Supporting Information

Divergent Synthesis of Selenide-Containing Spirocarbocycles and Phenanthrenes through $Cu(OTf)_2$-Promoted Selenylation of Alkyne-Containing Phenol-Based Biaryls

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General information

All commercially available reagents were used directly without purification unless otherwise stated. All solvents were used directly without purification. For chromatography, 200-300 mesh silica gel (Qingdao, China) was employed. ^{1}H, $^{13}C\{^{1}H\}$ and ^{19}F NMR spectra were recorded using $CDCl_3$ or DMSO-d_6 at 500, 126 and 470 MHz Brucker Advanced III instrument respectively. IR spectra were recorded on a FT-IR instrument. The HRMS analysis was obtained on a QTOF mass spectrometer. Melting points were determined with melting points apparatus and are uncorrected. Substrates **1** and **2** were synthesized in the lab by the reported procedures.

General procedure for the synthesis of selenylated spirocyclohexadienones 3.

Aryl phenol-tethered alkyne **1** (0.12 mmol, 1.0 eq.), diselenide **2** (0.144 mmol, 1.2 eq.), K_2CO_3 (0.24 mmol, 2.0 eq., 33.1 mg) and $Cu(OTf)_2$ (0.144 mmol, 1.2 eq., 52.1 mg) were added to a reaction tube successively under an air atmosphere, and then MeCN (0.1 M, 1.2 mL) was added via syringe. The mixture was heated in an oil bath at 80 ℃ for 12 h until reaction completion (monitored by TLC). After completion of the reaction, the mixture was cooled to room temperature. Then, the solvent was removed in a vacuum, and the resulting residue was purified on a silica gel column (petroleum ether/ethyl acetate = 20:1, v/v) to afford the product **3**.

2'-Phenyl-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3a)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (50 mg, 98% yield). Mp 168-169 ℃. IR 3937, 3889, 3842, 3794, 1660, 859, 737 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 – 7.23 (m, 10H), 7.20 – 7.13 (m, 4H), 6.59 (d, J = 10.0 Hz, 2H), 6.49 (d, J = 10.0 Hz, 2H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.9, 151.6, 148.0, 145.3,

140.8, 134.3, 132.1, 130.9, 129.8, 129.3, 128.8, 128.7, 128.6, 128.1, 127.2, 126.8, 123.5, 123.0, 62.2. HRMS (ESI) calcd for $C_{26}H_{18}NaOSe$ $[M + Na]^+$ 449.0417, found 449.0418.

3'-(Phenylselanyl)-2'-(p-tolyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3b)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (49.9 mg, 95% yield). Mp 156-157 ℃. IR 3926, 3797, 3665, 3504, 3346, 3177, 2934, 1630, 1439, 708 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 7.36 – 7.30 (m, 2H), 7.28 – 7.08 (m, 11H), 6.59 (d, *J* = 10.1 Hz, 2H), 6.49 (d, *J* = 10.0 Hz, 2H), 2.32 (s, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 186.0, 151.9, 148.2, 145.3, 140.7, 138.7, 131.5, 131.4, 130.9, 130.8, 130.0, 129.2, 128.82, 128.75, 128.4, 127.0, 126.7, 123.4, 122.9, 62.2, 21.3. HRMS (ESI) calcd for $C_{27}H_{20}NaOSe$ $[M + Na]^+$ 463.0573, found 463.0575.

2'-(4-Ethylphenyl)-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3c)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (47.9 mg, 88% yield). Mp 125-126 ℃. IR 3864, 3603, 2927, 2346, 1693, 1520 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 7.42 – 7.08 (m, 13H), 6.63 (d, *J* = 9.9 Hz, 2H), 6.53 (d, *J* = 9.9 Hz, 2H), 2.66 (s, 2H), 1.25 (t, *J* = 7.6 Hz, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 186.0, 151.8, 148.3, 145.4, 144.9, 140.6, 131.6, 131.4, 130.9, 130.8, 130.0, 129.2, 128.8, 128.5, 127.6, 127.0, 126.7, 123.4, 123.0, 62.2, 28.6, 15.1. HRMS (ESI) calcd for $C_{28}H_{22}NaOSe$ $[M + Na]^+$ 477.0730, found 477.0748.

2'-(4-Methoxyphenyl)-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-on e ***(3d)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow solid (45.4 mg, 83% yield). Mp 132-133 ℃. IR 3838, 3753, 3610, 2916, 1667, 1502 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 7.36 – 7.31 (m, 4H), 7.28 – 7.16 (m, 6H), 7.13 (d, *J* = 6.9 Hz, 1H), 6.83 (d, *J* = 8.9 Hz, 2H), 6.60 (d, *J* = 10.1 Hz, 2H), 6.51 (d, *J* = 10.0 Hz, 2H), 3.79 (s, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 186.0, 159.9, 151.5, 148.5, 145.5, 140.5,

130.9, 130.8, 130.7, 130.1, 129.9, 129.3, 128.8, 127.0, 126.74, 126.72, 123.4, 122.9, 113.6, 62.2, 55.2. HRMS (ESI) calcd for $C_{27}H_{20}NaO_2Se$ $[M + Na]^+$ 479.0522, found 479.0520.

2'-(4-Fluorophenyl)-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3e)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (48.6 mg, 91% yield). Mp 136-137 ℃. IR 3941, 3882, 3805, 3750, 1667, 1502, 1222, 1164, 1006, 829, 745 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 7.35 – 7.22 (m, 7H), 7.21 – 7.13 (m, 4H), 7.00 – 6.94 (m, 2H), 6.57 (d, J = 10.1 Hz, 2H), 6.50 (d, J = 10.1 Hz, 2H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 185.7, 162.7 (d, J_{C-F} = 249.4 Hz), 150.2, 147.8, 145.1, 140.6, 132.6, 131.1, 131.0, 130.4 (d, J_{C-F} = 8.2 Hz), 130.3 (d, J_{C-F} = 3.3 Hz), 129.6, 129.3, 128.9, 127.3, 126.9, 123.5, 123.0, 115.20 (d, J_{C-F} = 21.6 Hz), 62.2. ^{19}F NMR (470 MHz, $CDCl_3$) δ -111.98. HRMS (ESI) calcd for $C_{26}H_{17}NaFOSe$ $[M + Na]^+$ 467.0322, found 467.0320.

2'-(4-Chlorophenyl)-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3f)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (48.9 mg, 89% yield). Mp 164-165 ℃. IR 3790, 3669, 3357, 2908, 1663, 1450 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 7.34 – 7.23 (m, 9H), 7.21 – 7.13 (m, 4H), 6.56 (d, J = 10.2 Hz, 2H), 6.50 (d, J = 10.1 Hz, 2H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 185.7, 149.9, 147.7, 145.1, 140.7, 134.7, 133.0, 132.7, 131.13, 131.11, 129.9, 129.5, 129.3, 128.9, 128.4, 127.4, 127.0, 123.5, 123.1, 62.1. HRMS (ESI) calcd for $C_{26}H_{17}ClNaOSe$ $[M + Na]^+$ 483.0024, found 483.0017.

2'-(4-Bromophenyl)-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3g)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (46.8 mg, 77% yield). Mp 152-154 ℃. IR 3845, 3735, 3346, 2920, 1675, 1468 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 7.41 (d, J = 8.5 Hz, 2H), 7.33 – 7.13 (m, 11H), 6.56 (d, J = 10.2 Hz,

2H), 6.50 (d, J = 10.1 Hz, 2H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.7, 149.9, 147.7, 145.1, 140.7, 133.2, 133.0, 131.3, 131.2, 131.1, 130.1, 129.5, 129.3, 128.9, 127.4, 127.1, 123.5, 123.1, 123.0, 62.1. HRMS (ESI) calcd for $C_{26}H_{17}BrNaOSe$ $[M + Na]^+$ 526.9519, found 526.9512.

*3'-(Phenylselanyl)-2'-(4-(trifluoromethyl)phenyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one (**3h**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (42.7 mg, 72% yield). Mp 117-118 ℃. IR 3948, 3900, 3838, 3761, 1663, 1325, 1164, 1127, 1053, 1002, 840, 734, 679 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.55 (d, J = 8.2 Hz, 2H), 7.44 (d, J = 8.1 Hz, 2H), 7.39 – 7.27 (m, 5H), 7.20 (d, J = 7.4 Hz, 4H), 6.60 (d, J = 10.1 Hz, 2H), 6.52 (d, J = 10.1 Hz, 2H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.6, 149.1, 147.4, 144.9, 140.8, 137.9, 134.2, 131.4, 131.3, 130.5, 130.3, 129.4, 129.2, 129.0, 128.9, 127.7, 127.2, 125.07 (q, J_{C-F} = 3.7 Hz), 123.6, 123.2, 62.2. ^{19}F NMR (470 MHz, $CDCl_3$) δ -62.75. HRMS (ESI) calcd for $C_{26}H_{17}F_3NaOSe$ $[M + Na]^+$ 517.0291, found 517.0294.

*2'-(4-Nitrophenyl)-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one (**3i**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow solid (39.3 mg, 70% yield). Mp 166-167 ℃. IR 3822, 3805, 2927, 1652, 1527 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.11 (d, J = 8.8 Hz, 2H), 7.49 (d, J = 8.9 Hz, 2H), 7.40 – 7.29 (m, 5H), 7.18 (t, J = 7.4 Hz, 4H), 6.58 (d, J = 10.2 Hz, 2H), 6.52 (d, J = 10.1 Hz, 2H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.3, 147.7, 147.4, 147.1, 144.8, 141.0, 140.8, 135.6, 131.5, 131.4, 129.5, 129.4, 129.1, 128.9, 128.0, 127.4, 123.6, 123.33, 123.28, 62.1. HRMS (ESI) calcd for $C_{26}H_{17}NNaO_3Se$ $[M + Na]^+$ 494.0267, found 494.0268.

*3'-(Phenylselanyl)-2'-(m-tolyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one (**3j**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (43.6 mg, 83% yield). Mp 126-128 ℃. IR 3926, 3636, 3349, 2908, 1648, 1468, 723 cm^{-1}. ^{1}H NMR (500 MHz,

$CDCl_3$) δ 7.36 – 7.30 (m, 2H), 7.29 – 7.21 (m, 3H), 7.21 – 7.08 (m, 8H), 6.59 (d, J = 10.1 Hz, 2H), 6.49 (d, J = 10.0 Hz, 2H), 2.29 (s, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 186.0, 151.8, 148.1, 145.3, 140.8, 137.6, 134.3, 132.0, 131.1, 130.9, 129.9, 129.5, 129.3, 129.2, 128.8, 128.0, 127.1, 126.8, 125.6, 123.5, 123.0, 62.3, 21.5. HRMS (ESI) calcd for $C_{27}H_{20}NaOSe$ $[M + Na]^+$ 463.0573, found 463.0576.

*2'-(3-Fluorophenyl)-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one **(3k)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (45.6 mg, 86% yield). Mp 130-132 ℃. IR 3970, 3908, 3772, 3706, 2916, 1656, 1461, 1255, 1178, 1009, 844, 741 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 7.35 – 7.21 (m, 6H), 7.21 – 7.14 (m, 4H), 7.09 (d, J = 7.8 Hz, 1H), 7.06 – 6.96 (m, 2H), 6.59 – 6.54 (m, 2H), 6.53 – 6.48 (m, 2H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 185.7, 162.2 (d, J_{C-F} = 246.7 Hz), 149.6, 147.6, 145.0, 140.7, 136.3 (d, J_{C-F} = 8.1 Hz), 133.4, 131.3, 131.1, 129.7 (d, J_{C-F} = 8.4 Hz), 129.4, 129.3, 128.9, 127.5, 127.1, 124.4 (d, J_{C-F} = 2.9 Hz), 123.5, 123.1, 115.7 (d, J_{C-F} = 14.4 Hz), 115.5 (d, J_{C-F} = 13.1 Hz), 62.1. ^{19}F NMR (470 MHz, $CDCl_3$) δ -112.39. HRMS (ESI) calcd for $C_{26}H_{17}NaFOSe$ $[M + Na]^+$ 467.0322, found 467.0319.

*2'-(3-Chlorophenyl)-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one **(3l)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (46.4 mg, 84% yield). Mp 157-159 ℃. IR 2920, 1660, 1467 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 7.35 – 7.24 (m, 7H), 7.22 – 7.14 (m, 6H), 6.55 (d, J = 10.2 Hz, 2H), 6.50 (d, J = 10.1 Hz, 2H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 185.7, 149.2, 147.5, 145.0, 140.7, 136.0, 133.9, 133.7, 131.5, 131.2, 129.4, 129.3, 129.2, 128.9, 128.8, 128.6, 127.5, 127.2, 126.6, 123.5, 123.1, 62.1. HRMS (ESI) calcd for $C_{26}H_{17}ClNaOSe$ $[M + Na]^+$ 483.0024, found 483.0036.

*2'-(3-Bromophenyl)-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one **(3m)***. Purification by column chromatography on silica gel (petroleum ether/ethyl

acetate = 20:1, v/v) afforded the target compound as a yellow solid (39.3 mg, 65% yield). Mp 148-150 ℃. IR 3838, 3702, 3625, 1667, 737 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.44 – 7.39 (m, 2H), 7.35 – 7.24 (m, 5H), 7.23 – 7.11 (m, 6H), 6.55 (d, *J* = 10.2 Hz, 2H), 6.50 (d, *J* = 10.2 Hz, 2H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.7, 149.0, 147.5, 145.0, 140.7, 136.3, 133.8, 131.7, 131.65, 131.55, 131.2, 129.6, 129.3, 129.2, 128.9, 127.5, 127.2, 127.0, 123.5, 123.1, 122.1, 62.2. HRMS (ESI) calcd for $C_{26}H_{17}BrNaOSe$ $[M + Na]^+$ 526.9519, found 526.9512.

