

**Eosin, blue LEDs and DIPEA are employed in a simple synthesis of
(poly)cyclic O,O- and N,O-acetals**

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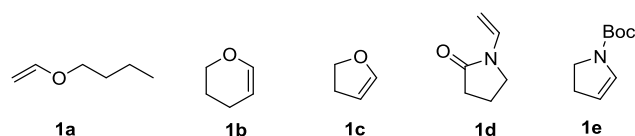
Part A: General methods, experimental procedures

General methods

NMR data were obtained for ^1H at 500 MHz and for ^{13}C at 125 MHz. ^1H NMR splitting patterns are designated as singlet (s), doublet (d), triplet (t), quartet (q), quintet (quint), multiplet (m), broad (br), doublet of doublets (dd), doublet of doublet of doublets (ddd), doublet of triplets (dt), doublet of quartets (dq), triplet of doublets (td), doublet of doublet of triplets (ddt), triplet of triplets (tt), quartet of doublets (qd) and quartet of triplets (qt).

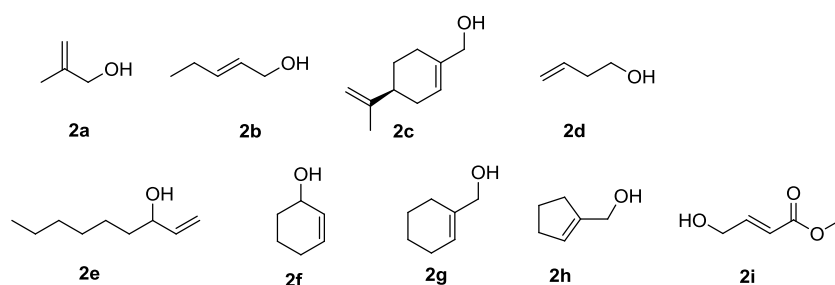
HRMS data was recorded on a Q-Exactive Plus Orbitrap MS, using ESI as ionization source.

Starting substrates (vinyl ethers and vinyl pyrrolidines)



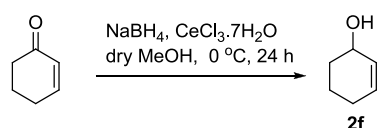
Compounds **1a-1e** are commercially available.

Starting alcohols



Compounds **2a-2d**, **2i** are commercially available and **2e** was synthesized according to our previously published procedure.¹

Experimental procedure for the synthesis of cyclohex-2-enol (**2f**)



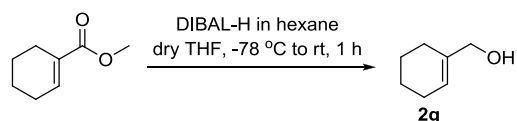
Under an argon atmosphere NaBH_4 (12 mmol, 454 mg) and $\text{CeCl}_3 \cdot 7\text{H}_2\text{O}$ (7.5 mmol, 2.80 g) were added in dry methanol (3 mL). Afterwards, a solution of 2-cyclohexen-1-one (5 mmol, 481 mg) in dry methanol (3 mL), was added dropwise at $0\text{ }^\circ\text{C}$. The

¹ D. Kalaitzakis, M. Triantafyllakis, G. I. Ioannou and G. Vassilikogiannakis, *Angew. Chem. Int. Ed.*, 2017, **56**, 4020.

reaction solution was allowed to warm to rt and stirred at this temperature. After the complete consumption of the starting material as was indicated by tlc analysis (24 h), the reaction was quenched by addition of a saturated aqueous solution of NH_4Cl (10 mL) and the mixture was extracted with Et_2O (2×30 mL). The combined organic layers were dried over MgSO_4 , filtered and concentrated under reduced pressure to afford **2f** as a yellow oil (yield = 363 g, 74%). No further purification was needed for alcohol **2f**.

^1H NMR (500 MHz, CDCl_3) δ 5.83 (m, 1H), 5.75 (m, 1H), 4.19 (m, 1H), 2.04 (m, 1H), 1.97 (m, 1H), 1.87 (m, 1H), 1.73 (m, 1H), 1.60 (m, 2H), 1.47 (brs, 1H) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 130.6, 129.9, 65.5, 32.0, 25.0, 18.9 ppm.

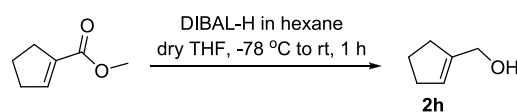
Experimental procedure for the synthesis of cyclohexenylmethanol (**2g**)



Under an argon atmosphere methyl-1-cyclohexene-1-carboxylate (5 mmol, 681 μL) was diluted in dry THF (17 mL). At -78 $^\circ\text{C}$, DIBAL-H (12.5 mmol, 12.5 mL of a 1 M solution in hexane) was added to the solution dropwise. The reaction solution was allowed to warm to rt. After the complete consumption of the starting material (1 h stirring at rt) as was indicated by tlc analysis, the solution was cooled using an ice bath, Rochelle's Salt (15 mL) was added and the mixture was extracted with Et_2O (3×30 mL). The combined organic layers were dried over MgSO_4 , filtered and concentrated under reduced pressure. The crude product **2g** was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = petroleum ether \rightarrow 10:1) to furnish **2g** as a pale yellow oil (yield = 389 mg, 69%).

^1H NMR (500 MHz, CDCl_3) δ 5.65 (m, 1H), 3.94 (s, 2H), 2.00 (m, 4H), 1.84 (brs, 1H), 1.63 (m, 2H), 1.56 (m, 2H) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 137.5, 122.8, 67.5, 25.5, 24.8, 22.5, 22.4 ppm.

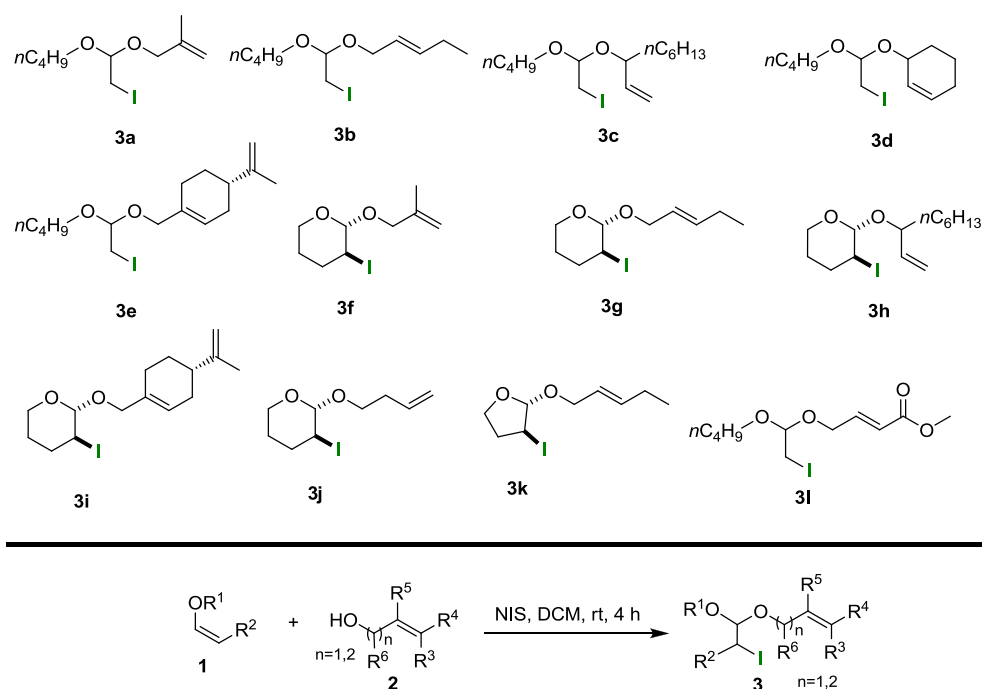
Synthesis of cyclopentenylmethanol (**2h**)



Product **2h** was synthesized from methyl-1-cyclopentene-carboxylate (5 mmol, 649 μL) according to the experimental procedure described above for the synthesis of **2g**. No further purification was needed for alcohol **2h**, which was afforded as a yellow oil. (yield = 376 mg, 77%).

^1H NMR (500 MHz, CDCl_3) δ 5.58 (m, 1H), 4.14 (s, 2H), 2.31 (m, 4H), 2.18 (brs, 1H), 1.88 (quint, $J=7.5$ Hz, 2H) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 144.2, 125.3, 62.0, 32.5, 32.2, 23.3 ppm.

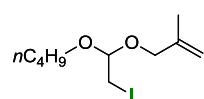
General experimental procedure for the synthesis of compounds of type 3



Compounds of type **1** (0.5 mmol, 64.7 μL for **1a**, 45.6 μL for **1b**, 37.8 μL for **1c**) were dissolved in CH_2Cl_2 (2.5 mL). The corresponding alcohol (0.5 mmol, 42.1 μL for **2a**, 50.8 μL for **2b**, 79.3 μL for **2c**, 43 μL for **2d**, 71.1 mg for **2e**, 49.1 mg for **2f**, 58 mg of **2i**) was added followed by NIS (112.5 mg, 0.5 mmol). The solution was stirred in the dark at room temperature. After completion of the reaction (4 h), as was indicated by tlc analysis, a saturated aqueous solution of $\text{Na}_2\text{S}_2\text{O}_3$ (3 mL) was added and the mixture was extracted with CH_2Cl_2 (2×4 mL). The combined organic layers were washed with distilled water (4 mL), dried over MgSO_4 and concentrated under reduced pressure. The products of type **3** were purified by flash column chromatography (silica gel, petroleum ether : EtOAc).

The trans stereochemistry of the products **3f-3k** was assigned according to previously reported analogues.²

1-(2-iodo-1-((2-methylallyl)oxy)ethoxy)butane (**3a**)

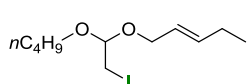


Product **3a** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 20:1) to furnish **3a** as a yellow oil (yield = 116.3 mg, 78%). This reaction was scaled up to 2 mmol of the starting materials and the results were almost identical (yield = 455 mg, 76%).

² (a) S. H. Kyne, M. Clémancey, G. Blondin, E. Derat, L. Fensterbank, A. Jutand, G. Lefèvre and C. Ollivier, *Organometallics*, 2018, **37**, 761; (b) J. Y. Hwang, J. H. Baek, T. I. Shin, J. H. Shin, J. W. Oh, K. P. Kim, Y. You and E. J. Kang, *Org. Lett.*, 2016, **18**, 4900; (c) A. Ekomié, G. Lefèvre, L. Fensterbank, E. Lacôte, M. Malacria, C. Ollivier and A. Jutand, *Angew. Chem. Int. Ed.*, 2012, **51**, 6942; (d) S. Mayer, J. Prandi, *Tetrahedron Lett.*, 1996, **37**, 3117; (e) M. N. Matos, C. A. M. Afonso and R. A. Batey, *Tetrahedron*, 2005, **61**, 1221.

^1H NMR (500 MHz, CHCl_3) δ 4.99 (m, 1H), 4.90 (m, 1H), 4.63 (t, $J=5.5$ Hz, 1H), 4.02 (d, $J=12.3$ Hz, 1H), 3.94 (d, $J=12.3$ Hz, 1H), 3.60 (dt, $J_1=9.2$ Hz, $J_2=6.5$ Hz, 1H), 3.48 (dt, $J_1=9.2$ Hz, $J_2=6.5$ Hz, 1H), 3.23 (d, $J=5.5$ Hz, 2H), 1.77 (s, 3H), 1.58 (m, 2H), 1.40 (m, 2H), 0.92 (t, $J=7.4$ Hz, 3H) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 141.5, 112.7, 101.2, 70.2, 66.3, 31.7, 19.7, 19.3, 13.8, 5.2 ppm. HRMS (Orbitrap ESI): $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{10}\text{H}_{19}\text{IO}_2\text{Na}$, 321.0325; found 321.0327.

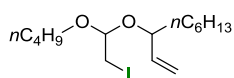
(E)-1-(1-butoxy-2-iodoethoxy)pent-2-ene (3b)



Product **3b** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 20:1) to furnish **3b** as a yellow oil (yield = 114 mg, 73%).

^1H NMR (500 MHz, CHCl_3) δ 5.76 (m, 1H), 5.54 (m, 1H), 4.63 (t, $J=5.5$ Hz, 1H), 4.07 (m, 1H), 3.98 (m, 1H), 3.58 (dt, $J_1=9.2$ Hz, $J_2=6.5$ Hz, 1H), 3.46 (dt, $J_1=9.2$ Hz, $J_2=6.5$ Hz, 1H), 3.21 (dd, $J_1=5.5$ Hz, $J_2=0.8$ Hz, 2H), 2.06 (m, 2H), 1.56 (m, 2H), 1.39 (m, 2H), 0.99 (t, $J=7.4$ Hz, 3H), 0.92 (t, $J=7.4$ Hz, 3H) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 136.7, 124.6, 101.1, 67.3, 66.2, 31.7, 25.2, 19.3, 13.8, 13.2, 5.4 ppm. HRMS (Orbitrap ESI): $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{11}\text{H}_{21}\text{IO}_2\text{Na}$, 335.0478; found 335.0472.

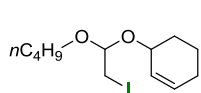
3-(1-butoxy-2-iodoethoxy)non-1-ene (3c)



Product **3c** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether) to furnish **3c** as an inseparable mixture of 1/1 diastereoisomers and as a yellow oil (yield = 121.5 mg, 66%).

^1H NMR (500 MHz, CHCl_3) δ 5.77 (ddd, $J_1=18.3$ Hz, $J_2=10.4$ Hz, $J_3=7.5$ Hz, 1H for one isomer), 5.67 (ddd, $J_1=18.3$ Hz, $J_2=10.4$ Hz, $J_3=7.5$ Hz, 1H for one isomer), 5.21-5.13 (m, 2H for both isomers), 4.60 (m, 1H for both isomers), 3.98 (q, $J=6.7$ Hz, 1H for one isomer), 3.86 (q, $J=6.7$ Hz, 1H for one isomer), 3.60 (dt, $J_1=9.2$ Hz, $J_2=6.5$ Hz, 1H for one isomer), 3.51 (m, 1H for both isomers), 3.40 (dt, $J_1=9.2$ Hz, $J_2=6.5$ Hz, 1H for one isomer), 3.19 (m, 2H for both isomers), 1.57 (m, 3H for both isomers), 1.41 (m, 3H for both isomers), 1.31-1.27 (m, 8H for both isomers), 0.93 (m, 3H for both isomers), 0.90-0.86 (m, 3H for both isomers) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 139.4 (for one isomer), 138.6 (for one isomer), 117.6 (for one isomer), 116.4 (for one isomer), 100.9 (for one isomer), 99.2 (for one isomer), 79.3 (for one isomer), 78.6 (for one isomer), 66.7 (for one isomer), 65.2 (for one isomer), 35.5 (for one isomer), 35.3 (for one isomer), 31.9 (for one isomer), 31.8 (for both isomers), 31.6 (for one isomer), 29.2 (for one isomer), 29.2 (for one isomer), 25.2 (for one isomer), 25.1 (for one isomer), 22.6 (for both isomers), 19.4 (for one isomer), 19.3 (for one isomer), 14.0 (for both isomers), 13.9 (for both isomers), 6.4 (for one isomer), 6.1 (for one isomer) ppm. HRMS (TOF ESI): $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{15}\text{H}_{29}\text{IO}_2\text{Na}$, 391.1104; found 391.1105.

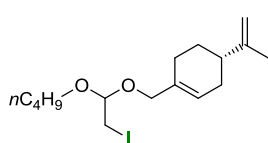
3-(1-butoxy-2-iodoethoxy)cyclohex-1-ene (3d)



Product **3d** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 40:1) to furnish **3d** as an inseparable mixture of 1/1 diastereoisomers and as a yellow oil (yield = 82.6 mg, 51%).

^1H NMR (500 MHz, CHCl_3) δ 5.88 (m, 1H for both isomers), 5.74 (m, 1H for both isomers), 4.75 (m, 1H for both isomers), 4.14 (m, 1H for both isomers), 3.59 (m, 1H for both isomers), 3.50 (m, 1H for both isomers), 3.23 (m, 2H for both isomers), 2.06 (m, 1H for both isomers), 1.95 (m, 1H for both isomers), 1.79 (m, 3H for both isomers), 1.59 (m, 2H for both isomers), 1.54 (m, 1H for both isomers), 1.41 (m, 2H for both isomers), 0.93 (t, $J=7.4$ Hz, 3H for both isomers) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 131.5 (for one isomer), 131.4 (for one isomer), 127.6 (for one isomer), 127.2 (for one isomer), 101.2 (for one isomer), 100.6 (for one isomer), 70.7 (for one isomer), 70.3 (for one isomer), 65.6 (for one isomer), 65.0 (for one isomer), 31.8 (for one isomer), 31.7 (for one isomer), 29.8 (for one isomer), 28.5 (for one isomer), 25.0 (for both isomers), 19.3 (for both isomers), 19.2 (for one isomer), 18.8 (for one isomer), 13.9 (for both isomers), 6.3 (for one isomer), 6.1 (for one isomer) ppm. HRMS (TOF ESI): $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{12}\text{H}_{21}\text{IO}_2\text{Na}$, 347.0480; found 347.0483.

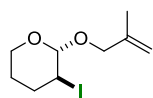
1-((1-butoxy-2-iodoethoxy)methyl)-4-(prop-1-en-2-yl)cyclohex-1-ene (3e)



Product **3e** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 20:1) to furnish **3e** as an inseparable mixture of 1/1 diastereoisomers and as a yellow oil (yield = 109.7 mg, 58%).

^1H NMR (500 MHz, CHCl_3) δ 5.73 (m, 1H for both isomers), 4.71 (m, 2H for both isomers), 4.61 (m, 1H for both isomers), 3.99 (m, 1H for both isomers), 3.90 (m, 1H for both isomers), 3.59 (m, 1H for both isomers), 3.48 (m, 1H for both isomers), 3.22 (m, 2H for both isomers), 2.22-2.08 (m, 4H for both isomers), 1.97 (m, 1H for both isomers), 1.85 (m, 1H for both isomers), 1.73 (s, 3H for both isomers), 1.58 (m, 2H for both isomers), 1.49 (m, 1H for both isomers), 1.40 (m, 2H for both isomers), 0.93 (t, $J=7.4$ Hz, 3H for both isomers) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 149.7 (for one isomer), 149.6 (for one isomer), 134.1 (for one isomer), 134.0 (for one isomer), 125.2 (for one isomer), 125.1 (for one isomer), 108.7 (for both isomers), 101.1 (for one isomer), 100.9 (for one isomer), 70.9 (for one isomer), 70.9 (for one isomer), 66.2 (for both isomers), 40.9 (for both isomers), 31.7 (for one isomer), 31.7 (for one isomer), 30.5 (for one isomer), 30.5 (for one isomer), 27.4 (for one isomer), 27.4 (for one isomer), 26.6 (for one isomer), 26.5 (for one isomer), 20.7 (for one isomer), 20.7 (for one isomer), 19.3 (for both isomers), 13.8 (for both isomers), 5.4 (for one isomer), 5.4 (for one isomer) ppm. HRMS (TOF ESI): $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{16}\text{H}_{27}\text{IO}_2\text{Na}$, 401.0948; found 401.0944.

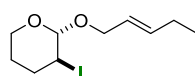
3-iodo-2-((2-methylallyl)oxy)tetrahydro-2H-pyran (**3f**)



Product **3f** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether) to furnish **3f** as a yellow oil (yield = 100.2 mg, 71%).

^1H NMR (500 MHz, CHCl_3) δ 5.01 (m, 1H), 4.91 (s, 1H), 4.64 (d, $J=5.4$ Hz, 1H), 4.14 (d, $J=12.4$ Hz, 1H), 4.11 (m, 1H), 3.99 (ddd, $J_1=10.8$ Hz, $J_2=6.4$ Hz, $J_3=3.8$ Hz, 1H), 3.94 (d, $J=12.4$ Hz, 1H), 3.58 (ddd, $J_1=10.8$ Hz, $J_2=6.4$ Hz, $J_3=3.8$ Hz, 1H), 2.39 (m, 1H), 2.03 (m, 1H), 1.78 (s, 3H), 1.75 (m, 1H), 1.58 (m, 1H) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 141.3, 112.9, 101.5, 71.8, 63.6, 32.9, 29.1, 25.6, 19.7 ppm. HRMS (TOF ESI): $[\text{M} + \text{Na}]^+$ calcd for $\text{C}_9\text{H}_{15}\text{IO}_2\text{Na}$ 305.0009; found 305.0008.

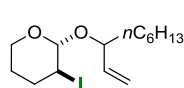
(*E*)-3-iodo-2-(pent-2-en-1-yloxy)tetrahydro-2H-pyran (**3g**)



Product **3g** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 20:1) to furnish **3g** as a yellow oil (yield = 103.6 mg, 70%).

^1H NMR (500 MHz, CHCl_3) δ 5.76 (m, 1H), 5.55 (m, 1H), 4.66 (d, $J=5.3$ Hz, 1H), 4.18 (m, 1H), 4.09 (dt, $J_1=8.1$ Hz, $J_2=4.7$ Hz, 1H), 3.97 (m, 2H), 3.56 (ddd, $J_1=11.1$ Hz, $J_2=7.3$ Hz, $J_3=3.5$ Hz, 1H), 2.36 (m, 1H), 2.06 (m, 2H), 1.99 (m, 1H), 1.76 (m, 1H), 1.56 (m, 1H), 0.99 (t, $J=7.5$ Hz, 3H) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 136.8, 124.4, 101.3, 68.9, 63.3, 32.6, 29.4, 25.4, 25.2, 13.2 ppm. HRMS (TOF ESI): $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{10}\text{H}_{18}\text{IO}_2$, 297.0346; found 297.0346.

3-iodo-2-(non-1-en-3-yloxy)tetrahydro-2H-pyran (**3h**)

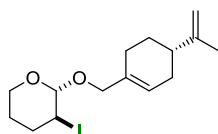


Product **3h** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether) to furnish **3h** as an inseparable mixture of three isomers 3.3/3.3/1 (see ^1H NMR integrations at 5.82, 5.66, 5.61, 4.67, 4.64, 3.88 and 3.53 ppm) and as a yellow oil (yield = 103.9 mg, 59%).

^1H NMR (500 MHz, CHCl_3) δ 5.82 (ddd, $J_1=17.4$ Hz, $J_2=10.4$ Hz, $J_3=7.3$ Hz, 1H for one isomer), 5.66 (ddd, $J_1=17.4$ Hz, $J_2=10.4$ Hz, $J_3=7.3$ Hz, 1H for one isomer), 5.61 (m, 1H for one isomer), 5.23-5.09 (m, 2H for all isomers), 4.67 (d, $J=5.2$ Hz, 1H for one isomer), 4.64 (d, $J=6.0$ Hz, 1H for two isomers), 4.10-3.95 (m, 3H for two isomers and 2H for one isomer), 3.88 (m, 1H for one isomer), 3.53 (m, 1H for all isomers), 2.38 (m, 1H for all isomers), 2.02 (m, 1H for all isomers), 1.80 (m, 1H for one isomer and 2H for one isomer), 1.71-1.45 (m, 5H for one isomer, 4H for one isomer and 3H for one isomer), 1.35-1.25 (m, 7H for all isomers), 0.89-0.86 (m, 3H for all isomers) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 139.3 (for one isomer), 138.7 (for one isomer), 138.0 (for one isomer), 118.1 (for one isomer), 117.1 (for one isomer), 115.6 (for one isomer), 101.8 (for one isomer), 98.7 (for one isomer), 95.0 (for one isomer), 80.8 (for one isomer), 78.0 (for one isomer), 76.5 (for one isomer), 64.2 (for one isomer), 63.3 (for one isomer), 62.2 (for one isomer), 35.6 (for one isomer), 35.4 (for one isomer), 34.6 (for one isomer), 33.8 (for one isomer), 32.7 (for two isomers),

31.8 (for one isomer), 31.7 (for one isomer), 31.7 (for one isomer), 30.8 (for one isomer), 30.3 (for one isomer), 29.9 (for one isomer), 29.2 (for one isomer), 29.2 (for two isomers), 26.2 (for one isomer), 25.6 (for one isomer), 25.5 (for one isomer), 25.4 (for one isomer), 25.2 (for one isomer), 24.9 (for one isomer), 22.6 (for all isomers), 19.6 (for one isomer), 14.0 (for two isomers) ppm. HRMS (TOF ESI): $[M+H]^+$ calcd for $C_{14}H_{26}IO_2$, 353.0972; found 353.0971.

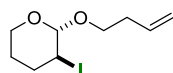
3-iodo-2-((4-(prop-1-en-2-yl)cyclohex-1-en-1-yl)methoxy)tetrahydro-2H-pyran (3i)



Product **3i** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 20:1) to furnish **3i** as an inseparable mixture of 1/1 diastereoisomers and as a yellow oil (yield = 144 mg, 80%).

1H NMR (500 MHz, $CHCl_3$) δ 5.73 (m, 1H for both isomers), 4.70 (m, 2H for both isomers), 4.60 (m, 1H for both isomers), 4.08 (m, 2H for both isomers), 3.98 (m, 1H for both isomers), 3.89 (m, 1H for both isomers), 3.56 (m, 1H for both isomers), 2.37 (m, 1H for both isomers), 2.24-2.08 (m, 4H for both isomers), 2.05-1.95 (m, 2H for both isomers), 1.83 (m, 1H for both isomers), 1.72 (s, 3H for both isomers), 1.72 (m, 1H for both isomers), 1.57 (m, 1H for both isomers), 1.48 (m, 1H for both isomers) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ 149.7 (for one isomer), 149.6 (for one isomer), 133.8 (for both isomers), 125.3 (for one isomer), 125.1 (for one isomer), 108.6 (for both isomers), 101.4 (for one isomer), 101.1 (for one isomer), 72.4 (for one isomer), 72.1 (for one isomer), 63.6 (for one isomer), 63.6 (for one isomer), 40.9 (for one isomer), 40.9 (for one isomer), 33.1 (for one isomer), 33.0 (for one isomer), 30.4 (for one isomer), 30.4 (for one isomer), 29.3 (for both isomers), 27.3 (for one isomer), 27.3 (for one isomer), 26.6 (for one isomer), 26.5 (for one isomer), 25.8 (for one isomer), 25.8 (for one isomer), 20.7 (for one isomer), 20.7 (for one isomer) ppm. HRMS (TOF ESI): $[M+H]^+$ calcd for $C_{15}H_{24}IO_2$, 363.0816; found 363.0809.

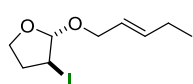
2-(but-3-en-1-yloxy)-3-iodotetrahydro-2H-pyran (3j)



Product **3j** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 20:1) to furnish **3j** as a yellow oil (yield = 97.3 mg, 69%).

1H NMR (500 MHz, $CHCl_3$) δ 5.84 (ddt, $J_1=17.1$ Hz, $J_2=10.3$ Hz, $J_3=6.8$ Hz, 1H), 5.10 (dq, $J_1=17.1$ Hz, $J_2=1.6$ Hz, 1H), 5.04 (dq, $J_1=10.3$ Hz, $J_2=1.6$ Hz, 1H), 4.61 (d, $J=5.6$ Hz, 1H), 4.07 (ddd, $J_1=8.5$ Hz, $J_2=5.6$ Hz, $J_3=4.5$ Hz, 1H), 3.98 (ddd, $J_1=8.5$ Hz, $J_2=5.6$ Hz, $J_3=4.5$ Hz, 1H), 3.80 (dt, $J_1=9.5$ Hz, $J_2=6.8$ Hz, 1H), 3.57 (m, 1H), 3.51 (dt, $J_1=9.5$ Hz, $J_2=6.8$ Hz, 1H), 2.36 (m, 3H), 2.01 (m, 1H), 1.73 (m, 1H), 1.57 (m, 1H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ 134.9, 116.5, 102.6, 67.9, 63.7, 33.9, 33.0, 29.4, 25.8 ppm. HRMS (TOF ESI): $[M+Na]^+$ calcd for $C_9H_{15}IO_2Na$, 305.0009; found 305.0007.

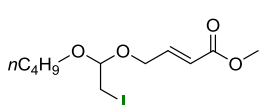
(E)-3-iodo-2-(pent-2-en-1-yloxy)tetrahydrofuran (**3k**)



Product **3k** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 60:1) to furnish **3k** as a yellow oil (yield = 76.9 mg, 55%).

^1H NMR (500 MHz, CHCl_3) δ 5.75 (m, 1H), 5.50 (m, 1H), 5.37 (s, 1H), 4.17 (dd, $J_1=6.3$ Hz, $J_2=2.1$ Hz, 1H), 4.13-4.08 (m, 2H), 4.02 (td, $J_1=8.3$ Hz, $J_2=3.7$ Hz, 1H), 3.91 (m, 1H), 2.61 (m, 1H), 2.18 (m, 1H), 2.06 (quint, $J=7.5$ Hz, 2H), 0.99 (t, $J=7.5$ Hz, 3H) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 136.9, 124.5, 109.6, 68.0, 66.9, 35.6, 25.2, 24.8, 13.2 ppm. HRMS (TOF ESI): $[\text{M}+\text{H}]^+$ calcd for $\text{C}_9\text{H}_{16}\text{IO}_2$, 283.0190; found 283.0188.

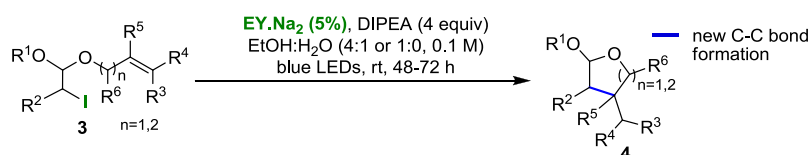
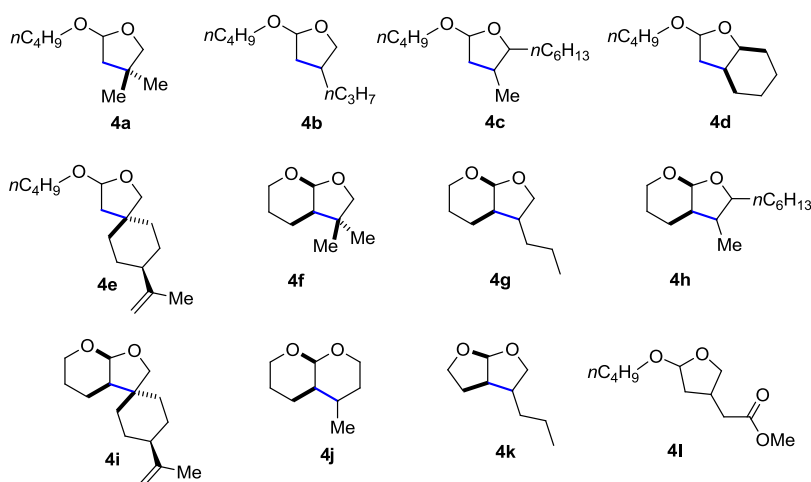
methyl (E)-4-(1-butoxy-2-iodoethoxy)but-2-enoate (**3l**)



Product **3l** was synthesized according to experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 60:1) to furnish **3l** as a yellow oil (yield = 124.9 mg, 73%).

^1H NMR (500 MHz, CHCl_3) δ 6.96 (dt, $J_1=15.8$ Hz, $J_2=4.2$ Hz, 1H), 6.14 (dt, $J_1=15.7$ Hz, $J_2=2.1$ Hz, 1H), 4.68 (t, $J=5.5$ Hz, 1H), 4.30 (ddd, $J_1=15.8$ Hz, $J_2=4.2$ Hz, $J_3=2.1$ Hz, 1H), 4.21 (ddd, $J_1=15.8$ Hz, $J_2=4.2$ Hz, $J_3=2.1$ Hz, 1H), 3.74 (s, 3H), 3.59 (dt, $J_1=9.2$ Hz, $J_2=6.5$ Hz, 1H), 3.48 (dt, $J_1=9.2$ Hz, $J_2=6.5$ Hz, 1H), 3.24 (d, $J=5.5$ Hz, 2H), 1.57 (m, 2H), 1.40 (m, 2H), 0.92 (t, $J=7.4$ Hz, 3H) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 166.6, 143.7, 121.0, 101.6, 66.5, 64.3, 51.6, 31.6, 19.3, 13.8, 4.4 ppm. HRMS (TOF ESI): $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{11}\text{H}_{19}\text{IO}_4\text{Na}$, 365.0220; found 365.0215.

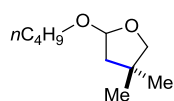
General experimental for the synthesis of substrates of type 4





To a solution of compounds of type **3** (0.2 mmol, 59.6 mg for **3a**, 62.4 mg for **3b**, 73.7 mg for **3c**, 64.8 mg for **3d**, 75.7 mg for **3e**, 56.4 mg for **3f**, 59.2 mg for **3g**, 70.4 mg for **3h**, 72.4 mg for **3i**, 56.4 mg for **3j**, 56.4 mg for **3k** and 68.4 mg for **3l**) in EtOH:H₂O (4:1, 1.6 mL EtOH and 0.4 mL H₂O), the photocatalyst EY.Na₂ (5%, 6.9 mg, 0.01 mmol) was added and argon (balloon) was gently bubbled through the solution for 10 min at rt. For compound **3a** EtOH (2 mL) was used in place of EtOH:H₂O because it gave a cleaner result. Afterwards, under an argon atmosphere, DIPEA (140 μ L, 0.8 mmol) was added and the solution was irradiated using blue LED light strips (60 LEDs/m, 10.8 w/m, 1000 lm/m) at the same temperature. The LED light strips were placed in a circular formation with a circumference of 47 cm. If only one reaction vessel was used, it was placed at the center of the circle at a distance of 7 cm from the LED strips (see, photo above). If more than 1 reaction vessel was used then they were attached around an empty vial in order to prevent wobbling and to allow the light to pass through every vessel evenly (see, photo above). After completion of the reaction, as indicated by tlc analysis (48 h in EtOH:H₂O or 72 h in EtOH), the solution was concentrated *in vacuo* and the product of type **4** was purified by flash column chromatography.

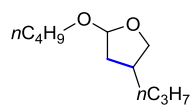
2-butoxy-4,4-dimethyltetrahydrofuran (**4a**)



Product **4a** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 20:1) to furnish **4a** and as a yellow oil (yield = 25.8 mg, 75%). This reaction was scaled up to 1 mmol of the starting material and the results were almost identical (yield = 125 mg, 73%).

¹H NMR (500 MHz, CDCl₃) δ 5.14 (dd, $J_1=5.8$ Hz, $J_2=3.2$ Hz, 1H), 3.68 (dt, $J_1=9.6$ Hz, $J_2=6.7$ Hz, 1H), 3.62 (d, $J=8.0$ Hz, 1H), 3.48 (d, $J=8.0$ Hz, 1H), 3.37 (dt, $J_1=9.6$ Hz, $J_2=6.7$ Hz, 1H), 1.90 (dd, $J_1=13.2$ Hz, $J_2=5.8$ Hz, 1H), 1.66 (dd, $J_1=13.2$ Hz, $J_2=3.2$ Hz, 1H), 1.55 (m, 2H), 1.36 (m, 2H), 1.14 (s, 3H), 1.06 (s, 3H), 0.91 (t, $J=7.4$ Hz, 3H) ppm; ¹³C NMR (125 MHz, CDCl₃) δ 105.2, 78.7, 67.6, 47.4, 38.8, 31.9, 27.9, 25.9, 19.4, 13.9 ppm. HRMS (TOF ESI): [M+H]⁺ calcd for C₁₀H₂₁O₂, 173.1536; found 173.1537.

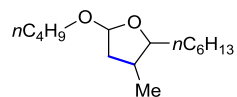
2-butoxy-4-propyltetrahydrofuran (**4b**)



Product **4b** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 50:1) to furnish **4b** as an inseparable mixture of 3.4/1 diastereoisomers (see ¹H NMR integrations at 4.03 and 3.93 ppm) and as a yellow oil (yield = 29.1 mg, 78%).

¹H NMR (500 MHz, CDCl₃) δ 5.09 (dd, *J*₁=5.5 Hz, *J*₂=3.1 Hz, 1H for both isomers), 4.03 (t, *J*=7.8 Hz, 1H for minor isomer), 3.93 (t, *J*=7.8 Hz, 1H for major isomer), 3.67 (dt, *J*₁=9.5 Hz, *J*₂=6.8 Hz, 1H for major isomer), 3.64 (m, 1H for minor isomer), 3.44 (t, *J*=8.6 Hz, 1H for both isomers), 3.37 (dt, *J*₁=9.5 Hz, *J*₂=6.8 Hz, 1H for both isomers), 2.40 (m, 1H for minor isomer), 2.24 (ddd, *J*₁=13.1 Hz, *J*₂=9.5 Hz, *J*₃=5.5 Hz, 1H for major isomer), 2.15 (m, 1H for major isomer), 2.02 (dd, *J*₁=12.7 Hz, *J*₂=7.4 Hz, 1H for minor isomer), 1.56-1.45 (m, 3H for both isomers), 1.42-1.29 (m, 6H for both isomers), 0.91 (m, 6H for both isomers) ppm; ¹³C NMR (125 MHz, CDCl₃) δ 104.5 (major), 104.1 (minor), 72.6 (minor), 71.8 (major), 67.4 (major), 67.0 (minor), 39.3 (minor), 39.1 (major), 38.4 (major), 36.8 (minor), 36.2 (minor), 35.3 (major), 31.9 (major), 31.8 (minor), 21.8 (major), 21.6 (minor), 19.4 (both isomers), 14.2 (both isomers), 13.9 (both isomers) ppm. HRMS (TOF ESI): [M+Na]⁺ calcd for C₁₁H₂₂O₂Na, 209.1512; found 209.1511.

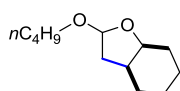
5-butoxy-2-hexyl-3-methyltetrahydrofuran (**4c**)



Product **4c** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 50:1) to furnish **4c** as an inseparable mixture of 1/1 diastereoisomers and as a yellow oil (yield = 33.9 mg, 70%).

¹H NMR (500 MHz, CDCl₃) δ 5.06 (dd, *J*₁=5.7 Hz, *J*₂=3.0 Hz, 1H for one isomer), 4.99 (d, *J*=5.0 Hz, 1H for one isomer), 3.67 (m, 1H for both isomers), 3.50 (m, 1H for both isomers), 3.37 (dt, *J*₁=9.5 Hz, *J*₂=6.6 Hz, 1H for one isomer), 3.33 (dt, *J*₁=9.5 Hz, *J*₂=6.6 Hz, 1H for one isomer), 2.31 (ddd, *J*₁=13.3, *J*₂=9.5, *J*₃=5.7 Hz, 1H for one isomer), 2.10 (m, 1H for one isomer), 2.04 (m, 1H for one isomer), 1.74 (m, 1H for one isomer), 1.61-1.45 (m, 6H for both isomers), 1.37-1.28 (m, 9H for both isomers), 1.04 (d, *J*= 6.6 Hz, 3H for one isomer), 1.02 (d, *J*= 6.6 Hz, 3H for one isomer), 0.92 (t, *J*=7.4 Hz, 3H for one isomer), 0.91 (t, *J*=7.4 Hz, 3H for one isomer), 0.90-0.87 (m, 3H for both isomers) ppm; ¹³C NMR (125 MHz, CDCl₃) δ 103.4 (for one isomer), 103.2 (for one isomer), 86.9 (for one isomer), 83.9 (for one isomer), 67.3 (for one isomer), 66.6 (for one isomer), 42.0 (for one isomer), 41.4 (for one isomer), 38.3 (for one isomer), 36.9 (for one isomer), 36.0 (for one isomer), 33.8 (for one isomer), 31.9 (for one isomer), 31.9 (for one isomer), 31.8 (for both isomers), 29.5 (for one isomer), 29.4 (for one isomer), 26.4 (for one isomer), 26.3 (for one isomer), 22.6 (for both isomers), 19.5 (for one isomer), 19.4 (for one isomer), 17.3 (for one isomer), 17.2 (for one isomer), 14.1 (for both isomers), 13.9 (for one isomer), 13.9 (for one isomer) ppm. HRMS (TOF ESI): [M+Na]⁺ calcd for C₁₅H₃₀O₂Na, 265.2138; found 265.2134.

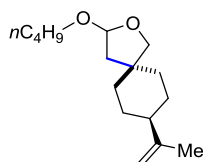
2-butoxyoctahydrobenzofuran (4d)



Product **4d** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 100:1) to furnish **4d** as an inseparable mixture of 2/1 diastereoisomers (see ^1H NMR integrations at 5.17, 5.09, 4.08, and 3.94 ppm) and as a yellow oil (yield = 25.8 mg, 65%).

^1H NMR (500 MHz, CDCl_3) δ 5.17 (t, $J=4.8$ Hz, 1H for major isomer), 5.09 (dd, $J_1=6.1$ Hz, $J_2=2.8$ Hz, 1H for minor isomer), 4.08 (q, $J=3.8$ Hz, 1H for major isomer), 3.94 (q, $J=5.3$ Hz, 1H for minor isomer), 3.73 (dt, $J_1=9.5$, $J_2=6.8$ Hz, 1H for both isomers), 3.38 (m, 1H for both isomers), 2.14-2.03 (m, 1H for major isomer and 2H for minor isomer), 1.96-1.91 (m, 2H for minor isomer), 1.88 (t, $J=4.7$ Hz, 2H for major isomer), 1.86-1.82 (m, 1H for minor isomer), 1.78-1.70 (m, 1H for both isomers), 1.68-1.63 (m, 1H for major isomer), 1.60-1.56 (m, 3H for major isomer and 2H for minor isomer), 1.55-1.53 (m, 2H for both isomers), 1.46-1.40 (m, 2H for both isomers), 1.39-1.34 (m, 2H for both isomers), 1.18-1.14 (m, 1H for both isomers), 0.92 (m, 3H for both isomers) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 104.6 (minor), 103.6 (major), 78.1 (minor), 75.4 (major), 67.9 (minor), 67.8 (major), 40.3 (major), 38.2 (minor), 37.0 (major), 36.5 (minor), 32.0 (minor), 31.9 (major), 29.2 (minor), 28.5 (major), 27.8 (major) 26.8 (minor), 24.2 (major), 22.9 (minor), 21.7 (minor), 20.4 (major), 19.4 (minor), 19.4 (major), 13.9 (major), 13.9 (minor) ppm. HRMS (TOF ESI): $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{12}\text{H}_{23}\text{O}_2$, 199.1693; found 199.1694.

3-butoxy-8-(prop-1-en-2-yl)-2-oxaspiro[4.5]decane (4e)

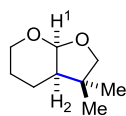


Product **4e** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 50:1) to furnish **4e** as an inseparable mixture of 2/1 diastereoisomers (see ^1H NMR integrations at 5.12, 5.09, 3.78 and 3.52 ppm) and as a yellow oil (yield = 39.9 mg, 79%).

^1H NMR (500 MHz, CDCl_3) δ 5.12 (dd, $J_1=5.7$ Hz, $J_2=2.4$ Hz, 1H for major isomer), 5.09 (dd, $J_1=5.7$ Hz, $J_2=2.4$ Hz, 1H for minor isomer), 4.67 (m, 2H for both isomers), 3.78 (d, $J=8.2$ Hz, 1H for minor isomer), 3.66 (m, 2H for both isomers), 3.52 (d, $J=8.2$ Hz, 1H for major isomer), 3.36 (m, 1H for both isomers), 1.96 (dd, $J_1=13.3$ Hz, $J_2=5.7$ Hz, 1H for major isomer), 1.90-1.80 (m, 2H for both isomers), 1.76-1.73 (m, 3H for minor isomer), 1.72 (s, 3H for major isomer), 1.70 (s, 3H for minor isomer), 1.68-1.66 (m, 2H for major isomer), 1.58-1.49 (m, 3H for both isomers), 1.40-1.22 (m, 7H for both isomers), 0.91 (t, $J=7.4$ Hz, 3H for both isomers) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 150.4 (major), 150.3 (minor), 108.2 (both isomers), 105.0 (major), 104.0 (minor), 78.9 (major), 74.2 (minor), 67.3 (both isomers), 47.9 (minor), 44.9 (major), 44.6 (minor), 42.5 (major), 42.4 (minor), 42.1 (major), 37.1 (major), 36.6 (minor), 36.6 (minor), 35.2 (major), 31.9 (both isomers), 29.4 (minor), 29.2 (minor), 29.1 (major), 28.3 (major), 21.0 (minor), 21.0 (major), 19.4 (both isomers),

13.9 (both isomers) ppm. HRMS (TOF ESI): $[M+H]^+$ calcd for $C_{16}H_{29}O_2$, 253.2162; found 253.2158.

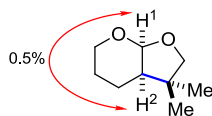
3,3-dimethylhexahydro-4H-furo[2,3-b]pyran (**4f**)



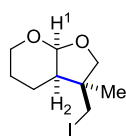
Product **4f** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 40:1) to furnish **4f** as a yellow oil (yield = 23.7 mg, 76%).

1H NMR (500 MHz, $CDCl_3$) δ 5.35 (d, $J=4.2$ Hz, 1H), 3.82 (d, $J=8.0$ Hz, 1H), 3.75 (m, 1H), 3.57 (m, 2H), 1.76 (m, 1H), 1.62 (m, 2H), 1.49 (m, 2H), 1.09 (s, 3H), 1.04 (s, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ 102.3, 78.7, 61.7, 44.5, 40.5, 27.7, 22.9, 21.8, 21.2 ppm. HRMS (TOF ESI): $[M+Na]^+$ calcd for $C_9H_{16}O_2Na$, 179.1043; found 179.1043.

Representative NOE for compound **4f**



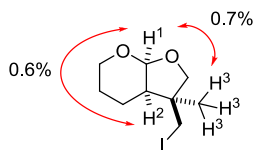
3-(iodomethyl)-3-methylhexahydro-4H-furo[2,3-b]pyran (**4f'**)



Intermediate **4f'** was isolated when the photocatalytic reaction that leads to the formation of **4f** was stopped after 12 h of irradiation. The crude product was purified by two very careful flash column chromatographies (silica gel, petroleum ether : EtOAc = 100:1 \rightarrow 40:1) to furnish a small amount of **4f'** as a yellow oil.

1H NMR (500 MHz, $CHCl_3$) δ 5.41(d, $J=4.0$ Hz, 1H), 3.97 (d, $J=8.4$ Hz, 1H), 3.75 (m, 1H), 3.60 (d, $J=8.4$ Hz, 1H), 3.58 (m, 1H), 3.36 (d, $J=9.8$ Hz), 3.19 (d, $J=9.8$ Hz), 1.91 (m, 1H), 1.80 (m, 1H), 1.61 (m, 1H), 1.51 (m, 2H), 1.28 (s, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ 101.7, 75.7, 61.4, 44.4, 43.8, 26.4, 22.7, 20.5, 14.6 ppm. HRMS (TOF ESI): $[M+H]^+$ calcd for $C_9H_{16}IO_2$, 283.0189; found 283.0187.

