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Supporting Information

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Asymmetric Total Synthesis of (+)-Merobatzelladine B**

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Experimental procedures, characterization data for new compounds, and copies of NMR spectra.

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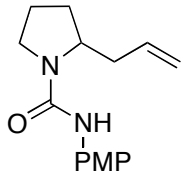
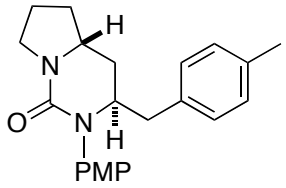
General: All reactions were carried out under a nitrogen atmosphere in flame-dried glassware. Tris(dibenzylideneacetone)dipalladium and tri-(2-furyl)phosphine were purchased from Strem Chemical Co. and used without further purification. Tricyclohexylphosphonium tetrafluoroborate was purchased from Acros Chemical Co. and used without further purification. All reagents were obtained from commercial sources and were used as obtained unless otherwise noted. $POCl_3$ was purified by distillation under N_2 prior to use. (*Z*)-1-bromobut-1-ene,[1] *tert*-butyl 2-allylpyrrolidine-1-carboxylate,[2] and (*E*)-1-bromodec-1-ene[3] were prepared according to published procedures. Toluene, THF, methylene chloride and diethyl ether were purified using a GlassContour solvent purification system. Structural and stereochemical assignments were made on the basis of 2-D COSY and NOESY experiments. Ratios of diastereomers were determined by either ^{1}H NMR or capillary GC analysis of crude reaction mixtures. Yields refer to isolated yields of compounds estimated to be ≥95% pure as determined by ^{1}H NMR.

Experimental Procedures and Compound Characterization Data

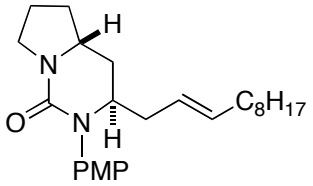


(±)-2-Allyl-*N*-(4-methoxyphenyl)pyrrolidine-1-carboxamide (11). A round bottomed flask equipped with a stirbar was charged with *tert*-butyl 2-allylpyrrolidine-1-carboxylate (465 mg, 2.2 mmol) and methylene chloride (2.2 mL). The resulting solution was cooled to 0 °C and trifluoroacetic acid (2.2 mL, 28.7 mmol) was added. The solution was gradually warmed to rt and stirred until the starting material had been consumed as judged by TLC analysis (ca. 30 min). The reaction mixture was diluted with water, basified with NH_4OH to pH > 12, and transferred to a separatory funnel. The layers were separated and the aqueous layer was extracted with CH_2Cl_2 (3 x 10 mL). The combined organic layers were dried over anhydrous sodium sulfate, filtered, and concentrated *in vacuo*. The crude product was dissolved in methylene chloride (11 mL) and 4-methoxyphenyl isocyanate (285 μL, 2.2 mmol) was added. The reaction mixture was stirred at rt until starting material had been completely consumed as judged by TLC analysis (ca. 1 h). The crude reaction mixture was concentrated *in vacuo*, and purified by flash chromatography on silica gel to afford 300 mg (53%) of the title compound as a colorless oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.29 (d, J = 9.5 Hz, 2 H), 6.83 (d, J = 9.0 Hz, 2 H), 6.07 (s, 1 H), 5.82 (ddt, J = 17.0, 10.0, 7.5 Hz, 1 H), 5.13-5.07 (m, 2 H), 4.07–4.04 (m, 1 H), 3.78 (s, 3 H), 3.45–3.42 (m, 2 H), 2.60–2.55 (m, 1 H), 2.22–2.16 (m, 1 H), 2.04–1.93 (m, 3 H), 1.83–1.79 (m, 1 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 155.6, 154.3, 135.2, 132.2, 121.7, 117.4, 114.1, 57.2, 55.5, 46.3, 38.7, 29.5, 23.8; IR (film) 3306, 1639 cm^{-1}. MS (ESI) 261.1599 (261.1598 calcd for $C_{15}H_{20}N_2O_2$, M + H$^+$).



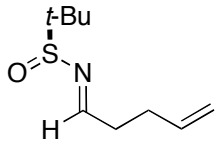
(±)-(3*R,4a*R**)-2-(4-Methoxyphenyl)-3-(4-methylbenzyl)hexahydropyrrolo[1,2-*c*]pyrimidin-1(2*H*)-one (12a).** A flame-dried Schlenk tube was cooled under a stream of N_2 and charged with $Pd_2(dba)_3$ (6.4 mg, 0.007 mmol), PCy_3•HBF_4 (10.3 mg, 0.028 mmol) and NaO^{t}Bu (50 mg, 0.52 mmol). The flask was purged with N_2, then a solution of **11** (83 mg, 0.35 mmol) in

toluene (3.5 mL) was added via syringe and the resulting mixture was stirred at rt for 5 min. 4-Bromotoluene (89 μL, 0.52 mmol) was added and the flask was heated to 110 °C and stirred overnight (ca. 14 h). The mixture was cooled to room temperature and saturated aqueous NH_4Cl (3 mL) and ethyl acetate (3 mL) were added. The organic layer was filtered through a plug of silica gel and the silica gel was washed with ethyl acetate (10 mL). The filtrate was dried over anhydrous sodium sulfate, filtered, and concentrated *in vacuo*. Analysis of the crude material by ^{1}H NMR revealed the product had been formed as a 14:1 mixture of diastereomers. The crude material was purified by flash chromatography on silica gel to afford 78 mg (70%) of the title compound as a pale yellow oil with 14:1 dr. Data are for the major isomer. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.19 (d, J = 9.0 Hz, 2 H), 7.06 (d, J = 8.0 Hz, 2 H), 6.92–6.90 (m, 4 H), 3.96 (dt, J = 11.5, 4.5 Hz, 1 H), 3.82 (s, 3 H), 3.82–3.76 (m, 1 H), 3.60 (dt, J = 11.5, 7.5 Hz, 1 H), 3.55–3.51 (m, 1 H), 3.02 (dd, J = 13.8, 3.8 Hz, 1 H), 2.64 (dd, J = 13.5, 11.0 Hz, 1 H), 2.30 (s, 3 H), 2.13 (dt, J = 12.0, 5.5 Hz, 1 H), 2.05–1.95 (m, 2 H), 1.88–1.82 (m, 1 H), 1.54 (dt, J = 12.5, 2.5 Hz, 1 H) 1.50–1.44 (m, 1 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 157.5, 154.4, 135.9, 135.5, 134.8, 130.1, 129.2, 128.8, 114.2, 60.4, 55.4, 52.5, 46.1, 38.1, 33.8, 29.5, 23.4, 20.9; IR (film) 1640 cm^{-1}. MS (ESI) 351.2071 (351.2071 calcd for $C_{22}H_{26}N_2O_2$, M + H$^+$).



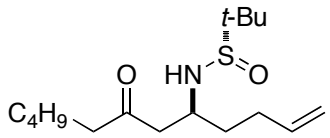
(±)-(*E*,3*R,4a*R**)-2-(4-Methoxyphenyl)-3-(undec-2-en-1-yl)hexahydropyrrolo[1,2-*c*]pyrimidin-1(2*H*)-one (12b).** A flame-dried Schlenk tube was cooled under a stream of N_2 and charged with $Pd_2(dba)_3$ (6.4 mg, 0.007 mmol), PCy_3•HBF_4 (10.3 mg, 0.028 mmol) and NaO^{t}Bu (67 mg, 0.70 mmol). The flask was purged with N_2, then a solution of **11** (83 mg, 0.35 mmol) in toluene (3.5 mL) was added via syringe and the resulting mixture was stirred at rt for 5 min. A solution of (*E*)-1-bromodec-1-ene (153 mg, 0.70 mmol) in toluene (1 mL) was added and the flask was heated to 110 °C and stirred overnight (ca. 14 h). The mixture was cooled to room temperature and saturated aqueous NH_4Cl (3 mL) and ethyl acetate (3 mL) were added. The organic layer was filtered through a plug of silica gel and the silica gel was washed with ethyl acetate (10 mL). The filtrate was dried over anhydrous sodium sulfate, filtered, and concentrated

in vacuo. Analysis of the crude material by ^{1}H NMR revealed the product had been formed as a 18:1 mixture of diastereomers. The crude material was purified by flash chromatography on silica gel to afford 98 mg (77%) of the title compound as a pale yellow oil with 18:1 dr. Data are for the major isomer. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.13 (d, J = 9.0 Hz, 2 H), 6.86 (d, J = 9.0 Hz, 2 H), 5.42 (dt, J = 15.5, 7.5 Hz, 1 H), 5.16 (dt, J = 15.0, 7.0 Hz, 1 H), 3.79 (s, 3 H), 3.76–3.73 (m, 1 H), 3.68–3.62 (m, 1 H), 3.58 (dt, J = 11.5, 7.5 Hz, 1 H), 3.50–3.46 (m, 1 H), 2.39 (dt, J = 13.5, 5.0 Hz, 1 H), 2.24 (ddt, J = 13.0, 2.0, 1.5 Hz, 1 H), 2.20-2.11 (m, 2 H), 2.00–1.91 (m, 3 H), 1.85–1.78 (m, 1 H), 1.62 (dt, J = 12.3, 5.0 Hz, 1 H), 1.49 (ddt, J = 12.0, 10.0, 7.5 Hz, 1 H), 1.30–1.23 (m, 12 H), 0.87 (t, J = 7.0 Hz, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 157.5, 154.4, 135.7, 134.2, 129.3, 125.4, 114.1, 58.7, 55.4, 52.5, 46.0, 35.9, 33.9, 32.5, 31.8, 30.3, 29.4, 29.2, 29.1, 23.4, 22.6, 14.1 (one carbon signal is absent due to incidental equivalence); IR (film) 1640 cm^{-1}. MS (ESI) 399.3009 (399.3006 calcd for $C_{25}H_{38}N_2O_2$, M + H$^+$).

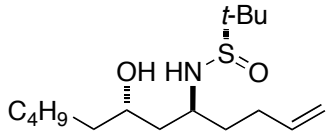


(+)-(S_S)-2-Methyl-*N*-(pent-4-en-1-ylidene)propane-2-sulfinamide (16). This compound was prepared according to a published procedure by Ellman.[4] A flame-dried flask was cooled under a stream of N_2 and charged with pent-4-enal (1.38 mL, 14 mmol) and THF (40 mL). Titanium ethoxide (4.2 mL, 20 mmol) was added and the reaction mixture was stirred at rt for 5 min. (*S*)-*tert*-butanesulfinamide (1.21 g, 10 mmol) was added in one portion and the mixture was stirred overnight (ca. 14 h) at rt. The reaction mixture was poured into brine (40 mL) and stirred for 10 min. Ethyl acetate (20 mL) was added, the mixture was filtered through celite and the celite was washed with ethyl acetate (100 mL). The mixture was transferred to a separatory funnel, brine (20 mL) was added, and the layers were separated. The aqueous phase was extracted with ethyl acetate (2 x 30 mL). The combined organic layers were dried over anhydrous sodium sulfate, filtered, and concentrated *in vacuo*. The crude material was purified by flash chromatography on silica gel to afford 1.62 g (87%) of the title compound as a colorless oil: $[\alpha]^{23}_D$ +244.8 (*c* 5.5, CH_2Cl_2). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.08 (t, J = 4.5 Hz, 1 H), 5.84 (ddt, J = 17.0, 10.0, 4.5 Hz, 1 H), 5.08 (dd, J = 17.0, 1.5 Hz, 1 H), 5.02 (dd, J = 10.0, 1.5 Hz, 1 H), 2.63 (td, J = 7.5, 4.0 Hz, 2 H), 2.40 (q, J = 7.0 Hz, 2 H), 1.19 (s, 9 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 168.8, 136.7,

115.8, 56.5, 35.2, 29.3, 22.3; IR (film) 1621 cm^{-1}. MS (ESI) 188.1101 (188.1104 calcd for $C_9H_{17}NOS$, M + H^+).

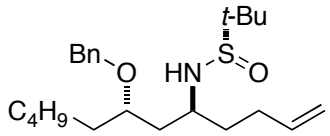


(+)-(*S*$_S$,5*S*)-2-Methyl-*N*-(7-oxododec-1-en-5-yl)propane-2-sulfinamide (17). This compound was prepared via a modification of a published procedure by Davis.[5] A flame-dried flask was cooled under a stream of N_2, charged with diethyl ether (80 mL), and cooled to –78 °C. Solid KHMDS (5.6 g, 28.0 mmol) was added and the reaction mixture was stirred for 5 min at –78 °C. Heptan-2-one (3.43 mL, 24.0 mmol) was slowly added to the reaction flask and the mixture was stirred at –78 °C for 1 h. A solution of **16** (1.50 g, 8.0 mmol) in diethyl ether (10 mL) was added to the reaction flask and stirred at –78 °C for 2 h. The reaction was quenched with saturated aqueous NH_4Cl (10 mL) at –78 °C and gradually warmed to rt. The mixture was transferred to a separatory funnel and the layers were separated. The organic layer was washed with water (1 x 10 mL) and then the combined aqueous layers were extracted with diethyl ether (2 x 20 mL). The combined organic layers were dried over anhydrous sodium sulfate, filtered, and concentrated *in vacuo*. The crude material was purified by flash chromatography on silica gel to afford 1.95 g (81%) of the title compound as a pale yellow oil: $[\alpha]^{23}_D$ +47.8 (*c* 3.2, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 5.77 (ddt, *J* = 16.8, 10.0, 6.8 Hz, 1 H), 5.04–4.96 (m, 2 H), 4.07 (d, *J* = 9.2 Hz, 1 H), 3.53 (oct, *J* = 4.8 Hz, 1 H), 2.90 (dd, *J* = 17.6, 5.6 Hz, 1 H), 2.77 (dd, *J* = 17.6, 4.4 Hz, 1 H), 2.39 (t, *J* = 7.6 Hz, 2 H), 2.24–2.02 (m, 2 H), 1.78–1.67 (m, 1 H), 1.60–1.50 (m, 3 H), 1.38–1.18 (m, 4 H), 1.22 (s, 9 H), 0.88 (t, *J* = 7.0 Hz, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 210.8, 137.7, 115.2, 55.8, 53.2, 48.0, 43.8, 34.7, 31.2, 30.4, 23.1, 22.6, 22.4, 13.9; IR (film) 3216, 1708 cm^{-1}. MS (ESI) 302.2155 (302.2148 calcd for $C_{16}H_{31}NO_2S$, M + H^+).



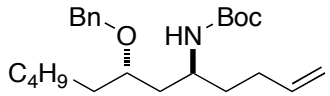
(+)-(*S*$_S$,5*S*,7*S*)-*N*-(7-Hydroxydodec-1-en-5-yl)-2-methylpropane-2-sulfinamide (18). A flame-dried flask was cooled under a stream of N_2 and charged with **17** (322 mg, 1.1 mmol) and THF

(11 mL). The reaction flask was cooled to 0 °C, $CeCl_3 \bullet 7H_2O$ (831 mg, 2.2 mmol) was added, and the mixture was stirred for 5 min. $NaBH_4$ (600 mg, 15.9 mmol) was added in a single portion and the resulting solution was stirred until the starting material had been consumed as judged by ESI^+ MS analysis (ca. 2 h). The reaction mixture was slowly quenched with water (3 mL) and the mixture was transferred to a separatory funnel. The layers were separated and the aqueous layer was extracted with ethyl acetate (3 x 5 mL). The combined organic layers were dried over anhydrous sodium sulfate, filtered, and concentrated *in vacuo*. Analysis of the crude material by ^1H NMR revealed the product had been formed as a 3:1 mixture of diastereomers. The crude material was purified by flash chromatography on silica gel to afford 204 mg (63%) of the title compound as a colorless oil with >20:1 dr: $[\alpha]^{23}_D$ +55.1 (*c* 2.1, CH_2Cl_2). ^1H NMR (500 MHz, $CDCl_3$) δ 5.79 (ddt, *J* = 17.3, 10.3, 6.8 Hz, 1 H), 5.03–4.95 (m, 2 H), 3.79 (m, 1 H), 3.65 (d, *J* = 8.0 Hz, 1 H), 3.52–3.45 (m, 1 H), 3.36 (d, *J* = 4.5 Hz, 1 H), 2.21–2.04 (m, 2 H), 1.80 (ddd, *J* = 14.5, 10.5, 4.0 Hz, 1 H), 1.64–1.21 (m, 11 H), 1.23 (s, 9 H), 0.87 (t, *J* = 7.0 Hz, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 138.0, 115.0, 67.8, 55.8, 53.9, 42.6, 37.8, 36.3, 31.9, 30.3, 25.5, 22.7, 22.6, 14.0; IR (film) 3243 cm^{-1}. MS (ESI) 304.2314 (304.2305 calcd for $C_{16}H_{33}NO_2S$, M + H^+).



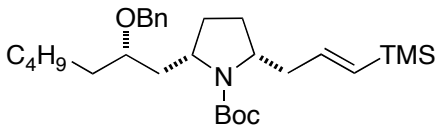
(+)-(*S*$_S$,5*S*,7*S*)-*N*-[7-(Benzyloxy)dodec-1-en-5-yl]-2-methylpropane-2-sulfinamide (S1). A flame-dried flask was cooled under a stream of N_2 and charged with **18** (345 mg, 1.1 mmol) and THF (11 mL). The reaction was cooled to 0 °C and NaH (65 mg, 1.6 mmol, 60% suspension in mineral oil) was added. The reaction flask was stirred for 5 min at 0 °C and then benzyl bromide (190 μL, 1.6 mmol) was added and the resulting mixture was stirred overnight at rt. The reaction was quenched with water (10 mL) and the mixture was transferred to a separatory funnel. The layers were separated and the aqueous layer was extracted with ethyl acetate (3 x 10 mL). The combined organic layers were dried over anhydrous sodium sulfate, filtered, and concentrated *in vacuo*. The crude material was purified by flash chromatography on silica gel to afford 428 mg (96%) of the title compound as a colorless oil. The enantiopurity was determined to be 99% ee by chiral HPLC analysis (Regis Tech. (R,R) WHELK-O1, 0.46 cm x 25 cm, 5% *i*PrOH/hexanes, 1.0 mL/min, λ = 254 nm, RT = 8.57 and 11.82 min). $[\alpha]^{23}_D$ +63.4 (*c* 2.1, CH_2Cl_2). ^1H NMR (500

MHz, $CDCl_3$) δ 7.37–7.24 (m, 5 H) 5.79 (ddt, *J* = 17.5, 11.5, 6.5 Hz, 1 H), 5.04–4.96 (m, 2 H), 4.60 (d, *J* = 11.0 Hz, 1 H), 4.45 (d, *J* = 11.0 Hz, 1 H), 4.13 (d, *J* = 6.0 Hz, 1 H), 3.76–3.69 (m, 1 H), 3.54-3.47 (m, 1 H), 2.18–2.03 (m, 2 H), 1.84 (ddd, *J* = 15.0, 9.5, 3.0 Hz, 1 H), 1.76–1.51 (m, 5 H), 1.35–1.24 (m, 6 H), 1.07 (s, 9 H), 0.89 (t, *J* = 6.8 Hz, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 138.5, 138.2, 128.3, 128.1, 127.6, 114.9, 76.9, 71.0, 55.4, 53.9, 39.1, 35.4, 33.0, 32.0, 30.0, 24.8, 22.7, 22.6, 14.0; IR (film) 3257 cm^{-1}. MS (ESI) 394.2777 (394.2774 calcd for $C_{23}H_{39}NO_2S$, $M + H^+$).

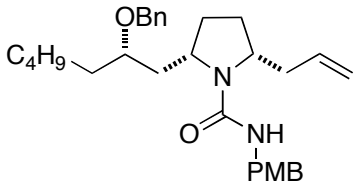


(+)-(5*S*,7*S*)-*tert*-Butyl 7-(benzyloxy)dodec-1-en-5-ylcarbamate 19. A flame-dried flask was cooled under a stream of N_2 and charged with (**S1**) (426 mg, 1.1 mmol) and methanol (5.5 mL). A solution of anhydrous hydrochloric acid (1.1 mL, 4.4 mmol, 4 M in dioxane) was added and the mixture was stirred at rt for 1 h, at which time TLC analysis indicated that the starting material had been completely consumed. The reaction mixture was diluted with water (5 mL) and CH_2Cl_2 (5 mL), basified with NH_4OH to pH > 12, and transferred to a separatory funnel. The layers were separated and the aqueous layer was extracted with CH_2Cl_2 (3 x 5 mL). The combined organic layers were dried over anhydrous sodium sulfate, filtered, and concentrated *in vacuo*. The crude product was dissolved in THF (11 mL), solid di-*tert*-butyldicarbonate (264 mg, 1.2 mmol) was added and the reaction mixture was stirred at rt for 3 h. 1 M NaOH (5 mL) was added and the resulting biphasic mixture was stirred overnight at rt. The mixture was transferred to a separatory funnel, the layers were separated and the aqueous layer was extracted with ethyl acetate (3 x 10 mL). The combined organic layers were dried over anhydrous sodium sulfate, filtered, and concentrated *in vacuo*. The crude material was purified by flash chromatography on silica gel to afford 401 mg (95%) of the title compound as a colorless oil: $[\alpha]^{23}_D$ +31.8 (*c* 1.5, CH_2Cl_2). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.41–7.32 (m, 4 H), 7.30–7.26 (m, 1 H), 5.81 (ddt, *J* = 17.0, 10.0, 7.5 Hz, 1 H), 5.01 (dd, *J* = 17.3, 1.8 Hz, 1 H), 4.95 (d, *J* = 10.0 Hz, 1 H), 4.79 (d, *J* = 14.0 Hz, 1 H), 4.55 (d, *J* = 11.0 Hz, 1 H), 4.45 (d, *J* = 11.0 Hz, 1 H), 3.84–3.76 (m, 1 H), 3.60–3.52 (m, 1 H), 2.18–2.02 (m, 2 H), 1.74–1.47 (m, 6 H), 1.44 (s, 9 H), 1.37–1.24 (m, 6 H), 0.90 (t, *J* = 7.3 Hz, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 155.5, 138.6, 138.3, 128.3, 128.1, 127.5, 114.6,

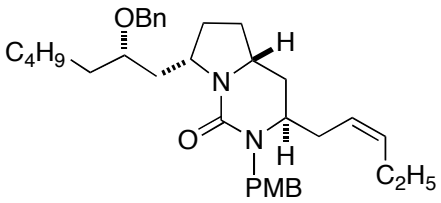
78.6, 76.3, 71.3, 47.9, 39.2, 34.8, 33.8, 32.0, 30.4, 28.4, 24.7, 22.6, 14.0; IR (film) 3347, 1702 cm^{-1}. MS (ESI) 390.3004 (390.3003 calcd for $C_{24}H_{39}NO_3$, M + H^+).



