

Traceless Electrophilic Amination for the Synthesis of Unprotected Cyclic β -Amino Acids

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Table of Contents

1. General information	S2
1-1. Reactions and purifications	S2
1-2. Characterizations	S2
1-3. Solvents and reagents	S2
1-4. List of abbreviation	S2
2. Synthesis of substituted isoxazolidin-5-ones	S3
3. Conditions screening	S29
4. Substrate scope for Rh-catalyzed electrophilic amination reactions	S30
4-1. General procedure for the synthesis of benzo-fused β -amino acids	S30
4-2. General procedure for the synthesis of spirocyclic β -proline derivatives	S37
4-3. Gram-scale synthesis	S39
5. X-Ray structure of 2f	S40
6. Hammett analysis	S41
7. References	S41
8. NMR Spectra	S42

1. General information

1-1. Reactions and purifications

Unless otherwise noted, all reactions were carried out under an air atmosphere and were stirred with Teflon-coated magnetically stirred bars. All work-up and purification procedures were carried out with reagent-grade solvents under ambient atmosphere. Thin layer chromatography (TLC) was performed on Merck TLC plates (0.25 mm) pre-coated with silica gel 60 F254 and visualized by UV quenching and staining with ninhydrin or KMnO₄. Flash column chromatography was performed on a Biotage Isolera Spektra One.

1-2. Characterizations

Infrared (IR) spectra were recorded on a HORIBA FT210 Fourier transform infrared spectrophotometer. NMR spectra were recorded on a Bruker AVANCE III HD400 NMR spectrometers. Chemical shifts (δ) are given in ppm relative to residual solvent peaks.¹ Data for ¹H NMR are reported as follows: chemical shift (multiplicity, coupling constants where applicable, number of hydrogens). Abbreviations are as follows: s (singlet), d (doublet), t (triplet), dd (doublet of doublet), dt (doublet of triplet), ddd (doublet of doublet of doublet), q (quartet), m (multiplet), br (broad). Single-crystal X-ray data were collected on a Rigaku R-Axis RAPID II imaging plate area detector with graphite-monochromated Cu-K α radiation. Melting points were measured on a Yanagimoto Seisakusho Micro Melting Point Apparatus. High-resolution mass spectra (ESI TOF (+)) were measured on a Thermo Fisher Scientific LTQ Orbitrap XL.

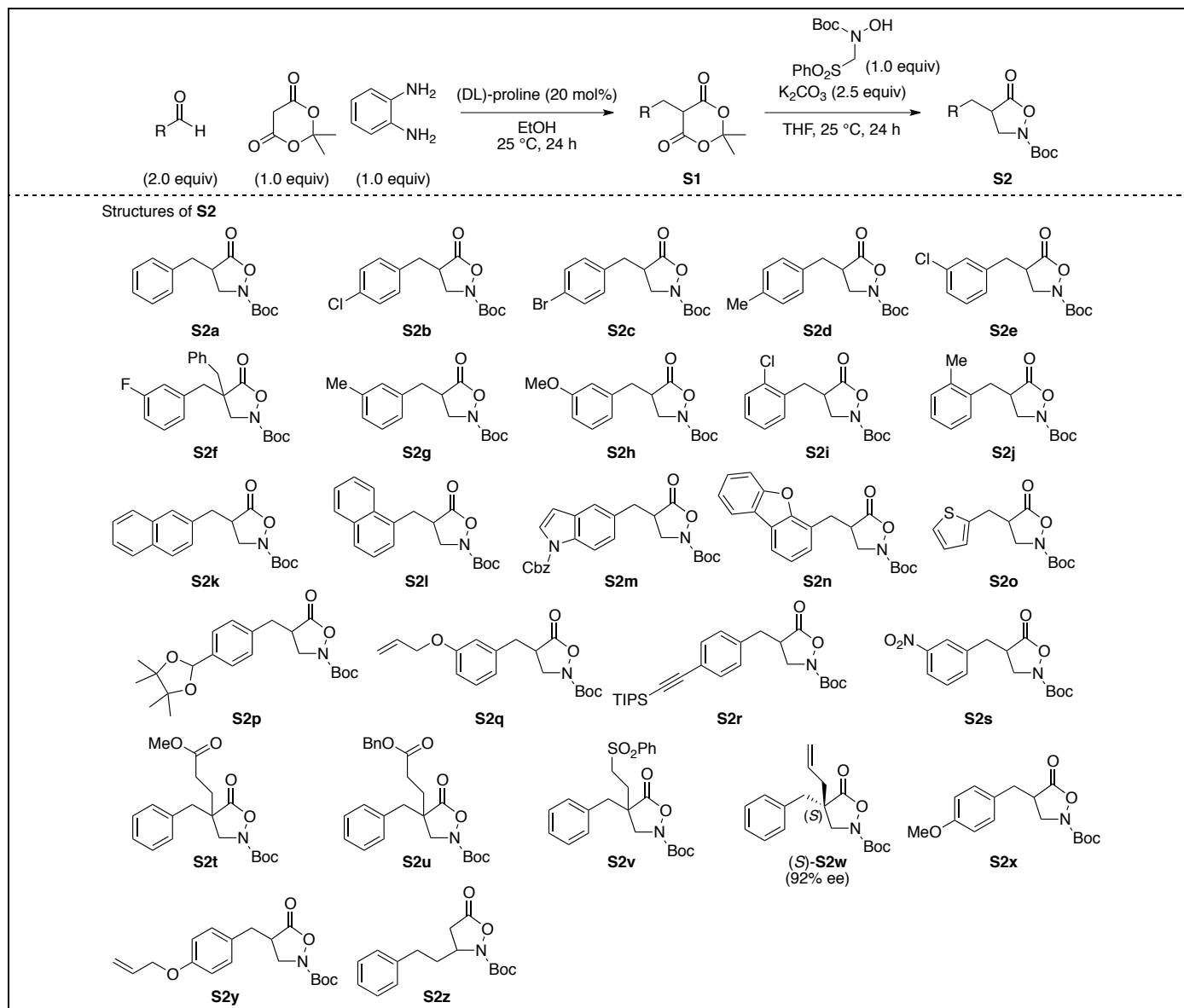
1-3. Solvents and reagents

Unless otherwise noted, materials were purchased from commercial suppliers and were used without further purification. Anhydrous MeOH were purchased from commercial suppliers. THF, CH₂Cl₂, and MeCN were purified by passing through a solvent purification system (Glass Contour). TFE was purchased from TCI Co., Ltd., and used as received. HFIP, Rh₂(esp)₂, and phenol-*d*₅ were purchased from Sigma-Aldrich, and used as received. Benzaldehyde-*d*₅ was purchased from CDI Isotope.

1-4. List of abbreviation

Entry	Chemical name	Abbreviation
1	Bis[rhodium($\alpha,\alpha,\alpha',\alpha'$ -tetramethyl-1,3-benzenedipropionic acid)]	Rh ₂ (esp) ₂
2	Pentamethylcyclopentadienyliridium(III) chloride dimer	[Cp*IrCl ₂] ₂
3	Rhodium(II) acetate dimer	[Rh(OAc) ₂] ₂
4	Pentamethylcyclopentadienylrhodium(III) chloride dimer	[Cp*RhCl ₂] ₂
5	Dichloro(<i>p</i> -cymene)ruthenium(II) dimer	[Ru(<i>p</i> -cymene)Cl ₂] ₂
6	1,1,1,3,3,3-Hexafluoro-2-propanol	HFIP
7	Trifluoroethanol	TFE
8	Trifluoroacetic acid	TFA

2. Synthesis of substituted isoxazolidin-5-ones

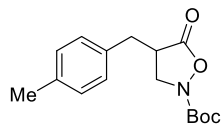


4-Substituted isoxazolidin-5-ones **S2a–c**, **S2e**, **S2i**, **S2k**, **S2w**, and **S2x** are known in the literature.² All compounds were prepared by the general procedure A according to the reported literature.^{2b} 5-Substituted isoxazolidin-5-one **S2z** was also known.³

General procedure A: To a solution of *ortho*-phenylenediamine (1.0 equiv) in EtOH (0.05 M) at 25 °C were added aldehyde (2.0 equiv), Meldrum's acid (1.0 equiv), and (DL)-proline (20 mol%). The resulting solution was vigorously stirred for 24 h and evaporated under reduced pressure to give the residue, which was dissolved in CH₂Cl₂, washed with 1M aq HCl. The resulting mixture was filtered through a pad of Celite and washed with CH₂Cl₂, and the filtrates were extracted with CH₂Cl₂ (3x). The combined organic layers were washed with water, dried over Na₂SO₄, filtered and concentrated in vacuo to afford crude **S1**, which was used directly in the next step without further purification.

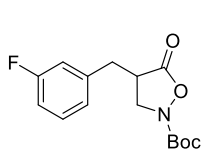
To a solution of crude **S1** in THF (0.1 M) were added *tert*-butyl hydroxy((phenylsulfonyl)methyl)carbamate (1.0 equiv) and K_2CO_3 (2.5 equiv) at 25 °C. After being stirred at 25 °C for 24 h, the mixture was filtered through a pad of Celite and washed with EtOAc, and the filtrates were evaporated under reduced pressure to give the crude residue, which was purified by silica gel column chromatography, eluting with hexane/EtOAc to afford **S2**.

tert-Butyl 4-(4-methylbenzyl)-5-oxoisoxazolidine-2-carboxylate (S2d): Prepared by the general procedure A from



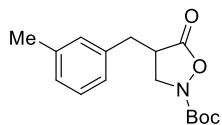
4-methylbenzaldehyde (2.4 g, 20.0 mmol), and isolated as a white solid (76% yield for 2 steps). **m.p.** 63–65 °C; **IR** (thin film): ν 2981, 1800, 1747, 1513, 1370, 1143, 850 cm^{-1} ; **1H NMR** (400 MHz, $CDCl_3$): δ 7.14 (d, J = 8.0 Hz, 2H), 7.07 (d, J = 8.0 Hz, 2H), 4.13 (dd, J = 11.2, 8.4 Hz, 1H), 3.71 (dd, J = 11.2, 9.2 Hz, 1H), 3.23–3.11 (m, 2H), 2.76 (dd, J = 14.0, 9.6 Hz, 1H), 2.33 (s, 3H), 1.51 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.3, 155.9, 136.9, 133.8, 129.6, 128.6, 84.1, 52.9, 42.3, 34.0, 28.0, 21.0; **HRMS** (ESI): m/z calc'd for $C_{16}H_{21}O_4NNa$ [$M + Na$] $^+$: 314.1363, found: 314.1354.

tert-Butyl 4-(3-fluorobenzyl)-5-oxoisoxazolidine-2-carboxylate (S2f): Prepared by the general procedure A from



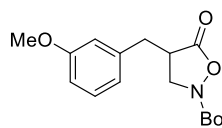
3-fluorobenzaldehyde (0.98 g, 7.9 mmol), and isolated as a white solid (81% yield for 2 steps). **m.p.** 68–70 °C; **IR** (thin film): ν 2981, 1799, 1717, 1589, 1371, 1144, 783 cm^{-1} ; **1H NMR** (400 MHz, $CDCl_3$): δ 7.33–7.27 (m, 1H), 6.99–6.89 (m, 3H), 4.16 (dd, J = 10.8, 8.4 Hz, 1H), 3.68 (dd, J = 11.2, 9.2 Hz, 1H), 3.26–3.16 (m, 2H), 2.81 (dd, J = 14.0, 9.6 Hz, 1H), 1.51 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 173.9, 163.0 (d, J = 245.6 Hz, 1C), 155.8, 139.3 (d, J = 7.2 Hz, 1C), 130.5 (d, J = 8.3 Hz, 1C), 124.4 (d, J = 2.8 Hz, 1C), 115.6 (d, J = 21.3 Hz, 1C), 114.3 (d, J = 20.9 Hz, 1C), 84.3, 52.8, 41.9, 34.1, 28.0; **^{19}F NMR** (376 MHz, $CDCl_3$): δ 112.2 (s, 1F); **HRMS** (ESI): m/z calc'd for $C_{15}H_{18}O_4NFNa$ [$M + Na$] $^+$: 318.1112, found: 318.1105.

tert-Butyl 4-(3-methylbenzyl)-5-oxoisoxazolidine-2-carboxylate (S2g): Prepared by the general procedure A from



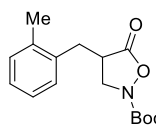
3-methylbenzaldehyde (2.4 g, 20.0 mmol), and isolated as a white solid (55% yield for 2 steps). **m.p.** 55–57 °C; **IR** (thin film): ν 2979, 1800, 1718, 1462, 1370, 1144, 779 cm^{-1} ; **1H NMR** (400 MHz, $CDCl_3$): δ 7.22 (t, J = 7.2 Hz, 1H), 7.08 (d, J = 7.2 Hz, 1H), 7.00–6.98 (m, 2H), 4.14 (dd, J = 10.8, 8.4 Hz, 1H), 3.71 (dd, J = 11.2, 9.2 Hz, 1H), 3.24–3.16 (m, 2H), 2.75 (dd, J = 13.6, 9.6 Hz, 1H), 2.34 (s, 3H), 1.51 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.2, 155.9, 138.6, 136.8, 129.4, 128.8, 127.9, 125.6, 84.1, 52.9, 42.2, 34.4, 28.0, 21.3; **HRMS** (ESI): m/z calc'd for $C_{16}H_{21}O_4NNa$ [$M + Na$] $^+$: 314.1363, found: 314.1356.

tert-Butyl 4-(3-methylbenzyl)-5-oxoisoxazolidine-2-carboxylate (S2h): Prepared by the general procedure A from



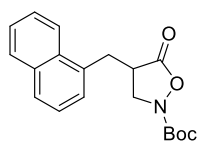
m-anisaldehyde (2.72 g, 20.0 mmol), and isolated as a light-yellow oil (91% yield for 2 steps). **IR** (thin film): ν 2980, 1799, 1717, 1601, 1340, 1260, 1144, 779 cm^{-1} ; **1H NMR** (400 MHz, $CDCl_3$): δ 7.25 (t, J = 8.0 Hz, 1H), 6.82–6.72 (m, 3H), 4.15 (dd, J = 10.8, 8.4 Hz, 1H), 3.80 (s, 3H), 3.71 (dd, J = 10.8, 9.2 Hz, 1H), 3.25–3.13 (m, 2H), 2.76 (dd, J = 14.0, 9.6 Hz, 1H), 1.51 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.2, 160.0, 155.9, 138.4, 130.0, 120.9, 114.5, 112.4, 84.2, 55.2, 52.9, 42.1, 34.5, 28.0; **HRMS** (ESI): m/z calc'd for $C_{16}H_{21}O_5NNa$ [$M + Na$] $^+$: 330.1312, found: 330.1309.

tert-Butyl 4-(2-methylbenzyl)-5-oxoisoxazolidine-2-carboxylate (S2j): Prepared by the general procedure A from



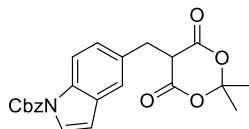
2-methylbenzaldehyde (2.4 g, 20.0 mmol), and isolated as a white solid (62% yield for 2 steps). **m.p.** 68–70 °C; **IR** (thin film): ν 2979, 1800, 1724, 1459, 1343, 1144, 847, 755 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.20–7.10 (m, 4H), 4.15 (dd, $J = 11.2, 8.4$ Hz, 1H), 3.72 (dd, $J = 11.2, 9.2$ Hz, 1H), 3.32 (dd, $J = 14.4, 4.4$ Hz, 1H), 3.19–3.12 (m, 1H), 2.76 (dd, $J = 14.4, 10.4$ Hz, 1H), 2.34 (s, 3H), 1.52 (s, 9H); **^{13}C NMR** (100 MHz, CDCl_3): δ 174.3, 155.9, 136.1, 135.3, 130.8, 129.0, 127.4, 126.5, 84.2, 53.2, 40.9, 31.9, 28.0, 19.3; **HRMS** (ESI): m/z calc'd for $\text{C}_{16}\text{H}_{21}\text{O}_4\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 314.1363, found: 314.1357.

tert-Butyl 4-(naphthalen-1-ylmethyl)-5-oxoisoxazolidine-2-carboxylate (S2l): Prepared by the general procedure



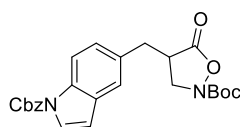
A from 1-naphthaldehyde (1.87 g, 12.0 mmol), and isolated as a white solid (86% yield for 2 steps). **m.p.** 92–94 °C; **IR** (thin film): ν 2981, 1798, 1716, 1370, 1143, 777 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 8.00 (d, $J = 8.0$ Hz, 1H), 7.91–7.89 (m, 1H), 7.81 (d, $J = 8.4$ Hz, 1H), 7.60–7.51 (m, 2H), 7.45–7.41 (m, 1H), 7.34 (d, $J = 6.0$ Hz, 1H), 4.04 (dd, $J = 11.2, 8.0$ Hz, 1H), 3.89 (dd, $J = 14.4, 4.0$ Hz, 1H), 3.77 (dd, $J = 11.2, 8.8$ Hz, 1H), 3.39–3.31 (m, 1H), 3.07 (dd, $J = 14.4, 10.8$ Hz, 1H), 1.51 (s, 9H); **^{13}C NMR** (100 MHz, CDCl_3): δ 174.4, 155.9, 134.0, 132.9, 131.2, 129.2, 128.2, 126.9, 126.7, 126.1, 125.5, 122.8, 84.2, 53.4, 41.4, 32.0, 28.0; **HRMS** (ESI): m/z calc'd for $\text{C}_{19}\text{H}_{21}\text{O}_4\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 350.1363, found: 350.1355.

Benzyl 5-((2,2-dimethyl-4,6-dioxo-1,3-dioxan-5-yl)methyl)-1H-indole-1-carboxylate (S1m): Prepared by the



general procedure A from benzyl 5-formyl-1H-indole-1-carboxylate (2.00 g, 7.3 mmol), and isolated as a white solid (83% yield). **m.p.** 106–107 °C; **IR** (thin film): ν 3003, 2946, 1784, 1745, 1471, 1395, 1347, 1296, 1256, 1218, 1132, 1085, 1028, 951, 760, 732, 698 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): 8.07 (d, $J = 7.6$ Hz, 1H), 7.61 (d, $J = 3.6$ Hz, 1H), 7.53 (d, $J = 1.2$ Hz, 1H), 7.50–7.46 (m, 2H), 7.44–7.36 (m, 3H), 7.27 (dd, $J = 8.4, 1.6$ Hz, 1H), 6.55 (dd, $J = 3.6, 0.4$ Hz, 1H), 5.44 (s, 2H), 3.79 (t, $J = 4.8$ Hz, 1H), 3.58 (d, $J = 4.8$ Hz, 2H), 1.71 (s, 3H), 1.44 (s, 3H); **^{13}C NMR** (100 MHz, CDCl_3): δ 165.6, 150.9, 135.2, 134.5, 132.0, 130.9, 128.9, 128.8, 128.6, 126.5, 126.1, 122.4, 115.4, 108.3, 105.3, 68.9, 48.6, 32.3, 28.6, 27.4; **HRMS** (ESI): m/z calc'd for $\text{C}_{23}\text{H}_{21}\text{O}_6\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 430.1261, found: 430.1262.

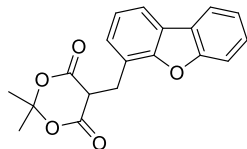
tert-Butyl 4-((1-((benzyloxy)carbonyl)-1H-indol-5-yl)methyl)-5-oxoisoxazolidine-2-carboxylate (S2m): Prepared



by the general procedure A from benzyl 5-((2,2-dimethyl-4,6-dioxo-1,3-dioxan-5-yl)methyl)-1H-indole-1-carboxylate **S1m** (1.23 g, 3.0 mmol), and isolated as a colorless oil (89% yield); **IR** (thin film): ν 2979, 2932, 1799, 1737, 1471, 1396, 1348, 1332, 1255, 1218, 1139, 1086, 1035, 761, 698 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 8.13 (d, $J = 7.6$ Hz, 1H), 7.64 (d, $J = 3.6$ Hz, 1H), 7.50–7.47 (m, 2H), 7.44–7.38 (m, 4H), 7.13 (dd, $J = 8.4, 1.6$ Hz, 1H), 6.56 (d, $J = 3.6$ Hz, 1H), 5.46 (s, 2H), 4.12 (dd, $J = 11.2, 8.4$ Hz, 1H), 3.73 (dd, $J = 11.2, 9.2$ Hz, 1H), 3.33 (dd, $J = 14.0, 4.4$ Hz, 1H), 3.24–3.16 (m, 1H), 2.90 (dd, $J = 14.0, 9.6$ Hz, 1H), 1.49 (s, 9H); **^{13}C NMR** (100 MHz, CDCl_3): δ 174.4, 156.1, 135.1,

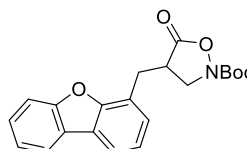
131.7, 131.2, 128.9, 128.6, 126.4, 125.3, 121.2, 115.8, 108.1, 84.3, 69.0, 53.0, 42.7, 34.5, 28.2; **HRMS** (ESI): m/z calc'd for $C_{25}H_{26}O_6N_2Na$ $[M + Na]^+$: 473.1683, found: 473.1688.

5-(Dibenzo[*b,d*]furan-4-ylmethyl)-2,2-dimethyl-1,3-dioxane-4,6-dione (S1n): Prepared by the general procedure A



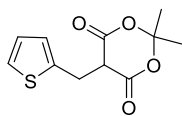
from dibenzofuran-4-carboxaldehyde (1.23 g, 6.3 mmol), and isolated as a white solid (81% yield). **m.p.** 151-152 °C; **IR** (thin film): ν 2884, 1786, 1748, 1450, 1385, 1301, 1184, 1072, 1019, 946, 755 cm^{-1} ; **1H NMR** (400 MHz, $CDCl_3$): δ 7.94 (dd, $J = 7.6, 0.4$ Hz, 1H), 7.87 (dd, $J = 7.6, 0.8$ Hz, 1H), 7.58 (d, $J = 8.4$ Hz, 1H), 7.49-7.44 (m, 2H), 7.35 (dt, $J = 7.6, 0.8$ Hz, 1H), 7.31 (t, $J = 7.6$ Hz, 1H), 4.27 (t, $J = 5.6$ Hz, 1H), 3.78 (d, $J = 6$ Hz, 1H), 1.81 (s, 3H), 1.74 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 165.2, 156.1, 154.3, 128.8, 127.3, 124.5, 124.3, 123.2, 123.0, 121.8, 120.9, 119.6, 111.9, 105.3, 46.6, 28.8, 26.9, 26.7; **HRMS** (ESI): m/z calc'd for $C_{19}H_{16}O_5Na$ $[M + Na]^+$: 347.0890, found: 347.0901.

tert-butyl 4-(dibenzo[*b,d*]furan-4-ylmethyl)-5-oxoisoxazolidine-2-carboxylate (S2n): Prepared by the general



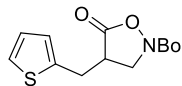
procedure A from 5-(dibenzo[*b,d*]furan-4-ylmethyl)-2,2-dimethyl-1,3-dioxane-4,6-dione **S1n** (0.57 g, 1.8 mmol), and isolated as a colorless oil (72% yield); **IR** (thin film): ν 2980, 2930, 1799, 1747, 1716, 1451, 1370, 1325, 1187, 1142, 846, 755 cm^{-1} ; **1H NMR** (400 MHz, $CDCl_3$): δ 7.96 (ddd, $J = 7.6, 0.8, 0.8$ Hz, 1H), 7.89 (dd, $J = 6.8, 2.0$ Hz, 1H), 7.59 (d, $J = 8.4$ Hz, 1H), 7.49 (dt, $J = 7.2, 1.2$ Hz, 1H), 7.37 (dt, $J = 7.6, 1.2$ Hz, 1H), 7.34-7.28 (m, 2H), 4.17 (dd, $J = 10.8, 8.4$ Hz, 1H), 3.80 (dd, $J = 11.2, 9.6$ Hz, 1H), 3.66 (dd, $J = 14.4, 4.8$ Hz, 1H), 3.55-3.47 (m, 1H), 3.13 (dd, $J = 14.0, 10$ Hz, 1H), 1.50 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.4, 156.2, 156.1, 154.6, 127.9, 127.6, 124.6, 124.4, 123.4, 123.2, 121.1, 121.0, 120.1, 112.0, 84.3, 53.5, 41.1, 29.3, 28.2; **HRMS** (ESI): m/z calc'd for $C_{21}H_{21}O_5NNa$ $[M + Na]^+$: 390.1312, found: 390.1313.

2,2-Dimethyl-5-(thiophen-2-ylmethyl)-1,3-dioxane-4,6-dione (S1o): Prepared by the general procedure A from



2-thiophenecarboxaldehyde (3 g, 27.0 mmol), and isolated as a red oil (99% yield); **IR** (thin film): ν 3000, 2943, 2876, 1779, 1746, 1295, 1203, 1073, 1011, 939, 705 cm^{-1} ; **1H NMR** (400 MHz, $CDCl_3$): δ 7.16 (dd, $J = 5.2, 1.2$ Hz, 1H), 6.99-6.98 (m, 1H), 6.92 (dd, $J = 4.8, 3.6$ Hz, 1H), 3.76 (t, $J = 5.2$ Hz, 1H), 3.70 (d, $J = 4.4$ Hz, 2H), 1.76 (s, 3H), 1.59 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 165.1, 138.3, 128.0, 127.0, 125.2, 105.4, 48.4, 28.5, 27.4, 26.6; **HRMS** (ESI): m/z calc'd for $C_{11}H_{12}O_4NaS$ $[M + Na]^+$: 263.0349, found: 263.0353.

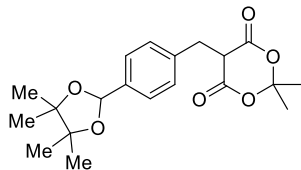
tert-Butyl 5-oxo-4-(thiophen-2-ylmethyl)isoxazolidine-2-carboxylate (S2o): Prepared by the general procedure A



from 2,2-dimethyl-5-(thiophen-2-ylmethyl)-1,3-dioxane-4,6-dione **S1o** (3.4 g, 14.2 mmol), and isolated as an orange solid (72% yield). **m.p.** 69-70 °C; **IR** (thin film): ν 2980, 2933, 1799, 1746, 1717, 1370, 1339, 1146, 848, 703 cm^{-1} ; **1H NMR** (400 MHz, $CDCl_3$): δ 7.20 (dd, $J = 5.2, 1.2$ Hz, 1H), 6.96 (dd, $J = 5.2, 3.2$ Hz, 1H), 6.88 (d, $J = 3.2$ Hz, 1H), 4.27 (dd, $J = 10.8, 8.4$ Hz, 1H), 3.75 (dd, $J = 11.2, 9.6$ Hz, 1H), 3.43 (dd, $J = 14.8, 4$ Hz, 1H), 3.25-3.17 (m, 1H), 3.09 (dd, $J = 14.8, 9.6$ Hz, 1H), 1.52 (s, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 173.8, 156.0, 138.8,

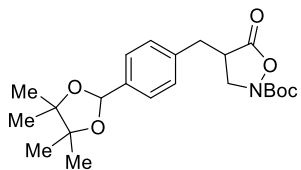
127.5, 126.6, 125.0, 84.4, 53.1, 42.6, 28.8, 28.2; **HRMS** (ESI): m/z calc'd for $C_{13}H_{17}O_4NNaS$ [$M + Na$] $^{+}$: 306.0770, found: 306.0774.

2,2-Dimethyl-5-(4-(4,4,5,5-tetramethyl-1,3-dioxolan-2-yl)benzyl)-1,3-dioxane-4,6-dione (S1p): Prepared by the



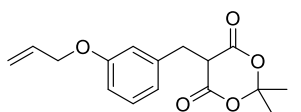
general procedure A from 4-(4,4,5,5-tetramethyl-1,3-dioxolan-2-yl)benzaldehyde (3.5 g, 15.0 mmol), and isolated as a white solid (90% yield). **m.p.** 119-120 °C; **IR** (thin film): ν 2979, 2943, 2871, 1785, 1749, 1387, 1300, 1207, 1158, 1076, 1018, 993, 941, 754 cm^{-1} ; **1H NMR** (400 MHz, $CDCl_3$): δ 7.42 (d, $J = 8.4$ Hz, 2H), 7.32 (d, $J = 8.4$ Hz, 2H), 5.94 (s, 1H), 3.73 (t, $J = 5.2$ Hz, 1H), 3.49 (d, $J = 4.8$ Hz, 2H), 1.73 (s, 3H), 1.51 (s, 3H), 1.31 (s, 6H), 1.25 (s, 6H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 165.3, 138.9, 137.8, 129.9, 126.8, 105.4, 99.8, 82.8, 48.4, 31.9, 28.6, 27.3, 24.5, 22.3; **HRMS** (ESI): m/z calc'd for $C_{20}H_{26}O_6Na$ [$M + Na$] $^{+}$: 385.1629, found: 385.1622.

tert-Butyl 5-oxo-4-(4-(4,4,5,5-tetramethyl-1,3-dioxolan-2-yl)benzyl)isoxazolidine-2-carboxylate (S2p): Prepared by



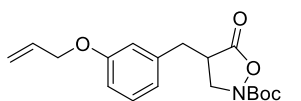
the general procedure A from 2,2-dimethyl-5-(4-(4,4,5,5-tetramethyl-1,3-dioxolan-2-yl)benzyl)-1,3-dioxane-4,6-dione **S1p** (3.0 g, 8.5 mmol), and isolated as a white solid (67% yield). **m.p.** 143-144 °C; **IR** (thin film): ν 2979, 2933, 1800, 1748, 1717, 1458, 1370, 1222, 1146, 1076, 992, 848, 761 cm^{-1} ; **1H NMR** (400 MHz, $CDCl_3$): δ 7.46 (d, $J = 8.0$ Hz, 2H), 7.19 (d, $J = 8.4$ Hz, 2H), 5.95 (s, 1H), 4.12 (dd, $J = 11.2, 8.4$ Hz, 1H), 3.68 (dd, $J = 11.2, 9.2$ Hz, 1H), 3.26 (dd, $J = 14.0, 4.4$ Hz, 1H), 3.19-3.11 (m, 1H), 2.79 (dd, $J = 14.0, 10.0$ Hz, 1H), 1.51 (s, 9H), 1.33 (s, 3H), 1.27 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 174.3, 156.0, 139.0, 137.5, 128.8, 127.2, 99.7, 84.3, 82.9, 53.1, 42.4, 34.3, 28.2, 24.5, 22.3; **HRMS** (ESI): m/z calc'd for $C_{22}H_{31}O_6NNa$ [$M + Na$] $^{+}$: 428.2053, found: 428.2044.

5-(3-(Allyloxy)benzyl)-2,2-dimethyl-1,3-dioxane-4,6-dione (S1q): Prepared by the general procedure A from



3-(allyloxy)benzaldehyde (0.9 g, 5.6 mmol), and isolated as a white solid (90% yield). **m.p.** 59-60 °C; **IR** (thin film): ν 3081, 3002, 2925, 2871, 1783, 1748, 1602, 1584, 1489, 1448, 1394, 1296, 1204, 1018, 948 cm^{-1} ; **1H NMR** (400 MHz, $CDCl_3$): δ 7.19 (t, $J = 8.0$ Hz, 1H), 6.91-6.89 (m, 2H), 6.80 (ddd, $J = 8.0, 2.4, 0.8$ Hz, 1H), 6.04 (ddt, $J = 17.2, 10.4, 5.2$ Hz, 1H), 5.41 (ddt, $J = 17.6, 1.6, 1.6$ Hz, 1H), 5.28 (ddt, $J = 10.4, 1.6, 1.2$ Hz, 1H), 4.52 (ddd, $J = 5.2, 1.6, 1.6$ Hz, 2H), 3.74 (t, $J = 4.8$ Hz, 1H), 3.46 (d, $J = 5.2$ Hz, 2H), 1.74 (s, 3H), 1.51 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$): δ 165.4, 158.9, 138.9, 133.3, 129.8, 122.3, 117.9, 116.2, 113.9, 105.4, 68.9, 48.3, 32.3, 28.7, 27.4; **HRMS** (ESI): m/z calc'd for $C_{16}H_{18}O_5NNa$ [$M + Na$] $^{+}$: 313.1046, found: 313.1050.

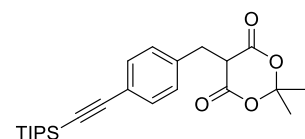
tert-Butyl 4-(3-(allyloxy)benzyl)-5-oxoisoxazolidine-2-carboxylate (S2q): Prepared by the general procedure A



from 5-(3-(allyloxy)benzyl)-2,2-dimethyl-1,3-dioxane-4,6-dione **S1q** (0.71 g, 2.4 mmol), and isolated as a colorless oil (82% yield); **IR** (thin film): ν 2981, 2933, 1799, 1747, 1716, 1600, 1584, 1489, 1450, 1370, 1260, 1143, 1027, 848, 777 cm^{-1} ; **1H NMR** (400 MHz, $CDCl_3$): δ

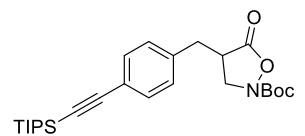
7.23 (t, $J = 8$ Hz, 1H), 6.83-6.81 (m, 1H), 6.78-6.74 (m, 2H), 6.05 (ddt, $J = 17.2, 10.4, 5.2$ Hz, 1H), 5.42 (ddt, $J = 17.6, 1.6, 1.6$ Hz, 1H), 5.30 (ddt, $J = 10.4, 1.6, 1.2$ Hz, 1H), 4.53 (ddd, $J = 5.2, 1.6, 1.6$ Hz, 2H), 4.15 (dd, $J = 10.8, 8.4$ Hz, 1H), 3.70 (dd, $J = 11.2, 9.6$ Hz, 1H), 3.24-3.12 (m, 2H), 2.76 (dd, $J = 14.0, 9.6$ Hz, 1H), 1.51 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3): δ 174.3, 159.2, 156.4, 138.6, 133.2, 130.2, 121.3, 118.0, 115.5, 113.4, 84.3, 68.9, 53.1, 42.3, 34.6, 28.2, 28.1; HRMS (ESI): m/z calc'd for $\text{C}_{18}\text{H}_{23}\text{O}_5\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 356.1468, found: 356.4172.

2,2-Dimethyl-5-(4-((triisopropylsilyl)ethynyl)benzyl)-1,3-dioxane-4,6-dione (S1r): Prepared by the general



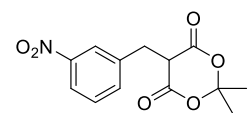
procedure A from 4-((triisopropylsilyl)ethynyl)benzaldehyde (3.8 g, 13.4 mmol), and isolated as a white solid (90% yield). **m.p.** 111–112 °C; **IR** (thin film): ν 2942, 2891, 2865, 2153, 1790, 1743, 1462, 1334, 1208, 1068, 940, 883, 677, 660 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3): δ 7.40 (d, $J = 8.4$ Hz, 2H), 7.27 (d, $J = 8.0$ Hz, 2H), 3.73 (t, $J = 4.8$ Hz, 1H), 3.47 (dd, $J = 5.2$ Hz, 2H), 1.74 (s, 3H), 1.58 (s, 3H), 1.12 (m, 21H); ^{13}C NMR (100 MHz, CDCl_3): δ 165.2, 137.6, 132.4, 129.9, 122.6, 106.9, 105.4, 90.9, 48.2, 32.0, 28.6, 27.3, 18.8, 11.5; HRMS (ESI): m/z calc'd for $\text{C}_{25}\text{H}_{30}\text{O}_4\text{NNaSi}$ [$\text{M} + \text{Na}$] $^+$: 437.2132, found: 437.2128.

tert-Butyl 5-oxo-4-(4-((triisopropylsilyl)ethynyl)benzyl)isoxazolidine-2-carboxylate (S2r): Prepared by the



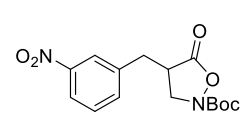
general procedure A from 2,2-dimethyl-5-(4-((triisopropylsilyl)ethynyl)benzyl)-1,3-dioxane-4,6-dione **S1r** (2.49 g, 6.0 mmol), and isolated as a white solid (53% yield). **m.p.** 72-73 °C; **IR** (thin film): ν 2943, 2892, 2865, 2155, 1800, 1748, 1720, 1462, 1370, 1143, 882, 841, 677, 659 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3): δ 7.44 (d, $J = 8.4$ Hz, 2H), 7.13 (d, $J = 8.0$ Hz, 2H), 4.13 (dd, $J = 11.2, 8.8$ Hz, 1H), 4.67 (dd, $J = 11.2, 9.2$ Hz, 1H), 3.25-3.11 (m, 2H), 2.81 (dd, $J = 14.0, 9.2$ Hz, 1H), 1.51 (s, 9H), 1.13 (m, 21H); ^{13}C NMR (100 MHz, CDCl_3): δ 174.1, 156.0, 137.2, 132.8, 128.8, 122.8, 106.6, 91.3, 84.4, 52.9, 42.2, 34.5, 28.2, 18.8, 11.5; HRMS (ESI): m/z calc'd for $\text{C}_{26}\text{H}_{39}\text{O}_4\text{NNaSi}$ [$\text{M} + \text{Na}$] $^+$: 480.2541, found: 480.2542.

2,2-Dimethyl-5-(3-nitrobenzyl)-1,3-dioxane-4,6-dione (S1s): Prepared by the general procedure A from



3-nitrobenzaldehyde (3 g, 20.0 mmol), and isolated as a colorless solid (59% yield). **m.p.** 149-150 °C; **IR** (thin film): ν 3853, 3734, 3627, 1777, 1740, 1530, 1350, 1324, 1278, 1198, 1063, 952, 683, 669 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3): δ 8.23-8.22 (m, 1H), 8.11 (ddd, $J = 8.4, 2.4, 1.2$ Hz, 1H), 7.72 (ddd, $J = 7.6, 1.6, 1.2$ Hz, 1H), 7.48 (t, $J = 8$ Hz, 1H), 3.82 (t, $J = 5.2$ Hz, 1H), 3.58 (d, $J = 5.2$ Hz, 2H), 1.80 (s, 3H), 1.69 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3): δ 164.7, 148.5, 139.3, 136.4, 129.6, 124.9, 122.5, 105.5, 47.9, 31.4, 28.5, 27.1; HRMS (ESI): m/z calc'd for $\text{C}_{13}\text{H}_{13}\text{O}_6\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 302.0635, found: 302.0645.

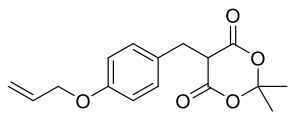
tert-butyl 4-(3-nitrobenzyl)-5-oxoisoxazolidine-2-carboxylate (S2s): Prepared by the general procedure A from



2,2-dimethyl-5-(3-nitrobenzyl)-1,3-dioxane-4,6-dione **S1s** (0.42 g, 1.5 mmol), and isolated as a white solid (99% yield). **m.p.** 65-67 °C; **IR** (thin film): ν 3734, 3709, 3628, 2981, 1799, 1746, 1717, 1529, 1351, 1143, 669 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3): δ 8.15 (dd, $J = 7.6, 2.0, 1.6$ Hz, 1H), 8.09

(t, $J = 1.6$ Hz, 1H), 7.59-7.52 (m, 2H), 4.22 (dd, $J = 10.8, 8.4$ Hz, 1H), 3.69 (dd, $J = 11.2, 9.6$ Hz, 1H), 3.34 (dd, $J = 14.4, 5.2$ Hz, 1H), 3.27-3.19 (m, 1H), 2.97 (dd, $J = 14.4, 9.2$ Hz, 1H), 1.51 (s, 9H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3): δ 173.6, 155.9, 148.7, 139.0, 135.1, 130.2, 123.8, 122.7, 84.7, 52.9, 51.9, 34.1, 28.2; **HRMS** (ESI): m/z calc'd for $\text{C}_{15}\text{H}_{18}\text{O}_6\text{N}_2\text{Na}$ [$\text{M} + \text{Na}$] $^+$: 345.1057, found: 345.1063.

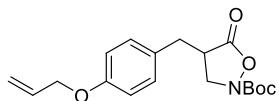
5-(4-(Allyloxy)benzyl)-2,2-dimethyl-1,3-dioxane-4,6-dione (S1y): Prepared by the general procedure A from 4-



(allyloxy)benzaldehyde (1.5 g, 9.2 mmol), and isolated as a yellow solid (97% yield). **m.p.**

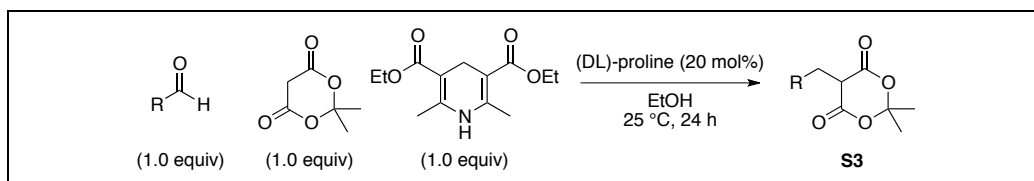
58-59 °C; **IR** (thin film): ν 3002, 2944, 2871, 1783, 1747, 1610, 1512, 1298, 1245, 1206, 1180, 1020, 939, 832 cm^{-1} ; $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.23 (d, $J = 8.8$ Hz, 2H), 6.83 (d, $J = 8.8$ Hz, 2H), 6.03 (ddt, $J = 17.2, 10.8, 5.2$ Hz, 1H), 5.39 (ddt, $J = 17.2, 1.6, 1.6$ Hz, 1H), 5.27 (ddt, $J = 10.4, 1.6, 1.6$ Hz, 1H), 4.50 (ddd, $J = 5.6, 1.2, 1.2$ Hz, 2H), 3.71 (t, $J = 4.8$ Hz, 1H), 3.44 (d, $J = 4.8$ Hz, 2H), 1.72 (s, 3H), 1.47 (s, 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3): δ 165.6, 157.9, 133.4, 131.1, 129.4, 117.8, 115.0, 105.4, 68.9, 48.5, 31.7, 28.6, 27.6; **HRMS** (ESI): m/z calc'd for $\text{C}_{16}\text{H}_{18}\text{O}_5\text{Na}$ [$\text{M} + \text{Na}$] $^+$: 313.1046, found: 313.1051.

tert-Butyl 4-(4-(allyloxy)benzyl)-5-oxoisoxazolidine-2-carboxylate (S2y): Prepared by the general procedure A



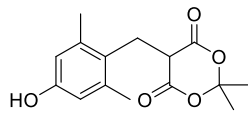
from 5-(4-(allyloxy)benzyl)-2,2-dimethyl-1,3-dioxane-4,6-dione **S1x** (1.0 g, 3.4 mmol), and

isolated as a colorless oil (81% yield); **IR** (thin film): ν 2980, 2930, 1799, 1745, 1718, 1512, 1370, 1247, 1143, 1021, 997, 847 cm^{-1} ; $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.10 (d, $J = 8.8$ Hz, 2H), 6.87 (d, $J = 8.4$ Hz, 2H), 6.05 (ddt, $J = 17.2, 10.4, 5.2$ Hz, 1H), 5.43 (ddt, $J = 17.6, 1.6, 1.6$ Hz, 1H), 5.29 (ddt, $J = 10.8, 1.6, 1.2$ Hz, 1H), 4.52 (ddd, $J = 5.6, 1.2, 1.2$ Hz, 2H), 4.13 (dd, $J = 10.8, 8.4$ Hz, 1H), 3.71 (dd, $J = 11.2, 9.2$ Hz, 1H), 3.20-3.08 (m, 2H), 2.76 (dd, $J = 14.0, 9.6$ Hz, 1H), 1.51 (s, 9H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3): δ 174.4, 158.0, 156.1, 133.3, 129.9, 129.1, 117.9, 115.4, 84.3, 69.0, 53.0, 42.5, 33.8, 28.2; **HRMS** (ESI): m/z calc'd for $\text{C}_{18}\text{H}_{23}\text{O}_5\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 356.1468, found: 356.1470.



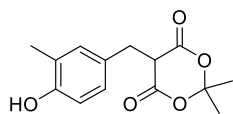
General procedure B for the synthesis of S3:⁴ Meldrum's acid (1.0 equiv), the corresponding aldehyde (1.0 equiv), (DL)-proline (20 mol%) and diethyl 2,6-dimethyl-1,4-dihydropyridine-3,5-dicarboxylate (1.0 equiv) were dissolved in EtOH (0.3 M). The solution was vigorously stirred until full conversion at room temperature, and then concentrated under reduced pressure. The obtained crude residue was purified directly by silica gel column chromatography, eluting with hexane/EtOAc to provide the desired Meldrum's acid derivatives **S3**.

5-(4-Hydroxy-2,6-dimethylbenzyl)-2,2-dimethyl-1,3-dioxane-4,6-dione (S3b): Prepared by the general procedure



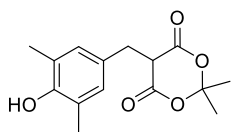
B from 4-hydroxy-2,6-dimethylbenzaldehyde (1.10 g, 7.39 mmol), and isolated as a white solid (78% yield). **m.p.** 128–130 °C; **IR** (thin film): ν 3404, 2960, 1747, 1597, 1297, 1201, 756 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 6.53 (s, 2H), 4.80 (s, 1H), 3.63 (t, J = 6.0 Hz, 1H), 3.41 (d, J = 6.0 Hz, 2H), 2.35 (s, 6H), 1.78 (s, 3H), 1.76 (s, 3H); **^{13}C NMR** (100 MHz, CDCl_3): δ 165.2, 154.0, 138.7, 127.1, 115.3, 105.0, 47.2, 28.8, 26.8, 26.2, 20.4; **HRMS** (ESI): m/z calc'd for $\text{C}_{15}\text{H}_{18}\text{O}_5\text{Na}$ [$\text{M} + \text{Na}$] $^+$: 301.1046, found: 301.1039.

5-(4-Hydroxy-3-methylbenzyl)-2,2-dimethyl-1,3-dioxane-4,6-dione (S3c): Prepared by the general procedure B



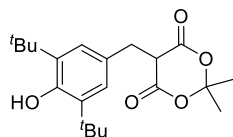
from 4-hydroxy-3-methylbenzaldehyde (1.0 g, 7.35 mmol), and isolated as a white solid (77% yield). **m.p.** 137–139 °C; **IR** (thin film): ν 3396, 2858, 1733, 1505, 1211, 756 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.06 (s, 1H), 7.02–6.99 (m, 1H), 6.66 (d, J = 8.0 Hz, 1H), 4.90 (brs, 1H), 3.71 (t, J = 4.8 Hz, 1H), 3.39 (d, J = 4.8 Hz, 2H), 2.20 (s, 3H), 1.72 (s, 3H), 1.47 (s, 3H); **^{13}C NMR** (100 MHz, CDCl_3): δ 165.5, 153.0, 132.4, 129.1, 128.4, 123.9, 115.0, 105.3, 48.3, 31.5, 28.5, 27.4, 15.7; **HRMS** (ESI): m/z calc'd for $\text{C}_{14}\text{H}_{16}\text{O}_5\text{Na}$ [$\text{M} + \text{Na}$] $^+$: 287.0890, found: 287.0880.

5-(4-Hydroxy-3,5-dimethylbenzyl)-2,2-dimethyl-1,3-dioxane-4,6-dione (S3d): Prepared by the general procedure

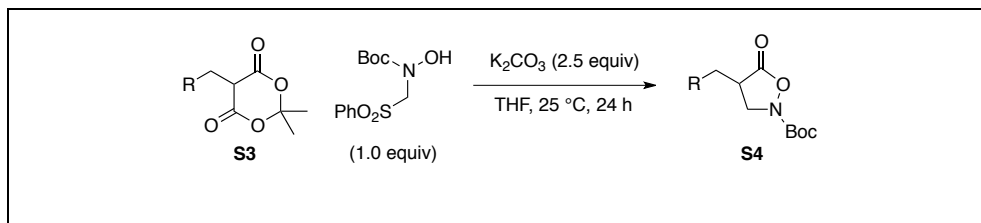


B from 4-hydroxy-3,5-dimethylbenzaldehyde (751 mg, 5.0 mmol), and isolated as an off-white solid (62% yield). **m.p.** 204–206 °C; **IR** (thin film): ν 3466, 2866, 1733, 1487, 1339, 1202, 1065, 960 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 6.92 (s, 2H), 3.69 (t, J = 4.8 Hz, 1H), 3.36 (d, J = 4.8 Hz, 2H), 2.20 (s, 6H), 1.72 (s, 3H), 1.48 (s, 3H); **^{13}C NMR** (100 MHz, CDCl_3): δ 165.5, 151.3, 129.9, 128.7, 123.1, 105.2, 48.4, 31.5, 28.5, 27.4, 15.8; **HRMS** (ESI): m/z calc'd for $\text{C}_{15}\text{H}_{18}\text{O}_5\text{Na}$ [$\text{M} + \text{Na}$] $^+$: 301.1046, found: 301.1035.

5-(3,5-Di-*tert*-butyl-4-hydroxybenzyl)-2,2-dimethyl-1,3-dioxane-4,6-dione (S3e): Prepared by the general



procedure B from 3,5-di-*tert*-butyl-4-hydroxybenzaldehyde (1.17 g, 5.0 mmol), and isolated as a white solid (83% yield). **m.p.** 121–123 °C; **IR** (thin film): ν 3629, 2957, 1748, 1436, 1298, 1204, 948, 764 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.10 (s, 2H), 5.14 (s, 1H), 3.71 (t, J = 4.8 Hz, 1H), 3.43 (d, J = 4.8 Hz, 2H), 1.70 (s, 3H), 1.41 (s, 18H), 1.28 (s, 3H); **^{13}C NMR** (100 MHz, CDCl_3): δ 165.7, 153.0, 136.1, 127.7, 126.5, 105.3, 48.5, 34.3, 32.7, 30.2, 28.5, 27.6; **HRMS** (ESI): m/z calc'd for $\text{C}_{21}\text{H}_{30}\text{O}_5\text{Na}$ [$\text{M} + \text{Na}$] $^+$: 385.1985, found: 385.1979.



General procedure C for the synthesis of S4:² To a solution of S3 in THF (0.1 M) were added *tert*-butyl hydroxy((phenylsulfonyl)methyl) carbamate (1.0 equiv), and K₂CO₃ (2.5 equiv) at 25 °C. After being stirred at 25 °C for 24 h, the mixture was filtered through a pad of Celite and washed with EtOAc, and the filtrates were evaporated under reduced pressure to give the crude residue, which was purified by silica gel column chromatography, eluting with hexane/EtOAc to afford the corresponding products S4.

***tert*-Butyl 4-(4-hydroxy-2,6-dimethylbenzyl)-5-oxoisoxazolidine-2-carboxylate (S4b):** Prepared by the general

procedure C from S3b (834.9 mg, 3.0 mmol), and isolated as off-white solid (78% yield). **m.p.** 128–130 °C; **IR** (thin film): ν 3422, 2980, 1800, 1720, 1460, 1307, 1143, 847, 758 cm⁻¹; **¹H NMR** (400 MHz, CDCl₃): δ 6.54 (s, 2H), 5.23 (s, 1H), 4.09 (dd, *J* = 11.2, 8.4 Hz, 1H), 3.72 (dd, *J* = 10.8, 8.4 Hz, 1H), 3.18 (dd, *J* = 14.4, 5.2 Hz, 1H), 3.08–3.00 (m, 1H), 2.90–2.84 (m, 1H), 2.27 (s, 6H), 1.52 (s, 9H); **¹³C NMR** (100 MHz, CDCl₃): δ 174.3, 155.8, 154.2, 138.0, 126.2, 115.4, 84.4, 53.5, 41.1, 28.0, 27.6, 20.3; **HRMS** (ESI): *m/z* calc'd for C₁₇H₂₃O₅NNa [M + Na]⁺: 344.1468, found: 344.1468.

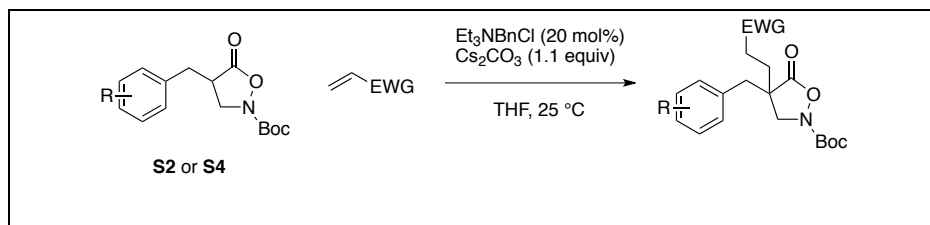
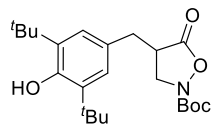
***tert*-Butyl 4-(4-hydroxy-3-methylbenzyl)-5-oxoisoxazolidine-2-carboxylate (S4c):** Prepared by the general

procedure C from S3c (607.9 mg, 2.3 mmol), and isolated as a white solid (76% yield). **m.p.** 103–105 °C; **IR** (thin film): ν 3433, 2979, 1799, 1717, 1509, 1370, 1145, 768 cm⁻¹; **¹H NMR** (400 MHz, CDCl₃): δ 6.93 (d, *J* = 2.0 Hz, 1H), 6.88 (dd, *J* = 8.0, 2.0 Hz, 1H), 6.72 (d, *J* = 8.0 Hz, 1H), 5.02 (s, 1H), 4.15–4.10 (m, 1H), 3.71 (dd, *J* = 11.2, 8.8 Hz, 1H), 3.15–3.11 (m, 2H), 2.71 (dd, *J* = 15.2, 10.4 Hz, 1H), 2.23 (s, 3H), 1.51 (s, 9H); **¹³C NMR** (100 MHz, CDCl₃): δ 174.3, 155.9, 153.1, 131.3, 128.7, 127.3, 124.4, 115.3, 84.2, 52.8, 42.4, 33.6, 28.0, 15.8; **HRMS** (ESI): *m/z* calc'd for C₁₆H₂₁O₅NNa [M + Na]⁺: 330.1312, found: 330.1302.

***tert*-Butyl 4-(4-hydroxy-3,5-dimethylbenzyl)-5-oxoisoxazolidine-2-carboxylate (S4d):** Prepared by the general

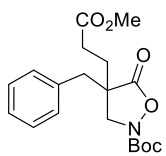
procedure C from S3d (278.3 mg, 1.0 mmol), and isolated as a white solid (76% yield). **m.p.** 129–131 °C; **IR** (thin film): ν 3788, 2979, 1795, 1710, 1490, 1208, 1146, 757 cm⁻¹; **¹H NMR** (400 MHz, CDCl₃): δ 6.78 (s, 2H), 4.65 (s, 1H), 4.13 (dd, *J* = 11.6, 8.4 Hz, 1H), 3.71 (dd, *J* = 11.2, 8.8 Hz, 1H), 3.15–3.07 (m, 2H), 2.70–2.63 (m, 1H), 2.22 (s, 6H), 1.51 (s, 9H); **¹³C NMR** (100 MHz, CDCl₃): δ 174.4, 155.9, 151.3, 128.8, 128.3, 123.5, 84.1, 52.9, 42.4, 33.7, 28.0, 15.9; **HRMS** (ESI): *m/z* calc'd for C₁₇H₂₃O₅NNa [M + Na]⁺: 344.1468, found: 344.1459.

tert-Butyl 4-(3,5-di-tert-butyl-4-hydroxybenzyl)-5-oxoisoxazolidine-2-carboxylate (S4e): Prepared by the general procedure C from **S3e** (1.27 g, 3.5 mmol), and isolated as a white solid (84% yield). **m.p.** 95–97 °C; **IR** (thin film): ν 3636, 2959, 1799, 1716, 1436, 1370, 1143, 758 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 6.97 (s, 2H), 5.17 (s, 1H), 4.17 (dd, $J = 12.4, 8.4$ Hz, 1H), 3.77 (dd, $J = 10.8, 8.8$ Hz, 1H), 3.18–3.07 (m, 2H), 2.70 (dd, $J = 14.0, 10.0$ Hz, 1H), 1.52 (s, 9H), 1.44 (s, 18H); **^{13}C NMR** (100 MHz, CDCl_3): δ 174.6, 156.1, 152.9, 136.4, 127.5, 125.2, 84.0, 53.0, 42.5, 34.5, 34.3, 30.2, 28.0; **HRMS** (ESI): m/z calc'd for $\text{C}_{23}\text{H}_{35}\text{O}_5\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 428.2407, found: 428.2413.

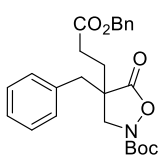


General procedure D: A 20 mL vial equipped with a magnetic stirring bar were charged with **S2** or **S4** (1.0 equiv), Et_3NBnCl (20 mol%), and Cs_2CO_3 (1.1 equiv), followed by the addition of THF (0.2 M). To the resulting reaction mixture was added an acceptor (1.5 equiv), and then the solution was stirred at room temperature until full consumption of **S2** was observed by TLC analysis. After the addition of H_2O , the aqueous phase was extracted with EtOAc (3x). The combined organic layers were washed with brine, dried over Na_2SO_4 , filtered, and concentrated under reduced pressure to give the residue, which was purified by silica gel column chromatography (5% to 60% EtOAc in hexane) to give products.

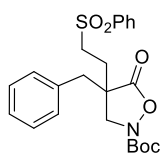
tert-Butyl 4-benzyl-4-(3-methoxy-3-oxopropyl)-5-oxoisoxazolidine-2-carboxylate (S2t): Prepared by the general procedure D from **S2a** (277 mg, 1.0 mmol), and methyl acrylate (129 mg, 1.5 mmol, 1.5 equiv), and isolated as a white solid (251 mg, 69% yield). **^1H NMR** (400 MHz, CDCl_3): δ 7.35–7.26 (m, 3H), 7.18–7.15 (m, 2H), 3.99 (d, $J = 11.2$ Hz, 1H), 3.80 (d, $J = 11.2$ Hz, 1H), 3.68 (s, 3H), 3.06 (d, $J = 14.0$ Hz, 1H), 2.85 (d, $J = 14.0$ Hz, 1H), 2.48–2.45 (m, 2H), 2.05–2.01 (m, 2H), 1.49 (s, 9H); **^{13}C NMR** (100 MHz, CDCl_3): δ 175.4, 172.5, 155.6, 134.6, 130.0, 128.8, 127.6, 84.1, 55.5, 51.9, 48.6, 39.7, 29.5, 28.8, 28.0. Spectroscopic data matched those reported.⁵



tert-Butyl 4-benzyl-4-(3-(benzyloxy)-3-oxopropyl)-5-oxoisoxazolidine-2-carboxylate (S2u): Prepared by the general procedure D from **S2a** (555 mg, 2.0 mmol), and benzyl acrylate (486 mg, 3.0 mmol, 1.5 equiv), and isolated as a light-yellow oil (778 mg, 89% yield). **^1H NMR** (400 MHz, CDCl_3): δ 7.39–7.27 (m, 8H), 7.17–7.15 (m, 2H), 5.12 (s, 2H), 3.99 (d, $J = 11.2$ Hz, 1H), 3.80 (d, $J = 11.2$ Hz, 1H), 3.05 (d, $J = 14.0$ Hz, 1H), 2.85 (d, $J = 14.0$ Hz, 1H), 2.53–2.50 (m, 2H), 2.07–2.03 (m, 2H), 1.48 (s, 9H); **^{13}C NMR** (100 MHz, CDCl_3): δ 175.4, 171.9, 155.5, 135.6, 134.5, 130.0, 128.8, 128.6, 128.35, 128.26, 127.6, 84.1, 66.7, 55.5, 48.6, 39.7, 29.4, 29.0, 28.0. Spectroscopic data matched those reported.⁵

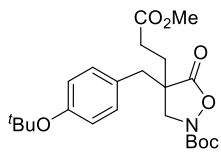


tert-Butyl 4-benzyl-5-oxo-4-(2-(phenylsulfonyl)ethyl)isoxazolidine-2-carboxylate (S2v): Prepared by the general



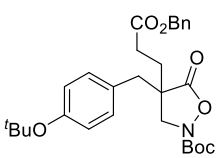
procedure D from **S2a** (555 mg, 2.0 mmol), and (vinylsulfonyl)benzene (505 mg, 3.0 mmol, 1.5 equiv), and isolated as a white solid (632 mg, 71% yield). $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.89–7.86 (m, 2H), 7.70–7.66 (m, 1H), 7.60–7.56 (m, 2H), 7.30–7.26 (m, 3H), 7.80–7.06 (m, 2H), 3.99 (d, J = 11.6 Hz, 1H), 3.73 (d, J = 11.6 Hz, 1H), 3.24–3.19 (m, 2H), 3.00 (d, J = 14.0 Hz, 1H), 2.81 (d, J = 14.0 Hz, 1H), 2.12–2.07 (m, 2H), 1.47 (s, 9H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3): δ 174.7, 155.3, 138.5, 134.1, 133.8, 129.8, 129.5, 128.9, 128.0, 127.8, 84.5, 55.8, 51.2, 48.0, 39.2, 27.9, 26.9. Spectroscopic data matched those reported.⁵

tert-Butyl 4-(4-(tert-butoxy)benzyl)-4-(3-methoxy-3-oxopropyl)-5-oxoisoxazolidine-2-carboxylate (S4f): Prepared



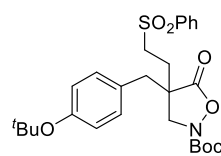
by the general procedure D from **S4a** (699 mg, 2.0 mmol), and methyl acrylate (259 mg, 3.0 mmol, 1.5 equiv), and isolated as a white solid (755 mg, 87% yield). **m.p.** 93–95 °C; **IR** (thin film): ν 2979, 1792, 1741, 1508, 1368, 1147, 848 cm^{-1} ; $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.06–7.03 (m, 2H), 6.95–6.92 (m, 2H), 3.96 (d, J = 11.2 Hz, 1H), 3.79 (d, J = 11.2 Hz, 1H), 3.67 (s, 3H), 3.01 (d, J = 14.0 Hz, 1H), 2.80 (d, J = 14.0 Hz, 1H), 2.46–2.43 (m, 2H), 2.04–2.00 (m, 2H), 1.49 (s, 9H), 1.33 (s, 9H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3): δ 175.5, 172.5, 155.7, 154.9, 130.5, 129.1, 124.2, 84.1, 78.5, 55.5, 51.9, 48.6, 38.9, 29.4, 28.81, 28.77, 28.0; **HRMS** (ESI): m/z calc'd for $\text{C}_{23}\text{H}_{33}\text{O}_7\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 458.2149, found: 458.2141.

tert-Butyl 4-(3-(benzyloxy)-3-oxopropyl)-4-(4-(tert-butoxy)benzyl)-5-oxoisoxazolidine-2-carboxylate (S4g):

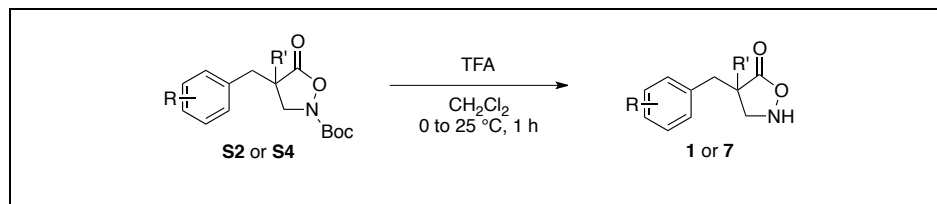


Prepared by the general procedure D from **S4a** (699 mg, 2.0 mmol), and benzyl acrylate (486 mg, 3.0 mmol, 1.5 equiv), and isolated as a white solid (700 mg, 91% yield). **m.p.** 75–77 °C; **IR** (thin film): ν 2978, 1792, 1737, 1507, 1367, 1147, 753 cm^{-1} ; $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.38–7.30 (m, 5H), 7.06–7.03 (m, 2H), 6.94–6.90 (m, 2H), 5.11 (s, 2H), 3.96 (d, J = 11.2 Hz, 1H), 3.78 (d, J = 11.2 Hz, 1H), 3.00 (d, J = 14.0 Hz, 1H), 2.80 (d, J = 14.0 Hz, 1H), 2.52–2.49 (m, 2H), 2.06–2.02 (m, 2H), 1.49 (s, 9H), 1.33 (s, 9H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3): δ 175.5, 171.9, 155.7, 154.9, 135.6, 130.5, 129.1, 128.6, 128.3, 128.2, 124.2, 84.1, 78.5, 66.6, 55.5, 48.6, 38.9, 29.4, 29.0, 28.8, 28.0; **HRMS** (ESI): m/z calc'd for $\text{C}_{29}\text{H}_{37}\text{O}_7\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 534.2462, found: 534.2457.

tert-Butyl 4-(4-(tert-butoxy)benzyl)-5-oxo-4-(2-(phenylsulfonyl)ethyl)isoxazolidine-2-carboxylate (S4h):

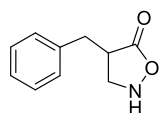


Prepared by the general procedure D from **S4a** (594 mg, 1.7 mmol), and (vinylsulfonyl)benzene **S3c** (429 mg, 2.55 mmol, 1.5 equiv), and isolated as a white solid (866 mg, 97% yield). **m.p.** 95–97 °C; **IR** (thin film): ν 2979, 1792, 1717, 1507, 1318, 1149, 745 cm^{-1} ; $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.88–7.86 (m, 2H), 7.69–7.65 (m, 1H), 7.59–7.55 (m, 2H), 6.96–6.94 (m, 2H), 6.89–6.87 (m, 2H), 3.97 (d, J = 11.2 Hz, 1H), 3.71 (d, J = 11.2 Hz, 1H), 3.23–3.16 (m, 2H), 2.93 (d, J = 14.0 Hz, 1H), 2.75 (d, J = 14.0 Hz, 1H), 2.07 (t, J = 8.8 Hz, 2H), 1.46 (s, 9H), 1.32 (s, 9H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3): δ 174.7, 155.4, 155.1, 138.5, 134.0, 130.4, 129.4, 128.3, 128.0, 124.2, 84.5, 78.6, 55.8, 51.2, 48.0, 38.5, 28.8, 27.9, 26.9; **HRMS** (ESI): m/z calc'd for $\text{C}_{27}\text{H}_{35}\text{O}_7\text{NNaS}$ [$\text{M} + \text{Na}$] $^+$: 540.2026, found: 540.2023.

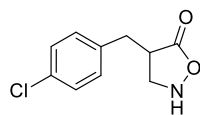


General procedure E: To a solution of **S2** or **S4** in CH_2Cl_2 (0.1 M) was added TFA (0.2 M) at 0°C , and the resulting mixture was then stirred at room temperature for 1 h. The reaction mixture was concentrated under reduced pressure after full consumption of starting materials **S2** or **S4**. The obtained residue was diluted with EtOAc, followed by the addition of sat aq NaHCO_3 . The aqueous phase was extracted with EtOAc (3x). The combined organic layers were washed with brine, dried over Na_2SO_4 , filtered, and concentrated under reduced pressure to give the crude product, which was purified by silica gel column chromatography (5% to 80% EtOAc in hexane) to afford products **1** or **7**.

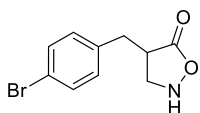
4-Benzylisoxazolidin-5-one (1a): Prepared by the general procedure E from **S2a** (2.00 g, 7.22 mmol), and isolated as a white solid (1.11 g, 86% yield). **m.p.** $55\text{--}57^\circ\text{C}$; **IR** (thin film): ν 3240, 2938, 1772, 1451, 1159, 981, 749 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.35–7.31 (m, 2H), 7.29–7.25 (m, 1H), 7.22–7.20 (m, 2H), 6.58 (brs, 1H), 3.66 (dd, $J = 11.2, 8.4$ Hz, 1H), 3.44 (t, $J = 11.2$ Hz, 1H), 3.26–3.22 (m, 1H), 3.14–3.06 (m, 1H), 2.88–2.83 (m, 1H); **^{13}C NMR** (100 MHz, CDCl_3): δ 178.5, 137.5, 128.9, 128.6, 127.1, 52.9, 43.1, 34.6; **HRMS** (ESI): m/z calc'd for $\text{C}_{10}\text{H}_{12}\text{O}_2\text{N}$ [$\text{M} + \text{H}$] $^+$: 178.0863, found: 178.0864.



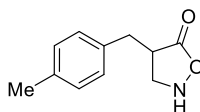
4-(4-Chlorobenzyl)isoxazolidin-5-one (1b): Prepared by the general procedure E from **S2b** (450 mg, 1.44 mmol), and isolated as a white solid (284 mg, 93% yield). **m.p.** $93\text{--}95^\circ\text{C}$; **IR** (thin film): ν 3231, 2942, 1769, 1492, 1156, 982, 798 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.31–7.28 (m, 2H), 7.15–7.13 (m, 2H), 6.65 (brs, 1H), 3.65 (dd, $J = 11.2, 8.0$ Hz, 1H), 3.41 (t, $J = 10.4$ Hz, 1H), 3.20 (dd, $J = 14.0, 4.4$ Hz, 1H), 3.12–3.04 (m, 1H), 2.83 (dd, $J = 14.0, 9.2$ Hz, 1H); **^{13}C NMR** (100 MHz, CDCl_3): δ 178.2, 135.9, 133.1, 129.9, 129.1, 52.8, 43.0, 33.9; **HRMS** (ESI): m/z calc'd for $\text{C}_{10}\text{H}_{11}\text{O}_2\text{NCl}$ [$\text{M} + \text{H}$] $^+$: 212.0484, found: 212.0478.



4-(4-Bromobenzyl)isoxazolidin-5-one (1c): Prepared by the general procedure E from **S2c** (600 mg, 1.68 mmol), and isolated as a white solid (400 mg, 93% yield). **m.p.** $105\text{--}107^\circ\text{C}$; **IR** (KBr): ν 3186, 2942, 1770, 1487, 1152, 982, 795 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.46–7.42 (m, 2H), 7.09–7.06 (m, 2H), 6.68 (brs, 1H), 3.64 (dd, $J = 11.2, 8.0$ Hz, 1H), 3.40 (t, $J = 10.4$ Hz, 1H), 3.17 (dd, $J = 14.0, 4.4$ Hz, 1H), 3.12–3.04 (m, 1H), 2.80 (dd, $J = 14.0, 9.2$ Hz, 1H); **^{13}C NMR** (100 MHz, CDCl_3): δ 178.2, 136.5, 132.0, 130.3, 121.0, 52.7, 42.9, 33.9; **HRMS** (ESI): m/z calc'd for $\text{C}_{10}\text{H}_{11}\text{O}_2\text{NBr}$ [$\text{M} + \text{H}$] $^+$: 255.9979, found: 255.9968.

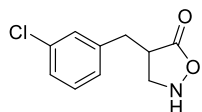


4-(4-Methylbenzyl)isoxazolidin-5-one (1d): Prepared by the general procedure E from **S2d** (437 mg, 1.5 mmol), and isolated as a white solid (254 mg, 66% yield). **m.p.** $42\text{--}44^\circ\text{C}$; **IR** (thin film): ν 3236, 2924, 1773, 1516, 1157, 988, 796 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.13 (d, $J = 8.0$ Hz, 2H), 7.09 (d, $J = 8.0$ Hz, 2H), 6.59 (brs, 1H), 3.67–3.62 (m, 1H), 3.44–3.39 (m, 1H), 3.20–3.16 (m, 1H), 3.11–3.03 (m,



1H), 2.84–2.81 (m, 1H), 2.33 (s, 3H); ¹³C NMR (100 MHz, CDCl₃): δ 178.7, 136.8, 134.4, 129.6, 128.4, 52.9, 43.1, 34.2, 21.0; HRMS (ESI): *m/z* calc'd for C₁₁H₁₃O₂NNa [M + Na]⁺: 214.0849, found: 214.0841.

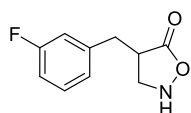
4-(3-Chlorobenzyl)isoxazolidin-5-one (1e): Prepared by the general procedure E from **S2e** (426 mg, 1.36 mmol),



and isolated as a colorless oil (268 mg, 93% yield). IR (thin film): ν 3244, 2934, 1776, 1599, 1476, 1160, 996, 781 cm⁻¹; ¹H NMR (400 MHz, CDCl₃): δ 7.30–7.25 (m, 2H), 7.22–7.21 (m, 1H), 7.12–7.10 (m, 1H), 6.73 (brs, 1H), 3.68 (dd, *J* = 11.2, 8.0 Hz, 1H), 3.44 (t, *J* = 10.4 Hz, 1H), 3.23 (dd, *J* = 14.0, 4.4 Hz, 1H), 3.16–3.08 (m, 1H), 2.82 (dd, *J* = 14.0, 9.2 Hz, 1H); ¹³C NMR (100 MHz, CDCl₃):

δ 178.2, 139.6, 134.6, 130.2, 128.7, 127.3, 126.8, 52.8, 42.9, 34.1; HRMS (ESI): *m/z* calc'd for C₁₀H₁₁O₂NCl [M + H]⁺: 212.0473, found: 212.0476.

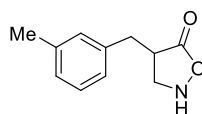
4-(2-Fluorobenzyl)isoxazolidin-5-one (1f): Prepared by the general procedure E from **S2f** (445 mg, 1.5 mmol), and



isolated as a colorless oil (263 mg, 90% yield). IR (thin film): ν 3243, 2933, 1773, 1589, 1450, 1253, 1159, 783 cm⁻¹; ¹H NMR (400 MHz, CDCl₃): δ 7.32–7.26 (m, 1H), 6.99–6.89 (m, 3H), 3.66 (dd, *J* = 11.6, 8.0 Hz, 1H), 3.42 (dd, *J* = 11.2, 10.4 Hz, 1H), 3.23 (dd, *J* = 14.4, 4.4 Hz, 1H), 3.15–3.08 (m, 1H), 2.83 (dd, *J* = 14.4, 9.2 Hz, 1H); ¹³C NMR (100 MHz, CDCl₃): δ 178.2, 163.0 (d, *J* = 245.4 Hz, 1C),

140.0 (d, *J* = 7.1 Hz, 1C), 130.5 (d, *J* = 8.3 Hz, 1C), 124.2 (d, *J* = 2.9 Hz, 1C), 115.5 (d, *J* = 21.2 Hz, 1C), 114.1 (d, *J* = 20.8 Hz, 1C), 52.8, 42.9, 34.2 (d, *J* = 1.7 Hz, 1C); HRMS (ESI): *m/z* calc'd for C₁₀H₉O₂NF [M – H]⁺: 194.0612, found: 194.0620.

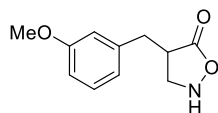
4-(3-Methylbenzyl)isoxazolidin-5-one (1g): Prepared by the general procedure E from **S2g** (400.0 mg, 1.37 mmol),



and isolated as a colorless oil (205.0 mg, 78% yield). IR (thin film): ν 3241, 2925, 1777, 1456, 1155, 993, 778 cm⁻¹; ¹H NMR (400 MHz, CDCl₃): δ 7.23–7.19 (m, 1H), 7.09–7.07 (m, 1H), 7.01–6.98 (m, 2H), 6.60 (brs, 1H), 3.65 (dd, *J* = 11.2, 8.0 Hz, 1H), 3.45–3.40 (m, 1H), 3.22–3.17 (m, 1H), 3.13–3.05 (m, 1H), 2.83–2.78 (m, 1H), 2.34 (m, 3H); ¹³C NMR (100 MHz, CDCl₃): δ 178.7, 138.6,

137.5, 129.3, 128.8, 127.8, 125.5, 52.9, 43.1, 34.5, 21.3; HRMS (ESI): *m/z* calc'd for C₁₁H₁₃O₂NNa [M + Na]⁺: 214.0838, found: 214.0838.

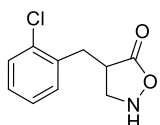
4-(3-Methoxybenzyl)isoxazolidin-5-one (1h): Prepared by the general procedure E from **S2h** (1.50 g, 4.88 mmol),



and isolated as a colorless oil (812 mg, 80% yield). IR (thin film): ν 3244, 2934, 1771, 1602, 1451, 1260, 1043, 778 cm⁻¹; ¹H NMR (400 MHz, CDCl₃): δ 7.23 (t, *J* = 8.0 Hz, 1H), 6.81–6.73 (m, 3H), 6.69 (brs, 1H), 3.79 (s, 3H), 3.66–3.61 (m, 1H), 3.44–3.39 (m, 1H), 3.21–3.17 (m, 1H), 3.13–3.05 (m, 1H), 2.82–2.77 (m, 1H); ¹³C NMR (100 MHz, CDCl₃): δ 178.7, 159.9, 139.1, 129.9, 120.8,

114.4, 112.2, 55.1, 52.9, 43.0, 34.6; HRMS (ESI): *m/z* calc'd for C₁₁H₁₃O₃NNa [M + Na]⁺: 230.0788, found: 230.0788.

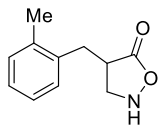
4-(2-Chlorobenzyl)isoxazolidin-5-one (1i): Prepared by the general procedure E from **S2i** (425 mg, 1.36 mmol),



and isolated as a colorless oil (271 mg, 94% yield). IR (thin film): ν 3245, 2934, 1773, 1474, 1161, 993, 754 cm⁻¹; ¹H NMR (400 MHz, CDCl₃): δ 7.41–7.39 (m, 1H), 7.30–7.22 (m, 3H), 6.76 (brs, 1H), 3.65 (dd, *J* = 11.6, 8.0 Hz, 1H), 3.51–3.40 (m, 2H), 3.29–3.21 (m, 1H), 2.96 (dd, *J* = 14.0, 9.2 Hz, 1H); ¹³C

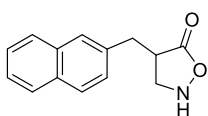
NMR (100 MHz, CDCl₃): δ 178.3, 135.4, 133.9, 130.9, 129.8, 128.6, 127.3, 52.9, 41.8, 31.9; **HRMS** (ESI): m/z calc'd for C₁₀H₁₁O₂NCl [M + H]⁺: 212.0473, found: 212.0476.

4-(2-Methylbenzyl)isoxazolidin-5-one (1j): Prepared by the general procedure E from **S2j** (437 mg, 1.5 mmol), and isolated as a colorless oil (286 mg, 99% yield). **IR** (thin film): ν 3242, 2939, 1772, 1457, 1158, 991, 755



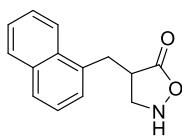
cm⁻¹; **¹H NMR** (400 MHz, CDCl₃): δ 7.20–7.09 (m, 4H), 6.74 (brs, 1H), 3.64 (dd, J = 11.2, 8.0 Hz, 1H), 3.44 (t, J = 10.4 Hz, 1H), 3.32 (dd, J = 14.4, 4.4 Hz, 1H), 3.13–3.05 (m, 1H), 2.77 (dd, J = 14.4, 10.0 Hz, 1H), 2.34 (m, 3H); **¹³C NMR** (100 MHz, CDCl₃): δ 178.7, 136.0, 130.7, 128.8, 127.1, 126.4, 53.3, 42.1, 31.8, 19.4; **HRMS** (ESI): m/z calc'd for C₁₁H₁₃O₂NNa [M + Na]⁺: 214.0838, found: 214.0838.

4-(Naphthalen-2-ylmethyl)isoxazolidin-5-one (1k): Prepared by the general procedure E from **S2k** (500 mg, 1.53



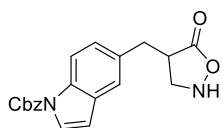
mmol), and isolated as a white solid (336 mg, 96% yield). **m.p.** 81–83 °C; **IR** (thin film): ν 3240, 2931, 1774, 1437, 1161, 991, 810, 749 cm⁻¹; **¹H NMR** (400 MHz, CDCl₃): δ 7.84–7.79 (m, 3H), 7.65 (s, 1H), 7.52–7.45 (m, 2H), 7.34–7.31 (m, 1H), 6.59 (brs, 1H), 3.65 (dd, J = 11.6, 8.4 Hz, 1H), 3.51–3.39 (m, 2H), 3.23–3.16 (m, 1H), 3.03–2.98 (m, 1H); **¹³C NMR** (100 MHz, CDCl₃): δ 178.5, 135.0, 133.5, 132.4, 128.8, 127.7, 127.5, 127.2, 126.6, 126.5, 125.9, 52.9, 43.1, 34.8; **HRMS** (ESI): m/z calc'd for C₁₄H₁₃O₂NNa [M + Na]⁺: 250.0838, found: 250.0839.

4-(Naphthalen-1-ylmethyl)isoxazolidin-5-one (1l): Prepared by the general procedure E from **S2l** (491 mg, 1.5



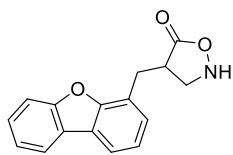
mmol), and isolated as a white solid (310 mg, 91% yield). **m.p.** 94–96 °C; **IR** (thin film): ν 3240, 2934, 1773, 1509, 1156, 975, 796, 776 cm⁻¹; **¹H NMR** (400 MHz, CDCl₃): δ 8.02 (d, J = 8.4 Hz, 1H), 7.90–7.88 (m, 1H), 7.79 (d, J = 8.4 Hz, 1H), 7.59–7.50 (m, 2H), 7.44–7.40 (m, 1H), 7.33 (d, J = 6.8 Hz, 1H), 3.88 (dd, J = 14.4, 4.0 Hz, 1H), 3.54–3.43 (m, 2H), 3.31–3.23 (m, 1H), 3.08 (dd, J = 14.4, 10.0 Hz, 1H); **¹³C NMR** (100 MHz, CDCl₃): δ 178.6, 134.0, 133.8, 131.3, 129.1, 128.0, 126.6, 126.5, 126.0, 125.5, 123.0, 53.4, 42.5, 31.9; **HRMS** (ESI): m/z calc'd for C₁₄H₁₃O₂NNa [M + Na]⁺: 250.0838, found: 250.0839.

tert-Butyl 4-((1-((benzyloxy)carbonyl)-1H-indol-5-yl)methyl)-5-oxoisoxazolidine-2-carboxylate (1m): Prepared by



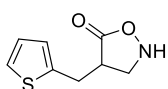
the general procedure E from *tert*-butyl 4-((1-((benzyloxy)carbonyl)-1H-indol-5-yl)methyl)-5-oxoisoxazolidine-2-carboxylate **S2m** (0.25 g, 0.62 mmol), and isolated as a white solid (63% yield). **m.p.** 99–100 °C; **IR** (thin film): ν 3244, 2928, 1772, 1733, 1471, 1397, 1348, 1332, 1256, 1218, 1133, 1034, 762 cm⁻¹; **¹H NMR** (400 MHz, CDCl₃): δ 8.12 (d, J = 7.6 Hz, 1H), 7.64 (d, J = 3.6 Hz, 1H), 7.50–7.47 (m, 2H), 7.44–7.38 (m, 4H), 7.14 (dd, J = 8.4, 1.6 Hz, 1H), 6.56–6.56 (m, 2H), 5.45 (s, 2H), 3.62 (dd, J = 10.4, 8.4 Hz, 1H), 3.45 (dd, J = 10.8, 10 Hz, 1H), 3.30 (br d, J = 13.6 Hz, 1H), 3.16–3.08 (m, 1H), 2.97–2.94 (m, 1H); **¹³C NMR** (100 MHz, CDCl₃): δ 178.8, 150.9, 135.1, 134.5, 132.3, 131.2, 128.9, 128.6, 126.4, 125.2, 121.0, 115.7, 108.1, 69.0, 53.0, 43.6, 34.7; **HRMS** (ESI): m/z calc'd for C₂₀H₁₈O₄N₂Na [M + Na]⁺: 373.1172, found: 373.1169.

4-(Dibenzo[b,d]furan-4-ylmethyl)isoxazolidin-5-one (1n): Prepared by the general procedure E from *tert*-butyl



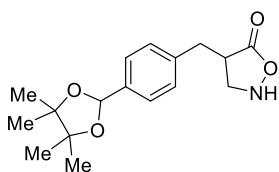
4-(dibenzo[b,d]furan-4-ylmethyl)-5-oxoisoxazolidine-2-carboxylate **S2n** (0.37 g, 1.0 mmol), and isolated as a white solid (91% yield). **m.p.** 76-77 °C; **IR** (thin film): ν 3243, 3058, 2933, 1774, 1450, 1423, 1186, 1158, 992, 754 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.96 (ddd, $J = 7.6, 1.2, 0.8$ Hz, 1H), 7.87 (dt, $J = 10.0, 3.6$ Hz, 1H), 7.59 (dt, $J = 8.4, 0.8$ Hz, 1H), 7.48 (dt, $J = 7.6, 1.6$ Hz, 1H), 7.37 (dt, $J = 7.2, 0.8$ Hz, 1H), 7.31 (d, $J = 4.8$ Hz, 2H), 6.69 (br s, 1H), 3.67-3.61 (m, 2H), 3.57-3.52 (m, 1H), 3.45-3.37 (m, 1H), 3.15 (dd, $J = 14.0, 10.0$ Hz, 1H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 178.7, 156.1, 154.6, 127.8, 127.6, 124.5, 124.4, 123.4, 123.2, 121.8, 121.0, 119.8, 111.9, 53.4, 42.4, 29.2; **HRMS** (ESI): m/z calc'd for $\text{C}_{16}\text{H}_{13}\text{O}_3\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 290.0788, found: 290.0789.

4-(Thiophen-2-ylmethyl)isoxazolidin-5-one (1o): Prepared by the general procedure E from *tert*-butyl



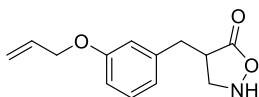
5-oxo-4-(thiophen-2-ylmethyl)isoxazolidine-2-carboxylate **S2o** (0.6 g, 2.1 mmol), and isolated as a white solid (74% yield). **m.p.** 58-59 °C; **IR** (thin film): ν 3241, 2923, 1769, 1437, 1240, 1165, 992, 703 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.19 (dd, $J = 5.2, 1.2$ Hz, 1H), 6.96 (dd, $J = 5.2, 3.6$ Hz, 1H), 6.88 (d, $J = 3.2$ Hz, 1H), 6.67 (br s, 1H), 3.79-3.74 (m, 1H), 3.51-3.38 (m, 2H), 3.17-3.09 (m, 1H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 178.2, 139.5, 127.5, 126.3, 124.8, 53.0, 43.5, 28.9; **HRMS** (ESI): m/z calc'd for $\text{C}_8\text{H}_9\text{O}_2\text{NNaS}$ [$\text{M} + \text{Na}$] $^+$: 206.0246, found: 206.0252.

4-(4-(4,4,5,5-Tetramethyl-1,3-dioxolan-2-yl)benzyl)isoxazolidin-5-one (1p): Prepared by the general procedure E



from *tert*-butyl 5-oxo-4-(4-(4,4,5,5-tetramethyl-1,3-dioxolan-2-yl)benzyl)isoxazolidine-2-carboxylate **S2p** (0.2 g, 0.5 mmol), and isolated as a colorless oil (48% yield); **IR** (thin film): ν 3235, 2979, 2928, 1776, 1390, 1369, 1222, 1154, 1073, 991, 884, 806 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.45 (d, $J = 8.4$ Hz, 2H), 7.20 (d, $J = 8.0$ Hz, 2H), 6.56 (br s, 1H), 5.95 (s, 1H), 3.62 (m, 1H), 3.41 (dd, $J = 10.0, 10.0$ Hz, 1H), 3.24 (dd, $J = 13.6, 2.8$ Hz, 1H), 3.12-3.04 (m, 1H), 2.86-2.81 (m, 1H), 1.32 (s, 6H), 1.27 (s, 6H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 178.2, 137.9, 132.8, 128.7, 122.7, 106.6, 91.2, 53.0, 43.2, 34.7, 18.8, 11.5; **HRMS** (ESI): m/z calc'd for $\text{C}_{17}\text{H}_{23}\text{O}_4\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 328.1519, found: 328.1524.

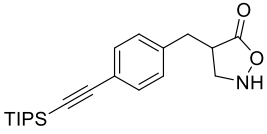
4-(3-(Allyloxy)benzyl)isoxazolidin-5-one (1q): Prepared by the general procedure E *tert*-Butyl



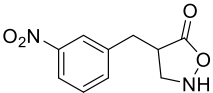
4-(3-(allyloxy)benzyl)-5-oxoisoxazolidine-2-carboxylate **S2q** (0.25 g, 0.75 mmol), and isolated as a yellow oil (83% yield); **IR** (thin film): ν 3239, 2926, 2866, 1775, 1601, 1584, 1488, 1449, 1260, 1160, 1027, 993, 930, 777, 697 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.23 (t, $J = 7.6$ Hz, 1H), 6.83-6.76 (m, 3H), 6.57 (br s, 1H), 6.05 (ddt, $J = 17.2, 10.4, 5.2$ Hz, 1H), 5.41 (ddt, $J = 17.6, 1.6, 1.6$ Hz, 1H), 5.29 (ddt, $J = 10.4, 1.6, 1.6$ Hz, 1H), 4.52 (ddd, $J = 5.2, 1.6, 1.6$ Hz, 2H), 3.66 (dd, $J = 10.4, 10.4$ Hz, 1H), 3.43 (dd, $J = 9.6$ Hz, 1H), 3.19 (br d, $J = 14.0$ Hz, 1H), 3.12-3.05 (m, 1H), 2.84-2.81 (m, 1H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 178.7, 159.1, 139.2, 133.2, 130.1, 121.2, 118.0, 115.4, 113.3, 68.9, 53.1, 43.2, 34.8; **HRMS** (ESI): m/z calc'd for $\text{C}_{13}\text{H}_{15}\text{O}_3\text{NNa}$ [M

+ Na]⁺: 256.0944, found: 256.0948.

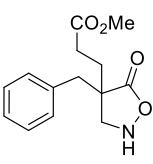
4-(4-((Trimethylsilyl)ethynyl)benzyl)isoxazolidin-5-one (1r): Prepared by the general procedure E from *tert*-butyl

 5-oxo-4-(4-((triisopropylsilyl)ethynyl)benzyl)isoxazolidine-2-carboxylate **S2r** (0.3 g, 0.65 mmol), and isolated as a colorless oil (63% yield); **IR** (thin film): ν 2942, 2891, 2865, 2155, 1776, 1507, 1462, 1159, 995, 882, 838, 677, 660 cm^{-1} ; **¹H NMR** (400 MHz, CDCl_3): δ 7.44 (d, J = 8.4 Hz, 2H), 7.14 (d, J = 8.0 Hz, 2H), 6.58 (br s, 1H), 3.67-3.61 (m, 1H), 3.41 (dd, J = 10.4, 10.4 Hz, 1H), 3.23 (dd, J = 14.4, 4.0 Hz, 1H), 3.12-3.04 (m, 1H), 2.87-2.81 (m, 1H), 1.13 (m, 21H); **¹³C NMR** (100 MHz, CDCl_3): δ 178.2, 137.9, 132.8, 128.7, 122.7, 106.6, 91.2, 53.0, 43.2, 34.7, 18.8, 11.5; **HRMS** (ESI): m/z calc'd for $\text{C}_{21}\text{H}_{31}\text{O}_2\text{NNaSi}$ [$\text{M} + \text{Na}$]⁺: 380.2016, found: 380.2017.

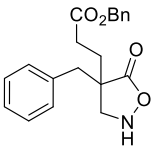
4-(3-Nitrobenzyl)isoxazolidin-5-one (1s): Prepared by the general procedure E from *tert*-butyl

 4-(3-nitrobenzyl)-5-oxoisoxazolidine-2-carboxylate **S2s** (0.22 g, 0.68 mmol), and isolated as a white solid (92% yield). **m.p.** 90-92 °C; **IR** (thin film): ν 3248, 2928, 1774, 1526, 1352, 1159, 994, 804, 735 cm^{-1} ; **¹H NMR** (400 MHz, CDCl_3): δ 8.14 (ddd, J = 8, 2.0, 1.2 Hz, 1H), 8.09 (dd, J = 2.0, 1.6 Hz, 1H), 7.58 (dd, J = 7.6, 1.6 Hz, 1H), 7.53 (t, J = 8.0 Hz, 1H), 6.77 (br s, 1H), 3.72 (dd, J = 11.2, 8.0 Hz, 1H), 3.46 (dd, J = 10.8, 10.8 Hz, 1H), 3.36 (dd, J = 14.4, 4.8 Hz, 1H), 3.23-3.15 (m, 1H), 2.98 (dd, J = 14.4, 8.8 Hz, 1H); **¹³C NMR** (100 MHz, CDCl_3): δ 177.8, 148.7, 139.7, 135.1, 130.1, 123.6, 122.5, 52.9, 42.9, 34.2; **HRMS** (ESI): m/z calc'd for $\text{C}_{10}\text{H}_{10}\text{O}_4\text{N}_2\text{Na}$ [$\text{M} + \text{Na}$]⁺: 245.0533, found: 245.0538.

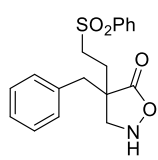
Methyl 3-(4-benzyl-5-oxoisoxazolidin-4-yl)propanoate (1t): Prepared by the general procedure E from **S2t** (185 mg,

 0.51 mmol), and isolated as a colorless oil (141 mg, 99% yield). **IR** (thin film): ν 3251, 2949, 1769, 1736, 1202, 1174, 757, 705 cm^{-1} ; **¹H NMR** (400 MHz, CDCl_3): δ 7.36-7.31 (m, 3H), 7.23-7.21 (m, 2H), 3.69 (s, 3H), 3.55-3.46 (m, 2H), 3.09 (d, J = 13.6 Hz, 1H), 2.80 (d, J = 13.6 Hz, 1H), 2.61-2.42 (m, 2H), 2.14-2.02 (m, 2H); **¹³C NMR** (100 MHz, CDCl_3): δ 180.3, 173.0, 135.2, 129.3, 129.1, 127.8, 55.7, 51.9, 48.4, 41.3, 30.5, 28.8; **HRMS** (ESI): m/z calc'd for $\text{C}_{14}\text{H}_{17}\text{O}_4\text{NNa}$ [$\text{M} + \text{Na}$]⁺: 286.1050, found: 286.1052.

Benzyl 3-(4-benzyl-5-oxoisoxazolidin-4-yl)propanoate (1u): Prepared by the general procedure E from **S2u** (527

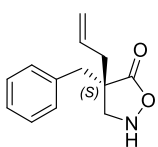
 mg, 1.2 mmol), and isolated as a colorless oil (382 mg, 94% yield). **IR** (thin film): ν 3248, 2949, 1769, 1733, 1455, 1171, 750, 701 cm^{-1} ; **¹H NMR** (400 MHz, CDCl_3): δ 7.38-7.31 (m, 8H), 7.22-7.20 (m, 2H), 5.14 (s, 2H), 3.53-3.45 (m, 2H), 3.09 (d, J = 13.6 Hz, 1H), 2.79 (d, J = 13.6 Hz, 1H), 2.65-2.51 (m, 2H), 2.12-2.06 (m, 2H); **¹³C NMR** (100 MHz, CDCl_3): δ 180.3, 172.3, 135.5, 135.2, 129.3, 129.1, 128.6, 128.4, 128.3, 127.8, 66.7, 55.7, 48.4, 41.2, 30.6, 29.1; **HRMS** (ESI): m/z calc'd for $\text{C}_{20}\text{H}_{21}\text{O}_4\text{NNa}$ [$\text{M} + \text{Na}$]⁺: 362.1363, found: 362.1361.

4-Benzyl-4-(2-(phenylsulfonyl)ethyl)isoxazolidin-5-one (1v): Prepared by the general procedure E from **S2v** (584



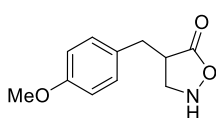
mg, 1.31 mmol), and isolated as a white solid (399 mg, 88% yield). **m.p.** 144–146 °C; **IR** (thin film): ν 3248, 2931, 1768, 1443, 13066, 1148, 751 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.92–7.90 (m, 2H), 7.71–7.67 (m, 1H), 7.62–7.57 (m, 2H), 7.31–7.30 (m, 3H), 7.15 (s, 2H), 5.66 (brs, 1H), 3.62–3.57 (m, 1H), 3.45–3.34 (m, 2H), 3.25–3.18 (m, 1H), 3.05 (d, $J = 13.6$ Hz, 1H), 2.76 (d, $J = 13.6$ Hz, 1H), 2.22–2.11 (m, 2H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 179.4, 138.6, 134.5, 134.1, 129.5, 129.2, 128.0, 55.8, 51.3, 47.8, 40.7, 28.0; **HRMS** (ESI): m/z calc'd for $\text{C}_{18}\text{H}_{19}\text{O}_4\text{NNaS}$ [$\text{M} + \text{Na}$] $^+$: 368.0927, found: 368.0928.

(S)-4-Allyl-4-benzylisoxazolidin-5-one (1w): Prepared by the general procedure E from (*S*)-**S2w** (92% ee, 130 mg,



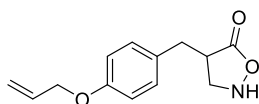
0.41 mmol), and isolated as a colorless oil (80.0 mg, 90% yield). **IR** (thin film): ν 3246, 2927, 1769, 1495, 1179, 1019, 924, 703 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.36–7.22 (m, 5H), 5.87–5.77 (m, 1H), 5.26–5.21 (m, 2H), 3.53 (s, 2H), 3.09 (d, $J = 13.6$ Hz, 1H), 2.82 (d, $J = 13.6$ Hz, 1H), 2.55–2.50 (m, 1H), 2.42–2.37 (m, 1H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 180.8, 135.6, 131.8, 129.3, 129.1, 127.7, 120.6, 55.1, 48.9, 41.7, 40.6; **HRMS** (ESI): m/z calc'd for $\text{C}_{13}\text{H}_{15}\text{O}_2\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 240.0995, found: 240.0992.

4-(4-Methoxybenzyl)isoxazolidin-5-one (1x): Prepared by the general procedure E from **S2x** (307 mg, 1.0 mmol),



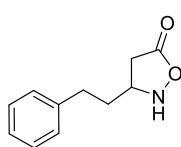
and isolated as a white solid (169 mg, 82% yield). **m.p.** 75–77 °C; **IR** (thin film): ν 3244, 2938, 1770, 1512, 1247, 1156, 1032, 806 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.12 (d, $J = 8.8$ Hz, 2H), 6.87–6.85 (m, 2H), 6.55 (brs, 1H), 3.79 (s, 3H), 3.67–3.63 (m, 1H), 3.44–3.39 (m, 1H), 3.16–3.13 (m, 1H), 3.09–3.01 (m, 1H), 2.84–2.82 (m, 1H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 178.7, 158.7, 129.6, 129.4, 114.3, 55.3, 52.8, 43.2, 33.8; **HRMS** (ESI): m/z calc'd for $\text{C}_{11}\text{H}_{12}\text{O}_3\text{N}$ [$\text{M} - \text{H}$] $^+$: 206.0823, found: 206.0826.

4-(4-(Allyloxy)benzyl)isoxazolidin-5-one (1y): Prepared by the general procedure E from *tert*-butyl



4-(4-(allyloxy)benzyl)-5-oxoisoxazolidine-2-carboxylate **S2y** (0.27 g, 0.83 mmol), and isolated as a yellow oil (75% yield); **IR** (thin film): ν 2984, 2926, 2859, 1777, 1612, 1512, 1458, 1372, 1245, 1221, 1167, 1131, 1022, 998, 832 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.11 (d, $J = 8.4$ Hz, 2H), 6.87 (d, $J = 8.8$ Hz, 2H), 6.52 (br s, 1H), 6.05 (ddt, $J = 17.2, 10.4, 5.2$ Hz, 1H), 5.41 (ddt, $J = 17.6, 1.6, 1.6$ Hz, 1H), 5.29 (ddt, $J = 10.4, 1.2, 1.2$ Hz, 1H), 4.52 (ddd, $J = 5.2, 1.6, 1.6$ Hz, 2H), 3.66 (dd, $J = 11.6, 8.0$ Hz, 1H), 3.42 (dd, $J = 11.2, 9.2$ Hz, 1H), 3.15 (dd, $J = 14.0, 4.4$ Hz, 1H), 3.09–3.01 (m, 1H), 2.82 (dd, $J = 13.6, 8.8$ Hz, 1H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 178.8, 157.9, 133.3, 129.8, 117.9, 115.3, 69.0, 53.0, 43.4, 33.9; **HRMS** (ESI): m/z calc'd for $\text{C}_{13}\text{H}_{15}\text{O}_3\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 256.0944, found: 256.0945.

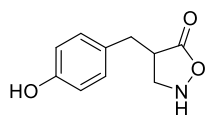
3-Phenethylisoxazolidin-5-one (1z): Prepared by the general procedure E from **S2z** (583 mg, 2.0 mmol), and



isolated as a colorless oil (355 mg, 93% yield). **IR** (thin film): ν 32333, 2928, 1782, 1454, 1177, 898, 702 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.33–7.29 (m, 2H), 7.24–7.17 (m, 3H), 6.71 (brs, 1H), 3.82–3.77 (m, 1H), 2.81–2.68 (m, 3H), 2.45–2.39 (m, 1H), 2.07–1.98 (m, 1H), 1.91–1.82 (m, 1H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 177.3, 140.3, 128.6, 128.3, 126.4, 58.6, 36.1, 34.2, 32.2; **HRMS** (ESI): m/z calc'd

for $C_{11}H_{12}O_2N$ $[M - H]^+$: 190.0874, found: 190.0874.

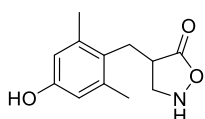
4-(4-Hydroxybenzyl)isoxazolidin-5-one (7a): Prepared by the general procedure E from **S4a** (3.50 g, 10.0 mmol),



and isolated as a white solid (1.76 g, 90% yield). **m.p.** 119–121 °C; **IR** (thin film): ν 3434, 2248, 1767, 1658, 1027, 821, 759 cm^{-1} ; **1H NMR** (400 MHz, $DMSO-d_6$): δ 9.25 (s, 1H), 8.25 (brs, 1H), 7.03–7.01 (m, 2H), 6.70–6.67 (m, 2H), 3.47–3.40 (m, 1H), 3.20 (dd, $J = 13.6, 10.8$ Hz, 1H), 3.10–3.02 (m, 1H), 2.91 (dd, $J = 14.0, 8.8$ Hz, 1H), 2.67–2.65 (m, 1H); **^{13}C NMR** (100 MHz, $DMSO-d_6$):

δ 179.8, 155.9, 129.7, 128.5, 115.2, 52.1, 42.7, 32.8; **HRMS** (ESI): m/z calc'd for $C_{10}H_{10}O_3N$ $[M - H]^+$: 192.0666, found: 192.0664.

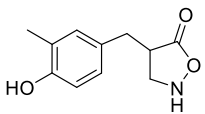
4-(4-Hydroxy-2,6-dimethylbenzyl)isoxazolidin-5-one (7b): Prepared by the general procedure E from **S4b** (321 mg,



1.0 mmol), and isolated as a white solid (195 mg, 88% yield). **m.p.** 151–153 °C; **IR** (KBr): ν 3151, 2938, 1782, 1594, 1469, 1309, 968, 844 cm^{-1} ; **1H NMR** (400 MHz, $DMSO-d_6$): δ 9.01 (s, 1H), 8.19 (brs, 1H), 6.42 (s, 2H), 3.50–3.44 (m, 1H), 3.30–3.25 (m, 1H), 2.96–2.86 (m, 2H), 2.74–2.71 (m, 1H), 2.18 (s, 6H); **^{13}C NMR** (100 MHz, $DMSO-d_6$): δ 179.9, 155.2, 137.2, 126.1, 115.0, 53.0, 41.9, 26.8,

20.0; **HRMS** (ESI): m/z calc'd for $C_{12}H_{15}O_3NNa$ $[M + Na]^+$: 244.0944, found: 244.0941.

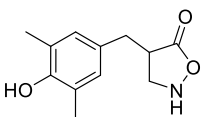
4-(4-Hydroxy-3-methylbenzyl)isoxazolidin-5-one (7c): Prepared by the general procedure E from **S4c** (415 mg,



1.35 mmol), and isolated as a colorless gum (202 mg, 42% yield). **IR** (thin film): ν 3240, 2924, 1768, 1510, 1264, 1161, 993, 757 cm^{-1} ; **1H NMR** (400 MHz, $DMSO-d_6$): δ 9.12 (brs, 1H), 8.24 (brs, 1H), 6.91 (d, $J = 1.6$ Hz, 1H), 6.85–6.82 (m, 1H), 6.69–6.67 (m, 1H), 3.46–3.41 (m, 1H), 3.23–3.16

(m, 1H), 3.08–3.03 (m, 1H), 2.90–2.86 (m, 1H), 2.63–2.61 (m, 1H), 2.08 (s, 3H); **^{13}C NMR** (100 MHz, $DMSO-d_6$): δ 179.8, 153.9, 130.9, 128.4, 126.8, 123.7, 114.5, 52.1, 42.7, 32.8, 16.0; **HRMS** (ESI): m/z calc'd for $C_{11}H_{13}O_3NNa$ $[M + Na]^+$: 230.0788, found: 230.0787.

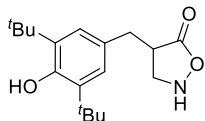
4-(4-Hydroxy-3,5-dimethylbenzyl)isoxazolidin-5-one (7d): Prepared by the general procedure E from **S4d** (200 mg,



0.62 mmol), and isolated as a white solid (118 mg, 86% yield). **m.p.** 94–96 °C; **IR** (KBr): ν 3246, 2911, 1756, 1490, 1328, 1212, 1002, 814 cm^{-1} ; **1H NMR** (400 MHz, $CDCl_3$): δ 6.80 (s, 2H), 5.00 (brs, 2H), 3.68–3.64 (m, 1H), 3.45–3.40 (m, 1H), 3.10–3.00 (m, 2H), 2.77–2.71 (m, 1H), 2.22 (s, 6H); **^{13}C**

NMR (100 MHz, $CDCl_3$): δ 178.8, 151.3, 128.9, 128.7, 123.6, 52.8, 43.2, 33.8, 15.9; **HRMS** (ESI): m/z calc'd for $C_{12}H_{14}O_3N$ $[M - H]^+$: 220.0979, found: 220.0978.

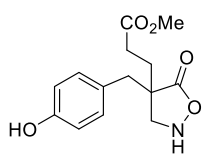
4-(3,5-Di-*tert*-butyl-4-hydroxybenzyl)isoxazolidin-5-one (7e): Prepared by the general procedure E from **S4e** (600



mg, 1.48 mmol), and isolated as a white solid (366 mg, 81% yield). **m.p.** 110–112 °C; **IR** (thin film): ν 3638, 2957, 1773, 1436, 1236, 1157, 880, 757 cm^{-1} ; **1H NMR** (400 MHz, $CDCl_3$): δ 6.98 (s, 2H), 5.89 (brs, 1H), 5.16 (brs, 1H), 3.70 (dd, $J = 11.6, 8.4$ Hz, 1H), 3.45 (dd, $J = 11.6, 8.8$ Hz, 1H),

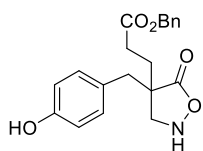
3.14–3.01 (m, 2H), 2.80 (dd, $J = 13.6, 8.4$ Hz, 1H), 1.43 (s, 18H); ^{13}C NMR (100 MHz, CDCl_3): δ 178.9, 152.8, 136.4, 128.0, 125.1, 53.0, 43.4, 34.7, 34.3, 30.2; HRMS (ESI): m/z calc'd for $\text{C}_{18}\text{H}_{27}\text{O}_3\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 328.1883, found: 328.1880.

Methyl 3-(4-(4-hydroxybenzyl)-5-oxoisoxazolidin-4-yl)propanoate (7f): Prepared by the general procedure E from



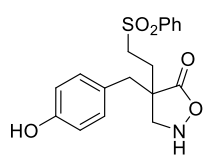
S4f (436 mg, 1.0 mmol), and isolated as a white solid (269 mg, 96% yield). **m.p.** 98–100 °C; **IR** (thin film): ν 3377, 2953, 1516, 1441, 1209, 1055, 754 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3): δ 7.08–7.06 (m, 2H), 6.80–6.77 (m, 2H), 5.74 (brs, 2H), 3.70 (s, 3H), 3.57–3.48 (m, 2H), 3.02 (d, $J = 13.6$ Hz, 1H), 2.73 (d, $J = 13.6$ Hz, 1H), 2.61–2.41 (m, 2H), 2.13–2.00 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ 180.7, 173.2, 155.5, 130.6, 126.8, 116.1, 55.6, 52.0, 48.6, 40.4, 30.4, 28.9; **HRMS** (ESI): m/z calc'd for $\text{C}_{14}\text{H}_{17}\text{O}_5\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 302.0999, found: 302.0996.

Benzyl 3-(4-(4-hydroxybenzyl)-5-oxoisoxazolidin-4-yl)propanoate (7g): Prepared by the general procedure E from



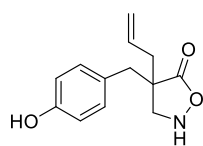
S4g (512 mg, 1.0 mmol), and isolated as a colorless gum (300 mg, 84% yield). **IR** (thin film): ν 3393, 2942, 1769, 1733, 1516, 1174, 751 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3): δ 7.39–7.32 (m, 5H), 7.07–7.04 (m, 2H), 6.79–6.75 (m, 2H), 5.14 (s, 2H), 3.53 (d, $J = 12.0$ Hz, 1H), 3.44 (d, $J = 12.0$ Hz, 1H), 3.01 (d, $J = 14.0$ Hz, 1H), 2.72 (d, $J = 14.0$ Hz, 1H), 2.65–2.46 (m, 2H), 2.14–2.01 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ 180.6, 172.5, 155.5, 135.5, 130.6, 128.6, 128.4, 128.3, 126.9, 116.1, 66.8, 55.7, 48.6, 40.2, 30.3, 29.1; **HRMS** (ESI): m/z calc'd for $\text{C}_{20}\text{H}_{21}\text{O}_5\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 378.1312, found: 378.1305.

4-(4-Hydroxybenzyl)-4-(2-(phenylsulfonyl)ethyl)isoxazolidin-5-one (7h): Prepared by the general procedure E



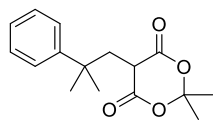
from **S4h** (518 mg, 1.0 mmol), and isolated as a white foam (318 mg, 88% yield). **IR** (thin film): ν 3396, 2977, 1769, 1517, 1307, 1148, 753 cm^{-1} ; ^1H NMR (400 MHz, $\text{DMSO}-d_6$): δ 9.28 (s, 1H), 8.39 (t, $J = 8.0$ Hz, 1H), 7.92–7.89 (m, 2H), 7.81–7.77 (m, 1H), 7.70–7.67 (m, 2H), 6.85–6.83 (m, 2H), 6.61–6.57 (m, 2H), 3.44–3.39 (m, 3H), 3.29–3.24 (m, 1H), 2.80–2.71 (m, 2H), 1.91–1.71 (m, 2H); ^{13}C NMR (100 MHz, $\text{DMSO}-d_6$): δ 179.7, 156.2, 138.5, 134.0, 131.0, 129.5, 127.8, 125.5, 115.0, 54.6, 50.3, 47.4, 36.4, 25.3; **HRMS** (ESI): m/z calc'd for $\text{C}_{18}\text{H}_{19}\text{O}_5\text{NNaS}$ [$\text{M} + \text{Na}$] $^+$: 384.0876, found: 384.0869.

4-Allyl-4-(4-hydroxybenzyl)isoxazolidin-5-one (7i): Prepared by the general procedure E from **S4i** (221 mg, 0.57



mmol), and isolated as a colorless oil (125 mg, 94% yield). **IR** (thin film): ν 3247, 1766, 1516, 1443, 1233, 1177, 924, 838 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3): δ 7.09–7.07 (m, 2H), 6.79–6.76 (m, 2H), 5.86–5.70 (m, 2H), 5.25–5.21 (m, 2H), 3.52 (brs, 2H), 3.02 (d, $J = 14.0$ Hz, 1H), 2.75 (d, $J = 14.0$ Hz, 1H), 2.54–2.49 (m, 1H), 2.41–2.35 (m, 1H); ^{13}C NMR (100 MHz, CDCl_3): δ 181.2, 155.5, 131.7, 130.6, 127.2, 120.7, 116.0, 55.0, 49.2, 40.9, 40.5; **HRMS** (ESI): m/z calc'd for $\text{C}_{13}\text{H}_{15}\text{O}_3\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 256.0944, found: 256.0941.

2,2-Dimethyl-5-(2-methyl-2-phenylpropyl)-1,3-dioxane-4,6-dione (S5): Prepared by the general procedure B from



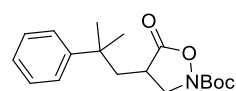
3-methyl-3-phenyl-butanal (0.61 g, 4.1 mmol), and isolated as a white solid (72% yield). **m.p.**

144-145 °C; **IR** (thin film): ν 3053, 2996, 2961, 2877, 1787, 1748, 1380, 1322, 1206, 1064, 960, 762,

699 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.41 (d, $J = 7.6$ Hz, 2H), 7.32 (t, $J = 7.6$ Hz, 2H), 7.20 (t, $J =$

7.2 Hz, 1H), 3.04 (t, $J = 4.0$ Hz, 1H), 2.57 (d, $J = 3.6$ Hz, 2H), 1.69 (s, 3H), 1.56 (s, 3H), 1.41 (s, 6H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 165.7, 146.9, 128.6, 126.6, 126.4, 104.5, 44.8, 38.4, 37.2, 29.2, 28.9, 25.8; **HRMS** (ESI): m/z calc'd for $\text{C}_{16}\text{H}_{20}\text{O}_4\text{NNa}$ $[\text{M} + \text{Na}]^+$: 299.1254, found: 299.1259.

tert-Butyl 4-(2-methyl-2-phenylpropyl)-5-oxoisoxazolidine-2-carboxylate (S6): Prepared by the general procedure



C from 2,2-dimethyl-5-(2-methyl-2-phenylpropyl)-1,3-dioxane-4,6-dione **S5** (0.76 g, 2.7 mmol),

and isolated as a colorless oil (97% yield); **IR** (thin film): ν 2970, 2935, 1798, 1749, 1718, 1370,

1334, 1143, 849, 768, 702 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.37-7.32 (m, 4H), 7.25-7.21 (m,

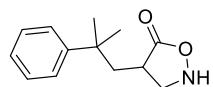
1H), 3.64 (dd, $J = 11.2, 8.4$ Hz, 1H), 3.08 (dd, $J = 11.2, 11.2$ Hz, 1H), 2.61-2.53 (m, 1H), 2.38 (dd, $J = 14.4, 2.4$ Hz, 1H),

1.81 (dd, $J = 14.4, 10.4$ Hz, 1H), 1.45 (s, 9H), 1.39 (s, 3H), 1.38 (s, 3H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 175.7, 155.9,

146.9, 128.8, 126.7, 125.9, 84.0, 54.9, 44.0, 38.0, 37.4, 30.0, 28.1, 28.0; **HRMS** (ESI): m/z calc'd for $\text{C}_{18}\text{H}_{25}\text{O}_4\text{NNa}$ $[\text{M} +$

$\text{Na}]^+$: 342.1676, found: 342.1680.

4-(2-Methyl-2-phenylpropyl)isoxazolidin-5-one (4): Prepared by the general procedure E from *tert*-butyl



4-(2-methyl-2-phenylpropyl)-5-oxoisoxazolidine-2-carboxylate **S6** (0.39 g, 1.2 mmol), and

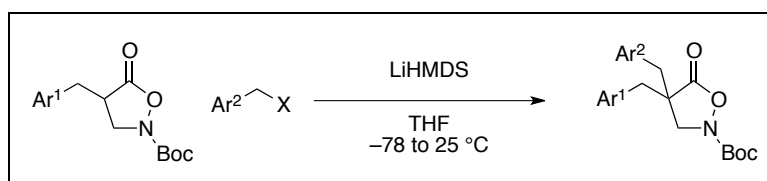
isolated as a colorless oil (99% yield); **IR** (thin film): ν 3242, 2965, 2875, 1772, 1496, 1445, 1370,

1239, 1158, 995, 887, 767, 702, 684 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.35-7.3 (m, 4H), 7.25-7.19

(m, 1H), 6.47 (s, 1H), 3.00 (dd, $J = 11.6, 8.8$ Hz, 1H), 2.91 (m, 1H), 2.49-2.47 (m, 2H), 2.36 (dd, $J = 14.4, 2.4$ Hz, 1H),

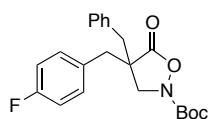
1.78 (dd, $J = 14.4, 10.0$ Hz, 1H), 1.39 (s, 3H), 1.38 (s, 3H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 180.3, 147.3, 128.6, 126.4,

125.9, 54.9, 44.1, 39.2, 37.4, 30.1, 28.1; **HRMS** (ESI): m/z calc'd for $\text{C}_{13}\text{H}_{17}\text{O}_2\text{NNa}$ $[\text{M} + \text{Na}]^+$: 242.1152, found: 242.1153.



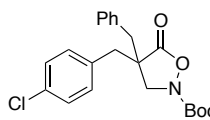
General procedure F: To a solution of Boc protected isoxazolidin-5-one in THF (0.3 M) was added LiHMDS (1.0 M in THF, 1.6 equiv) at -78 °C. The solution was stirred for 1 h at the same temperature, followed by the addition of the corresponding benzyl halide (2.0 equiv). The flask was gradually warmed to 25 °C. After the addition of sat aq NH_4Cl , the aqueous phase was extracted with EtOAc (3x). The combined organic layers were washed with brine, dried over Na_2SO_4 , filtered, and concentrated under reduced pressure. The obtained crude material was purified by silica gel column chromatography to provide the alkylated products.

tert-Butyl 4-benzyl-4-(4-fluorobenzyl)-5-oxoisoxazolidine-2-carboxylate (S7a): Prepared by the general procedure



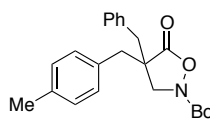
F from **S2a** (100 mg, 0.36 mmol) and 4-fluorobenzyl bromide (90 μ L, 0.72 mmol, 2.0 equiv), and isolated as a white solid (106 mg, 76% yield). **m.p.** 126–127 $^{\circ}$ C; **IR** (thin film): ν 2981, 2931, 1790, 1715, 1510, 1370, 1225, 1145 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.37–7.28 (m, 3H), 7.21–7.11 (m, 4H), 7.04–6.96 (m, 2H), 3.94 (d, $J = 11.2$ Hz, 1H), 3.87 (d, $J = 11.2$ Hz, 1H), 3.16 (d, $J = 5.6$ Hz, 1H), 3.13 (d, $J = 5.6$ Hz, 1H), 2.83 (d, $J = 13.9$ Hz, 1H), 2.79 (d, $J = 13.9$ Hz, 1H), 1.43 (s, 9H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 176.0, 162.4 (d, $J = 245.0$ Hz), 155.3, 132.1, 132.0, 130.6 (d, $J = 3.0$ Hz), 130.5, 129.0, 127.8, 115.8 (d, $J = 21.0$ Hz), 84.0, 52.8, 51.2, 40.9, 40.1, 28.2; **$^{19}\text{F NMR}$** (376 MHz, CDCl_3): δ -114.9; **HRMS** (ESI): m/z calc'd for $\text{C}_{22}\text{H}_{24}\text{O}_4\text{NFNa}$ [$\text{M} + \text{Na}$] $^{+}$: 408.1582, found: 408.1586.

tert-Butyl 4-benzyl-4-(4-chlorobenzyl)-5-oxoisoxazolidine-2-carboxylate (S7b): Prepared by the general



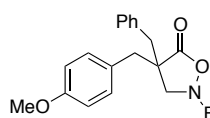
procedure F from **S2a** (600 mg, 2.16 mmol) and 4-chlorobenzyl bromide (889 μ L, 4.32 mmol, 2.0 equiv), and isolated as a white solid (623 mg, 72% yield). **m.p.** 141–143 $^{\circ}$ C; **IR** (thin film): ν 2981, 2931, 1790, 1715, 1493, 1369, 1145, 1092 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.37–7.27 (m, 5H), 7.21–7.16 (m, 2H), 7.15–7.08 (m, 2H), 3.95 (d, $J = 11.2$ Hz, 1H), 3.85 (d, $J = 11.2$ Hz, 1H), 3.16 (d, $J = 6.7$ Hz, 1H), 3.12 (d, $J = 6.7$ Hz, 1H), 2.82 (d, $J = 13.8$ Hz, 1H), 2.78 (d, $J = 13.8$ Hz, 1H), 1.43 (s, 9H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 175.9, 155.3, 134.7, 133.8, 133.4, 131.8, 130.5, 129.1, 129.0, 127.8, 84.1, 52.9, 51.2, 41.0, 40.2, 28.2; **HRMS** (ESI): m/z calc'd for $\text{C}_{22}\text{H}_{24}\text{O}_4\text{NCINa}$ [$\text{M} + \text{Na}$] $^{+}$: 424.1286, found: 424.1290.

tert-Butyl 4-benzyl-4-(4-methylbenzyl)-5-oxoisoxazolidine-2-carboxylate (S7c): Prepared by the general



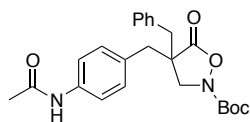
procedure F from **S2a** (600 mg, 2.16 mmol) and 4-methylbenzyl bromide (799 mg, 4.32 mmol, 2.0 equiv), and isolated as a white solid (667 mg, 81% yield). **m.p.** 126–127 $^{\circ}$ C; **IR** (thin film): ν 2980, 2923, 1790, 1715, 1369, 1146 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.36–7.25 (m, 3H), 7.21–7.16 (m, 2H), 7.15–7.10 (m, 2H), 7.08–7.06 (m, 2H), 3.94 (d, $J = 11.2$ Hz, 1H), 3.90 (d, $J = 11.2$ Hz, 1H), 3.16 (d, $J = 14.1$ Hz, 1H), 3.12 (d, $J = 14.1$ Hz, 1H), 2.82 (d, $J = 10.0$ Hz, 1H), 2.78 (d, $J = 10.0$ Hz, 1H), 2.33 (s, 3H), 1.43 (s, 9H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 176.2, 155.4, 137.3, 135.0, 131.8, 130.5, 130.4, 129.6, 128.9, 127.6, 83.8, 52.9, 51.2, 40.8, 40.5, 28.2, 21.2; **HRMS** (ESI): m/z calc'd for $\text{C}_{23}\text{H}_{27}\text{O}_4\text{NNa}$ [$\text{M} + \text{Na}$] $^{+}$: 404.1832, found: 404.1834.

tert-Butyl 4-benzyl-4-(4-methoxybenzyl)-5-oxoisoxazolidine-2-carboxylate (S7d): Prepared by the general



procedure F from **S2x** (400 mg, 1.30 mmol) and benzyl bromide (309 μ L, 2.60 mmol, 2.0 equiv), and isolated as a white solid (387 mg, 75% yield). **m.p.** 111–112 $^{\circ}$ C; **IR** (thin film): ν 2979, 2934, 1789, 1714, 1513, 1369, 1249, 1145, 1032 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.34–7.23 (m, 3H), 7.20–7.14 (m, 2H), 7.12–7.06 (m, 2H), 6.87–6.80 (m, 2H), 3.93 (d, $J = 11.2$ Hz, 1H), 3.89 (d, $J = 11.2$ Hz, 1H), 3.77 (s, 3H), 3.14 (d, $J = 13.8$ Hz, 1H), 3.09 (d, $J = 13.8$ Hz, 1H), 2.80 (d, $J = 13.9$ Hz, 1H), 2.76 (d, $J = 13.9$ Hz, 1H), 1.41 (s, 9H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 176.2, 162.7, 159.1, 155.3, 131.5, 130.4, 128.8, 127.6, 126.8, 114.2, 83.7, 55.3, 52.8, 51.3, 40.8, 40.1, 28.1; **HRMS** (ESI): m/z calc'd for $\text{C}_{23}\text{H}_{27}\text{O}_5\text{NNa}$ [$\text{M} + \text{Na}$] $^{+}$: 420.1781, found: 420.1786.

