

Supporting Information

Copper-Mediated Cascade C-H/N-H Annulation of Indolocarboxamides with Arynes: Construction of Tetracyclic Indoloquinoline alkaloids

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Contents

1. General information	S1
2. General procedures for the preparation of substrates	S1
3. Experimental details and characterization data	S11
4. General procedures for Cu-mediated C-H Annulation reactions	S14
5. Substrate scope of the Cu-mediated C-H annulation reactions	S15
6. X-Ray crystallographic analysis of 4 and 28	S26
7. Applications of copper-mediated C-H/N-H annulation in the construction of <i>Tetracyclic Indoloquinoline alkaloids</i>	S31
8. Preliminary mechanistic studies	S33
9. References	S36
10. Copies of ¹ H and ¹³ C NMR spectra	S37

1. General information

Solvents: Dichloromethane was distilled from CaH₂ and other solvents used in this manuscript were purchased in anhydrous form.

Reagents: All commercial materials, purchased from Aldrich, Adamas, Alfa Aesar, energy, TCI and Acros, were used as received unless otherwise noted. Cu(OAc)₂ (99.99%, Aldrich), 2-(trimethylsilyl)phenyl trifluoromethanesulfonate (97%, Energy), tetrabutylammonium iodide (TBAI) (98%, Energy) and cesium fluoride (CsF) (98%, Energy) were used in the Cu-mediated annulation reactions.

Reactions: All reactions were performed in oven-dried glassware under an atmosphere of oxygen unless otherwise noted. All yields reported were averages of at least three experimental runs.

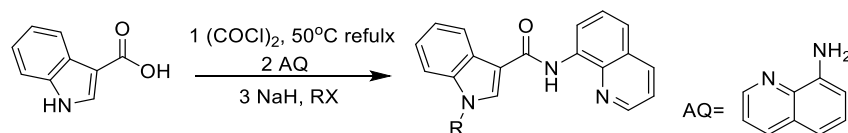
Chromatography: Thin layer chromatography (TLC) was carried out on silica gel 60 F254 pre-coated glass plates. Visualization was detected by irradiation with UV light (254 nm), or by treatment with a solution of phosphomolybdic acid in ethanol followed by heating. Flash chromatography was carried out on 200 – 300 mesh silica gel, eluting with a mixture of petroleum ether (b.p. 60 – 90 °C), ethyl acetate and dichloromethane.

NMR Spectroscopy: ¹H NMR and ¹³C NMR spectra were recorded on a Bruker AVANCE III HD 400 spectrometer, operating at 400 MHz and 100 MHz respectively. Chemical shifts (δ) were given in parts per million (ppm), and referenced relative to residual solvent CHCl₃ (7.26 ppm) in CDCl₃, or tetramethylsilane (0.00 ppm) as an internal standard for ¹H NMR spectra and deuterated solvent CDCl₃ (77.16 ppm) for ¹³C NMR spectra. Coupling constants (J) were reported in hertz (Hz). The following abbreviations are used to indicate the multiplicity of the signals: s = singlet, d = doublet, t = triplet, m = multiplet, and associated combinations, e.g. dd = doublet of doublets.

Mass Spectrometry: High resolution mass spectra (HRMS) were obtained on a Bruker Daltonics SolariX 7.0 Tesla Fourier Transform Ion Cyclotron Resonance (FT-ICR) Mass Spectrometer using the electrospray ionization (ESI) technique.

2. General procedures for the preparation of substrates

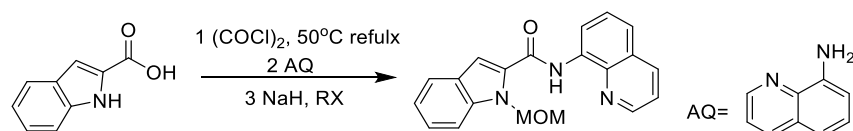
General procedure A:



According to literature procedure ^[1], 1H-indole 3-carboxylic acid (2 mmol) was heated at 50°C in oxalyl chloride (2 mL) for 1 h. The oxalyl chloride was then evaporated and the resulting solid was dissolved in anhydrous DCM (3 mL). The reaction was cooled in ice bath and 8-aminoquinoline (5 mmol) which dissolved in 3 mL DCM was added. The mixture was warmed to room temperature and stirred overnight after addition. Water (100 mL) was afterwards added and reaction mixture was extracted DCM (30 mL × 3). The organic layer was washed with a solution of HCl 10% (30 mL × 3), dried over anhydrous Na₂SO₄, filtered and concentrate in

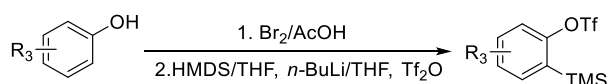
vacuum. The resulting residue was purified by flash column chromatography to give the amide. The amide was dissolved in THF (6 mL) was added in NaH (3 mmol) which dissolved in THF (9 mL) at 0°C. After addition, the mixture was warmed to room temperature and stirred for 1 h. The reaction was cooled in ice bath again and RX (3 mmol) was added. The solvent THF was then evaporated and the resulting solid was dissolved in chloroform (30 mL) and water (20 mL × 3) was afterwards added. The organic layer was dried over anhydrous Na₂SO₄, filtered and concentrate in vacuum. The resulting residue was purified by flash column chromatography to give the corresponding amide.

General procedure B:



According to literature procedure ^[1], 1*H*-indole 3-carboxylic acid (2 mmol) was heated at 50°C in oxalyl chloride (2 mL) for 1 h. The oxalyl chloride was then evaporated and the resulting solid was dissolved in anhydrous DCM (3 mL). The reaction was cooled in ice bath and 8-aminoquinoline (5 mmol) which dissolved in 3 mL DCM was added. The mixture was warmed to room temperature and stirred overnight after addition. Water (100 mL) was afterwards added and reaction mixture was extracted DCM (30 mL × 3). The organic layer was washed with a solution of HCl 10% (30 mL × 3), dried over anhydrous Na₂SO₄, filtered and concentrate in vacuum. The resulting residue was purified by flash column chromatography to give the amide. The amide was dissolved in THF (6 mL) was added in NaH (3 mmol) which dissolved in THF (9 mL) at 0°C. After addition, the mixture was warmed to room temperature and stirred for 1 h. The reaction was cooled in ice bath again and RX (3 mmol) was added. The solvent THF was then evaporated and the resulting solid was dissolved in chloroform (30 mL) and water (20 mL × 3) was afterwards added. The organic layer was dried over anhydrous Na₂SO₄, filtered and concentrate in vacuum. The resulting residue was purified by flash column chromatography to give the corresponding amide.

General procedure C:

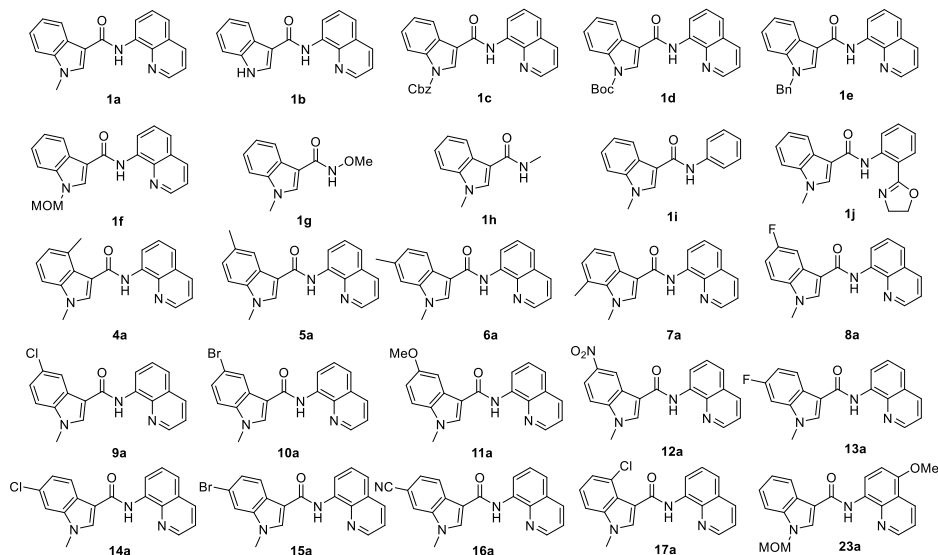


According to literature procedure^[2], to a solution of phenol (21.7 mmol) in AcOH (7 mL) was added a solution of bromine (1.0 mL, 19.4 mmol) in AcOH (4 mL) dropwise at 0 °C and the reaction mixture was stirred for 30 min at this temperature. This mixture was poured into ice and filtered off. The residual solid was washed with water and dried to afford product 2-bromophenol. To a solution of 2-bromophenol (5.58 mmol) in THF (20 mL) was added HMDS (1.2 mL, 5.65 mmol) under argon atmosphere. The reaction mixture was refluxed for 2 h. After cooling to room temperature, the solvent was removed in vacuo. The residue was dissolved in THF (30 mL) under argon atmosphere and cooled to –78 °C. To the solution was added *n*-butyllithium (2.17 mmol, 2.4 M solution in hexane) dropwise. After stirring at –78 °C for 1.5 h, Tf₂O (0.98 mL 58.4 mmol) was added to reaction mixture dropwise at –78 °C After stirring at –78 °C for 2 h, the reaction mixture was quenched with sat. NaHCO₃ aq. At –78 °C and this mixture was warmed to room temperature. The layers were separated, and then the aqueous layer was extracted with Et₂O three times. The combined organic layers were dried over Na₂SO₄. The solvent was removed in vacuo, and the residue was purified by silica gel column chromatography with

hexane to afford 2-(trimethylsilyl)phenyl trifluoromethanesulfonate as a colorless liquid.

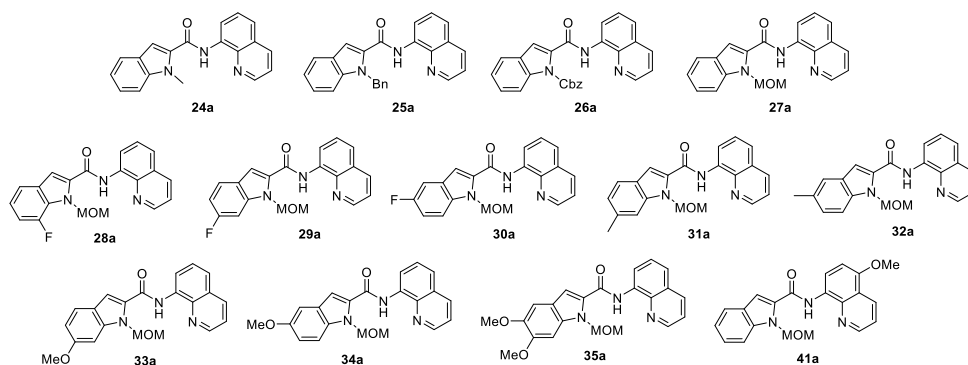
All these amides used are known compounds and were list as follows:

1) The substrates of amides **1a**^[3], **1b**, **1c**, **1d**, **1e**, **1f**, **1g**^[4], **1h**^[5], **1i**^[6], **1j**, **4a**, **5a**, **6a**, **7a**, **8a**, **9a**, **10a**, **11a**, **12a**, **13a**, **14a**, **15a**, **16a**, **17a** and **23a** were prepared according to the general procedure A.



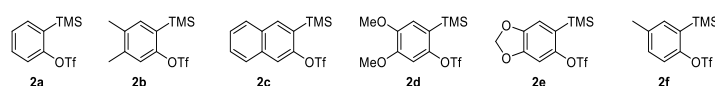
Scheme S1 Substrates of amides prepared according to the general procedure A

2) The substrates of amides **24a**^[7], **25a**, **26a**, **27a**, **28a**, **29a**, **30a**, **31a**, **32a**, **33a**, **34a**, **35a** and **43a** were prepared according to the general procedure B.

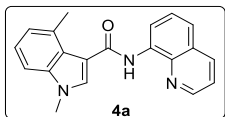


Scheme S2 Substrates of amides prepared according to the general procedure B

3) The substrates of benzyne precursors **2a**, **2b**, **2c**, **2d** and **2g** were purchased from TCI, and benzyne precursors **2e**^[2a] and **2f**^[2b] were prepared according to the general procedure C.

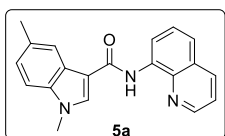


Scheme S3 Substrates of benzyne precursors



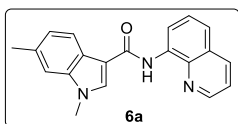
$R_f = 0.50$, 25 % EtOAc in hexanes

Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **4a** as white solid. **$^1\text{H NMR}$** (CDCl_3 , 400 MHz, ppm): δ 10.22 (s, 1 H), 8.94 (dd, $J = 7.6$, 1.1 Hz, 1 H), 8.78 (dd, $J = 4.2$, 1.6 Hz, 1 H), 8.17 (dd, $J = 8.3$, 1.6 Hz, 1 H), 7.69 (s, 1 H), 7.59 (t, $J = 7.9$ Hz, 1 H), 7.51 (dd, $J = 8.2$, 1.1 Hz, 1 H), 7.44 (dd, $J = 8.3$, 4.2 Hz, 1 H), 7.26-7.21 (m, 2 H), 7.05 (dd, $J = 5.9$, 1.3 Hz, 1 H), 3.85 (s, 3 H), 2.80 (s, 3 H); **$^{13}\text{C NMR}$** (CDCl_3 , 100 MHz, ppm) δ 164.4, 148.2, 138.7, 137.7, 136.5, 135.5, 132.5, 131.5, 128.2, 127.7, 125.0, 123.2, 123.2, 121.7, 121.1, 116.3, 114.1, 107.4, 33.5, 21.2; **HRMS**: calculated for $\text{C}_{20}\text{H}_{18}\text{N}_3\text{O}$ [$\text{M}+\text{H}^+$]: 316.1450; **found**: 316.1462.



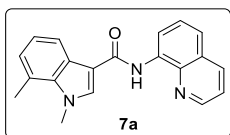
$R_f = 0.50$, 25 % EtOAc in hexanes

Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **5a** as white solid. **$^1\text{H NMR}$** (CDCl_3 , 400 MHz, ppm): δ 10.56 (s, 1 H), 8.96 (dd, $J = 7.6$, 1.1 Hz, 1 H), 8.90 (dd, $J = 4.2$, 1.6 Hz, 1 H), 8.32 (s, 1 H), 8.19 (dd, $J = 8.3$, 1.6 Hz, 1 H), 7.88 (s, 1 H), 7.60 (t, $J = 7.9$ Hz, 1 H), 7.52-7.47 (m, 2 H), 7.30 (d, $J = 8.4$ Hz, 1 H), 7.18 (d, $J = 8.4$ Hz, 1 H), 3.88 (s, 3 H), 2.59 (s, 3 H); **$^{13}\text{C NMR}$** (CDCl_3 , 100 MHz, ppm) δ 163.5, 148.2, 138.8, 136.5, 136.0, 135.6, 133.1, 131.4, 128.2, 127.8, 125.9, 124.4, 121.7, 120.84, 120.80, 116.3, 111.4, 109.9, 33.6, 21.9; **HRMS**: calculated for $\text{C}_{20}\text{H}_{18}\text{N}_3\text{O}$ [$\text{M}+\text{H}^+$]: 316.1450; **found**: 316.1459.



$R_f = 0.50$, 25 % EtOAc in hexanes

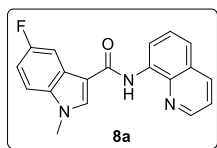
Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **6a** as white solid. **$^1\text{H NMR}$** (CDCl_3 , 400 MHz, ppm): δ 10.53 (s, 1 H), 8.96 (dd, $J = 7.6$, 1.2 Hz, 1 H), 8.89 (d, $J = 4.2$ Hz, 1 H), 8.34 (d, $J = 8.2$ Hz, 1 H), 8.18 (d, $J = 8.3$ Hz, 1 H), 7.85 (s, 1 H), 7.59 (t, $J = 7.9$ Hz, 1 H), 7.51-7.46 (m, 2 H), 7.22 (d, $J = 8.3$ Hz, 1 H), 7.20 (s, 1 H), 3.85 (s, 3 H), 2.54 (s, 3 H); **$^{13}\text{C NMR}$** (CDCl_3 , 100 MHz, ppm) δ 163.5, 148.3, 138.8, 138.0, 136.5, 135.5, 132.8, 128.2, 127.8, 123.7, 123.4, 121.7, 120.9, 120.5, 116.3, 111.8, 110.2, , 33.5, 21.9; **HRMS**: calculated for $\text{C}_{20}\text{H}_{18}\text{N}_3\text{O}$ [$\text{M}+\text{H}^+$]: 316.1450; **found**: 316.1454.



$R_f = 0.50$, 25 % EtOAc in hexanes

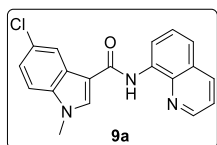
Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **7a** as white solid. **$^1\text{H NMR}$** (CDCl_3 , 400 MHz, ppm): δ 10.46 (s, 1 H), 8.94 (dd, $J = 7.7$, 1.1 Hz, 1 H), 8.84 (dd, $J = 4.2$, 1.6 Hz, 1 H), 8.31 (d, $J = 8.1$ Hz, 1 H), 8.14 (dd, $J = 8.2$, 1.6 Hz, 1 H), 7.74 (s, 1 H), 7.57 (t, $J = 8.0$ Hz, 1 H), 7.47 (dd, $J = 8.2$, 1.1 Hz, 1 H), 7.43 (dd, $J = 8.2$, 4.2 Hz, 1 H), 7.20 (t, $J = 7.6$ Hz, 1H),

7.00 (d, $J = 7.1$ Hz, 1 H), 4.90 (s, 3 H), 2.75 (s, 3 H); ^{13}C NMR (CDCl_3 , 100 MHz, ppm) δ 163.4, 148.2, 138.7, 136.4, 136.2, 135.5, 135.4, 128.1, 127.7, 126.9, 125.5, 122.1, 121.6, 120.8, 119.0, 116.3, 111.4, 37.8, 19.8; **HRMS**: calculated for $\text{C}_{20}\text{H}_{18}\text{N}_3\text{O}$ $[\text{M}+\text{H}^+]$: 316.1450; **found**: 316.1462.



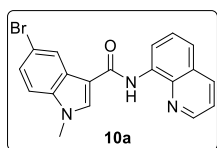
$R_f = 0.50$, 25 % EtOAc in hexanes

Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **8a** as white solid. ^1H NMR (CDCl_3 , 400 MHz, ppm): δ 10.46 (s, 1 H), 8.94-8.91 (m, 2 H), 8.20 (dd, $J = 5.5$, 1.6 Hz, 1 H), 8.18 (dd, $J = 7.4$, 2.1 Hz, 1 H), 7.94 (s, 1 H), 7.60 (t, $J = 7.9$ Hz, 1 H), 7.52 (dd, $J = 8.2$, 1.1 Hz, 1 H), 7.49 (dd, $J = 8.3$, 4.2 Hz, 1 H), 7.33 (dd, $J = 8.9$, 4.4 Hz, 1 H), 7.10 (td, $J = 8.9$, 2.4 Hz, 1 H), 3.91 (s, 3 H); ^{13}C NMR (CDCl_3 , 100 MHz, ppm) δ 163.0, 160.6, 158.2, 148.4, 138.7, 136.6, 135.3, 134.1, 134.0, 128.2, 127.7, 126.4, 126.2, 121.8, 121.1, 116.3, 111.9, 111.5, 111.2, 111.0, 110.9, 106.6, 106.4, 33.9; **HRMS**: calculated for $\text{C}_{19}\text{H}_{15}\text{FN}_3\text{O}$ $[\text{M}+\text{H}^+]$: 320.1199; **found**: 320.1205.



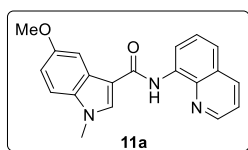
$R_f = 0.50$, 25 % EtOAc in hexanes

Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **9a** as white solid. ^1H NMR (CD_2Cl_2 , 400 MHz, ppm): δ 10.43 (s, 1 H), 8.93 (dd, $J = 4.2$, 1.6 Hz, 1 H), 8.87 (dd, $J = 7.5$, 1.4 Hz, 1 H), 8.48 (d, $J = 1.8$ Hz, 1 H), 8.26 (dd, $J = 8.3$, 1.5 Hz, 1 H), 7.97 (s, 1 H), 7.61 (t, $J = 8.1$ Hz, 1 H), 7.57-7.52 (m, 2 H), 7.38 (d, $J = 8.8$ Hz, 1 H), 7.31 (dd, $J = 8.7$, 1.9 Hz, 1 H), 3.89 (s, 3 H); ^{13}C NMR (CD_2Cl_2 , 100 MHz, ppm) δ 162.3, 160.5, 148.1, 138.2, 136.8, 135.9, 135.1, 133.5, 128.2, 127.6, 127.5, 126.9, 122.9, 121.7, 120.9, 120.5, 116.2, 111.3, 111.1, 33.6; **HRMS**: calculated for $\text{C}_{19}\text{H}_{15}\text{ClN}_3\text{O}$ $[\text{M}+\text{H}^+]$: 336.0904; **found**: 336.0909.



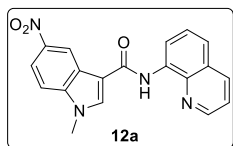
$R_f = 0.50$, 25 % EtOAc in hexanes

Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **10a** as white solid. ^1H NMR (CDCl_3 , 400 MHz, ppm): δ 10.49 (s, 1 H), 8.93-8.89 (m, 2 H), 8.72 (d, $J = 1.6$ Hz, 1 H), 8.19 (dd, $J = 8.2$, 1.4 Hz, 1 H), 7.88 (s, 1 H), 7.59 (t, $J = 7.9$ Hz, 1 H), 7.52 (dd, $J = 7.2$, 0.8 Hz, 1 H), 7.49 (dd, $J = 8.3$, 4.2 Hz, 1 H), 7.43 (dd, $J = 8.7$, 1.7 Hz, 1 H), 7.26 (t, $J = 4.4$ Hz, 1 H), 3.88 (s, 3 H); ^{13}C NMR (CDCl_3 , 100 MHz, ppm) δ 160.2, 151.7, 145.1, 141.4, 140.9, 138.7, 136.5, 136.1, 131.3, 130.0, 129.6, 129.0, 127.5, 126.9, 126.3, 125.2, 123.0, 122.1, 121.9, 117.9, 115.4, 114.3, 110.5, 107.6, 34.0; **HRMS**: calculated for $\text{C}_{19}\text{H}_{15}\text{BrN}_3\text{O}$ $[\text{M}+\text{H}^+]$: 380.0398; **found**: 380.0403.



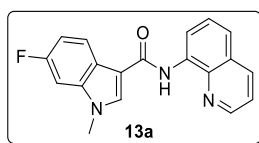
$R_f = 0.50$, 25 % EtOAc in hexanes

Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **11a** as white solid. **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 10.50 (s, 1 H), 8.97 (dd, *J* = 7.6, 0.9 Hz, 1 H), 8.84 (dd, *J* = 4.2, 1.6 Hz, 1 H), 8.19 (dd, *J* = 8.2, 1.6 Hz, 1 H), 7.99 (d, *J* = 2.3 Hz, 1 H), 7.87 (s, 1 H), 7.60 (t, *J* = 8.0 Hz, 1 H), 7.51 (dd, *J* = 8.2, 0.9 Hz, 1 H), 7.48 (dd, *J* = 8.4, 4.2 Hz, 1 H), 7.30 (d, *J* = 8.9 Hz, 1 H), 6.99 (dd, *J* = 8.9, 2.4 Hz, 1 H), 4.02 (s, 3 H), 3.88 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 163.5, 156.0, 148.1, 138.8, 136.6, 135.5, 133.1, 132.6, 128.2, 127.8, 126.2, 124.5, 121.7, 120.9, 116.3, 113.6, 111.4, 111.1, 102.0, 55.6, 33.8; **HRMS**: calculated for C₂₀H₁₈N₃O₂ [M+H⁺]: 332.1399; **found**: 332.1403.



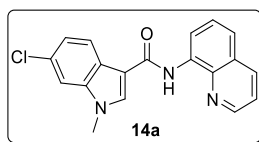
R_f = 0.50, 25 % EtOAc in hexanes

Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **12a** as yellow solid with a bad solubility. **¹H NMR** (CD₂Cl₂, 400 MHz, ppm): δ 11.70 (s, 1 H), 10.60 (s, 1 H), 9.49 (s, 1 H), 8.98 (s, 1 H), 8.86 (dd, *J* = 19.3, 7.4 Hz, 1 H), 8.34-8.21 (m, 2 H), 7.65-7.48 (m, 4 H), 3.96 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 161.7, 158.1, 149.2, 148.8, 143.6, 140.2, 139.3, 138.8, 136.6, 136.3, 135.9, 134.9, 133.4, 128.2, 127.7, 127.2, 124.9, 123.3, 122.1, 122.0, 121.5, 118.5, 118.3, 117.3, 116.4, 114.5, 110.4, 34.1; **HRMS**: calculated for C₁₉H₁₅N₄O₃ [M+H⁺]: 347.1144; **found**: 347.1142.



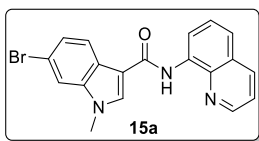
R_f = 0.50, 25 % EtOAc in hexanes

Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **13a** as white solid. **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 10.44 (s, 1 H), 8.92 (dd, *J* = 7.6, 1.2 Hz, 1 H), 8.86 (dd, *J* = 4.2, 1.6 Hz, 1 H), 8.38 (dd, *J* = 8.7, 2.5 Hz, 1 H), 8.17 (dd, *J* = 8.3, 1.6 Hz, 1 H), 7.85 (s, 1 H), 7.58 (t, *J* = 7.9 Hz, 1 H), 7.50 (dd, *J* = 8.2, 1.1 Hz, 1 H), 7.46 (dd, *J* = 8.2, 4.2 Hz, 1 H), 7.11 (td, *J* = 9.2, 2.2 Hz, 1 H), 7.04 (dd, *J* = 9.3, 2.2 Hz, 1 H), 3.83 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 163.0, 161.4, 159.0, 148.3, 138.7, 137.7, 137.6, 136.5, 135.2, 132.9, 132.87, 128.2, 127.7, 122.4, 122.2, 122.1, 121.7, 121.0, 116.3, 112.1, 110.7, 110.5, 96.8, 96.5, 33.7; **HRMS**: calculated for C₁₉H₁₅FN₃O [M+H⁺]: 320.1199; **found**: 320.1210.



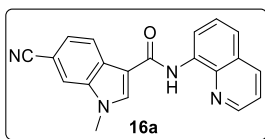
R_f = 0.50, 25 % EtOAc in hexanes

Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **14a** as white solid. **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 10.46 (s, 1 H), 8.92 (dd, *J* = 7.6, 1.2 Hz, 1 H), 8.87 (dd, *J* = 4.2, 1.6 Hz, 1 H), 8.37 (d, *J* = 8.6 Hz, 1 H), 8.18 (d, *J* = 8.2, 1.6 Hz, 1 H), 7.87 (s, 1 H), 7.59 (t, *J* = 7.9 Hz, 1 H), 7.51 (dd, *J* = 8.3, 1.2 Hz, 1 H), 7.48 (dd, *J* = 8.3, 1.2 Hz, 1 H), 7.38 (d, *J* = 1.7 Hz, 1 H), 7.33 (dd, *J* = 8.6, 1.8 Hz, 1 H), 3.86 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 162.9, 148.3, 138.7, 138.0, 136.6, 135.2, 133.2, 129.0, 128.2, 127.7, 124.4, 122.6, 122.0, 121.7, 121.1, 116.4, 112.2, 110.2, 33.7; **HRMS**: calculated for C₁₉H₁₅ClN₃O [M+H⁺]: 336.0904; **found**: 336.0914.



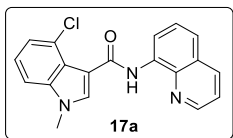
R_f = 0.50, 25 % EtOAc in hexanes

Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **15a** as white solid. $^1\text{H NMR}$ (CDCl_3 , 400 MHz, ppm): δ 10.45 (s, 1 H), 8.93-8.91 (m, 1 H), 8.87 (dd, J = 4.2, 1.5 Hz, 1 H), 8.32 (d, J = 8.5 Hz, 1 H), 8.18 (dd, J = 8.2, 1.5 Hz, 1 H), 7.85 (s, 1 H), 7.59 (t, J = 7.9 Hz, 1 H), 7.55-7.45 (m, 4 H), 3.85 (s, 3 H); $^{13}\text{C NMR}$ (CDCl_3 , 100 MHz, ppm) δ 162.8, 148.3, 138.7, 138.3, 136.5, 135.2, 133.1, 128.2, 127.7, 125.2, 124.7, 122.4, 121.7, 121.1, 116.6, 116.4, 113.3, 112.2, 33.7; **HRMS**: calculated for $\text{C}_{19}\text{H}_{15}\text{BrN}_3\text{O}$ [$\text{M}+\text{H}^+$]: 380.0398; **found**: 380.0418.



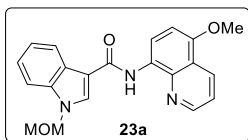
R_f = 0.50, 25 % EtOAc in hexanes

Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **16a** as white solid. $^1\text{H NMR}$ (CDCl_3 , 400 MHz, ppm): δ 10.48 (s, 1 H), 8.92-8.88 (m, 2 H), 8.21 (d, J = 7.7 Hz, 1 H), 8.07 (s, 1 H), 7.75 (s, 1 H), 7.63-7.49 (m, 4 H), 3.96 (s, 3 H); $^{13}\text{C NMR}$ (CDCl_3 , 100 MHz, ppm) δ 162.3, 148.4, 138.7, 136.7, 136.5, 135.6, 135.0, 129.0, 128.2, 127.7, 124.8, 122.1, 121.8, 121.4, 120.1, 116.5, 115.0, 112.9, 105.8, 33.9; **HRMS**: calculated for $\text{C}_{20}\text{H}_{15}\text{N}_4\text{O}$ [$\text{M}+\text{H}^+$]: 327.1246; **found**: 327.1249.



R_f = 0.50, 25 % EtOAc in hexanes

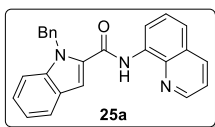
Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **17a** as white solid. $^1\text{H NMR}$ (CDCl_3 , 400 MHz, ppm): δ 10.43 (s, 1 H), 8.98 (dd, J = 7.6, 1.0 Hz, 1 H), 8.77 (dd, J = 4.2, 1.6 Hz, 1 H), 8.15 (dd, J = 8.2, 1.6 Hz, 1 H), 7.77 (s, 1 H), 7.59 (t, J = 7.8 Hz, 1 H), 7.51 (dd, J = 8.2, 1.0 Hz, 1 H), 7.42 (dd, J = 8.2, 4.2 Hz, 1 H), 7.30-7.20 (m, 3 H), 3.85 (s, 3 H); $^{13}\text{C NMR}$ (CDCl_3 , 100 MHz, ppm) δ 163.3, 148.2, 138.8, 138.6, 136.3, 135.3, 133.9, 128.2, 127.6, 126.4, 123.3, 122.9, 122.7, 121.6, 121.4, 116.7, 113.4, 108.7, 33.7; **HRMS**: calculated for $\text{C}_{19}\text{H}_{15}\text{ClN}_3\text{O}$ [$\text{M}+\text{H}^+$]: 336.0904; **found**: 334.0908.



R_f = 0.50, 25 % EtOAc in hexanes

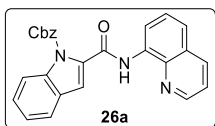
Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **22a** as white solid. $^1\text{H NMR}$ (CDCl_3 , 400 MHz, ppm): δ 10.35 (s, 1 H), 8.89 (dd, J = 4.2, 1.6 Hz, 1 H), 8.87 (d, J = 8.5 Hz, 1 H), 8.59 (dd, J = 8.4, 1.6 Hz, 1 H), 8.46 (d, J = 7.5 Hz, 1 H), 8.00 (s, 1H), 7.58 (d, J = 7.8 Hz, 1 H), 7.46 (dd, J = 8.4, 4.2 Hz, 1 H), 7.43-7.34 (m, 2 H), 6.89 (d, J = 8.6 Hz, 1H), 5.53 (s, 2 H), 4.00 (s, 3 H), 3.30 (s, 3 H); $^{13}\text{C NMR}$ (CDCl_3 , 100 MHz, ppm) δ 162.9, 150.1, 148.8,

139.4, 137.0, 132.1, 131.4, 128.7, 126.0, 123.3, 122.5, 120.9, 120.8, 120.6, 116.6, 113.5, 111.0, 104.6, 78.1, 56.3, 55.9; **HRMS**: calculated for $C_{21}H_{20}N_3O_3$ $[M+H]^+$: 362.1505; **found**: 362.1507.



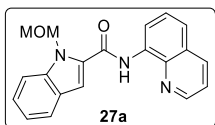
R_f = 0.50, 25 % EtOAc in hexanes

Prepared according to general procedure B. Purification of the crude product by flash column chromatography afforded the amide **24a** as white solid. **1H NMR** ($CDCl_3$, 400 MHz, ppm): δ 10.76 (s, 1 H), 8.89 (dd, J = 4.2, 1.6 Hz, 1 H), 8.85 (dd, J = 6.8, 2.2 Hz, 1 H), 8.19 (dd, J = 8.2, 1.6 Hz, 1 H), 7.77 (d, J = 7.9 Hz, 1 H), 7.58-7.52 (m, 2 H), 7.50 (dd, J = 8.2, 4.2 Hz, 1 H), 7.40-7.37 (m, 2 H), 7.31-7.18 (m, 5 H), 7.17-7.15 (m, 2 H), 5.98 (s, 2 H); **^{13}C NMR** ($CDCl_3$, 100 MHz, ppm) δ 160.6, 148.5, 139.3, 138.5, 136.5, 134.8, 132.2, 128.7, 128.2, 127.5, 127.2, 126.7, 126.5, 124.8, 122.3, 121.9, 121.7, 121.1, 116.5, 111.1, 106.0, 48.2; **HRMS**: calculated for $C_{25}H_{20}N_3O$ $[M+H]^+$: 378.1606; **found**: 368.1623.



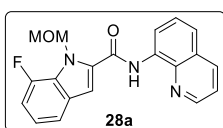
R_f = 0.50, 25 % EtOAc in hexanes

Prepared according to general procedure B. Purification of the crude product by flash column chromatography afforded the amide **25a** as white solid. **1H NMR** ($CDCl_3$, 400 MHz, ppm): δ 10.29 (s, 1 H), 8.82 (dd, J = 5.9, 2.9 Hz, 1 H), 8.75 (dd, J = 4.2, 1.7 Hz, 1 H), 8.19-8.16 (m, 2 H), 7.62 (d, J = 7.7 Hz, 1 H), 7.57-7.55 (m, 2 H), 7.46-7.39 (m, 2 H), 7.32-7.28 (m, 3 H), 7.10-7.06 (m, 2 H), 7.04-7.00 (m, 2 H), 5.37 (s, 2 H); **^{13}C NMR** ($CDCl_3$, 100 MHz, ppm) δ 160.4, 150.8, 148.4, 138.5, 137.2, 136.4, 134.9, 134.42, 134.37, 128.6, 128.5, 128.4, 128.2, 128.0, 127.5, 127.1, 126.7, 123.8, 122.2, 122.0, 121.8, 117.0, 115.5, 112.1, 69.7; **HRMS**: calculated for $C_{26}H_{20}N_3O_3$ $[M+H]^+$: 422.1499; **found**: 422.1509.



R_f = 0.50, 25 % EtOAc in hexanes

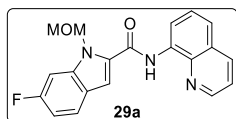
Prepared according to general procedure B. Purification of the crude product by flash column chromatography afforded the amide **26a** as white solid. **1H NMR** ($CDCl_3$, 400 MHz, ppm): δ 10.74 (s, 1 H), 8.88-8.84 (m, 2 H), 8.14 (dd, J = 8.3, 1.6 Hz, 1 H), 7.74 (d, J = 7.7 Hz, 1 H), 7.60 (dd, J = 9.1, 0.7 Hz, 1 H), 7.55 (d, J = 7.6 Hz, 1 H), 7.51 (dd, J = 8.2, 1.4 Hz, 1 H), 7.45 (dd, J = 8.2, 4.2 Hz, 1 H), 7.40-7.36 (m, 1 H), 7.34 (s, 1 H), 7.23 (td, J = 6.0, 0.8 Hz, 1 H), 6.08 (s, 2 H), 3.36 (s, 3 H); **^{13}C NMR** ($CDCl_3$, 100 MHz, ppm) δ 160.3, 148.5, 139.5, 138.6, 136.4, 134.6, 132.3, 128.1, 127.4, 126.6, 125.2, 122.3, 121.84, 121.82, 121.6, 116.5, 111.3, 107.2, 74.9, 56.2; **HRMS**: calculated for $C_{20}H_{18}N_3NaO$ $[M+Na]^+$: 354.1213; **found**: 354.1217.



R_f = 0.50, 25 % EtOAc in hexanes

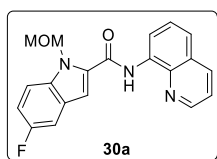
Prepared according to general procedure B. Purification of the crude product by flash column

chromatography afforded the amide **27a** as white solid. **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 10.76 (s, 1 H), 8.90-8.87 (m, 2 H), 8.2 (dd, *J* = 8.2, 1.2 Hz, 1 H), 7.61-7.55 (m, 2 H), 7.51-7.48 (m, 2 H), 7.35 (d, *J* = 1.5 Hz, 1 H), 7.15-7.04 (m, 2 H), 6.20 (s, 2 H), 3.35 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 160.0, 151.7, 149.2, 148.5, 138.7, 136.6, 134.6, 133.9, 130.3, 130.3, 128.2, 127.5, 127.3, 125.2, 122.1, 121.9, 121.7, 121.6, 118.14, 118.11, 116.8, 111.0, 110.9, 108.2, 56.1; **HRMS**: calculated for C₂₀H₁₆FN₃NaO₂ [M+Na⁺]: 372.1124; **found**: 372.1137.



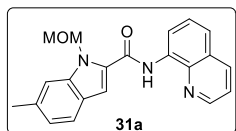
R_f = 0.50, 25 % EtOAc in hexanes

Prepared according to general procedure B. Purification of the crude product by flash column chromatography afforded the amide **28a** as white solid. **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 10.72 (s, 1 H), 8.89-8.85 (m, 2 H), 8.21 (dd, *J* = 8.3, 1.6 Hz, 1 H), 7.68 (dd, *J* = 8.7, 5.4 Hz, 1 H), 7.60 (t, *J* = 7.5 Hz, 1 H), 7.56 (dd, *J* = 8.3, 1.8 Hz, 1 H), 7.51 (dd, *J* = 8.2, 4.2 Hz, 1 H), 7.34 (s, 1 H), 7.28 (dd, *J* = 9.8, 2.2 Hz, 1 H), 7.00 (td, *J* = 9.2, 2.3 Hz, 1 H), 6.04 (s, 2 H), 3.37 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 162.9, 160.1, 148.5, 139.9, 138.7, 136.6, 134.6, 133.1, 128.2, 127.5, 123.5, 123.4, 123.1, 121.9, 116.6, 111.2, 110.9, 107.3, 97.9, 97.7, 75.3, 56.3; **HRMS**: calculated for C₂₀H₁₆FN₃NaO₂ [M+Na⁺]: 372.1124; **found**: 372.1135.



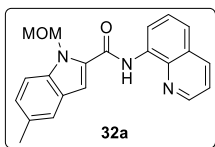
R_f = 0.50, 25 % EtOAc in hexanes

Prepared according to general procedure B. Purification of the crude product by flash column chromatography afforded the amide **29a** as white solid. **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 10.75 (s, 1 H), 8.89-8.86 (m, 2 H), 8.20 (dd, *J* = 8.3, 1.6 Hz, 1 H), 7.62-7.53 (m, 3 H), 7.50 (dd, *J* = 8.2, 4.2 Hz, 1 H), 7.38 (dd, *J* = 9.0, 2.5 Hz, 1 H), 7.30 (s, 1 H), 7.14 (td, *J* = 9.1, 2.5 Hz, 1 H), 6.07 (s, 2 H), 3.36 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 160.1, 160.0, 157.6, 148.6, 138.7, 136.6, 136.1, 134.6, 133.9, 128.2, 127.5, 127.0, 126.9, 122.1, 122.0, 116.6, 114.2, 113.9, 112.5, 112.4, 106.84, 106.80, 106.6, 75.2, 56.2; **HRMS**: calculated for C₂₀H₁₆FN₃NaO₂ [M+Na⁺]: 372.1124; **found**: 372.1130.



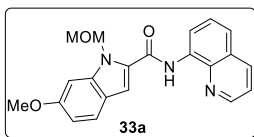
R_f = 0.50, 25 % EtOAc in hexanes

Prepared according to general procedure B. Purification of the crude product by flash column chromatography afforded the amide **30a** as white solid. **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 10.73 (s, 1 H), 8.89-8.96 (m, 2 H), 8.19 (dd, *J* = 8.2, 1.4 Hz, 1 H), 7.63 (d, *J* = 8.1 Hz, 1 H), 7.59 (t, *J* = 7.8 Hz, 1 H), 7.54 (dd, *J* = 8.2, 1.3 Hz, 1 H), 7.49 (dd, *J* = 8.2, 4.2 Hz, 1 H), 7.40 (s, 1 H), 7.32 (s, 1 H), 7.07 (d, *J* = 8.1 Hz, 1 H), 6.07 (s, 2 H), 3.38 (s, 3 H), 2.53 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 160.5, 148.5, 140.1, 138.7, 136.5, 135.5, 134.8, 131.8, 128.2, 127.5, 124.5, 123.7, 121.91, 121.89, 121.8, 116.5, 111.1, 107.3, 74.9, 56.2, 22.3; **HRMS**: calculated for C₂₁H₁₉N₃NaO₂ [M+Na⁺]: 368.1375; **found**: 368.1378.



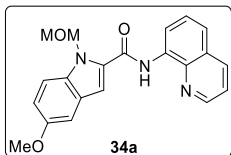
$R_f = 0.50$, 25 % EtOAc in hexanes

Prepared according to general procedure B. Purification of the crude product by flash column chromatography afforded the amide **31a** as white solid. **^1H NMR** (CDCl_3 , 400 MHz, ppm): δ 10.74 (s, 1 H), 8.88-8.86 (m, 2 H), 8.18 (dd, $J = 8.2, 1.6$ Hz, 1 H), 7.58 (t, $J = 7.8$ Hz, 1 H), 7.55-7.47 (m, 4 H), 7.26 (d, $J = 9.3$ Hz, 1 H), 7.21 (dd, $J = 8.5, 1.3$ Hz, 1 H), 6.07 (s, 2 H), 3.35 (s, 3 H), 2.48 (s, 3 H); **^{13}C NMR** (CDCl_3 , 100 MHz, ppm) δ 160.5, 148.5, 138.7, 138.1, 136.5, 134.8, 132.4, 131.0, 128.2, 127.5, 127.1, 126.9, 121.9, 121.8, 121.7, 116.5, 111.0, 106.8, 75.0, 56.1, 21.6; **HRMS**: calculated for $\text{C}_{21}\text{H}_{19}\text{N}_3\text{NaO}_2$ [$\text{M}+\text{Na}^+$]: 368.1375; **found**: 368.1383.



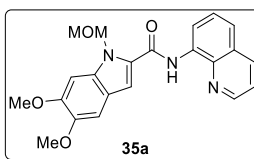
$R_f = 0.50$, 25 % EtOAc in hexanes

Prepared according to general procedure B. Purification of the crude product by flash column chromatography afforded the amide **32a** as white solid. **^1H NMR** (CDCl_3 , 400 MHz, ppm): δ 10.69 (s, 1 H), 8.88-8.84 (m, 2 H), 8.18 (dd, $J = 8.2, 1.6$ Hz, 1 H), 7.61 (d, $J = 8.7$ Hz, 1 H), 7.57 (d, $J = 7.6$ Hz, 1 H), 7.53 (dd, $J = 8.2, 1.4$ Hz, 1 H), 7.48 (dd, $J = 8.2, 4.2$, 1 H), 7.30 (s, 1 H), 7.02 (d, $J = 2.0$ Hz, 1 H), 6.90 (dd, $J = 8.7, 2.2$ Hz, 1 H), 6.07 (s, 2 H), 3.91 (s, 3 H), 3.38 (s, 3 H); **^{13}C NMR** (CDCl_3 , 100 MHz, ppm) δ 160.4, 158.8, 148.4, 140.8, 138.7, 136.5, 134.8, 131.3, 128.2, 127.5, 123.0, 121.9, 121.6, 120.7, 116.4, 112.8, 107.6, 93.7, 75.0, 56.1, 55.7; **HRMS**: calculated for $\text{C}_{21}\text{H}_{19}\text{N}_3\text{NaO}_3$ [$\text{M}+\text{Na}^+$]: 384.1324; **found**: 384.1325.



$R_f = 0.50$, 25 % EtOAc in hexanes

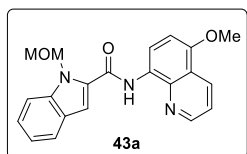
Prepared according to general procedure B. Purification of the crude product by flash column chromatography afforded the amide **33a** as white solid. **^1H NMR** (CDCl_3 , 400 MHz, ppm): δ 10.74 (s, 1 H), 8.89-8.86 (m, 2 H), 8.20 (dd, $J = 8.3, 1.6$ Hz, 1 H), 7.59 (t, $J = 7.8$ Hz, 1 H), 7.55 (dd, $J = 8.3, 1.6$ Hz, 1 H), 7.52-7.48 (m, 2 H), 7.29 (s, 1 H), 7.17 (d, $J = 2.4$ Hz, 1 H), 7.06 (dd, $J = 9.0, 2.5$ Hz, 1 H), 6.06 (s, 2 H), 3.89 (s, 3 H), 3.36 (s, 3 H); **^{13}C NMR** (CDCl_3 , 100 MHz, ppm) δ 160.4, 155.4, 148.5, 138.7, 136.5, 134.9, 134.7, 132.7, 128.2, 127.6, 127.0, 121.9, 121.8, 116.5, 116.3, 112.3, 106.8, 102.7, 75.1, 56.1, 55.9; **HRMS**: calculated for $\text{C}_{21}\text{H}_{19}\text{N}_3\text{NaO}_3$ [$\text{M}+\text{Na}^+$]: 384.1324; **found**: 384.1339.



$R_f = 0.50$, 25 % EtOAc in hexanes

Prepared according to general procedure B. Purification of the crude product by flash column chromatography afforded the amide **34a** as white solid. **^1H NMR** (CDCl_3 , 400 MHz, ppm): δ 10.68 (s, 1 H),

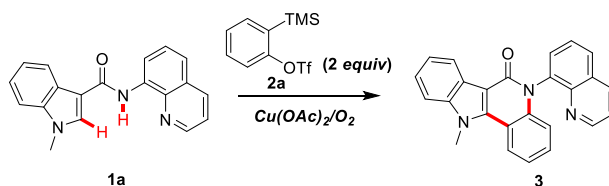
8.88-8.84 (m, 2 H), 8.19 (dd, $J = 8.3, 1.7$ Hz, 1 H), 7.59 (t, $J = 7.8$ Hz, 1 H), 7.53 (dd, $J = 8.3, 1.4$ Hz, 1 H), 7.49 (dd, $J = 8.3, 4.2$ Hz, 1 H), 7.28 (s, 1 H), 7.14 (s, 1 H), 7.03 (s, 1 H), 6.08 (s, 2 H), 4.00 (s, 3 H), 3.96 (s, 3 H), 3.38 (s, 3 H); ^{13}C NMR (CDCl_3 , 100 MHz, ppm) δ 160.4, 149.8, 148.4, 146.7, 138.7, 136.5, 134.9, 134.7, 130.8, 128.2, 127.6, 121.9, 121.6, 119.4, 116.4, 107.3, 102.5, 93.8, 75.2, 56.35, 56.34, 56.0; **HRMS**: calculated for $\text{C}_{22}\text{H}_{21}\text{N}_3\text{NaO}_4$ [$\text{M}+\text{Na}^+$]: 414.1430; **found**: 414.1444.



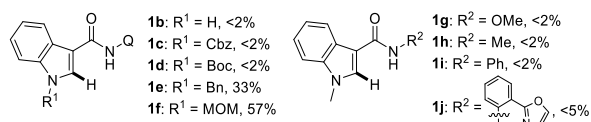
$R_f = 0.50$, 25 % EtOAc in hexanes

Prepared according to general procedure B. Purification of the crude product by flash column chromatography afforded the amide **43a** as white solid. ^1H NMR (CDCl_3 , 400 MHz, ppm): δ 10.52 (s, 1 H), 8.89 (dd, $J = 4.2, 1.7$ Hz, 1 H), 8.61 (dd, $J = 8.4, 1.7$ Hz, 1 H), 7.75 (d, $J = 7.9$ Hz, 1 H), 7.61 (d, $J = 8.4$ Hz, 1 H), 7.48 (dd, $J = 8.4, 4.2$ Hz, 1 H), 7.40-7.36 (m, 1 H), 7.32 (s, 1 H), 7.25-7.21 (m, 1 H), 6.89 (d, $J = 8.6$ Hz, 1 H), 6.09 (s, 2 H), 4.02 (s, 3 H), 3.37 (s, 3 H); ^{13}C NMR (CDCl_3 , 100 MHz, ppm) δ 160.1, 150.7, 149.0, 139.5, 132.8, 131.5, 128.1, 126.7, 125.0, 122.2, 121.6, 121.0, 120.7, 116.8, 111.3, 106.9, 104.5, 75.0, 56.2, 56.0; **HRMS**: calculated for $\text{C}_{21}\text{H}_{20}\text{N}_3\text{O}_3$ [$\text{M}+\text{H}^+$]: 362.1499; **found**: 362.1504.

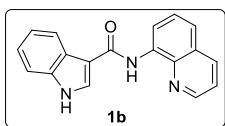
3. Cu-mediated annulation of C(sp²)-H/N-H bonds with 2-(trimethylsilyl)phenyl trifluoromethanesulfonate.^a



Entry ^a	reagents (equiv)	solvents	yield 3 (%) ^b
1	Cu(OAc) ₂ (0.35), CsF (1.2), TBAI (0.5), O ₂ , 80 °C	DMF	10
2	Cu(OAc) ₂ (0.35), CsF (1.2), TBAI (0.5), O ₂ , 80 °C	MeCN	12
3	Cu(OAc) ₂ (0.35), CsF (1.2), TBAI (0.5), O ₂ , 80 °C	DMF:MeCN(1:1)	21
4	Cu(OAc) ₂ (0.35), NaF (1.2), TBAI (0.5), O ₂ , 80 °C	DMF:MeCN(1:1)	<2
5	Cu(OAc) ₂ (0.35), KF (1.2), TBAI (0.5), O ₂ , 80 °C	DMF:MeCN(1:1)	18
6	Cu(OAc) ₂ (0.35), CsF (1.2), TBAB (0.5), O ₂ , 80 °C	DMF:MeCN(1:1)	20
7	Cu(OAc) ₂ (0.35), CsF (2.4), TBAI (0.5), O ₂ , 80 °C	DMF:MeCN(1:1)	23
8	Cu(OAc) ₂ (0.35), CsF (1.2), TBAI (1.0), O ₂ , 80 °C	DMF:MeCN(1:1)	31
9	Cu(OAc) ₂ (0.5), CsF (1.2), TBAI (0.5), O ₂ , 80 °C	DMF:MeCN(1:1)	43
10	Cu(OAc) ₂ (1.0), CsF (1.2), TBAI (0.5), O ₂ , 80 °C	DMF:MeCN(1:1)	12
11	Cu(OAc) ₂ (0.5), CsF (1.2), TBAI (1.0), O ₂ , 80 °C	DMF:MeCN(1:1)	78(81) ^c
12	Cu(OAc) ₂ (0.5), CsF (1.2), TBAI (1.0), O ₂ , 40 °C	DMF:MeCN(1:1)	19
13	Cu(OAc) ₂ (0.5), CsF (1.2), TBAI (1.0), O ₂ , 100 °C	DMF:MeCN(1:1)	55

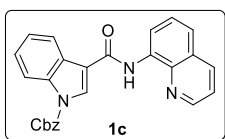


^aAll screening reactions were carried out in a 10 mL glass vial with a PTEE-lined cap on a 0.2 mmol scale. ^bYields are based on ¹H NMR analysis of the reaction mixture use 1,2-dichloroethane as an internal standard. ^cIsolated yield in parentheses. DMF = *N,N*-dimethylformamide, TBAB = tetra-*n*-butylammonium bromide, TBAI = tetra-*n*-butylammonium iodide.



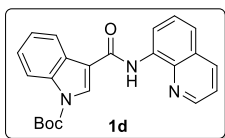
R_f = 0.50, 50 % EtOAc in hexanes

Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **1b** as white solid. ¹H NMR (DMSO, 400 MHz, ppm): δ 11.96 (s, 1 H), 10.40 (s, 1 H), 9.00 (dd, *J* = 4.1, 1.4 Hz, 1 H), 8.80 (dd, *J* = 7.0, 1.7 Hz, 1 H), 8.44 (dd, *J* = 8.2, 1.4 Hz, 1 H), 8.32-8.29 (m, 2 H), 7.68-7.55 (m, 4 H), 7.30-7.25 (m, 2 H); ¹³C NMR (DMSO, 100 MHz, ppm) δ 162.7, 148.9, 137.9, 136.7, 136.6, 134.8, 129.7, 127.8, 127.2, 124.9, 122.3, 122.2, 121.2, 121.1, 119.9, 115.8, 112.6, 111.0; **HRMS**: calculated for C₁₈H₁₅N₃O [M+H⁺]: 288.1137; **found**: 288.1157.



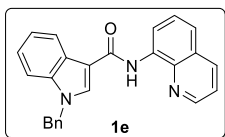
R_f = 0.50, 25 % EtOAc in hexanes

Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **1c** as white solid. ¹H NMR (CDCl₃, 400 MHz, ppm): δ 10.57 (s, 1 H), 8.92 (dd, *J* = 7.5, 1.3 Hz, 1 H), 8.87 (dd, *J* = 4.2, 1.6 Hz, 1 H), 8.42 (s, 1 H), 8.41-8.39 (m, 1 H), 8.27 (d, *J* = 6.6 Hz, 1 H), 8.19 (dd, *J* = 8.2, 1.6 Hz, 1 H), 7.59 (t, *J* = 7.9 Hz, 1 H), 7.55-7.52 (m, 3 H), 7.50-7.41 (m, 6 H), 5.53 (s, 2 H); ¹³C NMR (CDCl₃, 100 MHz, ppm) δ 162.1, 150.7, 148.5, 138.7, 136.5, 135.9, 134.8, 134.7, 129.1, 129.0, 128.8, 128.7, 128.1, 127.6, 127.3, 125.7, 124.5, 121.8, 121.7, 121.3, 118.1, 116.2, 115.6, 69.6; **HRMS**: calculated for C₂₆H₂₀N₃O₃ [M+H⁺]: 422.1505; **found**: 422.1517.



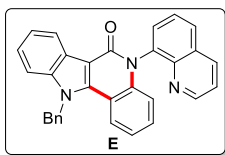
R_f = 0.50, 25 % EtOAc in hexanes

Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **1d** as white solid. ¹H NMR (CDCl₃, 400 MHz, ppm): δ 10.58 (s, 1 H), 8.93 (d, *J* = 7.0 Hz, 1 H), 8.86 (dd, *J* = 4.2, 1.4 Hz, 1 H), 8.43-8.40 (m, 2 H), 8.24-8.22 (m, 1 H), 8.16 (dd, *J* = 8.2, 1.4 Hz, 1 H), 7.59 (t, *J* = 7.9 Hz, 1 H), 7.52 (d, *J* = 7.5 Hz, 1 H), 7.48-7.40 (m, 3 H), 1.72 (s, 9 H); ¹³C NMR (CDCl₃, 100 MHz, ppm) δ 162.3, 149.4, 148.4, 138.7, 136.5, 135.8, 134.8, 129.1, 128.1, 127.6, 127.3, 125.3, 124.1, 121.8, 121.6, 121.2, 117.1, 116.6, 115.6, 85.2, 28.2; **HRMS**: calculated for C₂₃H₂₂N₃O₃ [M+H⁺]: 388.1661; **found**: 388.1666.



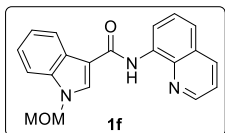
$R_f = 0.50$, 25 % EtOAc in hexanes

Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **1f** as white solid. **$^1\text{H NMR}$** (CDCl_3 , 400 MHz, ppm): δ 10.59 (dd, $J = 7.6$, 1.2 Hz, 1 H), 8.96 (dd, $J = 7.6$, 1.2 Hz, 1 H), 8.89 (dd, $J = 4.2$, 1.6 Hz, 1 H), 8.50 (d, $J = 7.9$ Hz, 1 H), 8.19 (dd, $J = 8.2$, 1.6 Hz, 1 H), 8.01 (s, 1 H), 7.60 (t, $J = 8.0$ Hz, 1 H), 7.51 (dd, $J = 8.2$, 1.2 Hz, 1 H), 7.48 (dd, $J = 8.2$, 4.2 Hz, 1 H), 7.40-7.27 (m, 6 H), 7.20-7.18 (m, 2 H), 5.42 (s, 2 H); **$^{13}\text{C NMR}$** (CDCl_3 , 100 MHz, ppm) δ 163.4, 148.3, 138.8, 137.2, 136.5, 136.2, 135.5, 132.8, 129.1, 128.22, 128.19, 127.8, 127.1, 125.8, 123.0, 122.2, 121.7, 121.0, 120.9, 116.5, 112.6, 110.8, 50.9; **HRMS**: calculated for $\text{C}_{25}\text{H}_{20}\text{N}_3\text{O}$ [$\text{M}+\text{H}^+$]: 378.1606; **found**: 378.1613.



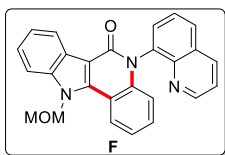
$R_f = 0.50$, 50 % EtOAc in hexanes

Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **F** as white solid in 33% yield (30 mg). **$^1\text{H NMR}$** (CDCl_3 , 400 MHz, ppm): δ 8.80 (dd, $J = 4.2$, 1.6 Hz, 1 H), 8.57 (d, $J = 7.5$ Hz, 1 H), 8.29 (dd, $J = 8.3$, 1.6 Hz, 1 H), 8.05 (dd, $J = 7.9$, 1.6 Hz, 1 H), 8.02 (d, $J = 8.3$ Hz, 1 H), 7.82 (dd, $J = 7.2$, 1.6 Hz, 1 H), 7.78 (t, $J = 7.7$ Hz, 1 H), 7.46-7.37 (m, 6 H), 7.34 (d, $J = 7.1$ Hz, 1 H), 7.31-7.29 (m, 2 H), 7.19-7.15 (m, 1 H), 7.09-7.06 (m, 1 H), 6.64 (d, $J = 8.4$ Hz, 1 H), 5.97 (s, 2 H); **$^{13}\text{C NMR}$** (CDCl_3 , 100 MHz, ppm) δ 160.5, 151.6, 145.2, 141.2, 140.4, 140.3, 136.51, 136.48, 136.3, 131.3, 130.0, 129.5, 129.4, 128.6, 128.0, 127.0, 126.1, 125.02, 124.98, 123.0, 122.7, 122.5, 122.0, 121.9, 117.7, 113.8, 109.3, 108.9, 49.6; **HRMS**: calculated for $\text{C}_{31}\text{H}_{22}\text{N}_3\text{O}$ [$\text{M}+\text{H}^+$]: 452.1763; **found**: 452.1770.



$R_f = 0.50$, 25 % EtOAc in hexanes

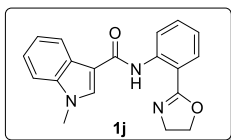
Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **1e** as white solid. **$^1\text{H NMR}$** (CDCl_3 , 400 MHz, ppm): δ 10.56 (s, 1 H), 8.95 (dd, $J = 7.6$, 1.2 Hz, 1 H), 8.86 (dd, $J = 4.2$, 1.3 Hz, 1 H), 8.47 (d, $J = 7.7$ Hz, 1 H), 8.14 (d, $J = 8.2$ Hz, 1 H), 8.00 (s, 1 H), 7.59-7.55 (m, 2 H), 7.48 (d, $J = 8.1$ Hz, 1 H), 7.45-7.33 (m, 3 H), 5.50 (s, 2 H), 3.28 (s, 3 H); **$^{13}\text{C NMR}$** (CDCl_3 , 100 MHz, ppm) δ 163.1, 148.3, 138.7, 136.9, 136.4, 135.2, 132.2, 128.1, 127.6, 126.0, 123.4, 122.6, 121.7, 121.1, 120.9, 116.4, 113.3, 111.0, 78.1, 56.3; **HRMS**: calculated for $\text{C}_{20}\text{H}_{18}\text{N}_3\text{O}_2$ [$\text{M}+\text{H}^+$]: 332.1399; **found**: 332.1408.



$R_f = 0.50$, 50 % EtOAc in hexanes

Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **E** as white solid in 57% yield (46.3 mg). **$^1\text{H NMR}$** (CDCl_3 , 400 MHz, ppm): δ 8.79 (dd, $J = 4.2$, 1.6 Hz, 1 H), 8.54-8.50 (m, 2 H), 8.28 (dd, $J = 8.4$, 1.7 Hz, 1 H), 8.05 (dd, $J = 7.9$, 1.7 Hz, 1

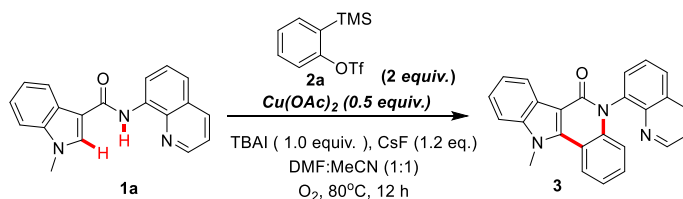
H), 7.81 (dd, $J = 7.1, 1.7$ Hz, 1 H), 7.77 (t, $J = 7.5$ Hz, 1 H), 7.64 (d, $J = 8.3$ Hz, 1 H), 7.47-7.40 (m, 2 H), 7.35 (t, $J = 7.6$ Hz, 1 H), 7.31-7.22 (m, 2 H), 6.65 (dd, $J = 8.2, 1.0$ Hz, 1 H), 5.95 (dd, $J = 13.2, 12.2$ Hz, 2 H), 3.56 (s, 3 H); ^{13}C NMR (CDCl_3 , 100 MHz, ppm) δ 160.4, 151.6, 145.1, 141.2, 140.9, 140.5, 136.5, 136.2, 131.3, 130.0, 129.5, 128.9, 127.0, 125.1, 125.0, 124.2, 122.8, 122.6, 122.2, 122.0, 117.5, 113.8, 109.7, 109.0, 75.6, 56.5; **HRMS**: calculated for $\text{C}_{26}\text{H}_{20}\text{N}_3\text{O}_2$ [$\text{M}+\text{H}^+$]: 406.1556; **found**: 406.1553.



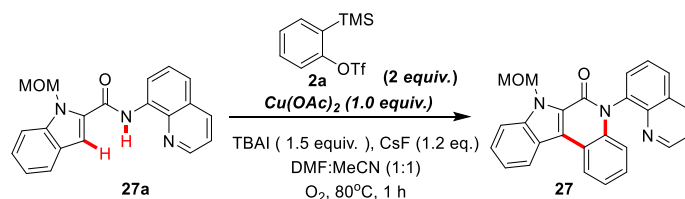
$R_f = 0.50$, 25 % EtOAc in hexanes

Prepared according to general procedure A. Purification of the crude product by flash column chromatography afforded the amide **1g** as white solid. ^1H NMR (CDCl_3 , 400 MHz, ppm): δ 12.59 (s, 1 H), 8.97-8.95 (m, 1 H), 8.47-8.43 (m, 1 H), 7.87 (dd, $J = 7.9, 1.6$ Hz, 1 H), 7.78 (s, 1 H), 7.52-7.48 (m, 1 H), 7.35-7.26 (m, 3 H), 7.07-7.03 (m, 1 H), 4.42-4.37 (m, 2 H), 4.20-4.15 (m, 2 H), 3.83 (s, 3 H); ^{13}C NMR (CDCl_3 , 100 MHz, ppm) δ 165.1, 164.0, 141.0, 137.4, 132.7, 132.2, 129.4, 126.7, 122.9, 122.0, 121.6, 119.9, 112.9, 112.1, 109.7, 66.2, 54.8, 33.6; **HRMS**: calculated for $\text{C}_{19}\text{H}_{18}\text{N}_3\text{O}_2$ [$\text{M}+\text{H}^+$]: 320.1399; **found**: 320.1407.

4. General procedures for Cu-mediated C(sp²)-H/N-H Annulation reactions with 2-(trimethylsilyl)phenyl trifluoromethanesulfonate.

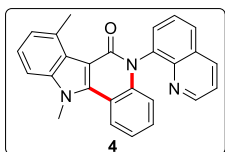


General procedure I : A mixture of amide **1a** (60 mg, 0.2 mmol, 1 equiv.), $\text{Cu}(\text{OAc})_2$ (18.2 mg, 0.1 mmol, 0.5 equiv.), TBAI (74 mg, 0.2 mmol, 1.0 equiv.), CsF (36.5 mg, 0.24 mmol, 1.2 equiv.), and 2-(trimethylsilyl)phenyl trifluoromethanesulfonate (120 mg, 2 equiv.) in DMF (1.0 mL)/MeCN (1.0 mL) in a 10 mL glass vial (purged with O_2 , sealed with PTFE cap) was heated at 80°C for 12 hours. The reaction mixture was cooled to RT. The resulting residue was purified by silica gel flash chromatography to give the annulation product **3** in 81% (62 mg) isolated yield ($R_f = 0.4$, 50% EtOAc in hexanes). ^1H NMR (DMSO, 400 MHz, ppm): δ 8.70 (d, $J = 2.6$ Hz, 1 H), 8.65-8.63 (m, 1 H), 8.56 (d, $J = 7.3$ Hz, 1 H), 8.26-8.21 (m, 2 H), 7.89-7.85 (m, 3 H), 7.59 (dd, $J = 8.2, 4.1$ Hz, 1 H), 7.47 (t, $J = 7.2$ Hz, 1 H), 7.35-7.29 (m, 3 H), 6.52-6.50 (m, 1 H), 4.43 (s, 3 H); ^{13}C NMR (DMSO, 100 MHz, ppm) δ 151.2, 144.3, 140.8, 139.7, 136.7, 135.8, 131.4, 129.5, 129.0, 127.0, 124.4, 123.7, 123.6, 122.2, 121.7, 120.8, 117.0, 113.5, 110.5, 106.7, 33.7; **HRMS**: calculated for $\text{C}_{25}\text{H}_{18}\text{N}_3\text{O}$ [$\text{M}+\text{H}^+$]: 376.1444; **found**: 376.1460. **1 gram scale reaction**: A mixture of amide **1a** (900 mg, 3.0 mmol, 1 equiv.), $\text{Cu}(\text{OAc})_2$ (272 mg, 1.5 mmol, 0.5 equiv.), TBAI (1.1 g, 3.0 mmol, 1.0 equiv.) and CsF (548 mg, 3.6 mmol, 1.2 equiv.) in DMF (15.0 mL)/MeCN (15.0 mL) in a 100 mL flask purged with O_2 and heated at 80°C for 30 min. And then 2-(trimethylsilyl)phenyl trifluoromethanesulfonate (1.8 mL, 6 mmol, 2 equiv.) was added under constant oxygen with a stainless steel needle. The mixture was cooled to RT after reacting for 12 hours under 80°C . The resulting residue was purified by silica gel flash chromatography to give the annulation product **3** in 65% isolated yield as white solid.



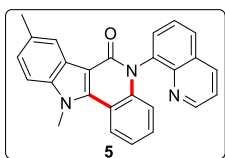
General procedure II: A mixture of amide **1a** (60 mg, 0.2 mmol, 1 equiv.), $\text{Cu}(\text{OAc})_2$ (27 mg, 0.15 mmol, 0.75 equiv.), TBAI (111 mg, 0.3 mmol, 1.5 equiv.), CsF (36.5 mg, 1.2 equiv.), and 2-(trimethylsilyl)phenyl trifluoromethanesulfonate (120 mg, 2 equiv.) in DMF (1.0 mL)/MeCN (1.0 mL) in a 10 mL glass vial (purged with O_2 , sealed with PTFE cap) was heated at 100°C for 0.5 hour. The reaction mixture was cooled to RT. The resulting residue was purified by silica gel flash chromatography to give the annulation product **27** in 65% (53 mg) isolated yield ($R_f = 0.4$, 50% EtOAc in hexanes). $^1\text{H NMR}$ (CDCl_3 , 400 MHz, ppm): δ 8.77 (dd, $J = 4.2$, 1.7 Hz, 1 H), 8.58 (dd, $J = 8.1$, 1.1 Hz, 1 H), 8.51 (d, $J = 8.1$ Hz, 1 H), 8.27 (dd, $J = 8.3$, 1.6 Hz, 1 H), 8.05 (dd, $J = 8.1$, 1.6 Hz, 1 H), 7.82 (dd, $J = 7.3$, 1.6 Hz, 1 H), 7.77 (t, $J = 7.6$ Hz, 2 H), 7.57 (td, $J = 7.2$, 0.8 Hz, 1 H), 7.45-7.40 (m, 2 H), 7.36-7.32 (m, 1 H), 7.18-7.14 (m, 1 H), 6.58 (dd, $J = 8.6$, 0.6 Hz, 1 H), 6.42 (d, $J = 10.4$ Hz, 1 H), 6.23 (d, $J = 10.4$ Hz, 1 H), 3.35 (s, 3 H); $^{13}\text{C NMR}$ (CDCl_3 , 100 MHz, ppm) δ 157.0, 151.6, 144.8, 140.9, 138.2, 136.5, 136.1, 131.0, 129.9, 129.6, 126.9, 126.8, 126.5, 126.4, 123.9, 123.0, 122.9, 122.8, 122.1, 122.1, 121.3, 119.3, 116.9, 112.1, 55.9; **HRMS**: calculated for $\text{C}_{26}\text{H}_{19}\text{N}_3\text{NaO}_2$ [$\text{M}+\text{Na}^+$]: 428.1375; **found**: 428.1372.

5. Substrate scope of the Cu-mediated C-H/N-H annulation reactions.



$R_f = 0.50$, 50 % EtOAc in hexanes

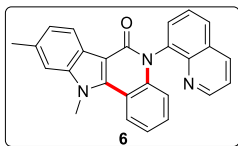
Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **4** as white solid in 42% yield (33 mg). $^1\text{H NMR}$ (CDCl_3 , 400 MHz, ppm): δ 8.79 (dd, $J = 4.2$, 1.7 Hz, 1 H), 8.42 (dd, $J = 8.1$, 1.6 Hz, 1 H), 8.27 (dd, $J = 8.3$, 1.7 Hz, 1 H), 8.02 (dd, $J = 8.0$, 1.6 Hz, 1 H), 7.81 (dd, $J = 7.2$, 1.7 Hz, 1 H), 7.76 (t, $J = 7.9$ Hz, 1 H), 7.41 (dd, $J = 8.3$, 4.2 Hz, 1 H), 7.36-7.30 (m, 2 H), 7.24-7.16 (m, 2 H), 7.09-7.08 (m, 1 H), 6.52 (dd, $J = 8.1$, 1.7 Hz, 1 H), 4.33 (s, 3 H), 3.09 (s, 3 H); $^{13}\text{C NMR}$ (CDCl_3 , 100 MHz, ppm) δ 160.1, 151.5, 145.1, 141.3, 141.0, 140.9, 137.1, 136.5, 134.6, 131.3, 130.1, 129.3, 128.4, 127.1, 124.7, 124.5, 124.2, 123.2, 122.0, 121.3, 117.4, 114.1, 109.5, 106.8, 34.4, 24.1; **HRMS**: calculated for $\text{C}_{26}\text{H}_{20}\text{N}_3\text{O}$ [$\text{M}+\text{H}^+$]: 390.1606; **found**: 390.1598.



$R_f = 0.55$, 50 % EtOAc in hexanes

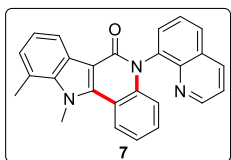
Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **5** as white solid in 86% yield (67 mg). $^1\text{H NMR}$ (CD_2Cl_2 , 400 MHz, ppm): δ 8.74 (dd, $J = 4.1$, 1.5 Hz, 1 H), 8.43 (dd, $J = 8.1$, 1.4 Hz, 1 H), 8.35 (dd, $J = 8.3$, 1.5 Hz, 1 H), 8.21 (s, 1 H), 8.13-8.08 (m, 1 H), 7.84-7.79 (m, 2 H), 7.47-7.44 (m, 2 H), 7.29-7.20 (m, 3 H), 6.62 (dd, $J = 8.2$, 0.9 Hz, 1 H), 4.30 (s, 3 H), 2.49 (s, 3 H); $^{13}\text{C NMR}$ (CD_2Cl_2 , 100 MHz, ppm) δ 160.4, 151.5, 145.2, 141.5, 140.4, 138.7, 136.9, 136.7, 131.8, 131.7, 130.2, 129.6, 128.6, 127.2, 126.3, 124.9, 123.3, 122.3, 121.9, 121.8, 117.7, 114.6,

109.3, 107.6, 34.1, 21.5; **HRMS**: calculated for $C_{26}H_{20}N_3O$ $[M+H]^+$: 390.1606; **found**: 390.1612.



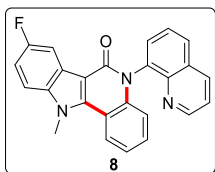
R_f = 0.55, 50 % EtOAc in hexanes

Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **6** as white solid in 78% yield (61 mg). **1H NMR** (CD_2Cl_2 , 400 MHz, ppm): δ 8.73 (d, J = 2.8 Hz, 1 H), 8.46 (dd, J = 8.2, 1.3 Hz, 1 H), 8.38 (d, J = 7.2 Hz, 1 H), 8.21 (d, J = 8.0 Hz, 1 H), 8.11-8.08 (m, 1 H), 7.82-7.78 (m, 2 H), 7.47 (dd, J = 8.3, 4.2, 1 H), 7.38 (s, 1 H), 7.28 (td, J = 7.2, 1.2 Hz, 1 H), 7.20 (td, J = 8.6, 1.5 Hz, 1 H), 7.15 (d, J = 7.9, 1 H), 6.59 (dd, J = 8.4, 1.0 Hz, 1 H), 4.33 (s, 3 H), 2.58 (s, 3 H); **^{13}C NMR** ($CDCl_3$, 100 MHz, ppm) δ 160.5, 151.6, 145.1, 141.0, 140.5, 140.0, 136.5, 136.4, 134.7, 131.4, 130.0, 129.5, 128.2, 127.0, 123.8, 122.8, 122.5, 122.2, 122.0, 121.6, 117.8, 114.7, 109.2, 108.3, 33.75, 22.42; **HRMS**: calculated for $C_{26}H_{20}N_3O$ $[M+H]^+$: 390.1606; **found**: 390.1609.



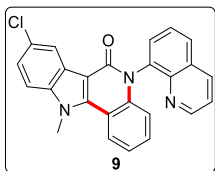
R_f = 0.55, 50 % EtOAc in hexanes

Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **7** as white solid in 44% yield (35 mg). **1H NMR** ($CDCl_3$, 400 MHz, ppm): δ 8.77 (dd, J = 4.2, 1.7, 1 H), 8.41-8.39 (m, 1 H), 8.33-8.31 (m, 1 H), 8.27 (dd, J = 8.3, 1.6 Hz, 1 H), 8.03 (dd, J = 8.0, 1.6 Hz, 1 H), 7.81 (dd, J = 7.2, 1.6 Hz, 1 H), 7.76 (t, J = 7.9 Hz, 1 H), 7.41 (dd, J = 8.3, 4.2 Hz, 1 H), 7.25-7.18 (m, 4 H), 6.66-6.64 (m, 1 H), 4.49 (s, 3 H), 2.87 (s, 3 H); **^{13}C NMR** ($CDCl_3$, 100 MHz, ppm) δ 160.4, 151.6, 145.1, 141.8, 141.2, 140.1, 136.5, 136.4, 131.3, 130.0, 129.4, 128.4, 128.1, 126.9, 125.8, 123.4, 122.2, 122.0, 121.5, 120.8, 120.7, 117.7, 114.3, 108.7, 37.2, 20.9; **HRMS**: calculated for $C_{26}H_{20}N_3O$ $[M+H]^+$: 390.1606; **found**: 390.1613.



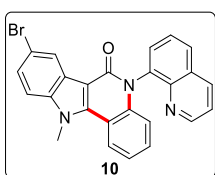
R_f = 0.50, 50 % EtOAc in hexanes

Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **8** as white solid in 84% yield (67 mg) with a bad solubility. **1H NMR** ($CDCl_3$, 400 MHz, ppm): δ 8.79 (s, 1 H), 8.42 (d, J = 7.90 Hz, 1 H), 8.30 (d, J = 8.2 Hz, 1 H), 8.15 (d, J = 9.0 Hz, 1 H), 8.06 (d, J = 7.6 Hz, 1 H), 7.83-7.76 (m, 2 H), 7.44-7.43 (m, 2 H), 7.31-7.22 (m, 2 H), 7.18 (t, J = 7.8 Hz, 1 H), 6.67 (d, J = 8.1 Hz, 1 H), 4.36 (s, 3 H); **^{13}C NMR** ($CDCl_3$, 100 MHz, ppm) δ 160.3, 159.9, 158.4, 151.7, 145.1, 141.3, 136.5, 136.5, 136.1, 131.3, 130.0, 129.6, 128.9, 127.0, 125.4, 125.3, 122.9, 122.1, 121.8, 117.9, 114.4, 112.9, 112.7, 109.9, 109.8, 108.1, 108.0, 107.8, 34.1; **HRMS**: calculated for $C_{25}H_{17}FN_3O$ $[M+H]^+$: 394.1356; **found**: 394.1368.



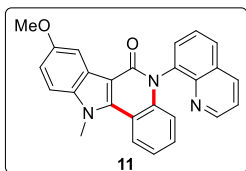
$R_f = 0.50$, 50 % EtOAc in hexanes

Prepared according to general procedure I . Purification of the crude product by flash column chromatography afforded the annulation product **9** as white solid in 87% yield (72 mg) with a bad solubility. **$^1\text{H NMR}$** (CDCl_3 , 400 MHz, ppm): δ 8.79 (d, $J = 4.1$ Hz, 1 H), 8.49 (d, $J = 1.9$ Hz, 1 H), 8.43 (dd, $J = 7.0$, 1.8 Hz, 1 H), 8.30 (d, $J = 8.3$ Hz, 1 H), 8.07 (dd, $J = 7.6$, 1.4 Hz, 1 H), 7.82-7.77 (m, 2 H), 7.46-7.38 (m, 3 H), 7.31-7.26 (m, 2 H), 6.69 (dd, $J = 7.7$, 1.5 Hz, 1 H), 4.35 (s, 3 H); **$^{13}\text{C NMR}$** (CDCl_3 , 100 MHz, ppm) δ 160.2, 151.7, 145.0, 141.3, 141.1, 138.4, 136.5, 136.1, 131.3, 130.0, 129.6, 129.0, 127.9, 127.0, 125.7, 124.9, 122.9, 122.1, 121.9, 117.9, 114.3, 110.1, 107.7, 34.1; **HRMS**: calculated for $\text{C}_{25}\text{H}_{17}\text{ClN}_3\text{O}$ [$\text{M}+\text{H}^+$]: 410.1055; **found**: 410.1060.



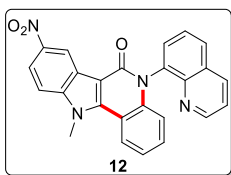
$R_f = 0.50$, 50 % EtOAc in hexanes

Prepared according to general procedure I . Purification of the crude product by flash column chromatography afforded the annulation product **10** as white solid in > 95% yield (89 mg) with a bad solubility. **$^1\text{H NMR}$** (CDCl_3 , 400 MHz, ppm): δ 8.79 (dd, $J = 4.2$, 1.6 Hz, 1 H), 8.65 (d, $J = 1.9$ Hz, 1 H), 8.44-8.41 (m, 1 H), 8.30 (dd, $J = 8.3$, 1.6 Hz, 1 H), 8.07 (dd, $J = 7.5$, 2.2 Hz, 1 H), 7.83-7.77 (m, 2 H), 7.53-7.51 (m, 1 H), 7.44 (dd, $J = 8.3$, 4.2 Hz, 1 H), 7.40 (d, $J = 8.8$ Hz, 1 H), 7.31-7.24 (m, 2 H), 6.70-6.68 (m, 1 H), 4.35 (s, 3 H); **HRMS**: calculated for $\text{C}_{25}\text{H}_{17}\text{BrN}_3\text{O}$ [$\text{M}+\text{H}^+$]: 456.0529; **found**: 456.0538.



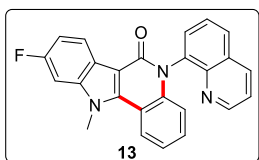
$R_f = 0.60$, 50 % EtOAc in hexanes

Prepared according to general procedure I . Purification of the crude product by flash column chromatography afforded the annulation product **11** as white solid in 68% yield (56 mg). **$^1\text{H NMR}$** (CDCl_3 , 400 MHz, ppm): δ 8.80 (dd, $J = 4.2$, 1.7 Hz, 1 H), 8.41 (dd, $J = 8.1$, 1.8 Hz, 1H), 8.29 (dd, $J = 8.3$, 1.7 Hz, 1 H), 8.05 (dd, $J = 8.1$, 1.6 Hz, 1 H), 8.01 (d, $J = 2.6$ Hz, 1 H), 7.83 (dd, $J = 7.2$, 1.6 Hz, 1 H), 7.78 (t, $J = 7.9$ Hz, 1H), 7.44-7.40 (m, 2 H), 7.28-7.20 (m, 2 H), 7.07 (dd, $J = 9.0$, 2.6 Hz, 1 H), 6.66 (dd, $J = 8.1$, 1.1 Hz, 1 H), 4.32 (s, 3 H), 3.85 (s, 3 H); **$^{13}\text{C NMR}$** (CDCl_3 , 100 MHz, ppm) δ 160.7, 155.8, 151.6, 145.2, 141.0, 140.2, 136.5, 136.4, 134.9, 131.4, 130.0, 129.4, 128.4, 127.0, 125.4, 122.8, 122.0, 121.7, 117.8, 115.3, 114.7, 110.0, 107.9, 103.2, 55.8, 33.9; **HRMS**: calculated for $\text{C}_{26}\text{H}_{20}\text{N}_3\text{O}_2$ [$\text{M}+\text{H}^+$]: 406.1556; **found**: 406.1554.



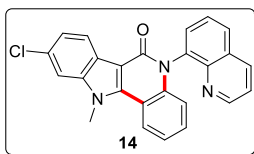
$R_f = 0.45$, 50 % EtOAc in hexanes

Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **12** as pale yellow solid in 45% yield (38 mg) with a bad solubility. **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 9.41 (d, *J* = 2.3 Hz, 1 H), 8.80 (dd, *J* = 4.2, 1.7 Hz, 1 H), 8.44-8.40 (m, 1 H), 8.34-8.30 (m, 2 H), 8.10 (dd, *J* = 7.2, 2.5 Hz, 1 H), 7.84-7.79 (m, 2 H), 7.59 (d, *J* = 9.0 Hz, 1 H), 7.46 (dd, *J* = 8.3, 4.2 Hz, 1 H), 7.34-7.31 (m, 2 H), 6.77-6.73 (m, 1 H), 4.42 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 151.7, 143.4, 142.8, 136.6, 131.2, 129.8, 129.7, 127.0, 124.3, 122.9, 122.2, 120.1, 119.3, 118.2, 109.3, 59.0, 34.5; **HRMS**: calculated for C₂₅H₁₇N₄O₃ [M+H⁺]: 421.1301; **found**: 421.1308.



