Supporting Information for

A BIOMIMETIC APPROACH TO THE SYNTHESIS OF TERPENE-AMINO ACID CONJUGATES. THE UGI REACTION IN THE HYPOTHETICAL BIOSYNTHESIS OF MARINE NATURAL PRODUCTS

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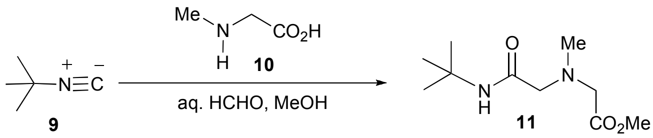
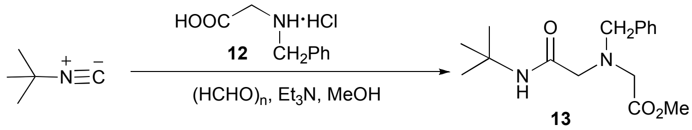
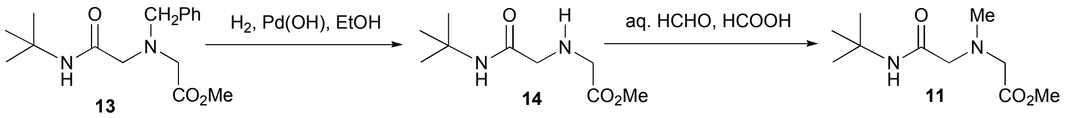
General: Melting points (mp) were recorded on a Yanaco MP-S3 melting point apparatus and were not corrected. Optical rotations were measured on a JASCO DIP-370 digital polarimeter. Infrared spectra (IR) were recorded on a JASCO FT/IR-460 spectrophotometer and were reported in wave number (cm^{-1}). Proton nuclear magnetic resonance (^1H NMR) spectra were recorded on JEOL LA 400 (400 MHz) and JEOL ECA 500 (500 MHz) spectrometers. Chemical shifts (δ) were reported in parts per million (ppm) relative to tetramethylsilane (TMS, δ 0.00, in $CDCl_3$), CD_3OH (δ3.31), *tert*-butanol (δ1.24, in D_2O) as an internal standard. Coupling constants (*J*) are given in Hz. Data were reported as follows: chemical shift, integration, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, br = broadened), coupling constant and assignment. Carbon nuclear magnetic resonance (^{13}C NMR) spectra were recorded on JEOL LA 400 (100 MHz) and JEOL ECA 500 (125 MHz) spectrometers. Chemical shifts (δ) were reported in parts per million (ppm) relative to $CDCl_3$ (δ77.0), CD_3OD (δ49.9), DMSO (δ40.5) as a internal standard. Reactions were monitored by thin-layer chromatography on glass plates 0.25 mm coated with silica gel 60 F_{254} (MERCK 1.05715). Open-column chromatography was carried out with Silica gel 60 (particle size 0.063-0.200 mm, 70-230 mesh ASTM). Reactions were run under atmosphere of argon when the reactions were sensitive to moisture or oxygen. Dichloromethane, acetonitrile and toluene were stored over molecular sieves 3A. All other commercially available reagents were used as received.



To a solution of sarcosine (**10**) (253 mg, 1.42 mmol) in MeOH (10.0 mL) at room temperature was added aqueous formaldehyde (37%, 0.53 mL, 7.10 mmol). After being stirred at 50 °C for 15 min, *t*-butyl isocyanide (**9**) (0.16 mL, 1.42 mmol) was added. The reaction mixture was stirred at 50 °C for 3 h and concentrated under reduced pressure. The resultant residue was treated with water, and the aqueous layer was extracted with AcOEt (× 3). The combined organic layer was washed with brine, and dried (Na_2SO_4). Concentration under reduced pressure provided the crude residue, which was purified by silica gel chromatography (AcOEt/hexane 2:1) to furnish methyl ester **11** (74 mg, 24%) as a colorless oil: IR (NaCl) ν_{max} 3473, 3335, 2965, 1746, 1680, 1521, 1202 cm^{-1}; ^{1}H NMR ($CDCl_3$, 500 MHz) δ 1.27 (s, 9H), 2.32 (s, 3H), 2.97 (s, 2H), 3.21 (s, 2H), 3.63 (s, 3H), 7.14 (brs, 1H); ^{1}H NMR (C_6D_6, 500 MHz) δ 1.34 (s, 9H), 2.02 (s, 3H), 2.84 (s, 2H), 2.92 (s, 2H), 3.26 (s, 3H), 7.23 (brs, 1H); ^{13}C NMR ($CDCl_3$, 125 MHz) δ 28.5, 42.8, 50.3, 51.5, 58.1, 61.3, 169.2, 170.9; ^{13}C NMR (C_6D_6, 125 MHz) δ 28.8, 42.7, 50.3, 51.1, 58.2, 61.9, 169.1, 171.0. HRMS(ESI): m/z calcd for $C_{10}H_{20}N_2O_3Na$ $[M+Na]^+$ 239.1372, found 239.1369.

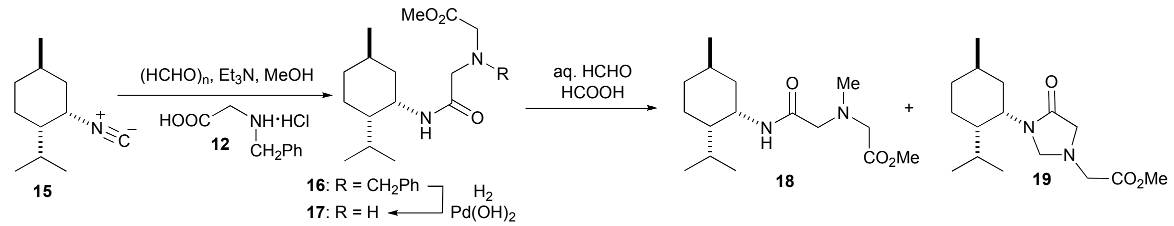


To a solution of *N*-benzylglycine hydrochloride (**12**) (540 mg, 2.67 mmol) in MeOH (20.0 mL) at room temperature was added triethylamine (0.75 mL, 5.34 mmol) and paraformaldehyde (267 mg, 8.70 mmol). After stirring at 50 °C for 2 h, *t*-butyl isocyanide (**9**) (0.20 mL, 1.78 mmol) was added. The solution was stirred at 50 °C for 4 h and concentrated under reduced pressure. The resulting residue was treated with water, and the aqueous layer was extracted with AcOEt (× 3). The combined organic layer was dried (Na_2SO_4), and concentrated under reduced pressure. The crude residue was purified by silica gel chromatography (AcOEt/hexane 1:1) to afford methyl ester **13** (383 mg, 73%) as a colorless oil: ^{1}H NMR ($CDCl_3$, 500 MHz) δ 1.29 (s, 9H), 2.09 (brs, 1H), 3.12 (s, 2H), 3.33 (s, 2H), 3.67 (s, 3H), 6.98 (brs, 1H); ^{13}C NMR ($CDCl_3$, 125 MHz) δ 28.6, 50.4, 50.5, 51.8, 52.9, 169.9, 170.3.



A solution of **13** (147 mg, 0.51 mmol) and Pearlman's catalyst (50 mg) in EtOH (4.0 mL) was stirred vigorously under hydrogen atmosphere for 40 min. The catalyst was removed by filtration through Celite. The filtrate was concentrated under reduced pressure to afford **14** as a pale yellow oil (99 mg), which was subsequently used for the next step without purification.

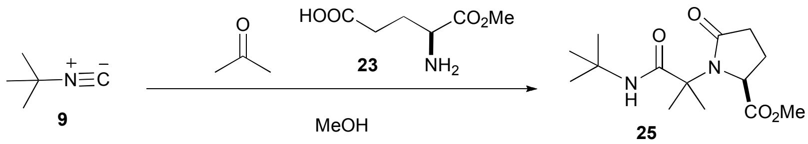
The crude amine **14** (99 mg) was dissolved in a mixture of aqueous formaldehyde (37%, 95 μL, 1.28 mmol) and formic acid (48 μL, 1.28 mmol). The solution was heated at 85 °C for 1.5 h, and concentrated under reduced pressure. The resulting residue was purified by silica gel chromatography (AcOEt/hexane 1:1 containing isopropylamine 1%) to afford **11** (66 mg, 60% in 2 steps) as a colorless oil.



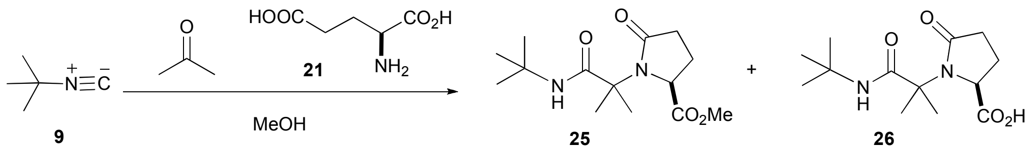
To a solution of *N*-benzylglycine hydrochloride (**12**) (534 mg, 2.65 mmol) in MeOH (7.0 mL) at room temperature was added triethylamine (0.66 mL, 4.77 mmol) and paraformaldehyde (239 mg, 7.95 mmol). After stirring at 50 °C for 4 h, isocyanide **15** (175 mg, 1.06 mmol) in MeOH (3.0 mL) was added. The solution was stirred at 50 °C for 20 min and concentrated under reduced pressure. The resulting residue was treated with water, and the aqueous layer was extracted with AcOEt (× 3). The combined organic layer was dried (Na_2SO_4), and concentrated under reduced pressure. The crude residue (768 mg) was purified by silica gel chromatography (1:1 AcOEt/hexane containing 0.1% isopropylamine) to afford methyl ester **16** (347 mg, 87%) as a colorless oil: ^{1}H NMR ($CDCl_3$, 500 MHz) δ 0.73–1.20 (m, 14 H), 1.32 (brs, 1H), 1.70 (brd, *J* = 11.4 Hz, 2H), 1.79 (brd, *J* = 13.7 Hz, 1H), 3.15 (s, 2H), 3.29 (s, 2H), 3.63 (d, *J* = 1.3 Hz, 3H), 3.67 (s, 2H), 4.22 (brd, *J* = 8.6 Hz, 1H), 7.15–7.26 (m, 5H), 7.53 (brd, *J* = 9.2 Hz, 1H); ^{13}C NMR ($CDCl_3$, 125 MHz) δ 20.6, 20.9, 22.1, 25.2, 26.7, 29.4, 34.7, 40.1, 45.6, 46.2, 51.6, 55.4, 57.6, 59.0, 127.5, 128.4, 128.7, 137.4, 169.4, 171.1.

A solution of **16** (100 mg, 0.27 mmol) and Pearlman's catalyst (33 mg) in EtOH (3.0 mL) was stirred vigorously under hydrogen atmosphere for 35 min. The catalyst was removed by filtration through Celite. The filtrate was concentrated under reduced pressure to afford **17** as a pale yellow oil (75 mg), which was subsequently used for the next step without purification.

The crude amine **17** (69 mg) was dissolved in a mixture of aqueous formaldehyde (37%, 50 μL, 0.67 mmol) and formic acid (25 μL, 0.66 mmol). The solution was heated at 85 °C for 1.5 h, and concentrated under reduced pressure to afford an inseparable mixture of **18** and **19** (71 mg).

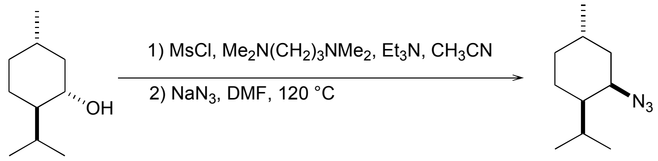


To a solution of L-glutamic acid 1-methyl ester (**23**) (430 mg, 2.67 mmol) and acetone (1.30 mL, 17.8 mmol) in MeOH (25.0 mL) was treated with *t*-butyl isocyanide (0.20 mL, 1.78 mmol). After stirring at room temperature for 1.5 h, the solution was heated at 50 °C for 24 h, followed by refluxing for 1 h. The reaction mixture was concentrated under reduced pressure, and the residue was dissolved in AcOEt and water. The organic layer was separated, and the aqueous layer was extracted with AcOEt. The combined organic extracts were dried (Na_2SO_4) and concentrated to afford the residue, which was purified by silica gel chromatography (AcOEt/hexane 1:1 to 8:1) to furnish γ-lactam **25** (347 mg, 69%): mp 109–110 °C (recrystallized from AcOEt and hexane); $[\alpha]_D^{23}$ –14.5 (*c* 1.00, $CHCl_3$); IR (KBr) ν_{max} 3363, 3339, 2976, 1731, 1689, 1547, 1232 cm^{-1}; ^1H NMR (C_6D_6, 500 MHz) δ 1.16 (s, 3H), 1.30 (m, 1H), 1.46 (m,1H) 1.54 (s, 9H), 1.62 (s, 3H), 1.81 (ddd, *J* = 16.6, 9.2, 1.7 Hz, 1H), 2.09 (ddd, *J* = 16.6, 11.4, 9.2 Hz, 1H), 3.16 (s, 3H), 3.77 (dd, *J* = 9.7, 1.1 Hz, 1H), 7.37 (brs, 1H); ^1H NMR ($CDCl_3$, 500 MHz) δ 1.30 (s, 3H), 1.33 (s, 9H), 1.44 (s, 3H) 2.05 (m, 1H), 2.28–2.41 (m, 2H), 2.47 (m, 1H), 3.83 (s, 3H), 4.39 (d, *J* = 9.2 Hz, 1H), 7.26 (brs, 1H); ^{13}C NMR (C_6D_6, 125 MHz) δ 23.3, 24.6, 25.3, 28.8, 29.9, 50.6 52.4, 57.7, 60.6, 172.4, 173.9, 175.9; ^{13}C NMR ($CDCl_3$, 125 MHz) δ 22.8, 24.8, 25.3, 29.8, 50.5, 53.1, 57.6, 60.2, 172.5, 174.5, 175.6. HRMS(ESI): m/z calcd for $C_{14}H_{24}N_2O_4Na$ $[M+Na]^+$ 307.1634, found 307.1629.

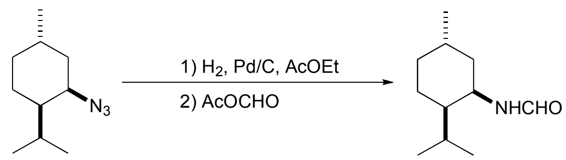


A solution of glutamic acid (**21**) (262 mg, 1.78 mmol) in a mixture of acetone (1.30 mL) and MeOH (25.0 mL) was stirred at 50 °C for 4.5 h. To this solution was added *t*-butyl isocyanide (**9**) (0.20 mL, 1.78 mmol). The reaction mixture was stirred at 50 °C for 24 h, and was refluxed for 3 h. Concentration of the reaction mixture under reduced pressure gave the residue, which was treated with AcOEt and water. The separated aqueous layer was extracted with AcOEt (× 3), and the combined organic layers were washed with brine, dried (Na_2SO_4) and concentrated under reduced pressure. The crude mixture of **25** and **26** (238 mg) was suspended in ether (40 mL) and washed with aqueous saturated $NaHCO_3$ (15 mL). The separated aqueous layer containing carboxylic acid **26** was washed with ether (× 3), acidified with 6 N HCl and then extracted with AcOEt (× 4). The combined AcOEt layers were washed with brine, dried (Na_2SO_4) and concentrated under reduced pressure to afford crude **26** (99mg), which was purified by silica gel chromatography (AcOEt/hexane 3:1 followed by CH_2Cl_2/MeOH 10:1) to afford carboxylic acid **26** (91 mg, 19%) as a white solid: mp 190–191 °C (recrystallized from AcOEt and hexane); IR (KBr) ν_{max} 3349, 3329, 2981, 2927, 1718, 1683, 1638, 1417, 1227 cm^{-1}; ^{1}H NMR (500 MHz, $CDCl_3$): δ 1.34 (s, 9H), 1.39 (s, 3H), 1.52 (s, 3H), 2.24–2.56 (m, 4H), 4.42 (d, *J* = 9.2 Hz, 1H), 7.00 (brs, 1H); ^{13}C NMR (125 MHz, $CDCl_3$): *δ* 22.8, 25.2, 25.4, 28.3, 29.9, 51.2, 58.1, 60.3, 174.1, 175.7, 176.3.

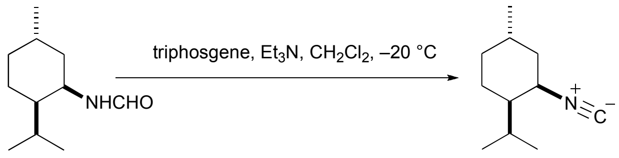
The combined ether layers containing **25** were washed with brine, dried (Na_2SO_4) and concentrated under reduced pressure. The crude **25** (80 mg) was purified by silica gel chromatography (AcOEt/hexane 1:1 followed by 3:1) to furnish methyl ester **25** (50 mg, 10%) as white crystals.



A solution of (+)-menthol (6.00 g, 38.4 mmol), triethylamine (6.5 mL, 46.1 mmol), *N,N,N',N'*-tetramethyl-1,3-propanediamine (0.8 mL, 4.61 mmol) in CH_3CN (60 mL) was cooled to 0 °C under argon atmosphere. To this solution was added methanesulfonyl chloride (3.5 mL, 46.1 mmol) at 0 °C, and stirring was continued at room temperature for 1.5 h. The reaction mixture was poured into water and the organic layer was separated. The aqueous layer was extracted with ether. The organic extracts were washed with 1 M $KHSO_4$, brine, dried (Na_2SO_4) and concentrated to afford the mesylate (9.26 g). This crude mesylate was dissolved DMF (60 mL), and sodium azide (12.50 g, 192 mmol) was added. The solution was heated at 120 °C for 4 h. After cooling to room temperature, water was added to the mixture and the organic layer was separated. The aqueous layer was extracted with AcOEt. The combined organic extracts were washed with brine, dried (Na_2SO_4), and concentrated to give the residue, which was purified by silica gel chromatography (hexane) to furnish azide (4.70 g, 68%): $[\alpha]_D^{24}$ –104.6 (*c* 1.00, $CHCl_3$). The IR, ^1H and ^{13}C NMR spectrum data matched those previously reported for the corresponding enantiomer (K. Saito, A. Nishimori, R. Mimura, K. Nakano, H. Kotsuki, T. Masuda, and Y. Ichikawa, *Eur. J. Org. Chem.*, 2013, **2013**, 7041).

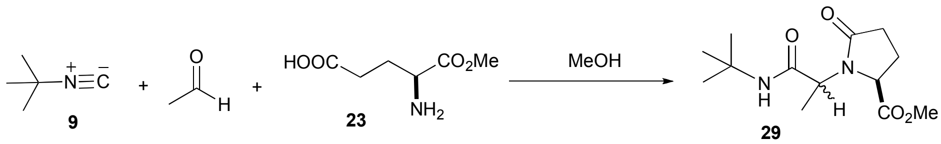


A solution of azide (1.00 g, 5.52 mmol) and palladium on carbon (10%, 200 mg) in AcOEt (50 mL) under hydrogen atmosphere was stirred at room temperature for 2 h. Formic acetic acid anhydride (1.10 mL, 13.8 mmol) was added to the solution. After stirring at room temperature for 1h, the reaction mixture was passed through Celite. The filtrate was poured into aqueous saturated $NaHCO_3$ and the organic layer was separated. The aqueous layer was extracted with AcOEt. The combined organic extracts were washed with brine, dried (Na_2SO_4), and concentrated to give the residue, which was purified by silica gel chromatography (AcOEt/hexane 2:1) to afford formamide (0.89 g, 88%): mp 114–115 °C (recrystallized from AcOEt and hexane); $[\alpha]_D^{24}$ –51.6 (c 1.00, $CHCl_3$). IR, ^1H and ^{13}C NMR spectra matched those previously reported for the corresponding enantiomer.



27

To a solution of formamide (0.50 g, 2.73 mmol) and triethlyamine (2.70 mL, 19.1 mmol) dissolved in CH_2Cl_2 (7.0 mL) cooled to –20 °C was added a solution of triphosgene (0.4 g, 1.36 mmol) in CH_2Cl_2 (2.0 mL). The reaction mixture was stirred at –20 °C for 30 min, and then poured into aqueous saturated $NaHCO_3$. The mixture was stirred vigorously at 0 °C for 1 h, and the aqueous layer was separated and extracted with CH_2Cl_2. The combined organic extracts were washed with brine, dried (Na_2SO_4), and concentrated to give the residue, which was purified by silica gel chromatography (AcOEt/hexane 1:20) to furnish isocyanide **27** (0.38 g, 83%): $[\alpha]_D^{25}$ –38.3 (c 1.00, $CHCl_3$). IR, ^1H and ^{13}C NMR spectra matched those previously reported for the corresponding enantiomer.



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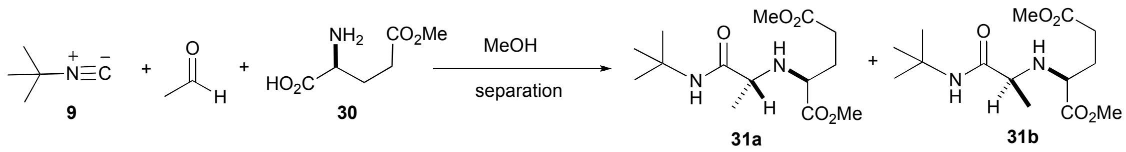
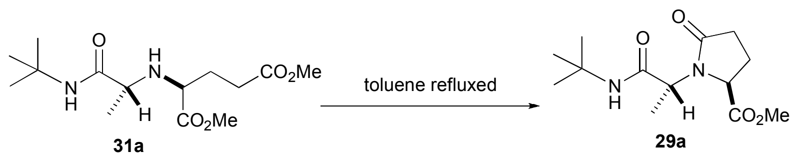
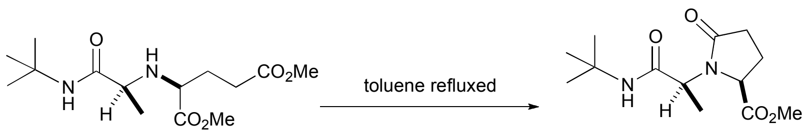
To a solution of L-glutamic acid 1-methyl ester (**23**) (430 mg, 2.67 mmol) and *t*-butyl isocyanide (**9**) (0.20 mL, 1.78 mmol) in MeOH (5.0 mL) was added acetaldehyde (1.00 mL, 17.8 mmol). After stirring at room temperature for 23 h, the reaction mixture was concentrated under reduced pressure. The resulting residue was dissolved in AcOEt and water, and the organic layer was separated. The aqueous layer was extracted with AcOEt, and the combined organic extracts were dried (Na_2SO_4) and concentrated. Purification by silica gel chromatography (AcOEt/hexane 1:4) furnished an inseparable mixture of **29a** and **29b** (104 mg, 22%, 3:1).



To a solution of L-glutamic acid 5-methyl ester (**30**) (860 mg, 5.34 mmol) and *t*-butyl isocyanide (**9**) (0.40 mL, 3.56 mmol) in MeOH (100 mL) was added acetaldehyde (1.00 mL, 17.8 mmol). After stirring at room temperature for 2 h, the reaction mixture was concentrated under reduced pressure. The resulting residue was dissolved in AcOEt and water, and the organic layer was separated. The aqueous layer was extracted with AcOEt, and the combined organic extracts were dried (Na_2SO_4) and concentrated. Purification by silica gel chromatography (AcOEt/hexane 1:1) furnished **31b** (67 mg), a mixture of **31a** and **31b** (116 mg, 2:1), and **31a** (212 mg). The combined yield of **31a** and **31b** was 37% in a ratio of 3:1. **31a**: $[\alpha]_D^{24}$ +0.1 (*c* 1.00, $CHCl_3$); $[\alpha]_D^{23}$ +5.7 (*c* 1.00, MeOH); IR (NaCl) ν_{max} 3329, 2968, 1740, 1660, 1524, 1227 cm^{-1}; ^{1}H NMR (C_6D_6, 500 MHz) δ 1.14 (d, *J* = 6.9 Hz, 3H), 1.35 (s, 9H), 1.74 (m, 1H), 1.84 (dt, *J* = 6.9, 13.7 Hz, 1H), 2.04–2.18 (m, 2H), 3.05 (dd, *J* = 14.3, 6.9 Hz, 1H), 3.16 (t, *J* = 6.3 Hz, 1H), 3.25 (s, 3H), 3.29 (s, 3H), 6.72 (brs, 1H); ^{13}C NMR (C_6D_6, 125 MHz) δ 19.5, 28.0, 28.8, 30.3, 50.3, 51.2, 51.5, 57.5, 59.2, 172.9, 173.3, 174.1. HRMS(ESI): m/z calcd for $C_{14}H_{27}N_2O_5$ $[M+H]^+$ 303.1920, found 303.1927. HRMS(ESI): m/z calcd for $C_{14}H_{26}N_2O_5Na$ $[M+Na]^+$ 325.1739, found 325.1757. **31b**; $[\alpha]_D^{24}$ –32.8 (*c* 1.00, $CHCl_3$); IR (NaCl) ν_{max} 3334, 2966, 1739, 1675, 1203 cm^{-1}; ^{1}H NMR (C_6D_6, 500 MHz) δ 1.21 (d, *J* = 6.9 Hz, 3H), 1.37 (s, 9H), 1.69 (m, 1H), 1.81 (m, 1H), 2.07–2.19 (m, 2H), 3.08–3.14 (m, 2H), 3.18 (s, 3H), 3.29 (s, 3H), 6.82 (brs, 1H); ^{13}C NMR (C_6D_6, 125 MHz) δ 20.4, 28.8, 29.0, 31.0, 50.2, 51.2, 51.5, 58.7, 60.1, 172.8, 173.0, 174.8. HRMS(ESI): m/z calcd for $C_{14}H_{27}N_2O_5$ $[M+H]^+$ 303.1920, found 303.1917. HRMS(ESI): m/z calcd for $C_{14}H_{26}N_2O_5Na$ $[M+Na]^+$ 325.1739, found 325.1732.

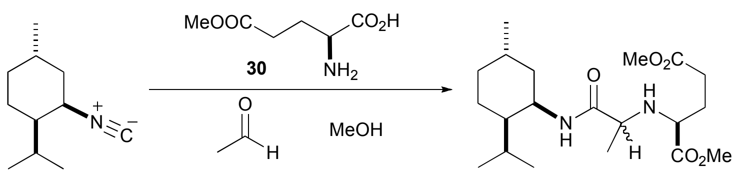


A solution of **31a** (445 mg, 1.47 mmol) in toluene (40.0 mL) was refluxed for 2 days, and then concentrated under reduced pressure. The resulting residue was purified by silica gel chromatography (AcOEt/hexane 3:2) to furnish γ-lactam **29a** as white solid (304 mg, 77%): mp 109–110 °C (recrystallized from hexane); $[\alpha]_D^{23}$ +39.4 (*c* 1.00, $CHCl_3$); IR (KBr) ν_{max} 3326, 2973, 1753, 1672, 1551, 1200 cm^{-1}; ^{1}H NMR (C_6D_6, 500 MHz) δ 1.34 (s, 9H), 1.30–1.42 (m, 4H), 1.62–1.72 (1H), 1.85 (ddd, *J* = 16.6, 9.7, 1.7 Hz, 1H), 2.24 (ddd, *J* = 16.6, 10.3, 9.2 Hz, 1H), 3.21 (s, 3H), 4.44 (dd, *J* = 9.2, 1.1 Hz, 1H), 4.51 (q, *J* = 7.4 Hz, 1H), 6.66 (brs, 1H); ^{13}C NMR (C_6D_6, 125 MHz) δ 15.6, 24.4, 29.8, 51.9, 52.4, 58.6, 170.7, 174.1, 175.5. HRMS(ESI): m/z calcd for $C_{13}H_{22}N_2O_4Na$ $[M+Na]^+$ 293.1477, found 293.1465.