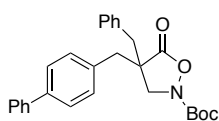
tert-Butyl 4-(4-acetamidobenzyl)-4-benzyl-5-oxoisoxazolidine-2-carboxylate (S7e): Prepared by the general



procedure F from **S2a** (300 mg, 1.08 mmol), *N*-(4-(bromomethyl)phenyl)acetamide (320 mg, 1.40 mmol, 1.3 equiv), and LiHMDS (2.7 mL, 2.70 mmol, 2.5 equiv), and isolated as a white solid (325 mg, 71% yield). **m.p.** 121–122 °C; **IR** (thin film): ν 3314, 2980, 2931, 1790, 1716,

1671, 1602, 1536, 1516, 1370, 1317, 1145 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.49–7.42 (m, 2H), 7.37–7.27 (m, 2H), 7.21–7.09 (m, 5H), 3.92 (d, $J = 11.3$ Hz, 1H), 3.88 (d, $J = 11.3$ Hz, 1H), 3.14 (d, $J = 9.0$ Hz, 1H), 3.11 (d, $J = 9.0$ Hz, 1H), 2.82 (d, $J = 10.5$ Hz, 1H), 2.78 (d, $J = 10.5$ Hz, 1H), 2.17 (s, 3H), 1.43 (s, 9H); **^{13}C NMR** (100 MHz, CDCl_3): δ 176.0, 168.3, 155.4, 137.4, 134.9, 131.2, 130.7, 130.5, 128.9, 127.7, 120.1, 84.0, 53.0, 51.2, 40.7, 40.1, 28.2, 24.8; **HRMS** (ESI): m/z calc'd for $\text{C}_{24}\text{H}_{28}\text{O}_5\text{N}_2\text{Na}$ [$\text{M} + \text{Na}$] $^+$: 447.1890, found: 447.1896.

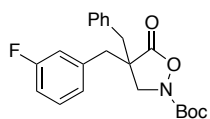
tert-Butyl 4-([1,1'-biphenyl]-4-ylmethyl)-4-benzyl-5-oxoisoxazolidine-2-carboxylate (S7f): Prepared by the



general procedure F from **S2a** (800 mg, 2.88 mmol) and 4-phenylbenzyl bromide (1.42 g, 5.76 mmol, 2.0 equiv), and isolated as a white solid (980 mg, 76% yield). **m.p.** 133–134 °C; **IR** (thin film): ν 3029, 2980, 2930, 1789, 1714, 1486, 1369, 1144 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.62–7.53 (m, 4H), 7.48–7.41 (m, 2H), 7.40–7.30 (m, 4H), 7.29–7.25 (m, 2H), 7.25–7.19 (m, 2H), 3.98 (s,

2H), 3.22 (d, $J = 13.8$ Hz, 1H), 3.20 (d, $J = 13.8$ Hz, 1H), 2.88 (d, $J = 13.8$ Hz, 1H), 2.87 (d, $J = 13.8$ Hz, 1H), 1.44 (s, 9H); **^{13}C NMR** (100 MHz, CDCl_3): δ 176.1, 155.4, 140.6, 140.5, 134.9, 133.9, 131.0, 130.5, 128.9, 128.9, 127.7, 127.5, 127.5, 127.1, 83.9, 52.9, 51.2, 40.8, 40.4, 28.2; **HRMS** (ESI): m/z calc'd for $\text{C}_{28}\text{H}_{29}\text{O}_4\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 466.1989, found: 466.1992.

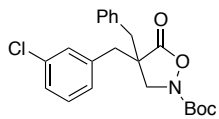
tert-Butyl 4-benzyl-4-(3-fluorobenzyl)-5-oxoisoxazolidine-2-carboxylate (S7g): Prepared by the general



procedure F from **S2a** (500 mg, 1.80 mmol) and 3-fluorobenzyl bromide (448 mL, 3.60 mmol, 2.0 equiv), and isolated as a white solid (576 mg, 83% yield). **m.p.** 113–114 °C; **IR** (thin film): ν 2980, 2932, 1789, 1717, 1587, 1369, 1255, 1145 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.37–7.25 (m, 4H), 7.22–7.16 (m, 2H), 7.02–6.94 (m, 2H), 6.92–6.88 (m, 1H), 3.97 (d, $J = 11.2$ Hz, 1H), 3.86 (d, $J = 11.2$

Hz, 1H), 3.17 (d, $J = 4.8$ Hz, 1H), 3.14 (d, $J = 4.8$ Hz, 1H), 2.84 (d, $J = 11.6$ Hz, 1H), 2.81 (d, $J = 11.6$ Hz, 1H), 1.43 (s, 9H); **^{13}C NMR** (100 MHz, CDCl_3): δ 175.8, 162.9 (d, $J = 245.0$ Hz), 155.3, 137.4 (d, $J = 7.0$ Hz), 134.7, 130.5, 130.5, 130.4 (d, $J = 8.0$ Hz), 128.9, 127.8, 117.5 (d, $J = 21.0$ Hz), 114.7 (d, $J = 21.0$ Hz), 84.0, 52.9, 51.1, 40.9, 40.3, 28.2; **^{19}F NMR** (376 MHz, CDCl_3): δ -112.3; **HRMS** (ESI): m/z calc'd for $\text{C}_{22}\text{H}_{24}\text{O}_4\text{NFNa}$ [$\text{M} + \text{Na}$] $^+$: 408.1582, found: 408.1581.

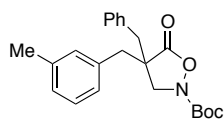
tert-Butyl 4-benzyl-4-(3-chlorobenzyl)-5-oxoisoxazolidine-2-carboxylate (S7h): Prepared by the general



procedure F from **S2a** (500 mg, 1.80 mmol) and 3-chlorobenzyl bromide (474 μL , 3.60 mmol, 2.0 equiv), and isolated as a white solid (570 mg, 79% yield). **m.p.** 135–136 °C; **IR** (thin film): ν 2980, 2932, 1789, 1715, 1476, 1370, 1145, 1081 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.37–7.29 (m, 3H), 7.28–7.22 (m, 2H), 7.21–7.15 (m, 3H), 7.09–7.06 (m, 1H), 3.97 (d, $J = 11.2$ Hz, 1H), 3.85 (d, $J =$

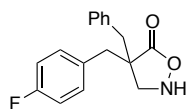
11.2 Hz, 1H), 3.15 (d, $J = 13.8$ Hz, 1H), 3.13 (d, $J = 13.8$ Hz, 1H), 2.83 (d, $J = 13.7$ Hz, 1H), 2.79 (d, $J = 13.7$ Hz, 1H), 1.44 (s, 9H); **^{13}C NMR** (100 MHz, CDCl_3): δ 175.7, 155.3, 137.0, 134.7, 134.6, 103.5, 130.5, 130.2, 129.0, 128.7, 128.0, 127.8, 84.1, 52.9, 51.0, 40.9, 40.2, 28.2; **HRMS** (ESI): m/z calc'd for $\text{C}_{22}\text{H}_{24}\text{O}_4\text{NClNa}$ [$\text{M} + \text{Na}$] $^+$: 424.1286, found: 424.1290.

tert-Butyl 4-benzyl-4-(3-methylbenzyl)-5-oxoisoxazolidine-2-carboxylate (S7i): Prepared by the general



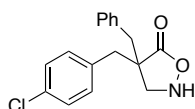
procedure F from **S2a** (500 mg, 1.80 mmol) and 3-methylbenzyl bromide (490 μ L, 3.60 mmol, 2.0 equiv), and isolated as a white solid (452 mg, 66% yield). **m.p.** 124–126 $^{\circ}$ C; **IR** (thin film): ν 2979, 2928, 1790, 1714, 1369, 1145 cm^{-1} ; $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.35–7.27 (m, 3H), 7.23–7.16 (m, 3H), 7.12–7.07 (m, 1H), 7.01–6.96 (m, 2H), 3.92 (s, 2H), 3.16 (d, $J = 10.0$ Hz, 1H), 3.13 (d, $J = 10.0$ Hz, 1H), 2.82 (d, $J = 13.8$ Hz, 1H), 2.79 (d, $J = 13.8$ Hz, 1H), 2.33 (s, 3H), 1.43 (s, 9H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3): δ 176.2, 155.3, 138.5, 135.0, 134.9, 131.3, 130.5, 128.9, 128.7, 128.4, 127.7, 127.6, 83.8, 52.9, 51.1, 40.9, 40.7, 28.2, 21.6; **HRMS** (ESI): m/z calc'd for $\text{C}_{23}\text{H}_{27}\text{O}_4\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 404.1832, found: 404.1839.

4-Benzyl-4-(4-fluorobenzyl)isoxazolidin-5-one (S8a): Prepared by the general procedure E from **S7a** (88 mg, 0.22



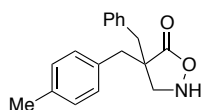
mmol), and isolated as a white solid (61 mg, 97% yield). **m.p.** 100–101 $^{\circ}$ C; **IR** (thin film): ν 3530, 3251, 3064, 3030, 2923, 1768, 1603, 1509, 1224, 1160, 1024 cm^{-1} ; $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.39–7.28 (m, 3H), 7.25–7.14 (m, 4H), 7.07–6.98 (m, 2H), 5.21 (s, 1H), 3.55 (s, 2H), 3.19 (d, $J = 5.2$ Hz, 1H), 3.15 (d, $J = 5.2$ Hz, 1H), 2.83 (s, 2H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3): δ 181.0, 162.4 (d, $J = 246.0$ Hz), 135.6, 131.6, 131.5 (d, $J = 3.0$ Hz), 129.7, 129.3, 128.0, 116.0 (d, $J = 19.0$ Hz), 54.6, 50.8, 42.6, 41.7; $^{19}\text{F NMR}$ (376 MHz, CDCl_3): δ –113.7, –115.2; **HRMS** (ESI): m/z calc'd for $\text{C}_{17}\text{H}_{16}\text{O}_2\text{NFNa}$ [$\text{M} + \text{Na}$] $^+$: 308.1057, found: 308.1062.

4-Benzyl-4-(4-chlorobenzyl)isoxazolidin-5-one (S8b): Prepared by the general procedure E from **S7b** (328 mg,



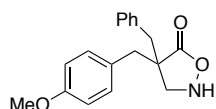
0.816 mmol), and isolated as a white solid (231 mg, 94% yield). **m.p.** 108–109 $^{\circ}$ C; **IR** (thin film): ν 3249, 3028, 2922, 1769, 1492, 1168, 1091, 1016 cm^{-1} ; $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.37–7.29 (m, 5H), 7.25–7.21 (m, 2H), 7.19–7.12 (m, 2H), 5.22 (s, 1H), 3.54 (s, 2H), 3.19 (d, $J = 6.9$ Hz, 1H), 3.15 (d, $J = 6.9$ Hz, 1H), 2.83 (s, 2H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3): δ 180.9, 135.5, 134.2, 133.8, 131.4, 131.3, 129.7, 129.3, 128.0, 54.7, 50.7, 42.7, 41.8; **HRMS** (ESI): m/z calc'd for $\text{C}_{17}\text{H}_{16}\text{O}_2\text{NCINa}$ [$\text{M} + \text{Na}$] $^+$: 324.0762, found: 324.0763.

4-Benzyl-4-(4-methylbenzyl)isoxazolidin-5-one (S8c): Prepared by the general procedure E from **S7c** (347 mg, 0.91



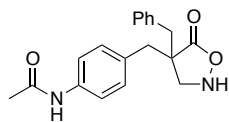
mmol), and isolated as a white solid (237 mg, 93% yield). **m.p.** 124–125 $^{\circ}$ C; **IR** (thin film): ν 3251, 3025, 2920, 1766, 1513, 1454, 1170, 1024 cm^{-1} ; $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.38–7.27 (m, 3H), 7.24–7.18 (m, 2H), 7.17–7.06 (m, 4H), 5.13 (t, $J = 9.1$ Hz, 1H), 3.66 (s, 1H), 3.42 (s, 1H), 3.17 (d, $J = 13.1$ Hz, 1H), 3.14 (d, $J = 13.1$ Hz, 1H), 2.83 (s, 2H), 2.33 (s, 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3): δ 181.4, 135.9, 132.6, 130.0, 129.9, 129.2, 129.1, 127.8, 127.7, 55.0, 50.8, 42.7, 42.4, 21.2; **HRMS** (ESI): m/z calc'd for $\text{C}_{18}\text{H}_{19}\text{O}_2\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 304.1308, found: 304.1312.

4-Benzyl-4-(4-methoxybenzyl)isoxazolidin-5-one (S8d): Prepared by the general procedure E from **S7d** (522 g,



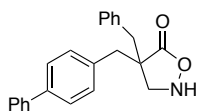
1.31 mmol), and isolated as a white solid (382 mg, 98% yield). **m.p.** 85–86 $^{\circ}$ C; **IR** (thin film): ν 3247, 3029, 2918, 2836, 1768, 1610, 1512, 1247, 1179, 1028 cm^{-1} ; $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.38–7.27 (m, 3H), 7.25–7.18 (m, 2H), 7.17–7.10 (m, 2H), 6.90–6.83 (m, 2H), 5.18 (t, $J = 8.9$ Hz, 1H), 3.79 (s, 3H), 3.61 (s, 2H), 3.17 (d, $J = 14.5$ Hz, 1H), 3.12 (d, $J = 14.5$ Hz, 1H), 2.82 (s, 2H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3): δ 181.4, 159.2, 135.8, 130.6, 130.0, 129.1, 127.8, 127.5, 114.5, 55.4, 54.9, 50.8, 42.6, 41.8; **HRMS** (ESI): m/z calc'd for $\text{C}_{18}\text{H}_{19}\text{O}_3\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 320.1257, found: 320.1264.

N-(4-((4-Benzyl-5-oxoisoxazolidin-4-yl)methyl)phenyl)acetamide (S8e): Prepared by the general procedure E



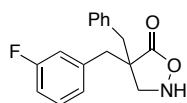
from **S7e** (299 mg, 0.704 mmol), and isolated as an amorphous solid (197 mg, 86% yield). **IR** (thin film): ν 3249, 3119, 3031, 2921, 1768, 1669, 1601, 1536, 1515, 1412, 1318, 1168, 1024, 910 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.77 (s, 1H), 7.47 (d, $J = 8.2$ Hz, 2H), 7.38–7.27 (m, 3H), 7.21 (dd, $J = 2.0, 7.4$ Hz, 2H), 7.14 (d, $J = 8.2$ Hz, 2H), 5.28 (s, 1H), 3.53 (s, 2H), 3.17 (d, $J = 13.4$ Hz, 1H), 3.13 (d, $J = 13.4$ Hz, 1H), 2.82 (s, 2H), 2.15 (s, 3H); **^{13}C NMR** (100 MHz, CDCl_3): δ 181.4, 168.8, 137.8, 135.6, 131.3, 130.4, 129.8, 129.2, 127.8, 120.3, 54.7, 50.9, 42.6, 41.9, 24.6; **HRMS** (ESI): m/z calc'd for $\text{C}_{19}\text{H}_{20}\text{O}_3\text{N}_2\text{Na}$ [$\text{M} + \text{Na}$] $^+$: 347.1366, found: 347.1374.

4-([1,1'-Biphenyl]-4-ylmethyl)-4-benzylisoxazolidin-5-one (S8f): Prepared by the general procedure E from **S7f**



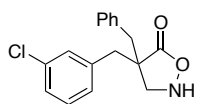
(532 mg, 1.19 mmol), and isolated as a white solid (380 mg, 93% yield). **m.p.** 153–154 °C; **IR** (thin film): ν 3518, 3243, 3079, 3027, 2924, 1768, 1485, 1449, 1167, 1028 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.63–7.54 (m, 4H), 7.50–7.42 (m, 2H), 7.41–7.28 (m, 6H), 7.27–7.23 (m, 2H), 5.25 (s, 1H), 3.66 (s, 1H), 3.53 (s, 1H), 3.25 (d, $J = 5.1$ Hz, 1H), 3.21 (d, $J = 5.1$ Hz, 1H), 2.90 (s, 2H); **^{13}C NMR** (100 MHz, CDCl_3): δ 181.2, 140.7, 140.4, 135.7, 134.7, 130.3, 130.1, 129.8, 129.2, 129.0, 127.8, 127.6, 127.1, 54.8, 50.8, 42.7, 42.2; **HRMS** (ESI): m/z calc'd for $\text{C}_{23}\text{H}_{21}\text{O}_2\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 366.1465, found: 366.1465.

4-Benzyl-4-(3-fluorobenzyl)isoxazolidin-5-one (S8g): Prepared by the general procedure E from **S7g** (314 mg,



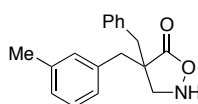
0.812 mmol), and isolated as a white solid (216 mg, 93% yield). **m.p.** 82–83 °C; **IR** (thin film): ν 3250, 3063, 3030, 2947, 2923, 1768, 1587, 1487, 1454, 1254, 1170, 1147, 1025 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.37–7.28 (m, 4H), 7.23 (dd, $J = 2.0, 7.5$ Hz, 2H), 7.05–6.97 (m, 2H), 6.93 (dt, $J = 2.0, 9.6$ Hz, 1H), 5.22 (s, 1H), 3.57 (s, 2H), 3.19 (d, $J = 13.6$ Hz, 1H), 3.17 (d, $J = 13.6$ Hz, 1H), 2.85 (s, 2H); **^{13}C NMR** (100 MHz, CDCl_3): δ 180.9, 163.0 (d, $J = 246.0$ Hz), 138.2 (d, $J = 7.0$ Hz), 135.5, 130.7, 129.5 (d, $J = 8.0$ Hz), 129.3, 128.1, 125.7, 117.0 (d, $J = 20.0$ Hz), 114.8 (d, $J = 20.0$ Hz), 54.8, 50.7, 42.7, 42.2; **^{19}F NMR** (376 MHz, CDCl_3): δ -111.1, -112.5; **HRMS** (ESI): m/z calc'd for $\text{C}_{17}\text{H}_{16}\text{O}_2\text{NFNa}$ [$\text{M} + \text{Na}$] $^+$: 308.1057, found: 308.1063.

4-Benzyl-4-(3-chlorobenzyl)isoxazolidin-5-one (S8h): Prepared by the general procedure E from **S7h** (316 mg,



0.786 mmol), and isolated as a white solid (216 mg, 91% yield). **m.p.** 112–114 °C; **IR** (thin film): ν 3250, 3062, 3029, 2922, 1769, 1596, 1572, 1455, 1167, 1024 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.39–7.31 (m, 3H), 7.31–7.25 (m, 2H), 7.25–7.18 (m, 3H), 7.15–7.09 (m, 1H), 5.24 (s, 1H), 3.56 (s, 2H), 3.19 (d, $J = 5.8$ Hz, 1H), 3.15 (d, $J = 5.8$ Hz, 1H), 2.83 (s, 2H); **^{13}C NMR** (100 MHz, CDCl_3): δ 180.8, 137.8, 135.4, 135.0, 130.4, 130.1, 129.7, 129.4, 128.5, 128.2, 128.1, 54.7, 50.7, 42.6, 42.0; **HRMS** (ESI): m/z calc'd for $\text{C}_{17}\text{H}_{16}\text{O}_2\text{NCINa}$ [$\text{M} + \text{Na}$] $^+$: 324.0762, found: 324.0772.

4-Benzyl-4-(3-methylbenzyl)isoxazolidin-5-one (S8i): Prepared by the general procedure E from **S7i** (338 mg,



0.886 mmol), and isolated as a white solid (251 mg, 99% yield). **m.p.** 74–75 °C; **IR** (thin film): ν 3526, 3247, 3028, 2946, 2920, 1769, 1604, 1494, 1455, 1444, 1167, 1026 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.38–7.28 (m, 3H), 7.25–7.19 (m, 3H), 7.11 (d, $J = 7.7$ Hz, 1H), 7.02 (d, $J = 7.3$ Hz, 2H), 5.14 (t, $J = 9.1$ Hz, 1H), 3.67 (s, 1H), 3.43 (s, 1H), 3.17 (d, $J = 13.4$ Hz, 1H), 3.14 (d, $J = 13.4$ Hz, 1H), 2.84 (s, 2H), 2.33 (s,

3H); ^{13}C NMR (100 MHz, CDCl_3): δ 181.4, 139.0, 135.8, 135.7, 130.2, 130.0, 129.3, 129.2, 129.1, 127.9, 126.6, 55.0, 50.7, 42.7, 42.6, 21.6; HRMS (ESI): m/z calc'd for $\text{C}_{18}\text{H}_{19}\text{O}_2\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 304.1308, found: 304.1316.

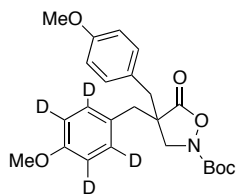
tert-Butyl 4-benzyl-5-oxoisoxazolidine-2-carboxylate- d_5 (S9): Prepared by the general procedure A from benzaldehyde- d_5 (1.00 g, 8.99 mmol), and isolated as a pale brown solid (1.73 g, 83% yield). **m.p.** 78–79 °C; IR (thin film): ν 2980, 2934, 1798, 1747, 1715, 1476, 1457, 1371, 1330, 1141 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3): δ 4.19–4.08 (m, 1H), 3.71 (dd, $J = 9.2, 11.1$ Hz, 1H), 3.26 (dd, $J = 4.5, 14.0$ Hz, 1H), 3.21–3.11 (m, 1H), 2.80 (dd, $J = 9.8, 14.0$ Hz, 1H), 1.51 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3): δ 174.3, 156.1, 136.9, 128.7 (t, $J = 22.0$ Hz), 128.4 (t, $J = 23.0$ Hz), 126.9 (t, $J = 24.0$ Hz), 84.3, 53.1, 42.3, 34.5, 28.2; HRMS (ESI): m/z calc'd for $\text{C}_{15}\text{H}_{14}\text{D}_5\text{O}_4\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 305.1520, found: 305.1521.

tert-Butyl 4,4-dibenzyl-5-oxoisoxazolidine-2-carboxylate- d_5 (S10): Prepared by the general procedure F from S9 (408 mg, 1.44 mmol) and benzyl bromide (343 μL , 2.88 mmol, 2.0 equiv), and isolated as a white solid (419 mg, 79% yield). **m.p.** 118–119 °C; IR (thin film): ν 3029, 2980, 2931, 1789, 1715, 1370, 1347, 1144, 1051 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3): δ 7.36–7.27 (m, 3H), 7.21–7.16 (m, 2H), 3.92 (s, 2H), 3.17 (d, $J = 13.9$ Hz, 1H), 3.16 (d, $J = 13.9$ Hz, 1H), 2.83 (d, $J = 13.9$ Hz, 1H), 2.81 (d, $J = 13.9$ Hz, 1H), 1.43 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3): δ 176.1, 155.4, 135.0, 134.8, 130.5, 130.1 (t, $J = 24.0$ Hz), 128.9, 128.4 (t, $J = 24.0$ Hz), 127.7, 127.2 (t, $J = 24.0$ Hz), 83.9, 52.9, 51.2, 40.8, 40.7, 28.2; HRMS (ESI): m/z calc'd for $\text{C}_{22}\text{H}_{20}\text{D}_5\text{O}_4\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 395.1990, found: 395.1987.

4,4-Dibenzylisoxazolidin-5-one- d_5 (S11): Prepared by the general procedure E from S10 (255 mg, 0.684 mmol), and isolated as a white solid (175 mg, 94% yield). **m.p.** 120–121 °C; IR (thin film): ν 3246, 3024, 2960, 2934, 1759, 1455, 1191, 1170, 1014 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3): δ 7.40–7.28 (m, 3H), 7.22 (dd, $J = 1.9, 7.6$ Hz, 2H), 5.12 (t, $J = 9.1$ Hz, 1H), 3.65 (s, 1H), 3.44 (s, 1H), 3.21 (d, $J = 13.6$ Hz, 1H), 3.17 (d, $J = 13.6$ Hz, 1H), 2.86 (s, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ 181.3, 135.8, 135.6, 130.3, 130.0, 129.8, 129.3, 127.9, 127.9, 54.9, 50.8, 42.7, 42.6; HRMS (ESI): m/z calc'd for $\text{C}_{17}\text{H}_{12}\text{D}_5\text{O}_2\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 295.1465, found: 295.1475.

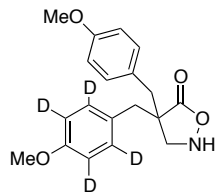
tert-Butyl 4-(4-methoxybenzyl)-5-oxoisoxazolidine-2-carboxylate- d_4 (S12): Prepared by the general procedure B from p-anisaldehyde- d_4 (378 mg, 2.69 mmol), and isolated as an amorphous solid (625 mg, 74% yield). IR (thin film): ν 2980, 2938, 1799, 1746, 1715, 1457, 1411, 1370, 1231, 1144 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3): δ 4.17–4.06 (m, 1H), 3.78 (s, 3H), 3.74–3.65 (m, 1H), 3.21–3.06 (m, 2H), 2.80–2.67 (m, 1H), 1.49 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3): δ 174.3, 158.7, 156.0, 129.4 (t, $J = 24.0$ Hz), 128.6, 114.0 (t, $J = 24.0$ Hz), 84.1, 55.3, 52.9, 42.4, 33.5, 28.1; HRMS (ESI): m/z calc'd for $\text{C}_{16}\text{H}_{17}\text{D}_4\text{O}_5\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 334.1563, found: 334.1568.

tert-Butyl 4,4-bis(4-methoxybenzyl)-5-oxoisoxazolidine-2-carboxylate- d_4 (S13): Prepared by the general procedure F from S12 (595 mg, 1.91 mmol) and PMB-Cl (519 μL , 3.82 mmol, 2.0 equiv), and isolated as a white solid (239 mg, 29% yield). **m.p.** 173–174 °C; IR (thin film): ν 2979, 2936, 1790, 1714, 1513, 1457, 1409, 1369, 1250, 1231, 1146, 1032 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3): δ 7.13–7.08 (m, 2H), 6.88–6.80 (m, 2H), 3.91 (s, 2H), 3.79 (s, 6H), 3.09 (d, $J = 13.9$ Hz, 2H), 2.75 (d, $J =$



13.9 Hz, 2H), 1.42 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3): δ 176.4, 159.1, 159.0, 155.4, 131.5, 131.1 (t, $J = 20.0$ Hz), 126.9, 126.7, 114.3, 113.9 (t, $J = 20.0$ Hz), 83.7, 55.3, 55.3, 52.8, 51.5, 40.1, 40.0, 28.2; **HRMS** (ESI): m/z calc'd for $\text{C}_{24}\text{H}_{25}\text{D}_4\text{O}_6\text{NNa}$ $[\text{M} + \text{Na}]^+$: 454.2138, found: 454.2140.

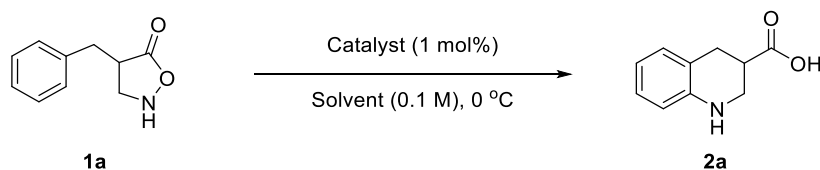
4,4-Bis(4-methoxybenzyl)isoxazolidin-5-one- d_4 (S14): Prepared by the general procedure E from **S13** (148 mg, 0.342 mmol), and isolated as a white solid (103 mg, 91% yield). **m.p.** 127–128 °C; **IR** (thin film):



ν 3246, 3006, 2936, 2837, 1768, 1611, 1586, 1512, 1455, 1408, 1302, 1247, 1230, 1179, 1027 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.20–7.08 (m, 2H), 6.90–6.82 (m, 2H), 5.19 (t, $J = 9.0$ Hz, 1H), 3.79 (s, 6H), 3.61 (brs, 1H), 3.40 (brs, 1H), 3.11 (d, $J = 9.0$ Hz, 2H), 2.77 (s, 2H); ^{13}C NMR (100 MHz, CDCl_3): δ 181.5, 159.3, 159.2, 131.0, 130.8, 127.7, 127.5, 114.6, 114.5, 55.4, 55.4, 54.9, 50.9, 41.8,

41.7; **HRMS** (ESI): m/z calc'd for $\text{C}_{19}\text{H}_{17}\text{D}_4\text{O}_4\text{NNa}$ $[\text{M} + \text{Na}]^+$: 354.1614, found: 354.1617.

3. Conditions screening



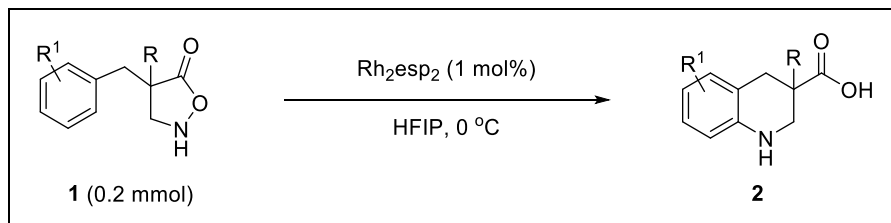
Entry ^a	Catalyst	Solvent	Time	Results / Yield ^b
1	Rh ₂ (esp) ₂	CH ₂ Cl ₂	24 h	no product 2a detected; 1a decomposed partly
2	Rh ₂ (esp) ₂	THF	24 h	no product 2a detected; 1a decomposed partly
3	Rh ₂ (esp) ₂	MeCN	24 h	no product 2a detected; 1a decomposed partly
4	Rh ₂ (esp) ₂	MeOH	24 h	no product 2a detected; 1a decomposed partly
5	Rh ₂ (esp) ₂	TFE	2.5 h	40% yield of 2a
6	Rh ₂ (esp) ₂	HFIP	10 min	97% yield of 2a
7	[Rh(OAc) ₂] ₂	HFIP	5 h	64% yield of 2a
8	[Cp*RhCl ₂] ₂	HFIP	24 h	no product 2a detected; 1a decomposed partly
9	[Cp*IrCl ₂] ₂	HFIP	24 h	no product 2a detected; 1a decomposed partly
10	[Ru(<i>p</i> -cymene)Cl ₂] ₂	HFIP	24 h	no product 2a detected; 1a decomposed partly
11	— ^c	HFIP	24 h	no reaction

^a Run on 0.1 mmol scale for entries 1-5; 0.2 mmol scale for entry 6-11. ^b Yield of isolated product is reported. ^c Without catalyst.

The procedure for the conditions screening was similar to the general procedure F described in 4-1 using the designated catalyst (1 mol%) and solvent (0.1 M) instead of Rh₂(esp)₂ and HFIP (0.1 M).

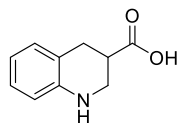
4. Substrate scope for Rh-catalyzed electrophilic amination reactions

4-1. General procedure for the synthesis of benzo-fused β -amino acids

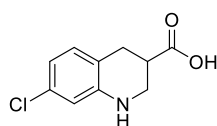


General procedure G: To a 10 mL test tube equipped with a magnetic stirring bar were added substrates **1** (0.2 mmol), $\text{Rh}_2(\text{esp})_2$ (1 mol%, 0.002 mmol), followed by the addition of HFIP (2.0 mL, 0.1 M) at $0\text{ }^\circ\text{C}$ (ice-water bath). The resulting mixture was stirred at the same temperature. After full consumption of **1** by TLC analysis, the reaction mixture was concentrated under reduced pressure. The obtained crude residue was purified by silica gel column chromatography (0% to 40% methanol in EtOAc) to afford analytically pure products **2**.

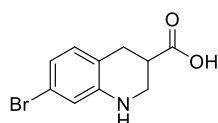
1,2,3,4-Tetrahydroquinoline-3-carboxylic acid (2a): Prepared by the general procedure G from **1a** (35.4 mg, 0.2 mmol), stirred for 10 min, and isolated as a light-yellow solid (35.3 mg, 99% yield). $^1\text{H NMR}$ (400 MHz, CDCl_3): δ 7.52 (brs, 2H), 7.03–6.99 (m, 2H), 6.71–6.67 (m, 1H), 6.56 (d, $J = 8.0$ Hz, 1H), 3.59–3.56 (m, 1H), 3.44–3.39 (m, 1H), 3.06–2.99 (m, 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3): δ 179.7, 143.4, 129.6, 127.1, 119.8, 118.1, 114.9, 43.3, 38.2, 29.2. **HRMS** (ESI): m/z calc'd for $\text{C}_{10}\text{H}_{10}\text{O}_2\text{N}$ [$\text{M} - \text{H}$] $^+$: 176.0717, found: 176.0713. Spectroscopic data matched those reported.⁶



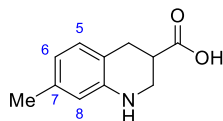
7-Chloro-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2b): Prepared by the general procedure G from **1b** (42.3 mg, 0.2 mmol), stirred for 30 min, and isolated as a light-yellow solid (32.3 mg, 76% yield). **m.p.** 144–146 $^\circ\text{C}$; **IR** (thin film): ν 3410, 2929, 1701, 1603, 1494, 1087, 788 cm^{-1} ; $^1\text{H NMR}$ (400 MHz, $\text{DMSO}-d_6$): δ 6.88 (d, $J = 8.0$ Hz, 1H), 6.47 (d, $J = 2.0$ Hz, 1H), 6.42 (dd, $J = 8.0, 2.0$ Hz, 1H), 6.08 (brs, 1H), 3.38 (dd, $J = 11.6, 2.4$ Hz, 1H), 3.17 (dd, $J = 11.6, 8.4$ Hz, 1H), 2.86–2.76 (m, 2H), 2.72–2.68 (m, 1H); $^{13}\text{C NMR}$ (100 MHz, $\text{DMSO}-d_6$): δ 174.6, 145.9, 130.8, 130.4, 117.5, 114.6, 112.1, 42.2, 36.9, 28.7; **HRMS** (ESI): m/z calc'd for $\text{C}_{10}\text{H}_9\text{ClO}_2\text{N}$ [$\text{M} + \text{H}$] $^+$: 212.0473, found: 212.0464.



7-Bromo-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2c): Prepared by the general procedure G from **1c** (51.2 mg, 0.2 mmol), stirred for 30 min, and isolated as a yellow brown solid (35.0 mg, 68% yield). **m.p.** 207–209 $^\circ\text{C}$; **IR** (KBr): ν 3424, 1703, 1597, 1491, 1216, 862, 772 cm^{-1} ; $^1\text{H NMR}$ (400 MHz, MeOD): δ 6.81 (d, $J = 8.0$ Hz, 1H), 6.65 (d, $J = 2.0$ Hz, 1H), 6.61 (dd, $J = 8.0, 2.0$ Hz, 1H), 3.51–3.47 (m, 1H), 3.30–3.25 (m, 1H), 2.93–2.79 (m, 3H); $^{13}\text{C NMR}$ (100 MHz, MeOD): δ 177.3, 147.3, 131.7, 121.1, 120.2, 119.6, 117.3, 44.2, 39.1, 30.4; **HRMS** (ESI): m/z calc'd for $\text{C}_{10}\text{H}_9\text{BrO}_2\text{N}$ [$\text{M} + \text{H}$] $^+$: 255.9968, found: 255.9959.

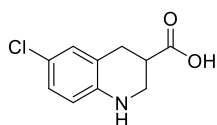


7-Methyl-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2d): Prepared by the general procedure G from **1d** (38.2 mg, 0.2 mmol), stirred for 15 min, and isolated as an off-white solid (38.2 mg, 99% yield).

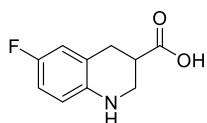


The ratio of C7-isomer and C6-isomer was 83:17; **m.p.** 168–170 °C; **IR** (thin film): ν 3402, 2922, 1702, 1618, 1498, 1308, 790 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3) for the mixture isomer: δ 6.91–6.89 (m, 0.86H), 6.84–6.82 (m, 0.35H), 6.52–6.48 (m, 1.07H), 6.38 (s, 0.98H), 6.09 (brs, 1.75H), 3.57–3.53 (m, 1H), 3.42–3.37 (m, 1H), 3.02–2.96 (m, 3H), 2.22 (s, 3H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3) for the mixture isomer: δ 179.0, 143.2, 140.9, 136.9, 130.1, 129.5, 127.7, 119.1, 116.7, 115.3, 115.1, 43.5, 43.3, 38.3, 29.2, 28.9, 21.1, 20.4; **HRMS** (ESI): m/z calc'd for $\text{C}_{11}\text{H}_{14}\text{O}_2\text{N}$ [$\text{M} + \text{H}$] $^+$: 192.1019, found: 192.1010.

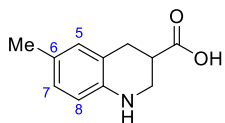
6-Chloro-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2e): Prepared by the general procedure G from **1e** (42.3 mg, 0.2 mmol), stirred for 10 min, and isolated as a yellow foam (38.3 mg, 91% yield). **IR** (thin film): ν 3414, 2927, 1708, 1497, 1213, 809, 756 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.20 (brs, 2H), 6.98–6.93 (m, 2H), 6.44 (d, $J = 8.4$ Hz, 1H), 3.54 (dd, $J = 11.6$ Hz, 3.6 Hz, 1H), 3.44–3.39 (m, 1H), 3.02–2.93 (m, 3H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 179.3, 142.0, 129.1, 127.0, 122.3, 121.0, 115.7, 43.2, 37.8, 28.9; **HRMS** (ESI): m/z calc'd for $\text{C}_{10}\text{H}_{11}\text{O}_2\text{NCl}$ [$\text{M} + \text{H}$] $^+$: 212.0473, found: 212.0467.



6-Fluoro-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2f): Prepared by the general procedure G from **1f** (39.5 mg, 0.2 mmol), stirred for 20 min, and isolated as an off-white solid (39.5 mg, 99% yield). **m.p.** 150–152 °C; **IR** (thin film): ν 2928, 1709, 1506, 1245, 1143, 948, 808 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, MeOD): δ 6.72–6.63 (m, 2H), 6.52–6.48 (m, 1H), 3.48–3.44 (m, 1H), 3.27–3.22 (m, 1H), 2.95–2.93 (m, 2H), 2.85–2.78 (m, 1H); **$^{13}\text{C NMR}$** (100 MHz, MeOD): δ 177.3, 157.0 (d, $J = 232.0$ Hz), 141.9 (d, $J = 1.7$ Hz), 122.6 (d, $J = 7.0$ Hz), 116.6 (d, $J = 7.6$ Hz), 116.2 (d, $J = 22.1$ Hz), 114.3 (d, $J = 22.5$ Hz), 44.8, 39.4, 30.6 (d, $J = 1.2$ Hz); **HRMS** (ESI): m/z calc'd for $\text{C}_{10}\text{H}_{11}\text{O}_2\text{NF}$ [$\text{M} + \text{H}$] $^+$: 196.768, found: 196.0760.

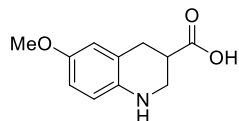


6-Methyl-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2g): Prepared by the general procedure G from **1g** (38.2 mg, 0.2 mmol), stirred for 15 min, and isolated as a light yellow foam (38.0 mg, 99% yield).



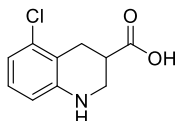
The ratio of C6-isomer and C8-isomer was 90:10; **IR** (thin film): ν 3385, 2923, 1709, 1512, 1266, 1204, 810, 735 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3) for the mixture isomer: δ 6.92–6.90 (m, 0.21H), 6.84–6.82 (m, 1.74H), 6.62 (t, $J = 7.6$ Hz, 0.12H), 6.48 (d, $J = 8.0$ Hz, 0.91H), 5.74 (brs, 2H), 3.67–3.63 (m, 0.10H), 3.54–3.51 (m, 0.88H), 3.50–3.45 (m, 0.10H), 3.42–3.37 (m, 0.91H), 3.06–2.96 (m, 2.93H), 2.22 (s, 2.61H), 2.10 (s, 0.26H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3) for the mixture isomer: δ 179.2, 179.1, 141.5, 140.9, 130.1, 128.3, 127.7, 127.5, 127.4, 121.7, 119.8, 118.9, 117.3, 114.9, 43.6, 43.5, 38.4, 38.1, 29.6, 29.1, 20.4, 17.1; **HRMS** (ESI): m/z calc'd for $\text{C}_{11}\text{H}_{14}\text{O}_2\text{N}$ [$\text{M} + \text{H}$] $^+$: 192.1019, found: 192.1012.

6-Methoxy-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2h): Prepared by the general procedure G from **1h** (41.4 mg, 0.2 mmol), stirred for 20 min, and isolated as a yellow foam (41.4 mg, 99% yield). **IR**



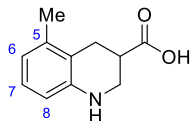
(thin film): ν 3382, 2934, 1714, 1506, 1250, 1036, 735 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 6.65–6.61 (m, 2H), 6.53 (d, $J = 8.4$ Hz, 1H), 5.64 (brs, 2H), 3.74 (s, 3H), 3.50 (dd, $J = 11.6, 3.2$ Hz, 1H), 3.39 (dd, $J = 11.6, 8.0$ Hz, 1H), 3.05–2.94 (m, 3H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 178.5, 152.8, 137.0, 121.3, 116.4, 114.6, 113.5, 55.7, 43.7, 38.3, 29.3; **HRMS** (ESI): m/z calc'd for $\text{C}_{11}\text{H}_{14}\text{O}_3\text{N}$ [$\text{M} + \text{H}$] $^+$: 208.0968, found: 208.0971.

5-Chloro-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2i): Prepared by the general procedure G from **1i** (42.3 mg, 0.2 mmol), stirred for 15 min, and isolated as a yellow solid (21.0 mg, 50% yield). **m.p.** 150–



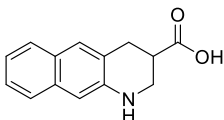
152 $^{\circ}\text{C}$; **IR** (thin film): ν 3423, 2926, 1703, 1597, 1273, 942, 768 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 6.92 (t, $J = 8.0$ Hz, 1H), 6.74 (dd, $J = 8.0, 1.2$ Hz, 1H), 6.43 (d, $J = 8.0$ Hz, 1H), 5.49 (brs, 2H), 3.55–3.51 (m, 1H), 3.42–3.37 (m, 1H), 3.19–3.11 (m, 1H), 3.03–2.95 (m, 2H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 178.8, 145.2, 134.9, 127.4, 118.5, 117.7, 113.0, 42.8, 38.1, 27.0; **HRMS** (ESI): m/z calc'd for $\text{C}_{10}\text{H}_{11}\text{O}_2\text{NCl}$ [$\text{M} + \text{H}$] $^+$: 212.0473, found: 212.0466.

5-Methyl-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2j): Prepared by the general procedure G from **1j** (38.2 mg, 0.2 mmol), stirred for 15 min, and isolated as a light-yellow solid (20.5 mg, 53% yield). The



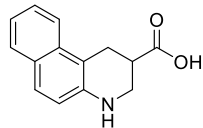
ratio of C5-isomer and C8-isomer was 6:1; **m.p.** 147–149 $^{\circ}\text{C}$; **IR** (thin film): ν 3396, 2934, 1710, 1590, 1482, 1272, 1202, 771 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3) for the mixture isomer: δ 6.95–6.91 (m, 1.10H), 6.64–6.58 (m, 1.06H), 6.44–6.42 (m, 0.93H), 6.15 (brs, 1.63H), 3.67–3.63 (m, 0.14H), 3.55–3.51 (m, 0.83H), 3.50–3.43 (m, 0.17H), 3.40–3.35 (m, 0.83H), 3.08–2.84 (m, 3H), 2.21 (s, 2.54H), 2.10 (s, 0.4H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3) for the mixture isomer: δ 179.1, 143.5, 137.4, 128.3, 127.5, 126.6, 120.0, 118.5, 117.4, 112.8, 42.9, 38.6, 38.1, 29.6, 26.6, 19.4, 17.1; **HRMS** (ESI): m/z calc'd for $\text{C}_{11}\text{H}_{14}\text{O}_2\text{N}$ [$\text{M} + \text{H}$] $^+$: 192.1019, found: 192.1011.

1,2,3,4-Tetrahydrobenzo[*g*]quinoline-3-carboxylic acid (2k): Prepared by the general procedure G from **1k** (45.5



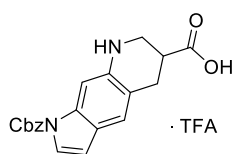
mg, 0.2 mmol), stirred for 1 h, and isolated as a light-pink solid (45.5 mg, 99% yield). **m.p.** 142–144 $^{\circ}\text{C}$; **IR** (KBr): ν 3414, 2931, 1697, 1521, 1399, 1287, 799 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.77–7.70 (m, 2H), 7.44–7.41 (m, 2H), 7.25–7.14 (m, 4H), 3.76–3.73 (m, 1H), 3.59–3.54 (m, 1H), 3.26–3.13 (m, 2H), 3.07–3.01 (m, 1H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 179.7, 137.9, 133.1, 128.5, 128.1, 125.3, 125.1, 123.4, 119.6, 118.1, 114.2, 43.6, 38.1, 29.7; **HRMS** (ESI): m/z calc'd for $\text{C}_{14}\text{H}_{14}\text{O}_2\text{N}$ [$\text{M} + \text{H}$] $^+$: 228.1019, found: 228.1009.

1,2,3,4-Tetrahydrobenzo[f]quinoline-2-carboxylic acid (2l): Prepared by the general procedure G from **11** (45.5 mg,



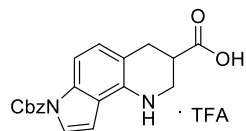
0.2 mmol), stirred for 30 min, and isolated as a light-pink solid (45.5 mg, 99% yield). **m.p.** 170–172 °C; **IR** (KBr): ν 3402, 2886, 1694, 1622, 1520, 1293, 800, 751 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.76 (d, J = 8.4 Hz, 1H), 7.69 (d, J = 8.0 Hz, 1H), 7.54 (d, J = 8.8 Hz, 1H), 7.47–7.43 (m, 1H), 7.28–7.24 (m, 1H), 6.81 (d, J = 8.8 Hz, 1H), 3.65–3.62 (m, 1H), 3.51–3.46 (m, 1H), 3.43–3.37 (m, 1H), 3.30–3.23 (m, 1H), 3.17–3.12 (m, 1H); **^{13}C NMR** (100 MHz, CDCl_3): δ 179.2, 140.9, 133.2, 128.5, 128.1, 127.7, 126.6, 122.2, 121.1, 118.0, 110.2, 43.0, 38.4, 25.5; **HRMS** (ESI): m/z calc'd for $\text{C}_{14}\text{H}_{14}\text{O}_2\text{N}$ [$\text{M} + \text{H}$] $^+$: 228.1019, found: 228.1008.

1-((Benzyloxy)carbonyl)-6-carboxy-5,6,7,8-tetrahydro-1H-pyrrolo[3,2-g]quinolin-8-ium trifluoro acetate



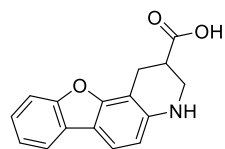
(2m-1•TFA): Prepared by the general procedure G from *tert*-butyl 4-((1-((benzyloxy)carbonyl)-1H-indol-5-yl)methyl)-5-oxoisoxazolidine-2-carboxylate **S1m** (70.0 mg, 0.2 mmol), obtained as a mixture of **2m-1** and **2m-2**, and isolated by reverse phase prep HPLC as an amorphous solid (33% yield); **IR** (thin film): ν 2925, 2852, 1730, 1626, 1395, 1282, 1214, 760, 697 cm^{-1} ; **^1H NMR** (400 MHz, Acetone- d_6): δ 7.55–7.52 (m, 2H), 7.44–7.35 (m, 5H), 7.15 (s, 1H), 6.45 (dd, J = 3.6, 0.4 Hz, 1H), 5.44 (s, 2H), 3.59 (dd, J = 11.2, 1.2 Hz, 1H), 3.41–3.35 (m, 1H), 3.10–3.00 (m, 2H), 2.92–2.86 (m, 1H); **^{13}C NMR** (100 MHz, Acetone- d_6): δ 174.9, 151.5, 143.5, 136.9, 129.5, 129.3, 129.2, 127.1, 123.2, 122.5, 121.9, 117.6, 108.9, 100.4, 68.8, 44.4, 38.9, 30.1; **^{19}F NMR** (376 MHz, Acetone- d_6): δ 76.76 (s, 3F); **HRMS** (ESI): m/z calc'd for $\text{C}_{20}\text{H}_{19}\text{O}_4\text{N}_2$ [$\text{M} + \text{H}$] $^+$: 351.1339, found: 351.1343.

7-((Benzyloxy)carbonyl)-3-carboxy-2,3,4,7-tetrahydro-1H-pyrrolo[2,3-h]quinolin-1-ium trifluoro acetate



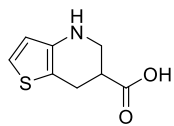
(2m-2•TFA): Isolated as an amorphous solid (66% yield); **IR** (thin film): ν 2922, 2851, 1739, 1703, 1405, 1347, 1278, 1156, 1053, 761, 718 cm^{-1} ; **^1H NMR** (400 MHz, Acetone- d_6): δ 7.57–7.54 (m, 2H), 7.50 (d, J = 3.6 Hz, 1H), 7.53–7.36 (m, 4H), 6.93 (d, J = 8.4 Hz, 1H), 6.72 (dd, J = 4.0, 0.8 Hz, 1H), 5.47 (s, 2H), 3.66 (dd, J = 12.0, 1.2 Hz, 1H), 3.41 (dd, J = 11.6, 9.2 Hz, 1H), 3.08–2.97 (m, 2H), 2.93–2.86 (m, 1H); **^{13}C NMR** (100 MHz, Acetone- d_6): δ 175.1, 151.6, 138.0, 136.8, 135.8, 129.5, 129.3, 129.2, 127.3, 123.8, 118.6, 112.9, 105.7, 104.6, 69.1, 44.0, 38.8, 30.3; **^{19}F NMR** (376 MHz, Acetone- d_6): δ 76.79 (s, 3F); **HRMS** (ESI): m/z calc'd $\text{C}_{20}\text{H}_{19}\text{O}_4\text{N}_2$ [$\text{M} + \text{H}$] $^+$: 351.1339, found: 351.1350.

1,2,3,4-Tetrahydrobenzofuro[2,3-f]quinoline-2-carboxylic acid (2n): Prepared by the general procedure G from



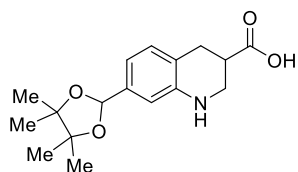
4-(dibenzo[b,d]furan-4-ylmethyl)isoxazolidin-5-one **1n** (53.5 mg, 0.2 mmol), and isolated as a light brown solid (99% yield). **m.p.** 207–208 °C; **IR** (thin film): ν 2961, 2924, 2850, 1706, 1636, 1452, 1261, 1188, 1103, 1017, 800, 746 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.77 (dd, J = 7.2, 1.6 Hz, 1H), 7.55 (d, J = 8.4 Hz, 1H), 7.49 (d, J = 7.6 Hz, 1H), 7.33–7.24 (m, 2H), 6.56 (d, J = 8.4 Hz, 1H), 5.83 (br s, 1H), 3.65 (ddd, J = 11.6, 3.2, 1.2 Hz, 1H), 3.52 (dd, J = 11.6, 8.4 Hz, 1H), 3.40 (dd, J = 16.8, 5.6 Hz, 1H), 3.26 (d, J = 16.4, 8.4 Hz, 1H), 3.14–3.07 (m, 1H); **^{13}C NMR** (100 MHz, CDCl_3): δ 178.6, 156.0, 155.8, 143.7, 125.3, 125.0, 122.7, 119.4, 119.0, 114.8, 111.3, 110.8, 103.7, 43.5, 37.7, 23.3; **HRMS** (ESI): m/z calc'd for $\text{C}_{16}\text{H}_{14}\text{O}_3\text{N}$ [$\text{M} + \text{H}$] $^+$: 268.0968, found: 268.0971.

4,5,6,7-Tetrahydrothieno[3,2-b]pyridine-6-carboxylic acid (2o): Prepared by the general procedure G from



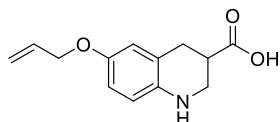
4-(thiophen-2-ylmethyl)isoxazolidin-5-one **1o** (36.7 mg, 0.2 mmol), and isolated as a brown solid (98% yield). **m.p.** >280 °C; **IR** (KBr): ν 3413, 2922, 1721, 1619, 1580, 1406, 1282, 1214 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, MeOD): δ 7.02 (dt, $J = 5.2, 0.8$ Hz, 1H), 6.52 (dt, $J = 5.2, 0.4$ Hz, 1H), 3.46 (ddd, $J = 12.0, 2.8, 0.4$ Hz, 1H), 3.20 (dd, $J = 12.0, 9.2$ Hz, 1H), 2.96-2.94 (m, 2H), 2.88-2.81 (m, 1H); **$^{13}\text{C NMR}$** (100 MHz, MeOD): δ 177.3, 143.0, 122.9, 120.9, 113.6, 45.7, 40.7, 26.5; **HRMS** (ESI): m/z calc'd for $\text{C}_8\text{H}_{10}\text{O}_2\text{NS}$ [$\text{M} + \text{H}$] $^+$: 184.0427, found: 184.0430.

7-(4,4,5,5-Tetramethyl-1,3-dioxolan-2-yl)-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2p): Prepared by the



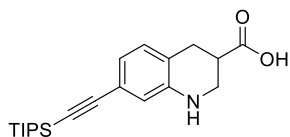
general procedure G from 4-(4-(4,4,5,5-tetramethyl-1,3-dioxolan-2-yl)benzyl)isoxazolidin-5-one **1p** (61.1 mg, 0.2 mmol), and isolated as a yellow oil (94% yield); **IR** (thin film): ν 3393, 2977, 2926, 2853, 1708, 1619, 1587, 1496, 1378, 1276, 1155, 1078, 987, 880 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 6.99 (d, $J = 8.0$ Hz, 2H), 6.80 (d, $J = 7.6, 1.2$ Hz, 1H), 6.67 (s, 1H), 5.86 (s, 1H), 3.56 (dd, $J = 11.6, 3.2$ Hz, 1H), 3.40 (dd, $J = 11.6, 8.4$ Hz, 1H), 3.03 (dd, $J = 6.8$ Hz, 2H), 2.99-2.93 (m, 1H), 1.30 (s, 6H), 1.25 (s, 6H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 178.0, 143.5, 139.0, 129.7, 120.1, 116.1, 112.4, 99.9, 82.7, 43.5, 38.2, 29.4, 24.5, 22.3; **HRMS** (ESI): m/z calc'd for $\text{C}_{17}\text{H}_{23}\text{O}_4\text{NNa}$ [$\text{M} + \text{Na}$] $^+$: 328.1519, found: 328.1522.

6-(Allyloxy)-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2q): Prepared by the general procedure G from



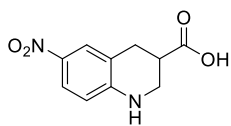
4-(4-(allyloxy)benzyl)isoxazolidin-5-one **1q** (46.6 mg, 0.2 mmol), and isolated as an orange solid (95% yield). **m.p.** 85-87 °C; **IR** (thin film): ν 3383, 2924, 2851, 1717, 1608, 1505, 1421, 1231, 1023, 924 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.67 (br s, 2H), 6.66-6.63 (m, 2H), 6.53 (d, $J = 8.4$ Hz, 1H), 6.04 (ddt, $J = 17.6, 10.8, 5.2$ Hz, 1H), 5.38 (ddt, $J = 17.2, 1.6, 1.6$ Hz, 1H), 5.26 (ddt, $J = 10.8, 1.6, 1.6$ Hz, 1H), 4.45 (ddd, $J = 5.2, 1.6, 1.6$ Hz, 2H), 3.50 (br dd, $J = 10.8, 2.4$ Hz, 1H), 3.36 (dd, $J = 11.2, 8.0$ Hz, 1H), 3.08-2.92 (m, 3H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 179.3, 151.9, 137.1, 133.9, 121.7, 117.5, 116.6, 116.0, 114.6, 69.7, 43.8, 38.5, 29.4; **HRMS** (ESI): m/z calc'd for $\text{C}_{13}\text{H}_{16}\text{O}_3\text{N}$ [$\text{M} + \text{H}$] $^+$: 234.1125, found: 234.1126.

7-((Triisopropylsilyl)ethynyl)-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2r): Prepared by the general



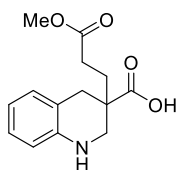
procedure G from 4-(4-((trimethylsilyl)ethynyl)benzyl)isoxazolidin-5-one **1r** (71.5 g, 0.2 mmol), and isolated as a yellow oil (89% yield); **IR** (thin film): ν 3414, 2942, 2891, 2153, 1708, 1609, 1569, 1464, 1274, 1177, 882, 676, 660, 625 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 6.93 (d, $J = 7.6$ Hz, 2H), 6.79 (dd, $J = 7.6, 1.2$ Hz, 2H), 6.65 (s, 1H), 3.54 (dd, $J = 11.6, 3.6$ Hz, 1H), 3.41 (dd, $J = 11.6, 8$ Hz, 1H), 3.02 (d, $J = 6.4$ Hz, 2H), 2.98-2.95 (m, 1H), 1.11 (m, 21H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 179.0, 143.4, 129.6, 122.2, 121.8, 120.2, 117.7, 107.6, 89.3, 43.3, 38.1, 29.3, 18.8, 11.5; **HRMS** (ESI): m/z calc'd for $\text{C}_{21}\text{H}_{32}\text{O}_2\text{NSi}$ [$\text{M} + \text{H}$] $^+$: 358.2197, found: 358.2206.

6-Nitro-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2s): Prepared by the general procedure G from



4-(3-nitrobenzyl)isoxazolidin-5-one **1s** (44.4 mg, 0.2 mmol), and isolated as a yellow oil (52% yield); **IR** (thin film): ν 3371, 3031, 2924, 2853, 1708, 1610, 1586, 1526, 1510, 1466, 1313, 1295, 1239, 1196, 1095, 909, 751 cm^{-1} ; **^1H NMR** (400 MHz, MeOD): δ 9.46–9.45 (m, 1H), 9.40 (dd, J = 9.2, 2.8 Hz, 1H), 8.05 (d, J = 8.8 Hz, 1H), 5.15 (ddd, J = 12.4, 4.0, 1.2 Hz, 1H), 5.01 (dd, J = 12.4, 8.4 Hz, 1H), 4.63–4.50 (m, 2H), 4.44–4.38 (m, 1H); **^{13}C NMR** (100 MHz, MeOD): δ 176.7, 152.2, 137.7, 126.9, 125.3, 119.4, 113.1, 44.0, 38.3, 30.7; **HRMS** (ESI): m/z calc'd for $\text{C}_{10}\text{H}_{10}\text{O}_4\text{N}_2\text{Na}$ [$\text{M} + \text{Na}$] $^+$: 245.0533, found: 245.0541.

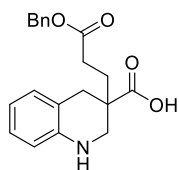
3-(3-Methoxy-3-oxopropyl)-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2t): Prepared by the general procedure



G from **1t** (52.7 mg, 0.2 mmol), stirred for 30 min, and isolated as an off-white solid (52.6 mg, 99% yield). **m.p.** 110–112 $^{\circ}\text{C}$; **IR** (thin film): ν 3400, 2949, 1732, 1603, 1498, 1216, 751 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.01–6.97 (m, 2H), 6.70–6.66 (m, 1H), 6.53 (d, J = 7.6 Hz, 1H), 3.64 (s, 3H), 3.53–3.50 (m, 1H), 3.18 (d, J = 13.2 Hz, 2H), 2.72 (d, J = 16.4 Hz, 1H), 2.45–2.41 (m, 2H), 2.06–1.95 (m, 2H); **^{13}C NMR** (100 MHz, CDCl_3): δ 179.9, 173.4, 142.9, 128.8, 127.1, 119.0, 118.2, 114.6, 51.7, 47.3,

43.5, 34.8, 30.5, 29.2; **HRMS** (ESI): m/z calc'd for $\text{C}_{14}\text{H}_{18}\text{O}_4\text{N}$ [$\text{M} + \text{H}$] $^+$: 264.1230, found: 264.1221.

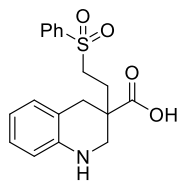
3-(3-(Benzyloxy)-3-oxopropyl)-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2u): Prepared by the general



procedure G from **1u** (67.8 mg, 0.2 mmol), stirred for 10 min, and isolated as a colorless oil (65.7 mg, 97% yield). **IR** (thin film): ν 3404, 2938, 1732, 1498, 1283, 1173, 750 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.37–7.33 (m, 5H), 7.01–6.96 (m, 4H), 6.69–6.65 (m, 1H), 6.51–6.49 (m, 1H), 5.09 (s, 2H), 3.51–3.48 (m, 1H), 3.20–3.15 (m, 2H), 2.70 (d, J = 16.4 Hz, 1H), 2.51–2.46 (m, 2H), 2.10–1.96 (m, 2H); **^{13}C NMR** (100 MHz, CDCl_3): δ 180.4, 172.8, 142.9, 135.7, 129.7, 128.5, 128.3, 128.2, 127.0,

118.9, 118.1, 114.5, 66.5, 47.3, 43.5, 34.7, 30.3, 29.4; **HRMS** (ESI): m/z calc'd for $\text{C}_{20}\text{H}_{22}\text{O}_4\text{N}$ [$\text{M} + \text{H}$] $^+$: 340.1543, found: 340.1536.

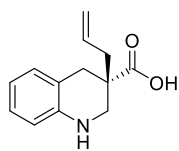
3-(2-(Phenylsulfonyl)ethyl)-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2v): Prepared by the general procedure



G from **1v** (69.1 mg, 0.2 mmol), stirred for 10 min, and isolated as a light-yellow solid (68.8 mg, 99% yield). **m.p.** 171–173 $^{\circ}\text{C}$; **IR** (thin film): ν 3404, 2975, 1723, 1306, 1148, 1049, 749 cm^{-1} ; **^1H NMR** (400 MHz, CDCl_3): δ 7.87–7.85 (m, 2H), 7.66–7.61 (m, 1H), 7.55–7.51 (m, 2H), 7.01–6.92 (m, 2H), 6.70–6.66 (m, 1H), 6.51–6.49 (m, 1H), 4.94 (brs, 2H), 3.47 (d, J = 11.6 Hz, 1H), 3.24–3.11 (m, 4H), 2.65 (d, J = 16.4 Hz, 1H), 2.13–1.97 (m, 2H); **^{13}C NMR** (100 MHz, CDCl_3): δ 178.4, 142.4, 138.6,

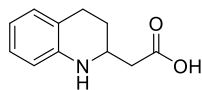
133.9, 129.7, 129.3, 127.9, 127.3, 118.7, 118.3, 114.8, 51.8, 47.1, 43.0, 34.9, 27.7; **HRMS** (ESI): m/z calc'd for $\text{C}_{18}\text{H}_{20}\text{O}_4\text{NS}$ [$\text{M} + \text{H}$] $^+$: 346.1108, found: 346.1101.

(S)-3-Allyl-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2w): Prepared by the general procedure G from **1w** (43.4



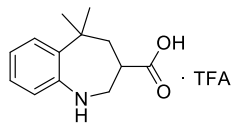
mg, 0.2 mmol), stirred for 20 min, and isolated as a colorless oil (15.9 mg, 37% yield). $[\alpha]_D^{23} = -60.7$ ($c = 0.65$, CHCl_3); **IR** (thin film): ν 3414, 2924, 1703, 1501, 1237, 921, 749 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.02–6.98 (m, 2H), 6.70–6.68 (m, 1H), 6.54–6.52 (m, 1H), 5.84–5.75 (m, 1H), 5.13–5.08 (m, 2H), 3.52–3.48 (m, 1H), 3.20–3.13 (m, 2H), 2.75 (d, $J = 16.0$ Hz, 1H), 2.46–2.36 (m, 2H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 180.2, 142.9, 132.6, 129.8, 127.0, 119.3, 118.9, 118.1, 114.5, 47.2, 44.2, 40.1, 34.6; **HRMS** (ESI): m/z calc'd for $\text{C}_{13}\text{H}_{16}\text{O}_2\text{N}$ [$\text{M} + \text{H}$] $^+$: 218.1176, found: 218.1167.

2-(1,2,3,4-Tetrahydroquinolin-2-yl)acetic acid (2z): Prepared by the general procedure F from **1z** (38.3 mg, 0.2



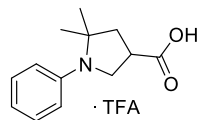
mmol), stirred for 10 min, and isolated as a brown oil (33.4 mg, 87% yield). **IR** (thin film): ν 3389, 2926, 1711, 1496, 1309, 1206, 749 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.22–7.18 (m, 2H), 7.01–6.97 (m, 2H), 6.69–6.65 (m, 1H), 6.55 (d, $J = 7.6$ Hz, 1H), 3.78–3.71 (m, 1H), 2.91–2.72 (m, 2H), 2.61–2.59 (m, 2H), 2.03–1.96 (m, 1H), 1.82–1.72 (m, 1H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 177.7, 143.5, 129.3, 126.9, 121.2, 117.9, 115.0, 47.7, 40.6, 27.8, 25.5; **HRMS** (ESI): m/z calc'd for $\text{C}_{11}\text{H}_{14}\text{O}_2\text{N}$ [$\text{M} + \text{H}$] $^+$: 192.1019, found: 192.1010.

3-Carboxy-5,5-dimethyl-2,3,4,5-tetrahydro-1H-benzo[b]azepin-1-ium trifluoro acetate (5•TFA): Prepared by the



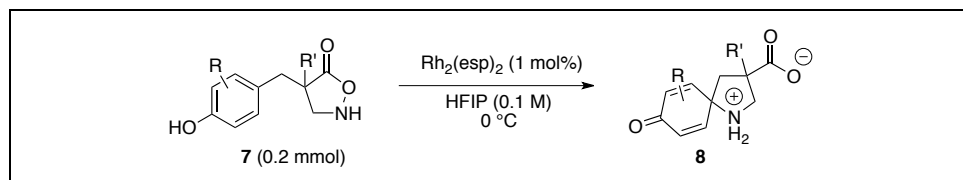
general procedure G from 4-(2-methyl-2-phenylpropyl)isoxazolidin-5-one **4** (43.9 mg, 0.2 mmol), obtained as a mixture of **5** and **6**, and isolated by reverse phase prep HPLC as an amorphous solid (65% yield); **IR** (thin film): ν 3426, 2971, 1673, 1621, 1439, 1197, 1140, 840, 799, 762, 723 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.53–7.48 (m, 2H), 7.41 (t, $J = 7.26$ Hz, 1H), 7.28 (dt, $J = 8.0, 0.8$ Hz, 1H), 3.71 (d, $J = 3.6$ Hz, 2H), 3.26 (br s, 1H), 2.30–2.22 (m, 2H), 1.48 (s, 3H), 1.46 (s, 3H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 176.6, 142.1, 134.8, 130.2, 129.5, 128.4, 127.3 (q, $J = 256.9$ Hz), 124.8, 50.0, 40.5, 39.3, 38.6, 32.2, 29.2; **$^{19}\text{F NMR}$** (376 MHz, CDCl_3): δ 75.76 (s, 3F); **HRMS** (ESI): m/z calc'd for $\text{C}_{13}\text{H}_{18}\text{O}_2\text{N}$ [$\text{M} + \text{H}$] $^+$: 220.1332, found: 220.1332.

4-Carboxy-2,2-dimethyl-1-phenylpyrrolidin-1-ium trifluoro acetate (6•TFA): Isolated by reverse phase prep



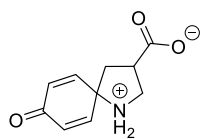
HPLC as an amorphous solid (22% yield); **IR** (thin film): ν 3439, 3069, 2985, 1725, 1668, 1496, 1196, 1137, 798, 722, 706 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, CDCl_3): δ 7.52 (s, 5H), 4.30 (dd, $J = 11.6, 7.6$ Hz, 1H), 4.13 (dd, $J = 11.6, 9.6$ Hz, 1H), 3.71–3.62 (m, 1H), 2.63 (dd, $J = 14.0, 11.2$ Hz, 1H), 2.52 (dd, $J = 13.6, 6.0$ Hz, 1H), 1.40 (s, 3H), 1.28 (s, 3H); **$^{13}\text{C NMR}$** (100 MHz, CDCl_3): δ 174.7, 134.5, 130.5, 130.1, 123.8, 72.8, 53.6, 40.8, 38.4, 23.6, 23.0; **$^{19}\text{F NMR}$** (376 MHz, CDCl_3): δ 75.64 (s, 3F); **HRMS** (ESI): m/z calc'd for $\text{C}_{13}\text{H}_{18}\text{O}_2\text{N}$ [$\text{M} + \text{H}$] $^+$: 220.1332, found: 220.1335.

4-2. General procedure for the synthesis of spirocyclic β -proline derivatives



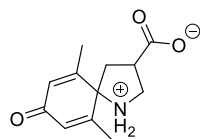
General procedure H: To a 10 mL test tube equipped with a magnetic stirring bar were added substrates **7** (0.2 mmol), $\text{Rh}_2(\text{esp})_2$ (1 mol%, 0.002 mmol), followed by the addition of HFIP (2 mL, 0.1 M) at 0°C (ice-water bath). The resulting mixture was stirred at the same temperature. After full consumption of **7** by TLC analysis, the reaction mixture was concentrated under reduced pressure. The obtained crude residue was then washed with CH_2Cl_2 (3x) to remove impurity, and gave analytically pure products **8**.

8-Oxo-1-azaspiro[4.5]deca-6,9-dien-1-ium-3-carboxylate (8a): Prepared by the general procedure H from **7a** (38.6 mg, 0.2 mmol), stirred for 1 h, and isolated as a white powder (38.6 mg, 99% yield). **m.p.** 170°C (decomp.); **IR** (KBr): ν 3446, 2978, 1686, 1553, 1391, 1262, 855 cm^{-1} ; **^1H NMR** (400 MHz, D_2O): δ 7.16–7.10 (m, 2H), 6.45–6.41 (m, 2H), 3.81–3.72 (m, 2H), 3.48–3.41 (m, 1H), 2.52–2.39 (m, 2H); **^{13}C NMR** (100 MHz, D_2O): δ 186.6, 178.3, 144.9, 144.3, 130.1, 129.9, 63.3, 48.0, 44.6, 39.9;

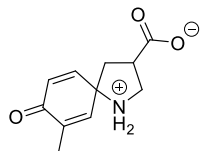


HRMS (ESI): m/z calc'd for $\text{C}_{10}\text{H}_{12}\text{O}_3\text{N}$ $[\text{M} + \text{H}]^+$: 194.0812, found: 194.0803.

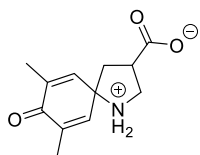
6,10-Dimethyl-8-oxo-1-azaspiro[4.5]deca-6,9-dien-1-ium-3-carboxylate (8b): Prepared by the general procedure H from **7b** (44.3 mg, 0.2 mmol), stirred for 2 h, and isolated as an off-white powder (42.5 mg, 96% yield). **m.p.** 175°C (decomp.); **IR** (thin film): ν 3445, 2976, 1680, 1559, 1388, 905, 603 cm^{-1} ; **^1H NMR** (400 MHz, D_2O): δ 6.32–6.28 (m, 2H), 3.94–3.89 (m, 1H), 3.79–3.73 (m, 1H), 3.62–3.53 (m, 1H), 2.65–2.55 (m, 2H), 2.25 (s, 3H), 2.24 (s, 3H); **^{13}C NMR** (100 MHz, D_2O): δ 187.2, 176.9, 156.9, 128.2, 127.6, 68.7, 51.0, 46.9, 39.1, 18.7; **HRMS** (ESI): m/z calc'd for $\text{C}_{12}\text{H}_{15}\text{O}_3\text{NNa}$ $[\text{M} + \text{Na}]^+$: 244.0944, found: 244.0933.



7-Methyl-8-oxo-1-azaspiro[4.5]deca-6,9-dien-1-ium-3-carboxylate (8c): Prepared by the general procedure H from **7c** (31.0 mg, 0.15 mmol), stirred for 15 min, and isolated as a light-yellow solid (30.2 mg, 97% yield). **^1H NMR** analysis revealed that the dr value was 1.3:1. **m.p.** 155°C (decomp.); **IR** (thin film): ν 3431, 2982, 1673, 1583, 1396, 1123, 831, 707 cm^{-1} ; **^1H NMR** (400 MHz, D_2O) for the mixture isomer: δ 7.11–7.05 (m, 1H), 6.90–6.85 (m, 1H), 6.42–6.39 (m, 1H), 3.76–3.73 (m, 2H), 3.48–3.39 (m, 1H), 2.48–2.35 (m, 2H), 1.85 (m, 3H); **^{13}C NMR** (100 MHz, D_2O) for the mixture isomer: δ 187.2, 178.4, 144.3, 143.6, 139.7, 139.0, 138.0, 137.6, 130.2, 129.9, 63.8, 47.7, 47.6, 44.6, 44.5, 39.7, 14.93, 14.91; **HRMS** (ESI): m/z calc'd for $\text{C}_{11}\text{H}_{14}\text{O}_3\text{N}$ $[\text{M} + \text{H}]^+$: 208.0968, found: 208.0958.

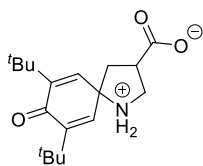


7,9-Dimethyl-8-oxo-1-azaspiro[4.5]deca-6,9-dien-1-ium-3-carboxylate (8d): Prepared by the general procedure H



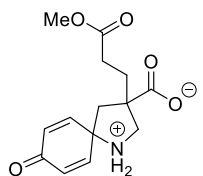
from **7d** (44.3 mg, 0.2 mmol), stirred for 30 min, and isolated as a white powder (35.6 mg, 80% yield). **m.p.** 210 °C (decomp.); **IR** (thin film): ν 3445, 2986, 1651, 1581, 1390, 904, 703 cm^{-1} ; **¹H NMR** (400 MHz, D₂O): δ 6.95–6.89 (m, 2H), 3.85–3.76 (m, 2H), 3.55–3.46 (m, 1H), 2.52–2.40 (m, 2H), 1.95 (s, 3H), 1.94 (s, 3H); **¹³C NMR** (100 MHz, D₂O): δ 187.8, 178.6, 139.2, 138.4, 137.9, 137.5, 63.7, 47.4, 44.6, 39.6, 15.17; **HRMS** (ESI): m/z calc'd for C₁₂H₁₆O₃N [M + H]⁺: 222.1125, found: 222.1115.

7,9-Di-tert-butyl-8-oxo-1-azaspiro[4.5]deca-6,9-dien-1-ium-3-carboxylate (8e): Prepared by the general procedure



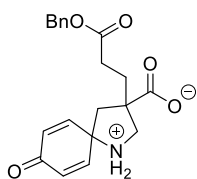
H from **7e** (61.1 mg, 0.2 mmol), stirred for 1 h, and isolated as a white powder (60.2 mg, 98% yield). **m.p.** 265 °C (decomp.); **IR** (thin film): ν 3446, 2962, 1651, 1571, 1369, 1188, 881 cm^{-1} ; **¹H NMR** (400 MHz, CD₃COOD): δ 6.72–6.70 (m, 2H), 3.96–3.86 (m, 2H), 3.72–3.64 (m, 1H), 2.44 (d, J = 8.4 Hz, 2H), 1.12 (s, 9H), 1.11 (s, 9H); **¹³C NMR** (100 MHz, CD₃COOD): δ 184.7, 175.8, 149.25, 149.18, 134.6, 134.0, 64.3, 46.5, 41.9, 40.2, 34.8, 34.78, 28.32, 28.29; **HRMS** (ESI): m/z calc'd for C₁₈H₂₈O₃N [M + H]⁺: 306.2064, found: 306.2054.

3-(3-Methoxy-3-oxopropyl)-8-oxo-1-azaspiro[4.5]deca-6,9-dien-1-ium-3-carboxylate (8f): Prepared by the general



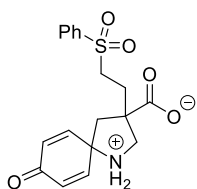
procedure H from **7f** (55.9 mg, 0.2 mmol), stirred for 15 min, and isolated as a white powder (48.1 mg, 86% yield). **m.p.** 145 °C (decomp.); **IR** (KBr): ν 3438, 2962, 1737, 1551, 1387, 1267, 864 cm^{-1} ; **¹H NMR** (400 MHz, D₂O): δ 7.22–7.13 (m, 2H), 6.51–6.45 (m, 2H), 4.13 (d, J = 12.0 Hz, 1H), 3.72 (s, 3H), 3.49 (d, J = 12.0 Hz, 1H), 2.73 (d, J = 14.0 Hz, 1H), 2.44–2.35 (m, 3H), 2.24–2.17 (m, 1H), 2.11–2.03 (m, 1H); **¹³C NMR** (100 MHz, D₂O): δ 186.5, 179.1, 175.8, 145.3, 144.9, 129.6, 129.3, 62.9, 54.8, 52.7, 52.3, 45.6, 32.4, 30.8; **HRMS** (ESI): m/z calc'd for C₁₄H₁₈O₅N [M + H]⁺: 280.1179, found: 280.1173.

3-(3-(Benzyloxy)-3-oxopropyl)-8-oxo-1-azaspiro[4.5]deca-6,9-dien-1-ium-3-carboxylate (8g): Prepared by the



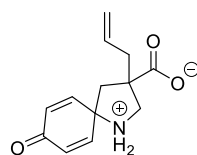
general procedure H from **7g** (71.1 mg, 0.2 mmol), stirred for 10 min, and isolated as a white powder (61.1 mg, 86% yield). **m.p.** 175 °C (decomp.); **IR** (KBr): ν 3447, 2934, 1734, 1547, 1382, 1183, 865, 761 cm^{-1} ; **¹H NMR** (400 MHz, DMSO-*d*₆): δ 7.39–7.31 (m, 5H), 7.02 (dd, J = 10.0, 2.8 Hz, 1H), 6.93 (dd, J = 10.0, 2.8 Hz, 1H), 6.01–5.97 (m, 2H), 5.08 (s, 2H), 3.40 (d, J = 10.4 Hz, 1H), 2.99 (d, J = 10.4 Hz, 1H), 2.41–2.25 (m, 3H), 2.09–2.01 (m, 1H), 1.99–1.91 (m, 1H), 1.76 (d, J = 14.0 Hz, 1H); **¹³C NMR** (100 MHz, DMSO-*d*₆): δ 185.2, 176.6, 172.2, 153.8, 153.7, 136.1, 128.4, 128.0, 127.9, 125.1, 125.0, 65.6, 60.3, 54.9, 54.2, 43.6, 31.9, 30.5; **HRMS** (ESI): m/z calc'd for C₂₀H₂₂O₅N [M + H]⁺: 356.1492, found: 356.1480.

8-Oxo-3-(2-(phenylsulfonyl)ethyl)-1-azaspiro[4.5]deca-6,9-dien-1-ium-3-carboxylate (8h): Prepared by the general



procedure H from **7h** (72.3 mg, 0.2 mmol), stirred for 10 min, and isolated as an off-white powder (62.0 mg, 85% yield). **m.p.** 150 °C (decomp.); **IR** (KBr): ν 3446, 1633, 1447, 1296, 1147, 1087, 750 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, $\text{DMSO-}d_6$): δ 7.93–7.91 (m, 2H), 7.79–7.75 (m, 1H), 7.70–7.66 (m, 2H), 6.96–6.87 (m, 2H), 6.00–5.96 (m, 2H), 3.38–3.30 (m, 2H), 3.23–3.15 (m, 1H), 2.96 (d, J = 10.8 Hz, 1H), 2.31 (d, J = 13.6 Hz, 1H), 2.06–1.90 (m, 2H), 1.76 (d, J = 13.6 Hz, 1H); **$^{13}\text{C NMR}$** (100 MHz, $\text{DMSO-}d_6$): δ 185.1, 175.9, 153.6, 153.1, 138.6, 133.9, 129.5, 127.7, 125.3, 125.0, 60.4, 54.8, 53.4, 51.9, 43.4, 29.4; **HRMS** (ESI): m/z calc'd for $\text{C}_{18}\text{H}_{20}\text{O}_5\text{NS}$ [$\text{M} + \text{H}$] $^+$: 362.1057, found: 362.1050.

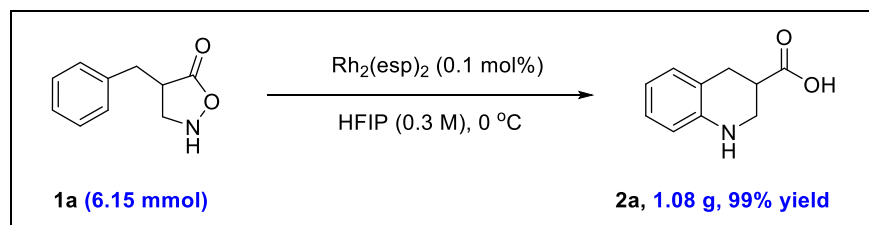
3-Allyl-8-oxo-1-azaspiro[4.5]deca-6,9-dien-1-ium-3-carboxylate (8i): Prepared by the general procedure H from **7i**



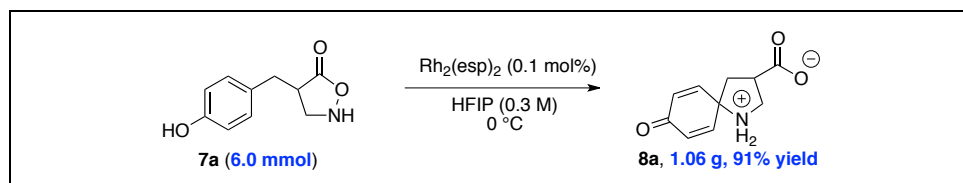
(22.0 mg, 0.095 mmol), stirred for 1 h, and the reaction mixture was purified directly by silica gel column chromatography (0% to 100% methanol in EtOAc) to afford the product as a yellow solid (10.0 mg, 45% yield). **m.p.** 120 °C (decomp.); **IR** (thin film): ν 3437, 1674, 1548, 1385, 1003, 857 cm^{-1} ; **$^1\text{H NMR}$** (400 MHz, $\text{DMSO-}d_6$): δ 7.02–6.96 (m, 2H), 6.02–5.95 (m, 2H),

5.76–5.66 (m, 1H), 5.10–5.01 (m, 2H), 3.41 (d, J = 10.4 Hz, 1H), 2.96 (d, J = 10.4 Hz, 1H), 2.54–2.50 (m, 1H), 2.42–2.33 (m, 2H), 1.77 (d, J = 13.6 Hz, 1H); **$^{13}\text{C NMR}$** (100 MHz, $\text{DMSO-}d_6$): δ 185.7, 177.3, 154.5, 154.2, 135.4, 125.7, 125.3, 118.1, 61.1, 55.2, 55.1, 44.2, 41.9; **HRMS** (ESI): m/z calc'd for $\text{C}_{13}\text{H}_{16}\text{O}_3\text{N}$ [$\text{M} + \text{H}$] $^+$: 234.1125, found: 234.1115.

4-3. Gram-scale synthesis



To a 50 mL flask equipped with a magnetic stirring bar were added substrate **1a** (1.09 g, 6.15 mmol) and $\text{Rh}_2(\text{esp})_2$ (4.70 mg, 0.1 mol%, 0.00615 mmol), followed by the addition of HFIP (20 mL, 0.3 M) at 0 °C (ice-water bath). The resulting mixture was stirred at the same temperature. After full consumption of **1a** by TLC analysis (about 30 min), the reaction mixture was concentrated under reduced pressure. The obtained crude residue was purified by silica gel column chromatography (0% to 20% methanol in EtOAc) to afford product **2a** as a light-yellow solid (1.08 g, 99% yield).



To a 50 mL flask equipped with a magnetic stirring bar were added substrate **7a** (1.16 g, 6.0 mmol), $\text{Rh}_2(\text{esp})_2$ (4.60 mg, 0.1 mol%, 0.006 mmol), followed by the addition of HFIP (20 mL, 0.3 M) at 0 °C (ice-water bath). The resulting mixture was stirred at the same temperature. After full consumption of **7a** by TLC analysis (about 1 h), the reaction mixture was concentrated under reduced pressure. The obtained crude product was further washed with CH_2Cl_2 for three times to afford the pure product **8a** as an off-white solid (1.06 g, 91% yield).

5. X-Ray structure of **2f**

Single crystals of **2f** were obtained by slow diffusion of the solution of **2f** in EtOAc at RT. A suitable crystal was selected and the sample was measured on a Rigaku R-AXIS RAPID diffractometer using graphite monochromated Cu-K α radiation. The data were collected at 93.15 K. Refined structure and crystallographic parameters are summarized in Figure S1 and Table S1. CCDC 1885044 contains the supplementary crystallographic data for **2f**.

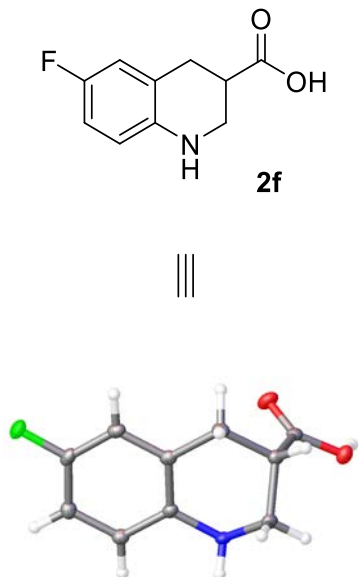
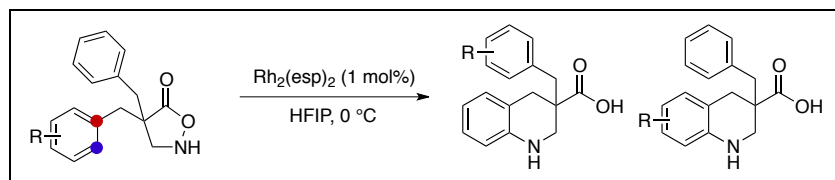


Figure S1. ORTEP diagram of **2f**.

Table S1. Selected crystal data of **2f**.

Empirical Formula	$\text{C}_{10}\text{H}_{10}\text{FNO}_2$
Formula Weight	195.19
Crystal Size	$0.2 \times 0.2 \times 0.2$ mm
Crystal System	Monoclinic
Lattice Parameters	
a	20.7185(5) Å
b	9.30450(10) Å
c	12.4912(3) Å
α	90 °
β	133.858(4) °
γ	90 °
V	1736.31(10) Å ³
Space Group	C2/c
Z value	8
D_{calc}	1.493 g/cm ³
F_{000}	816.0
$\mu(\text{CuK}\alpha)$	1.007 mm ⁻¹

6. Hammett analysis



Procedure: To a solution of dibenzyl substituted substrate (0.1 mmol) in HFIP (0.1 M) was added $\text{Rh}_2(\text{esp})_2$ (0.8 mg, 1 mol%) at 0 °C. After the substrate was consumed, the solution was diluted with CHCl_3 and filtered through a pad of celite, and removed under reduced pressure. The crude material was analyzed by NMR and HPLC (detection wavelength 210 nm). All experiments were repeated twice.

Discussion: Figure S2 displays two plots for the Hammett analysis: one for the *ipso* carbon and the other for the *ortho* carbon. The latter plot shows lower correlation than the former one. In particular, given the observed isomer ratio in Table 2, electron withdrawing groups are more likely to undergo the direct 6-membered ring formation (path i in Figure 2). Nevertheless, the plot is less smooth in the $\sigma > 0$ region. Thus, we conclude that the current system involves spiro formation for both electron donating and withdrawing substituents.

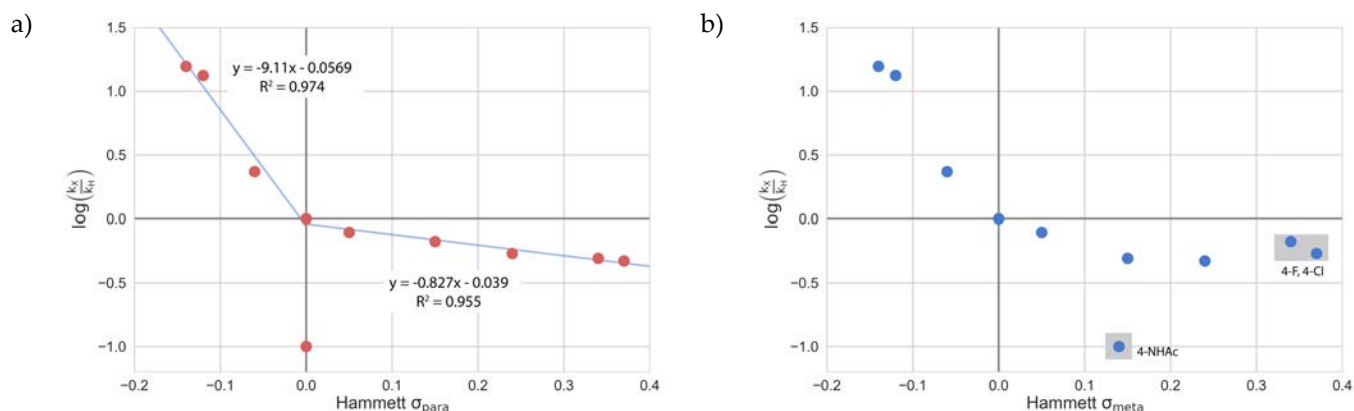


Figure S2. (a) Hammett plot with respect to the *ipso* carbon. (b) Hammett plot with respect to the *ortho* carbon.

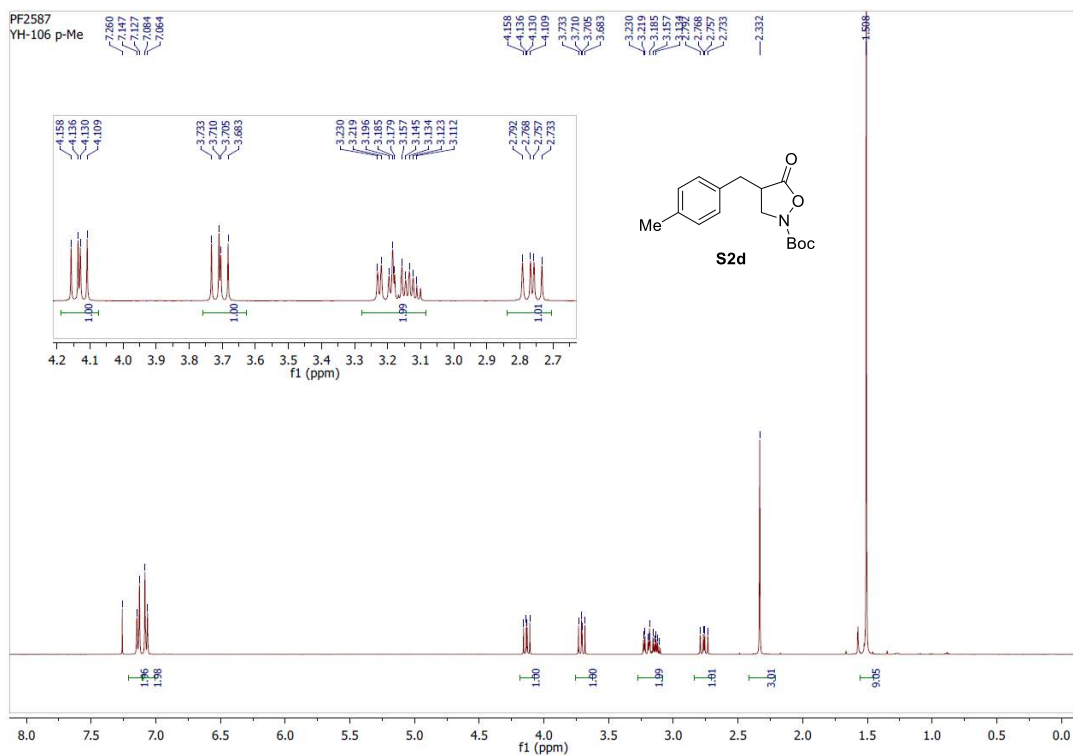
7. References

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- (4) (a) Cadart, T.; Berthonneau, C.; Levacher, V.; Perrio, S.; Brière, J.-F. *Chem. Eur. J.* **2016**, *22*, 15261. (b) Ramachary, D. B.; Kishor, M.; Reddy, Y. V. *Eur. J. Org. Chem.* **2008**, 975.
- (5) Cadart, T.; Levacher, V.; Perrio, S.; Brière, J.-F. *Adv. Synth. Catal.* **2018**, *360*, 1499.
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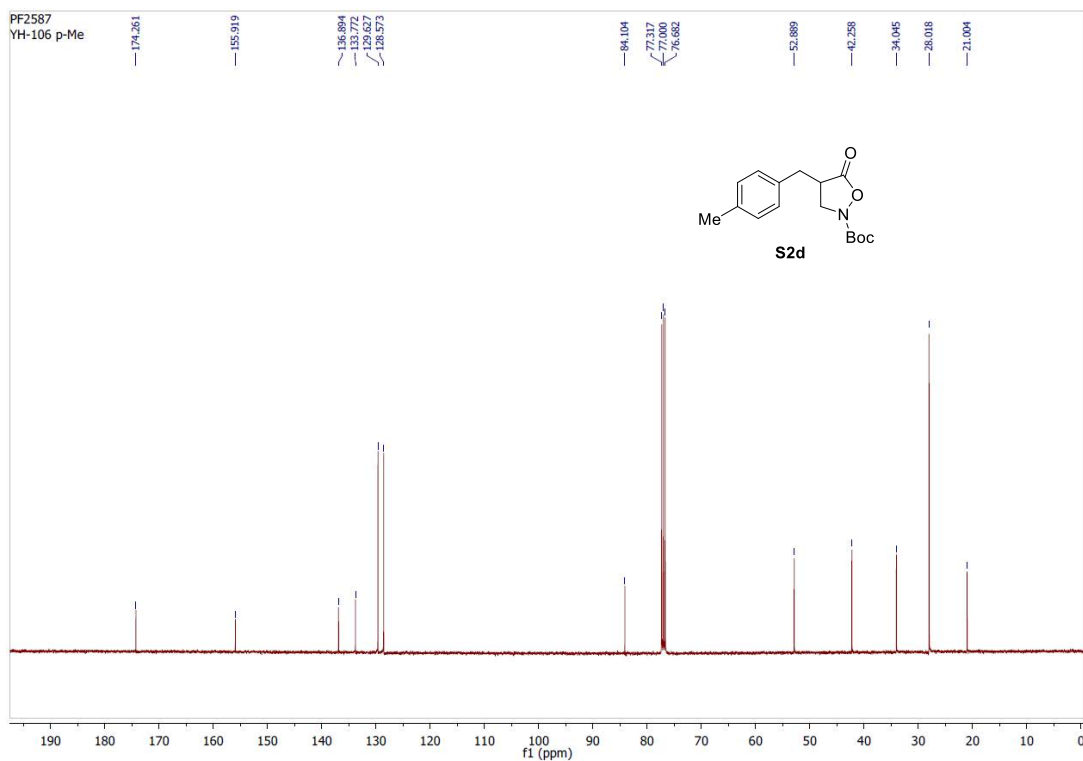
8. NMR Spectra

tert-Butyl 4-(4-methylbenzyl)-5-oxoisoxazolidine-2-carboxylate (S2d):

^1H NMR (400 MHz, CDCl_3)

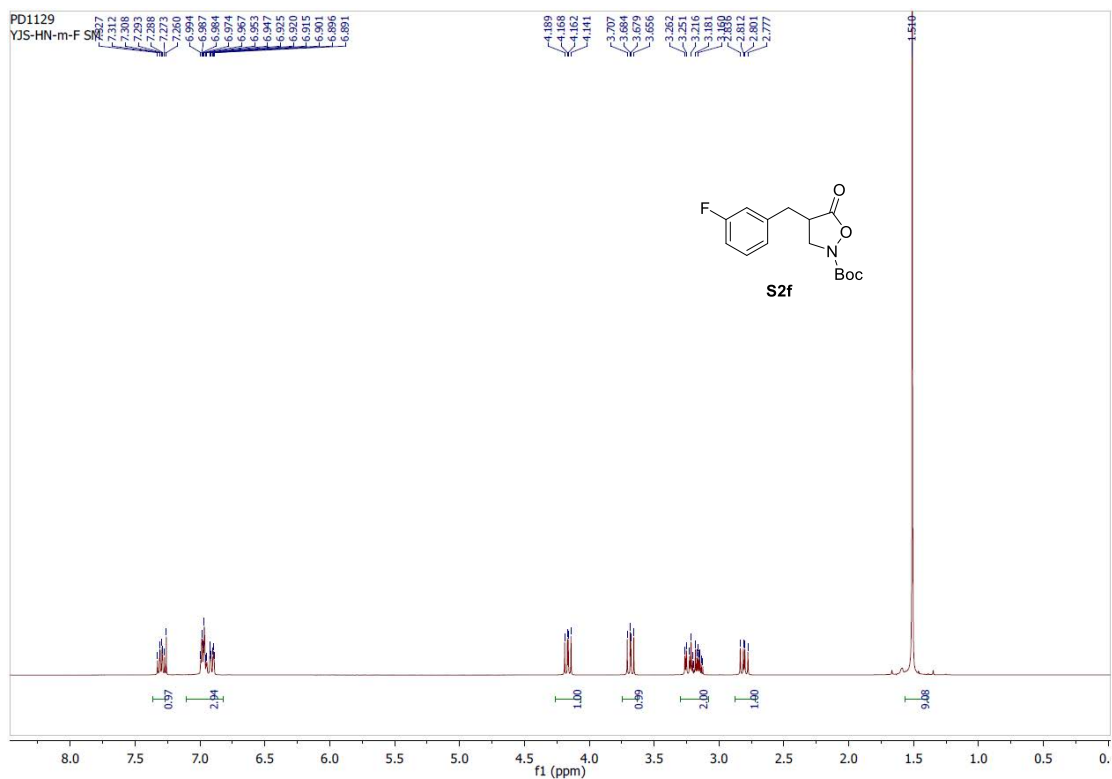


^{13}C NMR (100 MHz, CDCl_3)

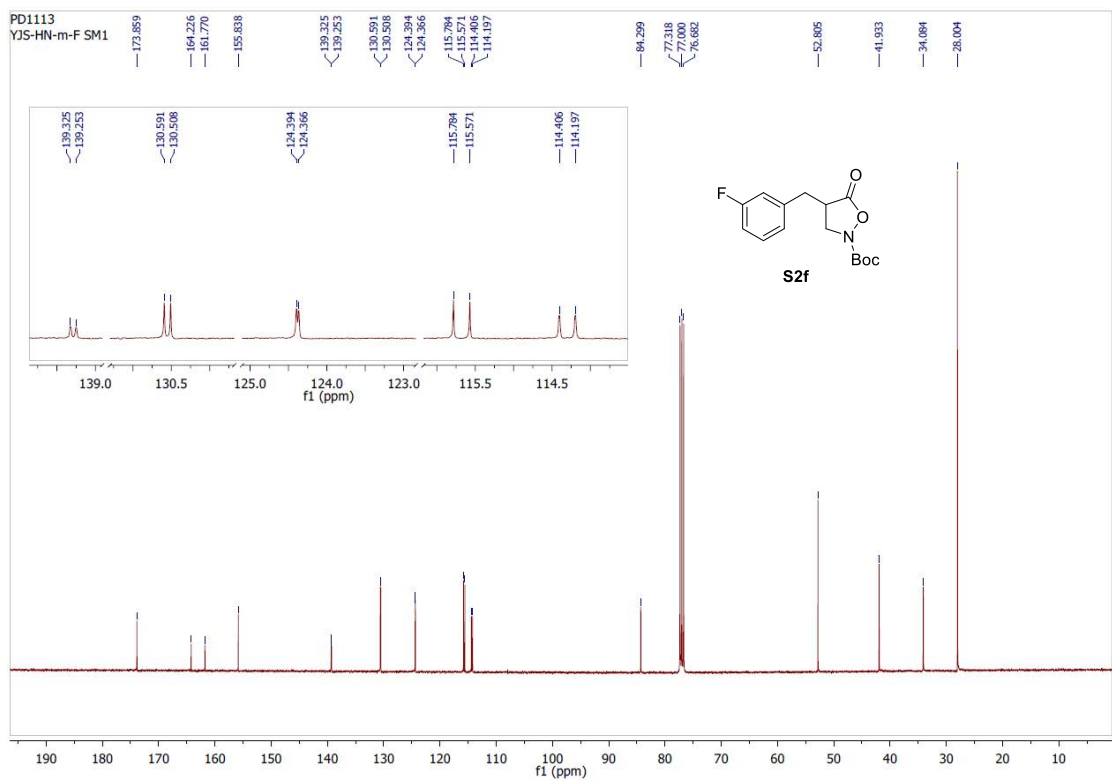


tert-Butyl 4-(3-fluorobenzyl)-5-oxoisoxazolidine-2-carboxylate (S2f):

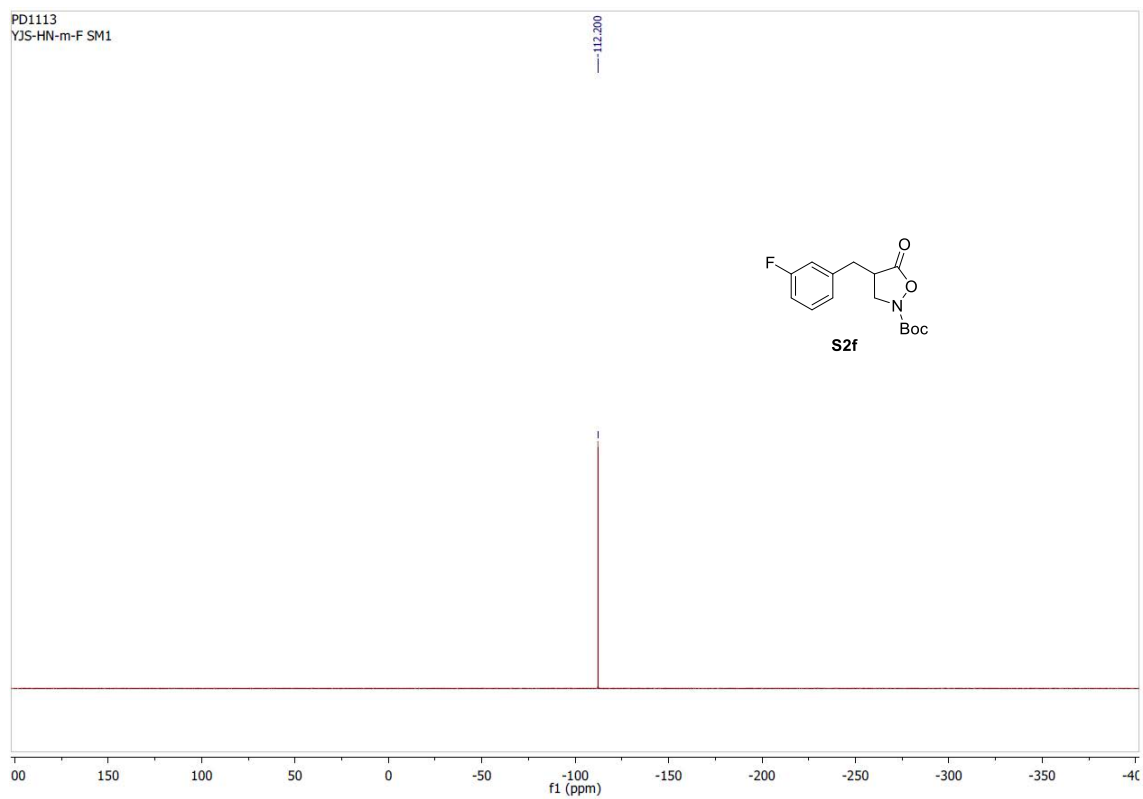
¹H NMR (400 MHz, CDCl₃)



¹³C NMR (100 MHz, CDCl₃)

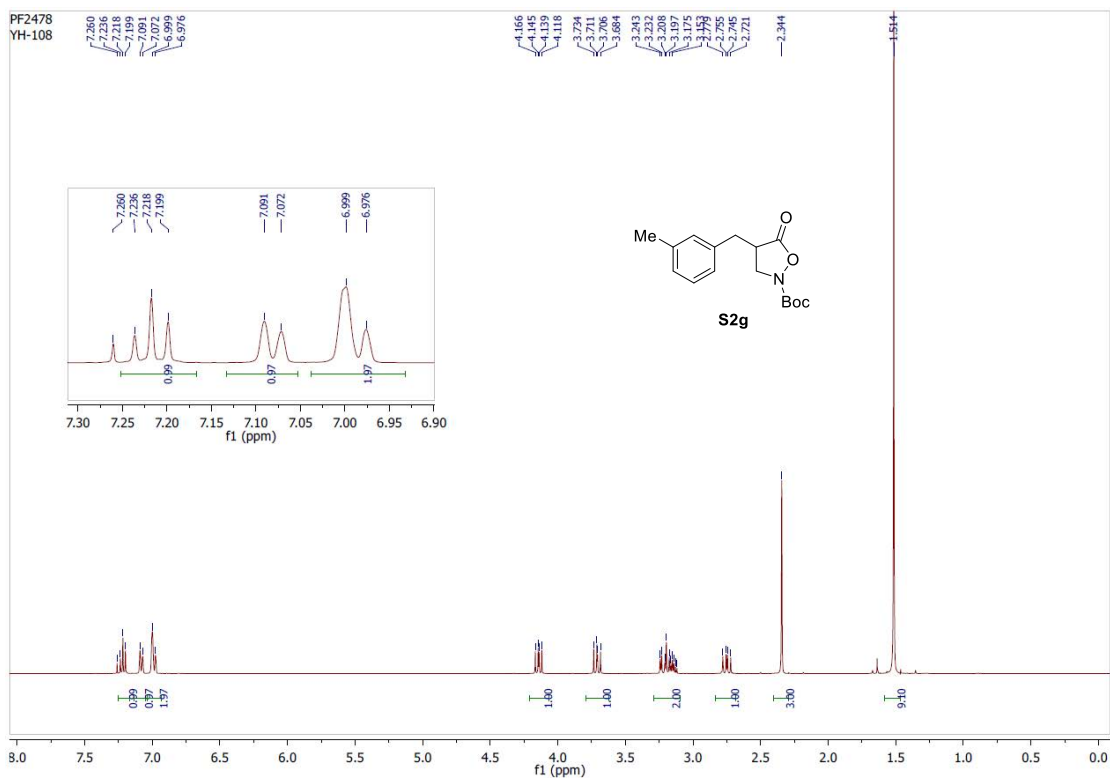


^{19}F NMR (376 MHz, CDCl_3)

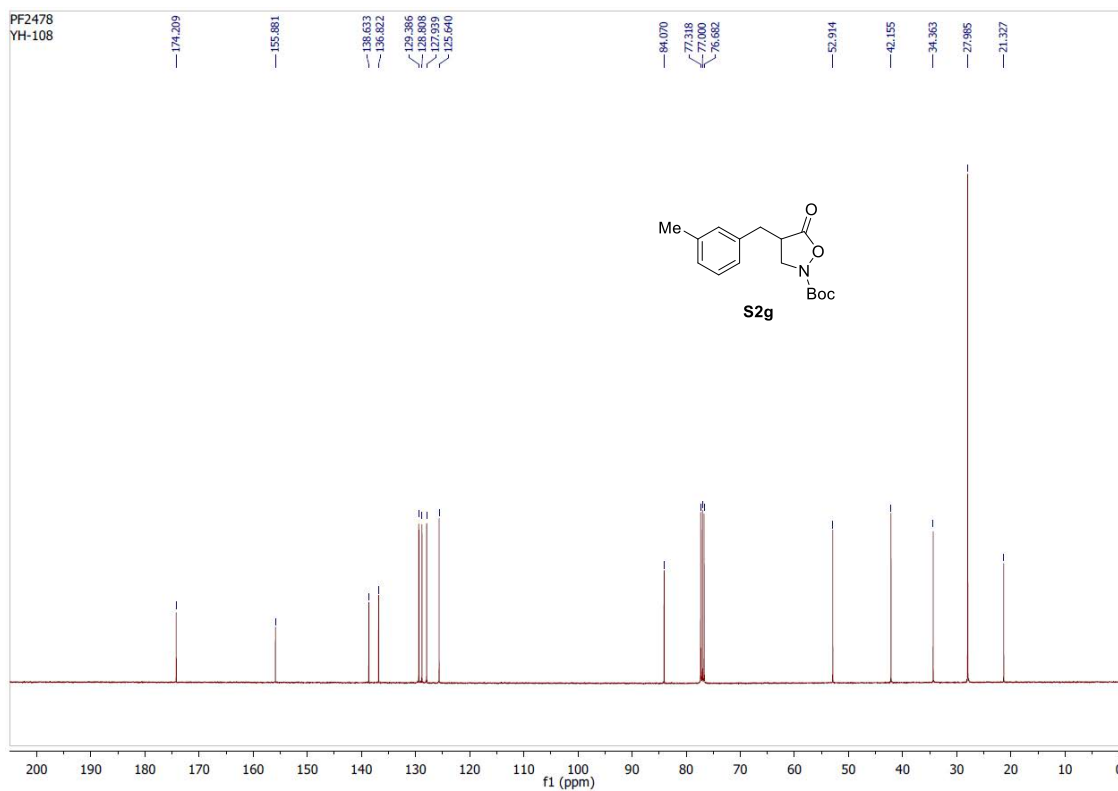


tert-Butyl 4-(3-methylbenzyl)-5-oxisoxazolidine-2-carboxylate (S2g):

¹H NMR (400 MHz, CDCl₃)

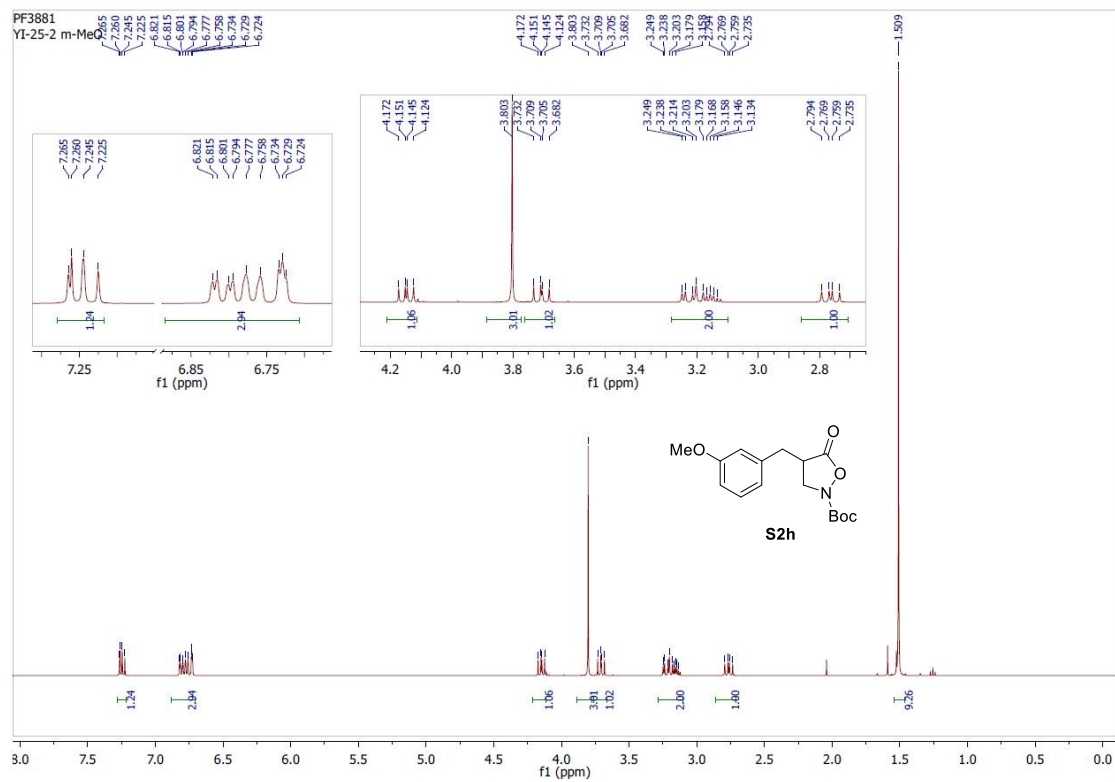


¹³C NMR (100 MHz, CDCl₃)

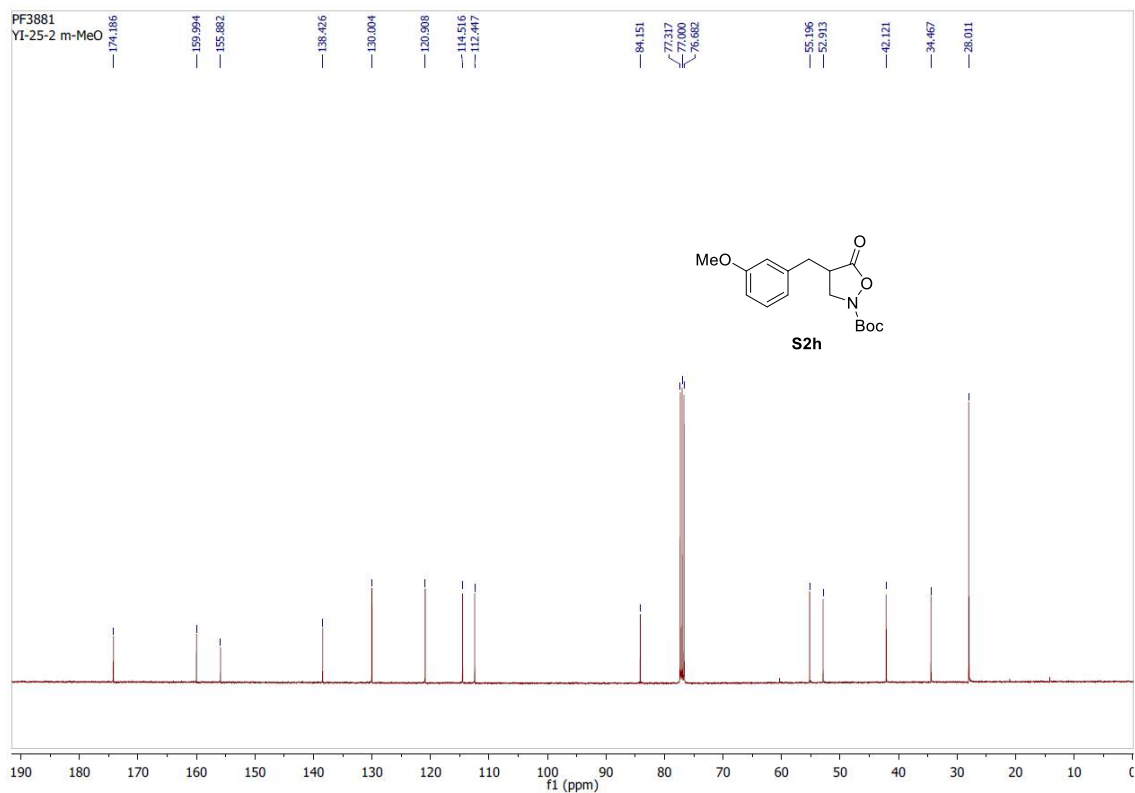


tert-Butyl 4-(3-methoxybenzyl)-5-oxoisoxazolidine-2-carboxylate (S2h):

¹H NMR (400 MHz, CDCl₃)

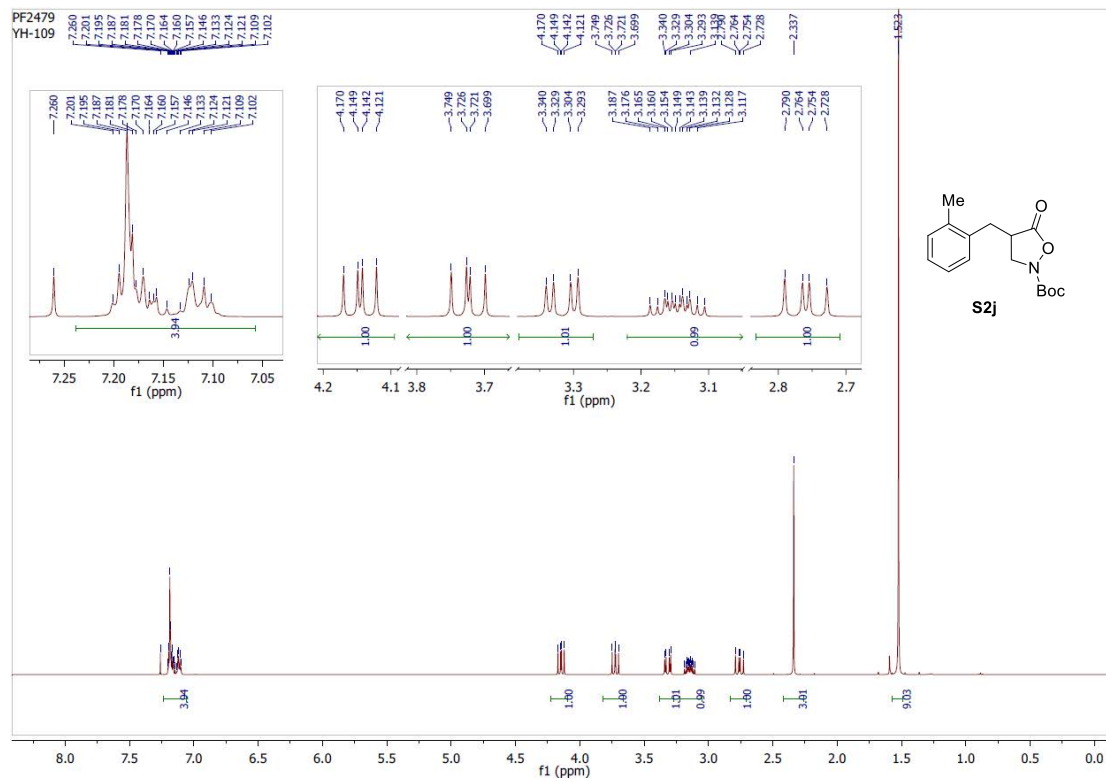


¹³C NMR (100 MHz, CDCl₃)

