Electronic Supplementary Material (ESI) for ChemComm.


# Supporting Information

## Synthesis of *N*-(Acyloxy)-*N*-alkynylamides *via* Generation of "$C_2$" from Hypervalent Alkynyliodane and Weak Base

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## 1. General Comments

All reactions were carried out under argon atmosphere unless otherwise noted. All melting points were measured on a Yanagimoto micro melting point apparatus, and are uncorrected. IR spectra were recorded on a Shimadzu IR Prestige-21 spectrophotometer. $^{1}H$ and $^{13}C$-NMR spectra were measured on a JEOL JNM-AL300 (300 MHz), a JEOL JNM-AL400 (400 MHz), a JEOL JNM-ECS400 (400 MHz), or a JEOL JNM-ECZ500 (500 MHz) spectrometer with tetramethylsilane as an internal standard. *J*-Values were given in Hertz. Mass spectra were recorded on a JEOL JMS 700 instrument with a direct inlet system. Column chromatography was carried out on a silica gel [Fuji Silysia Co Inc. (silica gel PSQ 60B)].

## 2. Materials

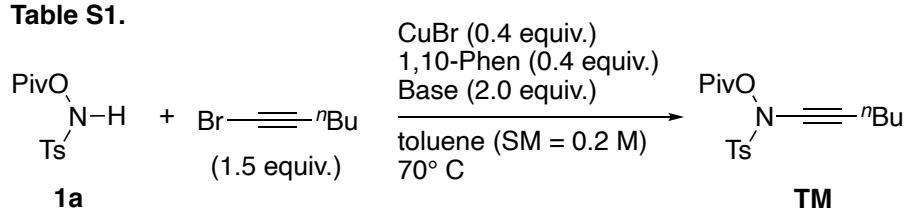
All commercially available materials were purchased from Sigma–Aldrich Co., Tokyo Chemical Industry Co. and Wako Pure Chemical Industries, and were used as received. The following amides were synthesized and characterized by the previous reports: **1a**,[1] **1d**,[1] **1s,**[1] **1b**,[2] **1g**,[2] **1i**,[2] **1c**,[3] **1e**,[4] **1f**,[5] **1p**,[5] **1h**,[6] **1j**,[6] **1r**.[7] The hypervalent alkyny-$\lambda^3$-liodane **3** was prepared to the literature[8] and the alkynylation reaction used a rubbed test tube.

## 3. Experimental Results Described in Scheme 1.

### 3-1. Attempt to Synthesized *N*-(acyloxy)ynamides by C-N Cross Coupling

We first tried to synthesize *N*-(pivaloyloxy)ynamide (**TM**) by well-established copper-mediated C-N coupling reaction of *N*-(pivaloyloxy)tosylamide (**1a**) and 1-bromohexyne, and a part of experimental results are described in Table S1. We thoroughly investigated the reaction conditions, but in most cases, we could only confirm the decomposition of the starting materials and could not obtain the target product.

**Table S1.**

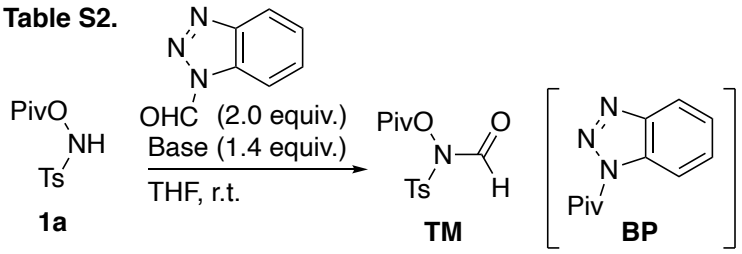



| Entry | Base | Time (h) | TM (%) | **1a** recovery (%) |
|---|---|---|---|---|
| 1 | $Na_2CO_3$ | 17 | - | - |
| 2 | $K_2CO_3$ | 15 | - | - |
| 3 | $LiCO_3$ | 19 | - | - |
| 4 | $Cs_2CO_3$ | 15 | - | - |
| 5 | $CaCO_3$ | 16 | 4 | - |
| 6 | $K_3PO_4$ | 19 | - | - |
| 7 | $NaHCO_3$ | 26 | - | - |
| 8 | KHMDS | 15 | - | - |

### 3-2. Attempt to Synthesized *N*-(acyloxy)ynamides by Corey-Fuchs Method

We have also attempted to synthesize *N*-(pivaloyloxy)ynamide (**TM**) using Corey-Fuchs method (Table S2). However, the *N*-formylation of *N*-(pivaloyloxy)tosylamide did not proceed as expected, and in many cases the raw material was recovered, and depending on the base, only *N*-formylbenzotriazole was obtained as a by-product. When monitoring the progress of the reaction with TLC, it is possible to observe a spot that seems to be the target product, but it decomposed and returnd to the starting material (**1a**) during the work-up stage. It was thought that the target molecule *N*-formylbenzotoriazole was very unstable due to humidity.

**Table S2.**

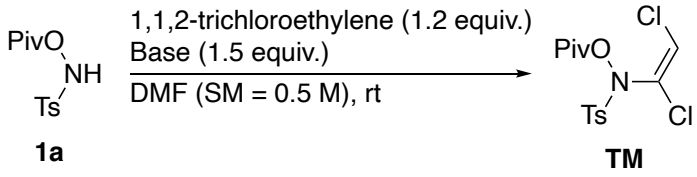



| Entry | Base | Time (h) | **TM** (%) | **1a** recovery (%) | **BP** (%) |
|---|---|---|---|---|---|
| 1 | NaH | 22 | - | 66 | 17 |
| 2 | LHMDS | 26 | - | 93 | trace |
| 3 | NaHMDS | 26 | - | 36 | - |
| 4 | KHMDS | 22 | - | 81 | 3 |
| 5 | $Li_2CO_3$ | 19 | - | 100 | - |
| 6 | $Na_2CO_3$ | 19 | - | 90 | - |
| 7 | $K_2CO_3$ | 19 | - | 61 | 5 |
| 8 | $Rb_2CO_3$ | 19 | - | 68 | - |
| 8 | $Cs_2CO_3$ | 16 | - | 58 | - |

## 3-2. Attempt to Synthesized *N*-(Acyloxy)ynamides via Dichloroolefination

We have also attempted to synthesize *N*-(pivaloyloxy)ynamide (**TM**) via dichloroolefinaiton (Table S3). We thoroughly investigated the reaction conditions, but the target dichloroalkenylamide could only be obtained with low yield. Therefore, it was concluded that this method could not be adopted.

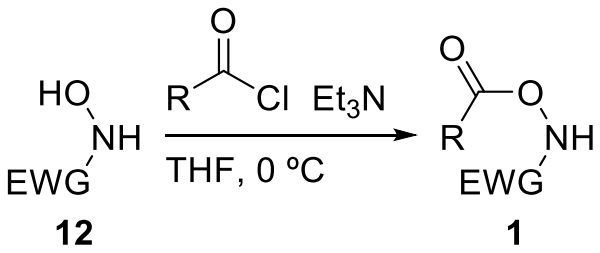
**Table S3.**




| Entry | Base | Time (h) | **TM** (%) | **1a** recovery (%) |
|---|---|---|---|---|
| 1 | $Li_2CO_3$ | 15 | - | 46 |
| 2 | $Na_2CO_3$ | 20 | - | 63 |
| 3 | $Rb_2CO_3$ | 23 | - | 50 |
| 4 | $Cs_2CO_3$ | 23 | - | 84 |
| 5 | $K_2CO_3$ | 23 | 8 | 69 |
| 6 | NaH | 17 | 23 | 36 |

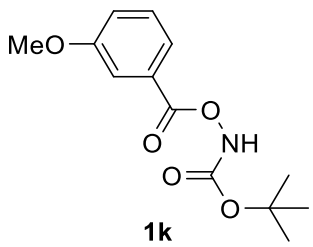
## 4. Spectroscopic and Analytical Data

### General procedure for the synthesis of *N*-(acyloxy)amides 1




To a solution of *N*-(hydroxy)amide **12** in THF ([**7**] = 0.1 M) was added $Et_3N$ (1.0 equiv.) at room temperature. After cooling the reaction mixture to 0 °C, acyl chloride was slowly added dropwise. Then, the reaction was gradually raised to a temperature and stirred overnight. The reaction mixture was diluted with $H_2O$ and extracted with AcOEt. The combined organic layers were washed with brine, dried over $Na_2SO_4$ and concentrated under reduced pressure. The crude residue was purified by silica gel chromatography or recrystallization to give *N*-(acyloxy)amide **1**.

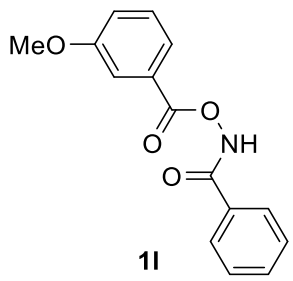
### *N*-(Acyloxy)amide (1k)




A crude product, which was obtained from *N*-(*tert*-Butoxycarbonyl)hydroxyamide **12a** (665.0 mg, 5.0 mmol), $Et_3N$ (0.70 mL, 5.0 mmol) and *m*-methoxybenzoyl chloride (0.68 mL, 5.0 mmol) for 18 h, was purified by silica gel chromatography with *n*-hexane/$Et_2O$ (2/1) to give **1k** (1.35 g, 5.0 mmol, 100%) as a colorless solid. M.p. 48-52 °C; IR (neat): 3279, 2837, 1766, 1740, 1585, 1251, 1369 $cm^{-1}$; $^1$H-NMR (500 MHz, $CDCl_3$/TMS) δ 8.18 (s, 1H), 7.70 (ddd, *J* = 8.0, 1.4, 0.9 Hz, 1H), 7.59 (dd, *J* = 2.6, 1.4 Hz, 1H), 7.38 (dd, *J* = 8.0, 8.0 Hz, 1H), 7.17 (ddd, *J* = 8.0, 2.6, 0.9 Hz, 1H), 3.86 (s, 3H), 1.52 (s, 9H); $^{13}$C-NMR (125 MHz, $CDCl_3$/TMS) δ 166.2, 159.8, 155.7, 129.9, 128.2,

122.5, 121.1, 114.2, 83.6, 55.7, 28.2 (3C); LRMS (EI) m/z: 267 $[M]^+$, 211, 194, 167, 152, 135, 107, 92, 77, 57; HRMS (EI) m/z: $[M]^+$ Calcd for $C_{13}H_{17}NO_5$ 267.1107; found 267.1105.

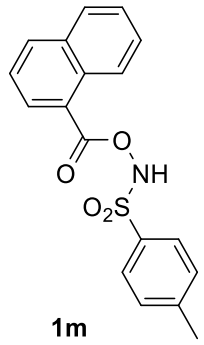
***N*-(Acyloxy)amide (1l)**



**1l**

A crude product, which was obtained from *N*-(Benzonyl)hydroxyamide **12b** (685.7 mg, 5.0 mmol), triethylamine (0.70 mL, 5.0 mmol) and *m*-methoxybenzoyl chloride (0.68 mL, 5.0 mmol) for 17 h, was purified by silica gel chromatography with *n*-hexane/$Et_2O$ (1/1) to give **1l** (863.3 mg, 3.2 mmol, 64%) as a colorless solid. M.p. 104-107 °C; IR (neat): 3194, 1769, 1668, 1506, 1182 $cm^{-1}$; $^1$H-NMR (500 MHz, $CDCl_3$/TMS) δ 9.81 (s, 1H), 7.89–7.85 (m, 2H), 7.75 (brd, *J* = 8.0 Hz, 1H), 7.63 (dd, *J* = 2.6, 1.4 Hz, 1H), 7.58 (brdd, *J* = 7.7, 7.7 Hz, 1H), 7.47 (brdd, *J* = 7.7, 7.7 Hz, 2H), 7.40 (dd, *J* = 8.0, 8.0 Hz, 1H), 7.19 (ddd, *J* = 8.0, 2.6, 0.9 Hz, 1H), 3.87 (s, 3H); $^{13}$C-NMR (125 MHz, $CDCl_3$/TMS) δ 166.8, 165.3, 159.8, 133.0, 130.9, 129.9 (2C), 129.0, 127.9, 127.7 (2C), 122.6, 121.2, 114.3, 55.7; LRMS (EI) m/z: 271 $[M]^+$, 152, 135, 119, 107, 105, 91, 81, 77, 64, 51; HRMS (EI) m/z: $[M]^+$ Calcd for $C_{15}H_{13}NO_4$ 271.0845; found 271.0847.

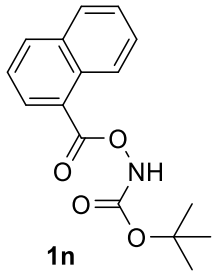
***N*-(Acyloxy)amide (1m)**



**1m**

A crude product, which was obtained from *N*-(*p*-Toluenesulfonyl)hydroxyamide **12c** (373.9 mg, 2.0 mmol), $Et_3N$ (0.30 mL, 2.1 mmol) and 1-naphthoyl chloride (0.30 mL, 2.0 mmol) for 18 h, was purified by silica gel chromatography with *n*-hexane/AcOEt (2/1) to give **1m** (580.3 mg, 1.7 mmol, 85%) as a colorless solid. M.p. 50-53 °C; IR (neat): 3156, 1763, 1748, 1508, 1384, 1238, 1170 $cm^{-1}$; $^1$H-NMR (500 MHz, $CDCl_3$/TMS) δ 9.39 (s, 1H), 8.32–7.87 (m, 1H), 8.14 (dd, *J* = 7.2, 1.1 Hz, 1H), 8.09 (brd, *J* = 8.3 Hz, 1H), 7.90–7.88 (m, 1H), 7.86 (brd, *J* = 8.3 Hz, 2H), 7.57–7.55 (m, 2H), 7.53–7.50 (m, 1H), 7.25 (brd, *J* = 8.3 Hz, 2H), 2.37 (s, 3H); $^{13}$C-NMR (125 MHz, $CDCl_3$/TMS) δ 165.7, 145.9, 135.3, 133.8, 132.4, 131.1, 130.9, 130.1 (2C), 129.1 (2C), 128.9, 128.5, 126.9, 125.1, 124.6, 122.5, 21.8; LRMS (EI) m/z: 341 $[M]^+$, 172, 171, 155, 139, 127, 91, 77, 65, 51; HRMS (EI) m/z: $[M]^+$ Calcd for $C_{18}H_{15}NO_4S$ 341.0722; found 341.0721.

***N*-(Acyloxy)amide (1n)**

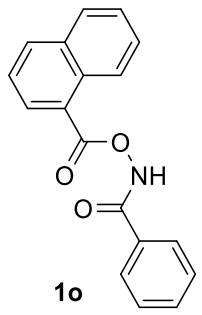


**1n**

A crude product, which was obtained from **12a** (668.2 mg, 5.0 mmol), $Et_3N$ (0.75 mL, 5.0 mmol) and 1-naphthoyl chloride (0.70 mL, 5.0 mmol) for 18 h, was purified by recrystallization from AcOEt to give **1n** (1.076 g, 3.7 mmol, 75%) as a colorless solid. M.p. 77-79 °C; IR (neat): 3275, 1761, 1720, 1748, 1510, 1384, 1238, 1163 $cm^{-1}$; $^1$H-NMR (500 MHz, $CDCl_3$/TMS) δ 8.84 (d, *J* = 8.6 Hz, 1H), 8.32 (d, *J* =7.4 Hz, 1H), 8.26 (s, 1H), 8.08 (d, *J* = 8.3 Hz, 1H), 7.90 (d, *J* = 7.8 Hz, 1H), 7.65 (dd, *J* = 7.4, 7.4 Hz, 1H), 7.56 (dd, *J* = 7.8, 7.8 Hz, 1H), 7.53 (dd, *J* = 7.8, 7.8 Hz, 1H), 1.55 (s, 9H); $^{13}$C-NMR (125 MHz, $CDCl_3$/TMS) δ 167.2, 155.9, 134.7, 133.9, 131.4, 131.2, 128.8, 128.5, 126.7, 125.5,

124.7, 123.8, 83.6, 28.2 (3C); LRMS (ESI) m/z: 310 $[M+Na]^+$; HRMS (ESI) m/z: $[M+Na]^+$ Calcd for $C_{16}H_{17}NNaO_4$ 310.1055; found 310.1056.

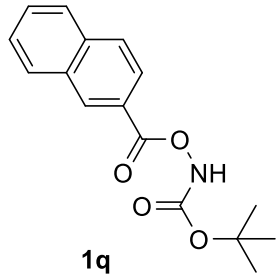
**_N_-(Acyloxy)amide (1o)**



**1o**

A crude product, which was obtained from **12b** (685.5 mg, 5.0 mmol), $Et_3N$ (0.70 mL, 5.0 mmol) and 1-naphthoyl chloride (0.75 mL, 5.0 mmol) for 24 h, was purified by recrystallization from AcOEt to give **1o** (1.38 g, 4.7 mmol, 94%) as a colorless amorphous. IR (neat): 3192, 1769, 1668, 1506 $cm^{-1}$; $^1$H-NMR (500 MHz, $CDCl_3$/TMS) δ 9.86 (s, 1H), 8.89 (brd, $J$ = 8.7 Hz, 1H), 8.44 (dd, $J$ = 7.2, 1.1 Hz, 1H), 7.94–7.91 (m, 3H), 8.12 (d, $J$ = 8.0 Hz, 1H), 7.68–7.66 (m, 1H), 7.62–7.54 (m, 3H), 7.51 (brd, $J$ = 7.6 Hz, 2H); $^{13}$C-NMR (125 MHz, $CDCl_3$/TMS) δ 167.0, 166.3, 135.0, 133.9, 133.0, 131.50, 131.47, 131.0, 129.1 (2C), 128.9, 128.6, 127.7 (2C), 126.8, 125.6, 124.7, 123.4; LRMS (EI) m/z: 291 $[M]^+$, 172, 155, 127, 119, 105, 91, 77, 51; HRMS (EI) m/z: $[M]^+$ Calcd for $C_{18}H_{13}NO_3$ 291.0895; found 291.0890.

**_N_-(Acyloxy)amide (1q)**

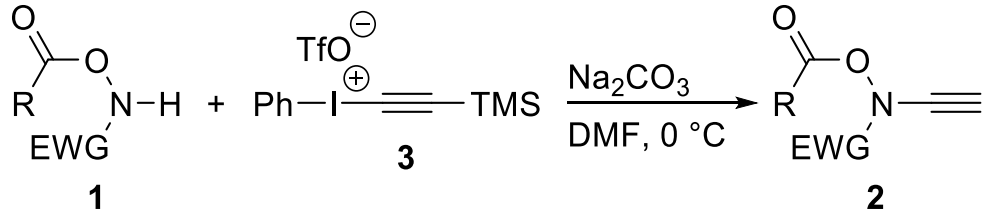


**1q**

A crude product, which was obtained from **12a** (667.4 mg, 5.0 mmol), $Et_3N$ (0.70 mL, 5.0 mmol) and 2-naphthoyl chloride (953.8 mg, 5.0 mmol) for 17 h, was purified by recrystallization from AcOEt to give **1q** (978.6 mg, 3.4 mmol, 68%) as a colorless solid. M.p. 114-116 °C; IR (neat): 3277, 1734, 1761, $cm^{-1}$; $^1$H-NMR (500 MHz, $CDCl_3$/TMS) δ 8.71 (s, 1H), 8.26 (s, 1H), 8.08 (dd, $J$ = 8.6, 1.7 Hz, 1H), 7.97 (brd, $J$ = 7.8 Hz, 1H), 7.92 (d, $J$ = 8.6 Hz, 1H), 7.90 (d, $J$ = 7.8 Hz, 1H), 7.65–7.62 (m, 1H), 7.59–7.56 (m, 1H),

1.54 (s, 9H); $^{13}$C-NMR (125 MHz, $CDCl_3$/TMS) δ 166.4, 155.8, 136.2, 132.1, 129.7, 129.1, 128.7, 128.1, 128.0, 127.2, 125.0, 124.2, 83.6, 28.2 (3C); LRMS (EI) m/z: 287 $[M]^+$, 231, 214, 187, 172, 155, 127, 101, 77, 57; HRMS (EI) m/z: $[M]^+$ Calcd for $C_{16}H_{17}NO_4$ 287.1158; found 287.1156.

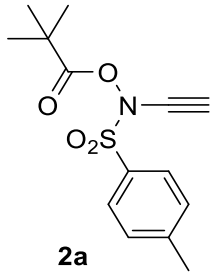
**General procedures for synthesis of *N*-(acyloxy)ynamides 2**




**Method A:** To a solution of **3** (1.0 equiv.) in DMF ([**3**] = 0.2 M) were added **1** and $Na_2CO_3$ (1.0 equiv.) at 0 ℃, and the mixture was stirred for 1 h at the same temperature. The reaction mixture was diluted with $H_2O$ and extracted with AcOEt. The combined organic layers were washed with brine, dried over $Na_2SO_4$ and concentrated under reduced pressure. The crude residue was purified by silica gel column chromatography to give **2**.

**Method B:** After adding DMF ([**1**] = 0.6 M) to **1** and $Na_2CO_3$ (1.0 equiv.) at room temperature, the reaction mixture was stirred at 0 ℃. A DMF ([**3**] = 0.33 M) solution of **3** (1.0 equiv.) was added dropwise at the same temperature over 1 h using a syringe pump (KDS 100). The reaction mixture was diluted with $H_2O$ and extracted with AcOEt. The combined organic layers were washed with brine, dried over $Na_2SO_4$ and concentrated under reduced pressure. The crude residue was purified by silica gel column chromatography to give **2**.

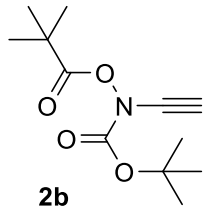
***N*-(Acyloxy)ynamide (2a)**



**2a**

According to the general procedure (Method **B**), a crude product, which was obtained from **3** (136.3 mg, 0.30 mmol), **1a** (80.9 mg, 0.30 mmol) and $Na_2CO_3$ (31.3 mg, 0.30 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (5/2) to give **2a** (63.6 mg, 0.22 mmol, 72%) as a colorless solid. M.p. 73-76 °C; IR (neat): 3269, 2066, 1794, 1595, 1384, 1339, 1176, 1163 $cm^{-1}$; $^1$H-NMR (300 MHz, $CDCl_3$) δ 7.87 (d, *J* = 8.4 Hz, 2H), 7.42 (d, *J* = 8.4 Hz, 2H), 3.37 (s, 1H), 2.50 (s, 3H), 1.26 (s, 9H); $^{13}$C-NMR (100 MHz, $CDCl_3$) δ 173.0, 146.8, 130.1, 130.0 (2C), 129.6 (2C), 74.4, 69.3, 38.5, 27.0 (3C), 21.9; LRMS (EI) m/z: 295 $[M]^+$, 211, 155, 139, 108, 91, 85, 77, 65, 57, 51, 41 39; HRMS (EI) m/z: $[M]^+$ Calcd for $C_{14}H_{17}NO_4S$ 295.0878; found 295.0884.

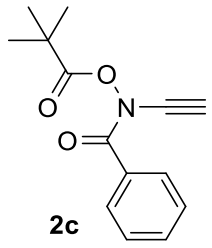
***N*-(Acyloxy)ynamide (2b)**



**2b**

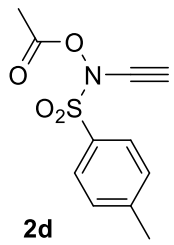
According to the general procedure (Method **B**), a crude product, which was obtained from **3** (136.0 mg, 0.30 mmol), **1b** (64.5 mg, 0.30 mmol) and $Na_2CO_3$ (32.5 mg, 0.31 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (3/1) to give **2b** (29.0 mg, 0.12 mmol, 40%) as a colorless oil. IR (neat): 3284, 2980, 2139, 1793, 1753, 1371, 1257 $cm^{-1}$; $^1$H-NMR (400 MHz, $CDCl_3$/TMS) δ 3.54 (s, 1H), 1.52 (s, 9H), 1.31 (s, 9H); $^{13}$C-NMR (100 MHz, $CDCl_3$/TMS) δ 174.5, 137.6, 85.4, 73.1, 68.4, 38.3, 28.0 (3C), 27.0 (3C); LRMS (FAB, NBA) m/z: 264 $[M+Na]^+$; HRMS (ESI) m/z: $[M+Na]^+$ Calcd for $C_{12}H_{19}NNaO_4$ 264.1206; found 264.1211.

***N*-(Acyloxy)ynamide (2c)**



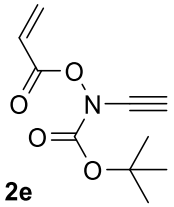

According to the general procedure (Method **B**), a crude product, which was obtained from **3** (136.3 mg, 0.30 mmol), **1c** (66.2 mg, 0.30 mmol) and $Na_2CO_3$ (32.2 mg, 0.30 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (4/1) to give **2c** (41.8 mg, 0.17 mmol, 57%) as a colorless oil. IR (neat): 3294, 2976, 2133, 1791, 1711, 1572, 1281 $cm^{-1}$; $^1$H-NMR (500 MHz, $CDCl_3$/TMS) δ 7.84–7.82 (m, 2H), 7.56–7.53 (m, 1H), 7.45–7.42 (m, 2H), 3.60 (s, 1H), 1.31 (s, 9H); $^{13}$C-NMR (125 MHz, $CDCl_3$/TMS) δ 174.1, 166.4, 132.6, 130.5, 129.0 (2C), 128.3 (2C), 73.9, 70.4, 38.5, 26.6 (3C); LRMS (FAB, NBA) m/z: 246 $[M+H]^+$; HRMS (FAB, NBA) m/z: $[M+H]^+$ Calcd for $C_{14}H_{16}NO_3$ 246.1130; found 246.1127.

***N*-(Acyloxy)ynamide (2d)**



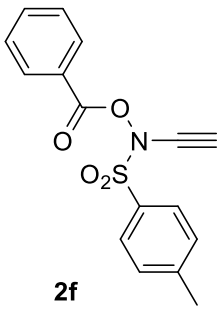

According to the general procedure (Method **B**), a crude product, which was obtained from **3** (136.0 mg, 0.30 mmol), **1d** (67.6 mg, 0.29 mmol) and $Na_2CO_3$ (32.0 mg, 0.30 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (5/2 to 1/1) to give **2d** (45.5 mg, 0.18 mmol, 61%) as a colorless solid. M.p. 63-69 °C; IR (neat): 3283, 2120, 1809, 1595, 1383, 1306, 1192, 1176 $cm^{-1}$; $^1$H-NMR (400 MHz, $CDCl_3$/TMS) δ 7.87 (d, $J$ = 8.1 Hz, 2H), 7.42 (d, $J$ = 8.1 Hz, 2H), 3.40 (s, 1H), 2.50 (s, 3H), 2.18 (s, 3H); $^{13}$C-NMR (100 MHz, $CDCl_3$/TMS) δ 166.2, 146.9, 130.0 (2C), 129.92, 129.86 (2C), 74.3, 69.7, 22.0, 18.5; LRMS (ESI) m/z: 276 $[M+Na]^+$; HRMS (ESI) m/z: $[M+Na]^+$ Calcd for $C_{11}H_{11}NNaO_4S$ 276.0307; found 276.0307.

***N*-(Acyloxy)ynamide (2e)**


**2e**

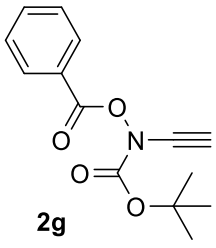
According to the general procedure (Method **A**), a crude product, which was obtained from **3** (225.1 mg, 0.50 mmol), **1e** (93.6 mg, 0.50 mmol) and $Na_2CO_3$ (52.8 mg, 0.50 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (3/1) to give **2e** (49.7 mg, 0.24 mmol, 47%) as a colorless oil. IR (neat): 3287, 2982, 2139, 1782, 1753, 1632, 1371, 1257 $cm^{-1}$; $^1$H-NMR (300 MHz, $CDCl_3$/TMS) δ 6.65 (d, *J* = 17.3 Hz, 1H), 6.23 (dd, *J* = 17.3, 10.7 Hz, 1H), 6.08 (d, *J* = 10.7 Hz, 1H), 3.60 (s, 1H), 1.52 (s, 9H); $^{13}$C-NMR (100 MHz, $CDCl_3$/TMS) δ 162.6, 150.6, 135.1, 124.1, 85.8, 72.8, 69.0, 28.0 (3C); HRMS (ESI) m/z: 234 $[M+Na]^+$; HRMS (ESI) m/z: $[M+Na]^+$ Calcd for $C_{10}H_{13}NNaO_4$ 234.0742; found 234.0745.

***N*-(Acyloxy)ynamide (2f)**


**2f**

According to the general procedure (Method **B**), a crude product, which was obtained from **3** (135.6 mg, 0.30 mmol), **1f** (87.3 mg, 0.30 mmol) and $Na_2CO_3$ (32.1 mg, 0.30 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (gradient 4/1 to 5/2) to give **2f** (61.5 mg, 0.20 mmol, 65%) as a colorless solid; M.p. 104-106 °C; IR (neat): 3289, 2120, 1774, 1597, 1384, 1233, 1177 $cm^{-1}$; $^1$H-NMR (400 MHz, $CDCl_3$/TMS) δ 7.97–7.93 (m, 4H), 7.67–7.63 (m, 1H), 7.50–7.45 (m, 4H), 3.44 (s, 1H), 2.52 (s, 3H); $^{13}$C-NMR (100 MHz, $CDCl_3$/TMS) δ 162.1, 146.9, 134.5, 130.2 (2C), 130.1 (2C), 129.9 (3C), 129.0 (2C), 126.6, 74.6, 69.8, 22.1; LRMS (FAB, NBA) m/z: 315 $[M]^+$, 155, 139, 122, 105, 91, 77, 65, 51, 39; HRMS (EI) m/z: $[M]^+$ Calcd for $C_{16}H_{13}NO_4S$ 315.0565; found 315.0564.