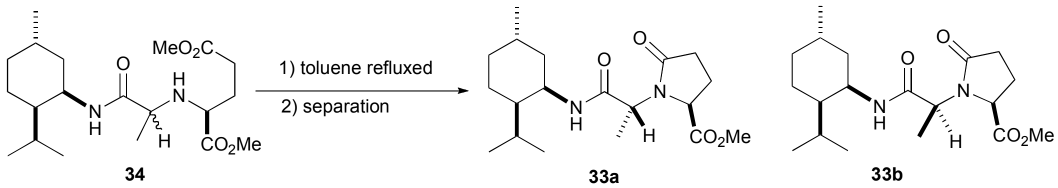
31b **29b**

A solution of **31b** (122 mg, 0.405 mmol) in toluene (20.0 mL) was refluxed for 2 days, and then concentrated under reduced pressure. The resulting residue was purified by silica gel chromatography (AcOEt/hexane 3:2) to furnish γ-lactam **29b** as white solid (77 mg, 71%): mp 96–97 °C (recrystallized from hexane); $[\alpha]_D^{23}$ –129.8 (*c* 1.00, $CHCl_3$) ; IR (KBr) ν_{max} 3365, 2968, 1734, 1672, 1542, 1289 cm^{-1}; ^{1}H NMR (C_6D_6, 500 MHz) δ 1.15 (d, *J* = 7.4 Hz, 3H), 1.33 (s, 9H), 1.30–1.46 (m, 2H), 1.85 (ddd, *J* = 16.6, 9.2, 2.3, 1H), 2.31 (dt, *J* = 16.6, 9.7 Hz, 1H), 3.37 (s, 3H), 3.94 (dd, *J* = 9.2, 1.7 Hz, 1H), 4.60 (q, *J* = 7.4, 1H), 6.74 (brs, 1H); ^{13}C NMR (C_6D_6, 125 MHz) δ 14.8, 24.2, 19.6, 51.5, 51.8, 57.1, 169.1, 172.5, 175.4. HRMS(ESI): m/z calcd for $C_{13}H_{22}N_2O_4Na$ $[M+Na]^+$ 293.1477, found 293.1466.



27 **34**

To a solution of L-glutamic acid 5-methyl ester (**30**) (730 mg, 4.55 mmol) and isocyanide **27** (499 mg, 3.02 mmol) in MeOH (10 mL) was added acetaldehyde (0.80 mL, 15.1 mmol). After stirring at room temperature for 1 h, the reaction mixture was concentrated under reduced pressure. The resulting residue was dissolved in ether and water, and the organic layer was separated. The aqueous layer was extracted with ether, and the combined organic extracts were dried (Na_2SO_4) and concentrated under reduced pressure to afford the residue (1.05 g). Purification by silica gel chromatography (ether/hexane 1:1 followed by ether) furnished an inseparable mixture of **34** (328 mg, 28%).

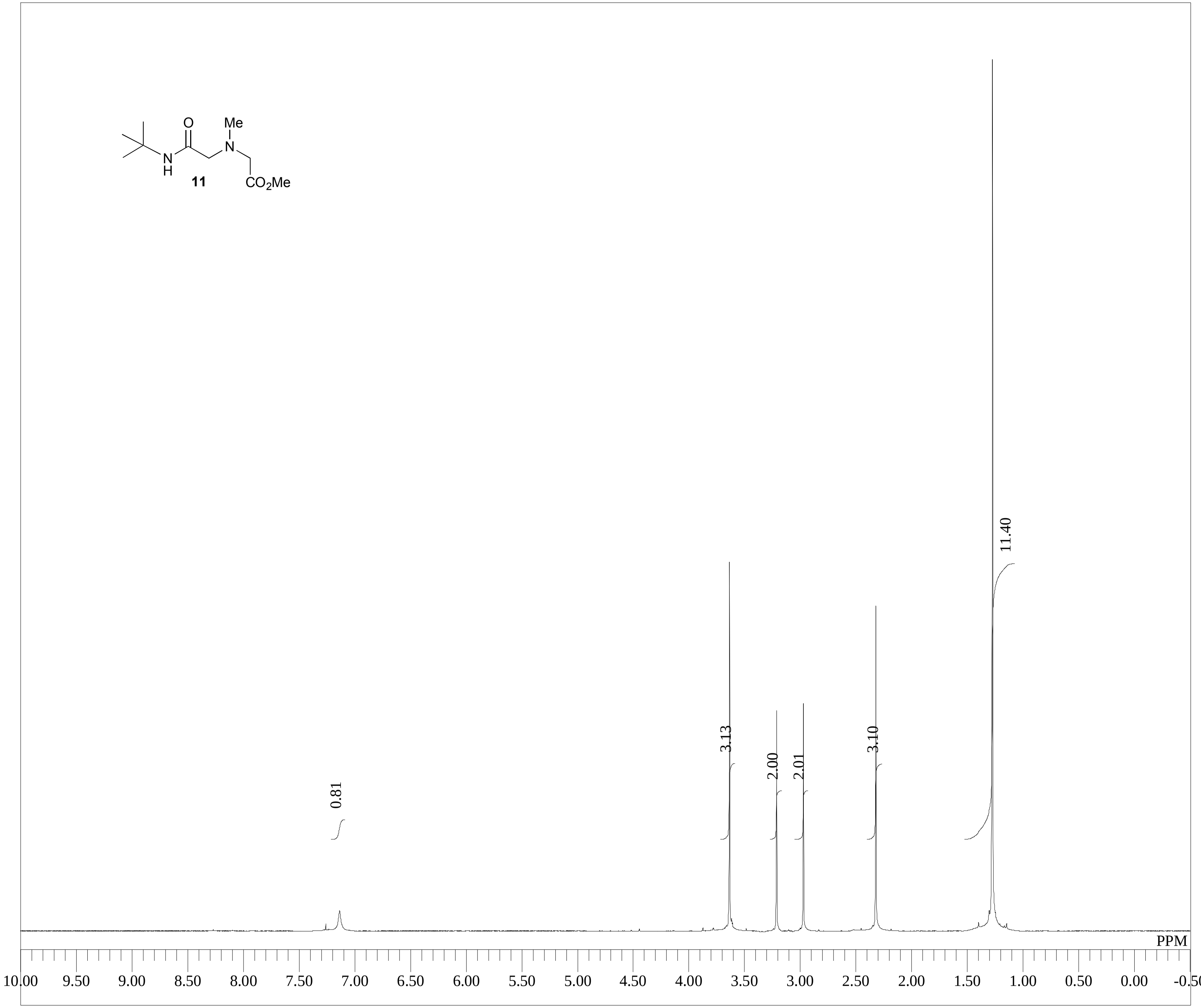


A solution of **34** (127 mg, 0.33 mmol) in toluene (17 mL) was heated at reflux for 5 h, and concentrated under reduced pressure. The resulting residue was purified by silica gel chromatography (AcOEt/hexane 2:1) to furnish recovered starting material **34** (21 mg) and a 3:2 mixture of γ-lactam **33a** and **33b** (93 mg, 80%). For characterization, the mixture was subjected to repeated silica gel chromatography (AcOEt/hexane 2:1) to obtain γ-lactam **33a** as crystals and **33b** as an oil.

33a: mp 73–74 °C (recrystallized from AcOEt and hexane); $[\alpha]_D^{30}$ = –4.10 (*c* 1.00, $CHCl_3$); IR (KBr) ν_{max} 3446, 3362, 3235, 2963, 2931, 1743, 1675, 1648, 1560, 1206 cm^{-1}; ^1H NMR ($CDCl_3$, 500 MHz) δ 0.84 (d, *J* = 6.5 Hz, 3H), 0.87 (dd, *J* = 6.5 Hz, 6H), 0.80–1.11 (m, 3H), 1.33 (d, *J* = 7.0 Hz, 3H), 1.19–1.42 (m, 2H), 1.68–1.86 (m, 4H), 2.02–2.12 (m, 1H), 2.26–2.38 (m, 2H), 2.53–2.64 (m, 1H), 3.77 (s, 3H), 4.27 (dd, *J* = 9.0, 2.5 Hz, 1H), 4.37 (q, *J* = 7.0 Hz, 2H), 6.65 (d, *J* = 9.0 Hz, 1H); ^1H NMR (C_6D_6, 500 MHz) δ 0.86 (d, *J* = 6.5, 3H), 0.88 (d, *J* = 6.5, 3H), 1.02 (d, *J* = 6.5, 3H), 0.65–1.08 (m, 3H), 1.09–1.32 (m, 2H), 1.42 (d, *J* = 7.0, 3H), 1.34–1.76 (m, 6H), 1.85 (brdd, *J* = 16.5, 10.0 Hz, 1H), 2.03 (d, *J* = 13.5, 1H), 2.24 (dt, *J* = 16.5, 10.0 Hz, 1H), 3.25 (s, 3H), 4.37 (brd, *J* = 10.0 Hz, 1H), 4.57–4.61 (1H), 4.61 (q, *J* = 7.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 125 MHz) δ 13.8, 20.7, 20.9, 22.2, 24.4, 25.2, 26.7, 29.4, 29.5, 34.7, 39.9, 46.1, 46.3, 52.4, 52.6, 58.7, 169.7, 173.4, 175.7; ^{13}C NMR (C_6D_6, 125 MHz) δ 15.3, 21.3, 21.6, 22.9, 24.6, 25.9, 27.2, 30.0, 30.1, 35.5, 40.9, 46.7, 46.9, 52.2, 53.2, 59.2, 170.5, 174.0, 175.7. HRMS (ESI): m/z calcd for $C_{19}H_{33}N_2O_4$ $[M+H]^+$ 353.24403 found 353.24918. HRMS (ESI): m/z calcd for $C_{19}H_{32}N_2O_4$ Na $[M+ Na]^+$ 375.22598, found 375.22501.

33b: $[\alpha]_D^{29}$ = –90.1 (*c* 0.50, $CHCl_3$); IR (NaCl) ν_{max} 3489, 3340, 2950, 1747, 1667, 1538, 1210 cm^{-1}; ^1H NMR ($CDCl_3$, 500 MHz) δ 0.84 (d, *J* = 6.5 Hz, 3H), 0.87 (d, *J* = 6.5

Hz, 3H), 0.88 (d, J = 6.5 Hz, 3H), 0.65–1.17 (m, 3H), 1.41 (d, J = 7.0 Hz, 3H), 1.18–1.53 (m, 3H), 1.65–2.01 (m, 3H), 2.03–2.15 (m, 1H), 2.25–2.43 (m, 2H), 2.58 (dt, J = 16.0, 9.5 Hz 1H), 3.73 (s, 3H), 4.18 (dd, J = 8.0, 3.5 Hz, 1H), 4.35 (dd, J = 9.0, 2.5 Hz, 1H), 4.41 (q, J = 7.0 Hz, 1H), 7.01 (d, J = 8.0 Hz, 1H); ^{1}H NMR (C_6D_6, 500 MHz) δ 0.83 (d, J = 6.5 Hz, 3H), 0.93 (d, J = 6.5 Hz, 3H), 0.65–1.07 (m, 3H), 1.09 (d, J = 6.5 Hz, 3H), 1.26 (d, J = 7.0 Hz, 3H), 1.15–1.53 (m, 4H), 1.55–1.78 (m, 3H), 1.86 (ddd, J = 16.5, 9.5, 3.5 Hz, 1H), 2.17 (dq, J = 13.5, 3.0 Hz, 1H), 2.27 (dt, J = 16.5, 9.5 Hz, 1H), 3.38 (s, 3H), 3.90 (dd, J = 9.0, 3.0 Hz, 1H), 4.49 (dd, J = 8.0, 3.5 Hz, 1H), 4.60 (q, J = 7.0 Hz, 1H), 7.29 (d, J = 8.0 Hz, 1H); ^{13}C NMR ($CDCl_3$, 125 MHz) δ 14.0, 20.7, 21.1, 22.2, 23.8, 25.1, 26.6, 29.0, 29.8, 34.8, 39.8, 46.4, 46.6, 52.4, 52.9, 58.2, 169.6, 172.2, 176.2; ^{13}C NMR (C_6D_6, 125 MHz) δ 14.2, 21.6, 21.7, 22.8, 23.9, 25.8, 27.2, 29.6, 30.1, 35.5, 40.7, 47.0, 47.2, 52.1, 52.6, 58.0, 169.6, 172.4, 176.0. HRMS (ESI): m/z calcd for $C_{19}H_{33}N_2O_4$ [M+H]$^+$ 353.24403 found 353.24616. HRMS (ESI): m/z calcd for $C_{19}H_{32}N_2O_4$ Na [M+ Na]$^+$ 375.22598, found 375.22438.



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SCANS	8
ACQTM	1.7459 sec
PD	5.0000 sec
PW1	4.68 usec
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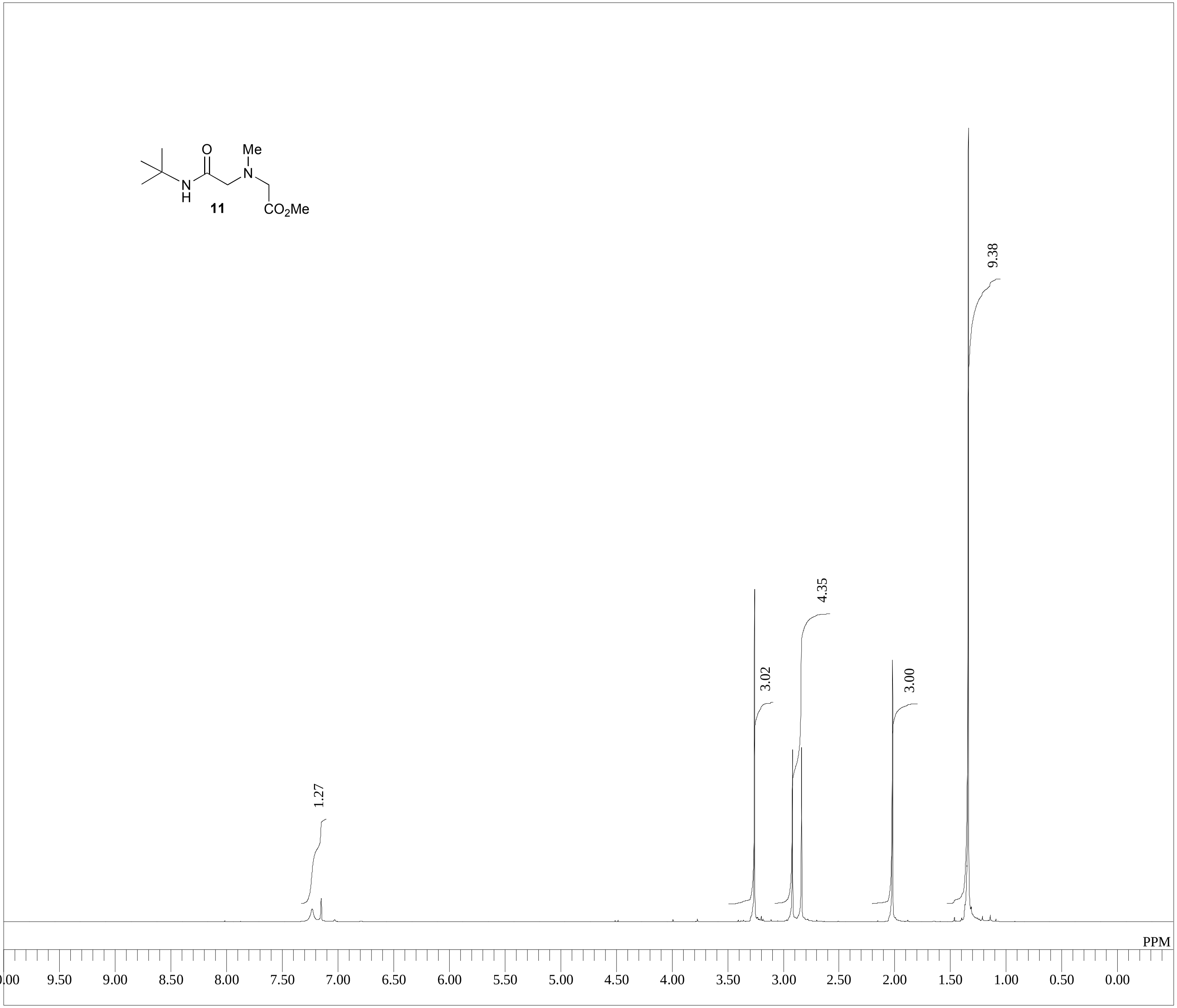
CTEMP	20.8 c
SLVNT	CDCL3
EXREF	7.26 ppm
BF	0.12 Hz
RGAIN	22



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POINT	13107
FREQU	7507.51 Hz
SCANS	8
ACQTM	1.7459 sec
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CTEMP	22.2 c
SLVNT	C6D6
EXREF	7.15 ppm
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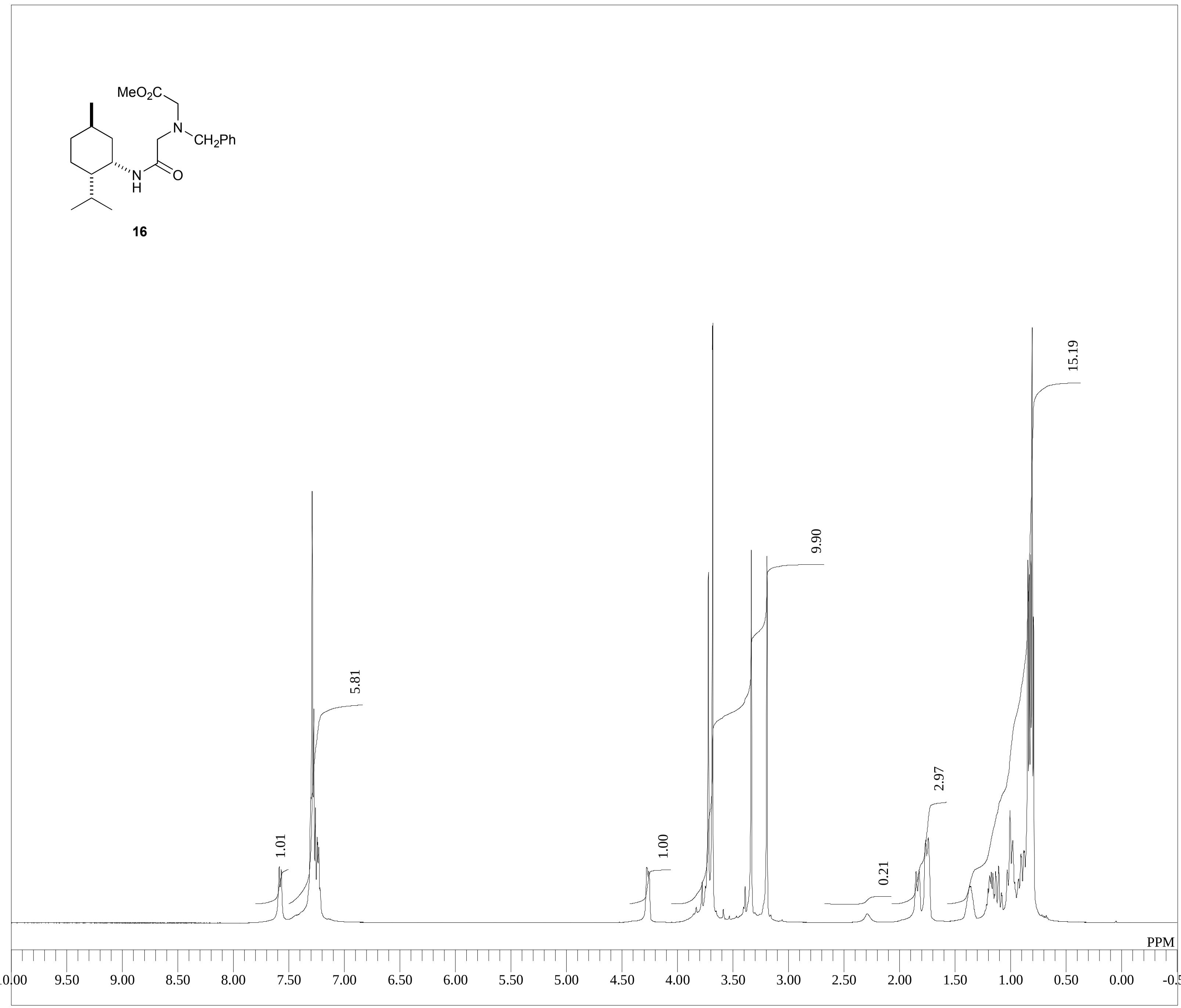
RGAIN	26



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POINT	13120
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SCANS	16
ACQTM	1.7459 sec
PD	5.0000 sec
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CTEMP	24.5 c
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EXREF	12.51 ppm
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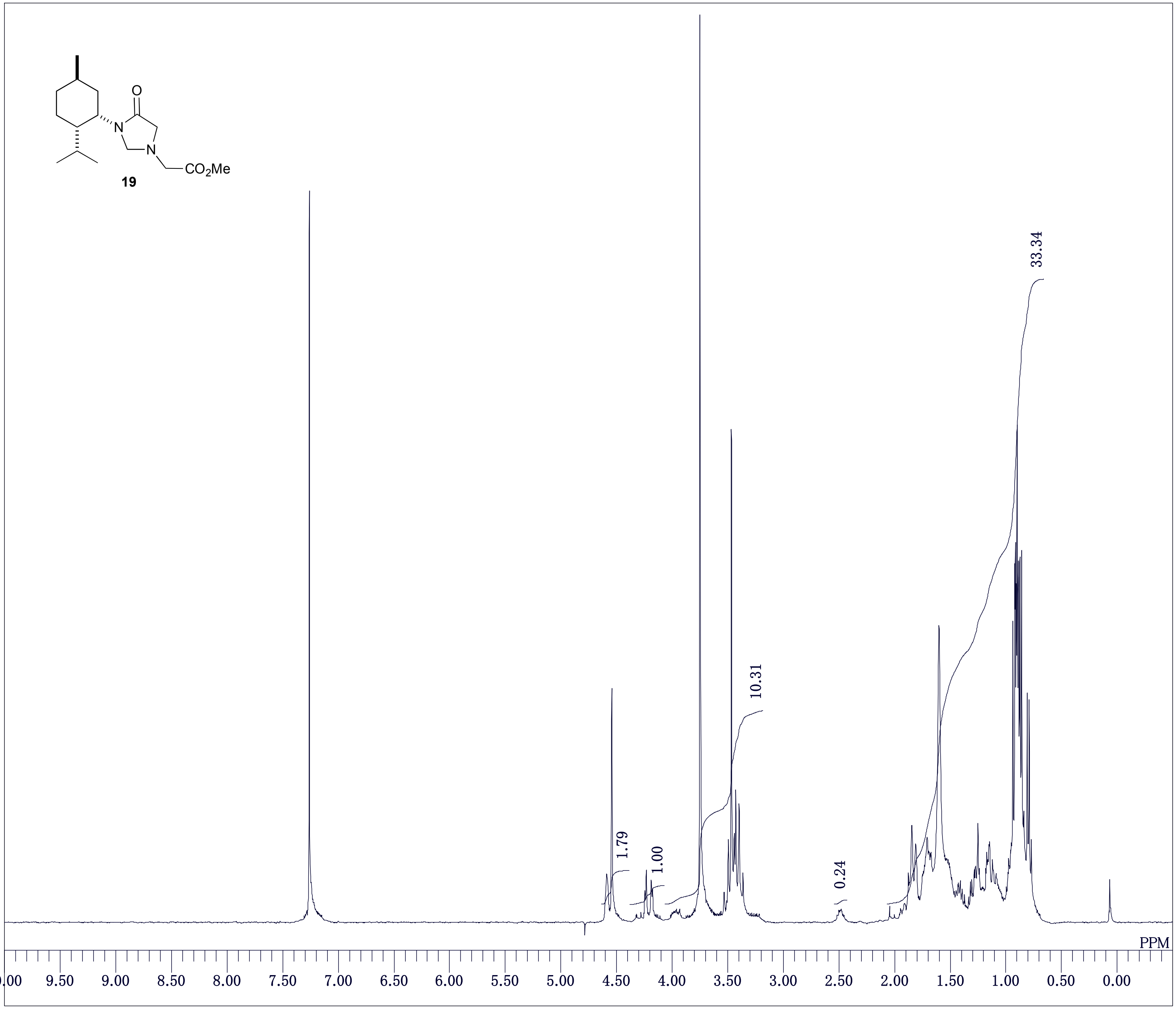
RGAIN	24



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POINT	8192
FREQU	7993.60 Hz
SCANS	16
ACQTM	1.0248 sec
PD	5.9752 sec
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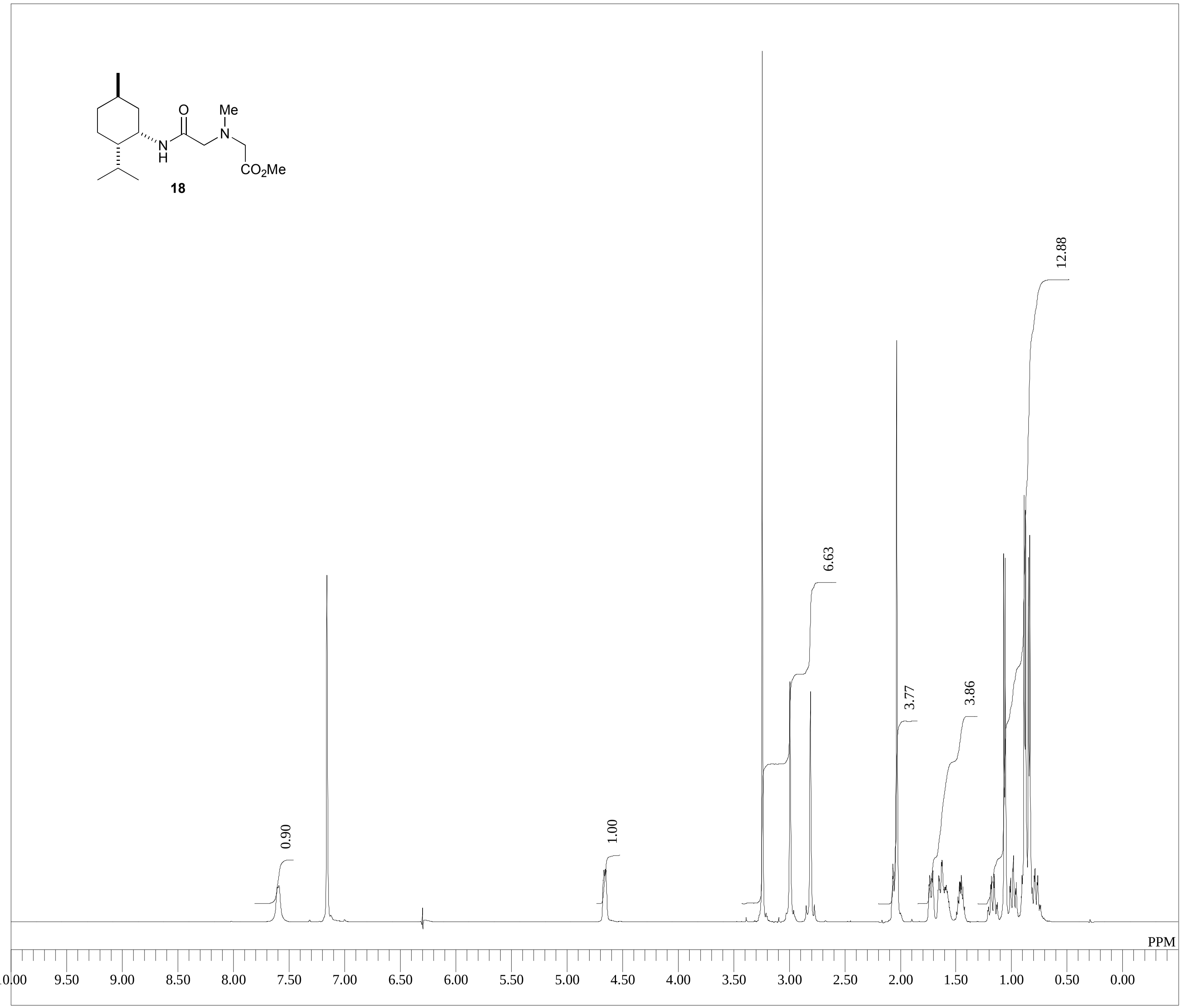
CTEMP	21.3 c
SLVNT	CDCL3
EXREF	7.26 ppm
BF	0.12 Hz
RGAIN	8