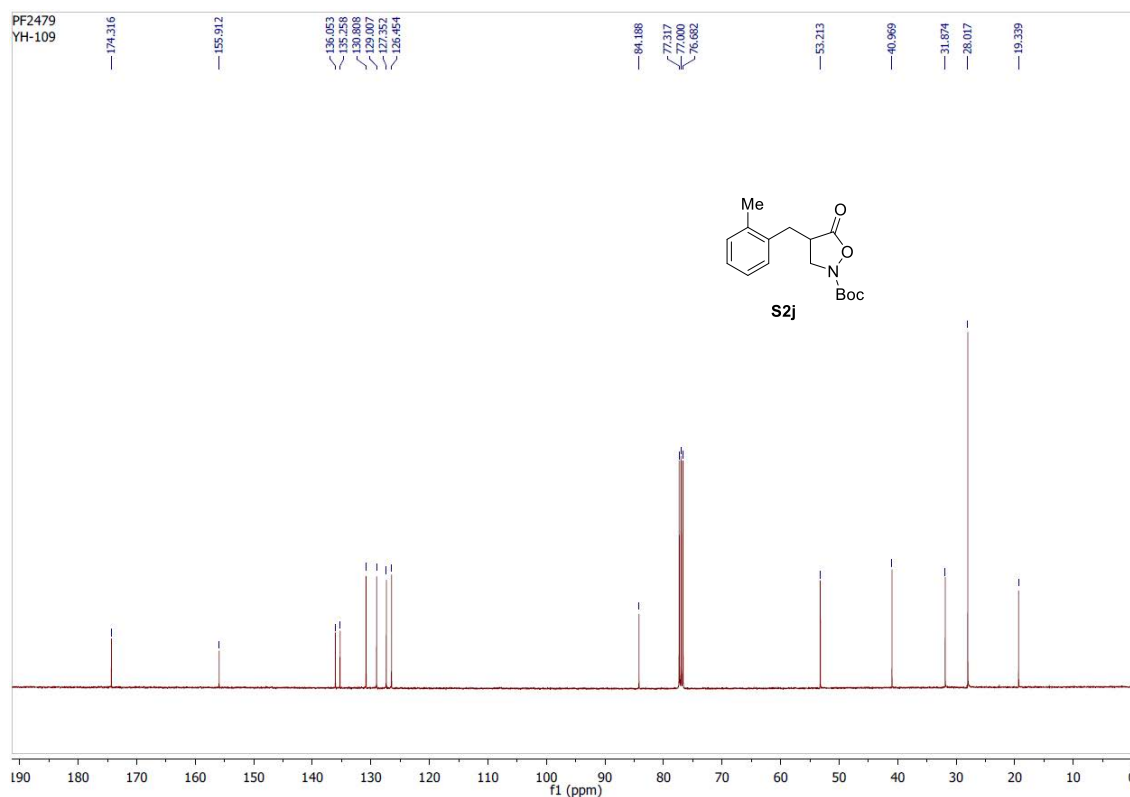


tert-Butyl 4-(2-methylbenzyl)-5-oxisoxazolidine-2-carboxylate (S2j):

¹H NMR (400 MHz, CDCl₃)

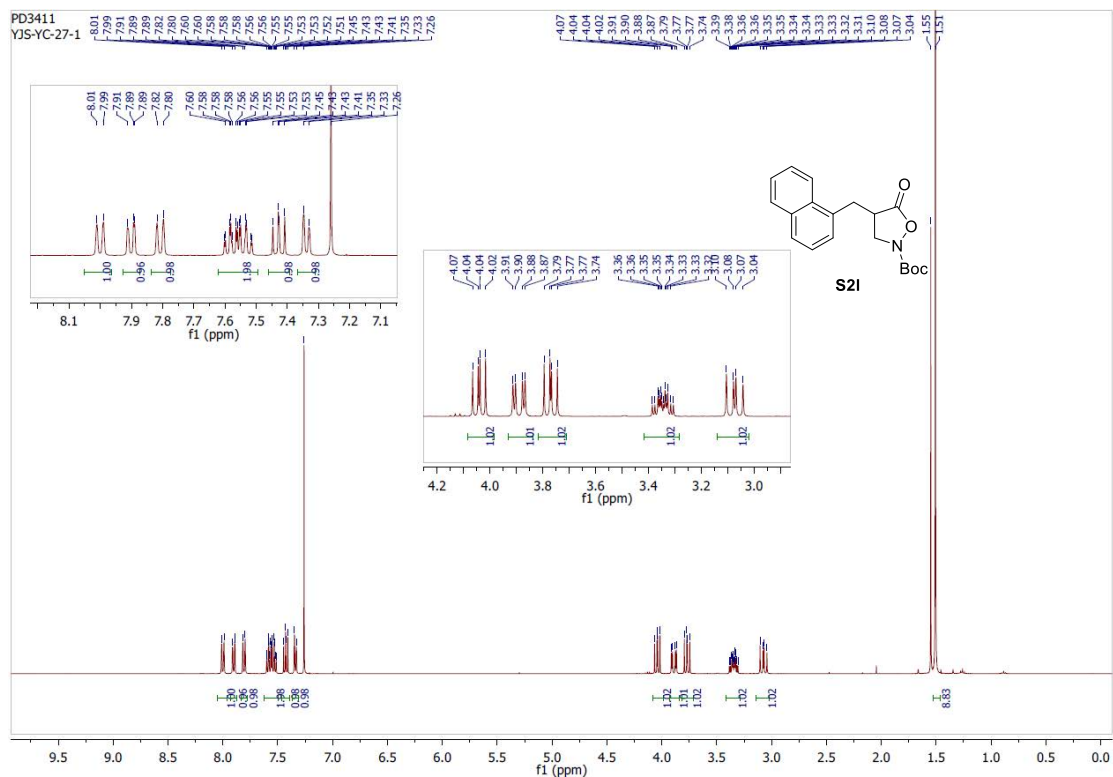


¹³C NMR (100 MHz, CDCl₃)

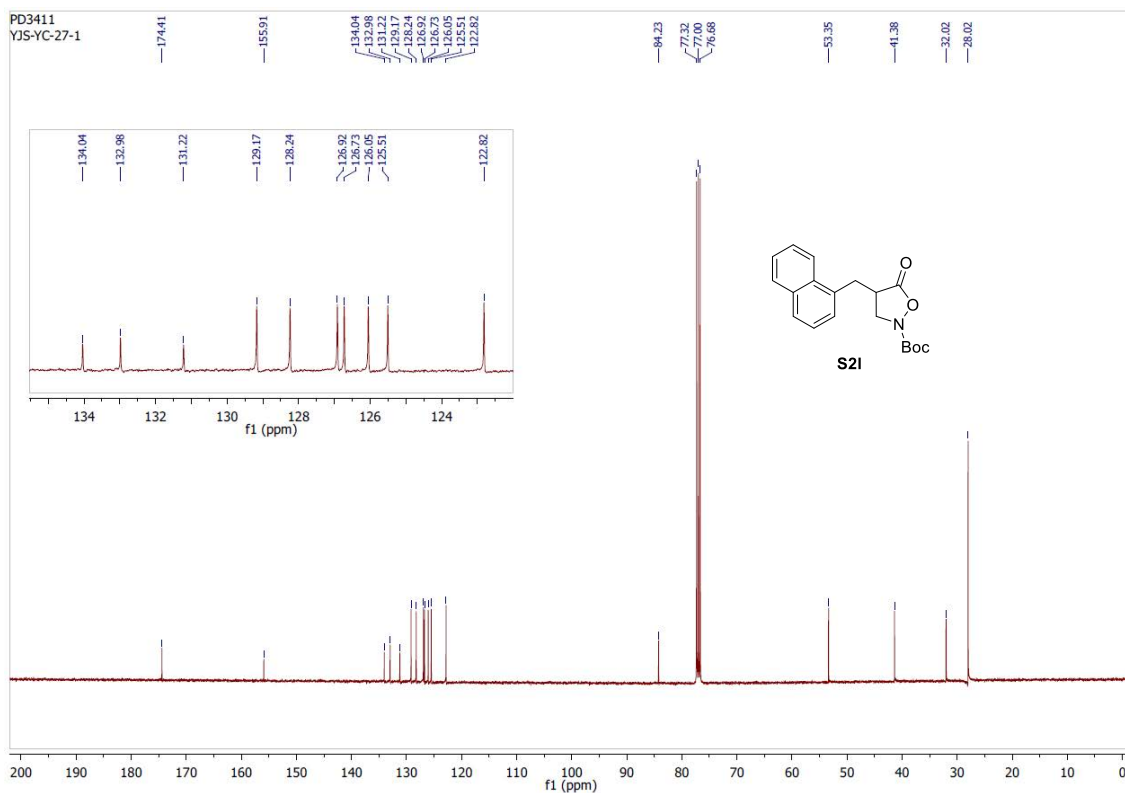


tert-Butyl 4-(naphthalen-1-ylmethyl)-5-oxoisoxazolidine-2-carboxylate (S21):

¹H NMR (400 MHz, CDCl₃)

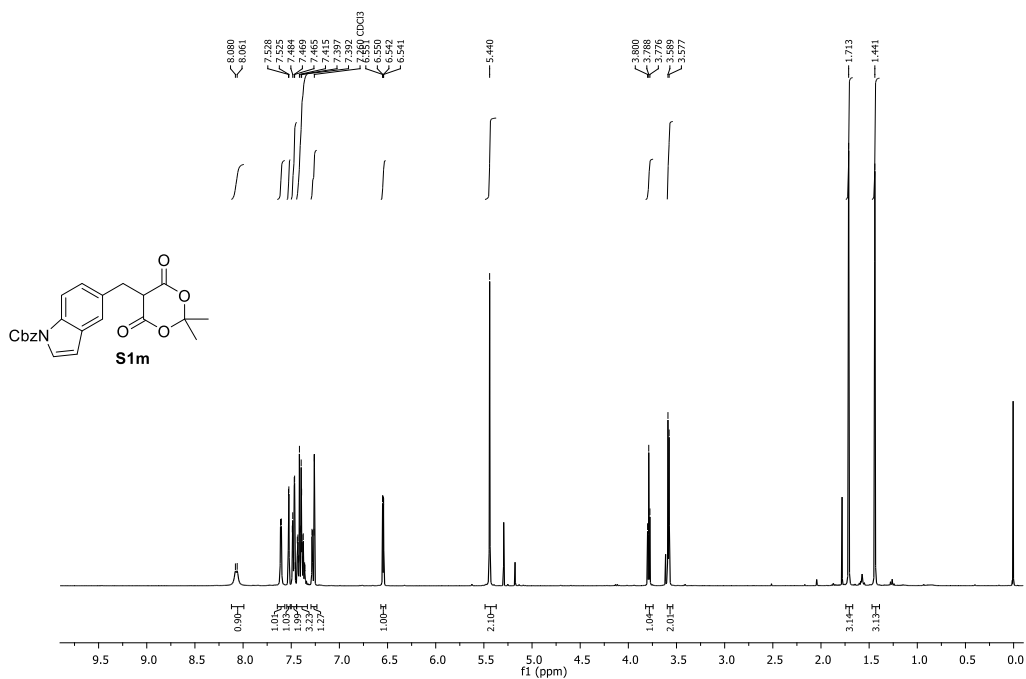


¹³C NMR (100 MHz, CDCl₃)

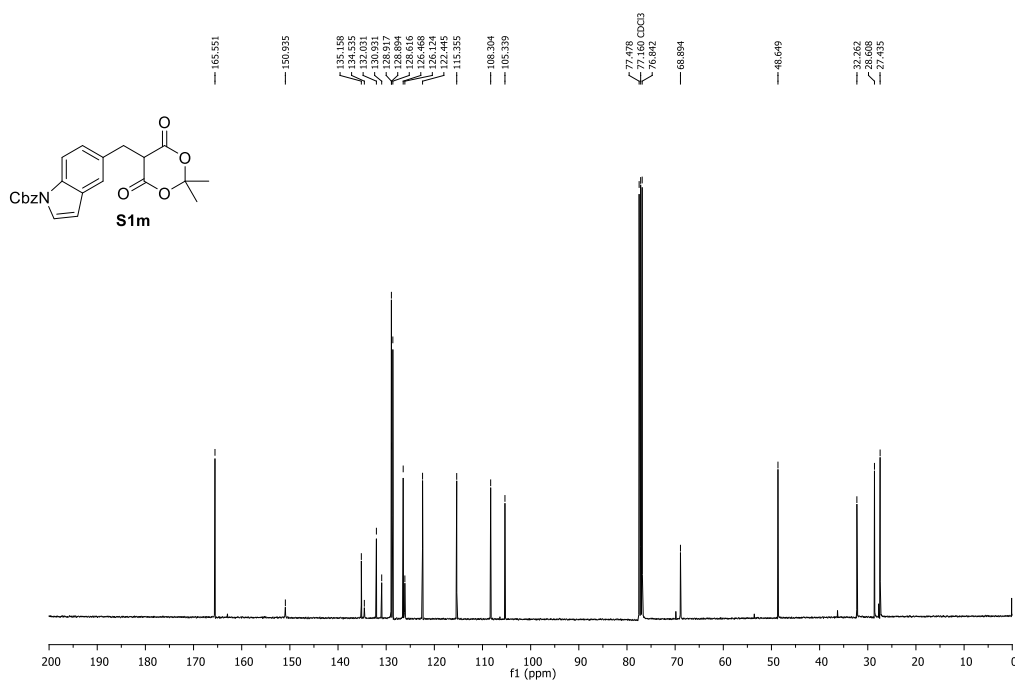


Benzyl 5-((2,2-dimethyl-4,6-dioxo-1,3-dioxan-5-yl)methyl)-1H-indole-1-carboxylate (S1m):

¹H NMR (400 MHz, CDCl₃)

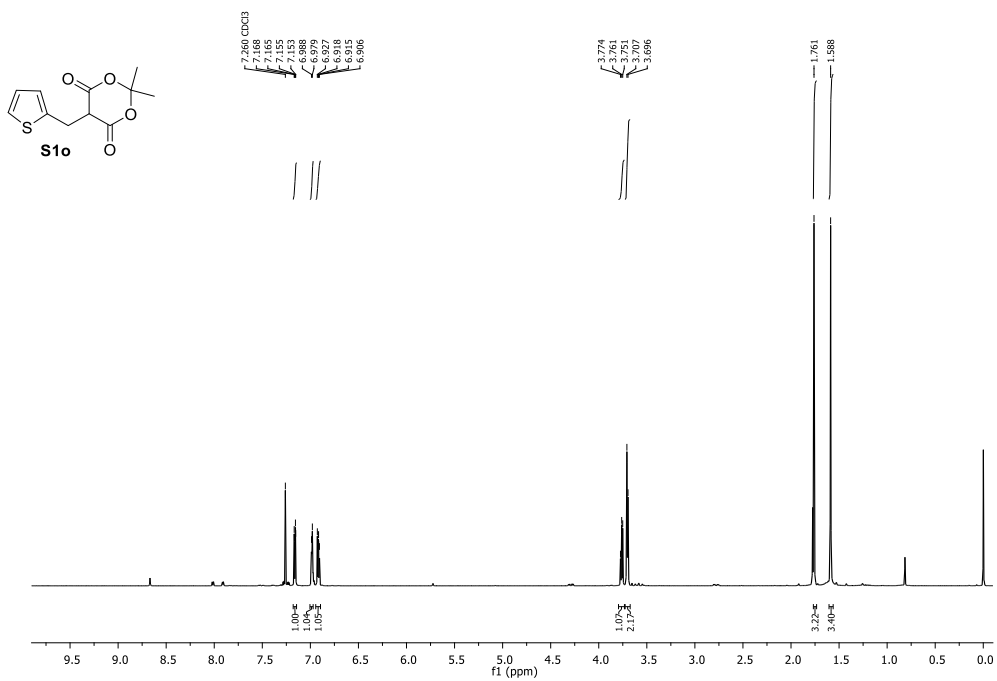


¹³C NMR (100 MHz, CDCl₃)

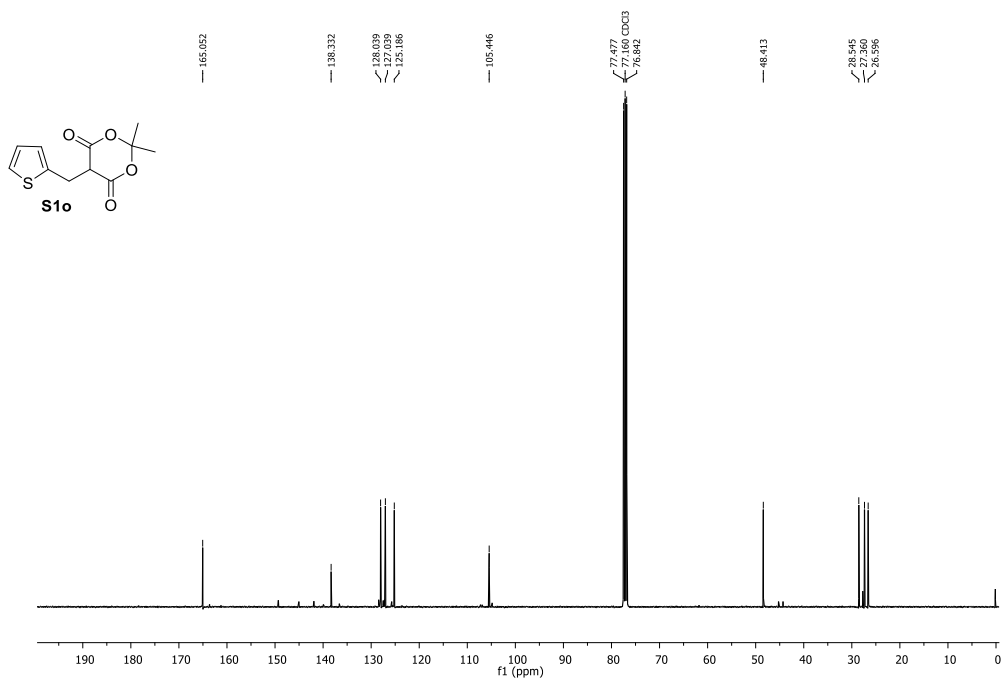


2,2-Dimethyl-5-(thiophen-2-ylmethyl)-1,3-dioxane-4,6-dione (S1o):

^1H NMR (400 MHz, CDCl_3)

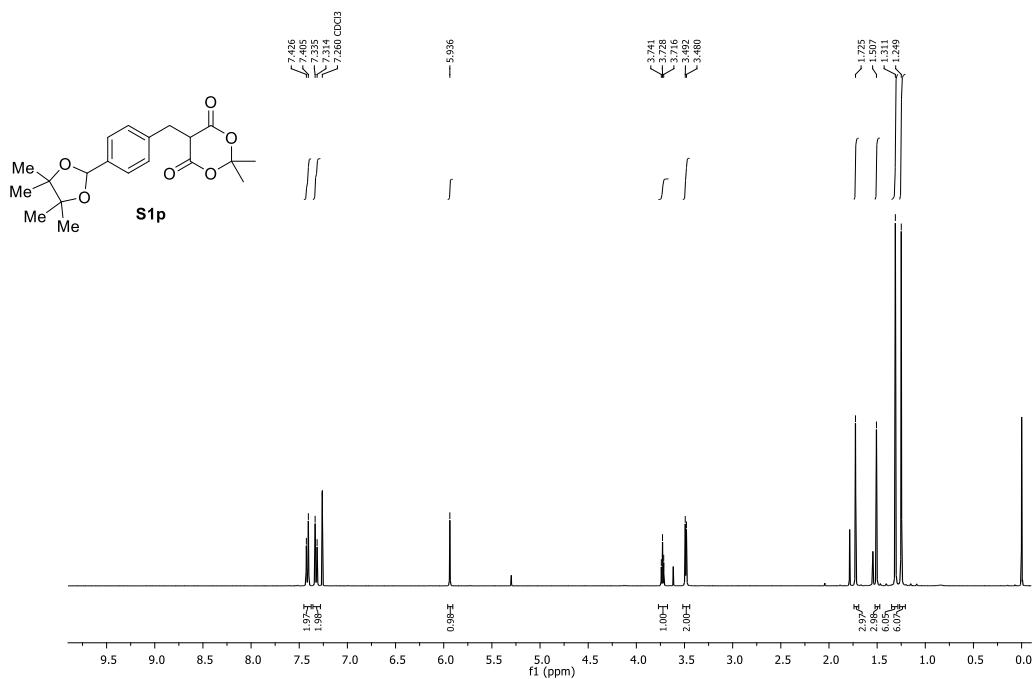


^{13}C NMR (100 MHz, CDCl_3)

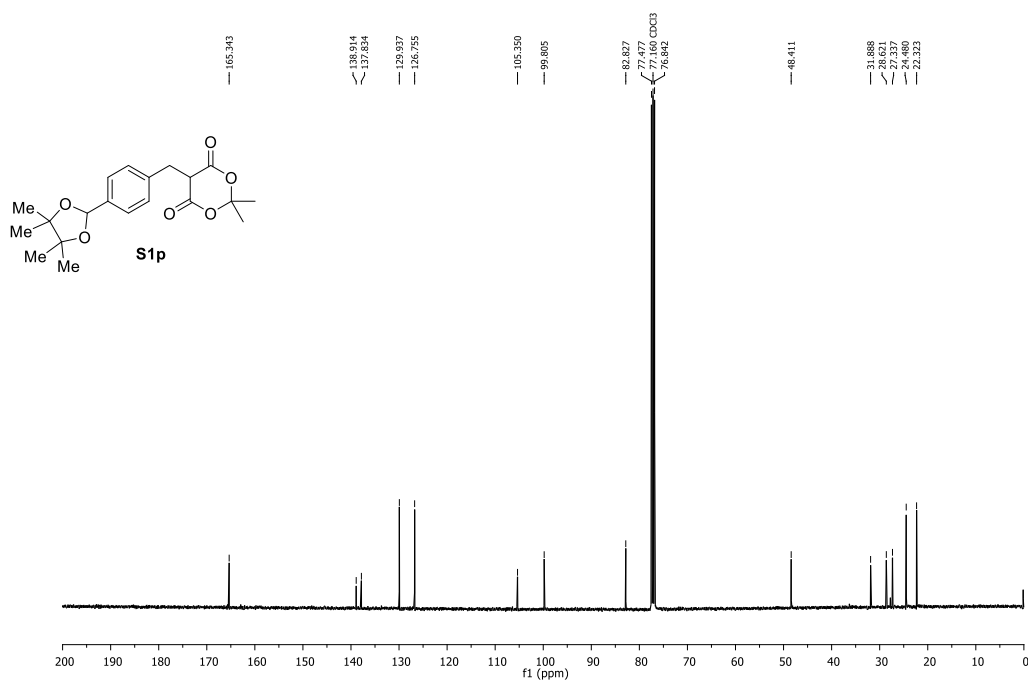


2,2-Dimethyl-5-(4-(4,4,5,5-tetramethyl-1,3-dioxolan-2-yl)benzyl)-1,3-dioxane-4,6-dione (S1p):

¹H NMR (400 MHz, CDCl₃)

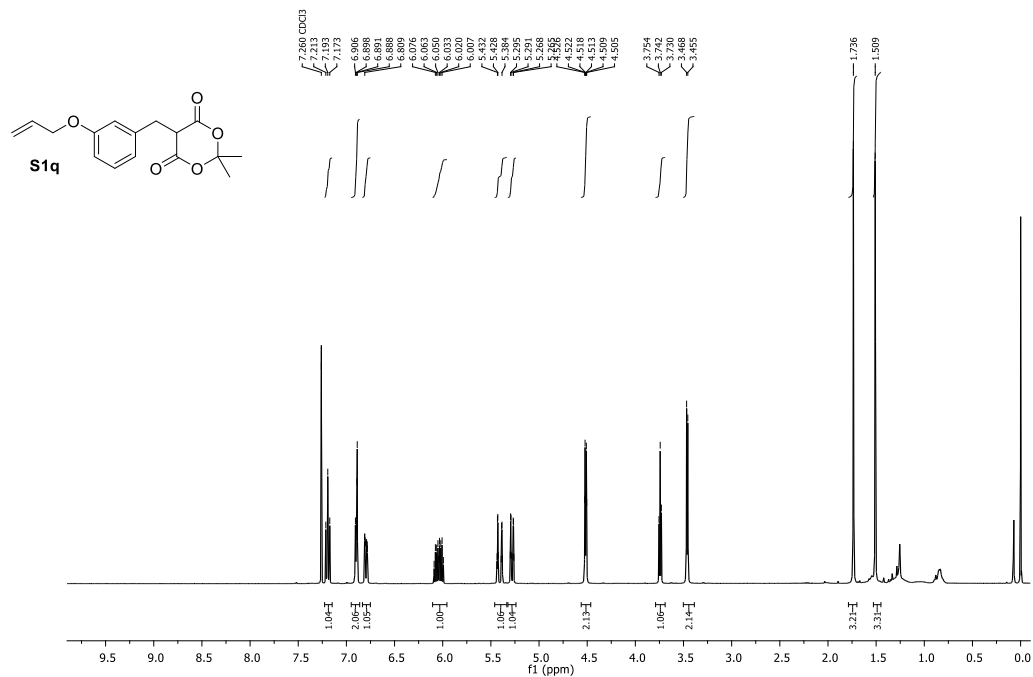


¹³C NMR (100 MHz, CDCl₃)

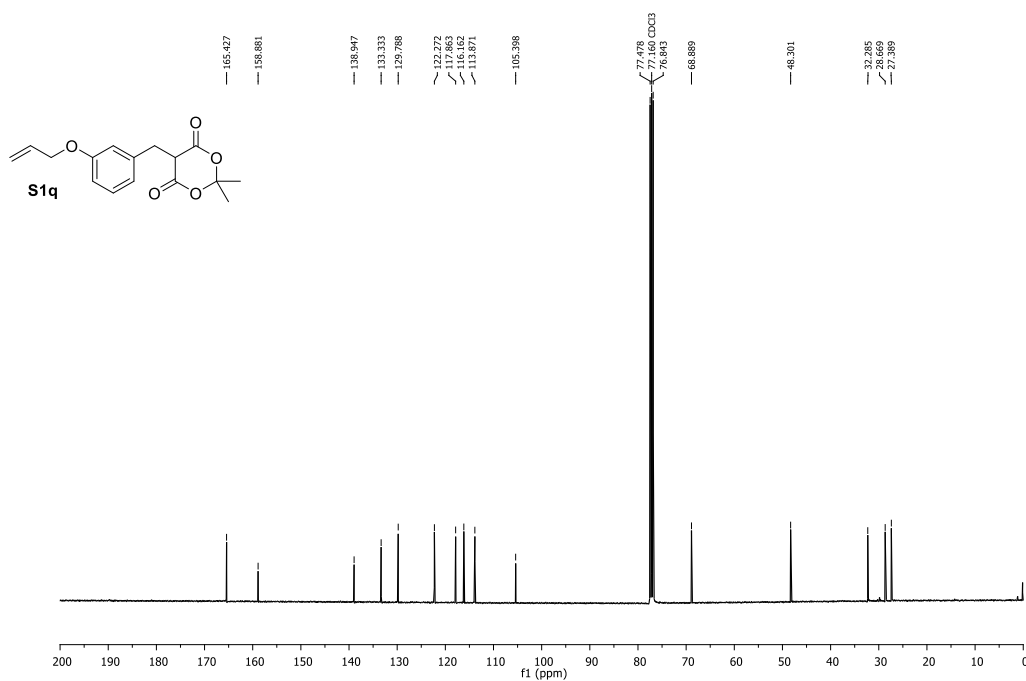


5-(3-(Allyloxy)benzyl)-2,2-dimethyl-1,3-dioxane-4,6-dione (S1q):

^1H NMR (400 MHz, CDCl_3)

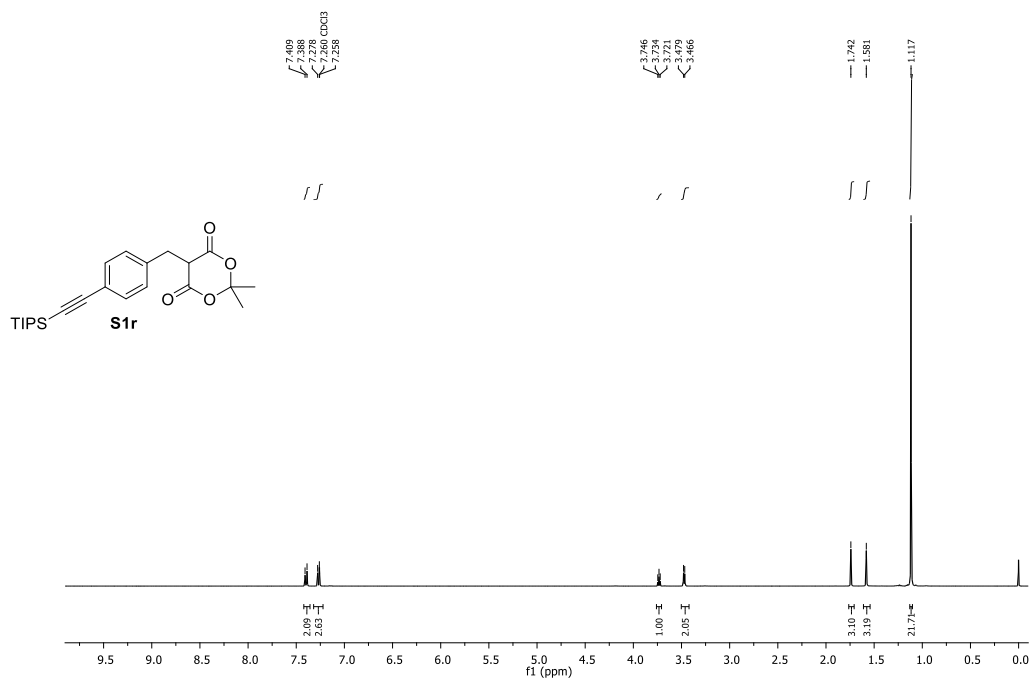


^{13}C NMR (100 MHz, CDCl_3)

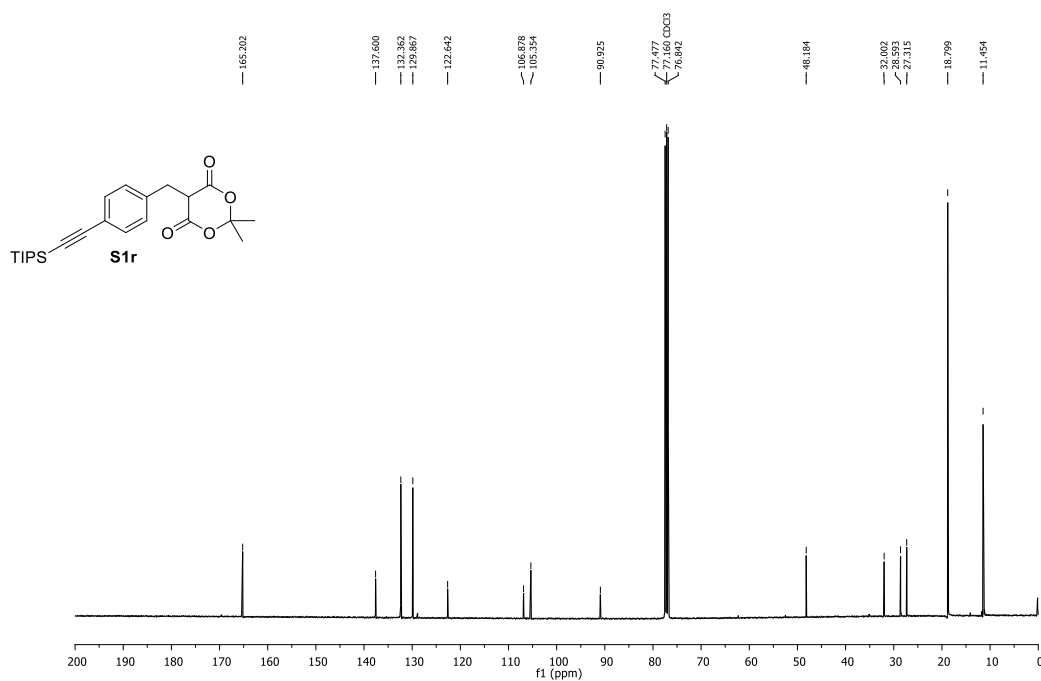


2,2-Dimethyl-5-(4-((triisopropylsilyl)ethynyl)benzyl)-1,3-dioxane-4,6-dione (**S1r**):

^1H NMR (400 MHz, CDCl_3)

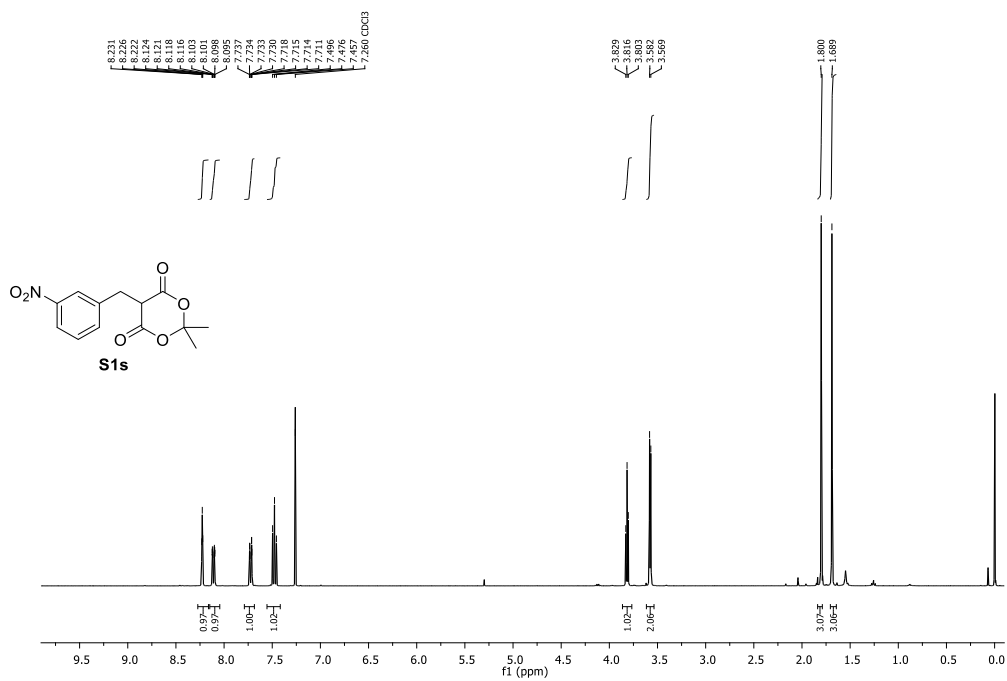


^{13}C NMR (100 MHz, CDCl_3)

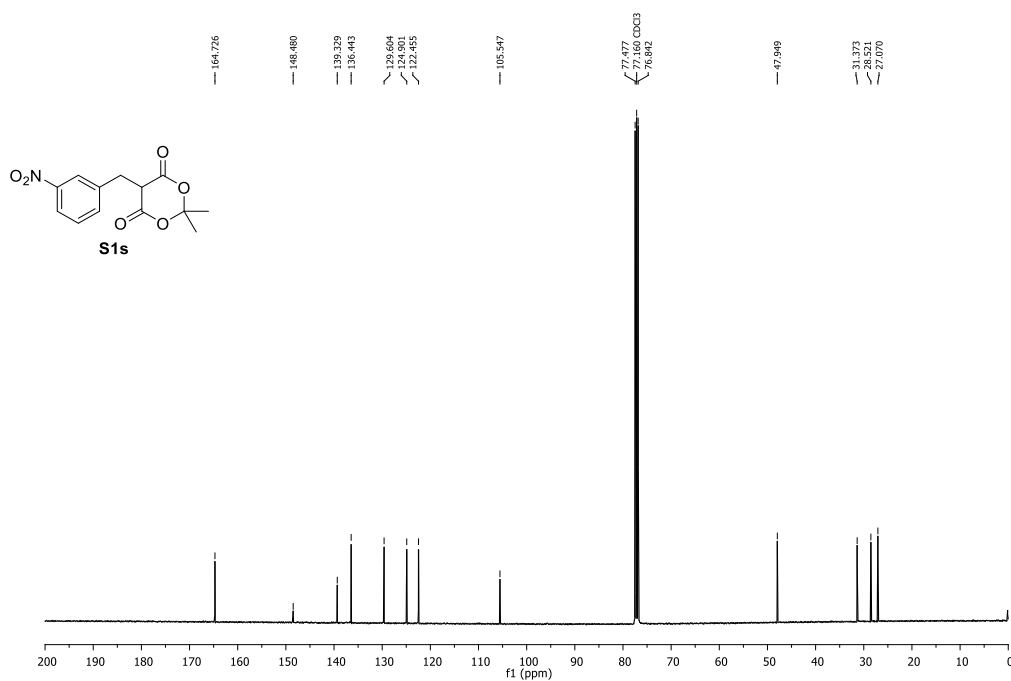


2,2-Dimethyl-5-(3-nitrobenzyl)-1,3-dioxane-4,6-dione (S1s):

^1H NMR (400 MHz, CDCl_3)

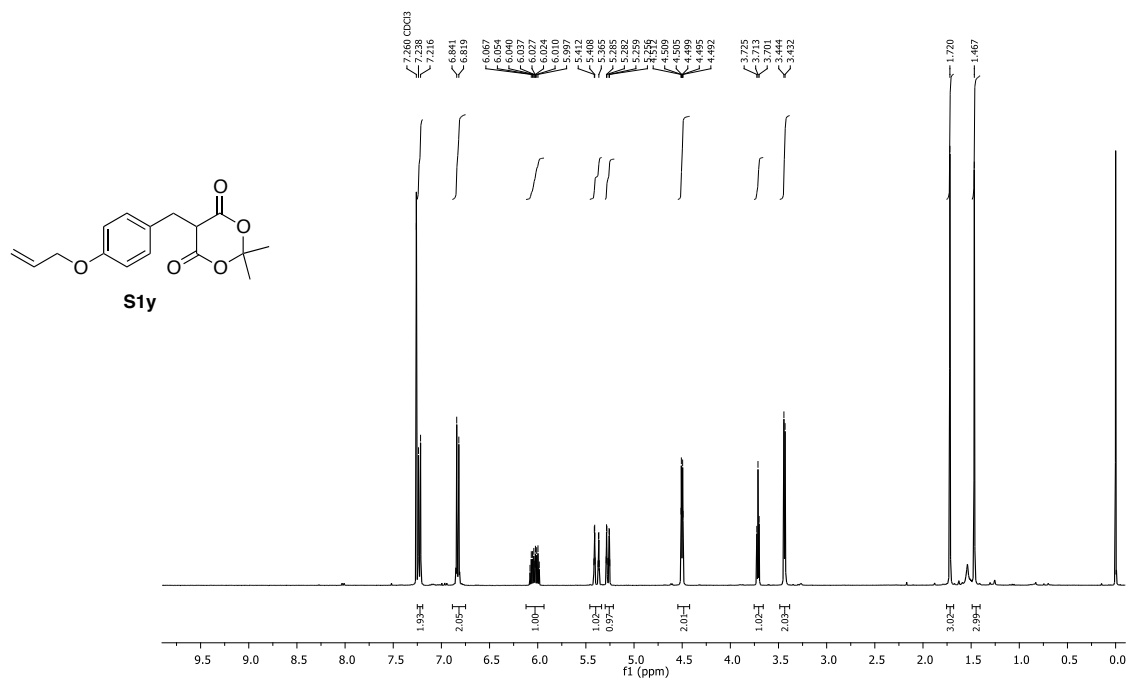


^{13}C NMR (100 MHz, CDCl_3)

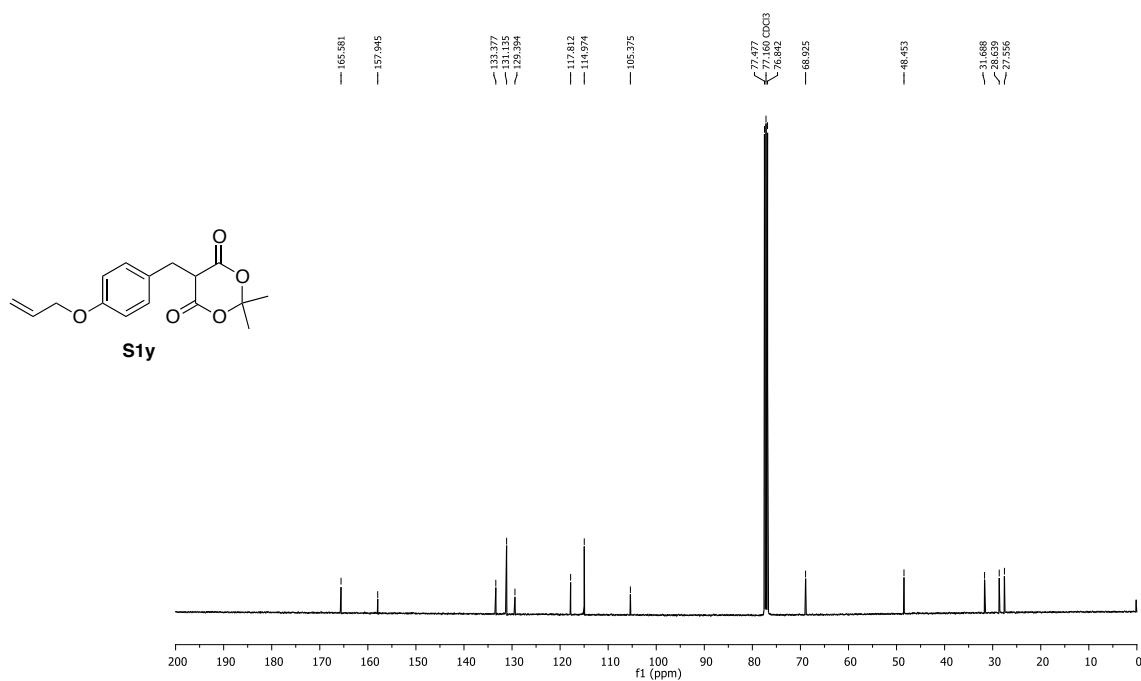


5-(4-(Allyloxy)benzyl)-2,2-dimethyl-1,3-dioxane-4,6-dione (S1y):

^1H NMR (400 MHz, CDCl_3)

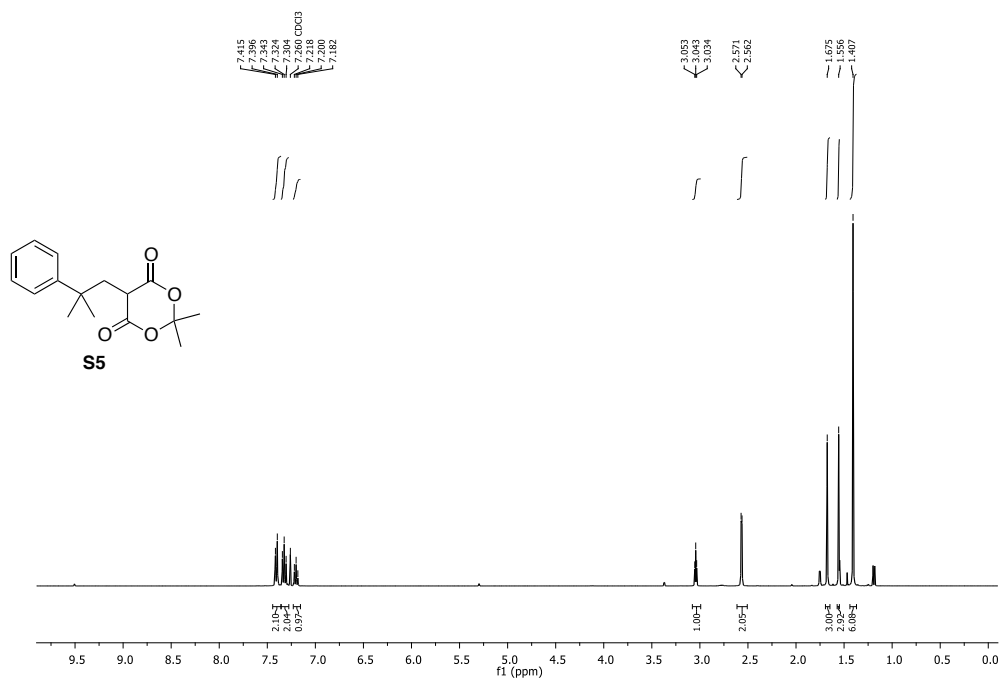


^{13}C NMR (100 MHz, CDCl_3)

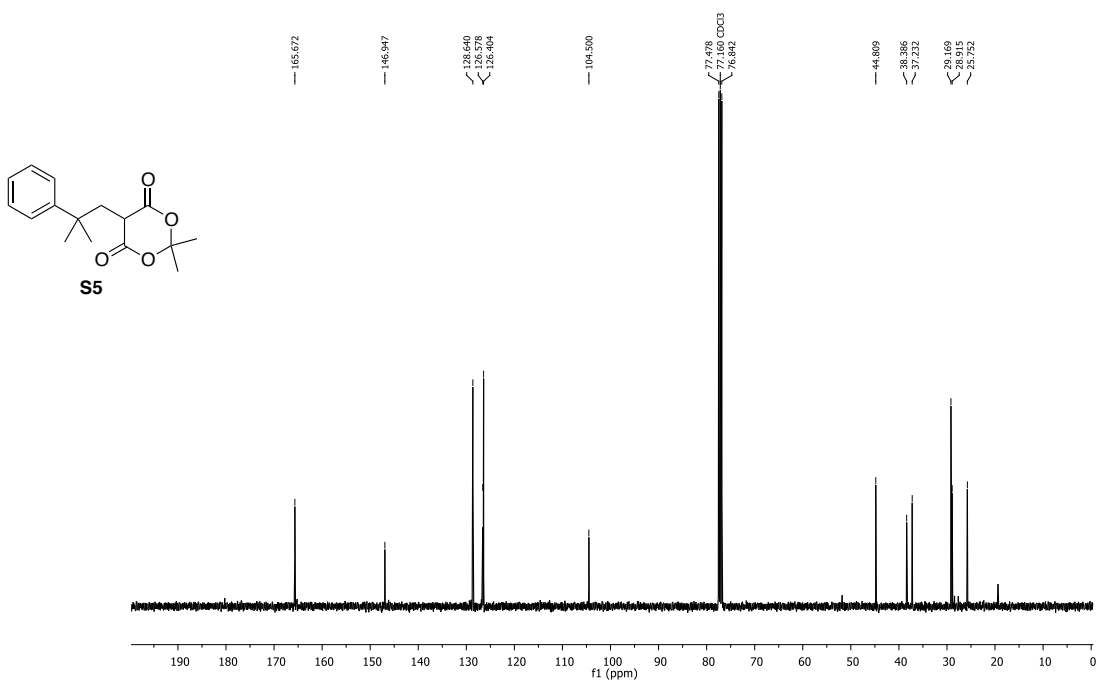


2,2-Dimethyl-5-(2-methyl-2-phenylpropyl)-1,3-dioxane-4,6-dione (S5):

¹H NMR (400 MHz, CDCl₃)

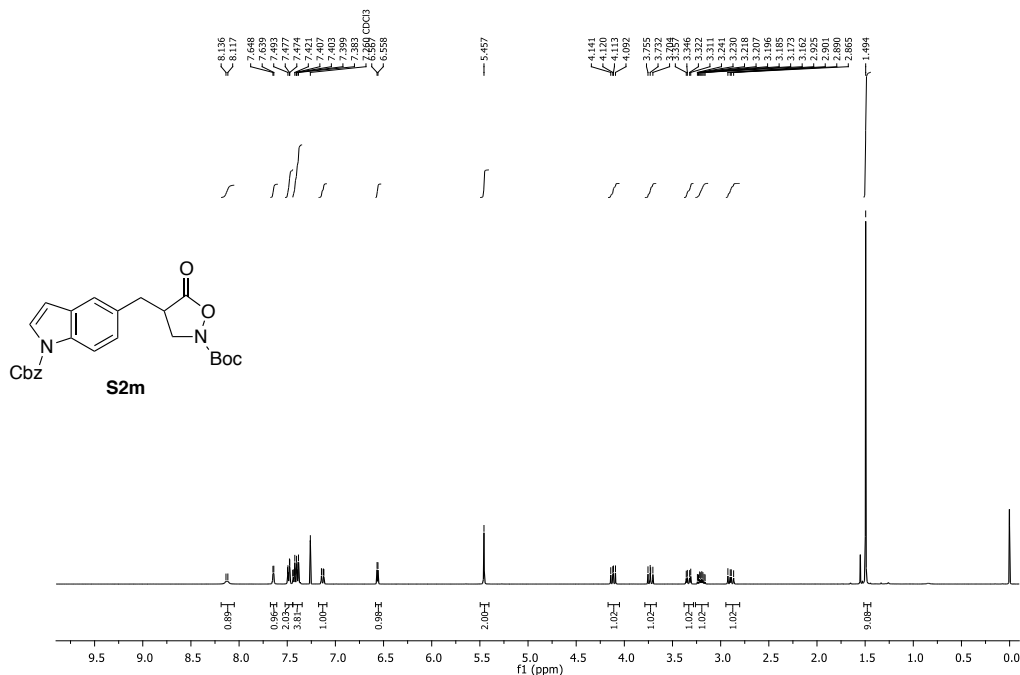


¹³C NMR (100 MHz, CDCl₃)

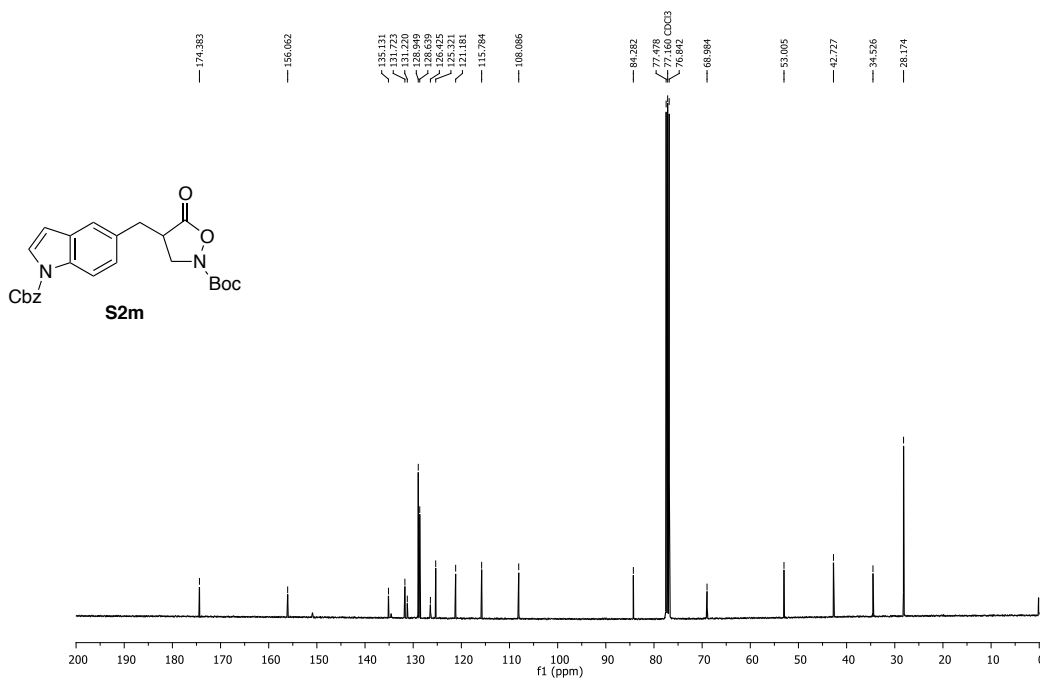


***tert*-Butyl 4-((1-((benzyloxy)carbonyl)-1*H*-indol-5-yl)methyl)-5-oxoisoxazolidine-2-carboxylate (S2m):**

¹H NMR (400 MHz, CDCl₃)

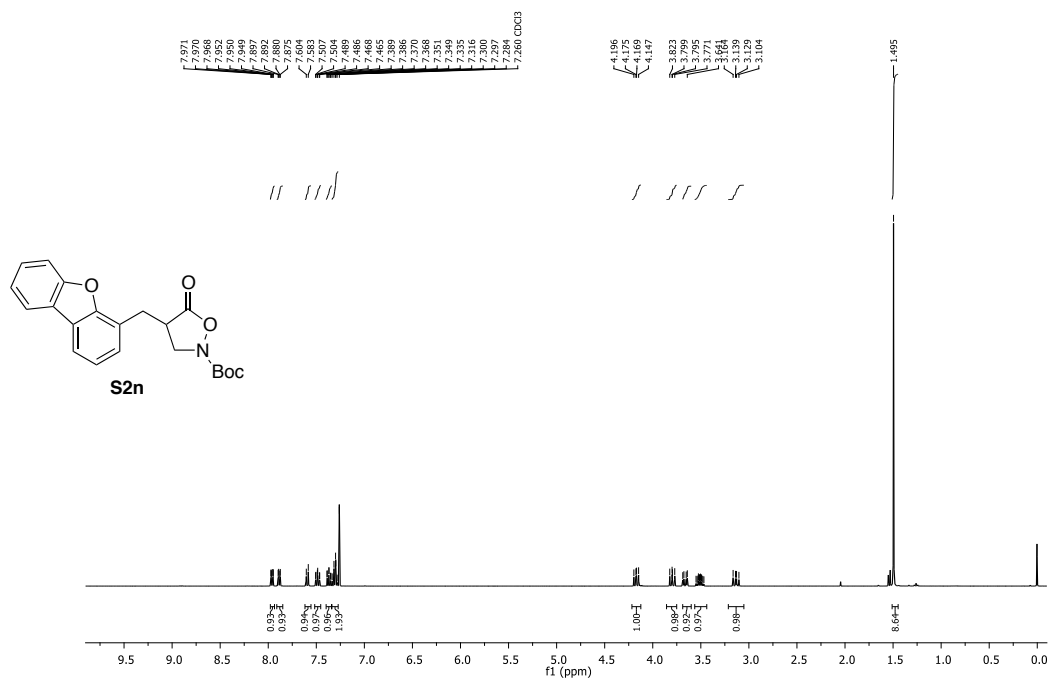


¹³C NMR (100 MHz, CDCl₃)

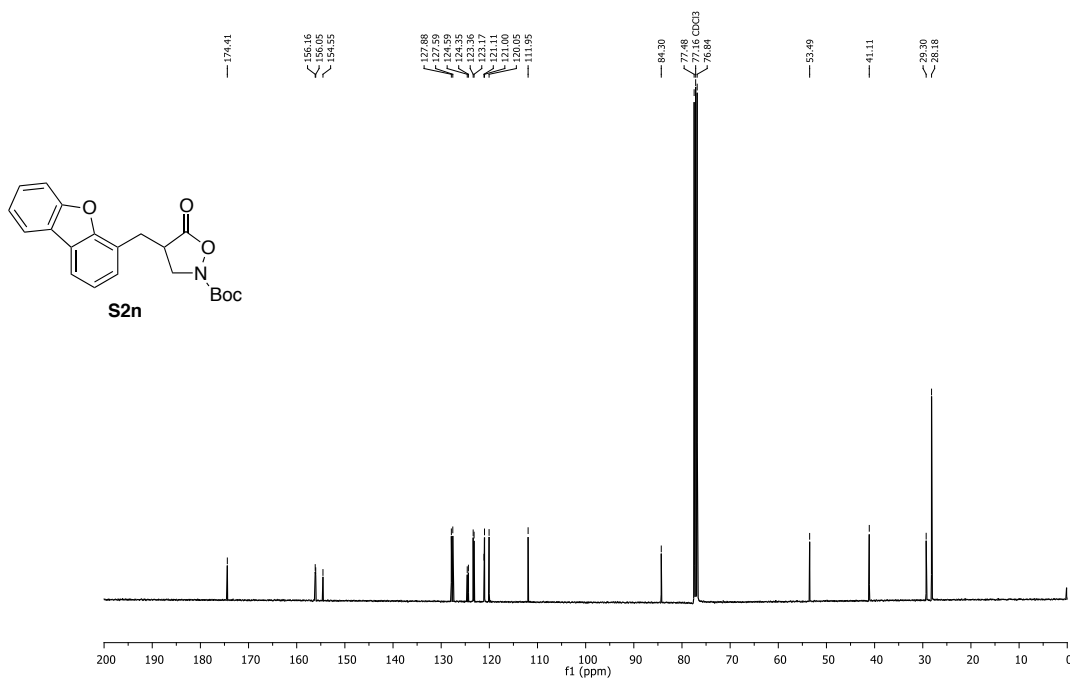


***tert*-butyl 4-(dibenzo[*b,d*]furan-4-ylmethyl)-5-oxoisoxazolidine-2-carboxylate (S2n):**

¹H NMR (400 MHz, CDCl₃)

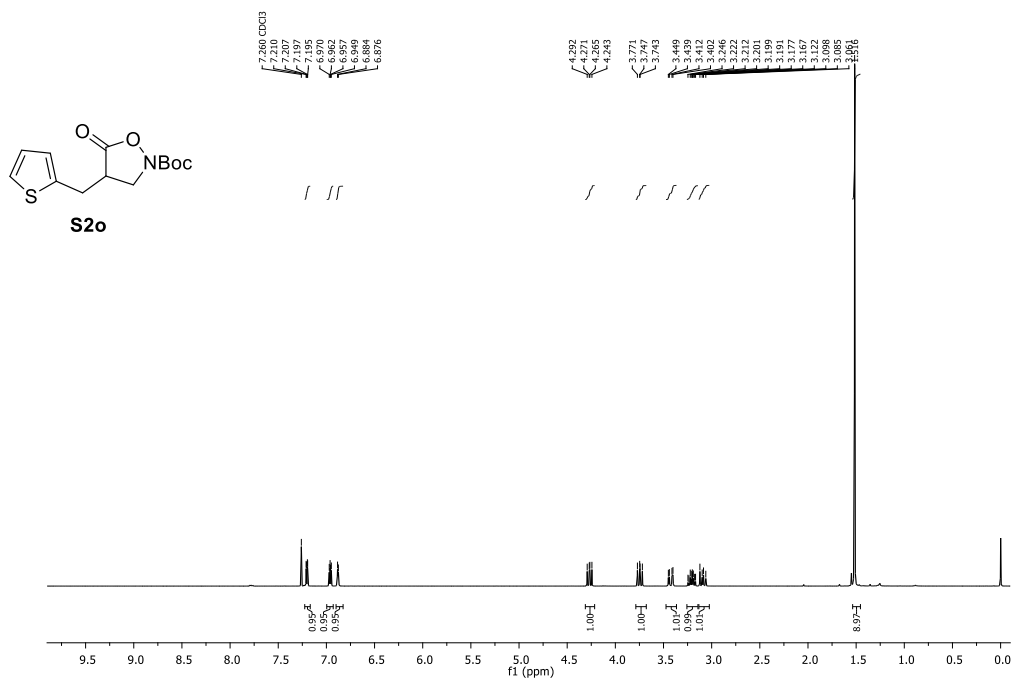


¹³C NMR (100 MHz, CDCl₃)

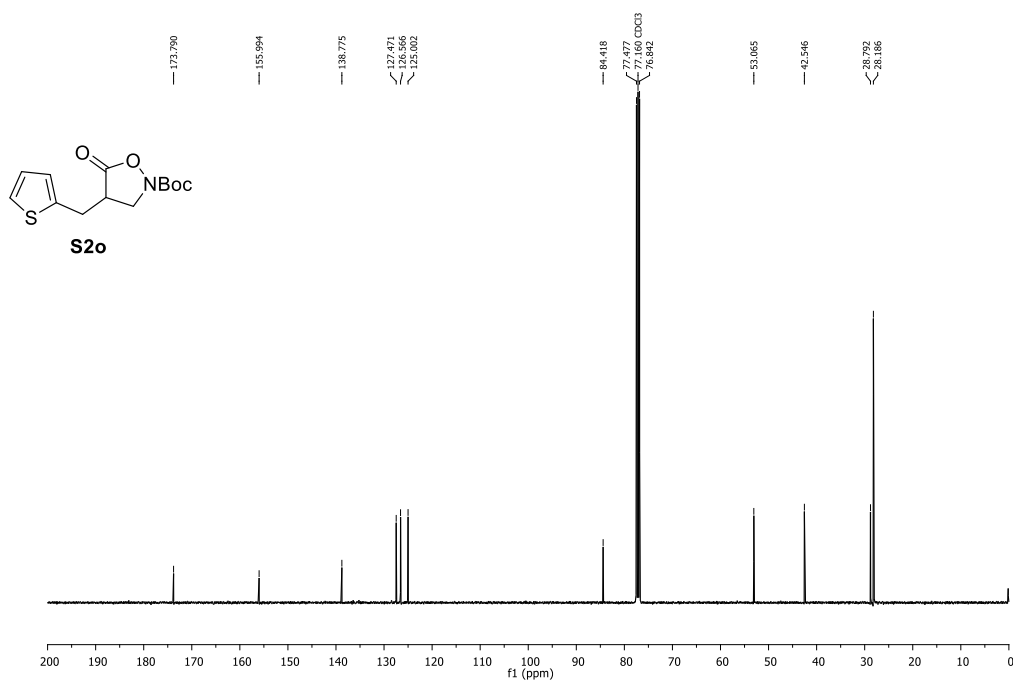


***tert*-Butyl 5-oxo-4-(thiophen-2-ylmethyl)isoxazolidine-2-carboxylate (S2o):**

¹H NMR (400 MHz, CDCl₃)

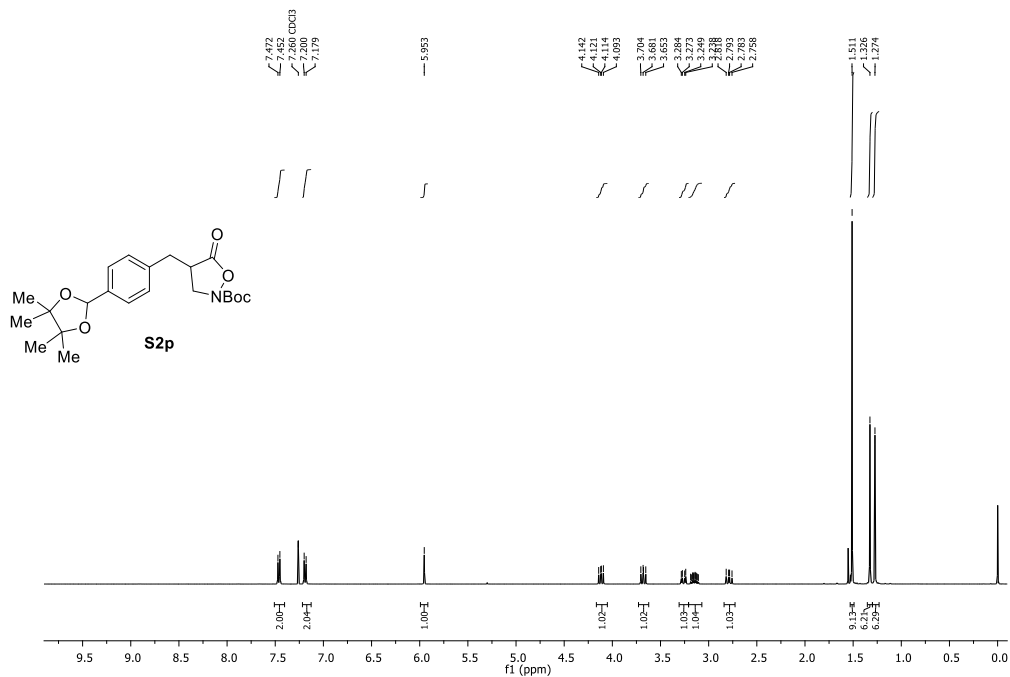


¹³C NMR (100 MHz, CDCl₃)

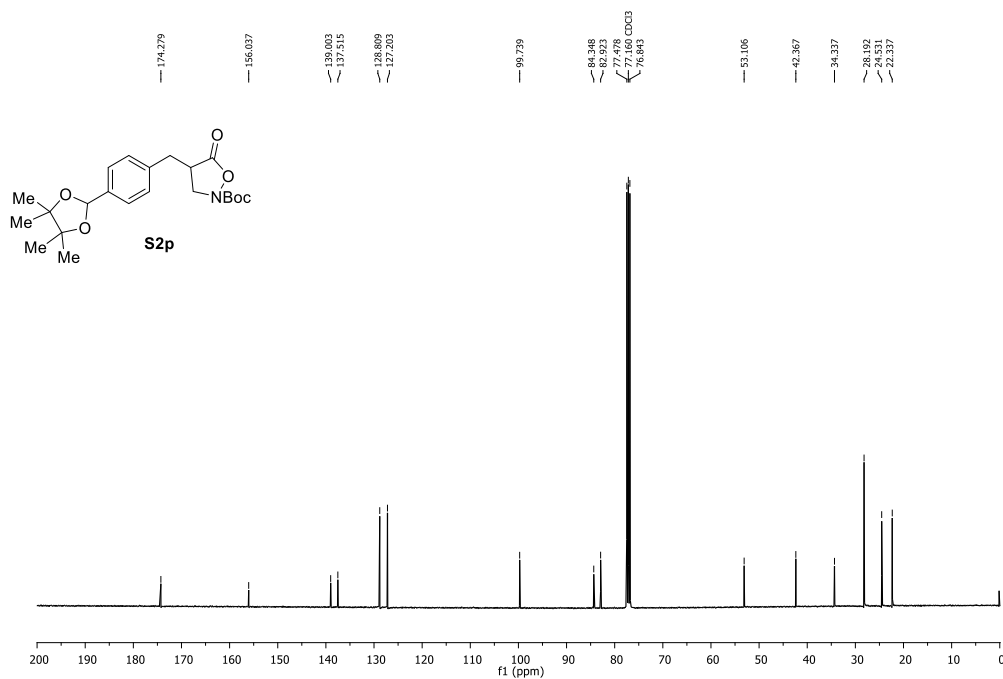


***tert*-Butyl 5-oxo-4-(4-(4,4,5,5-tetramethyl-1,3-dioxolan-2-yl)benzyl)isoxazolidine-2-carboxylate (S2p):**

¹H NMR (400 MHz, CDCl₃)

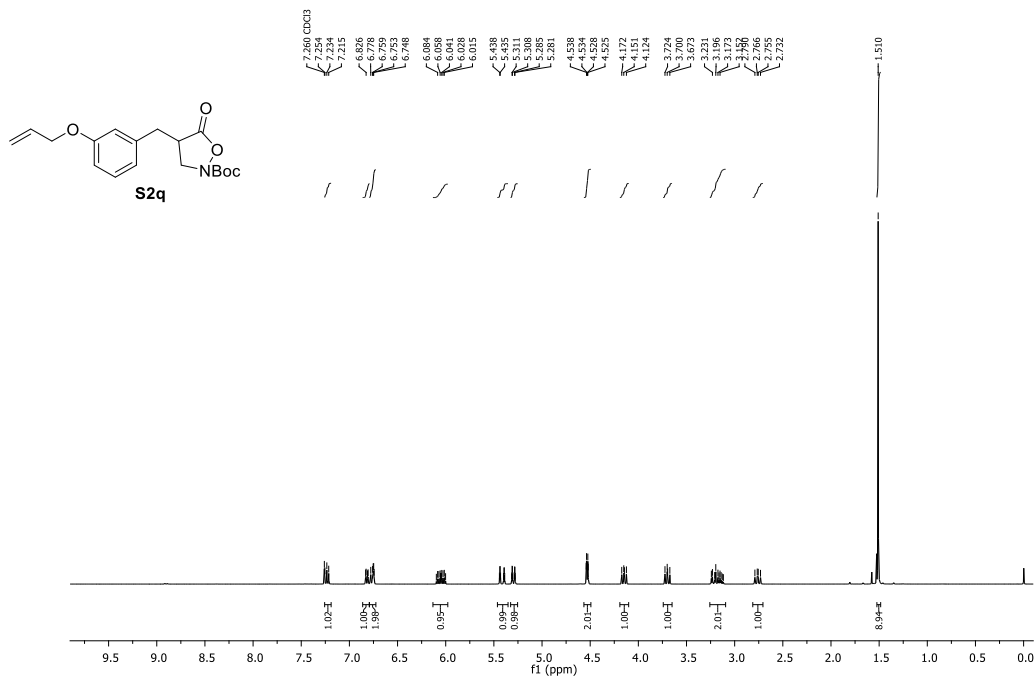


¹³C NMR (100 MHz, CDCl₃)

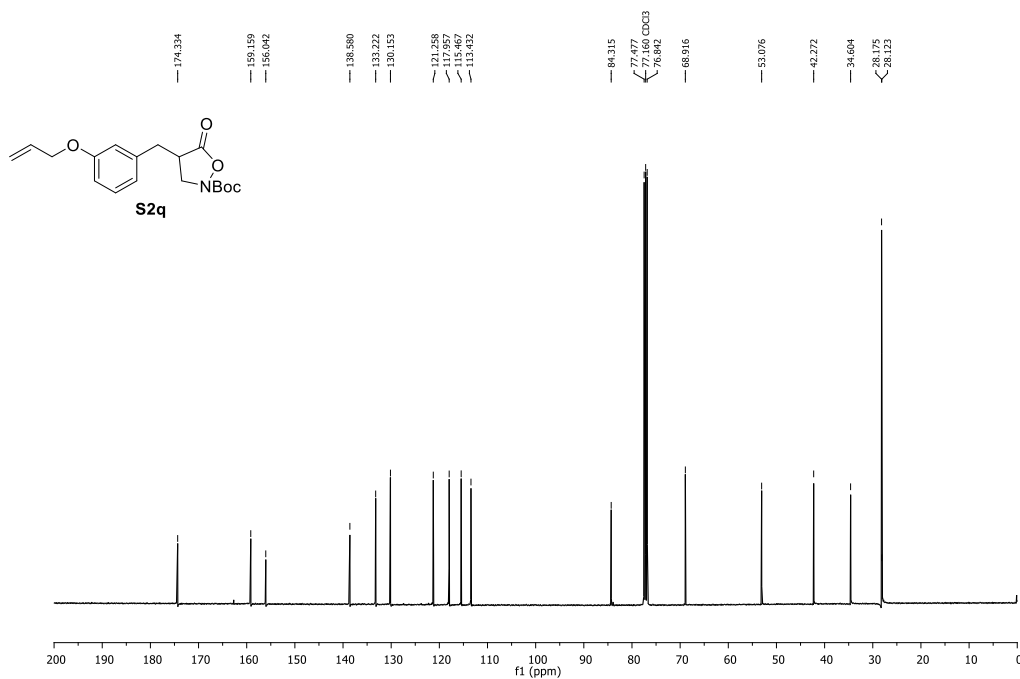


tert-Butyl 4-(3-(allyloxy)benzyl)-5-oxoisoxazolidine-2-carboxylate (S2q):

¹H NMR (400 MHz, CDCl₃)

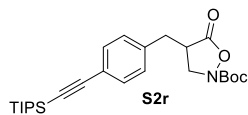
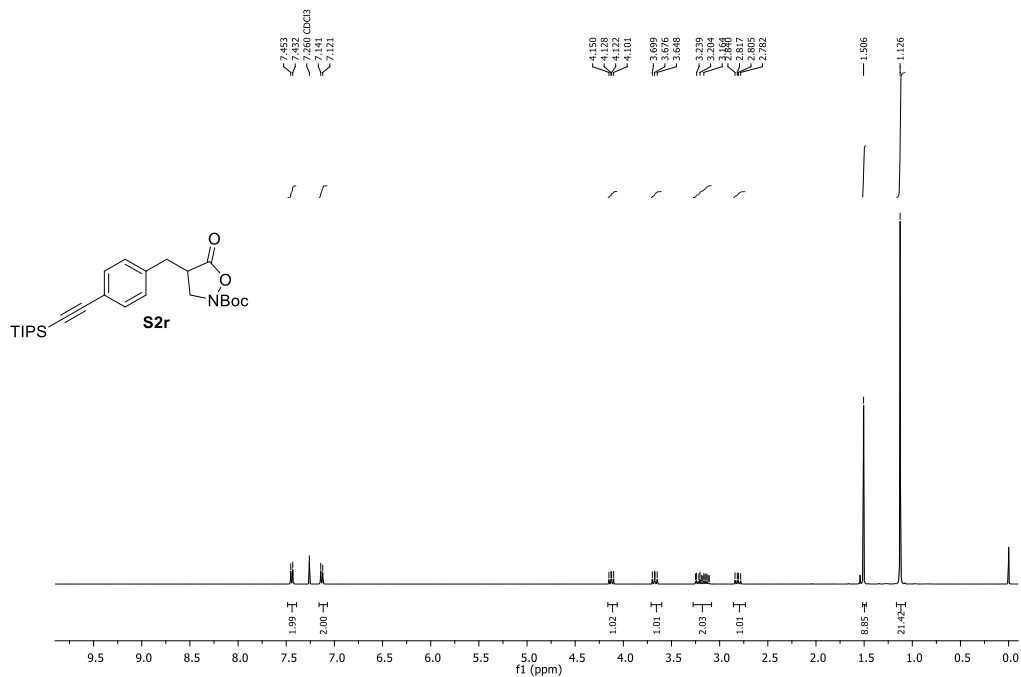


¹³C NMR (100 MHz, CDCl₃)

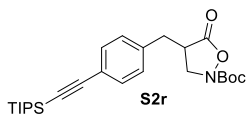
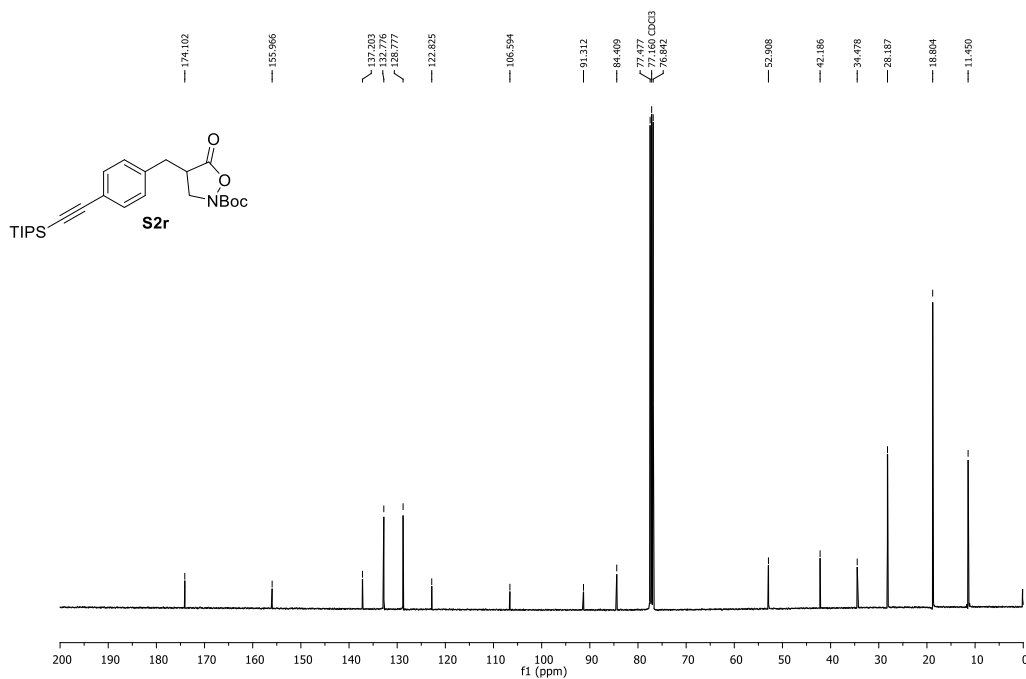


tert-Butyl 5-oxo-4-(4-((triisopropylsilyl)ethynyl)benzyl)isoxazolidine-2-carboxylate (S2r):

¹H NMR (400 MHz, CDCl₃)

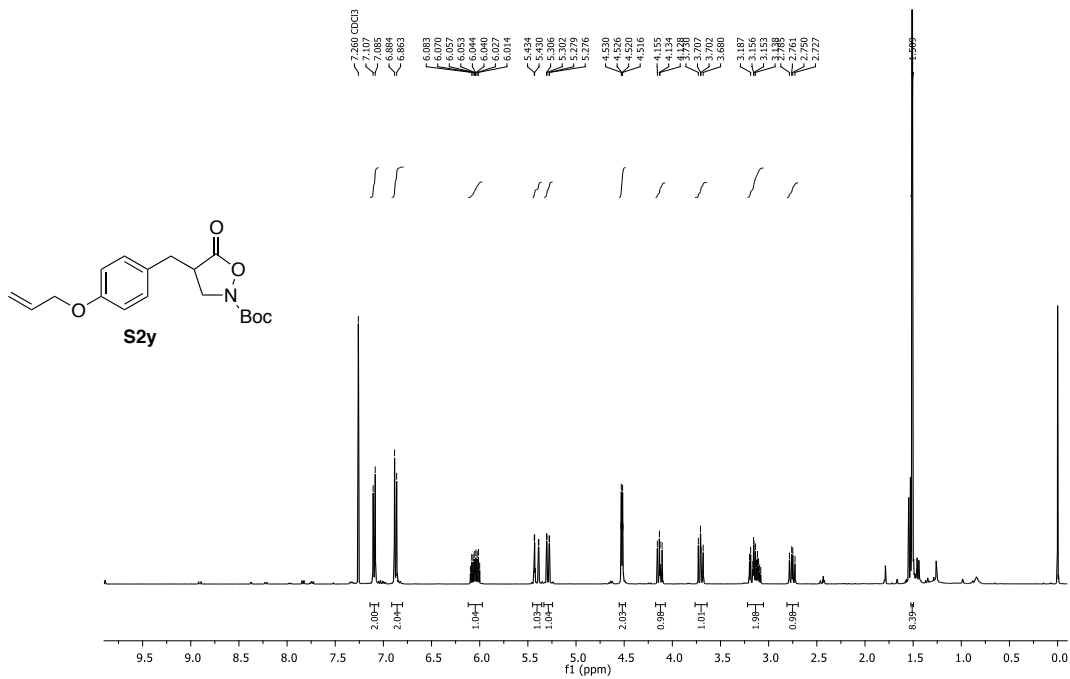


¹³C NMR (100 MHz, CDCl₃)

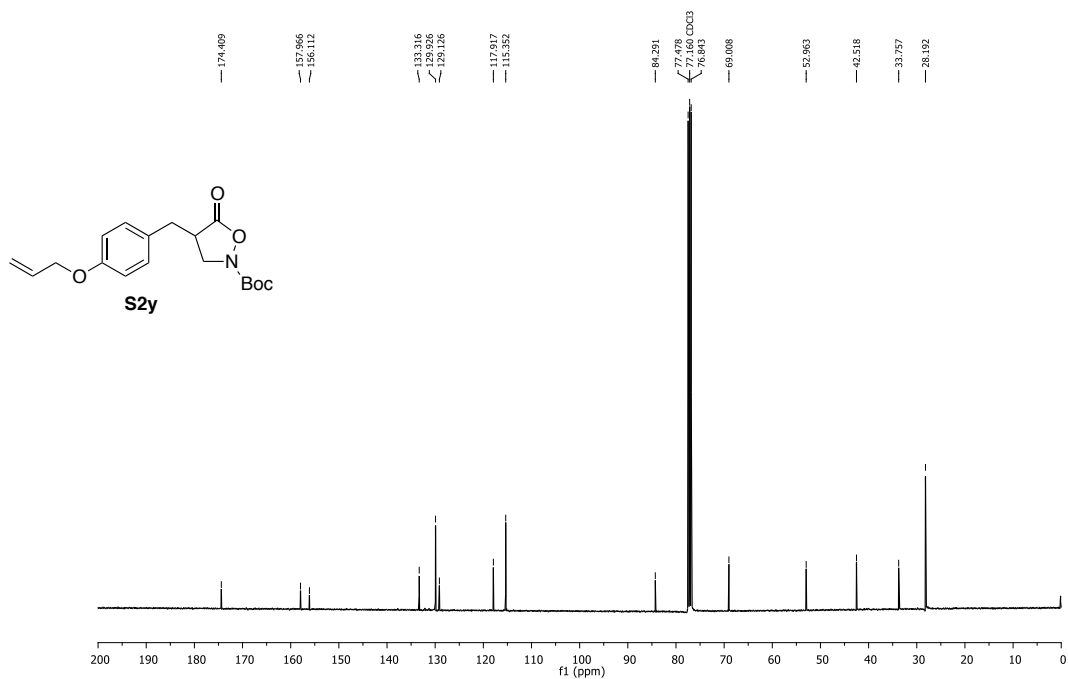


***tert*-Butyl 4-(4-(allyloxy)benzyl)-5-oxoisoxazolidine-2-carboxylate (S2y):**

¹H NMR (400 MHz, CDCl₃)

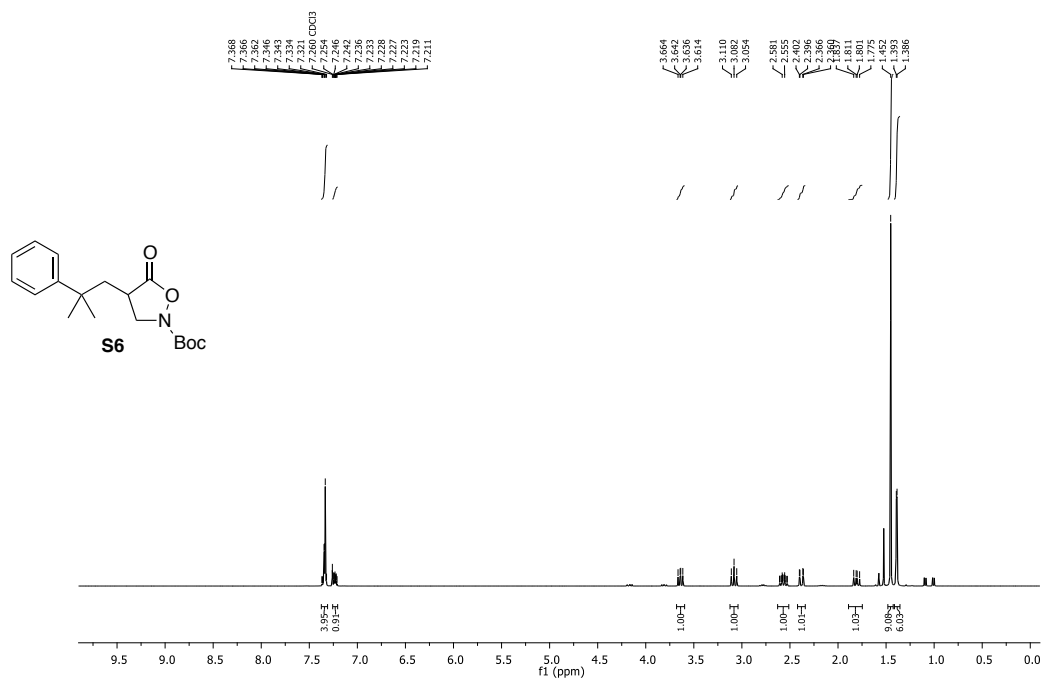


¹³C NMR (100 MHz, CDCl₃)

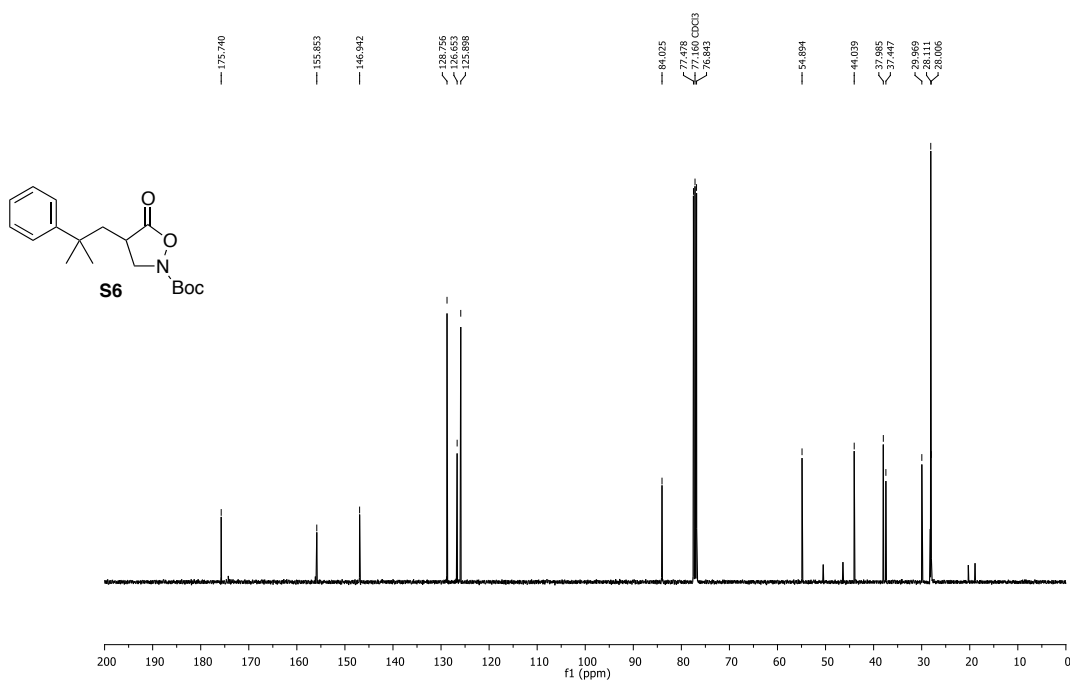


tert-Butyl 4-(2-methyl-2-phenylpropyl)-5-oxoisoxazolidine-2-carboxylate (S6):

¹H NMR (400 MHz, CDCl₃)

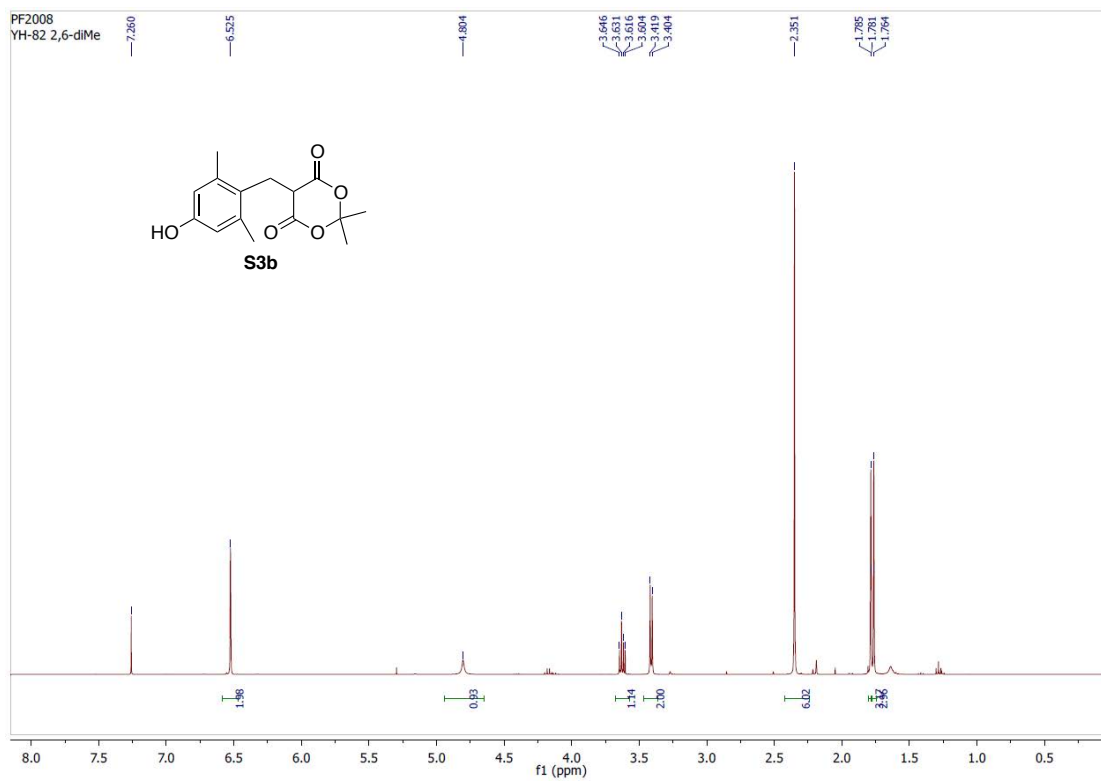


¹³C NMR (100 MHz, CDCl₃)

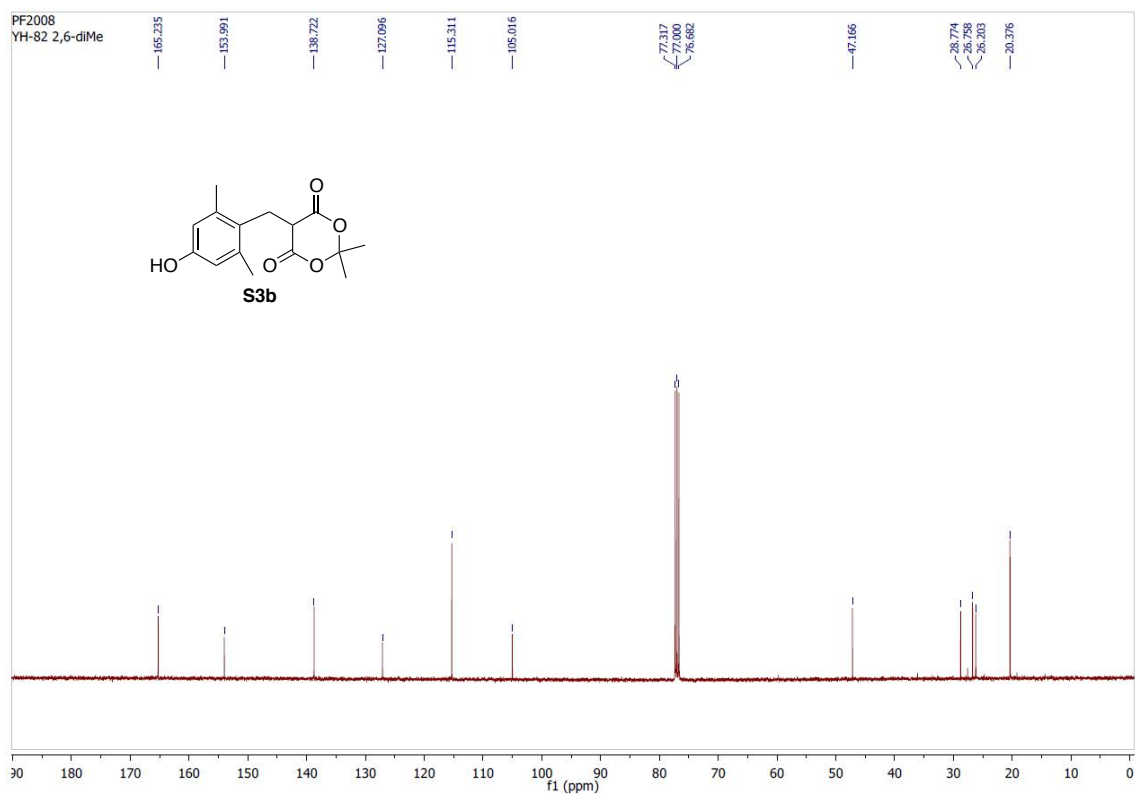


5-(4-Hydroxy-2,6-dimethylbenzyl)-2,2-dimethyl-1,3-dioxane-4,6-dione (S3b):

^1H NMR (400 MHz, CDCl_3)

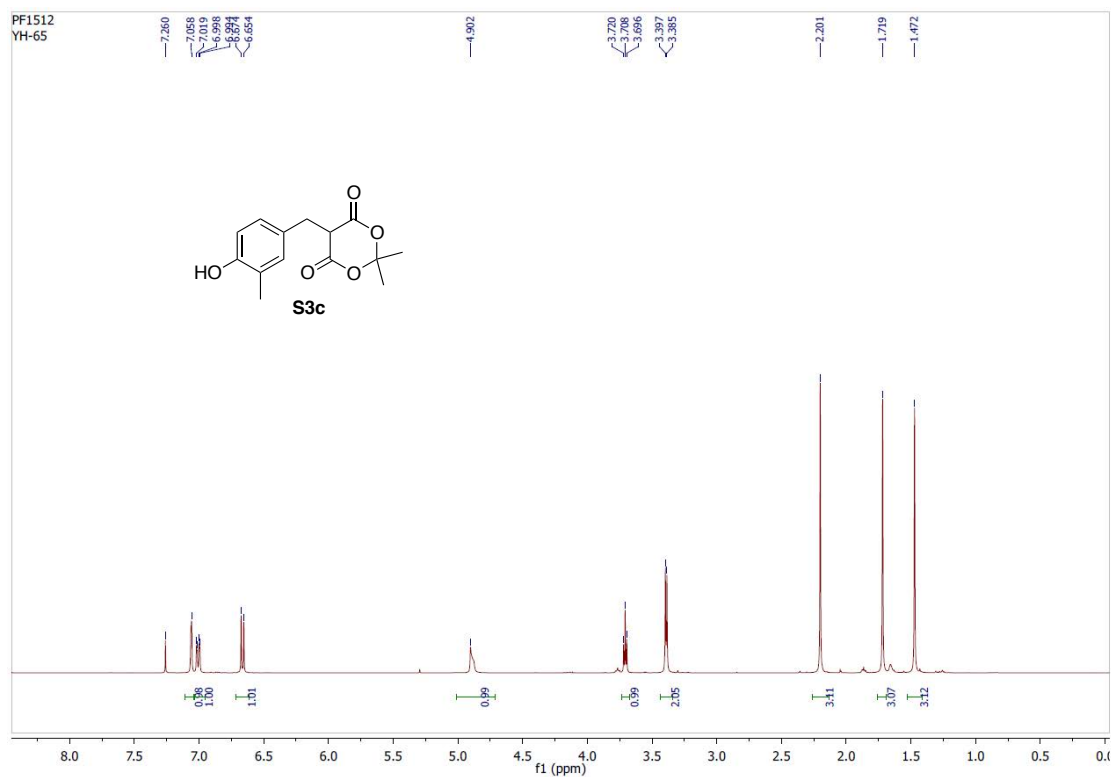


^{13}C NMR (100 MHz, CDCl_3)

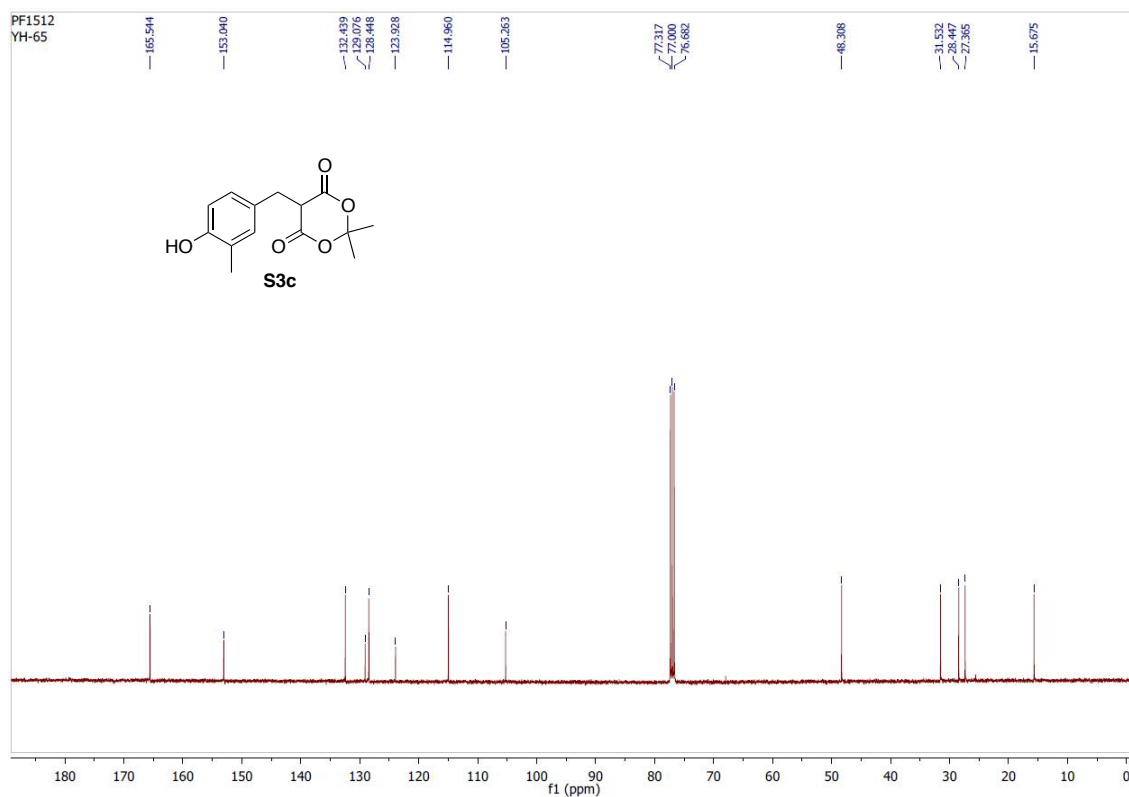


5-(4-Hydroxy-3-methylbenzyl)-2,2-dimethyl-1,3-dioxane-4,6-dione (S3c):

¹H NMR (400 MHz, CDCl₃)

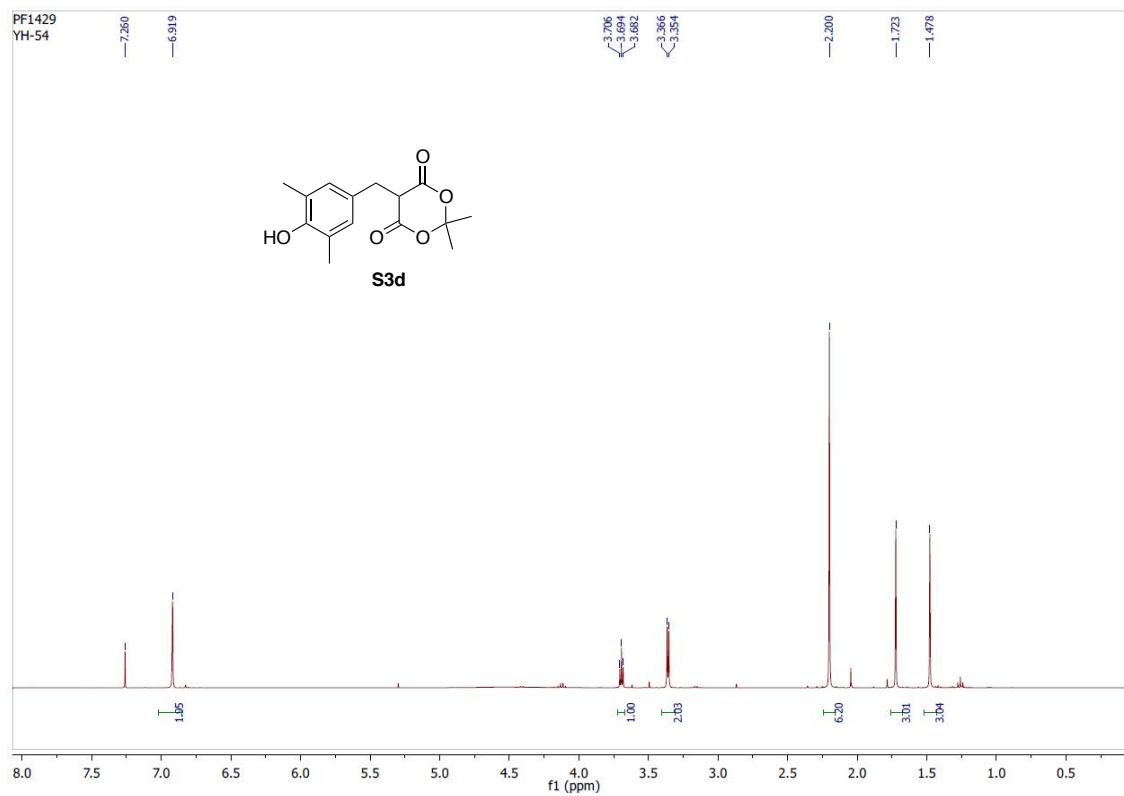


¹³C NMR (100 MHz, CDCl₃)

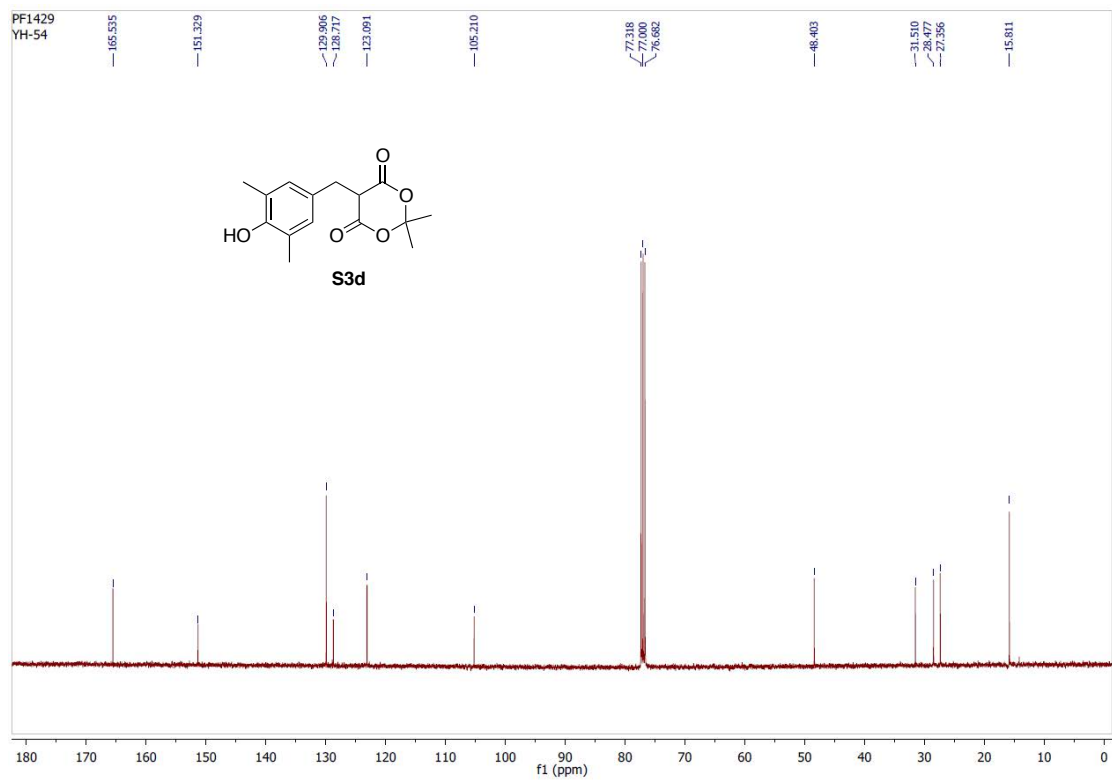


5-(4-Hydroxy-3,5-dimethylbenzyl)-2,2-dimethyl-1,3-dioxane-4,6-dione (S3d):

^1H NMR (400 MHz, CDCl_3)

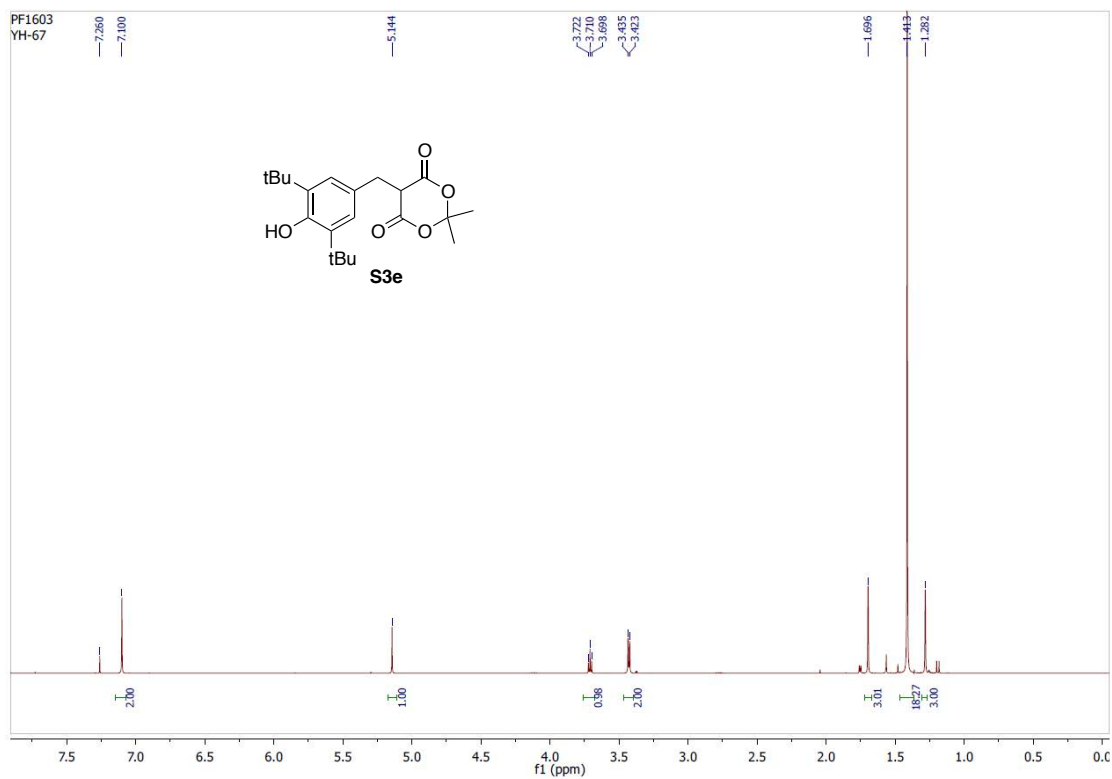


^{13}C NMR (100 MHz, CDCl_3)

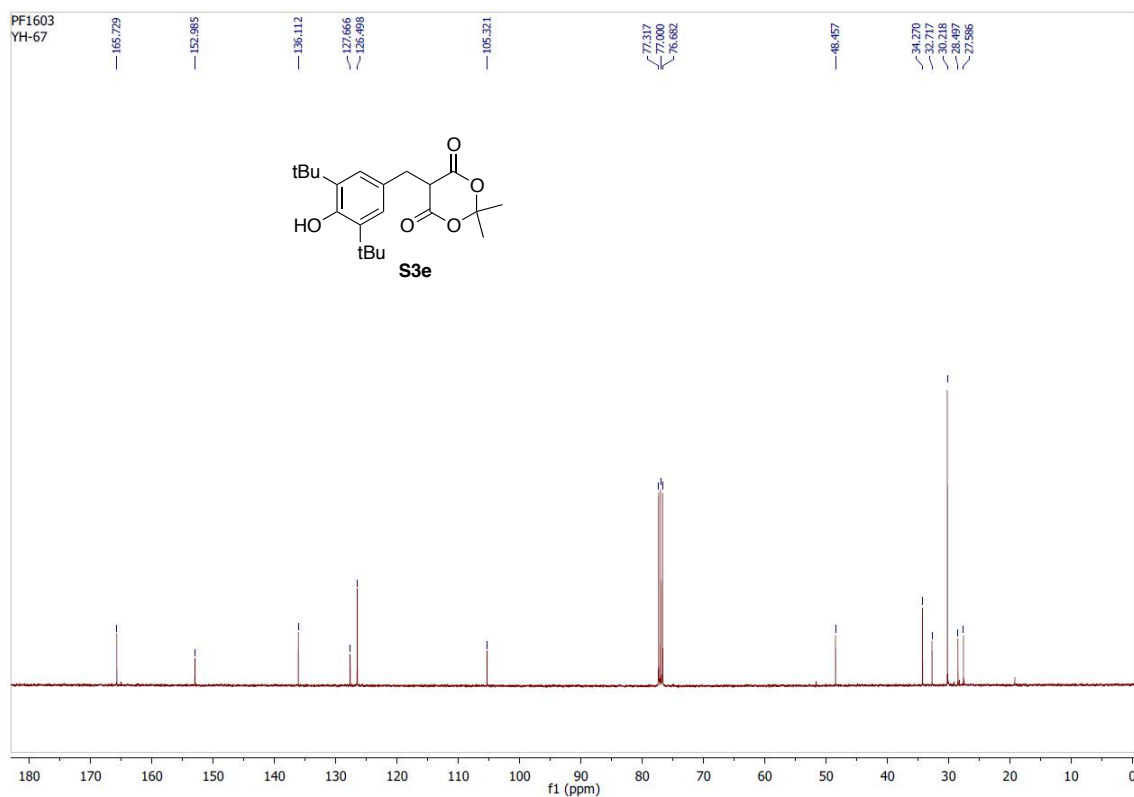


5-(3,5-Di-*tert*-butyl-4-hydroxybenzyl)-2,2-dimethyl-1,3-dioxane-4,6-dione (S3e):

^1H NMR (400 MHz, CDCl_3)

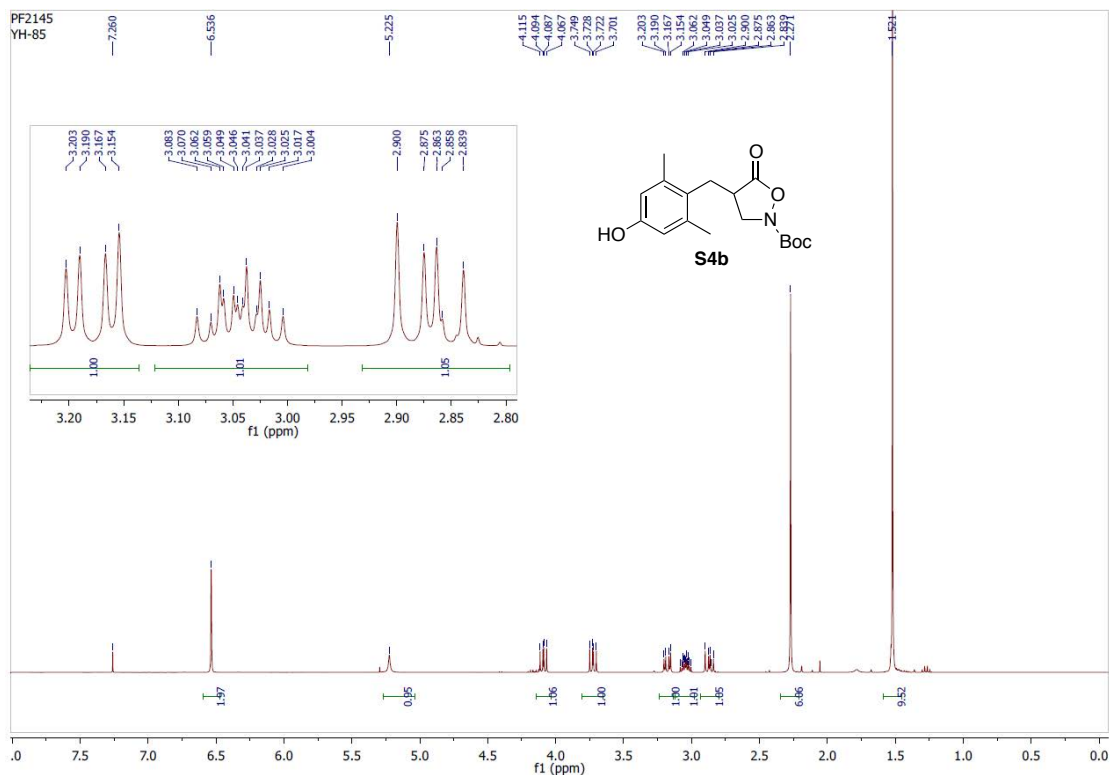


^{13}C NMR (100 MHz, CDCl_3)

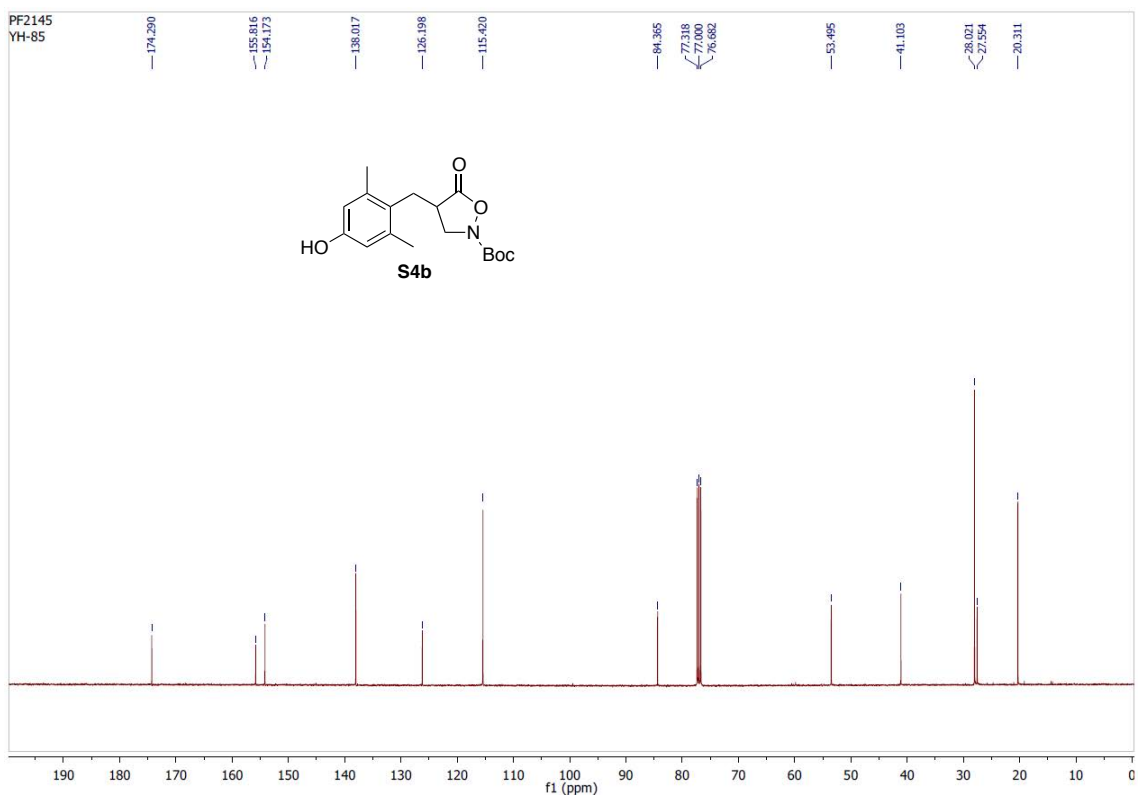


tert-Butyl 4-(4-hydroxy-2,6-dimethylbenzyl)-5-oxoisoxazolidine-2-carboxylate (S4b):

¹H NMR (400 MHz, CDCl₃)

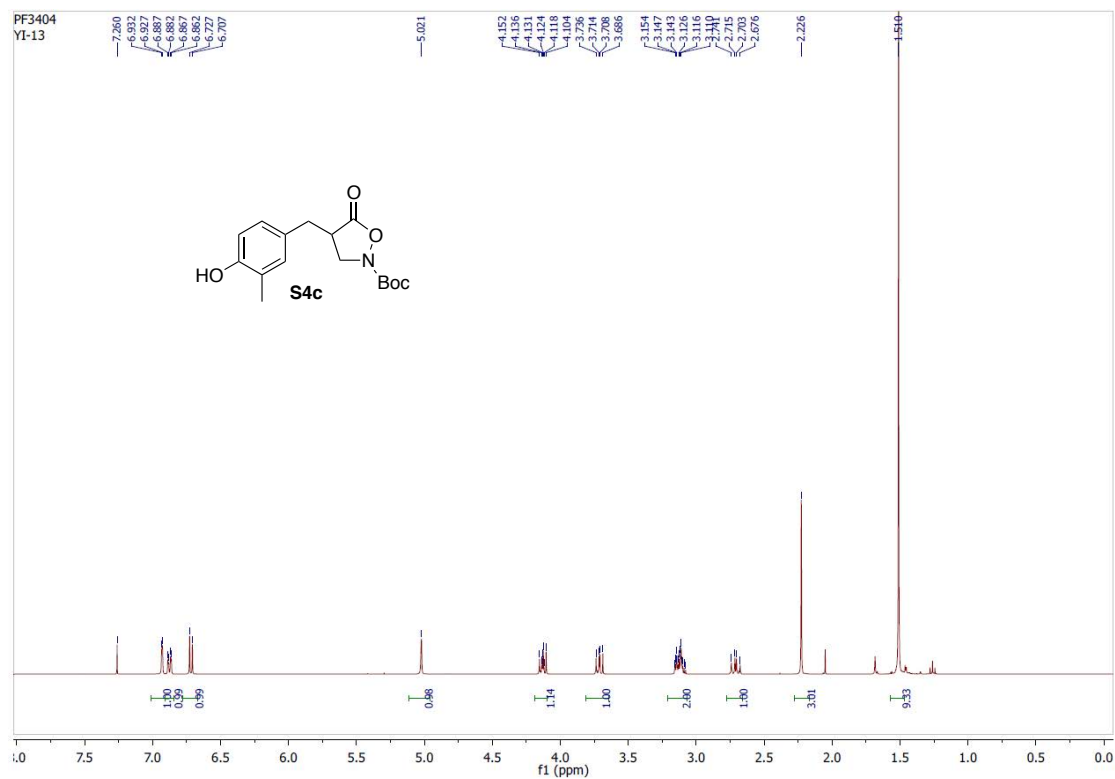


¹³C NMR (100 MHz, CDCl₃)

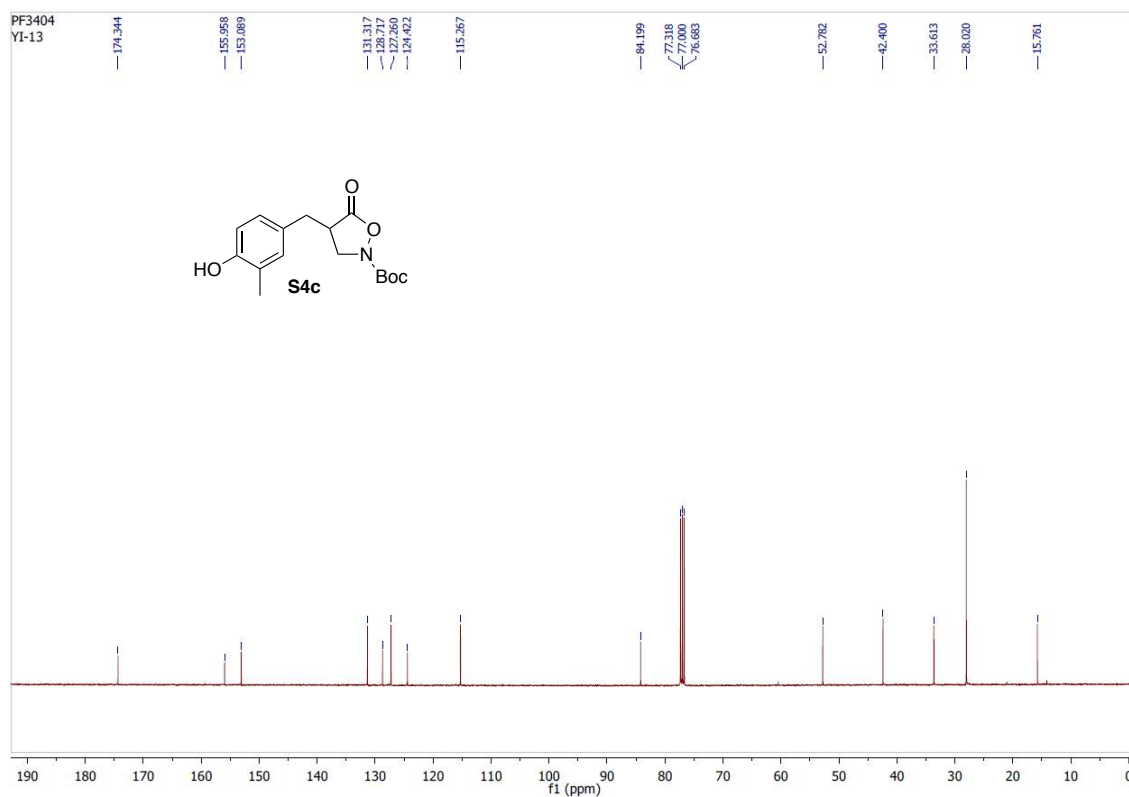


***tert*-Butyl 4-(4-hydroxy-3-methylbenzyl)-5-oxisoxazolidine-2-carboxylate (S4c):**

¹H NMR (400 MHz, CDCl₃)

