Supporting Information

Note on the Importance of Stirring and Solvent Ratio

In order for this procedure to be successful for the cyanation of (hetero)aryl halides, efficient stirring is absolutely essential. All 1 mmol scale reactions were performed using a stir plate set to 900 rpm. Deviations in reaction vessel size, stir bar size, and reaction scale may require optimization of stirring efficiency to guarantee best results. Additionally, deviation from a 1:1 organic:water solvent mixture can result in incomplete conversions. It is important to make sure no solvent can escape the vessel or be absorbed by the septum to ensure optimal yields.

General Reagent Information

Commercial materials were used as received unless otherwise noted. 1,4-dioxane (anhydrous, 99.8%), cyclohexane (anhydrous, 99.5%) and potassium carbonate (anhydrous, 99%) were purchased from Aldrich. Potassium acetate (99%) was purchased from Sigma. Potassium hexacyanoferrate(II) trihydrate (ReagentPlus, 98.5%) was purchased from Aldrich and ground into a fine powder using a mortar and pestle prior to use. $[(allyl)PdCl]_2$ was received as a gift from Johnson Matthey. $Pd(OAc)_2$ was purchased from Johnson Matthey. Pd_2dba_3, SPhos, XPhos, and

RuPhos, P(*o*-tol)$_3$, and PCy$_3$ were purchased from Strem. PPh$_3$, dppf, and P(*t*-Bu)$_3$ were purchased from Aldrich. BrettPhos was a gift from Aldrich. *t*-BuXPhos was received as a gift from Amgen. DavePhos was received as a gift from Saltigo. *t*-BuBrettPhos,[1] precatalysts,[2] and (COD)Pd(CH$_2$TMS)$_2$[3] were synthesized according to literature procedures.

(Hetero)aryl halides:
4-chloroanisole (99%), 2-chloro-*m*-xylene (97%), 4-chloroacetophenone (97%), 3-chloroaniline (99%), 4-chlorobenzyl alcohol (98%), 4-chlorophenol (99%), 6-chloroquinoxaline (97%), 3-chloro-6-methoxypyridazine (95%), 3-chlorothiophene (98%), ethyl 4-bromopyrrole-2-carboxylate (97%), and 5-chlorobenzotriazole (99%) were purchased from Aldrich. Ethyl 4-chlorobenzoate (98%) and 4-chlorobenzonitrile (99%) were purchased from Avocado. 4-chlorobenzamide (98%), 4-chlorosulfonamide (98%), 7-chloroindole (98%), 2-acetyl-4-chlorothiophene (97%), and 2-chlorobenzimidazole (97%) were purchased from Alfa. 3-bromoquinoline (98%) and 3-chloroindazole (99%) were purchased from Acros. 4-bromothiazole (97%) was purchased from Oakwood. 3-bromopyrazole (95%) was purchased from Frontier. 4-bromopyrazole (98%), 4-chloro-7-azaindole (98%), and 4-bromoimidazole (98%) was purchased from CombiBlocks. 4-chloro-7-azaindole was recrystallized from toluene prior to use. 1-Chloro-4-fluorobenzene (98%) was purchased from Aldrich. Prior to use in stoichiometric palladium complex formation, 1-chloro-4-fluorobenzene was passed through a plug of basic alumina and degassed by sonication under vacuum.

Preparation of Degassed Aqueous Solutions

Performing a freeze/pump/thaw of aqueous solutions is time consuming and not necessary for highly efficient cyanation reactions. Degassed water can be prepared in less than 30 s by sonication under vacuum. A 100 mL round bottom flask was filled with deionized water and fitted with a rubber septum. The flask was placed into a water-filled sonication bath, vacuum was applied for 5 s, and the vessel was refilled with nitrogen gas. This process was repeated for a total of five cycles. The degassed water was then added via syringe to a volumetric flask under a nitrogen atmosphere equipped with a Teflon-lined screw-cap septum containing base (e.g., KOAc, K$_2$CO$_3$).

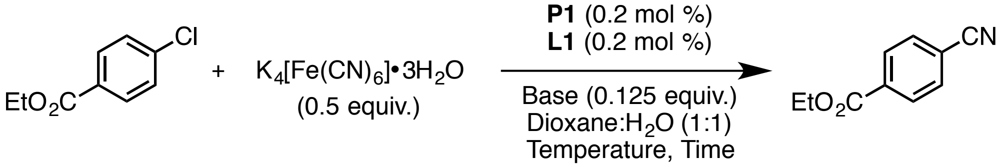
General Analytical Information

All compounds were characterized by ^{1}H NMR, ^{13}C NMR, IR spectroscopy, and, for most, elemental analysis. Nuclear Magnetic Resonance spectra were recorded on Varian XL 300 NMR or Varian Inova 500 MHz instruments. Copies of the ^{1}H and ^{13}C spectra can be found at the end of the Supporting Information. All ^{1}H NMR experiments were reported in δ units, parts per million (ppm), and were measured relative to the signals for residual chloroform (7.24 ppm), methanol (3.31 ppm), dichloromethane (5.32 ppm), or DMSO (2.50 ppm) in the deuterated solvent. All ^{13}C NMR spectra are reported in ppm relative to deuterochloroform (77.23 ppm), deuteromethanol (49.15 ppm), deuterodichloromethane (54.00 ppm), or d^6-DMSO (39.51 ppm) and all were obtained with ^{1}H decoupling. All IR spectra were obtained on a Thermo Scientific Nicolet iS5 spectrometer (iD5 ATR, diamond). GC analyses were performed on an Agilent 7980A chromatograph with an FID detector using a J & W DB-1 column (10 m, 0.1 mm I.D.). GC-MS analyses were performed on an Agilent 6850 chromatograph with an Agilent 5965 inert mass selective detector using an HP-5MS column (30 m, 0.25 mm I.D.). HPLC analyses were performed on an Agilent chromatograph using an Eclipse XDB-C18 column (5 uL, 4.6 x 150 mm) eluting with a solvent gradient of 60:40–90:10 (Methanol:0.1 % trifluoroacetic acid in H_2O). Powder X-ray diffraction patterns were recorded on a Bruker Advance D8 diffractometer using Nickel-filtered Cu-Kα radiation (λ = 1.5418 Å) with accelerating voltage 40 kV and a current of 40 mA. ESI-MS spectra were recorded on a Bruker Daltonics APEXIV 4.7 Tesla Fourier transform ion cyclotron resonance mass spectrometer (FT-ICR-MS). Elemental analyses were performed by Atlantic Microlabs Inc., Norcross, GA. Flash chromatography was performed using Silicycle Silia P60 silica gel. Thin-layer chromatography was performed on EMD Silica Gel 60 F254 TLC plates and visualized using UV or/and ceric ammonium molybdate (CAM), potassium permanganate ($KMnO_4$), or ninhydrin stain.

Safety Considerations

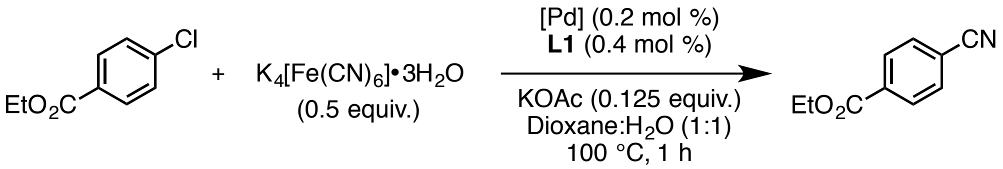
While $K_4[Fe(CN)_6]\bullet 3H_2O$ and Prussian Blue are non-toxic, crude reaction mixtures and aqueous phases from extractions should still be treated with caution. **NEVER** expose the crude reaction mixture or the aqueous layer to acidic conditions as formation of hydrogen cyanide is possible. All waste from crude reaction mixtures and aqueous workups should be disposed using accepted protocols in a basic aqueous solution (pH >12).[4] Finally, always wear appropriate personal protective equipment (gloves, etc) to avoid the possibilty of contact with cyanide.

Experimental Procedure for Figure 1



To each of six screw-top test tubes equipped with a magnetic stir bar was added $K_4[Fe(CN)_6]\bullet 3H_2O$ (211 mg, 0.5 equiv.). To a separate screw-top test tube equipped with a magnetic stir bar was added **P1** (14.7 mg) and **L1** (7.6 mg) (enough for 8 reactions at 0.2 mol % Pd loading, 1:2 Pd:L ratio). After sealing with a Teflon-lined screw-cap septum, all vessels were evacuated and backfilled with nitrogen (this process was repeated for a total of three cycles). Dioxane (20 mL) was added to the precatalyst/ligand tube via syringe, and the solution was stirred until all solids dissolved. Ethyl 4-chlorobenzoate (156 μL, 184 mg, 1 mmol), Pd/L (2.5 mL) solution, and 0.05 M base in degassed water (2.5 mL) were then added via syringe to the reaction tube containing $K_4[Fe(CN)_6]\bullet 3H_2O$. The test tube was placed in an oil bath preheated to the specified temperature. After stirring for the designated amount of time, the reaction mixture was then cooled to room temperature. EtOAc (10 mL), brine (10 mL), and dodecane (50 µL) were added to each reaction vessel. The reaction vessels were sealed and shaken. A portion of the organic layer from each was filtered through a plug of silica gel, which was eluted with EtOAc. The eluents were then analyzed by GC.

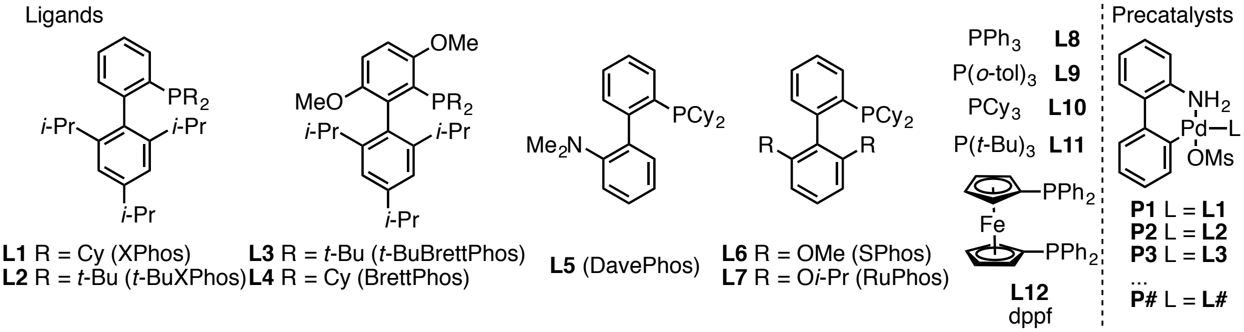
Experimental Procedure for Figure 2

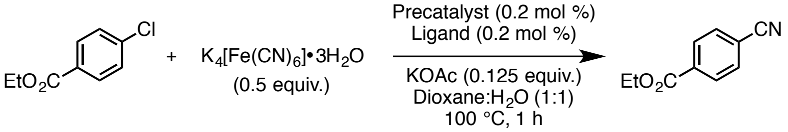


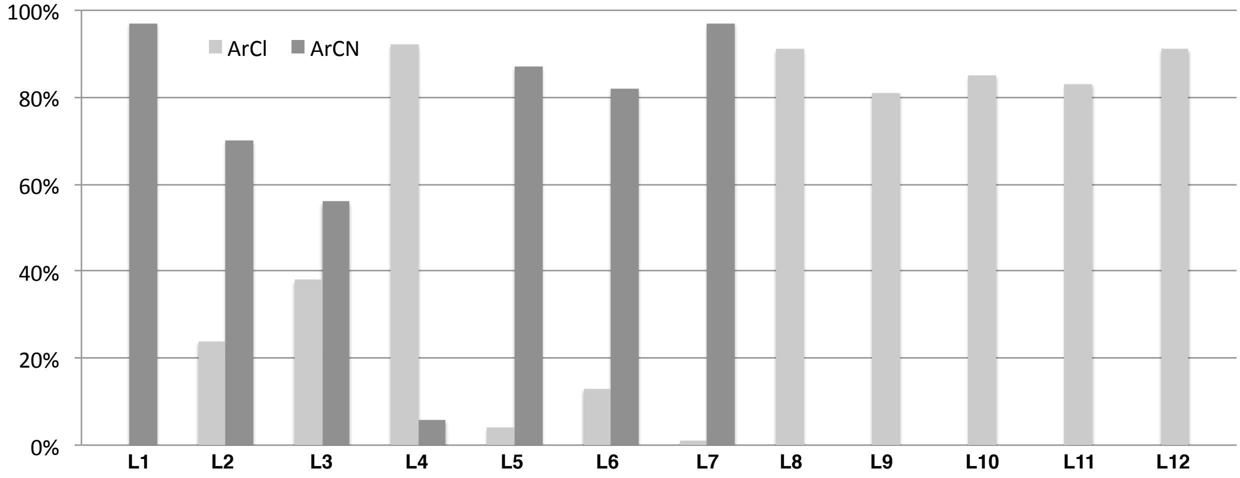
To each of five screw-top tests tube equipped with a magnetic stir bar was added $K_4[Fe(CN)_6]•3H_2O$ (211 mg, 0.5 equiv.). To a separate screw-top test tube equipped with a magnetic stir bar was added palladium source and **L1** (enough for 4 reactions at 0.2 mol % Pd loading, 1:2 Pd:L ratio). After sealing with a Teflon-lined screw-cap septum, all vessels were evacuated and backfilled with nitrogen (this process was repeated for a total of three cycles). Dioxane (10 mL) was added to the Pd/**L1** tube via syringe, and the solution was stirred until all solids dissolved. For the Pd_2dba_3 preincubation run, the Pd/**L1** solution was stirred in an oil bath preheated to 120 °C for 3 min and cooled to room temperature. Ethyl 4-chlorobenzoate (156 µL, 184 mg, 1 mmol), Pd/L solution (2.5 mL), and 0.05 M KOAc in degassed water (2.5 mL) were then added via syringe to the reaction tube containing $K_4[Fe(CN)_6]•3H_2O$. The test tube was placed in an oil bath preheated to 100 °C. After stirring for 1 h, the reaction mixture was then cooled to room temperature. EtOAc (10 mL), brine (10 mL), and dodecane (50 µL) were added to each reaction vessel. The reaction vessels were sealed and shaken. A portion of the organic layer from each was filtered through a plug of silica gel, which was eluted with EtOAc. The eluents were then analyzed by GC.

Ligand Screen

To each of fifteen screw-top test tubes equipped with a magnetic stir bar was added $K_4[Fe(CN)_6]•3H_2O$ (211 mg, 0.5 equiv.). To a separate screw-top test tube equipped with a magnetic stir bar was added precatalyst and ligand (enough for 4 reactions at 0.2 mol % Pd loading, 1:2 Pd:L ratio). For reactions utilizing **L10** and **L11**, precatalyst and ligand was weighed out in a nitrogen-filled glove box due to the oxygen-sensitive nature of these ligands. After sealing with a Teflon-lined screw-cap septum, all vessels were evacuated and backfilled with nitrogen (this process was repeated for a total of three cycles). Dioxane (10 mL) was added to each precatalyst/ligand tube via syringe, and the solution was stirred until all solids dissolved. Ethyl 4-chlorobenzoate (156 µL, 184 mg, 1 mmol), Pd/L solution (2.5 mL), and 0.05 M KOAc in degassed water (2.5 mL) were then added via syringe to the reaction tube containing $K_4[Fe(CN)_6]•3H_2O$. The test tube was placed in an oil bath preheated to 100 °C. After 1 h of stirring at 100 °C, the reaction mixture was then cooled to room temperature. EtOAc (10 mL), brine (10 mL), and dodecane (50 µL) were added to each reaction vessel. The reaction vessels were sealed and shaken. A portion of the organic layer from each was filtered through a plug of silica gel, which was eluted with EtOAc. The eluents were then analyzed by GC.



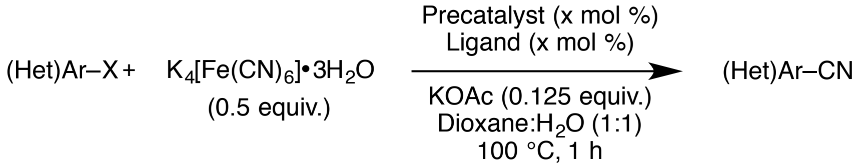




Regarding Ligand Rearrangement

Recently, our group[5] and others[6] reported the dearomative rearrangement of di-*tert*-butyl biaryl phosphine ligands. As both *t*-BuXPhos (**L2**) and *t*-BuBrettPhos (**L3**) were used in this study, we conducted preliminary investigations on select examples to see whether a rearrangement was occurring in this reaction as well. In the cyanation of 3-chloroindazole, a total of 8 mol % **L2** was used (Table 2, entry **2k**). 30 mg of **L2** was recovered from the reaction, representing 88% ligand recovery. Recovery of **L3** or derivatives thereof from the cyanation of 4-bromo-1-benzylimidazole was not successful, however spiking the crude reaction with additional **L3** showed only one peak via ^{31}P NMR. In light of this data, we believe that ligand rearrangement does not occur to a significant extent in this reaction.

General Experimental Procedure for Tables 1 and 2



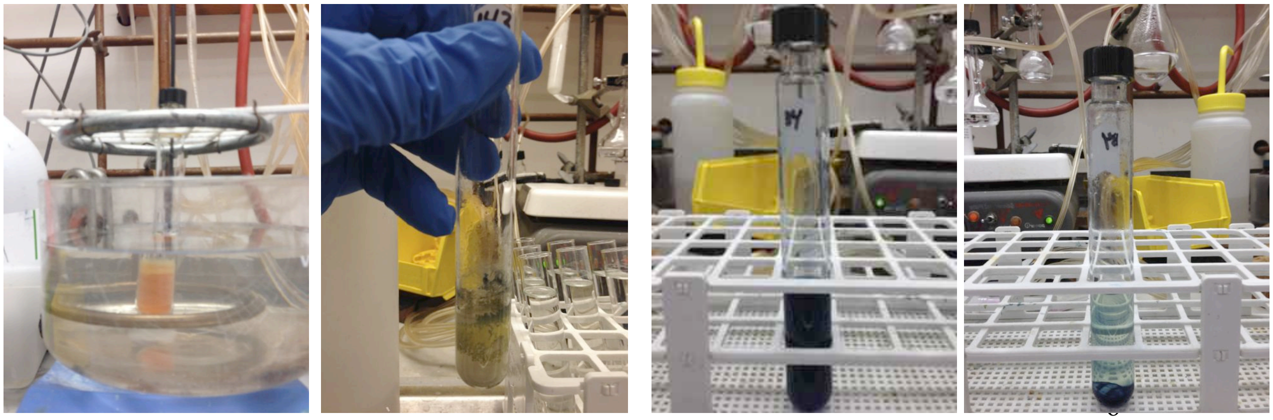
All reactions were set up on the bench top open to the air and all reagents for these processes were weighed and added to the reaction tube in the air.

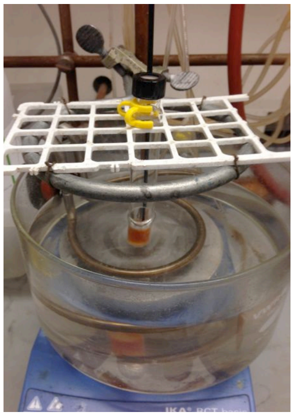
To a screw-top test tube equipped with a magnetic stir bar was added precatalyst, ligand, $K_4[Fe(CN)_6]•3H_2O$ (211 mg, 0.5 equiv.), and (if solid) (hetero)aryl halide (1 mmol). After sealing with a Teflon-lined screw-cap septum, the vessel was evacuated and backfilled with nitrogen (this process was repeated for a total of three cycles). (Hetero)aryl halide (if liquid) (1 mmol), dioxane (2.5 mL), and 0.05 M KOAc in degassed water (2.5 mL) were then added to the reaction tube via syringe. The test tube was placed in an oil bath preheated to 100 °C and stirred for 1 h. Upon initial stirring, a clear, yellow solution was observed. During the course of the reaction, a yellow or green precipitate formed on the walls of the reaction vessel. After 1 h of stirring at 100 °C, the reaction mixture was then cooled to room temperature. The contents of the test tube were transferred to a separatory funnel using EtOAc (15 mL) and brine (15 mL), and the organic layer was separated from the aqueous layer. If the reaction was successful, during the extraction process the color of the aqueous layer turns dark blue. This is a colloidal suspension of insoluble fine particles. Isolation and PXRD analysis revealed this solid to be Prussian Blue. The aqueous layer was further extracted with EtOAc (total 2 x 15 mL). The combined organic layers were dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The resulting mixture was adsorbed onto silica gel, dried *in vacuo*, and purified via column chromatography to yield the product.

Notes:

1) In order for this procedure to be successful for the cyanation of (hetero)aryl halides, efficient stirring is absolutely essential. All 1 mmol scale reactions were performed using a stir plate set to 900 rpm. Deviations in reaction vessel size, stir bar size, and reaction scale may require optimization of stirring efficiency to guarantee best results.
2) Deviation from a 1:1 organic:water solvent mixture can result in incomplete conversions. It is important to make sure no solvent can escape the vessel or be absorbed by the septum to ensure optimal yields.

Pictures of Reactions



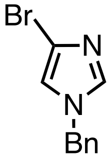


(1) (2) (3) (4)
(5)

1) Top down view of early reaction progress
2) Reaction progresses, yellow precipitate begins to form
3) Completed crude reaction, large amount of yellow precipitate on walls of reaction vessel
4) Aqueous layer of reaction workup
5) Aqueous layer of reaction workup, colloidal blue solid allowed to settle

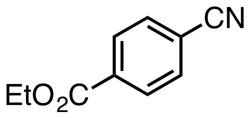
Note: Pictures are only given as examples and not every reaction will looks exactly the same. These are not all pictures of the same reaction.

Preparation of 1-Benzyl-4-bromo-1H-imidazole

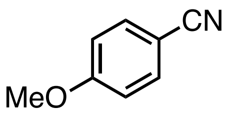


To a 100 mL round bottom flask equipped with a magnetic stir bar was added 4-bromo-1*H*-imidazole (2 g, 13.6 mmol, 1 equiv.), anhydrous K_2CO_3 (2.07 g, 15.0 mmol, 1.1 equiv.), acetone (40 mL), and benzyl bromide (1.8 mL, 2.59 g, 15.1 mmol, 1.1 equiv.). The vessel was capped and the reaction mixture was stirred at room temperature for 22 h. The reaction mixture was poured onto EtOAc (80 mL), washed with deionized water (2x80 mL), and brine (80 mL). ^{1}H NMR of the crude reaction mixture showed an 82:18 mixture of 4-bromo and 5-bromo isomers. The organic layer was dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The resulting mixture was adsorbed onto silica gel, dried *in vacuo*, and purified via column chromatography (silica gel, 80:20 to 50:50 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield the product as a white solid (2.19 g, 68%), **mp** = 92–93 °C (lit. 91–93 °C).[7] **^{1}H NMR (300 MHz, $CDCl_3$)**: δ 7.45–7.28 (m, 4H), 7.19–7.11 (m, 2H), 6.84 (d, *J* = 1.6 Hz, 1H), 5.04 (s, 2H). **^{13}C NMR (126 MHz, $CDCl_3$)**: δ 137.0, 135.3, 129.2, 128.6, 127.6, 118.6, 115.6, 51.4. **IR (neat, cm^{-1})**: 3144, 3109, 3024, 1496, 1391, 1236, 1106, 944.

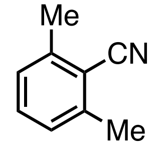
Characterization Data for Table 1



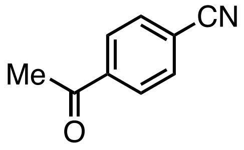
Ethyl 4-cyanobenzoate (1a). Following a modification of the general procedure with ethyl 4-chlorobenzoate (156 µL, 184 mg, 1 mmol). **P1** (0.2 mol %) and **L1** (0.2 mol %) were added to the reaction vessel via syringe as a solution in dioxane (due to low catalyst loading). The product was purified by column chromatography (silica gel, 95:5 to 85:15 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield ethyl 4-cyanobenzoate as a white solid. (168 mg, 96%), **mp** = 53–54 °C (lit. 54 °C).[8] **^{1}H NMR (300 MHz, $CDCl_3$)**: δ 8.17–8.08 (m, 2H), 7.76–7.68 (m, 2H), 4.39 (q, *J* = 7.1 Hz, 2H), 1.39 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR (126 MHz, $CDCl_3$)**: δ 164.9, 134.3, 132.2, 130.0, 118.0, 116.2, 61.8, 14.2. **IR (neat, cm^{-1})**: 2230, 1715, 1366, 1276, 1185, 1107, 1022, 873. **Anal.** Cald. for $C_{10}H_9NO_2$: C, 68.56; H, 5.18. Found: C, 68.77; H, 5.28.



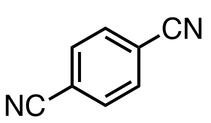
4-Methoxybenzonitrile (1b). Following the general procedure with 1-chloro-4-methoxybenzene (122 µL ,142 mg, 1 mmol), **P1** (3.7 mg, 0.4 mol %), and **L1** (1.9 mg, 0.4 mol %). The product was purified by column chromatography (silica gel, 95:5 to 80:20 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield 4-methoxybenzonitrile as a white solid. (126 mg, 95%), **mp** = 58–59 °C (lit. 57–59 °C).[9] **^{1}H NMR (300 MHz, $CDCl_3$)**: δ 7.52 (d, *J* = 8.9 Hz, 2H), 6.90 (d, *J* = 9.0 Hz, 2H), 3.80 (s, 3H). **^{13}C NMR (75 MHz, $CDCl_3$)**: δ 162.9, 134.0, 119.3, 114.8, 103.9, 55.6. **IR (neat, cm^{-1})**: 2216, 1604, 1506, 1255, 1174, 1020, 827, 682. **Anal.** Cald. for C_8H_7NO : C, 72.16; H, 5.30. Found: C, 72.10; H, 5.43.



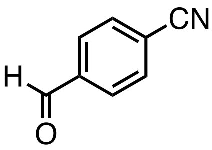
2,6-Dimethylbenzonitrile (1c). Following the general procedure with 2-chloro-1,3-dimethylbenzene (133 µL, 141 mg, 1 mmol), **P1** (5.5 mg, 0.6 mol %),and **L1** (2.9 mg, 0.6 mol %). The product was purified by column chromatography (silica gel, 100:0 to 97:3 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield 2,6-dimethylbenzonitrile as a white solid. (113 mg, 86%), **mp** = 89–90 °C (lit. 89–91 °C).[10] **^{1}H NMR (300 MHz, $CDCl_3$)**: δ 7.32 (t, *J* = 7.7 Hz, 1H), 7.10 (d, *J* = 7.7 Hz, 2H), 2.51 (s, 6H). **^{13}C NMR (126 MHz, $CDCl_3$)**: δ 142.1, 132.2, 127.4, 117.3, 113.4, 20.8. **IR (neat, cm^{-1})**: 2949, 2922, 2215, 1596, 1472, 1380, 1174, 1037. **Anal.** Cald. for C_9H_9N : C, 82.41; H, 6.92. Found: C, 82.21; H, 6.96.



4-Acetylbenzonitrile (1d). Following the general procedure with 1-(4-chlorophenyl)ethanone (130 µL, 155 mg, 1 mmol), **P1** (2.8 mg, 0.3 mol %), and **L1** (1.4 mg, 0.3 mol %). The product was purified by column chromatography (silica gel, 95:5 to 85:15 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield 4-acetylbenzonitrile as a white solid. (138 mg, 95%), **mp** = 58–59 °C (lit. 57–58 °C).[11] **^{1}H NMR (300 MHz, $CDCl_3$)**: δ 8.02 (dt, *J* = 7.9, 0.9 Hz, 2H), 7.75 (dt, *J* = 8.1, 1.0 Hz, 2H), 2.62 (s, 3H). **^{13}C NMR (126 MHz, $CDCl_3$)**: δ 196.5, 139.8, 132.4, 128.6, 117.9, 116.1, 26.7. **IR (neat, cm^{-1})**: 2229, 1686, 1401, 1354, 1261, 958. **Anal.** Cald. for C_9H_7NO : C, 74.47; H, 4.86. Found: C, 74.50; H, 4.86.

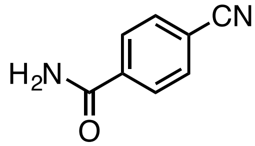


Terephthalonitrile (1e). Following the general procedure with 4-chlorobenzonitrile (138 mg, 1 mmol), **P2** (6.4 mg, 0.8 mol %), and **L2** (3.4 mg, 0.8 mol %). The product was purified by column chromatography (silica gel, 90:10 to 70:30 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield terephthalonitrile as a white solid. (120 mg, 94%), **mp** = 225–226°C (lit. 225–227 °C).[12] **^{1}H NMR (300 MHz, $CDCl_3$)**: δ 7.78 (s, 4H). **^{13}C NMR (126 MHz, $CDCl_3$)**: δ 133.0, 117.2, 116.9. **IR (neat, cm^{-1})**: 3097, 3053, 2232, 1505, 1401, 1277, 1201, 1167. **Anal.** Cald. for $C_8H_4N_2$: C, 74.99; H, 3.15. Found: C, 74.76; H, 3.18.

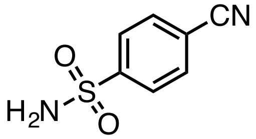


4-Formylbenzonitrile (1f). Following a modification of the general procedure with 4-chlorobenzaldehyde (141 mg, 1 mmol), **P2** (14.3 mg, 1.8 mol %), and **L2** (7.6 mg, 1.8 mol %). The reaction was stirred in an oil bath preheated to 70 °C for 12 hours. The product was purified by column chromatography (silica gel, 95:5 to 80:20 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield 4-formylbenzonitrile as a pale yellow solid. (109 mg, 83%), **mp** = 98–99 °C (lit. 96–98 °C).[13] **^{1}H NMR (300**

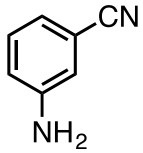
MHz, $CDCl_3$): δ 10.07 (s, 1H), 8.01–7.94 (m, 2H), 7.88–7.79 (m, 2H). **^{13}C NMR (126 MHz, $CDCl_3$)**: δ 190.8, 138.7, 132.9, 129.9, 117.8, 117.5. **IR (neat, cm^{-1})**: 3093, 3046, 2229, 1699, 1385, 1296, 1201, 1172. **Anal.** Cald. for C_8H_5NO : C, 73.27; H, 3.84. Found: C, 73.17; H, 3.81.



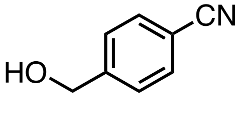
4-Cyanobenzamide (1g). Following the general procedure with 4-chlorobenzamide (156 mg, 1 mmol), **P2** (6.4 mg, 0.8 mol %), and **L2** (3.4 mg, 0.8 mol %). The product was purified by column chromatography (silica gel, 1:1 to 1:7 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield 4-cyanobenzamide as a white solid. (133 mg, 91%), **mp** = 226–227 °C (lit. 222.1–223.3 °C).[14] **^1H NMR (300 MHz, d^6-DMSO)**: δ 8.22 (br s, 1H), 8.06–7.99 (m, 2H), 7.98–7.90 (m, 2H), 7.69 (br s, 1H). **^{13}C NMR (126 MHz, d^6-DMSO)**: δ 166.5, 138.3, 132.4, 128.3, 118.4, 113.7. **IR (neat, cm^{-1})**: 3440, 3165, 2230, 1695, 1616, 1561, 1411, 770. **Anal.** Cald. for $C_8H_6N_2O$: C, 65.75; H, 4.14. Found: C, 65.74; H, 4.09.



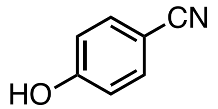
4-Cyanobenzenesulfonamide (1h). Following the general procedure with 4-chlorobenzenesulfonamide (156 mg, 1 mmol), **P2** (5.7 mg, 0.7 mol %), and **L2** (3.0 mg, 0.7 mol %). The product was purified by column chromatography (silica gel, 70:30 to 50:50 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield 4-cyanobenzenesulfonamide as a white solid. (165 mg, 91%), **mp** = 169–170 °C (lit. 168 °C).[15] **^1H NMR (300 MHz, CD_3OD)**: δ 8.09–8.02 (m, 2H), 7.96–7.89 (m, 2H). **^{13}C NMR (126 MHz, CD_3OD)**: δ 149.2, 134.2, 128.1, 118.7, 116.7. **IR (neat, cm^{-1})**: 3340, 3253, 2228, 1490, 1335, 1096, 1091, 901. **Anal.** Cald. for $C_7H_6N_2O_2S$: C, 46.14; H, 3.32. Found: C, 46.17; H, 3.44.



3-Aminobenzonitrile (1i). Following the general procedure with 3-chloroaniline (106 µL, 128 mg, 1 mmol), **P2** (6.4 mg, 0.8 mol %), and **L2** (3.4 mg, 0.8 mol %). The product was purified by column chromatography (silica gel, 80:20 to 65:35 hexanes:EtOAc gradient, visualized with UV and ninhydrin) to yield 3-aminobenzonitrile as an off-white solid. (107 mg, 91%), **mp** = 47–48 °C (lit. 49–50 °C).[16] **^1H NMR (300 MHz, $CDCl_3$)**: δ 7.19 (ddd, *J* = 8.2, 7.6, 0.6 Hz, 1H), 6.98 (ddd, *J* = 7.6, 1.5, 1.0 Hz, 1H), 6.91–6.78 (m, 2H), 3.88 (br s, 2H). **^{13}C NMR (126 MHz, $CDCl_3$)**: δ 147.2, 130.0, 121.7, 119.4, 119.3, 117.3, 112.6. **IR (neat, cm^{-1})**: 3469, 3375, 2222, 1625, 1577, 1447, 1298, 867. **Anal.** Cald. for $C_7H_6N_2$: C, 71.17; H, 5.12. Found: C, 71.07; H, 5.28.