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EXMOD	proton.jxp
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OBSET	2.41 KHz
OBFIN	6.01 Hz
POINT	13120
FREQU	7507.51 Hz
SCANS	16
ACQTM	1.7459 sec
PD	5.0000 sec
PW1	4.68 usec
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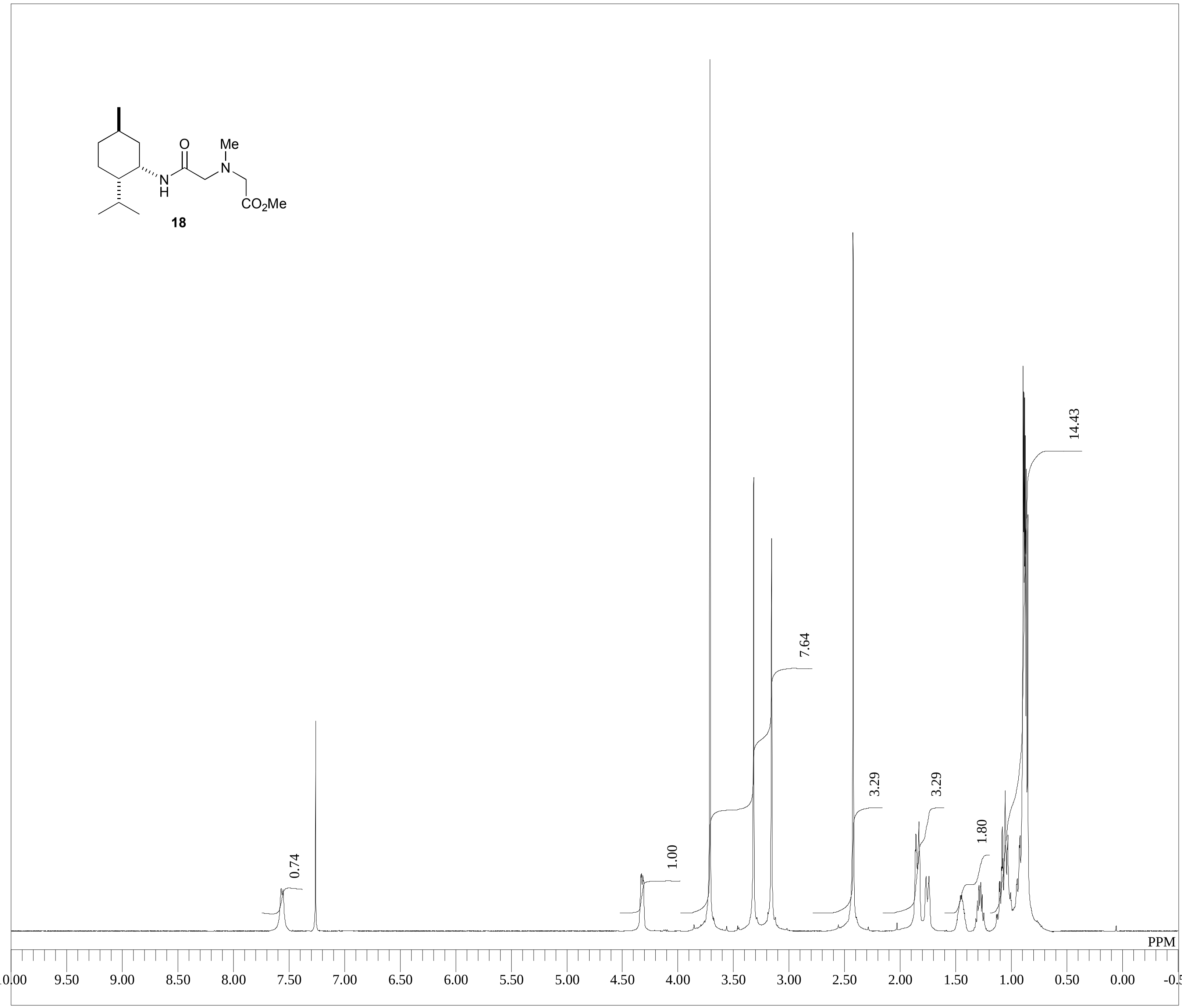
CTEMP	23.6 c
SLVNT	C6D6
EXREF	7.16 ppm
BF	0.12 Hz
RGAIN	36



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SCANS	16
ACQTM	1.7459 sec
PD	5.0000 sec
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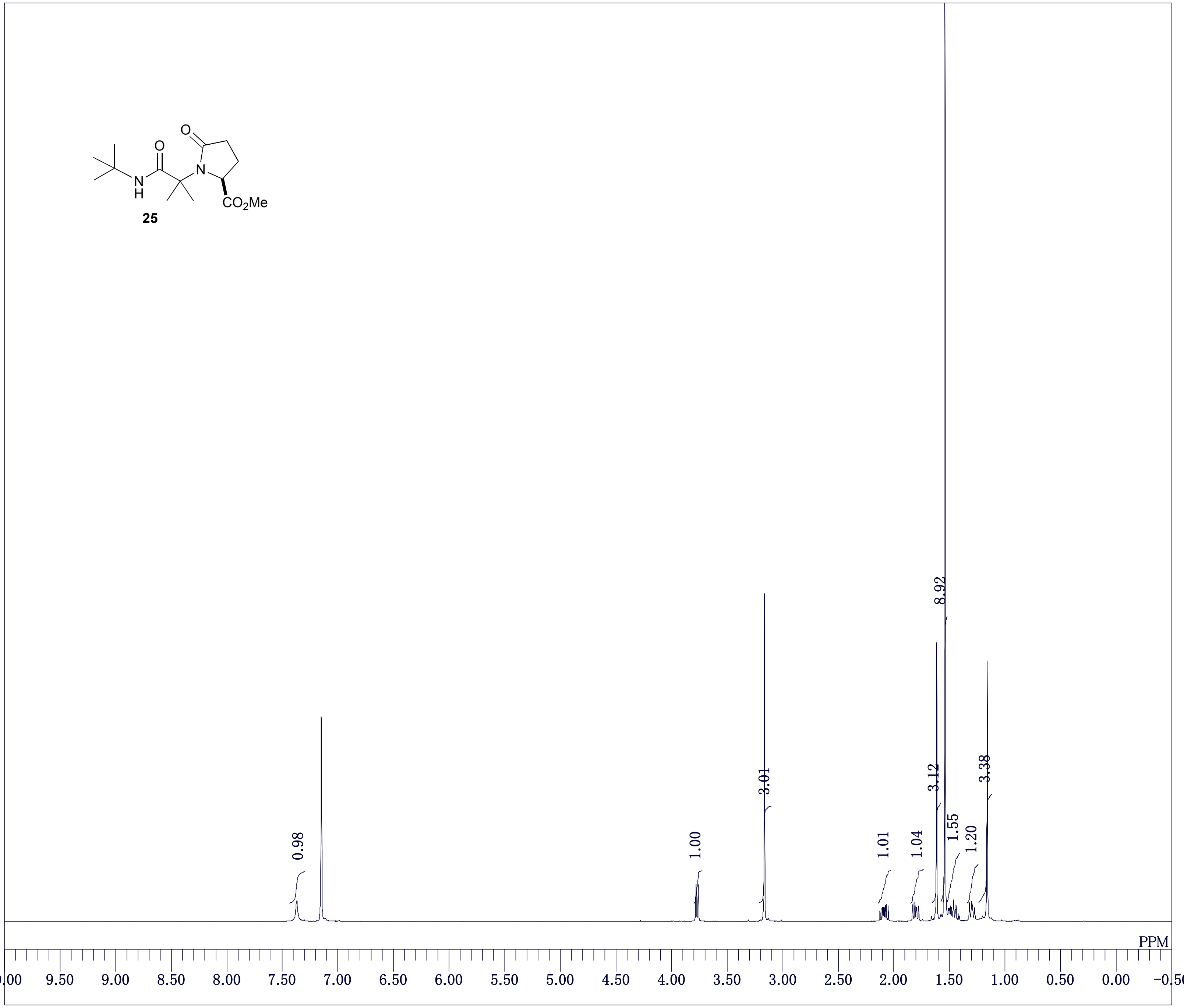
CTEMP	24.9 c
SLVNT	CDCL3
EXREF	7.26 ppm
BF	0.12 Hz
RGAIN	34



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POINT	16400
FREQU	9384.38 Hz
SCANS	8
ACQTM	1.7459 sec
PD	5.0000 sec
PW1	4.68 usec
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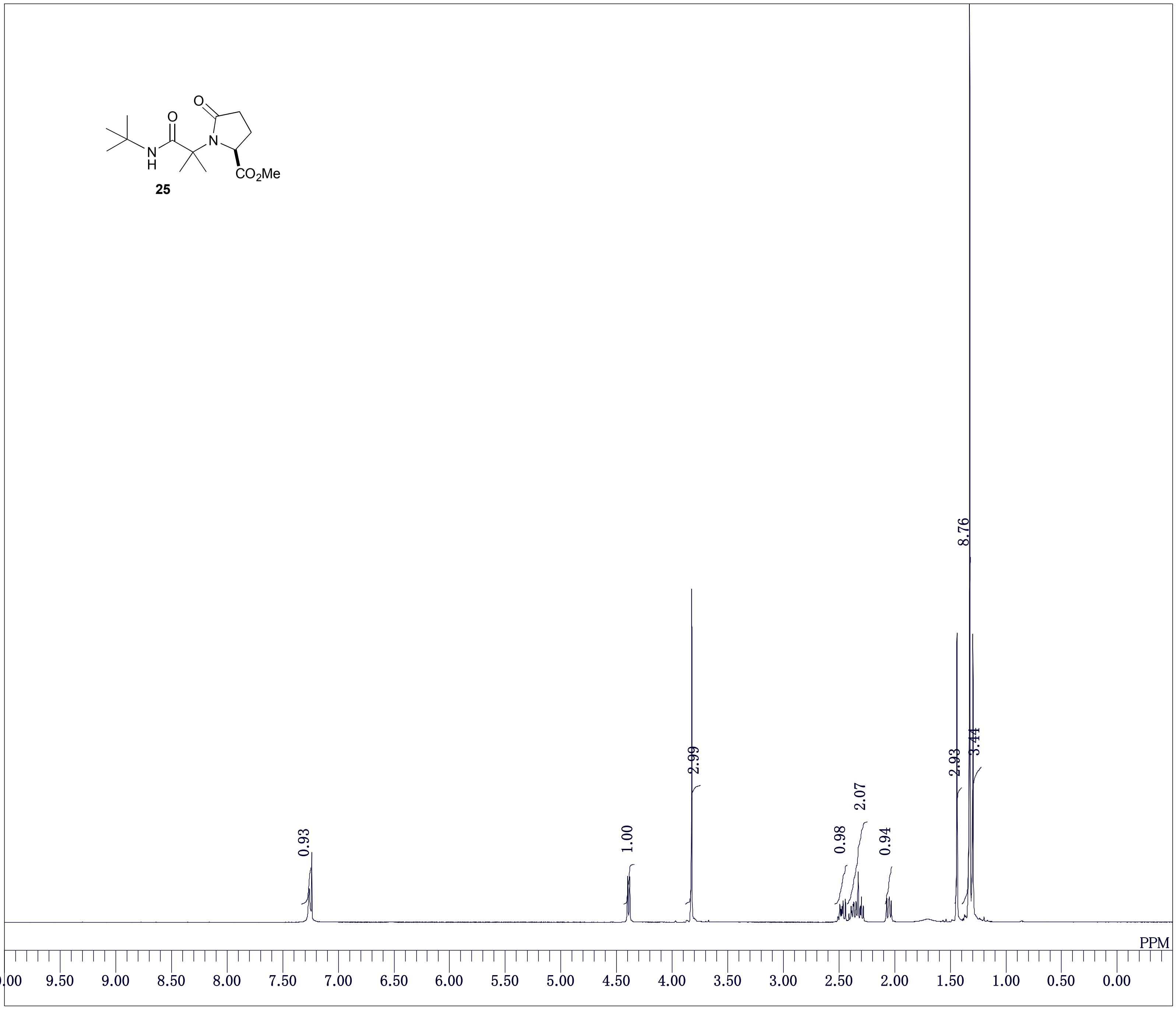
CTEMP	16.4 c
SLVNT	C6D6
EXREF	7.15 ppm
BF	0.12 Hz
RGAIN	50



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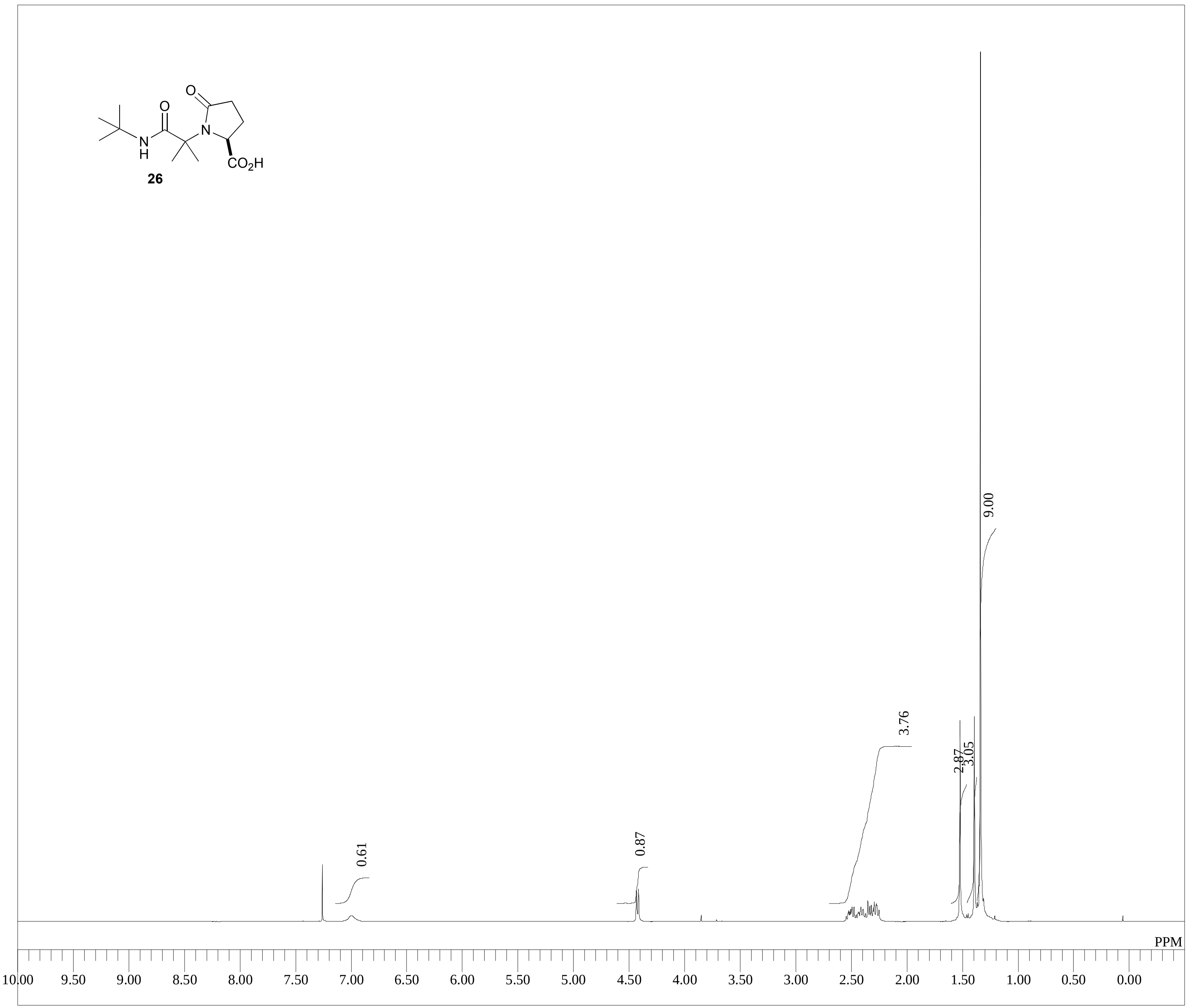
POINT	16400
FREQU	9384.38 Hz
SCANS	8
ACQTM	1.7459 sec
PD	5.0000 sec
PW1	4.68 usec
IRNUC	1H
CTEMP	16.5 c
SLVNT	CDCL3
EXREF	7.24 ppm
BF	0.12 Hz
RGAIN	50



DFILE	MIM1045-COOH_proton-2-1.jdf
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EXMOD	proton.jxp
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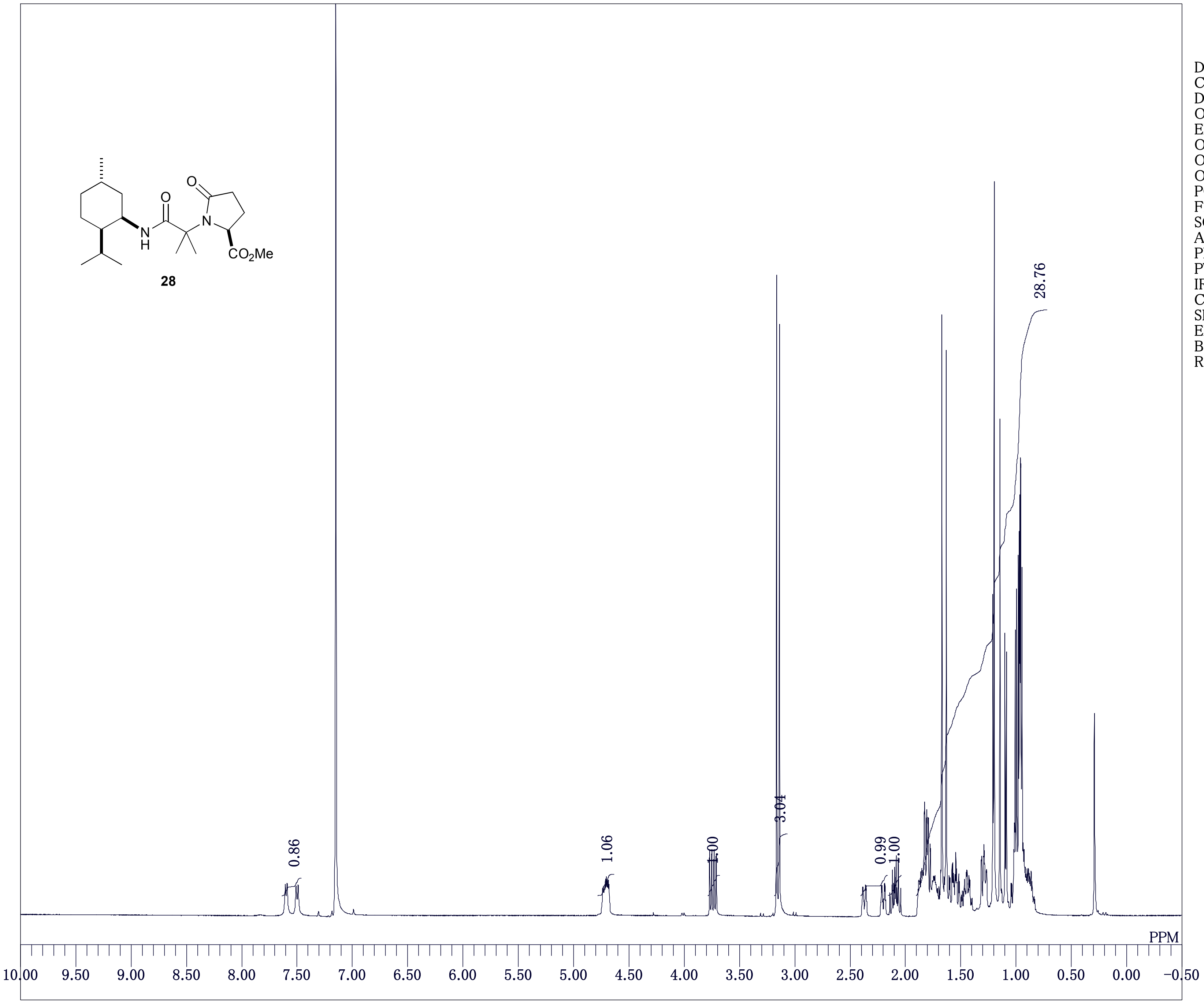
OBSET	2.41 KHz
OBFIN	6.01 Hz
POINT	16384
FREQU	9384.38 Hz
SCANS	16
ACQTM	1.7459 sec
PD	5.0000 sec
PW1	4.68 usec
IRNUC	1H
CTEMP	21.1 c
SLVNT	CDCL3
EXREF	7.26 ppm
BF	0.12 Hz
RGAIN	40



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OBFIN	6.01 Hz
POINT	16400
FREQU	9384.38 Hz
SCANS	8
ACQTM	1.7459 sec
PD	5.0000 sec
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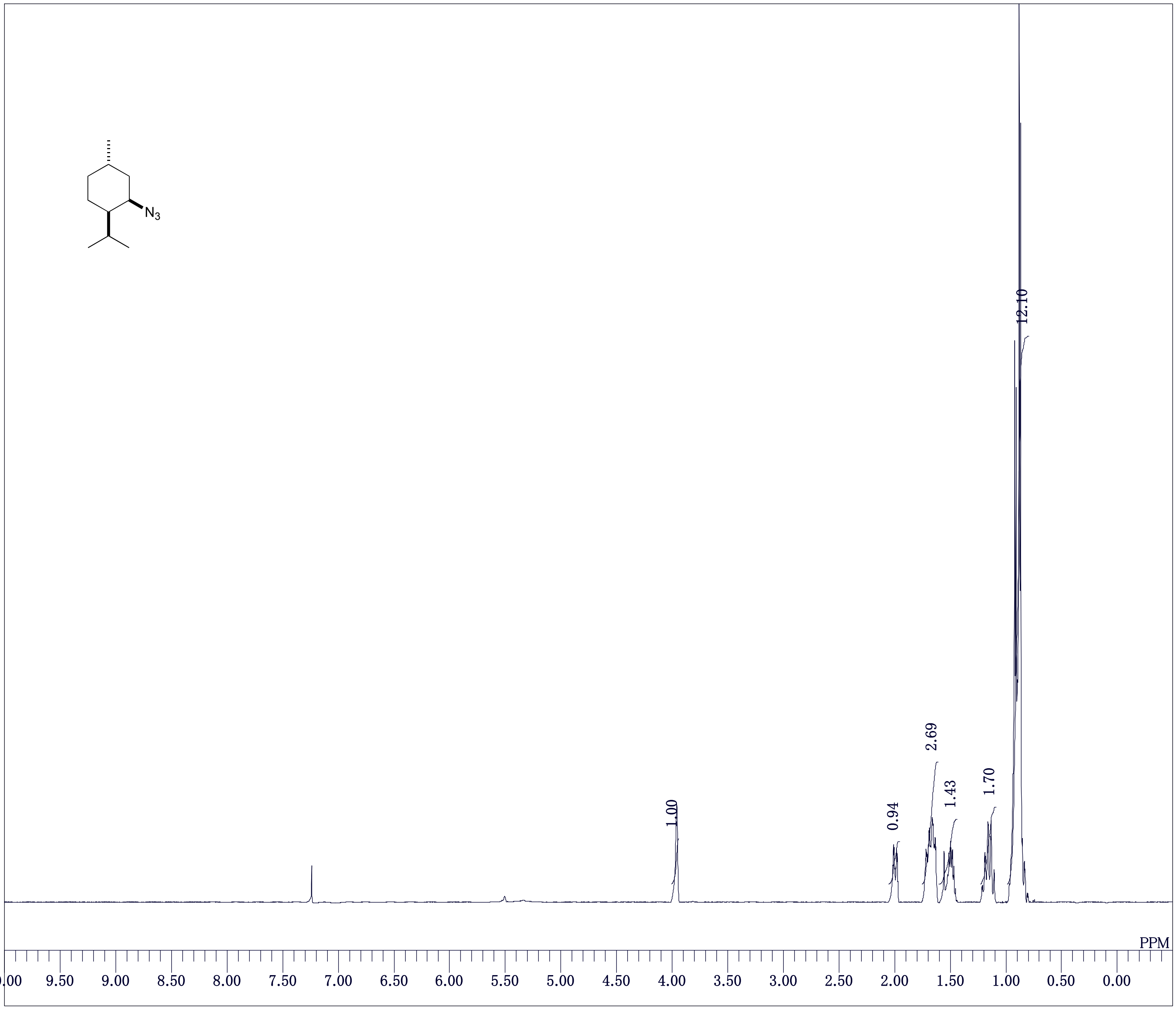
CTEMP	16.7 c
SLVNT	C6D6
EXREF	7.15 ppm
BF	0.12 Hz
RGAIN	50



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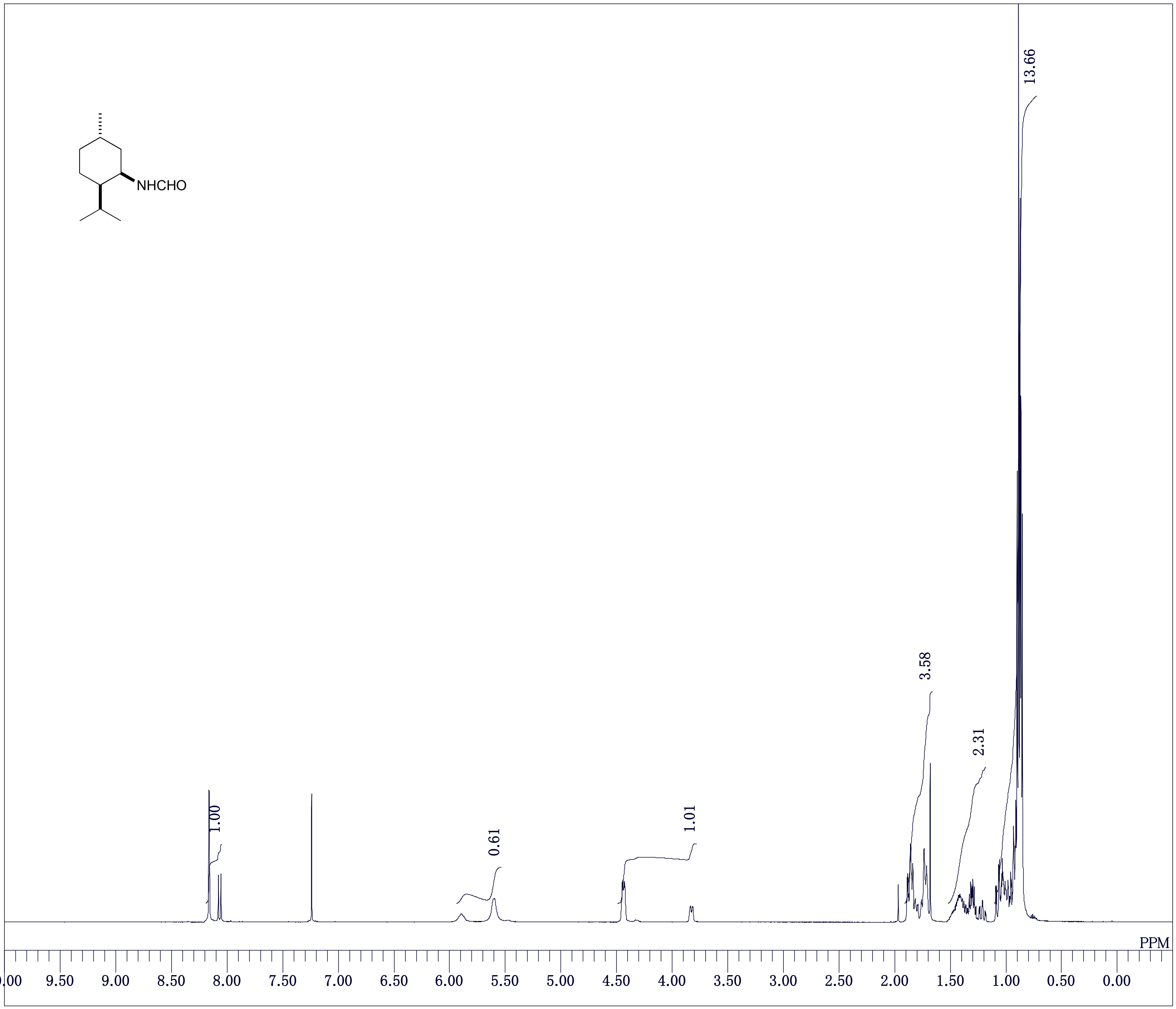
OBSET	2.41 KHz
OBFIN	6.01 Hz
POINT	16400
FREQU	9384.38 Hz
SCANS	8
ACQTM	1.7459 sec
PD	5.0000 sec
PW1	4.68 usec
IRNUC	1H
CTEMP	16.4 c
SLVNT	CDCL3
EXREF	7.24 ppm
BF	0.12 Hz
RGAIN	50



