Supporting Information for

Nickel and nucleophilic cobalt-catalyzed trideuteriomethylation of aryl halides using trideuteriomethyl *p*-toluenesulfonate

Kimihiro Komeyama,* Yuta Yamahata, and Itaru Osaka

Department of Applied Chemistry, Graduate School of Engineering, Hiroshima University
1-4-1 Kagamiyama, Higashi-Hiroshima City, Hiroshima 739-8527, Japan
kkome@hiroshima-u.ac.jp

General Information.

All reactions were performed on oven-and flame-dried glassware under argon using standard Schlenk techniques. Flash column chromatography was performed with silica gel 60 (KANTO Chemical Co. Inc., 40-50 nm). TLC monitoring was carried out with silica gel aluminum sheets (Merck, type 60 F_{254}). Gas chromatography (GC) monitoring was carried out on Shimadzu GC-2014. Nuclear magnetic resonance (NMR) spectra were recorded with Varian-400 (^{1}H NMR: 400 MHz; ^{13}C NMR: 101 MHz) spectrometer or Varian-500 (^{1}H NMR: 500 MHz; ^{13}C NMR: 126 MHz) spectrometers, calibrated from residual chloroform and deuterated chloroform as internal standards at 7.26 ppm for ^{1}H NMR spectra and at 77.0 ppm for ^{13}C NMR spectra, respectively. ^{2}H NMR (77 MHz on Varian-500) was recorded in $CHCl_3$ solvent using $CDCl_3$ (7.26 ppm) as an external standard. Low-resolution mass spectrum (LRMS) was recorded on Shimadzu GCMS-QP2010SE (EI, 70 eV). High-resolution mass spectrum (HRMS) was performed by the Natural Science Center for Basic Research and Development (N-BARD) of Hiroshima University using LTQ Orbitrap XL from Thermo Fisher Scientific.

Materials.

Nickel complexes were synthesized by the literature method.[1] $CoCl(dmgH)_2py$,[2] Co(salen) derivatives,[3] and Me–Co(salen)(H_2O)[4] were prepared by the reported methods. *N*,*N*-dimethylformamide (DMF) were dried over activated MS 4Å, distilled and stored with activated MS 4Å under argon. Unless otherwise noted, commercially available reagents were used as received without further purification.

Representative procedure for the trideuteriomethylation of aryl halides (Table 1 by Co(salen)).

In an oven-dried Schlenk tube, Mn powder (110.0 mg, 2.0 mmol) was added and heated at 400 ºC for 15 min under vacuum. After cooling, the Schlenk tube was charged with $NiBr_2$bpy (37.5 mg, 0.1 mmol) and Co(salen) (32.5 mg, 0.1 mmol), and then heated again at ca. 80 ºC under vacuum. After cooling, DMF (4 mL) and TMSCl (6.4 μL) were poured and stirred for 10 min at room temperature. 4-Phenyl iodobenzene (**1a**, 280.1 mg, 1.0 mmol) and CD_3OTs (283.9 mg, 1.5 mmol) were successfully added. The reaction mixture was stirred for 24 h at 30 ºC. The obtained mixture was diluted and quenched with ethyl acetate and brine. The aqueous phase was extracted with ethyl acetate. The combined organic phase was dried over $MgSO_4$. After filtration and removal of the solvent, the residue was purified by a silica-gel column chromatography to get **3a**[5] as a white solid (Mp.: 255–255.5 ºC) in 140.4 mg (82%). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.61 – 7.55 (m, 2H), 7.52 – 7.47 (m, 2H), 7.45 – 7.39 (m, 2H), 7.32 (ddt, *J* = 7.9, 6.8, 1.2 Hz, 1H), 7.28 – 7.22 (m, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 141.14, 138.34, 136.89, 129.46, 128.68, 126.97, 126.95, 126.94, 20.26 (hept, *J* = 19.3 Hz); ^{2}H NMR (77 MHz, $CHCl_3$) δ 2.31; EI-MS m/z (relative intensity): 171(M^+, 100), 154 (11).

3b: Isolated as a colorless oil in 62% yield (137.1 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (d, *J* = 8.1 Hz, 2H), 7.20 (d, *J* = 8.1 Hz, 2H), 1.35 (s, 12H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 141.26, 134.77, 128.49, 83.59, 20.88 (hept, *J* = 19.0 Hz); ^{2}H NMR (77 MHz, $CHCl_3$) δ 2.33; EI-MS m/z (relative intensity): 221 (M^+, 25), 206(29), 135(73), 122(100); HRMS calcd for $C_{13}H_{16}D_3BO_2$ [M^+]: 221.1666, found: 221.1666.

3c: Isolated as a colorless oil in 40% yield (95.0 mg); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.08 (d, *J* = 8.7 Hz, 2H), 6.80 (d, *J* = 8.7 Hz, 2H), 3.93 (t, *J* = 6.6 Hz, 2H), 1.82 – 1.72 (m, 1H), 1.50 – 1.40 (m, 1H), 1.39 – 1.24 (m, 3H), 0.93 – 0.86 (m, 2H); ^{13}C NMR (500 MHz, $CHCl_3$) δ 157.29, 130.53, 126.68, 120.00, 110.87, 67.86, 31.83, 29.36, 29.28, 26.16, 22.67, 15.44 (hept. *J* = 19.3 Hz), 14.11; ^{2}H NMR (77 MHz, $CHCl_3$) δ 2.22; EI-MS m/z (relative intensity): 223 (M^+, 10), 111 (100); HRMS calcd for $C_{15}H_{21}D_3O$ [M^+]: 223.2015, found: 223.2015.

3d: Isolated as a colorless oil in 55 yield (103.0 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 –

7.27 (m, 2H), 7.18 – 7.10 (m, 2H), 7.07 (tt, *J* = 7.1, 1.1 Hz, 1H), 7.02 – 6.94 (m, 1H), 6.97 – 6.88 (m, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.79, 154.69, 132.78, 130.21, 129.62, 122.76, 119.10, 118.31, 19.87 (hept, *J* = 19.2 Hz); ^{2}H NMR (77 MHz, $CHCl_3$) δ 2.21; EI-MS m/z (relative intensity): 187 (M^+, 100), 169 (5), 94 (64), 77 (18); HRMS calcd for $C_{13}H_9D_3O$ [M^+]: 187.1076, found: 187.1076.

A gram-scale procedure for the trideuteriomethylation of 1e.

In an oven-dried 50mL Schlenk tube, Mn powder (769.0 mg, 14.0 mmol) was added and heated at 400 ºC for 15 min under vacuum. After cooling, the Schlenk tube was charged with $NiBr_2$bpy (259.5 mg, 0.7 mmol) and Co(salen) (227.7 mg, 0.7 mmol), and then heated again at ca. 80 ºC under vacuum. After cooling, DMF (28 mL) and TMSCl (20.0 μL) were poured and stirred for 1 h at room temperature. **1e** (1.93 g, 7.0 mmol) and CD_3OTs (1.99 g, 10.5 mmol) were successfully added. The reaction mixture was stirred for 30 h at 30 ºC. The obtained mixture was diluted and quenched with ethyl acetate and brine. The aqueous phase was extracted with ethyl acetate. The combined organic phase was dried over $MgSO_4$. After filtration and removal of the solvent, the residue was purified by a silica-gel column chromatography to get **3e** as a white solid (Mp.: 81–81.5 ºC) in 87% yield (1.01 g); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 (d, *J* = 8.3 Hz, 2H), 7.05 (d, *J* = 8.3 Hz, 2H), 3.23 (s, 3H), 1.85 (s, 3H); ^{13}C NMR (125.72 MHz, $CDCl_3$) δ 168.16, 135.33, 133.83, 129.46, 120.02, 24.49, 20.00 (hept, *J*= 19.3 Hz); ^{2}H NMR (77 MHz, $CHCl_3$) δ 2.34; EI-MS m/z (relative intensity): 166 (M^+, 37), 124 (100); HRMS calcd for $C_{10}H_{10}D3NO_2$ [M+H]$^+$: 167.1185, found: 167.1257.

3f: Isolated as a white solid (Mp.: 180–180.5 ºC) in 65% yield (156.2 mg); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.91–7.88 (m, 4H), 7.75–7.72 (m, 4H); ^{13}C NMR (125.72 MHz, $CDCl_3$) δ 167.43 138.08, 134.30, 131.83, 129.78, 128.97, 126.45, 123.68, 20.58 (hept, *J* = 19.3 Hz); ^{2}H NMR (77 MHz, $CHCl_3$) δ 2.37; EI-MS m/z (relative intensity): 240 (M^+, 100), 196 (50); HRMS calcd for $C_{15}H_8D_3NO_2$ [M^+]: 240.09878, found: 240.09878.

3g: Isolated as a yellow oil in 62% yield (123.5 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.4 Hz, 2H), 7.28 (d, *J* = 8.3 Hz, 2H), 2.60 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 197.86, 143.77, 134.74, 129.24, 128.43, 26.65 – 26.45 (m), 20.83 (hept, *J* = 19.5 Hz); ^{2}H NMR (77 MHz, $CHCl_3$) δ 2.49; EI-MS m/z (relative intensity): 137 (M^+, 31), 122 (100);

HRMS calcd for $C_9H_7D_3O$ [M^+]: 137.0920, found: 137.0925.

3h: Isolated as a colorless oil in 58% yield (137.7 mg); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.15 (m, 2H), 6.84 (m, 2H), 3.96 (t, *J* = 6.5 Hz, 2H), 1.81 (q, *J* = 6.5 Hz, 2H), 1.55–1.30 (m, 10H), 0.90 (t, *J* = 6.4 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.28, 130.52, 126.71, 126.67, 119.99, 110.87, 67.86, 31.82, 29.37, 29.36, 29.26, 26.15, 22.66, 15.42 (hept, *J* = 19.3 Hz), 14.10; ^{2}H NMR (77 MHz, $CHCl_3$) δ 2.20; EI-MS m/z (relative intensity): 223 (M^+, 9), 111 (100); HRMS calcd for $C_{15}H_{21}D_3O$ [M^+]: 223.2015, found: 223.2015.

3i: Isolated as a colorless oil in 61% yield (163.2 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.13 – 7.11 (m, 1H), 7.06 – 7.02(m, 1H), 6.85 – 6.78 (m, 1H), 1.35 – 1.26 (m, 3H), 1.12 (d, *J* = 7.4 Hz, 18H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.32, 130.84, 128.43, 126.52, 120.57, 117.92, 18.04, 16.21 (hept, *J* = 19.8 Hz), 13.02; ^{2}H NMR (77 MHz, $CHCl_3$) δ 2.20; EI-MS m/z (relative intensity): 267 (M^+, 29), 224 (100), 196(56); HRMS calcd for $C_{16}H_{25}D_3OSi$ [M^+]: 267.2098, found: 267.2097.

3j: Isolated as a colorless oil in 65% yield (129.5 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82 – 7.79 (m, 2H), 7.61 – 7.56 (m, 1H), 7.48 – 7.44 (m, 2H), 7.42 – 7.38 (m, 1H), 7.33 – 7.28 (m, 2H), 7.27 – 7.23 (m, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 198.65, 138.60, 137.72, 133.11, 130.97, 130.12, 128.52, 128.44, 125.18, 19.18 (hept, *J* = 19.3 Hz); ^{2}H NMR (77 MHz, $CHCl_3$) δ 2.28; EI-MS m/z (relative intensity): 199 (M^+, 11), 197 (100), 121(70); HRMS calcd for $C_{14}H_9D_3O$ [M^+]: 199.1076, found: 199.1080.

3k: Isolated as a colorless oil in 58% yield (111.5 mg); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.28 – 7.24(m, 1H), 7.22 – 7.19 (m, 3H), 3.67 (t, *J* = 6.2 Hz, 2H), 3.14 (t, *J* = 6.2 Hz, 2H); ^{13}C NMR (125.72 MHz, $CDCl_3$) δ 137.92, 133.60, 130.35, 128.69, 125.84, 125.11, 48.33, 45.26, 25.99, 24.60, 10.14 (hept, *J* = 19.3); ^{2}H NMR (77 MHz, $CHCl_3$) δ 2.29; EI-MS m/z (relative intensity): 192 (M^+, 42), 122 (100); HRMS calcd for $C_{12}H_{12}D_3NO$ [M^+]: 192.1342, found: 192.1344.

3l: Isolated as a white solid (Mp.: 179 – 179.5 ºC) in 45% yield (108.1 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 – 7.80 (m, 4H), 7.37 – 7.21 (m, 4H), ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.34, 136.41, 134.30, 132.00, 131.13, 130.57, 129.43, 128.68, 126.87, 123.75, 17.23

(hept, *J* = 19.0 Hz); ^{2}H NMR (77 MHz, $CHCl_3$) δ 2.18; EI-MS m/z (relative intensity): 240 (M^+, 89), 220 (100), 76 (64); HRMS calcd for $C_{15}H_8D_3NO_2$ [M^+]: 240.0978, found: 240.0978.

3m: Isolated as a colorless oil in 48% yield (115.4 mg); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.65 (d, *J* = 7.7 Hz, 1H), 7.28-7.08 (m, 6H), 7.00 (d, *J* = 2.5 Hz, 1H), 6.74 (d, *J* = 7.4 Hz, 1H), 6.54 (d, *J* = 2.2 Hz, 1H), 5.27 (s, 2H); ^{13}C NMR (125.72 MHz, $CDCl_3$) δ 136.34, 135.57, 135.18, 130.38, 128.60, 127.95, 127.69, 127.35, 126.35, 121.61, 120.95, 119.50, 109.53, 101.57, 48.08, 18.26 (hept, *J* = 19.3 Hz); ^{2}H NMR (77 MHz, $CHCl_3$) δ 2.27; EI-MS m/z (relative intensity): 224 (M^+, 34), 108 (100); HRMS calcd for $C_{16}H_{12}D_3N$ [M^+]: 224.1393, found: 224.1393.

3n:[5] Isolated as a white solid (Mp.: 105–105.5 ºC) in 60% yield (173.0 mg); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.98 (dt, *J* = 8.3, 0.9 Hz, 1H), 7.74 (d, *J* = 8.4 Hz, 2H), 7.45 (dt, *J* = 7.4, 1.1 Hz, 1H), 7.35 – 7.27 (m, 2H), 7.24 (td, *J* = 7.4, 0.9 Hz, 1H), 7.19 (d, *J* = 8.1 Hz, 2H), 2.32 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 144.59, 135.38, 135.21, 131.76, 129.73, 126.70, 124.51, 123.04, 122.92, 119.34, 118.43, 113.63, 21.51, 8.92 (hept, *J* = 19.9 Hz); ^{2}H NMR (77 MHz, $CHCl_3$) δ 2.19; EI-MS m/z (relative intensity): 288 (M^+, 28), 133 (100), 91 (23).

3o: Isolated as a yellow oil in 45% yield (65.8 mg); ^{1}H NMR (500 MHz, $CDCl_3$) δ ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.77 (d, *J* = 2.2 Hz, 1H), 8.07 (d, *J* = 8.6 Hz, 1H), 7.91 (d, *J* = 2.4 Hz, 1H), 7.74 (dd, *J* = 8.1, 1.7 Hz, 1H), 7.64 (ddt, *J* = 8.4, 6.8, 1.3 Hz, 1H), 7.51 (tt, *J* = 6.7, 1.3 Hz, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 152.40, 146.54, 134.69, 130.33, 129.14, 128.41, 128.11, 127.11, 126.52, 17.93 (hept, *J* = 19.7 Hz); ^{2}H NMR (77 MHz, $CDCl_3$) δ 2.60; EI-MS m/z (relative intensity): 146 (M^+, 100), 118 (26), 91 (7); HRMS calcd for $C_{10}H_6D_3N$ [M^+]: 146.0923, found: 146.0922.

3p: Isolated as a red oil in 67% yield (133.5 mg); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.78 (d, *J* = 6.2 Hz, 2H), 7.73 (d, *J* = 6.7 Hz, 2H), 7.57 (s, 1H), 7.48 (s, 2H), 7.31 – 7.24 (m, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 196.51, 143.10, 137.91, 134.85, 132.13, 130.27, 129.90, 128.94, 128.17, 20.81 (hept, *J* = 19.6 Hz); ^{2}H NMR (77 MHz, $CHCl_3$) δ 2.41; EI-MS *m/z* (relative intensity): 199 (M^+, 38), 181 (M^+-CD_3, 8), 122 (100), 105 (27), 94 (33), 77 (25);

HRMS calcd for $C_{14}H_9D_3O$ [M^+]: 199.1076, found: 199.1076

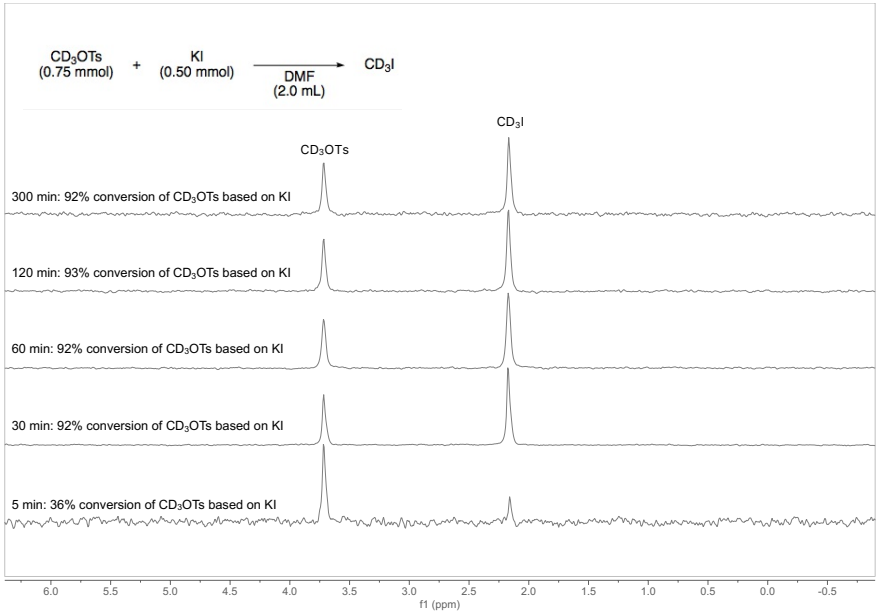
4:[6] Isolated as a white solid (Mp.81–81.5 ºC) in 75% yield (122.4 mg); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.21 (d, *J* = 7.9 Hz, 2H), 7.06 (d, *J* = 8.2 Hz, 2H), 3.24 (s, 3H), 2.38 (s, 3H), 1.86 (s, 3H); ^{13}C NMR (125.72 MHz, $CDCl_3$) δ170.71, 142.05, 137.60, 130.32, 126.80, 37.17, 21.04; EI-MS m/z (relative intensity): 163 (M^+, 30), 120 (100), 91(22).

5:[7] Isolated as a colorless oil in 54% yield (142.8 mg); ^{1}H NMR (400 MHz, $CHCl_3$) δ 7.13 – 7.11 (m, 1H), 7.04 – 7.02(m, 1H), 6.85 – 6.77(m, 1H), 2.25 (s, 3H), 1.33 – 1.29(m, 3H), 1.12 (d, *J* = 7.3 Hz, 18H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.31, 130.86, 128.54, 126.52, 120.58, 117.95, 18.04, 16.99, 13.05; EI-MS m/z (relative intensity): 264 (M^+, 29), 221 (100).

6:[8] Isolated as a colorless oil in 63% yield (161.5 mg); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.91 – 7.83 (m, 2H), 7.48 – 7.36 (m, 4H), 7.34 (t, *J* = 7.2 Hz, 1H), 6.90 (d, *J* = 9.3 Hz, 1H), 5.14 (s, 2H), 3.88 (s, 3H), 2.31 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 166.98, 160.51, 136.56, 132.00, 129.16, 128.51, 127.90, 126.99, 126.90, 122.12, 110.44, 69.79, 51.74, 16.28; EI-MS m/z (relative intensity): 256 (M^+, 5), 91 (100).

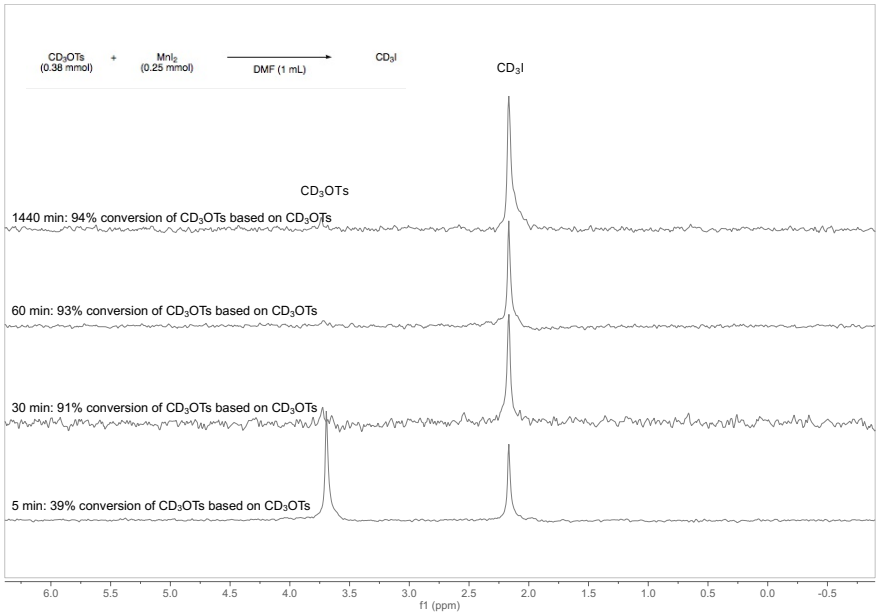
^{2}H NMR monitoring of the reaction of CD_3OTs with KI

In an oven-dried Schlenk tube, KI (84.0 mg, 0.50 mmol), DMF (2 mL), and CD_3OTs (118 μL, 0.75 mmol) were successfully added and then followed by stirring. A part of the mixture (ca. 100 μL) was collected, diluted with chloroform to monitor by ^{2}H NMR using $CDCl_3$ as an external standard.

