Supporting Information – Experimental

Mechanism of Triflimide-Catalyzed [3,3] Sigmatropic Rearrangements of *N*–Allylhydrazones—Predictions and Experimental Validation

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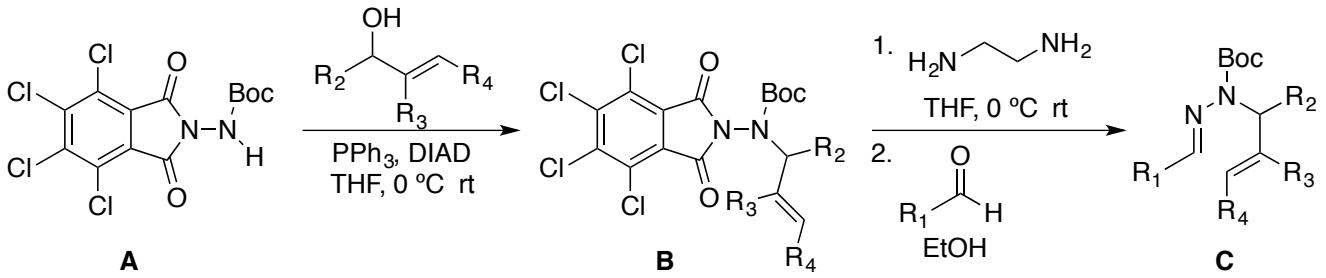
1. General Methods. All reactions were carried out under a nitrogen atmosphere in flame-dried glassware with magnetic stirring unless otherwise stated. THF, Et_2O and CH_2Cl_2 were purified by passage through a bed of activated alumina.[1] Reagents were purified prior to use unless otherwise stated following the guidelines of Armarego and Chai.[2] Purification of reaction products was carried out by flash chromatography using EM Reagent silica gel 60 (230-400 mesh). Analytical thin layer chromatography was performed on EM Reagent 0.25 mm silica gel 60-F plates. Visualization was accomplished with UV light and anisaldehyde stain, ceric ammonium molybdate stain, or potassium permanganate stain followed by heating. Film infrared spectra were recorded using a Bruker Tensor ATR. ^{1}H-NMR spectra were recorded on a Bruker Avance III 500 (500 MHz) or Varian Inova 400 (400 MHz) spectrometer and are reported in ppm using solvent as an internal standard ($CDCl_3$ at 7.26 ppm). Data are reported as (app = apparent, obs = obscured, s = singlet, d = doublet, t = triplet, q = quartet, p = pentet, h = hextet, sep = septet, o = octet, m = multiplet, b = broad; coupling constant(s) in Hz; integration. Proton-decoupled ^{13}C-NMR spectra were recorded on a Bruker Avance III 500 (500 MHz) spectrometer and are reported in ppm using solvent as an internal standard ($CDCl_3$ at 77.00 ppm). Mass spectra data were obtained on an Agilent 6210 Time-of-Flight LC/MS and a Thermo Finnegan Mat 900 XL High Resolution Magnetic Sector.

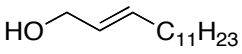
1. A. B. Pangborn, M. A. Giardello, R. H. Grubbs, R. K. Rosen, F. J. Timmers, *Organometal*. 1996, **15**, 1518–1520.
2. W. L. F. Armarego, C. L. L. Chai, *Purification of Laboratory Chemicals;* 5th Ed., Butterworth-Heinemann, 2003.

2. Experimental Procedures

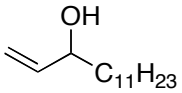
Synthesis of *N*-allylhydrazones:



Scheme S1: Outline of *N*–allylhydrazone formation starting from the corresponding allylic alcohol.

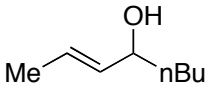


(*E*)-Tetradec-2-en-1-ol (S1): To a solution of dodecyl aldehyde (2.0 g, 10.7 mmol) in DCM (20 mL), under N_2, was cannulated a solution of methyl(triphenylphosphoranylidene)acetate (3.74 g, 11.2 mmol) in DCM (20 mL + 20 mL rinse). After heating resulting mixture at reflux for 16 hours, reaction was cooled to room temperature and solvent was removed under reduced pressure. Crude material was flushed through a plug of silica using 5% EtOAc in hexanes as the eluent. Concentration under reduced pressure produced an oil which was diluted in hexanes (67 mL) and cooled to –78 ºC, under N_2. Diisobutylaluminum hydride (25.5 mL, 25.5 mmol, 1.0 M in hexanes) was slowly added and resulting mixture was stirred at –78 ºC for 1 hour. Methanol (20 mL) was added to quench and reaction was warmed to room temperature. After transferring to a separatory funnel, solution was diluted with 1.0 M HCl (100 mL). The organic layer was collected and the aqueous phase extracted with hexanes (2 x 50 mL). The combined organics were dried with Na_2SO_4 and solvent was removed under reduced pressure. Flash column chromatography on silica gel with 10% EtOAc in hexanes as the eluent afforded the title compound as a clear oil (1.63 g, 7.7 mmol, 72% yield): IR (film) 3312, 2921, 2852, 968 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) 5.66 (qt, 2H, J = 16.6, 6.0 Hz); 4.08 (t, 2H, J = 5.7 Hz); 2.04 (p, 2H, J = 7.2 Hz); 1.36 (q, 2H, J = 7.1 Hz); 1.31–1.25 (m, 18H); 0.88 (t, 3H, J = 6.9 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 133.7, 128.7, 63.9, 32.2, 31.9, 29.6(6), 29.6(3), 29.6(0), 29.5, 29.3, 29.2, 29.1, 22.7, 14.1; HRMS (EI): Exact mass calculated for $C_{14}H_{28}O$ $[M–H_2O]^+$, 194.2035. Found 194.2029.

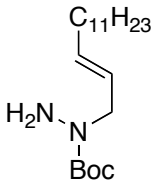


Tetradec-1-en-3-ol (S2): Vinyl magnesium bromide (14 mL, 19.5 mmol, 1.4 M in THF) was slowly added to a stirred solution of dodecyl aldehyde (3.0 g, 16.3 mmol) in THF (80 mL) at 0 ºC, under N_2. Reaction was stirred for 30 minutes and cautiously quenched with saturated NH_4Cl (100 mL). Resulting solution was transferred to a separatory funnel and organic layer collected. Remaining aqueous phase was extracted with Et_2O (2 x 50 mL). Combined organics were dried with $MgSO_4$ and solvent was removed under reduced pressure. Flash column chromatography on silica gel using 10% EtOAc in hexanes as an eluent afforded the desired alcohol (3.07 g, 14.5 mmol, 89% yield) as a clear oil: IR (film) 3341, 2922, 2853, 989, 919 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) 5.86 (ddd, 1H, J = 17.1, 10.5, 6.4 Hz); 5.22 (d, 1H, J = 17.2 Hz); 5.10 (d, 1H,

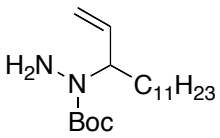
J = 10.4 Hz); 4.10 (q, 1H, J = 5.2 Hz); 1.56–1.28 (m, 21H); 0.88 (t, 3H, J = 6.9 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 141.3, 114.5, 73.3, 37.0, 31.9, 29.6(5), 29.6(2), 29.6(0), 29.5, 29.3, 25.3, 22.7, 14.1; HRMS (ESI): Exact mass calculated for $C_{14}H_{28}O$ [M–H]$^-$, 211.2067. Found 211.2059.



(*E*)-Oct-2-en-4-ol (S3): Butyl magnesium bromide (21.0 mL, 27.3 mmol, 1.3 M in Et_2O) was slowly added to a solution of crotonaldehyde (1.54 g, 22.0 mmol) in Et_2O (25 mL) at 0 ºC, under N_2. Reaction was stirred for 1 hour and cautiously quenched with saturated NH_4Cl (50 mL). Resulting solution was transferred to a separatory funnel and organic layer was collected. Remaining aqueous phase was extracted with Et_2O (2 x 50 mL). Combined organics were dried with $MgSO_4$ and solvent was removed under reduced pressure. Flash column chromatography on silica gel using 10% EtOAc in hexanes as an eluent afforded the title compound as a clear oil (2.8 g, 21.8 mmol, 99% yield): IR (film) 3341, 2957, 2931, 2859, 964 cm^{-1}; ^{1}H NMR (500 MHz, $CDCl_3$) 5.69–5.62 (m, 1H); 5.51–5.46 (m, 1H); 4.03 (q, 1H, J = 6.7 Hz); 1.70 (d, 3H, J = 6.5 Hz); 1.54–1.28 (m, 7H); 0.90 (t, 3H, J = 6.9 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 134.3, 126.7, 73.2, 37.0, 27.6, 22.6, 17.7, 14.1; HRMS (EI): Exact mass calculated for $C_8H_{16}O$ [M–H_2O]$^+$, 110.1096. Found 110.1120.



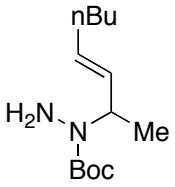
(*E*)-*tert*-Butyl 1-(tetradec-2-en-1-yl)hydrazinecarboxylate (S4): To a stirred solution of triphenylphosphine (1.78 g, 6.8 mmol) in THF (14 mL) at 0 ºC, under N_2, was added diisopropylazodicarboxylate (1.18 mL, 6.0 mmol). After 10 minutes a solid white cake had formed. To this was cannulated a stirred mixture of (*E*)-tetradec-2-en-1-ol **(S1)** (725 mg, 3.4 mmol) and *tert*-butyl 4,5,6,7-tetrachloro-1,3-dioxoisoindolin-2-ylcarbamate[3] (**A**, 1.36 g, 3.4 mmol) in THF (7 mL + 7 mL rinse). The resulting solution was warmed to room temperature and stirred for 3.5 hours. Reaction was concentrated under reduced pressure and resulting brown oil was loaded directly onto a column. Flash column chromatography using 5% EtOAc in hexanes as an eluent afforded desired intermediate, **B**, as a mixture with triphenylphosphine. Ethylenediamine (455 μL, 6.8 mmol) was added to this mixture as a solution in THF (20 mL) at 0 ºC, under N_2. Reaction was warmed to room temperature and stirred for 12 hours. The newly formed white precipitate was removed by filtration over celite and filtrate was concentrated under reduced pressure. The resulting clear oil was purified by flash column chromatography on silica gel using 10% EtOAc in hexanes as the eluent, affording the title compound (818 mg, 2.5 mmol, 74% yield) as a clear oil: IR (film) 2923, 2853, 1696, 1365, 1168, 966 cm^{-1}; ^{1}H NMR (500 MHz, $CDCl_3$) 5.59 (dt, 1H, J = 14.8, 7.2 Hz); 5.45–5.39 (m, 1H); 3.96 (s, 2H); 3.90 (d, 2H, J = 6.1 Hz); 2.02 (q, 2H, J = 7.0 Hz); 1.47 (s, 9H); 1.35 (m, 2H); 1.29–1.25 (m, 16H); 0.87 (t, 3H, J = 6.9 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 156.8, 134.1, 124.5, 80.4, 52.7, 32.3, 31.9, 29.6(6), 26.6(3), 26.6(1), 29.5, 29.3, 29.2(0), 29.1(7), 28.4, 22.7, 14.1; HRMS (ESI): Exact mass calculated for $C_{19}H_{38}N_2O_2$ [M+Na]$^+$, 349.2825. Found 349.2825.

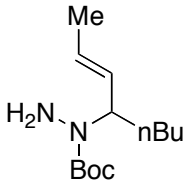


***tert*-Butyl 1-(tetradec-1-en-3-yl)hydrazinecarboxylate (S5):** To a stirred solution of triphenylphosphine (2.13 g, 8.12 mmol) in THF (16 mL) at 0 ºC, under N_2, was added diisopropylazodicarboxylate (1.2 mL, 6.09 mmol). After 10 minutes a solid white cake had formed. To this was cannulated a stirred mixture of tetradec-1-en-3-ol **(S2)** (846 mg, 4.06 mmol) and *tert*-butyl 4,5,6,7-tetrachloro-1,3-dioxoisoindolin-2-ylcarbamate (**A**, 1.63 g, 4.06 mmol) in THF (7.5 mL + 7.5 mL rinse). The resulting solution was warmed to room

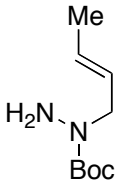
3. M. F. Pinto, N. Brosse, B. Jamart-Gregoire, *Synth. Commun.* 2002, **32**, 3603–3610.

temperature and stirred for 12 hours. Reaction was concentrated under reduced pressure and resulting brown oil was loaded directly onto a column. Flash column chromatography using 5% EtOAc in hexanes as an eluent afforded desired intermediate, **B**, as a mixture with triphenylphosphine. Ethylenediamine (542 μL, 8.12 mmol) was added to this mixture as a solution in THF (20 mL) at 0 ºC, under N_2. Reaction was warmed to room temperature and stirred for 12 hours. The newly formed white precipitate was removed by filtration over celite and filtrate was concentrated under reduced pressure. The resulting clear oil was purified by flash column chromatography on silica gel using 10% EtOAc in hexanes as the eluent, affording the title compound (836 mg, 2.56 mmol, 63% yield) as a clear oil: IR (film) 2923, 2854, 1690, 1387, 1366, 1168 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) 5.85 (ddd, 1H, J = 17.1, 10.6, 6.4 Hz); 5.11–5.07 (m, 2H); 4.43–4.41 (m, 1H); 3.66 (s, 2H); 1.77–1.73 (m, 1H); 1.51–1.48 (m, 10 H); 1.32–1.22 (m, 18H); 0.89 (t, 3H, J = 6.9 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 157.3, 137.7, 115.3, 80.4, 59.4, 31.9, 31.3, 29.7, 29.6, 29.3, 28.4, 26.2, 22.7, 14.1; HRMS (ESI): Exact mass calculated for $C_{19}H_{38}N_2O_2$ $[M+Na]^+$, 349.2825. Found 349.2827.



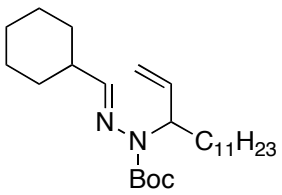


(*E*)-*tert*-Butyl 1-(oct-3-en-4-yl)hydrazinecarboxylate and (*E*)-*tert*-Butyl 1-(oct-2-en-4-yl)hydrazinecarboxylate (S6): To a stirred solution of triphenylphosphine (8.15 g, 31.1 mmol) in THF (38 mL) at 0 ºC, under N_2, was added diisopropylazodicarboxylate (4.4 mL, 23.3). After 10 minutes a solid white cake had formed. To this was cannulated a stirred mixture of (*E*)-oct-2-en-4-ol **(S3)** (2.0 g, 15.6 mmol) and *tert*-butyl 4,5,6,7-tetrachloro-1,3-dioxoisoindolin-2-ylcarbamate (**A**, 6.22 g, 15.6 mmol) in THF (19 mL + 19 mL rinse). The resulting solution was warmed to room temperature and stirred for 12 hours. Reaction was concentrated under reduced pressure and resulting brown oil was loaded directly onto a column. Flash column chromatography using 5% EtOAc in hexanes as an eluent afforded desired intermediate, **B**, as a mixture with triphenylphosphine. Ethylenediamine (2.08 mL, 31.1 mmol) was added to this mixture as a solution in THF (70 mL) at 0 ºC, under N_2. Reaction was warmed to room temperature and stirred for 12 hours. The newly formed white precipitate was removed by filtration over celite and filtrate was concentrated under reduced pressure. The resulting clear oil was purified by flash column chromatography on silica gel using 10% EtOAc in hexanes as the eluent, affording the title compounds (1.98 mg, 8.17 mmol, 53% yield, 1:1 mixture of regioisomers as determined by ^1H NMR spectroscopy in $CDCl_3$) as a clear oil: IR (film) 2960, 2930, 2860, 1688, 1366, 1174, 968 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) mixture of regioisomers, major signals: 5.57–5.45 (m, 4H); 4.57 (bs, 1H), 4.36 (bs, 1H); 3.63 (s, 4H); 2.01 (q, 2H, J = 6.5 Hz); 1.69 (m, 5H); 1.47 (s, 9H); 1.32 (m, 6H); 1.21 (m, 5H); 0.89 (m, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) mixture of regioisomers, major signals: δ 156.8(8), 156.8(4), 131.5, 130.5, 129.9, 126.6, 80.3, 80.2, 58.8, 54.2, 32.0, 31.6, 31.4, 28.5, 28.4, 22.5, 22.4, 17.9, 17.8, 14.1, 14.0; HRMS (ESI): Exact mass calculated for $C_{13}H_{26}N_2O_2$ $[M+Na]^+$, 265.1886. Found 265.1886.

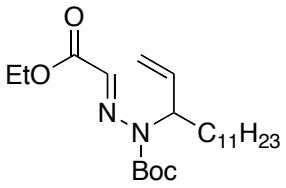


(*E*)-*tert*-Butyl 1-(but-2-en-1-yl)hydrazinecarboxylate (S7): To a stirred solution of tert-butyl 1,3-dioxoisoindolin-2-ylcarbamate (5.25 g, 20.0 mmol), benzyltriethylammonium chloride (640 mg, 2.8 mmol), and K_2CO_3 (7.7 g, 56 mmol) in acetonitrile (80 mL), under N_2, was added crotyl bromide (2.88 mL, 28 mmol). The resulting mixture was stirred for 24 hours at room temperature. Reaction was then transferred to a separatory funnel and diluted with H_2O (75 mL) and Et_2O (50 mL). The organic phase was collected and the aqueous layer was extracted with Et_2O (2 x 50 mL). Combined organics were washed with brine (75 mL) and dried using Na_2SO_4. Concentration under reduced pressure afforded a thick yellow oil. This

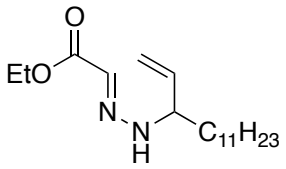
crude oil was dissolved in THF (75 mL) and cooled to 0 ºC, under N_2. Methyl hydrazine (2.1 mL, 40.0 mL) was added and the reaction was stirred for 12 hours. Reaction was washed with brine (40 mL) and aqueous layer extracted with Et_2O (2 x 40 mL). Combined organics were dried with Na_2SO_4 and concentrated under reduced pressure. Flash column chromatography on silica gel using 10% EtOAc in hexanes as the eluent afforded the title compound as a clear oil (2.07 g, 11.1 mmol, 56% yield, 5:1 *E:Z*, by ^{1}H NMR spectroscopy in $CDCl_3$): IR (film) 3334, 2976, 1691, 1392, 1366, 1169, 1136 cm^{-1}; ^{1}H NMR (500 MHz, $CDCl_3$) mixture of stereoisomers, major signals: 5.61 (dq, 1H, J = 14.1, 6.3 Hz); 5.46 (ddd, 1H, J = 15.2, 6.2, 4.6 Hz); 3.96 (s, 2H); 3.89 (d, 2H, J = 6.1 Hz); 1.70 (d, 3H, J = 6.5 Hz); 1.46 (s, 9H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 157.8, 128.5, 126.1, 80.4, 52.6, 28.4, 17.7; HRMS (ESI): Exact mass calculated for $C_9H_{18}N_2O_2$ [M+Na]$^+$, 209.1260. Found 209.1282.



(*E*)-tert-Butyl 2-(cyclohexylmethylene)-1-(tetradec-1-en-3-yl)hydrazinecarboxylate (1): To a solution of *tert*-butyl 1-(tetradec-1-en-3-yl)hydrazinecarboxylate (**S5**) (400 mg, 1.23 mmol) in ethanol (6.5 mL) at room temperature, under N_2, was added cyclohexanecarboxaldehyde (148 μL, 1.23 mmol). After stirring for 12 hours the solvent was removed under reduced pressure. Flash column chromatography on silica gel using 10% EtOAc in hexanes afforded the title compound (380 mg, 0.90 mmol, 74% yield) as a clear oil: IR (film) 2923, 2853, 1697, 1295, 1157 cm^{-1}; ^{1}H NMR (500 MHz, $CDCl_3$) 7.75 (d, 1H, J = 5.5 Hz); 5.92 (ddd, 1H, J = 17.3, 10.4, 6.8 Hz); 5.12–5.03 (m, 2H); 4.58 (q, 1H, J = 7.5 Hz); 2.35–2.28 (m, 1H); 1.83–1.49 (m, 8H); 1.46 (s, 9H); 1.35–1.18 (m, 22H); 0.86 (t, 3H, J = 6.9 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 166.9, 153.5, 138.1, 115.5, 80.6, 60.7, 41.6, 32.1, 31.9, 30.0, 29.9, 29.7, 29.6(2), 29.6(0), 29.5(6), 29.3(5), 29.3(0), 28.4, 25.9(9), 25.9(6), 25.4, 25.3, 22.7, 14.1; HRMS (ESI): Exact mass calculated for $C_{26}H_{48}N_2O_2$ [M+H]$^+$, 421.3789. Found 421.3783.



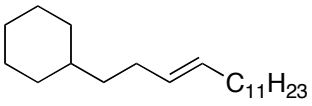
(*E*)-*tert*-Butyl 2-(2-ethoxy-2-oxoethylidene)-1-(tetradec-1-en-3-yl)hydrazinecarboxylate (2): To a solution of *tert*-butyl 1-(tetradec-1-en-3-yl)hydrazinecarboxylate (**S5**) (32 mg, 0.1 mmol) in ethanol (0.5 mL) at room temperature, under N_2, was added ethyl glyoxalate (21.4 μL, 0.11 mmol, 50% in toluene). After stirring for 12 hours the solvent was removed under reduced pressure. Flash column chromatography on silica gel using 10% EtOAc in hexanes afforded the title compound (37.5 mg, 0.09 mmol, 91% yield) as a clear oil: IR (film) 2924, 2854, 1712, 1242, 1144 cm^{-1}; ^{1}H NMR (500 MHz, $CDCl_3$) 8.11 (s, 1H); 5.92 (ddd, 1H, J = 17.2, 10.6, 6.5 Hz); 5.16–5.10 (m, 2H); 4.85 (q, 1H, J = 7.5 Hz); 4.30–4.25 (m, 2H); 1.90 (dt, 1H, J = 9.1, 4.9 Hz); 1.69 (td, 1H, J = 9.2, 5.0 Hz); 1.53 (s, 9H); 1.32 (t, 3H, J = 7.1 Hz); 1.29–1.24 (m, 18H); 0.87 (t, 3H, J = 7.0 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 164.2, 152.3, 136.8, 135.0, 116.4, 83.0, 62.1, 61.0, 31.9, 31.7, 29.6(2), 29.6(0), 29.5(7), 29.5, 29.3, 29.2, 28.1, 26.1, 22.7, 14.2, 14.1; HRMS (ESI): Exact mass calculated for $C_{23}H_{42}N_2O_4$ [M+Na]$^+$, 433.3037. Found 433.3038.



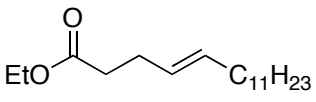
(*E*)-Ethyl 2-(2-(tetradex-1-en-3-yl)hydrazono)ethanoate (3): HCl (5 mL, 1M in dioxanes) was added to *tert*-butyl 1-(tetradec-1-en-3-yl)hydrazinecarboxylate (**S5**) (200 mg, 0.61 mmol), under N_2. After 12 hours the solvent was removed under reduced pressure and residue taken up in ethanol (4.5 mL). To the resulting solution was added K_2CO_3 (85 mg, 0.61 mmol) and ethyl glyoxalate (61 μL, 0.61 mmol, 50% in toluene), under N_2.

The reaction was stirred for 12 hours and solvent removed under reduced pressure. The resulting oil was purified by flash column chromatography on silica gel using 5% EtOAc in hexanes as an eluent, affording the title compound (75 mg, 0.24 mmol, 40% yield) as a yellow oil: IR (film) 3261, 2923, 2853, 1677, 1530, 1198, 1145 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) 10.43 (d, 1H, J = 4.3 Hz); 6.43 (s, 1H); 5.80 (ddd, 1H, J = 17.2, 10.4, 6.7 Hz); 5.15 (m, 2H); 4.16 (q, 2H, J = 7.1 Hz); 3.92 (p, 1H, J = 6.5 Hz); 1.68–1.53 (m, 2H); 1.36–1.26 (m, 21H); 0.87 (t, 3H, J = 7.0 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 163.9, 138.9, 115.9, 115.8, 63.3, 59.7, 34.0, 31.9, 29.6(3), 29.6(1), 29.6, 29.5, 29.4, 29.3, 25.7, 22.7, 14.2, 14.1; HRMS (ESI): Exact mass calculated for $C_{18}H_{34}N_2O_2$ $[M+H]^+$, 311.2693. Found 311.2696.

General procedure for [3,3] sigmatropic rearrangement of *N*–allylhydrazones: Triflimide (0.025 mmol, 0.25M in CH_2Cl_2) was added to a flame dried round bottom flask, under N_2. The triflimide was returned to its crystalline nature by purging the flask with N_2 until solvent is removed. The resulting white crystalline solid was diluted in diglyme (2.5 mL) and fitted with a reflux condenser. A solution of the hydrazone (0.25 mmol) was cannulated as a solution in diglyme (1.25 mL + 1.25 mL rinse) into the reaction vessel. The resulting solution was rapidly heated to 125ºC and stirred until deemed complete by TLC (10% EtoAc/Hexanes). The reaction mixture was cooled to room temperature and washed with $NaHCO_3$ and Brine. After drying over $MgSO_4$ the solvent was removed under reduced pressure. Flash column chromatography on silica gel using Et_2O in pentanes as the eluent afforded the desired alkene.

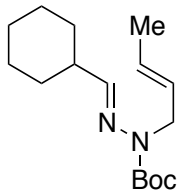


(*E*)-Pentadec-3-en-1-ylcyclohexane (4): To a flame dried 10 mL round bottom flask, under N_2, was added triflimide (95 µL, 0.024 mmol, 0.25 M in CH_2Cl_2). The triflimide was returned to its crystalline nature by purging the flask with N_2 until the CH_2Cl_2 was removed. The resulting white crystalline solid was diluted in diglyme (2.2 mL) and fitted with a reflux condenser. To this solution was cannulated (*E*)-tert-butyl 2-(cyclohexylmethylene)-1-(tetradec-1-en-3-yl)hydrazinecarboxylate (**1**) (100 mg, 0.24 mmol) using diglyme (1.1 mL + 1.1 mL rinse). The resulting solution was rapidly heated to 125 ºC and stirred for 4 hours. At this time reaction was cooled to room temperature and transferred to a separatory funnel using pentanes (10 mL). Resulting mixture was diluted with $NaHCO_3$ (10 mL) and organic phase collected. The aqueous layer was extracted with pentanes (2 x 10 mL). The combined organics were washed with brine (20 mL) and dried over $MgSO_4$. The solvent was removed under reduced pressure. The resulting oil was purified by flash column chromatography on silica gel using 5% Et_2O in pentanes as an eluent, affording the title compound (45 mg, 0.15 mmol, 65% yield, 4:1 *E:Z*, by ^1H NMR spectroscopy in $CDCl_3$) as a clear oil: IR (film) 2920, 2851, 1449, 966 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) 5.41–5.33 (m, 2H); 2.04–1.97 (m, 4H); 1.70–1.62 (m, 5H); 1.32–1.12 (m, 26H); 0.92–0.82 (m, 5H); ^{13}C NMR (125 MHz, $CDCl_3$) mixture of olefin isomers, major signals: δ 130.6, 130.2, 37.4, 37.1, 33.3(3), 33.2(9), 32.6, 31.9, 29.9, 29.6(9), 29.6(6), 29.5, 29.4, 29.2, 26.7, 26.4, 22.7, 14.1; HRMS (EI): Exact mass calculated for $C_{21}H_{40}$ $[M]^+$, 292.3130. Found 292.3143.