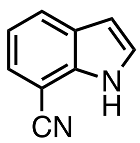


4-(Hydroxymethyl)benzonitrile (1j). Following the general procedure with (4-chlorophenyl)methanol (143 mg, 1 mmol), **P2** (3.9 mg, 0.5 mol %), and **L2** (2.1 mg, 0.5 mol %). The product was purified by column chromatography (silica gel, 60:40 to 50:50 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield 4-(hydroxymethyl)benzonitrile as a white solid. (125 mg, 94%), **mp** = 43–44 °C (lit. 42–44 °C).[17] **^1H NMR (300 MHz, $CDCl_3$)**: δ 7.64–7.53 (m, 2H), 7.49–7.38 (m, 2H), 4.73 (d, *J* = 5.6 Hz, 2H), 2.33 (t, *J* = 5.7 Hz, 1H). **^{13}C NMR (126 MHz, $CDCl_3$)**: δ 146.7, 132.2, 127.0, 118.9, 110.5, 63.7. **IR (neat, cm^{-1})**: 3317 (br), 2232, 1610, 1508, 1415, 1346, 1209, 1018. **Anal.** Cald. for C_8H_7NO : C, 72.16; H, 5.30. Found: C, 71.93; H, 5.47.

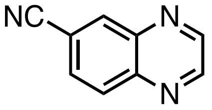


4-hydroxybenzonitrile (1k). Following the general procedure with 4-chlorophenol (129 mg, 1 mmol), **P2** (23.8 mg, 3 mol %), and **L2** (12.7 mg, 3 mol %). The product was purified by column chromatography (silica gel, 90:10 to 75:25 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield 4-hydroxybenzonitrile as a white solid. (101 mg, 85%), **mp** = 110–111 °C (lit. 109–110 °C).[18] **^{1}H NMR (300 MHz, CDCl$_3$)**: δ 7.61–7.48 (m, 2H), 6.97–6.85 (m, 2H), 6.38 (br s, 1H). **^{13}C NMR (126 MHz, CDCl$_3$)**: δ 160.5, 134.5, 119.5, 116.7, 103.1. **IR (neat, cm^{-1})**: 3266 (br), 2232, 1601, 1586, 1508, 1248, 1220, 1165. **Anal.** Cald. for C_7H_5NO : C, 70.58; H, 4.23. Found: C, 70.52; H, 4.46.

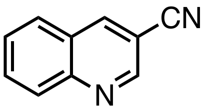
Characterization Data for Table 2



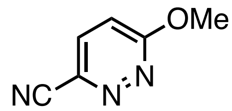
1*H*-Indole-7-carbonitrile (2a). Following the general procedure with 7-chloro-1*H*-indole (152 mg, 1 mmol), **P1** (6.4 mg, 0.7 mol %), and **L1** (3.3 mg, 0.7 mol %). The product was purified by column chromatography (silica gel, 100:0 to 80:20 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield 1*H*-indole-7-carbonitrile as a white solid. (134 mg, 94%), **mp** = 102–103 °C (lit. 96 °C).[19] **^{1}H NMR (300 MHz, CDCl$_3$)**: δ 9.12 (br s, 1H), 7.86 (d, *J* = 8.0 Hz, 1H), 7.51 (dt, *J* = 7.4, 0.5 Hz, 1H), 7.33 (t, *J* = 2.4 Hz, 1H), 7.15 (t, *J* = 7.7 Hz, 1H), 6.63 (dd, *J* = 3.3, 2.0 Hz, 1H). **^{13}C NMR (126 MHz, CDCl$_3$)**: δ 136.4, 128.8, 126.5, 126.3, 126.2, 119.5, 117.9, 103.4, 94.0. **IR (neat, cm^{-1})**: 3307 (br), 3105, 2221, 1609, 1447, 1348, 1334, 1113. **Anal.** Cald. for $C_9H_6N_2$: C, 76.04; H, 4.25. Found: C, 75.84; H, 4.19.



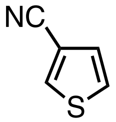
Quinoxaline-6-carbonitrile (2b). Following the general procedure with 6-chloroquinoxaline (165 mg, 1 mmol), **P2** (7.9 mg, 1 mol %), and **L2** (4.2 mg, 1 mol %). The product was purified by column chromatography (silica gel, 80:20 to 50:50 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield quinoxaline-6-carbonitrile as a white solid. (149 mg, 96%), **mp** = 181–182 °C (lit. 176–178 °C).[20] **^{1}H NMR (300 MHz, CDCl$_3$)**: δ 8.96 (s, 2H), 8.49 (dd, *J* = 1.8, 0.6 Hz, 1H), 8.21 (dd, *J* = 8.7, 0.6 Hz, 1H), 7.92 (dd, *J* = 8.7, 1.8 Hz, 1H). **^{13}C NMR (126 MHz, CDCl$_3$)**: δ 147.5, 146.9, 144.4, 142.1, 135.7, 131.3, 130.9, 117.9, 113.8. **IR (neat, cm^{-1})**: 3063, 2229, 1498, 1418, 1374, 1302, 1131, 1018. **HRMS-ESI (*m/z*)** $[M + H]^+$ calcd for $C_9H_5N_3$, 156.0556; found, 156.0557.



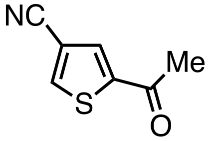
Quinoline-3-carbonitrile (2c). Following the general procedure with 3-bromoquinoline (136 µL, 208 mg, 1 mmol), **P2** (15.6 mg, 2 mol %), and **L2** (8.5 mg, 2 mol %). The product was purified by column chromatography (silica gel, 90:10 to 80:20 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield quinoline-3-carbonitrile as a white solid. (142 mg, 92%), **mp** = 107–108 °C (lit. 106–107 °C).[21] **^{1}H NMR (300 MHz, CDCl$_3$)**: δ 9.02 (d, *J* = 2.1 Hz, 1H), 8.53 (dd, *J* = 2.1, 0.8 Hz, 1H), 8.16 (dq, *J* = 9.0, 0.8 Hz, 1H), 7.95–7.81 (m, 2H), 7.68 (ddd, *J* = 8.0, 6.9, 1.2 Hz, 1H). **^{13}C NMR (126 MHz, CDCl$_3$)**: δ 150.4, 149.4, 142.1, 133.5, 130.5, 129.2, 129.0, 126.8, 117.8, 107.1. **IR (neat, cm^{-1})**: 3036, 2228, 1619, 1567, 1489, 1371, 1130, 981. **Anal.** Cald. for $C_{10}H_6N_2$: C, 77.91; H, 3.92. Found: C, 77.84; H, 3.87.



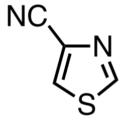
6-methoxypyridazine-3-carbonitrile (2d). Following a modification of the general procedure with 3-chloro-6-methoxypyridazine (145 mg, 1 mmol), **P2** (31.8 mg, 4 mol %), and **L2** (17 mg, 4 mol %). A 0.2 M solution of KOAc in degassed water (2.5 mL, 0.5 equiv. KOAc) was used. The product was purified by column chromatography (silica gel, 90:10 to 75:25 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield 6-methoxypyridazine-3-carbonitrile as a white solid. (90 mg, 67%), **mp** = 93–94 °C (lit. 92–93.5 °C).[22] **^{1}H NMR (300 MHz, $CDCl_3$)**: δ 7.66 (d, *J* = 9.1 Hz, 1H), 7.07 (d, *J* = 9.2 Hz, 1H), 4.21 (s, 3H). **^{13}C NMR (126 MHz, $CDCl_3$)**: δ 165.4, 135.2, 132.5, 117.2, 115.8, 56.1. **IR (neat, cm^{-1})**: 3067, 2246, 1575, 1469, 1395, 1336, 1298, 1103. **Anal.** Cald. for $C_6H_5N_3O$: C, 53.33; H, 3.73. Found: C, 53.50; H, 3.80.



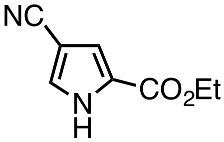
Thiophene-3-carbonitrile (2e). Following a modification of the general procedure with 3-chlorothiophene (93 µL, 119 mg, 1 mmol), **P2** (12.7 mg, 1.6 mol %), and **L2** (6.8 mg, 1.6 mol %). During workup, the extraction was performed with Et_2O. The product was purified by column chromatography (silica gel, 95:5 to 80:20 pentane:Et_2O gradient, visualized with UV and $KMnO_4$) to yield thiophene-3-carbonitrile as a clear liquid. (77 mg, 71%). **^{1}H NMR (300 MHz, $CDCl_3$)**: δ 7.93 (dd, *J* = 3.0, 1.2 Hz, 1H), 7.41 (dd, *J* = 5.1, 3.0 Hz, 1H), 7.29 (dd, *J* = 5.1, 1.2 Hz, 1H). **^{13}C NMR (126 MHz, $CDCl_3$)**: δ 135.6, 128.9, 127.5, 115.3, 110.8. **IR (neat, cm^{-1})**: 3110, 2229, 1404, 1368, 1223, 1154, 930, 874. **HRMS-ESI (*m/z*)** $[M + H]^+$ calcd for C_5H_3NS, 110.0059; found, 110.0065.



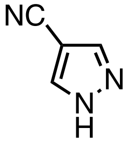
5-Acetylthiophene-3-carbonitrile (2f). Following the general procedure with 1-(4-chlorothiophen-2-yl)ethanone (120 uL, 160 mg, 1 mmol), **P2** (31.8 mg, 4 mol %), and **L2** (17 mg, 4 mol %). The product was purified by column chromatography (silica gel, 95:5 to 80:20 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield 5-acetylthiophene-3-carbonitrile as an off-white solid. (137 mg, 91%), **mp** = 81–82 °C (lit. 78.5–80 °C).[23] **^{1}H NMR (300 MHz, $CDCl_3$)**: δ 8.14 (d, *J* = 1.3 Hz, 1H), 7.80 (d, *J* = 1.3 Hz, 1H), 2.57 (s, 3H). **^{13}C NMR (126 MHz, $CDCl_3$)**: δ 189.7, 146.2, 142.0, 133.0, 114.1, 111.5, 26.8. **IR (neat, cm^{-1})**: 3092, 2228, 1659, 1528, 1415, 1268, 1219, 1149. **Anal.** Cald. for C_7H_5NOS : C, 55.61; H, 3.33. Found: C, 56.17; H, 3.56.



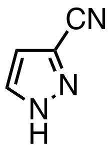
Thiazole-4-carbonitrile (2g). Following a modification of the general procedure with 4-bromothiazole (90 µL, 165 mg, 1 mmol), **P2** (31.8 mg, 4 mol %), and **L2** (17 mg, 4 mol %). During workup, the extraction was performed with Et_2O. The product was purified by column chromatography (silica gel, 80:20 to 33:64 pentane:Et_2O gradient, visualized with UV and $KMnO_4$) to yield thiazole-4-carbonitrile as a white solid. (98 mg, 89%), **mp** = 59–60 °C (lit. 55–56 °C).[24] **^{1}H NMR (300 MHz, $CDCl_3$)**: δ 8.89 (d, *J* = 2.0 Hz, 1H), 8.08 (d, *J* = 2.0 Hz, 1H). **^{13}C NMR (126 MHz, $CDCl_3$)**: δ 154.8, 130.7, 127.7, 113.9. **IR (neat, cm^{-1})**: 3118, 3090, 2236, 1422, 1298, 1218, 1130, 892. **Anal.** Cald. for $C_4H_2N_2S$: C, 43.62; H, 1.83. Found: C, 43.79; H, 2.01.



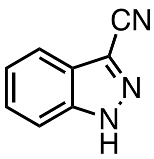
Ethyl 4-cyano-1*H*-pyrrole-2-carboxylate (2h). Following the general procedure with ethyl 4-bromo-1*H*-pyrrole-2-carboxylate (218 mg 1 mmol), **P2** (11.1 mg, 1.4 mol %), and **L2** (5.9 mg, 1.4 mol %). The product was purified by column chromatography (silica gel, 85:15 to 70:30 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield ethyl 4-cyano-1*H*-pyrrole-2-carboxylate as a white solid. (152 mg, 93%), **mp** = 84–85 °C **^{1}H NMR (300 MHz, $CDCl_3$)**: δ 10.17 (s, 1H), 7.40 (dd, *J* = 3.2, 1.5 Hz, 1H), 7.11 (dd, *J* = 2.5, 1.5 Hz, 1H), 4.34 (q, *J* = 7.1 Hz, 2H), 1.35 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR (126 MHz, $CDCl_3$)**: δ 160.6, 129.5, 124.2, 117.8, 115.6, 94.7, 61.5, 14.3. **IR (neat, cm^{-1})**: 3259, 3131, 2228, 1691, 1566, 1383, 1269, 1205. **Anal.** Cald. for $C_8H_8N_2O_2$: C, 58.53; H, 4.91. Found: C, 58.66; H, 4.88.



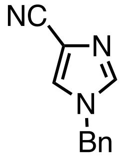
1*H*-Pyrazole-4-carbonitrile (2i). Following the general procedure with 4-bromo-1*H*-pyrazole (147 mg, 1 mmol), **P2** (7.9 mg, 1 mol %), and **L2** (4.2 mg, 1 mol %). The product was purified by column chromatography (silica gel, 2:1 to 1:2 hexanes:EtOAc gradient, visualized with CAM) to yield 1*H*-pyrazole-4-carbonitrile as a white solid. (84 mg, 90%), **mp** = 90–91 °C (lit. 91–92 °C).[25] **^{1}H NMR (300 MHz, CD_3OD)**: δ 8.13 (s, 2H). **^{13}C NMR (126 MHz, CD_3OD)**: δ 139.6, 114.9, 92.6. **IR (neat, cm^{-1})**: 3126, 2925, 2852, 2909, 2235, 1514, 1385, 1155. **Anal.** Cald. for $C_4H_3N_3$: C, 51.61; H, 3.25. Found: C, 51.63; H, 3.27.



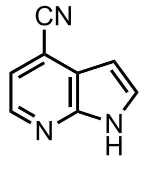
1*H*-pyrazole-3-carbonitrile hydrochloride (2j). Following a modification of the general procedure with 3-bromo-1*H*-pyrazole (147 mg, 1 mmol), **P3** (42.7 mg, 5 mol %), and **L3** (24.2 mg, 5 mol %). The product was purified by column chromatography (silica gel, 99:1 to 96:4 CH_2Cl_2:MeOH, visualized with CAM) to yield a light brown solid. The solid was dissolved in Et_2O (5 mL) and passed though a PTFE syringe filter. The filter was washed with Et_2O (2 mL), and the combined Et_2O solution was dried *in vacuo*. The solid was dissolved in Et_2O (1 mL) and 2 M HCl in Et_2O (0.6 mL) was added. Pentane (12 mL) was layered onto the solution. After 2 h, a solid was observed. The pentane layer was decanted, and the solid was washed with pentane (2x8mL). Drying *in vacuo* afforded 1*H*-pyrazole-3-carbonitrile hydrochloride as a light brown solid (95:5 mixture of 1*H*-pyrazole-3-carbonitrile hydrochloride:3-bromo-1*H*-pyrazole hydrochloride) (86 mg, 63%). **^{1}H NMR (300 MHz, d^6-DMSO)**: δ 13.73 (br s, 1H), 8.03 (d, *J* = 2.5 Hz, 1H), 6.95 (d, *J* = 2.4 Hz, 1H). **^{13}C NMR (126 MHz, d^6-DMSO)**: δ 130.8, 123.3, 115.0, 110.6. **IR (neat, cm^{-1})**: 3268, 3147, 2245, 1508, 1456, 1348, 1271, 1176. **HRMS-ESI (*m/z*)** [M]$^+$ calcd for $C_4H_3N_3$, 93.0327; found, 93.0703.



1*H*-indazole-3-carbonitrile (2k). Following the general procedure with 3-chloro-1*H*-indazole (153 mg, 1 mmol), **P2** (31.8 mg, 4 mol %), and **L2** (17 mg, 4 mol %). The product was purified by column chromatography (silica gel, 85:15 to 65:35 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield 1*H*-indazole-3-carbonitrile as a white solid. (132 mg, 92%), **mp** = 140–141 °C (lit. 140 °C).[26] **^{1}H NMR (300 MHz, CD_3OD)**: δ 7.78 (dt, *J* = 8.2, 1.0 Hz, 1H), 7.66 (dt, *J* = 8.5, 0.9 Hz, 1H), 7.49 (ddd, *J* = 8.5, 6.9, 1.1 Hz, 1H), 7.34 (ddd, *J* = 8.2, 6.9, 0.9 Hz, 1H). **^{13}C NMR (126 MHz, CD_3OD)**: δ 141.6, 129.0, 125.4, 124.6, 119.6, 119.5, 114.9, 112.3. **IR (neat, cm^{-1})**: 3234 (br), 2239, 1622, 1470, 1344, 1251, 1170, 1073. **Anal.** Cald. for $C_8H_5N_3$: C, 67.12; H, 3.52. Found: C, 67.09; H, 3.65.

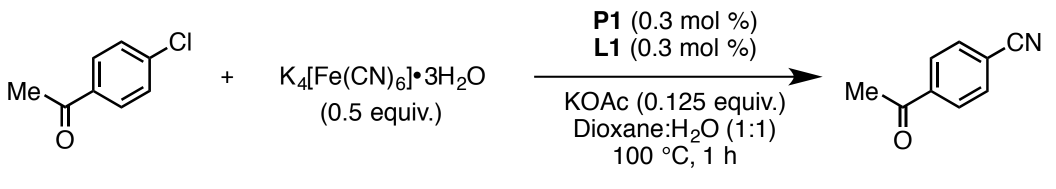


1-Benzyl-1*H*-imidazole-4-carbonitrile (2l). Following the general procedure with 1-benzyl-4-bromo-1*H*-imidazole (237 mg, 1 mmol), **P3** (12.8 mg, 1.5 mol %), and **L3** (7.3 mg, 1.5 mol %). The product was purified by column chromatography (silica gel, 70:30 to 40:60 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield 1-benzyl-1*H*-imidazole-4-carbonitrile as a pale pink oil. (181 mg, 99%). **^{1}H NMR (300 MHz, $CDCl_3$)**: δ 7.54 (d, *J* = 1.3 Hz, 1H), 7.42 (d, *J* = 1.3 Hz, 1H), 7.40–7.33 (m, 3H), 7.19–7.13 (m, 2H), 5.13 (s, 2H). **^{13}C NMR (126 MHz, $CDCl_3$)**: δ 138.8, 134.4, 129.3, 128.9, 127.9, 127.7, 114.9, 114.4, 51.5. **IR (neat, cm^{-1})**: 3116, 2230, 1533, 1496, 1455, 1230, 1146, 976. **Anal.** Cald. for $C_{11}H_9N_3$: C, 72.11; H, 4.95. Found: C, 71.84; H, 4.92.



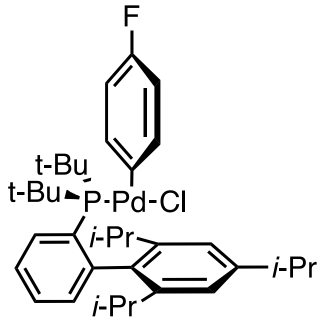
1*H*-pyrrolo[2,3-*b*]pyridine-4-carbonitrile Following the general procedure with 4-chloro-1*H*-pyrrolo[2,3-*b*]pyridine (153 mg, 1 mmol), **P2** (12.7 mg, 1.6 mol %), and **L2** (6.8 mg, 1.6 mol %). The product was purified by column chromatography (silica gel, 2:1 to 1:3 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield 1*H*-pyrrolo[2,3-*b*]pyridine-4-carbonitrile as a white solid. (108 mg, 72%, 95:5 mixture of 1*H*-pyrrolo[2,3-*b*]pyridine-4-carbonitrile:4-chloro-1*H*-pyrrolo[2,3-*b*]pyridine). **^{1}H NMR (300 MHz, DMSO)**: δ ^{1}H NMR (300 MHz, DMSO-d6) δ 12.38 (s, 1H), 8.40 (d, *J* = 4.9 Hz, 1H), 7.83 (d, *J* = 3.5 Hz, 1H), 7.55 (d, *J* = 4.9 Hz, 1H), 6.65 (d, *J* = 3.4 Hz, 1H). **^{13}C NMR (126 MHz, DMSO)**: δ 148.5, 142.4, 130.3, 119.59, 118.2, 116.9, 108.9, 98.3. **IR (neat, cm^{-1})**: 3129, 3069, 2909, 2233, 1599, 1326, 1277, 1121. **Anal.** Cald. for $C_8H_5N_3$: C, 67.12; H, 3.52. Found: C, 66.81; H, 3.74.

Experimental Procedure for a Reaction on a 10 mmol Scale



To a Schlenk tube equipped with a magnetic stir bar was added $K_4[Fe(CN)_6]•3H_2O$ (2.11 g, 0.5 equiv.). Separately, to a 25 mL screw-cap volumetric flask was added **P1** (27.6 mg, 0.3 mol %) and **L1** (14.3 mg, 0.3 mol %). After sealing the vessels with a plug valve (Schlenk tube) or Teflon-lined screw-cap (volumetric flask), both vessels were evacuated and backfilled with nitrogen (this process was repeated for a total of three cycles). 1-(4-chlorophenyl)ethanone (1.3 mL, 1.55 g, 10 mmol) was added via syringe to the Schlenk tube. Dioxane (25 mL) was added via syringe to the volumetric flask to obtain a clear precatalyst and ligand solution. Subsequently, the precatalyst and ligand solution was added to the Schlenk tube via cannula, followed by 0.05 M KOAc in degassed water (25 mL). The Schlenk tube was sealed with a Teflon plug valve, placed in an oil bath preheated to 100 °C, and stirred for 1 h. Upon initial stirring, a clear, yellow solution is observed. During the course of the reaction, a yellow precipitate forms on the walls of the reaction vessel. After 1 h of stirring at 100 °C, the reaction mixture was then cooled to room temperature. EtOAc (50 mL) and brine (50 mL) was added to the Schenk tube. The solution was transferred to a separatory funnel, and the organic layer was separated from the dark blue aqueous layer. The aqueous layer was further extracted with EtOAc (total 2 x 50 mL). The combined organic layers were dried over $MgSO_4$, filtered, and concentrated *in vacuo*. The resulting mixture was adsorbed onto silica gel, dried *in vacuo*, and purified via column chromatography (silica gel, 95:5 to 75:25 hexanes:EtOAc gradient, visualized with UV and $KMnO_4$) to yield 4-acetylbenzonitrile as a white solid (1.4 g, 96%). Analytical data was as is described for the experiment carried out on a 1 mmol scale (*vide supra*).

Preparation of Oxidative Addition Complex 6

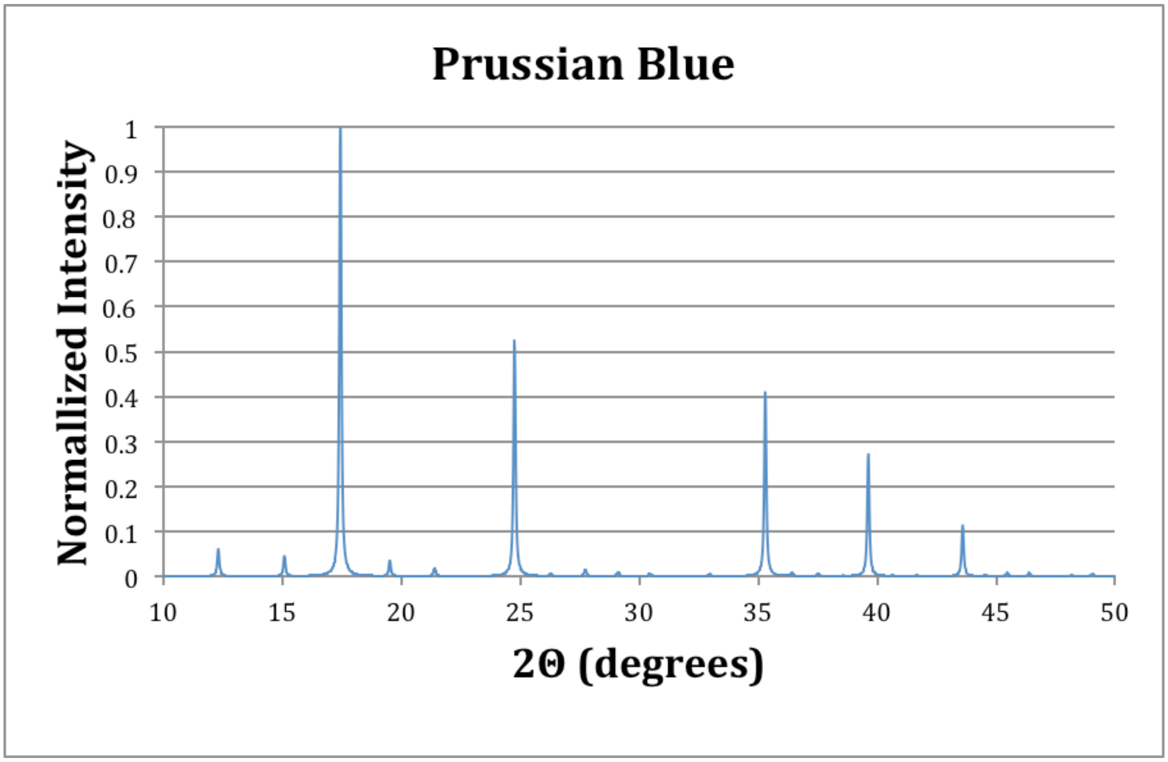


In a nitrogen-filled glove box, to an oven-dried screw-top reaction vial containing a magnetic stirbar was added **L2** (467 mg, 1.1 mmol, 1.1 equiv.), 1-chloro-4-fluoro-benzene (0.53 mL, 650 mg, 6 mmol, 5 equiv.) and cyclohexane (1 mL). The reaction mixture was stirred until **L2** had completely dissolved to yield a clear solution. (COD)Pd(CH_2TMS)$_2$ (389 mg, 1 mmol, 1 equiv.) was added to the solution, the vessel was sealed with a screw cap, and the reaction was stirred at room temperature for 18 h, during which time a yellow precipitate formed. Pentane (2 mL) was added, and the vial was transferred to a -20 °C freezer and left for for 2 h. The cold suspension was then filtered and washed with cold pentane (4x2mL). Drying *in vacuo* afforded complex **6** as a yellow solid (451 mg, 68%). During characterization, approx. 4% dearomative rearrangement product was observed via ^{31}P and ^{19}F NMR . **^{1}H NMR (500 MHz, CD_2Cl_2)**: δ 7.99 (td, *J* = 6.1, 3.0 Hz, 1H), 7.46–7.34 (m, 2H), 7.08 (s, 2H), 7.02 (ddd, *J* = 8.8, 5.9, 1.7 Hz, 2H), 6.79 (dt, *J* = 5.9, 3.4 Hz, 1H), 6.66 (t, *J* = 9.1 Hz, 2H), 3.01 (hept, *J* = 6.9 Hz, 1H), 2.54 (hept, *J* = 6.7 Hz, 2H), 1.57 (d, *J* = 6.8 Hz, 6H), 1.39 (d, *J* = 14.0 Hz, 18H), 1.36 (d, *J* = 7.0 Hz, 6H), 0.90 (d, *J* = 6.7 Hz, 6H). **^{13}C NMR (126 MHz, $CDCl_3$)**: δ 162.0, 160.1, 157.8, 152.8, 147.9, 147.8, 138.7, 138.7, 138.7, 138.7, 136.9, 136.6, 135.8, 134.9, 134.8, 134.8, 130.7, 130.6, 127.7, 127.7, 127.6, 126.3, 126.3, 125.1, 125.0, 113.4, 113.4, 113.3, 113.3, 39.8, 39.7, 35.1, 31.9, 31.9, 31.9, 25.8, 25.0, 24.9. Observed complexity is due to C–P and C–F coupling. **^{19}F NMR (471 MHz, CD_2Cl_2)**: δ -124.8. **^{31}P NMR (121 MHz, CD_2Cl_2)**: δ 52.7. **IR (neat, cm^{-1})**: 2962, 2929, 2864, 1608, 1474, 1213, 1045, 1008.

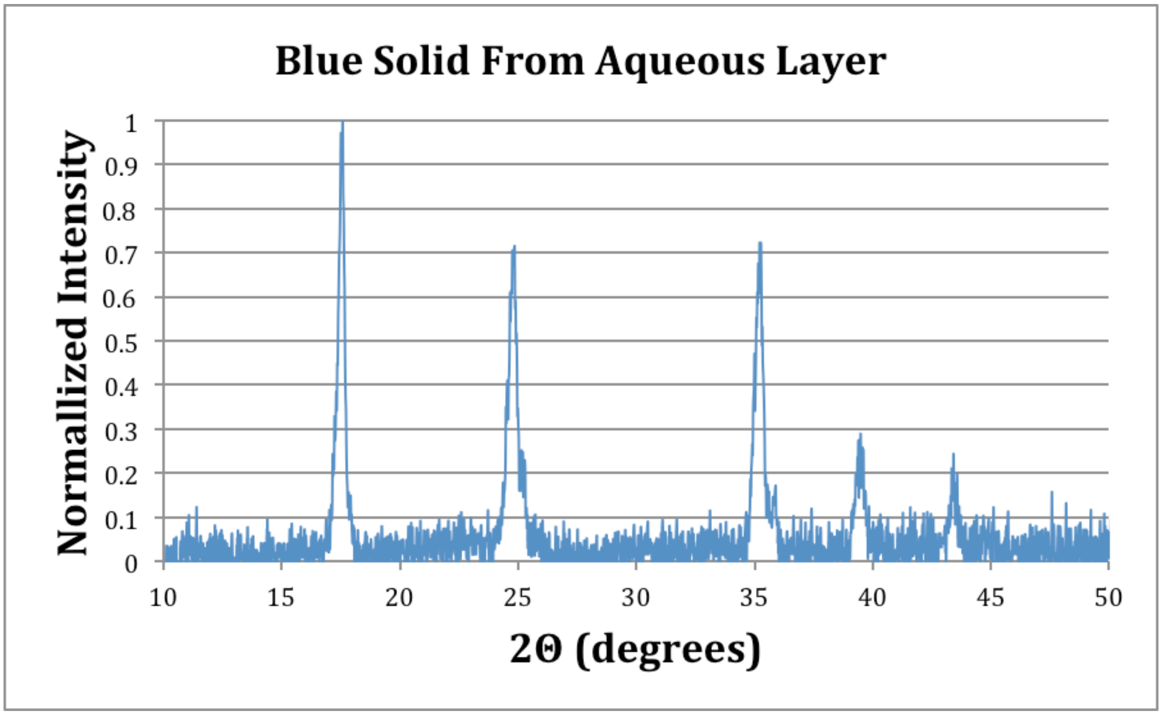
General Procedure for Table 3

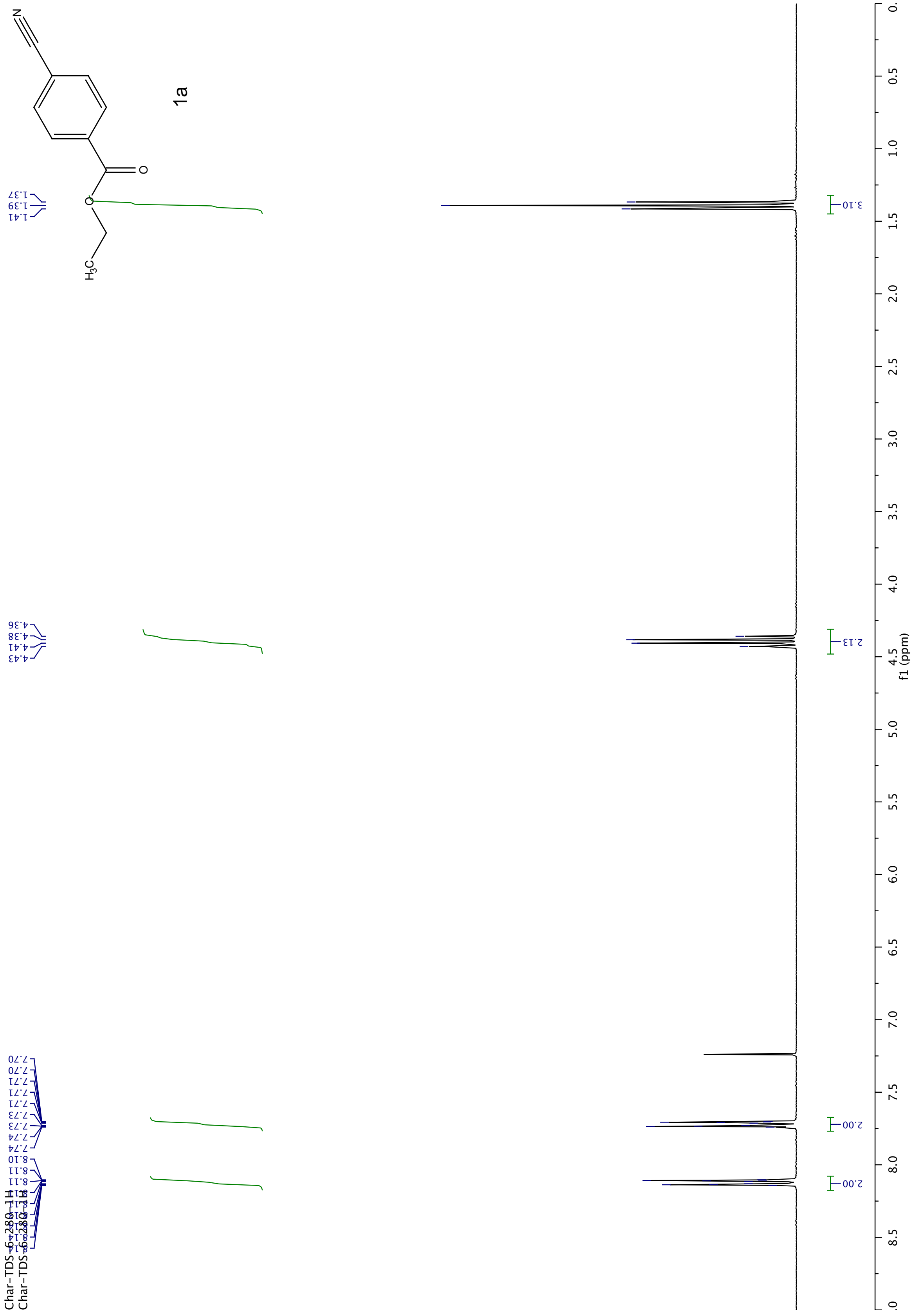
In a nitrogen-filled glove box, to an oven-dried screw-top reaction vial containing a magnetic stirbar was added oxidative addition complex **6** (15 mg, 0.023 mmol, 1 equiv.). The vessel was sealed with a screw-cap and removed from the glove box. 1-fluoronaphthalene (2.9 µL, 3.3 mg, 0.022 mmol, 1 equiv.) and organic solvent (1 mL) were added via syringe. The reaction mixture was stirred, and a degassed aqueous solution of 0.023 M cyanide source and 0.023 M base (1 mL, 0.023 mmol, 1 equiv.) was added via syringe. For the 100 °C trial, the vial was then transferred to an oil bath preheated to 100 °C. The reaction mixture was stirred for the allotted period of time. At the end of this period, (after cooling to room temperature for the 100 °C trial), Et_2O (1 mL) was added to the reaction vessel via syringe and the vial was shaken. A portion of each organic layer was removed via syringe, filtered through a plug of silica gel, and eluted with Et_2O (0.3 mL). The eluents were then analyzed via ^{19}F NMR.