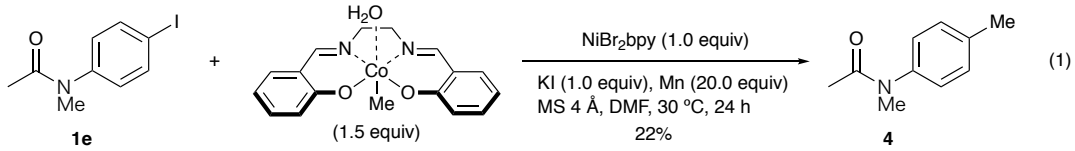


^{2}H NMR monitoring of the reaction of CD_3OTs with MnI_2

In an oven-dried Schlenk tube, MnI_2 (77.0 mg, 0.25 mmol), DMF (1 mL), and CD_3OTs (59 μL, 0.38 mmol) were successfully added and then followed by stirring. A part of the mixture (ca. 100 μL) was collected, passed through a short Celite-column, and diluted with chloroform to monitor by ^{2}H NMR using $CDCl_3$ as an external standard.



Stoichiometric reaction of 1e with Me–Co(salen) in the presence of $NiBr_2$bpy and Mn powder (eq 1).



In an oven-dried Schlenk tube, Mn powder (274.0 mg, 5 mmol) and activated MS 4Å (80 mg) were added and heated at 400 ºC for 15 min under vacuum. After cooling, the Schlenk tube was charged with $NiBr_2$bpy (93.5 mg, 0.25 mmol), KI (42.0 mg, 0.25 mmol), DMF (1.0 mL), and TMSCl (38 μL, 0.3 mmol) were successfully added and then followed by stirring for 10 min. 4-acetylmethylaminophenyl iodide (**1e**, 70.0 mg, 0.25 mmol) and Me–Co(salen)(H_2O) (134.0 mg, 0.38 mmol) were added into the solution. The reaction mixture was stirred for 24 h at 30 ºC. The reaction mixture was quenched with water and poured EtOAc to dilute the mixture. The yield of the product **4** (22%) was estimated by gas chromatography using triisopropylbenzene as an internal standard.

References

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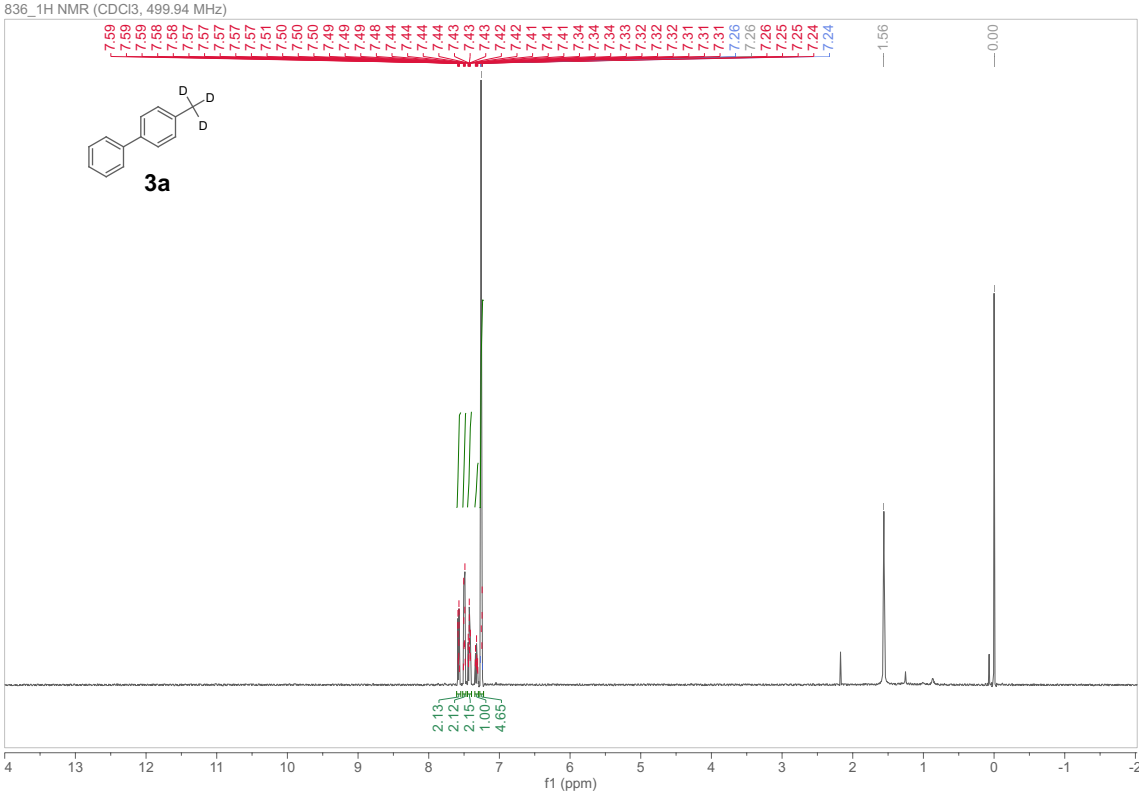
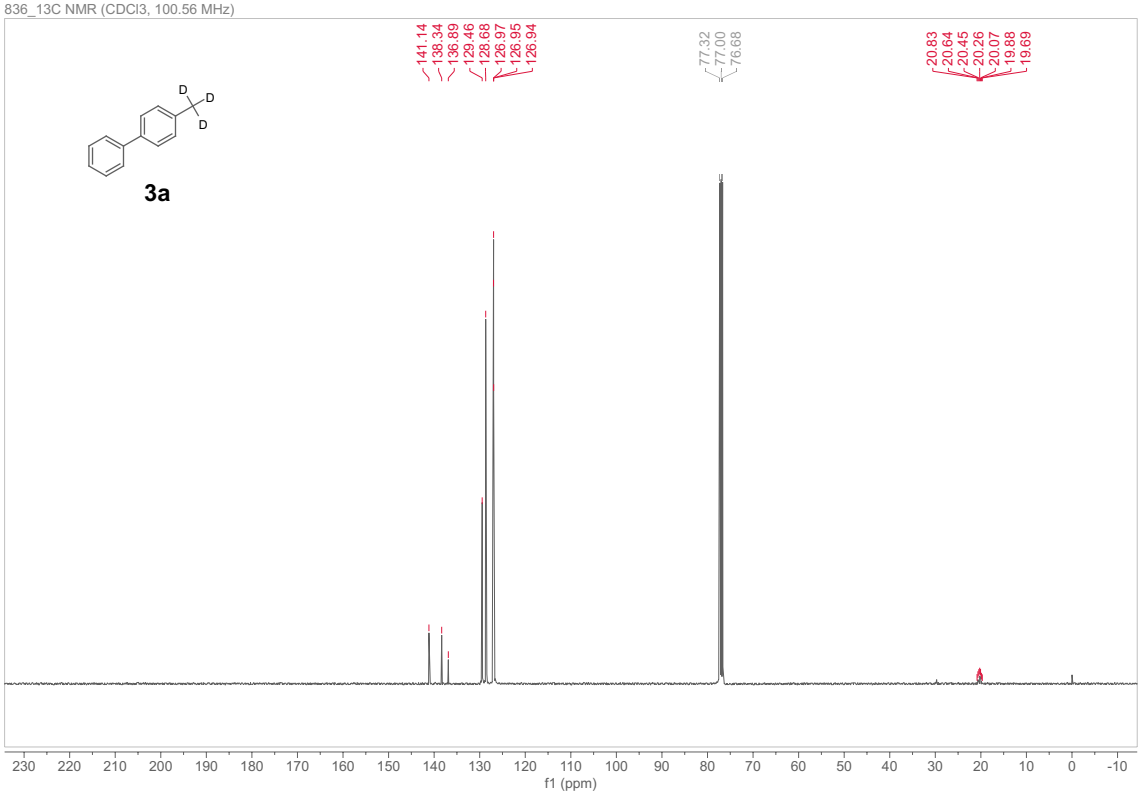
NMR chart for products

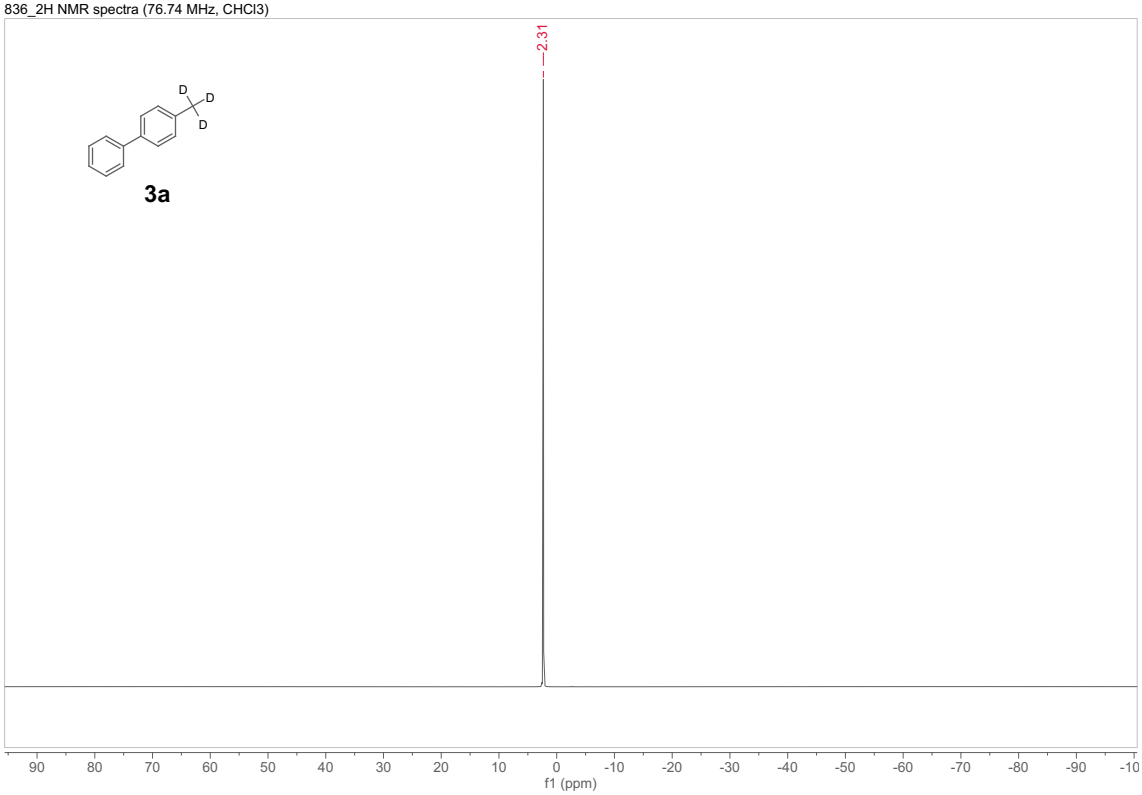
836_1H NMR (CDCl3, 499.94 MHz)



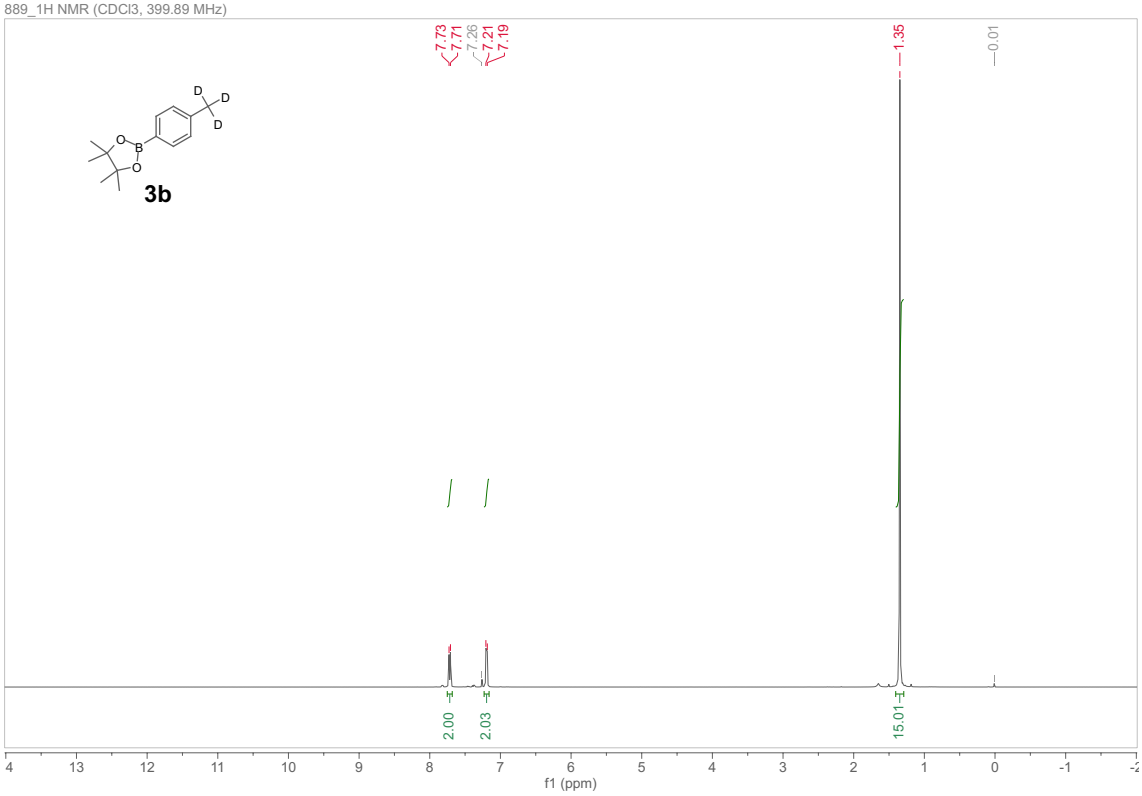
836_13C NMR (CDCl3, 100.56 MHz)



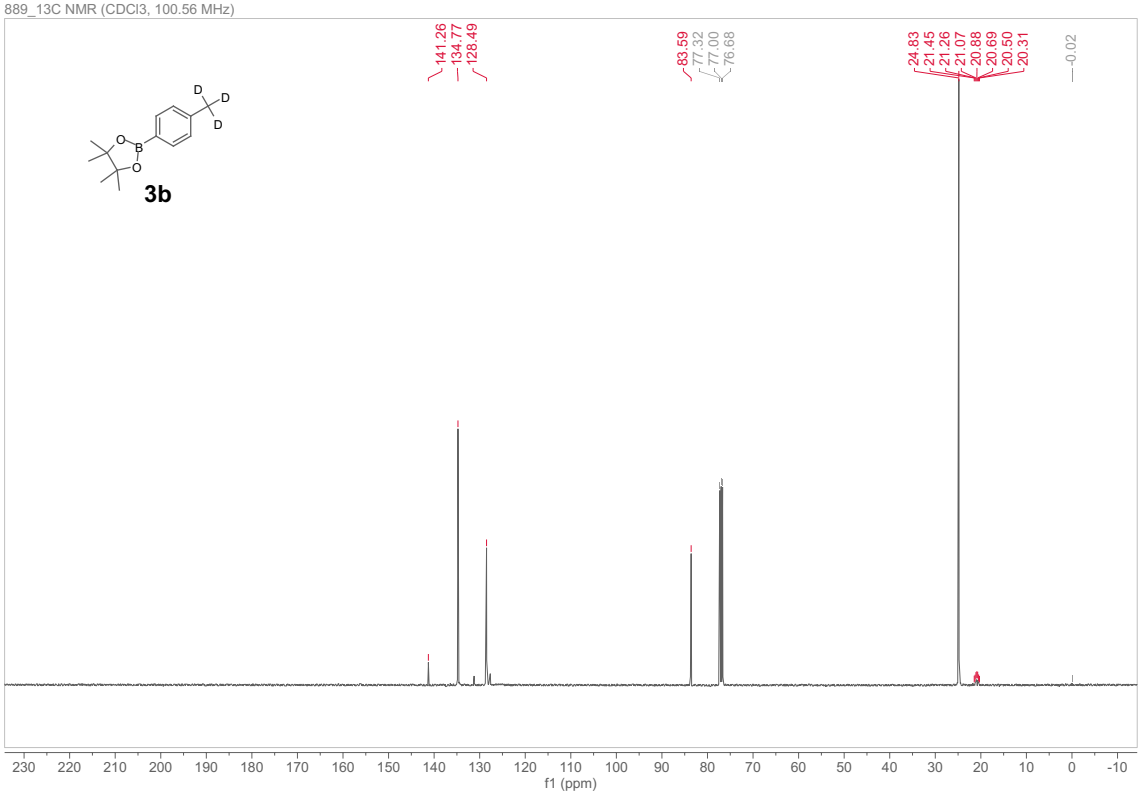
836_2H NMR spectra (76.74 MHz, CHCl3)



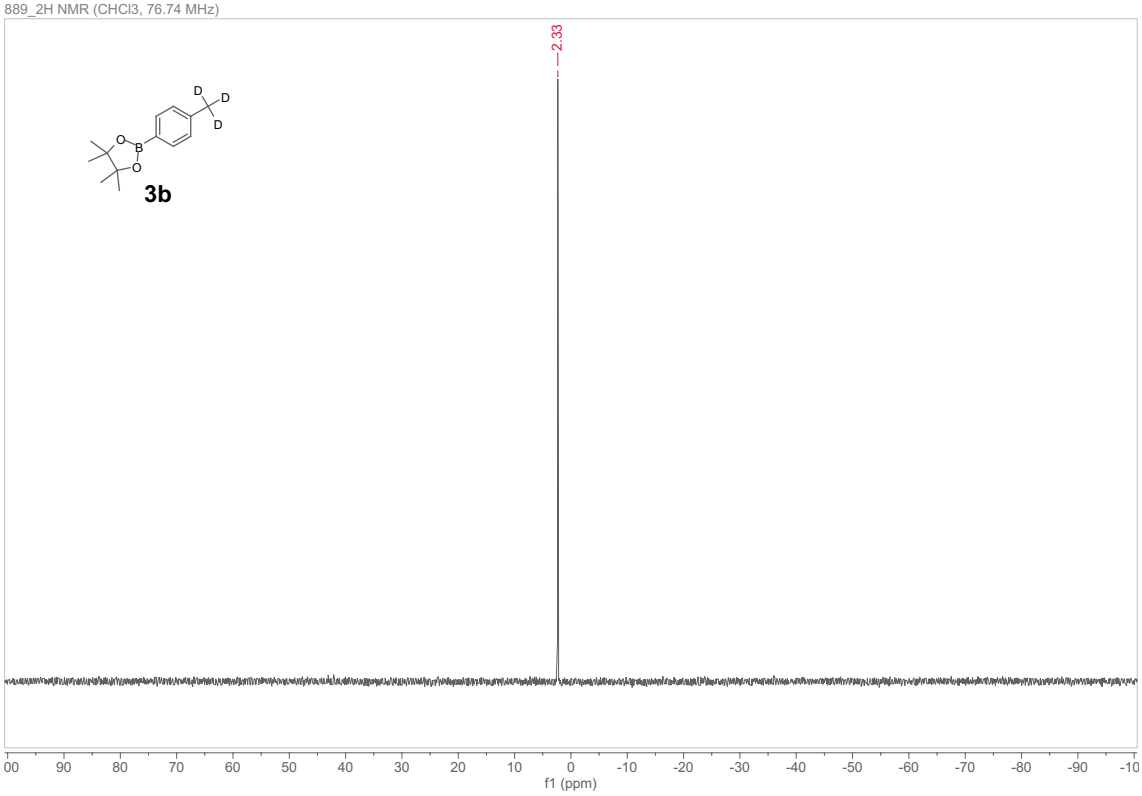
889_1H NMR (CDCl3, 399.89 MHz)



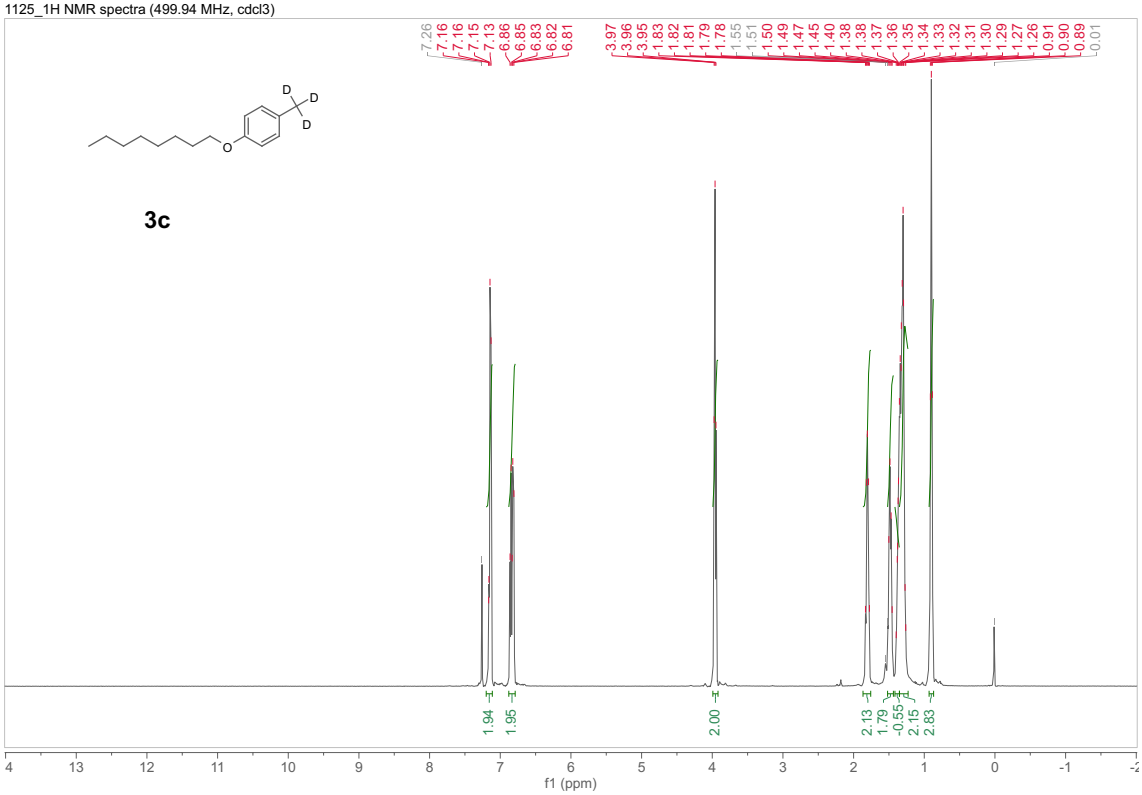
889_13C NMR (CDCl3, 100.56 MHz)