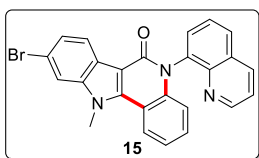
R_f = 0.50, 50 % EtOAc in hexanes

Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **13** as white solid in > 95% yield (76 mg) with a bad solubility. **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 8.79 (s, 1 H), 8.44 (d, *J* = 7.8 Hz, 2 H), 8.30 (d, *J* = 8.4 Hz, 1 H), 8.06 (d, *J* = 7.5 Hz, 1 H), 7.81-7.78 (m, 2 H), 7.43 (dd, *J* = 6.9, 3.7 Hz, 1 H), 7.26-7.20 (m, 3 H), 7.08 (t, *J* = 8.6 Hz, 1 H), 6.67 (d, *J* = 8.4 Hz, 1 H), 4.34 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 162.3, 160.7, 160.3, 151.7, 145.1, 141.0, 140.9, 140.6, 140.5, 136.5, 136.2, 131.3, 130.0, 129.6, 128.6, 127.0, 123.7, 122.7, 122.1, 121.9, 121.1, 117.9, 114.4, 110.7, 110.5, 108.3, 96.2, 96.1, 34.1; **HRMS**: calculated for C₂₅H₁₇FN₃O [M+H⁺]: 394.1350; **found**: 394.1356.



R_f = 0.50, 50 % EtOAc in hexanes

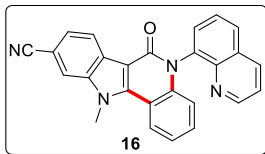
Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **14** as white solid in 77% yield (64 mg) with a bad solubility. **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 8.79 (dd, *J* = 4.2, 1.6 Hz, 1 H), 8.43 (dd, *J* = 8.1, 1.9 Hz, 1 H), 8.40 (d, *J* = 8.4 Hz, 1 H), 8.30 (dd, *J* = 8.3, 1.6 Hz, 1 H), 8.06 (dd, *J* = 7.7, 1.9 Hz, 1 H), 7.83-7.76 (m, 2 H), 7.54 (d, *J* = 1.6 Hz, 1 H), 7.43 (dd, *J* = 8.3, 4.2 Hz, 1 H), 7.32-7.23 (m, 3 H), 6.68 (dd, *J* = 7.9, 1.7 Hz, 1 H), 4.35 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 160.2, 151.7, 145.0, 141.2, 140.9, 140.6, 136.5, 136.1, 131.3, 130.6, 130.0, 129.6, 128.9, 127.0, 123.5, 123.3, 122.9, 122.8, 122.1, 121.9, 117.9, 114.3, 109.4, 34.0; **HRMS**: calculated for C₂₅H₁₇FN₃O [M+H⁺]: 410.1055; **found**: 410.1054.



R_f = 0.50, 50 % EtOAc in hexanes

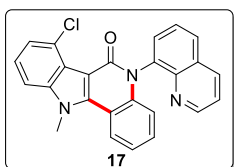
Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **15** as white solid in 92% yield (84 mg) with a bad solubility. **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 8.79 (dd, *J* = 4.2, 1.7 Hz, 1 H), 8.43 (dd, *J* = 8.2, 2.0 Hz, 1 H), 8.35 (d, *J* = 8.4 Hz, 1 H), 8.30 (dd, *J* = 8.4, 1.7 Hz, 1 H), 8.06 (dd, *J* = 7.7, 2.0 Hz, 1 H), 7.83-7.76 (m, 2 H), 7.70 (d, *J*

= 1.4 Hz, 1 H), 7.45-7.42 (m, 2 H), 7.30-7.25 (m, 2 H), 6.68-6.66 (m, 1 H), 4.34 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 151.7, 145.0, 141.3, 140.9, 136.5, 136.1, 131.3, 130.0, 129.6, 128.9, 127.0, 125.4, 123.8, 123.7, 122.9, 122.1, 121.9, 118.4, 118.0, 114.3, 112.4, 34.0; **HRMS**: calculated for C₂₅H₁₇BrN₃O [M+H⁺]: 456.0529; **found**: 456.0549.



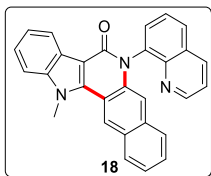
R_f = 0.45, 50 % EtOAc in hexanes

Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **12** as white solid in 77% yield (62 mg) with a bad solubility. **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 8.79 (dd, J = 4.1, 1.5 Hz, 1 H), 8.57 (d, J = 8.2 Hz, 1 H), 8.47-8.44 (m, 1 H), 8.31 (dd, J = 8.3, 1.4, 1 H), 8.17 (s, 1 H), 8.08 (dd, J = 7.2, 2.3 Hz, 1 H), 7.86 (s, 1 H), 7.83-7.76 (m, 2 H), 7.58 (d, J = 8.2 Hz, 1 H), 6.71-6.88 (m, 1 H), 4.41 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 160.0, 151.6, 142.8, 141.8, 139.0, 131.4, 130.1, 129.9, 129.8, 128.1, 127.1, 125.2, 123.3, 123.2, 122.3, 120.3, 118.1, 113.9, 113.8, 108.3, 107.2, 34.2; **HRMS**: calculated for C₂₆H₁₇N₄O [M+H⁺]: 401.1397; **found**: 410.1402.



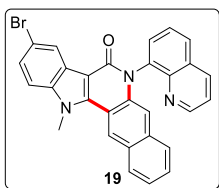
R_f = 0.65, 50 % EtOAc in hexanes

Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **17** as white solid in 72% yield (59 mg) with a bad solubility. **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 8.78 (dd, J = 4.2, 1.7 Hz, 1 H), 8.43-8.41 (m, 1 H), 8.27 (dd, J = 8.3, 1.7 Hz, 1 H), 8.02 (dd, J = 8.2, 1.5 Hz, 1 H), 7.83 (dd, J = 7.3, 1.5 Hz, 1 H), 7.76 (t, J = 8.0 Hz, 1 H), 7.44 (dd, J = 7.2, 2.0 Hz, 1 H), 7.41 (t, J = 4.1 Hz, 1 H), 7.36-7.31 (m, 2 H), 7.24-7.21 (m, 2 H), 6.58-6.55 (m, 1 H), 4.36 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 158.9, 151.5, 145.0, 141.9, 141.7, 136.7, 136.5, 131.5, 131.0, 130.1, 129.3, 129.1, 128.3, 127.1, 125.0, 124.7, 123.4, 123.0, 122.0, 121.5, 117.5, 113.5, 107.9, 34.6; **HRMS**: calculated for C₂₅H₁₇ClN₃O [M+H⁺]: 410.1060; **found**: 410.1075.



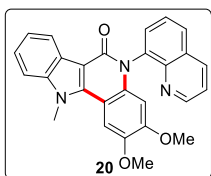
R_f = 0.70, 50 % EtOAc in hexanes

Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **18** as white solid in 67% yield (57 mg) with a bad solubility. **¹H NMR** (CD₂Cl₂, 400 MHz, ppm): δ 8.96 (s, 1 H), 8.70 (s, 1 H), 8.44 (s, 1 H), 8.39 (d, J = 19.6 Hz, 1 H), 8.18 (s, 1 H), 8.04 (d, J = 7.6 Hz, 1 H), 7.96 (d, J = 19.2 Hz, 1 H), 7.88 (d, J = 6.8 Hz, 1 H), 7.65 (d, J = 8.0 Hz, 1 H), 7.49-7.43 (m, 5 H), 7.31 (s, 1 H), 6.99 (s, 1H), 4.51 (s, 3 H); **HRMS**: calculated for C₂₉H₂₀N₃O [M+H⁺]: 426.1601; **found**: 426.1605.



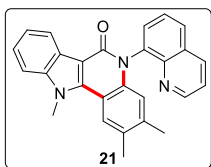
$R_f = 0.65$, 50 % EtOAc in hexanes

Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **19** as white solid in 92% yield (93 mg) with a bad solubility. **^1H NMR** (CD_2Cl_2 , 400 MHz, ppm): δ 8.92 (s, 1 H), 8.61 (s, 1 H), 8.58-8.46 (m, 2 H), 8.18 (s, 1 H), 8.04 (s, 1 H), 7.96 (s, 1 H), 7.87 (s, 1 H), 7.55-7.44 (m, 6 H), 7.98 (s, 1 H), 4.44 (s, 3 H); **HRMS**: calculated for $\text{C}_{29}\text{H}_{19}\text{BrN}_3\text{O}$ [$\text{M}+\text{H}^+$]: 504.0706; **found**: 504.0711



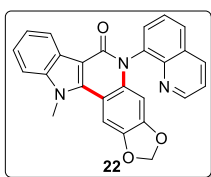
$R_f = 0.45$, 50 % EtOAc in hexanes

Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **20** as white solid in 46% yield (41 mg). **^1H NMR** (CDCl_3 , 400 MHz, ppm): δ 8.81 (dd, $J = 4.2, 1.7$ Hz, 1 H), 8.47 (d, $J = 7.7$ Hz, 1 H), 8.29 (dd, $J = 8.3, 1.6$ Hz, 1 H), 8.05 (dd, $J = 8.2, 1.4$ Hz, 1 H), 7.87-7.84 (m, 2 H), 7.78 (t, $J = 7.9$ Hz, 1 H), 7.50 (d, $J = 8.3$ Hz, 1 H), 7.45-7.40 (m, 2 H), 7.32 (t, $J = 7.8$ Hz, 1 H), 6.13 (s, 1 H), 4.35 (s, 3H), 4.00 (s, 3H), 3.42 (s, 3 H); **^{13}C NMR** (CDCl_3 , 100 MHz, ppm) δ 160.3, 151.7, 150.4, 145.0, 144.8, 140.7, 139.9, 137.1, 136.5, 131.4, 129.9, 129.5, 126.9, 125.0, 124.2, 122.4, 122.1, 122.0, 108.8, 107.2, 107.1, 105.5, 101.1, 56.8, 55.7, 33.5; **HRMS**: calculated for $\text{C}_{27}\text{H}_{22}\text{N}_3\text{O}_3$ [$\text{M}+\text{H}^+$]: 436.1661; **found**: 436.1664.



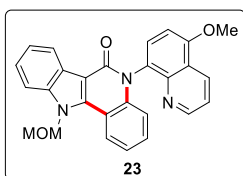
$R_f = 0.45$, 50 % EtOAc in hexanes

Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **21** as white solid in 47% yield (38 mg) with a bad solubility. **^1H NMR** (CDCl_3 , 400 MHz, ppm): δ 8.80 (dd, $J = 4.1, 1.5$ Hz, 1 H), 8.49 (d, $J = 7.8$ Hz, 1 H), 8.29 (dd, $J = 8.3, 1.6$ Hz, 1 H), 8.19 (s, 1 H), 8.05 (dd, $J = 7.5, 2.2$ Hz, 1 H), 7.81-7.76 (m, 2 H), 7.53-7.51 (m, 1 H), 7.46-7.40 (m, 2 H), 7.32 (t, $J = 7.1$ Hz, 1 H), 6.44 (s, 1 H), 4.37 (s, 3 H), 2.38 (s, 3 H), 2.10 (s, 3 H); **^{13}C NMR** (CDCl_3 , 100 MHz, ppm) δ 160.5, 151.6, 145.3, 140.5, 140.0, 139.7, 138.1, 136.6, 136.4, 131.4, 130.3, 130.0, 129.3, 126.9, 125.0, 124.3, 123.3, 122.6, 122.0, 121.9, 118.4, 112.5, 108.9, 107.8, 33.8, 20.5, 19.9; **HRMS**: calculated for $\text{C}_{27}\text{H}_{22}\text{N}_3\text{O}$ [$\text{M}+\text{H}^+$]: 404.1757; **found**: 404.1763.



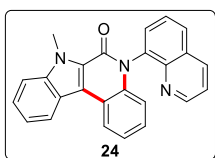
$R_f = 0.55$, 50 % EtOAc in hexanes

Prepared according to general procedure I. Purification of the crude product by flash column chromatography afforded the annulation product **22** as white solid in 72% yield (61 mg) with a bad solubility. **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 8.81 (dd, *J* = 4.1, 1.6 Hz, 1 H), 8.46 (d, *J* = 7.8 Hz, 1 H), 8.29 (dd, *J* = 8.3, 1.6 Hz, 1 H), 8.05 (dd, *J* = 7.8, 2.0 Hz, 1 H), 7.87 (s, 1 H), 7.82-7.75 (m, 2 H), 7.50 (d, *J* = 8.3 Hz, 1 H), 7.45-7.41 (m, 2 H), 7.34-7.30 (m, 1 H), 6.15 (s, 1 H), 5.79 (dd, *J* = 12.7, 1.2 Hz, 2 H), 4.31 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 161.2, 151.7, 149.5, 143.5, 140.9, 136.5, 131.3, 129.6, 127.0, 124.4, 122.4, 122.1, 108.8, 101.9, 101.4, 98.9, 33.6; **HRMS**: calculated for C₂₆H₁₈N₃O₃ [M+H⁺]: 420.1343; **found**: 420.1366.



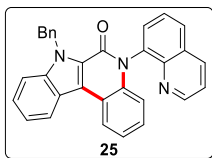
R_f = 0.60, 50 % EtOAc in hexanes

A mixture of amide **23a** (72 mg, 0.2 mmol, 1 equiv.), Cu(OAc)₂ (27 mg, 0.15 mmol, 0.75 equiv.), TBAI (111 mg, 0.3 mmol, 1.5 equiv.), CsF (36.5 mg, 1.2 equiv.), and 2-(trimethylsilyl)phenyl trifluoromethanesulfonate (120 mg, 2 equiv.) in DMF (1.0 mL)/MeCN (1.0 mL) in a 10 mL glass vial (purged with O₂, sealed with PTFE cap) was heated at 100 °C for 2 hour. The reaction mixture was cooled to RT. The resulting residue was purified by silica gel flash chromatography to give the annulation product **23** in 62% (54 mg) isolated yield (*R_f* = 0.4, 50% EtOAc in hexanes). **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 8.77 (dd, *J* = 4.2, 1.7 Hz, 1 H), 8.68 (dd, *J* = 8.5, 1.8 Hz, 1 H), 8.54-8.50 (m, 2 H), 7.70 (d, *J* = 8.2 Hz, 1 H), 7.65 (d, *J* = 8.3 Hz, 1H), 7.46 (td, *J* = 7.8, 1.3 Hz, 1 H), 7.41-7.33 (m, 2 H), 7.31-7.23 (m, 2 H), 7.06 (d, *J* = 8.2 Hz, 1 H), 6.76-6.73 (m, 1 H), 5.97 (dd, *J* = 14.8, 12.0 Hz, 2 H), 4.12 (s, 3 H), 3.47 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 160.7, 156.1, 151.8, 145.5, 141.5, 140.9, 140.5, 131.4, 131.1, 128.9, 128.4, 125.1, 125.0, 124.1, 122.9, 122.6, 122.24, 122.16, 121.1, 117.7, 113.9, 113.6, 109.8, 109.0, 104.5, 75.6, 56.5, 56.2; **HRMS**: calculated for C₂₇H₂₂N₃O₃ [M+H⁺]: 436.1661; **found**: 436.1661.



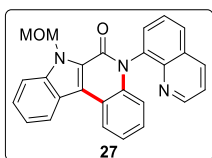
R_f = 0.50, 50 % EtOAc in hexanes

Prepared according to general procedure II. Purification of the crude product by flash column chromatography afforded the annulation product **24** as white solid in 63% yield (48 mg). **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 8.81 (dd, *J* = 4.2, 1.7 Hz, 1 H), 8.56 (dd, *J* = 8.0, 1.2 Hz, 1 H), 8.51 (d, *J* = 8.2 Hz, 1 H), 8.30 (dd, *J* = 8.4, 1.7 Hz, 1 H), 8.06 (dd, *J* = 7.8, 1.8 Hz, 1 H), 7.82 (dd, *J* = 7.3, 1.9 Hz, 1 H), 7.78 (t, *J* = 7.5 Hz, 1H), 7.61-7.55 (m, 2 H), 7.44 (t, *J* = 4.1 Hz, 1 H), 7.42-7.39 (m, 1 H), 7.36-7.32 (m, 1 H), 7.15-7.11 (m, 1 H), 6.55 (dd, *J* = 8.5, 0.8 Hz, 1 H), 4.38 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 157.6, 151.7, 144.9, 141.1, 138.0, 136.5, 136.3, 131.0, 129.9, 129.6, 126.9, 126.5, 126.2, 125.9, 123.7, 123.0, 122.7, 122.3, 122.1, 121.2, 119.9, 119.7, 116.9, 110.8, 31.7; **HRMS**: calculated for C₂₅H₁₈N₃O [M+H⁺]: 376.1450; **found**: 376.1452.



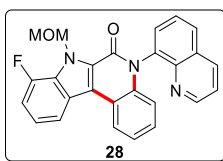
$R_f = 0.50$, 50 % EtOAc in hexanes

Prepared according to general procedure II. Purification of the crude product by flash column chromatography afforded the annulation product **25** as white solid in 64% yield (57 mg). **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 8.79 (dd, $J = 4.2, 1.7$ Hz, 1 H), 8.59 (dd, $J = 8.0, 1.1$ Hz, 1 H), 8.53 (d, $J = 8.1$ Hz, 1 H), 8.28 (dd, $J = 8.4, 1.6$ Hz, 1 H), 8.04 (dd, $J = 8.1, 1.4$ Hz, 1 H), 7.83 (dd, $J = 7.2, 1.5$ Hz, 1 H), 7.76 (t, $J = 7.6$ Hz, 1 H), 7.54 (d, $J = 8.2$ Hz, 1 H), 7.49 (td, $J = 6.9, 0.8$ Hz, 1 H), 7.44-7.39 (m, 2 H), 7.38-7.33 (m, 1 H), 7.23-7.13 (m, 6 H), 6.60-6.57 (m, 1 H), 6.31 (d, $J = 16.1$ Hz, 1 H), 6.10 (d, $J = 16.1$ Hz, 1 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 157.3, 151.6, 144.9, 140.7, 138.4, 138.1, 136.5, 136.2, 131.1, 130.0, 129.6, 128.6, 127.1, 126.9, 126.4, 126.2, 126.1, 123.8, 123.1, 122.8, 122.7, 122.1, 121.5, 120.4, 119.6, 116.9, 111.7, 48.1; **HRMS**: calculated for C₃₁H₂₂N₃O [M+H⁺]: 452.1763; **found**: 452.1774.



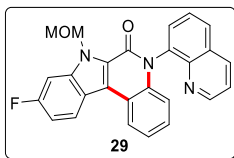
$R_f = 0.55$, 50 % EtOAc in hexanes

Prepared according to general procedure II. Purification of the crude product by flash column chromatography afforded the annulation product **27** as white solid in 65% yield (53 mg). **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 8.77 (dd, $J = 4.2, 1.7$ Hz, 1 H), 8.58 (dd, $J = 8.1, 1.1$ Hz, 1 H), 8.51 (d, $J = 8.1$ Hz, 1 H), 8.27 (dd, $J = 8.3, 1.6$ Hz, 1 H), 8.05 (dd, $J = 8.1, 1.6$ Hz, 1 H), 7.82 (dd, $J = 7.3, 1.6$ Hz, 1 H), 7.77 (t, $J = 7.6$ Hz, 2 H), 7.57 (td, $J = 7.2, 0.8$ Hz, 1 H), 7.45-7.40 (m, 2 H), 7.36-7.32 (m, 1 H), 7.18-7.14 (m, 1 H), 6.58 (dd, $J = 8.6, 0.6$ Hz, 1 H), 6.42 (d, $J = 10.4$ Hz, 1 H), 6.23 (d, $J = 10.4$ Hz, 1 H), 3.35 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 157.0, 151.6, 144.8, 140.9, 138.2, 136.5, 136.1, 131.0, 129.9, 129.6, 126.9, 126.8, 126.5, 126.4, 123.9, 123.0, 122.9, 122.8, 122.1, 122.1, 121.3, 119.3, 116.9, 112.1, 55.9; **HRMS**: calculated for C₂₆H₁₉N₃NaO₂ [M+Na⁺]: 428.1375; **found**: 428.1372.



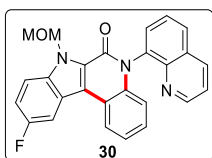
$R_f = 0.50$, 50 % EtOAc in hexanes

Prepared according to general procedure II. Purification of the crude product by flash column chromatography afforded the annulation product **28** as white solid in 41% yield (35 mg). **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 8.77 (dd, $J = 4.2, 1.7$ Hz, 1 H), 8.56 (dd, $J = 8.0, 1.2$ Hz, 1 H), 8.31 (d, $J = 1.6$ Hz, 1 H), 8.29 (d, $J = 1.7$ Hz, 1 H), 8.07 (dd, $J = 8.0, 1.7$ Hz, 1 H), 7.83 (dd, $J = 7.3, 1.7$ Hz, 1 H), 7.79 (t, $J = 7.6$ Hz, 1 H), 7.44 (dd, $J = 8.3, 4.2$ Hz, 1 H), 7.38-7.28 (m, 3 H), 7.21-7.17 (m, 1 H), 6.60 (dd, $J = 8.5, 0.8$ Hz, 1 H), 6.53 (d, $J = 10.4$ Hz, 1 H), 6.37 (d, $J = 10.4$ Hz, 1 H), 3.36 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 156.9, 152.2, 151.6, 149.8, 144.7, 138.4, 136.5, 135.9, 131.0, 130.0, 129.7, 128.9, 128.8, 127.2, 126.9, 126.7, 126.7, 123.9, 122.9, 122.2, 122.1, 121.8, 118.9, 118.9, 117.0, 112.8, 112.6, 56.0; **HRMS**: calculated for C₂₆H₁₈FN₃NaO₂ [M+Na⁺]: 446.1281; **found**: 446.1288.



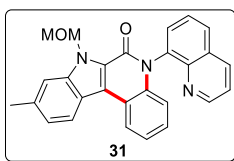
$R_f = 0.50$, 50 % EtOAc in hexanes

Prepared according to general procedure II. Purification of the crude product by flash column chromatography afforded the annulation product **29** as white solid in 62% yield (53 mg). **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 8.77 (dd, $J = 4.2, 1.7$ Hz, 1 H), 8.41 (dd, $J = 7.9, 1.2$ Hz, 1 H), 8.28 (dd, $J = 8.4, 1.7$ Hz, 1 H), 8.12 (dd, $J = 9.6, 2.6$ Hz, 1 H), 8.06 (dd, $J = 8.0, 1.7$ Hz, 1 H), 7.82 (dd, $J = 7.3, 1.7$ Hz, 1 H), 7.77 (t, $J = 7.6$ Hz, 1 H), 7.72 (dd, $J = 9.1, 4.5$ Hz, 1H), 7.42 (dd, $J = 8.3, 4.2$ Hz, 1 H), 7.37-7.29 (m, 2 H), 7.18-7.14 (m, 1 H), 6.58 (dd, $J = 8.4, 0.7$ Hz, 1 H), 6.38 (d, $J = 10.8$ Hz, 1 H), 6.19 (d, $J = 10.6$ Hz, 1 H), 3.34 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 163.5, 161.1, 156.7, 151.6, 144.7, 141.7, 141.6, 138.3, 136.5, 135.9, 131.00, 129.9, 129.7, 126.9, 126.8, 124.3, 124.2, 123.7, 122.8, 122.2, 121.4, 119.5, 118.8, 117.0, 111.3, 111.0, 98.7, 98.4, 75.2, 56.0; **HRMS**: calculated for C₂₆H₁₈FN₃NaO₂ [M+Na⁺]: 446.1281; **found**: 446.1291.



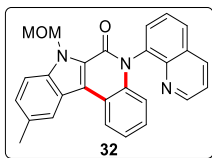
$R_f = 0.50$, 50 % EtOAc in hexanes

Prepared according to general procedure II. Purification of the crude product by flash column chromatography afforded the annulation product **30** as white solid in 56% yield (48 mg). **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 8.77 (dd, $J = 4.2, 1.7$ Hz, 1 H), 8.50 (dd, $J = 8.0, 1.1$ Hz, 1 H), 8.43 (dd, $J = 8.9, 5.2$ Hz, 1 H), 8.30 (dd, $J = 8.4, 1.6$ Hz, 1 H), 8.06 (dd, $J = 7.9, 1.7$ Hz, 1 H), 7.82 (dd, $J = 7.3, 1.8$ Hz, 1 H), 7.78 (t, $J = 7.5$ Hz, 1 H), 7.46-7.42 (m, 2 H), 7.36-7.32 (m, 1 H), 7.21-7.15 (m, 2 H), 6.59-6.57 (m, 1 H), 6.37 (d, $J = 10.6$ Hz, 1 H), 6.15 (d, $J = 10.6$ Hz, 1 H), 3.36 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 160.0, 157.7, 156.9, 151.6, 144.7, 138.1, 137.3, 136.5, 135.9, 131.0, 130.0, 129.7, 127.4, 126.9, 126.6, 123.5, 123.0, 122.9, 122.8, 122.2, 120.9, 120.8, 118.9, 117.0, 115.5, 115.3, 113.1, 113.0, 108.1, 107.8, 75.1, 55.9; **HRMS**: calculated for C₂₆H₁₈FN₃NaO₂ [M+Na⁺]: 446.1281; **found**: 446.1291.



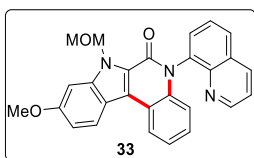
$R_f = 0.55$, 50 % EtOAc in hexanes

Prepared according to general procedure II. Purification of the crude product by flash column chromatography afforded the annulation product **31** as white solid in 66% yield (56 mg). **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 8.77 (dd, $J = 4.2, 1.6$ Hz, 1 H), 8.55 (dd, $J = 8.0, 1.0$ Hz, 1 H), 8.34 (d, $J = 8.3$ Hz, 1 H), 8.28 (dd, $J = 8.4, 1.7$ Hz, 1 H), 8.05 (dd, $J = 8.0, 1.6$ Hz, 1 H), 7.82 (dd, $J = 7.2, 1.6$ Hz, 1 H), 7.77 (t, $J = 7.6$ Hz, 1 H), 7.57 (s, 1H), 7.42 (dd, $J = 8.3, 4.2$ Hz, 1 H), 7.35-7.32 (m, 1 H), 7.27 (d, $J = 8.2$ Hz, 1 H), 7.17-7.13 (m, 1 H), 6.57 (d, $J = 8.2$ Hz, 1 H), 6.39 (d, $J = 10.6$ Hz, 1 H), 6.20 (d, $J = 10.6$ Hz, 1 H), 3.36 (s, 3 H), 2.60 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 157.0, 151.6, 144.8, 141.3, 138.2, 137.2, 136.5, 136.1, 131.0, 129.9, 129.6, 126.9, 126.4, 126.0, 124.0, 124.0, 122.7, 122.6, 122.1, 121.4, 120.8, 119.3, 116.9, 111.8, 74.9, 55.9, 22.3; **HRMS**: calculated for C₂₇H₂₁N₃NaO₂ [M+Na⁺]: 442.1531; **found**: 442.1541.



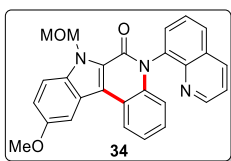
R_f = 0.50, 50 % EtOAc in hexanes

Prepared according to general procedure II. Purification of the crude product by flash column chromatography afforded the annulation product **32** as white solid in 71% yield (63 mg). **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 8.77 (dd, J = 4.0, 1.4 Hz, 1 H), 8.58 (d, J = 7.9 Hz, 1 H), 8.28-8.26 (m, 2 H), 8.04 (dd, J = 8.0, 1.2 Hz, 1 H), 7.82-7.81 (m, 1 H), 7.77 (t, J = 7.6 Hz, 1 H), 7.66 (d, J = 8.5 Hz, 1H), 7.43-7.39 (m, 2 H), 7.34 (t, J = 7.5 Hz, 1 H), 7.16-7.13 (m, 1 H), 6.57 (d, J = 8.4 Hz, 1 H), 6.38 (d, J = 10.5 Hz, 1 H), 6.19 (d, J = 10.6 Hz, 1 H), 3.33 (s, 3 H), 2.61 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 157.1, 151.6, 144.8, 139.3, 138.1, 136.5, 136.1, 131.4, 131.0, 129.9, 129.6, 128.5, 126.9, 126.4, 126.3, 123.9, 123.1, 122.7, 122.5, 122.1, 120.8, 119.4, 116.9, 111.7, 74.9, 55.9, 21.9; **HRMS**: calculated for C₂₇H₂₁N₃NaO₂ [M+Na⁺]: 442.1531; **found**: 442.1538.



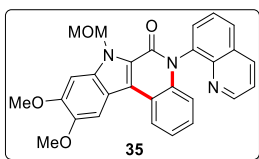
R_f = 0.55, 50 % EtOAc in hexanes

Prepared according to general procedure II. Purification of the crude product by flash column chromatography afforded the annulation product **33** as white solid in 64% yield (56 mg). **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 8.78 (dd, J = 4.2, 1.7 Hz, 1 H), 8.50 (dd, J = 8.0, 1.1 Hz, 1 H), 8.33 (d, J = 8.9 Hz, 1 H), 8.27 (dd, J = 8.4, 1.7 Hz, 1 H), 8.04 (dd, J = 8.1, 1.6 Hz, 1 H), 7.82 (dd, J = 7.3, 1.6 Hz, 1 H), 7.76 (t, J = 7.6 Hz, 1H), 7.41 (dd, J = 8.3, 4.2 Hz, 1 H), 7.33-7.29 (m, 1 H), 7.16-7.12 (m, 2 H), 7.04 (dd, J = 8.9, 2.3 Hz, 1 H), 6.56 (d, J = 7.8 Hz, 1 H), 6.37 (d, J = 10.6 Hz, 1 H), 6.16 (d, J = 10.4 Hz, 1 H), 3.94 (s, 3 H), 3.36 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 159.6, 156.8, 151.5, 144.8, 142.4, 138.2, 136.5, 136.1, 131.0, 129.9, 129.6, 126.9, 126.4, 125.6, 123.8, 123.7, 122.6, 122.1, 121.7, 119.0, 116.9, 116.8, 112.8, 94.2, 74.9, 55.8, 55.7; **HRMS**: calculated for C₂₇H₂₁N₃NaO₃ [M+Na⁺]: 458.1481; **found**: 458.1493.



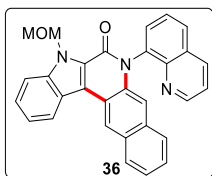
R_f = 0.50, 50 % EtOAc in hexanes

Prepared according to general procedure II. Purification of the crude product by flash column chromatography afforded the annulation product **34** as white solid in 68% yield (60 mg). **¹H NMR** (CDCl₃, 400 MHz, ppm): δ 8.78 (dd, J = 4.2, 1.6 Hz, 1 H), 8.50 (dd, J = 7.9, 0.8 Hz, 1 H), 8.29 (dd, J = 8.4, 1.6 Hz, 1 H), 8.06 (dd, J = 8.0, 1.6 Hz, 1 H), 7.89 (d, J = 2.2 Hz, 1 H), 7.83 (dd, J = 7.8, 1.6 Hz, 1 H), 7.78 (t, J = 7.6 Hz, 1H), 7.70 (d, J = 9.0 Hz, 1 H), 7.40 (dd, J = 8.3, 4.2 Hz, 1 H), 7.38-7.34 (m, 1 H), 7.25 (dd, J = 9.0, 2.3 Hz, 1 H), 7.18-7.13 (m, 1 H), 6.58 (d, J = 7.9 Hz, 1 H), 6.40 (d, J = 10.6 Hz, 1 H), 6.20 (d, J = 10.6 Hz, 1 H), 4.02 (s, 3 H), 3.34 (s, 3 H); **¹³C NMR** (CDCl₃, 100 MHz, ppm) δ 157.6, 155.6, 151.6, 144.8, 138.1, 136.5, 136.1, 131.0, 129.9, 129.6, 126.9, 126.7, 126.2, 123.6, 123.2, 122.7, 122.2, 120.7, 119.4, 117.0, 116.97, 112.9, 104.6, 75.05, 56.2, 55.9; **HRMS**: calculated for C₂₇H₂₁N₃NaO₃ [M+Na⁺]: 458.1481; **found**: 458.1493.



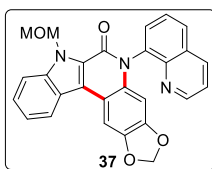
$R_f = 0.50$, 50 % EtOAc in hexanes

Prepared according to general procedure II. Purification of the crude product by flash column chromatography afforded the annulation product **35** as white solid in 85% yield (79 mg). **^1H NMR** (CDCl_3 , 400 MHz, ppm): δ 8.79 (dd, $J = 4.2, 1.7$ Hz, 1 H), 8.43 (dd, $J = 8.0, 1.0$ Hz, 1 H), 8.28 (dd, $J = 8.4, 1.7$ Hz, 1 H), 8.05 (dd, $J = 8.0, 1.6$ Hz, 1 H), 7.83 (dd, $J = 7.3, 1.6$ Hz, 1 H), 7.79-7.76 (m, 2 H), 7.42 (dd, $J = 8.3, 4.2$ Hz, 1 H), 7.35-7.31 (m, 1 H), 7.18 (s, 1 H), 7.14 (td, $J = 7.9, 1.3$ Hz, 1 H), 6.57-6.55 (m, 1 H), 6.37 (d, $J = 10.8$ Hz, 1 H), 6.16 (d, $J = 10.8$ Hz, 1 H), 4.08 (s, 3 H), 4.04 (s, 3 H), 3.34 (s, 3 H); **^{13}C NMR** (CDCl_3 , 100 MHz, ppm) δ 156.8, 151.5, 150.7, 146.7, 144.9, 138.2, 136.5, 136.4, 136.2, 131.1, 129.9, 129.6, 126.9, 126.2, 125.2, 123.5, 122.6, 122.1, 121.3, 119.2, 116.9, 115.3, 103.7, 94.1, 75.0, 56.7, 56.3, 55.8; **HRMS**: calculated for $\text{C}_{28}\text{H}_{23}\text{N}_3\text{NaO}_4$ [$\text{M}+\text{Na}^+$]: 488.1586; **found**: 488.1595.



$R_f = 0.50$, 50 % EtOAc in hexanes

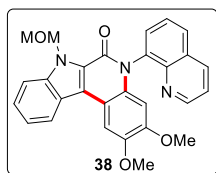
Prepared according to general procedure II. Purification of the crude product by flash column chromatography afforded the annulation product **36** as white solid in 62% yield (57 mg). **^1H NMR** (CDCl_3 , 400 MHz, ppm): δ 9.02 (s, 1 H), 8.75 (dd, $J = 4.1, 1.6$ Hz, 1 H), 8.69 (d, $J = 8.1$ Hz, 1 H), 8.32 (dd, $J = 8.3, 1.6$ Hz, 1 H), 8.11 (dd, $J = 8.2, 1.5$ Hz, 1 H), 8.03 (d, $J = 8.2$ Hz, 1 H), 7.90 (dd, $J = 7.2, 1.5$ Hz, 1 H), 7.85 (d, $J = 8.0$ Hz, 1 H), 7.82 (t, $J = 3.6$ Hz, 1 H), 7.61 (td, $J = 7.1, 0.9$ Hz, 1 H), 7.54-7.50 (m, 1 H), 7.48 (d, $J = 8.3$ Hz, 1 H), 7.45-7.40 (m, 2 H), 7.35-7.31 (m, 1 H), 6.93 (s, 1 H), 6.44 (d, $J = 10.6$ Hz, 1 H), 6.23 (d, $J = 10.6$ Hz, 1 H), 3.39 (s, 3 H); **^{13}C NMR** (CDCl_3 , 100 MHz, ppm) δ 157.6, 151.6, 144.9, 140.8, 137.4, 136.6, 136.2, 131.7, 131.2, 130.1, 130.0, 129.6, 127.7, 127.4, 127.0, 126.8, 126.4, 126.1, 125.0, 123.2, 123.0, 122.6, 122.4, 122.2, 120.5, 120.0, 113.3, 112.2, 75.1, 56.1; **HRMS**: calculated for $\text{C}_{30}\text{H}_{21}\text{N}_3\text{NaO}_2$ [$\text{M}+\text{Na}^+$]: 478.1531; **found**: 478.1547.



$R_f = 0.45$, 50 % EtOAc in hexanes

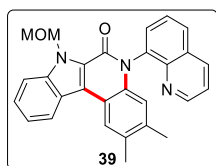
Prepared according to general procedure II. Purification of the crude product by flash column chromatography afforded the annulation product **37** as white solid in 63% yield (57 mg). **^1H NMR** (CDCl_3 , 400 MHz, ppm): δ 8.80 (dd, $J = 4.2, 1.6$ Hz, 1 H), 8.41 (d, $J = 8.2$ Hz, 1 H), 8.28 (dd, $J = 8.4, 1.9$ Hz, 1 H), 8.05 (dd, $J = 7.9, 1.8$ Hz, 1 H), 7.98 (s, 1 H), 7.81 (dd, $J = 7.2, 1.8$ Hz, 1 H), 7.77 (t, $J = 7.5$ Hz, 2 H), 7.59-7.55 (m, 1 H), 7.45-7.43 (m, 1 H), 7.41 (d, $J = 8.2$ Hz, 1 H), 6.40 (d, $J = 10.8$ Hz, 1 H), 6.20 (d, $J = 10.6$ Hz, 1 H), 6.07 (s, 1 H), 5.94 (dd, $J = 13.6, 1.3$ Hz, 2 H), 3.35 (s, 3 H); **^{13}C NMR** (CDCl_3 , 100 MHz, ppm) δ 156.6, 151.7, 147.2, 144.6, 144.1, 140.9, 136.5, 136.4, 134.2, 130.9, 130.0, 129.8, 126.9, 126.8, 125.4, 122.7,

122.6, 122.2, 121.81, 121.78, 113.2, 112.0, 102.5, 101.6, 98.2, 74.9, 55.9; **HRMS**: calculated for $C_{27}H_{19}N_3NaO_4 [M+Na^+]$: 472.1273; **found**: 472.1290.



$R_f = 0.45$, 50 % EtOAc in hexanes

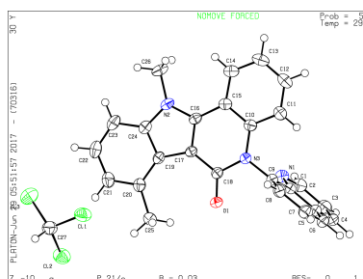
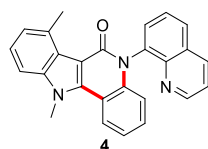
Prepared according to general procedure II. Purification of the crude product by flash column chromatography afforded the annulation product **38** as white solid in 56% yield (53 mg). **1H NMR** ($CDCl_3$, 400 MHz, ppm): δ 8.79 (dd, $J = 4.2, 1.6$ Hz, 1 H), 8.41 (d, $J = 8.2$, 1 H), 8.28 (dd, $J = 8.32, 1.6$ Hz, 1 H), 8.06 (dd, $J = 8.2, 1.4$ Hz, 1 H), 7.97 (s, 1 H), 7.86 (dd, $J = 7.2, 1.4$ Hz, 1 H), 7.81-7.76 (m, 2 H), 7.59-7.55 (m, 1 H), 7.45-7.40 (m, 2 H), 6.41 (d, $J = 10.5$ Hz, 1 H), 6.21 (d, $J = 10.6$ Hz, 1 H), 6.07 (s, 1 H), 4.09 (s, 3 H), 3.44 (s, 3 H), 3.35 (s, 3 H); **^{13}C NMR** ($CDCl_3$, 100 MHz, ppm) δ 156.7, 151.6, 148.6, 145.8, 144.6, 140.9, 136.5, 136.2, 133.2, 131.0, 129.8, 129.7, 126.8, 126.7, 125.5, 122.6, 122.5, 122.2, 121.7, 121.4, 112.3, 112.0, 105.7, 100.6, 74.9, 56.5, 55.9, 55.8; **HRMS**: calculated for $C_{28}H_{23}N_3NaO_4 [M+Na^+]$: 488.1586; **found**: 488.1602.



$R_f = 0.45$, 50 % EtOAc in hexanes

Prepared according to general procedure II. Purification of the crude product by flash column chromatography afforded the annulation product **39** as white solid in 65% yield (57 mg). **1H NMR** ($CDCl_3$, 400 MHz, ppm): δ 8.78 (dd, $J = 4.2, 1.6$ Hz, 1 H), 8.53 (d, $J = 8.2$ Hz, 1 H), 8.33 (s, 1 H), 8.29 (dd, $J = 8.4, 1.7$ Hz, 1 H), 8.05 (dd, $J = 7.6, 2.0$ Hz, 1 H), 7.82-7.76 (m, 3 H), 7.59-7.55 (m, 1 H), 7.45-7.44 (m, 1 H), 7.42 (t, $J = 4.1$ Hz, 1 H), 6.43 (d, $J = 10.5$ Hz, 1 H), 6.35 (s, 1 H), 6.21 (d, $J = 10.6$ Hz, 1 H), 3.35 (s, 3 H), 2.41 (s, 3 H), 2.10 (s, 3 H); **^{13}C NMR** ($CDCl_3$, 100 MHz, ppm) δ 157.0, 151.6, 144.9, 140.9, 136.6, 136.5, 136.3, 135.7, 131.5, 131.0, 129.9, 129.6, 126.9, 126.6, 126.1, 124.4, 123.1, 123.0, 122.1, 121.8, 121.3, 117.5, 117.1, 112.0, 75.0, 55.9, 20.4, 19.8; **HRMS**: calculated for $C_{28}H_{23}N_3NaO_2 [M+Na^+]$: 456.1688; **found**: 456.1700.

6. X-ray structure of compound 4 and compound 28:



A colorless block shaped crystal of **4** ($C_{26}H_{19}N_3O$) was used for the X-ray crystallographic analysis. The X-ray intensity data were measured at 293(2) K, on a Bruker D8 VENTURE CMOS photon 100

diffractometer with helios mx multilayer monochromator Cu K α radiation ($\lambda = 1.54178 \text{ \AA}$).

Table S1. Sample and crystal data for **4**.

Identification code	4		
Empirical formula	C ₂₆ H ₁₉ N ₃ O		
Formula weight	508.81		
Temperature	293(2) K		
Wavelength	1.54178 Å		
Crystal habit	colorless block		
Crystal system	monoclinic		
Space group	P 21/c		
Unit cell dimensions	a = 11.0528(4) Å	α = 90°	
	b = 27.2266(9) Å	β = 101.4370(10)°	
	c = 7.6920(3) Å	γ = 90°	
Volume	2268.79(14) Å ³		
Z	4		
Density (calculated)	1.490 g/cm ³		
Absorption coefficient	3.876 mm ⁻¹		
F(000)	968		

Table S2. Data collection and structure refinement for **4**

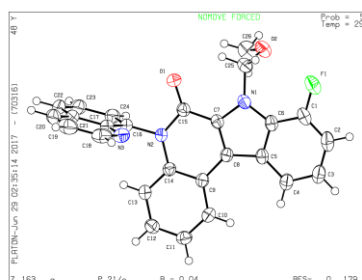
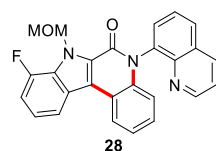
Diffractometer	CCD area detector
Radiation source	fine-focus sealed tube, CuK/ α
Data collection method	phi and omega scans
Theta range for data collection	3.246 to 66.541°
Index ranges	$-13 \leq h \leq 13$, $-32 \leq k \leq 32$, $-8 \leq l \leq 9$

Table S3. Atomic coordinates and equivalent isotropic atomic displacement parameters ($\text{\AA}^2$) for **4**. $U(\text{eq})$ is defined as one third of the trace of the orthogonalized U_{ij} tensor.

	x	y	z	$U(\text{eq})$
C(1)	10527(1)	841(1)	646(2)	26(1)
C(2)	9420(2)	880(1)	-2195(2)	35(1)
C(3)	10070(2)	485(1)	-2748(2)	37(1)
C(4)	10983(2)	268(1)	-1547(2)	34(1)
C(5)	11257(1)	447(1)	216(2)	28(1)
C(6)	12202(2)	252(1)	1550(2)	34(1)
C(7)	12410(2)	435(1)	3231(2)	35(1)

C(8)	11675(1)	820(1)	3677(2)	30(1)
C(9)	10757(1)	1016(1)	2420(2)	26(1)
C(10)	10329(1)	1896(1)	2675(2)	26(1)
C(11)	11471(2)	2003(1)	2239(2)	33(1)
C(12)	11818(2)	2484(1)	2069(2)	38(1)
C(13)	11048(2)	2865(1)	2323(2)	40(1)
C(14)	9923(2)	2766(1)	2752(2)	34(1)
C(15)	9533(1)	2281(1)	2941(2)	26(1)
C(16)	8376(1)	2136(1)	3395(2)	25(1)
C(17)	8055(1)	1645(1)	3563(2)	23(1)
C(18)	8861(1)	1254(1)	3242(2)	24(1)
C(19)	6841(1)	1633(1)	4009(2)	25(1)
C(20)	6025(1)	1266(1)	4410(2)	29(1)
C(21)	4912(2)	1425(1)	4787(2)	37(1)
C(22)	4585(2)	1919(1)	4806(2)	42(1)
C(23)	5366(2)	2281(1)	4454(2)	38(1)
C(24)	6492(1)	2132(1)	4065(2)	29(1)
C(25)	6299(2)	724(1)	4514(2)	35(1)
C(26)	7362(2)	2963(1)	3752(3)	39(1)
C(27)	4664(2)	824(1)	9700(2)	40(1)
Cl(1)	6231(1)	940(1)	9769(1)	46(1)
Cl(2)	4122(1)	373(1)	8086(1)	48(1)
Cl(3)	3777(1)	1361(1)	9289(1)	65(1)
N(1)	9606(1)	1056(1)	-566(2)	30(1)
N(2)	7431(1)	2429(1)	3706(2)	28(1)
N(3)	9989(1)	1405(1)	2865(2)	25(1)
O(1)	8644(1)	811(1)	3290(2)	30(1)
H(2)	8813	1029	-3042	42
H(3)	9880	374	-3914	44
H(4)	11422	4	-1881	41
H(6)	12688	-4	1275	41
H(7)	13041	305	4090	42
H(8)	11817	941	4830	36
H(11)	11996	1749	2063	40
H(12)	12579	2552	1780	46
H(13)	11289	3189	2205	47
H(14)	9409	3025	2921	41
H(21)	4358	1191	5038	45

H(22)	3825	2004	5061	51
H(23)	5154	2612	4475	45
H(25A)	6928	658	5540	53
H(25B)	6581	623	3467	53
H(25C)	5563	547	4600	53
H(26A)	8084	3090	4524	59
H(26B)	6640	3060	4183	59
H(26C)	7316	3091	2578	59
H(27)	4578	695	10860	48



A colorless block shaped crystal of **28** (C₂₆H₁₈FN₃O₂) was used for the X-ray crystallographic analysis. The X-ray intensity data were measured at 293(2) K, on a Bruker D8 VENTURE CMOS photon 100 diffractometer with helios mx multilayer monochromator Cu K α radiation (λ = 1.54178 Å).

Table S1. Sample and crystal data for **28**.

Identification code	28		
Empirical formula	C ₂₆ H ₁₈ FN ₃ O ₂		
Formula weight	423.43		
Temperature	293(2) K		
Wavelength	1.54178 Å		
Crystal habit	colorless block		
Crystal system	monoclinic		
Space group	P 21/c		
Unit cell dimensions	a = 18.9157(7)Å	α= 90°	
	b = 8.9179(4) Å	β= 100.847(2)°	
	c = 11.8376(5) Å	γ = 90°	
Volume	1961.19(14) Å ³		
Z	4		
Density (calculated)	1.434 g/cm ³		
Absorption coefficient	0.811 mm ⁻¹		

F(000)	912
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Table S2. Date collection and structure refinement for **28**

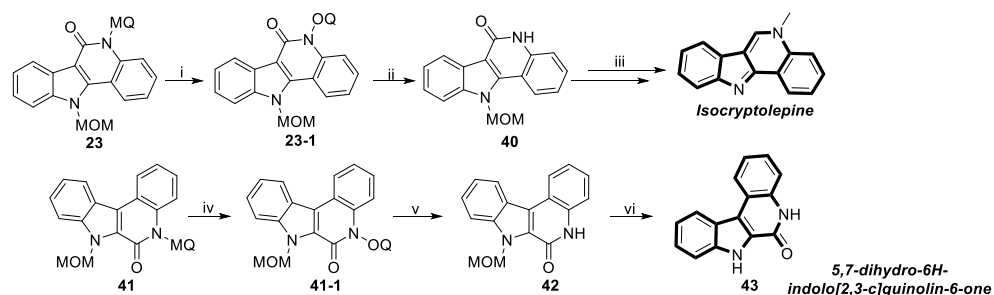
Diffractionmeter	CCD area detector
Radiation source	fine-focus sealed tube, CuK/ α
Data collection method	phi and omega scans
Theta range for data collection	4.76 to 66.51°
Index ranges	-19<=h<=22, -10<=k<=10, -14<=l<=13

Table S3. Atomic coordinates and equivalent isotropic atomic displacement parameters ($\text{\AA}^2$) for **28**. $U(\text{eq})$ is defined as one third of the trace of the orthogonalized U_{ij} tensor.

	x	y	z	$U(\text{eq})$
C1 C	0.09260(8)	0.82260(19)	-0.18524(12)	0.0381(3)
C2 C	0.06850(9)	0.6845(2)	-0.22310(13)	0.0454(4)
C3 C	0.08710(9)	0.5585(2)	-0.15303(14)	0.0444(4)
C4 C	0.13060(8)	0.57110(18)	-0.04624(13)	0.0381(3)
C5 C	0.15653(7)	0.71332(17)	-0.00733(11)	0.0317(3)
C6 C	0.13562(7)	0.84078(17)	-0.07600(12)	0.0334(3)
C7 C	0.20402(7)	0.92280(16)	0.08593(11)	0.0295(3)
C8 C	0.20247(7)	0.76866(16)	0.09557(11)	0.0291(3)
C9 C	0.24393(7)	0.69523(16)	0.19494(11)	0.0291(3)
C10 C	0.24947(8)	0.53925(16)	0.21101(12)	0.0329(3)
C11 C	0.28973(8)	0.47737(17)	0.30878(13)	0.0365(3)
C12 C	0.32417(8)	0.57081(17)	0.39671(13)	0.0373(3)
C13 C	0.32036(8)	0.72419(17)	0.38312(12)	0.0342(3)
C14 C	0.28241(7)	0.78786(15)	0.28175(12)	0.0292(3)
C15 C	0.24426(7)	1.02075(16)	0.17261(12)	0.0311(3)
C16 C	0.33039(7)	1.03426(15)	0.34838(11)	0.0298(3)
C17 C	0.40139(8)	1.05689(15)	0.32782(12)	0.0314(3)
C18 C	0.48818(9)	1.01839(19)	0.22031(16)	0.0479(4)
C19 C	0.53903(9)	1.1040(2)	0.29365(19)	0.0554(5)
C20 C	0.51922(9)	1.16736(19)	0.38672(17)	0.0511(4)
C21 C	0.44917(8)	1.14477(16)	0.40884(13)	0.0377(3)
C22 C	0.42540(10)	1.20441(18)	0.50545(14)	0.0458(4)
C23 C	0.35713(10)	1.17957(18)	0.52257(13)	0.0442(4)
C24 C	0.30931(8)	1.09379(17)	0.44243(12)	0.0365(3)
C25 C	0.14910(8)	1.12221(17)	-0.06056(13)	0.0362(3)
C26 C	0.06242(10)	1.1862(2)	0.05293(15)	0.0523(4)

F1 F	0.07492(5)	0.94377(12)	-0.25343(8)	0.0535(3)
N1 N	0.16361(6)	0.96884(14)	-0.01895(10)	0.0329(3)
N2 N	0.28164(6)	0.94445(13)	0.26721(9)	0.0299(3)
N3 N	0.42129(7)	0.99394(14)	0.23357(11)	0.0379(3)
O1 O	0.24702(6)	1.15831(11)	0.16731(9)	0.0409(3)
O2 O	0.07815(6)	1.16764(13)	-0.05936(9)	0.0433(3)
H2 H	0.0397	0.6736	-0.2955	0.054
H3 H	0.0697	0.4647	-0.1791	0.053
H4 H	0.1427	0.4867	-0.0005	0.046
H10 H	0.2253	0.4762	0.1540	0.039
H11 H	0.2940	0.3738	0.3162	0.044
H12 H	0.3497	0.5296	0.4644	0.045
H13 H	0.3433	0.7860	0.4420	0.041
H18 H	0.5025	0.9749	0.1569	0.058
H19 H	0.5852	1.1172	0.2789	0.066
H20 H	0.5519	1.2261	0.4364	0.061
H22 H	0.4568	1.2616	0.5583	0.055
H23 H	0.3422	1.2191	0.5869	0.053
H24 H	0.2626	1.0776	0.4540	0.044
H25A H	0.1821	1.1899	-0.0128	0.043
H25B H	0.1579	1.1293	-0.1385	0.043
H26A H	0.0610	1.0898	0.0885	0.079
H26B H	0.0166	1.2347	0.0474	0.079
H26C H	0.0991	1.2467	0.0985	0.079

7. Applications of Cu-mediated *ortho*-C-H/N-H annulation in the synthesis of cryptolepine alkaloids.



i) 5 equiv. BBr_3/DCM , 0.05 N in DCM, r.t., 3 h, 67% yield. ii) 3 equiv $\text{K}_2\text{Cr}_2\text{O}_7$, $\text{AcOH}:\text{H}_2\text{O}(1:1)$, 60°C , 12 h, 65% yield. iii) *ref* 8
iv) 10 equiv BBr_3/DCM , 0.05 N in DCM, r.t., 5.5 h, 58% yield. v) 3.5 equiv $\text{PhI}(\text{TFA})_2$, $\text{MeCN}:\text{H}_2\text{O}(1:1)$, 2 d DMSO , 0°C , 6 h, 43% yield. vi) 1 N HCl , dioxane, 80°C , 1 h, >90 yield.

1) The synthesis of Isocryptolepine.

Intermediate 23-1: 23 (0.10 mmol, 43 mg) and anhydrous dichloromethane (2.0 ml) was added into a 10 mL glass vial (purged with Ar, sealed with PTFE cap). The resulting solution was cooled to 0°C , and BBr_3 (1.0 M in

dichloromethane solution, 5.0 equiv., 0.50 ml) was added under 0°C, then allowed to warm to room temperature and stirred for 3 h, which was then quenched by H₂O at 0°C. The combined organic phase was dried over anhydrous Na₂SO₄ and concentrated under reduced pressure. The resulting residue was purified by silica gel flash chromatography to give the annulation product **23-1** in 67% (29 mg) isolated yield (*R_f* = 0.45, 3.33% MeOH in CHCl₃). ¹H NMR (DMSO, 400 MHz, ppm): δ 10.97 (s, 1 H), 8.65-8.63 (m, 2 H), 8.48-8.45 (m, 1 H), 8.26 (d, *J* = 7.6 Hz, 1 H), 8.06 (d, *J* = 8.4 Hz, 1 H), 7.66 (d, *J* = 8.1 Hz, 1 H), 7.52-7.47 (m, 2 H), 7.37-7.31 (m, 3 H), 7.16 (d, *J* = 7.9 Hz, 1 H), 6.62-6.59 (m, 1 H), 6.15 (s, 2 H), 3.47 (s, 3 H); ¹³C NMR (DMSO, 100 MHz, ppm) δ 159.3, 154.1, 151.0, 144.9, 141.2, 140.1, 139.7, 131.5, 131.3, 129.1, 126.1, 124.8, 124.0, 123.7, 122.1, 121.7, 121.0, 120.7, 120.6, 117.1, 112.7, 110.4, 108.4, 108.3, 74.9, 55.6; HRMS: calculated for C₂₆H₂₀N₃O₃ [M+H⁺]: 422.1499; found: 422.1516.

Compound 40: 23-1 (0.1 mmol, 42 mg) and AcOH (1.0 ml) were in 10 mL glass vial (purged with Ar, sealed with PTFE cap), and K₂Cr₂O₇ (3.0 equiv., 88 mg) dissolved in H₂O (1.0 ml) was sequentially added under argon protection. The reaction was stirred at 60°C for 12 h, and then quenched with H₂O. The mixture was extracted with chloroform. The combined organic phase was dried over anhydrous Na₂SO₄, concentrated under reduced pressure and purified by column chromatography (*R_f* = 0.50, 50 % EtOAc in hexanes) to afford **40** in 65% yield. Compound **40** is known compound which could be seen in reference 8. ¹H NMR (CDCl₃, 400 MHz, ppm): δ 10.29 (s, 1 H), 8.62 (d, *J* = 7.8 Hz, 1 H), 8.41 (d, *J* = 8.2 Hz, 1 H), 7.65 (d, *J* = 8.0 Hz, 1 H), 7.56 (t, *J* = 7.5 Hz, 1 H), 7.52-7.48 (m, 2 H), 7.44 (t, *J* = 7.4 Hz, 1 H), 7.35 (t, *J* = 7.7 Hz, 1 H), 5.95 (s, 2 H), 3.51 (s, 3 H).

2) The synthesis of 5,7-dihydro-6H-indolo[2,3-c]quinolin-6-one 43.

Compound 41: A mixture of amide **41a** (72 mg, 0.2 mmol, 1.0 equiv.), Cu(OAc)₂ (27 mg, 0.15 mmol, 0.75 equiv.), TBAI (111 mg, 0.3 mmol, 1.5 equiv.), CsF (36.5 mg, 1.2 equiv.), and 2-(trimethylsilyl)phenyl trifluoromethanesulfonate (120 mg, 2 equiv.) in DMF (1.0 mL)/MeCN (1.0 mL) in a 10 mL glass vial (purged with O₂, sealed with PTFE cap) was heated at 100 °C for 1 hour. The reaction mixture was cooled to RT. The resulting residue was purified by silica gel flash chromatography to give the annulation product **41** in 63% (55 mg) isolated yield (*R_f* = 0.4, 50% EtOAc in hexanes). ¹H NMR (CDCl₃, 400 MHz, ppm): δ 8.75 (dd, *J* = 4.2, 1.7 Hz, 1 H), 8.68 (dd, *J* = 8.5, 1.7 Hz, 1 H), 8.58 (dd, *J* = 8.0, 1.2 Hz, 1 H), 8.52 (d, *J* = 8.2 Hz, 1 H), 7.79 (d, *J* = 8.4 Hz, 1 H), 7.72 (d, *J* = 8.2 Hz, 1 H), 7.58 (td, *J* = 7.2, 0.9 Hz, 1 H), 7.46-7.42 (m, 1 H), 7.40 (dd, *J* = 8.5, 4.2 Hz, 1 H), 7.37-7.33 (m, 1 H), 7.20-7.15 (m, 1 H), 7.06 (d, *J* = 8.2 Hz, 1 H), 6.68 (dd, *J* = 8.5, 0.8 Hz, 1 H), 6.44 (d, *J* = 10.6 Hz, 1 H), 6.24 (d, *J* = 10.6 Hz, 1 H), 4.11 (s, 3 H), 3.37 (s, 3 H); ¹³C NMR (CDCl₃, 100 MHz, ppm) δ 157.3, 156.2, 151.8, 145.2, 140.9, 138.6, 131.4, 130.9, 128.3, 126.7, 126.5, 126.4, 123.9, 123.0, 122.7, 122.2, 122.0, 121.21, 121.18, 119.3, 117.1, 112.1, 104.4, 75.0, 56.2, 56.0; HRMS: calculated for C₂₇H₂₂N₃O₃ [M+Na⁺]: 458.1475; found: 458.1479.

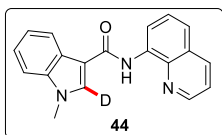
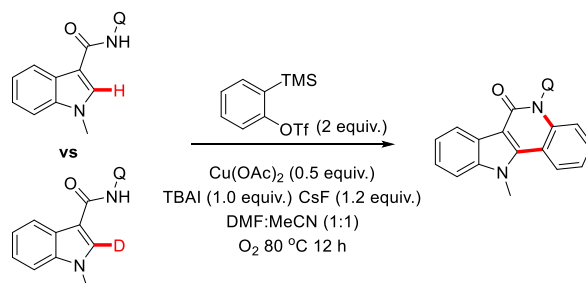
Intermediate 41-1: 41 (0.10 mmol, 43 mg) and anhydrous dichloromethane (2.0 ml) was added into a 10 mL glass vial (purged with Ar, sealed with PTFE cap). The resulting solution was cooled to 0°C, and BBr₃ (1.0 M in dichloromethane solution, 10.0 equiv., 1.0 ml) was added under 0°C, then allowed to warm to room temperature and stirred for 5.5 h, which was then quenched by H₂O at 0°C. The combined organic phase was dried over anhydrous Na₂SO₄ and concentrated under reduced pressure. The resulting residue was purified by silica gel flash chromatography to give the annulation product **41-1** in 58% (25 mg) isolated yield (*R_f* = 0.55, 10% MeOH in CHCl₃). ¹H NMR (DMSO, 400 MHz, ppm): δ 11.01 (s, 1 H), 8.69-8.63 (m, 4 H), 7.91 (d, *J* = 8.4 Hz, 1 H), 7.70 (d, *J* = 8.1 Hz, 1 H), 7.65-7.61 (m, 1 H), 7.52-7.46 (m, 2 H), 7.39-7.35 (m, 1 H), 7.23 (td, *J* = 8.5, 1.2 Hz, 1 H), 7.16 (d, *J* = 8.1 Hz, 1 H), 6.56 (dd, *J* = 8.4, 0.7 Hz, 1 H), 6.24 (dd, *J* = 24.6, 10.5 Hz, 2 H),

3.21 (s, 3 H); ^{13}C NMR (DMSO, 100 MHz, ppm) δ 156.0, 154.2, 151.1, 144.7, 140.2, 138.3, 131.3, 126.7, 126.6, 125.9, 125.8, 123.6, 122.9, 122.6, 122.1, 121.8, 120.7, 119.9, 117.9, 116.7, 112.1, 108.3, 74.0, 55.3; **HRMS**: calculated for $\text{C}_{26}\text{H}_{20}\text{N}_3\text{O}_3$ $[\text{M}+\text{H}^+]$: 422.1499; found: 422.1498.

Compound 42: **41-1** (0.1 mmol, 42 mg) and MeCN:H₂O (2 mL, 1:1 v/v) were added in flask under argon protection, and then PhI(TFA)₂ (3.5 mmol, 150 mg) and 2d DMSO was added at 0°C. The reaction was stirred at 0°C for 6 h, and then quenched with H₂O. The mixture was extracted with chloroform. The combined organic phase was dried over anhydrous Na₂SO₄, concentrated under reduced pressure and purified by column chromatography (R_f = 0.50, 33 % EtOAc in hexanes) to afford **42** in 43 % yield (12 mg). ^1H NMR (DMSO, 400 MHz, ppm): δ 12.00 (s, 1 H), 8.58 (d, J = 8.1 Hz, 1 H), 8.53 (d, J = 7.9 Hz, 1 H), 7.85 (d, J = 8.1 Hz, 1 H), 7.59 (t, J = 7.4 Hz, 1 H), 7.52 (d, J = 7.7 Hz, 1 H), 7.47-7.41 (m, 2 H), 7.36 (t, J = 7.4 Hz, 1 H), 6.31 (s, 2 H), 3.22 (s, 3 H); ^{13}C NMR (DMSO, 100 MHz, ppm) δ 170.1, 156.0, 155.8, 135.2, 128.6, 126.7, 126.4, 126.1, 123.3, 122.7, 122.5, 121.9, 120.1, 115.9, 112.0, 73.9, 55.2; **HRMS**: calculated for $\text{C}_{17}\text{H}_{15}\text{N}_2\text{O}_2$ $[\text{M}+\text{H}^+]$: 279.1128; found: 278.1130.

Compound 43: A solution of **42** (0.035 mmol, 10 mg) and 1 N HCl (0.6 mL) in 1,4-dioxane (1.3 mL) was stirred at 80 °C for 50 min. and the solution was neutralized by a saturated aqueous NaHCO₃ solution (pH=10) after cooling, and extracted with DCM. The combined organic phases were dried over Na₂SO₄ and concentrated under reduced pressure and purified by column chromatography (R_f = 0.40, 50 % EtOAc in hexanes) to afford **43** in 90 % yield. Compound **43** is known compound which could be seen in reference 9. ^1H NMR (DMSO, 400 MHz, ppm): δ 12.35 (s, 1 H), 11.85 (s, 1 H), 8.46 (dd, J = 14.2, 8.3 Hz, 2 H), 7.64 (d, J = 8.2 Hz, 1 H), 7.48 (dd, J = 17.0, 8.4 Hz, 2 H), 7.41 (t, J = 7.2 Hz, 1 H), 7.33 (dd, J = 15.4, 7.9 Hz, 2 H).

8. Preliminary mechanistic studies

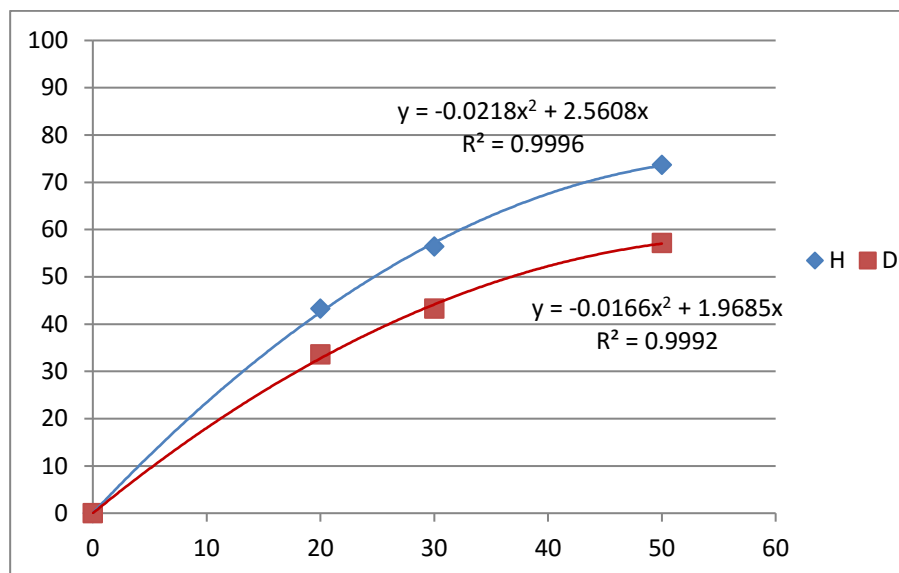


R_f = 0.60, 50 % EtOAc in hexanes

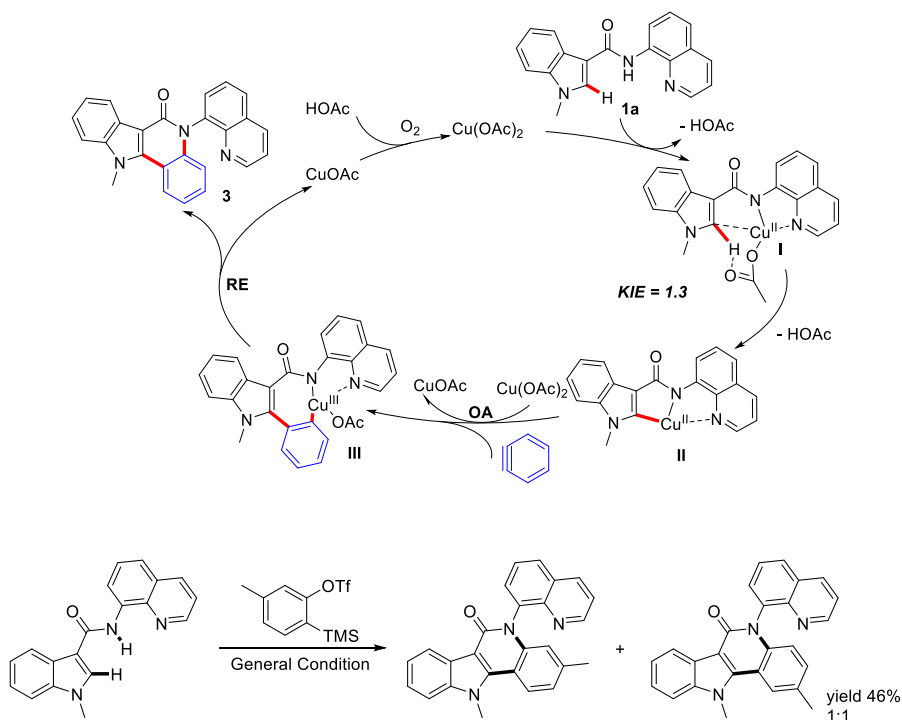
^1H NMR (CDCl₃, 400 MHz, ppm): δ 10.54 (s, 1 H), 8.96 (dd, J = 7.6, 1.2 Hz, 1 H), 8.89 (dd, J = 4.2, 1.7 Hz, 1 H), 8.47 (dd, J = 6.8, 1.1 Hz, 1 H), 8.17 (dd, J = 8.2, 1.6 Hz, 1H), 7.91 (s, 0.2 H), 7.59 (t, J = 7.9 Hz, 1 H), 7.50 (dd, J = 8.2, 1.2 Hz, 1 H), 7.46 (dd, J = 8.3, 4.2 Hz, 1 H), 7.42-7.33 (m, 3 H), 3.88 (s, 3 H); ^{13}C NMR (CDCl₃, 100 MHz, ppm) δ 163.4, 148.3, 138.8, 137.5, 136.5, 135.5, 128.2, 127.7, 125.6, 122.8, 122.0, 121.7, 120.9, 120.9, 116.4, 111.8, 110.2, 33.5; **HRMS**: calculated for $\text{C}_{19}\text{H}_{15}\text{DN}_3\text{O}$ $[\text{M}+\text{H}^+]$: 303.1356; found: 303.1371.

Kinetic isotope effect (KIE) of the amination of substrate 1a and 44 with 2-(trimethylsilyl)phenyl trifluoromethanesulfonate (Aryne Precursor)

Substrate **1a** or **44** was subjected to the annulation reaction with 2-(trimethylsilyl)phenyl trifluoromethanesulfonate under the general reaction condition for 0.1-1.0 h. Data was collected at 0.2, 0.3 and 0.5 hours. Data collecting method: at specified reaction time, the reaction vial was quenched and isolated by silica gel flash chromatography. Average data of three repeating experiments were used. k_H/k_D (~1.3) was estimated based on the ratio of annulation yield.



Proposed Reaction Pathway Study



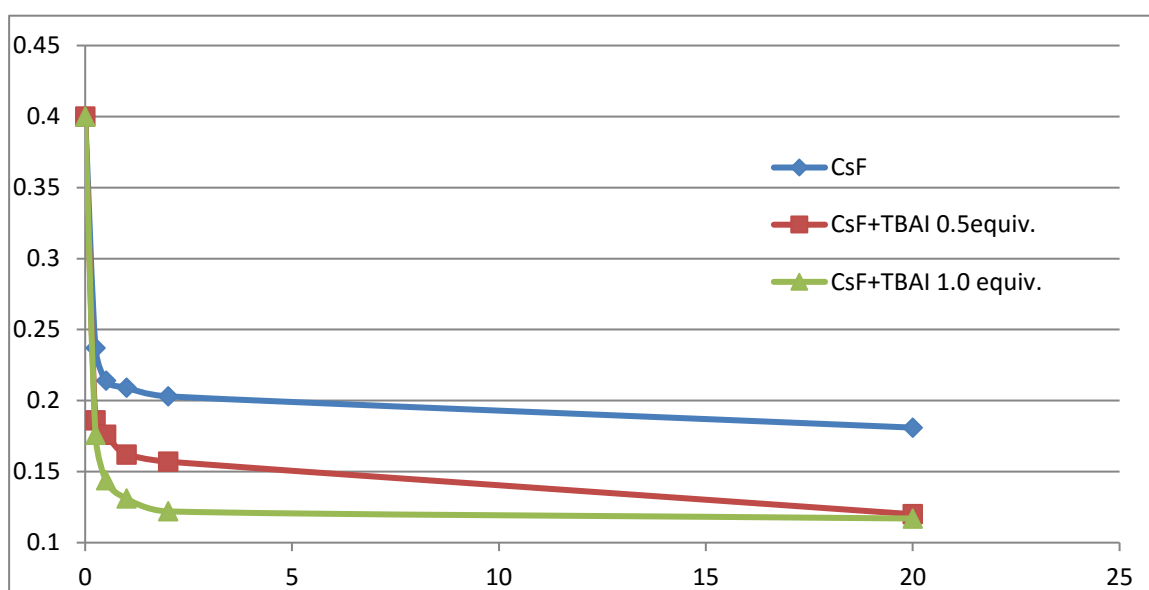
The study on generation of benzyne: A mixture of amide **1a** (60 mg, 0.2 mmol, 1 equiv.), Cu(OAc)₂ (18.2 mg, 0.1mmol, 0.5 equiv.), TBAI (74 mg, 0.2 mmol, 1.0 equiv.), CsF (36.5 mg, 0.24 mmol, 1.2 equiv.), and

2-(trimethylsilyl)phenyl trifluoromethanesulfonate (122 mg, 2 equiv.) in DMF (1.0 mL)/MeCN (1.0 mL) in a 10 mL glass vial (purged with O₂, sealed with PTFE cap) was heated at 80°C for 12 hours. The reaction mixture was cooled to RT. The resulting residue was purified by silica gel flash chromatography to give the annulation mix product in 60% isolated yield with ratio = 1:1.

Interval NMR Experiment on 2-(trimethylsilyl)phenyl trifluoromethanesulfonate (Aryne Precursor) Consumption

Experiment Procedure: To the solution of 2-(trimethylsilyl)phenyl trifluoromethanesulfonate (0.4 mmol) in MeCN/DMF (2 mL, 1:1), fluoride reagent (2.4 mmol) and additives were added. Benzotrifluoride (0.4 mmol) was also added as the internal standard. Then the reaction system was heated at 80°C, the concentration of residual aryne precursor was monitored by interval ¹⁹F-NMR experiment. The obtained data was list in the table below.

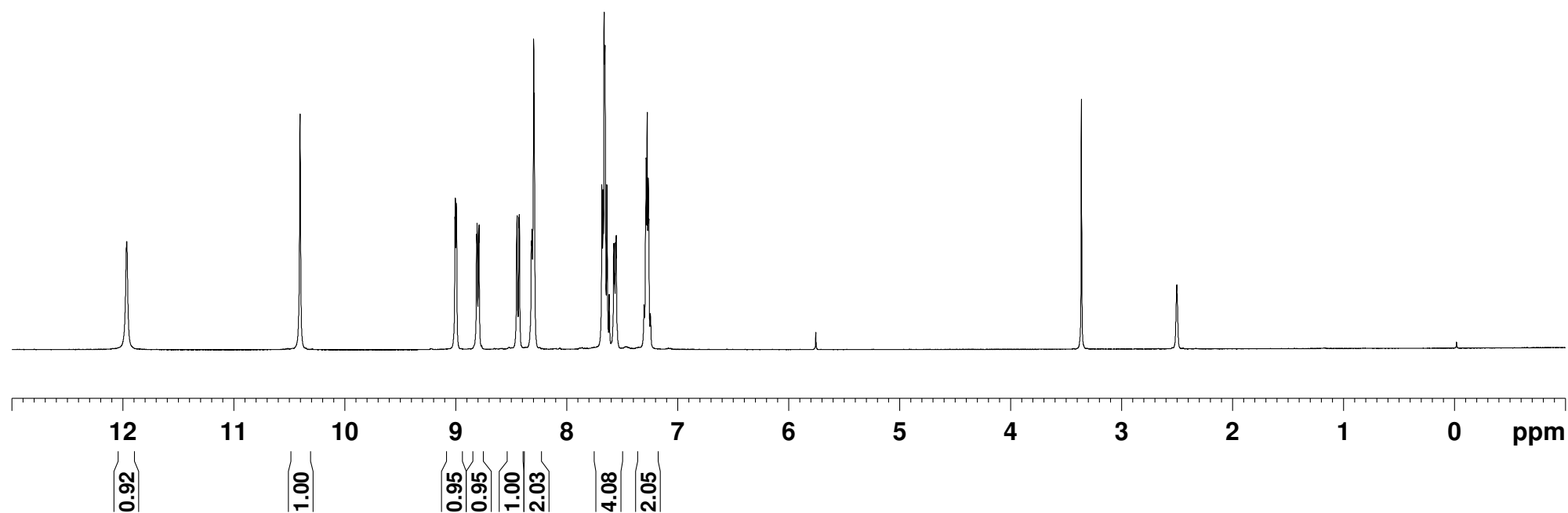
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0.25h	0.237	0.186	0.176
0.5h	0.214	0.176	0.144
1h	0.209	0.162	0.131
2h	0.203	0.157	0.122
20h	0.181	0.12	0.117



9. References:

- (1) Vaillard, V. A.; Rossi, R. A.; Argüello J. E. *Org. Biomol. Chem.* **2012**, *10*, 9255.
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- (3) Truong, T.; Klimovica, K.; Daugulis, O. *J. Am. Chem. Soc.*, **2013**, *135*, 9342.
- (4) Li, B.; Feng, H.-L.; Xu, S.-S.; Wang, B.-Q. *Chem. Eur. J.* **2011**, *17*, 12573.
- (5) Lee, S.-H.; Mu, Y.; Kim, G.-W.; Kim, J.-S.; Park, S.-H.; Jin, T.; Lee, K.-Y.; Ham, W.-H. *Heterocycles*, **2013**, *87*, 1749.
- (6) Sauer, D. R.; Kalvin, D.; Phelan, K. M. *Org. Lett.*, **2003**, *5*, 4721.
- (7) Nishino, M.; Hirano, K.; Satoh, T.; Miura M. *Angew. Chem., Int. Ed.* **2013**, *52*, 4457.
- (8) Hayashi, K.; Choshi, T.; Chikaraishi, K.; Oda, A.; Yoshinaga, R.; Hatae, N.; Ishikura, M.; Hibino, S. *Tetrahedron*. **2012**, *68*, 4274.
- (9) Putey, A.; Popowycz, F.; Do, Q.-T.; Bernard, P.; Talapatra, S. K.; Kozielski, F.; Galmarini, C. M.; Joseph, B. *J. Med. Chem.* **2009**, *52*, 5916.