Representative NOE for compound **4f'**



3-propylhexahydro-4H-furo[2,3-b]pyran (**4g**)

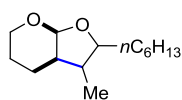


Product **4g** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 30:1) to furnish **4g** as an inseparable mixture of 5.5/1 diastereoisomers (see 1H NMR integrations at 5.26, 4.97, and 4.26 ppm) and as a yellow oil (yield 24.8 mg, 73%).

1H NMR (500 MHz, $CDCl_3$) δ 5.26 (d, $J=3.6$ Hz, 1 H for major isomer), 4.97 (d, $J=3.6$ Hz, 1H for minor isomer), 4.26 (t, $J=8.2$ Hz, 1H for minor isomer), 3.92 (t,

$J=8.2$ Hz, 1H for major isomer), 3.86 (m, 1H for minor isomer), 3.73 (m, 1H for major isomer), 3.62 (m, 2H for major isomer), 3.51 (t, $J=8.2$ Hz, 1H for minor), 3.40 (td, $J_1=11.5$ Hz, $J_2=2.3$ Hz 1H for minor isomer), 2.35-2.26 (m, 1H for both isomers), 1.92 (m, 1H for major isomer), 1.81 (m, 2H for minor isomer), 1.72-1.68 (m, 2H for minor isomer), 1.66-1.60 (m, 1H for both isomers), 1.58-1.54 (m, 2H for major isomer), 1.54-1.50 (m, 2H for minor isomer), 1.40-1.34 (m, 2H for major isomer), 1.30-1.24 (m, 3H for major isomer and 1H for minor isomer), 1.18 (m, 1H for minor isomer), 0.90 (t, $J=7.2$ Hz, 3H for both isomers) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 102.1 (minor), 102.0 (major), 74.2 (minor), 70.1 (major), 64.4 (minor), 60.9 (major), 44.1 (minor), 40.8 (major), 37.6 (minor), 36.5 (major), 34.9 (minor), 29.2 (major), 23.2 (major), 22.4 (minor), 21.7 (minor), 21.4 (major), 20.7 (minor), 19.2 (major), 14.2 (both isomers) ppm. HRMS (TOF ESI): $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{10}\text{H}_{18}\text{O}_2\text{Na}$, 193.1199; found 193.1199.

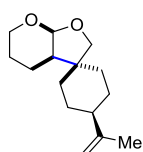
2-hexyl-3-methylhexahydro-4H-furo[2,3-b]pyran (4h)



Product **4h** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 50:1) to furnish **4h** as an inseparable mixture of 1.6/1 diastereoisomers (see ^1H NMR integrations at 5.27 and 4.93 ppm) and as a yellow oil (yield = 28.1 mg, 62%).

^1H NMR (500 MHz, CDCl_3) δ 5.27 (d, $J=3.7$ Hz, 1H for minor isomer), 4.93 (d, $J=3.7$ Hz, 1H for major isomer), 3.86 (m, 1H for major isomer), 3.77 (m, 2H for minor isomer), 3.62 (m, 1H for minor isomer), 3.56 (m, 1H for major isomer), 3.38 (td, $J_1=11.8$ Hz, $J_2=2.2$ Hz, 1H for major isomer), 2.00-1.91 (m, 1H for major isomer and 2H for minor isomer), 1.80 (m, 2H for major isomer), 1.71-1.63 (m, 1H for major and 3H for minor), 1.62-1.57 (m, 3H for major isomer and 1H for minor isomer), 1.56-1.50 (m, 1H for major isomer and 3H for minor isomer), 1.46-1.43 (m, 1H for major isomer), 1.35-1.27 (m, 7H for both isomers), 0.99 (d, $J=6.6$ Hz, 3H for major isomer), 0.95 (d, $J=6.6$ Hz, 3H for minor isomer), 0.89-0.86 (m, 3H for both isomers) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 101.5 (major), 100.9 (minor), 87.8 (major), 82.8 (minor), 64.5 (major), 61.1 (minor), 46.3 (major), 40.8 (minor), 39.2 (minor), 37.7 (major), 36.3 (major), 35.2 (minor), 31.9 (major), 31.8 (minor), 29.5 (major), 29.4 (minor), 26.5 (major), 26.2 (minor), 23.3 (minor), 22.6 (both isomers), 21.9 (major), 20.7 (major), 20.2 (minor), 15.3 (major), 14.1 (both isomers), 11.7 (minor) ppm. HRMS (TOF ESI): $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{14}\text{H}_{27}\text{O}_2$, 227.2006; found 227.2002.

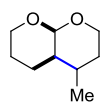
4-(prop-1-en-2-yl)tetrahydro-2'H,4'H-spiro[cyclohexane-1,3'-furo[2,3-b]pyran] (4i)



Product **4i** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 50:1) to furnish **4i** as an inseparable mixture of 1/1 diastereoisomers and as a yellow oil (yield = 37.8 mg, 80%).

^1H NMR (500 MHz, CDCl_3) δ 5.45 (d, $J=3.8$ Hz, 1H for one isomer), 5.24 (d, $J=3.8$ Hz, 1H for one isomer), 4.67 (m, 2H for both isomers), 3.92 (dd, $J_1=8.2$ Hz, $J_2=1.1$ Hz, 1H for one isomer), 3.80 (m, 1H for both isomers), 3.77 (d, $J=8.2$ Hz 1H for one isomer), 3.71 (m, 1H for one isomer), 3.65 (m, 1H for one isomer), 3.52 (m, 1H for one isomer), 3.47 (d, $J=8.2$ Hz, 1H for one isomer), 1.95-1.88 (m, 2H for both isomers), 1.86-1.73 (m, 4H for both isomers), 1.72 (s, 3H for one isomer), 1.70 (s, 3H for one isomer), 1.65-1.58 (m, 3H for both isomers), 1.45-1.35 (m, 2H for both isomers), 1.31-1.23 (m, 2H for both isomers), 1.20-1.10 (m, 1H for both isomers) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 150.1 (for one isomer), 150.0 (for one isomer), 108.4 (for one isomer), 108.3 (for one isomer), 102.0 (for one isomer), 101.4 (for one isomer), 77.5 (for one isomer), 75.0 (for one isomer), 62.4 (for one isomer), 60.7 (for one isomer), 46.0 (for one isomer), 44.7 (for one isomer), 44.5 (for one isomer), 44.4 (for one isomer), 43.7 (for one isomer), 37.6 (for one isomer), 36.3 (for one isomer), 35.8 (for one isomer), 32.0 (for one isomer), 29.5 (for one isomer), 28.8 (for one isomer), 28.8 (for one isomer), 28.7 (for one isomer), 27.9 (for one isomer), 23.5 (for one isomer), 22.9 (for one isomer), 21.1 (for one isomer), 21.0 (for one isomer), 20.6 (for one isomer), 20.6 (for one isomer) ppm. HRMS (TOF ESI): $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{15}\text{H}_{25}\text{O}_2$, 237.1849; found 237.1846.

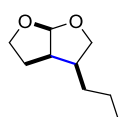
4-methylhexahydro-2H,5H-pyrano[2,3-b]pyran (**4j**)



Product **4j** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 20:1) to furnish **4j** as an inseparable mixture of 1.3/1 diastereoisomers (see ^1H NMR integrations at 4.72 and 4.65 ppm) and as a yellow oil (yield = 23.4 mg, 75%).

^1H NMR (500 MHz, CDCl_3) δ 4.72 (d, $J=2.5$ Hz, 1H for one isomer), 4.65 (d, $J=1.9$ Hz, 1H for one isomer), 4.04 (m, 1H for both isomers), 3.95 (td, $J_1=11.5$ Hz, $J_2=2.8$ Hz, 1H for one isomer), 3.88 (m, 1H for one isomer), 3.70-3.63 (m, 1H for both isomers), 3.55 (td, $J_1=11.5$ Hz, $J_2=2.8$ Hz, 1H for one isomer), 3.49 (m, 1H for one isomer), 2.04-1.96 (m, 1H for both isomers), 1.79 (m, 1H for one isomer), 1.70-1.66 (m, 2H for both isomers), 1.59 (m, 1H for one isomer), 1.54-1.24 (m, 4H for one isomer and 3H for the other isomer), 1.20 (m, 1H for one isomer), 0.94 (d, $J=6.7$ Hz, 3H for one isomer), 0.91 (d, $J=6.9$ Hz, 3H for one isomer) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 98.7 (one isomer), 97.8 (one isomer), 67.0 (one isomer), 66.5 (one isomer), 61.8 (one isomer), 61.4 (one isomer), 41.9 (one isomer), 40.0 (one isomer), 33.2 (one isomer), 32.8 (one isomer), 28.6 (one isomer), 26.1 (one isomer), 25.1 (one isomer), 24.4 (one isomer), 21.0 (one isomer), 19.2 (one isomer), 18.0 (one isomer), 16.8 (one isomer) ppm. HRMS (TOF ESI): $[\text{M}+\text{H}]^+$ calcd for $\text{C}_9\text{H}_{17}\text{O}_2$, 157.1223; found 157.1224.

3-propylhexahydrofuro[2,3-b]furan (**4k**)

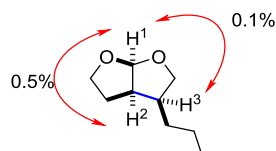


Product **4k** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 80:1) to furnish **4k**

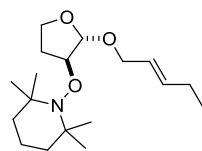
as a yellow oil (yield = 21.2 mg, 68%).

^1H NMR (500 MHz, CDCl_3) δ 5.72 (d, $J=5.0$ Hz, 1H), 3.93 (t, $J=7.6$ Hz, 1H), 3.86 (dd, $J_1=7.6$ Hz, $J_2=6.2$ Hz, 2H), 3.41 (dd, $J_1=11.4$ Hz, $J_2=8.4$ Hz, 1H), 2.79 (m, 1H), 2.31 (m, 1H), 1.86 (m, 2H), 1.35 (m, 4H), 0.94 (t, $J=7.0$ Hz, 3H) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 109.8, 72.7, 69.1, 45.5, 41.9, 29.8, 25.0, 21.7, 14.3 ppm. HRMS (TOF ESI): $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_9\text{H}_{17}\text{O}_2$, 157.1223; found 157.1224.

Representative NOE for compound **4k**

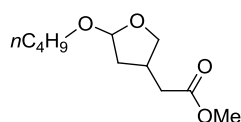


2,2,6,6-tetramethyl-1-(2-((E)-pent-2-enyloxy)tetrahydrofuran-3-yloxy)piperidine (**3k-TEMPO**)



When the general experimental procedure for the synthesis of **4k** was run in the presence of 4 equiv. of TEMPO, the product of radical trapping **3k-TEMPO** was isolated by flash column chromatography (silica gel, petroleum ether : EtOAc = 40:1) as a yellow oil (yield = 13.5 mg, 22%). ^1H NMR (500 MHz, CHCl_3) δ 5.79 (dt, $J_1=15.4$ Hz, $J_2=6.2$ Hz, 1H), 5.57 (td, $J_1=15.4$ Hz, $J_2=6.2$ Hz, 1H), 5.29 (s, 1H), 4.43 (dd, $J_1=6.9$ Hz, $J_2=3.4$ Hz, 1H), 4.13 (dd, $J_1=11.7$ Hz, $J_2=5.6$ Hz, 1H), 4.04 (dt, $J_1=8.1$ Hz, $J_2=5.5$ Hz, 1H), 3.92 (m, 2H), 2.29 (m, 1H), 2.08 (m, 3H), 1.49 (m, 4H), 1.30 (m, 2H), 1.20 (brs, 6H), 1.12 (brs, 6H), 1.04 (t, $J=7.5$ Hz, 3H) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 136.1, 124.7, 105.4, 89.4, 67.4, 66.2, 59.3, 39.9, 33.8, 31.0, 25.0, 20.0, 16.9, 13.0 ppm. HRMS (TOF ESI): $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{18}\text{H}_{34}\text{NO}_3$, 312.2533; found 312.2527.

methyl 2-(5-butoxytetrahydrofuran-3-yl)acetate (**4l**)

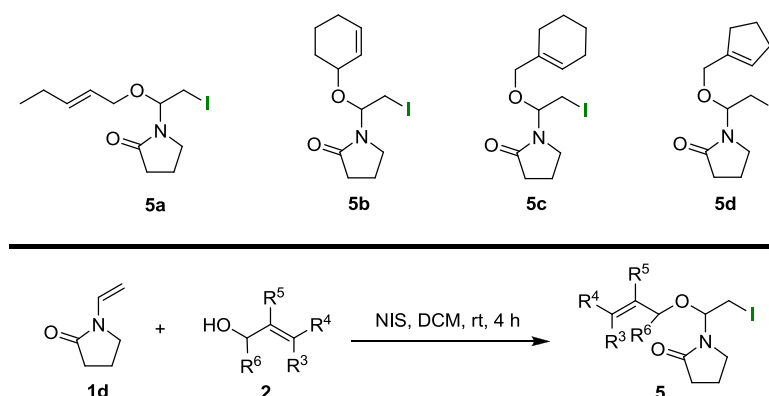


Product **4l** was synthesized according to experimental procedure described above. The reaction completed in just 36 h. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 40:1 to furnish **4l** as an inseparable mixture of 4/1 diastereoisomers (see ^1H NMR integrations at 2.26 and 2.09 ppm) and as a yellow oil (yield = 28.9 mg, 67%).

^1H NMR (500 MHz, CHCl_3) δ 5.10 (dd, $J_1=5.4$ Hz, $J_2=2.0$ Hz, 1H for both isomers), 4.09 (dd, $J_1=8.6$ Hz, $J_2=7.5$ Hz, 1H for minor isomer), 4.06 (dd, $J_1=8.5$ Hz, $J_2=7.4$ Hz, 1H for major isomer), 3.67 (s, 3H for both isomers), 3.64 (m, 1H for both isomers), 3.53 (dd, $J_1=8.5$ Hz, $J_2=7.4$ Hz, 1H for both isomers), 3.35 (dt, $J_1=9.4$ Hz, $J_2=6.5$ Hz, 1H for both isomers), 2.80 (m, 1H for minor isomer), 2.55 (m, 3H for major isomer), 2.39 (m, 2H for minor isomer), 2.26 (ddd, $J_1=13.5$ Hz, $J_2=9.4$ Hz, $J_3=5.5$ Hz, 1H for major isomer), 2.09 (ddd, $J_1=8.6$ Hz, $J_2=7.7$ Hz, $J_3=1.0$ Hz, 1H for minor isomer), 1.55 (m, 3H for both isomers), 1.35 (m, 2H for both isomers), 0.91 (t, $J=7.4$ Hz, 3H for major isomer), 0.91 (t, $J=7.5$ Hz, 3H for minor isomer) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 173.1 (major), 172.8 (minor), 104.1 (major), 103.7 (minor), 71.6

(minor), 71.5 (major), 67.2 (major), 67.0 (minor), 51.6 (minor), 51.6 (major), 38.9 (minor), 38.6 (major), 38.3 (minor), 38.1 (major), 33.9 (major), 33.6 (minor), 31.8 (major), 31.8 (minor), 19.4 (major), 19.3 (minor), 13.8 (both isomers) ppm. HRMS (TOF ESI): $[M+Na]^+$ calcd for $C_{11}H_{20}O_4Na$, 239.1254; found 239.1248.

General experimental procedure for the synthesis of compounds of type 5



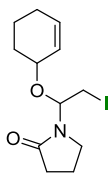
Compound **1d** (0.5 mmol, 53.4 μ L) was dissolved in CH_2Cl_2 (2.5 mL). The corresponding alcohol (0.5 mmol, 50.8 μ L for **2b**, 49.1 mg for **2f**, 56.1 mg for **2g**, 49.1 mg for **2h**) was added followed by NIS (112.5 mg, 0.5 mmol). The solution was stirred in the dark at room temperature. After completion of the reaction, as was indicated by tlc analysis (4 h), a saturated aqueous solution of $Na_2S_2O_3$ (3 mL) was added and the mixture was extracted with CH_2Cl_2 (2×4 mL). The combined organic layers were washed with distilled water (4 mL), dried over $MgSO_4$ and concentrated under reduced pressure. The products of type **5** were purified by flash column chromatography (silica gel, petroleum ether : EtOAc).

(E)-1-(2-iodo-1-(pent-2-enyloxy)ethyl)pyrrolidin-2-one (**5a**)

Product **5a** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 5:1) to furnish **5a** as a yellow oil (yield = 108.3 mg, 67%). This reaction was scaled up to 2 mmol of the starting materials and the results were almost identical (yield = 441 mg, 68%).

1H NMR (500 MHz, $CDCl_3$) δ 5.73 (m, 1H), 5.48 (m, 1H), 5.43 (dd, $J_1=8.2$ Hz, $J_2=5.9$ Hz, 1H), 3.87 (m, 2H), 3.32 (m, 3H), 3.13 (dd, $J_1=10.5$ Hz, $J_2=8.2$ Hz, 1H), 2.43 (m, 2H), 2.03 (m, 4H), 0.96 (t, $J=7.5$ Hz, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ 175.9, 137.4, 123.8, 80.0, 69.7, 40.5, 31.3, 25.2, 18.1, 13.1, 3.0 ppm. HRMS (TOF ESI): $[M+H]^+$ calcd for $C_{11}H_{19}INO_2$, 324.0455; found 324.0449.

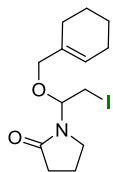
1-(1-(cyclohex-2-enyloxy)-2-iodoethyl)pyrrolidin-2-one (**5b**)



Product **5b** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 5:1) to furnish **5b** as an inseparable mixture of 1/0.8 diastereoisomers (see ^1H NMR integrations at 3.90 and 3.83 ppm) and as a yellow oil (yield = 102.2 mg, 61%).

^1H NMR (500 MHz, CDCl_3) δ 5.79 (m, 1H for major isomer, 2H for minor isomer), 5.51 (m, 2H for major, 1H for minor isomer), 3.90 (m, 1H for minor isomer), 3.83 (m, 1H for major isomer), 3.36 (td, $J_1=8.9$ Hz, $J_2=5.3$ Hz, 1H for both isomers), 3.27 (m, 2H for both isomers), 3.09 (m, 1H for both isomers), 2.38 (m, 2H for both isomers), 2.00 (m, 3H for both isomers), 1.88 (m, 1H for both isomers), 1.70 (m, 3H for both isomers), 1.52 (m, 1H for both isomers) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 175.8 (1C for one isomer), 175.6 (1C for one isomer), 132.0 (1C for one isomer), 131.5 (1C for one isomer), 126.8 (1C for one isomer), 126.4 (1C for one isomer), 79.4 (1C for one isomer), 78.7 (1C for one isomer), 72.0 (1C for one isomer), 70.8 (1C for one isomer), 40.6 (1C for one isomer), 40.5 (1C for one isomer), 31.4 (1C for one isomer), 31.3 (1C for one isomer), 29.2 (1C for one isomer), 27.6 (1C for one isomer), 25.0 (1C for one isomer), 24.9 (1C for one isomer), 19.0 (1C for one isomer), 18.6 (1C for one isomer), 18.2 (1C for both isomers), 3.9 (1C for one isomer), 3.8 (1C for one isomer) ppm. HRMS (TOF ESI): $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{12}\text{H}_{19}\text{INO}_2$, 336.0455; found 336.0452.

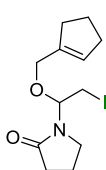
1-(1-(cyclohexenylmethoxy)-2-iodoethyl)pyrrolidin-2-one (**5c**)



Product **5c** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 4:1) to furnish **5c** as a yellow oil (yield = 127.4 mg, 73%).

^1H NMR (500 MHz, CDCl_3) δ 5.69 (m, 1H), 5.43 (dd, $J_1=7.9$ Hz, $J_2=6.1$ Hz, 1H), 3.80 (d, $J=11.9$ Hz, 1H), 3.77 (d, $J=11.9$ Hz, 1H), 3.34 (m, 3H), 3.15 (dd, $J_1=10.5$ Hz, $J_2=7.9$ Hz, 1H), 2.44 (m, 2H), 2.03 (m, 6H), 1.63 (m, 2H), 1.56 (m, 2H) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 175.9, 133.7, 126.3, 80.1, 73.8, 40.6, 31.3, 26.1, 25.0, 22.4, 22.2, 18.2, 3.1 ppm. HRMS (TOF ESI): $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{13}\text{H}_{21}\text{INO}_2$, 350.0612; found 350.0614.

1-(1-(cyclopentenylmethoxy)-2-iodoethyl)pyrrolidin-2-one (**5d**)

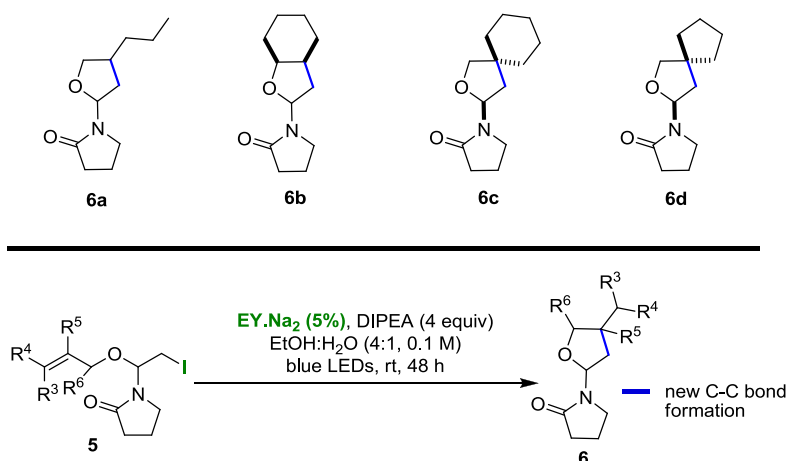


Product **5d** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 6:1) to furnish **5d** as a yellow oil (yield = 75.4 mg, 45%).

^1H NMR (500 MHz, CDCl_3) δ 5.64 (m, 1H), 5.43 (dd, $J_1=8.0$ Hz, $J_2=6.0$ Hz, 1H), 3.97 (s, 2H), 3.34 (m, 3H), 3.15 (dd, $J_1=10.5$ Hz, $J_2=8.0$ Hz, 1H), 2.43 (m, 2H), 2.30 (m, 4H), 2.04 (m, 2H), 1.87 (quin, $J=7.5$ Hz, 2H) ppm; ^{13}C NMR (125

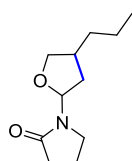
MHz, CDCl₃) δ 176.0, 140.0, 128.6, 80.2, 67.6, 40.5, 33.0, 32.4, 31.3, 23.2, 18.1, 3.0 ppm. HRMS (TOF ESI): [M+Na]⁺ calcd for C₁₂H₁₈INO₂Na, 358.0274; found 358.0270.

General experimental for the synthesis of substrates of type 6



To a solution of compounds of type **5** (0.2 mmol, 64.6 mg for **5a**, 67 mg for **5b**, 69.8 mg for **5c**, 67 mg for **5d**) in EtOH:H₂O (4:1, 1.6 mL EtOH and 0.4 mL H₂O), the photocatalyst EY.Na₂ (5%, 6.9 mg, 0.01 mmol) was added and argon (balloon) was gently bubbled through the solution for 10 min at rt. Afterwards, under an argon atmosphere, DIPEA (140 μ L, 0.8 mmol) was added and the solution was irradiated using blue LED light strips (60 LEDs/m, 10.8 w/m, 1000 lm/m) at the same temperature. After completion of the reaction, as indicated by tlc analysis (48 h), the solution was concentrated *in vacuo* and the product of type **6** was purified by flash column chromatography.

1-(4-propyltetrahydrofuran-2-yl)pyrrolidin-2-one (**6a**)

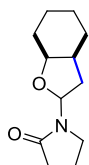


Product **6a** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 4:1 \rightarrow 2:1) to furnish **6a** as inseparable mixture of 1/0.25 diastereoisomers (see ¹H NMR integrations at 5.91, 5.86, 4.08 and 3.96 ppm) and as a yellow oil (yield = 31.9 mg, 81%). This reaction was scaled up to 1 mmol of the starting material and the results were very similar (yield = 148.5 mg, 75%).

¹H NMR (500 MHz, CDCl₃) δ 5.91 (dd, $J_1=7.7$ Hz, $J_2=4.0$ Hz, 1H for major isomer), 5.86 (dd, $J_1=8.6$ Hz, $J_2=6.2$ Hz, 1H for minor isomer), 4.08 (dd, $J_1=8.2$ Hz, $J_2=7.0$ Hz, 1H for major), 3.96 (t, $J=7.7$ Hz, 1H for minor isomer), 3.47 (m, 1H for both isomers), 3.41 (m, 2H for minor isomer), 3.34 (m, 2H for major isomer), 2.38 (t, $J=7.7$ Hz, 2H for both isomers), 2.28 (m, 1H for major isomer), 2.16 (m, 1H for minor isomer), 2.00 (m, 3H, for both isomers), 1.77 (m, 1H for both isomers), 1.36 (m, 4H for both isomers), 0.90 (t, $J=7.0$ Hz, 3H for both isomers) ppm; ¹³C NMR (125 MHz,

CDCl₃) δ 175.5 (minor), 175.2 (major), 82.5 (minor), 81.8 (major), 73.6 (major), 73.1 (minor), 42.1 (major), 41.8 (minor), 39.4 (minor), 38.6 (major), 35.4 (major), 35.1 (major), 34.8 (minor), 34.6 (minor), 31.7 (minor), 31.6 (major), 21.5 (both isomers), 17.9 (minor), 17.8 (major), 14.1 (both isomers) ppm. HRMS (TOF ESI): [M+H]⁺ calcd for C₁₁H₂₀NO₂, 198.1489; found 198.1488.

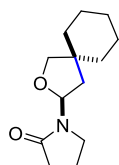
1-(octahydrobenzofuran-2-yl)pyrrolidin-2-one (**6b**)



Product **6b** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 4:1 \rightarrow 1:1) to furnish **6b** as inseparable mixture of 1/0.25 diastereoisomers (see ¹H NMR integrations at 6.07, 5.83, 4.09 and 3.84 ppm) and as a yellow oil (yield = 26.4 mg, 63%).

¹H NMR (500 MHz, CDCl₃) δ 6.07 (t, *J*=7.2 Hz, 1H for major isomer), 5.83 (t, *J*=7.4 Hz, 1H for minor isomer), 4.09 (q, *J*=3.7 Hz, 1H for major isomer), 3.84 (q, *J*=5.1 Hz, 1H for minor isomer), 3.59 (td, *J*₁=8.8 Hz, *J*₂=6.0 Hz, 1H for minor isomer), 3.48 (td, *J*₁=8.8 Hz, *J*₂=6.0 Hz, 1H for major isomer), 3.44 (m, 1H for minor isomer), 3.39 (td, *J*₁=8.8 Hz, *J*₂=5.7 Hz, 1H for major isomer), 2.42 (m, 2H for minor isomer), 2.38 (t, *J*=8.2 Hz, 2H for major isomer), 2.14 (m, 1H for both isomers), 2.01 (m, 2H for both isomers), 1.95 (m, 1H for both isomers), 1.88 (dd, *J*₁=6.9 Hz, *J*₂=2.6 Hz, 1H for major isomer), 1.86 (dd, *J*₁=6.9 Hz, *J*₂=2.6 Hz, 1H for minor isomer), 1.60 (m, 3H for major), 1.48 (m, 2H for major isomer and 4H for minor isomer), 1.38 (m, 1H for major isomer and 3H for minor isomer), 1.29 (m, 1H for both isomers), 1.17 (m, 1H for major isomer) ppm; ¹³C NMR (125 MHz, CDCl₃) δ 175.7 (minor), 175.4 (major), 81.1 (both isomers), 77.9 (major), 75.7 (minor), 42.3 (minor), 41.9 (major), 38.2 (major), 36.5 (minor), 35.0 (major), 33.2 (minor), 31.7 (both isomers), 28.8 (minor), 28.3 (major), 28.2 (minor), 27.2 (major), 23.7 (major), 23.4 (minor), 21.5 (minor), 20.2 (major), 17.8 (major), 17.7 (minor) ppm. HRMS (TOF ESI): [M+Na]⁺ calcd for C₁₂H₁₉NO₂Na, 232.1308; found 232.1304.

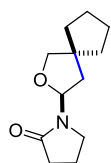
1-(2-oxaspiro[4.5]decan-3-yl)pyrrolidin-2-one (**6c**)



Product **6c** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 10:1 \rightarrow 3:1) to furnish **6c** as a white solid (yield = 30.4 mg, 68%).

¹H NMR (500 MHz, CDCl₃): δ = 5.91 (dd, *J*₁=8.2 Hz, *J*₂=7.0 Hz, 1H), 3.64 (d, *J*=8.4 Hz, 1H), 3.57 (d, *J*=8.4 Hz, 1H), 3.48 (td, *J*₁=8.8, *J*₂=6.0 Hz, 1H), 3.38 (td, *J*₁=8.8 Hz, *J*₂=6.0 Hz, 1H), 2.39 (t, *J*=8.2 Hz, 2H), 1.99 (m, 3H), 1.58 (dd, *J*₁=13.0 Hz, *J*₂=8.4 Hz, 1H), 1.46 (m, 10H) ppm; ¹³C NMR (125 MHz, CDCl₃) δ 175.4, 81.8, 77.8, 43.7, 41.7, 39.7, 36.1, 34.9, 31.7, 25.9, 24.0, 23.1, 17.9 ppm; HRMS (TOF ESI): [M+Na]⁺ calcd for C₁₃H₂₁NO₂Na, 246.1465; found 246.1463.

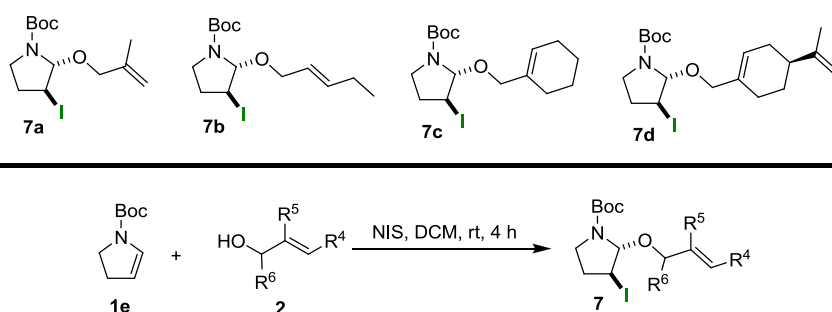
1-(2-oxaspiro[4,4]nonan-3-yl)pyrrolidin-2-one (**6d**)



Product **6d** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 25:1 → 2:1) to furnish **6d** as a yellow oil (yield = 31.8 mg, 76%).

^1H NMR (500 MHz, CDCl_3) δ 5.92 (t, $J=7.4$ Hz, 1H), 3.65 (d, $J=8.0$ Hz, 1H), 3.60 (d, $J=8.0$ Hz, 1H), 3.51 (td, $J_1=8.6$ Hz, $J_2=6.0$ Hz, 1H), 3.38 (td, $J_1=8.6$ Hz, $J_2=6.0$ Hz, 1H), 2.40 (t, $J=8.2$ Hz, 2H), 2.02 (m, 2H), 1.94 (dd, $J_1=12.8$ Hz, $J_2=6.6$ Hz, 1H), 1.82 (dd, $J_1=12.8$ Hz, $J_2=8.2$ Hz, 1H), 1.68-1.62 (m, 8H) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 175.5, 82.2, 78.1, 50.6, 41.8, 40.7, 37.4, 35.7, 31.7, 24.8, 24.6, 17.9 ppm. HRMS (TOF ESI): $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{12}\text{H}_{19}\text{NO}_2\text{Na}$, 232.1308; found 232.1307.

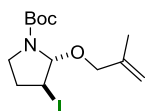
General experimental procedure for the synthesis of compounds of type **7**



Compound **1e** (0.5 mmol, 86.3 μL) was dissolved in CH_2Cl_2 (2.5 mL). The corresponding alcohol (0.5 mmol, 42.1 μL for **2a**, 50.8 μL for **2b**, 79.3 μL for **2c**, 56.1 mg for **2g**) was added followed by NIS (112.5 mg, 0.5 mmol). The solution was stirred in the dark at room temperature. After completion of the reaction (4 h), as was indicated by tlc analysis, a saturated aqueous solution of $\text{Na}_2\text{S}_2\text{O}_3$ (3 mL) was added and the mixture was extracted with CH_2Cl_2 (2×4 mL). The combined organic layers were washed with distilled water (4 mL), dried over MgSO_4 and concentrated under reduced pressure. The products of type **7** were purified by flash column chromatography (silica gel, petroleum ether : EtOAc).

The stereochemistry of the corresponding products was assigned by comparison with previously synthesized compounds.²

tert-butyl 3-iodo-2-(2-methylallyloxy)pyrrolidine-1-carboxylate (**7a**)

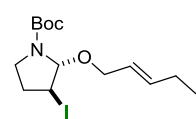


Product **7a** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 20:1) to furnish

7a as a mixture of 1/1 Boc-isomers and as a yellow oil (yield = 112 mg, 61%). This reaction was scaled up to 2 mmol of the starting materials and the results were identical (yield = 445 mg, 61%).

^1H NMR (500 MHz, CDCl_3) δ 5.48 (s, 1H for one Boc-isomer), 5.34 (s, 1H for one Boc-isomer), 4.94 (s, 1H for both Boc-isomers), 4.86 (m, 1H for both Boc-isomers), 4.23 (m, 1H for both Boc-isomers), 3.98 (m, 2H for both Boc-isomers), 3.62 (m, 1H for both Boc-isomers), 3.43 (m, 1H for both Boc-isomers), 2.53 (m, 1H for both Boc-isomers), 2.11 (m, 1H for both Boc-isomers), 1.71 (s, 3H for both Boc-isomers), 1.48 (s, 9H for both Boc-isomers) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 155.0 (one Boc-isomer), 154.2 (one Boc-isomer), 142.1 (one Boc-isomer), 141.8 (one Boc-isomer), 112.2 (one Boc-isomer), 112.0 (one Boc-isomer), 95.2 (one Boc-isomer), 94.8 (one Boc-isomer), 80.6 (one Boc-isomer), 80.2 (one Boc-isomer), 72.6 (one Boc-isomer), 72.4 (one Boc-isomer), 44.9 (one Boc-isomer), 44.3 (one Boc-isomer), 33.8 (one Boc-isomer), 32.9 (one Boc-isomer), 28.3 (both Boc-isomers), 27.5 (one Boc-isomer), 26.8 (one Boc-isomer), 19.5 (both Boc-isomers) ppm. HRMS (TOF ESI): $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{13}\text{H}_{22}\text{INO}_3\text{Na}$, 390.0537; found 390.0533.

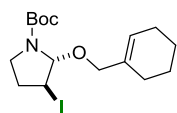
(E)-tert-butyl 3-iodo-2-(pent-2-en-1-yloxy)pyrrolidine-1-carboxylate (7b)



Product **7b** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 20:1) to furnish **7b** as a mixture of 1/1 Boc-isomers and as a yellow oil (yield = 138.5 mg, 73%).

^1H NMR (500 MHz, CDCl_3) δ 5.72 (m, 1H for both isomers), 5.51-5.45 (m, 1H for both isomers), 5.43 (s, 1H for one isomer), 5.29 (s, 1H for one isomer), 4.18 (m, 1H for both isomers), 4.00 (m, 2H for both isomers), 3.58 (m, 1H for both isomers), 3.40 (m, 1H for both isomers), 2.48 (m, 1H for both isomers), 2.09-2.01 (m, 3H for both isomers), 1.46 (s, 9H for both isomers), 0.98-0.94 (m, 3H for both isomers) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 154.8 (one isomer), 154.1 (one isomer), 136.6 (one isomer), 136.4 (one isomer), 124.9 (one isomer), 124.8 (one isomer), 94.9 (one isomer), 94.7 (one isomer), 80.4 (one isomer), 80.1 (one isomer), 69.8 (one isomer), 69.4 (one isomer), 44.8 (one isomer), 44.3 (one isomer), 33.7 (one isomer), 32.8 (one isomer), 28.3 (one isomer), 28.3 (one isomer), 27.8 (one isomer), 27.1 (one isomer), 25.2 (both isomers), 13.2 (both isomers) ppm. HRMS (TOF ESI): $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{14}\text{H}_{24}\text{INO}_3\text{Na}$, 404.0693; found 404.0687.

tert-butyl 2-(cyclohex-1-en-1-ylmethoxy)-3-iodopyrrolidine-1-carboxylate (7c)

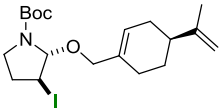


Product **7c** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 60:1) to furnish **7c** as a mixture of 1.3/1 Boc-isomers (see ^1H NMR integrations at 5.43 and 5.29 ppm) and as a yellow oil (yield = 142.6 mg, 70%).

^1H NMR (500 MHz, CDCl_3) δ 5.67 (m, 1H for both isomers), 5.43 (s, 1H for minor isomer), 5.29 (s, 1H for major isomer), 4.19 (m, 1H for both isomers), 4.00-3.91 (m,

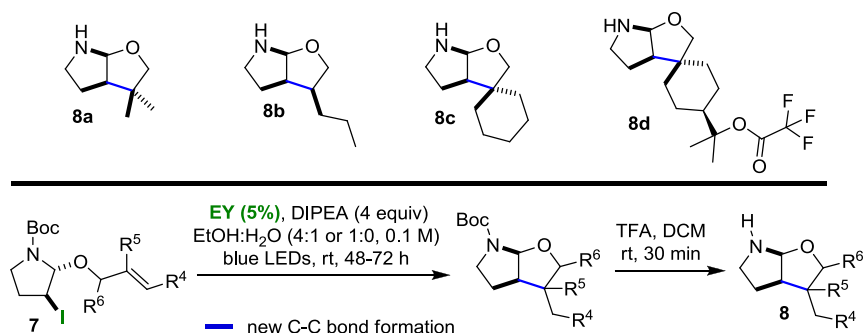
2H for major isomer and 1H for minor isomer), 3.83 (m, 1H for minor isomer), 3.58 (m, 1H for both isomers), 3.41 (m, 1H for both isomers), 2.49 (m, 1H for both isomers), 2.08 (m, 1H for both isomers), 2.00-1.95 (m, 4H for both isomers), 1.62-1.54 (m, 4H for both isomers), 1.47 (s, 9H for both isomers) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 154.8 (minor), 154.2 (major), 134.8 (minor), 134.6 (major), 125.2 (major), 125.1 (minor), 95.2 (major), 94.8 (minor), 80.4 (major), 80.0 (minor), 73.8 (minor), 73.5 (major), 44.8 (minor), 44.3 (major), 33.7 (minor), 32.8 (major), 28.3 (major), 28.3 (minor), 27.8 (major), 27.1 (minor), 25.9 (major), 25.9 (minor), 24.9 (both isomers), 22.4 (minor), 22.4 (major), 22.2 (minor), 22.2 (major) ppm. HRMS (TOF ESI): $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{16}\text{H}_{26}\text{INO}_3\text{Na}$, 430.0845; found 430.0844.

tert-butyl 3-iodo-2-((4-(prop-1-en-2-yl)cyclohex-1-en-1-yl)methoxy)pyrrolidine-1-carboxylate (**7d**)

 Product **7d** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 40:1) to furnish **7d** as an inseparable mixture of two pairs of diastereoisomers with a ratio of 1.3/1.3/1/1 (see ^1H NMR integrations at 5.70, 5.45 and 5.30 ppm) and as a yellow oil (yield = 158.8 mg, 71%).

^1H NMR (500 MHz, CDCl_3) δ 5.70 (m, 1H for all isomers), 5.45 (d, $J=8.2$ Hz, 1H for the minor pair of isomers), 5.30 (d, $J=8.2$ Hz, 1H for the major pair of isomers), 4.69 (m, 2H for all isomers), 4.20 (m, 1H for all isomers), 3.98 (m, 2H for the major pair of isomers and 1H for the minor pair of isomers), 3.87 (m, 1H for the minor pair of isomers), 3.60 (m, 1H for all isomers), 3.42 (m, 1H for all isomers), 2.50 (m, 1H for all isomers), 2.15-2.05 (m, 6H for all isomers), 1.95 (m, 1H for all isomers), 1.83 (m, 1H for all isomers), 1.71 (s, 3H for all isomers), 1.48 (s, 9H for all isomers) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 154.9, 154.2, 149.7, 149.5, 134.5, 134.4, 124.7, 124.6, 124.4, 108.7, 108.6, 95.2, 95.2, 94.8, 80.5, 80.1, 73.2, 73.1, 73.0, 44.8, 44.3, 40.9, 33.8, 32.9, 30.4, 28.4, 27.7, 27.6, 27.3, 27.1, 27.0, 26.5, 26.4, 20.7 ppm. HRMS (TOF ESI): $[\text{M}+\text{Na}]^+$ calcd for $\text{C}_{19}\text{H}_{30}\text{INO}_3\text{Na}$, 470.1163; found 470.1158.

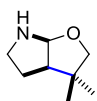
General experimental procedure for the synthesis of compounds of type **8**



To a solution of compounds of type **7** (0.2 mmol, 73.4 mg for **7a**, 76.2 mg for **7b**, 81.5 mg for **7c**, 89.5 mg for **7d**) in EtOH:H₂O (4:1, 1.6 mL EtOH and 0.4 mL H₂O),

the photocatalyst EY.Na₂ (5%, 6.9 mg, 0.01 mmol) was added and argon (balloon) was gently bubbled through the solution for 10 min at rt. For compound **7a** EtOH (2 mL) was used in place of EtOH:H₂O because it gave a cleaner result. Afterwards, under an argon atmosphere, DIPEA (140 μL, 0.8 mmol) was added and the solution was irradiated using blue LED light strips (60 LEDs/m, 10.8 w/m, 1000 lm/m) at the same temperature. After completion of the reaction (48 h in EtOH:H₂O or 72 h in EtOH), as was indicated by tlc analysis and ¹H-NMR spectra, the solution was concentrated *in vacuo*. The remaining crude product was then dissolved in CH₂Cl₂ (2 mL) and TFA (1 mL) was added. After consumption of the starting material as was indicated by tlc analysis (30 min stirring at rt), the solution was concentrated *in vacuo*. Products of type **8** were purified by flash column chromatography (silica gel, petroleum ether : EtOAc).

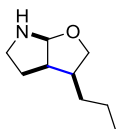
3,3-dimethylhexahydro-2H-furo[2,3-b]pyrrole (**8a**)



Product **8a** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 1:2) to furnish **8a** as a yellow oil (yield = 16.4 mg, 58%). This reaction was scaled up to 1 mmol of the starting material and the results were almost identical (yield = 79 mg, 56%).

¹H NMR (500 MHz, CDCl₃) δ 5.68 (d, *J*=6.2 Hz, 1H), 3.75 (d, *J*=8.7 Hz, 1H), 3.62 (d, *J*=8.7 Hz, 1H), 3.38 (m, 1H), 3.09 (m, 1H), 2.56 (m, 1H), 2.01 (m, 2H), 1.12 (s, 3H), 1.07 (s, 3H) ppm; ¹³C NMR (125 MHz, CDCl₃) δ 95.3, 79.4, 53.2, 45.1, 41.6, 28.1, 25.7, 19.3 ppm. HRMS (TOF ESI): [M+H]⁺ calcd for C₈H₁₆NO, 142.1226; found 142.1229.

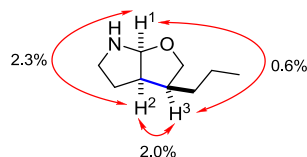
3-propylhexahydro-2H-furo[2,3-b]pyrrole (**8b**)



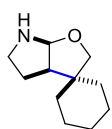
Product **8b** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 1:2) to furnish **8b** as a yellow oil (yield = 18.9 mg, 61%).

¹H NMR (500 MHz, CDCl₃) δ 5.63 (d, *J*=5.5 Hz, 1H), 4.03 (t, *J*=8.0 Hz, 1H), 3.59 (dd, *J*₁=11.2 Hz, *J*₂=9.0 Hz, 1H), 3.37 (m, 1H), 3.16 (m, 1H), 2.98 (m, 1H), 2.39 (m, 1H), 2.02 (m, 2H), 1.43-1.27 (m, 4H), 0.93 (t, *J*=7.0 Hz, 3H) ppm; ¹³C NMR (125 MHz, CDCl₃) δ 95.4, 73.4, 45.4, 45.3, 41.8, 28.5, 23.7, 21.7, 14.1 ppm. HRMS (TOF ESI): [M+H]⁺ calcd for C₉H₁₈NO, 156.1383; found 156.1384.

Representative NOE for compound **8b**



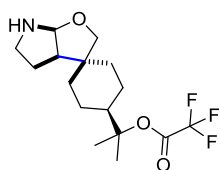
tetrahydro-2'H,4'H-spiro[cyclohexane-1,3'-furo[2,3-b]pyrrole] (**8c**)



Product **8c** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 1:2) to furnish **8c** as a white solid (yield = 23.6 mg, 65%).

^1H NMR (500 MHz, CDCl_3) δ 5.64 (d, $J=6.3$ Hz, 1H), 3.82 (d, $J=9.0$ Hz, 1H), 3.69 (d, $J=9.0$ Hz, 1H), 3.37 (m, 1H), 3.10 (m, 1H), 2.69 (m, 1H), 2.03 (m, 2H), 1.53-1.37 (m, 10H) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 95.0, 77.6, 50.7, 45.6, 45.2, 35.8, 29.6, 25.8, 24.7, 23.8, 22.4 ppm. HRMS (TOF ESI): $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{11}\text{H}_{20}\text{NO}$, 182.1540; found 182.1541.

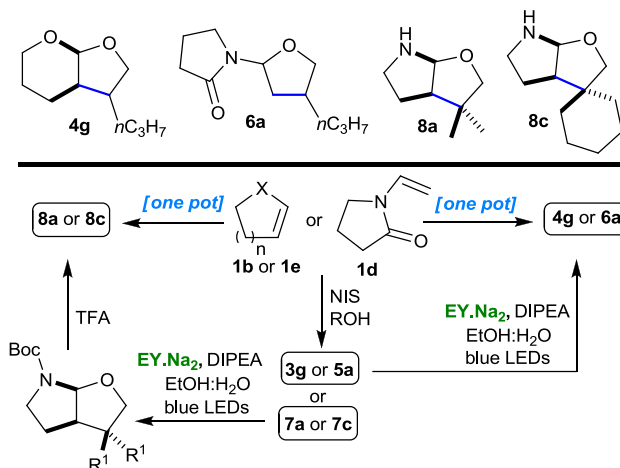
2-(tetrahydro-2'H,4'H-spiro[cyclohexane-1,3'-furo[2,3-b]pyrrol]-4-yl)propan-2-yl 2,2,2-trifluoroacetate (**8d**)



Product **8d** was synthesized according to the experimental procedure described above. The crude product was purified by flash column chromatography (silica gel, petroleum ether : EtOAc = 1:1) to furnish **8d** as inseparable mixture of 1/1 diastereoisomers and as a brown solid (yield = 28.3 mg, 42%).

