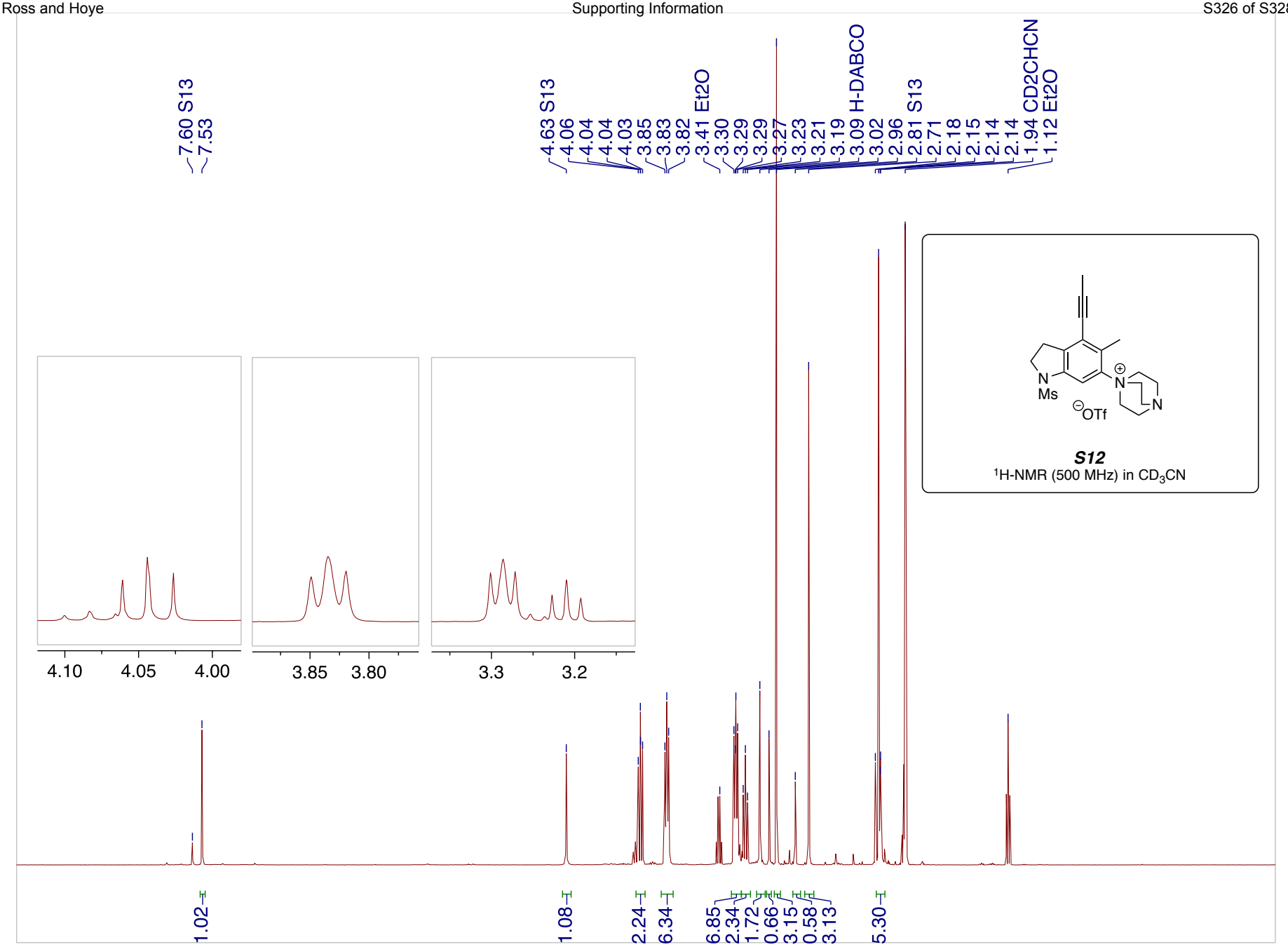

MsN
N
N
N
N
N
OMe
P45
HMBC (500 MHz) in CDCl3
{6.97,123.47}
{7.83,147.60}
{4.63,125.59}
{4.68,140.32}
{3.85,159.57}
{2.09,75.32}
{2.10,93.20}
{2.38,112.57}
{2.38,117.88}
{2.38,141.25}
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5