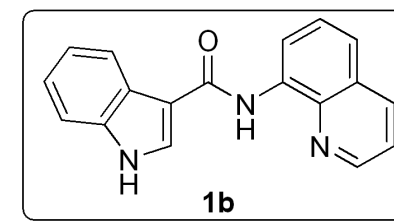
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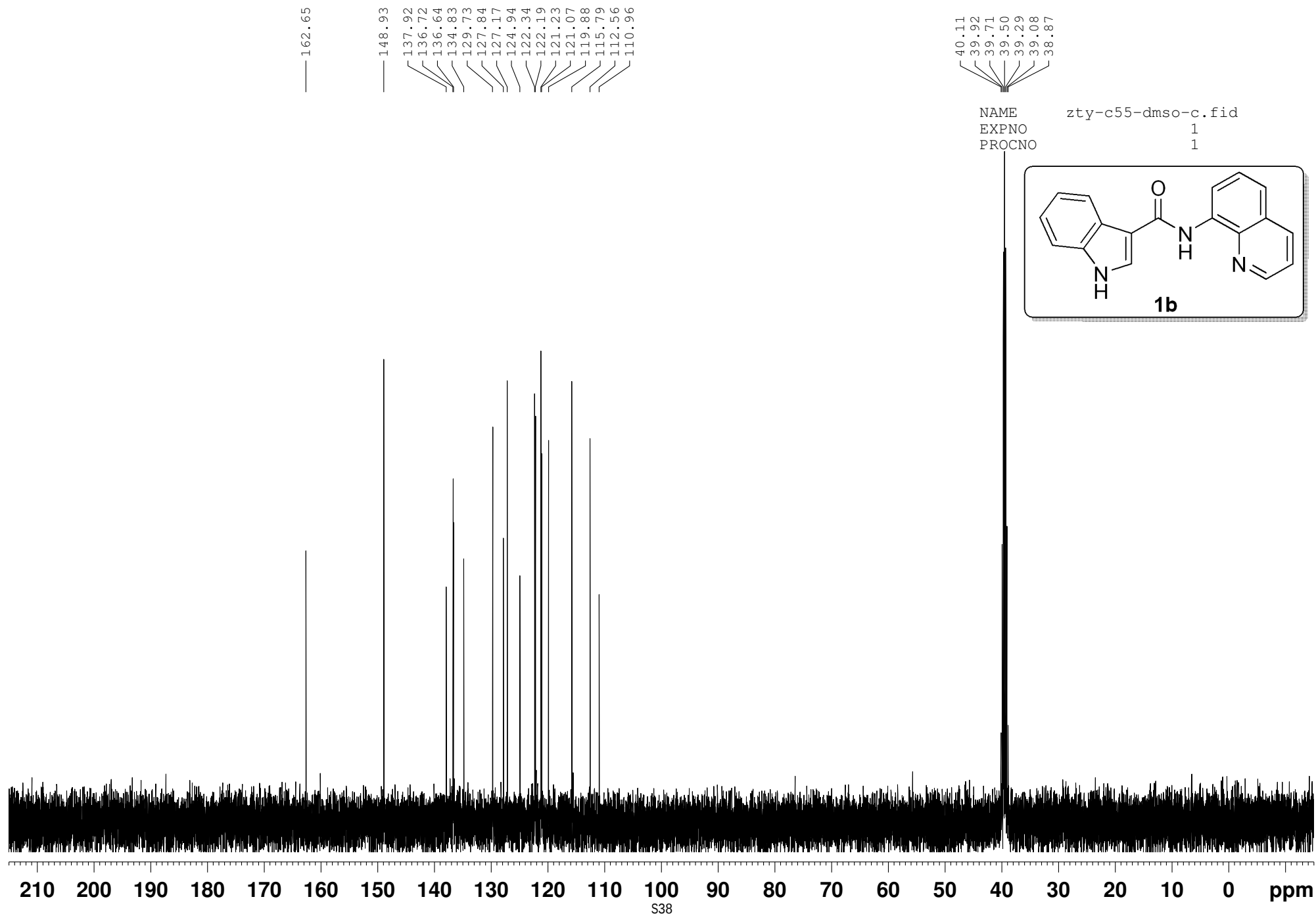


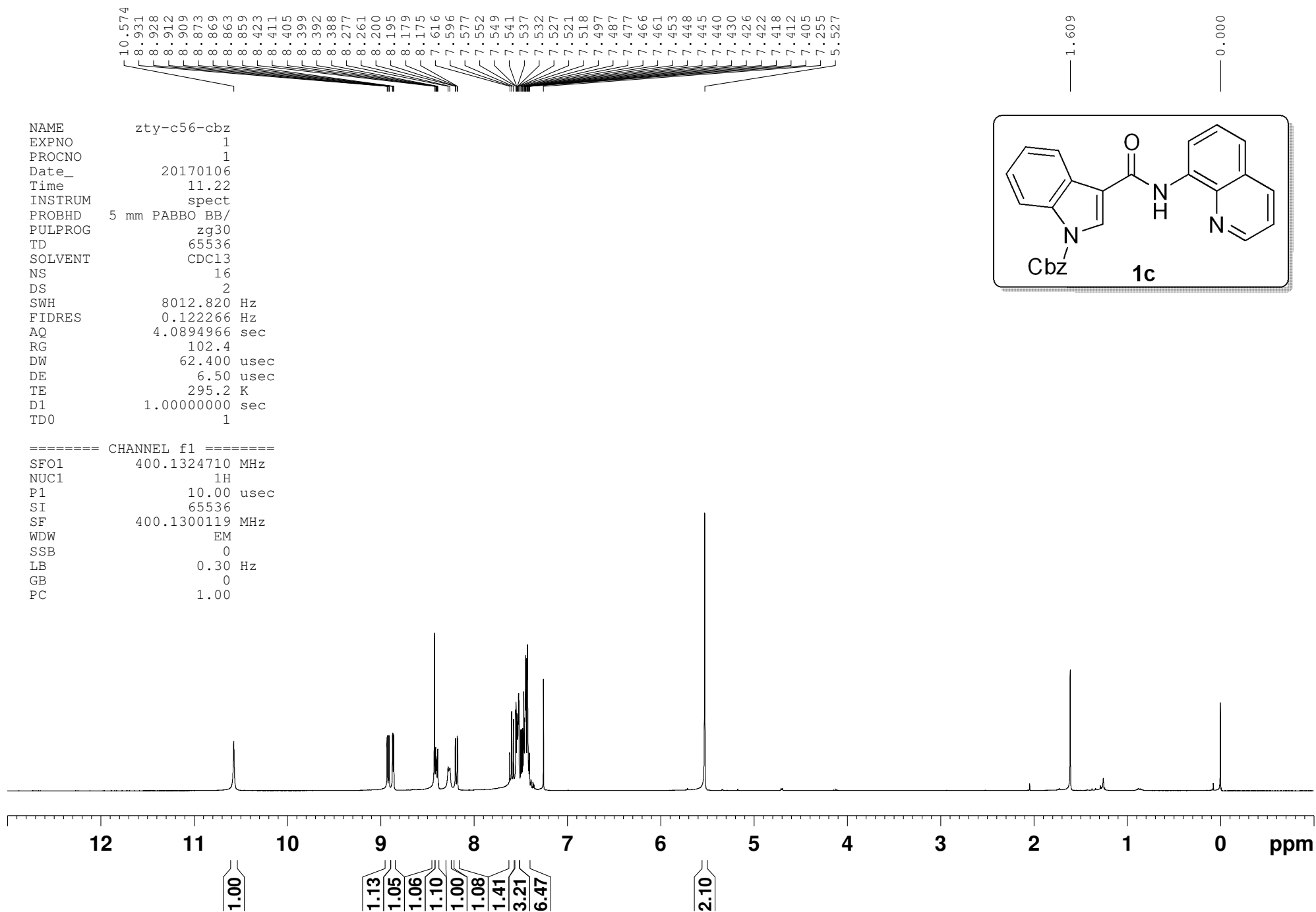
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3.360

2.500



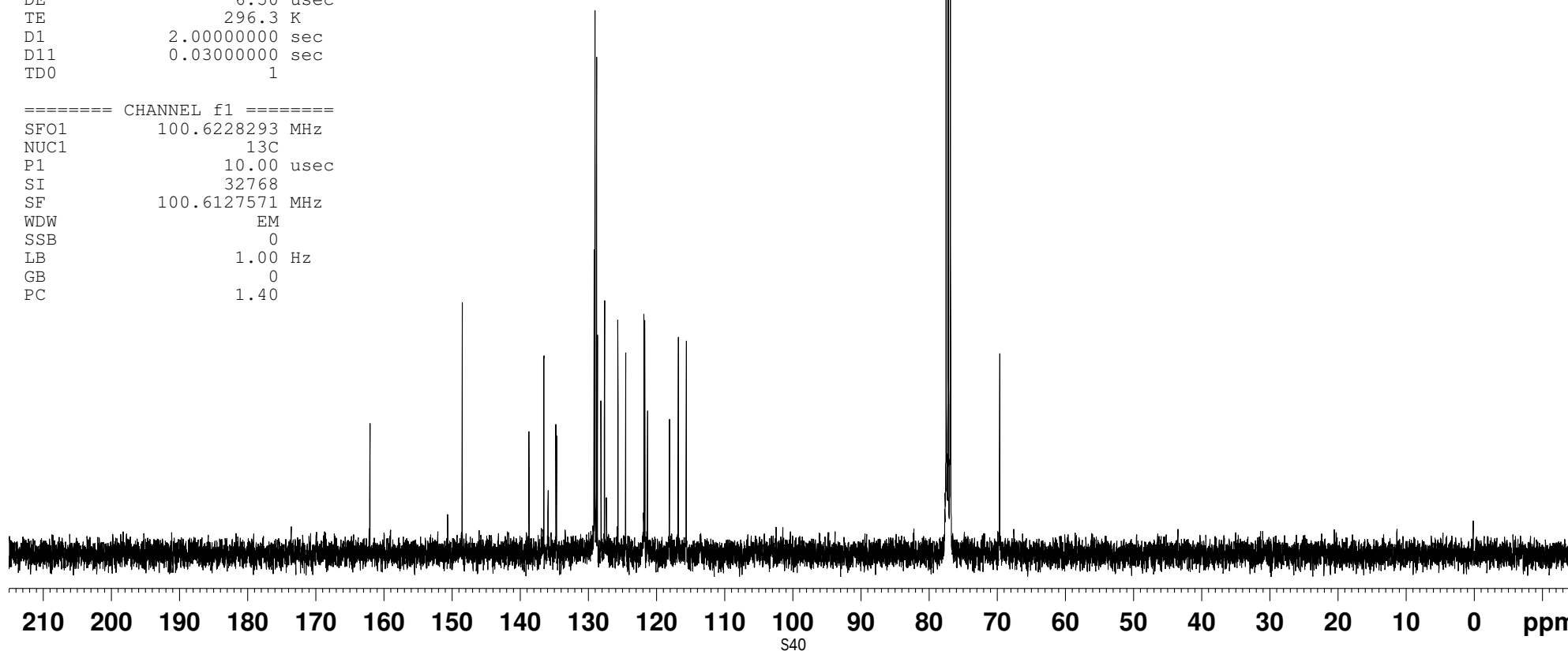
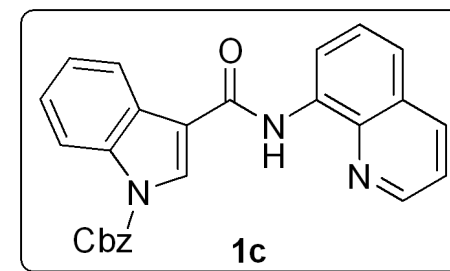


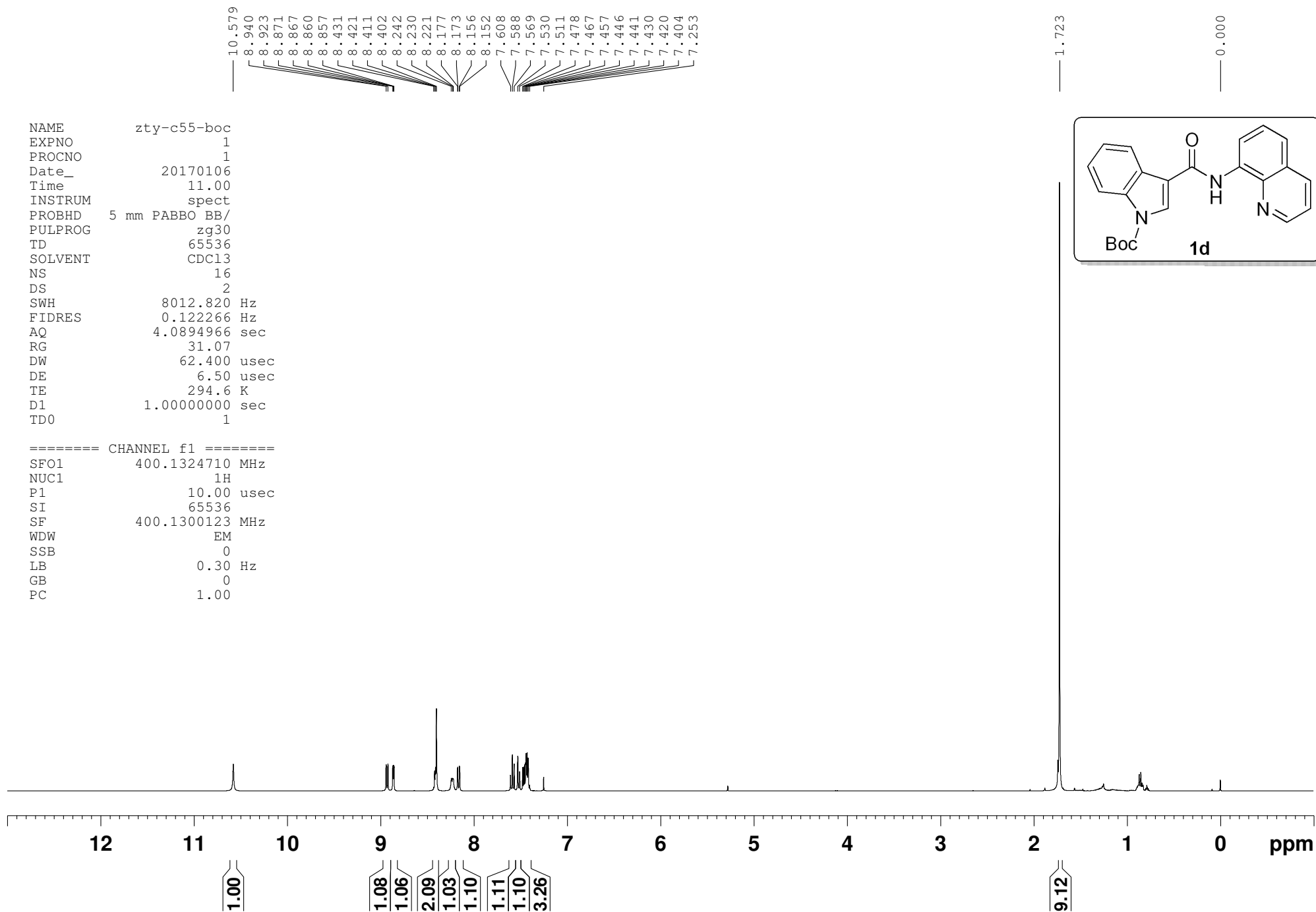


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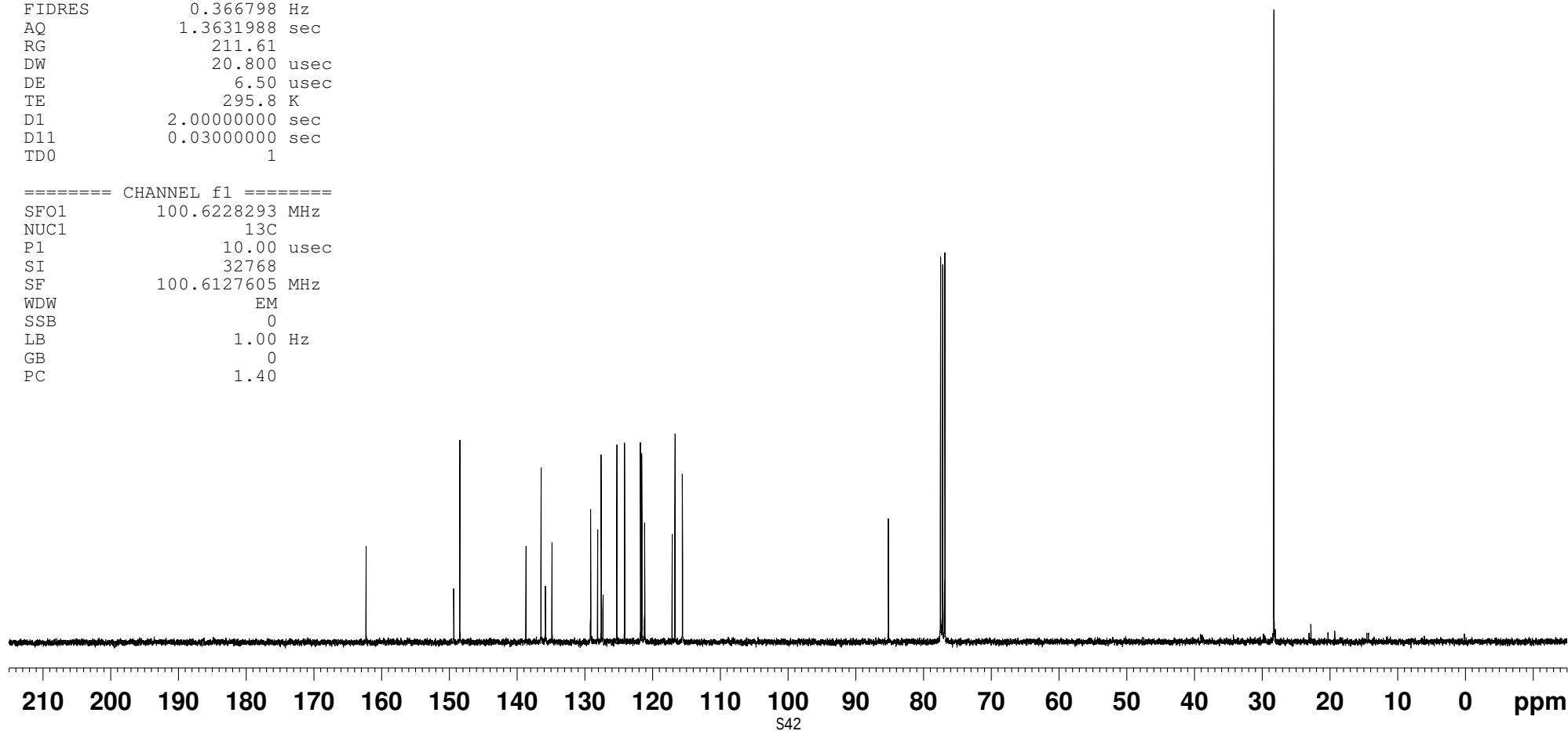
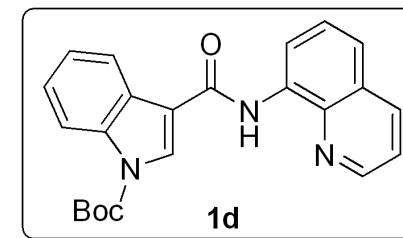


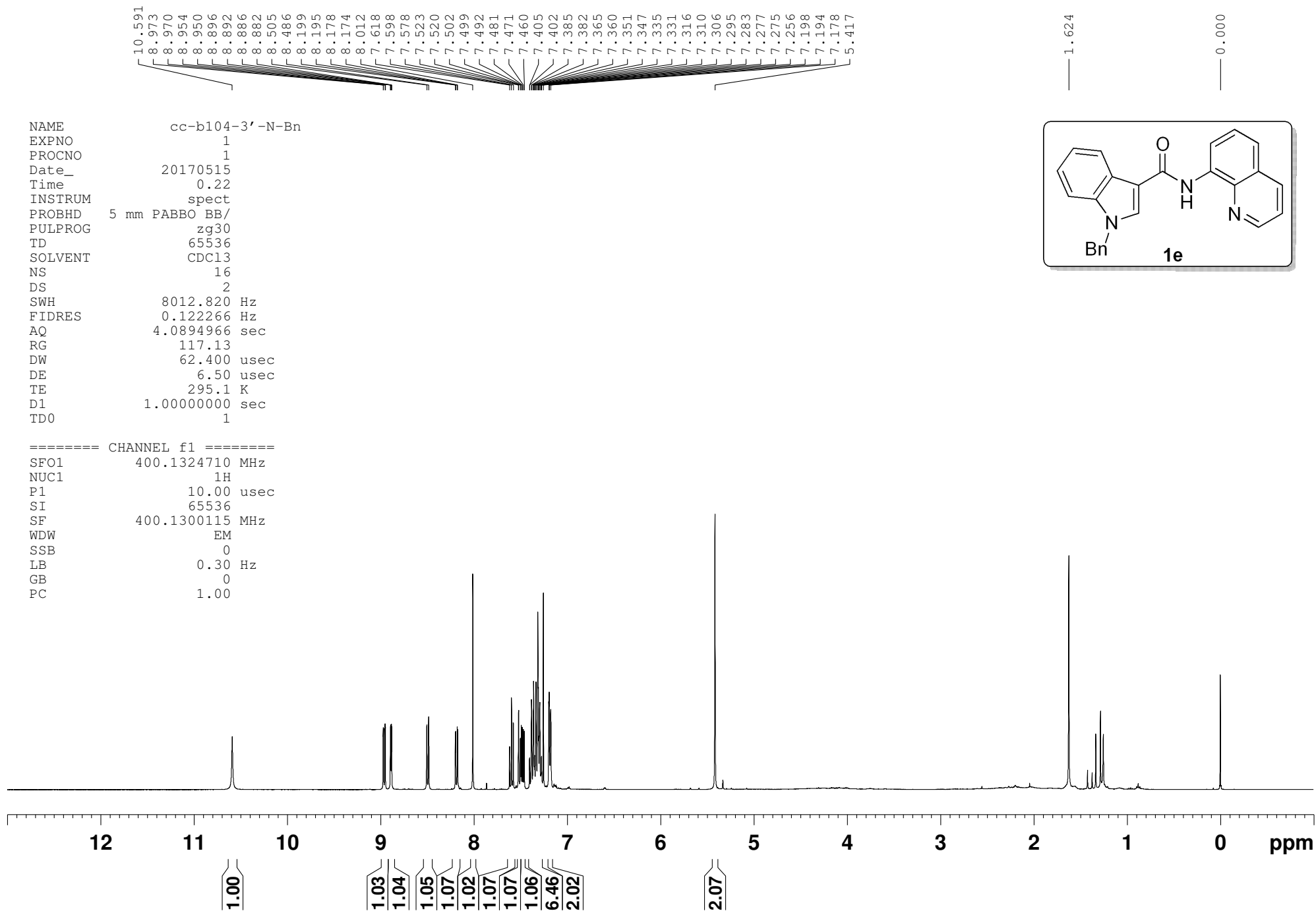


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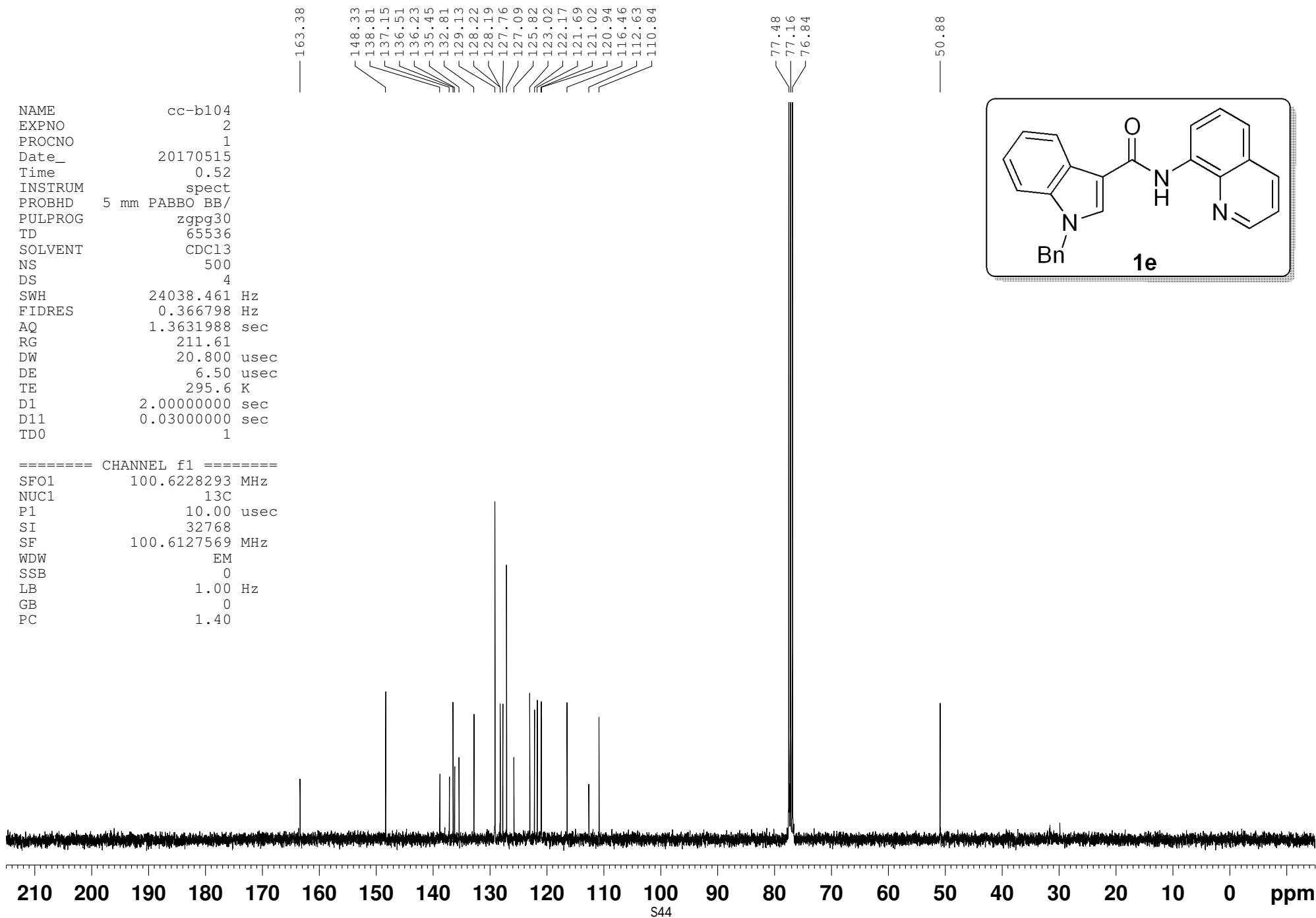
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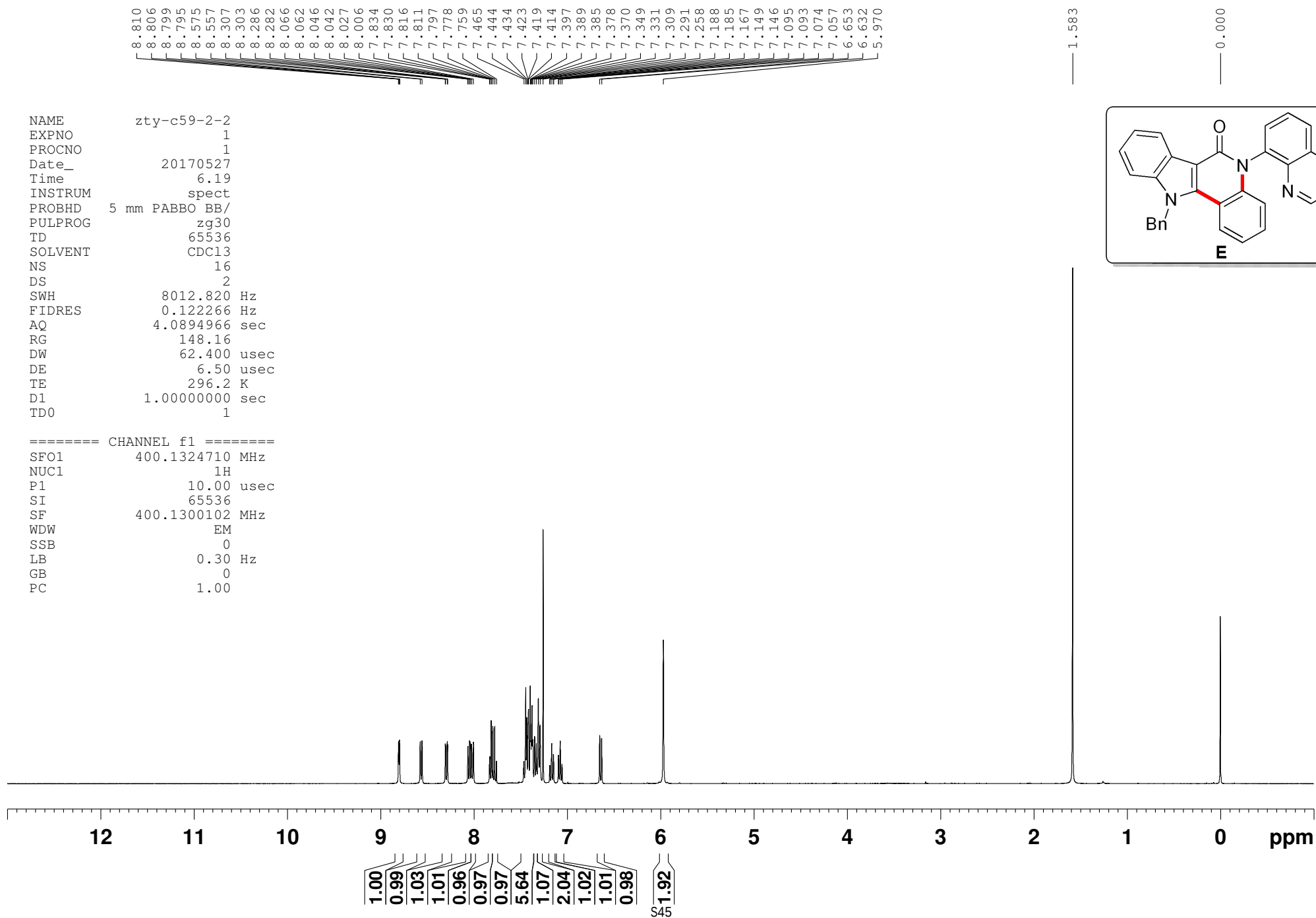


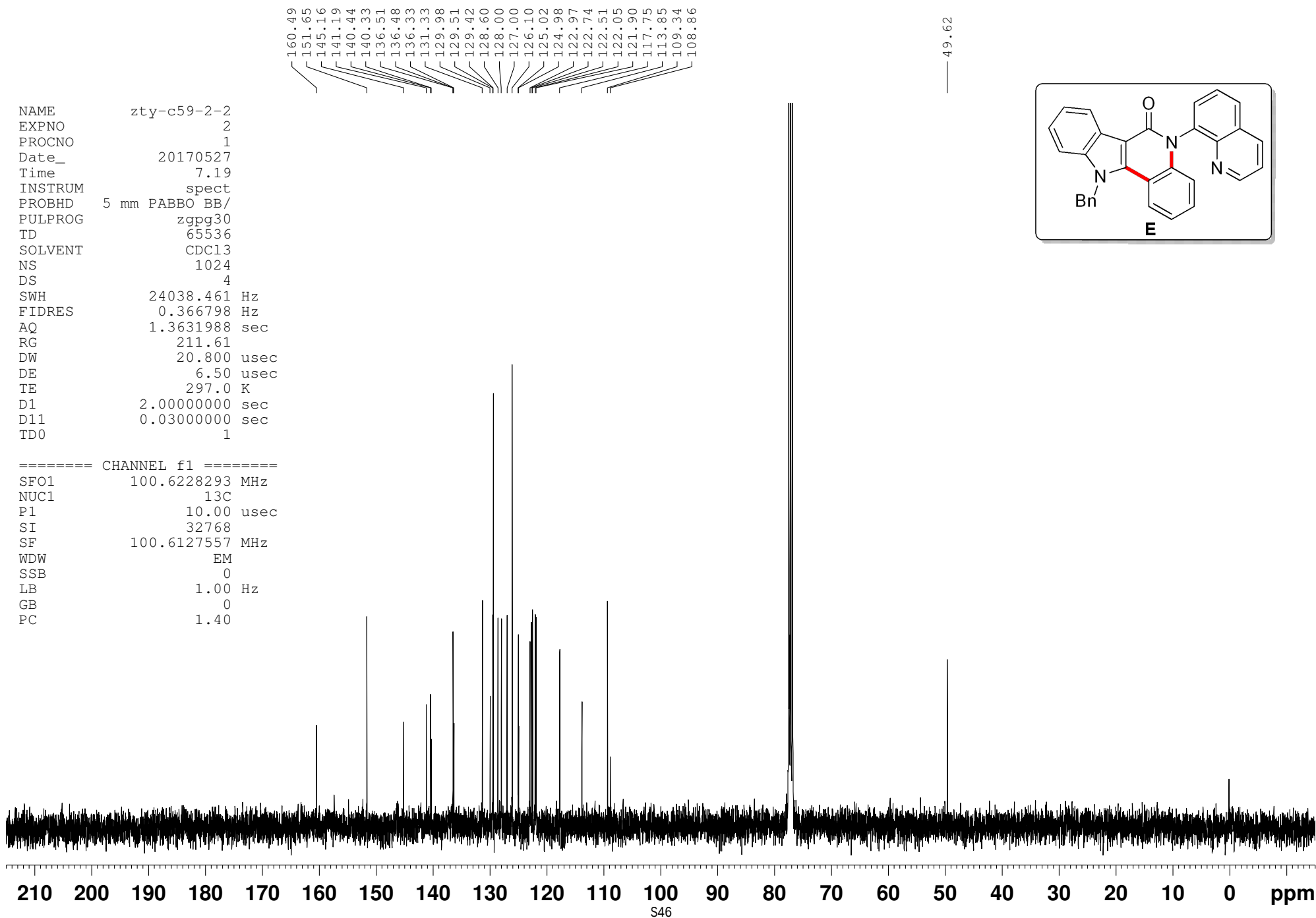


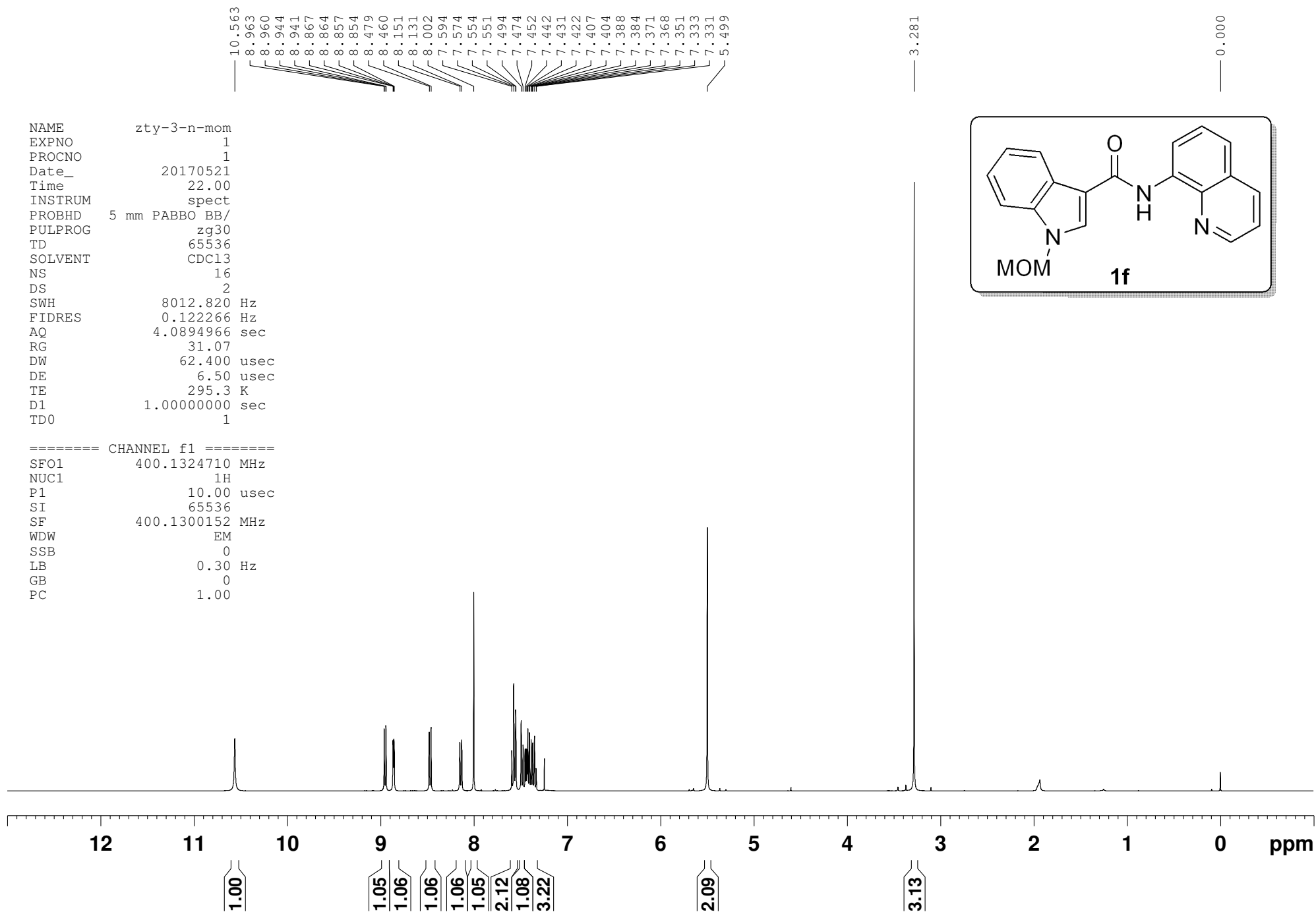
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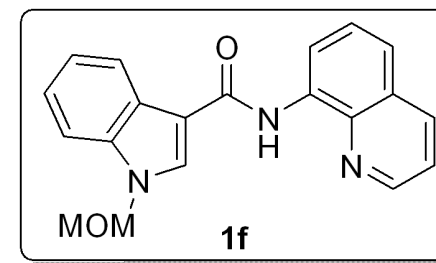
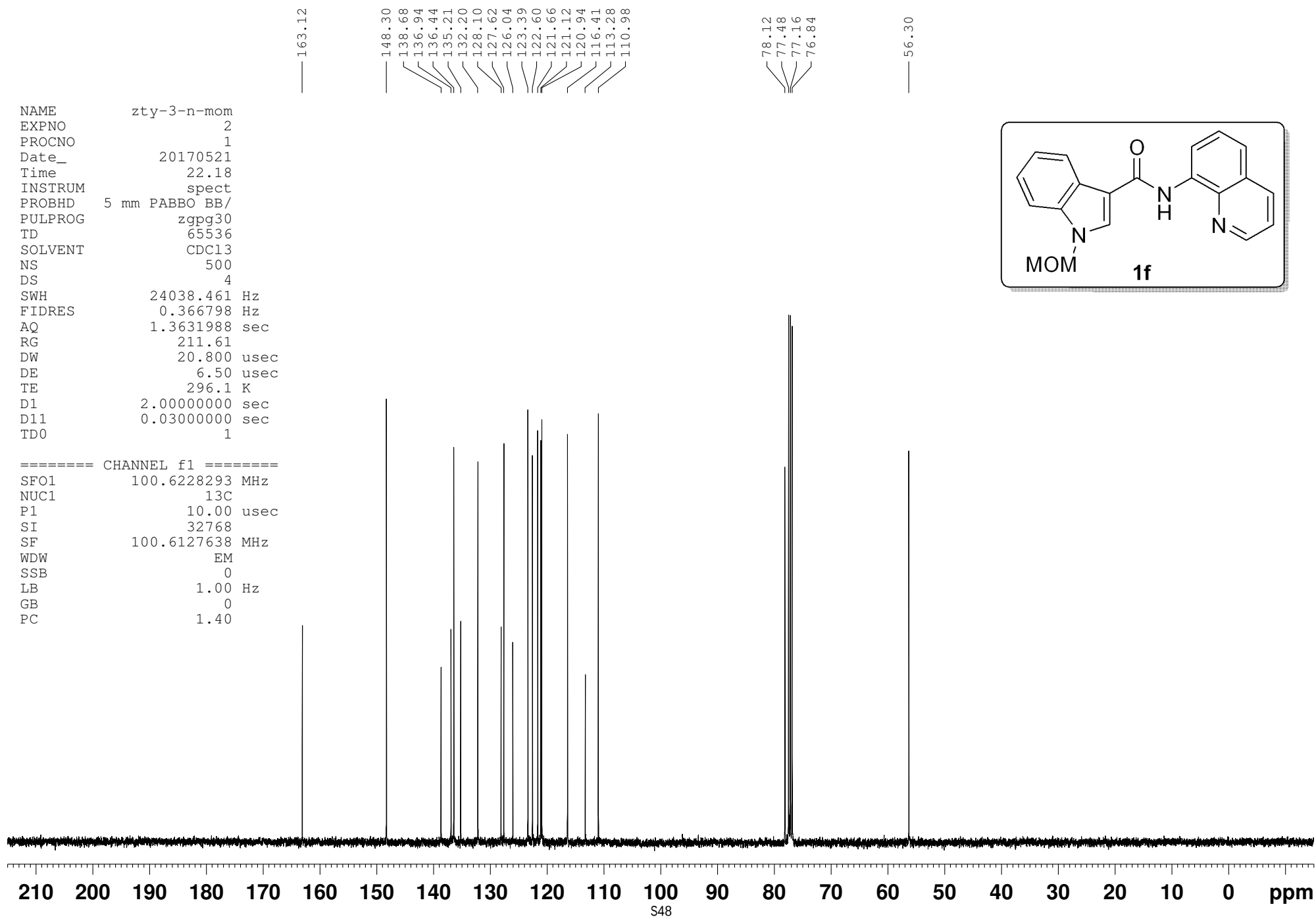


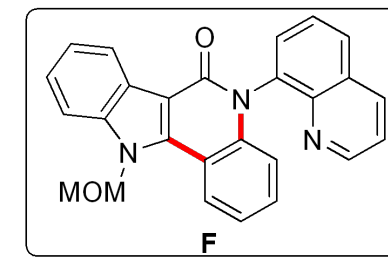
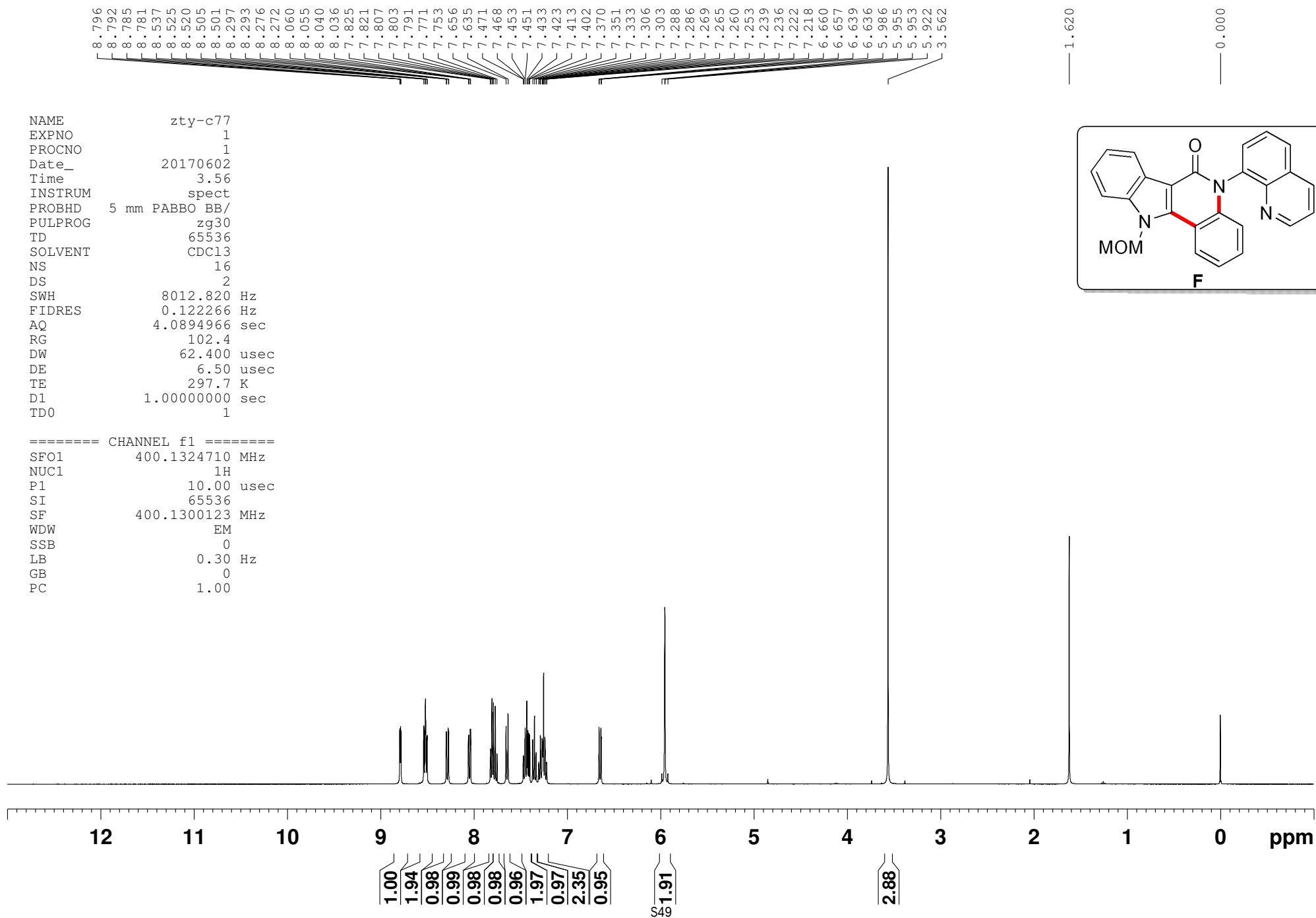




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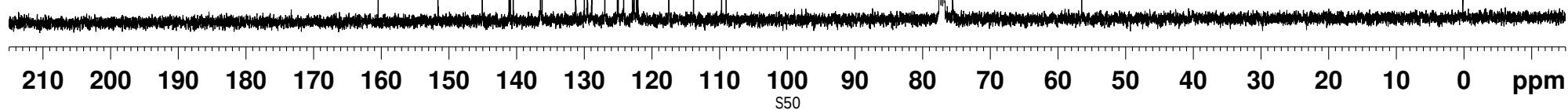
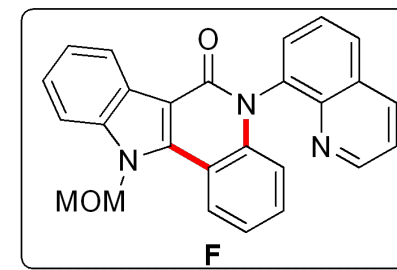




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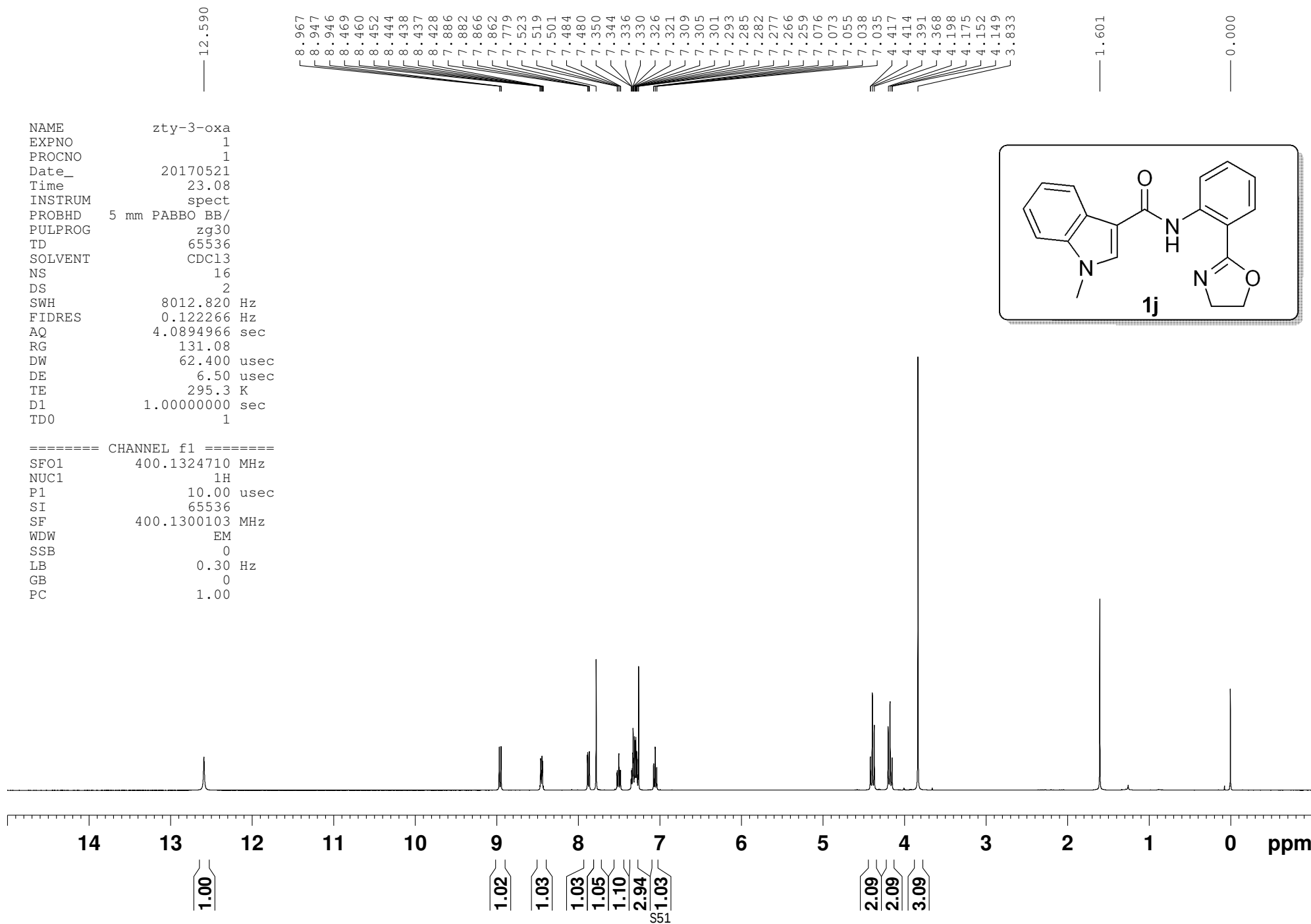
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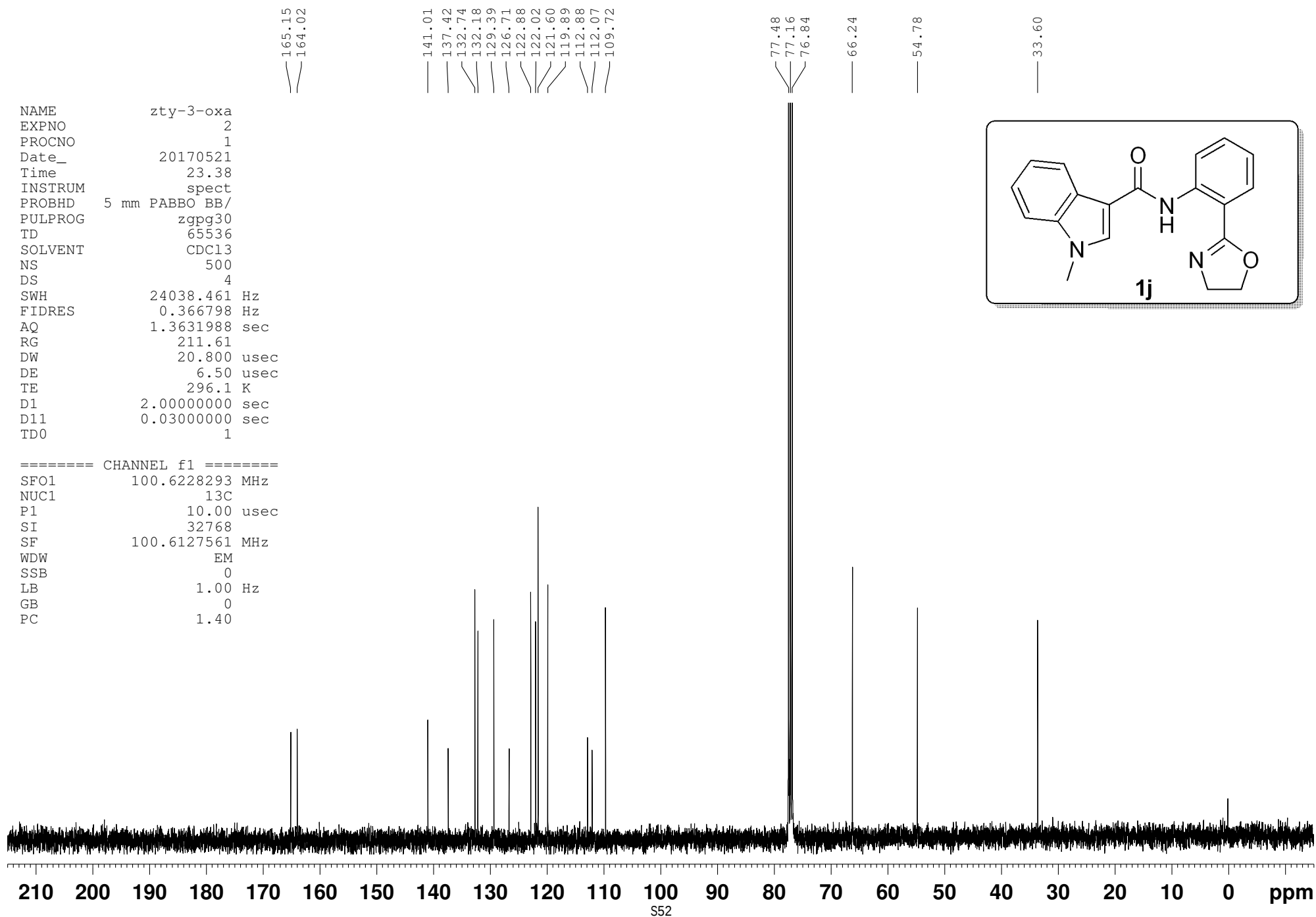
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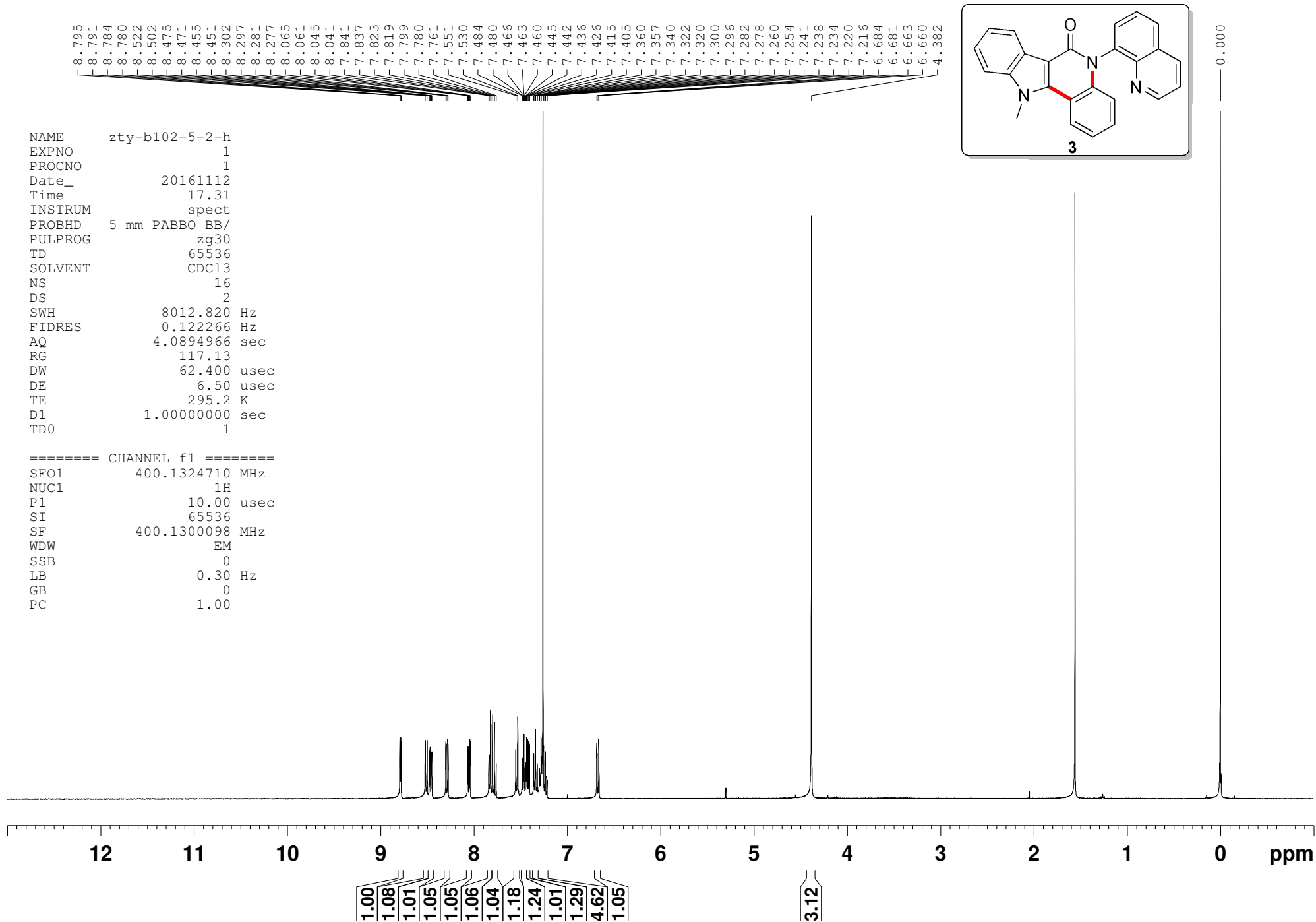
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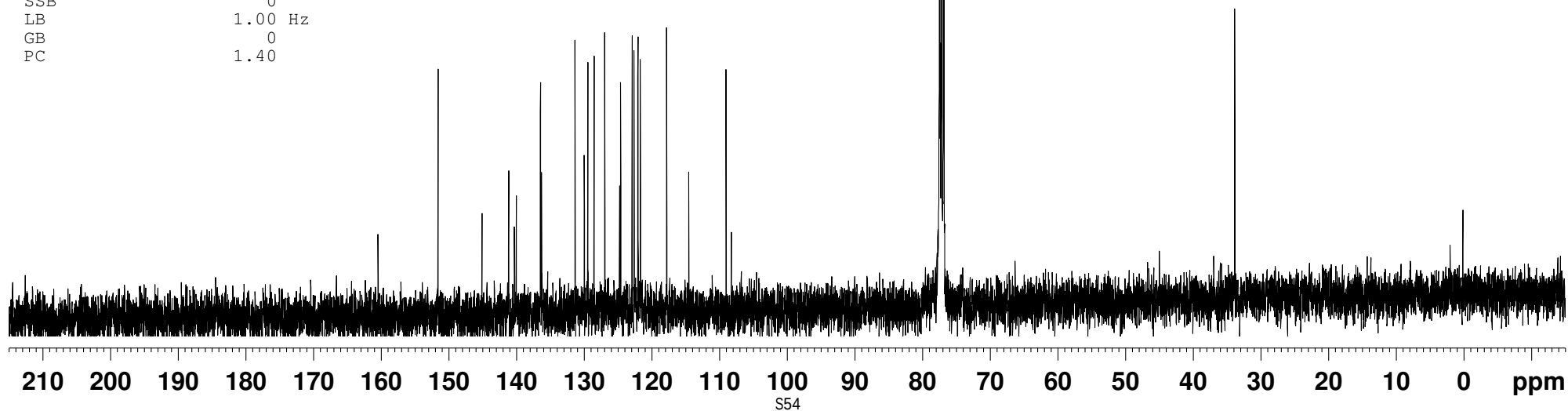
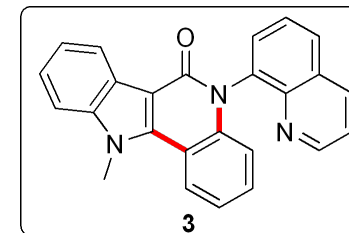
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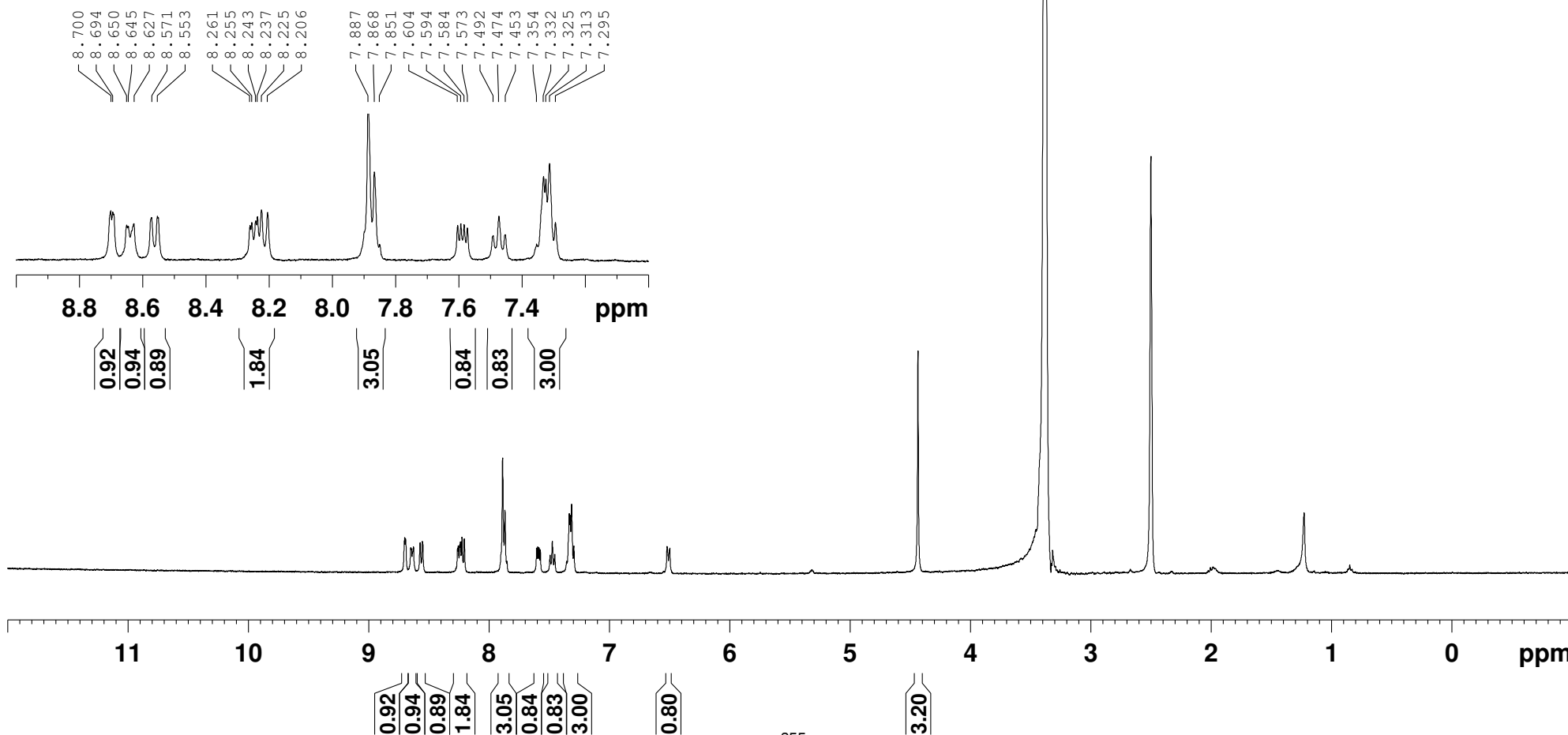
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NAME
EXPNO
PROCNO

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1
1

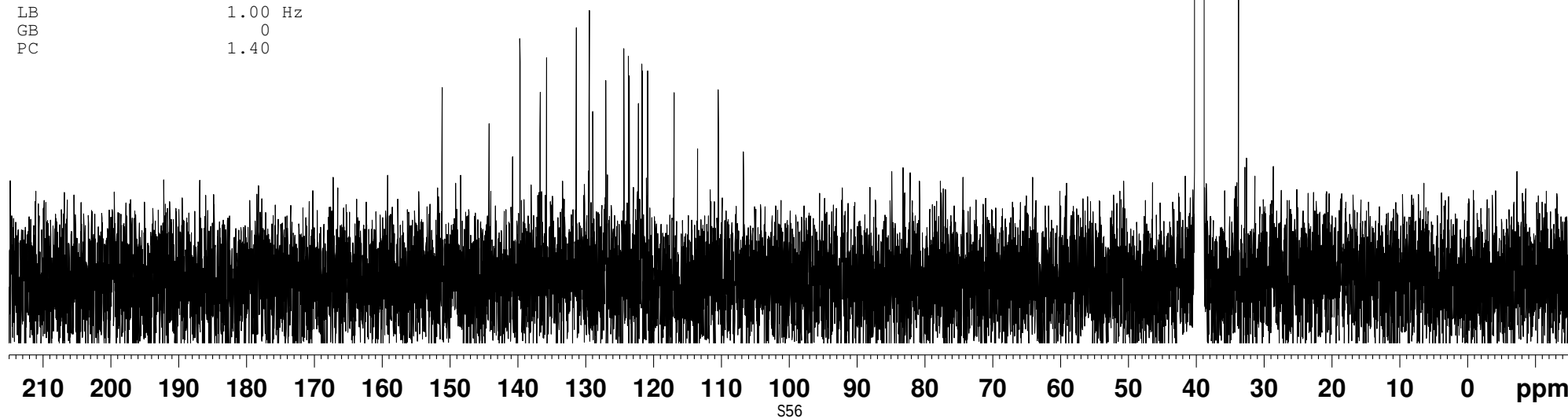
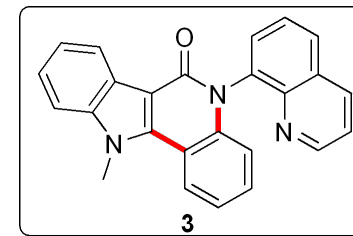


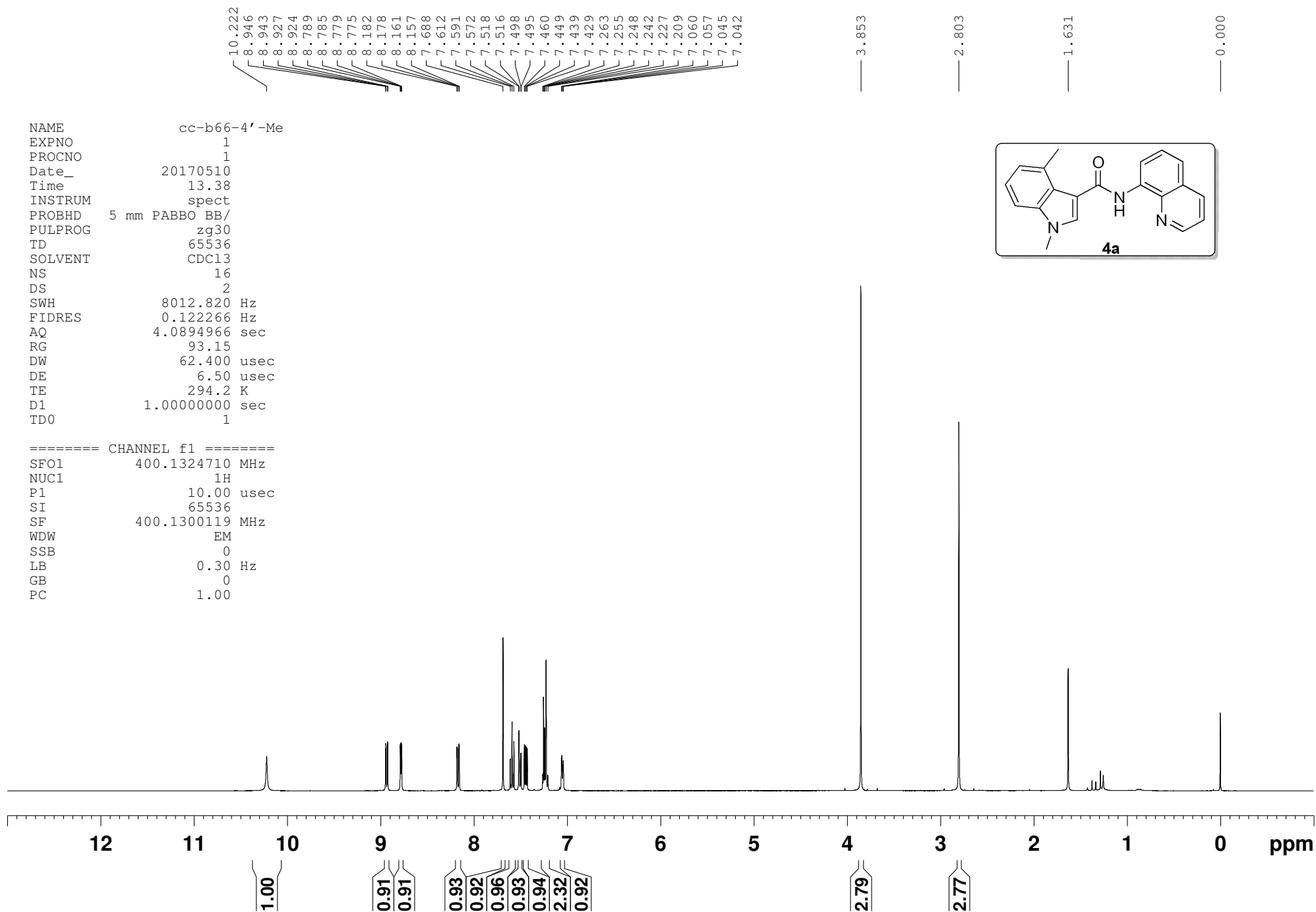
NAME 3'-N-Me-AQ
EXPNO 1
PROCNO 1
Date_ 20170903
Time 23.28
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT DMSO
NS 10000
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 296.7 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6128097 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

151.18
144.27
140.80
139.70
136.72
135.77
131.39
129.49
128.97
127.04
124.38
123.71
123.59
122.23
121.72
120.85
116.99
113.51
110.47
106.74

40.15
39.94
39.73
39.52
39.31
39.10
38.89
33.75





NAME cc-b66
EXPNO 2
PROCNO 1
Date_ 20170510
Time 13.54
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 256
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 295.0 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127576 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

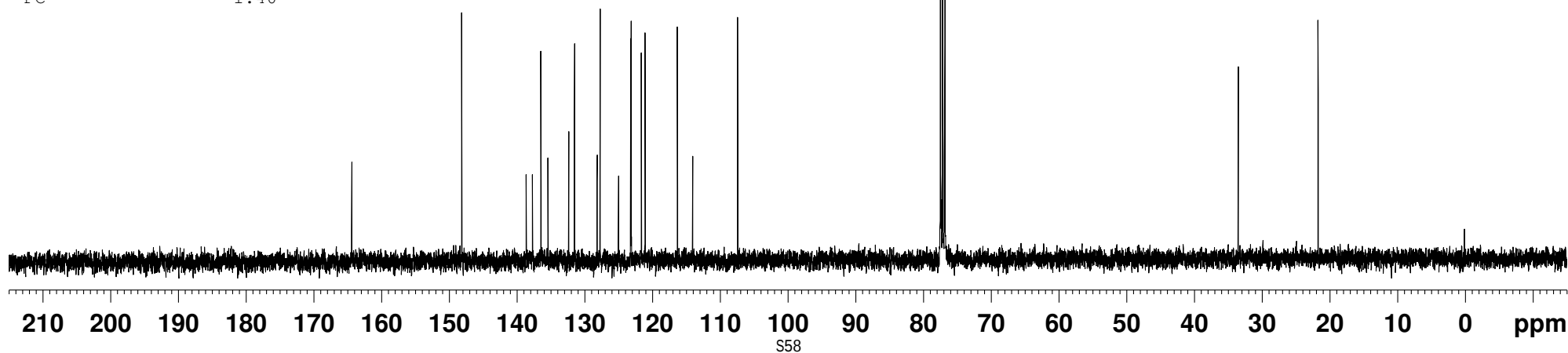
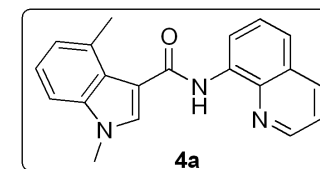
164.42

148.18
138.68
137.74
136.49
135.46
132.36
131.53
128.19
127.73
125.03
123.23
123.16
121.67
121.11
116.33
114.07
107.44

77.48
77.16
76.84

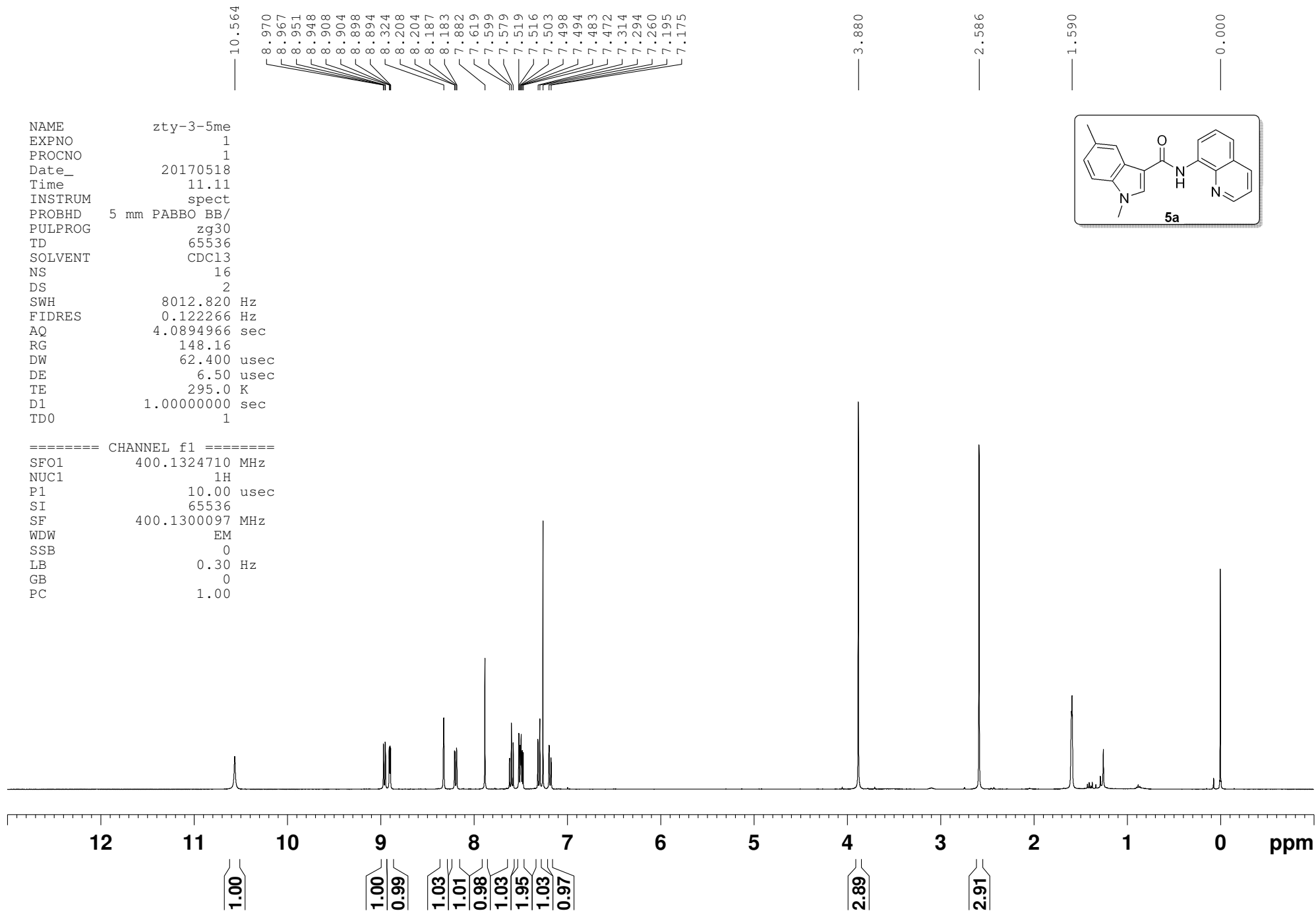
33.52

21.73



NAME zty-3-5me
 EXPNO 1
 PROCNO 1
 Date_ 20170518
 Time 11.11
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 8012.820 Hz
 FIDRES 0.122266 Hz
 AQ 4.0894966 sec
 RG 148.16
 DW 62.400 usec
 DE 6.50 usec
 TE 295.0 K
 D1 1.00000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 400.1324710 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 400.1300097 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00



NAME zty-3-5me
 EXPNO 3
 PROCNO 1
 Date_ 20170519
 Time 18.22
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 1024
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 295.9 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127557 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

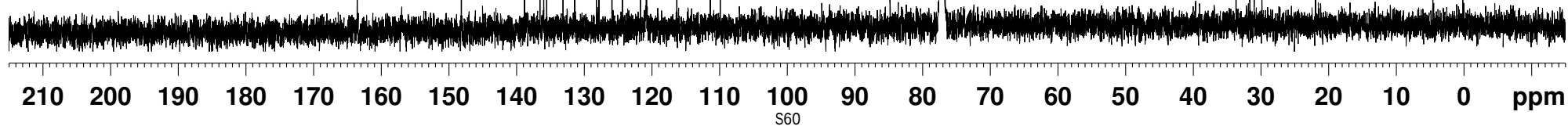
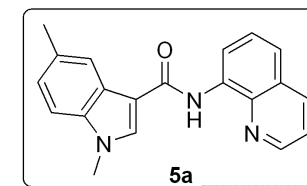
— 163.54

— 148.18
 — 138.84
 — 136.53
 — 136.01
 — 135.59
 — 133.14
 — 131.42
 — 128.22
 — 127.82
 — 125.90
 — 124.37
 — 121.68
 — 120.84
 — 120.80
 — 116.31
 — 111.38
 — 109.88

— 77.48
 — 77.16
 — 76.84

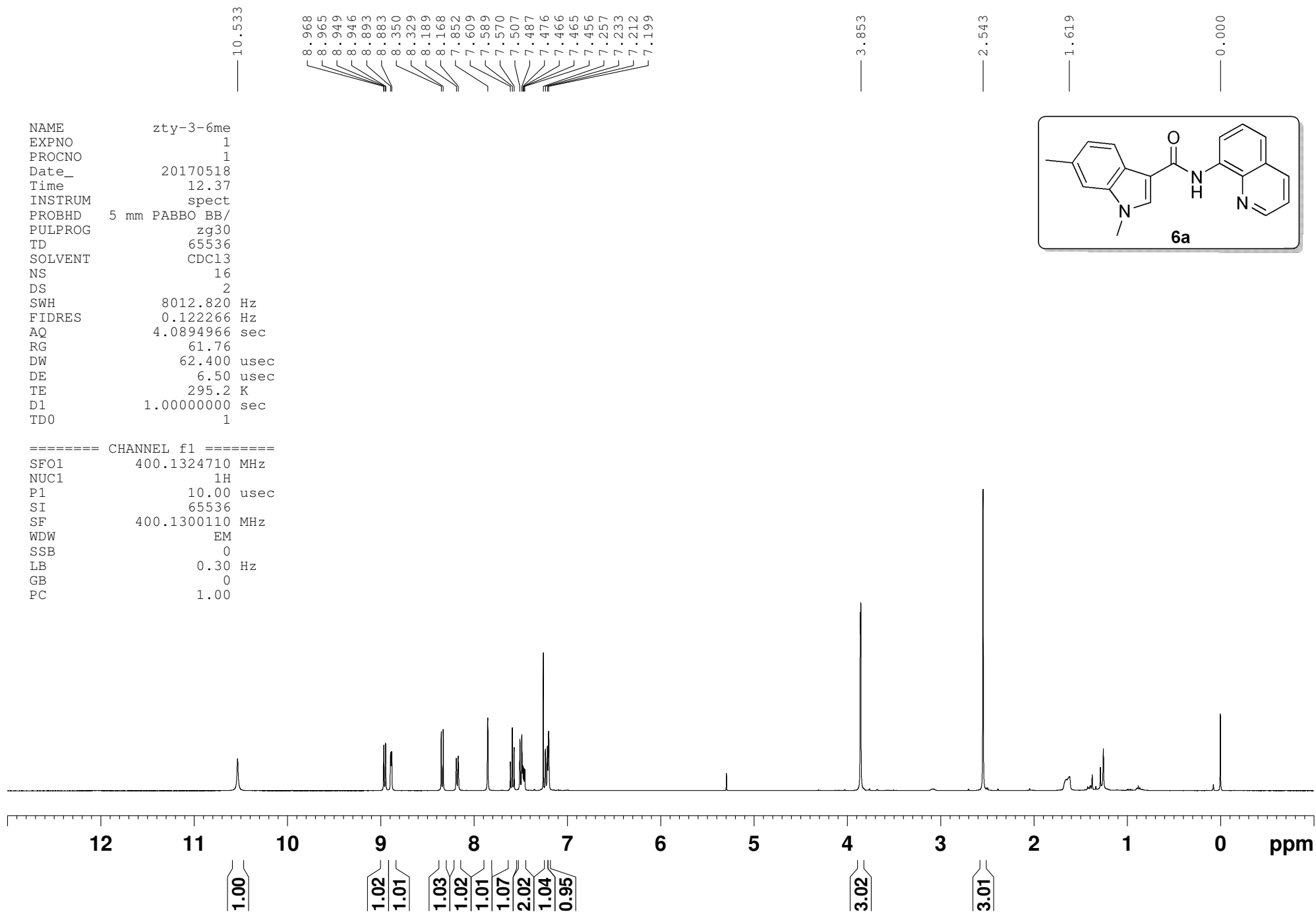
— 33.63

— 21.92



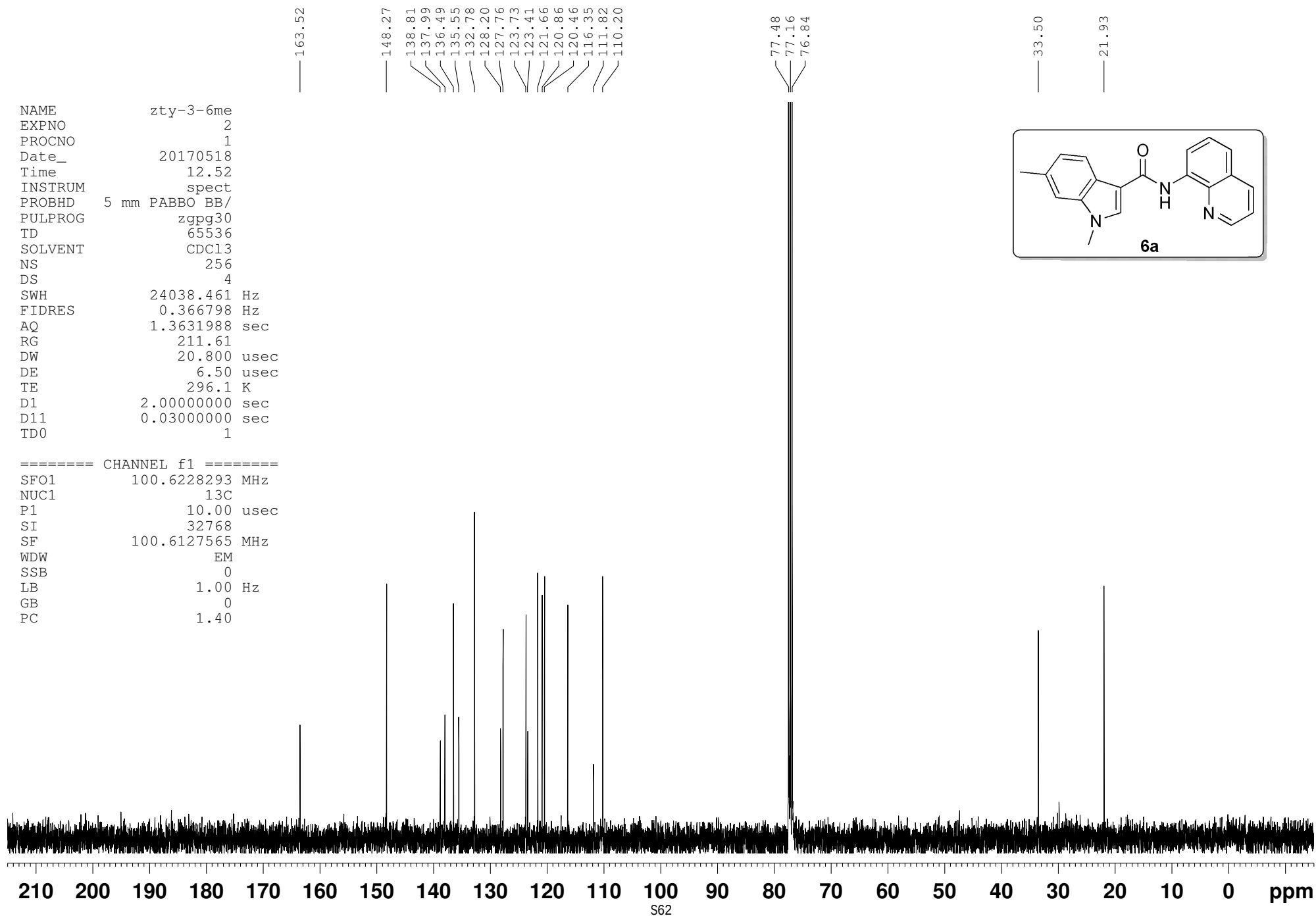
NAME zty-3-6me
 EXPNO 1
 PROCNO 1
 Date_ 20170518
 Time 12.37
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 8012.820 Hz
 FIDRES 0.122266 Hz
 AQ 4.0894966 sec
 RG 61.76
 DW 62.400 usec
 DE 6.50 usec
 TE 295.2 K
 D1 1.00000000 sec
 TD0 1

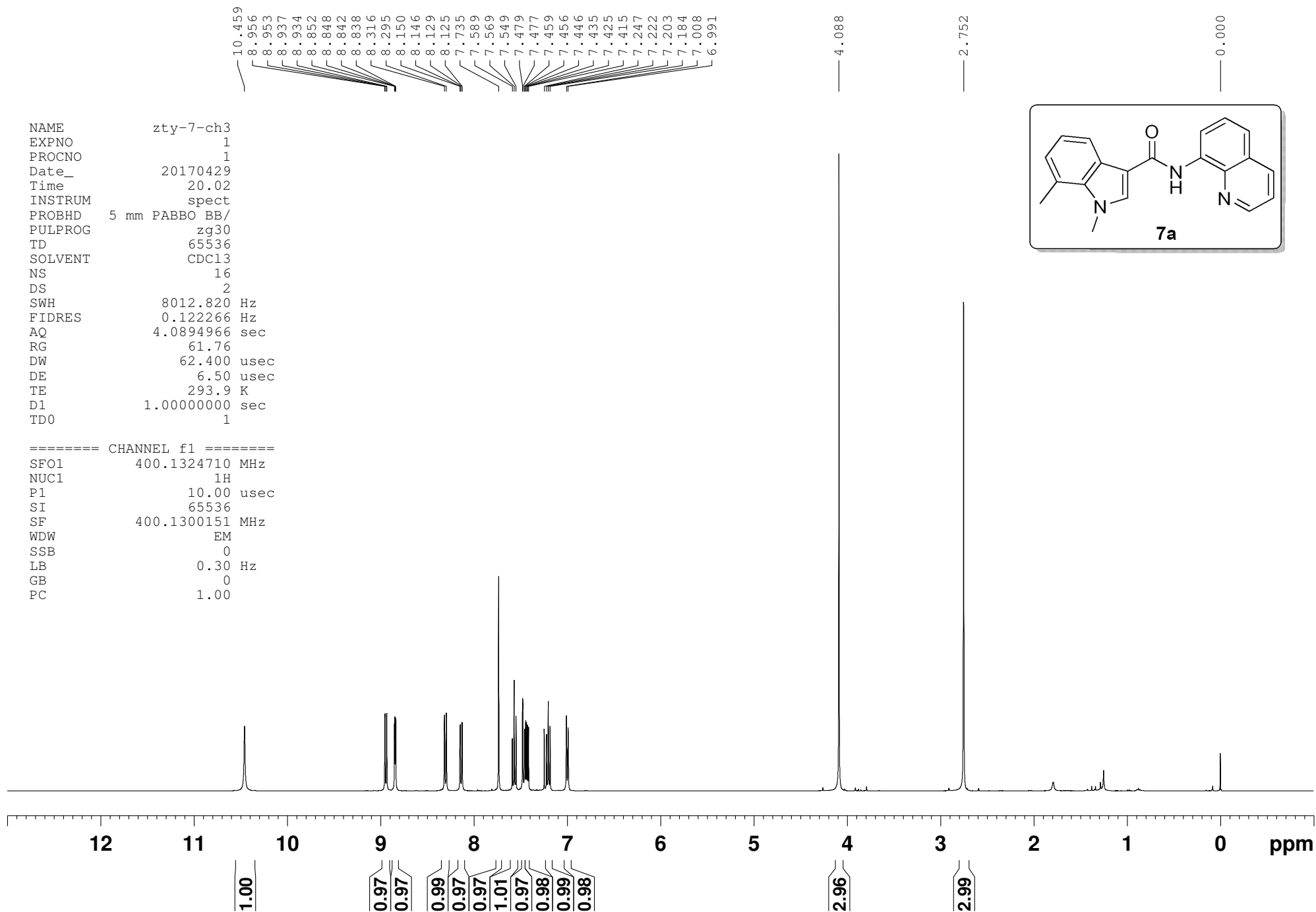
===== CHANNEL f1 =====
 SFO1 400.1324710 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 400.1300110 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00



NAME zty-3-6me
EXPNO 2
PROCNO 1
Date_ 20170518
Time 12.52
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 256
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 296.1 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127565 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40





NAME zty-7-ch3
EXPNO 2
PROCNO 1
Date_ 20170429
Time 20.31
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 488
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 294.7 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