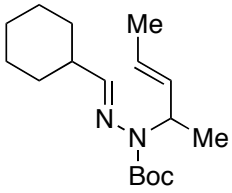


(*E*)-Ethyl hexadec-4-enoate (5): To a flame dried 10 mL round bottom flask, under N_2, was added triflimide (29.2 µL, 0.0073 mmol, 0.25 M in CH_2Cl_2). The triflimide was returned to its crystalline nature by purging the flask with N_2 until the CH_2Cl_2 was removed. The resulting white crystalline solid was diluted in diglyme (0.72 mL) and fitted with a reflux condenser. To this solution was cannulated (*E*)-*tert*-butyl 2-(2-ethoxy-2-oxoethylidene)-1-(tetradec-1-en-3-yl)hydrazinecarboxylate (**2**) (30 mg, 0.073 mmol) using diglyme (0.36 mL + 0.36 mL rinse). The resulting solution was rapidly heated to 125 ºC and

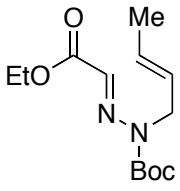
stirred for 4 hours. At this time reaction was cooled to room temperature and transferred to a separatory funnel using pentanes (10 mL). Resulting mixture was diluted with $NaHCO_3$ (10 mL) and organic phase collected. The aqueous layer was extracted with pentanes (2 x 10 mL). The combined organics were washed with brine (20 mL) and dried over $MgSO_4$. The solvent was removed under reduced pressure. The resulting oil was purified by flash column chromatography on silica gel using 5% Et_2O in pentanes as an eluent, affording the title compound (17 mg, 0.060 mmol, 82% yield) as a clear oil: IR (film) 2923, 2853, 1738, 1161 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) 5.49–5.35 (m, 2H); 4.12 (q, 2H, J = 7.1 Hz); 2.37–2.28 (m, 4H); 1.96 (q, 2H, J = 6.9 Hz); 1.33-1.24 (m, 2H); 0.88 (t, 3H, J = 6.9 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 173.3, 131.8, 127.9, 60.2, 34.4, 32.5, 31.9, 29.6(8), 29.6(4), 29.6(2), 29.5(1), 29.4(5), 29.4, 28.0, 22.7, 14.3, 14.1; HRMS (ESI): Exact mass calculated for $C_{18}H_{34}O_2$ $[M+H]^+$, 283.2632. Found 283.2632.



(*E*)-tert-Butyl 1-((*E*)-but-2-enyl)-2-(cyclohexylmethylene)hydrazinecarboxylate (6): To a solution of (*E*)-*tert*-butyl 1-(but-2-en-1-yl)hydrazinecarboxylate (**S7**) (274 mg, 1.47 mmol) in ethanol (8 mL) at room temperature, under N_2, was added cyclohexylcarboxaldehyde (178 μL, 1.47 mmol). After stirring for 12 hours the solvent was removed under reduced pressure. Flash column chromatography on silica gel using 10% EtOAc in hexanes afforded the title compound (391 mg, 1.39 mmol, 95% yield, 5:1 *E:Z*, by ^1H NMR spectroscopy in $CDCl_3$) as a clear oil: IR (film) 2977, 2928, 2853, 1700, 1414, 1158 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) mixture of olefin isomers, major signals: 6.93 (d, 1H, J = 6.0 Hz); 5.49 (m, 1H); 5.32 (m, 1H); 4.24 (d, 2H, J = 3.6 Hz); 2.31 (dtd, 1H, J = 10.5, 7.0, 3.5 Hz); 1.80 (m, 2H); 1.73 (dq, 2H, J = 12.4, 3.8 Hz); 1.66 (d, 3H, J = 6.5 Hz); 1.51 (s, 9H); 1.34–1.15 (m, 6H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 153.4, 150.2, 127.7, 124.1, 81.0, 45.7, 41.3, 30.4, 28.3, 25.9, 25.4, 17.6; HRMS (ESI): Exact mass calculated for $C_{16}H_{28}N_2O_2$ $[M+Na]^+$, 303.2043. Found 303.2045.



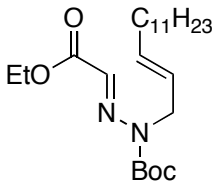
(*E*)-*tert*-Butyl 2-(cyclohexylmethylene)-1-((*E*)-pent-3-en-2-yl)hydrazinecarboxylate (7): To a solution of (*E*)-*tert*-butyl 1-(pent-3-en-2-yl)hydrazinecarboxylate[4] (295 mg, 1.47 mmol) in ethanol (8 mL) at room temperature, under N_2, was added cyclohexanecarboxaldehyde (178 μL, 1.47 mmol). After stirring for 12 hours the solvent was removed under reduced pressure. Flash column chromatography on silica gel using 10% EtOAc in hexanes afforded the title compound (374 mg, 1.27 mmol, 86% yield) as a clear oil: IR (film) 2974, 2927, 2853, 1695, 1297, 1167 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) 7.68 (d, 1H, J = 5.9 Hz); 5.58–5.52 (m, 2H); 4.73 (t, 1H, J = 6.5 Hz); 2.36–2.31 (m, 1H); 1.83–1.81 (m, 2H); 1.75 (dd, 2H, J = 8.3, 3.4 Hz); 1.66 (d, 3H, J = 5.1 Hz); 1.46 (s, 9H); 1.33–1.27 (m, 6H); 1.24 (d, 3H, J = 6.9 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 167.9, 153.3, 131.8, 126.0, 80.5, 55.5, 41.6, 29.9(2), 29.8(9), 28.4, 26.0, 25.3, 18.5, 17.8; HRMS (ESI): Exact mass calculated for $C_{17}H_{30}N_2O_2$ $[M+Na]^+$, 317.2199. Found 317.2199.



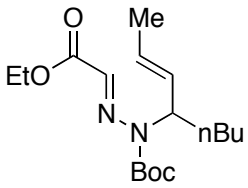
(*E*)-*tert*-Butyl 1-((*E*)-but-2-en-1-yl)-2-(2-ethoxy-2-oxoethylidene)hydrazinecarboxylate (8): To a solution of (*E*)-*tert*-butyl 1-(but-2-en-1-yl)hydrazinecarboxylate (**S7**) (300 mg, 1.61 mmol) in ethanol (16 mL) at room temperature, under N_2, was added ethyl glyoxalate (320 μL, 1.61 mmol, 50% in toluene). After stirring for 12 hours the solvent was removed under reduced pressure. Flash column chromatography on silica gel using 10% EtOAc in hexanes afforded the title compound

4. Prepared according to: K. E. Lutz, R. J. Thomson, *Angew. Chem. Int. Ed.* 2011, **50**, 4437–4440.

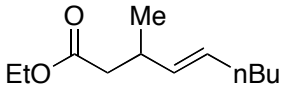
(417 mg, 1.54 mmol, 96% yield, 5:1 *E:Z*, by ^{1}H NMR spectroscopy in $CDCl_3$) as a clear oil: IR (film) 2980, 2936, 1708, 1132 cm^{-1}; ^{1}H NMR (500 MHz, $CDCl_3$) mixture of olefin isomers, major signals: 7.04 (s, 1H); 5.60–5.52 (m, 1H); 5.34–5.27 (m, 1H); 4.37 (dd, 2H, J = 3.6, 1.5 Hz); 4.29 (q, 3H, J = 7.1 Hz); 1.67 (dq, 3H, J = 4.9, 1.6 Hz); 1.55 (s, 9H); 1.34 (t, 3H, J = 7.1 Hz); ^{13}C NMR (125 MHz, $CDCl_3$) mixture of olefin isomers, major signals: δ 163.8, 152.1, 129.5, 129.2, 122.0, 83.2, 61.3, 46.2, 28.0, 17.6, 14.1; HRMS (ESI): Exact mass calculated for $C_{13}H_{22}N_2O_4$ [M+H]$^+$, 271.1652. Found 271.1652.



(*E*)-*tert*-Butyl 2-(ethoxy-2-oxoethylidene)-1-((*E*)-tetradec-2-en-1-yl)hydrazinecarboxylate (9): To a solution of (*E*)-*tert*-butyl 1-(tetradec-2-en-1-yl)hydrazinecarboxylate (**S4**) (600 mg, 1.84 mmol) in ethanol (20 mL) at room temperature, under N_2, was added ethyl glyoxalate (364 μL, 1.84 mmol, 50% in toluene). After stirring for 12 hours the solvent was removed under reduced pressure. Flash column chromatography on silica gel using 5% → 10% EtOAc in hexanes afforded the title compound (710 mg, 1.73 mmol, 94% yield) as a clear oil: IR (film) 2924, 2853, 1711, 1136 cm^{-1}; ^{1}H NMR (500 MHz, $CDCl_3$) 7.07 (s, 1H); 5.55 (dt, 1H, J = 14.9, 7.2 Hz); 5.31–5.26 (m, 1H); 4.40 (d, 2H, J = 4.8 Hz); 4.31 (q, 2H, J = 7.1 Hz); 2.01 (q, 2H, J = 7.0 Hz); 1.57 (s, 9H); 1.36 (t, 3H, J = 7.2 Hz); 1.33–1.25 (m, 18H); 0.89 (t, 3H, J = 6.8 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 163.7, 152.1, 134.8, 129.6, 120.5, 83.2, 61.4, 46.3, 32.1, 31.9, 29.7, 29.6(2), 29.5(8), 29.5, 29.3, 29.1, 28.9, 28.0, 22.7, 14.1; HRMS (ESI): Exact mass calculated for $C_{23}H_{42}N_2O_4$ [M+Na]$^+$, 433.3037. Found 433.3042.



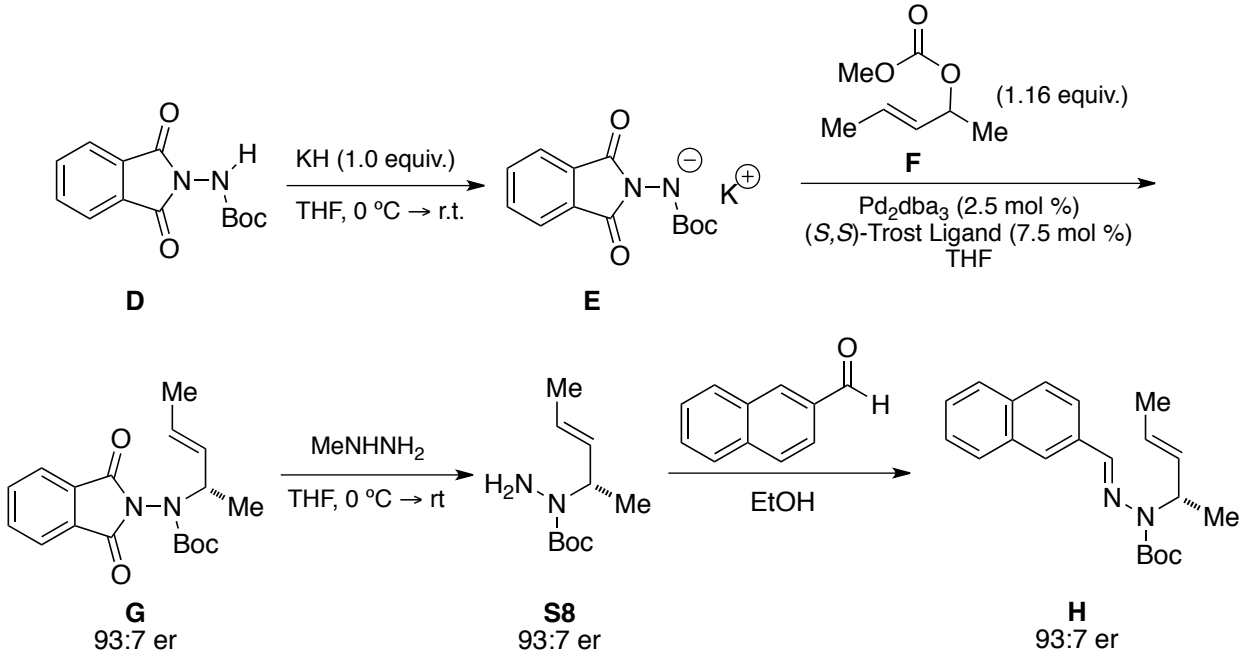
(*E*)-*tert*-Butyl 2-(2-ethoxy-2-oxoethylidene)-1-((*E*)-oct-2-en-4-yl)hydrazinecarboxylate (10): To a solution of 1:1 mixture of (*E*)-*tert*-butyl 1-(oct-2-en-4-yl)hydrazinecarboxylate and (*E*)-*tert*-butyl 1-(oct-3-en-2-yl)hydrazinecarboxylate (**S6**) (1.0 g, 4.1 mmol) in ethanol (40 mL) at room temperature, under N_2, was added ethyl glyoxalate (818 μL, 4.1 mmol, 50% in toluene). After stirring for 12 hours the solvent was removed under reduced pressure. Flash column chromatography on silica gel using 10% EtOAc in hexanes afforded the title compound, as a mixture of regioisomers, as a clear oil (1.14 g, 3.48 mmol, 85% yield). Desired (*E*)-*tert*-Butyl 2-(2-ethoxy-2-oxoethylidene)-1-((*E*)-oct-2-en-4-yl)hydrazinecarboxylate **(10)** was gradually siphoned off by flash column chromatography on silica gel using 5% Et_2O in pentanes and the spectral data is listed below (confirmed by COSY correlation analysis)**:** IR (film) 2959, 2933, 2860, 1709, 1143 cm^{-1}; ^{1}H NMR (500 MHz, $CDCl_3$) 8.10 (s, 1H); 5.59–5.57 (m, 2H); 4.81–4.77 (m, 1H); 4.30–4.25 (m, 2H); 1.86 (m, 1H); 1.69–1.62 (m, 4H); 1.53 (s, 9H); 1.34–1.16 (m, 7H); 0.87 (t, 3H, J = 7.2 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 164.3, 152.3, 134.7, 129.7, 127.9, 82.8, 61.7, 61.0, 32.0, 28.4, 28.1, 22.3, 17.8, 14.2, 14.0; HRMS (ESI): Exact mass calculated for $C_{17}H_{30}N_2O_4$ [M+Na]$^+$, 349.2098. Found 349.2098.



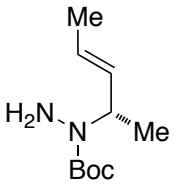
(*E*)-Ethyl 3-methylnon-4-enoate (15): To a flame dried 10 mL round bottom flask, under N_2, was added triflimide (193 μL, 0.048 mmol, 0.25 M in CH_2Cl_2). The triflimide was returned to its crystalline nature by purging the flask with N_2 until the CH_2Cl_2 was removed. The resulting white crystalline solid was diluted in diglyme (2.2 mL) and fitted with a reflux condenser. To this solution was cannulated (*E*)-*tert*-butyl 2-(2-ethoxy-2-oxoethylidene)-1-((*E*)-oct-2-en-4-yl)hydrazinecarboxylate (**10**) (78.9 mg, 0.242 mmol) using diglyme (1.1 mL + 1.1 mL rinse). The resulting solution was rapidly heated to 125 ºC and stirred for 4 hours. At this time reaction was cooled to room temperature and transferred to a separatory funnel using pentanes (10 mL). Resulting mixture was diluted with $NaHCO_3$ (10 mL) and

organic phase collected. The aqueous layer was extracted with pentanes (2 x 10 mL). The combined organics were washed with brine (20 mL) and dried over $MgSO_4$. The solvent was removed under reduced pressure and resulting oil was purified by flash column chromatography on silica gel using 5% Et_2O in pentanes as an eluent, affording the title compound (33 mg, 0.166 mmol, 69% yield) as a clear oil: IR (film) 2959, 2928, 2873, 1736, 1173 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) 5.24 (dt, 1H, J = 14.8, 7.2 Hz); 5.30 (dd, 1H, J = 15.3, 7.3 Hz); 4.11 (q, 2H, J = 7.1 Hz); 2.60 (dt, 1H, J = 14.1, 7.0 Hz); 2.26 (qd, 2H, J = 14.9, 7.4 Hz); 1.96 (q, 2H, J = 6.7 Hz); 1.32–1.27 (m, 4H); 1.24 (t, 3H, J = 7.1 Hz); 1.02 (d, 3H, J = 6.8 Hz); 0.87 (t, 3H, J = 7.1 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 172.7, 133.9, 129.5, 60.1, 42.1, 33.8, 32.1, 31.6, 22.1, 20.5, 14.3, 13.9; HRMS (EI): Exact mass calculated for $C_{12}H_{22}O_2$ $[M]^+$, 198.1620. Found 198.1627.

Synthesis of Enantioenriched Hydrazide:



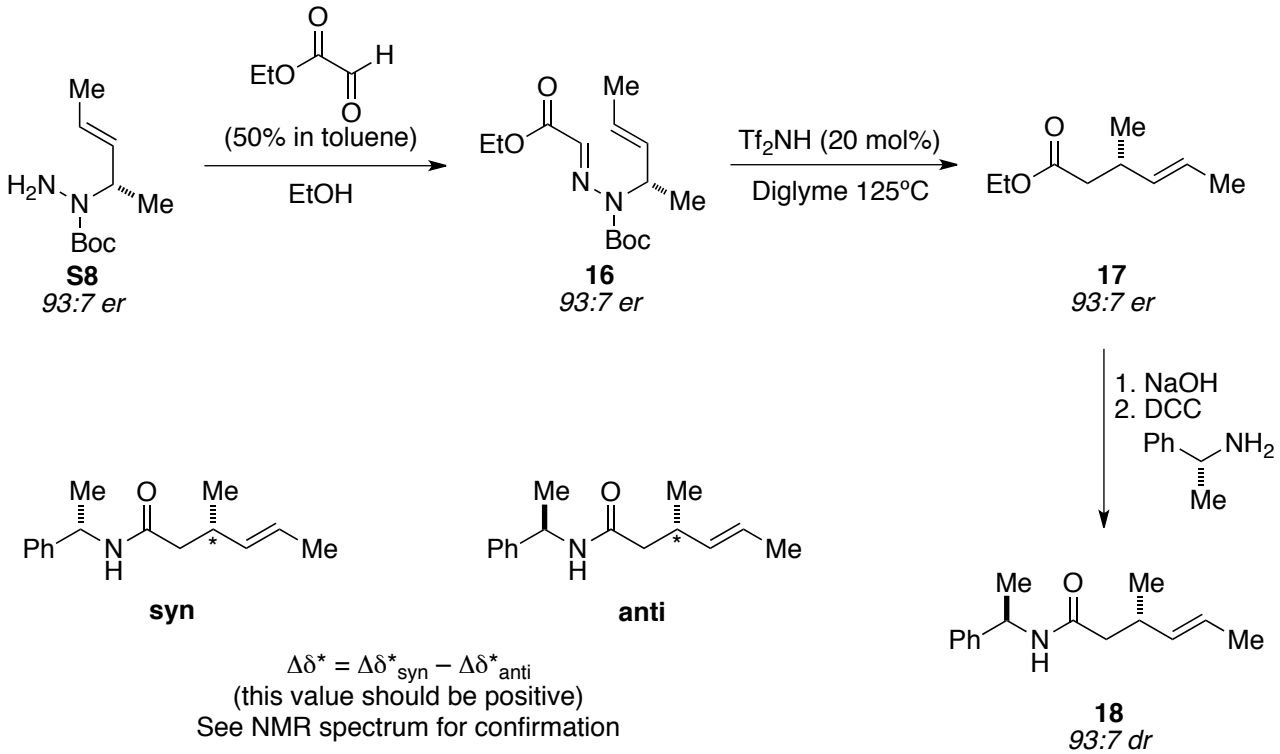
Scheme S2: Outline of enantioenriched hydrazide synthesis and characterization by derivation to the corresponding napthyl hydrazone.[4]



(S,*E*)-*tert*-Butyl 1-(pent-3-en-2-yl)hydrazinecarboxylate (S8): *tert*-Butyl (1,3-dioxoisoindolin-2-yl)carbamate **D** (5.2 g, 19.7 mmol) was dissolved in anhydrous THF (50 mL, 10 mL rinse) then cannulated into a stirred suspension of potassium hydride (0.8 g, 19.7 mmol) in anhydrous THF (140 mL) at 0 °C, under N_2, and allowed to stir for 30 min as it warmed to room temperature. The solution was then concentrated under reduced pressure. Tris(dibenzylideneacetone)dipalladium(0) (451 mg, 0.49 mmol) and 2-Diphenylphosphanyl-N-[(*1S,2S*)-2-[(2-diphenylphosphanylbenzoyl) amino]cyclohexyl]benzamide (0.95 g, 1.5 mmol) were combined under inert atmosphere in a glovebox in a flame-dried round bottom flask equipped with a stir bar. Anhydrous THF (65 mL) was added, forming a red/brown solution, which was allowed to pre-mix at room temperature for 25 min. (*E*)-methyl pent-3-en-2-yl **F** (3.30 g, 22.9 mmol) was added neat by cannula to the palladium solution (5 mL THF rinse), forming a green solution. The palladium solution was then transferred by cannula to

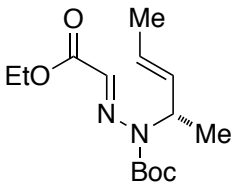
the dry potassiate salt **E**. The resulting solution was allowed to stir for 24 h, under N_2, at which time the solution was a caramel color and the starting material was deemed consumed by TLC. After filtration through filter paper to remove palladium, the red filtrate was concentrated in vacuo and purified by flash column chromatography with DCM as the eluent. (S,*E*)-*tert*-Butyl (1,3-dioxoisoindolin-2-yl)(pent-3-en-2-yl)carbamate **G** (4.9 g, 14.9 mmol) was then redissolved in THF (150 mL) and cooled to 0 °C. Methyl hydrazine (1.6 mL, 31.0 mmol) was added carefully to the solution. The reaction was complete as determined by TLC after 15 h. The resulting white precipitate was removed by filtration over a pad of celite, rinsing with THF. The yellow filtrate was concentrated under reduced pressure and purified by flash chromatography with 15% EtOAC/hexanes as the eluent to yield the title compound **S8** (2.4 g, 62% yield from **D**): (S,*E*)-*tert*-Butyl 1-(pent-3-en-2-yl)hydrazinecarboxylate (**S8**) was converted into naphthyl hydrazone **H** and enantiomeric ratio was determined by HPLC on an OD-H column running 0.2% 2-propanol in hexanes, with a flow rate of 1.0 mL/min. Retention times: 9.03 min [*S*, major enantiomer], 10.55 min [*R*, minor enantiomer]: 97:3 e.r. $[\alpha]^{20}D$ = –36.9 (c 2.5, $CHCl_3$); IR (film) 3340, 3225, 2976, 1694, 1391, 1177 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) 5.61–5.46 (m, 2H); 4.57 (p, 1H, J = 6.4 Hz); 3.64 (s, 2H); 1.68 (d, 2H, J = 4.6 Hz); 1.47 (s, 9H); 1.21 (d, 3H, J = 6.8 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 156.8, 131.3, 126.0, 80.3, 54.1, 28.4, 17.8, 17.6; HRMS (ESI): Exact mass calculated for $C_{10}H_{20}N_2O_2$ $[M+Na]^+$, 223.1417. Found 223.1430.

Investigation of Stereochemical Transfer:

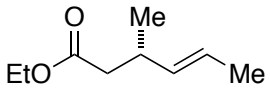


Scheme S3: Outline of enantioenriched substrate preparation and subsequent stereochemical transfer study. Enantiomeric ratios and absolute configuration were determined by a technique reported by Hoye and coworkers.[5]

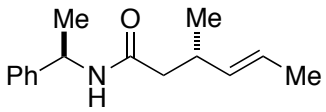
5. T. R. Hoye, D. O. Koltun, *J. Am. Chem. Soc.* 1998, **120**, 4638–4643.



(*E*)-*tert*-Butyl 2-(2-ethoxy-2-oxoethylidene)-1-((S,*E*)-pent-3-en-2-yl)hydrazinecarboxylate (16): To a solution of (S,*E*)-*tert*-butyl 1-(pent-3-en-2-yl)hydrazinecarboxylate[4] (**S8**) (89 mg, 0.44 mmol) in ethanol (0.9 mL) at room temperature, under N_2, was added ethyl glyoxalate (88 μL, 0.44 mmol, 50% in toluene). After stirring for 12 hours the solvent was removed under reduced pressure. Flash column chromatography on silica gel using 10% EtOAc in hexanes afforded the title compound (97 mg, 0.32 mmol, 72% yield) as a clear oil: 93:7 e.r. $[\alpha]^{20}D$ = +76.8 (c 1.7, $CHCl_3$); IR (film) 2978, 1709, 1370, 1240, 1151 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) 8.08 (s, 1H); 5.59 (m, 2H); 5.00 (dd, 1H, J = 6.9, 4.8 Hz); 4.28 (q, 2H, J = 7.1 Hz); 1.69–1.68 (m, 3H); 1.53 (s, 9H); 1.39 (d, 3H, J = 7.0 Hz); 1.33 (t, 3H, J = 7.1 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 164.3, 152.0, 134.6, 130.6, 127.1, 82.9, 61.0, 57.0, 28.1, 17.9, 17.7, 14.2; HRMS (ESI): Exact mass calculated for $C_{14}H_{24}N_2O_4$ $[M+Na]^+$, 307.1628. Found 307.1647.