CHCl3
8.27 8.27 8.21 8.21 8.21 8.20 7.49 7.48 7.40 7.39 7.37 7.26 7.20 7.19 7.18 7.17 7.17 7.17 7.03 7.02 6.71 6.70 5.39 4.49 4.48 4.46 4.45 4.15 4.14 4.14 4.13 4.09 3.94 3.93 3.92 3.91 3.91 3.90 3.89 3.88 3.18 3.16 3.15 3.15 3.13 3.01 2.93 2.84 2.83 2.82 2.09 2.09 2.07 2.07 2.05 2.04 2.04 2.01 2.00 1.88 1.79 1.63 1.61 1.60 1.26
Br
N
O
H
Ms
P46
1H NMR (500 MHz) in CDCl3
8.28 8.26
8.21 8.19
7.40 7.38
7.20 7.15
7.03 7.01
6.72 6.65
4.50 4.47 4.44
3.96 3.87
3.2 3.1 3.0 2.9
1.62 1.60
0.90 0.86 1.01 0.88 0.88 0.92 0.81 0.79 0.82 0.93 1.87 1.97 1.83 0.81 1.90 1.85 3.49 6.39 1.40 1.16 2.83
.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5


Br
N
N
N
O
O
N
H
N
H
N
Ms
P46
COSY (500 MHz) in CDCl3
-1
0
1
2
3
4
5
6
7
8
9
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0