2'-(2-Fluorophenyl)-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3n)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (38.9 mg, 73% yield). Mp 145-147 ℃. IR 3955, 3897, 3753, 1645, 866, 745 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.42 – 7.37 (m, 2H), 7.35 – 7.26 (m, 4H), 7.24 – 7.17 (m, 4H), 7.12 – 7.03 (m, 3H), 6.62 (d, *J* = 9.0 Hz, 2H), 6.46 (d, *J* = 10.0 Hz, 2H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.9, 159.6 (d, J_{C-F} = 246.4 Hz), 146.9, 145.1, 144.7, 141.7, 135.9, 131.9, 130.9 (d, J_{C-F} = 38.2 Hz), 130.8 (d, J_{C-F} = 2.3 Hz), 130.5 (d, J_{C-F} = 8.2 Hz), 129.2, 128.9, 128.8, 127.3, 127.1, 123.7 (d, J_{C-F} = 3.7 Hz), 123.6, 122.9, 121.8 (d, J_{C-F} = 16.1 Hz), 115.8 (d, J_{C-F} = 22.4 Hz), 62.7. ^{19}F NMR (470 MHz, $CDCl_3$) δ -111.11. HRMS (ESI) calcd for $C_{26}H_{17}NaFOSe$ $[M + Na]^+$ 467.0322, found 467.0327.

2'-(2-Chlorophenyl)-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3o)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (39.3 mg, 71% yield). Mp 146-148 ℃. IR 3742, 3382, 2927, 1667, 741 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.47 – 7.12 (m, 12H), 7.05 (dd, *J* = 7.7, 1.6 Hz, 1H), 6.78 (dd, *J* = 9.9, 2.8 Hz, 1H), 6.62 (dd, *J* = 9.9, 2.8 Hz, 1H), 6.52 (dd, *J* = 9.9, 1.6 Hz, 1H), 6.38 (dd, *J* = 9.9, 1.6 Hz, 1H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.9, 147.8, 146.6, 145.2, 144.6, 141.6, 135.9, 134.0, 132.7, 132.0, 131.4, 130.9, 130.8, 129.8, 129.7, 129.2, 128.9, 128.8, 127.3, 127.1, 126.2, 123.6, 122.9, 63.2. HRMS (ESI) calcd for $C_{26}H_{17}ClNaOSe$ $[M + Na]^+$ 483.0024, found 483.0038.

2'-(Ferrocen-2-yl)-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3p)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a red solid (25.4 mg, 40% yield). Mp 177-179 ℃. IR 3728, 3474, 3342, 2931, 1667, 1461 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.40 (d, *J* = 6.9 Hz, 2H), 7.30 (d, *J* = 7.4 Hz, 1H), 7.27 – 7.17 (m, 5H), 7.05 (d, *J* = 7.1 Hz, 1H), 6.71 (d, *J* = 10.0 Hz, 2H), 6.62 (d, *J* = 10.0 Hz, 2H), 5.15 (s, 2H), 4.36 (s, 2H), 4.03 (s, 5H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 186.2, 152.6, 150.7, 147.0, 138.4, 130.8, 129.9, 129.8, 129.5, 129.0, 126.6, 126.4, 125.6, 123.1, 121.8, 78.0, 69.9, 69.8, 69.0, 61.9. HRMS (ESI) calcd for $C_{30}H_{22}NaFeOSe$ $[M + Na]^+$ 557.0080, found 557.0067.

4'-Methyl-2'-phenyl-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3q)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (38 mg, 72% yield). Mp 162-164 ℃. IR 3827, 3551, 2934, 1593, 756 cm^{-1}. ^{1}H NMR (500 MHz, CDCl3) δ 7.28 – 7.08 (m, 12H), 7.04 (d, *J* = 7.3 Hz, 1H), 6.57 (d, *J* = 9.8 Hz, 2H), 6.44 (d, *J* = 9.8 Hz, 2H), 2.62 (s, 3H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.9, 154.6, 147.8, 141.9, 141.4, 134.8, 133.9, 133.1, 132.3, 131.6, 130.9, 129.4, 129.1, 128.7, 128.4, 127.9, 127.0, 126.2, 121.6, 62.1, 19.3. HRMS (ESI) calcd for $C_{27}H_{20}NaOSe$ $[M + Na]^+$ 463.0573, found 463.0578.

4'-Fluoro-2'-phenyl-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3r)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (39.6 mg, 74% yield). Mp 138-140 ℃. IR 3944, 3838, 3753, 1660, 1465, 1252, 1086, 862, 730 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.34 – 7.31 (m, 2H), 7.31 – 7.23 (m, 6H), 7.18 (t, *J* = 2.1 Hz, 2H), 7.17 – 7.16 (m, 1H), 7.05 – 7.02 (m, 1H), 7.01 – 6.99 (m, 1H), 6.63 – 6.57 (m, 2H), 6.52 – 6.47 (m, 2H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.6, 156.7 (d, J_{C-F} = 255.1 Hz), 151.6, 147.0, 143.7, 133.9, 131.7, 131.6, 131.1, 130.9 (d, J_{C-F} = 2.7 Hz), 129.1, 128.7, 128.67, 128.64, 128.5, 128.0, 126.8, 119.6 (d, J_{C-F} = 3.6 Hz),

116.7 (d, J_{C-F} = 21.1 Hz), 62.5. ^{19}F NMR (470 MHz, $CDCl_3$) δ -118.98. HRMS (ESI) calcd for $C_{26}H_{17}NaFOSe$ $[M + Na]^+$ 467.0322, found 467.0331.

5'-Methyl-2'-phenyl-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3s)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (42.7 mg, 81% yield). Mp 133-135 ℃. IR 3801, 2912, 1648, 1061, 822 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.38 – 7.25 (m, 7H), 7.17 (d, *J* = 32.0 Hz, 4H), 7.07 (dd, *J* = 17.1, 7.6 Hz, 2H), 6.60 (d, *J* = 9.8 Hz, 2H), 6.49 (d, *J* = 9.8 Hz, 2H), 2.32 (s, 3H). ^{13}C{^{1}H} NMR (126 MHz, $CDCl_3$) δ 186.1, 151.9, 148.3, 145.5, 139.0, 137.7, 134.4, 132.1, 130.9, 130.8, 130.0, 129.3, 128.6, 128.6, 128.08, 128.06, 126.8, 123.6, 123.2, 62.0, 21.5. HRMS (ESI) calcd for $C_{27}H_{20}NaOSe$ $[M + Na]^+$ 463.0573, found 463.0562.

5'-Fluoro-2'-phenyl-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3t)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (47.1 mg, 89% yield). Mp 143-144 ℃. IR 3955, 3893, 3849, 3750, 1660, 1472, 1248, 1160, 726 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.38 – 7.32 (m, 7H), 7.25 – 7.21 (m, 3H), 7.12 (dd, *J* = 8.2, 4.8 Hz, 1H), 7.01 – 6.97 (m, 1H), 6.95 (dd, *J* = 8.4, 2.4 Hz, 1H), 6.62 – 6.58 (m, 2H), 6.54 – 6.50 (m, 2H). ^{13}C{^{1}H} NMR (126 MHz, $CDCl_3$) δ 185.7, 163.5 (d, J_{C-F} = 246.4 Hz), 153.7, 147.6, 147.5, 136.2, 136.1, 134.1, 131.2, 131.1, 129.4, 129.3, 128.9, 128.5, 128.2, 127.2, 124.6 (d, J_{C-F} = 9.3 Hz), 114.1 (d, J_{C-F} = 23.7 Hz), 110.3 (d, J_{C-F} = 24.8 Hz), 61.6. ^{19}F NMR (470 MHz, $CDCl_3$) δ -112.27. HRMS (ESI) calcd for $C_{26}H_{17}NaFOSe$ $[M + Na]^+$ 467.0322, found 467.0324.

5'-Chloro-2'-phenyl-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3u)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (50.5 mg, 92% yield). Mp 123-125 ℃. IR 3904, 3706, 3559, 3342, 2931, 1663, 1531 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.34 (d, *J* = 9.3 Hz, 7H), 7.27 (s, 1H), 7.23 (td, *J* = 5.7, 5.1, 1.9 Hz, 4H), 7.09 (d, *J* = 8.0 Hz, 1H), 6.58 (d, *J* = 10.1 Hz, 2H), 6.51 (d, *J* = 10.1 Hz, 2H).

$^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.6, 153.4, 147.2, 147.1, 139.9, 139.6, 139.1, 135.0, 133.9, 131.2, 131.2, 129.4, 129.3, 129.0, 128.5, 128.2, 127.2, 124.5, 123.2, 61.7. HRMS (ESI) calcd for $C_{26}H_{17}ClNaOSe$ $[M + Na]^+$ 483.0024, found 483.0037.

6'-Methyl-2'-phenyl-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3v)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (41.3 mg, 78% yield). Mp 134-136 °C. IR 3900, 3735, 2912, 1660, 1509, 752 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 – 7.27 (m, 6H), 7.25 (s, 1H), 7.20 – 7.12 (m, 4H), 7.09 – 7.04 (m, 1H), 6.96 (d, *J* = 1.5 Hz, 1H), 6.63 – 6.57 (m, 2H), 6.51 – 6.46 (m, 2H), 2.33 (s, 3H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 186.0, 150.4, 148.4, 142.8, 140.8, 137.4, 134.5, 131.9, 130.9, 130.8, 129.9, 129.6, 129.2, 128.6, 128.1, 126.8, 124.2, 122.7, 62.1, 21.4. HRMS (ESI) calcd for $C_{27}H_{20}NaOSe$ $[M + Na]^+$ 463.0573, found 463.0584.

6'-Fluoro-2'-phenyl-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3w)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (42.5 mg, 80% yield). Mp 139-141 °C. IR 3897, 3820, 3753, 3691, 1663, 1476, 1255, 862, 745 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35 – 7.29 (m, 7H), 7.22 – 7.17 (m, 4H), 6.96 (td, *J* = 8.8, 2.4 Hz, 1H), 6.88 (dd, *J* = 8.0, 2.4 Hz, 1H), 6.59 (d, *J* = 10.1 Hz, 2H), 6.51 (d, *J* = 10.1 Hz, 2H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.6, 162.4 (d, J_{C-F} = 248.3 Hz), 151.4, 147.2, 143.1, 143.0, 141.1 (d, J_{C-F} = 2.4 Hz), 134.1, 131.3, 131.1, 129.5, 129.4, 128.8, 128.6, 128.2, 127.0, 124.0 (d, J_{C-F} = 8.5 Hz), 115.9 (d, J_{C-F} = 22.9 Hz), 111.3 (d, J_{C-F} = 24.1 Hz), 62.0. ^{19}F NMR (470 MHz, $CDCl_3$) δ -113.60. HRMS (ESI) calcd for $C_{26}H_{17}NaFOSe$ $[M + Na]^+$ 467.0322, found 467.0323.

6'-Chloro-2'-phenyl-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3x)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (45.6 mg, 83% yield). Mp 137-138 °C. IR 3831, 3364, 2938, 1663, 1428, 737 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 – 7.31 (m, 7H), 7.27 – 7.20 (m, 4H), 7.16 (dd, *J* = 11.9, 5.0 Hz,

2H), 6.60 (d, *J* = 10.1 Hz, 2H), 6.53 (d, *J* = 10.1 Hz, 2H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.6, 151.9, 147.0, 143.7, 142.6, 134.0, 133.2, 131.4, 131.3, 131.1, 129.4, 129.3, 129.1, 128.9, 128.5, 128.2, 127.1, 123.9, 62.0. HRMS (ESI) calcd for $C_{26}H_{17}ClNaOSe$ $[M + Na]^+$ 483.0024, found 483.0027.

*2'-Phenyl-3'-(phenylselanyl)-6'-(trifluoromethyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one (**3y**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (52.9 mg, 89% yield). Mp 149-150 ℃. IR 3952, 3886, 3772, 1641, 1333, 1171, 1166, 737, 686 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.57 – 7.53 (m, 1H), 7.38 (d, *J* = 19.2 Hz, 9H), 7.23 (dd, *J* = 5.1, 1.8 Hz, 3H), 6.62 – 6.54 (m, 4H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.4, 154.5, 148.5, 146.5, 141.8, 133.8, 131.7, 131.5, 131.2, 129.5, 129.4, 129.20, 129.19, 128.5, 128.3, 127.3, 126.2 (q, J_{C-F} = 3.8 Hz), 123.2, 122.9, 120.4 (q, J_{C-F} = 3.7 Hz), 62.0. ^{19}F NMR (470 MHz, $CDCl_3$) δ -61.77. HRMS (ESI) calcd for $C_{26}H_{17}F_3NaOSe$ $[M + Na]^+$ 517.0291, found 517.0305.

*4-Oxo-2'-phenyl-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-diene-6'-carbonitrile (**3z**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow solid (39 mg, 72% yield). Mp 160-162 ℃. IR 3908, 3860, 3797, 3717, 1656, 866, 737 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.55 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.42 – 7.40 (m, 1H), 7.37 – 7.29 (m, 8H), 7.23 – 7.18 (m, 3H), 6.55 (s, 4H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.1, 155.6, 149.5, 145.8, 142.1, 133.4, 133.1, 131.8, 131.2, 129.5, 129.4, 128.9, 128.4, 128.3, 127.4, 126.8, 123.5, 118.5, 110.5, 61.9. HRMS (ESI) calcd for $C_{27}H_{17}NNaOSe$ $[M + Na]^+$ 474.0369, found 474.0372.

*6'-Nitro-2'-phenyl-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one (**3a'**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow solid (43.8 mg, 78% yield). Mp 178-179 ℃. IR 3839, 3750, 3669, 3518, 3342, 2908, 1652, 1527 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.15 (dd, *J* = 8.5, 2.1 Hz, 1H), 7.99 (d, *J* = 2.0 Hz, 1H),

7.39 – 7.31 (m, 8H), 7.21 (d, *J* = 6.2 Hz, 3H), 6.57 (s, 4H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.0, 157.1, 151.2, 146.9, 145.5, 142.4, 133.4, 132.0, 131.3, 131.2, 129.54, 129.48, 129.4, 128.8, 128.3, 127.5, 124.9, 123.1, 118.8, 61.9. HRMS (ESI) calcd for $C_{26}H_{17}NNaO_3Se$ $[M + Na]^+$ 494.0267, found 494.0254.

7'-Methyl-2'-phenyl-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3b')***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (35 mg, 66% yield). Mp 144-145 ℃. IR 3827, 3761, 3577, 3485, 3364, 2931, 1667, 1427, 1171 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.32 – 7.13 (m, 12H), 7.03 (dd, *J* = 6.6, 1.5 Hz, 1H), 6.60 – 6.51 (m, 4H), 2.19 (s, 3H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.7, 151.4, 146.5, 145.4, 138.4, 135.1, 134.0, 133.1, 132.4, 130.9, 130.1, 129.5, 129.2, 128.9, 128.7, 128.5, 127.9, 126.7, 120.7, 62.7, 16.9. HRMS (ESI) calcd for $C_{27}H_{20}NaOSe$ $[M + Na]^+$ 463.0573, found 463.0570.