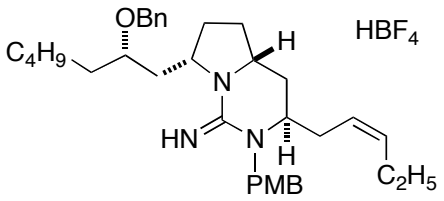
(+)-(*E*,2*S*,2'*S*,5*R*)-*tert*-Butyl 2-[2'-(benzyloxy)heptyl]-5-[3-(trimethylsilyl)allyl]pyrrolidine-1-carboxylate (20). A flame-dried Schlenk flask was cooled under a stream of N_2 and charged with $Pd_2(dba)_3$ (18.3 mg, 0.02 mmol), tri-(2-furyl)phosphine (18.6 mg, 0.08 mmol) and NaO^{t}Bu (200 mg, 2.08 mmol). The flask was purged with N_2, then a solution of **19** (406 mg, 1.04 mmol) in distilled xylenes (5.2 mL) was added via syringe and the resulting mixture was stirred at rt for 5 min. (*E*)-(2-bromovinyl)trimethylsilane (319 μL, 2.08 mmol) was added and the flask was heated to 140 °C and stirred overnight (ca. 14 h). The mixture was cooled to room temperature and saturated aqueous NH_4Cl (5 mL) and ethyl acetate (5 mL) were added. The mixture was filtered through a plug of silica gel and the silica gel was washed with ethyl acetate (20 mL). The mixture was transferred to a separatory funnel, water was added (10 mL), the layers were separated, and the aqueous layer was extracted with ethyl acetate (3 x 10 mL). The combined organic layers were dried over anhydrous sodium sulfate, filtered, and concentrated *in vacuo*. The crude material was purified by flash chromatography on silica gel to afford 347 mg (68%) of the title compound as a pale brown oil. This compound was found to exist as a mixture of rotamers as judged by ^1H and ^{13}C NMR analysis; data are for the mixture. $[\alpha]^{23}_D$ +14.5 (*c* 0.7, CH_2Cl_2). ^1H NMR (500 MHz, $CDCl_3$) δ 7.38–7.26 (m, 5 H), 6.00–5.91 (m, 1 H), 5.69 (d, *J* = 18.5 Hz, 1 H), 4.57–4.42 (m, 2 H), 3.99–3.60 (m, 2 H), 3.58–3.24 (m, 1 H), 2.59–2.52 (m, 1 H), 2.37–2.18 (m, 1 H), 2.02–1.81 (m, 3 H), 1.78–1.63 (m, 2 H), 1.59–1.23 (m, 9 H), 1.46 (s, 9 H), 0.90 (t, *J* = 7.3 Hz, 3 H), 0.04 (s, 9 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 154.5, 143.1, 138.9, 133.1, 128.3, 127.8, 127.5, 127.4, 79.0, 78.1, 70.7, 57.5, 57.1, 41.7, 40.8, 34.0, 32.0, 30.2, 28.6, 28.4, 24.8, 22.6, 14.1, 0.0, –1.0, –1.2, –1.4; IR (film) 1693 cm^{-1}. MS (ESI) 488.3553 (488.3554 calcd for $C_{29}H_{49}NO_3Si$, M + H^+).



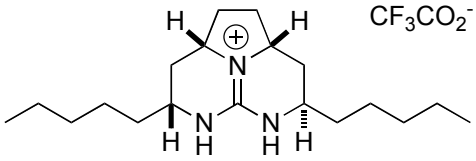
(+)-(2*R*,2'*S*,5*S*)-2-Allyl-5-[2'-(benzyloxy)heptyl]-*N*-(4-methoxybenzyl)pyrrolidine-1-carboxamide (21). A round bottomed flask equipped with a stirbar was charged with **20** (397 mg, 0.81 mmol) and methylene chloride (1.6 mL). The resulting solution was cooled to 0 °C and trifluoroacetic acid (1.6 mL, 20.9 mmol) was added. The solution was gradually warmed to rt and stirred until the starting material had been consumed as judged by TLC analysis (ca. 15 min). The reaction mixture was diluted with water, basified with NH_4OH to pH > 12, and transferred to a separatory funnel. The layers were separated and the aqueous layer was extracted with CH_2Cl_2 (3 x 10 mL). The combined organic layers were dried over anhydrous sodium sulfate, filtered, and concentrated *in vacuo*. The crude product was dissolved in methylene chloride (8 mL) and 4-methoxybenzyl isocyanate (159 μL, 0.97 mmol) was added. The reaction mixture was stirred at rt until starting material had been completely consumed as judged by TLC analysis (ca. 1 h). The crude reaction mixture was concentrated *in vacuo*, and purified by flash chromatography on silica gel to afford 282 mg (72%) of the title compound as a colorless oil: $[\alpha]^{23}_D$ +52.7 (*c* 4.3, CH_2Cl_2). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.31–7.24 (m, 3 H), 7.22–7.18 (m, 2 H), 6.97 (d, *J* = 9.0 Hz, 2 H), 6.73 (d, *J* = 9.0 Hz, 2 H), 5.96–5.88 (m, 1 H), 5.78 (ddt, *J* = 17.8, 10.3, 7.5 Hz, 1 H), 5.07 (dd, *J* = 17.5, 2.0 Hz, 1 H), 5.03 (dd, *J* = 11.5, 2.0 Hz, 1 H), 4.49 (d, *J* = 11.5 Hz, 1 H), 4.20 (d, *J* = 11.5 Hz, 1 H), 4.13 (dd, *J* = 14.5, 5.5 Hz, 1 H), 4.10–4.05 (m, 1 H), 4.02 (dd, *J* = 14.5, 5.5 Hz, 1 H), 3.94–3.88 (m, 1 H), 3.76 (s, 3 H), 3.68–3.62 (m, 1 H), 2.64–2.57 (m, 1 H), 2.27–2.20 (m, 1 H), 2.05–1.89 (m, 2 H), 1.76–1.55 (m, 5 H), 1.56–1.42 (m, 1 H), 1.34–1.22 (m, 6 H), 0.89 (t, *J* = 7.0 Hz, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 158.3, 158.3, 138.2, 135.3, 132.5, 128.7, 128.3, 127.4, 126.8, 116.8, 113.5, 75.8, 67.4, 57.9, 55.1, 54.9, 43.6, 40.5, 40.3, 32.2, 31.8, 31.8, 28.7, 24.6, 22.5, 13.9; IR (film) 3361, 1642 cm^{-1}. MS (ESI) 479.3271 (479.3268 calcd for $C_{30}H_{42}N_2O_3$, M + H$^+$).



(+)-(*Z*,2'*S*,3*R*,4a*R*,7*S*)-7-[2'-(Benzyloxy)heptyl]-2-(4-methoxybenzyl)-3-(pent-2-en-1-yl)hexahydropyrrolo[1,2-c]pyrimidin-1(2*H*)-one (22). A flame-dried Schlenk tube was cooled under a stream of N_2 and charged with $Pd_2(dba)_3$ (8.0 mg, 0.009 mmol), $PCy_3 \bullet HBF_4$ (12.9 mg, 0.04 mmol) and NaO^{t}Bu (56 mg, 0.58 mmol). The flask was purged with N_2, then a solution of **21** (138 mg, 0.29 mmol) in toluene (1.5 mL) was added via syringe and the resulting mixture was stirred at rt for 5 min. A solution of (*Z*)-1-bromobut-1-ene (78.3 mg, 0.58 mmol) in toluene (1 mL) was added and the flask was heated to 110 $^{\circ}$C and stirred overnight (ca. 14 h). The mixture was cooled to room temperature and saturated aqueous NH_4Cl (2 mL) and ethyl acetate (2 mL) were added. The mixture was filtered through a plug of silica gel and the silica gel was washed with ethyl acetate (10 mL). The mixture was transferred to a separatory funnel, water was added (5 mL), the layers were separated, and the aqueous layer was extracted with ethyl acetate (3 x 5 mL). The combined organic layers were dried over anhydrous sodium sulfate, filtered, and concentrated *in vacuo*. The crude material was purified by flash chromatography on silica gel to afford 139 mg (91%) of the title compound as a pale yellow oil: $[\alpha]^{23}_{D}$ +35.3 (*c* 2.7, CH_2Cl_2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37–7.29 (m, 3 H), 7.28–7.23 (m, 2 H), 7.17 (d, *J* = 8.4 Hz, 2 H), 6.83 (d, *J* = 8.4 Hz, 2 H), 5.51–5.42 (m, 1 H), 5.22–5.12 (m, 2 H), 4.55 (d, *J* = 11.4 Hz, 1 H), 4.49 (d, *J* = 11.4 Hz, 1 H), 4.02 (d, *J* = 15.2 Hz, 1 H), 4.01–3.94 (m, 1 H), 3.77 (s, 3 H), 3.60–3.48 (m, 2 H), 3.24–3.16 (m, 1 H), 2.46–2.38 (m, 1 H), 2.26 (dd, *J* = 13.2, 3.6 Hz, 1 H), 2.19–2.10 (m, 1 H), 2.05–1.81 (m, 6 H), 1.65–1.20 (m, 11 H), 0.94 (t, *J* = 7.4 Hz, 3 H) 0.89 (t, *J* = 6.8 Hz, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 158.5, 154.6, 139.0, 134.4, 131.3, 128.7, 128.2, 127.7, 127.3, 124.4, 113.7, 78.9, 70.9, 56.8, 55.1, 53.6, 52.2, 47.3, 39.0, 34.1, 32.0, 31.3, 31.0, 30.9, 29.7, 24.7, 22.6, 20.8, 14.0, 14.0; IR (film) 1631 cm^{-1}. MS (ESI) 533.3737 (533.3738 calcd for $C_{34}H_{48}N_2O_3$, M + H$^+$).



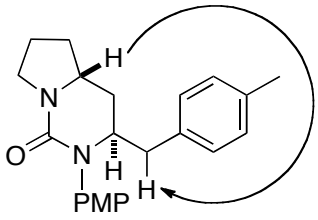
(+)-(*Z*,2'*S*,3*R*,4a*R*,7*S*)-7-[2'-(Benzyloxy)heptyl]-2-(4-methoxybenzyl)-3-(pent-2-en-1-yl)hexahydropyrrolo[1,2-c]pyrimidin-1(2*H*)-iminium tetrafluoroborate (23). A flame-dried flask was cooled under a stream of N_2 and charged with **22** (86 mg, 0.16 mmol) and toluene (1.6 mL). Freshly distilled $POCl_3$ (1.6 mL, 17.2 mmol) was added, and the reaction mixture was refluxed overnight (ca. 14 h). The reaction mixture was cooled to rt and concentrated *in vacuo*. The crude product was dissolved in acetonitrile (1.6 mL) and a solution of ammonia (6.4 mL, 2 M in ethanol) was added. The mixture was stirred at rt until the starting material had been consumed as judged by ESI^+ MS analysis (ca. 15 min). The reaction mixture was concentrated and dissolved in methylene chloride (5 mL). Water (5 mL) was added and the mixture was transferred to a separatory funnel. The layers were separated and the organic layer was washed with saturated aqueous $NaBF_4$ (3 x 10 mL). The combined aqueous layers were extracted with methylene chloride (3 x 10 mL). The combined organics layers were dried over anhydrous sodium sulfate, filtered, and concentrated *in vacuo*. The crude material was purified by flash chromatography on silica gel to afford 88 mg (89%) of the title compound as a pale brown oil: $[\alpha]^{23}_D$ +59.9 (*c* 3.6, CH_2Cl_2). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.30–7.21 (m, 5 H), 7.10 (d, *J* = 8.5 Hz, 2 H), 6.90 (d, *J* = 8.5 Hz, 2 H), 5.99 (s, 2 H), 5.62–5.51 (m, 1 H), 5.20–5.12 (m, 1 H), 4.63 (d, *J* = 17.0 Hz, 1 H), 4.58 (d, *J* = 17.5 Hz, 1 H), 4.57 (d, *J* = 11.0 Hz, 1 H), 4.45 (d, *J* = 11.0 Hz, 1 H), 4.09–4.06 (m, 1 H), 3.80 (s, 3 H), 3.68–3.62 (m, 1 H), 3.61–3.52 (m, 2 H), 2.56–2.44 (m, 1 H), 2.36–2.20 (m, 2 H), 2.19–2.08 (m, 2 H), 2.02–1.93 (m, 4 H), 1.78–1.56 (m, 4 H), 1.43–1.20 (m, 7 H), 0.95 (t, *J* = 7.5 Hz, 3 H) 0.87 (t, *J* = 7.0 Hz, 3 H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 159.5, 151.5, 137.7, 136.2, 128.4, 128.2, 127.8, 127.4, 125.8, 122.3, 114.7, 77.2, 71.4, 57.6, 55.9, 55.3, 55.3, 52.6, 51.2, 38.3, 32.5, 32.0, 31.8, 31.2, 29.8, 29.5, 24.9, 22.5, 20.9, 13.9; IR (film) 3366, 3252, 1592 cm^{-1}. MS (ESI) 532.3908 (532.3898 calcd for $C_{34}H_{49}N_3O_2$, M^+).



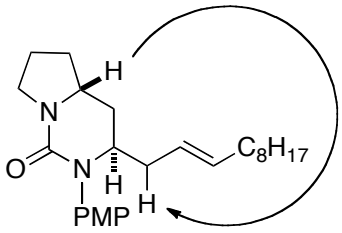
(+)-Merobatzelladine B (5). A glass vial equipped with a magnetic stirbar was charged with **23** (43 mg, 0.07 mmol), Pd/C (43 mg), and methanol (3 mL). The glass vial was placed in a stainless steel bomb equipped with a regulator. The vessel was pressurized to 45 psig with H_2 and stirred overnight (ca. 14 h) at rt under a hydrogen atmosphere (45 psig). Complete consumption of starting material was confirmed with ESI^+ MS analysis. The mixture was filtered through a plug of celite and washed with methanol (20 mL). The crude product was transferred to a round-bottomed flask and concentrated *in vacuo*. The Mitsunobu reaction was carried out based on a published procedure by Nagasawa.[6] The crude product was dissolved in toluene (3.5 mL) and PPh_3 (22 mg, 0.08 mmol) was added. The reaction flask was cooled to 0 °C and DIAD (16.3 μL, 0.083 mmol) was added. The reaction mixture was stirred at 0 °C until the starting material had been consumed as judged by ESI^+ MS analysis (ca. 1 h). The reaction was quenched with a drop of water and concentrated *in vacuo*. The material was purified by flash chromatography on silica (EtOAc, 2:98 MeOH:CH_2Cl_2, 10:90 MeOH:CH_2Cl_2) to provide *N*-*p*-methoxybenzyl merobatzealladine B in ca 70% purity (the remaining impurities were not identified). The PMB deprotection was carried out using the procedure of Gin, with slight modifications.[7] This material was dissolved in methylene chloride (2 mL) and trifluoroacetic acid (6 mL, 78 mmol) was added. The reaction mixture was refluxed overnight (ca. 15 h). The crude material was concentrated *in vacuo* and then purified by flash chromatography on silica gel to afford 11.9 mg (41%) of the title compound as a pale brown oil. Spectroscopic properties are identical to those reported for the natural product.[8] $[\alpha]^{23}_D$ +40.1 (*c* 0.7, MeOH) [lit.[8] $[\alpha]^{25}_D$ +27 (*c* 0.15, MeOH)]. ^{1}H NMR (700 MHz, CD_3OD) δ 3.78–3.71 (m, 2 H), 3.52–3.48 (m, 1 H), 3.42 (dtd, *J* = 11.6, 6.3, 3.2 Hz, 1 H), 2.28–2.21 (m, 3 H), 2.17 (ddd, *J* = 13.3, 4.6, 1.8 Hz, 1 H), 1.62–1.22 (m, 20 H), 0.93–0.88 (m, 6 H); ^{13}C NMR (175 MHz, CD_3OD) δ 150.6, 57.5, 53.5, 51.6, 50.2, 36.2, 35.9, 34.8, 32.8, 32.7, 31.9, 31.2, 30.8, 26.8, 25.9, 23.6, 23.6, 14.3, 14.3; IR (film) 3188, 3107, 1679 cm^{-1}. MS (ESI) 306.2909 (306.2904 calcd for $C_{19}H_{36}N_3$, M^+).

Assignment of Stereochemistry of 12a-b

The relative stereochemistry of compound **12a** was assigned on the basis of observed ^{1}H NMR nOe experiments. Significant nOe relationships are shown below.



The relative stereochemistry of compound **12b** was assigned on the basis of observed ^{1}H NMR nOe experiments. Significant nOe relationships are shown below.



References

[1] H. Arada, R. K. Thalji, R. G. Bergman, J. A. Ellman, *J. Org. Chem.* **2008**, *73*, 6772–6779.

[2] R. E. Gawley, E. Low, Q. Zhang, R. Harris, *J. Am. Chem. Soc.* **2000**, *122*, 3344–3350.

[3] S. Hanessian, A. Tehim, P. Chen, *J. Org. Chem.* **1993**, *58*, 7768–7781.

[4] G. Liu, D. A. Cogan, T. D. Owens, T. P. Tang, J. A. Ellman, *J. Org. Chem.* **1999**, *64*, 1278–1284.

[5] F. A. Davis, B. Yang, *Org. Lett.* **2003**, *5*, 5011–5014.

[6] J. Shimokawa, K. Shirai, A. Tanatani, Y. Hashimoto, K. Nagasawa, *Angew. Chem. Int. Ed.* **2004**, *43*, 1559–1562.

[7] M. A. Arnold, K. A. Day, S. G. Durón, D. Y. Gin, *J. Am. Chem. Soc.* **2006**, *128*, 13255–13260.

[8] S. Takishima, A. Ishiyama, M. Iwatsuki, K. Otoguro, H. Yamada, S. Omura, H. Kobayahi, R. W. M. van Soest, S. Matsunaga, *Org. Lett.* **2009**, *11*, 2655–2658.