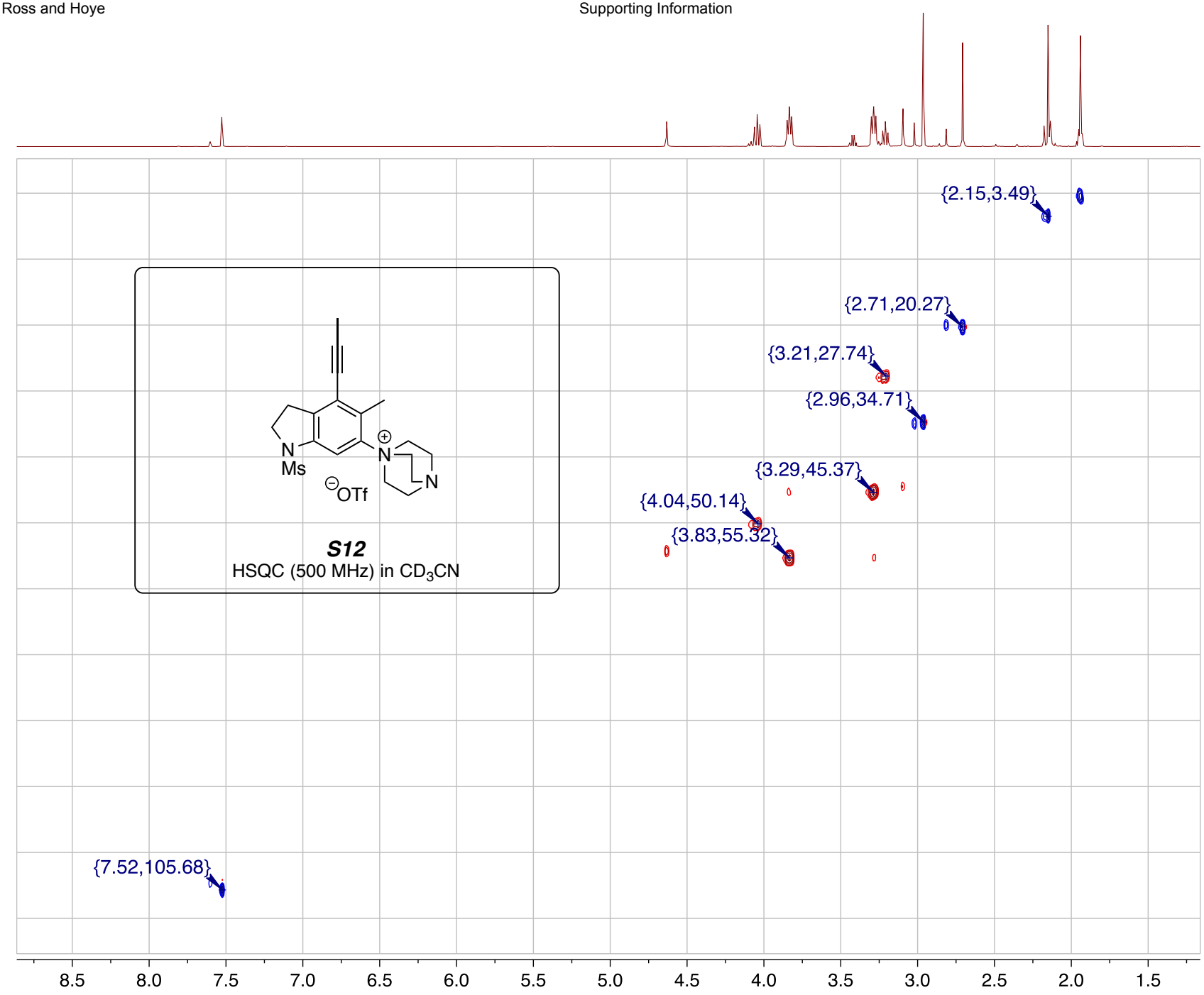

{1.61,15.38}
{2.00,14.98}
{3.11,28.19}
{2.07,28.01}
{2.08,35.84}
{2.84,34.16}
{4.47,45.42}
{3.16,52.02}
{3.91,50.66}
{3.49,55.44}
{4.08,65.91}
{5.39,71.34}
{7.23,106.43}
{6.71,110.00}
{7.16,121.12}
{7.20,123.82}
{7.48,121.81}
{8.26,137.78}
{8.20,141.95}
{7.39,140.66}
Br
N
O
H
Ms
P46
HSQC (500 MHz) in CDCl3

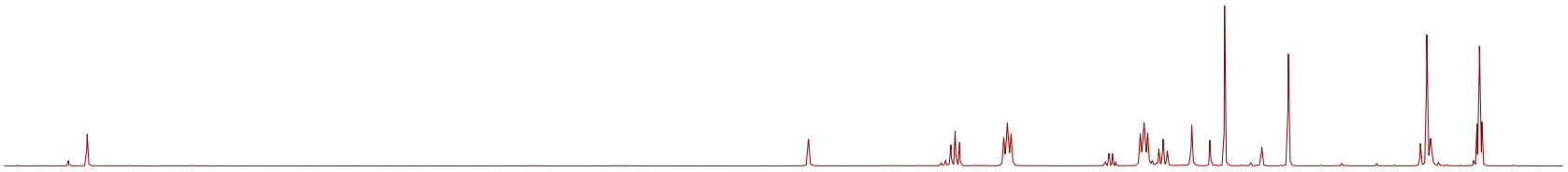

{7.38,138.43}
{7.48,144.71}
{8.26,154.99}
{7.38,163.23}
{3.00,129.24}
{2.01,127.76}
{3.00,125.91}
{2.97,140.45}
{2.01,152.53}
Br
N
O
H
Ms
P46
HMBC (500 MHz) in CDCl3

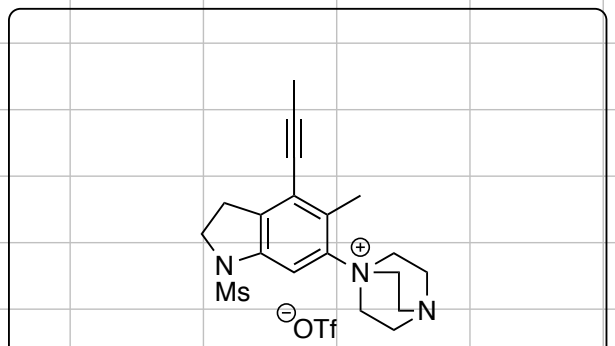


S12

^{1}H-NMR (500 MHz) in CD_3CN


{2.15,3.49}
{2.71,20.27}
{3.21,27.74}
{2.96,34.71}
{3.29,45.37}
{4.04,50.14}
{3.83,55.32}
{7.52,105.68}
N
Ms
N
N
OTf
S12
HSQC (500 MHz) in CD3CN
0
10
20
30
40
50
60
70
80
90
100
110
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5





S12

HMBC (500 MHz) in CD_3CN

{2.18,74.49}

{2.19,99.00}

{2.73,126.86}

{4.07,137.22}

{4.07,141.28}

{3.85,143.19}

{7.55,142.08}