889_2H NMR (CHCl3, 76.74 MHz)

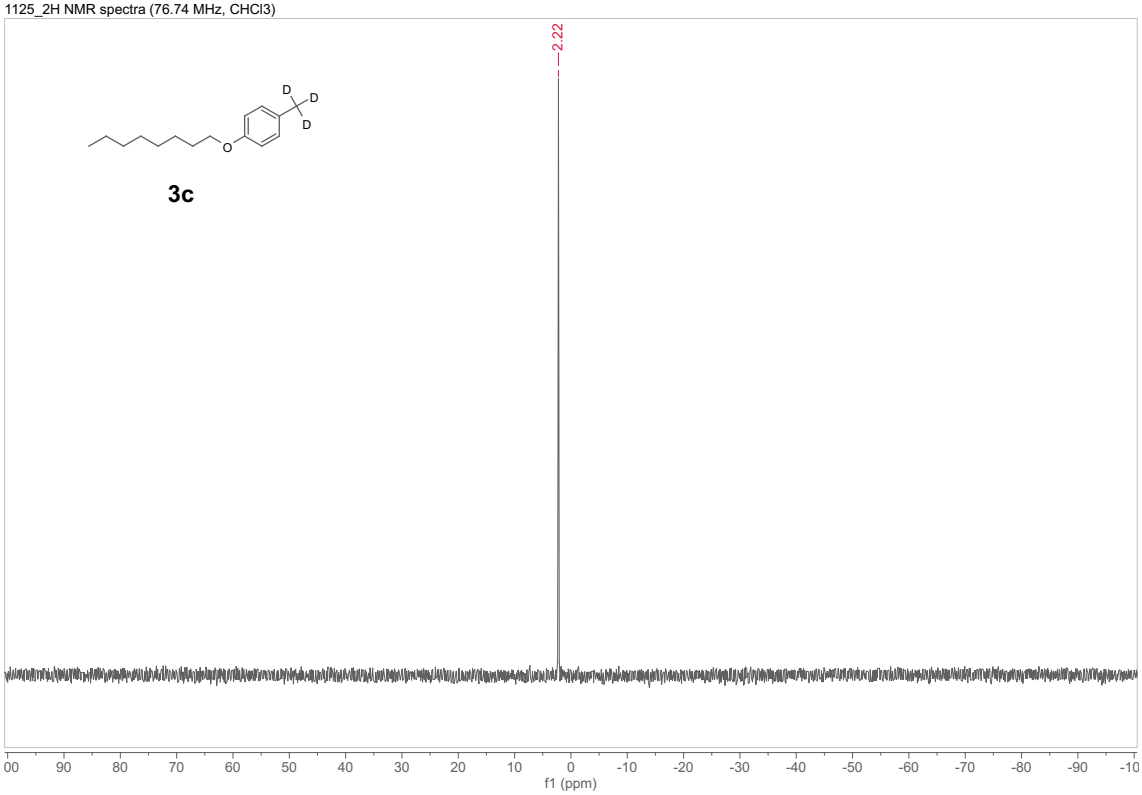


1125_1H NMR spectra (499.94 MHz, cdcl3)

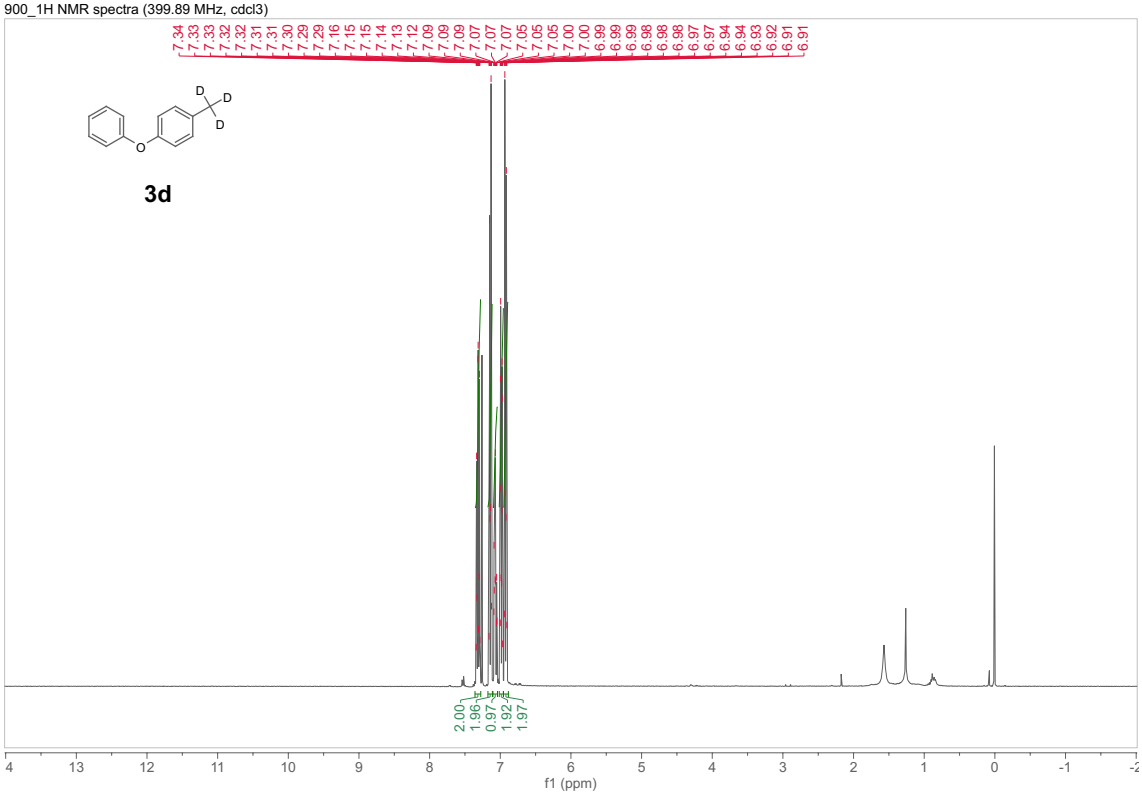


1125_13C NMR spectra (125.72 MHz, cdcl3)

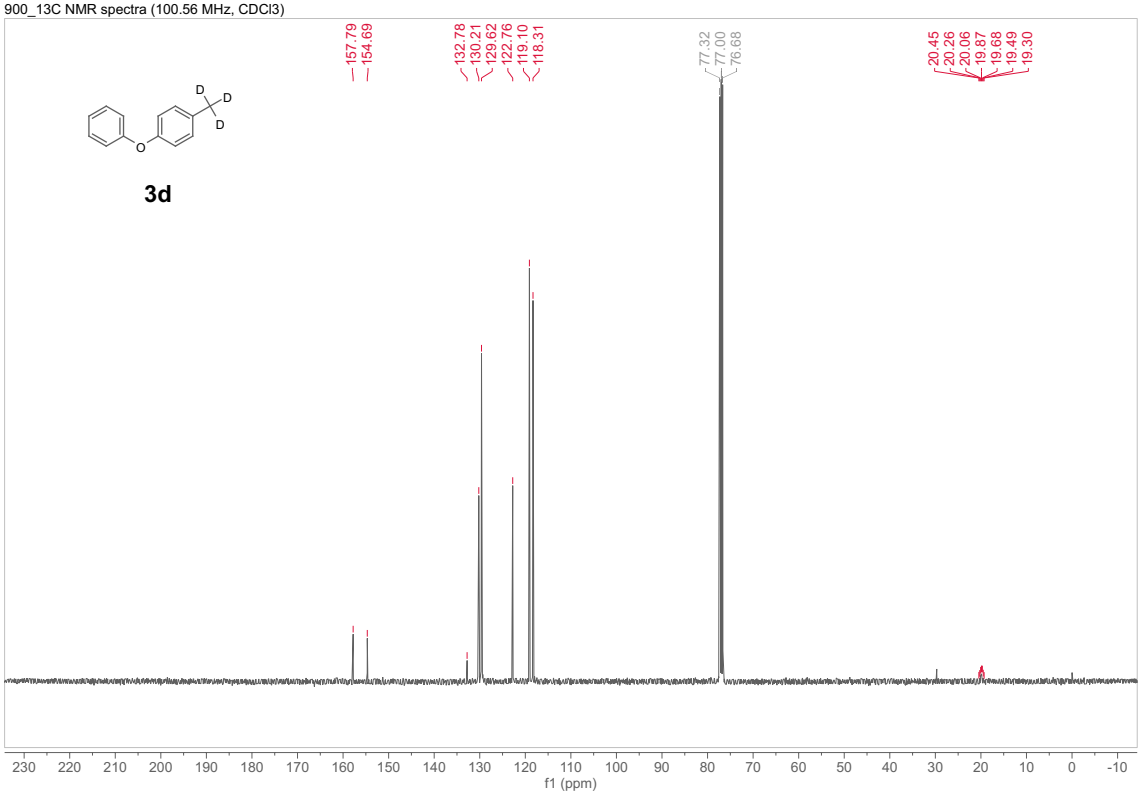
1125_2H NMR spectra (76.74 MHz, CHCl3)



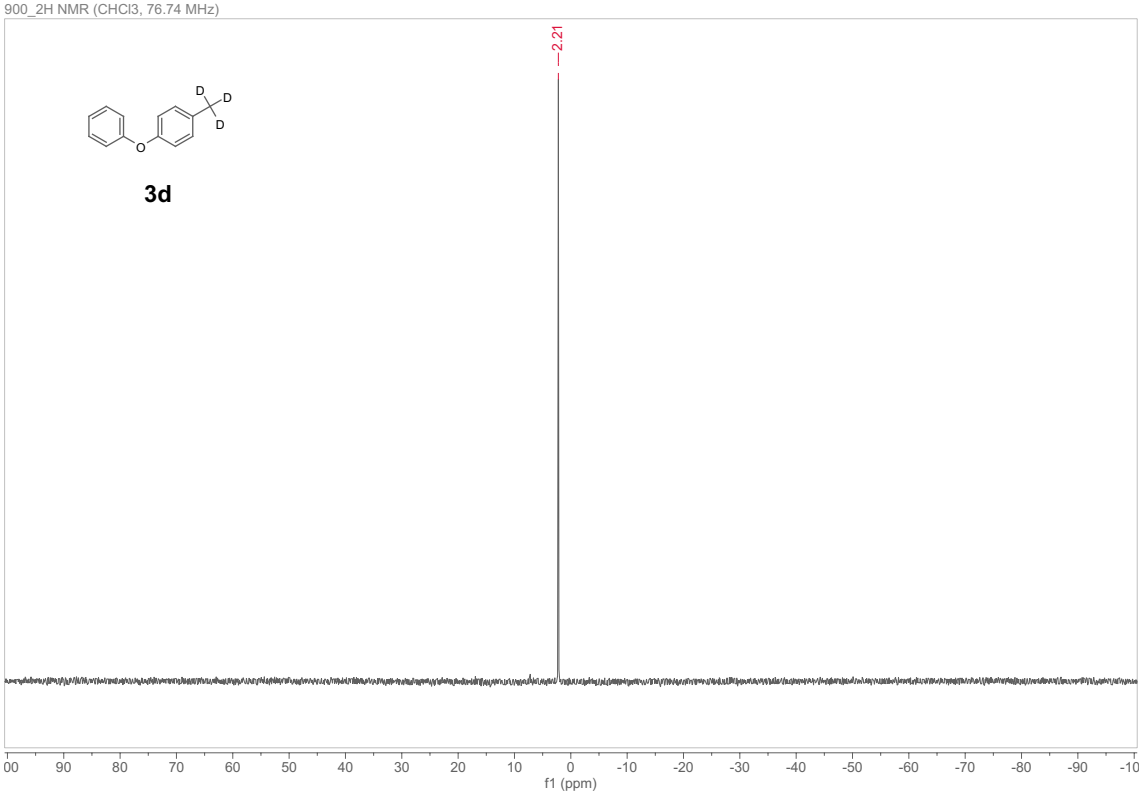
900_1H NMR spectra (399.89 MHz, cdcl3)



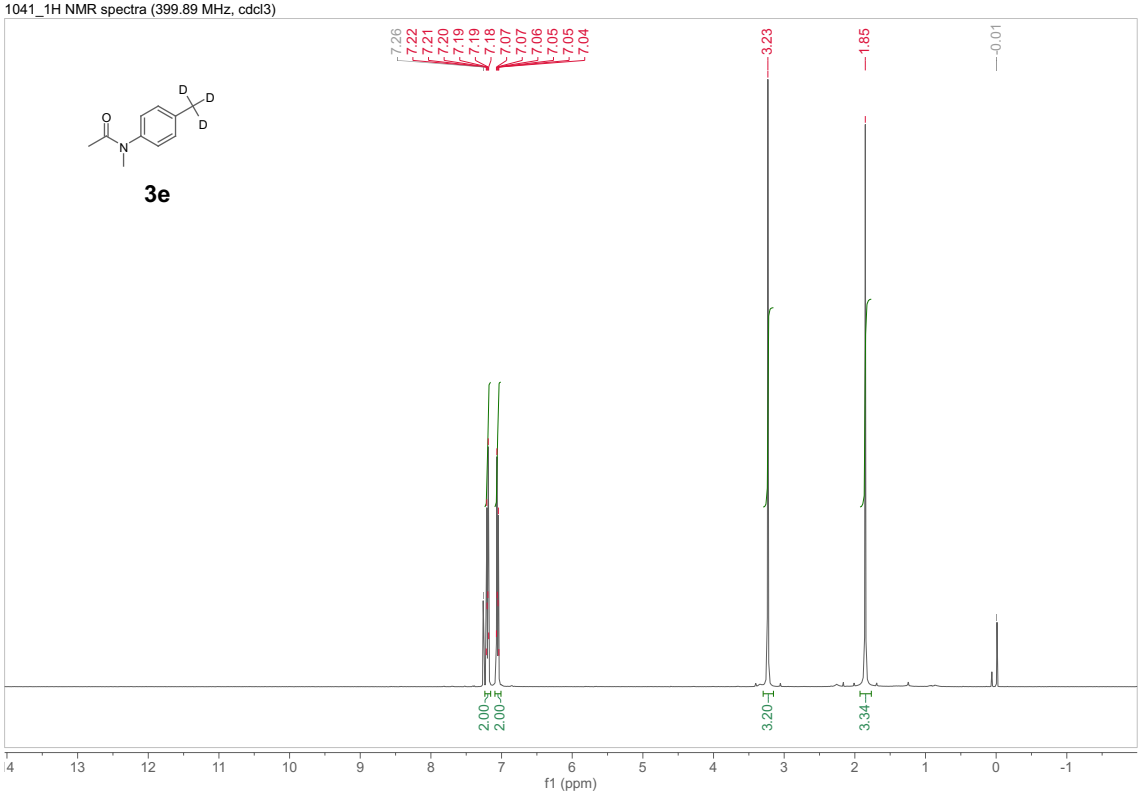
900_13C NMR spectra (100.56 MHz, CDCl3)



900_2H NMR (CHCl3, 76.74 MHz)

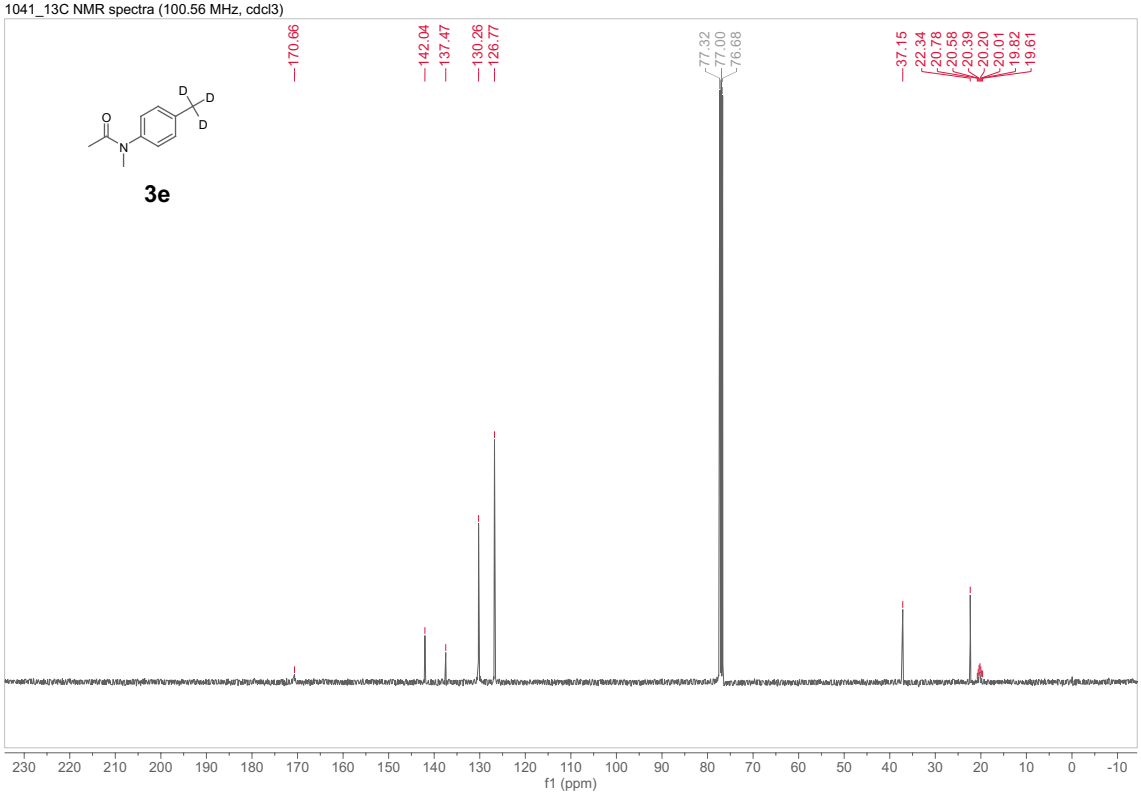


1041_1H NMR spectra (399.89 MHz, cdcl3)



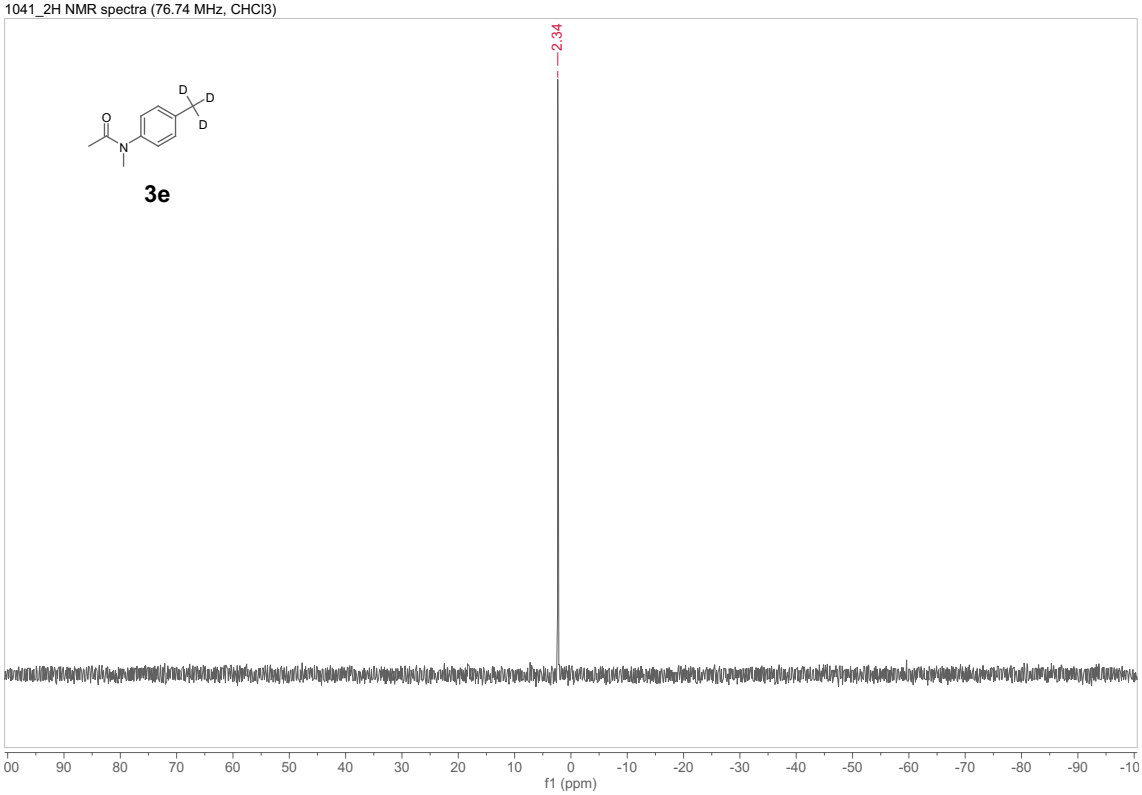
3e

1041_13C NMR spectra (100.56 MHz, cdcl3)