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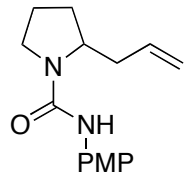
Agilent Technologies



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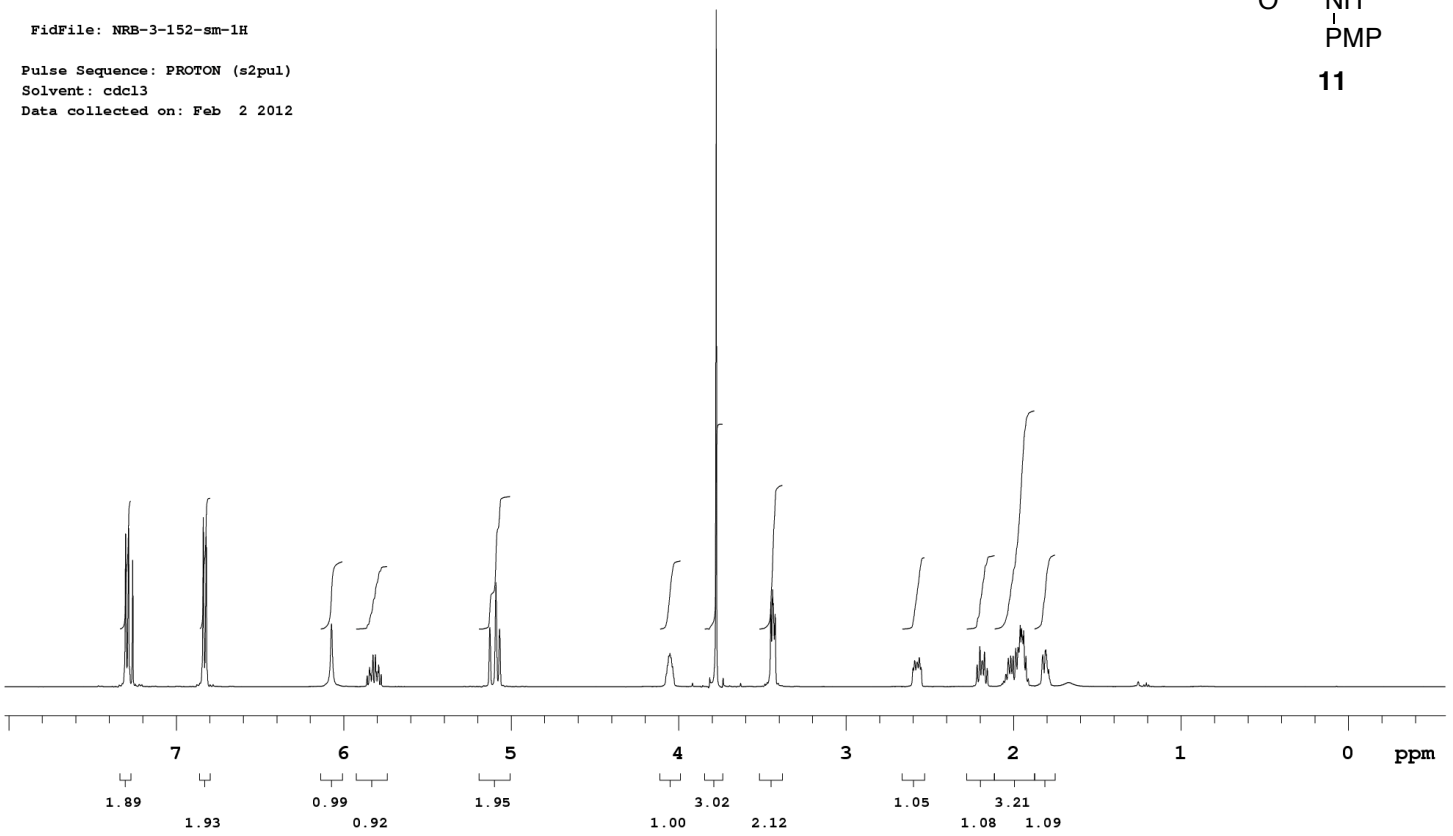

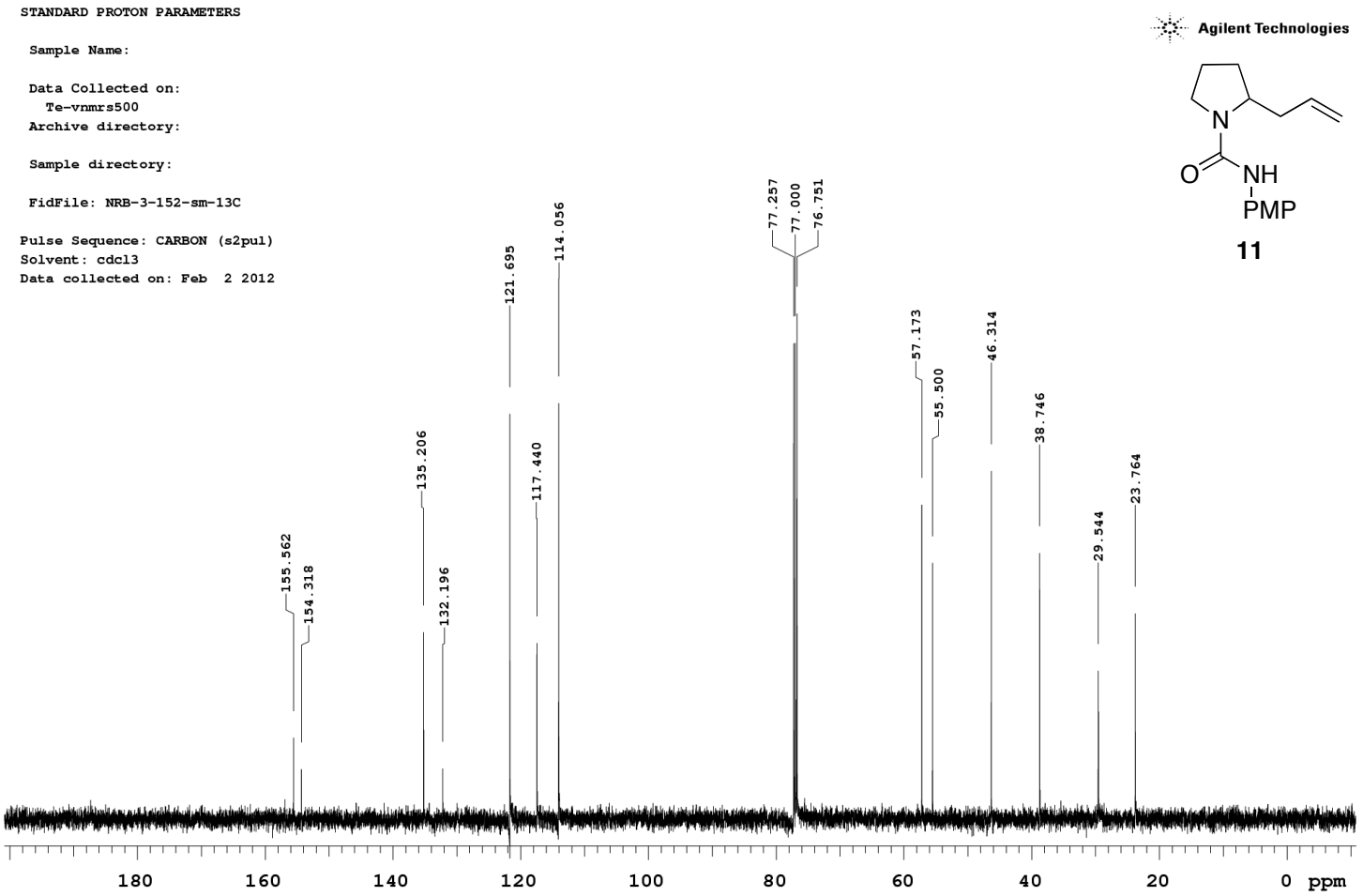
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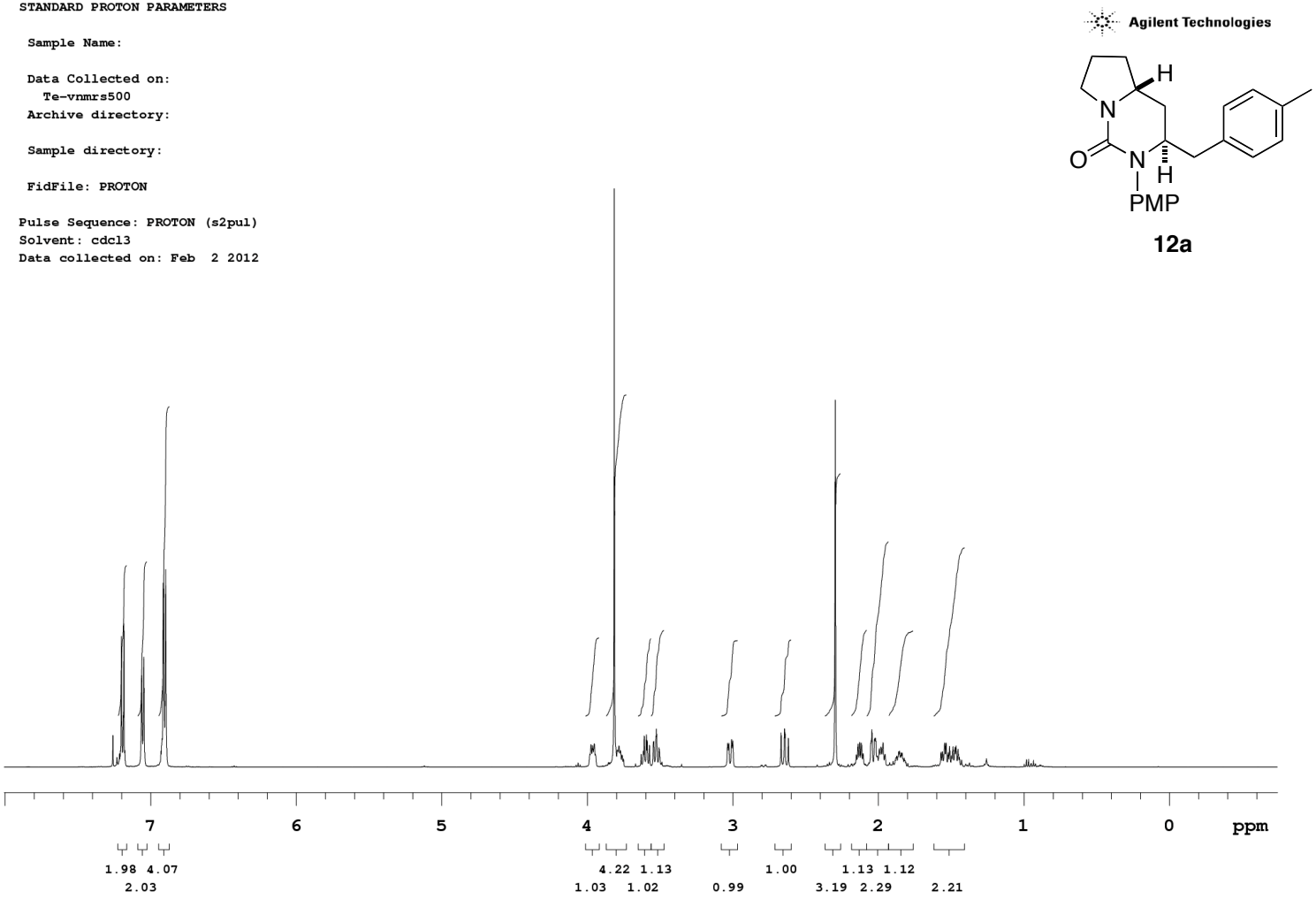
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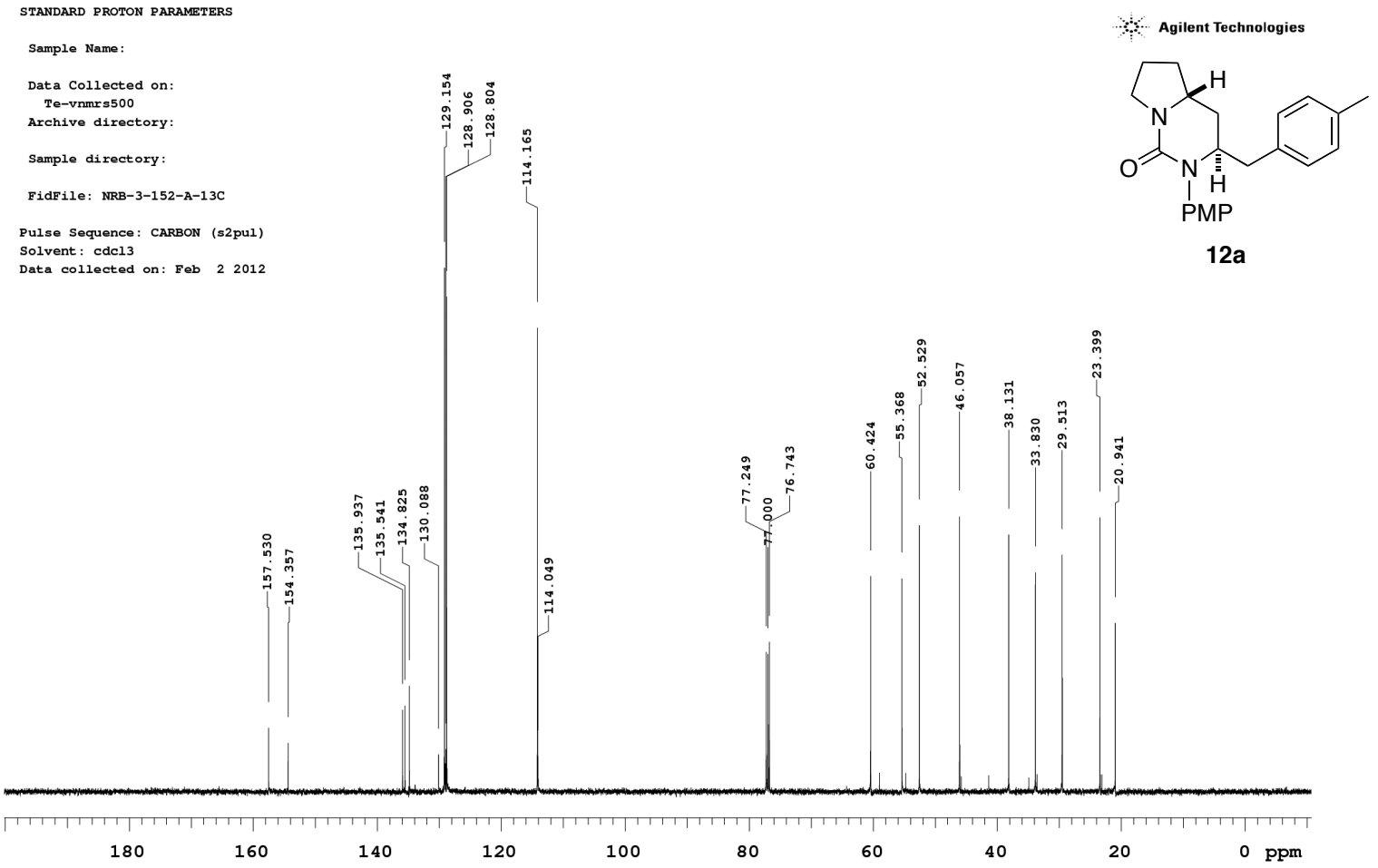
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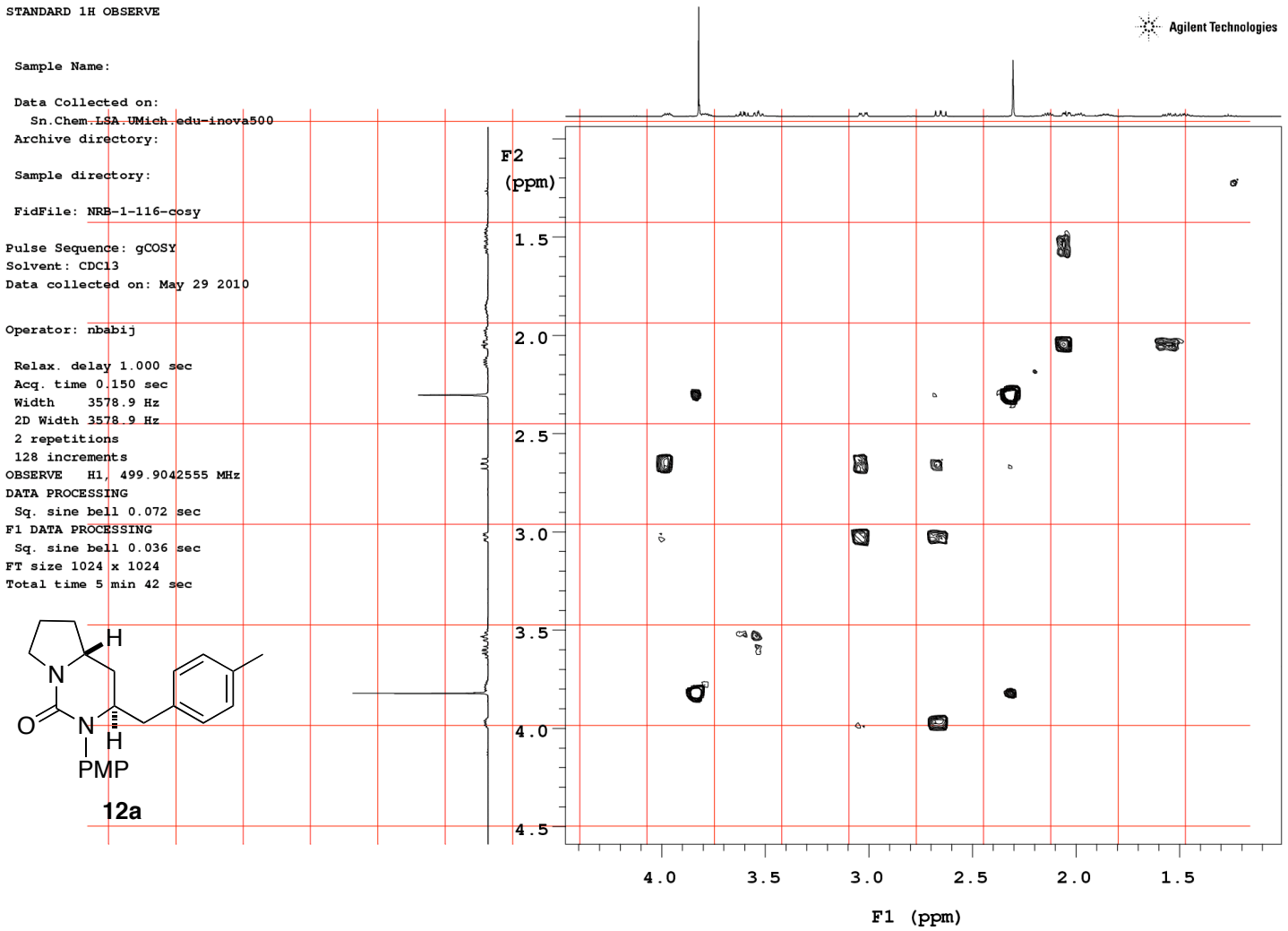
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Agilent Technologies
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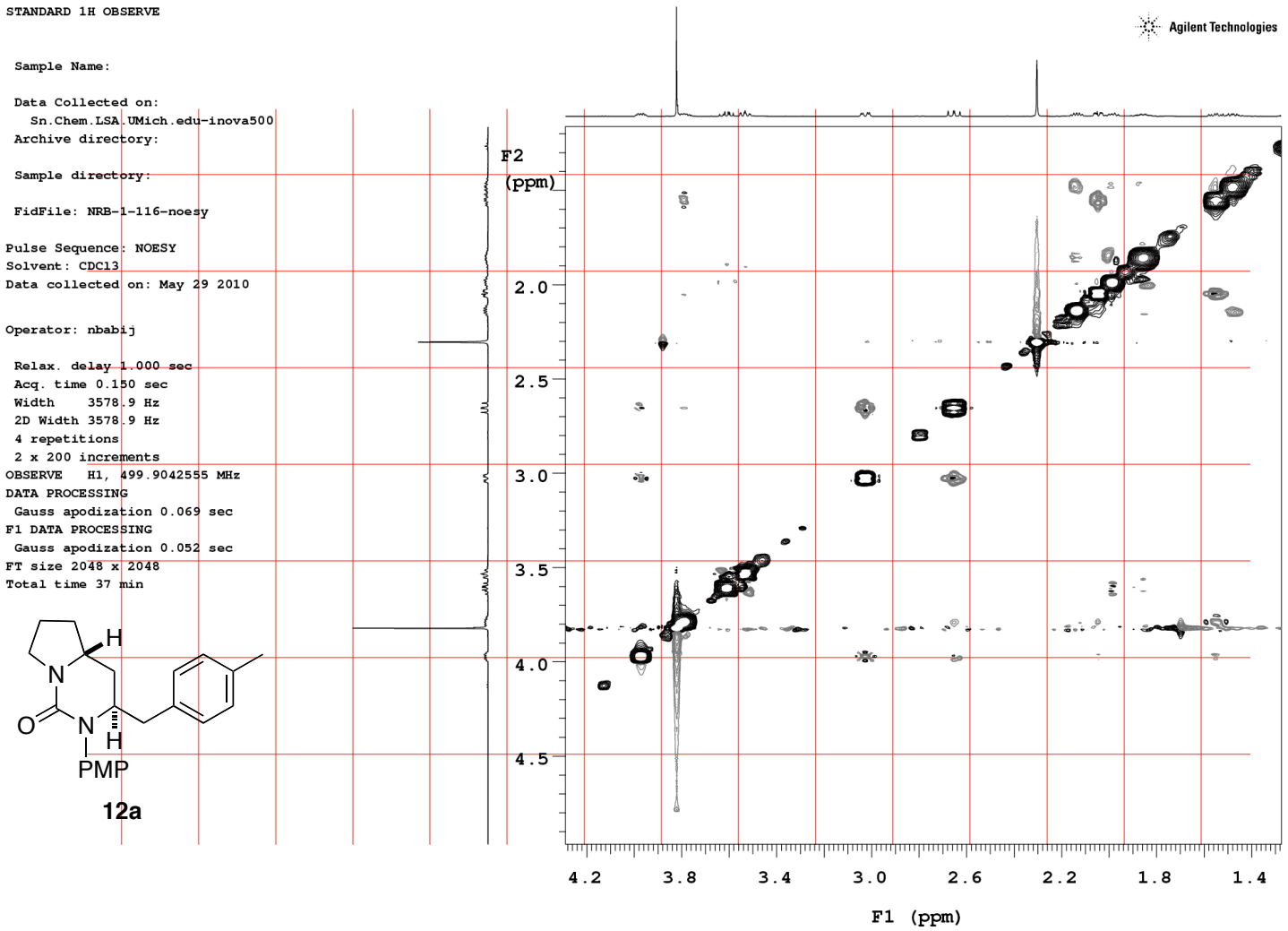
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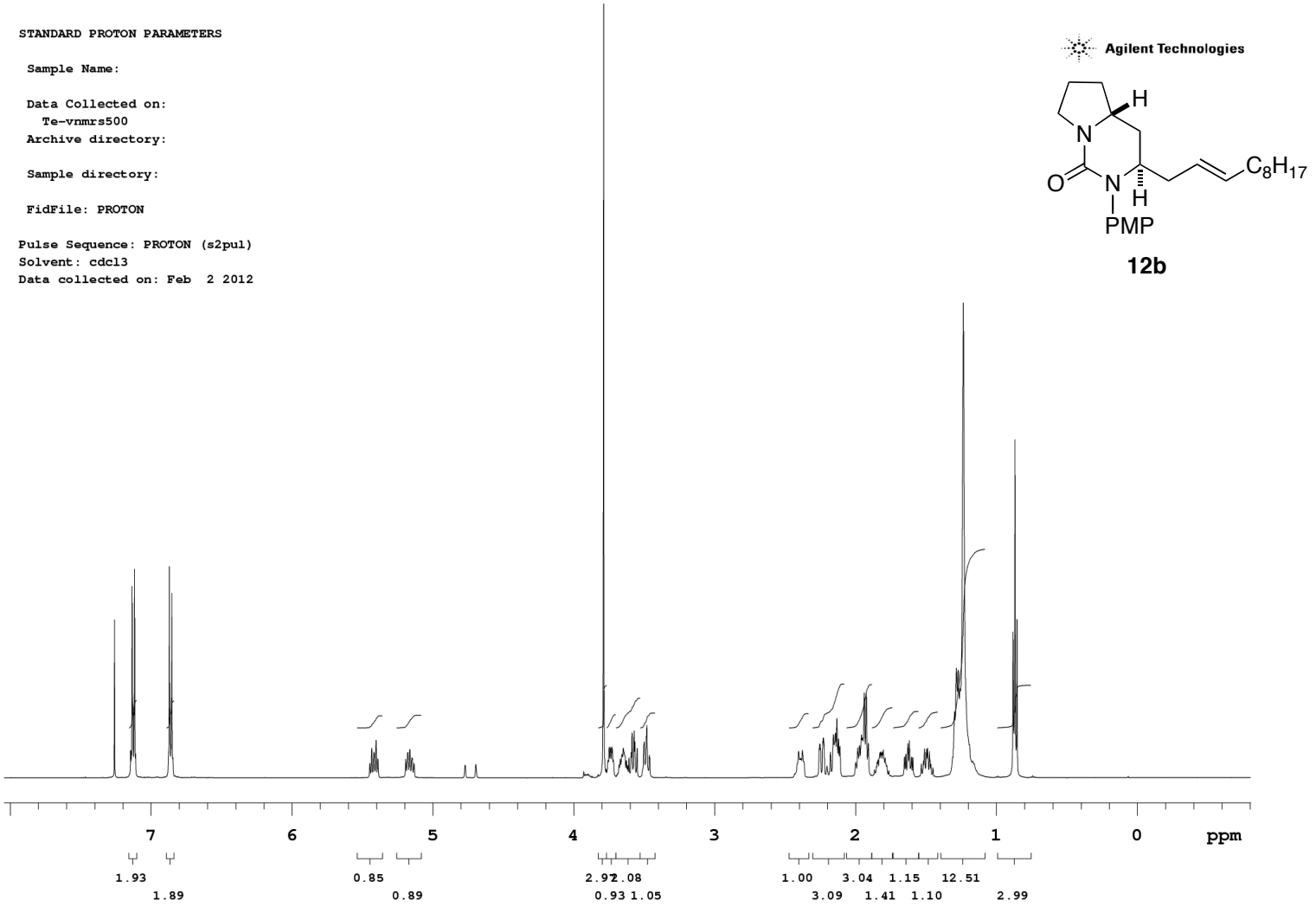
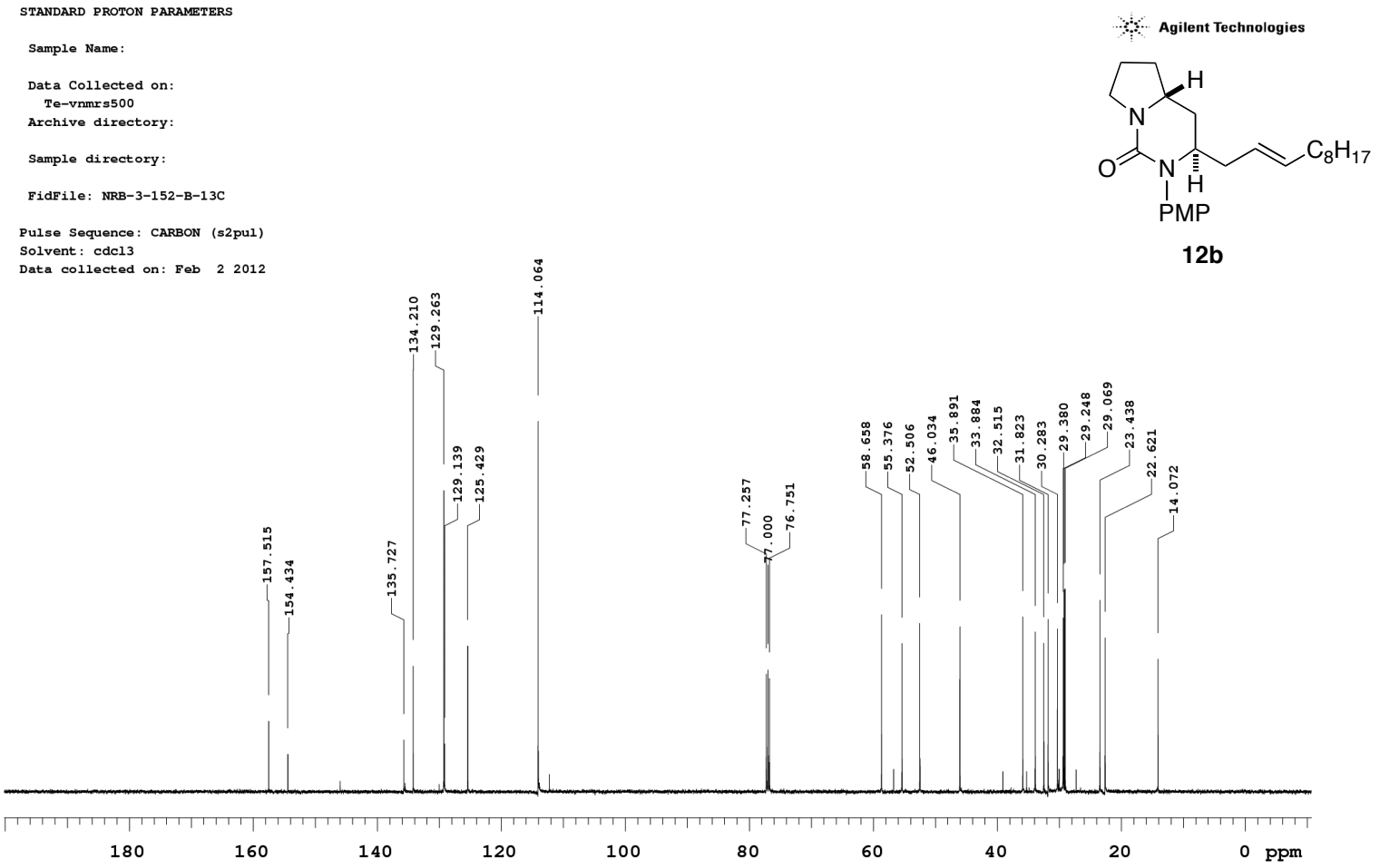
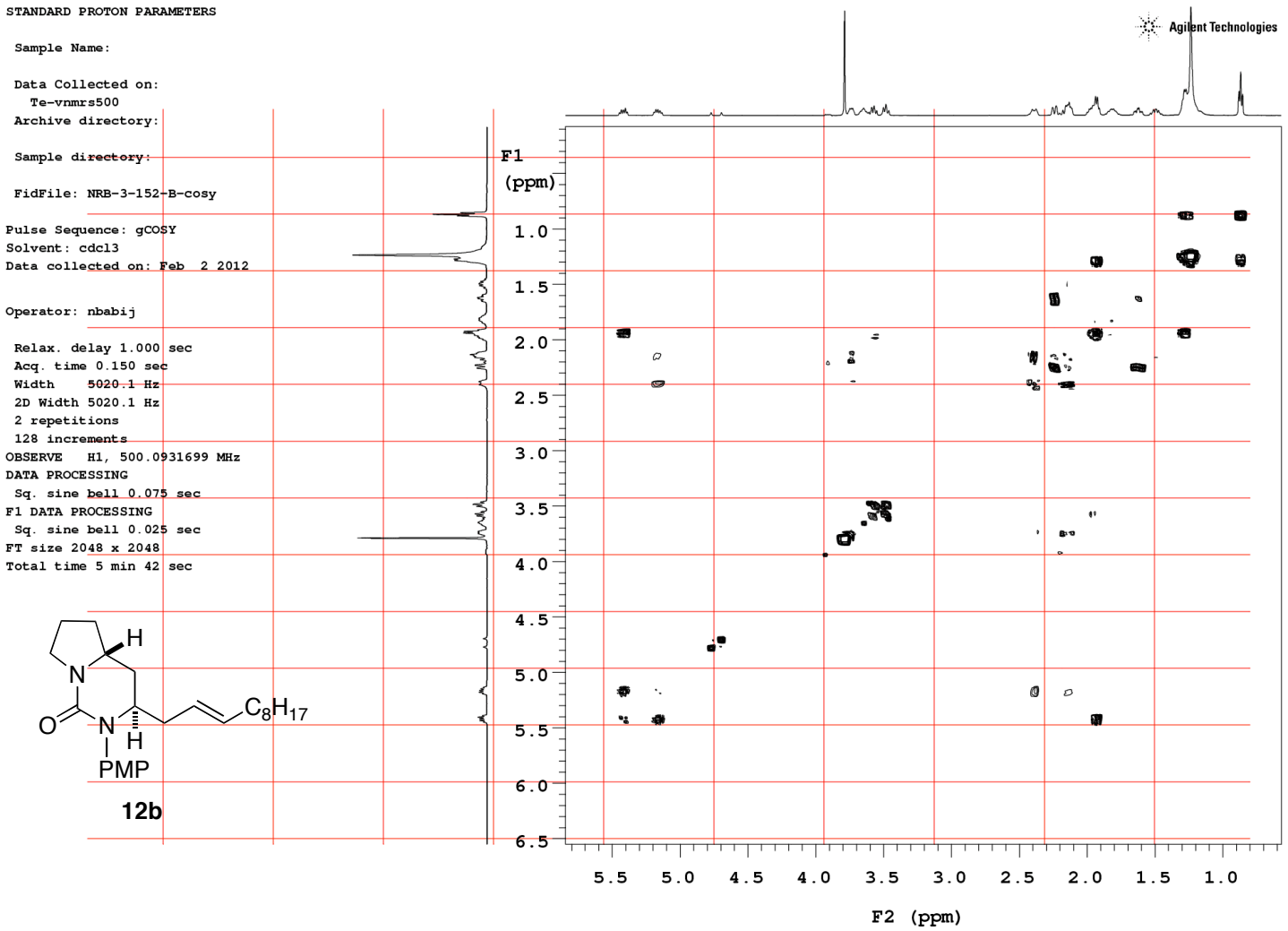
H
PMP
12a