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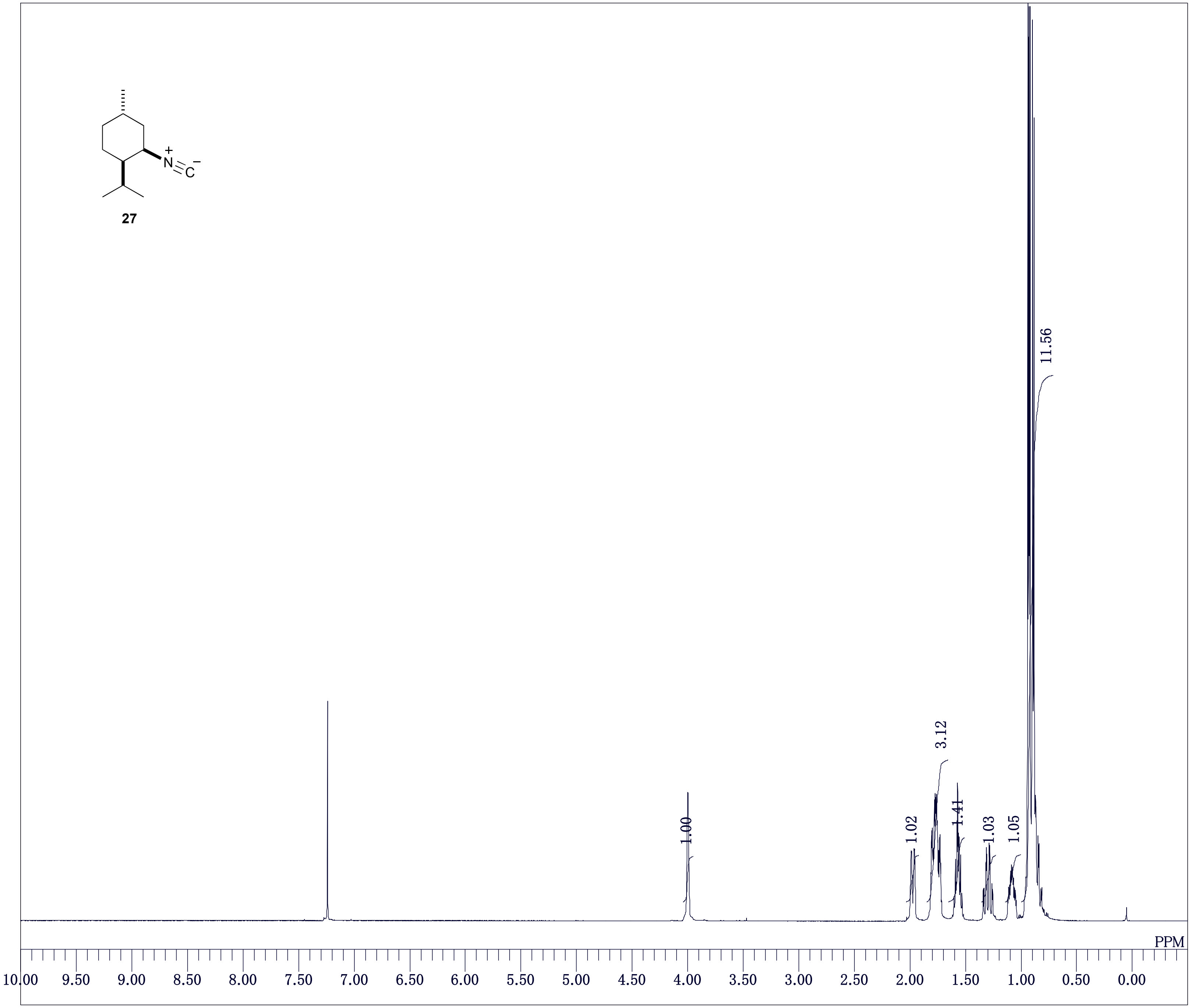
OBFIN	6.01 Hz
POINT	16400
FREQU	9384.38 Hz
SCANS	8
ACQTM	1.7459 sec
PD	5.0000 sec
PW1	4.68 usec
IRNUC	1H
CTEMP	16.4 c
SLVNT	CDCL3
EXREF	7.24 ppm
BF	0.12 Hz
RGAIN	50



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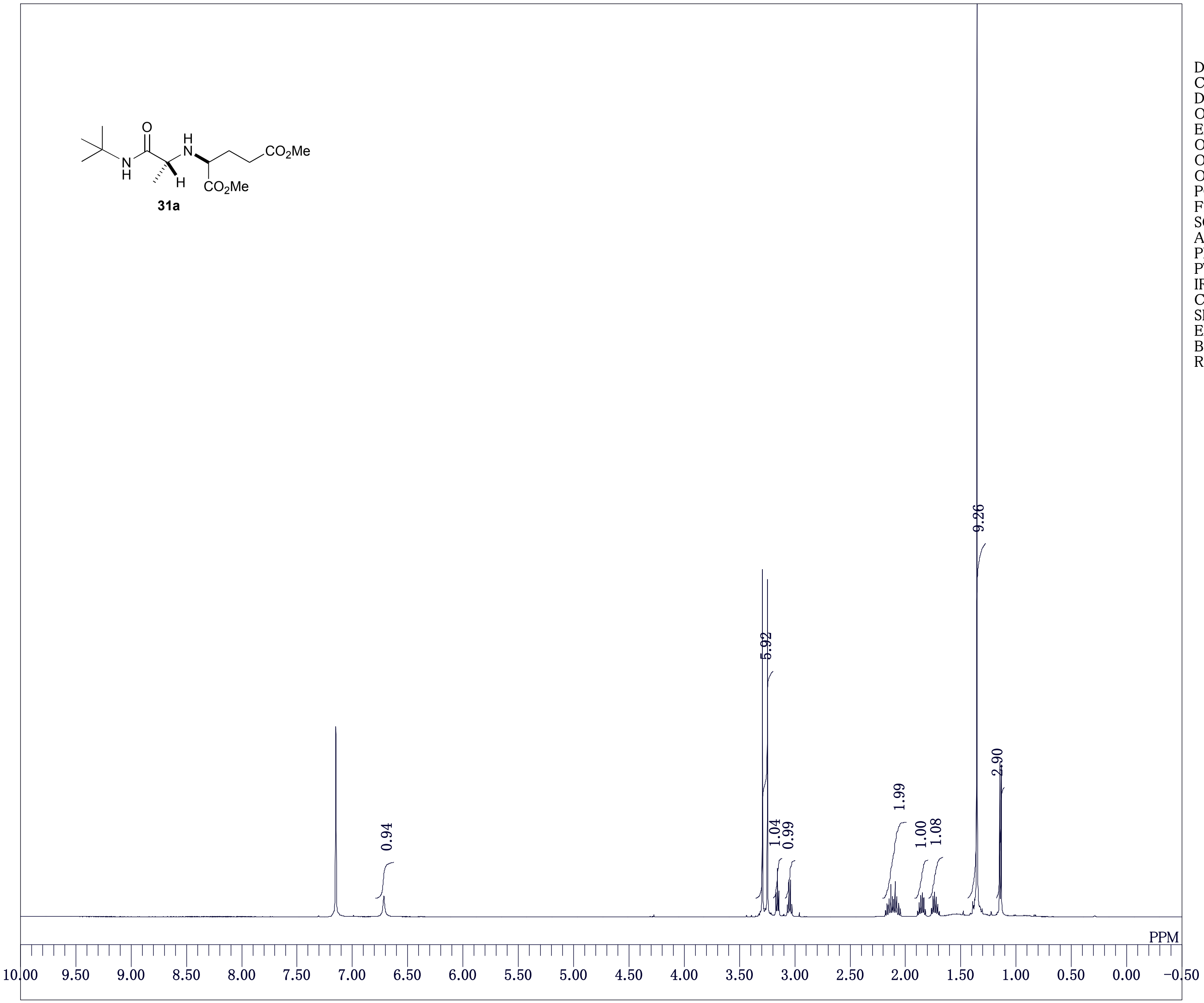
OBFIN	6.01 Hz
POINT	16400
FREQU	9384.38 Hz
SCANS	8
ACQTM	1.7459 sec
PD	5.0000 sec
PW1	4.68 usec
IRNUC	1H
CTEMP	16.5 c
SLVNT	CDCL3
EXREF	7.24 ppm
BF	0.12 Hz
RGAIN	50



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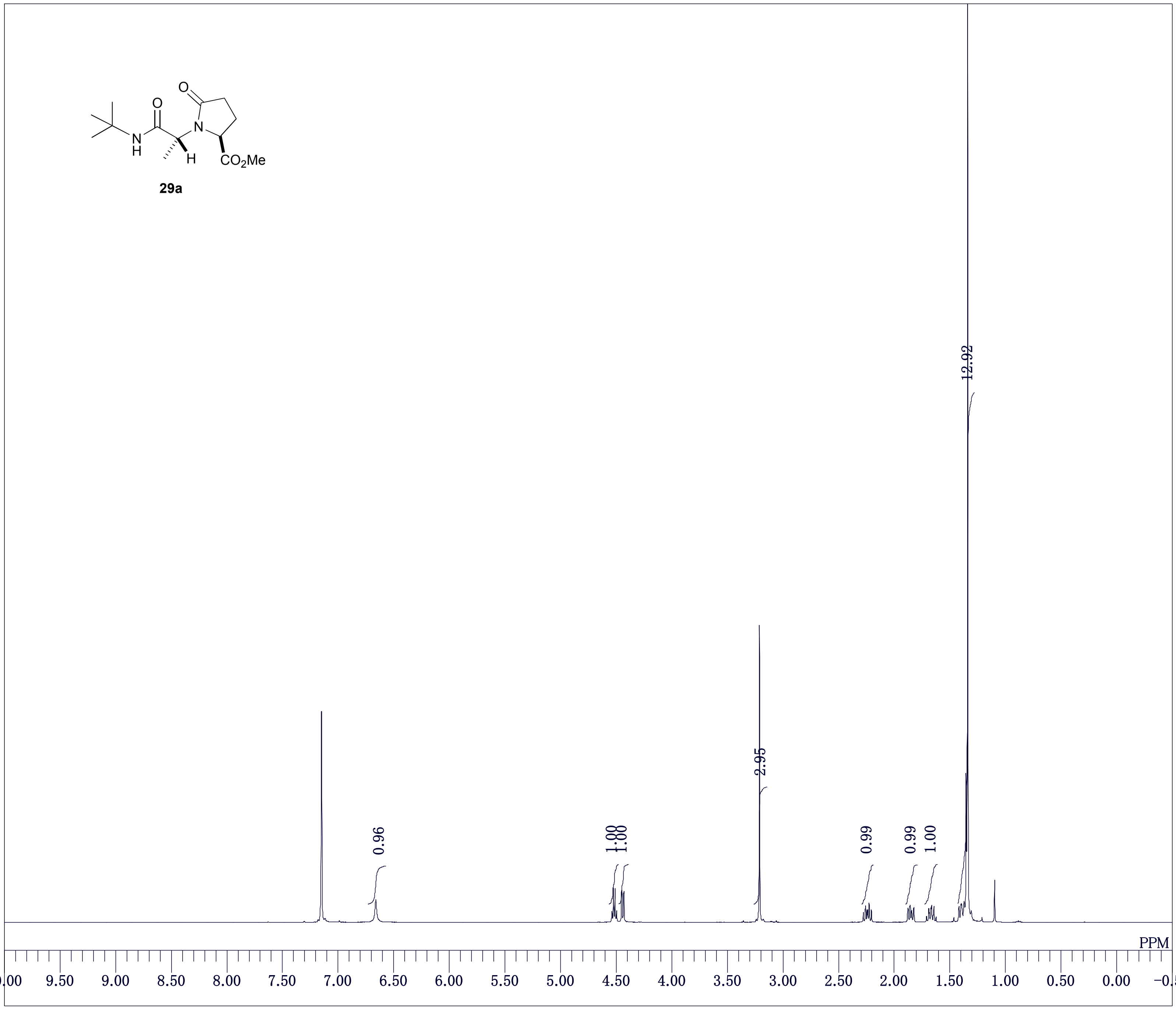
OBFIN	6.01 Hz
POINT	16400
FREQU	9384.38 Hz
SCANS	8
ACQTM	1.7459 sec
PD	5.0000 sec
PW1	4.68 usec
IRNUC	1H
CTEMP	17.1 c
SLVNT	C6D6
EXREF	7.15 ppm
BF	0.12 Hz
RGAIN	50



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EXMOD	proton.jxp
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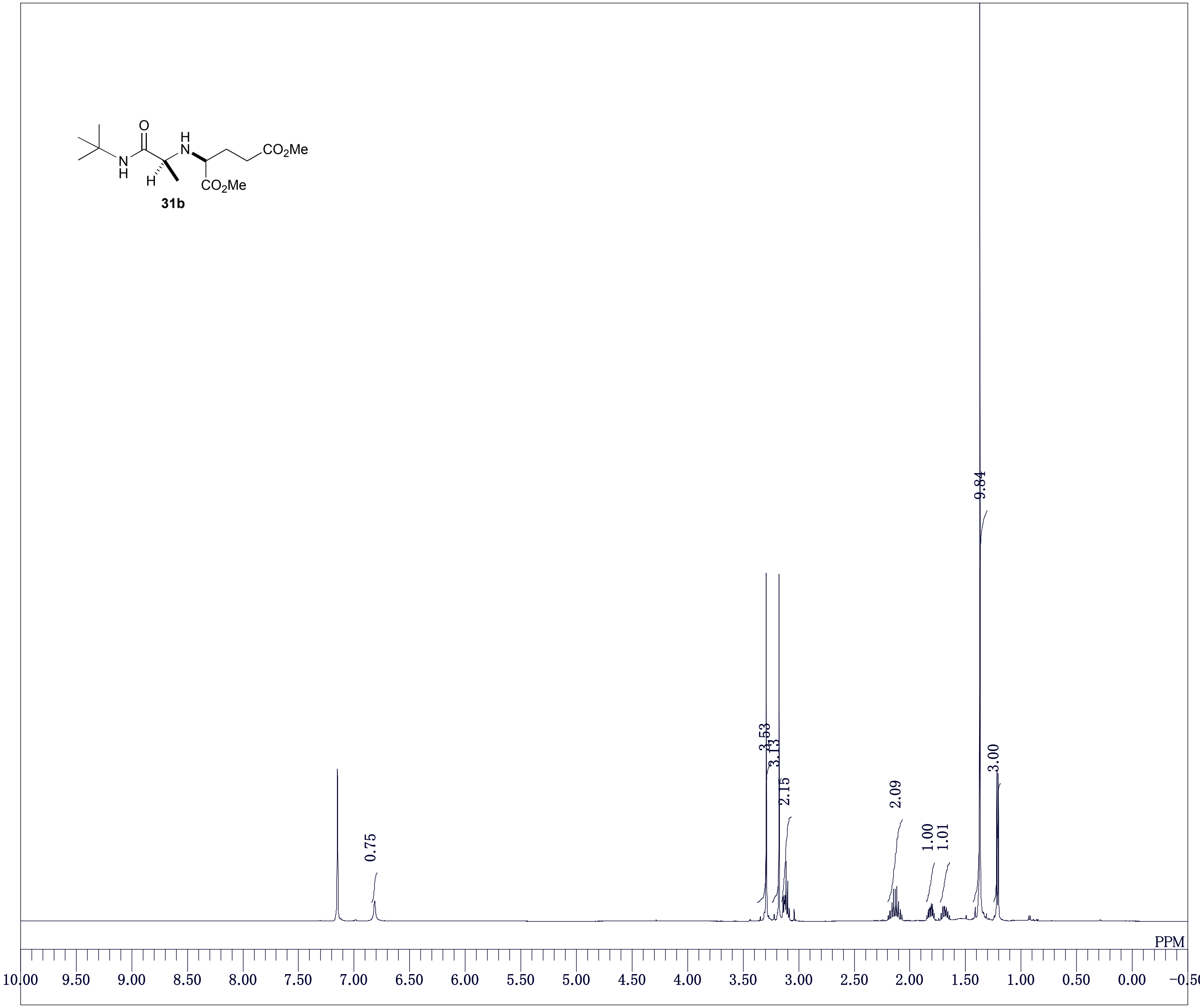
OBSET	2.41 KHz
OBFIN	6.01 Hz
POINT	16400
FREQU	9384.38 Hz
SCANS	8
ACQTM	1.7459 sec
PD	5.0000 sec
PW1	4.68 usec
IRNUC	1H
CTEMP	16.4 c
SLVNT	C6D6
EXREF	7.15 ppm
BF	0.12 Hz
RGAIN	50



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OBFIN	6.01 Hz
POINT	16400
FREQU	9384.38 Hz
SCANS	8
ACQTM	1.7459 sec
PD	5.0000 sec
PW1	4.68 usec
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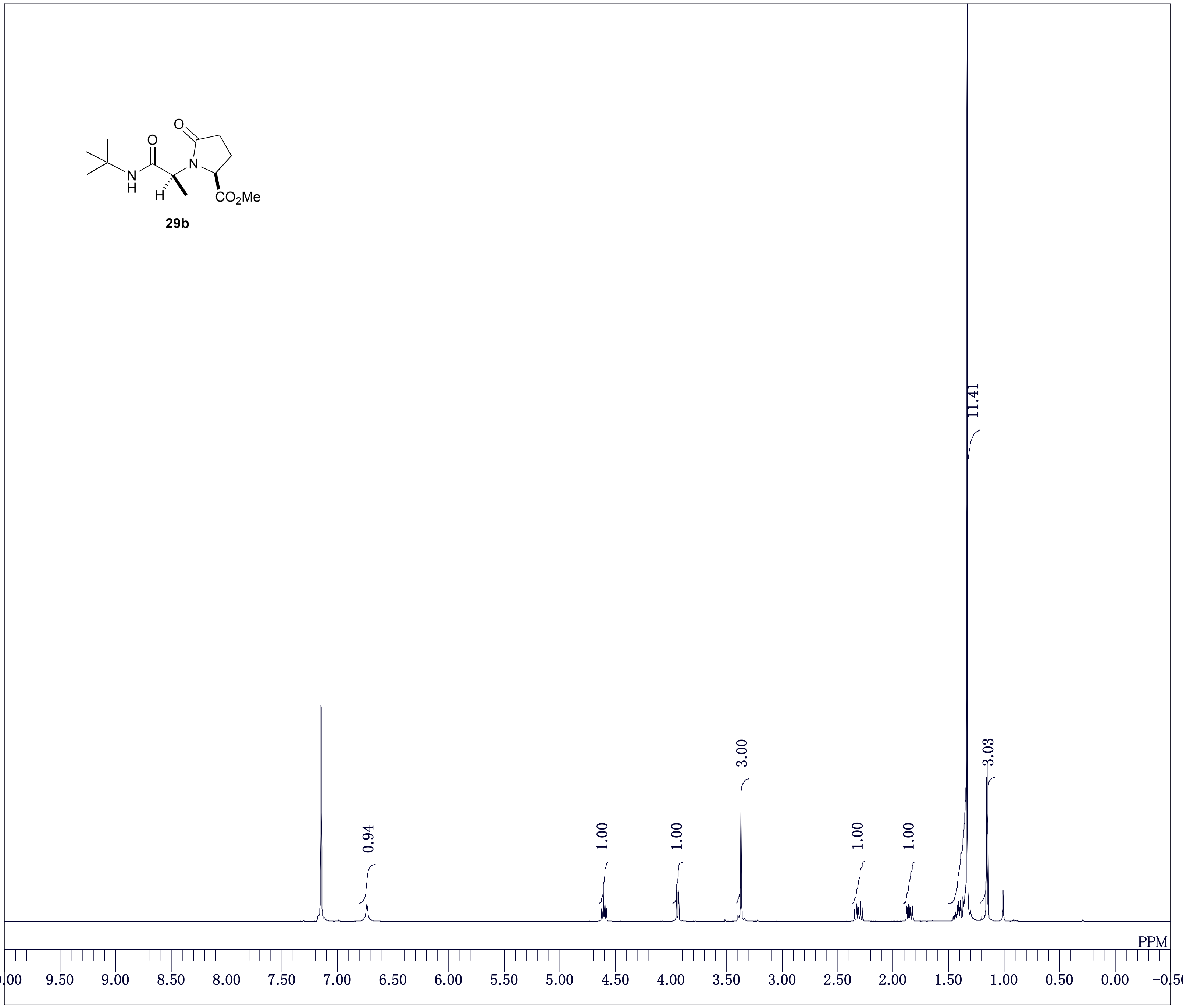
CTEMP	17.0 c
SLVNT	C6D6
EXREF	7.15 ppm
BF	0.12 Hz
RGAIN	50



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OBFIN	6.01 Hz
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FREQU	9384.38 Hz
SCANS	8
ACQTM	1.7459 sec
PD	5.0000 sec
PW1	4.68 usec
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CTEMP	16.5 c
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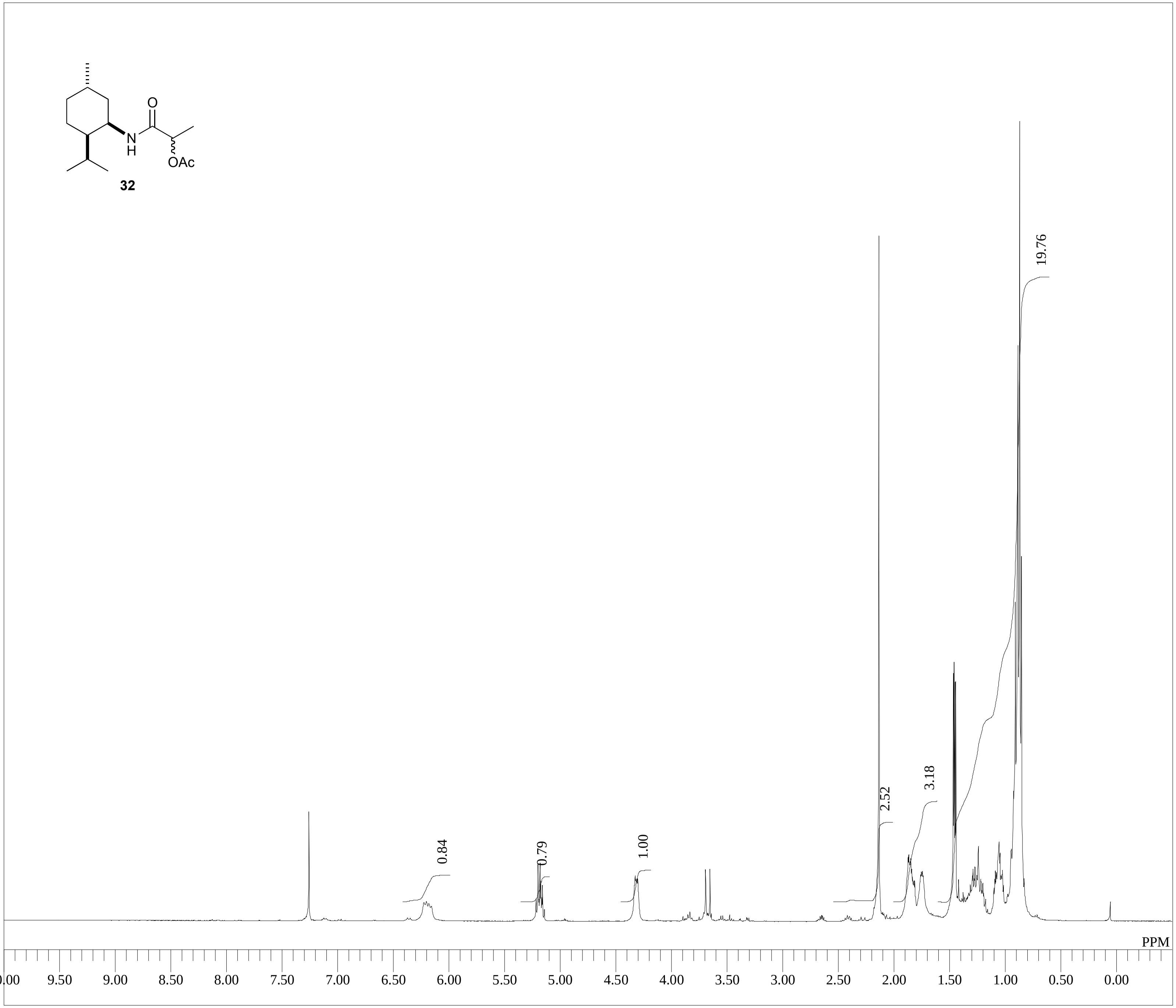
EXREF	7.15 ppm
BF	0.12 Hz
RGAIN	50