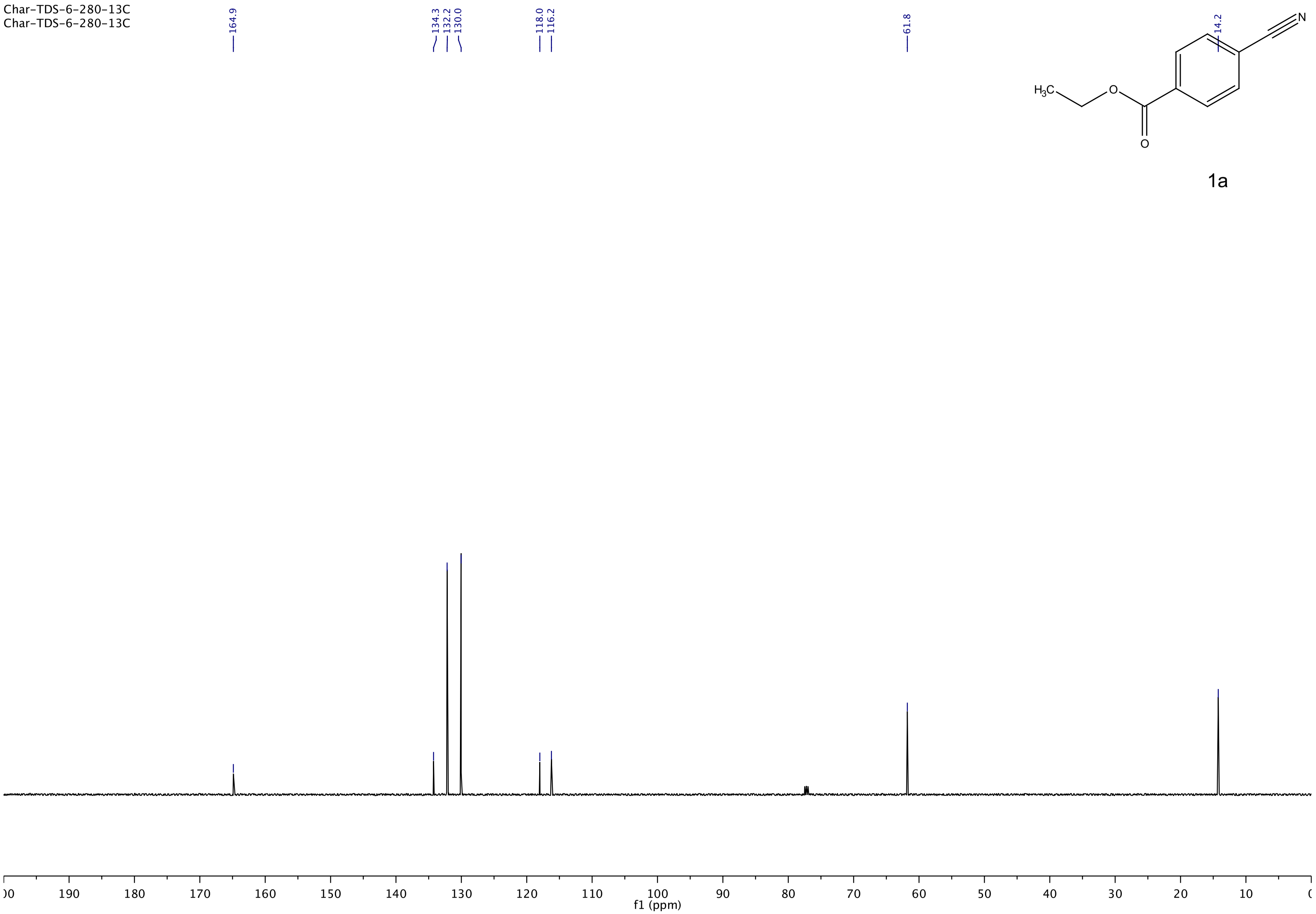
PXRD Spectra

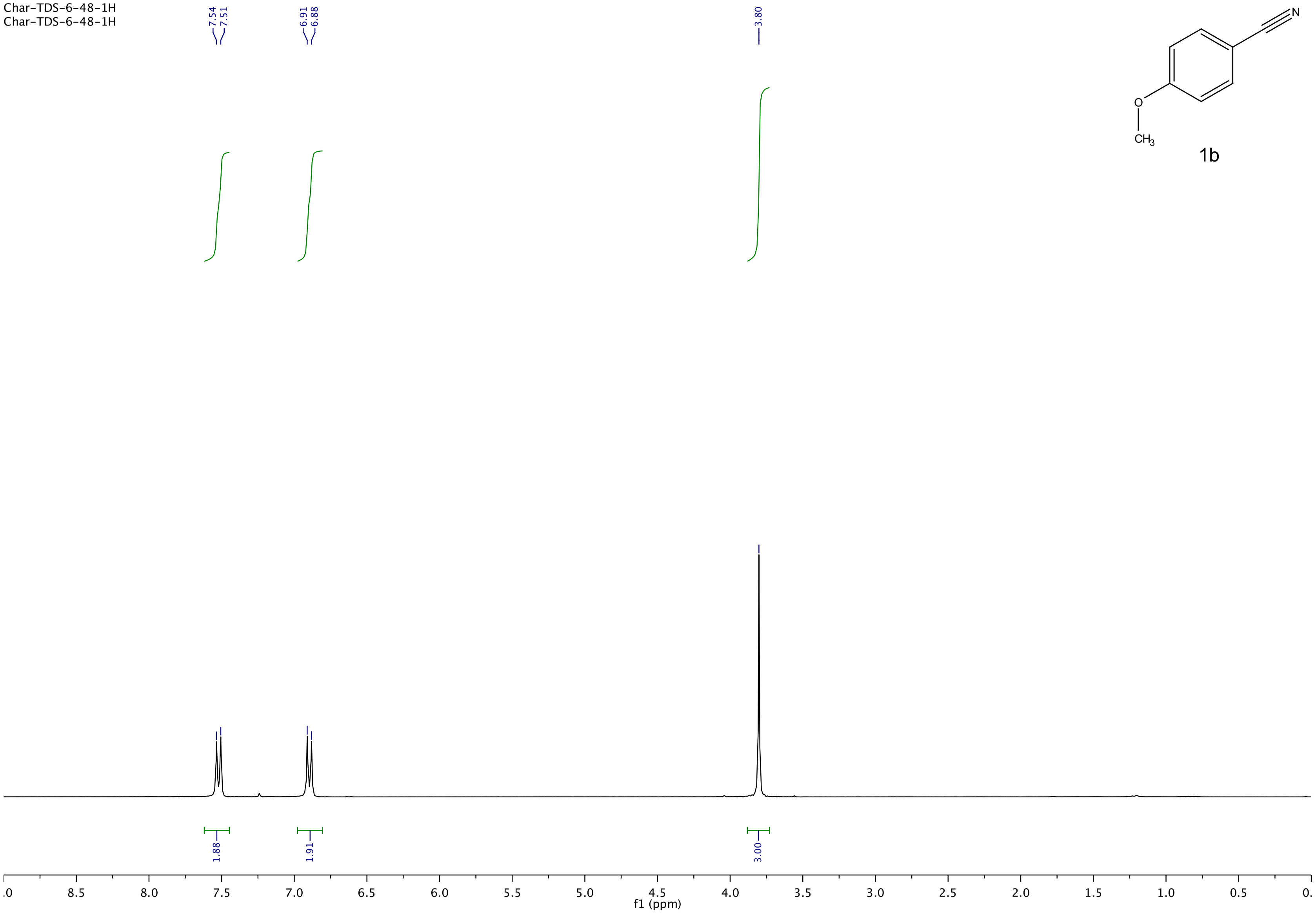


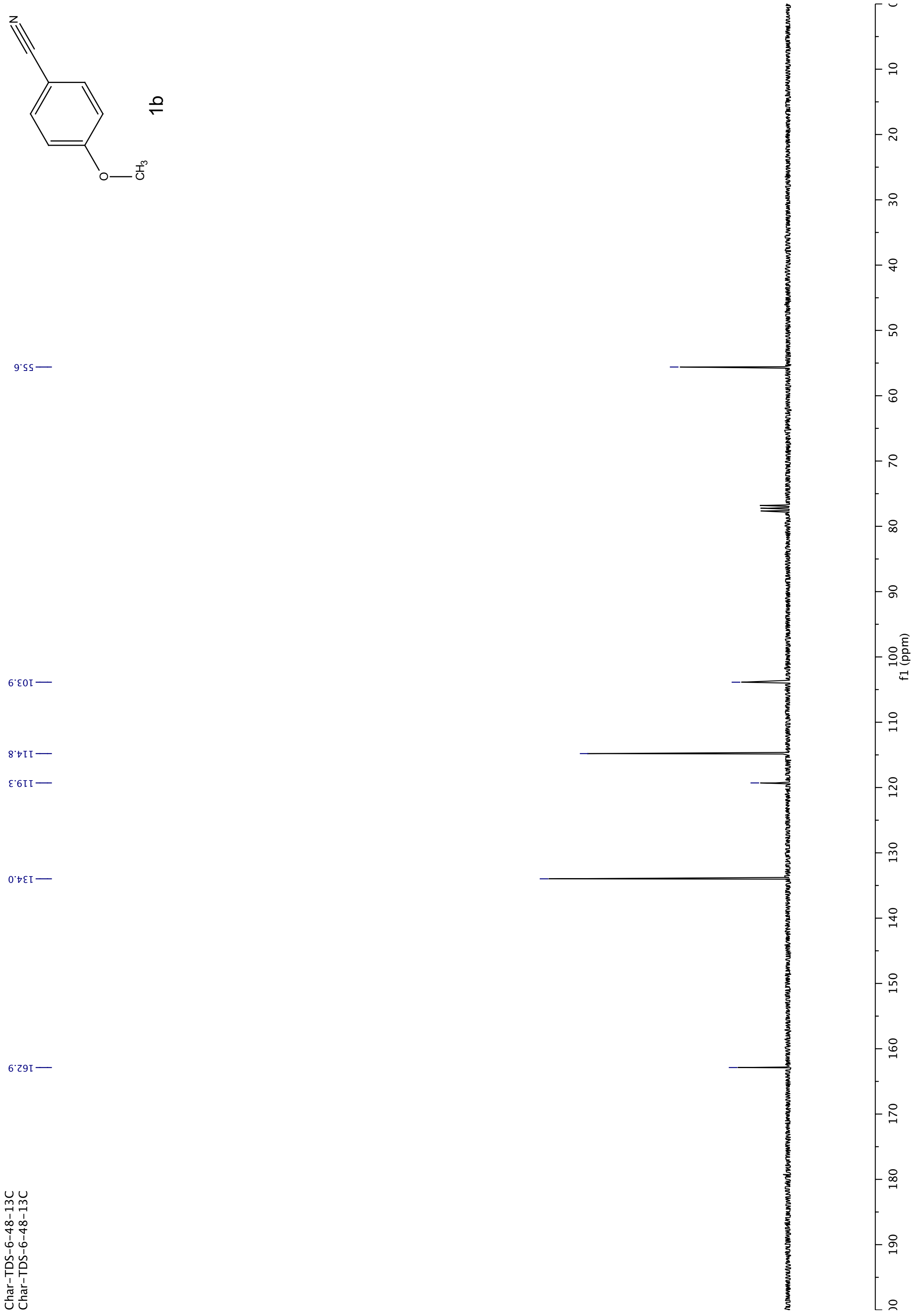
Extrapolated from Buser, H.J.; Schwarzenbach, D.; Petter, W.; Ludi, A. *Inorg. Chem.* **1977**, *16*, 2704-2710.

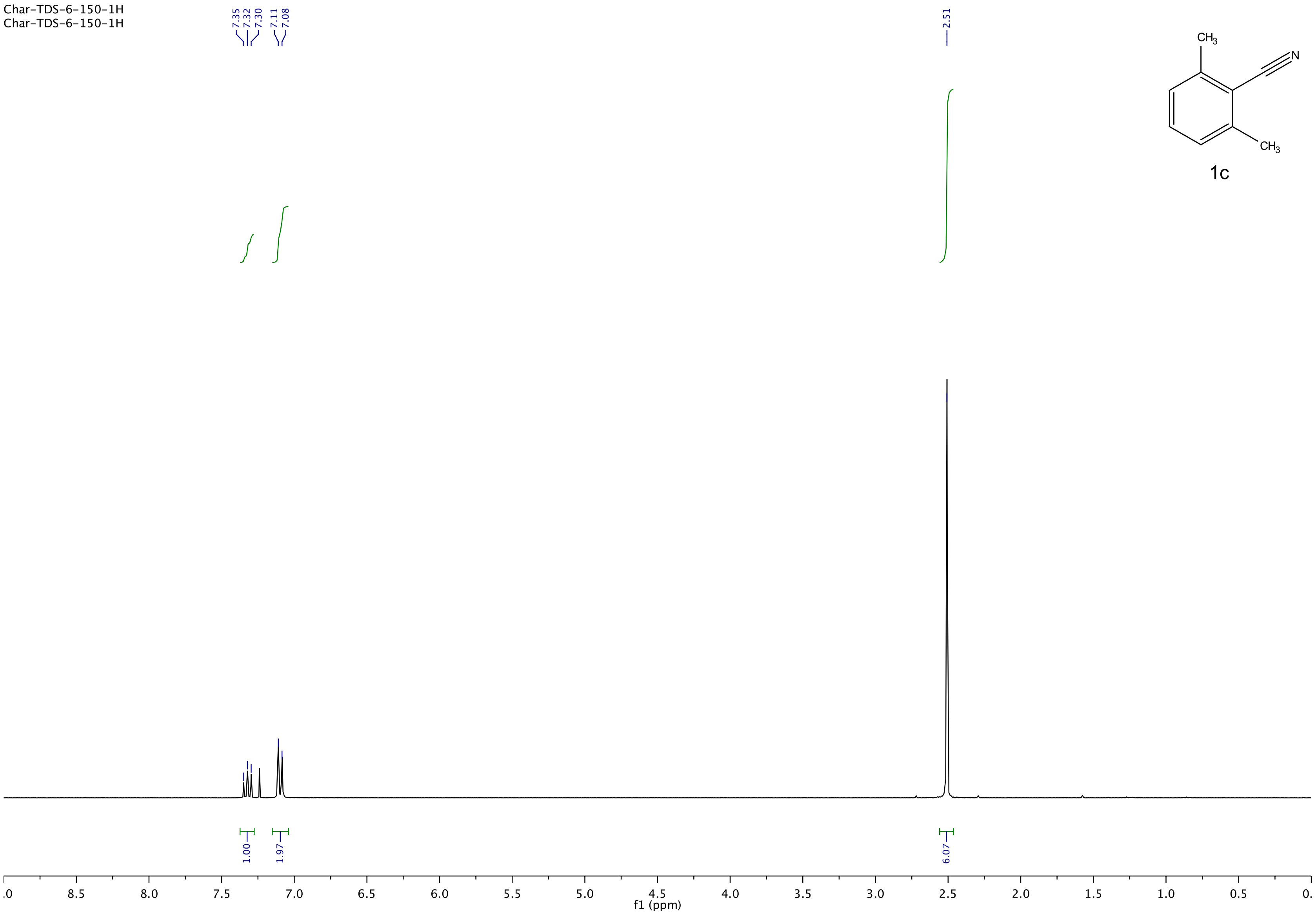


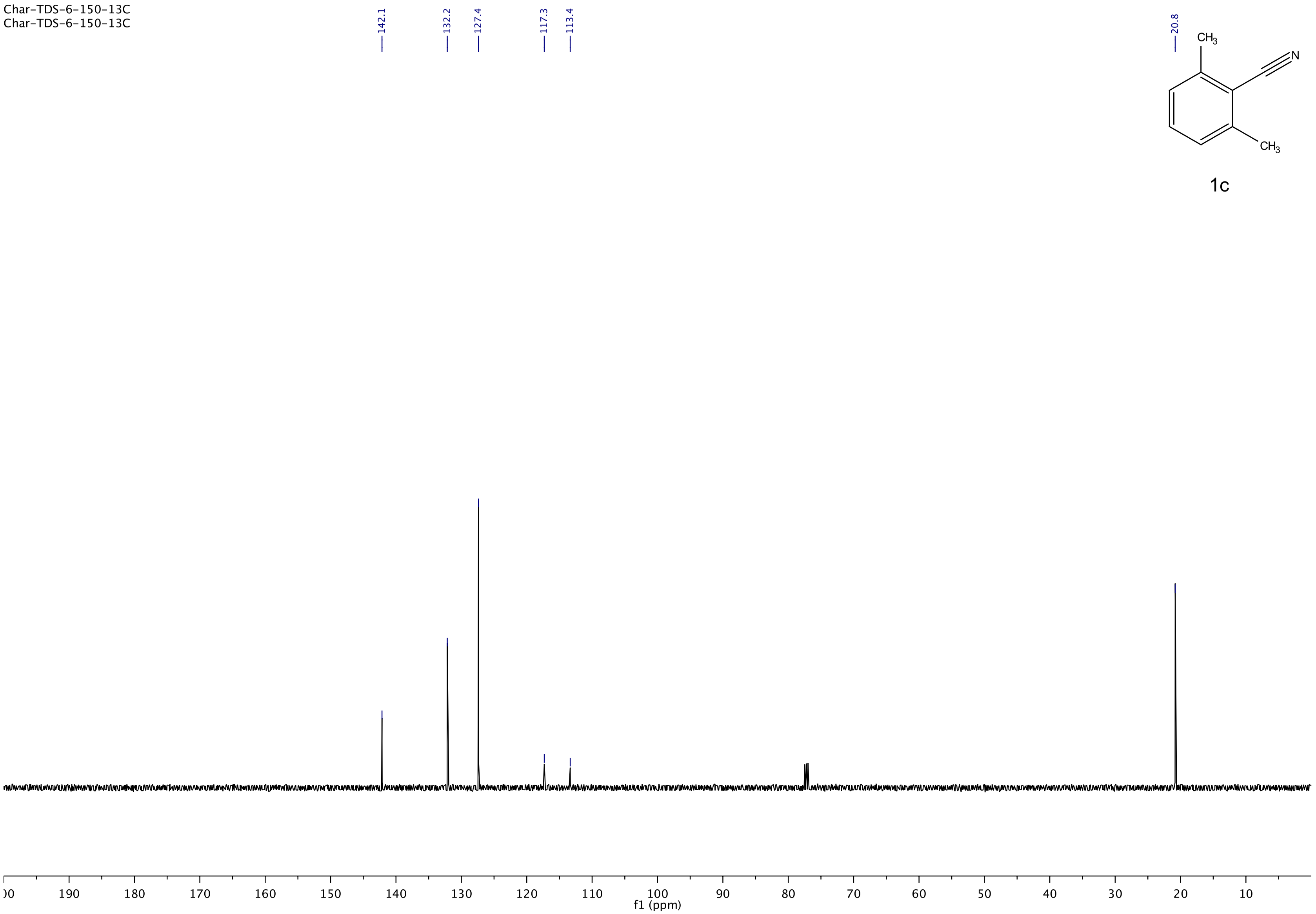

Char-TDS-6-280-1H
1a
N
O
O
H3C
1.37
1.39
1.41
4.36
4.38
4.41
4.43
7.70
7.70
7.71
7.71
7.71
7.73
7.73
7.74
7.74
8.10
8.11
8.11
3.10
2.13
2.00
2.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
f1 (ppm)


Char-TDS-6-280-13C
Char-TDS-6-280-13C
164.9
134.3
132.2
130.0
118.0
116.2
61.8
14.2
H_3C
O
O
N
1a
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

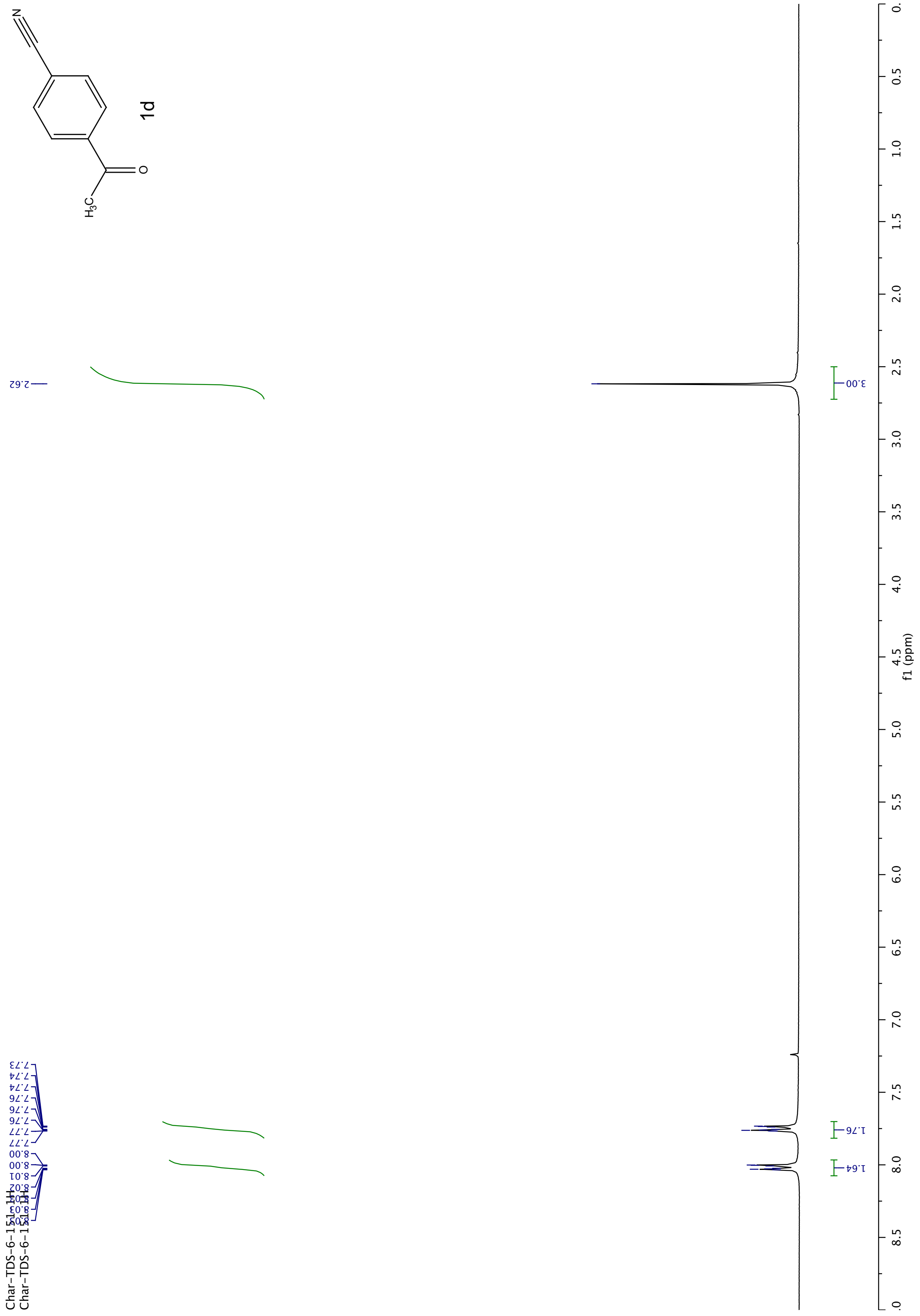

Char-TDS-6-48-1H
Char-TDS-6-48-1H
7.54
7.51
6.91
6.88
3.80
N
O
CH3
1b
1.88
1.91
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

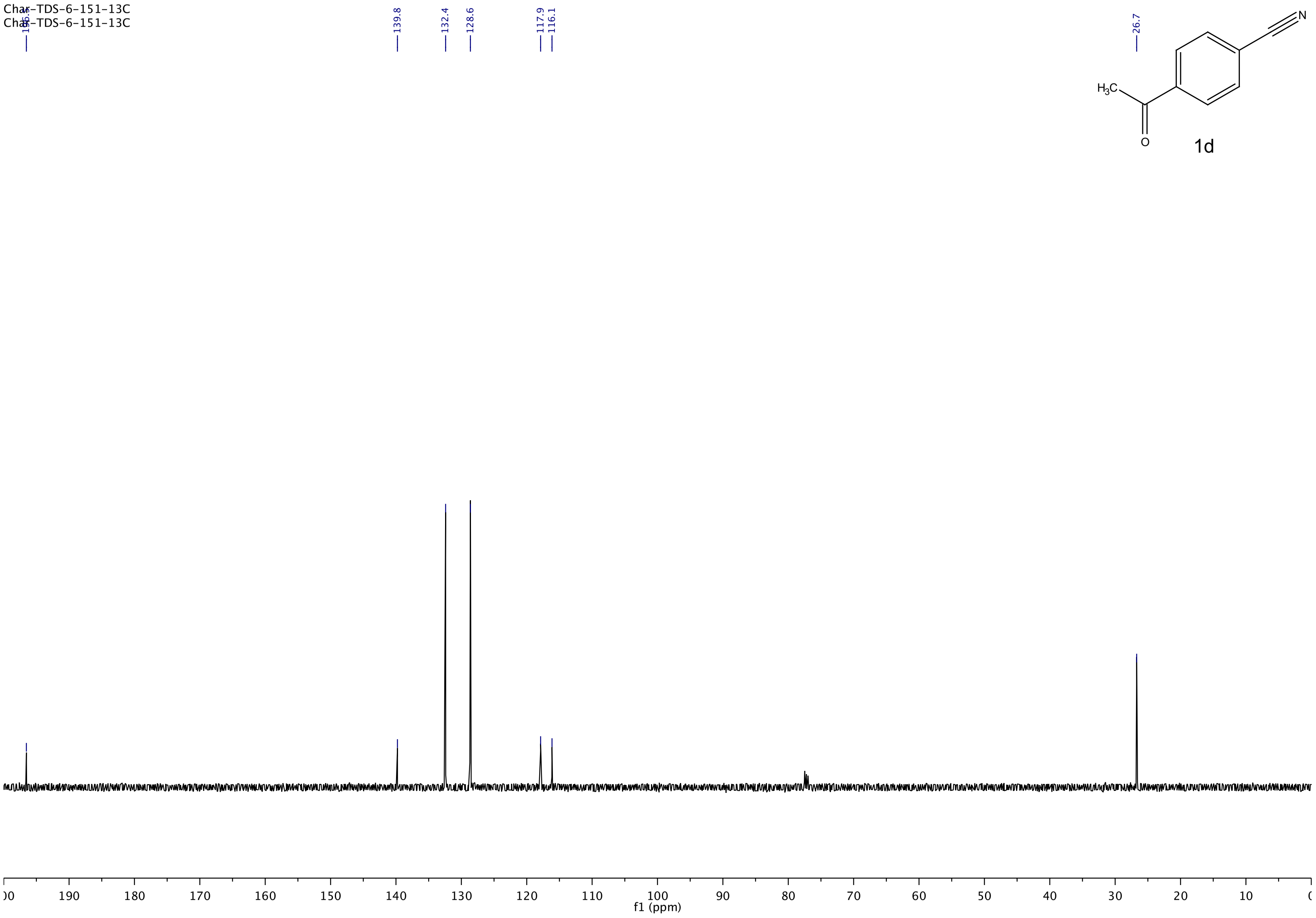

Char-TDS-6-48-13C
Char-TDS-6-48-13C
N
O
CH3
1b
55.6
103.9
114.8
119.3
134.0
162.9
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
f1 (ppm)

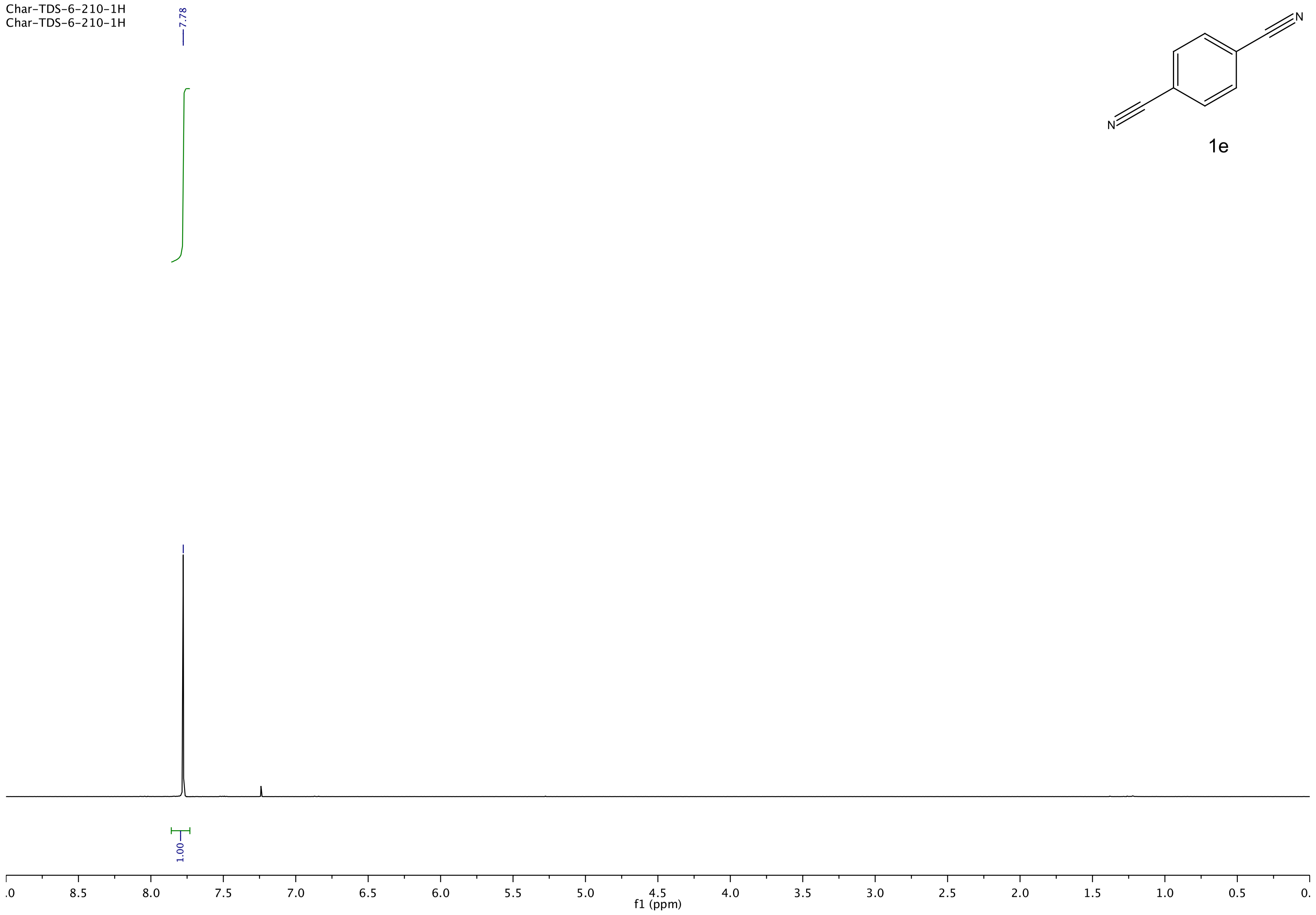

Char-TDS-6-150-1H
Char-TDS-6-150-1H
7.35
7.32
7.30
7.11
7.08
2.51
CH3
N
CH3
1c
1.00
1.97
6.07
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


Char-TDS-6-150-13C
Char-TDS-6-150-13C
142.1
132.2
127.4
117.3
113.4
20.8
CH3
N
CH3
00
190
180
170
160
150
140
130
120
110
100
f1 (ppm)
90
80
70
60
50
40
30
20
10