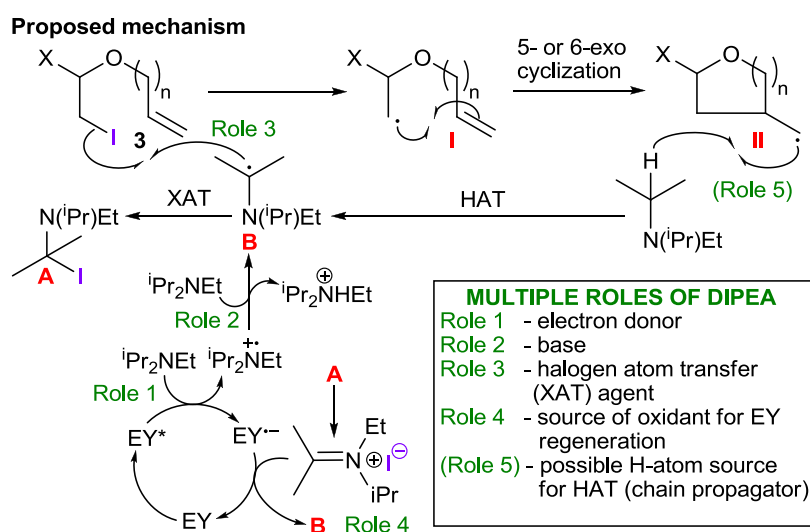
^1H NMR (500 MHz, CDCl_3) δ 10.37 (brs, 1H for both isomers), 5.66 (m, 1H for both isomers), 4.01 (d, $J=9.0$ Hz, 1H for one isomer), 3.79 (d, $J=8.8$ Hz, 1H for one isomer), 3.67 (d, $J=9.0$ Hz, 1H for one isomer), 3.58 (d, $J=8.8$ Hz, 1H for one isomer), 3.40 (m, 1H for both isomers), 3.12 (m, 1H for both isomers), 2.84 (m, 1H for one isomer), 2.52 (m, 1H for one isomer), 2.09 (m, 1H for both isomers), 2.00 (m, 1H for both isomers), 1.89 (m, 1H for both isomers), 1.83-1.66 (m, 4H for both isomers), 1.55 (s, 3H for one isomer), 1.54 (s, 3H for one isomer), 1.52 (s, 3H for one isomer), 1.51 (s, 3H for one isomer), 1.31 (m, 3H for both isomers), 1.11 (m, 1H for both isomers) ppm; ^{13}C NMR (125 MHz, CDCl_3) δ 156.0 (q, $^2J_{\text{C-F}}=41$ Hz, 114.4 (q, $^1J_{\text{C-F}}=288$ Hz), 95.2, 94.5, 91.2, 79.6, 74.4, 53.9, 47.0, 45.9, 45.3, 45.2, 45.1, 35.5, 35.0, 30.1, 28.1, 27.0, 26.9, 24.8, 24.7, 24.6, 23.9, 23.2, 23.0, 23.0, 22.9 ppm. HRMS (TOF ESI): $[\text{M}+\text{H}]^+$ calcd for $\text{C}_{16}\text{H}_{25}\text{F}_3\text{NO}_3$ 336.1781; found 336.1777.

One pot synthesis of products **4g**, **6a** and **8a**, **8c** from starting materials of type **1** (**1b** and **1e** respectively) without intermediate purifications

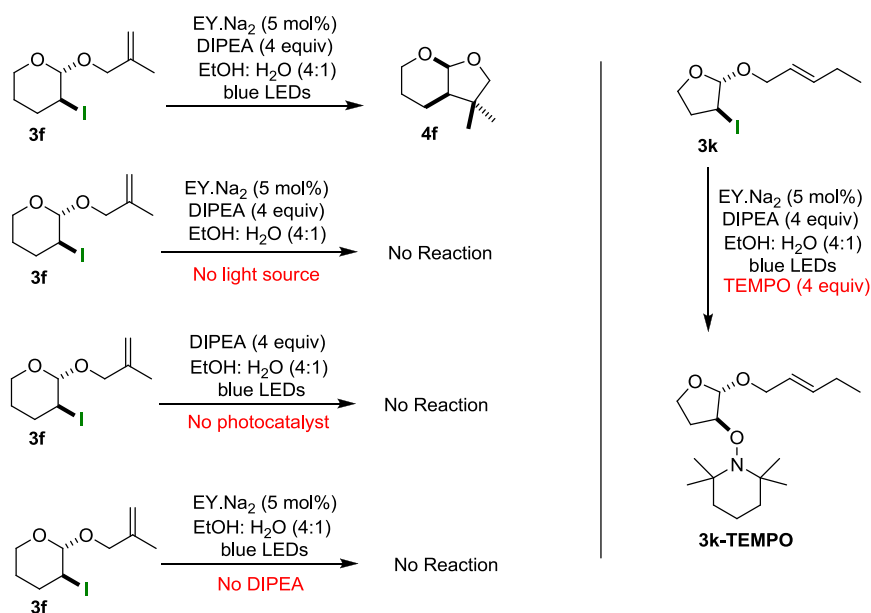


The corresponding starting material of type **1** (1 mmol, 91.2 μL for **1b**, 106.8 μL for **1d** and 172.7 μL for **1e**) was dissolved in CH_2Cl_2 (5 mL). The corresponding alcohol (1 mmol, 84.1 μL for **2a**, 101.7 μL for **2b**, 112.2 mg for **2g**) was added followed by NIS (225 mg, 1 mmol). The solution was stirred in the dark at room temperature for 4 h until full consumption of the starting compound of type **1** as was indicated by tlc and ^1H NMR analysis. Then, CH_2Cl_2 was removed under reduced pressure and the crude products **3g**, **5a**, **7a** and **7c** were dissolved in $\text{EtOH}:\text{H}_2\text{O}$ (4:1, 8 mL EtOH and 2 mL H_2O). The photocatalyst $\text{EY}.\text{Na}_2$ (5%, 0.05 mmol, 34.6 mg) was added. Argon (balloon) was then bubbled gently through the solution for 15 min at room temperature. Afterwards, under argon atmosphere, DIPEA (695.4 μL , 4 mmol) was added and the solution was irradiated using blue LED strips (60 LEDs/m, 10.8 w/m, 1000 lm/m) at the same temperature. After completion of the reaction (72 h), as was indicated by tlc and ^1H NMR analysis, the solution was concentrated under reduced pressure. The crude product **4g** was purified by flash column chromatography with an overall isolated yield of 66.4 mg (39%). The crude product **6a** was purified by flash column chromatography with an overall isolated yield of 84.5 mg (43%). The crude products **9a** and **9c** were dissolved in CH_2Cl_2 (10 mL) and then TFA (5 mL) was added. After consumption of the starting material as was indicated by tlc analysis (30 min), the solution was concentrated under reduced pressure and the remaining crude products **8a** and **8c** were purified by flash column chromatography. Overall isolated yields: **8a** (24.1 mg, 17%), **8c** (41.7 mg, 23%). When the scale of the one pot protocol for the synthesis of **8a** and **8c** (3 synthetic steps) was doubled (2 mmol of starting material **1e**), the overall yield for **8a** increased to 27% while for **8c** it increased to 32%.

Mechanistic Investigations:



[1] Control and Trapping Experiments



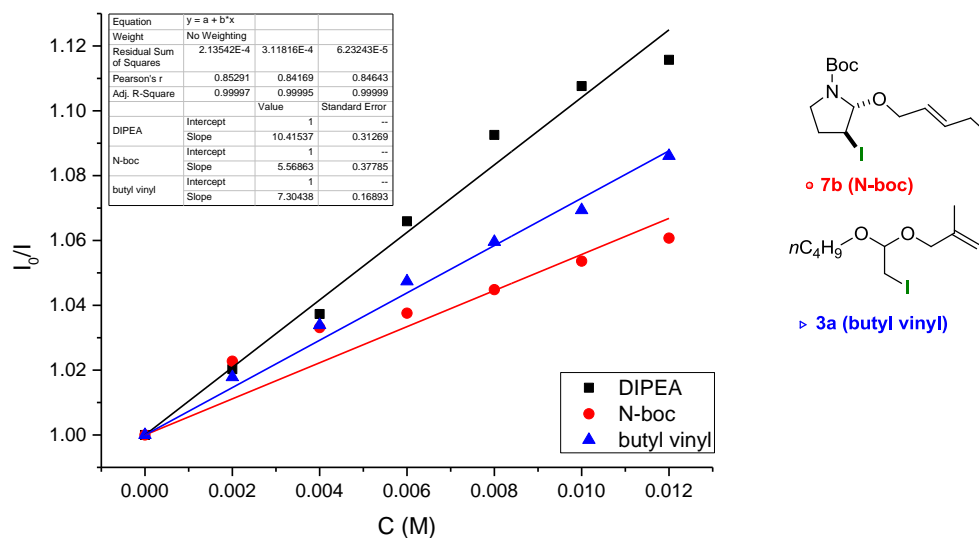
[2] Emission Quenching Experiments - Stern-Volmer Plots

The emission spectra were measured on a JASCO FP-6500 fluorescence spectrophotometer equipped with a red-sensitive WRE-343 photomultiplier tube (wavelength range: 200-850 nm). All the EY.Na₂ solutions were excited at 400 nm and the emission intensity was collected at 555 nm.

Experimental procedure

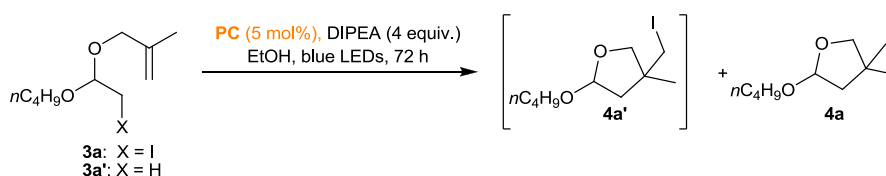
A screw-top quartz cuvette was charged with a 0.1 mM of a degassed solution of EY in EtOH (2.0 mL) and the initial emission was collected. Then the appropriate amount of the quencher as a 0.2 M degassed solution in EtOH was added. The sample was shaken for 30 sec and then the emission of the sample was collected.

Combined Stern-Volmer plots



The Stern-Volmer quenching studies clearly illustrate that it is DIPEA that preferentially quenches the excited state of eosin rather than either of the reaction substrates (**3a** or **7b**) tested. This supports the mechanistic analysis that there is a SET step in which an electron is transferred from DIPEA to excited state eosin; thus, reducing the eosin ($EY^* \rightarrow EY^{\bullet-}$ and $DIPEA \rightarrow DIPEA^{\bullet+}$).

[3] Photocatalyst changes



Photocatalyst	E (PC/PC ^{•-}) (V vs SCE)	Conversion (%) ^[a]	3a':4a':4a
PC1 = EY.Na ₂ ³	-1.06	100	0:0:1
PC2 = [Ir(ppy) ₂ (dtbpy)]PF ₆ ⁴	-1.51	100 ^[b]	1:0:4.8
PC3 = riboflavin ⁵	-0.79	63	0:1:1
PC4 = 9,10-Dicyanoanthracene ³	-0.91	40	0:1.2:1
PC5 = rhodamine ³	-1.14	68	0:2.5:1

[a] As measured by ¹H NMR. [b] The reaction was completed in 3 h using 0.5 mol% of PC2.

In order to support the assumption that the direct reduction of the C-I bond by PC^{•-} does not occur in the eosin-facilitated reactions described above, a number of other photocatalysts were tested in the reaction of substrate **3a**. The iridium ([Ir(ppy)₂(dtbpy)]PF₆) catalyst which is the strongest reductant can directly reduce the C-I as evidenced by the production of significant amounts of the reduced substrate **3a'**; however, all the other photocatalysts (PC1 and PC3-5) which are much weaker reducing agents can still facilitate the reaction under investigation (**3a** → **4a'**:**4a**). Of particular note are riboflavin and 9,10-dicyanoanthracene (DCA) because these photocatalysts are more commonly used as oxidants rather than reductants and they have reduction potentials that definitely preclude direct reduction of the C-I bond; however, both are capable of oxidising DIPEA which has an $E_{ox} = +0.68$ V vs SCE⁶ and can therefore initiate the reaction sequence being investigated as we have described in the proposed mechanism (*vide supra*). Both riboflavin and 9,10-dicyanoanthracene (DCA) did catalyze the desired reaction. It is also consistent that these two photocatalysts produced greater amounts of the other product **4a'** (by the secondary cycle in which intermediate **II** reacts with starting material **3** via halogen atom transfer XAT producing **I** that then feeds into the main cycle) which

³ N. A. Romero and D. A. Nicewicz, *Chem. Rev.*, 2016, 10075.

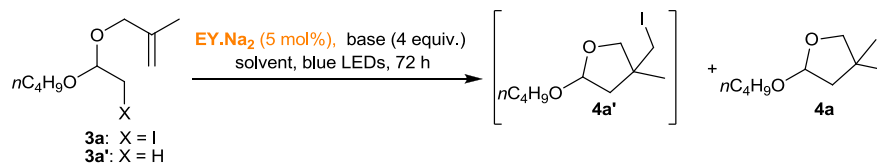
⁴ J. D. Slinker, A. A. Gorodetsky, M. S. Lowry, J. Wang, S. Parker, R. Rohl, S. Bernhard and G. G. Malliaras, *J. Am. Chem. Soc.*, 2004, **126**, 2763.

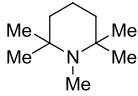

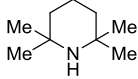
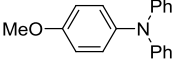
⁵ S. L. J. Tan and R. D. Webster, *J. Am. Chem. Soc.*, 2012, **134**, 5954.

⁶ U. Pischel, K. Zhang, B. Hellrung, E. Haselbach, P.-A. Muller and W. M. Nau, *J. Am. Chem. Soc.*, 2000, **122**, 2027.

subsequently converts to the desired product **4a**, exactly because they are weaker reducing agents.

[4] Changes of base (electron donor)



Base (electron donor)	Solvent	Eox (V vs SCE)	Conversion (%) ^[a]	4a':4a
diisopropylethylamine (DIPEA)	EtOH	+0.68 ⁶	100	0:1
 1,2,2,6,6-pentamethyl piperidine	EtOH	+0.78 ⁷	74	1.3:1
 DABCO	dry ACN	+0.69 ⁸	messy	-
 2,2,6,6-tetramethyl piperidine	EtOH	+0.98 ⁷	0	-
Ph ₃ N	dry ACN	+0.73 ⁹	0	-
 4-methoxy- <i>N,N</i> -diphenylaniline	dry ACN	+0.74 ¹⁰	0	-

[a] As measured by ¹H NMR

A series of amines capable of quenching the excited triplet state of eosin ($T_1 E_{*PC/PC} = +0.83$) were tested in the reaction (see, table immediately above). Only the amines with α -CH alkyl bonds that can also support formation of a radical at this α -position (namely, DIPEA and 1,2,2,6,6-pentamethylpiperidine) could promote the reaction. It should be noted that while DABCO possesses an α -CH alkyl bond, it has been shown to be unable to form radicals at this position, and, thus, it couldn't cleanly promote the reaction.¹¹ Likewise, triphenylamine and 4-methoxy-*N,N*-diphenylaniline, which are both competent electron donors, but which do not possess an α -CH alkyl bond, do not

⁷ T. Constantin, M. Zanini, A. Regni, N. S. Sheikh, F. Juliá and D. Leonori, *Science*, 2020, **367**, 1021.

⁸ J. L. Jeffrey, F. R. Petronijević and D. W. C. MacMillan, *J. Am. Chem. Soc.*, 2015, **137**, 8404.

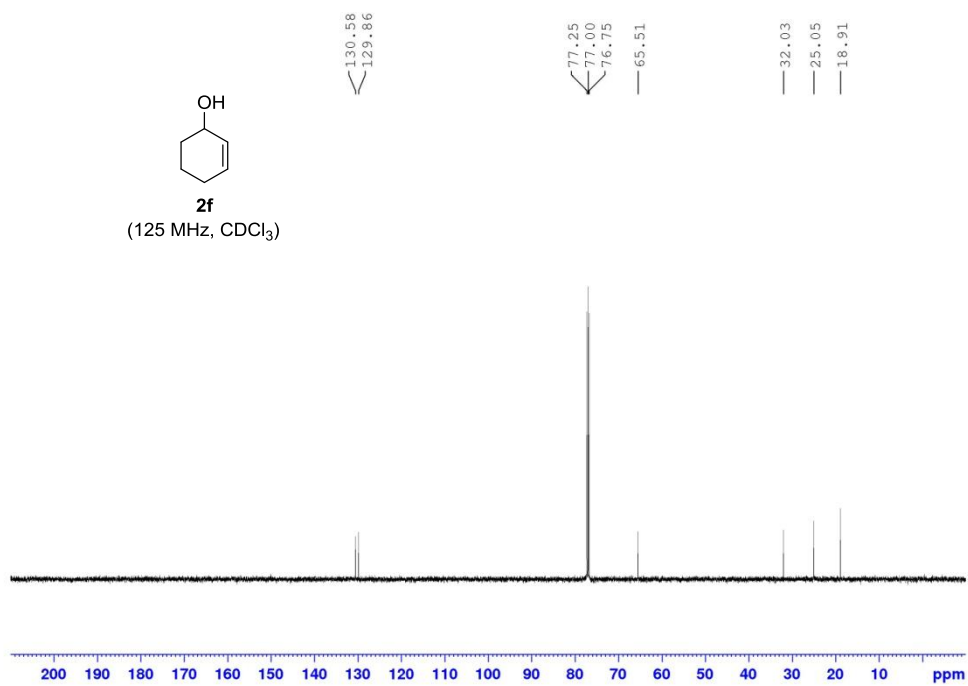
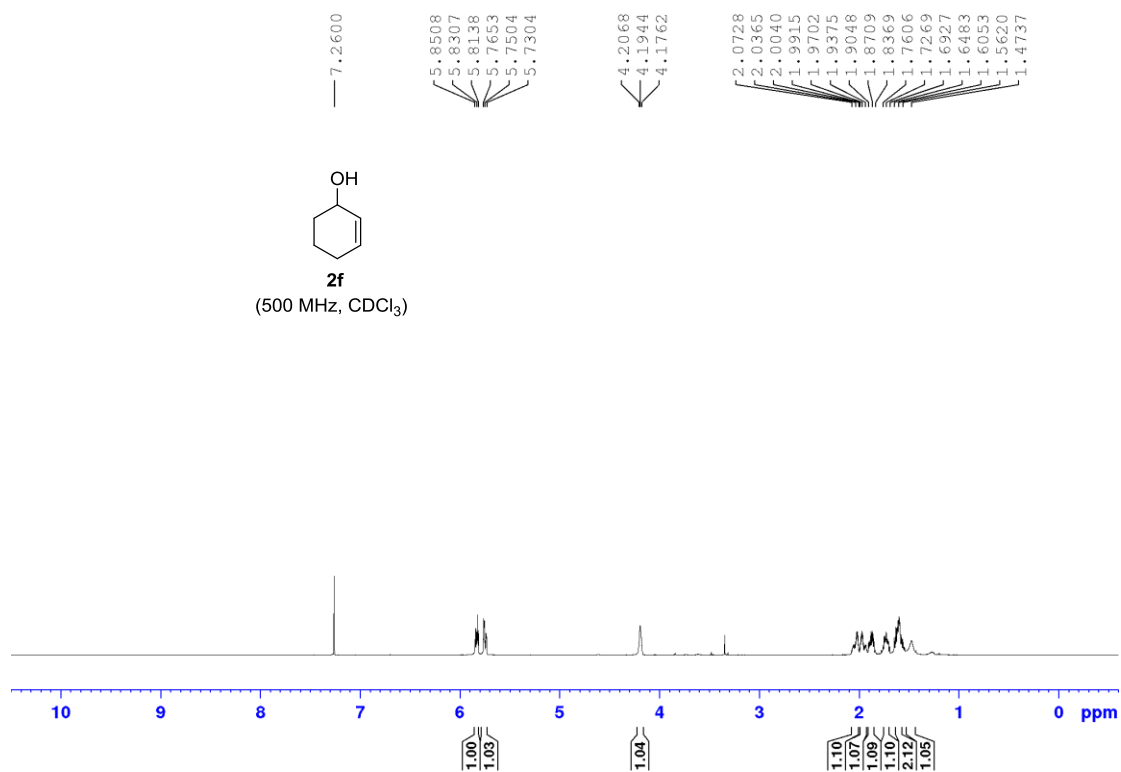
⁹ C. Gascó, L. Rodríguez-Santiago, M. Sodupe and R. M. Sebastián, *Microchem. J.*, 2022, **182**, 107878.

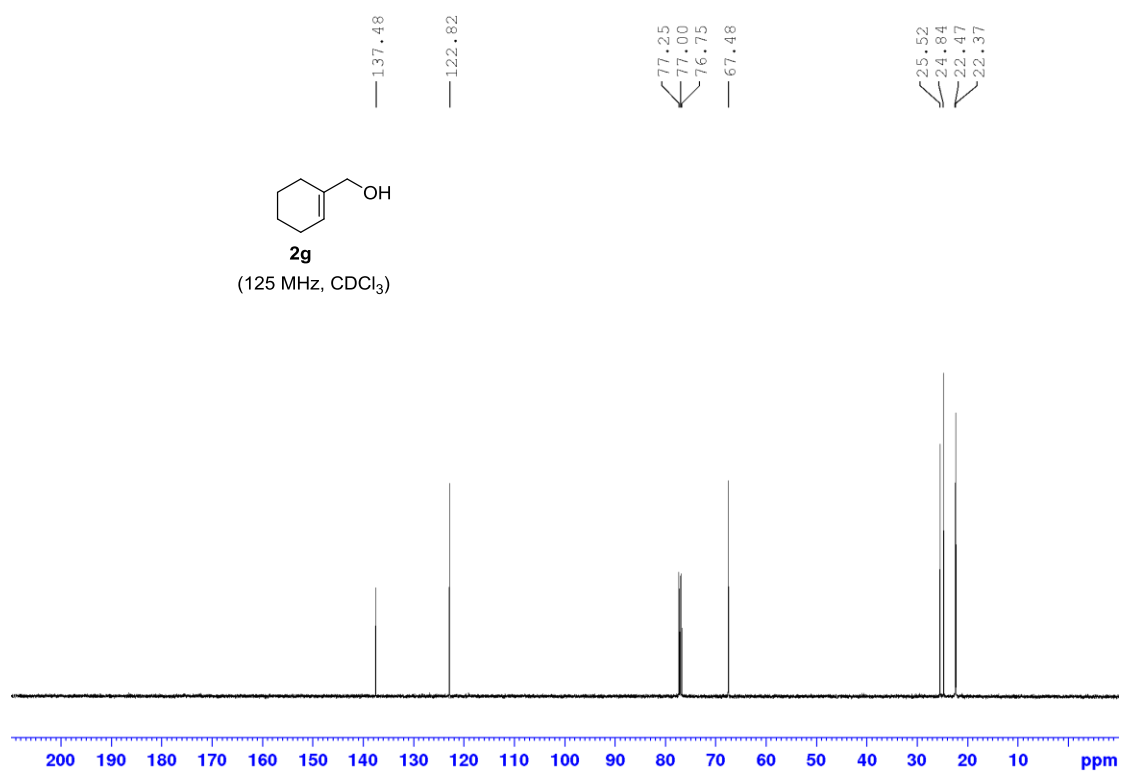
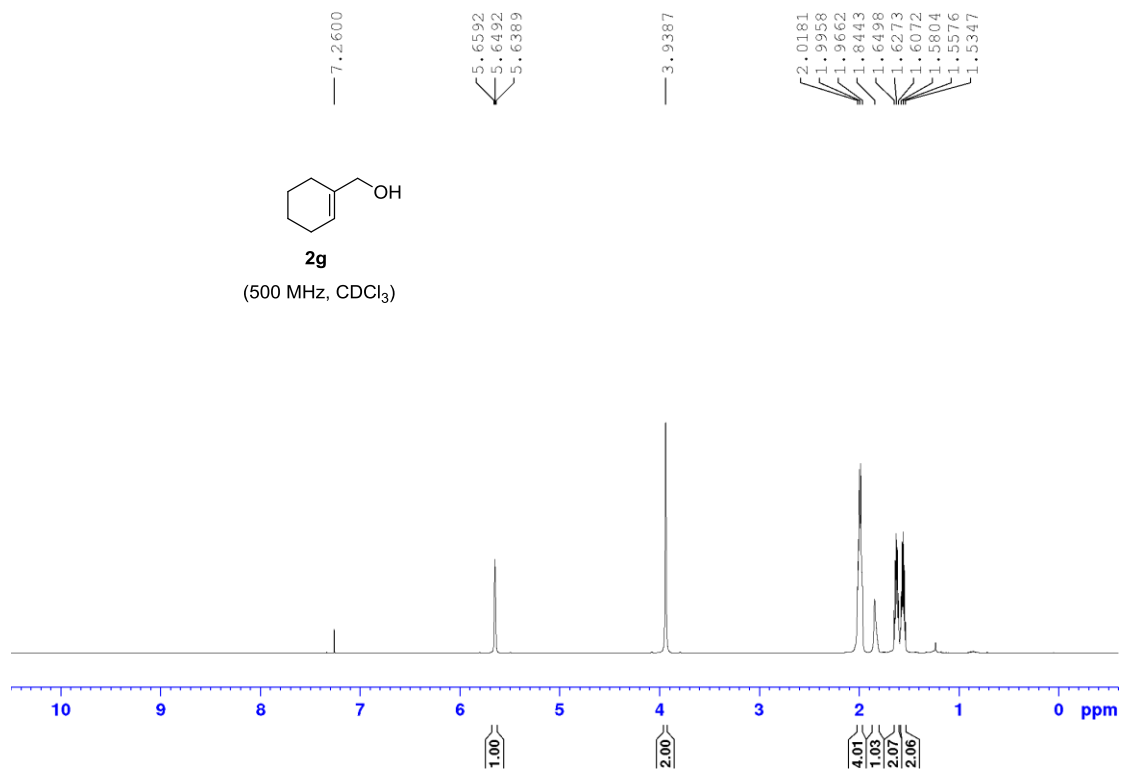
¹⁰ M. J. Sevrin, L. Furst, J. D. Nguyen, J. L. Collins 3rd and C. R. J. Stephenson, *Tetrahedron*, 2018, **74**, 3246.

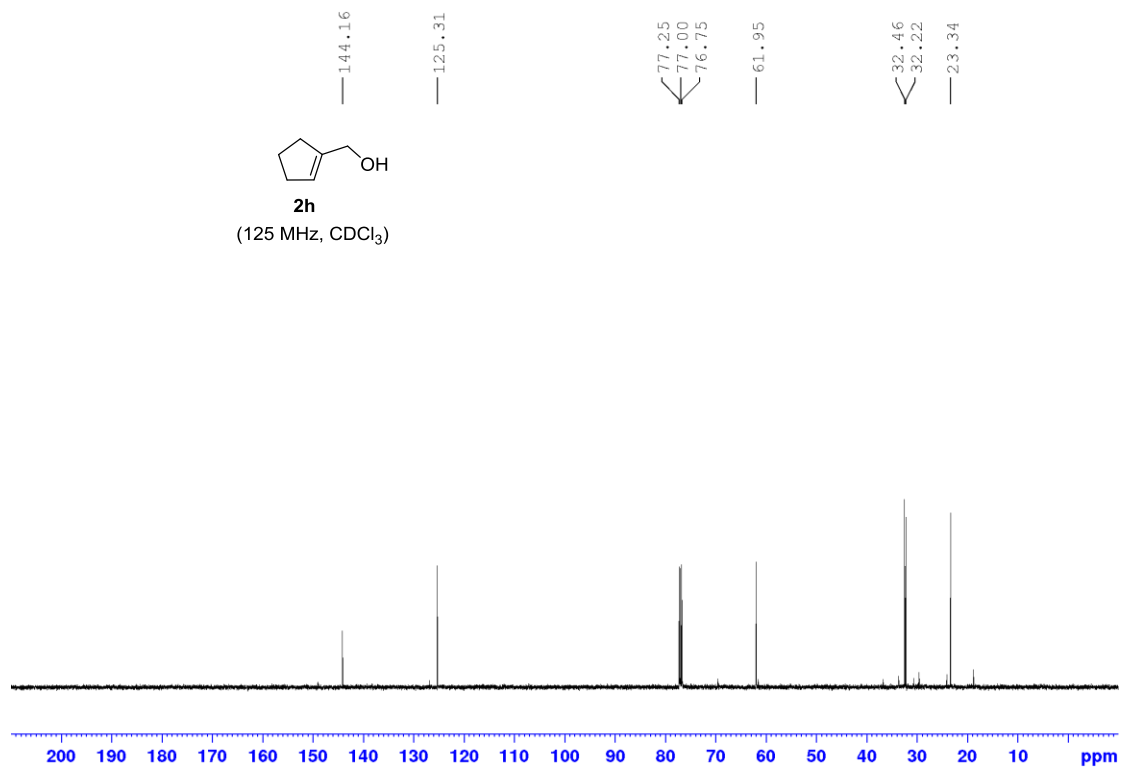
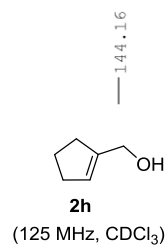
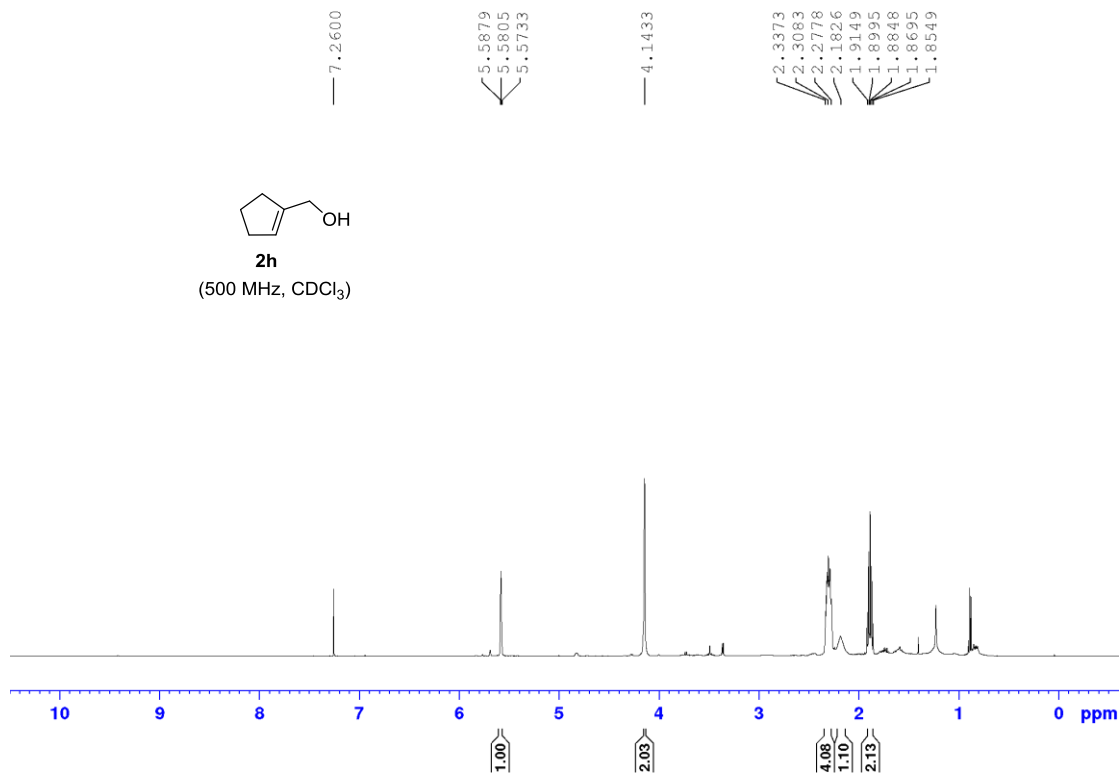
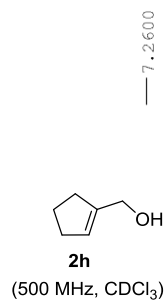
¹¹ (a) D. Griller, J. A. Howard, P. R. Marriott and J. C. Scaiano, *J. Am. Chem. Soc.*, 1981, **103**, 619; (b) Z.-R. Zheng, D. H. Evans and S. F. Nelsen, *J. Org. Chem.*, 2000, **65**, 1793.

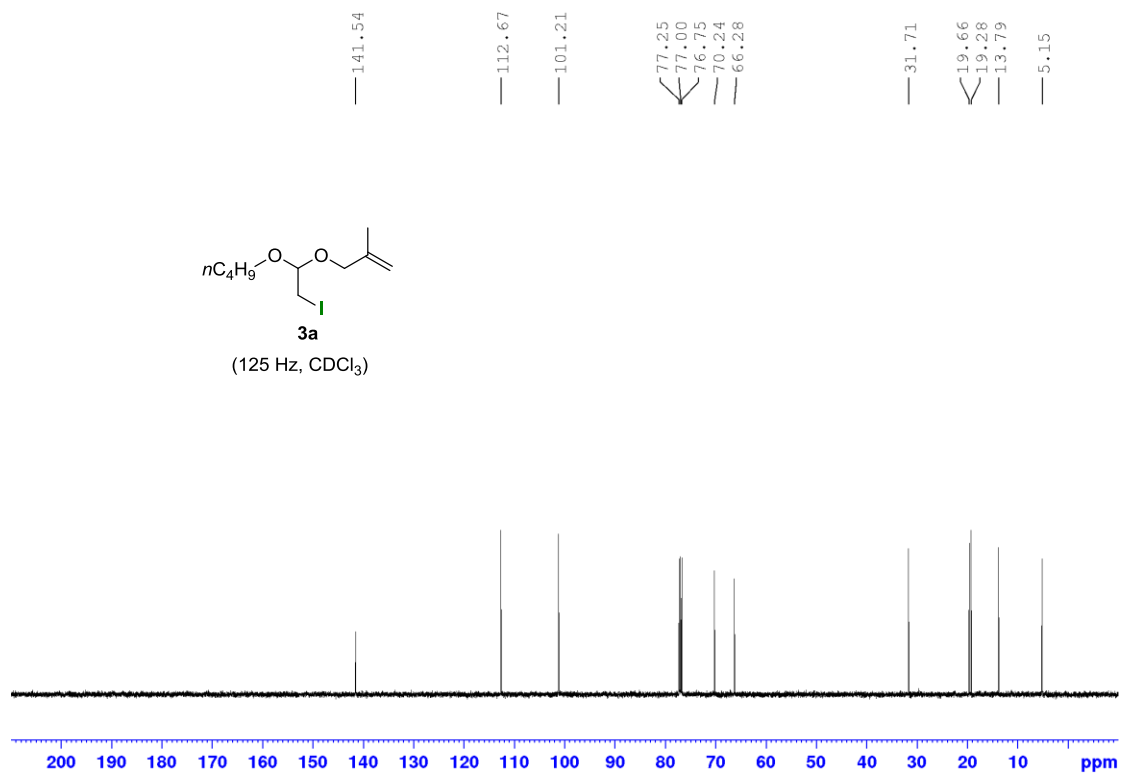
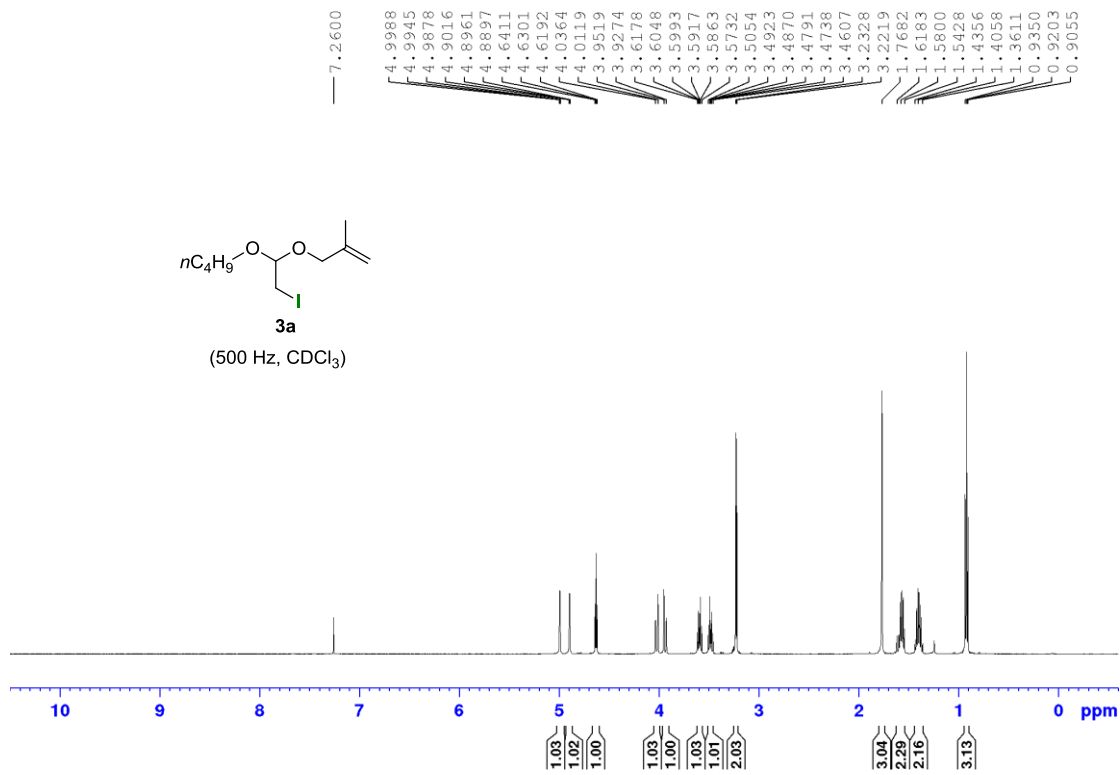
promote the reaction. These results support Roles 1-3 assigned to DIPEA in the proposed mechanism (*vide supra*).

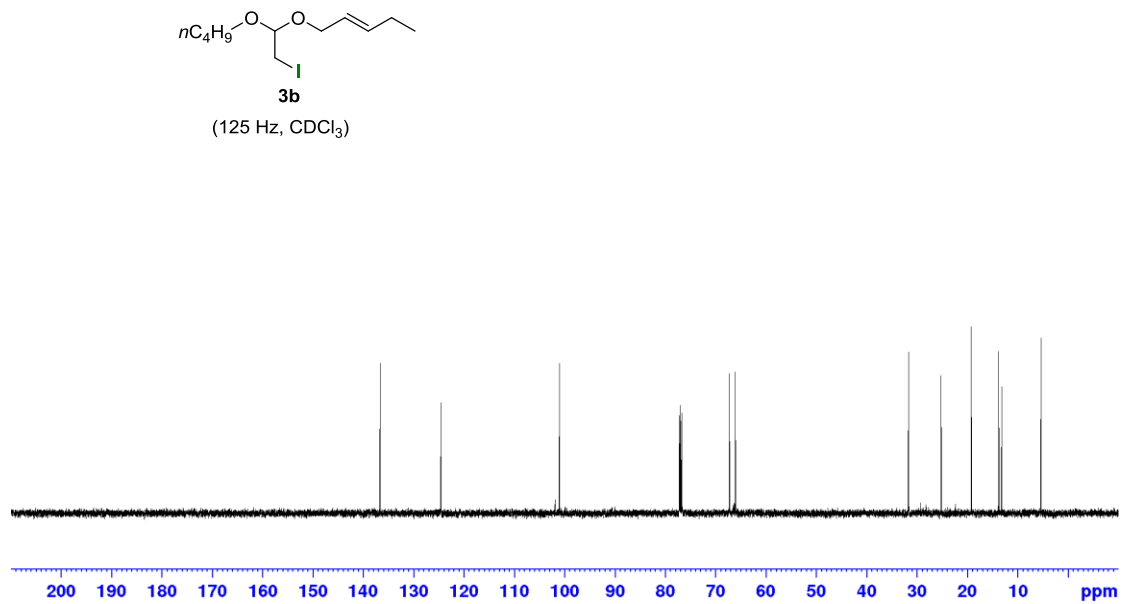
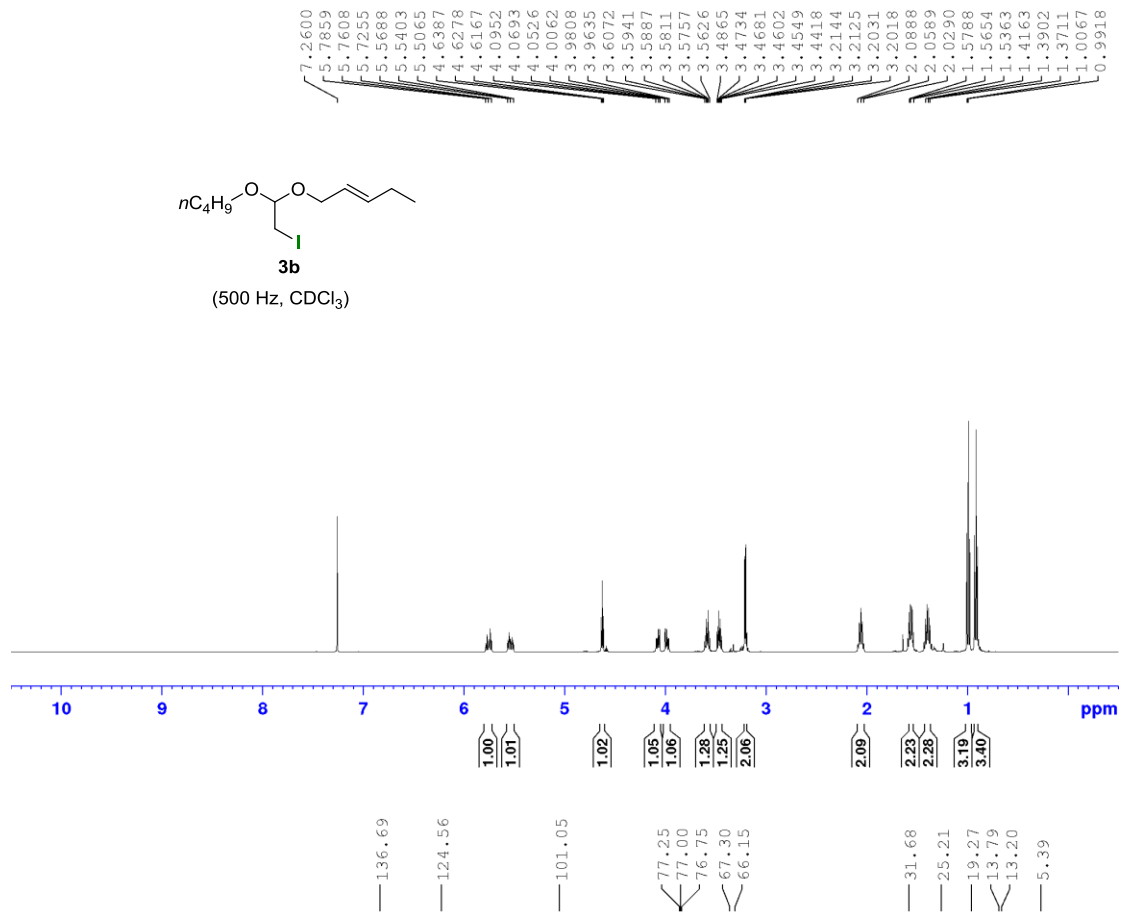
Part B: Copies of $^1\text{H-NMR}$, $^{13}\text{C-NMR}$, HSQC and NOE spectra

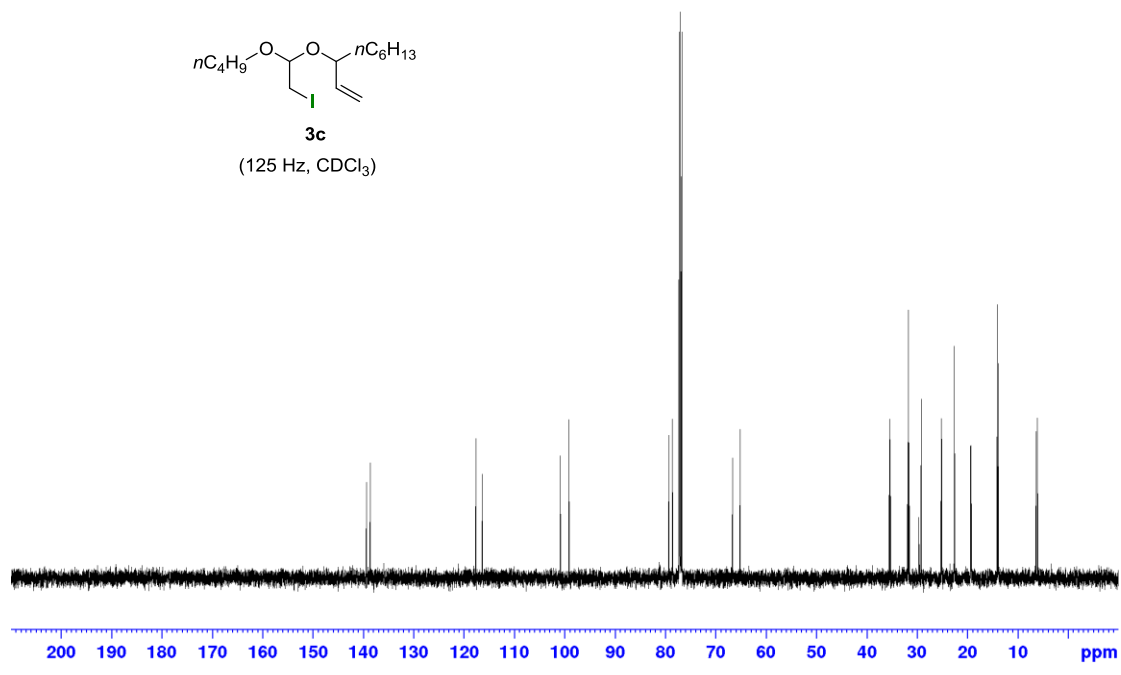
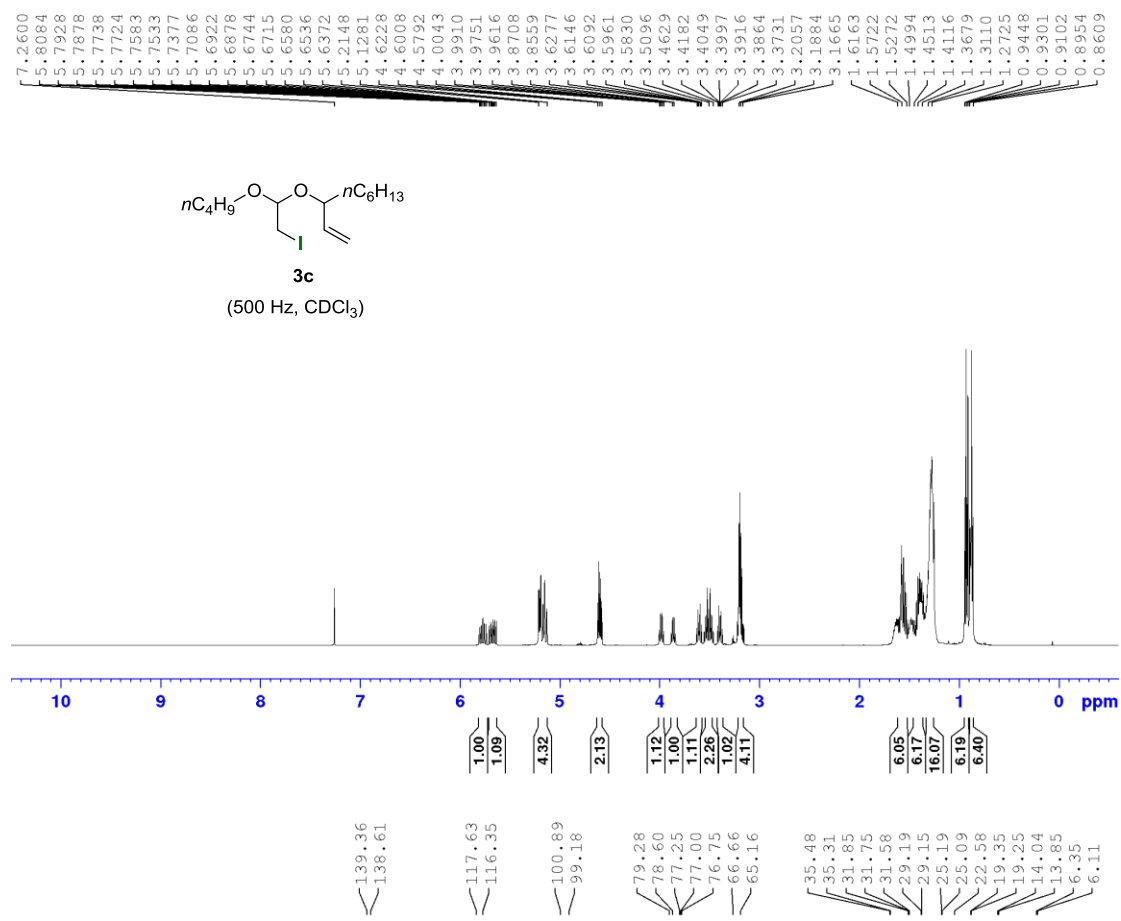