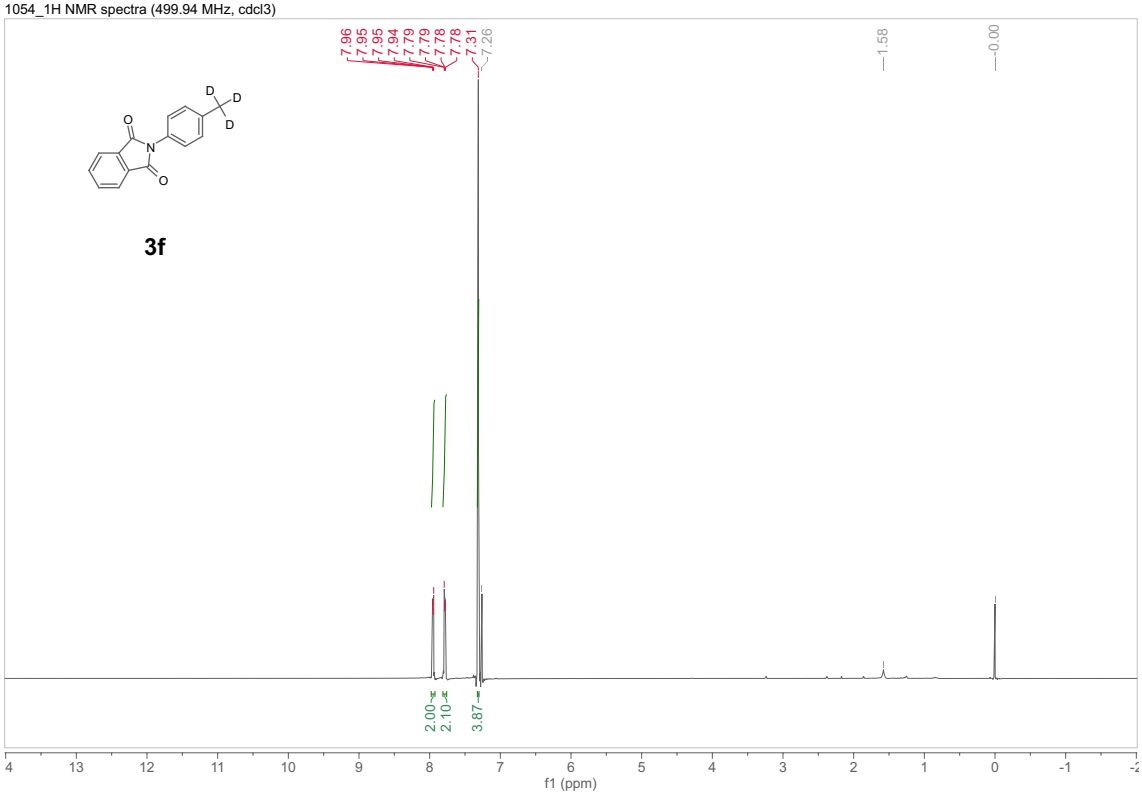
3e

1041_2H NMR spectra (76.74 MHz, CHCl3)



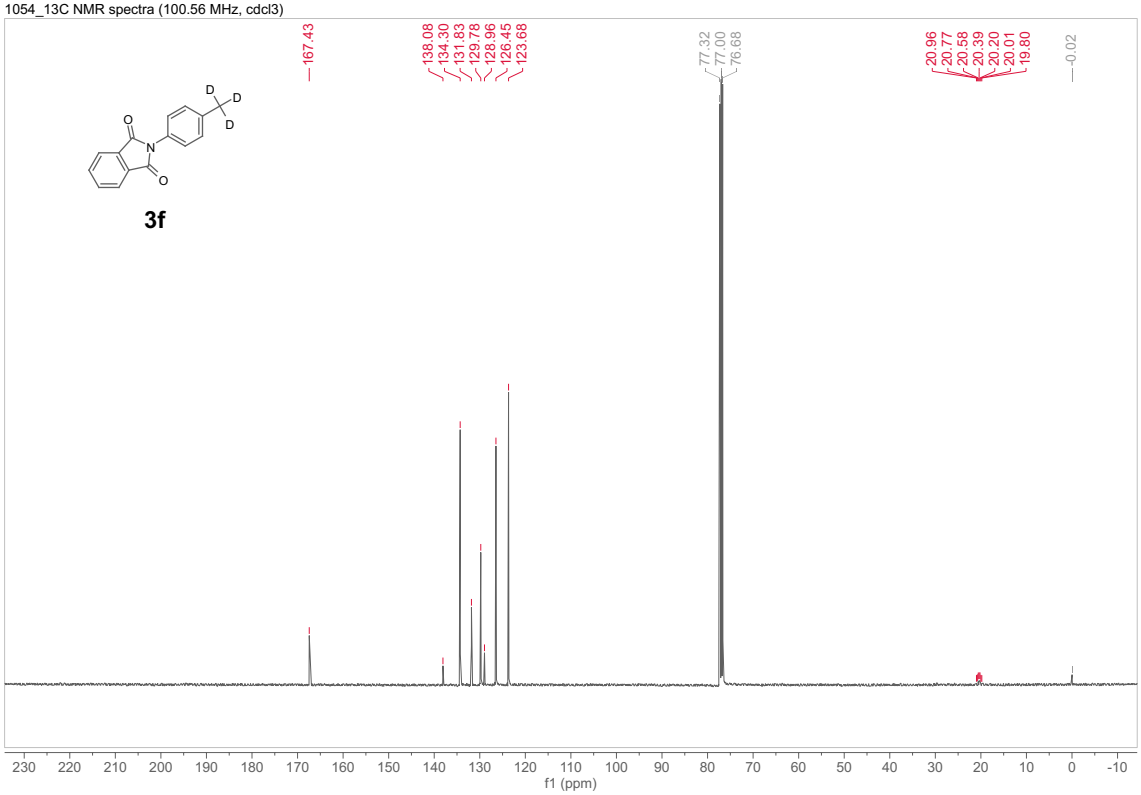
3e

1054_1H NMR spectra (499.94 MHz, cdcl3)

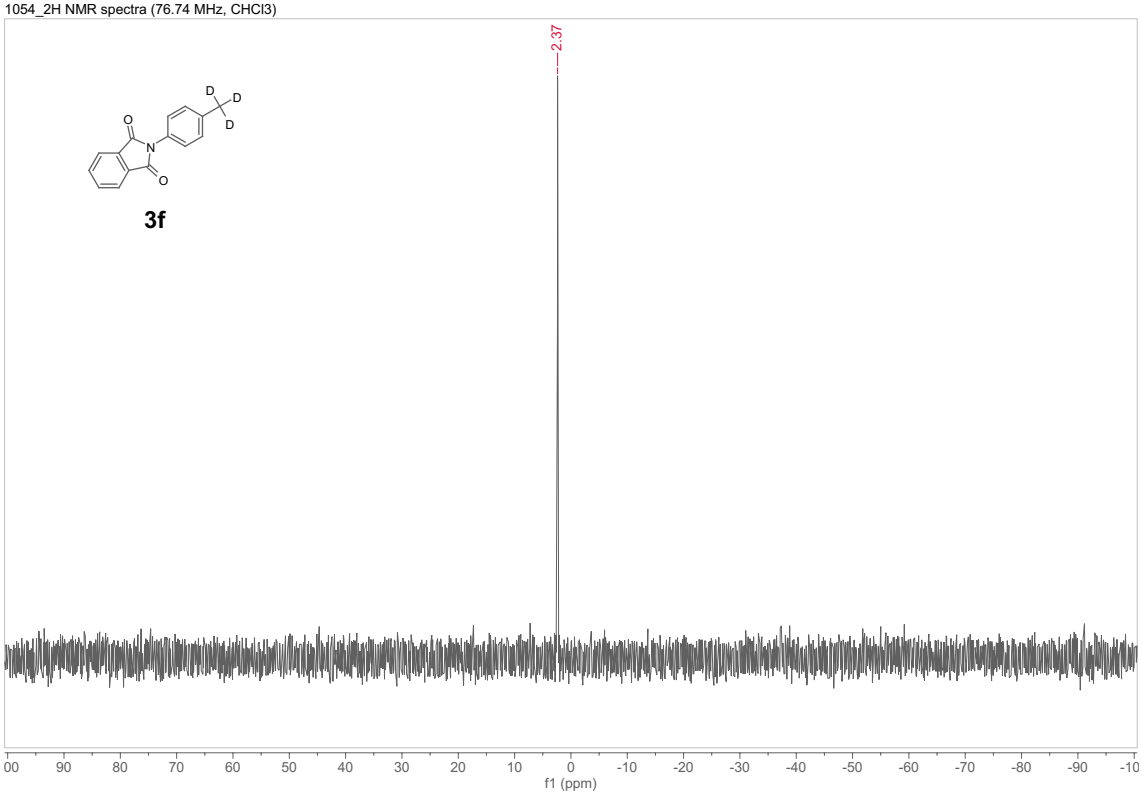


3f

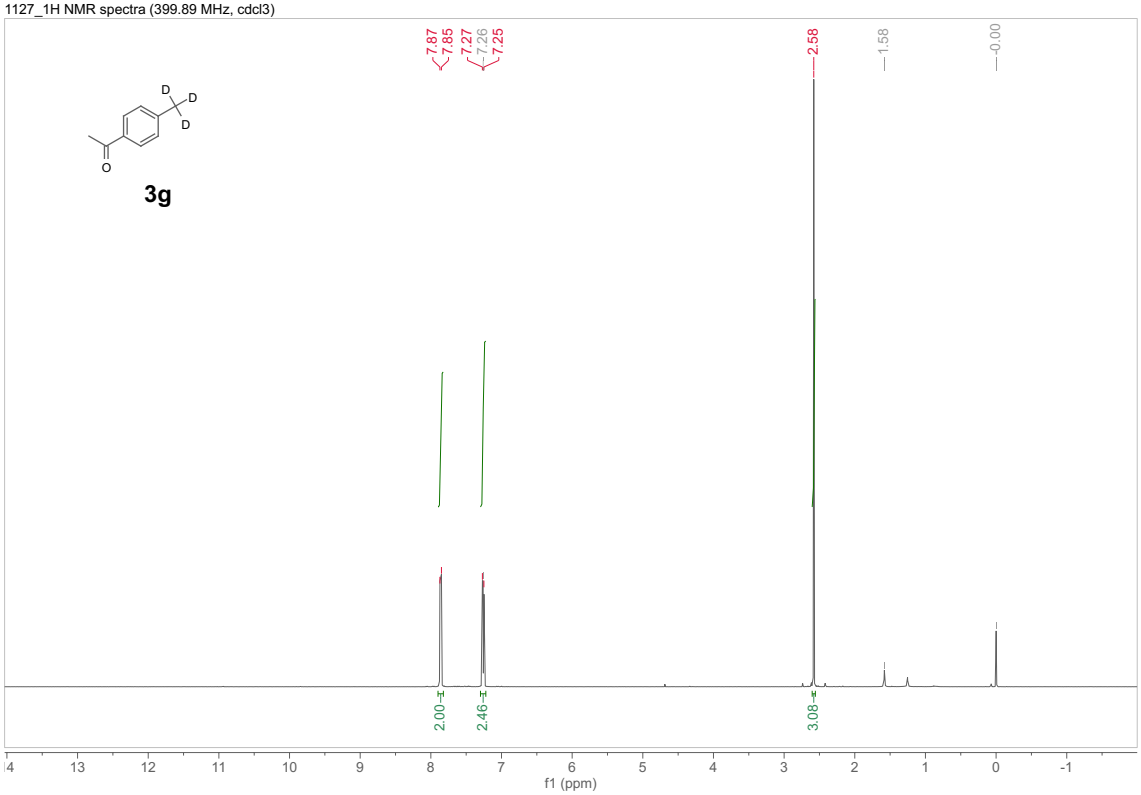
1054_13C NMR spectra (100.56 MHz, cdcl3)



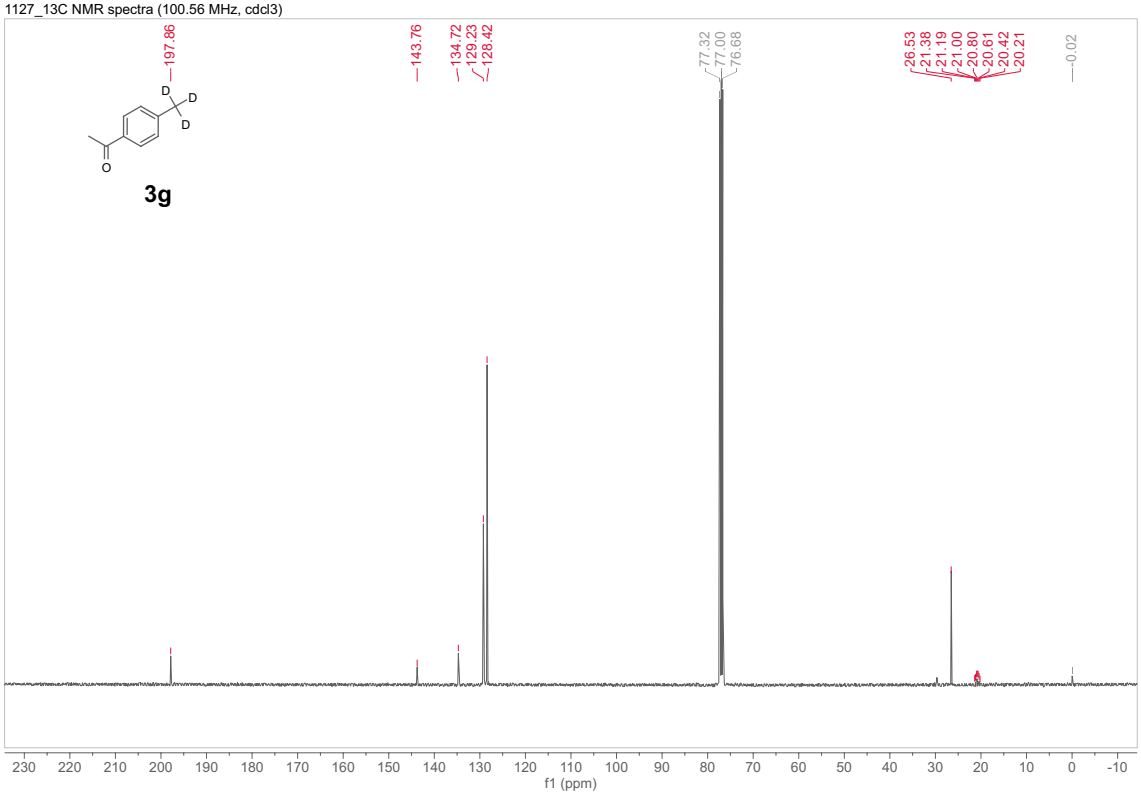
1054_2H NMR spectra (76.74 MHz, CHCl3)



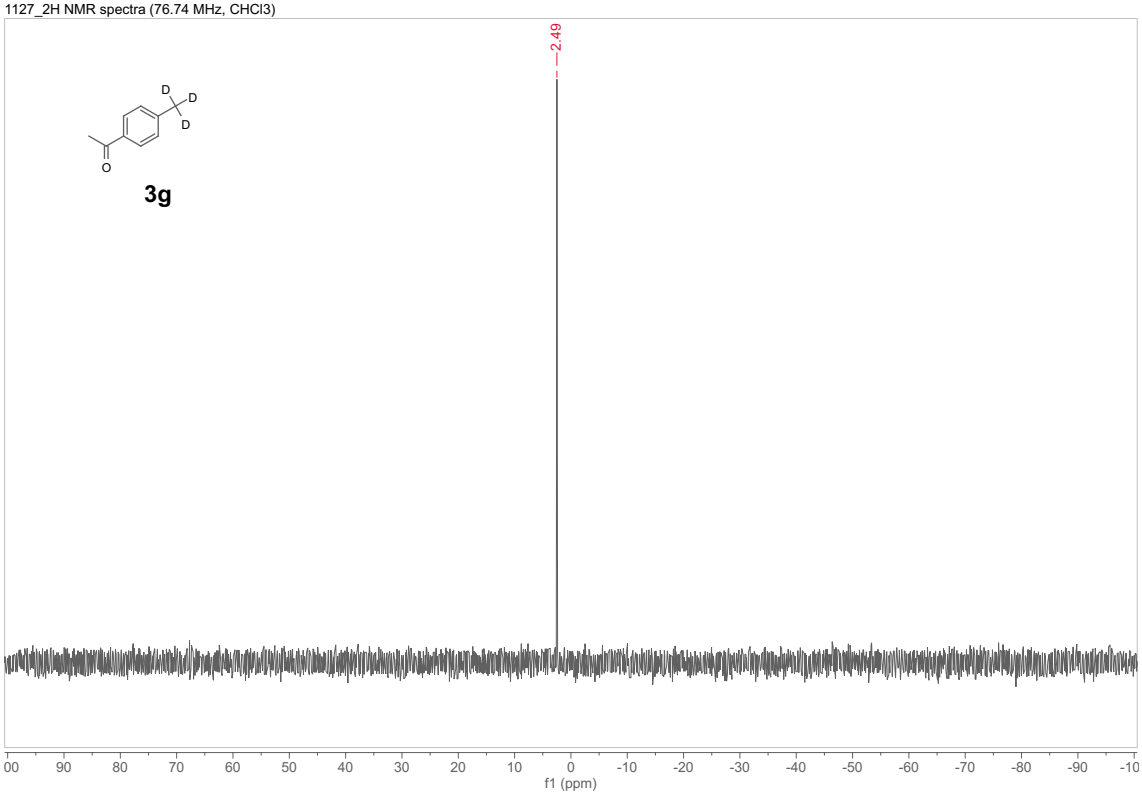
1127_1H NMR spectra (399.89 MHz, cdcl3)



1127_13C NMR spectra (100.56 MHz, cdcl3)

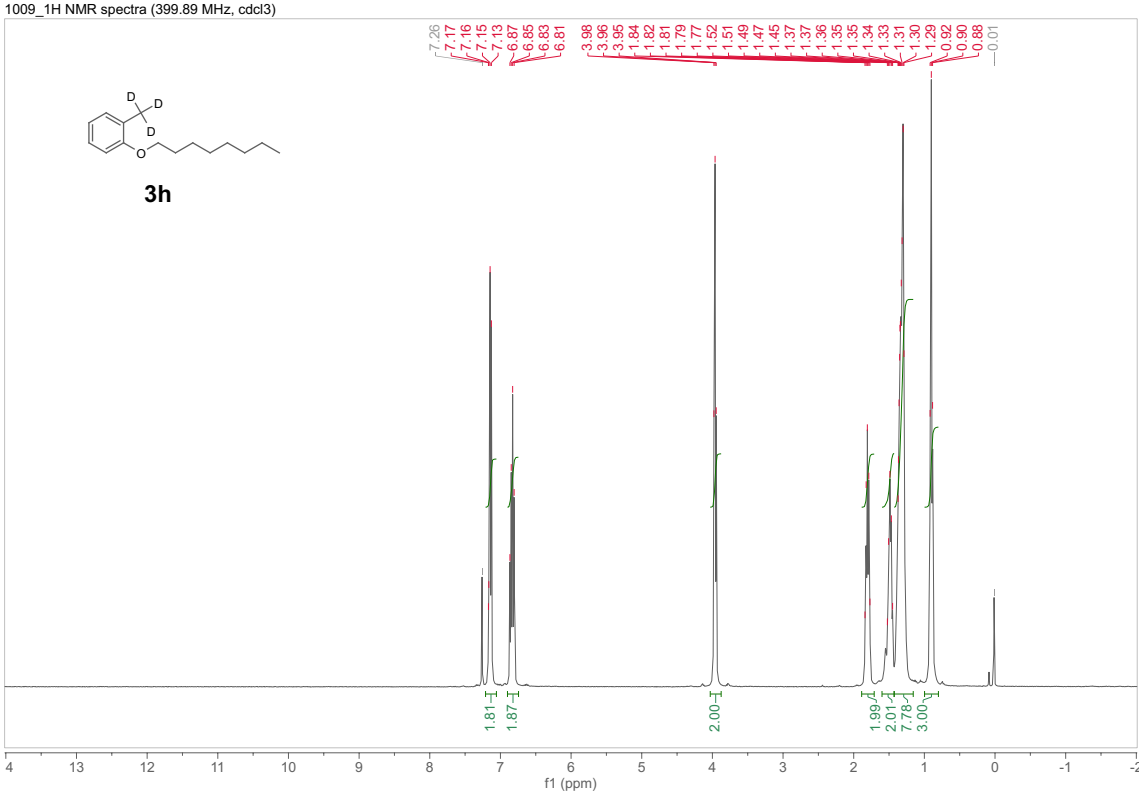


1127_2H NMR spectra (76.74 MHz, CHCl3)



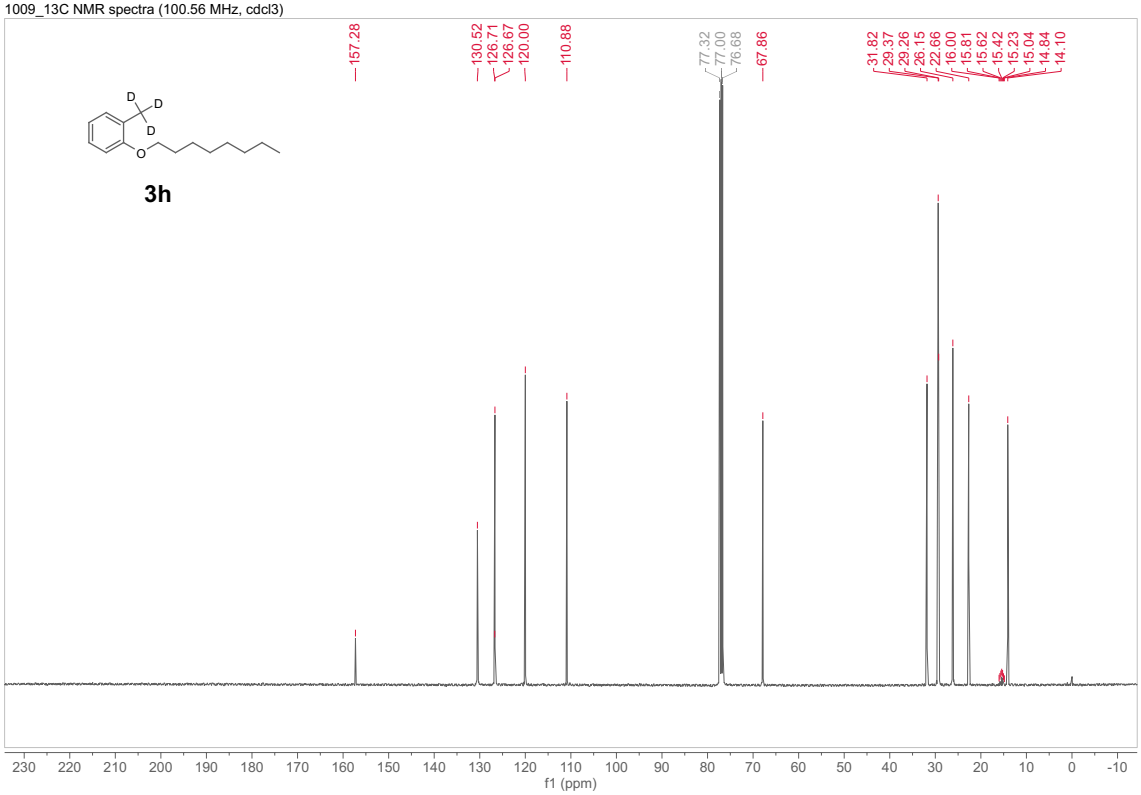
3g

1009_1H NMR spectra (399.89 MHz, cdcl3)