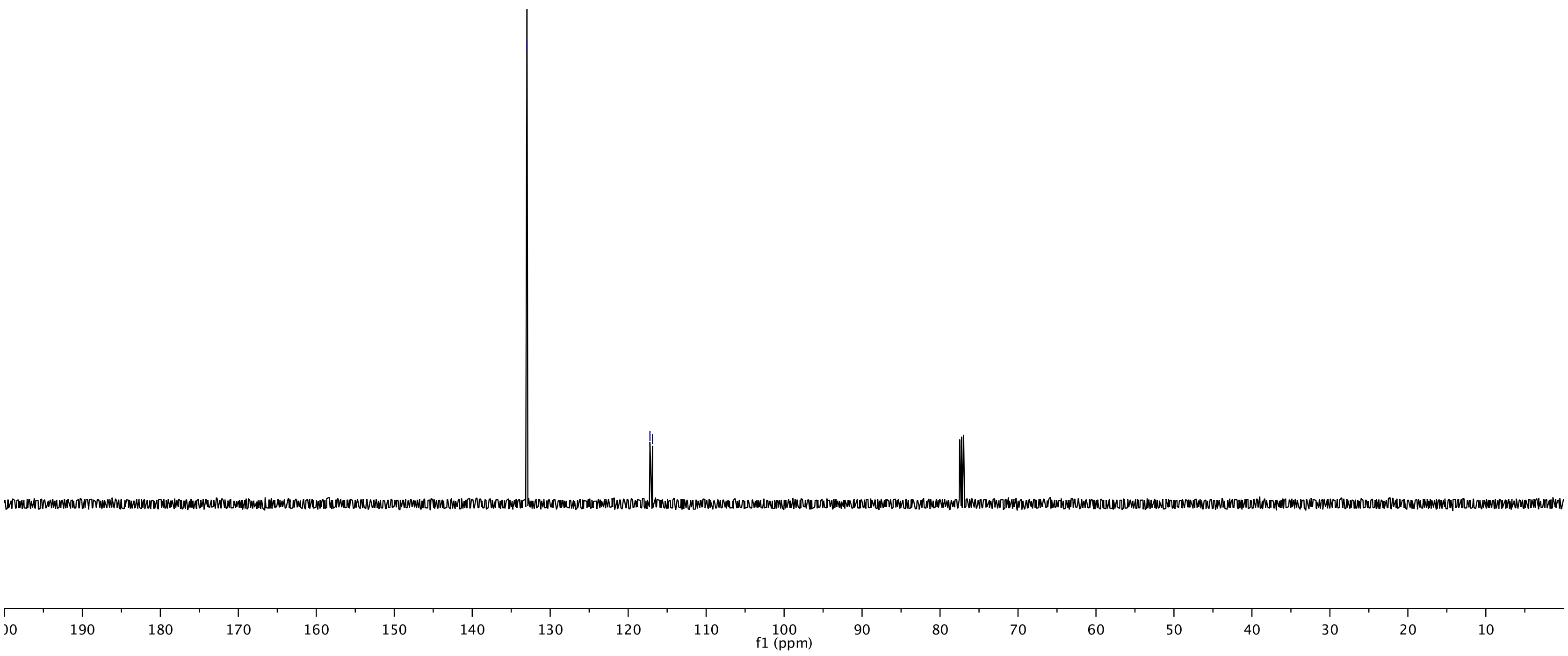
1c

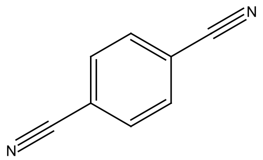

1d
Char-TDS-6-151-1H
Char-TDS-6-151-1H
2.62
7.73
7.74
7.74
7.76
7.76
7.76
7.77
7.77
8.00
8.00
8.01
8.02
8.03
8.03
8.03
3.00
1.76
1.64
f1 (ppm)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0


Char-TDS-6-151-13C
Char-TDS-6-151-13C
139.8
132.4
128.6
117.9
116.1
26.7
H_3C
O
N
1d
f1 (ppm)
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10

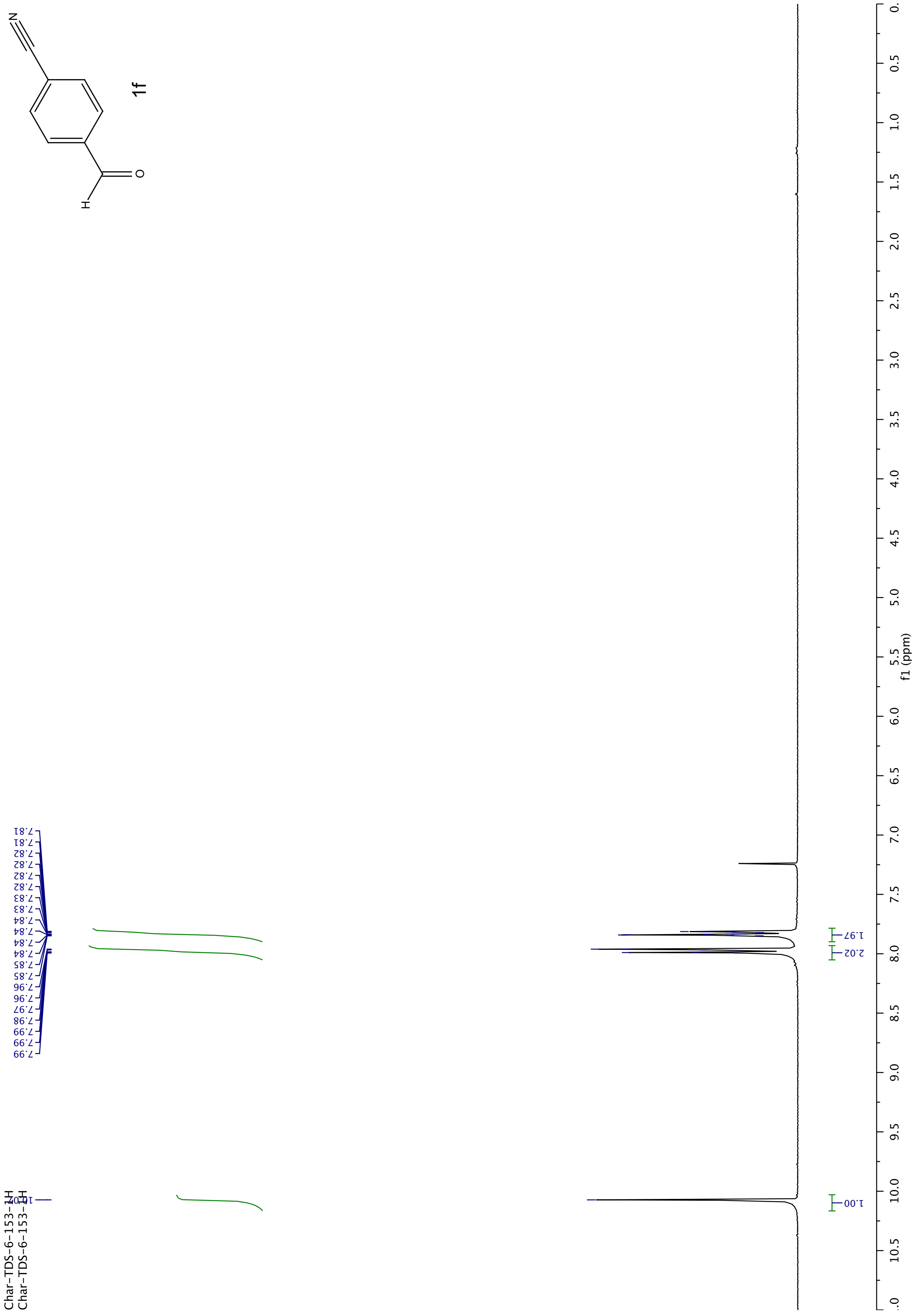

Char-TDS-6-210-1H
Char-TDS-6-210-1H
7.78
1.00
.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.
f1 (ppm)
N
N

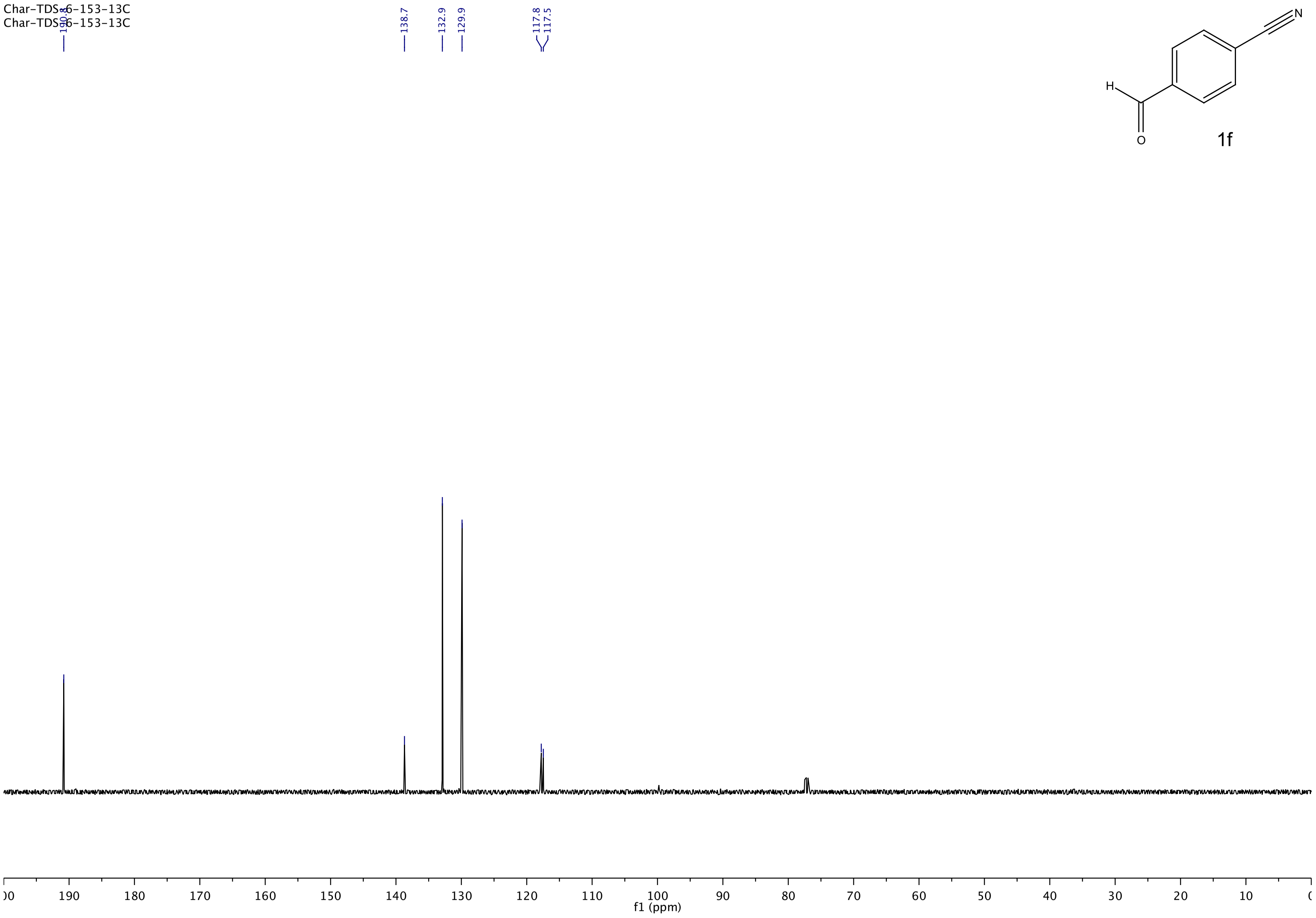
1e

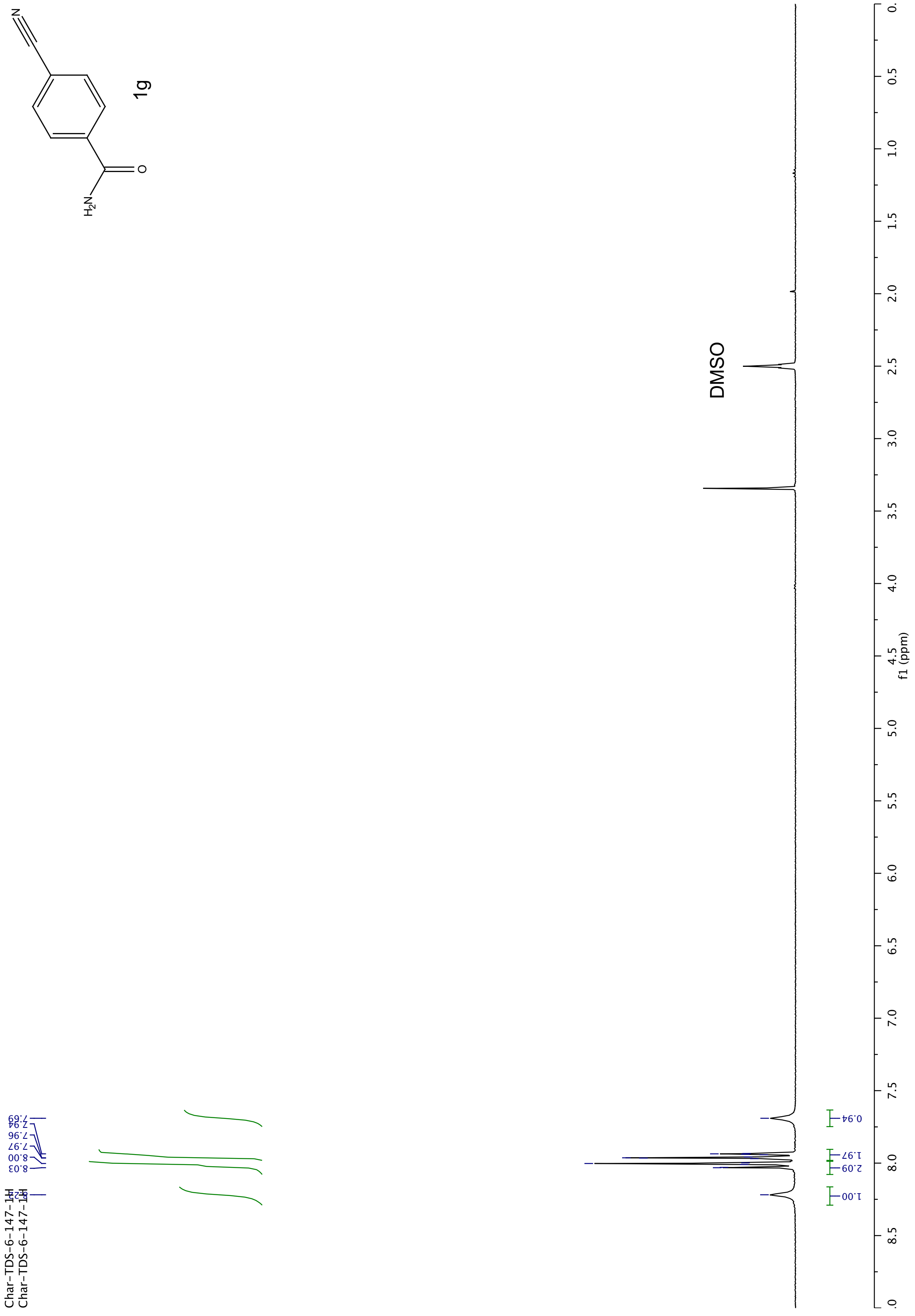

Char-TDS-6-210-13C
Char-TDS-6-210-1H
133.0
117.2
116.9
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

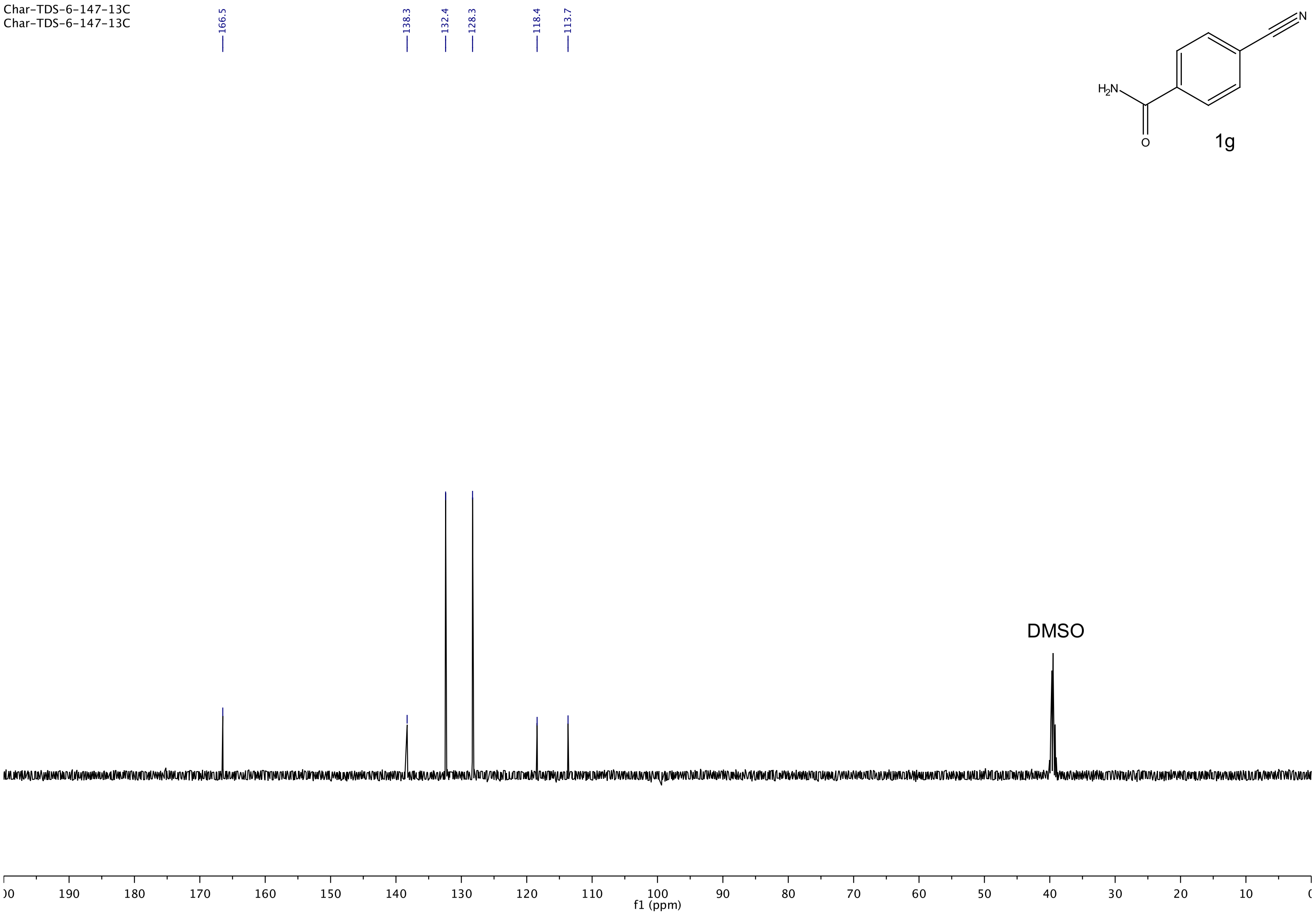

N
N

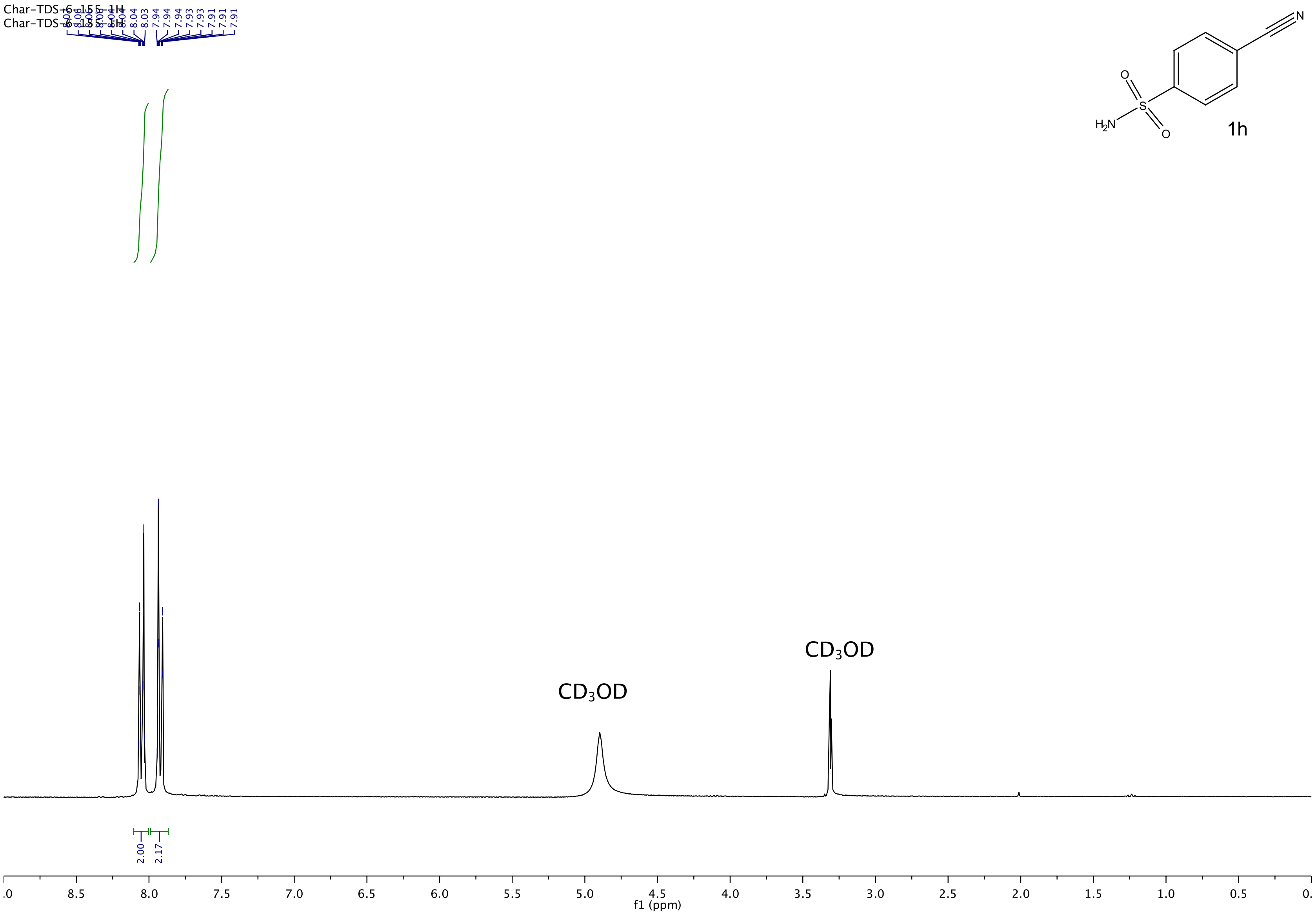
1e

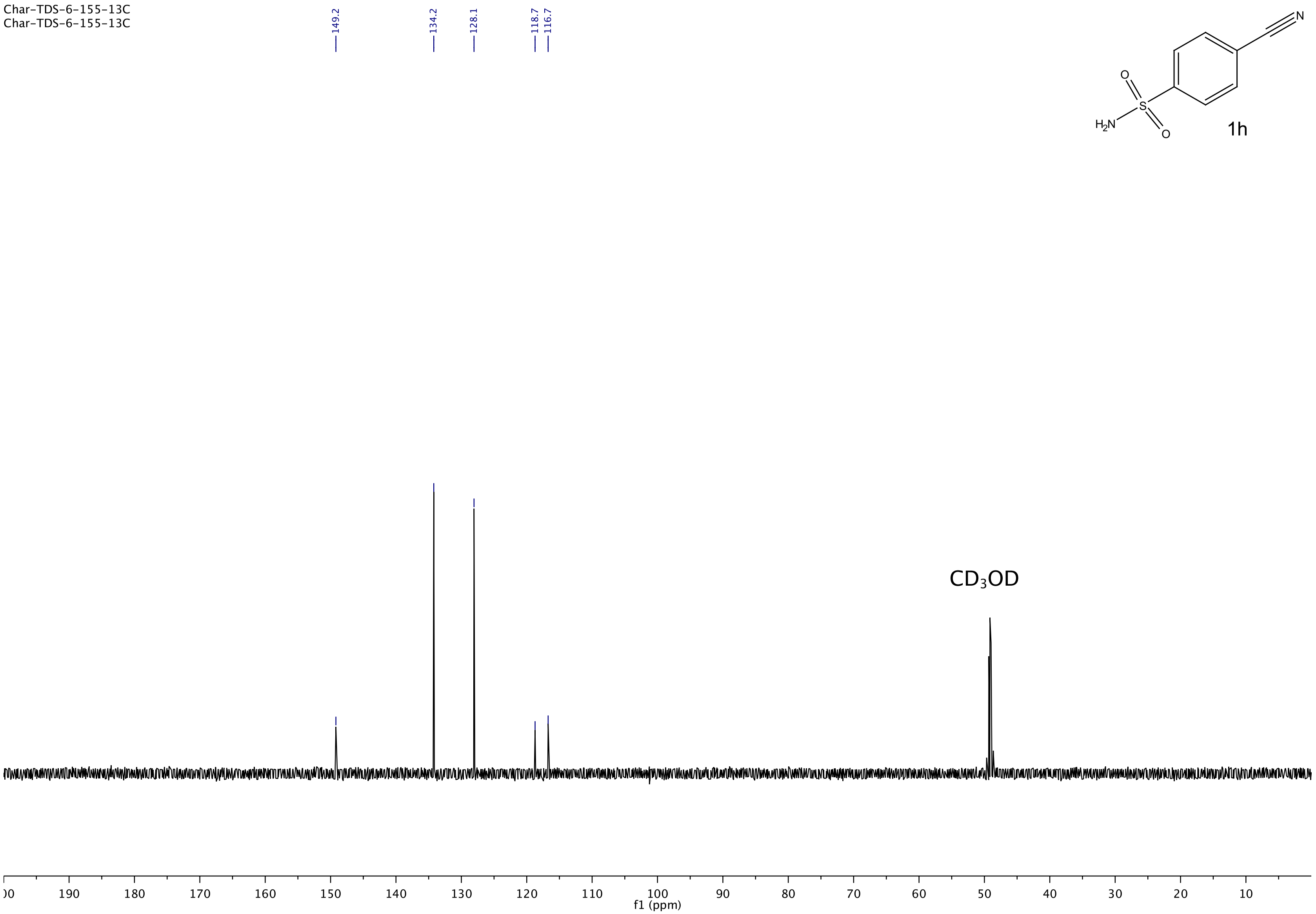

Char-TDS-6-153-1H
Char-TDS-6-153-1H
1f
N
O
H
10.07
7.81
7.81
7.82
7.82
7.82
7.82
7.83
7.83
7.84
7.84
7.84
7.84
7.85
7.85
7.96
7.96
7.97
7.98
7.99
7.99
7.99
1.00
2.02
1.97
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

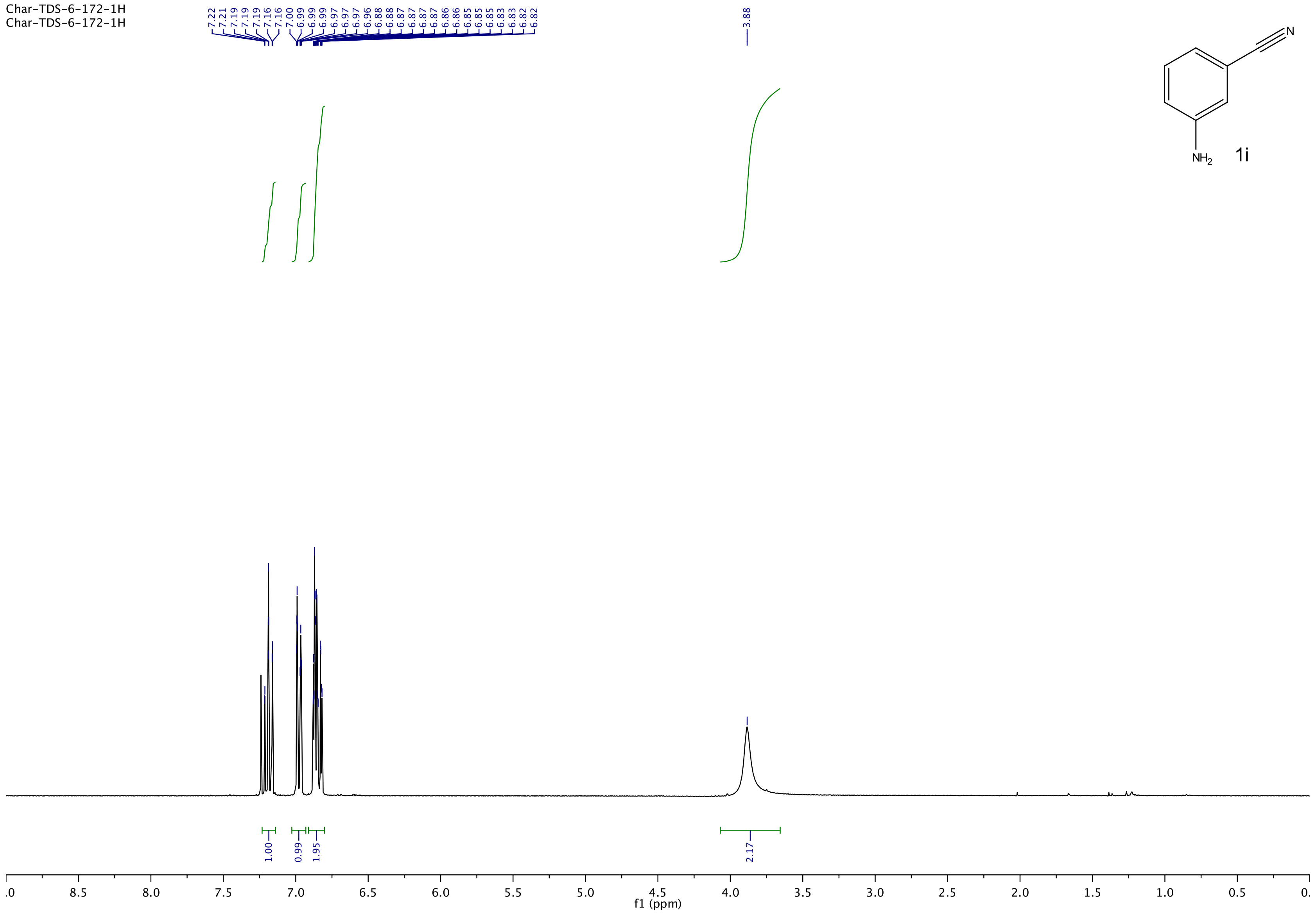

Char-TDS-6-153-13C
Char-TDS-6-153-13C
190.8
138.7
132.9
129.9
117.8
117.5
H
O
N
1f
f1 (ppm)
0
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0


Char-TDS-6-147-1H
Char-TDS-6-147-1H
8.21
8.03
8.00
7.97
7.96
7.94
7.69
1g
DMSO
1.00
2.09
1.97
0.94
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.
f1 (ppm)

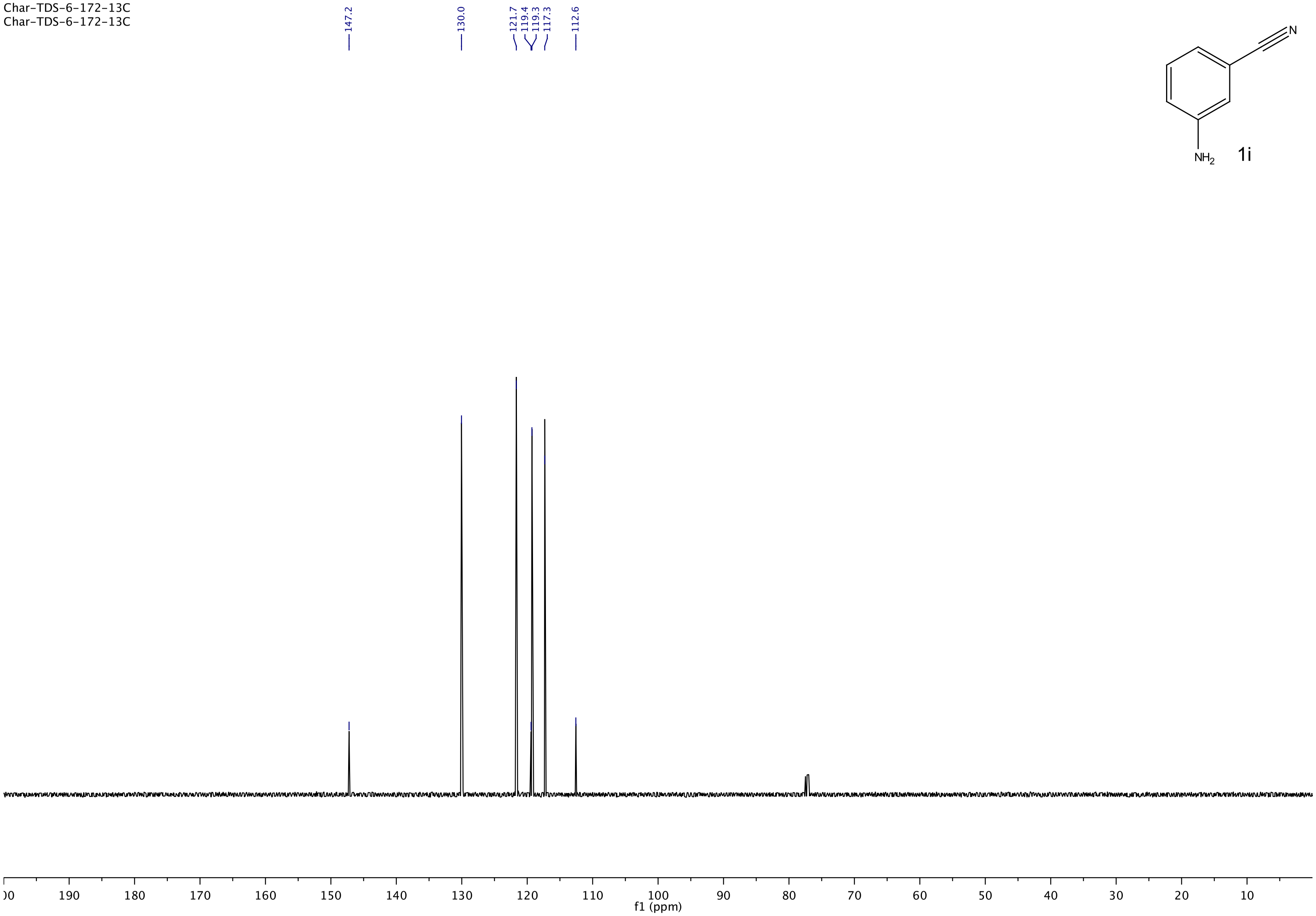

Char-TDS-6-147-13C
Char-TDS-6-147-13C
166.5
138.3
132.4
128.3
118.4
113.7
H2N
O
N
1g
DMSO
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


Char-TDS-6-155-1H
Char-TDS-6-155-1H
8.07
8.06
8.06
8.06
8.04
8.04
8.04
8.03
7.94
7.94
7.94
7.93
7.93
7.91
7.91
7.91
H$_2$N
S
O
O
N
1h
CD$_3$OD
CD$_3$OD
2.00
2.17
.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.
f1 (ppm)