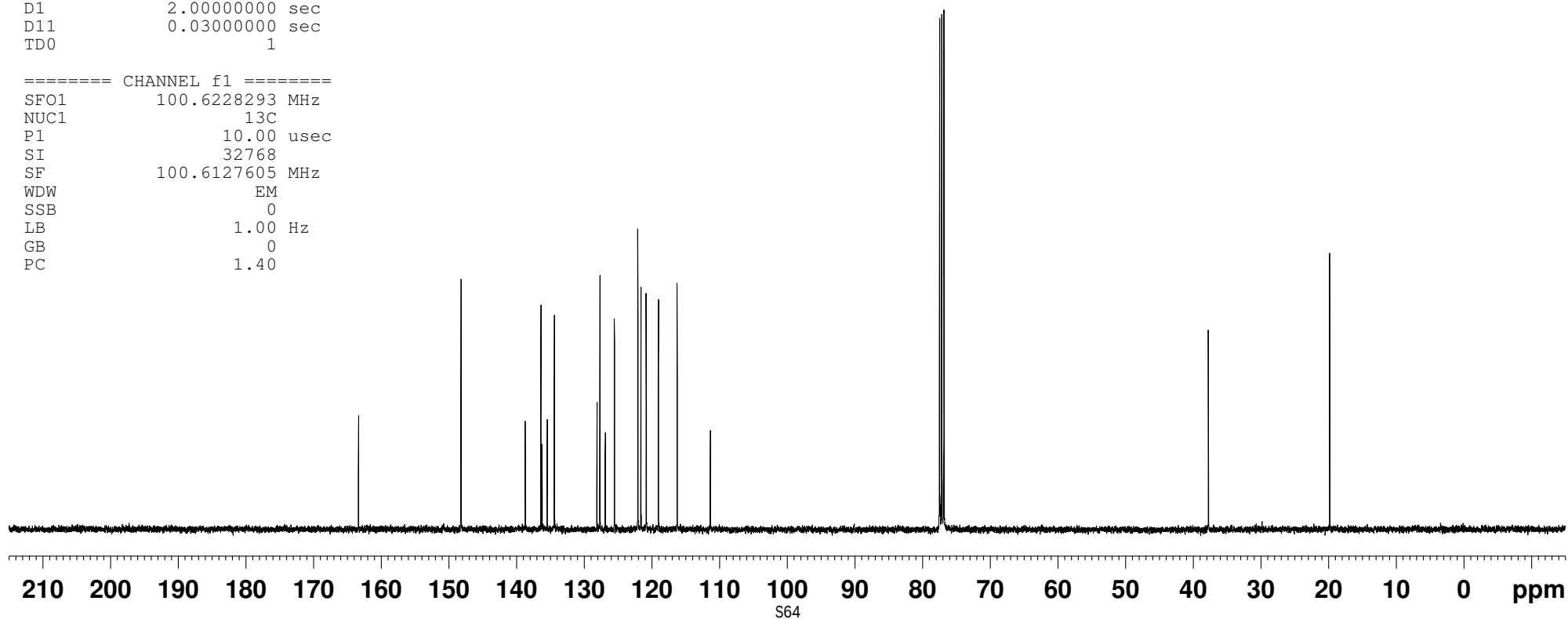
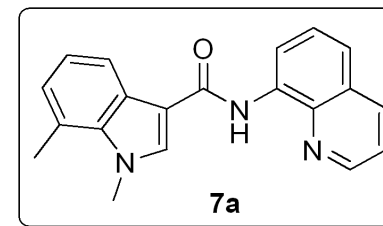
===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127605 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

163.37
148.22
138.72
136.41
136.24
135.46
134.41
128.13
127.68
126.89
125.54
122.08
121.61
120.84
119.04
116.26
111.36

77.48
77.16
76.84

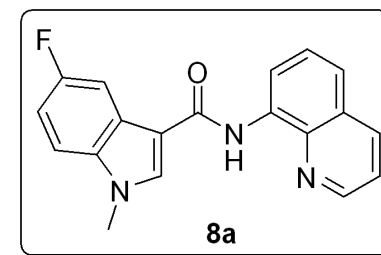
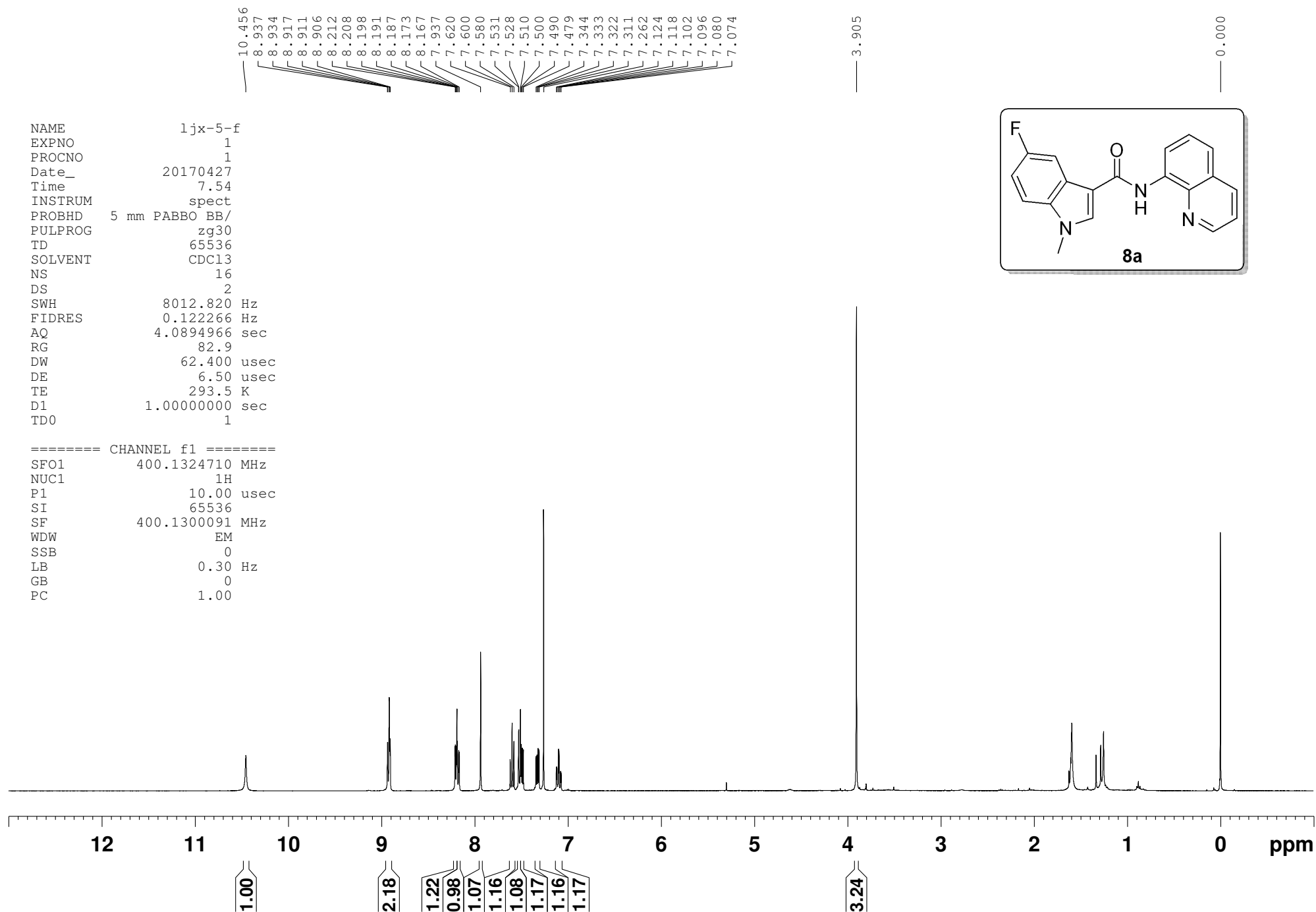
37.76

19.82



NAME 1jx-5-f
EXPNO 1
PROCNO 1
Date_ 20170427
Time 7.54
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
SWH 8012.820 Hz
FIDRES 0.122266 Hz
AQ 4.0894966 sec
RG 82.9
DW 62.400 usec
DE 6.50 usec
TE 293.5 K
D1 1.00000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 400.1324710 MHz
NUC1 1H
P1 10.00 usec
SI 65536
SF 400.1300091 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00



NAME 1jx-5-f
EXPNO 3
PROCNO 1
Date_ 20170429
Time 19.56
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDC13
NS 1024
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 294.6 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

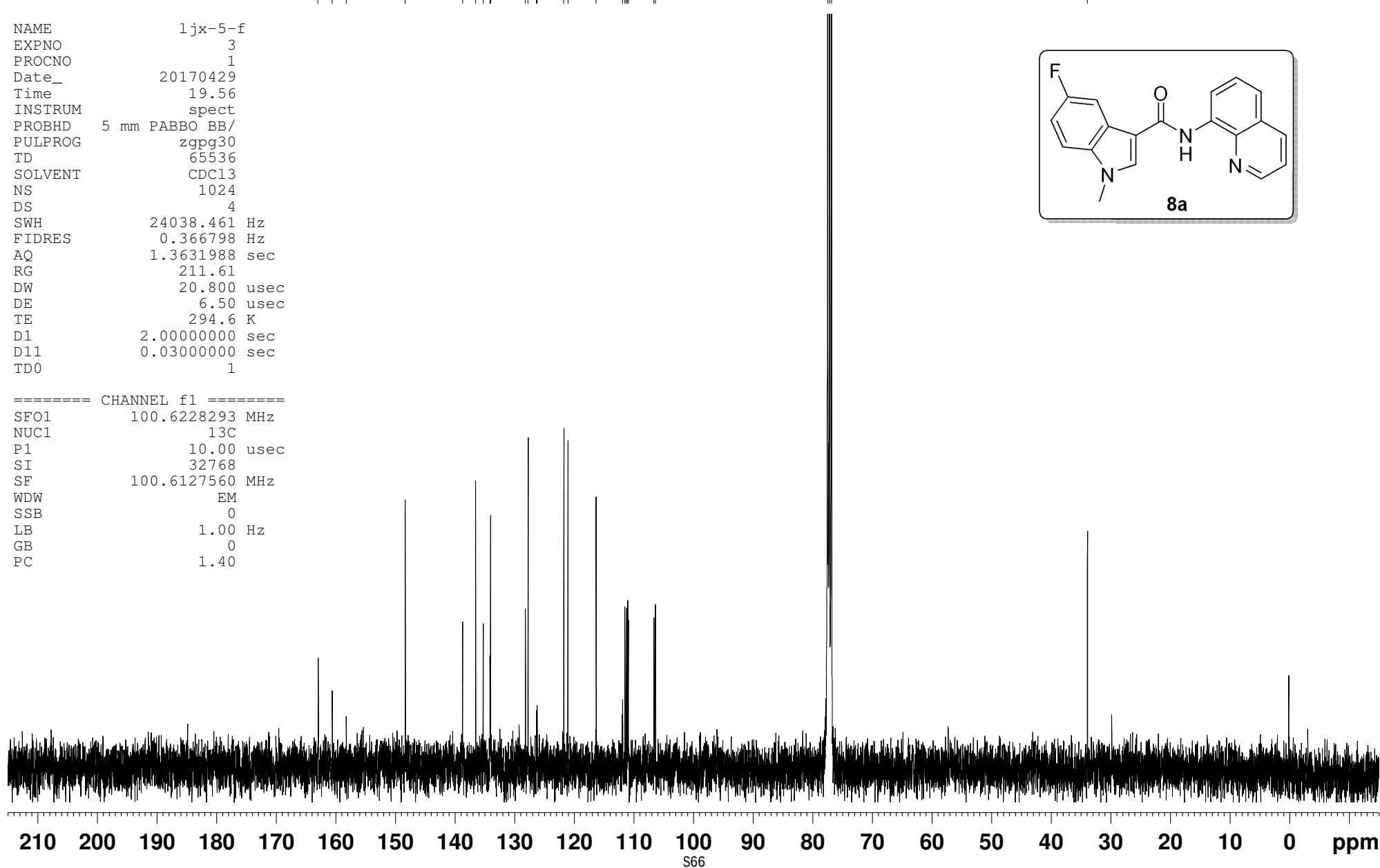
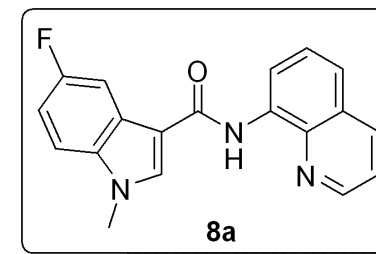
===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127560 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

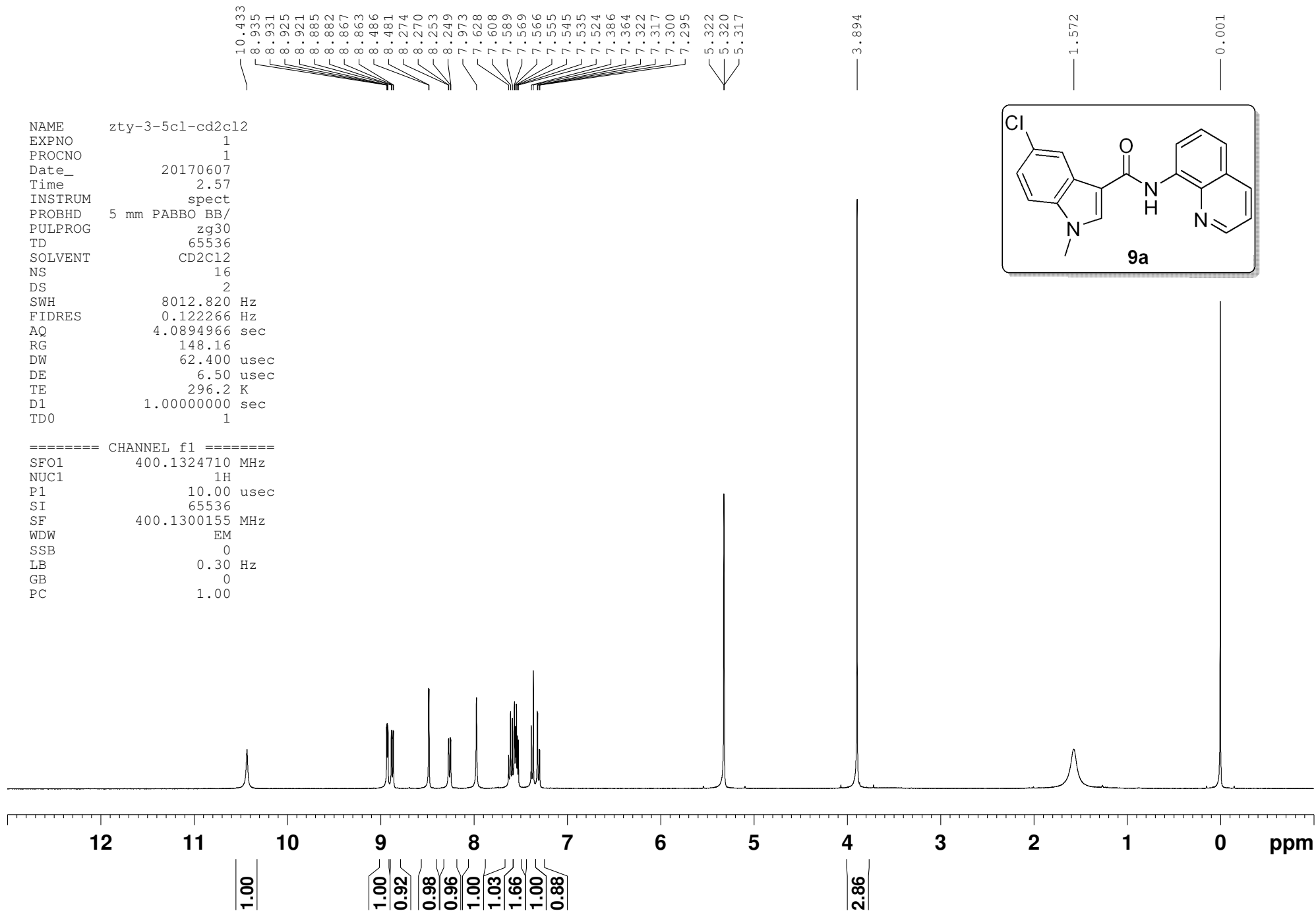
162.98
160.61
158.25

148.37
138.74
136.57
135.27
134.15
134.04
128.19
127.75
126.36
126.25
121.76
121.06
116.34
111.89
111.51
111.24
111.03
110.93
106.63
106.38

77.48
77.16
76.84

33.91

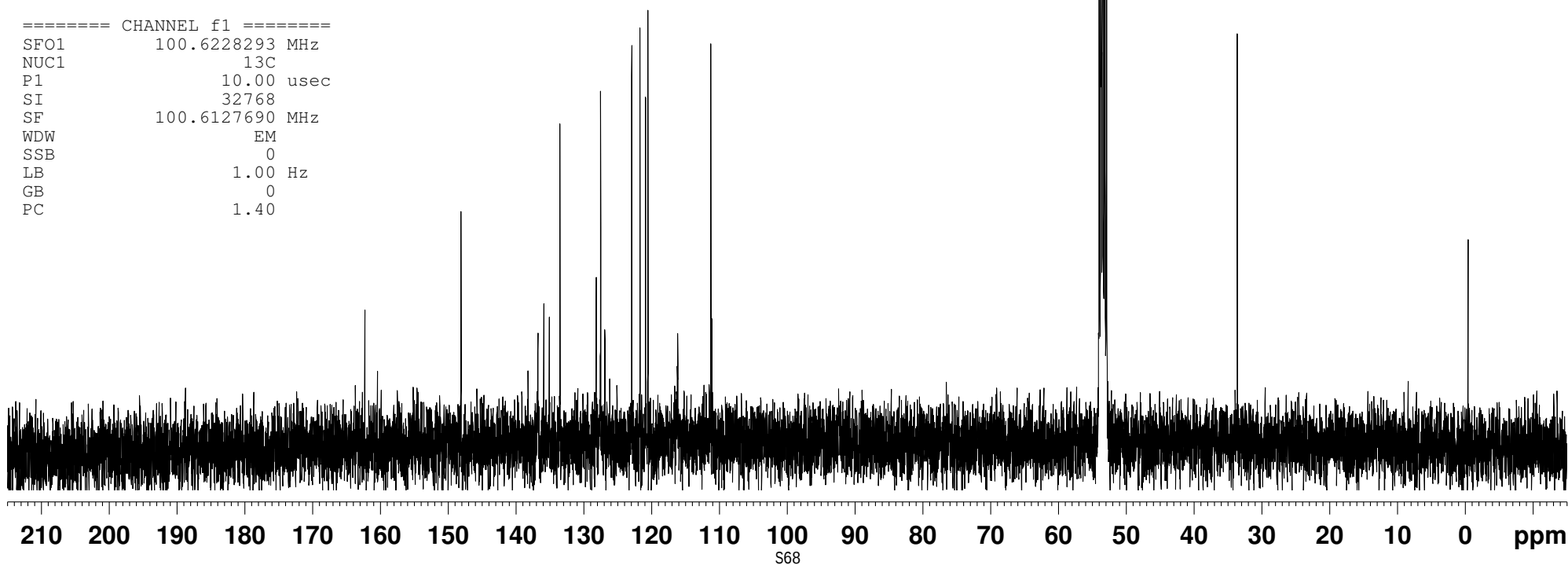
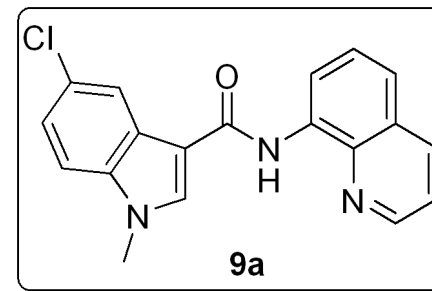




NAME zty-3-5cl-cd2cl2
EXPNO 2
PROCNO 1
Date_ 20170607
Time 3.56
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CD2Cl2
NS 1000
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 296.8 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

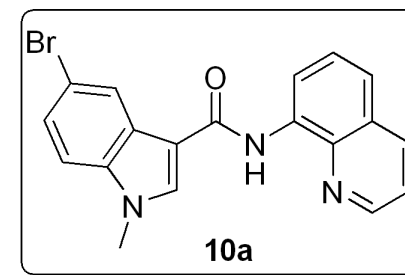
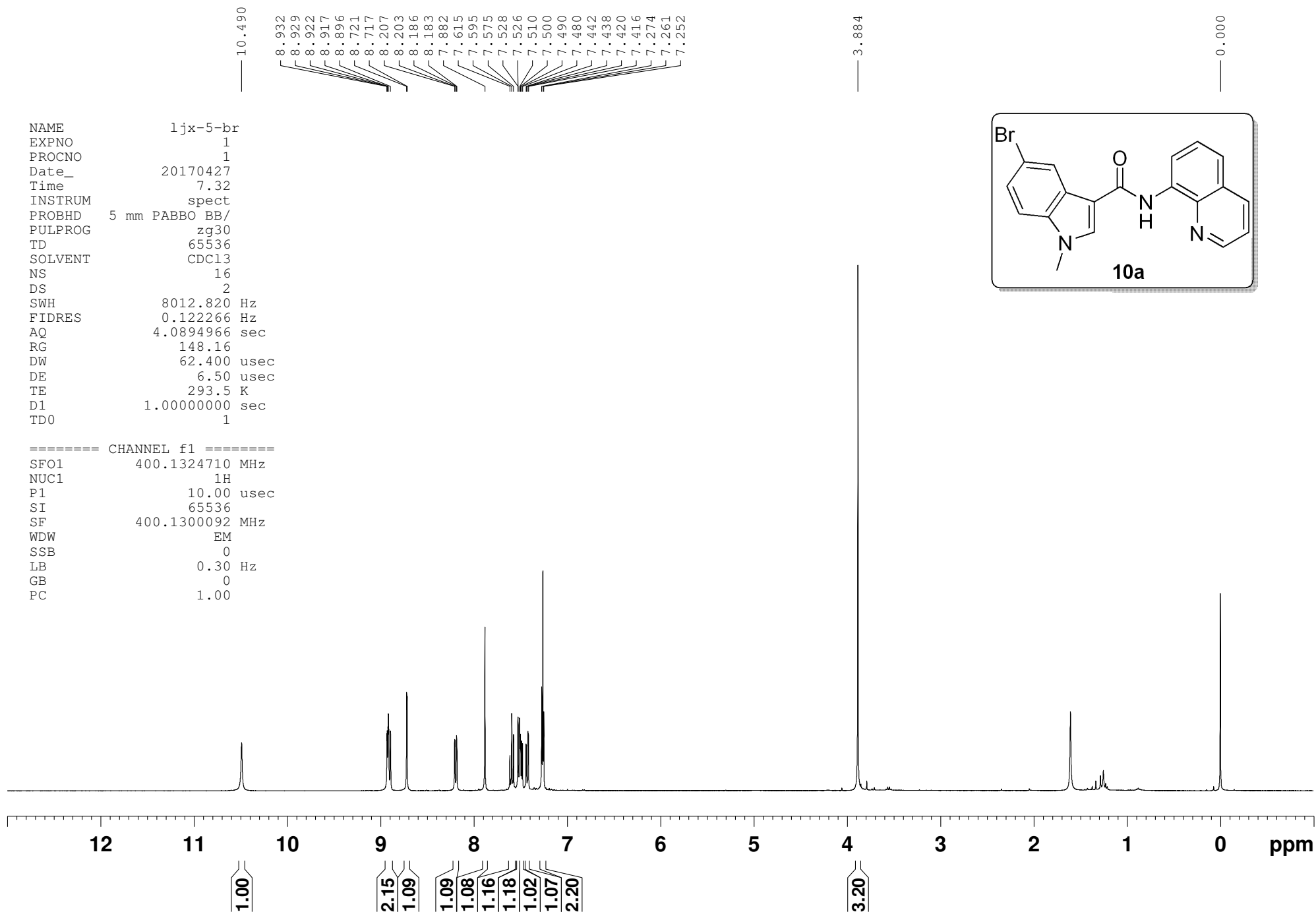
===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127690 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

162.31
160.45
148.13
138.23
136.79
135.91
135.08
133.54
128.17
127.57
127.52
126.90
122.94
121.72
120.90
120.54
116.17
111.27
111.09
53.97
53.70
53.43
53.16
52.89
33.61



NAME 1jx-5-br
 EXPNO 1
 PROCNO 1
 Date_ 20170427
 Time 7.32
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 8012.820 Hz
 FIDRES 0.122266 Hz
 AQ 4.0894966 sec
 RG 148.16
 DW 62.400 usec
 DE 6.50 usec
 TE 293.5 K
 D1 1.00000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 400.1324710 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 400.1300092 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00



```

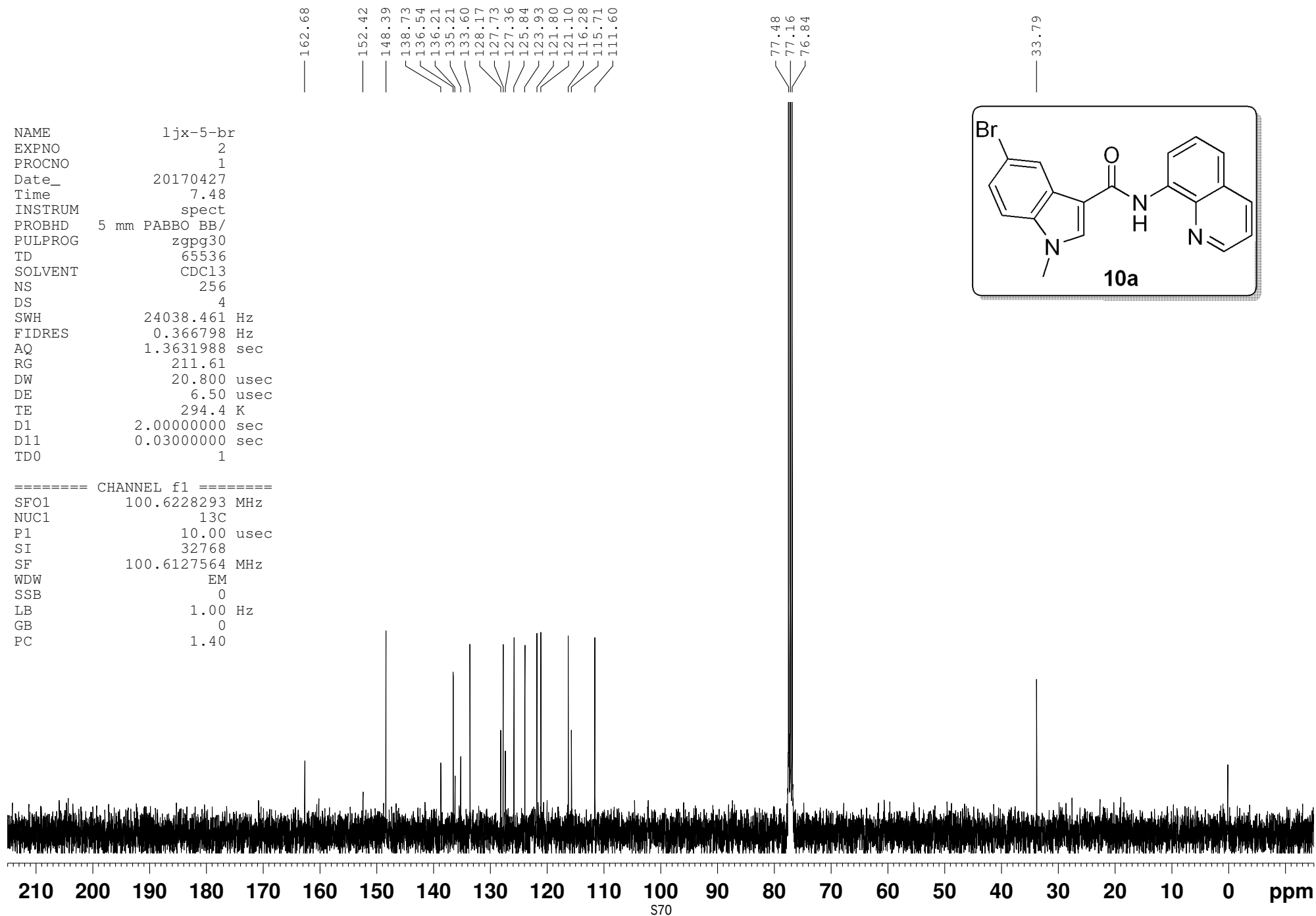
NAME          1jx-5-br
EXPNO          2
PROCNO         1
Date_          20170427
Time           7.48
INSTRUM        spect
PROBHD         5 mm PABBO BB/
PULPROG        zgpg30
TD             65536
SOLVENT        CDC13
NS             256
DS             4
SWH            24038.461 Hz
FIDRES         0.366798 Hz
AQ             1.3631988 sec
RG             211.61
DW             20.800 usec
DE             6.50 usec
TE             294.4 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0            1

```

```

===== CHANNEL f1 =====
SFO1          100.6228293 MHz
NUC1           13C
P1             10.00 usec
SI             32768
SF            100.6127564 MHz
WDW            EM
SSB            0
LB             1.00 Hz
GB             0
PC             1.40

```



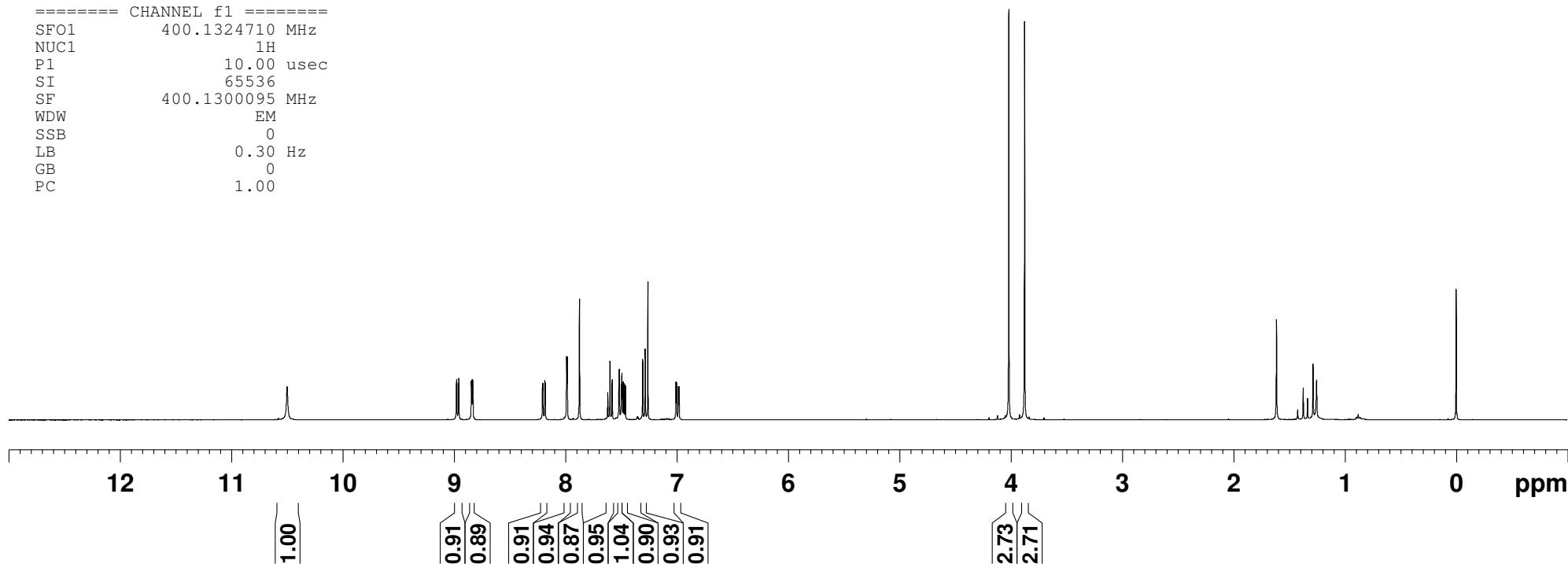
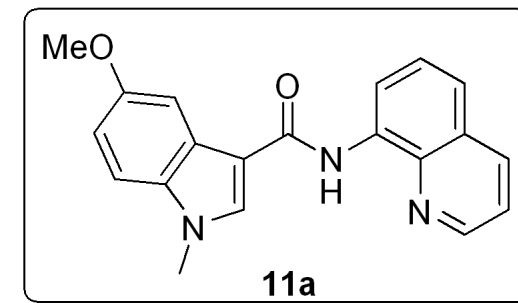
NAME 1jx-5-meo
 EXPNO 1
 PROCNO 1
 Date_ 20170427
 Time 12.08
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 8012.820 Hz
 FIDRES 0.122266 Hz
 AQ 4.0894966 sec
 RG 131.08
 DW 62.400 usec
 DE 6.50 usec
 TE 293.7 K
 D1 1.00000000 sec
 TD0 1

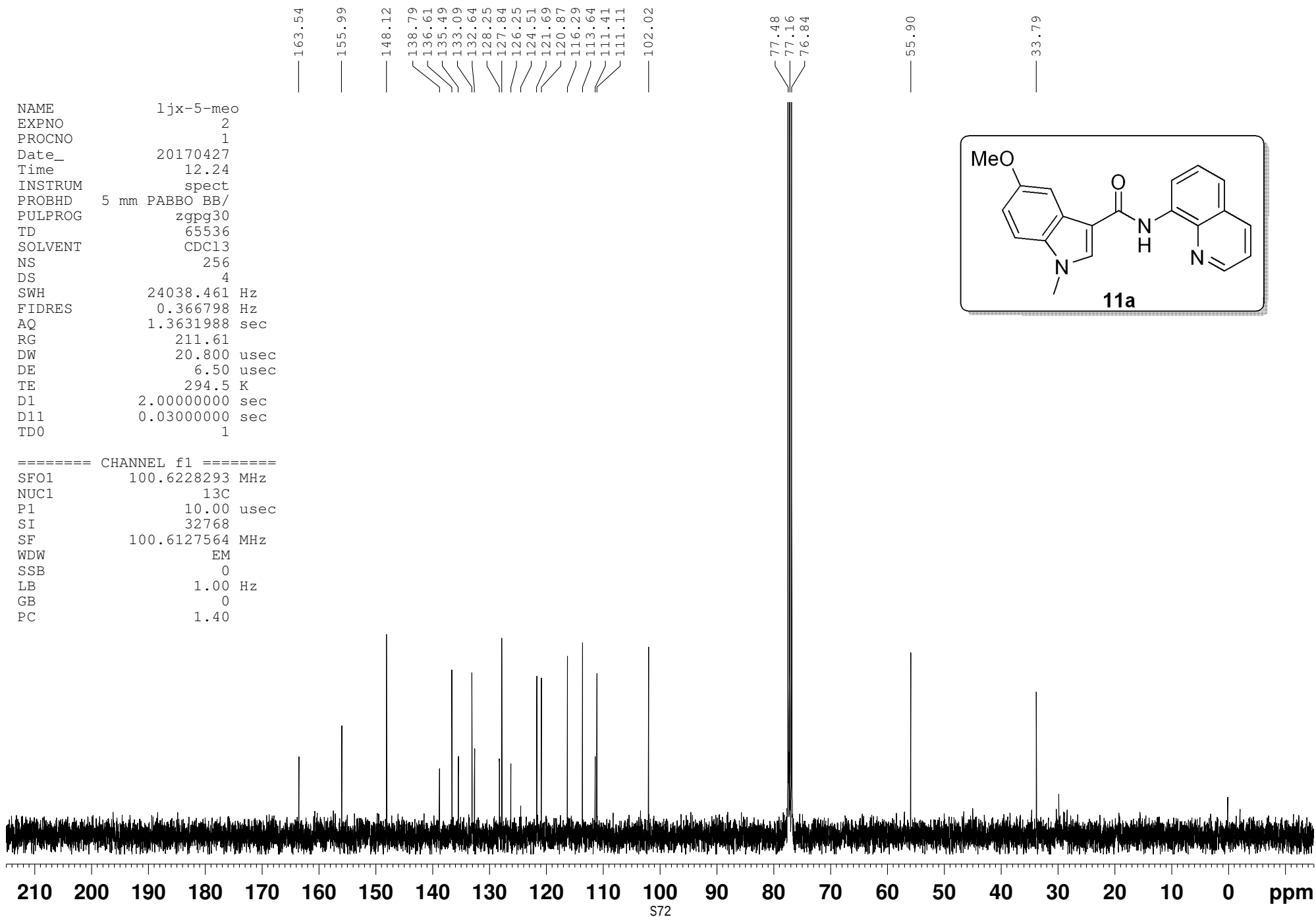
===== CHANNEL f1 =====
 SFO1 400.1324710 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 400.1300095 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00

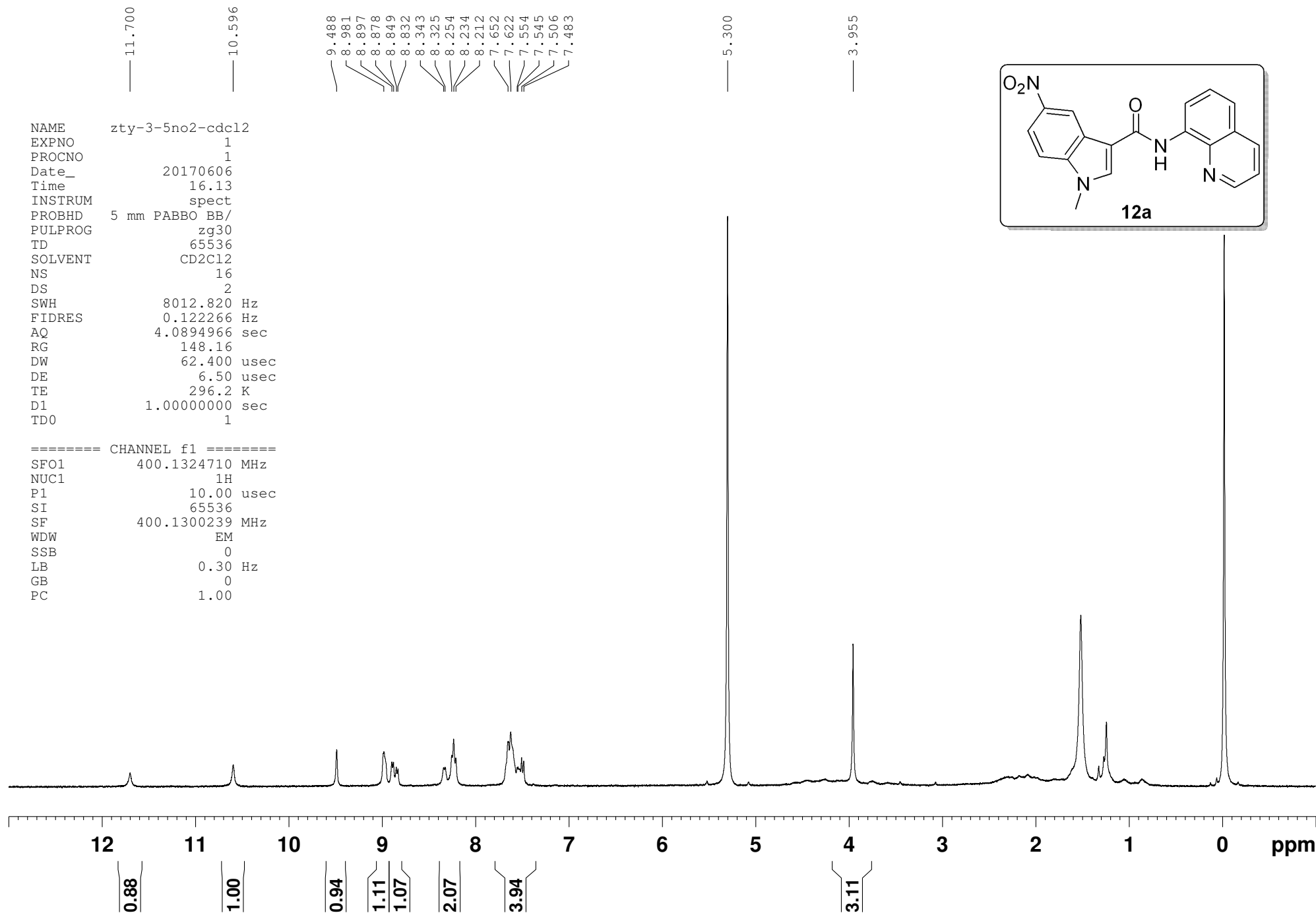
10.501
 8.980
 8.978
 8.961
 8.958
 8.846
 8.842
 8.836
 8.832
 8.207
 8.203
 8.186
 8.182
 7.990
 7.985
 7.875
 7.621
 7.601
 7.581
 7.519
 7.517
 7.499
 7.494
 7.483
 7.473
 7.462
 7.307
 7.285
 7.260
 7.008
 7.003
 6.986
 6.980

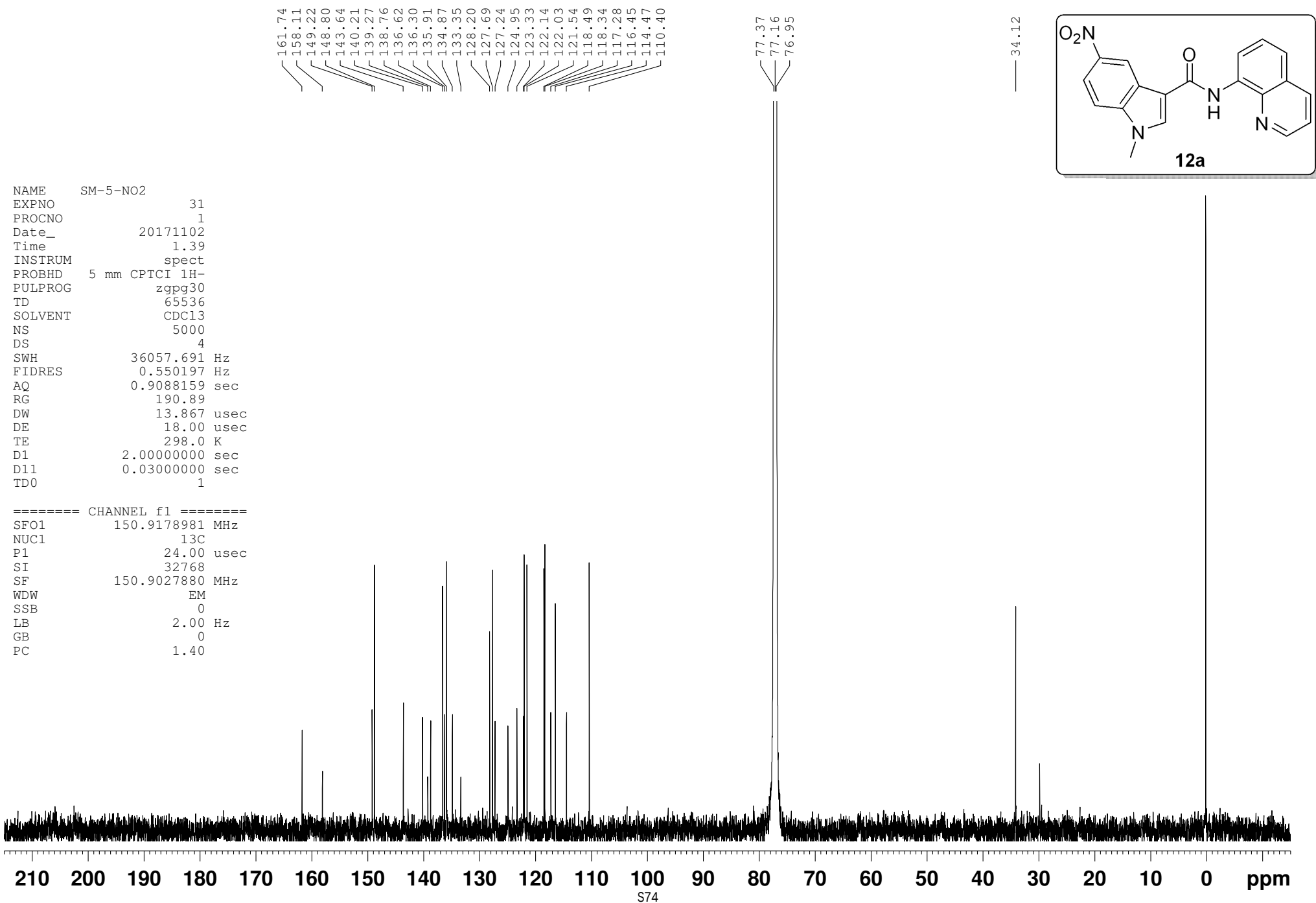
4.018
 3.877

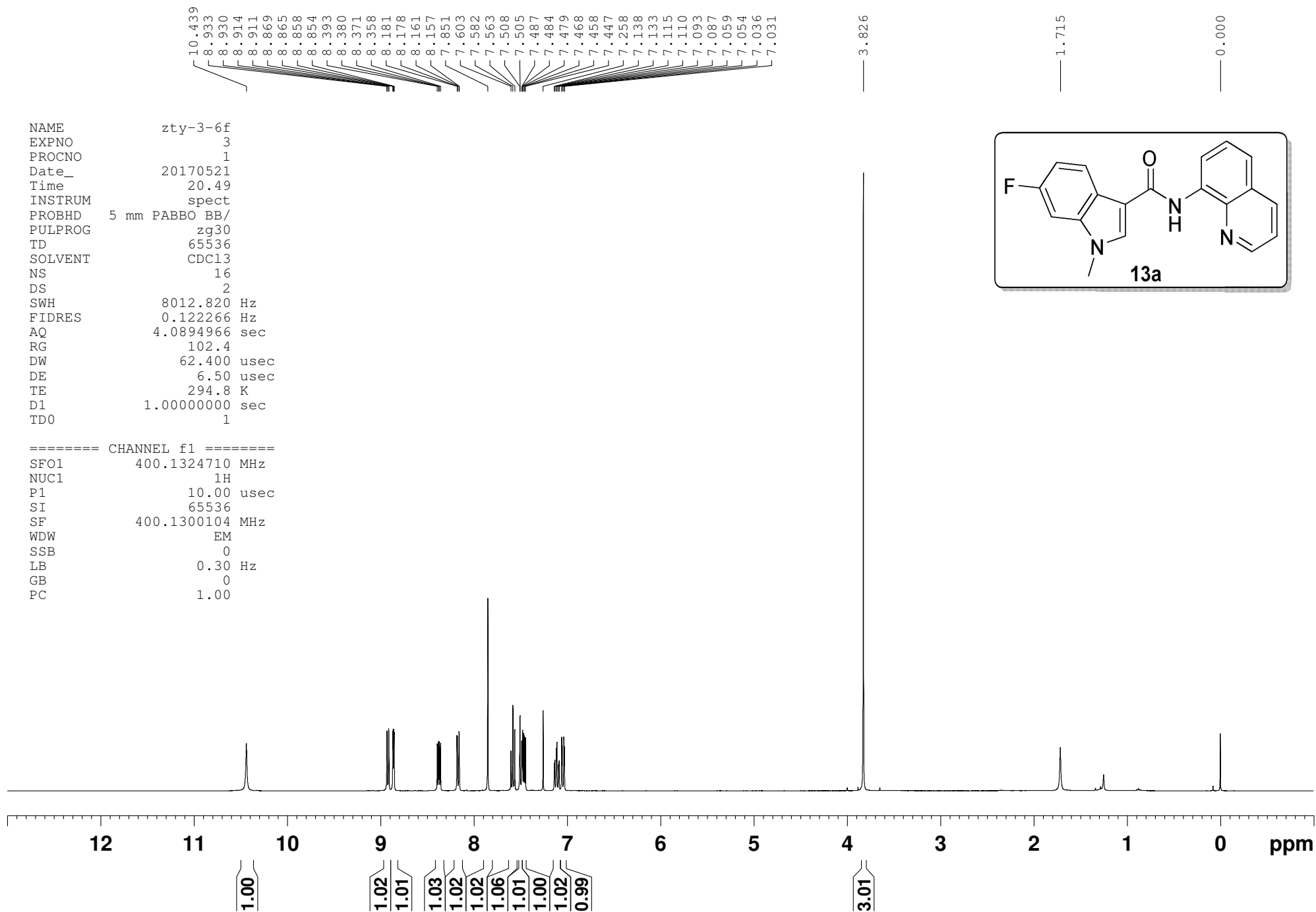
0.000







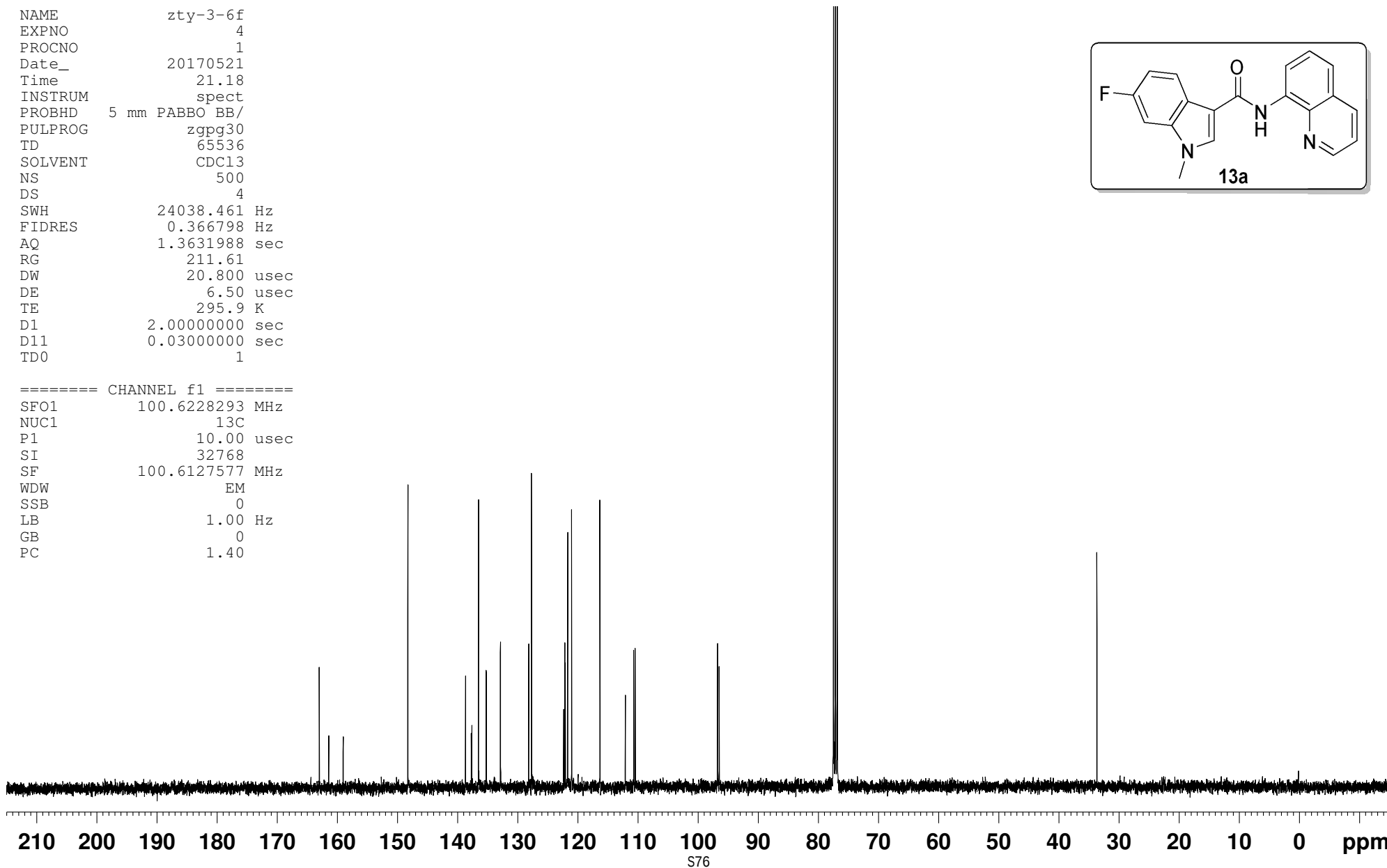
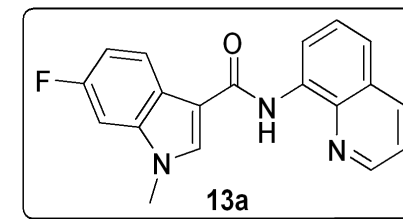


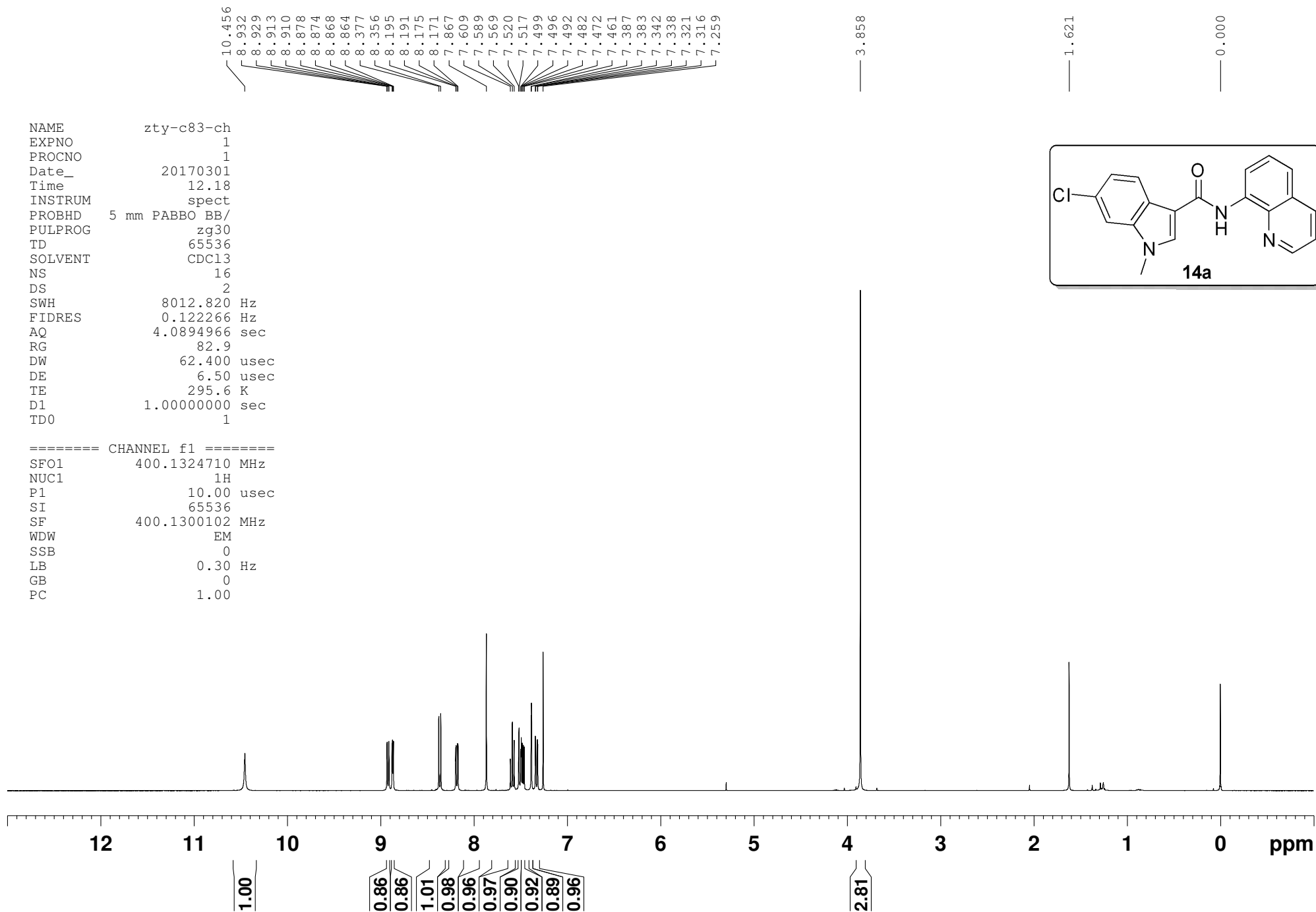


NAME zty-3-6f
 EXPNO 4
 PROCNO 1
 Date_ 20170521
 Time 21.18
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 500
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 295.9 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127577 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

163.02
 161.44
 159.05
 148.29
 138.69
 137.75
 137.63
 136.53
 135.25
 132.90
 132.87
 128.17
 127.70
 122.36
 122.18
 122.09
 121.70
 121.05
 116.34
 112.10
 110.71
 110.47
 96.77
 96.51
 77.48
 77.16
 76.84

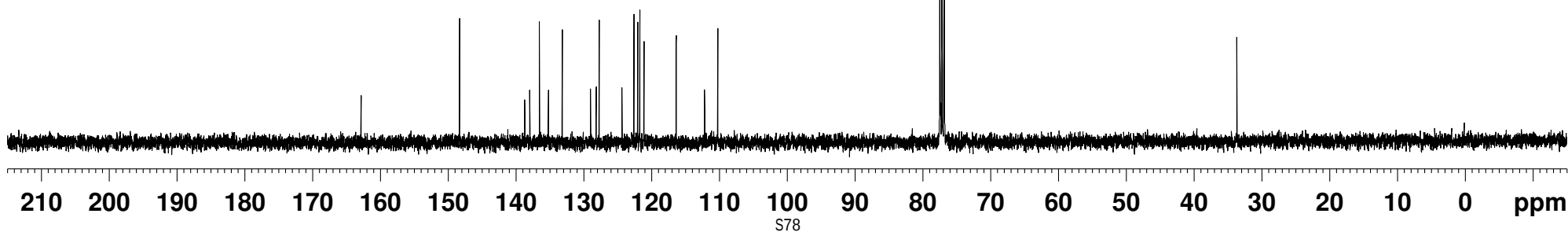
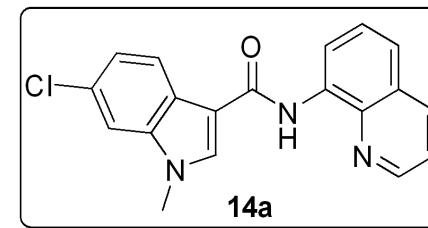




NAME zty-c83-ch
EXPNO 2
PROCNO 1
Date_ 20170301
Time 12.34
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 256
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 296.4 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

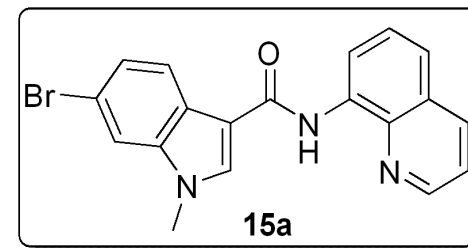
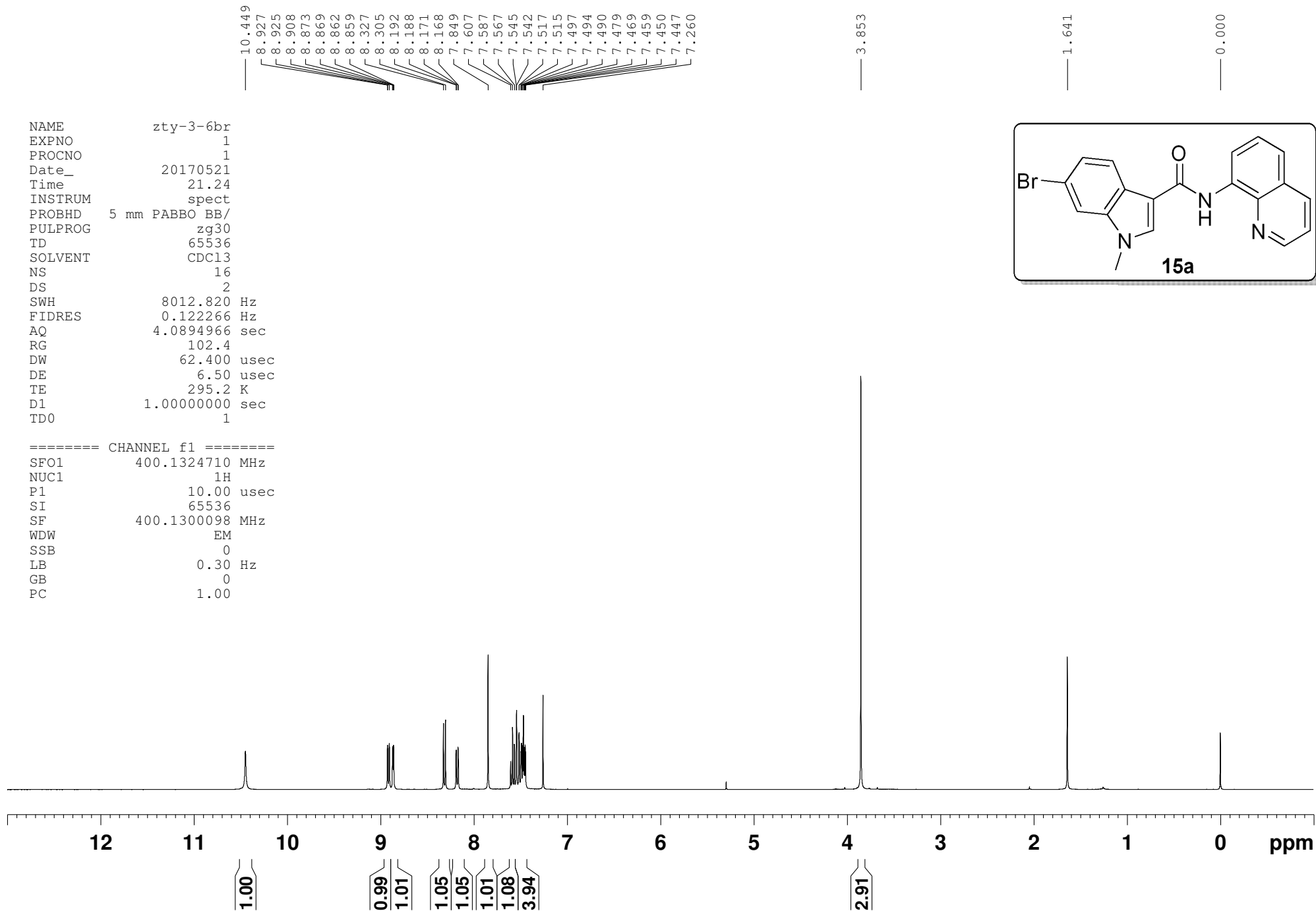
===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127562 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

162.87
148.32
138.72
137.98
136.56
135.23
133.19
129.01
128.19
127.73
124.40
122.62
122.04
121.73
121.11
116.38
112.19
110.25
77.48
77.16
76.84
33.68



NAME zty-3-6br
 EXPNO 1
 PROCNO 1
 Date_ 20170521
 Time 21.24
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 8012.820 Hz
 FIDRES 0.122266 Hz
 AQ 4.0894966 sec
 RG 102.4
 DW 62.400 usec
 DE 6.50 usec
 TE 295.2 K
 D1 1.00000000 sec
 TD0 1

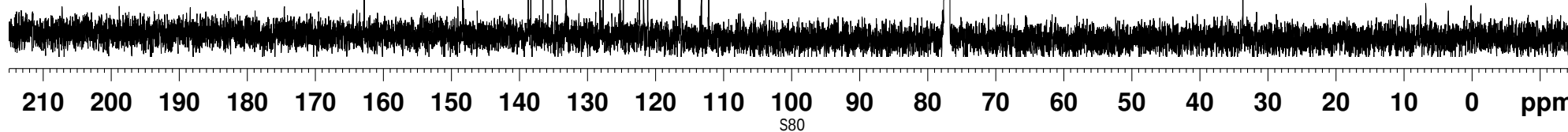
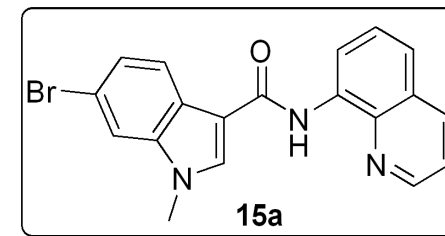
===== CHANNEL f1 =====
 SFO1 400.1324710 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 400.1300098 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00



NAME zty-3-6br
EXPNO 2
PROCNO 1
Date_ 20170521
Time 21.54
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 500
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 296.1 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127564 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

162.84
148.32
138.70
138.33
136.55
135.20
133.12
128.18
127.72
125.20
124.71
122.36
121.74
121.12
116.58
116.38
113.26
112.18
77.48
77.16
76.84
33.68



```

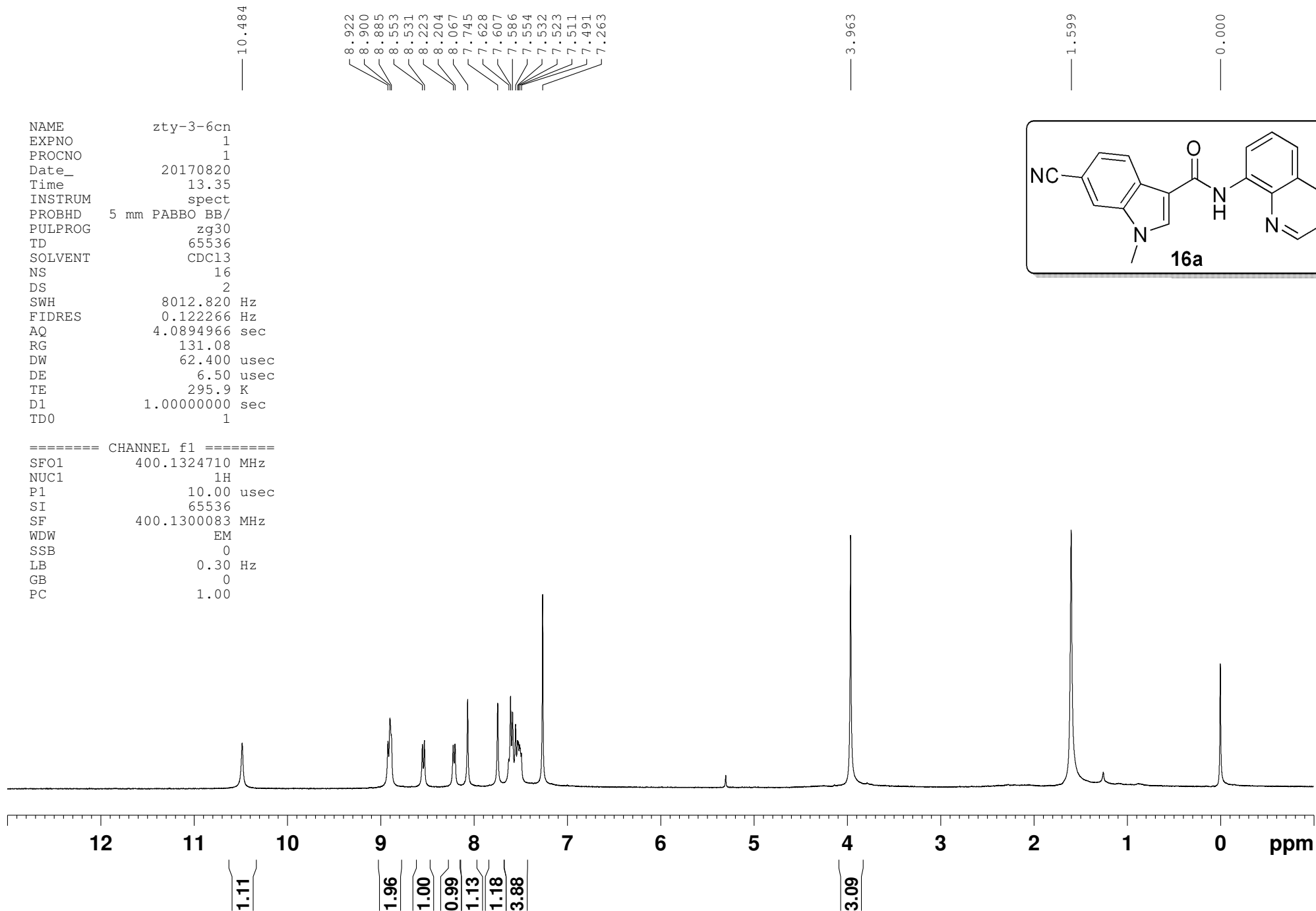
NAME          zty-3-6cn
EXPNO         1
PROCNO        1
Date_         20170820
Time          13.35
INSTRUM       spect
PROBHD        5 mm PABBO BB/
PULPROG       zg30
TD            65536
SOLVENT       CDCl3
NS            16
DS            2
SWH           8012.820 Hz
FIDRES        0.122266 Hz
AQ            4.0894966 sec
RG            131.08
DW            62.400 usec
DE            6.50 usec
TE            295.9 K
D1            1.00000000 sec
TD0           1

```

```

===== CHANNEL f1 =====
SFO1          400.1324710 MHz
NUC1           1H
P1            10.00 usec
SI            65536
SF            400.1300083 MHz
WDW           EM
SSB           0
LB            0.30 Hz
GB            0
PC            1.00

```



```

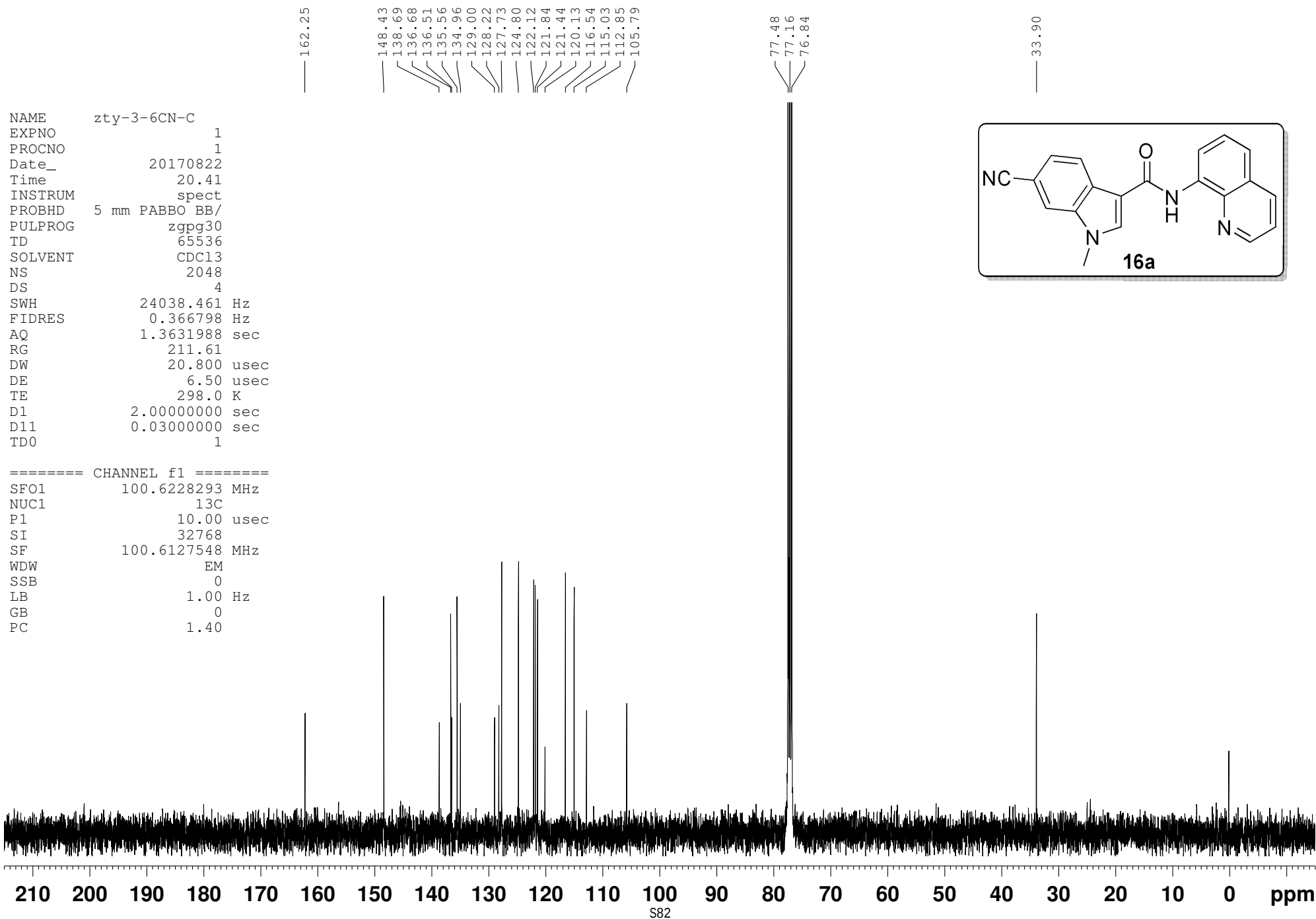
NAME      zty-3-6CN-C
EXPNO      1
PROCNO     1
Date_      20170822
Time       20.41
INSTRUM    spect
PROBHD     5 mm PABBO BB/
PULPROG    zgpg30
TD         65536
SOLVENT    CDC13
NS         2048
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         211.61
DW         20.800 usec
DE         6.50 usec
TE         298.0 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1

```

```

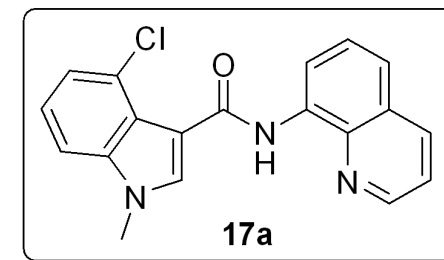
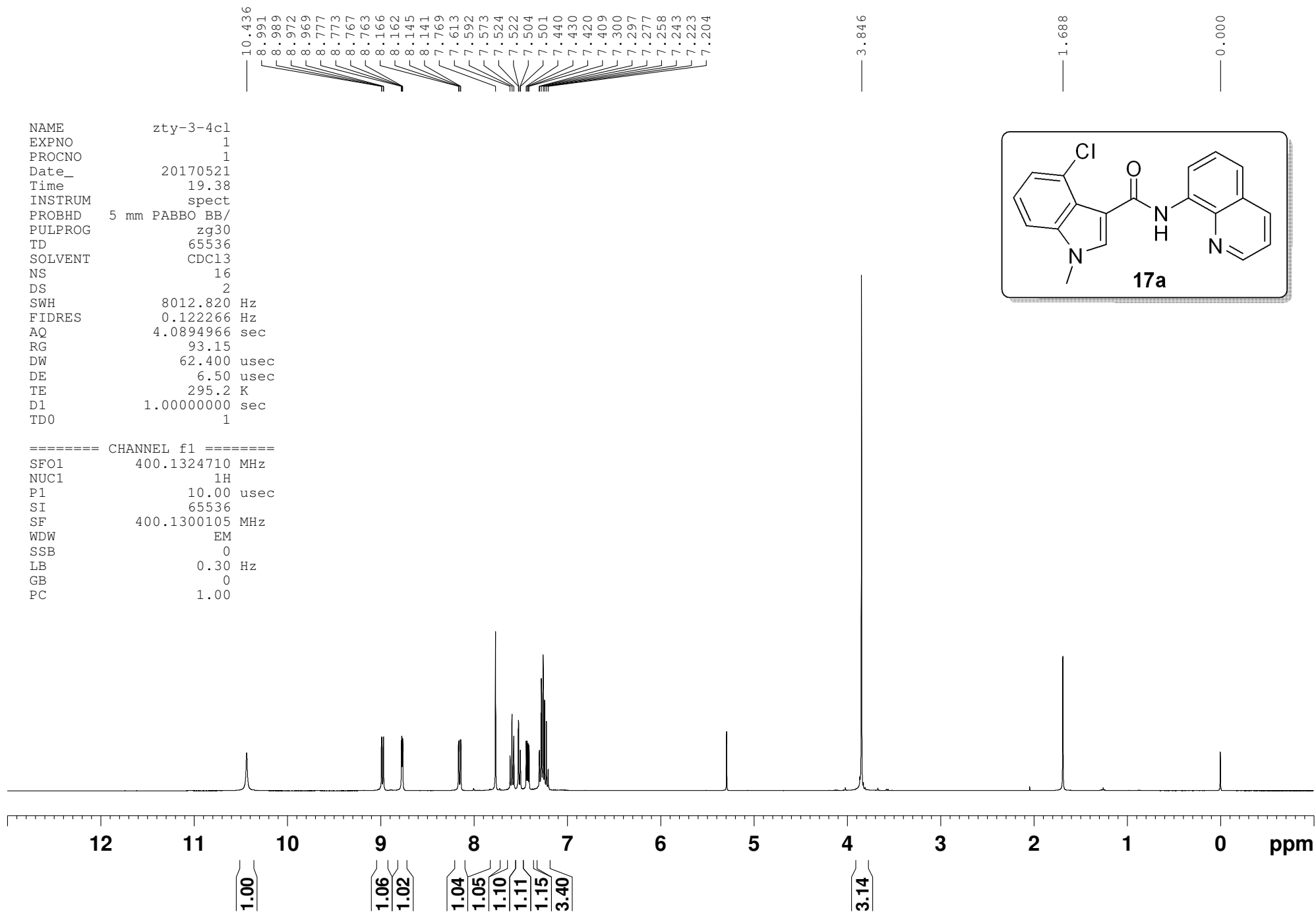
===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1      13C
P1        10.00 usec
SI        32768
SF        100.6127548 MHz
WDW       EM
SSB       0
LB        1.00 Hz
GB        0
PC        1.40

```



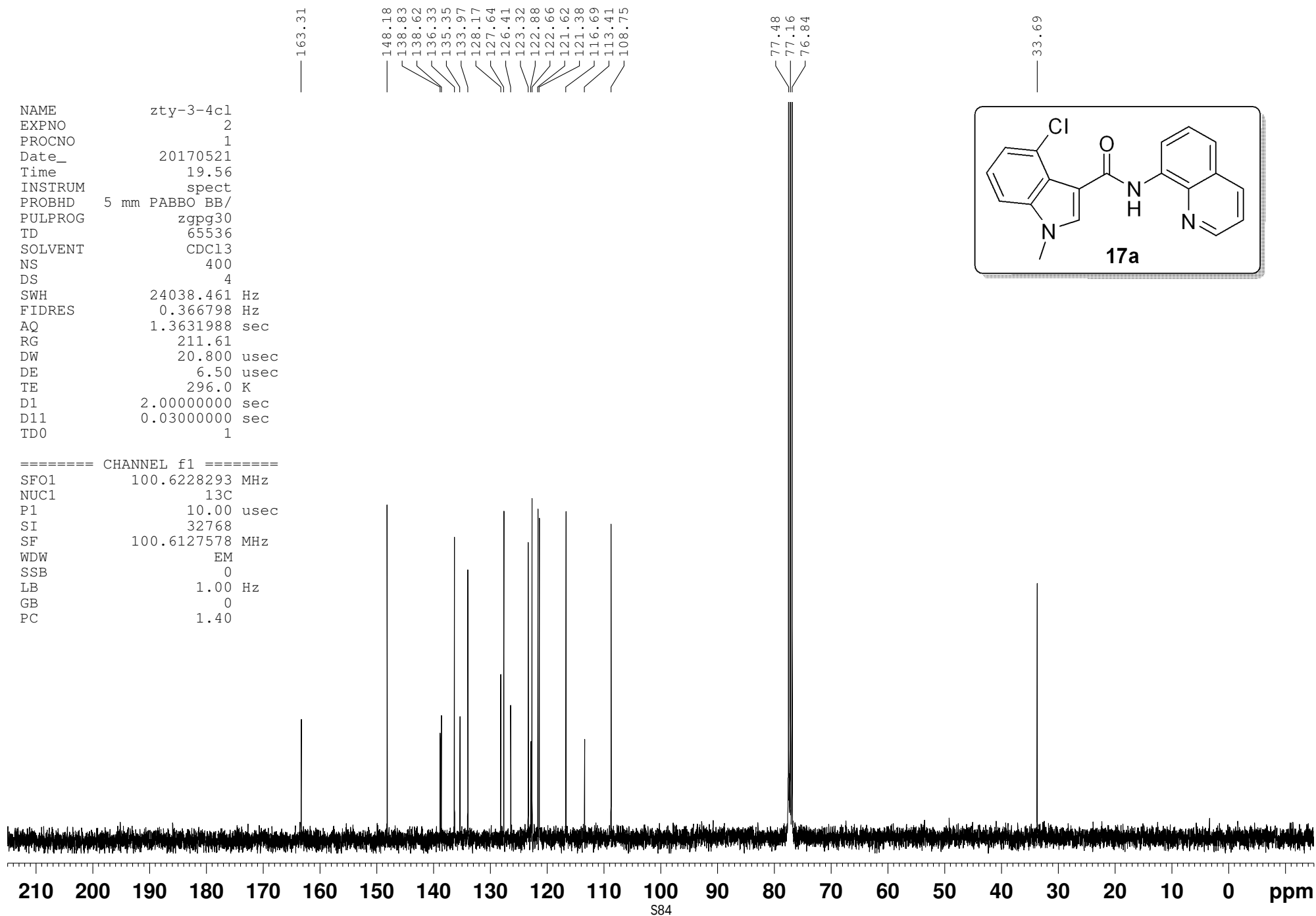
NAME zty-3-4c1
 EXPNO 1
 PROCNO 1
 Date_ 20170521
 Time 19.38
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 8012.820 Hz
 FIDRES 0.122266 Hz
 AQ 4.0894966 sec
 RG 93.15
 DW 62.400 usec
 DE 6.50 usec
 TE 295.2 K
 D1 1.00000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 400.1324710 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 400.1300105 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00



NAME zty-3-4c1
EXPNO 2
PROCNO 1
Date_ 20170521
Time 19.56
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 400
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 296.0 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127578 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40



NAME cc-b100
 EXPNO 1
 PROCNO 1
 Date_ 20170513
 Time 11.38
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 8012.820 Hz
 FIDRES 0.122266 Hz
 AQ 4.0894966 sec
 RG 61.76
 DW 62.400 usec
 DE 6.50 usec
 TE 294.1 K
 D1 1.00000000 sec
 TD0 1

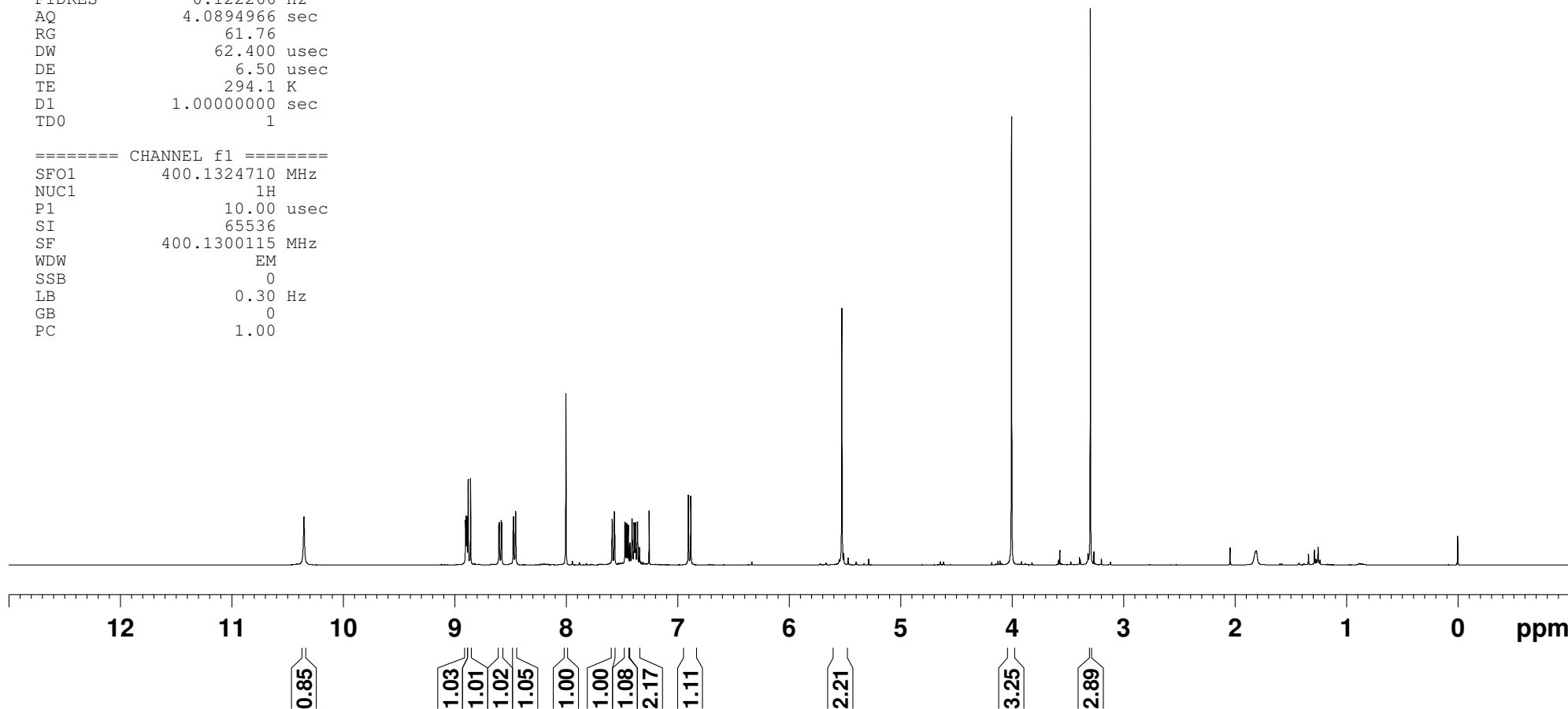
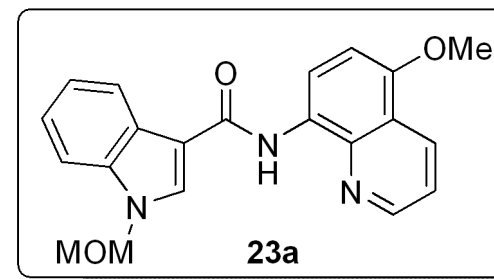
===== CHANNEL f1 =====
 SFO1 400.1324710 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 400.1300115 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00