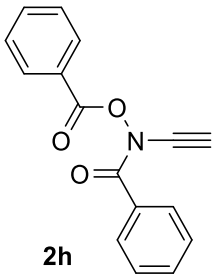
***N*-(Acyloxy)ynamide (2g)**



**2g**

According to the general procedure (Method **A**), a crude product, which was obtained from **3** (135.4 mg, 0.30 mmol), **1g** (70.5 mg, 0.30 mmol) and $Na_2CO_3$ (31.8 mg, 0.30 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (5/1) to give **2g** (47.0 mg, 0.18 mmol, 61%) as a yellow solid. M.p. 85-88 °C; IR (neat): 3275, 2980, 2137, 1773, 1749, 1506, 1371, 1238 $cm^{-1}$; $^1$H-NMR (400 MHz, $CDCl_3$/TMS) δ 8.09 (d, *J* = 7.8 Hz, 2H), 7.65 (dd, *J* = 7.8, 7.8 Hz, 1H), **7**.49 (dd, *J* = 7.8, 7.8 Hz, 2H), 3.62 (s, 1H), 1.53 (s, 9H); $^{13}$C-NMR (100 MHz, $CDCl_3$/TMS) δ 163.4, 150.7, 134.5, 130.3 (2C), 128.9 (2C), 126.5, 85.7, 73.0, 69.0, 28.0 (3C); LRMS (FAB, NBA) m/z: 262 $[M+H]^+$; HRMS (FAB, NBA) m/z: $[M+H]^+$ Calcd for $C_{14}H_{16}NO_4$ 262.1079; found 262.1094.

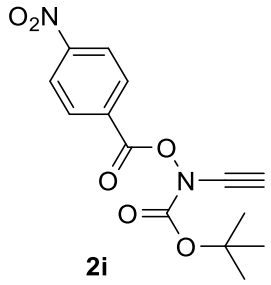
***N*-(Acyloxy)ynamide (2h)**



**2h**

According to the general procedure (Method **B**), a crude product, which was obtained from **3** (136.1 mg, 0.30 mmol), **1h** (72.0 mg, 0.30 mmol) and $Na_2CO_3$ (31.9 mg, 0.30 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (4/1) to give **2h** (52.5 mg, 0.20 mmol, 66%) as a yellow solid. M.p. 85-88 °C; IR (neat): 3280, 2926, 2133, 1773, 1715, 1240 $cm^{-1}$; $^1$H-NMR (500 MHz, $CDCl_3$/TMS) δ 8.12 (d, *J* = 7.5 Hz, 2H), 7.92 (d, *J* = 7.5 Hz, 2H), 7.65 (dd, *J* = 7.5, 7.5 Hz, 1H), 7.55 (dd, *J* = 7.5, 7.5 Hz, 1H), 7.50 (dd, *J* = 7.5, 7.5 Hz, 2H), 7.46 (dd, *J* = 7.5, 7.5 Hz, 2H), 3.67 (s, 1H); $^{13}$C-NMR (125 MHz, $CDCl_3$/TMS) δ 166.1, 162.9, 134.6, 132.8, 130.4 (2C), 130.3, 129.2 (2C), 128.9 (2C), 128.4 (2C), 126.3, 74.1, 71.0; LRMS (FAB, NBA) m/z: 266 $[M+H]^+$; HRMS (FAB, NBA) m/z: $[M+H]^+$ Calcd for $C_{16}H_{12}NO_3$ 266.0817; found 266.0822.

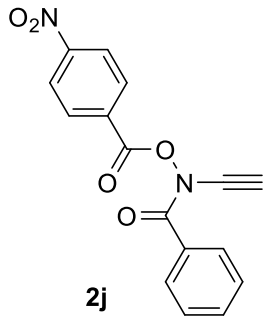
***N*-(Acyloxy)ynamide (2i)**



**2i**

According to the general procedure (Method **B**), a crude product, which was obtained from **3** (135.4 mg, 0.30 mmol), **1i** (79.2 mg, 0.28 mmol) and $Na_2CO_3$ (32.0 mg, 0.30 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (4/1) to give **2i** (23.0 mg, 0.08 mmol, 27%) as a yellowish oil. IR (neat): 3287, 2980, 2139, 1793, 1753, 1477, 1371, 1306, 1253 $cm^{-1}$; $^1$H-NMR (400 MHz, $CDCl_3$/TMS) δ 8.36 (d, *J* = 8.5 Hz, 2H), 8.29 (d, *J* = 8.5 Hz, 2H), 3.69 (s, 1H), 1.54 (s, 9H); $^{13}$C-NMR (100 MHz, $CDCl_3$/TMS) δ 161.8, 151.4, 150.4, 131.9, 131.5 (2C), 124.0 (2C), 86.4, 72.5, 70.0, 28.0 (3C); LRMS (FAB, DTT / TG11) m/z: 306 $[M]^+$; HRMS (FAB, DTT / TG11) m/z: $[M+K]^+$ Calcd for $C_{14}H_{14}KN_2O_6$ 345.0489; found 345.0505.

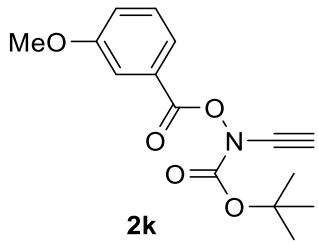
***N*-(Acyloxy)ynamide (2j)**



**2j**

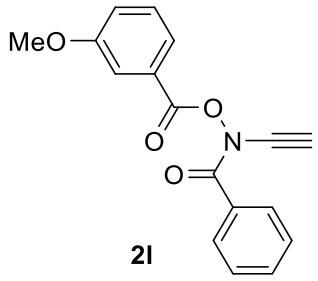
According to the general procedure (Method **A**), a crude product, which was obtained from **3** (135.1 mg, 0.30 mmol), **1j** (85.4 mg, 0.30 mmol) and $Na_2CO_3$ (32.3 mg, 0.30 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (4/1) to give **2j** (35.5 mg, 0.11 mmol, 38%) as a colorless oil. IR (neat): 3287, 2926, 2133, 1778, 1713, 1530, 1348, 1279 $cm^{-1}$; $^1$H-NMR (400 MHz, $CDCl_3$/TMS) δ 8.36 (d, *J* = 8.8 Hz, 2H), 8.32 (d, *J* = 8.8 Hz, 2H), 7.94 (d, *J* = 7.8 Hz, 2H), 7.60 (dd, *J* = 7.8, 7.8 Hz, 1H), 7.49 (dd, *J* = 7.8, 7.8 Hz, 2H), 3.74 (s, 1H); $^{13}$C-NMR (100 MHz, $CDCl_3$/TMS) δ 165.7, 161.3, 151.4, 133.2, 131.8, 131.6 (2C), 129.8, 129.3 (2C), 128.5 (2C), 124.0 (2C), 73.7, 72.0; LRMS (FAB, NBA) m/z: 311 $[M+H]^+$; HRMS (ESI) m/z: $[M+Na]^+$ Calcd for $C_{16}H_{10}N_2NaO_5$ 333.0487; found 333.0494.

***N*-(Acyloxy)ynamide (2k)**




According to the general procedure (Method **B**), a crude product, which was obtained from **3** (135.7 mg, 0.30 mmol), **1k** (80.2 mg, 0.30 mmol) and $Na_2CO_3$ (31.8 mg, 0.30 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (3/1) to give **2k** (17.6 mg, 0.06 mmol, 20%) as a yellowish oil. IR (neat): 3286, 2837, 2139, 1776, 1753, 1489, 1371, 1271 $cm^{-1}$; $^1$H-NMR (400 MHz, $CDCl_3$/TMS) δ 7.69 (ddd, *J* = 8.0, 1.4, 1.4 Hz, 1H), 7.58 (dd, J = 2.8, 1.4 Hz, 1H), 7.40 (dd, *J* = 8.0, 8.0 Hz, 1H), 7.19 (ddd, *J* = 8.0, 2.8, 1.4 Hz, 1H), 3.86 (s, 3H), 3.63 (s, 1H), 1.53 (s, 9H); $^{13}$C-NMR (100 MHz, $CDCl_3$/TMS) δ 163.4, 159.8, 150.7, 130.0, 127.6, 122.7, 121.4, 114.4, 85.8, 73.0, 69.1, 55.7, 28.0 (3C); LRMS (FAB, NBA) m/z: 292 $[M+H]^+$; HRMS (FAB, NBA) m/z: $[M+H]^+$ Calcd for $C_{15}H_{18}NO_5$ 292.1185; found 292.1186.

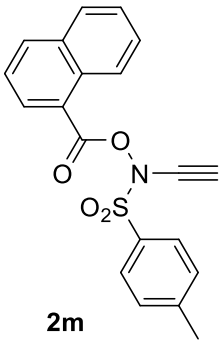
***N*-(Acyloxy)ynamide (2l)**




According to the general procedure (Method **A**), a crude product, which was obtained from **3** (225.7 mg, 0.50 mmol), **1l** (135.6 mg, 0.50 mmol) and $Na_2CO_3$ (53.2 mg, 0.50 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (5/2) to give **2l** (139.9 mg, 0.47 mmol, 95%) as a yellowish oil. IR (neat): 3286, 2837, 2133, 1772, 1710, 1487, 1269 $cm^{-1}$; $^1$H-NMR (500 MHz, $CDCl_3$/TMS) δ 7.92–7.91 (m, 2H), 7.73–7.71 (m, 1H), 7.61 (dd, *J* = 2.6, 1.4 Hz, 1H), 7.57–7.54 (m, 1H), 7.47–7.44 (m, 2H), 7.40 (dd, *J* = 8.3, 7.8 Hz, 1H), 7.19 (ddd, J = 8.3, 2.6, 0.9 Hz, 1H), 3.85 (s, 3H), 3.67 (s, 1H); $^{13}$C-NMR (125 MHz, $CDCl_3$/TMS) δ 166.1, 162.8, 159.8, 132.8, 130.3, 130.0, 129.2 (2C), 128.4 (2C), 127.4, 122.8, 121.4, 114.5, 74.0, 71.1, 55.6; LRMS (FAB, NBA) m/z:

296 $[M+H]^+$; HRMS (FAB, NBA) m/z: $[M+H]^+$ Calcd for $C_{17}H_{14}NO_4$ 296.0923; found 296.0929.

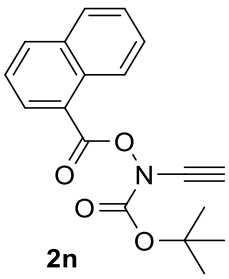
***N*-(Acyloxy)ynamide (2m)**



**2m**

According to the general procedure (Method **B**), a crude product, which was obtained from **3** (136.0 mg, 0.30 mmol), **1m** (102.1 mg, 0.30 mmol) and $Na_2CO_3$ (32.1 mg, 0.30 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (gradient 3/1 to 1/1) to give **2m** (63.3 mg, 0.17 mmol, 58%) as a colorless solid. M.p. 96-100 °C; IR (neat): 3283, 2117, 1769, 1508, 1384, 1234, 1177 $cm^{-1}$; $^1$H-NMR (400 MHz, $CDCl_3$) δ 8.75 (brd, *J* = 8.7 Hz, 1H), 8.10 (brd, *J* = 8.2 Hz, 1H), 8.06 (dd, *J* = 7.3, 1.4 Hz, 1H), 7.95 (d, *J* = 8.2 Hz, 2H), 7.91 (d, *J* = 8.2 Hz 1H), 7.65 (ddd, *J* = 8.7, 6.9, 1.4 Hz, 1H), 7.58 (ddd, *J* = 8.2, 6.9, 0.9 Hz, 1H), 7.50 (dd, *J* = 8.2, 7.3 Hz 1H), 7.42 (d, *J* = 8.2 Hz, 2H), 3.49 (s, 1H), 2.49 (s, 3H); $^{13}$C-NMR (100 MHz, $CDCl_3$) δ 162.5, 146.8, 135.0, 133.9, 131.5, 130.6, 130.3, 130.1 (2C), 129.9 (2C), 128.8, 128.7, 126.7, 125.5, 124.4, 123.2, 74.7, 69.9, 22.0; LRMS (EI) m/z: 365 $[M]^+$, 172, 155, 127, 91, 77, 51; HRMS (ESI) m/z: $[M+Na]^+$ Calcd for $C_{20}H_{15}NNaO_4S$ 388.0620, found 388.0611.

***N*-(Acyloxy)ynamide (2n)**

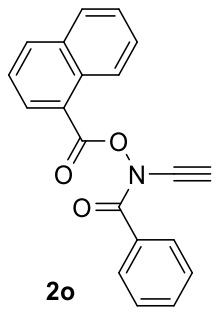


**2n**

According to the general procedure (Method **B**), a crude product, which was obtained from **3** (136.1 mg, 0.30 mmol), **1n** (85.8 mg, 0.30 mmol) and $Na_2CO_3$ (32.3 mg, 0.30 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (5/1) to give **2n** (54.2 mg, 0.17 mmol, 58%) as a colorless oil. IR (neat): 3292, 2980, 2137, 1769, 1749, 1508, 1456,

1371, 1236 $cm^{-1}$; $^1$H-NMR (400 MHz, $CDCl_3$/TMS) δ 8.83 (d, *J* = 8.4 Hz, 1H), 8.28 (d, *J* = 7.3 Hz, 1H), 8.11 (d, *J* = 8.2 Hz, 1H), 7.92 (d, *J* = 8.2 Hz, 1H), 7.67 (ddd, *J* = 8.4, 7.0, 1.5 Hz, 1H), 7.60–7.56 (m, 1H), 7.54 (dd, *J* = 8.2, 7.3 Hz, 1H), 3.65 (s, 1H), 1.56 (s, 9H); $^{13}$C-NMR (100 MHz, $CDCl_3$/TMS) δ 164.0, 151.0, 135.0, 133.9, 131.5, 131.2, 128.9, 128.6, 126.9, 125.5, 124.6, 123.2, 85.9, 73.3, 69.0, 28.1 (3C); LRMS (FAB, NBA) m/z: 312 $[M+H]^+$; HRMS (FAB, NBA) m/z: $[M+H]^+$ Calcd for $C_{18}H_{18}NO_4$ 312.1236; found 312.1245.

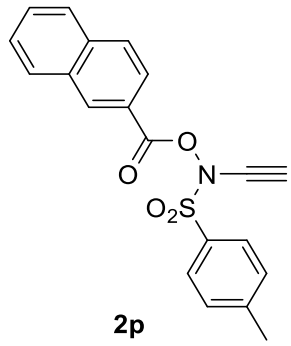
***N*-(Acyloxy)ynamide (2o)**



**2o**

According to the general procedure (Method **B**), a crude product, which was obtained from **3** (135.7 mg, 0.30 mmol), **1o** (87.2 mg, 0.30 mmol) and $Na_2CO_3$ (32.1 mg, 0.30 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (3/1) to give **2o** (69.0 mg, 0.22 mmol, 73%) as a colorless oil. IR (neat): 3292, 2922, 2133, 1772, 1712, 1508, 1238 $cm^{-1}$; $^1$H-NMR (400 MHz, $CDCl_3$/TMS) δ 8.83 (brd, *J* = 8.5 Hz, 1H), 8.32 (brd, *J* = 7.4 Hz, 1H), 8.09 (brd, *J* = 8.3 Hz, 1H), 7.98–7.96 (m, 2H), 7.89 (brd, *J* = 8.0 Hz, 1H), 7.68–7.64 (m, 1H), 7.58–7.44 (m, 5H), 3.70 (s, 1H); $^{13}$C-NMR (100 MHz, $CDCl_3$/TMS) δ 166.3, 163.4, 135.1, 133.8, 132.8, 131.5, 131.3, 130.4, 129.2 (2C), 128.8, 128.6, 128.4, 126.8, 125.4, 124.6, 122.9, 77.4, 74.2, 71.0; LRMS (FAB, NBA) m/z: 316 $[M+H]^+$; HRMS (FAB, NBA) m/z: $[M+H]^+$ Calcd for $C_{20}H_{14}NO_3$ 316.0974; found 316.0984.

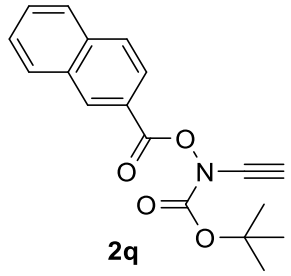
***N*-(Acyloxy)ynamide (2p)**



**2p**

According to the general procedure (Method **B**), a crude product, which was obtained from **3** (136.3 mg, 0.30 mmol), **1p** (102.5 mg, 0.30 mmol) and $Na_2CO_3$ (32.5 mg, 0.31 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (gradient 3/1 to 1/1) to give **2p** (79.6 mg, 0.22 mmol, 73%) as a colorless solid. M.p. 88-92 °C; IR (neat): 3291, 2120, 1770, 1506, 1384, 1274, 1176 $cm^{-1}$; $^1$H-NMR (400 MHz, $CDCl_3$/TMS) δ 8.53 (s, 1H), 7.97 (d, *J* = 8.2 Hz, 2H), 7.98–7.89 (m, 4H), 7.65 (ddd, *J* = 8.2, 6.9, 1.4 Hz, 1H), 7.59 (ddd, *J* = 8.2, 6.9, 1.4 Hz, 1H), 7.48 (d, *J* = 8.2 Hz, 2H), 3.48 (s, 1H), 2.54 (s, 3H); $^{13}$C-NMR (100 MHz, $CDCl_3$/TMS) δ 162.3, 147.0, 136.2, 132.4, 132.3, 130.2, 130.1 (2C), 129.9 (2C), 129.6, 129.3, 128.9, 128.1, 127.3, 125.0, 123.7, 74.6, 69.9, 22.1; LRMS (ESI) m/z: 365 $[M]^+$; HRMS (ESI) m/z: $[M+Na]^+$ Calcd for $C_{20}H_{15}NNaO_4S$ 388.0620; found 388.0618.

***N*-(Acyloxy)ynamide (2q)**

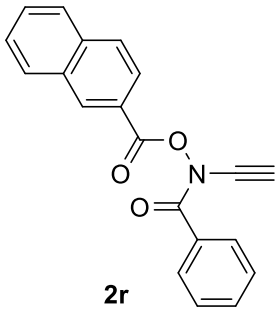


**2q**

According to the general procedure (Method **B**), a crude product, which was obtained from **3** (136.1 mg, 0.30 mmol), **1q** (85.9 mg, 0.30 mmol) and $Na_2CO_3$ (32.2 mg, 0.30 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (5/1) to give **2q** (57.4 mg, 0.18 mmol, 62%) as a colorless solid. M.p. 102-105 °C; IR (neat): 3287, 2982, 2139, 1763, 1740, 1371, 1276 $cm^{-1}$; $^1$H-NMR (300 MHz, $CDCl_3$/TMS) δ 8.68 (s, 1H), 8.06 (dd, *J* = 8.5, 1.7 Hz, 1H), 7.97–7.87 (m, 3H), 7.65–7.54 (m, 2H), 3.67 (s, 1H), 1.55 (s, 9H); $^{13}$C-NMR (100 MHz, $CDCl_3$/TMS) δ 163.6, 150.8, 136.2, 132.39, 132.37, 129.6, 129.2, 128.8, 128.0, 127.2, 125.1, 123.5, 85.8, 73.1, 69.1, 28.0 (3C); LRMS (FAB,

NBA) m/z: 312 $[M+H]^+$; HRMS (FAB, NBA) m/z: $[M+H]^+$ Calcd for $C_{18}H_{18}NO_4$ 312.1236; found 312.1249.

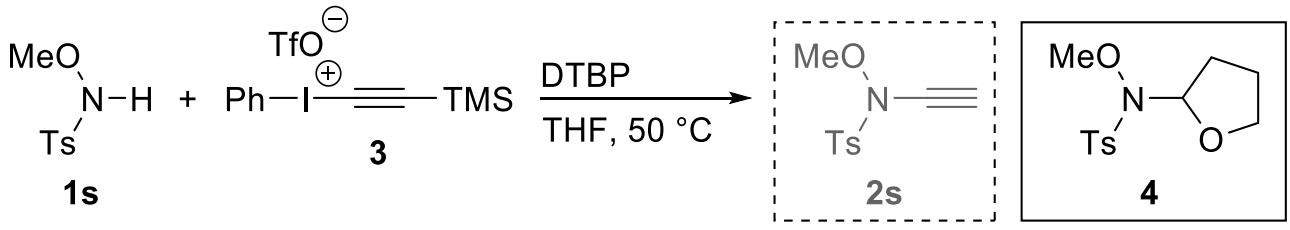
***N*-(Acyloxy)ynamide (2r)**



**2r**

According to the general procedure (Method **A**), a crude product, which was obtained from **3** (135.1 mg, 0.30 mmol), **1r** (86.8 mg, 0.30 mmol) and $Na_2CO_3$ (31.9 mg, 0.30 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (4/1) to give **2r** (58.0 mg, 0.18 mmol, 62%) as a colorless solid. M.p. 106-108 °C; IR (neat): 3292, 3059, 2133, 1769, 1711, 1506, 1274 $cm^{-1}$; $^1$H-NMR (500 MHz, $CDCl_3$/TMS) δ 8.73 (s, 1H), 8.09 (d, *J* = 8.4 Hz, 1H), 8.00–7.95 (m, 3H), 7.93 (d, *J* = 8.4 Hz, 1H), 7.89 (d, *J* = 8.4 Hz, 1H), 7.64 (dd, *J* = 7.3, 7.3 Hz, 1H), 7.59–7.55 (m, 2H), 7.47 (dd, *J* = 7.6, 7.6 Hz, 2H), 3.71 (s, 1H); $^{13}$C-NMR (125 MHz, $CDCl_3$/TMS) δ 166.2, 163.1, 136.2, 132.8, 132.5, 132.4, 130.4, 129.7, 129.3, 129.2 (2C), 128.8, 128.4 (2C), 128.0, 127.2, 125.1, 123.4, 74.1, 71.1; LRMS (FAB, NBA) m/z: 316 $[M+H]^+$; HRMS (FAB, NBA) m/z: $[M+H]^+$ Calcd for $C_{20}H_{14}NO_3$ 316.0974; found 316.0982.

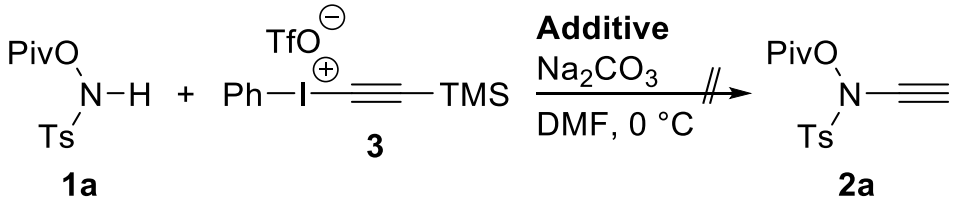
**Formation of α-aminotetrahydrofuran derivative 4 (Scheme 2, Eq 1)**




To a solution of **1s** (41.6 mg, 0.21 mmol) and **3** (293.6 mg, 0.65 mmol, 3.0 equiv.) in THF (1.5 mL, [**1s**] = 0.2 M) were added DTBP (0.14 mL, 0.65 mmol, 3.0 equiv.) at 50 ℃, and the mixture was stirred at the temperature described above for 70 h. After filtering

the reaction mixture, the filtrate was concentrated under reduced pressure. The crude residue was purified by silica gel column chromatography to give **4** (41.6 mg, 0.15 mmol, 74%) as a colorless oil. IR (neat): 1597, 1346, 1165, 1059, 1001, 814, 706 $cm^{-1}$; $^{1}$H-NMR (300 MHz, $CDCl_3$/TMS) δ 7.81 (d, *J* = 8.2 Hz, 2H), 7.29 (d, *J* = 8.2 Hz, 2H), 5.59 (m, 1H), 3.88 (s, 3H), 3.71–3.63 (m, 2H), 2.43 (s, 3H), 1.93–1.78 (m, 4H); $^{13}$C-NMR (100 MHz, $CDCl_3$/TMS) δ 144.4, 133.8, 129.6 (2C), 129.2 (2C), 90.7, 69.3, 66.2, 29.0, 24.8, 21.8; LRMS (EI) m/z: 271 $[M]^+$, 201, 171, 155, 139, 91, 77, 71, 65, 51, 43; HRMS (EI) m/z: $[M]^+$ Calcd for $C_{12}H_{17}NO_4S$ 271.0878; found 271.0876.

**General procedure for radical inhibition experiments (Scheme 2, Eq 2)**




To a solution of **3** (1.0 equiv.) and free radical (1.0 equiv.) in DMF ([**3**] = 0.2 M) were added **1a** and $Na_2CO_3$ (1.0 equiv.) at 0 ℃, and the mixture was stirred for 1 h at the same temperature. The reaction mixture was diluted with $H_2O$ and extracted with AcOEt. The combined organic layers were washed with brine, dried over $Na_2SO_4$ and concentrated under reduced pressure. The crude residue was purified by silica gel column chromatography.

**TEMPO**

According to the general procedure, a crude product, which was obtained from **3** (90.7 mg, 0.20 mmol), TEMPO (31.2 mg, 0.20 mmol), **1a** (53.3 mg, 0.20 mmol) and $Na_2CO_3$ (21.9 mg, 0.21 mmol), were purified by silica gel column chromatography with *n*-

hexane/$Et_2O$ (4/1), but the product **2a** was not obtained.

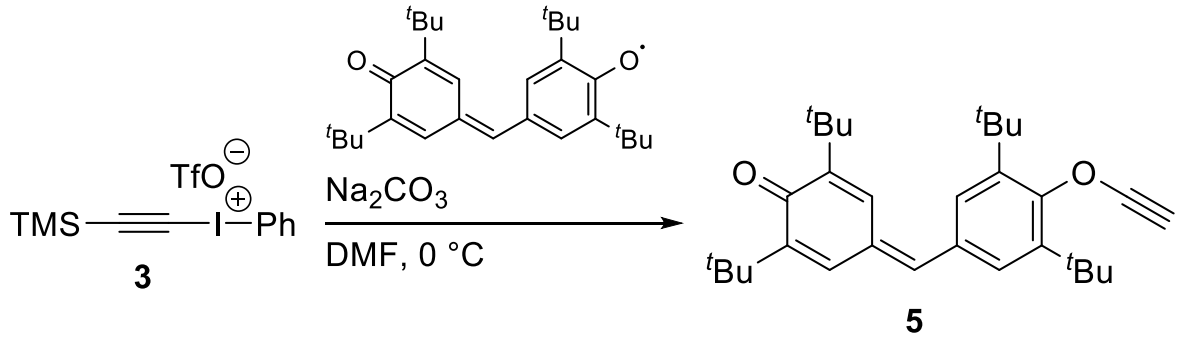
**Galvinoxyl Free Radical**

According to the general procedure, a crude product, which was obtained from **3** (90.7 mg, 0.20 mmol), Galvinoxyl Free Radical (84.3 mg, 0.20 mmol), **1a** (53.3 mg, 0.20 mmol) and $Na_2CO_3$ (21.7 mg, 0.20 mmol), were purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (4/1), but the product **2a** was not obtained.

**Alkynylation with TBAF instead of $Na_2CO_3$ (Scheme 2, Eq 3)**

To a solution of **3** (90.1 mg, 0.20 mmol) in DMF ([**3**] = 0.2 M) were added **1a** (53.8 mg, 0.2 mmol) and TBAF (1.0 M in THF, 0.2 mL, 0.20 mmol) at 0 ℃, and the mixture was stirred for 1 h at the same temperature. The reaction mixture was diluted with $H_2O$ and extracted with AcOEt. The combined organic layers were washed with brine, dried over $Na_2SO_4$ and concentrated under reduced pressure. The crude residue was purified by silica gel column chromatography with *n*-hexane/ $Et_2O$ (3/1) to give **2a** (32.2 mg, 0.11 mmol, 55%) and recovered **1a** (9.2 mg, 0.034 mmol, 17%), respectively.

**Reaction of 3 and Galvinoxyl Free Radical (Scheme 2, Eq 4)**

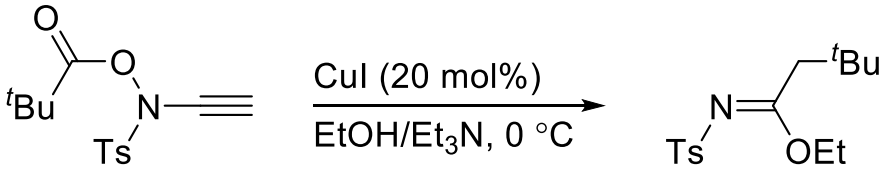



**3** **5**

To a solution of **3** (450.4 mg, 1.0 mmol) and galvinoxyl free radical (421.5 mg, 1.0 mmol)

in DMF (5 mL, [**3**] = 0.2 M) was added $Na_2CO_3$ (106.1 mg, 1.0 mmol) at 0 ℃, and the mixture was stirred for 3 h at the same temperature. After the reaction mixture was concentrated, the crude product was purified by silica gel column chromatography with *n*-hexane/$Et_2O$ (4/1 + 1% $Et_3N$) followed by preparative TLC with *n*-hexane/ethyl acetate (15/1) to give **5** (4.2 mg, 0.0094 mmol, 1%) as a brown oil. IR (neat): 2957, 2181, 2149, 1612, 1362, 758 $cm^{-1}$; $^1$H-NMR (500 MHz, $CDCl_3$/TMS) δ 7.50 (d, *J* = 2.3 Hz, 1H), 7.41 (s, 2H), 7.15 (s, 1H), 7.01 (d, *J* = 2.3 Hz, 1H), 1.78 (s, 1H), 1.54 (s, 18H), 1.33 (s, 9H), 1.31 (s, 9H); $^{13}$C-NMR (125 MHz, $CDCl_3$/TMS) δ 186.6, 155.4, 149.7, 147.9, 143.4, 142.3, 135.3, 133.6, 132.0, 129.3 (2C), 127.7, 90.5 (**C**≡CH), 36.3, 35.6, 35.1, 31.6 (6C), 30.4, 30.1 (C≡**C**H), 29.82, 29.76 (3C), 29.6 (3C); LRMS (ESI) m/z: 446 $[M]^+$; HRMS (EI) m/z: $[M]^+$ Calcd for $C_{31}H_{42}O_2$ 446.3185; found 446.3187.