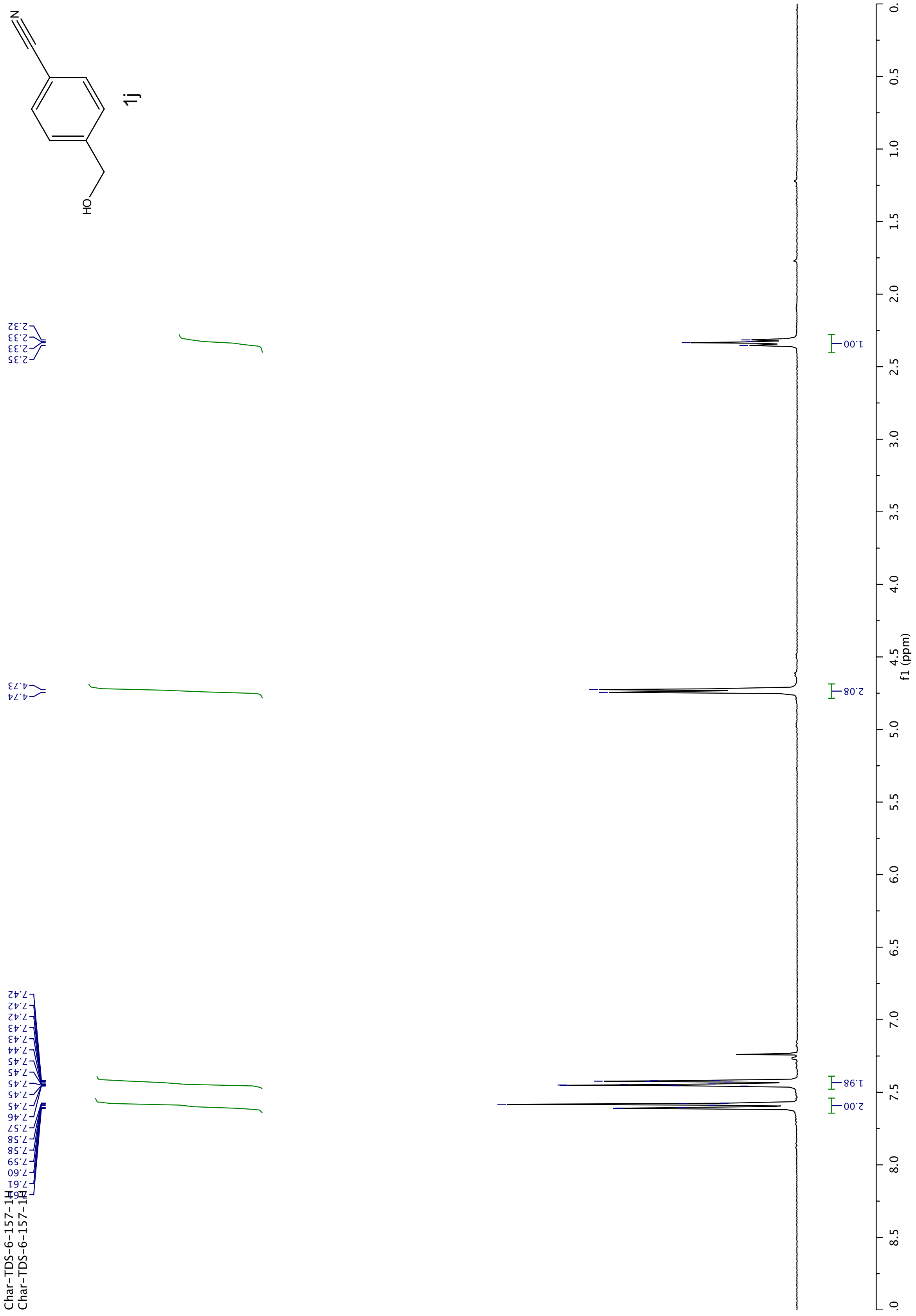

Char-TDS-6-155-13C
Char-TDS-6-155-13C
149.2
134.2
128.1
118.7
116.7
1h
O
O
S
H2N
N
CD3OD
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

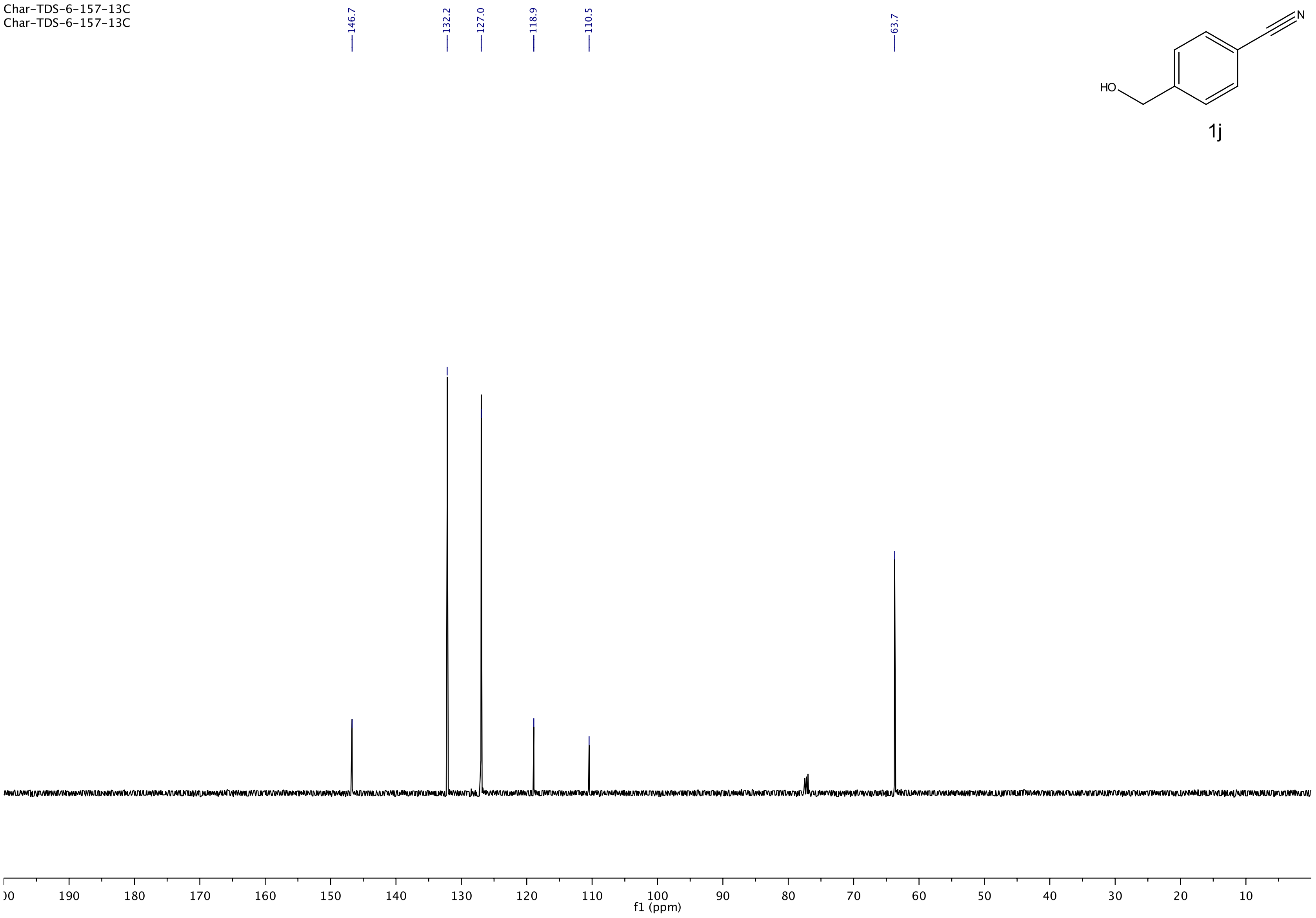

Char-TDS-6-172-1H
Char-TDS-6-172-1H
7.22
7.21
7.19
7.19
7.19
7.16
7.16
7.00
6.99
6.99
6.99
6.97
6.97
6.97
6.96
6.88
6.88
6.87
6.87
6.87
6.87
6.86
6.86
6.85
6.85
6.85
6.83
6.83
6.82
6.82
3.88
N
NH2
1i
1.00
0.99
1.95
2.17
.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
f1 (ppm)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.

Char-TDS-6-172-13C
Char-TDS-6-172-13C

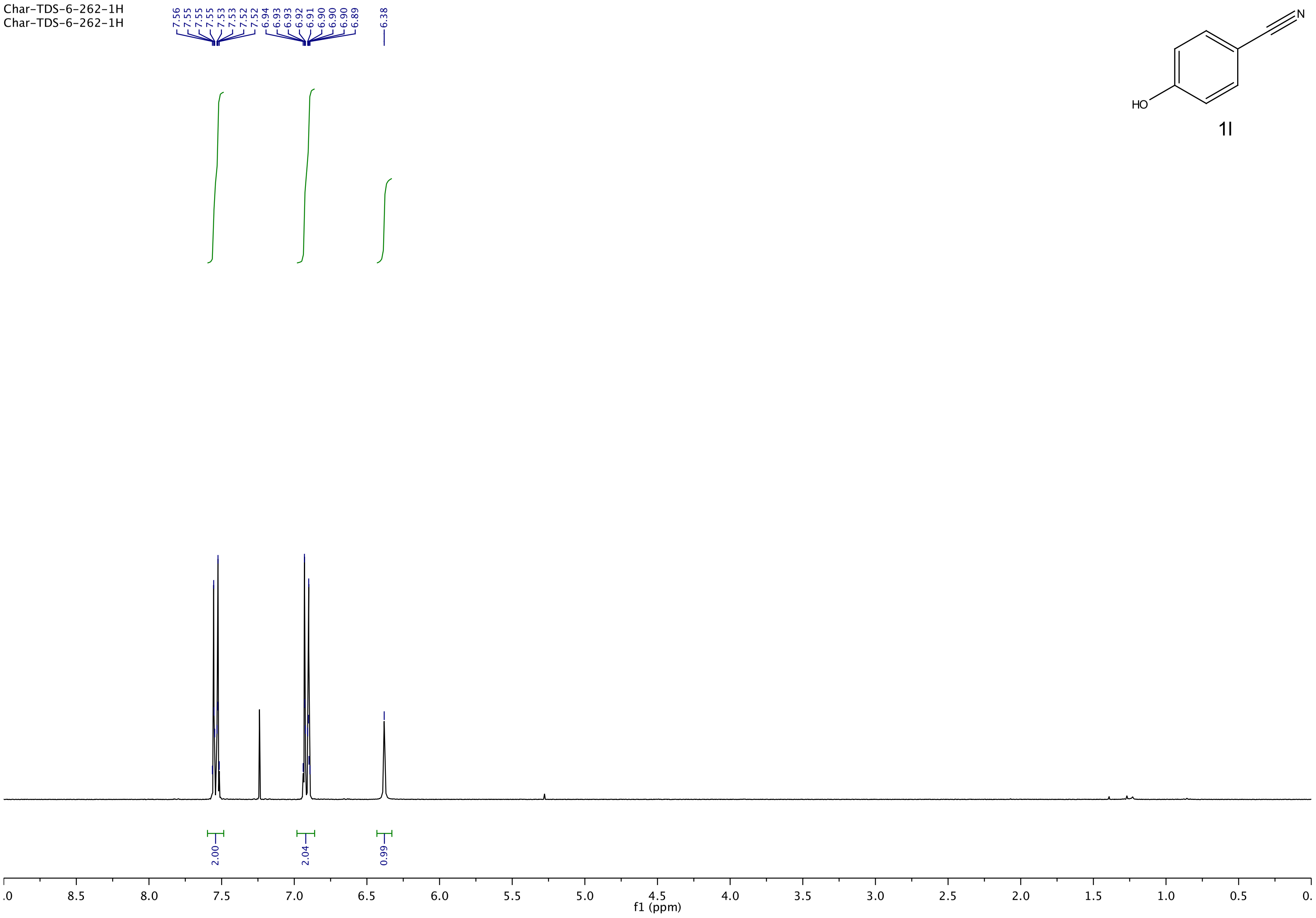


1i

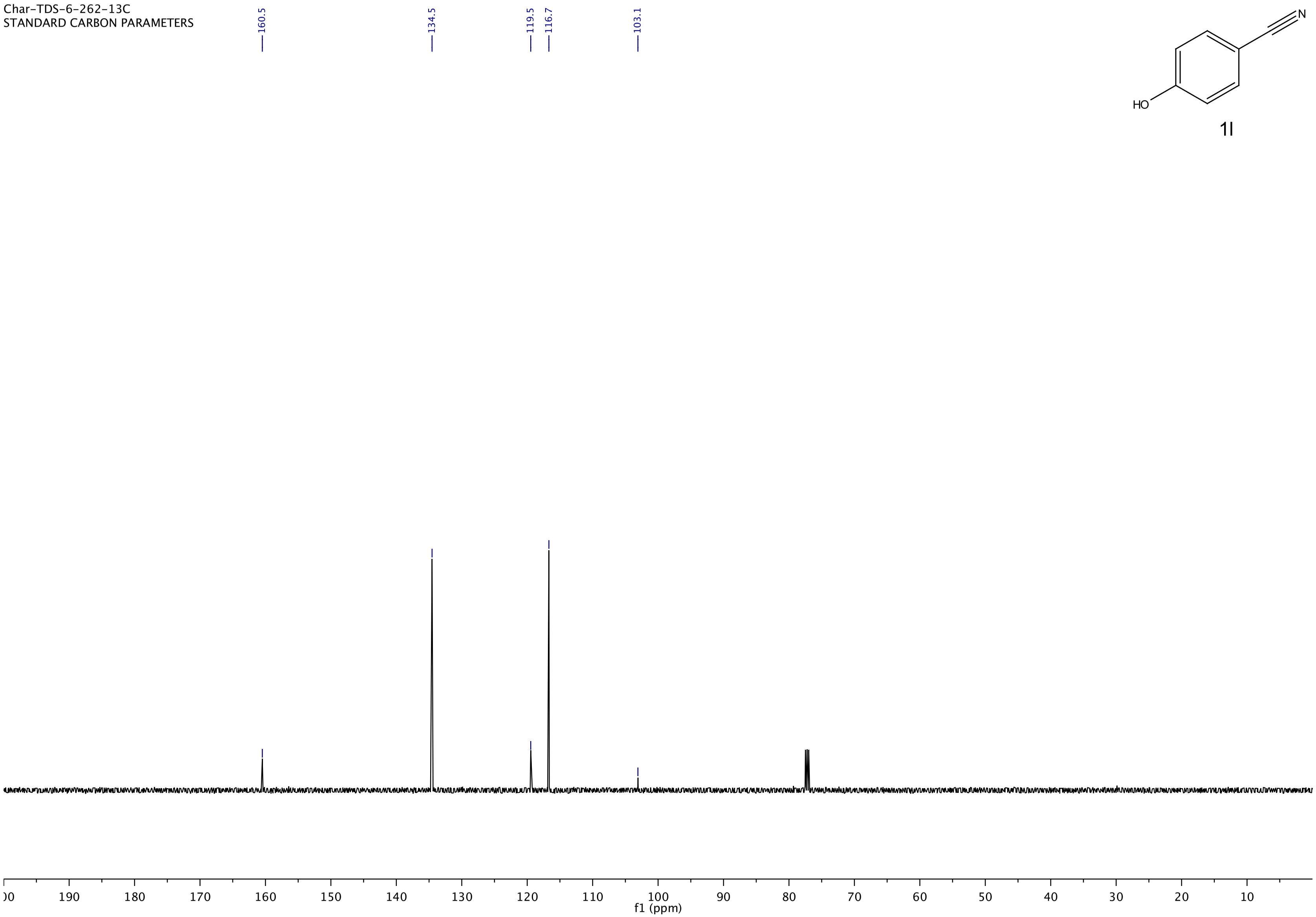

Char-TDS-6-157-1H
Char-TDS-6-157-1H
1j
HO
N
2.32
2.33
2.33
2.35
4.73
4.74
7.42
7.42
7.42
7.43
7.43
7.44
7.45
7.45
7.45
7.45
7.45
7.46
7.57
7.58
7.58
7.59
7.60
7.61
1.00
2.08
1.98
2.00
f1 (ppm)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0

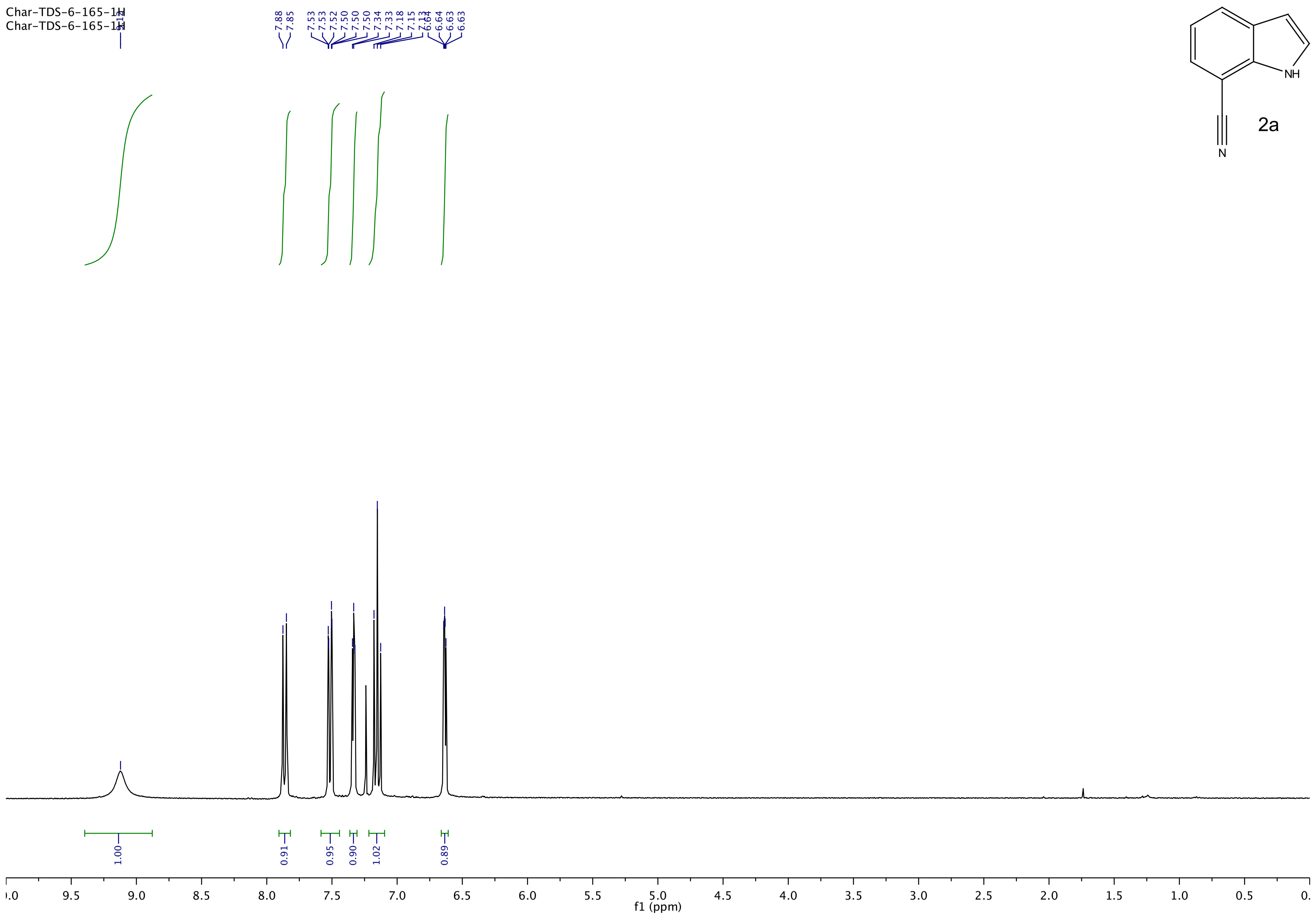

Char-TDS-6-157-13C
Char-TDS-6-157-13C
146.7
132.2
127.0
118.9
110.5
63.7
HO
N
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

1j

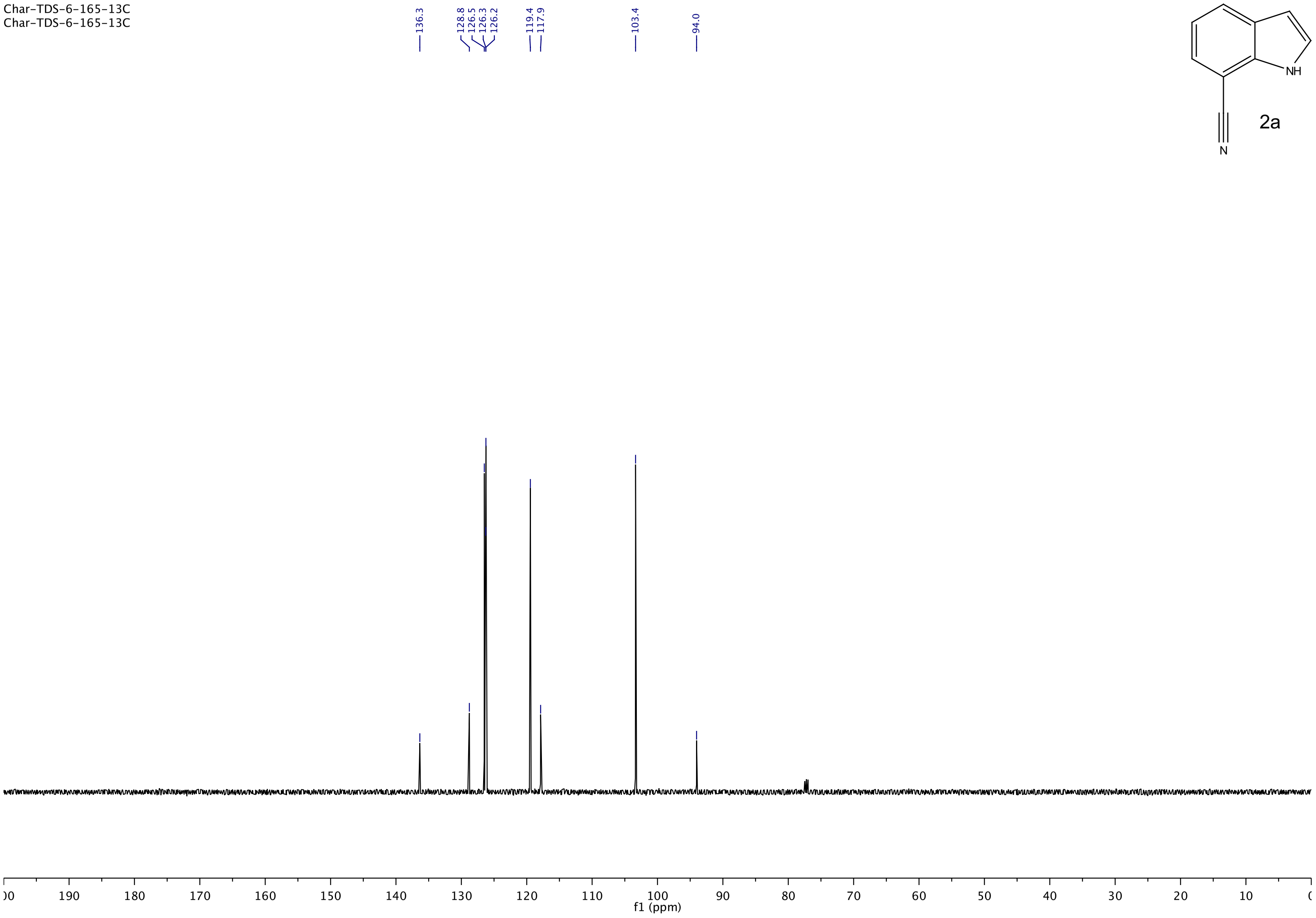

Char-TDS-6-262-1H
Char-TDS-6-262-1H
7.56
7.55
7.55
7.53
7.53
7.52
7.52
6.94
6.93
6.93
6.92
6.91
6.90
6.90
6.90
6.89
6.38
HO
N
2.00
2.04
0.99
.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.
f1 (ppm)

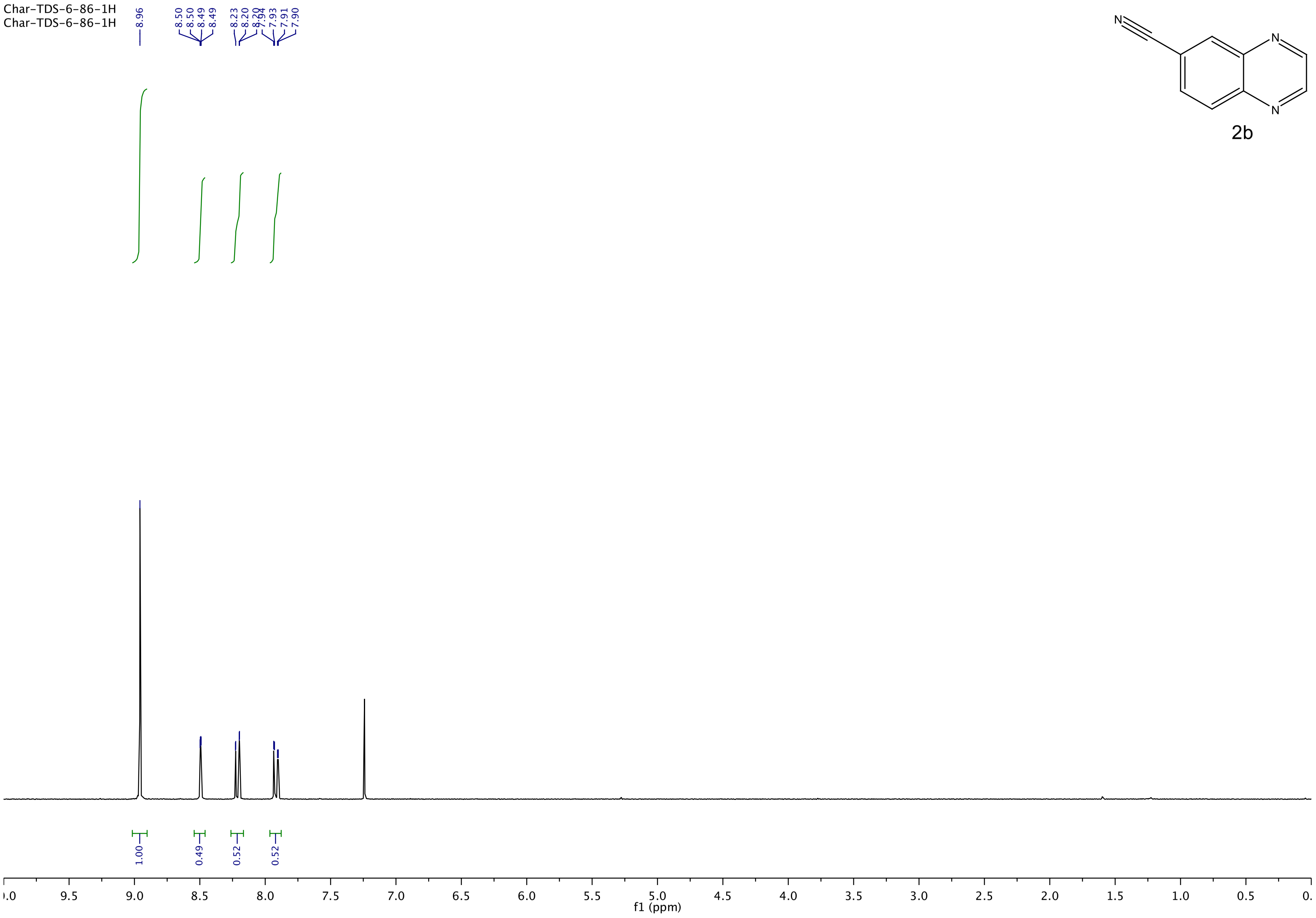
1l


Char-TDS-6-262-13C
STANDARD CARBON PARAMETERS
160.5
134.5
119.5
116.7
103.1
HO
N
1l
)0
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

Char-TDS-6-165-1H
Char-TDS-6-165-1H
9.12
7.88
7.85
7.53
7.53
7.52
7.50
7.50
7.50
7.34
7.33
7.18
7.15
7.13
6.64
6.64
6.63
6.63
NH
N
1.00
0.91
0.95
0.90
1.02
0.89
10.0
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
f1 (ppm)

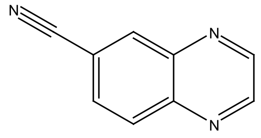
2a


Char-TDS-6-165-13C
Char-TDS-6-165-13C
136.3
128.8
126.5
126.3
126.2
119.4
117.9
103.4
94.0
NH
N
2a
f1 (ppm)
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10

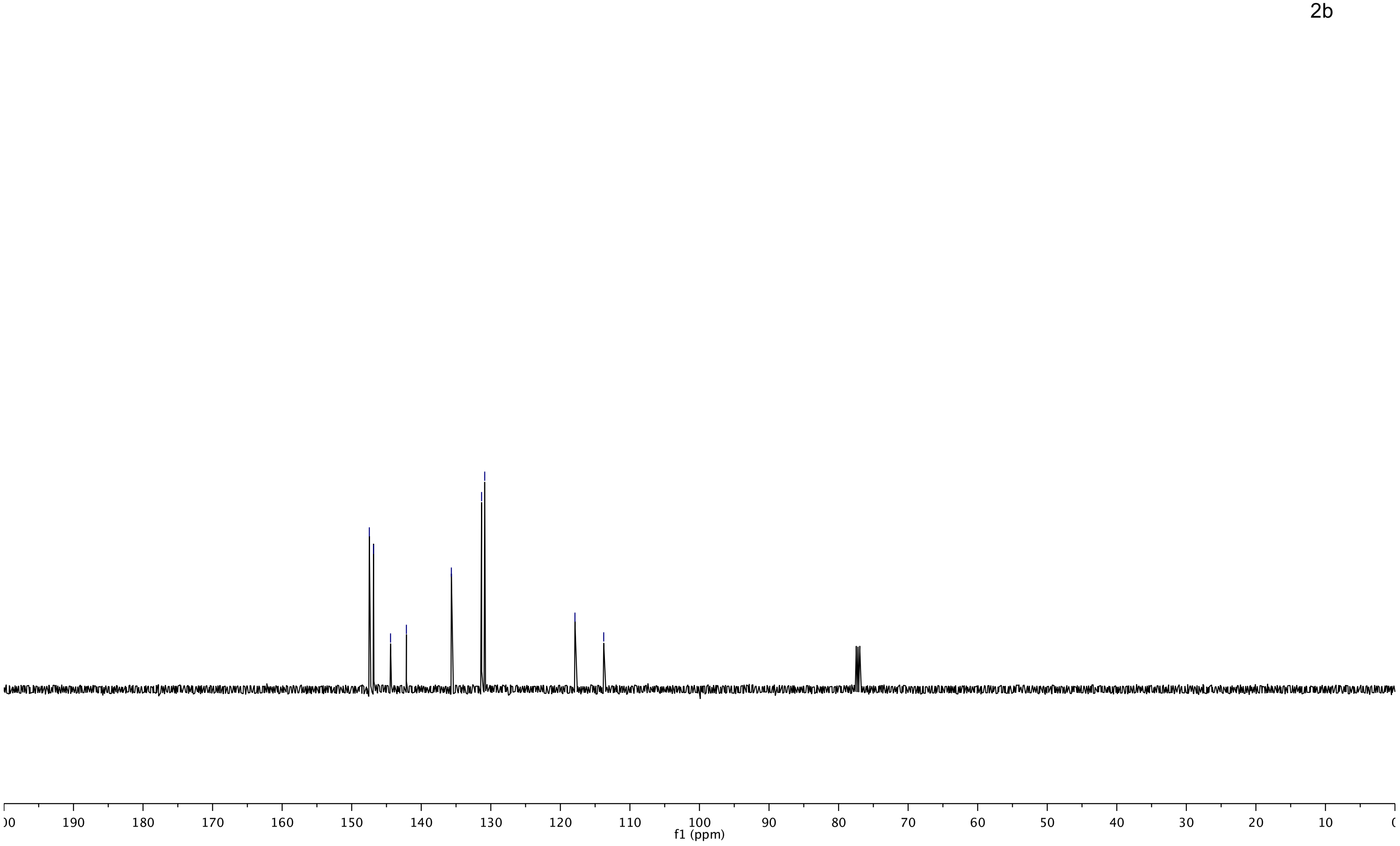

Char-TDS-6-86-1H
Char-TDS-6-86-1H
8.96
8.50
8.50
8.49
8.49
8.23
8.20
8.20
7.94
7.93
7.91
7.90
1.00
0.49
0.52
0.52
N
N
N
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.
f1 (ppm)