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POINT	8192
FREQU	7993.60 Hz
SCANS	16
ACQTM	1.0248 sec
PD	5.9752 sec
PW1	5.50 usec
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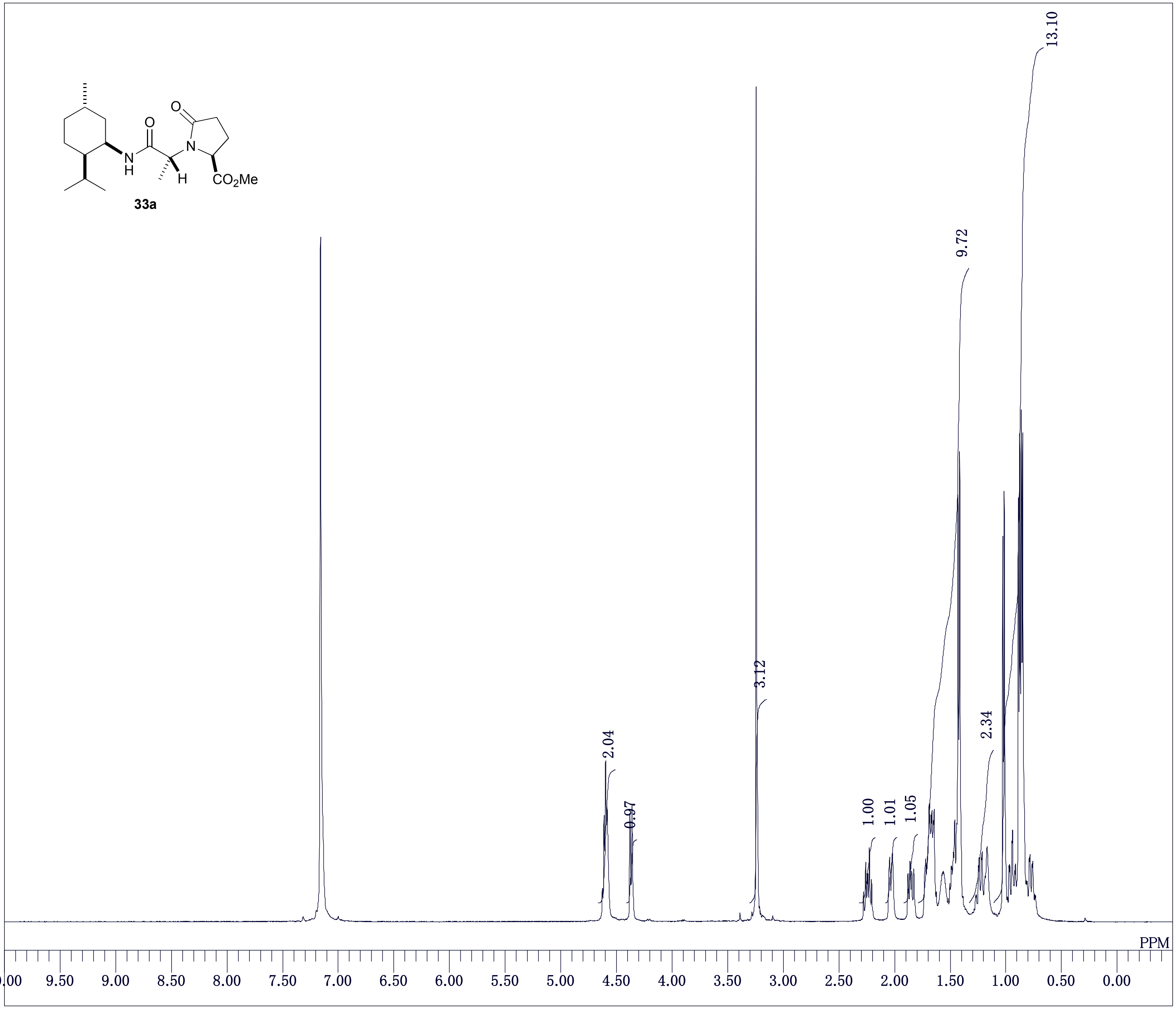
CTEMP	18.4 c
SLVNT	CDCL3
EXREF	7.26 ppm
BF	0.12 Hz
RGAIN	19



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EXMOD	proton.jxp
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OBFIN	6.01 Hz
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FREQU	9384.38 Hz
SCANS	8
ACQTM	1.7459 sec
PD	5.0000 sec
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CTEMP	25.0 c
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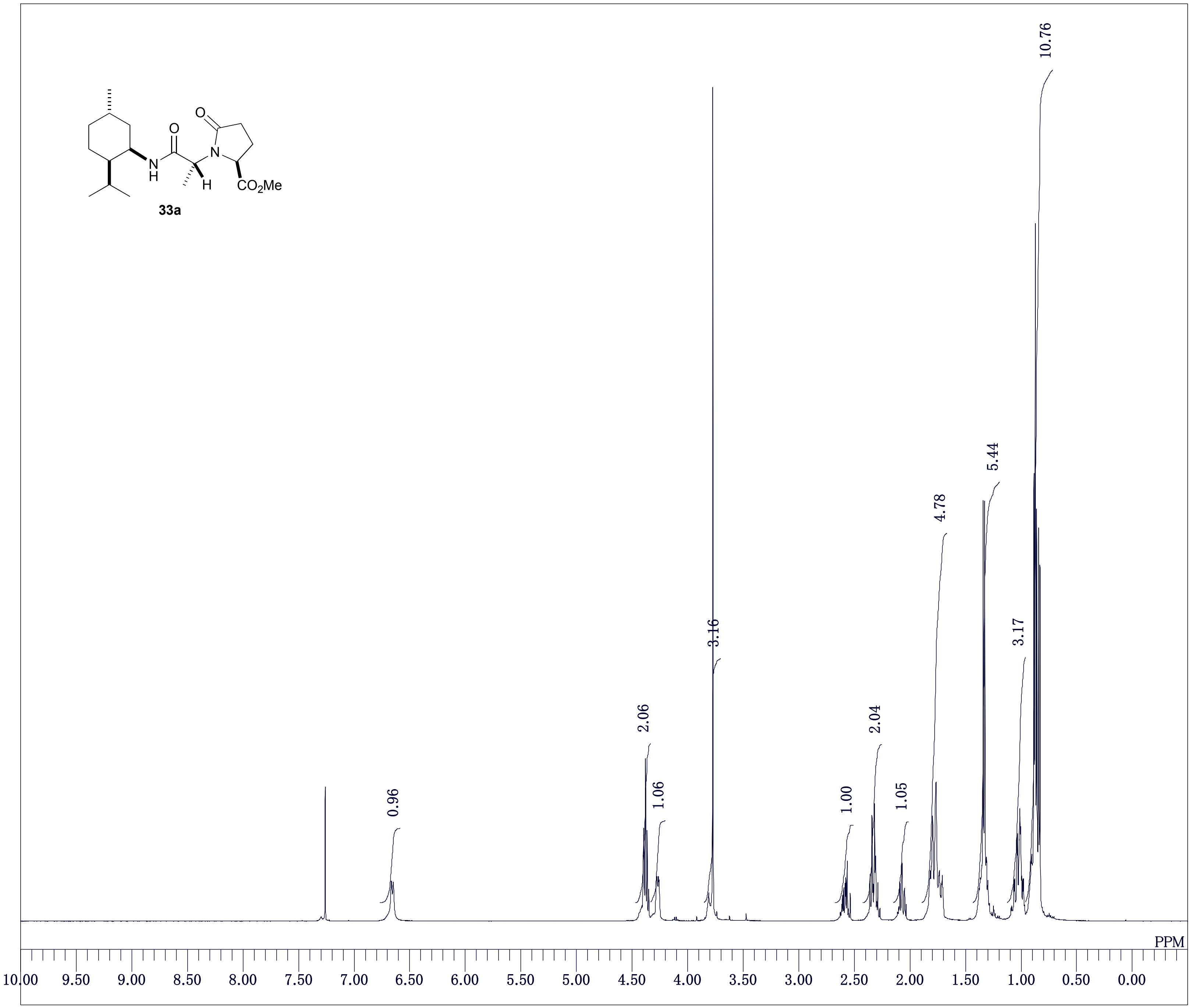
EXREF	7.16 ppm
BF	0.12 Hz
RGAIN	38



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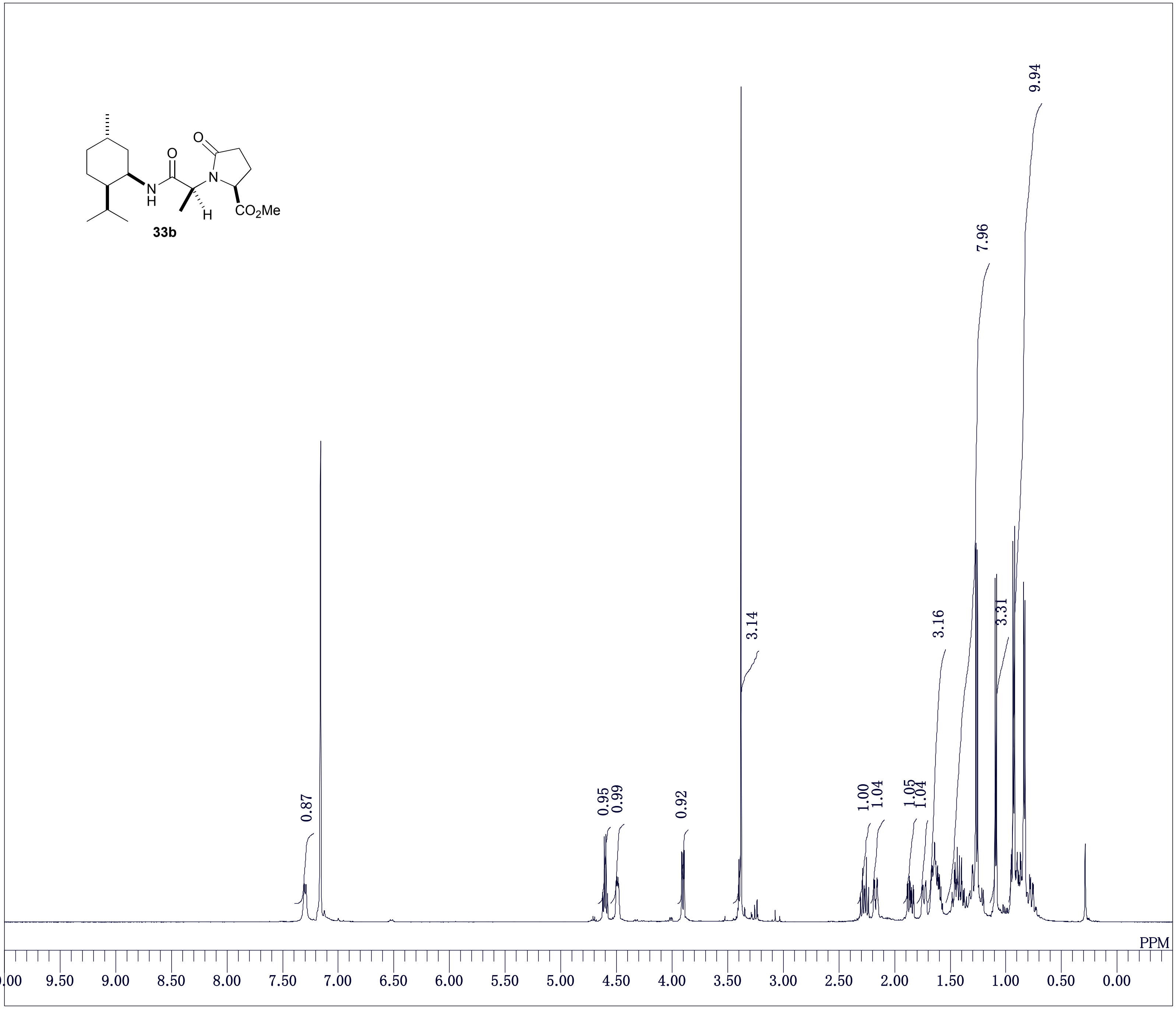
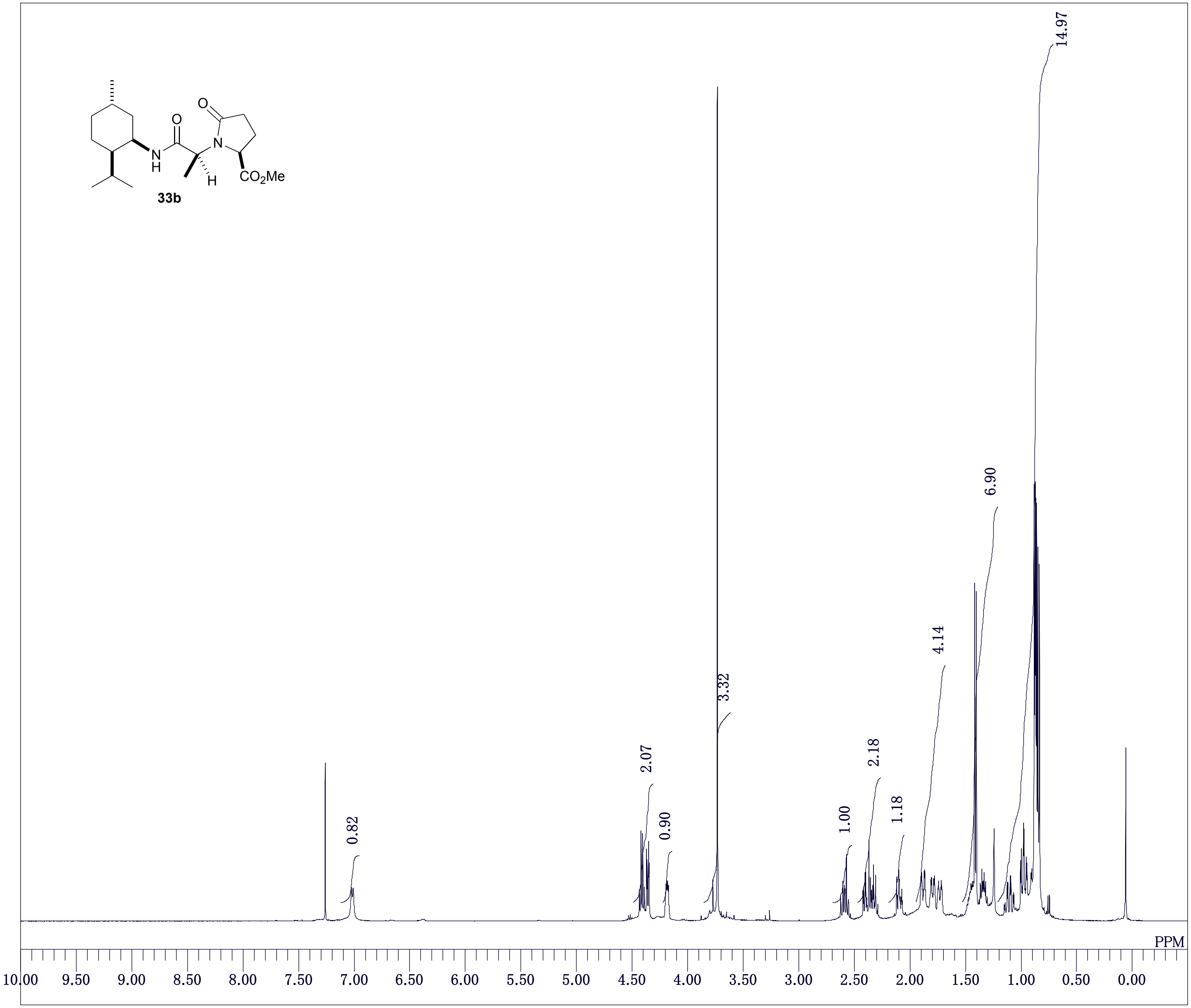
OBSET	2.41 KHz
OBFIN	6.01 Hz
POINT	16384
FREQU	9384.38 Hz
SCANS	8
ACQTM	1.7459 sec
PD	5.0000 sec
PW1	4.68 usec
IRNUC	1H
CTEMP	23.1 c
SLVNT	CDCL3
EXREF	7.26 ppm
BF	0.12 Hz
RGAIN	40

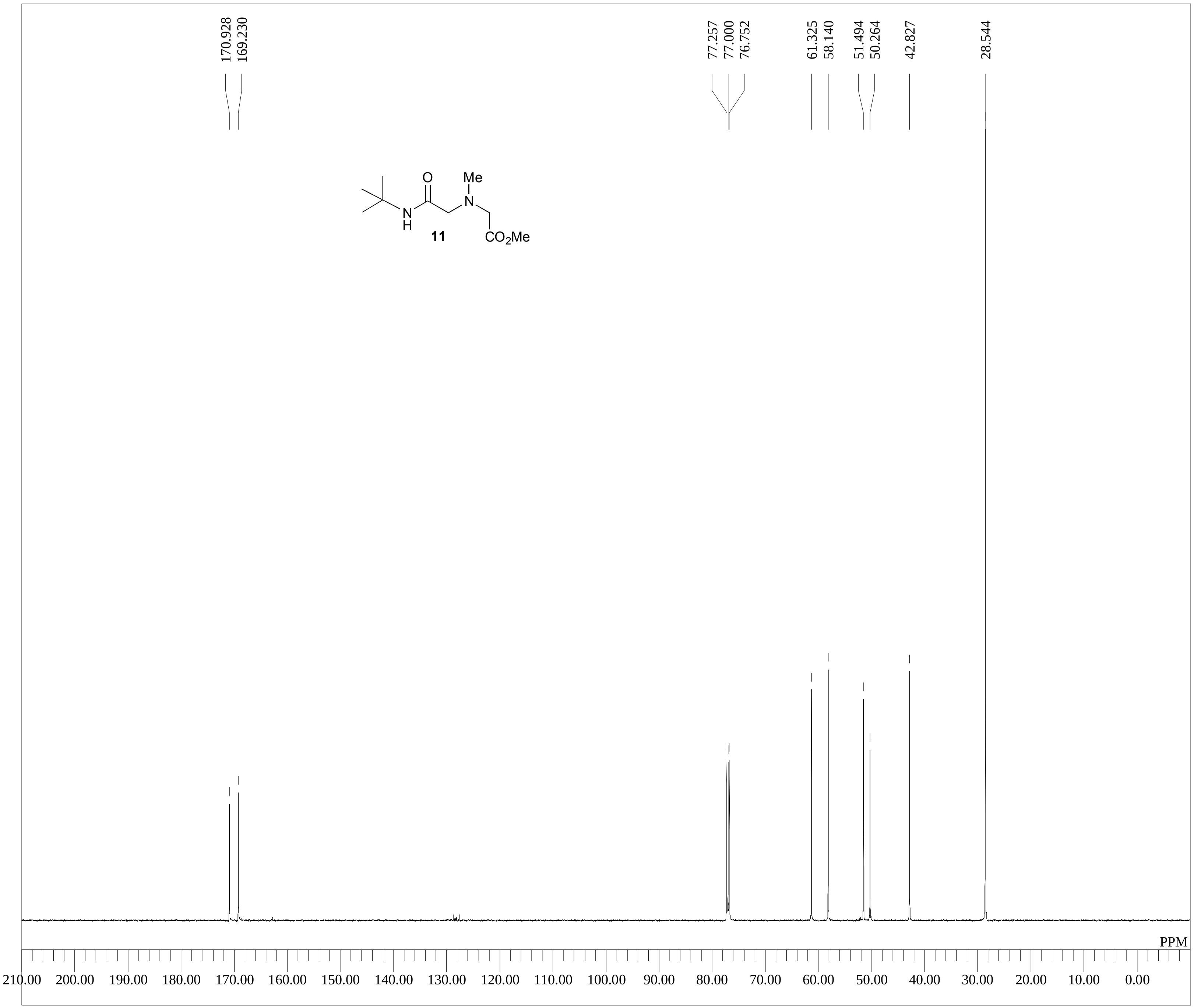


DFILE	mat1156 sita C6D6_proton-1-1.jdf
COMNT	single_pulse
DATIM	2015-07-28 17:15:13
OBNUC	1H
EXMOD	proton.jxp
OBFRQ	500.16 MHz
OBSET	2.41 KHz
OBFIN	6.01 Hz
POINT	16384
FREQU	9384.38 Hz
SCANS	8
ACQTM	1.7459 sec
PD	5.0000 sec
PW1	4.68 usec
IRNUC	1H
CTEMP	22.9 c
SLVNT	C6D6
EXREF	7.16 ppm
BF	0.12 Hz
RGAIN	38

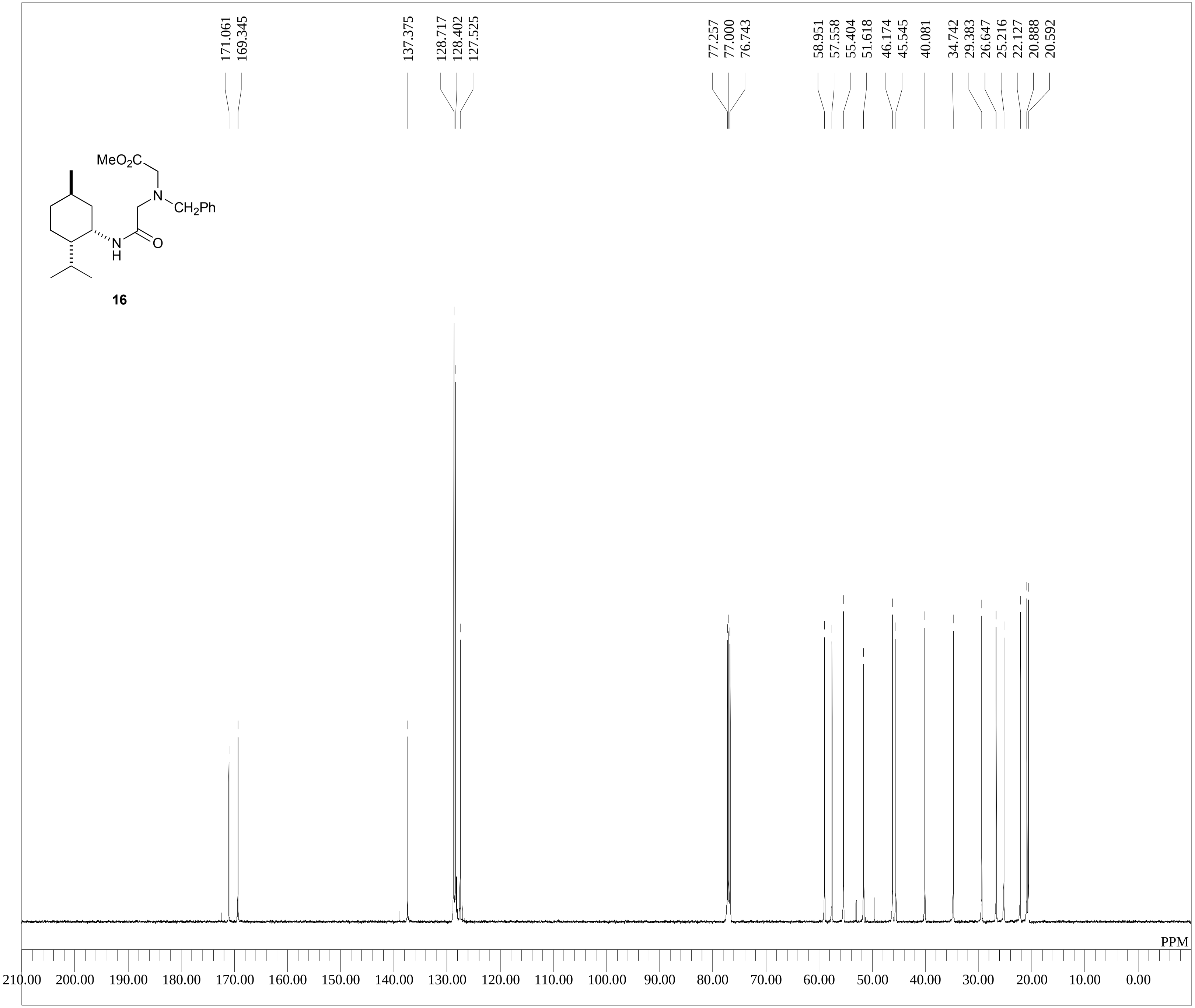


33b

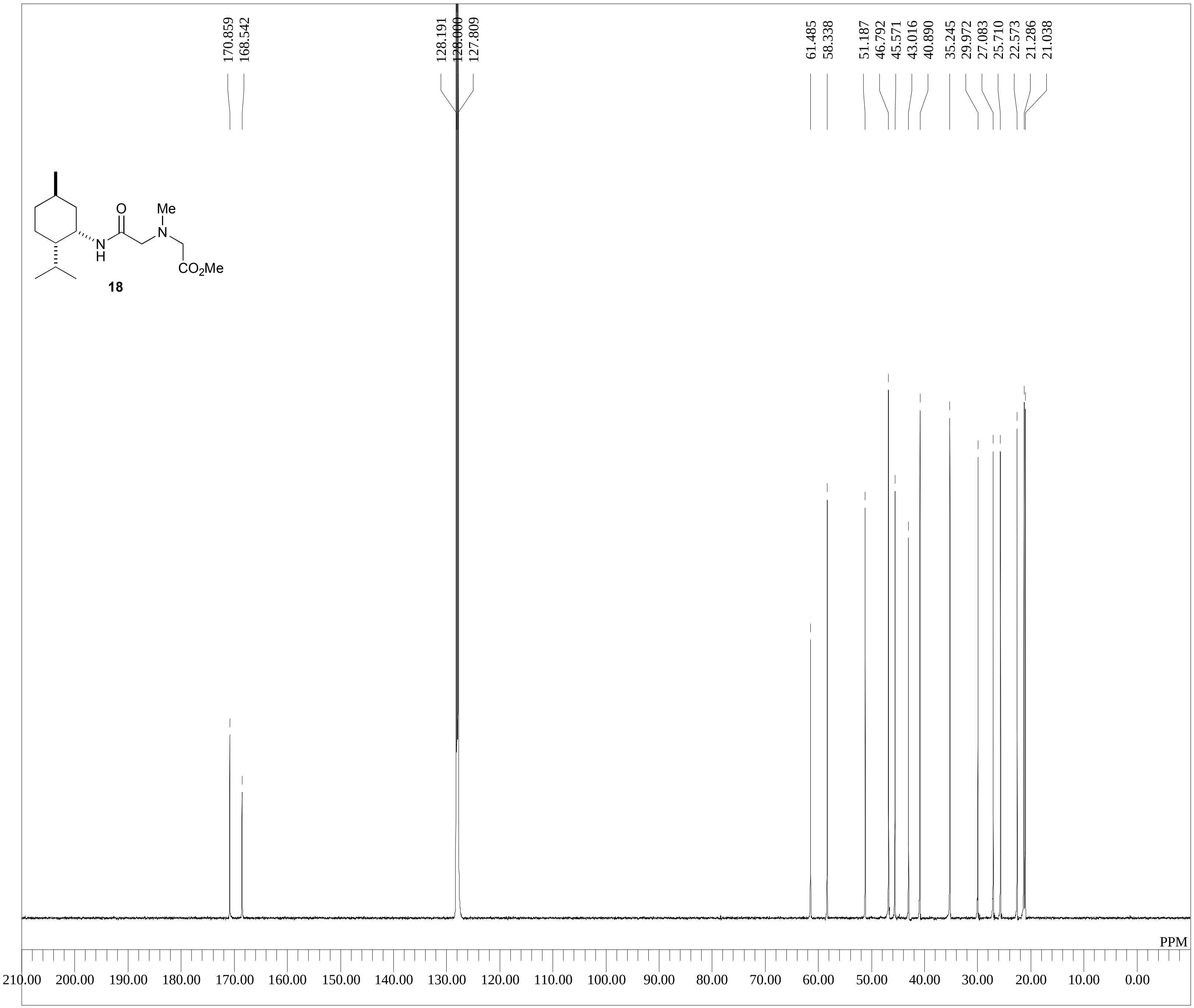
DFILE	mat 1156 sita TLC CDCl3_proton-6
COMNT	single_pulse
DATIM	2015-07-31 23:24:19
OBNUC	1H
EXMOD	proton.jxp
OBFRQ	500.16 MHz
OBSET	2.41 KHz
OBFIN	6.01 Hz
POINT	16384
FREQU	9384.38 Hz
SCANS	8
ACQTM	1.7459 sec
PD	5.0000 sec
PW1	4.68 usec
IRNUC	1H
CTEMP	23.6 c
SLVNT	CDCL3
EXREF	7.26 ppm
BF	0.12 Hz
RGAIN	40