**Cu(I)-Catalyzed Transformation of 2a into 8 (Scheme 4)**



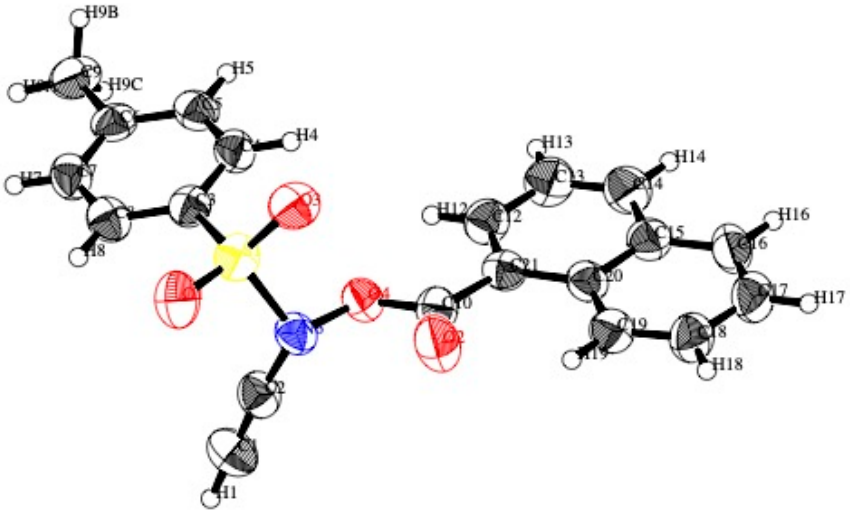

**2a** **8**

To a solution of CuI (9.6 mg, 0.050 mmol, 20 mol%) in $Et_3N$ (1.3 mL, [**2a**] = 0.2 M) were added **2a** (74.2 mg, 0.25 mmol) in EtOH (1.3 mL, [**2a**] = 0.2 M) at 0 ℃, and the mixture was stirred for 16 h. The reaction mixture was diluted with $H_2O$ and extracted with AcOEt. The combined organic layers were washed with brine, dried over $Na_2SO_4$ and concentrated under reduced pressure. The crude residue was purified by silica gel column chromatography with *n*-hexane/ $Et_2O$ (3/1) to give **8** (38.3 mg, 0.129 mmol, 51%) as a colorless oil. IR (neat): 2955, 1599, 1312, 1148, 1094, 685 $cm^{-1}$; $^1$H-NMR (400 MHz,

$CDCl_3$/TMS) δ 7.81 (d, *J* = 8.2 Hz, 2H), 7.28 (d, *J* = 8.2 Hz, 2H), 4.15 (q, *J* = 7.2 Hz, 2H), 2.85 (s, 2H), 2.41 (s, 3H), 1.27 (t, *J* = 7.2 Hz, 3H), 1.07 (s, 9H); $^{13}$C-NMR (100 MHz, $CDCl_3$/TMS) δ 174.4, 143.1, 139.7, 129.4 (2C), 126.7 (2C), 64.3, 45.7, 32.1, 30.3 (3C), 21.7, 13.9; LRMS (EI) m/z: 297 $[M]^+$, 241, 236, 177, 176, 156, 155, 149, 119, 108, 107, 106, 105, 92, 91, 65, 57, 42, 41; HRMS (EI) m/z: $[M]^+$ Calcd for $C_{15}H_{23}NO_3S$ 297.1399; found 297.1394.

## 5. X-ray Crystallographic Analysis

X-ray crystallographic data was recorded on a Rigaku R-AXIS RAPID with a MicroMax-007HF diffractometer using multi-layer mirror monochromated Cu-Kα radiation. The structure was solved by a direct method (SHELXT ver. 2014/5) and expanded using a Fourier technique. Refinement was performed using all reflections. The non-hydrogen atoms were refined anisotropically. Hydrogen atoms were refined using the riding model. All calculations were performed using the CrystalStructure 4.3 crystallographic software package except for refinement, which was performed using SHELXL ver. 2016/4.




ORTEP drawing of **2m**

Crystal data

| | |
|---|---|
| Chemical formula | $C_{20}H_{15}NO_4S$ |
| Moiety formula | $C_{20}H_{15}NO_4S$ |
| MW | 365.40 |
| Crystal system, space group | Monoclinic, P21/c (#14) |
| Temperature (K) | 93 |
| a, b, c (Å), $V$ (Å$^3$) | 15.1244(11), 14.9547(10) |

| | |
|---|---|
| | 7.6969(5), 1711.3(2) |
| *Z* | 4 |
| *F*(000) | 760.00 |
| Radiation type | Cu Kα (λ = 1.54187 Å) |
| μ ($mm^{-1}$) | 1.91 |
| Crystal size (mm), and color | 0.200 × 0.200 × 0.200, prizm, colorless |
| Data collection | |
| Diffractometer | Rigaku R-AXIS RAPID |
| Absorption correction | Lorentz-polarization Absorption |
| $T_{min}$, $T_{max}$ | 0.456, 0.683 |
| No. of measured, independent, and observed [$F^2 > 2.0\sigma(F^2)$] reflections | 19298, 3079 |
| $R_{int}$ | 0.1378 |
| $2\theta_{max}$ cutoff | 136.4° |
| Refinement | |
| R[$F^2 > 2\sigma(F^2)$], *w*R($F^2$) | 0.0723, 0.2044 |
| No. of reflections | 3079 |
| No. of parameters | 295 |
| Goodness of Fit Indicator | 1.194 |
| H-atom treatment | H atoms parameters constrained |
| $\Delta\rho_{max}$, $\Delta\rho_{min}$ (e $Å^{-3}$) | 0.48, -0.69 |

## 6. References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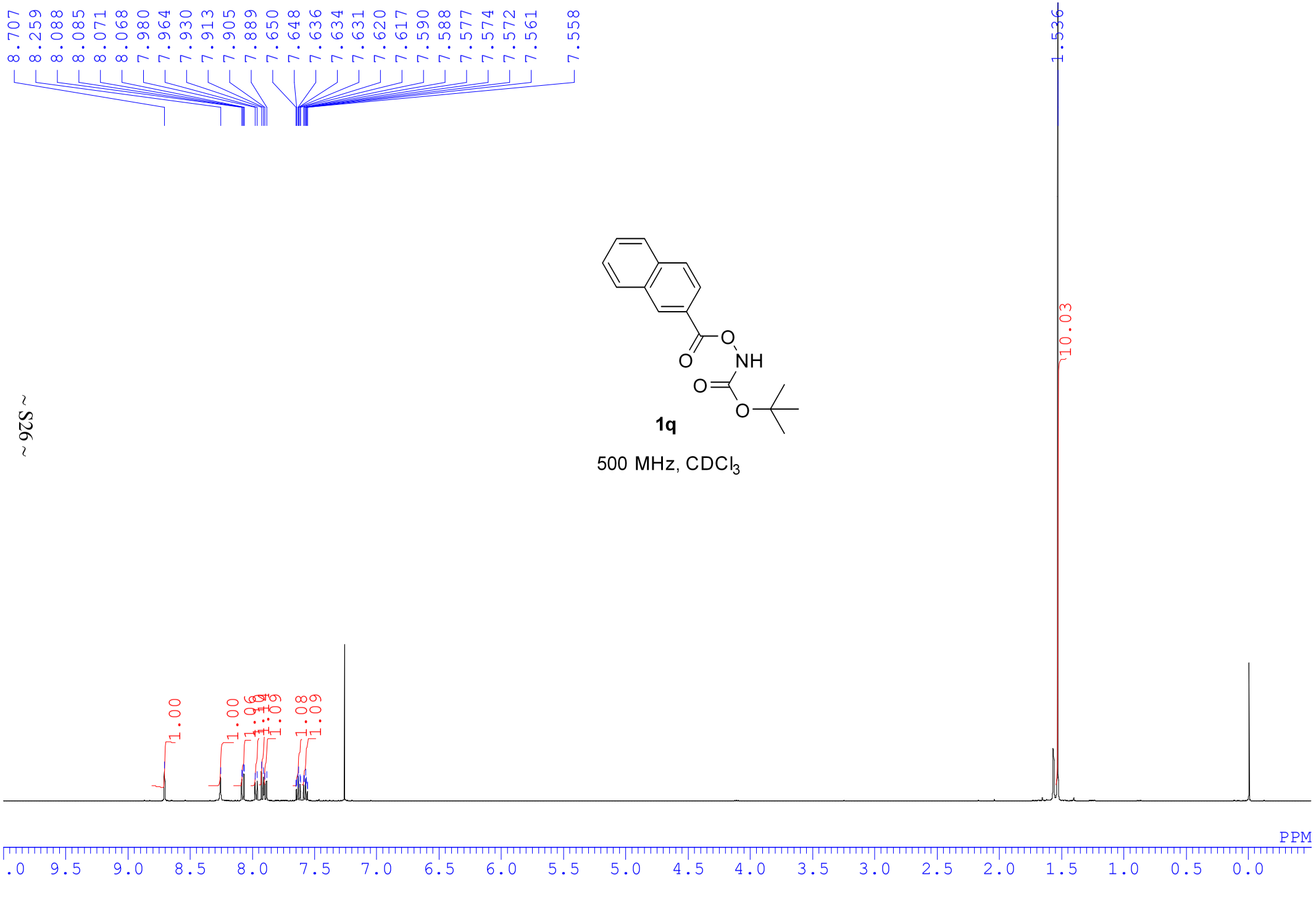
8.707
8.259
8.088
8.085
8.071
8.068
7.980
7.964
7.930
7.913
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7.650
7.648
7.636
7.634
7.631
7.620
7.617
7.590
7.588
7.577
7.574
7.572
7.561
7.558
1.536
10.03
1.00
1.00
1.06
1.14
1.09
1.08
1.09
O
O
NH
O
O
1q
500 MHz, CDCl3
PPM
.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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4.5
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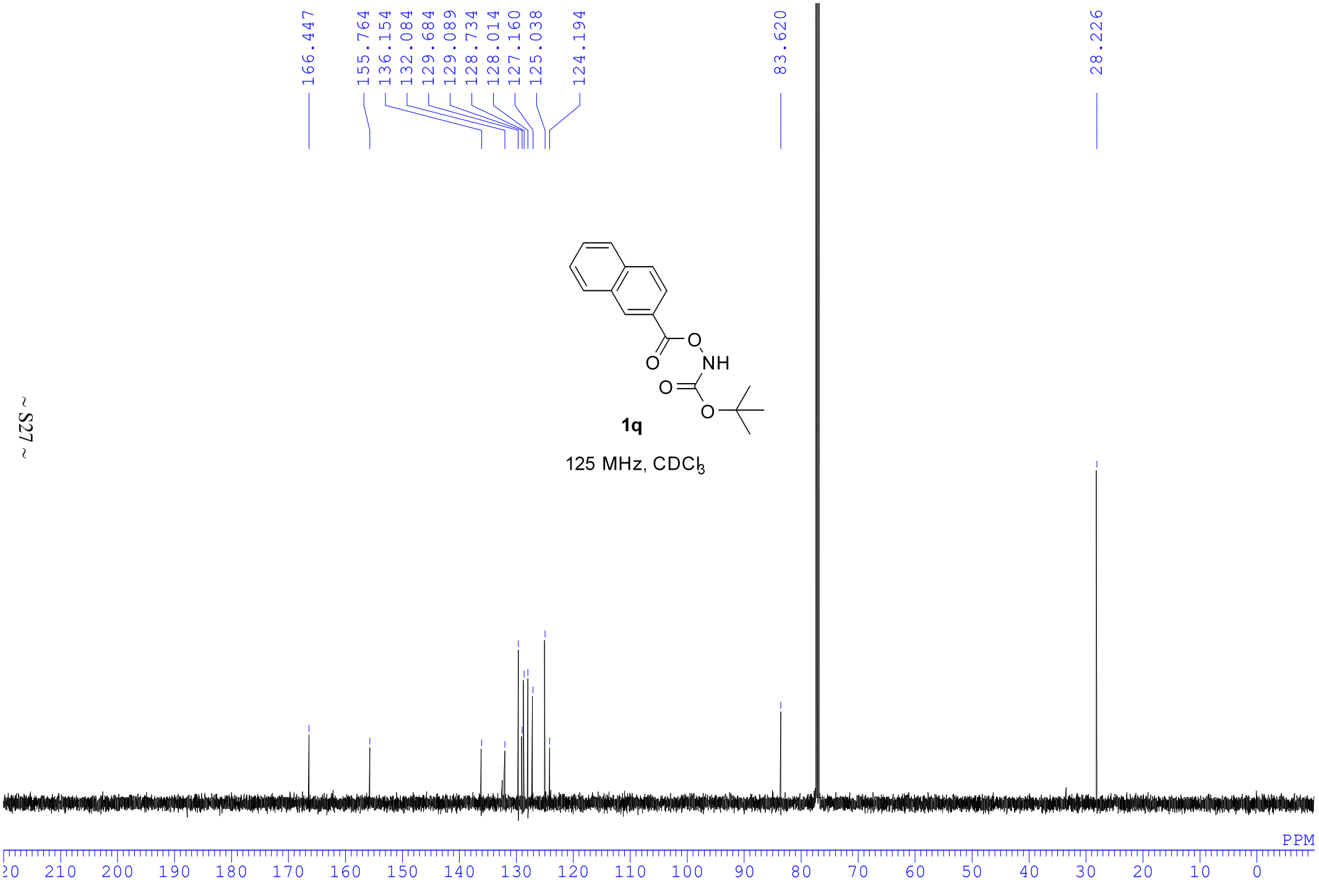
166.447
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136.154
132.084
129.684
129.089
128.734
128.014
127.160
125.038
124.194
83.620
28.226
O
O
NH
O
O
1q
125 MHz, CDCl3
PPM
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
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10
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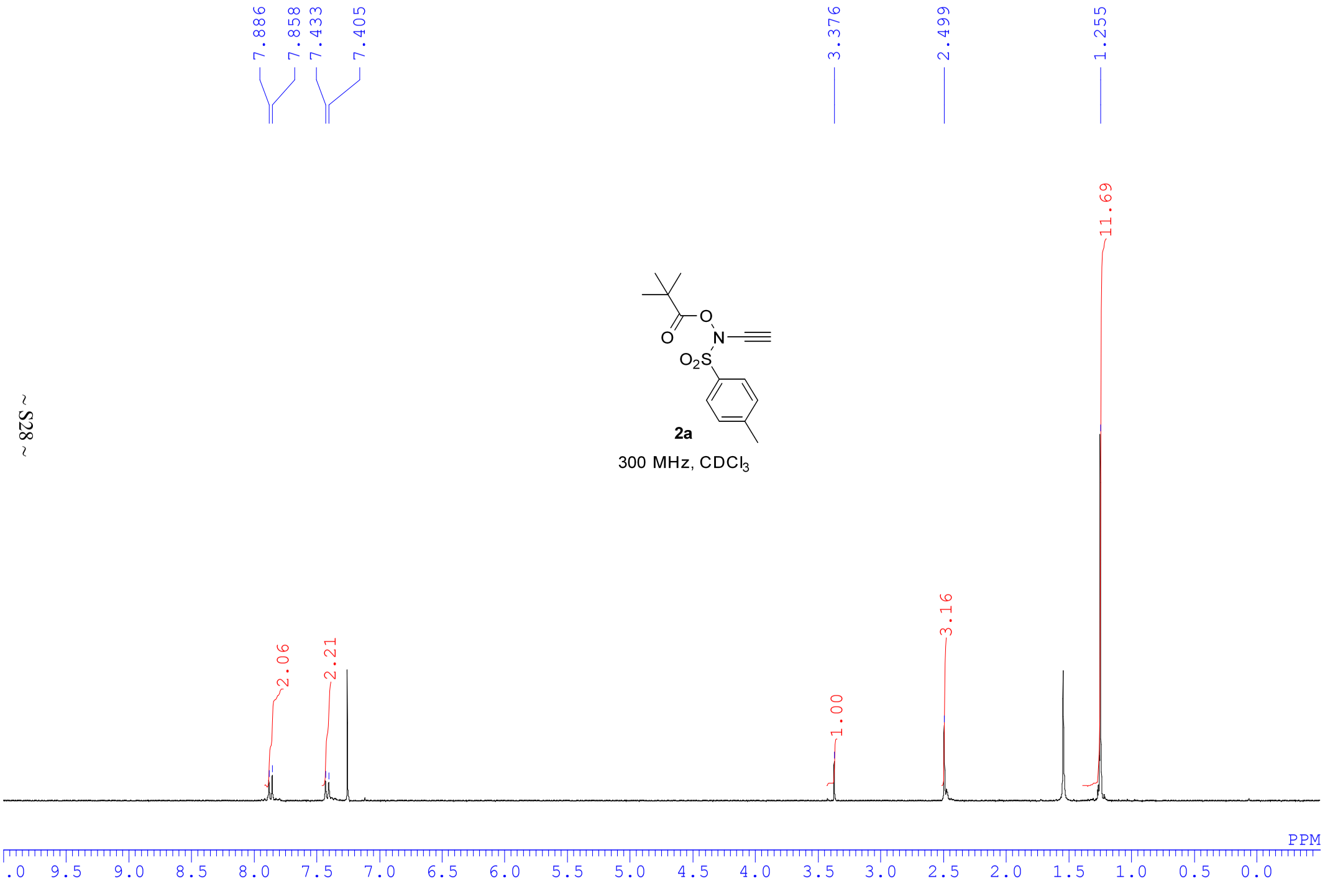
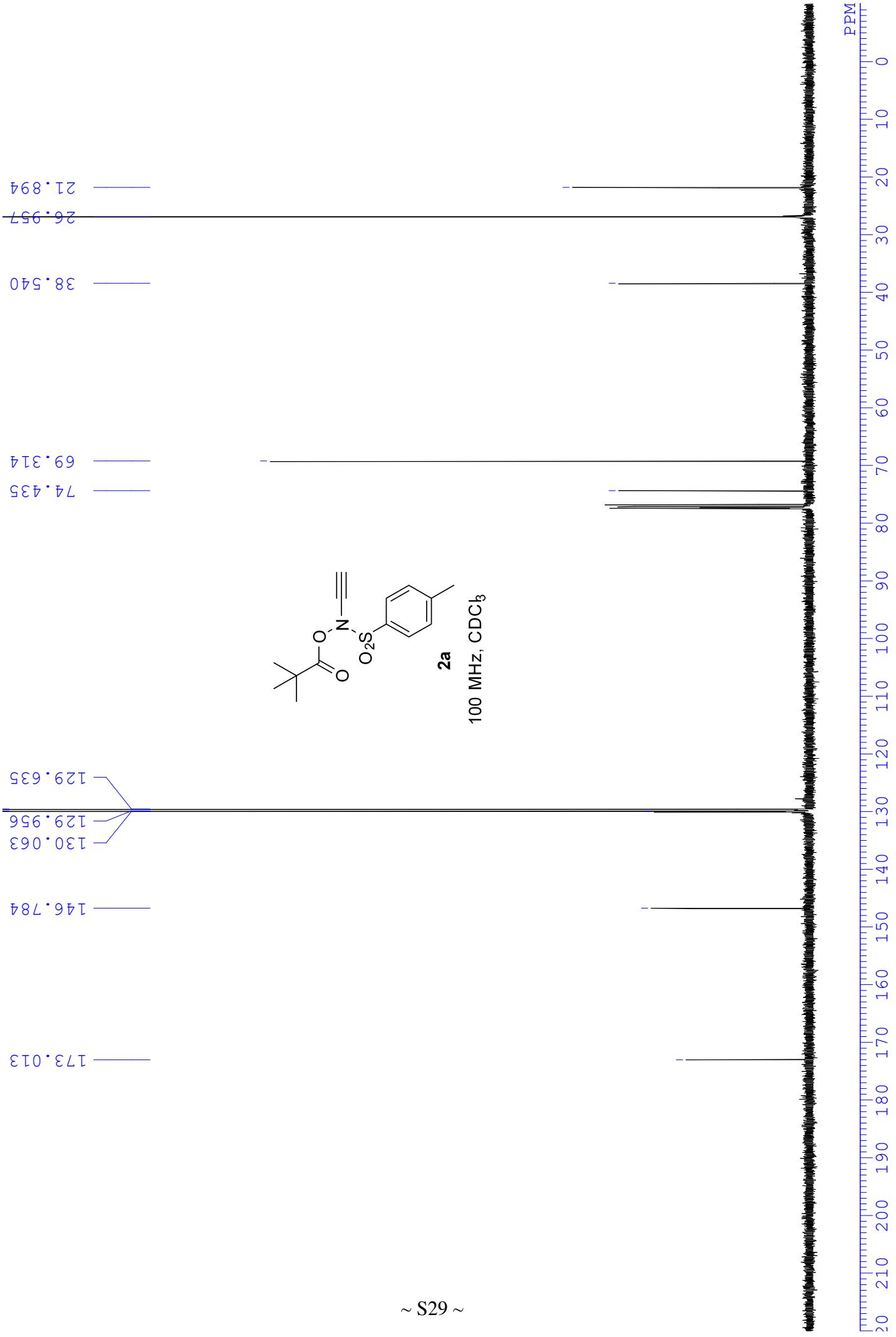



**2a**

300 MHz, $CDCl_3$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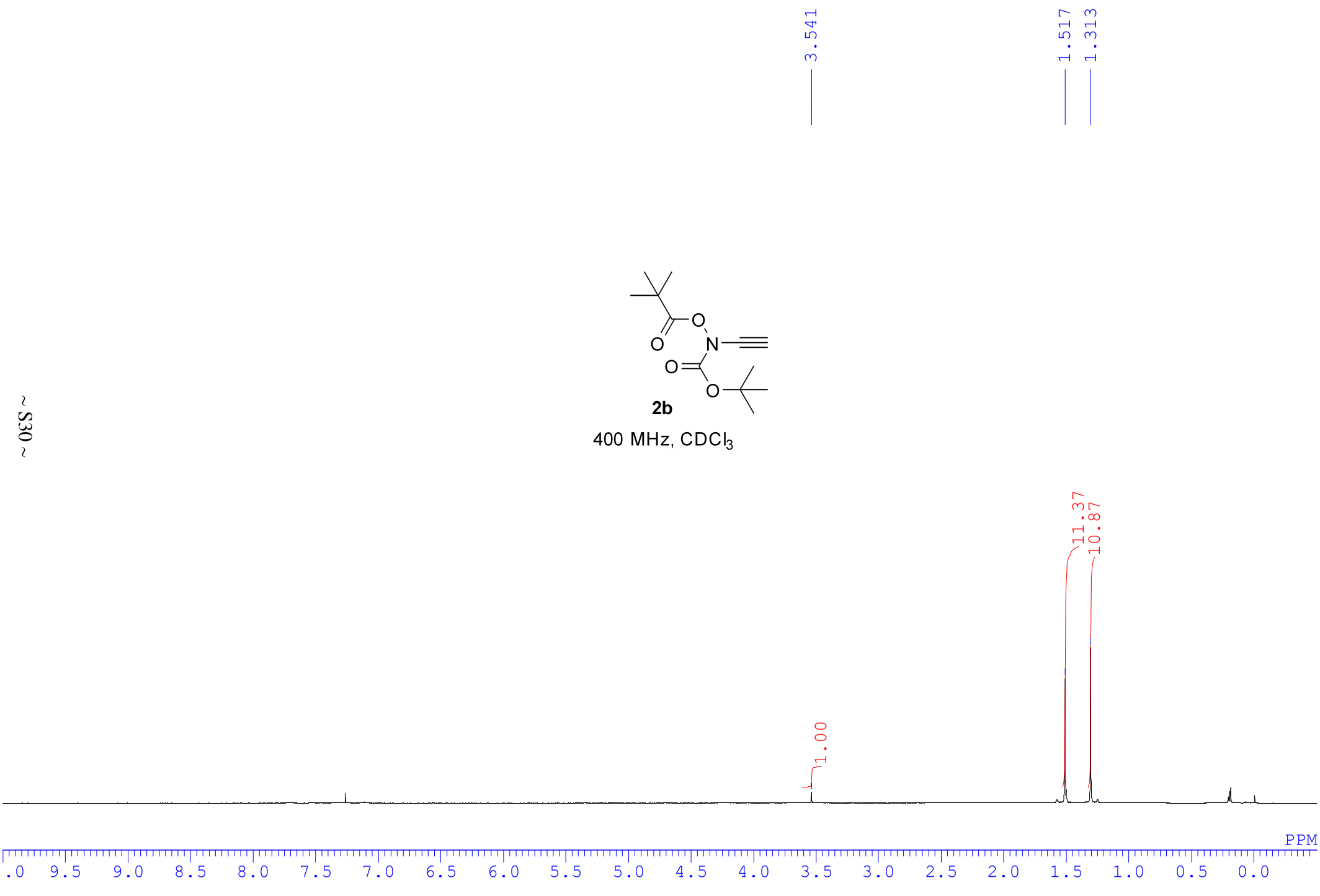
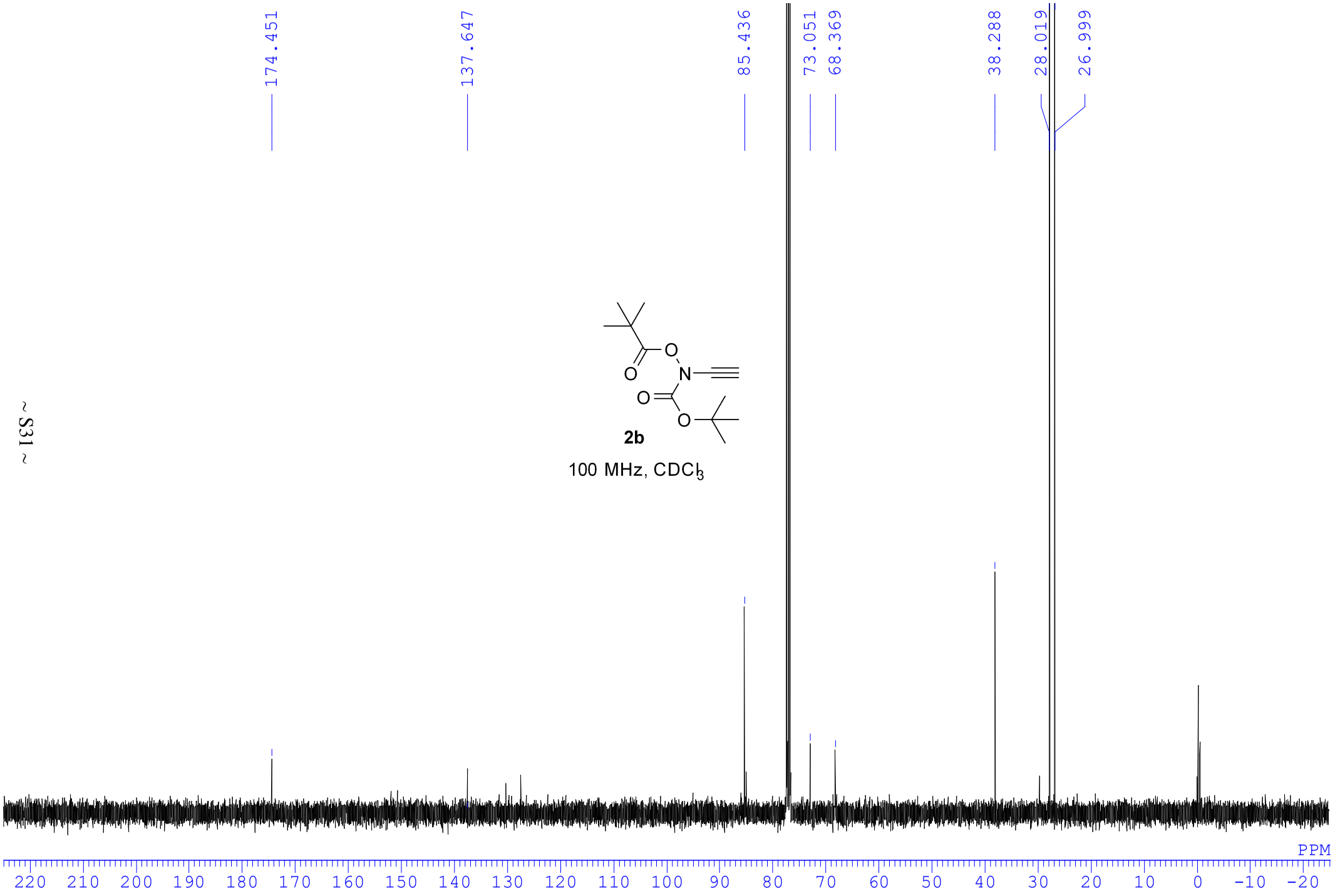
26.957
38.540
69.314
74.435
129.635
129.956
130.063
146.784
173.013
PPM
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
O
N
O
O2S
2a
100 MHz, CDCl3


3.541
1.517
1.313
2b
400 MHz, CDCl3
11.37
10.87
1.00
PPM
.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0