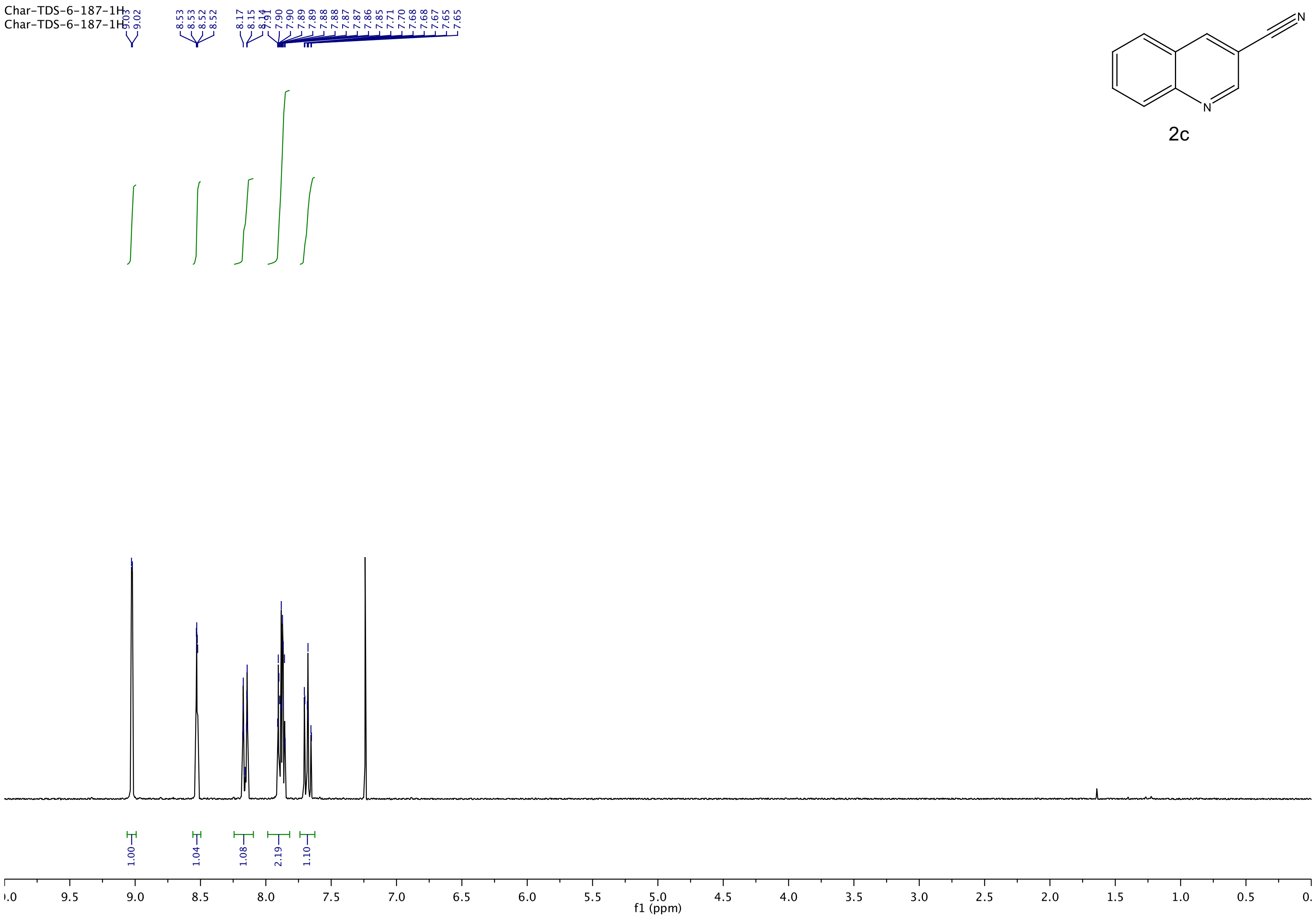
2b

Char-TDS-6-86-1-13C
Char-TDS-6-86-1-13C



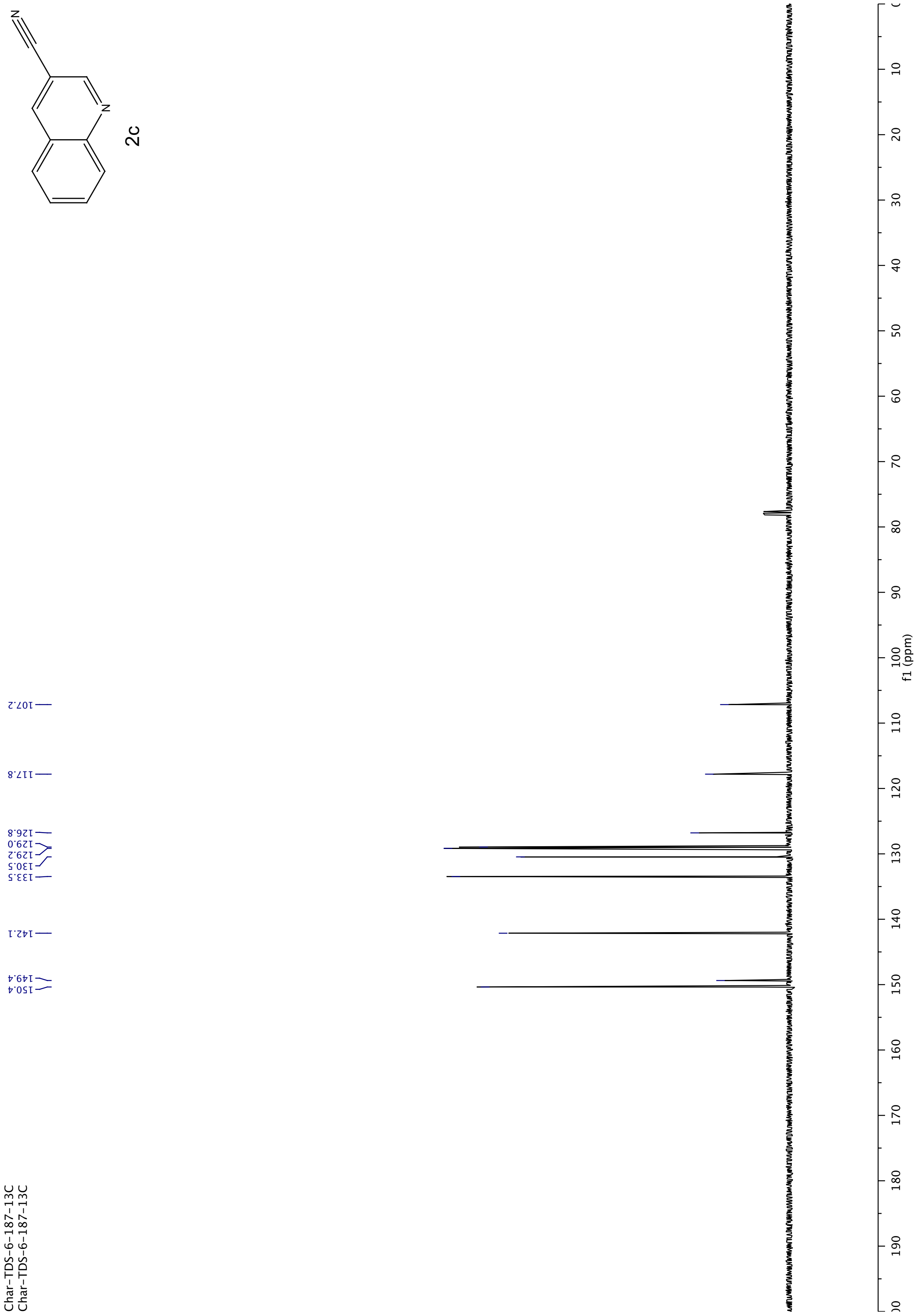
2b

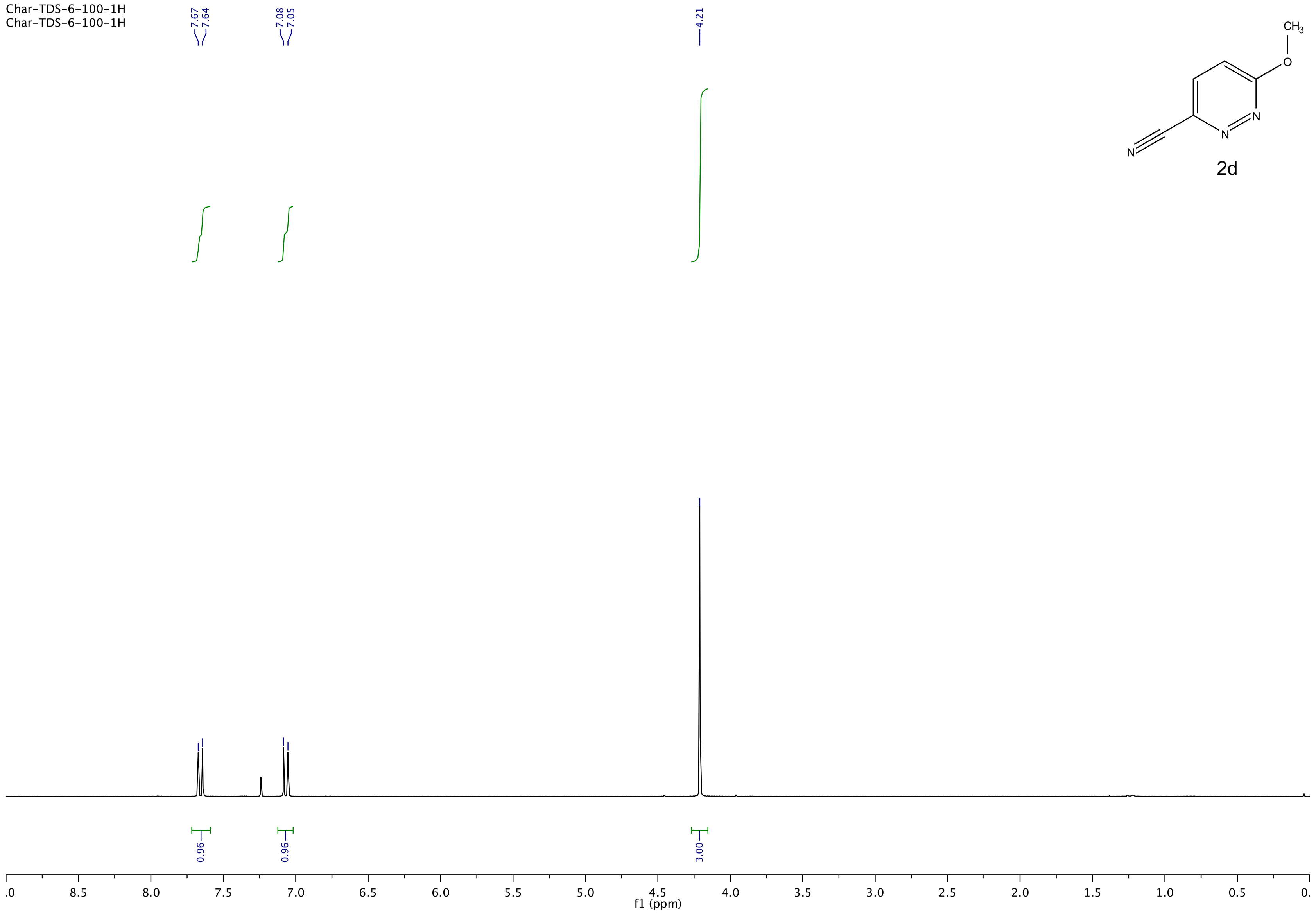


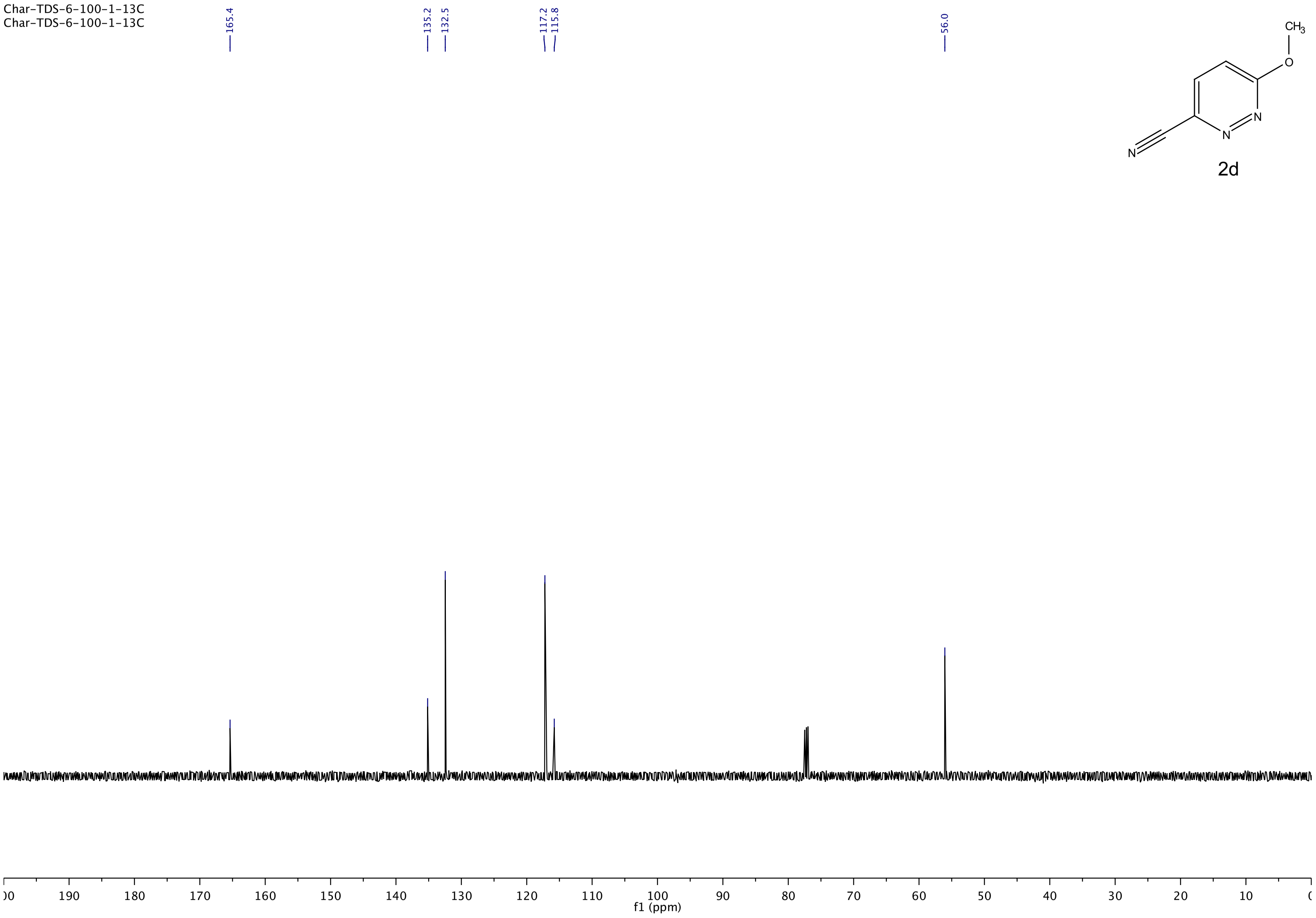

Char-TDS-6-187-1H
Char-TDS-6-187-1H
9.03
9.02
8.53
8.53
8.52
8.52
8.17
8.15
8.14
7.91
7.90
7.90
7.89
7.89
7.88
7.88
7.87
7.87
7.86
7.85
7.71
7.70
7.68
7.68
7.67
7.65
7.65
1.00
1.04
1.08
2.19
1.10
.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.
f1 (ppm)

N
N

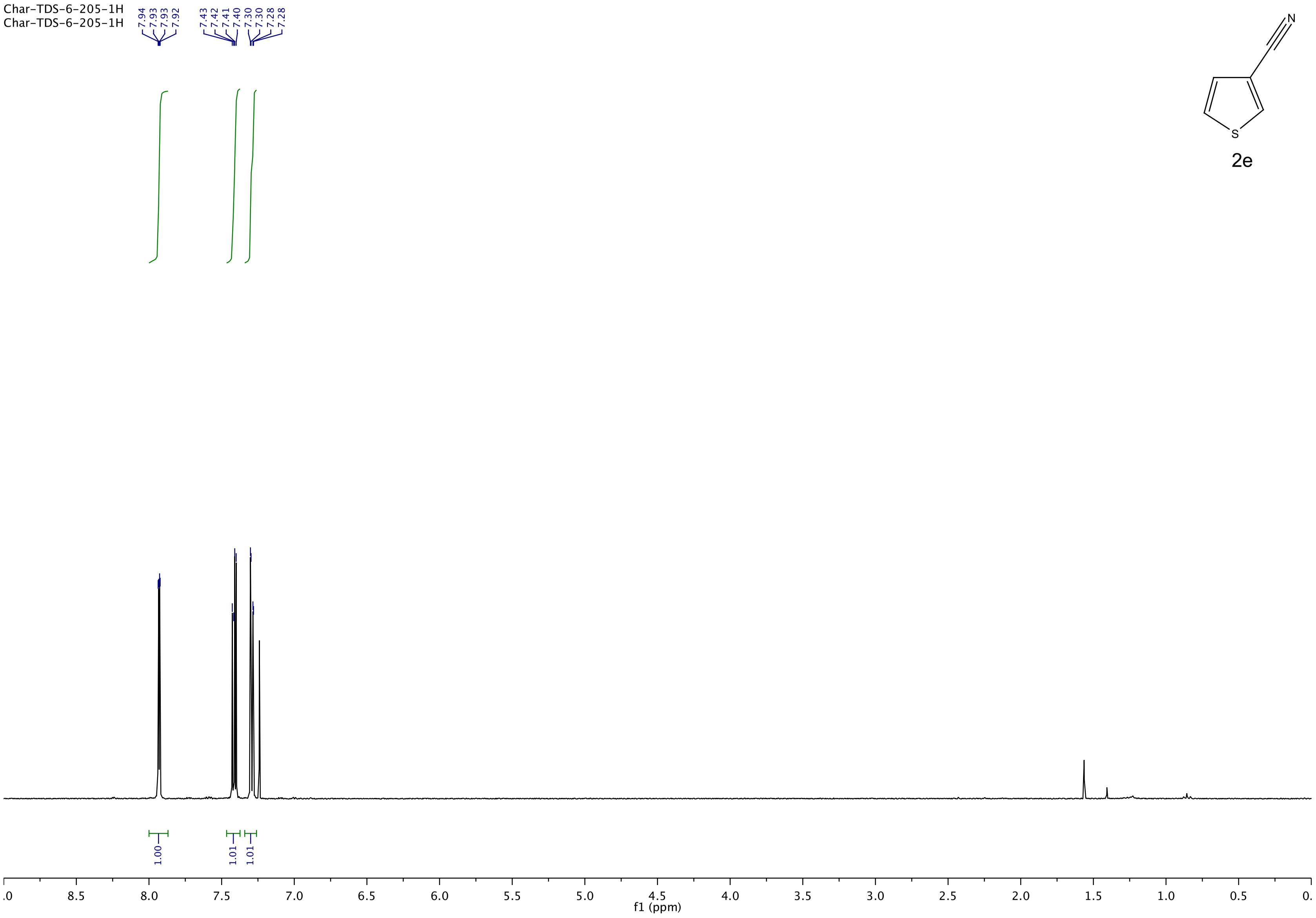
2c


2c
Char-TDS-6-187-13C
Char-TDS-6-187-13C
150.4
149.4
142.1
133.5
130.5
129.2
129.0
126.8
117.8
107.2
N
N
f1 (ppm)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200

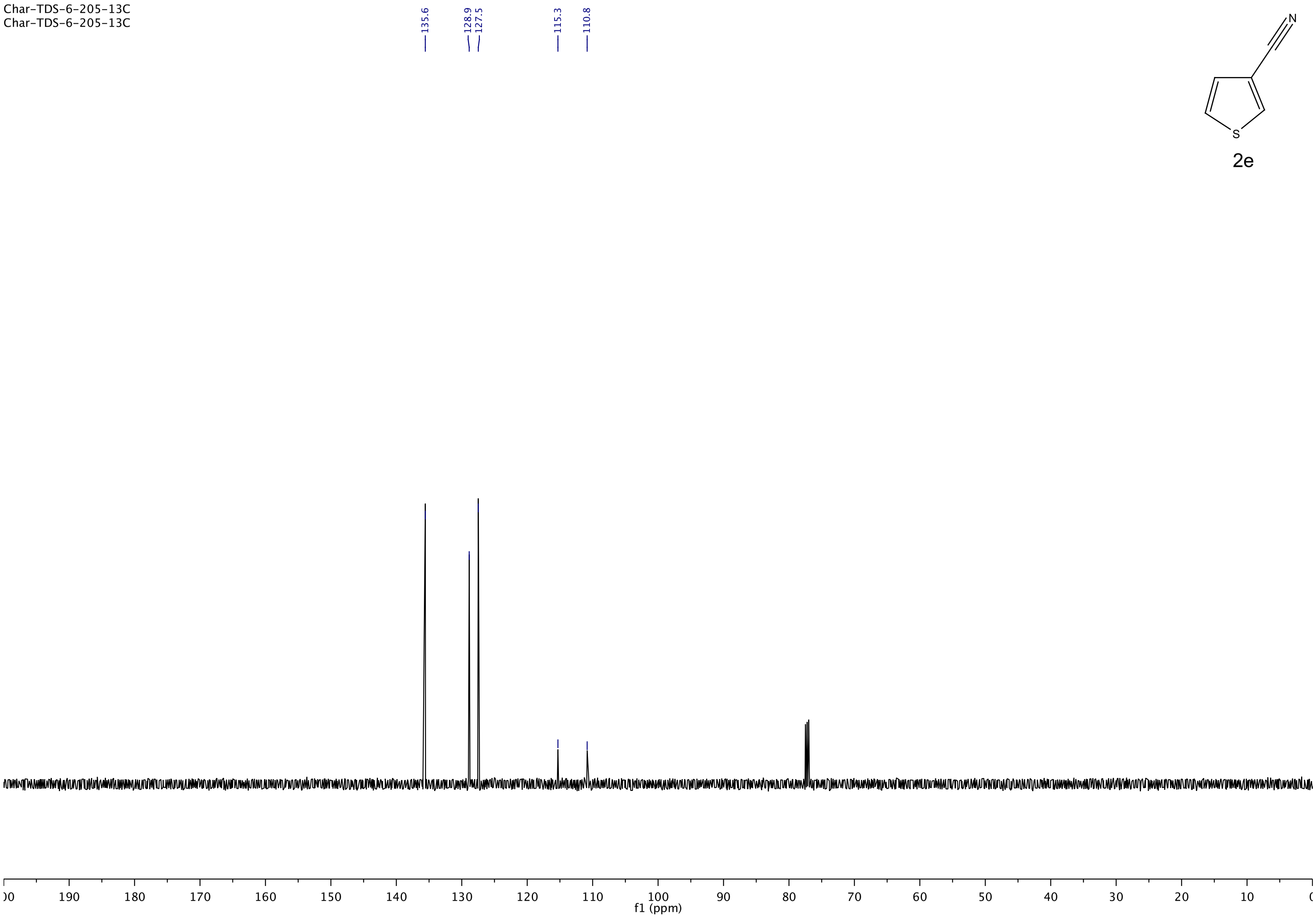

Char-TDS-6-100-1H
Char-TDS-6-100-1H
7.67
7.64
7.08
7.05
4.21
CH3
O
N
N
N
2d
0.96
0.96
3.00
.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.
f1 (ppm)

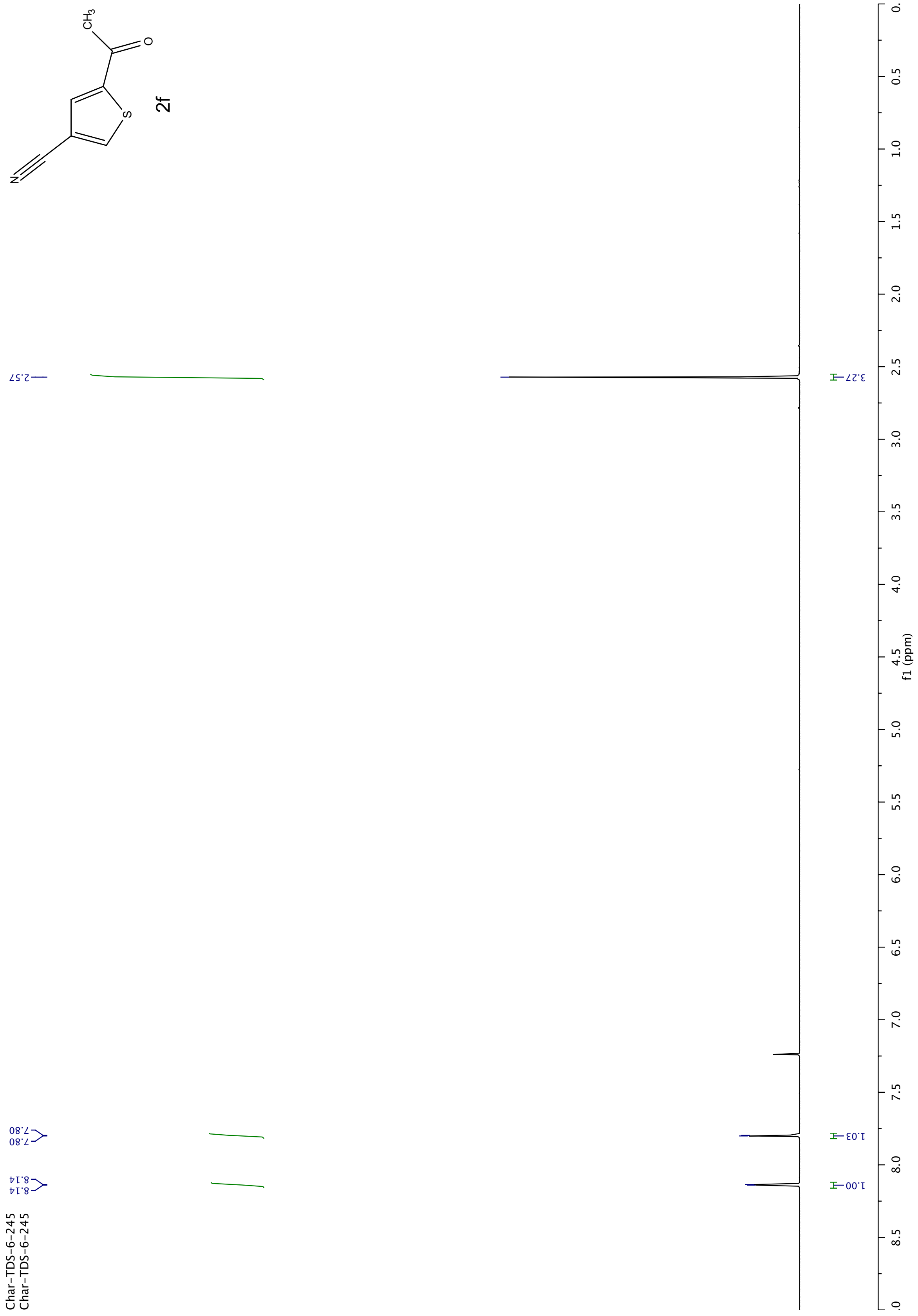

Char-TDS-6-100-1-13C
Char-TDS-6-100-1-13C
165.4
135.2
132.5
117.2
115.8
56.0
CH3
O
N
N
N
f1 (ppm)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

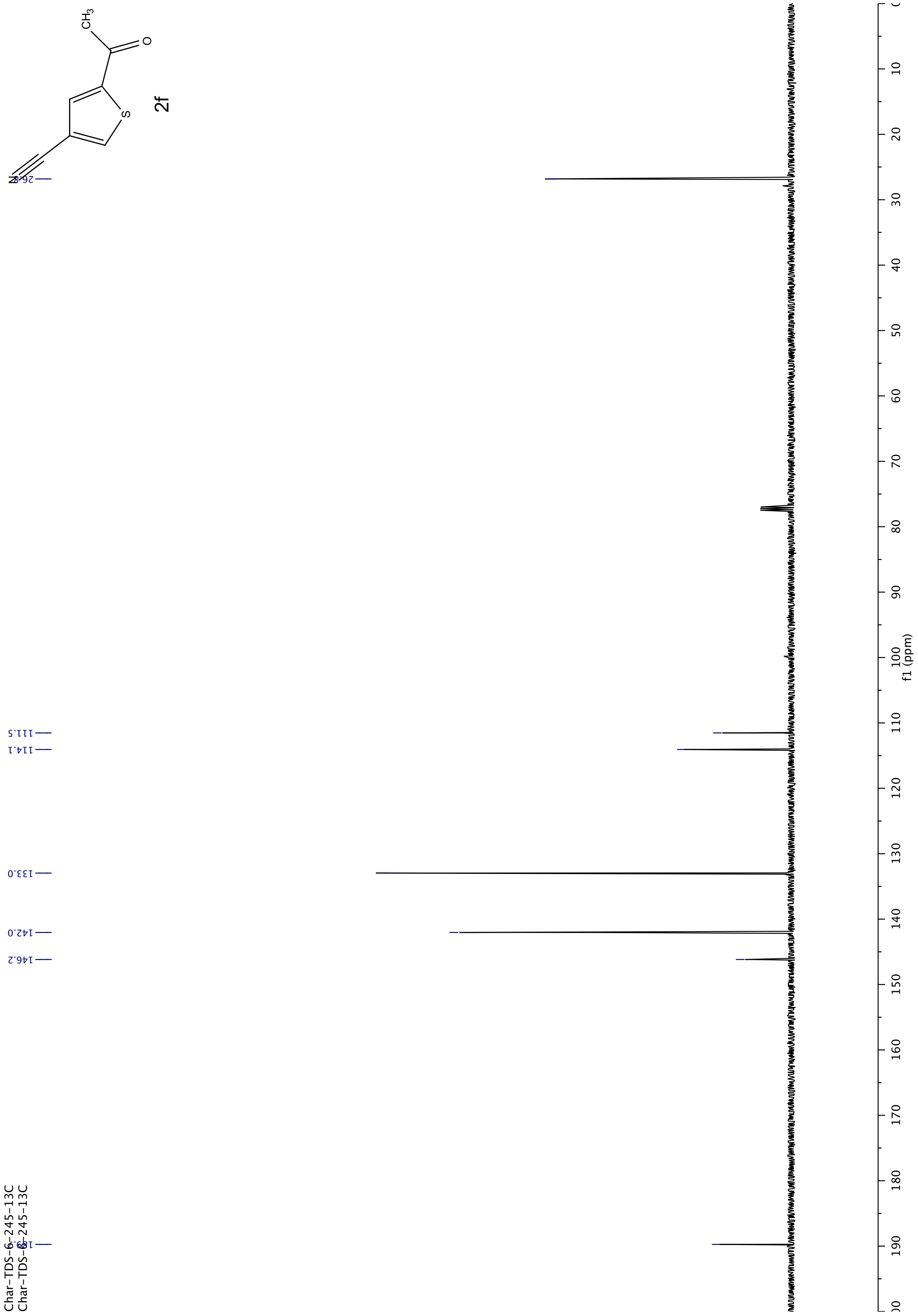
2d

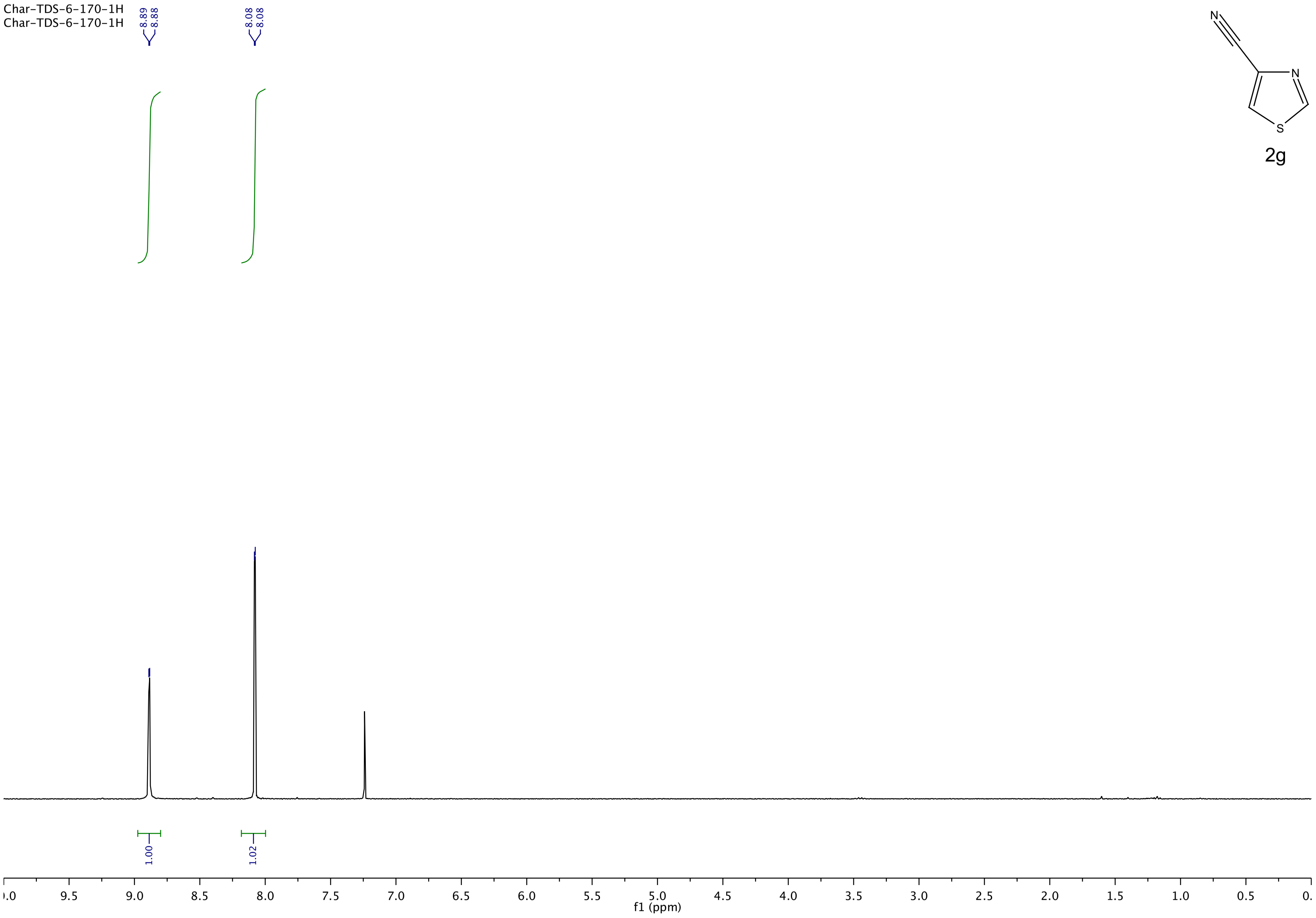

2e

Char-TDS-6-205-1H
Char-TDS-6-205-1H
7.94
7.93
7.93
7.92
7.43
7.42
7.41
7.40
7.30
7.30
7.28
7.28
S
N
1.00
1.01
1.01
.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.
f1 (ppm)


Char-TDS-6-205-13C
Char-TDS-6-205-13C
135.6
128.9
127.5
115.3
110.8
N
S
2e
00
190
180
170
160
150
140
130
120
110
100
f1 (ppm)
90
80
70
60
50
40
30
20
10
0