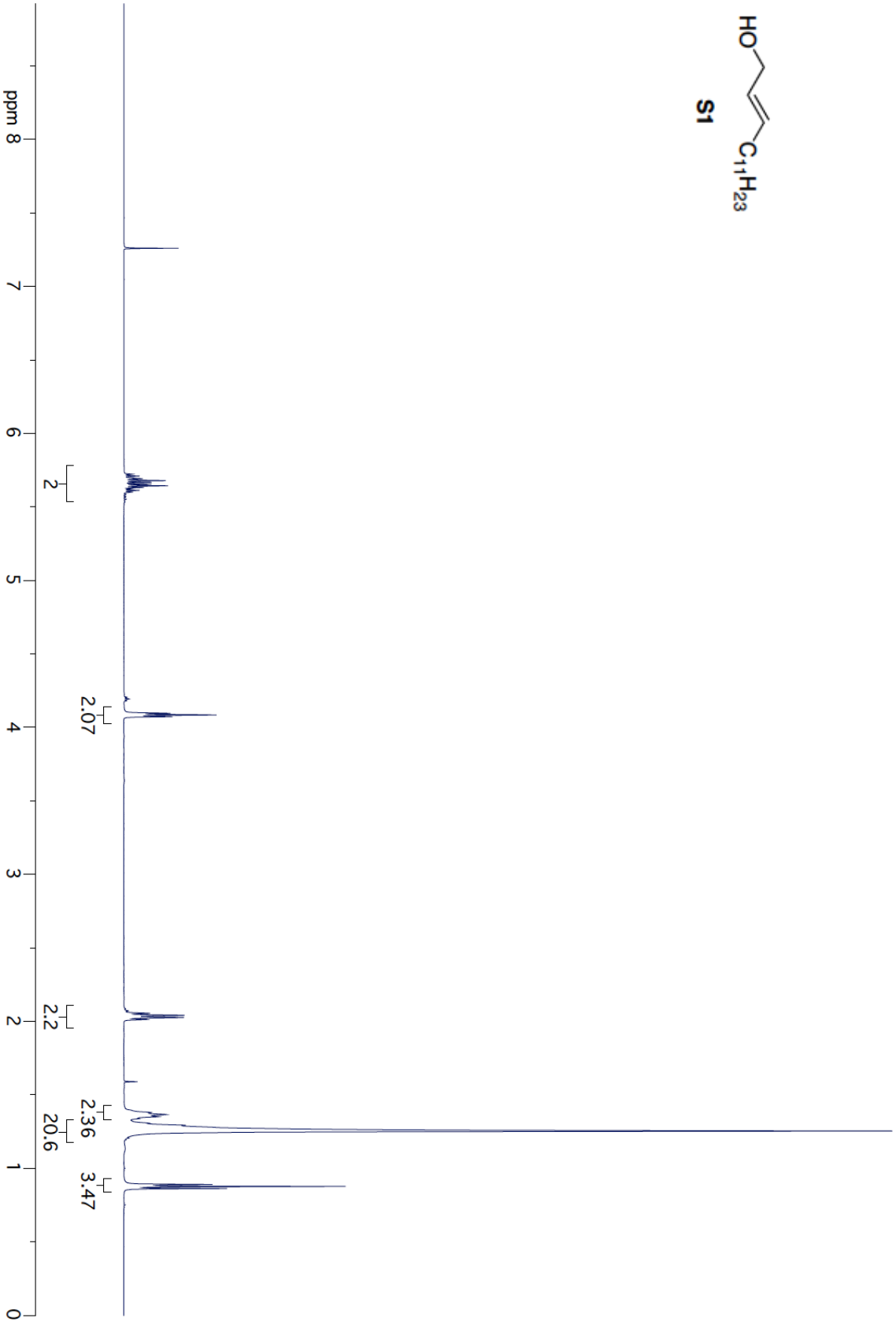
(S,*E*)-Ethyl 3-methylhex-4-enoate (17): To a flame dried 10 mL round bottom flask, under N_2, was added triflimide (225 μL, 0.056 mmol, 0.25 M in CH_2Cl_2). The triflimide was returned to its crystalline nature by purging the flask with N_2 until the CH_2Cl_2 was removed. The resulting white crystalline solid was diluted in diglyme (2.5 mL) and fitted with a reflux condenser. To this solution was cannulated (*E*)-*tert*-butyl 2-(2-ethoxy-2-oxoethylidene)-1-((S,*E*)-pent-3-en-2-yl)hydrazinecarboxylate (**16**) (80.0 mg, 0.281 mmol) using diglyme (1.25 mL + 1.25 mL rinse). The resulting solution was rapidly heated to 125 ºC and stirred for 46 hours. At this time reaction was cooled to room temperature and transferred to a separatory funnel using pentanes (10 mL). Resulting mixture was diluted with $NaHCO_3$ (10 mL) and organic phase collected. The aqueous layer was extracted with pentanes (2 x 10 mL). The combined organics were washed with brine (20 mL) and dried over $MgSO_4$. The solvent was carefully removed under reduced pressure. An NMR yield was obtained using durene as an internal standard (23 mg, 0.15 mmol, 52% yield). The resulting oil was purified by flash column column chromatography on silica gel using 5% Et_2O in pentanes as an eluent, affording the title compound as a clear oil. (S,*E*)-Ethyl 3-methylhex-4-enoate was converted into enamide **18** and enantiomeric ratio and absolute configuration was determined by an NMR analysis technique established by Hoye and coworkers:[5] 93:7 e.r. $[\alpha]^{20}D$ = +10.9 (c 2.3, $CHCl_3$); IR (film) 2963, 2933, 2121, 1737, 1245 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) 5.47–5.32 (m, 2H); 4.12 (q, 2H, J = 7.1 Hz); 2.65–2.59 (m, 1H); 2.31–2.21 (m, 2H); 1.63 (d, 3H, J = 6.2 Hz); 1.24 (t, 3H, J = 7.1 Hz); 1.02 (d, 3H, J = 6.8 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 172.7, 135.2, 123.9, 60.1, 42.0, 33.7, 20.4, 17.9, 14.3; HRMS (EI): Exact mass calculated for $C_9H_{16}O_2$ $[M]^+$, 156.1150. Found 156.1155.

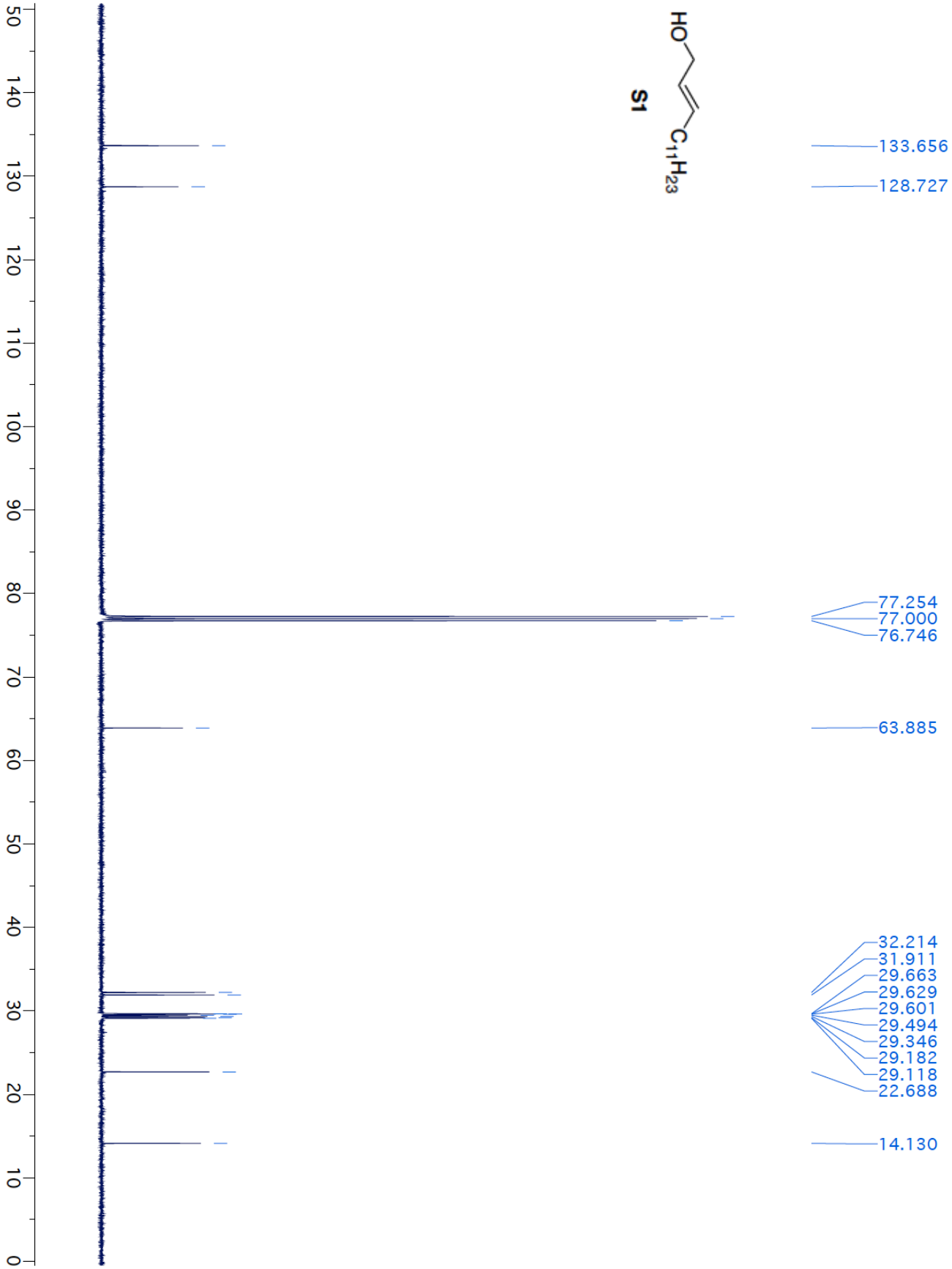


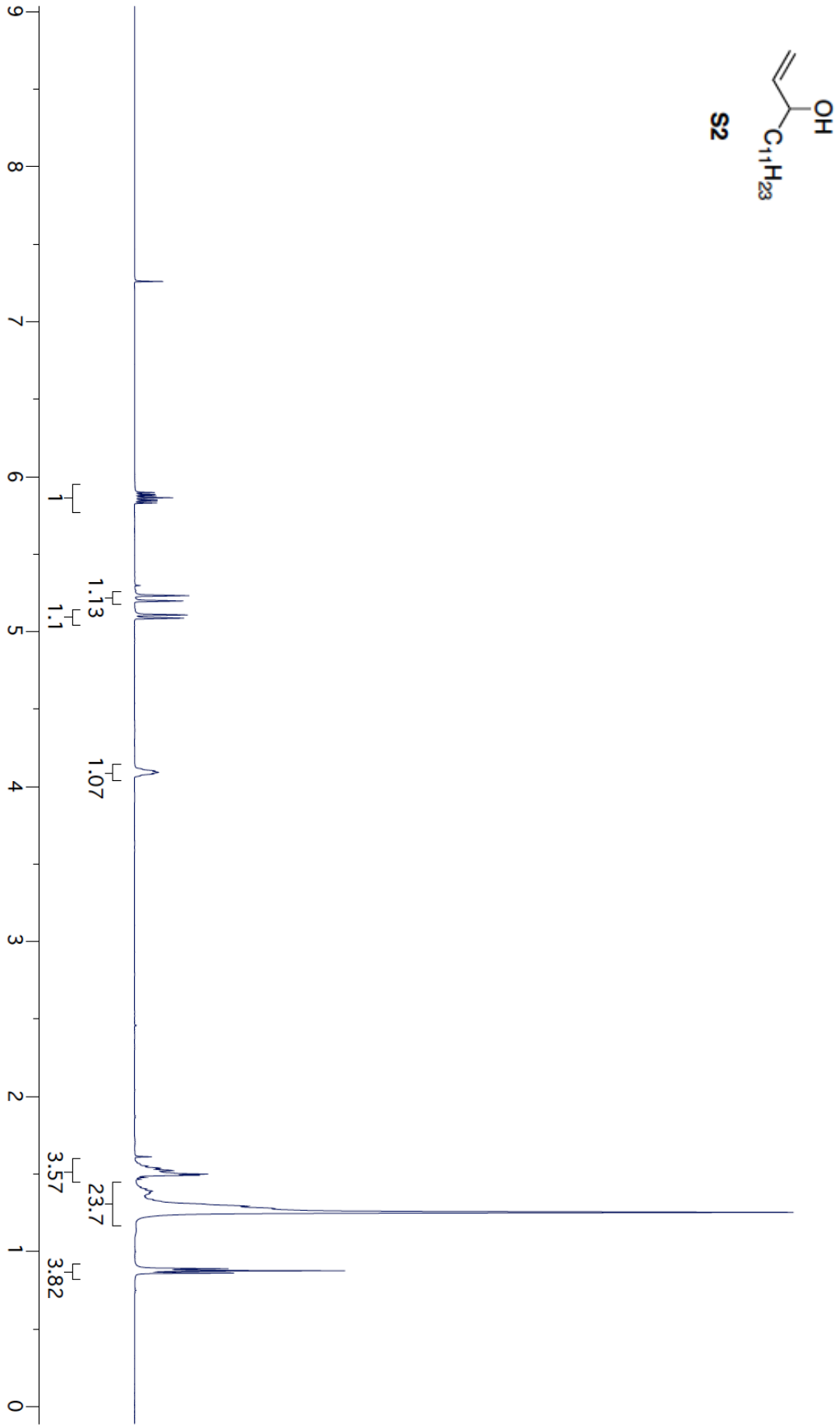
(S,*E*)-3-Methyl-*N*-((R)-1-phenylethyl)hex-4-enamide (18): To a solution of (S,*E*)-ethyl 3-methylhex-4-enoate (**17**) (10 mg, 0.064 mmol) in ethanol (200 μL) was added NaOH (560 μL, 3M in H_2O). Reaction was heated to reflux for 2 hours. After cooling to room temperature, reaction was diluted with Et_2O (2 mL) and transferred to a separatory funnel. Resulting mixture was acidified with 1M HCl (2 mL) and aqueous layer extracted with Et_2O (3 x 2 mL). Combined organics were dried over $MgSO_4$ and concentrated under reduced pressure. Flash column chromatography using Et_2O as an eluent afforded (S,*E*)-3-methylhex-4-enoic acid as a clear oil. To a solution of (S,*E*)-3-methylhex-4-enoic acid (8.0 mg, 0.062 mmol) in DCM (100 μL) was added dicyclohexylcarbodiimide (12.9 mg, 0.62 mmol), 4-dimethylaminopyridine (1 mg, 0.0062 mmol), and (R)-(+)-alpha-methylbenzylamine (8 μL, 0.062 mmol) in sequential order, under N_2. After 2 hours, the newly formed white precipitate was

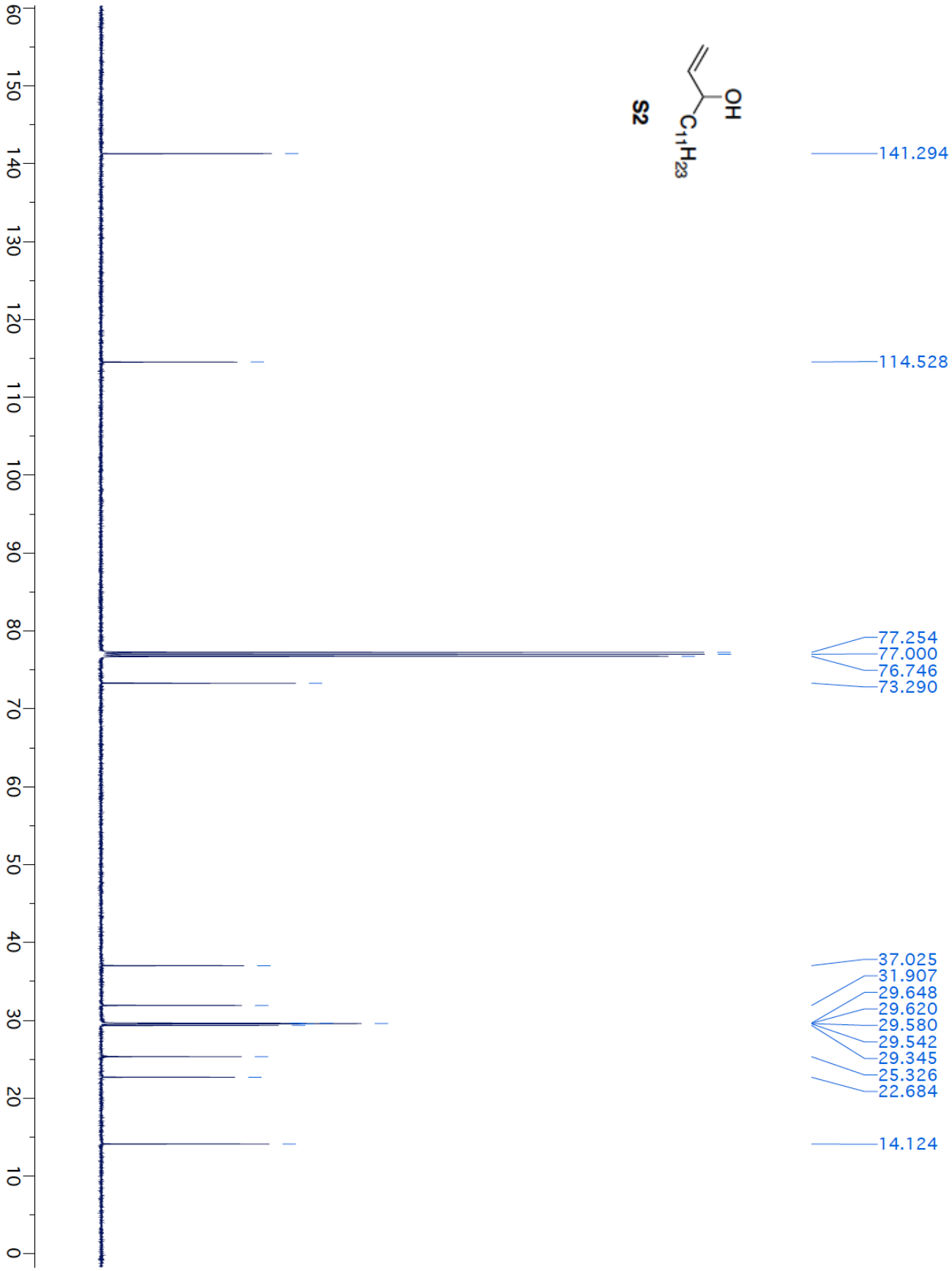
removed by filtration over celite, washed with dichloromethane, and filtrate was concentrated under reduced pressure. The resulting white solid was purified by flash column chromatography on silica gel using 25% EtOAc in hexanes as the eluent, affording the title compound (9 mg, 0.035 mmol, 55% yield) as a white solid: 93:7 d.r. $[\alpha]^{20}D$ = +92.8 (c 1.6, $CHCl_3$); melting point (decomp) 48 °C; IR (film) 3290, 2965, 1634, 1547, 964, 698 cm^{-1}; ^1H NMR (500 MHz, $CDCl_3$) 7.36–7.28 (m, 5H); 5.66 (bs, 1H); 5.51–5.43 (m, 1H); 5.36–5.31 (m, 1H); 5.19–5.11 (m, 1H); 2.63 (dt, 1H, J = 14.0, 7.0 Hz); 2.14–2.13 (m, 2H); 1.64 (d, 3H, J = 6.3 Hz); 1.48 (d, 3H, J = 6.9 Hz); 1.01 (d, 3H, J = 6.8 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 171.0, 143.2, 135.5, 128.6, 127.3, 126.2, 124.5, 48.5, 44.6, 34.3, 21.7, 20.6, 17.9; HRMS (ESI): Exact mass calculated for $C_{15}H_{21}NO$ $[M+Na]^+$, 254.1515. Found 254.1522.

3. ^{1}H and ^{13}C-NMR Spectra





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73.290
37.025
31.907
29.648
29.620
29.580
29.542
29.345
25.326
22.684
14.124
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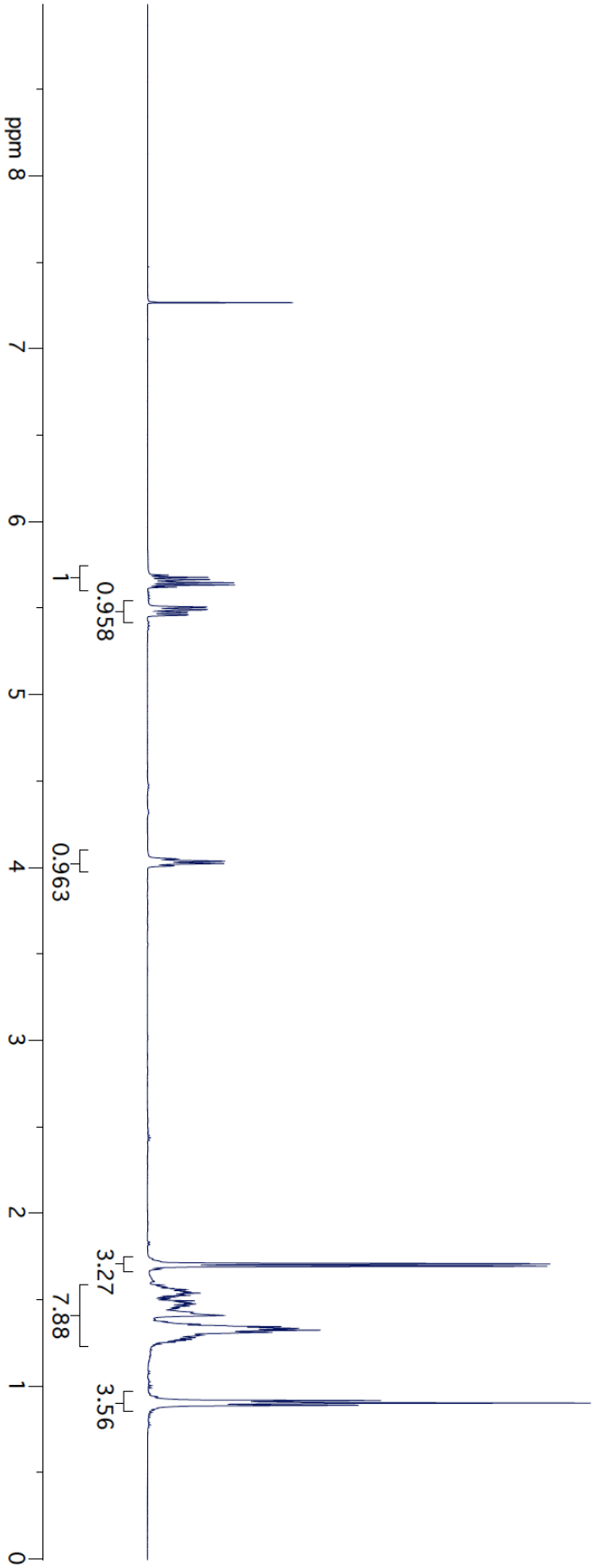
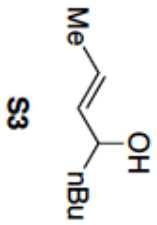
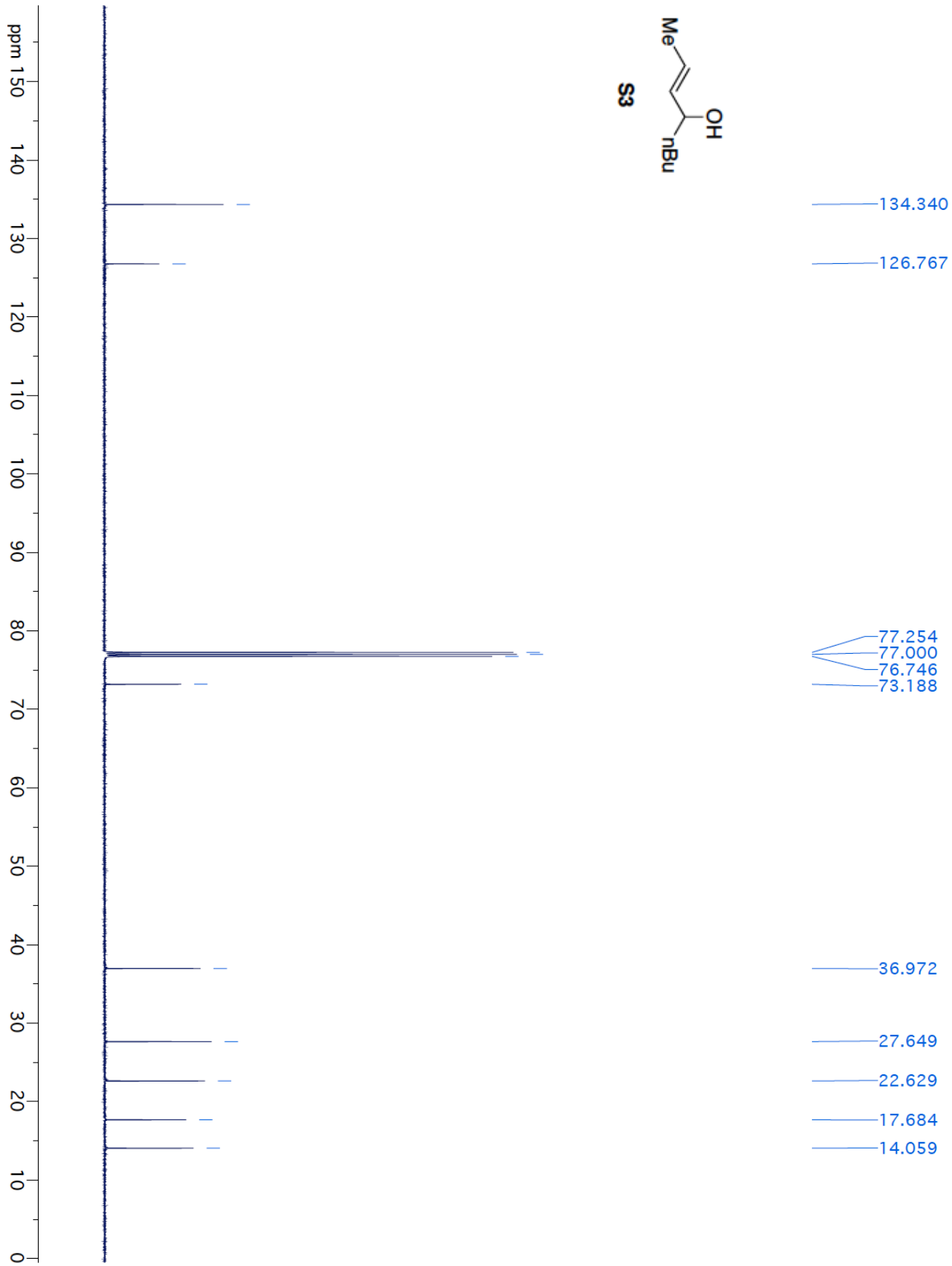
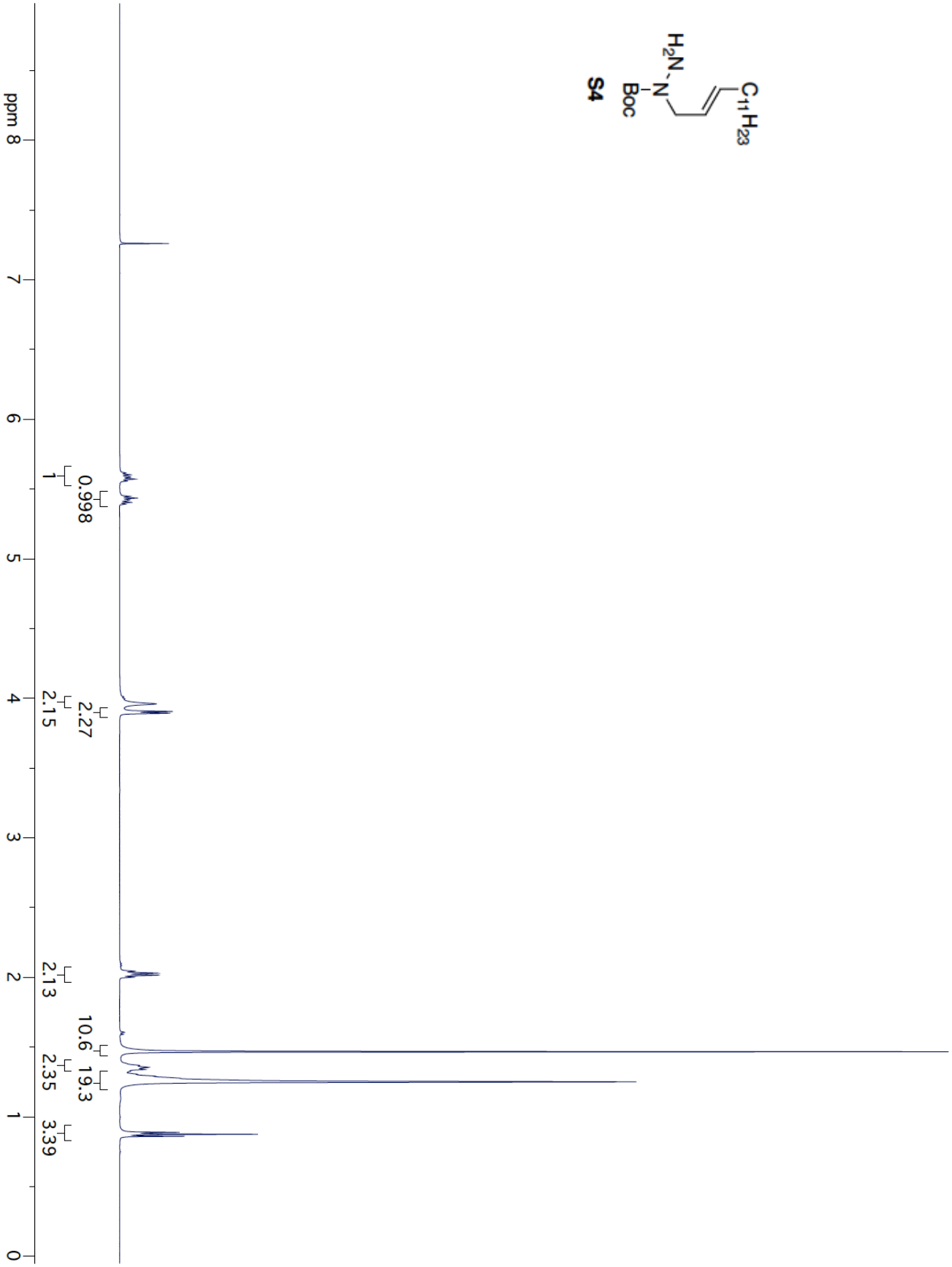
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160