174.451
137.647
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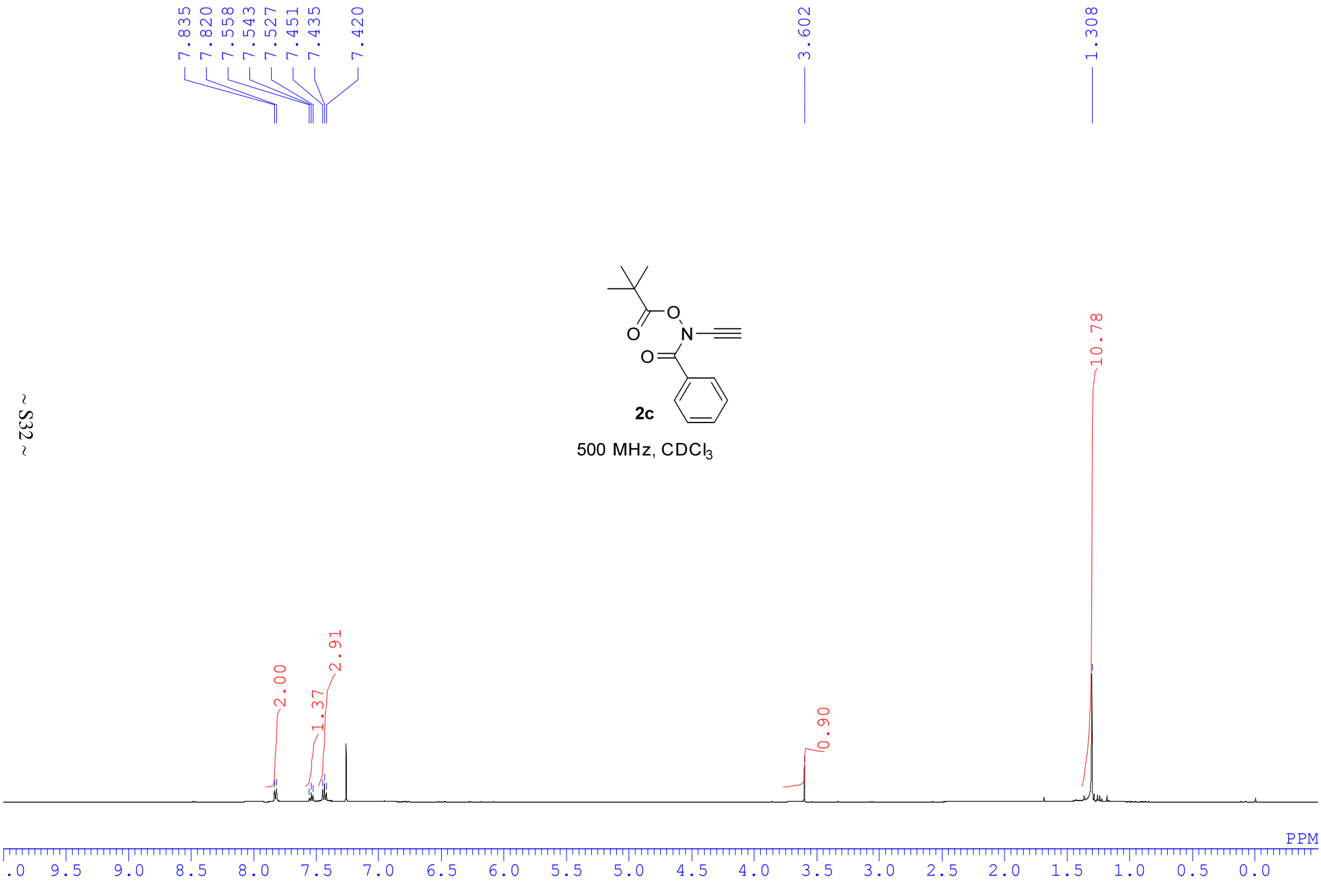
73.051
68.369
38.288
28.019
26.999
O
O
N
O
O
2b
100 MHz, CDCl3
PPM
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20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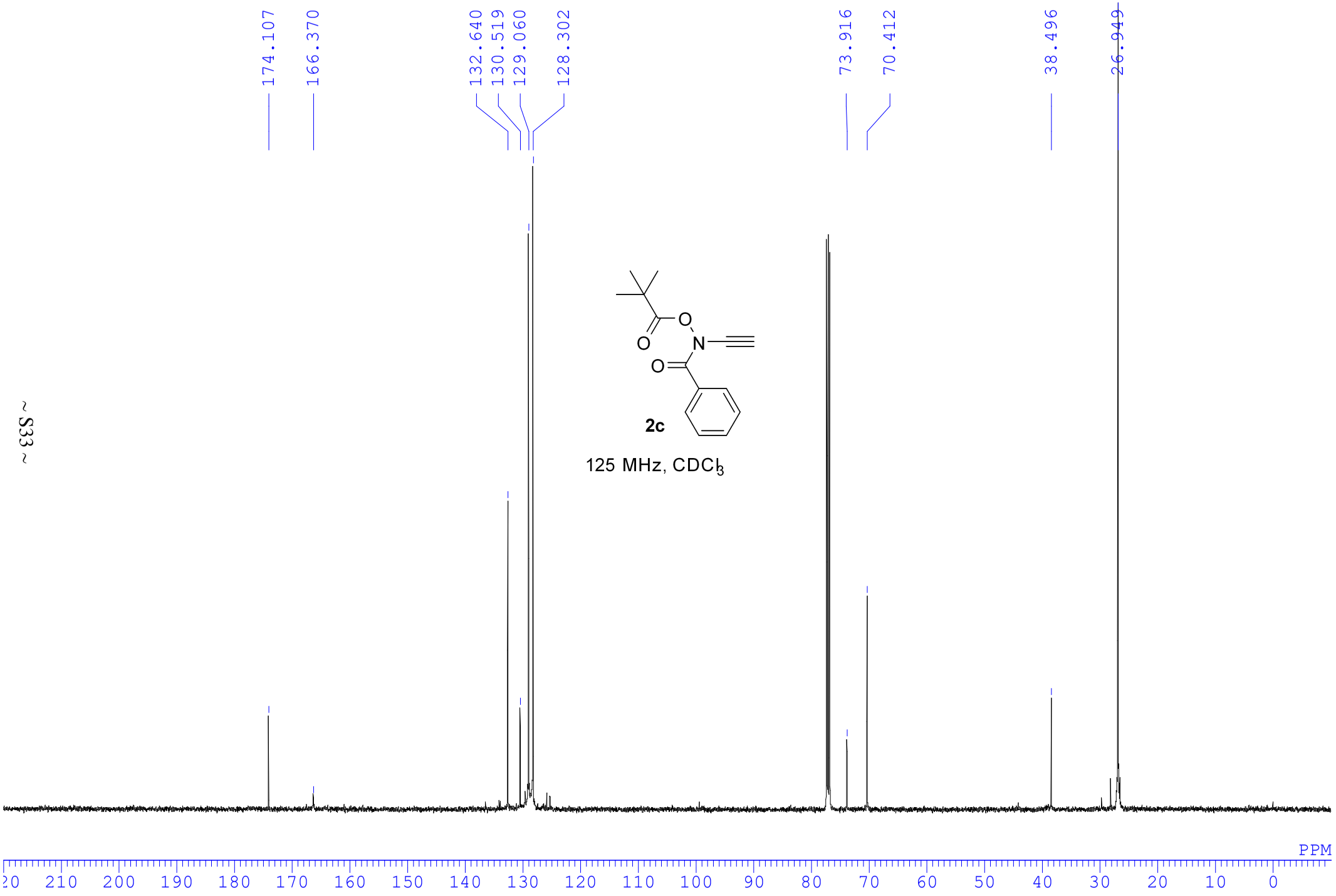
7.527
7.451
7.435
7.420
3.602
1.308
10.78
2.91
2.00
1.37
0.90
2c
500 MHz, CDCl3
PPM
.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0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130.519
129.060
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70.412
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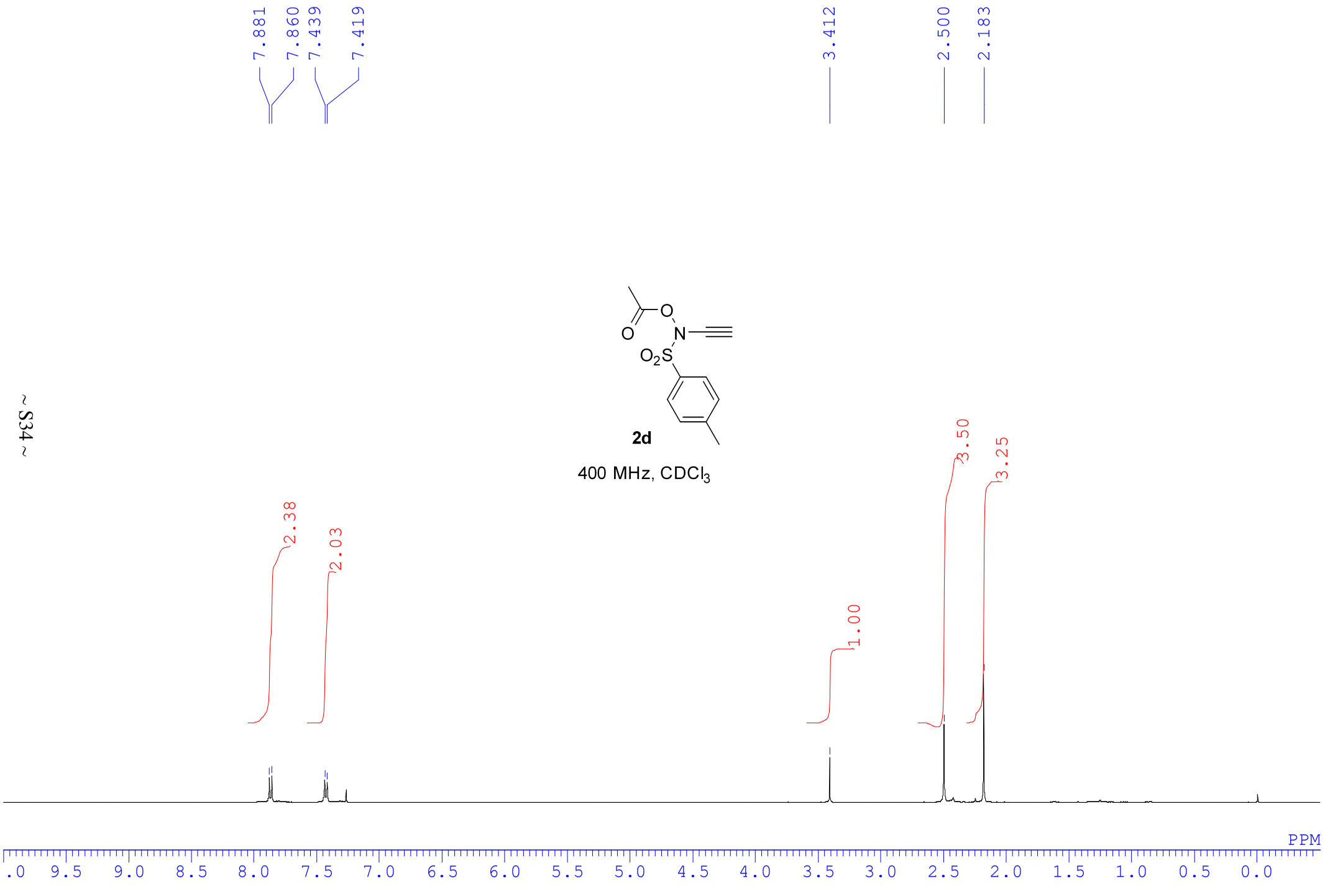
O
O
N
O
2c
125 MHz, CDCl3
PPM
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0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3.412
2.500
2.183
2d
400 MHz, CDCl3
2.38
2.03
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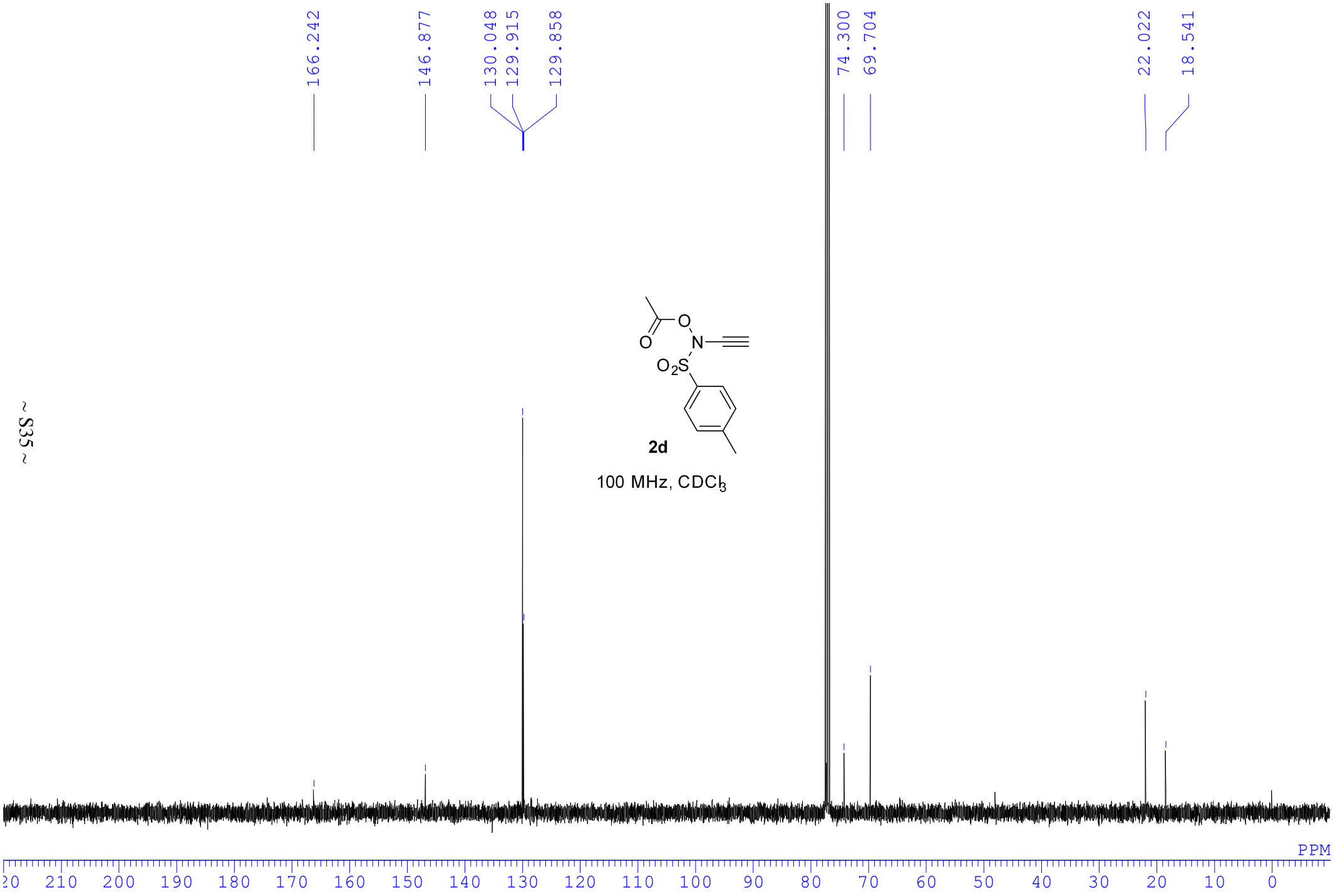
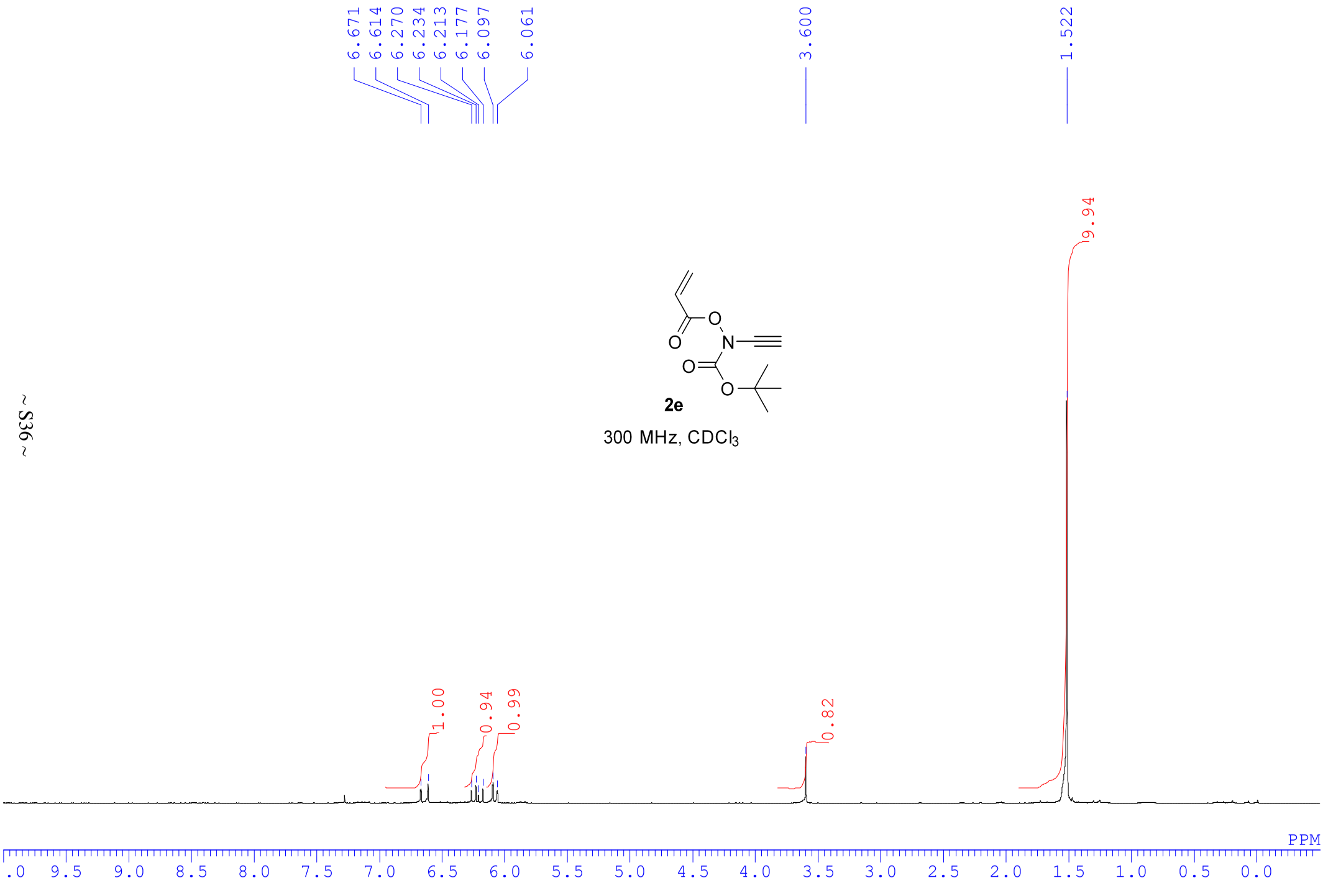
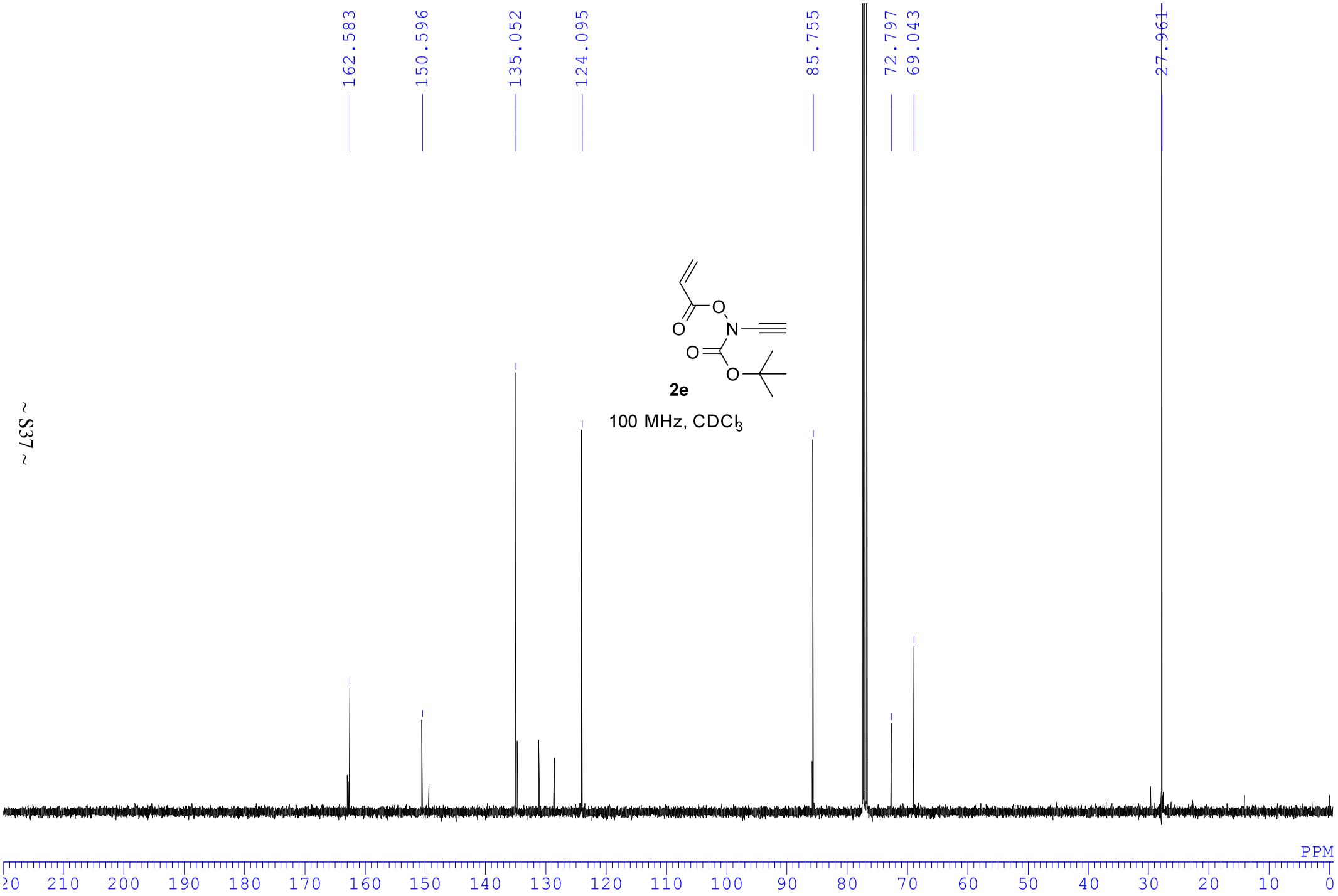
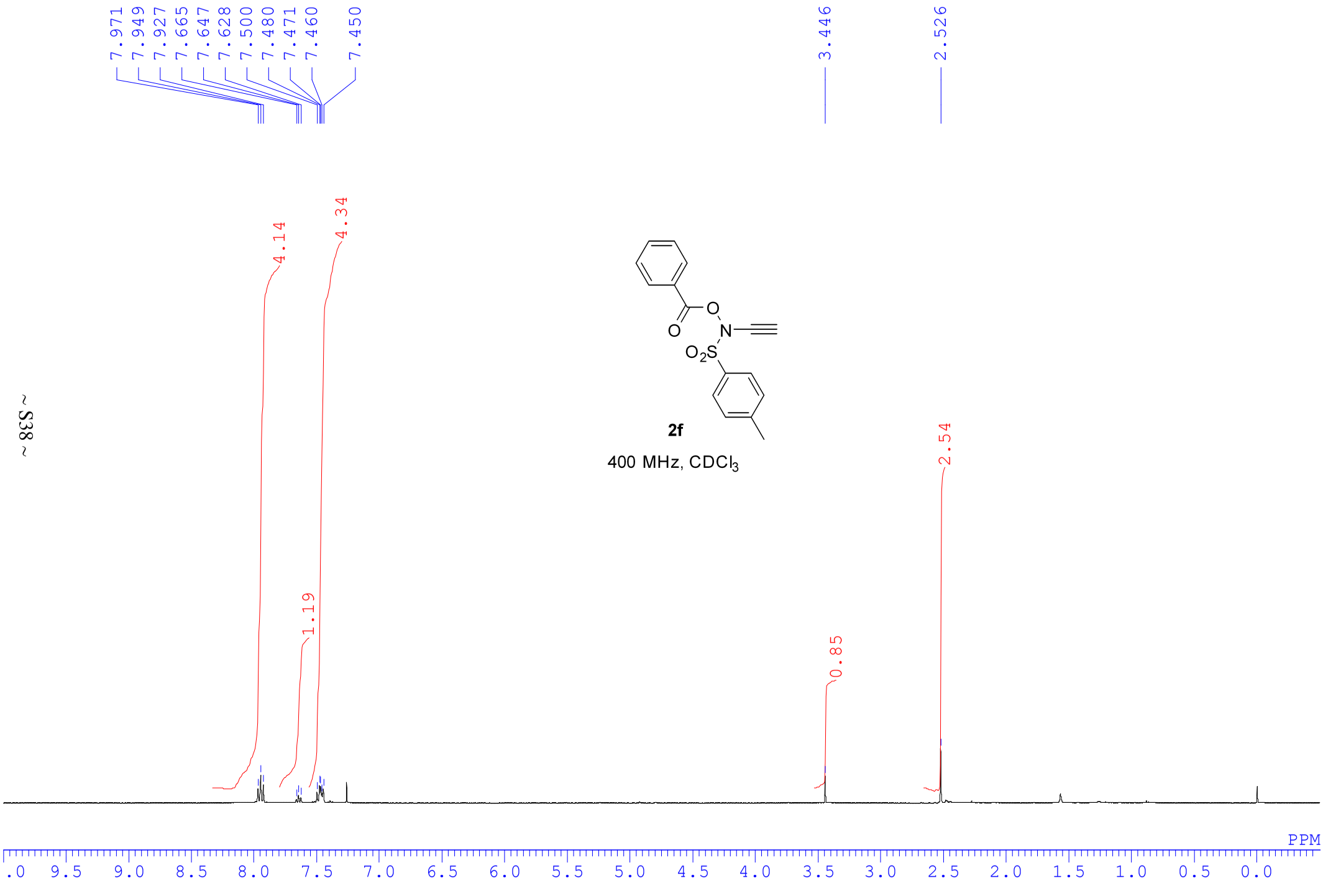
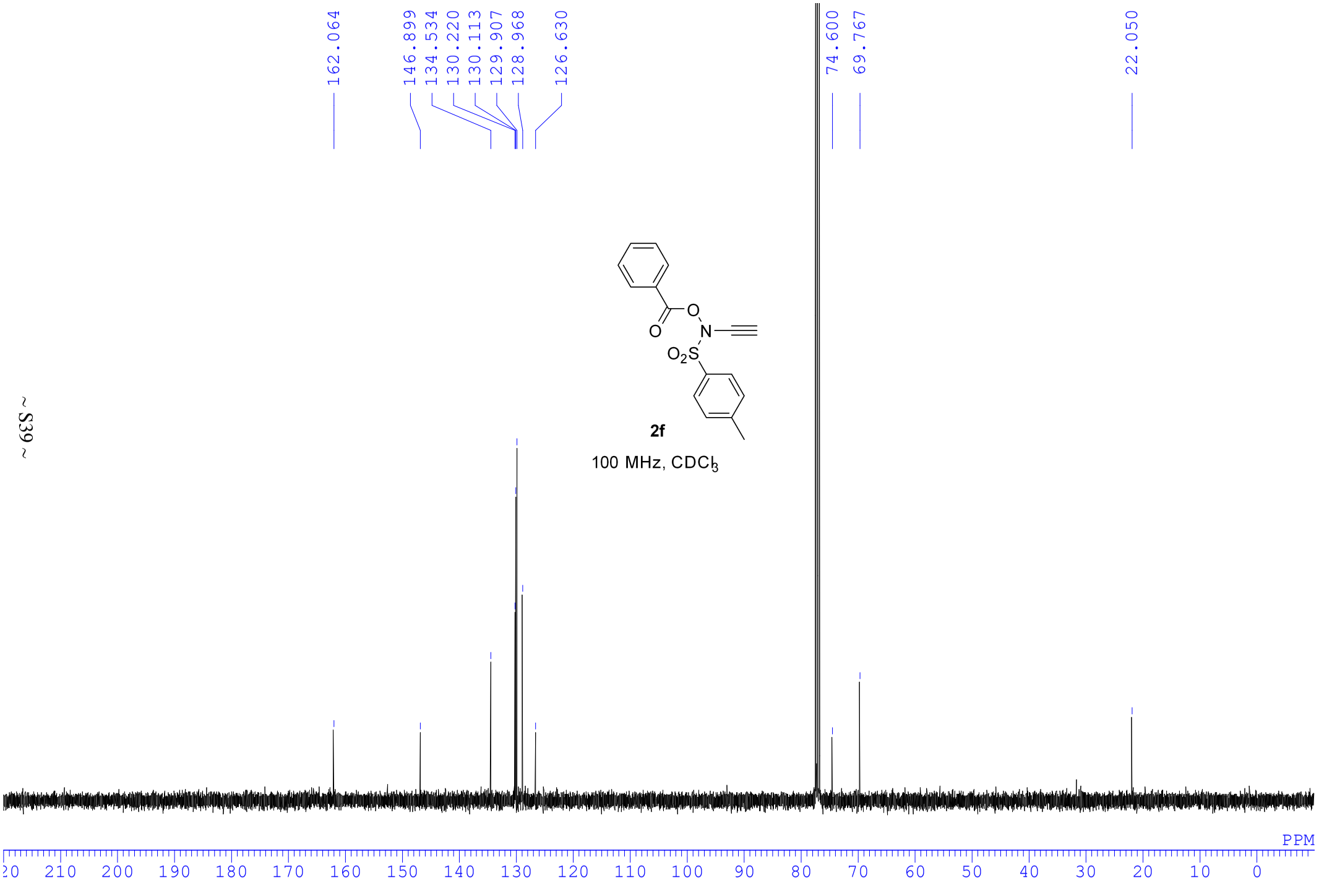
3.25
PPM
.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