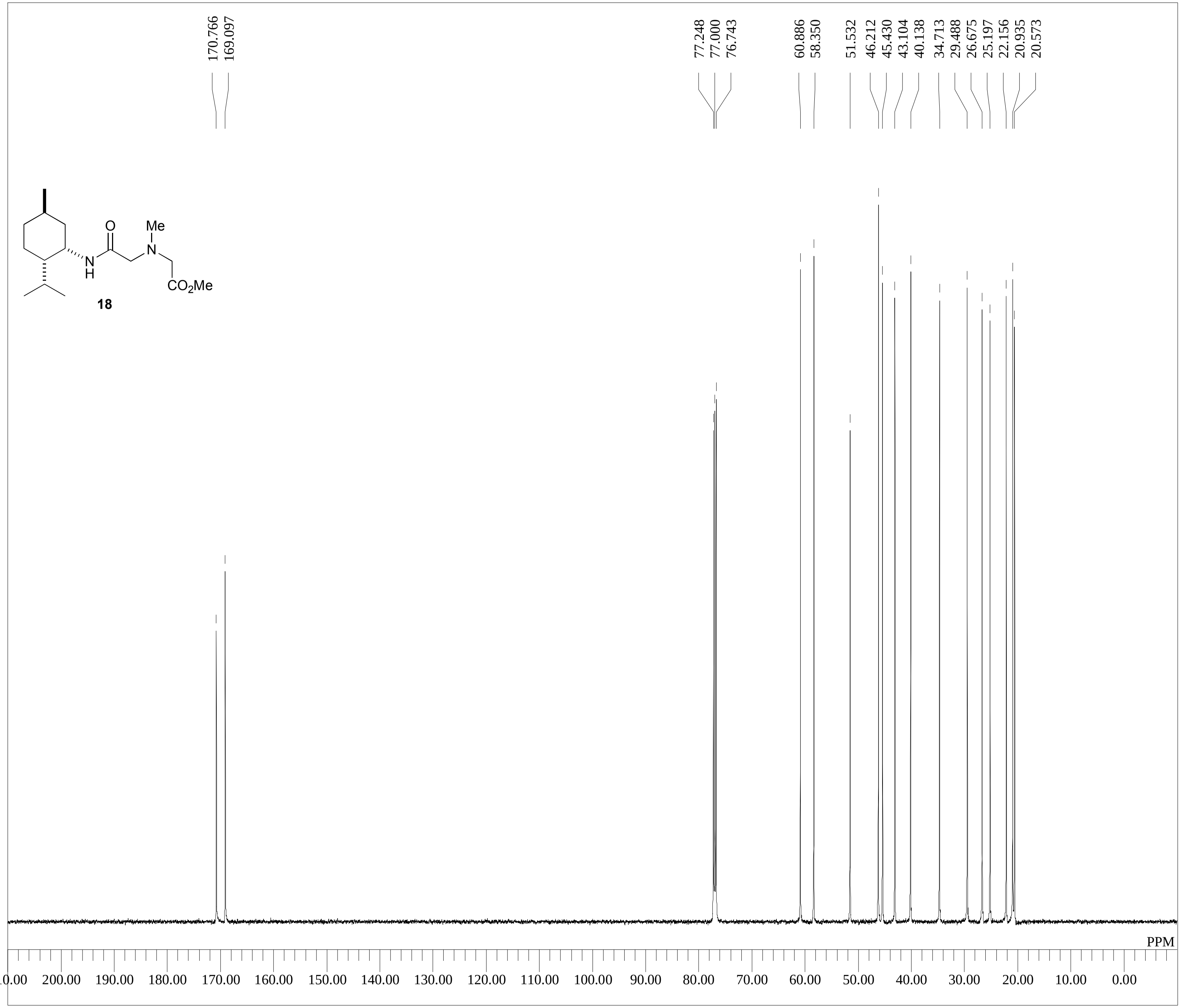
DFILE	tBu-exi carbon.als
COMNT	single pulse decoupled gated NOE
DATIM	2015-04-24 17:27:39
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	26224
FREQU	31446.54 Hz
SCANS	1024
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	21.5 c
SLVNT	CDCL3
EXREF	77.00 ppm
BF	0.12 Hz
RGAIN	50



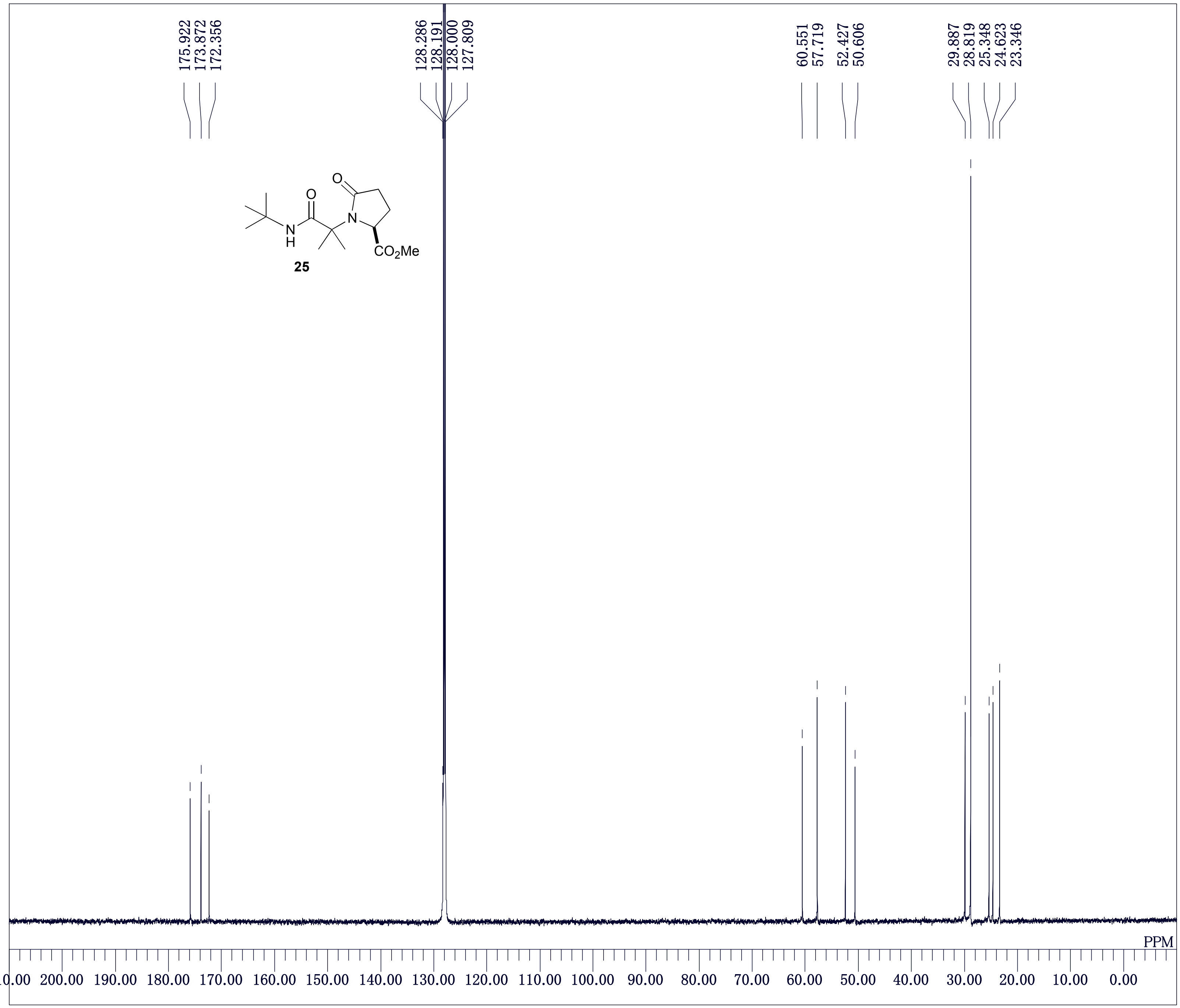
DFILE	AKI 2069 colmun2_carbon-1-1.jdf
COMNT	single pulse decoupled gated NOE
DATIM	2015-06-10 17:14:53
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32780
FREQU	39308.18 Hz
SCANS	1024
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	25.0 c
SLVNT	CDCL3
EXREF	77.00 ppm
BF	0.12 Hz
RGAIN	56



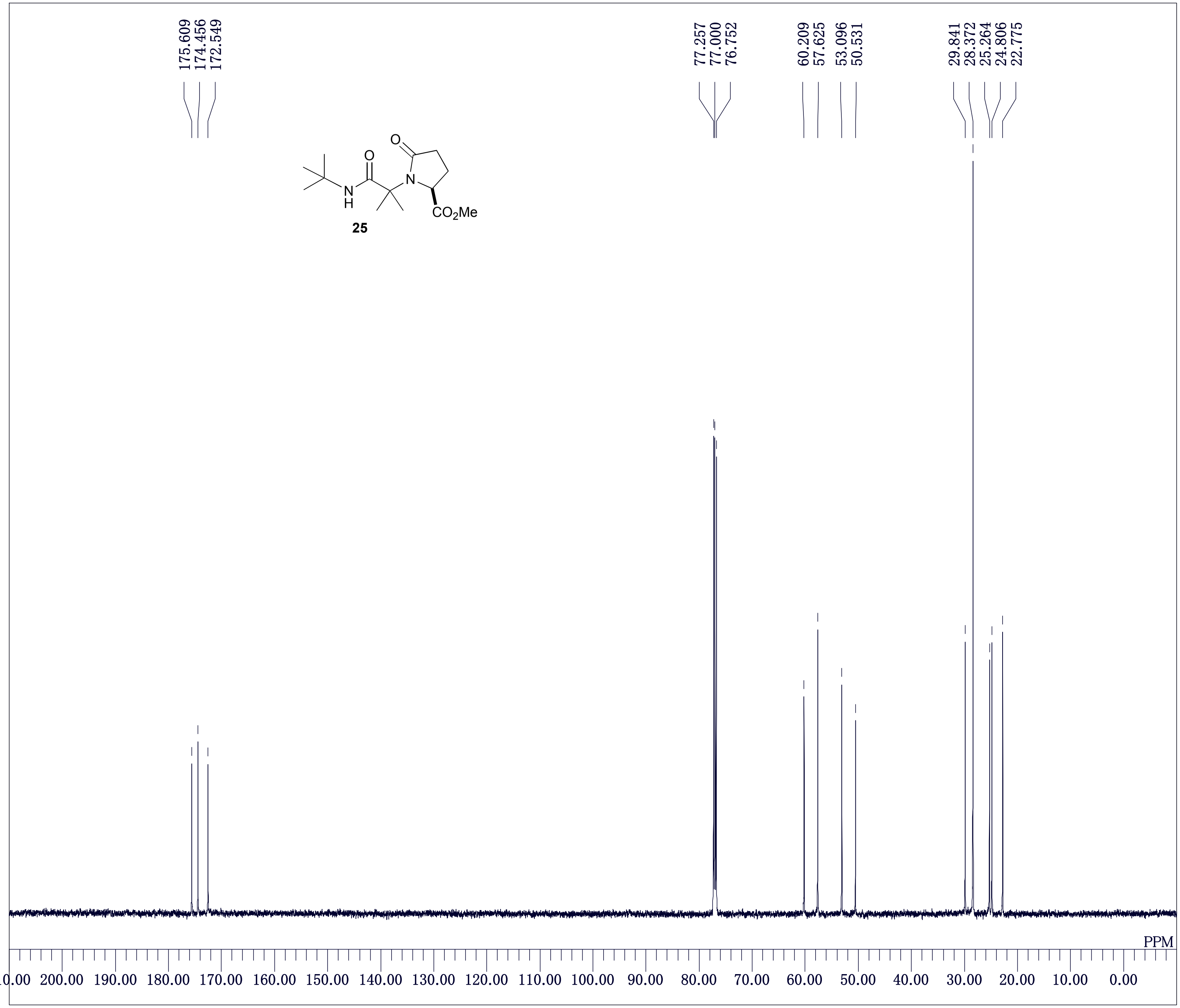
DFILE	terp exi 13c c6d6.als
COMNT	single pulse decoupled gated NOE
DATIM	2015-06-17 17:45:12
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	26224
FREQU	31446.54 Hz
SCANS	1024
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	25.8 c
SLVNT	C6D6
EXREF	128.00 ppm
BF	0.12 Hz
RGAIN	56



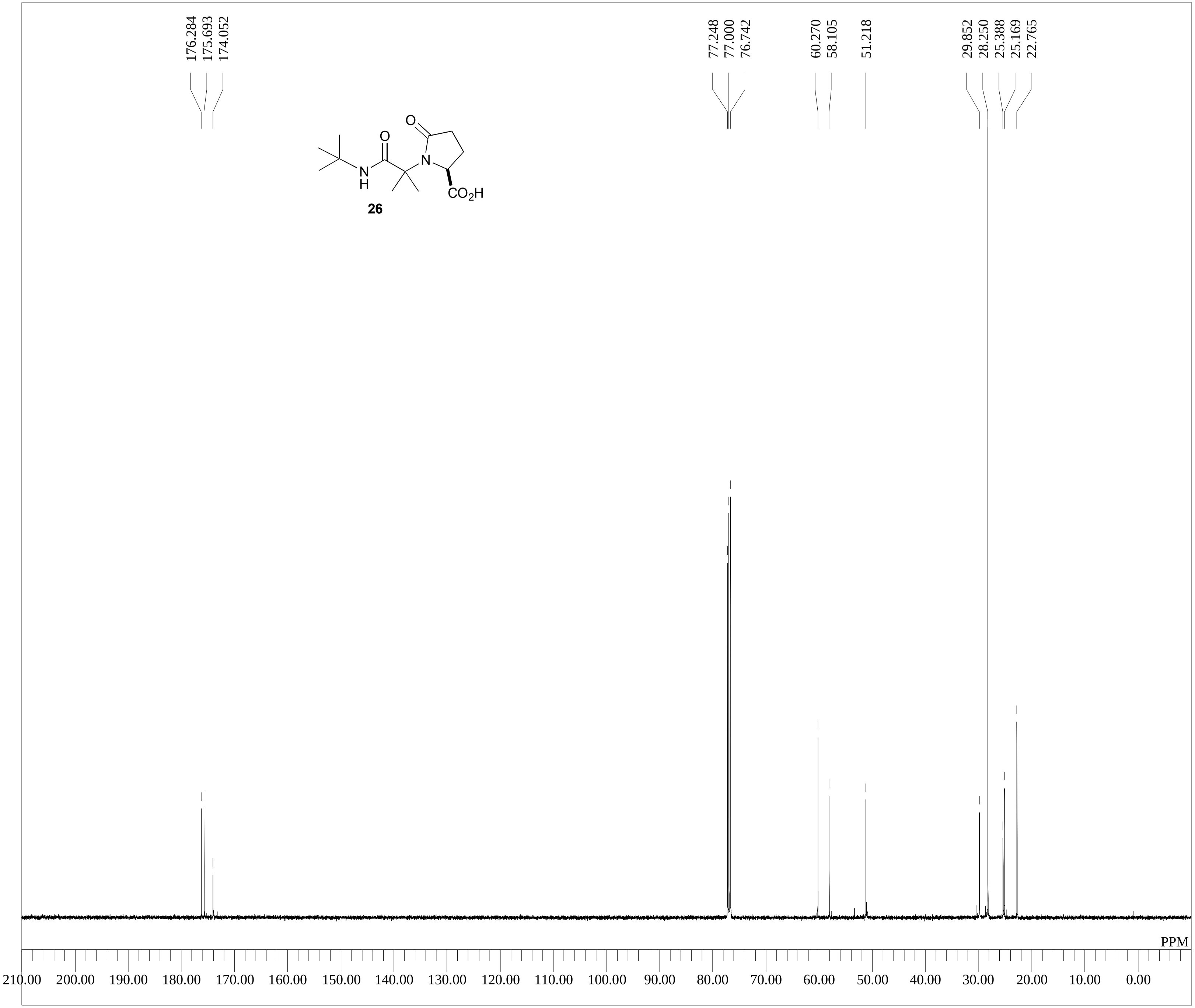
DFILE	terp exi 13c.als
COMNT	single pulse decoupled gated NOE
DATIM	2015-06-15 15:21:59
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	26224
FREQU	31446.54 Hz
SCANS	1024
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	25.3 c
SLVNT	CDCL3
EXREF	77.00 ppm
BF	0.12 Hz
RGAIN	56



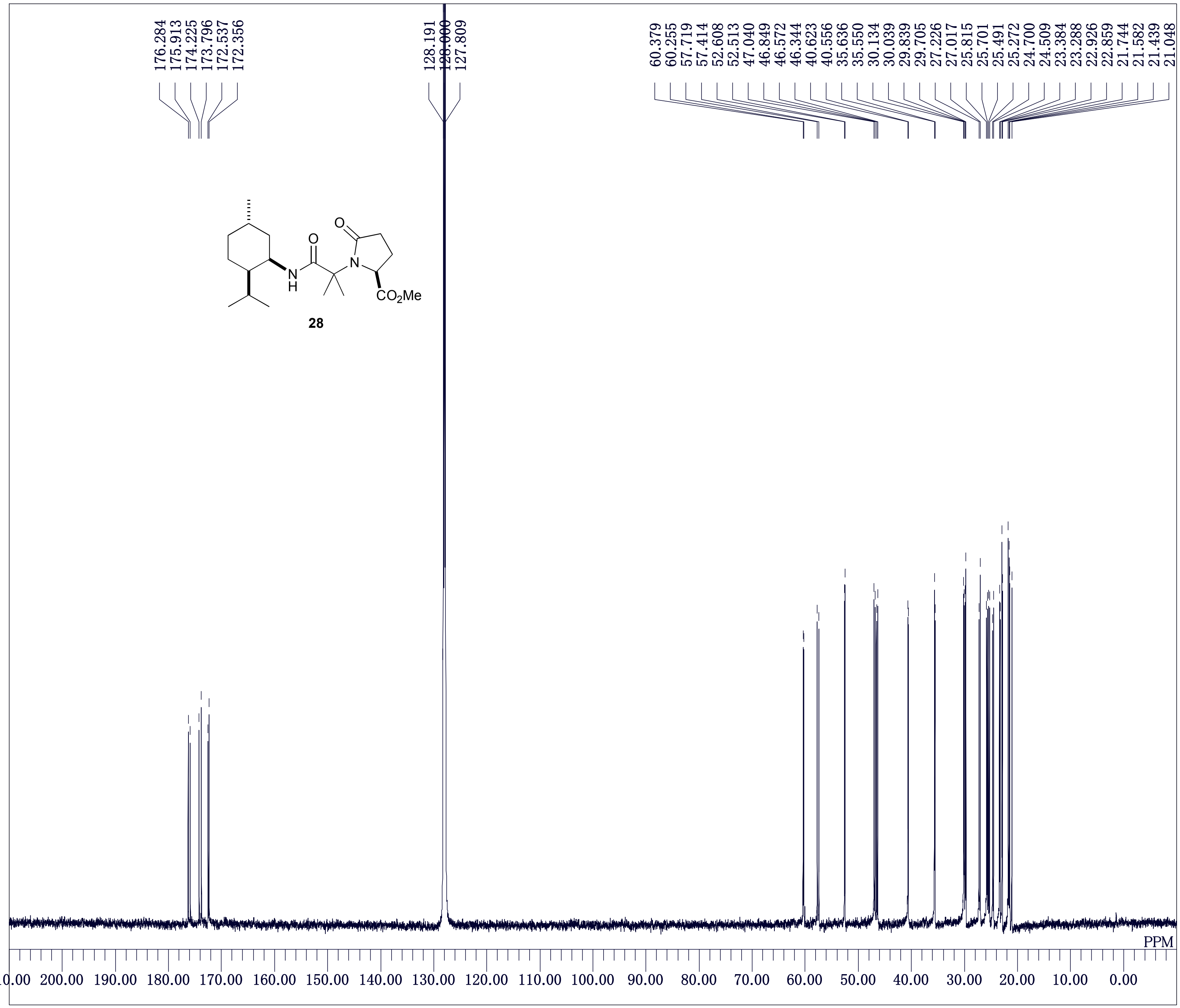
DFILE	sik-ugi-1-c6d6_Carbon-1-1.jdf
COMNT	single pulse decoupled gated NOE
DATIM	2013-01-22 22:57:45
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32780
FREQU	39308.18 Hz
SCANS	256
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	17.0 c
SLVNT	C6D6
EXREF	128.00 ppm
BF	0.12 Hz
RGAIN	50



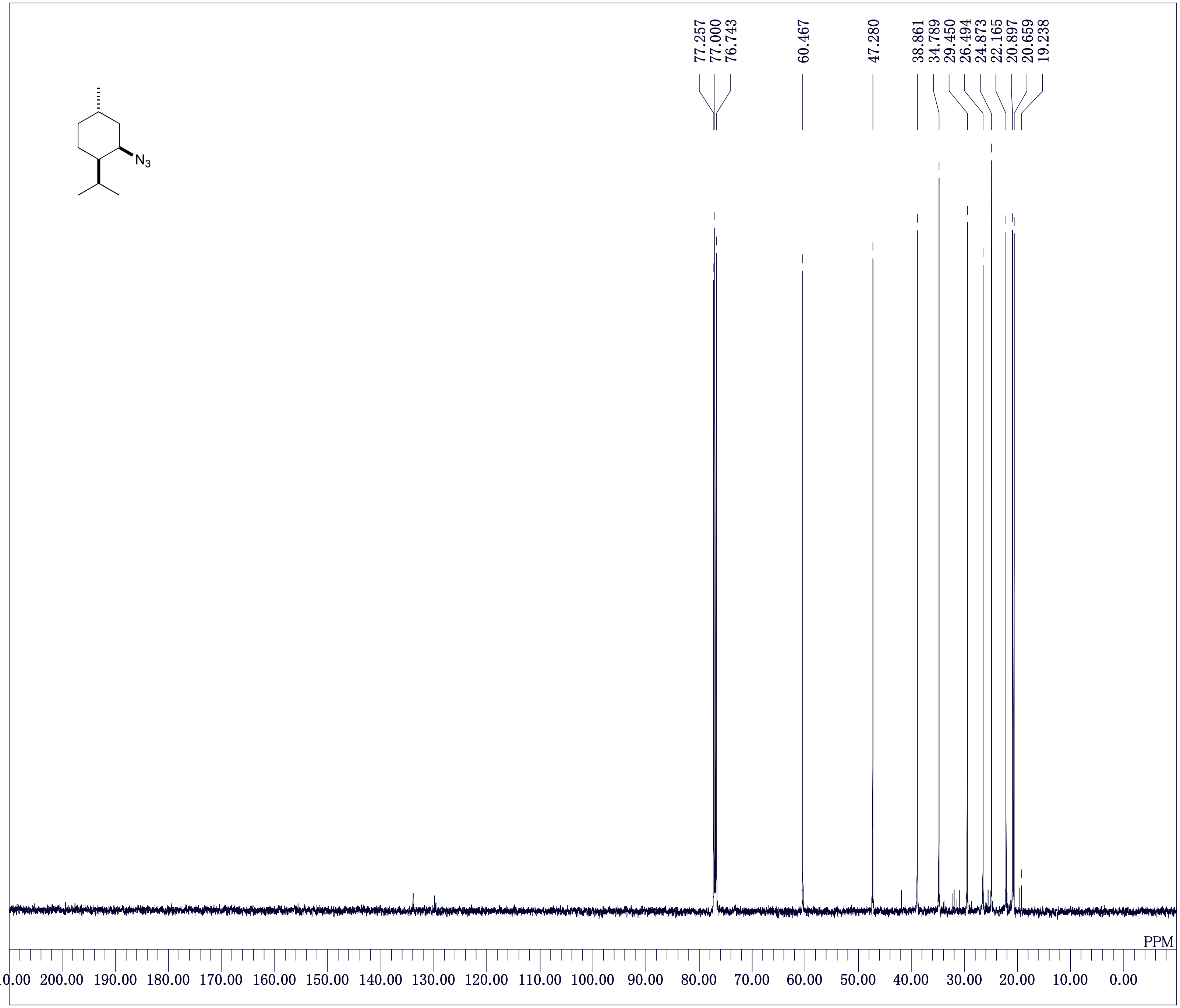
DFILE	sik-ugi-1-cdcl3_Carbon-1-1.jdf
COMNT	single pulse decoupled gated NOE
DATIM	2013-01-22 13:37:09
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32780
FREQU	39308.18 Hz
SCANS	256
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	16.9 c
SLVNT	CDCL3
EXREF	77.00 ppm
BF	0.12 Hz
RGAIN	50



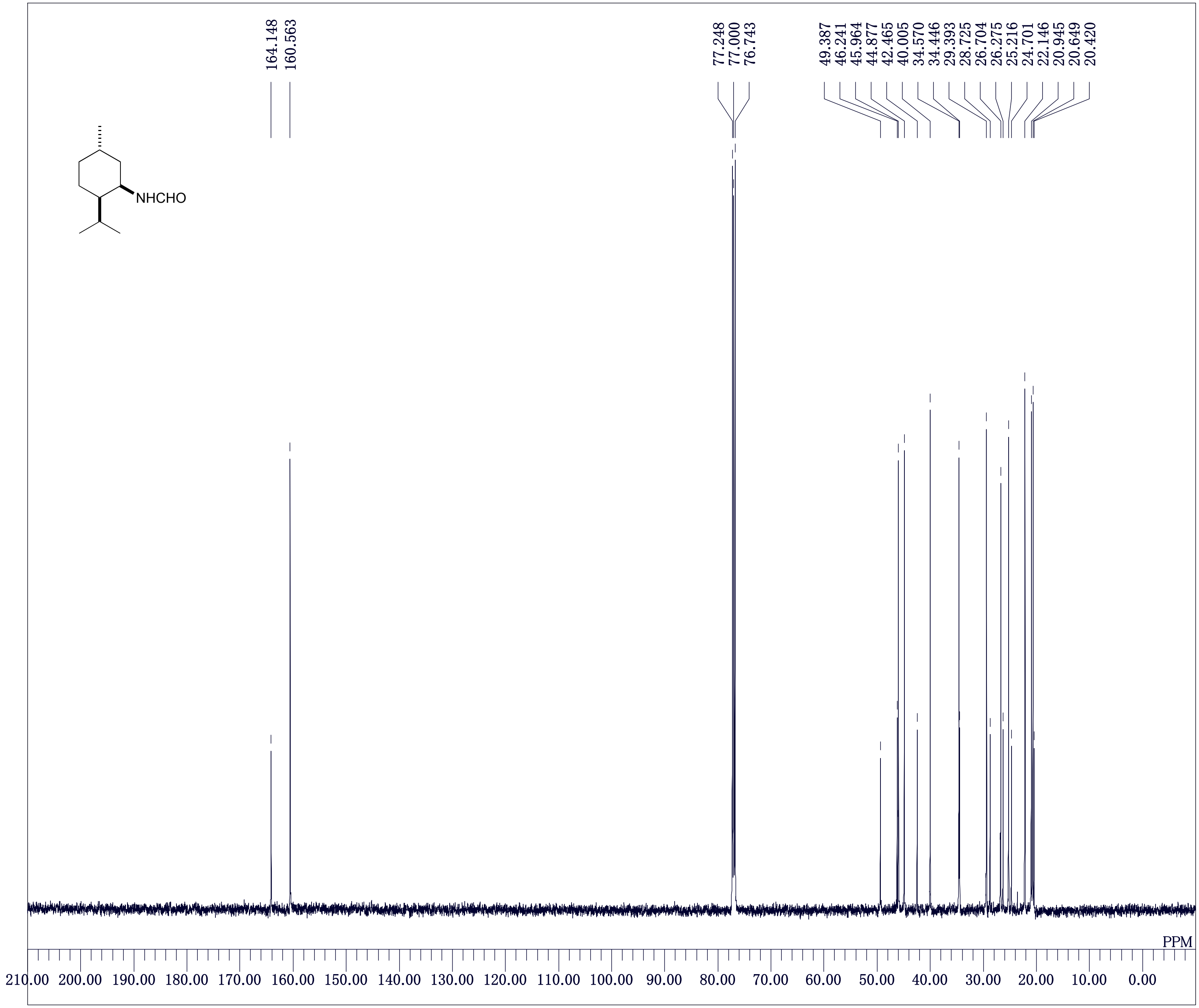
DFILE	MIM1045-COOH_carbon-1-1.jdf
COMNT	single pulse decoupled gated NOE
DATIM	2015-10-01 00:29:52
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32767
FREQU	39308.18 Hz
SCANS	1024
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	21.4 c
SLVNT	CDCL3
EXREF	77.00 ppm
BF	0.12 Hz
RGAIN	50