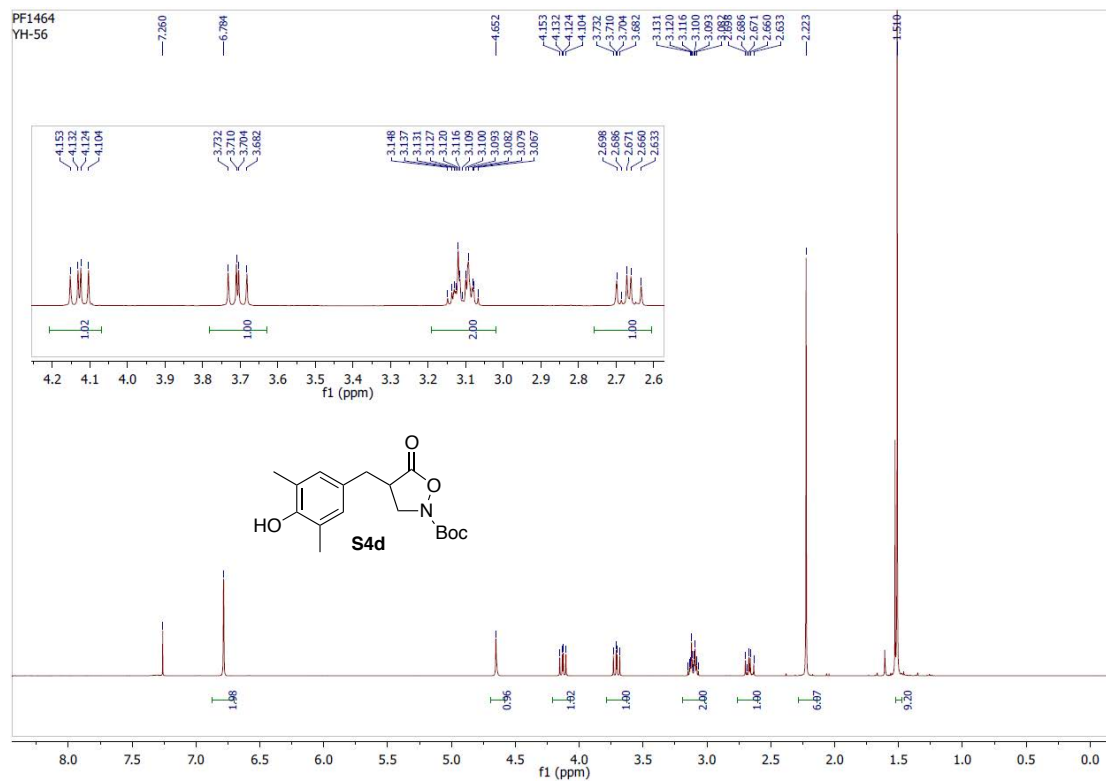


¹³C NMR (100 MHz, CDCl₃)

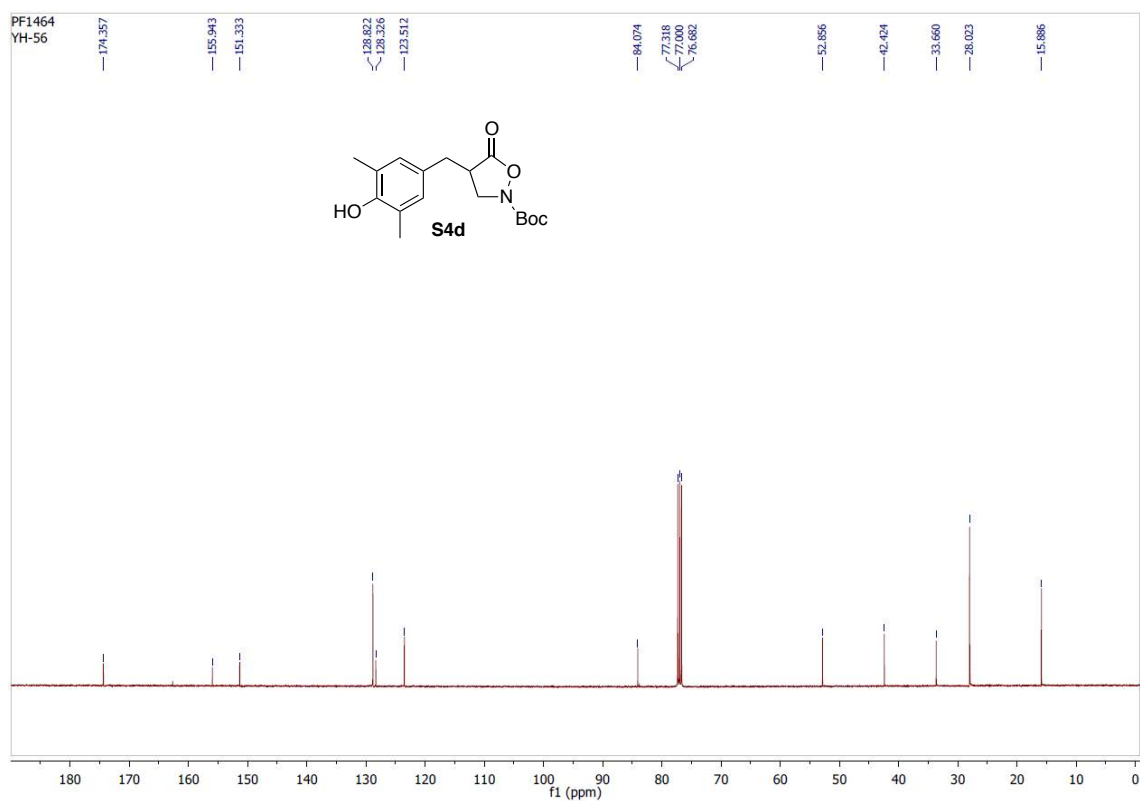


tert-Butyl 4-(4-hydroxy-3,5-dimethylbenzyl)-5-oxoisoxazolidine-2-carboxylate (S4d):

¹H NMR (400 MHz, CDCl₃)

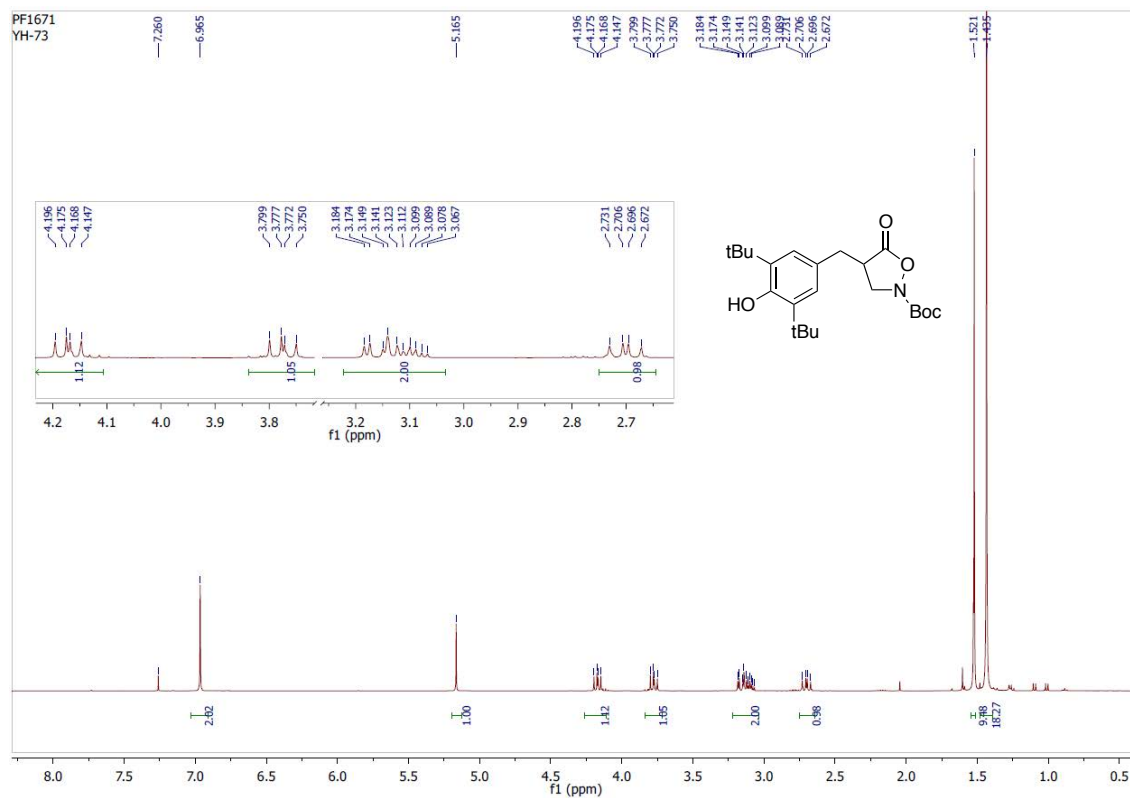


¹³C NMR (100 MHz, CDCl₃)

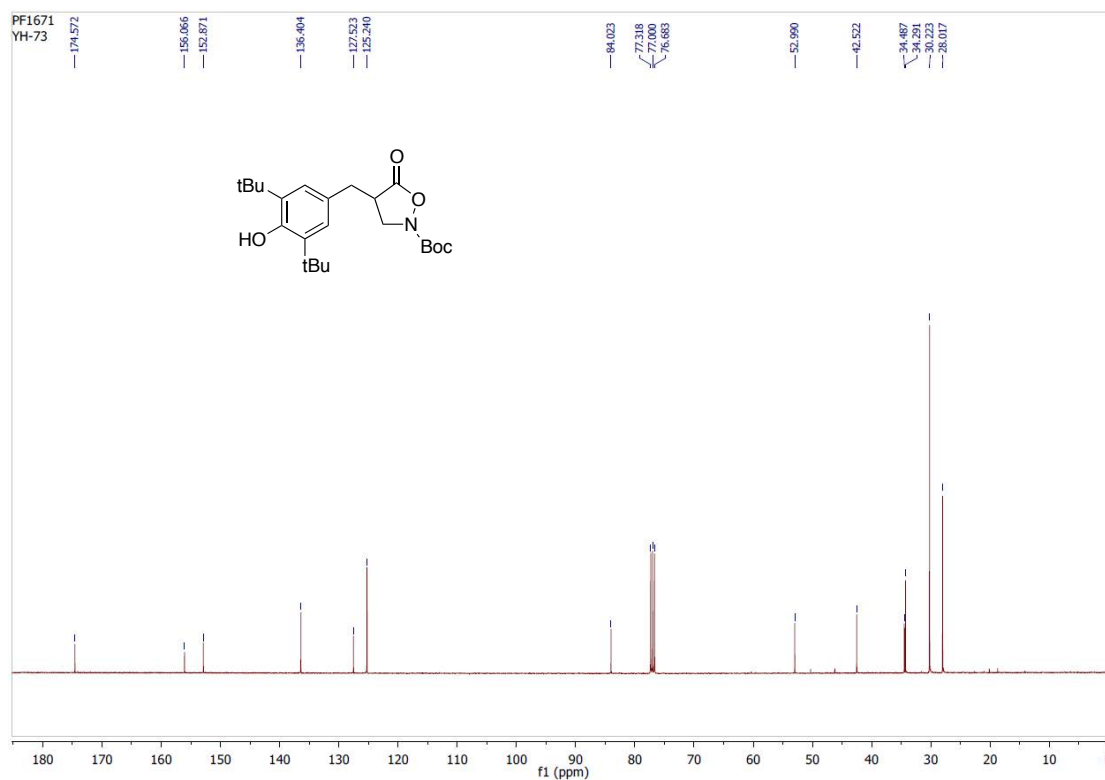


***tert*-Butyl 4-(3,5-di-*tert*-butyl-4-hydroxybenzyl)-5-oxoisoxazolidine-2-carboxylate (S4e):**

¹H NMR (400 MHz, CDCl₃)

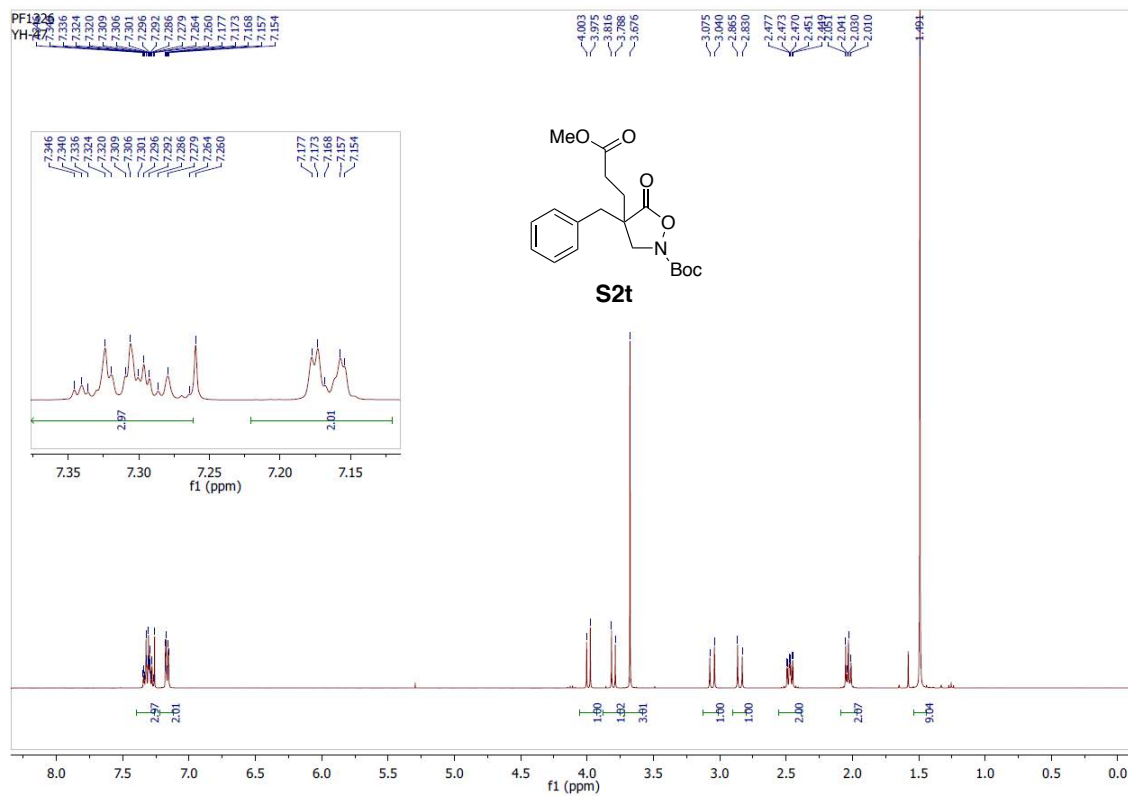


¹³C NMR (100 MHz, CDCl₃)

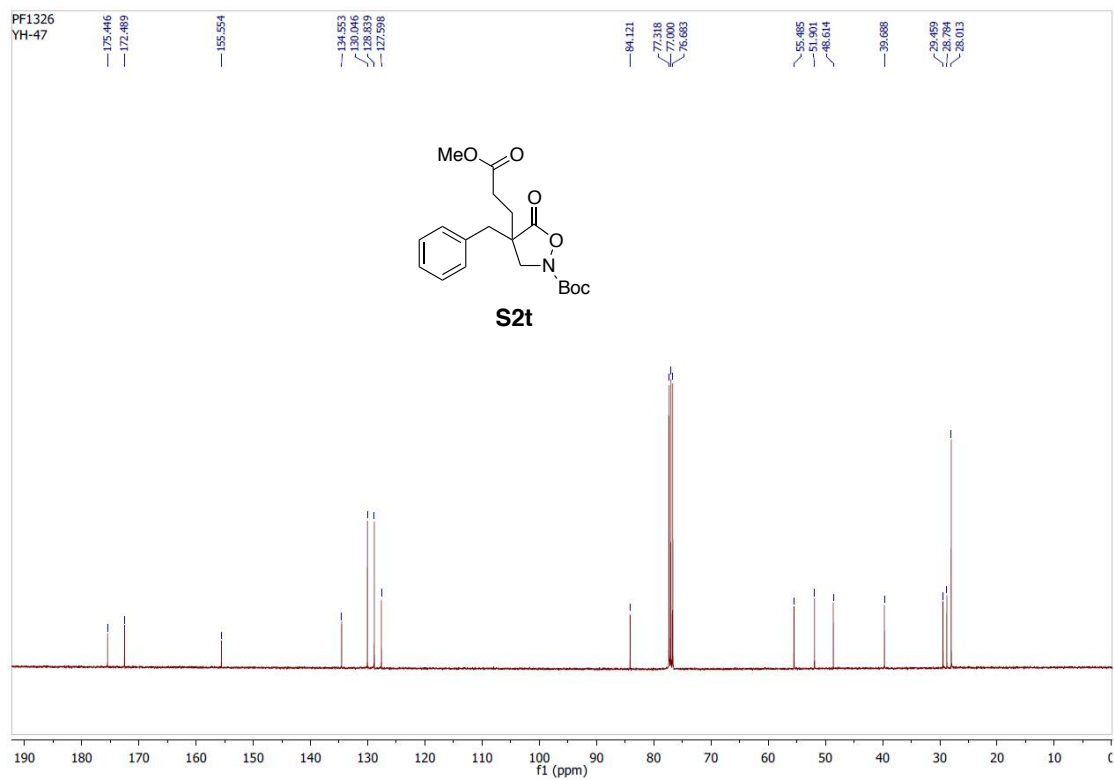


tert-Butyl 4-benzyl-4-(3-methoxy-3-oxopropyl)-5-oxisoxazolidine-2-carboxylate (S2t):

¹H NMR (400 MHz, CDCl₃)

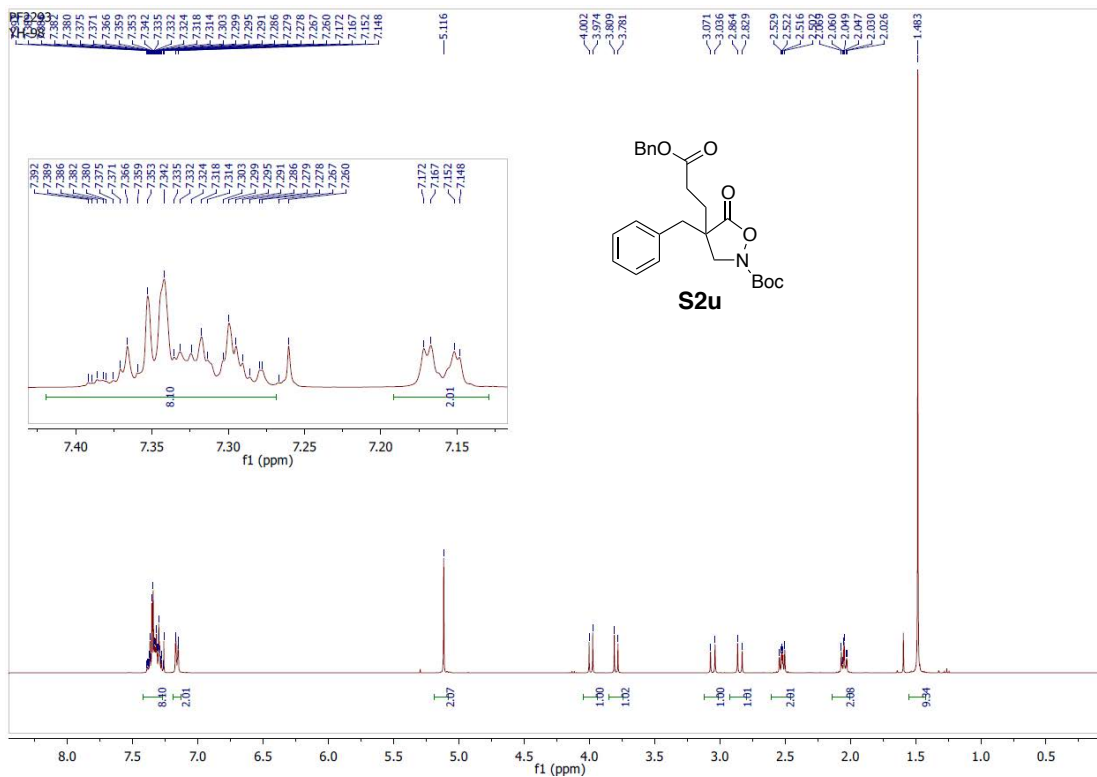


¹³C NMR (100 MHz, CDCl₃)

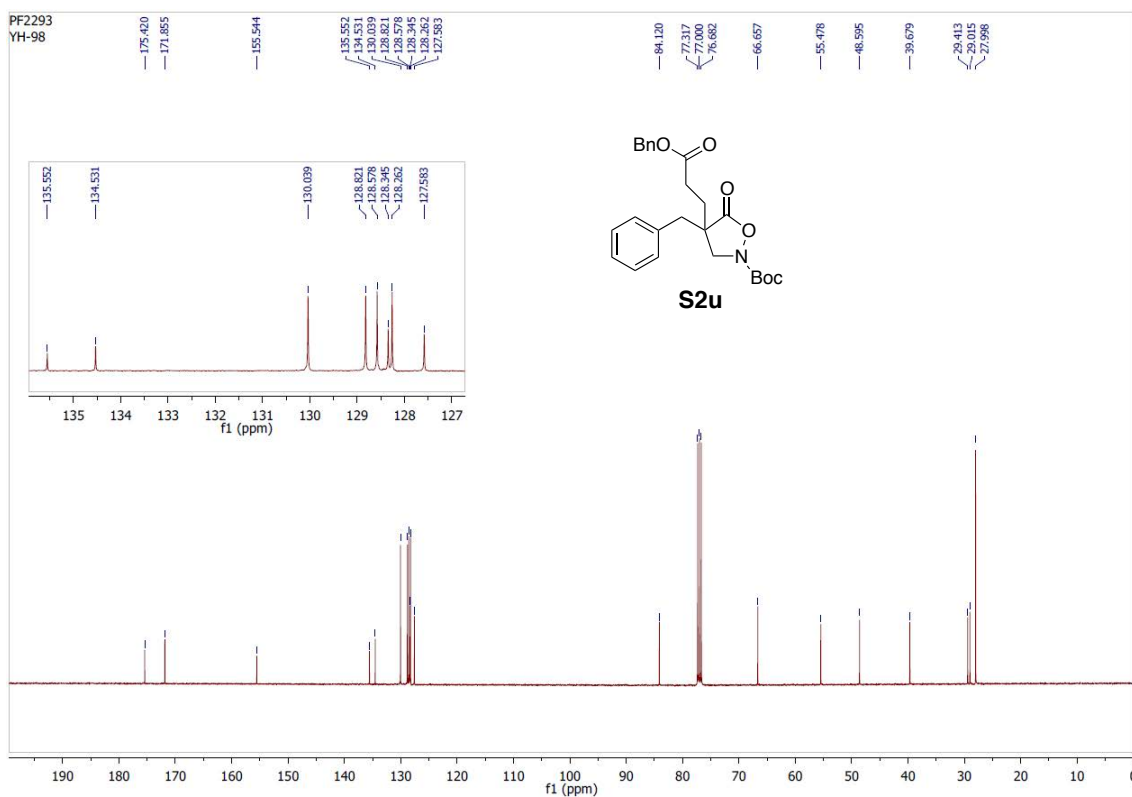


tert-Butyl 4-benzyl-4-(3-(benzyloxy)-3-oxopropyl)-5-oxoisoxazolidine-2-carboxylate (S2u):

^1H NMR (400 MHz, CDCl_3)

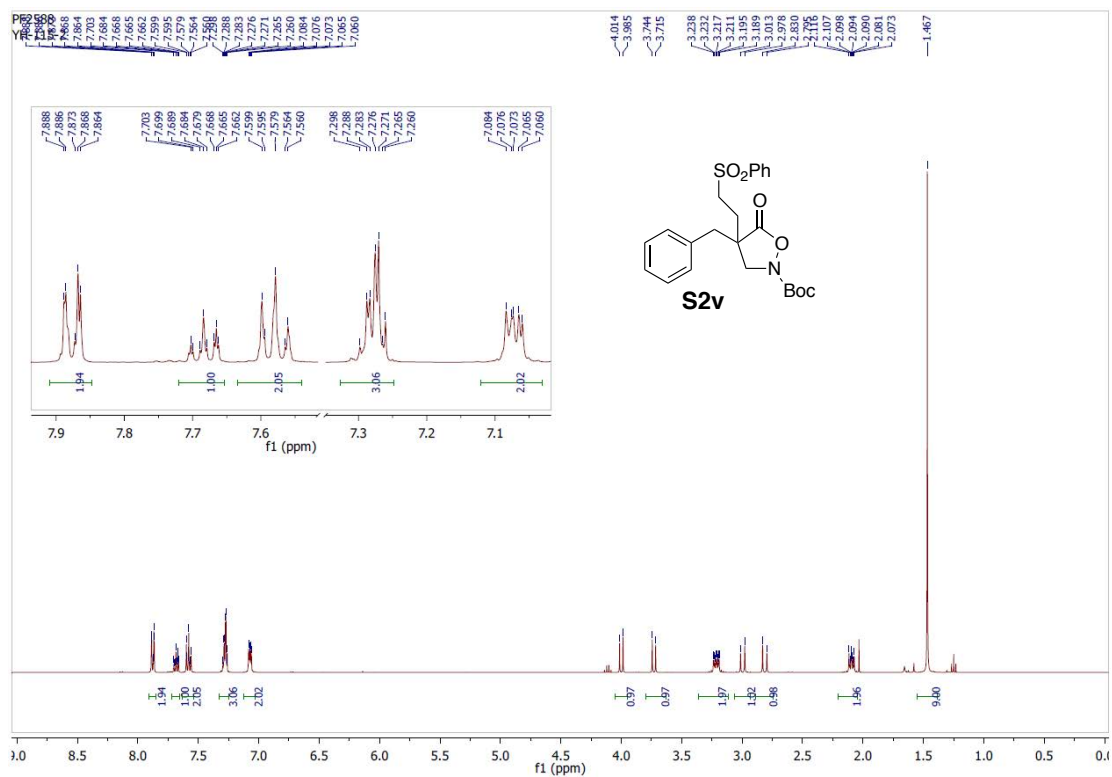


^{13}C NMR (100 MHz, CDCl_3)

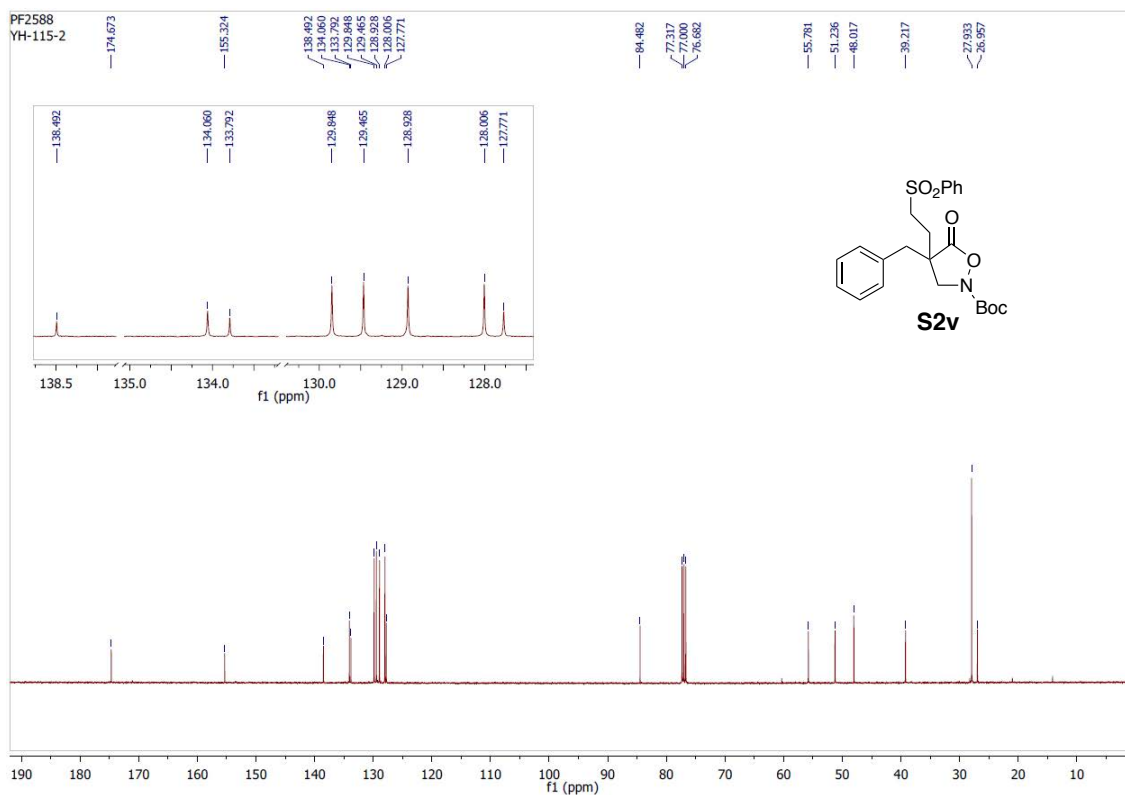


tert-Butyl 4-benzyl-5-oxo-4-(2-(phenylsulfonyl)ethyl)isoxazolidine-2-carboxylate (S2v):

¹H NMR (400 MHz, CDCl₃)

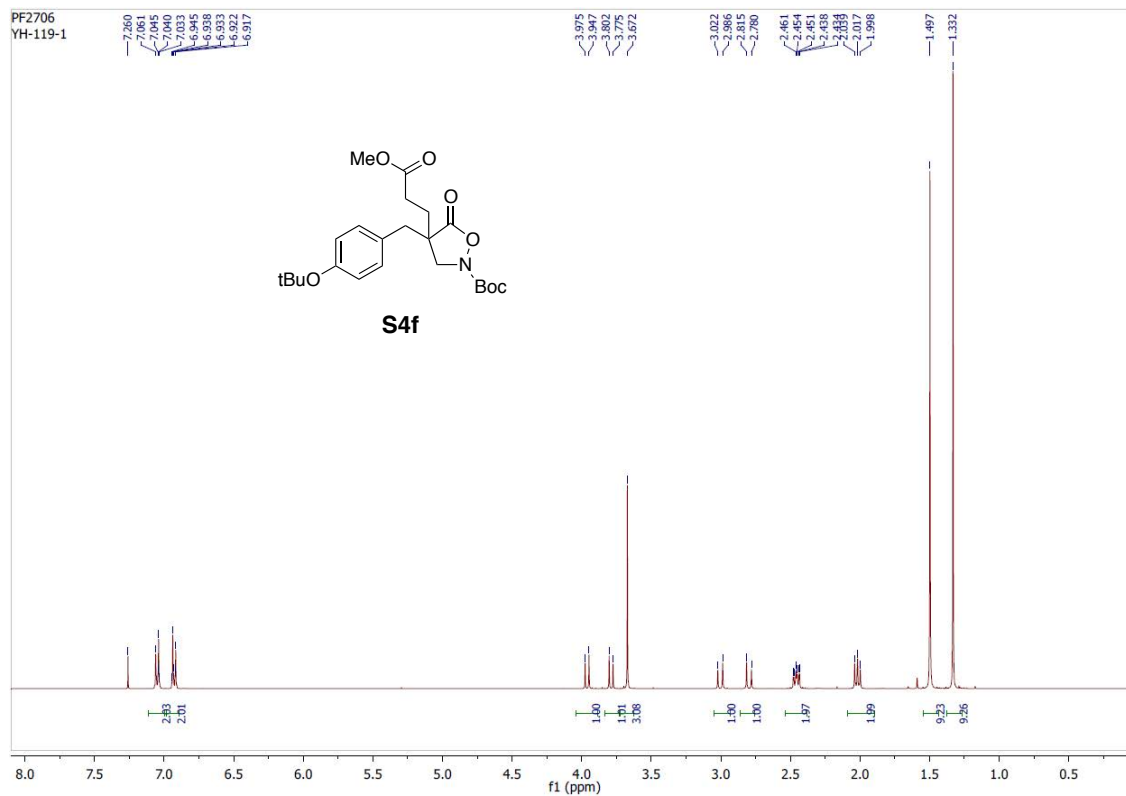


¹³C NMR (100 MHz, CDCl₃)

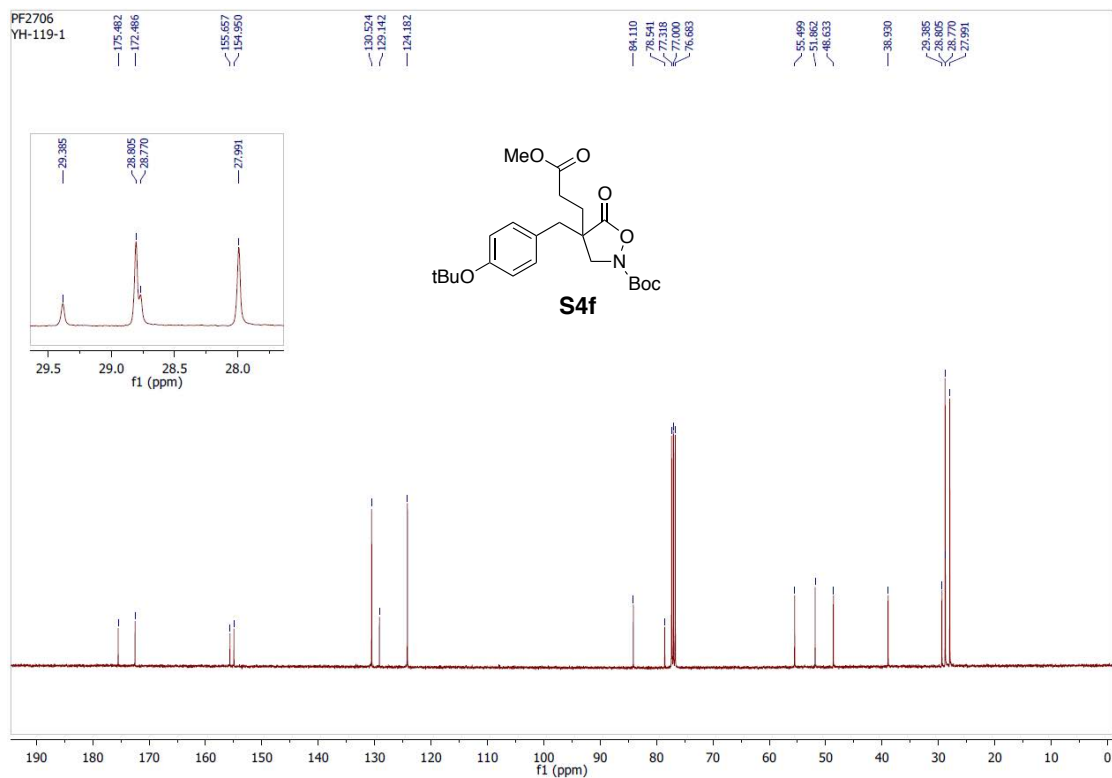


***tert*-Butyl 4-(4-(*tert*-butoxy)benzyl)-4-(3-methoxy-3-oxopropyl)-5-oxisoxazolidine-2-carboxylate (S4f):**

¹H NMR (400 MHz, CDCl₃)

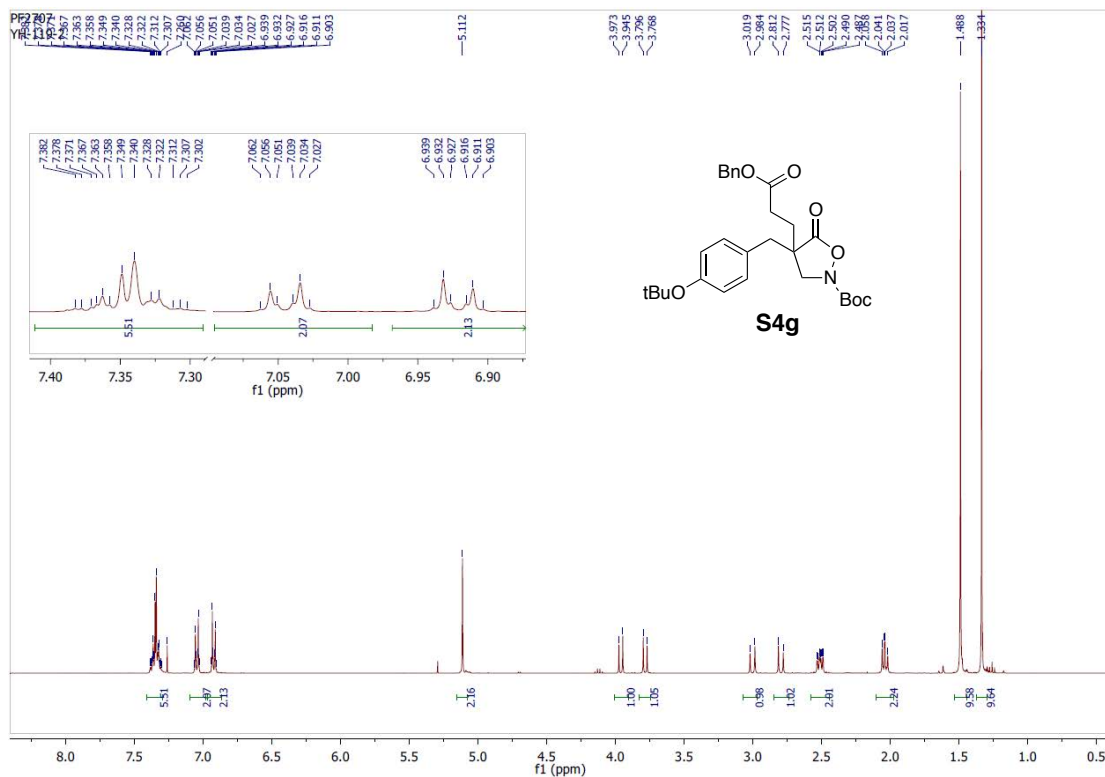


¹³C NMR (100 MHz, CDCl₃)

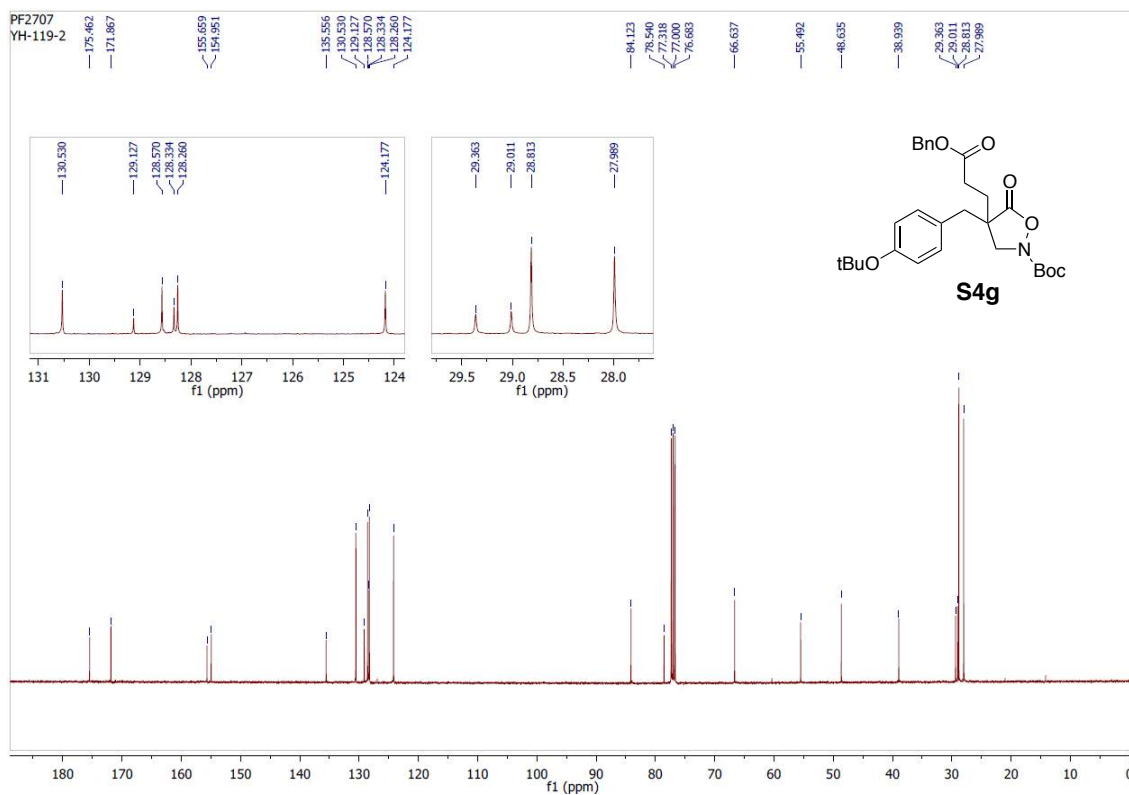


tert-Butyl 4-(3-(benzyloxy)-3-oxopropyl)-4-(4-(tert-butoxy)benzyl)-5-oxoisoxazolidine-2-carboxylate (S4g):

¹H NMR (400 MHz, CDCl₃)

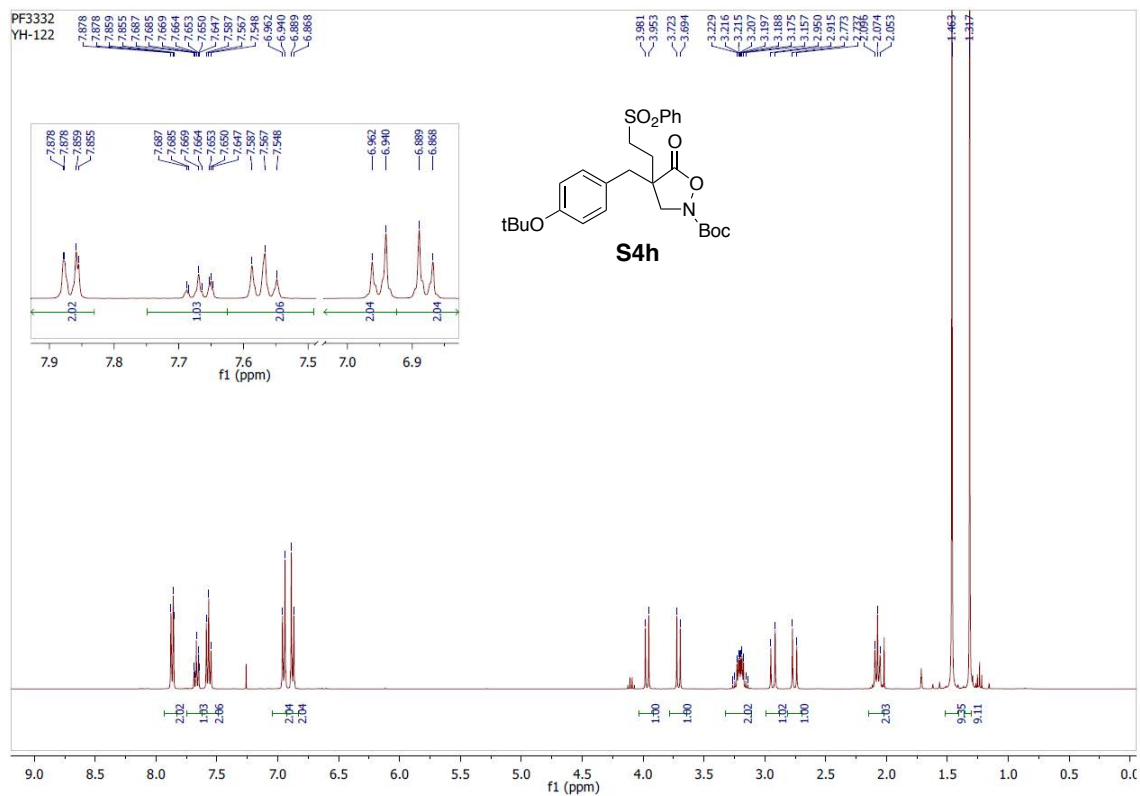


¹³C NMR (100 MHz, CDCl₃)

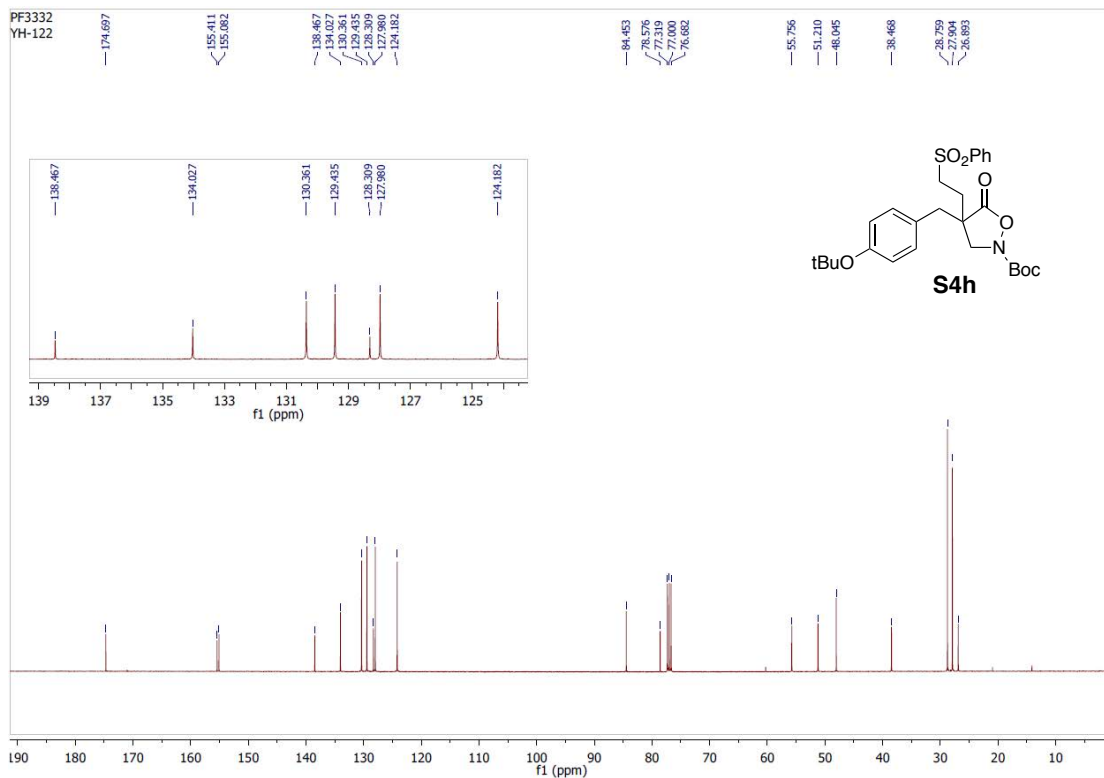


***tert*-Butyl 4-(4-(*tert*-butoxy)benzyl)-5-oxo-4-(2-(phenylsulfonyl)ethyl)isoxazolidine-2-carboxylate (S4h):**

¹H NMR (400 MHz, CDCl₃)

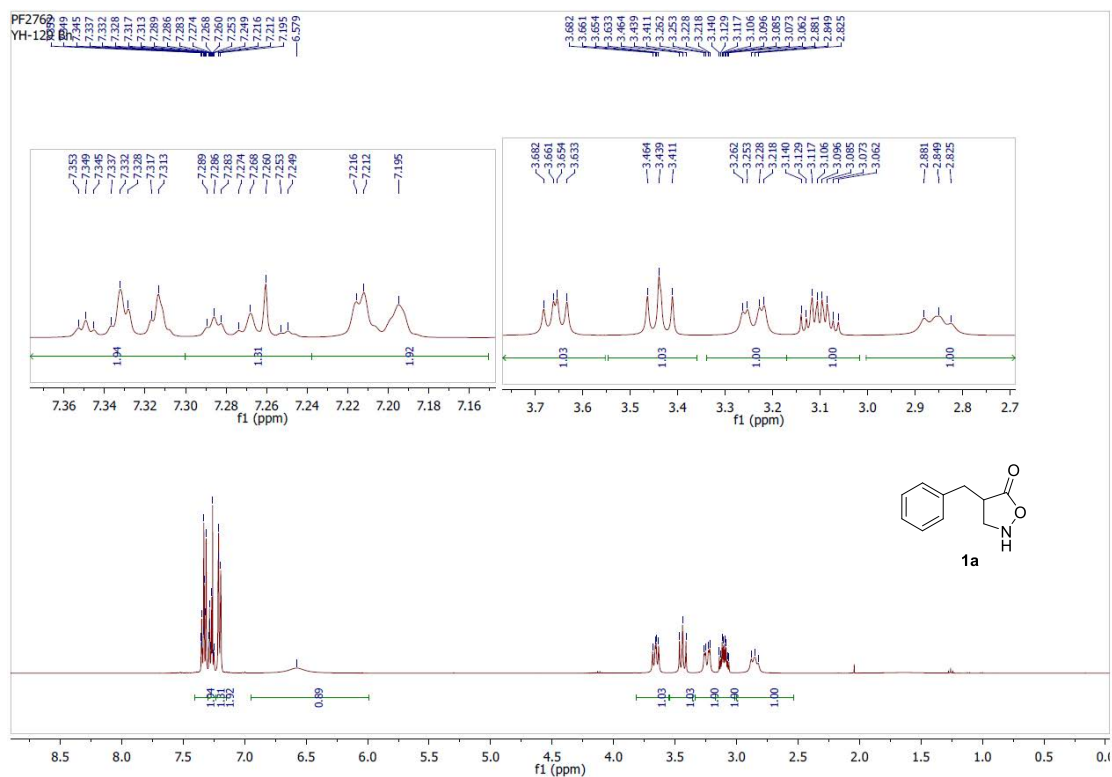


¹³C NMR (100 MHz, CDCl₃)

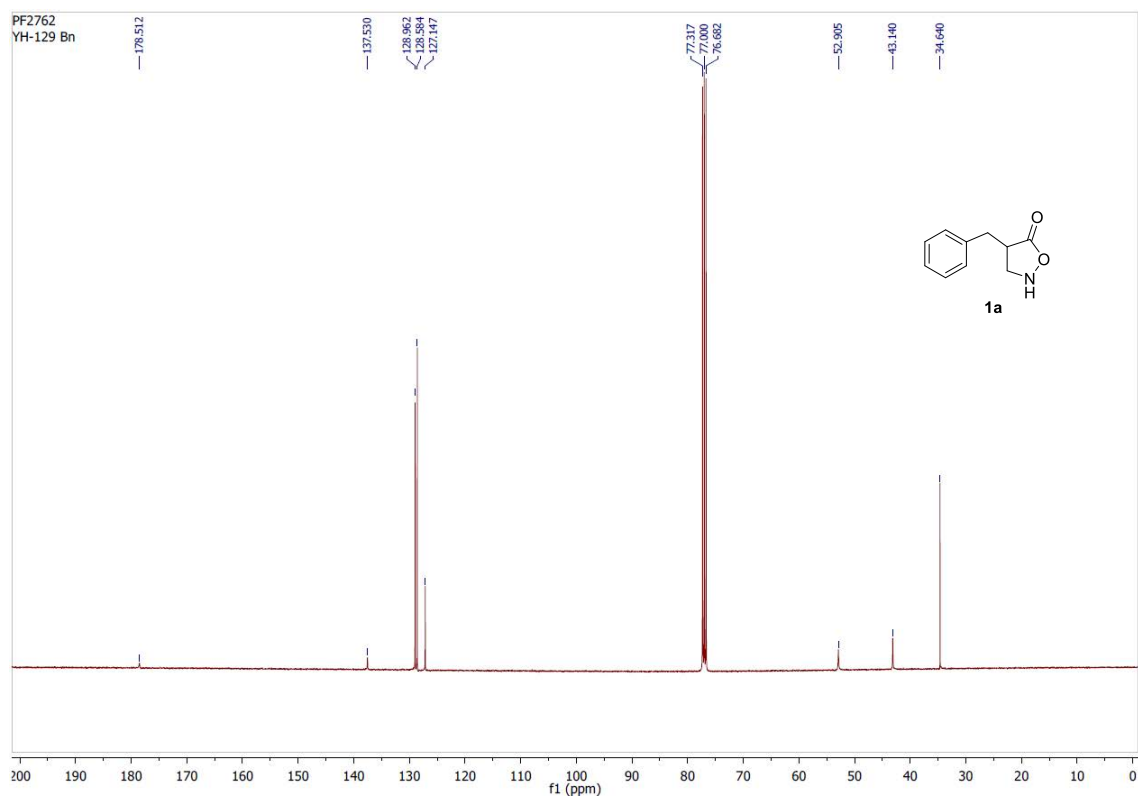


4-Benzylisoxazolidin-5-one (1a):

^1H NMR (400 MHz, CDCl_3)

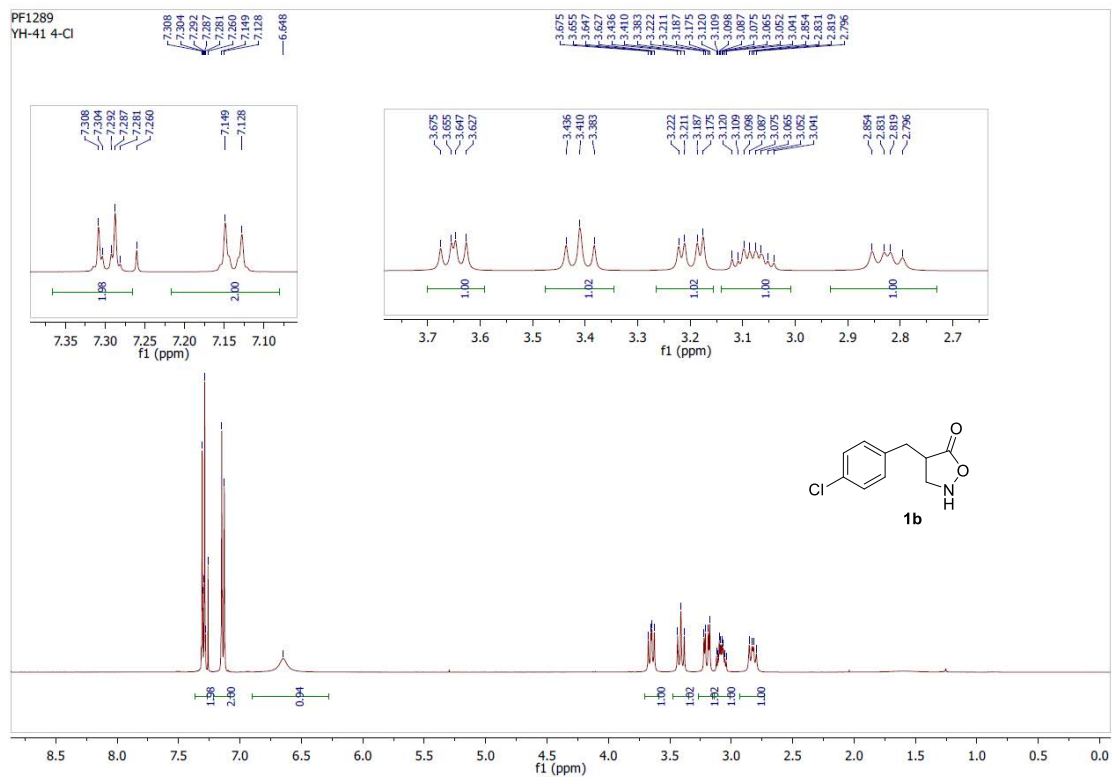


^{13}C NMR (100 MHz, CDCl_3)

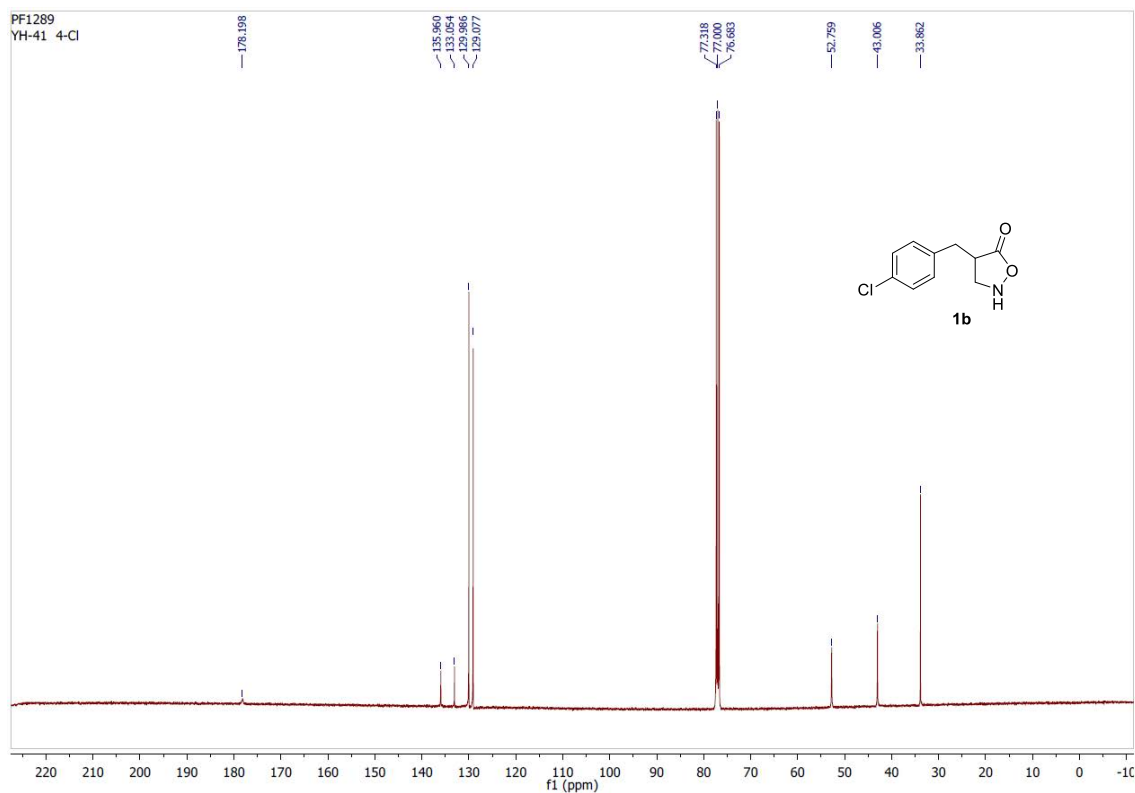


4-(4-Chlorobenzyl)isoxazolidin-5-one (**1b**):

¹H NMR (400 MHz, CDCl₃)

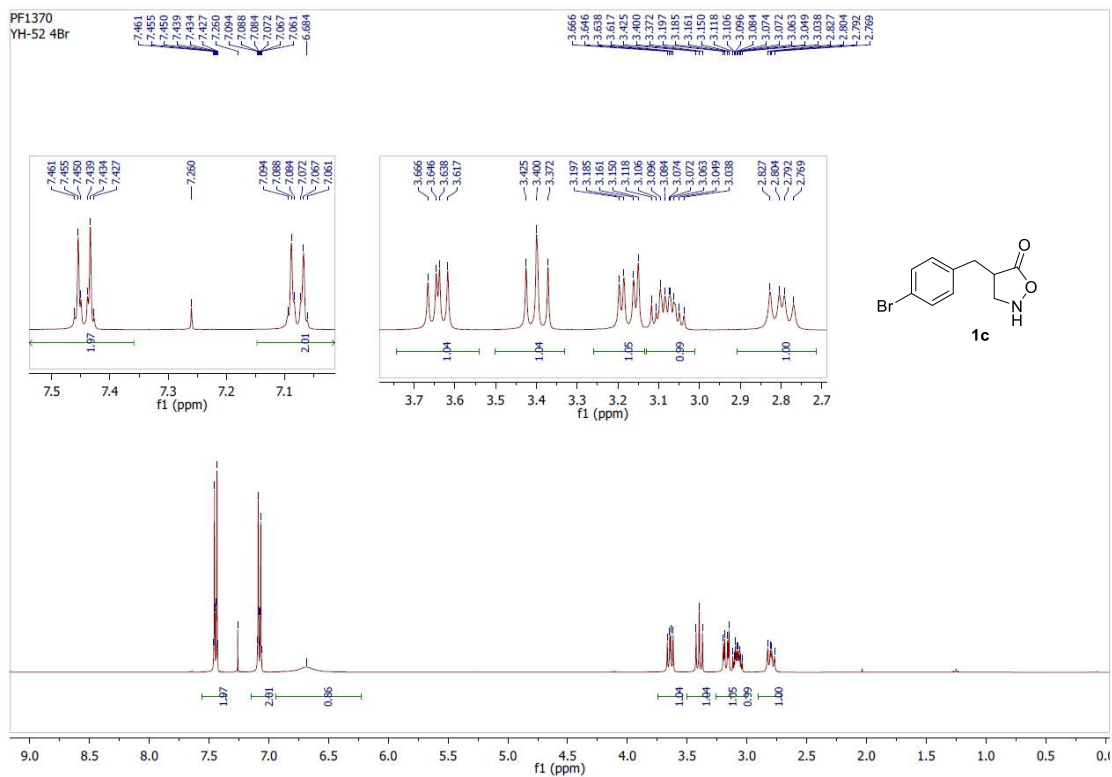


¹³C NMR (100 MHz, CDCl₃)

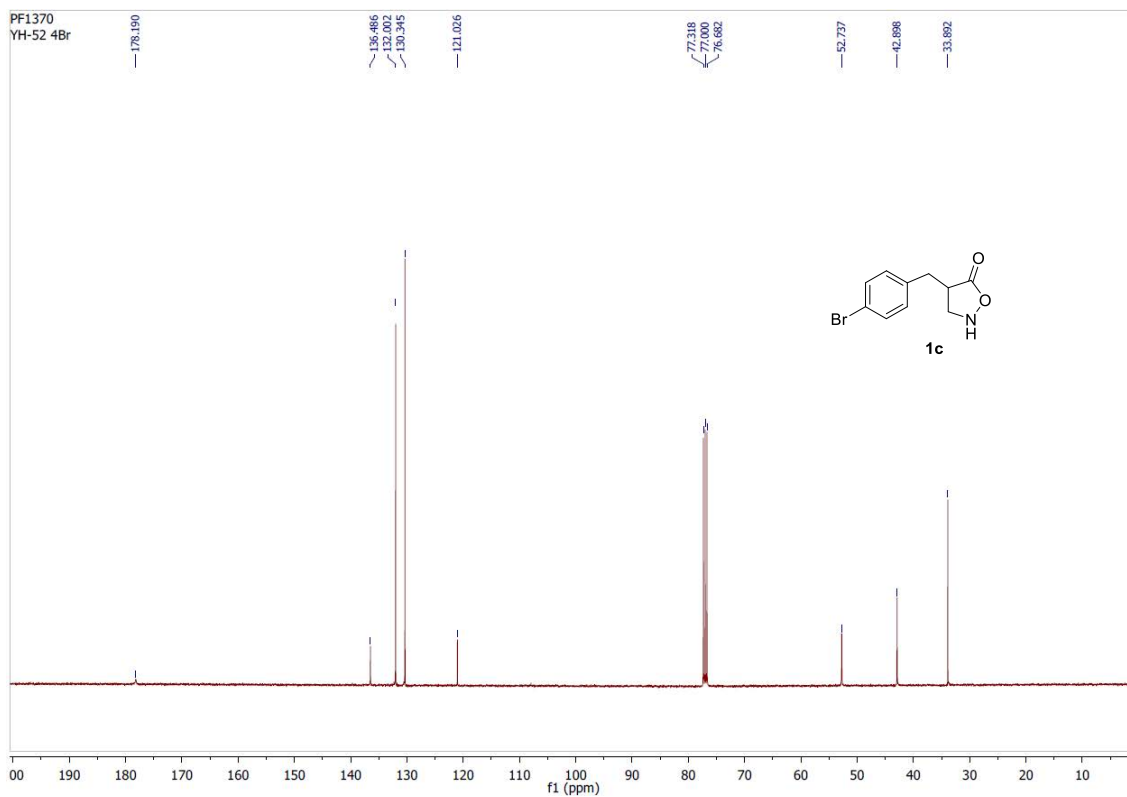


4-(4-Bromobenzyl)isoxazolidin-5-one (**1c**):

^1H NMR (400 MHz, CDCl_3)

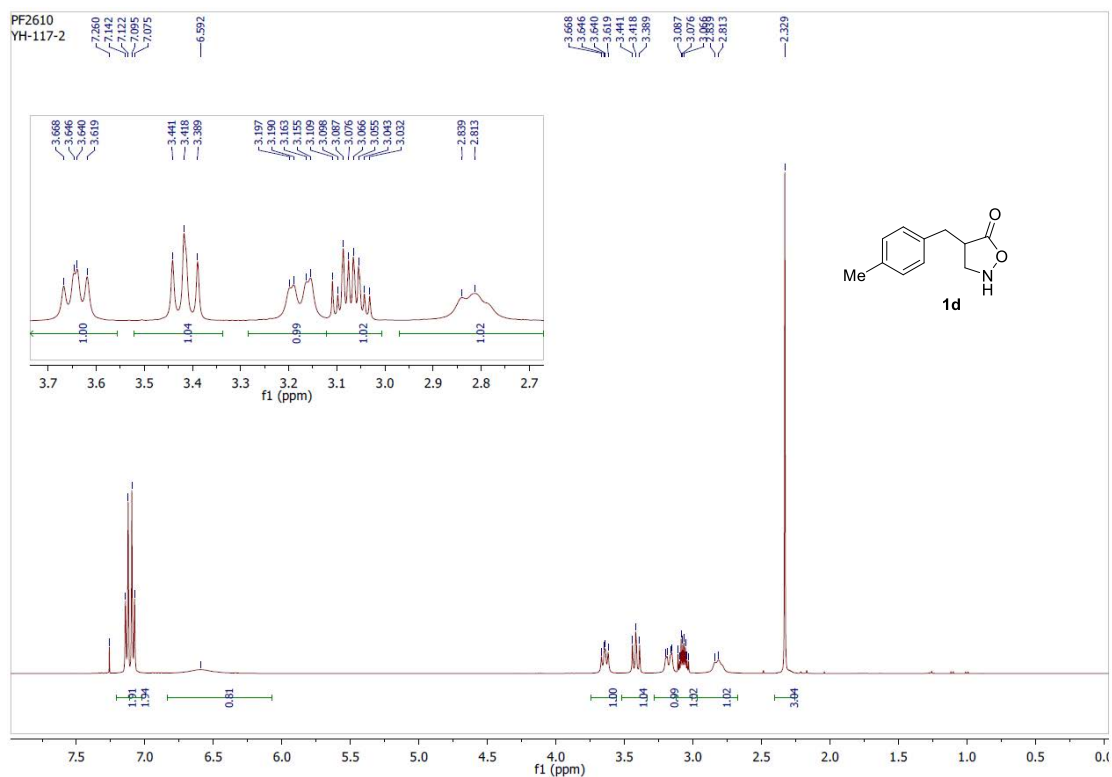


^{13}C NMR (100 MHz, CDCl_3)

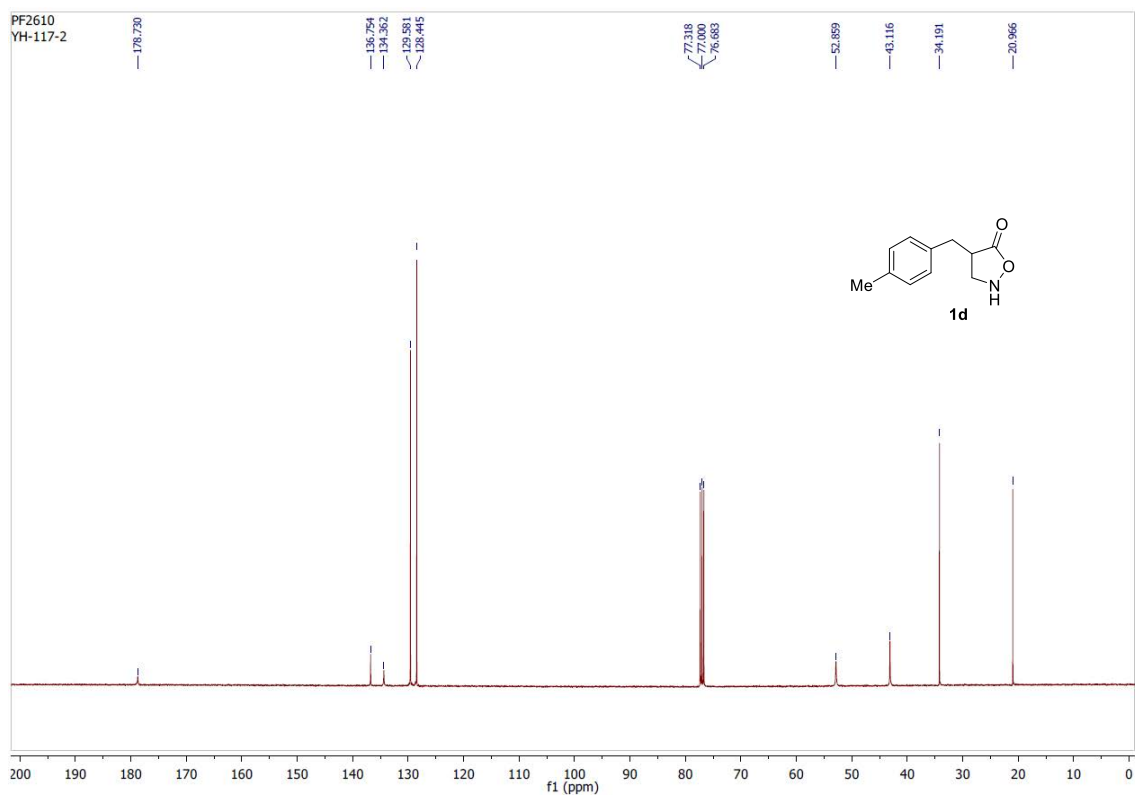


4-(4-Methylbenzyl)isoxazolidin-5-one (**1d**):

^1H NMR (400 MHz, CDCl_3)

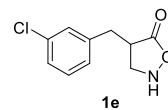
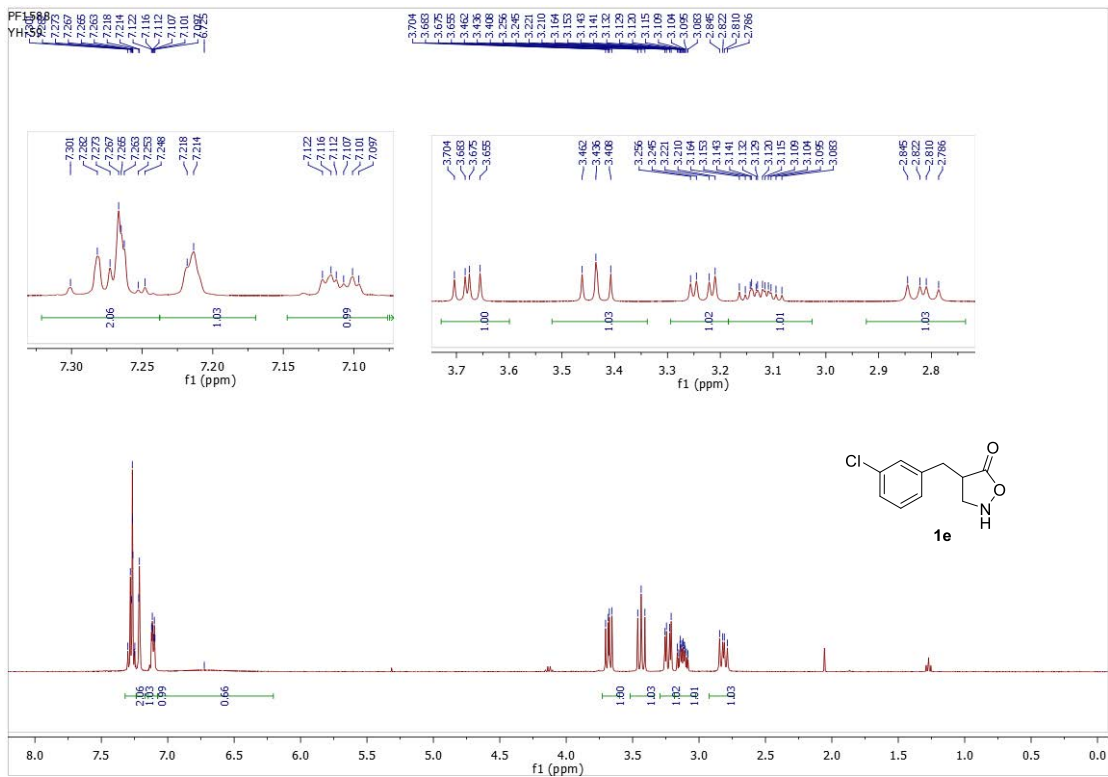


^{13}C NMR (100 MHz, CDCl_3)

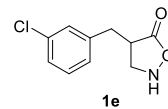
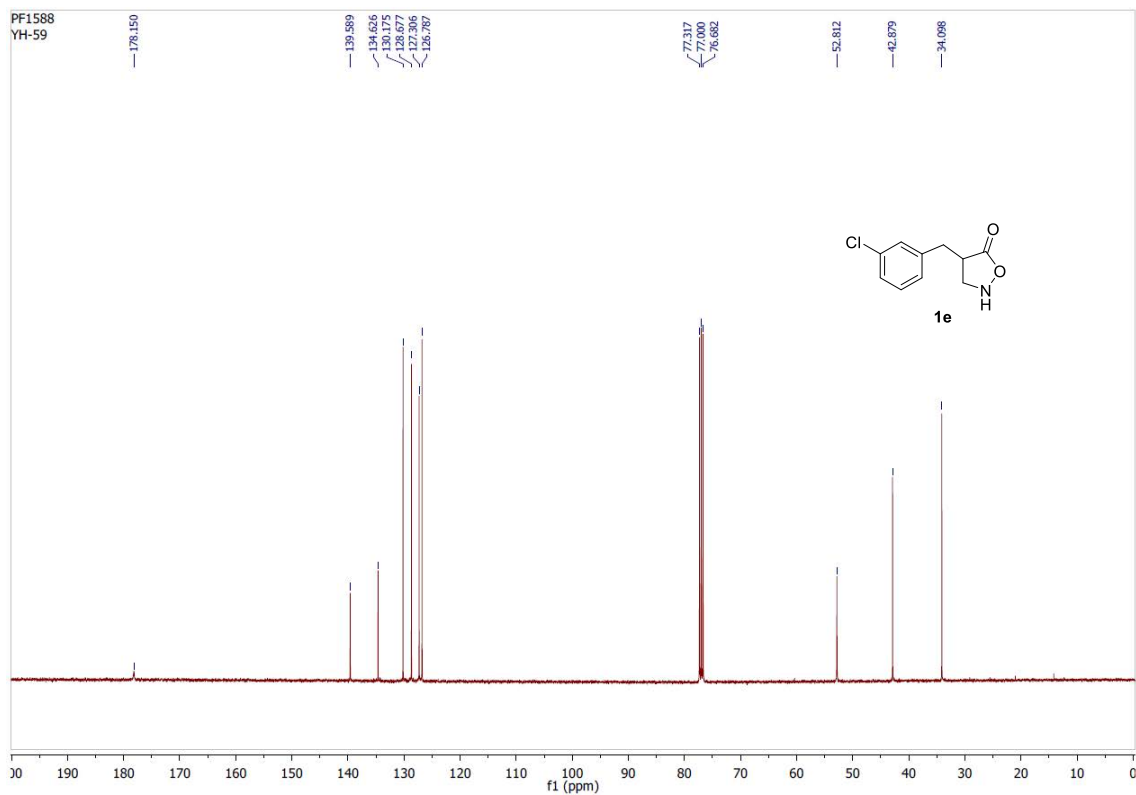


4-(3-Chlorobenzyl)isoxazolidin-5-one (1e):

¹H NMR (400 MHz, CDCl₃)

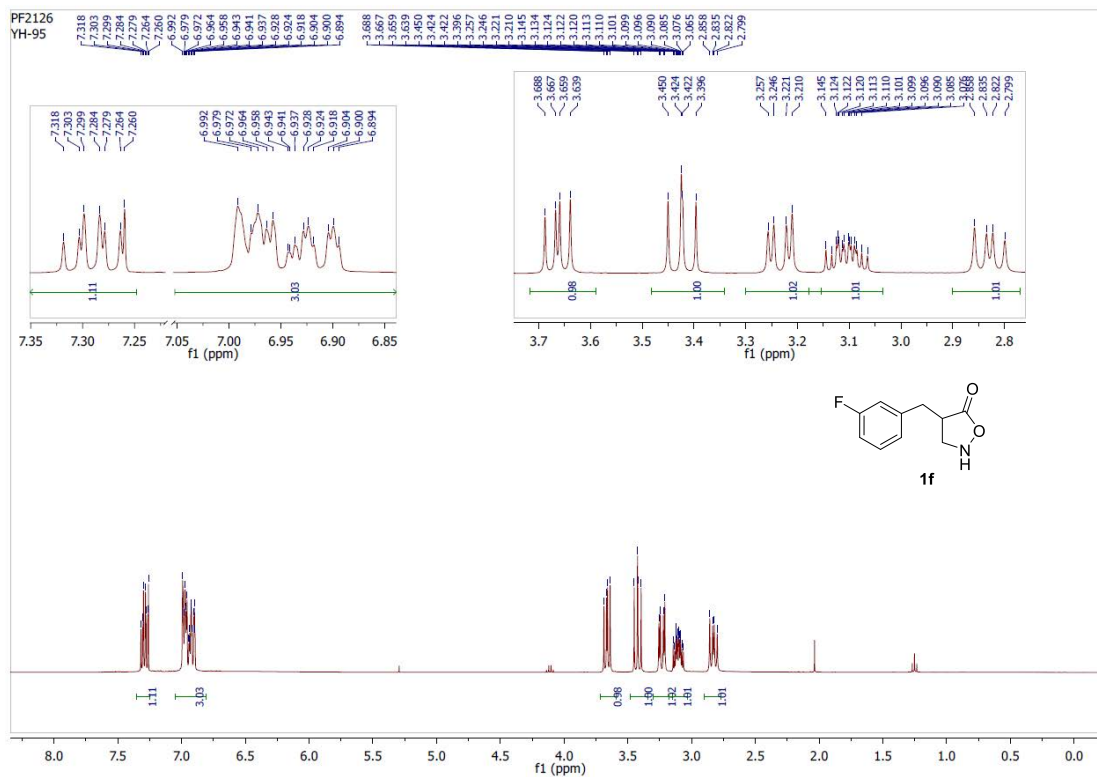


¹³C NMR (100 MHz, CDCl₃)

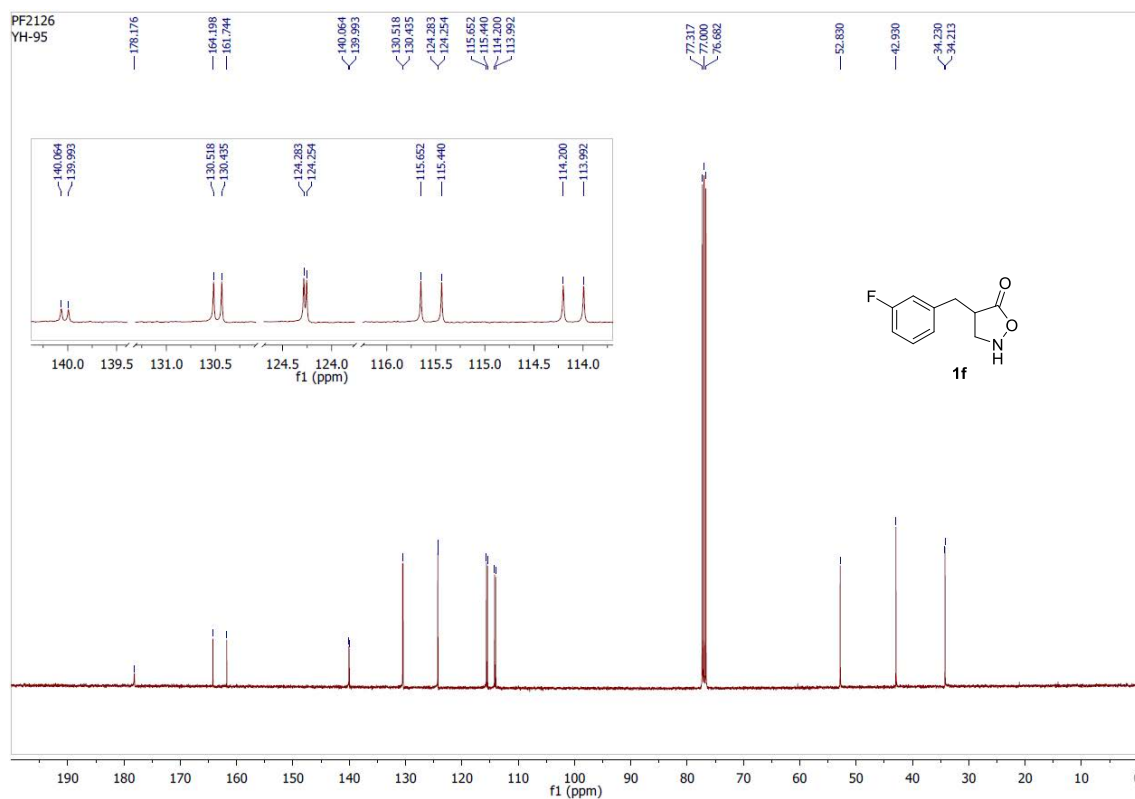


4-(2-Fluorobenzyl)isoxazolidin-5-one (1f):

¹H NMR (400 MHz, CDCl₃)

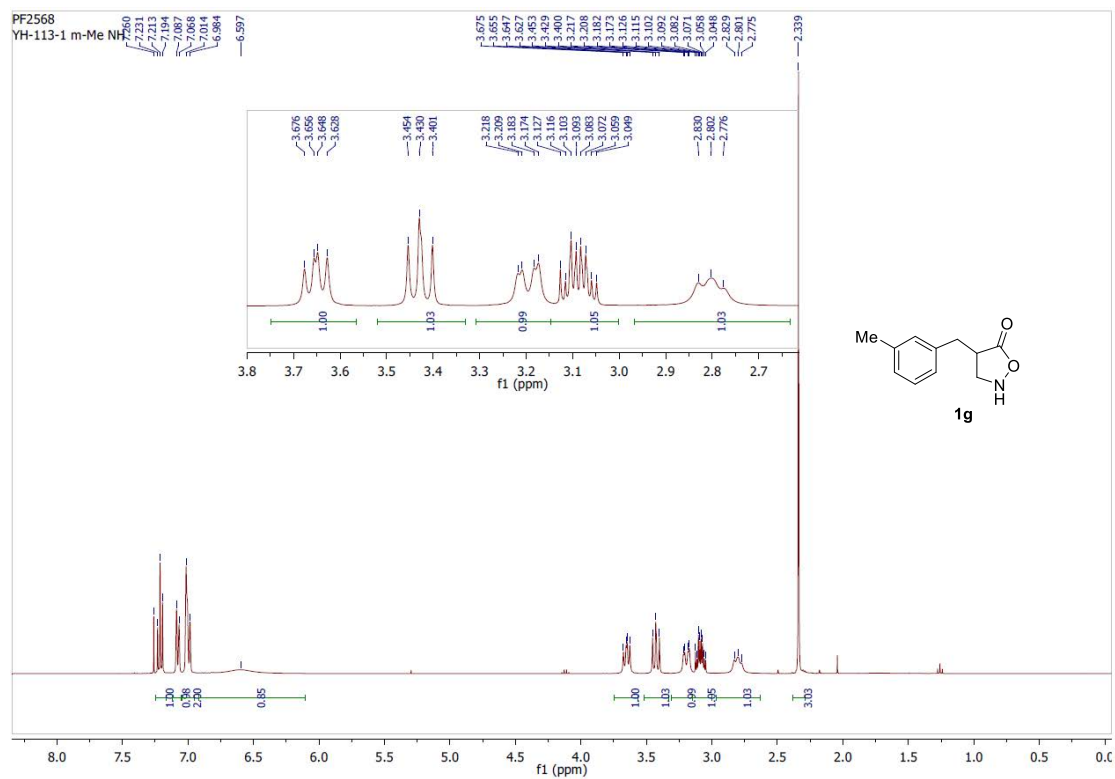


¹³C NMR (100 MHz, CDCl₃)

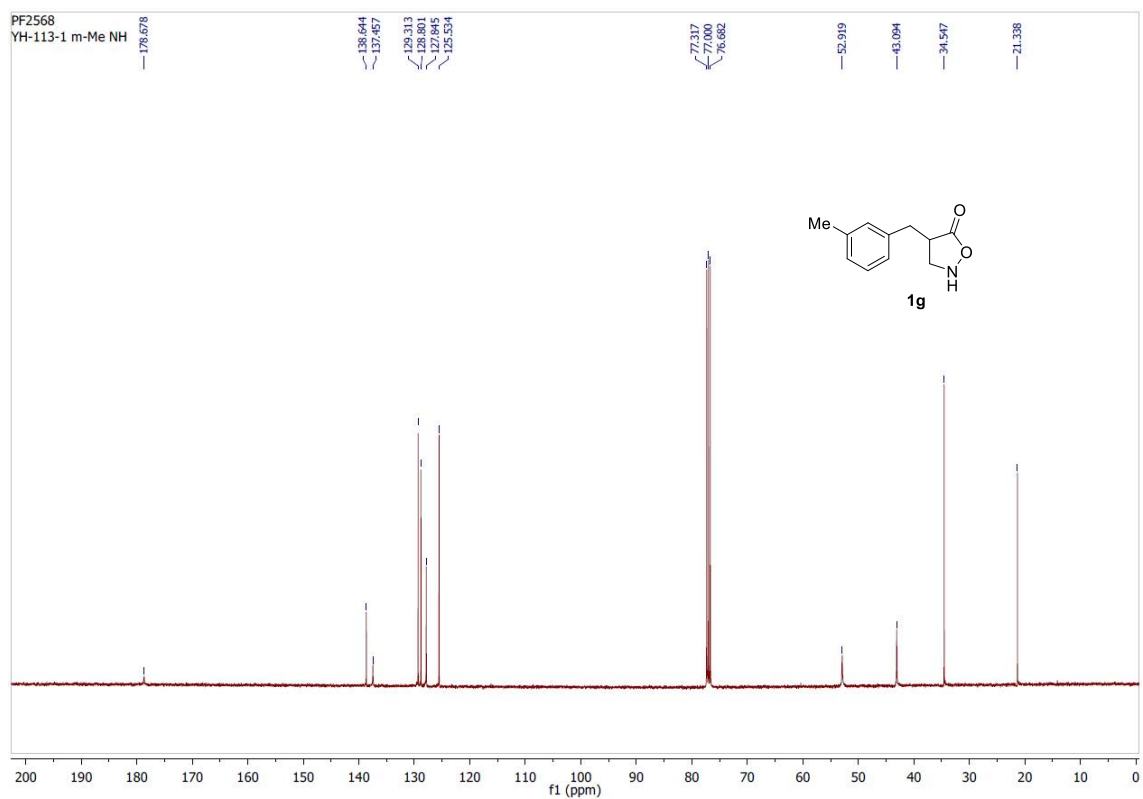


4-(3-Methylbenzyl)isoxazolidin-5-one (**1g**):

^1H NMR (400 MHz, CDCl_3)

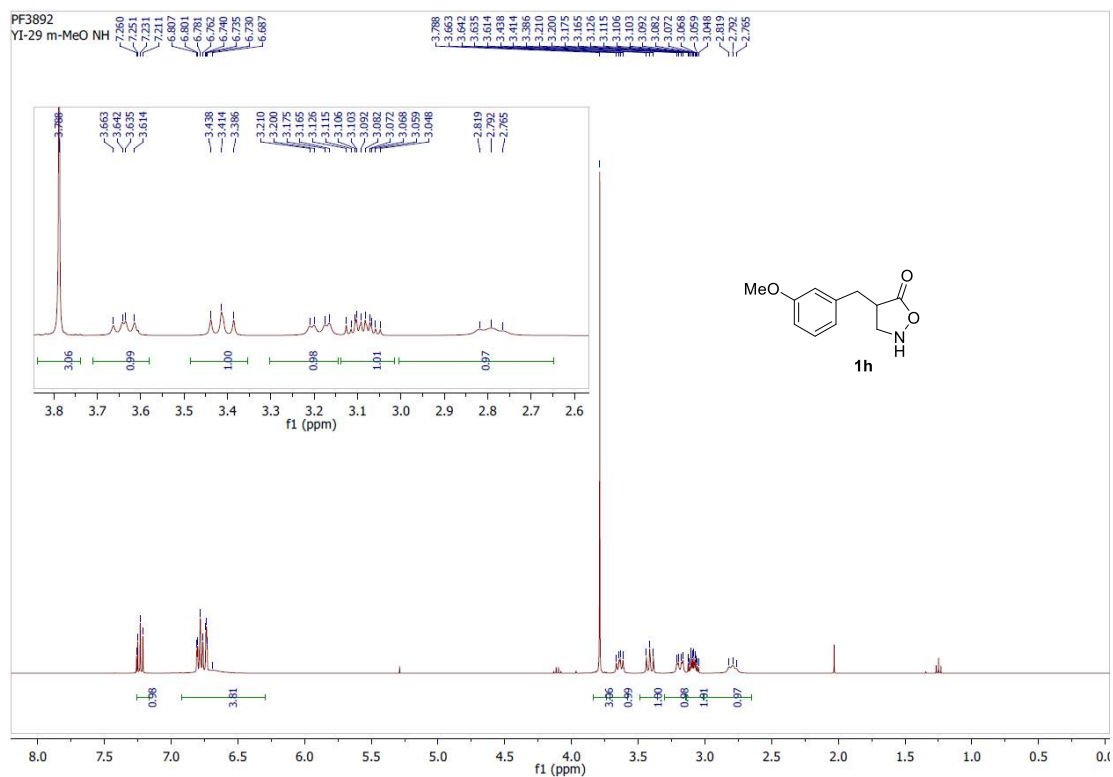


^{13}C NMR (100 MHz, CDCl_3)

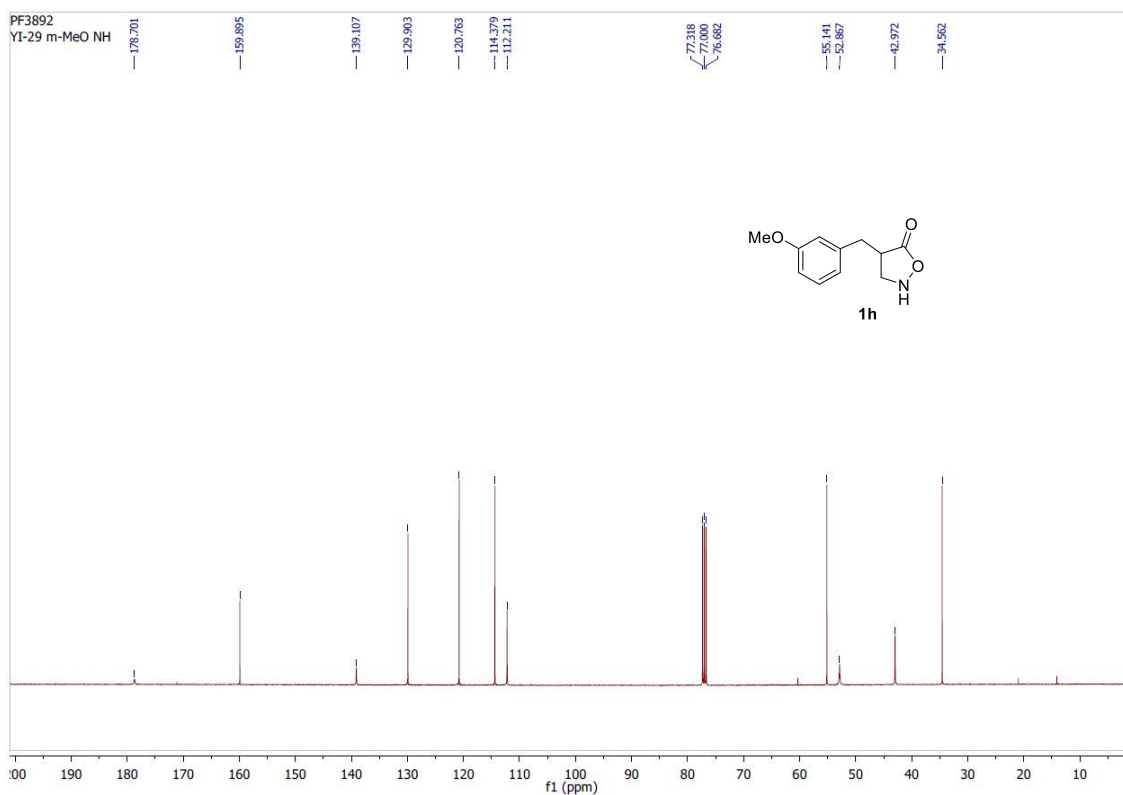


4-(3-Methoxybenzyl)isoxazolidin-5-one (1h):

¹H NMR (400 MHz, CDCl₃)

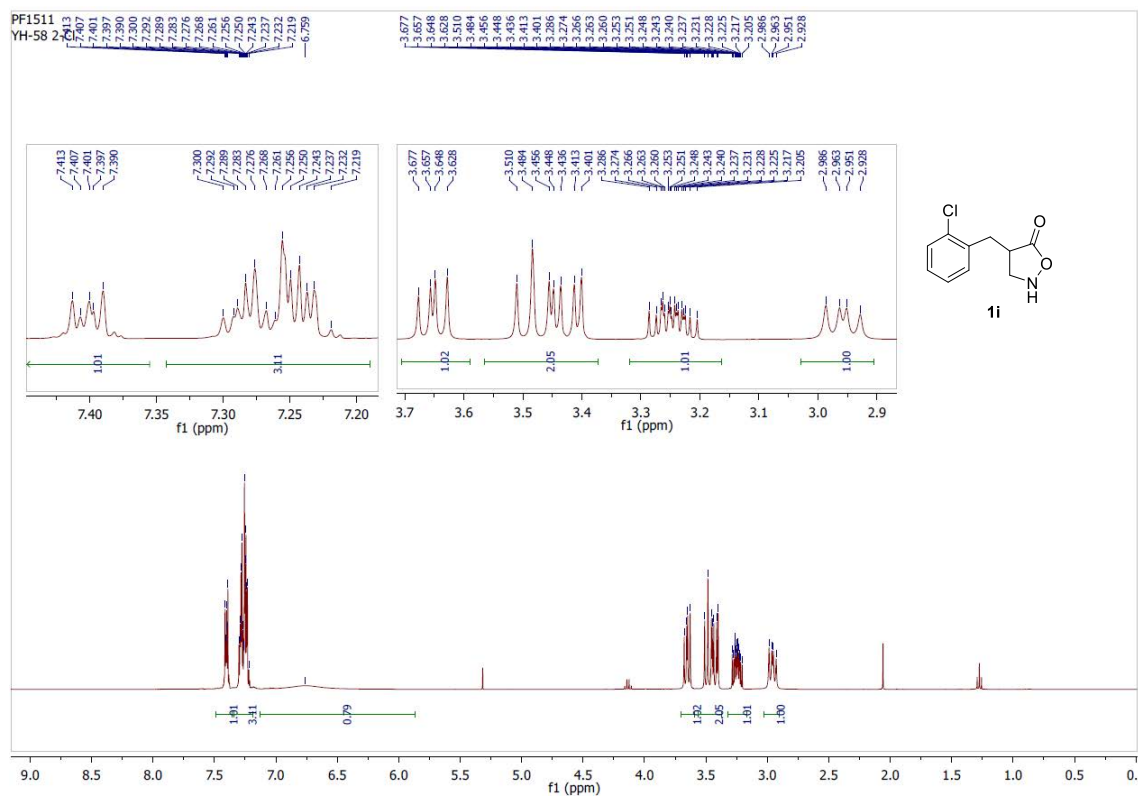


¹³C NMR (100 MHz, CDCl₃)

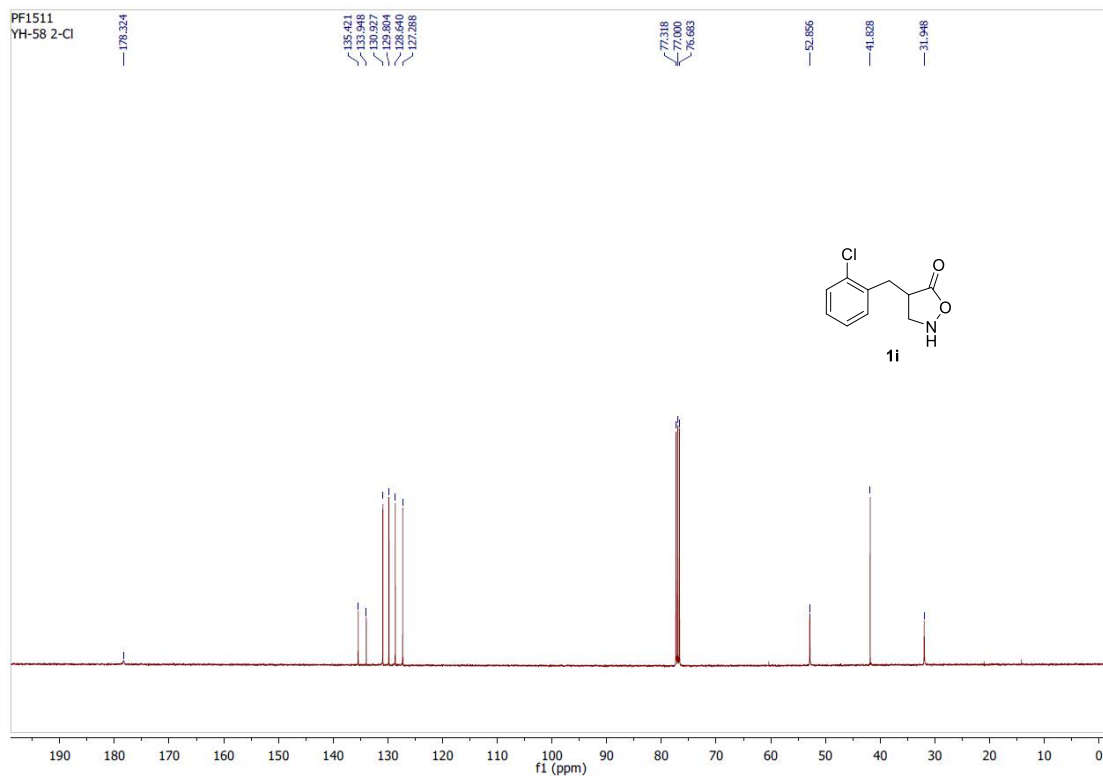


4-(2-Chlorobenzyl)isoxazolidin-5-one (1i):

¹H NMR (400 MHz, CDCl₃)

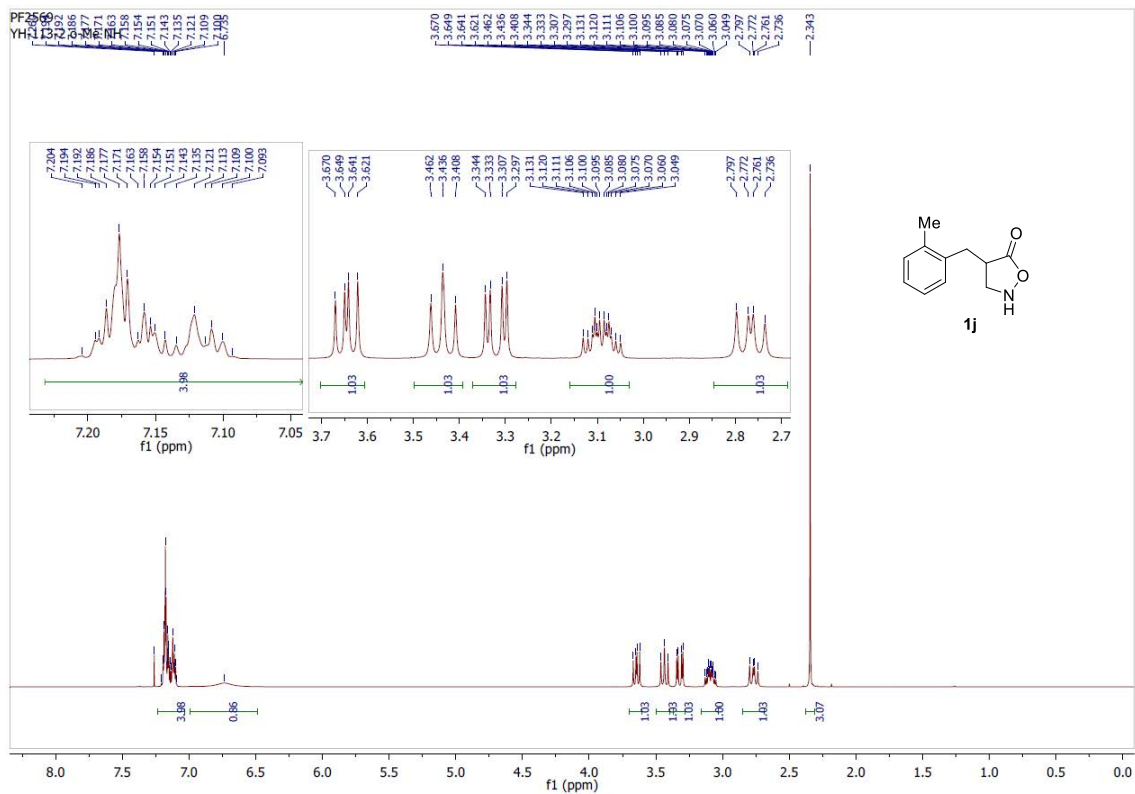


¹³C NMR (100 MHz, CDCl₃)

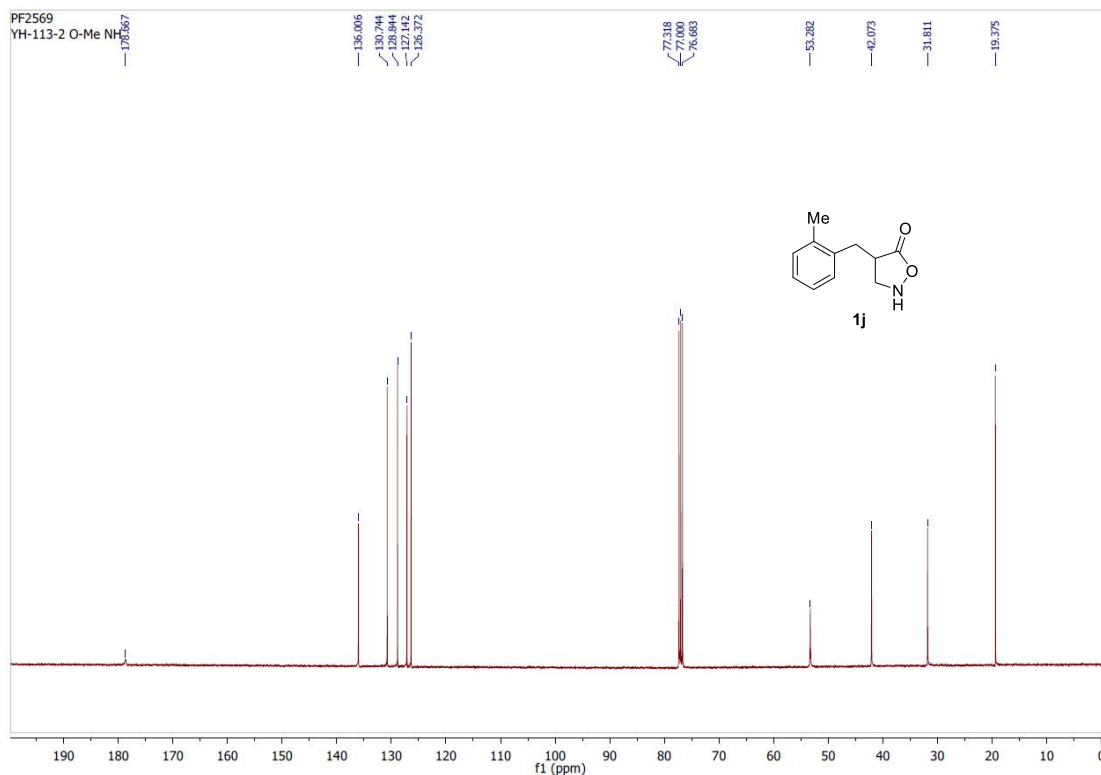


4-(2-Methylbenzyl)isoxazolidin-5-one (**1j**):

¹H NMR (400 MHz, CDCl₃)

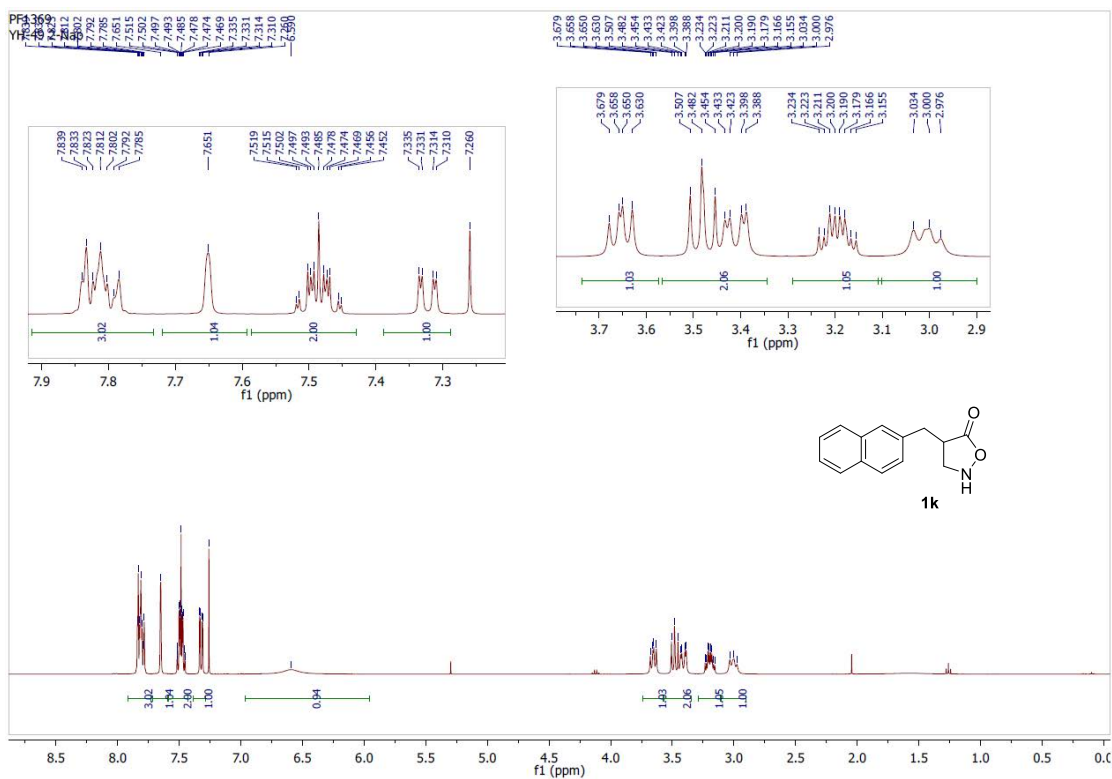


¹³C NMR (100 MHz, CDCl₃)

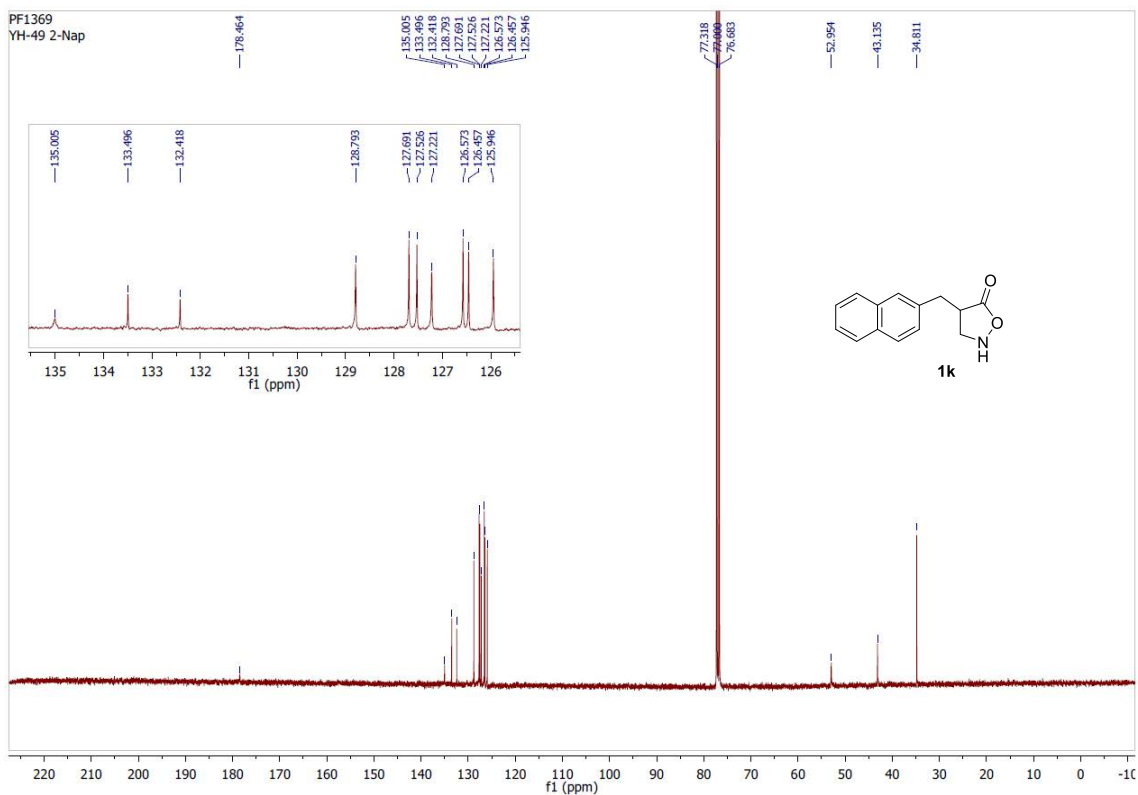


4-(Naphthalen-2-ylmethyl)isoxazolidin-5-one (**1k**):

^1H NMR (400 MHz, CDCl_3)

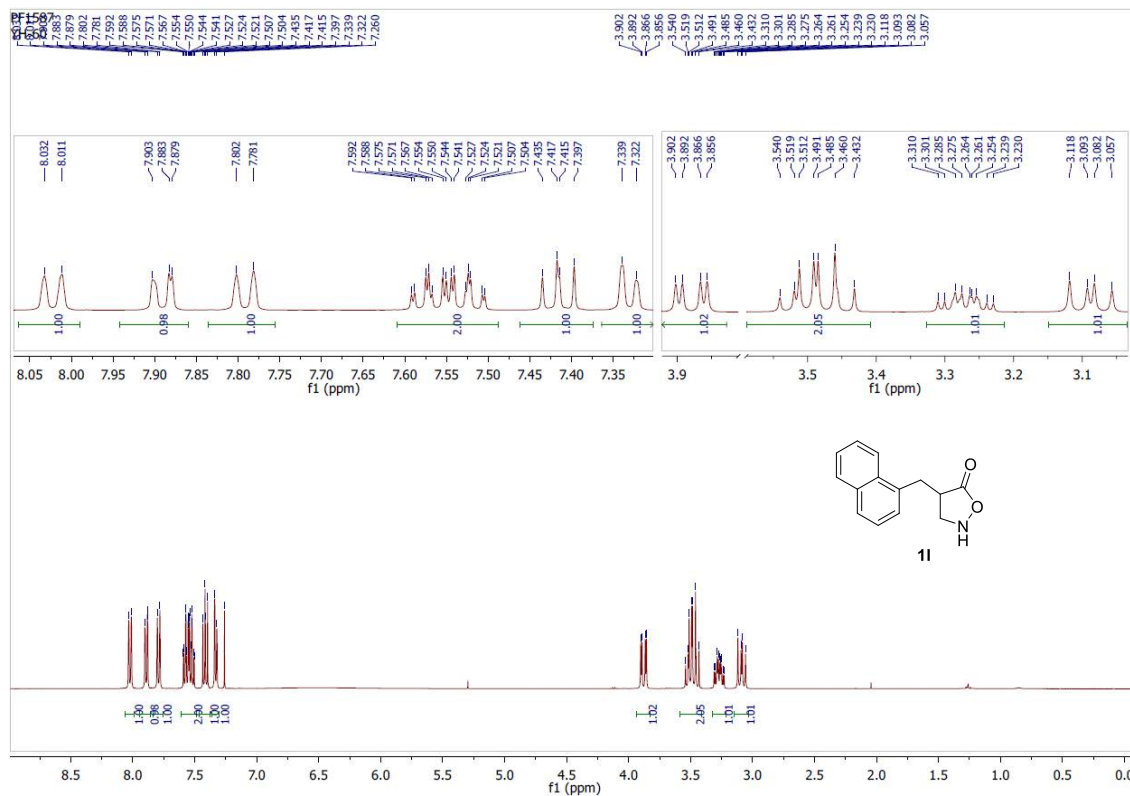


^{13}C NMR (100 MHz, CDCl_3)

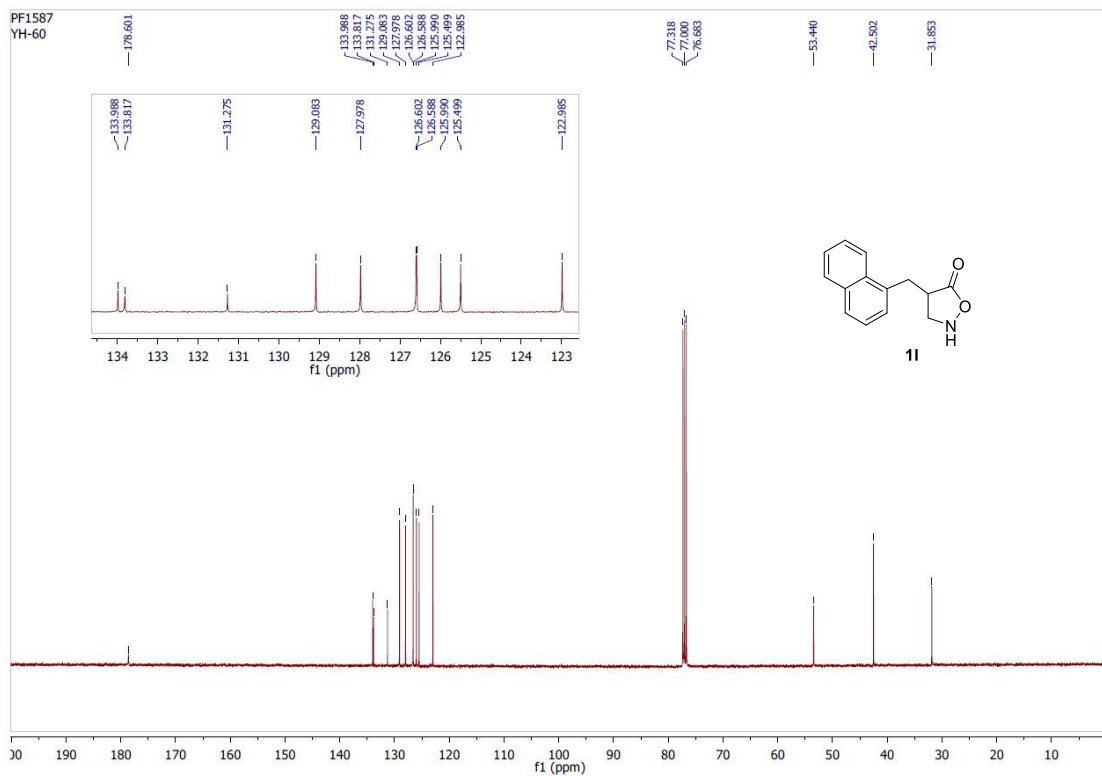


4-(Naphthalen-1-ylmethyl)isoxazolidin-5-one (11):

¹H NMR (400 MHz, CDCl₃)

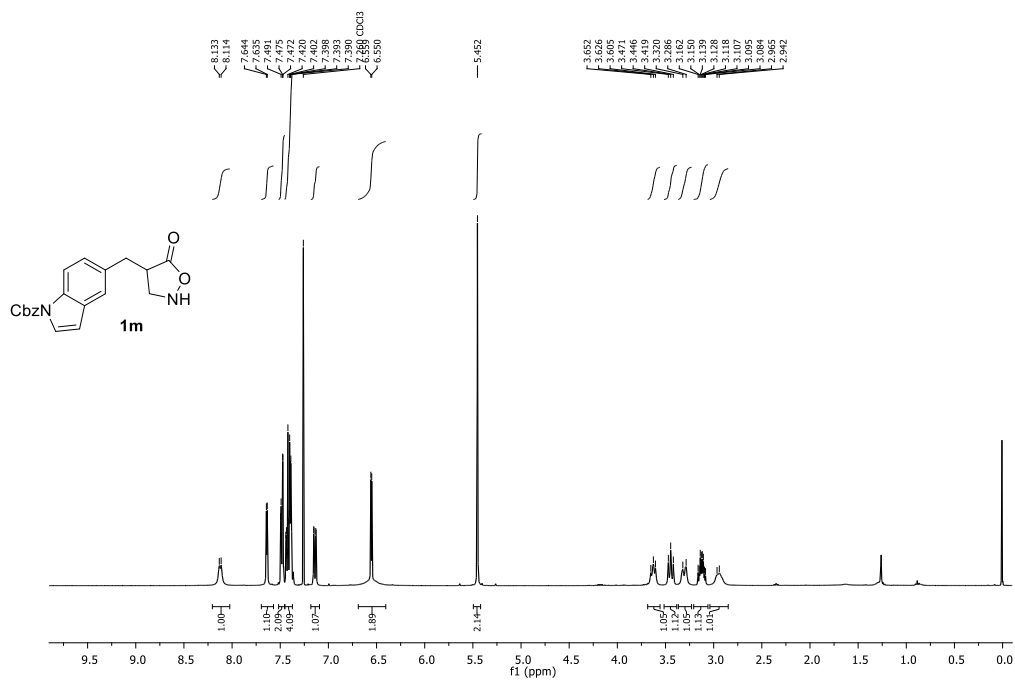


¹³C NMR (100 MHz, CDCl₃)

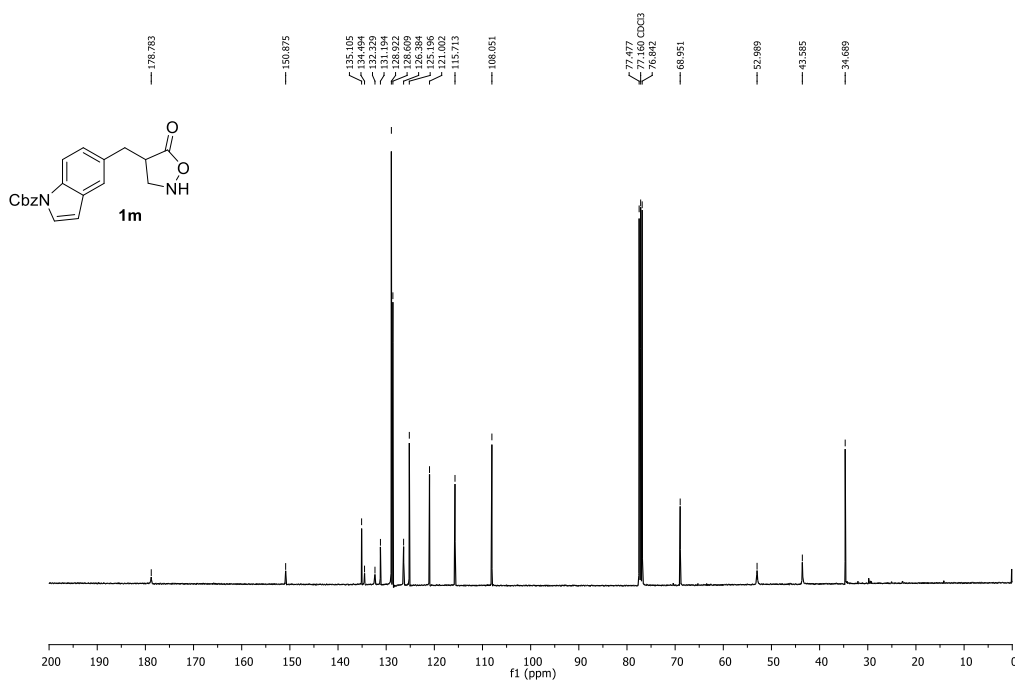


***tert*-Butyl 4-((1-((benzyloxy)carbonyl)-1*H*-indol-5-yl)methyl)-5-oxoisoxazolidine-2-carboxylate (**1m**):**

¹H NMR (400 MHz, CDCl₃)