3-Methyl-2'-phenyl-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3c')***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 30:1, v/v) afforded the target compound as a yellow solid (35.1 mg, 67% yield). Mp 108-110 ℃. IR 3823, 3353, 2927, 1645, 1432, 1072 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 – 7.20 (m, 11H), 7.18 – 7.16 (m, 2H), 7.12 (d, *J* = 6.6 Hz, 1H), 6.56 (dd, *J* = 9.7, 2.8 Hz, 1H), 6.47 (d, *J* = 9.7 Hz, 1H), 6.38 (d, *J* = 1.2 Hz, 1H), 1.94 (s, 3H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 186.6, 152.3, 147.6, 145.2, 142.8, 141.3, 137.6, 134.5, 131.5, 130.9, 130.7, 130.0, 129.3, 128.6, 128.5, 128.0, 127.0, 126.8, 123.3, 123.0, 62.5, 16.1. HRMS (ESI) calcd for $C_{27}H_{20}NaOSe$ $[M + Na]^+$ 463.0573, found 463.0563.

3-Chloro-2'-phenyl-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3d')***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 30:1, v/v) afforded the target compound as a yellow solid (39 mg, 71% yield). Mp 102-103 ℃. IR 3911, 3805, 3673, 1693, 1531 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 – 7.33 (m, 5H), 7.30 (dd, *J* = 6.9, 2.0 Hz, 4H), 7.23 – 7.18 (m, 5H),

6.81 (d, *J* = 2.5 Hz, 1H), 6.62 (dd, *J* = 9.7, 2.5 Hz, 1H), 6.58 (d, *J* = 9.7 Hz, 1H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 178.9, 150.3, 148.1, 145.2, 143.6, 139.6, 134.5, 133.8, 133.0, 131.2, 130.1, 129.5, 129.3, 129.2, 128.9, 128.5, 128.3, 127.4, 127.0, 123.5, 123.3, 63.9. HRMS (ESI) calcd for $C_{26}H_{17}ClNaOSe$ $[M + Na]^+$ 483.0024, found 483.0039.

2-Methyl-2'-phenyl-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3e')***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 30:1, v/v) afforded the target compound as a yellow solid (38 mg, 72% yield). Mp 104-106 ℃. IR 3698, 3485, 3371, 3213, 3092, 2920, 1652, 752 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 – 7.16 (m, 13H), 7.06 (s, 1H), 6.50 (dd, *J* = 22.5, 9.2 Hz, 2H), 6.39 (s, 1H), 1.55 (s, 3H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 186.9, 157.4, 151.8, 148.8, 145.7, 142.4, 134.1, 132.4, 131.0, 130.3, 130.0, 129.8, 129.3, 128.8, 128.7, 128.3, 128.2, 127.3, 126.9, 123.1, 122.7, 64.9, 18.9. HRMS (ESI) calcd for $C_{27}H_{20}NaOSe$ $[M + Na]^+$ 463.0573, found 463.0570.

2-Chloro-2'-phenyl-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3f')***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 30:1, v/v) afforded the target compound as a yellow solid (49.7 mg, 90% yield). Mp 115-117 ℃. IR 3893, 3735, 3540, 3357, 2920, 1637 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.43 – 7.26 (m, 11H), 7.22 – 7.20 (m, 2H), 7.17 (dd, *J* = 5.8, 3.2 Hz, 1H), 6.70 (d, *J* = 1.4 Hz, 1H), 6.59 (d, *J* = 9.7 Hz, 1H), 6.50 (dd, *J* = 9.7, 1.4 Hz, 1H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.0, 153.9, 150.3, 147.7, 145.6, 141.1, 134.0, 133.5, 131.6, 131.0, 129.8, 129.3, 129.2, 128.9, 128.6, 128.2, 127.5, 126.8, 123.2, 122.7, 66.1. HRMS (ESI) calcd for $C_{26}H_{17}ClNaOSe$ $[M + Na]^+$ 483.0024, found 483.0025.

(2'-Phenyl-3'-(p-tolylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3ab)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (40.7 mg, 77% yield). Mp 120-121 ℃. IR 3853, 3658, 3375, 3169, 2931, 1637, 1450, 1270, 737 cm^{-1}. ^{1}H NMR

(500 MHz, $CDCl_3$) δ 7.34 – 7.31 (m, 2H), 7.31 – 7.28 (m, 3H), 7.28 – 7.25 (m, 2H), 7.25 – 7.22 (m, 3H), 7.14 (d, *J* = 6.8 Hz, 1H), 6.99 (d, *J* = 8.0 Hz, 2H), 6.60 – 6.56 (m, 2H), 6.51 – 6.46 (m, 2H), 2.27 (s, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 185.9, 151.0, 148.1, 145.4, 140.7, 136.9, 134.4, 132.5, 131.3, 130.9, 130.1, 128.8, 128.7, 128.6, 128.1, 127.1, 125.8, 123.4, 123.1, 62.2, 21.0. HRMS (ESI) calcd for $C_{27}H_{20}NaOSe$ $[M + Na]^+$ 463.0573, found 463.0576.

*3'-((4-Methoxyphenyl)selanyl)-2'-phenylspiro[cyclohexane-1,1'-indene]-2,5-dien-4-on e (**3ac**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow solid (29.8 mg, 55% yield). Mp 141-142 ℃. IR 3834, 3739, 3573, 3313, 2912, 1648, 1468, 1255, 719 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 7.31 (s, 6H), 7.29 (d, *J* = 2.2 Hz, 1H), 7.28 (dd, *J* = 6.5, 1.2 Hz, 2H), 7.24 – 7.20 (m, 1H), 7.13 (d, *J* = 7.2 Hz, 1H), 6.75 – 6.70 (m, 2H), 6.59 – 6.54 (m, 2H), 6.50 – 6.45 (m, 2H), 3.75 (s, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 186.0, 159.2, 150.1, 148.2, 145.5, 140.8, 134.5, 133.7, 133.3, 130.9, 128.7, 128.6, 128.5, 128.1, 127.0, 123.4, 122.9, 119.3, 115.0, 62.2, 55.2. HRMS (ESI) calcd for $C_{27}H_{20}NaO_2Se$ $[M + Na]^+$ 479.0522, found 479.0533.

*3'-((4-Chlorophenyl)selanyl)-2'-phenylspiro[cyclohexane-1,1'-indene]-2,5-dien-4-one. (**3ad**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (40 mg, 73% yield). Mp 147-148 ℃. IR 3886, 3357, 2920, 1649, 1439, 715 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 7.33 – 7.22 (m, 10H), 7.18 – 7.12 (m, 3H), 6.58 (d, *J* = 10.1 Hz, 2H), 6.49 (d, *J* = 10.1 Hz, 2H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 185.9, 151.9, 147.7, 144.9, 140.8, 134.1, 133.1, 132.3, 131.9, 131.1, 129.5, 128.9, 128.8, 128.5, 128.1, 127.9, 127.3, 123.7, 122.8, 62.2. HRMS (ESI) calcd for $C_{26}H_{17}ClNaOSe$ $[M + Na]^+$ 483.0024, found 483.0018.

*3'-((4-Bromophenyl)selanyl)-2'-phenylspiro[cyclohexane-1,1'-indene]-2,5-dien-4-one (**3ae**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (42.7 mg, 71%

yield). Mp 152-153 ℃. IR 3908, 3709, 3588, 3291, 2908, 1674, 1439 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35 – 7.24 (m, 10H), 7.20 – 7.14 (m, 3H), 6.58 (d, *J* = 10.0 Hz, 2H), 6.50 (d, *J* = 10.0 Hz, 2H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.9, 152.1, 147.7, 144.9, 140.8, 134.1, 132.5, 132.3, 131.7, 131.1, 128.9, 128.8, 128.7, 128.5, 128.2, 127.4, 123.6, 122.9, 121.0, 62.2. HRMS (ESI) calcd for $C_{26}H_{17}BrNaOSe$ $[M + Na]^+$ 526.9519, found 526.9524.

*4-((4-Oxo-2'-phenylspiro[cyclohexane-1,1'-indene]-2,5-dien-3'-yl)selanyl)benzonitril e (**3af**)*. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow solid (39.2 mg, 73% yield). Mp 163-165 ℃. IR 3820, 3735, 2923, 1660, 1516 cm^{-1}. ^{1}H NMR (500 MHz, DMSO) δ 7.66 (d, *J* = 8.4 Hz, 2H), 7.56 (d, *J* = 8.4 Hz, 2H), 7.39 – 7.30 (m, 7H), 7.23 (d, *J* = 7.0 Hz, 1H), 7.19 (d, *J* = 7.0 Hz, 1H), 6.91 (d, *J* = 10.0 Hz, 2H), 6.47 (d, *J* = 9.9 Hz, 2H). $^{13}C\{^{1}H\}$ NMR (126 MHz, DMSO) δ 185.0, 154.8, 147.9, 144.1, 141.1, 138.1, 133.9, 132.8, 130.7, 129.9, 129.4, 128.9, 128.8, 128.4, 128.0, 127.6, 123.8, 122.1, 118.6, 108.8, 62.0. HRMS (ESI) calcd for $C_{27}H_{17}NNaOSe$ $[M + Na]^+$ 474.0369, found 474.0367.

*3'-((4-Nitrophenyl)selanyl)-2'-phenylspiro[cyclohexane-1,1'-indene]-2,5-dien-4-one (**3ag**)*. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow solid (34.3 mg, 61% yield). Mp 155-156 ℃. IR 3878, 3750, 3346, 2912, 1645, 730 cm^{-1}. ^{1}H NMR (500 MHz, DMSO) δ 8.05 (d, *J* = 8.9 Hz, 2H), 7.62 (d, *J* = 8.9 Hz, 2H), 7.40 – 7.31 (m, 7H), 7.23 (dd, *J* = 17.3, 6.9 Hz, 2H), 6.94 (d, *J* = 10.0 Hz, 2H), 6.47 (d, *J* = 9.9 Hz, 2H). $^{13}C\{^{1}H\}$ NMR (126 MHz, DMSO) δ 185.0, 155.2, 147.8, 145.8, 144.1, 141.2, 141.0, 133.9, 130.7, 129.8, 129.4, 129.1, 128.8, 128.4, 128.1, 127.7, 124.1, 123.8, 122.1, 62.1. HRMS (ESI) calcd for $C_{26}H_{17}NNaO_3Se$ $[M + Na]^+$ 494.0267, found 494.0258.

*2'-Phenyl-3'-(m-tolylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one (**3ah**)*. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate =

20:1, v/v) afforded the target compound as a yellow solid (44 mg, 83% yield). Mp 129-130 ℃. IR 3658, 2908, 1656, 1450 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35 – 7.23 (m, 8H), 7.20 – 7.11 (m, 2H), 7.10 (d, *J* = 7.7 Hz, 1H), 7.05 (t, *J* = 7.6 Hz, 1H), 6.98 (d, *J* = 7.4 Hz, 1H), 6.59 (d, *J* = 10.0 Hz, 2H), 6.49 (d, *J* = 10.0 Hz, 2H), 2.25 (s, 3H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.9, 151.3, 148.1, 145.4, 140.7, 139.0, 134.4, 132.3, 131.7, 130.9, 129.5, 129.1, 128.8, 128.6, 128.5, 128.1, 128.0, 127.8, 127.1, 123.4, 123.1, 62.3, 21.3. HRMS (ESI) calcd for $C_{27}H_{20}NaOSe$ $[M + Na]^+$ 463.0573, found 463.0578.

3'-((3-Fluorophenyl)selanyl)-2'-phenylspiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3ai)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (32.5 mg, 61% yield). Mp 135-136 ℃. IR 3860, 3753, 3338, 2905, 1656, 1487, 756 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33 – 7.26 (m, 8H), 7.18 – 7.12 (m, 2H), 7.10 (dt, *J* = 7.8, 1.2 Hz, 1H), 7.01 (ddd, *J* = 8.7, 2.4, 1.6 Hz, 1H), 6.87 (tdd, *J* = 9.3, 2.5, 1.1 Hz, 1H), 6.61 – 6.57 (m, 2H), 6.52 – 6.49 (m, 2H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.9, 162.7 (d, $J_{C\text{-}F}$ = 250.0 Hz), 152.5, 147.7, 144.9, 140.8, 134.1, 131.7, 131.5, 131.1, 130.5 (d, $J_{C\text{-}F}$ = 8.2 Hz), 130.4, 128.9, 128.5, 128.2, 127.4, 126.3 (d, $J_{C\text{-}F}$ = 3.1 Hz), 123.6, 122.9, 117.7 (d, $J_{C\text{-}F}$ = 22.9 Hz), 113.9 (d, $J_{C\text{-}F}$ = 21.2 Hz), 62.3. ^{19}F NMR (470 MHz, $CDCl_3$) δ -111.41. HRMS (ESI) calcd for $C_{26}H_{17}NaFOSe$ $[M + Na]^+$ 467.0322, found 467.0327.

3'-((3-Chlorophenyl)selanyl)-2'-phenylspiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3aj)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (44.2 mg, 80% yield). Mp 142-144 ℃. IR 3871, 3728, 3551, 3353, 2920, 1674, 1520, 1061, 881, 697 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33 – 7.24 (m, 9H), 7.19 – 7.12 (m, 3H), 7.08 (t, *J* = 7.8 Hz, 1H), 6.59 (d, *J* = 10.1 Hz, 2H), 6.50 (d, *J* = 10.1 Hz, 2H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 185.8, 152.3, 147.7, 144.9, 140.8, 134.9, 134.0, 131.5, 131.4,

131.2, 130.6, 130.2, 129.3, 128.9, 128.8, 128.5, 128.1, 127.4, 127.1, 123.6, 122.8, 62.3. HRMS (ESI) calcd for $C_{26}H_{17}ClNaOSe$ $[M + Na]^+$ 483.0024, found 483.0030.