STANDARD PROTON PARAMETERS
Sample Name:
Data Collected on:
Te-vnmrs500
Archive directory:
Sample directory:
FidFile: PROTON
Pulse Sequence: PROTON (s2pul)
Solvent: cdcl3
Data collected on: Feb 2 2012
Agilent Technologies
H
N
O
N
H
PMP
C8H17
12b
7
6
5
4
3
2
1
0
ppm
1.93
1.89
0.85
0.89
2.97
2.08
0.93
1.05
1.00
3.04
1.15
12.51
3.09
1.41
1.10
2.99


STANDARD PROTON PARAMETERS
Sample Name:
Data Collected on:
Te-vnmrs500
Archive directory:
Sample directory:
FidFile: NRB-3-152-B-13C
Pulse Sequence: CARBON (s2pul)
Solvent: cdcl3
Data collected on: Feb 2 2012
Agilent Technologies
H
N
O
N
H
PMP
C8H17
12b
157.515
154.434
135.727
134.210
129.263
129.139
125.429
114.064
77.257
77.000
76.751
58.658
55.376
52.506
46.034
35.891
33.884
32.515
31.823
30.283
29.380
29.248
29.069
23.438
22.621
14.072
180
160
140
120
100
80
60
40
20
0 ppm


STANDARD PROTON PARAMETERS
Sample Name:
Data Collected on:
Te-vnmrs500
Archive directory:
Sample directory:
FidFile: NRB-3-152-B-cosy
Pulse Sequence: gCOSY
Solvent: cdcl3
Data collected on: Feb 2 2012
Operator: nbabij
Relax. delay 1.000 sec
Acq. time 0.150 sec
Width 5020.1 Hz
2D Width 5020.1 Hz
2 repetitions
128 increments
OBSERVE H1, 500.0931699 MHz
DATA PROCESSING
Sq. sine bell 0.075 sec
F1 DATA PROCESSING
Sq. sine bell 0.025 sec
FT size 2048 x 2048
Total time 5 min 42 sec
Agilent Technologies
F1 (ppm)
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0
F2 (ppm)
H
N
O
N
H
PMP
C8H17
12b

STANDARD PROTON PARAMETERS

Sample Name:

Data Collected on:
Te-vnmrs500
Archive directory:

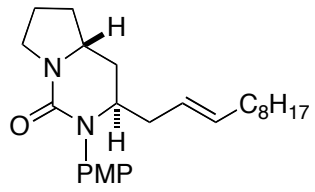
Sample directory:

FidFile: NRB-3-152-B-noesy

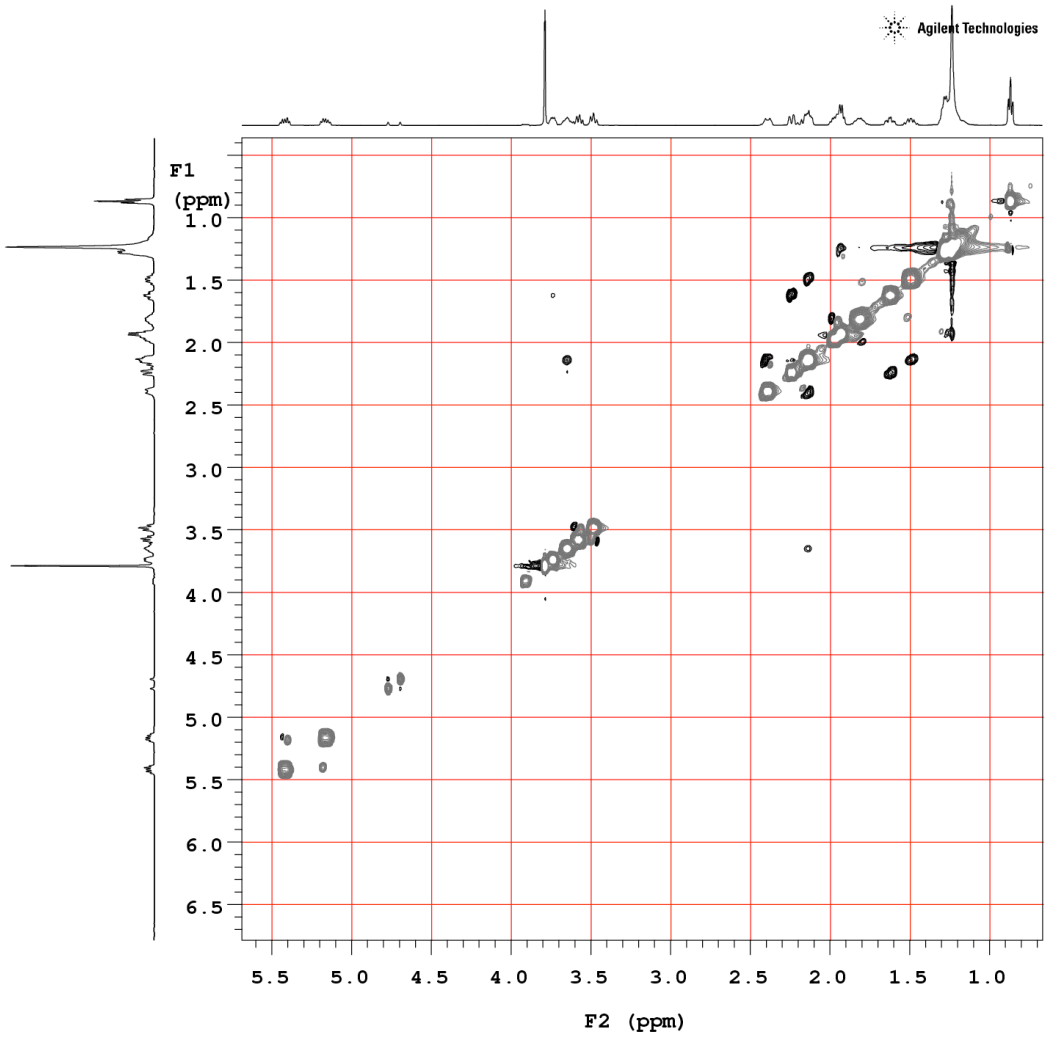
Pulse Sequence: NOESY
Solvent: cdcl3
Data collected on: Feb 2 2012