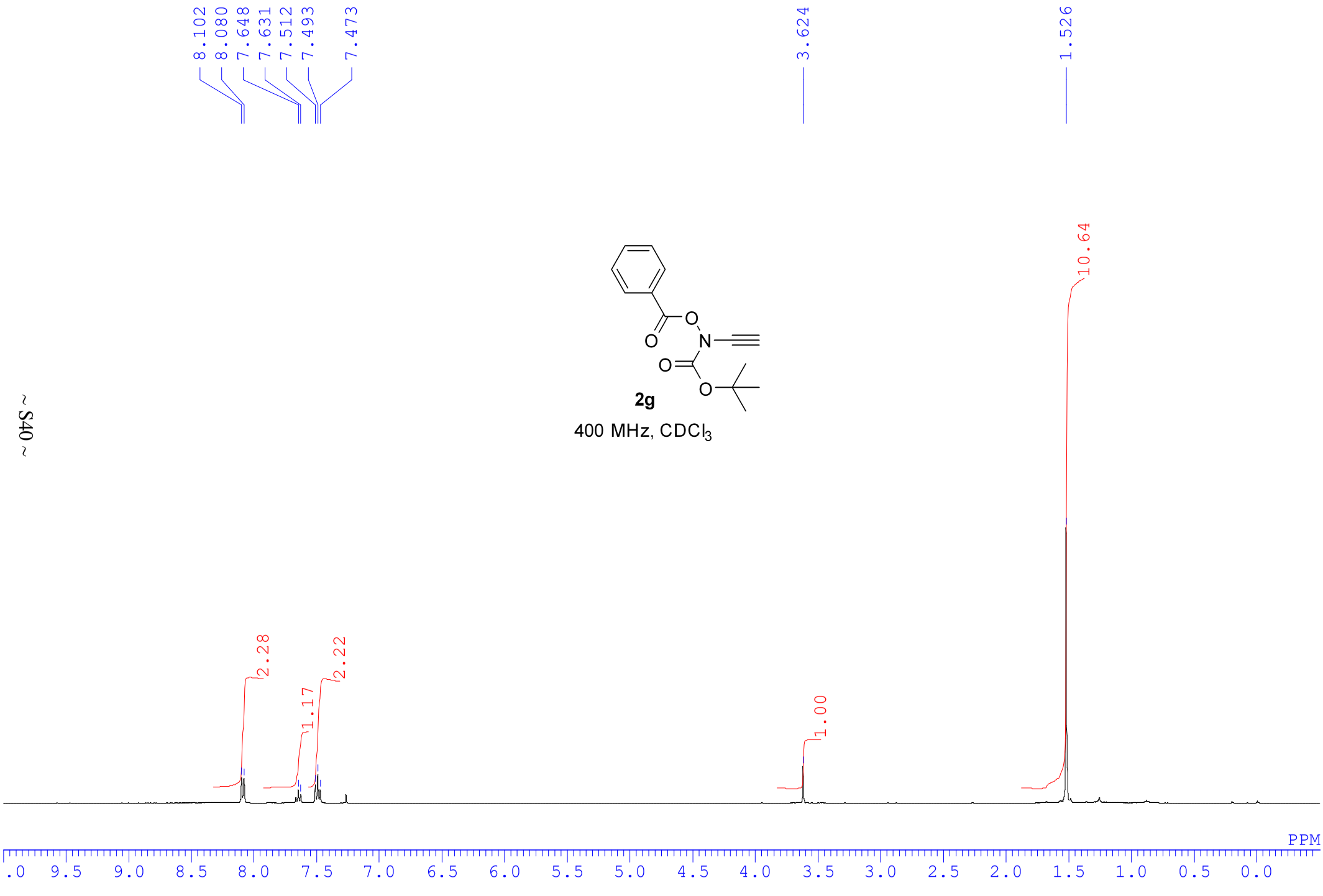

166.242
146.877
130.048
129.915
129.858
74.300
69.704
22.022
18.541
O
O
N
O2S
2d
100 MHz, CDCl3
PPM
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

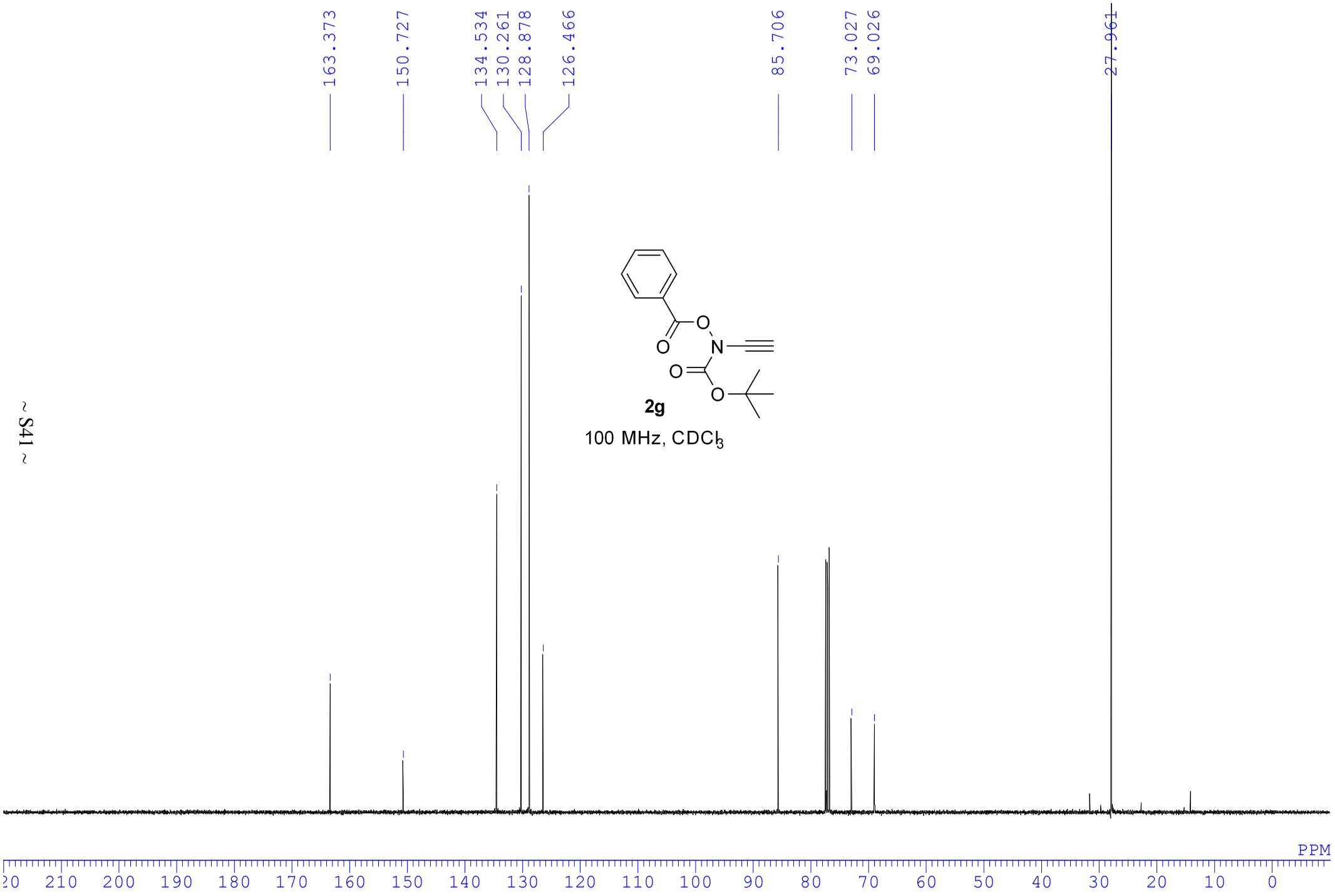

6.671
6.614
6.270
6.234
6.213
6.177
6.097
6.061
3.600
1.522
9.94
1.00
0.94
0.99
0.82
O
O
N
O
O
2e
300 MHz, CDCl3
PPM
.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

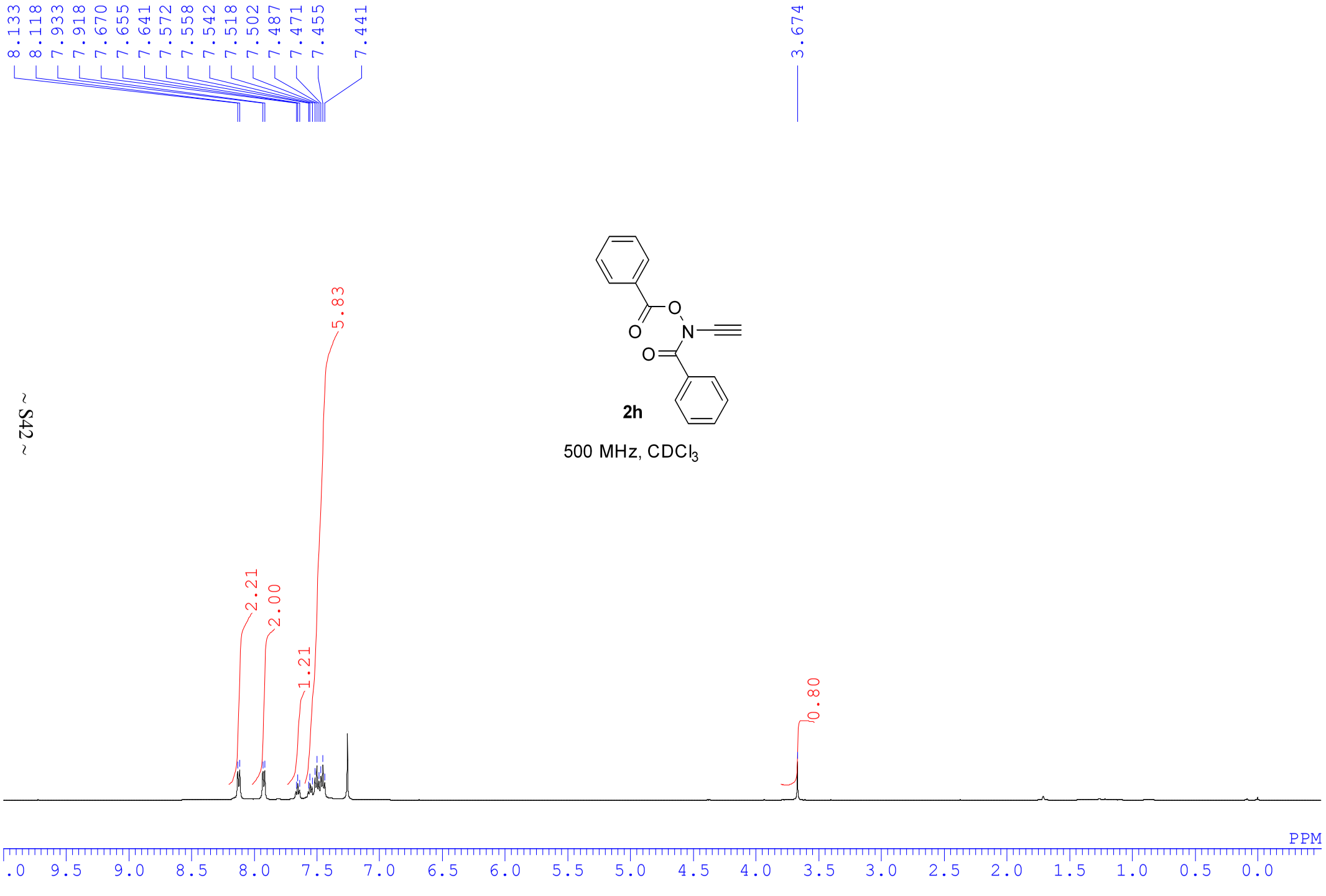

162.583
150.596
135.052
124.095
85.755
72.797
69.043
27.961
O
O
N
O
O
2e
100 MHz, CDCl3
PPM
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0


7.971
7.949
7.927
7.665
7.647
7.628
7.500
7.480
7.471
7.460
7.450
3.446
2.526
4.14
4.34
1.19
0.85
2.54
O
O
N
O2S
2f
400 MHz, CDCl3
PPM
.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0


162.064
146.899
134.534
130.220
130.113
129.907
128.968
126.630
74.600
69.767
22.050
O
O
N
O2S
2f
100 MHz, CDCl3
PPM
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

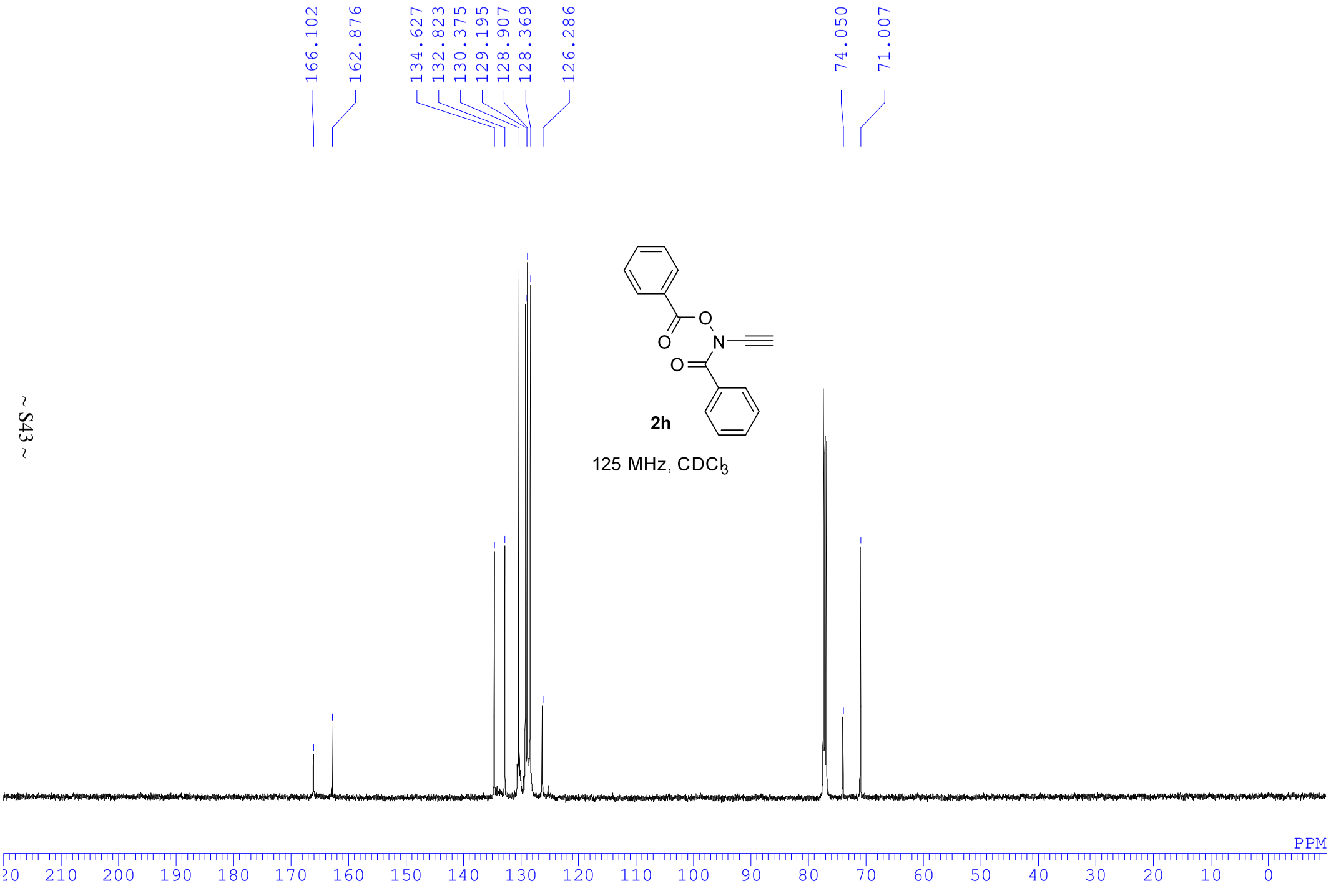

8.102
8.080
7.648
7.631
7.512
7.493
7.473
3.624
1.526
10.64
2.28
1.17
2.22
1.00
O
O
N
O
O
2g
400 MHz, CDCl3
PPM
.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

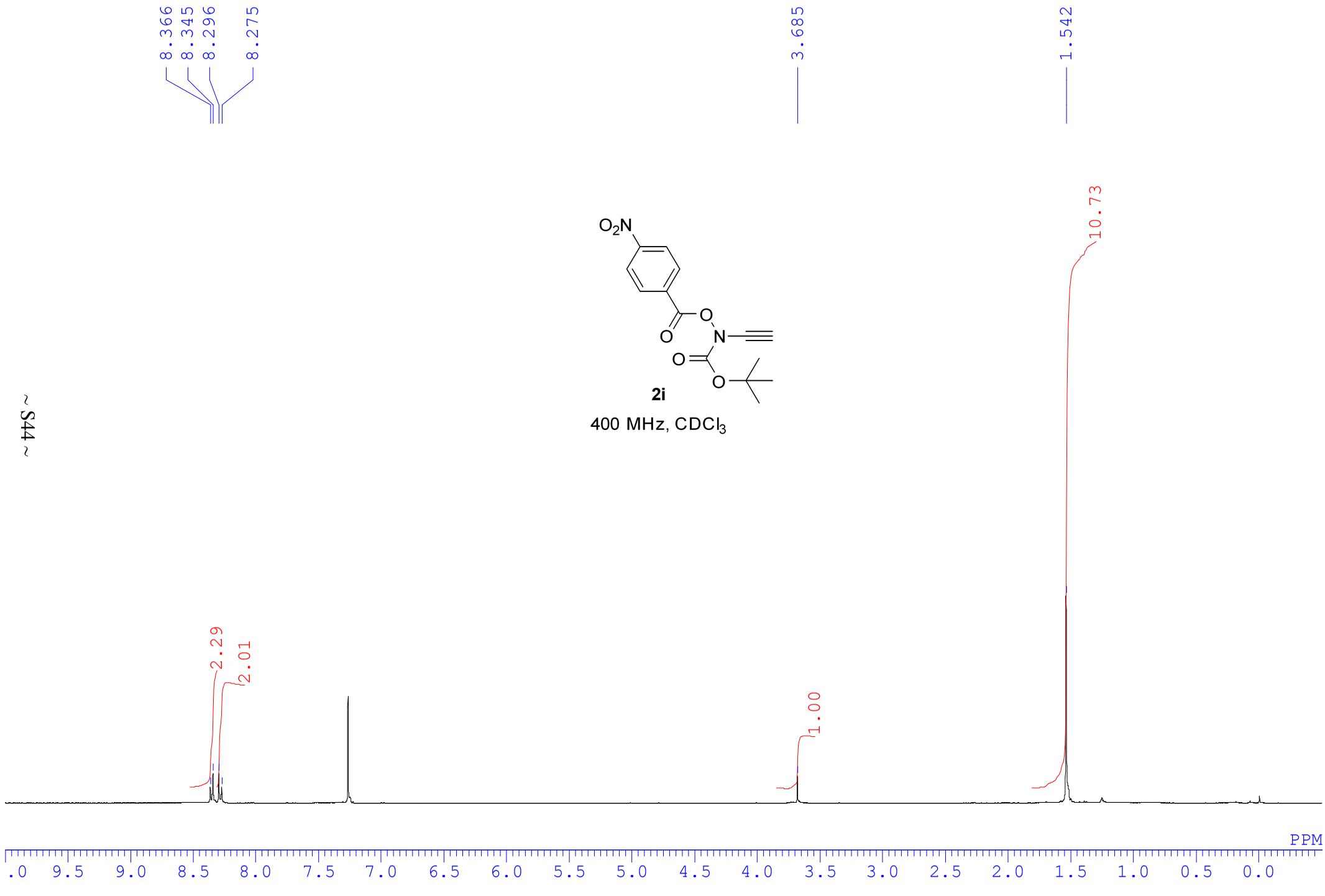

163.373
150.727
134.534
130.261
128.878
126.466
85.706
73.027
69.026
27.961
O
O
N
O
O
2g
100 MHz, CDCl3
PPM
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