2'-Phenyl-3'-(o-tolylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3ak)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (47.5 mg, 90% yield). Mp 150-151 ℃. IR 3889, 3856, 3797, 3727, 1667, 1457, 1274, 862, 756 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 7.34 – 7.31 (m, 2H), 7.29 (dd, J = 5.8, 4.3 Hz, 3H), 7.25 (dt, J = 6.2, 2.2 Hz, 2H), 7.23 – 7.20 (m, 1H), 7.18 – 7.13 (m, 3H), 7.12 – 7.08 (m, 1H), 6.95 (dd, J = 10.7, 4.1 Hz, 1H), 6.60 (t, J = 6.2 Hz, 2H), 6.50 (t, J = 6.2 Hz, 2H), 2.37 (s, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 185.9, 151.6, 148.0, 145.3, 140.7, 138.3, 134.3, 132.1, 131.0, 130.9, 130.5, 130.3, 128.9, 128.7, 128.4, 128.1, 127.2, 126.9, 126.7, 123.5, 122.9, 62.3, 21.9. HRMS (ESI) calcd for $C_{27}H_{20}NaOSe$ $[M + Na]^+$ 463.0573, found 463.0574.

3'-((2-Fluorophenyl)selanyl)-2'-phenylspiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3al)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (28 mg, 53% yield). Mp 145-146 ℃. IR 3878, 3735, 3665, 3562, 3335, 2901, 1663, 1531, 726 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 7.35 – 7.24 (m, 8H), 7.21 – 7.14 (m, 3H), 7.02 – 6.97 (m, 1H), 6.95 – 6.91 (m, 1H), 6.59 (d, J = 10.1 Hz, 2H), 6.50 (d, J = 10.1 Hz, 2H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 185.9, 160.9 (d, $J_{C\text{-}F}$ = 244.1 Hz), 152.2, 147.8, 145.1, 140.7, 134.2, 132.6 (d, $J_{C\text{-}F}$ = 3.0 Hz), 131.1, 130.7 (d, $J_{C\text{-}F}$ = 2.1 Hz), 128.98, 128.91, 128.8, 128.5, 128.1, 127.3, 124.9 (d, $J_{C\text{-}F}$ = 3.4 Hz), 123.5, 122.7, 116.5 (d, $J_{C\text{-}F}$ = 21.8 Hz), 115.7 (d, $J_{C\text{-}F}$ = 22.6 Hz), 62.3. ^{19}F NMR (470 MHz, $CDCl_3$) δ -104.44. HRMS (ESI) calcd for $C_{26}H_{17}NaFOSe$ $[M + Na]^+$ 467.0322, found 467.0322.

3'-((2-Chlorophenyl)selanyl)-2'-phenylspiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3am)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (25.5 mg, 46% yield). Mp 139-140 ℃. IR 3860, 3761, 3669, 3540, 3338, 3169, 2905, 1630, 1424,

756 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 7.36 – 7.24 (m, 9H), 7.19 (d, *J* = 6.7 Hz, 1H), 7.14 – 7.09 (m, 1H), 7.07 – 7.04 (m, 1H), 7.02 – 6.97 (m, 1H), 6.63 (d, *J* = 10.1 Hz, 2H), 6.52 (d, *J* = 10.0 Hz, 2H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 185.9, 153.6, 147.8, 144.9, 140.9, 134.1, 134.0, 131.1, 130.7, 130.6, 129.7, 129.0, 128.9, 128.3, 128.2, 127.6, 127.5, 127.3, 123.6, 122.9, 62.4. HRMS (ESI) calcd for $C_{26}H_{17}ClNaOSe$ $[M + Na]^+$ 483.0024, found 483.0026.

3'-(Naphthalen-1-ylselanyl)-2'-phenylspiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3an)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow solid (22.4 mg, 39% yield). Mp 165-167 ℃. IR 3797, 3684, 3364, 2920, 1637, 1450, 737 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 7.84 (s, 1H), 7.77 – 7.71 (m, 1H), 7.65 (dd, *J* = 13.4, 5.5 Hz, 2H), 7.47 – 7.40 (m, 2H), 7.38 – 7.33 (m, 3H), 7.32 – 7.26 (m, 4H), 7.24 – 7.20 (m, 2H), 7.15 (dd, *J* = 5.6, 2.8 Hz, 1H), 6.62 (d, *J* = 10.0 Hz, 2H), 6.51 (d, *J* = 10.0 Hz, 2H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 186.0, 151.7, 148.0, 145.4, 140.8, 134.3, 133.9, 132.2, 132.1, 131.0, 129.9, 128.9, 128.8, 128.7, 128.6, 128.1, 127.8, 127.3, 127.2, 126.6, 126.1, 123.5, 123.1, 62.3. HRMS (ESI) calcd for $C_{30}H_{20}NaOSe$ $[M + Na]^+$ 499.0574, found 499.0578.

3'-(Butylselanyl)-2'-phenylspiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(3ao)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow oil (45 mg, 93% yield). IR 3886, 3750, 3606, 3493, 3327, 2927, 1663, 1513, 1435, 1226, 741 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 7.61 (d, *J* = 7.5 Hz, 1H), 7.46 – 7.41 (m, 1H), 7.39 – 7.36 (m, 2H), 7.33 – 7.29 (m, 3H), 7.28 (dd, *J* = 7.5, 1.1 Hz, 1H), 7.15 (d, *J* = 7.4 Hz, 1H), 6.55 – 6.51 (m, 2H), 6.48 – 6.42 (m, 2H), 2.67 – 2.60 (m, 2H), 1.50 (ddd, *J* = 14.9, 8.3, 6.5 Hz, 2H), 1.28 – 1.17 (m, 2H), 0.78 (t, *J* = 7.4 Hz, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 186.1, 148.7, 148.4, 146.4, 140.4, 134.8, 132.5, 130.9, 128.6, 128.4, 128.1, 127.1, 125.8, 123.5, 122.3, 62.4, 32.2, 26.7, 22.5, 13.4. HRMS (ESI) calcd for $C_{24}H_{22}NaOSe$ $[M + Na]^+$ 429.0729, found 429.0714.

General procedure for the synthesis of selenylated-phenanthrenes 4.

Aryl phenol-tethered alkyne **1** (0.12 mmol, 1.0 eq.), diselenide **2** (0.144 mmol, 1.2 eq.) and $Cu(OTf)_2$ (0.144 mmol, 1.2 eq., 52.1 mg) were added to a reaction tube successively under an air atmosphere, and then MeCN (0.1 M, 1.2 mL) was added via syringe. The mixture was heated in an oil bath at 80 ℃ for 12 h until reaction completion (monitored by TLC). After completion of the reaction, the mixture was cooled to room temperature. Then, the solvent was removed in a vacuum, and the resulting residue was purified on a silica gel column (petroleum ether/ethyl acetate = 10:1, v/v) to afford the product **4**.

10-Phenyl-9-(phenylselanyl)phenanthren-2-ol ***(4a)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow solid (49.9 mg, 98% yield). Mp 171-173 ℃. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.73 – 8.70 (m, 1H), 8.70 – 8.66 (m, 2H), 7.68 (ddd, *J* = 8.3, 7.0, 1.3 Hz, 1H), 7.55 (ddd, *J* = 8.2, 7.0, 1.1 Hz, 1H), 7.45 (dd, *J* = 4.9, 1.8 Hz, 3H), 7.28 – 7.24 (m, 3H), 7.09 (s, 5H), 6.84 (d, *J* = 2.7 Hz, 1H), 5.04 (s, 1H). ^{13}C{^{1}H} NMR (126 MHz, $CDCl_3$) δ 154.1, 145.8, 141.9, 134.2, 133.6, 131.4, 130.7, 130.6, 129.6, 129.1, 128.9, 128.4, 128.0, 127.3, 127.1, 126.6, 125.5, 125.4, 124.6, 122.1, 117.4, 112.3. HRMS (ESI) calcd for $C_{26}H_{17}OSe$ $[M - H]^-$ 425.0450, found 425.0454.

9-(Phenylselanyl)-10-(p-tolyl)phenanthren-2-ol ***(4b)***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (34.1 mg, 65% yield). IR 3827, 3728, 3526, 2934, 1656, 1502 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.63 (d, *J* = 9.0 Hz, 1H), 8.62 – 8.58 (m, 2H), 7.60 (ddd, *J* = 8.3, 7.0, 1.3 Hz, 1H), 7.47 (ddd, *J* = 8.2, 7.0, 1.1 Hz, 1H), 7.22 – 7.18 (m, 3H), 7.09 (d, *J* = 8.0 Hz, 2H), 7.02 (s, 5H), 6.80 (d, *J* = 2.7 Hz, 1H), 4.87 (s, 1H), 2.42 (s, 3H). ^{13}C{^{1}H} NMR (126 MHz, $CDCl_3$) δ 154.1, 145.9, 139.0, 137.0, 134.3, 133.8, 131.4, 130.8, 130.7, 129.5, 129.1, 128.9, 128.8, 128.5, 127.1, 126.6,

125.54, 125.46, 124.6, 122.1, 117.3, 112.4, 21.4. HRMS (ESI) calcd for $C_{27}H_{19}OSe$ $[M - H]^-$ 439.0607, found 439.0609.

*10-(4-Ethylphenyl)-9-(phenylselanyl)phenanthrene-2-ol (**4c**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (34.8 mg, 64% yield). IR 3842, 3346, 2916, 1641, 734 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.63 (dd, *J* = 17.4, 8.7 Hz, 3H), 7.61 (t, *J* = 7.6 Hz, 1H), 7.47 (t, *J* = 7.7 Hz, 1H), 7.23 (d, *J* = 8.0 Hz, 4H), 7.11 (d, *J* = 7.8 Hz, 2H), 7.03 (s, 4H), 6.81 (s, 1H), 4.91 (s, 1H), 2.73 (q, *J* = 7.6 Hz, 2H), 1.31 (t, *J* = 7.6 Hz, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 154.1, 145.9, 143.2, 139.2, 134.3, 133.8, 131.4, 130.73, 130.65, 129.5, 129.2, 128.9, 128.6, 127.5, 127.1, 126.6, 125.5, 125.4, 124.6, 122.1, 117.3, 112.4, 28.6, 15.3. HRMS (ESI) calcd for $C_{28}H_{21}OSe$ $[M - H]^-$ 453.0763, found 453.0768.

*10-(4-Methoxyphenyl)-9-(phenylselanyl)phenanthren-2-ol (**4d**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 5:1, v/v) afforded the target compound as a yellow solid (30 mg, 55% yield). Mp 110-111 °C. IR 3889, 3691, 3522, 3298, 3198, 1637, 1524, 969, 845, 737 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.66 (d, *J* = 8.9 Hz, 1H), 8.64 – 8.60 (m, 2H), 7.64 – 7.59 (m, 1H), 7.51 – 7.46 (m, 1H), 7.25 (s, 2H), 7.11 (d, *J* = 8.6 Hz, 2H), 7.03 (s, 4H), 6.94 (d, *J* = 8.6 Hz, 2H), 6.84 (d, *J* = 2.2 Hz, 1H), 5.00 (s, 1H), 3.86 (s, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 158.8, 154.2, 145.5, 134.4, 134.3, 134.0, 131.5, 130.8, 130.7, 129.2, 129.0, 128.9, 127.1, 126.6, 125.6, 125.5, 124.6, 122.1, 117.4, 113.5, 112.4, 55.3. HRMS (ESI) calcd for $C_{27}H_{19}O_2Se$ $[M - H]^-$ 455.0556, found 455.0560.

*10-(4-Fluorophenyl)-9-(phenylselanyl)phenanthren-2-ol (**4e**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (27.8 mg, 52% yield). IR 3900, 3786, 1604, 1487, 1211, 726 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.64 (dd, *J* = 17.2, 8.4 Hz, 3H), 7.64 (t, *J* = 7.6 Hz, 1H), 7.51 (t, *J* = 7.6 Hz, 1H), 7.24 (q, *J* = 5.9, 4.2 Hz, 2H), 7.14 – 6.98 (m, 8H), 6.75 (d, *J* = 2.3 Hz, 1H), 5.00 (s, 1H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ

162.11 (d, J_{C-F} = 246.2 Hz), 154.2, 144.7, 137.7, 134.0, 133.6, 131.4, 131.3 (d, J_{C-F} = 7.9 Hz), 130.8, 130.7, 129.2, 129.1, 128.9, 127.3, 126.7, 125.6, 125.5, 124.7, 122.2, 117.5, 115.1 (d, J_{C-F} = 21.4 Hz), 112.1. ^{19}F NMR (470 MHz, $CDCl_3$) δ -114.64. HRMS (ESI) calcd for $C_{26}H_{16}OFSe$ $[M - H]^-$ 443.0356, found 443.0358.

*10-(4-Chlorophenyl)-9-(phenylselanyl)phenanthren-2-ol (**4f**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (33.6 mg, 61% yield). IR 3860, 3728, 3636, 2916, 1645, 1524, 752 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.63 (dd, *J* = 17.1, 8.5 Hz, 3H), 7.64 (t, *J* = 7.6 Hz, 1H), 7.51 (t, *J* = 7.6 Hz, 1H), 7.35 (d, *J* = 8.2 Hz, 2H), 7.23 (d, *J* = 6.5 Hz, 2H), 7.09 (d, *J* = 8.2 Hz, 2H), 7.04 – 6.98 (m, 4H), 6.73 (d, *J* = 2.2 Hz, 1H), 5.02 (s, 1H). ^{13}C{^{1}H} NMR (126 MHz, $CDCl_3$) δ 154.2, 144.5, 140.2, 134.0, 133.4, 133.3, 131.4, 131.0, 130.8, 130.6, 129.2, 129.0, 128.7, 128.3, 127.4, 126.8, 125.7, 125.5, 124.7, 122.2, 117.6, 112.0. HRMS (ESI) calcd for $C_{26}H_{16}OClSe$ $[M - H]^-$ 459.0060, found 459.0062.