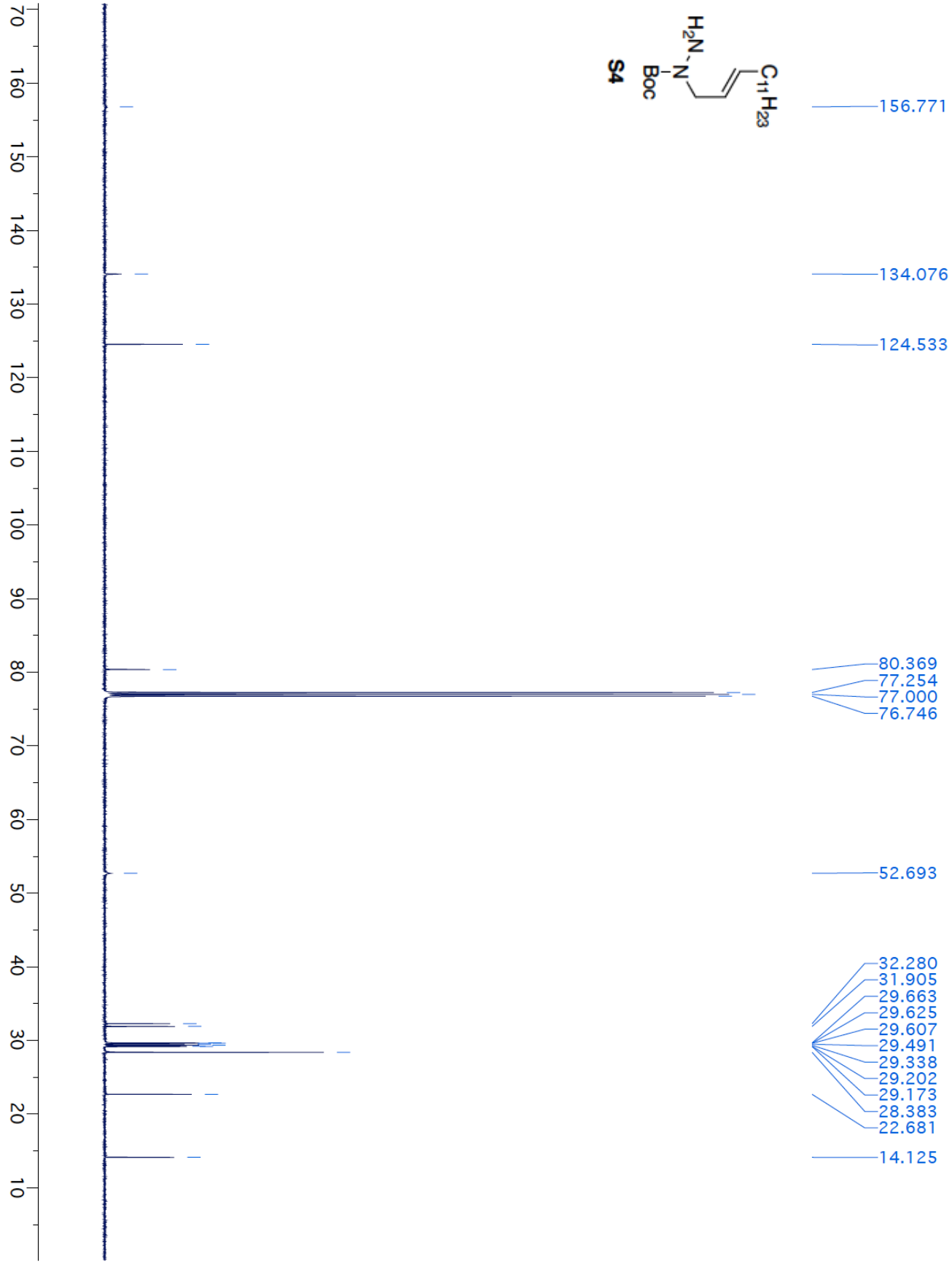


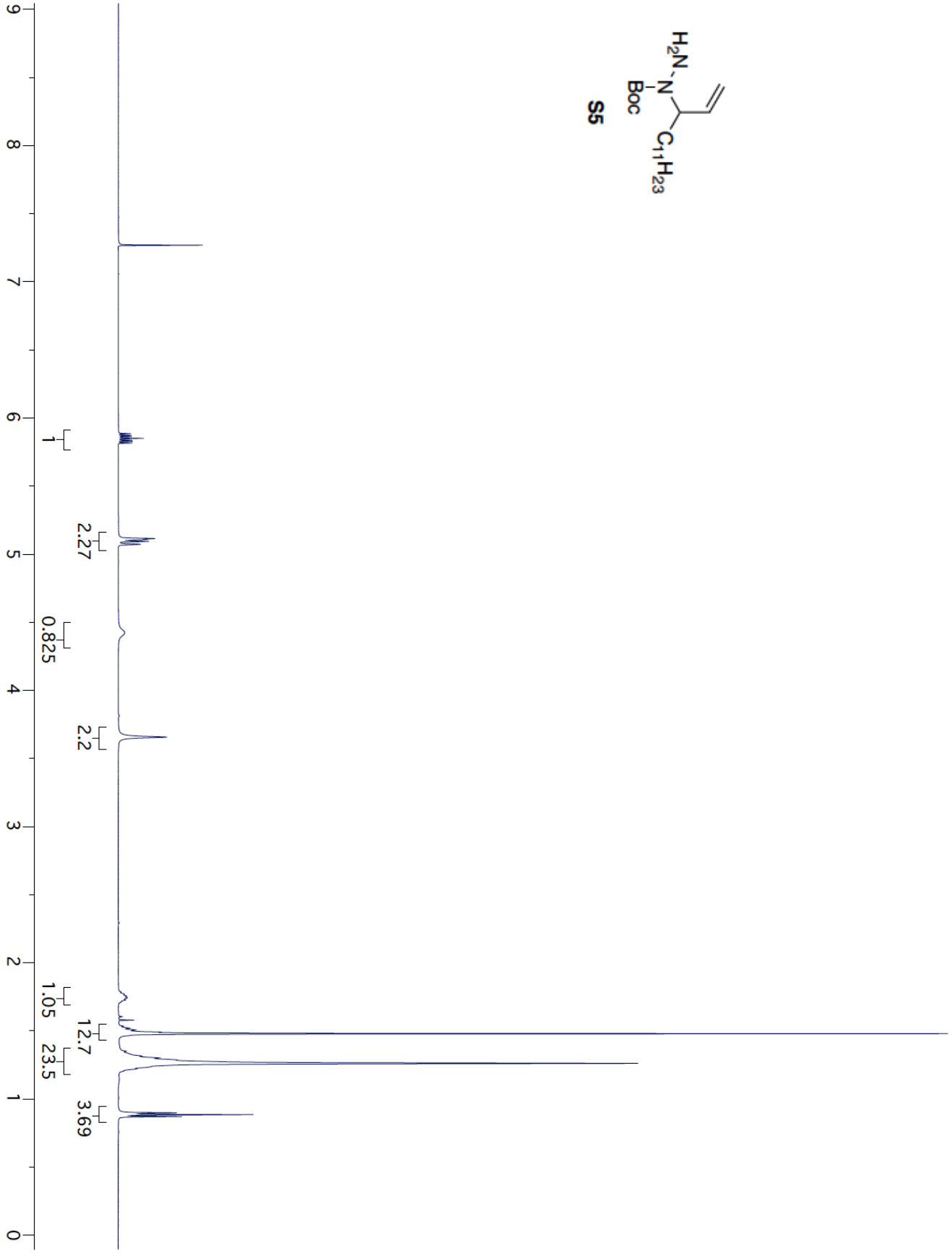


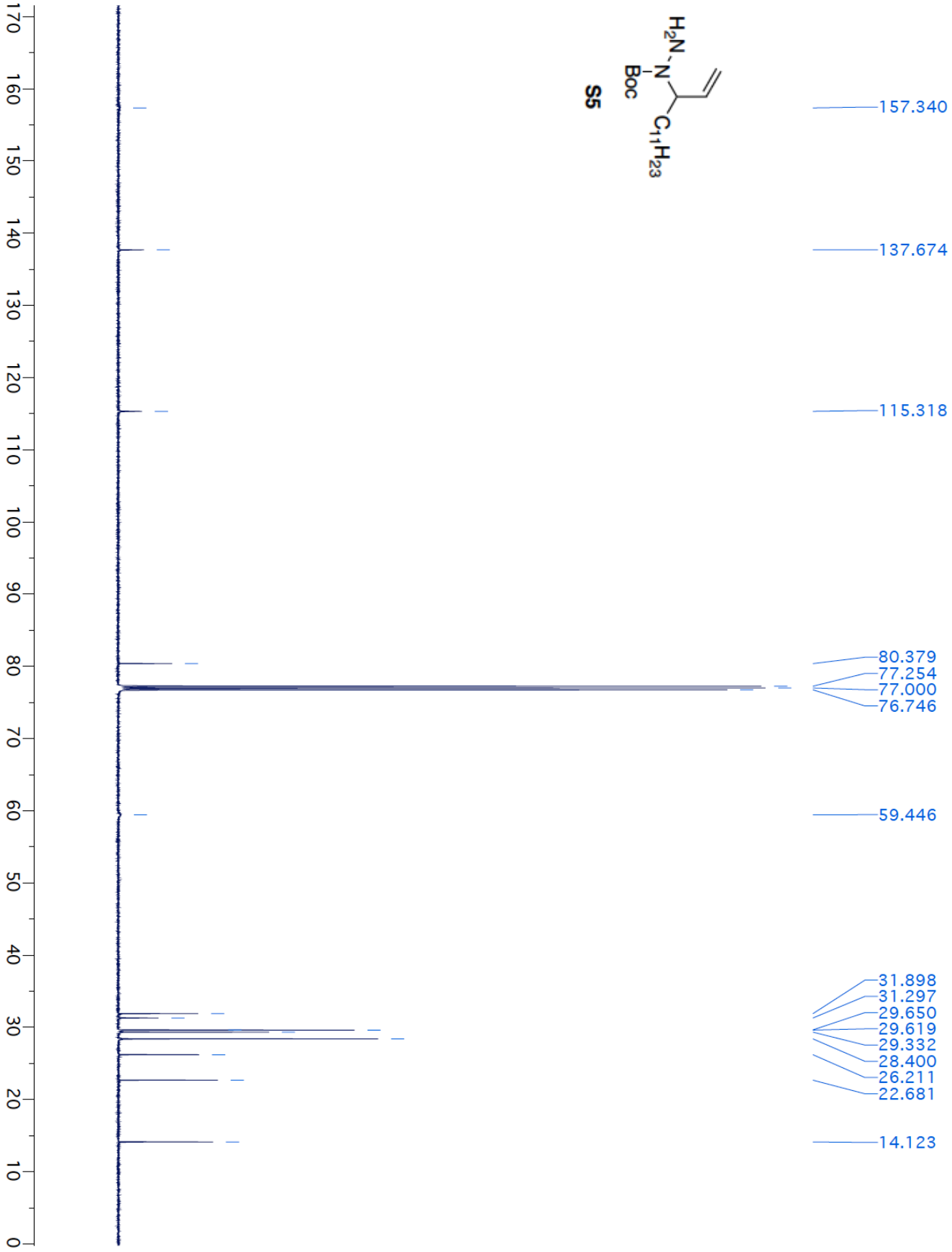
S3

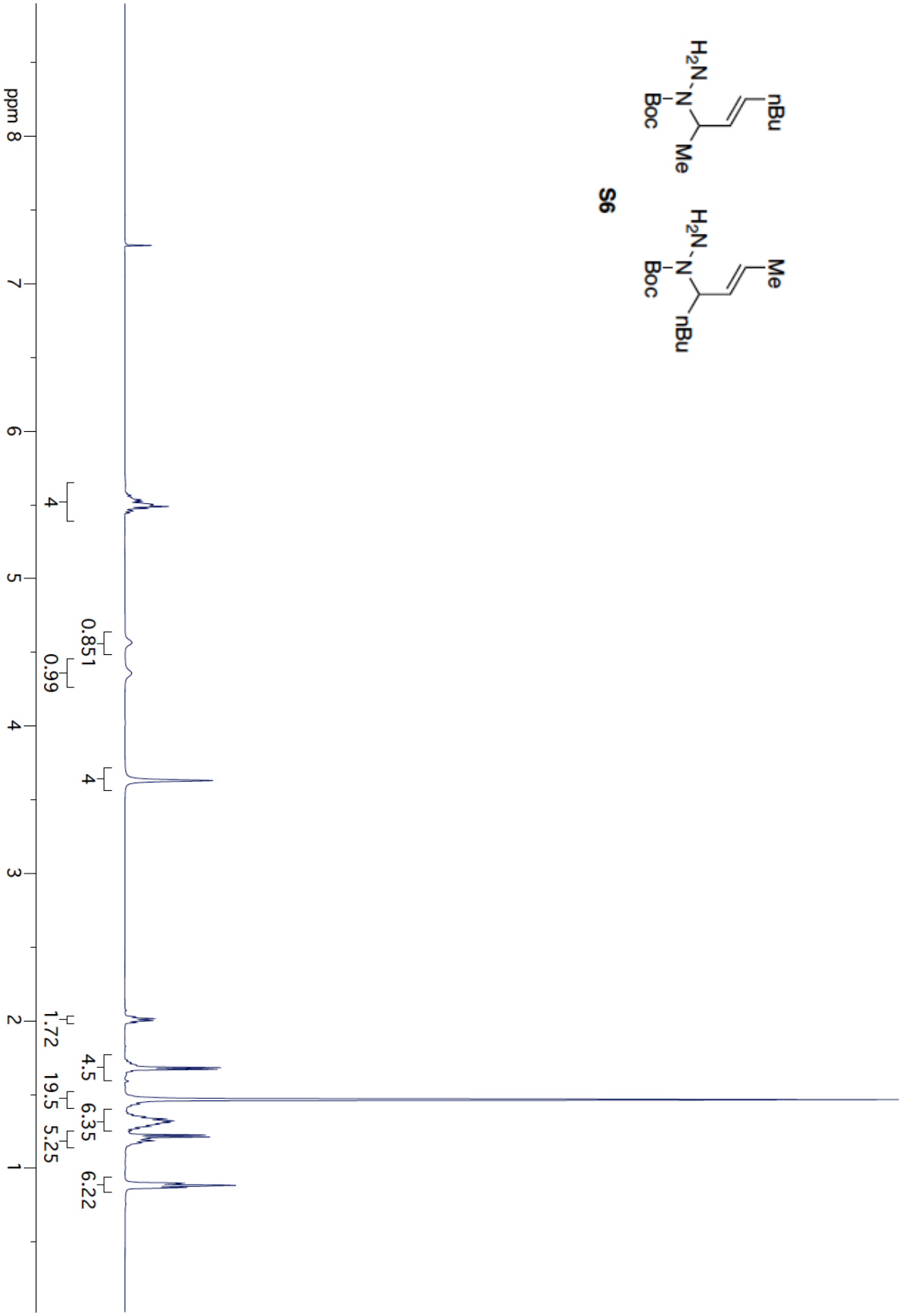


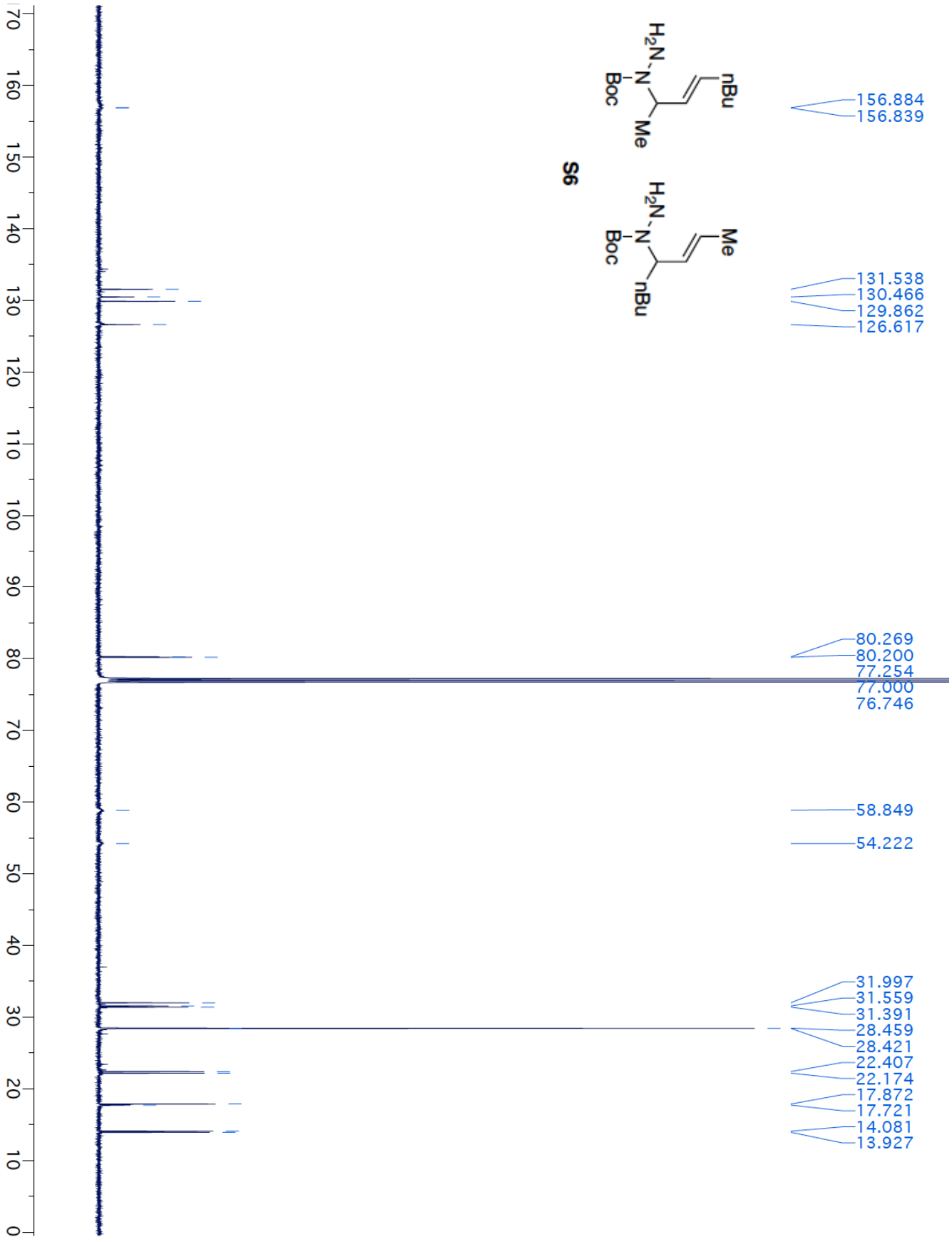


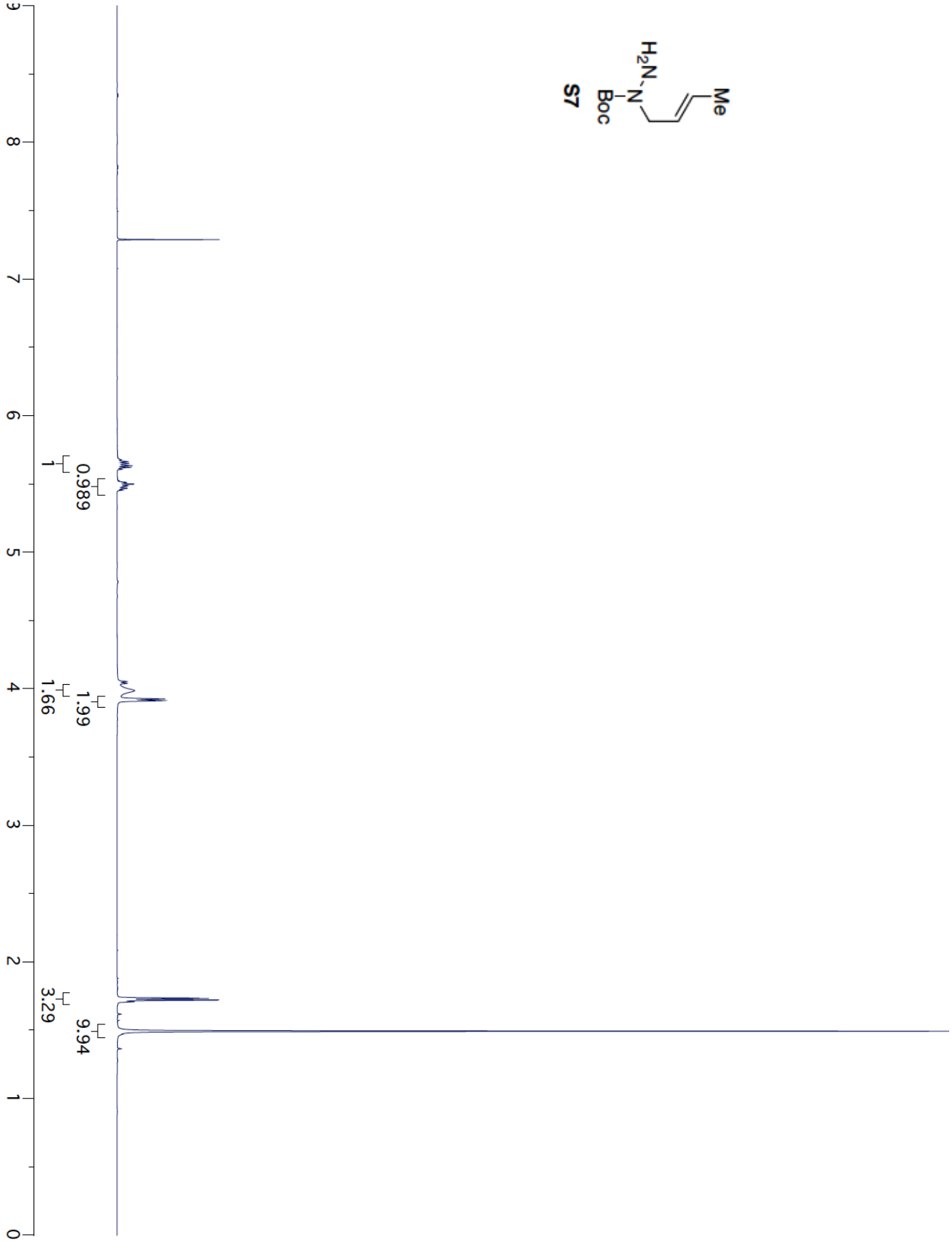


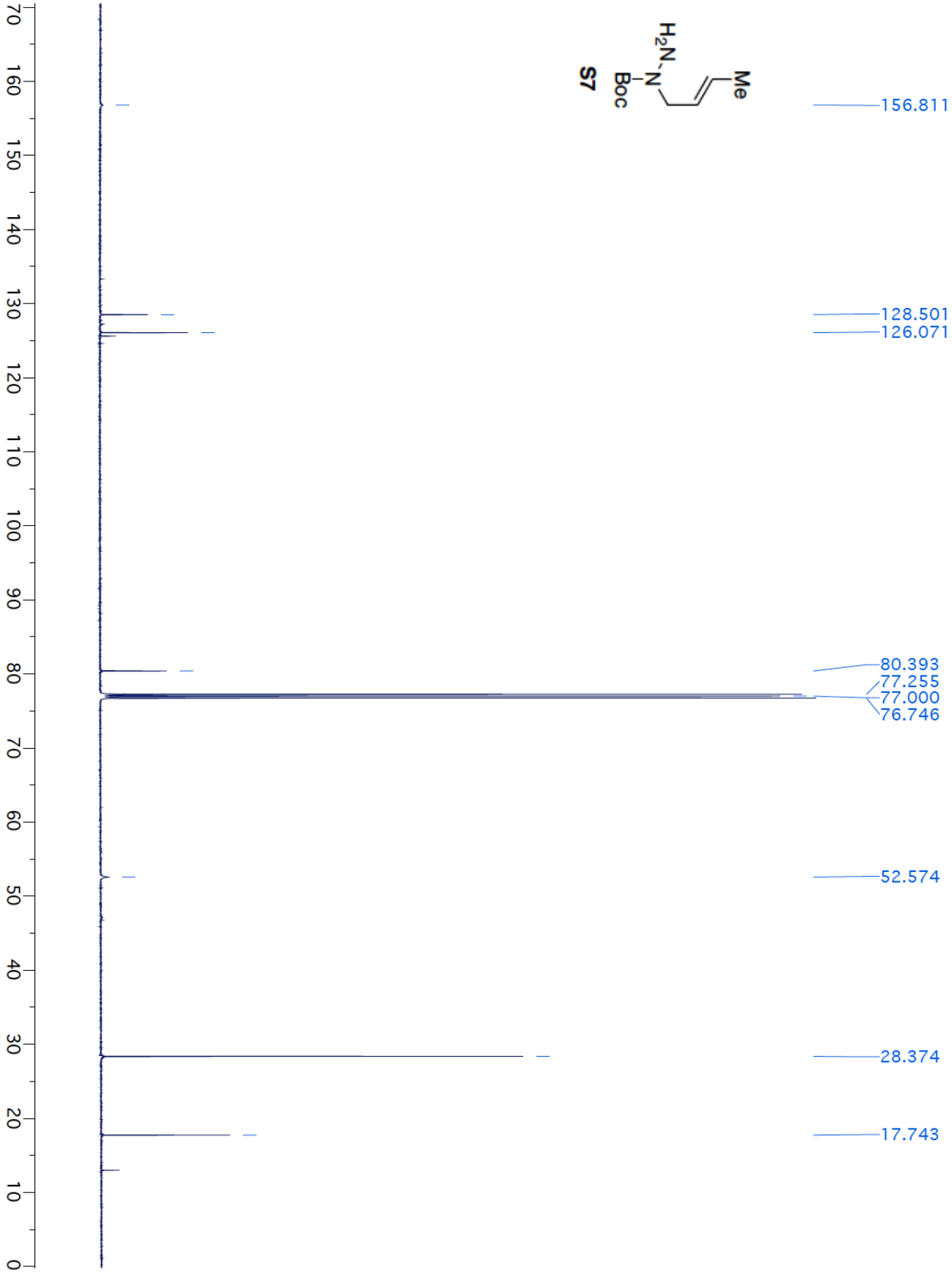


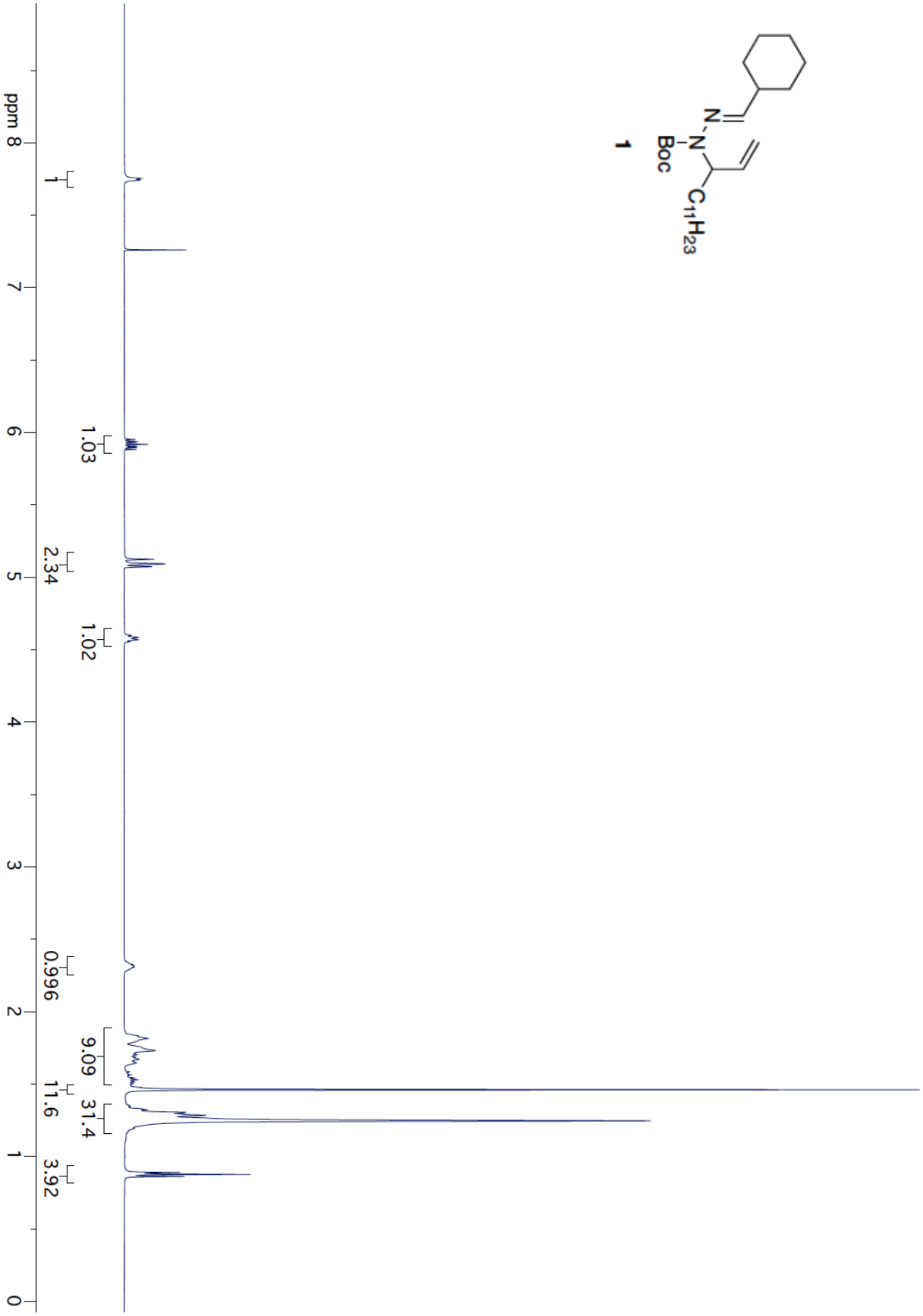