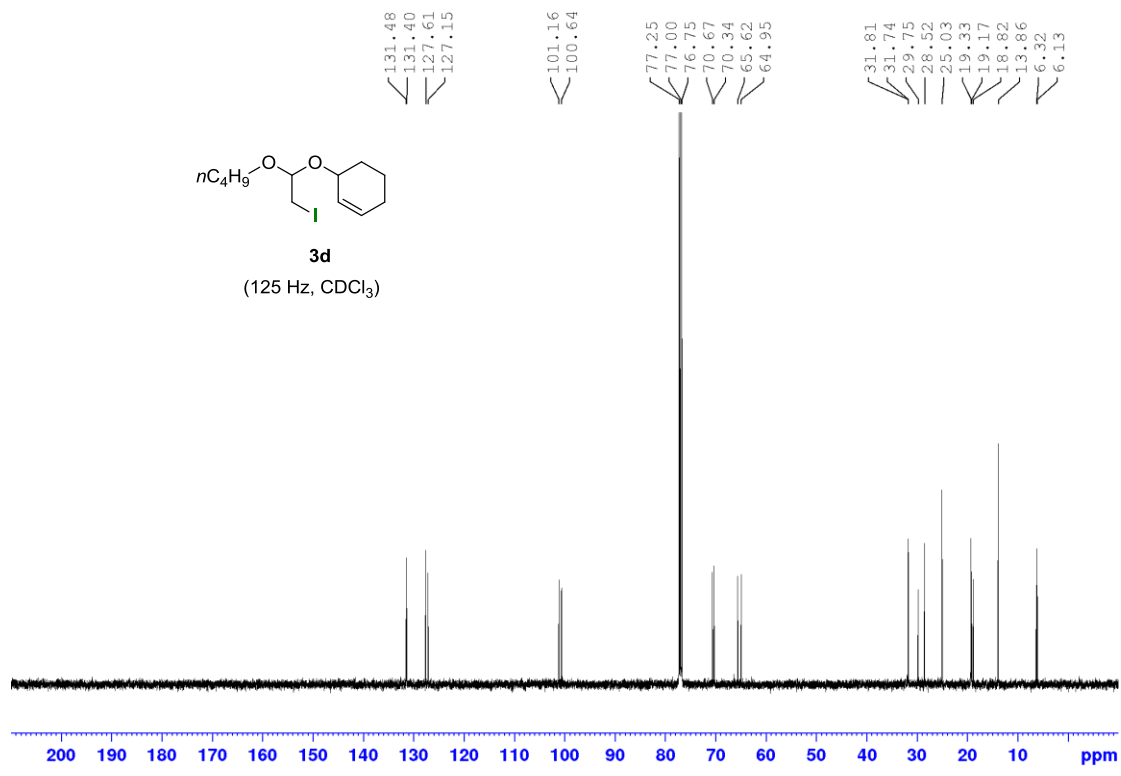
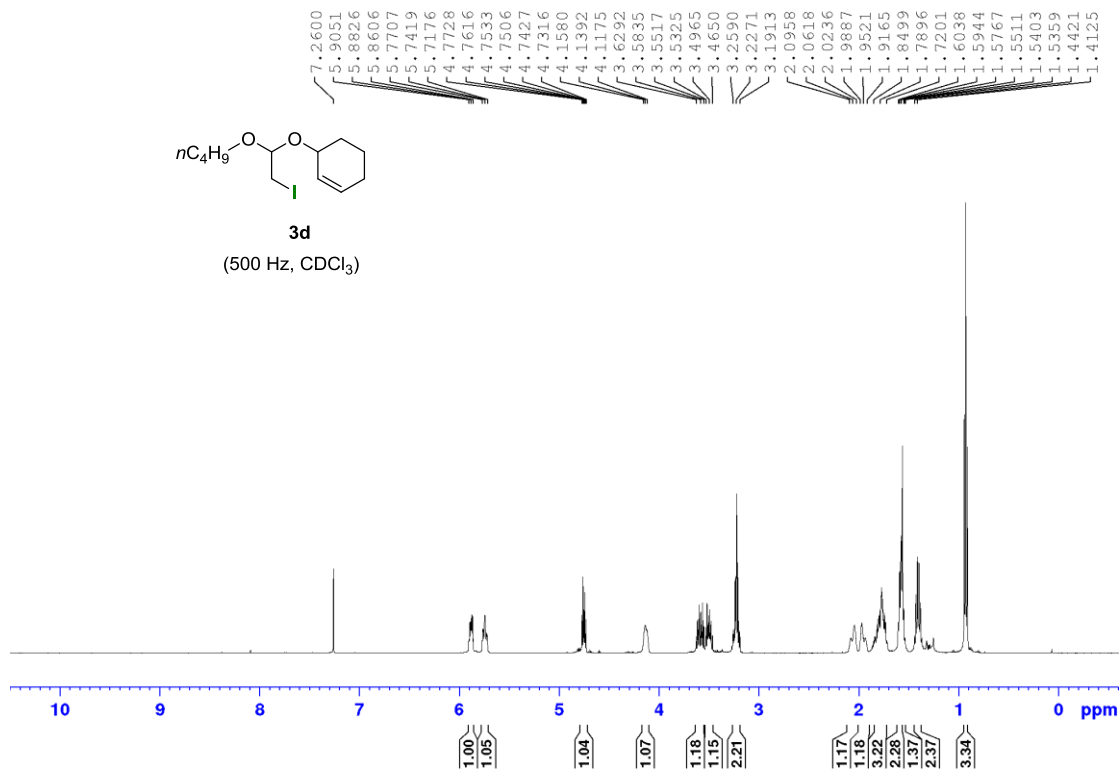


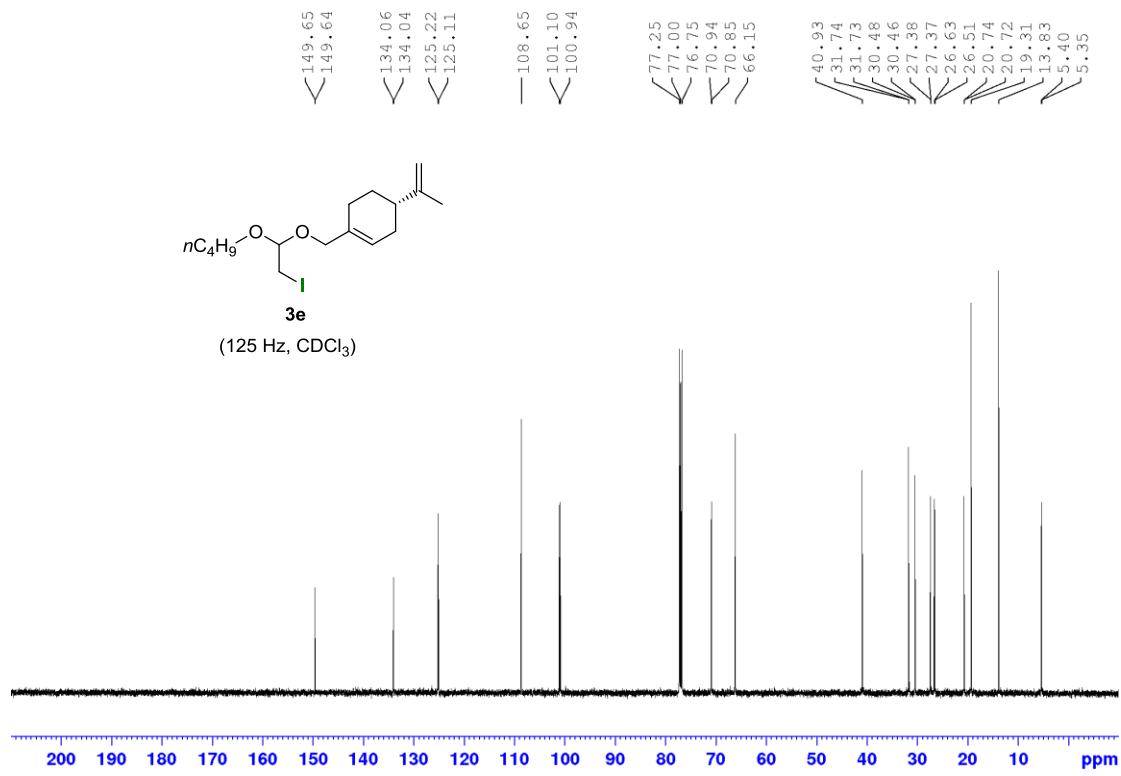
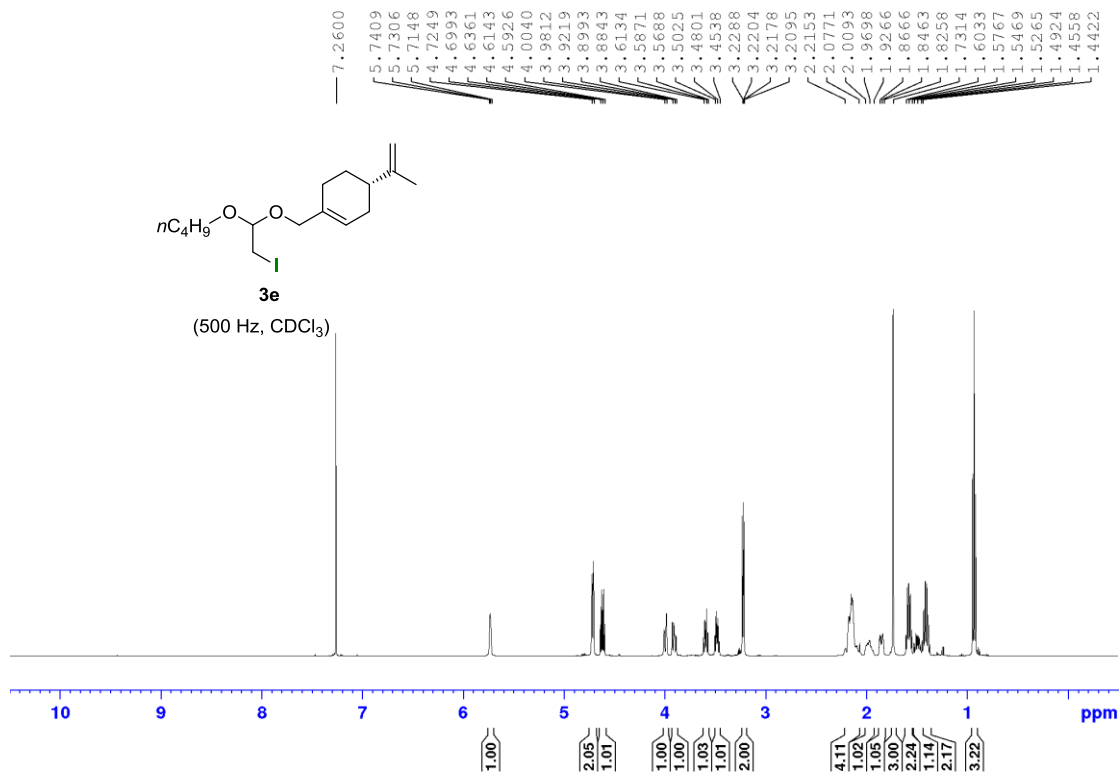


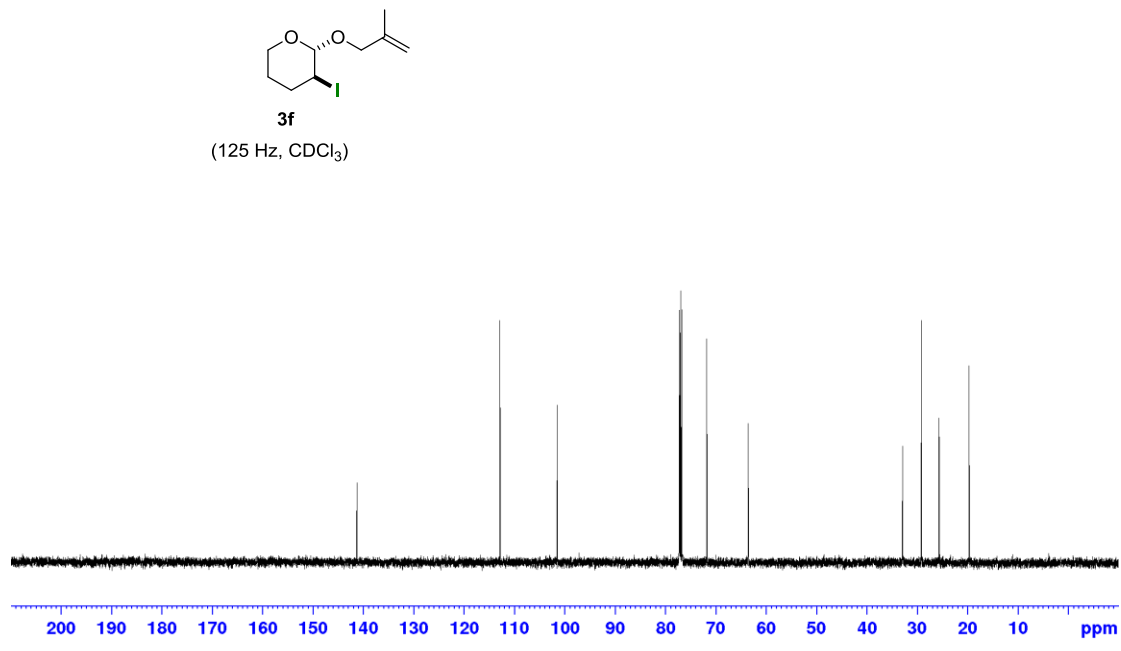
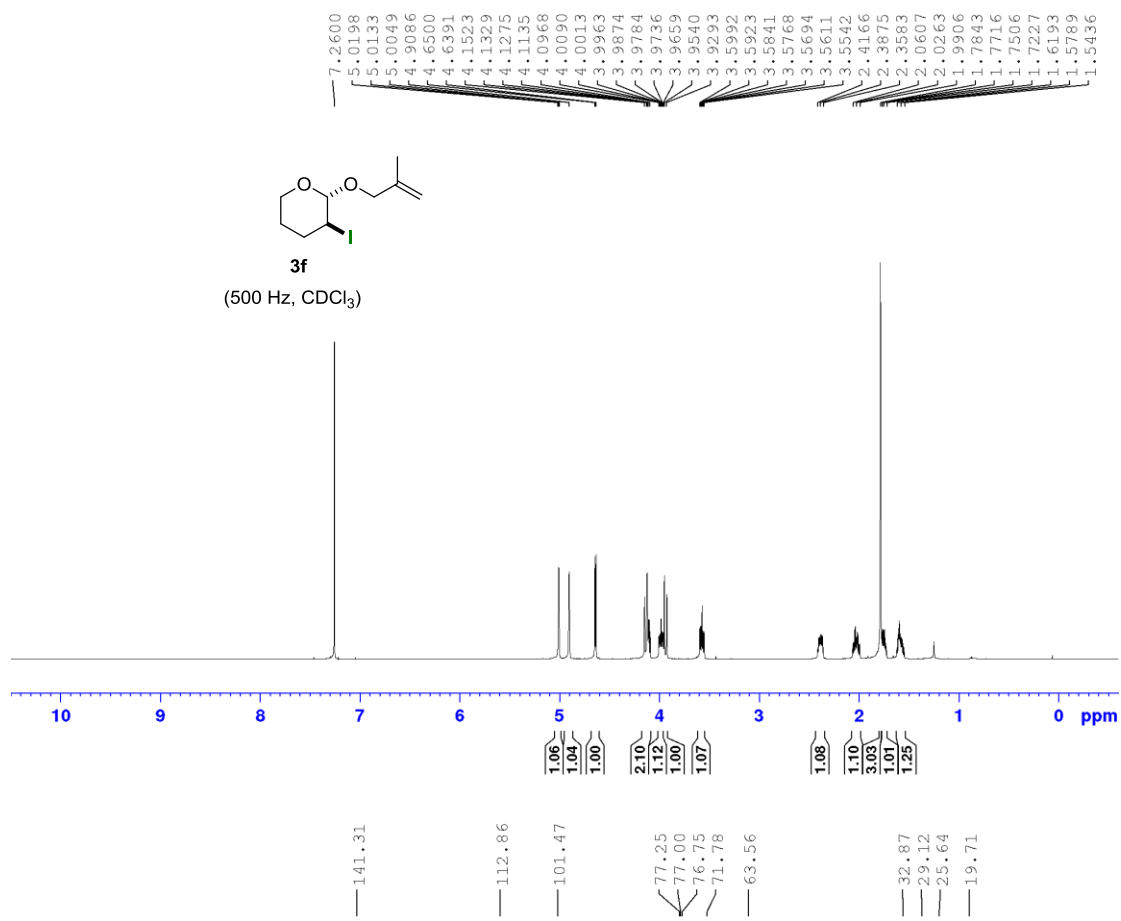


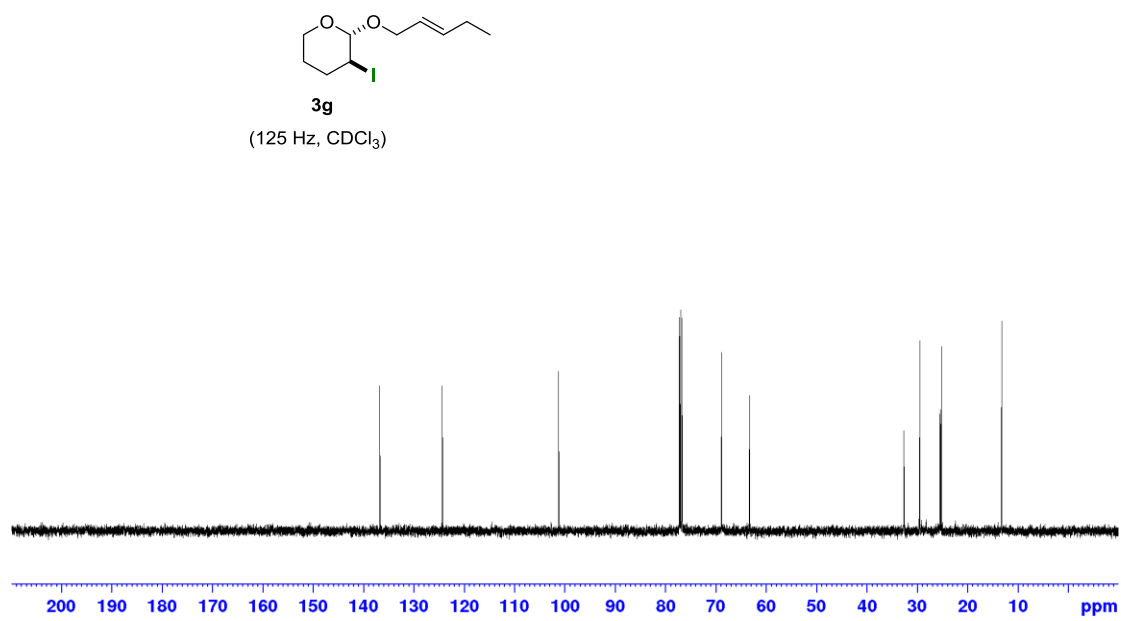
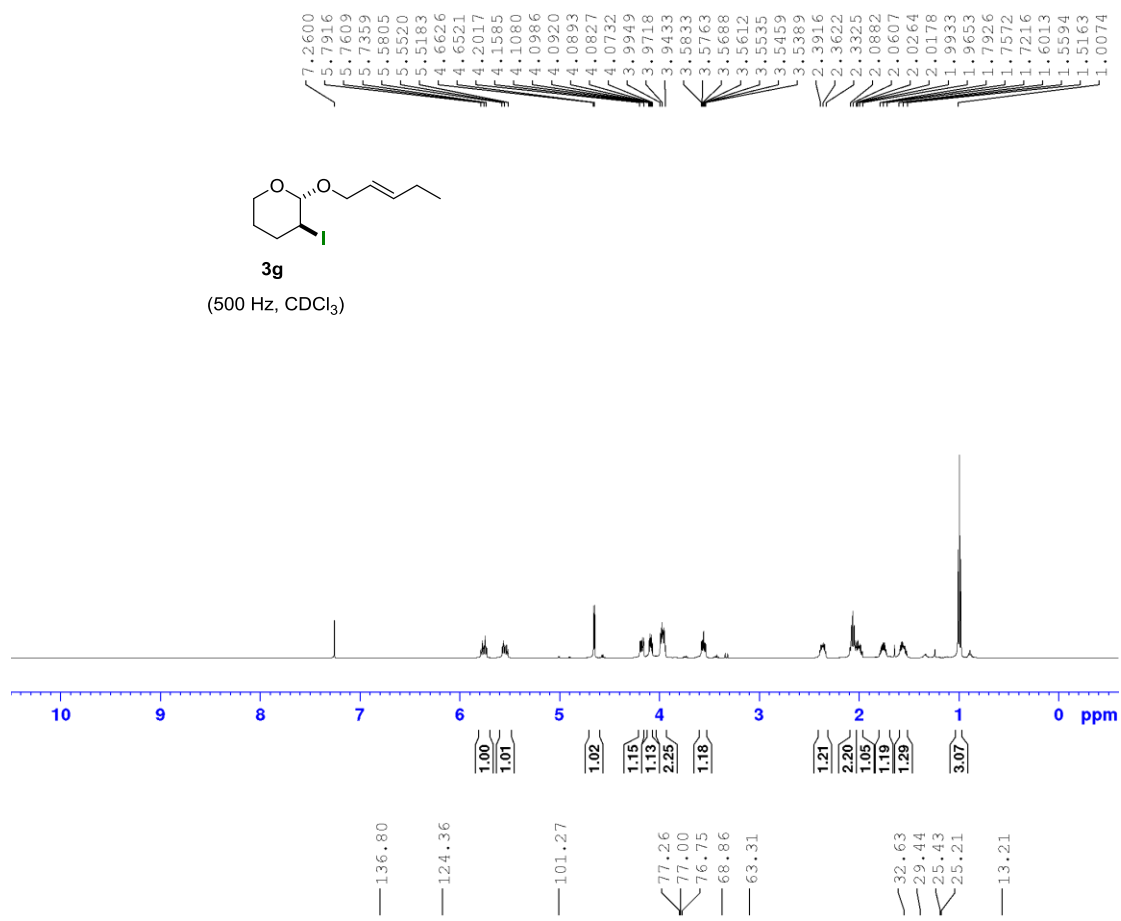


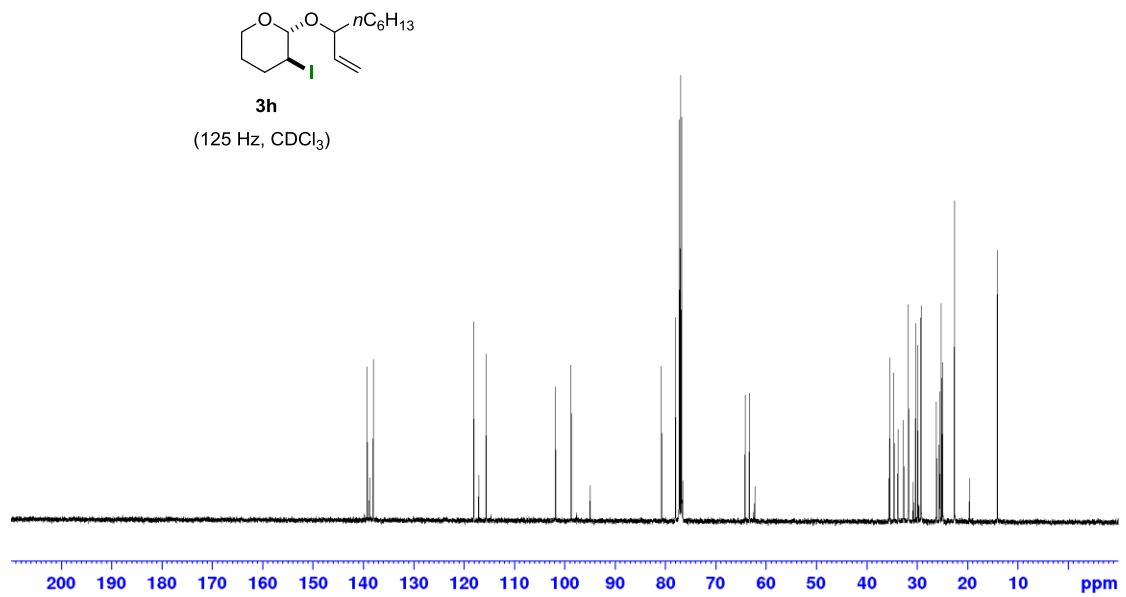
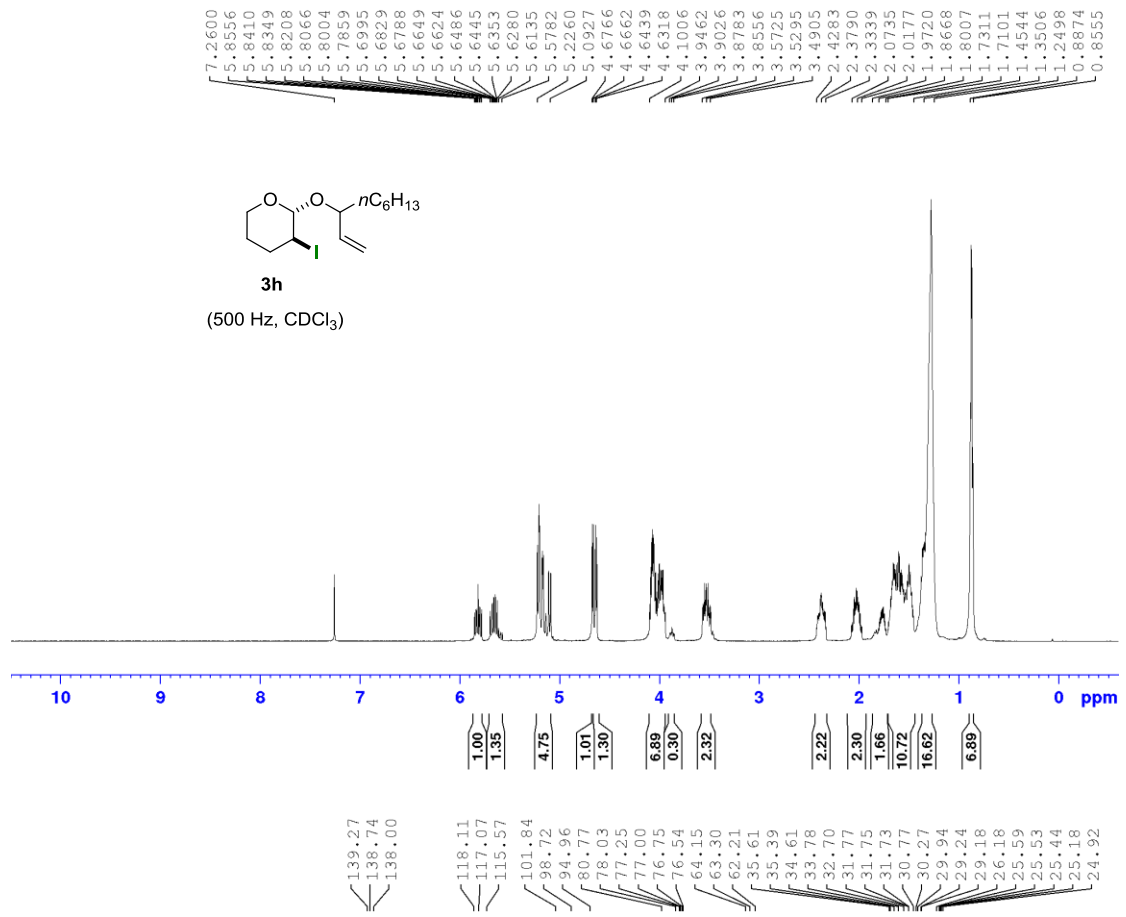


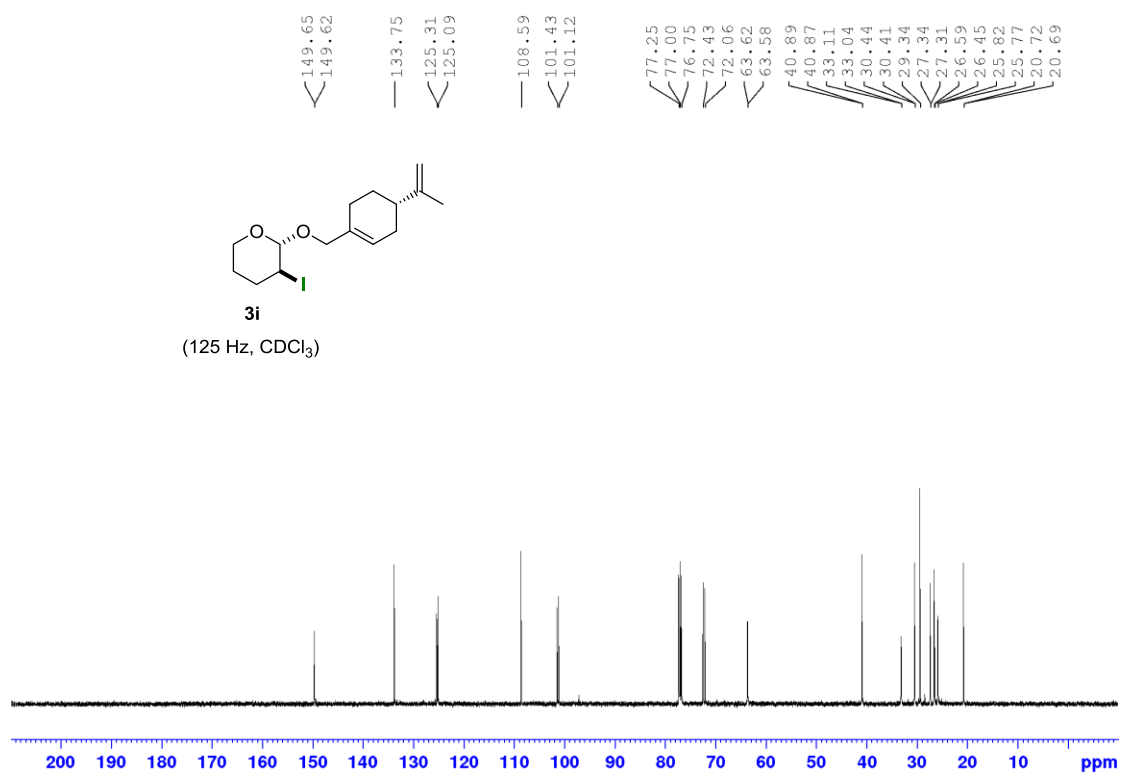
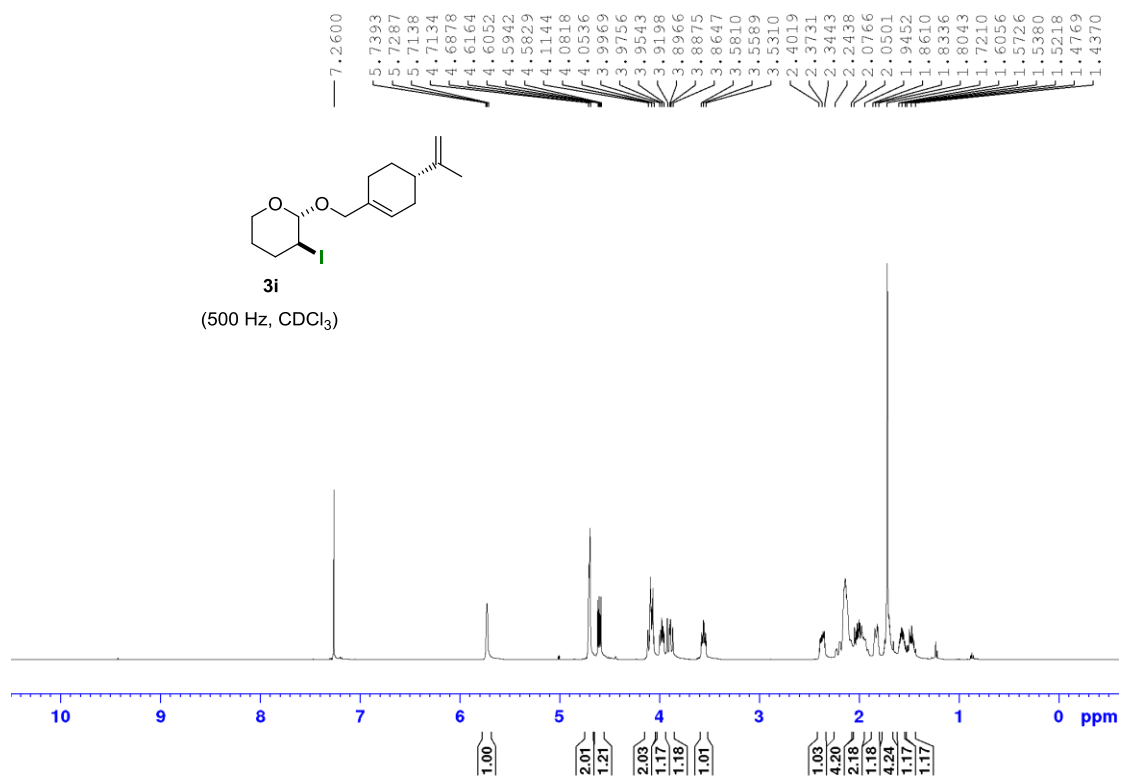


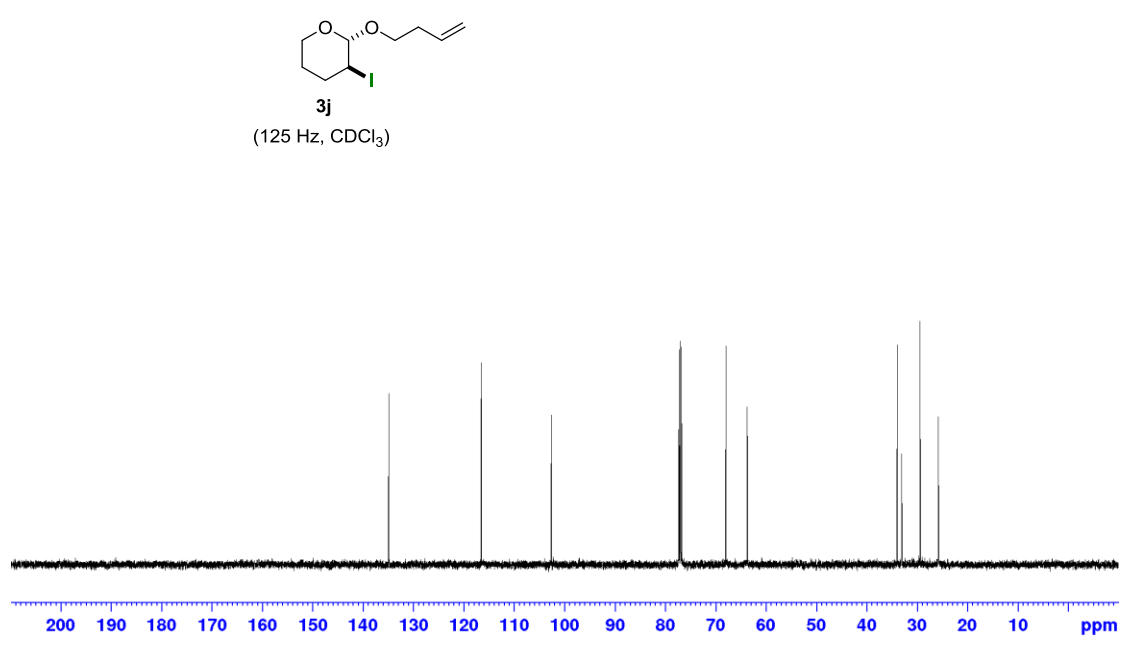
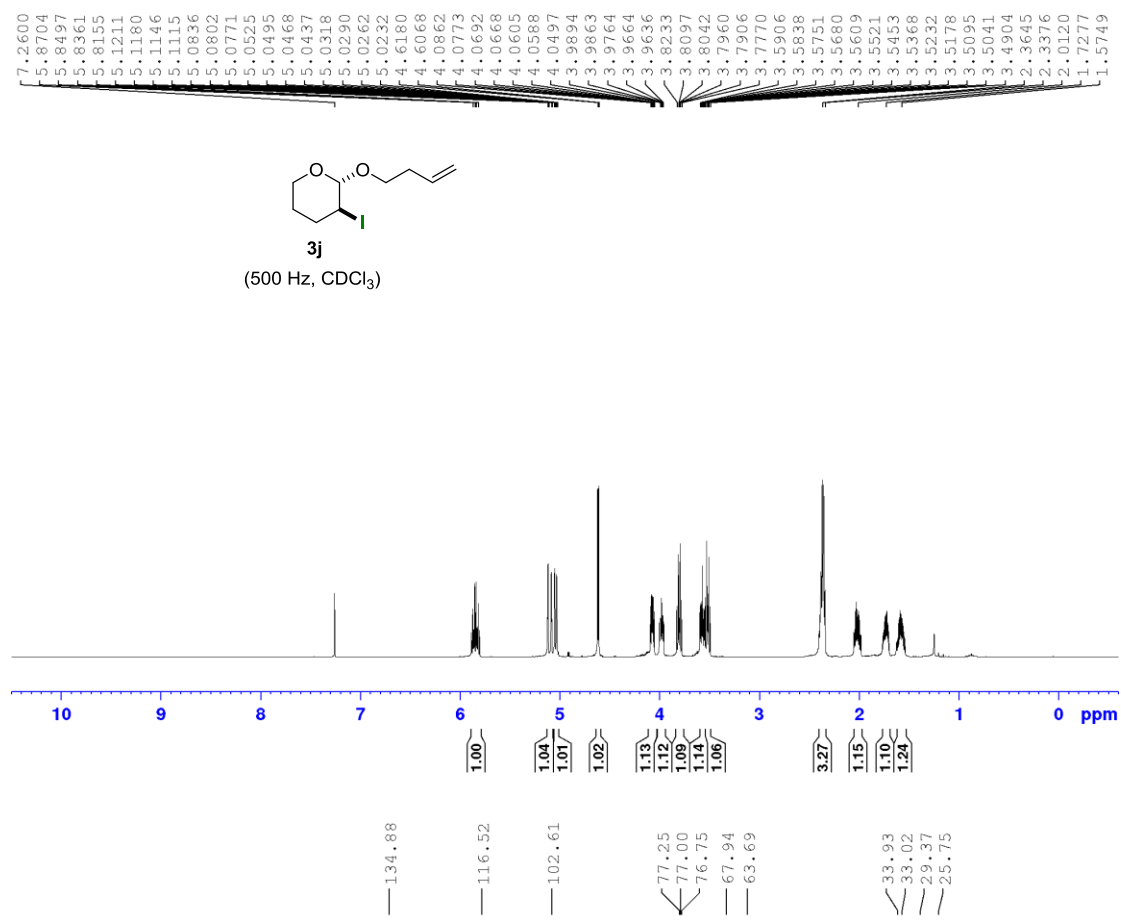


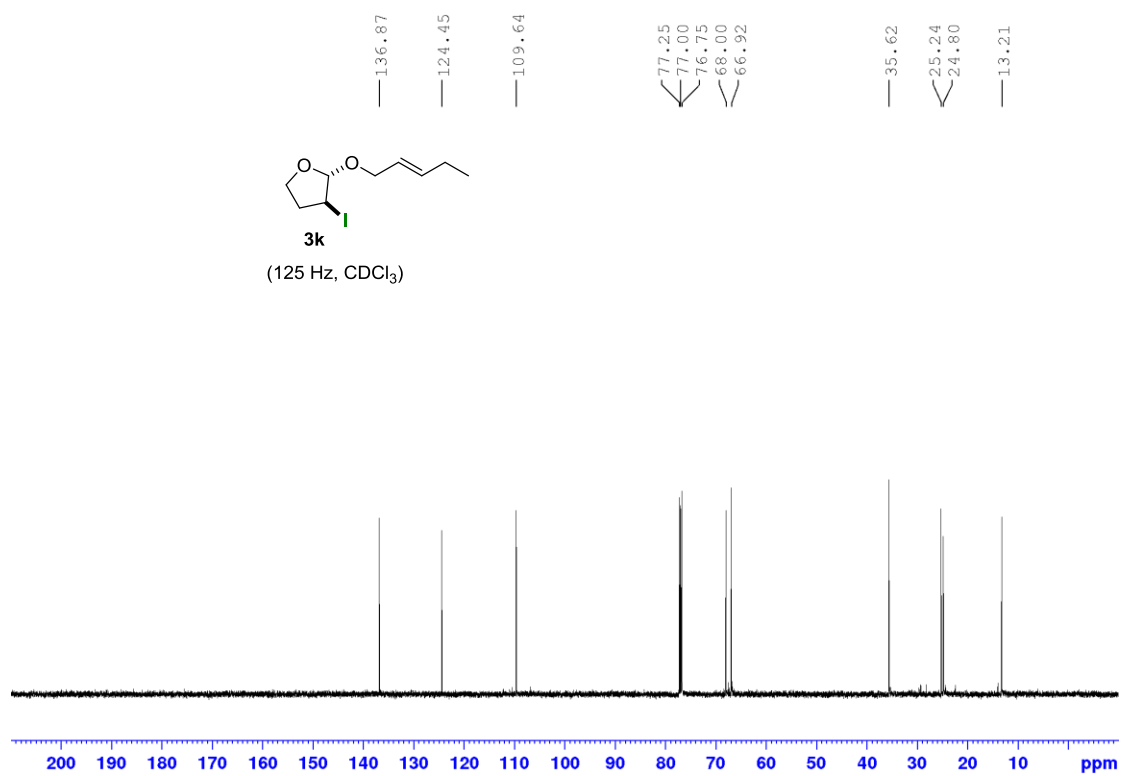
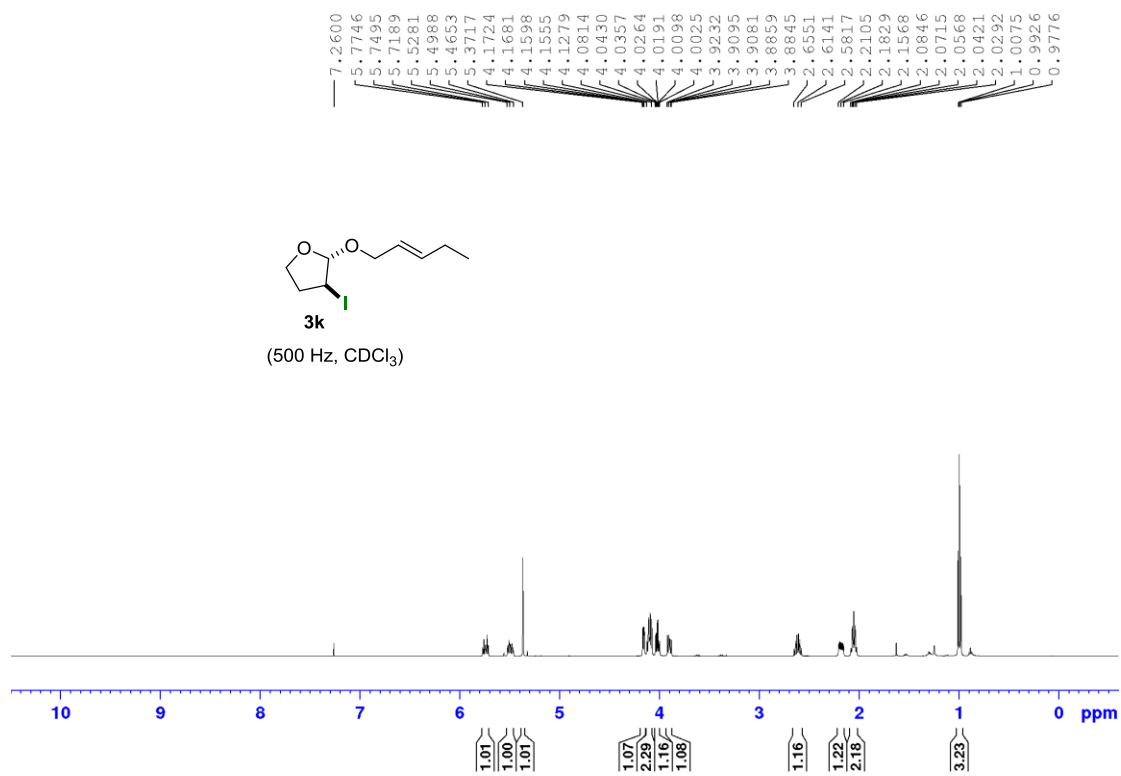