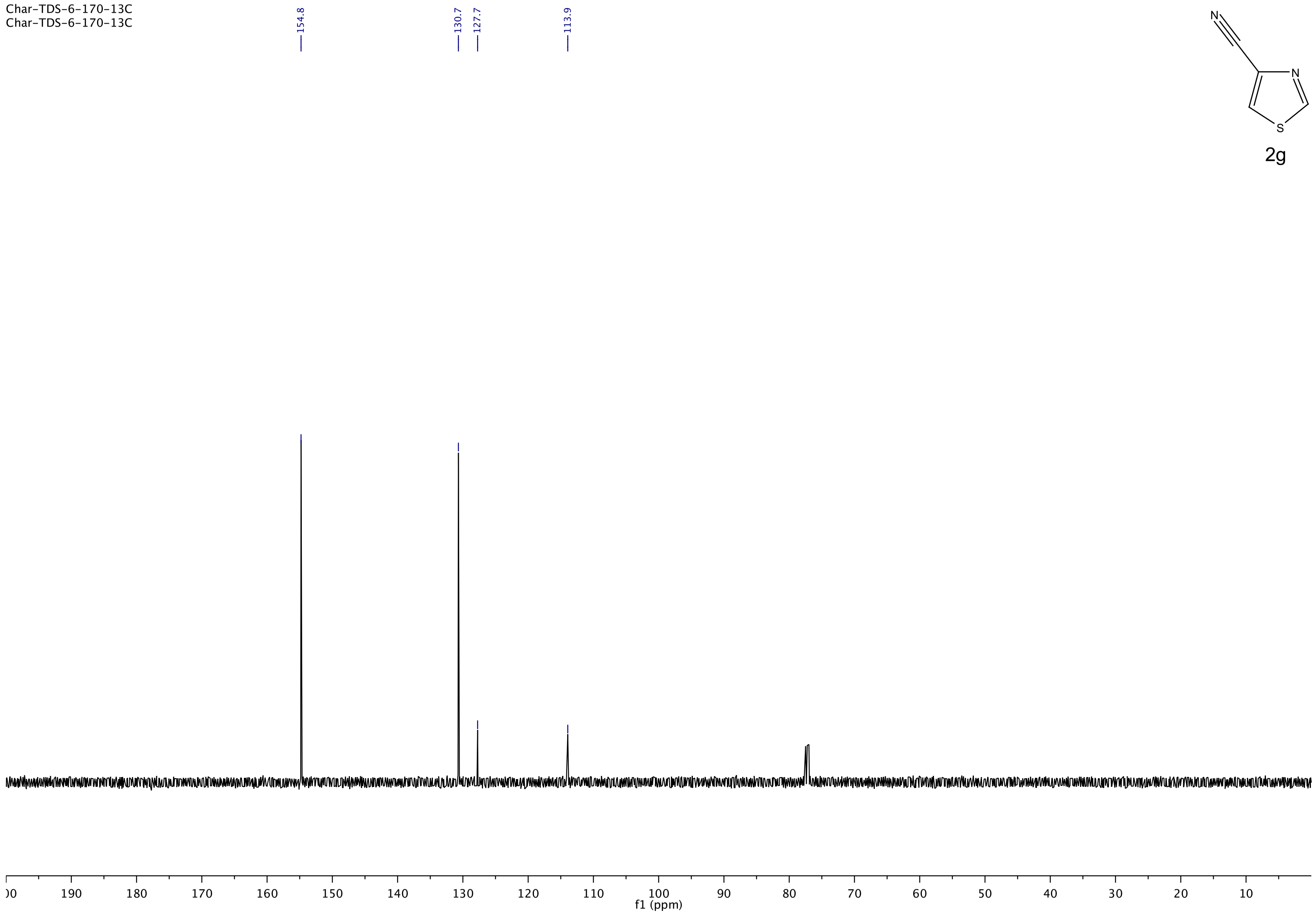

Char-TDS-6-245
Char-TDS-6-245
2f
CH3
O
S
N
2.57
7.80
7.80
8.14
8.14
3.27
1.03
1.00
f1 (ppm)
0.
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
.0


Char-TDS-6-245-13C
Char-TDS-6-245-13C
2f
CH$_3$
O
S
N
26.8
111.5
114.1
133.0
142.0
146.2
189.7
f1 (ppm)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200

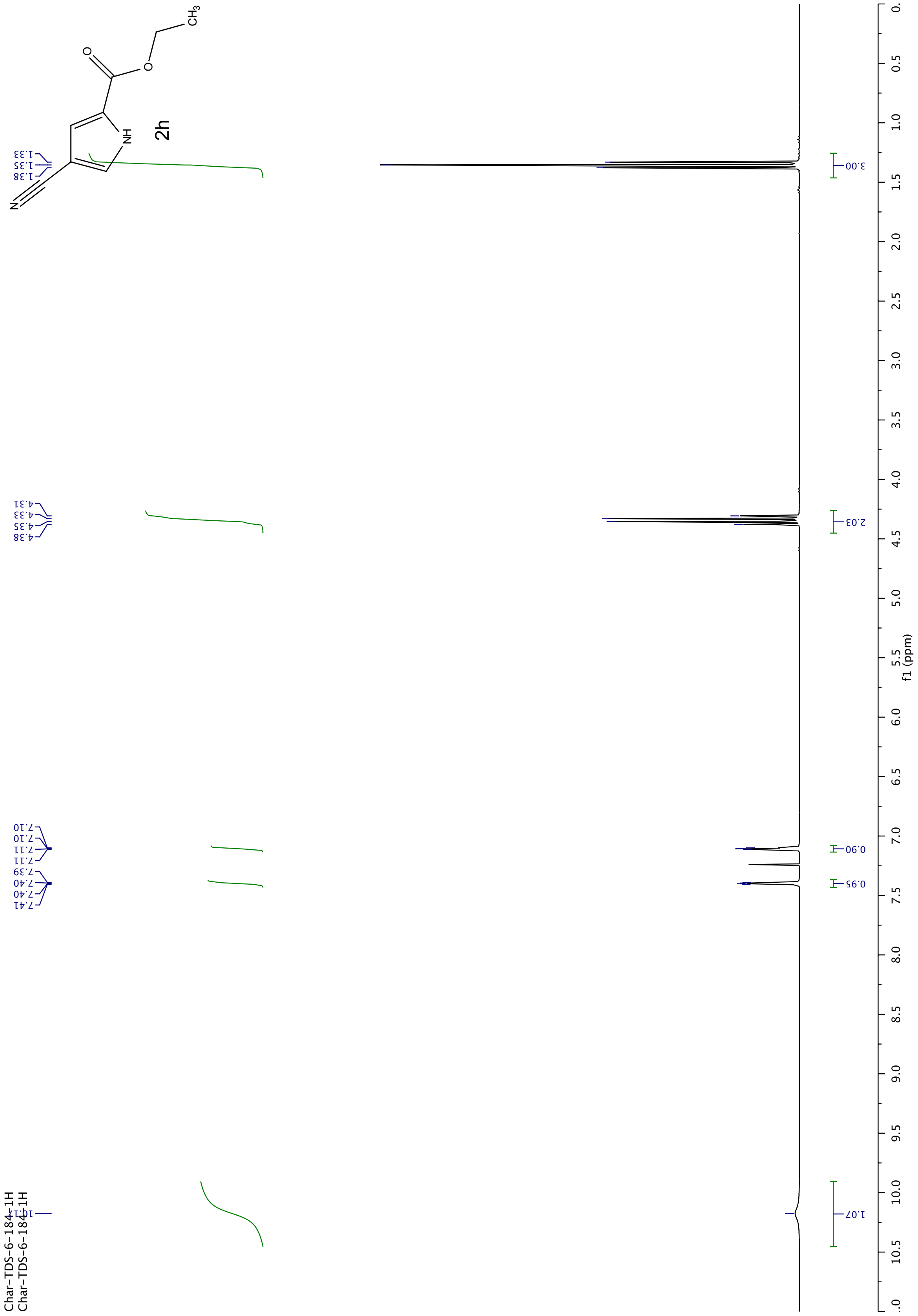


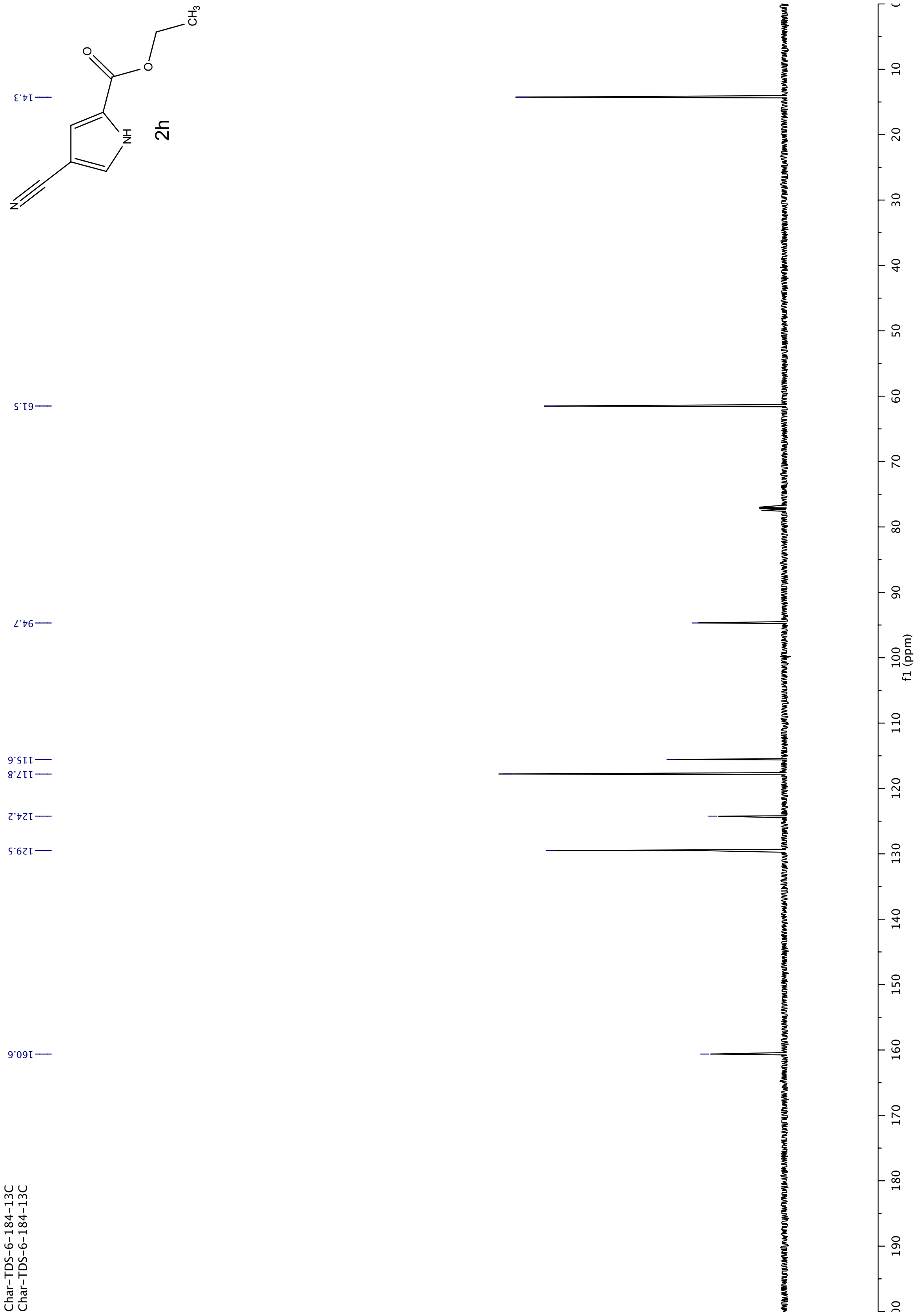
2g

Char-TDS-6-170-1H
Char-TDS-6-170-1H
8.89
8.88
8.08
8.08
N
N
S
1.00
1.02
10.0
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.
f1 (ppm)


Char-TDS-6-170-13C
Char-TDS-6-170-13C
154.8
130.7
127.7
113.9
N
N
S
00
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

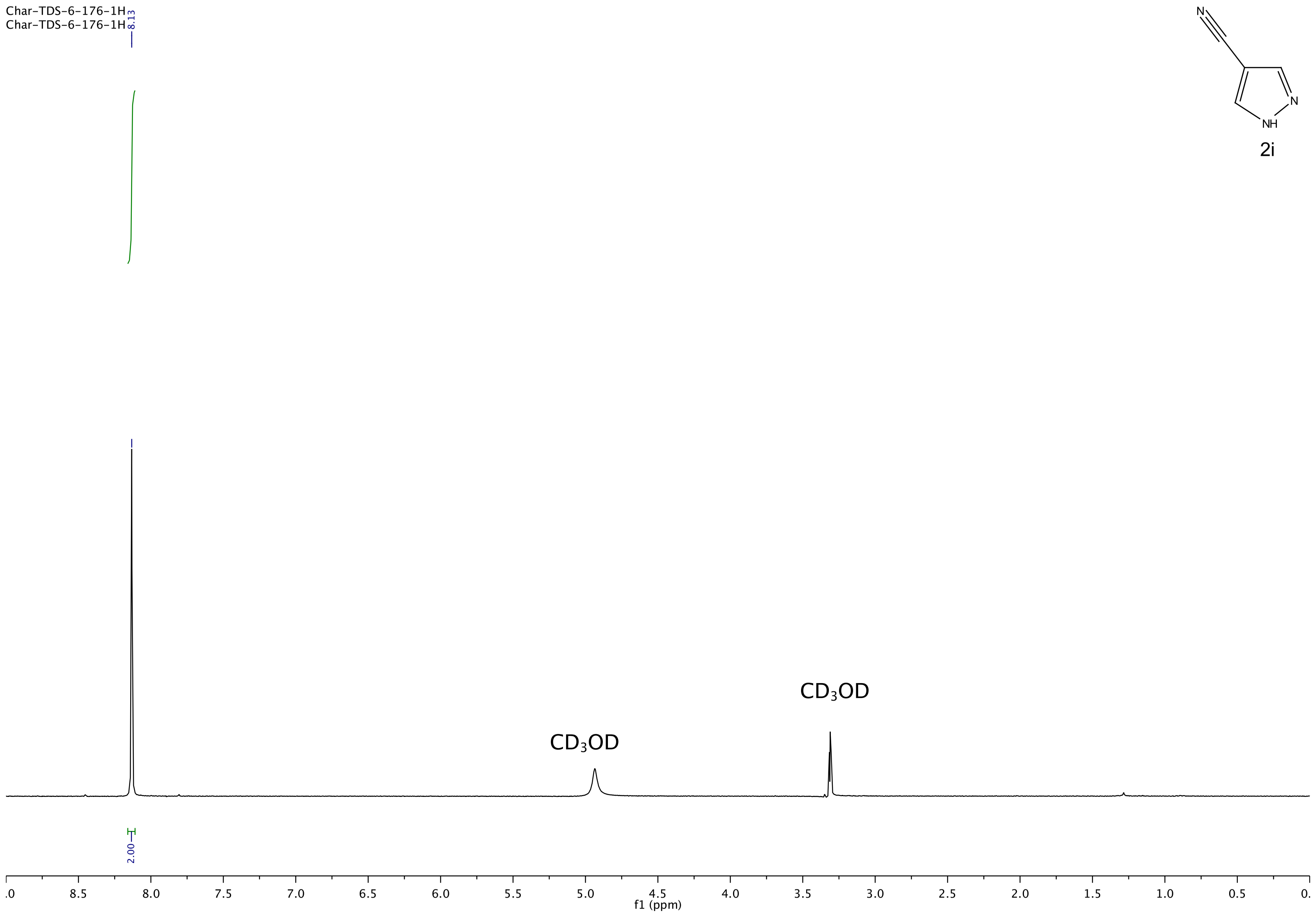
2g

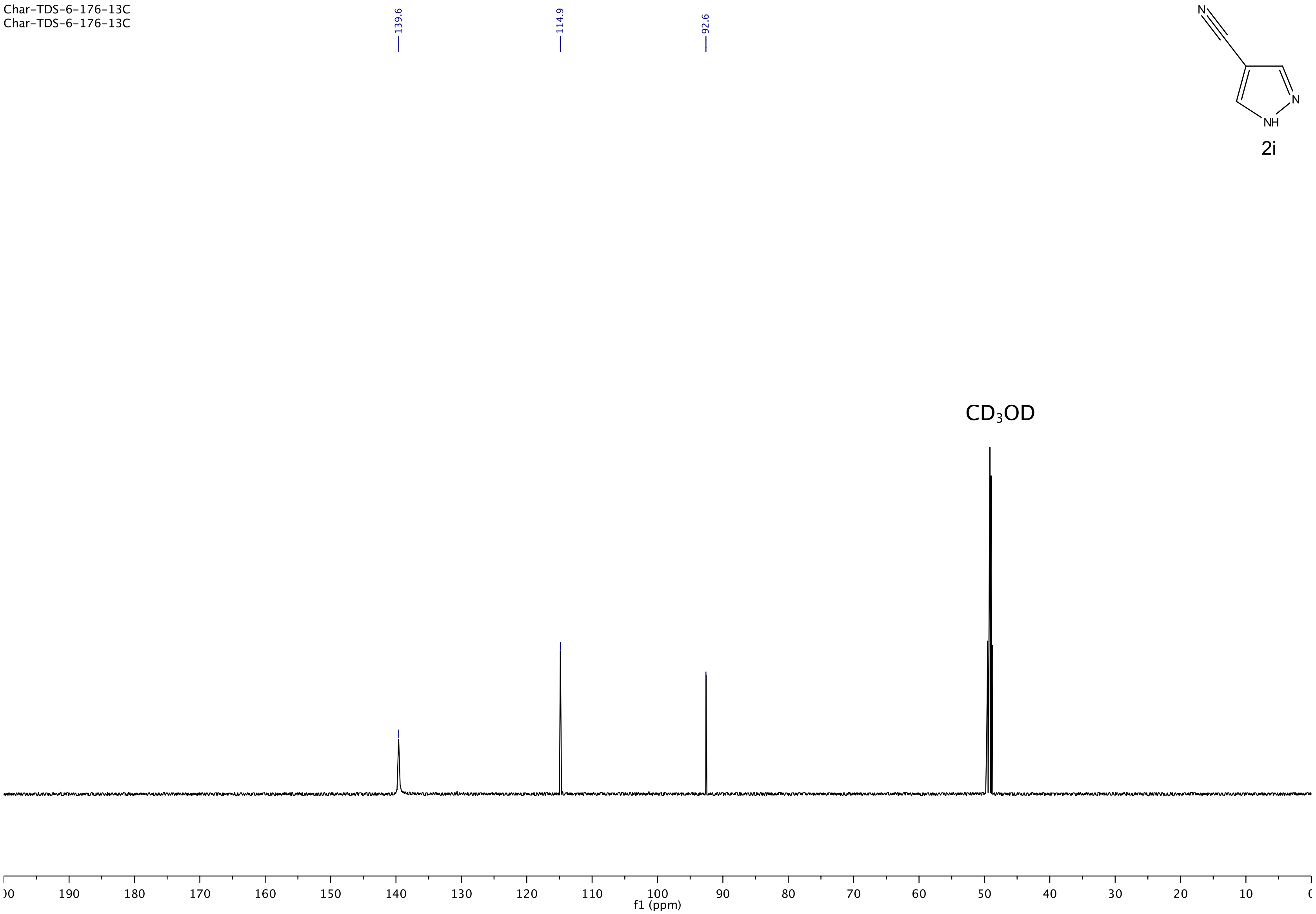

Char-TDS-6-184-1H
Char-TDS-6-184-1H
10.11
7.41
7.40
7.40
7.39
7.11
7.11
7.10
7.10
4.38
4.35
4.33
4.31
1.38
1.35
1.33
2h
NH
N
O
O
CH3
1.07
0.95
0.90
2.03
3.00
f1 (ppm)
0.
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
10.5
.0

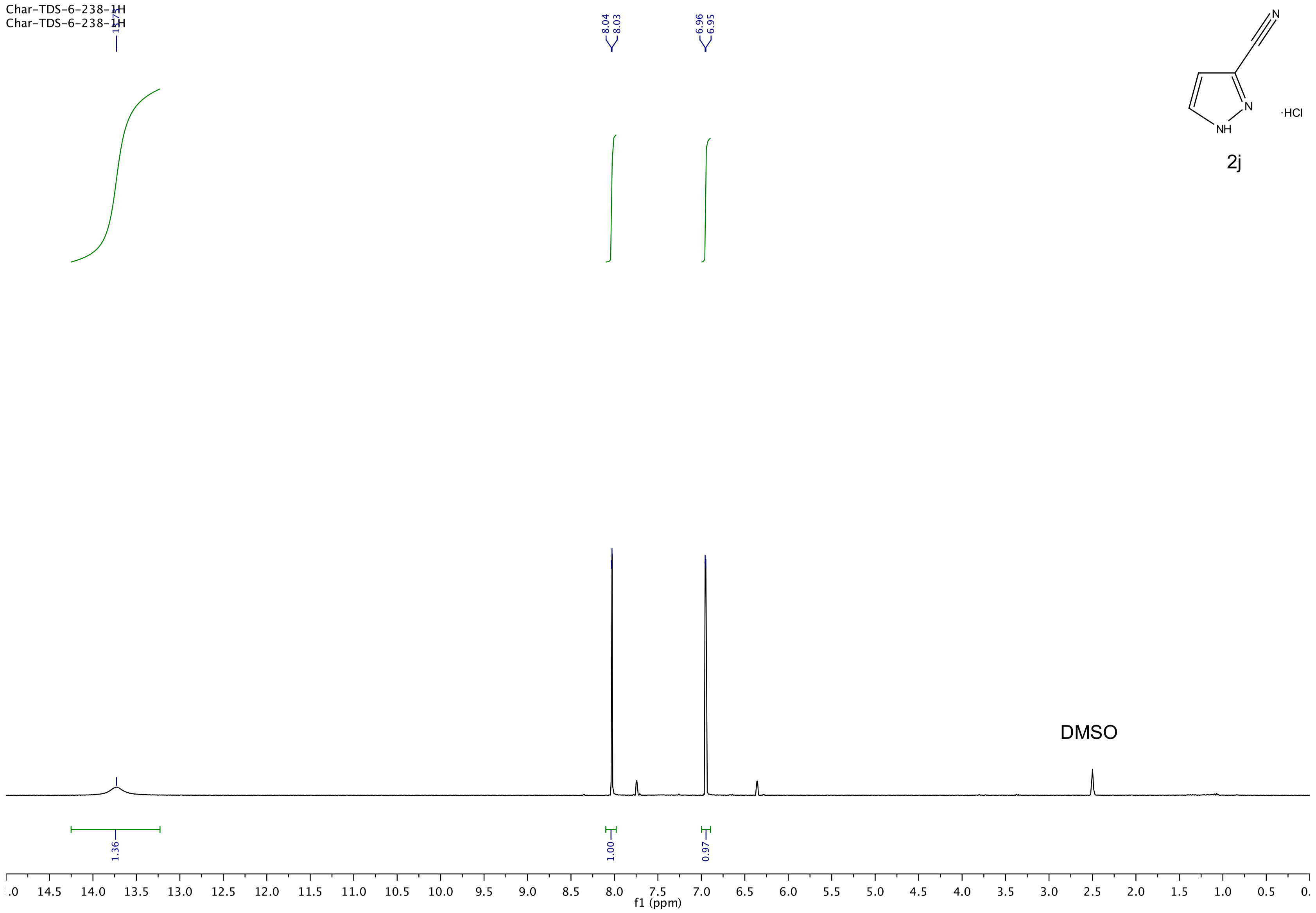


2h

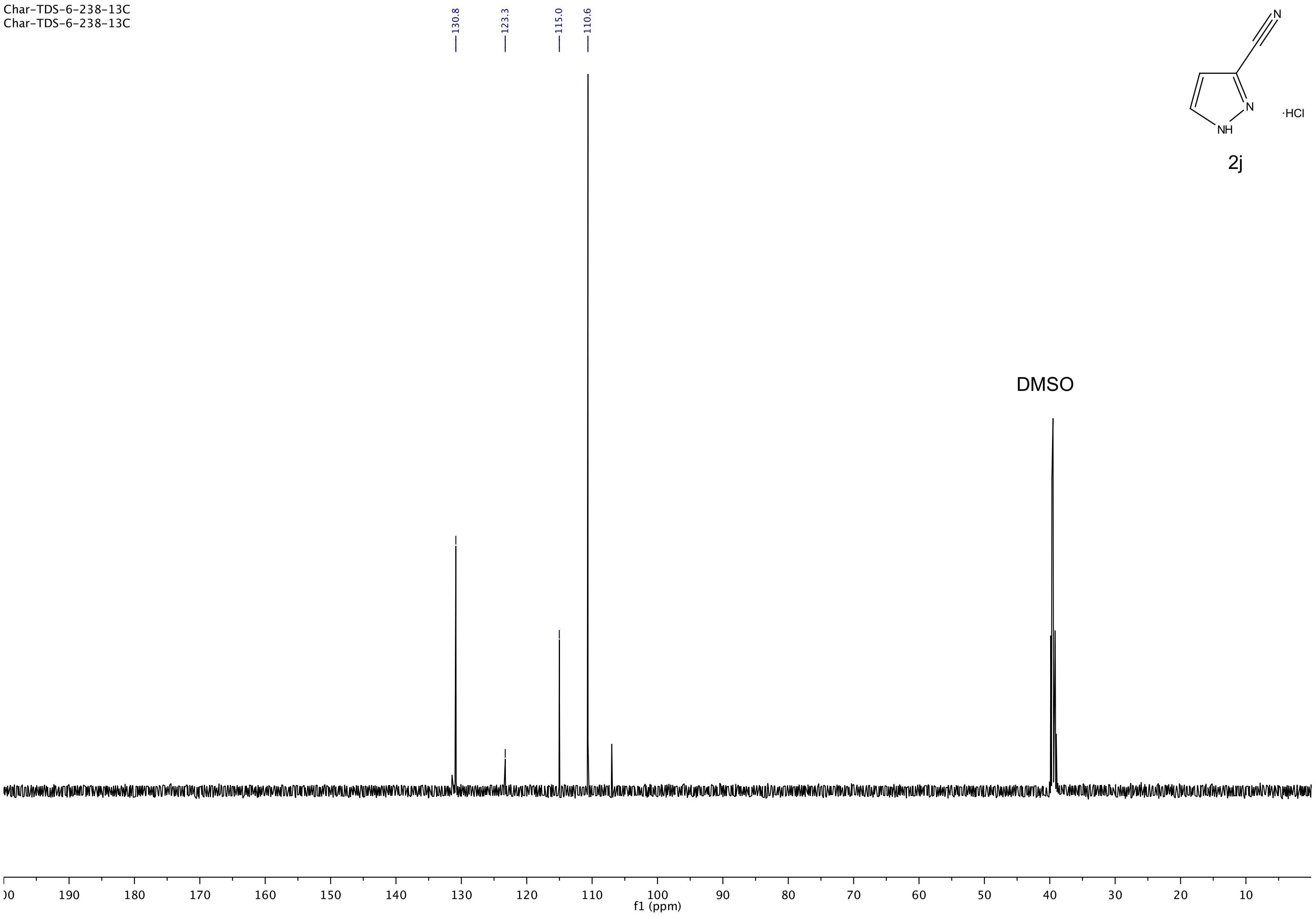
Char-TDS-6-184-13C
Char-TDS-6-184-13C
14.3
61.5
94.7
115.6
117.8
124.2
129.5
160.6
N
NH
O
O
CH3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
f1 (ppm)

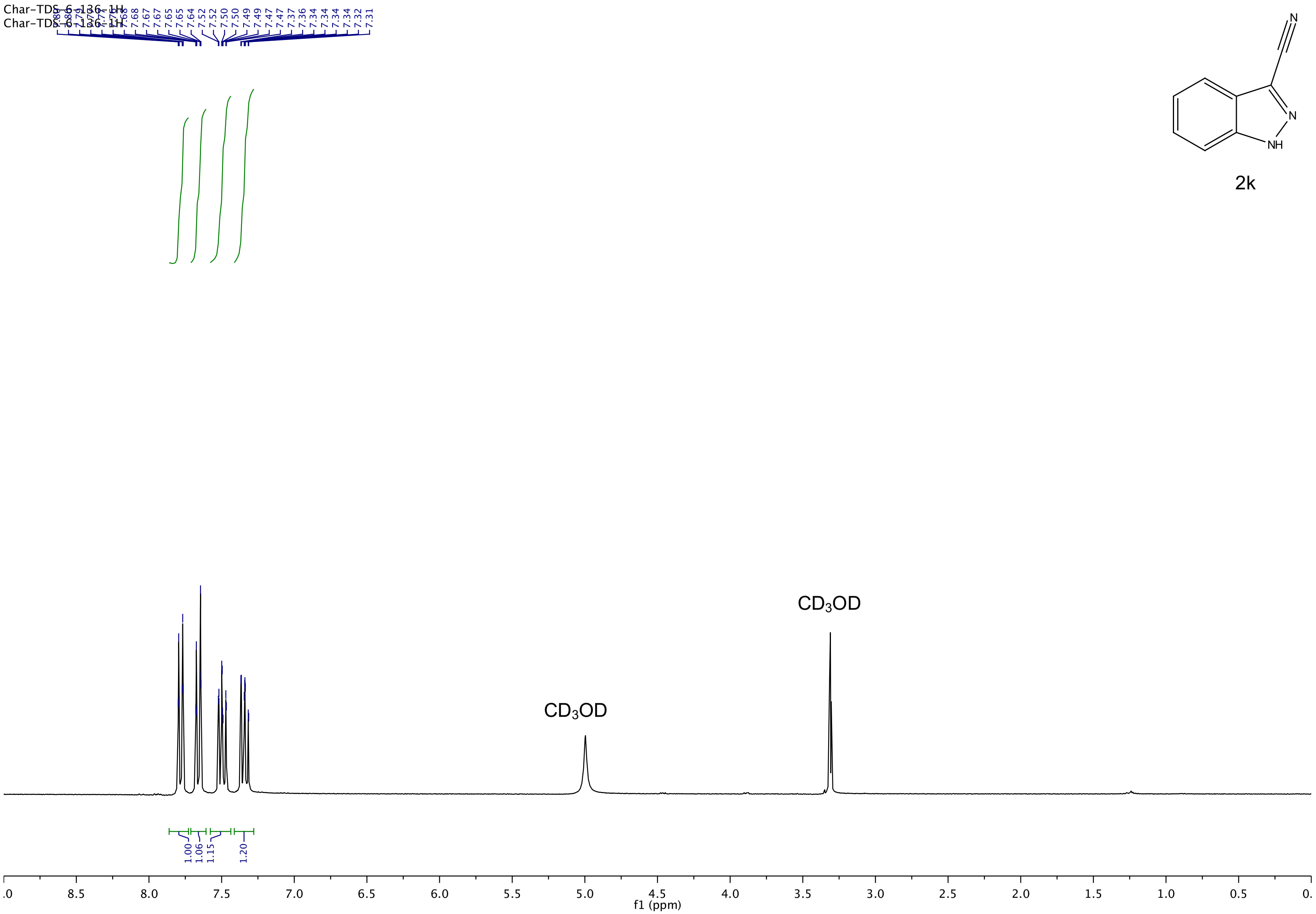

Char-TDS-6-176-1H
Char-TDS-6-176-1H
8.13
2.00
CD3OD
CD3OD
N
N
NH
2i
.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.
f1 (ppm)

Char-TDS-6-176-13C
Char-TDS-6-176-13C
139.6
114.9
92.6
N
N
NH
2i
CD3OD
f1 (ppm)
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10


2j

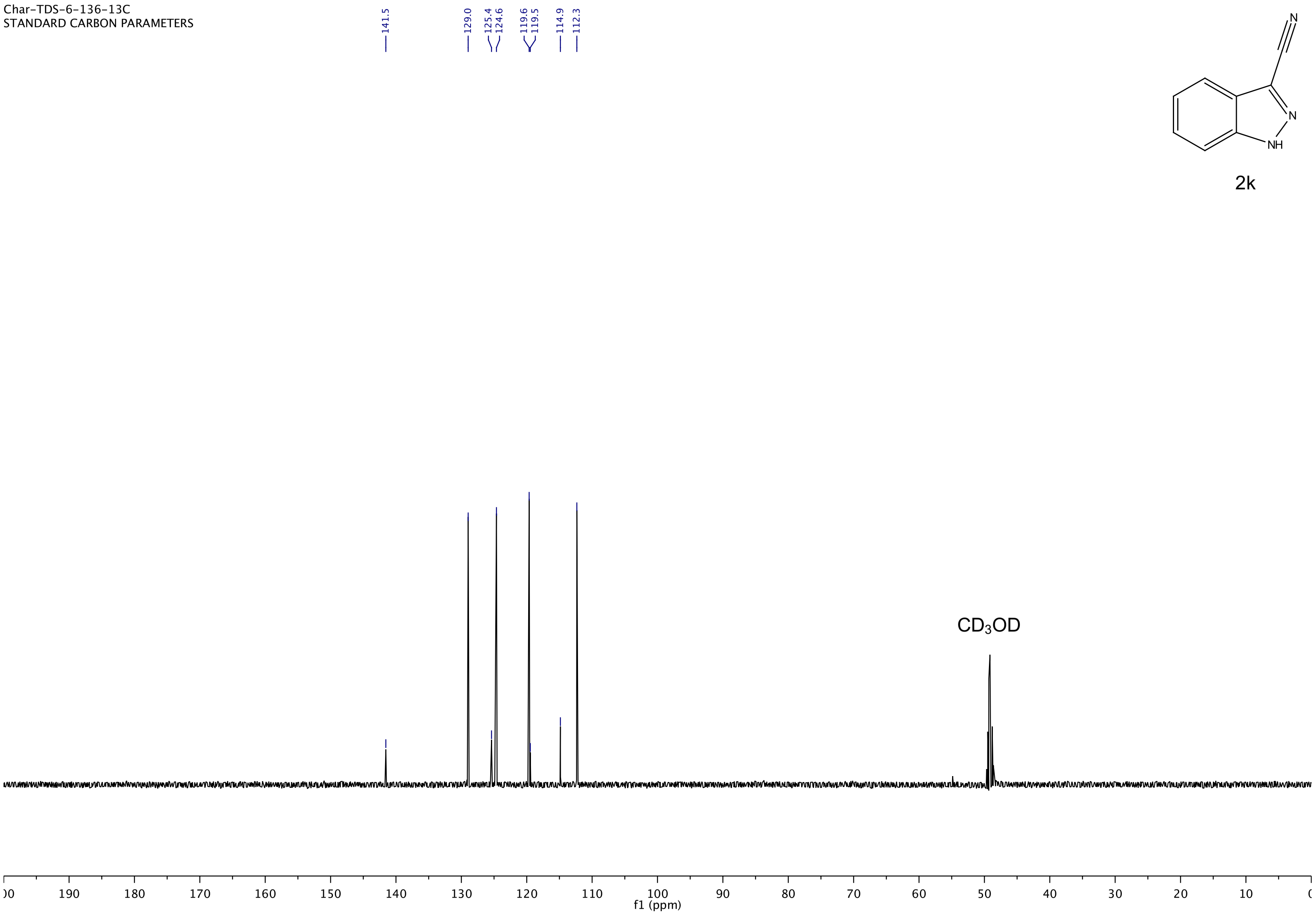
Char-TDS-6-238-1H
Char-TDS-6-238-1H
8.04
8.03
6.96
6.95
N
N
NH
·HCl
DMSO
1.36
1.00
0.97
14.5
14.0
13.5
13.0
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