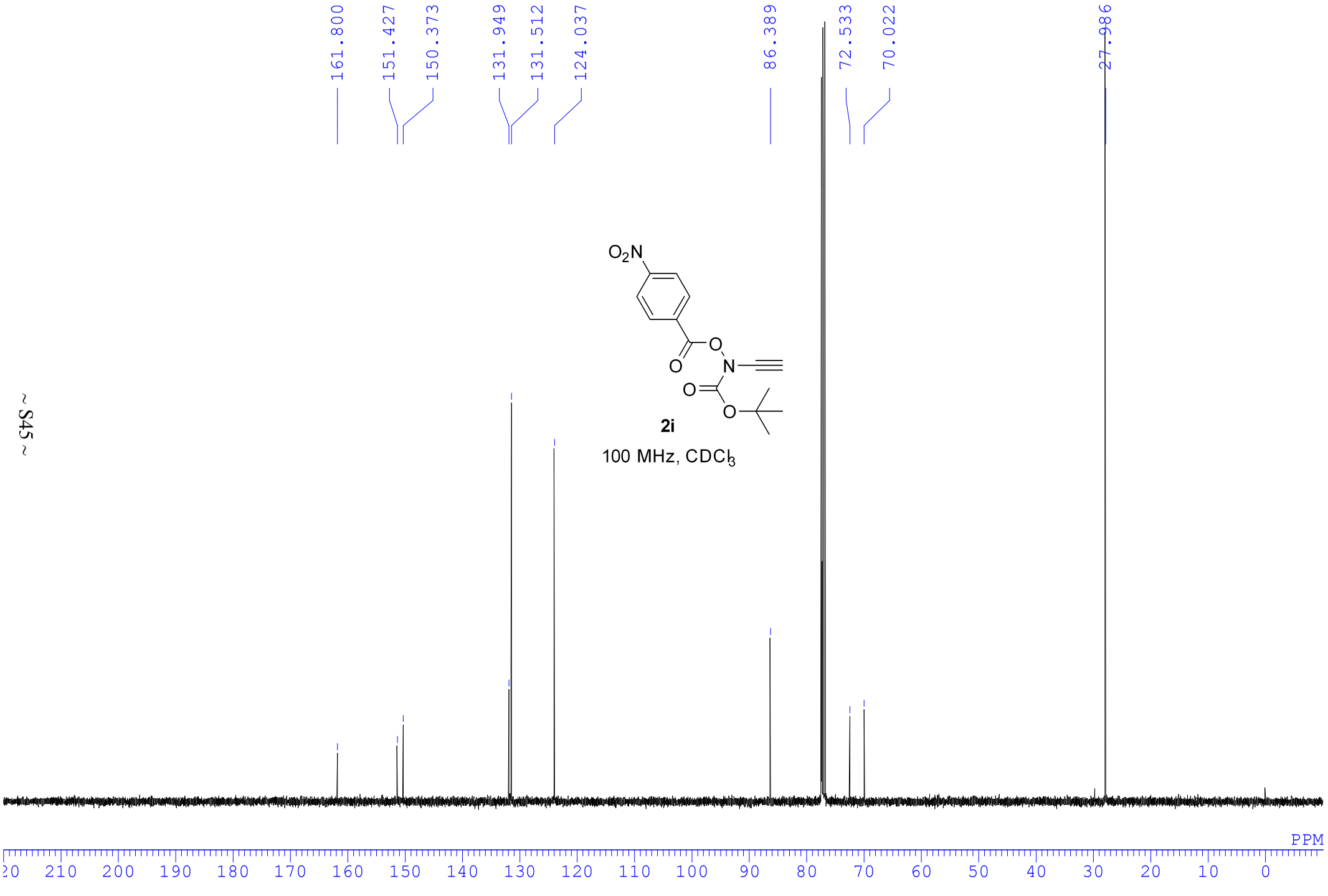


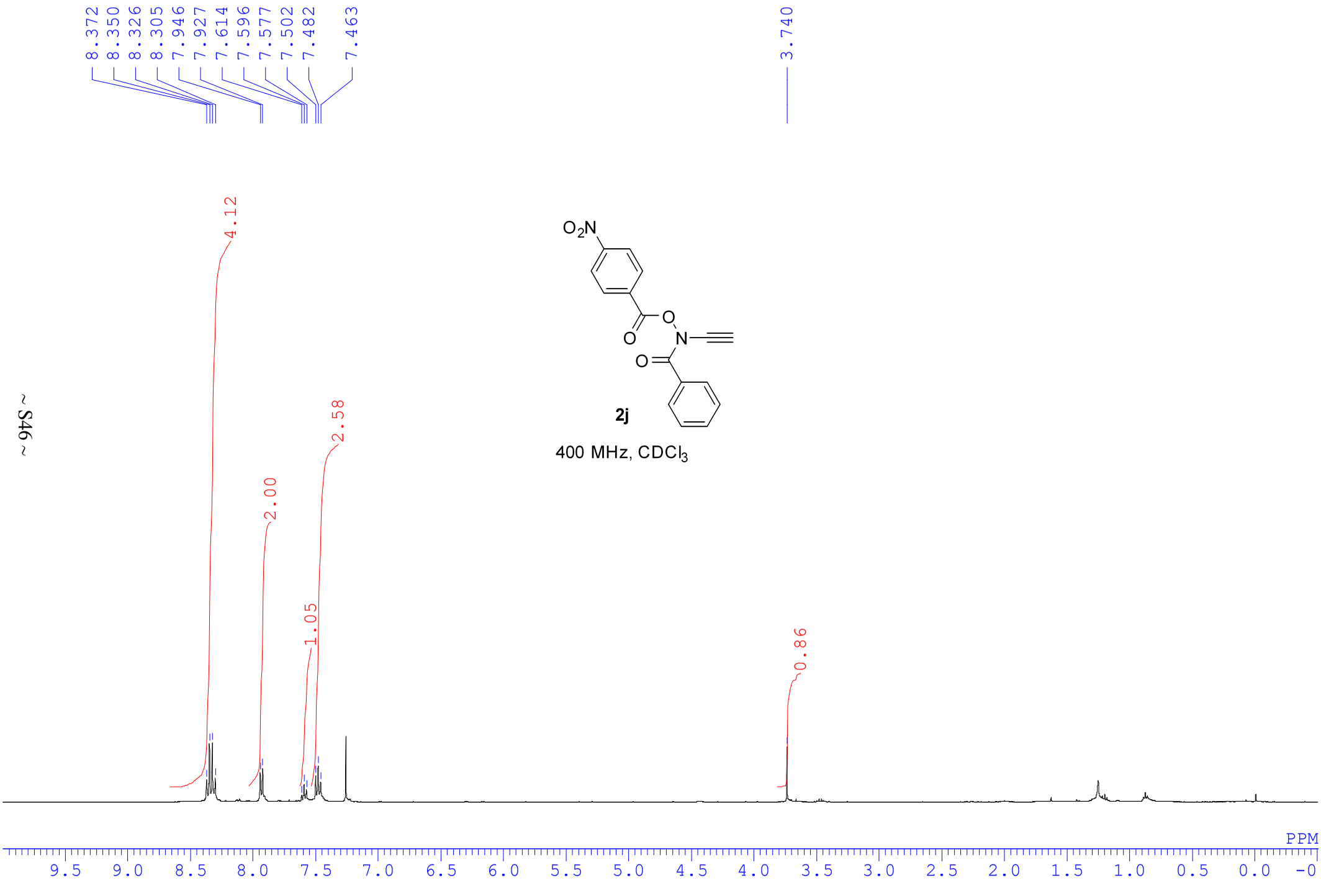

**2h**

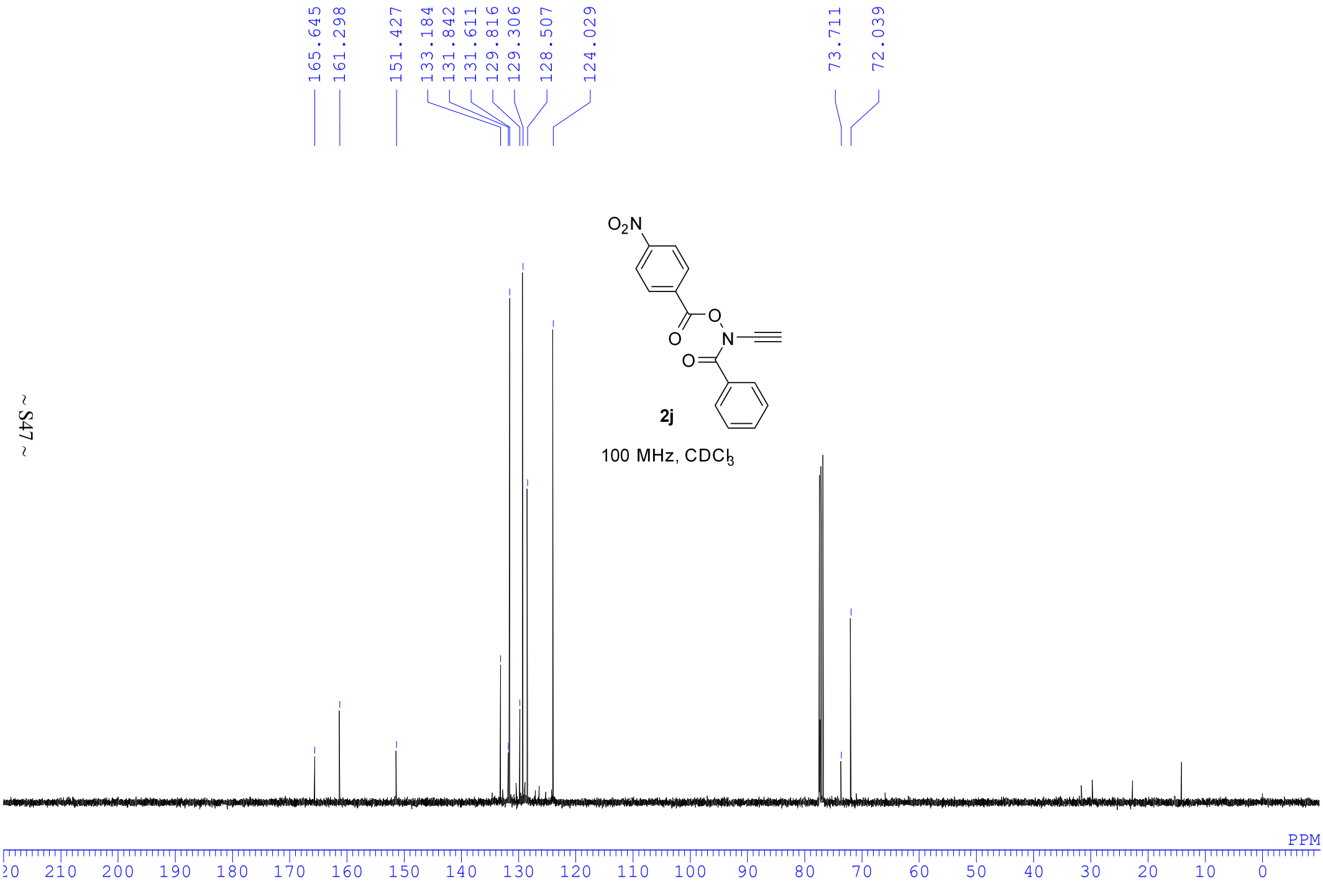
500 MHz, $CDCl_3$

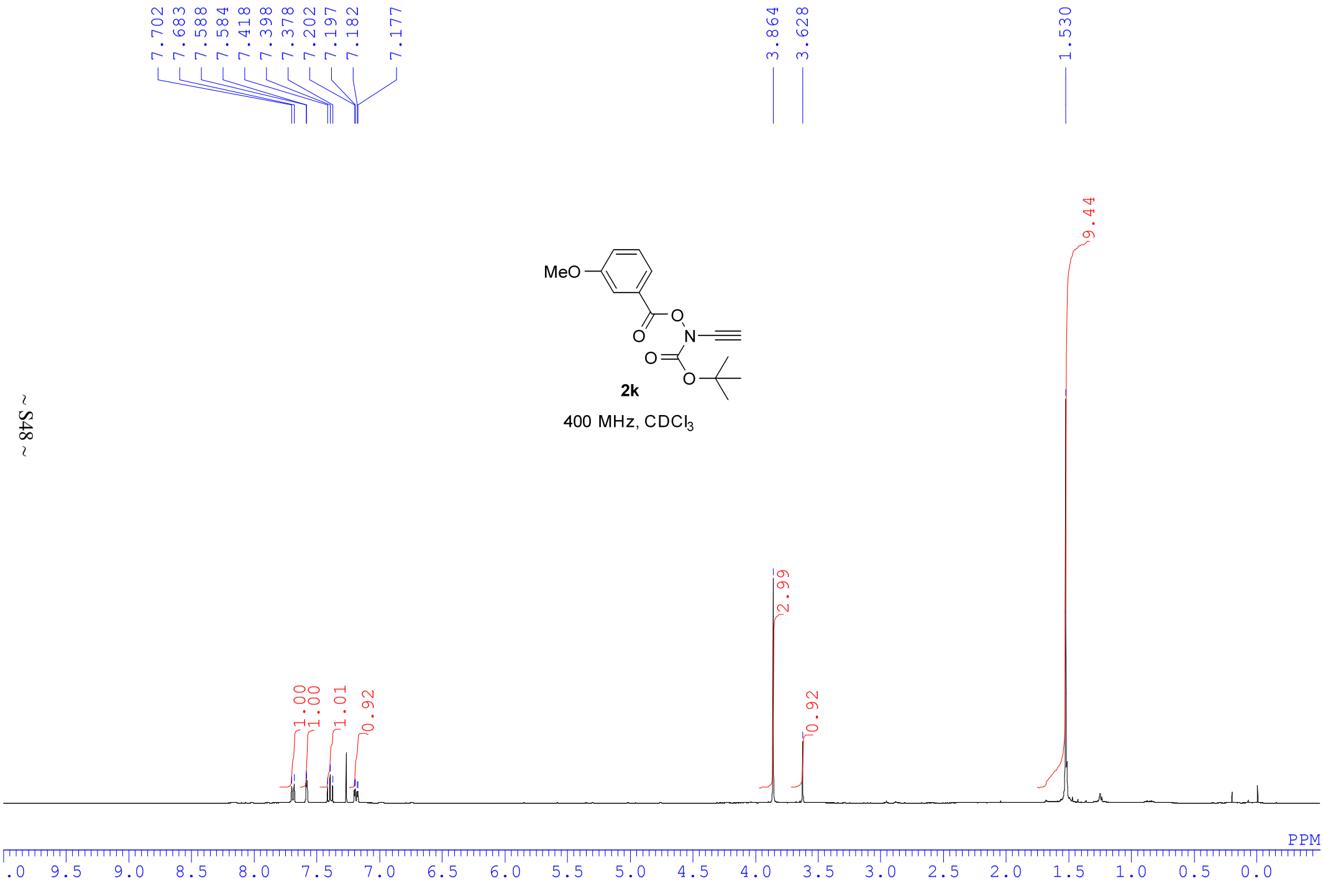

166.102
162.876
134.627
132.823
130.375
129.195
128.907
128.369
126.286
74.050
71.007
O
O
N
O
2h
125 MHz, CDCl3
PPM
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

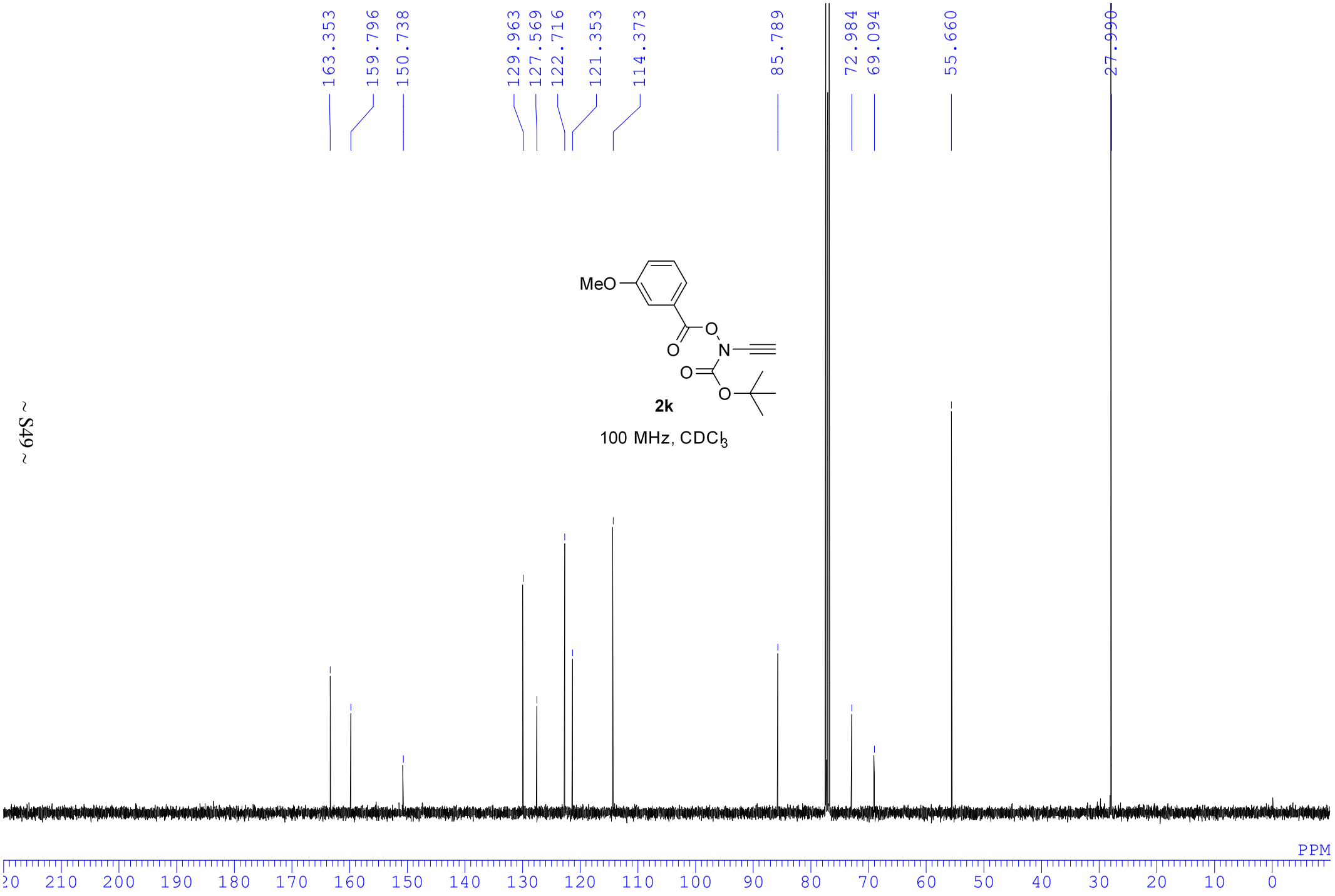

8.366
8.345
8.296
8.275
3.685
1.542
10.73
2.29
2.01
1.00
O2N
O
O
N
O
O
2i
400 MHz, CDCl3
PPM
.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

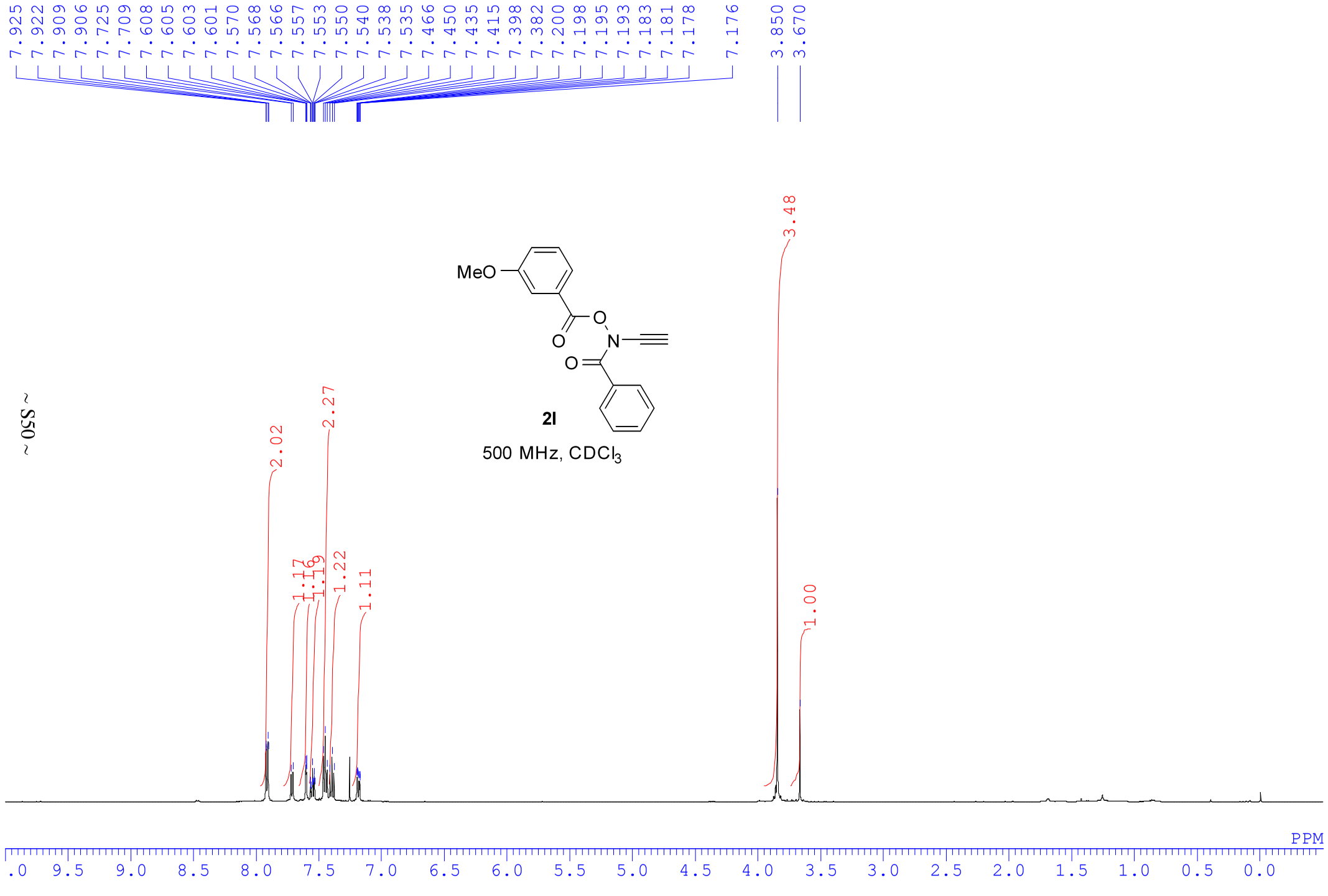

161.800
151.427
150.373
131.949
131.512
124.037
86.389
72.533
70.022
27.986
O2N
O
O
N
O
O
2i
100 MHz, CDCl3
PPM
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

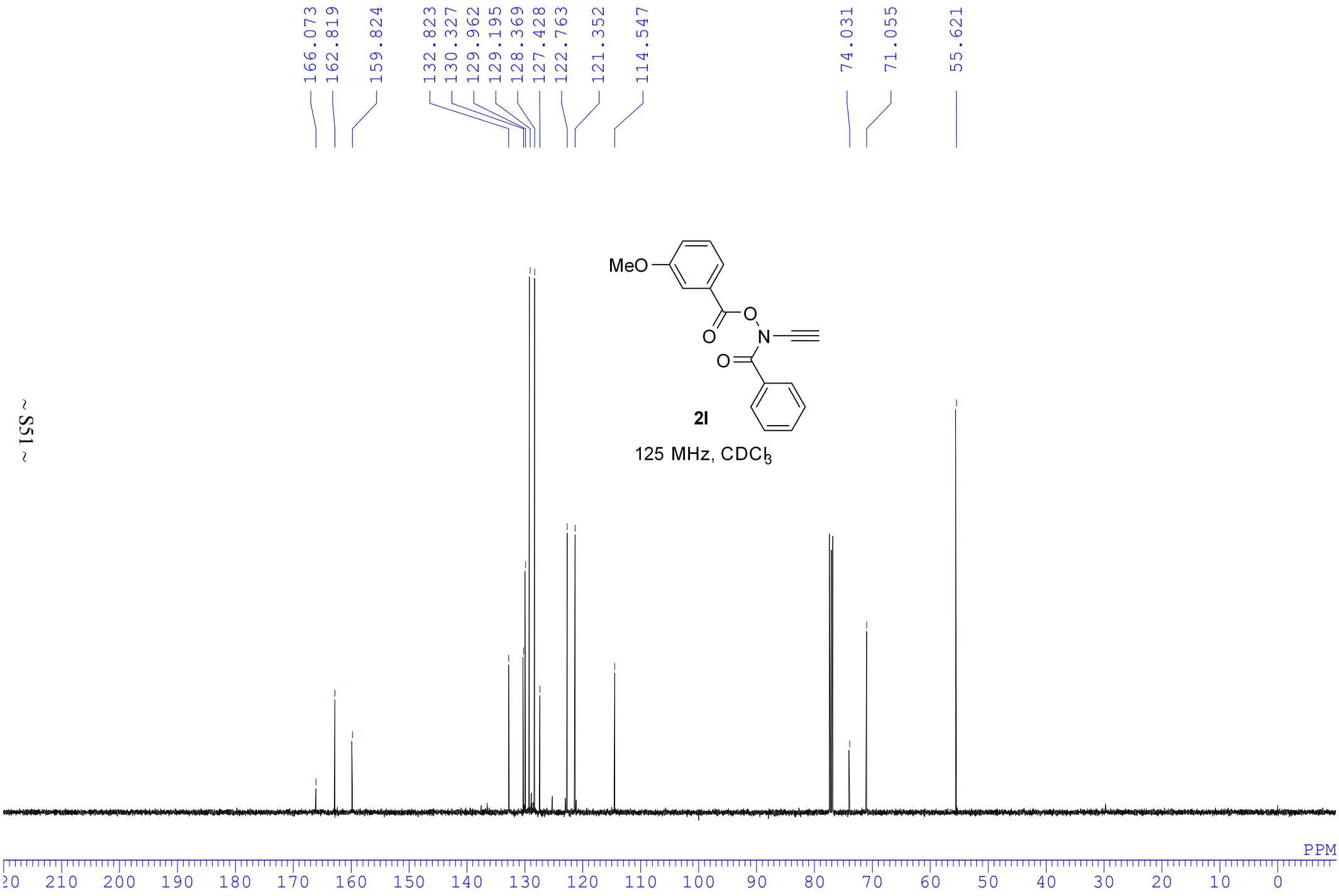

8.372
8.350
8.326
8.305
7.946
7.927
7.614
7.596
7.577
7.502
7.482
7.463
3.740
4.12
2.00
1.05
2.58
0.86
O2N
O
O
N
O
2j
400 MHz, CDCl3
PPM
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0

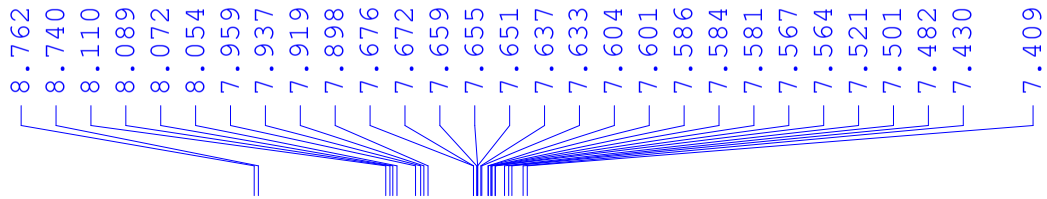

165.645
161.298
151.427
133.184
131.842
131.611
129.816
129.306
128.507
124.029
73.711
72.039
O2N
O
O
N
O
2j
100 MHz, CDCl3
PPM
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

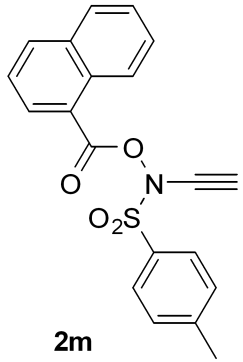

7.702
7.683
7.588
7.584
7.418
7.398
7.378
7.202
7.197
7.182
7.177
3.864
3.628
1.530
9.44
2.99
1.00
1.00
1.01
0.92
0.92
MeO
O
O
N
O
O
2k
400 MHz, CDCl3
PPM
.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0


163.353
159.796
150.738
129.963
127.569
122.716
121.353
114.373
85.789
72.984
69.094
55.660
27.990
MeO
O
O
N
O
O
2k
100 MHz, CDCl3
PPM
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0


7.925
7.922
7.909
7.906
7.725
7.709
7.608
7.605
7.603
7.601
7.570
7.568
7.566
7.557
7.553
7.550
7.540
7.538
7.535
7.466
7.450
7.435
7.415
7.398
7.382
7.200
7.198
7.195
7.193
7.183
7.181
7.178
7.176
3.850
3.670
MeO
O
O
N
O
2l
500 MHz, CDCl3
~ S50 ~
2.02
1.17
1.16
1.19
2.27
1.22
1.11
3.48
1.00
PPM
.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

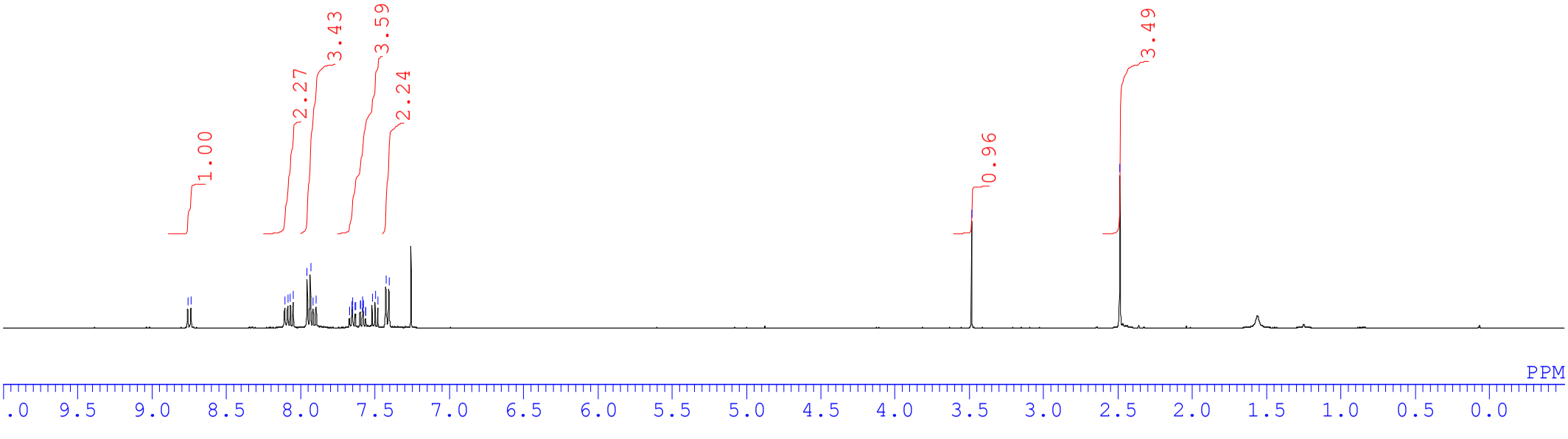

166.073
162.819
159.824
132.823
130.327
129.962
129.195
128.369
127.428
122.763
121.352
114.547
74.031
71.055
55.621
MeO
O
O
N
O
2l
125 MHz, CDCl3
PPM
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