10.353
 8.902
 8.899
 8.892
 8.888
 8.879
 8.858
 8.603
 8.599
 8.582
 8.578
 8.472
 8.453
 8.002
 7.587
 7.567
 7.472
 7.462
 7.451
 7.441
 7.428
 7.425
 7.410
 7.408
 7.391
 7.388
 7.380
 7.377
 7.360
 7.342
 7.340
 7.256
 6.903
 6.882
 5.526

4.003

3.296

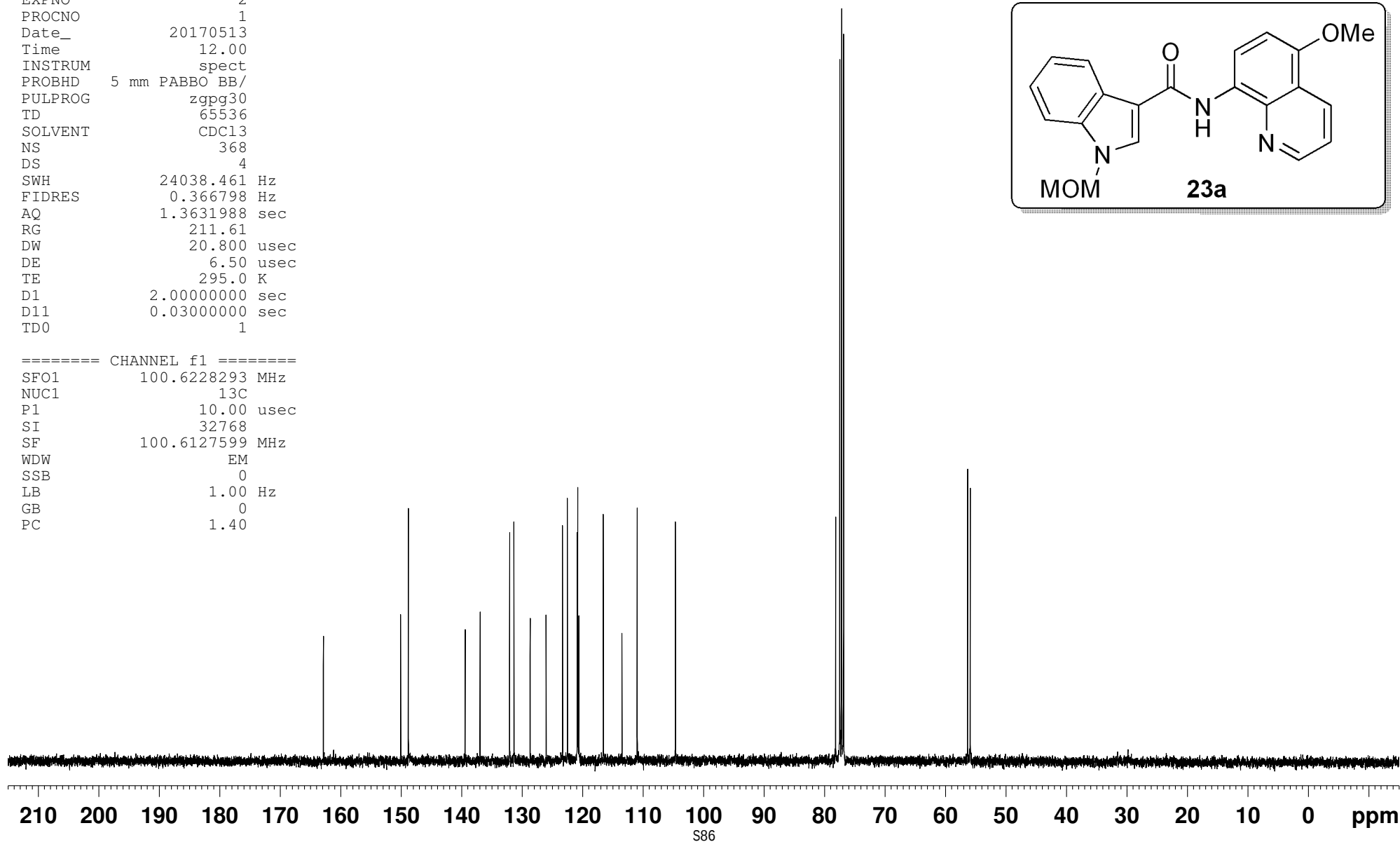
0.000

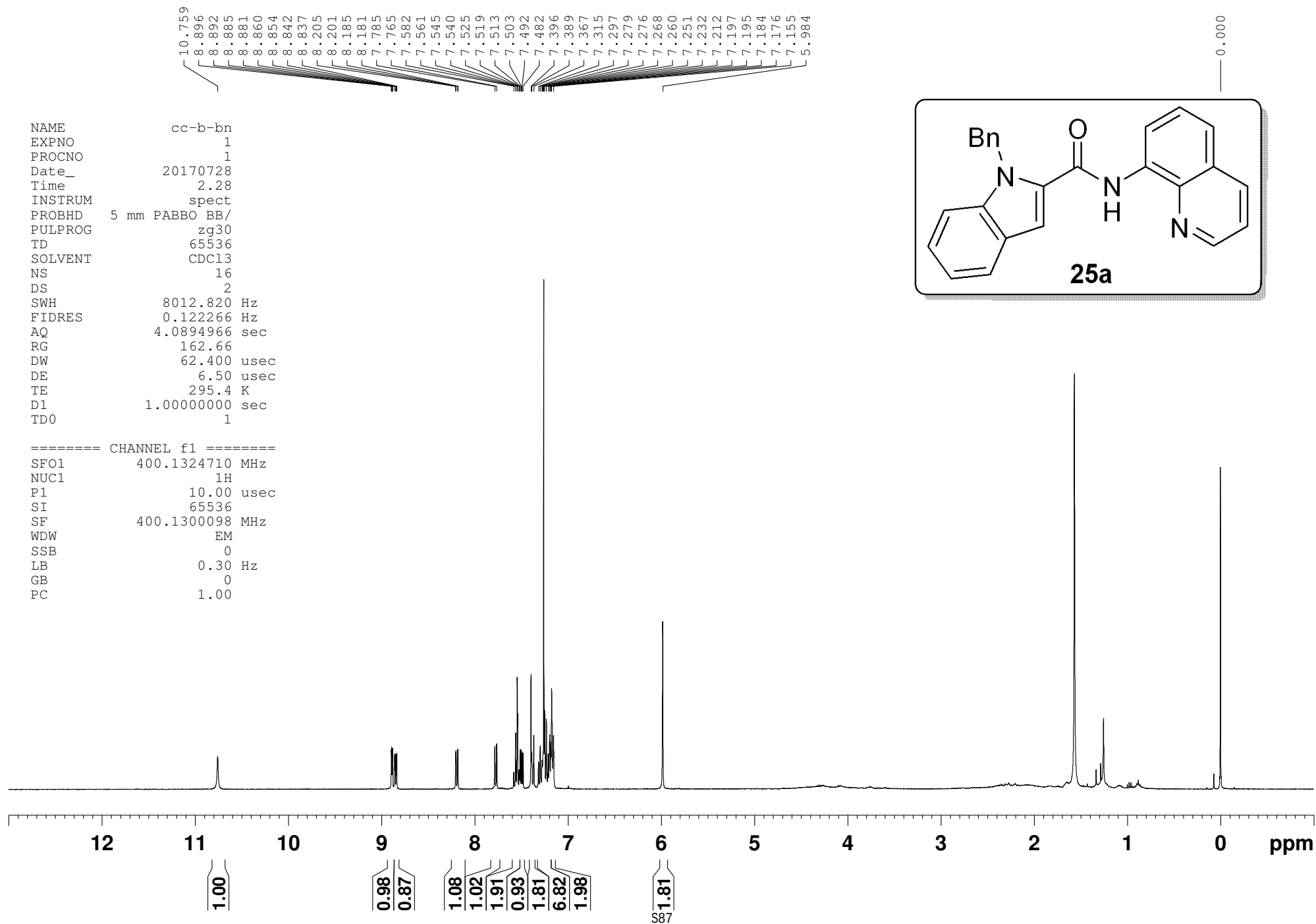
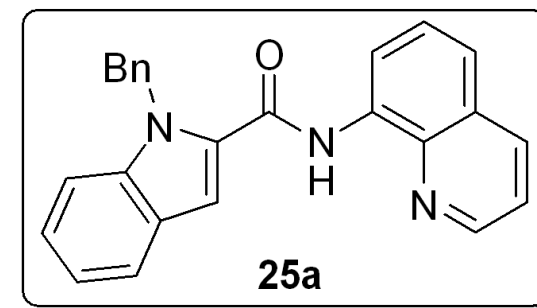


NAME cc-b100
EXPNO 2
PROCNO 1
Date_ 20170513
Time 12.00
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 368
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 295.0 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127599 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

162.88
150.11
148.82
139.43
136.96
132.08
131.36
128.69
126.04
123.33
122.53
120.92
120.81
120.62
116.59
113.50
110.98
104.65
78.15
77.48
77.16
76.84
56.32
55.89

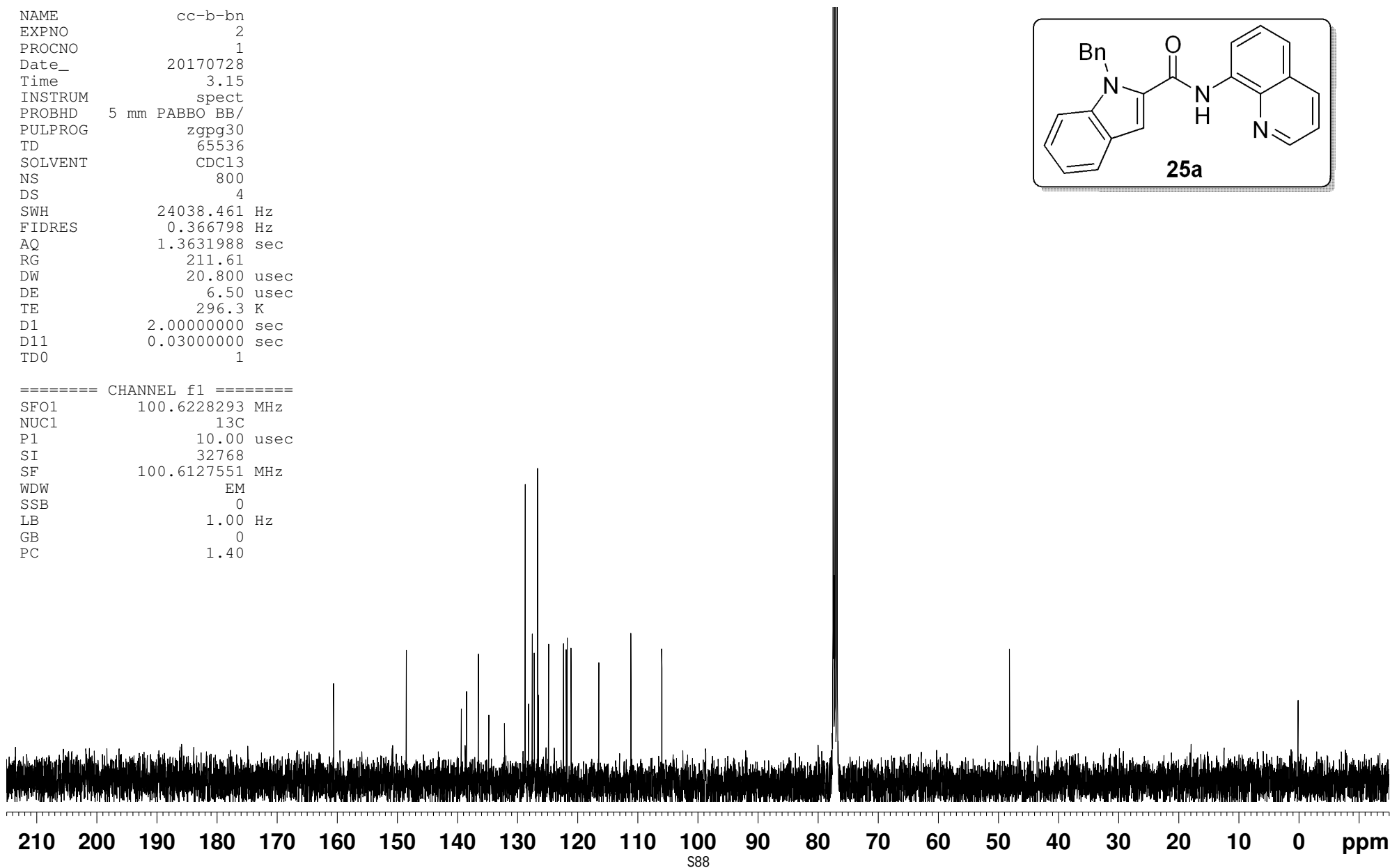
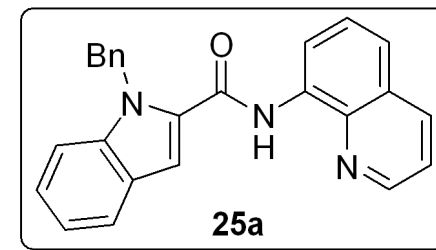


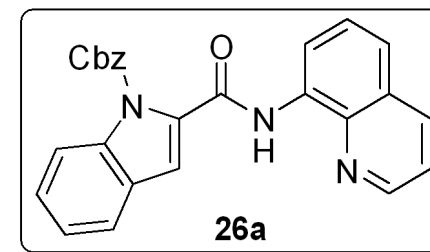
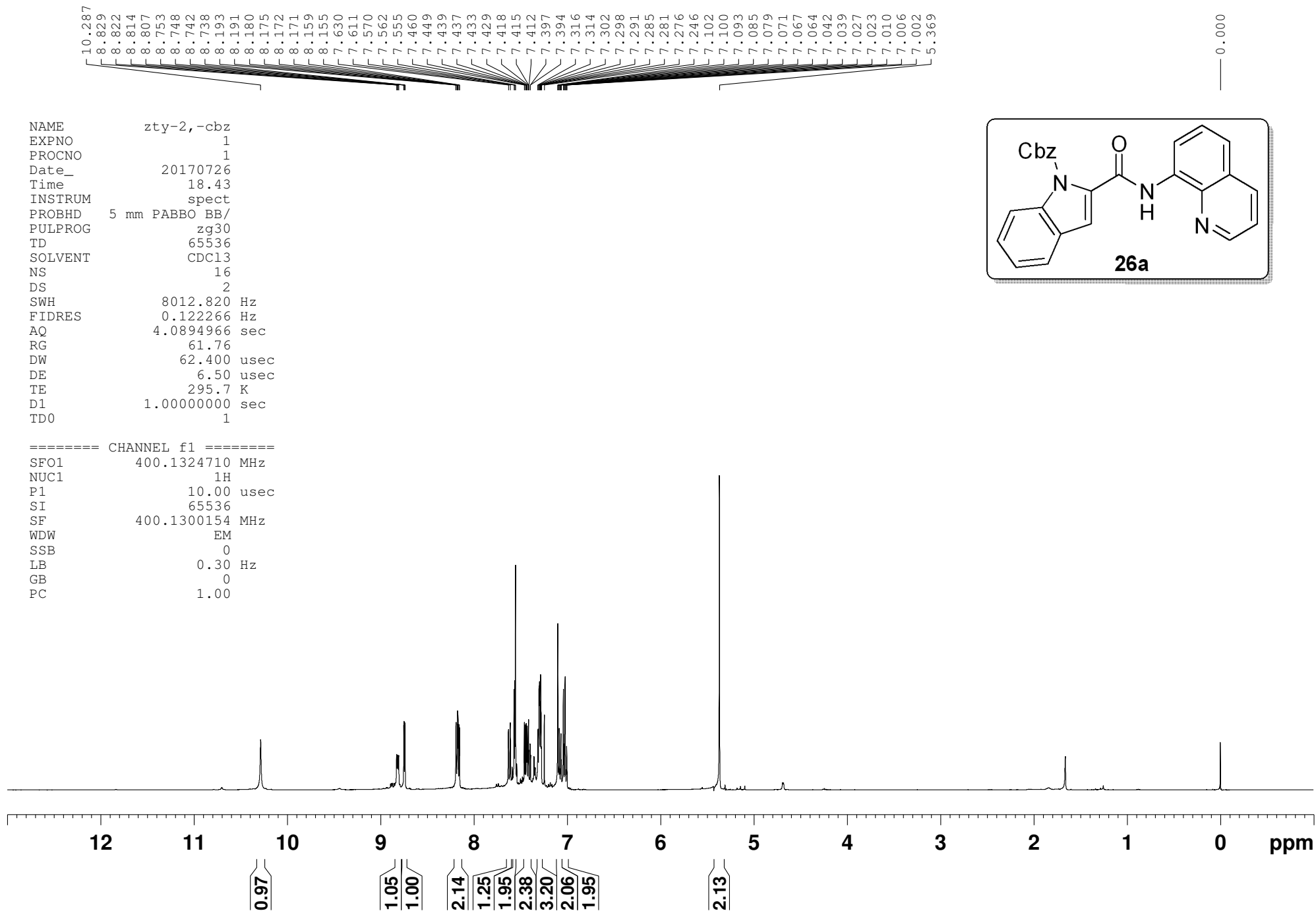


NAME cc-b-bn
EXPNO 2
PROCNO 1
Date_ 20170728
Time 3.15
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 800
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 296.3 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127551 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

160.60
148.51
139.35
138.49
136.53
134.80
132.18
128.72
128.18
127.54
127.23
126.65
126.54
124.84
122.34
121.89
121.74
121.09
116.50
111.14
106.00
77.48
77.16
76.84
48.15



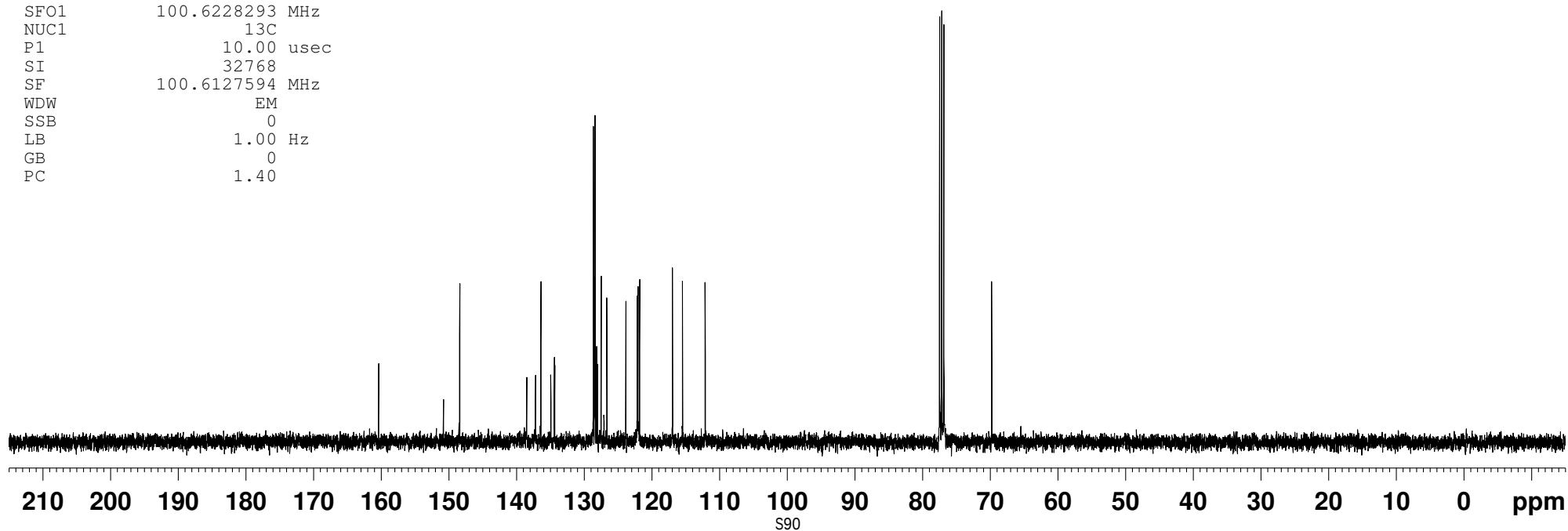
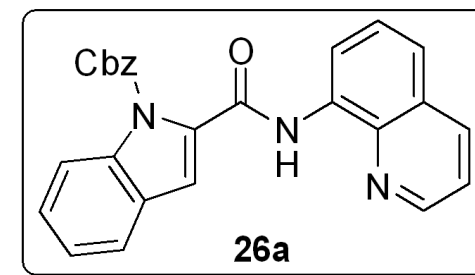


NAME zty-2,-cbz
EXPNO 2
PROCNO 1
Date_ 20170726
Time 19.06
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 71
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 296.7 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127594 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

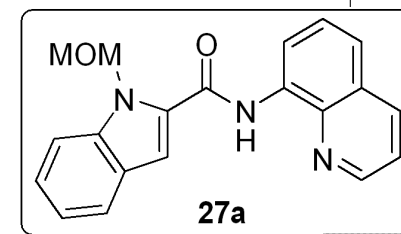
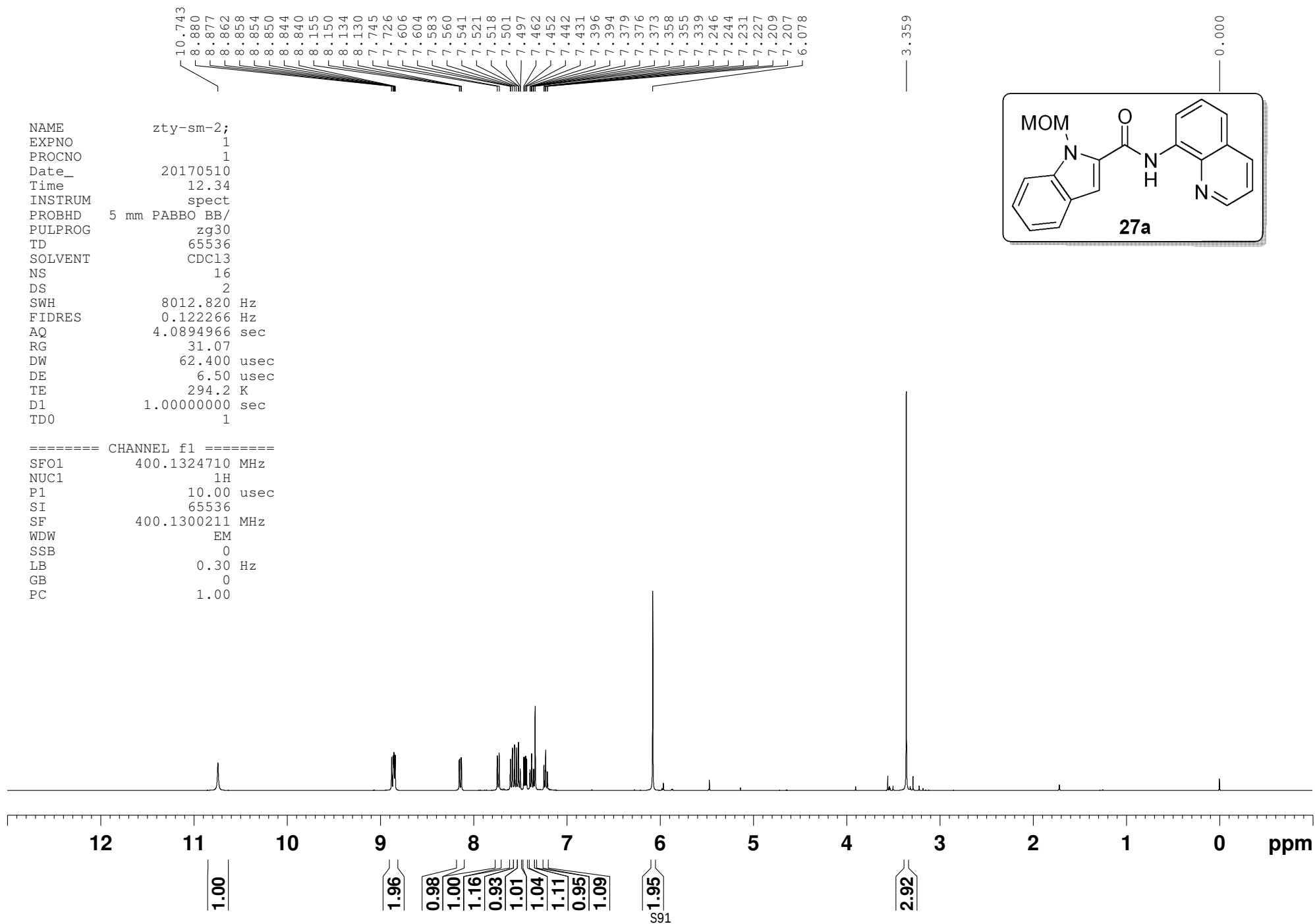
160.39
150.80
148.41
138.51
137.21
136.41
134.93
134.42
134.37
128.63
128.46
128.39
128.17
128.04
127.50
127.08
126.66
123.84
122.16
122.05
121.82
116.96
115.49
112.12

77.48
77.16
76.84
69.77



NAME zty-sm-2;
 EXPNO 1
 PROCNO 1
 Date_ 20170510
 Time 12.34
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 8012.820 Hz
 FIDRES 0.122266 Hz
 AQ 4.0894966 sec
 RG 31.07
 DW 62.400 usec
 DE 6.50 usec
 TE 294.2 K
 D1 1.00000000 sec
 TD0 1

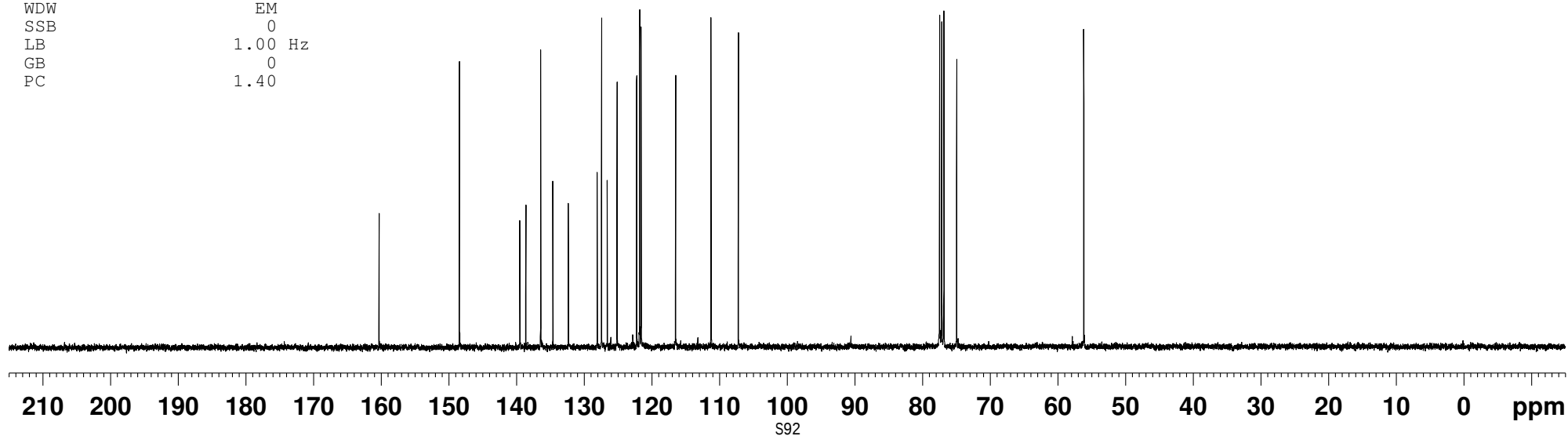
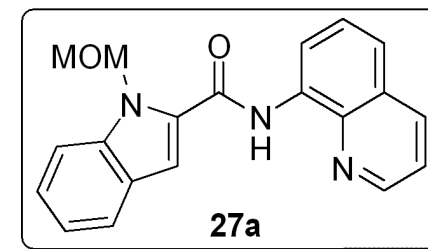
===== CHANNEL f1 =====
 SFO1 400.1324710 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 400.1300211 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00



NAME zty-sm-2;
 EXPNO 2
 PROCNO 1
 Date_ 20170510
 Time 12.50
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 256
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 294.9 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

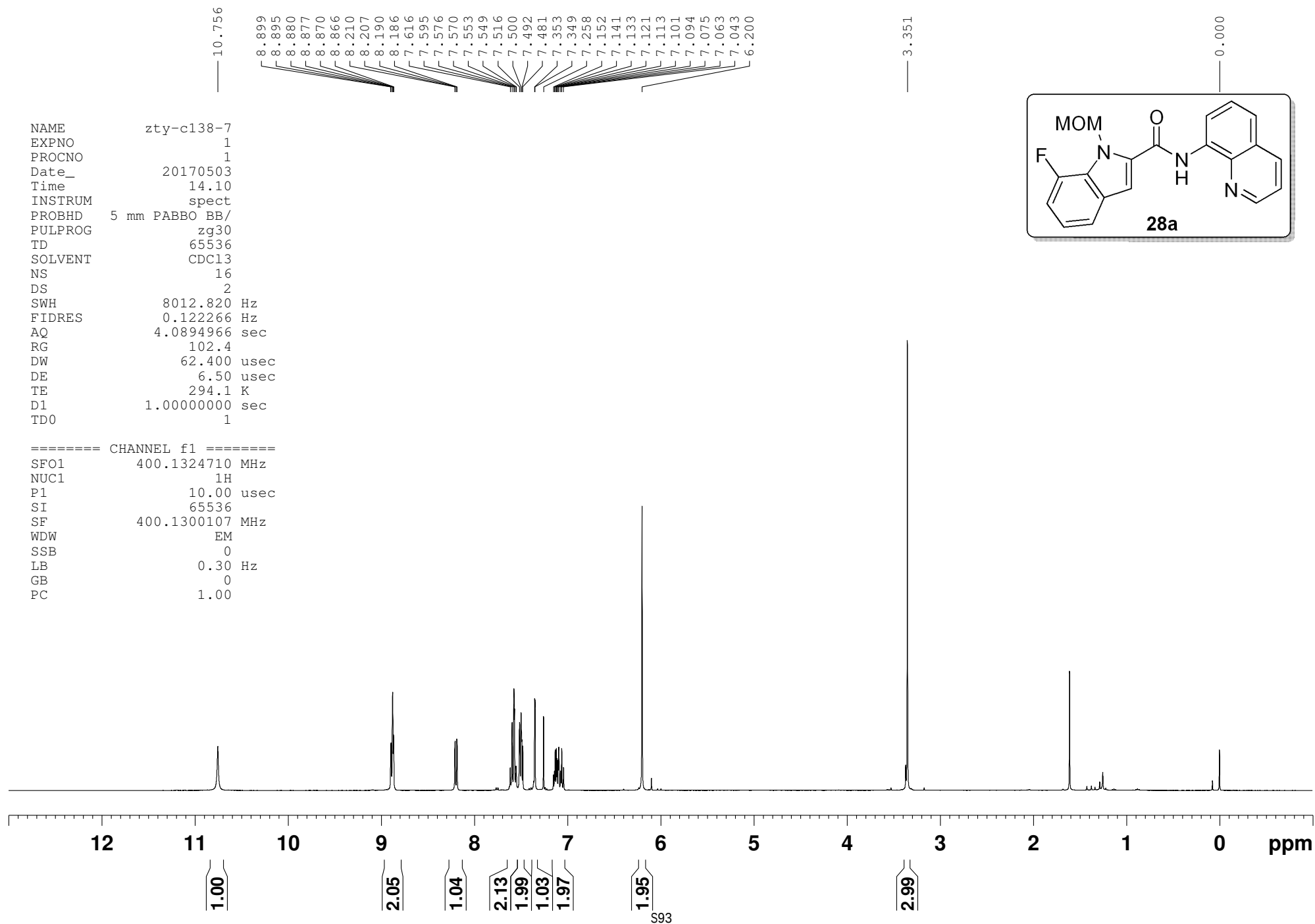
===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127641 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

160.33
 148.46
 139.54
 138.64
 136.45
 134.65
 132.34
 128.09
 127.45
 126.60
 125.16
 122.26
 121.84
 121.82
 121.60
 116.50
 111.26
 107.23
 77.48
 77.16
 76.84
 74.95
 56.16



NAME zty-cl38-7
EXPNO 1
PROCNO 1
Date_ 20170503
Time 14.10
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
SWH 8012.820 Hz
FIDRES 0.122266 Hz
AQ 4.0894966 sec
RG 102.4
DW 62.400 usec
DE 6.50 usec
TE 294.1 K
D1 1.00000000 sec
TD0 1

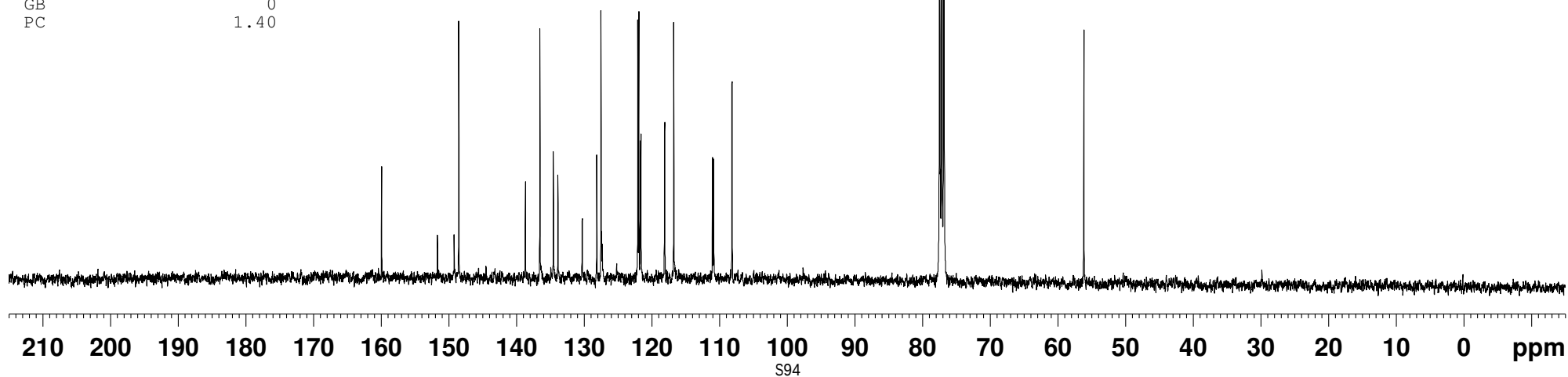
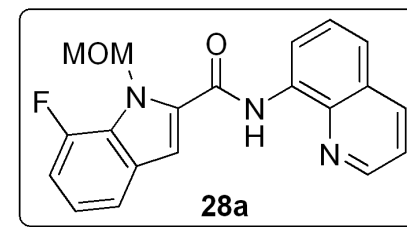
===== CHANNEL f1 =====
SFO1 400.1324710 MHz
NUC1 1H
P1 10.00 usec
SI 65536
SF 400.1300107 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00



NAME zty-c138-7
 EXPNO 2
 PROCNO 1
 Date_ 20170503
 Time 14.30
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 1024
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 294.9 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127570 MHz
 WDW EM
 SSB 0
 LB 3.00 Hz
 GB 0
 PC 1.40

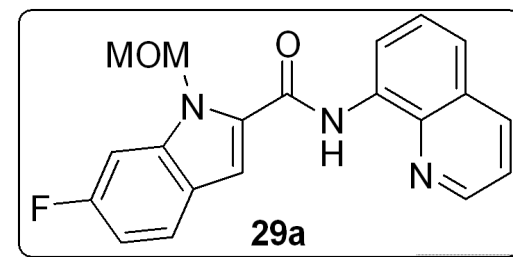
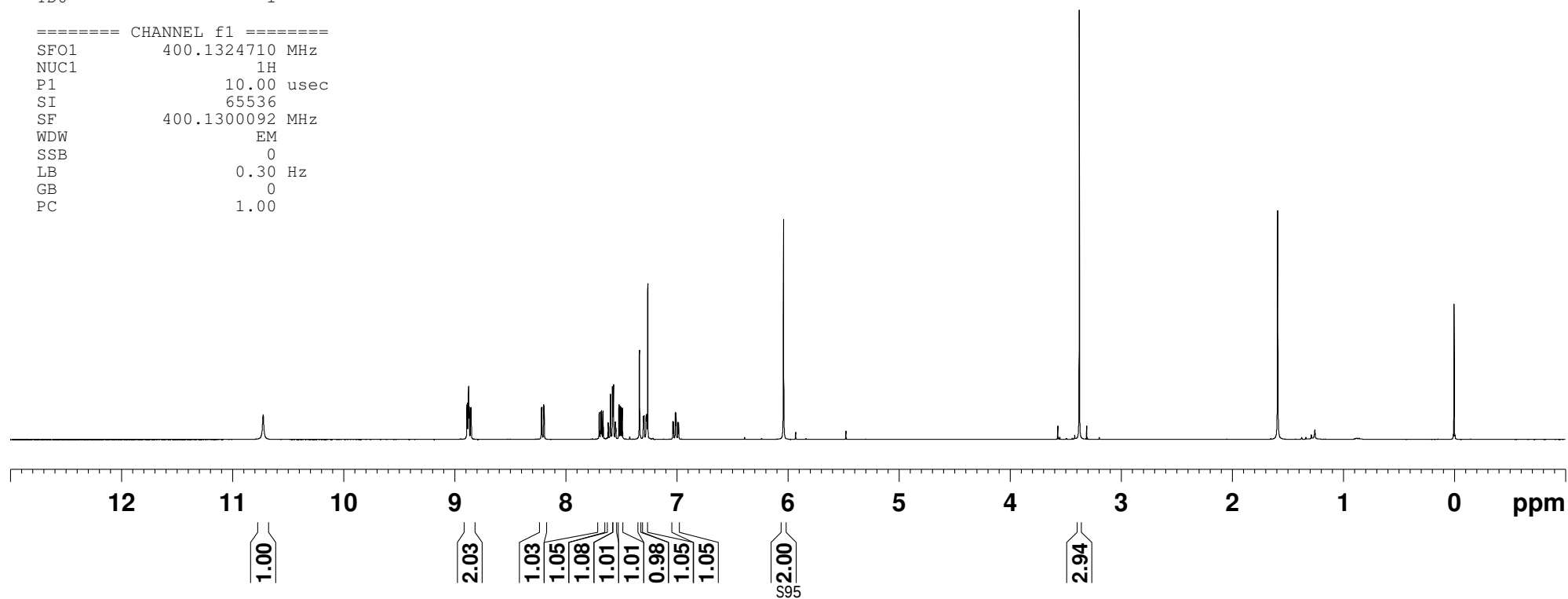
159.96
 151.70
 149.25
 148.55
 138.70
 136.56
 134.57
 133.89
 130.33
 130.28
 128.15
 127.53
 127.34
 125.21
 122.09
 121.94
 121.69
 121.63
 118.14
 118.11
 116.77
 111.05
 110.86
 108.16
 77.48
 77.16
 76.84
 56.15



NAME cc-b91-6F
 EXPNO 1
 PROCNO 1
 Date_ 20170518
 Time 10.27
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 8012.820 Hz
 FIDRES 0.122266 Hz
 AQ 4.0894966 sec
 RG 82.9
 DW 62.400 usec
 DE 6.50 usec
 TE 294.4 K
 D1 1.00000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 400.1324710 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 400.1300092 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00

10.725
 8.889
 8.885
 8.879
 8.874
 8.868
 8.855
 8.851
 8.219
 8.215
 8.198
 8.194
 7.698
 7.685
 7.676
 7.663
 7.617
 7.597
 7.579
 7.574
 7.569
 7.553
 7.548
 7.521
 7.510
 7.500
 7.490
 7.336
 7.300
 7.275
 7.270
 7.261
 7.035
 7.029
 7.012
 7.007
 6.990
 6.984
 6.038



3.375

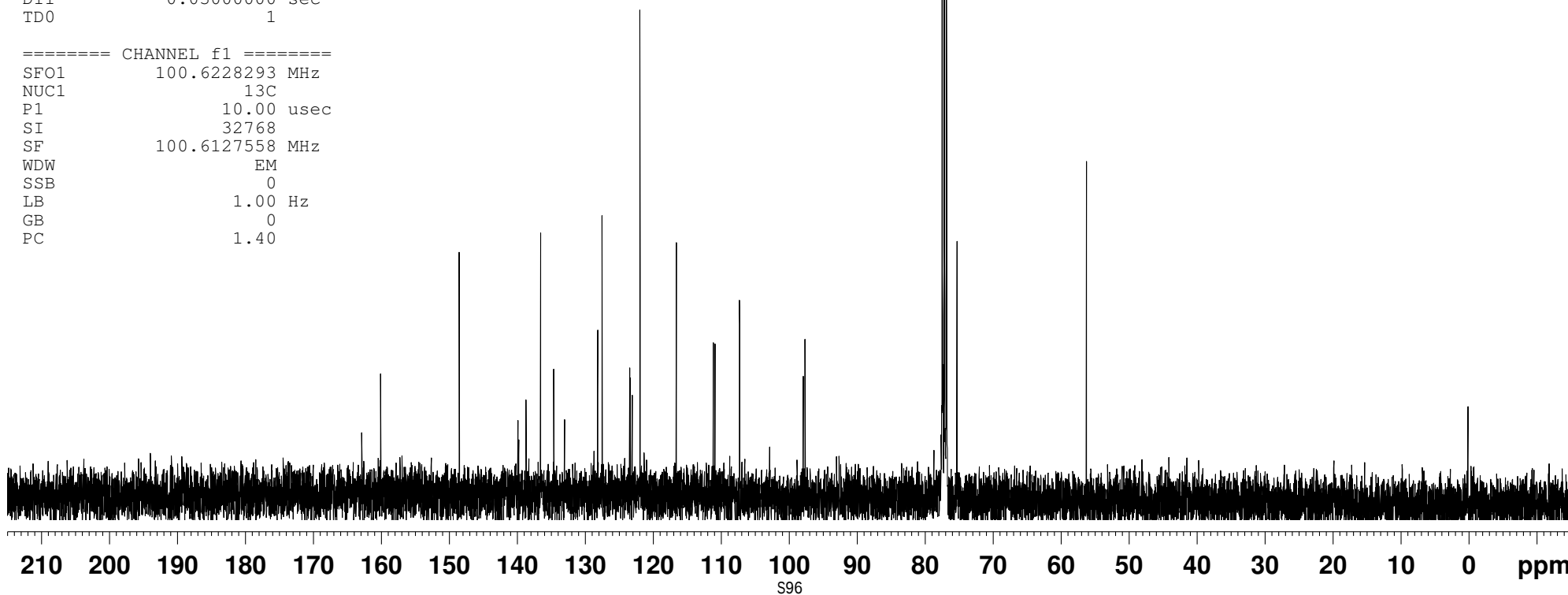
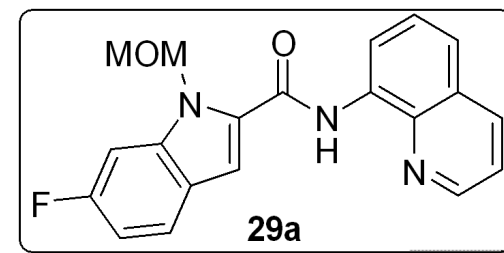
1.589

0.000

NAME cc-b91-2
EXPNO 2
PROCNO 1
Date_ 20170518
Time 10.43
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 256
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 295.5 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

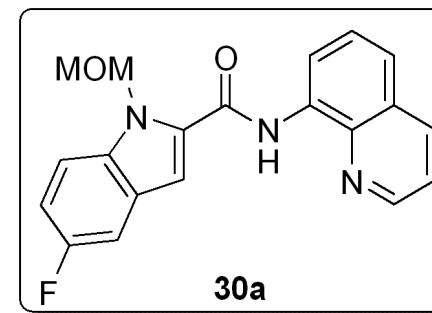
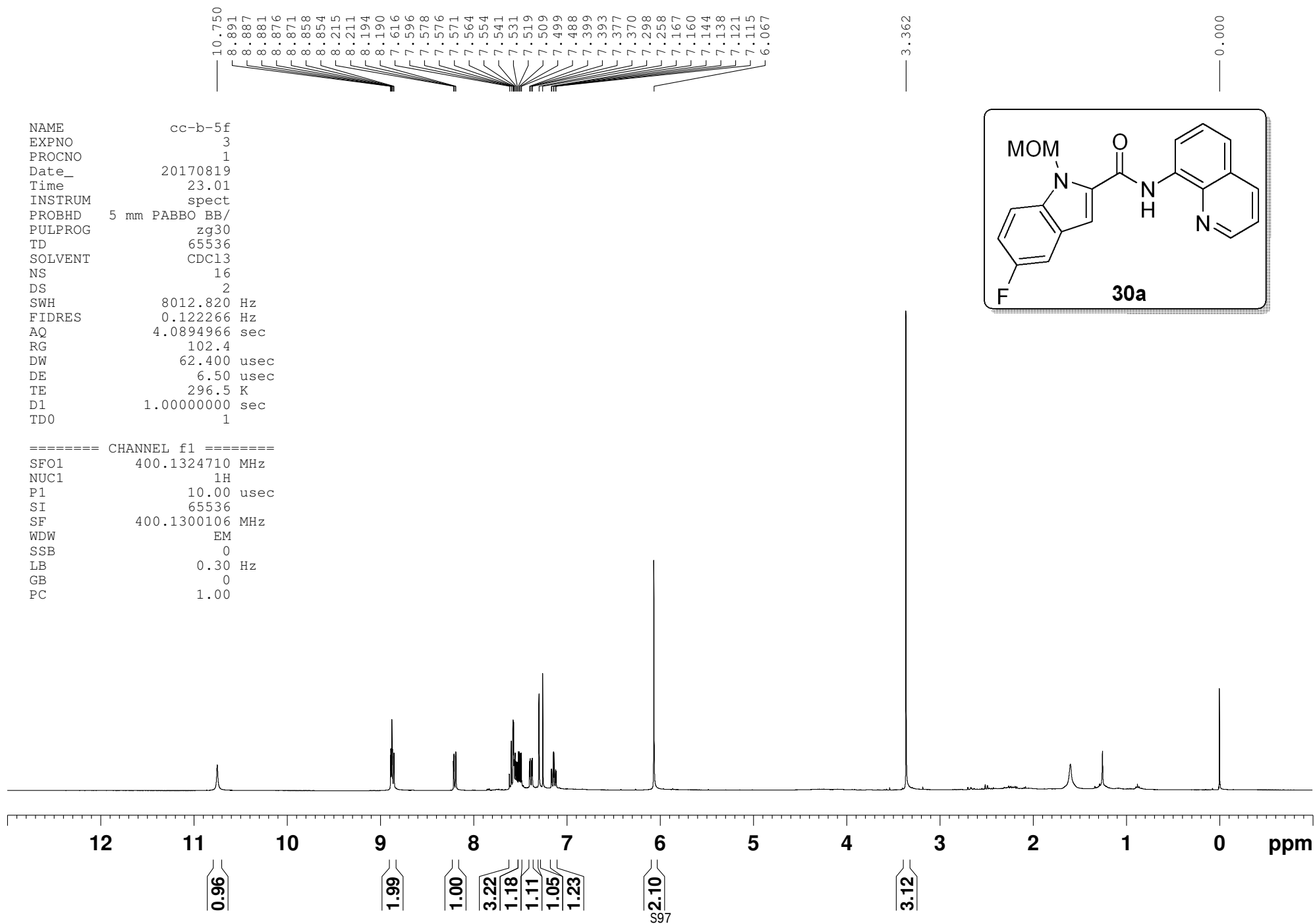
===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127558 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

162.88
160.11
148.55
139.93
138.72
136.58
134.64
133.06
128.19
127.55
123.48
123.37
123.10
121.95
116.60
111.16
110.91
107.31
97.94
97.68
77.48
77.16
76.84
75.30
56.26



NAME cc-b-5f
EXPNO 3
PROCNO 1
Date_ 20170819
Time 23.01
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
SWH 8012.820 Hz
FIDRES 0.122266 Hz
AQ 4.0894966 sec
RG 102.4
DW 62.400 usec
DE 6.50 usec
TE 296.5 K
D1 1.00000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 400.1324710 MHz
NUC1 1H
P1 10.00 usec
SI 65536
SF 400.1300106 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00



NAME cc-b-5f
EXPNO 4
PROCNO 1
Date_ 20170819
Time 23.31
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 500
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 297.1 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

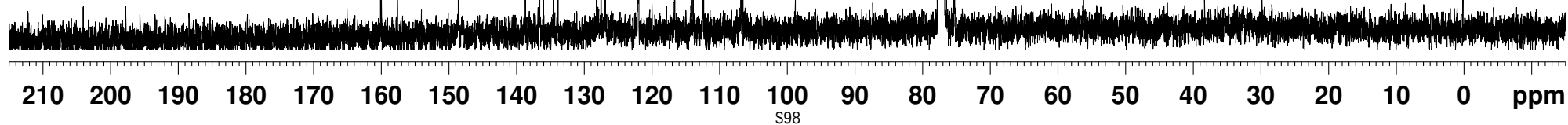
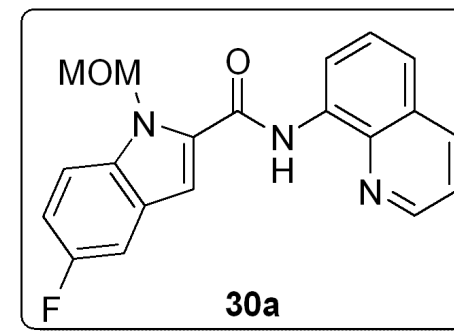
===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127558 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

160.09
159.99
157.63

148.59
138.72
136.57
136.07
134.58
133.87
128.19
127.52
126.97
126.87
122.06
121.97
116.65
114.15
113.88
112.47
112.38
106.84
106.80
106.57

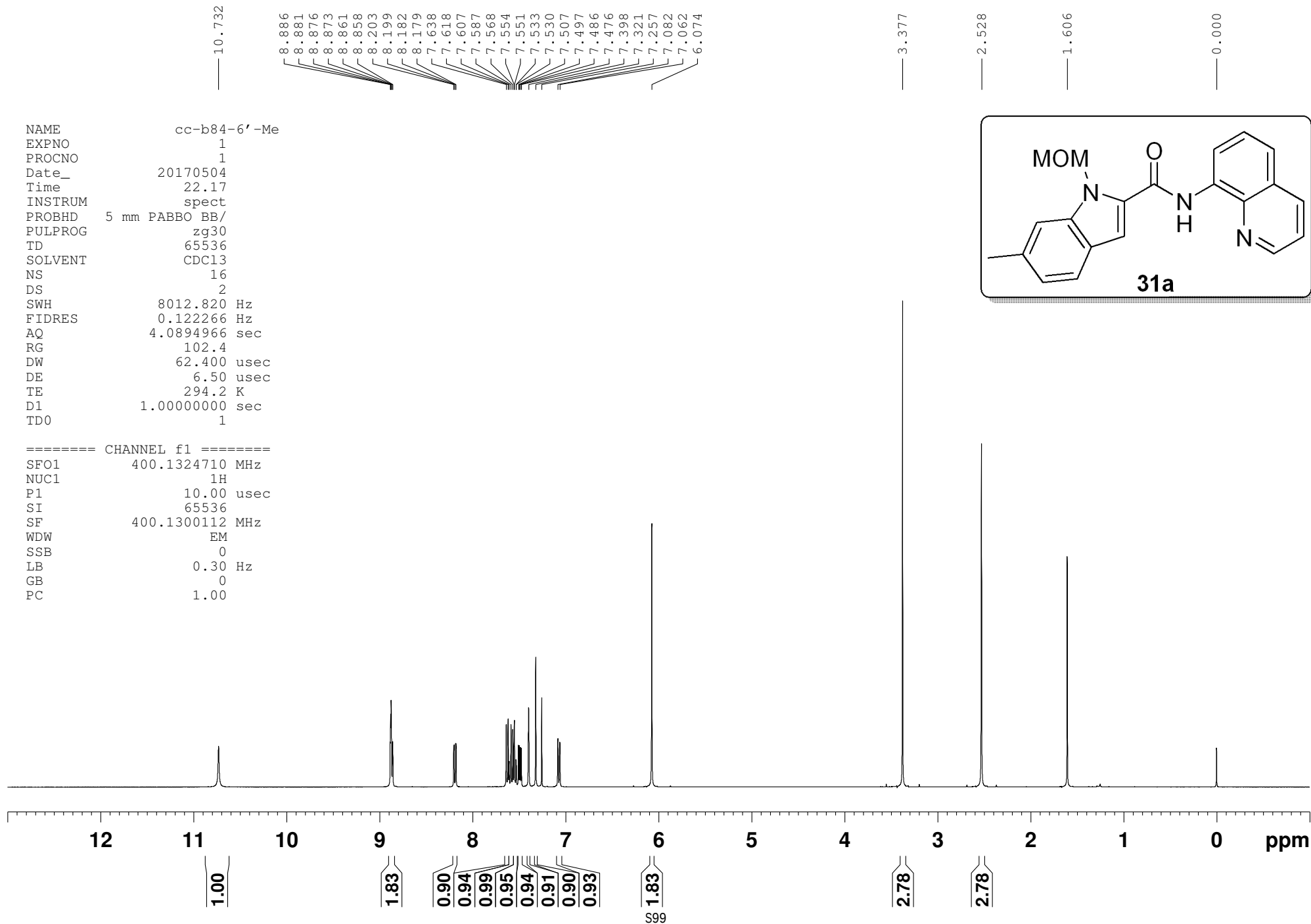
77.48
77.16
76.84
75.24

56.22



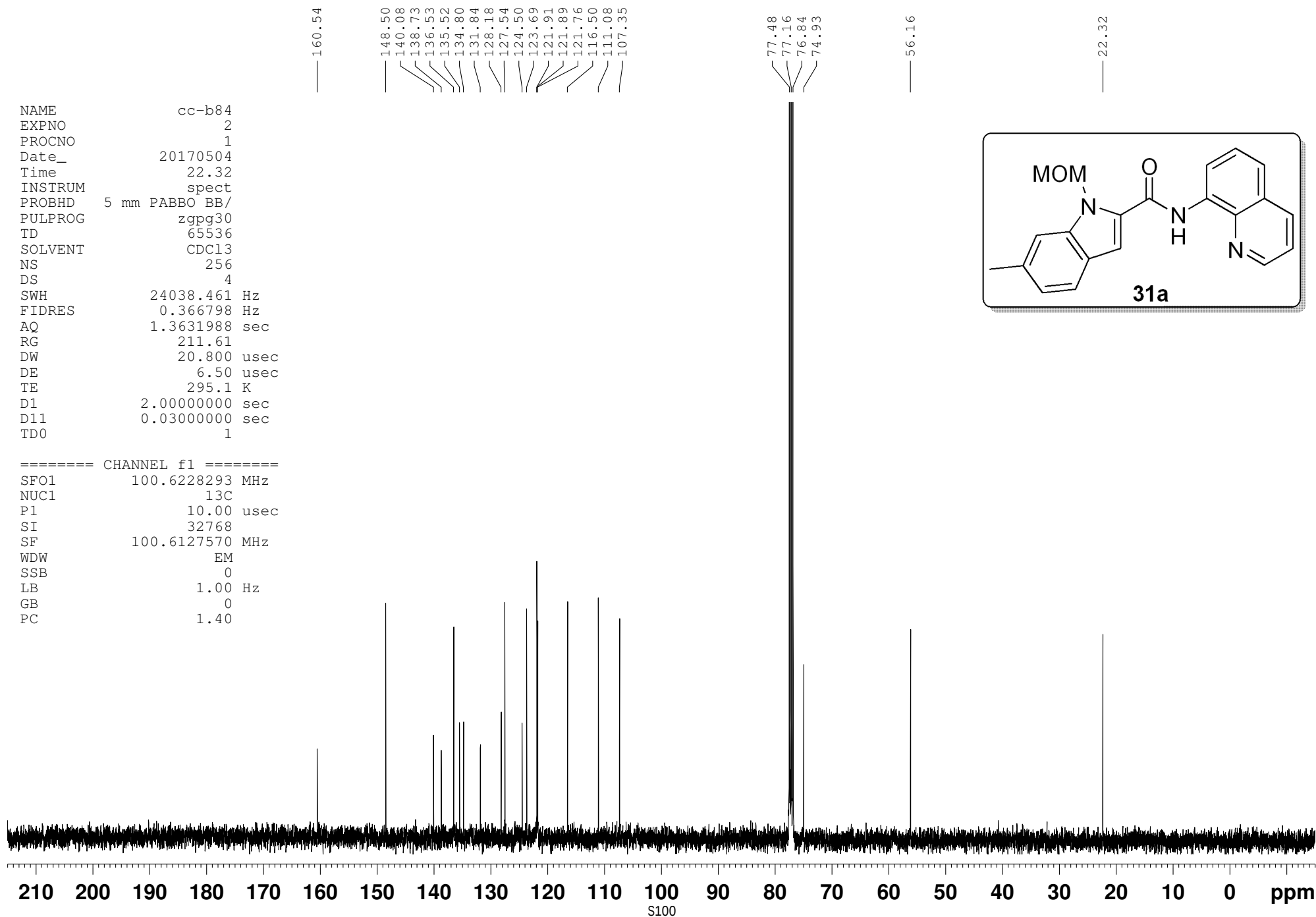
NAME cc-b84-6'-Me
 EXPNO 1
 PROCNO 1
 Date_ 20170504
 Time 22.17
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 8012.820 Hz
 FIDRES 0.122266 Hz
 AQ 4.0894966 sec
 RG 102.4
 DW 62.400 usec
 DE 6.50 usec
 TE 294.2 K
 D1 1.00000000 sec
 TD0 1

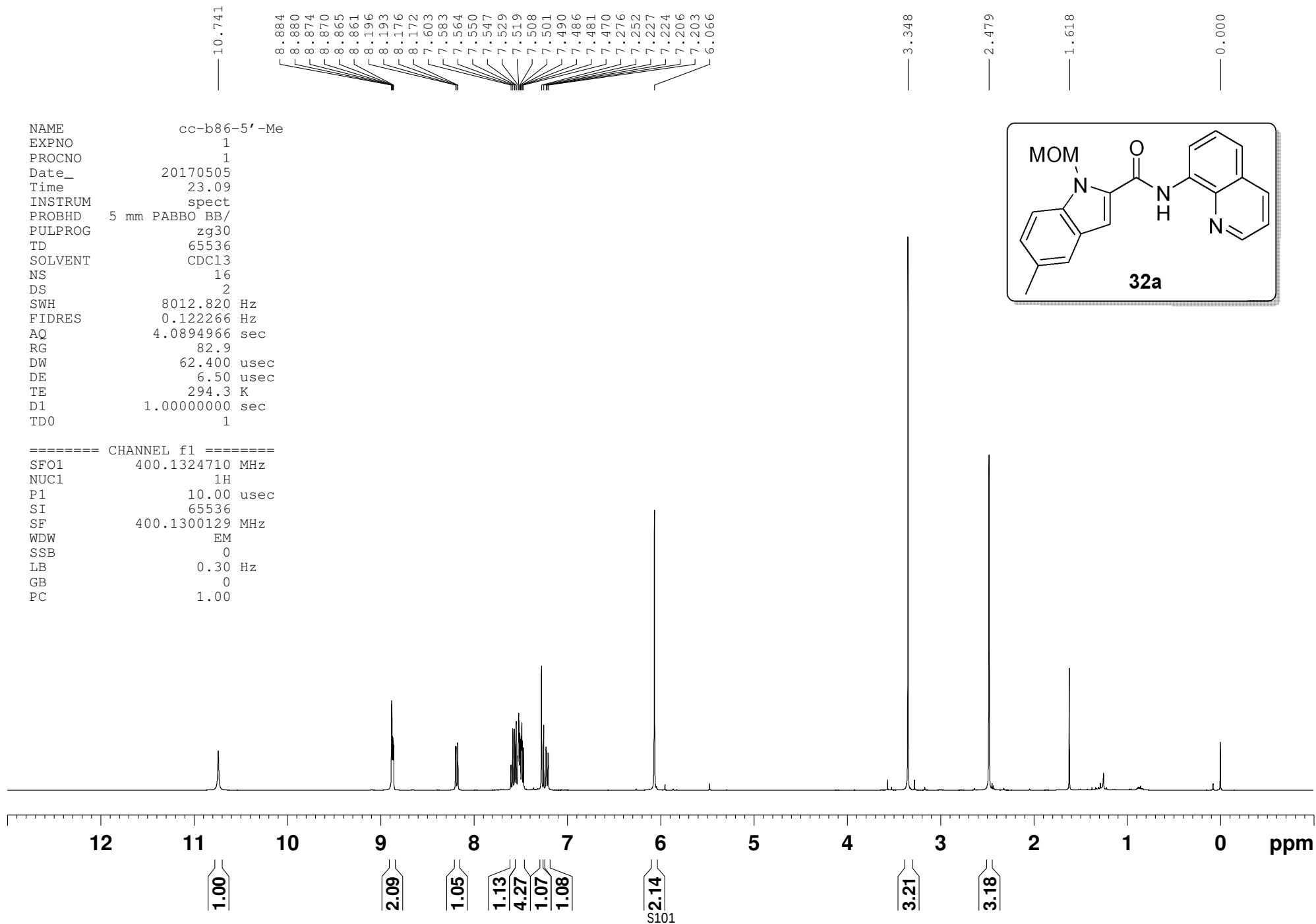
===== CHANNEL f1 =====
 SFO1 400.1324710 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 400.1300112 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00



NAME cc-b84
EXPNO 2
PROCNO 1
Date_ 20170504
Time 22.32
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 256
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 295.1 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127570 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

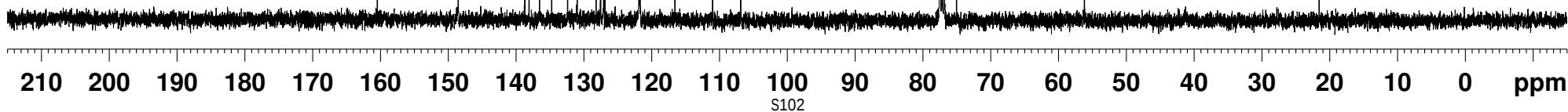
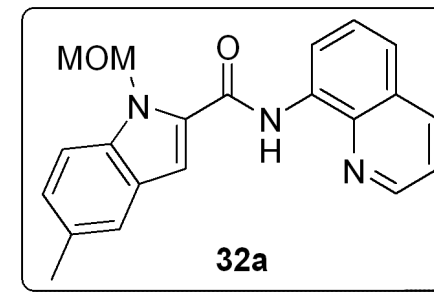




NAME cc-b86
EXPNO 2
PROCNO 1
Date_ 20170505
Time 23.25
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 256
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 295.1 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

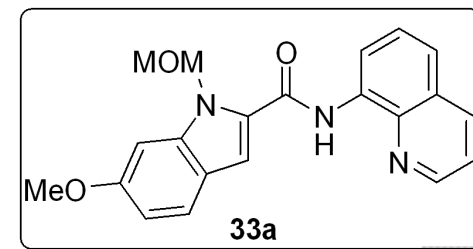
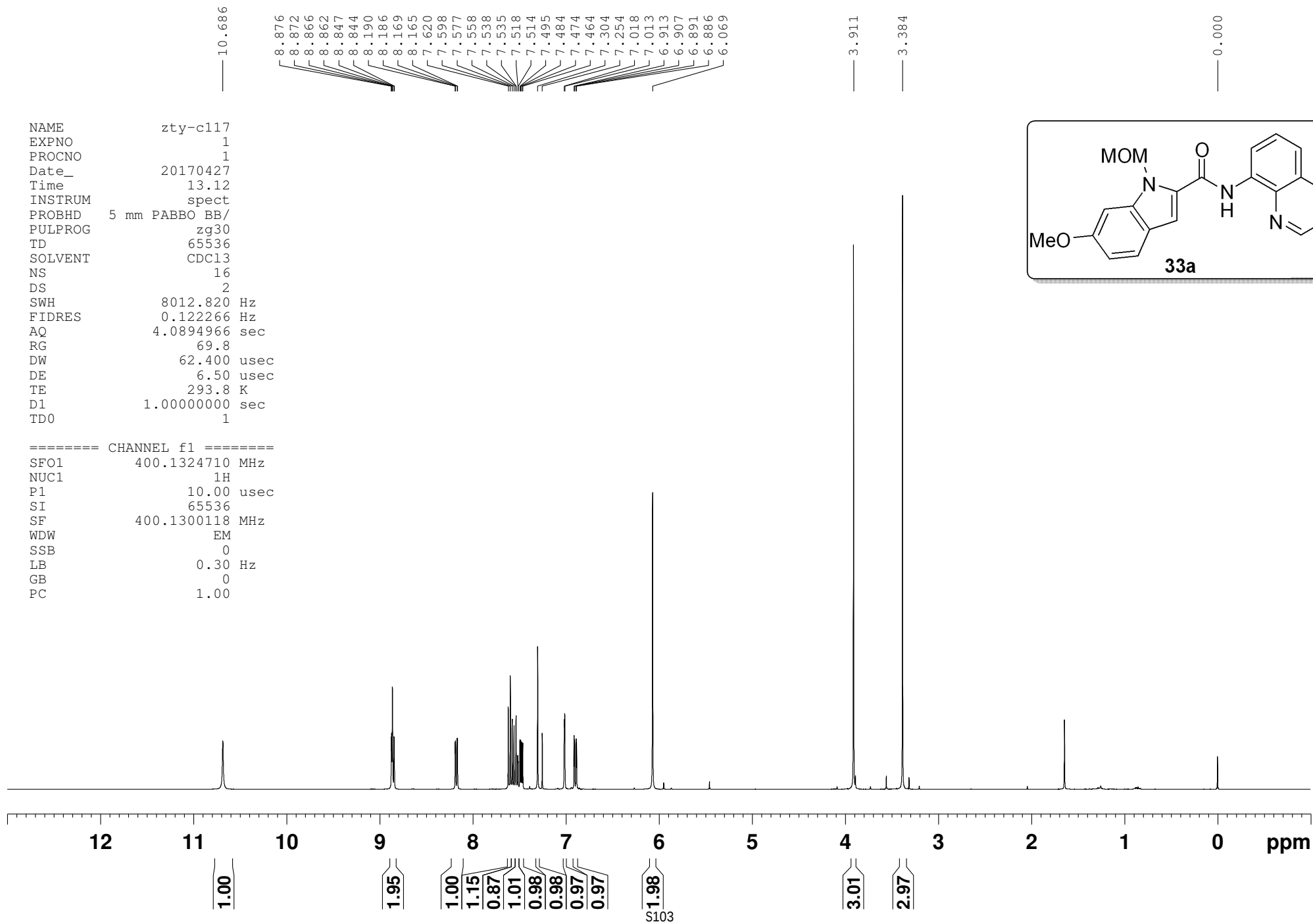
===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127580 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

160.48
148.50
138.72
138.06
136.52
134.76
132.38
131.00
128.16
127.53
127.06
126.87
121.88
121.79
121.66
116.53
110.98
106.84
77.48
77.16
76.84
75.04
56.14
21.56



NAME zty-c117
 EXPNO 1
 PROCNO 1
 Date_ 20170427
 Time 13.12
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 8012.820 Hz
 FIDRES 0.122266 Hz
 AQ 4.0894966 sec
 RG 69.8
 DW 62.400 usec
 DE 6.50 usec
 TE 293.8 K
 D1 1.00000000 sec
 TD0 1

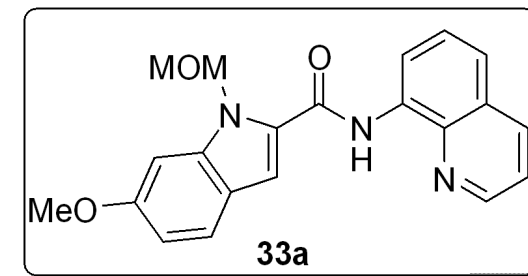
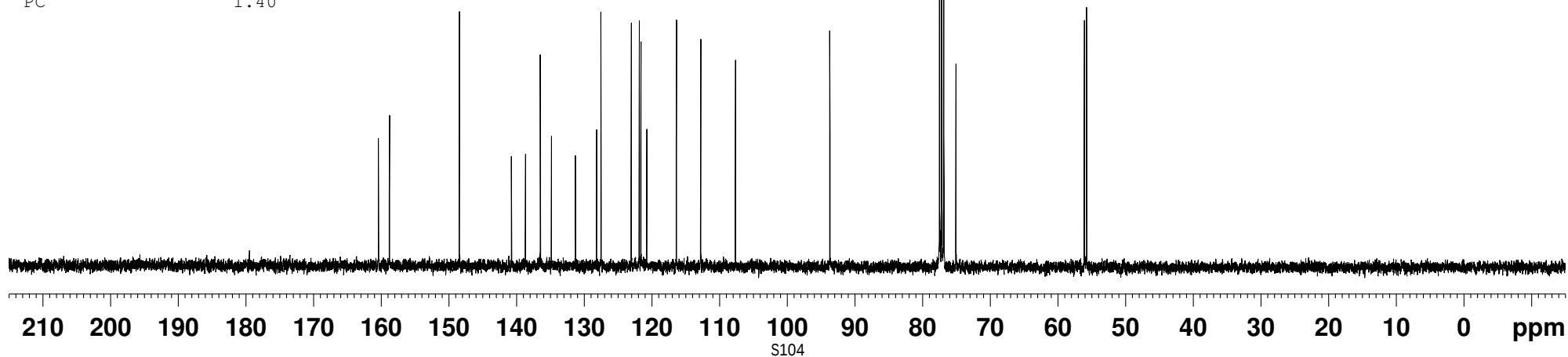
===== CHANNEL f1 =====
 SFO1 400.1324710 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 400.1300118 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00



NAME zty-cl17
 EXPNO 2
 PROCNO 1
 Date_ 20170427
 Time 13.28
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 256
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 294.6 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

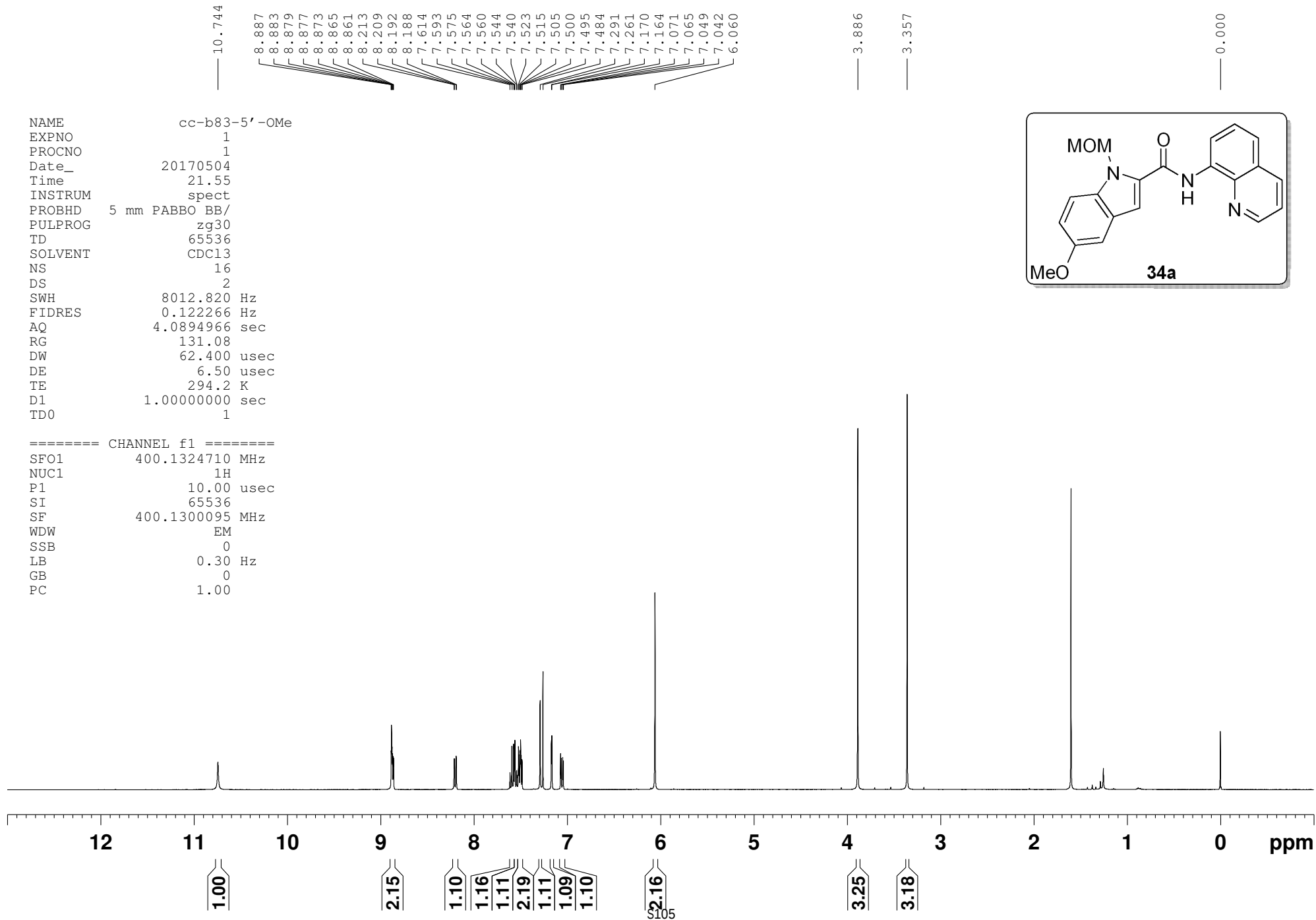
===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127585 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

160.42
 158.80
 148.45
 140.76
 138.70
 136.50
 134.84
 131.31
 128.16
 127.53
 123.05
 121.86
 121.64
 120.75
 116.38
 112.78
 107.65
 93.70
 77.48
 77.16
 76.84
 75.05
 56.09
 55.74



NAME cc-b83-5'-OMe
 EXPNO 1
 PROCNO 1
 Date_ 20170504
 Time 21.55
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 8012.820 Hz
 FIDRES 0.122266 Hz
 AQ 4.0894966 sec
 RG 131.08
 DW 62.400 usec
 DE 6.50 usec
 TE 294.2 K
 D1 1.00000000 sec
 TD0 1

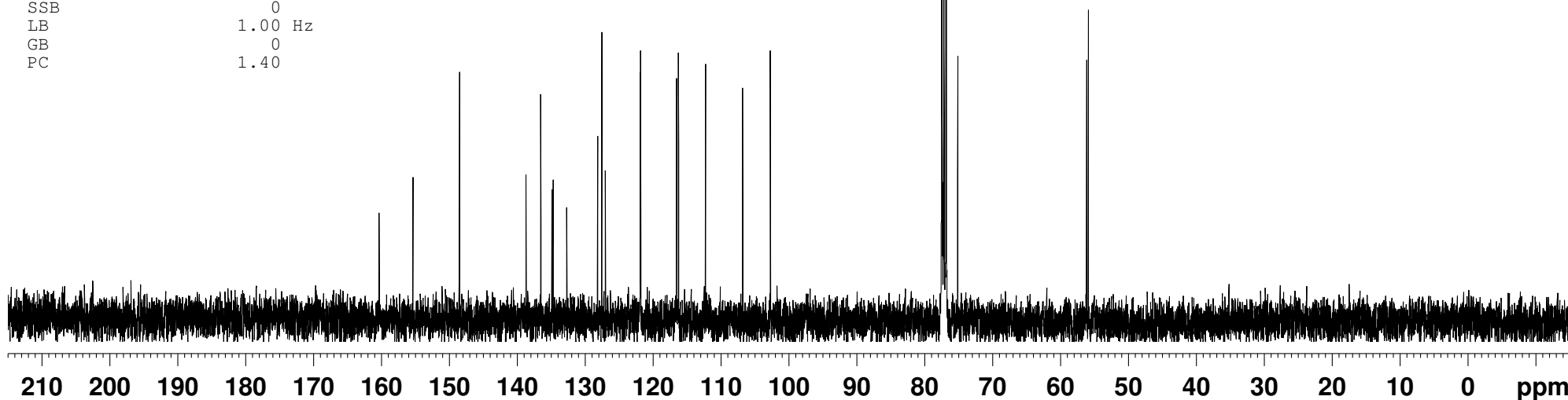
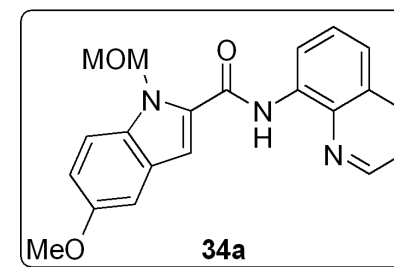
===== CHANNEL f1 =====
 SFO1 400.1324710 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 400.1300095 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00



NAME cc-b83
EXPNO 2
PROCNO 1
Date_ 20170504
Time 22.11
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 256
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 294.9 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

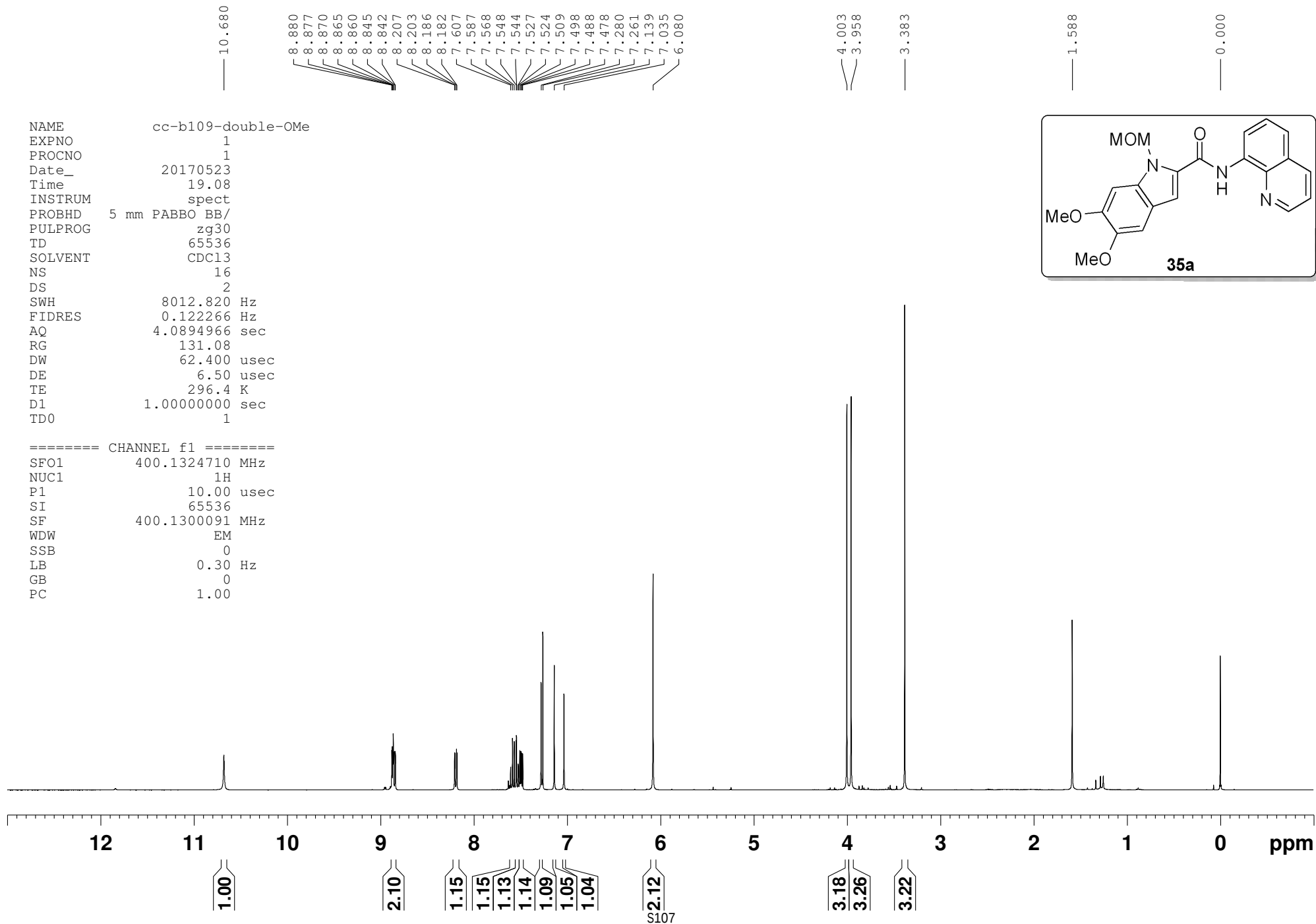
===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127564 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

160.37
155.38
148.51
138.73
136.55
134.90
134.75
132.72
128.18
127.56
127.03
121.91
121.83
116.54
116.26
112.28
106.82
102.74
77.48
77.16
76.84
75.14
56.15
55.89



NAME cc-b109-double-OMe
EXPNO 1
PROCNO 1
Date_ 20170523
Time 19.08
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
SWH 8012.820 Hz
FIDRES 0.122266 Hz
AQ 4.0894966 sec
RG 131.08
DW 62.400 usec
DE 6.50 usec
TE 296.4 K
D1 1.00000000 sec
TD0 1

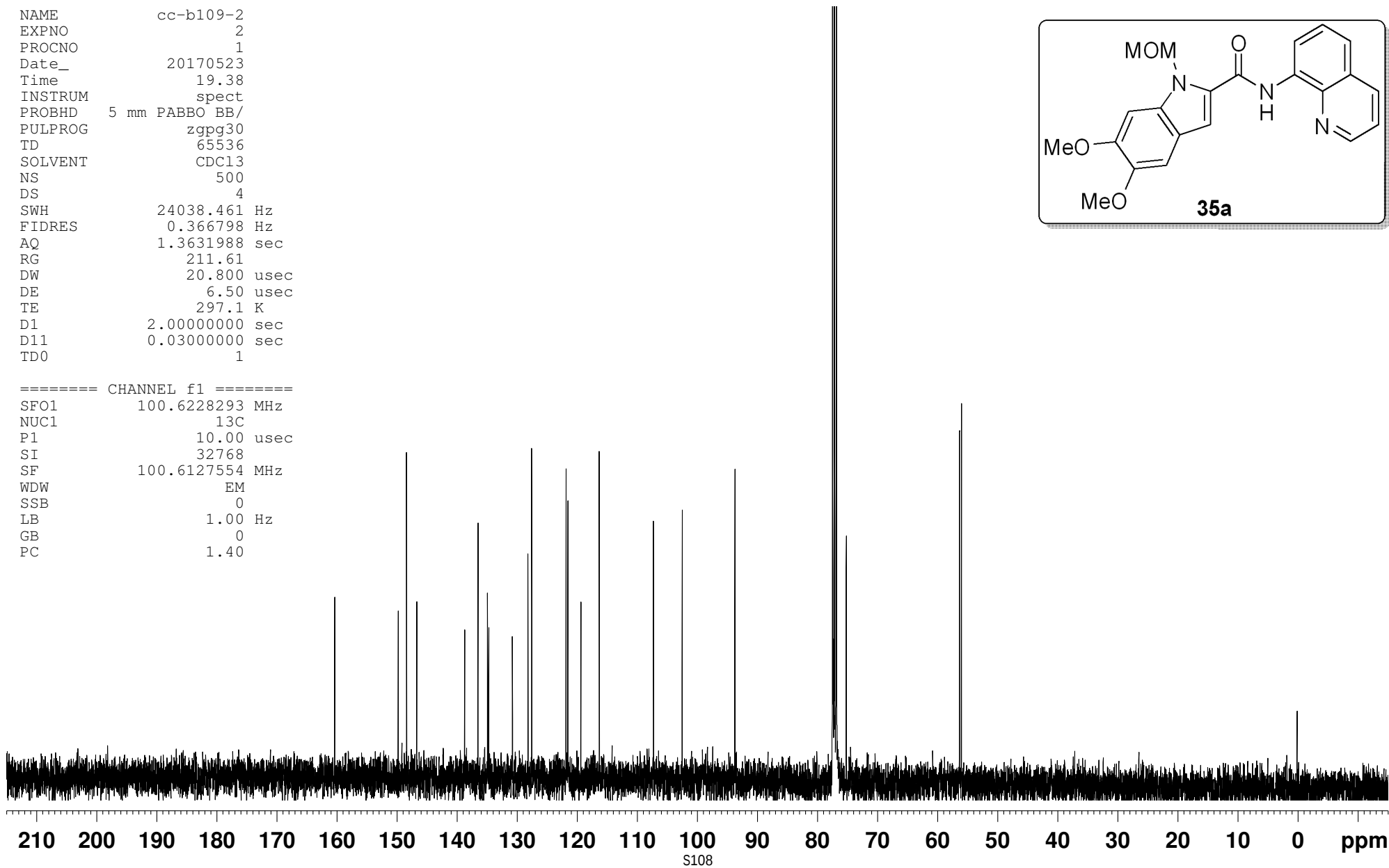
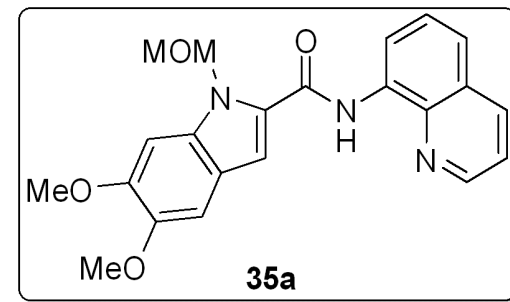
===== CHANNEL f1 =====
SFO1 400.1324710 MHz
NUC1 1H
P1 10.00 usec
SI 65536
SF 400.1300091 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