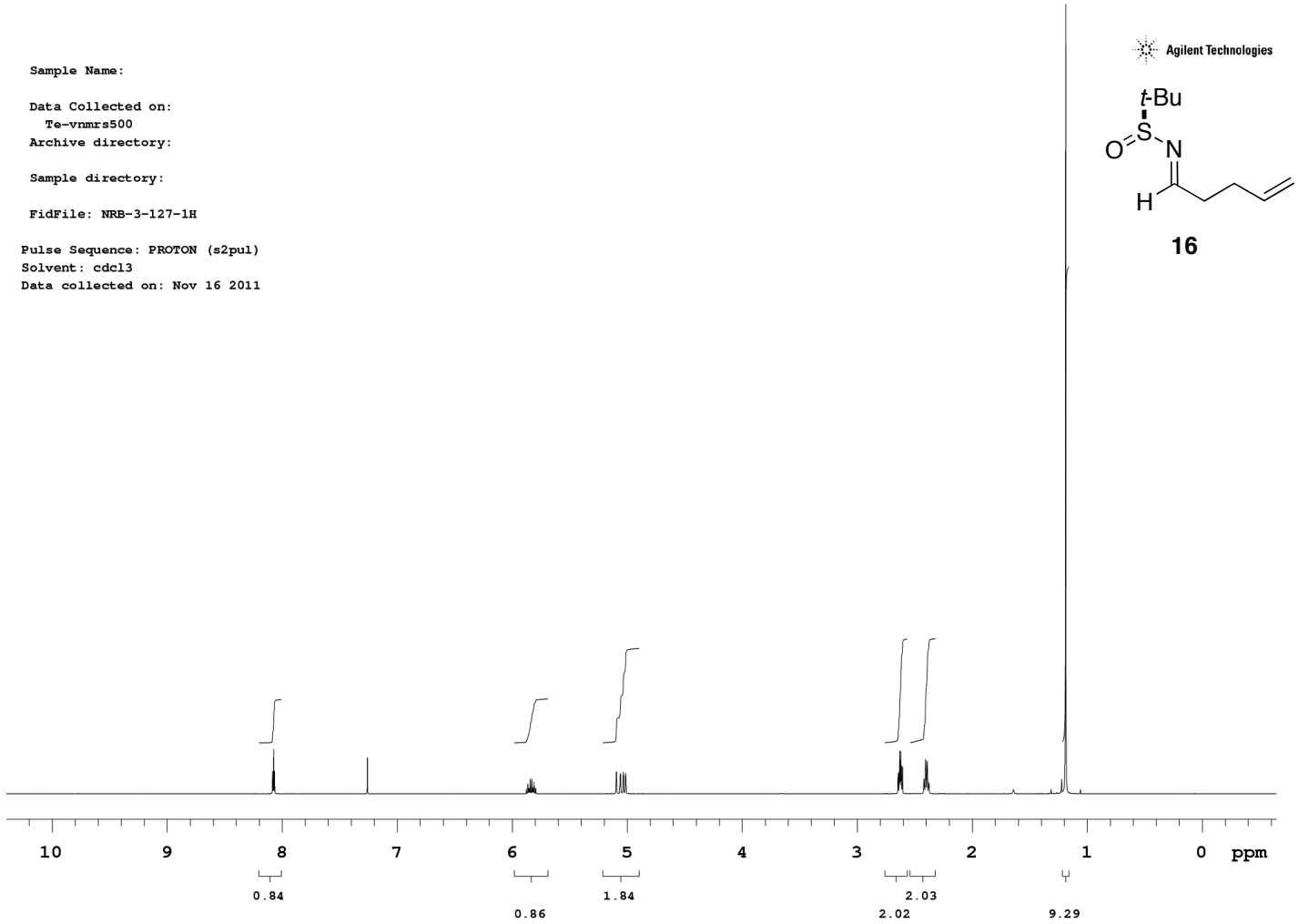
Operator: nbabij

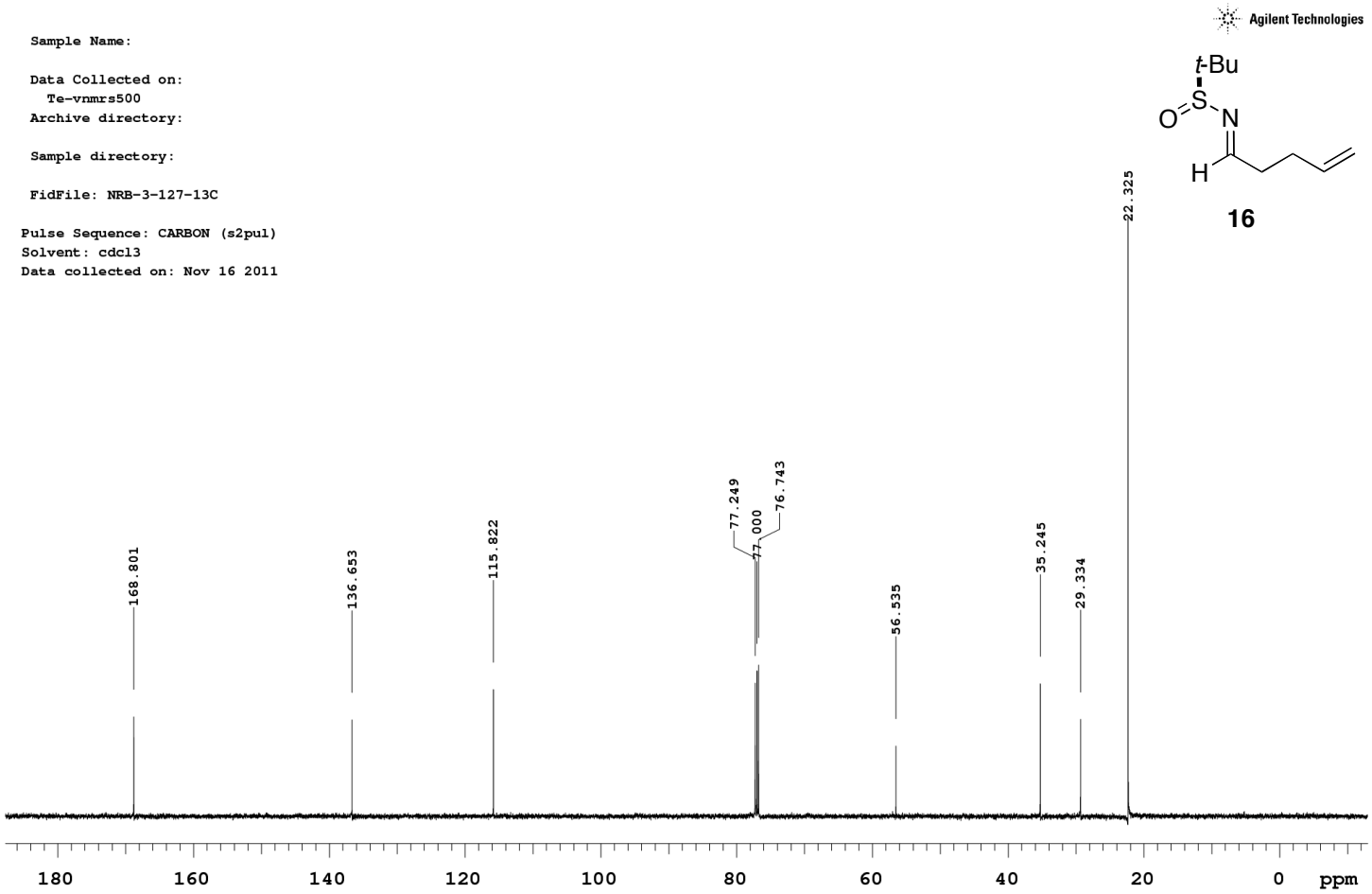
Relax. delay 1.000 sec
Acq. time 0.150 sec
Width 5020.1 Hz
2D Width 5020.1 Hz
4 repetitions
2 x 128 increments
OBSERVE H1, 500.0931699 MHz
DATA PROCESSING
Gauss apodization 0.069 sec
F1 DATA PROCESSING
Gauss apodization 0.023 sec
FT size 2048 x 2048
Total time 24 min

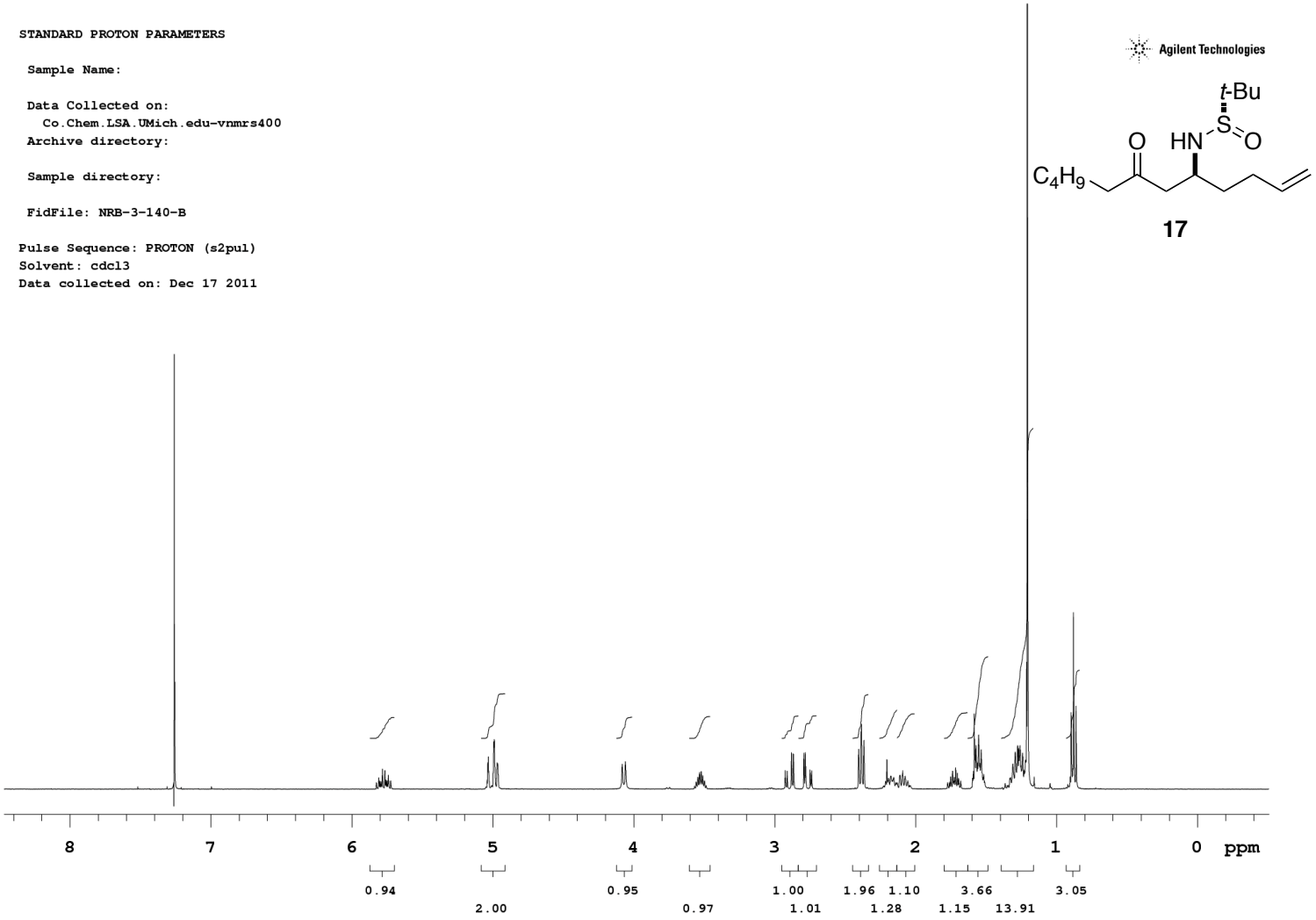


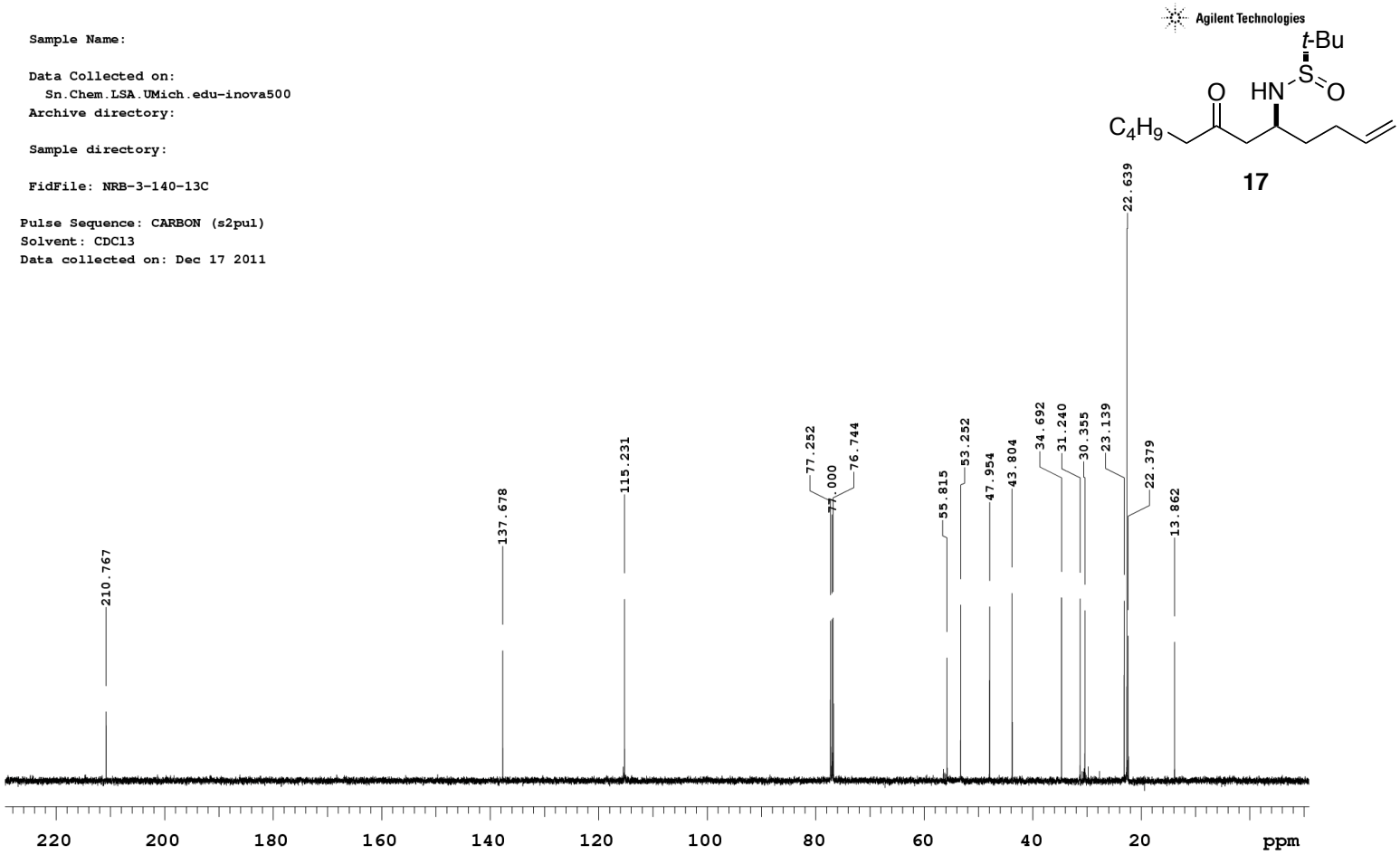
12b

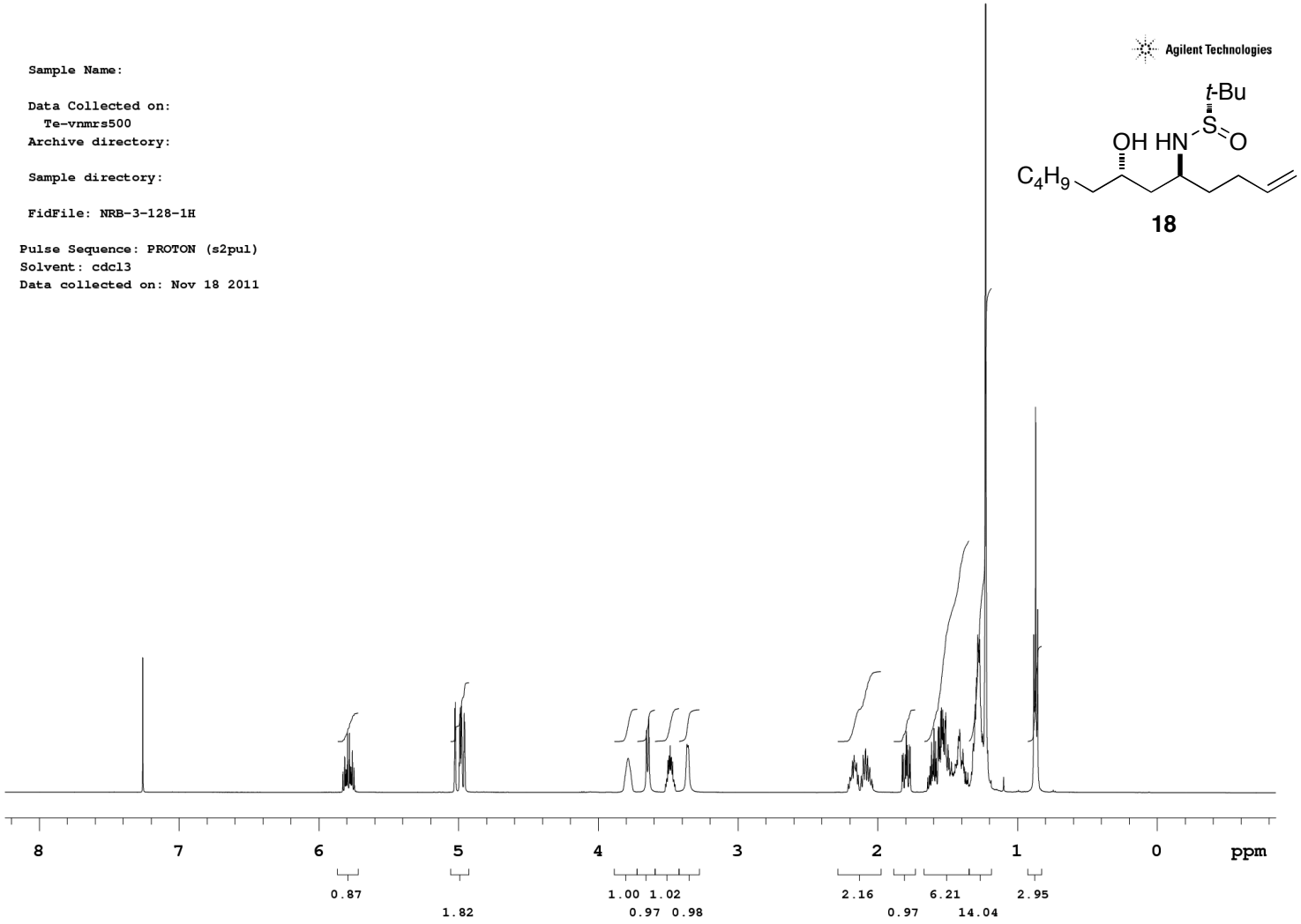


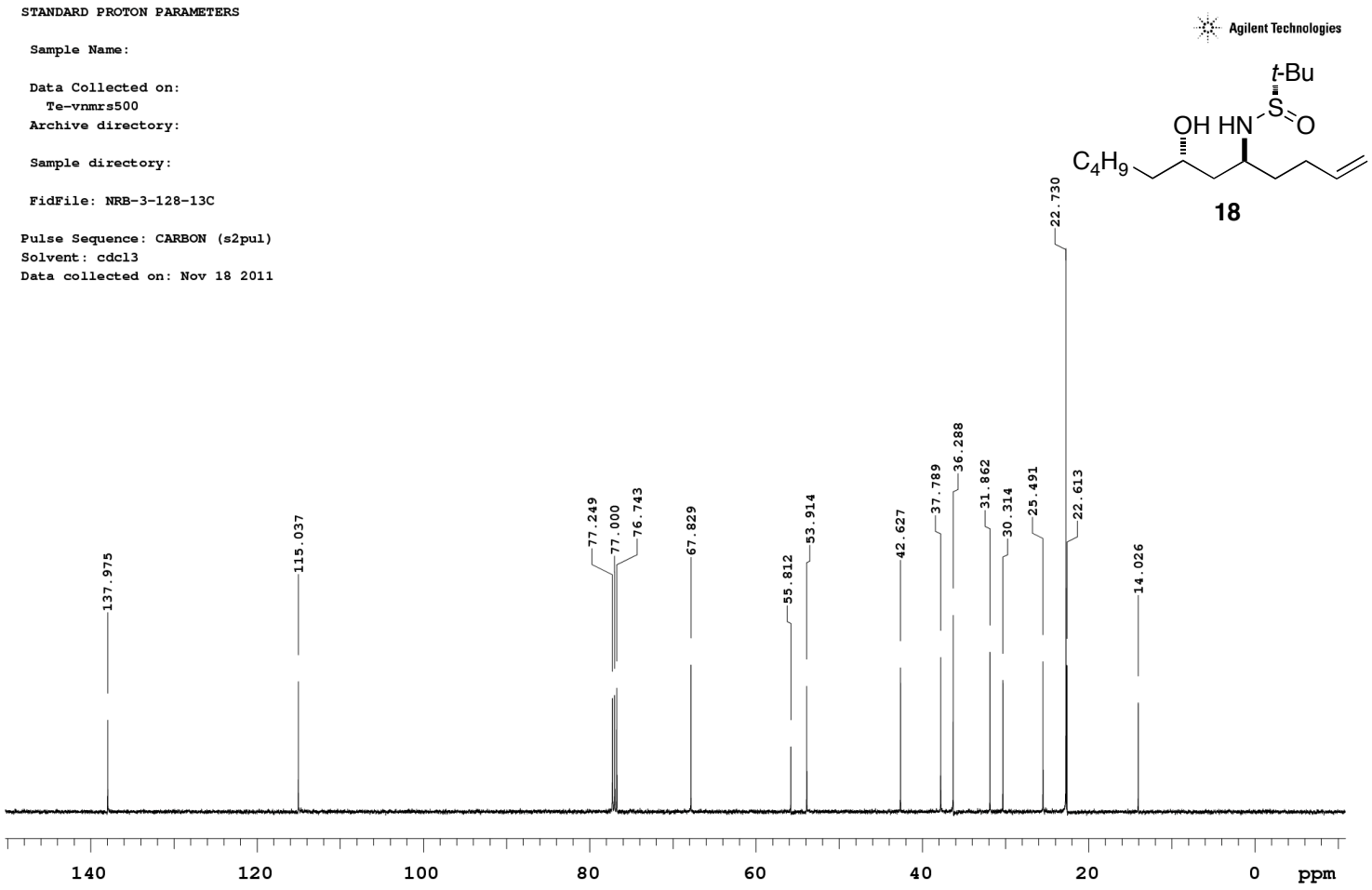

Sample Name:
Data Collected on:
Te-vnmrs500
Archive directory:
Sample directory:
FidFile: NRB-3-127-1H
Pulse Sequence: PROTON (s2pul)
Solvent: cdcl3
Data collected on: Nov 16 2011
Agilent Technologies
t-Bu
S
O
N
H
16
10
9
8
7
6
5
4
3
2
1
0
ppm
0.84
0.86
1.84
2.02
2.03
9.29

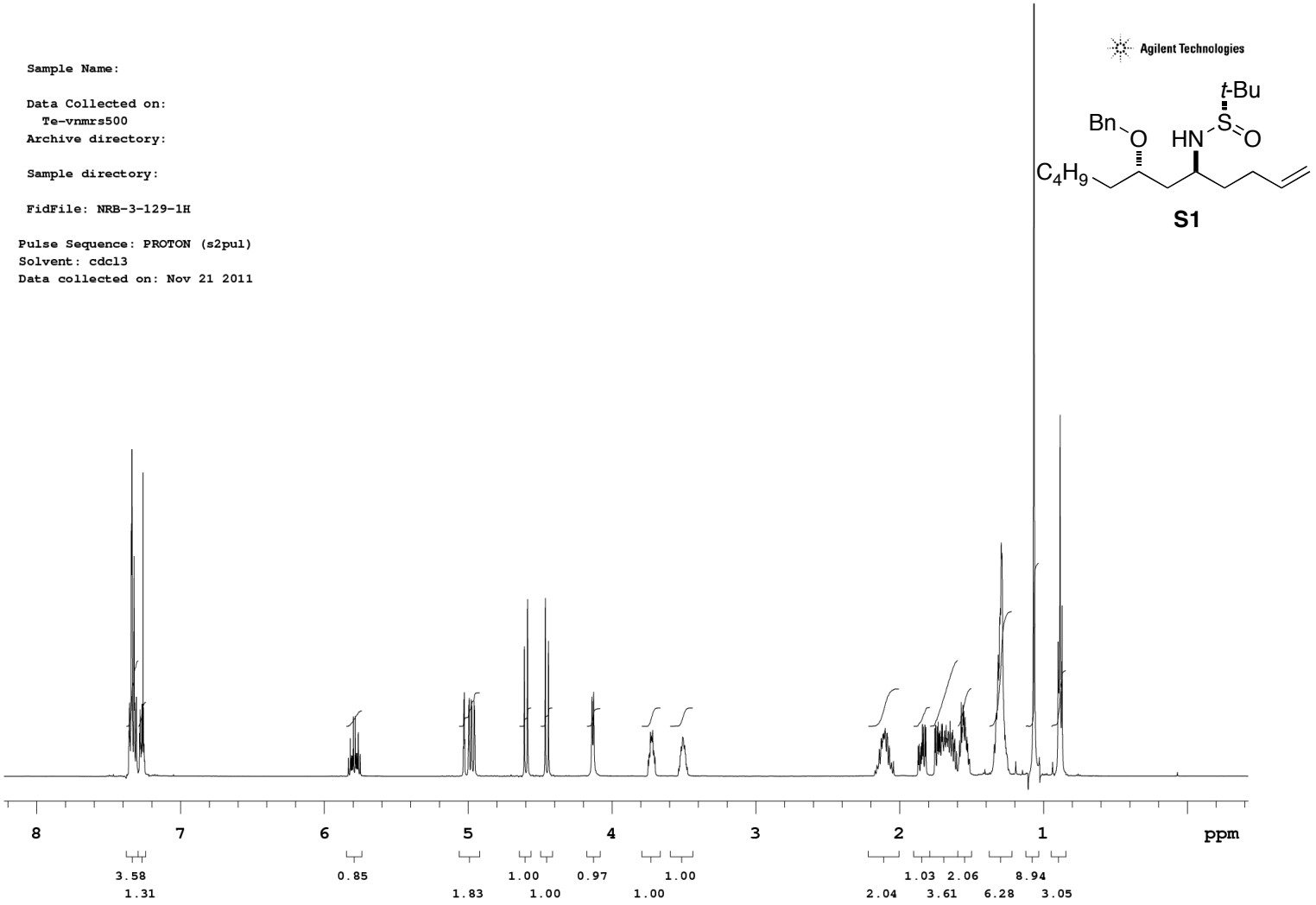

Agilent Technologies
Sample Name:
Data Collected on:
Te-vnmrs500
Archive directory:
Sample directory:
FidFile: NRB-3-127-13C
Pulse Sequence: CARBON (s2pul)
Solvent: cdcl3
Data collected on: Nov 16 2011
t-Bu
S
O
N
H
16
168.801
136.653
115.822
77.249
77.000
76.743
56.535
35.245
29.334
22.325
180
160
140
120
100
80
60
40
20
0
ppm