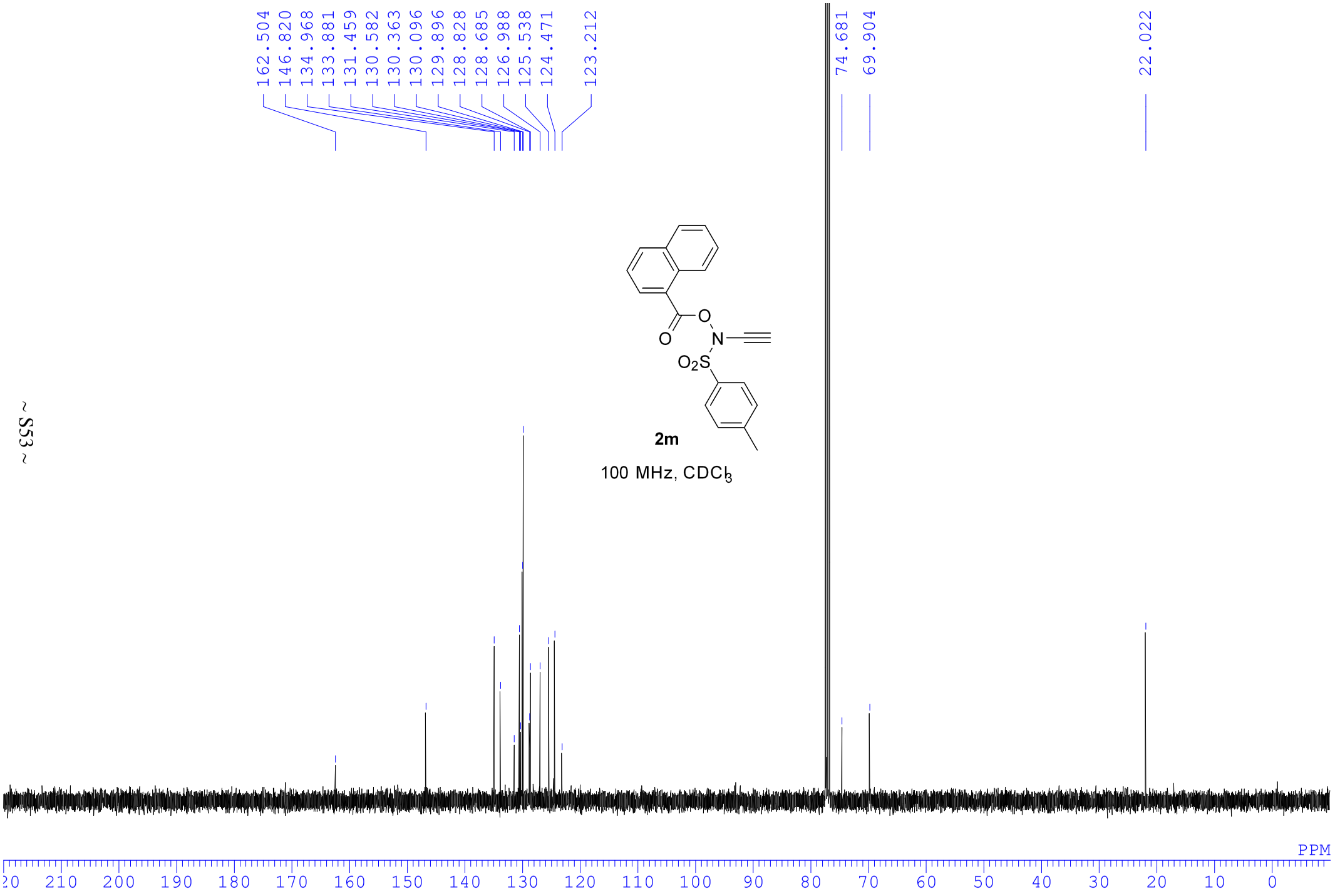


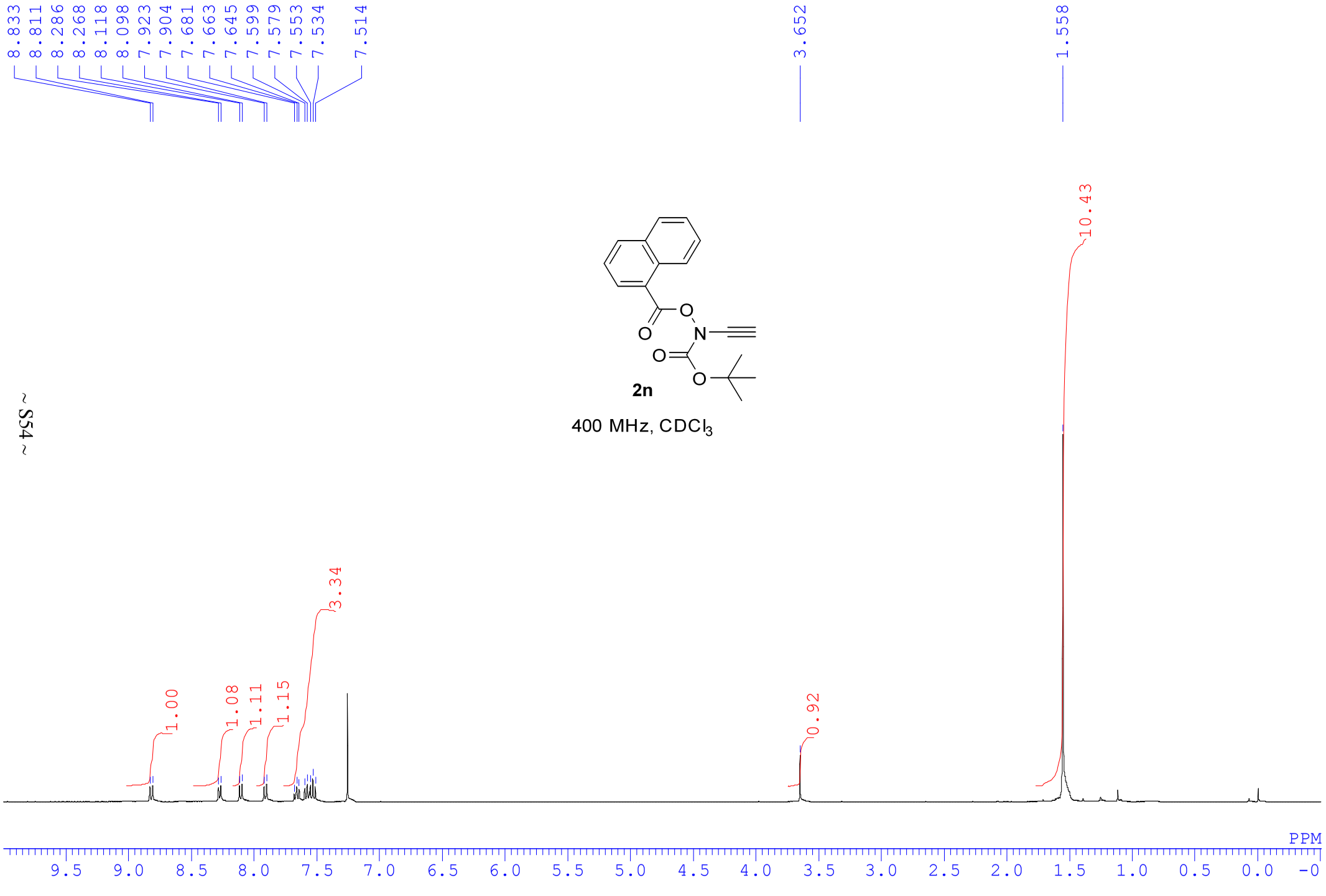



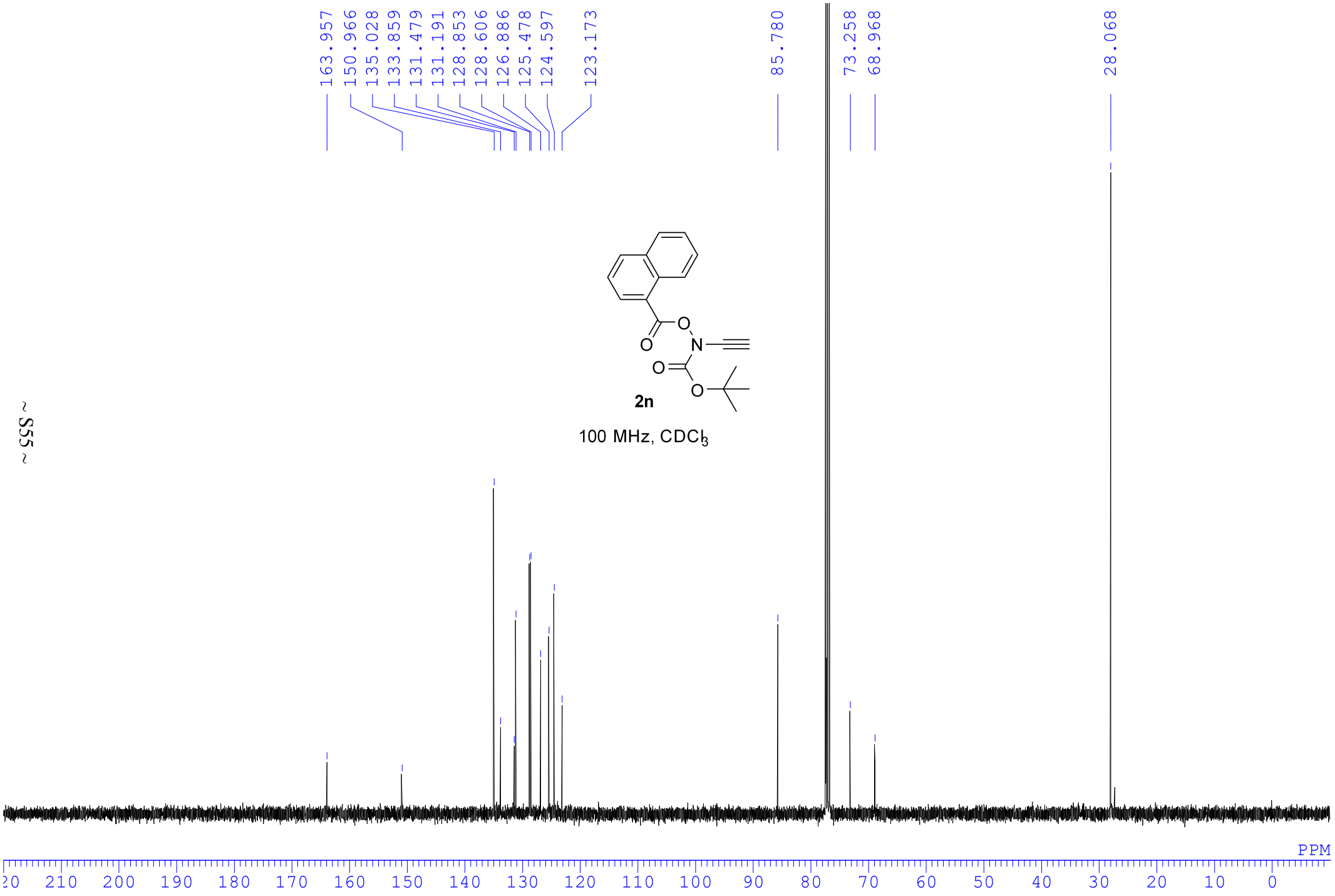

**2m**

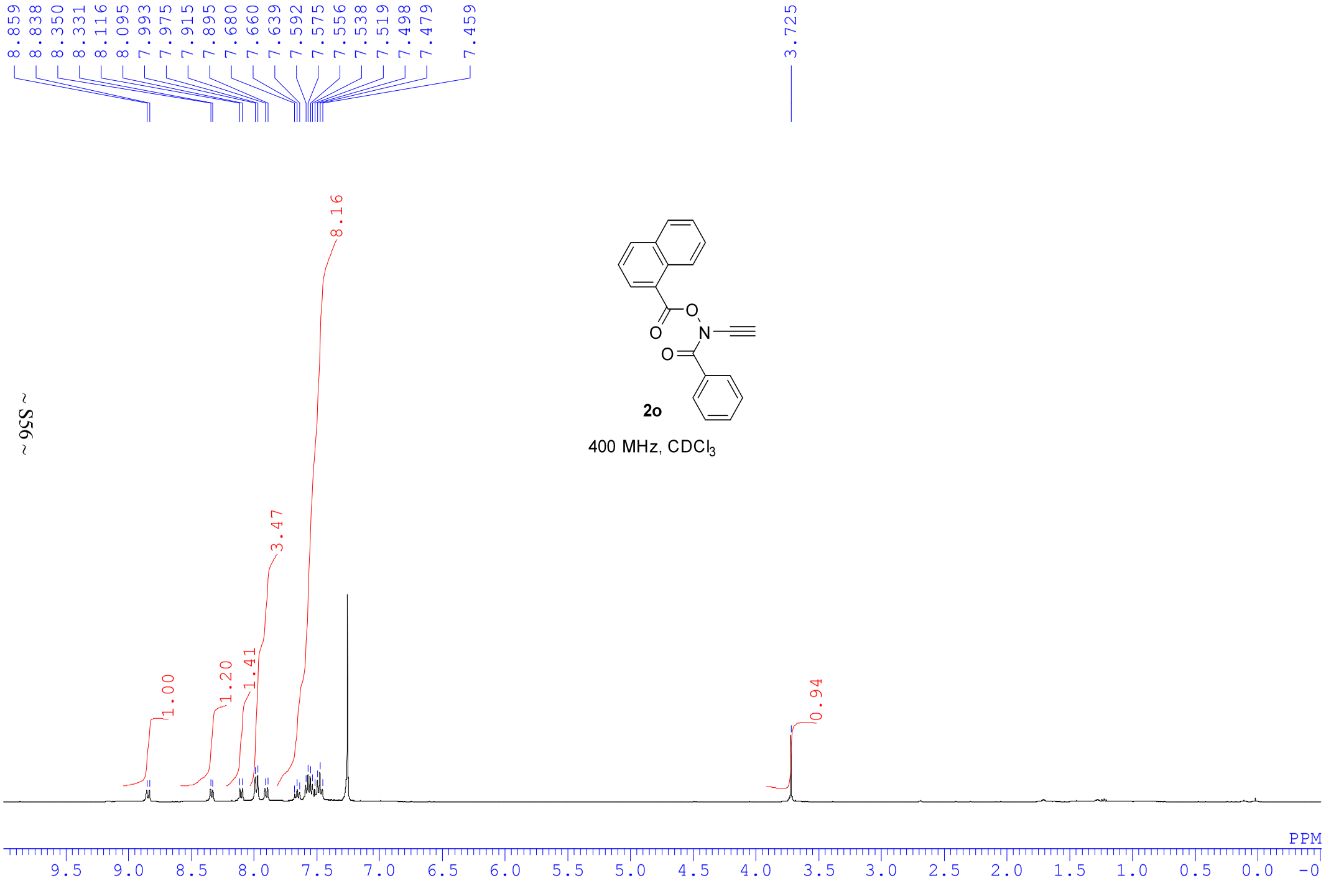
400 MHz, $CDCl_3$

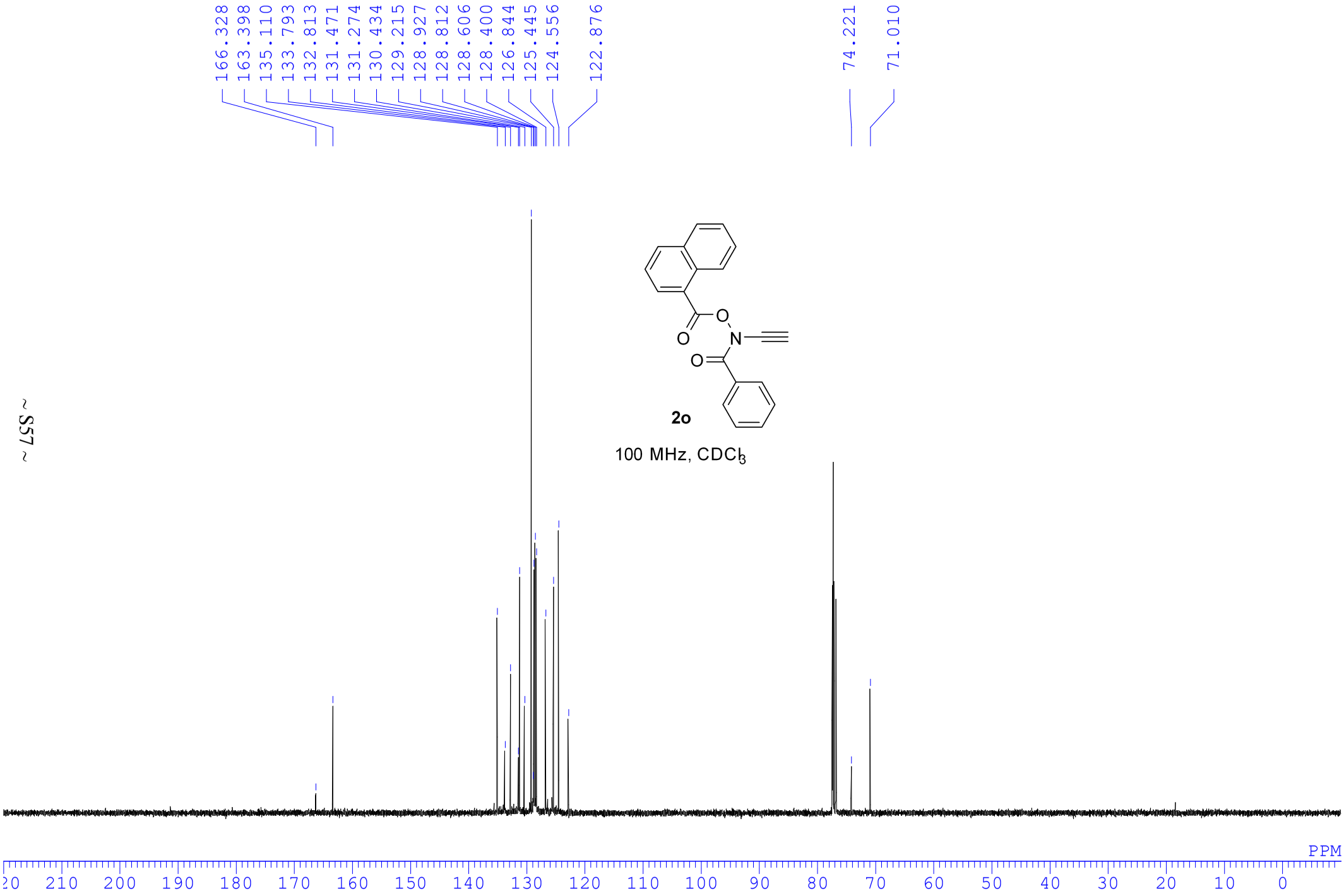


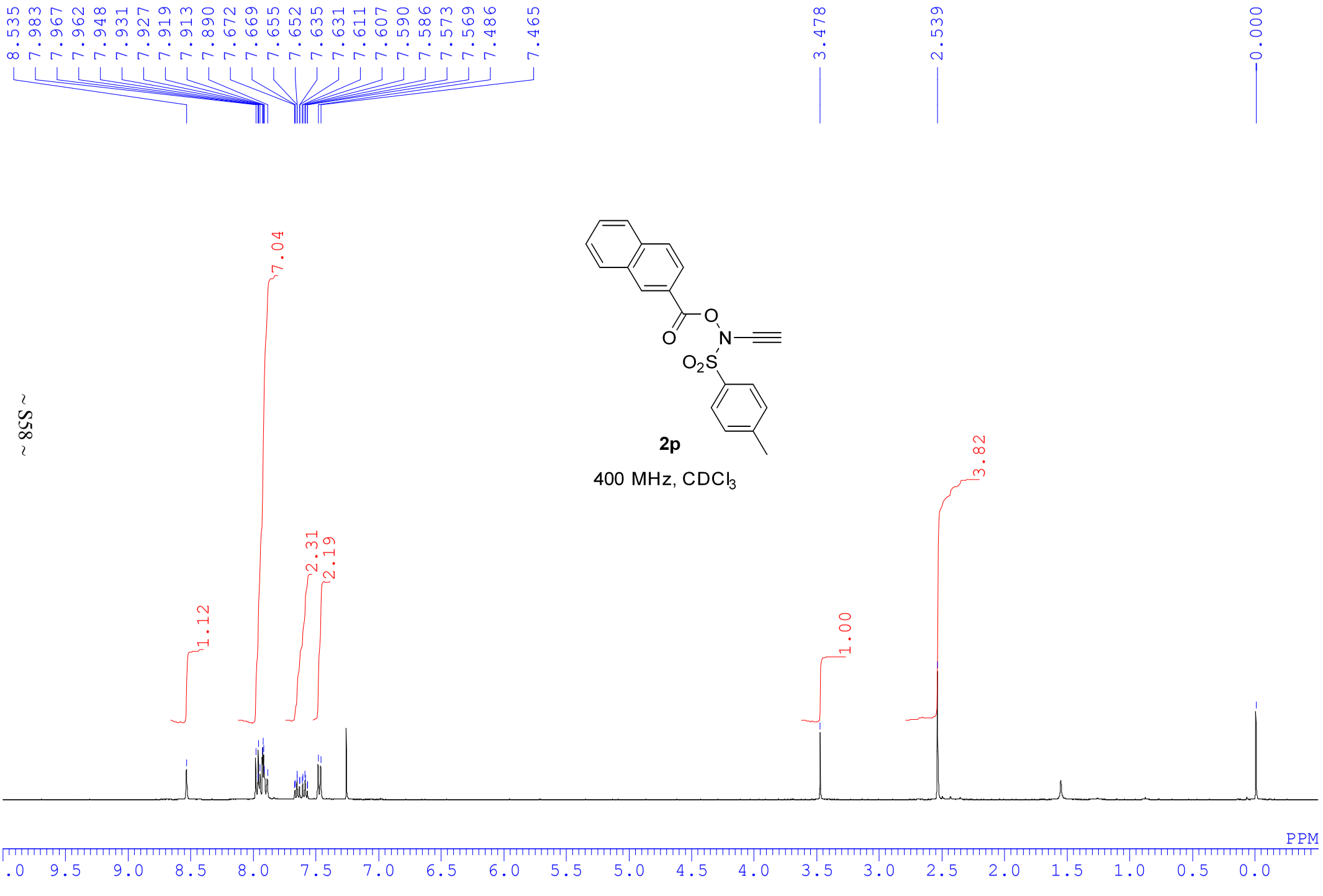

162.504
146.820
134.968
133.881
131.459
130.582
130.363
130.096
129.896
128.828
128.685
126.988
125.538
124.471
123.212
74.681
69.904
22.022
O
O
N
O2S
2m
100 MHz, CDCl3
PPM
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

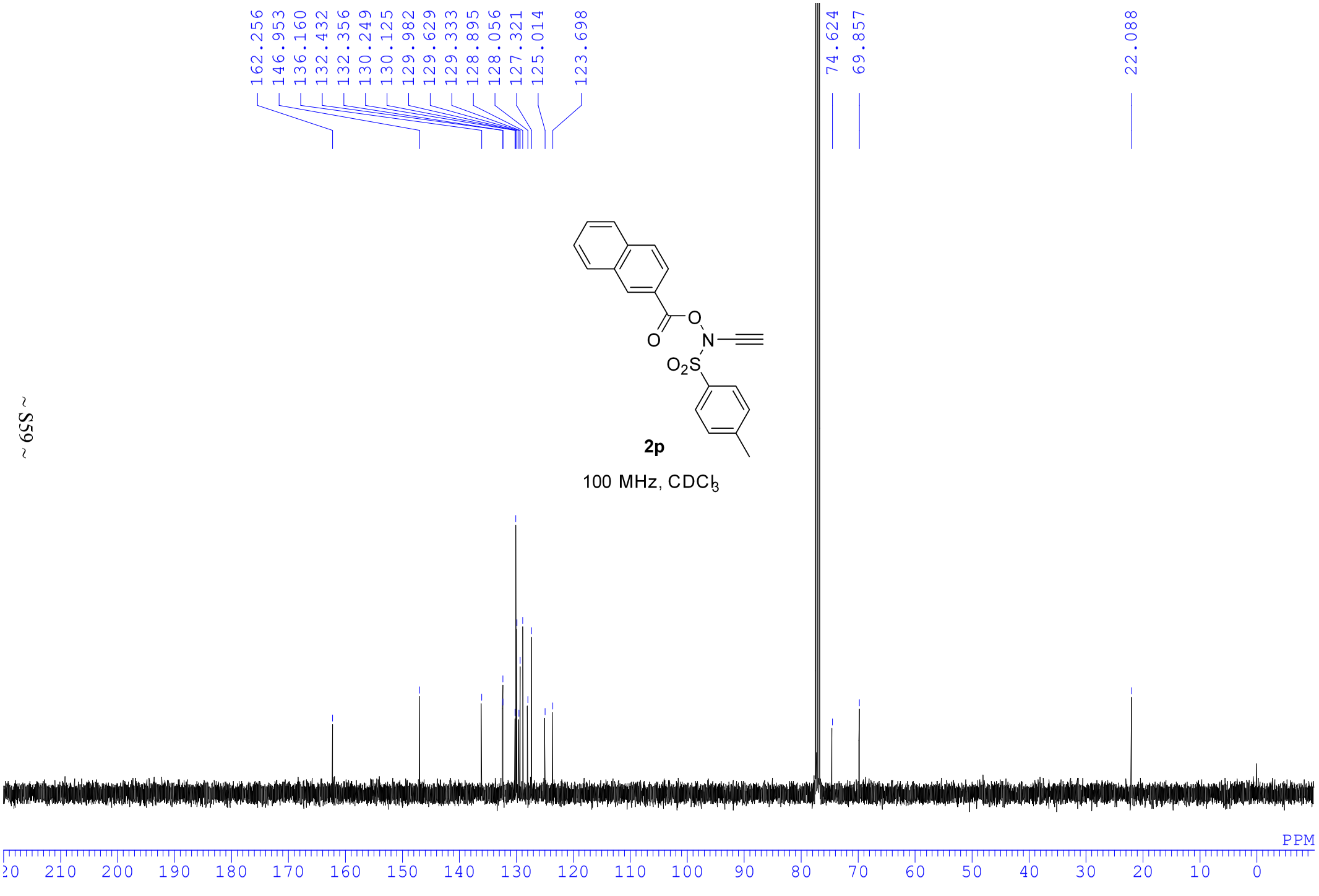

8.833
8.811
8.286
8.268
8.118
8.098
7.923
7.904
7.681
7.663
7.645
7.599
7.579
7.553
7.534
7.514
3.652
1.558
10.43
3.34
1.00
1.08
1.11
1.15
0.92
2n
400 MHz, CDCl3
PPM
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0

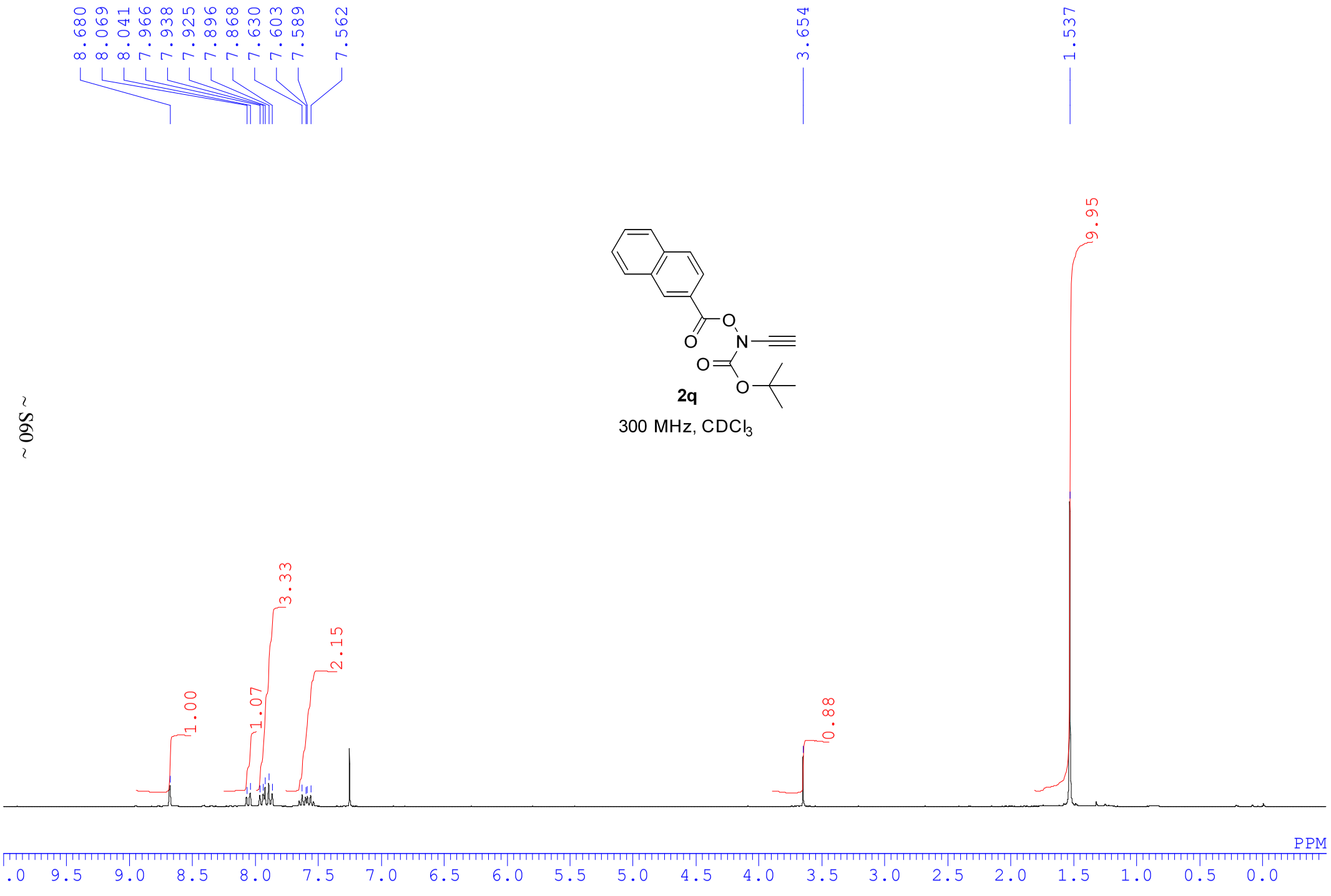

163.957
150.966
135.028
133.859
131.479
131.191
128.853
128.606
126.886
125.478
124.597
123.173
85.780
73.258
68.968
28.068
O
O
N
O
O
2n
100 MHz, CDCl3
PPM
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

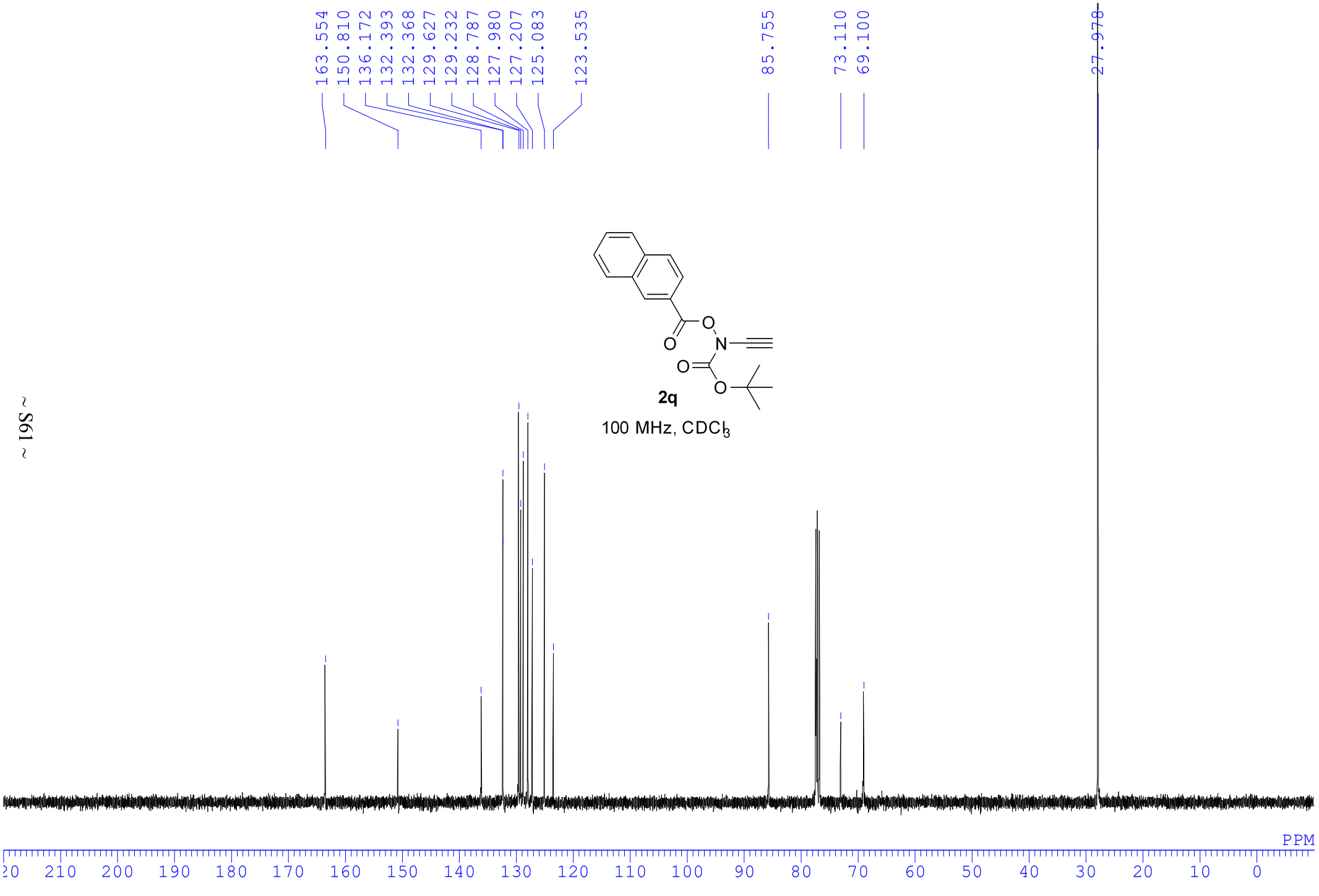

8.859
8.838
8.350
8.331
8.116
8.095
7.993
7.975
7.915
7.895
7.680
7.660
7.639
7.592
7.575
7.556
7.538
7.519
7.498
7.479
7.459
3.725
8.16
3.47
1.41
1.20
1.00
0.94
2o
400 MHz, CDCl3
PPM
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0

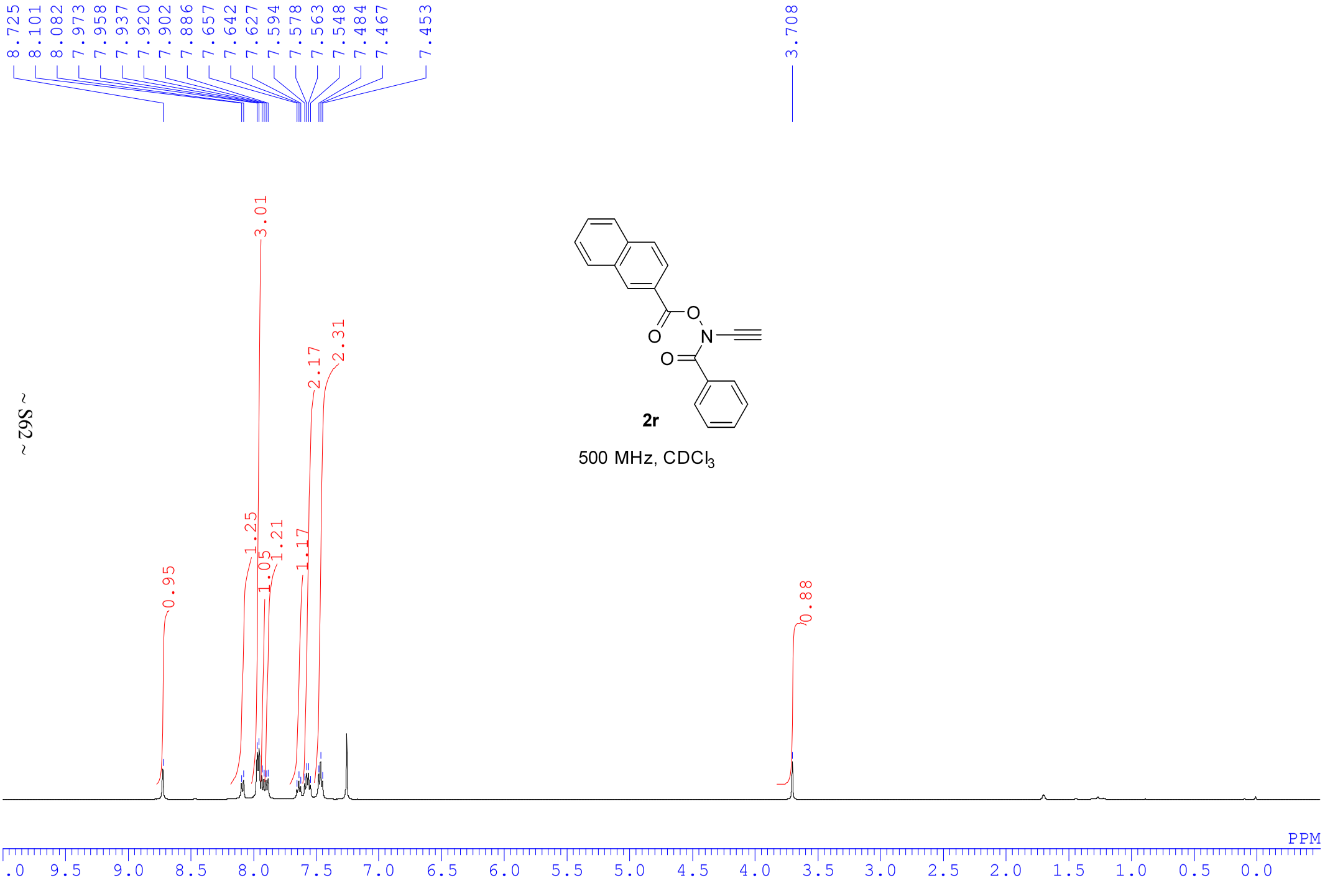

166.328
163.398
135.110
133.793
132.813
131.471
131.274
130.434
129.215
128.927
128.812
128.606
128.400
126.844
125.445
124.556
122.876
74.221
71.010
O
O
N
O
2o
100 MHz, CDCl3
PPM
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0