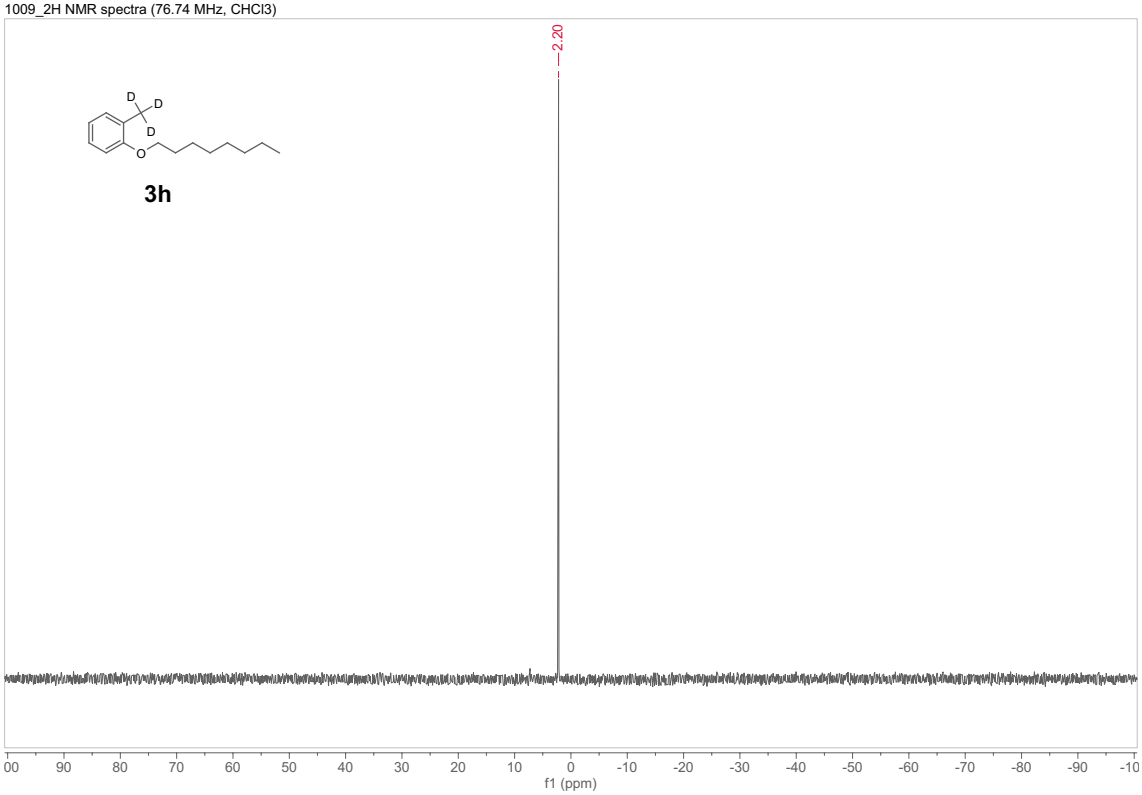


3h

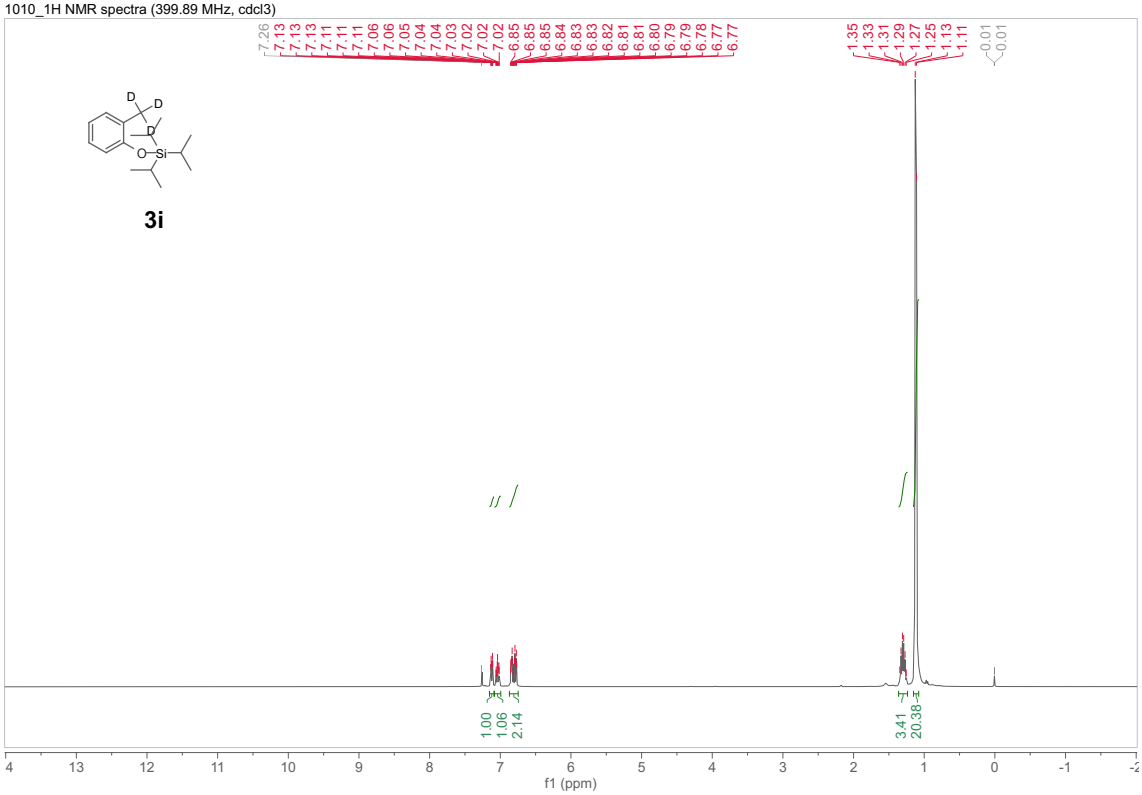
1009_13C NMR spectra (100.56 MHz, cdcl3)



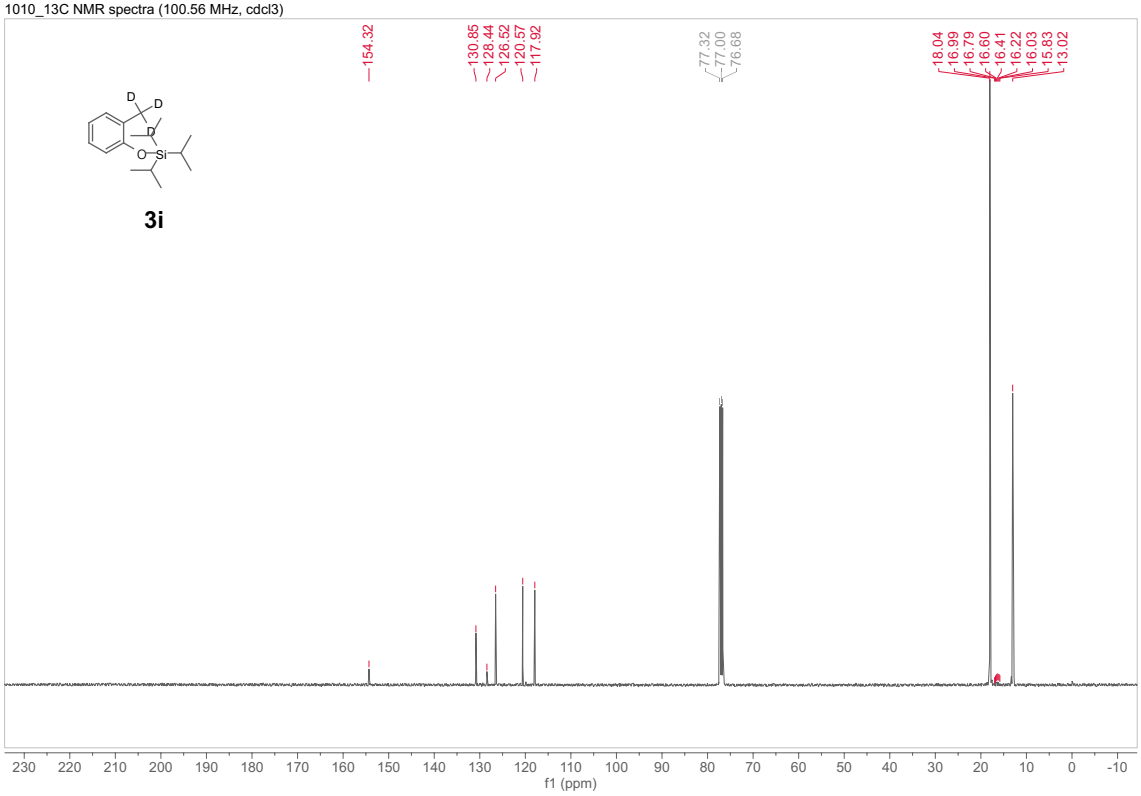
1009_2H NMR spectra (76.74 MHz, CHCl3)



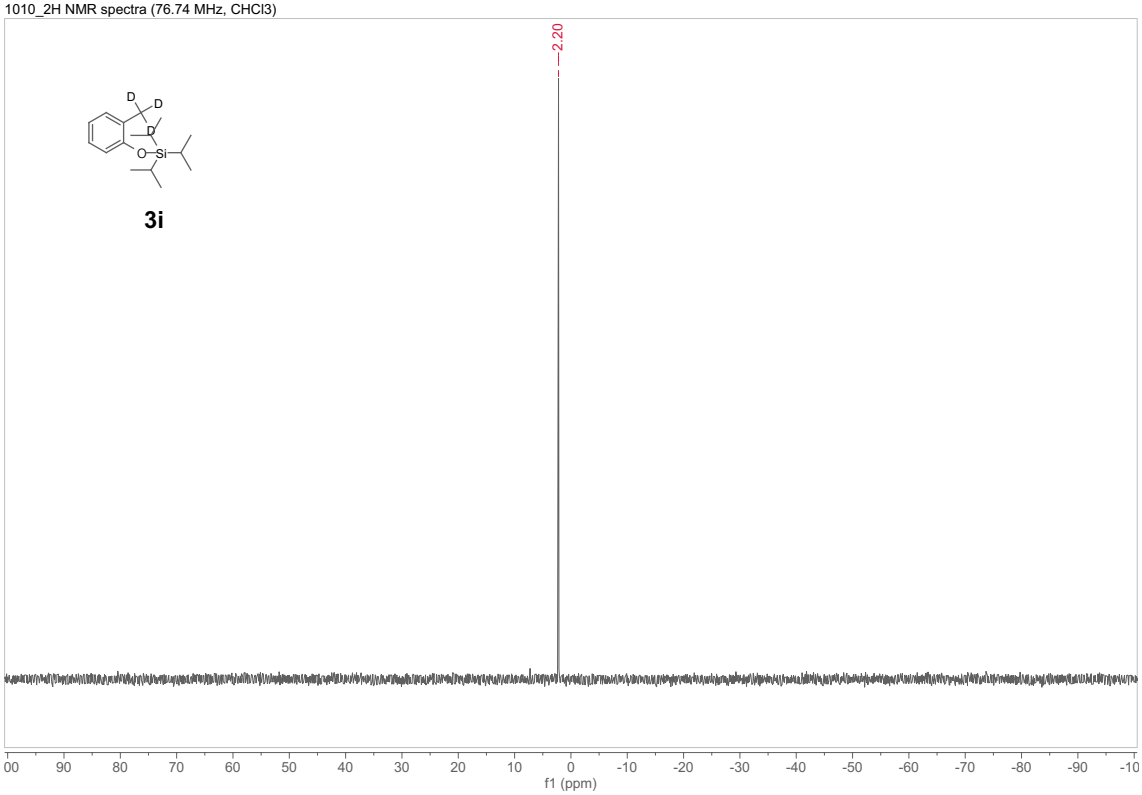
1010_1H NMR spectra (399.89 MHz, cdcl3)



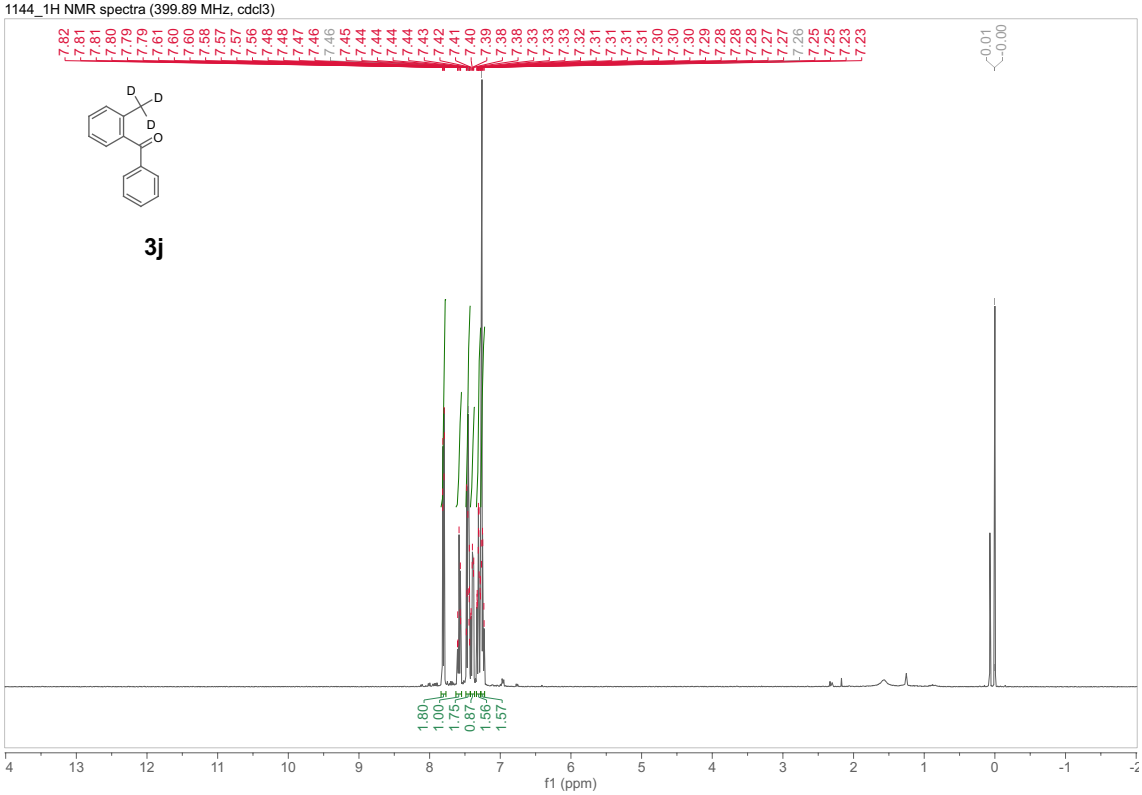
1010_13C NMR spectra (100.56 MHz, cdcl3)



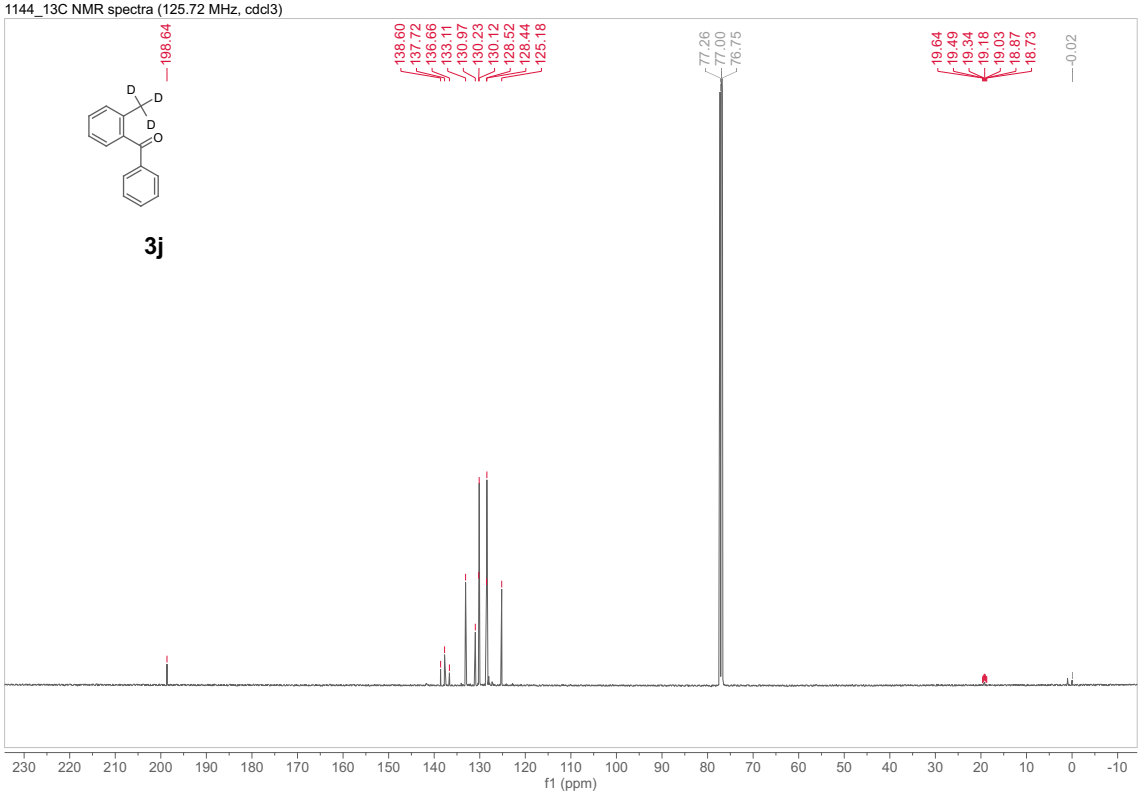
1010_2H NMR spectra (76.74 MHz, CHCl3)



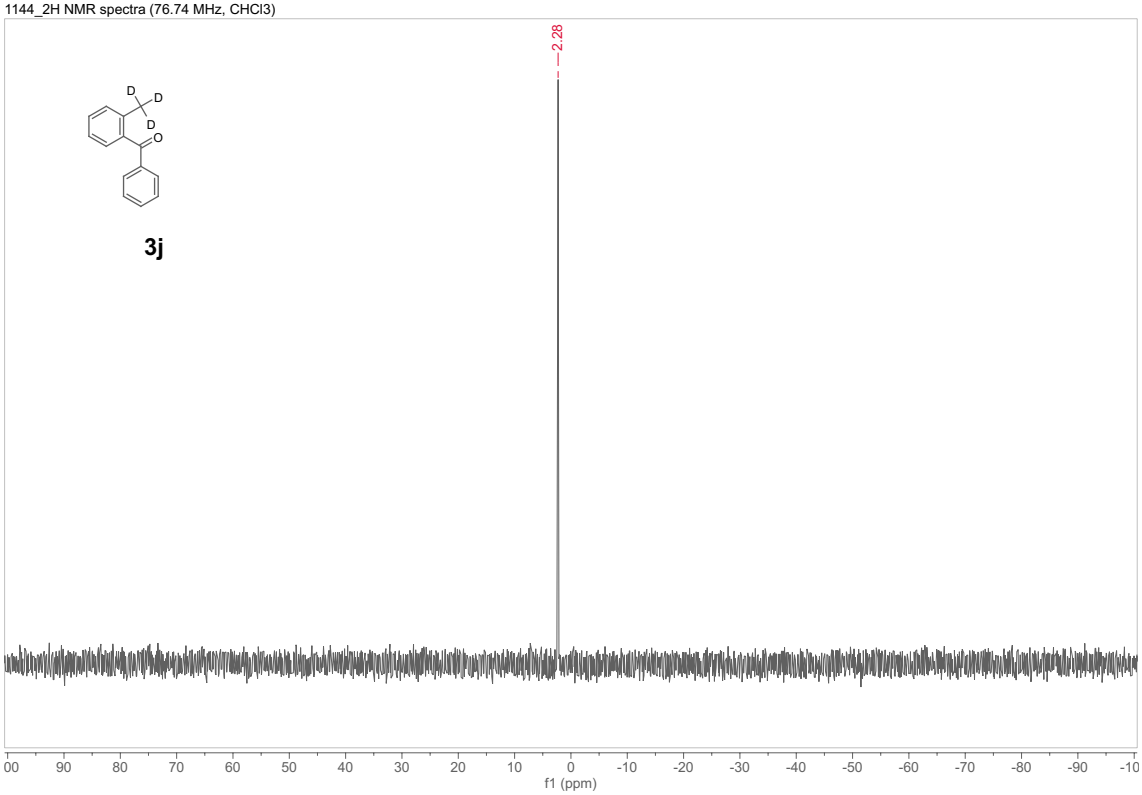
1144_1H NMR spectra (399.89 MHz, cdcl3)



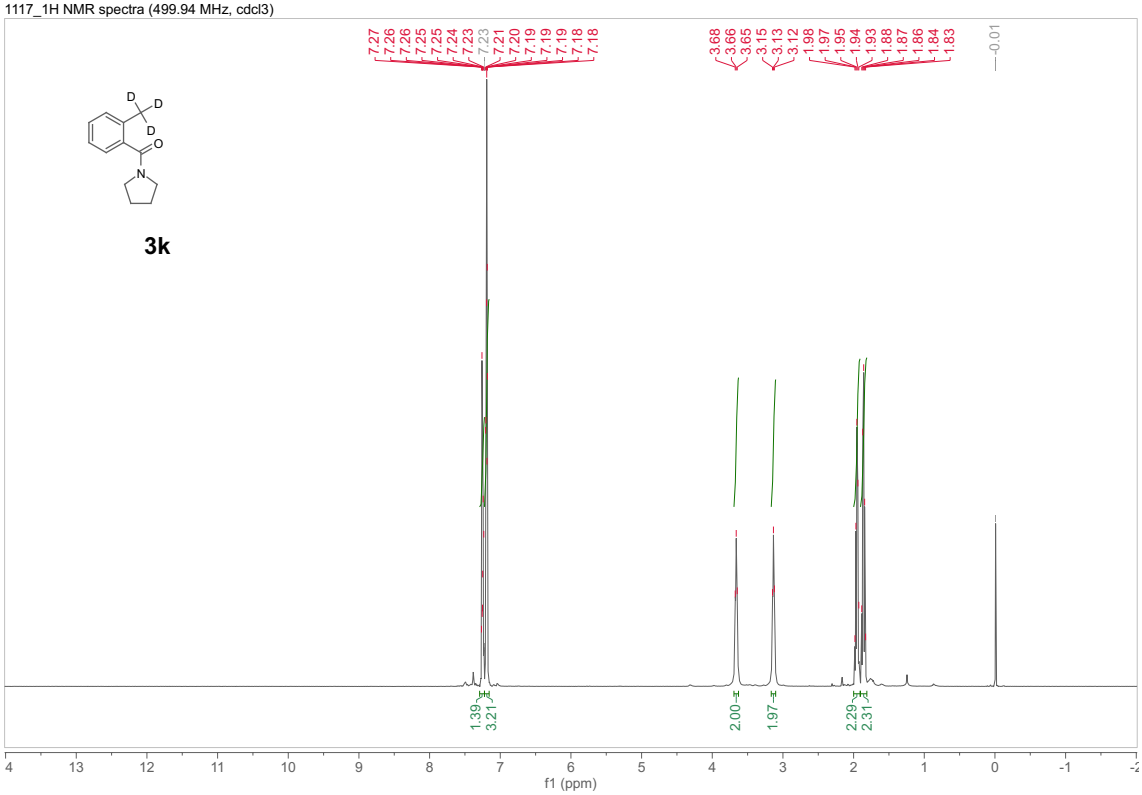
1144_13C NMR spectra (125.72 MHz, cdcl3)