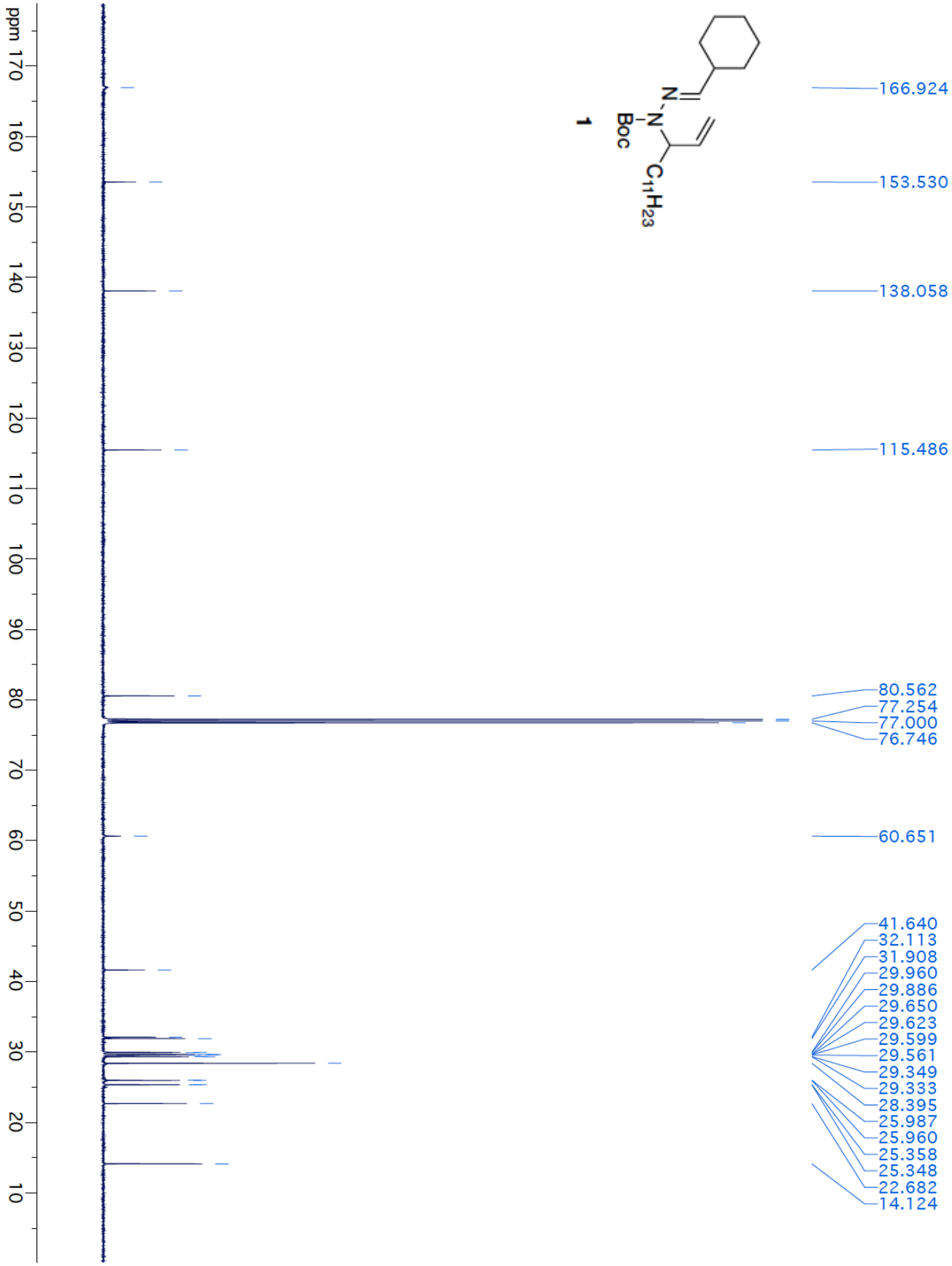


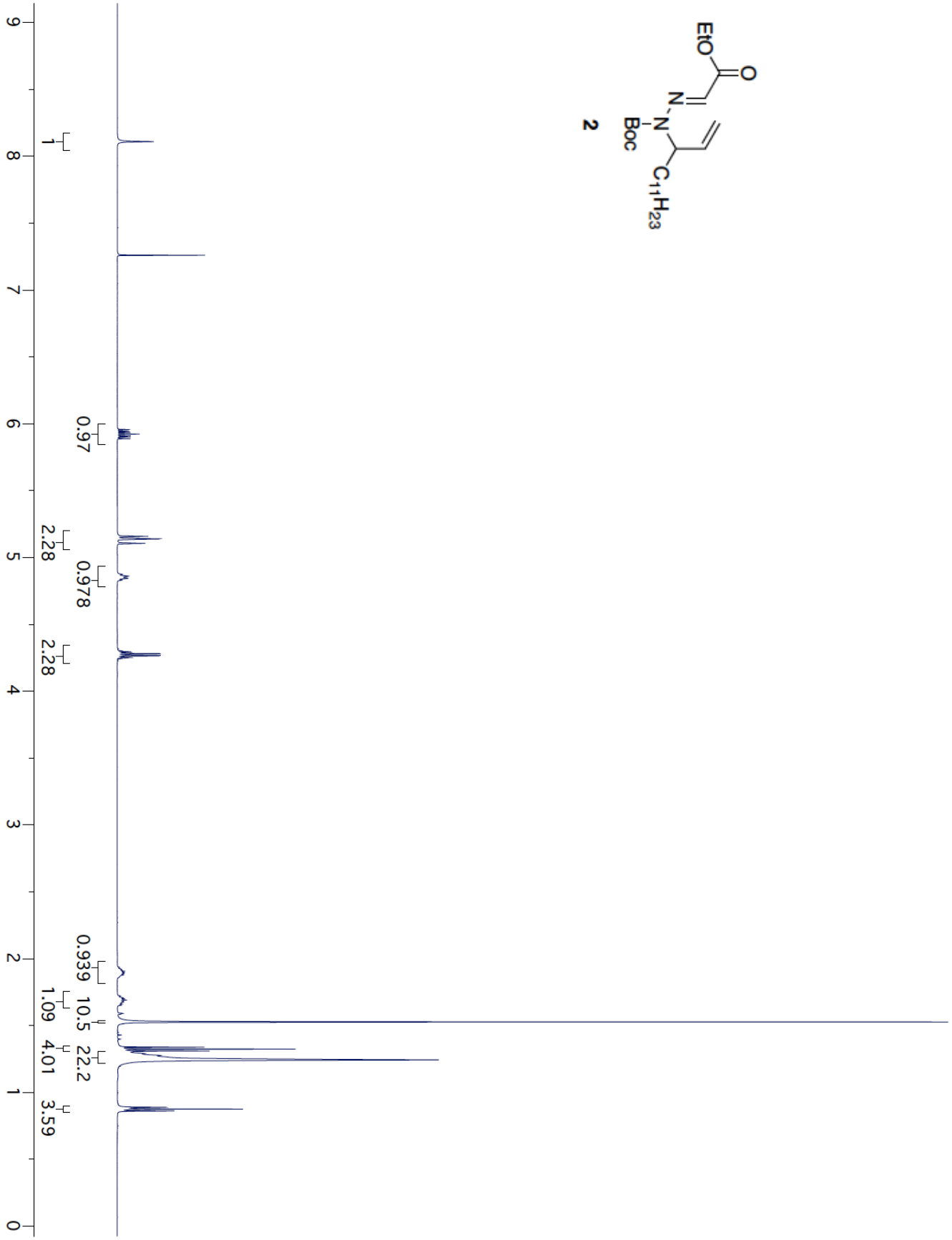


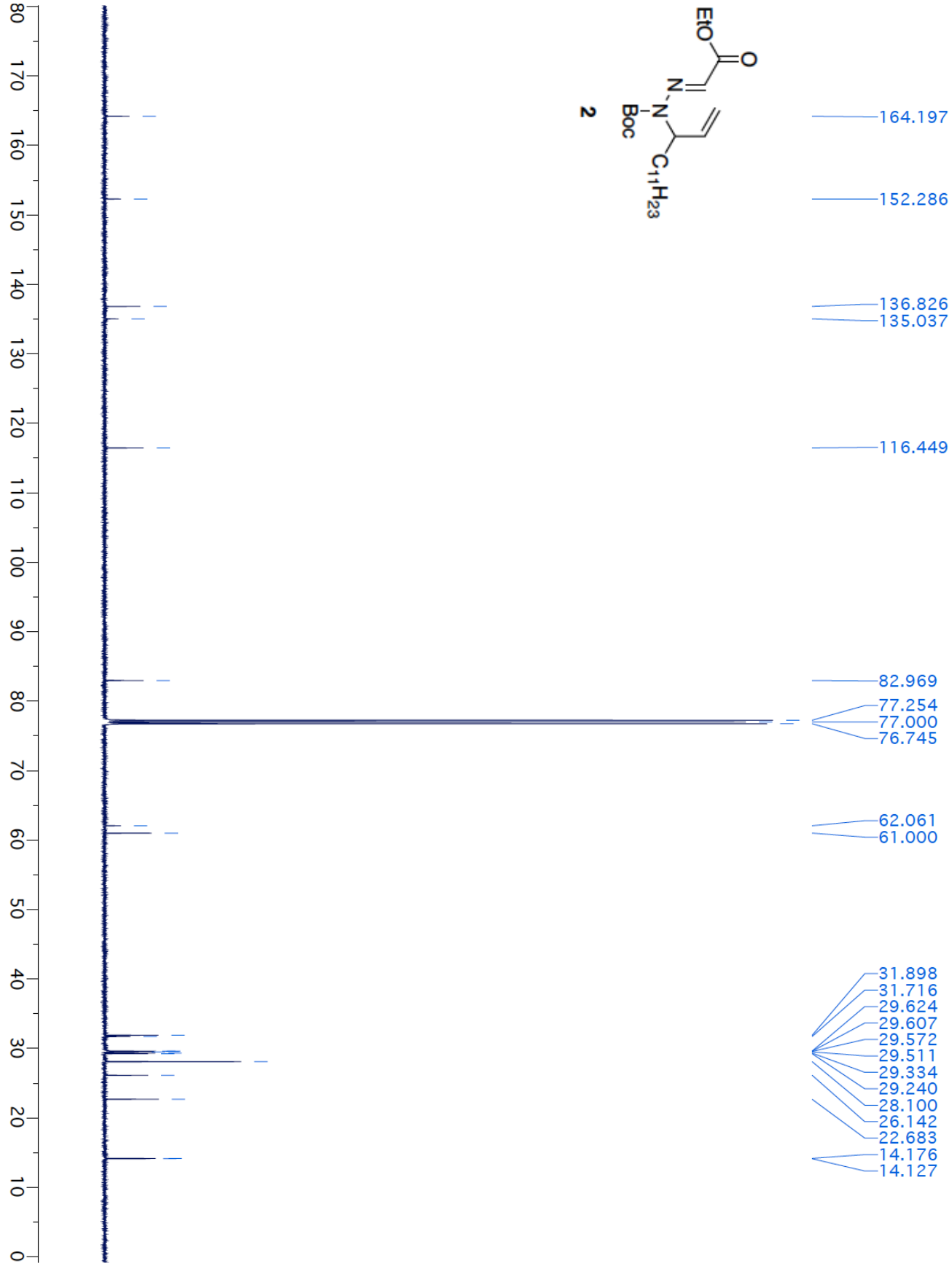


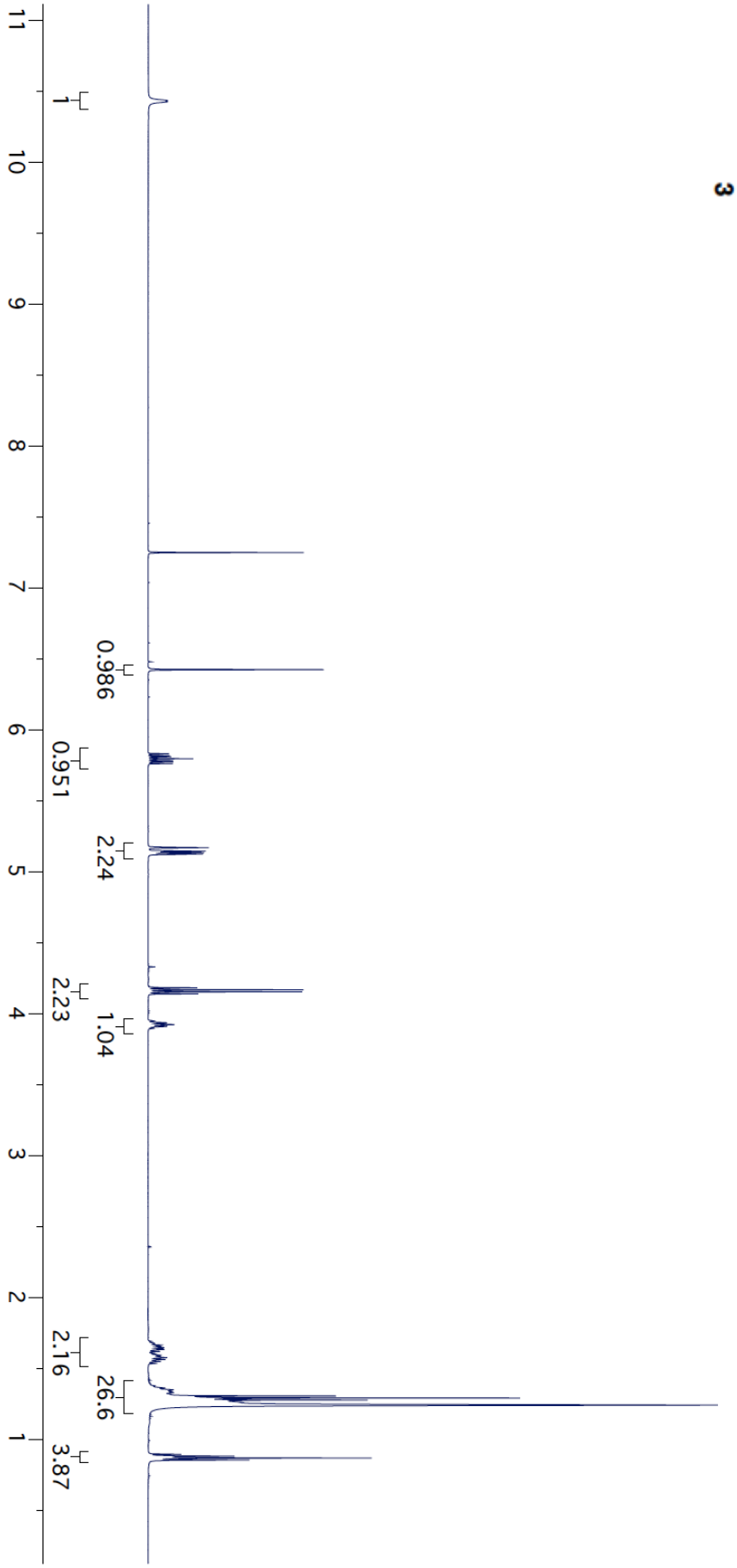


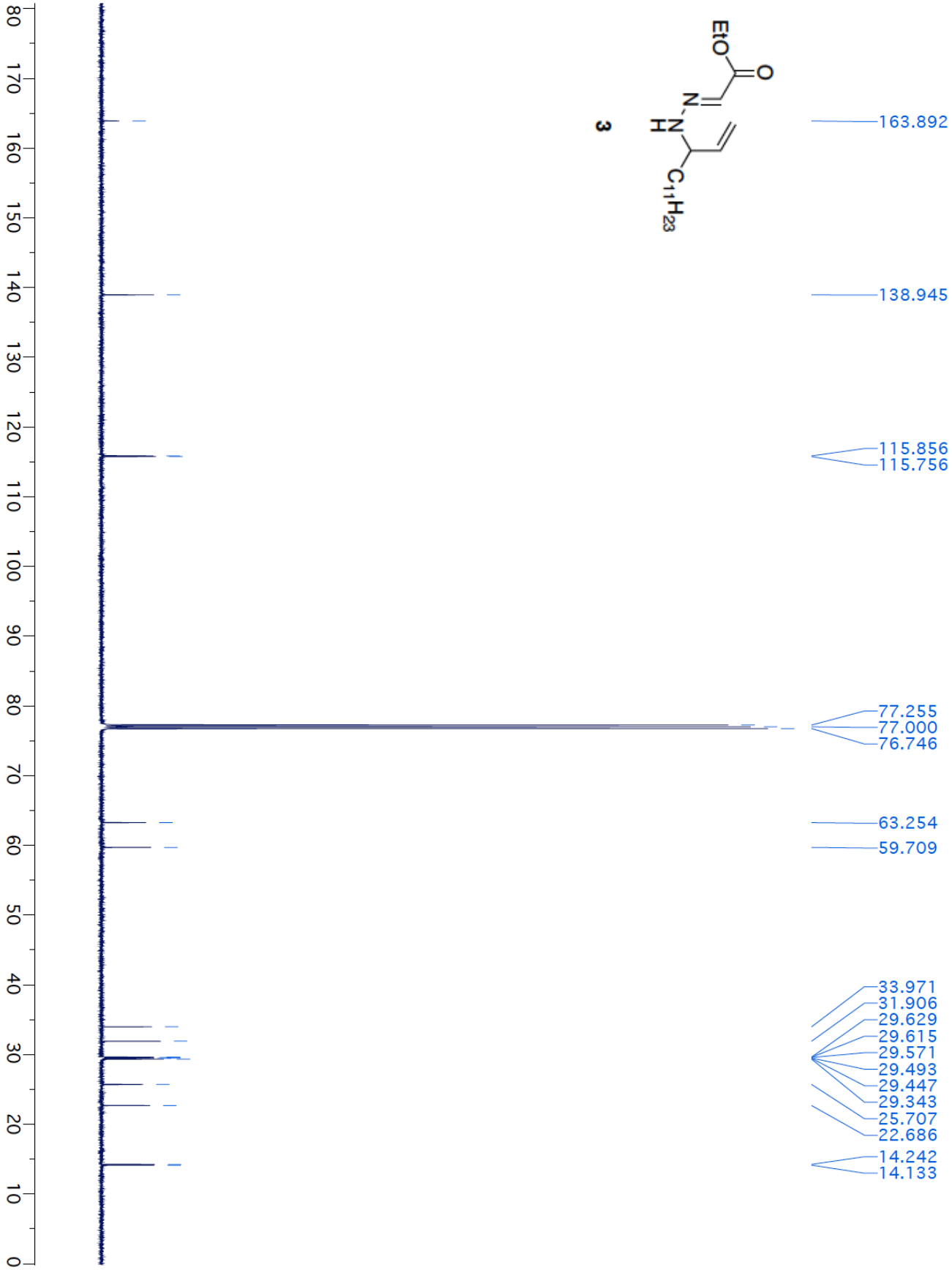











3
EtO
O
N
N
H
$C_{11}H_{23}$
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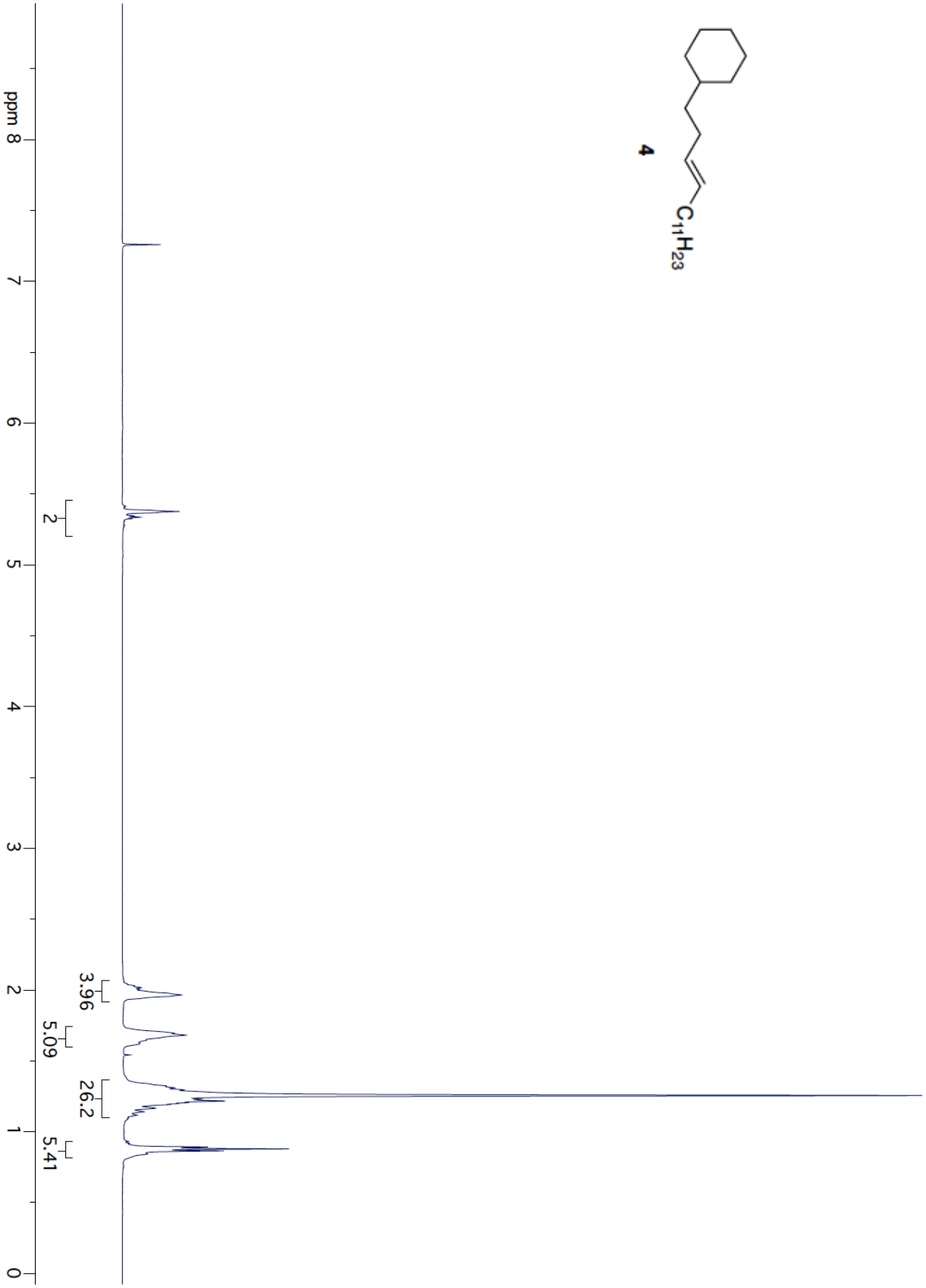