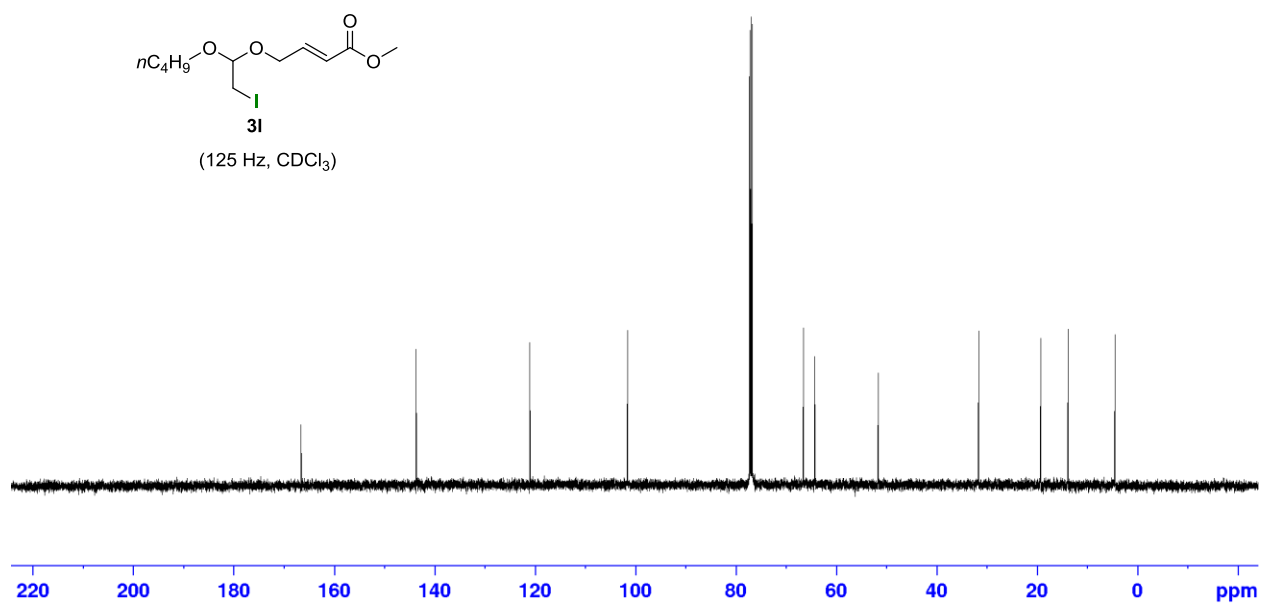
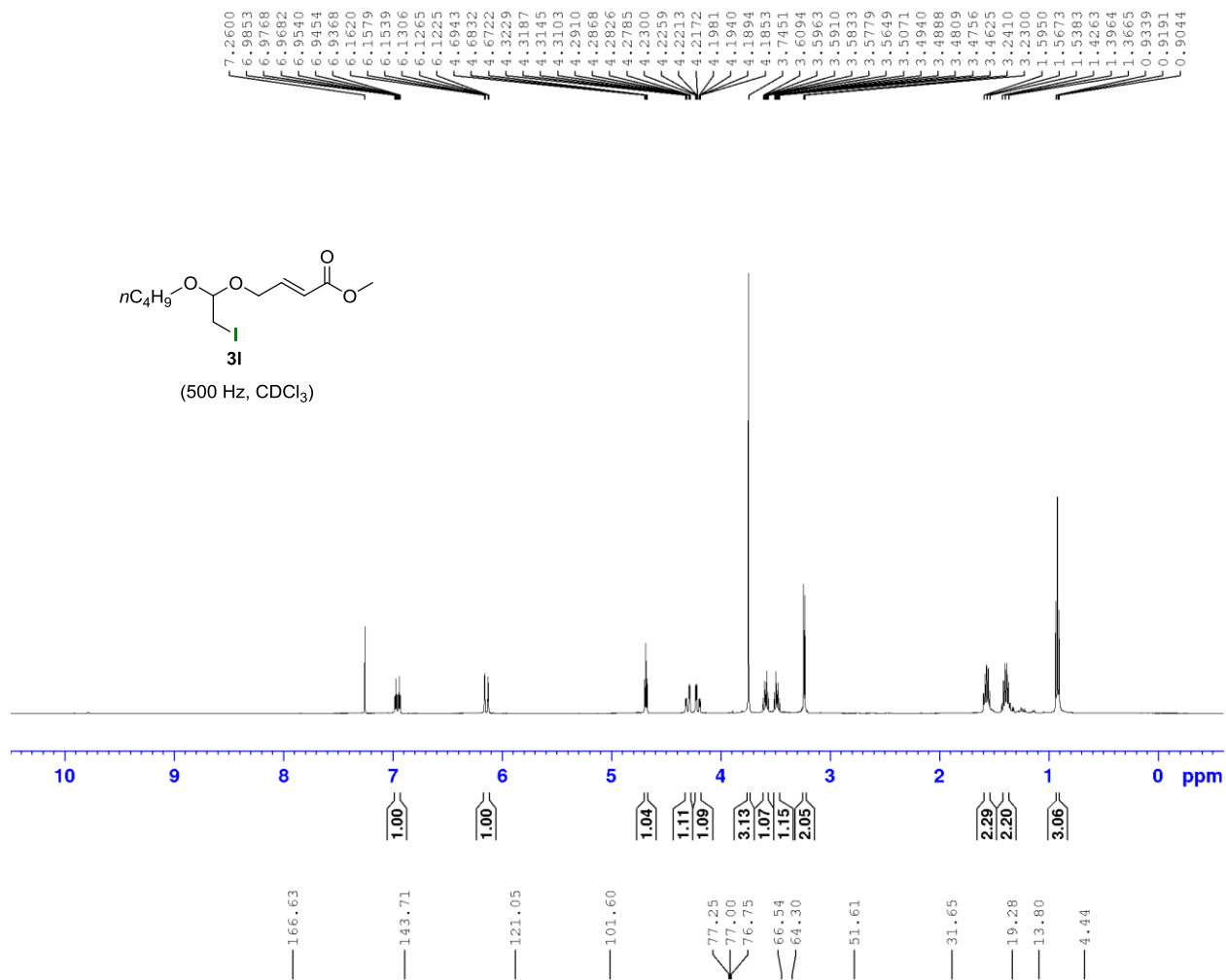


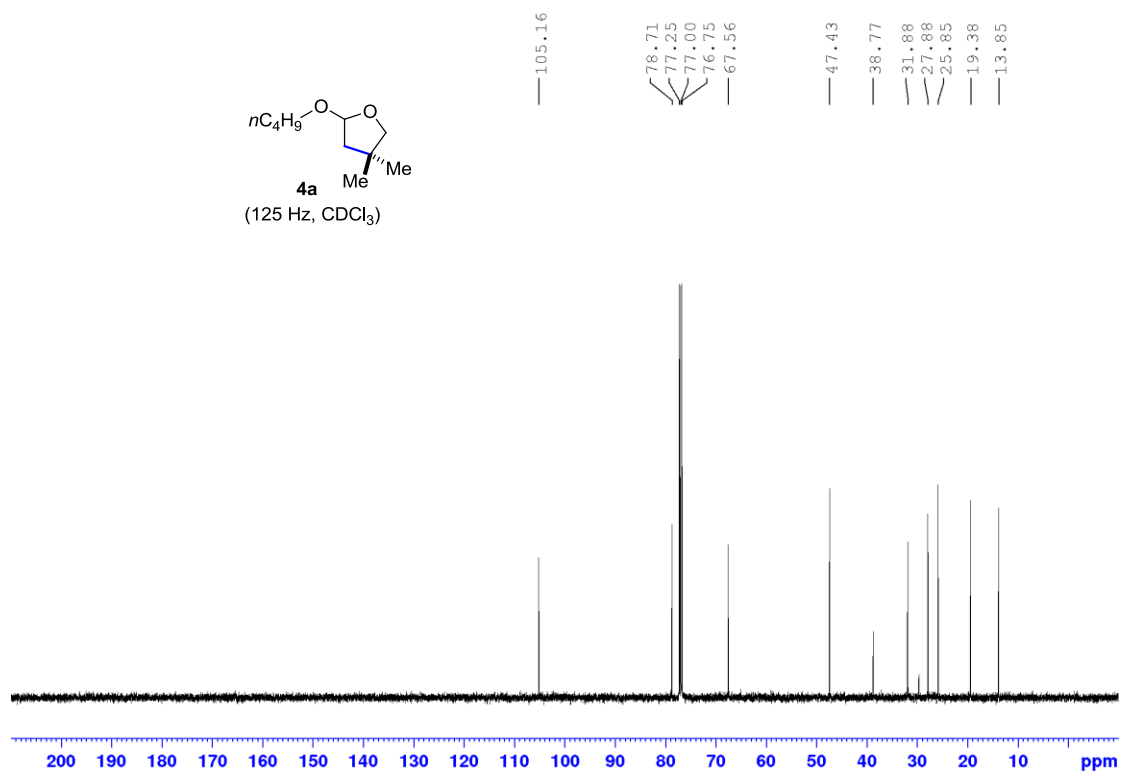
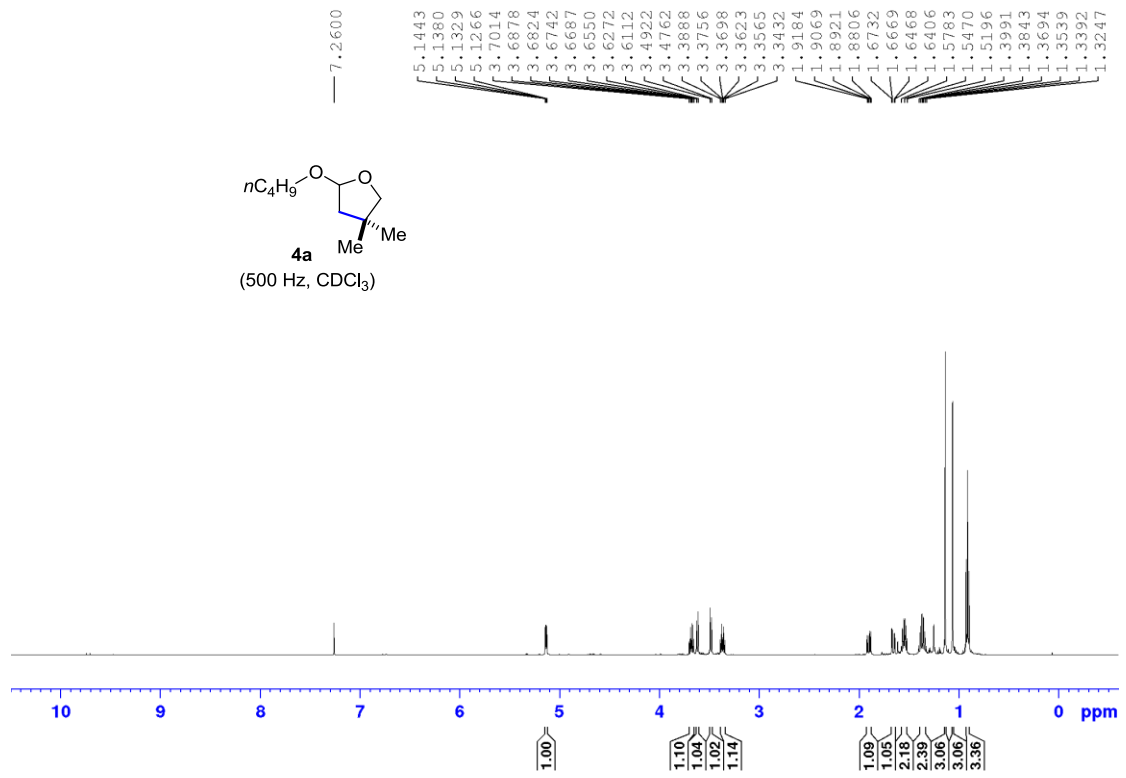


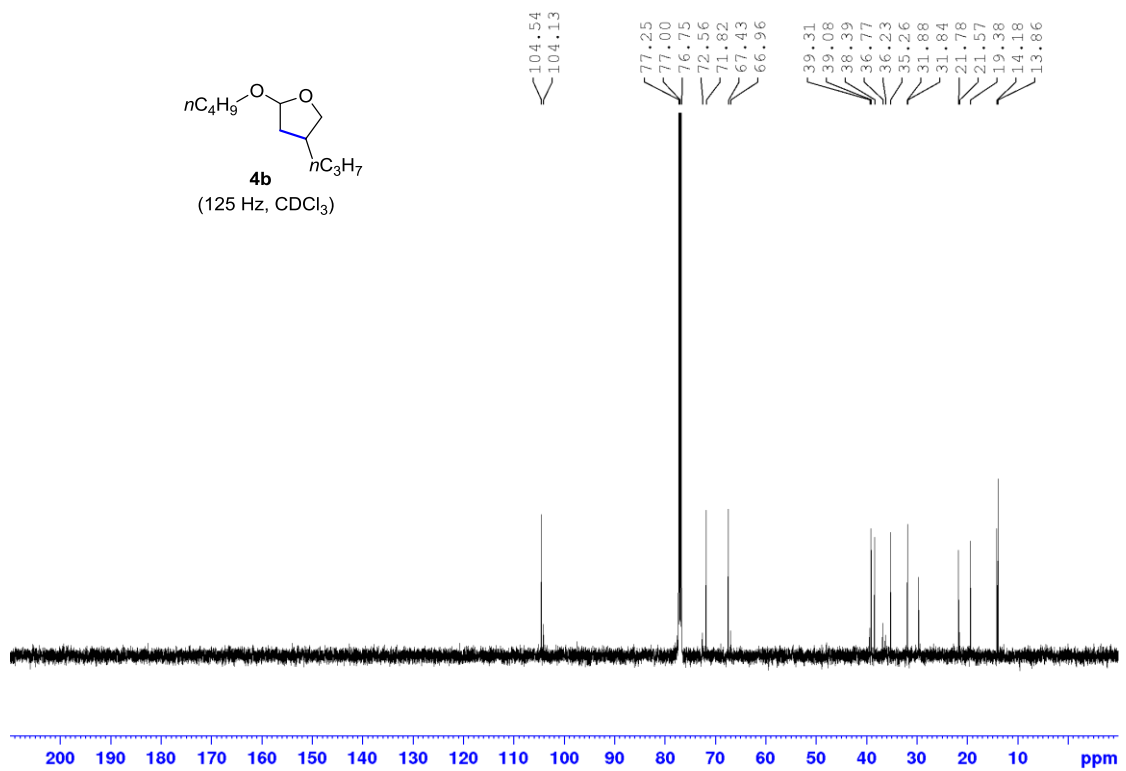
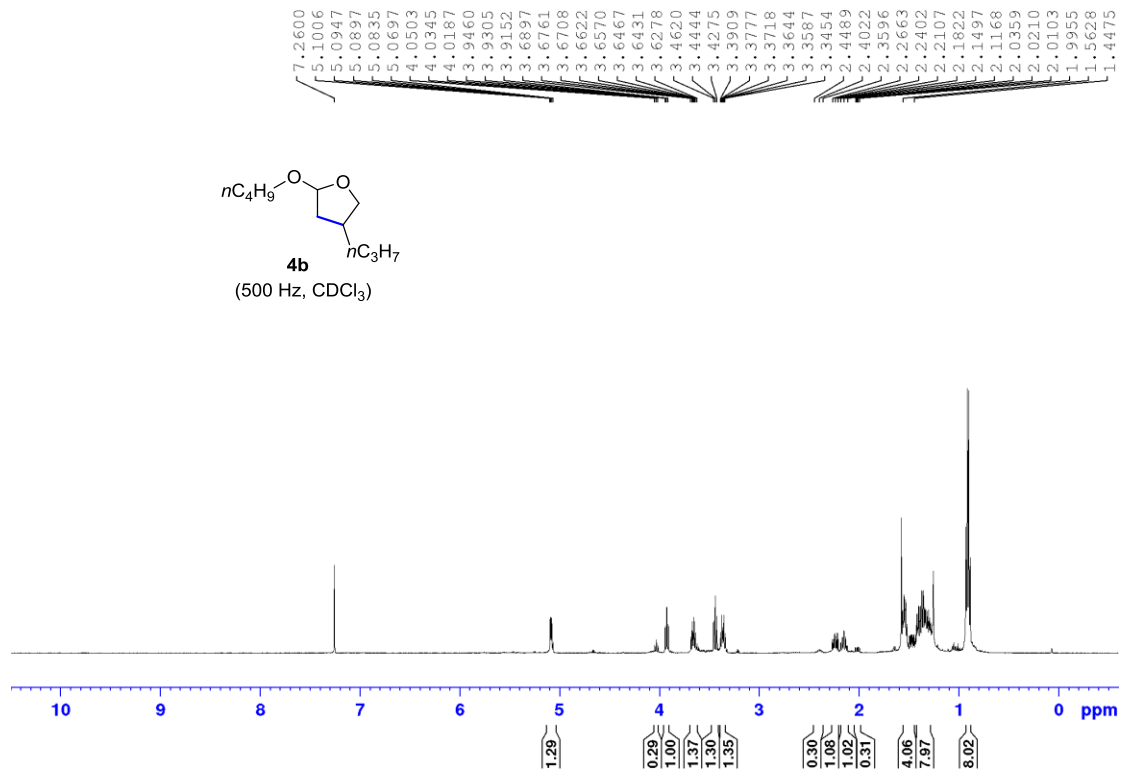


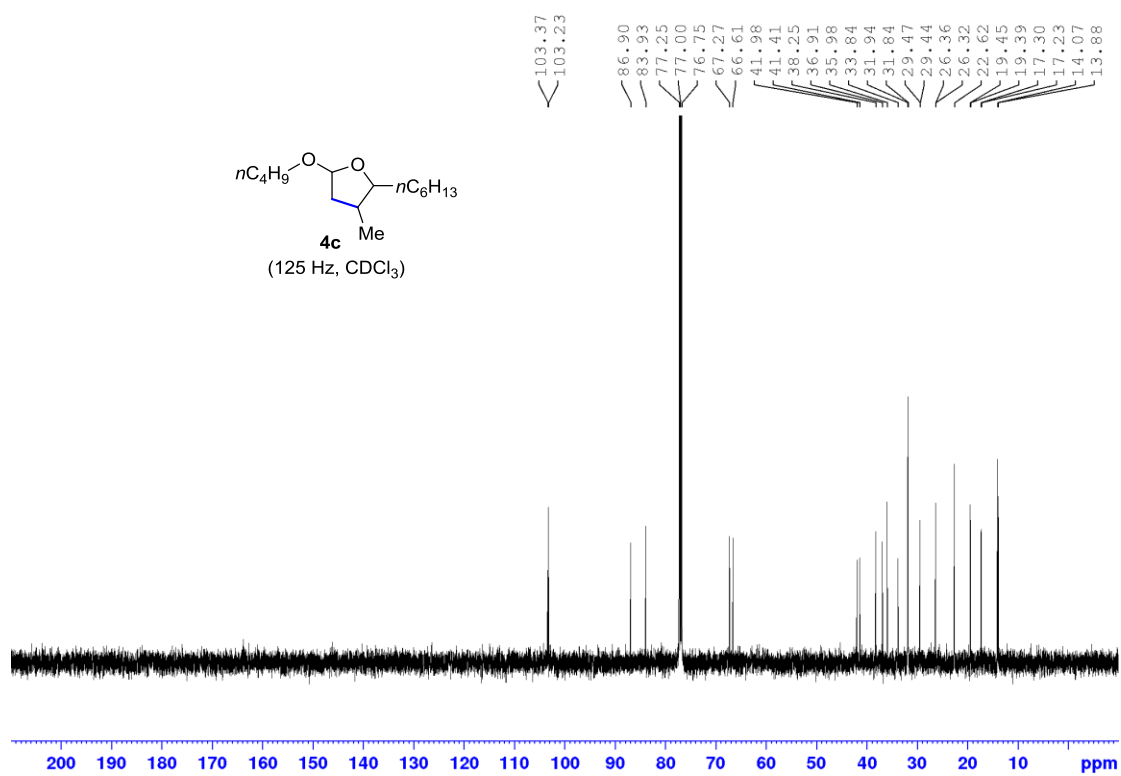
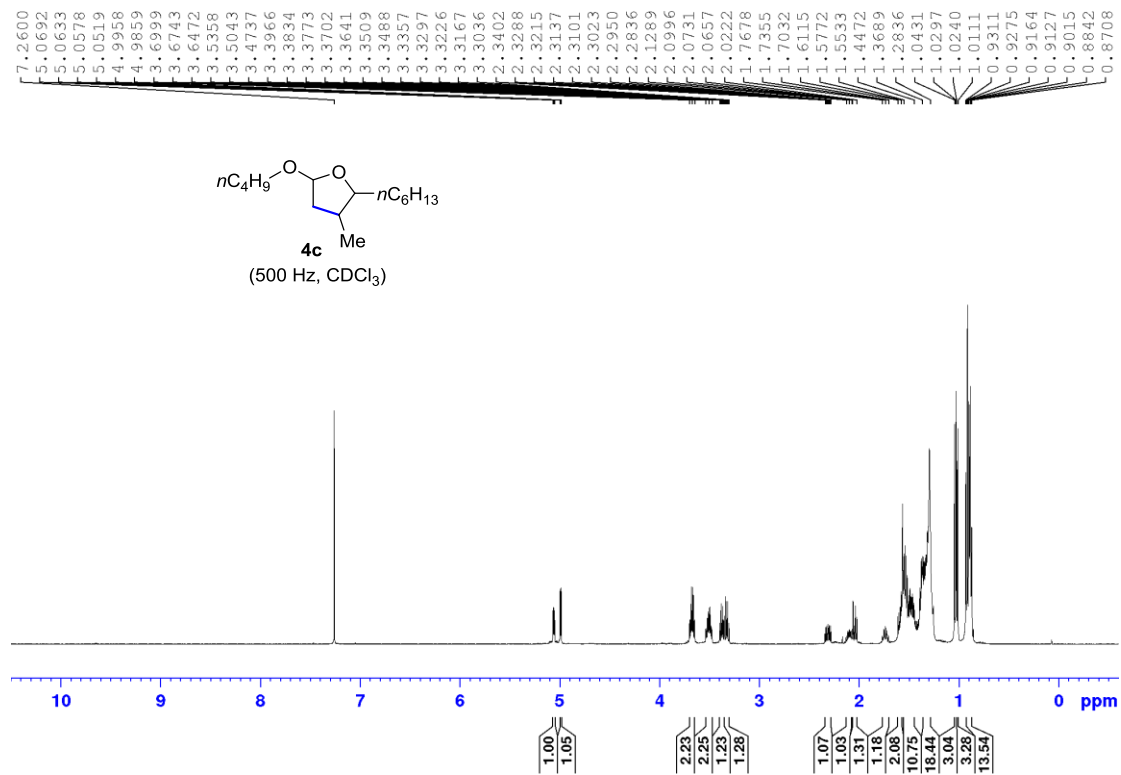


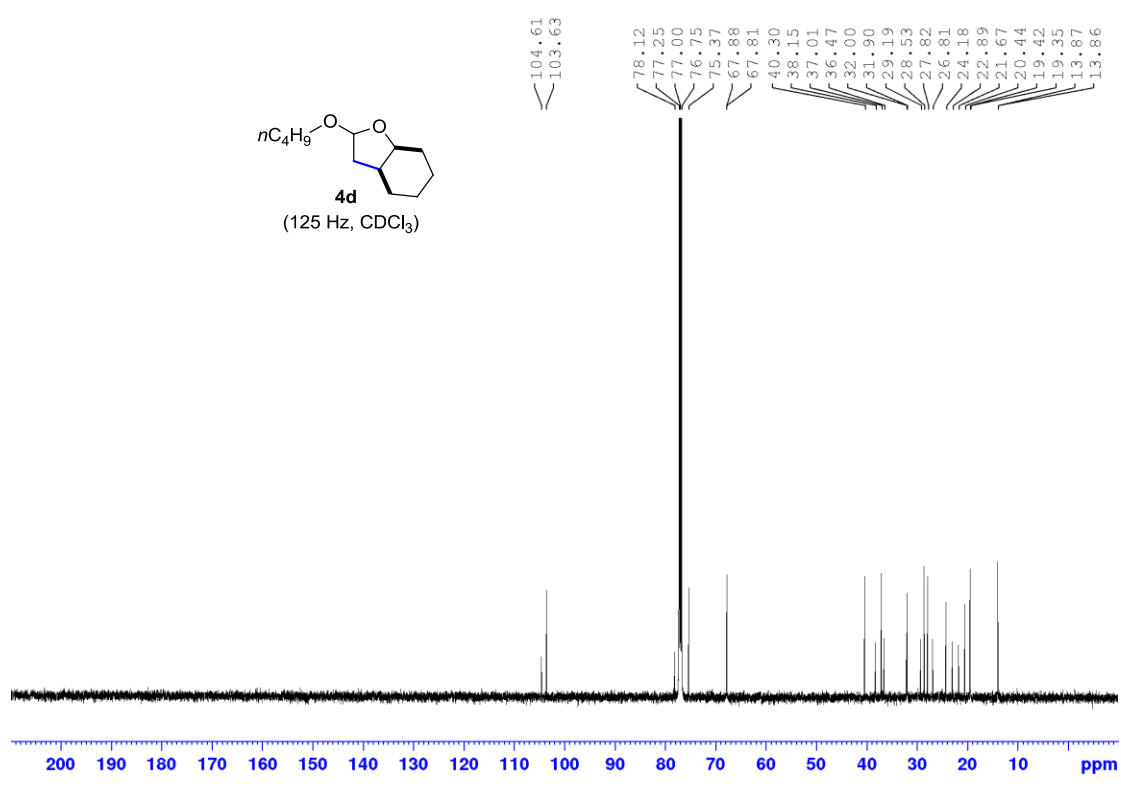
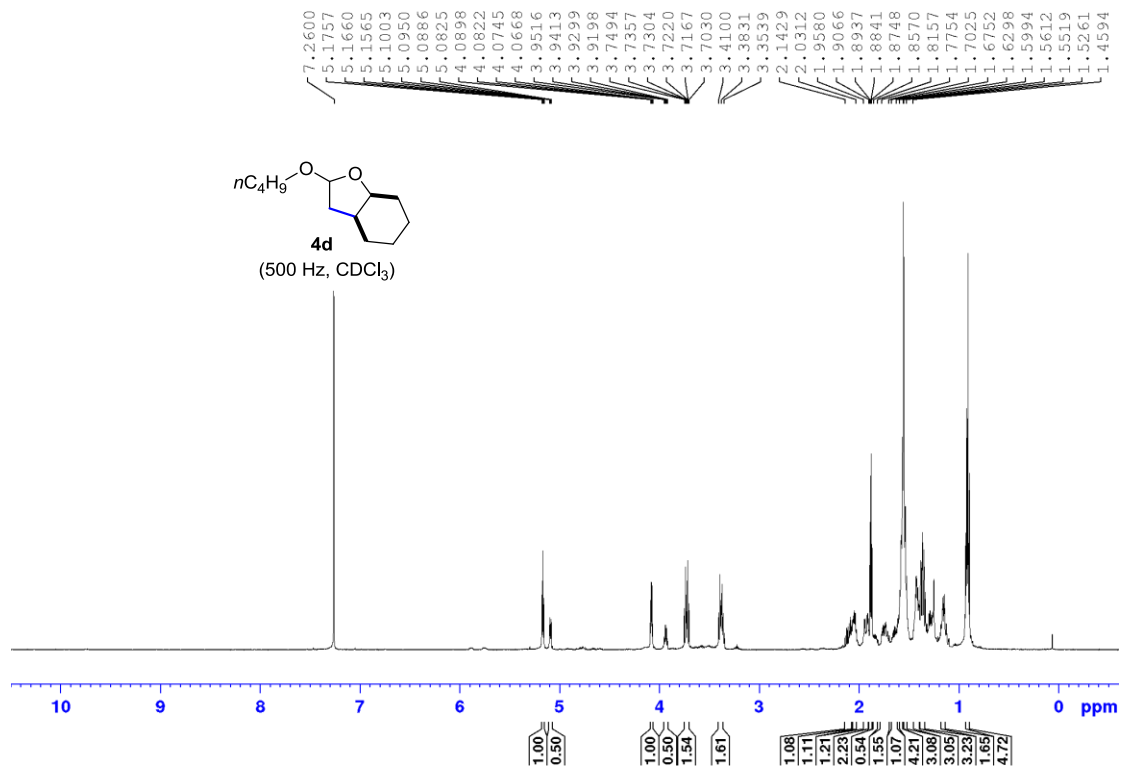


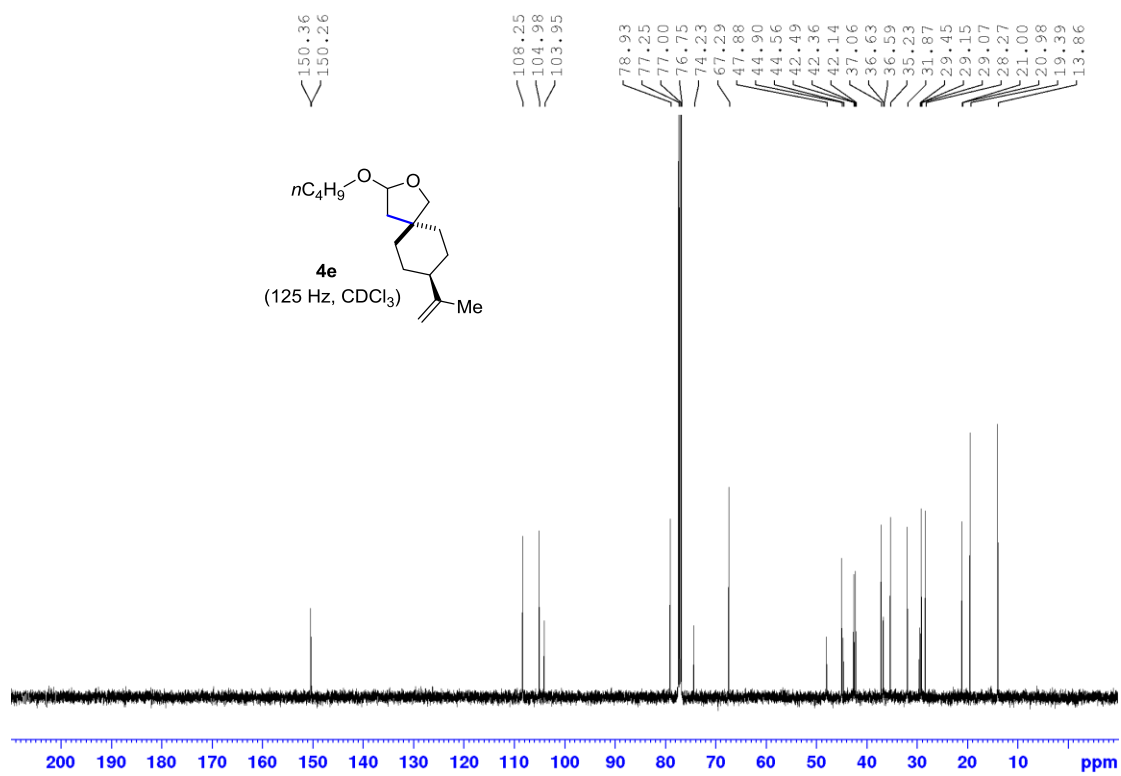
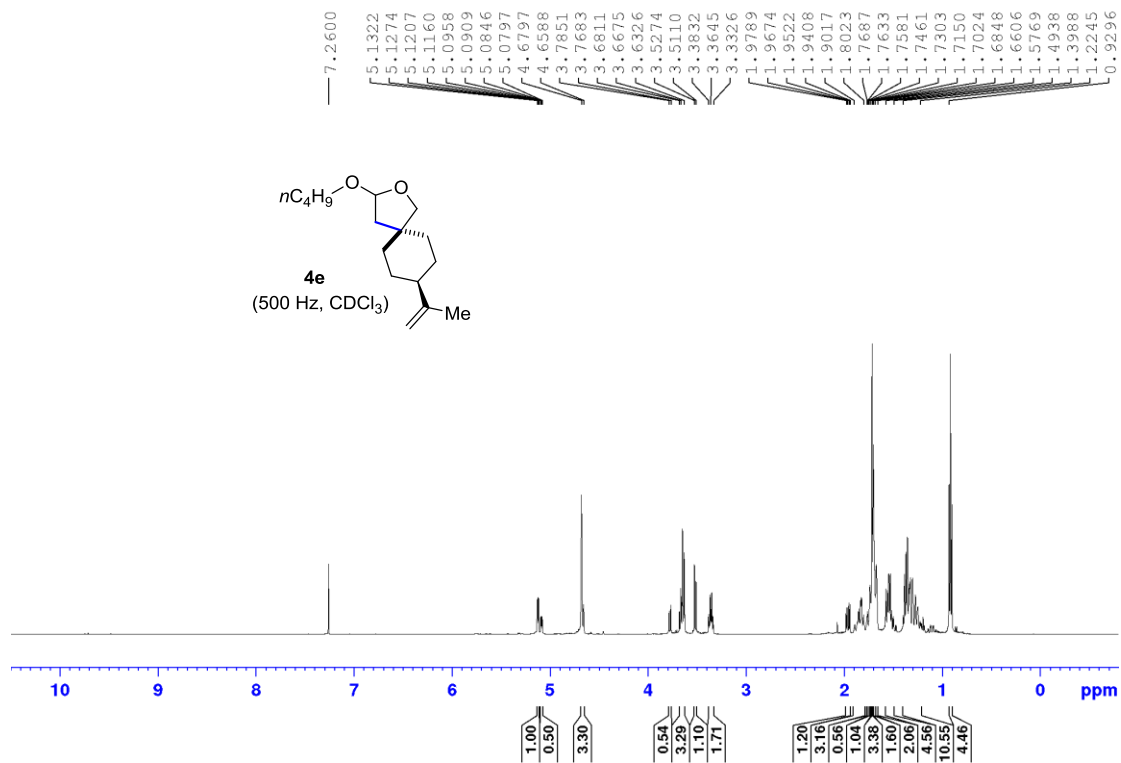


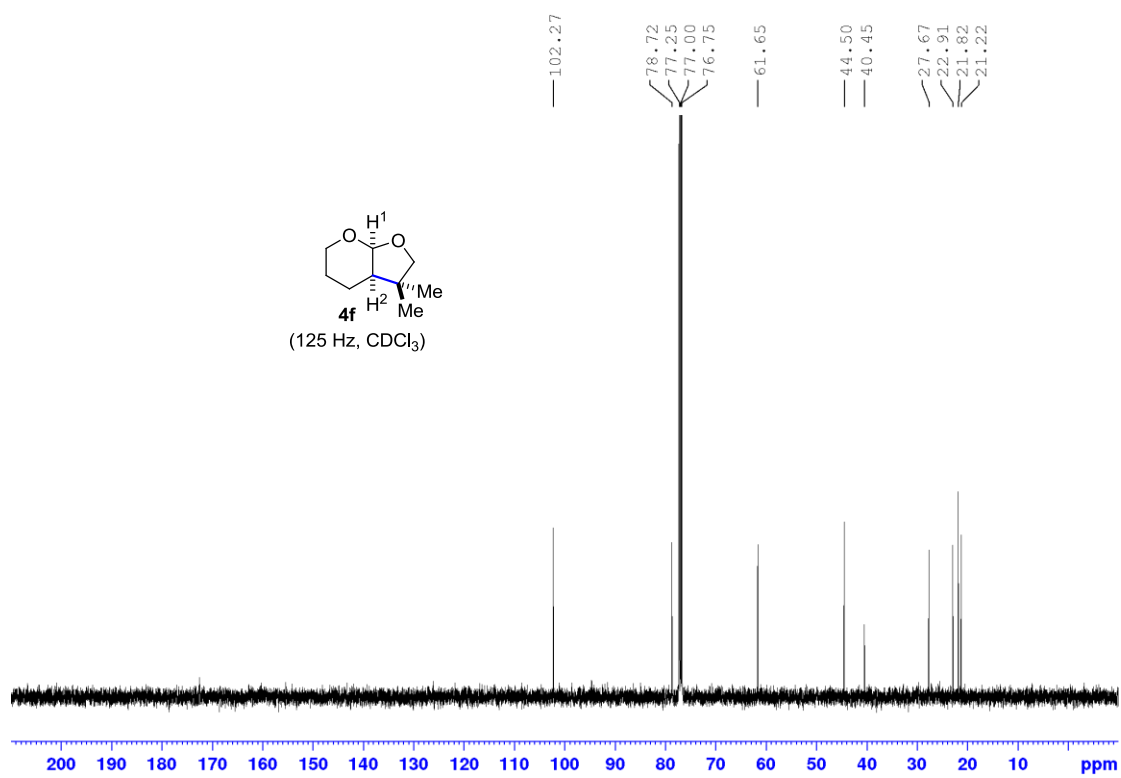
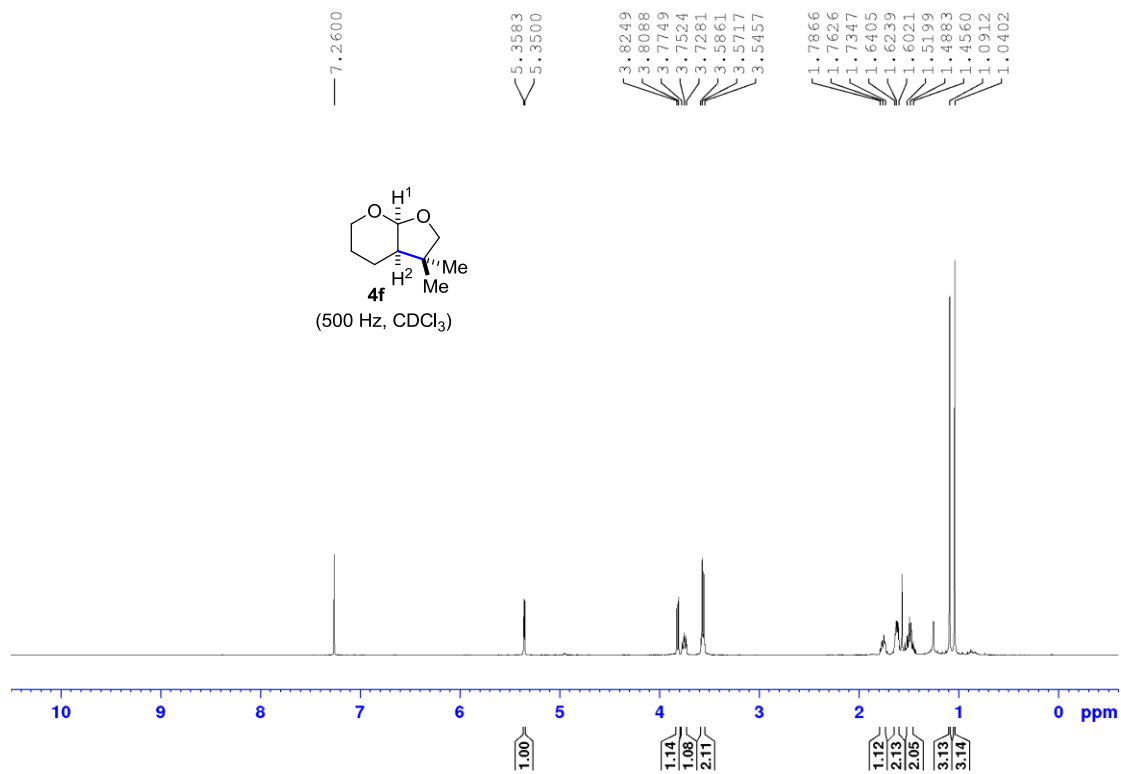




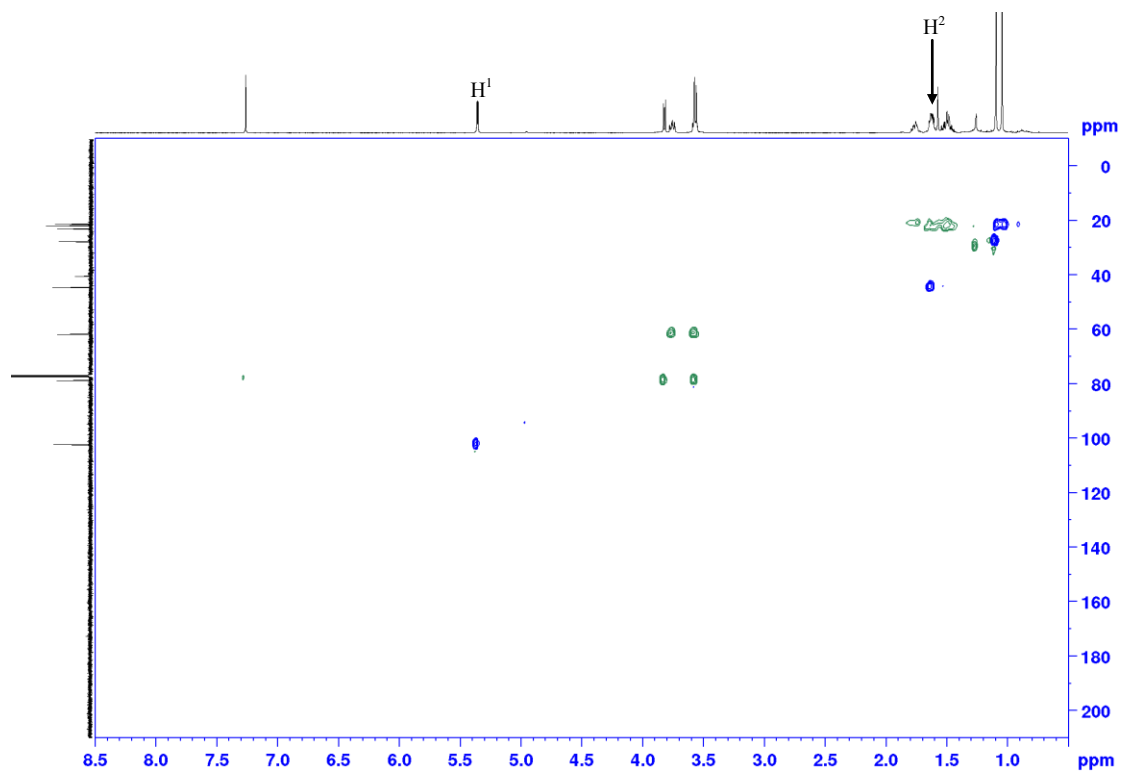
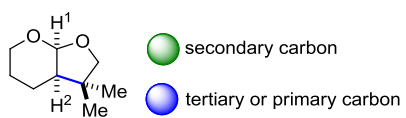




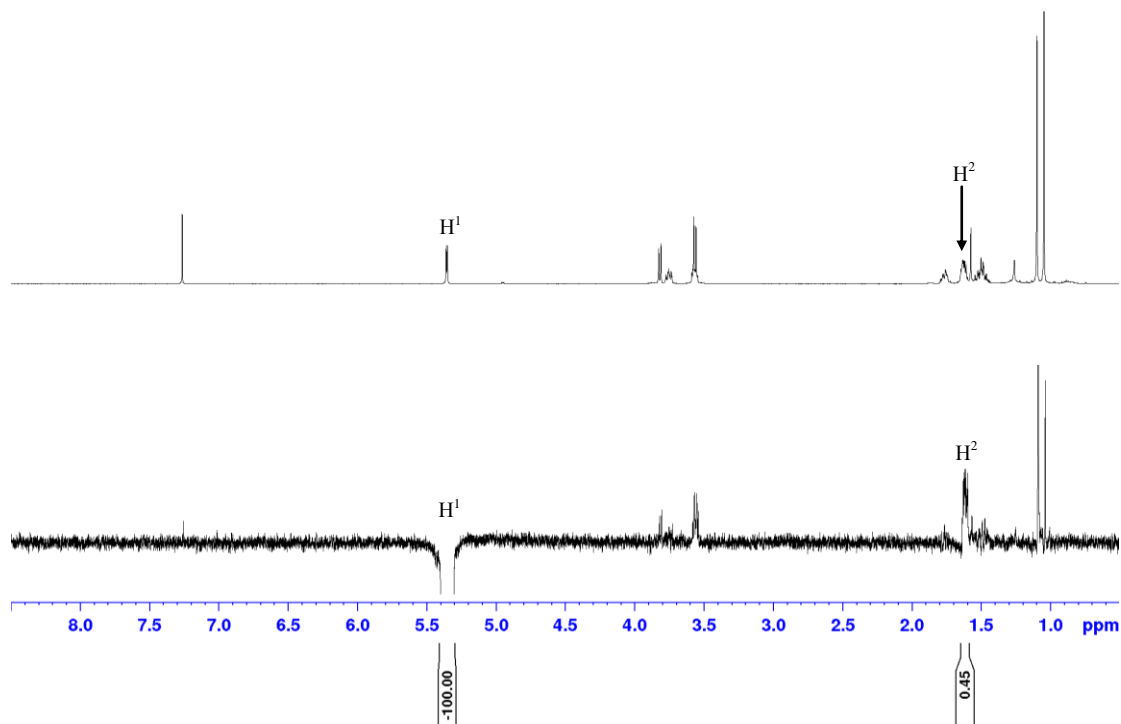
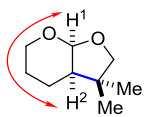