*10-(4-Bromophenyl)-9-(phenylselanyl)phenanthren-2-ol (**4g**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (44 mg, 73% yield). IR 3904, 3805, 1615, 1428, 1208, 730 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.69 (dd, *J* = 8.3, 0.9 Hz, 1H), 8.63 (dd, *J* = 15.3, 8.6 Hz, 2H), 7.64 (ddd, *J* = 8.3, 7.0, 1.3 Hz, 1H), 7.54 – 7.48 (m, 2H), 7.28 (t, *J* = 1.7 Hz, 1H), 7.25 – 7.21 (m, 2H), 7.12 – 7.09 (m, 1H), 7.06 – 7.03 (m, 3H), 7.02 – 6.98 (m, 2H), 6.72 (d, *J* = 2.6 Hz, 1H), 4.97 (s, 1H). ^{13}C{^{1}H} NMR (126 MHz, $CDCl_3$) δ 154.2, 144.1, 143.8, 133.9, 133.3, 132.7, 131.5, 130.8, 130.7, 130.4, 129.6, 129.5, 129.0, 128.4, 127.4, 126.8, 125.9, 125.5, 124.7, 122.2, 117.6, 112.0. HRMS (ESI) calcd for $C_{26}H_{16}OBrSe$ $[M - H]^-$ 502.9555, found 502.9557.

*9-(Phenylselanyl)-10-(4-(trifluoromethyl)phenyl)phenanthren-2-ol (**4h**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (45.2 mg, 76% yield). IR 3911, 3812, 3735, 1601, 1446, 1314, 1120, 737 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.74 – 8.57

(m, 3H), 7.65 (dd, *J* = 16.5, 7.8 Hz, 3H), 7.53 (t, *J* = 7.1 Hz, 1H), 7.32 – 7.20 (m, 3H), 7.00 (dd, *J* = 30.7, 7.7 Hz, 5H), 6.64 (d, *J* = 2.6 Hz, 1H), 5.00 (s, 1H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 154.3, 145.4, 144.2, 133.8, 133.4, 133.1, 131.4, 130.8, 130.6, 130.1, 129.6, 129.3, 129.0, 128.7, 127.6, 126.8, 125.8, 125.7, 125.0 (dd, J_{C-F} = 7.4, 3.7 Hz), 124.8, 122.2, 117.6, 111.8. ^{19}F NMR (470 MHz, $CDCl_3$) δ -62.28. HRMS (ESI) calcd for $C_{27}H_{16}OF_3Se$ $[M - H]^-$ 493.0324, found 493.0327.

*10-(4-Nitrophenyl)-9-(phenylselanyl)phenanthren-2-ol (**4i**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 5:1, v/v) afforded the target compound as a yellow solid (49 mg, 87% yield). Mp 124-126 ℃. IR 3926, 3834, 3651, 3559, 3342, 3188, 2927, 1637, 1624, 730 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.72 – 8.64 (m, 3H), 8.23 (d, *J* = 8.6 Hz, 2H), 7.73 – 7.66 (m, 1H), 7.60 – 7.51 (m, 1H), 7.33 (d, *J* = 8.5 Hz, 2H), 7.29 (d, *J* = 8.6 Hz, 1H), 7.25 (s, 1H), 7.07 – 7.04 (m, 2H), 6.96 (dq, *J* = 6.5, 2.3 Hz, 2H), 6.62 (d, *J* = 1.9 Hz, 1H), 5.18 (s, 1H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 154.5, 148.7, 147.1, 143.4, 133.6, 132.7, 131.3, 130.9, 130.8, 130.5, 129.2, 129.1, 128.5, 127.8, 127.0, 126.0, 125.6, 125.0, 123.4, 122.3, 117.9, 111.5. HRMS (ESI) calcd for $C_{26}H_{16}O_3NSe$ $[M - H]^-$ 470.0301, found 470.0302.

*9-(Phenylselanyl)-10-(m-tolyl)phenanthren-2-ol (**4j**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (40.9 mg, 78% yield). IR 3785, 3366, 2918, 1649, 1452, 1192, 734 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.63 (dd, *J* = 15.9, 8.5 Hz, 3H), 7.62 (t, *J* = 7.5 Hz, 1H), 7.49 (t, *J* = 7.6 Hz, 1H), 7.29 (t, *J* = 7.6 Hz, 1H), 7.23 – 7.20 (m, 2H), 7.03 (s, 6H), 6.95 (s, 1H), 6.79 (d, *J* = 2.1 Hz, 1H), 4.90 (s, 1H), 2.32 (s, 3H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 154.1, 145.9, 141.8, 137.6, 134.4, 133.7, 131.5, 130.7, 130.6, 130.4, 129.4, 128.9, 128.5, 128.1, 127.9, 127.1, 126.7, 126.6, 125.5, 124.6, 122.1, 117.4, 112.4, 21.5. HRMS (ESI) calcd for $C_{27}H_{19}OSe$ $[M - H]^-$ 439.0607, found 439.0604.

*10-(3-Fluorophenyl)-9-(phenylselanyl)phenanthren-2-ol (**4k**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (47.2 mg, 89% yield). IR 3889, 3801, 3735, 1612, 1435, 1219, 726 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.64 (dd, *J* = 17.6, 8.5 Hz, 3H), 7.64 (t, *J* = 7.5 Hz, 1H), 7.51 (t, *J* = 7.6 Hz, 1H), 7.36 (q, *J* = 7.7 Hz, 1H), 7.24 (d, *J* = 4.9 Hz, 2H), 7.13 – 7.07 (m, 1H), 7.05 – 7.01 (m, 4H), 6.97 (d, *J* = 7.5 Hz, 1H), 6.89 (d, *J* = 9.3 Hz, 1H), 6.75 (d, *J* = 2.2 Hz, 1H), 4.95 (s, 1H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 162.6 (d, J_{C-F} = 246.8 Hz), 154.2, 144.4, 143.9 (d, J_{C-F} = 7.9 Hz), 133.9, 133.3, 131.4, 130.8, 130.7, 129.7, 129.6, 129.3, 129.0, 128.7, 127.4, 126.8, 125.8, 125.6, 124.7, 122.2, 117.6, 116.9 (d, J_{C-F} = 21.4 Hz), 114.3 (d, J_{C-F} = 20.9 Hz), 112.0. ^{19}F NMR (470 MHz, $CDCl_3$) δ -113.15. HRMS (ESI) calcd for $C_{26}H_{16}OFSe$ $[M - H]^-$ 443.0356, found 443.0357.

*10-(3-Chlorophenyl)-9-(phenylselanyl)phenanthren-2-ol (**4l**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (42.7 mg, 77% yield). IR 3917, 3814, 3614, 2908, 1649, 1539, 710 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.72 – 8.57 (m, 3H), 7.64 (t, *J* = 7.6 Hz, 1H), 7.52 (t, *J* = 7.6 Hz, 1H), 7.38 (d, *J* = 8.1 Hz, 1H), 7.31 (t, *J* = 7.8 Hz, 1H), 7.24 (s, 1H), 7.13 (s, 1H), 7.08 – 6.96 (m, 6H), 6.73 (d, *J* = 1.9 Hz, 1H), 4.96 (s, 1H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 154.2, 144.2, 143.5, 134.0, 133.9, 133.3, 131.4, 130.8, 130.7, 129.9, 129.5, 129.4, 129.1, 129.0, 128.0, 127.5, 127.4, 126.8, 125.8, 125.5, 124.7, 122.2, 117.6, 112.0. HRMS (ESI) calcd for $C_{26}H_{16}OClSe$ $[M - H]^-$ 459.0060, found 459.0063.

*10-(3-Bromophenyl)-9-(phenylselanyl)phenanthren-2-ol (**4m**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (41.4 mg, 68% yield). IR 3678, 3362, 3199, 2922, 1632, 1455, 1216, 717 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.62 – 8.48 (m, 3H), 7.58 – 7.51 (m, 1H), 7.47 – 7.37 (m, 3H), 7.17 – 7.13 (m, 1H), 6.93 (ddd, *J* = 25.2, 6.9, 3.3 Hz, 7H), 6.65 (d, *J* = 2.6 Hz, 1H), 4.91 (s, 1H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ

154.2, 144.5, 140.7, 134.0, 133.3, 131.4, 131.3, 130.8, 130.6, 129.6, 129.2, 129.0, 128.7, 128.4, 127.4, 126.8, 125.9, 125.7, 125.6, 124.8, 122.2, 121.5, 117.6, 112.0. HRMS (ESI) calcd for $C_{26}H_{16}OBrSe$ $[M - H]^-$ 502.9555, found 502.9557.

*10-(2-Fluorophenyl)-9-(phenylselanyl)phenanthren-2-ol (**4n**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (47.1 mg, 89% yield). IR 3805, 1615, 1446, 1200, 737 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.72 – 8.63 (m, 3H), 7.70 – 7.65 (m, 1H), 7.57 – 7.50 (m, 1H), 7.49 – 7.42 (m, 1H), 7.29 – 7.27 (m, 1H), 7.24 – 7.16 (m, 3H), 7.15 – 7.04 (m, 5H), 6.82 (d, J = 1.9 Hz, 1H), 5.04 (s, 1H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 159.95 (d, J_{C-F} = 245.6 Hz), 154.4, 139.7, 133.5, 133.2, 131.9 (d, J_{C-F} = 3.2 Hz), 131.4, 131.1, 130.7, 130.1, 129.7 (d, J_{C-F} = 7.9 Hz), 129.6, 129.3 (d, J_{C-F} = 17.0 Hz), 129.0, 127.5, 126.7, 125.8, 125.6, 124.8, 123.9 (d, J_{C-F} = 3.5 Hz), 122.3, 117.7, 115.7 (d, J_{C-F} = 21.8 Hz), 111.5. ^{19}F NMR (470 MHz, $CDCl_3$) δ -113.23. HRMS (ESI) calcd for $C_{26}H_{16}OFSe$ $[M - H]^-$ 443.0356, found 443.0357.

*10-(2-Chlorophenyl)-9-(phenylselanyl)phenanthren-2-ol (**4o**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (43.8 mg, 79% yield). IR 3854, 3730, 3615, 3470, 2904, 1656, 1521, 1206, 849, 752 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.69 – 8.56 (m, 3H), 7.63 (t, J = 7.5 Hz, 1H), 7.54 – 7.45 (m, 2H), 7.40 – 7.33 (m, 1H), 7.29 – 7.23 (m, 2H), 7.14 (d, J = 7.5 Hz, 1H), 7.09 – 7.00 (m, 5H), 6.65 (d, J = 2.2 Hz, 1H), 4.93 (s, 1H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 154.4, 142.9, 140.5, 134.2, 133.5, 132.8, 131.4, 131.3, 131.0, 130.6, 129.6, 129.4, 129.2, 129.1, 128.9, 127.4, 126.61, 126.59, 125.7, 125.6, 124.8, 122.3, 117.6, 111.4. HRMS (ESI) calcd for $C_{26}H_{16}OClSe$ $[M - H]^-$ 459.0060, found 459.0062.

*7-Methyl-10-phenyl-9-(phenylselanyl)phenanthren-2-ol (**4p**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (38.7 mg, 73% yield). IR 3854, 3740, 3605, 2915, 1646, 1525, 1205, 800 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.65 (d, J = 9.0 Hz, 1H),

8.58 – 8.45 (m, 2H), 7.54 – 7.39 (m, 4H), 7.30 – 7.17 (m, 3H), 7.08 (s, 5H), 6.79 (d, *J* = 2.6 Hz, 1H), 4.95 (s, 1H), 2.50 (s, 3H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 153.8, 145.7, 142.0, 136.3, 134.4, 133.2, 131.6, 130.1, 129.7, 129.3, 128.9, 128.9, 128.6, 128.3, 128.0, 127.3, 125.6, 125.5, 124.4, 122.1, 117.4, 112.3, 21.6. HRMS (ESI) calcd for $C_{27}H_{19}OSe$ $[M - H]^-$ 439.0607, found 439.0608.

*7-Chloro-10-phenyl-9-(phenylselanyl)phenanthren-2-ol (**4q**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (42 mg, 76% yield). IR 3879, 3695, 3542, 3345, 3189, 2929, 1643, 1462, 727 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.68 (d, *J* = 1.8 Hz, 1H), 8.55 (dd, *J* = 23.4, 8.9 Hz, 2H), 7.56 (dd, *J* = 8.8, 1.9 Hz, 1H), 7.40 (d, *J* = 5.4 Hz, 3H), 7.23 (d, *J* = 5.9 Hz, 2H), 7.19 – 7.12 (m, 2H), 7.08 – 6.96 (m, 4H), 6.76 (d, *J* = 2.0 Hz, 1H), 4.92 (s, 1H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 154.4, 147.0, 141.6, 133.64, 133.60, 132.9, 132.6, 129.8, 129.5, 129.1, 129.0, 128.1, 127.64, 127.61, 127.5, 125.9, 125.1, 124.6, 123.9, 117.8, 112.5. HRMS (ESI) calcd for $C_{26}H_{16}OClSe$ $[M - H]^-$ 459.0060, found 459.0061.

*6-Methyl-10-phenyl-9-(phenylselanyl)phenanthren-2-ol (**4r**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (37.6 mg, 71% yield). IR 3899, 3747, 2929, 2693, 1643, 1466, 731 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.64 (d, *J* = 9.0 Hz, 1H), 8.50 (d, *J* = 8.4 Hz, 1H), 8.40 (s, 1H), 7.39 (dd, *J* = 4.9, 1.8 Hz, 3H), 7.31 (dd, *J* = 8.5, 1.2 Hz, 1H), 7.20 (td, *J* = 8.3, 7.5, 3.4 Hz, 3H), 7.02 (s, 5H), 6.74 (d, *J* = 2.5 Hz, 1H), 4.88 (s, 1H), 2.58 (s, 3H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 154.0, 144.8, 142.0, 137.0, 134.3, 133.8, 130.8, 130.5, 129.7, 129.4, 129.2, 128.9, 128.4, 128.3, 128.0, 127.3, 125.4, 125.3, 124.6, 122.0, 117.2, 112.3, 21.9. HRMS (ESI) calcd for $C_{27}H_{19}OSe$ $[M - H]^-$ 439.0607, found 439.0608.

*6-Chloro-10-phenyl-9-(phenylselanyl)phenanthren-2-ol (**4s**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (42.3 mg, 77% yield). IR 3915, 3786, 3731, 3654,

1608, 1483, 1424, 1204, 1083, 1020, 826, 734 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.54 (dd, *J* = 8.9, 6.8 Hz, 3H), 7.40 (dq, *J* = 5.9, 2.0 Hz, 4H), 7.22 – 7.16 (m, 3H), 7.07 – 6.96 (m, 5H), 6.76 (d, *J* = 2.5 Hz, 1H), 5.00 (br, 1H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 154.7, 146.0, 141.6, 134.0, 133.9, 133.4, 132.4, 131.8, 129.8, 129.6, 129.2, 129.0, 128.1, 128.0, 127.5, 127.0, 125.7, 124.7, 124.5, 121.8, 117.7, 112.5. HRMS (ESI) calcd for $C_{26}H_{16}OClSe$ $[M - H]^-$ 459.0060, found 459.0063.