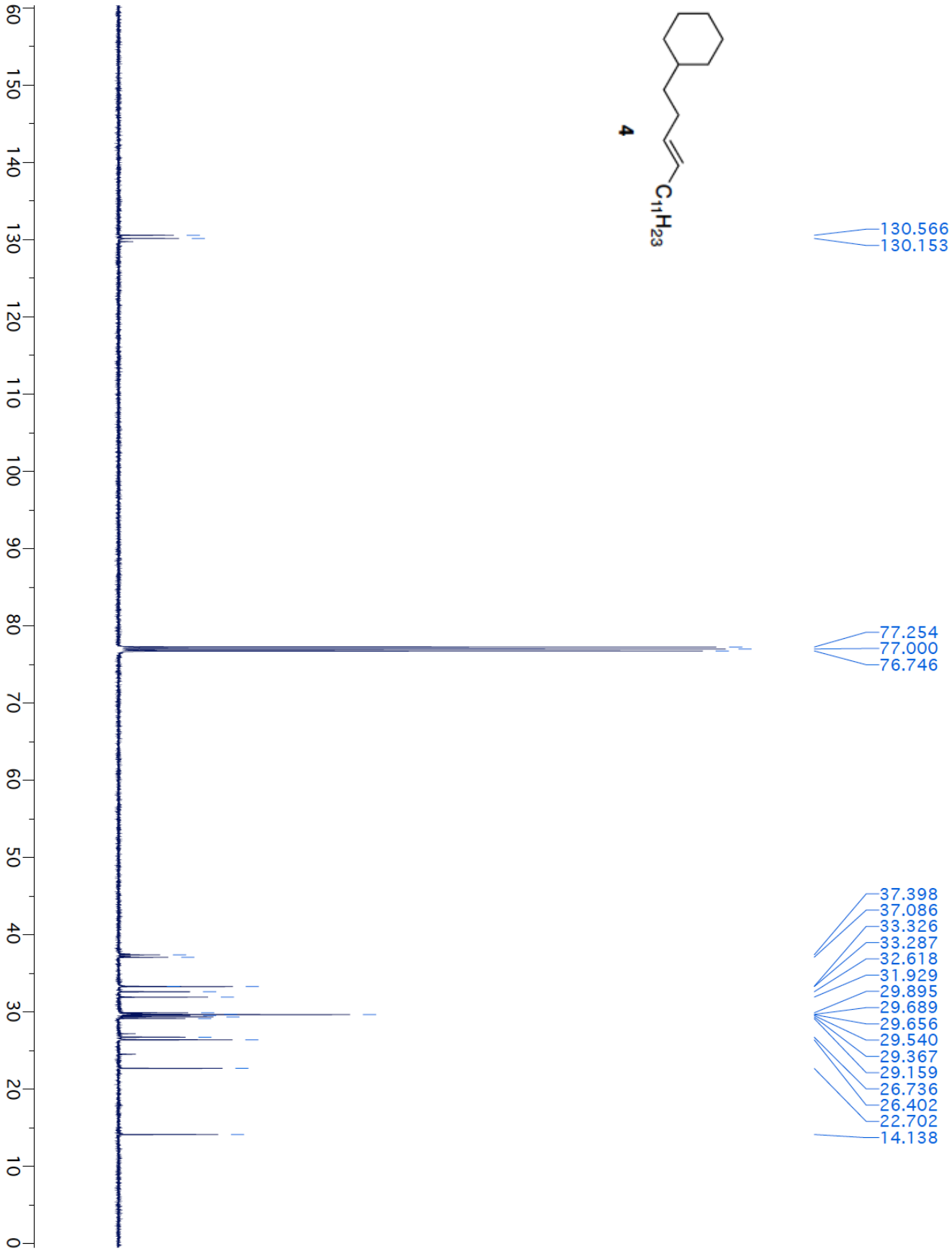
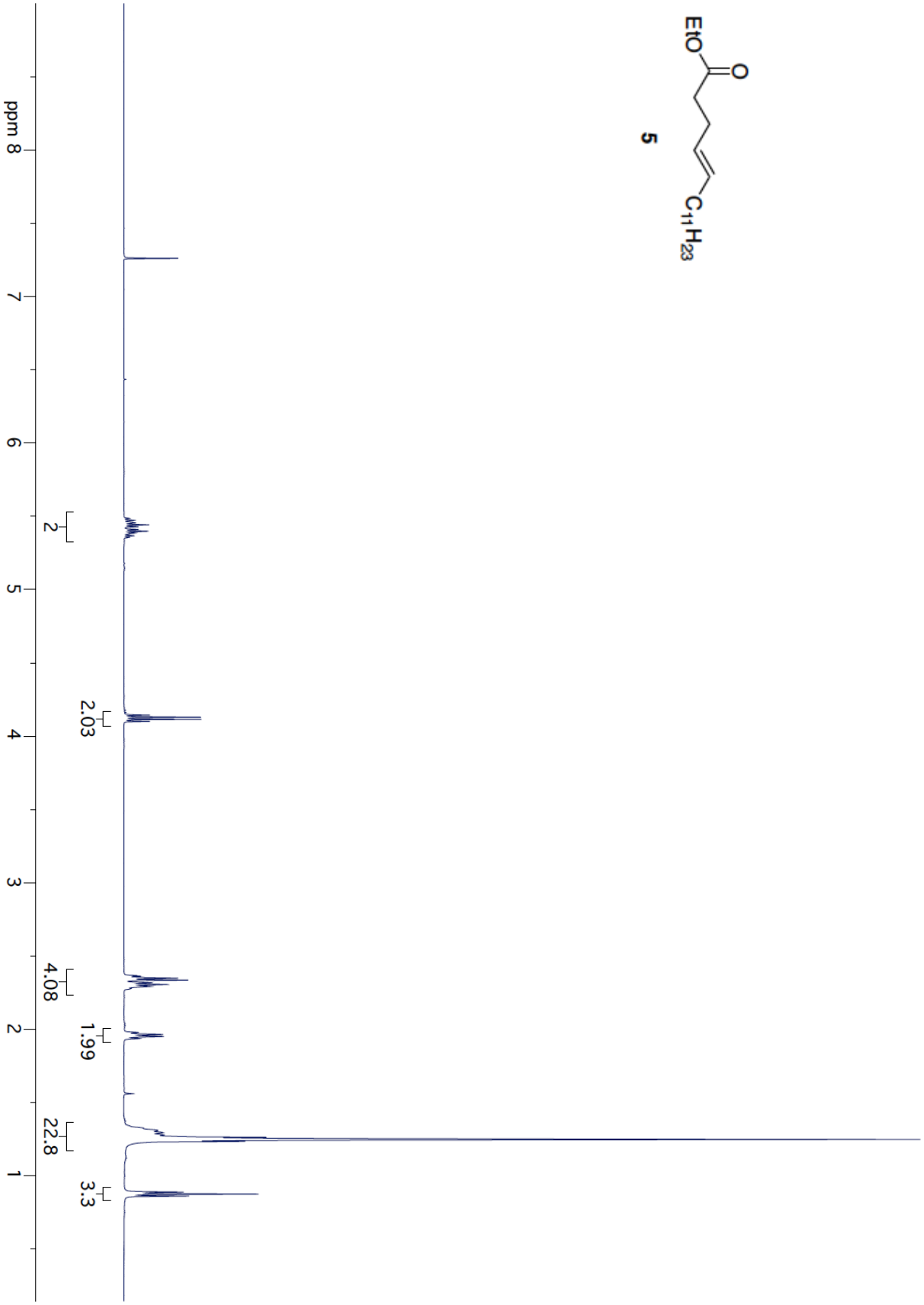
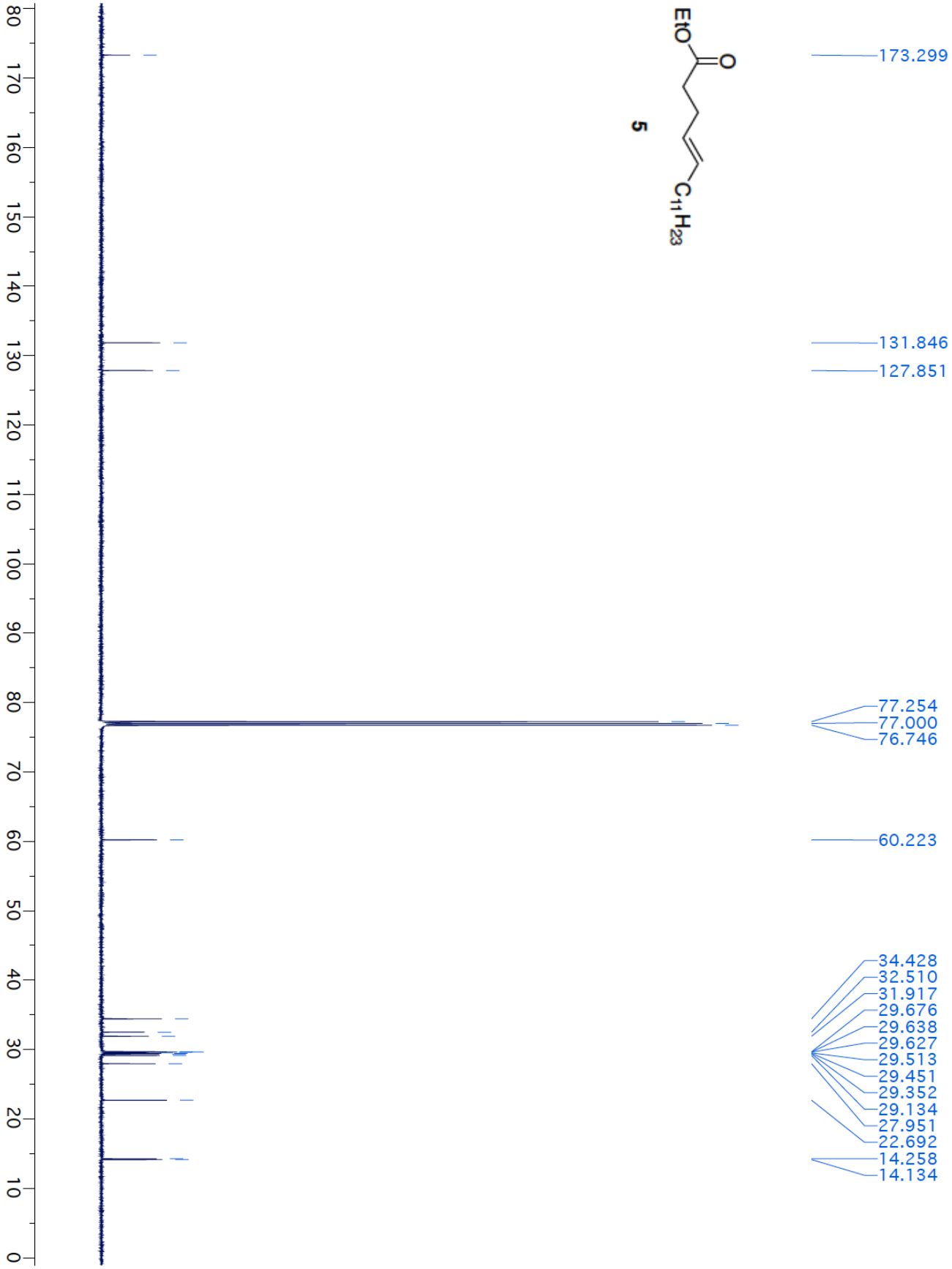
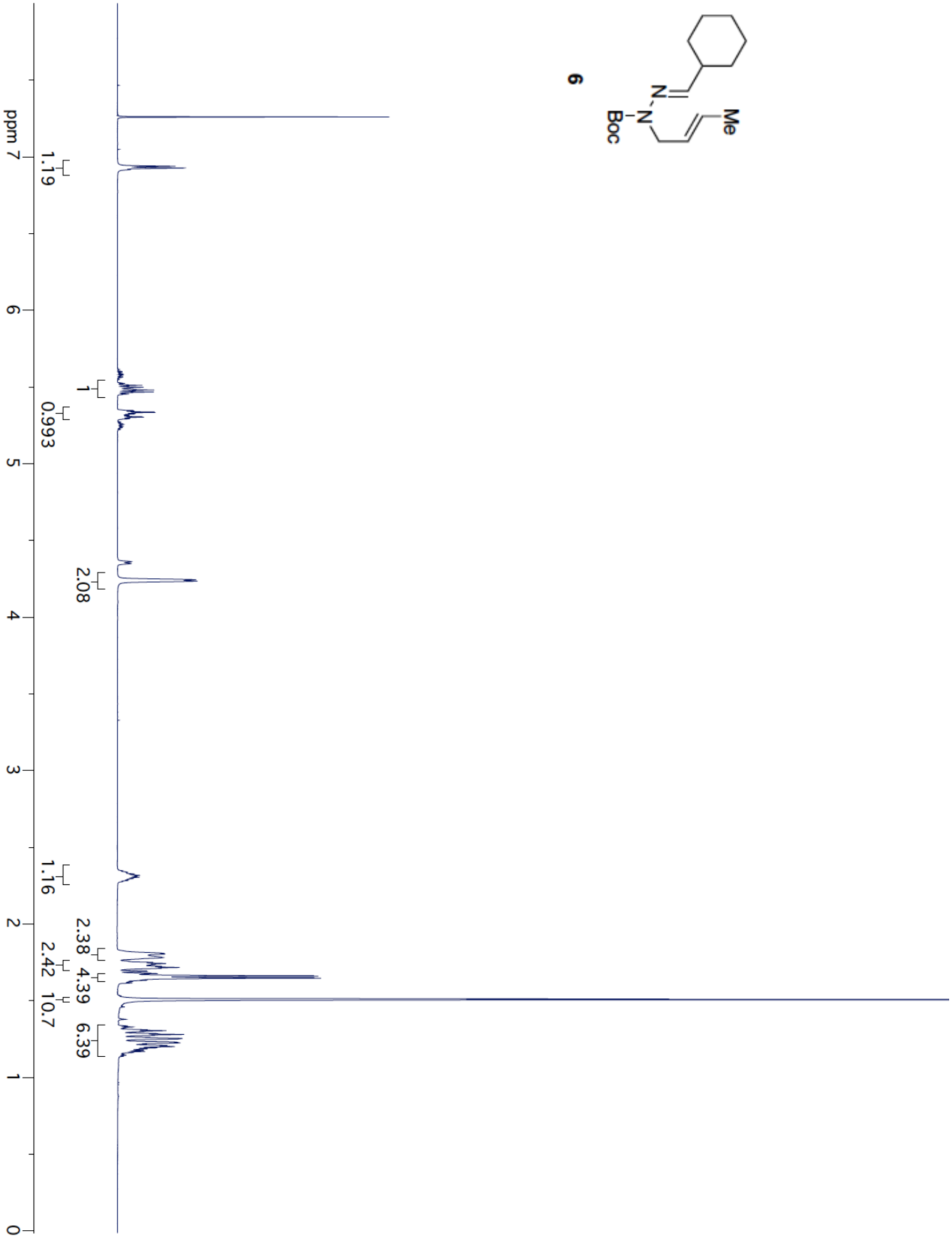
138.945
115.856
115.756
77.255
77.000
76.746
63.254
59.709
33.971
31.906
29.629
29.615
29.571
29.493
29.447
29.343
25.707
22.686
14.242
14.133
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