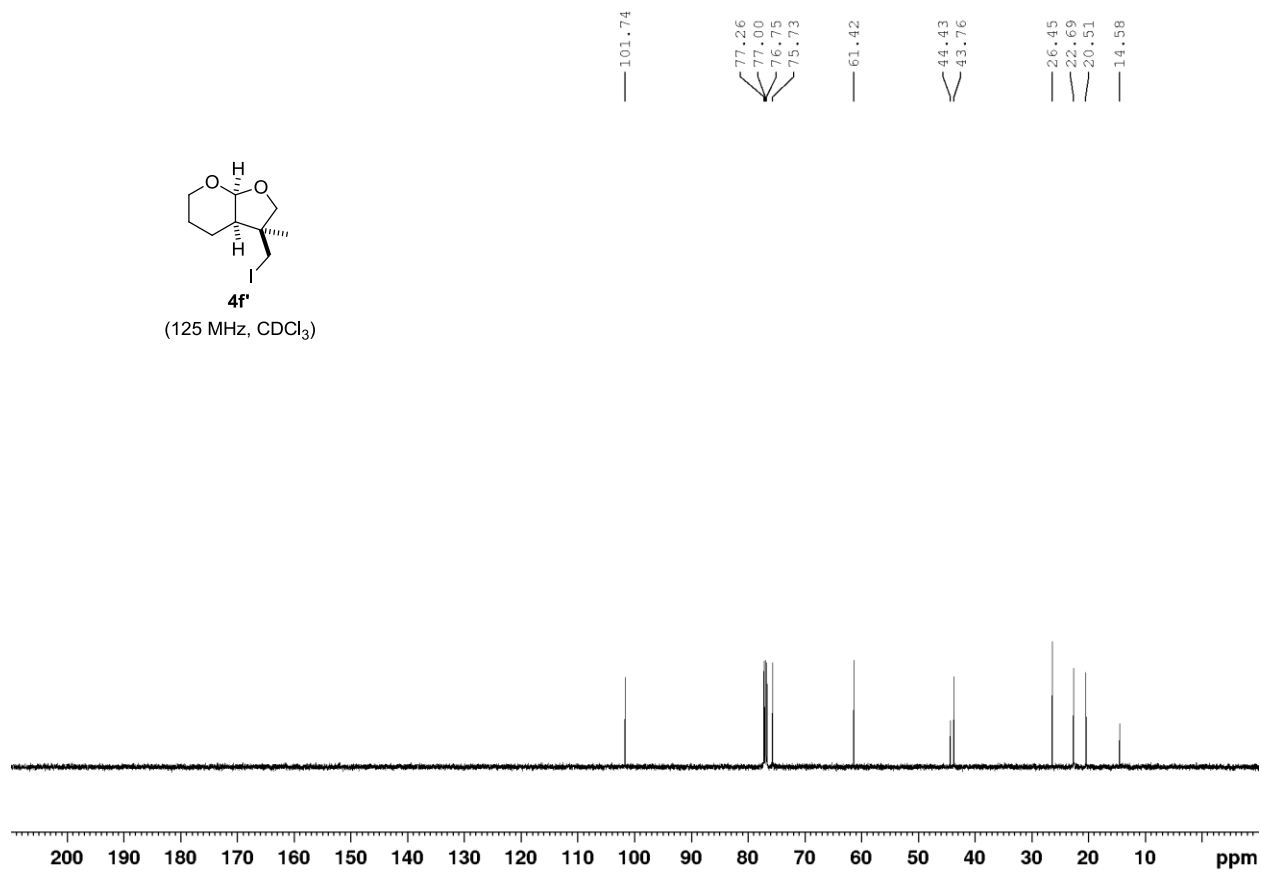
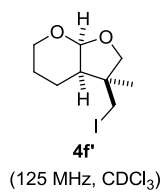
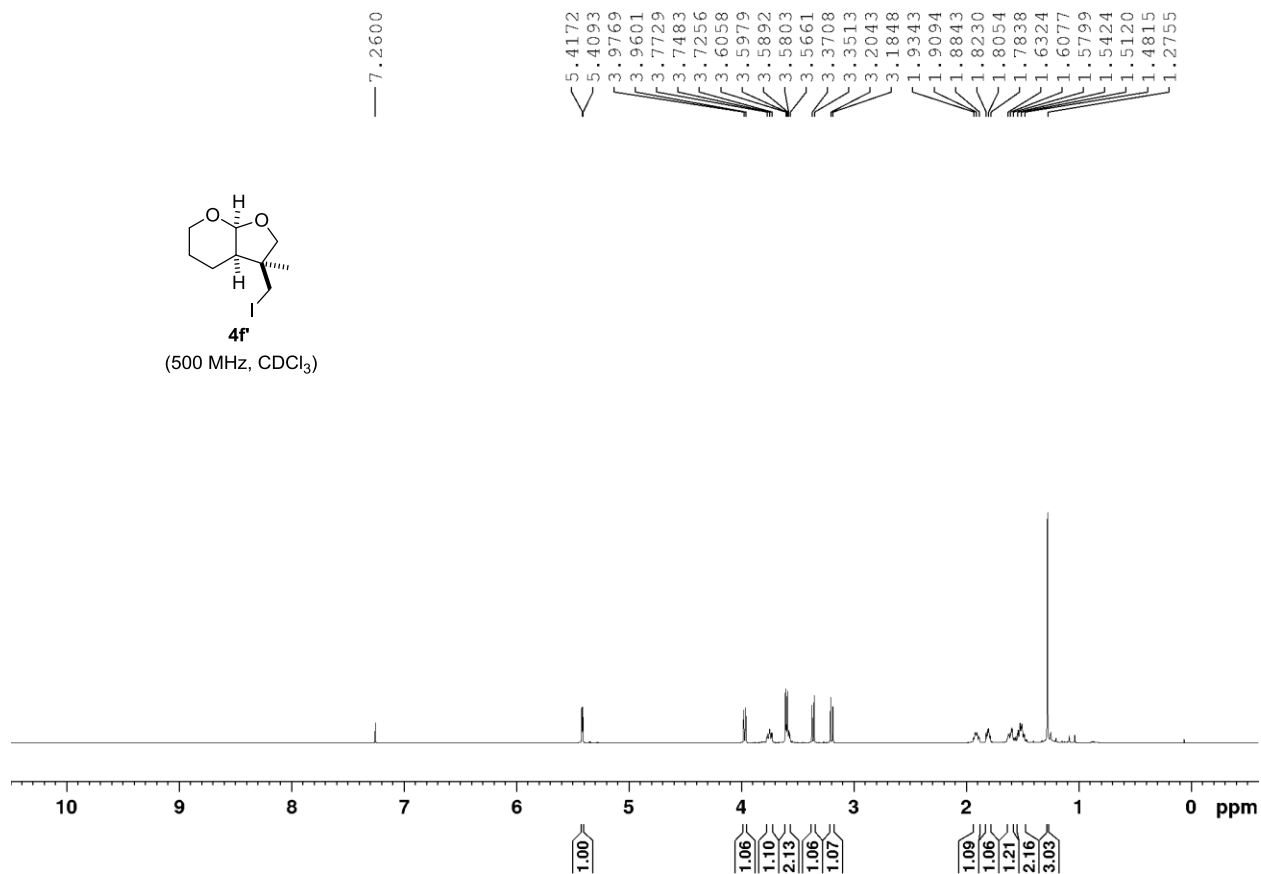
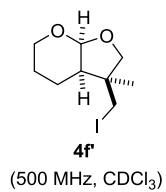


HSQC correlations of compound 4f

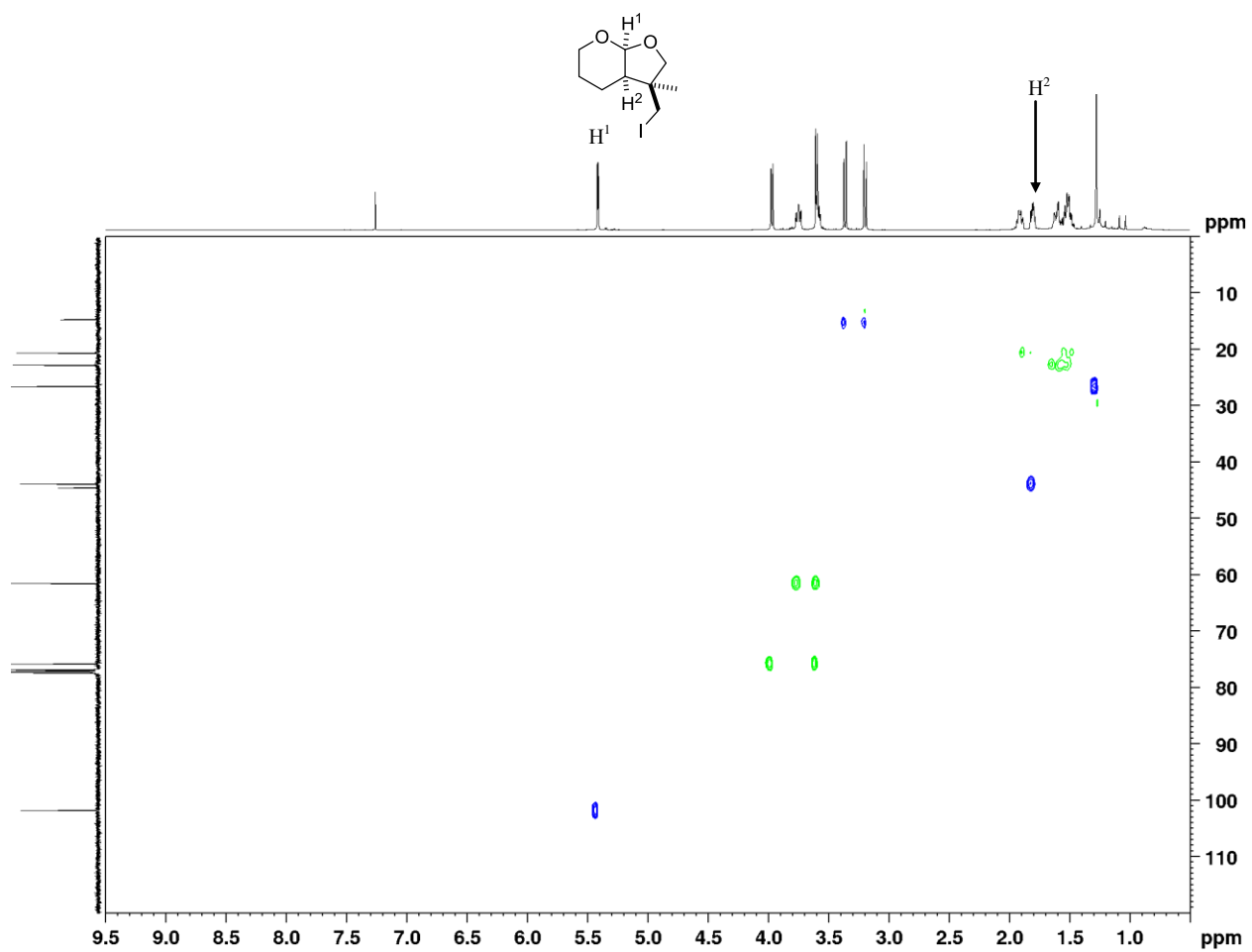


Representative NOE of compound 4f

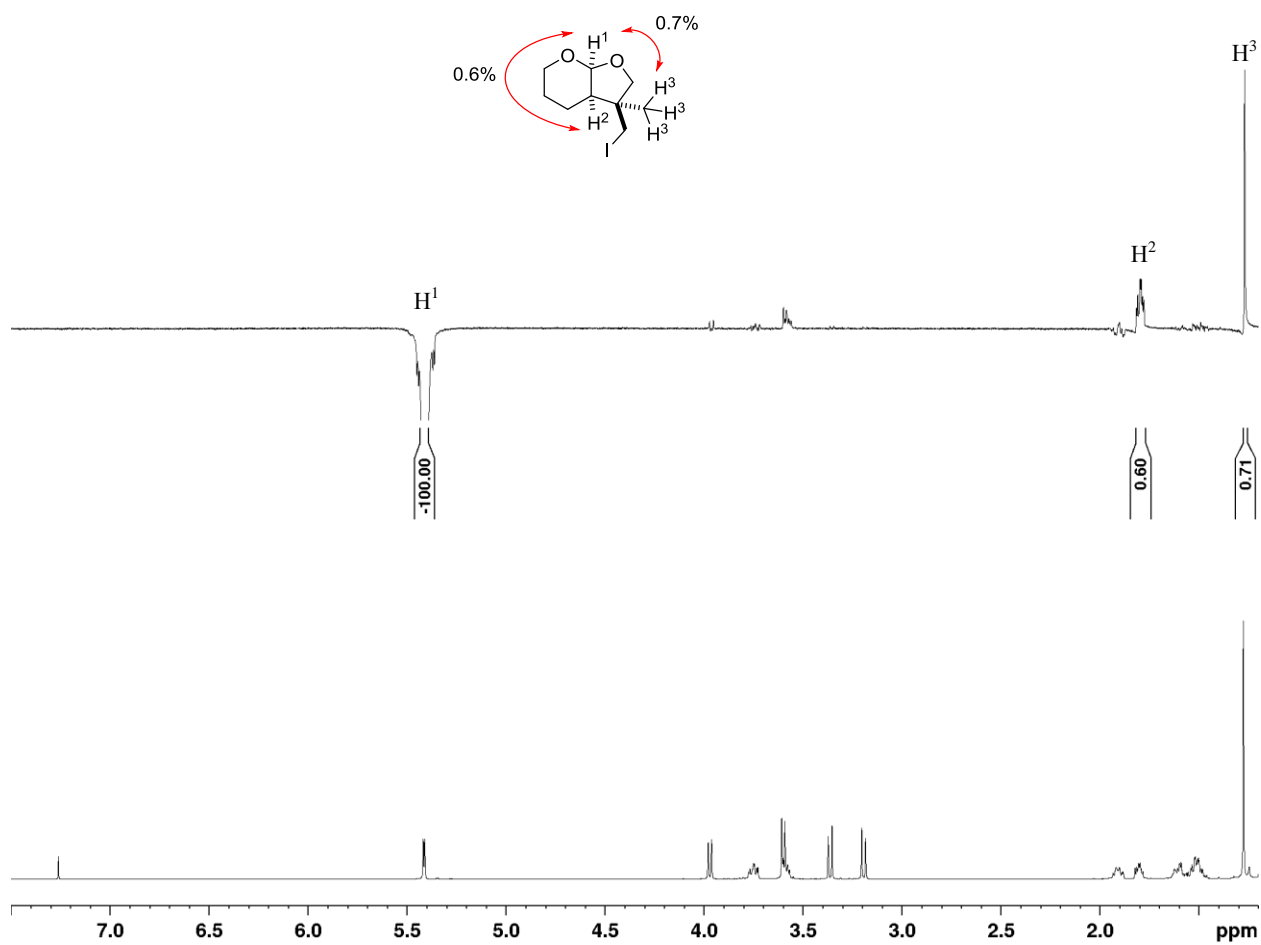


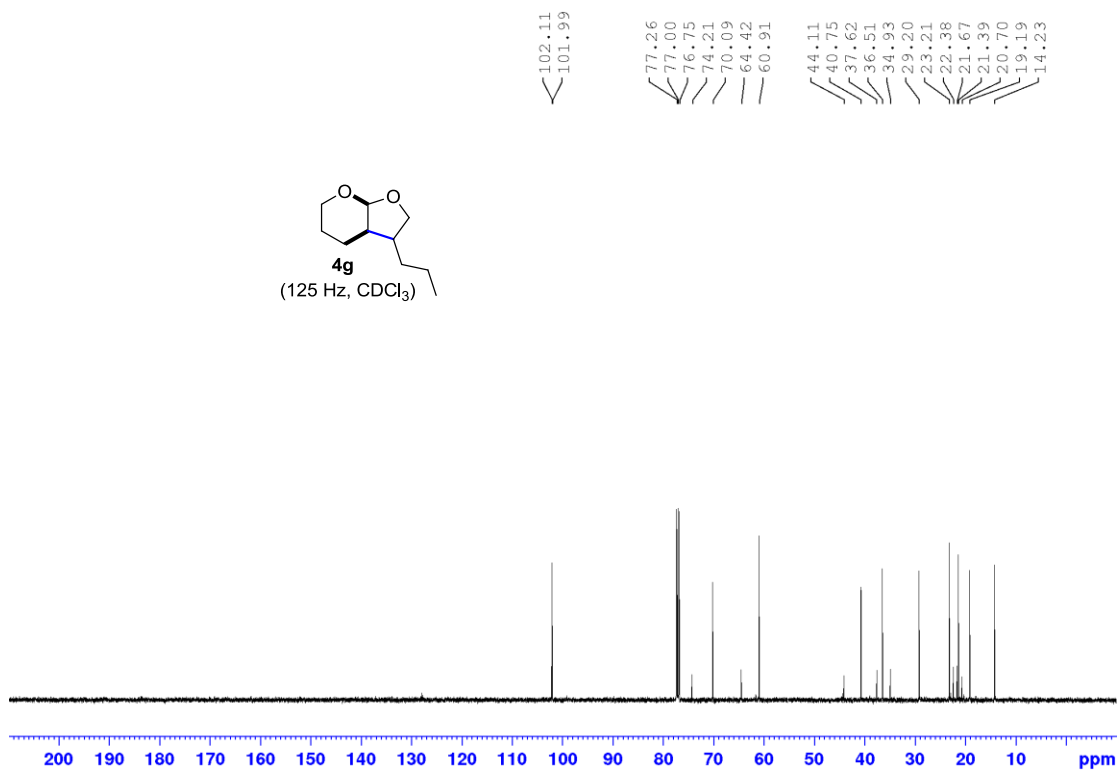
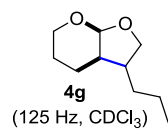
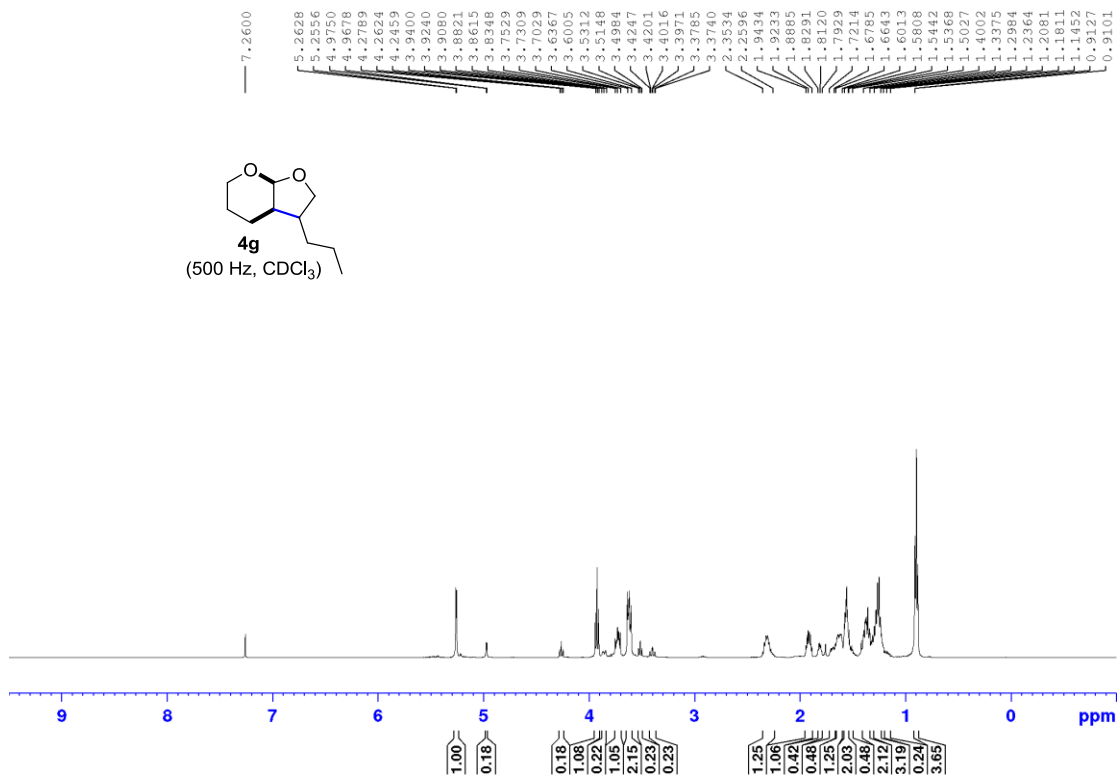
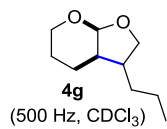


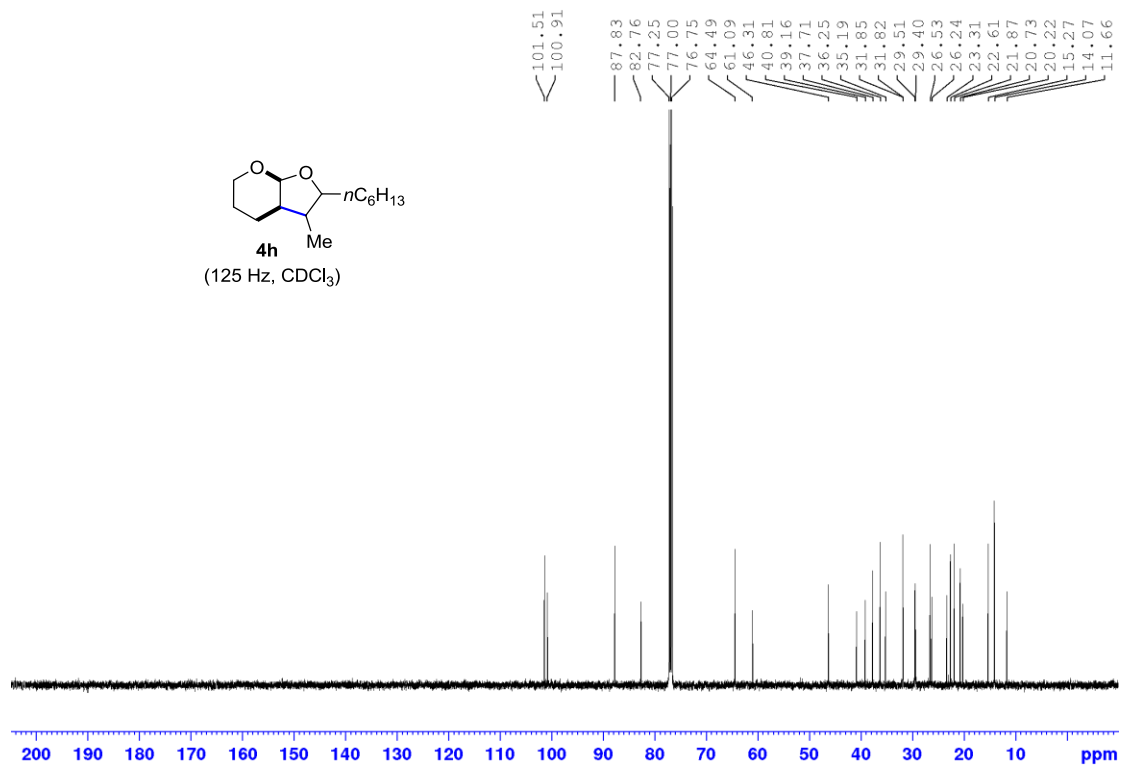
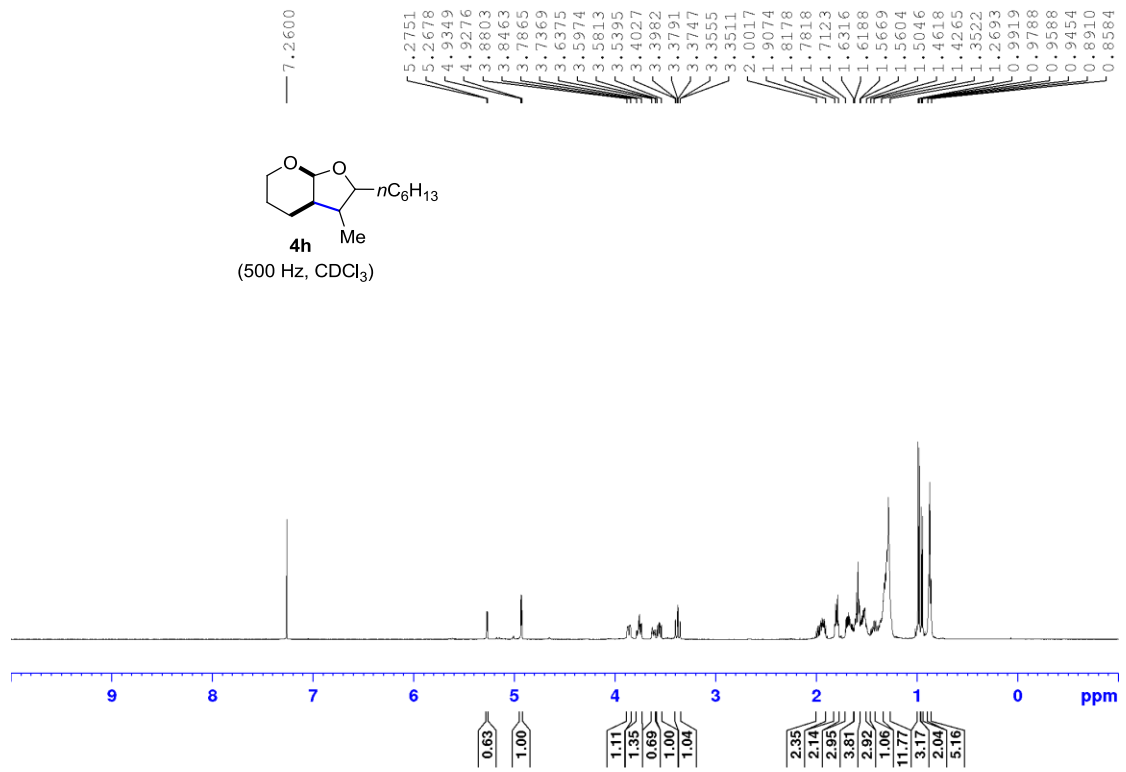
HSQC correlations of compound 4f

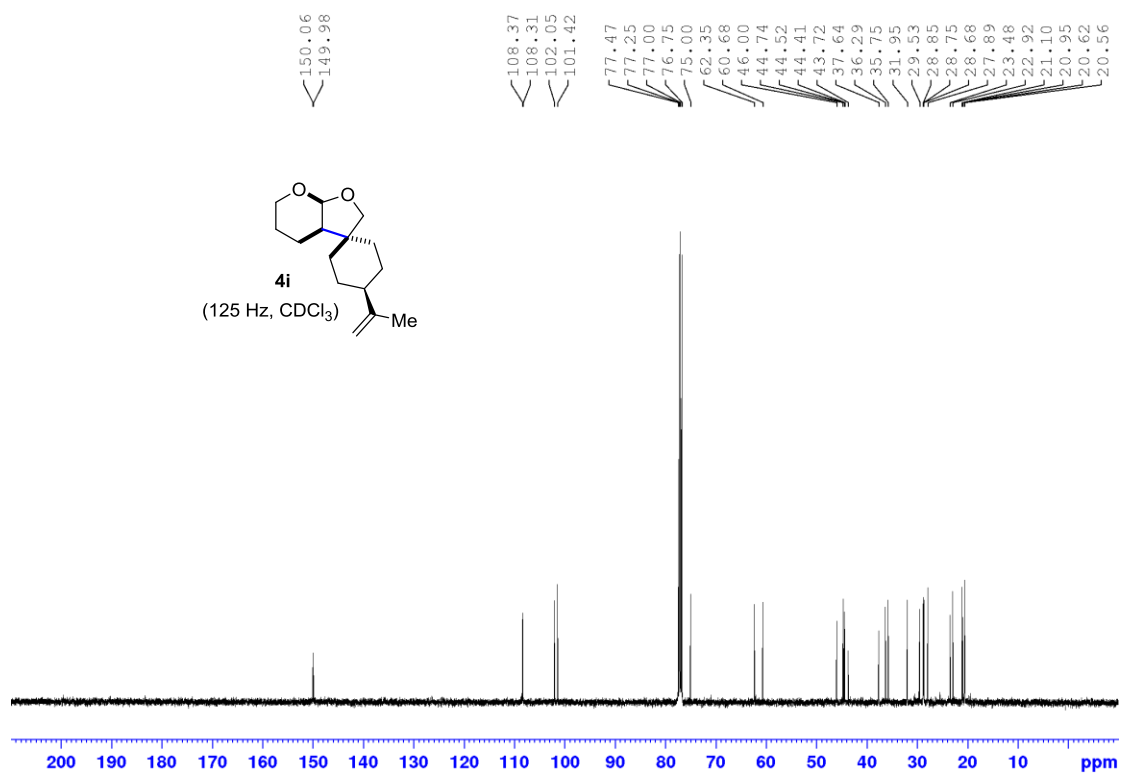
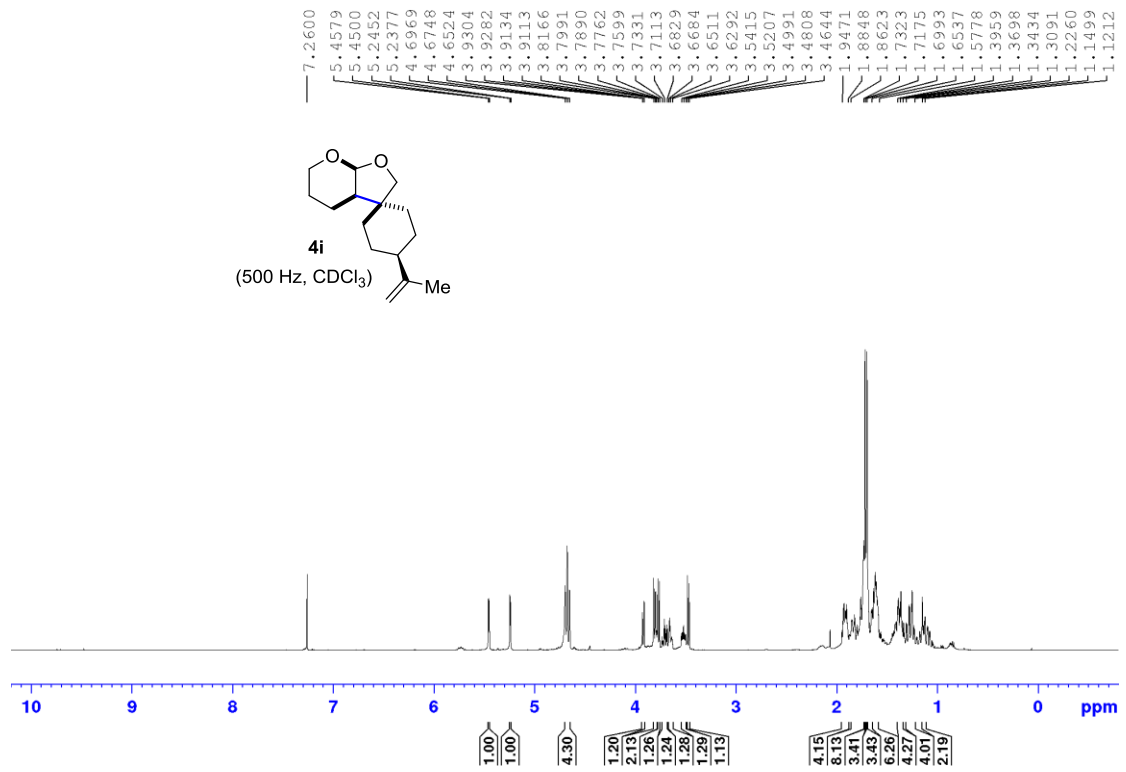


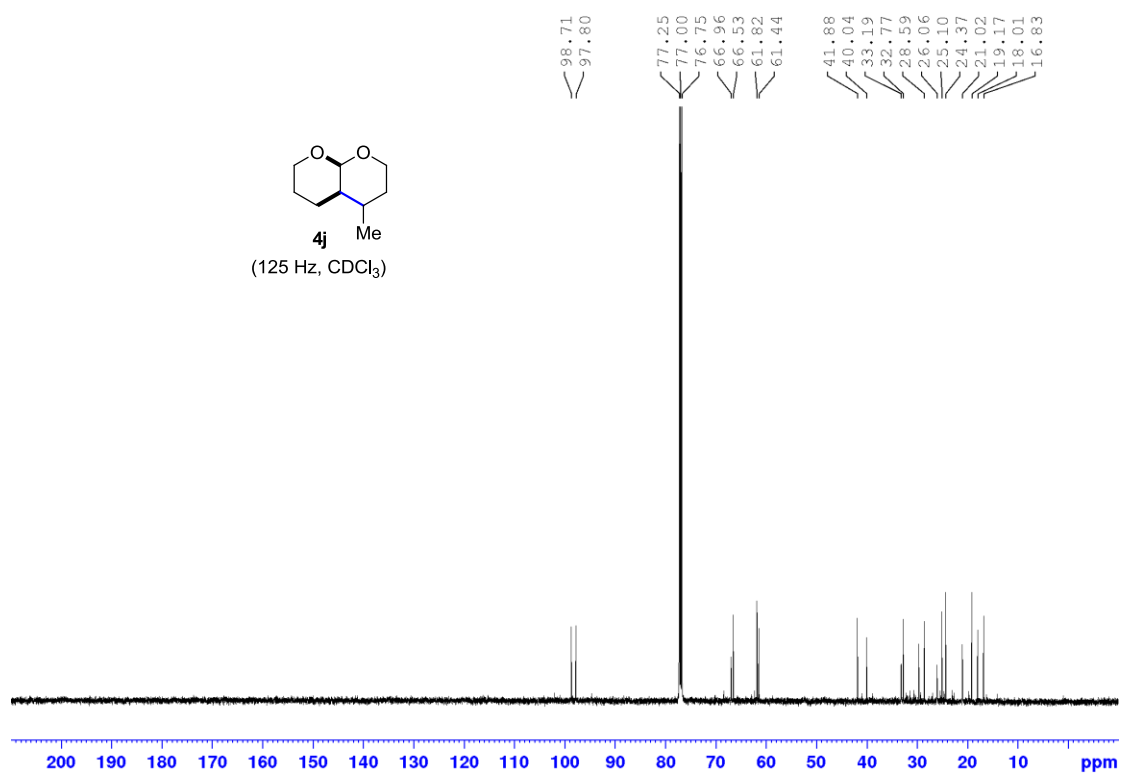
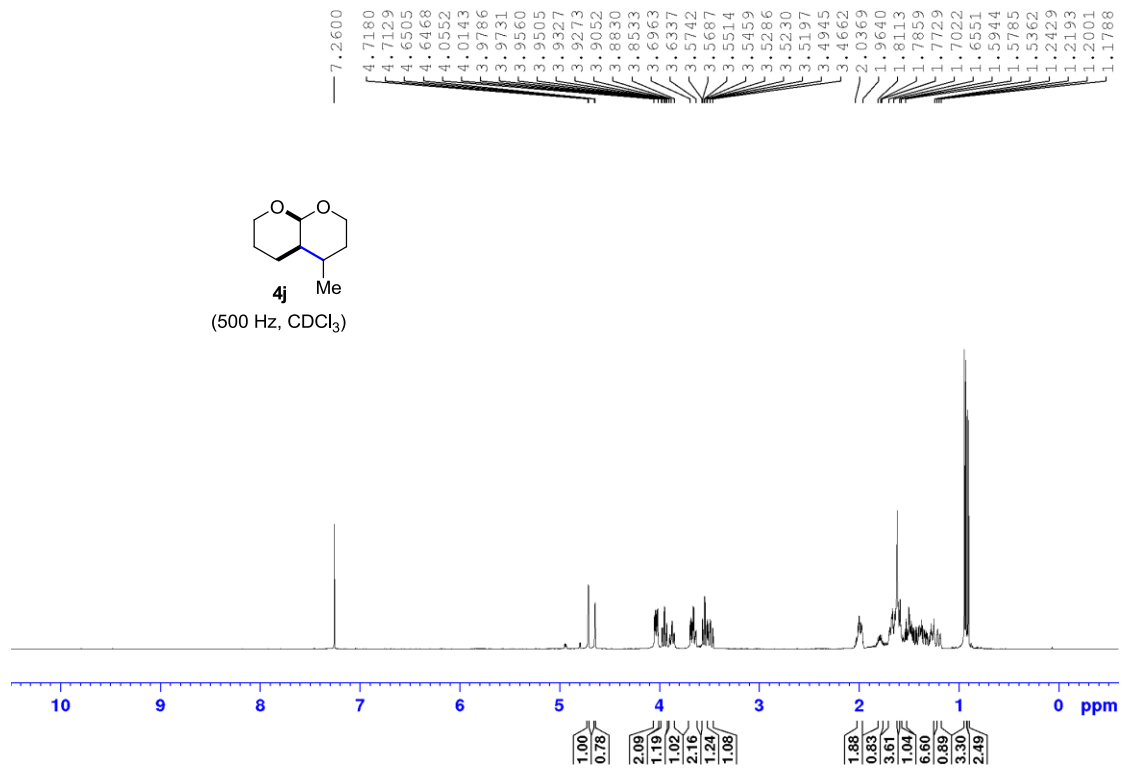
Representative NOE of compound 4f⁷

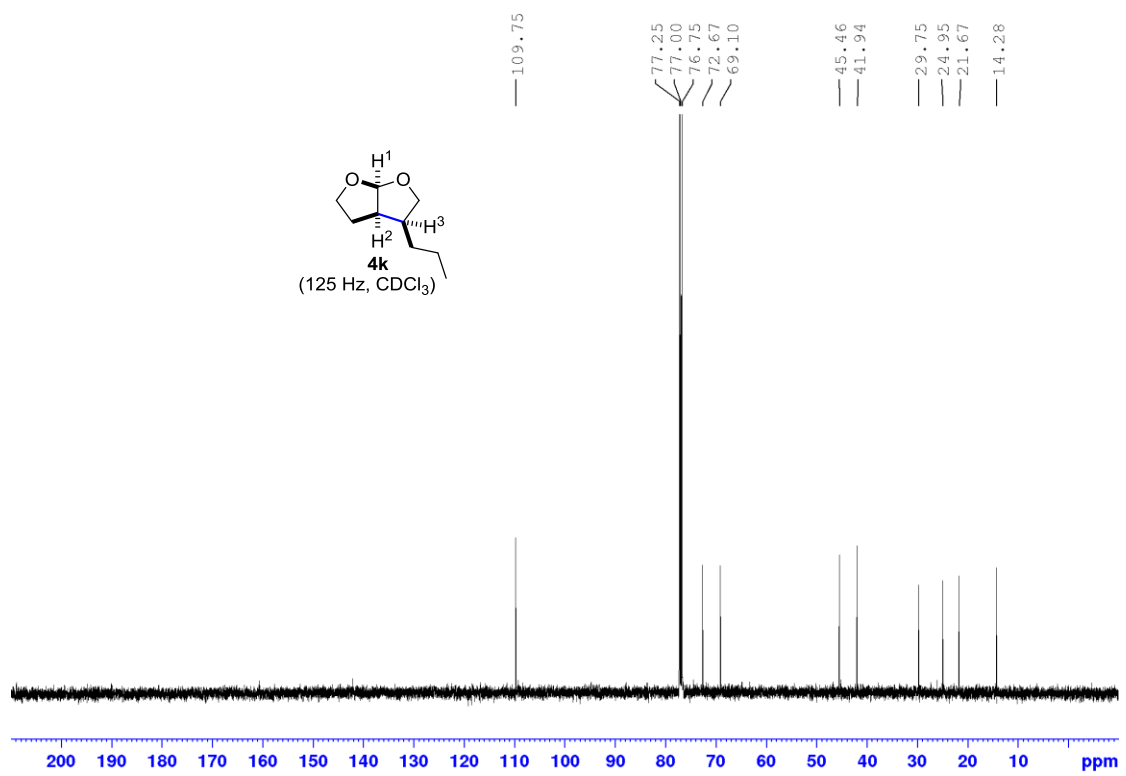
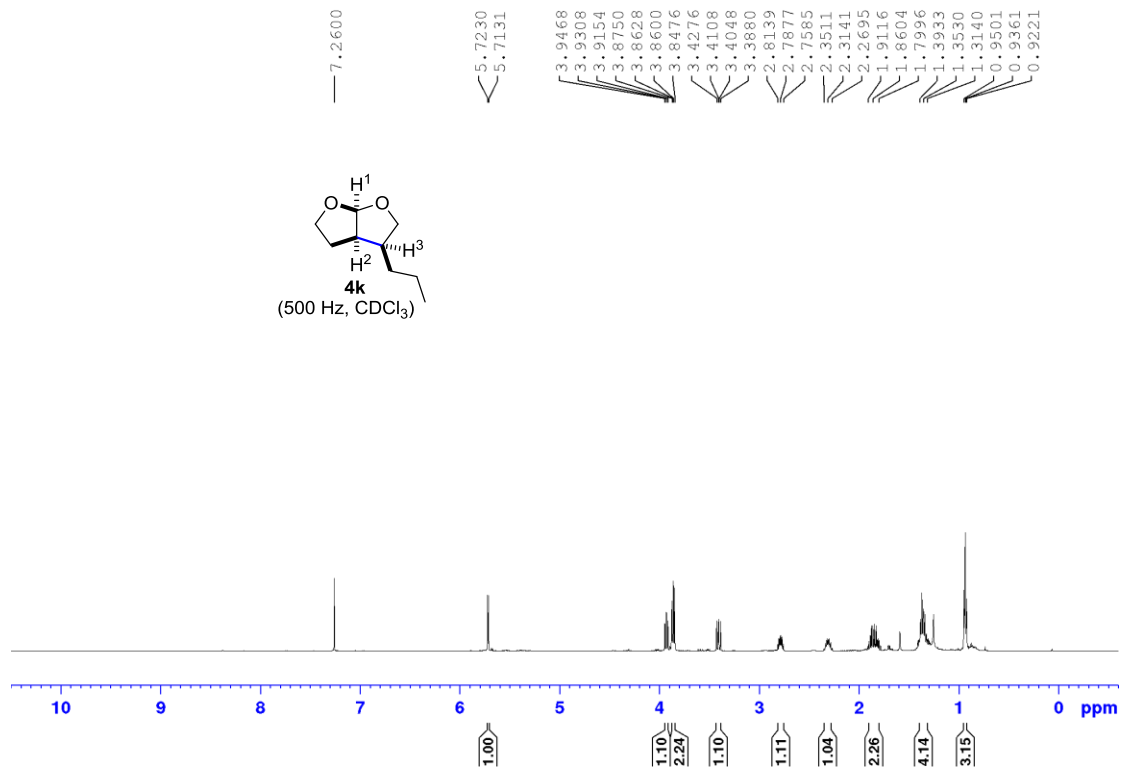




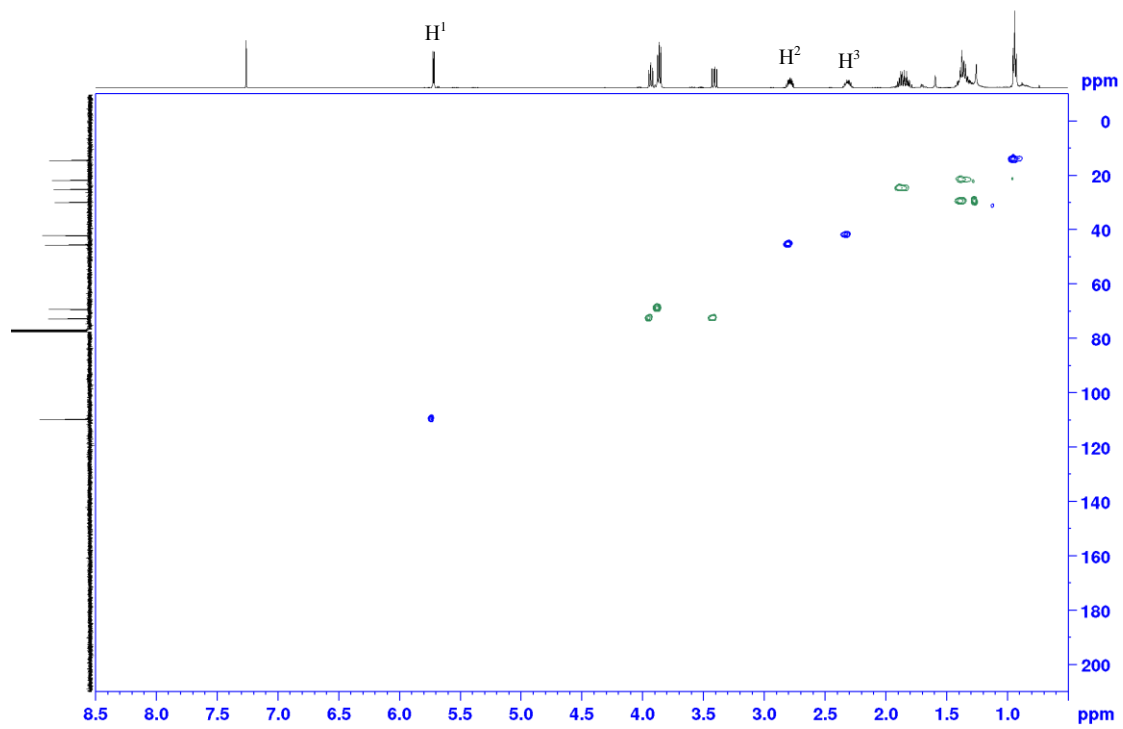
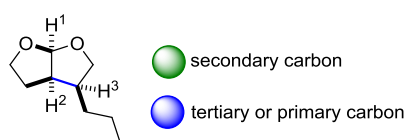




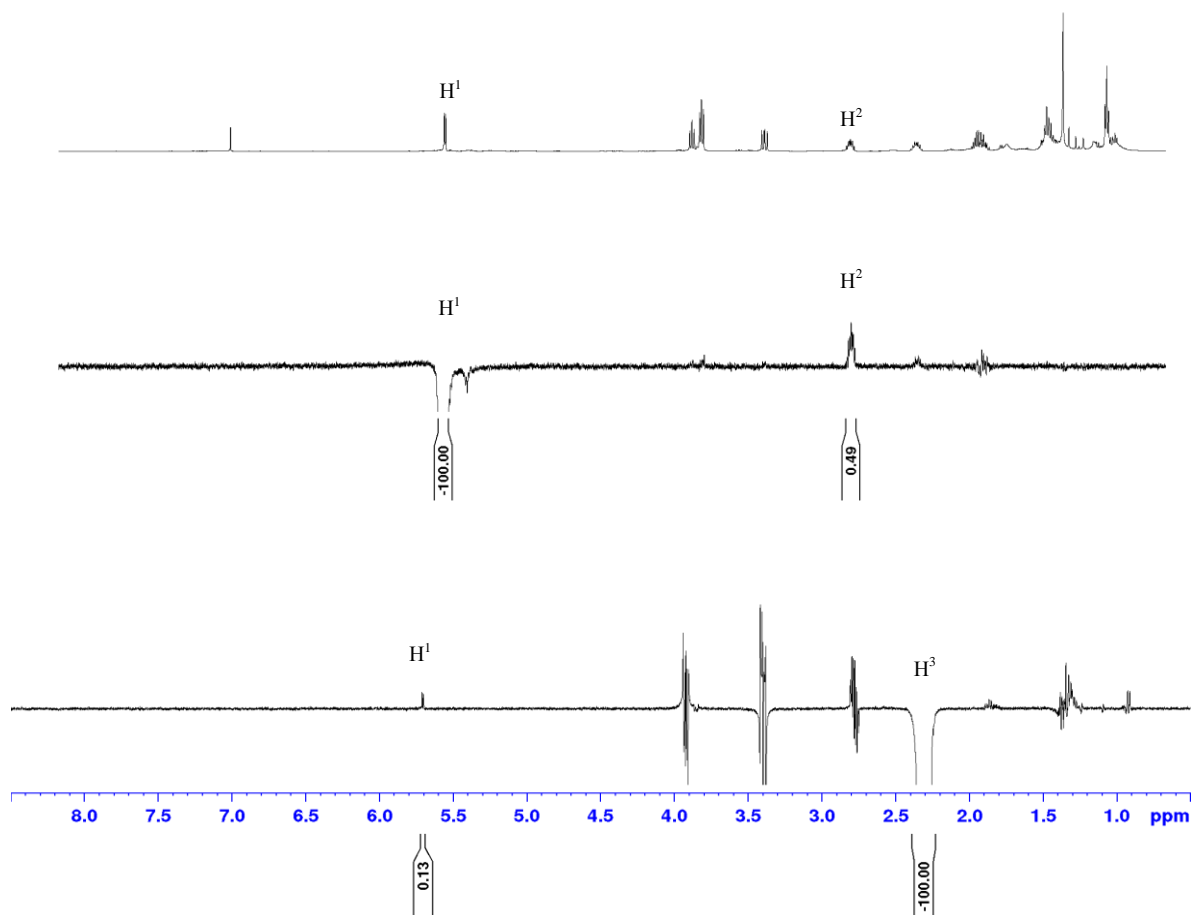
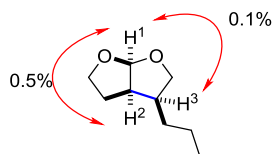