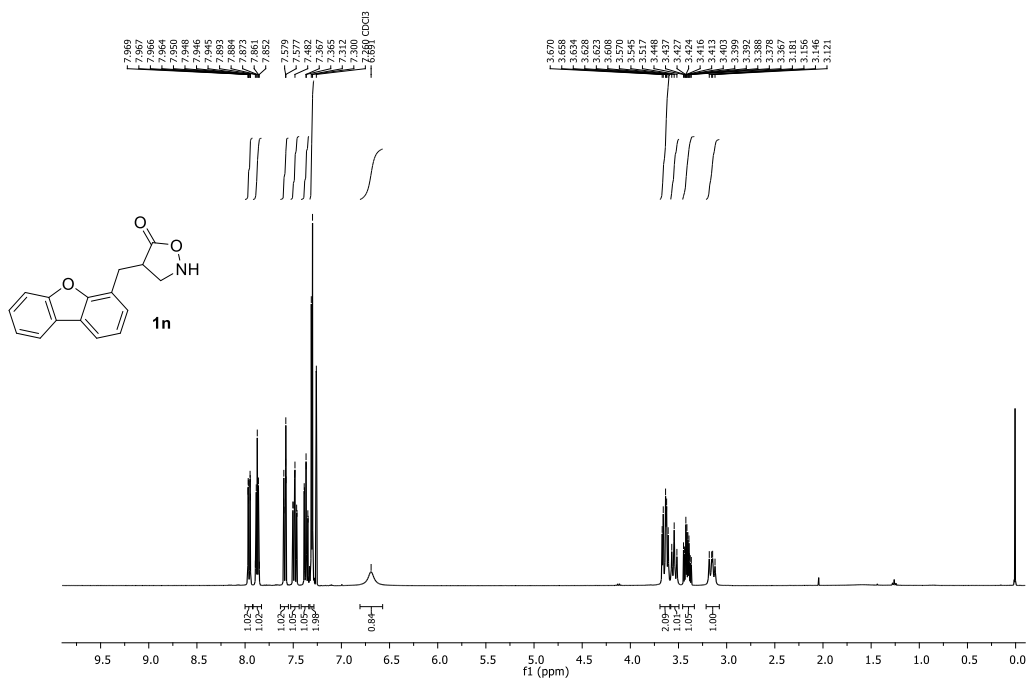


¹³C NMR (100 MHz, CDCl₃)

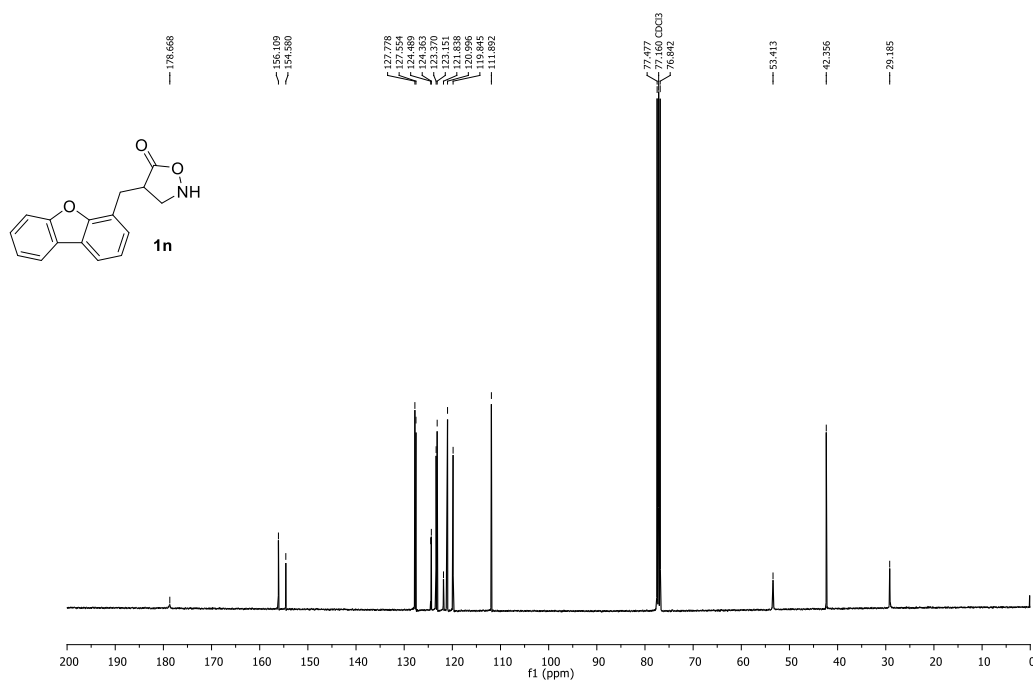


4-(Dibenzo[*b,d*]furan-4-ylmethyl)isoxazolidin-5-one (1n):

¹H NMR (400 MHz, CDCl₃)

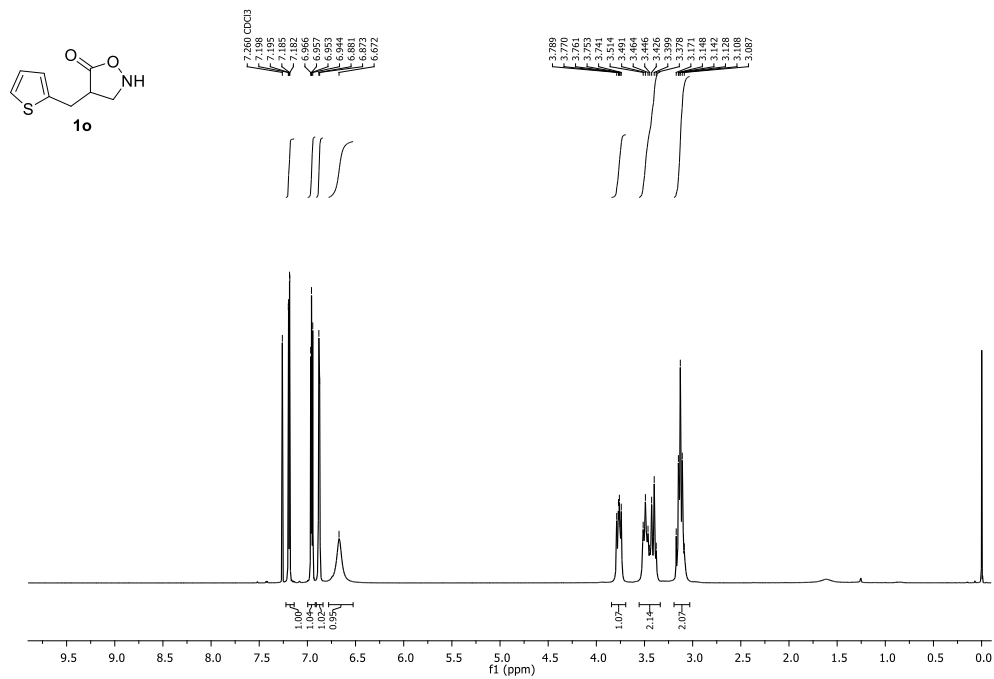


¹³C NMR (100 MHz, CDCl₃)

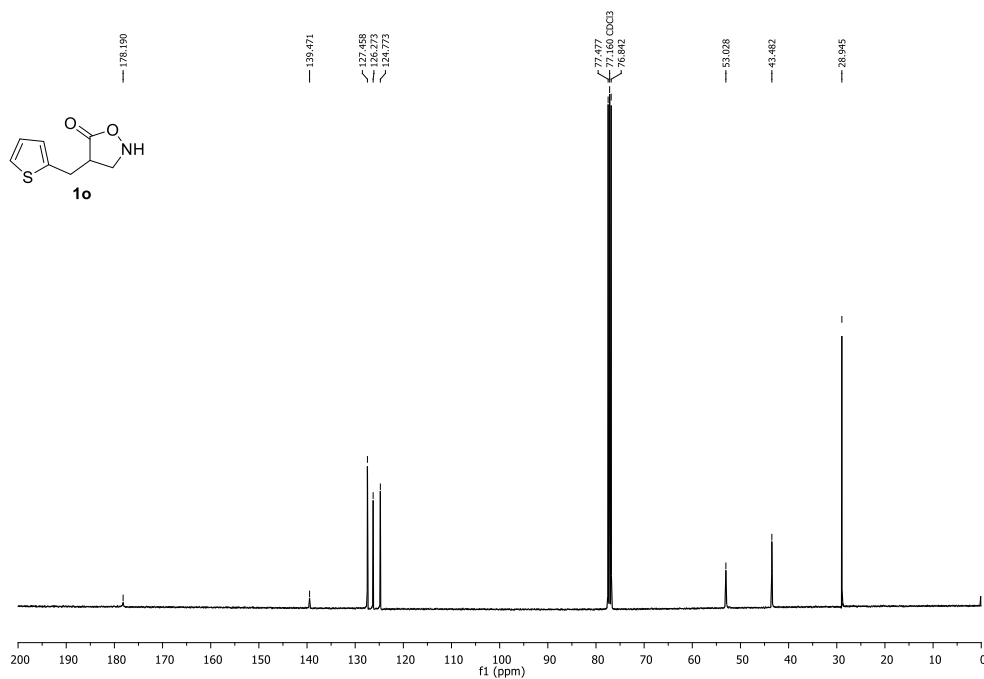


4-(Thiophen-2-ylmethyl)isoxazolidin-5-one (**1o**):

^1H NMR (400 MHz, CDCl_3)

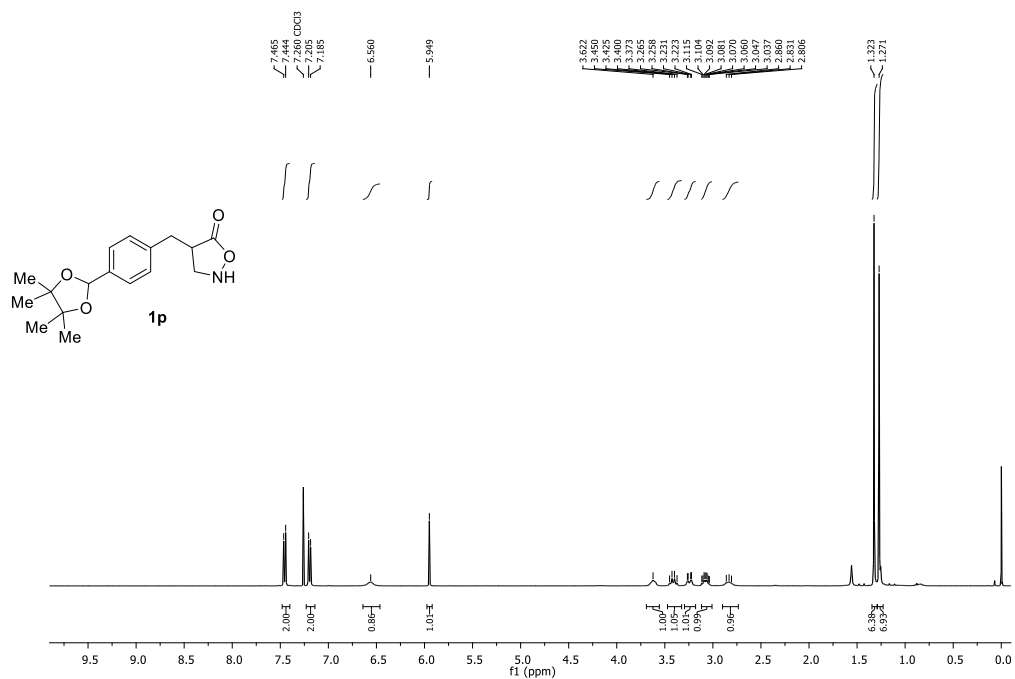


^{13}C NMR (100 MHz, CDCl_3)

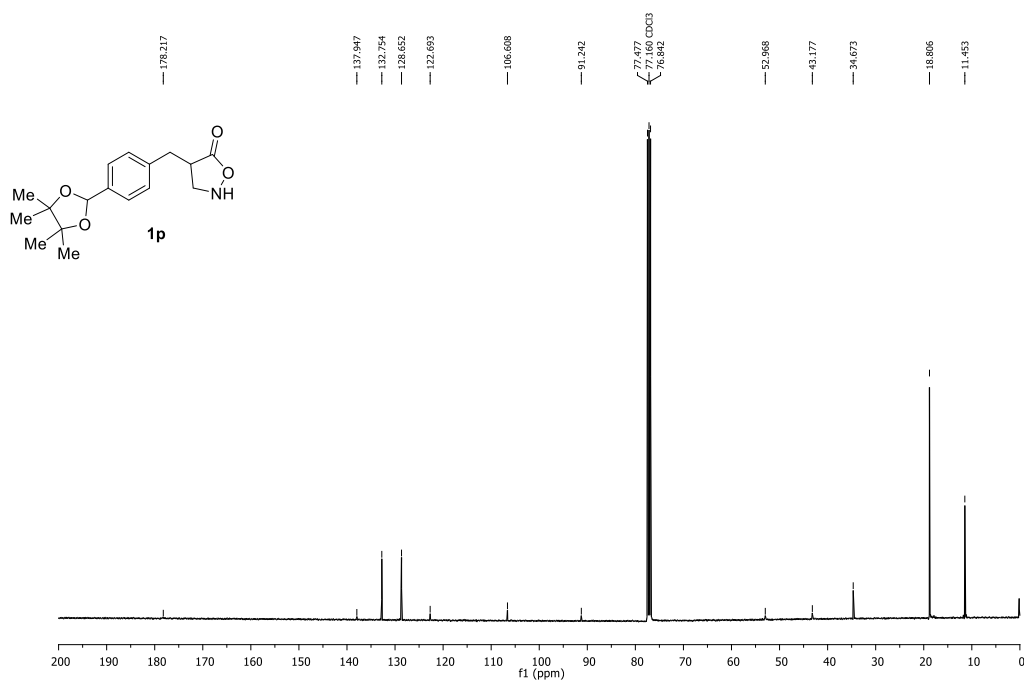


4-(4-(4,4,5,5-Tetramethyl-1,3-dioxolan-2-yl)benzyl)isoxazolidin-5-one (1p):

^1H NMR (400 MHz, CDCl_3)

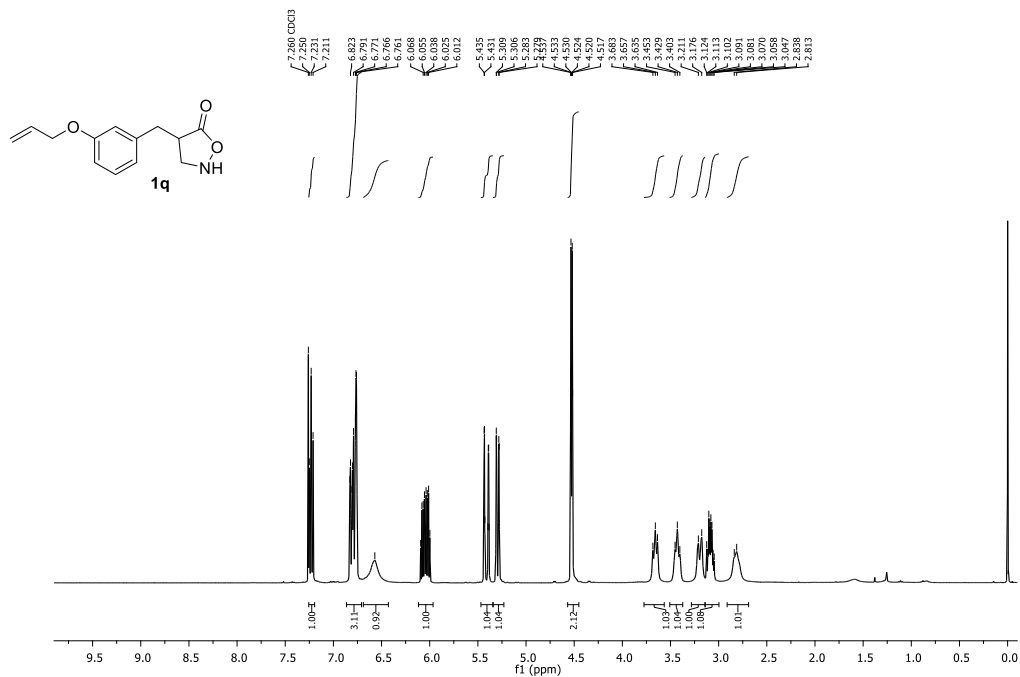


^{13}C NMR (100 MHz, CDCl_3)

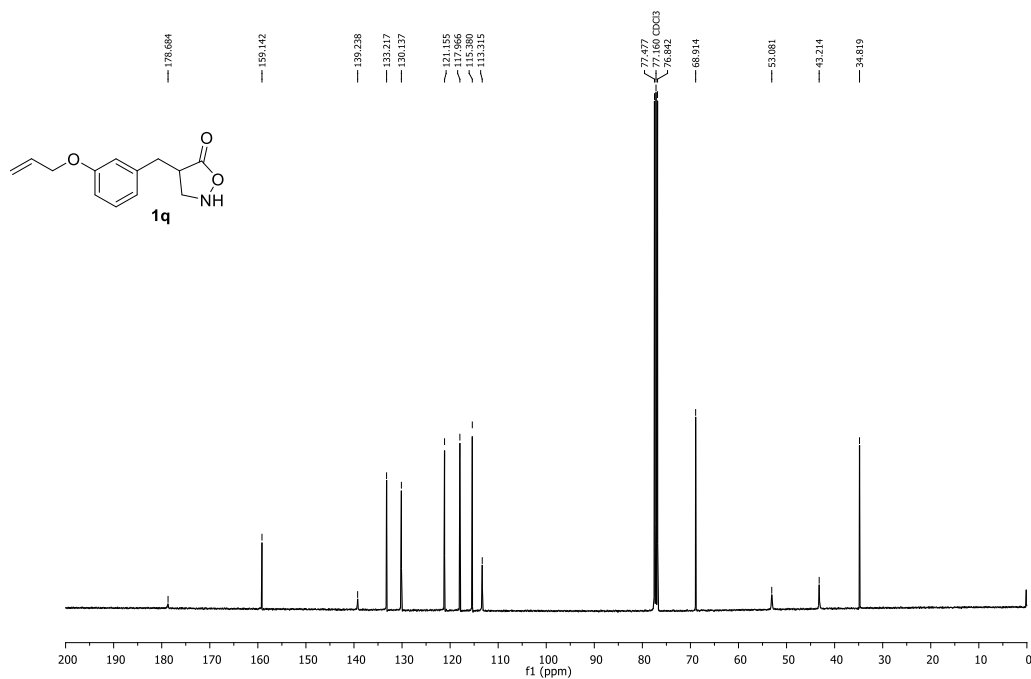


4-(3-(Allyloxy)benzyl)isoxazolidin-5-one (**1q**):

¹H NMR (400 MHz, CDCl₃)

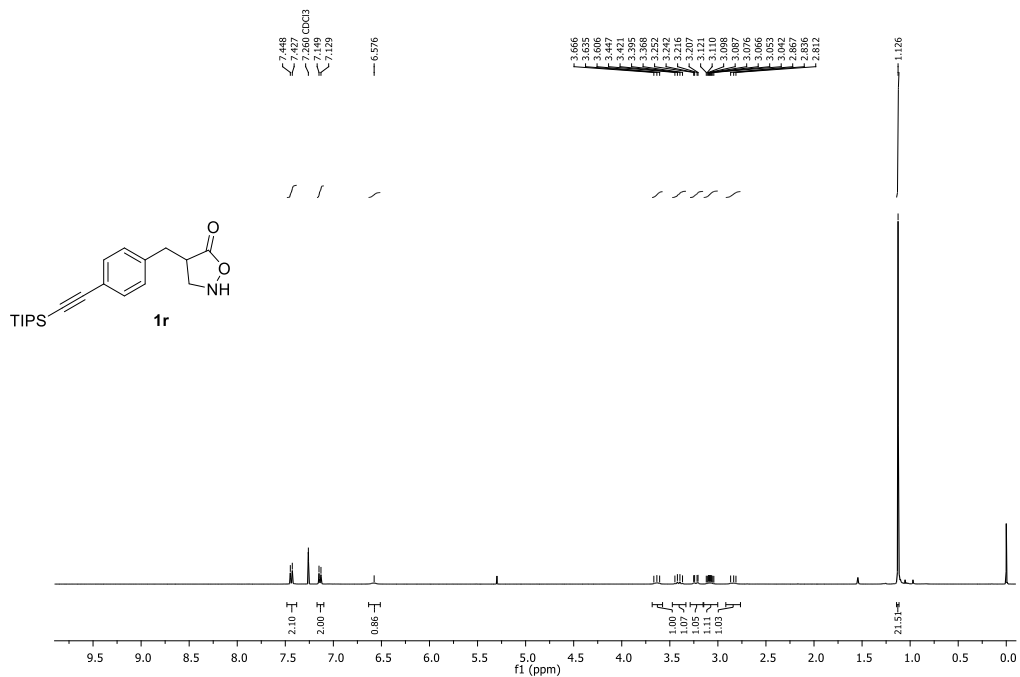


¹³C NMR (100 MHz, CDCl₃)

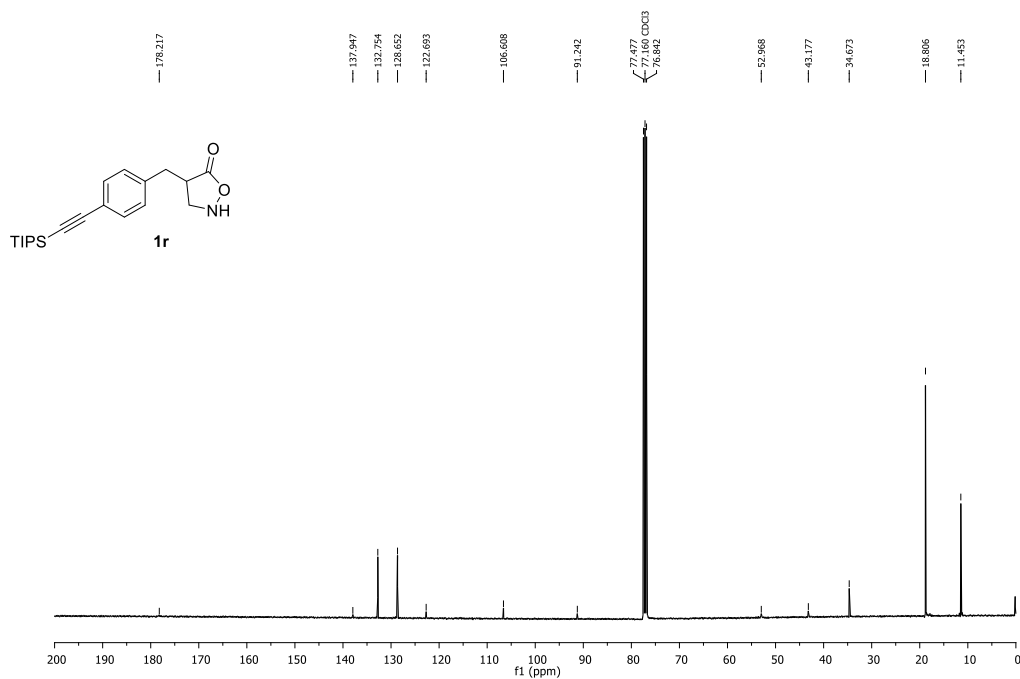


4-(4-((Trimethylsilyl)ethynyl)benzyl)isoxazolidin-5-one (**1r**):

^1H NMR (400 MHz, CDCl_3)

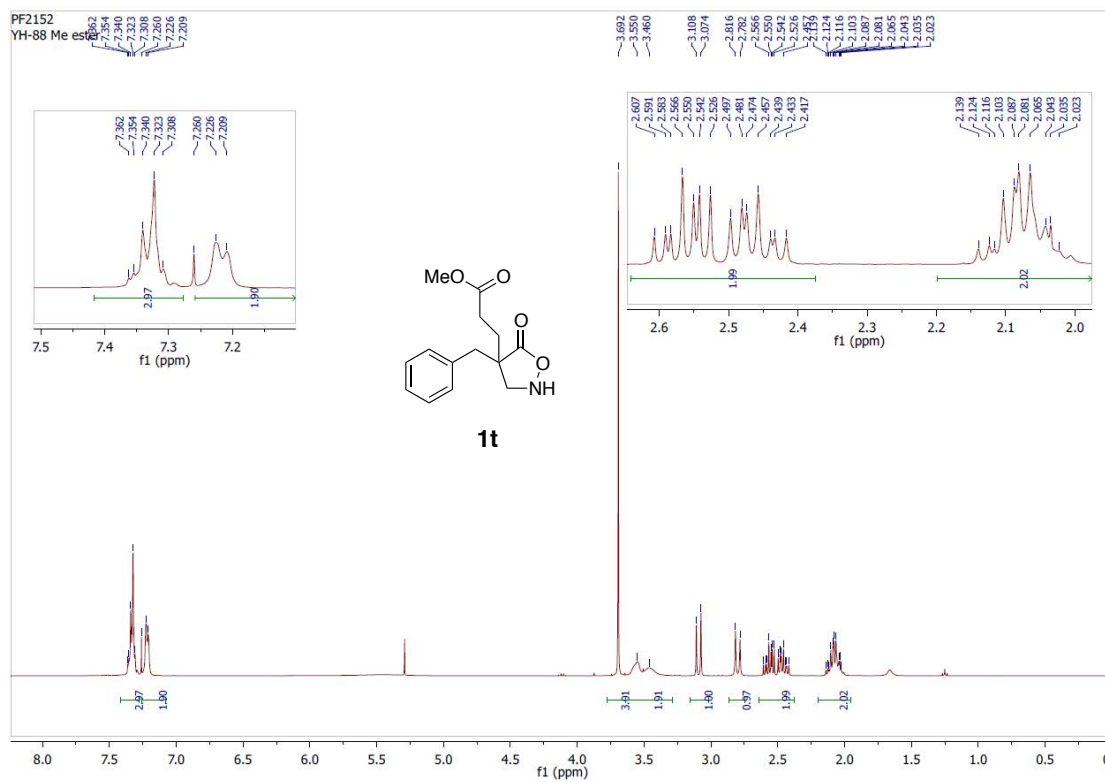


^{13}C NMR (100 MHz, CDCl_3)

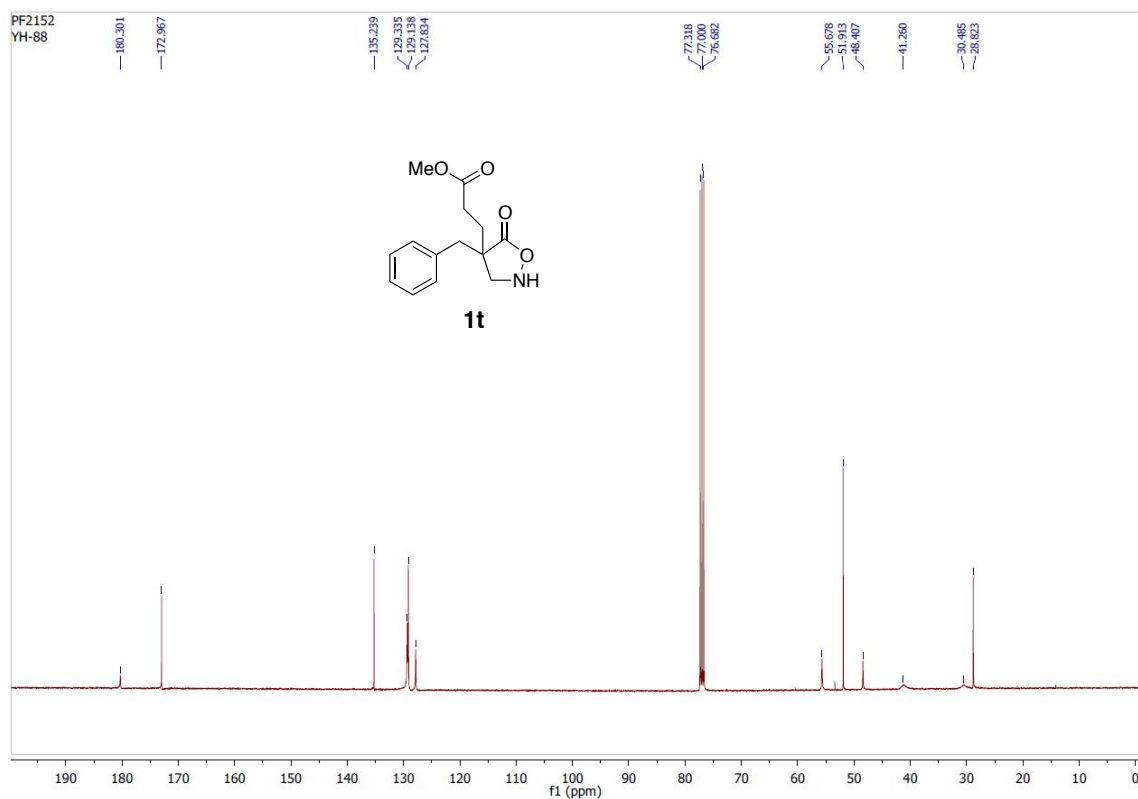


Methyl 3-(4-benzyl-5-oxoisoxazolidin-4-yl)propanoate (1t):

¹H NMR (400 MHz, CDCl₃)

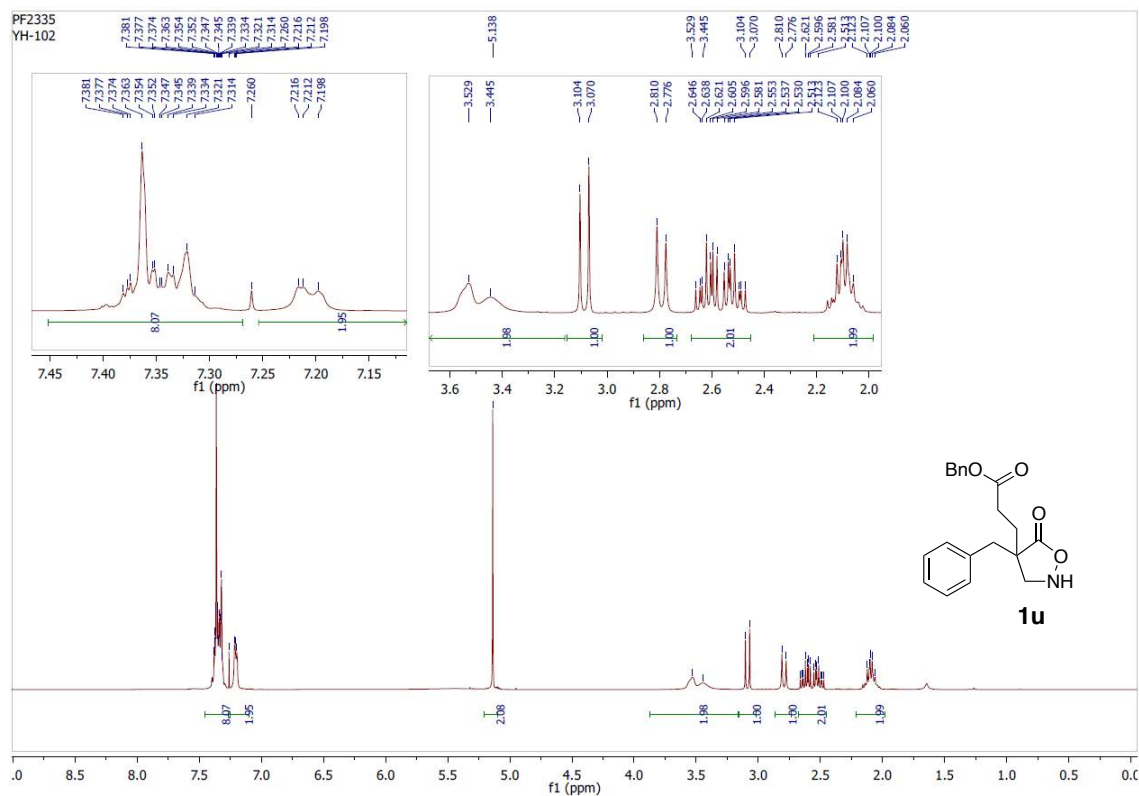


¹³C NMR (100 MHz, CDCl₃)

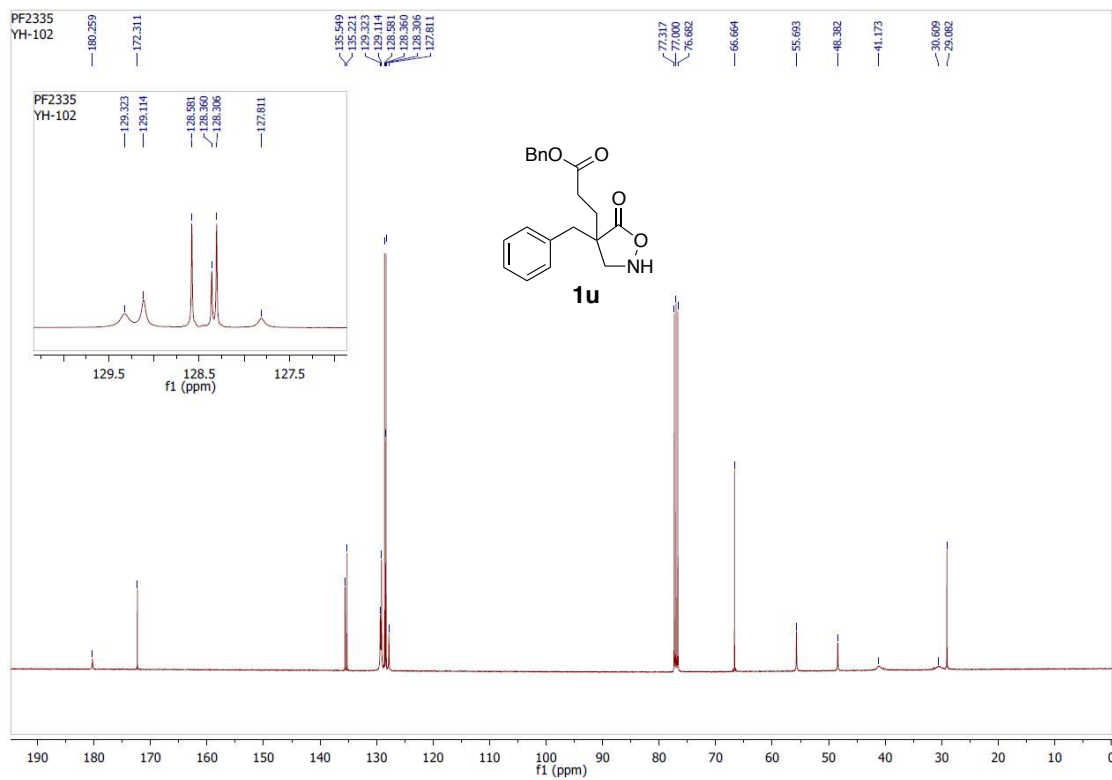


Benzyl 3-(4-benzyl-5-oxisoxazolidin-4-yl)propanoate (1u):

¹H NMR (400 MHz, CDCl₃)

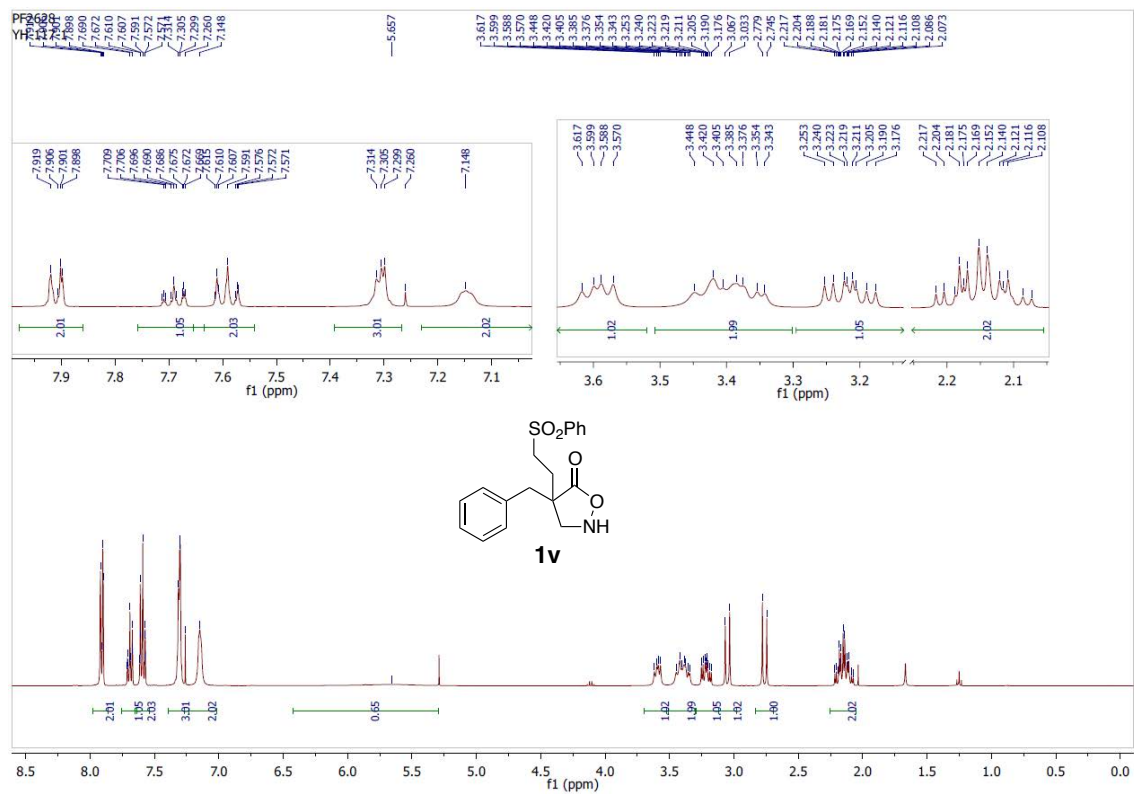


¹³C NMR (100 MHz, CDCl₃)

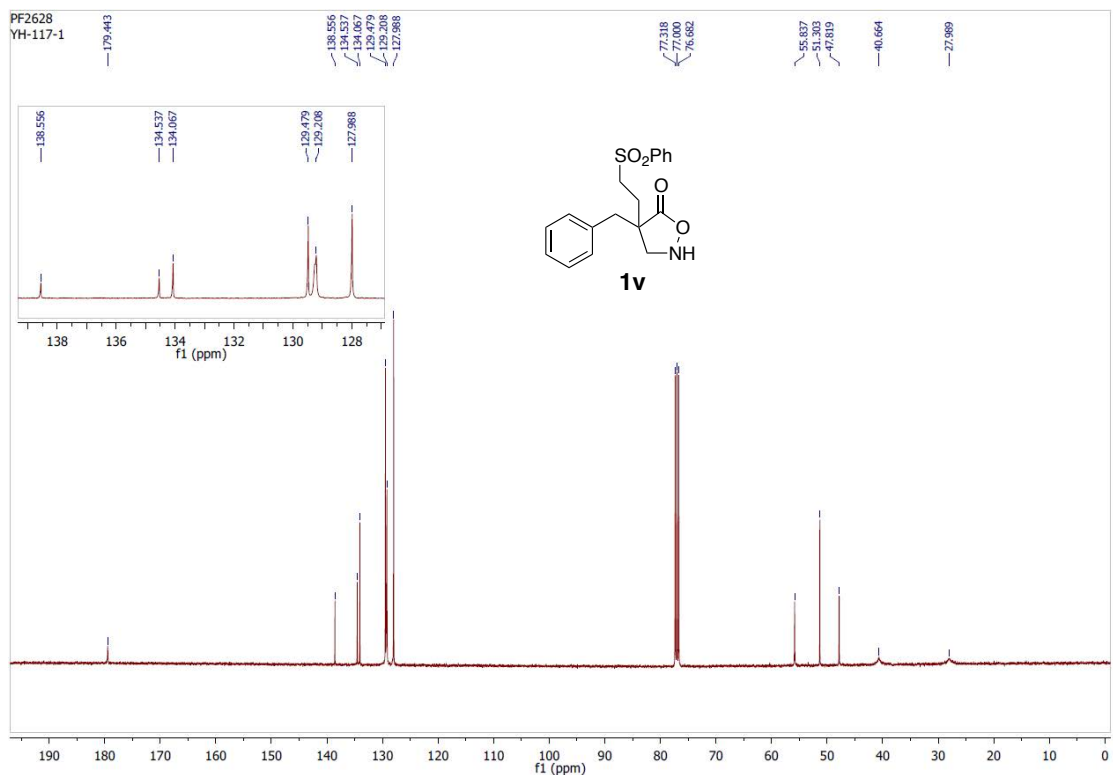


4-Benzyl-4-(2-(phenylsulfonyl)ethyl)isoxazolidin-5-one (**1v**):

¹H NMR (400 MHz, CDCl₃)

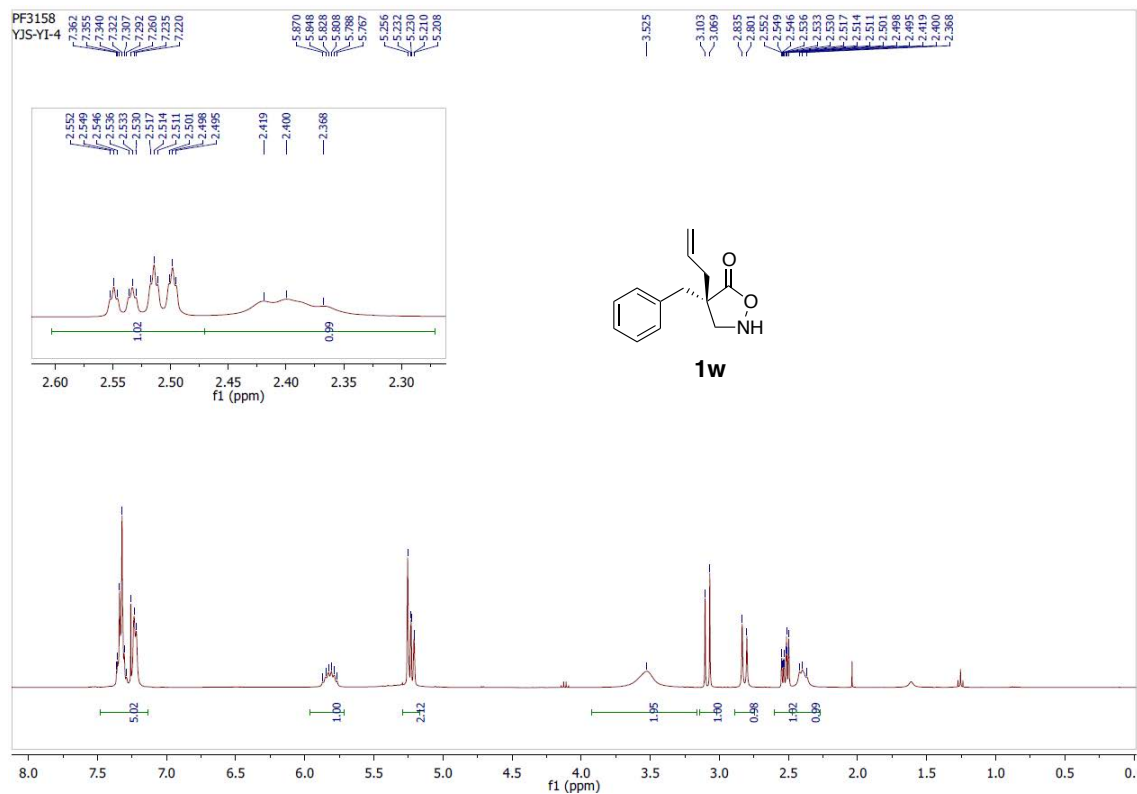


¹³C NMR (100 MHz, CDCl₃)

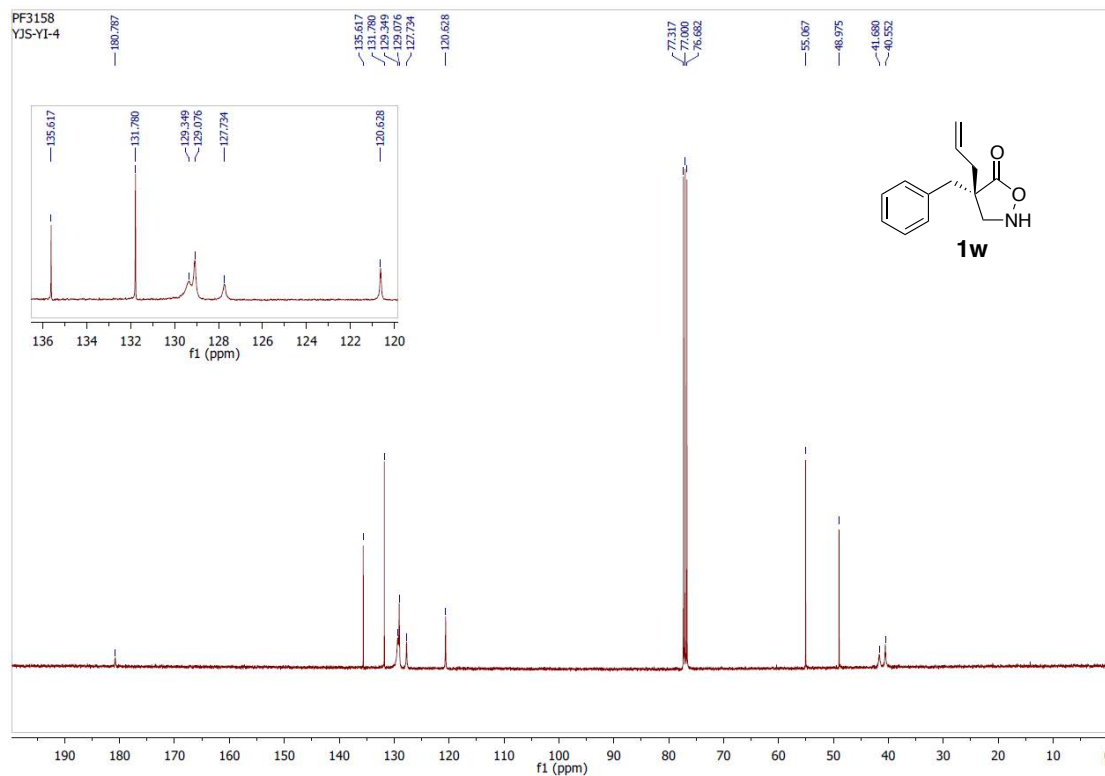


(S)-4-Allyl-4-benzylisoxazolidin-5-one (**1w**):

¹H NMR (400 MHz, CDCl₃)

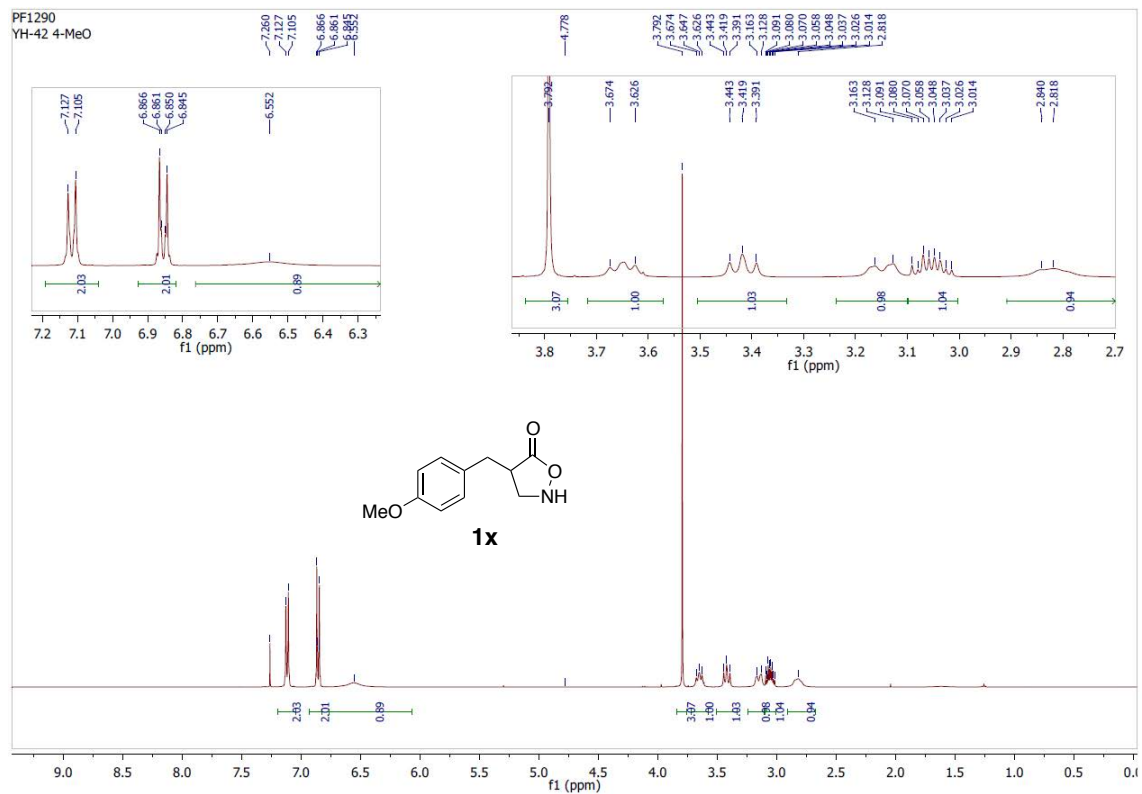


¹³C NMR (100 MHz, CDCl₃)

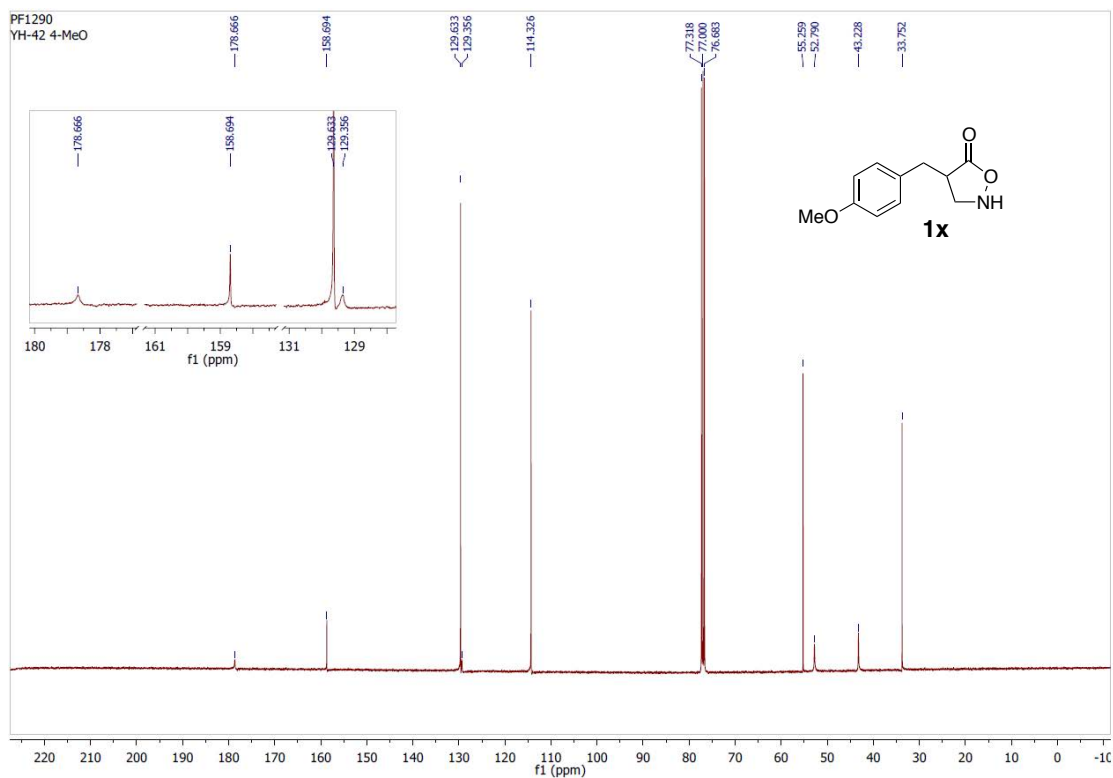


4-(4-Methoxybenzyl)isoxazolidin-5-one (1x):

¹H NMR (400 MHz, CDCl₃)

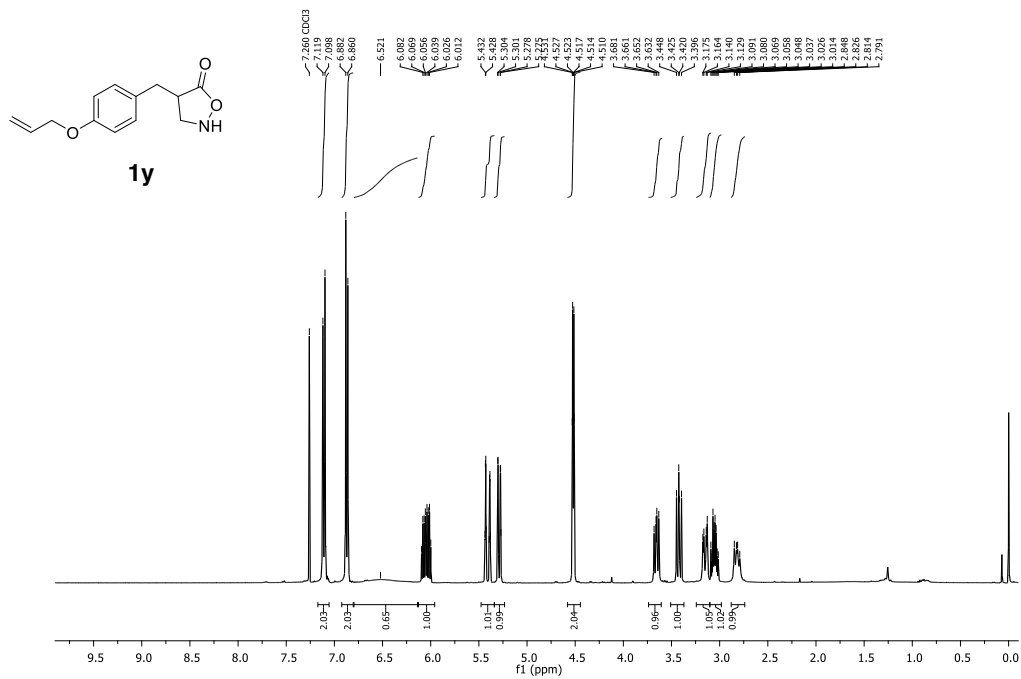


¹³C NMR (100 MHz, CDCl₃)

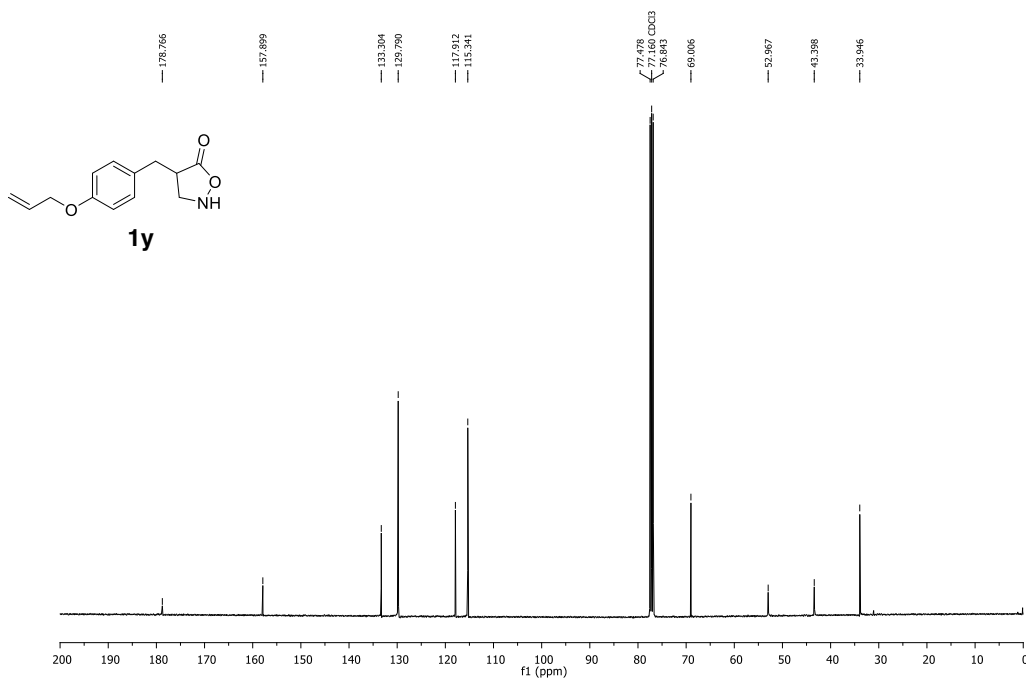


4-(4-(Allyloxy)benzyl)isoxazolidin-5-one (**1y**):

^1H NMR (400 MHz, CDCl_3)

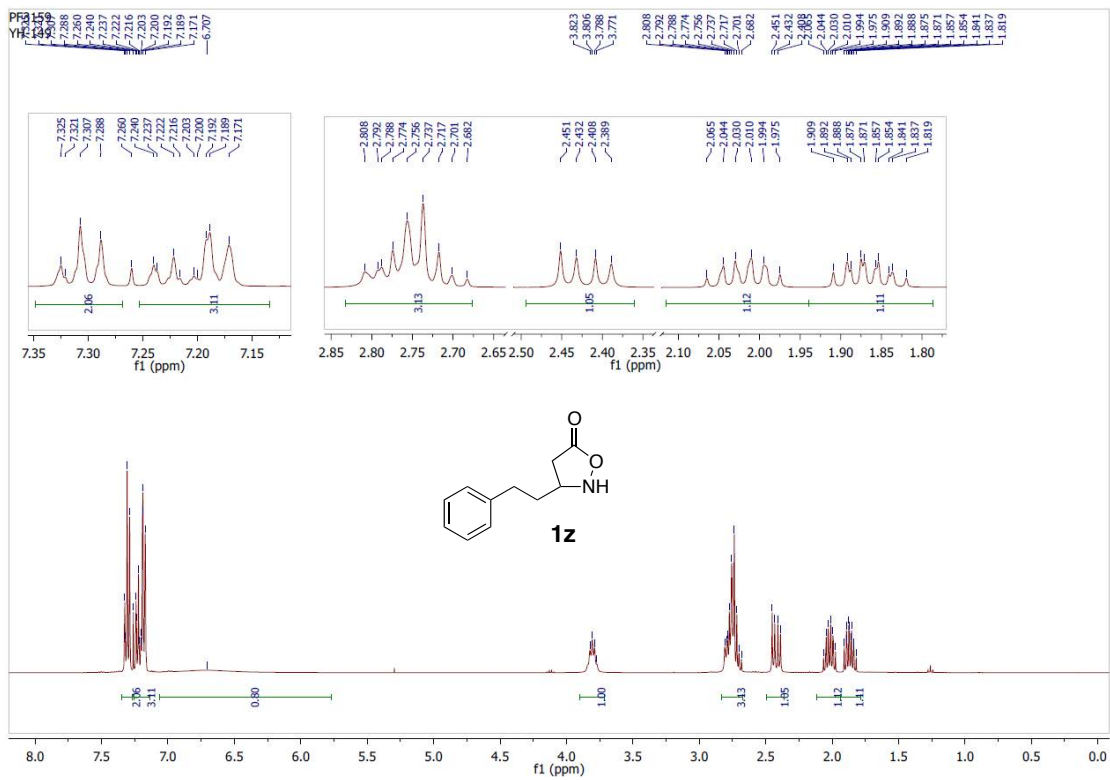


^{13}C NMR (100 MHz, CDCl_3)

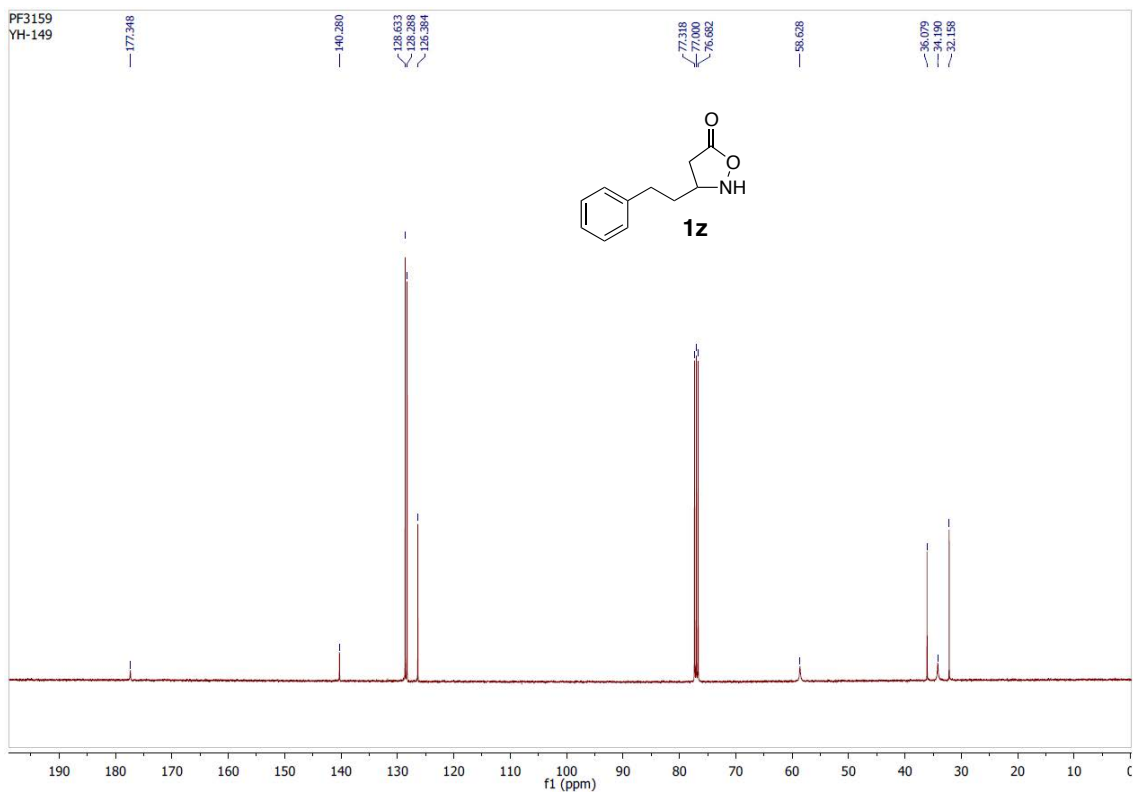


3-Phenethylisoxazolidin-5-one (**1z**):

^1H NMR (400 MHz, CDCl_3)

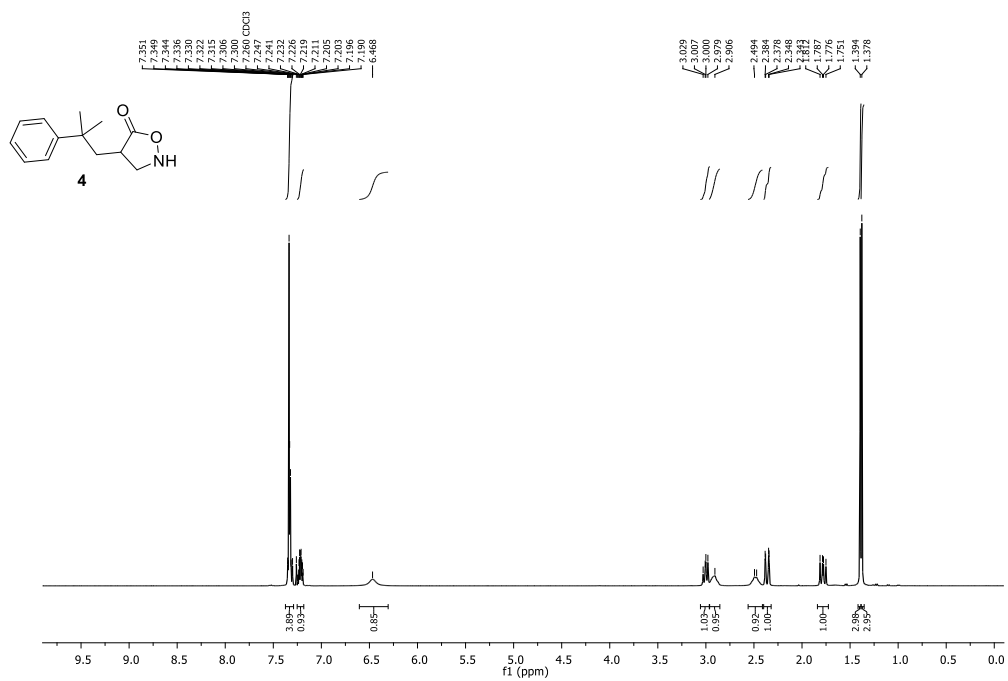


^{13}C NMR (100 MHz, CDCl_3)

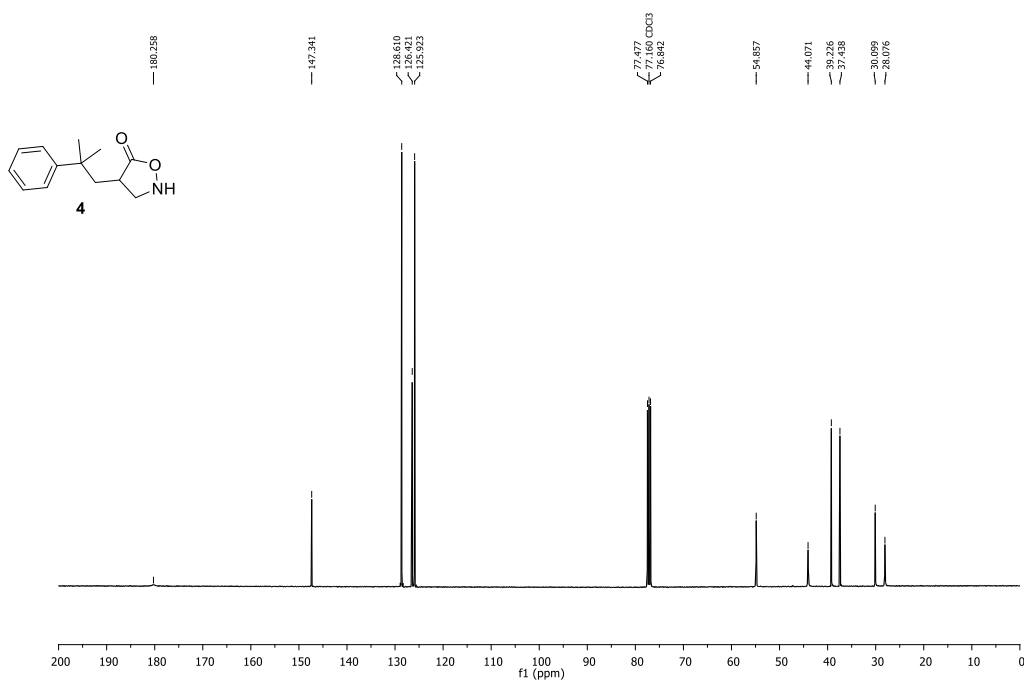


4-(2-Methyl-2-phenylpropyl)isoxazolidin-5-one (4):

^1H NMR (400 MHz, CDCl_3)

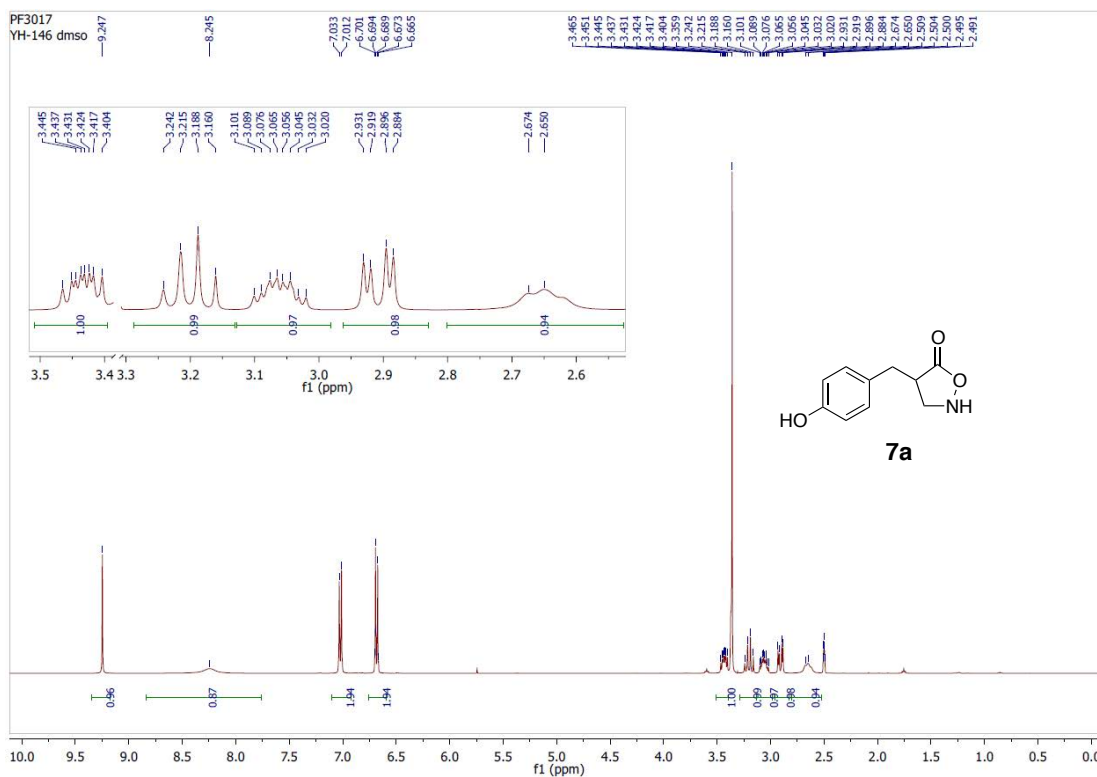


^{13}C NMR (100 MHz, CDCl_3)

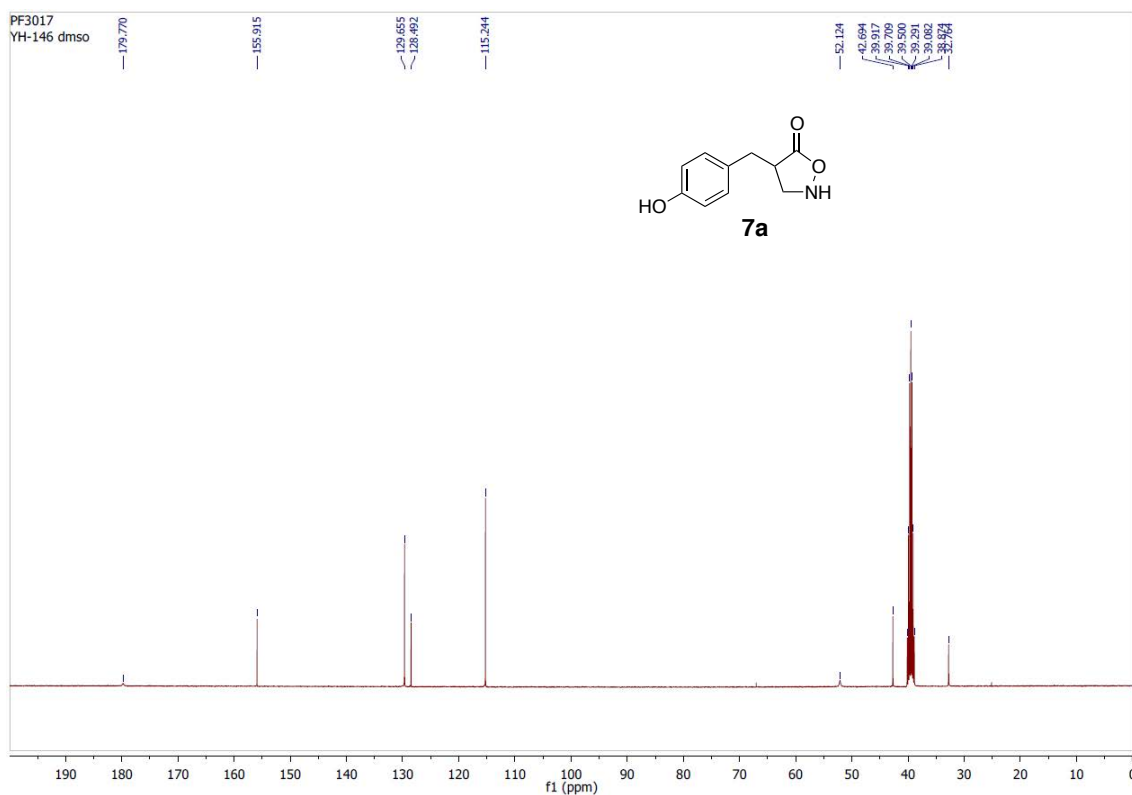


4-(4-Hydroxybenzyl)isoxazolidin-5-one (**7a**):

^1H NMR (400 MHz, $\text{DMSO-}d_6$)

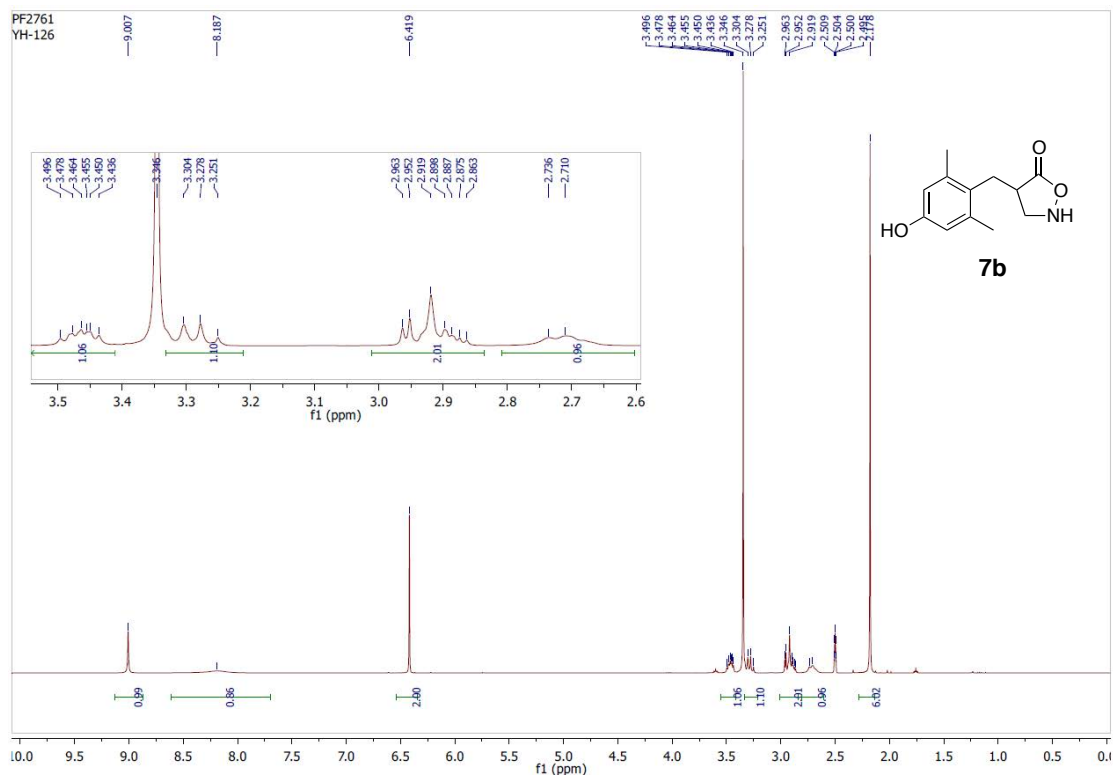


^{13}C NMR (100 MHz, $\text{DMSO-}d_6$)

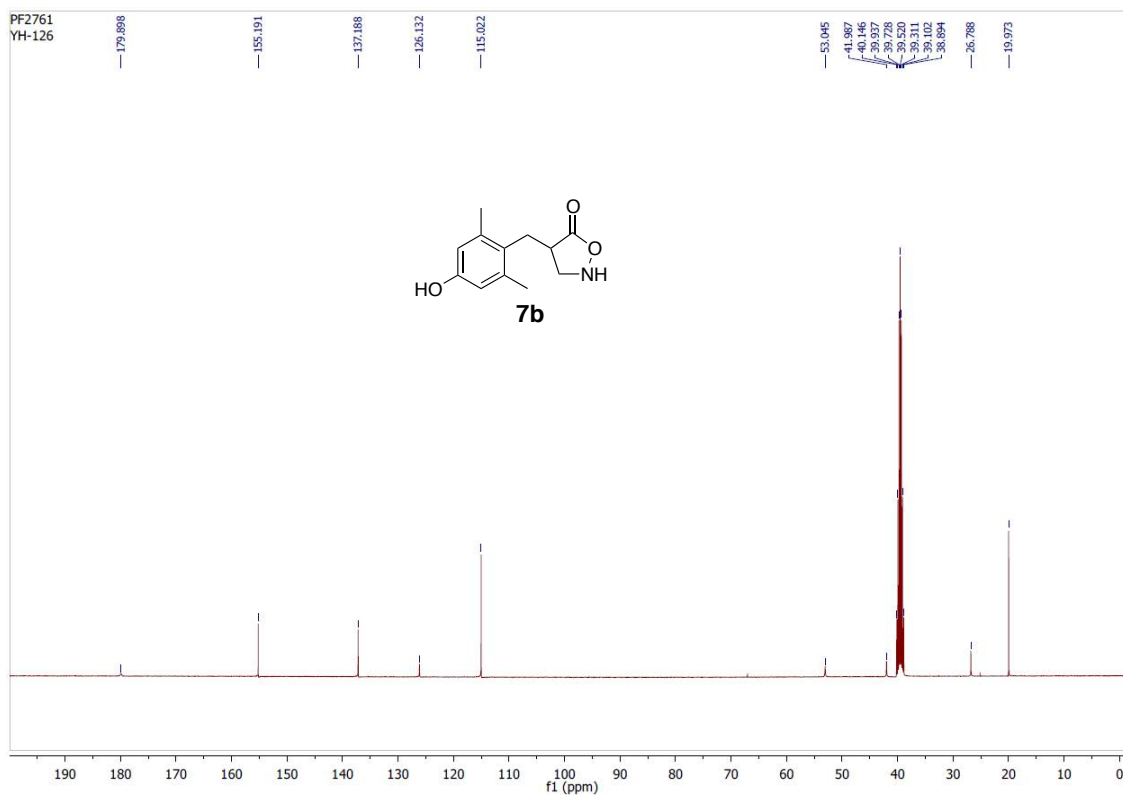


4-(4-Hydroxy-2,6-dimethylbenzyl)isoxazolidin-5-one (7b):

^1H NMR (400 MHz, $\text{DMSO-}d_6$)

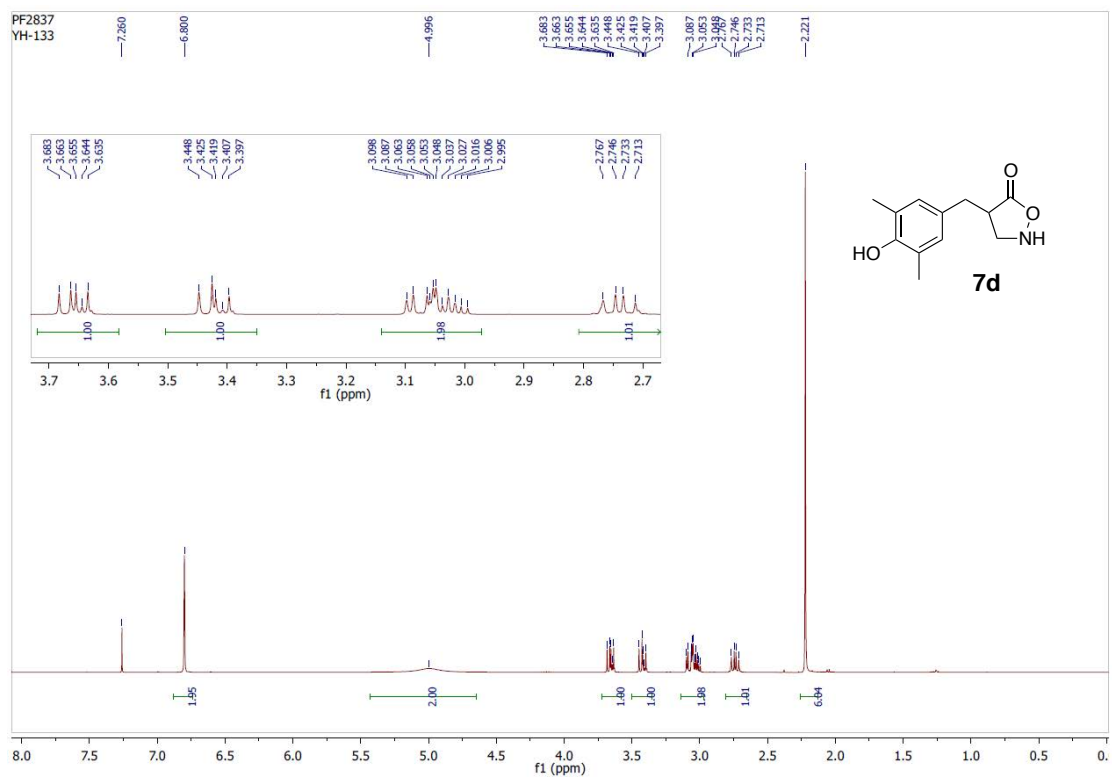


^{13}C NMR (100 MHz, $\text{DMSO-}d_6$)

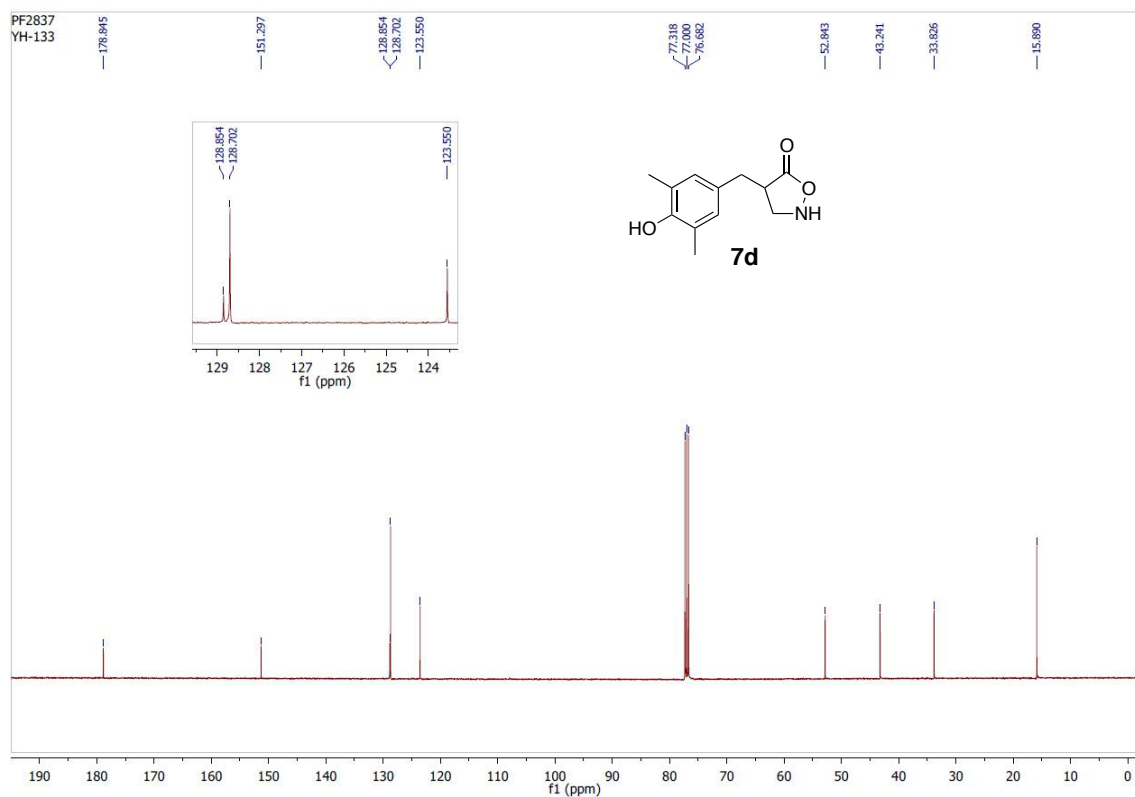


4-(4-Hydroxy-3,5-dimethylbenzyl)isoxazolidin-5-one (7d):

^1H NMR (400 MHz, CDCl_3)

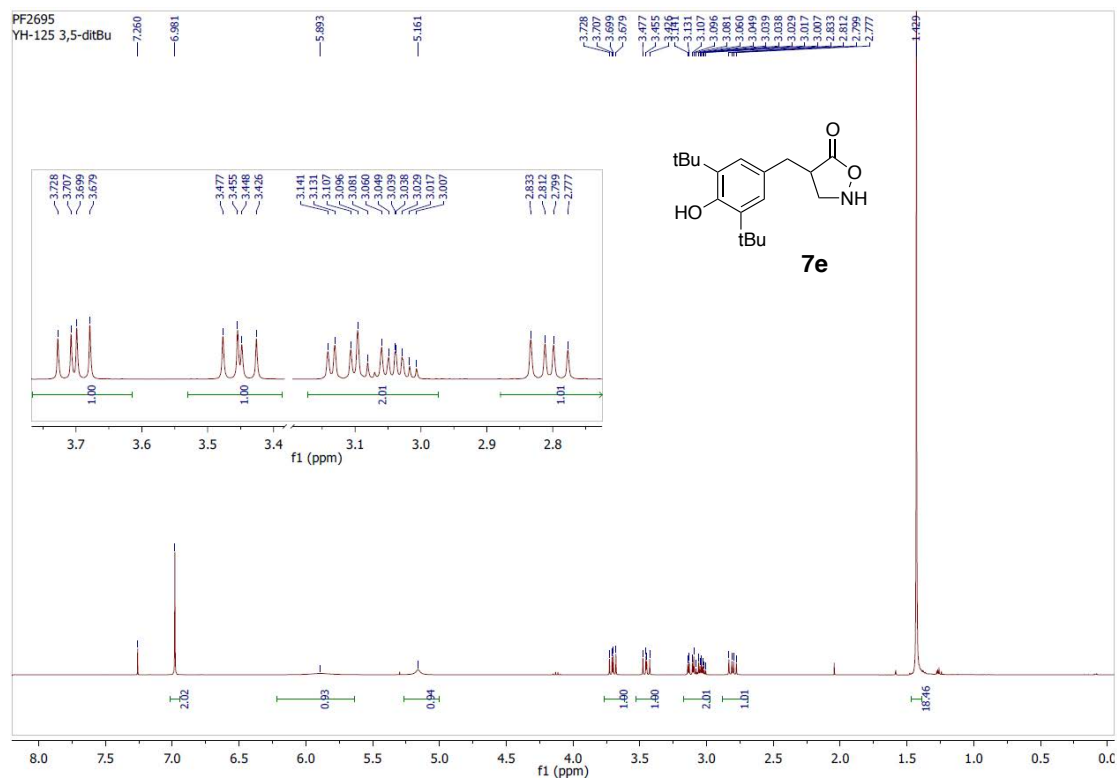


^{13}C NMR (100 MHz, CDCl_3)

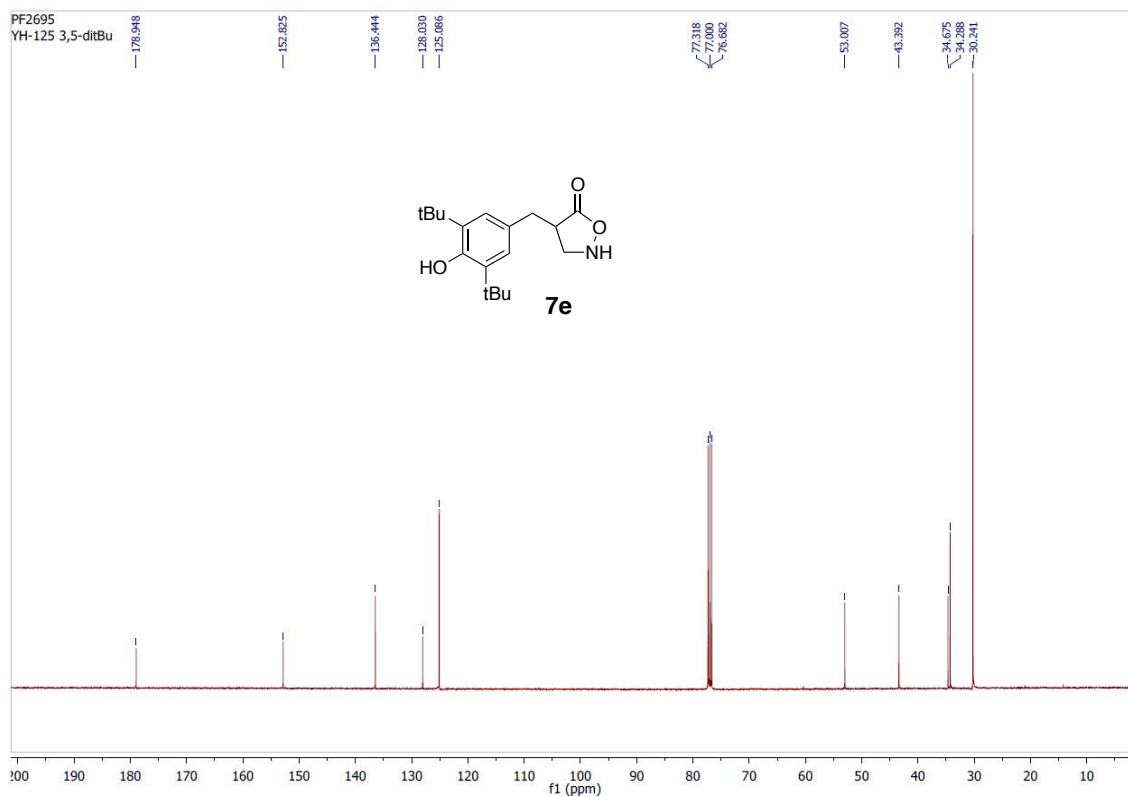


4-(3,5-Di-*tert*-butyl-4-hydroxybenzyl)isoxazolidin-5-one (**7e**):

^1H NMR (400 MHz, CDCl_3)

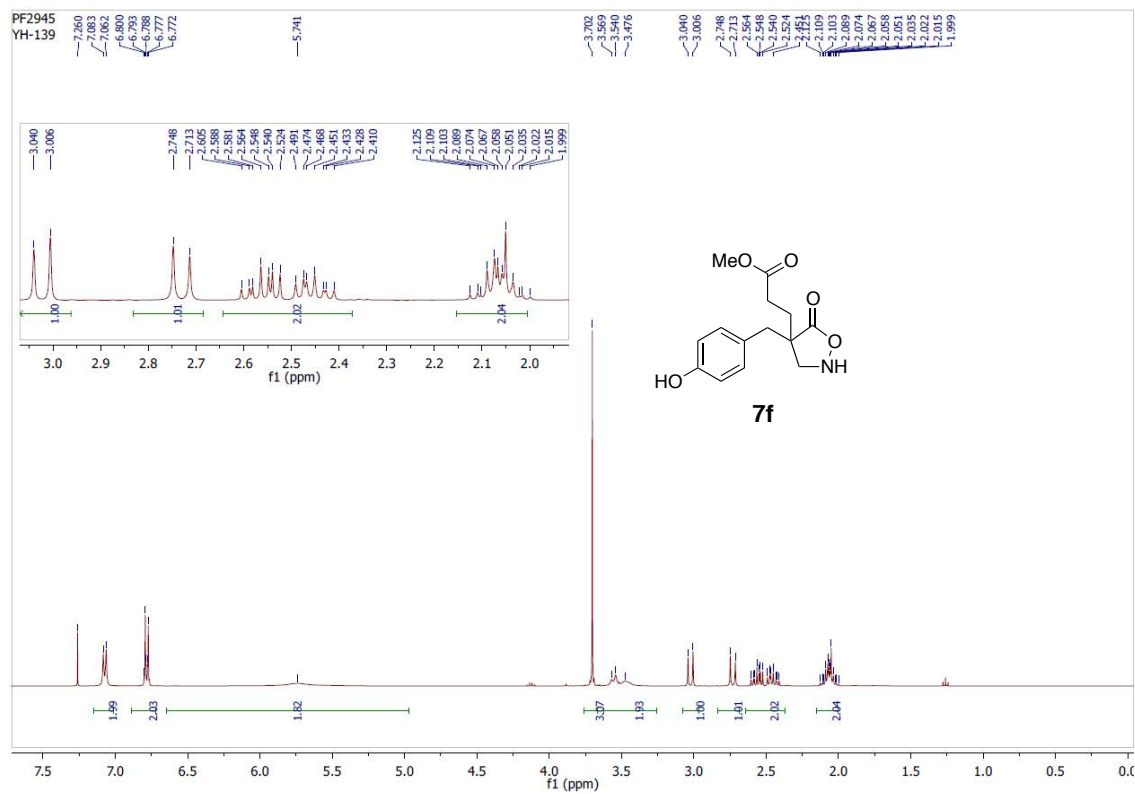


^{13}C NMR (100 MHz, CDCl_3)

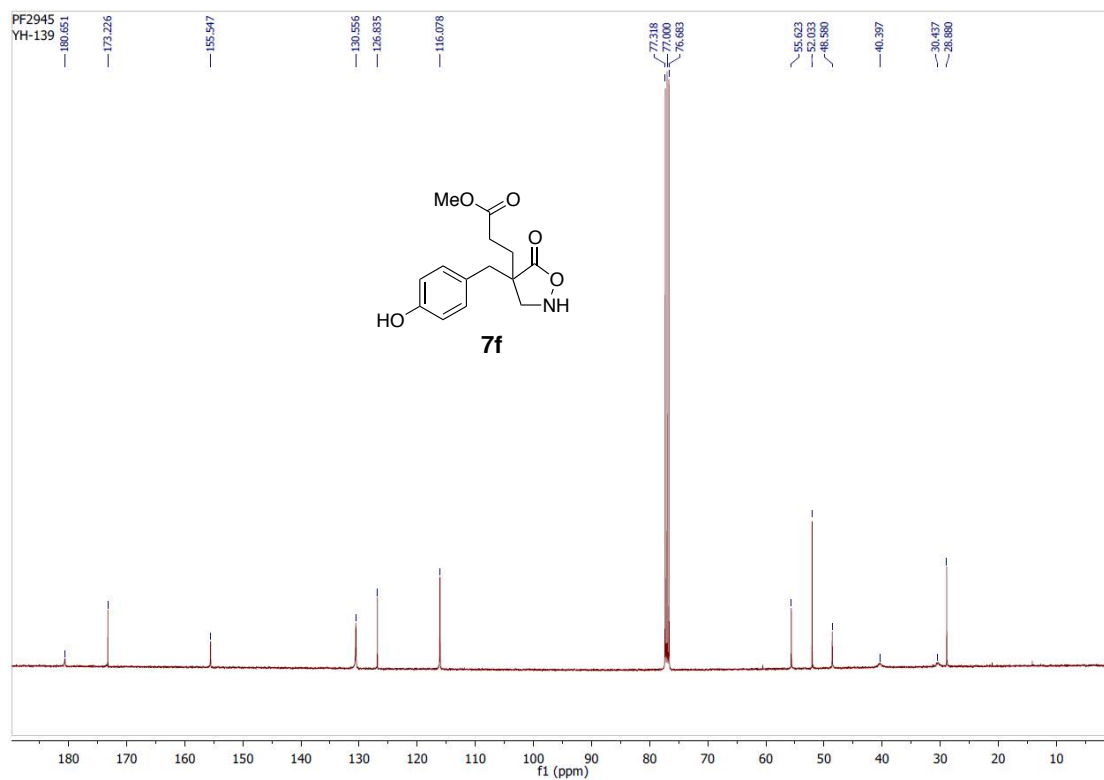


Methyl 3-(4-(4-hydroxybenzyl)-5-oxoisoxazolidin-4-yl)propanoate (7f):

^1H NMR (400 MHz, CDCl_3)

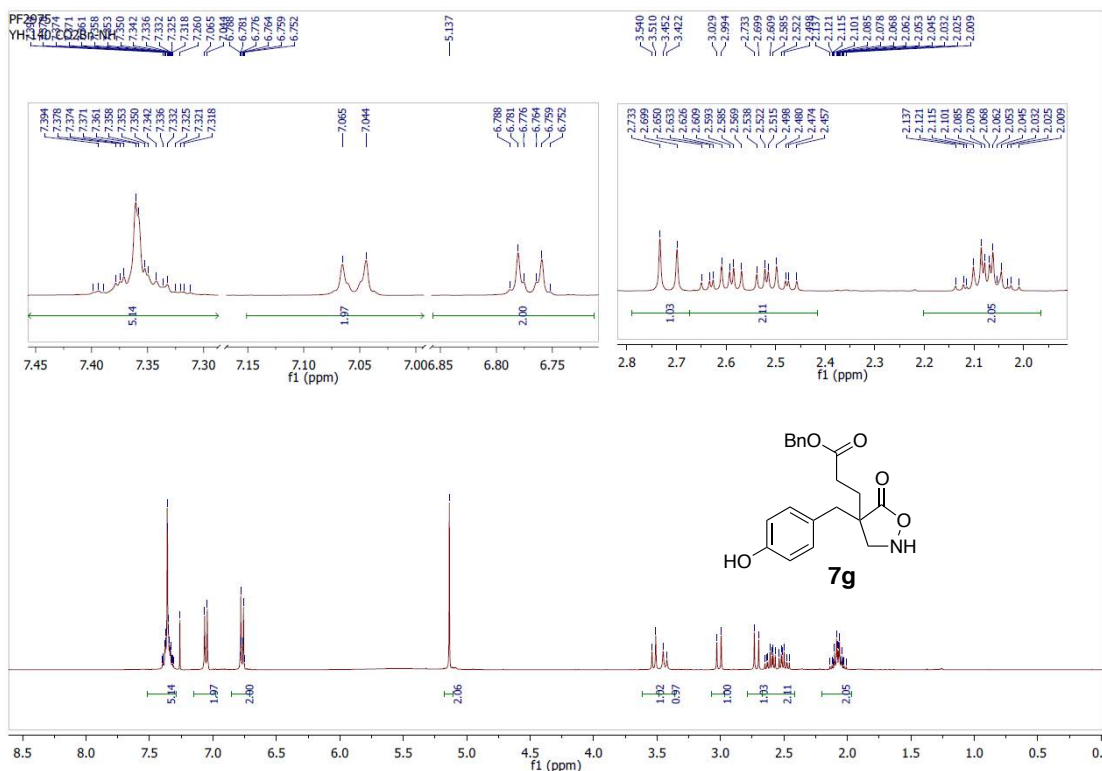


^{13}C NMR (100 MHz, CDCl_3)

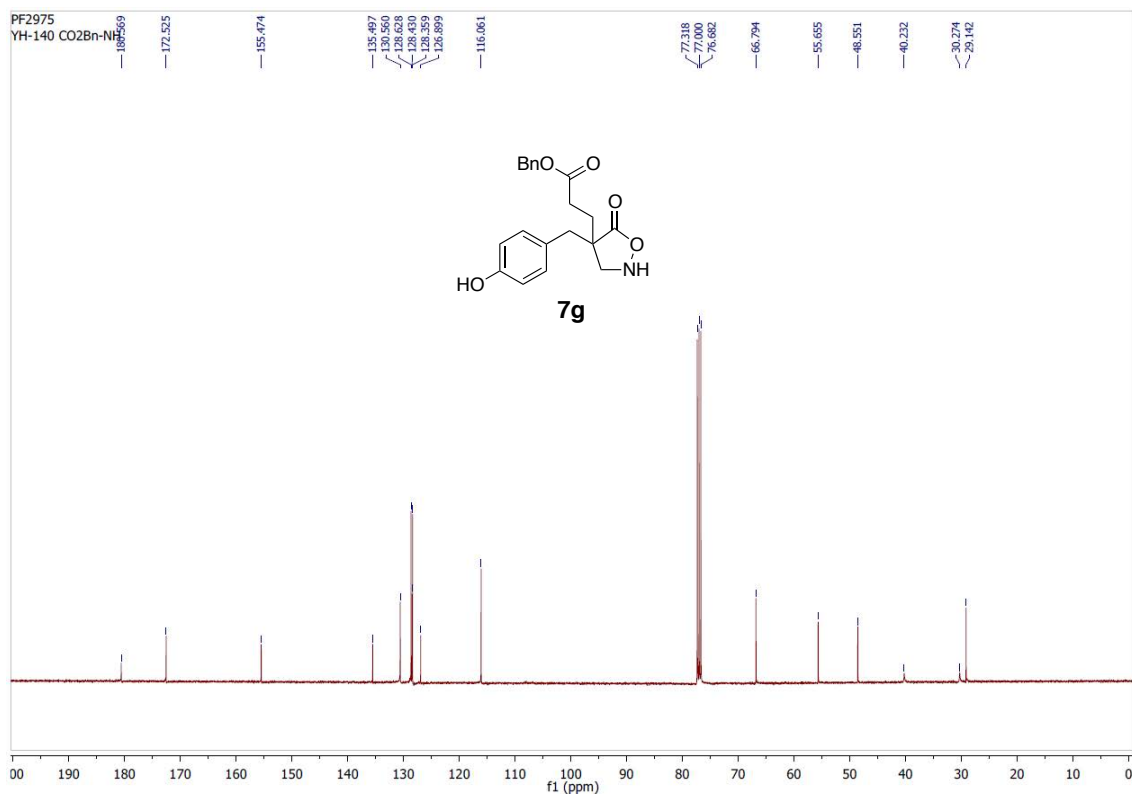


Benzyl 3-(4-(4-hydroxybenzyl)-5-oxisoxazolidin-4-yl)propanoate (7g):

^1H NMR (400 MHz, CDCl_3)

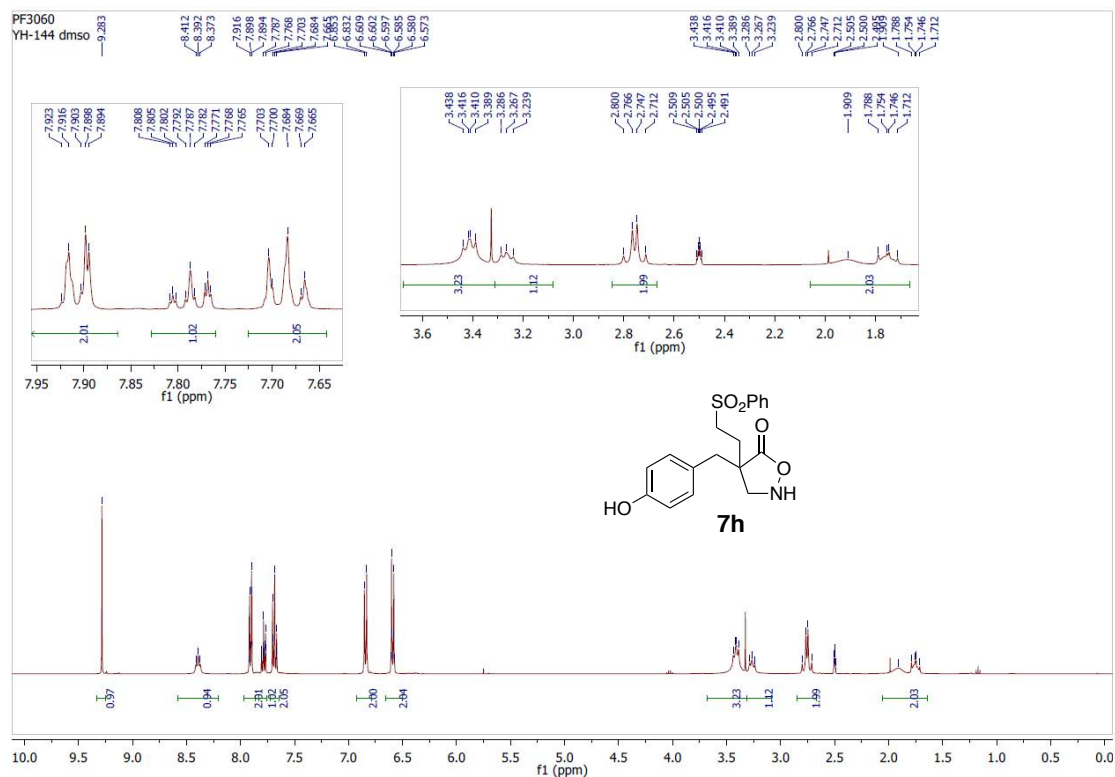


^{13}C NMR (100 MHz, CDCl_3)

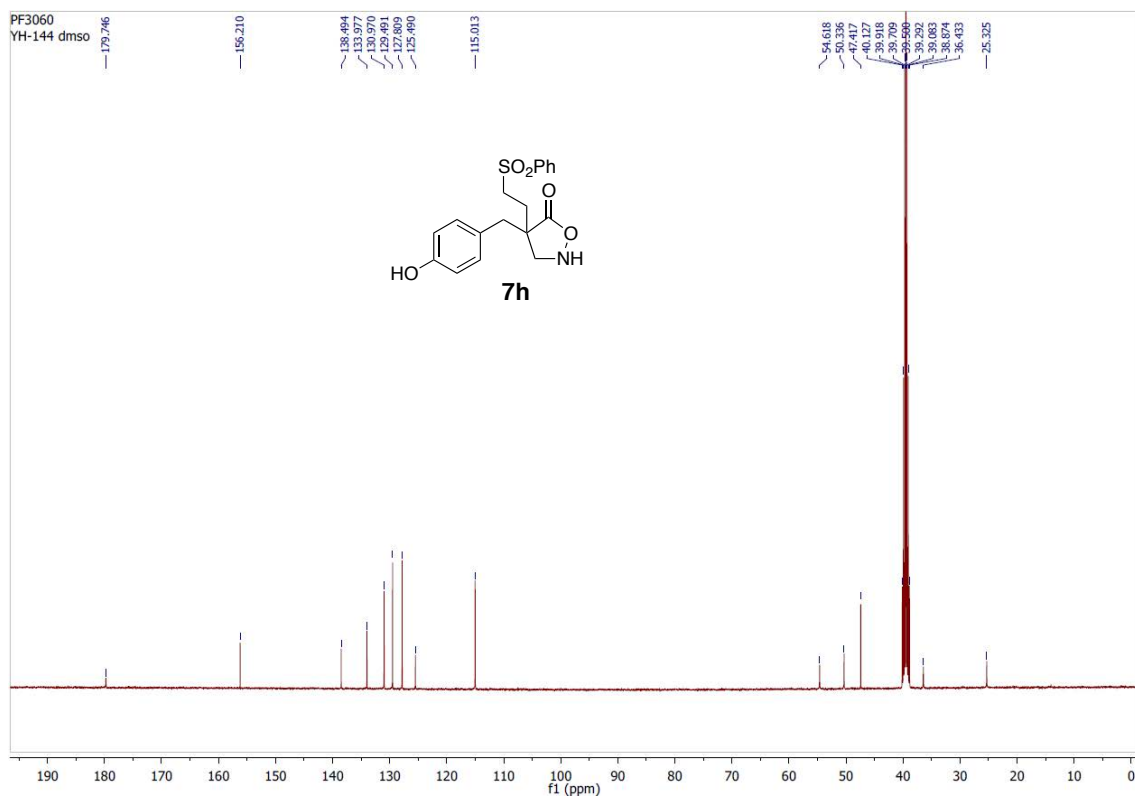


4-(4-Hydroxybenzyl)-4-(2-(phenylsulfonyl)ethyl)isoxazolidin-5-one (7h):

¹H NMR (400 MHz, DMSO-*d*₆)

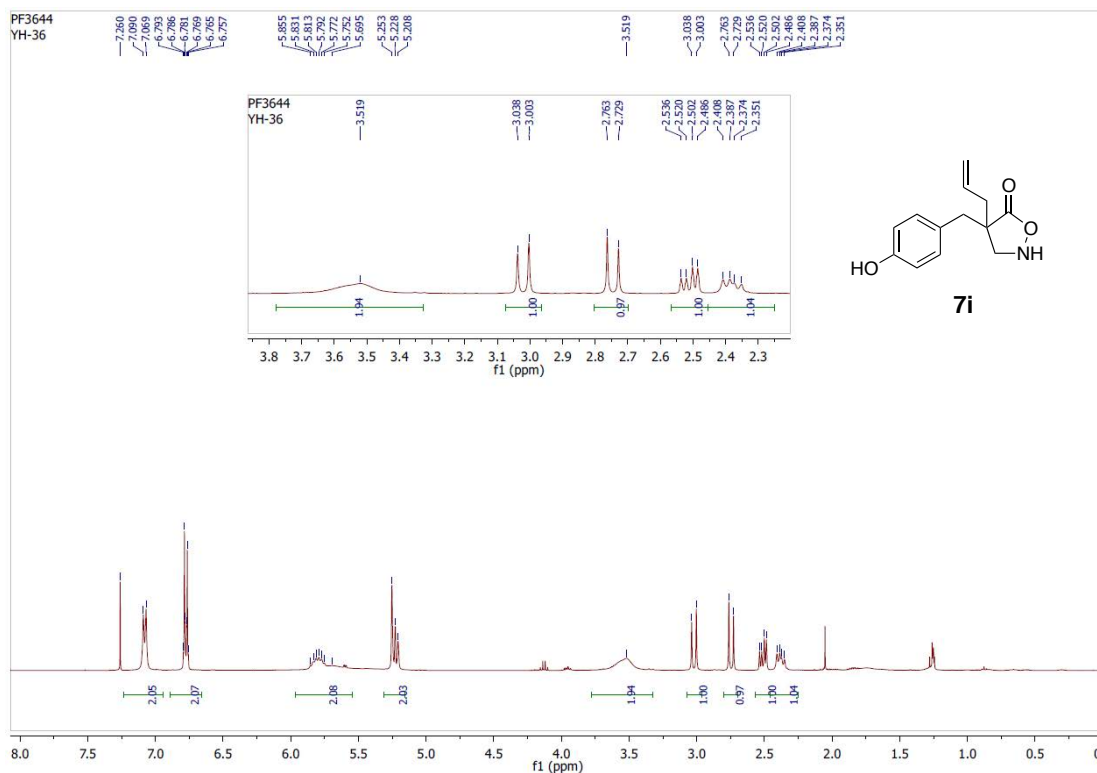


¹³C NMR (100 MHz, DMSO-*d*₆)

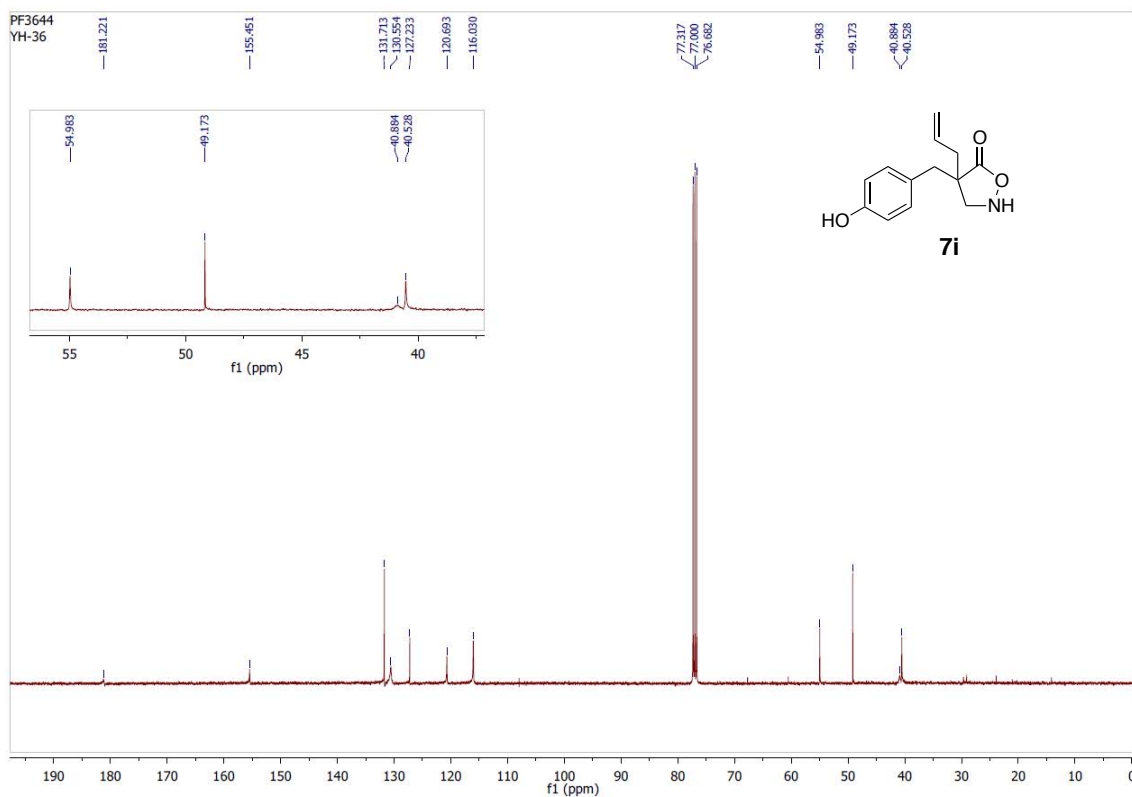


4-Allyl-4-(4-hydroxybenzyl)isoxazolidin-5-one (**7i**):

^1H NMR (400 MHz, CDCl_3)

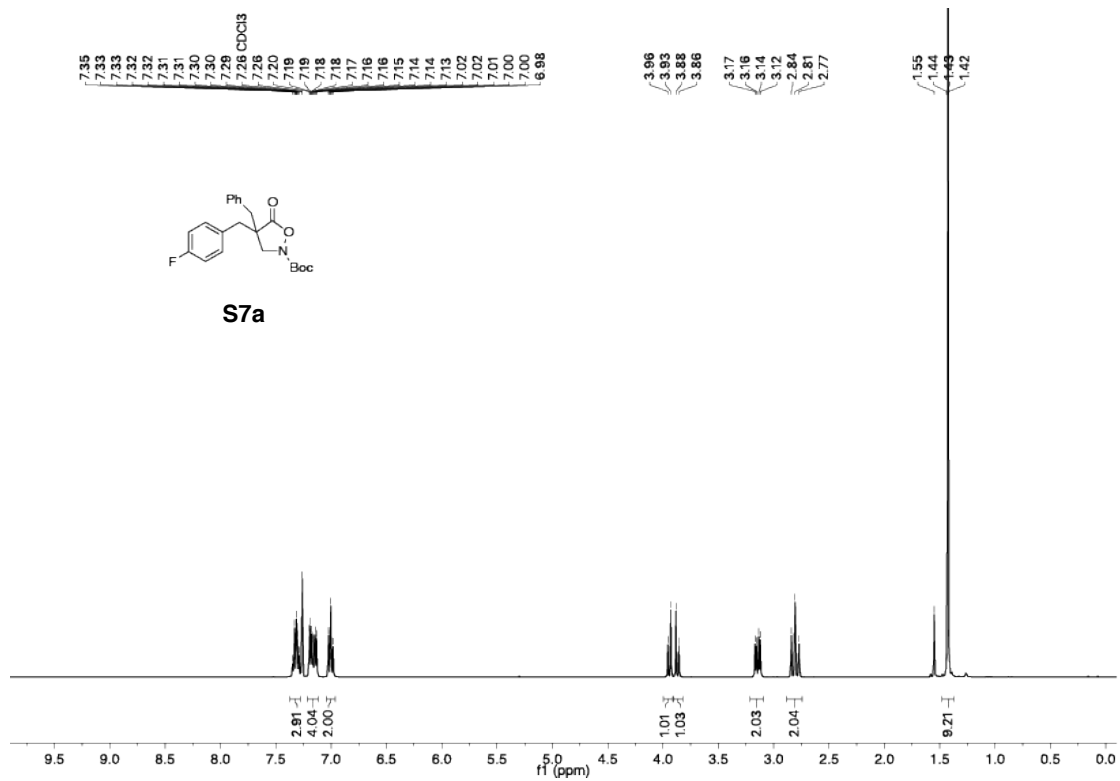


^{13}C NMR (100 MHz, CDCl_3)

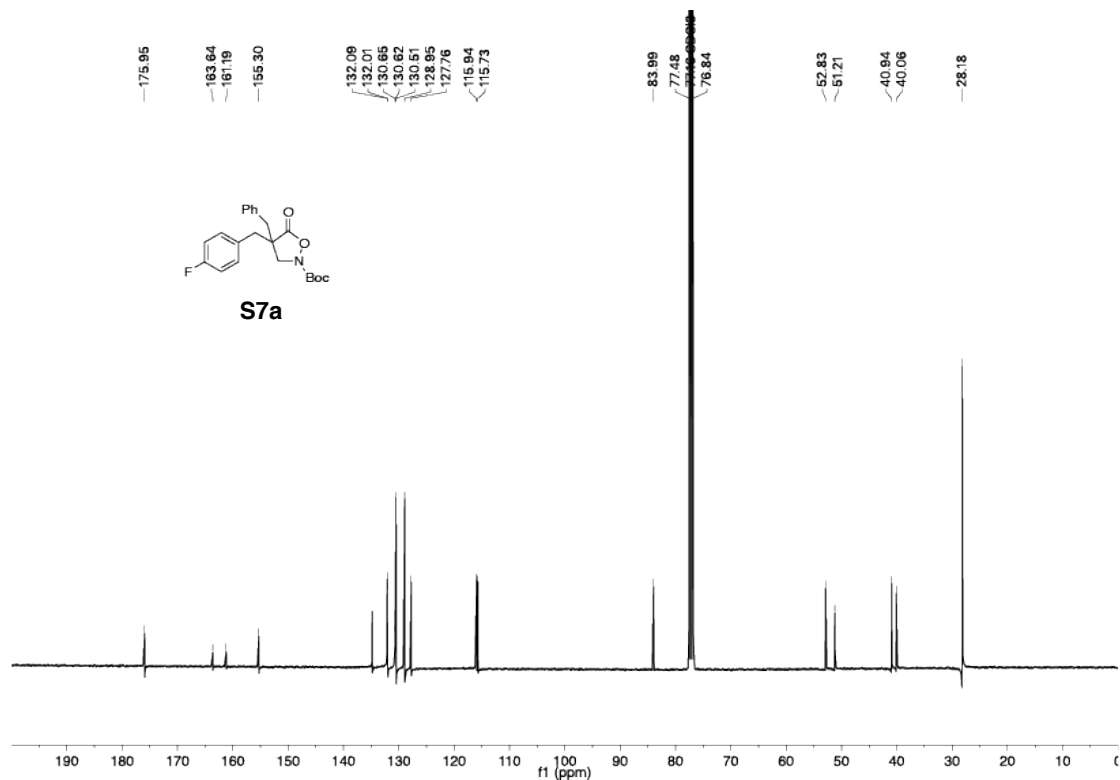


***tert*-Butyl 4-benzyl-4-(4-fluorobenzyl)-5-oxoisoxazolidine-2-carboxylate (S7a):**

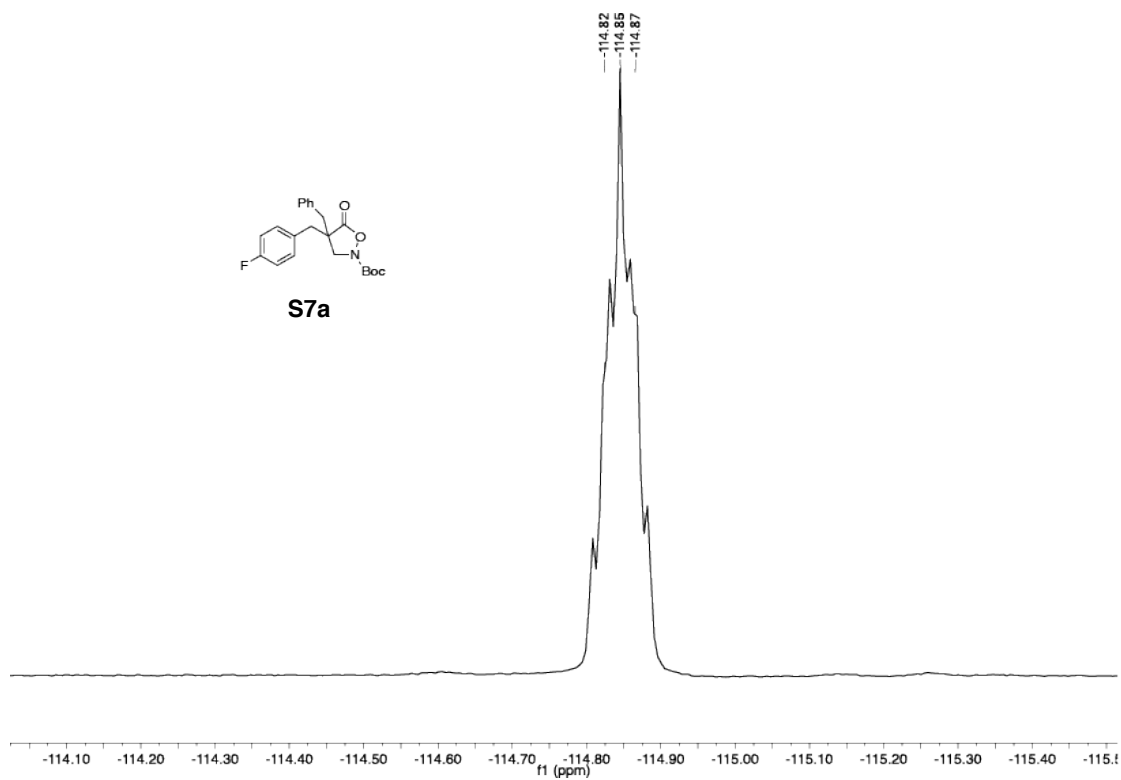
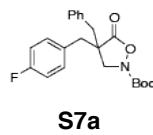
¹H NMR (400 MHz, CDCl₃)