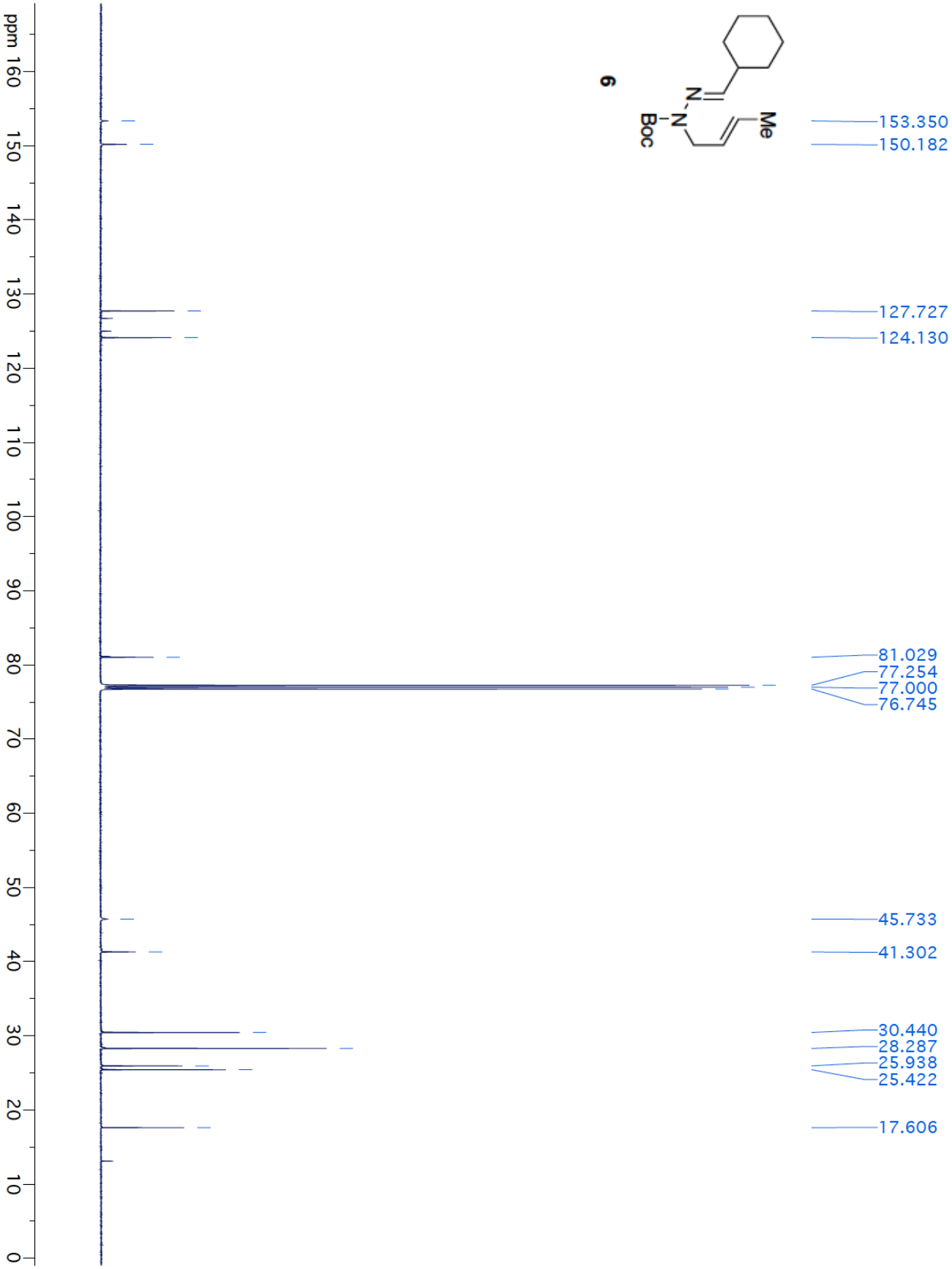

4
$C_{11}H_{23}$
ppm
8
7
6
5
4
3
2
1
0
2
3.96
5.09
26.2
5.41

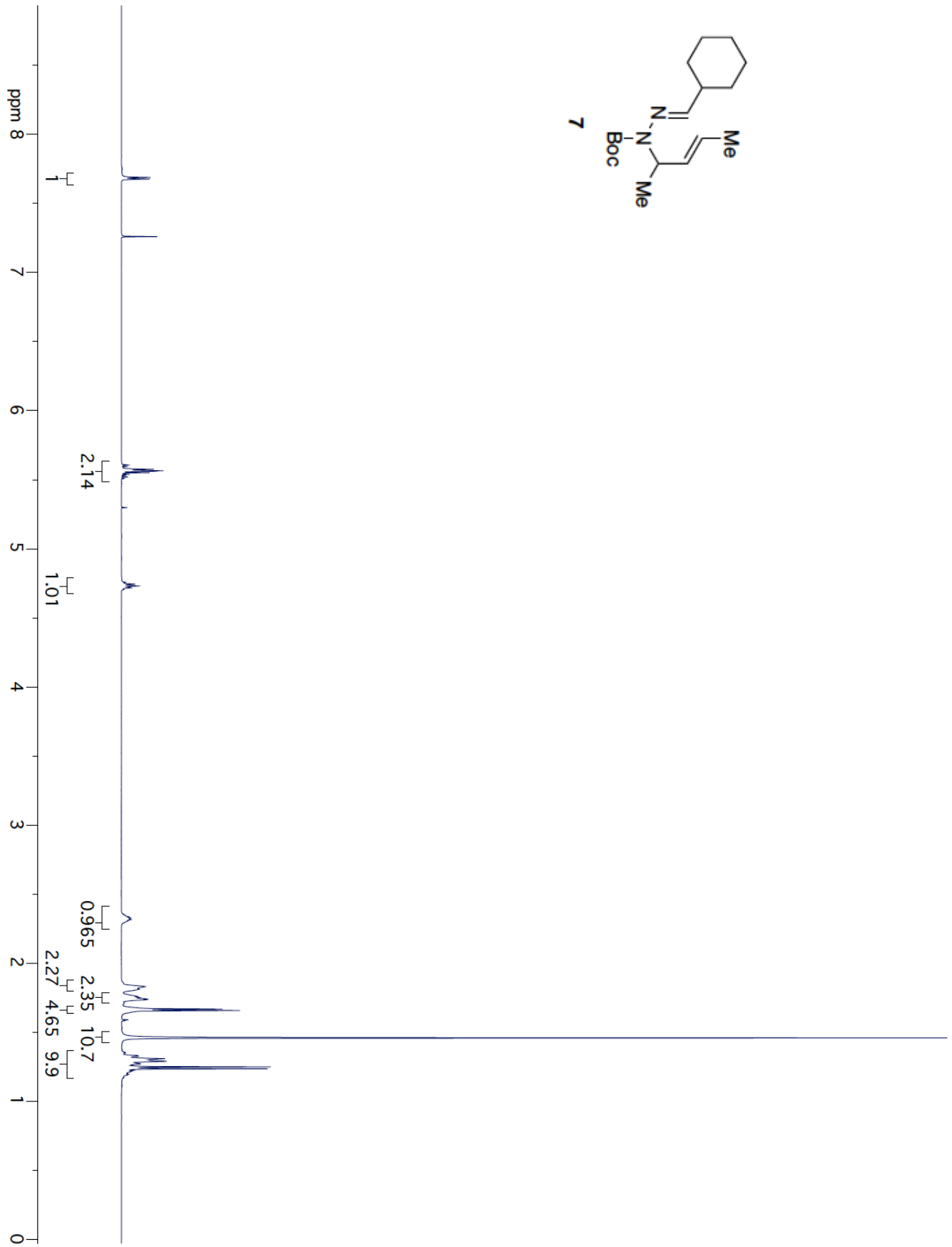


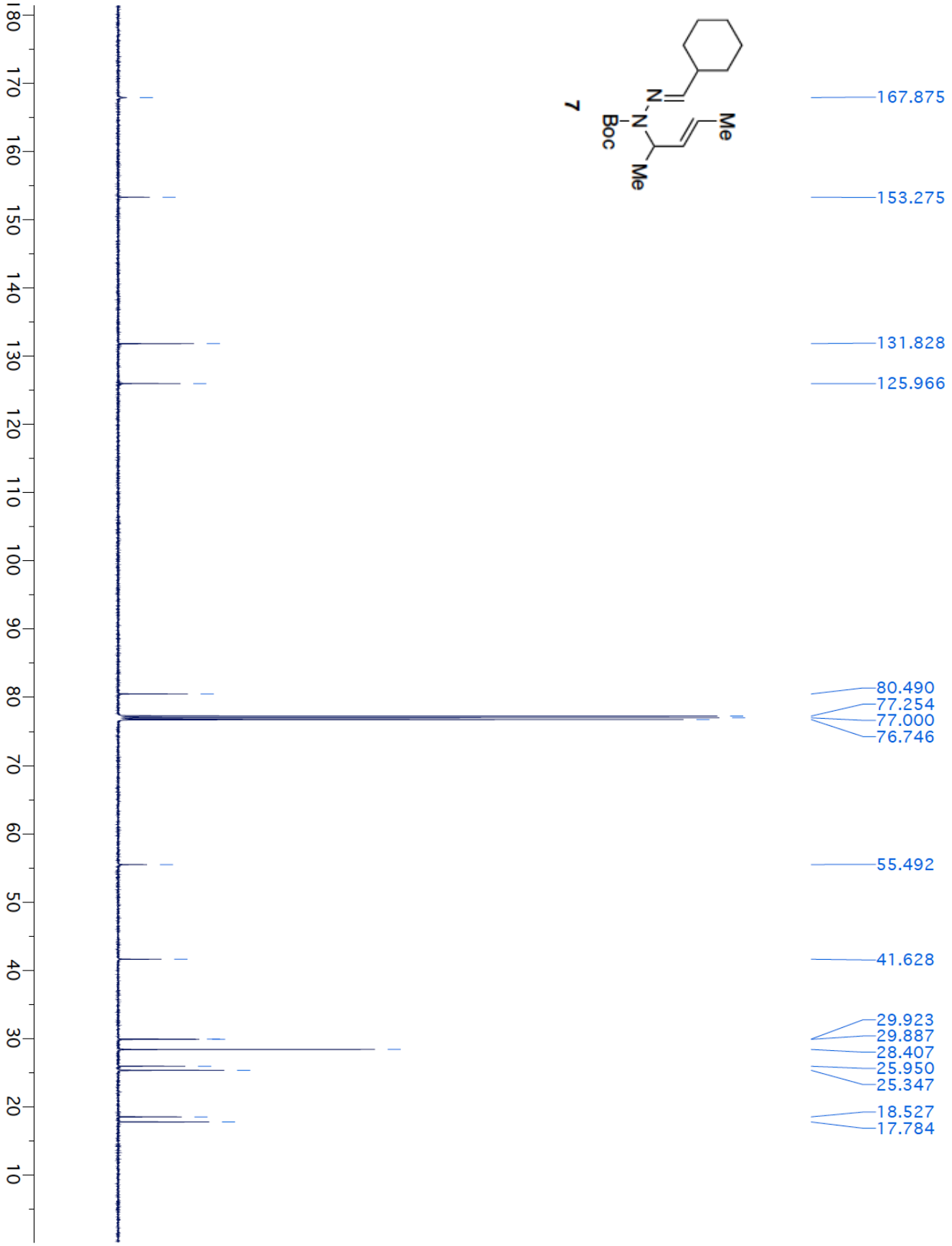


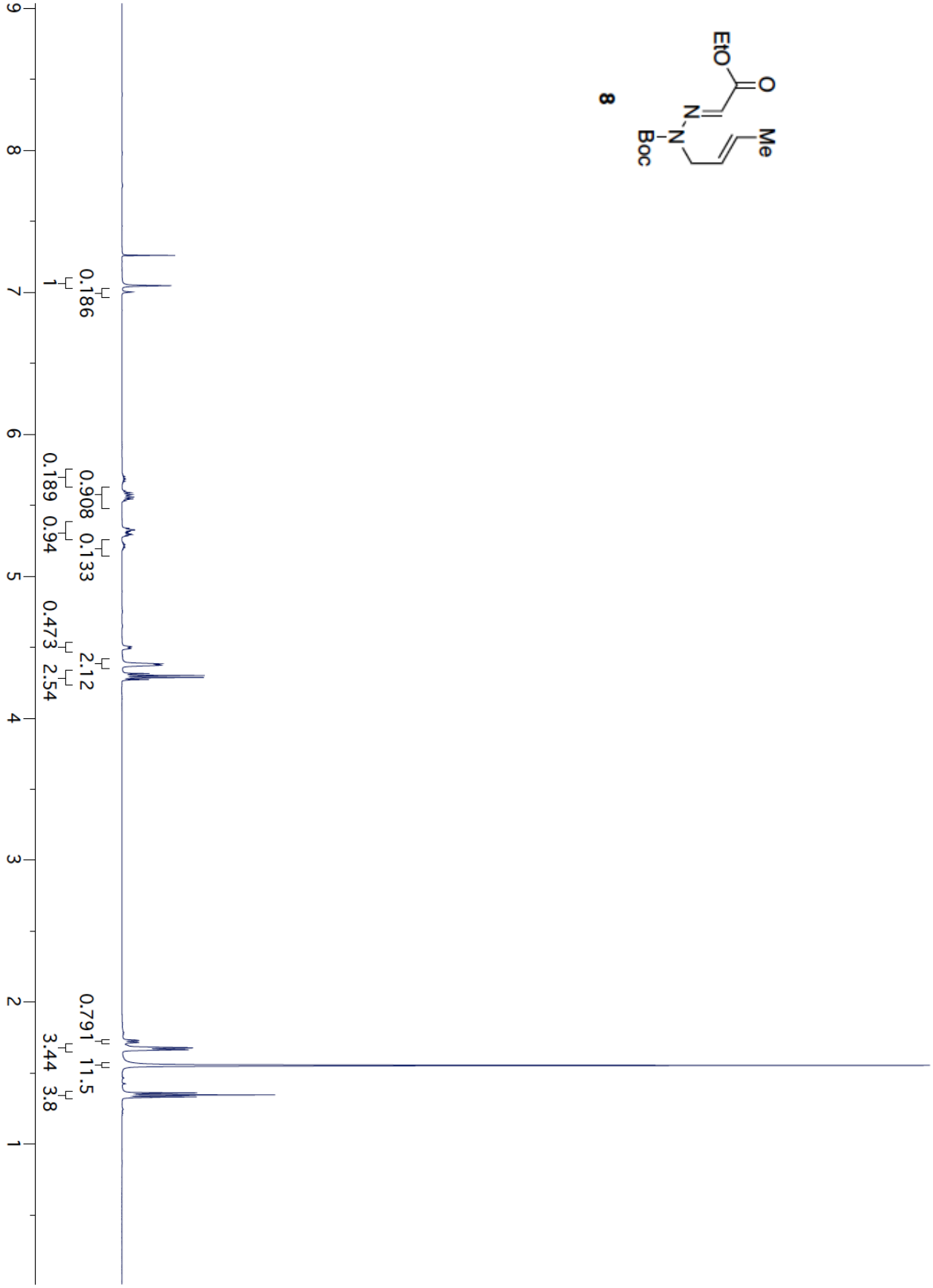


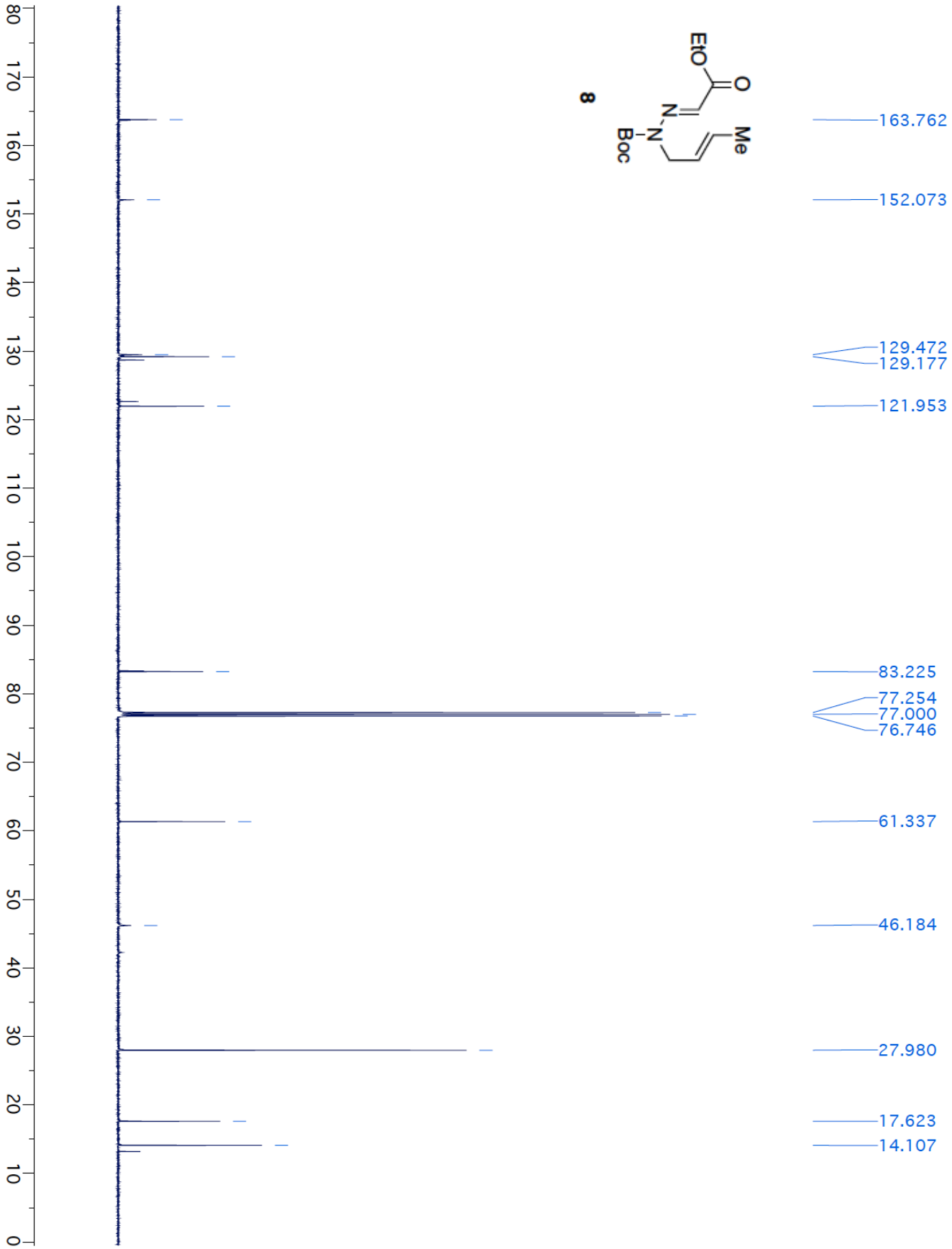


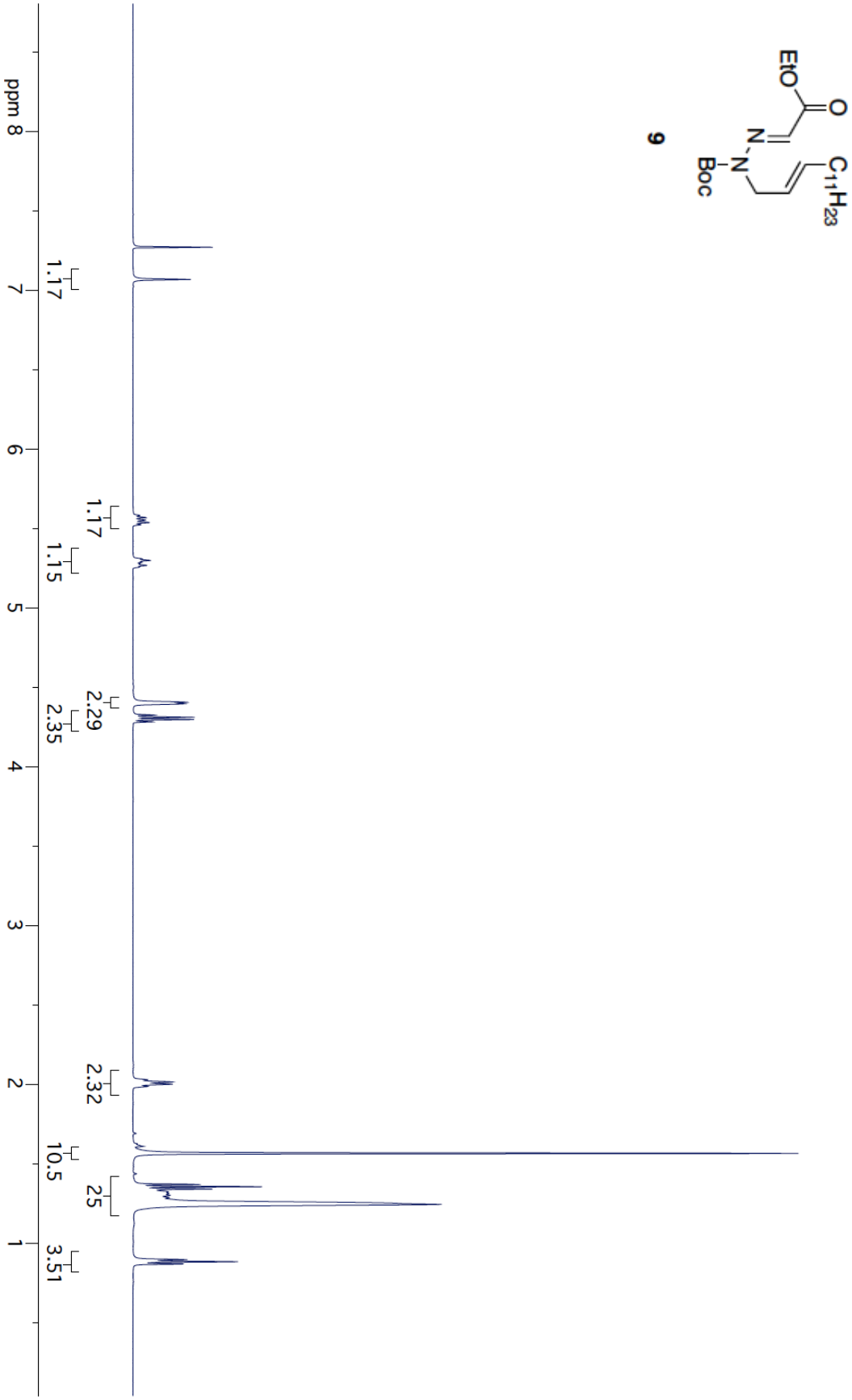


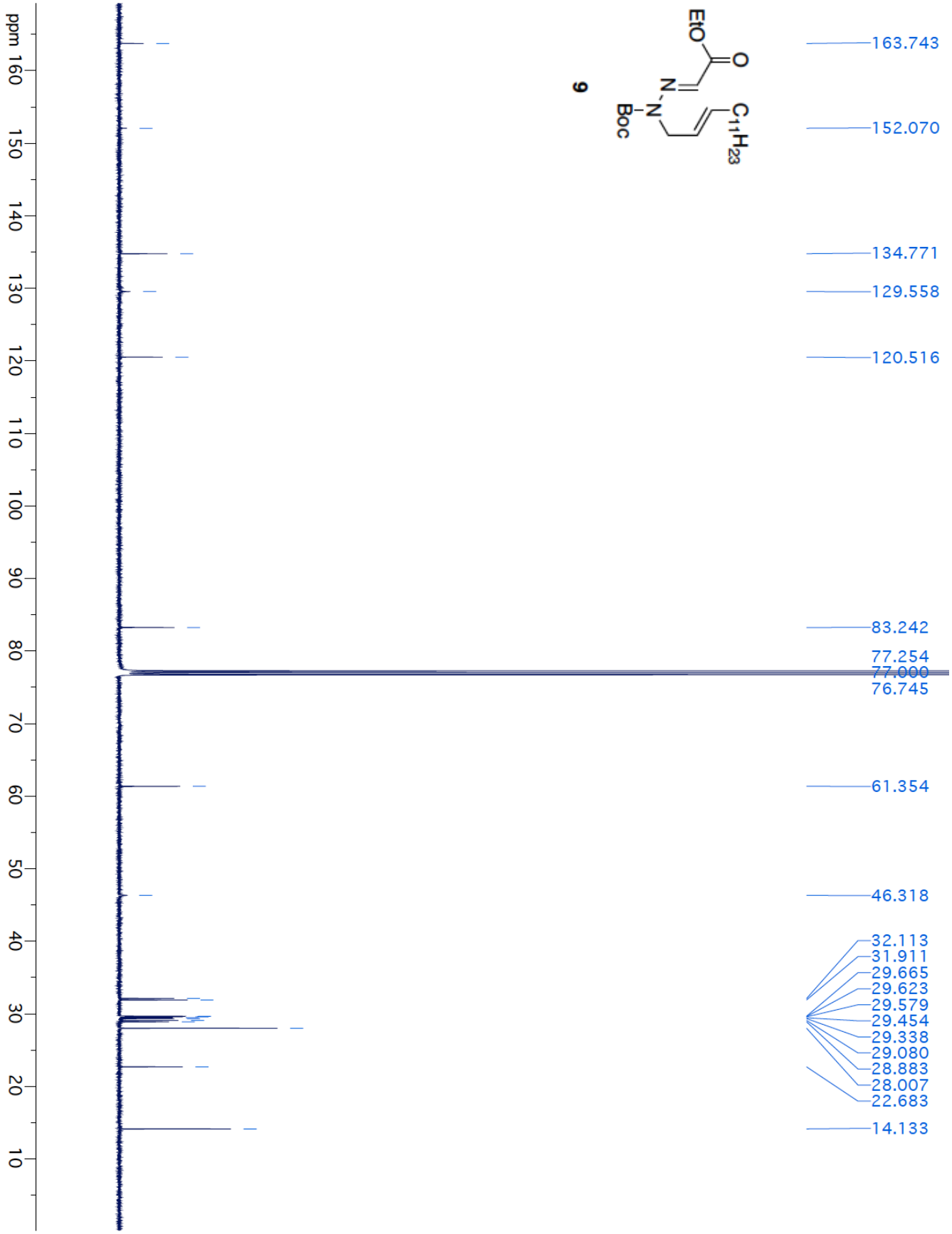


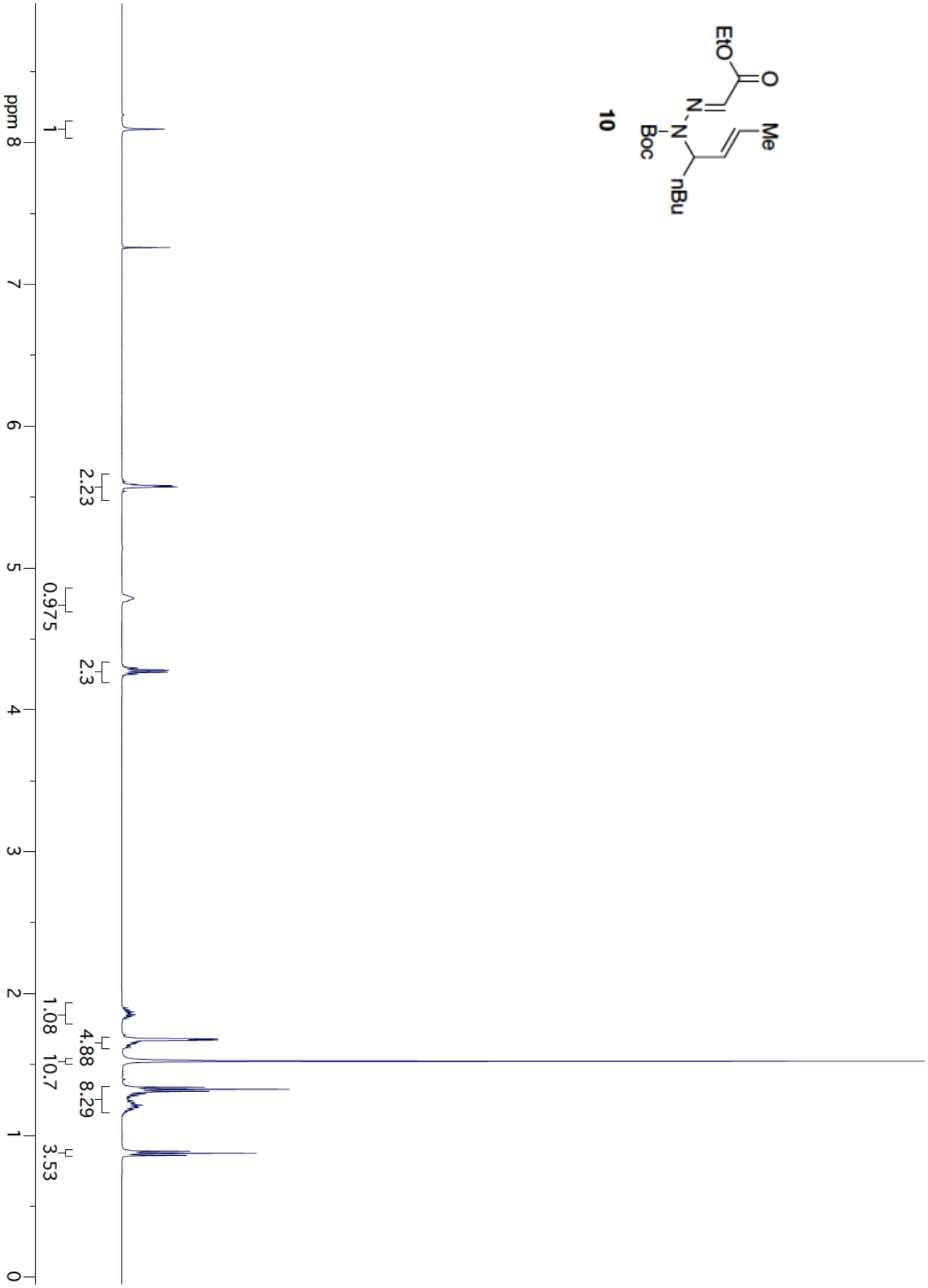


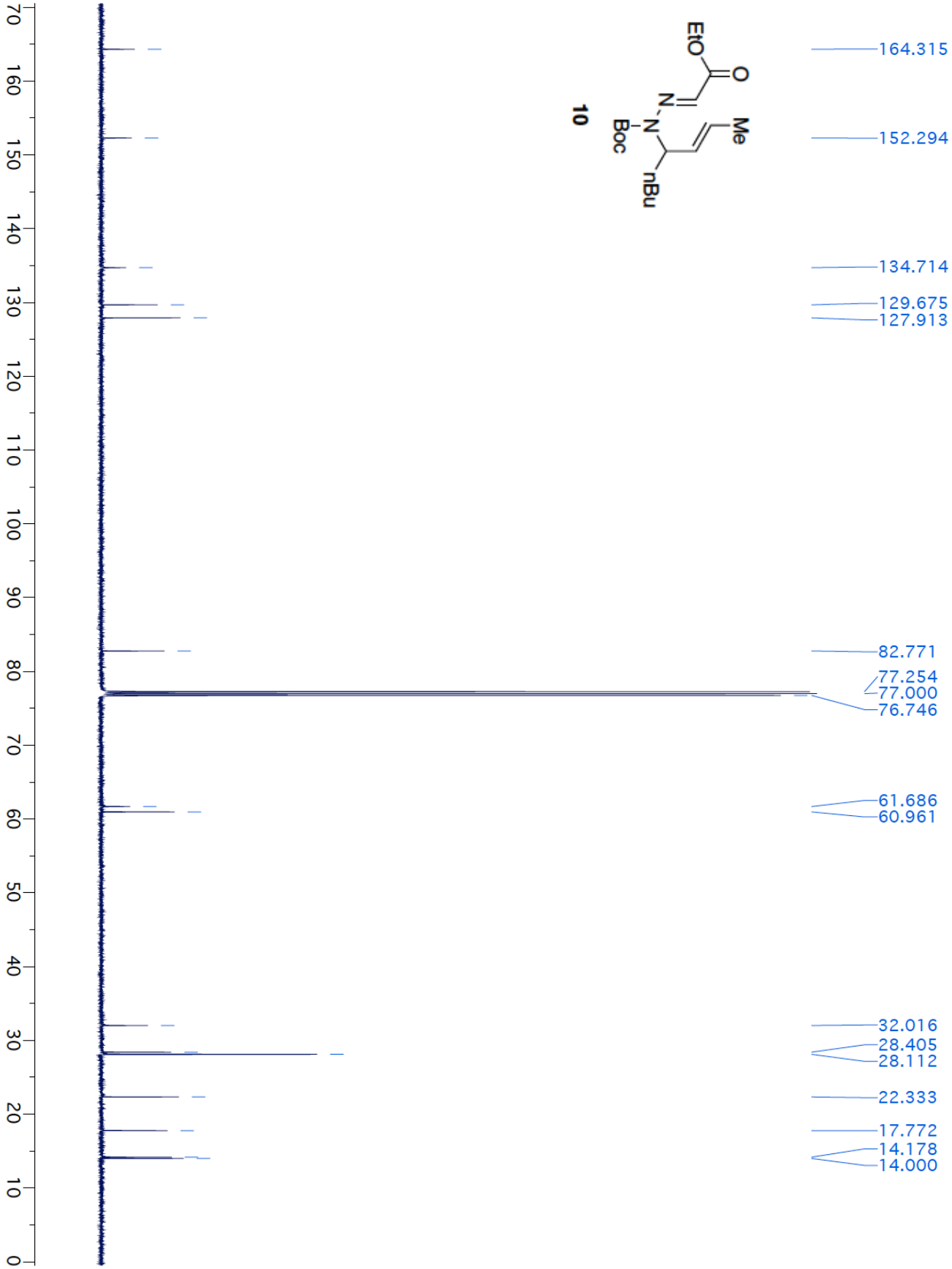


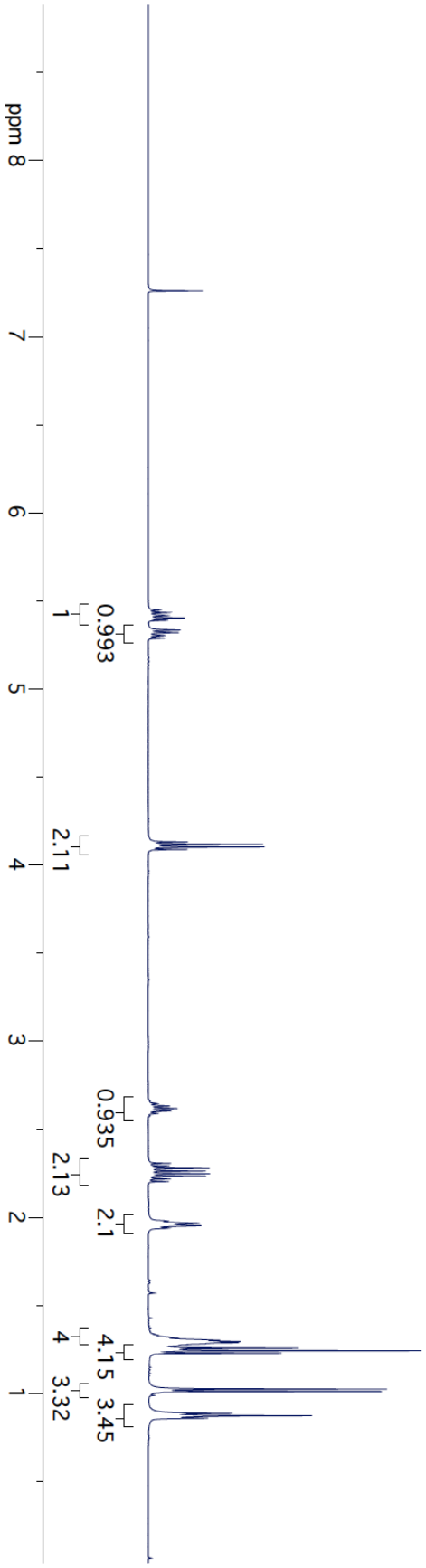


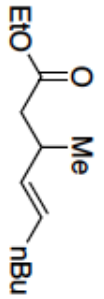












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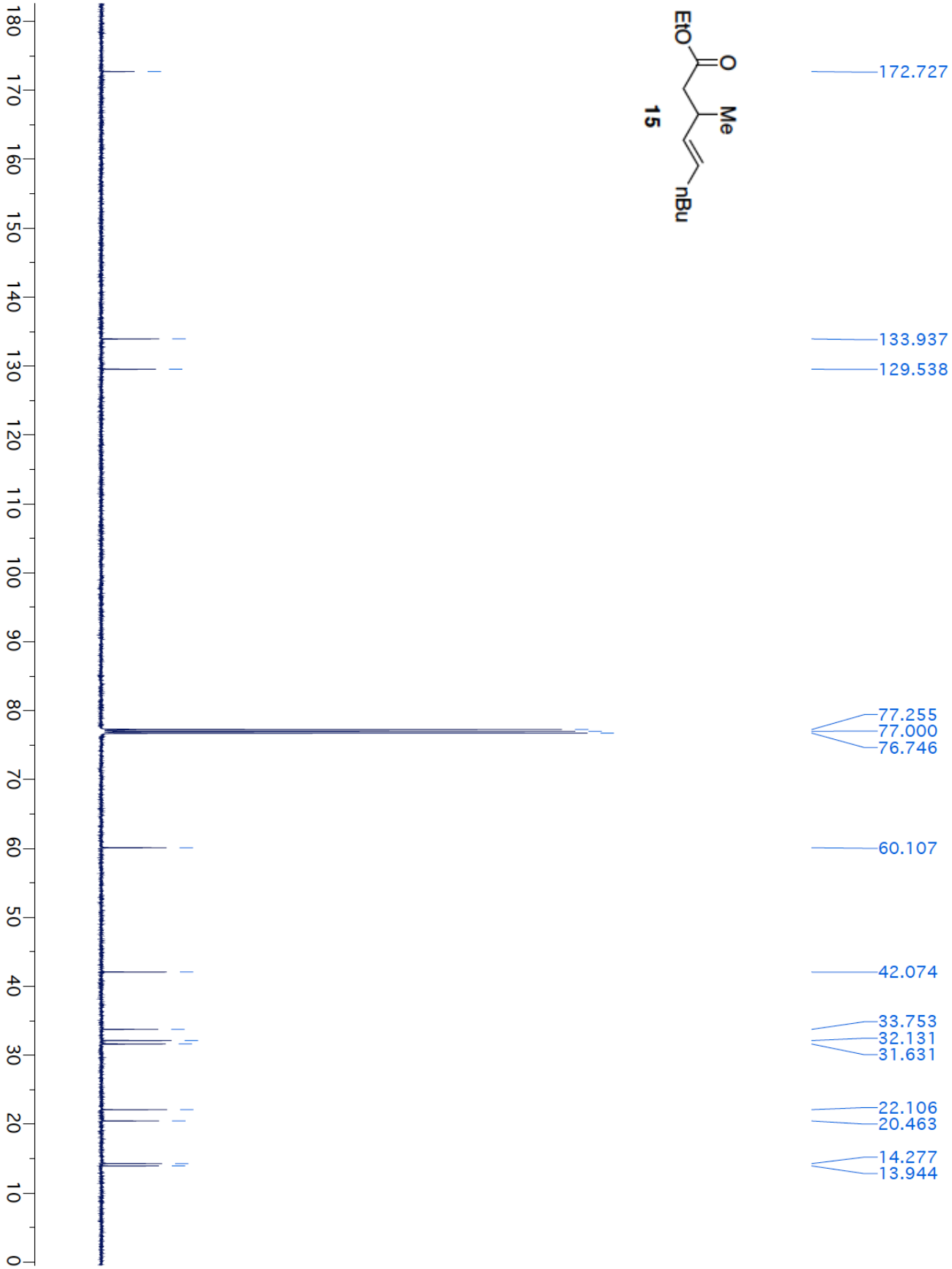