*7-Hydroxy-9-phenyl-10-(phenylselanyl)phenanthrene-3-carbonitrile (**4t**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 5:1, v/v) afforded the target compound as a yellow solid (38.8 mg, 72% yield). Mp 170-171 °C. IR 3879, 3376, 2918, 1636, 1452, 1223, 1025, 713 cm^{-1}. ^1H NMR (500 MHz, DMSO) δ 10.09 (s, 1H), 9.37 – 9.30 (m, 1H), 8.92 (d, *J* = 9.1 Hz, 1H), 8.55 (d, *J* = 8.6 Hz, 1H), 7.80 (dd, *J* = 8.6, 1.4 Hz, 1H), 7.53 – 7.40 (m, 3H), 7.34 – 7.23 (m, 3H), 7.16 – 6.97 (m, 5H), 6.73 (d, *J* = 2.5 Hz, 1H). $^{13}C\{^1H\}$ NMR (126 MHz, DMSO) δ 157.3, 149.1, 141.2, 133.7, 132.9, 132.6, 130.9, 130.7, 129.4, 129.0, 128.7, 128.2, 127.64, 127.57, 126.3, 126.0, 125.5, 123.0, 119.2, 119.1, 111.8, 109.7. HRMS (ESI) calcd for $C_{27}H_{16}ONSe$ $[M - H]^-$ 450.0403, found 450.0408.

*5-Methyl-10-phenyl-9-(phenylselanyl)phenanthren-2-ol (**4u**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (22 mg, 42% yield). IR 3854, 3736, 3355, 3203, 2911, 1646, 1445, 727 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.83 (d, *J* = 9.2 Hz, 1H), 8.73 – 8.66 (m, 1H), 7.54 (d, *J* = 7.0 Hz, 1H), 7.47 – 7.39 (m, 4H), 7.26 – 7.19 (m, 3H), 7.06 (dq, *J* = 5.7, 3.4, 2.9 Hz, 5H), 6.86 (d, *J* = 2.7 Hz, 1H), 4.98 (s, 1H), 3.17 (s, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 153.3, 145.8, 142.3, 135.0, 134.5, 134.2, 132.7, 131.9, 131.0, 129.6, 129.5, 129.3, 129.2, 129.1, 128.9, 128.1, 127.3, 126.6, 125.8, 125.4, 115.6, 112.5, 27.3. HRMS (ESI) calcd for $C_{27}H_{19}OSe$ $[M - H]^-$ 439.0607, found 439.0609.

*3-Methyl-10-phenyl-9-(phenylselanyl)phenanthren-2-ol (**4v**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the

target compound as a yellow oil (32.4 mg, 61% yield). IR 3896, 3830, 3733, 3594, 3497, 3352, 2922, 1646, 1528, 720 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.66 – 8.58 (m, 2H), 8.52 (s, 1H), 7.65 – 7.56 (m, 1H), 7.49 – 7.44 (m, 1H), 7.40 (dd, *J* = 5.0, 1.9 Hz, 3H), 7.21 – 7.15 (m, 2H), 7.02 (d, *J* = 1.4 Hz, 5H), 6.70 (s, 1H), 4.85 (s, 1H), 2.50 (s, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 153.1, 145.7, 142.2, 134.4, 132.1, 131.5, 130.6, 130.5, 129.6, 129.2, 129.1, 128.9, 128.0, 127.3, 127.1, 126.9, 126.6, 126.5, 125.6, 125.4, 124.9, 122.2, 111.8, 16.7. HRMS (ESI) calcd for $C_{27}H_{19}OSe$ $[M - H]^-$ 439.0607, found 439.0609.

*3-Chloro-10-phenyl-9-(phenylselanyl)phenanthren-2-ol (**4w**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (36.5 mg, 66% yield). IR 3896, 3712, 3504, 3359, 2929, 1639, 1438, 707 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.65 (s, 1H), 8.56 (d, *J* = 8.2 Hz, 1H), 8.47 (d, *J* = 8.2 Hz, 1H), 7.57 (t, *J* = 8.2 Hz, 1H), 7.45 (t, *J* = 7.6 Hz, 1H), 7.35 (dd, *J* = 5.0, 1.8 Hz, 3H), 7.18 (s, 1H), 7.11 (dd, *J* = 6.4, 3.1 Hz, 2H), 6.96 (tt, *J* = 6.9, 3.8 Hz, 5H), 5.57 (s, 1H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 149.6, 145.6, 141.5, 134.0, 132.7, 131.7, 130.8, 129.7, 129.5, 129.3, 129.0, 128.9, 128.2, 127.5, 127.4, 127.2, 126.1, 125.6, 123.3, 122.2, 122.1, 113.8. HRMS (ESI) calcd for $C_{26}H_{16}OClSe$ $[M - H]^-$ 459.0060, found 459.0064.

*4-Methyl-10-phenyl-9-(phenylselanyl)phenanthren-2-ol (**4x**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (35.9 mg, 68% yield). IR 3868, 3730, 3646, 3535, 3449, 3355, 2918, 1636, 1455, 717 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.76 – 8.65 (m, 2H), 7.64 – 7.52 (m, 1H), 7.48 (ddd, *J* = 8.1, 7.0, 1.1 Hz, 1H), 7.39 (dd, *J* = 5.0, 1.8 Hz, 3H), 7.20 – 7.15 (m, 2H), 7.10 (d, *J* = 2.0 Hz, 1H), 7.02 (s, 5H), 6.68 (d, *J* = 2.5 Hz, 1H), 4.81 (s, 1H), 3.11 (s, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 152.7, 146.3, 142.7, 137.5, 135.3, 134.2, 132.4, 131.9, 130.5, 129.7, 129.2, 128.9, 128.6, 128.1, 127.3, 126.9, 126.0, 125.9, 125.8, 125.5, 121.4, 111.2, 27.3. HRMS (ESI) calcd for $C_{27}H_{19}OSe$ $[M - H]^-$ 439.0607, found 439.0609.

*4-Chloro-10-phenyl-9-(phenylselanyl)phenanthren-2-ol (**4y**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (44 mg, 80% yield). IR 3906, 3820, 3736, 3504, 3359, 2929, 1646, 1431, 1275, 745 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 9.76 – 9.64 (m, 1H), 8.69 (dd, *J* = 8.3, 1.2 Hz, 1H), 7.60 (ddd, *J* = 8.5, 6.9, 1.4 Hz, 1H), 7.51 (ddd, *J* = 8.2, 7.0, 1.1 Hz, 1H), 7.41 – 7.35 (m, 3H), 7.33 (d, *J* = 2.6 Hz, 1H), 7.17 – 7.12 (m, 2H), 7.05 – 6.98 (m, 5H), 6.74 (d, *J* = 2.7 Hz, 1H), 4.98 (s, 1H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 152.6, 145.3, 142.1, 136.0, 133.9, 132.4, 132.3, 130.4, 130.3, 130.0, 129.7, 129.4, 129.0, 128.2, 127.5, 127.0, 126.6, 126.1, 125.7, 123.0, 120.9, 112.5. HRMS (ESI) calcd for $C_{26}H_{16}OClSe$ $[M - H]^-$ 459.0060, found 459.0063.

*9-(Phenylselanyl)-10-(thiophen-2-yl)phenanthren-2-ol (**4z**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (33.1 mg, 64% yield). IR 3906, 3743, 3632, 3490, 3348, 3206, 2922, 1636, 1435, 693 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.67 – 8.55 (m, 4H), 7.64 – 7.60 (m, 1H), 7.49 – 7.41 (m, 2H), 7.11 (dd, *J* = 5.1, 3.4 Hz, 1H), 7.09 – 7.02 (m, 5H), 7.00 (d, *J* = 2.6 Hz, 1H), 6.92 (dd, *J* = 3.4, 1.0 Hz, 1H), 4.98 (s, 1H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 154.4, 142.6, 138.1, 134.3, 134.2, 132.1, 131.2, 130.9, 129.3, 129.0, 128.2, 127.7, 126.7, 126.6, 125.8, 125.7, 125.4, 124.6, 122.2, 117.6, 112.1. HRMS (ESI) calcd for $C_{24}H_{15}OSSe$ $[M - H]^-$ 431.0014, found 431.0015.

*10-Butyl-9-(phenylselanyl)phenanthren-2-ol (**4a'**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow oil (20.9 mg, 43% yield). IR 3872, 3733, 3629, 1660, 1528, 731 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.67 – 8.62 (m, 2H), 8.55 (d, *J* = 8.1 Hz, 1H), 7.58 – 7.52 (m, 2H), 7.45 (ddd, *J* = 8.2, 7.0, 1.1 Hz, 1H), 7.26 (s, 2H), 7.14 – 7.03 (m, 4H), 5.16 (s, 1H), 3.58 – 3.51 (m, 2H), 1.68 – 1.60 (m, 2H), 1.52 (h, *J* = 7.2 Hz, 2H), 0.96 (t, *J* = 7.3 Hz, 3H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 154.4, 144.2, 133.8, 132.4, 132.1, 130.6, 130.2, 129.1, 128.8, 128.3, 126.4, 125.9, 125.5, 125.1,

122.0, 117.2, 110.0, 35.1, 33.0, 23.2, 14.0. HRMS (ESI) calcd for $C_{24}H_{21}OSe$ $[M - H]^-$ 405.0763, found 405.0763.

10-Octyl-9-(phenylselanyl)phenanthren-2-ol ***(4b')***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow oil (29.1 mg, 53% yield). IR 3875, 3799, 3730, 3653, 3601, 3293, 2894, 2312, 1646, 1525, 779 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.67 – 8.62 (m, 2H), 8.55 (d, *J* = 8.1 Hz, 1H), 7.57 – 7.51 (m, 2H), 7.45 (ddd, *J* = 8.1, 7.0, 1.1 Hz, 1H), 7.27 (s, 1H), 7.14 – 7.03 (m, 5H), 5.15 (s, 1H), 3.54 (t, *J* = 8.3 Hz, 2H), 1.66 (p, *J* = 7.7 Hz, 2H), 1.49 (p, *J* = 7.2 Hz, 2H), 1.35 – 1.26 (m, 8H), 0.89 – 0.86 (m, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 154.5, 144.3, 133.8, 132.4, 132.1, 131.5, 130.6, 130.2, 129.1, 128.7, 126.4, 125.9, 125.5, 125.1, 122.0, 117.2, 110.0, 35.4, 31.9, 30.9, 30.2, 29.4, 29.3, 22.7, 14.1. HRMS (ESI) calcd for $C_{28}H_{29}OSe$ $[M - H]^-$ 461.1389, found 461.1393.

10-Phenyl-9-(p-tolylselanyl)phenanthren-2-ol ***(4d')***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (39.7 mg, 75% yield). IR 3823, 3719, 2922, 1653, 1528 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.73 – 8.59 (m, 3H), 7.71 – 7.59 (m, 1H), 7.53 (t, *J* = 7.6 Hz, 1H), 7.49 – 7.40 (m, 3H), 7.26 (td, *J* = 5.8, 2.6 Hz, 3H), 6.98 (d, *J* = 8.2 Hz, 2H), 6.90 (d, *J* = 8.0 Hz, 2H), 6.81 (d, *J* = 2.5 Hz, 1H), 4.99 (s, 1H), 2.23 (s, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 154.1, 145.6, 142.0, 135.3, 133.6, 131.4, 130.72, 130.70, 130.3, 129.8, 129.7, 129.3, 128.7, 128.1, 127.3, 127.1, 126.6, 125.5, 124.6, 122.1, 117.3, 112.3, 20.9. HRMS (ESI) calcd for $C_{27}H_{19}OSe$ $[M - H]^-$ 439.0607, found 439.0606.

9-((4-Chlorophenyl)selanyl)-10-phenylphenanthren-2-ol ***(4e')***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (48.9 mg, 89% yield). IR 3906, 3712, 3362, 2918, 1639, 1435, 752 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.73 – 8.56 (m, 3H), 7.67 (t, *J* = 7.4 Hz, 1H), 7.59 – 7.38 (m, 4H), 7.25 (dd, *J* = 33.4, 5.4 Hz, 3H), 6.99 (dd, *J* = 36.7,

8.4 Hz, 4H), 6.80 (d, *J* = 1.6 Hz, 1H), 5.02 (s, 1H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 154.2, 145.9, 141.8, 134.3, 133.6, 132.4, 131.5, 131.2, 130.8, 130.42, 130.38, 129.6, 129.0, 128.1, 127.5, 127.3, 126.8, 125.6, 124.7, 122.3, 117.6, 112.4. HRMS (ESI) calcd for $C_{26}H_{16}OClSe$ $[M - H]^-$ 459.0060, found 459.0062.

4-((2-Hydroxy-10-phenylphenanthren-9-yl)selanyl)benzonitrile ***(4f')***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 5:1, v/v) afforded the target compound as a yellow solid (43.4 mg, 80% yield). Mp 191-193 ℃. IR 3861, 3768, 3698, 3476, 3317, 2911, 1653, 1476, 745 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.71 (dd, *J* = 14.8, 8.6 Hz, 2H), 8.53 – 8.45 (m, 1H), 7.75 – 7.65 (m, 1H), 7.57 – 7.49 (m, 1H), 7.46 – 7.42 (m, 2H), 7.34 – 7.27 (m, 4H), 7.22 – 7.15 (m, 2H), 7.10 – 7.04 (m, 2H), 6.81 (d, *J* = 2.6 Hz, 1H), 5.07 (s, 1H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 154.5, 146.6, 142.4, 141.6, 133.5, 132.2, 131.0, 130.8, 129.9, 129.3, 128.8, 128.2, 127.7, 127.5, 126.9, 126.7, 125.7, 124.7, 122.4, 118.9, 118.1, 112.5, 108.6. HRMS (ESI) calcd for $C_{27}H_{16}ONSe$ $[M - H]^-$ 450.0403, found 450.0407.