1144_2H NMR spectra (76.74 MHz, CHCl3)

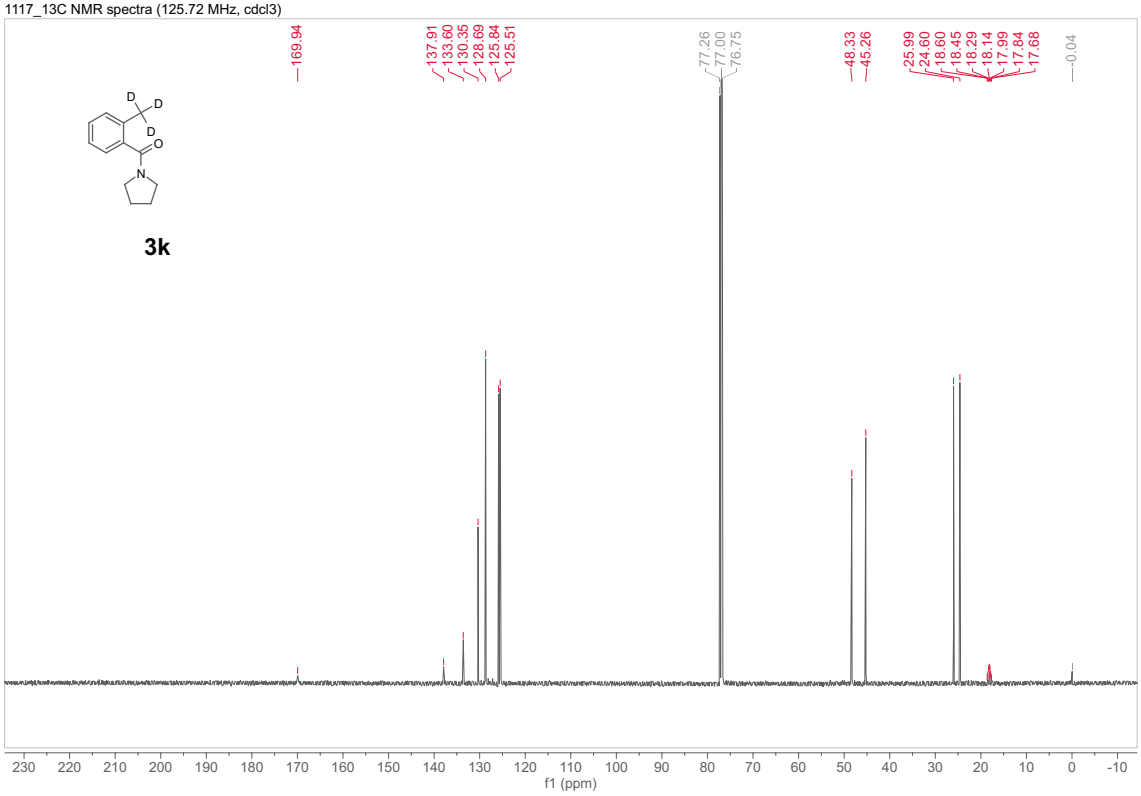


1117_1H NMR spectra (499.94 MHz, cdcl3)



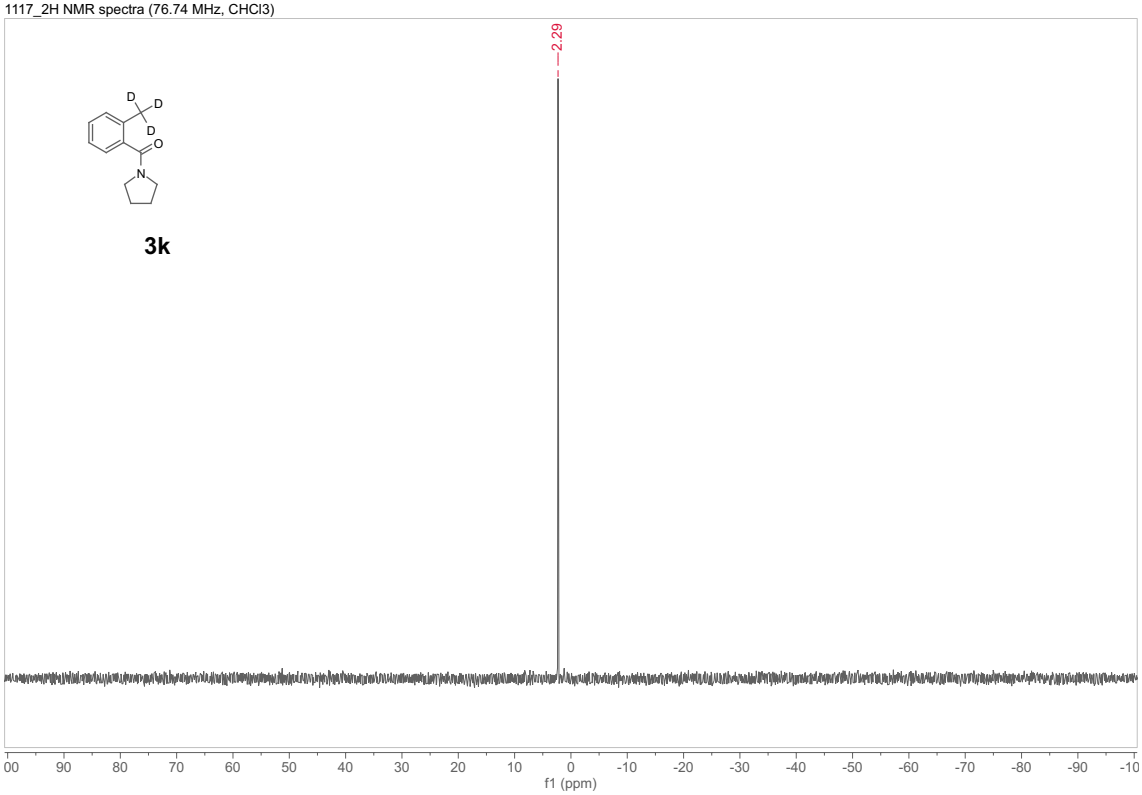
3k

1117_13C NMR spectra (125.72 MHz, cdcl3)



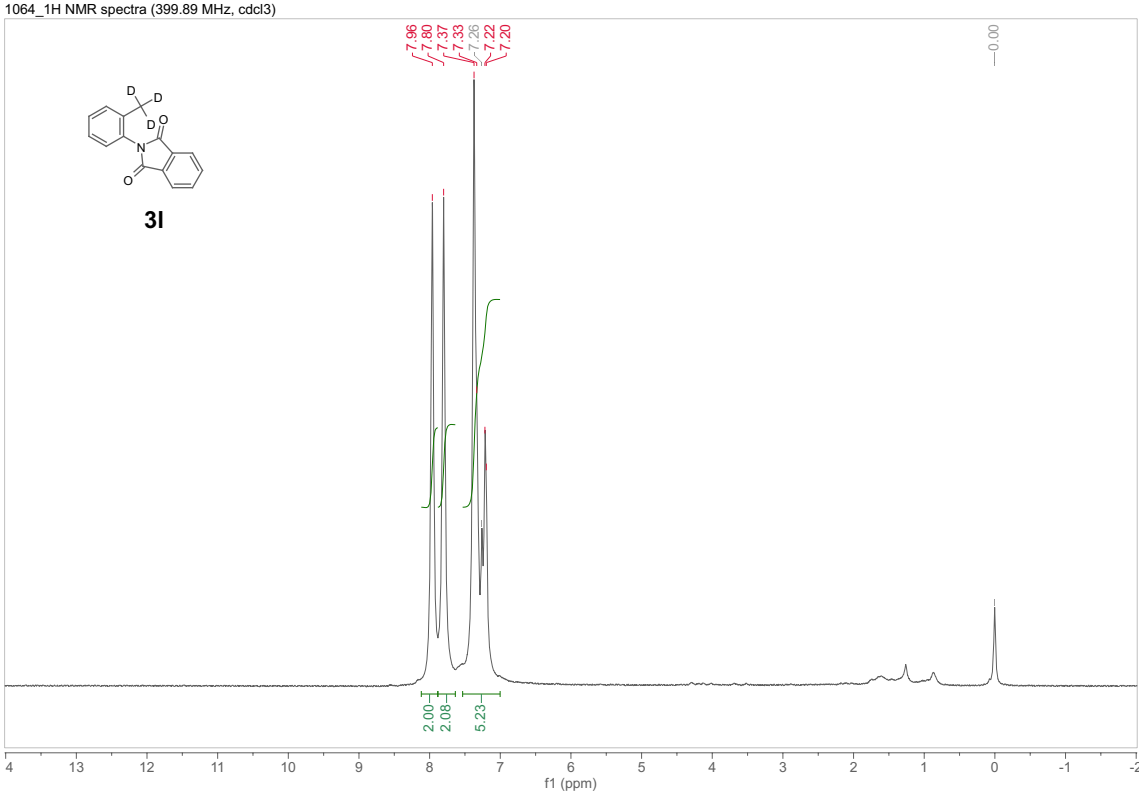
3k

1117_2H NMR spectra (76.74 MHz, CHCl3)



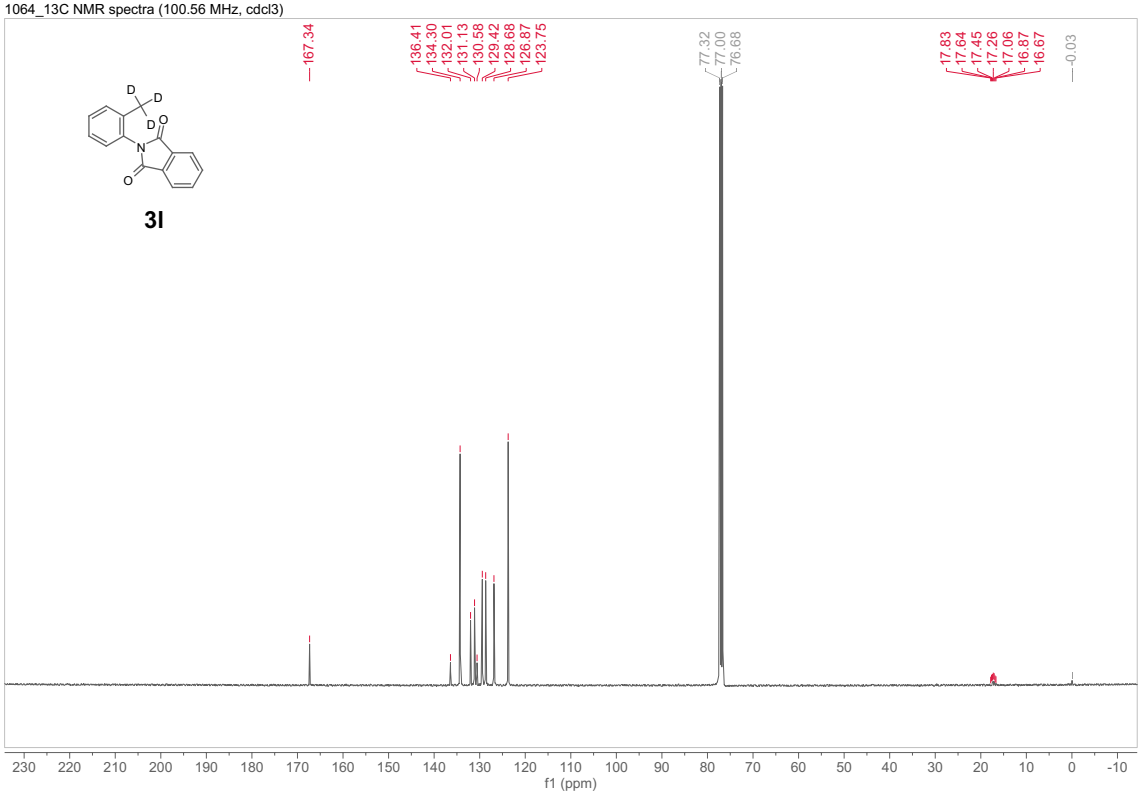
3k

1064_1H NMR spectra (399.89 MHz, cdcl3)

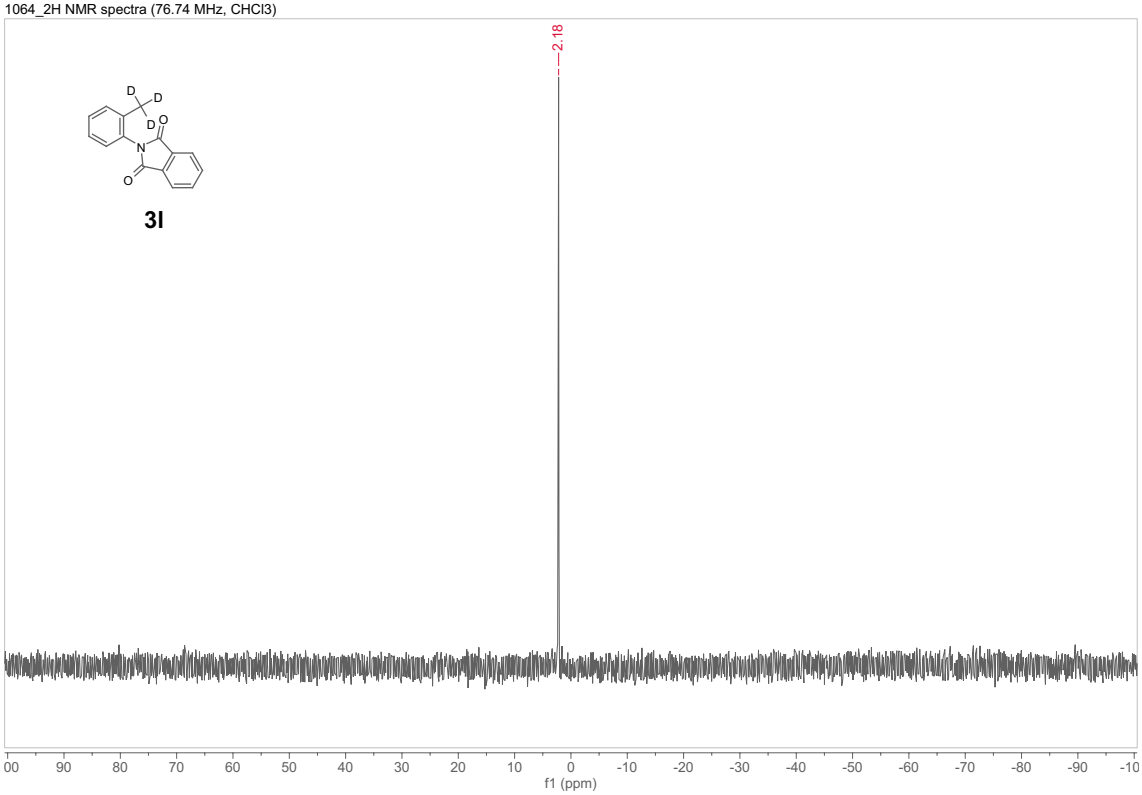


3l

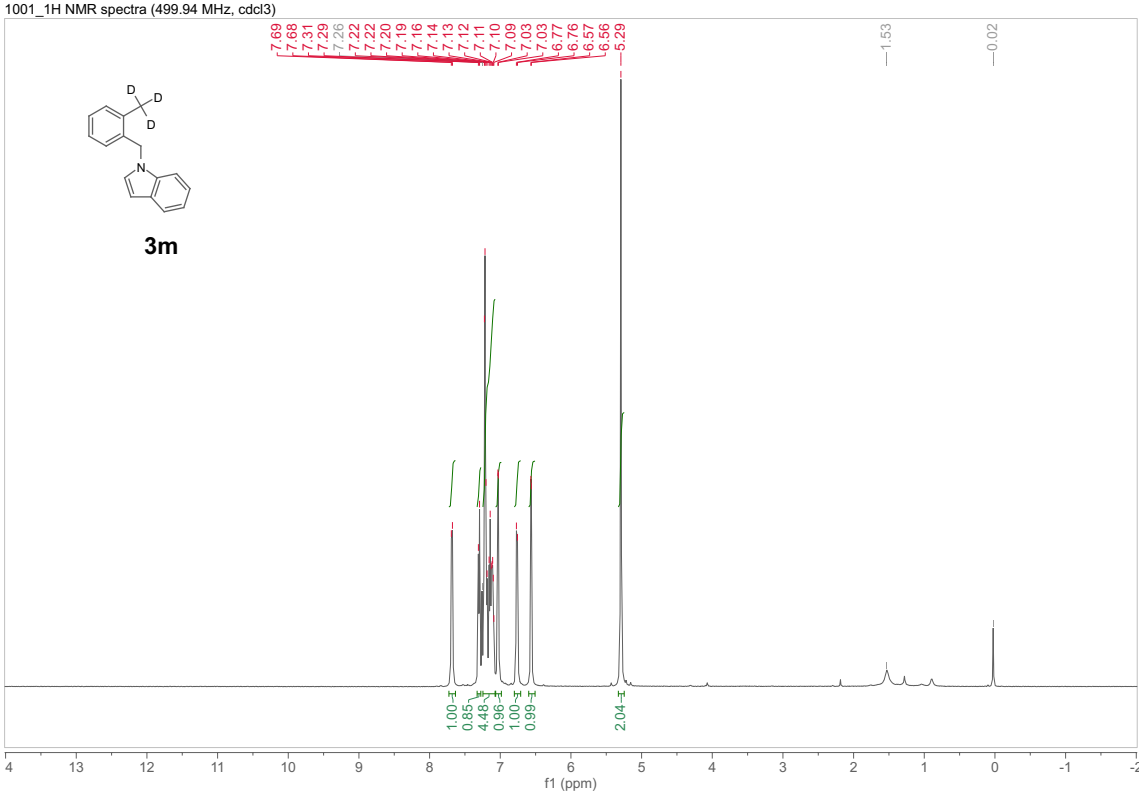
1064_13C NMR spectra (100.56 MHz, cdcl3)



1064_2H NMR spectra (76.74 MHz, CHCl3)

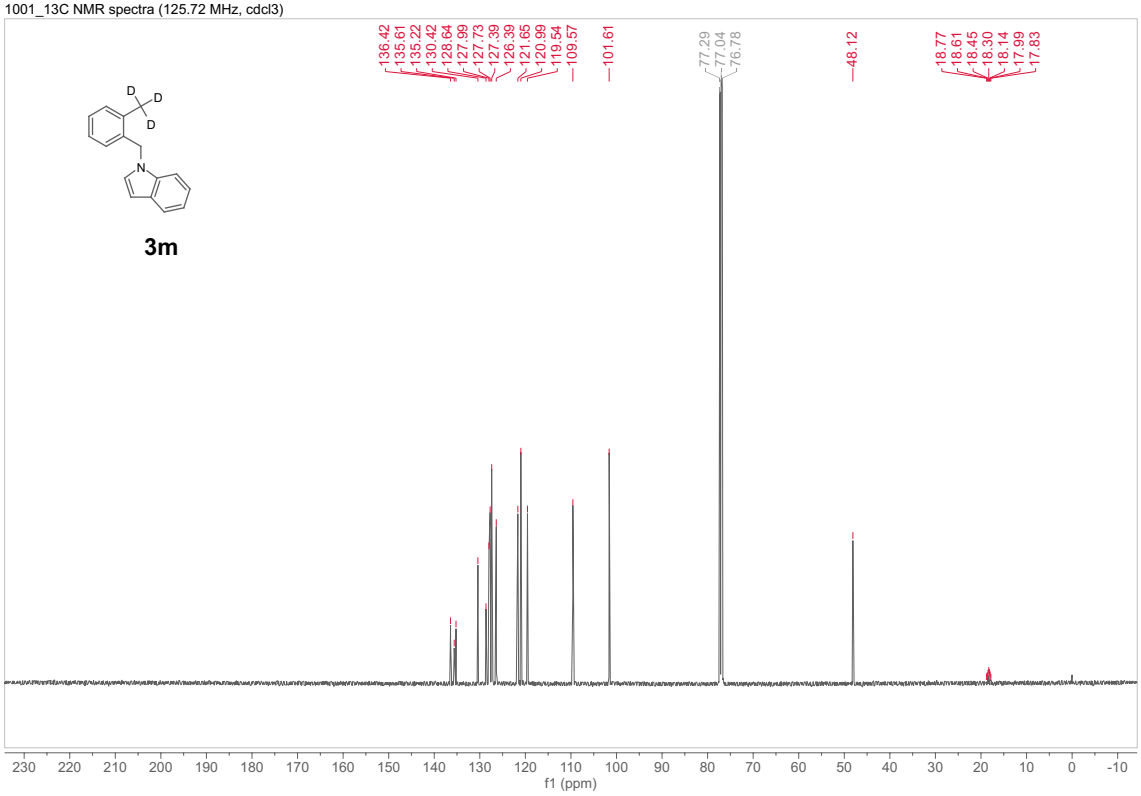


1001_1H NMR spectra (499.94 MHz, cdcl3)