¹³C NMR (100 MHz, CDCl₃)

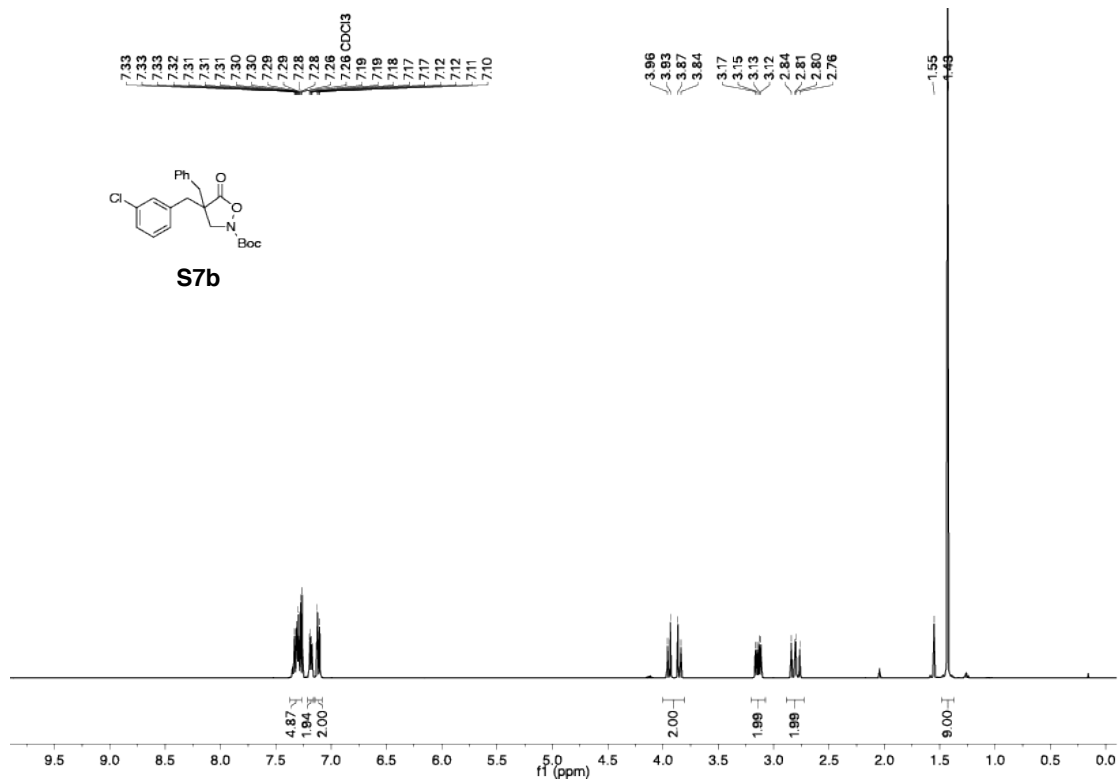


^{19}F NMR (376 MHz, CDCl_3)

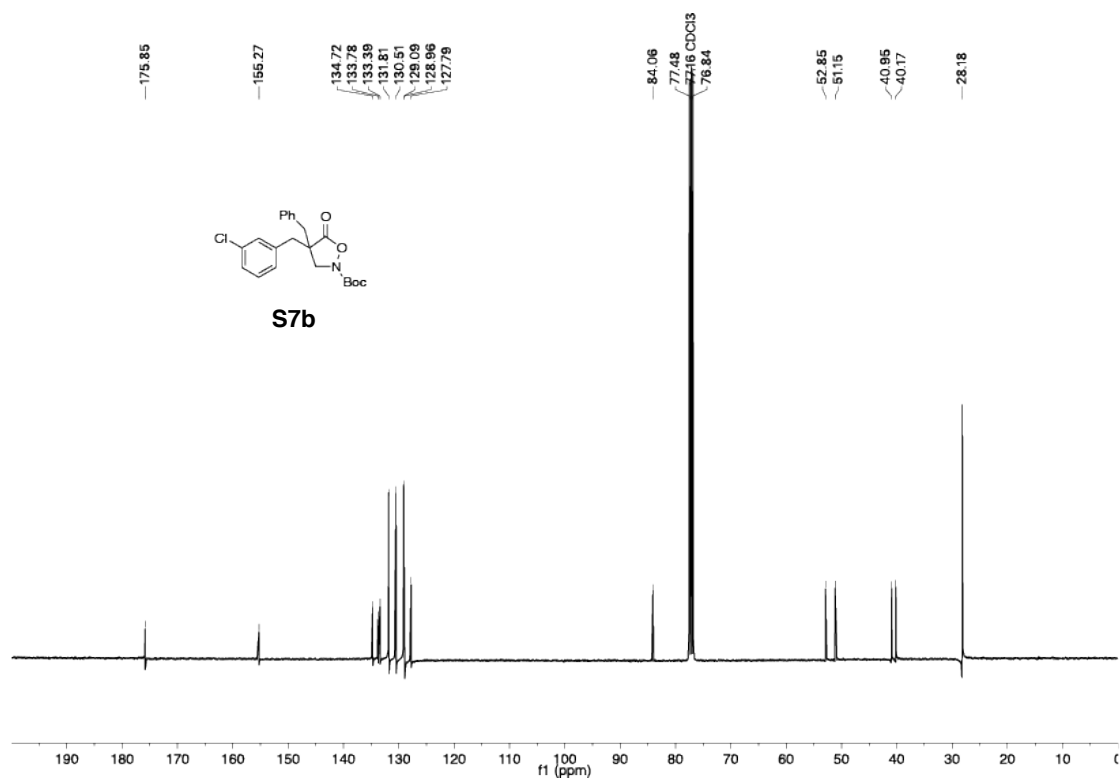


tert-Butyl 4-benzyl-4-(4-chlorobenzyl)-5-oxoisoxazolidine-2-carboxylate (S7b):

¹H NMR (400 MHz, CDCl₃)

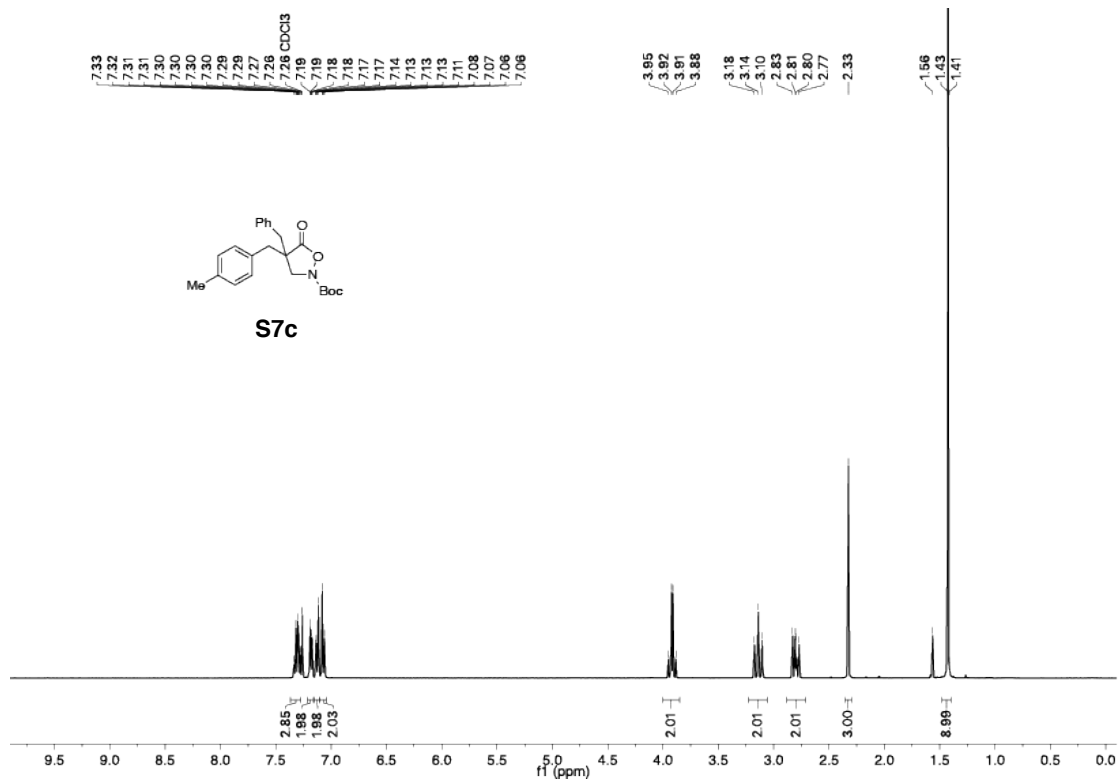


¹³C NMR (100 MHz, CDCl₃)

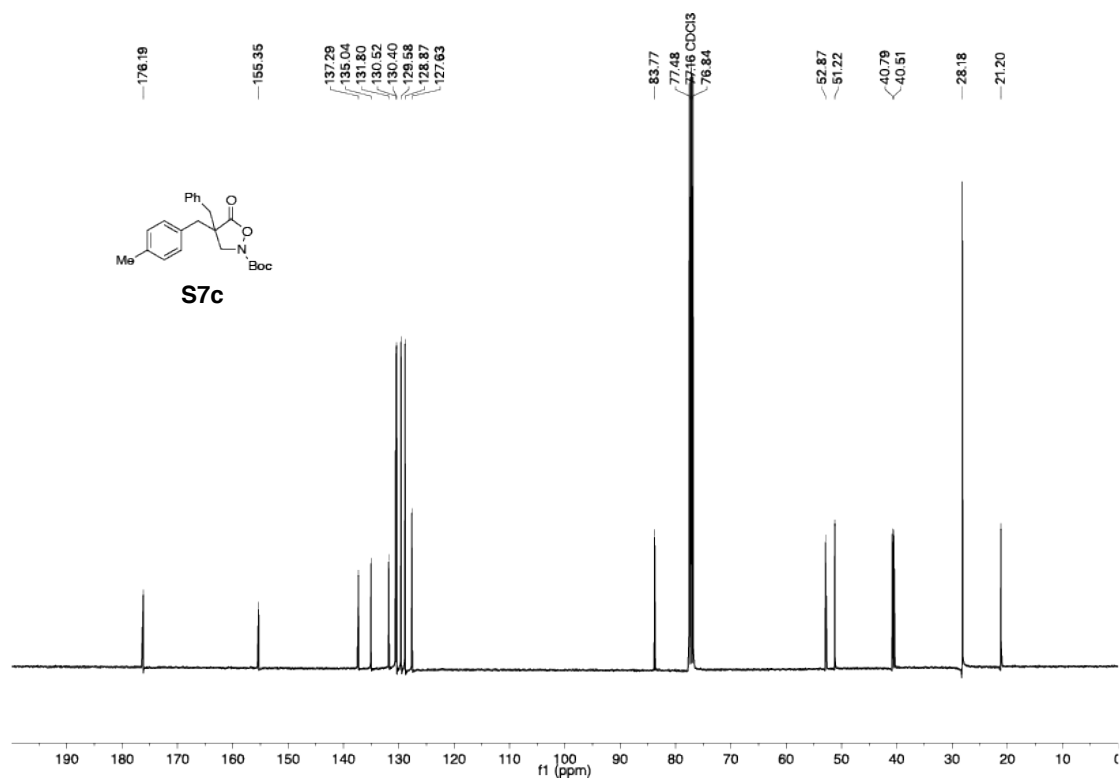


tert-Butyl 4-benzyl-4-(4-methylbenzyl)-5-oxoisoxazolidine-2-carboxylate (S7c):

¹H NMR (400 MHz, CDCl₃)

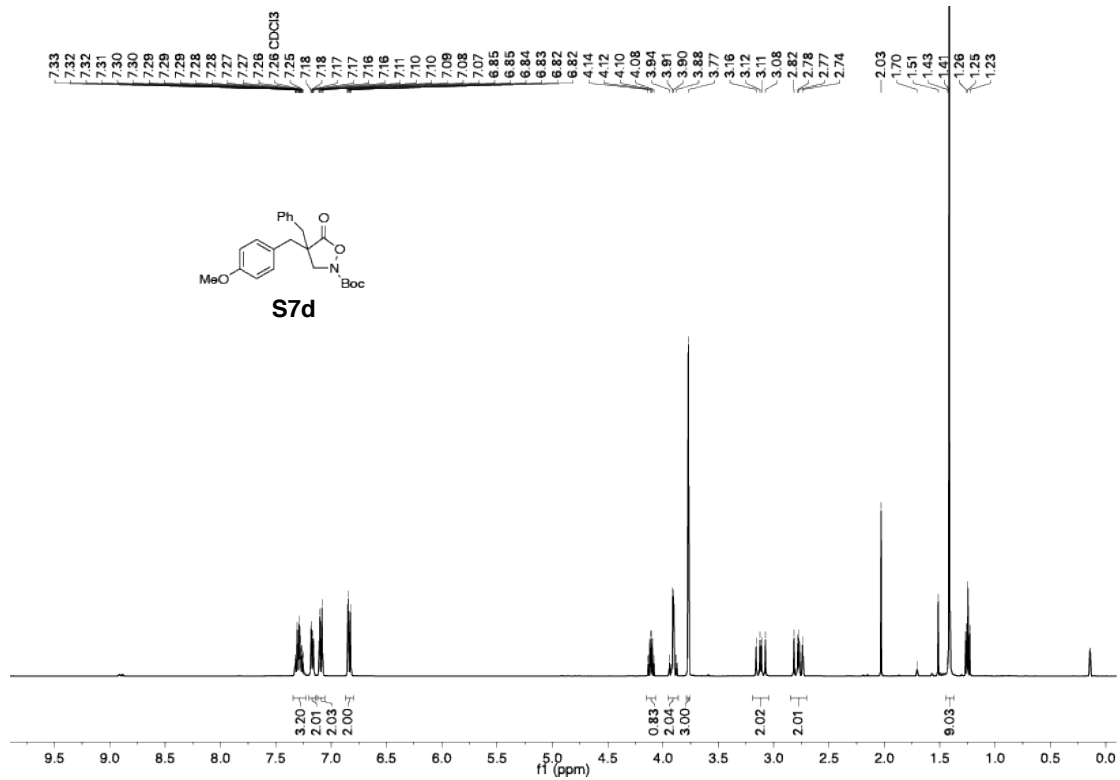


¹³C NMR (100 MHz, CDCl₃)

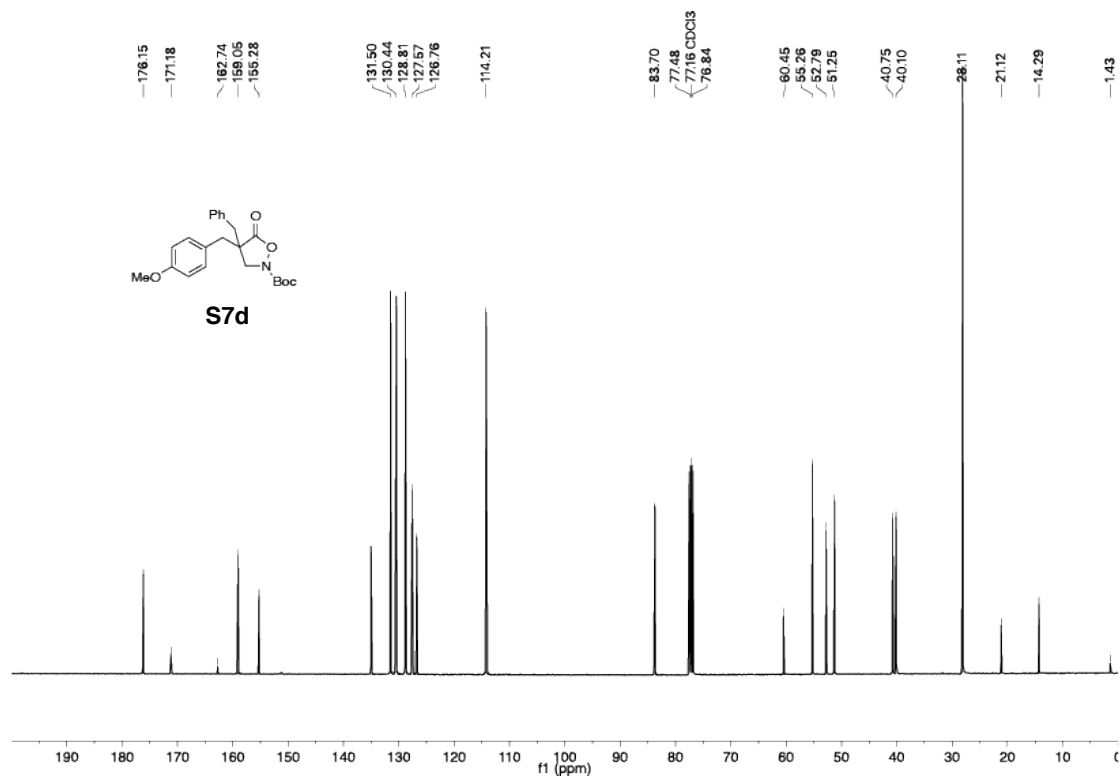


tert-Butyl 4-benzyl-4-(4-methoxybenzyl)-5-oxoisoxazolidine-2-carboxylate (S7d):

¹H NMR (400 MHz, CDCl₃)

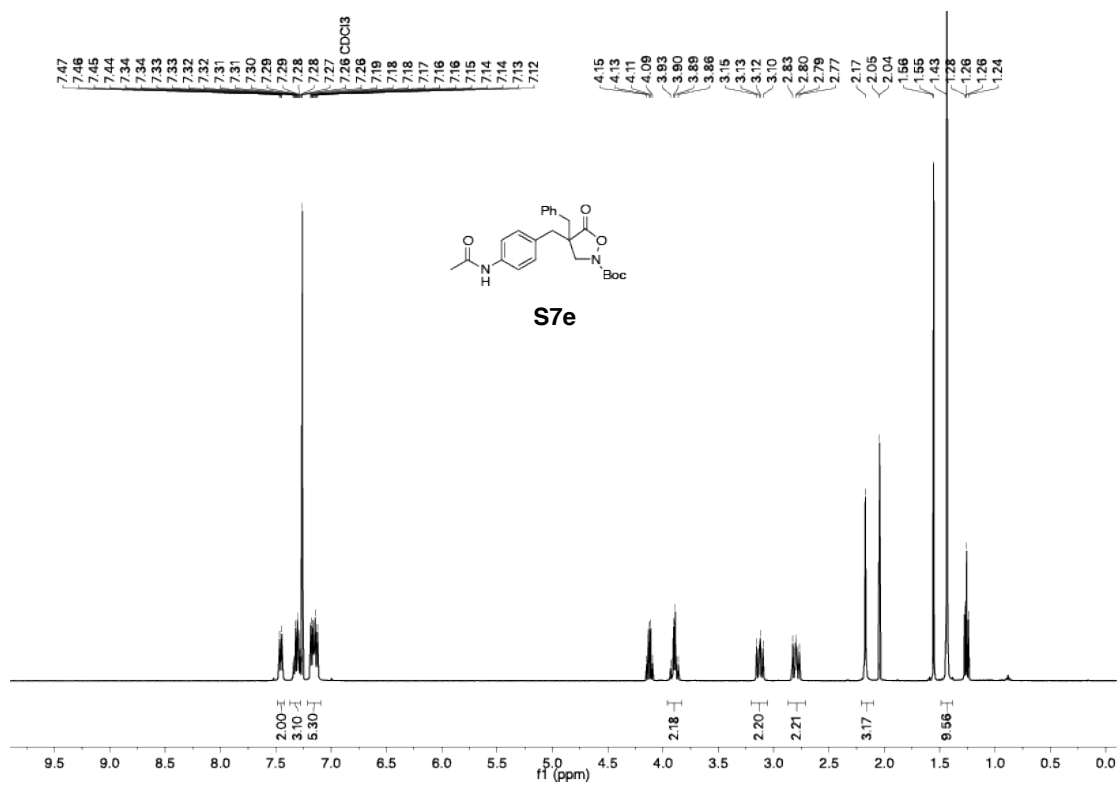


¹³C NMR (100 MHz, CDCl₃)

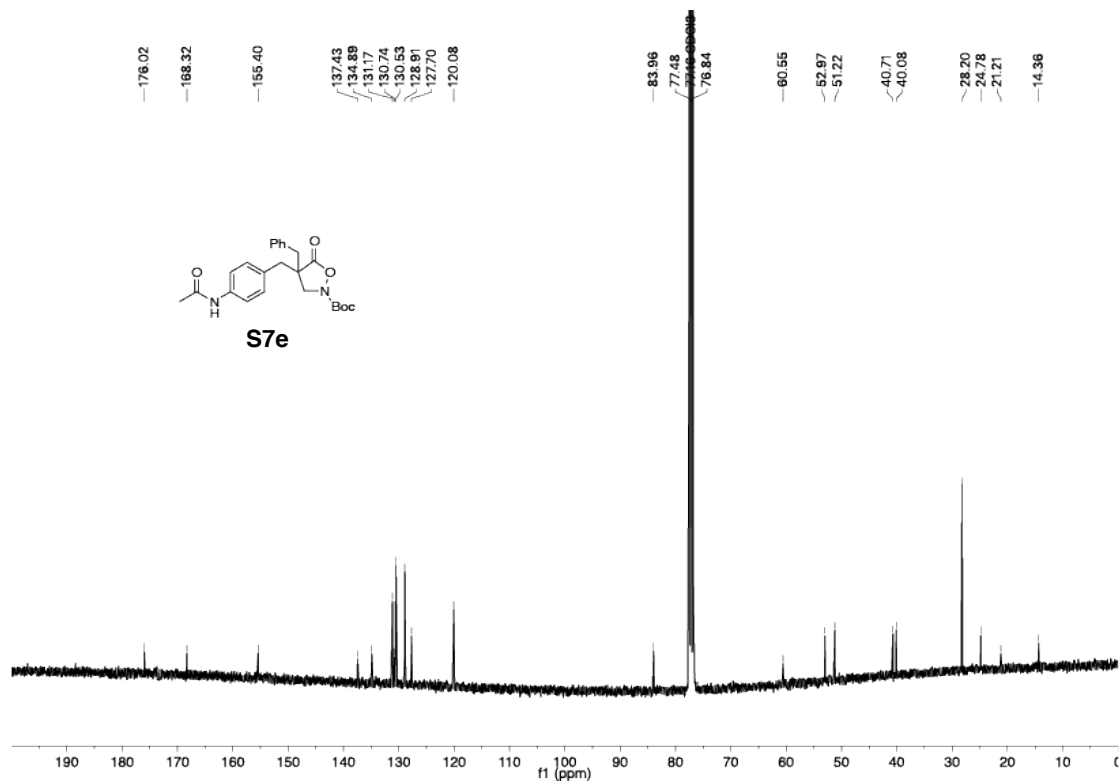


tert-Butyl 4-(4-acetamidobenzyl)-4-benzyl-5-oxoisoxazolidine-2-carboxylate (S7e):

¹H NMR (400 MHz, CDCl₃)

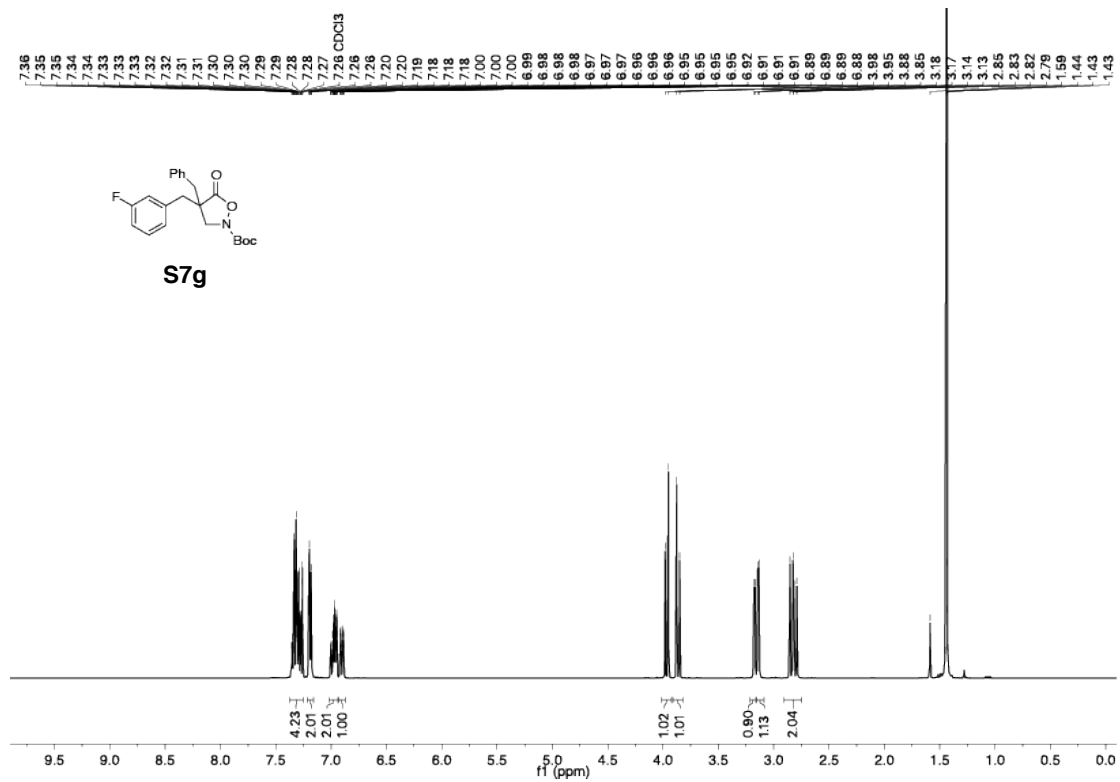


¹³C NMR (100 MHz, CDCl₃)

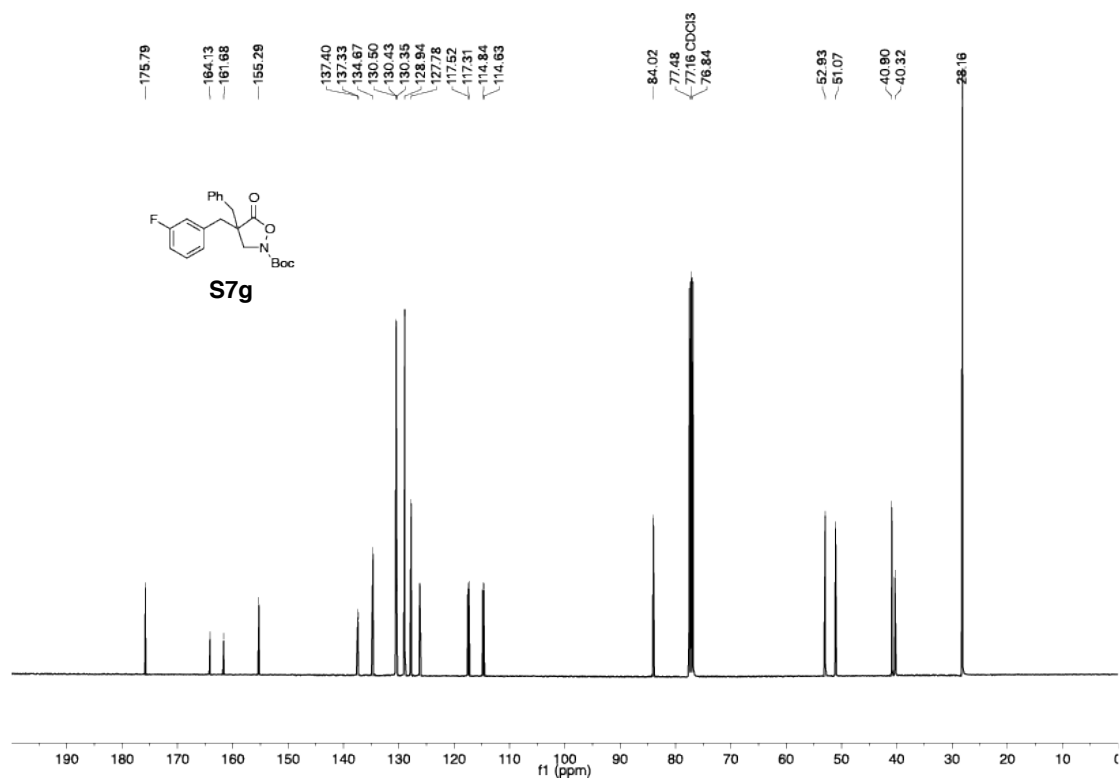


tert-Butyl 4-benzyl-4-(3-fluorobenzyl)-5-oxoisoxazolidine-2-carboxylate (S7g):

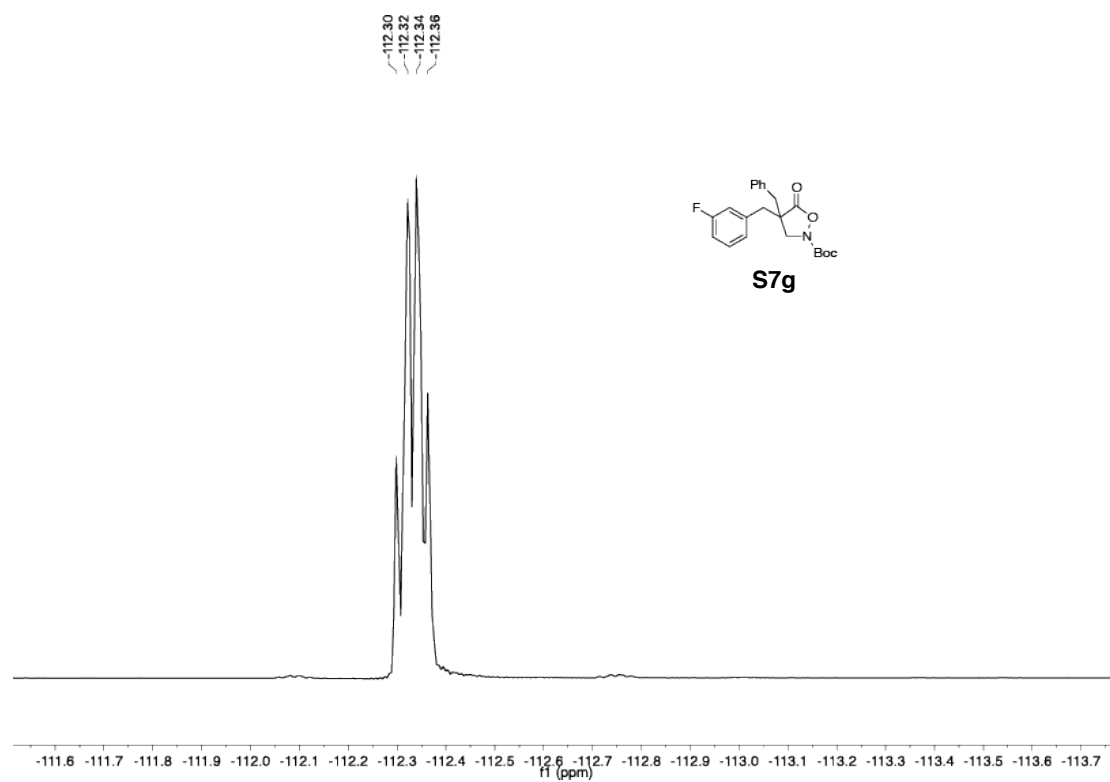
¹H NMR (400 MHz, CDCl₃)



¹³C NMR (100 MHz, CDCl₃)

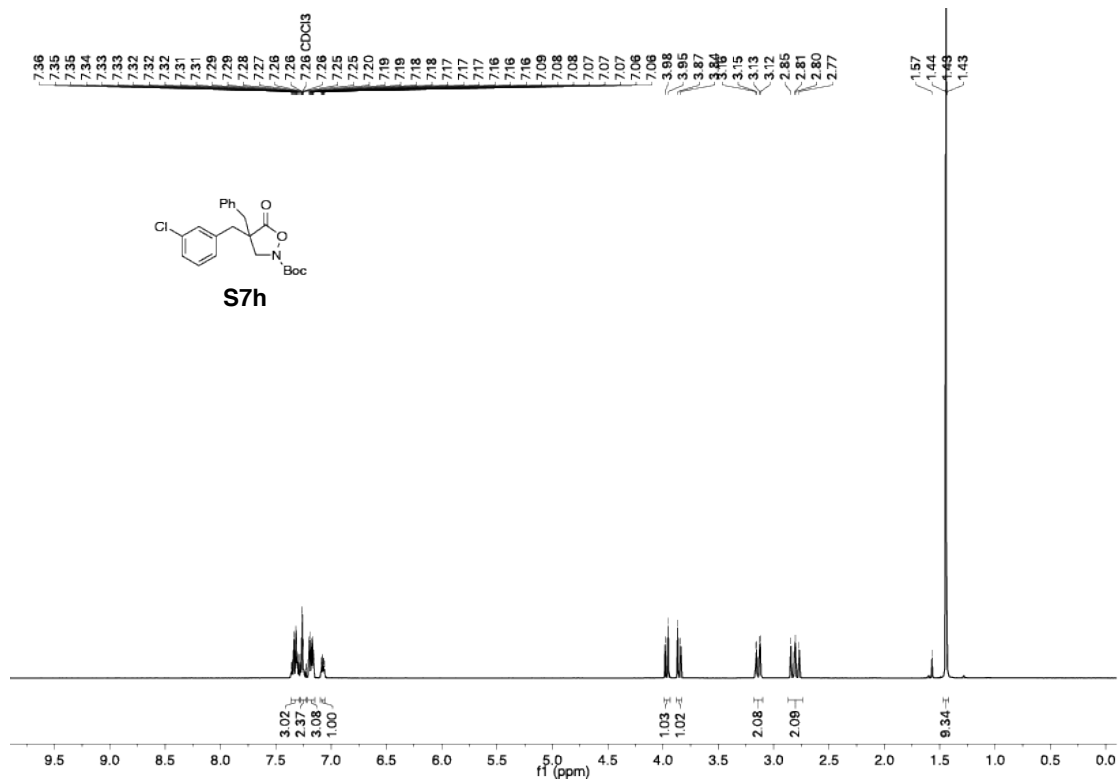


^{19}F NMR (376 MHz, CDCl_3)

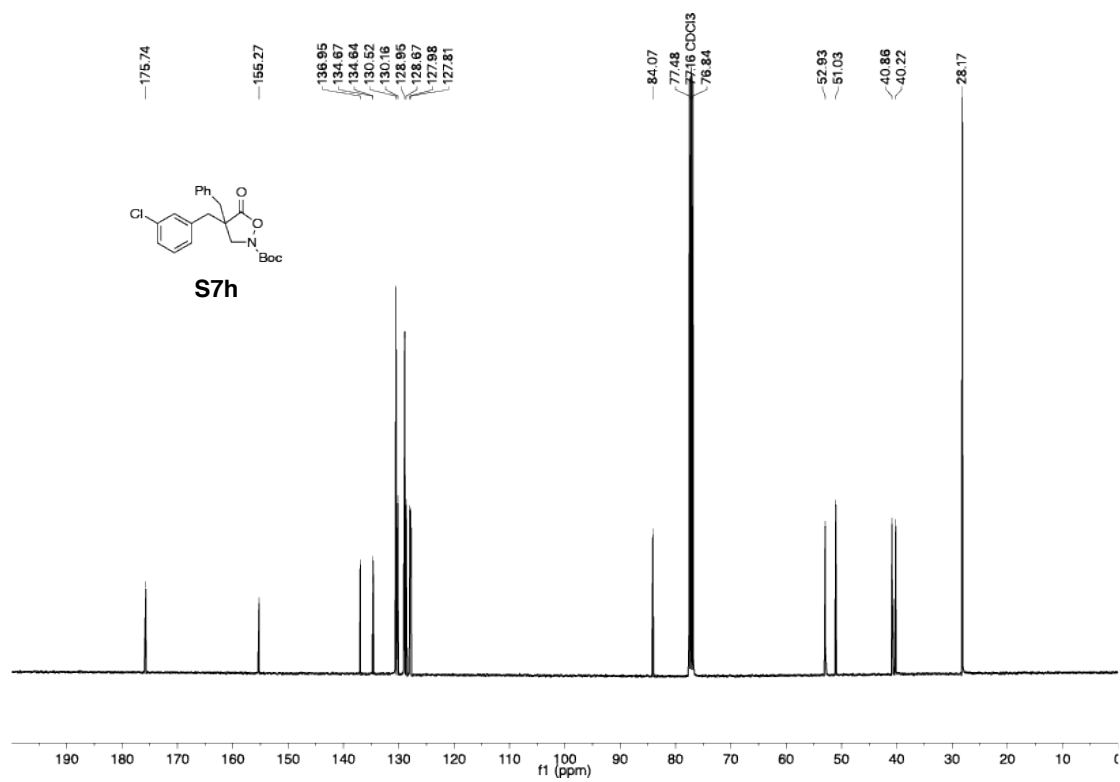


tert-Butyl 4-benzyl-4-(3-chlorobenzyl)-5-oxoisoxazolidine-2-carboxylate (S7h):

¹H NMR (400 MHz, CDCl₃)

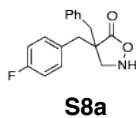
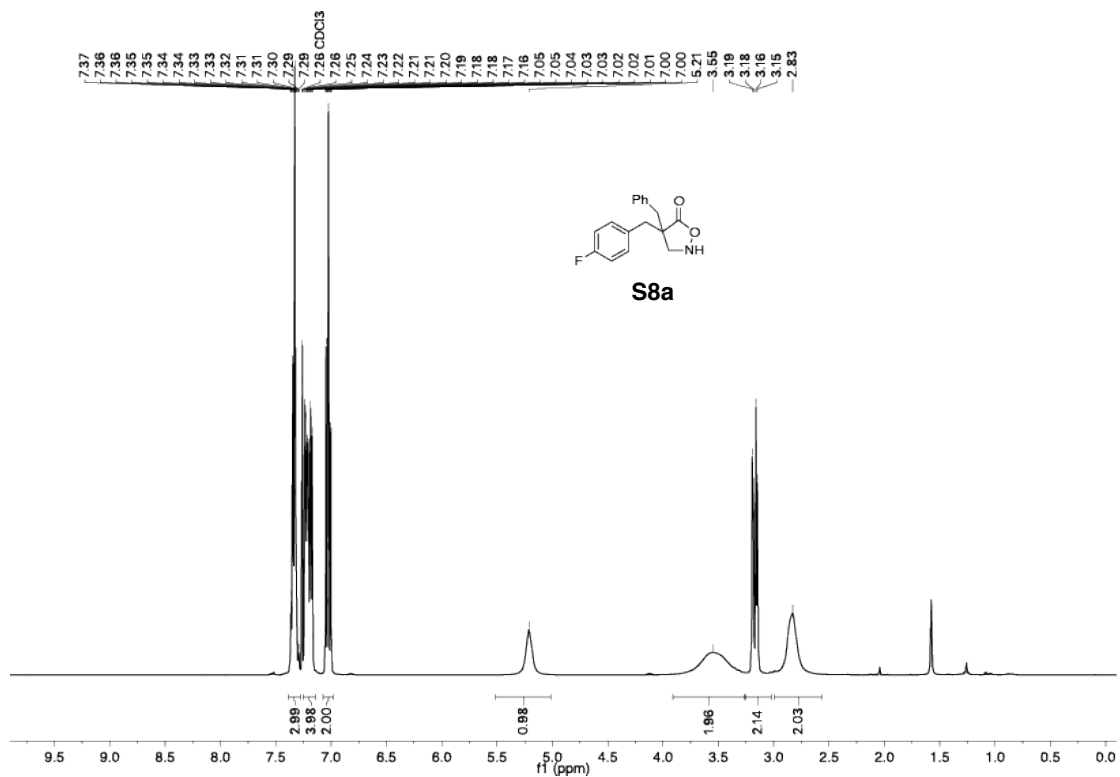


¹³C NMR (100 MHz, CDCl₃)

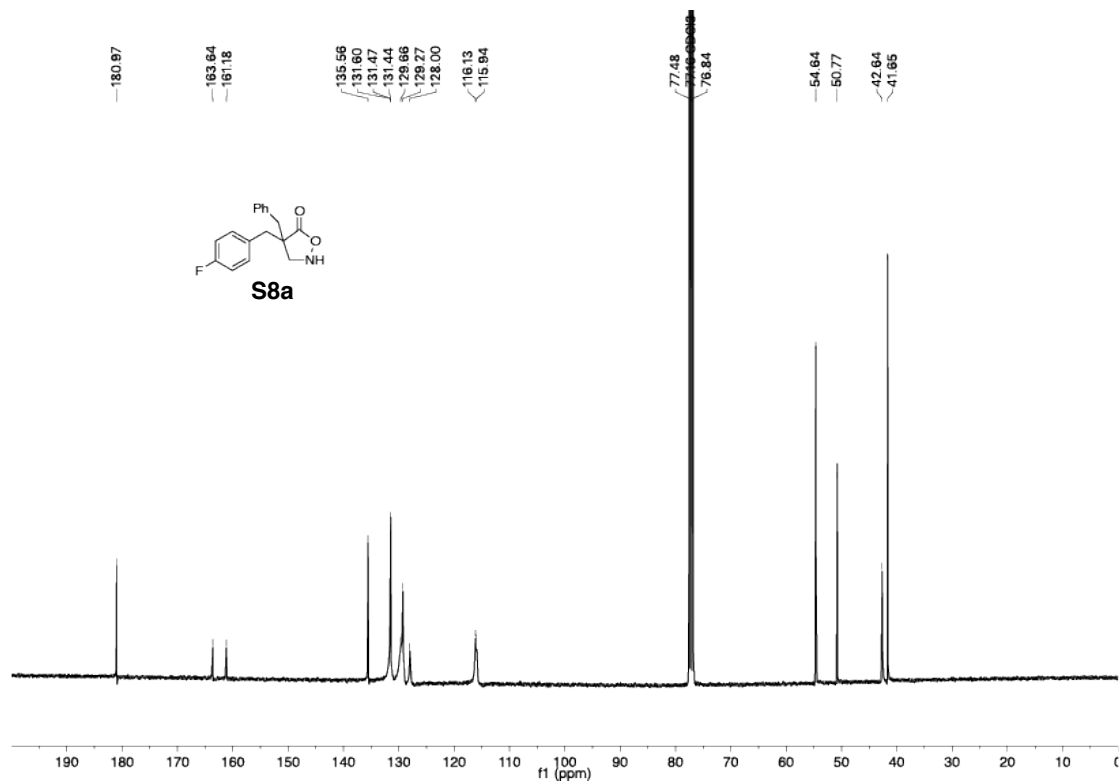


4-Benzyl-4-(4-fluorobenzyl)isoxazolidin-5-one (S8a):

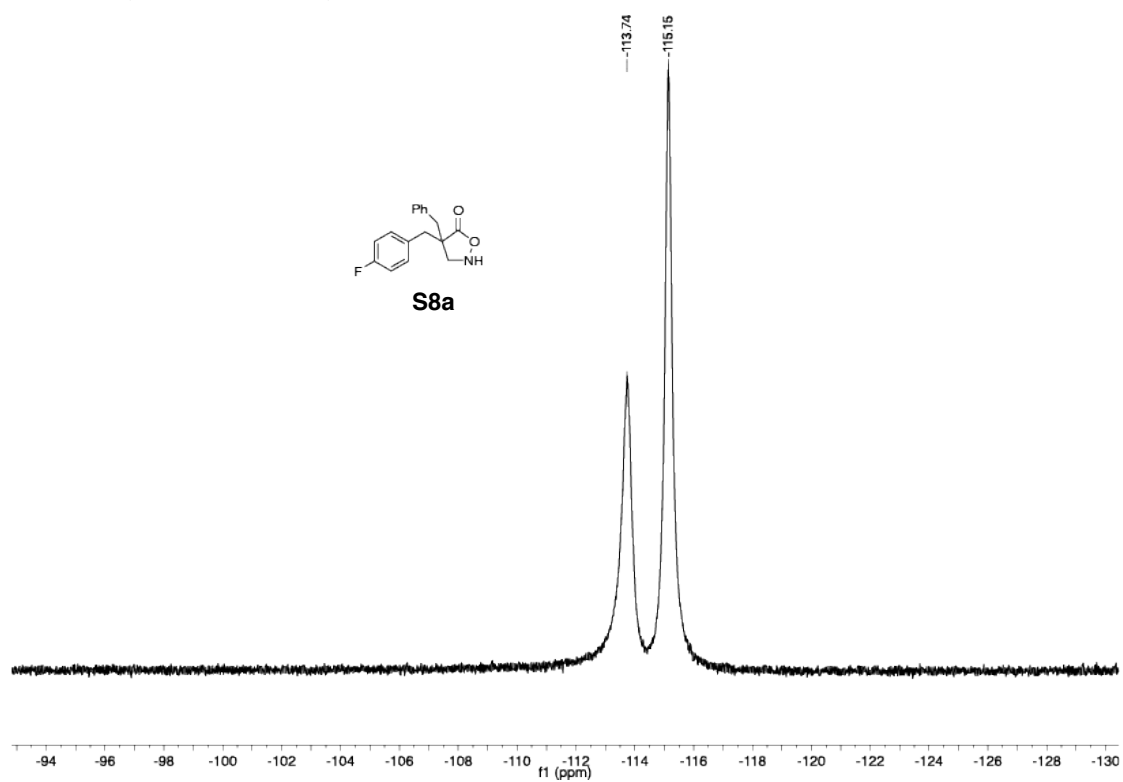
^1H NMR (400 MHz, CDCl_3)



^{13}C NMR (100 MHz, CDCl_3)

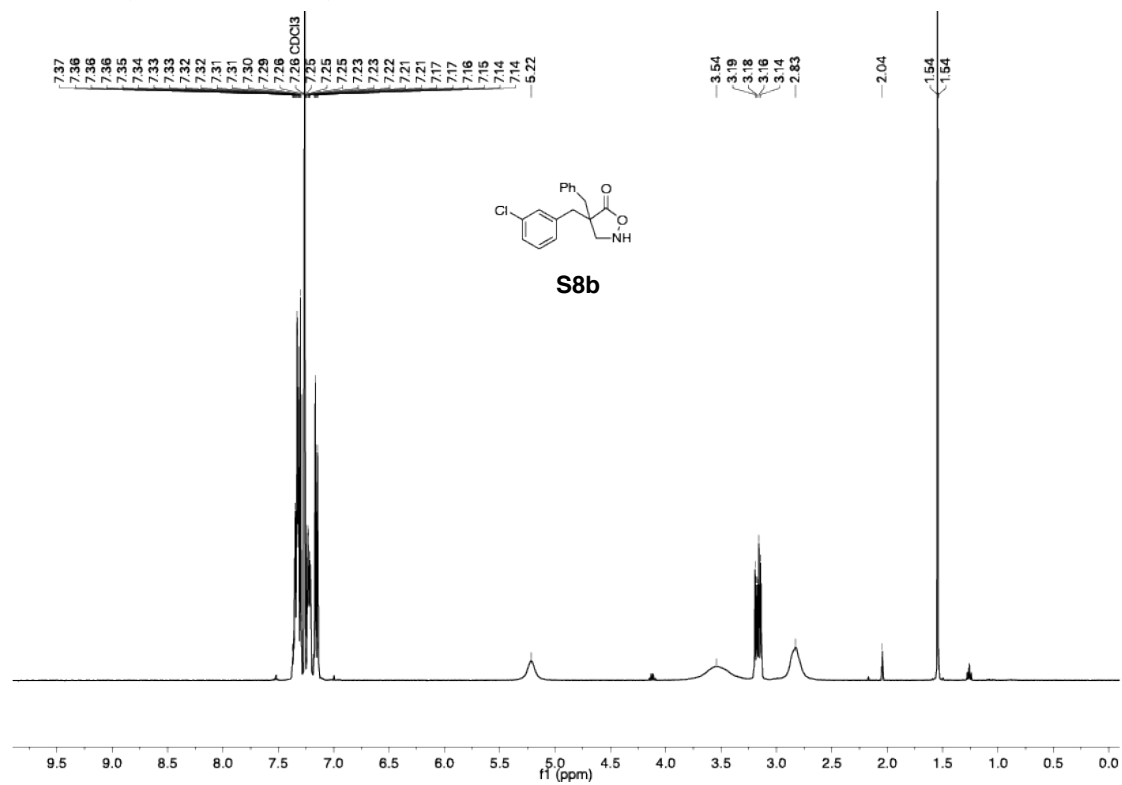


^{19}F NMR (376 MHz, CDCl_3)

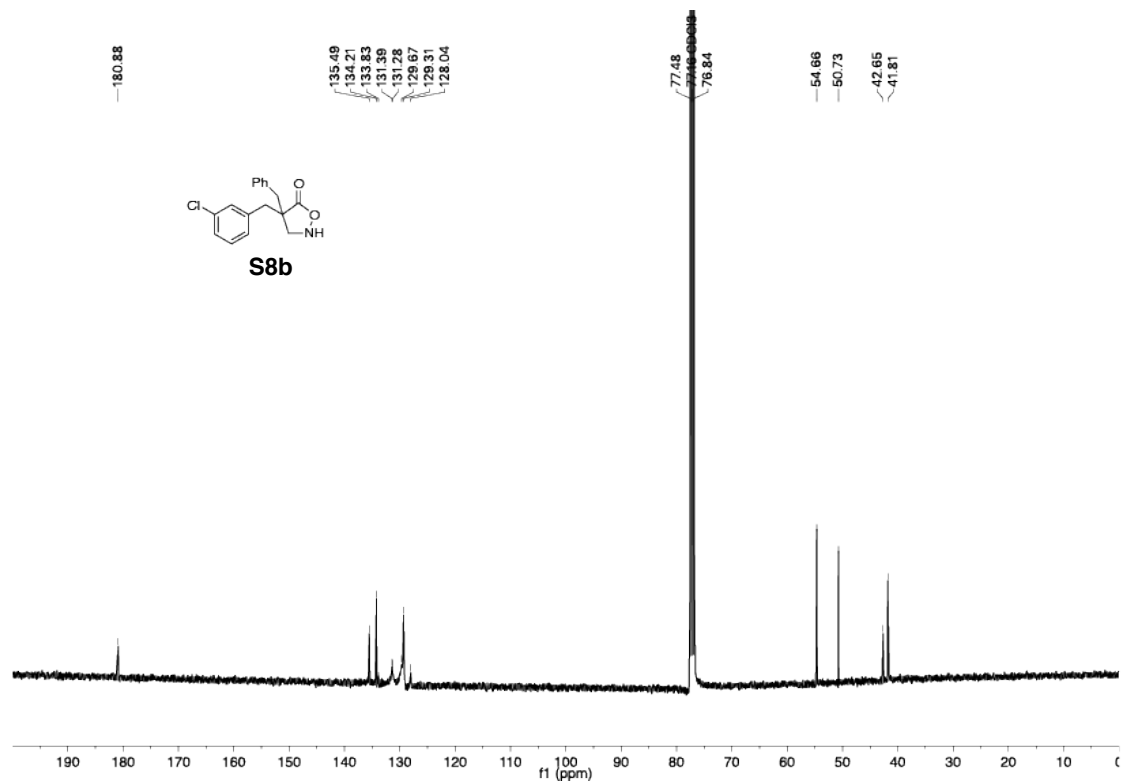


4-Benzyl-4-(4-chlorobenzyl)isoxazolidin-5-one (S8b):

^1H NMR (400 MHz, CDCl_3)

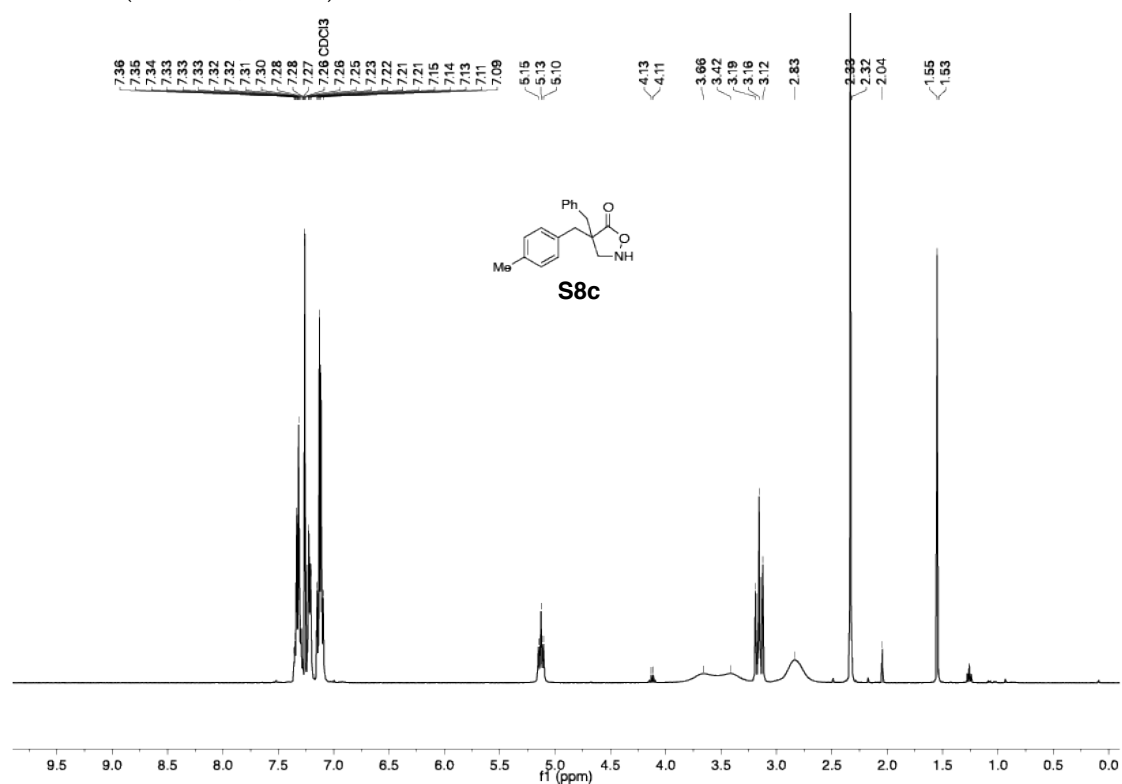


^{13}C NMR (100 MHz, CDCl_3)

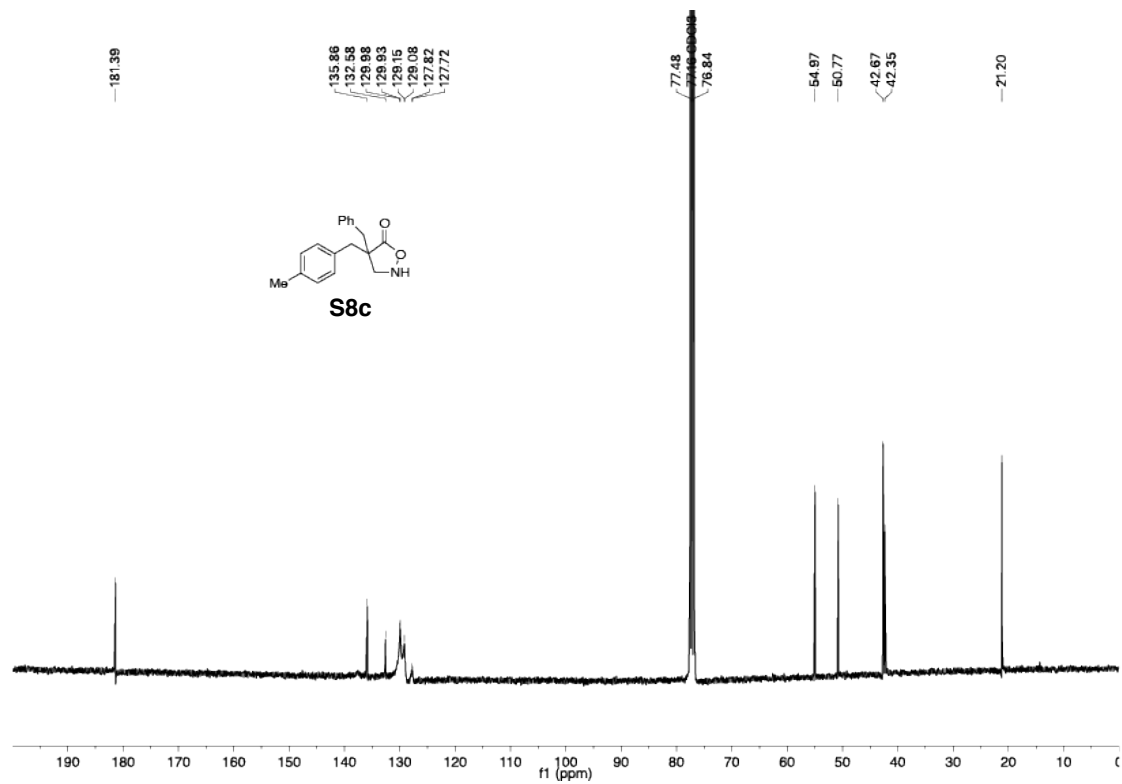


4-Benzyl-4-(4-methylbenzyl)isoxazolidin-5-one (S8c):

^1H NMR (400 MHz, CDCl_3)

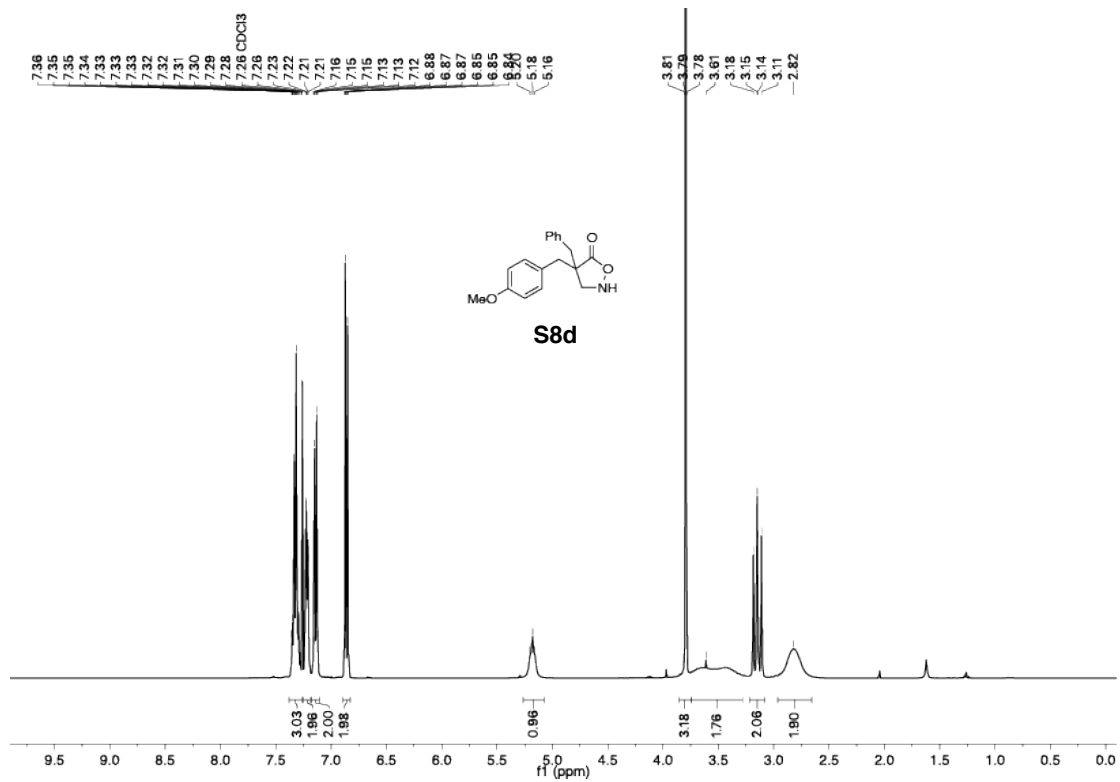


^{13}C NMR (100 MHz, CDCl_3)

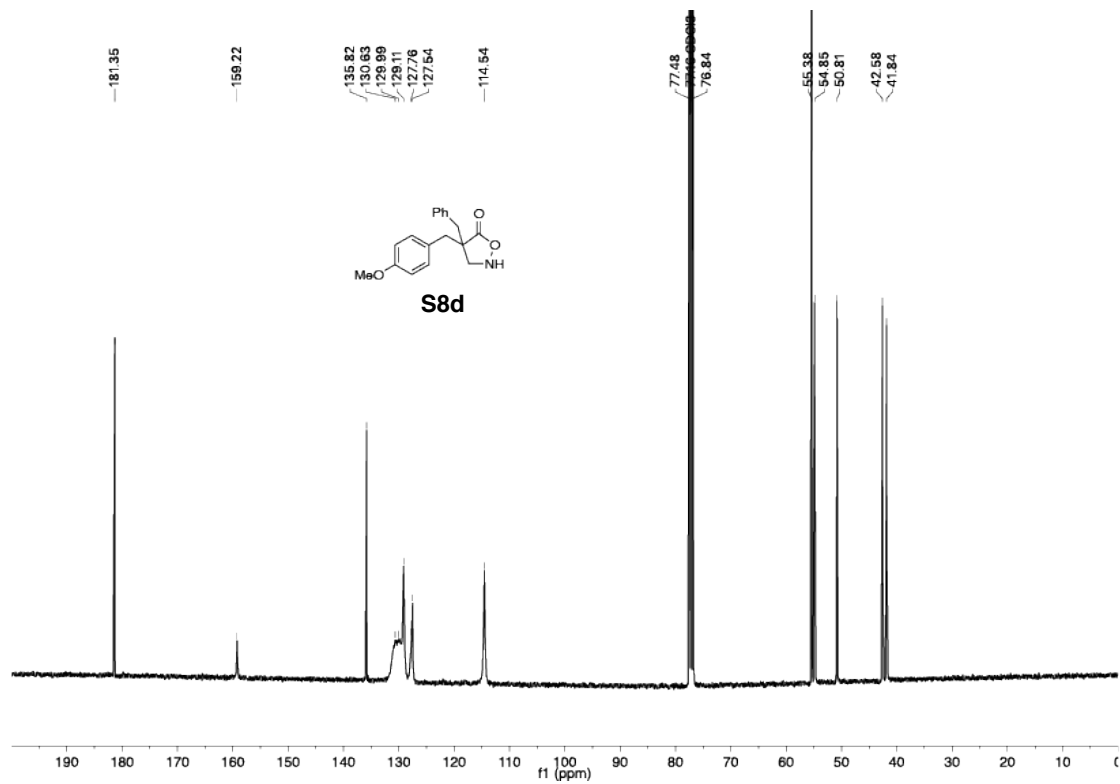


4-Benzyl-4-(4-methoxybenzyl)isoxazolidin-5-one (S8d):

^1H NMR (400 MHz, CDCl_3)

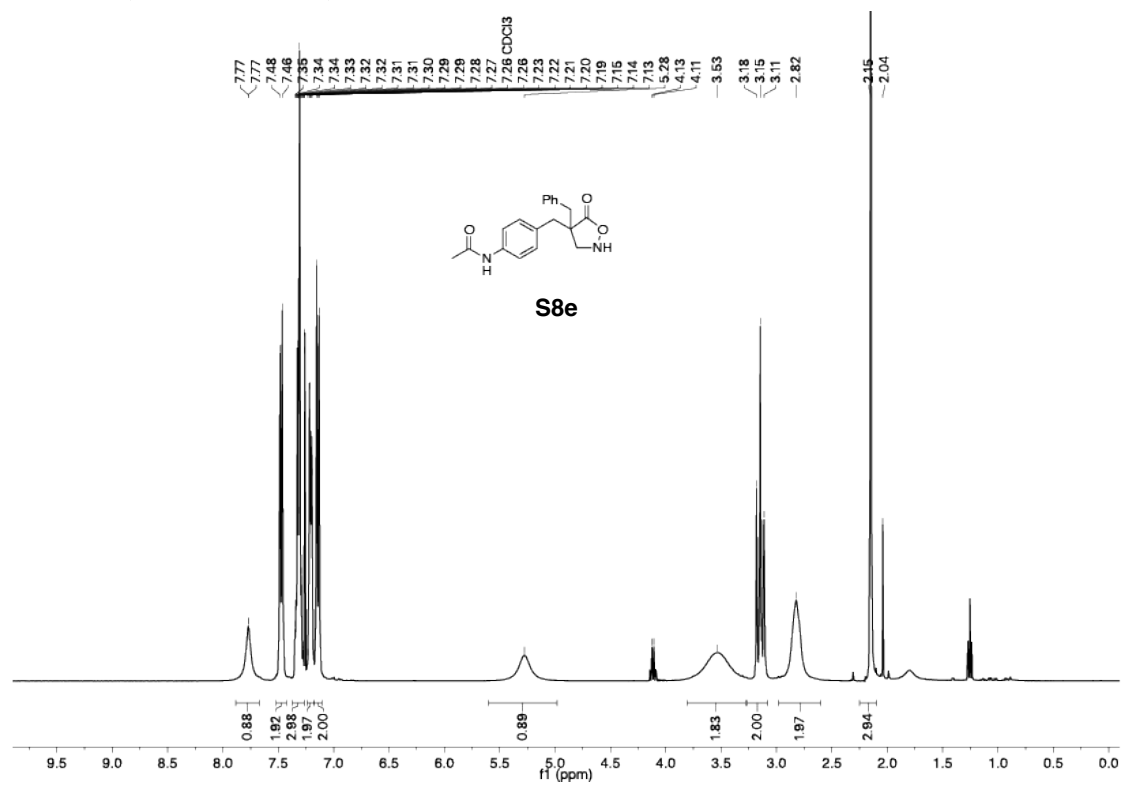


^{13}C NMR (100 MHz, CDCl_3)

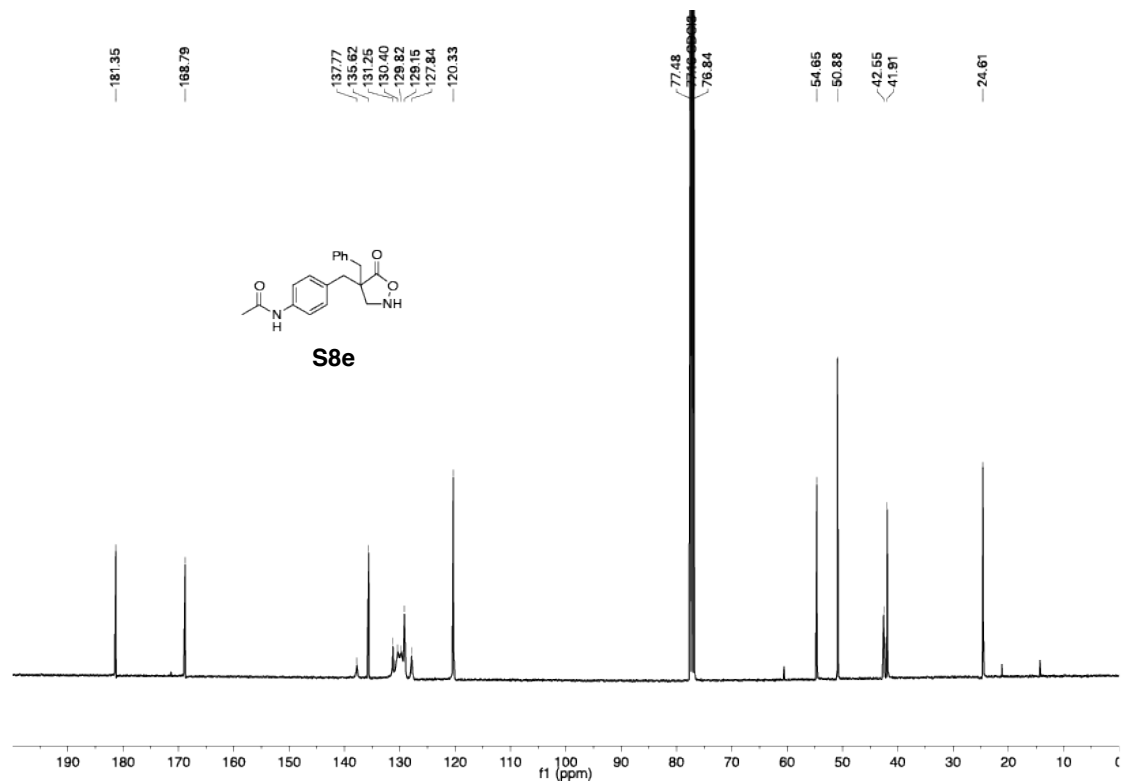


***N*-((4-(4-Benzyl-5-oxoisoxazolidin-4-yl)methyl)phenyl)acetamide (S8e):**

¹H NMR (400 MHz, CDCl₃)

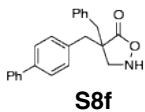
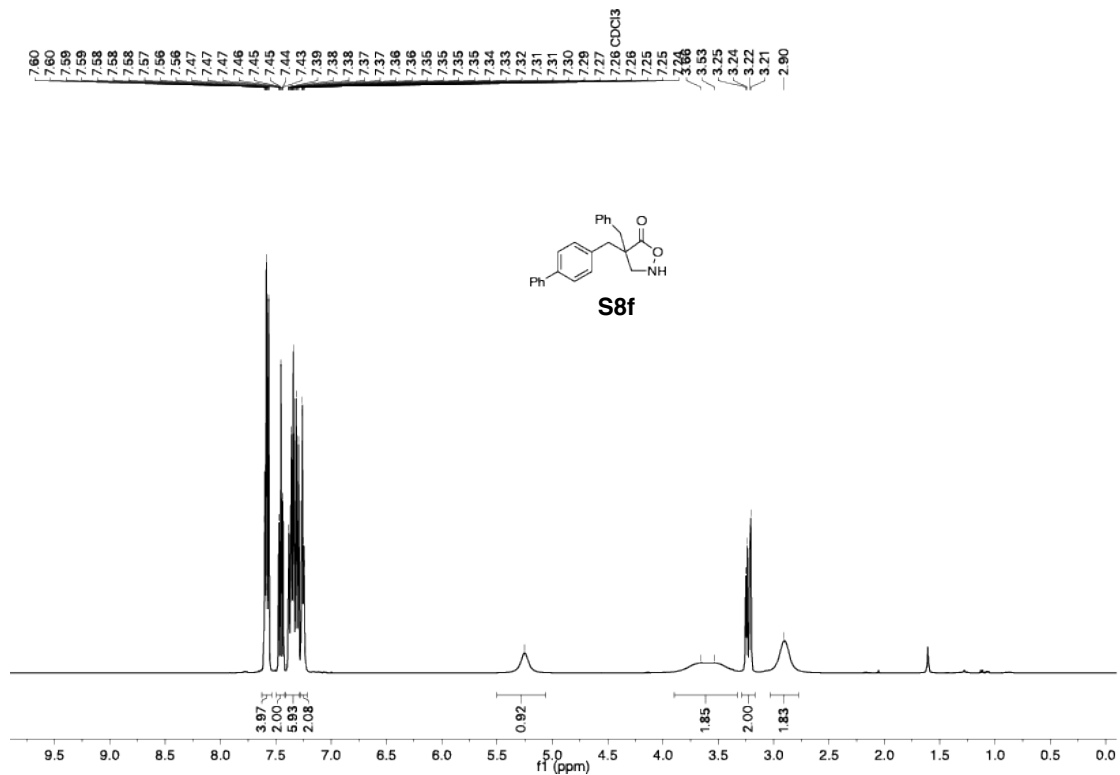


¹³C NMR (100 MHz, CDCl₃)

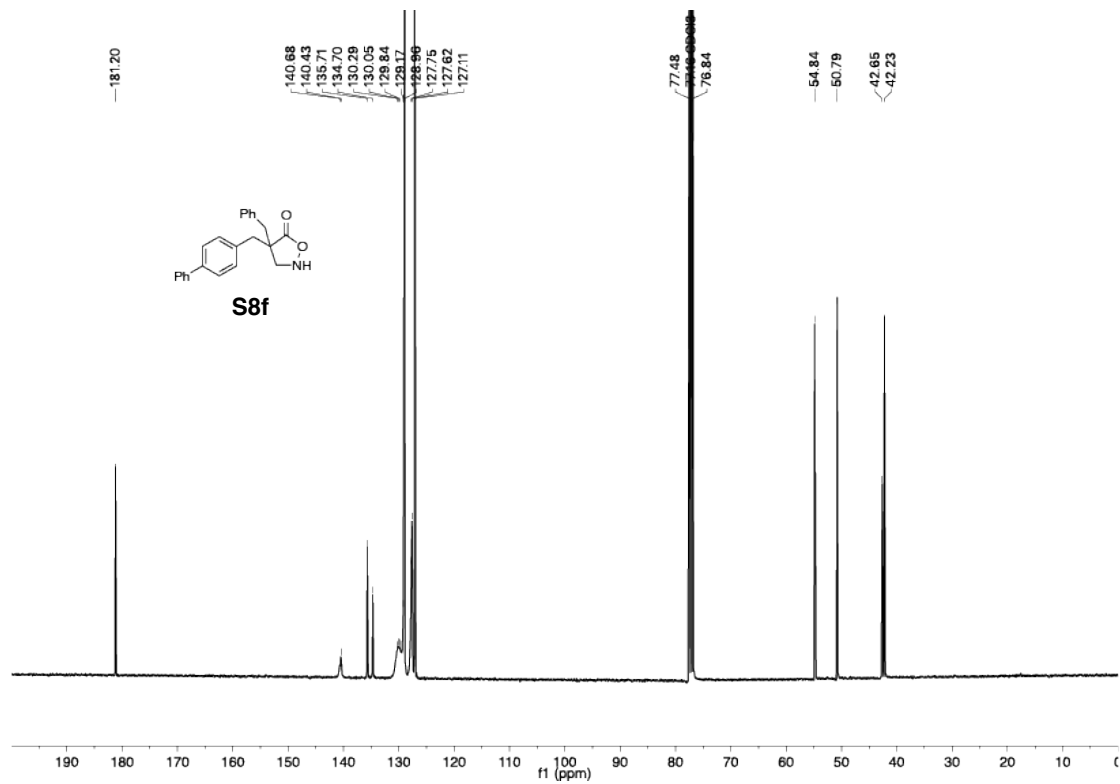


4-([1,1'-Biphenyl]-4-ylmethyl)-4-benzylisoxazolidin-5-one (S8f):

^1H NMR (400 MHz, CDCl_3)

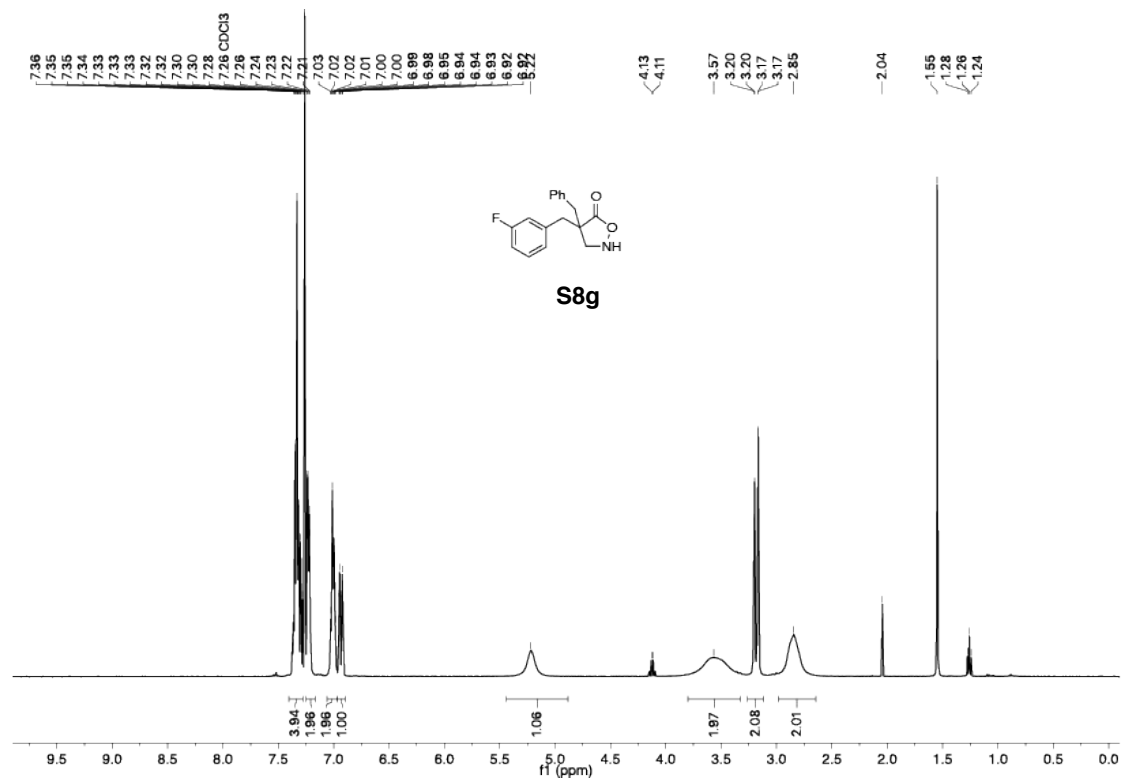


^{13}C NMR (100 MHz, CDCl_3)

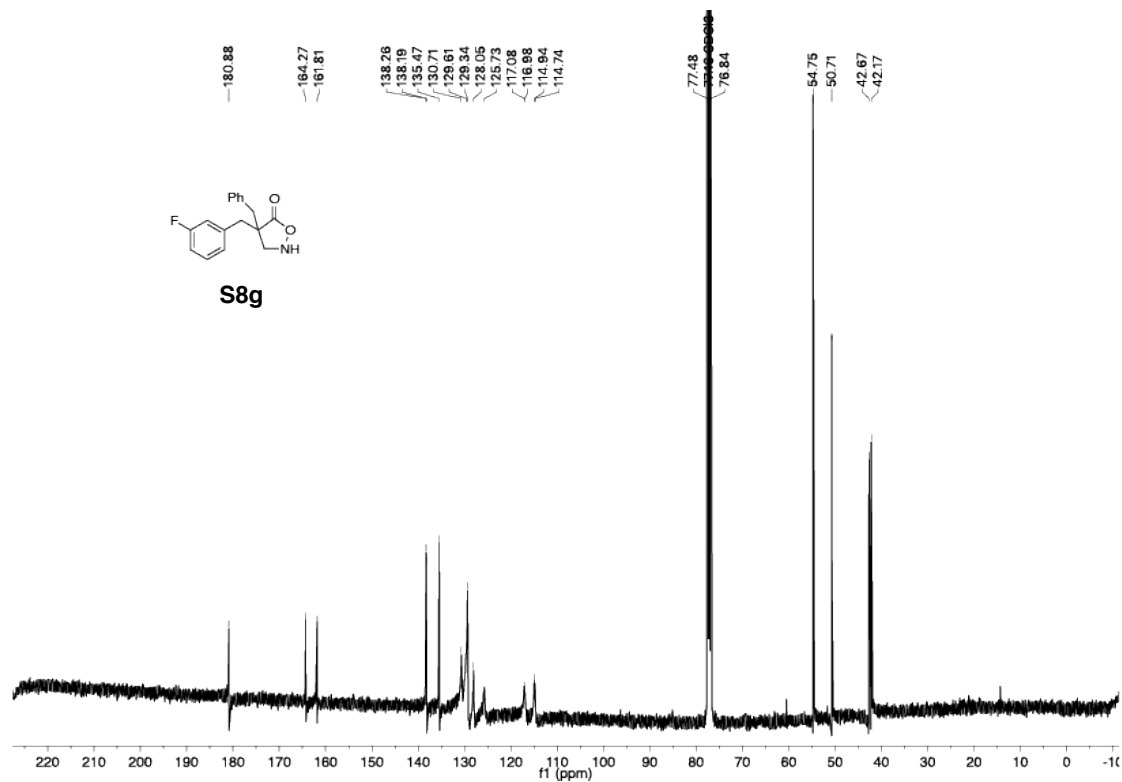


4-Benzyl-4-(3-fluorobenzyl)isoxazolidin-5-one (S8g):

^1H NMR (400 MHz, CDCl_3)

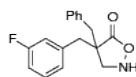


^{13}C NMR (100 MHz, CDCl_3)

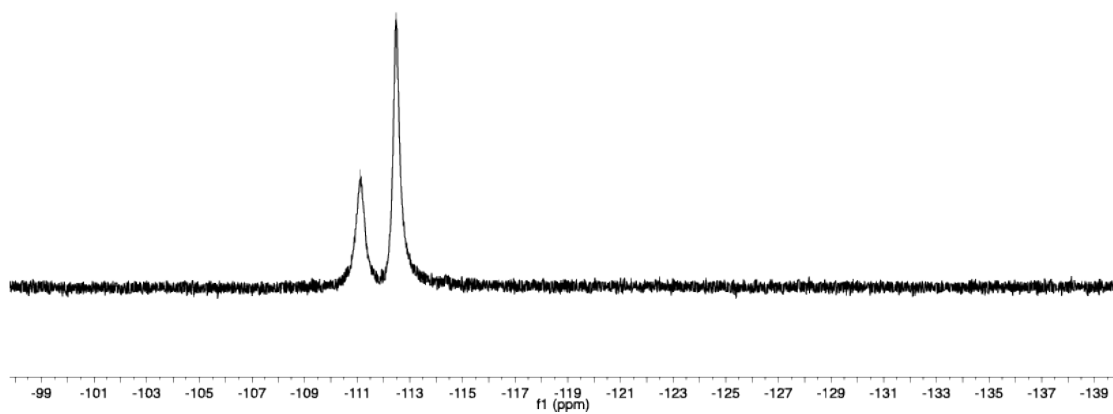


^{19}F NMR (376 MHz, CDCl_3)

— -111.11
— -112.48

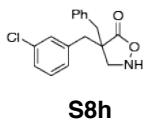
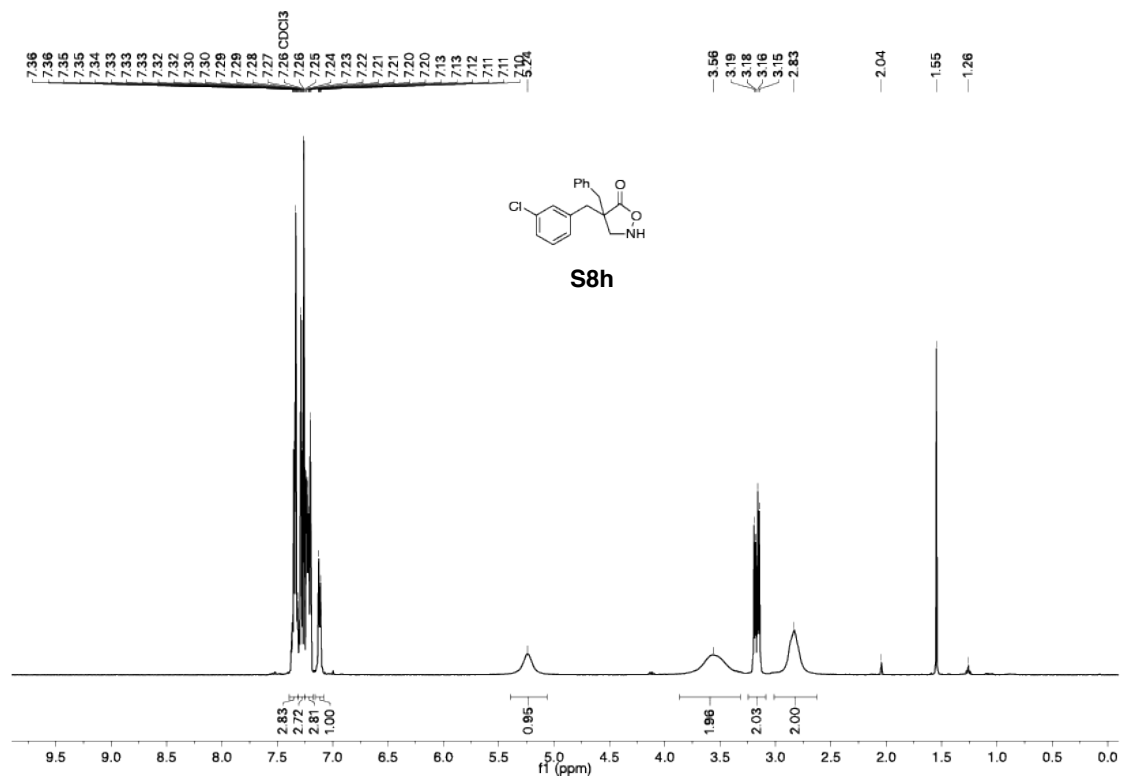


S8g

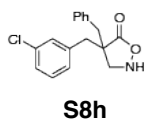
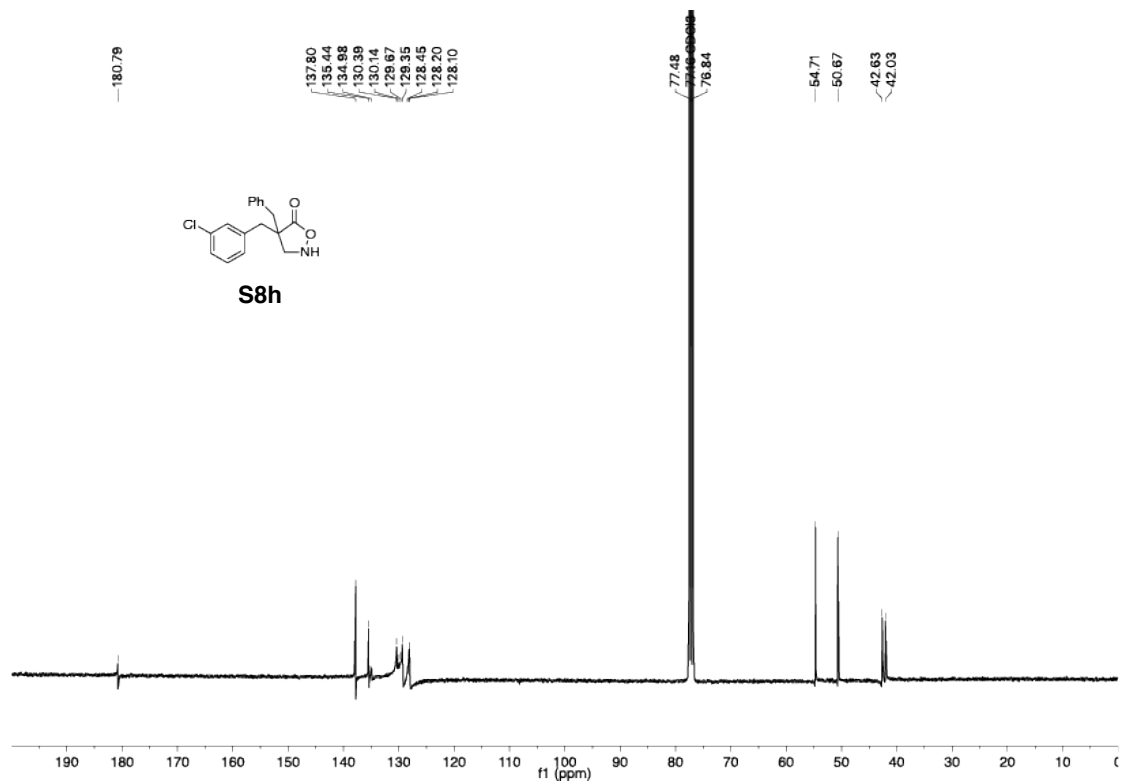


4-Benzyl-4-(3-chlorobenzyl)isoxazolidin-5-one (S8h):

^1H NMR (400 MHz, CDCl_3)

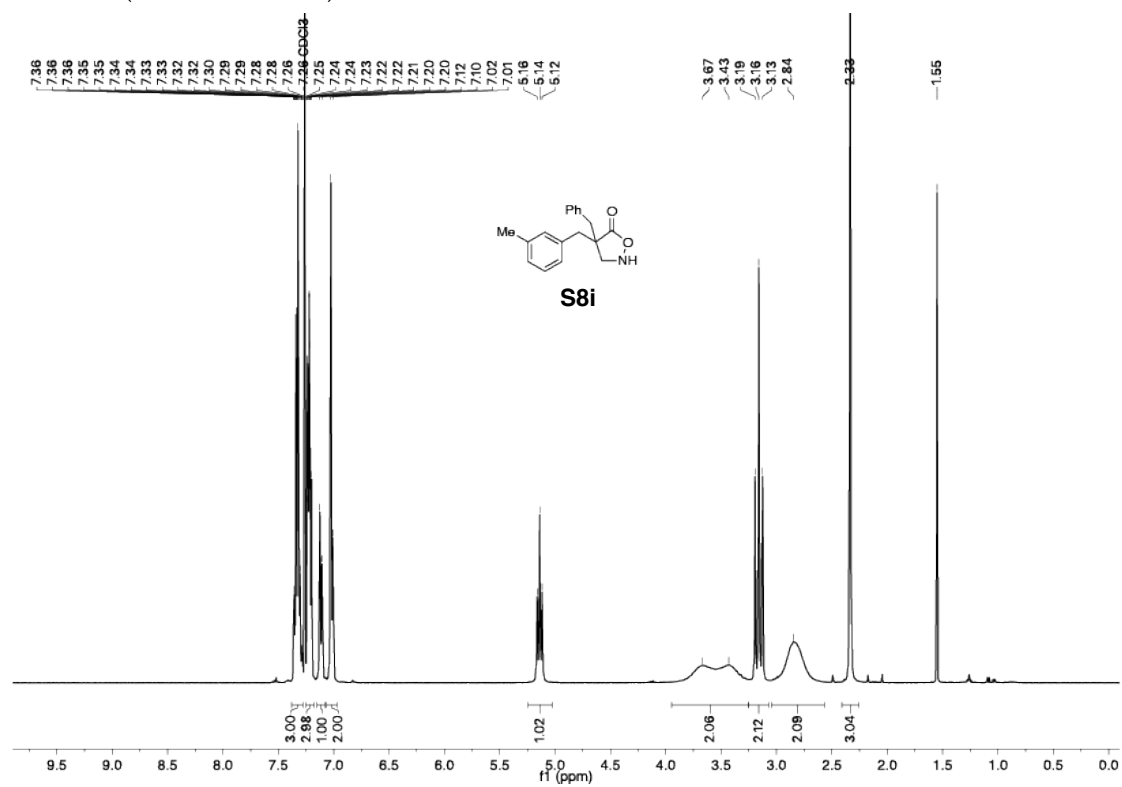


^{13}C NMR (100 MHz, CDCl_3)

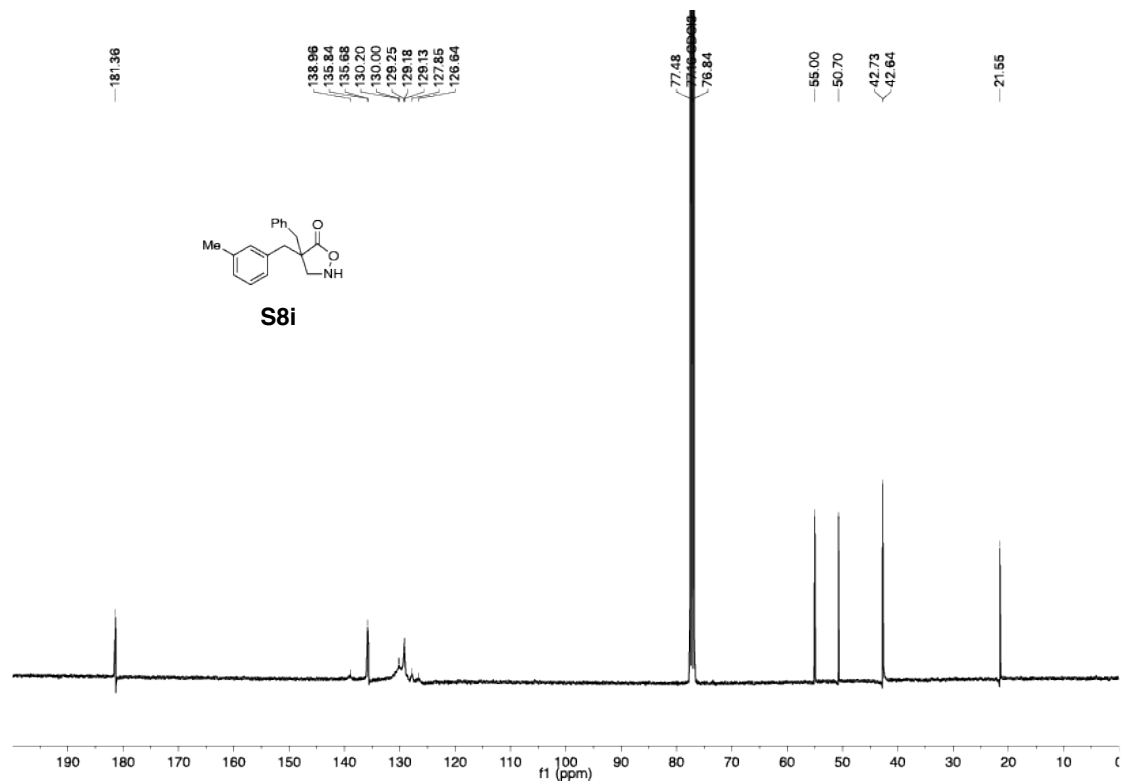


4-Benzyl-4-(3-methylbenzyl)isoxazolidin-5-one (S8i):

^1H NMR (400 MHz, CDCl_3)

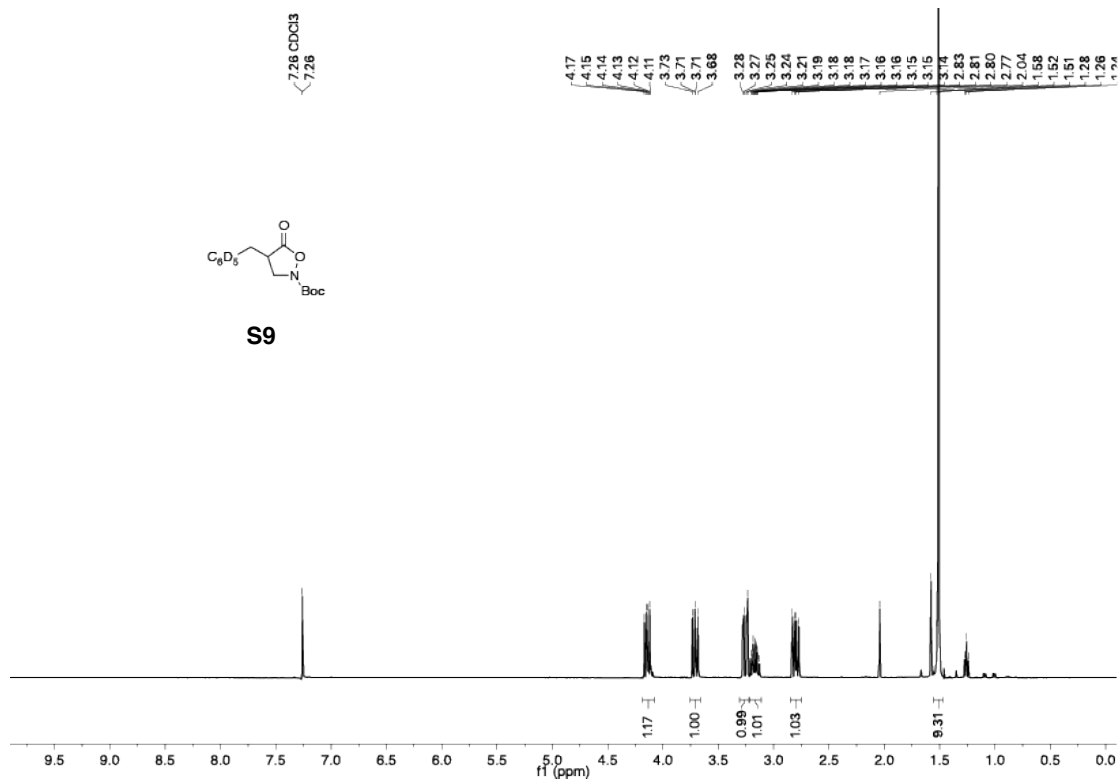


^{13}C NMR (100 MHz, CDCl_3)

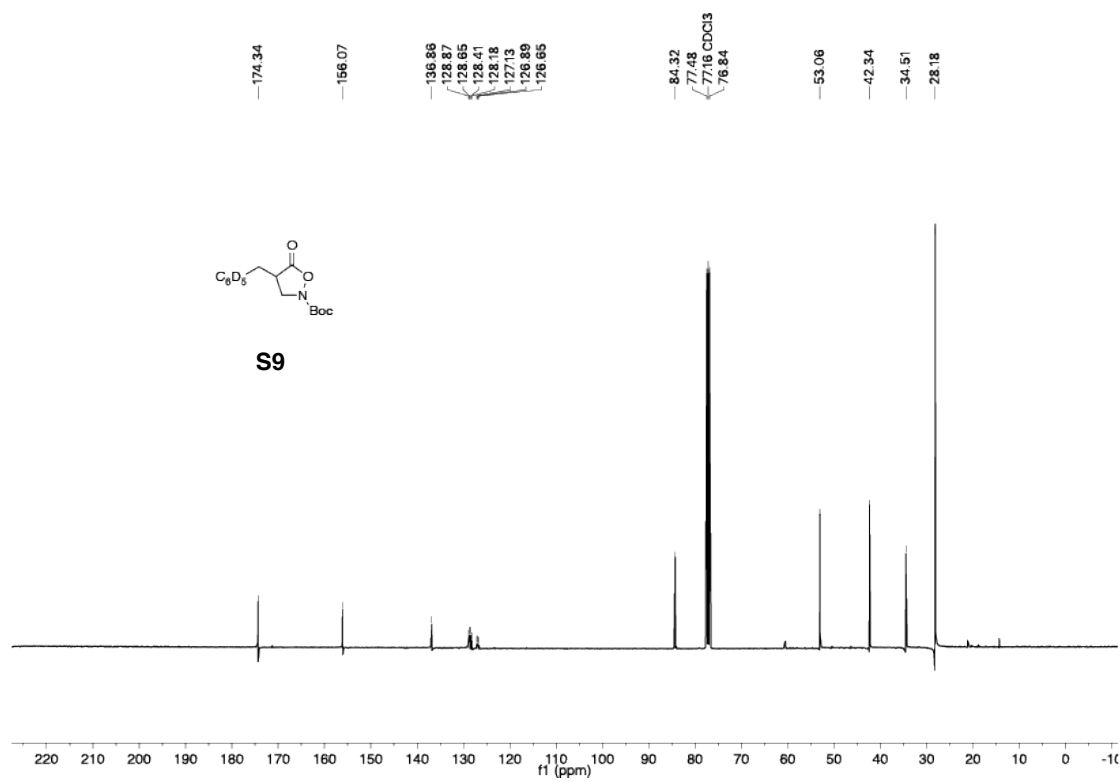


tert-Butyl 4-benzyl-5-oxoisoxazolidine-2-carboxylate-*d*₅ (S9):

¹H NMR (400 MHz, CDCl₃)

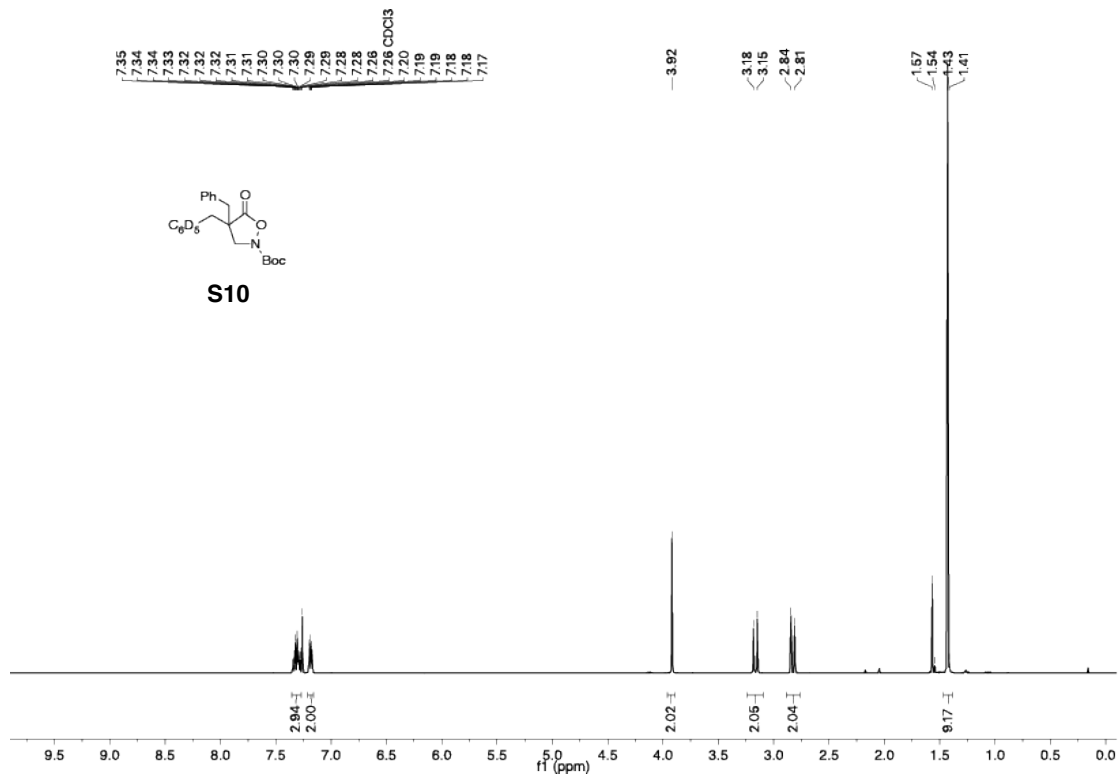


¹³C NMR (100 MHz, CDCl₃)

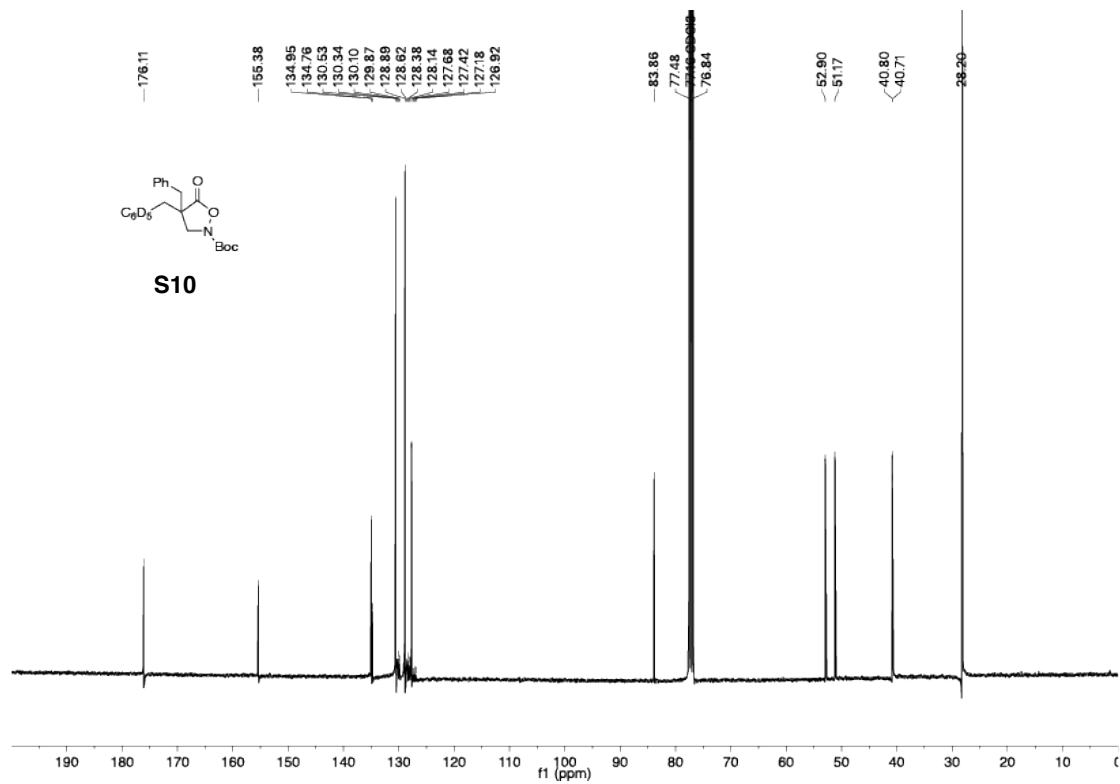


tert-Butyl 4,4-dibenzyl-5-oxisoxazolidine-2-carboxylate-*d*₅ (S10):

¹H NMR (400 MHz, CDCl₃)

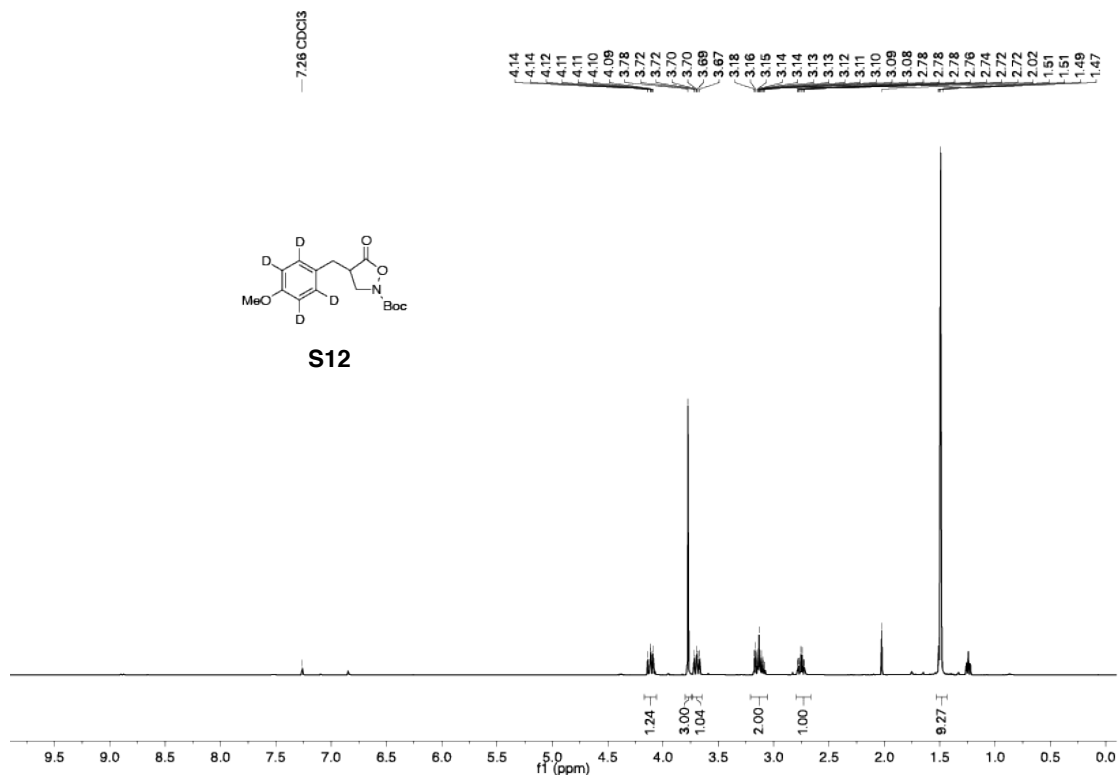


¹³C NMR (100 MHz, CDCl₃)

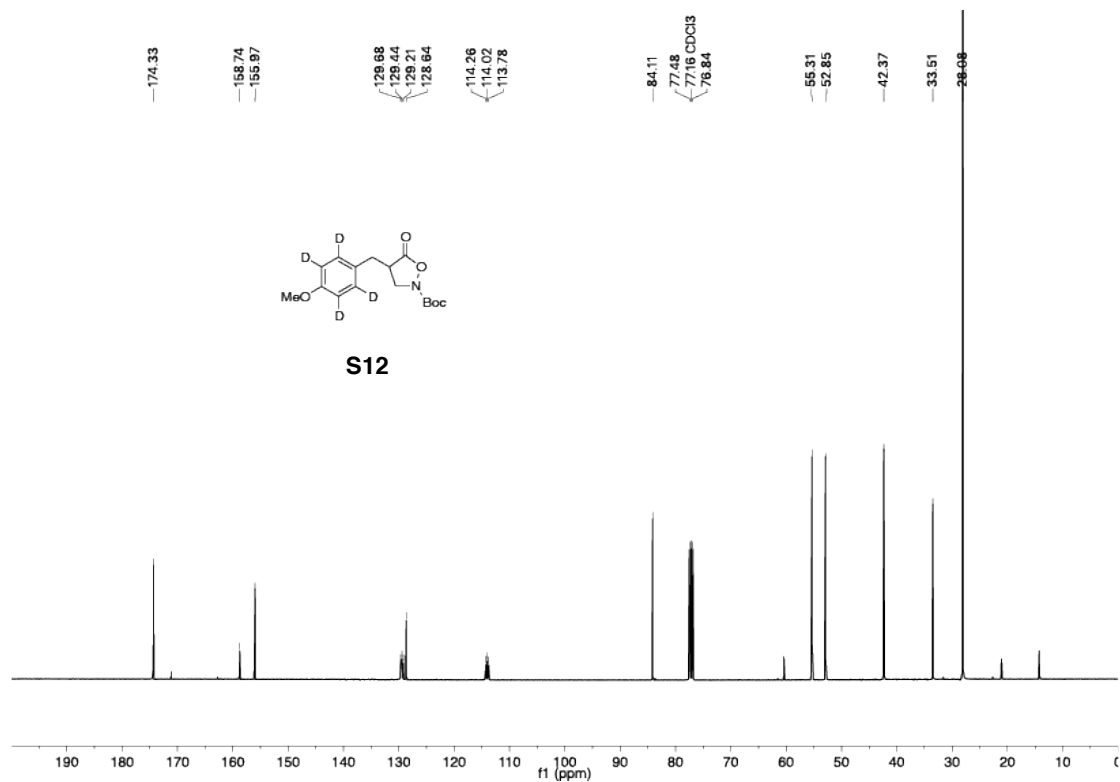


***tert*-Butyl 4-(4-methoxybenzyl)-5-oxoisoxazolidine-2-carboxylate-*d*₄ (S12):**

¹H NMR (400 MHz, CDCl₃)

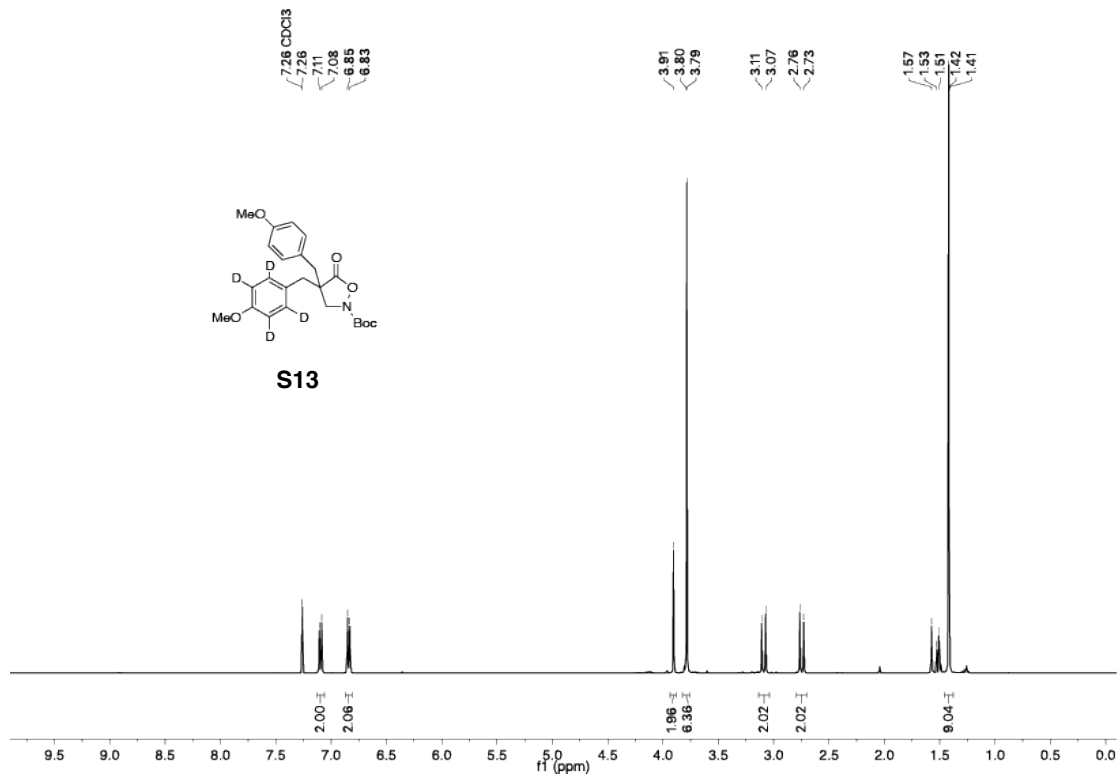


¹³C NMR (100 MHz, CDCl₃)

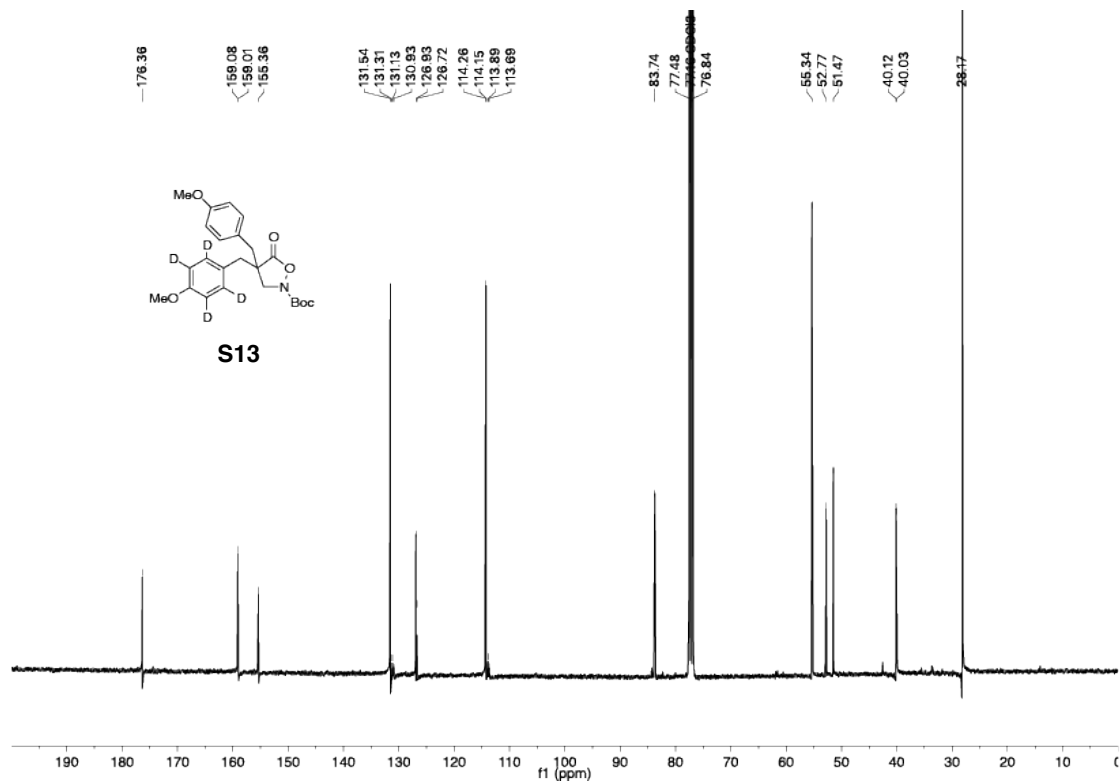


***tert*-Butyl 4,4-bis(4-methoxybenzyl)-5-oxisoxazolidine-2-carboxylate-*d*₄ (S13):**

¹H NMR (400 MHz, CDCl₃)

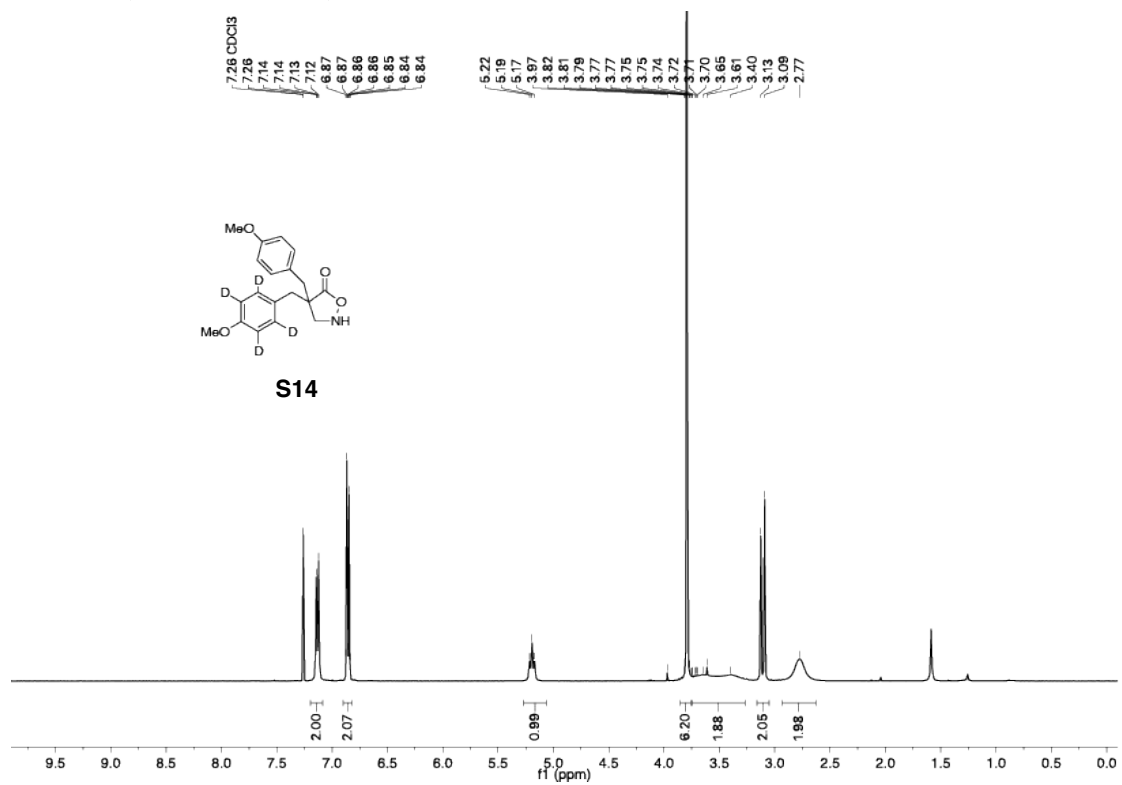


¹³C NMR (100 MHz, CDCl₃)

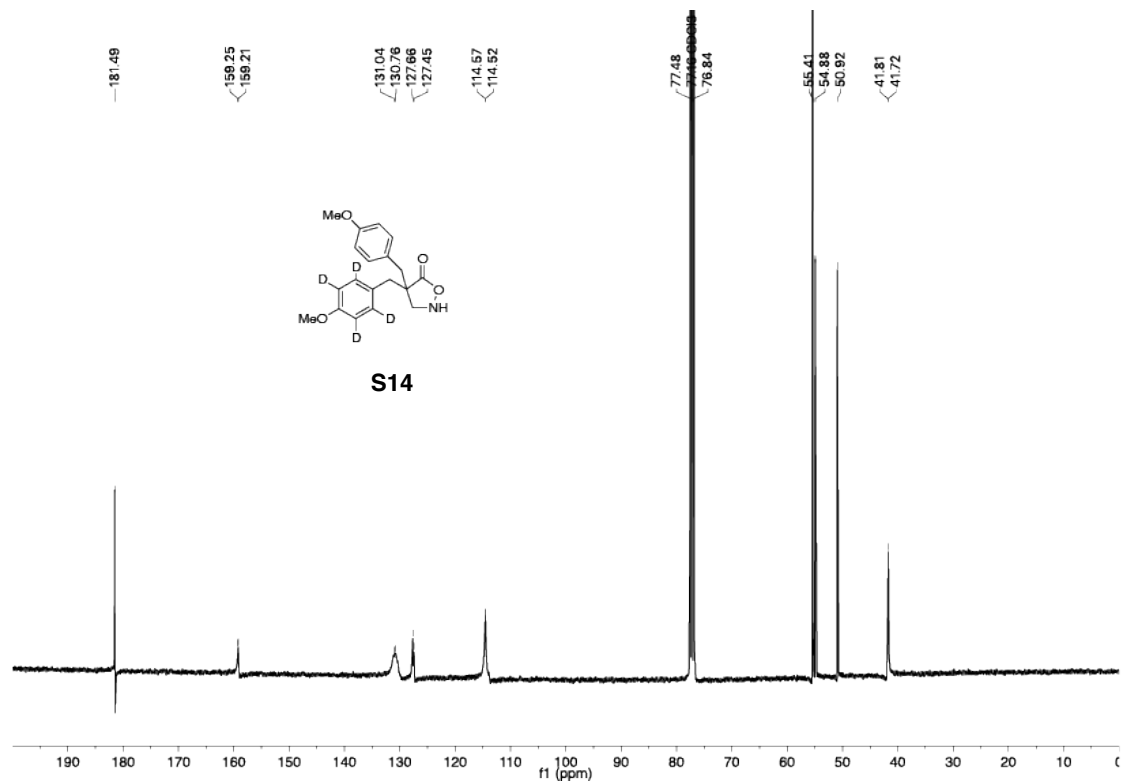


4,4-Bis(4-methoxybenzyl)isoxazolidin-5-one-*d*₄ (S14):