10-Phenyl-9-(m-tolylselanyl)phenanthren-2-ol ***(4g')***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (38.9 mg, 74% yield). IR 3875, 3688, 3591, 3348, 3175, 3067, 2911, 1646, 1441, 1209, 731 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.67 – 8.55 (m, 3H), 7.61 (ddd, *J* = 8.3, 7.0, 1.3 Hz, 1H), 7.49 (ddd, *J* = 8.2, 7.0, 1.1 Hz, 1H), 7.39 (dd, *J* = 4.9, 1.7 Hz, 3H), 7.21 – 7.16 (m, 3H), 6.92 – 6.86 (m, 2H), 6.83 (d, *J* = 7.5 Hz, 1H), 6.78 – 6.73 (m, 2H), 4.89 (s, 1H), 2.14 (s, 3H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 154.1, 145.7, 141.9, 138.6, 133.9, 133.7, 131.5, 130.72, 130.70, 129.8, 129.7, 128.7, 128.6, 128.0, 127.3, 127.1, 126.6, 126.5, 126.4, 125.5, 124.6, 122.1, 117.3, 112.3, 21.3. HRMS (ESI) calcd for $C_{27}H_{19}OSe$ $[M - H]^-$ 439.0607, found 439.0607.

9-((3-Chlorophenyl)selanyl)-10-phenylphenanthren-2-ol ***(4h')***. Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (43.1 mg, 78% yield). IR 3736, 3355,

2929, 1636, 1445, 707 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.68 – 8.55 (m, 3H), 7.64 (ddd, *J* = 8.3, 7.0, 1.3 Hz, 1H), 7.51 (ddd, *J* = 8.2, 7.0, 1.1 Hz, 1H), 7.40 (qd, *J* = 4.6, 3.8, 1.1 Hz, 3H), 7.25 – 7.22 (m, 1H), 7.19 – 7.15 (m, 2H), 7.03 – 6.98 (m, 2H), 6.95 – 6.89 (m, 1H), 6.84 (dt, *J* = 7.8, 1.3 Hz, 1H), 6.77 (d, *J* = 2.6 Hz, 1H), 4.91 (s, 1H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 154.2, 146.0, 141.7, 135.9, 134.6, 133.8, 131.2, 130.8, 130.3, 129.9, 129.6, 128.8, 128.1, 127.9, 127.5, 127.3, 127.3, 126.8, 125.8, 125.6, 124.7, 122.3, 117.6, 112.4. HRMS (ESI) calcd for $C_{26}H_{16}OClSe$ $[M - H]^-$ 459.0060, found 459.0064.

10-Phenyl-9-(o-tolylselanyl)phenanthren-2-ol ***(4i')****.* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (33.2 mg, 63% yield). IR 3875, 3591, 3168, 2922, 1639, 1449, 1199, 755 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.64 (dd, *J* = 17.2, 8.6 Hz, 2H), 8.55 (dd, *J* = 8.3, 1.0 Hz, 1H), 7.62 (ddd, *J* = 8.3, 7.0, 1.3 Hz, 1H), 7.48 (ddd, *J* = 8.2, 7.0, 1.1 Hz, 1H), 7.39 – 7.32 (m, 3H), 7.22 (d, *J* = 7.6 Hz, 1H), 7.16 (dq, *J* = 6.5, 2.3, 1.9 Hz, 2H), 7.03 (d, *J* = 7.3 Hz, 1H), 6.95 (td, *J* = 7.4, 1.2 Hz, 1H), 6.76 – 6.70 (m, 2H), 6.65 (dd, *J* = 7.9, 1.1 Hz, 1H), 4.88 (s, 1H), 2.22 (s, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 154.1, 146.0, 141.9, 136.5, 135.2, 133.8, 131.6, 130.7, 130.6, 129.7, 129.5, 129.2, 128.6, 128.0, 127.3, 127.2, 126.7, 126.4, 125.5, 125.4, 124.6, 122.2, 117.4, 112.3, 21.6. HRMS (ESI) calcd for $C_{27}H_{19}OSe$ $[M - H]^-$ 439.0607, found 439.0609.

9-((2-Chlorophenyl)selanyl)-10-phenylphenanthren-2-ol ***(4j')****.* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (25.3 mg, 46% yield). IR 3915, 3055, 2916, 1656, 1457, 1233, 859, 745 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.69 (d, *J* = 9.0 Hz, 1H), 8.65 (d, *J* = 8.2 Hz, 1H), 8.51 (dd, *J* = 8.3, 0.9 Hz, 1H), 7.65 (ddd, *J* = 8.3, 7.0, 1.3 Hz, 1H), 7.49 (ddd, *J* = 8.2, 7.0, 1.1 Hz, 1H), 7.44 – 7.36 (m, 3H), 7.27 (dd, *J* = 8.9, 2.6 Hz, 1H), 7.23 (d, *J* = 1.3 Hz, 1H), 7.22 – 7.16 (m, 2H), 6.97 (td, *J* = 7.7, 1.5 Hz, 1H), 6.82 – 6.75 (m, 2H), 6.55 (dd, *J* = 8.0, 1.5 Hz, 1H), 4.91 (s, 1H). $^{13}C\{^1H\}$ NMR (126

MHz, $CDCl_3$) δ 154.2, 146.6, 141.6, 134.7, 133.7, 132.4, 131.2, 130.8, 130.4, 129.6, 129.3, 129.1, 128.2, 127.7, 127.6, 127.4, 127.1, 126.9, 126.3, 125.7, 124.7, 122.2, 117.7, 112.5. HRMS (ESI) calcd for $C_{26}H_{16}OClSe$ $[M - H]^-$ 459.0060, found 459.0063.

*9-(Naphthalen-1-ylselanyl)-10-phenylphenanthren-2-ol (**4k'**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow solid (14 mg, 25% yield). Mp 188-189 ℃. IR 3910, 3775, 3345, 3192, 2915, 1643, 1445, 703 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.67 (ddd, *J* = 12.7, 11.6, 8.6 Hz, 3H), 7.69 – 7.59 (m, 2H), 7.54 – 7.43 (m, 4H), 7.42 – 7.32 (m, 5H), 7.28 – 7.25 (m, 1H), 7.21 (d, *J* = 1.7 Hz, 2H), 7.13 (dd, *J* = 8.6, 1.7 Hz, 1H), 6.80 (d, *J* = 2.6 Hz, 1H), 4.89 (s, 1H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 154.2, 145.9, 141.9, 134.0, 133.7, 131.9, 131.6, 131.5, 130.8, 130.6, 129.7, 128.3, 128.2, 128.1, 127.7, 127.4, 127.34, 127.30, 127.2, 127.0, 126.7, 126.2, 125.7, 125.3, 124.7, 122.2, 117.5, 112.4. HRMS (ESI) calcd for $C_{30}H_{19}OSe$ $[M - H]^-$ 475.0607, found 475.0610.

*9-(Butylselanyl)-10-phenylphenanthren-2-ol (**4l'**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the target compound as a yellow oil (32.4 mg, 67% yield). IR 3924, 3844, 3698, 3348, 3189, 2915, 1643, 1455, 717 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.87 – 8.77 (m, 1H), 8.61 (d, *J* = 8.6 Hz, 2H), 7.71 – 7.54 (m, 2H), 7.47 (tdd, *J* = 8.6, 6.8, 3.7 Hz, 3H), 7.28 (d, *J* = 1.7 Hz, 1H), 7.23 (s, 1H), 7.18 (dd, *J* = 9.0, 2.7 Hz, 1H), 6.73 (d, *J* = 2.6 Hz, 1H), 4.96 (s, 1H), 2.65 – 2.58 (m, 2H), 1.46 – 1.32 (m, 2H), 1.27 – 1.11 (m, 2H), 0.75 (t, *J* = 7.4 Hz, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 154.1, 144.8, 142.4, 133.5, 131.9, 130.6, 130.5, 130.3, 129.4, 128.0, 127.2, 126.9, 126.4, 125.0, 124.5, 122.3, 116.9, 112.0, 32.2, 29.6, 22.8, 13.4. HRMS (ESI) calcd for $C_{24}H_{21}OSe$ $[M - H]^-$ 405.0763, found 405.0767.

*9-(Cyclohexylselanyl)-10-phenylphenanthren-2-ol (**4m'**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 20:1, v/v) afforded the

target compound as a yellow oil (25.1 mg, 48% yield). IR 3854, 3757, 3345, 3220, 3060, 2929, 1632, 1452, 1192, 717 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 8.86 (dd, *J* = 8.1, 1.3 Hz, 1H), 8.68 – 8.53 (m, 2H), 7.74 – 7.55 (m, 2H), 7.51 – 7.44 (m, 3H), 7.25 (d, *J* = 5.3 Hz, 2H), 7.20 (dd, *J* = 8.9, 2.6 Hz, 1H), 6.74 (d, *J* = 2.6 Hz, 1H), 4.85 (s, 1H), 3.05 (tt, *J* = 10.6, 3.7 Hz, 1H), 1.77 – 1.66 (m, 2H), 1.56 (dt, *J* = 7.5, 3.2 Hz, 2H), 1.49 – 1.40 (m, 1H), 1.39 – 1.33 (m, 2H), 1.19 – 1.05 (m, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 154.1, 145.0, 142.4, 133.6, 132.4, 130.8, 130.5, 130.4, 129.5, 127.9, 127.1, 126.9, 126.3, 125.1, 124.5, 122.2, 116.8, 112.1, 44.8, 34.1, 26.7, 25.7. HRMS (ESI) calcd for $C_{26}H_{23}OSe$ $[M - H]^-$ 431.0920, found 431.0918.

General procedure for the synthesis of ketoxime 5.

The compound **3a** (0.1 mmol, 1.0 eq., 42.5 mg) and methoxyamine hydrochloride (0.25 mmol, 2.5 eq., 21.0 mg) were placed into an oven dried reaction tube with a magnetic stir and a condenser within nitrogen atmosphere. Then, pyridine (1.0 mL) was added and the mixture was allowed to stir in an oil bath at 120 ℃ for 20 h. After completion of the reaction, volatiles were removed under reduced pressure and the crude reaction mixture was directly purified by silica gel column chromatography (petroleum ether/ethyl acetate = 100:1, v/v) to provide ketoxime **5** (44.7 mg, 98% yield) as yellow solid.

*2'-Phenyl-3'-(phenylselanyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one O-methyl oxime (**5**).* Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 100:1, v/v) afforded the target compound as a yellow solid (44.7 mg, 98% yield). Mp 98-100 ℃. IR 3897, 3845, 3728, 1454, 1050, 914, 737 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$) δ 7.39 (dd, *J* = 6.3, 2.6 Hz, 2H), 7.34 – 7.25 (m, 5H), 7.25 – 7.12 (m, 7H), 7.08 (dd, *J* = 10.0, 0.8 Hz, 1H), 6.49 (dd, *J* = 9.9, 0.8 Hz, 1H), 5.91 (dd, *J* = 10.1, 1.8 Hz, 1H), 5.81 (dd, *J* = 9.9, 1.8 Hz, 1H), 3.94 (s, 3H). $^{13}C\{^1H\}$ NMR (126 MHz, $CDCl_3$) δ 155.2, 147.9, 145.5, 144.2, 138.5, 135.1, 134.1, 130.6, 130.3, 129.9, 129.2, 128.8, 128.3, 128.2, 127.9, 126.8, 126.5, 125.1, 123.9, 122.6, 117.6, 62.2, 62.0. HRMS (ESI) calcd for $C_{27}H_{21}NaNOSe$ $[M + Na]^+$ 478.0682, found 478.0680.

General procedure for the synthesis of selenoxide 6.

The compound **3a** (0.1 mmol, 1.0 eq., 42.5 mg) and DCM (1.0 mL) were placed into an oven dried reaction tube. Then, *m*-CPBA (0.22 mmol, 2.2 eq., 38.1 mg) was added and the mixture was allowed to stir 10 min under 0 ℃. After that, the mixture was allowed to stir 12 h under room temperature. After completion of the reaction, volatiles were removed under reduced pressure and the crude reaction mixture was directly purified by silica gel column chromatography (ethyl acetate) to provide ketoxime **6** (36 mg, 82% yield) as yellow solid.

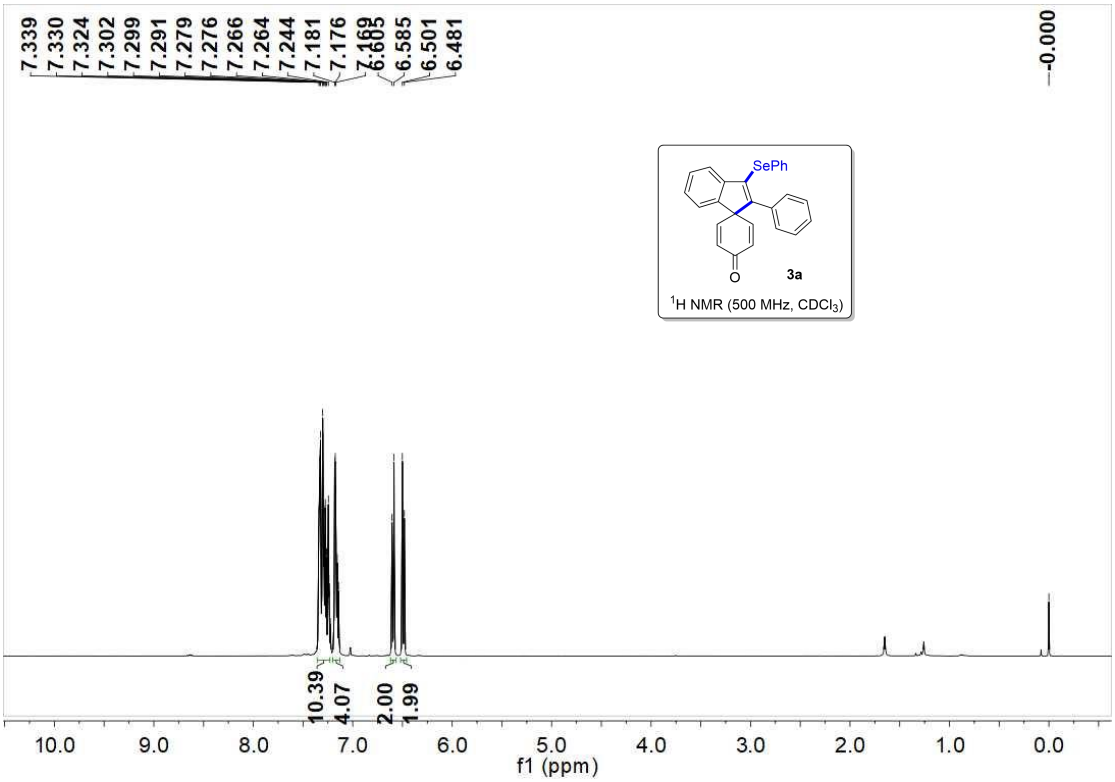
2'-Phenyl-3'-(phenylseleninyl)spiro[cyclohexane-1,1'-indene]-2,5-dien-4-one ***(6)***. Purification by column chromatography on silica gel (ethyl acetate) afforded the target compound as a yellow solid (36 mg, 82% yield). Mp 167-169 ℃. IR 3853, 3720, 1663, 1461, 870, 741 cm^{-1}. ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.53 (d, *J* = 7.8 Hz, 1H), 7.58 – 7.45 (m, 4H), 7.40 (t, *J* = 7.5 Hz, 1H), 7.33 – 7.20 (m, 5H), 7.12 (t, *J* = 7.7 Hz, 2H), 6.98 (d, *J* = 7.4 Hz, 2H), 6.42 (s, 4H). $^{13}C\{^{1}H\}$ NMR (126 MHz, $CDCl_3$) δ 184.9, 155.3, 144.1, 144.0, 142.9, 140.3, 138.9, 133.7, 132.1, 129.8, 129.7, 129.6, 129.5, 128.7, 128.6, 128.0, 126.5, 124.1, 124.0, 62.7. HRMS (ESI) calcd for $C_{26}H_{18}NaO_2Se$ $[M + Na]^+$ 465.0366, found 465.0359.