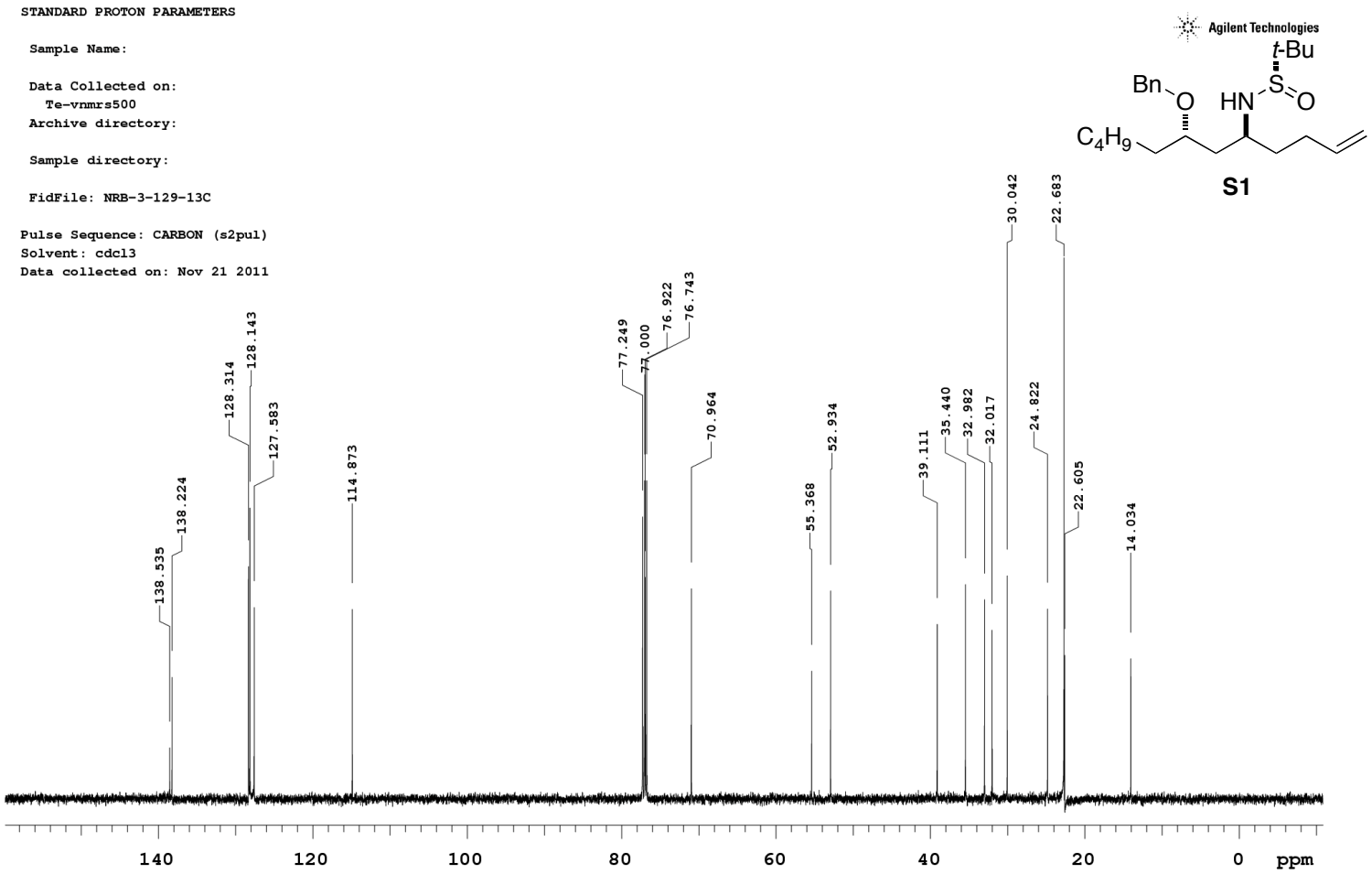

STANDARD PROTON PARAMETERS
Sample Name:
Data Collected on:
Co.Chem.LSA.UMich.edu-vnmrs400
Archive directory:
Sample directory:
FidFile: NRB-3-140-B
Pulse Sequence: PROTON (s2pul)
Solvent: cdcl3
Data collected on: Dec 17 2011
Agilent Technologies
t-Bu
S
O
HN
O
C4H9
17
8
7
6
5
4
3
2
1
0
ppm
0.94
2.00
0.95
0.97
1.00
1.01
1.96
1.10
1.28
3.66
1.15
13.91
3.05


Sample Name:
Data Collected on:
Sn.Chem.LSA.UMich.edu-inova500
Archive directory:
Sample directory:
FidFile: NRB-3-140-13C
Pulse Sequence: CARBON (s2pul)
Solvent: CDCl3
Data collected on: Dec 17 2011
Agilent Technologies
t-Bu
S
O
HN
O
C4H9
17
210.767
137.678
115.231
77.252
77.000
76.744
55.815
53.252
47.954
43.804
34.692
31.240
30.355
23.139
22.639
22.379
13.862
220
200
180
160
140
120
100
80
60
40
20
ppm

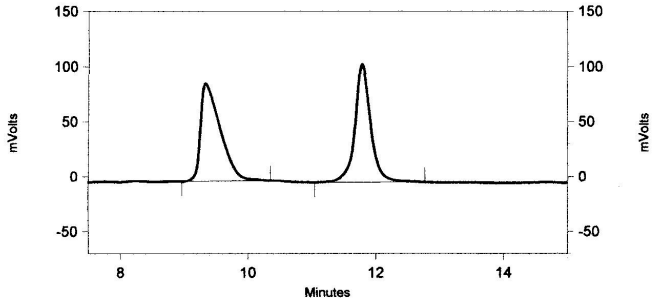

Sample Name:
Data Collected on:
Te-vnmrs500
Archive directory:
Sample directory:
FidFile: NRB-3-128-1H
Pulse Sequence: PROTON (s2pul)
Solvent: cdcl3
Data collected on: Nov 18 2011
Agilent Technologies
t-Bu
S
O
OH HN
C4H9
18
8
7
6
5
4
3
2
1
0
ppm
0.87
1.82
1.00 1.02
0.97 0.98
2.16
0.97
6.21
14.04
2.95

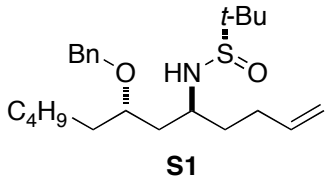

STANDARD PROTON PARAMETERS
Sample Name:
Data Collected on:
Te-vnmrs500
Archive directory:
Sample directory:
FidFile: NRB-3-128-13C
Pulse Sequence: CARBON (s2pul)
Solvent: cdcl3
Data collected on: Nov 18 2011
Agilent Technologies
t-Bu
S
O
OH HN
C4H9
18
137.975
115.037
77.249
77.000
76.743
67.829
55.812
53.914
42.627
37.789
36.288
31.862
30.314
25.491
22.730
22.613
14.026
140
120
100
80
60
40
20
0
ppm


Sample Name:
Data Collected on:
Te-vnmrs500
Archive directory:
Sample directory:
FidFile: NRB-3-129-1H
Pulse Sequence: PROTON (s2pul)
Solvent: cdcl3
Data collected on: Nov 21 2011
Agilent Technologies
t-Bu
Bn
O
HN
S
O
C4H9
S1
8
7
6
5
4
3
2
1
ppm
3.58
1.31
0.85
1.83
1.00
1.00
0.97
1.00
1.00
2.04
1.03
3.61
2.06
6.28
8.94
3.05


STANDARD PROTON PARAMETERS
Sample Name:
Data Collected on:
Te-vnmrs500
Archive directory:
Sample directory:
FidFile: NRB-3-129-13C
Pulse Sequence: CARBON (s2pul)
Solvent: cdcl3
Data collected on: Nov 21 2011
Agilent Technologies
t-Bu
Bn
O
HN
S
O
C4H9
S1
138.535
138.224
128.314
128.143
127.583
114.873
77.249
77.000
76.922
76.743
70.964
55.368
52.934
39.111
35.440
32.982
32.017
30.042
24.822
22.683
22.605
14.034
140
120
100
80
60
40
20
0
ppm

C:\CLASS-VP\Enterprise\Projects\Default\Data\Babij\HPLC\RACEMIC-NRB-III-149-WHELK-5%IPA-1.0ml_min.dat
System (1/18/2012 4:17:57 PM) (Reprocessed) (Aborted Run)



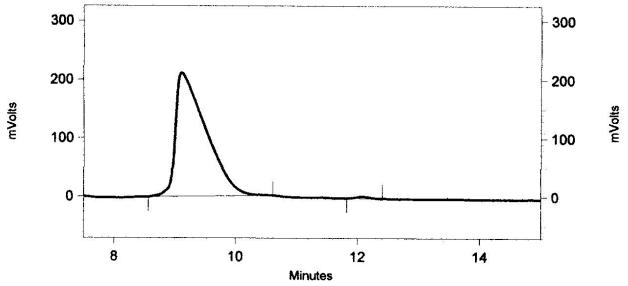


S1

SPD-10Avp Ch2-254nm
Results

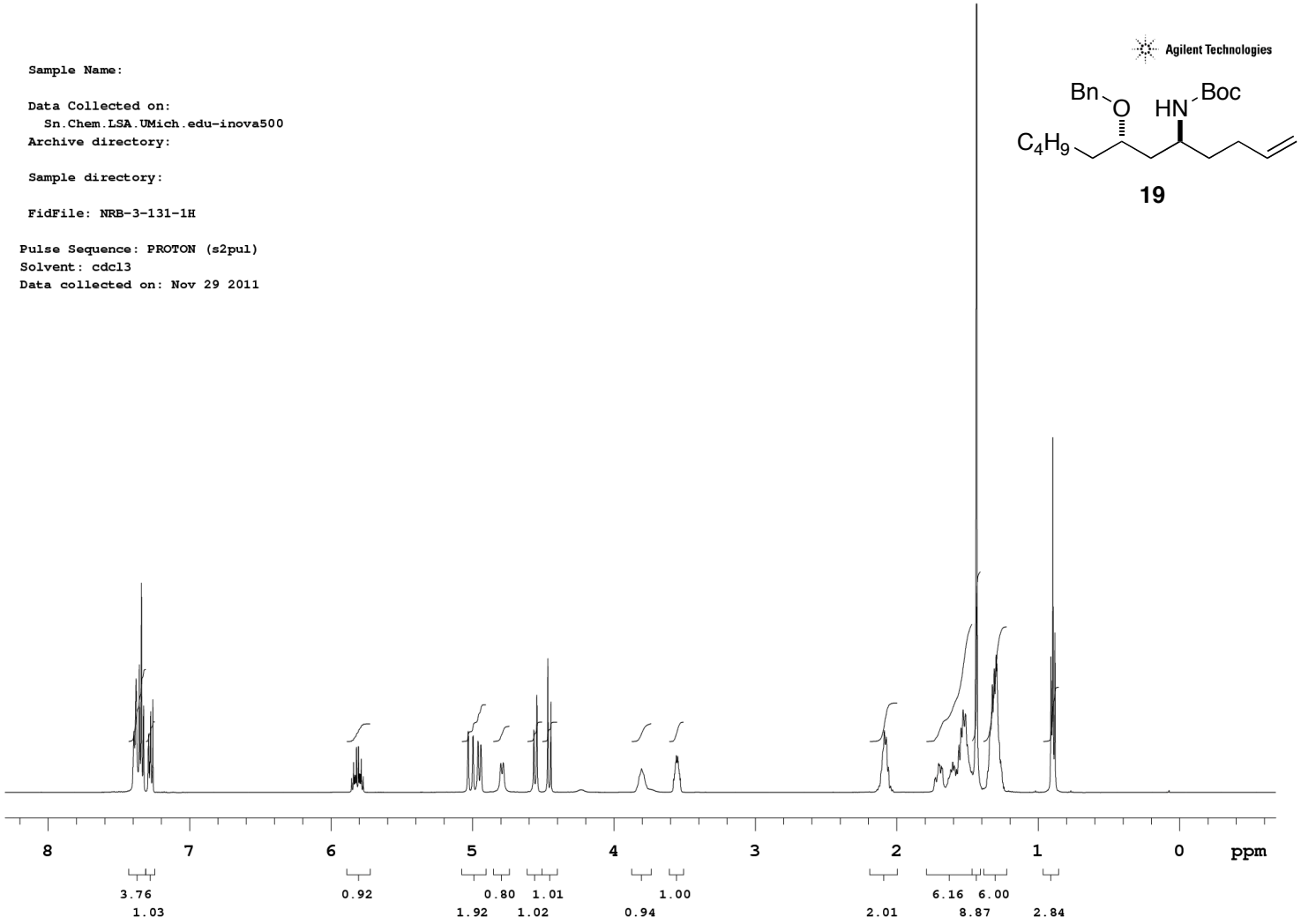
Start Time	Stop Time	Area Percent
8.97	10.35	51.161
11.05	12.77	48.839

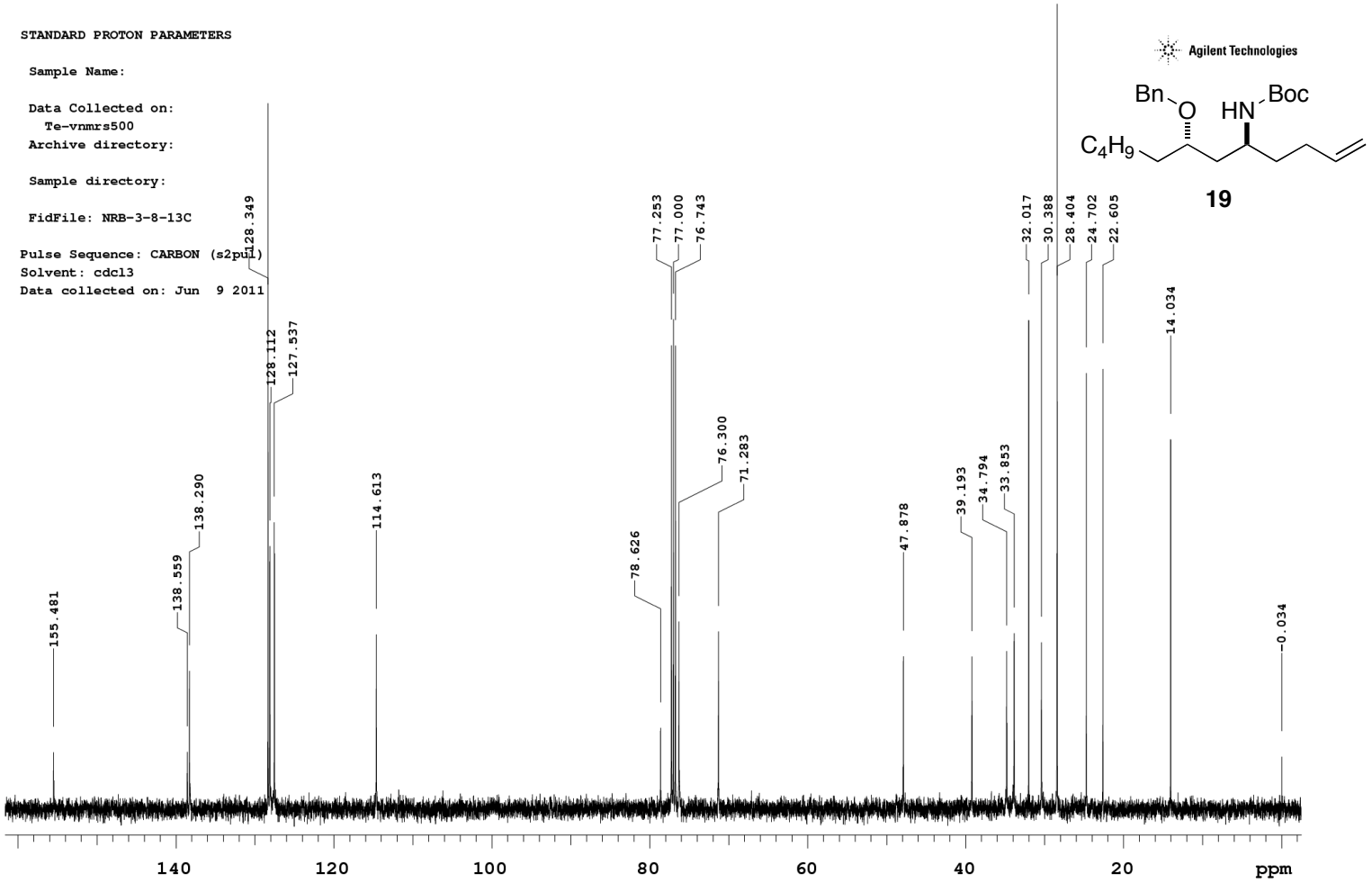
C:\CLASS-VP\Enterprise\Projects\Default\Data\Babij\HPLC\CHRAL-NRB-III-149-WHELK-5%IPA-1.0ml_min.dat
System (1/18/2012 5:00:56 PM) (Reprocessed) (Aborted Run)