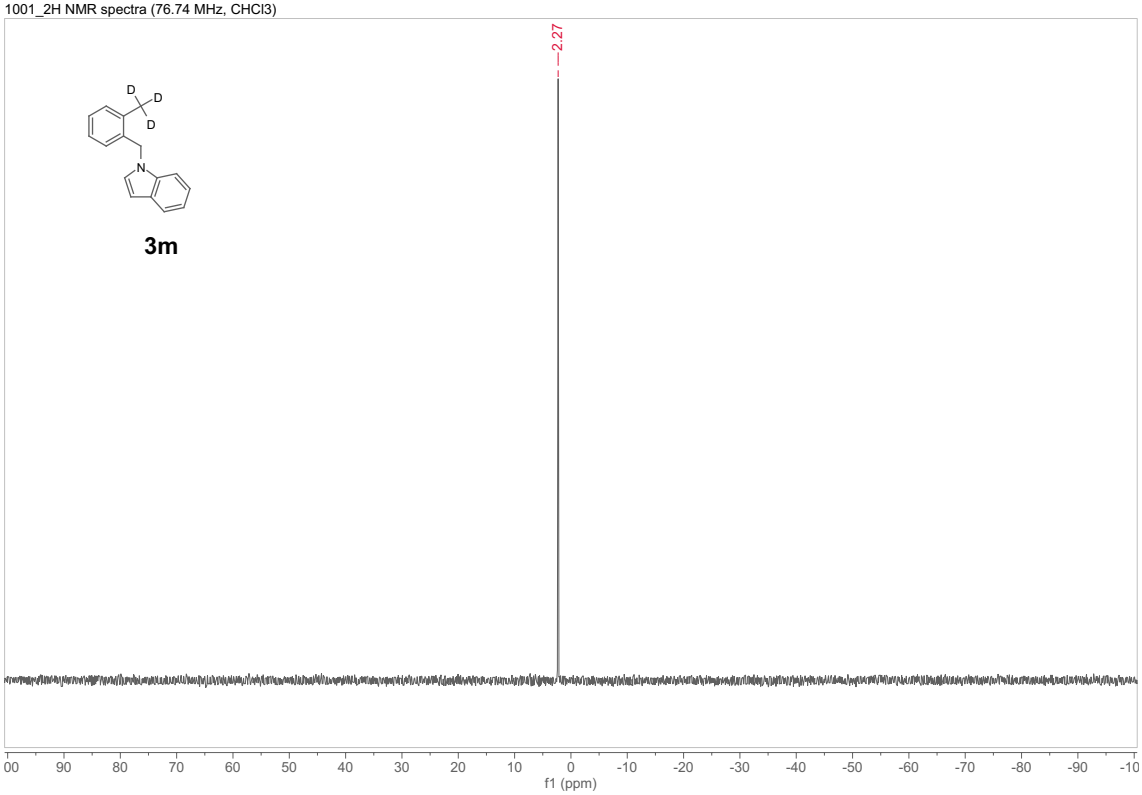
3m

1001_13C NMR spectra (125.72 MHz, cdcl3)

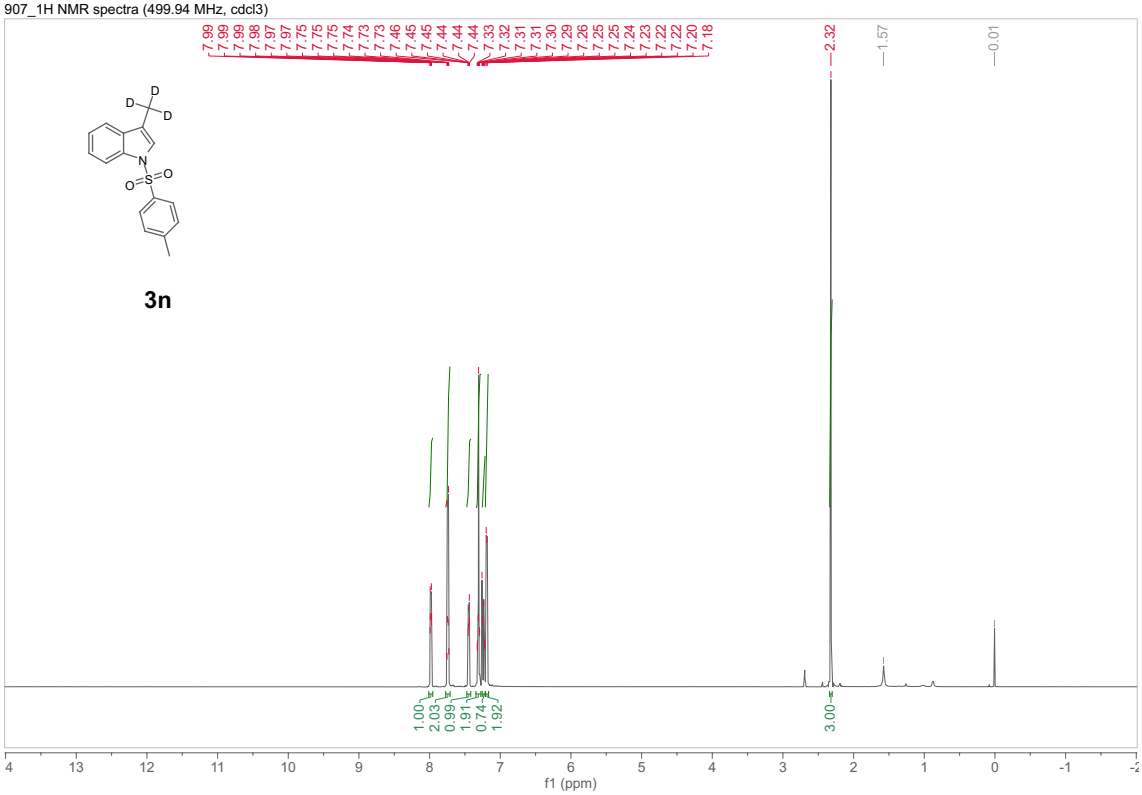


3m

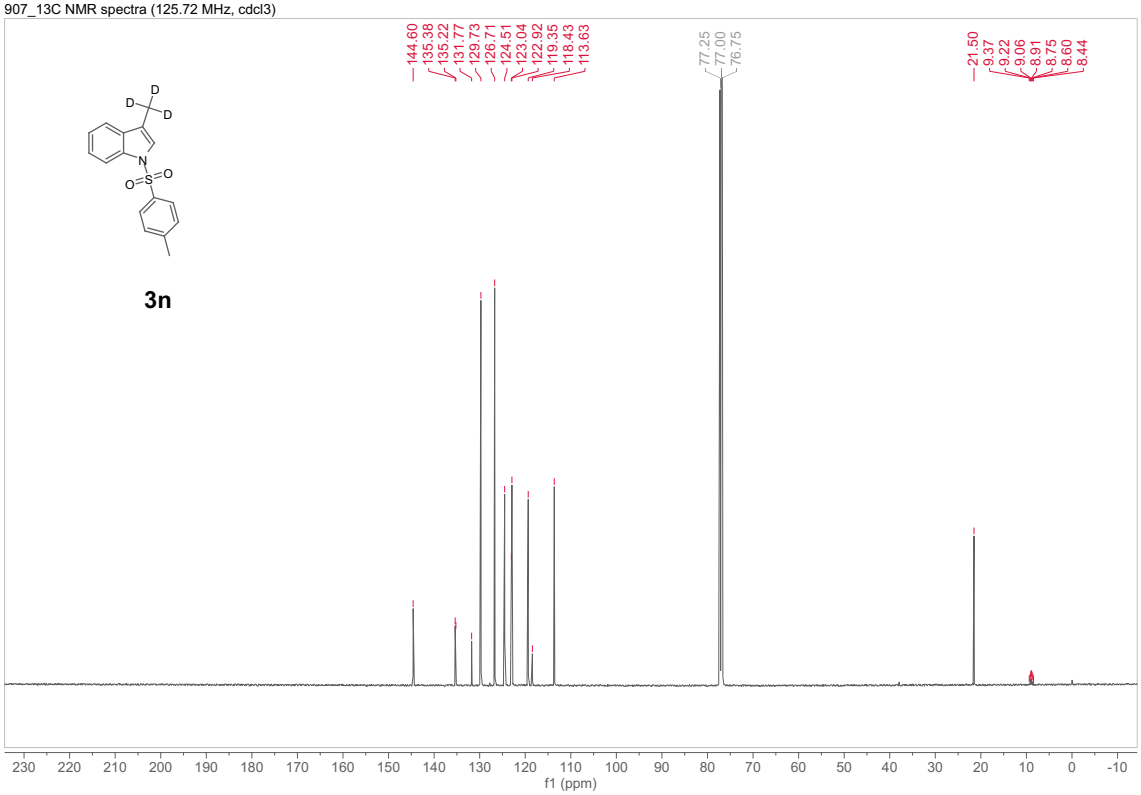
1001_2H NMR spectra (76.74 MHz, CHCl3)



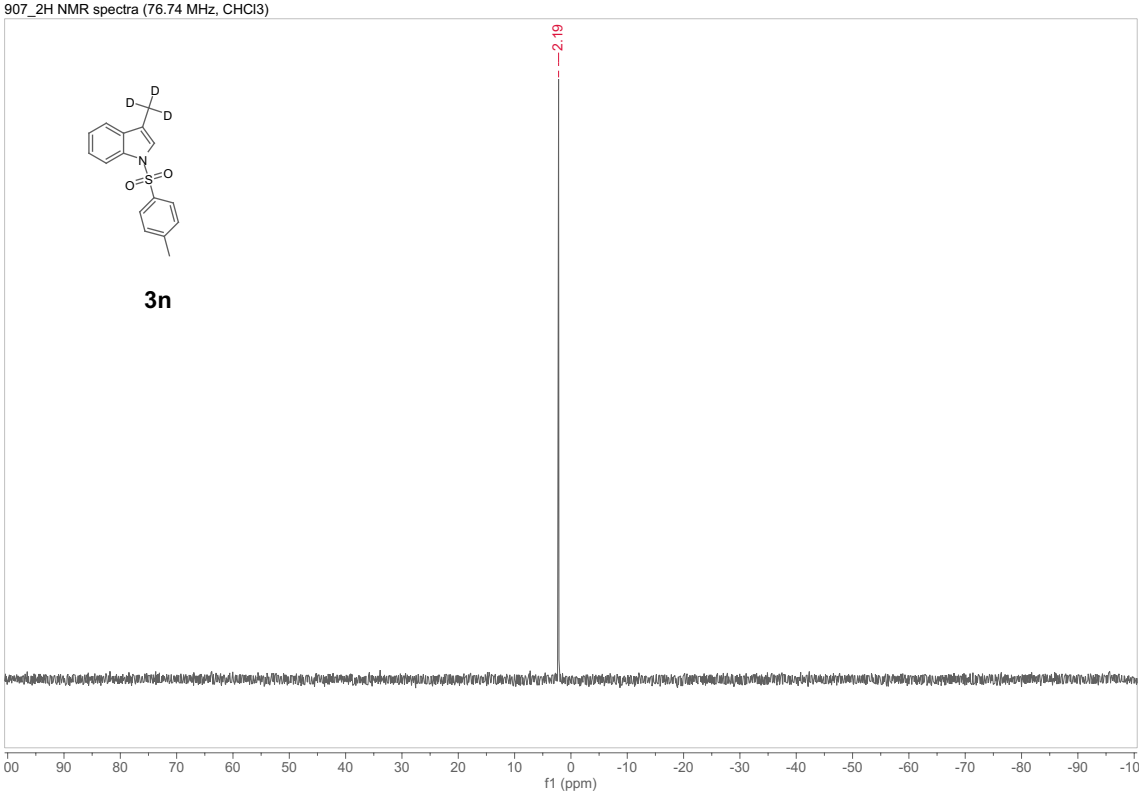
907_1H NMR spectra (499.94 MHz, cdcl3)



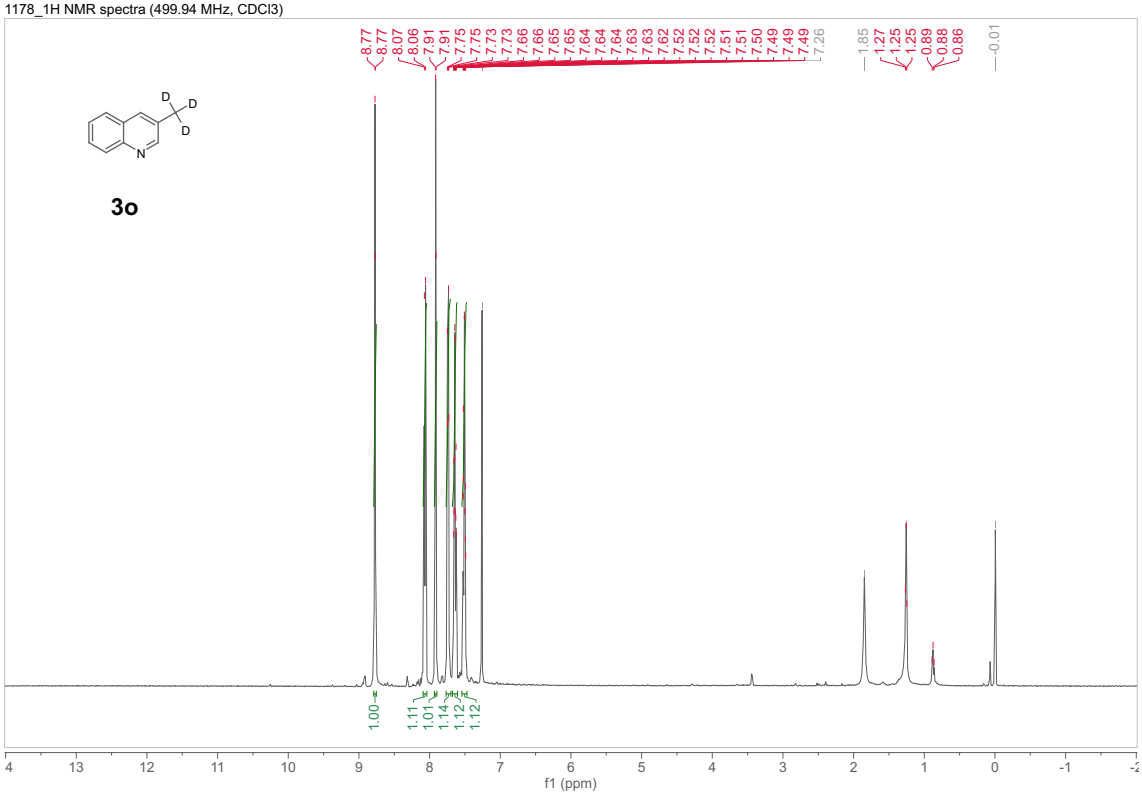
907_13C NMR spectra (125.72 MHz, cdcl3)



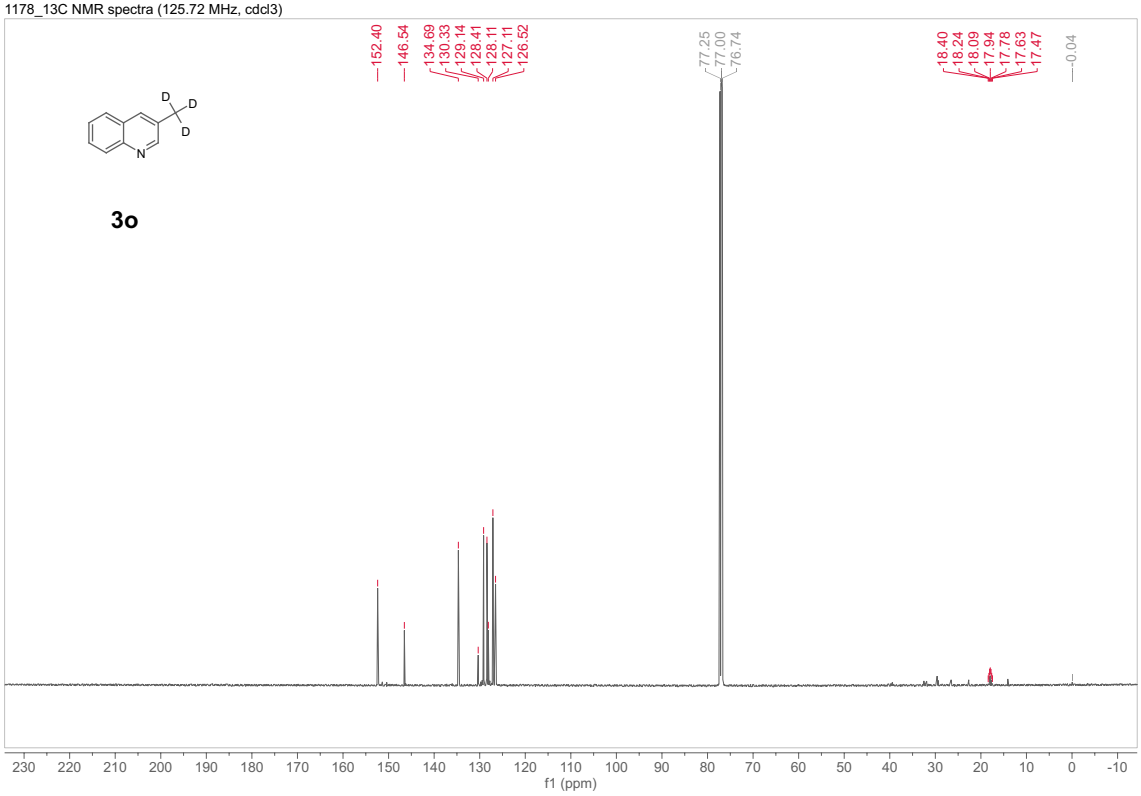
907_2H NMR spectra (76.74 MHz, CHCl3)



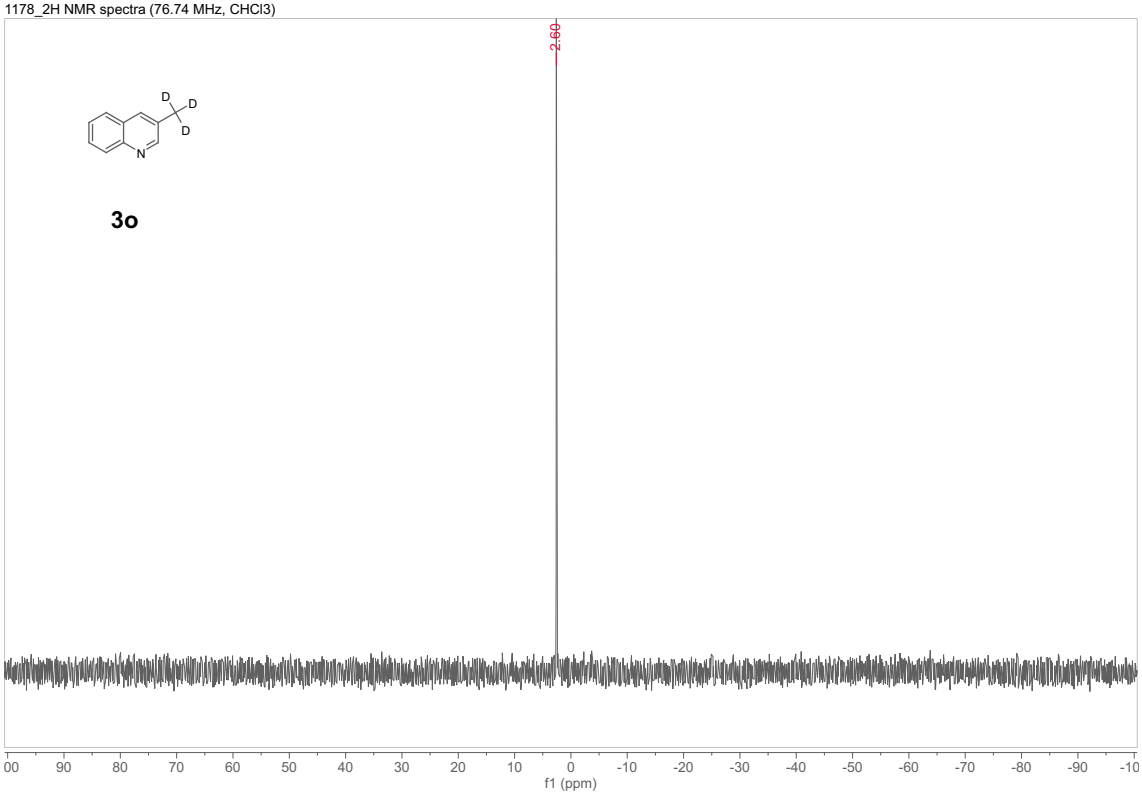
1178_1H NMR spectra (499.94 MHz, CDCl3)



1178_13C NMR spectra (125.72 MHz, cdcl3)

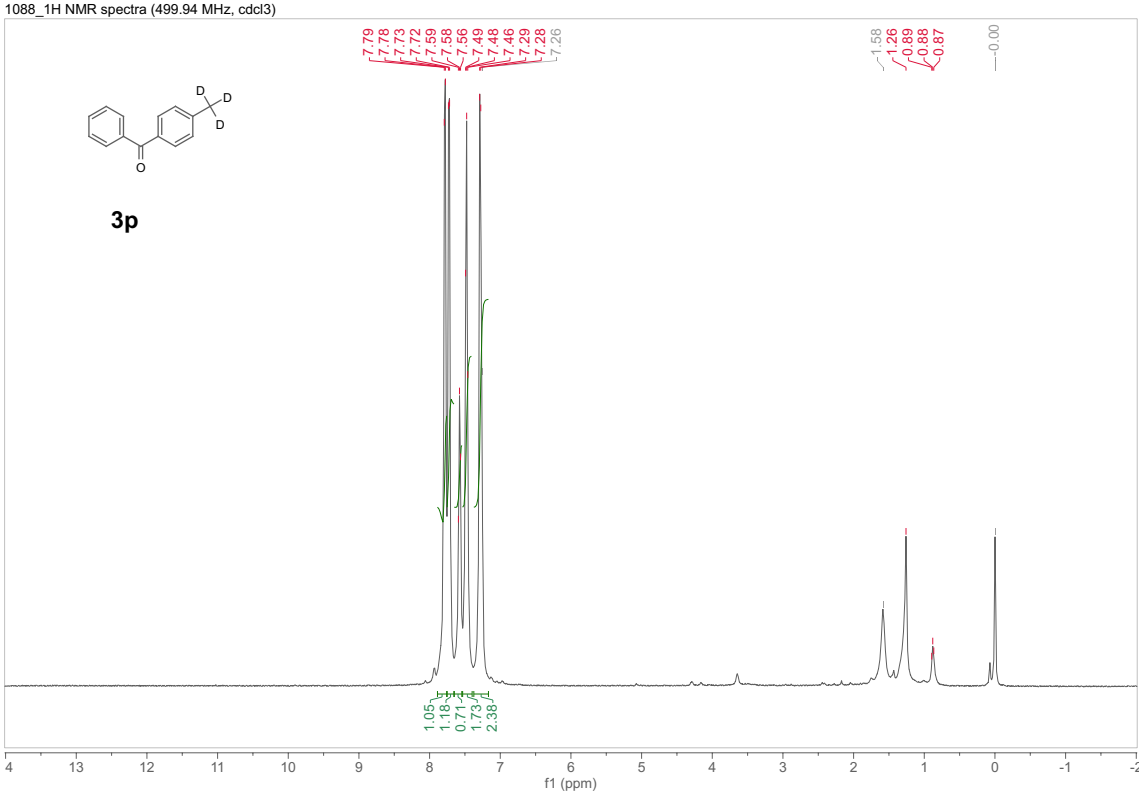


1178_2H NMR spectra (76.74 MHz, CHCl3)