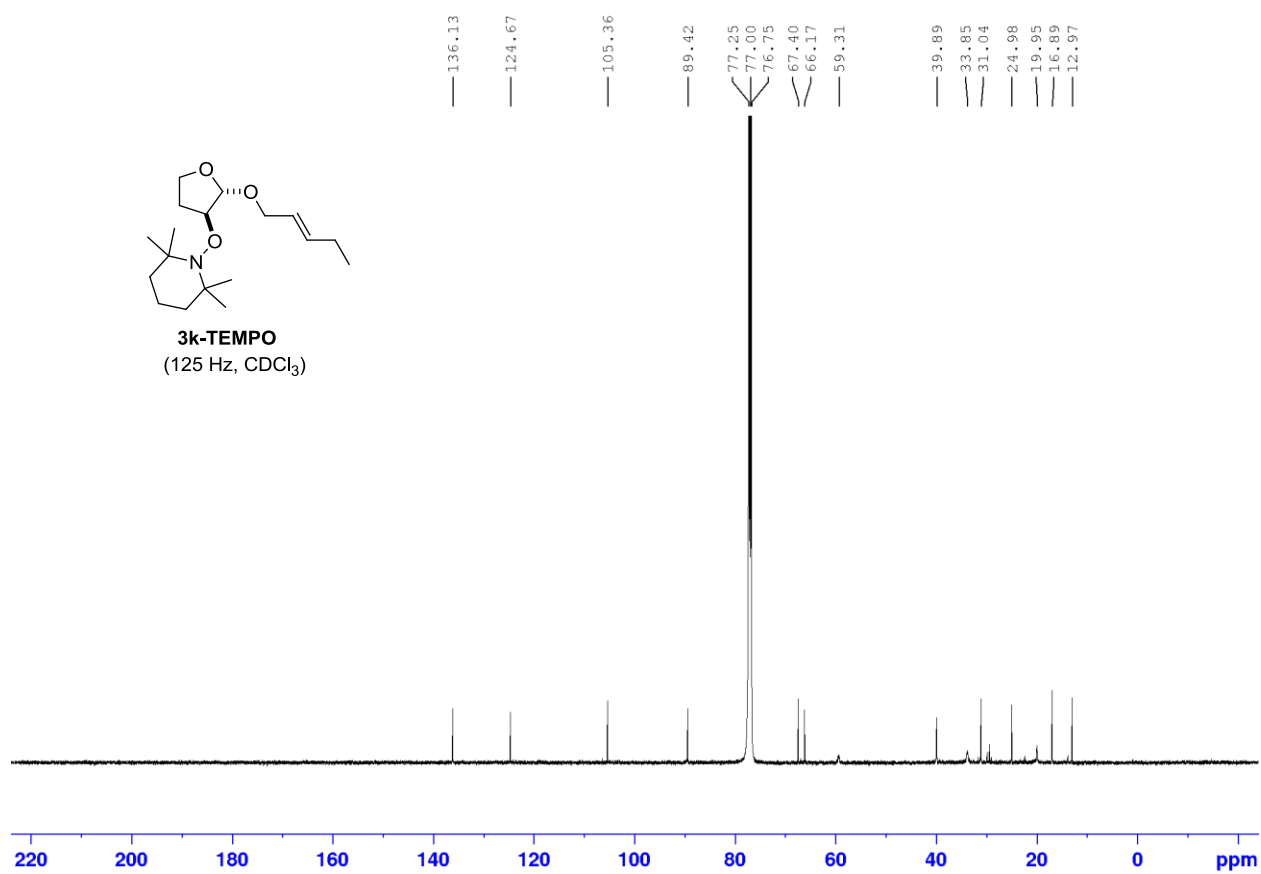
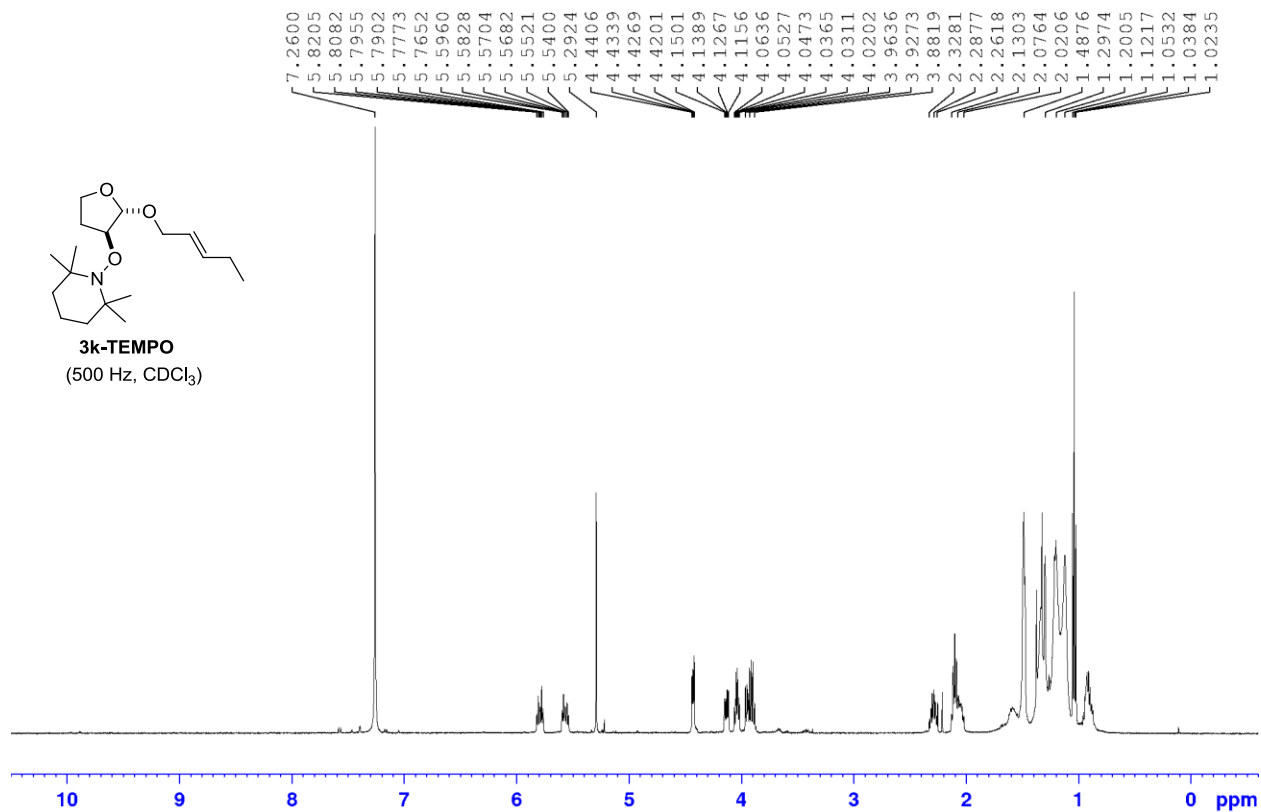


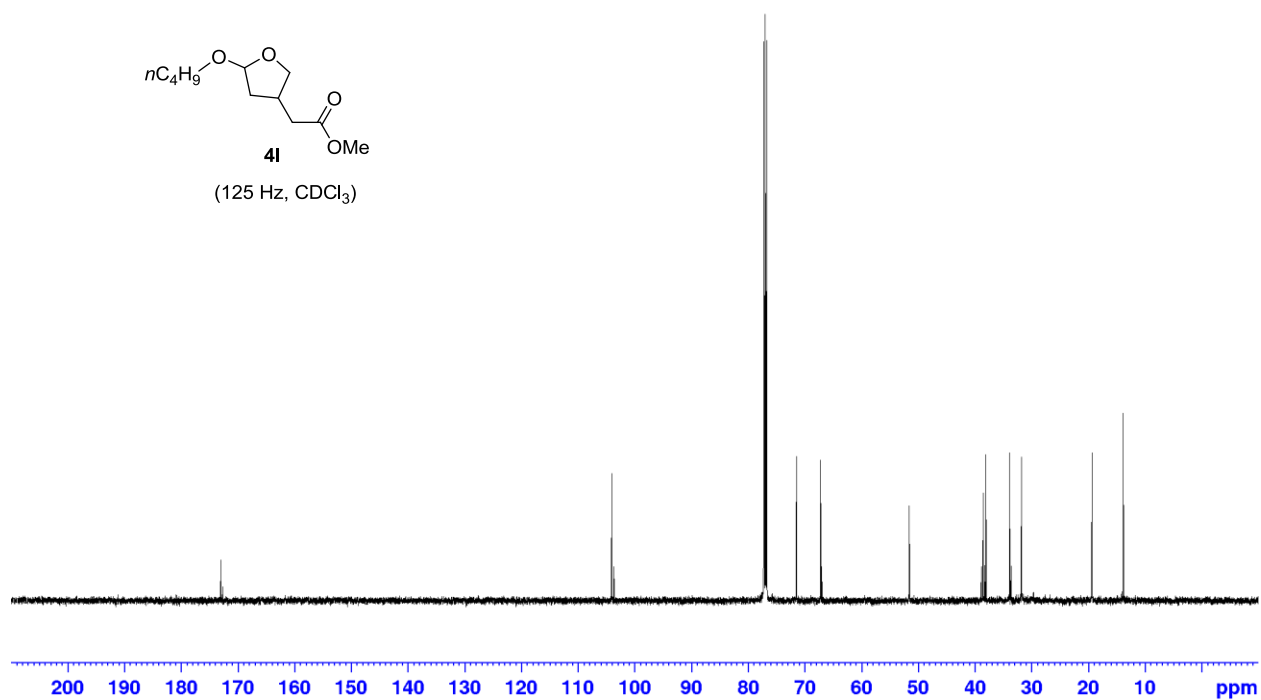
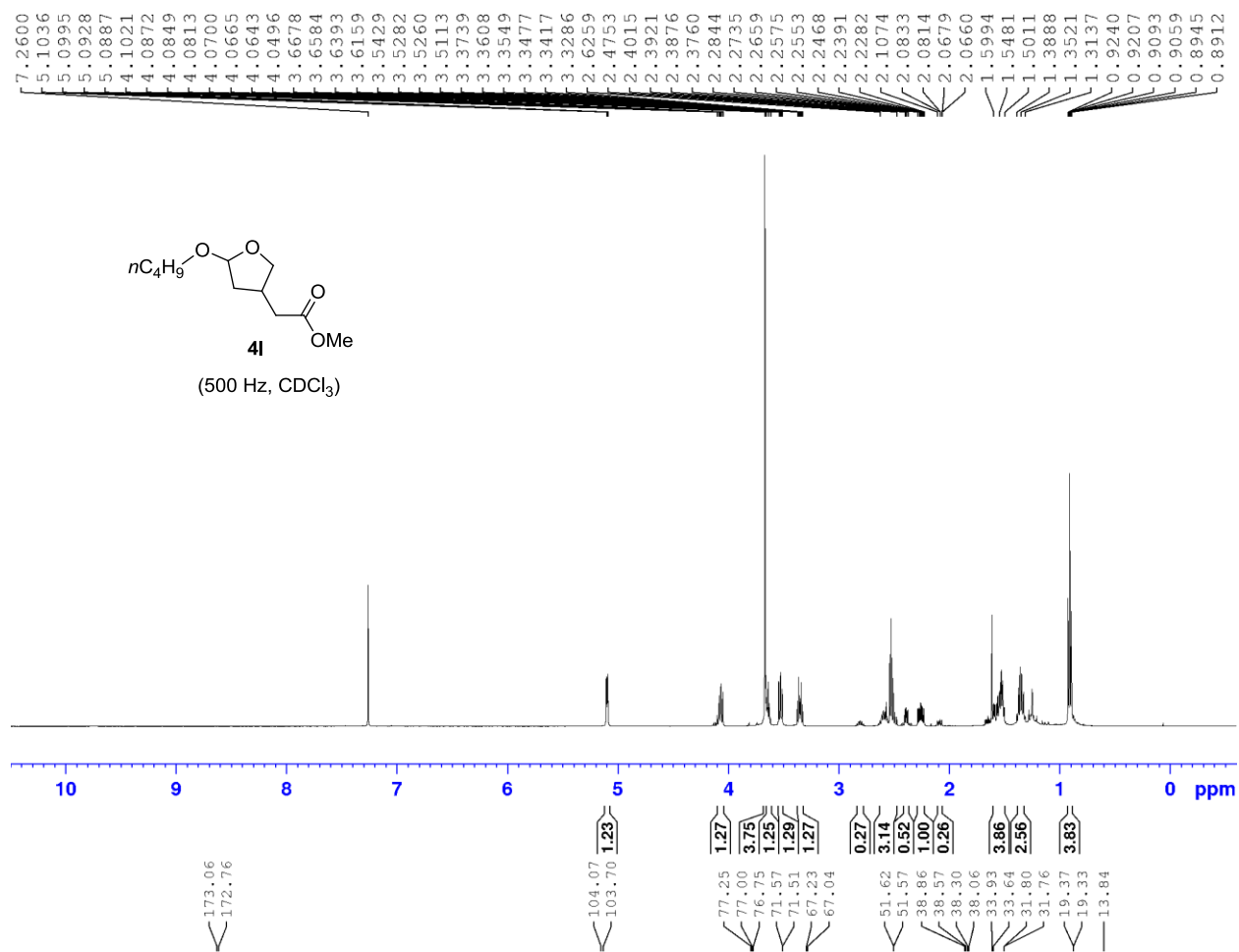
HSQC correlations of compound 4k

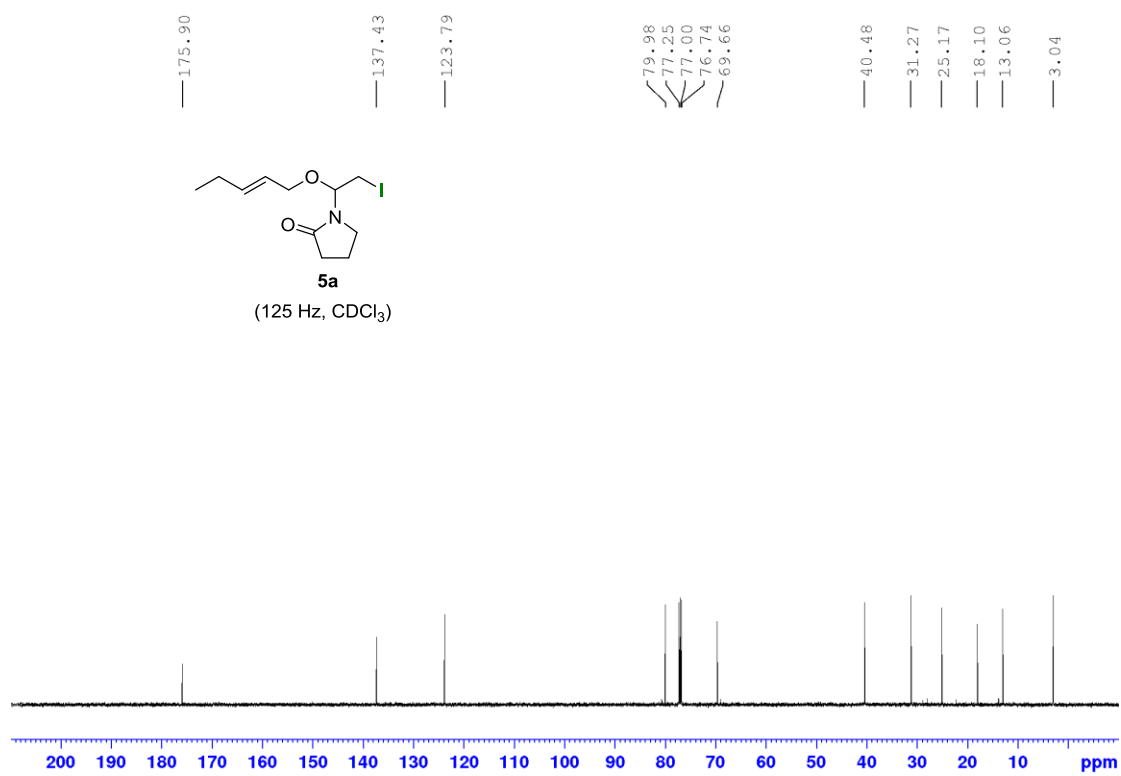
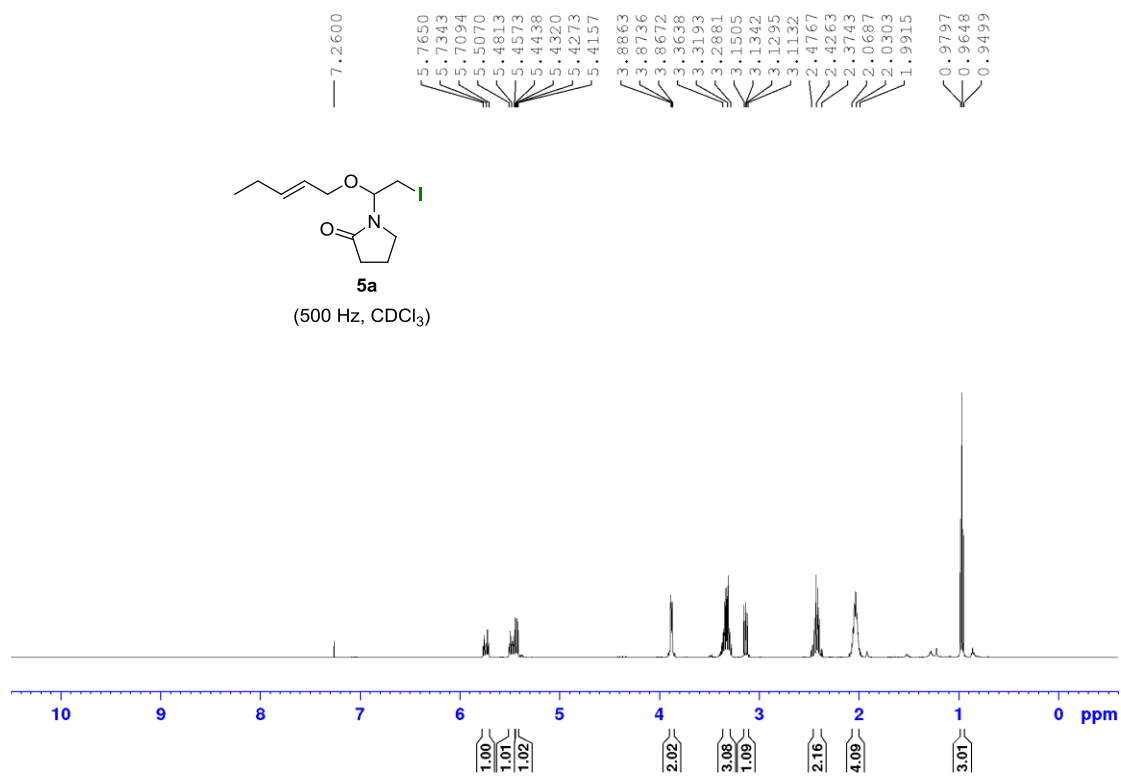


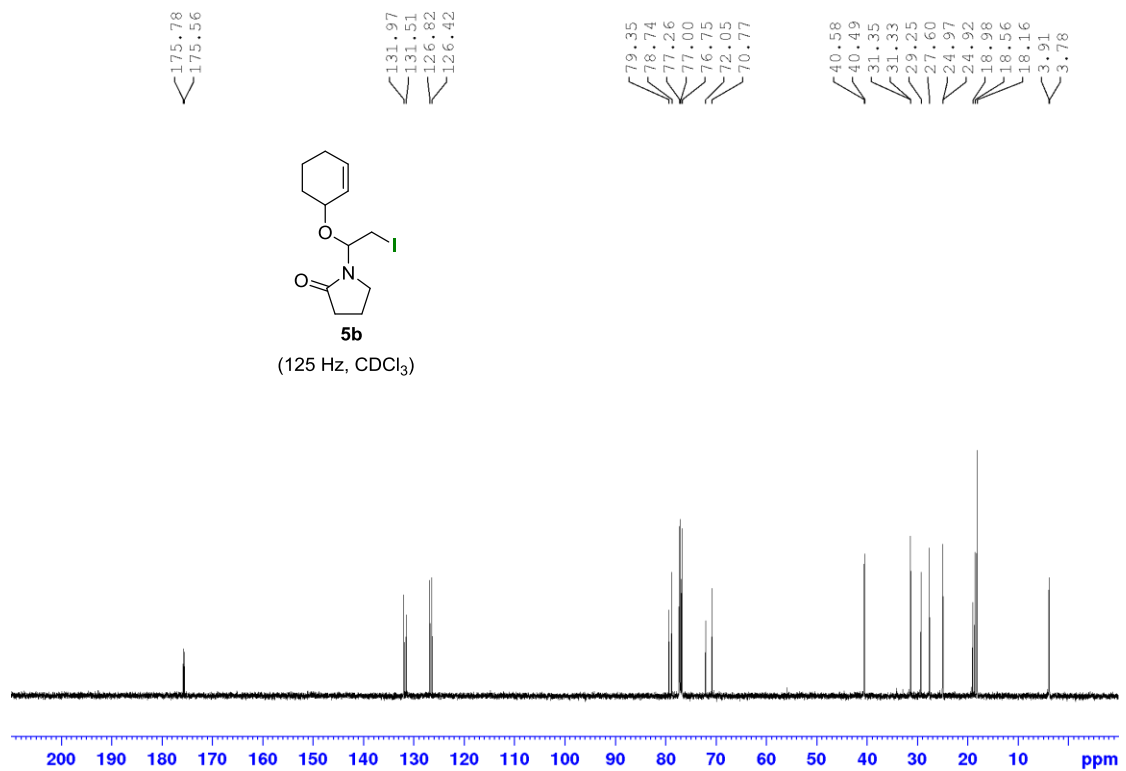
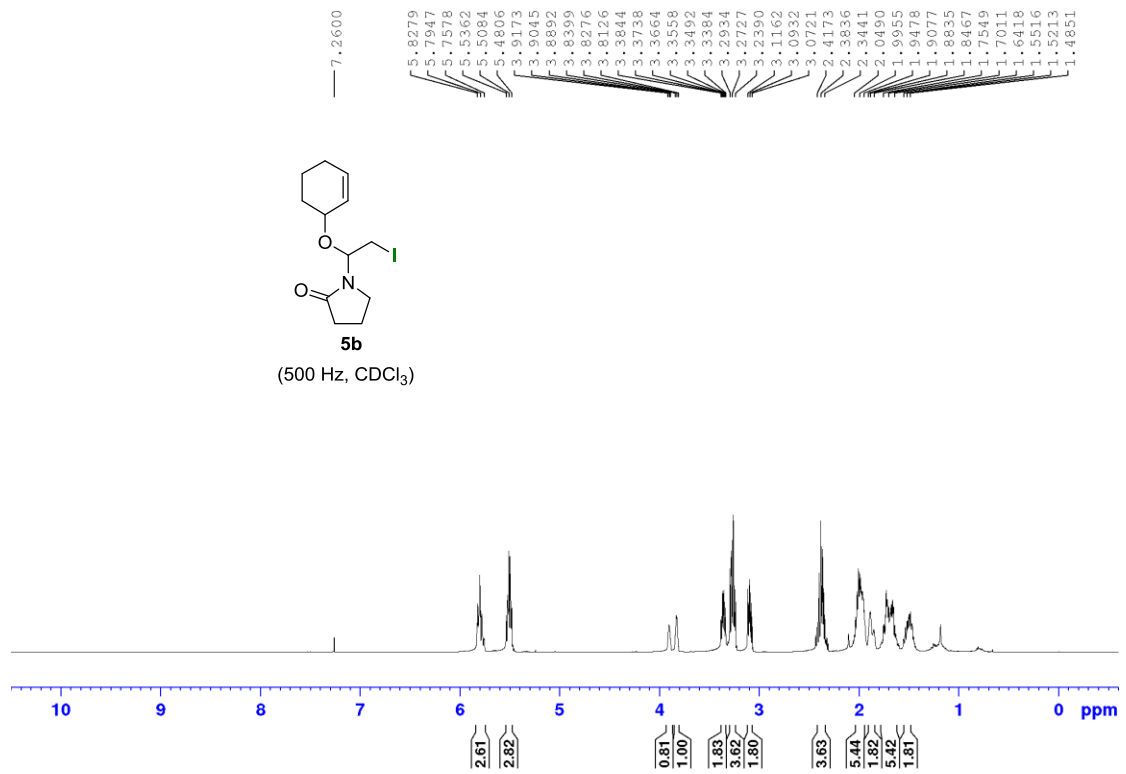
Representative NOE of compound 4k

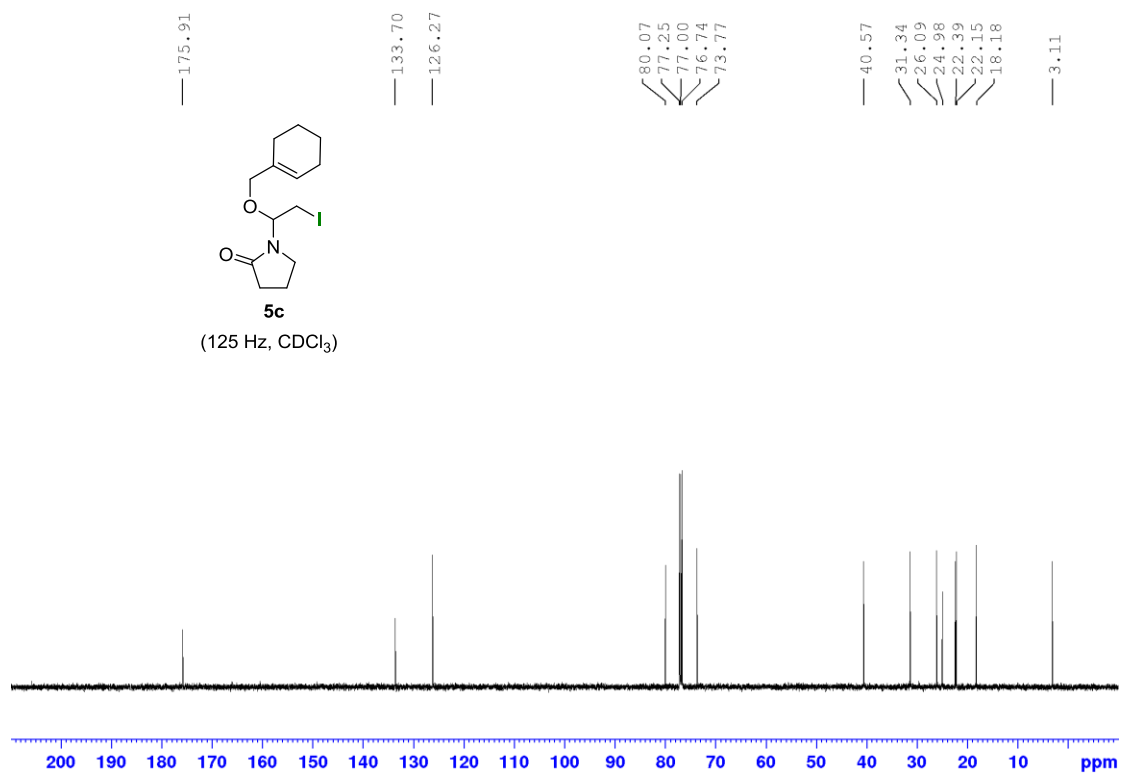
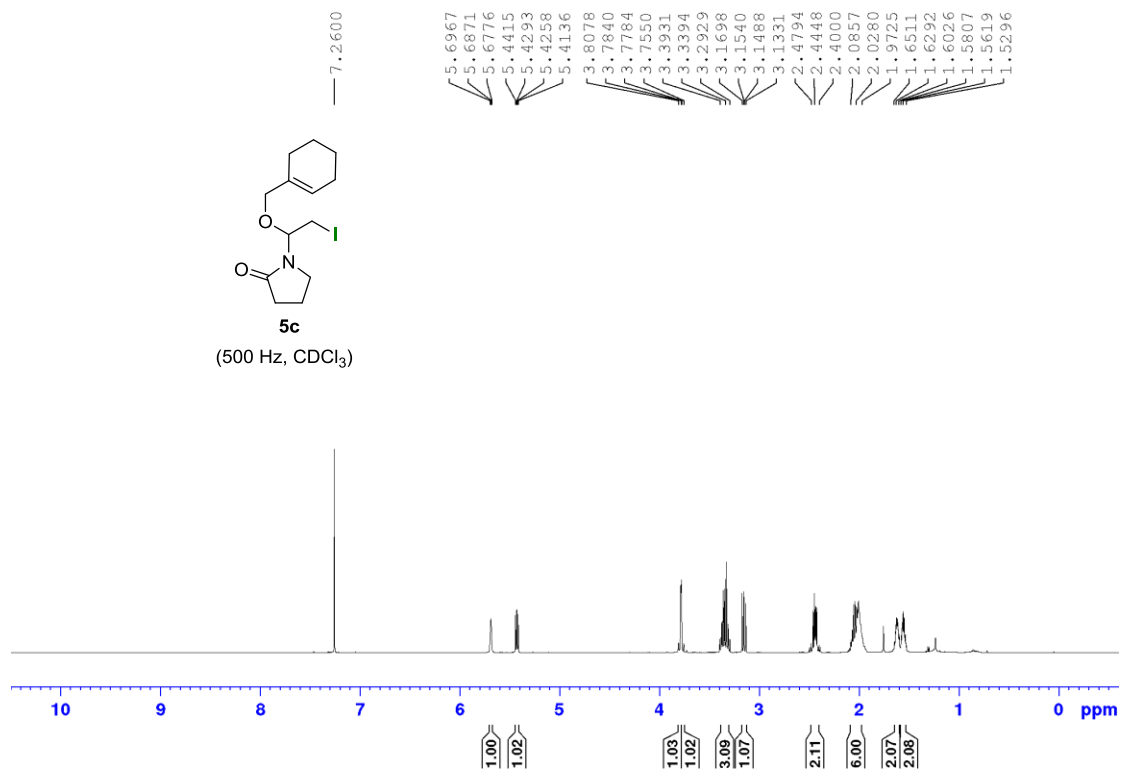


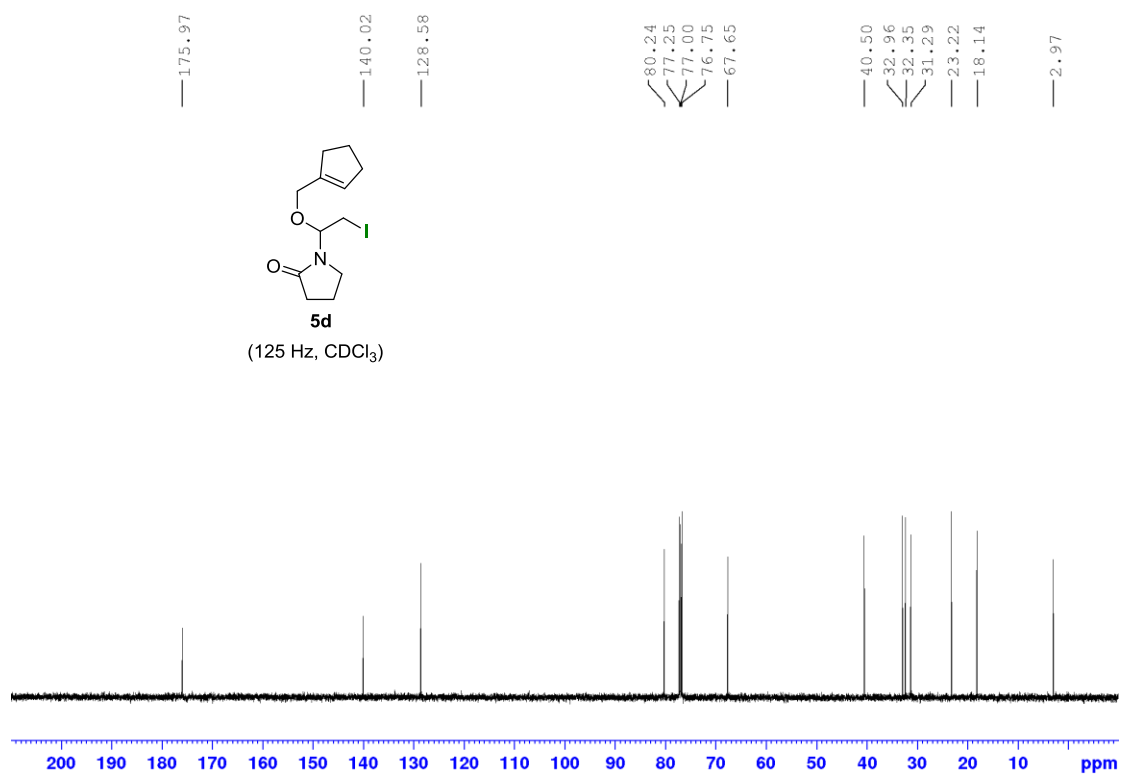
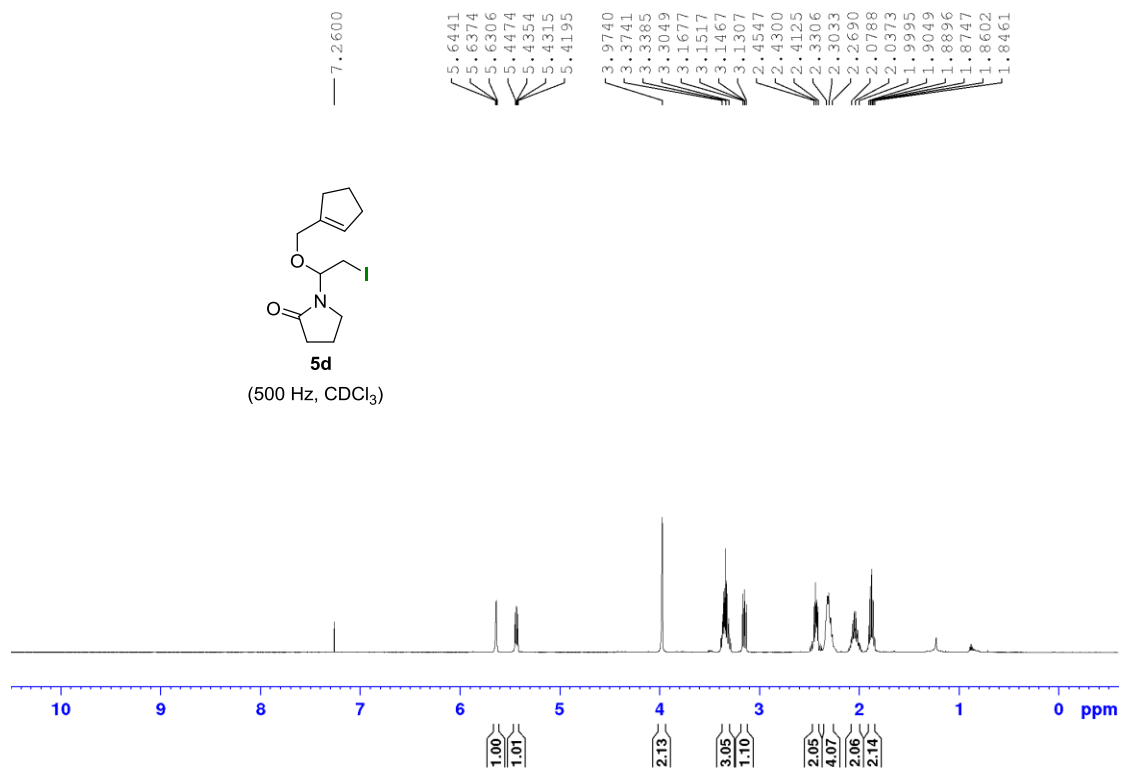


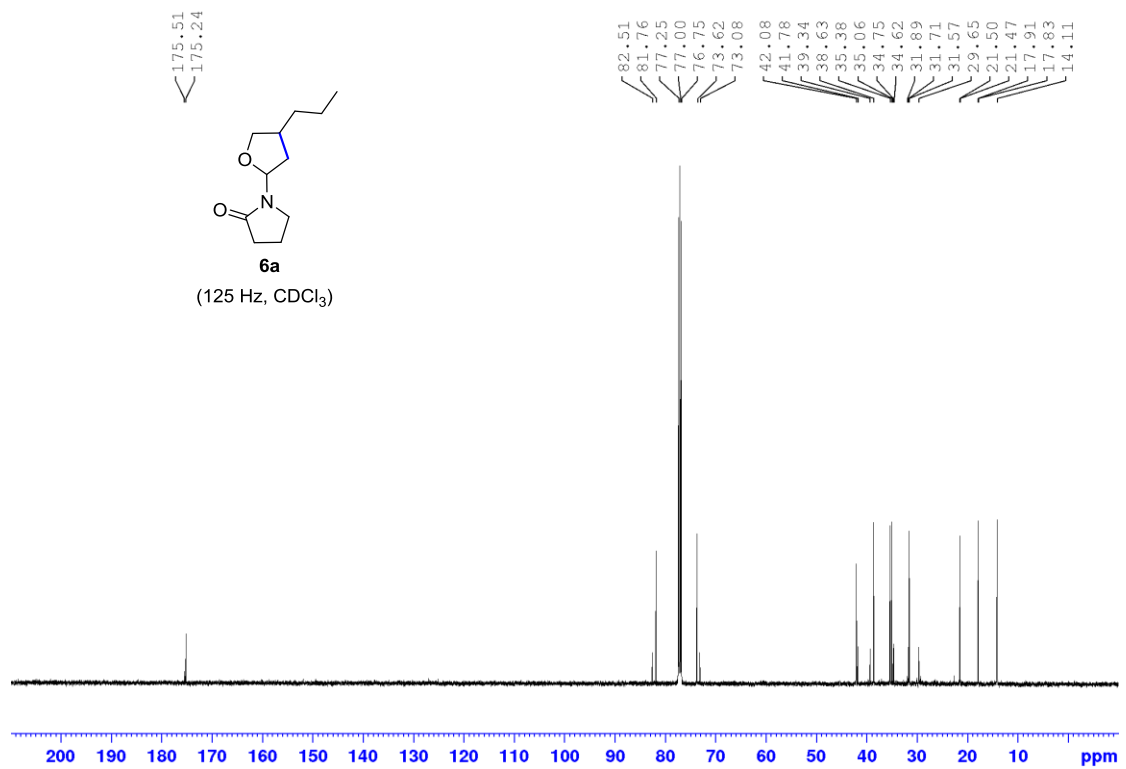
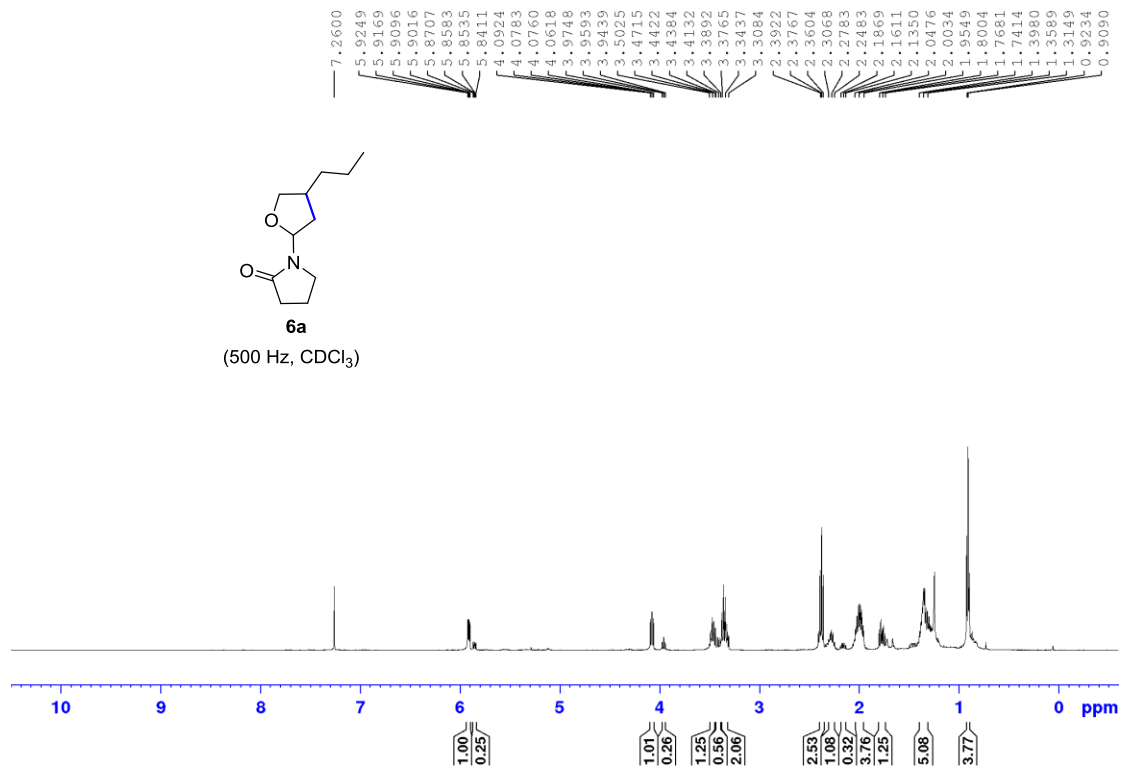




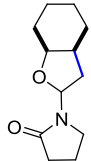






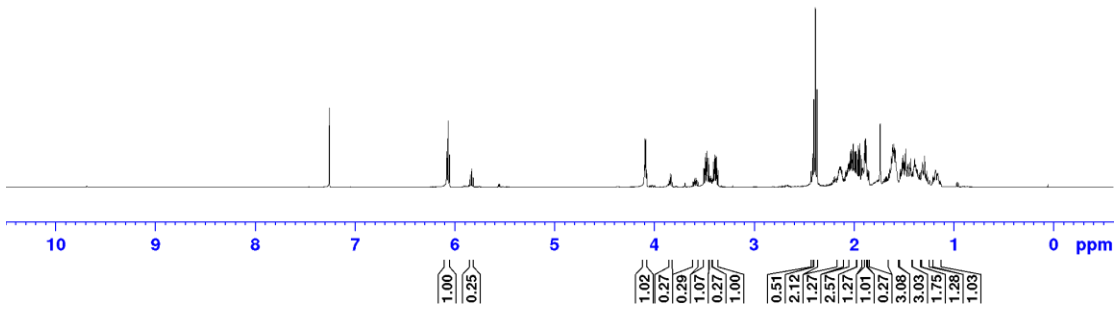


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5.8198
4.1047
4.0976
4.0901
4.0823
3.8556
3.8455
3.8353
3.6168
3.6048
3.5988
3.5867
3.5814
3.5694
3.5089
3.4969
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3.4527
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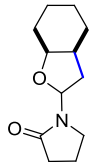


6b

(500 Hz, CDCl₃)