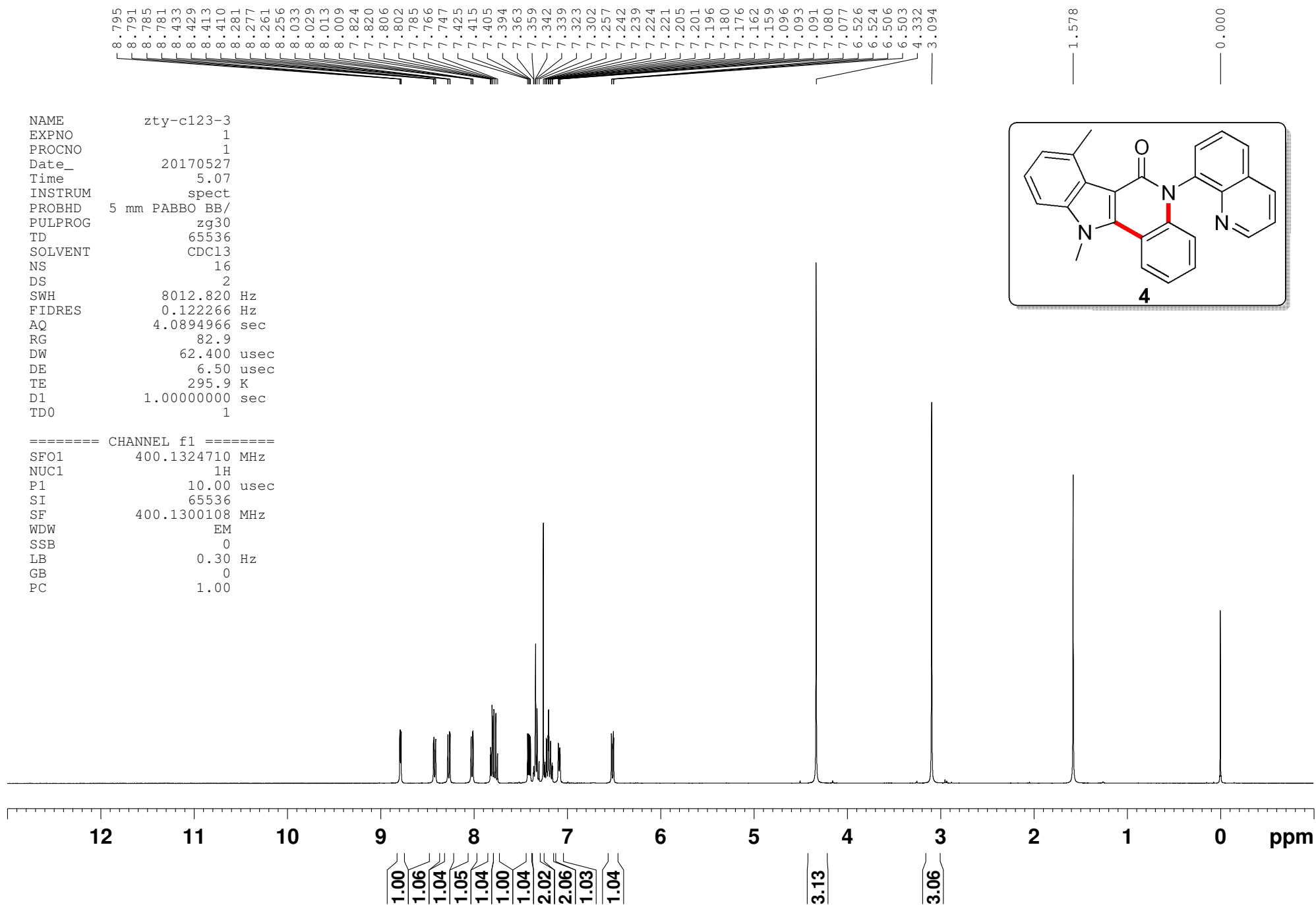


NAME cc-b109-2
EXPNO 2
PROCNO 1
Date_ 20170523
Time 19.38
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 500
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 297.1 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127554 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

160.39
149.82
148.44
146.73
138.75
136.54
134.94
134.75
130.80
128.21
127.58
121.87
121.58
119.39
116.35
107.31
102.53
93.76
77.48
77.16
76.84
75.20
56.35
56.34
56.02





NAME zty-c123-3
EXPNO 2
PROCNO 1
Date_ 20170527
Time 5.37
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 500
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 296.8 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

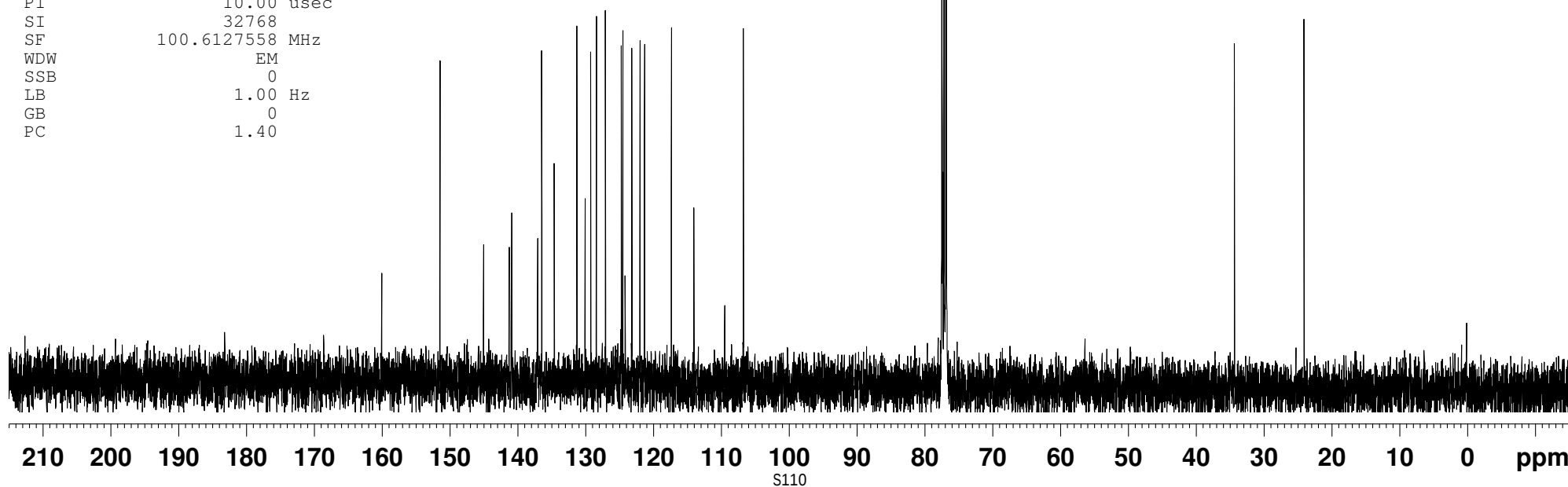
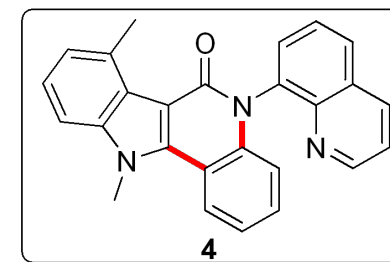
===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127558 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

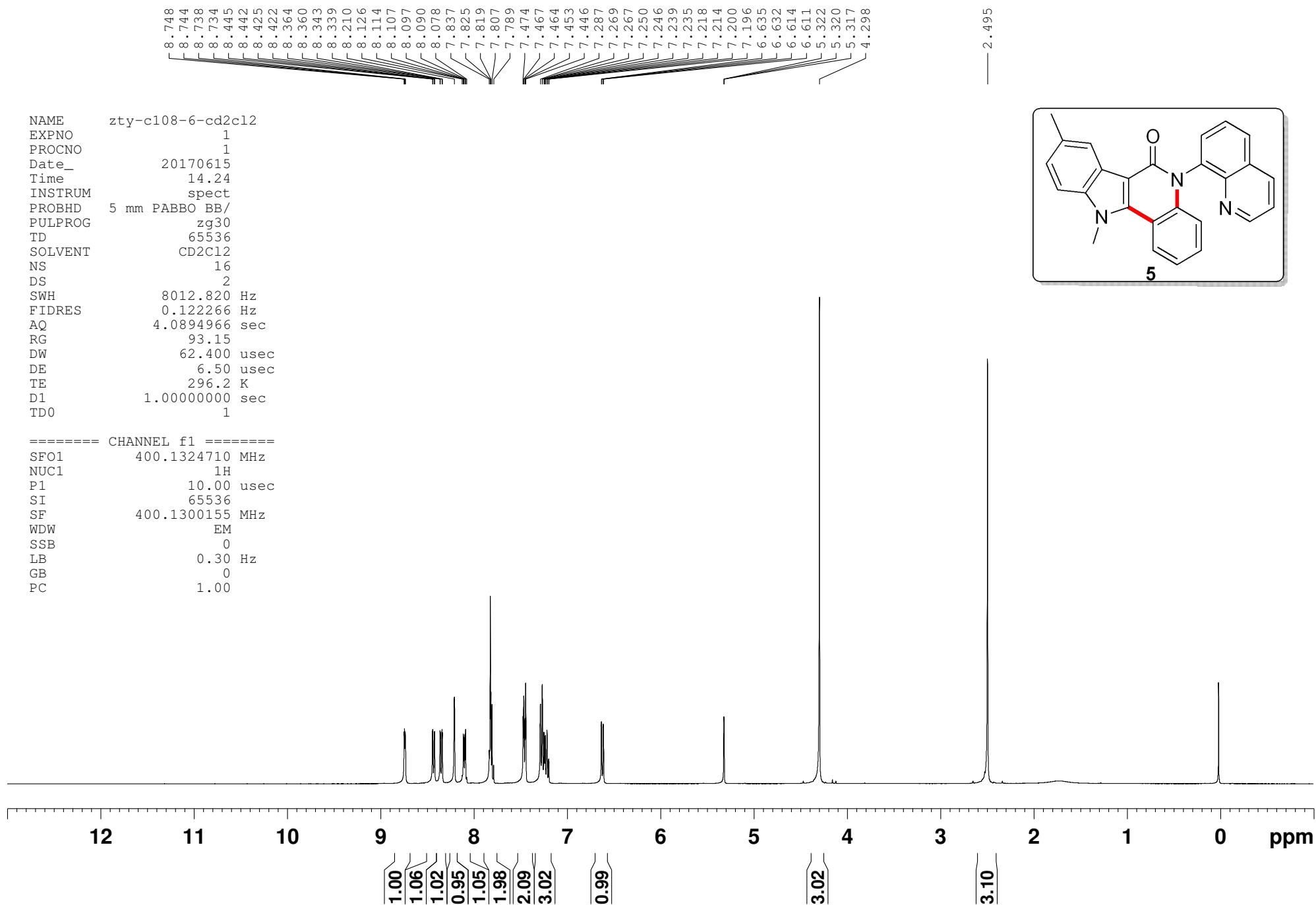
160.08
151.49
145.07
141.30
140.99
140.91
137.09
136.49
134.64
131.32
130.10
129.26
128.42
127.10
124.75
124.53
124.18
123.20
121.99
121.33
117.37
114.07
109.51
106.76

77.48
77.16
76.84

34.36

24.10





NAME zty-c108-6-cd2c12
 EXPNO 2
 PROCNO 1
 Date_ 20170615
 Time 15.22
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CD2Cl2
 NS 1000
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 296.9 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

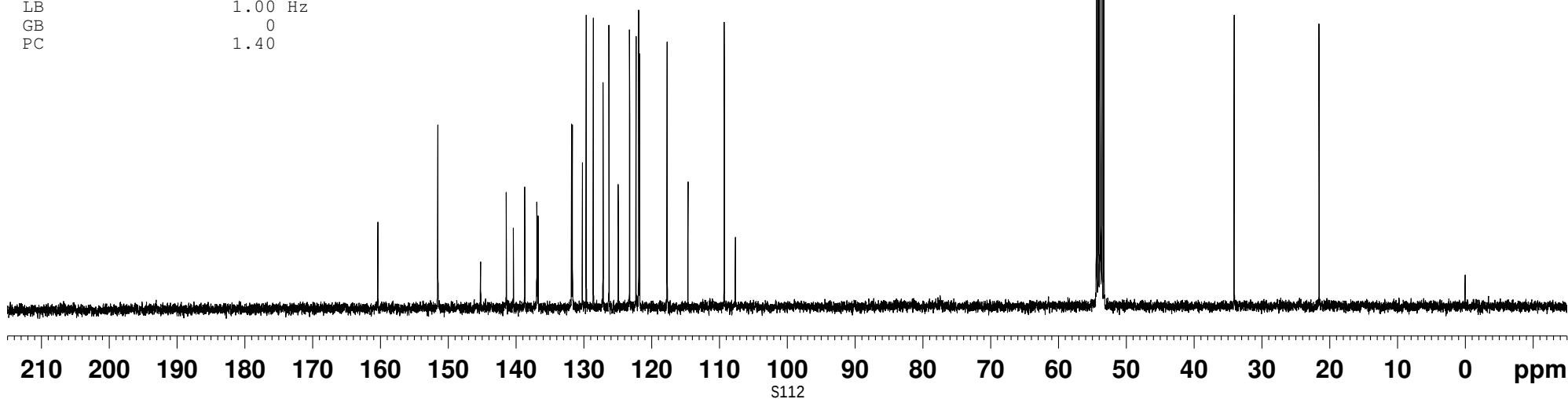
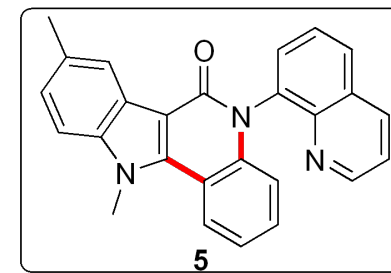
===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127298 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

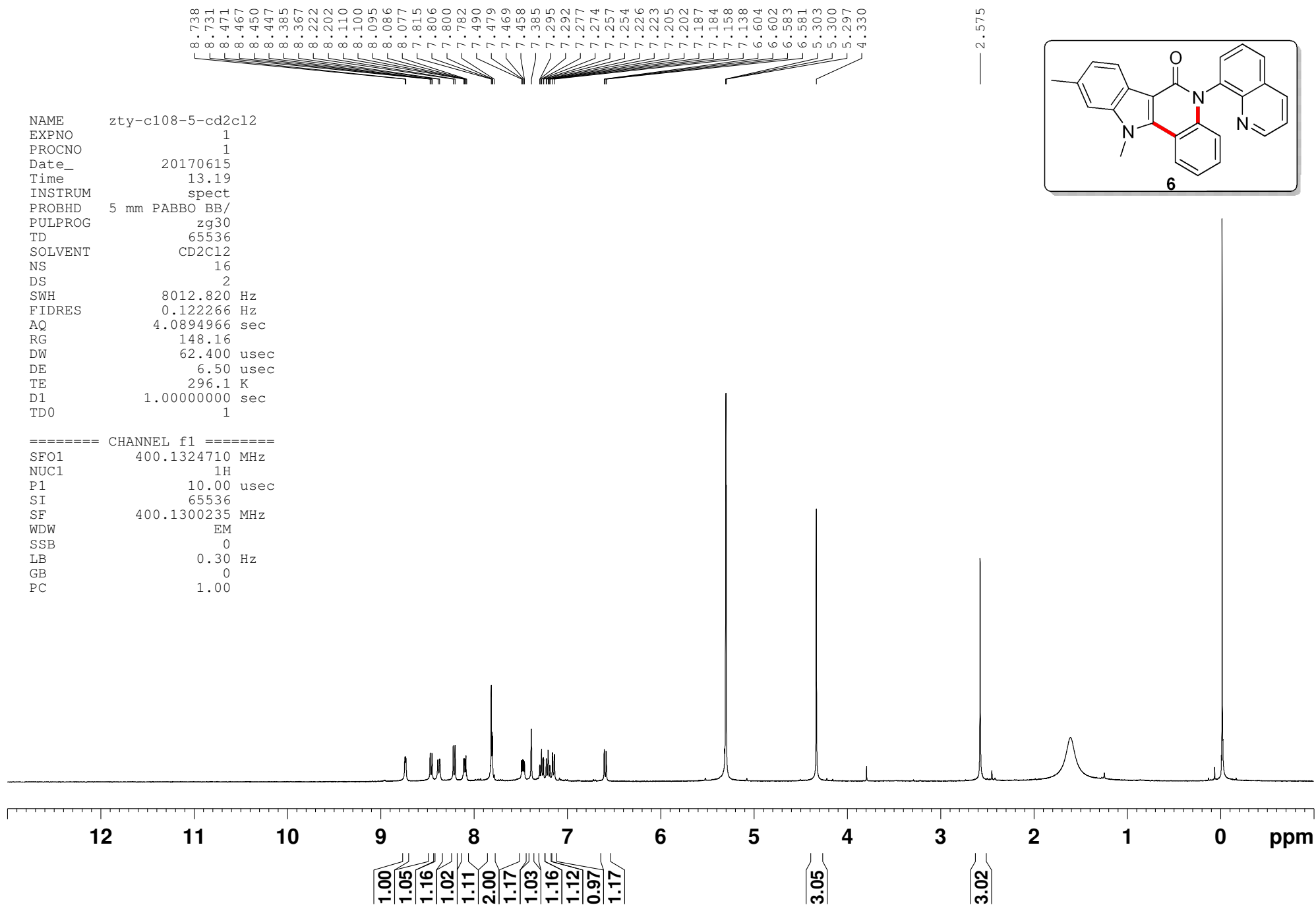
160.38
 151.54
 145.23
 141.45
 140.40
 138.72
 136.93
 136.74
 131.82
 131.69
 130.22
 129.65
 128.61
 127.17
 126.30
 124.92
 123.26
 122.31
 121.91
 121.79
 117.71
 114.65
 109.28
 107.65

54.38
 54.11
 53.84
 53.57
 53.30

34.07

21.54

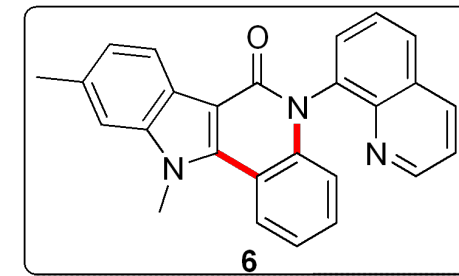
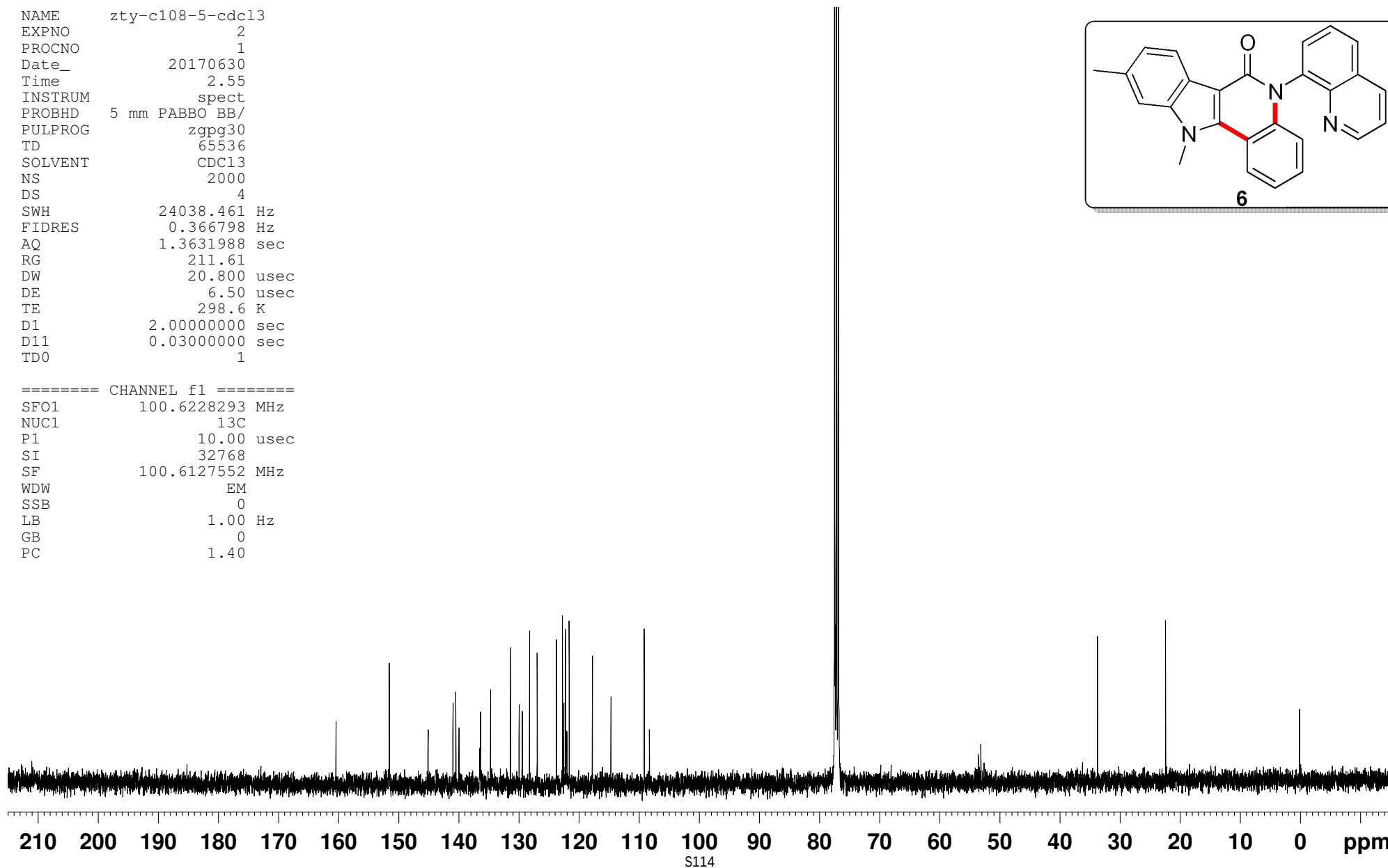


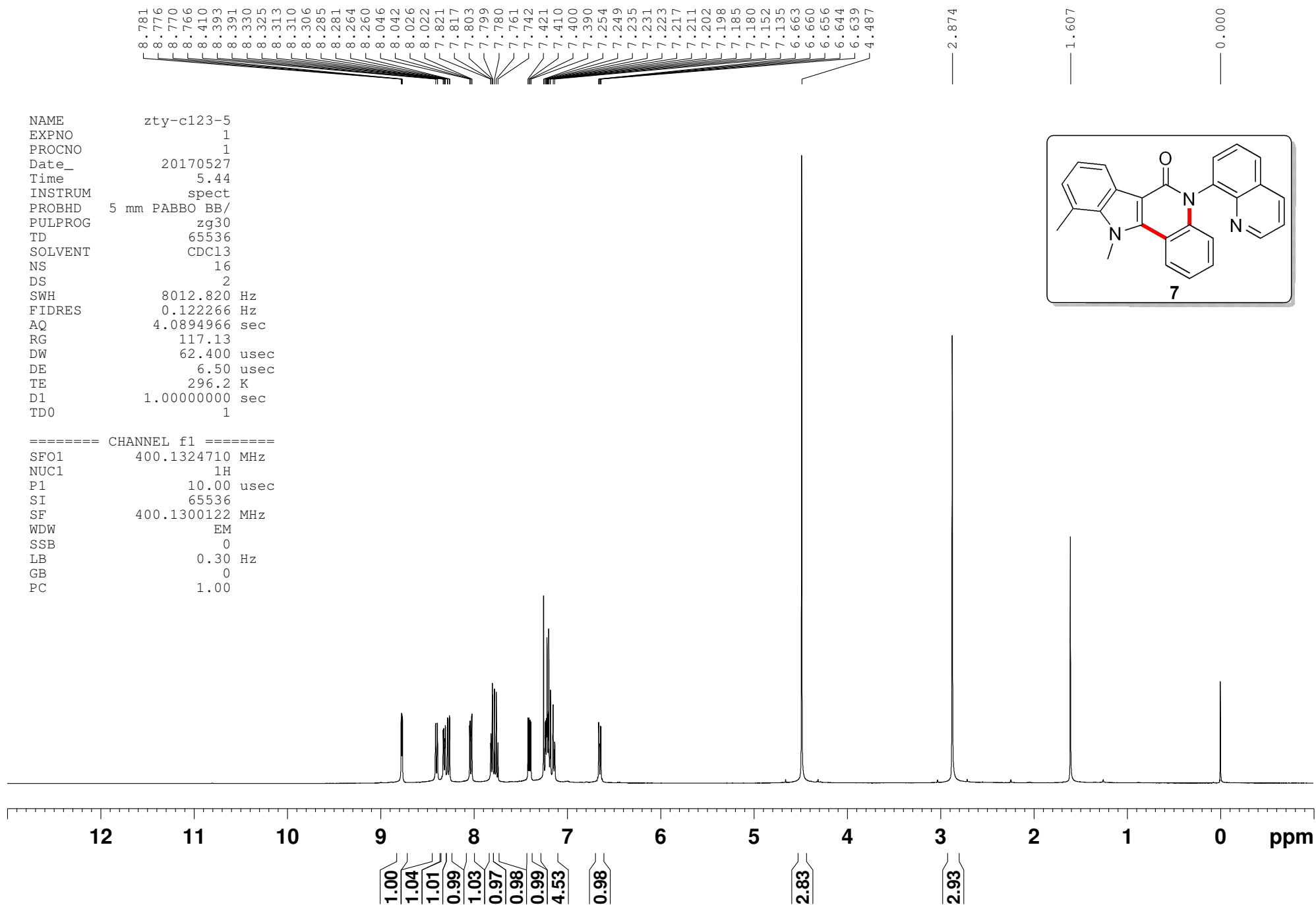


NAME zty-c108-5-cdcl3
 EXPNO 2
 PROCNO 1
 Date_ 20170630
 Time 2.55
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 2000
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 298.6 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127552 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

160.45
 151.57
 145.13
 140.99
 140.51
 139.98
 136.53
 136.41
 134.72
 131.40
 129.98
 129.45
 128.24
 126.98
 123.77
 122.76
 122.54
 122.25
 122.04
 121.64
 117.78
 114.70
 109.16
 108.30





NAME zty-c123-5
EXPNO 2
PROCNO 1
Date_ 20170527
Time 6.13
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 500
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 296.9 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

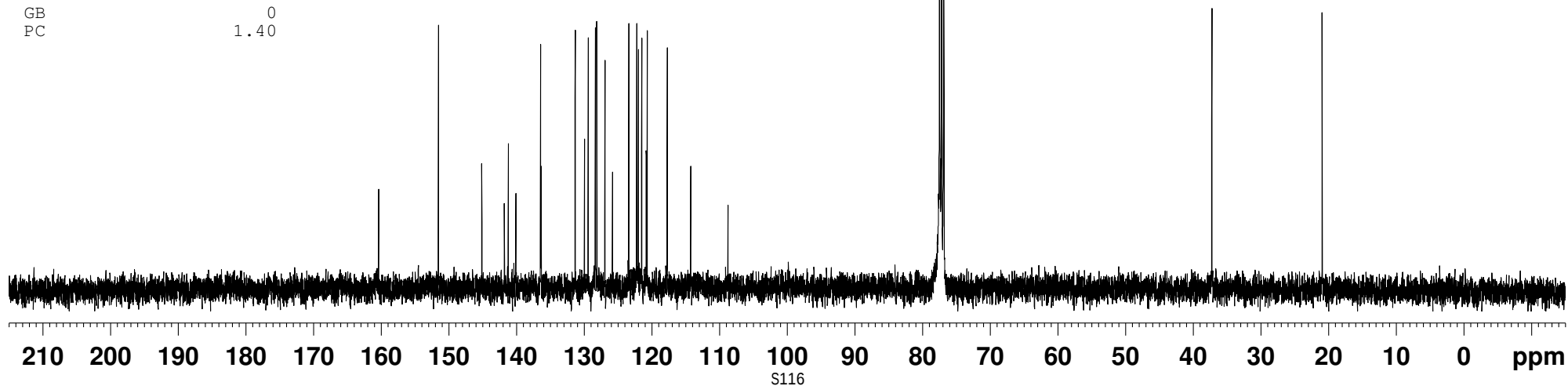
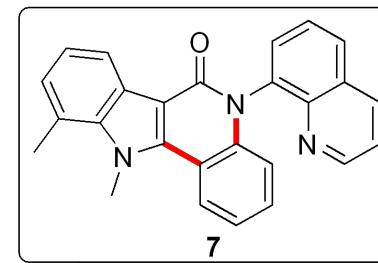
===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127572 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

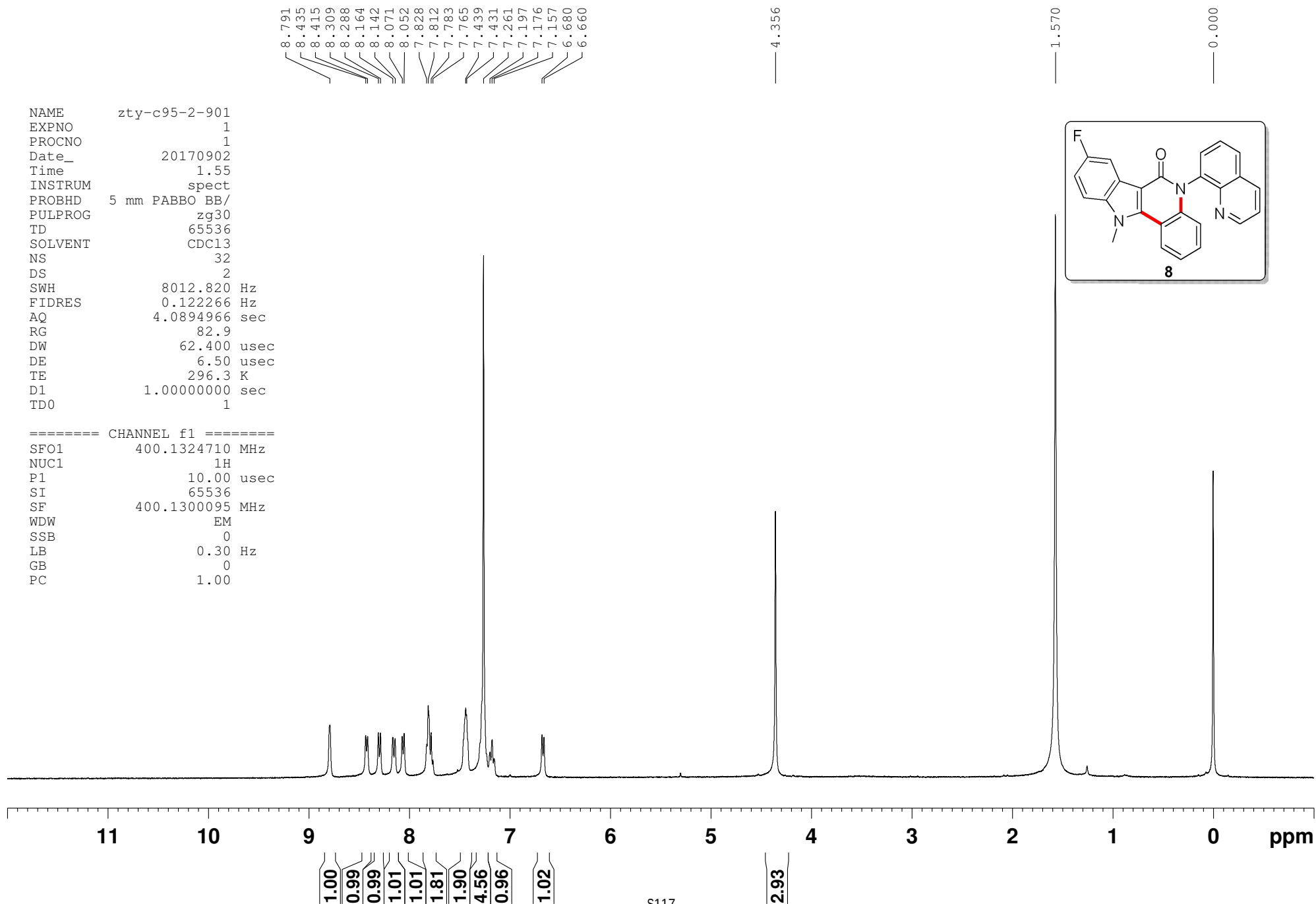
160.37
151.55
145.13
141.81
141.23
140.11
136.45
136.37
131.34
129.96
129.42
128.36
128.14
126.94
125.82
123.40
122.24
122.00
121.51
120.84
120.70
117.74
114.27
108.75

77.48
77.16
76.84

37.24

20.94





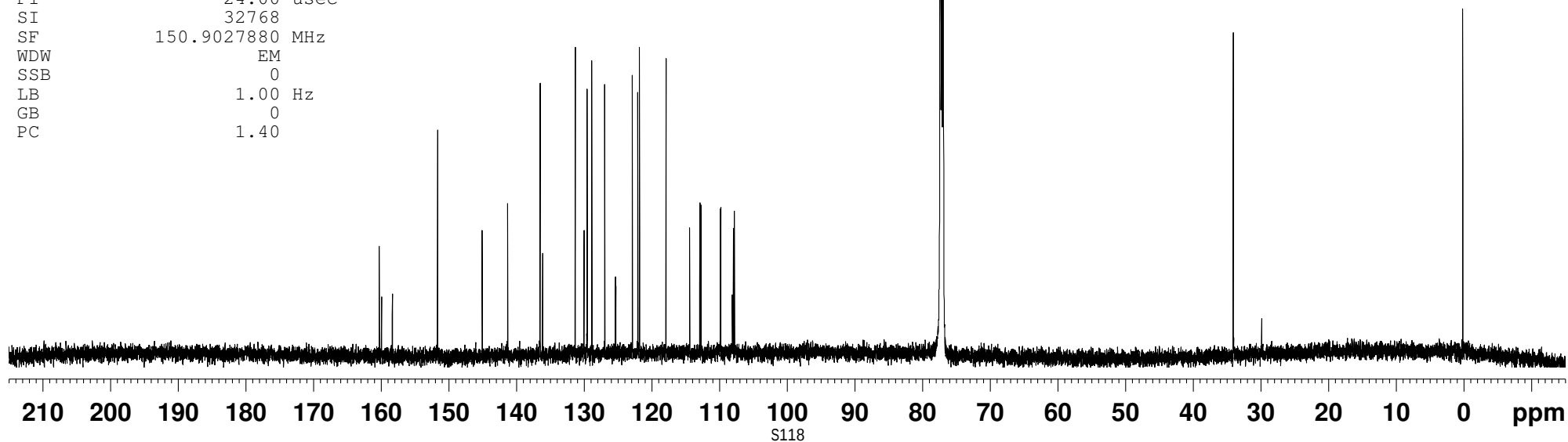
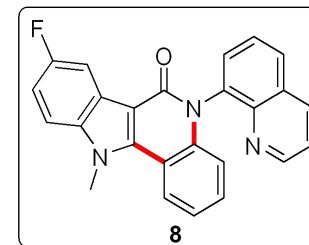
NAME 31
EXPNO 31
PROCNO 1
Date_ 20170929
Time 12.04
INSTRUM spect
PROBHD 5 mm CPTCI 1H-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 2614
DS 4
SWH 36057.691 Hz
FIDRES 0.550197 Hz
AQ 0.9088159 sec
RG 190.89
DW 13.867 usec
DE 18.00 usec
TE 298.0 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

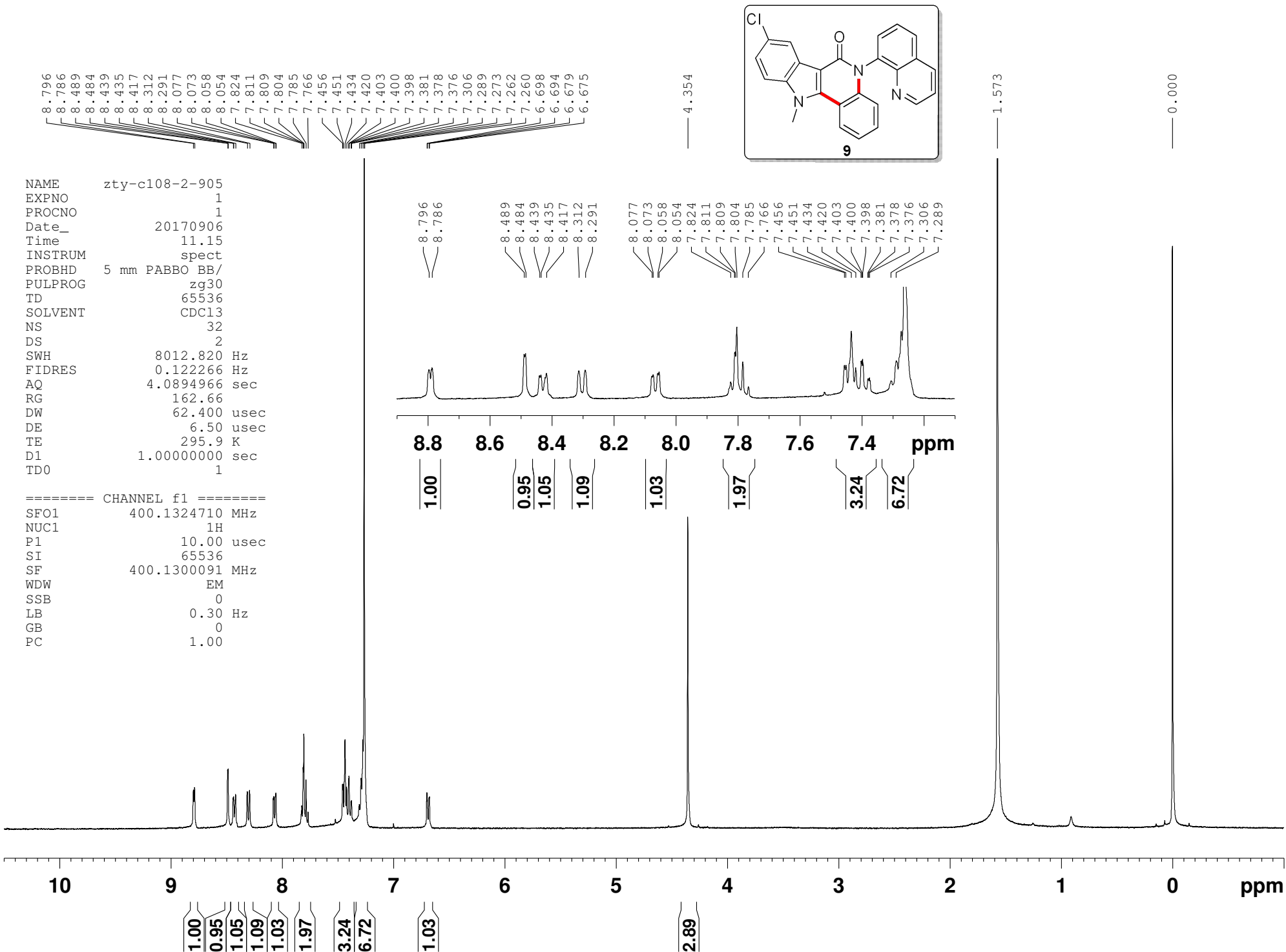
===== CHANNEL f1 =====
SFO1 150.9178981 MHz
NUC1 13C
P1 24.00 usec
SI 32768
SF 150.9027880 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

160.30
159.94
158.36
151.66
145.08
141.33
136.52
136.50
136.13
131.32
130.01
129.57
128.88
126.98
125.40
125.33
122.90
122.09
121.83
117.91
114.43
112.92
112.74
109.88
109.81
108.14
108.11
107.97
107.81

77.37
77.16
76.95

34.08





```

NAME          41
EXPNO         41
PROCNO        1
Date_         20170928
Time          13.29
INSTRUM       spect
PROBHD        5 mm CPTCI 1H-
PULPROG       zgpg30
TD            65536
SOLVENT       CDC13
NS            4000
DS            4
SWH           36057.691 Hz
FIDRES        0.550197 Hz
AQ            0.9088159 sec
RG            190.89
DW            13.867 usec
DE            18.00 usec
TE            298.0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0           1

```

```

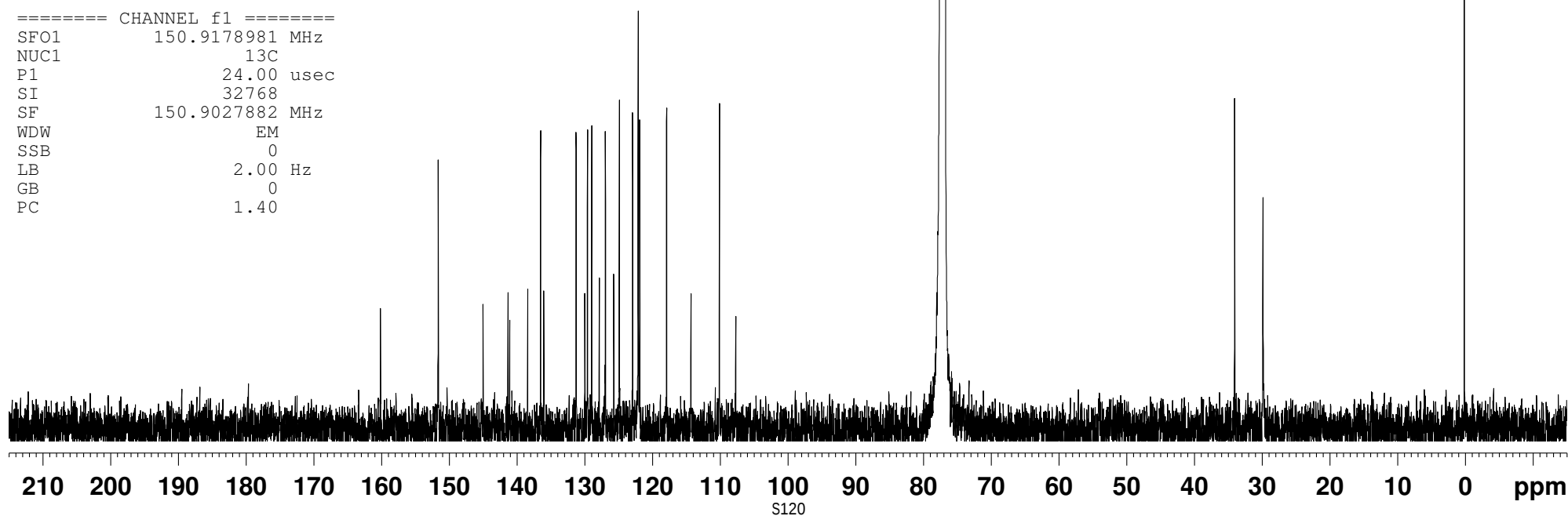
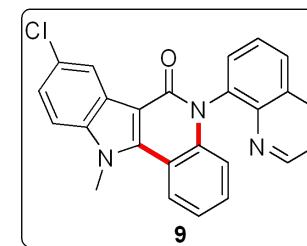
===== CHANNEL f1 =====
SF01          150.9178981 MHz
NUC1           13C
P1            24.00 usec
SI            32768
SF            150.9027882 MHz
WDW           EM
SSB           0
LB            2.00 Hz
GB            0
PC            1.40

```

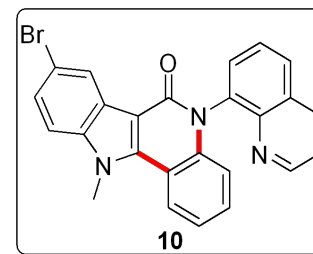
160.19
 151.65
 145.04
 141.34
 141.09
 138.42
 136.54
 136.07
 131.28
 130.00
 129.61
 128.99
 127.86
 126.96
 125.73
 124.90
 122.94
 122.12
 121.90
 117.93
 114.33
 110.12
 107.72

77.37
 77.16
 76.95

34.05
 29.86

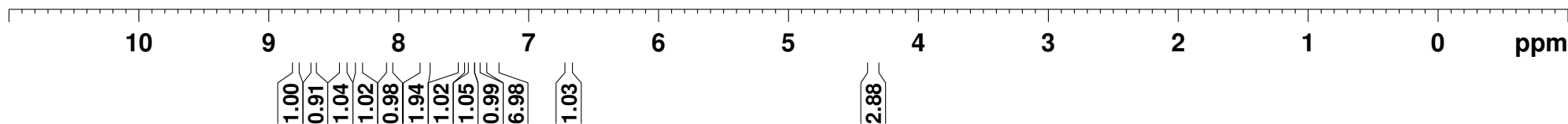
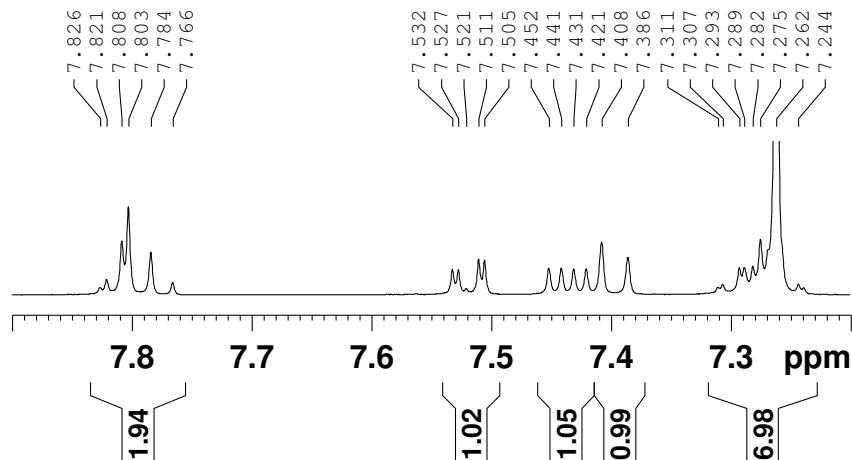


8.788
8.784
8.654
8.650
8.437
8.431
8.420
8.417
8.413
8.315
8.311
8.294
8.290
8.079
8.074
8.060
8.055
7.826
7.821
7.808
7.803
7.784
7.766
7.532
7.527
7.521
7.511
7.505
7.452
7.441
7.431
7.421
7.408
7.386
7.311
7.307
7.293
7.289
7.282
7.275
7.262
7.244
7.239
6.705
6.702
6.698
6.681
4.347



NAME zty-c123-1-901
EXPNO 1
PROCNO 1
Date_ 20170902
Time 2.20
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 32
DS 2
SWH 8012.820 Hz
FIDRES 0.122266 Hz
AQ 4.0894966 sec
RG 93.15
DW 62.400 usec
DE 6.50 usec
TE 296.3 K
D1 1.00000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 400.1324710 MHz
NUC1 1H
P1 10.00 usec
SI 65536
SF 400.1300090 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00



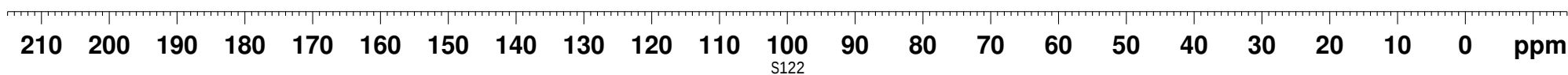
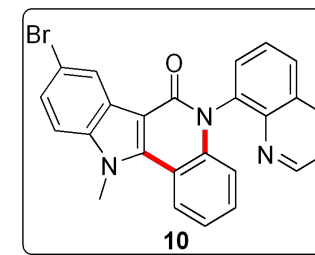
NAME 5Brproduct
 EXPNO 11
 PROCNO 1
 Date_ 20170928
 Time 13.12
 INSTRUM spect
 PROBHD 5 mm CPTCI 1H-
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 1930
 DS 4
 SWH 36057.691 Hz
 FIDRES 0.550197 Hz
 AQ 0.9088159 sec
 RG 190.89
 DW 13.867 usec
 DE 18.00 usec
 TE 298.0 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

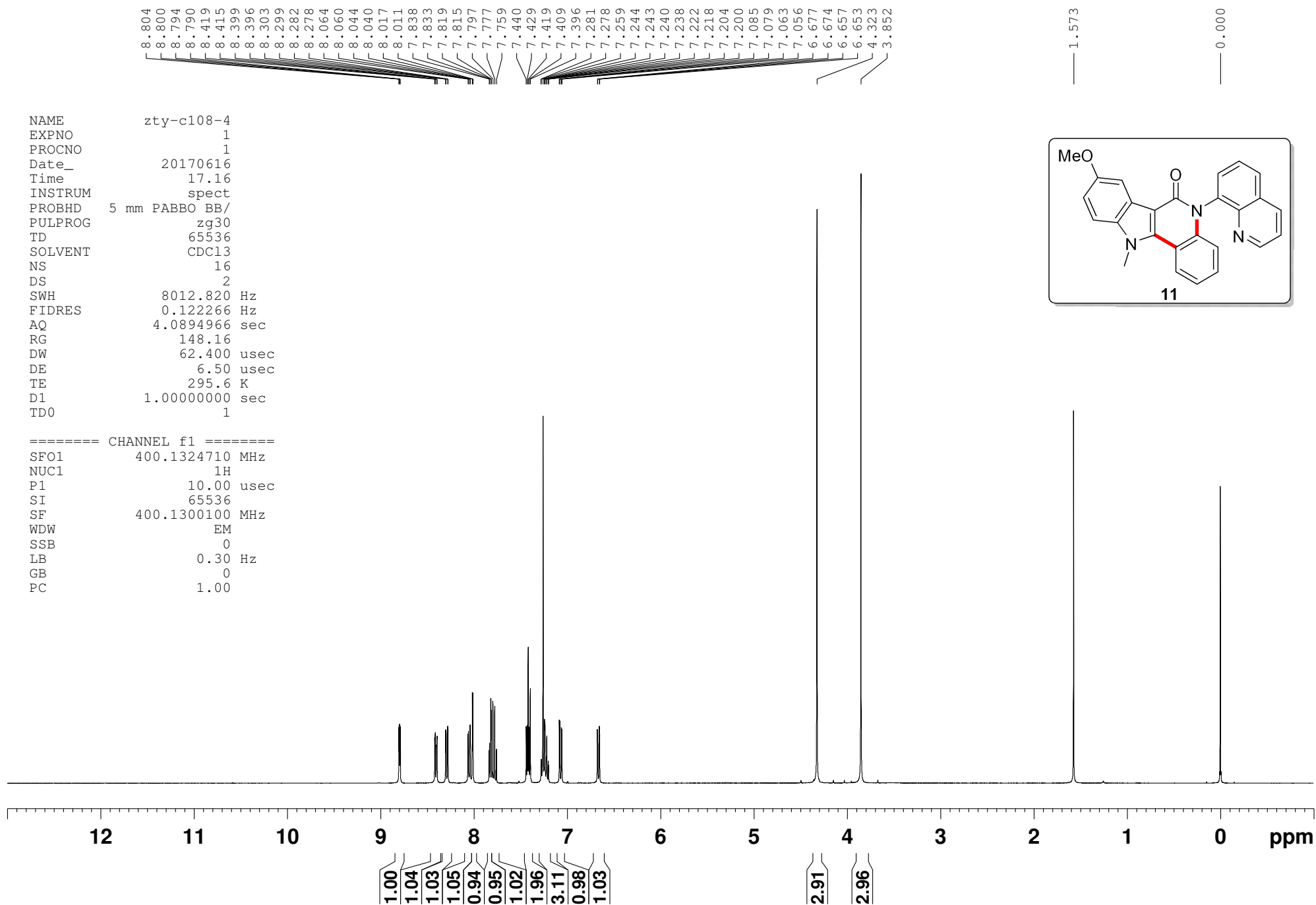
===== CHANNEL f1 =====
 SF01 150.9178981 MHz
 NUC1 13C
 P1 24.00 usec
 SI 32768
 SF 150.9027880 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

160.16
 151.66
 145.05
 141.36
 140.94
 138.74
 136.51
 136.07
 131.25
 129.99
 129.60
 129.01
 127.49
 126.95
 126.27
 125.19
 122.97
 122.09
 121.92
 117.94
 115.44
 114.29
 110.55
 107.61

77.37
 77.16
 76.95

34.03





NAME zty-c108-4-C
 EXPNO 2
 PROCNO 1
 Date_ 20170618
 Time 5.51
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 2000
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 296.6 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

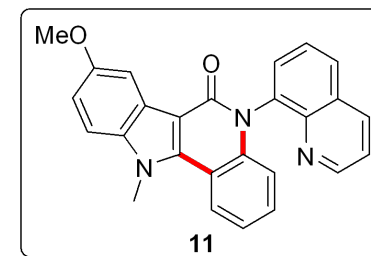
===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127556 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

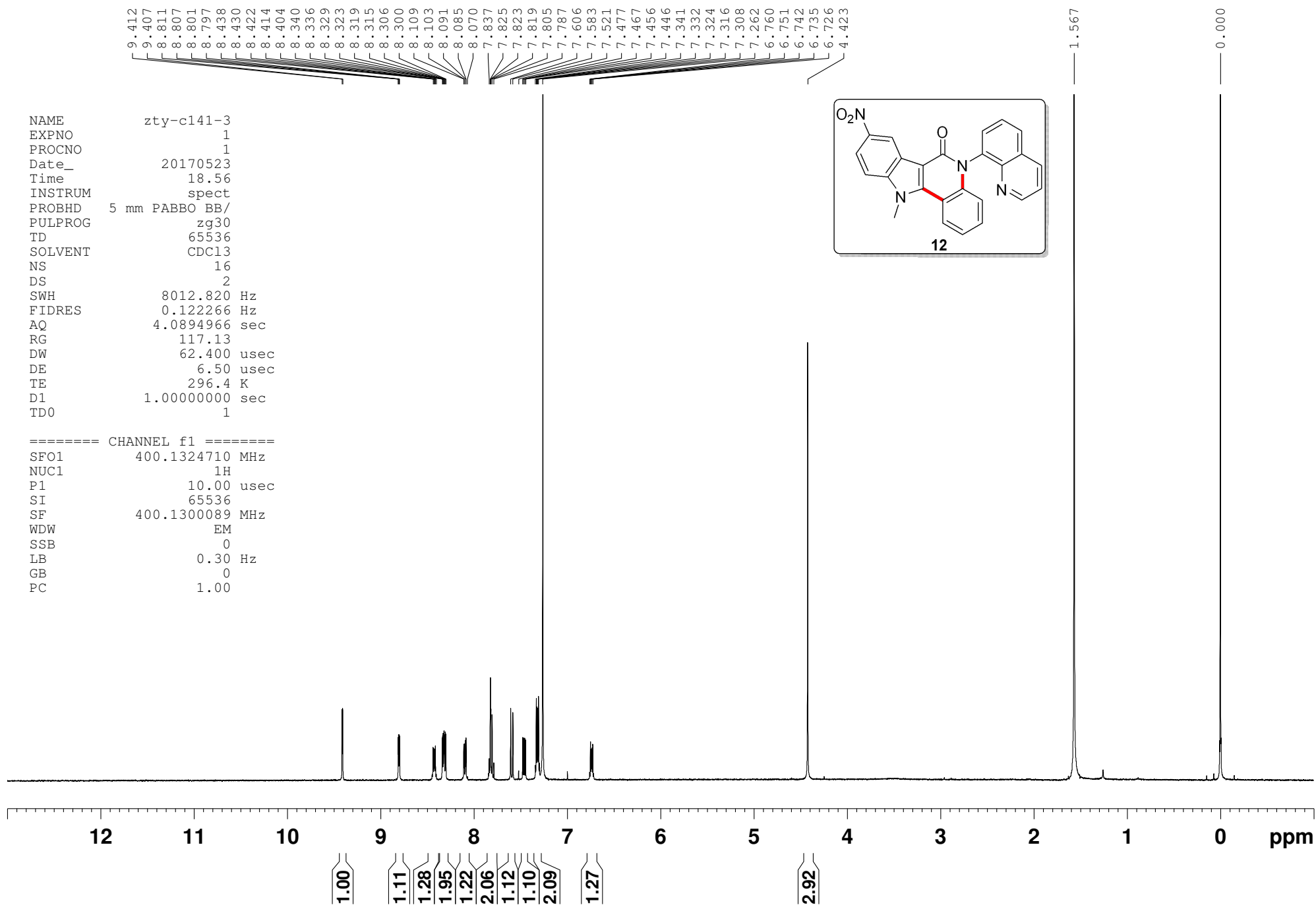
160.70
 155.78
 151.65
 145.16
 141.03
 140.22
 136.46
 136.34
 134.92
 131.36
 129.98
 128.40
 126.96
 125.36
 122.77
 122.05
 121.73
 117.82
 115.34
 114.74
 109.98
 107.92
 103.21

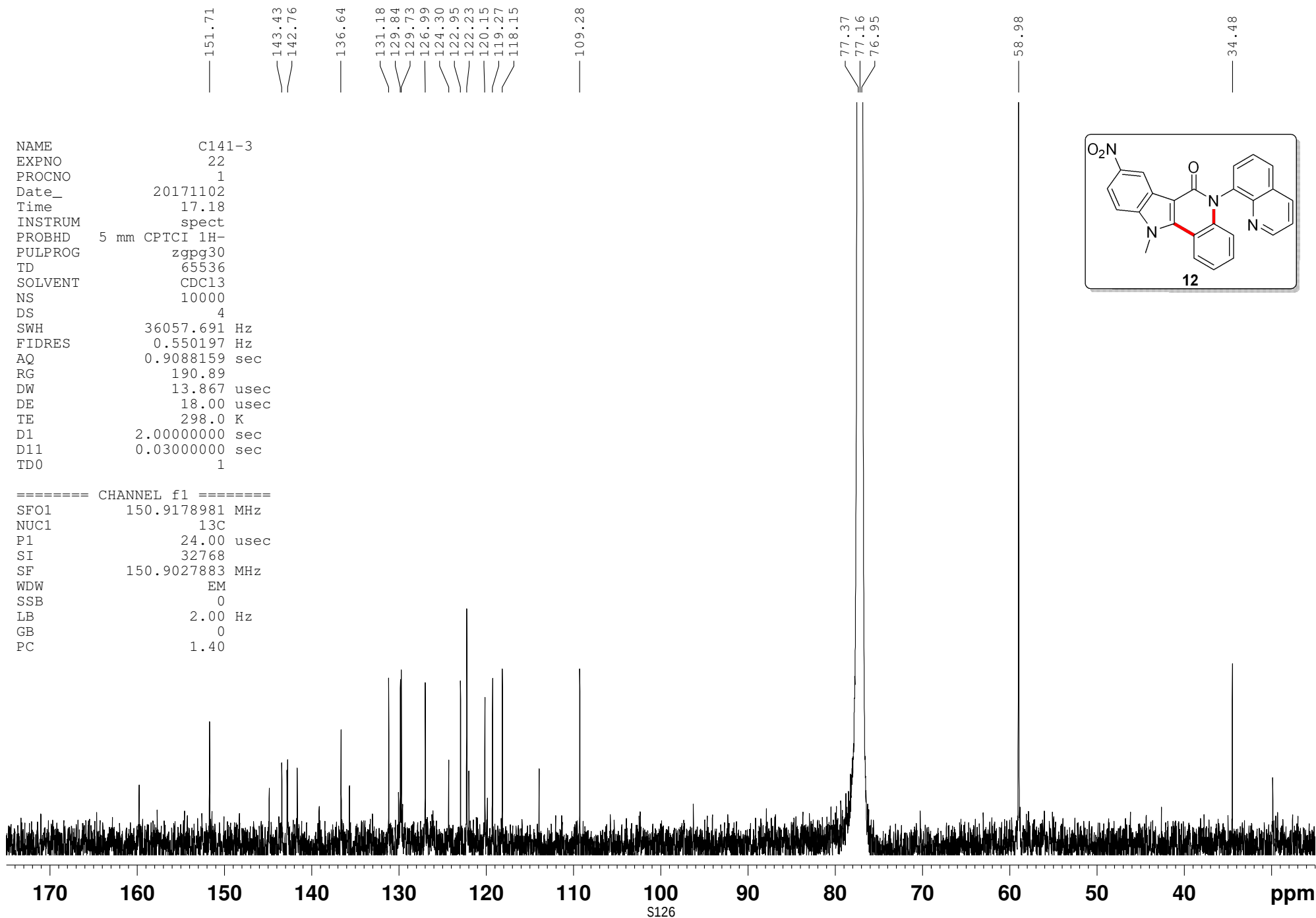
77.48
 77.16
 76.84

55.78

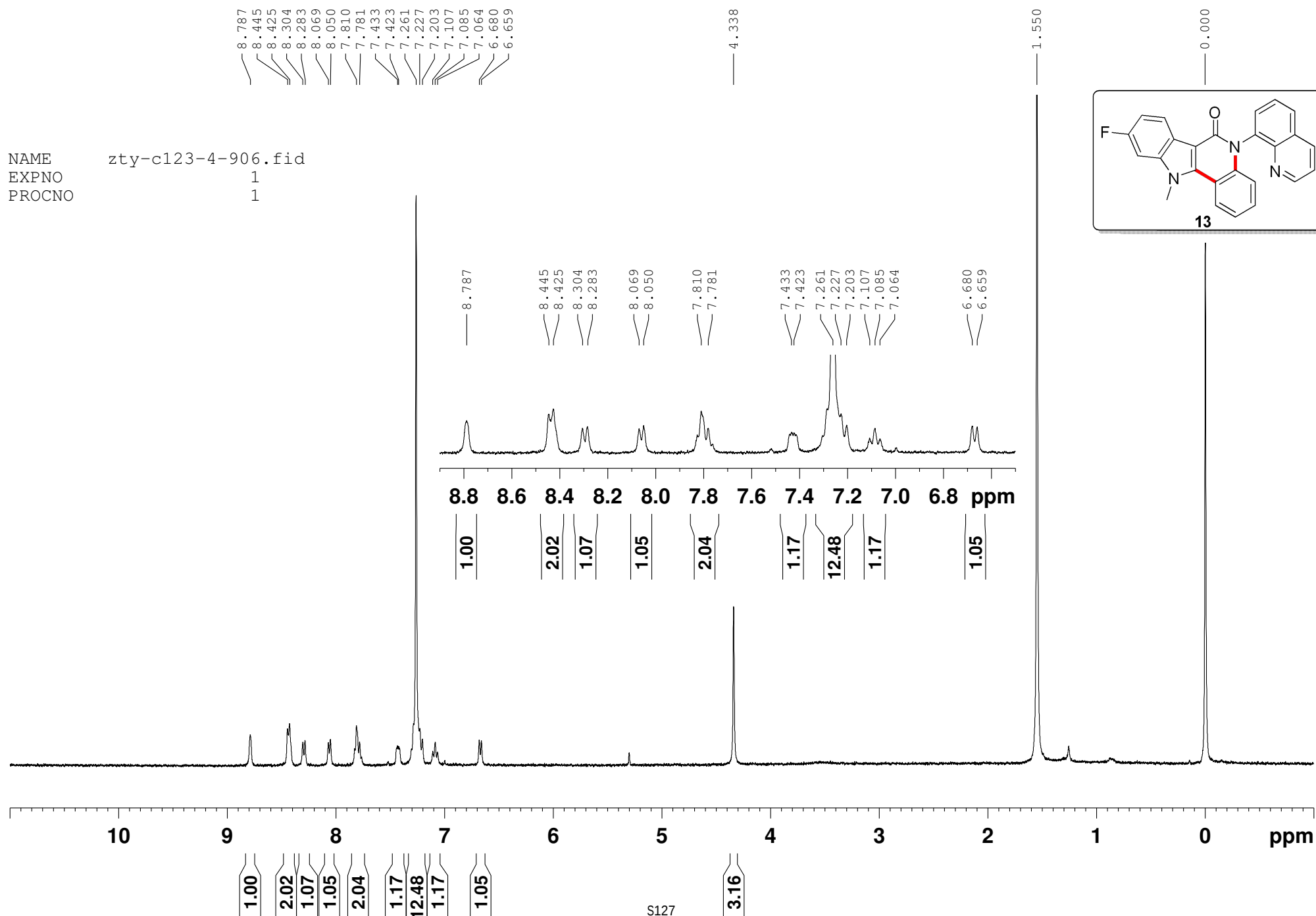
33.92

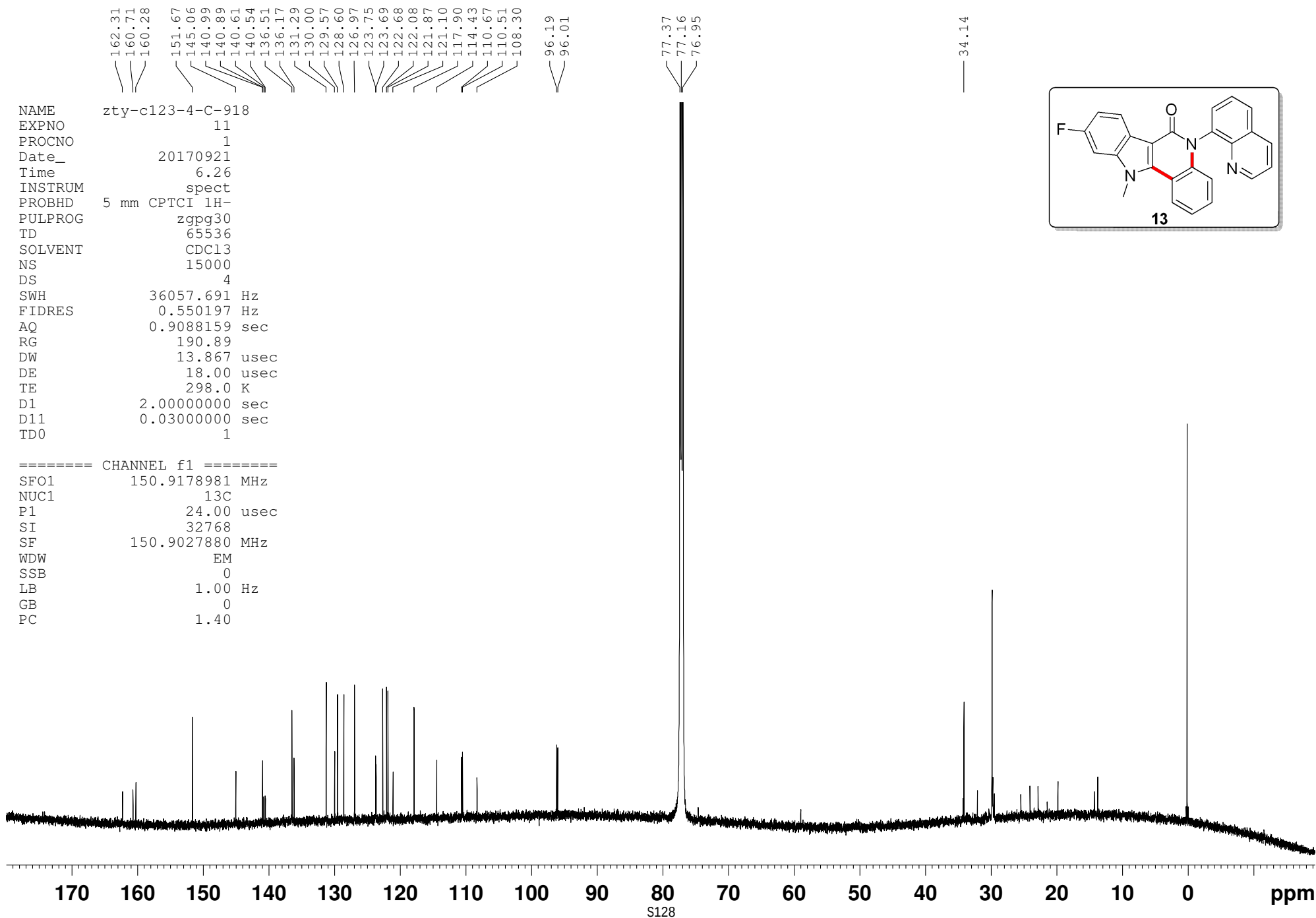


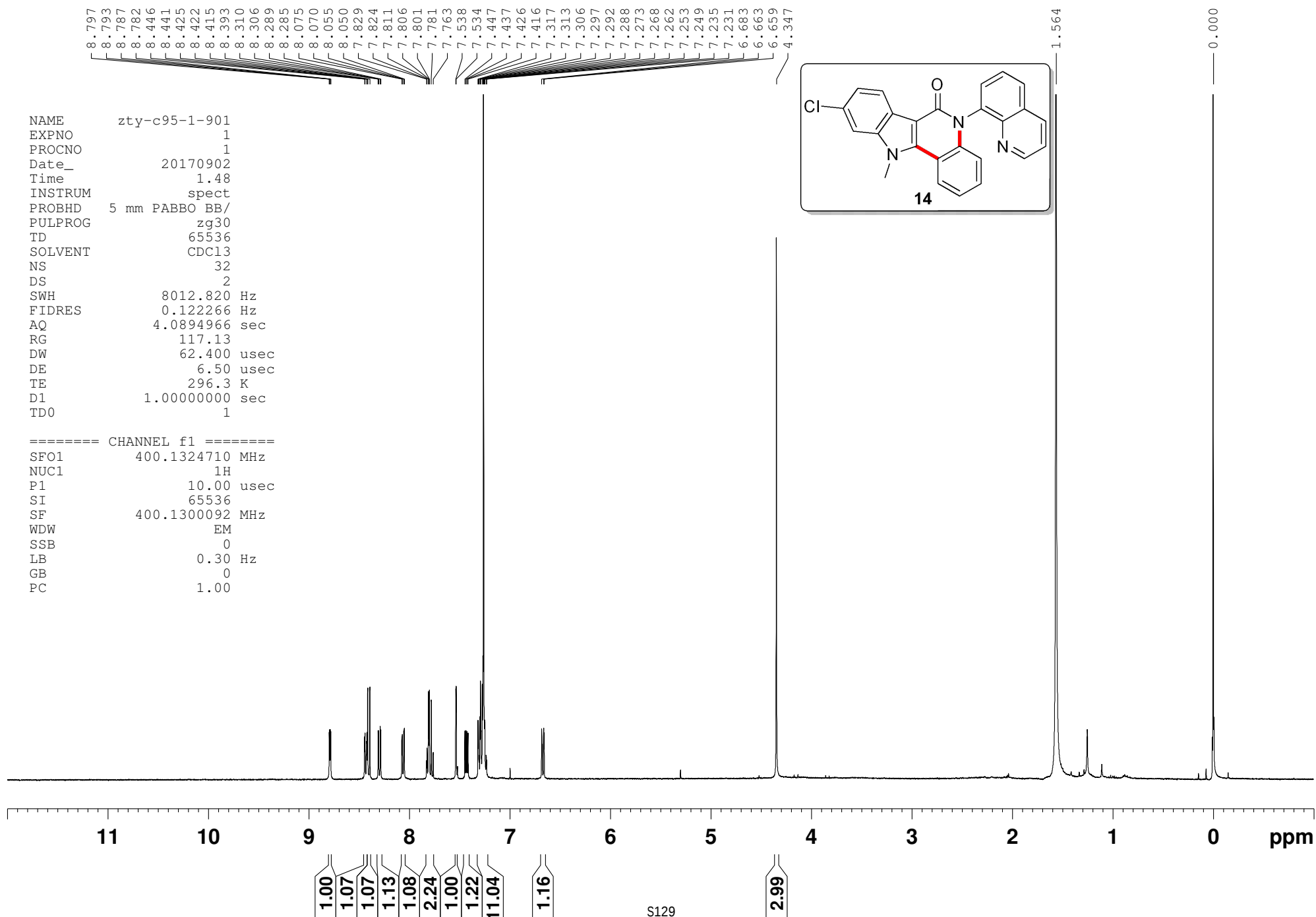




NAME zty-c123-4-906.fid
EXPNO 1
PROCNO 1







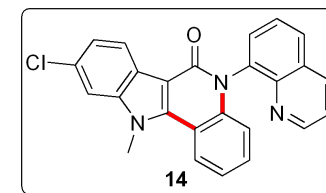
NAME ZTY-C95-1-901-8h
 EXPNO 1
 PROCNO 1
 Date_ 20170915
 Time 11.53
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 8000
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 296.0 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127551 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

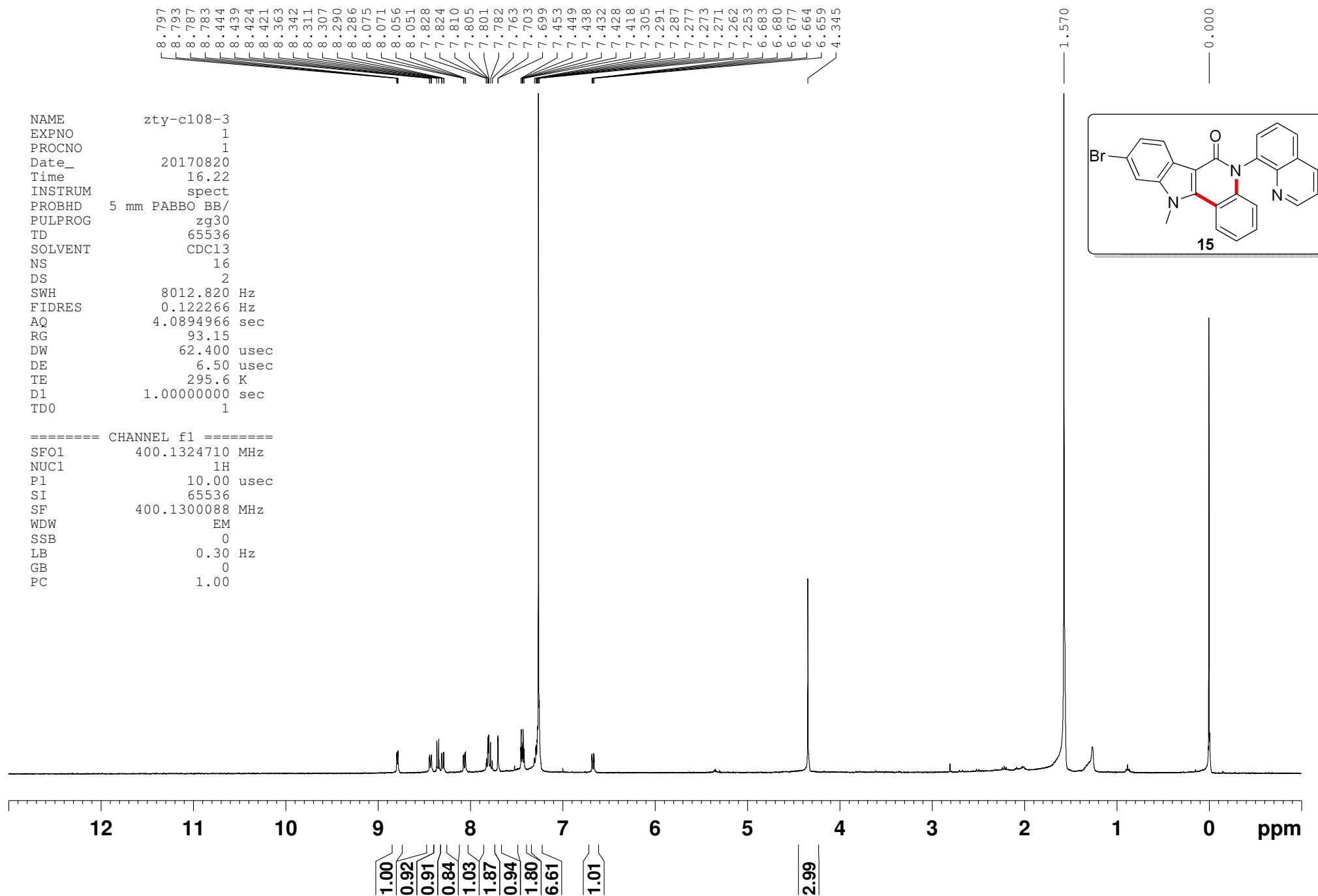
160.23
 151.69
 145.03
 141.24
 140.92
 140.59
 136.53
 136.09
 131.28
 130.62
 130.01
 129.60
 128.87
 126.97
 123.49
 123.31
 122.86
 122.78
 122.10
 121.92
 117.94
 114.32
 109.40

77.48
 77.16
 76.84

34.04



210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm
 S130



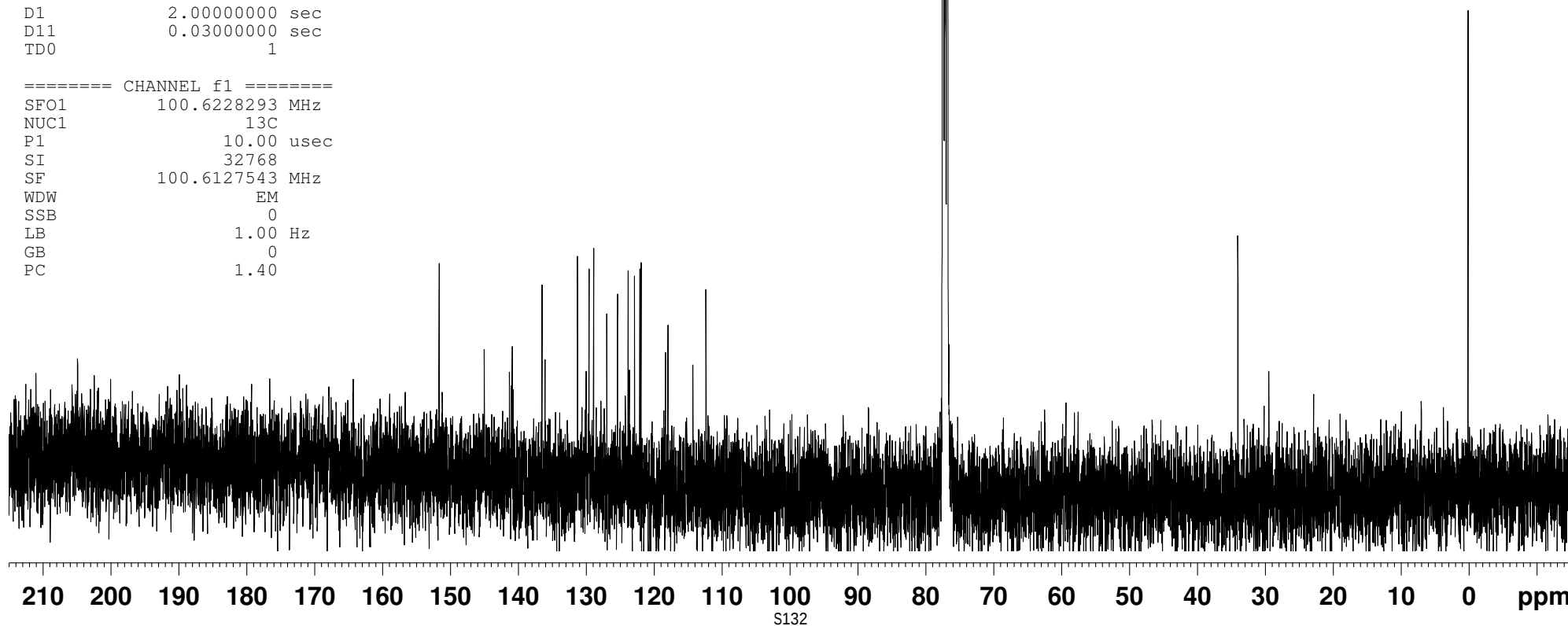
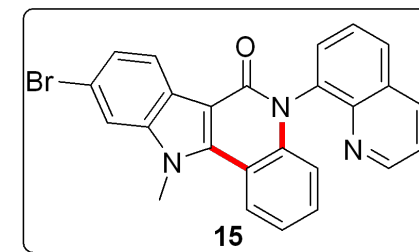
NAME zty-c108-3-c
EXPNO 1
PROCNO 1
Date_ 20170823
Time 0.34
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 4000
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 298.0 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

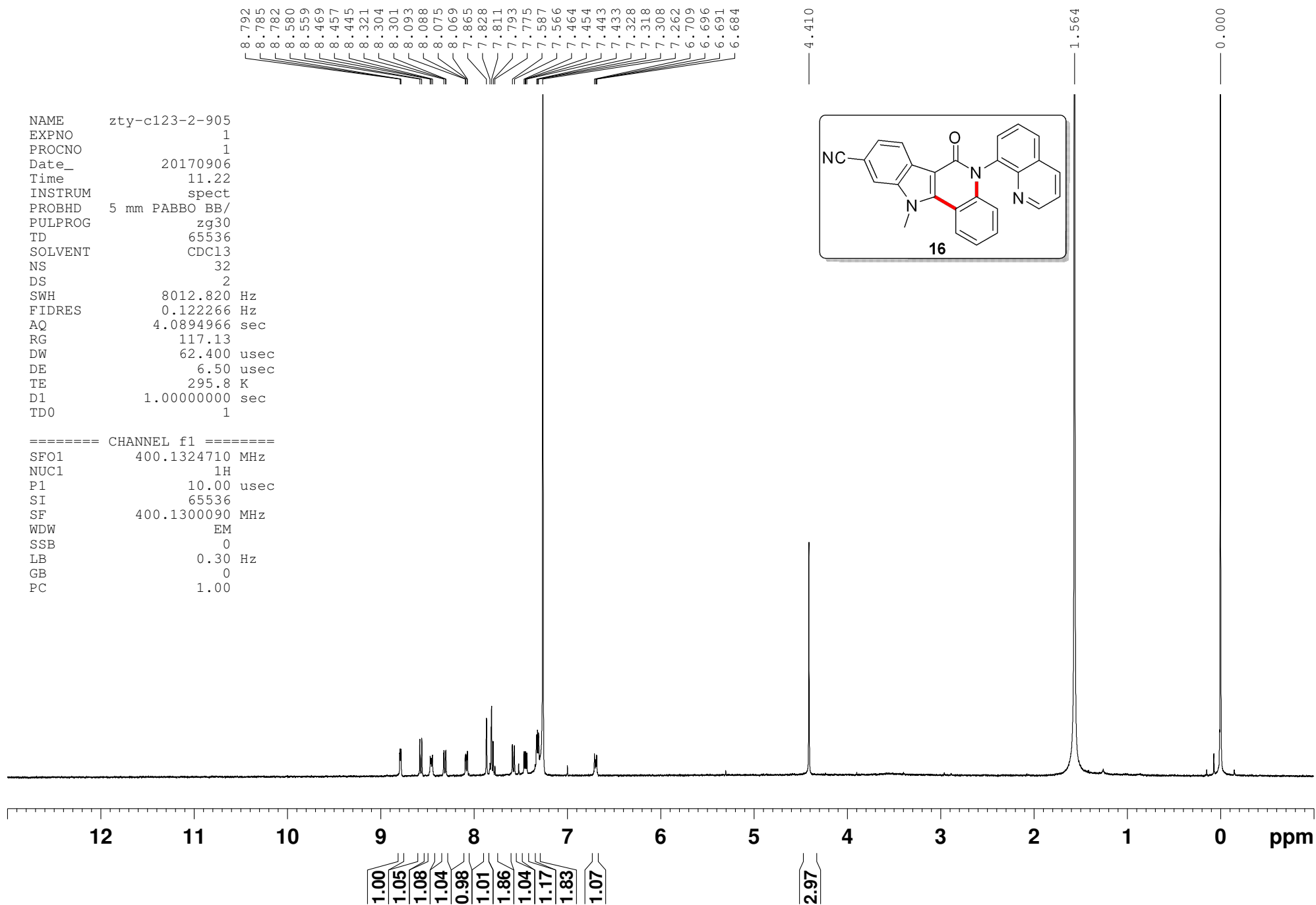
===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127543 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