8.535
7.983
7.967
7.962
7.948
7.931
7.927
7.919
7.913
7.890
7.672
7.669
7.655
7.652
7.635
7.631
7.611
7.607
7.590
7.586
7.573
7.569
7.486
7.465
3.478
2.539
0.000
7.04
2.31
2.19
1.12
1.00
3.82
O
O
N
O2S
2p
400 MHz, CDCl3
PPM
.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0


162.256
146.953
136.160
132.432
132.356
130.249
130.125
129.982
129.629
129.333
128.895
128.056
127.321
125.014
123.698
74.624
69.857
22.088
O
O
N
O2S
2p
100 MHz, CDCl3
PPM
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

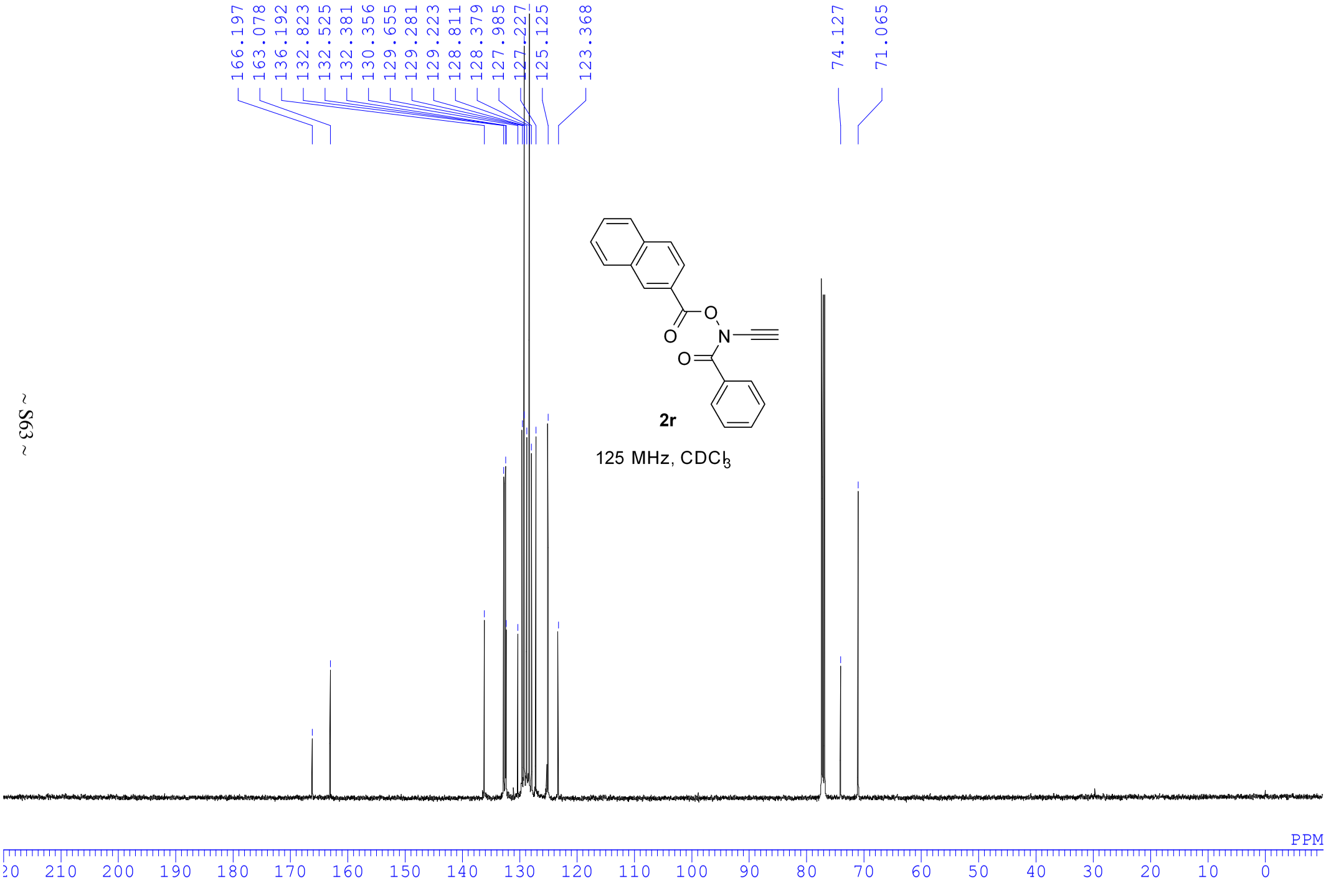

8.680
8.069
8.041
7.966
7.938
7.925
7.896
7.868
7.630
7.603
7.589
7.562
3.654
1.537
9.95
3.33
2.15
1.00
1.07
0.88
2q
300 MHz, CDCl3
PPM
.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

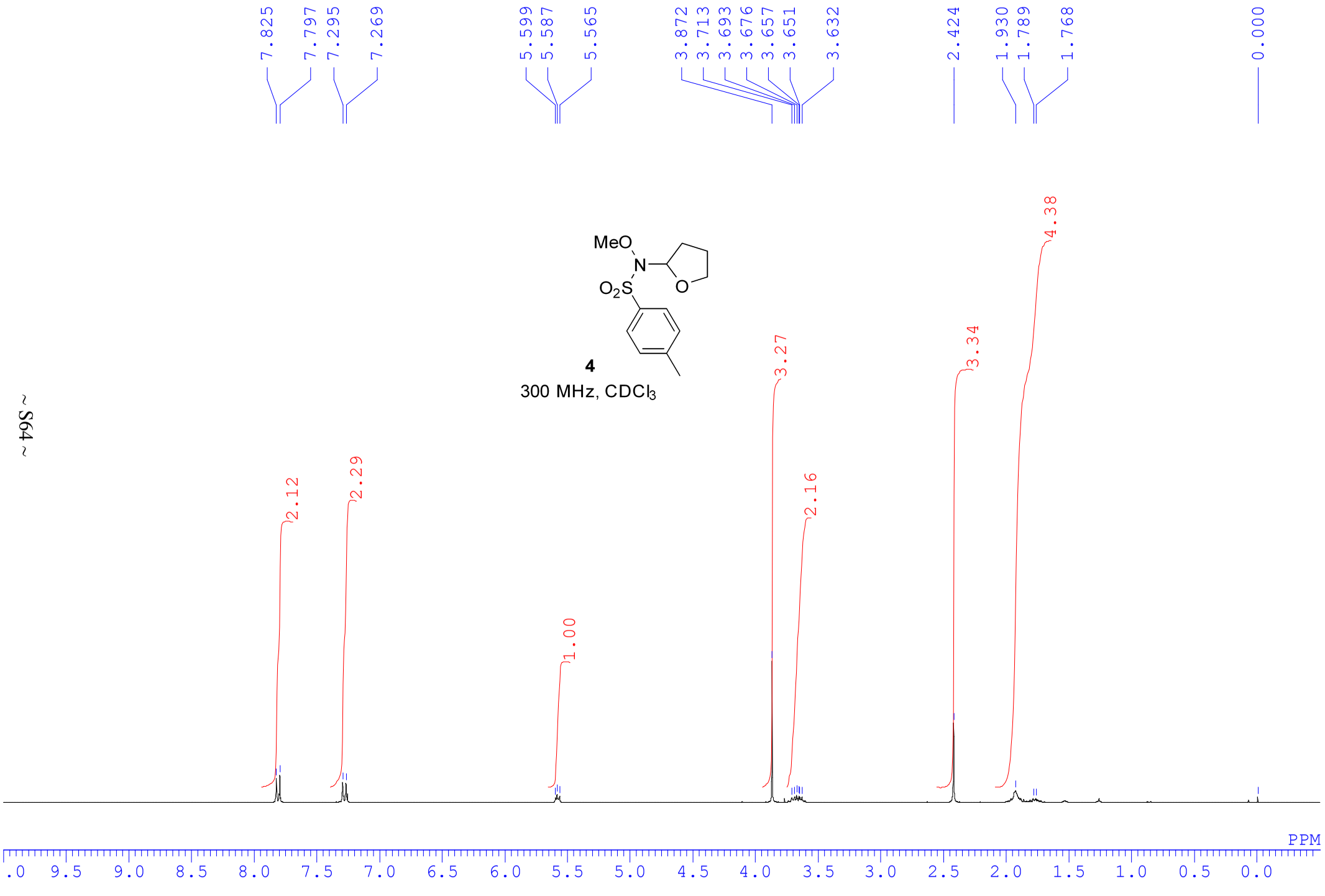

163.554
150.810
136.172
132.393
132.368
129.627
129.232
128.787
127.980
127.207
125.083
123.535
85.755
73.110
69.100
27.978
O
O
N
O
O
2q
100 MHz, CDCl3
PPM
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

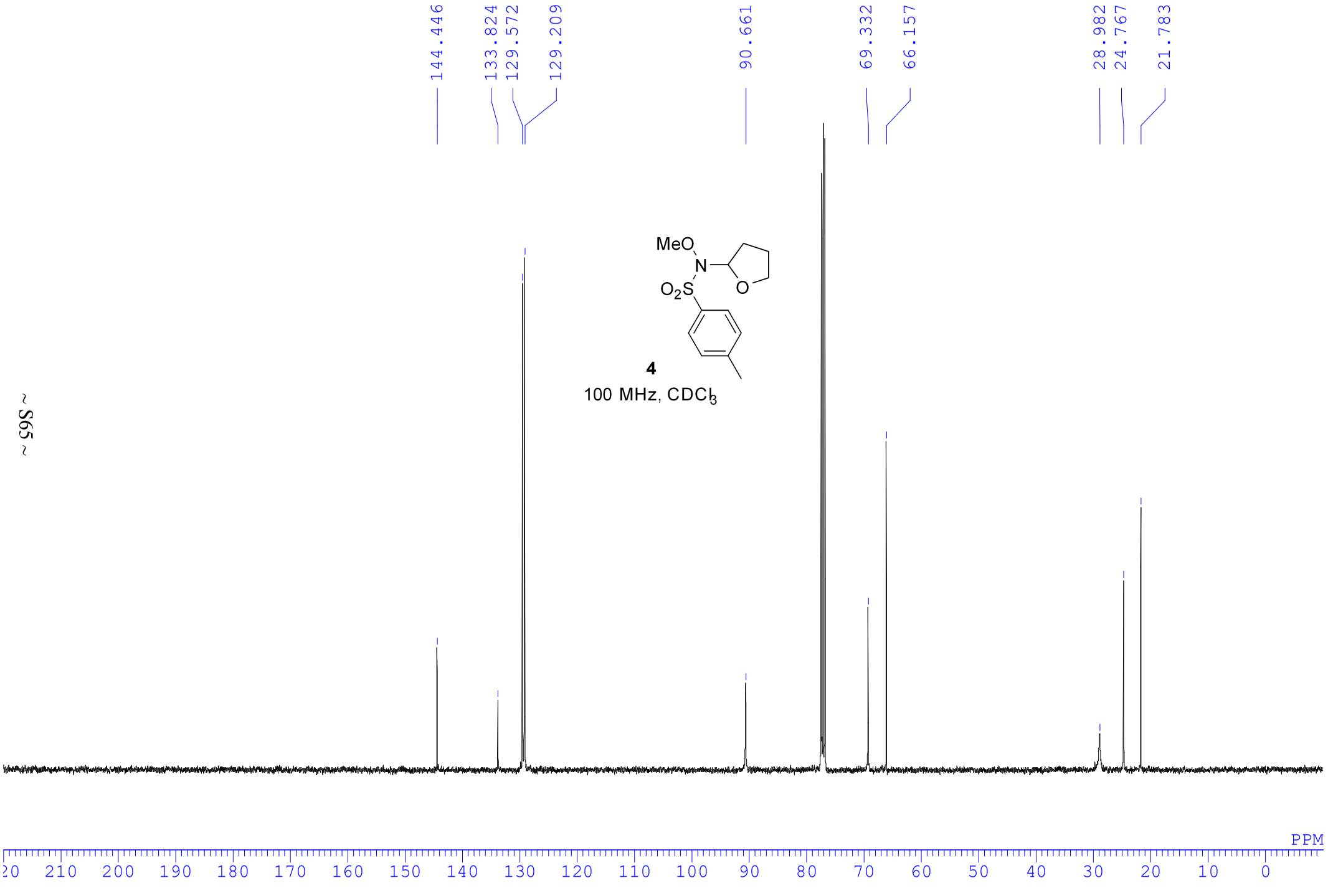


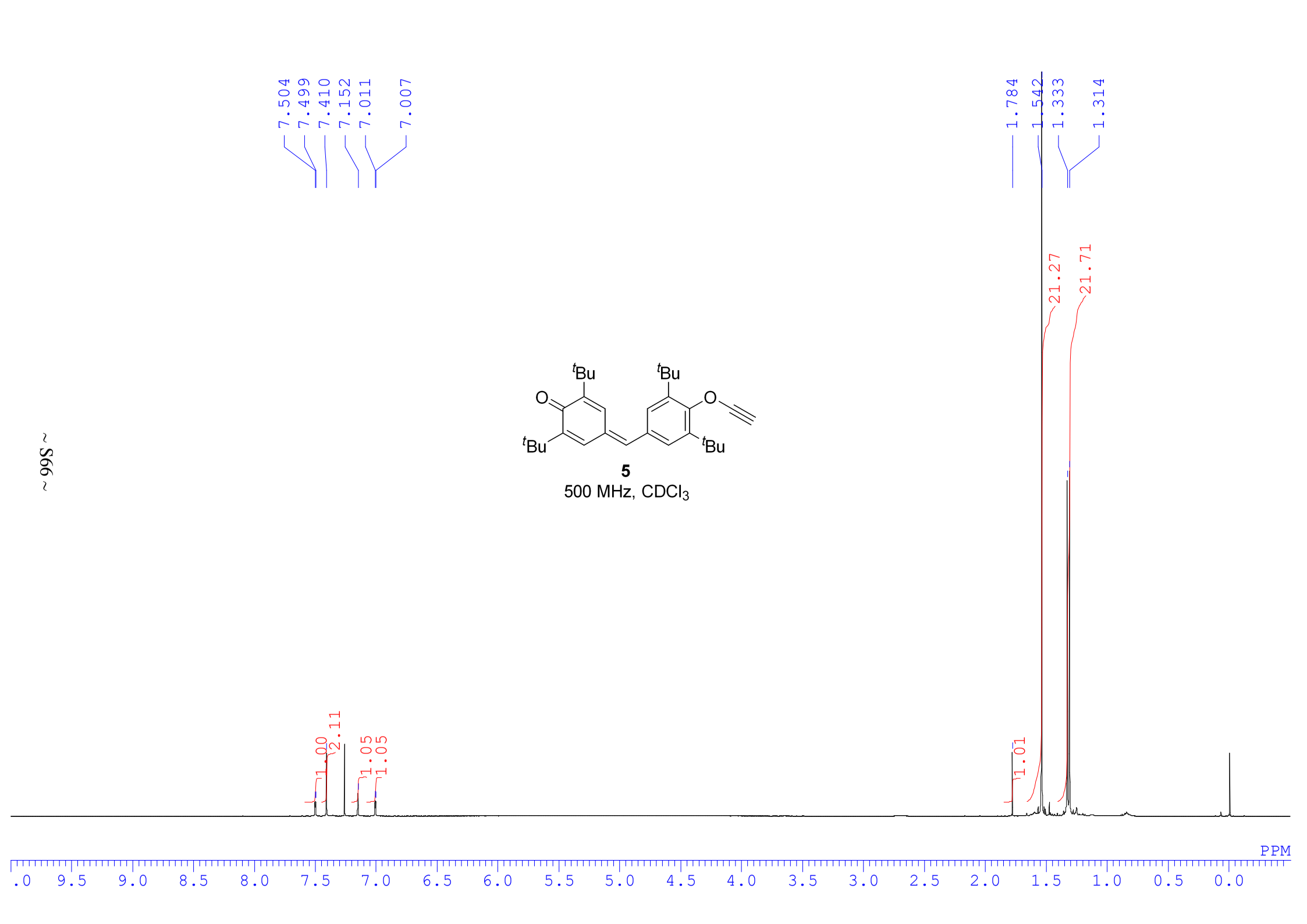

**2r**

500 MHz, $CDCl_3$


166.197
163.078
136.192
132.823
132.525
132.381
130.356
129.655
129.281
129.223
128.811
128.379
127.985
127.227
125.125
123.368
74.127
71.065
O
O
N
O
2r
125 MHz, CDCl3
PPM
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0


7.825
7.797
7.295
7.269
5.599
5.587
5.565
3.872
3.713
3.693
3.676
3.657
3.651
3.632
2.424
1.930
1.789
1.768
0.000
MeO
N
O
O2S
4
300 MHz, CDCl3
4.38
3.34
3.27
2.16
2.29
2.12
1.00
PPM
.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0


144.446
133.824
129.572
129.209
90.661
69.332
66.157
28.982
24.767
21.783
MeO
N
O2S
O
4
100 MHz, CDCl3
PPM
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

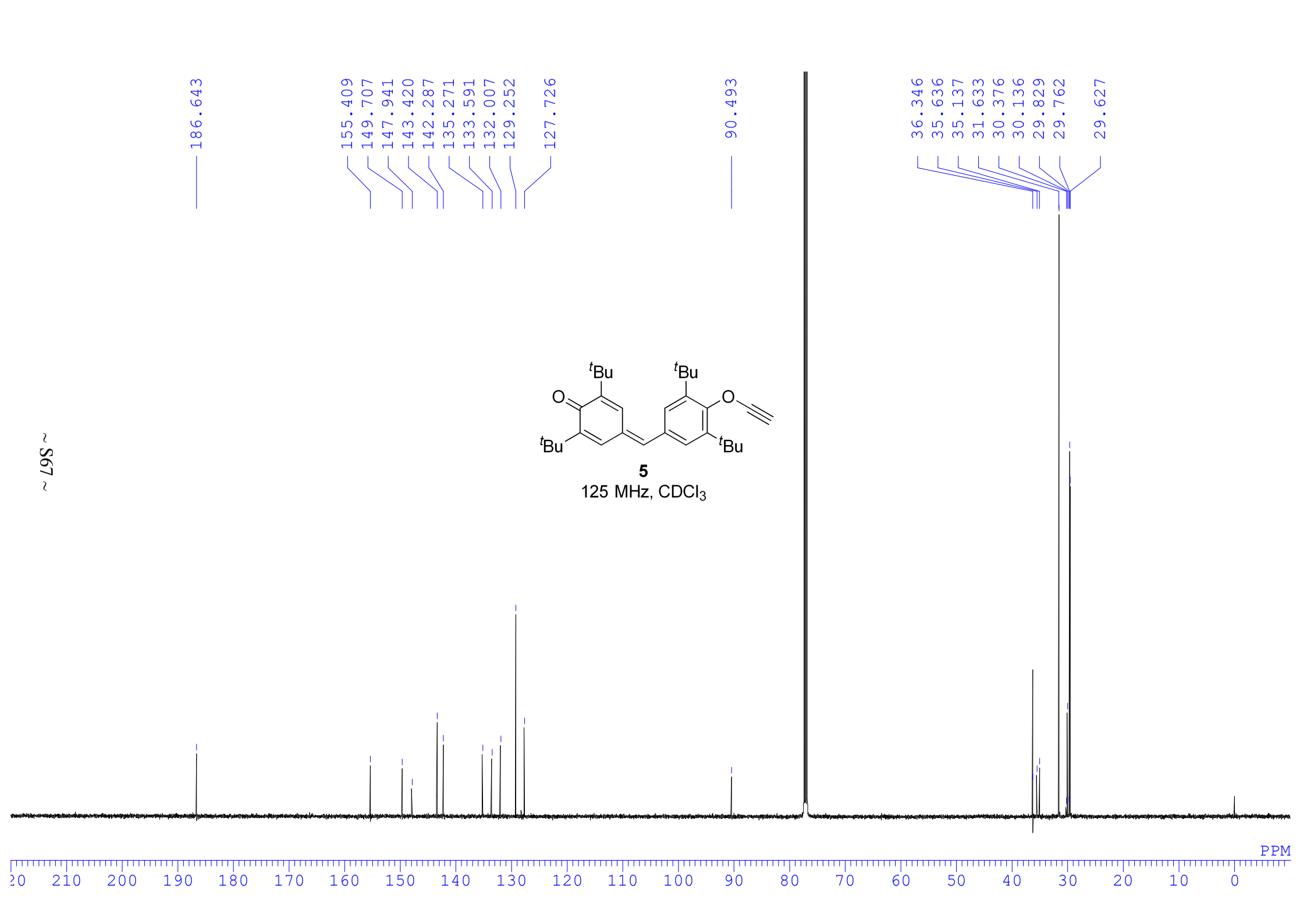


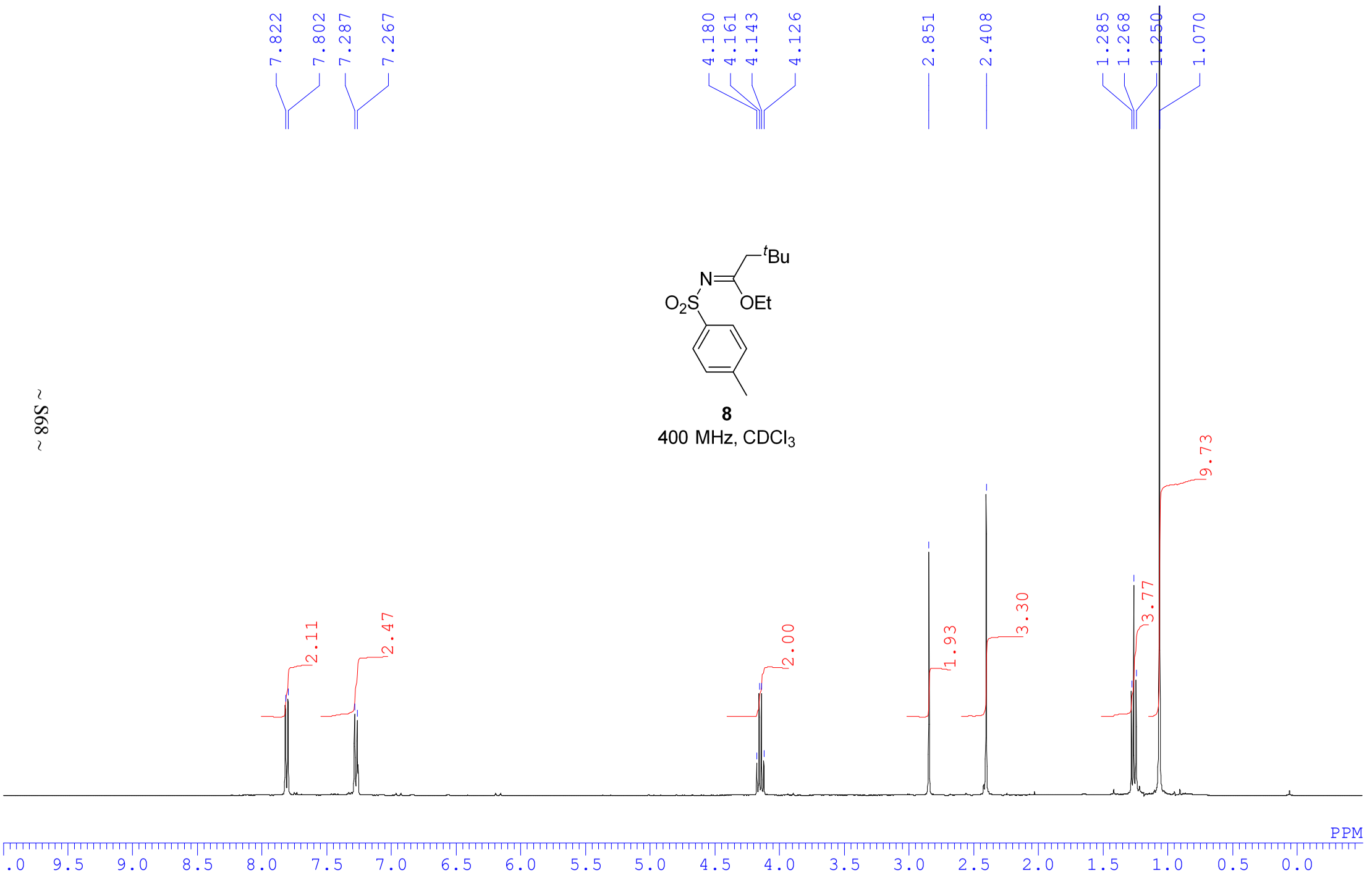


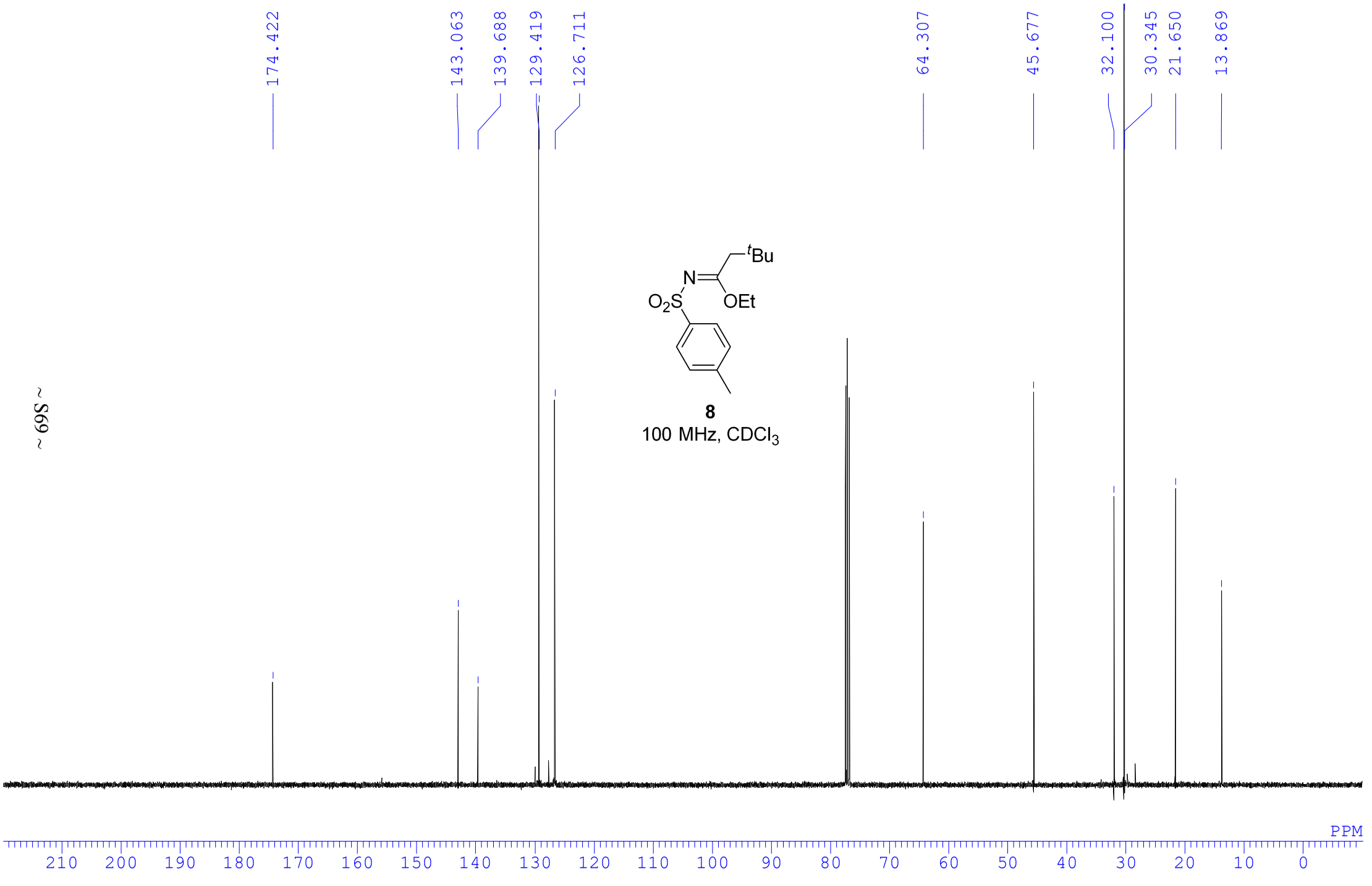


**5**

500 MHz, $CDCl_3$


186.643
155.409
149.707
147.941
143.420
142.287
135.271
133.591
132.007
129.252
127.726
90.493
36.346
35.636
35.137
31.633
30.376
30.136
29.829
29.762
29.627
tBu
tBu
O
O
tBu
tBu
5
125 MHz, CDCl3
PPM
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0


7.822
7.802
7.287
7.267
4.180
4.161
4.143
4.126
2.851
2.408
1.285
1.268
1.250
1.070
tBu
N
O2S
OEt
8
400 MHz, CDCl3
2.11
2.47
2.00
1.93
3.30
3.77
9.73
PPM
.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0


174.422
143.063
139.688
129.419
126.711
64.307
45.677
32.100
30.345
21.650
13.869
tBu
N
O2S
OEt
8
100 MHz, CDCl3
PPM
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0