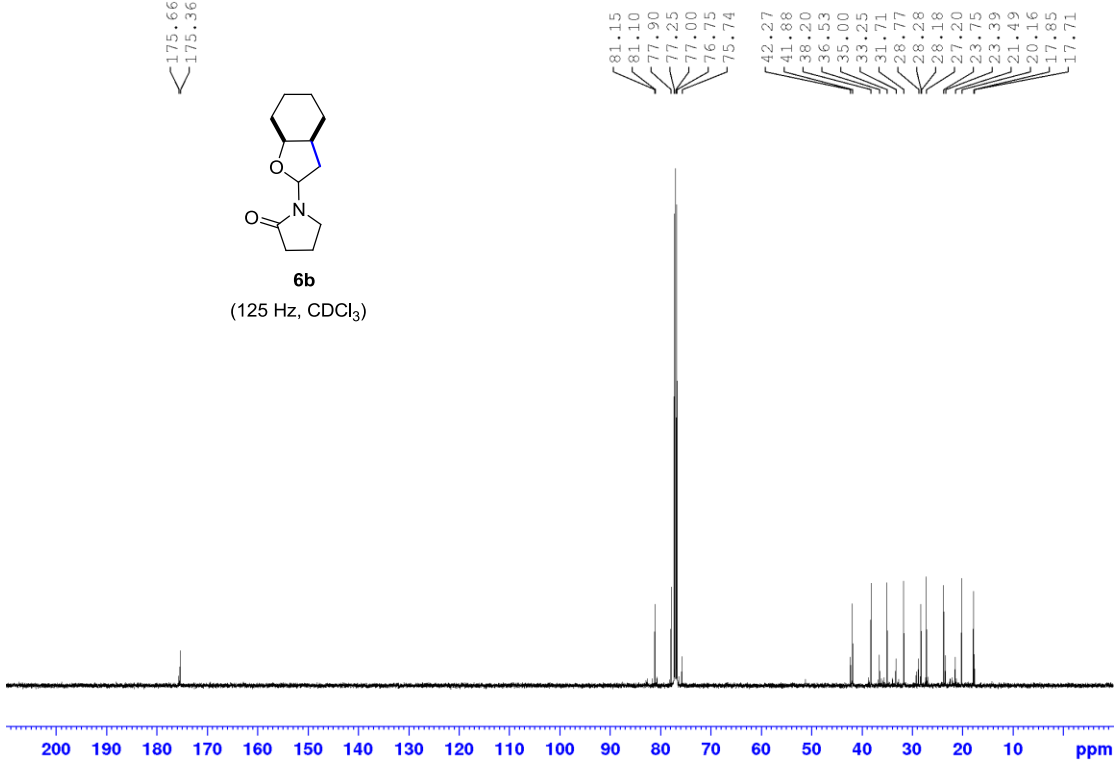


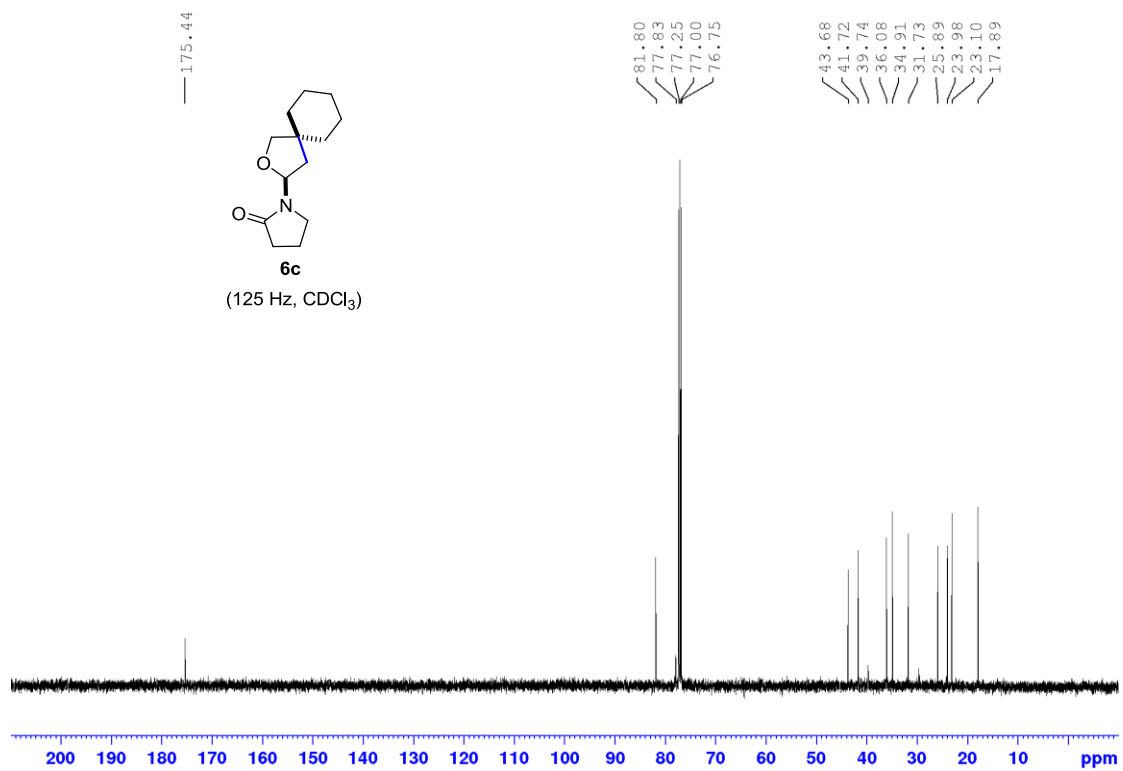
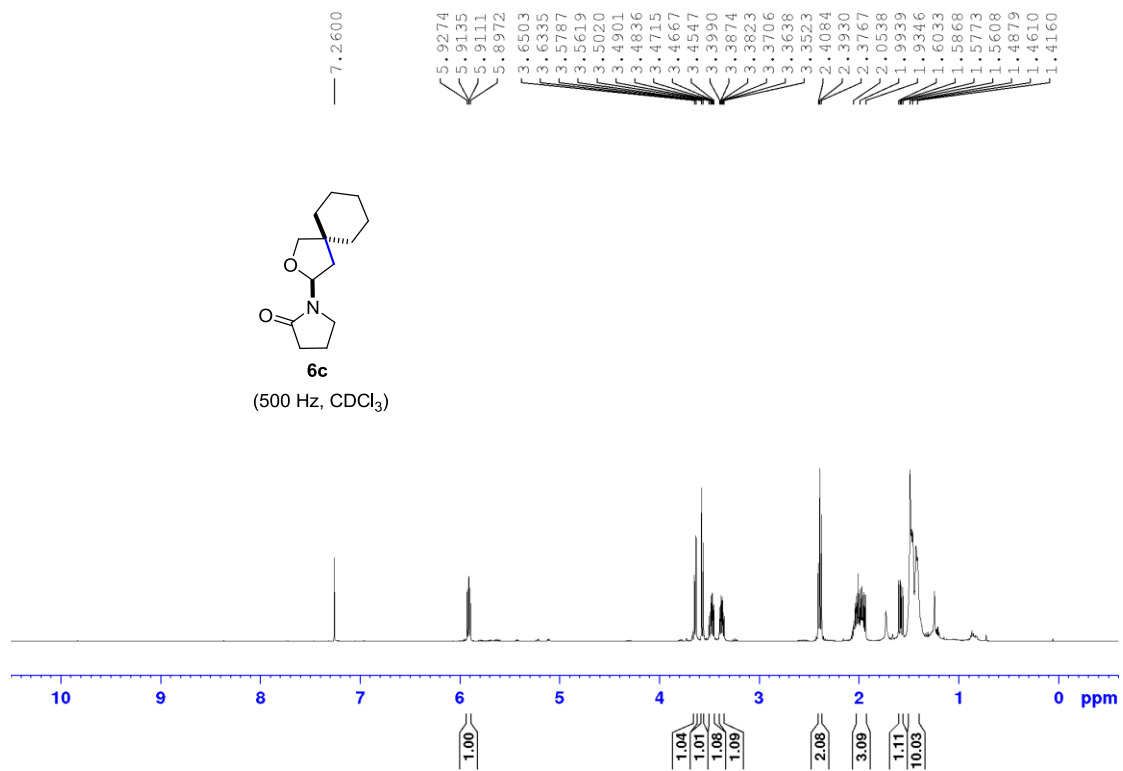
175.66
175.36

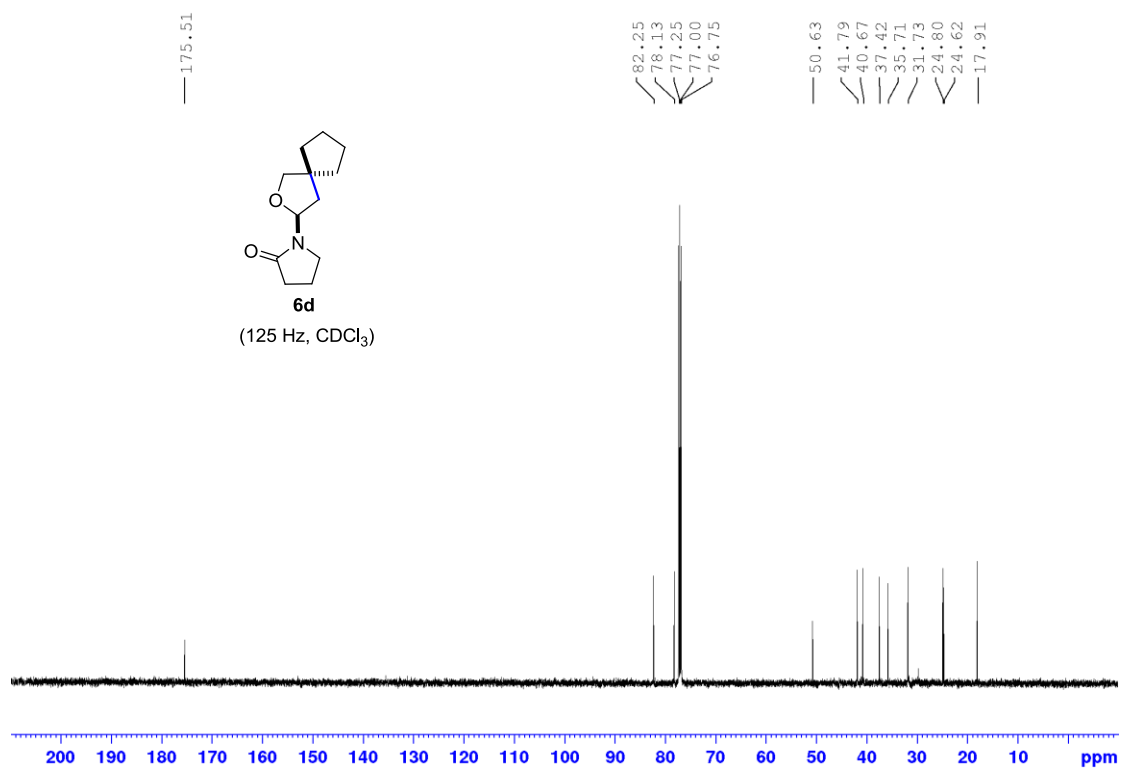
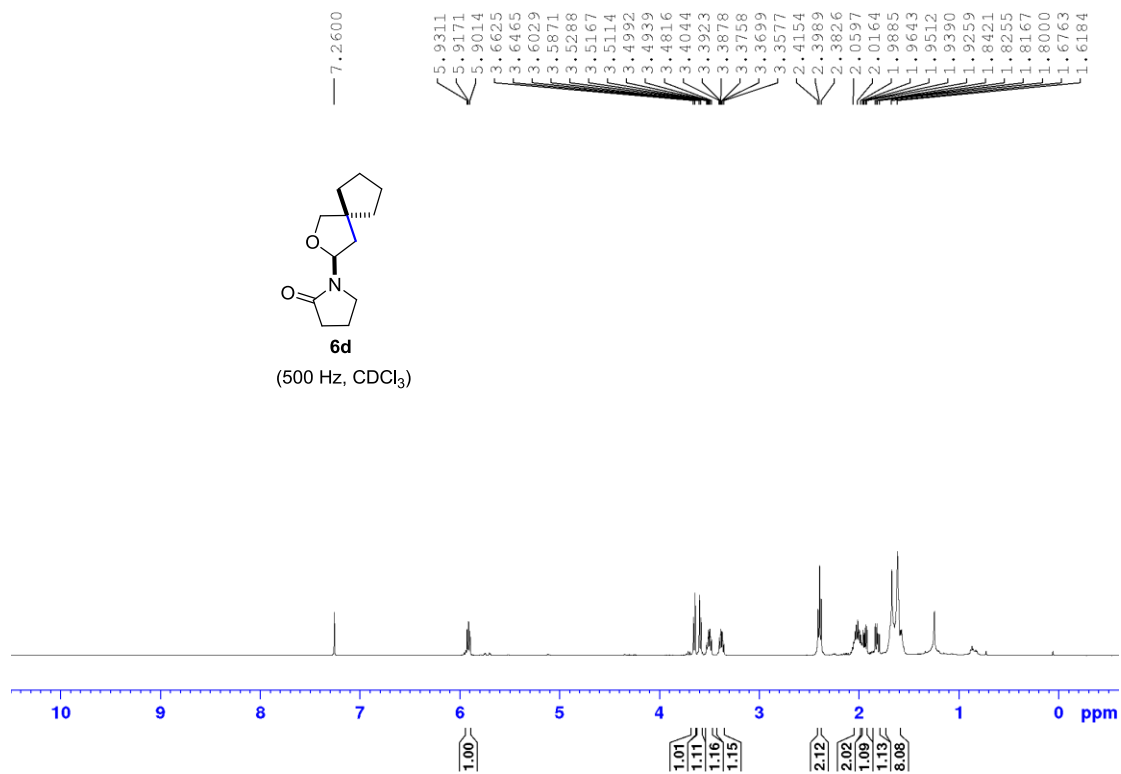


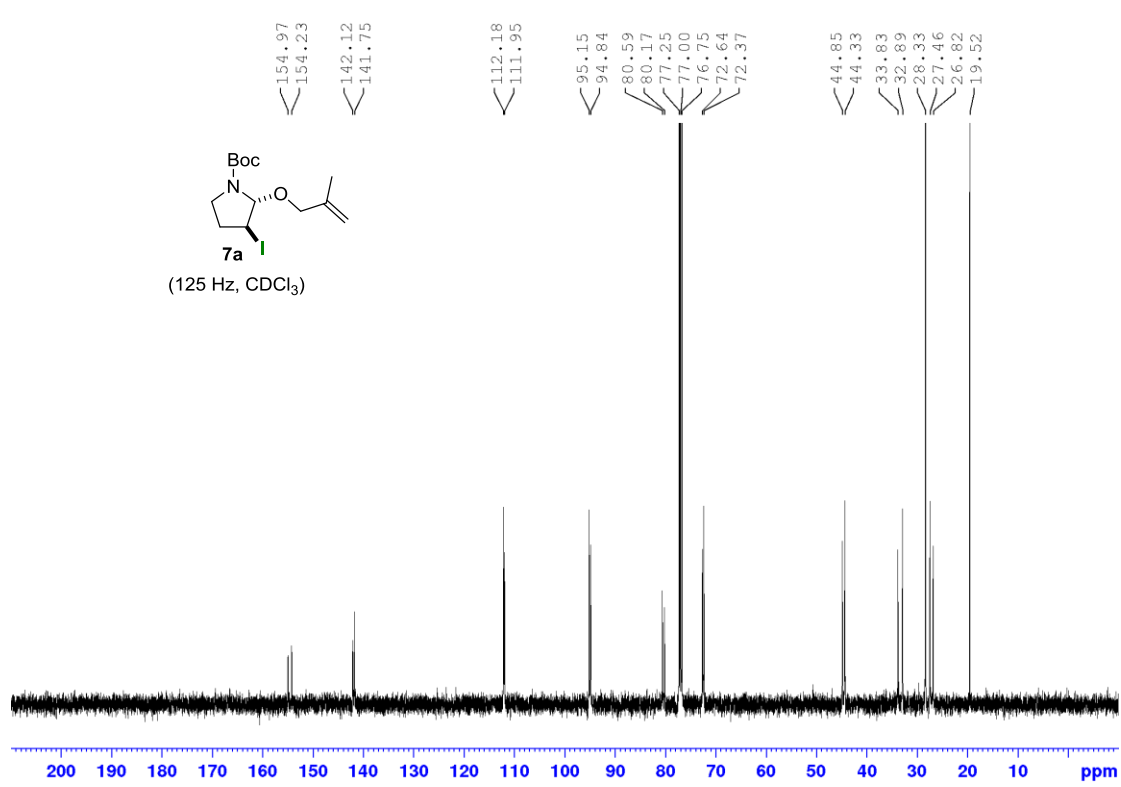
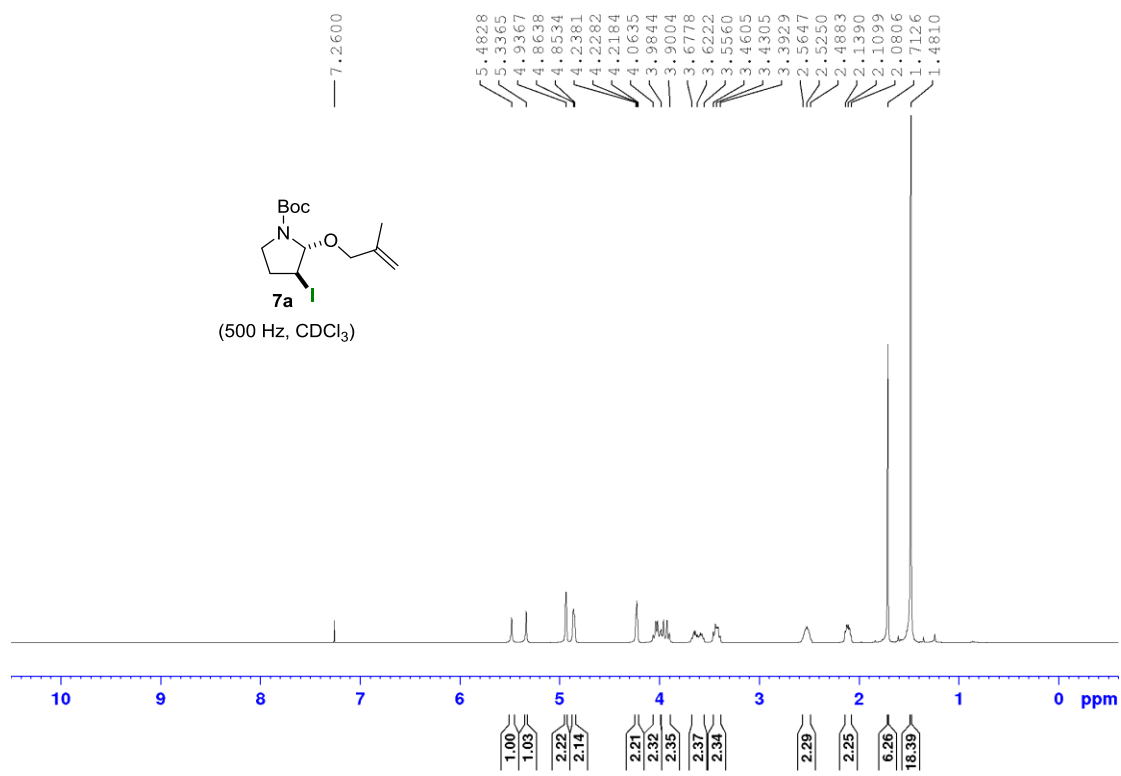
6b

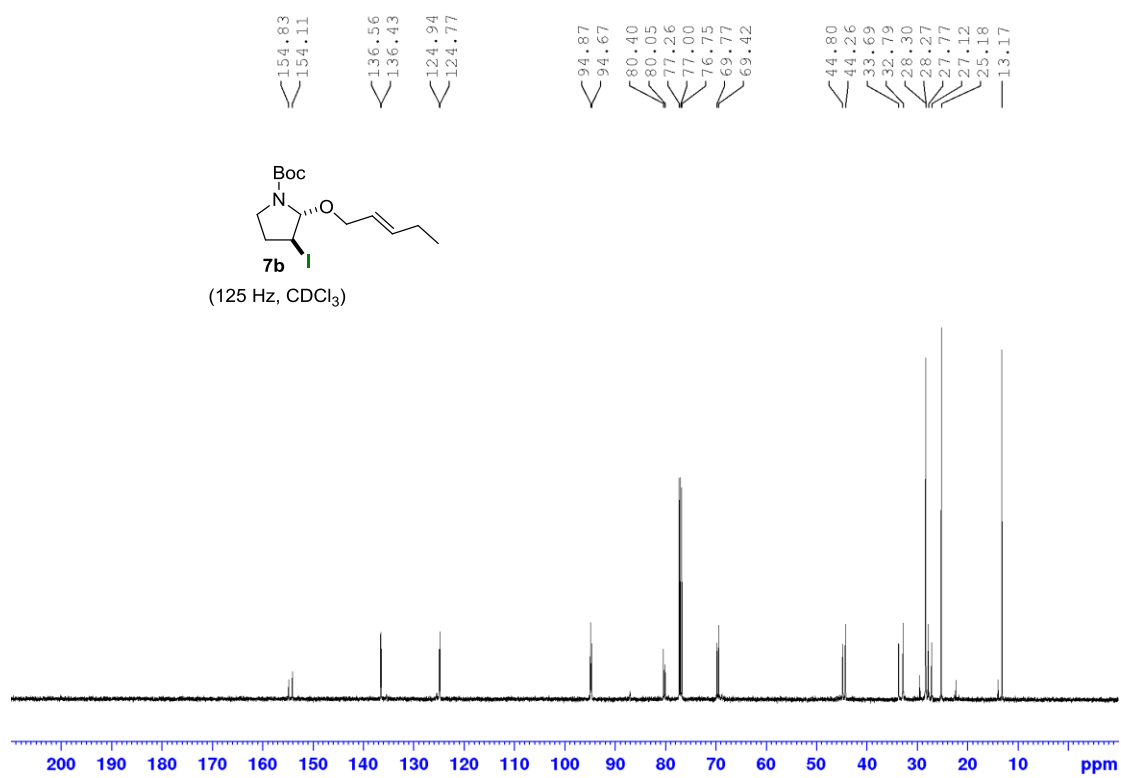
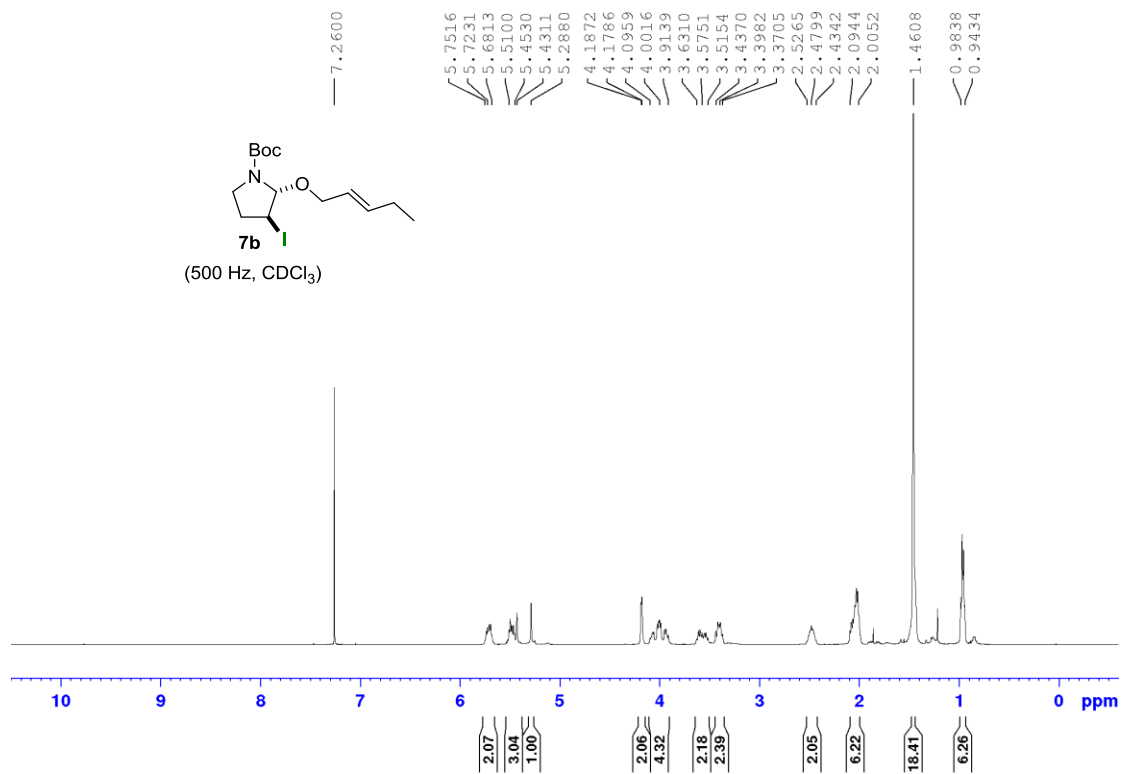
(125 Hz, CDCl₃)

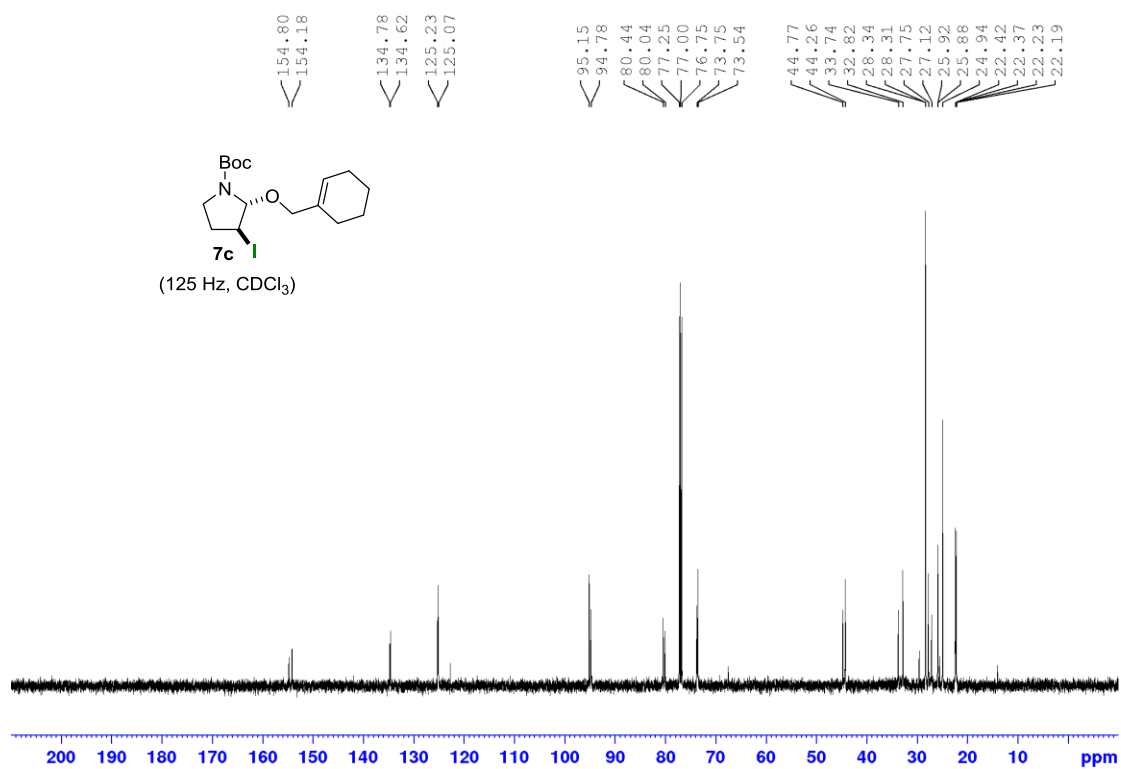
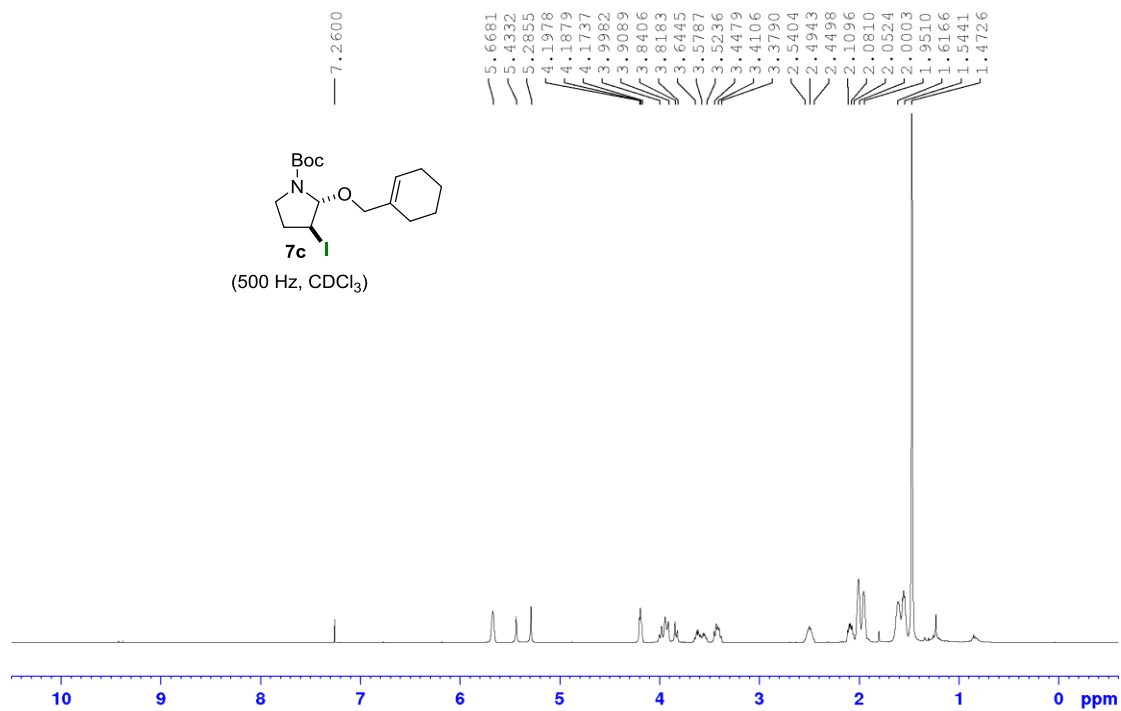


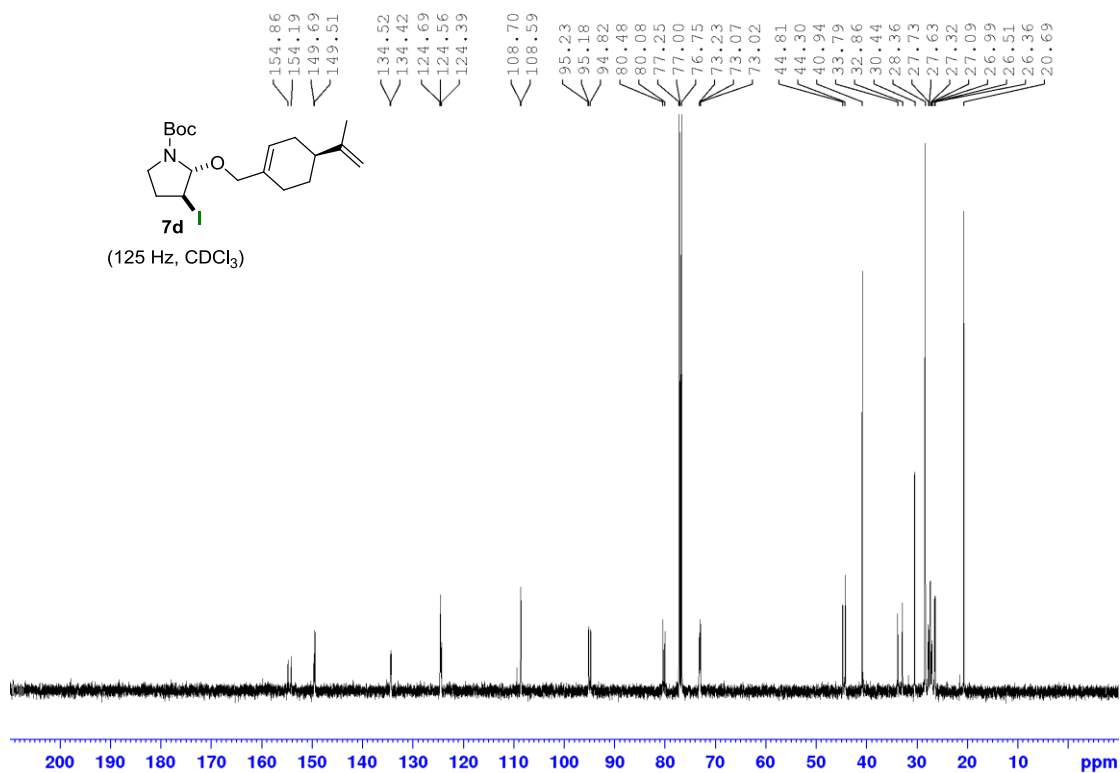
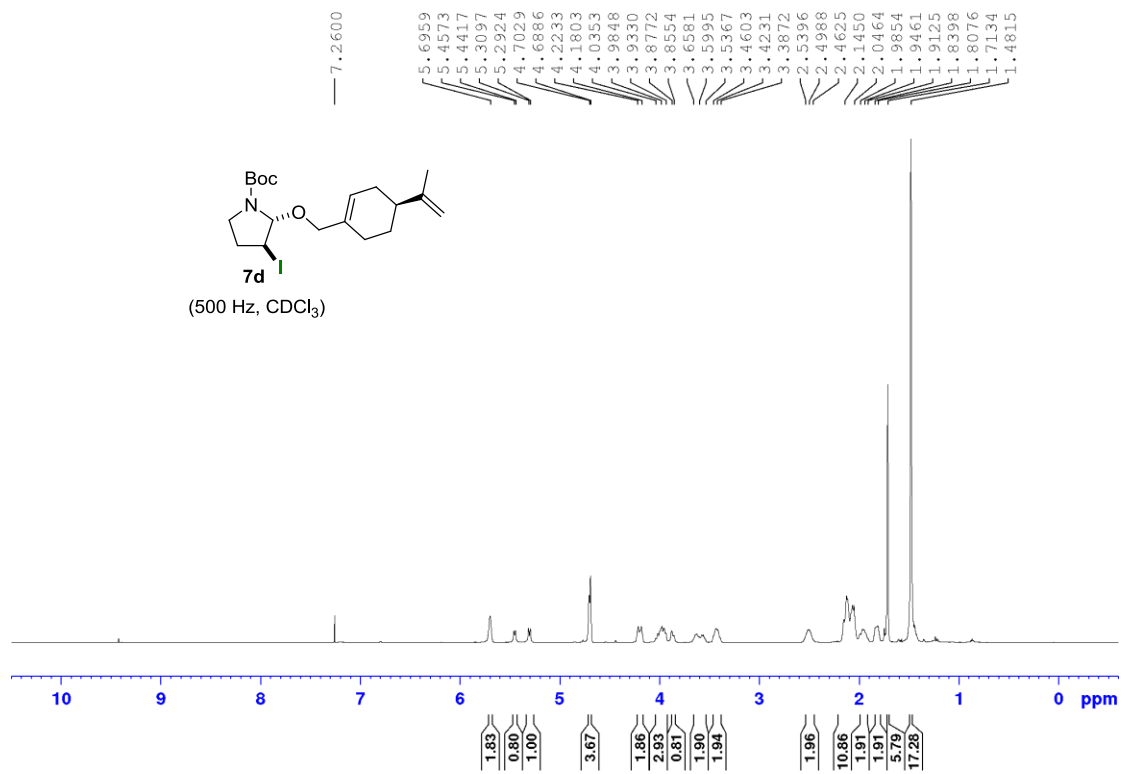


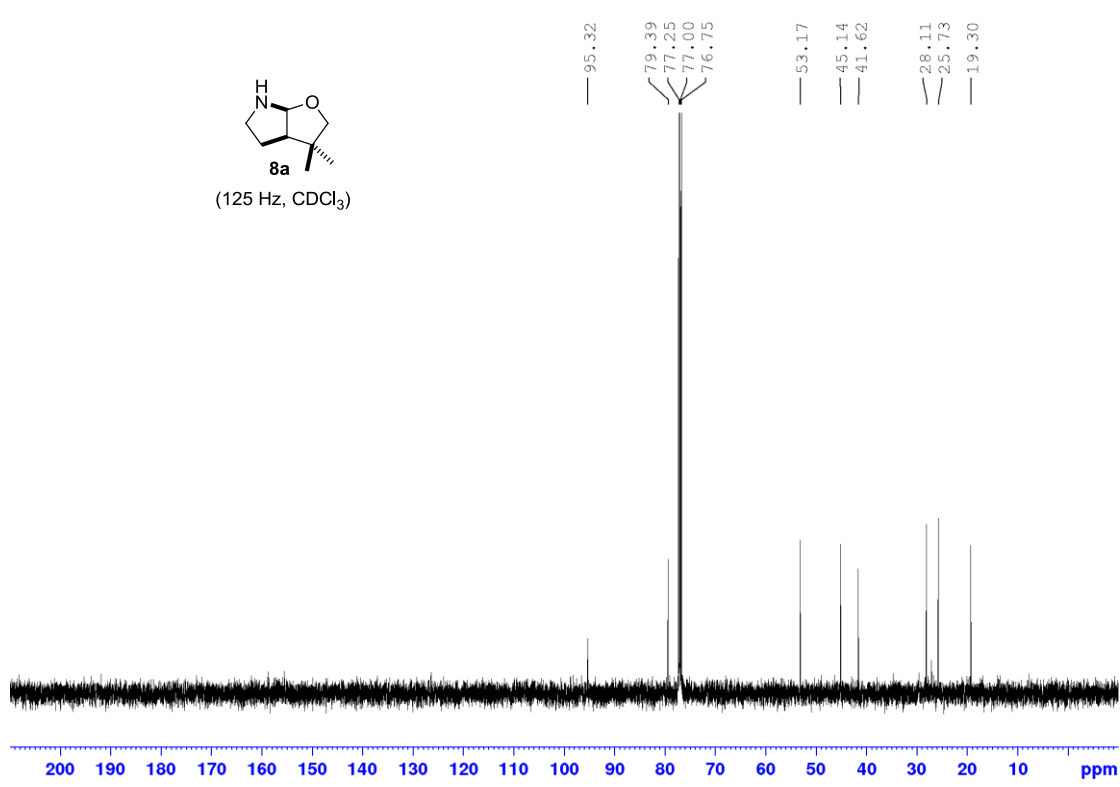
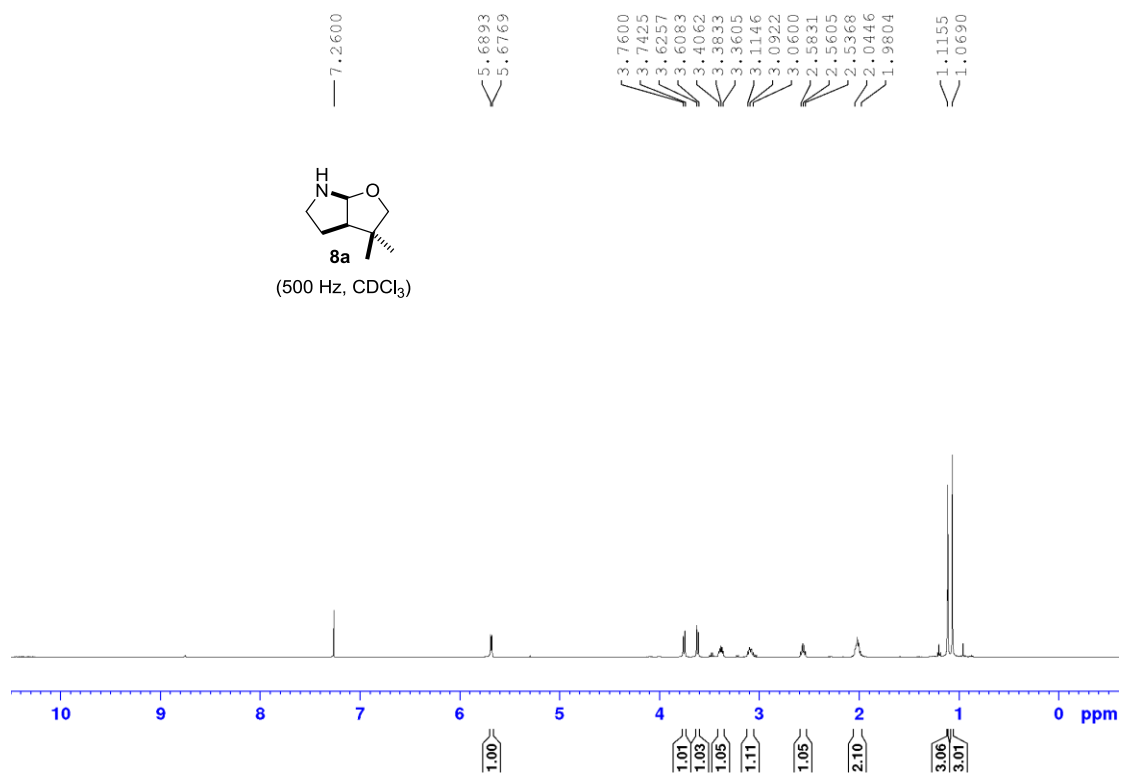


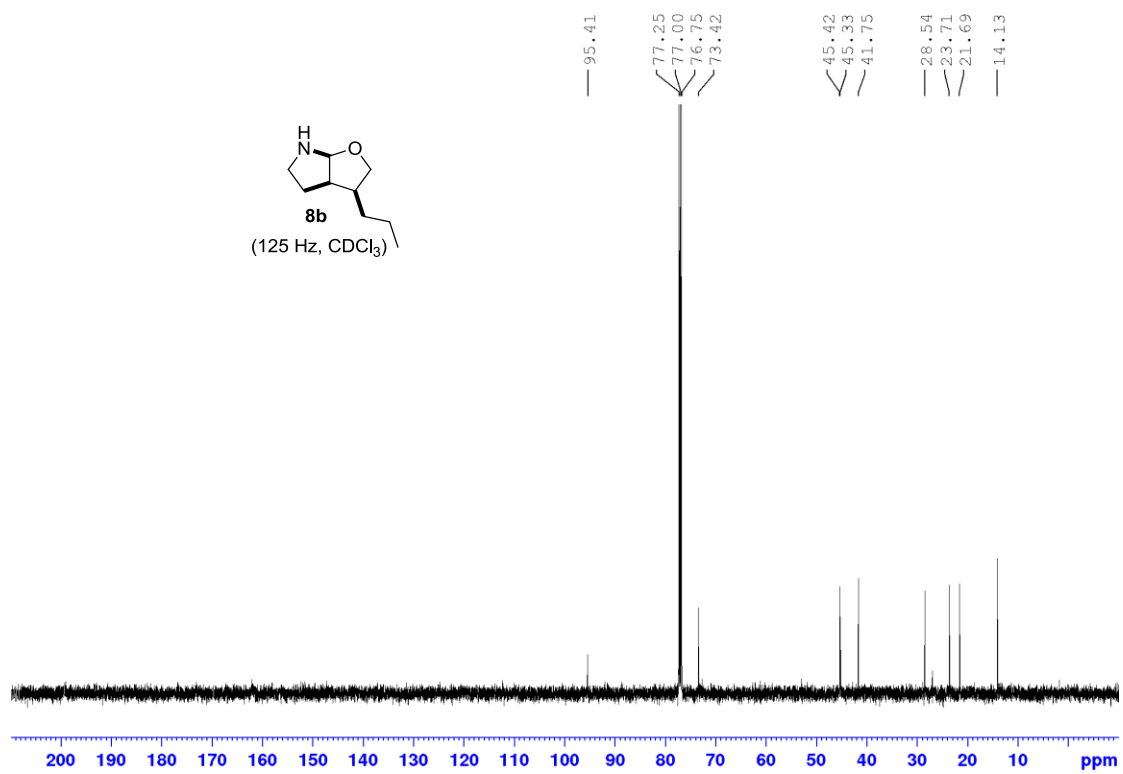
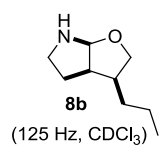
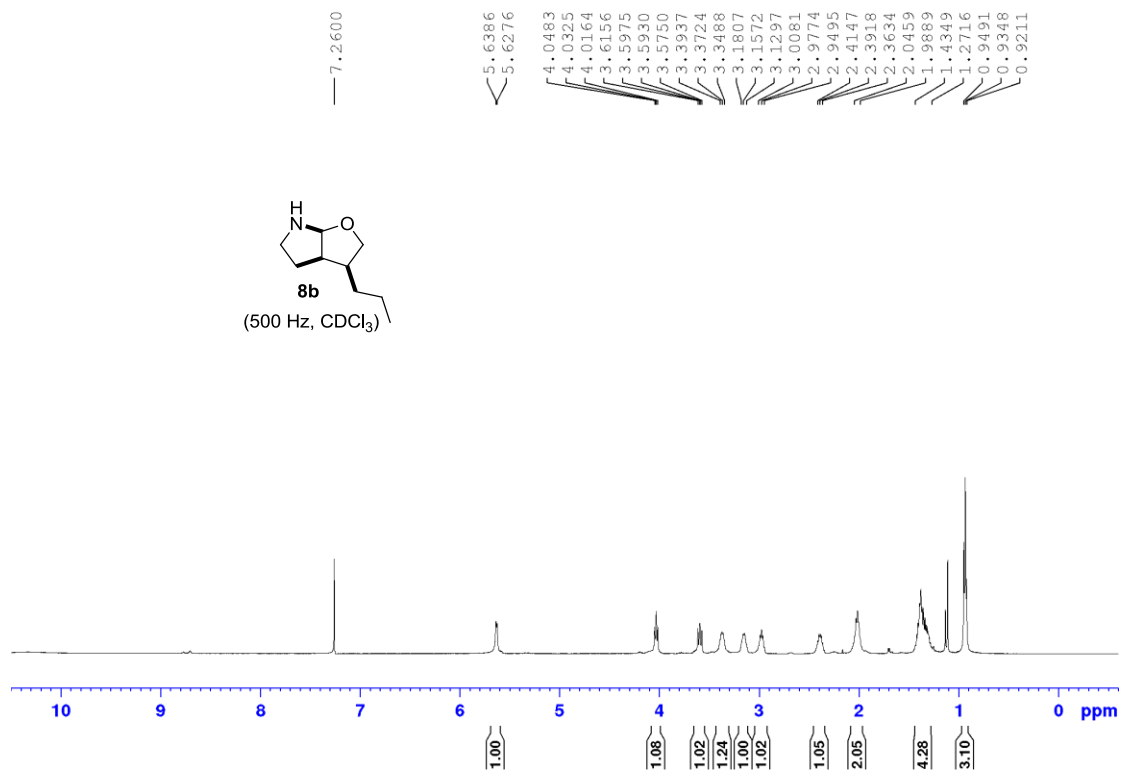
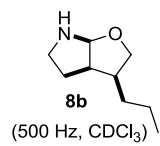




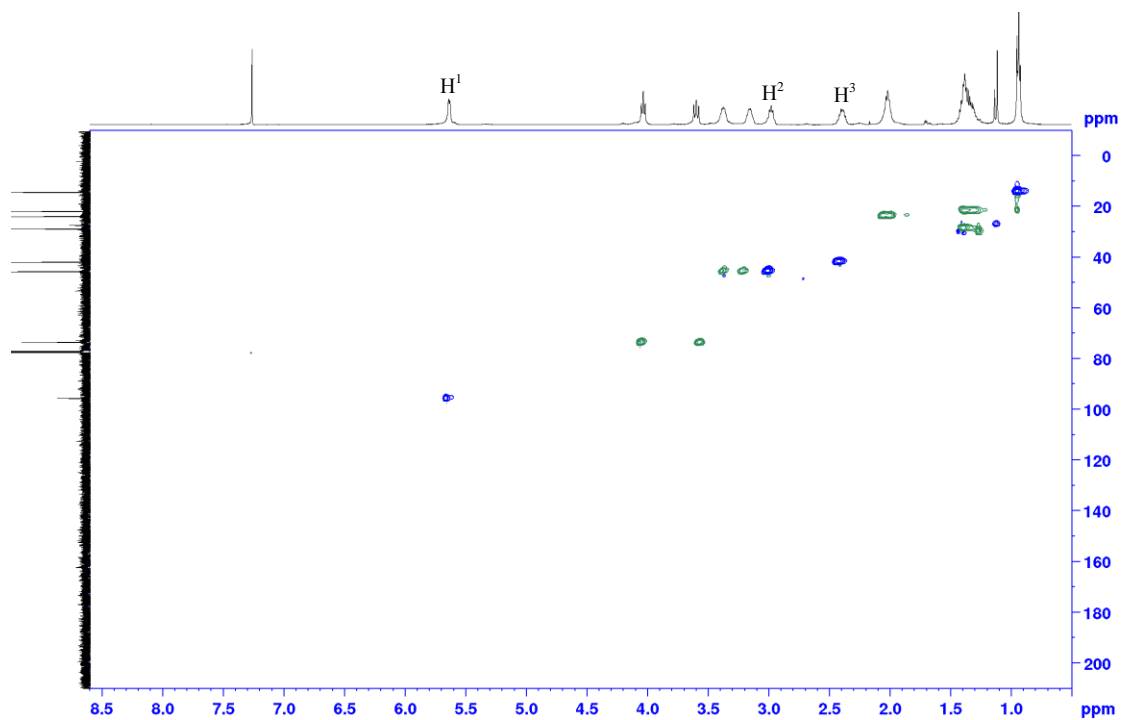
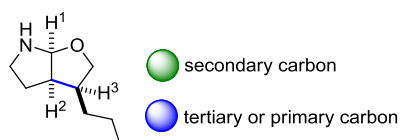








HSQC correlations of compound 8b



Representative NOE of compound 8b