151.69
145.03
141.32
140.90
136.53
136.09
131.29
130.01
129.61
128.92
126.98
125.41
123.82
123.68
122.90
122.10
121.93
118.35
117.96
114.29
112.37

77.48
77.16
76.84

34.03





```

NAME                21
EXPNO               21
PROCNO              1
Date_              20170928
Time               17.56
INSTRUM             spect
PROBHD             5 mm CPTCI 1H-
PULPROG             zgpg30
TD                 65536
SOLVENT             CDC13
NS                 18426
DS                  4
SWH                36057.691 Hz
FIDRES             0.550197 Hz
AQ                 0.9088159 sec
RG                 190.89
DW                 13.867 usec
DE                 18.00 usec
TE                 298.0 K
D1                 2.00000000 sec
D11                 0.03000000 sec
TD0                 1

```

```

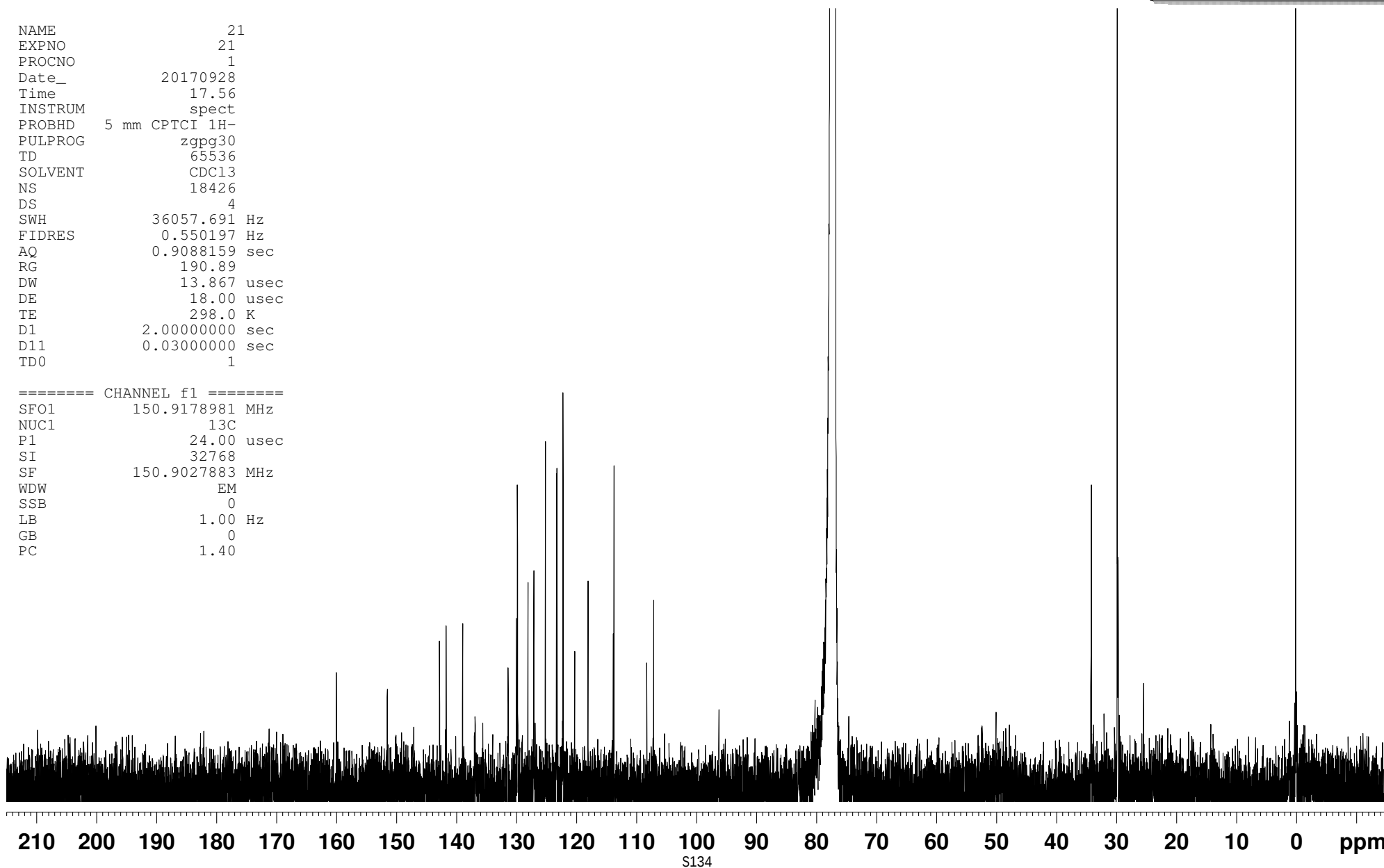
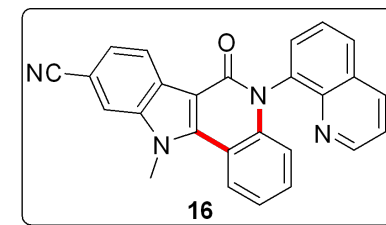
===== CHANNEL f1 =====
SFO1             150.9178981 MHz
NUC1              13C
P1                24.00 usec
SI                32768
SF               150.9027883 MHz
WDW               EM
SSB               0
LB                1.00 Hz
GB                0
PC                1.40

```

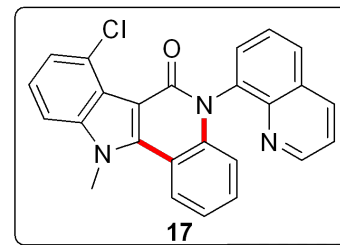
160.04
 151.55
 142.85
 141.76
 139.01
 131.41
 130.07
 129.86
 129.82
 128.11
 127.13
 125.20
 123.34
 123.26
 122.26
 120.31
 118.08
 113.90
 113.77
 108.31
 107.15

77.37
 77.16
 76.95

34.19
 29.87

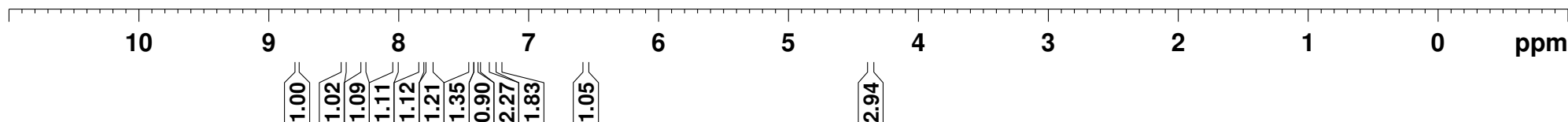
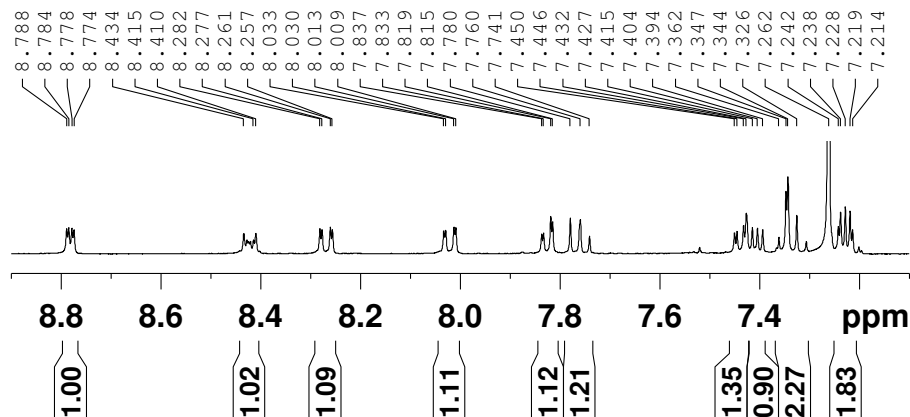


8.784
8.778
8.774
8.434
8.428
8.425
8.421
8.415
8.410
8.282
8.277
8.261
8.257
8.033
8.030
8.013
8.009
7.837
7.833
7.819
7.815
7.780
7.760
7.741
7.450
7.446
7.432
7.427
7.415
7.404
7.394
7.362
7.347
7.344
7.326
7.307
7.262
7.242
7.238
7.228
7.219
7.214
6.580
6.572
6.567
6.561
6.557
6.553
6.548
4.364



NAME zty-c108-1-901
EXPNO 1
PROCNO 1
Date_ 20170902
Time 2.03
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT CDC13
NS 32
DS 2
SWH 8012.820 Hz
FIDRES 0.122266 Hz
AQ 4.0894966 sec
RG 117.13
DW 62.400 usec
DE 6.50 usec
TE 296.3 K
D1 1.00000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 400.1324710 MHz
NUC1 1H
P1 10.00 usec
SI 65536
SF 400.1300092 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00



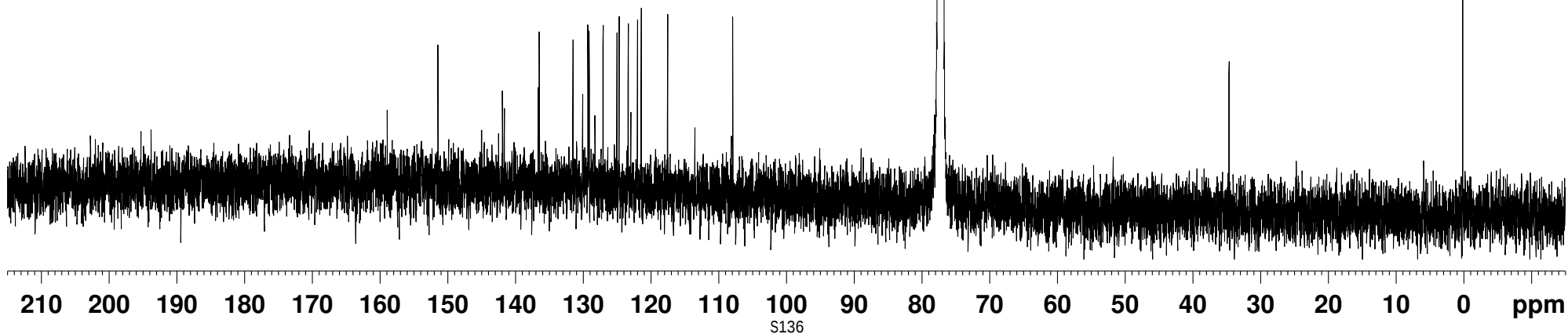
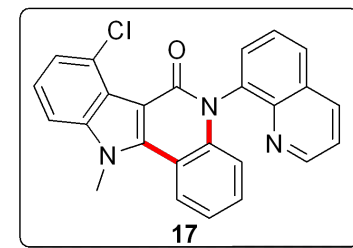
NAME zty-c108-1-901-8h
EXPNO 1
PROCNO 1
Date_ 20170917
Time 9.33
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 8000
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 296.2 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127550 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

158.94
151.46
145.01
141.94
141.67
136.66
136.49
131.50
130.98
130.11
129.31
129.12
128.27
127.08
125.00
124.70
123.36
122.99
121.98
121.45
117.53
113.50
107.92

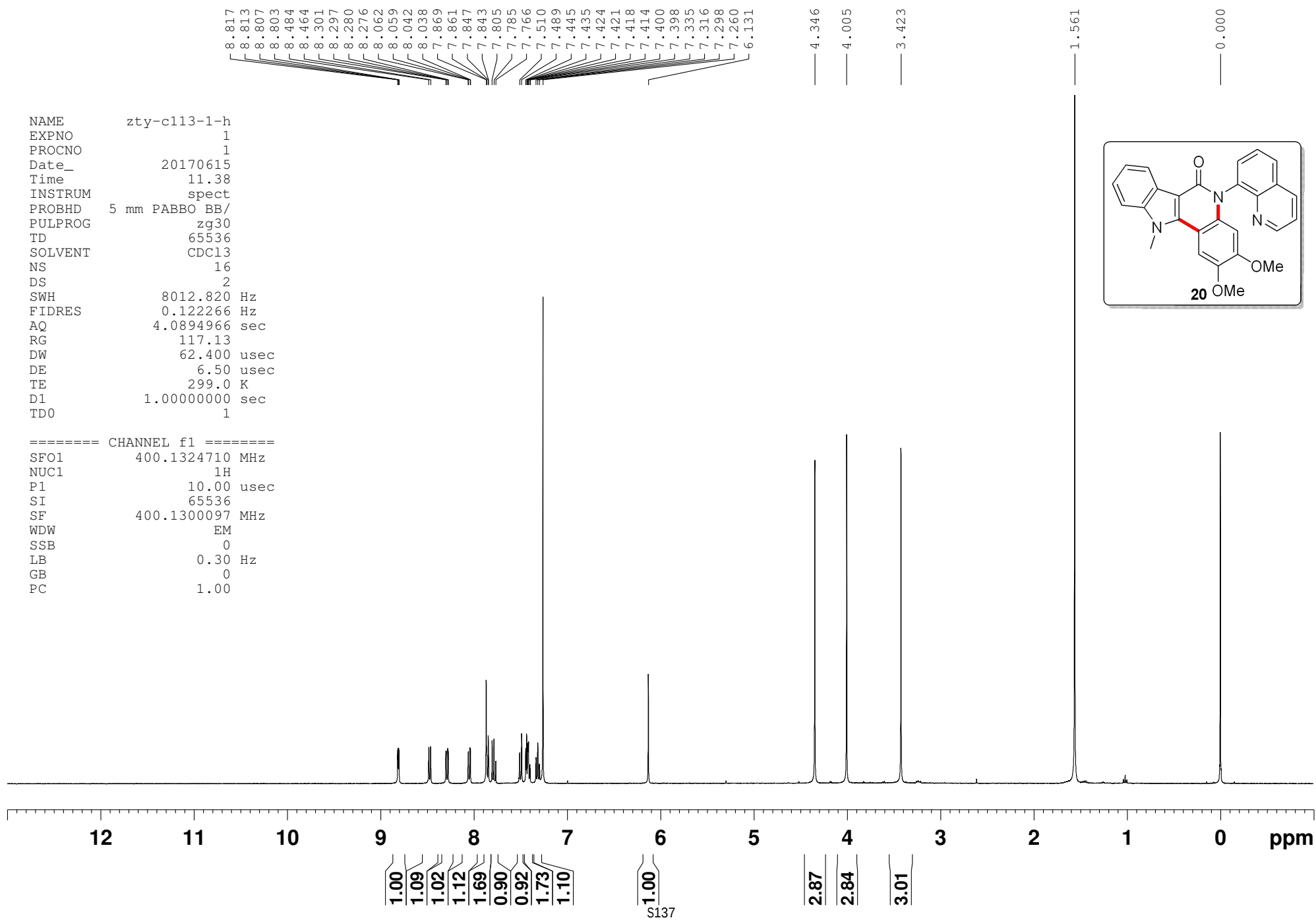
77.48
77.16
76.84

34.65



NAME zty-cl13-1-h
 EXPNO 1
 PROCNO 1
 Date_ 20170615
 Time 11.38
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 8012.820 Hz
 FIDRES 0.122266 Hz
 AQ 4.0894966 sec
 RG 117.13
 DW 62.400 usec
 DE 6.50 usec
 TE 299.0 K
 D1 1.00000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 400.1324710 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 400.1300097 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00



NAME zty-cl113-1-c
 EXPNO 1
 PROCNO 1
 Date_ 20170616
 Time 19.21
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 2000
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 296.6 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

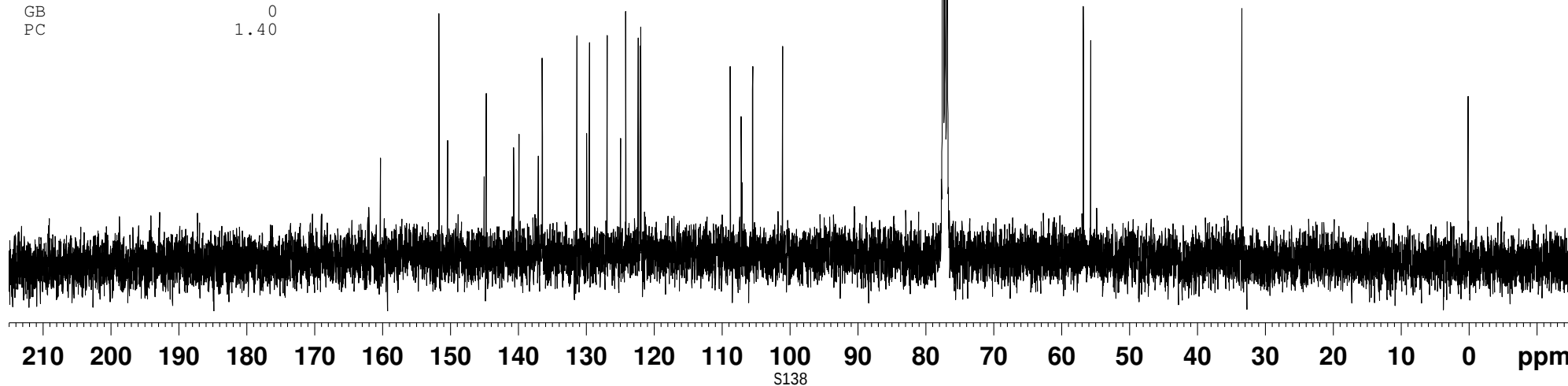
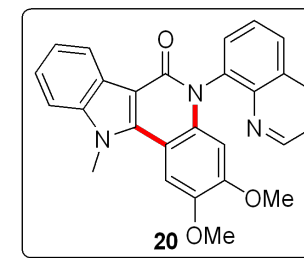
===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127550 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

160.34
 151.70
 150.42
 145.04
 144.76
 140.69
 139.92
 137.08
 136.48
 131.39
 129.93
 129.55
 126.93
 124.97
 124.20
 122.37
 122.06
 121.96
 108.79
 107.18
 107.08
 105.50
 101.10

77.48
 77.16
 76.84

56.78
 55.69

33.46



NAME zty-c113-3-830
 EXPNO 1
 PROCNO 1
 Date_ 20170831
 Time 9.41
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 32
 DS 2
 SWH 8012.820 Hz
 FIDRES 0.122266 Hz
 AQ 4.0894966 sec
 RG 117.13
 DW 62.400 usec
 DE 6.50 usec
 TE 296.0 K
 D1 1.00000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 400.1324710 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 400.1300090 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00

8.803
 8.799
 8.793
 8.789
 8.789
 8.495
 8.475
 8.304
 8.300
 8.283
 8.279
 8.192
 8.062
 8.057
 8.044
 8.038
 7.817
 7.812
 7.799
 7.794
 7.775
 7.757
 7.535
 7.521
 7.514
 7.462
 7.459
 7.444
 7.441
 7.436
 7.425
 7.420
 7.415
 7.404
 7.337
 7.319
 7.300
 7.262
 6.439

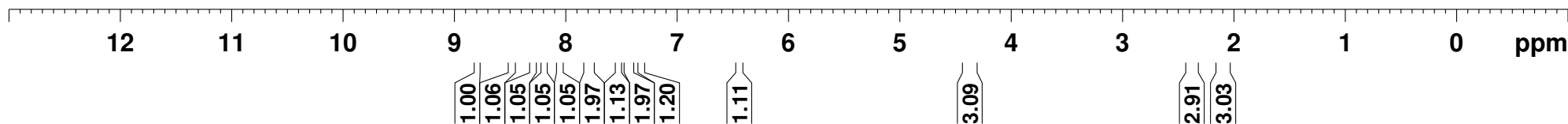
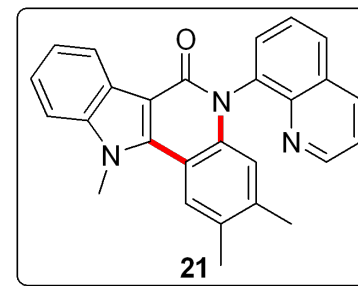
4.374