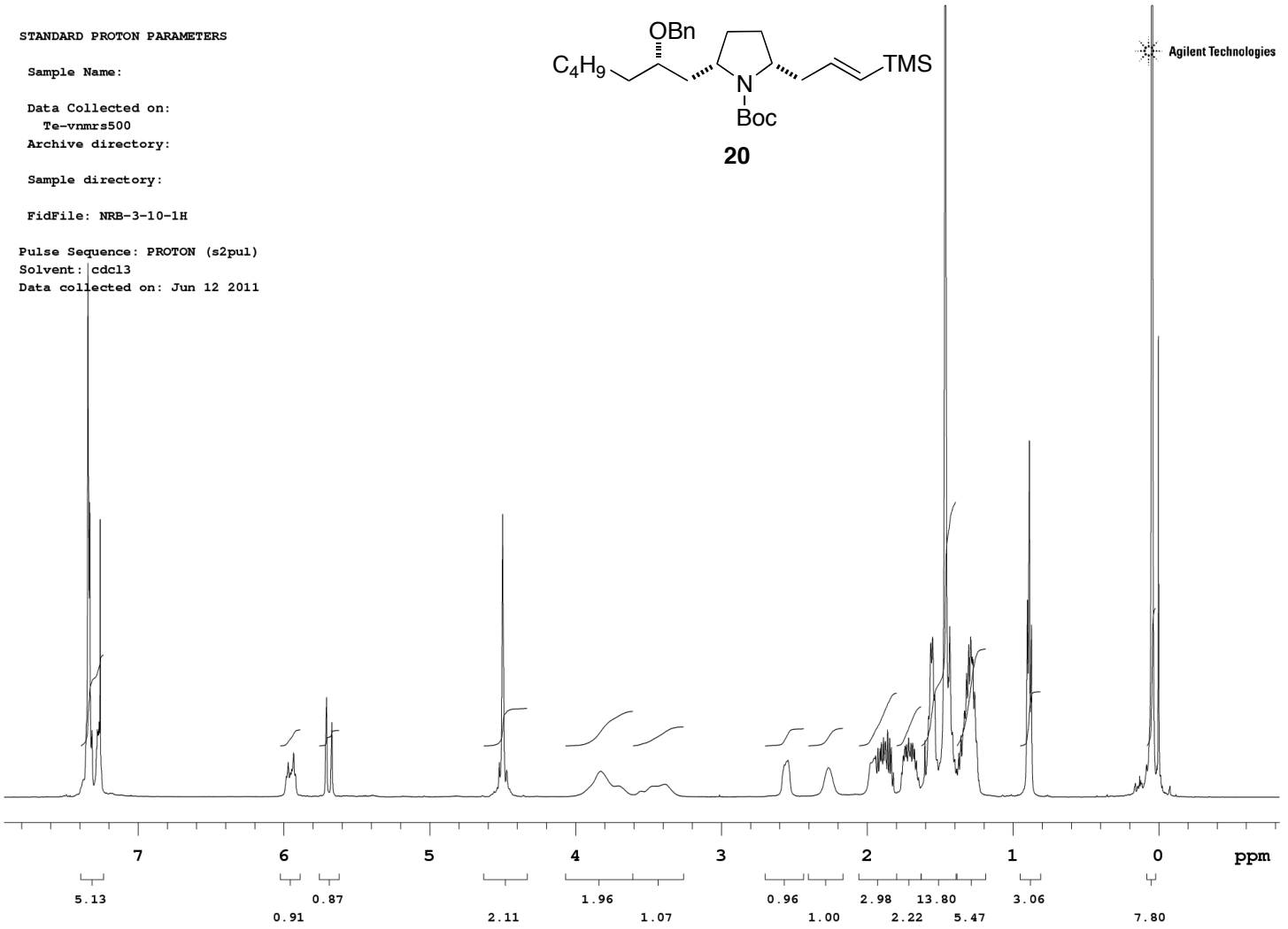


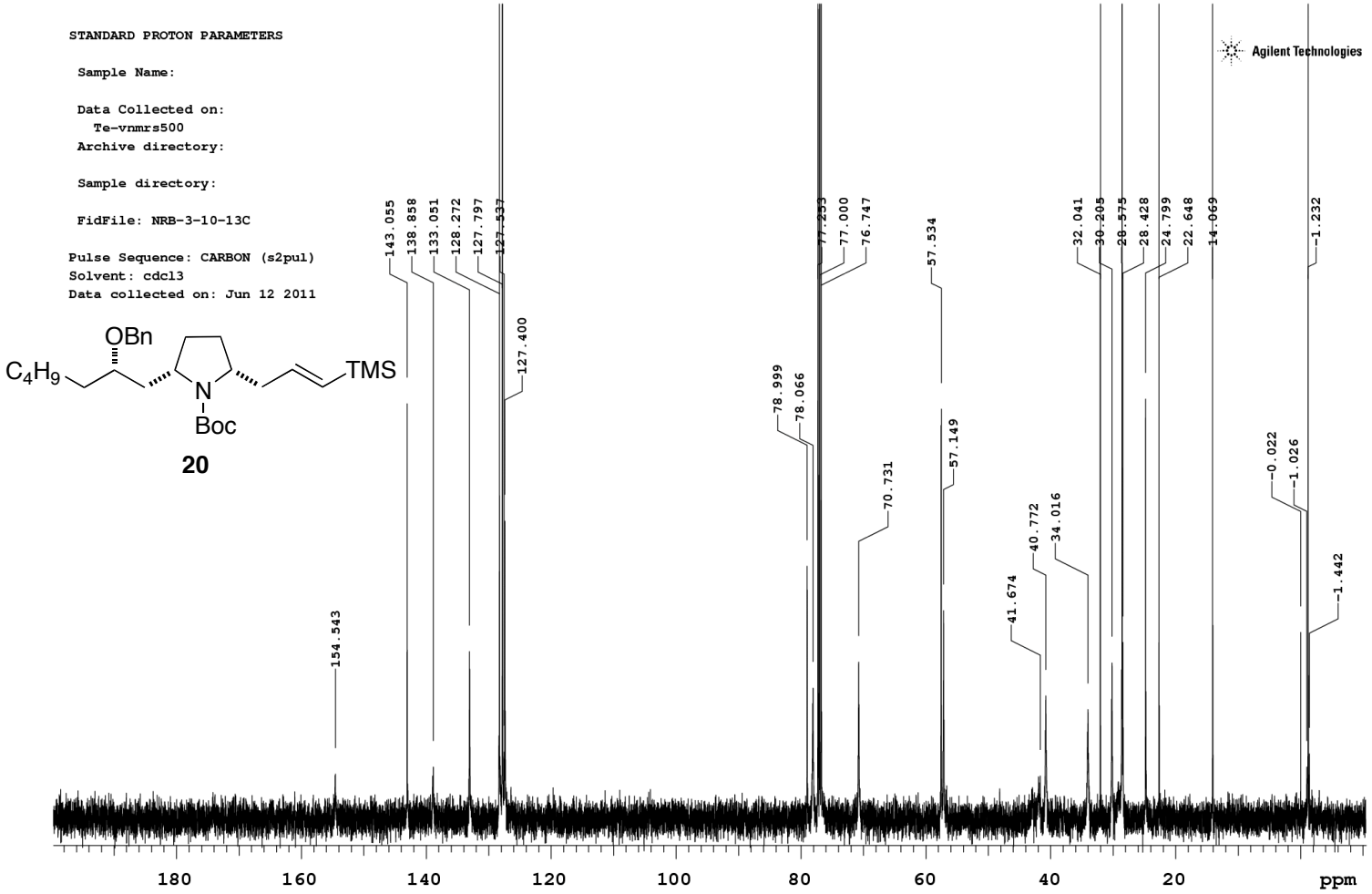
SPD-10Avp Ch2-254nm
Results

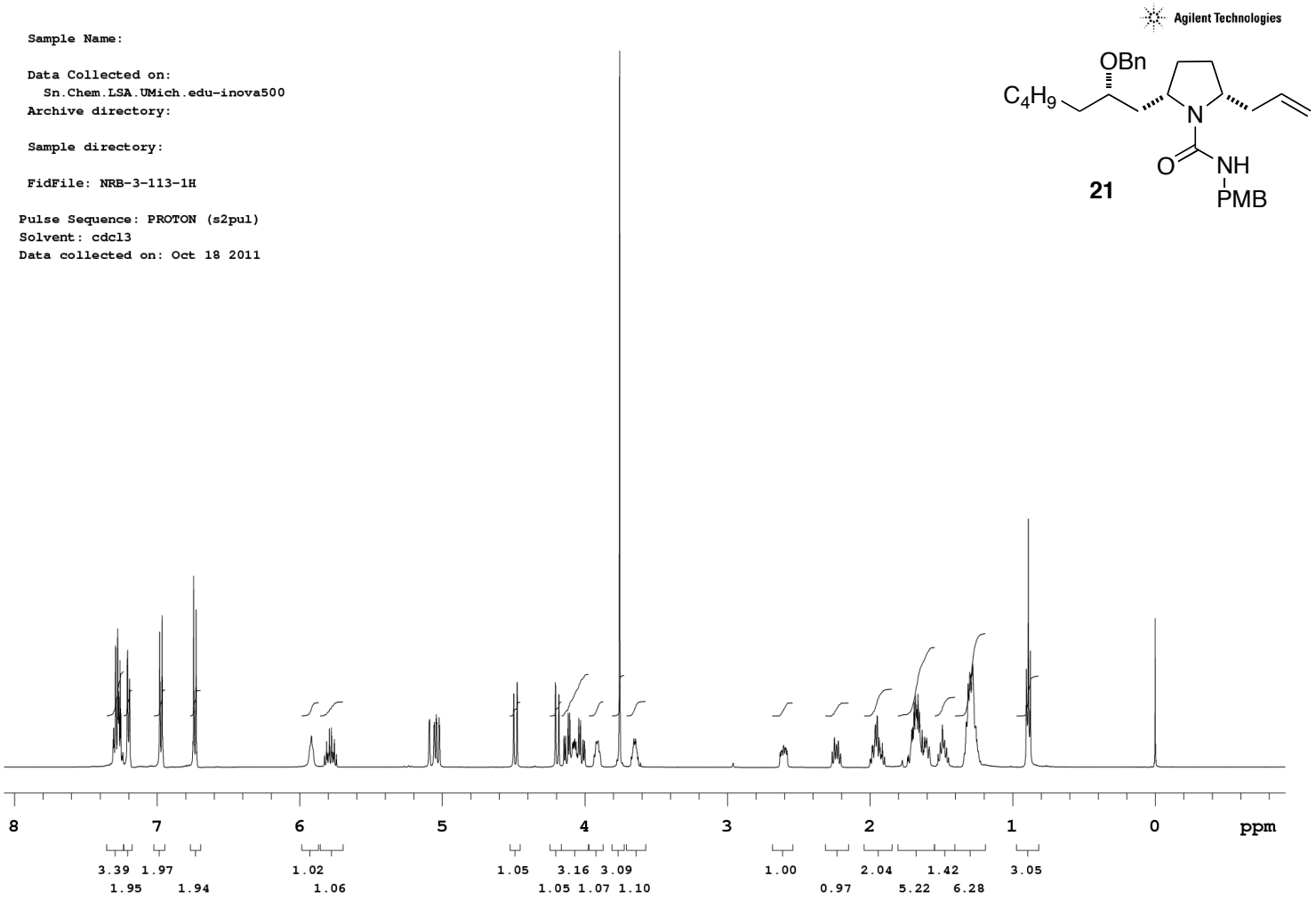
Start Time	Stop Time	Area Percent
8.57	10.62	99.315
11.82	12.41	0.685

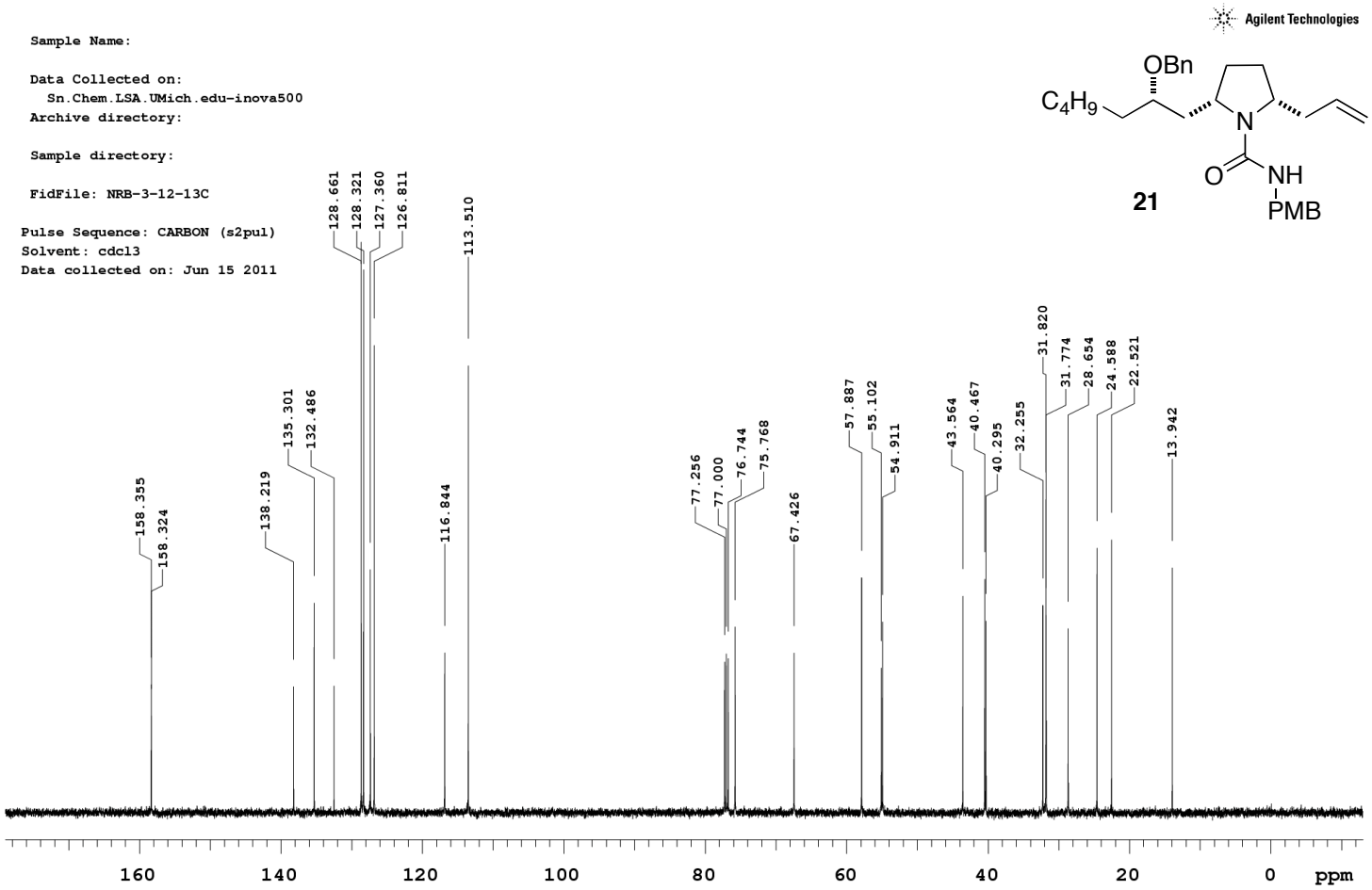

Sample Name:
Data Collected on:
Sn.Chem.LSA.UMich.edu-inova500
Archive directory:
Sample directory:
FidFile: NRB-3-131-1H
Pulse Sequence: PROTON (s2pul)
Solvent: cdcl3
Data collected on: Nov 29 2011
Agilent Technologies
Bn
O
HN
Boc
C4H9
19
8
7
6
5
4
3
2
1
0
ppm
3.76
1.03
0.92
1.92
0.80
1.02
1.01
0.94
1.00
2.01
6.16
8.87
6.00
2.84

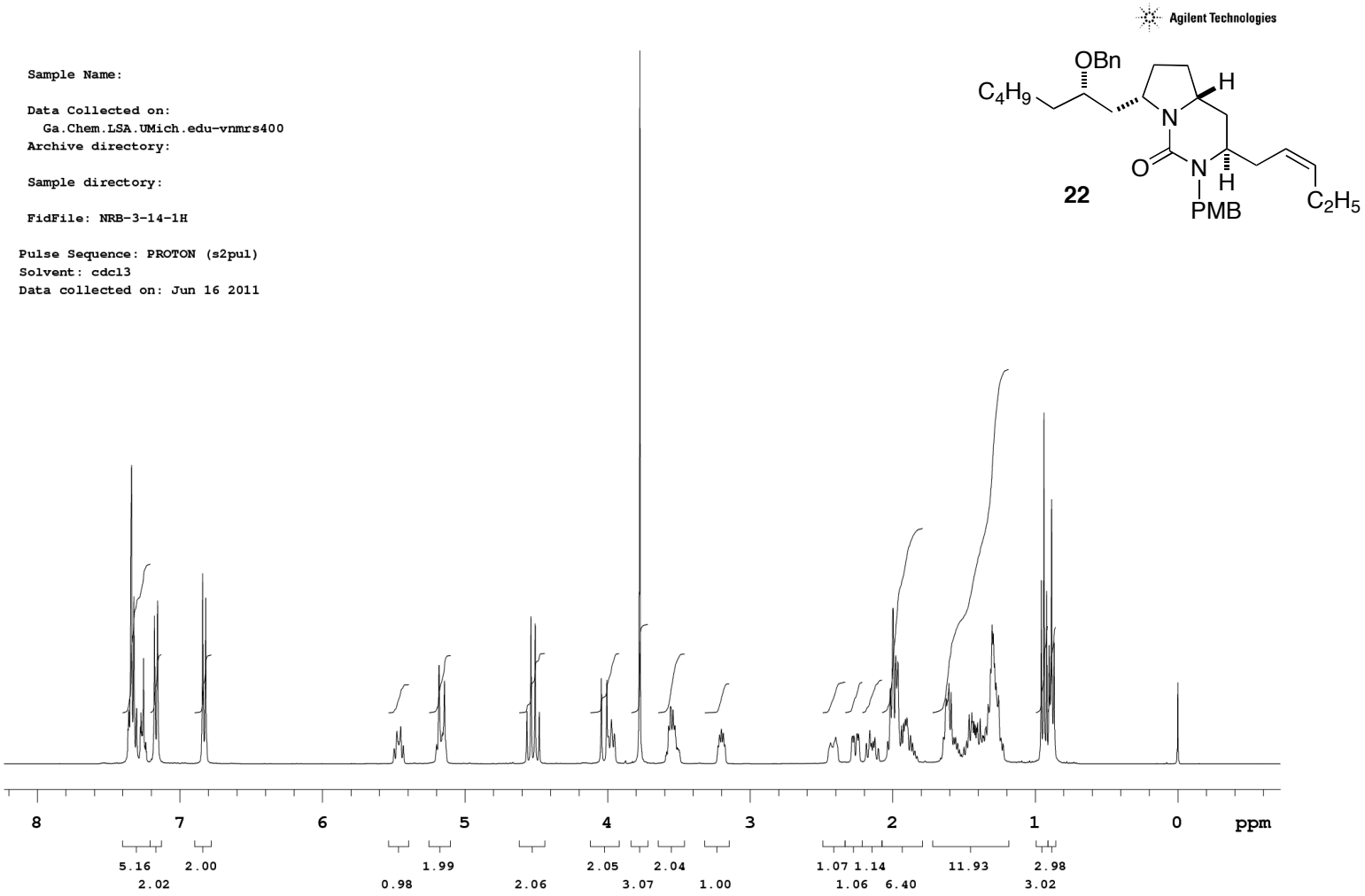

STANDARD PROTON PARAMETERS
Sample Name:
Data Collected on:
Te-vnmrs500
Archive directory:
Sample directory:
FidFile: NRB-3-8-13C
Pulse Sequence: CARBON (s2pul)
Solvent: cdcl3
Data collected on: Jun 9 2011
Agilent Technologies
Bn
O
HN
Boc
C_4H_9
19
155.481
138.559
138.290
128.349
128.112
127.537
114.613
78.626
77.253
77.000
76.743
76.300
71.283
47.878
39.193
34.794
33.853
32.017
30.388
28.404
24.702
22.605
14.034
-0.034
140
120
100
80
60
40
20
ppm

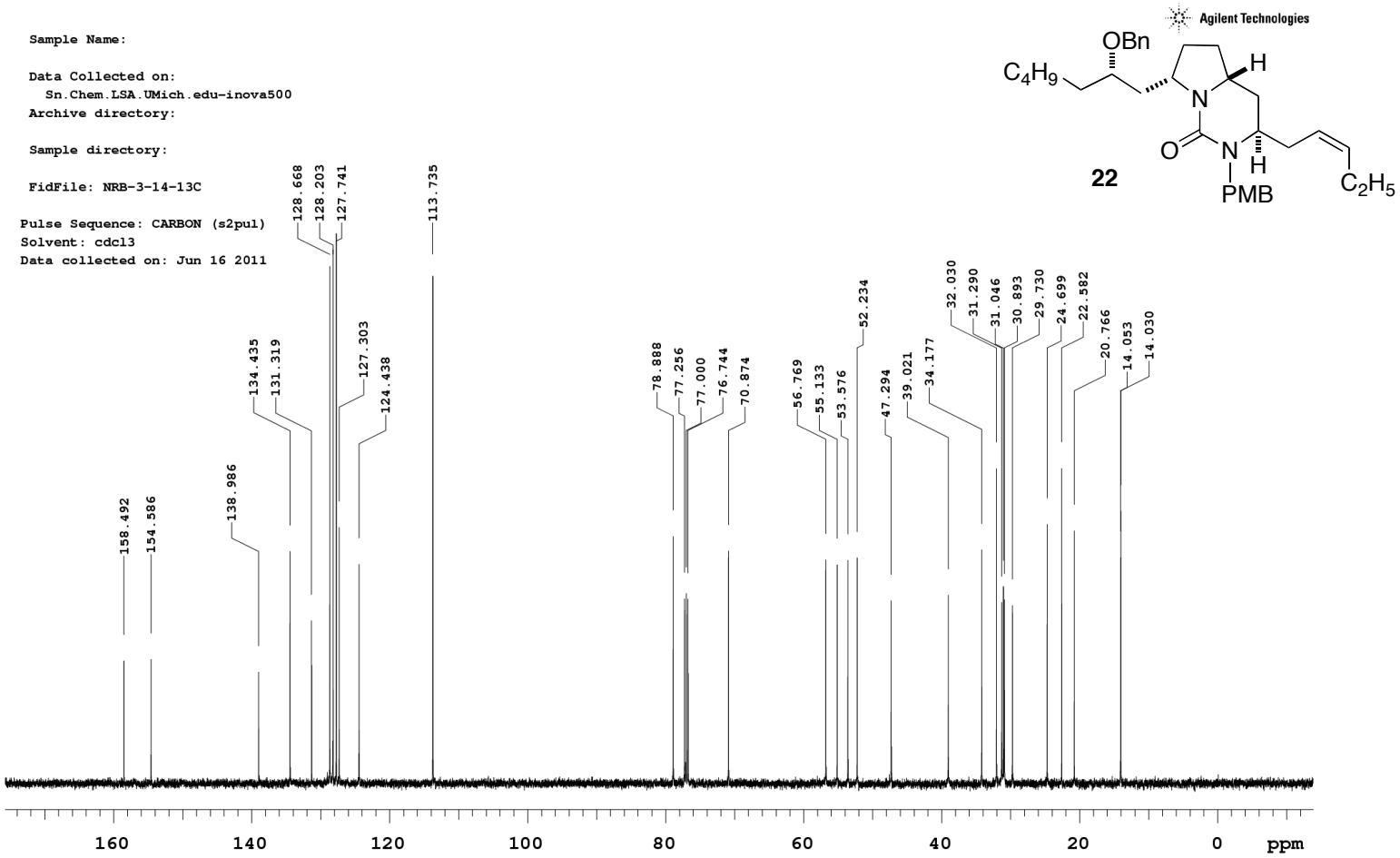

STANDARD PROTON PARAMETERS
Sample Name:
Data Collected on:
Te-vnmrs500
Archive directory:
Sample directory:
FidFile: NRB-3-10-1H
Pulse Sequence: PROTON (s2pul)
Solvent: cdcl3
Data collected on: Jun 12 2011
OBn
C4H9
TMS
N
Boc
20
Agilent Technologies
7
6
5
4
3
2
1
0
ppm
5.13
0.91
0.87
2.11
1.96
1.07
0.96
1.00
2.98
13.80
2.22
5.47
3.06
7.80