¹H NMR (400 MHz, CDCl₃)

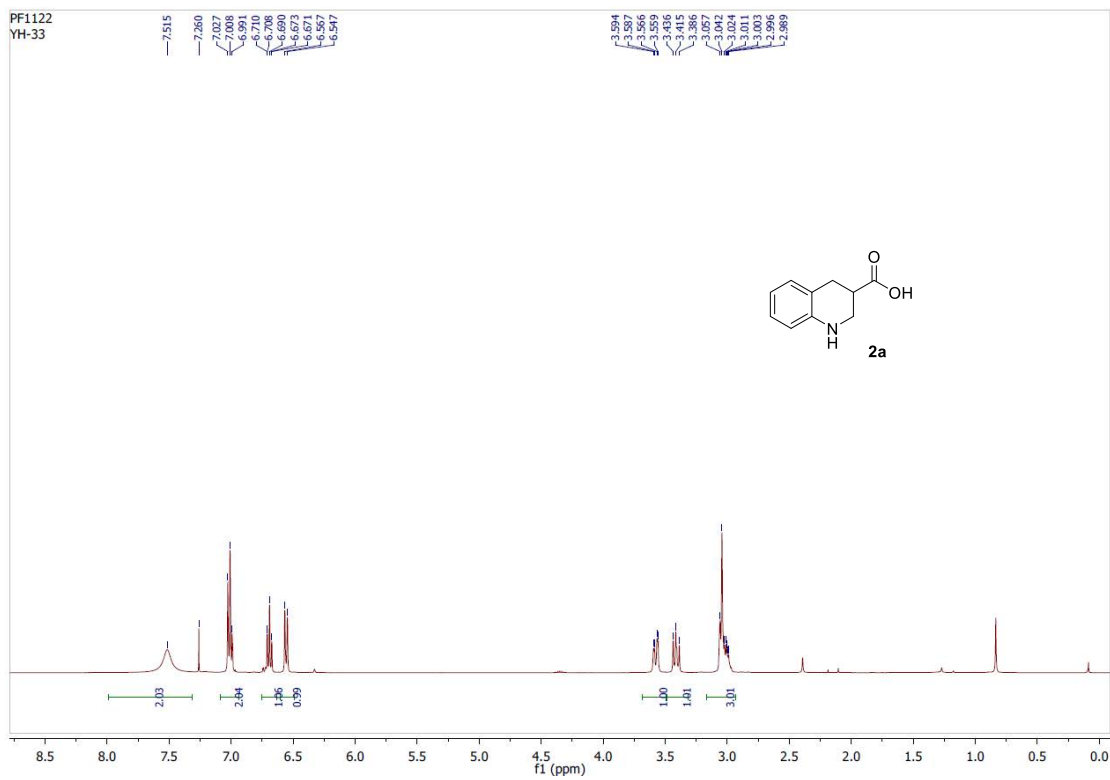


¹³C NMR (100 MHz, CDCl₃)

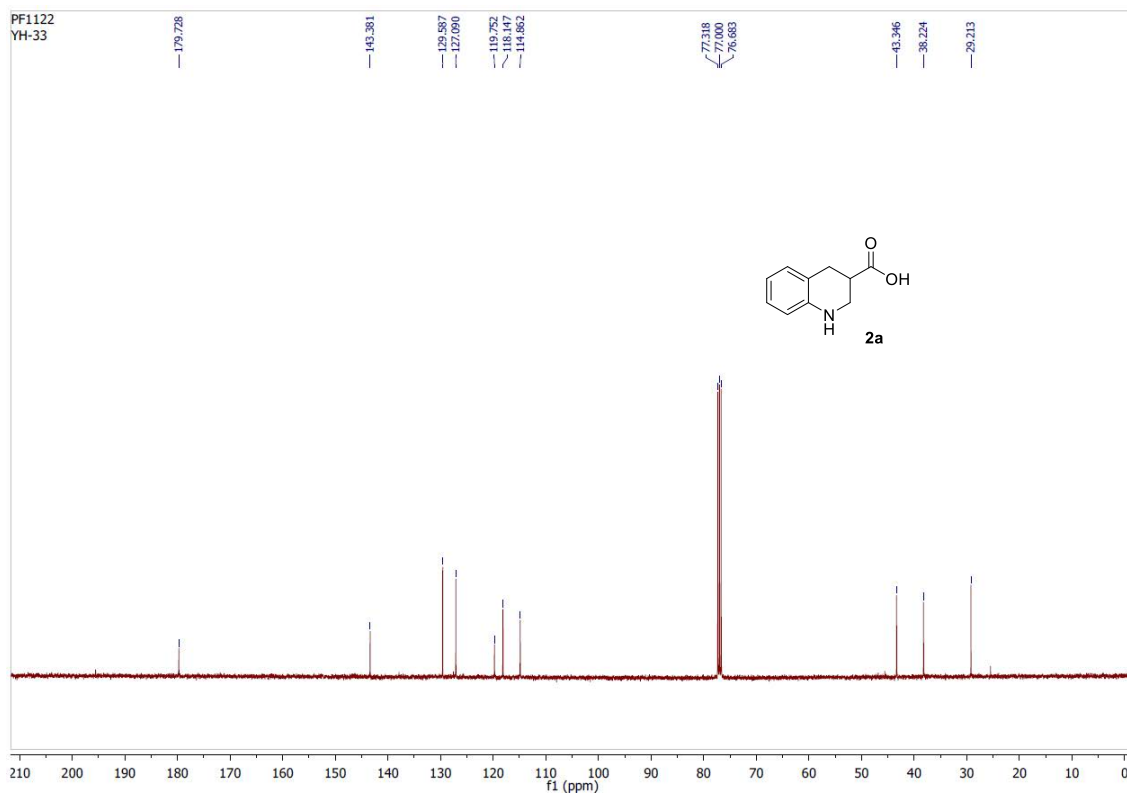


1,2,3,4-Tetrahydroquinoline-3-carboxylic acid (2a)

^1H NMR (400 MHz, CDCl_3)

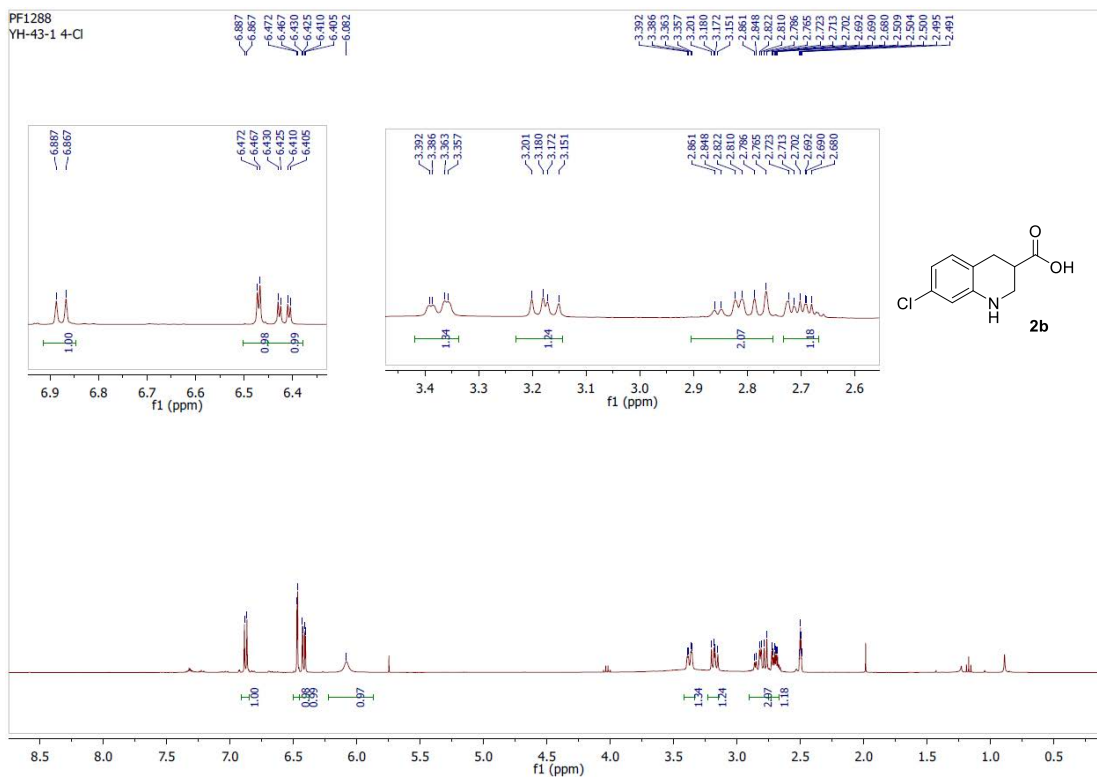


^{13}C NMR (100 MHz, CDCl_3)

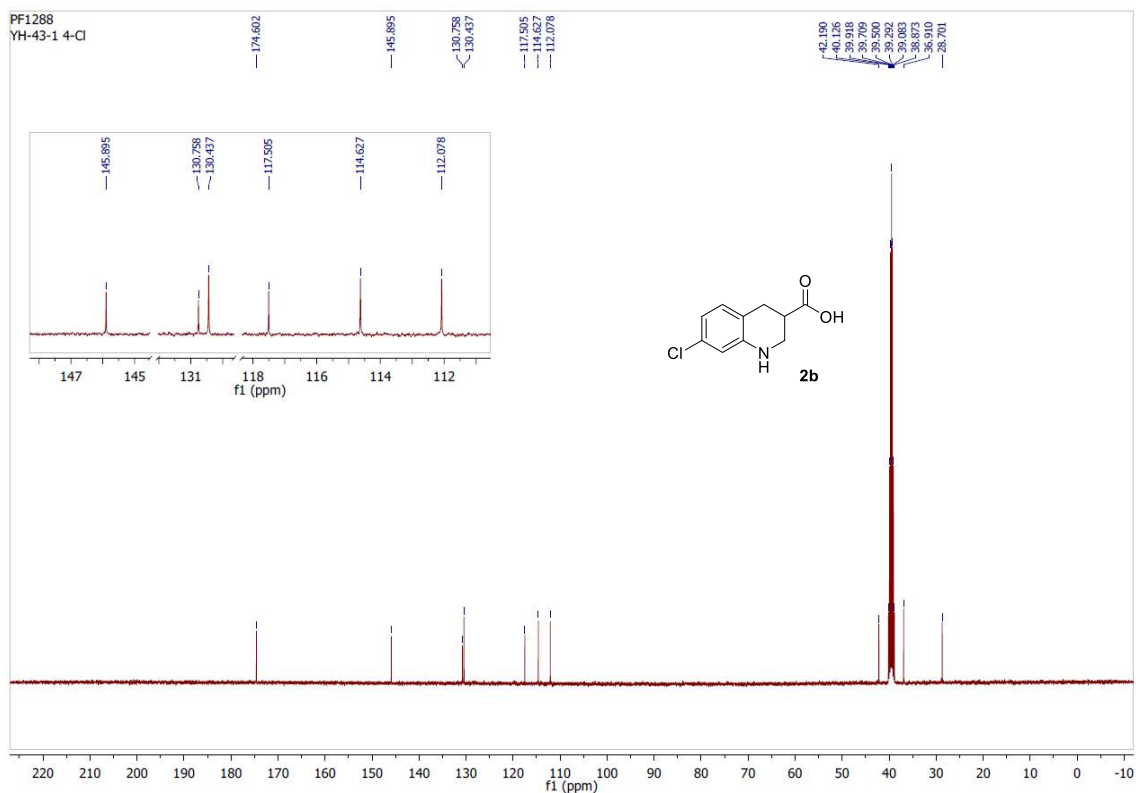


7-Chloro-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (**2b**):

^1H NMR (400 MHz, $\text{DMSO-}d_6$)

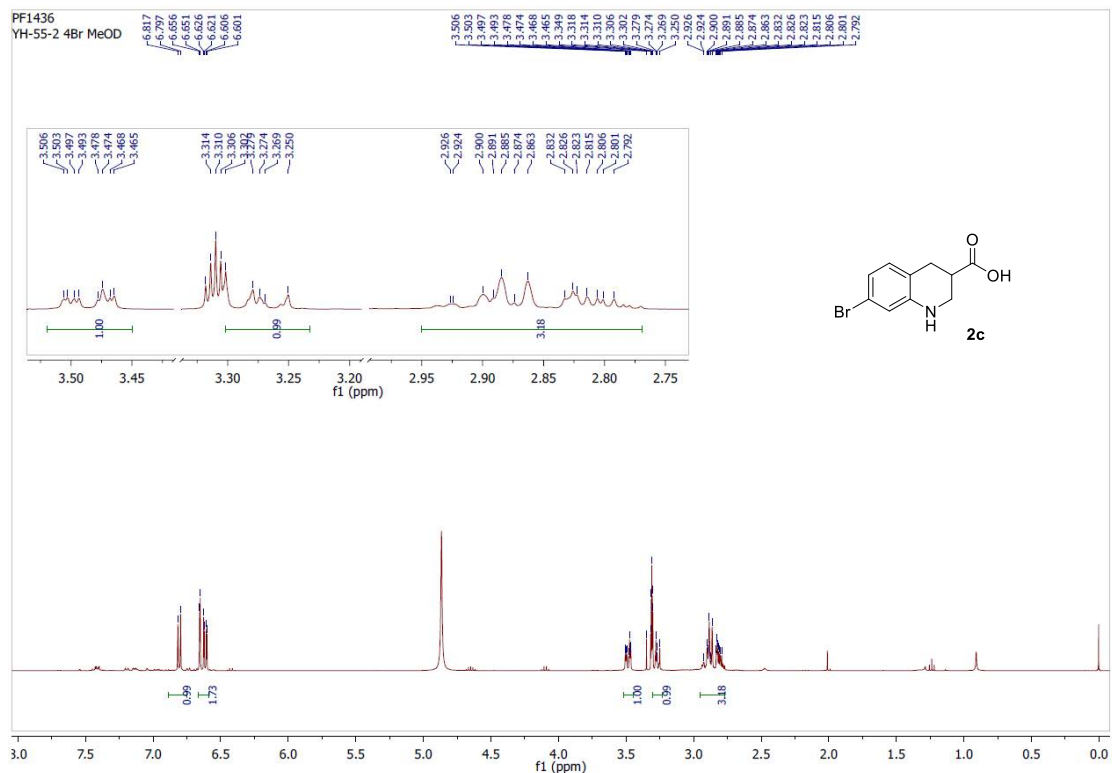


^{13}C NMR (100 MHz, $\text{DMSO-}d_6$)

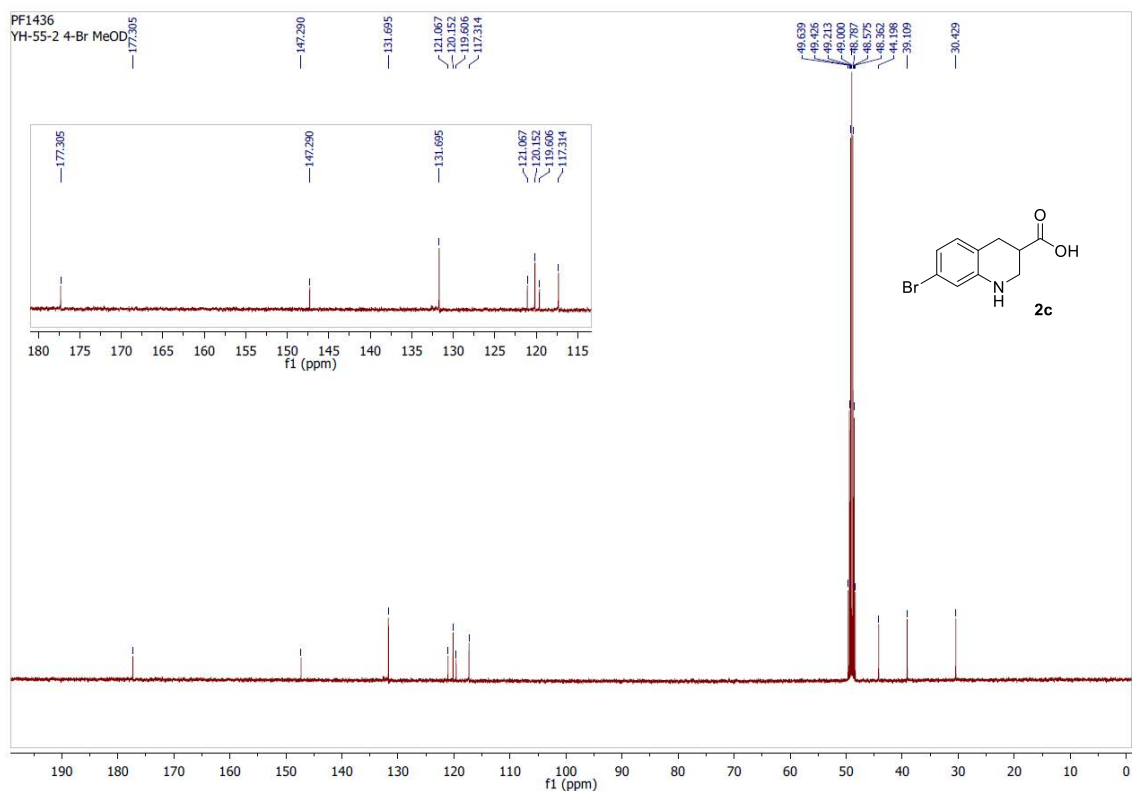


7-Bromo-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (**2c**):

^1H NMR (400 MHz, CD_3OD)

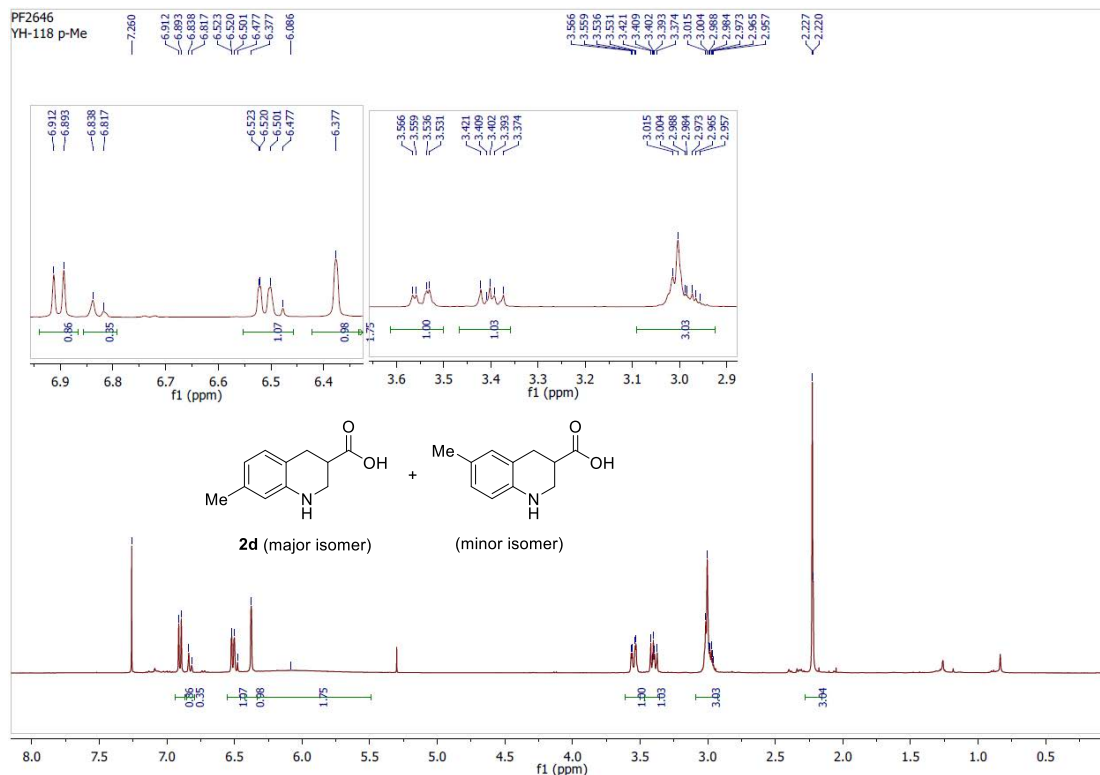


^{13}C NMR (100 MHz, CD_3OD)

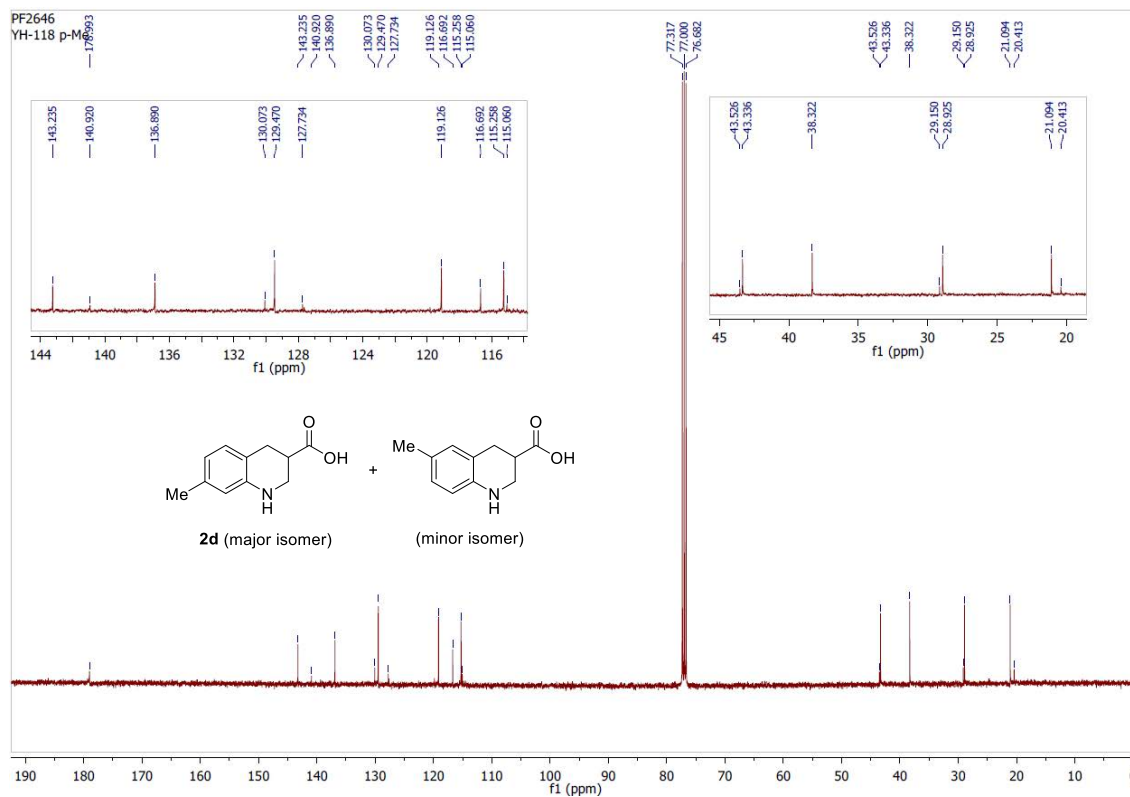


7-Methyl-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (**2d**):

¹H NMR (400 MHz, CDCl₃)

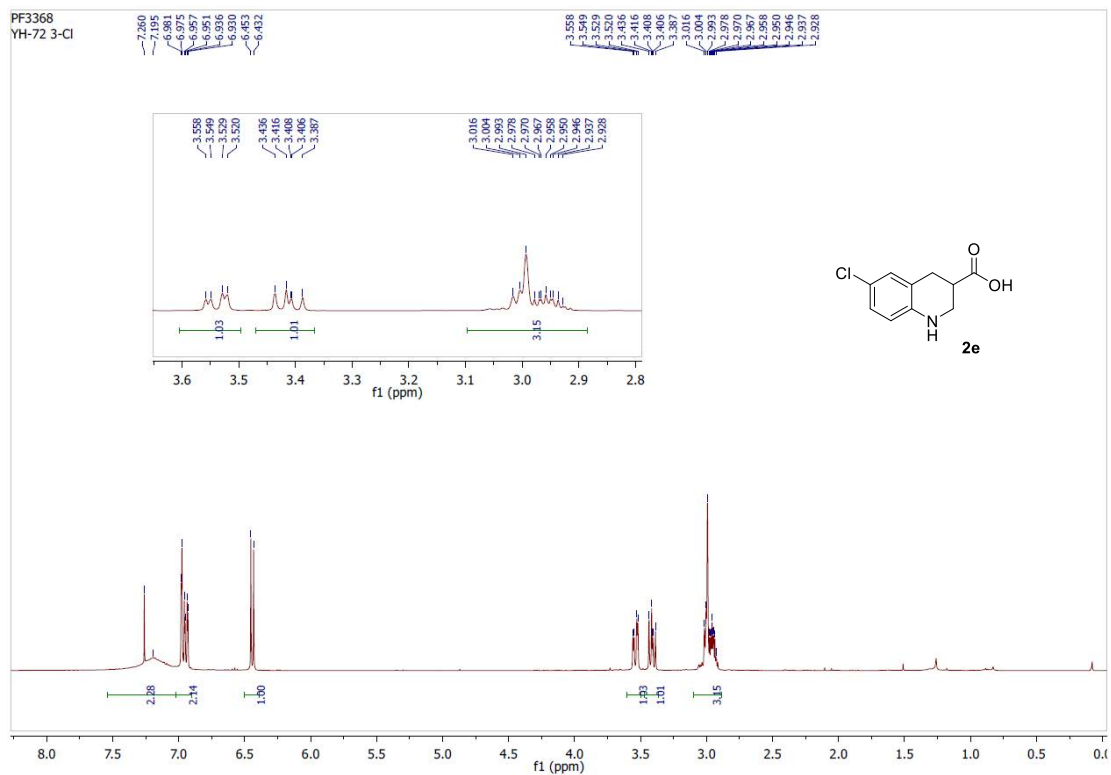


¹³C NMR (100 MHz, CDCl₃)

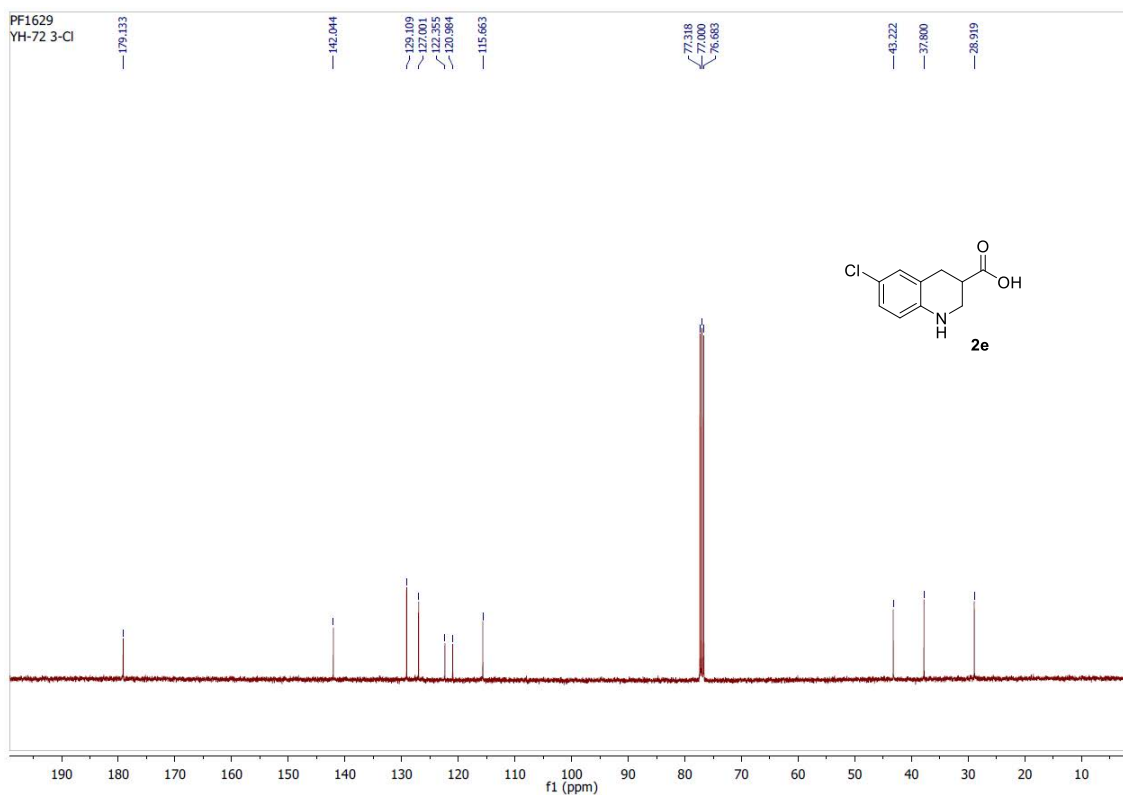


6-Chloro-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2e):

¹H NMR (400 MHz, CDCl₃)

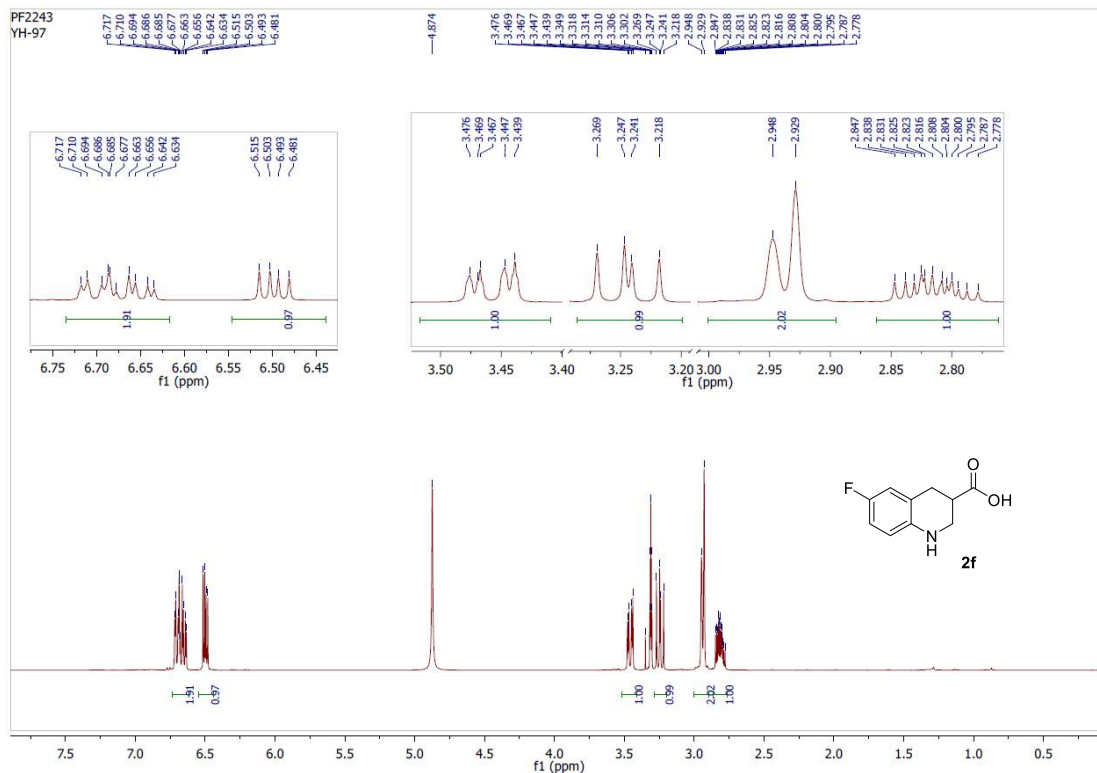


¹³C NMR (100 MHz, CDCl₃)

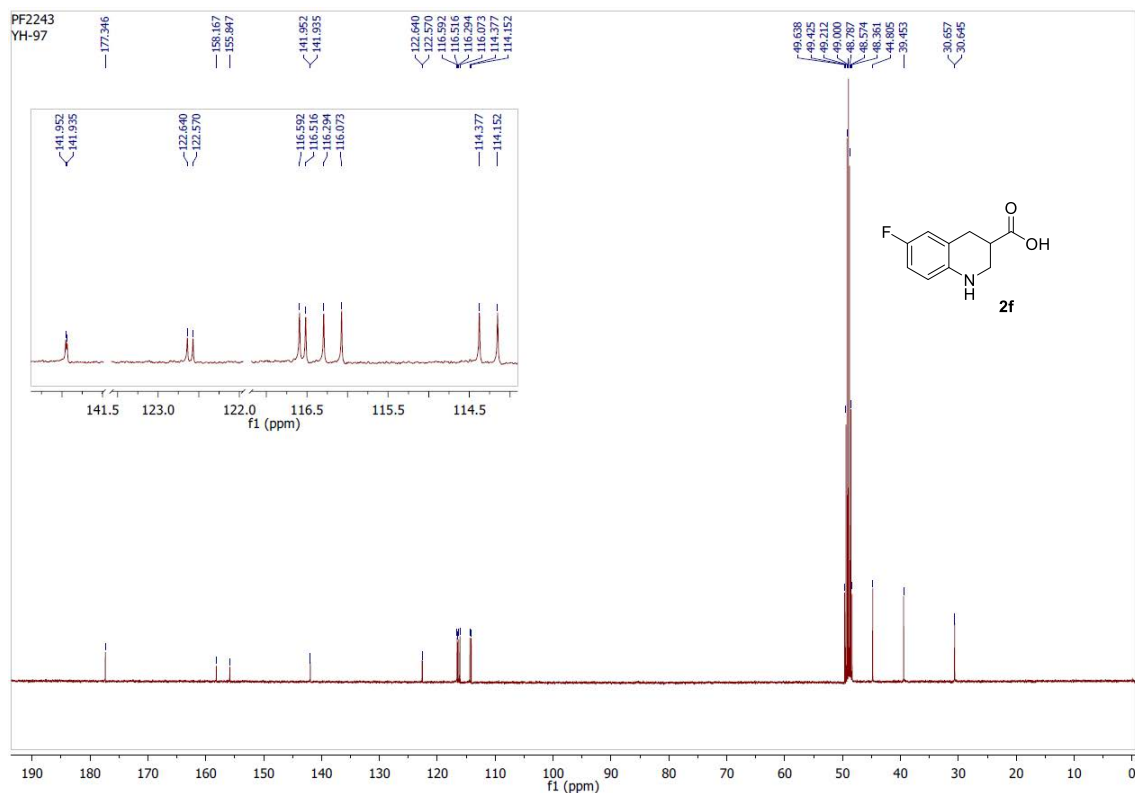


6-Fluoro-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (**2f**):

^1H NMR (400 MHz, CD_3OD)

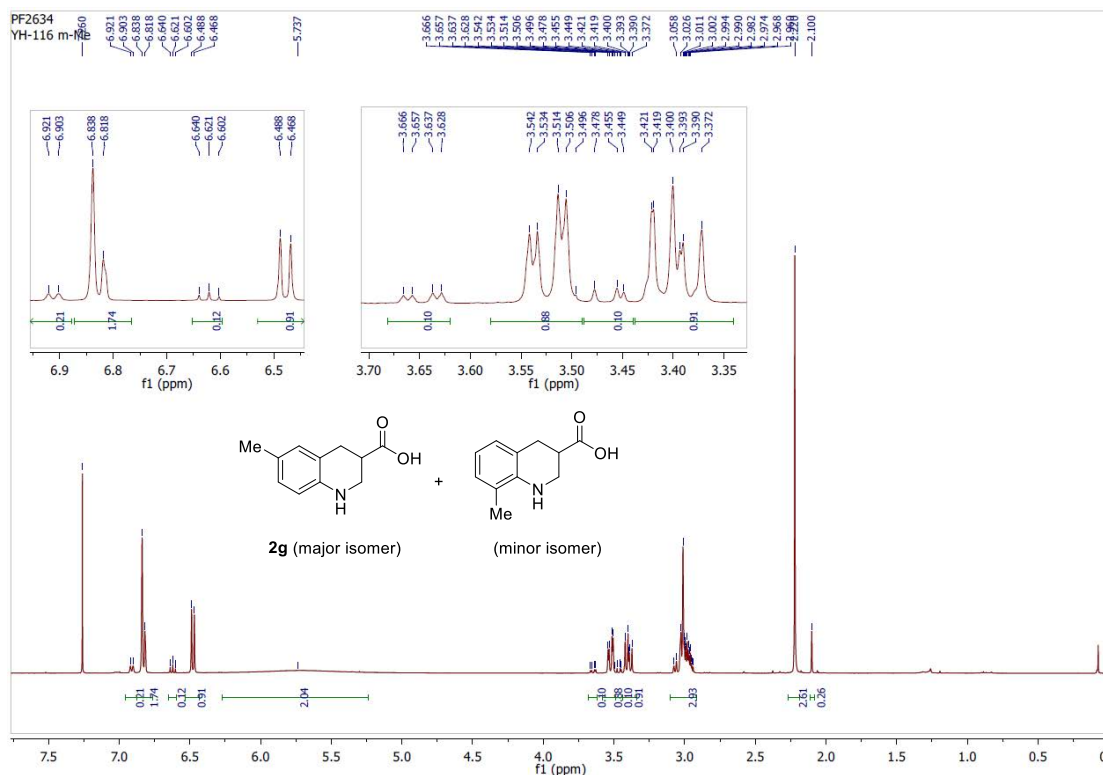


^{13}C NMR (100 MHz, CD_3OD)

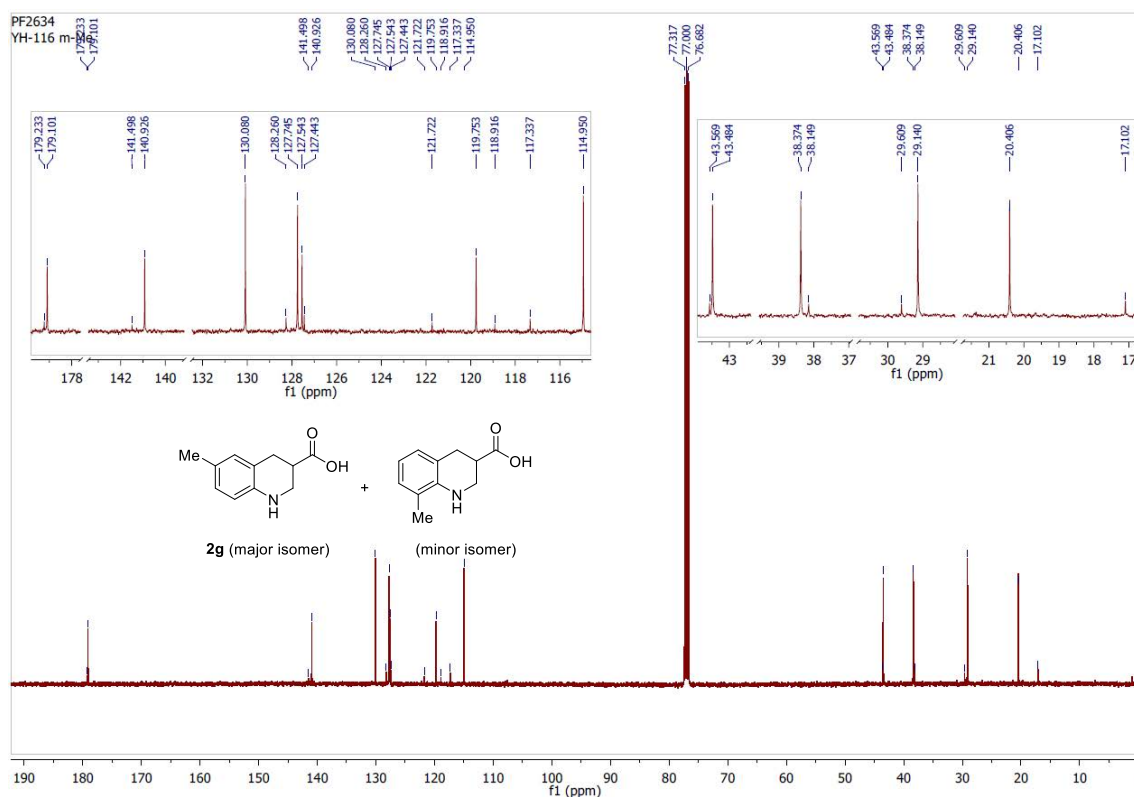


6-Methyl-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (**2g**):

^1H NMR (400 MHz, CDCl_3)

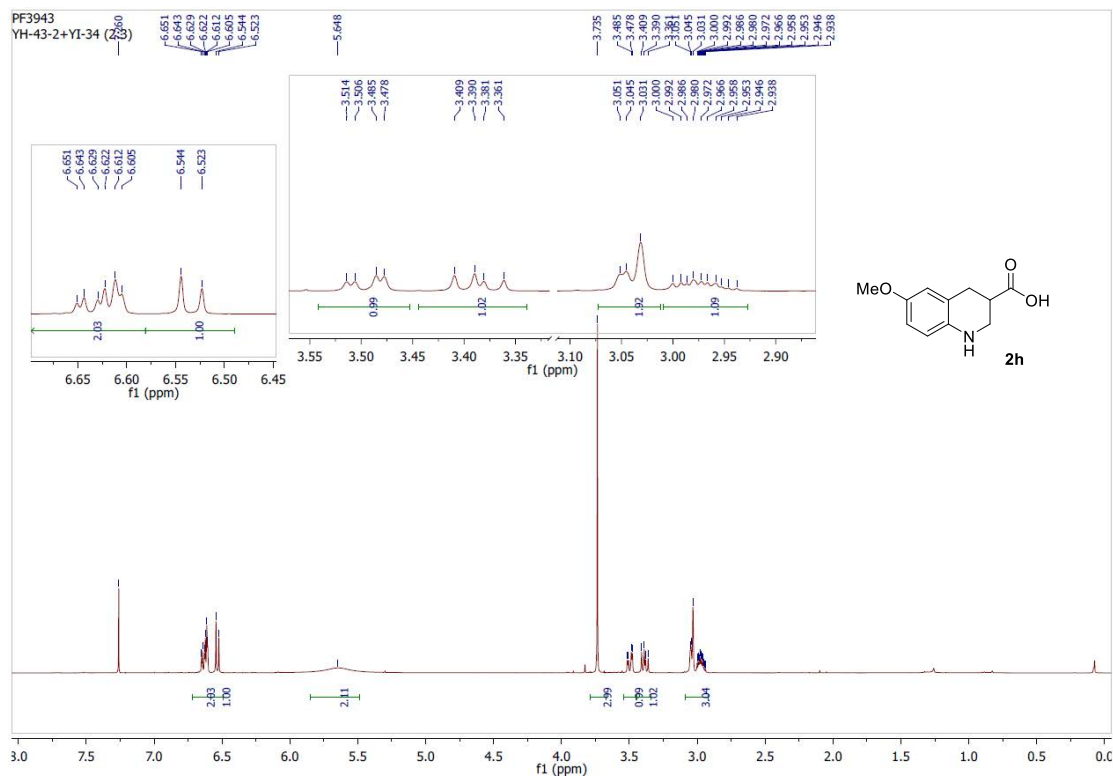


^{13}C NMR (100 MHz, CDCl_3)

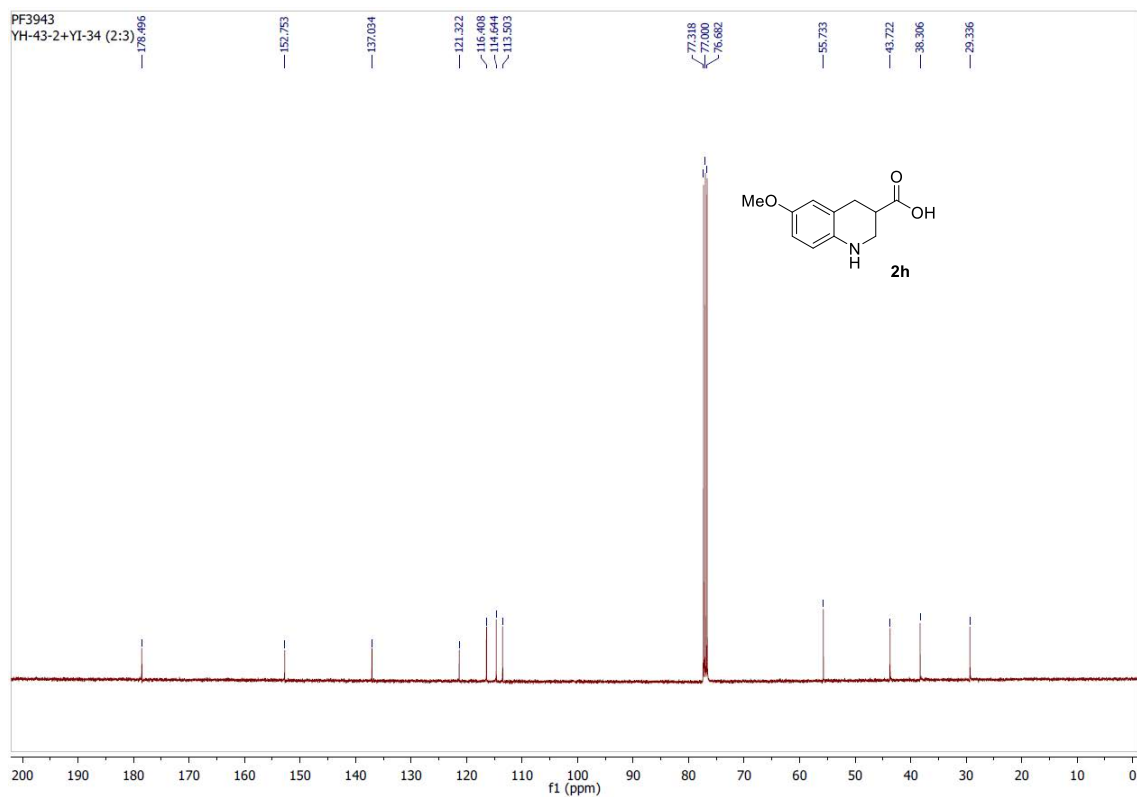


6-Methoxy-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2h):

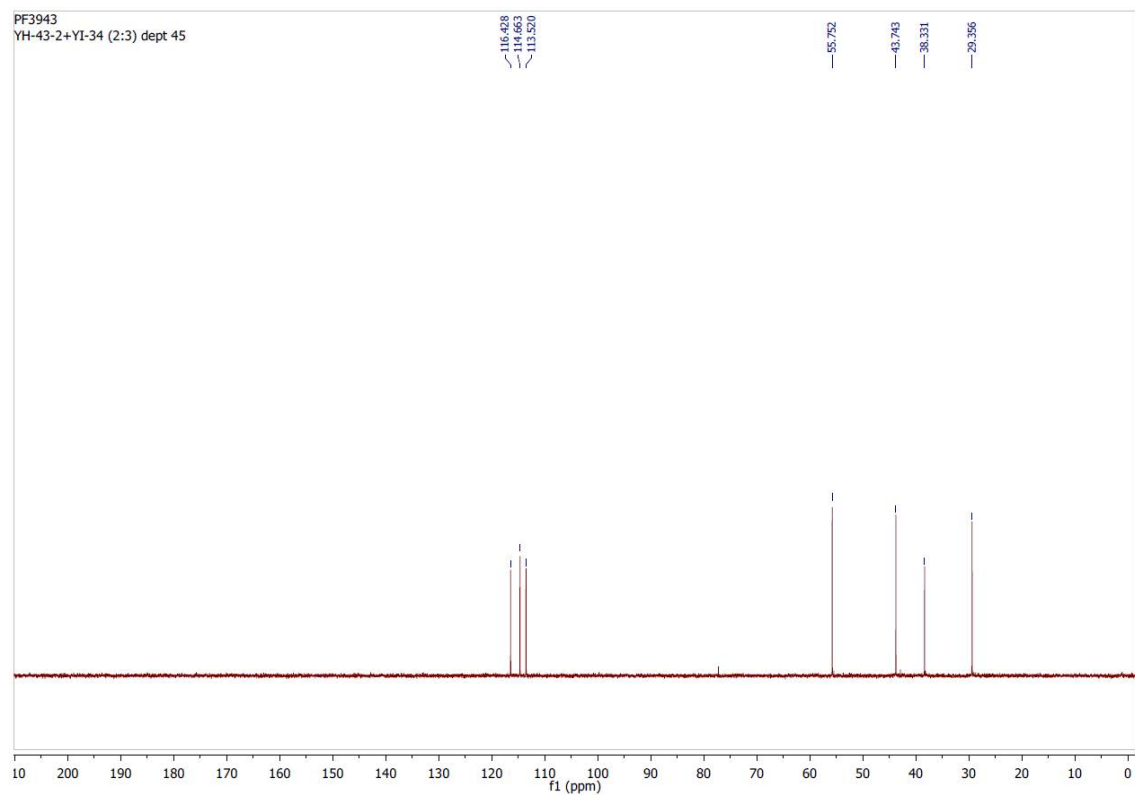
¹H NMR (400 MHz, CDCl₃)



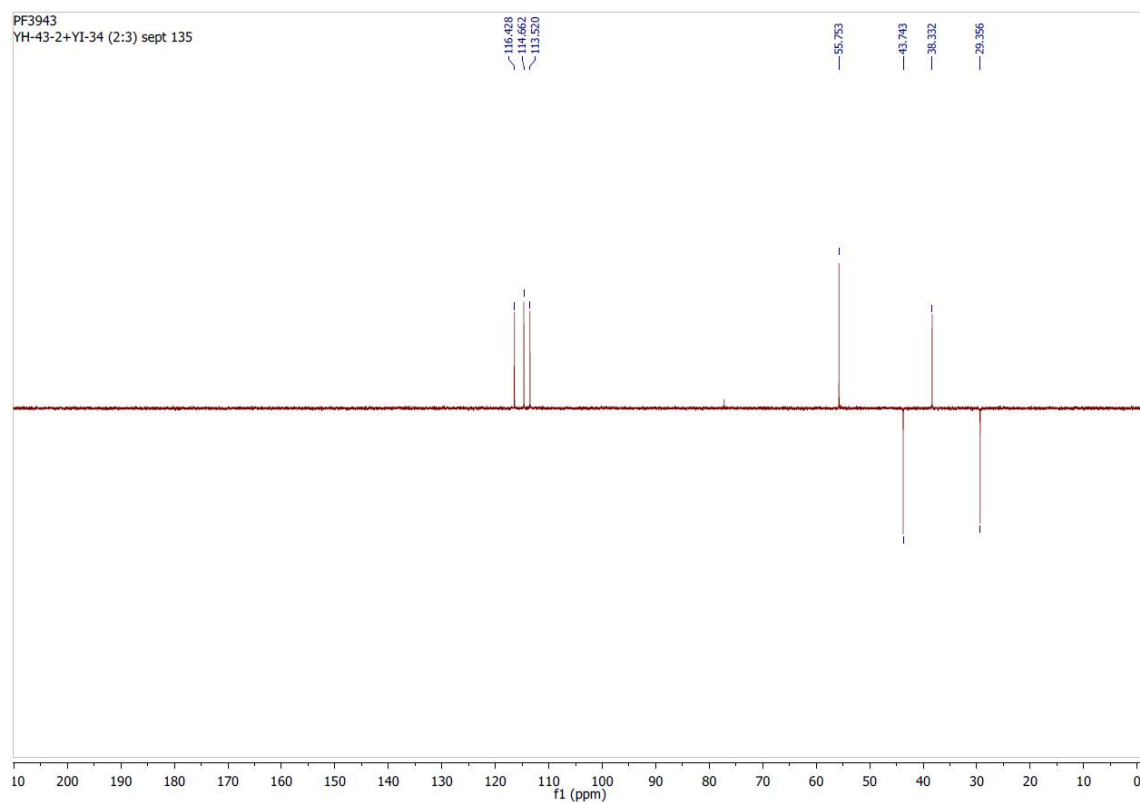
¹³C NMR (100 MHz, CDCl₃)



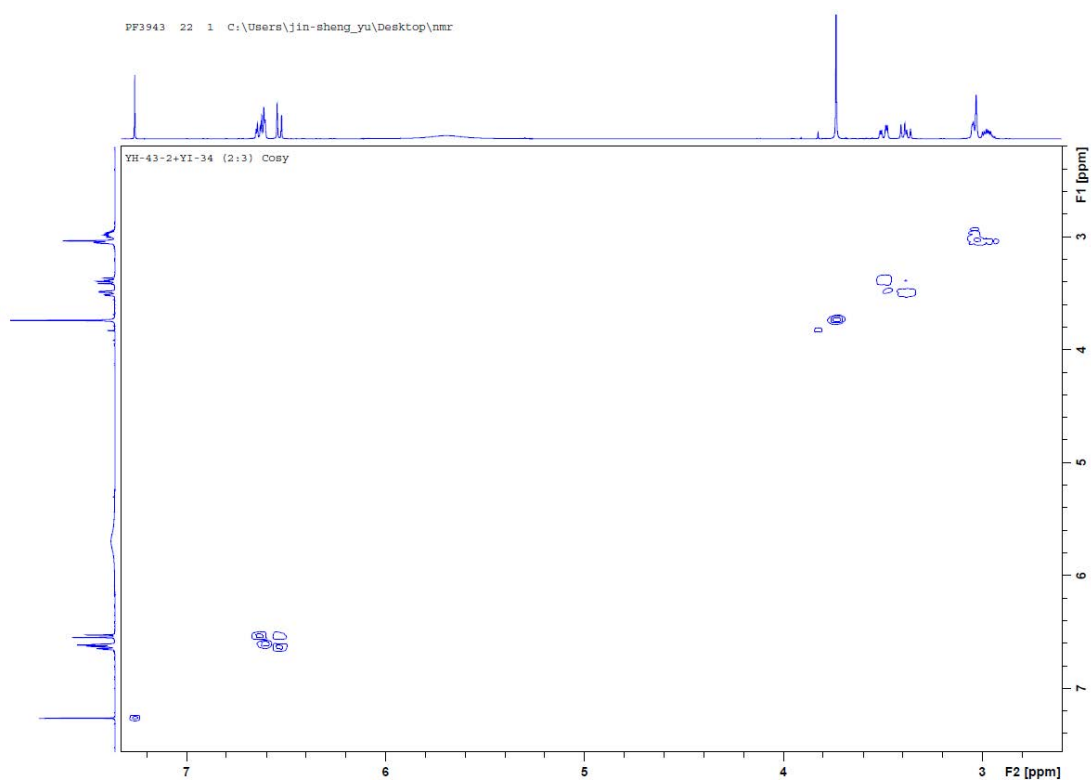
DEPT 45 (100 MHz, CDCl₃) for **2h**



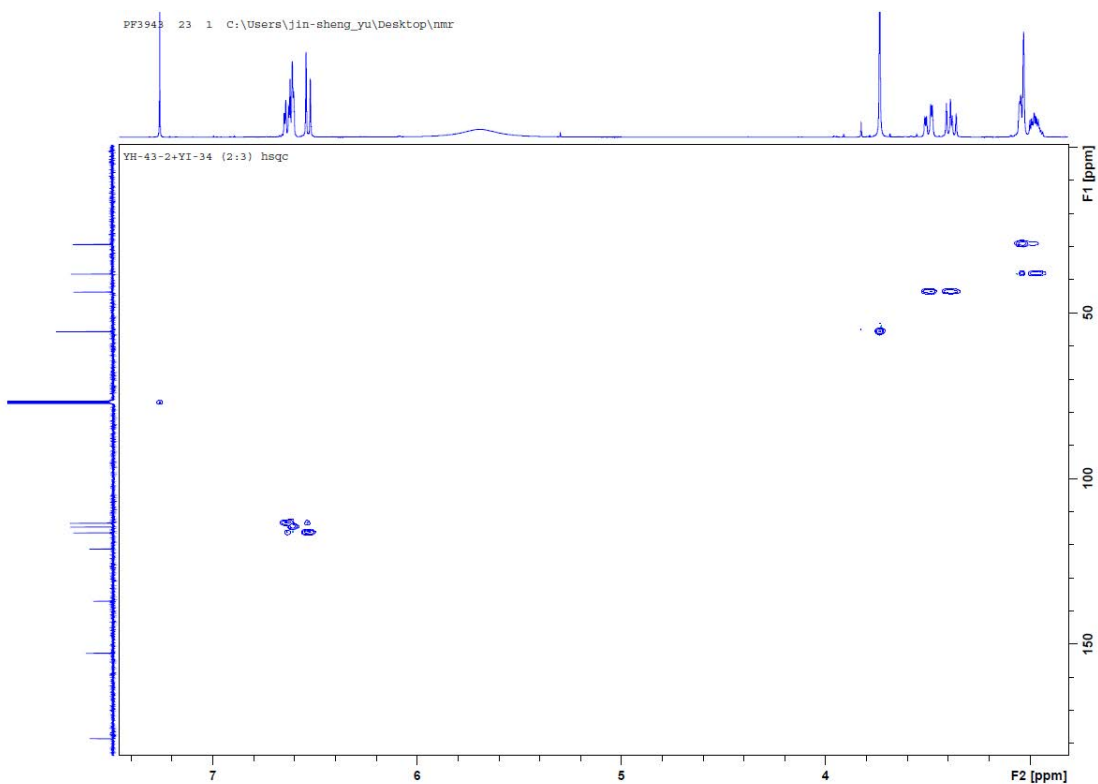
DEPT 135 (100 MHz, CDCl₃) for **2h**



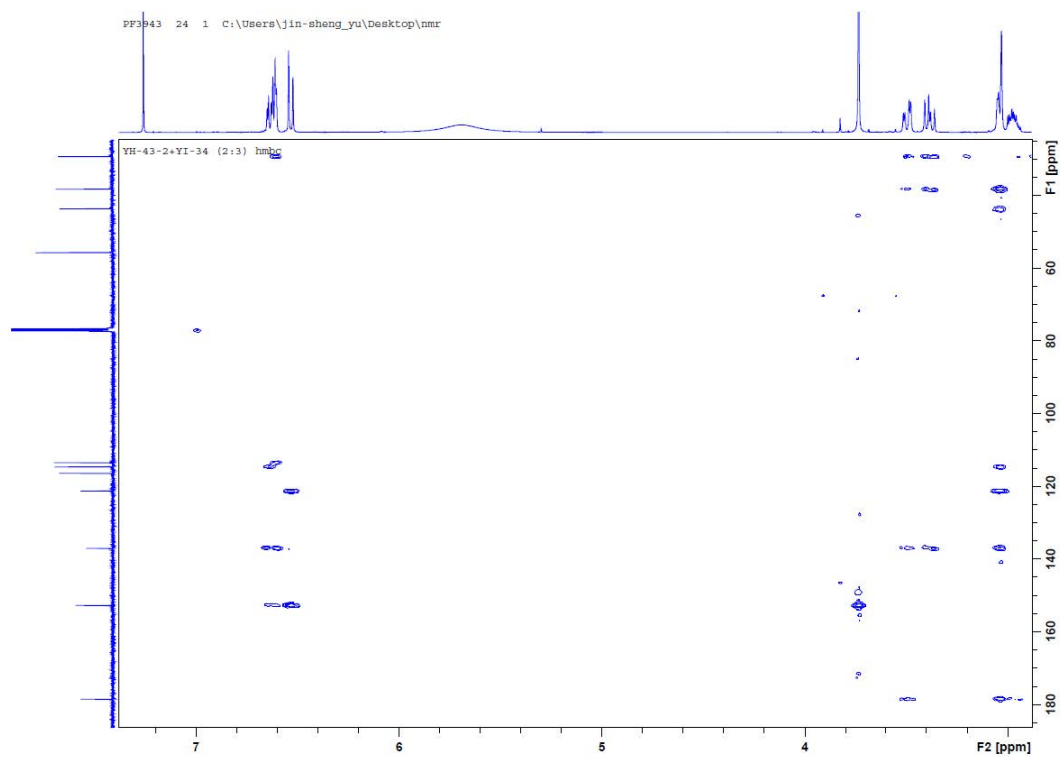
H-H COSY (400 MHz, CDCl₃) for 2h



HSQC (400 MHz, CDCl₃) for 2h

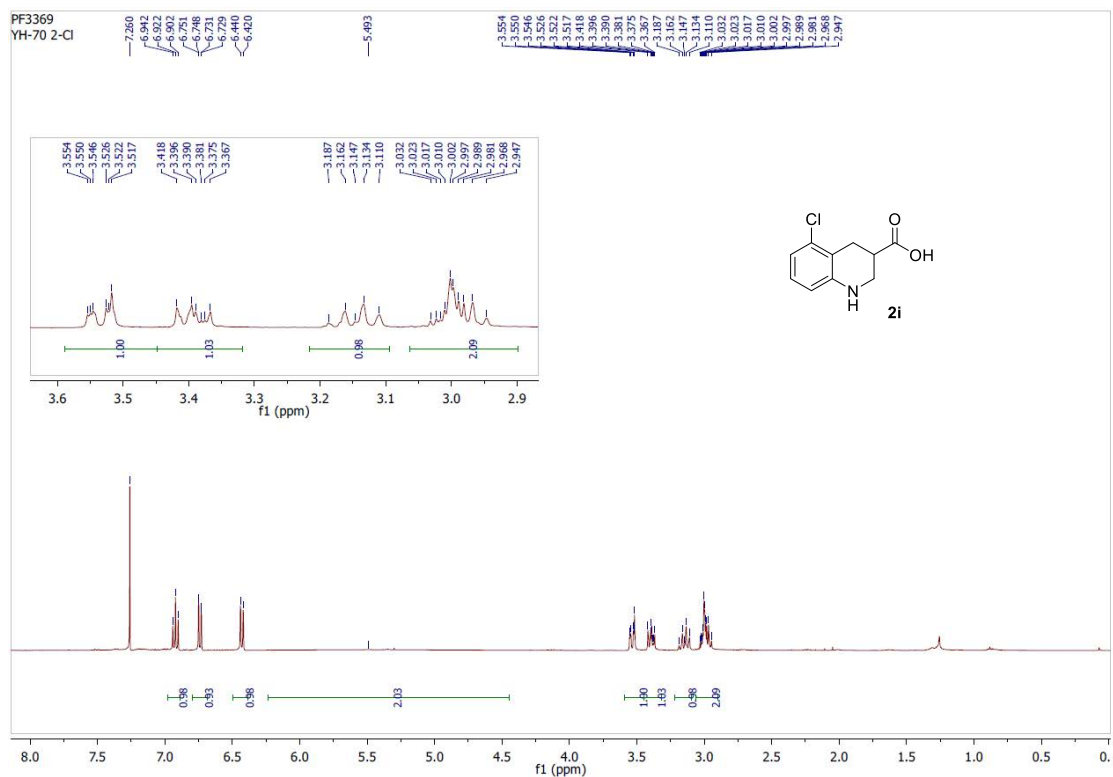


HMBC (400 MHz, CDCl₃) for 2h

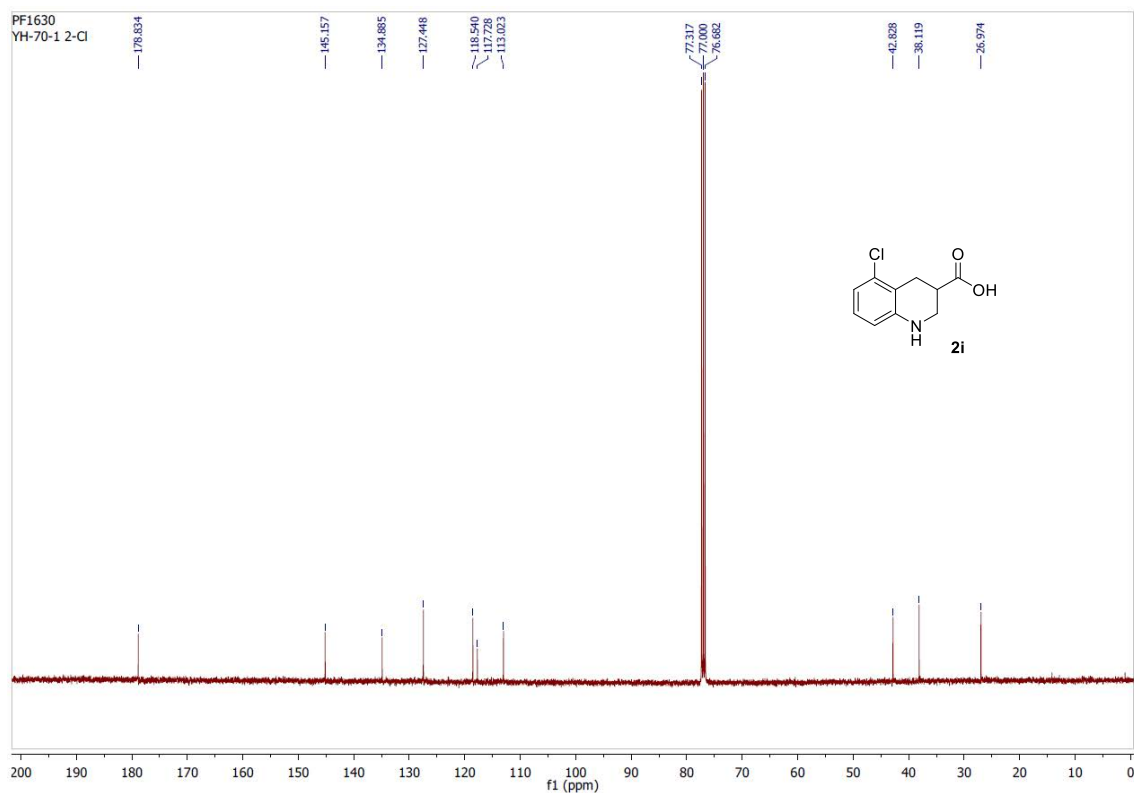


5-Chloro-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2i):

^1H NMR (400 MHz, CDCl_3)

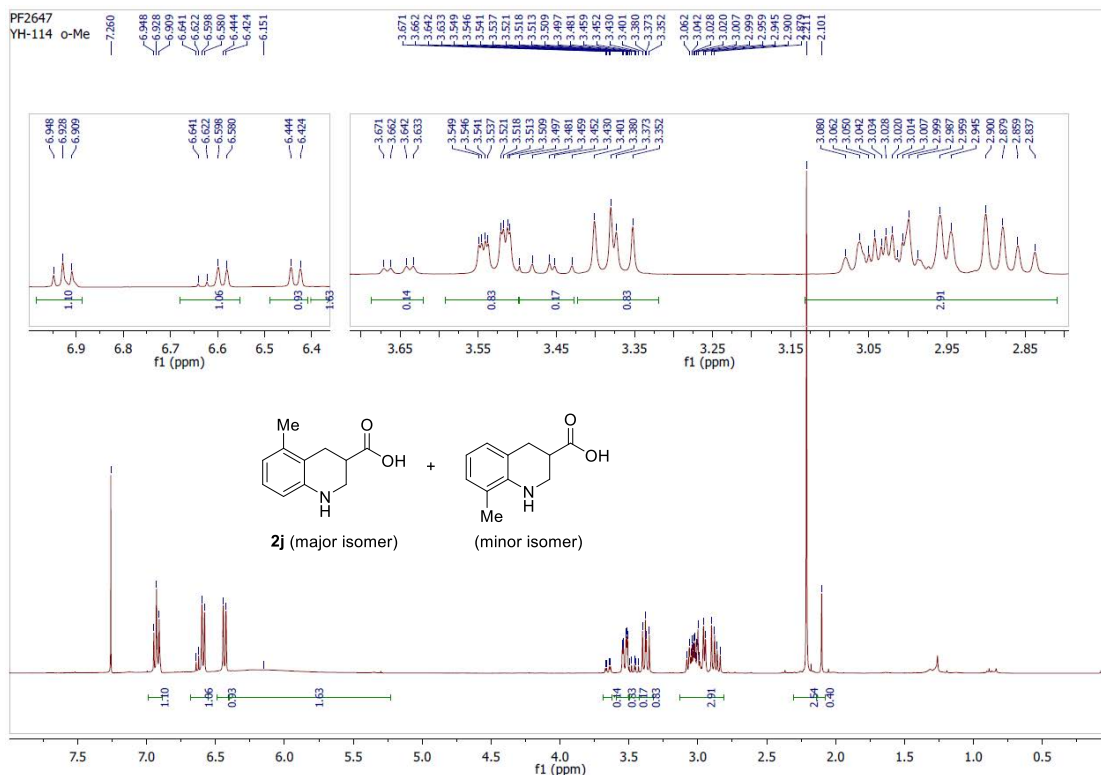


^{13}C NMR (100 MHz, CDCl_3)

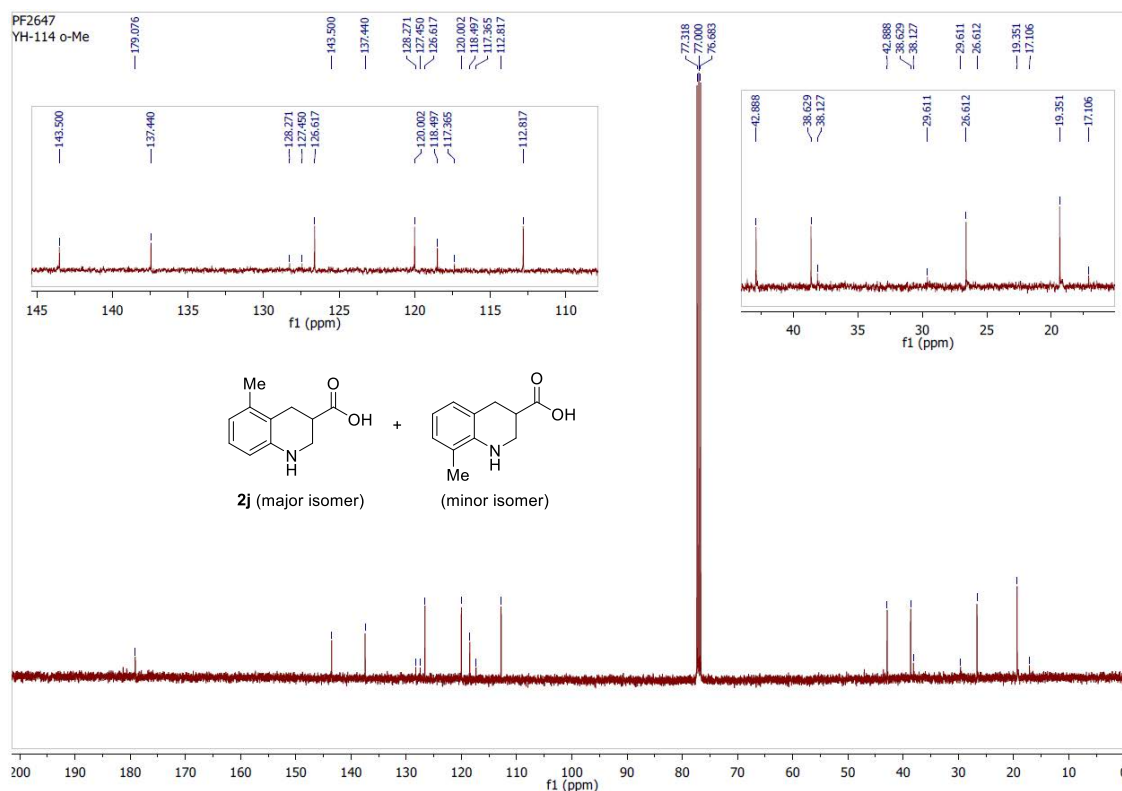


5-Methyl-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (**2j**):

^1H NMR (400 MHz, CDCl_3)

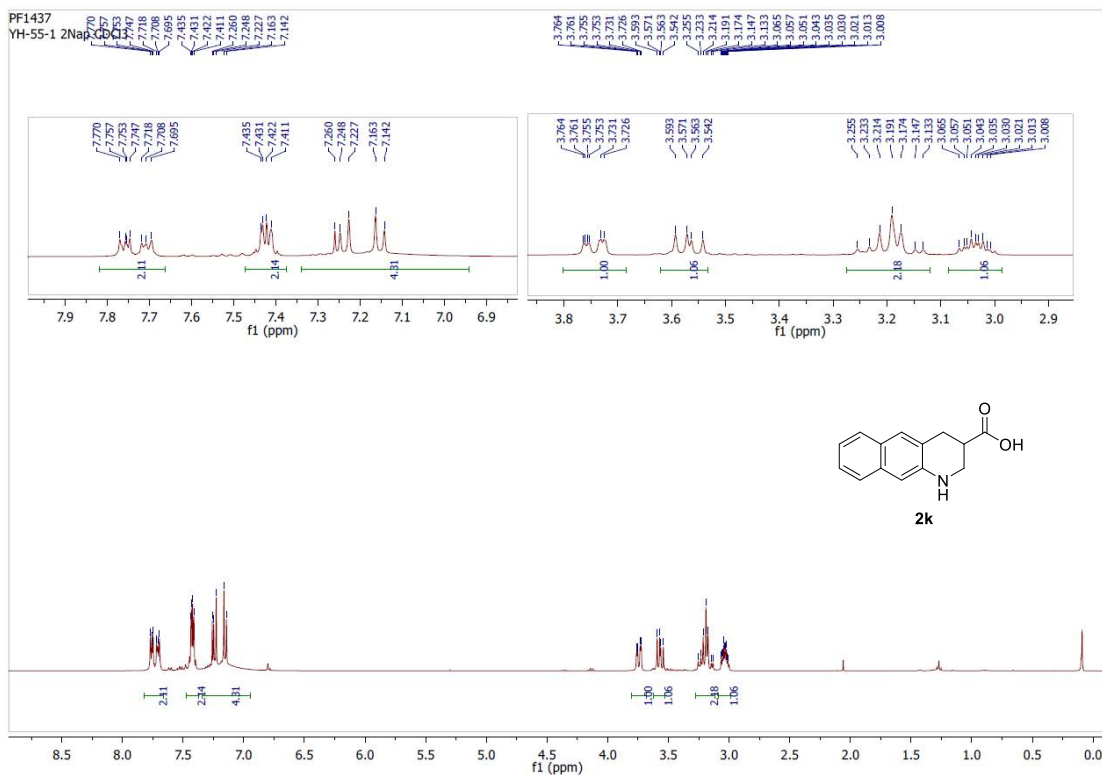


^{13}C NMR (100 MHz, CDCl_3)

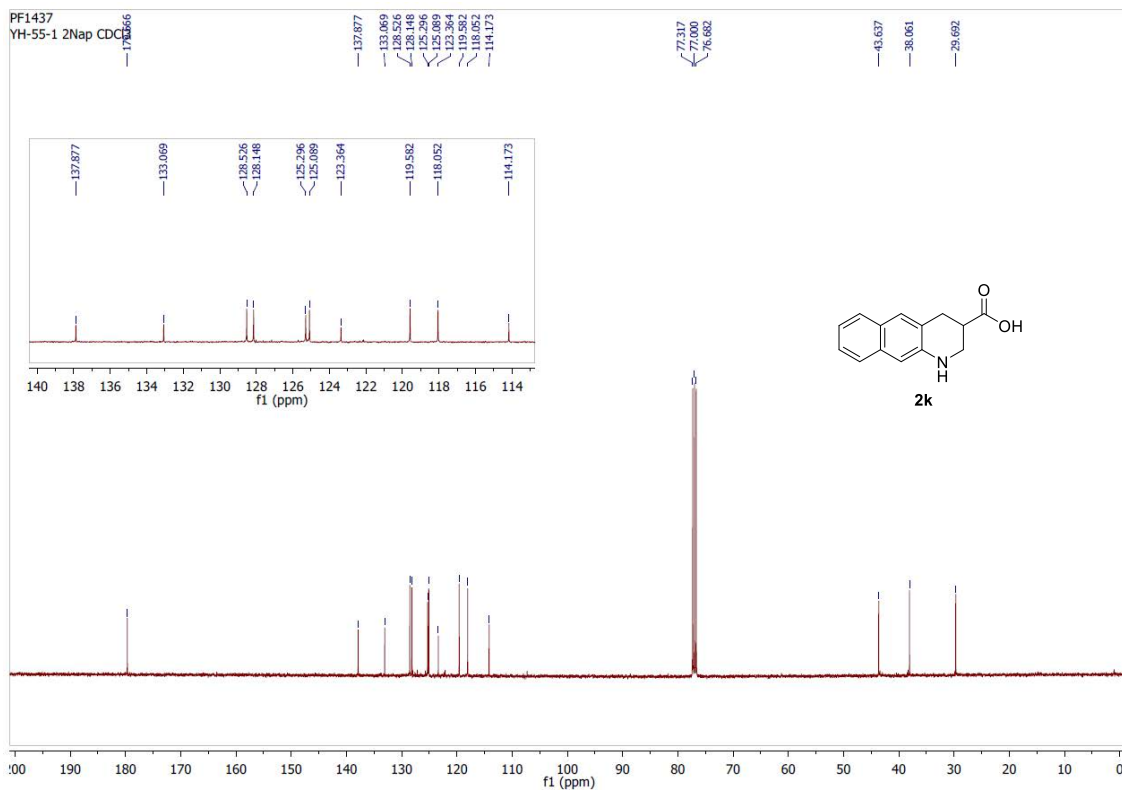


1,2,3,4-Tetrahydrobenzo[*g*]quinoline-3-carboxylic acid (**2k**):

¹H NMR (400 MHz, CDCl₃)

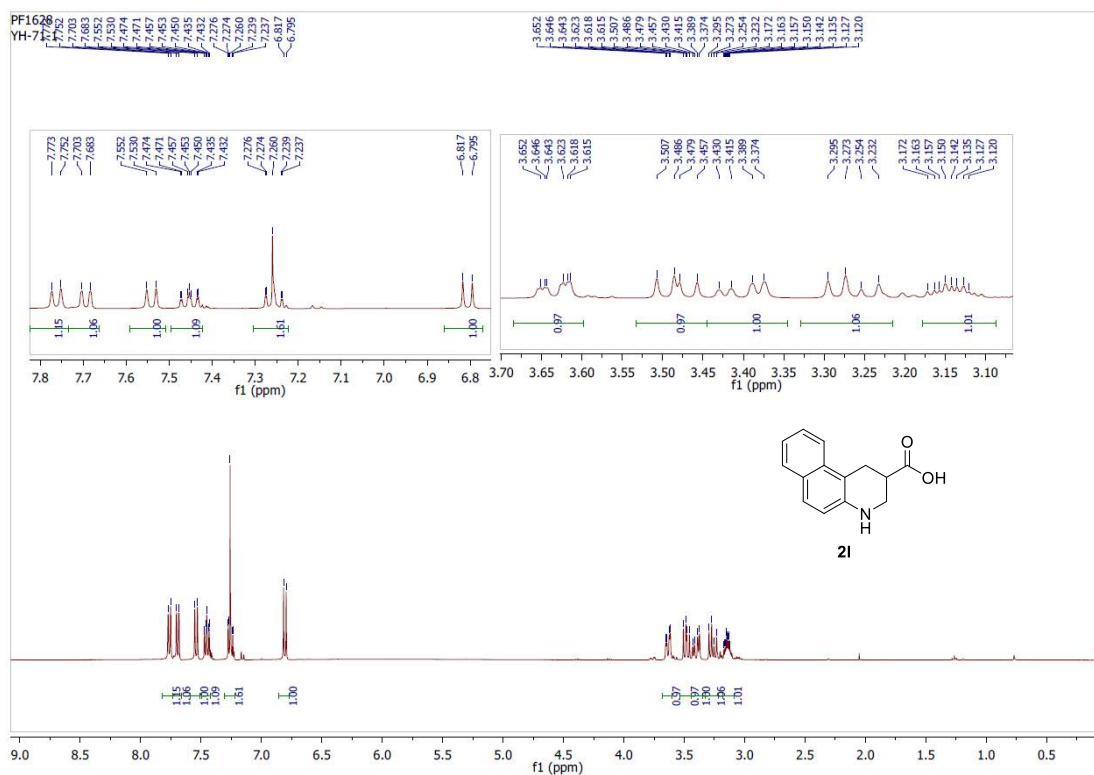


¹³C NMR (100 MHz, CDCl₃)

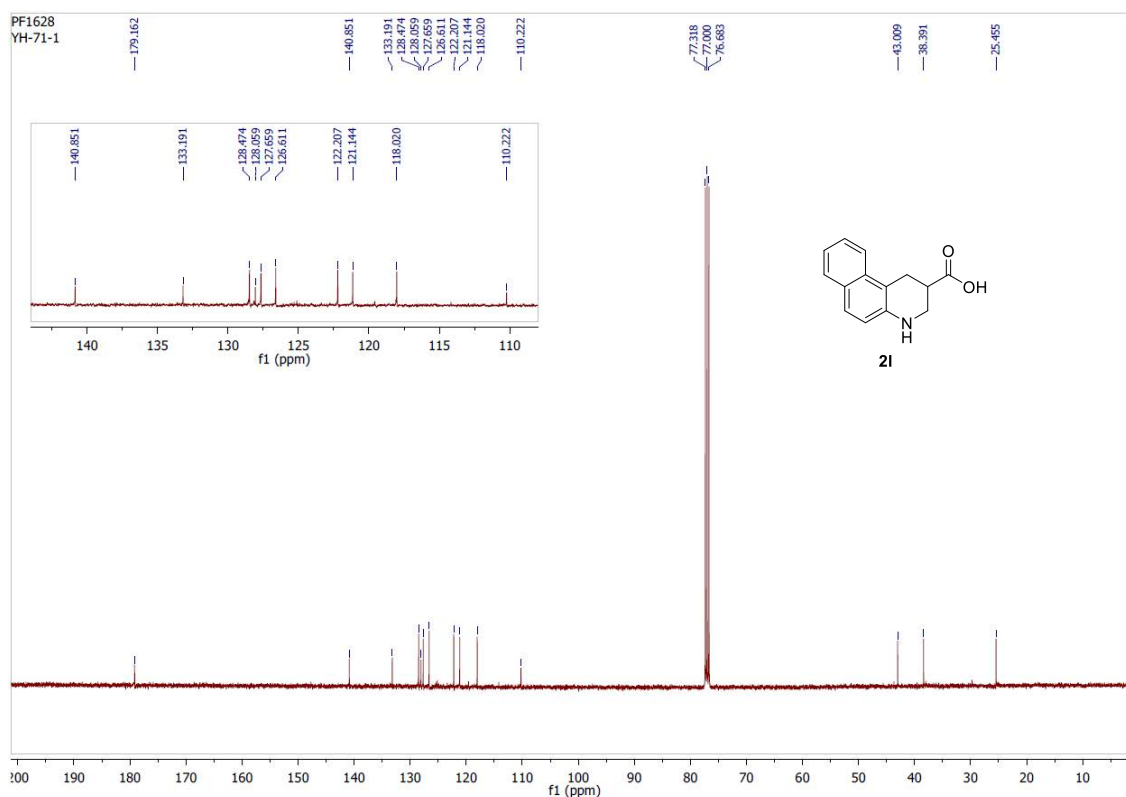


1,2,3,4-Tetrahydrobenzo[f]quinoline-2-carboxylic acid (**2I**):

^1H NMR (400 MHz, CDCl_3)

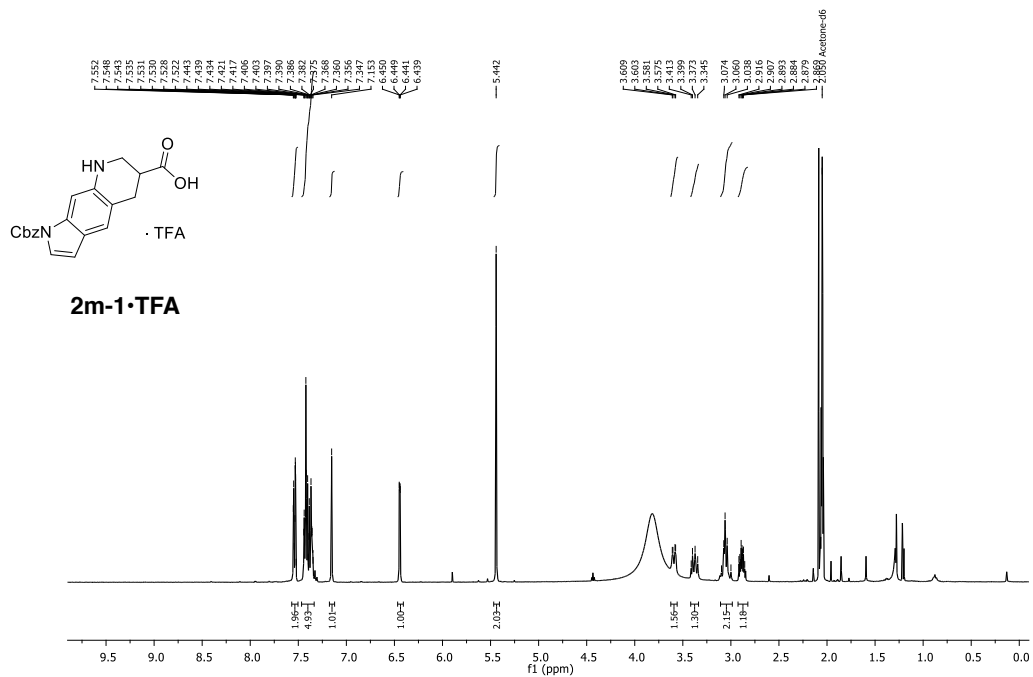


^{13}C NMR (100 MHz, CDCl_3)

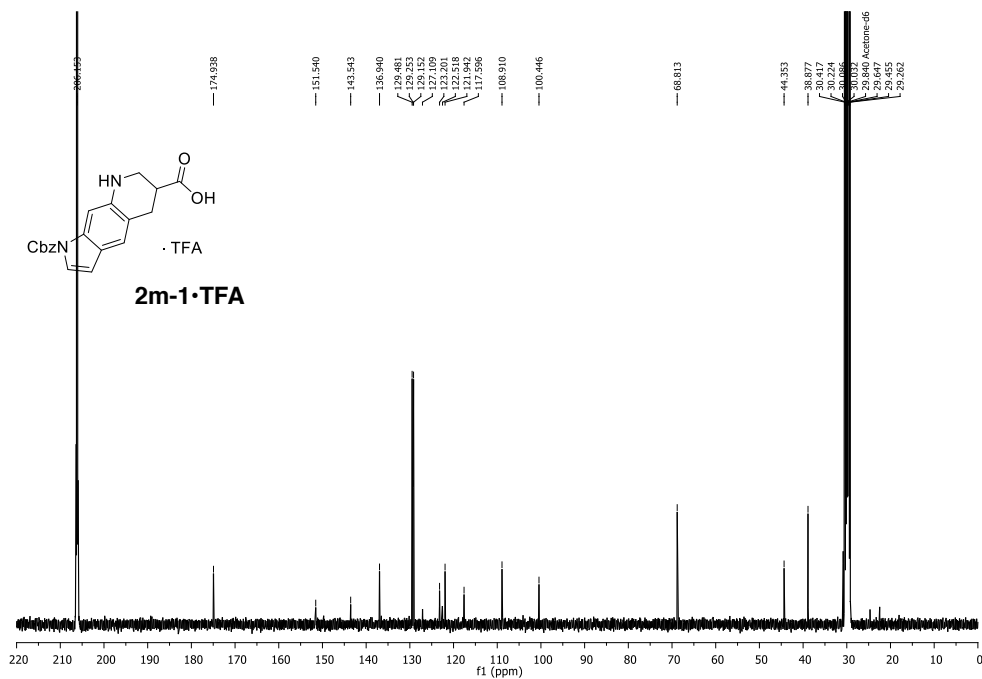


1-((Benzyloxy)carbonyl)-6-carboxy-5,6,7,8-tetrahydro-1H-pyrrolo[3,2-g]quinolin-8-ium trifluoro acetate
(2m-1•TFA):

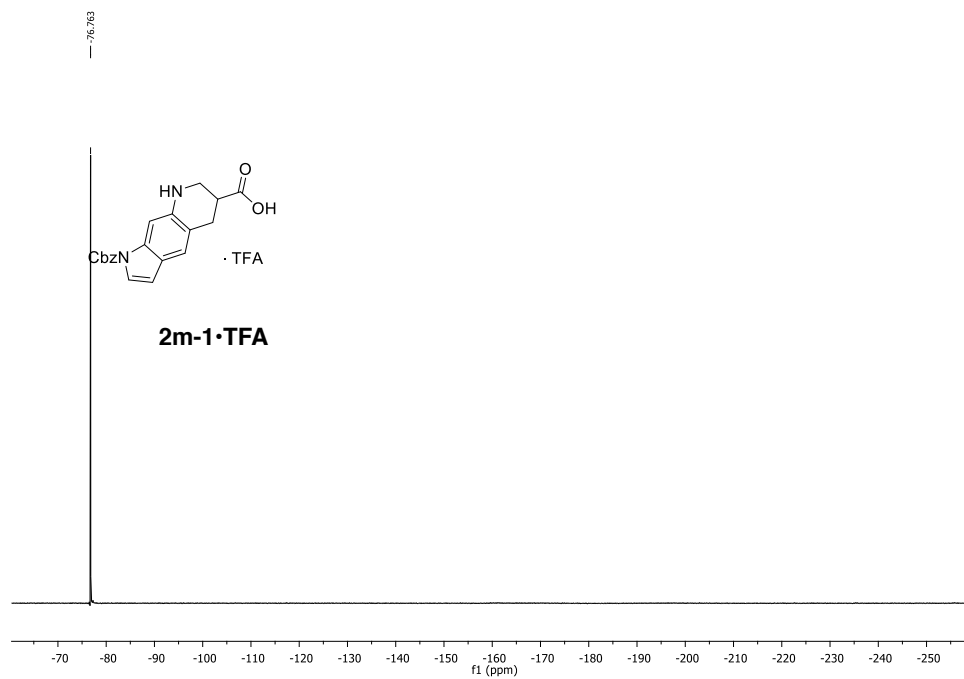
¹H NMR (400 MHz, Acetone-d₆)



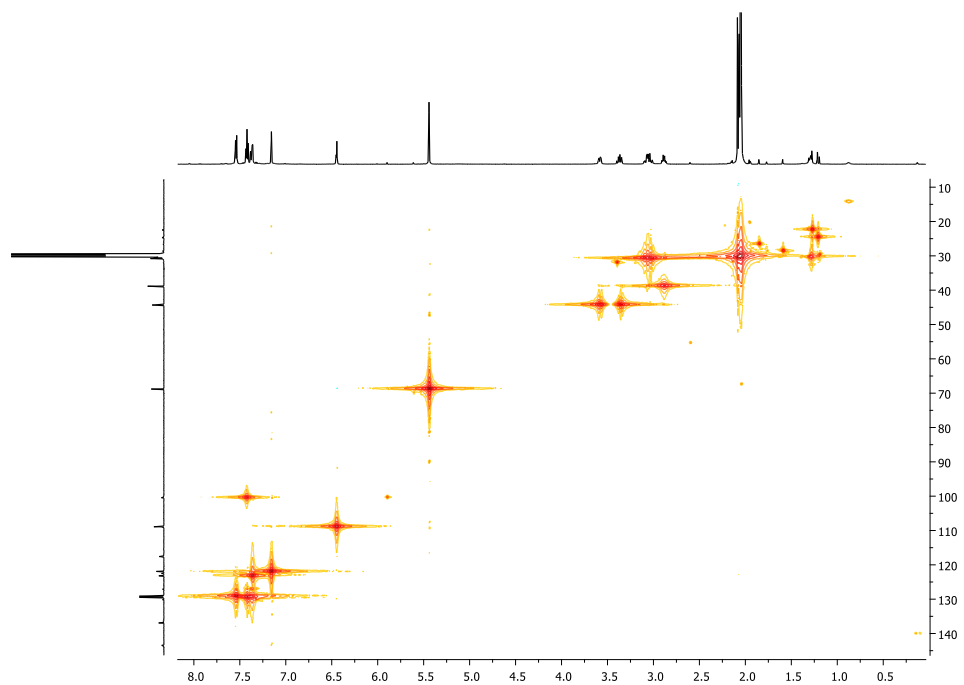
¹³C NMR (100 MHz, Acetone-d₆)



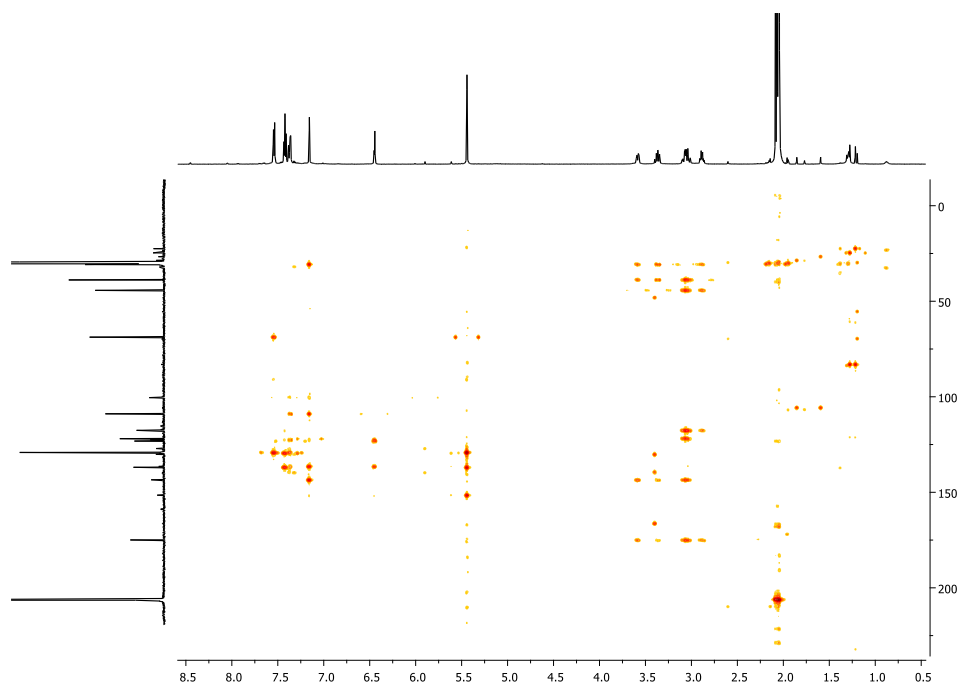
^1H NMR (376 MHz, Acetone- d_6)



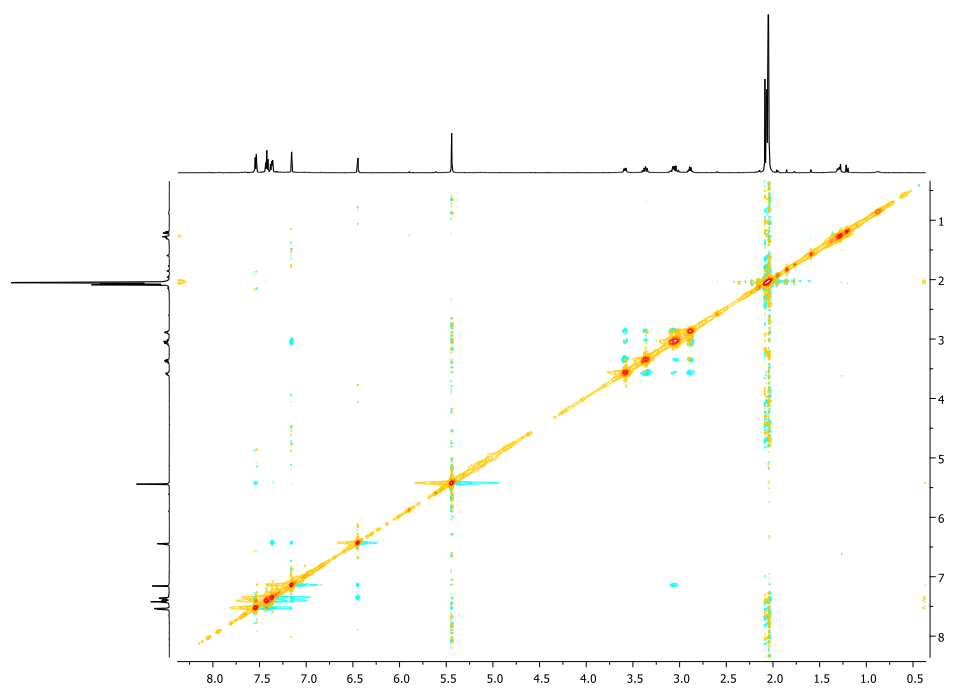
HMQC (400 MHz, Acetone- d_6)



HMBC (400 MHz, Acetone-d₆)

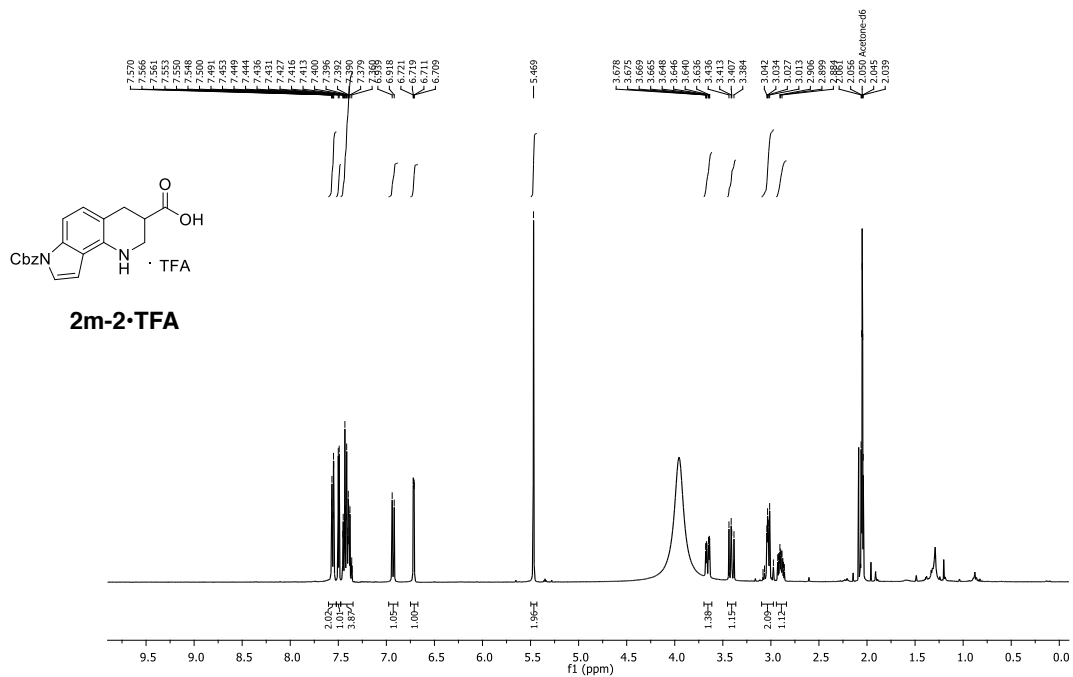


NOESY (400 MHz, Acetone-d₆)

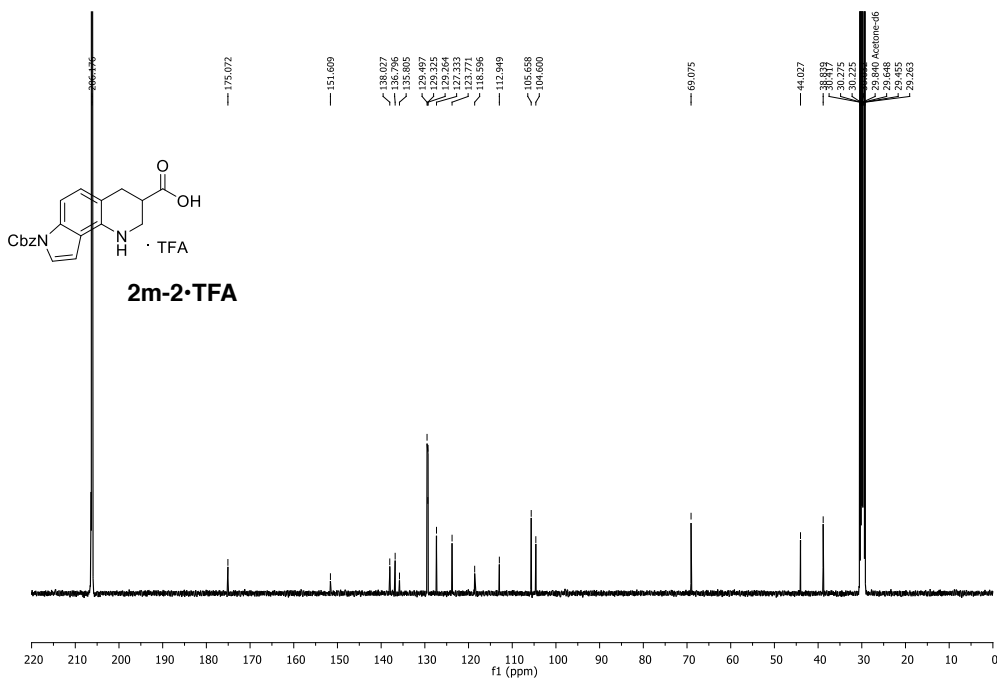


7-((Benzyloxy)carbonyl)-3-carboxy-2,3,4,7-tetrahydro-1H-pyrrolo[2,3-h]quinolin-1-ium trifluoro acetate
(2m-2•TFA):

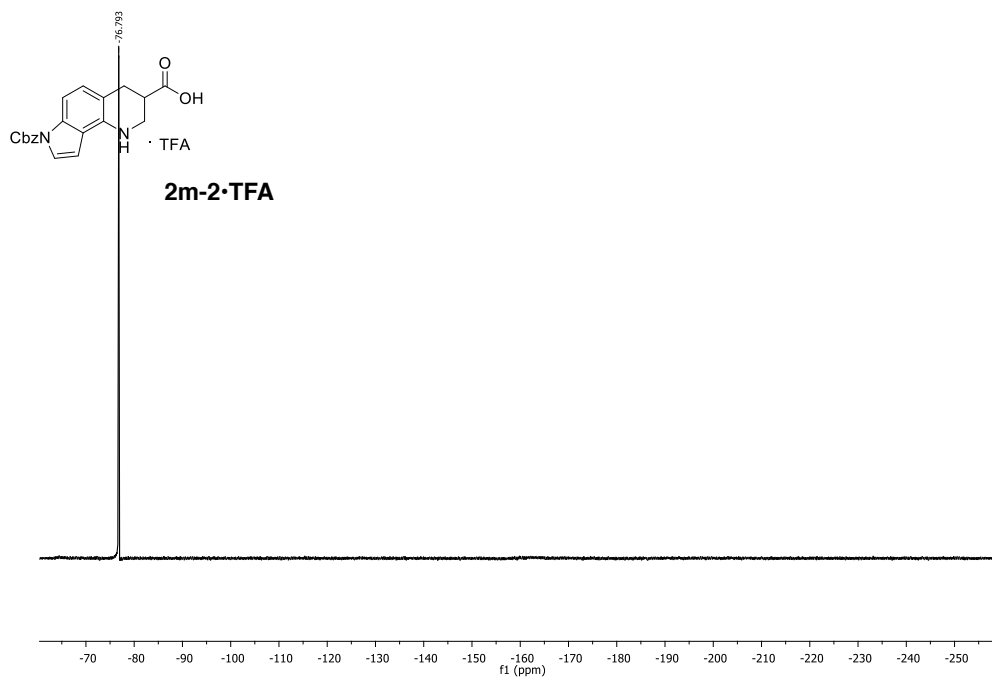
¹H NMR (400 MHz, Acetone-d₆)



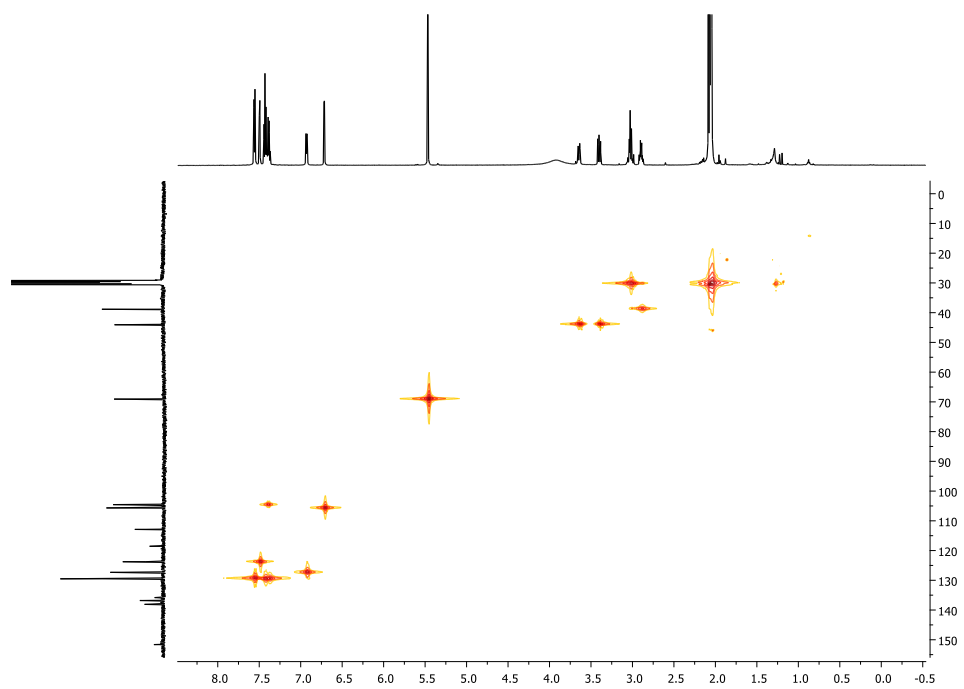
¹³C NMR (100 MHz, Acetone-d₆)



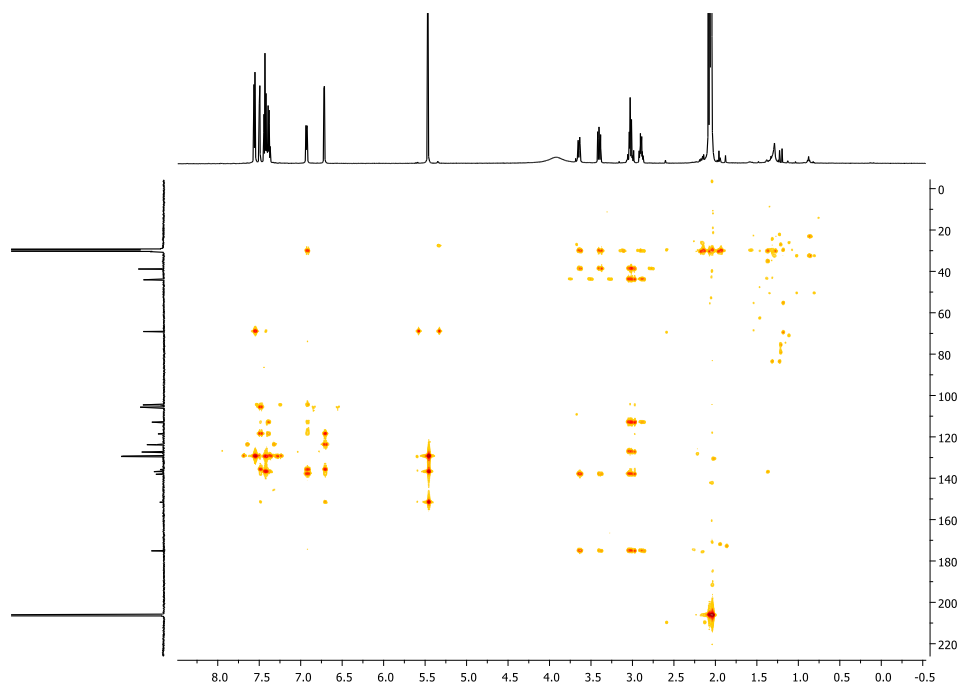
^{19}F NMR (376 MHz, Acetone- d_6)



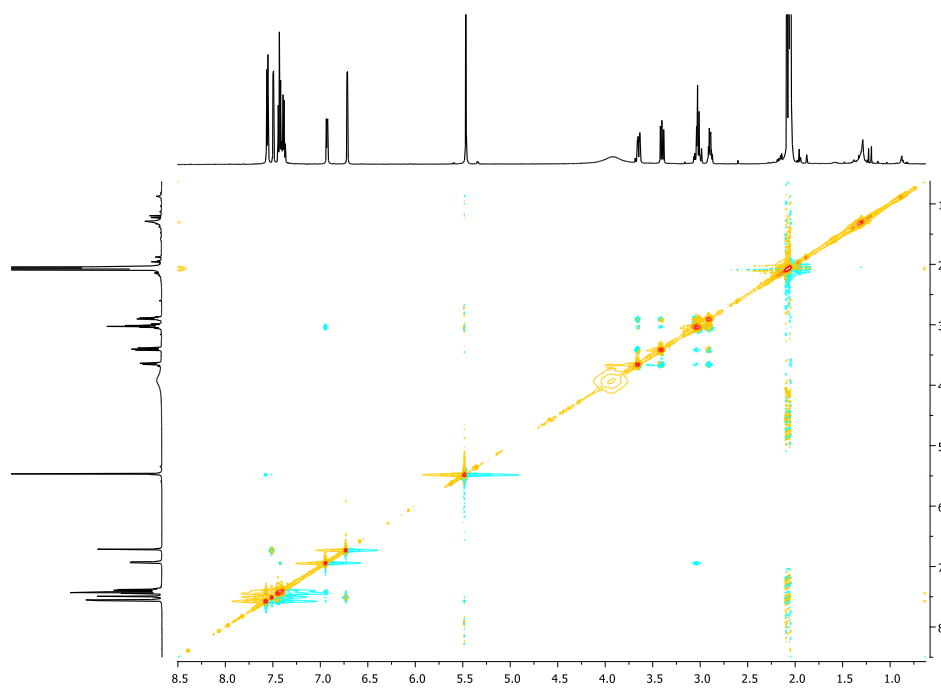
HMQC (400 MHz, Acetone- d_6)



HMBC (400 MHz, CDCl₃)

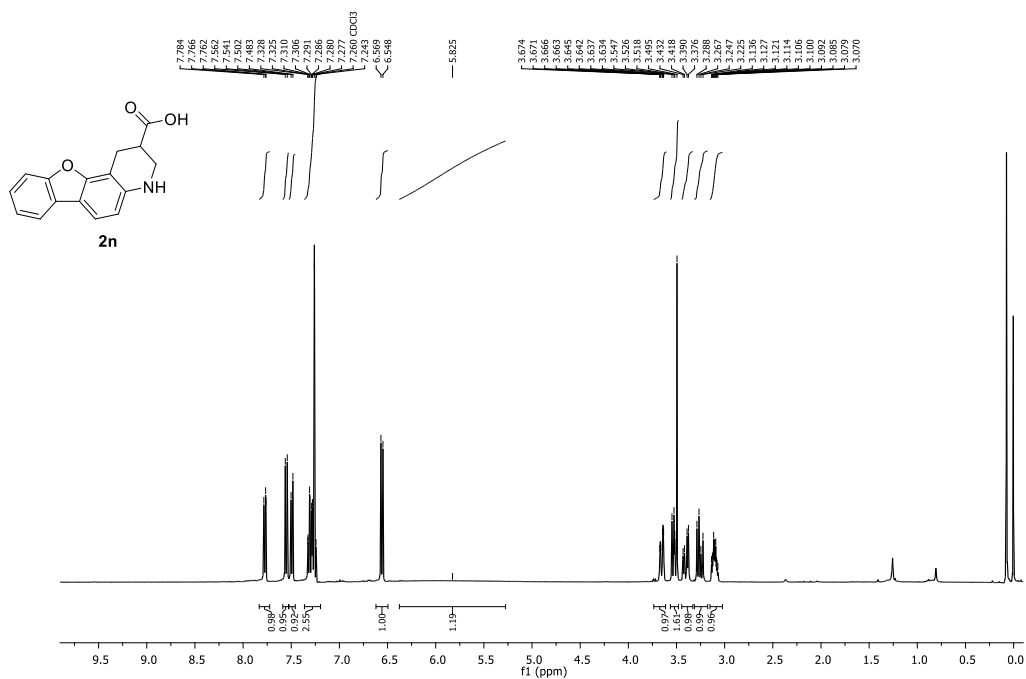


NOESY (400 MHz, Acetone-d₆)

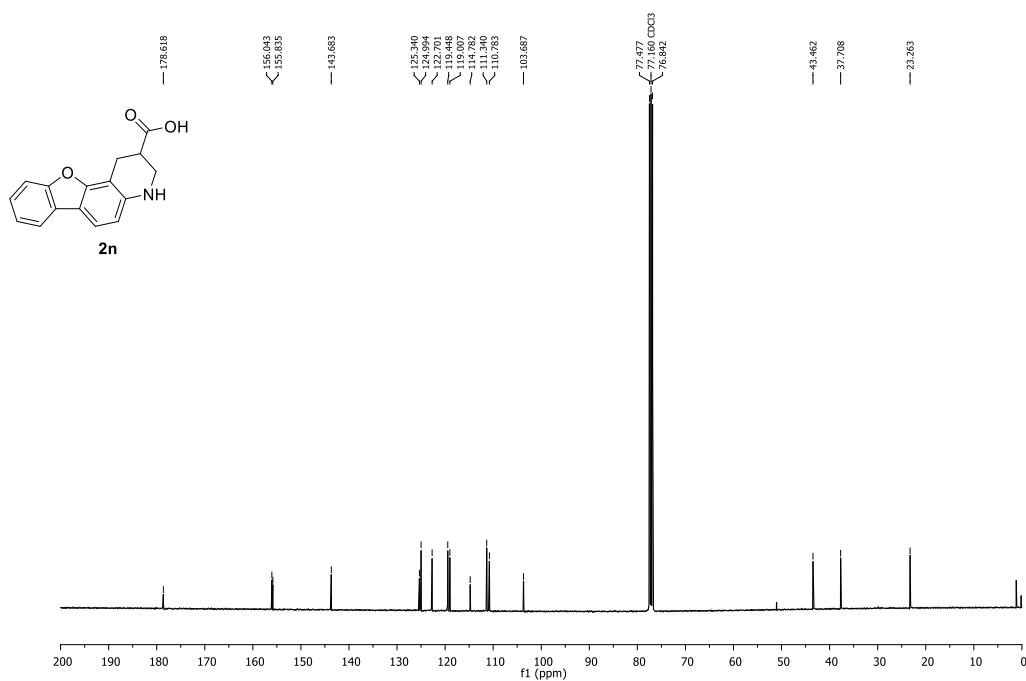


1,2,3,4-Tetrahydrobenzofuro[2,3-f]quinoline-2-carboxylic acid (**2n**):

^1H NMR (400 MHz, CDCl_3)

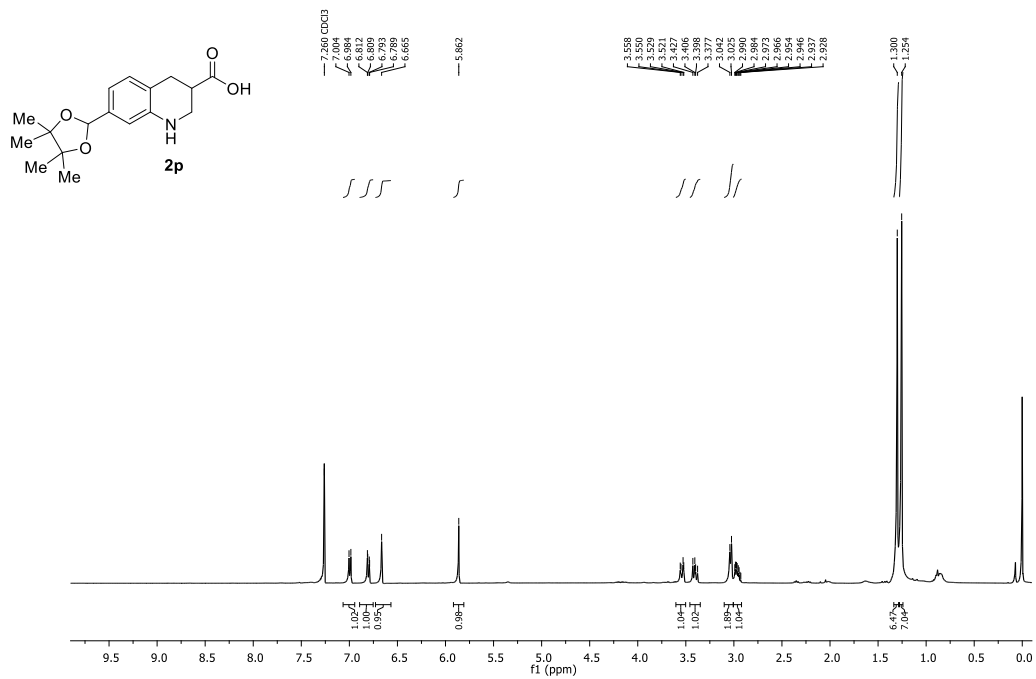


^{13}C NMR (100 MHz, CDCl_3)

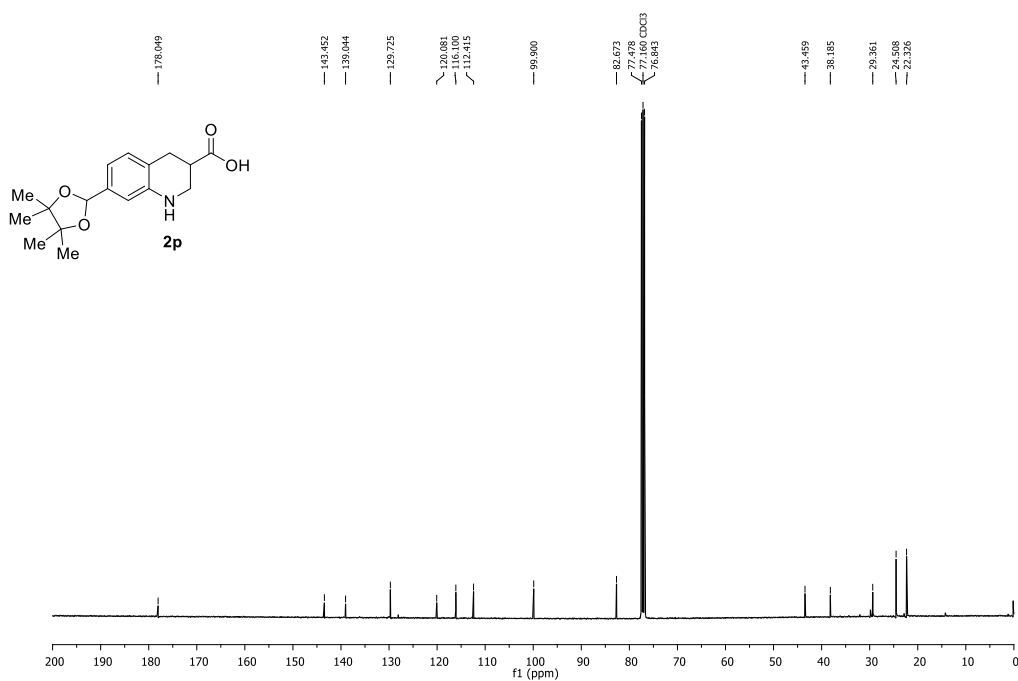


7-(4,4,5,5-Tetramethyl-1,3-dioxolan-2-yl)-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (**2p**):

^1H NMR (400 MHz, CDCl_3)

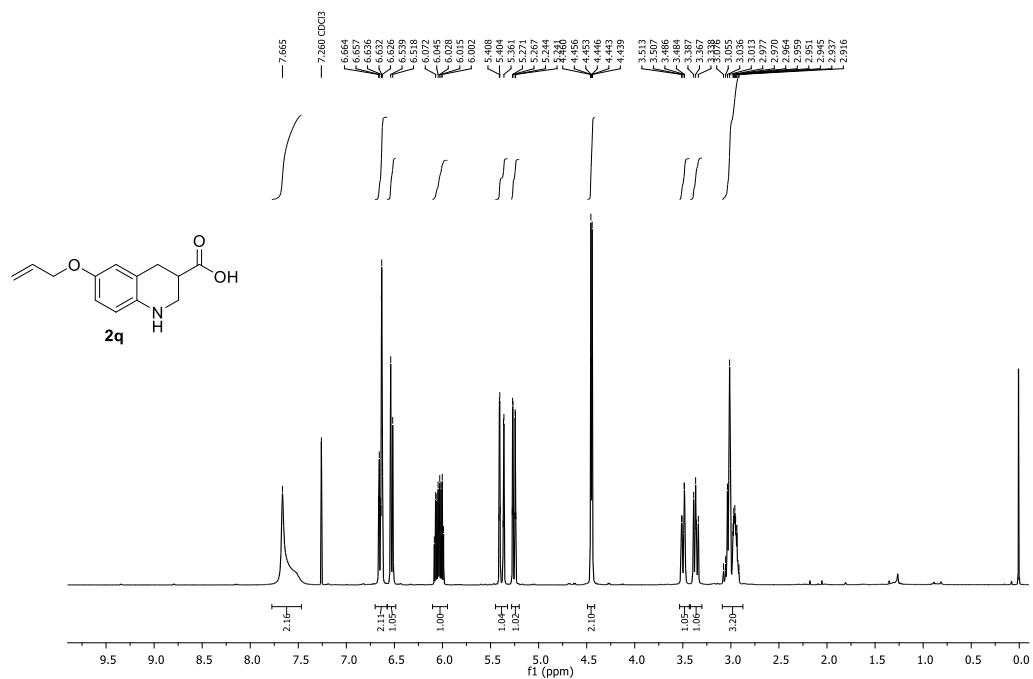


^{13}C NMR (100 MHz, CDCl_3)