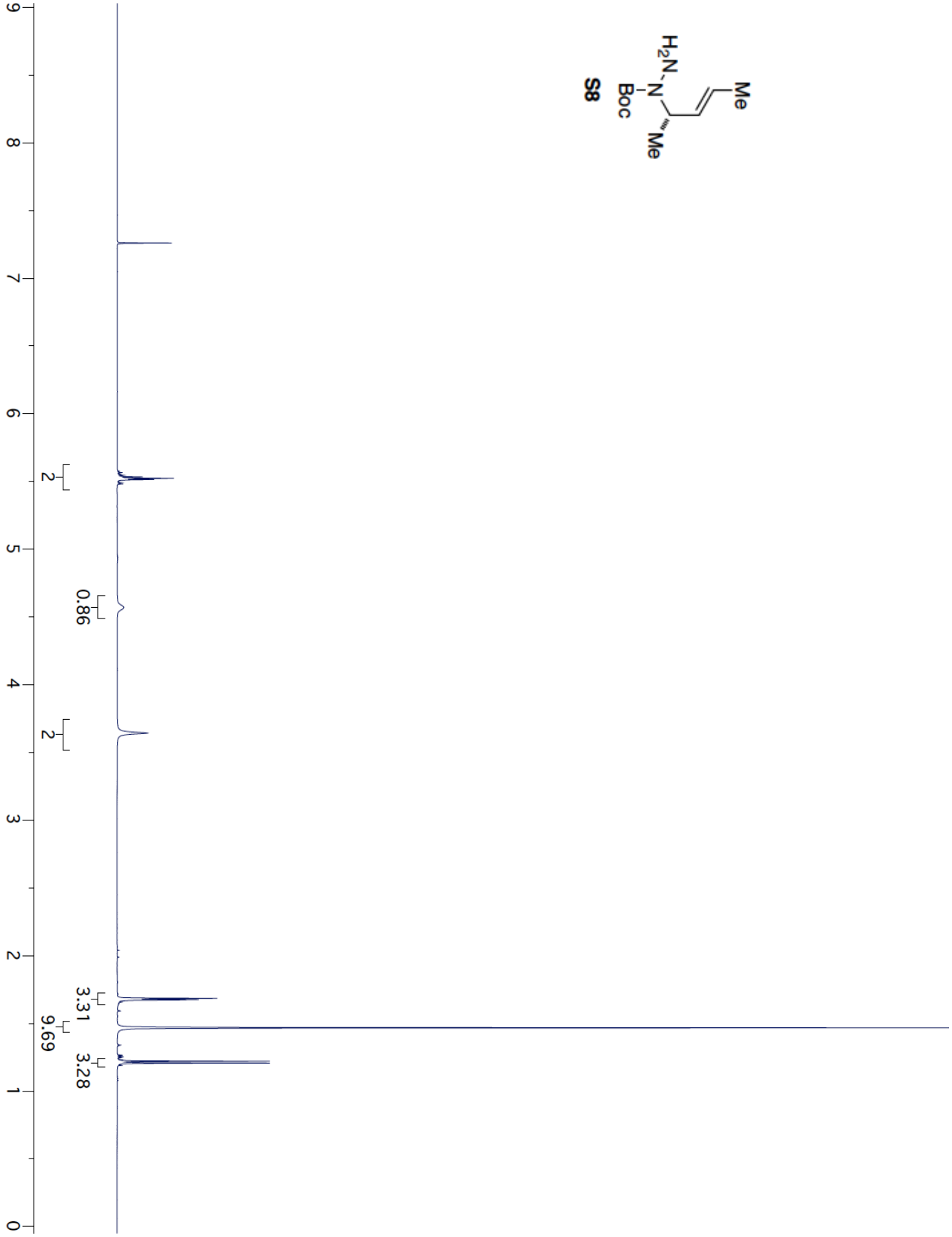

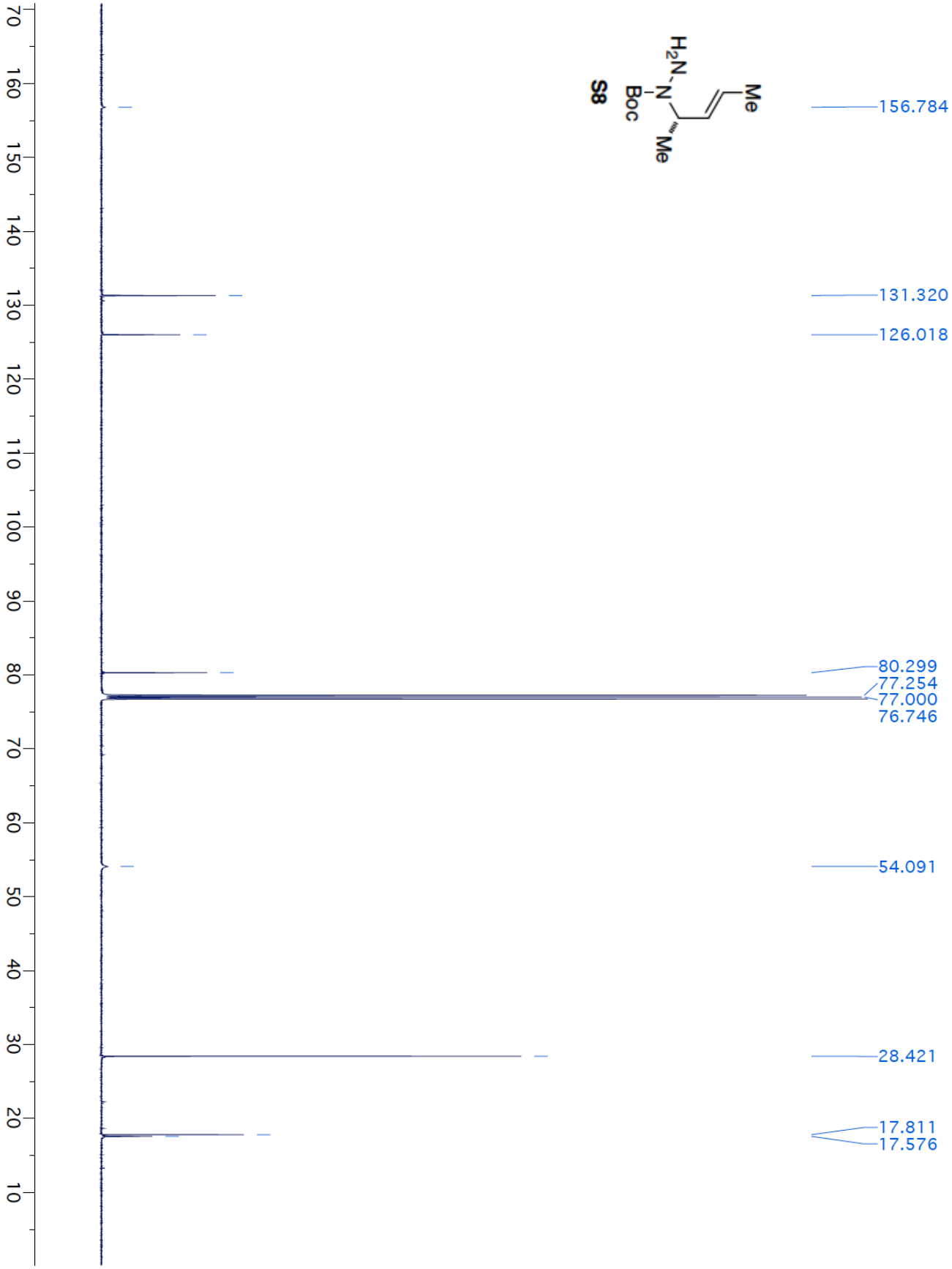

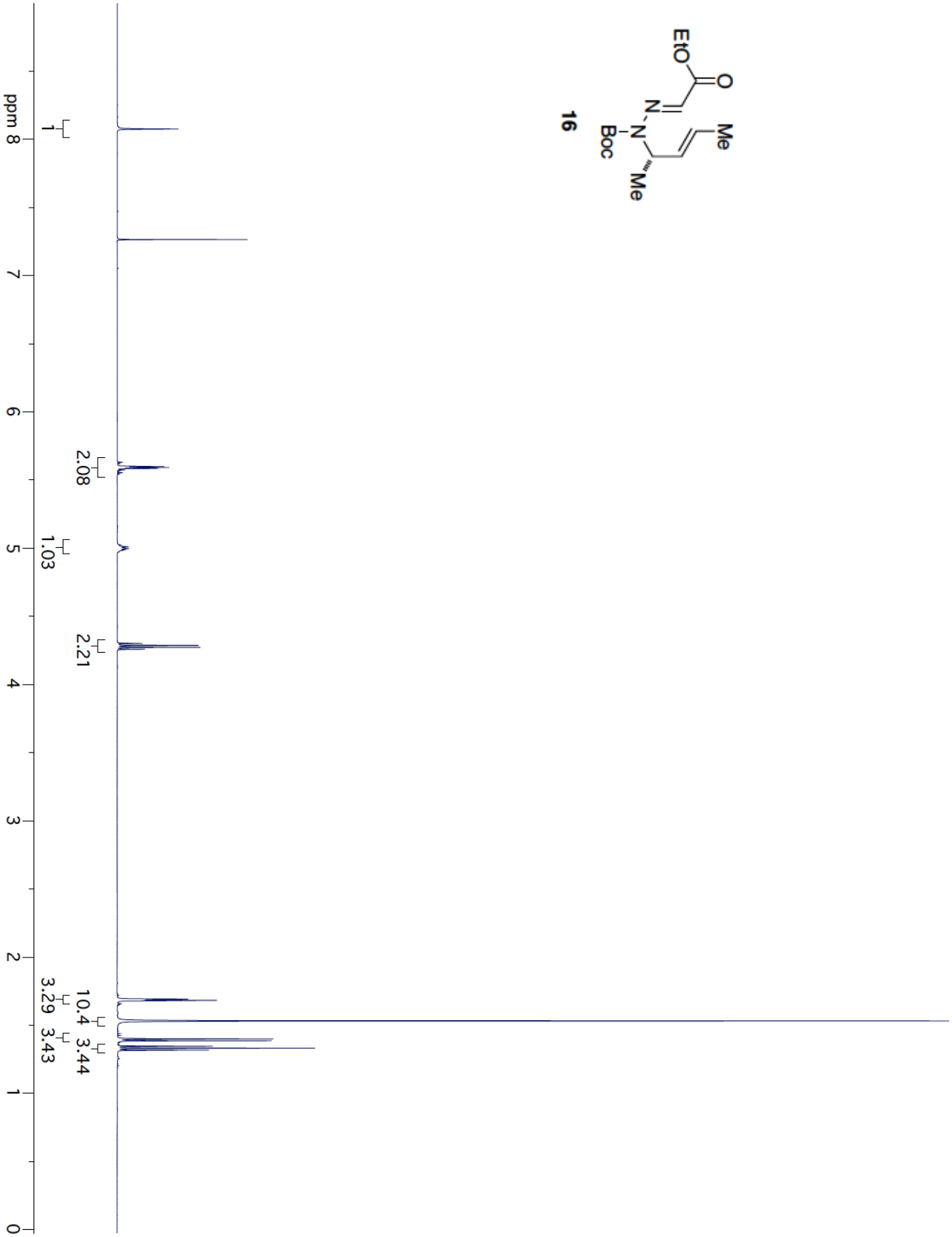

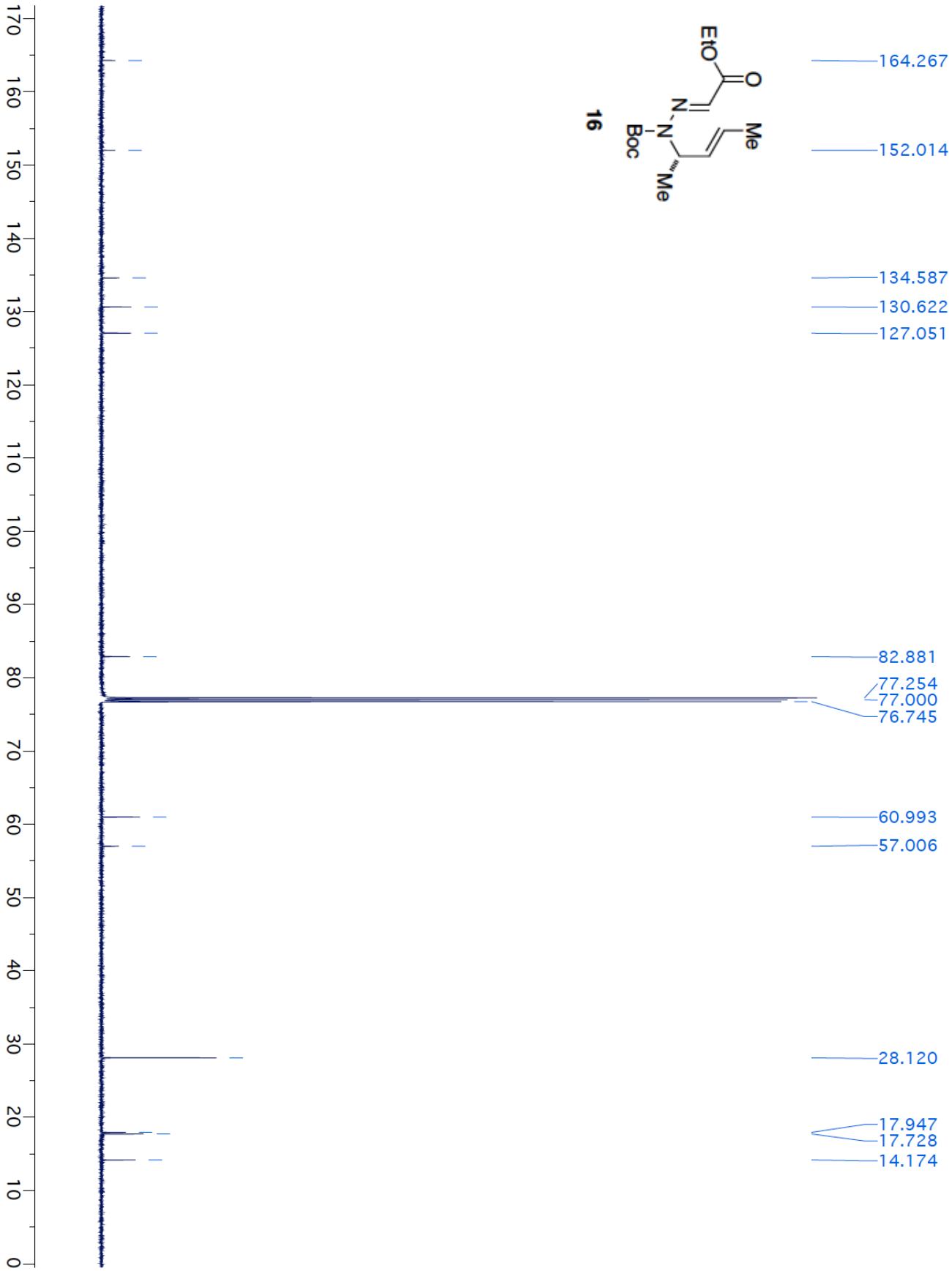

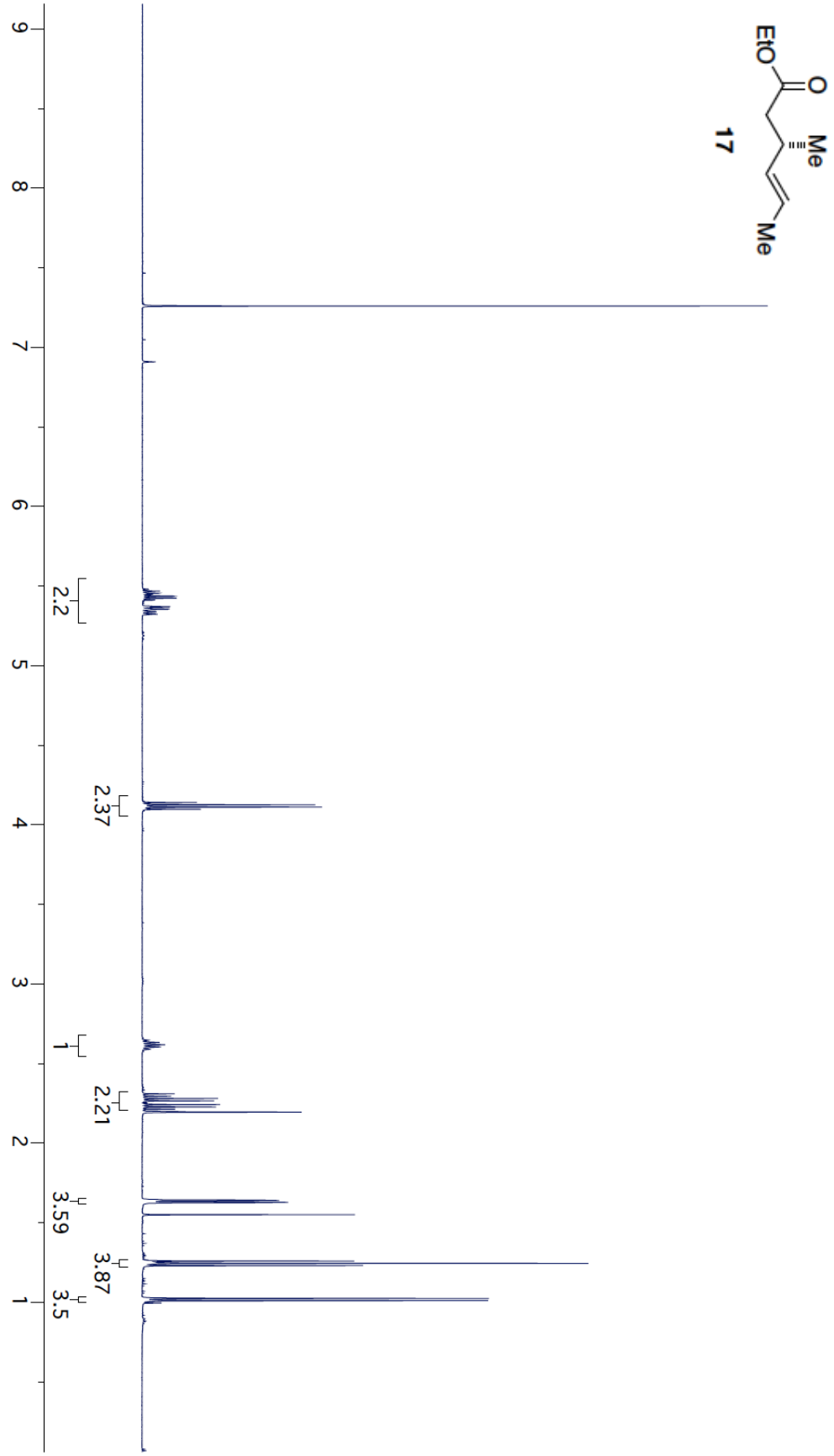

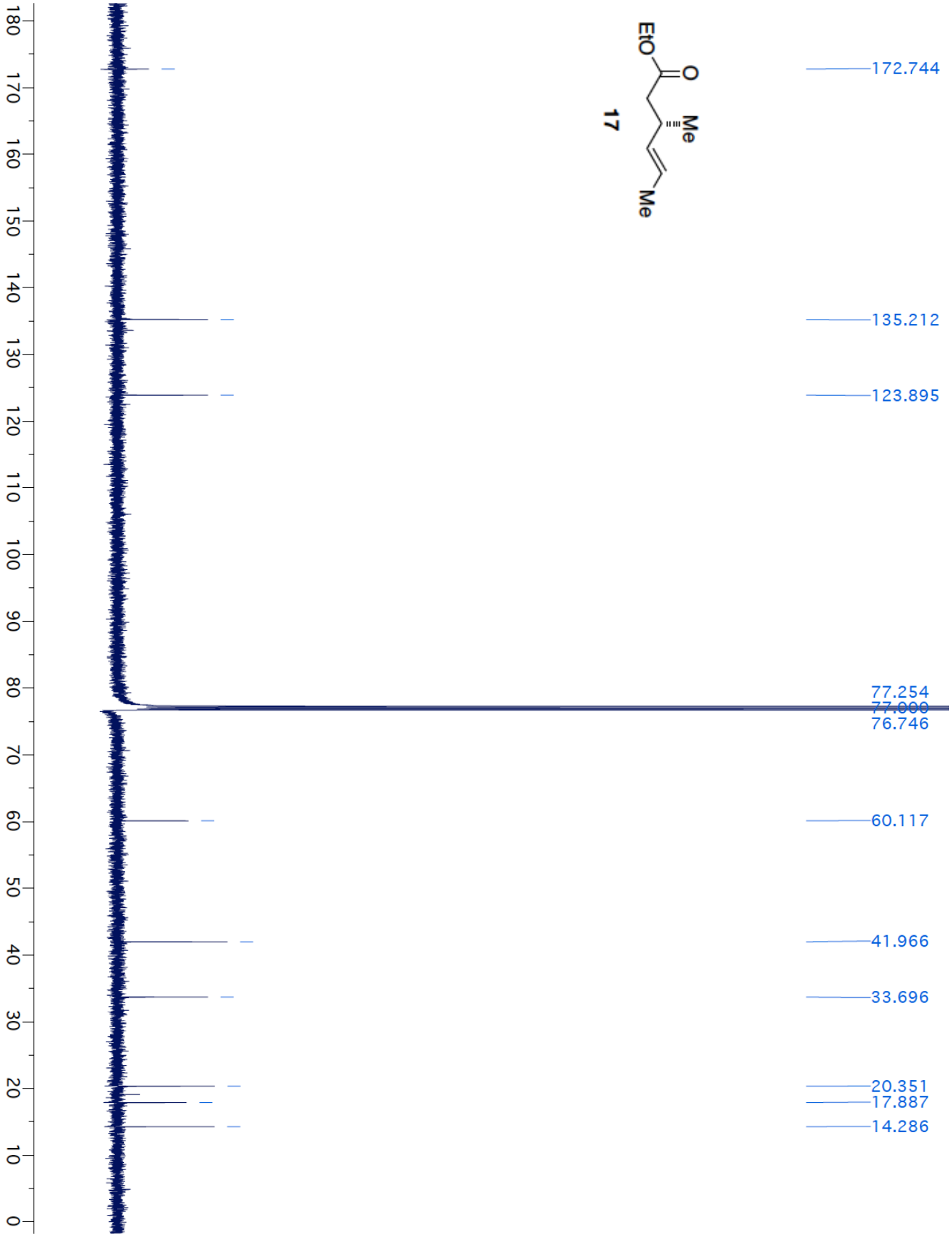

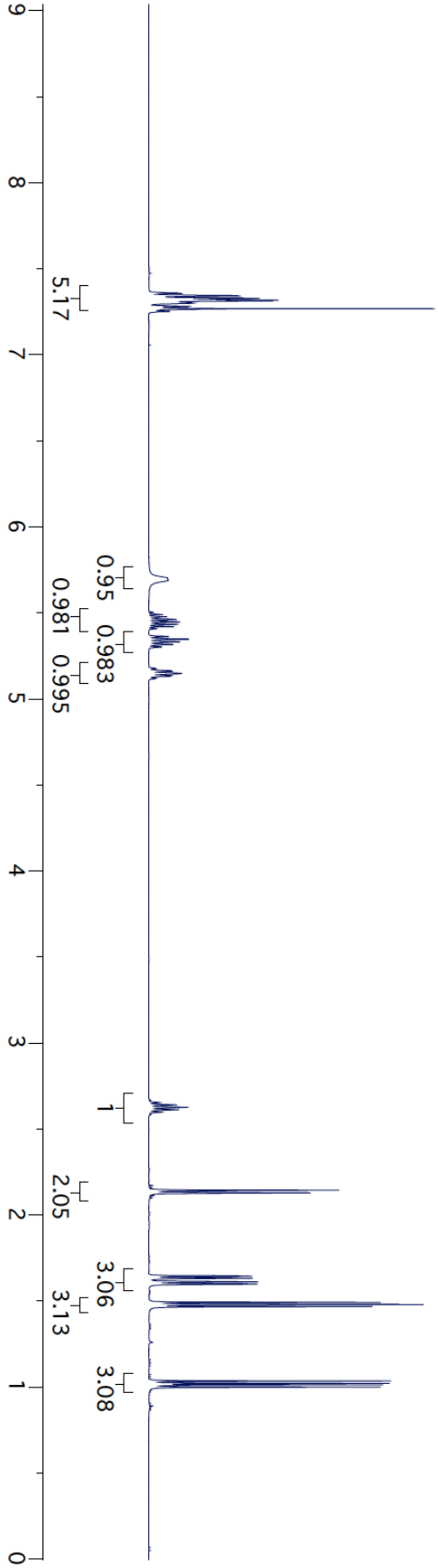

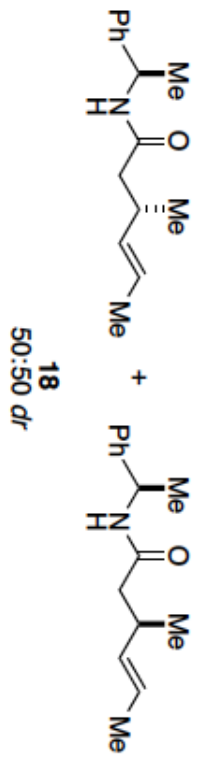

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50:50 *dr*