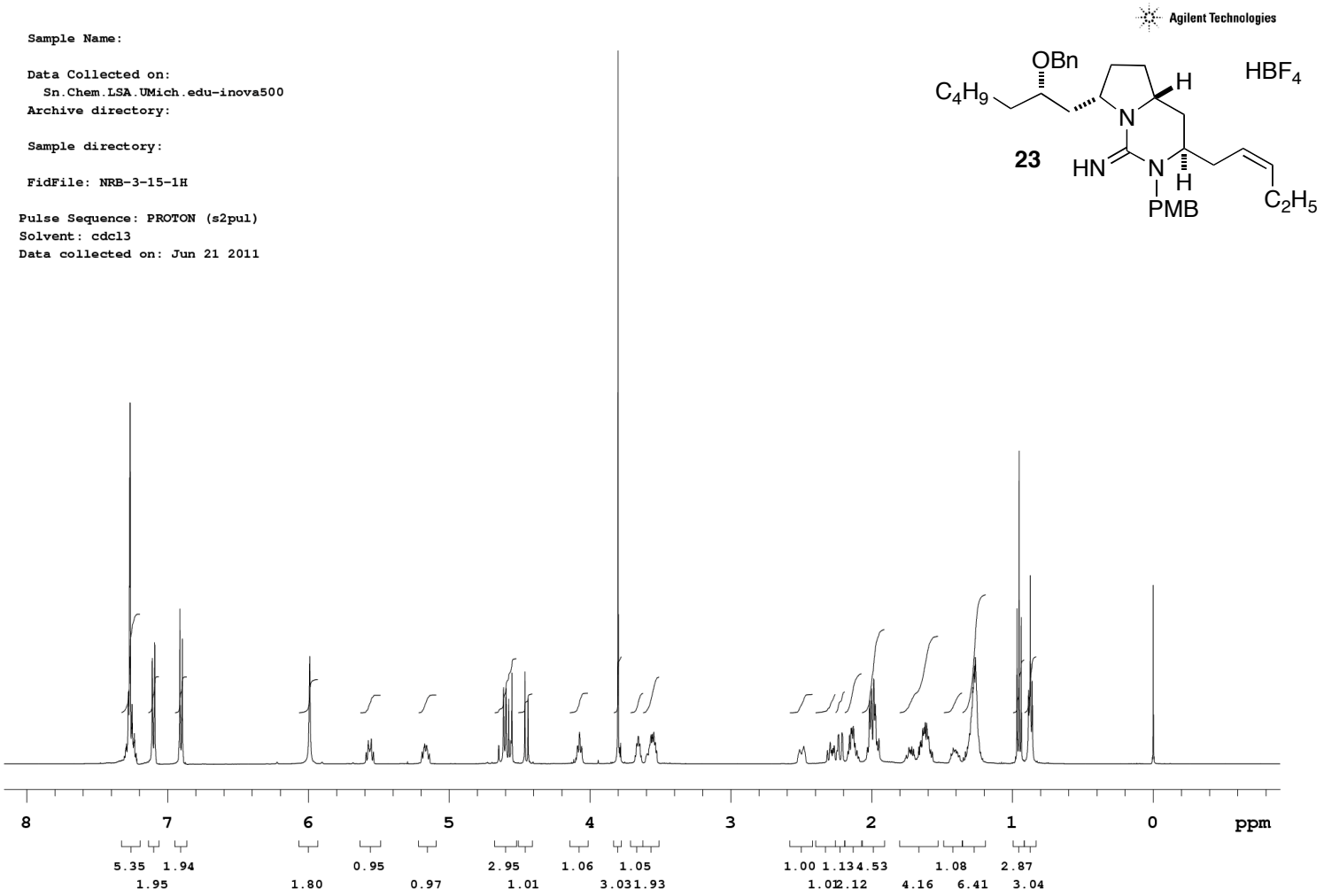

STANDARD PROTON PARAMETERS
Sample Name:
Data Collected on:
Te-vnmrs500
Archive directory:
Sample directory:
FidFile: NRB-3-10-13C
Pulse Sequence: CARBON (s2pul)
Solvent: cdcl3
Data collected on: Jun 12 2011
OBn
C4H9
TMS
N
Boc
20
Agilent Technologies
143.055
138.858
133.051
128.272
127.797
127.537
127.400
78.999
78.066
77.255
77.000
76.747
70.731
57.534
57.149
41.674
40.772
34.016
32.041
30.205
28.575
28.428
24.799
22.648
14.069
-0.022
-1.026
-1.232
-1.442
154.543
180
160
140
120
100
80
60
40
20
ppm

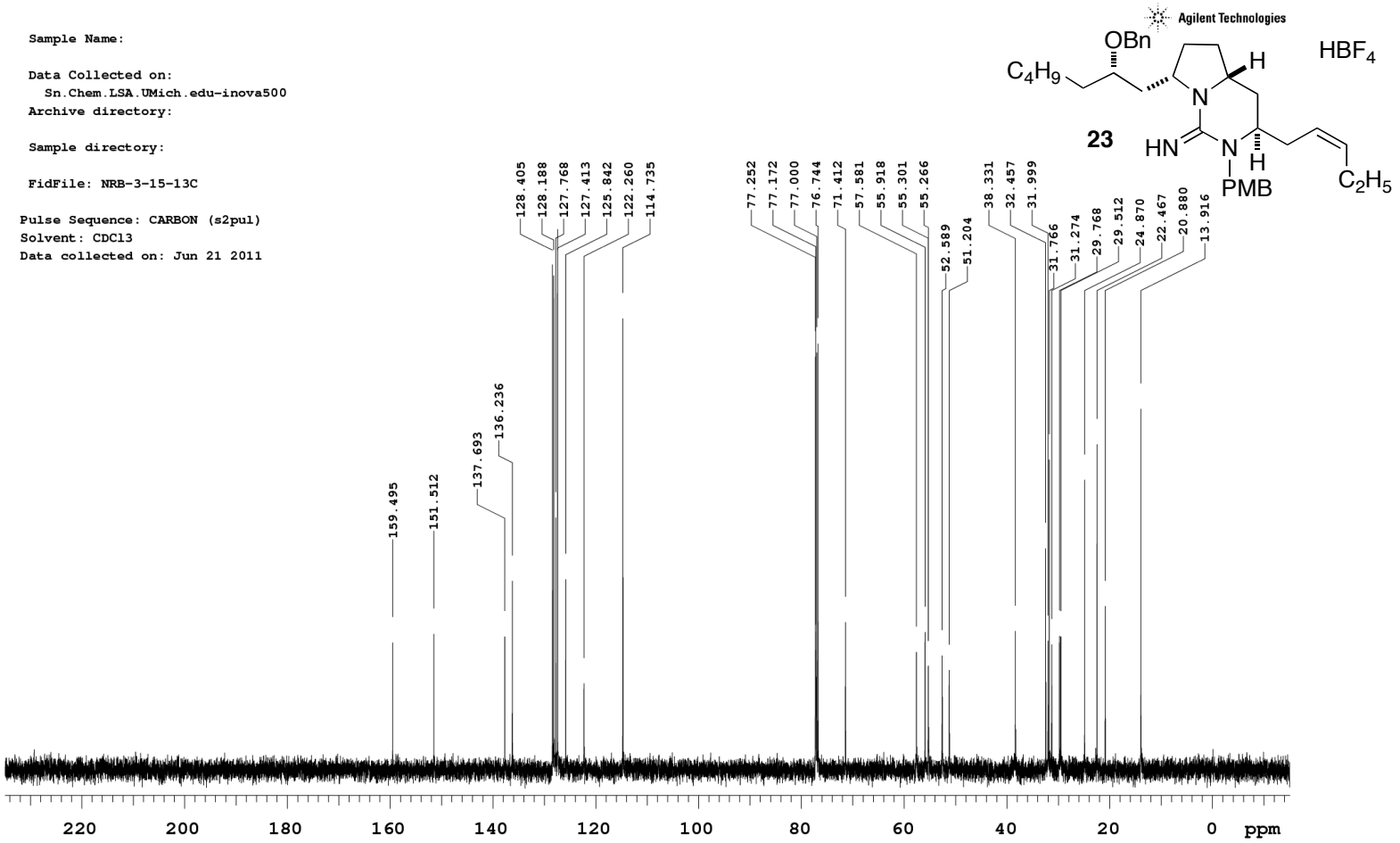

Agilent Technologies
Sample Name:
Data Collected on:
Sn.Chem.LSA.UMich.edu-inova500
Archive directory:
Sample directory:
FidFile: NRB-3-113-1H
Pulse Sequence: PROTON (s2pul)
Solvent: cdcl3
Data collected on: Oct 18 2011
OBn
C4H9
N
O
NH
PMB
21
8
7
6
5
4
3
2
1
0
ppm
3.39 1.97
1.95 1.94
1.02
1.06
1.05
3.16 3.09
1.05 1.07 1.10
1.00
0.97
2.04
1.42
5.22 6.28
3.05

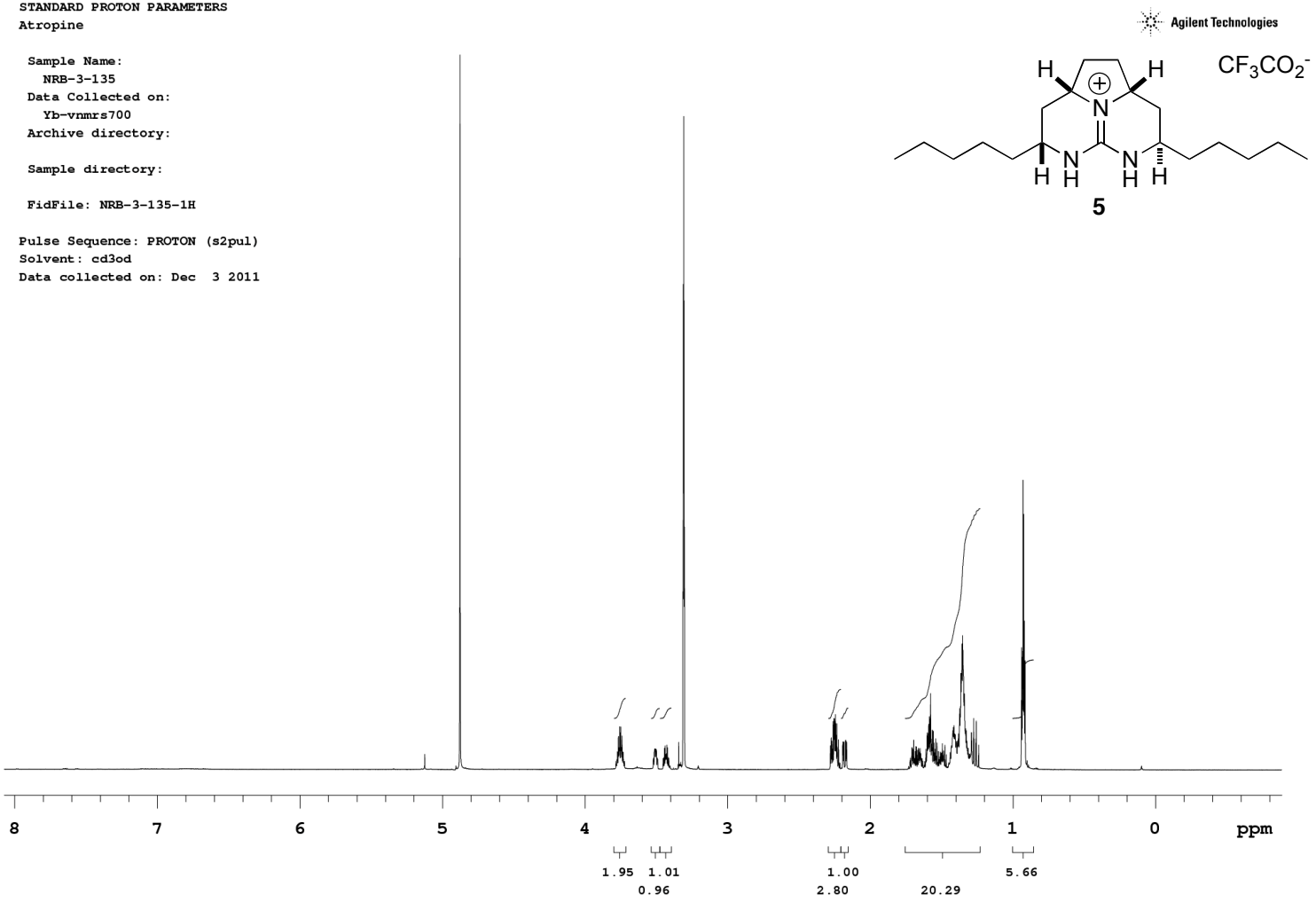

Agilent Technologies
Sample Name:
Data Collected on:
Sn.Chem.LSA.UMich.edu-inova500
Archive directory:
Sample directory:
FidFile: NRB-3-12-13C
Pulse Sequence: CARBON (s2pul)
Solvent: cdcl3
Data collected on: Jun 15 2011
OBn
C4H9
N
O
NH
PMB
21
158.355
158.324
138.219
135.301
132.486
128.661
128.321
127.360
126.811
116.844
113.510
77.256
77.000
76.744
75.768
67.426
57.887
55.102
54.911
43.564
40.467
40.295
32.255
31.820
31.774
28.654
24.588
22.521
13.942
160
140
120
100
80
60
40
20
0
ppm

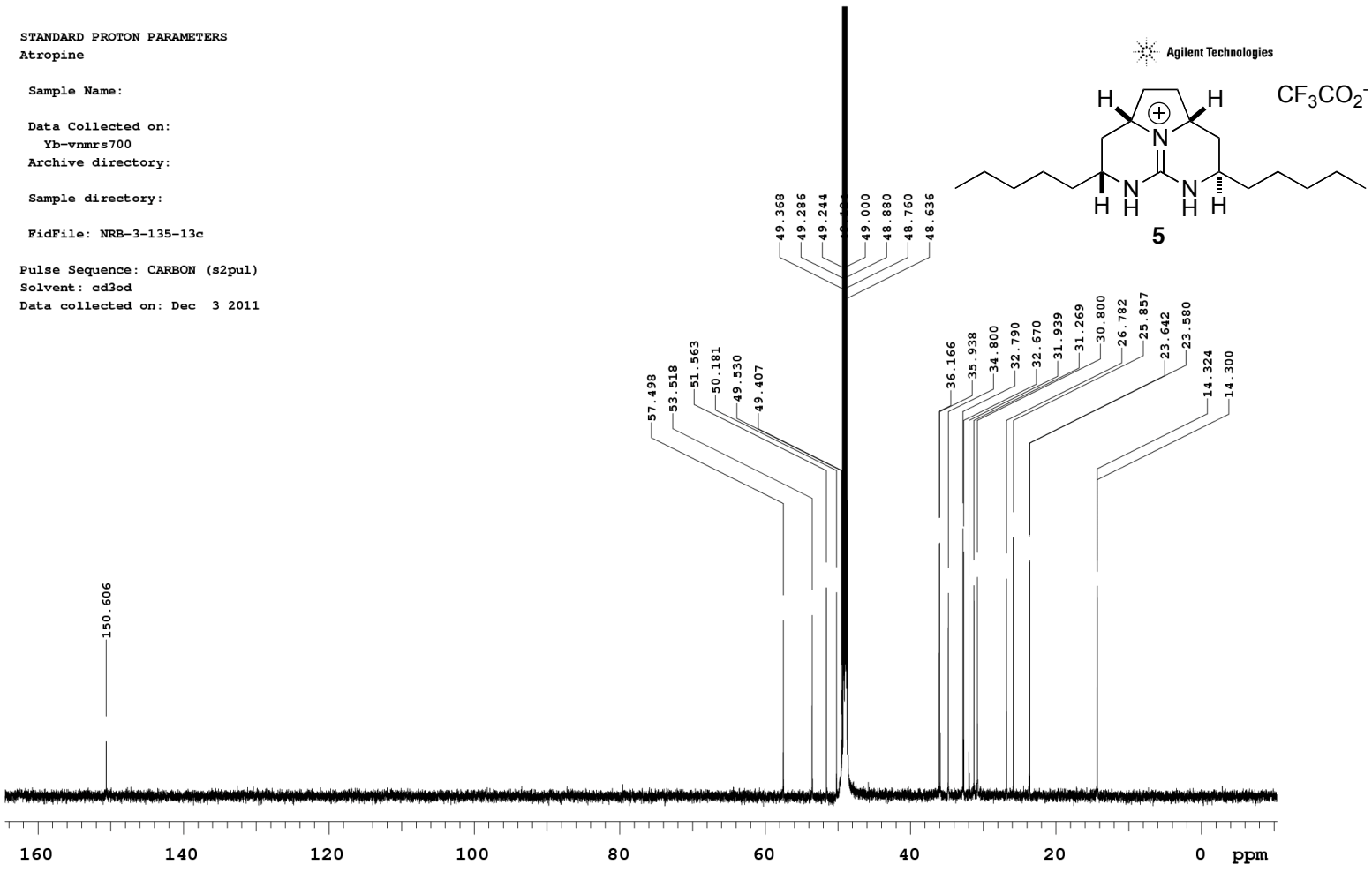

Agilent Technologies
Sample Name:
Data Collected on:
Ga.Chem.LSA.UMich.edu-vnmrs400
Archive directory:
Sample directory:
FidFile: NRB-3-14-1H
Pulse Sequence: PROTON (s2pul)
Solvent: cdcl3
Data collected on: Jun 16 2011
OBn
C4H9
H
N
O
N
H
PMB
C2H5
22
8
7
6
5
4
3
2
1
0
ppm
5.16
2.00
2.02
0.98
1.99
2.06
2.05
2.04
3.07
1.00
1.07
1.14
1.06
6.40
11.93
2.98
3.02


Sample Name:
Data Collected on:
Sn.Chem.LSA.UMich.edu-inova500
Archive directory:
Sample directory:
FidFile: NRB-3-14-13C
Pulse Sequence: CARBON (s2pul)
Solvent: cdcl3
Data collected on: Jun 16 2011
Agilent Technologies
OBn
C4H9
H
N
O
N
H
PMB
C2H5
22
158.492
154.586
138.986
134.435
131.319
128.668
128.203
127.741
127.303
124.438
113.735
78.888
77.256
77.000
76.744
70.874
56.769
55.133
53.576
52.234
47.294
39.021
34.177
32.030
31.290
31.046
30.893
29.730
24.699
22.582
20.766
14.053
14.030
160
140
120
100
80
60
40
20
0
ppm


Agilent Technologies
Sample Name:
Data Collected on:
Sn.Chem.LSA.UMich.edu-inova500
Archive directory:
Sample directory:
FidFile: NRB-3-15-1H
Pulse Sequence: PROTON (s2pul)
Solvent: cdcl3
Data collected on: Jun 21 2011
OBn
C4H9
H
HBF4
N
23
HN
N
H
PMB
C2H5
8
7
6
5
4
3
2
1
0
ppm
5.35 1.94
1.95
1.80
0.95
0.97
2.95
1.01
1.06
1.05
3.03 1.93
1.00 1.13 4.53
1.01 2.12
4.16
1.08
6.41
2.87
3.04


Sample Name:
Data Collected on:
Sn.Chem.LSA.UMich.edu-inova500
Archive directory:
Sample directory:
FidFile: NRB-3-15-13C
Pulse Sequence: CARBON (s2pul)
Solvent: CDCl3
Data collected on: Jun 21 2011
Agilent Technologies
OBn
H
HBF4
C4H9
N
23
HN
N
H
PMB
C2H5
128.405
128.188
127.768
127.413
125.842
122.260
114.735
77.252
77.172
77.000
76.744
71.412
57.581
55.918
55.301
55.266
52.589
51.204
38.331
32.457
31.999
31.766
31.274
29.768
29.512
24.870
22.467
20.880
13.916
159.495
151.512
137.693
136.236
220
200
180
160
140
120
100
80
60
40
20
0
ppm


STANDARD PROTON PARAMETERS
Atropine
Sample Name:
NRB-3-135
Data Collected on:
Yb-vnmrs700
Archive directory:
Sample directory:
FidFile: NRB-3-135-1H
Pulse Sequence: PROTON (s2pul)
Solvent: cd3od
Data collected on: Dec 3 2011
Agilent Technologies
$CF_3CO_2^-$
5
8
7
6
5
4
3
2
1
0
ppm
1.95
1.01
0.96
1.00
2.80
20.29
5.66


STANDARD PROTON PARAMETERS
Atropine
Sample Name:
Data Collected on:
Yb-vnmrs700
Archive directory:
Sample directory:
FidFile: NRB-3-135-13c
Pulse Sequence: CARBON (s2pul)
Solvent: cd3od
Data collected on: Dec 3 2011
Agilent Technologies
$CF_3CO_2^-$
5
49.368
49.286
49.244
49.000
48.880
48.760
48.636
57.498
53.518
51.563
50.181
49.530
49.407
36.166
35.938
34.800
32.790
32.670
31.939
31.269
30.800
26.782
25.857
23.642
23.580
14.324
14.300
150.606
160
140
120
100
80
60
40
20
0
ppm