Char-TDS-6-238-13C
Char-TDS-6-238-13C
130.8
123.3
115.0
110.6
DMSO
N
N
NH
·HCl
2j
00
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

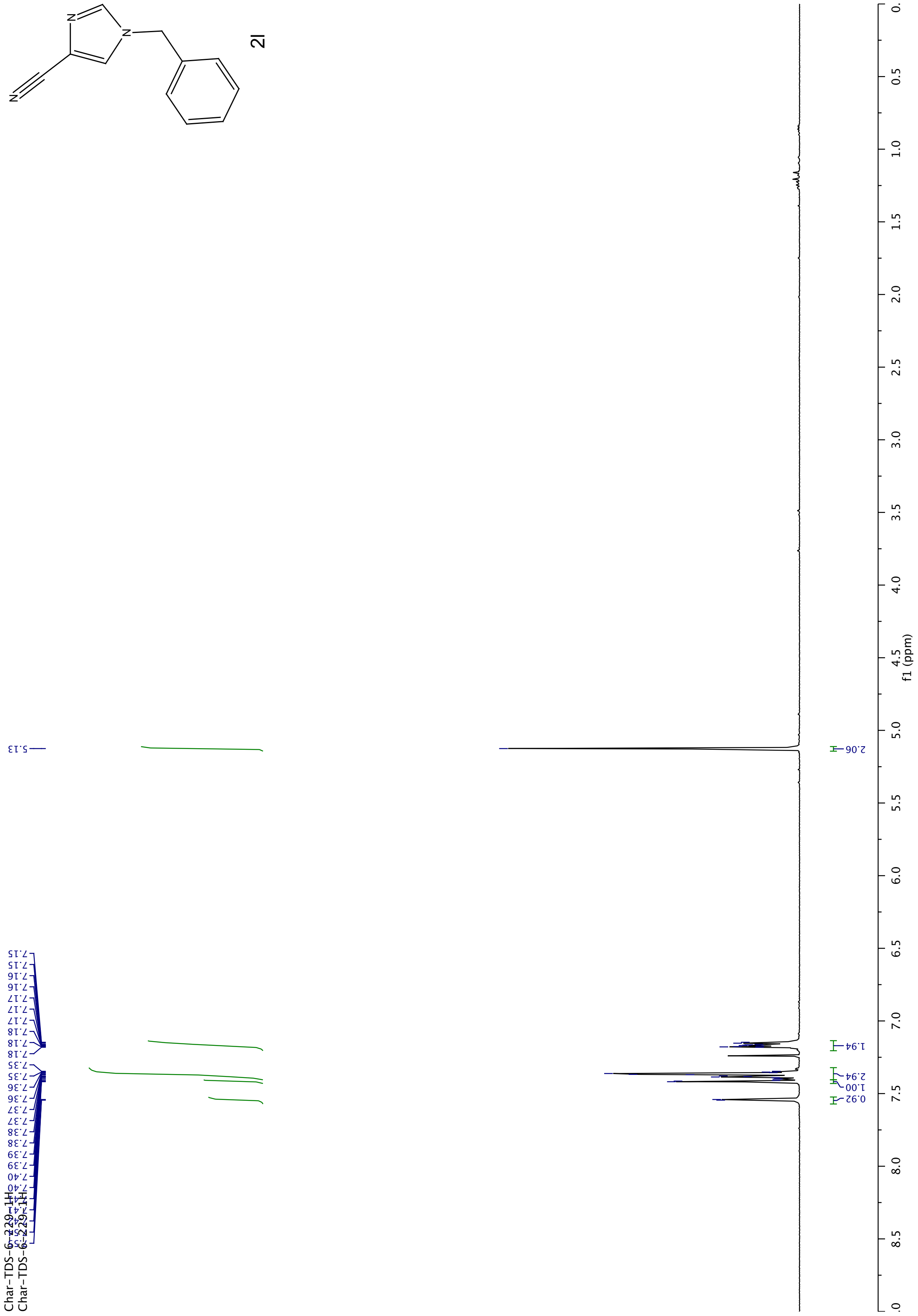

Char-TDS-6-136-1H
Char-TDS-6-136-1H
7.68
7.67
7.67
7.65
7.65
7.64
7.52
7.52
7.50
7.50
7.49
7.49
7.47
7.47
7.37
7.36
7.34
7.34
7.34
7.34
7.32
7.31
CD3OD
CD3OD
1.00
1.06
1.15
1.20
.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.
f1 (ppm)

N
N
NH

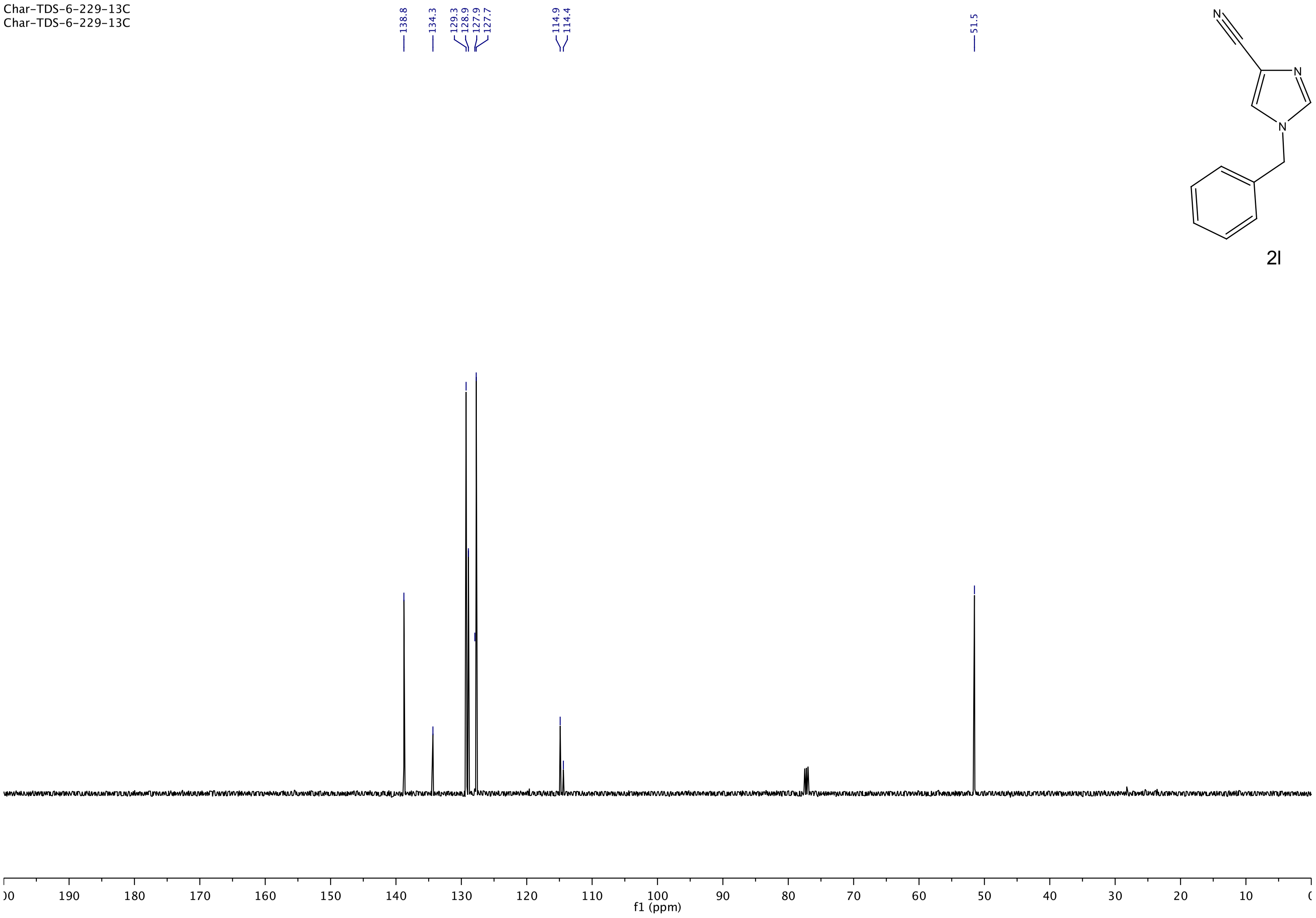
2k


Char-TDS-6-136-13C
STANDARD CARBON PARAMETERS
141.5
129.0
125.4
124.6
119.6
119.5
114.9
112.3
N
N
NH
CD$_3$OD
f1 (ppm)
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10

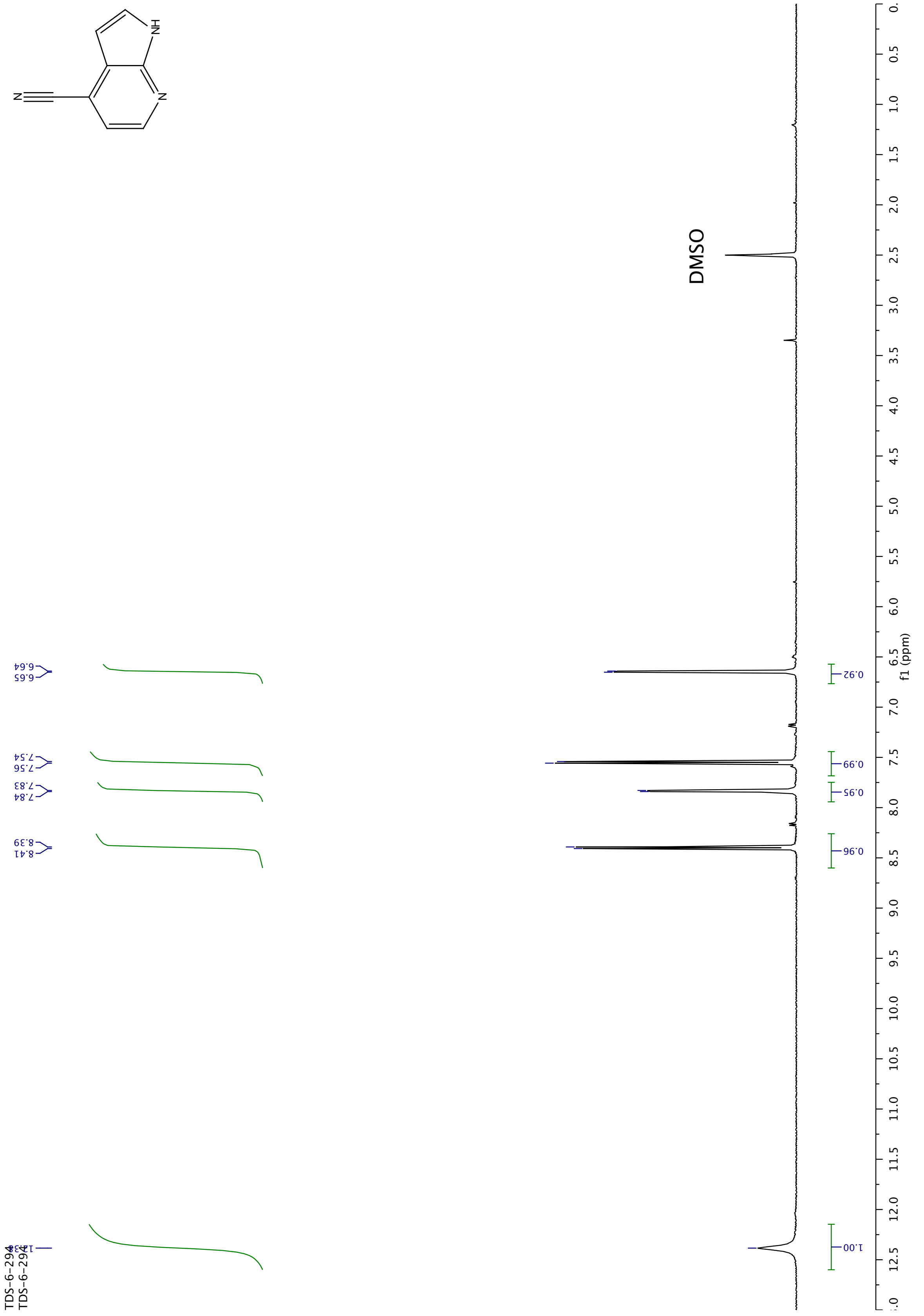
2k

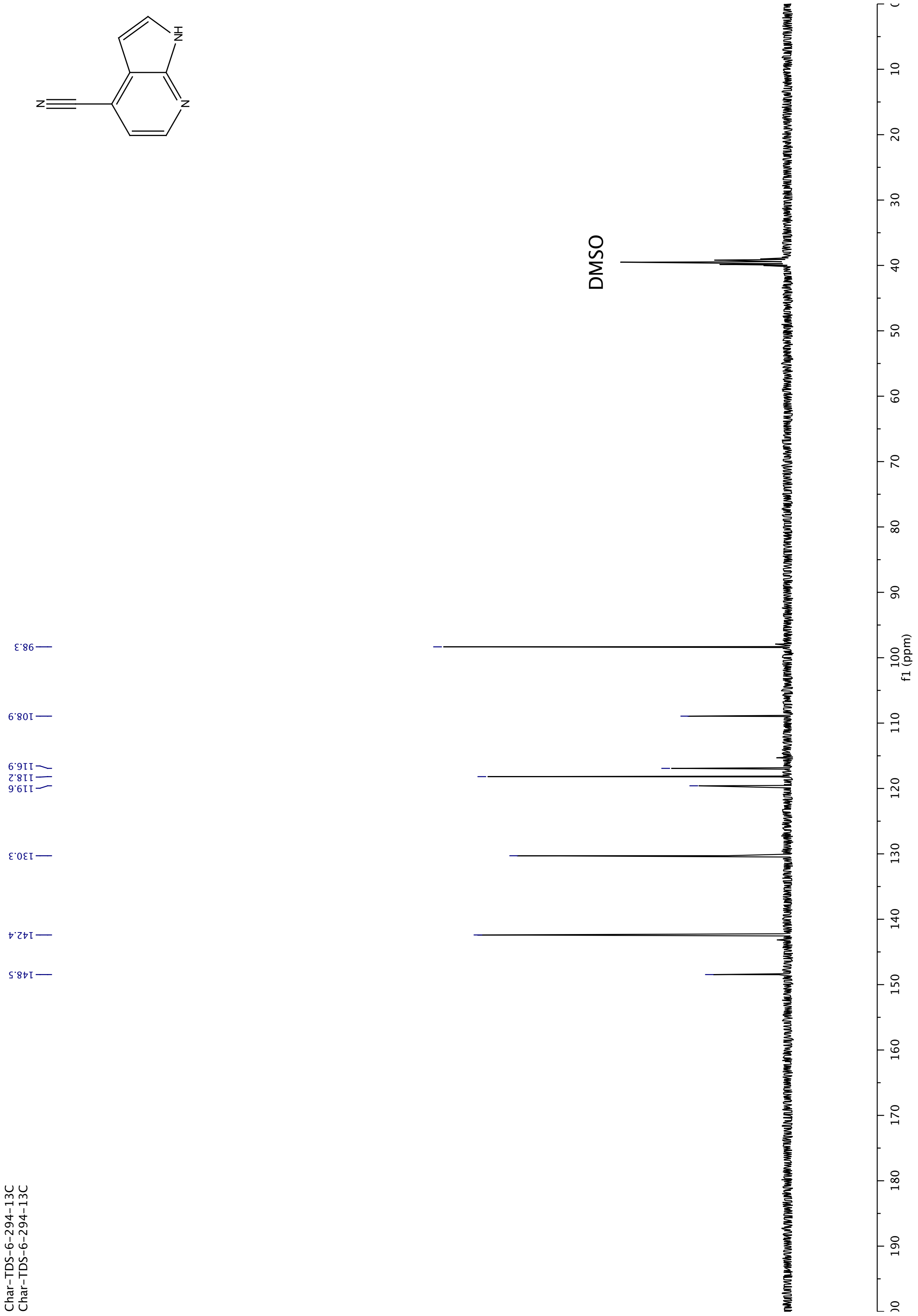

Char-TDS-6-229-1H
Char-TDS-6-229-1H
5.13
7.15
7.15
7.16
7.16
7.17
7.17
7.17
7.18
7.18
7.18
7.35
7.35
7.36
7.36
7.37
7.37
7.38
7.38
7.39
7.39
7.40
7.40
2.06
1.94
2.94
1.00
0.92
f1 (ppm)
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
N
N
N

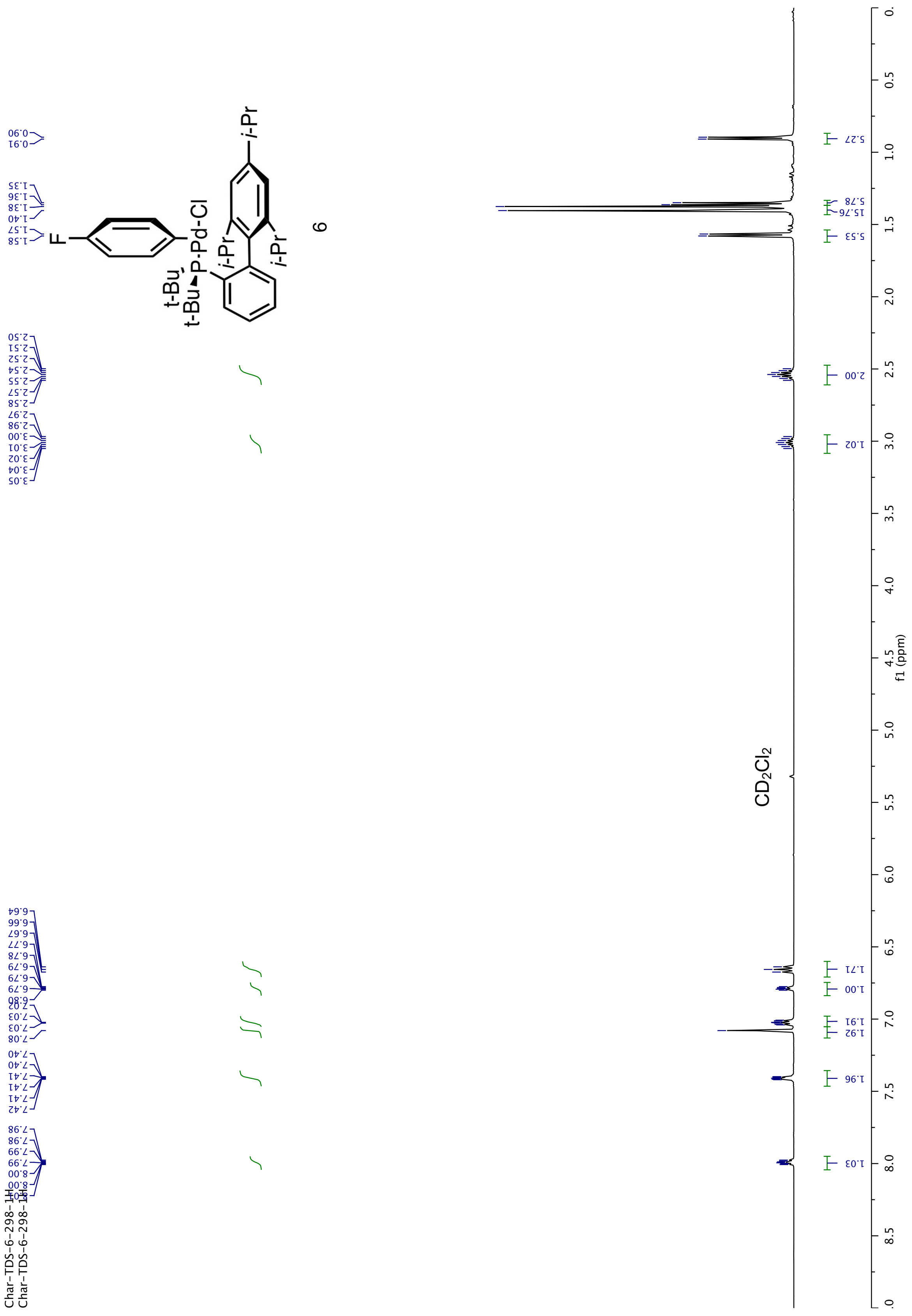
2l

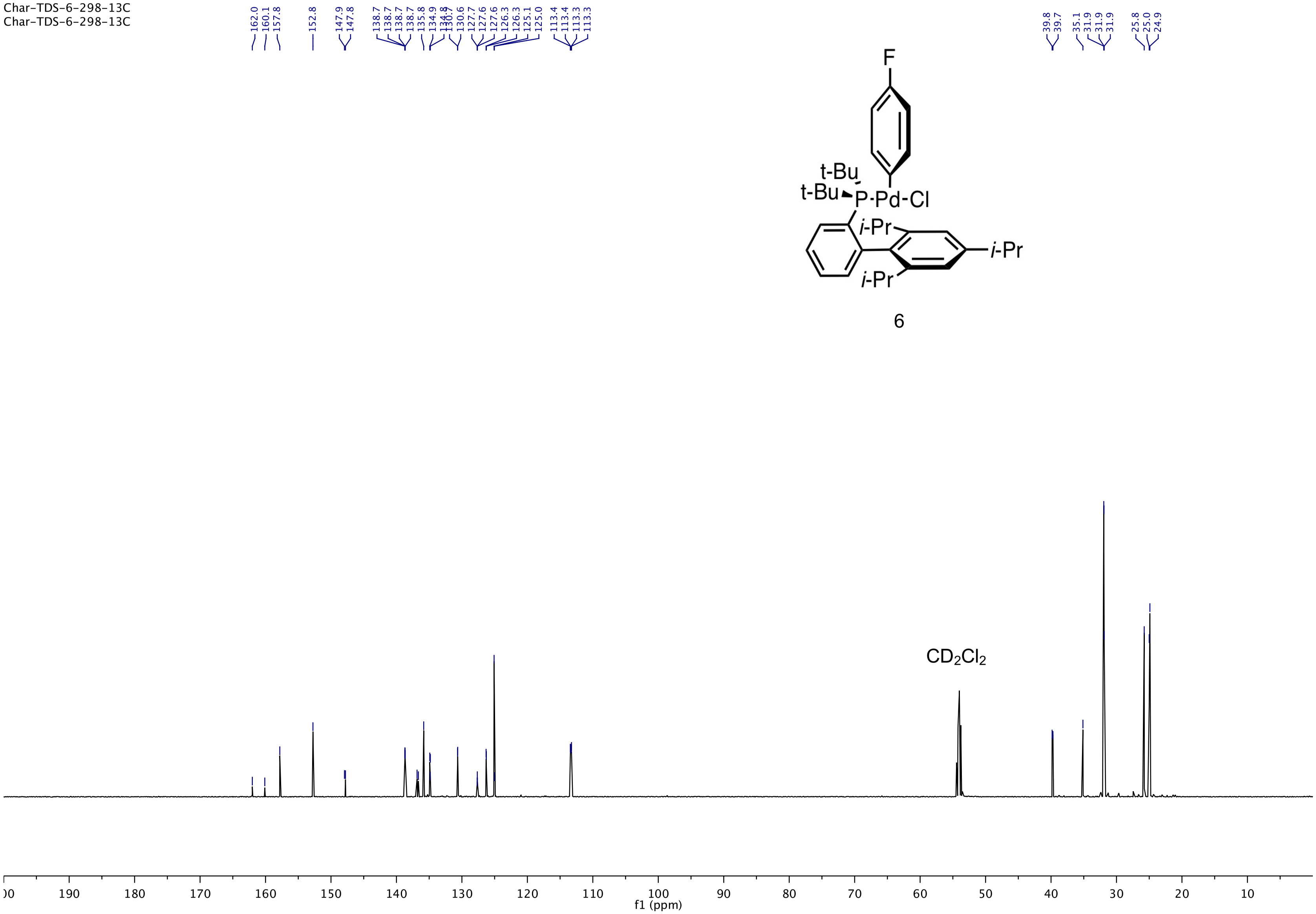

Char-TDS-6-229-13C
Char-TDS-6-229-13C
138.8
134.3
129.3
128.9
127.9
127.7
114.9
114.4
51.5
N
N
N
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

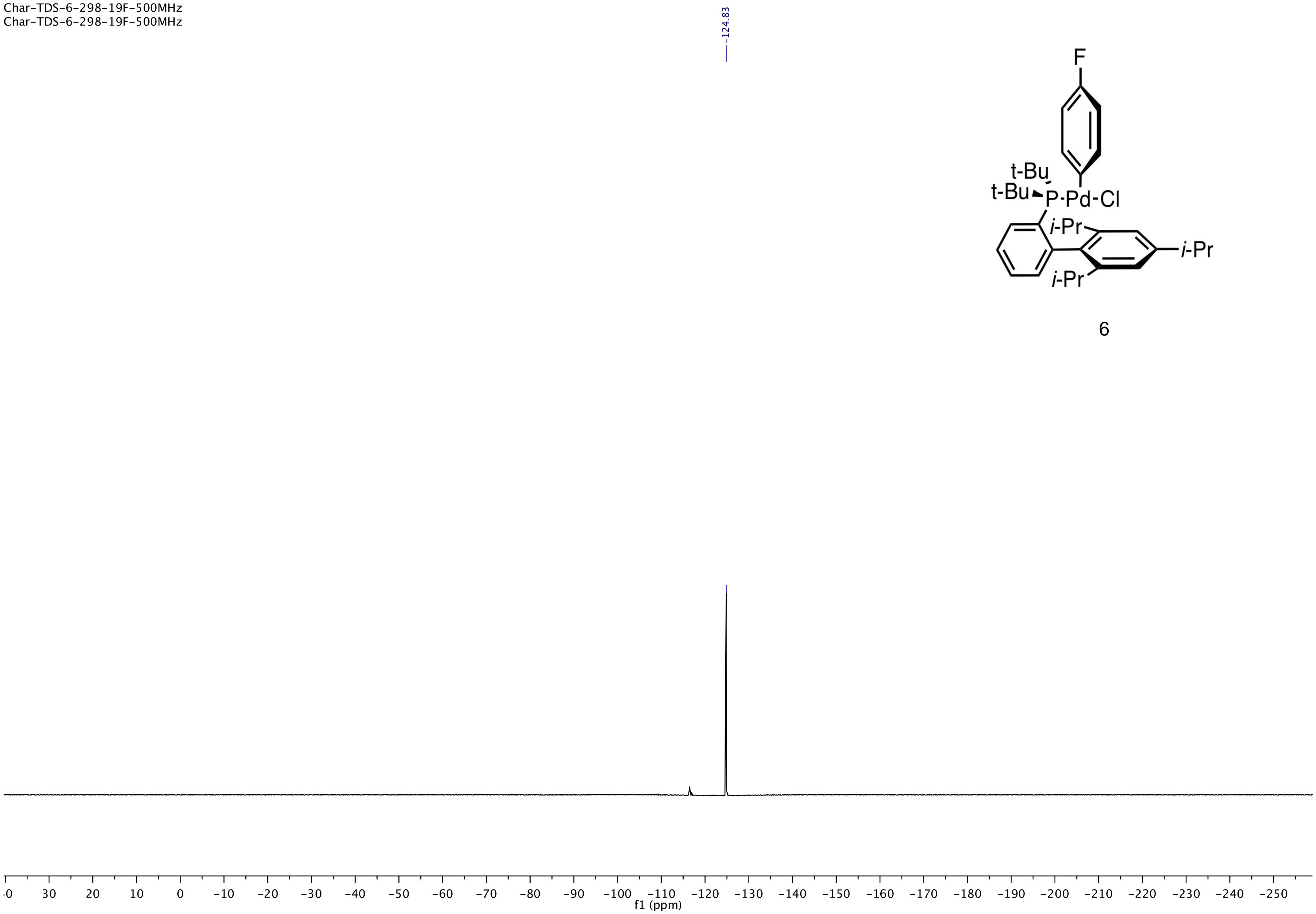
2l


TDS-6-294
TDS-6-294
12.38
8.41
8.39
7.84
7.83
7.56
7.54
6.65
6.64
NH
N
N
DMSO
0.92
0.99
0.95
0.96
1.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
10.5
11.0
11.5
12.0
12.5
13.0
f1 (ppm)


Char-TDS-6-294-13C
Char-TDS-6-294-13C
N
N
NH
DMSO
98.3
108.9
116.9
118.2
119.6
130.3
142.4
148.5
f1 (ppm)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200

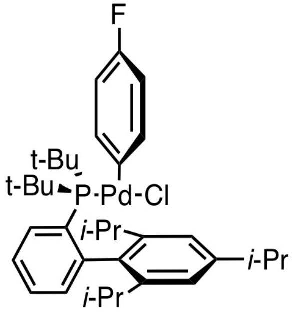

Char-TDS-6-298-1H
Char-TDS-6-298-1H
0.90
0.91
1.35
1.36
1.38
1.40
1.57
1.58
2.50
2.51
2.52
2.54
2.55
2.57
2.58
2.97
2.98
3.00
3.01
3.02
3.04
3.05
6.64
6.66
6.67
6.77
6.78
6.79
6.79
6.79
6.80
7.02
7.03
7.03
7.08
7.40
7.40
7.41
7.41
7.41
7.42
7.98
7.98
7.99
7.99
8.00
8.00
8.01
F
t-Bu
t-Bu
P
Pd-Cl
i-Pr
i-Pr
i-Pr
6
CD2Cl2
5.27
5.78
15.76
5.53
2.00
1.02
1.71
1.00
1.91
1.92
1.96
1.03
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
f1 (ppm)


Char-TDS-6-298-13C
Char-TDS-6-298-13C
162.0
160.1
157.8
152.8
147.9
147.8
138.7
138.7
138.7
138.7
135.8
134.9
134.8
130.7
130.6
127.7
127.6
127.6
126.3
126.3
125.1
125.0
113.4
113.4
113.3
113.3
39.8
39.7
35.1
31.9
31.9
31.9
25.8
25.0
24.9
F
t-Bu
t-Bu
P
Pd-Cl
i-Pr
i-Pr
i-Pr
6
CD2Cl2
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

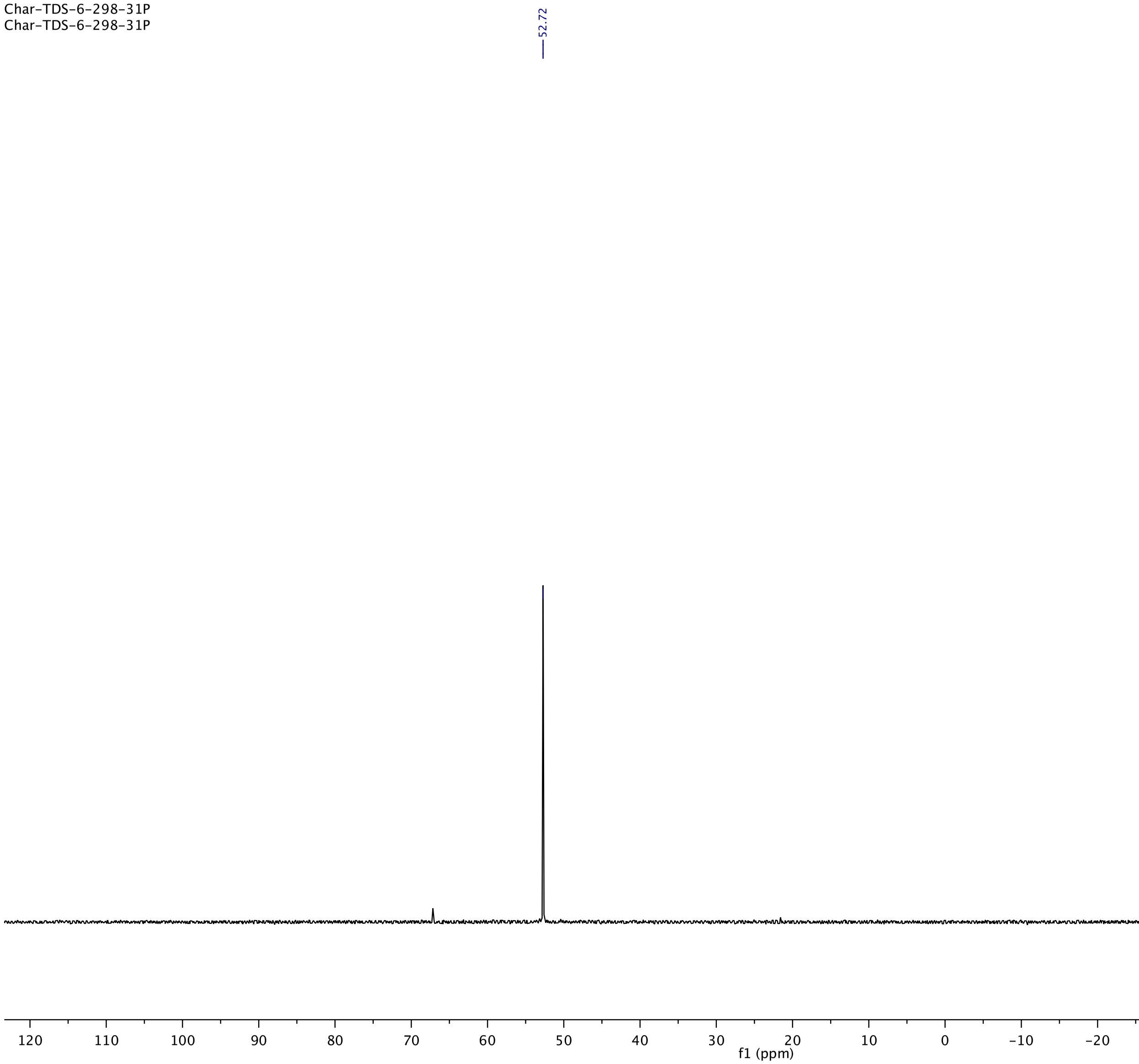

Char-TDS-6-298-19F-500MHz
Char-TDS-6-298-19F-500MHz
-124.83
F
t-Bu
t-Bu
P
Pd
Cl
i-Pr
i-Pr
i-Pr
·0
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
-220
-230
-240
-250
f1 (ppm)

6

Char-TDS-6-298-31P
Char-TDS-6-298-31P



6



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