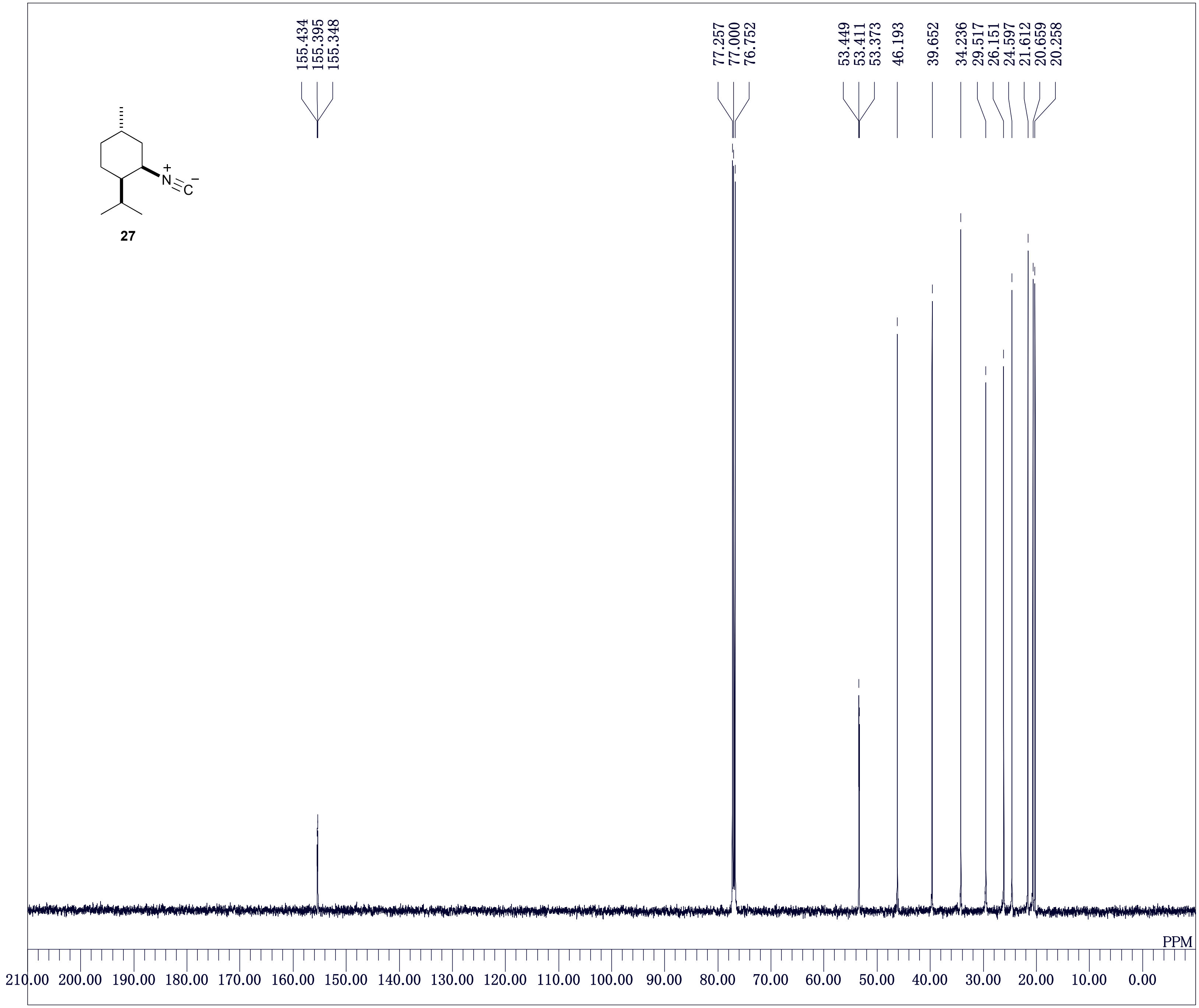
DFILE	sik-ugi-10_Carbon-1-1.jdf
COMNT	single pulse decoupled gated NOE
DATIM	2013-01-29 18:10:18
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32780
FREQU	39308.18 Hz
SCANS	256
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	17.2 c
SLVNT	C6D6
EXREF	128.00 ppm
BF	0.12 Hz
RGAIN	50



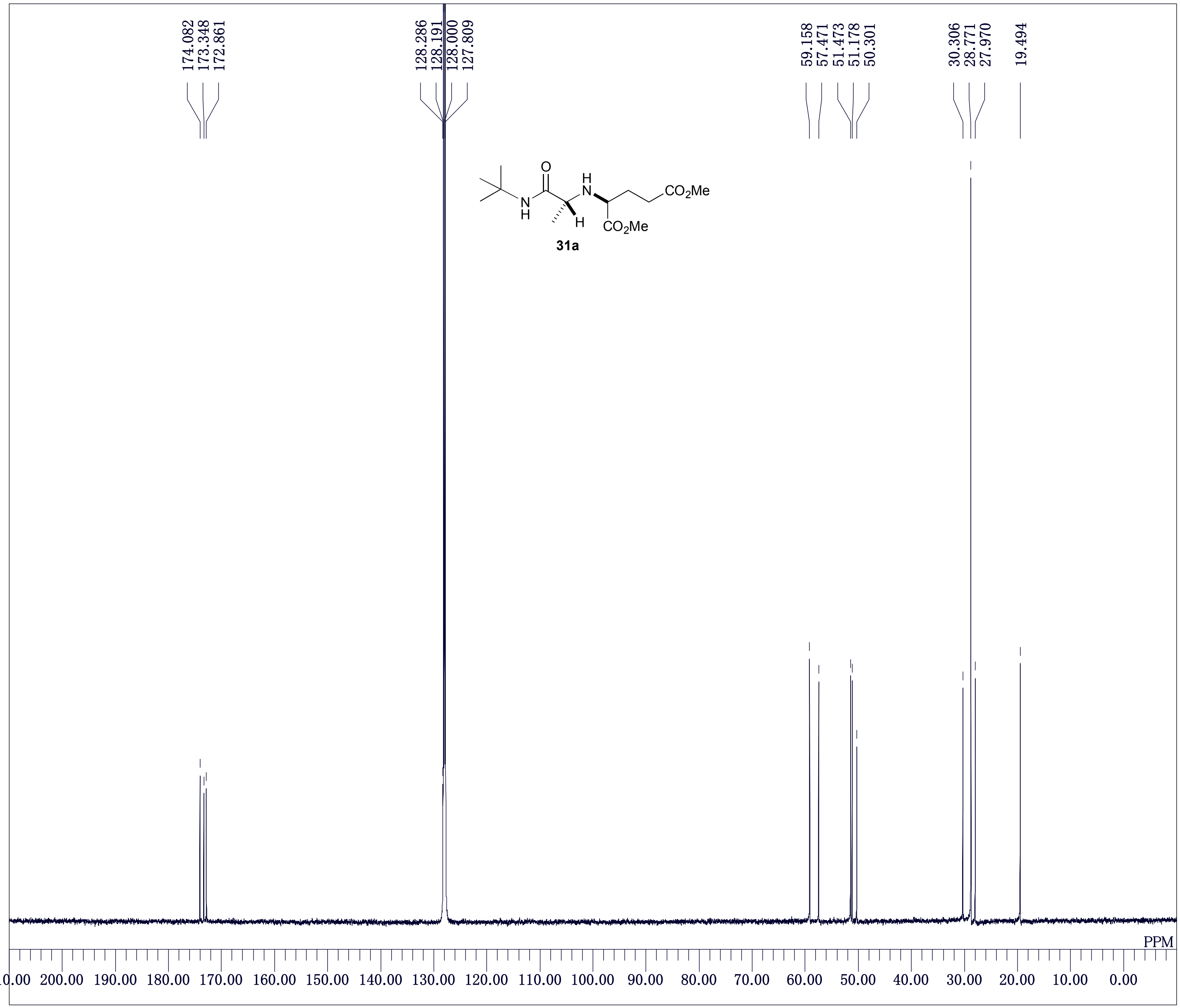
DFILE	sik-ugi-7_Carbon-1-1.jdf
COMNT	single pulse decoupled gated NOE
DATIM	2013-01-22 13:54:07
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32780
FREQU	39308.18 Hz
SCANS	256
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	17.1 c
SLVNT	CDCL3
EXREF	77.00 ppm
BF	0.12 Hz
RGAIN	50



DFILE	sik-ugi-8_Carbon-1-1.jdf
COMNT	single pulse decoupled gated NOE
DATIM	2013-01-22 14:10:12
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32780
FREQU	39308.18 Hz
SCANS	256
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	17.1 c
SLVNT	CDCL3
EXREF	77.00 ppm
BF	0.12 Hz
RGAIN	50

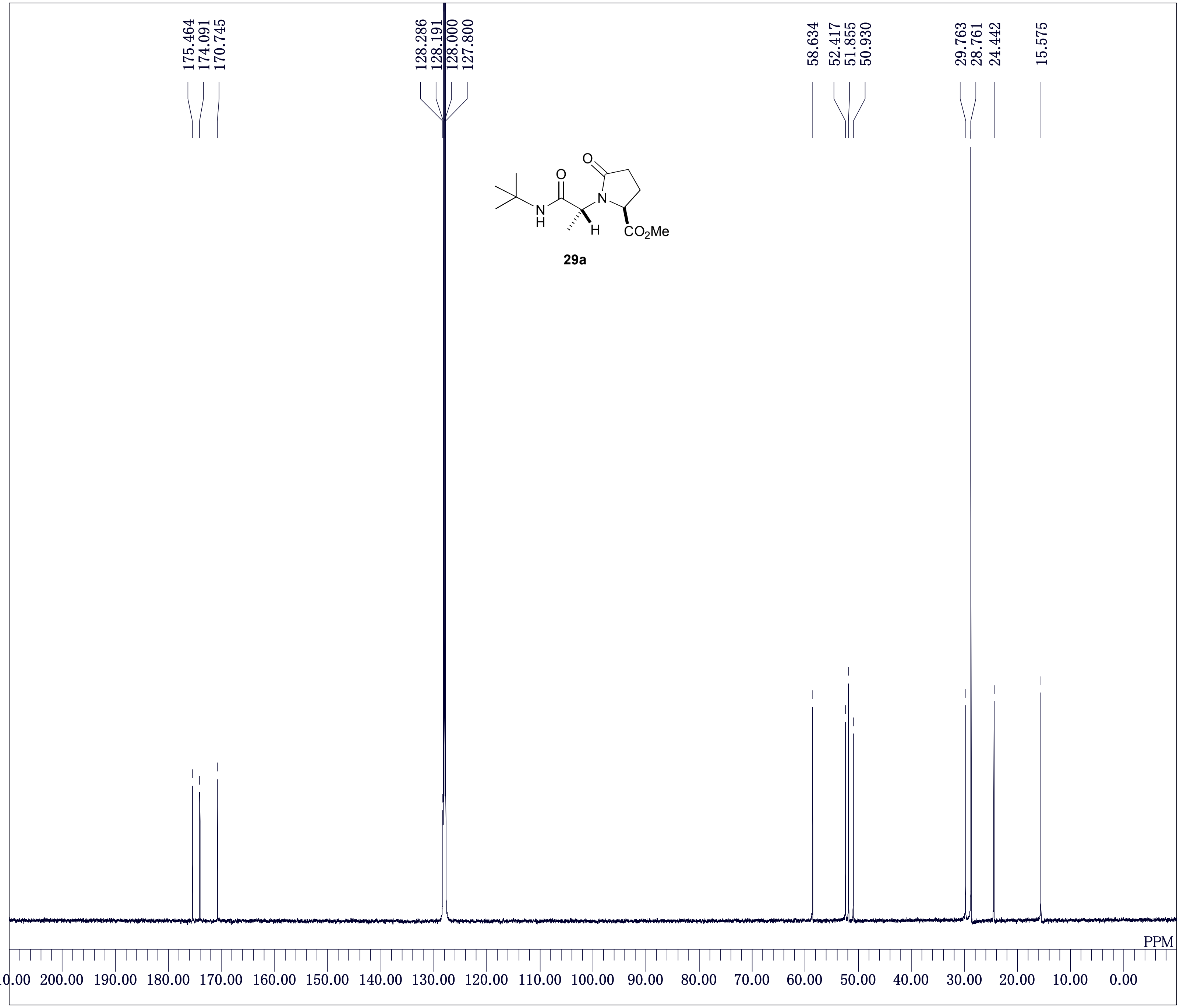


DFILE	sik-ugi-9_Carbon-1-1.jdf
COMNT	single pulse decoupled gated NOE
DATIM	2013-01-22 14:27:01
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32780
FREQU	39308.18 Hz
SCANS	256
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	17.1 c
SLVNT	CDCL3
EXREF	77.00 ppm
BF	0.12 Hz
RGAIN	50

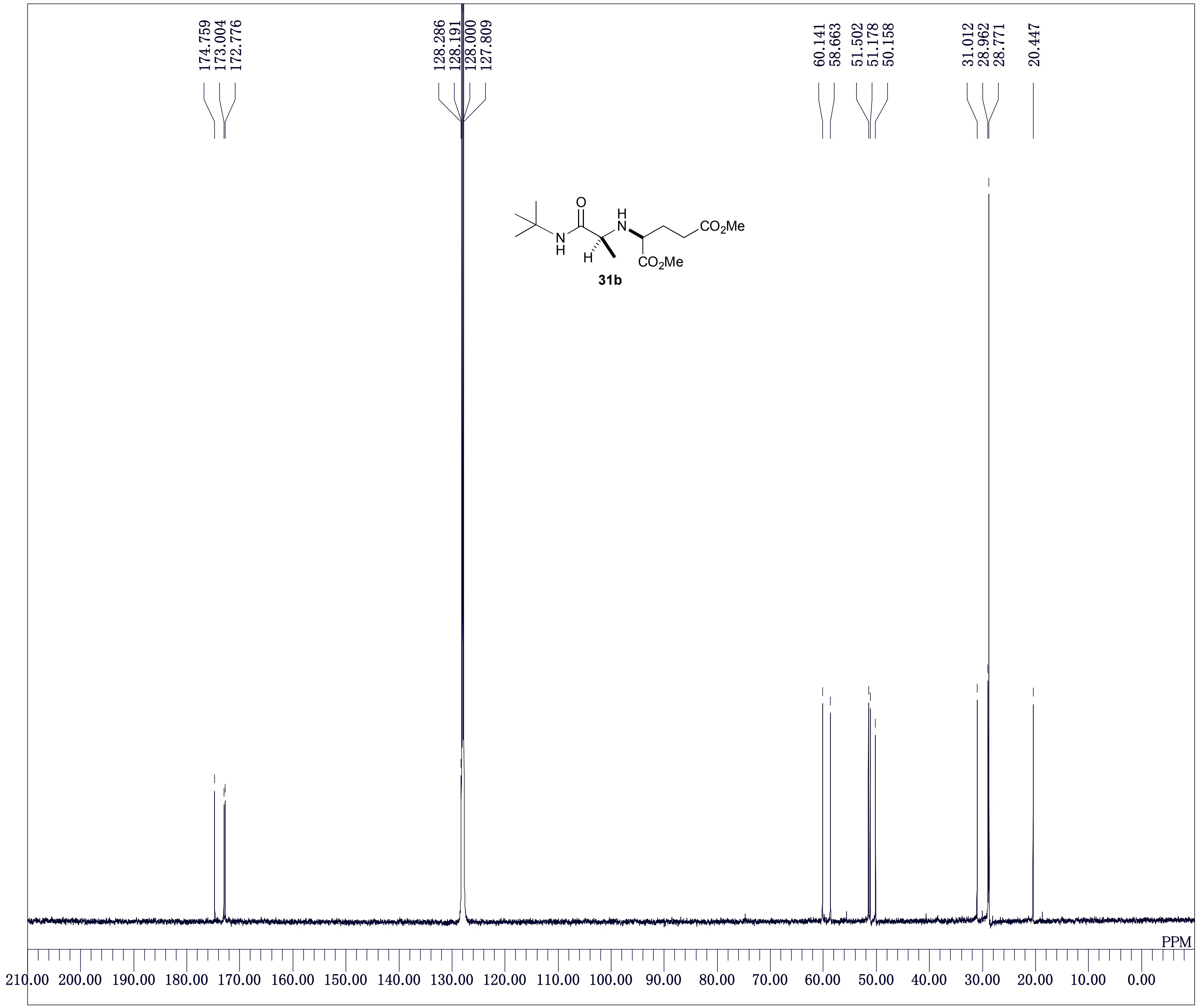


31a

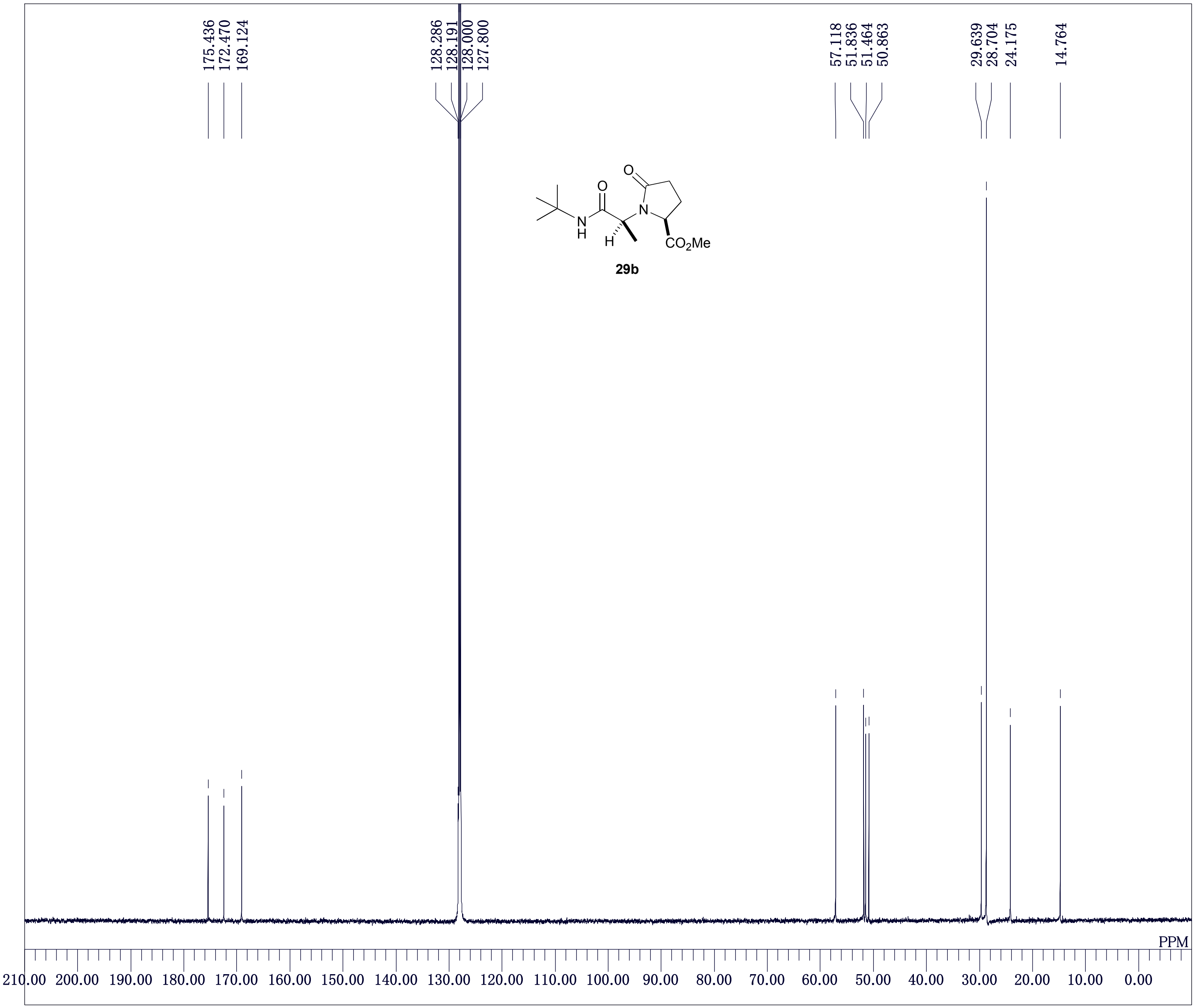
DFILE	sik-ugi-5_Carbon-2-1.jdf
COMNT	single pulse decoupled gated NOE
DATIM	2013-01-28 23:26:29
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32780
FREQU	39308.18 Hz
SCANS	256
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	17.4 c
SLVNT	C6D6
EXREF	128.00 ppm
BF	0.12 Hz
RGAIN	50



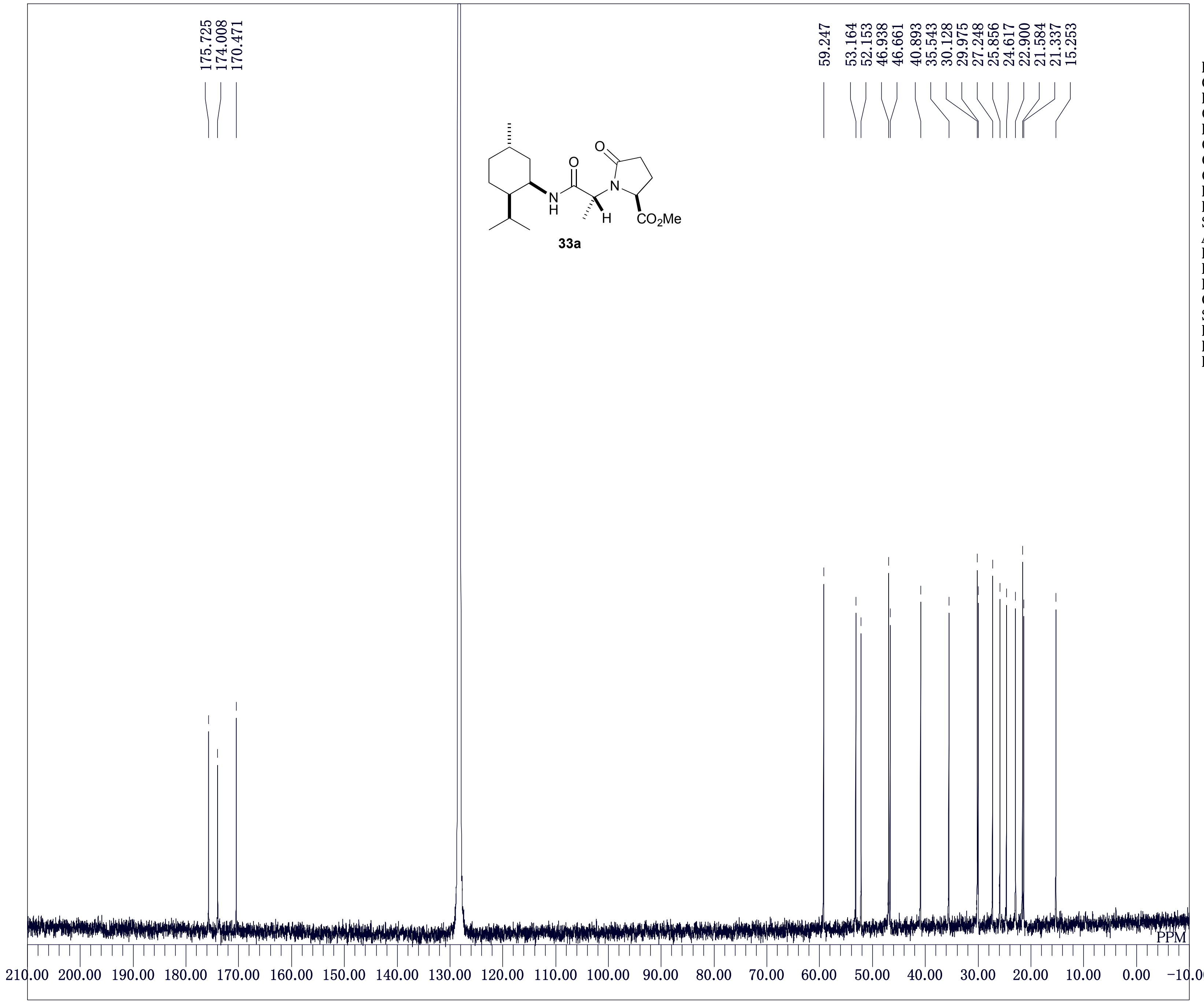
DFILE	sik-ugi-3_Carbon-1-1.jdf
COMNT	single pulse decoupled gated NOE
DATIM	2013-01-23 22:59:29
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32780
FREQU	39308.18 Hz
SCANS	256
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	16.9 c
SLVNT	C6D6
EXREF	128.00 ppm
BF	0.12 Hz
RGAIN	50



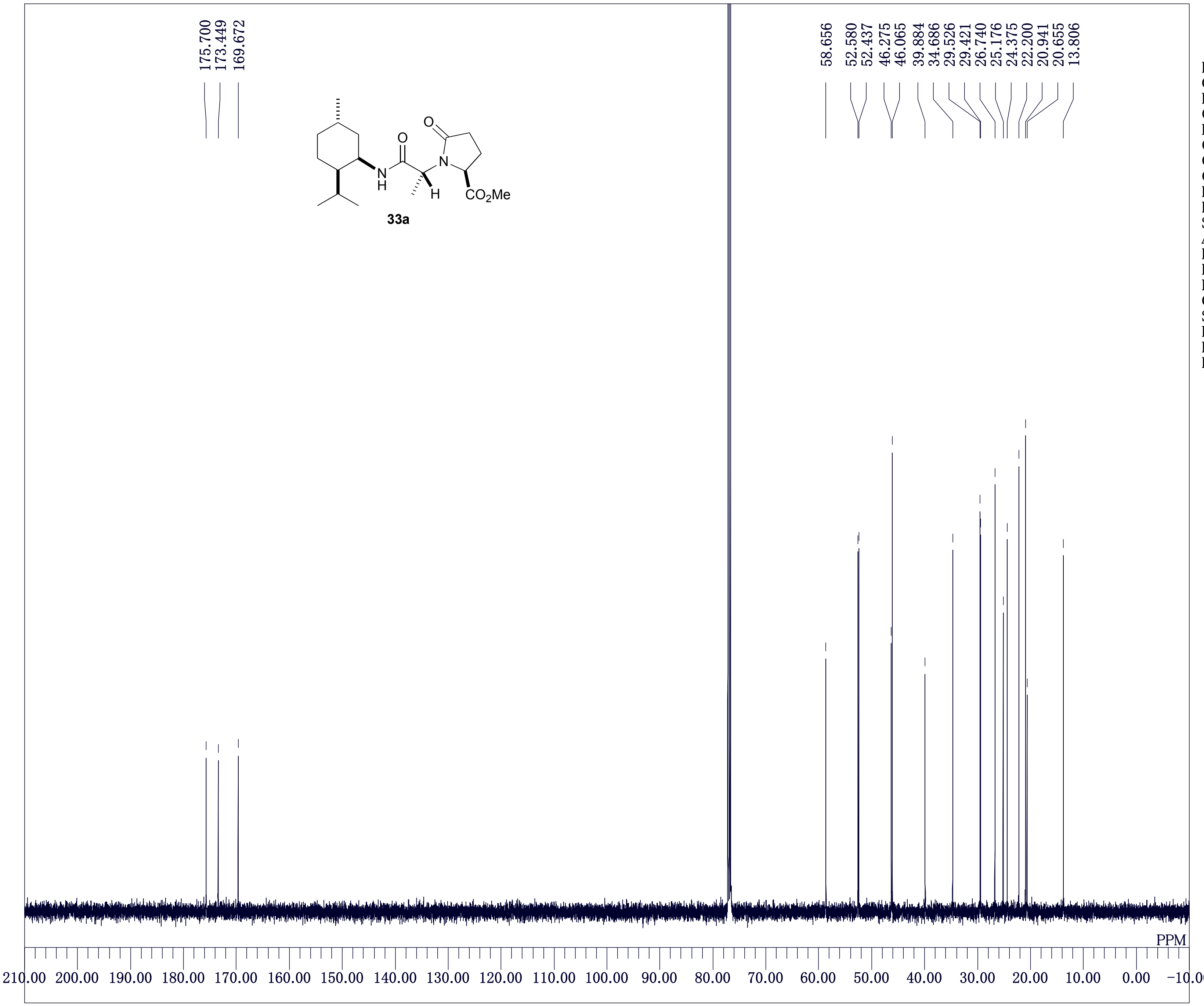
DFILE	sik-ugi-4_Carbon-2-1.jdf
COMNT	single pulse decoupled gated NOE
DATIM	2013-01-28 23:02:54
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32780
FREQU	39308.18 Hz
SCANS	256
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	17.3 c
SLVNT	C6D6
EXREF	128.00 ppm
BF	0.12 Hz
RGAIN	50