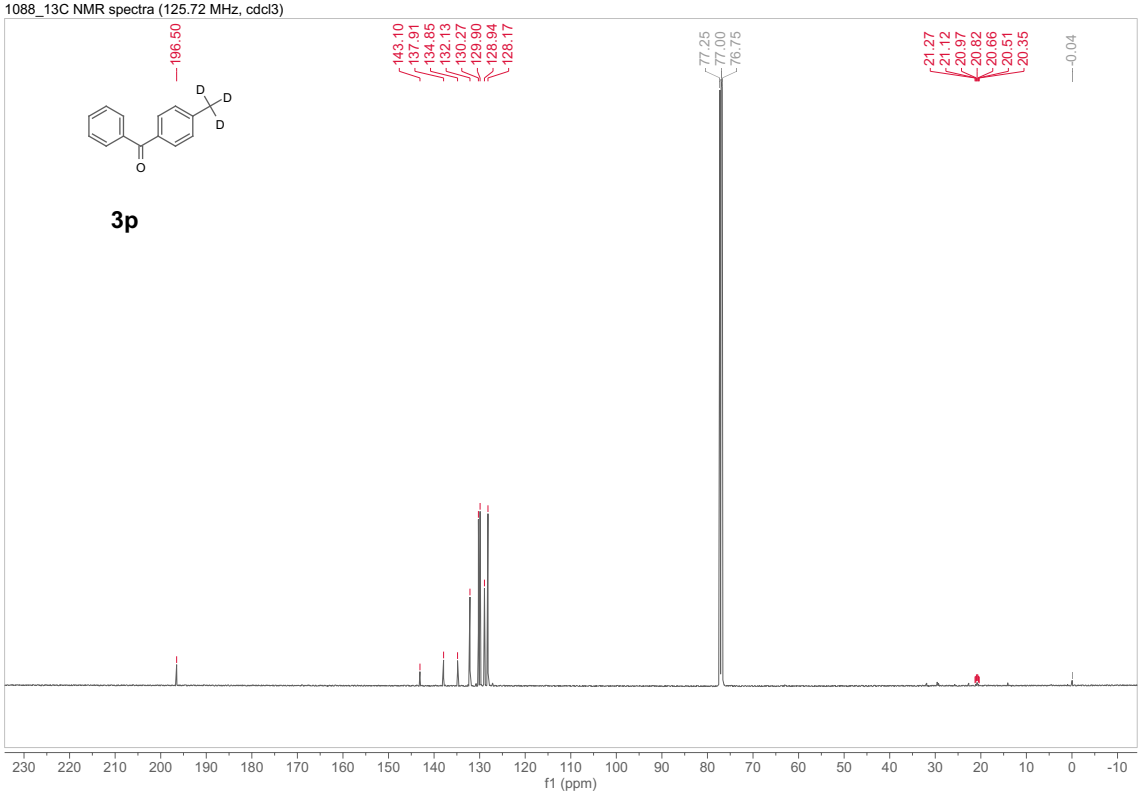
3o

1088_1H NMR spectra (499.94 MHz, cdcl3)

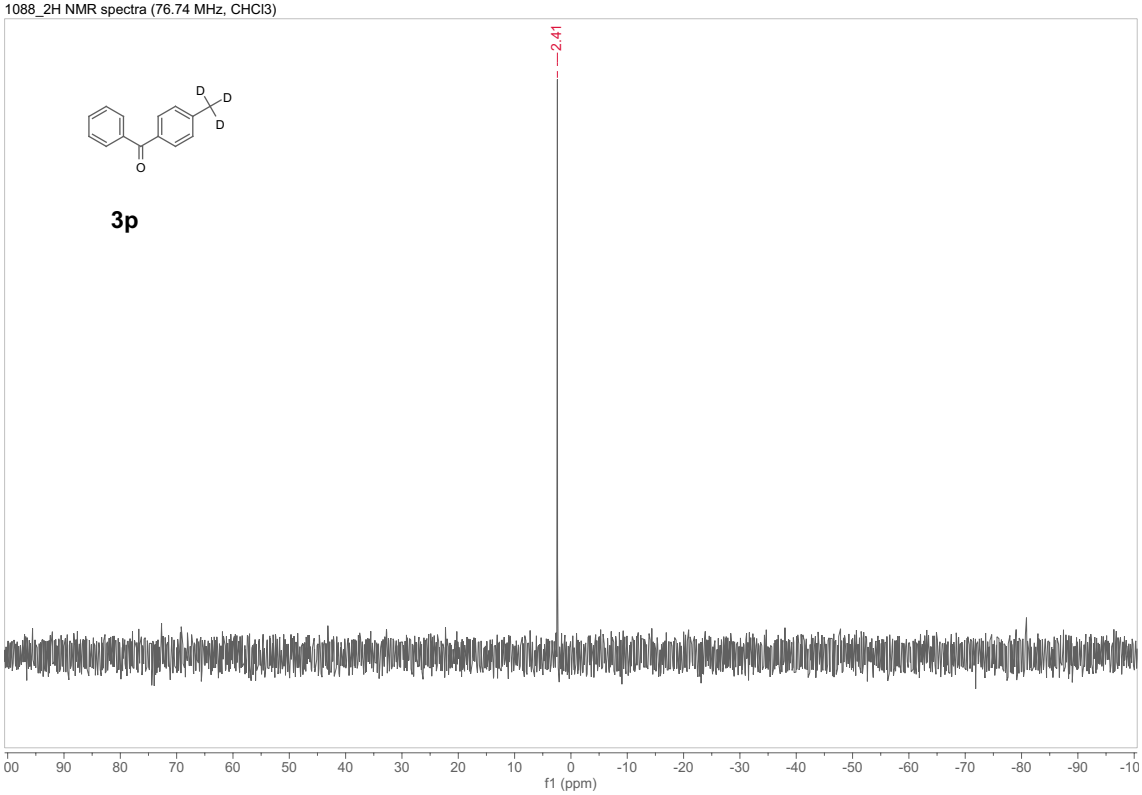


3p

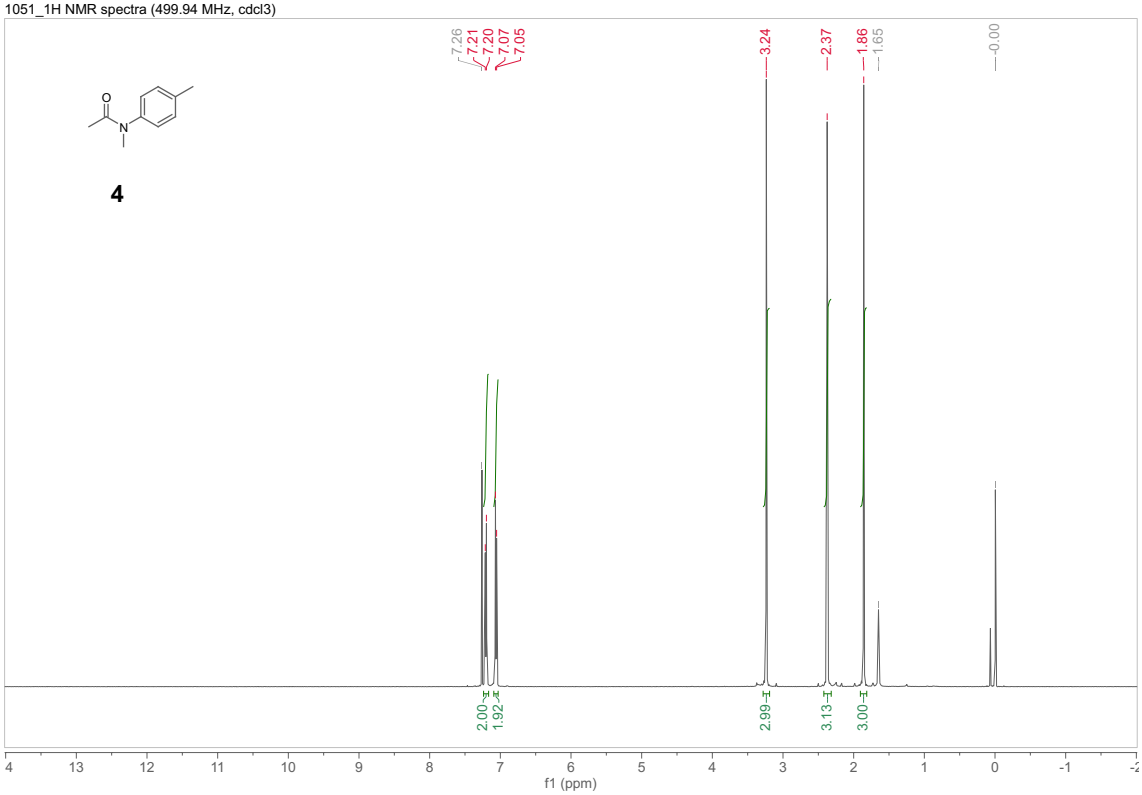
1088_13C NMR spectra (125.72 MHz, cdcl3)



1088_2H NMR spectra (76.74 MHz, CHCl3)

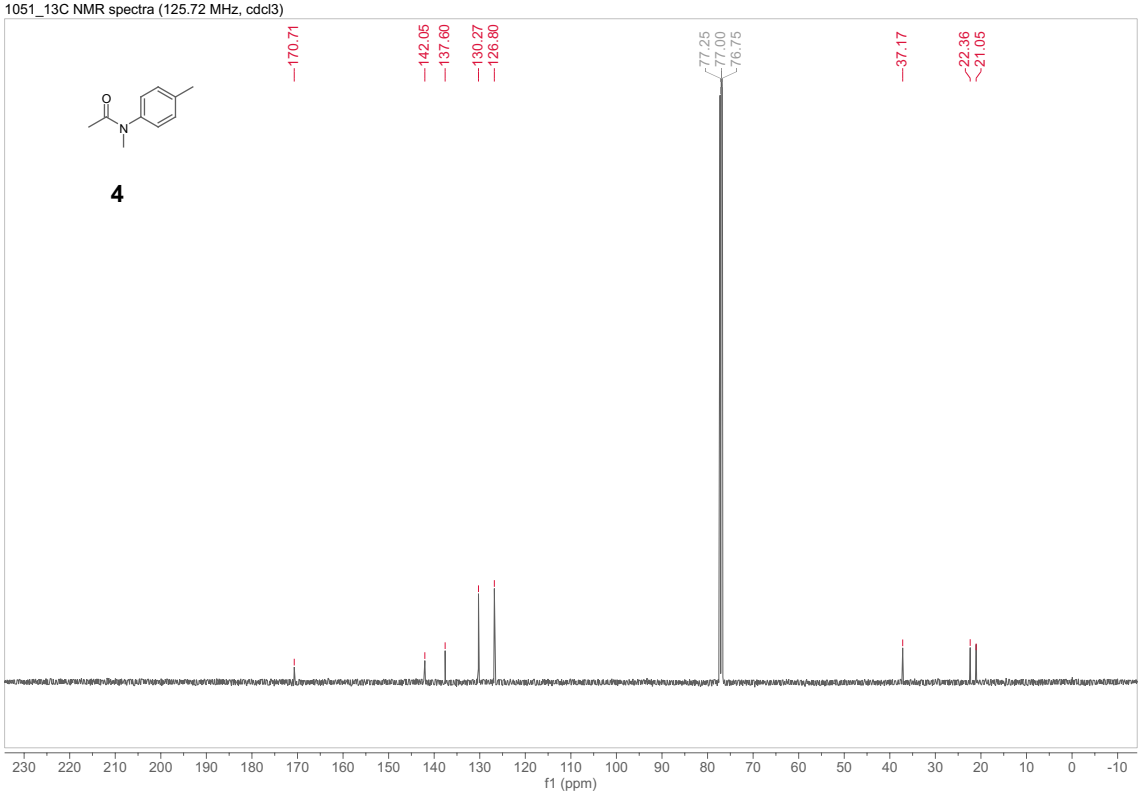


1051_1H NMR spectra (499.94 MHz, cdcl3)



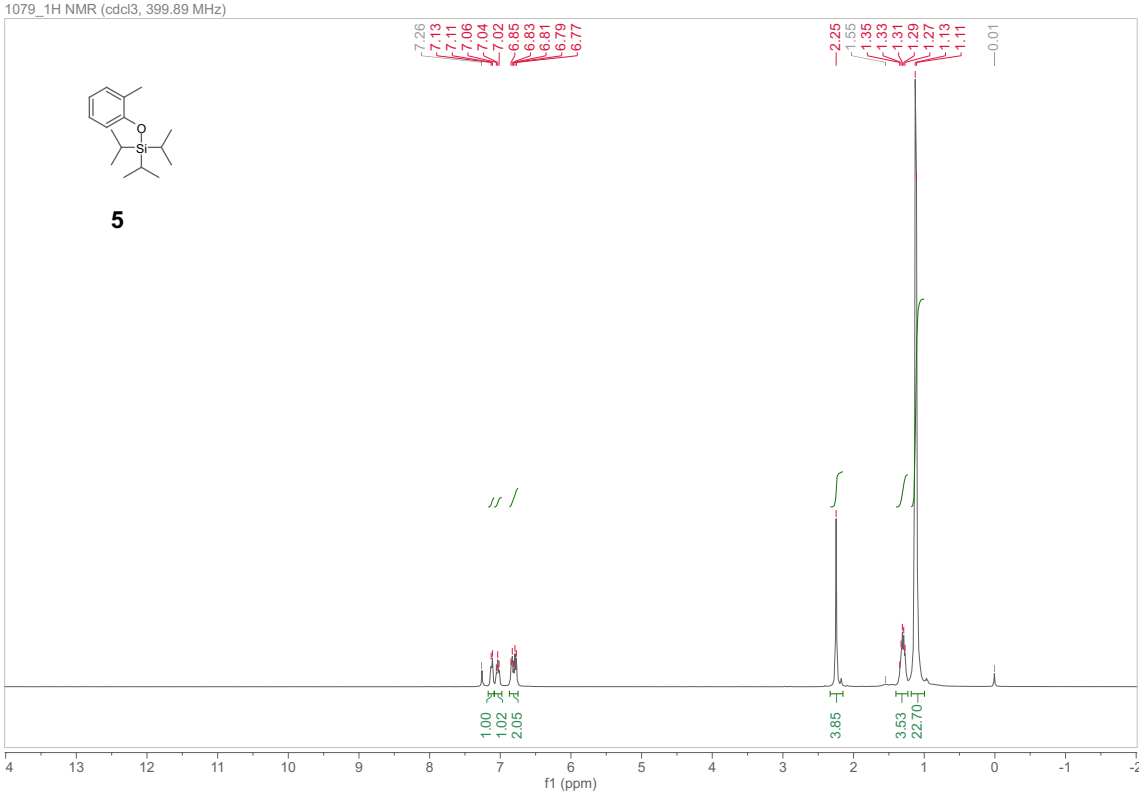
4

1051_13C NMR spectra (125.72 MHz, cdcl3)



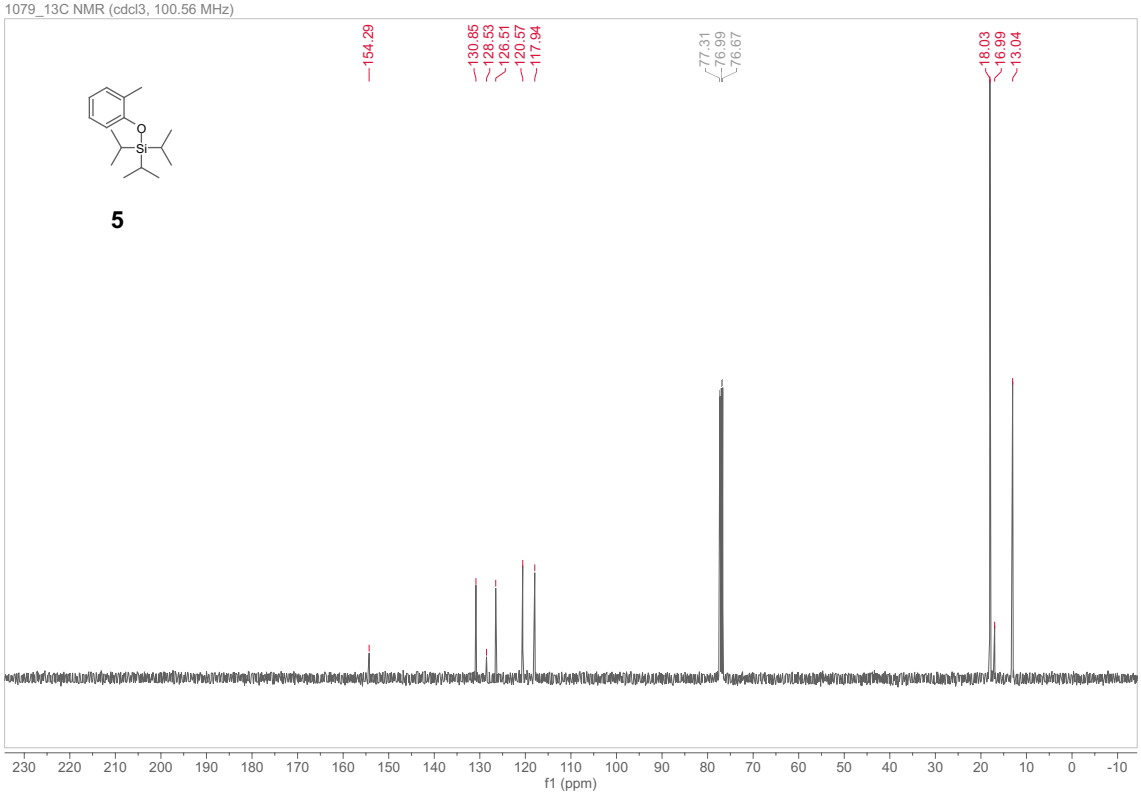
4

1079_1H NMR (cdcl3, 399.89 MHz)



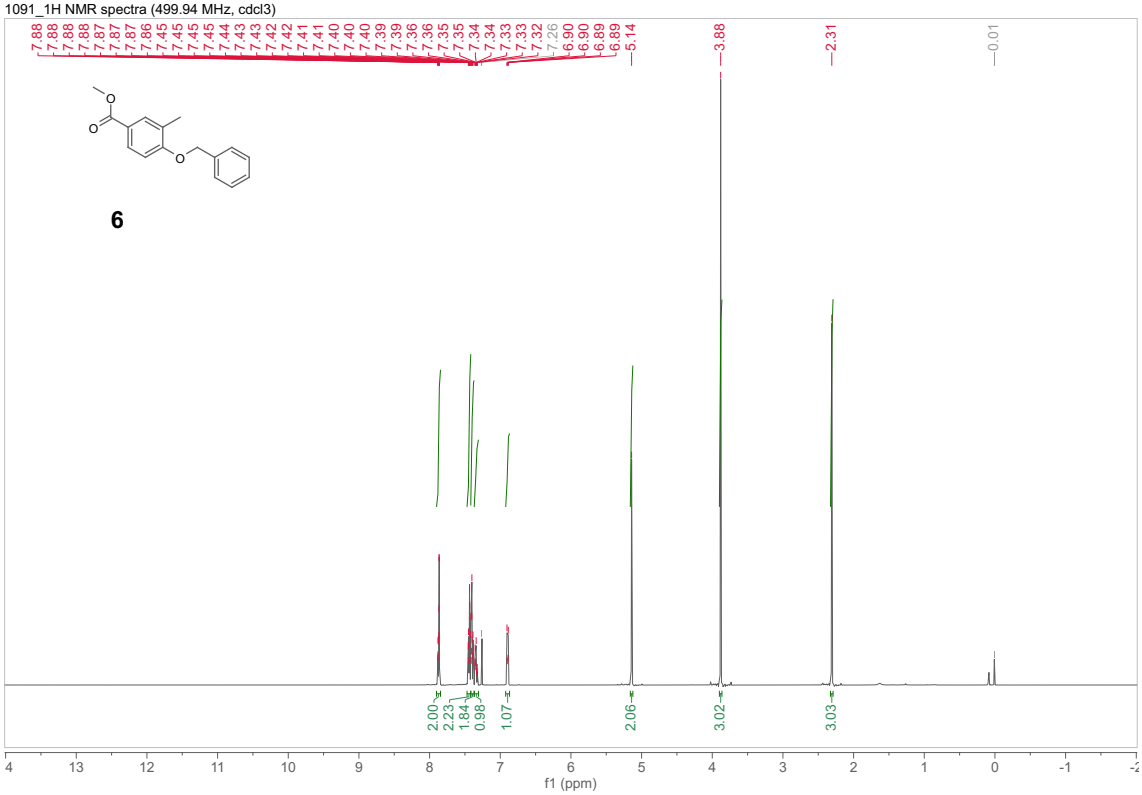
5

1079_13C NMR (cdcl3, 100.56 MHz)



5

1091_1H NMR spectra (499.94 MHz, cdcl3)



1091_13C NMR spectra (125.72 MHz, cdcl3)