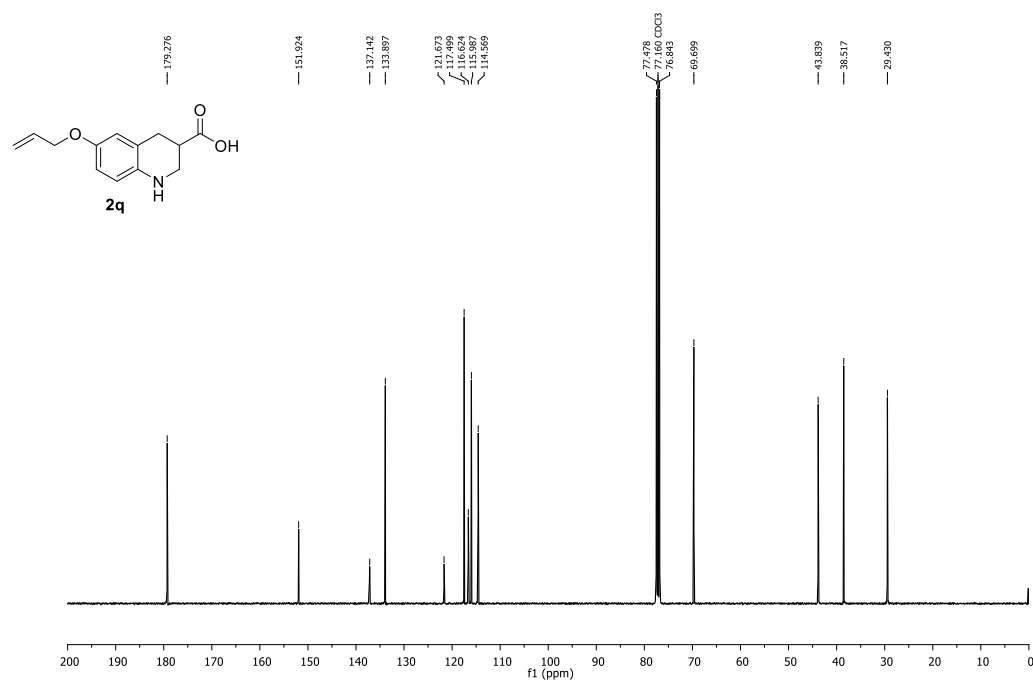


6-(Allyloxy)-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (**2q**):

^1H NMR (400 MHz, CDCl_3)

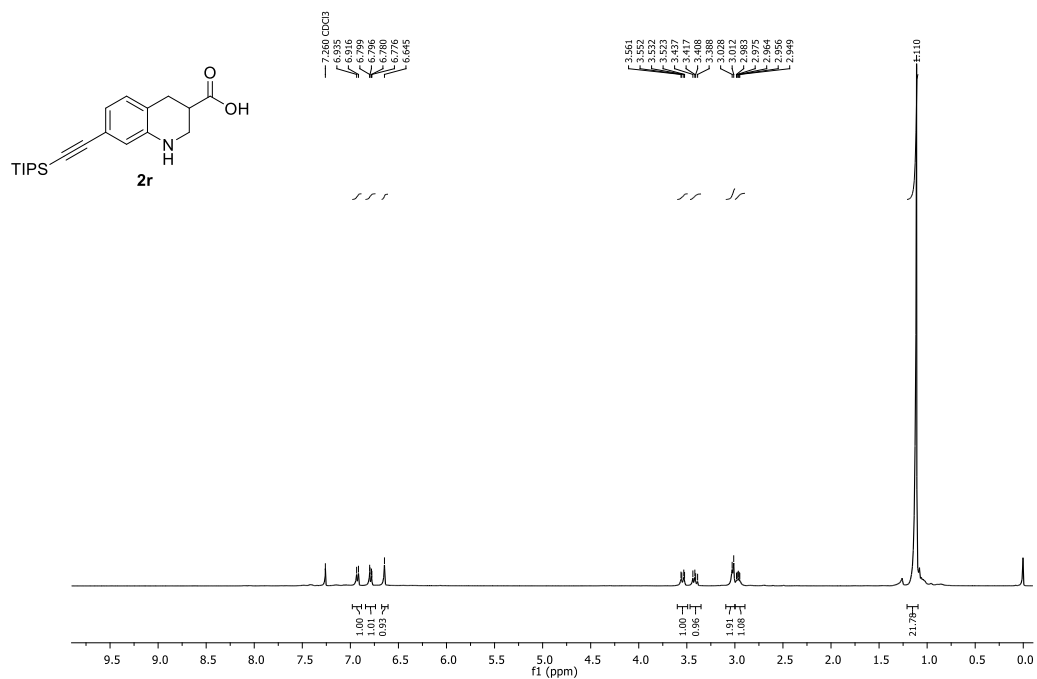


^{13}C NMR (100 MHz, CDCl_3)

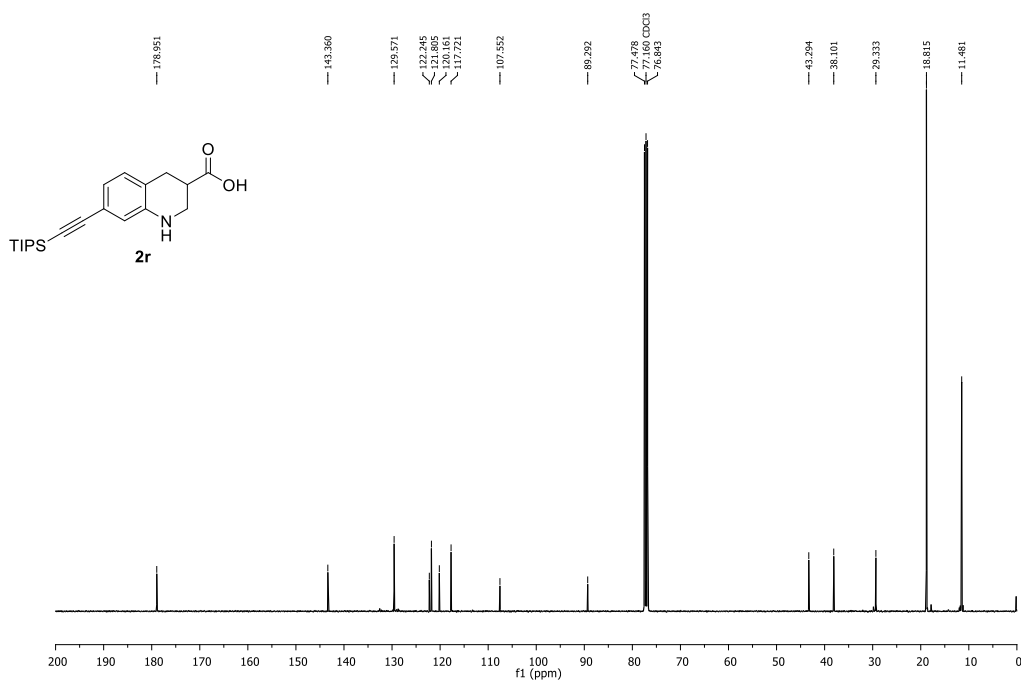


7-((Triisopropylsilyl)ethynyl)-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (**2r**):

^1H NMR (400 MHz, CDCl_3)

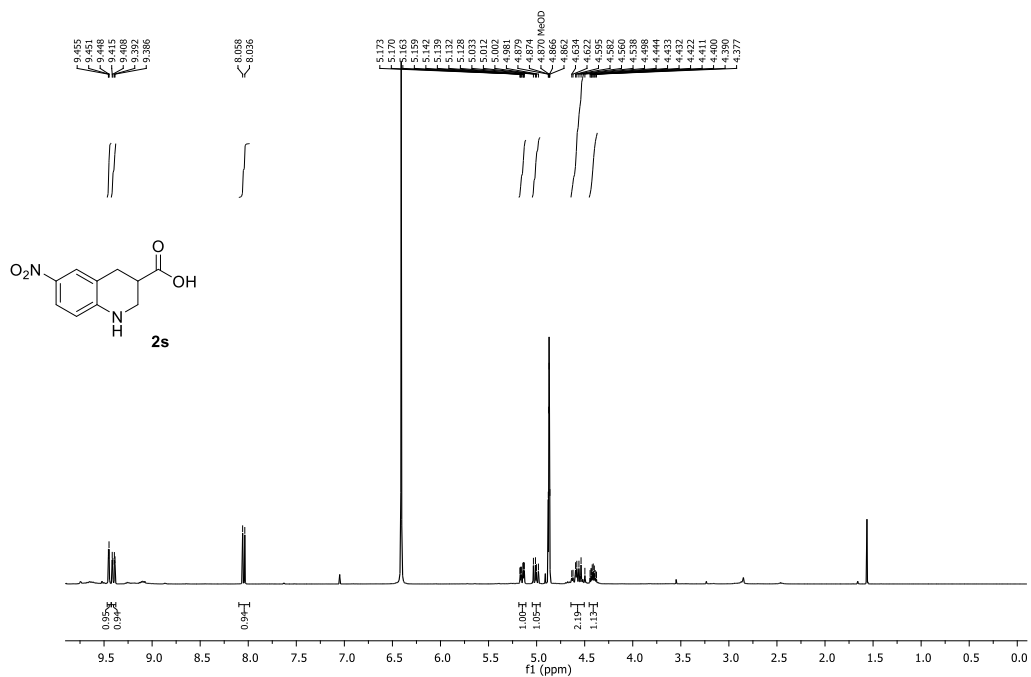


^{13}C NMR (100 MHz, CDCl_3)

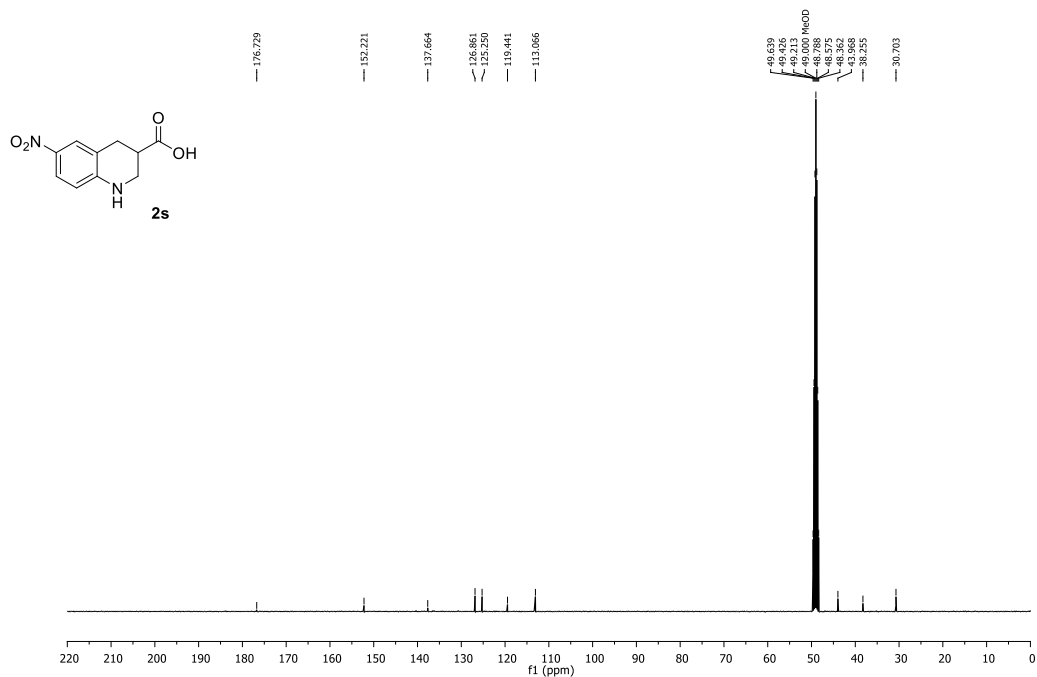


6-Nitro-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (**2s**):

¹H NMR (400 MHz, MeOD)

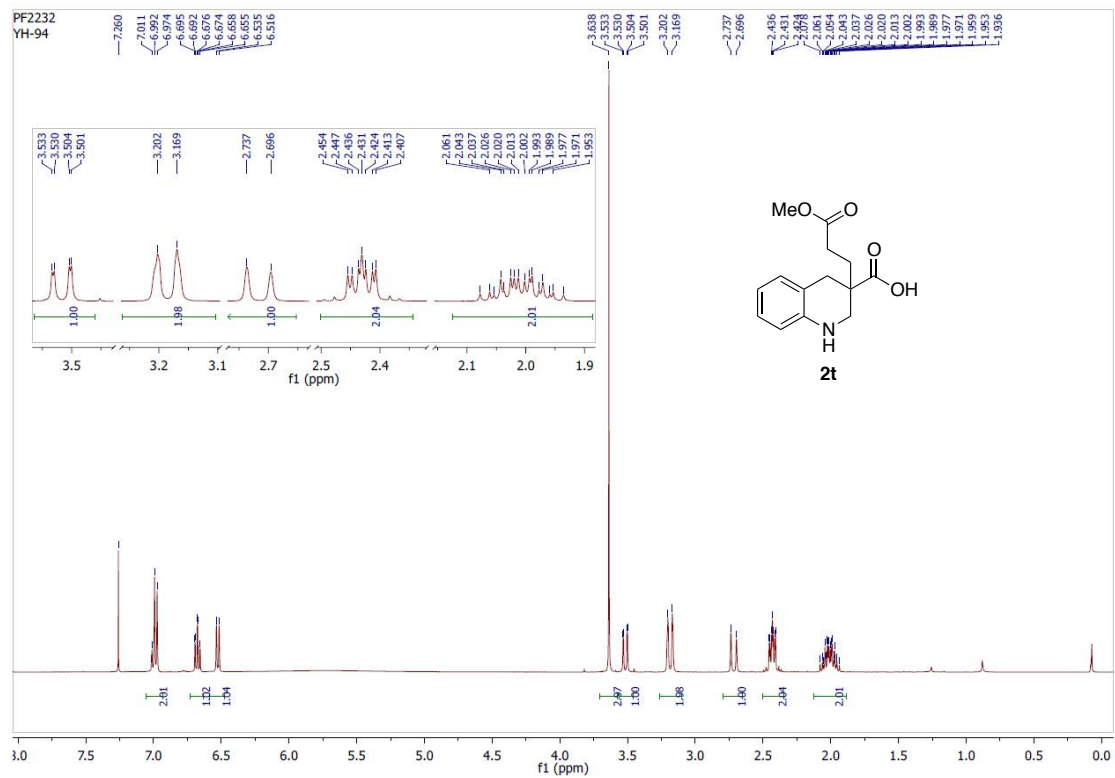


¹³C NMR (100 MHz, MeOD)

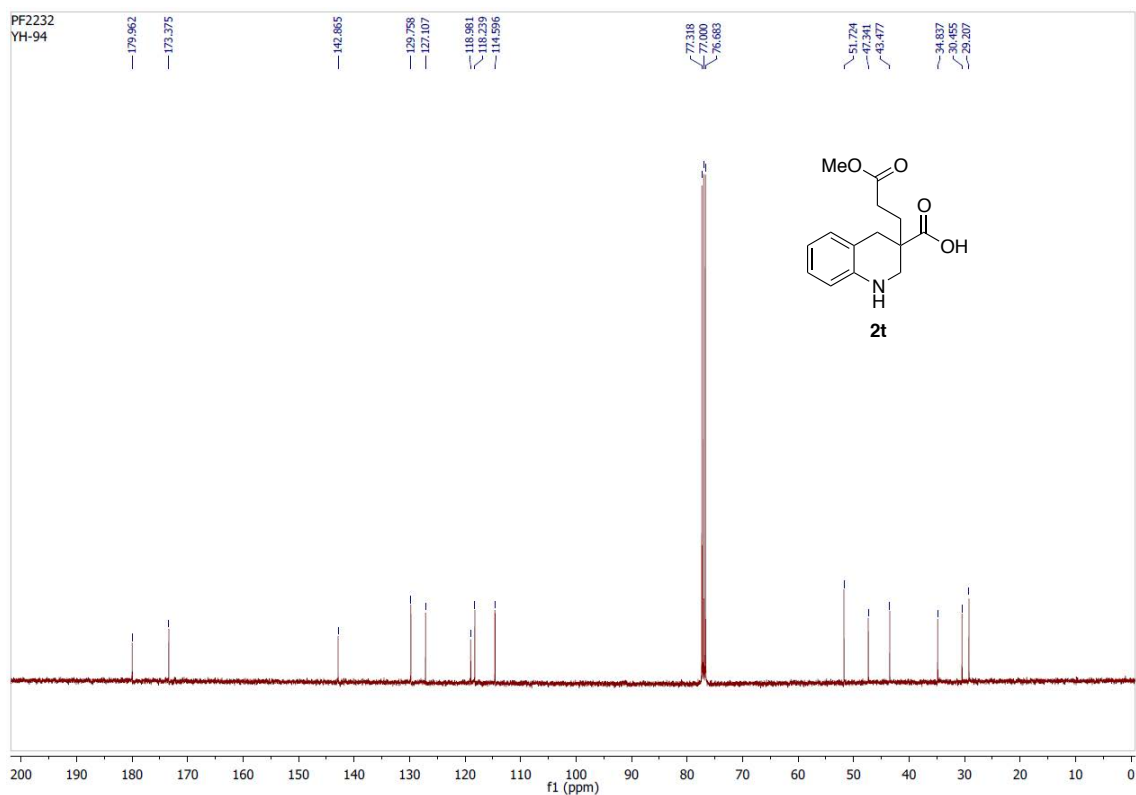


3-(3-Methoxy-3-oxopropyl)-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (2t):

¹H NMR (400 MHz, CDCl₃)

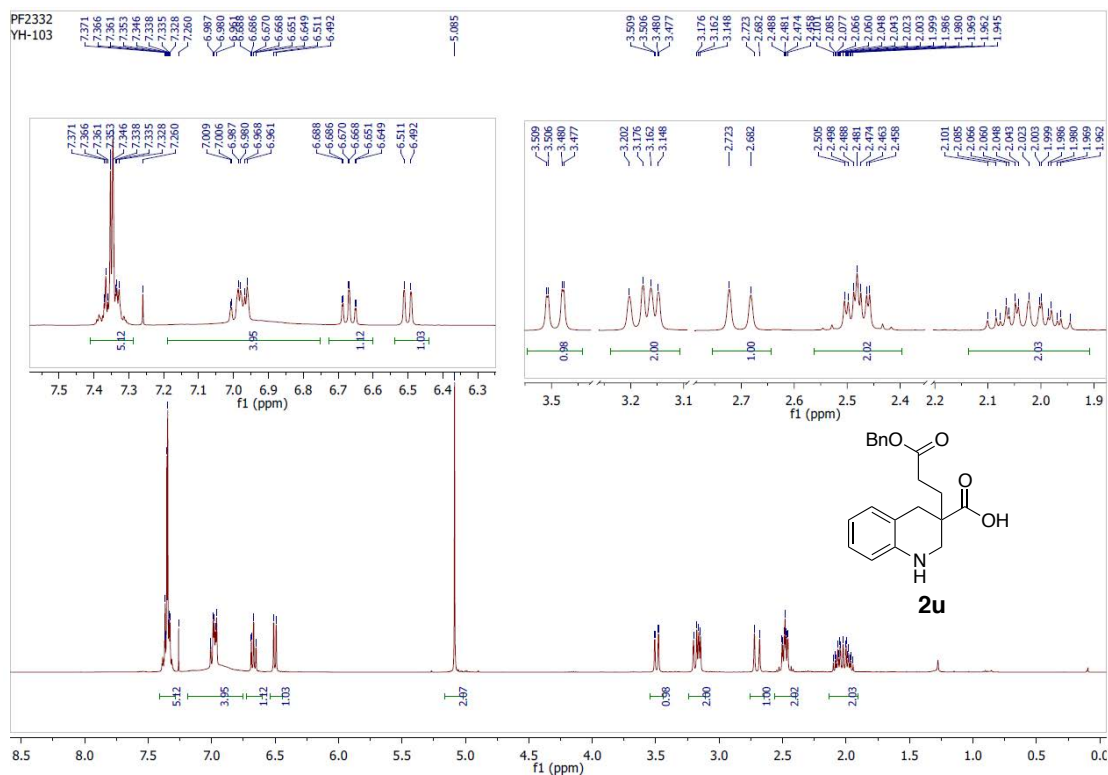


¹³C NMR (100 MHz, CDCl₃)

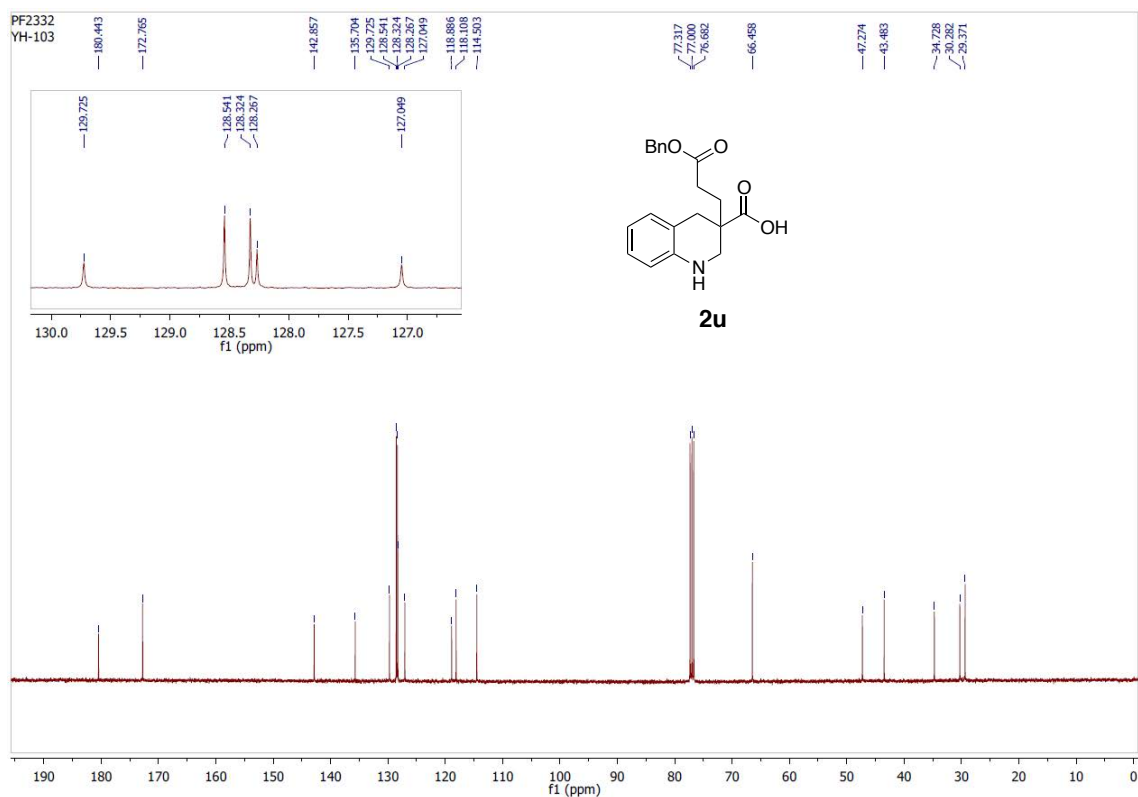


3-(3-(Benzyloxy)-3-oxopropyl)-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (**2u**):

^1H NMR (400 MHz, CDCl_3)

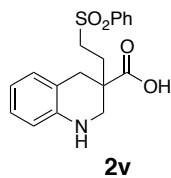
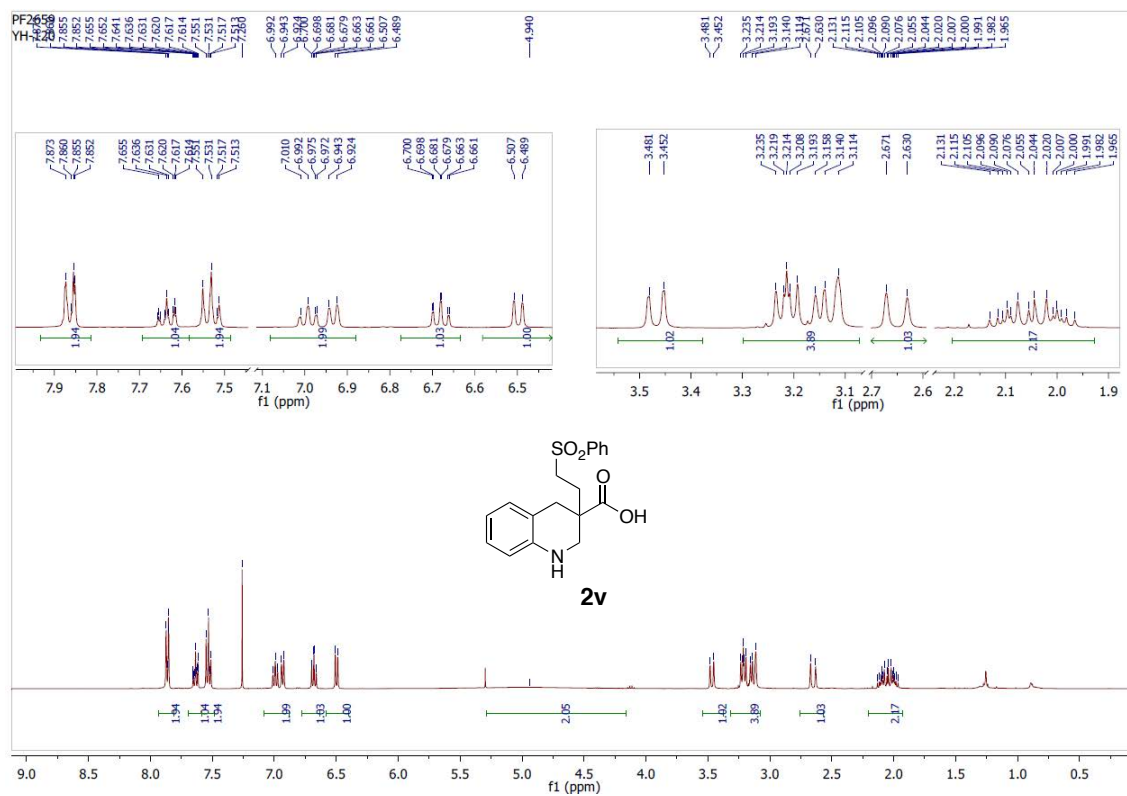


^{13}C NMR (100 MHz, CDCl_3)

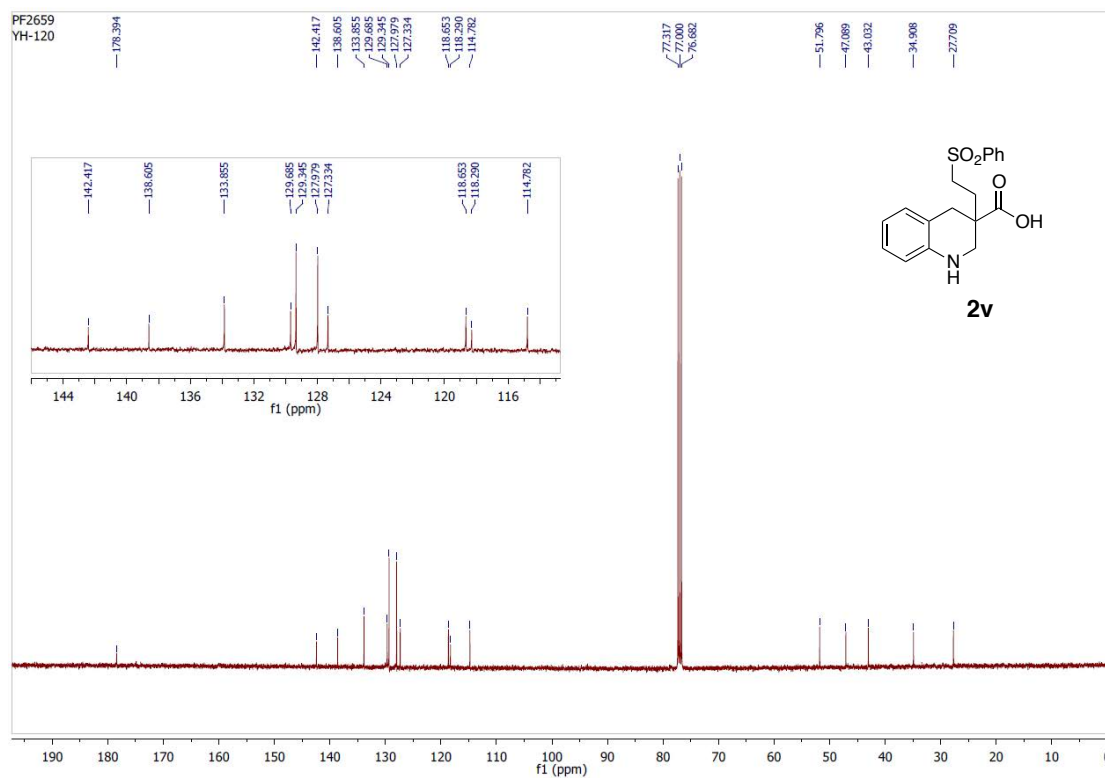


3-(2-(Phenylsulfonyl)ethyl)-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (**2v**):

¹H NMR (400 MHz, CDCl₃)

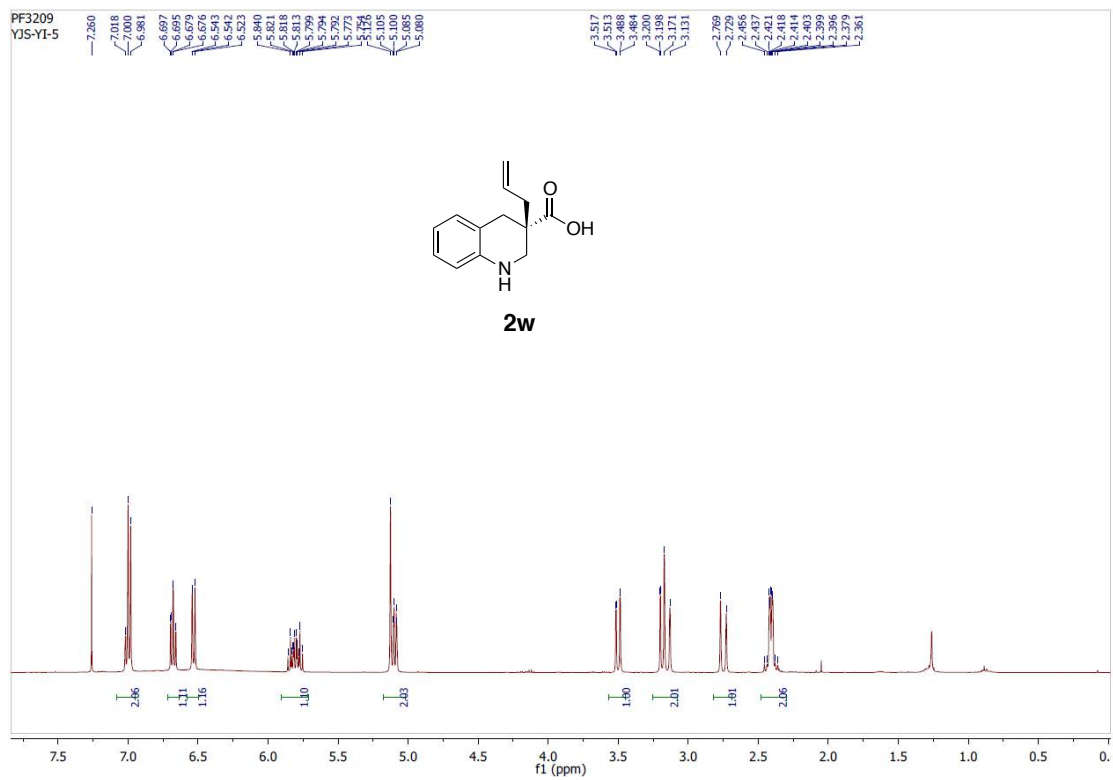


¹³C NMR (100 MHz, CDCl₃)

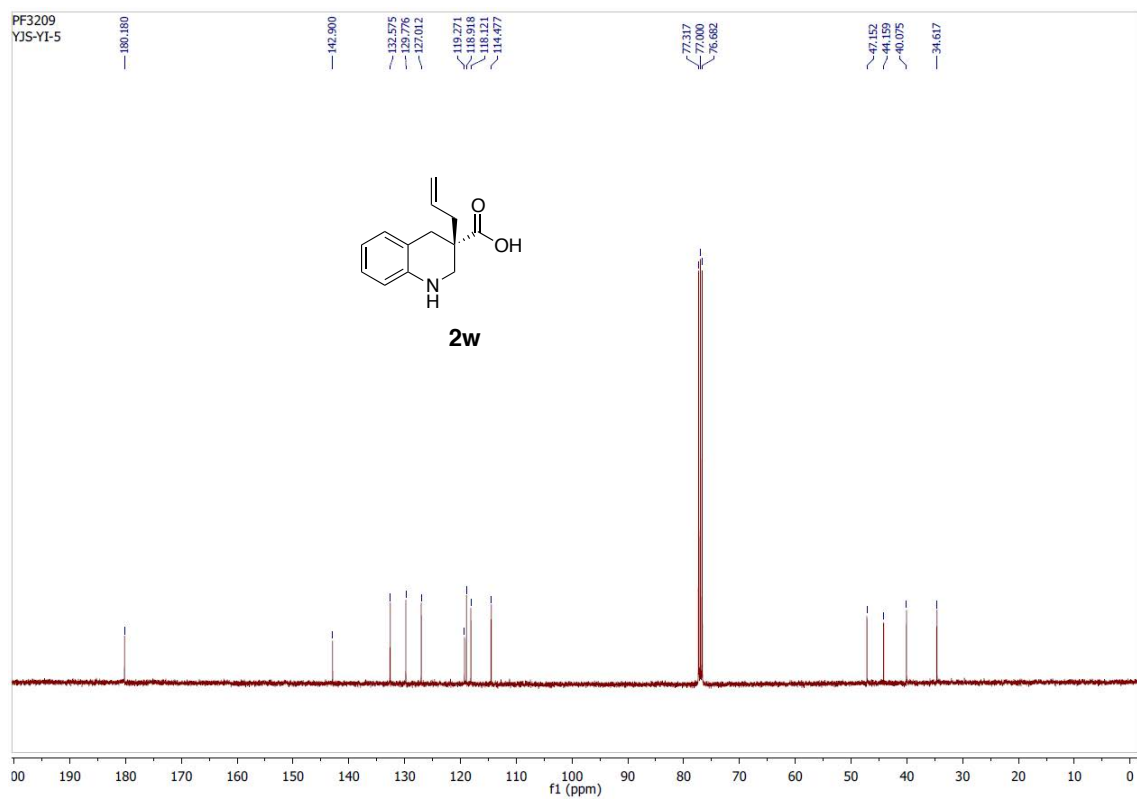


(S)-3-Allyl-1,2,3,4-tetrahydroquinoline-3-carboxylic acid (**2w**):

^1H NMR (400 MHz, CDCl_3)

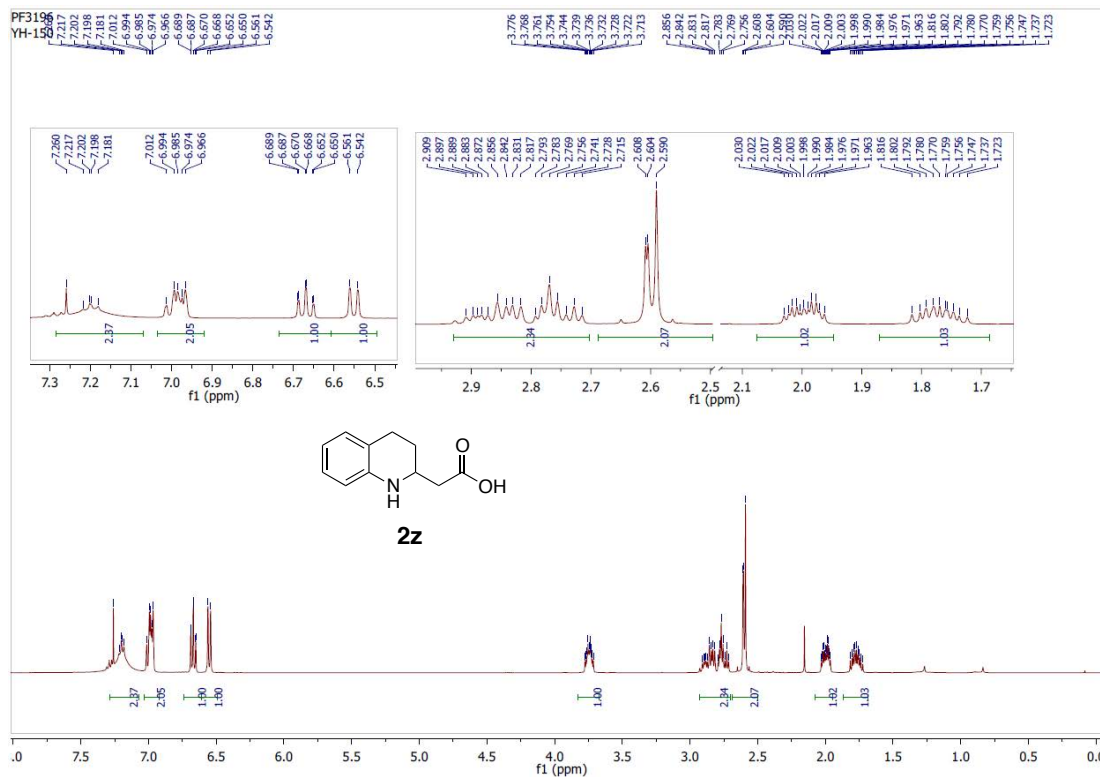


^{13}C NMR (100 MHz, CDCl_3)

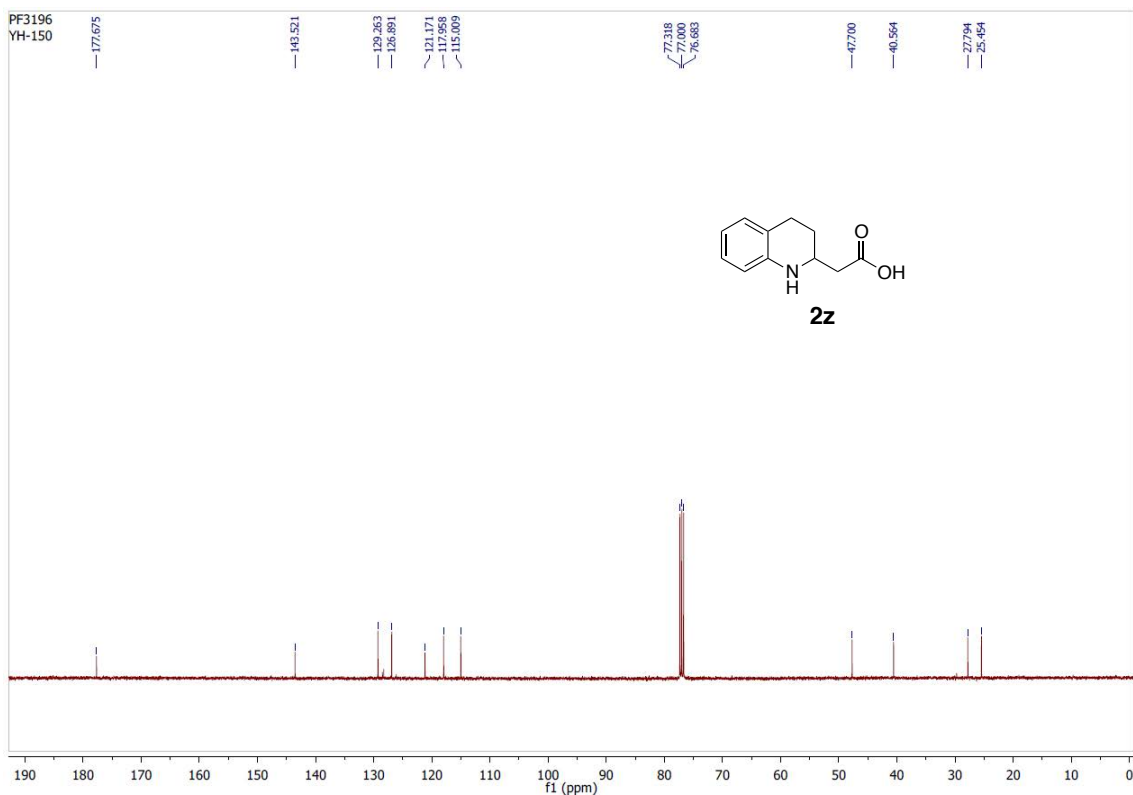


2-(1,2,3,4-Tetrahydroquinolin-2-yl)acetic acid (**2z**):

^1H NMR (400 MHz, CDCl_3)

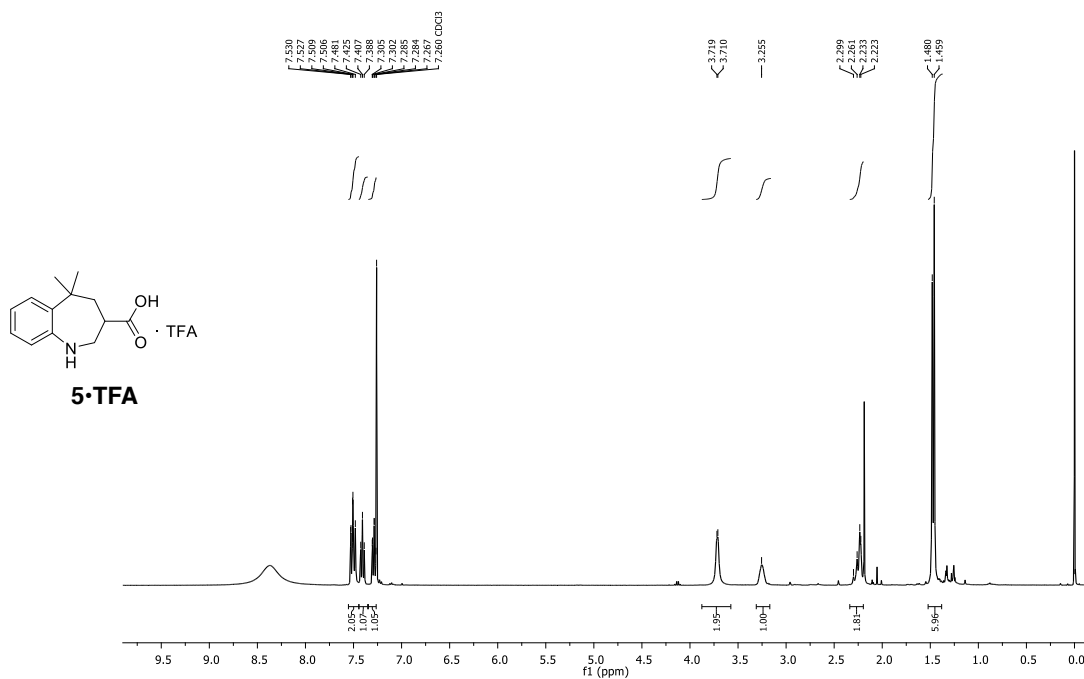


^{13}C NMR (100 MHz, CDCl_3)

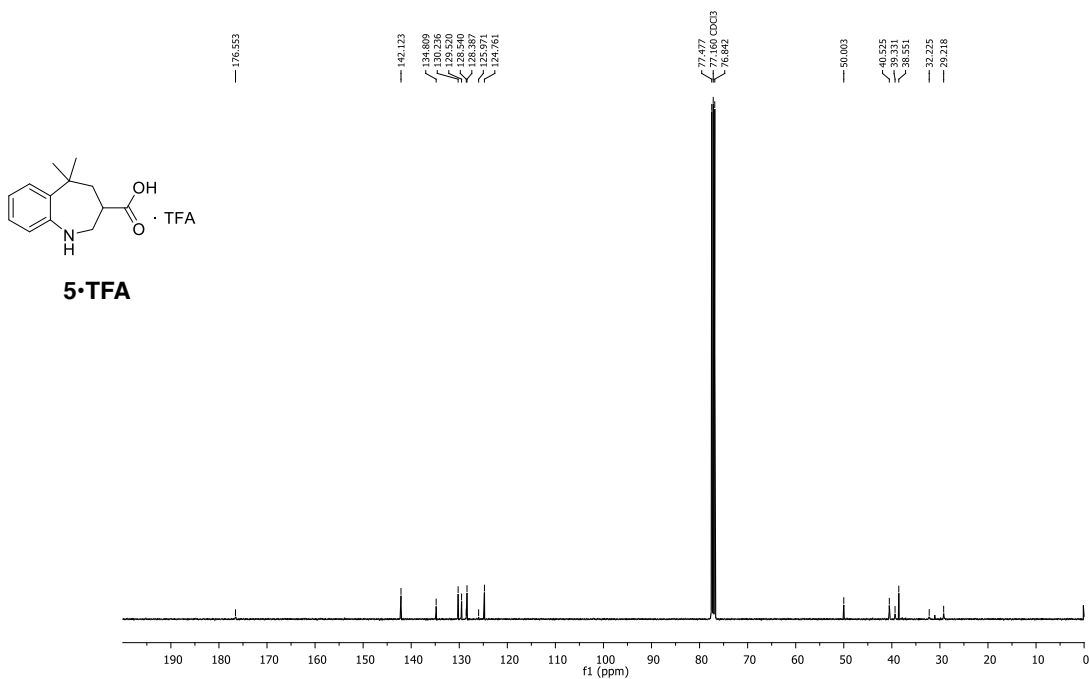


3-Carboxy-5,5-dimethyl-2,3,4,5-tetrahydro-1H-benzo[b]azepin-1-ium trifluoro acetate (5•TFA)

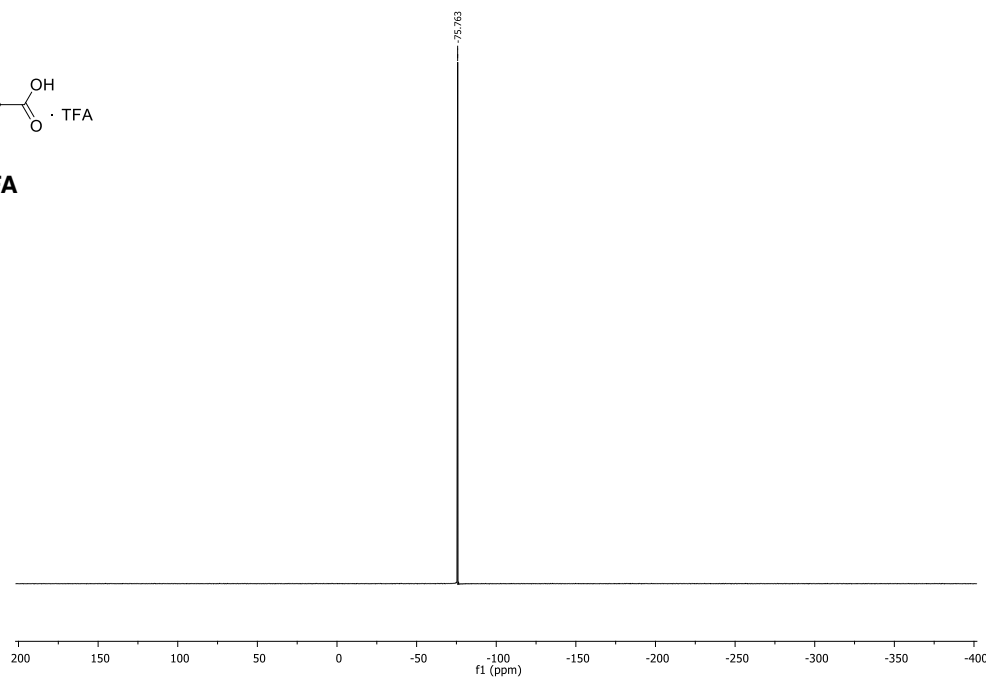
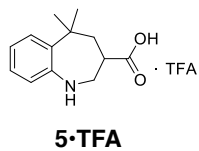
¹H NMR (400 MHz, CDCl₃)



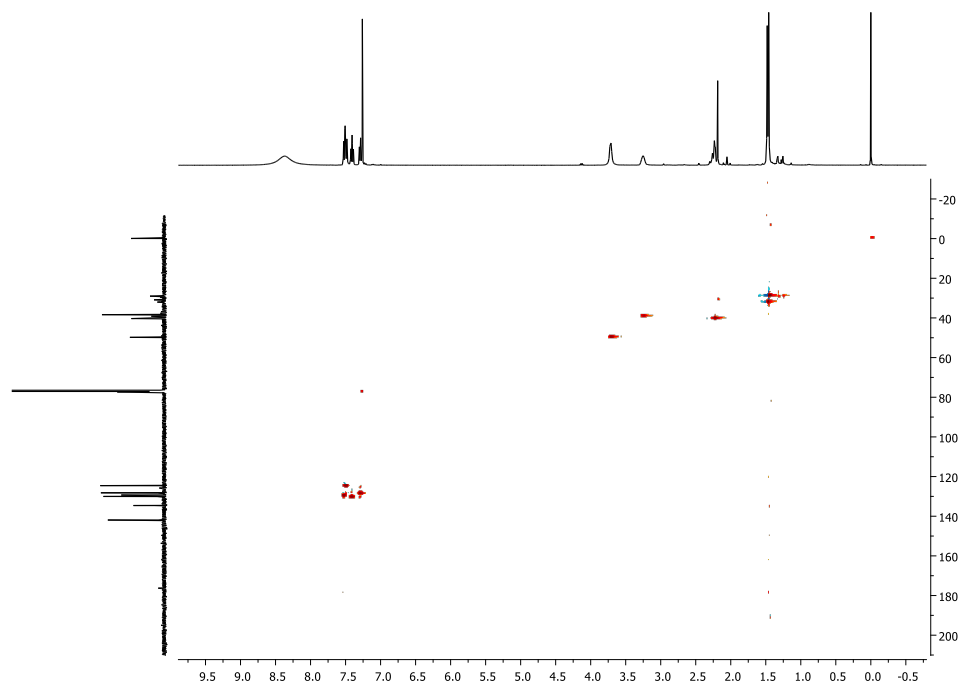
¹³C NMR (100 MHz, CDCl₃)



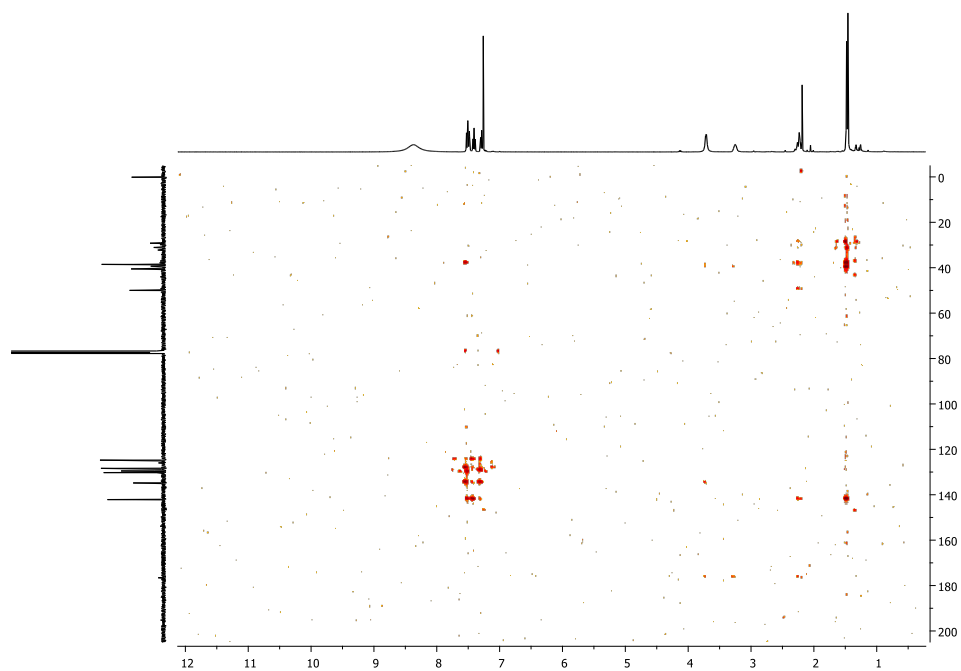
^{19}F NMR (376 MHz, CDCl_3)



HSQC (400 MHz, CDCl_3)

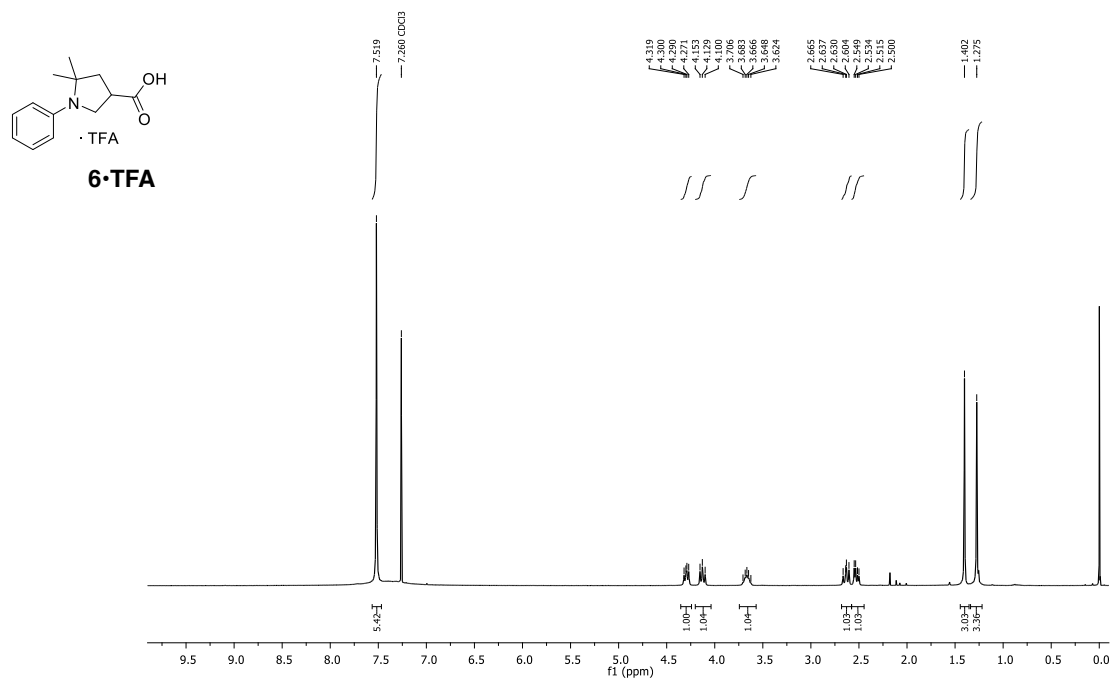


HMBC (400 MHz, CDCl₃)

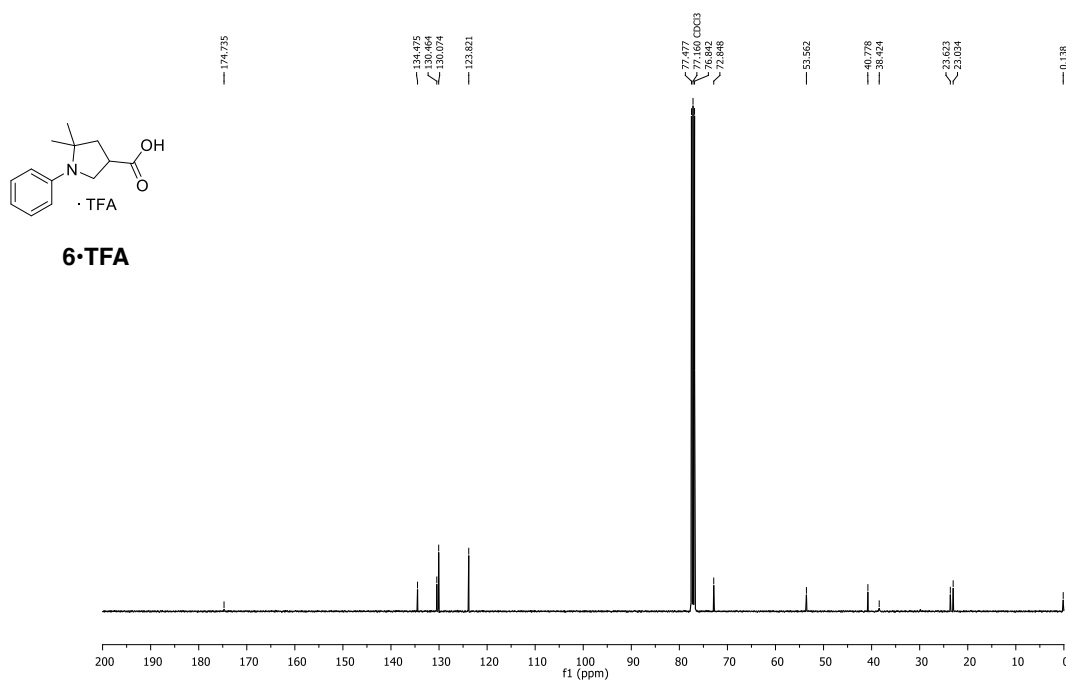


4-Carboxy-2,2-dimethyl-1-phenylpyrrolidin-1-ium trifluoro acetate (6•TFA)

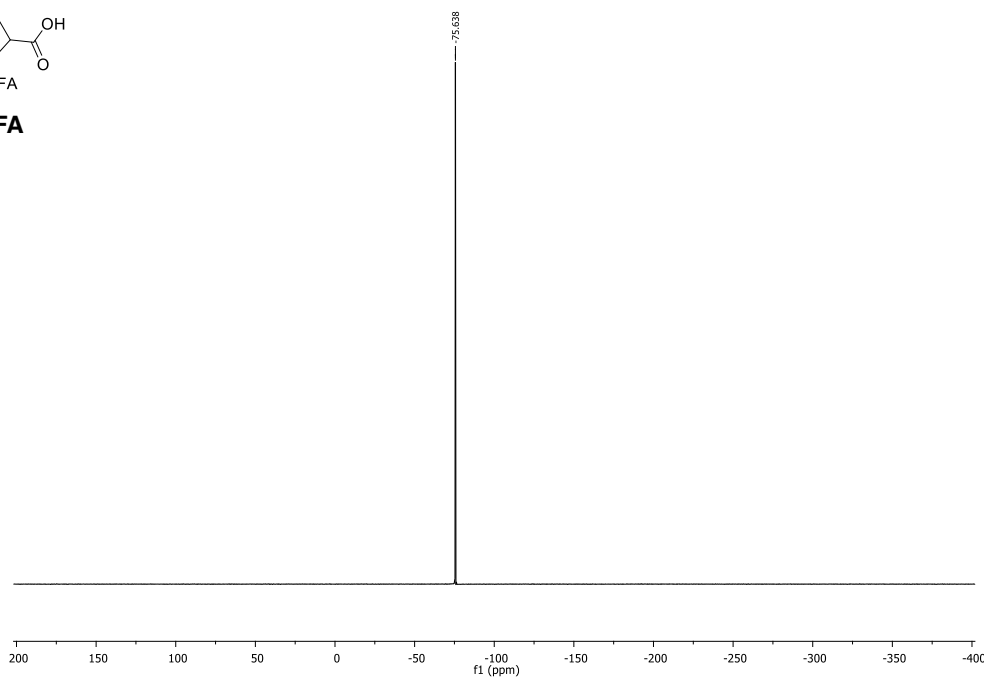
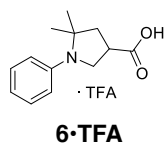
¹H NMR (400 MHz, CDCl₃)



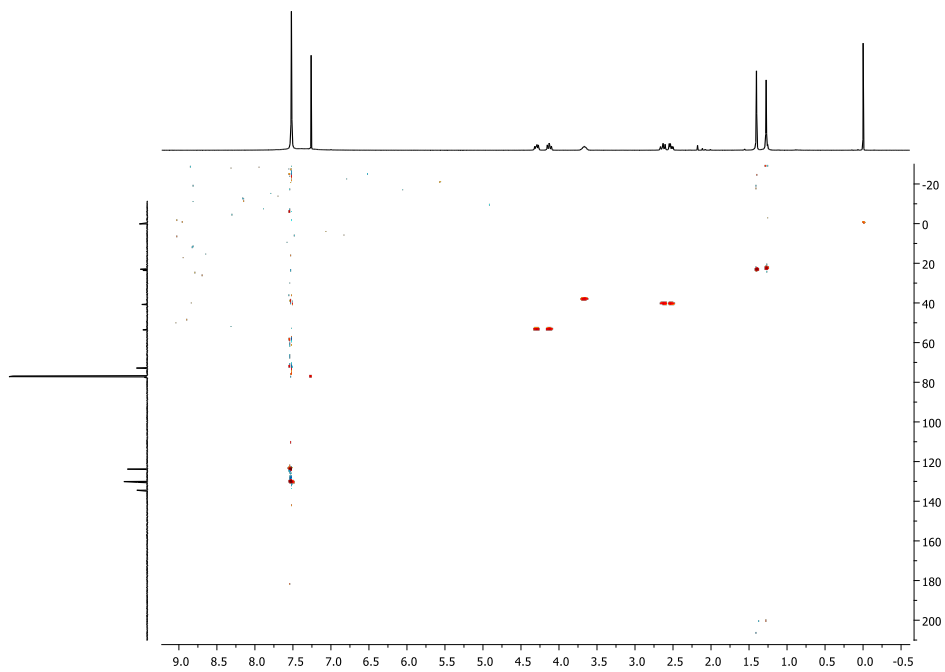
¹³C NMR (100 MHz, CDCl₃)



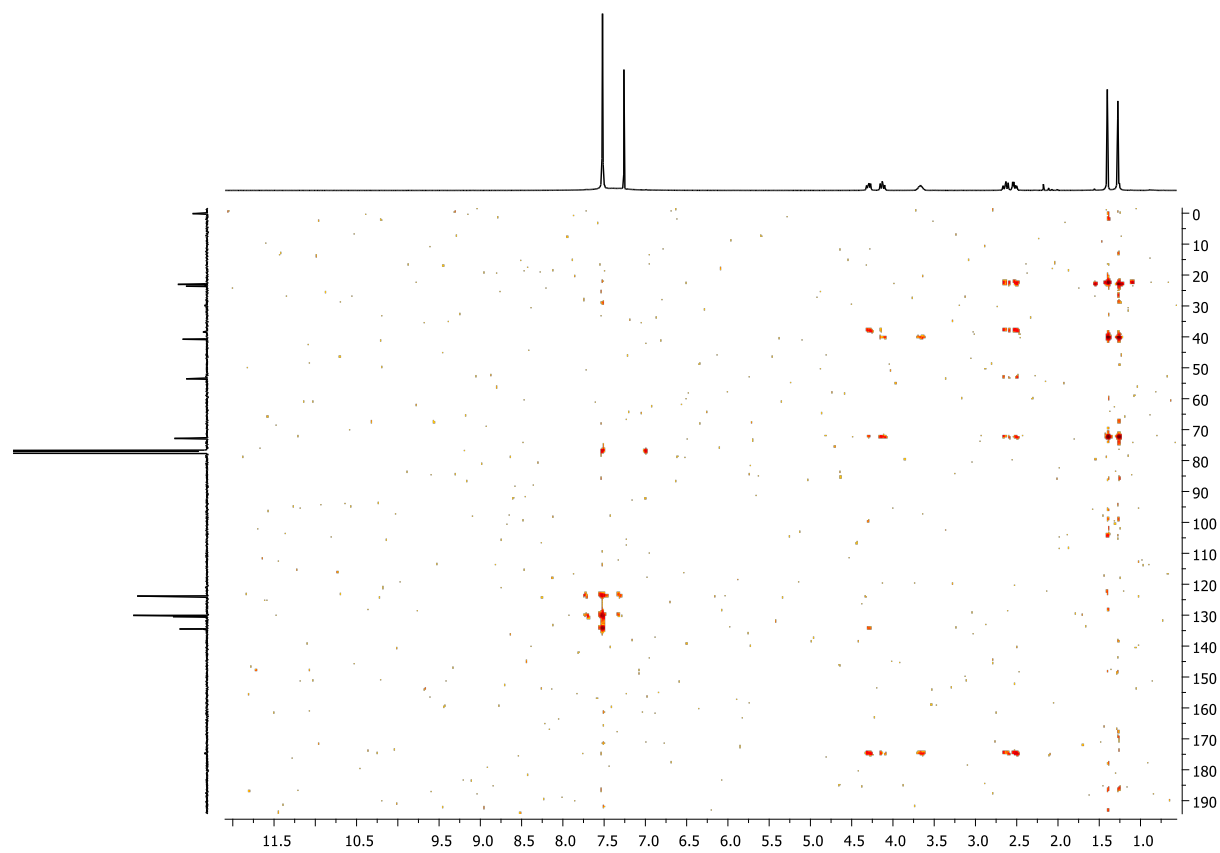
^{19}F NMR (376 MHz, CDCl_3)



HSQC (400 MHz, CDCl_3)

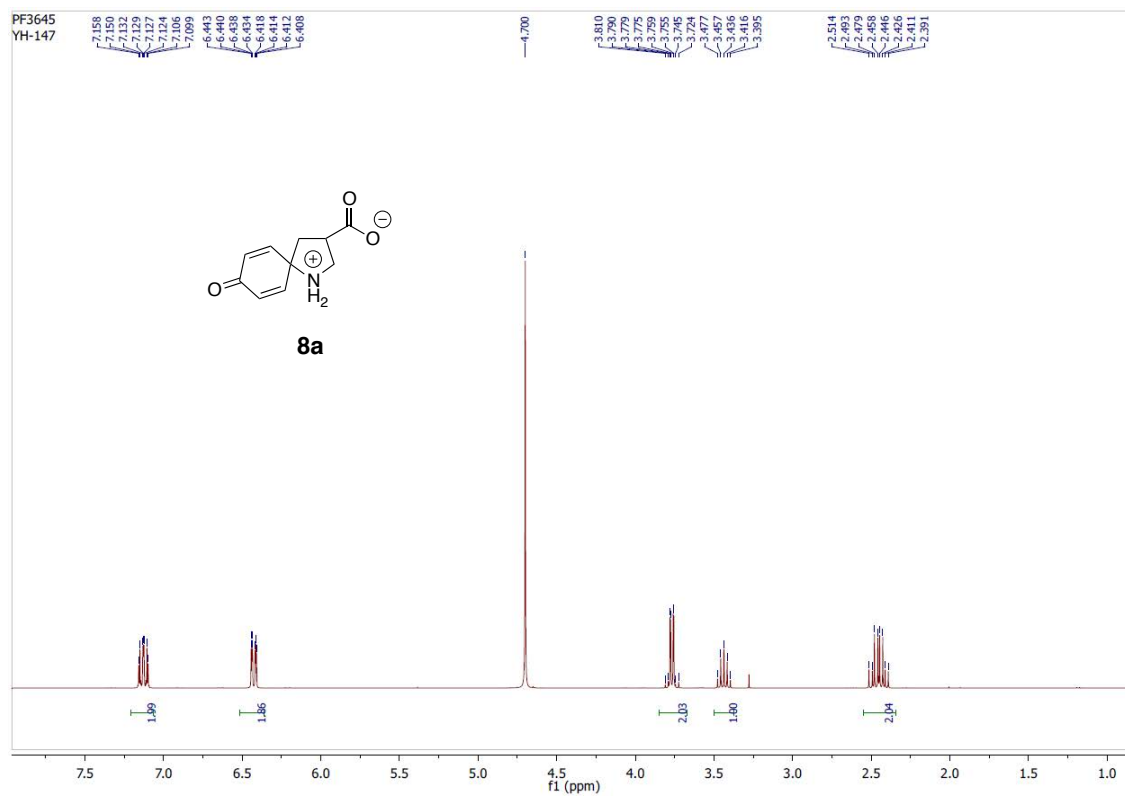


HMBC (400 MHz, CDCl₃)

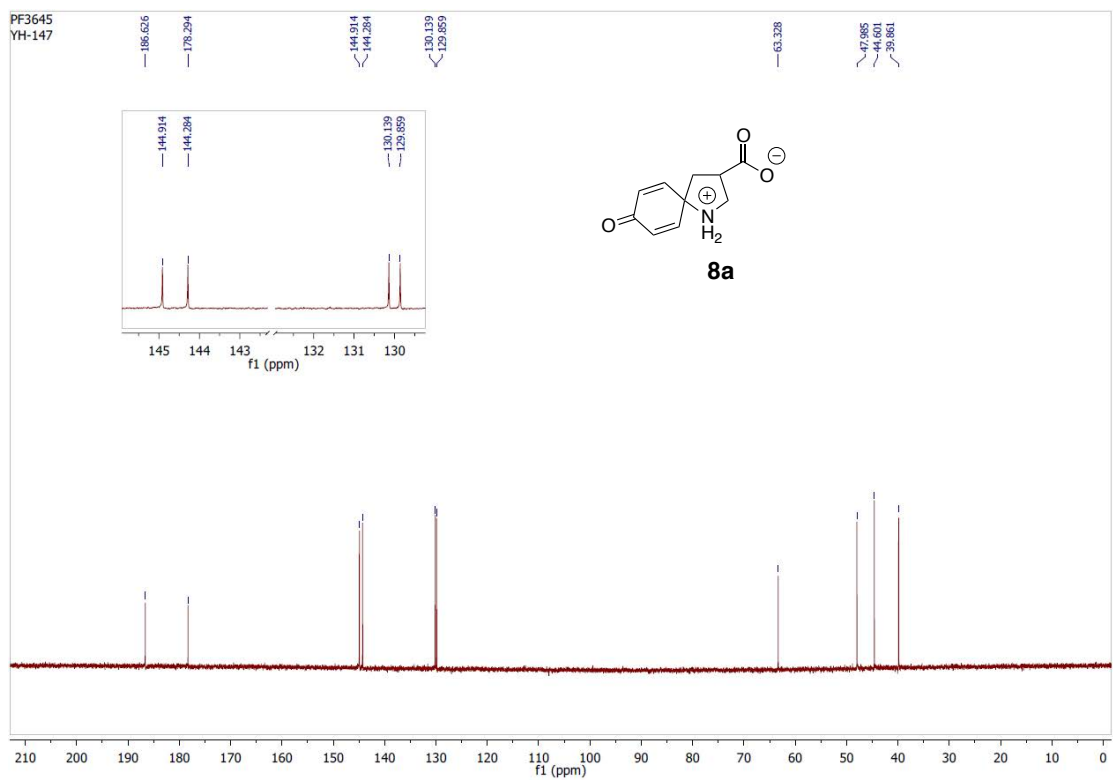


8-Oxo-1-azaspiro[4.5]deca-6,9-dien-1-ium-3-carboxylate (8a):

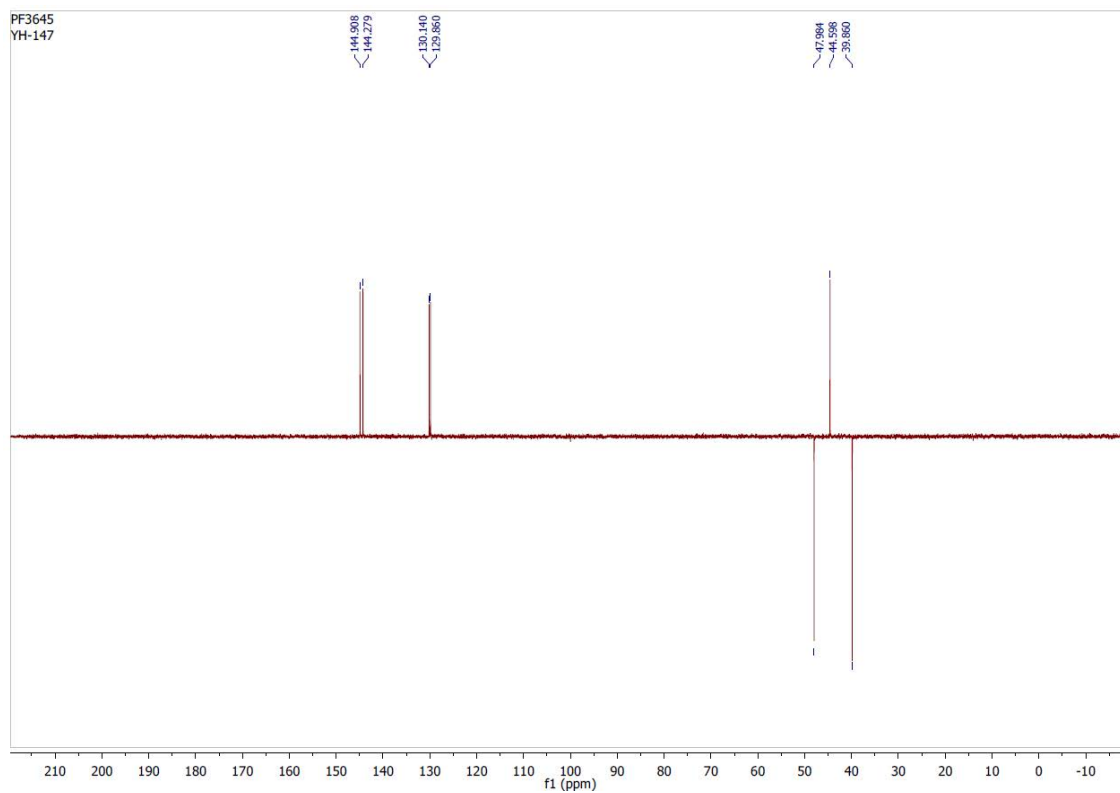
^1H NMR (400 MHz, D_2O)



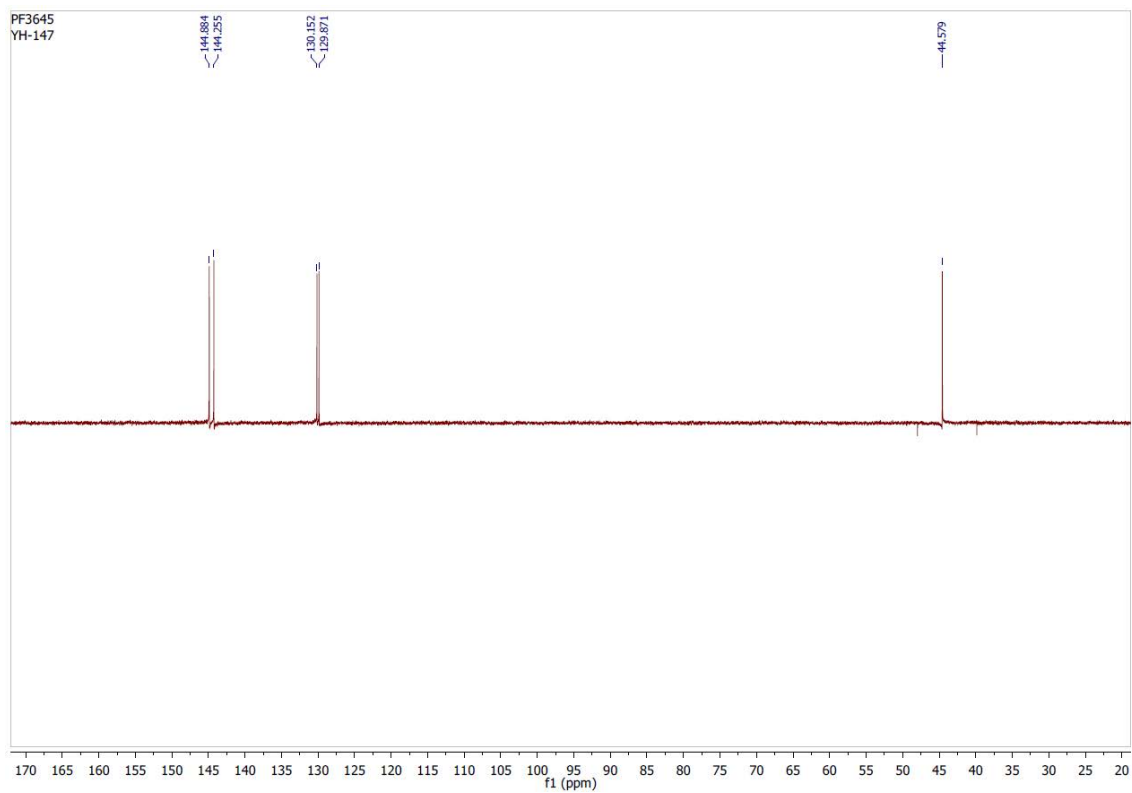
^{13}C NMR (100 MHz, D_2O)



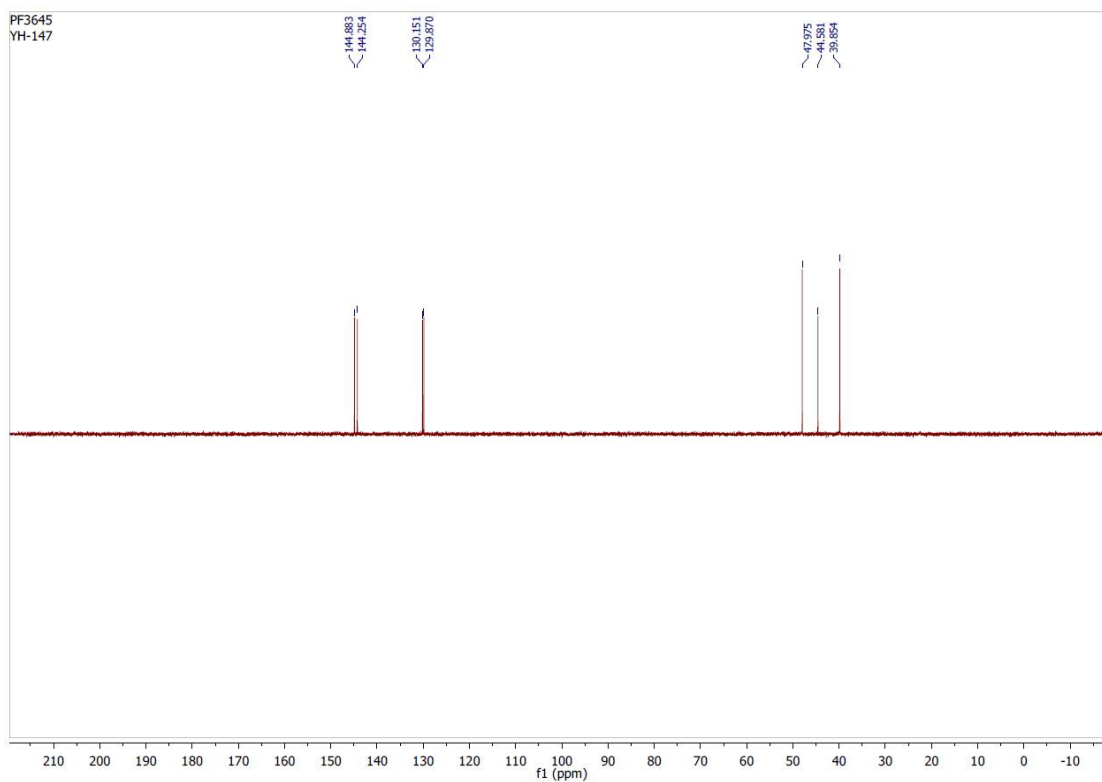
DEPT 135 (100 MHz, D₂O) for 4a



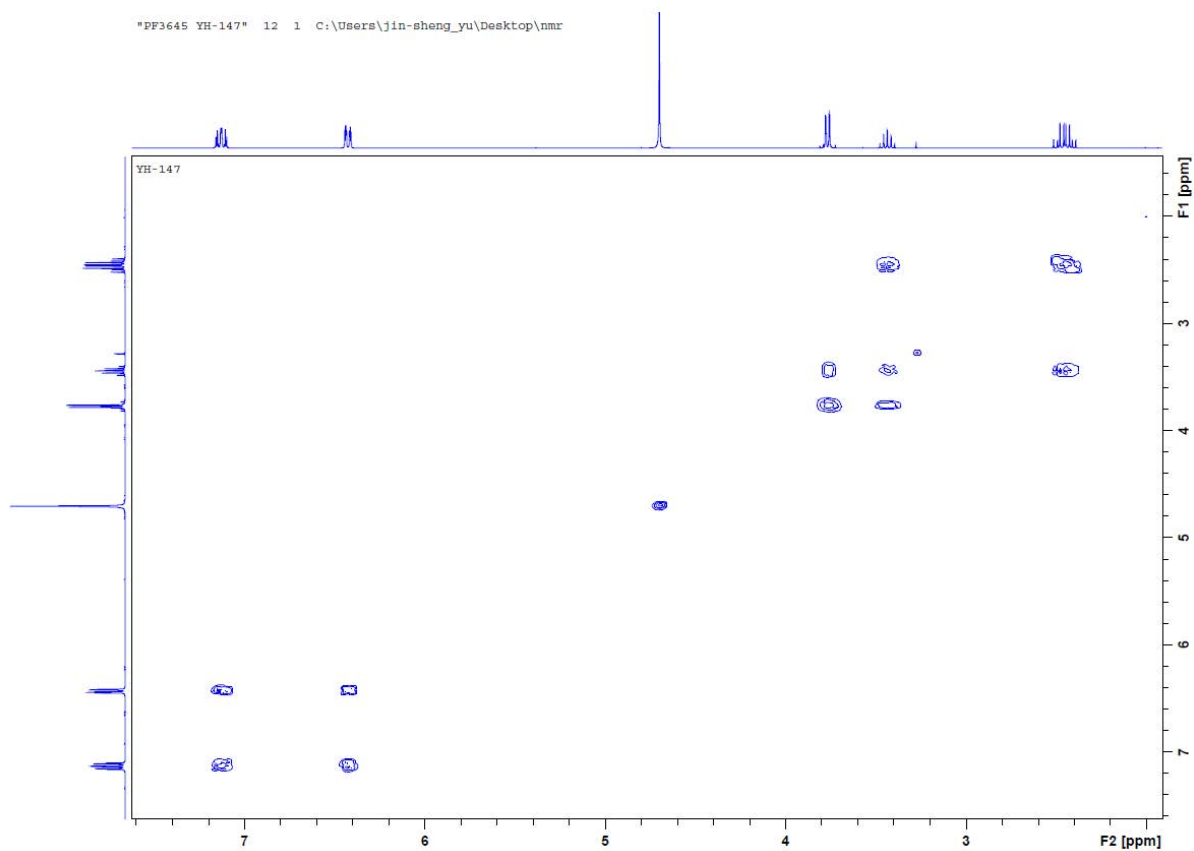
DEPT 90 (100 MHz, D₂O) for 4a



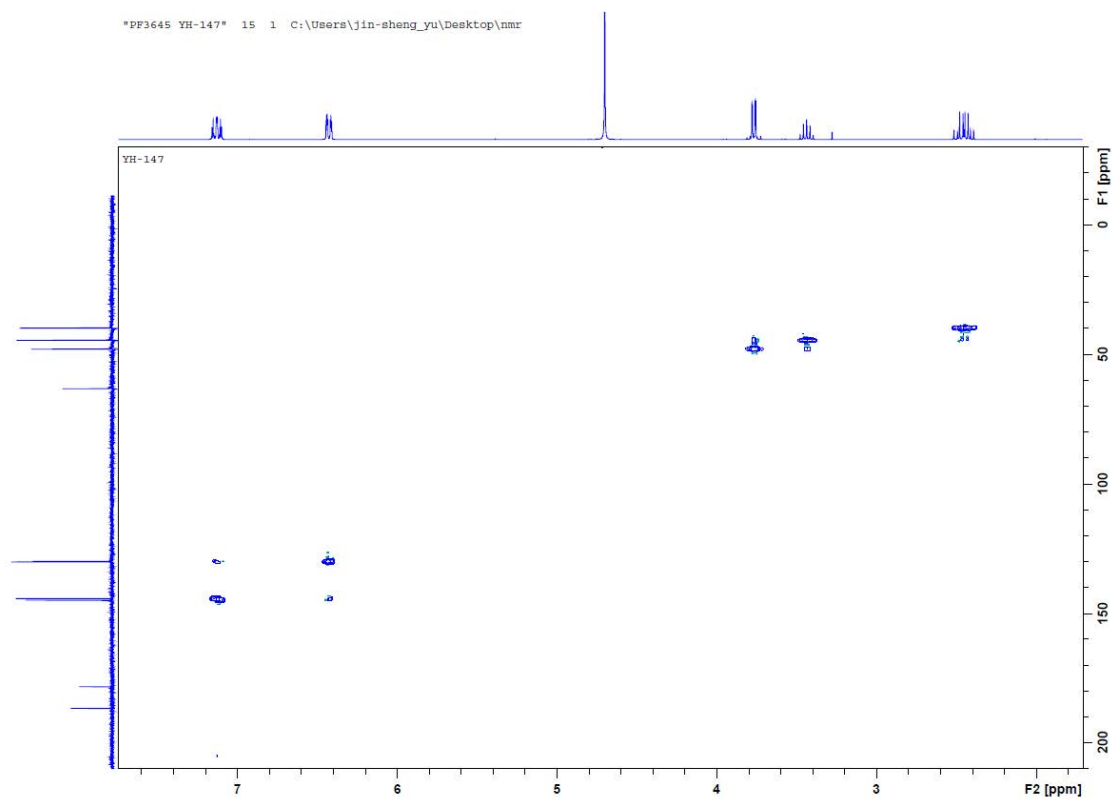
DEPT 45 (100 MHz, D₂O) for **4a**



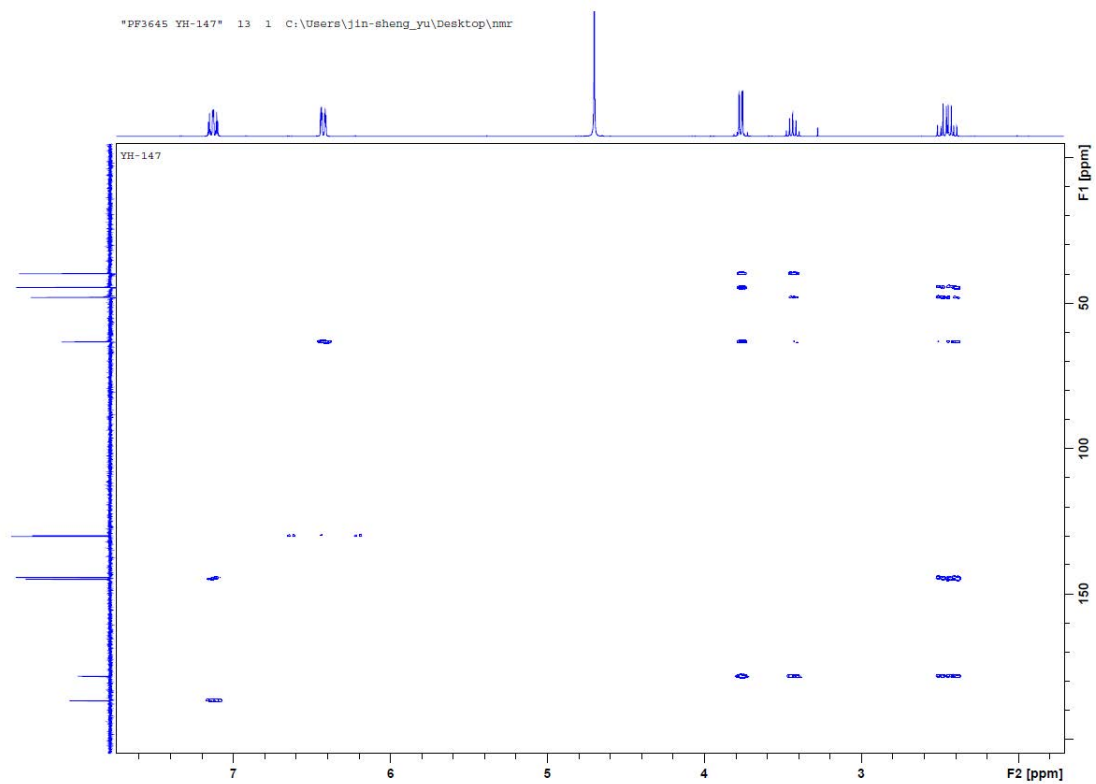
H-H COSY (400 MHz, D₂O) for **4a**



HSQC (400 MHz, D₂O) for 4a

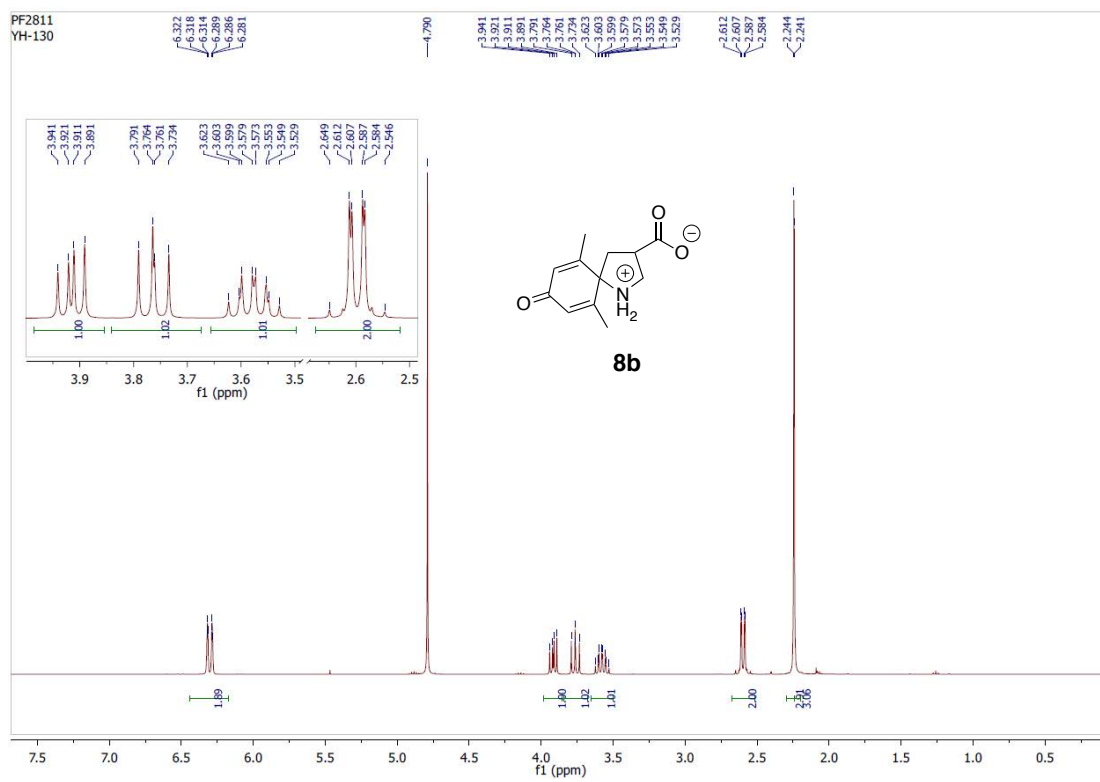


HMBC (400 MHz, D₂O) for 4a

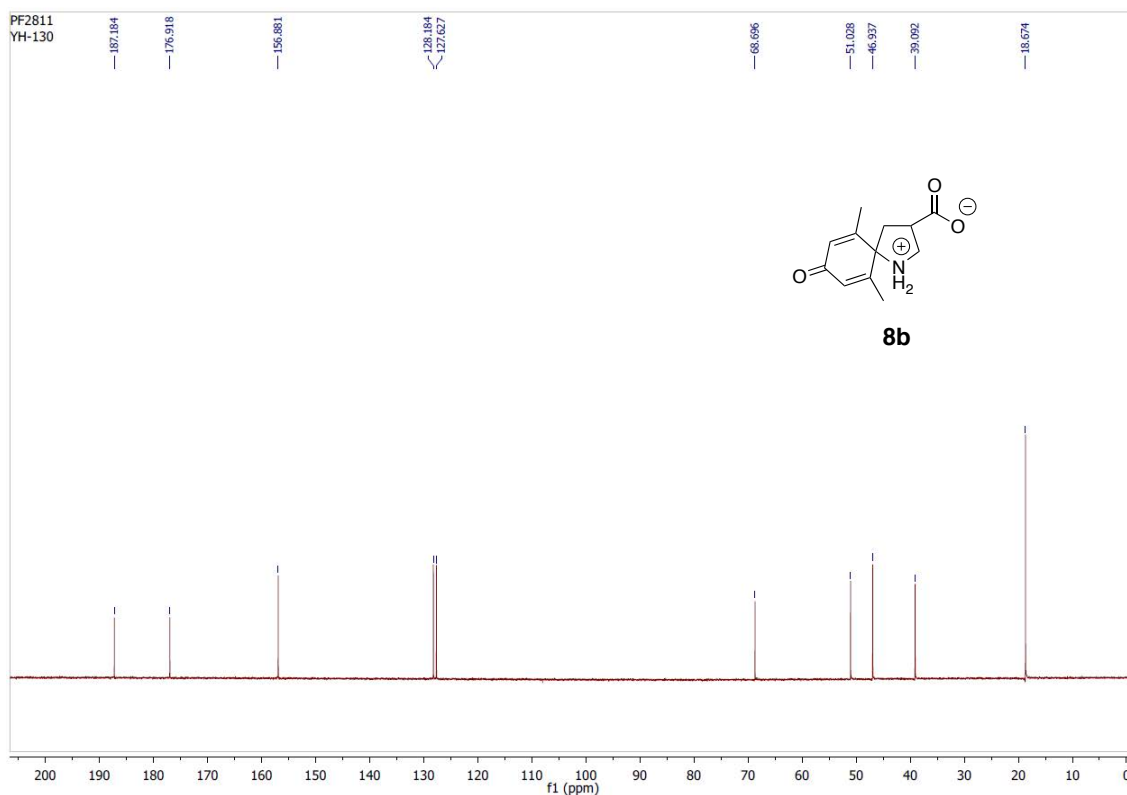


6,10-Dimethyl-8-oxo-1-azaspiro[4.5]deca-6,9-dien-1-ium-3-carboxylate (8b):

^1H NMR (400 MHz, D_2O)

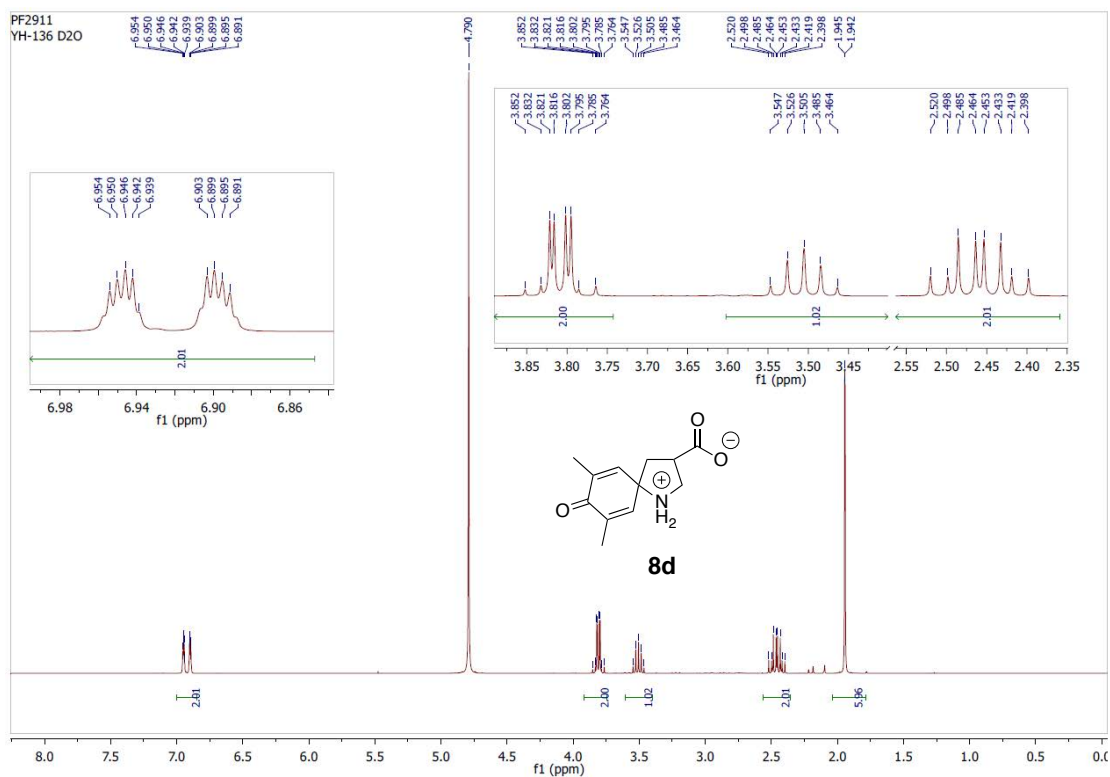


^{13}C NMR (100 MHz, D_2O)

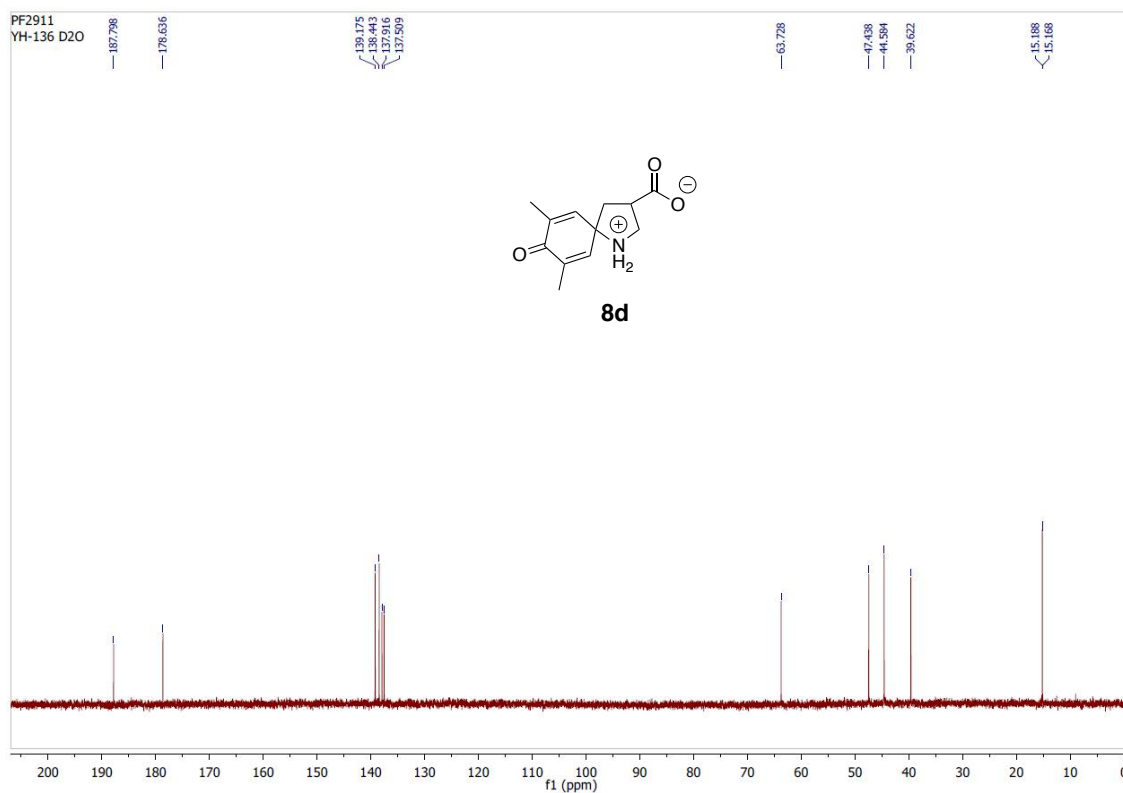


7,9-Dimethyl-8-oxo-1-azaspiro[4.5]deca-6,9-dien-1-ium-3-carboxylate (8d):

^1H NMR (400 MHz, D_2O)

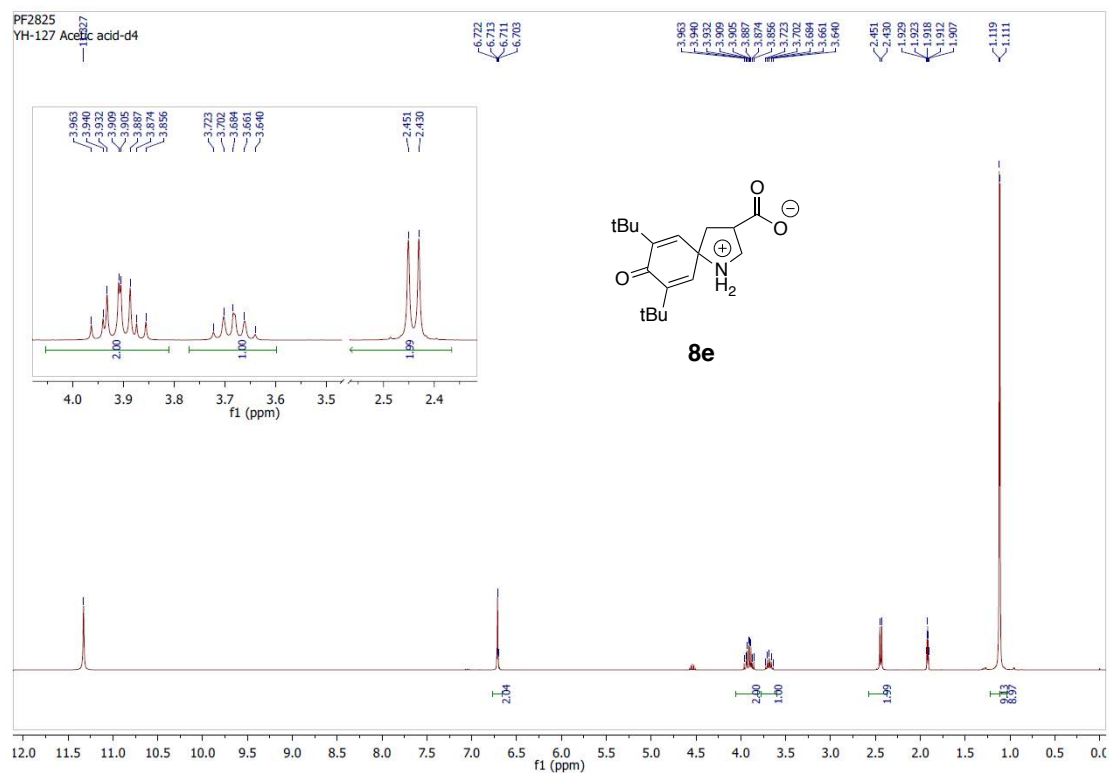


^{13}C NMR (100 MHz, D_2O)

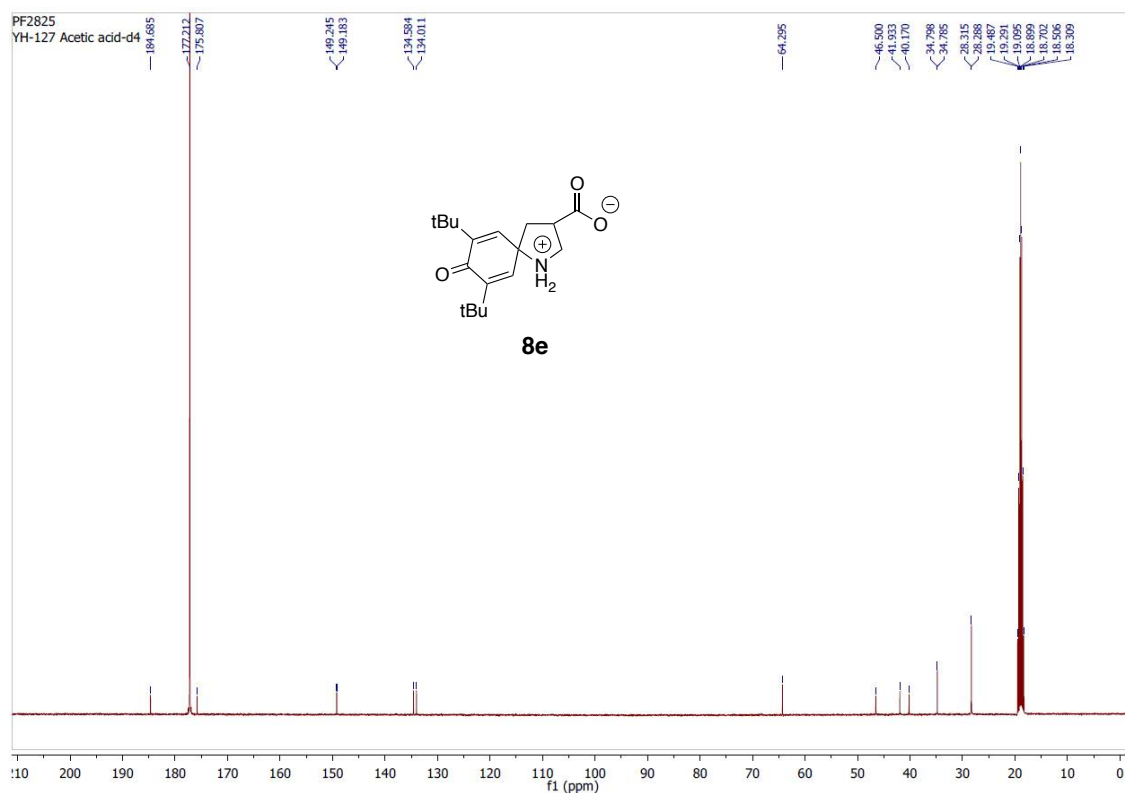


7,9-Di-*tert*-butyl-8-oxo-1-azaspiro[4.5]deca-6,9-dien-1-ium-3-carboxylate (**8e**):

^1H NMR (400 MHz, CD_3COOD)

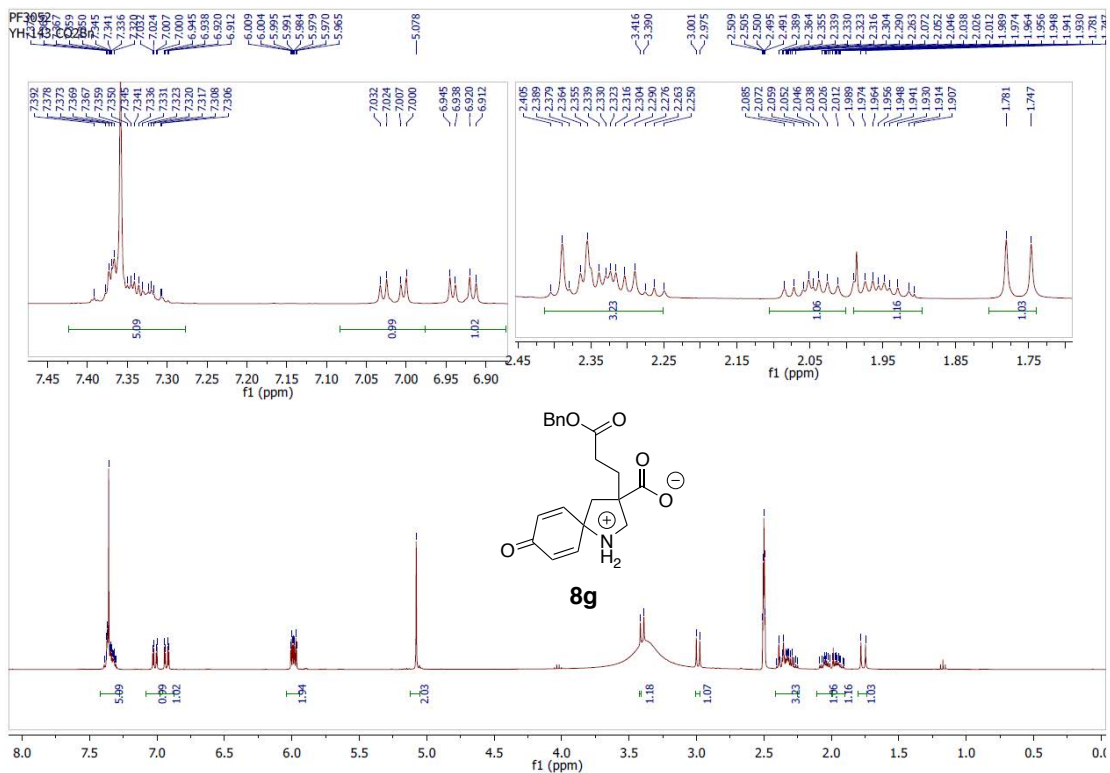


^{13}C NMR (100 MHz, CD_3COOD)

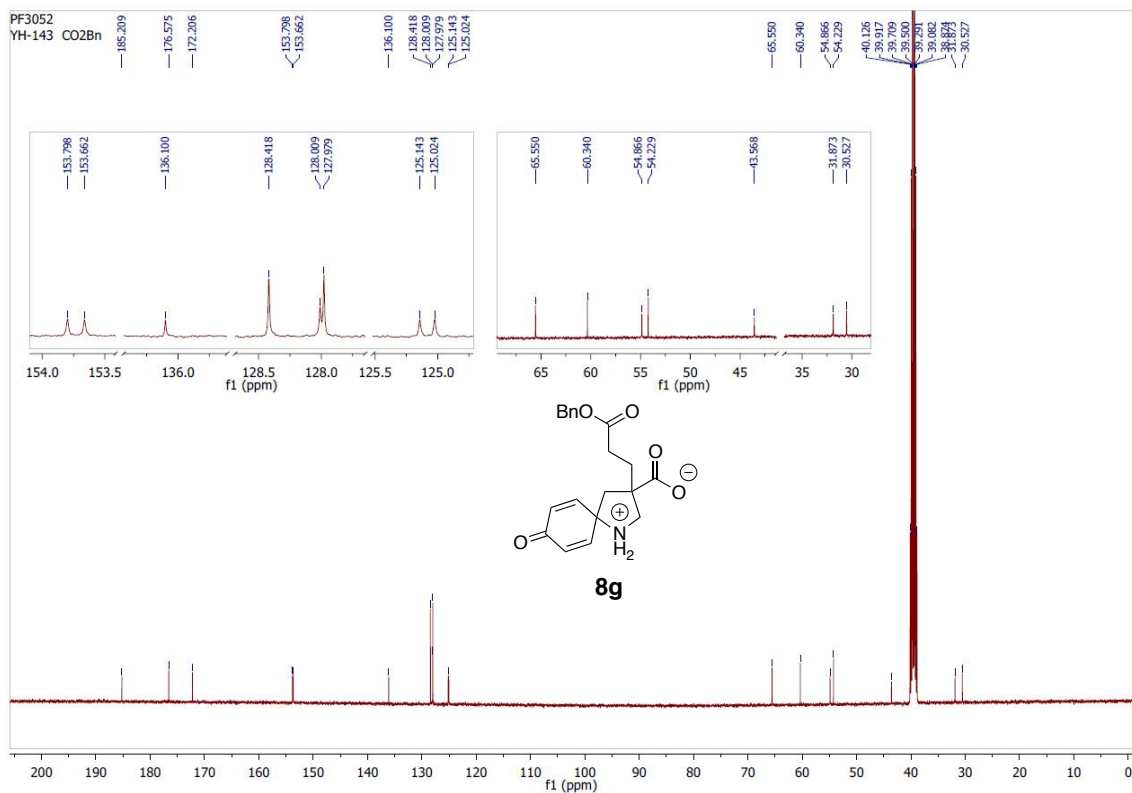


3-(3-(Benzyloxy)-3-oxopropyl)-8-oxo-1-azaspiro[4.5]deca-6,9-dien-1-ium-3-carboxylate (8g):

^1H NMR (400 MHz, $\text{DMSO-}d_6$)

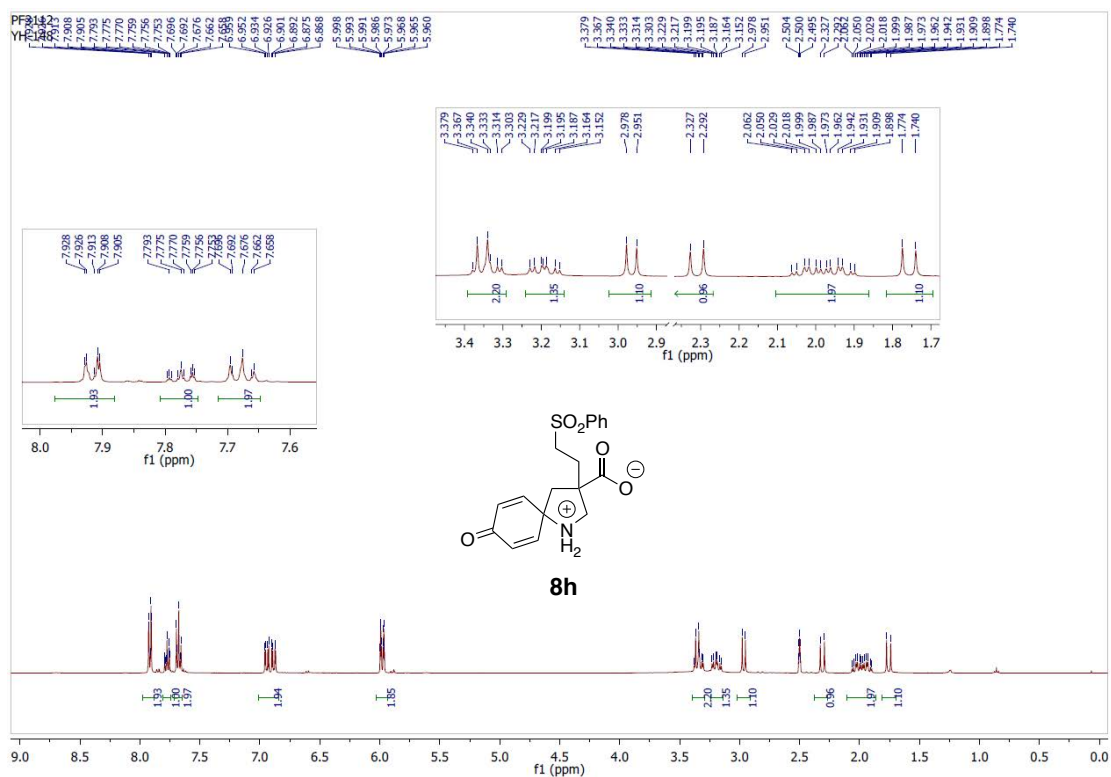


^{13}C NMR (100 MHz, $\text{DMSO-}d_6$)

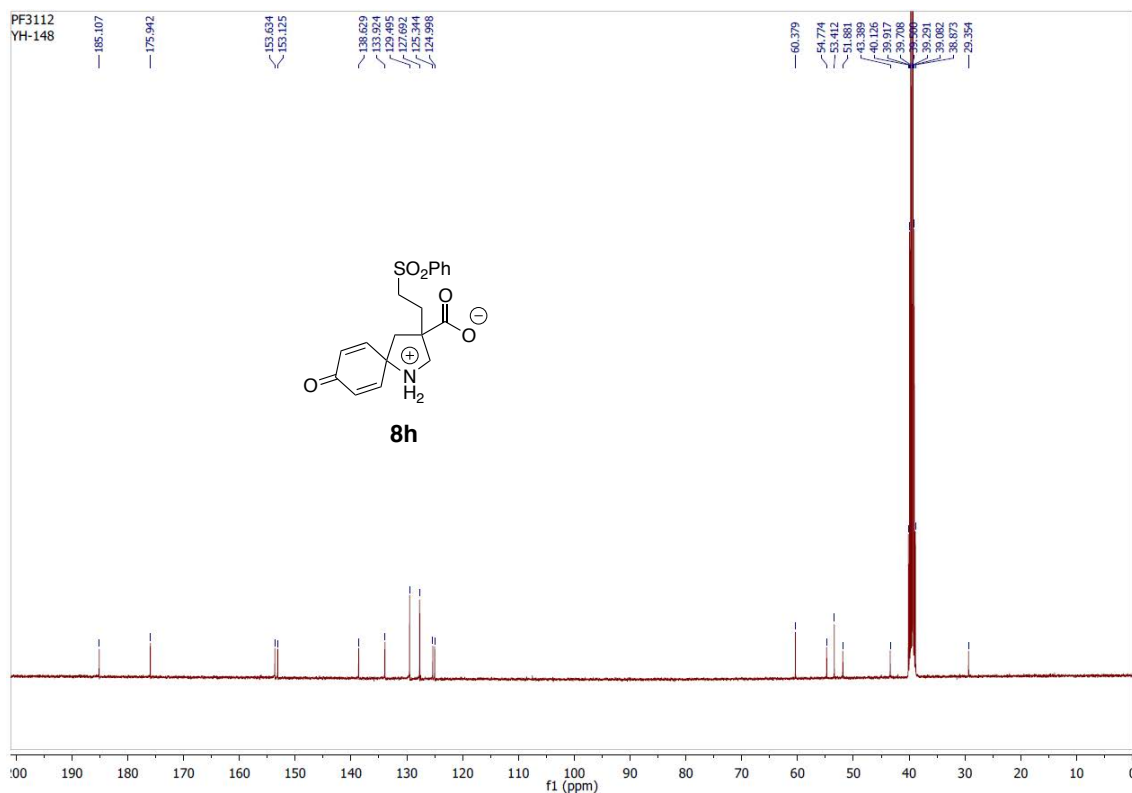


8-Oxo-3-(2-(phenylsulfonyl)ethyl)-1-azaspiro[4.5]deca-6,9-dien-1-ium-3-carboxylate (8h):

^1H NMR (400 MHz, $\text{DMSO-}d_6$)

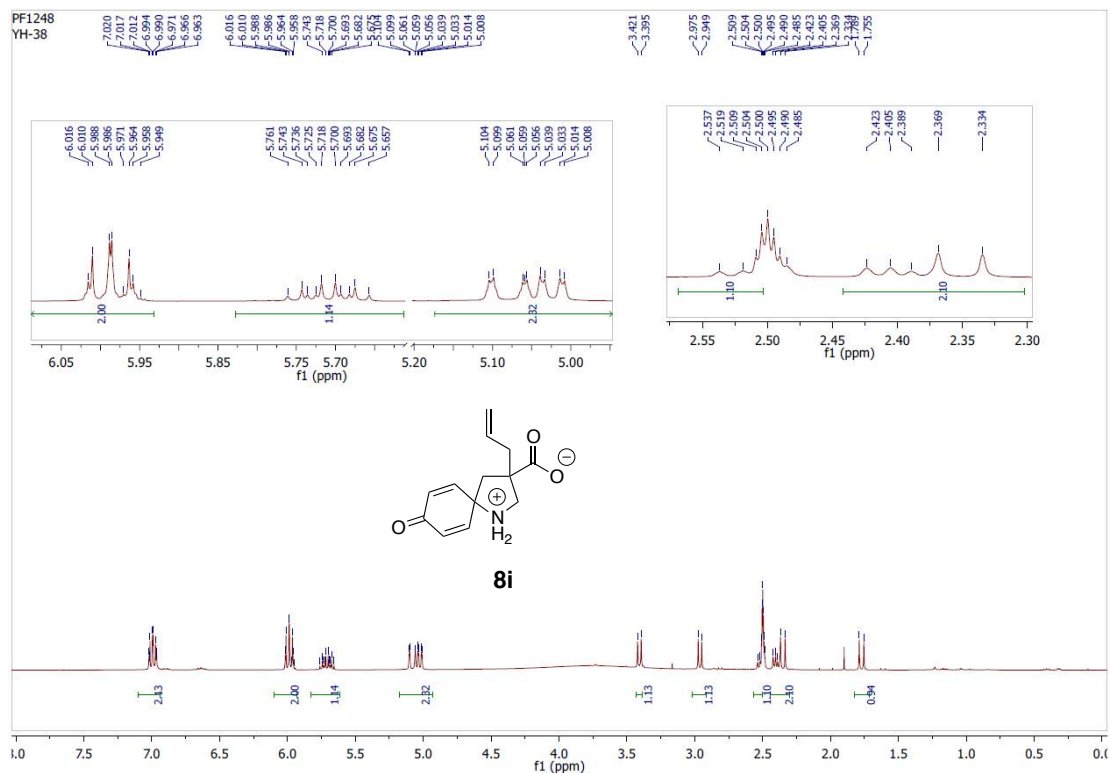


^{13}C NMR (100 MHz, $\text{DMSO-}d_6$)



3-Allyl-8-oxo-1-azaspiro[4.5]deca-6,9-dien-1-ium-3-carboxylate (**8i**):

^1H NMR (400 MHz, $\text{DMSO-}d_6$)



^{13}C NMR (100 MHz, $\text{DMSO-}d_6$)