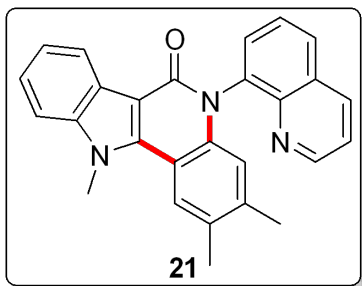
2.378

2.104

1.569

0.000





```

NAME          113-3
EXPNO         11
PROCNO        1
Date_         20171102
Time          5.51
INSTRUM       spect
PROBHD        5 mm CPTCI 1H-
PULPROG       zgpg30
TD            65536
SOLVENT       CDC13
NS            5000
DS            4
SWH           36057.691 Hz
FIDRES        0.550197 Hz
AQ            0.9088159 sec
RG            190.89
DW            13.867 usec
DE            18.00 usec
TE            298.0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0           1

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===== CHANNEL f1 =====
SFO1          150.9178981 MHz
NUC1           13C
P1            24.00 usec
SI            32768
SF            150.9027877 MHz
WDW           EM
SSB           0
LB            2.00 Hz
GB            0
PC            1.40

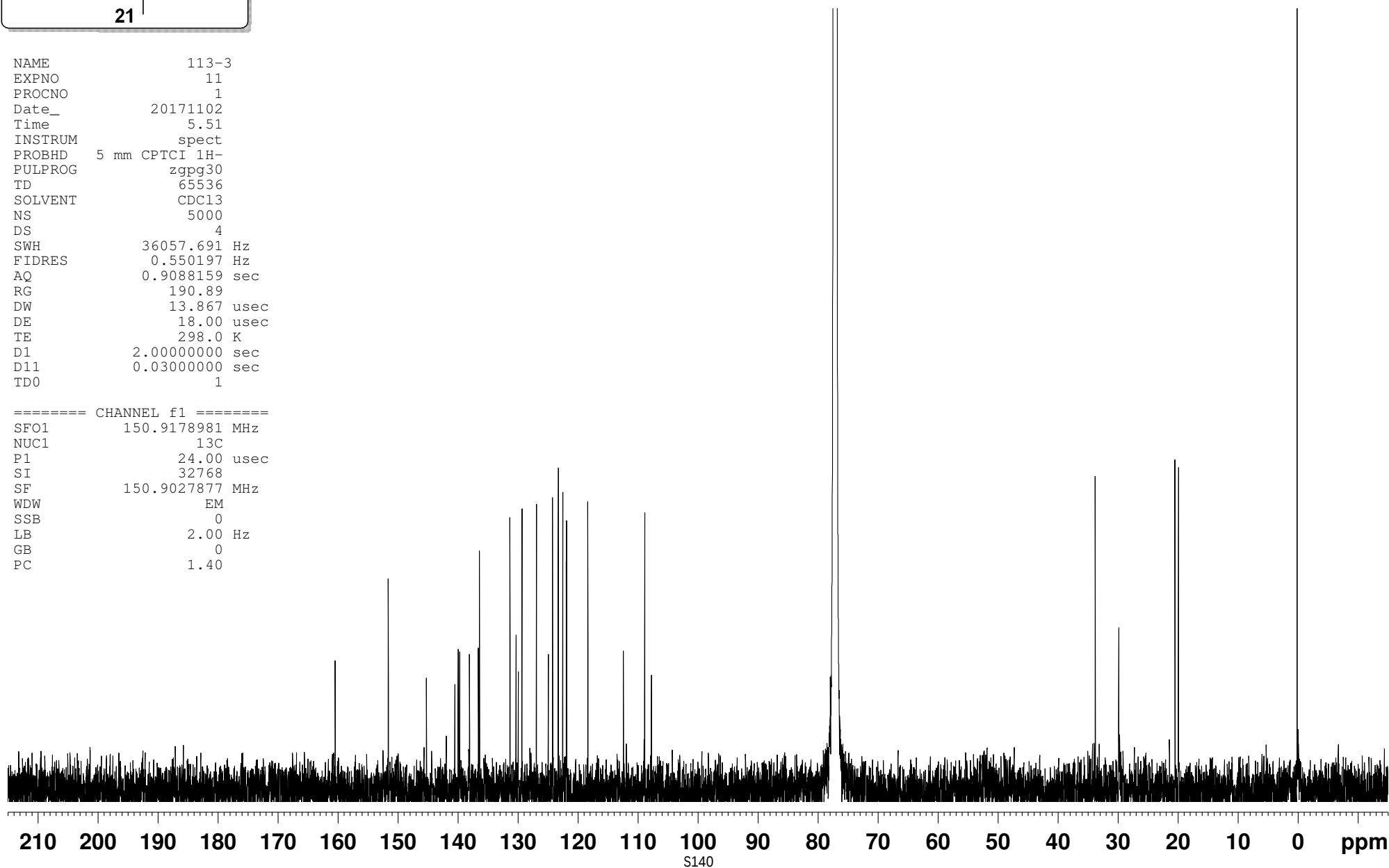
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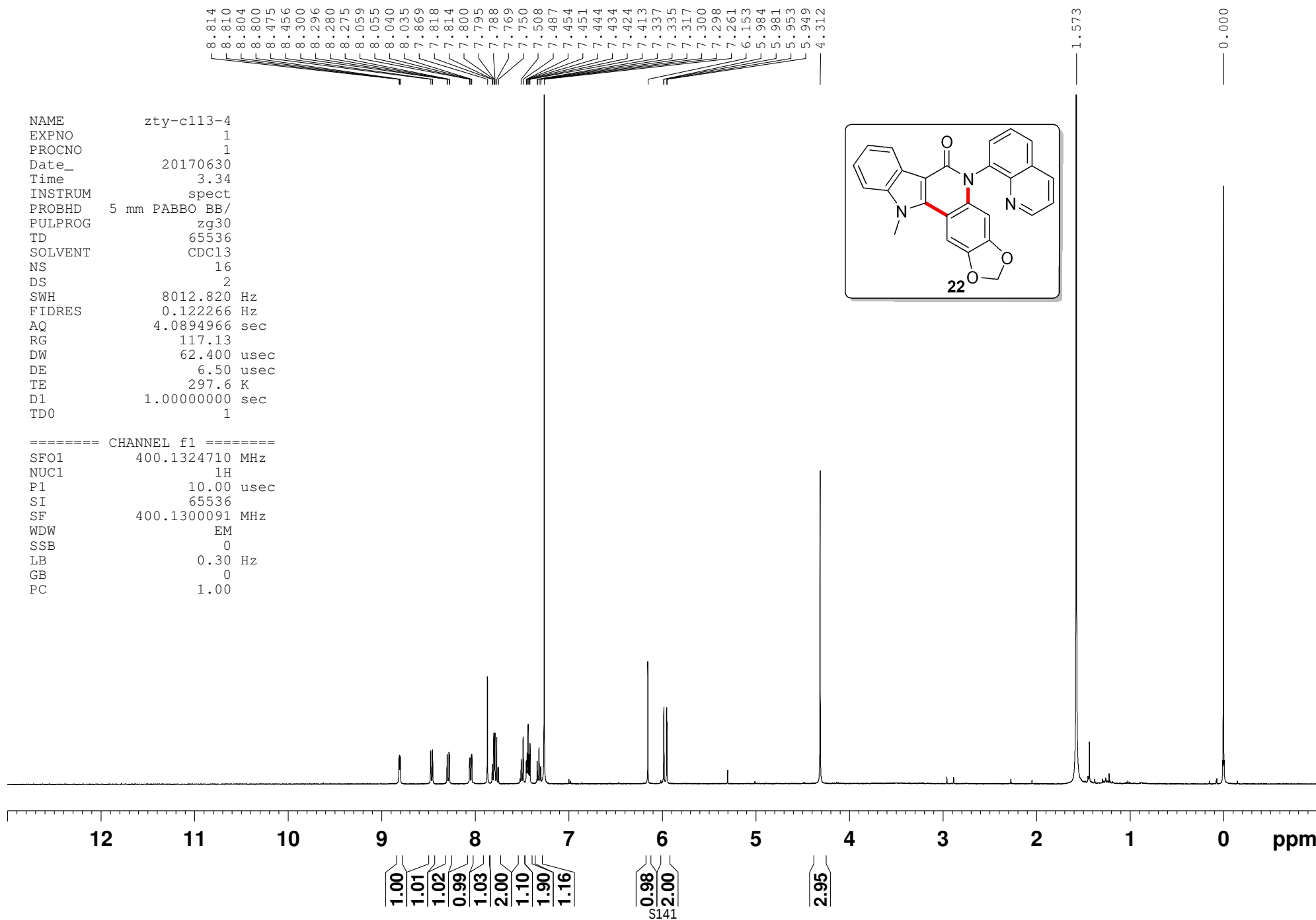
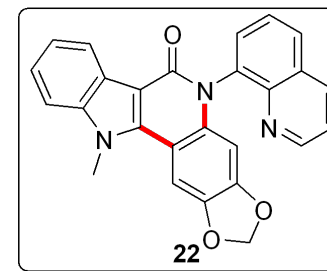
160.49
 151.63
 145.27
 140.53
 139.97
 139.73
 138.10
 136.62
 136.44
 131.36
 130.34
 129.96
 129.35
 126.94
 124.97
 124.27
 123.31
 122.55
 121.96
 121.91
 118.37
 112.46
 108.90
 107.76

77.37
 77.16
 76.95

33.81

20.51
 19.93



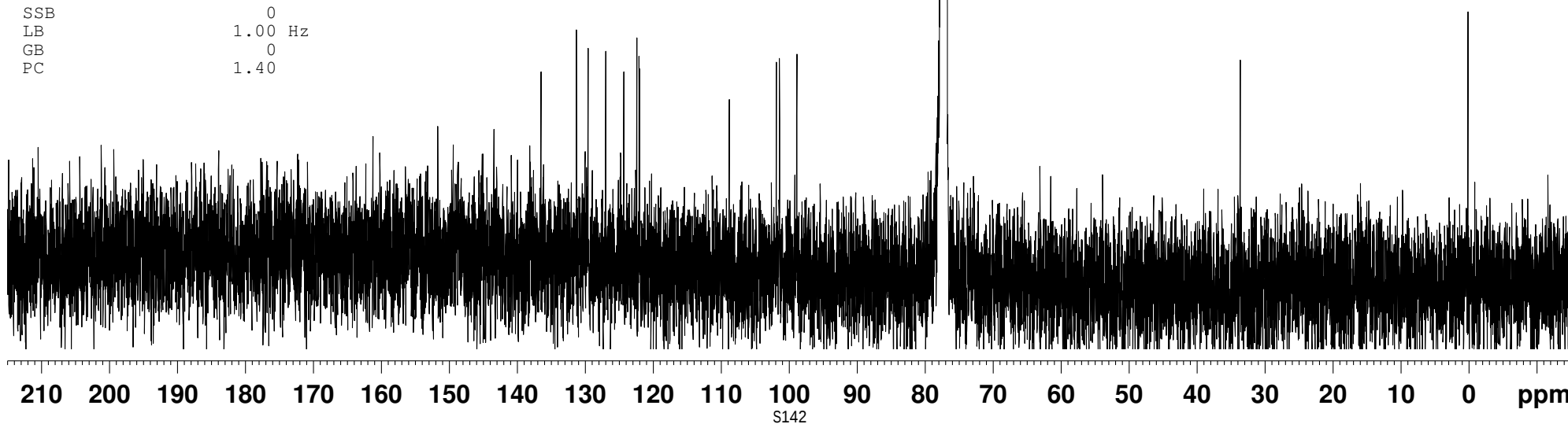
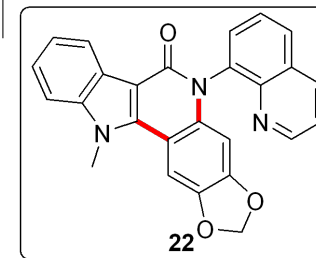


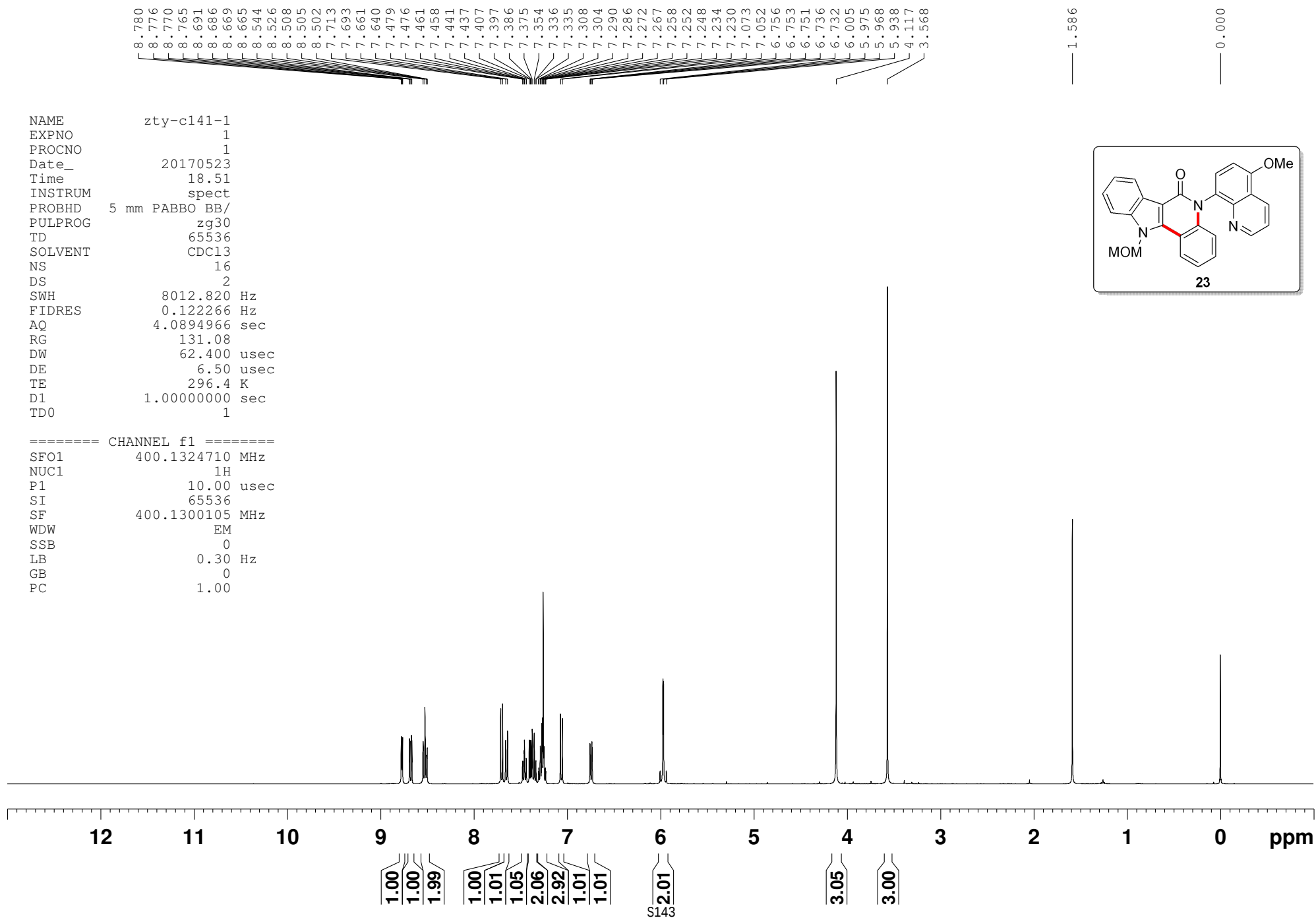
NAME zty-c113-4-c
EXPNO 1
PROCNO 1
Date_ 20170820
Time 4.59
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 2000
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 296.6 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127548 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

161.24
151.71
149.45
143.45
140.89
136.53
131.30
129.58
127.00
124.35
122.43
122.08
108.82
101.87
101.42
98.88
77.48
77.16
76.84

33.65





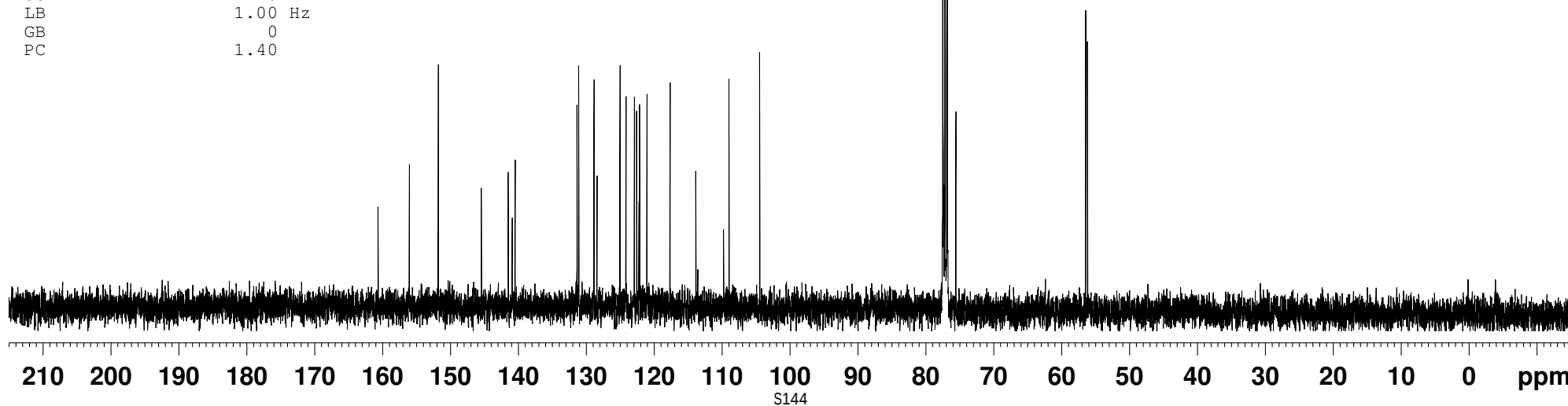
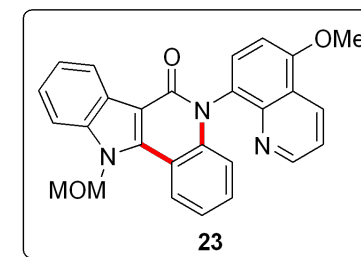
— 1.586

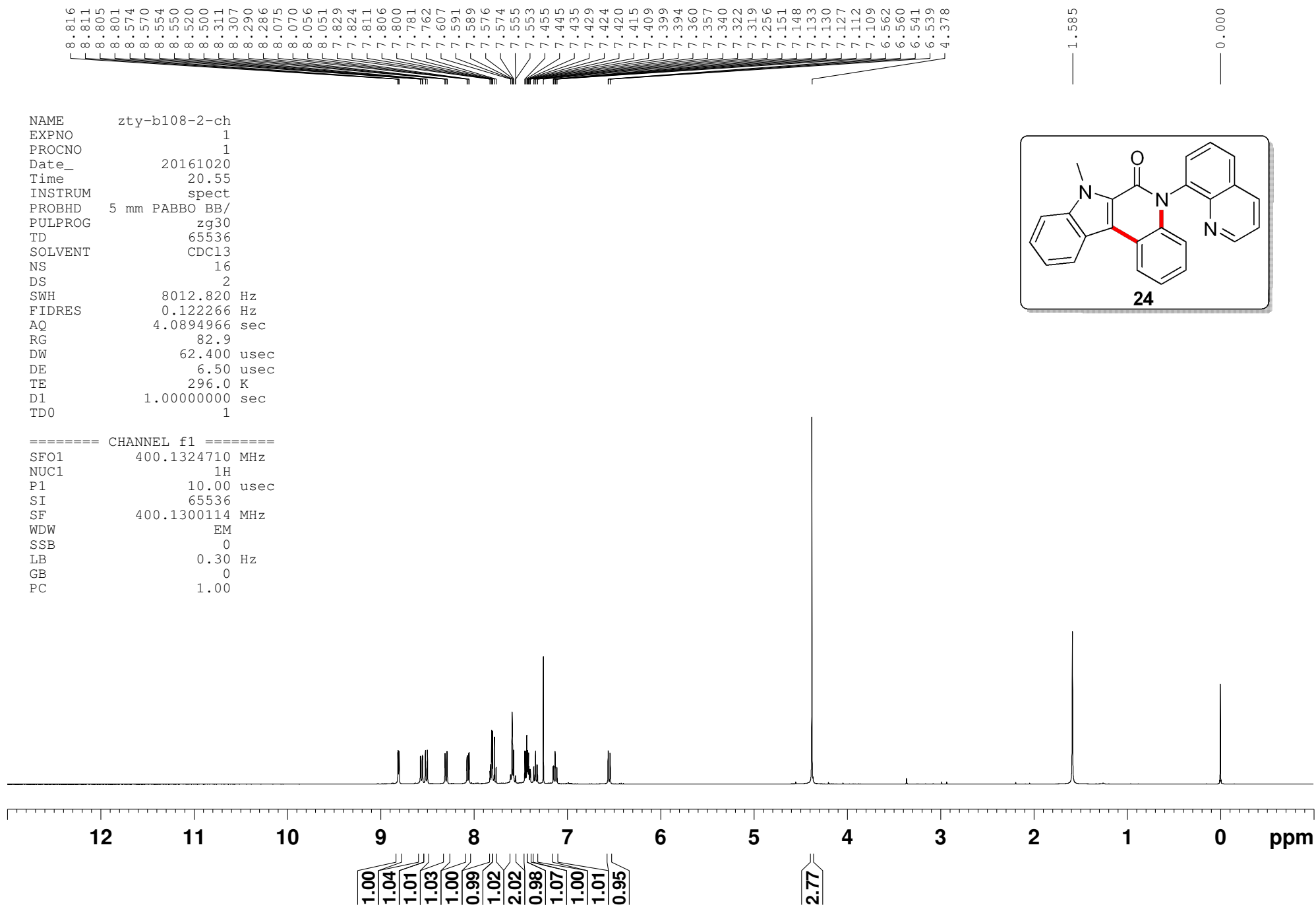
— 0.000

NAME zty-cl41-1-C
 EXPNO 2
 PROCNO 1
 Date_ 20170524
 Time 16.31
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 500
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 296.9 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127559 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

160.67
 156.06
 151.78
 145.47
 141.49
 140.92
 140.50
 131.37
 131.11
 128.87
 128.42
 125.05
 125.02
 124.15
 122.92
 122.59
 122.24
 122.16
 121.07
 117.67
 113.87
 113.59
 109.77
 108.99
 104.46
 77.48
 77.36
 77.16
 76.84
 75.57
 56.46
 56.19





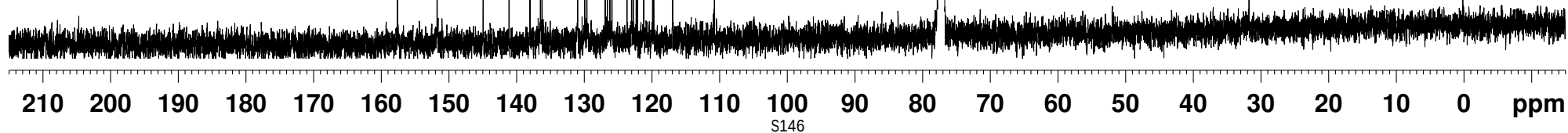
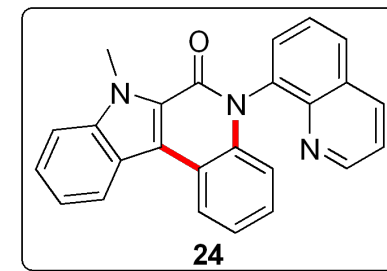
NAME zty-b108-2-ch
 EXPNO 2
 PROCNO 1
 Date_ 20161020
 Time 21.55
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 1024
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 296.6 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127563 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

157.59
 151.73
 144.94
 141.12
 138.02
 136.50
 136.27
 131.01
 129.94
 129.60
 126.93
 126.55
 126.22
 125.92
 123.67
 123.00
 122.72
 122.29
 122.15
 121.20
 119.89
 119.75
 116.93
 110.79

77.48
 77.16
 76.84

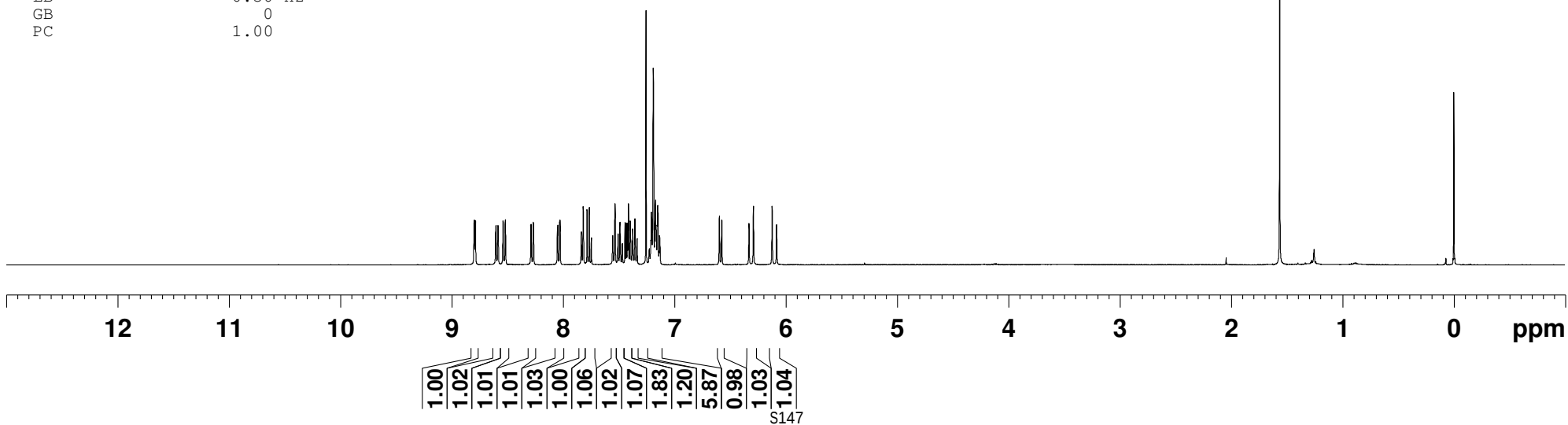
31.75



8.798
8.791
8.787
8.606
8.604
8.586
8.584
8.540
8.520
8.291
8.287
8.270
8.266
8.052
8.049
8.032
8.028
7.840
7.836
7.822
7.818
7.786
7.766
7.747
7.555
7.535
7.509
7.507
7.491
7.489
7.471
7.468
7.445
7.434
7.424
7.417
7.414
7.397
7.395
7.380
7.376
7.373
7.356
7.338
7.335
7.256
7.230
7.227
7.223
7.213
7.208
7.206
7.192
7.189
7.173
7.170
7.155
7.152
7.149
7.139
7.134
7.131
6.596
6.577
6.575
6.331
6.291
6.123
6.083

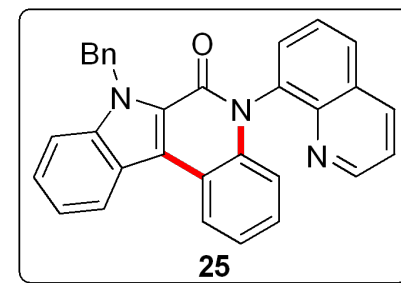
NAME zty-c143-2
EXPNO 1
PROCNO 1
Date_ 20170525
Time 18.30
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
SWH 8012.820 Hz
FIDRES 0.122266 Hz
AQ 4.0894966 sec
RG 82.9
DW 62.400 usec
DE 6.50 usec
TE 296.1 K
D1 1.00000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 400.1324710 MHz
NUC1 1H
P1 10.00 usec
SI 65536
SF 400.1300115 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00



1.565

0.000



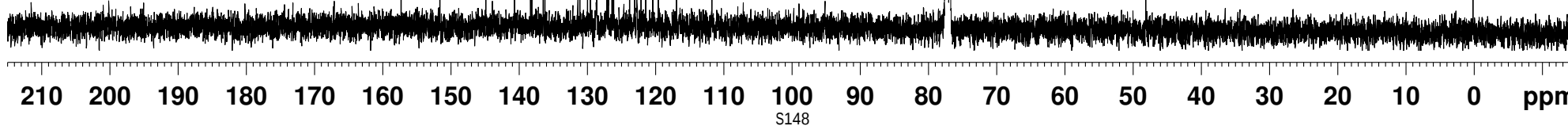
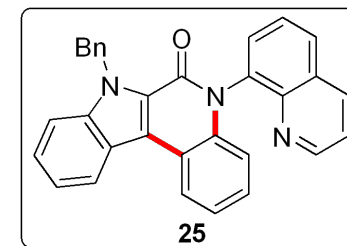
NAME zty-c143-2
 EXPNO 2
 PROCNO 1
 Date_ 20170525
 Time 19.15
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 755
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 297.0 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

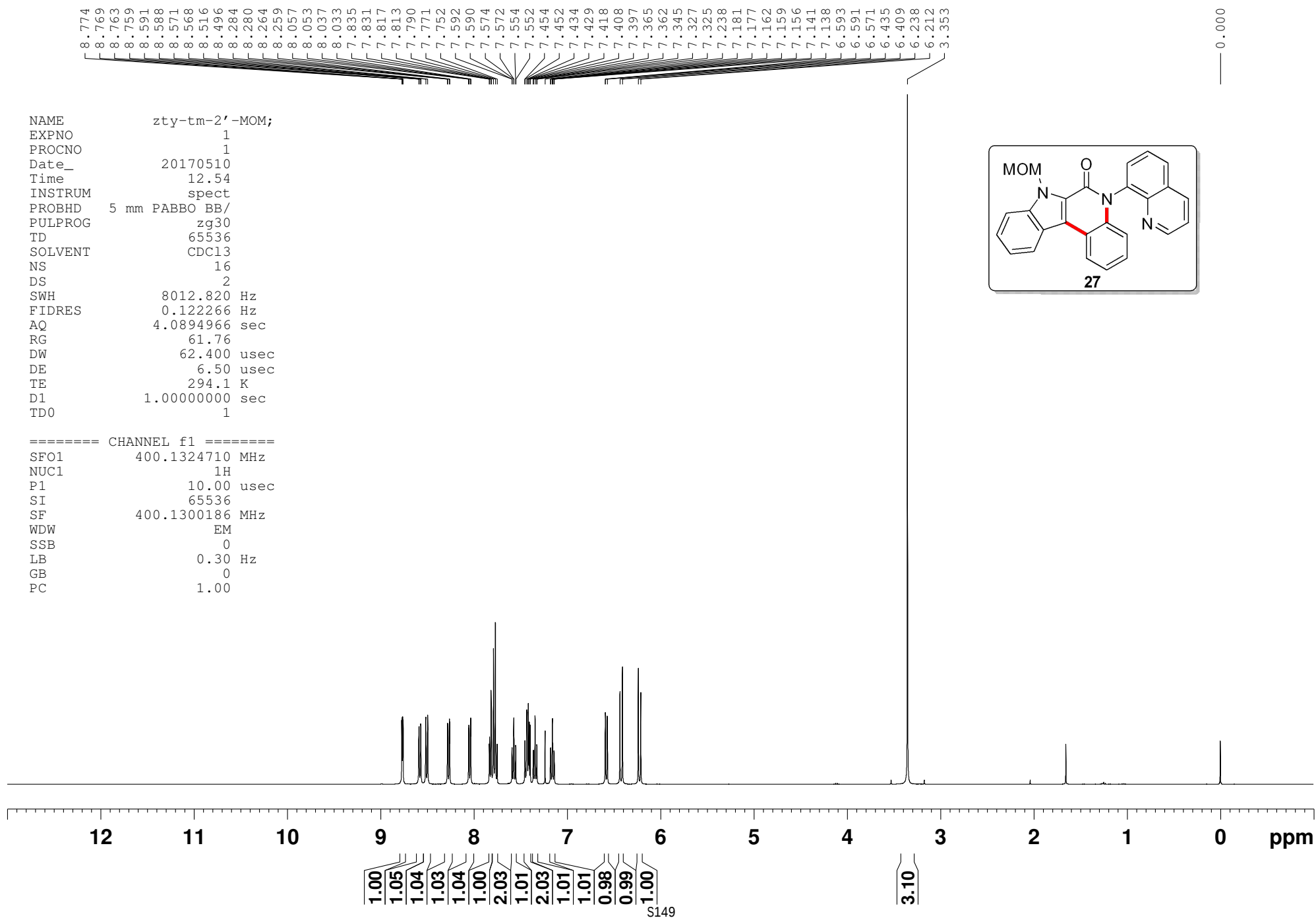
===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127557 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

157.31
 151.62
 144.89
 140.70
 138.36
 138.14
 136.46
 136.21
 131.08
 129.96
 129.57
 128.63
 127.14
 126.90
 126.40
 126.23
 126.14
 123.80
 123.09
 122.75
 122.70
 122.14
 121.45
 120.42
 119.62
 116.95
 111.72

77.48
 77.16
 76.84

48.11





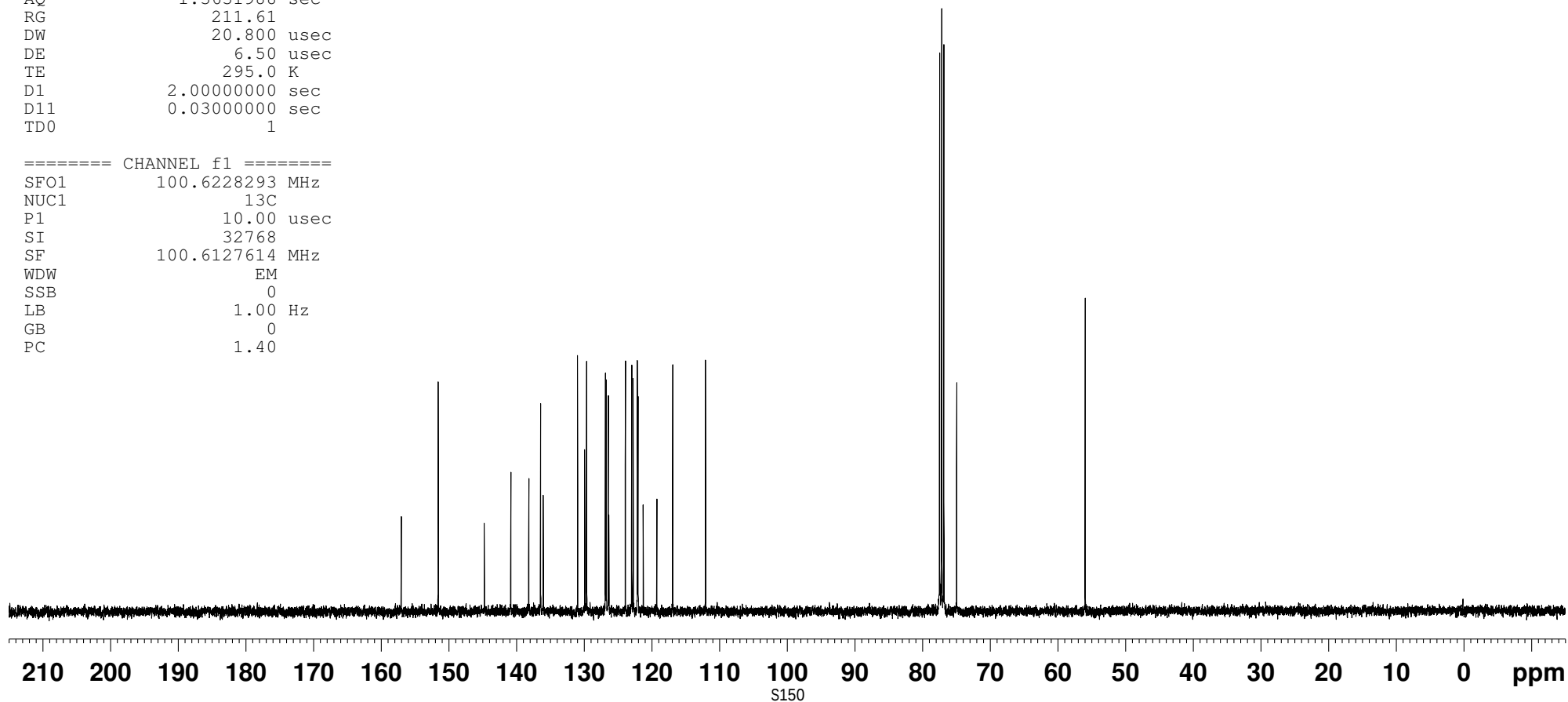
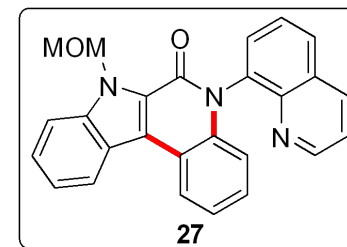
NAME zty-tm-2;
EXPNO 2
PROCNO 1
Date_ 20170510
Time 13.10
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 256
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 295.0 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

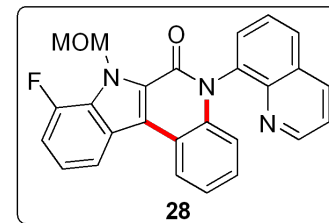
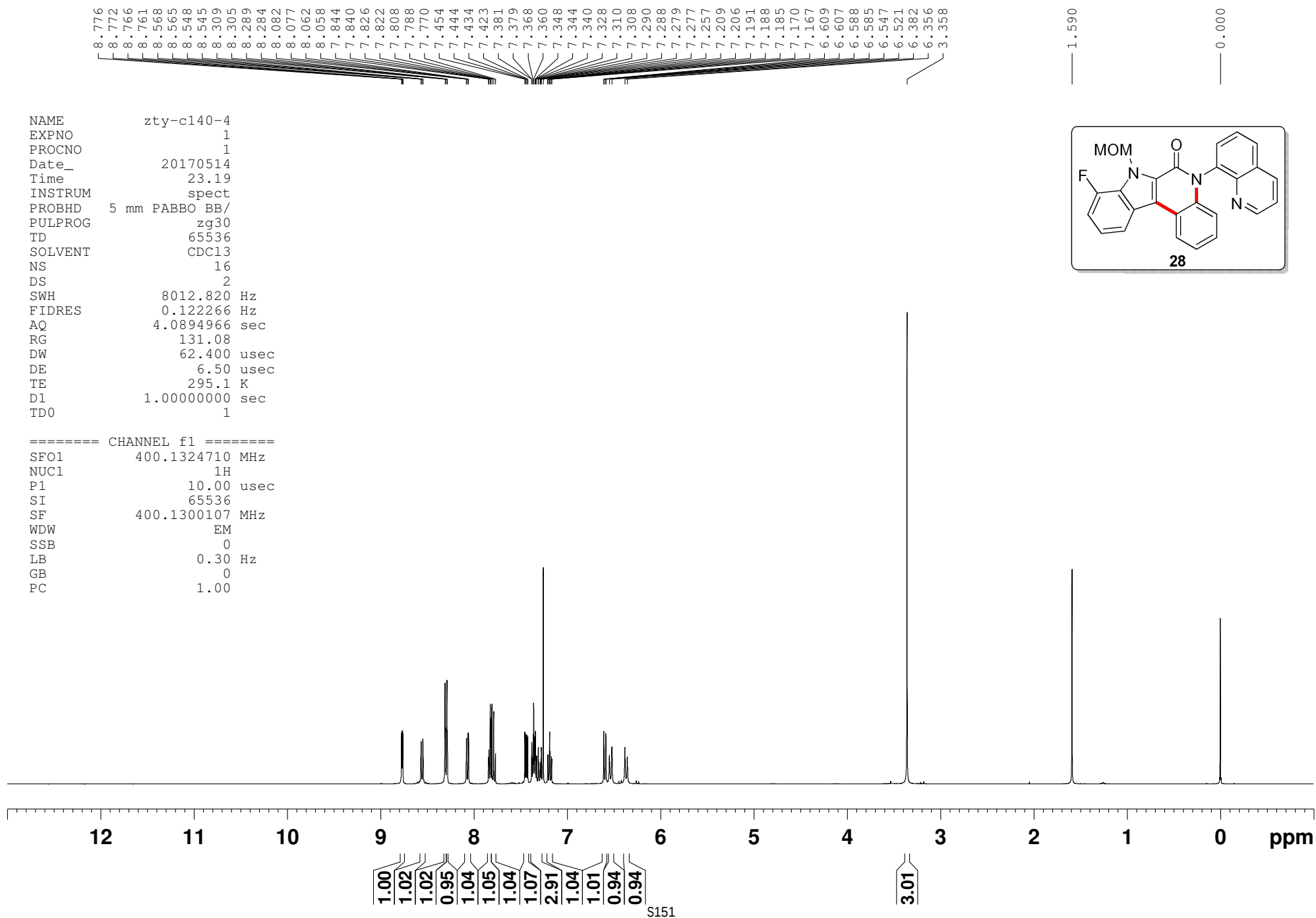
===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127614 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

157.05
151.59
144.78
140.86
138.21
136.46
136.06
130.99
129.93
129.65
126.87
126.75
126.45
126.36
123.93
122.99
122.95
122.77
122.14
122.05
121.28
119.27
116.93
112.07

77.48
77.16
76.84
74.96

55.95





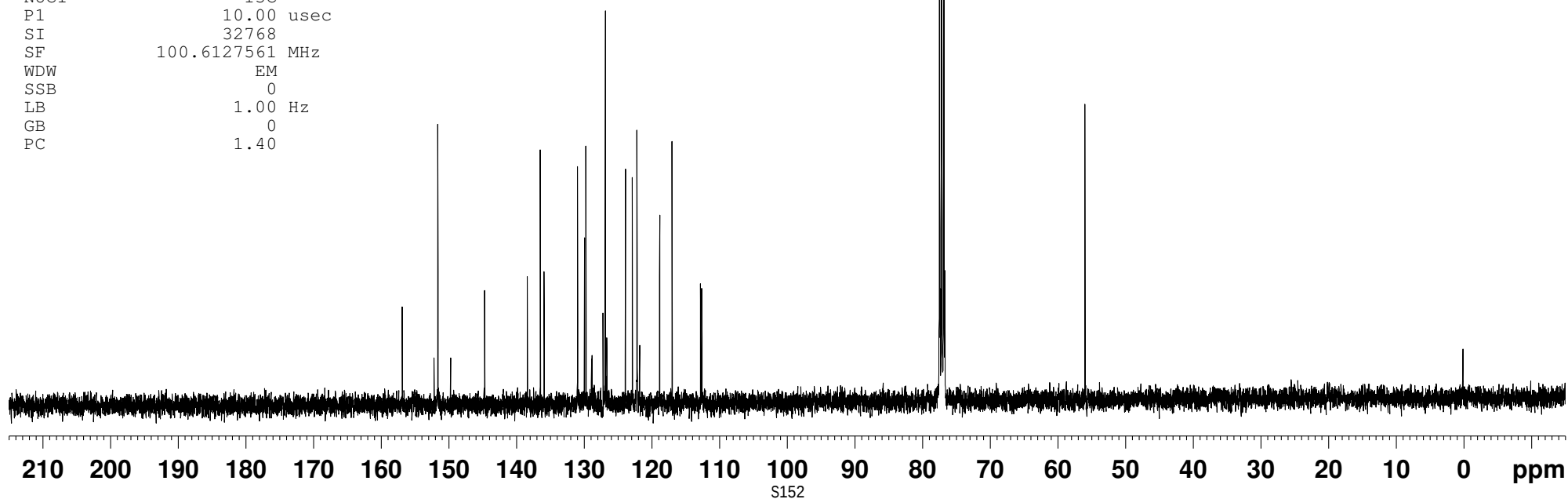
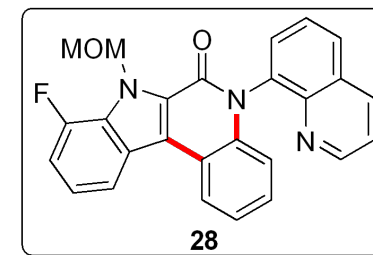
NAME zty-c140-4
EXPNO 2
PROCNO 1
Date_ 20170515
Time 0.17
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 1000
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 295.9 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

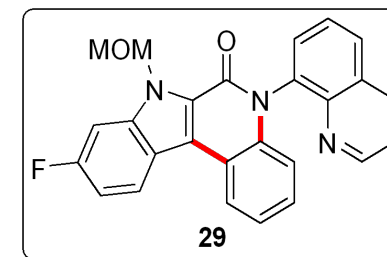
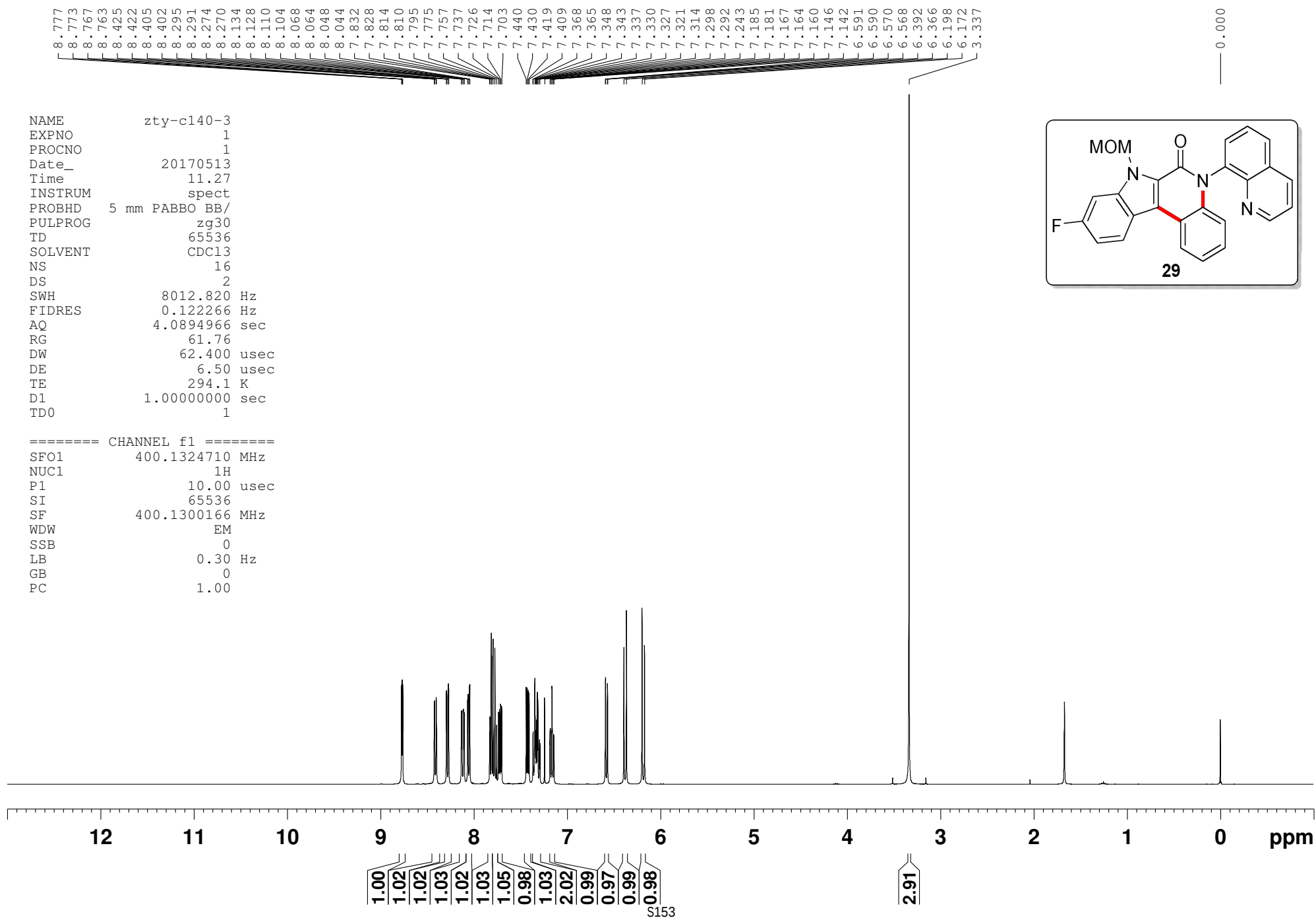
===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127561 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

156.91
152.22
151.64
149.76
144.72
138.42
136.51
135.93
130.99
129.97
129.75
128.94
128.84
127.22
126.89
126.70
126.66
123.91
122.90
122.21
122.16
121.82
118.88
118.83
117.02
112.80
112.62

77.48
77.16
76.84

56.00

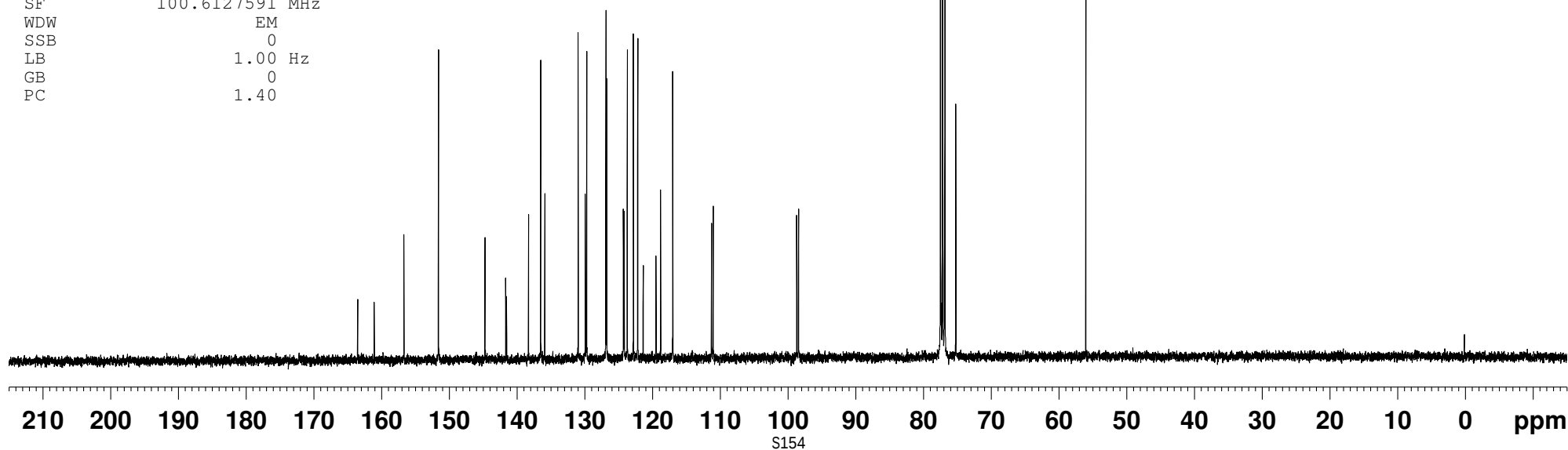
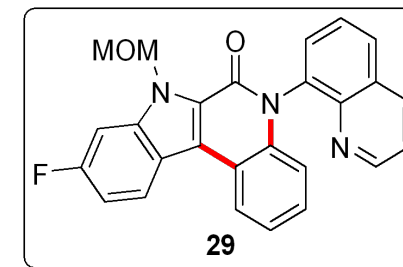


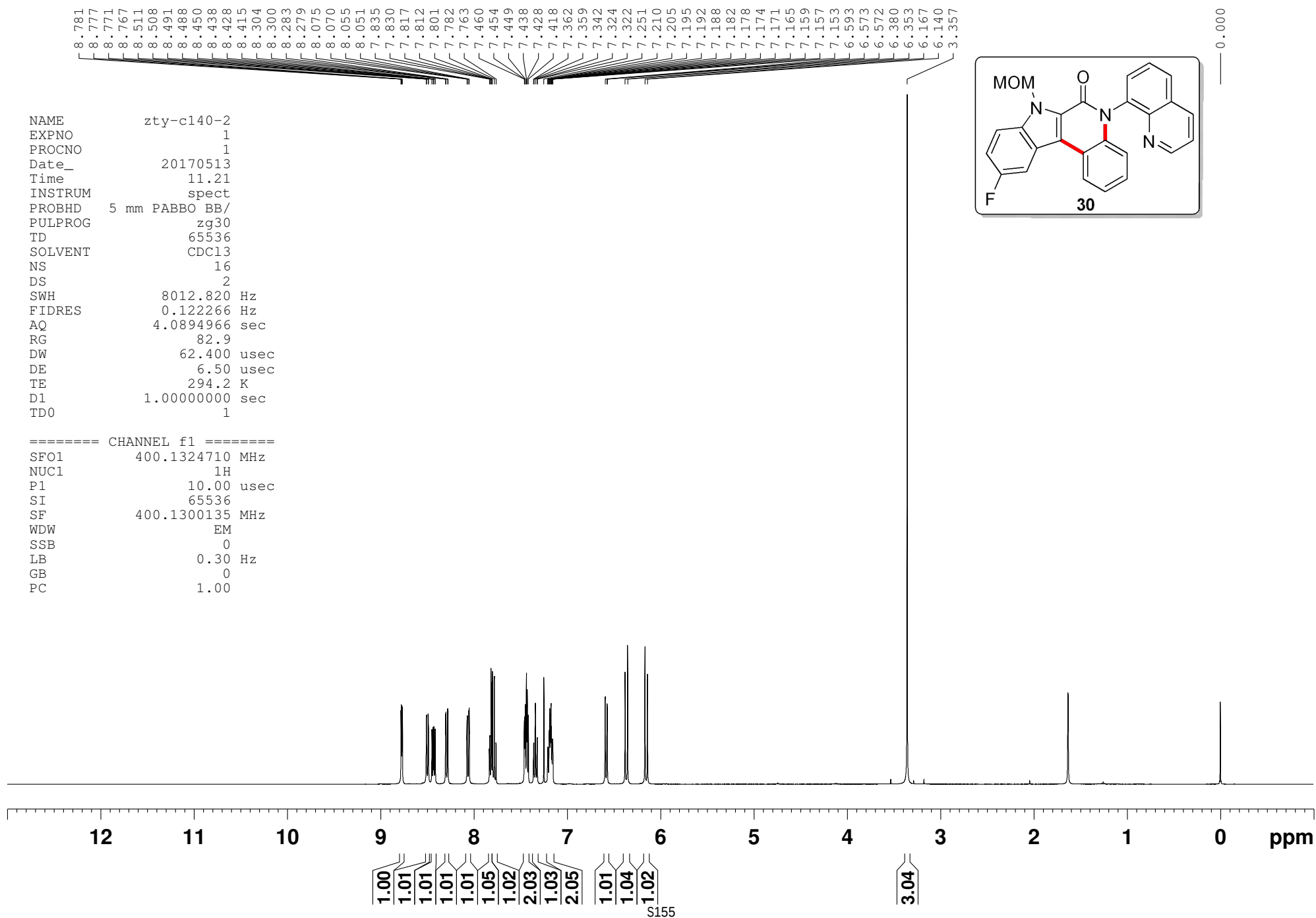


NAME zty-c140-3
 EXPNO 2
 PROCNO 1
 Date_ 20170515
 Time 5.45
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 1024
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 295.7 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127591 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

163.54
 161.11
 156.73
 151.62
 144.73
 141.68
 141.56
 138.31
 136.52
 135.91
 130.99
 129.96
 129.73
 126.89
 126.77
 124.31
 124.20
 123.74
 122.84
 122.19
 121.39
 119.49
 118.82
 117.03
 111.29
 111.04
 98.71
 98.45
 77.48
 77.16
 76.84
 75.23
 56.02





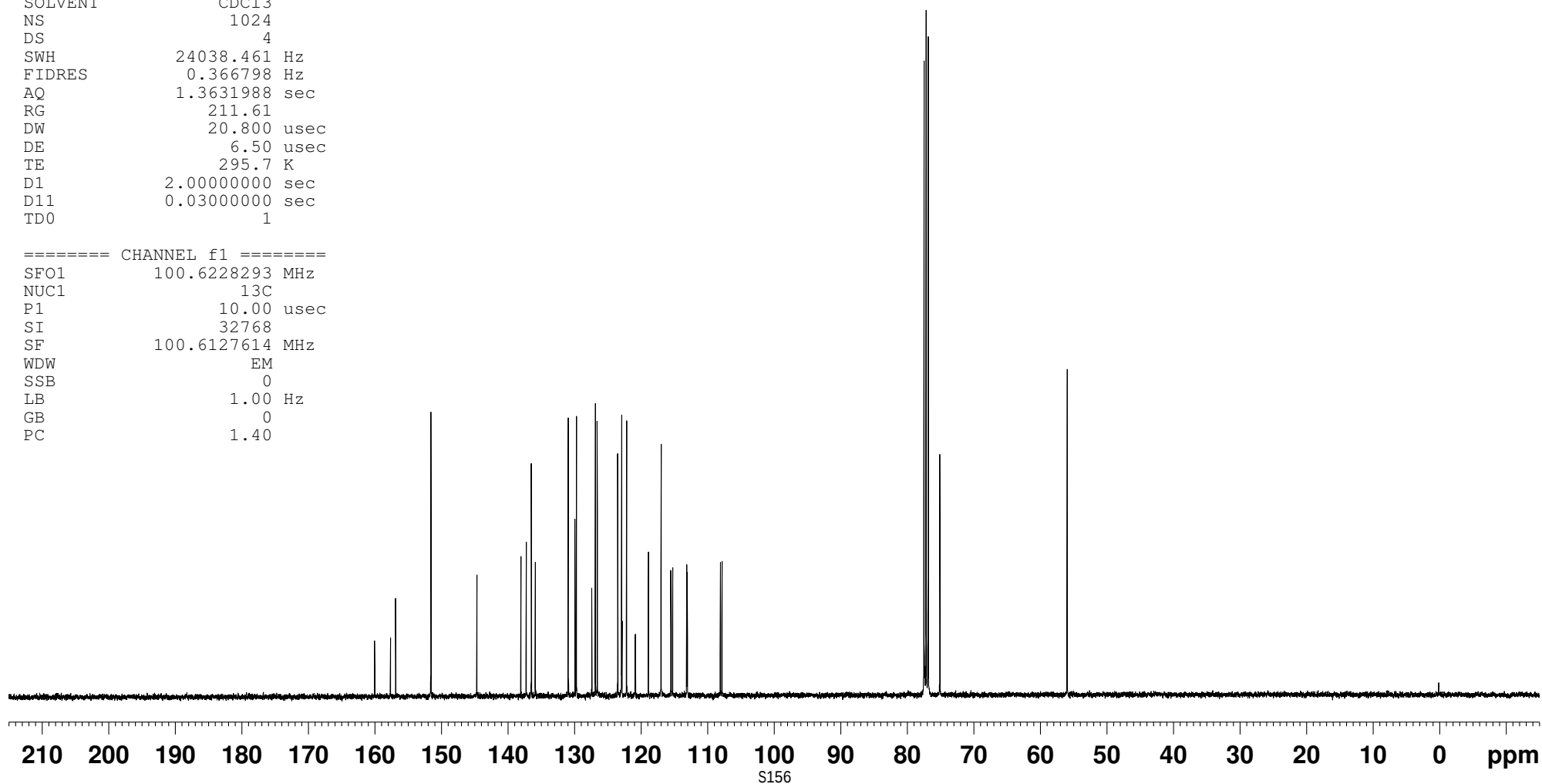
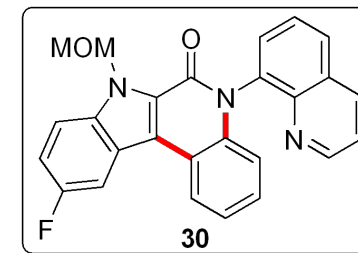
NAME zty-cl40-2
 EXPNO 2
 PROCNO 1
 Date_ 20170515
 Time 4.42
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 1024
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 295.7 K
 D1 2.0000000 sec
 D11 0.0300000 sec
 TD0 1

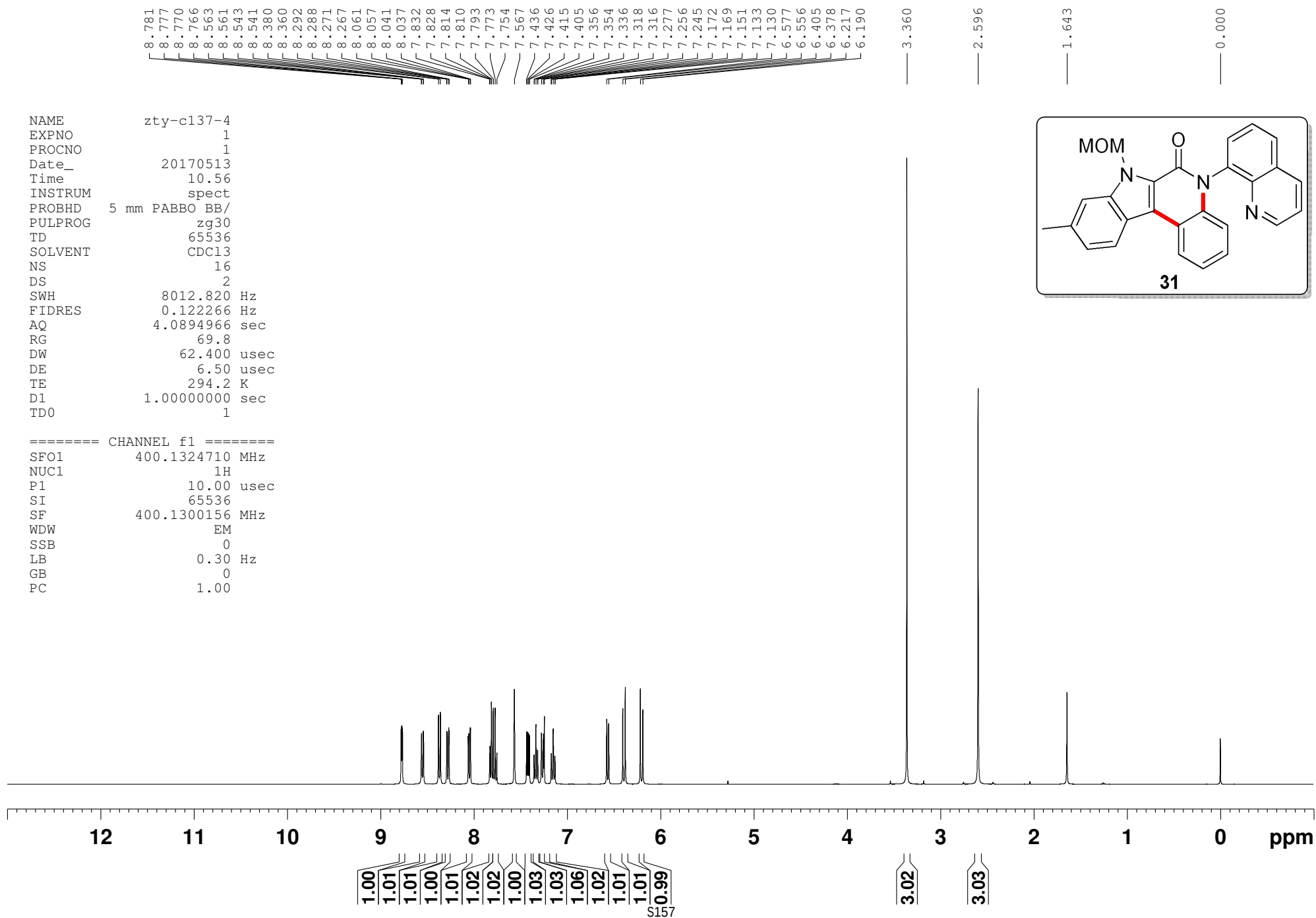
===== CHANNEL f1 =====
 SF01 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127614 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

160.04
 157.68
 156.90
 151.60
 144.68
 138.07
 137.28
 136.50
 135.89
 130.95
 129.94
 129.72
 127.42
 126.87
 126.59
 123.51
 122.96
 122.93
 122.86
 122.18
 120.90
 120.85
 118.90
 117.00
 115.53
 115.27
 113.14
 113.05
 108.09
 107.85

77.48
 77.16
 76.84
 75.10

55.96





NAME zty-c137-4
 EXPNO 2
 PROCNO 1
 Date_ 20170515
 Time 3.03
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 500
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 295.7 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

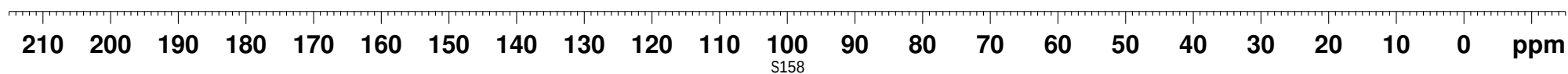
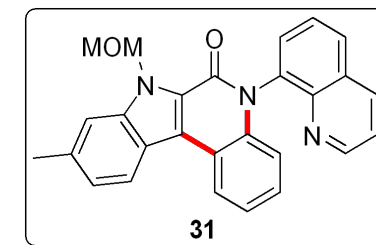
===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127600 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

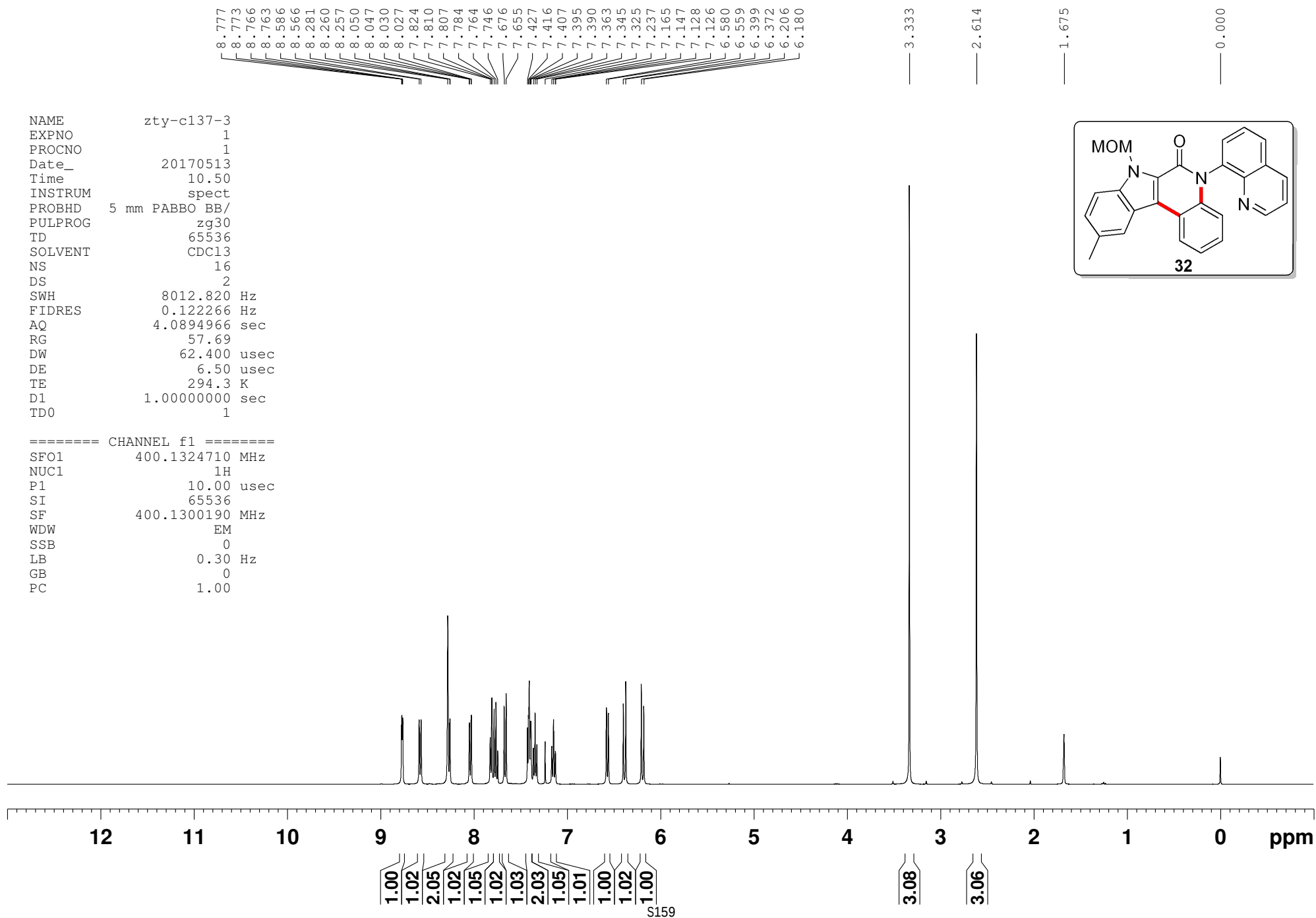
157.05
 151.59
 144.82
 141.35
 138.20
 137.23
 136.48
 136.13
 131.03
 129.93
 129.62
 126.89
 126.38
 126.01
 124.02
 123.96
 122.68
 122.60
 122.13
 121.42
 120.79
 119.26
 116.89
 111.83

77.48
 77.16
 76.84
 74.87

55.91

22.32





NAME zty-c137-3
 EXPNO 2
 PROCNO 1
 Date_ 20170515
 Time 2.30
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 500
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 295.7 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

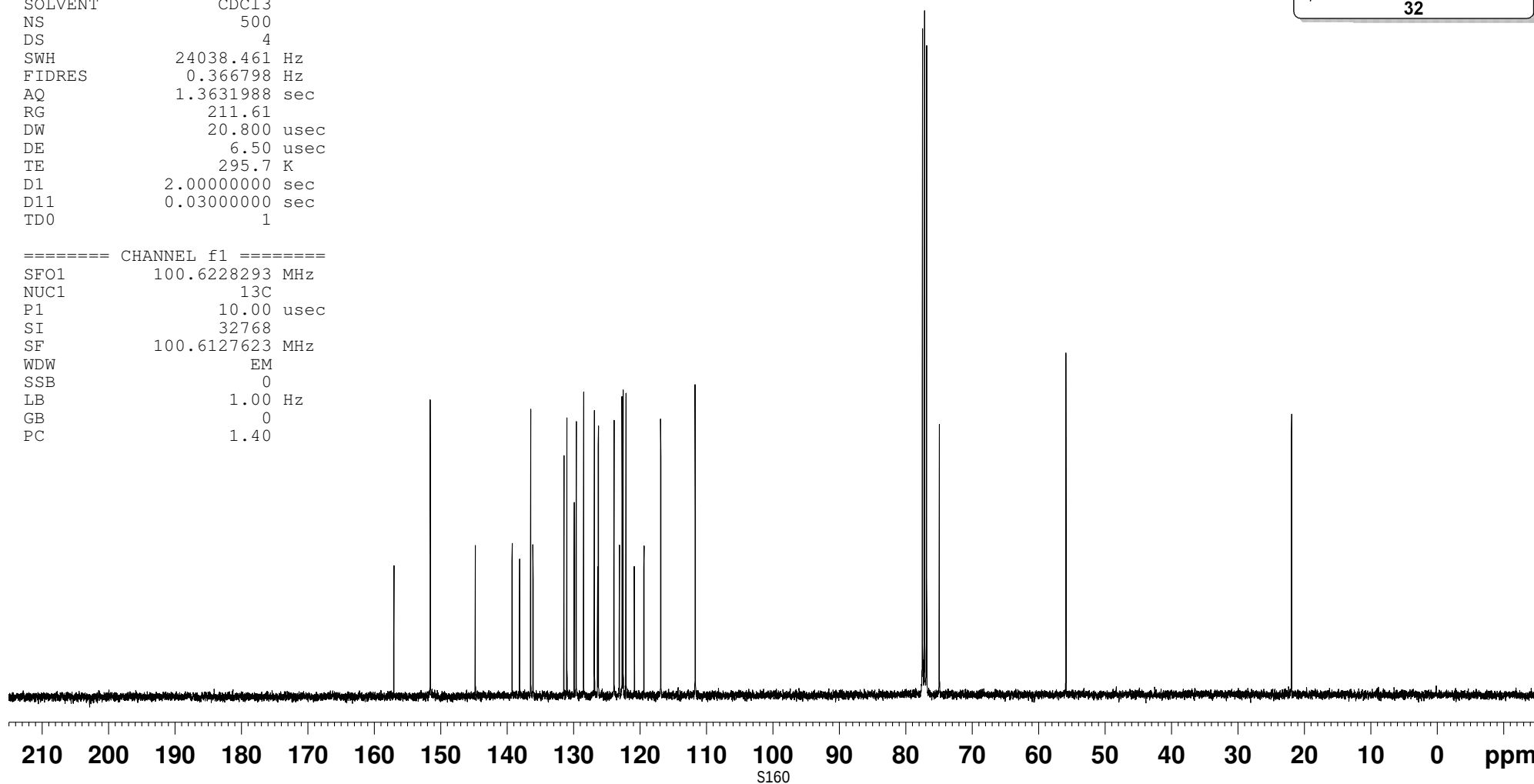
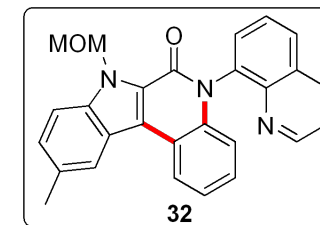
===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127623 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

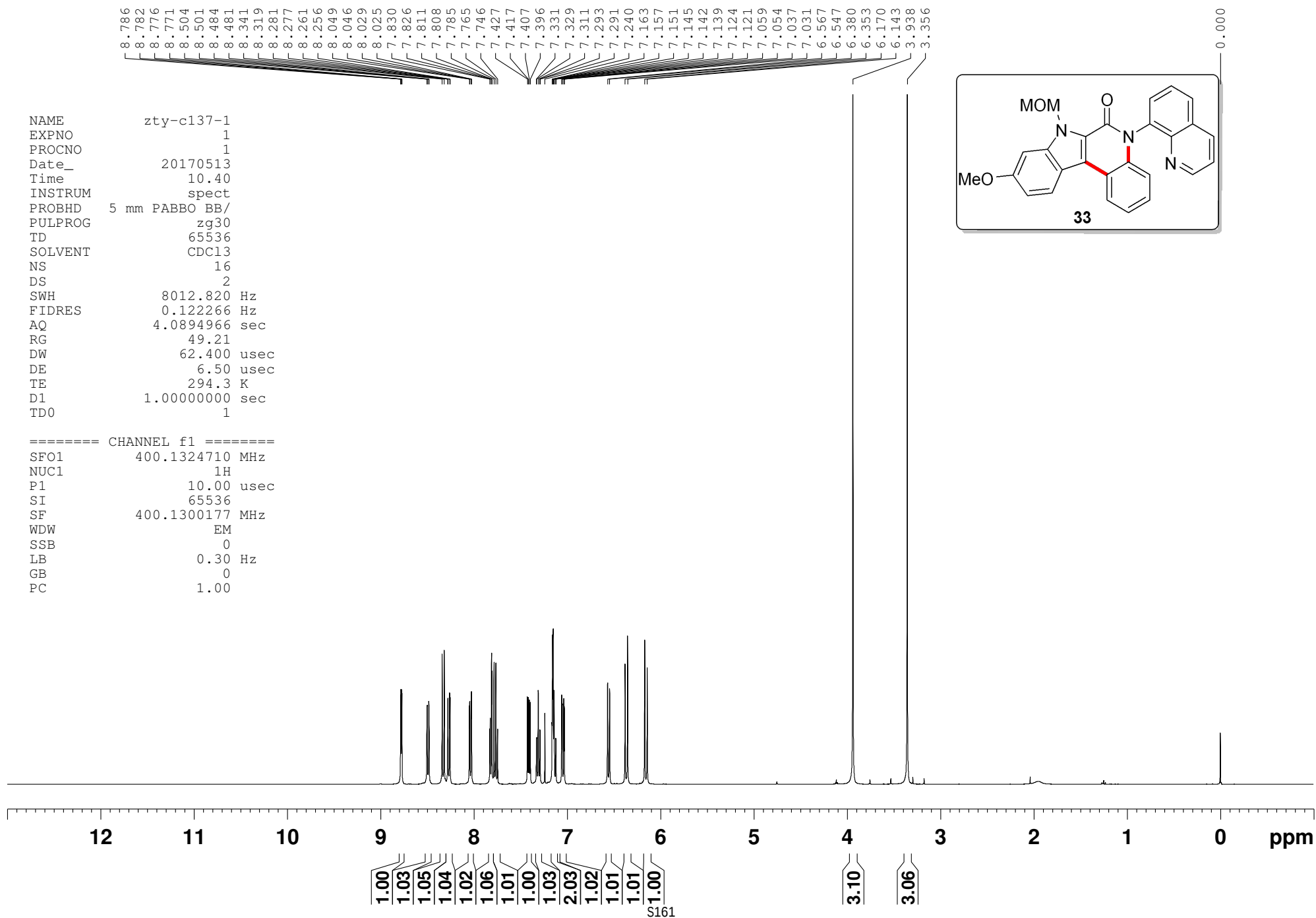
157.06
 151.57
 144.79
 139.26
 138.12
 136.47
 136.11
 131.45
 131.01
 129.91
 129.61
 128.49
 126.87
 126.40
 126.28
 123.92
 123.12
 122.69
 122.54
 122.12
 120.85
 119.41
 116.88
 111.69

77.48
 77.16
 76.84
 74.94

55.87

21.91

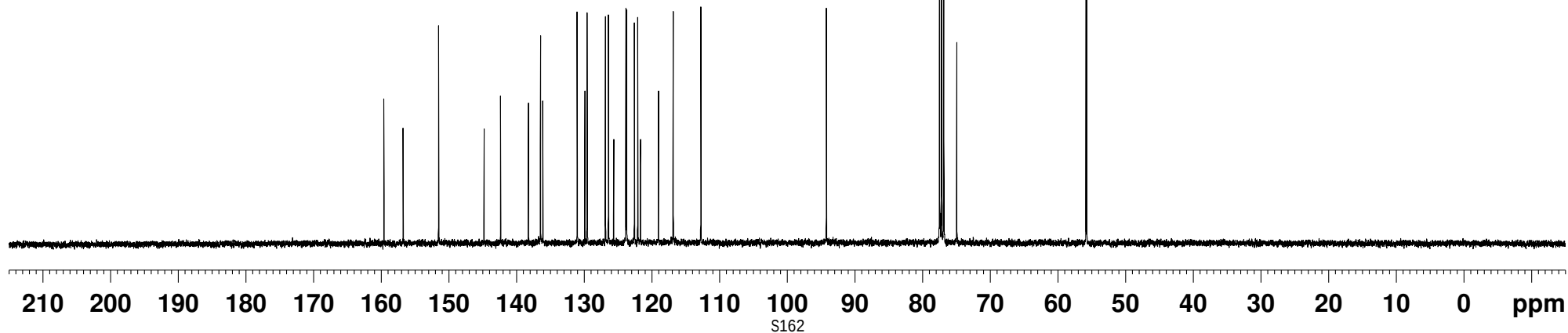
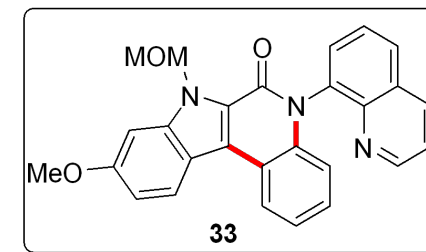


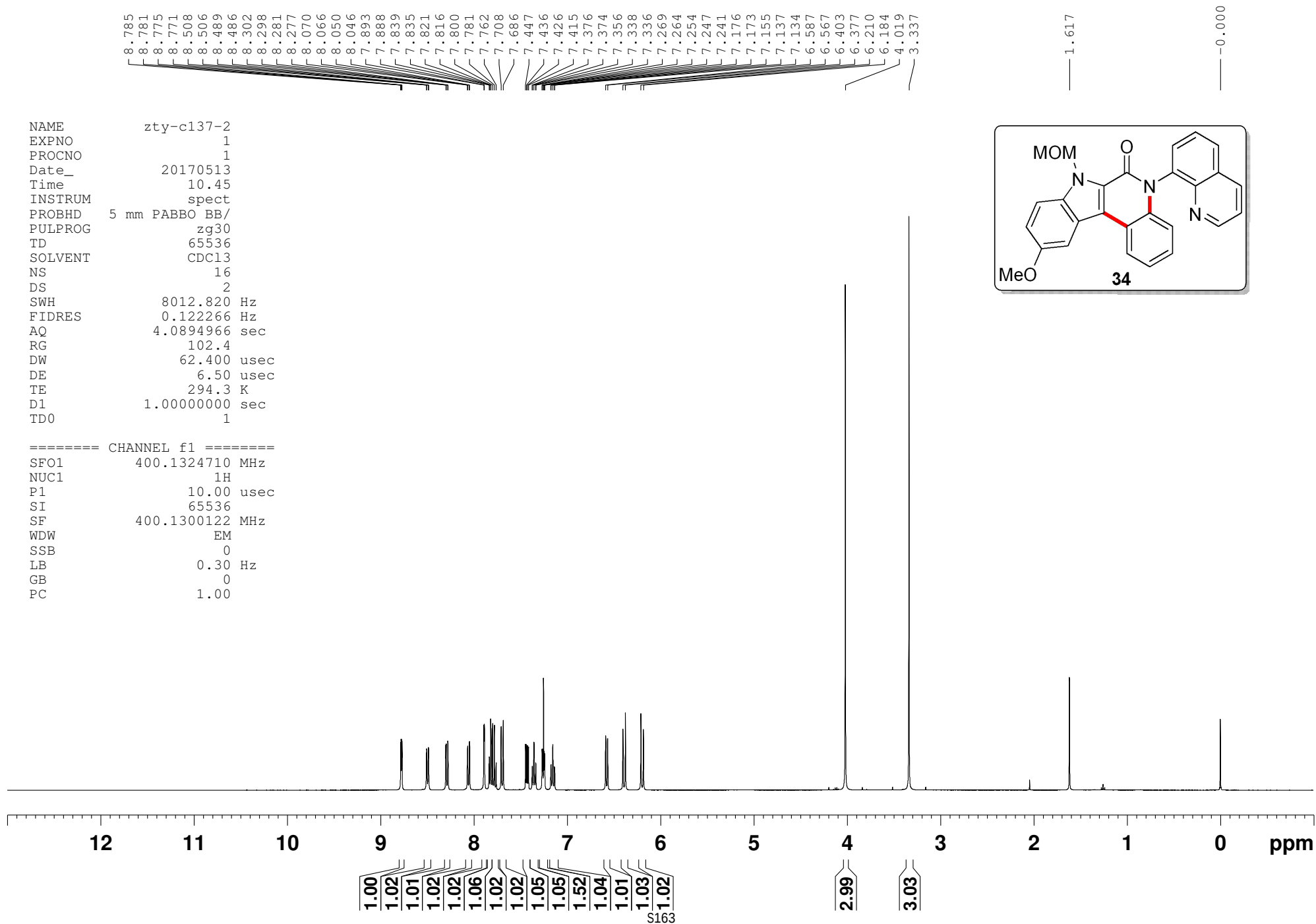


NAME zty-c137-1
 EXPNO 2
 PROCNO 1
 Date_ 20170515
 Time 1.25
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 500
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 295.6 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127630 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

159.61
 156.78
 151.53
 144.81
 142.37
 138.25
 136.47
 136.12
 131.05
 129.91
 129.58
 126.87
 126.43
 125.65
 123.85
 123.74
 122.59
 122.10
 121.70
 119.03
 116.87
 116.85
 112.76
 94.22
 77.48
 77.16
 76.84
 74.94
 55.83
 55.72

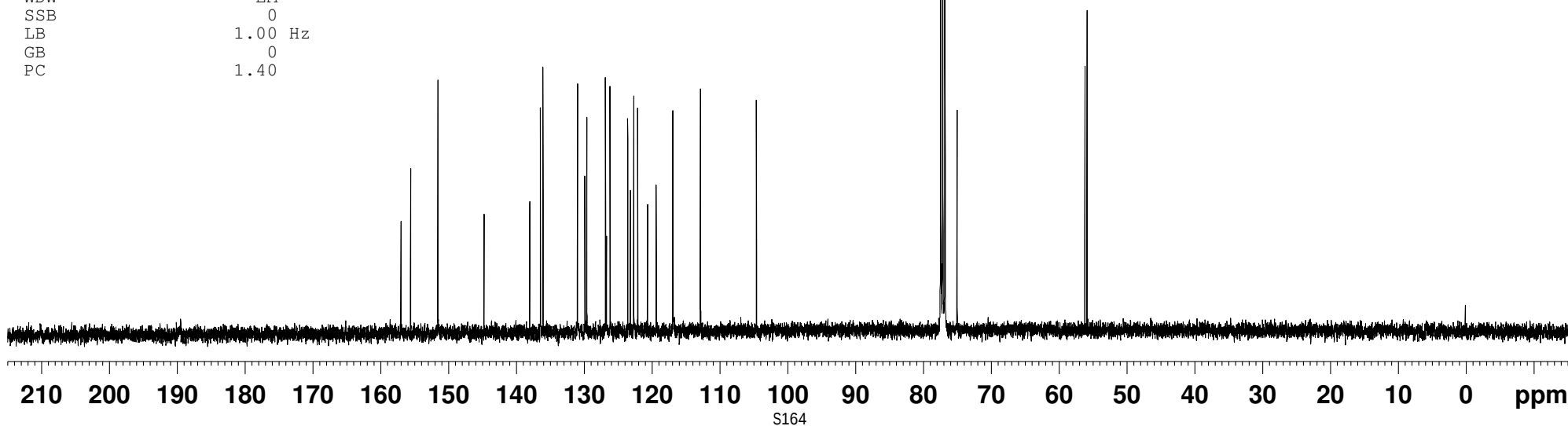
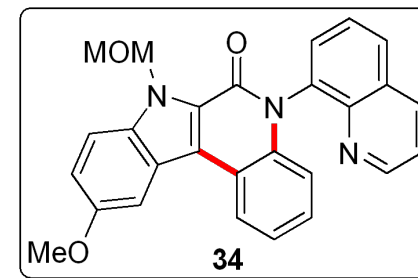


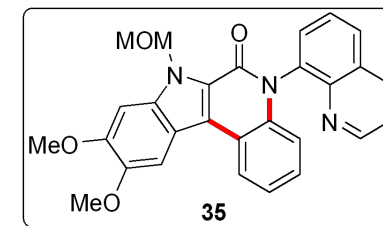
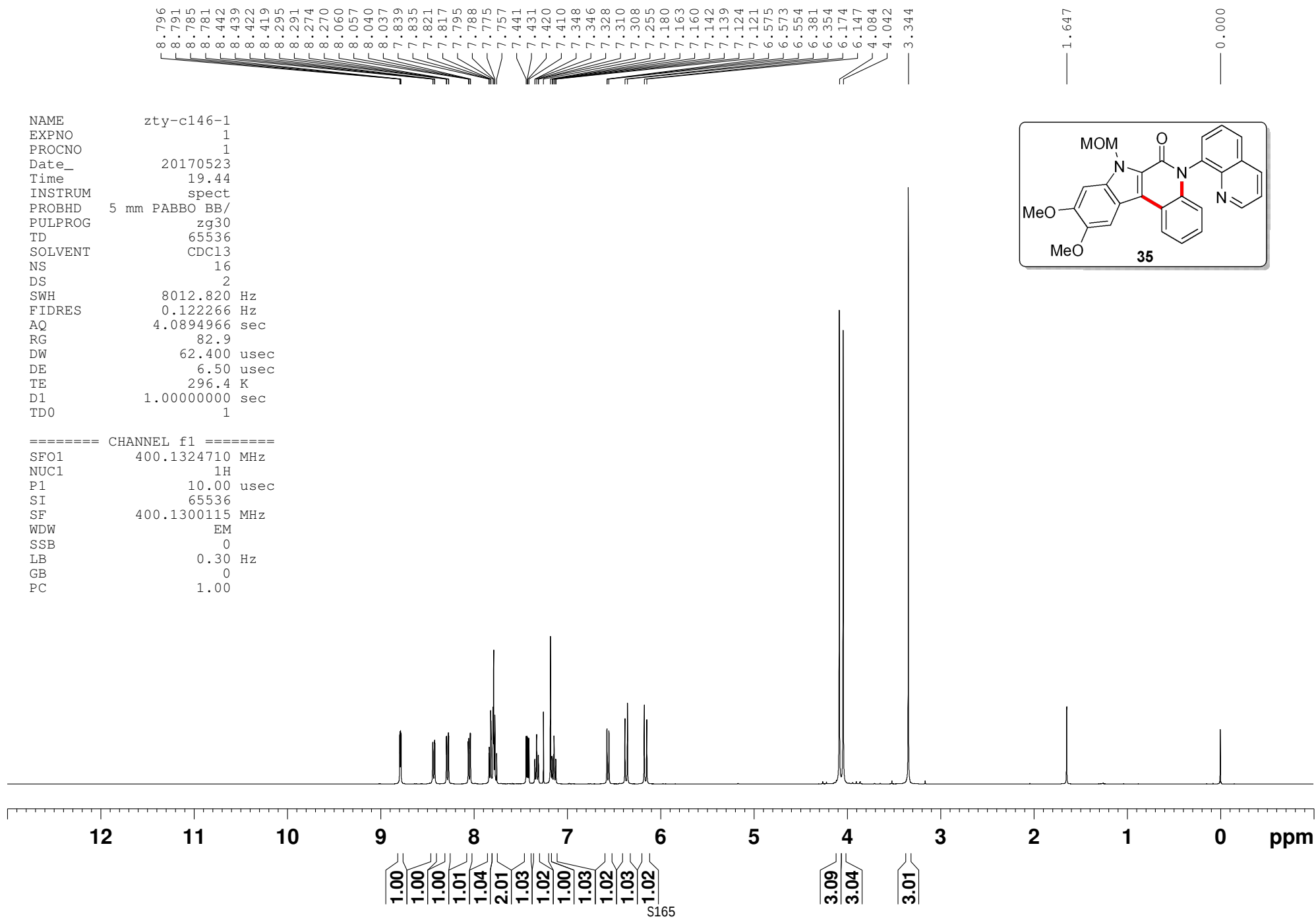


NAME zty-c137-2
 EXPNO 2
 PROCNO 1
 Date_ 20170515
 Time 1.58
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 500
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 295.7 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127579 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

157.06
 155.64
 151.61
 144.81
 138.07
 136.50
 136.11
 131.03
 129.95
 129.65
 126.90
 126.75
 126.24
 123.62
 123.23
 122.74
 122.16
 120.70
 119.42
 117.02
 116.97
 112.89
 104.65
 77.48
 77.16
 76.84
 75.05
 56.22
 55.90





NAME zty-cl46-1
EXPNO 2
PROCNO 1
Date_ 20170523
Time 20.00
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 256
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 297.1 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

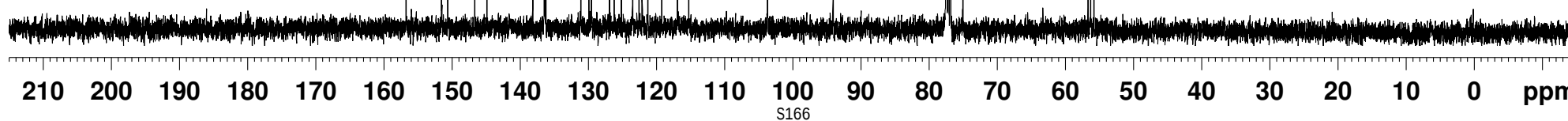
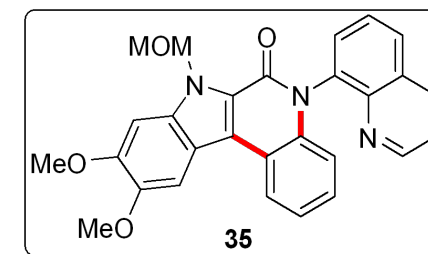
===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127590 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

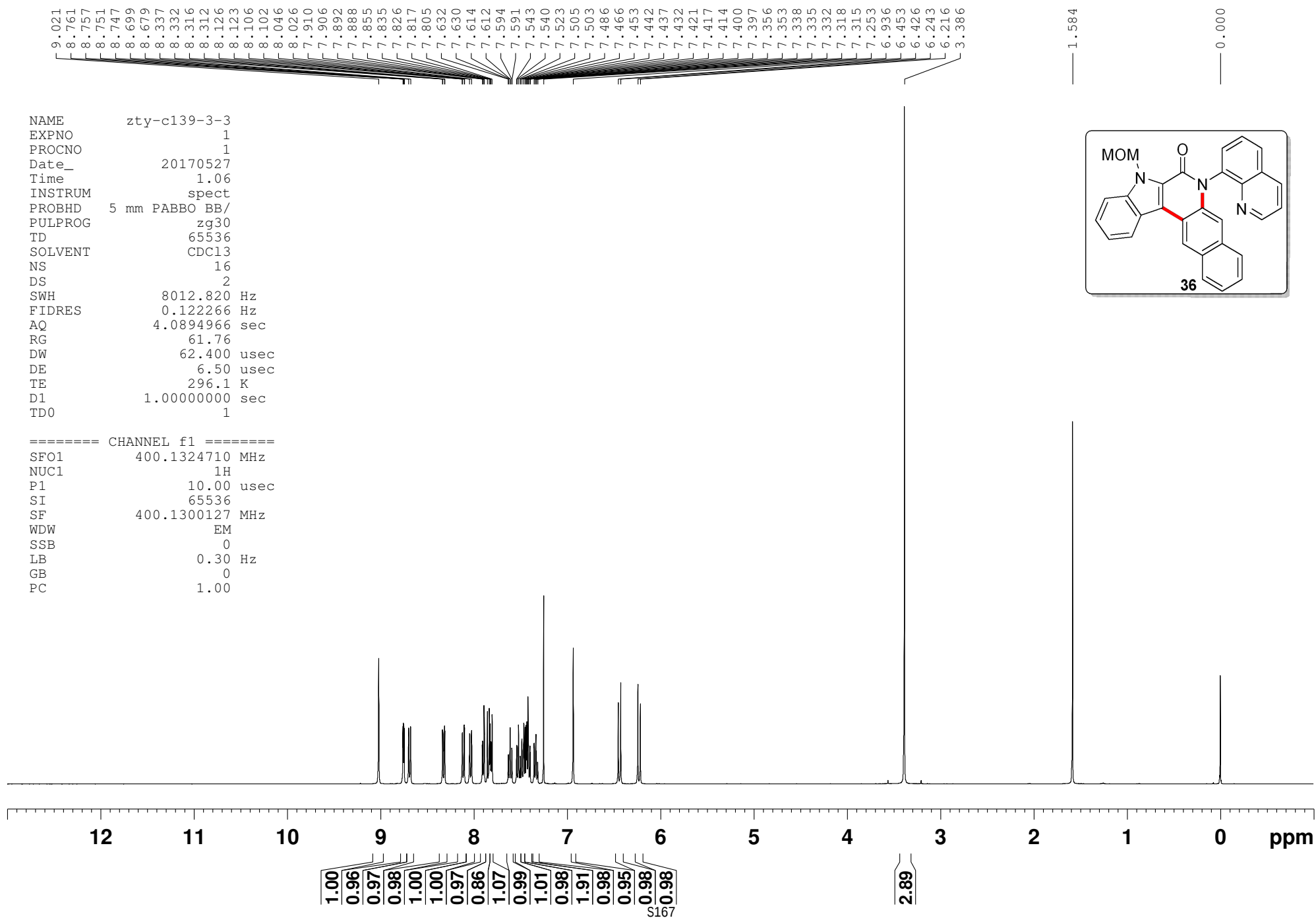
156.77
151.54
150.66
146.66
144.89
138.18
136.48
136.36
136.23
131.09
129.94
129.57
126.89
126.22
125.17
123.51
122.55
122.11
121.27
119.22
116.92
115.26
103.72

94.09

77.48
77.16
76.84
75.04

56.69
56.30
55.79





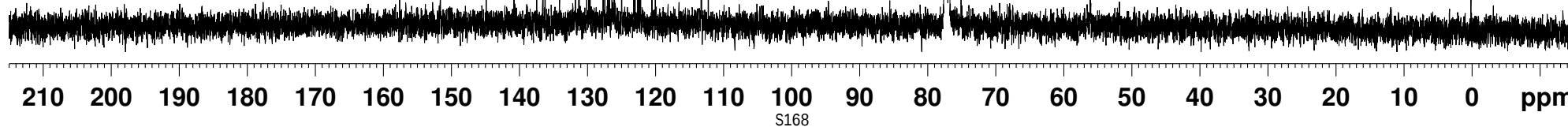
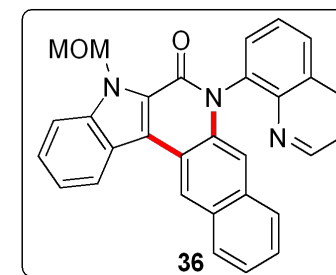
NAME zty-c139-3-3
EXPNO 2
PROCNO 1
Date_ 20170527
Time 2.06
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 1024
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631988 sec
RG 211.61
DW 20.800 usec
DE 6.50 usec
TE 296.9 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

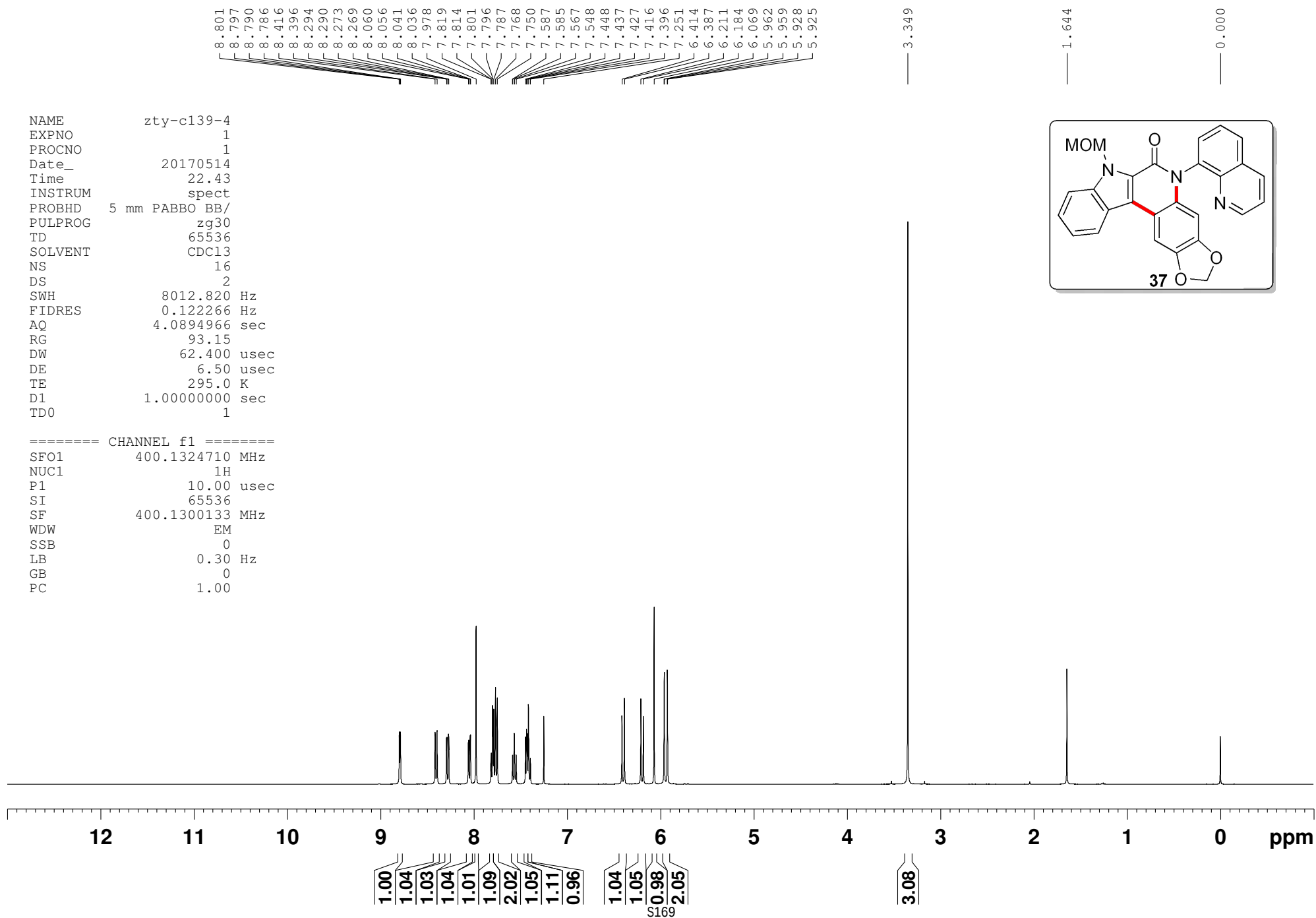
===== CHANNEL f1 =====
SFO1 100.6228293 MHz
NUC1 13C
P1 10.00 usec
SI 32768
SF 100.6127565 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

157.60
151.65
144.87
140.81
137.45
136.56
136.22
131.75
131.25
130.10
129.77
129.60
127.71
127.44
127.02
126.76
126.40
126.07
124.97
123.17
122.99
122.60
122.40
122.21
120.53
120.04
113.26
112.24

77.48
77.16
76.84
75.08

56.12

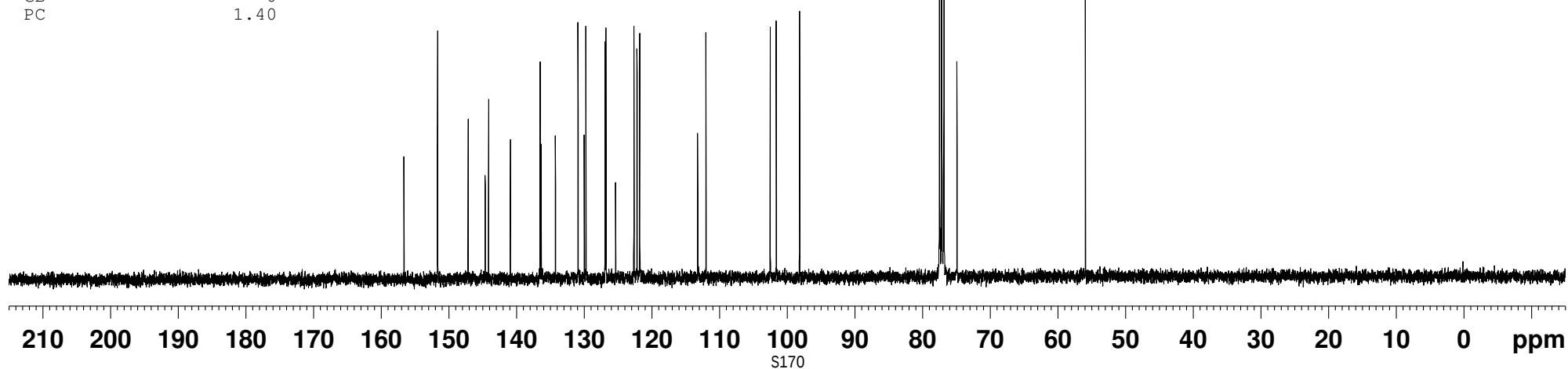
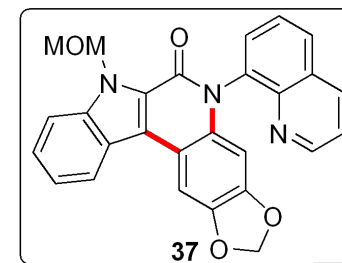


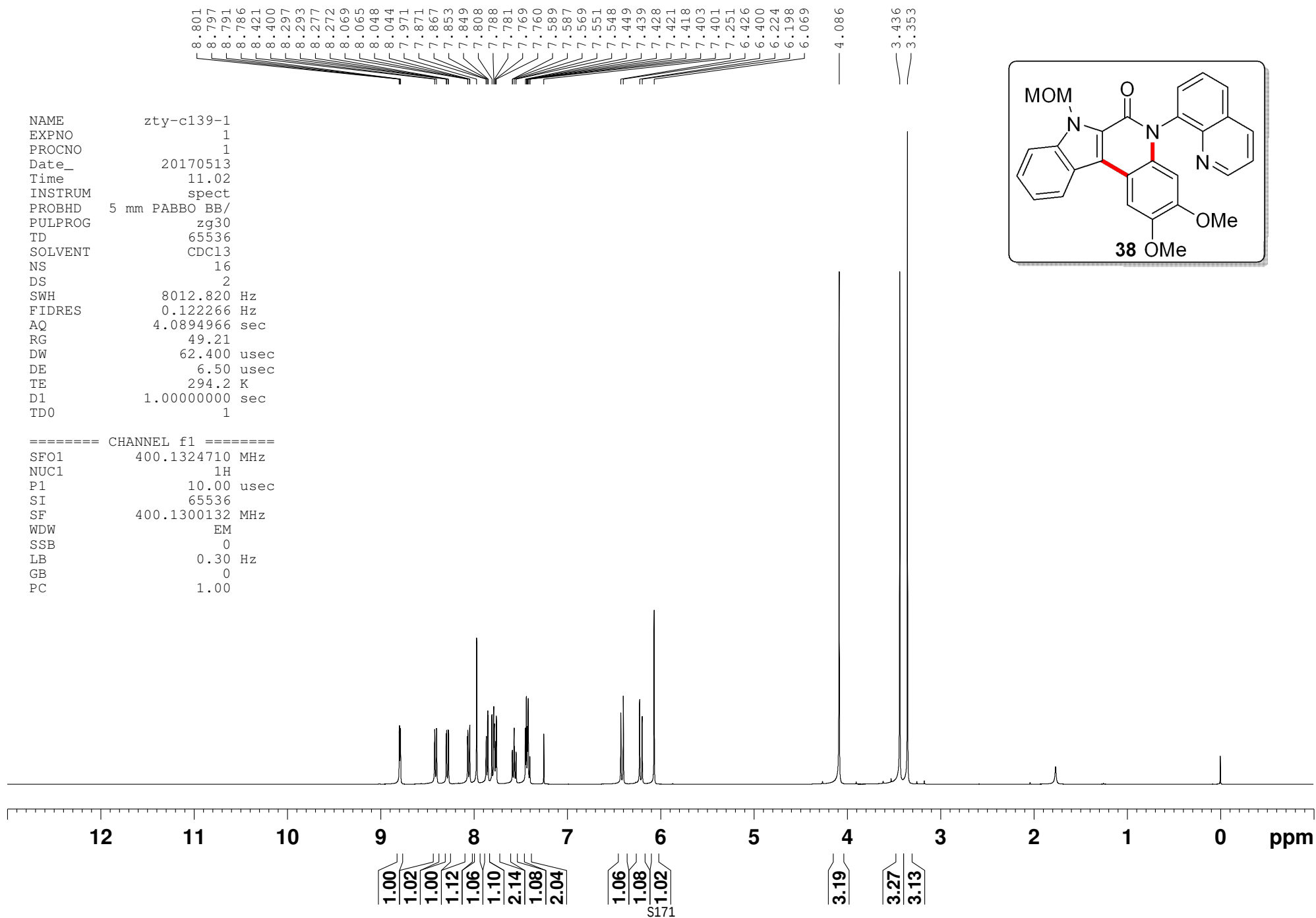


NAME zty-c139-4
 EXPNO 2
 PROCNO 1
 Date_ 20170514
 Time 23.13
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 500
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 295.8 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127589 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

156.65
 151.69
 147.16
 144.64
 144.14
 140.92
 136.53
 136.37
 134.25
 130.91
 130.00
 129.76
 126.92
 126.79
 125.36
 122.68
 122.64
 122.20
 121.81
 121.78
 113.23
 112.01
 102.51
 101.62
 98.18
 77.48
 77.16
 76.84
 74.90
 55.93





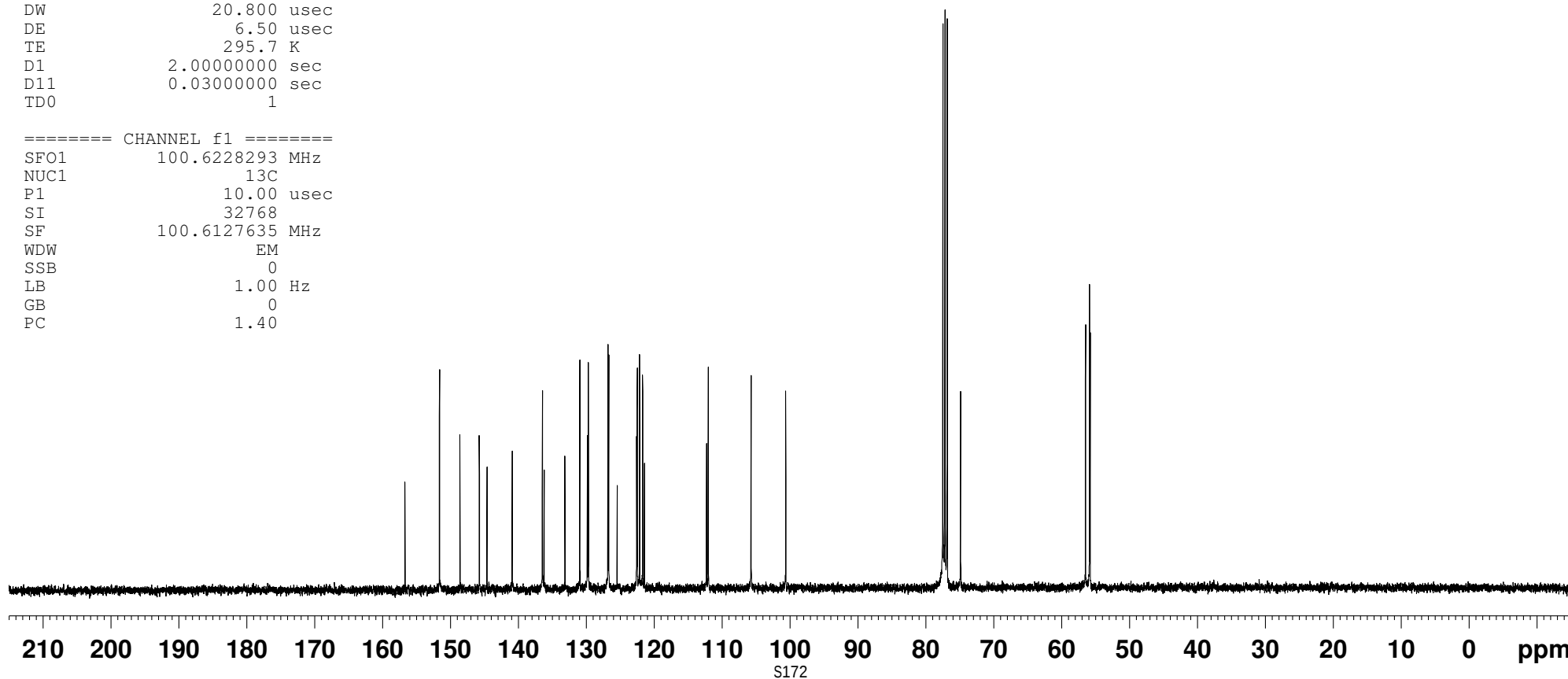
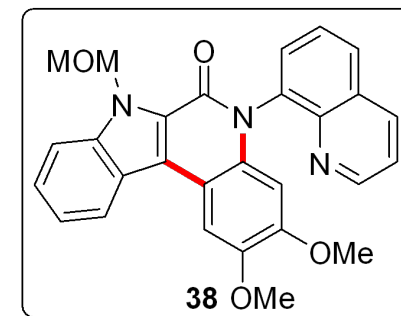
NAME zty-c139-1
 EXPNO 2
 PROCNO 1
 Date_ 20170515
 Time 3.38
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 500
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 295.7 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127635 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

156.72
 151.63
 148.61
 145.76
 144.64
 140.91
 136.47
 136.22
 133.15
 130.96
 129.85
 129.70
 126.81
 126.70
 125.46
 122.61
 122.51
 122.15
 121.71
 121.43
 112.29
 112.04
 105.73
 100.63

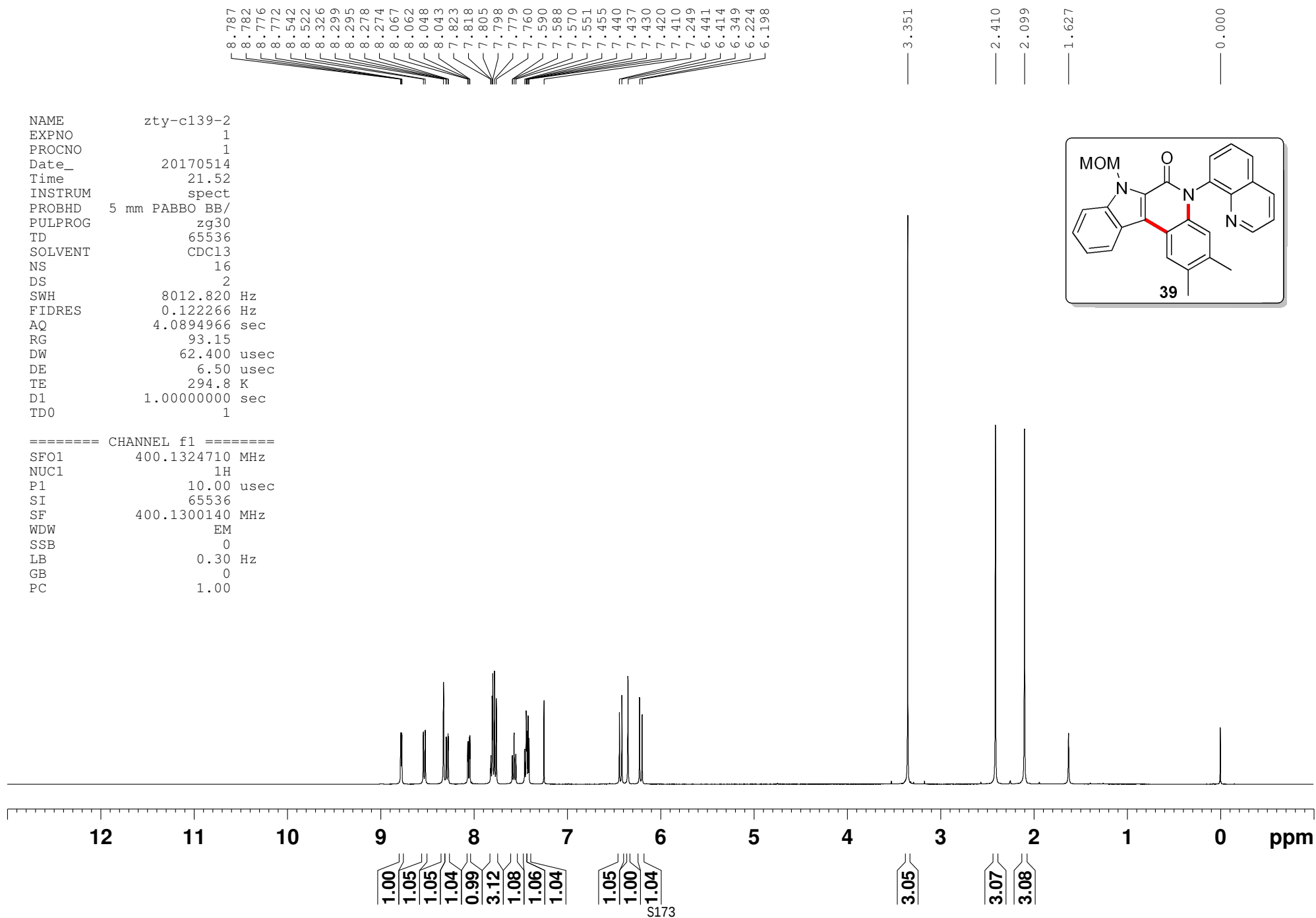
77.48
 77.16
 76.84
 74.87

56.47
 55.87
 55.78



NAME zty-c139-2
EXPNO 1
PROCNO 1
Date_ 20170514
Time 21.52
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
SWH 8012.820 Hz
FIDRES 0.122266 Hz
AQ 4.0894966 sec
RG 93.15
DW 62.400 usec
DE 6.50 usec
TE 294.8 K
D1 1.00000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 400.1324710 MHz
NUC1 1H
P1 10.00 usec
SI 65536
SF 400.1300140 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00



NAME zty-c139-2
 EXPNO 2
 PROCNO 1
 Date_ 20170514
 Time 22.22
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 500
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 295.8 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

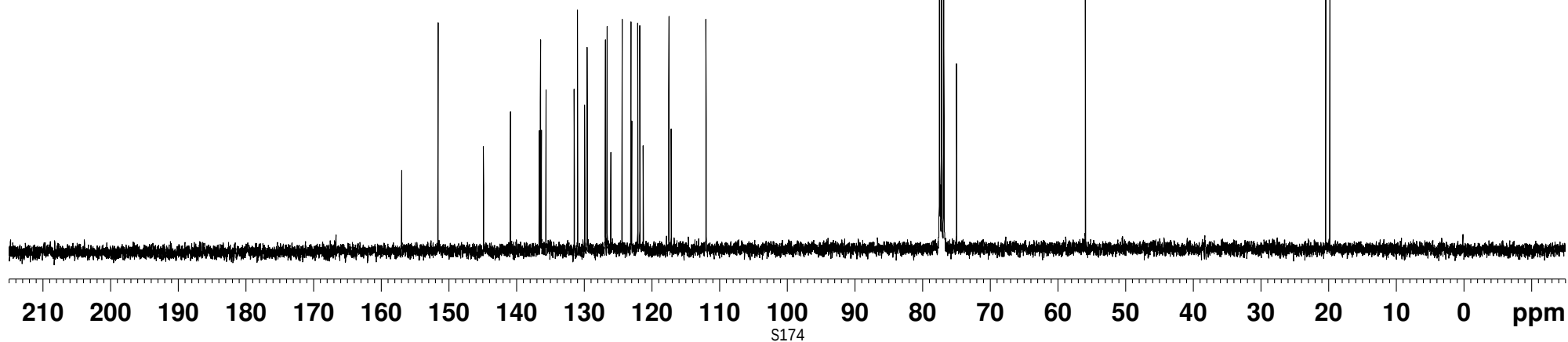
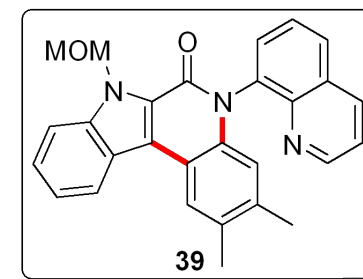
===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127579 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

157.00
 151.61
 144.89
 140.90
 136.65
 136.47
 136.34
 135.66
 131.47
 131.00
 129.93
 129.56
 126.88
 126.62
 126.08
 124.41
 123.09
 122.98
 122.10
 121.79
 121.29
 117.50
 117.15
 112.00

77.48
 77.16
 76.84
 74.97

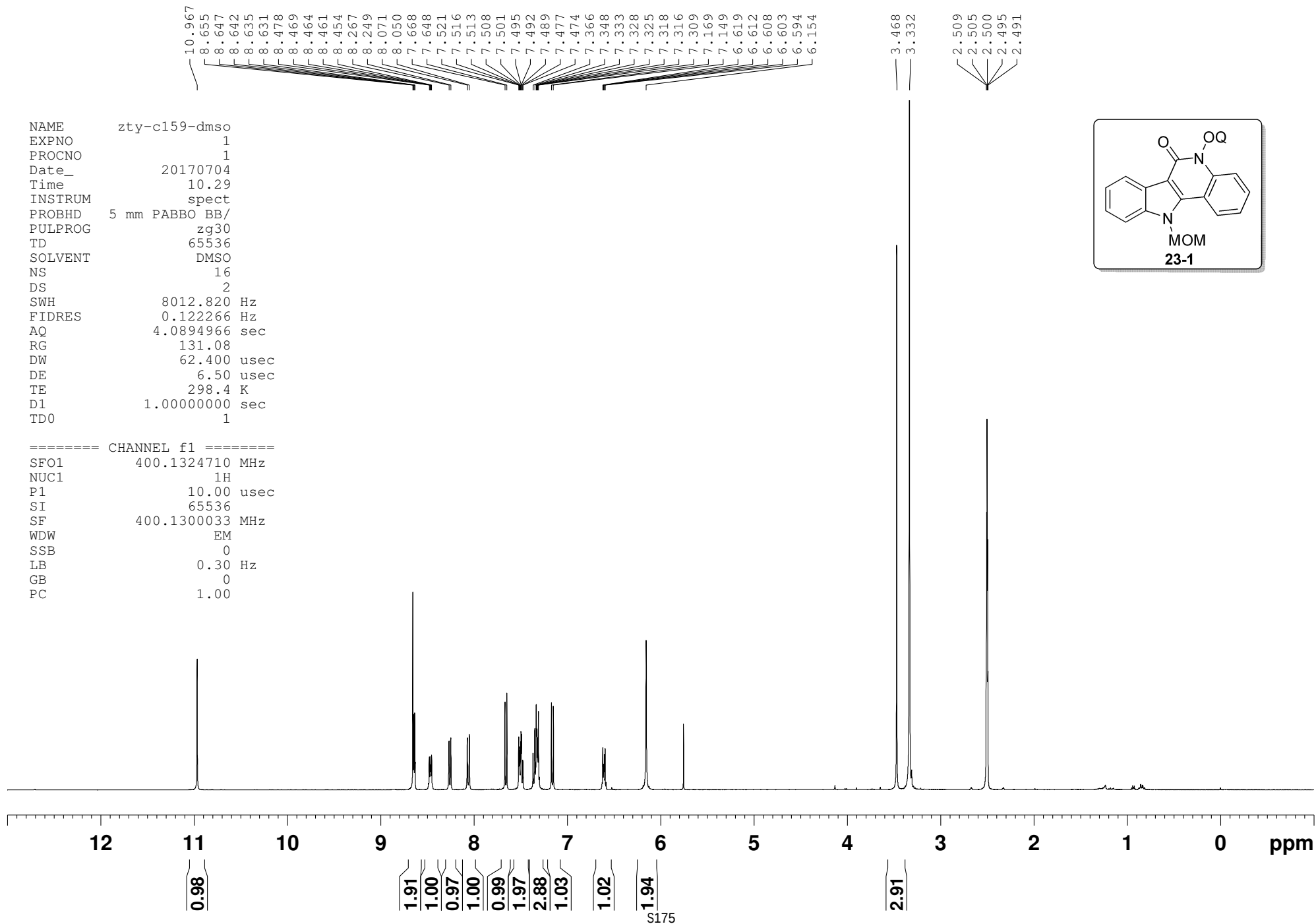
55.93

20.41
 19.79



NAME zty-cl59-dmsd
EXPNO 1
PROCNO 1
Date_ 20170704
Time 10.29
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 16
DS 2
SWH 8012.820 Hz
FIDRES 0.122266 Hz
AQ 4.0894966 sec
RG 131.08
DW 62.400 usec
DE 6.50 usec
TE 298.4 K
D1 1.00000000 sec
TD0 1

===== CHANNEL f1 =====
SFO1 400.1324710 MHz
NUC1 1H
P1 10.00 usec
SI 65536
SF 400.1300033 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00



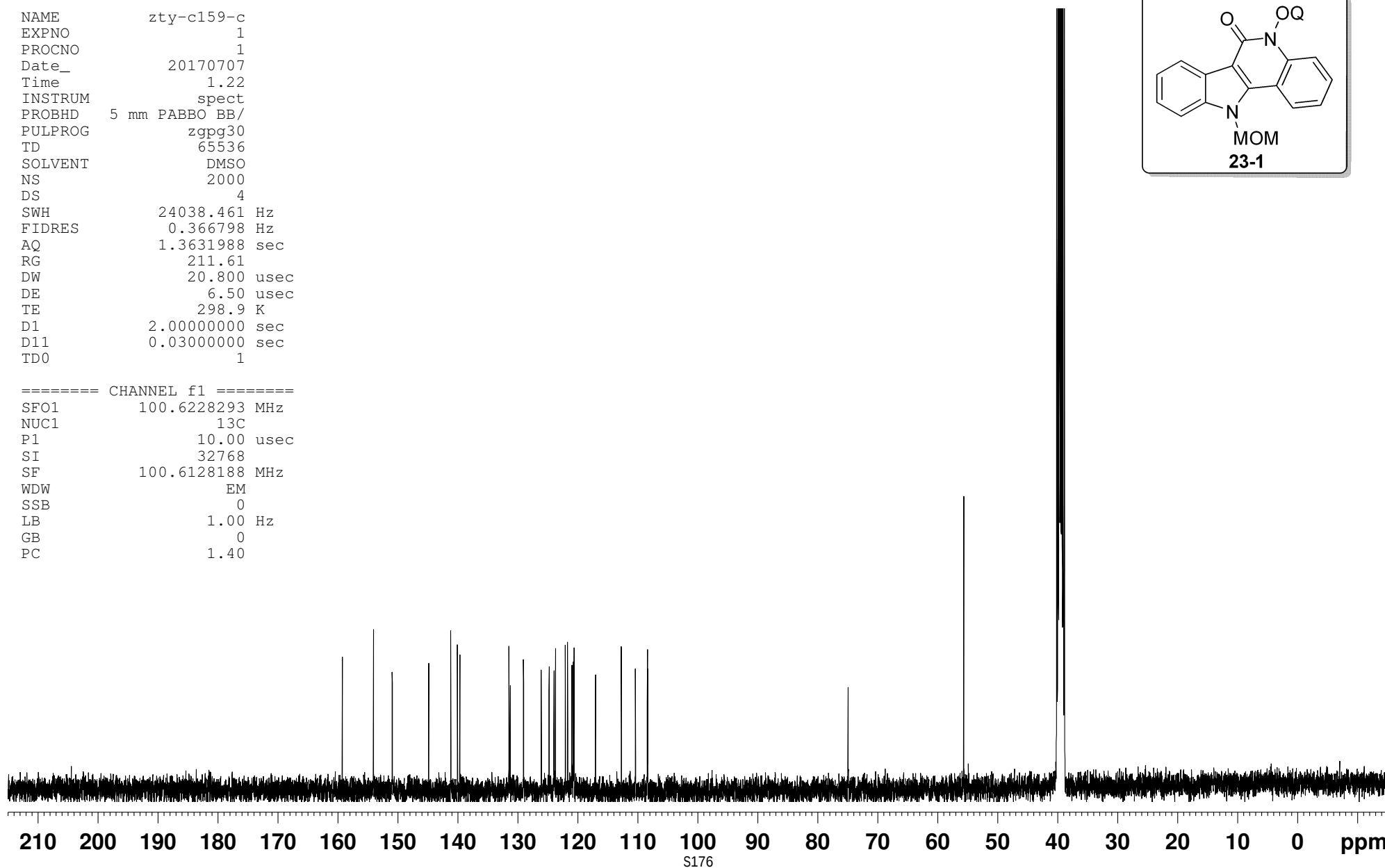
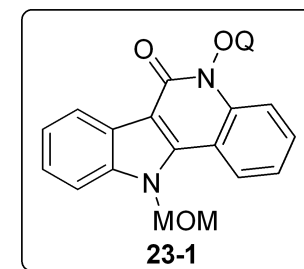
NAME zty-c159-c
 EXPNO 1
 PROCNO 1
 Date_ 20170707
 Time 1.22
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT DMSO
 NS 2000
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 298.9 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

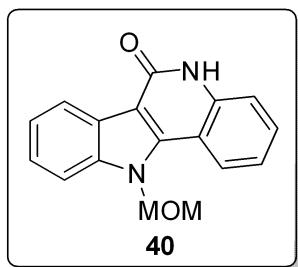
===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6128188 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

159.27
 154.08
 150.95
 144.87
 141.19
 140.09
 139.67
 131.48
 131.27
 129.06
 126.10
 124.79
 123.98
 123.74
 122.09
 121.72
 120.99
 120.75
 120.63
 117.06
 112.74
 110.41
 108.40
 108.33

74.93

55.64





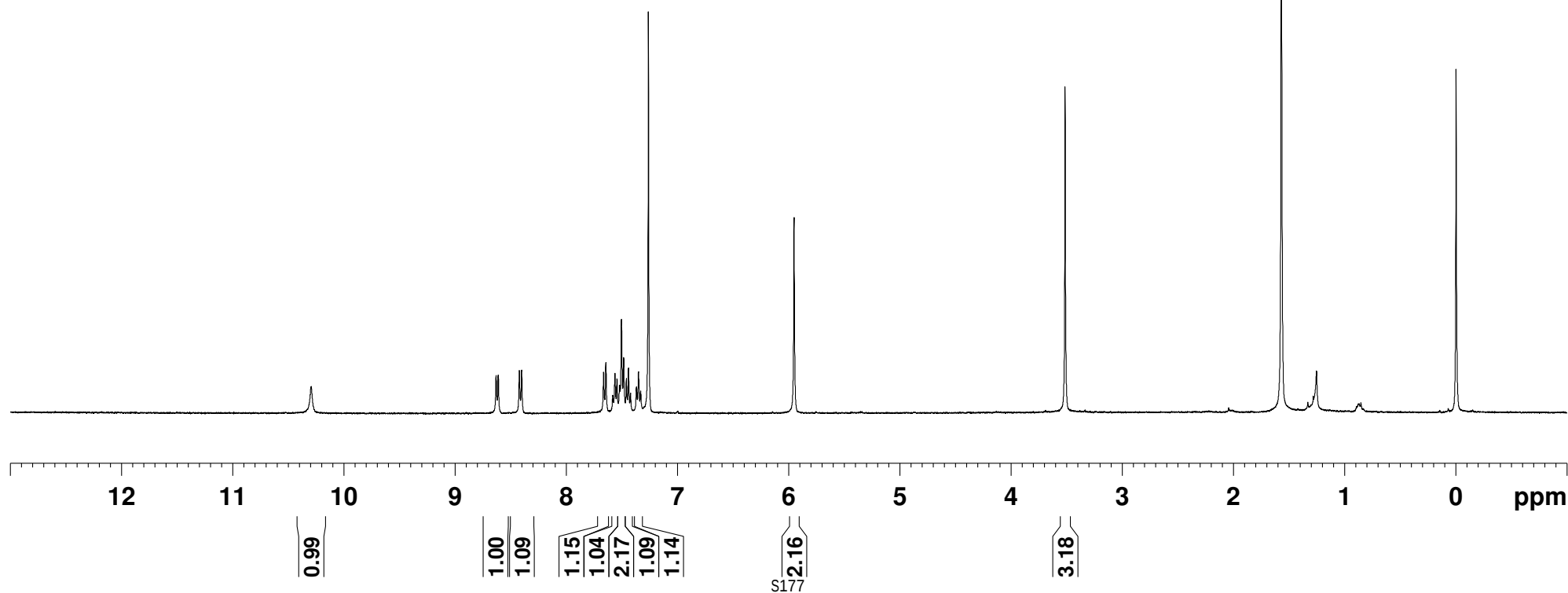
— 10.292

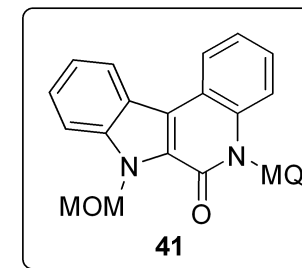
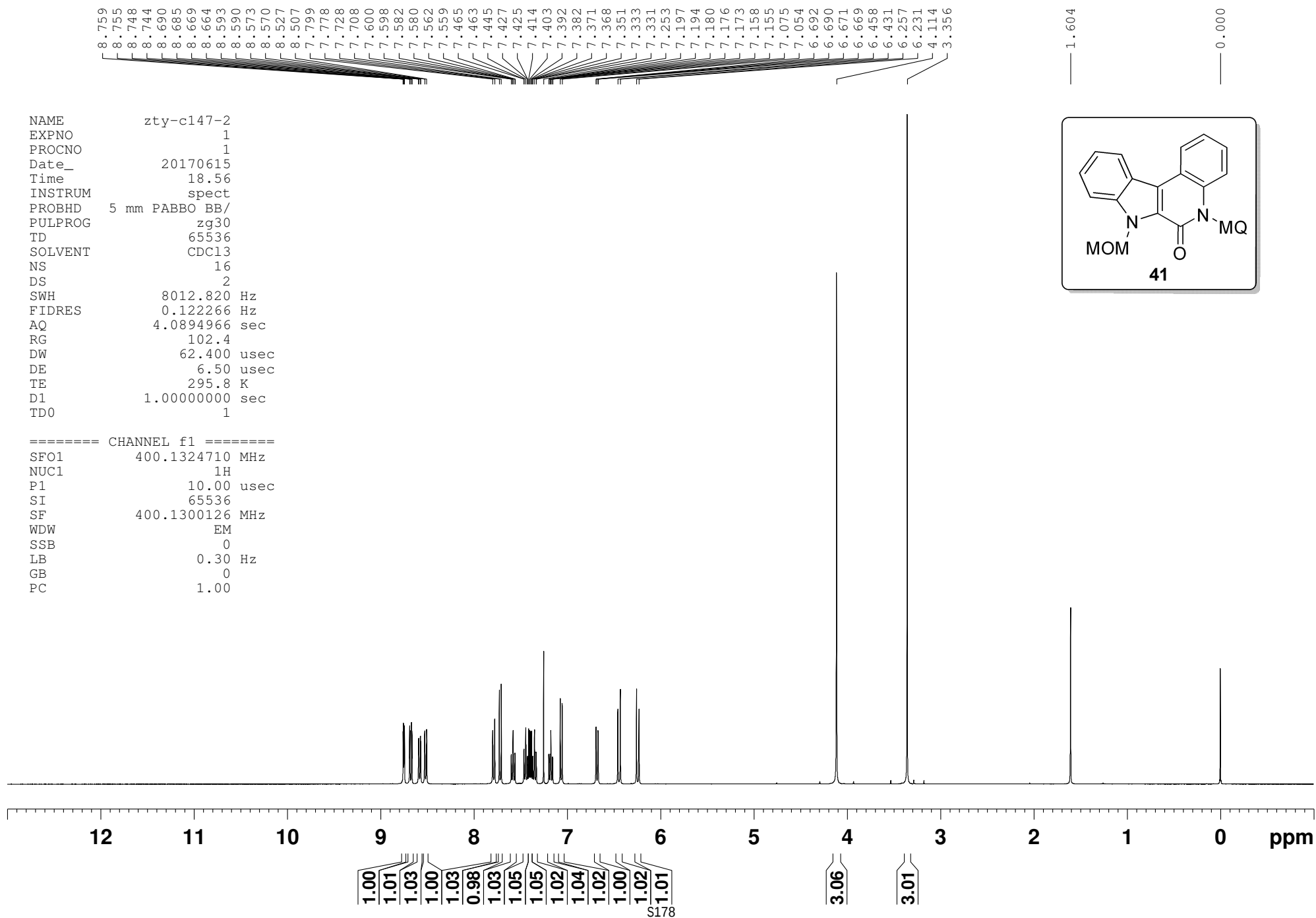
8.630
8.611
8.421
8.400
7.663
7.643
7.580
7.561
7.542
7.519
7.502
7.483
7.457
7.439
7.421
7.367
7.349
7.329
7.260
— 5.950

— 3.513

— 0.000

NAME zty-c171-3.fid
EXPNO 1
PROCNO 1

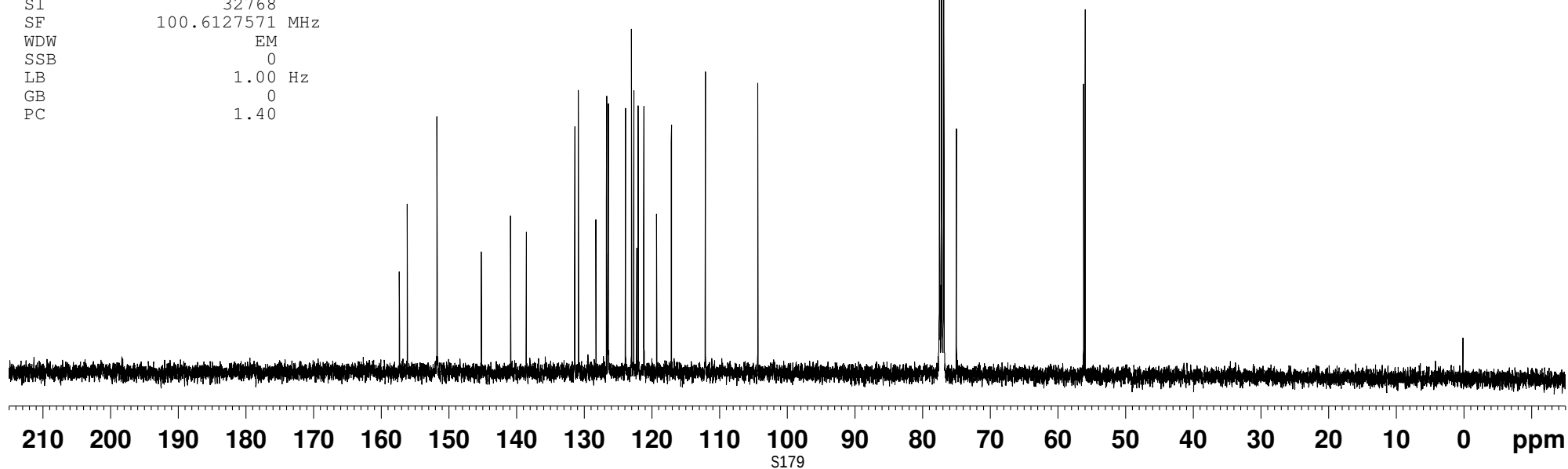
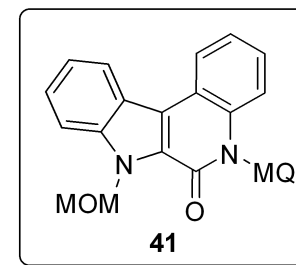


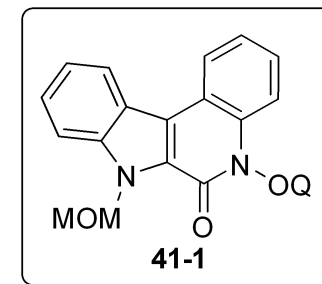
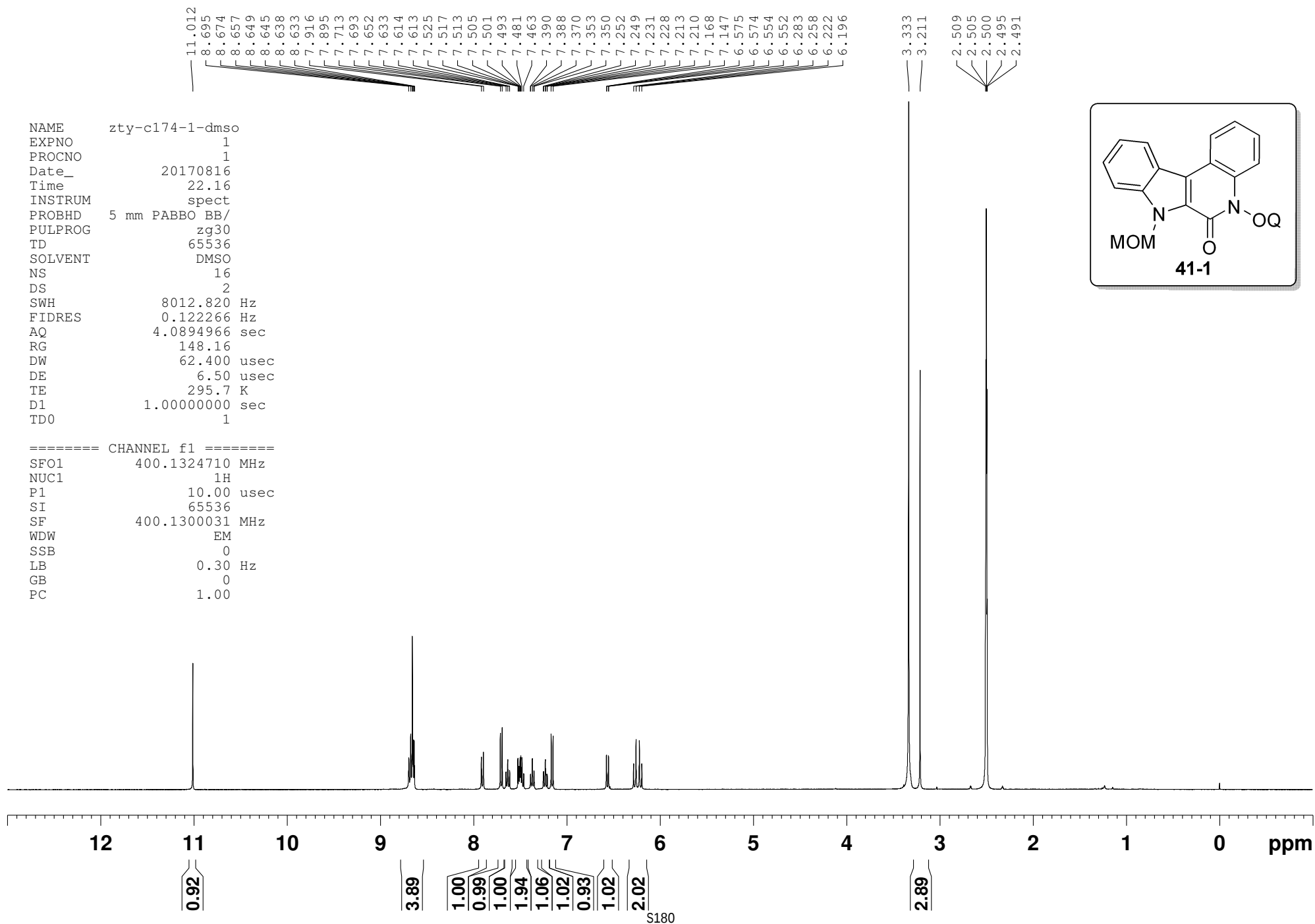


NAME zty-c147-2
 EXPNO 2
 PROCNO 1
 Date_ 20170615
 Time 19.24
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 800
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 296.7 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6127571 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

157.32
 156.17
 151.76
 145.22
 140.88
 138.56
 131.40
 130.87
 128.29
 126.70
 126.51
 126.44
 123.90
 123.02
 122.69
 122.22
 122.02
 121.21
 121.18
 119.30
 117.13
 112.10
 104.36
 77.48
 77.16
 76.84
 74.99
 56.19
 55.96

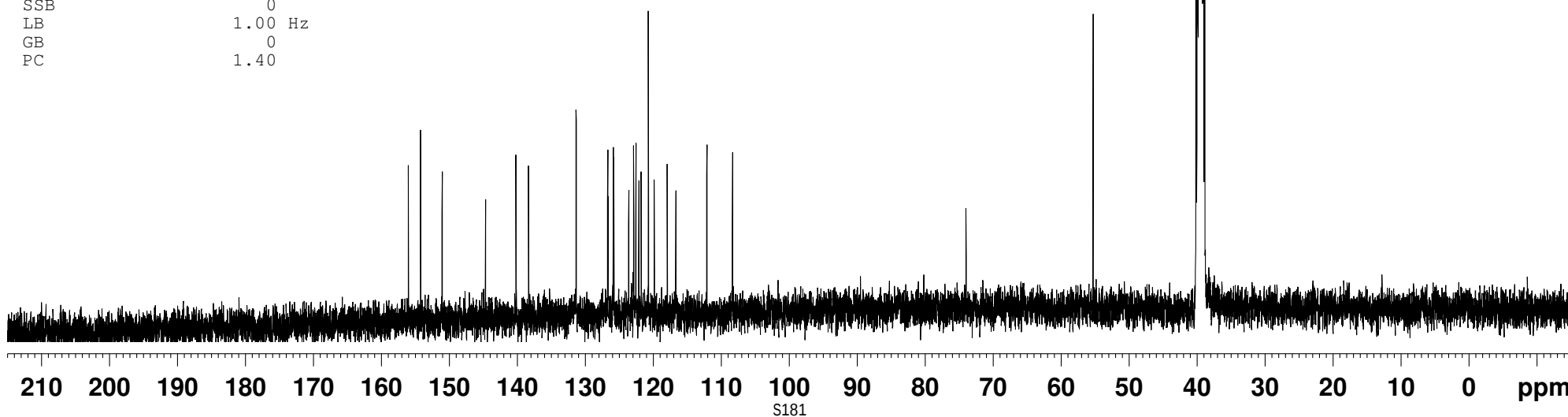
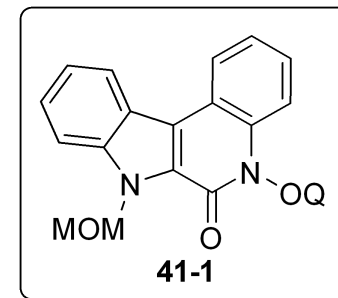


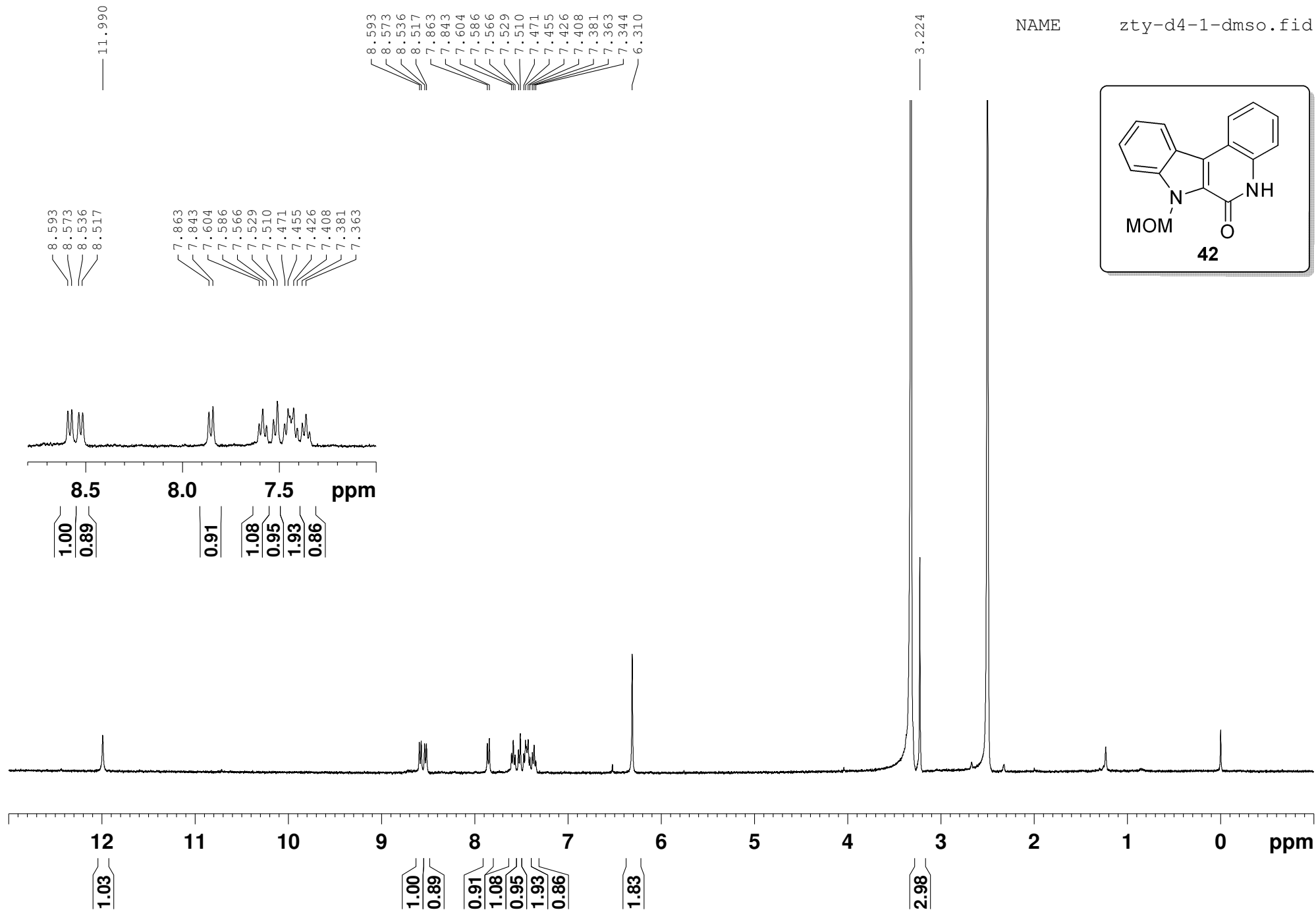


NAME zty-c174-c
 EXPNO 4
 PROCNO 1
 Date_ 20170906
 Time 4.09
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT DMSO
 NS 2000
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 296.9 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6128173 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

156.04
 154.24
 151.07
 144.67
 140.21
 138.35
 131.34
 126.70
 126.63
 125.87
 125.80
 123.61
 122.89
 122.55
 122.11
 121.78
 120.72
 119.85
 117.94
 116.67
 112.11
 108.33
 89.52
 80.19
 73.98
 55.27
 40.13
 39.92
 39.71
 39.50
 39.29
 39.08
 38.87





NAME zty-D4-1-dmsO
 EXPNO 4
 PROCNO 1
 Date_ 20170906
 Time 8.04
 INSTRUM spect
 PROBHD 5 mm PABBO BB/
 PULPROG zgpg30
 TD 65536
 SOLVENT DMSO
 NS 4000
 DS 4
 SWH 24038.461 Hz
 FIDRES 0.366798 Hz
 AQ 1.3631988 sec
 RG 211.61
 DW 20.800 usec
 DE 6.50 usec
 TE 297.1 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1

===== CHANNEL f1 =====
 SFO1 100.6228293 MHz
 NUC1 13C
 P1 10.00 usec
 SI 32768
 SF 100.6128175 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

— 170.09

155.96
 155.75

135.17
 128.58
 126.71
 126.42
 126.08
 123.29
 122.72
 122.53
 121.92
 120.13
 115.90
 112.04

— 73.93

— 55.17

40.13
 39.92
 39.71
 39.50
 39.29
 39.08
 38.87