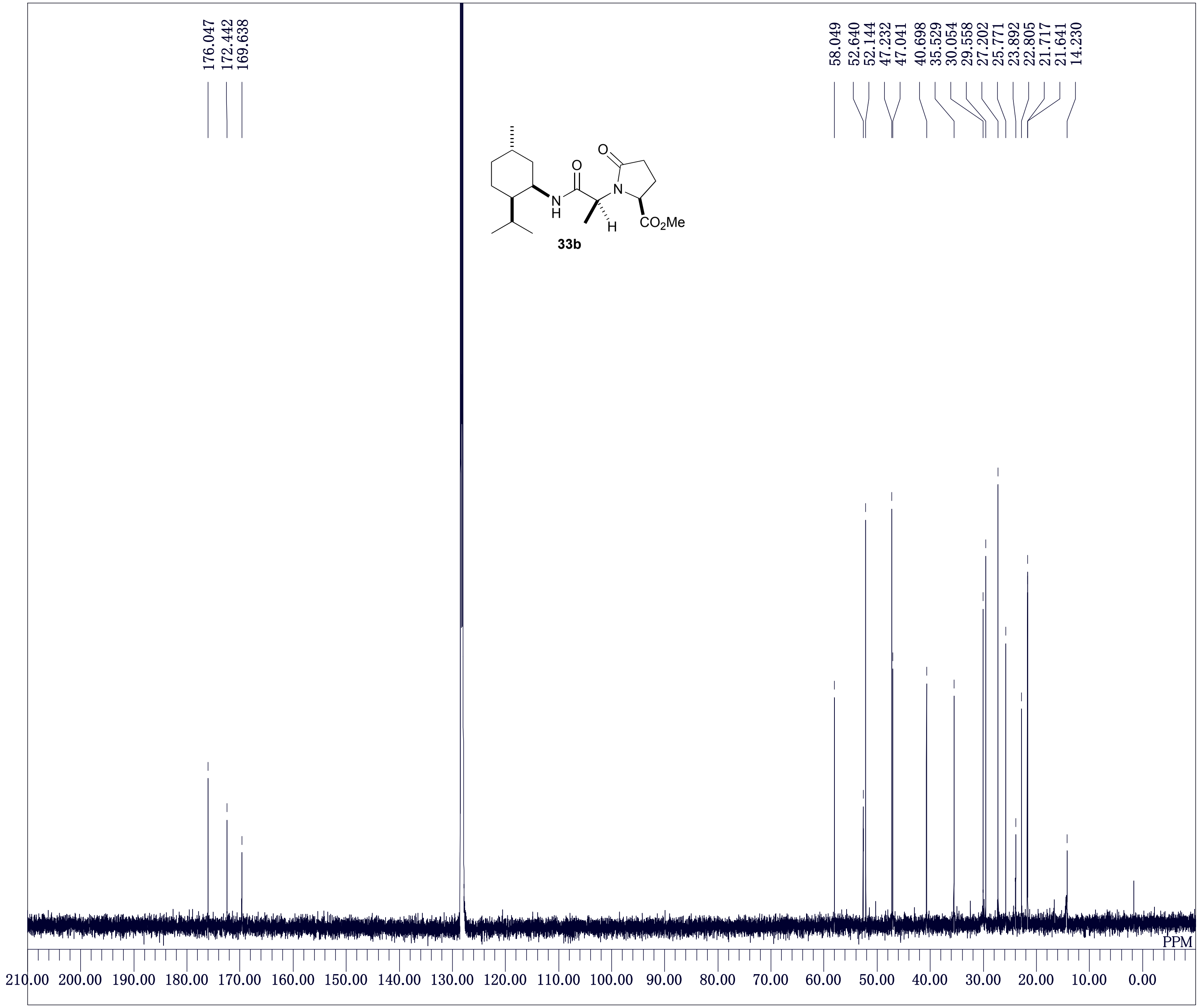
DFILE	sik-ugi-2_Carbon-1-1.jdf
COMNT	single pulse decoupled gated NOE
DATIM	2013-01-23 22:34:50
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32780
FREQU	39308.18 Hz
SCANS	256
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	17.0 c
SLVNT	C6D6
EXREF	128.00 ppm
BF	0.12 Hz
RGAIN	50



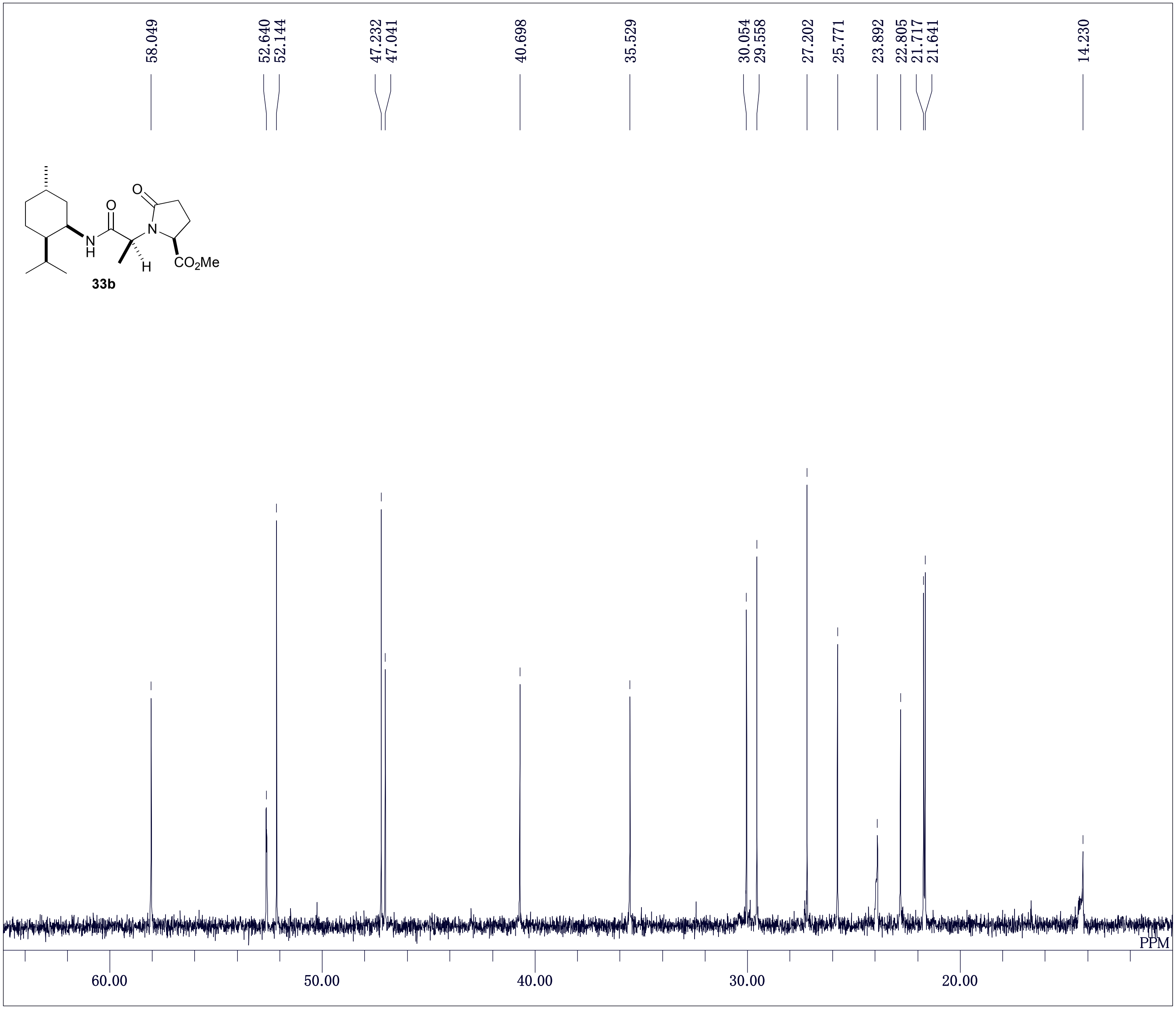
DFILE	mat1155 −2_carbon−1−1.jdf
COMNT	single pulse decoupled gated NOE
DATIM	2015−06−17 16:02:53
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32780
FREQU	39308.18 Hz
SCANS	1024
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	25.6 c
SLVNT	C6D6
EXREF	128.06 ppm
BF	0.12 Hz
RGAIN	58



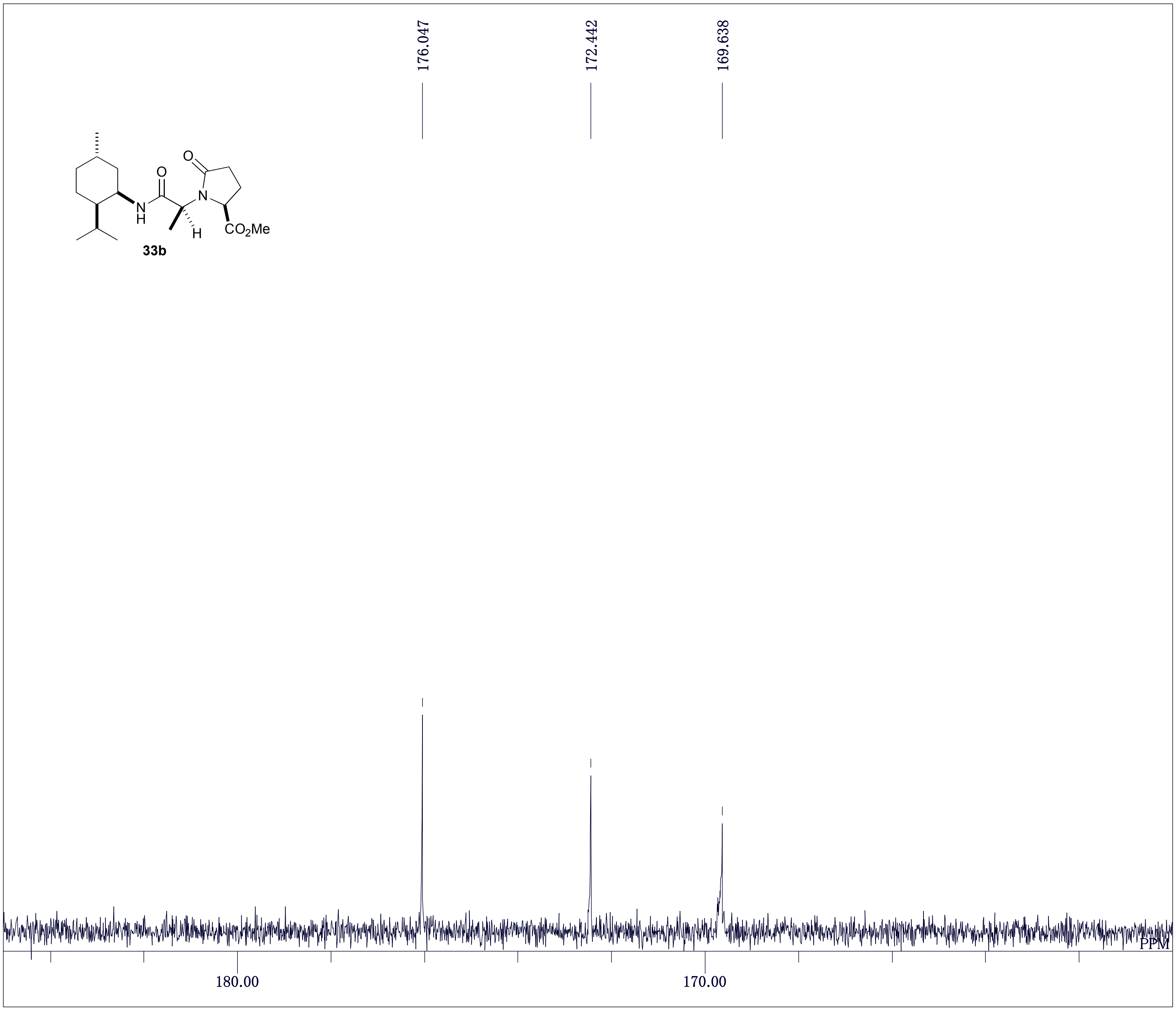
DFILE	mat1155 TLC ue CDCl3_carbon-1-1
COMNT	single pulse decoupled gated NOE
DATIM	2015-07-30 20:51:09
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32767
FREQU	39308.18 Hz
SCANS	1024
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	23.4 c
SLVNT	CDCL3
EXREF	77.16 ppm
BF	0.12 Hz
RGAIN	56



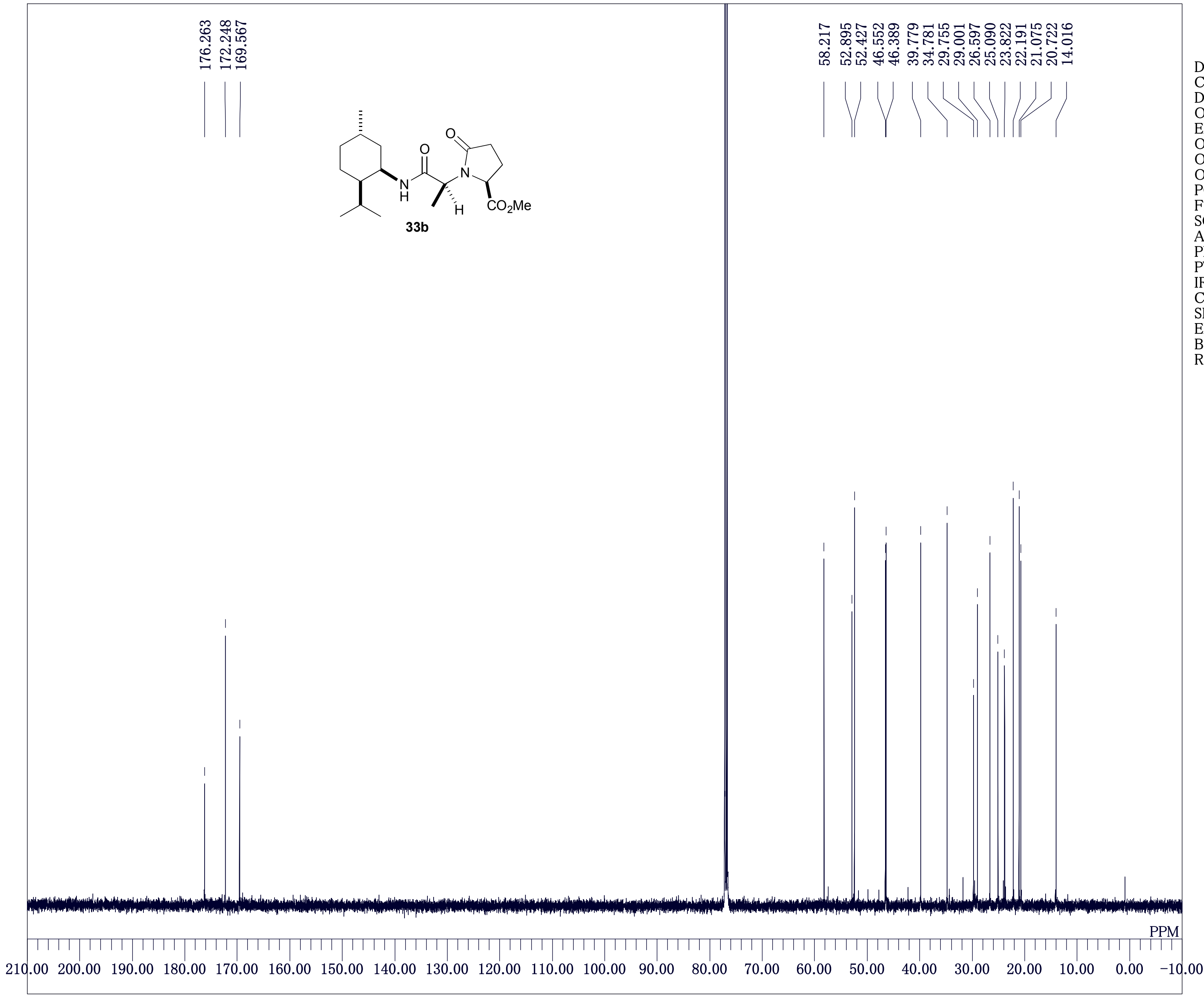
DFILE	mat1156sita-after-column_carbon_C
COMNT	single pulse decoupled gated NOE
DATIM	2015-07-24 11:22:34
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32767
FREQU	39308.18 Hz
SCANS	1329
ACQTM	0.0000 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	22.2 c
SLVNT	C6D6
EXREF	128.06 ppm
BF	0.12 Hz
RGAIN	56



DFILE	mat1156sita-after-column_carbon_C
COMNT	single pulse decoupled gated NOE
DATIM	2015-07-24 11:22:34
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32767
FREQU	39308.18 Hz
SCANS	1329
ACQTM	0.0000 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	22.2 c
SLVNT	C6D6
EXREF	128.06 ppm
BF	0.12 Hz
RGAIN	56

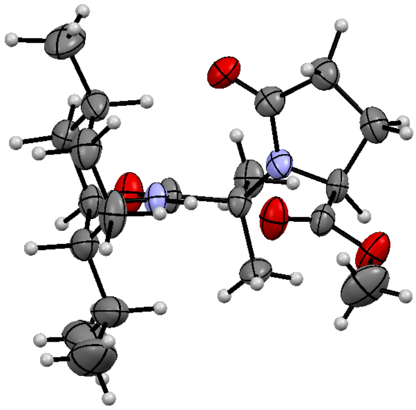


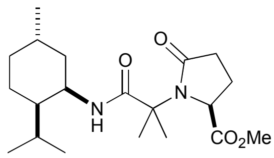
DFILE	mat1156sita-after-column_carbon_C
COMNT	single pulse decoupled gated NOE
DATIM	2015-07-24 11:22:34
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32767
FREQU	39308.18 Hz
SCANS	1329
ACQTM	0.0000 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	22.2 c
SLVNT	C6D6
EXREF	128.06 ppm
BF	0.12 Hz
RGAIN	56



DFILE	mat1156after−column−sita_carbon−1−
COMNT	single pulse decoupled gated NOE
DATIM	2015−07−23 11:54:51
OBNUC	13C
EXMOD	carbon.jxp
OBFRQ	125.77 MHz
OBSET	7.87 KHz
OBFIN	4.21 Hz
POINT	32767
FREQU	39308.18 Hz
SCANS	2048
ACQTM	0.8336 sec
PD	2.0000 sec
PW1	2.72 usec
IRNUC	1H
CTEMP	21.9 c
SLVNT	CDCL3
EXREF	77.16 ppm
BF	0.12 Hz
RGAIN	56

X-ray crystallogrpphic structure of despiro boneratamide A **28**





28

CCDC 1050947

Empirical Formula C20H33N2O4

Formula Weight 365.49

Crystal Color, Habit colorless, prism

Crystal Dimensions 0.500 X 0.500 X 0.300 mm

Crystal System triclinic

Lattice Type Primitive

Lattice Parameters a = 10.83(3) Å

b = 12.40(3) Å

c = 16.53(4) Å

a = 100.96(4) o

b = 92.29(4) o

g = 94.95(2) o

V = 2168(9) Å3

Space Group P1 (#1)

Z value 4

Dcalc 1.120 g/cm3

F000 796.00

m(MoKa)0.774 cm-1

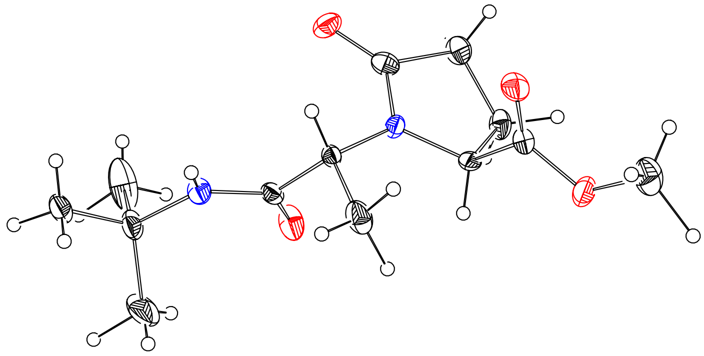
B. Intensity Measurements

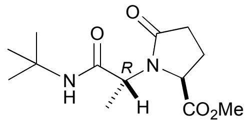
Diffractometer	XtaLAB mini
Radiation	MoKa (l = 0.71075 Å)
Voltage, Current	50kV, 12mA
Temperature	0.0^{o}C
Detector Aperture	75 mm (diameter)
Detector Position	0.00 mm
Pixel Size	0.073 mm
$2q_{max}$	55.2^{o}
No. of Reflections Measured	Total: 20594 Unique: 17267 (R_{int} = 0.0368)
Corrections	Lorentz-polarization Absorption (trans. factors: 0.755 - 0.977)

C. Structure Solution and Refinement

Structure Solution	Direct Methods
Refinement	Full-matrix least-squares on F
Function Minimized	S w (|Fo| - |Fc|)^2
Least Squares Weights	1
$2q_{max}$ cutoff	55.2^o
Anomalous Dispersion	All non-hydrogen atoms
No. Observations (All reflections)	17267
No. Variables	1073
Reflection/Parameter Ratio	16.09
Residuals: R (I>2.00s(I))	0.0799
Residuals: R (All reflections)	0.1302
Residuals: wR (All reflections)	0.1213
Goodness of Fit Indicator	8.189
Max Shift/Error in Final Cycle	2.255
Maximum peak in Final Diff. Map	0.55 $e^-/Å^3$
Minimum peak in Final Diff. Map	-0.67 $e^-/Å^3$

X-ray crystallograpphic structure of the major isomer **29a**





29a

CCDC 1050946

Empirical Formula	$C_{13}H_{22}N_2O_4$
Formula Weight	270.33
Crystal Color, Habit	colorless, prism
Crystal Dimensions	0.200 X 0.200 X 0.200 mm
Crystal System	orthorhombic
Lattice Type	Primitive
Lattice Parameters	a = 7.440(8) Å
	b = 11.634(13) Å
	c = 17.06(2) Å
	V = 1476(3) Å^3
Space Group	$P2_12_12_1$ (#19)
Z value	4
D_{calc}	1.216 g/cm^3
F_{000}	584.00
m(MoKa)	0.900 cm^{-1}

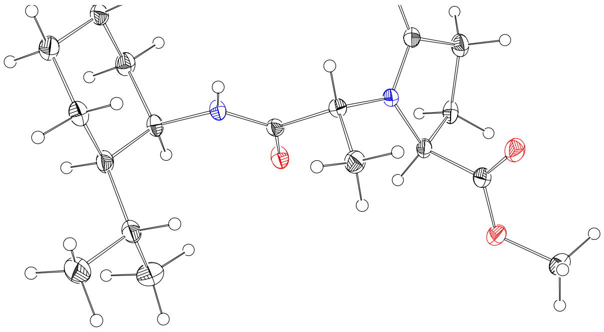
B. Intensity Measurements

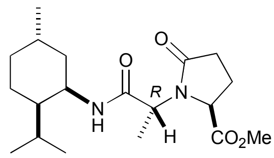
Diffractometer	XtaLAB mini
Radiation	MoKa (l = 0.71075 Å)
Voltage, Current	50kV, 12mA
Temperature	0.0^{o}C
Detector Aperture	75 mm (diameter)
Detector Position	0.00 mm
Pixel Size	0.073 mm
$2q_{max}$	55.0^{o}
No. of Reflections Measured	Total: 15732 Unique: 3408 (R_{int} = 0.1357)
Corrections	Lorentz-polarization Absorption (trans. factors: 0.668 - 0.982)

C. Structure Solution and Refinement

Structure Solution	Direct Methods (SIR92)
Refinement	Full-matrix least-squares on F
Function Minimized	S w (|Fo| - |Fc|)^2
Least Squares Weights	1
2q$_{max}$ cutoff	55.0^o
Anomalous Dispersion	All non-hydrogen atoms
No. Observations (I>4.00s(I))	1269
No. Variables	260
Reflection/Parameter Ratio	4.88
Residuals: R (I>4.00s(I))	0.0433
Residuals: wR (I>4.00s(I))	0.0467
Goodness of Fit Indicator	1.976
Max Shift/Error in Final Cycle	1.943
Maximum peak in Final Diff. Map	0.21 e^-/Å^3
Minimum peak in Final Diff. Map	-0.33 e^-/Å^3

X-ray analysis of despiro-bonaratamide B or C **33a**





33a

CCDC 1429372

Empirical Formula	$C_{19}H_{32}N_2O_4$
Formula Weight	352.47
Crystal Color, Habit	colorless, prism
Crystal Dimensions	0.500 X 0.200 X 0.100 mm
Crystal System	monoclinic
Lattice Type	Primitive
Lattice Parameters	a = 10.755(12) Å
	b = 6.736(7) Å
	c = 15.187(17) Å
	b = 109.442(10) ^{o}
	V = 1037(2) Å^3
Space Group	$P2_1$ (#4)
Z value	2
D_{calc}	1.128 g/cm^3
F_{000}	384.00
m(MoKa)	0.785 cm^{-1}

B. Intensity Measurements

Diffractometer	XtaLAB mini
Radiation	MoKa (l = 0.71075 Å)
Voltage, Current	50kV, 12mA
Temperature	$0.0^{o}C$
Detector Aperture	75.0 mm (diameter)
Detector Position	0.00 mm
Pixel Size	0.073 mm
$2q_{max}$	54.9^{o}
No. of Reflections Measured	Total: 10851 Unique: 4711 (R_{int} = 0.0725)
Corrections	Lorentz-polarization Absorption (trans. factors: 0.526 - 0.992) Secondary Extinction (coefficient: 9.17250e+001)

C. Structure Solution and Refinement

Structure Solution	Direct Methods (SIR92)
Refinement	Full-matrix least-squares on F
Function Minimized	S w (|Fo| - |Fc|)^2
Least Squares Weights	1/[0.0010Fo^2+1.0000s(Fo^2)]
2q_{max} cutoff	54.9^o
Anomalous Dispersion	All non-hydrogen atoms
No. Observations (I>0.20s(I))	4601
No. Variables	341
Reflection/Parameter Ratio	13.49
Residuals: R (I>2.00s(I))	0.0459
Residuals: R (I>0.20s(I))	0.0615
Residuals: wR (I>0.20s(I))	0.0606
Goodness of Fit Indicator	0.755
Max Shift/Error in Final Cycle	0.001
Maximum peak in Final Diff. Map	0.39 e^-/Å^3
Minimum peak in Final Diff. Map	-0.51 e^-/Å^3