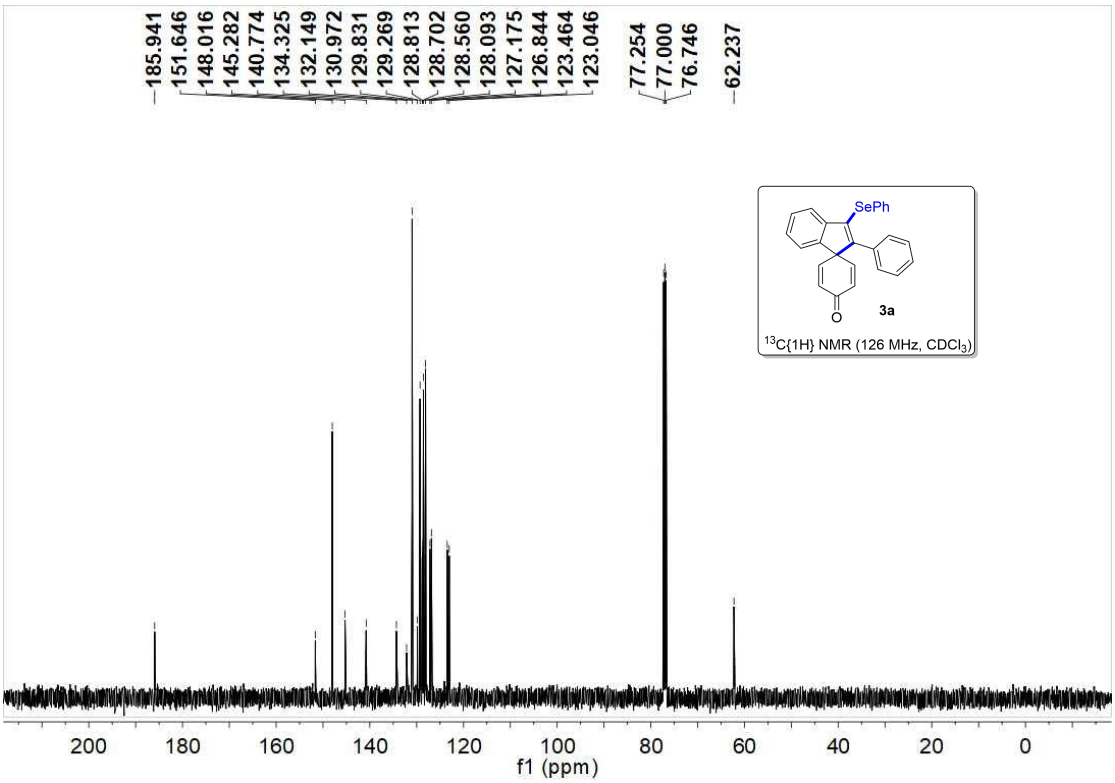
General procedure for the synthesis of compound 7.

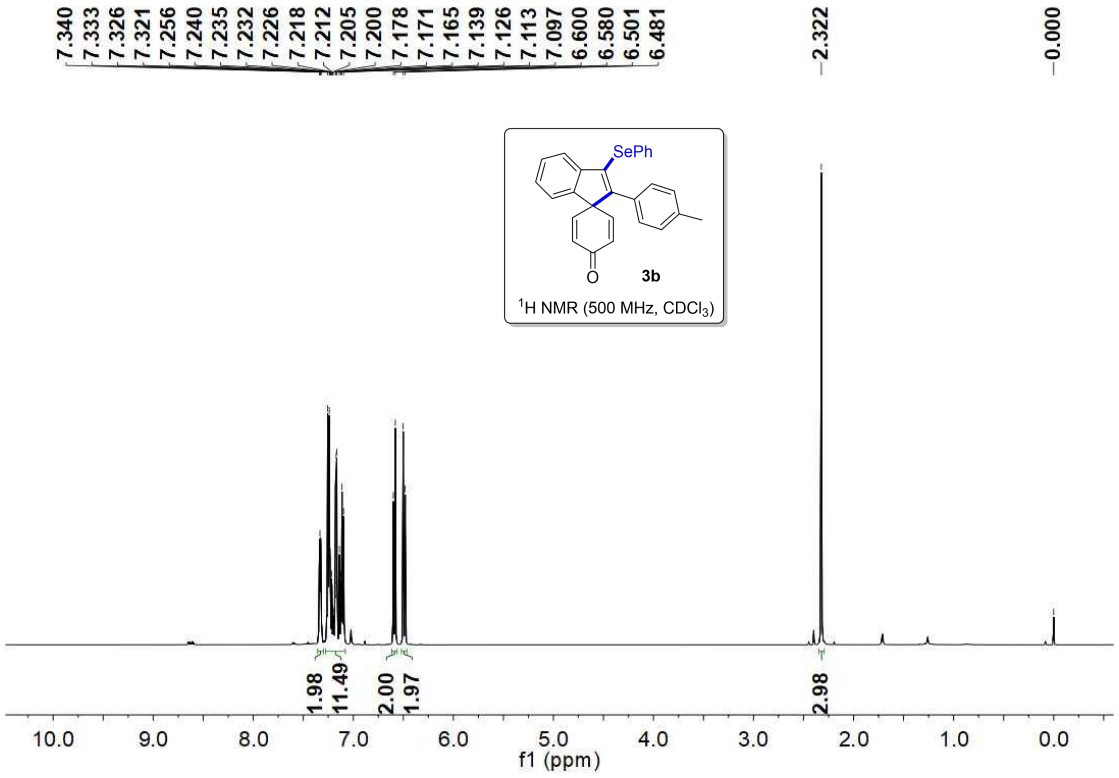
To a stirred solution of **3a** (0.1 mmol, 1.0 eq., 42.5 mg) in MeOH (1.0 mL) at room temperature was added $CeCl_3 \cdot 7H_2O$ (0.35 mmol, 3.5 eq., 0.131 g). After the reaction was cooled down to 0 ℃, $NaBH_4$ (0.25 mmol, 2.5 eq., 9.5 mg) was added to the reaction, and the reaction was stirred for 30 min, and then the reaction allowed to stir 12 h under room temperature. After completion of the reaction, volatiles were removed under reduced pressure and the crude reaction mixture was directly purified by silica gel column chromatography (ethyl acetate) to provide **7** (32 mg, 78% yield) as yellow oil.

Phenyl(10-phenylphenanthren-9-yl)selane (7). Purification by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1, v/v) afforded the target compound as a yellow oil (32 mg, 78% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.76 (dd, *J* = 11.0, 8.9 Hz, 2H), 8.68 (d, *J* = 8.3 Hz, 1H), 7.70 – 7.61 (m, 2H), 7.56 (t, *J* = 7.6 Hz, 1H), 7.48 – 7.40 (m, 5H), 7.23 (s, 2H), 7.03 (s, 5H). ^{13}C{^{1}H} NMR (126 MHz, $CDCl_3$) δ 146.8, 141.9, 134.3, 132.5, 132.2, 131.1, 130.7, 130.6, 129.7, 129.2, 128.9, 127.9, 127.7, 127.6, 127.4, 127.3, 127.0, 126.7, 125.5, 122.7, 122.6. HRMS (ESI) calcd for $C_{26}H_{18}Se$ $[M]^+$ 410.0568, found 410.0567.

^{1}H, ^{13}C and ^{19}F NMR spectra



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O
3b
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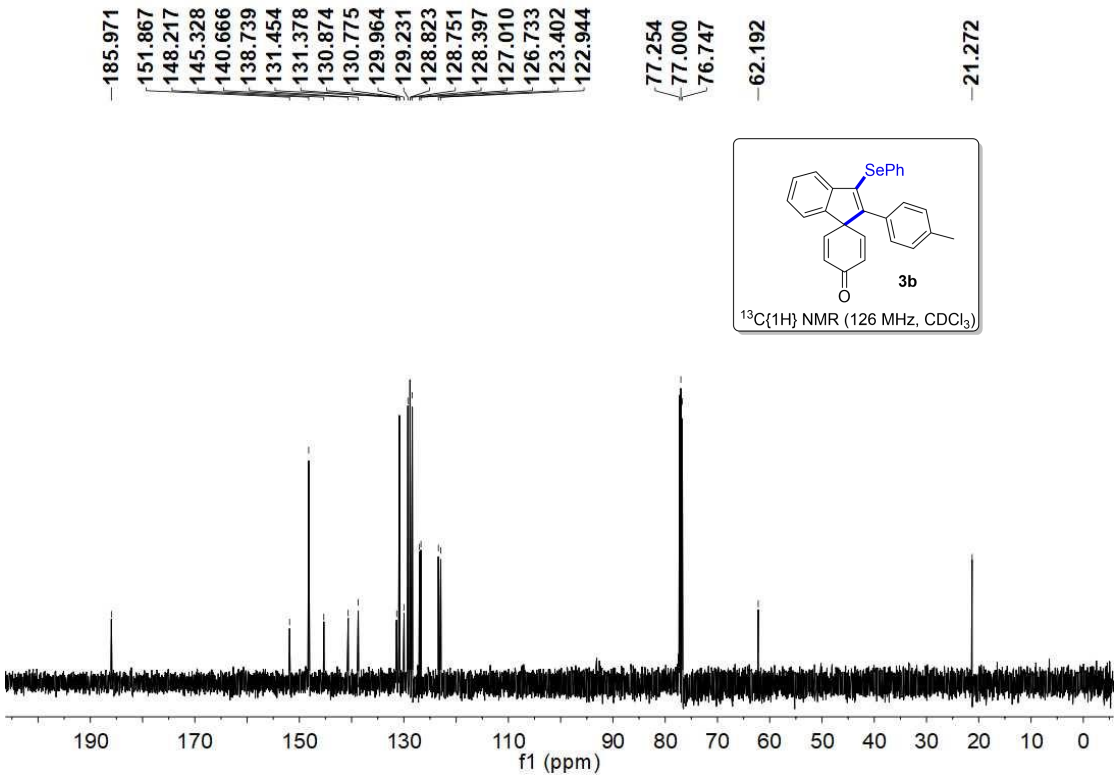
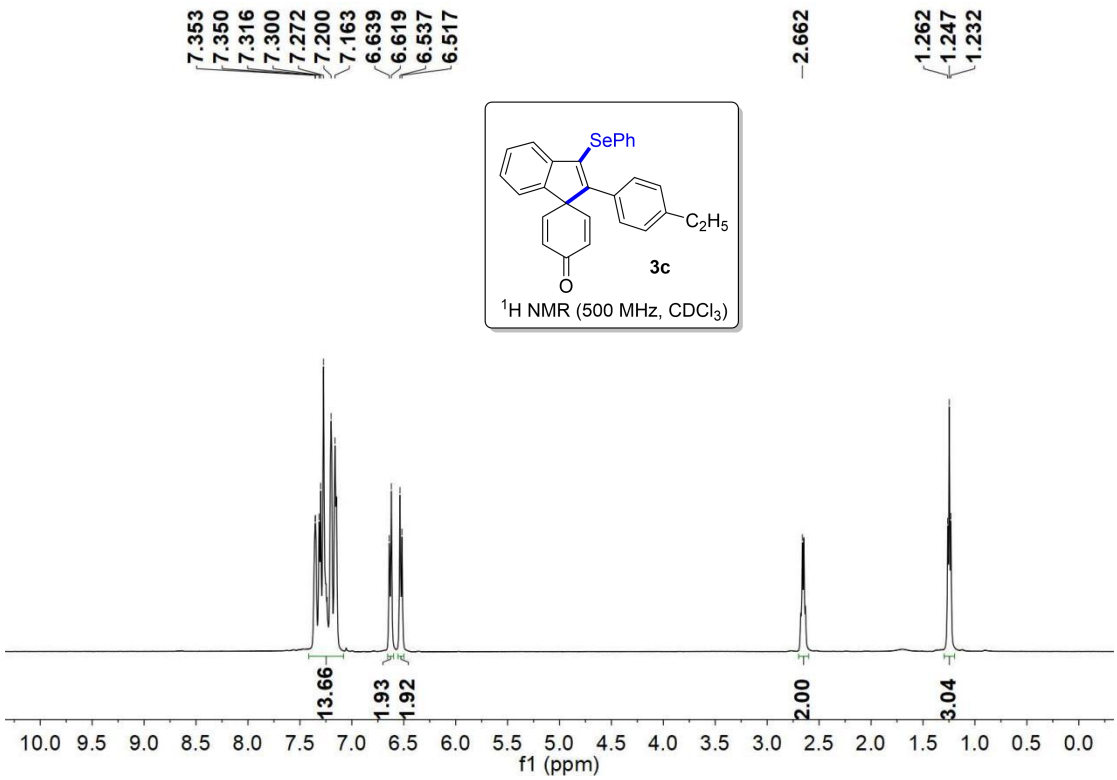
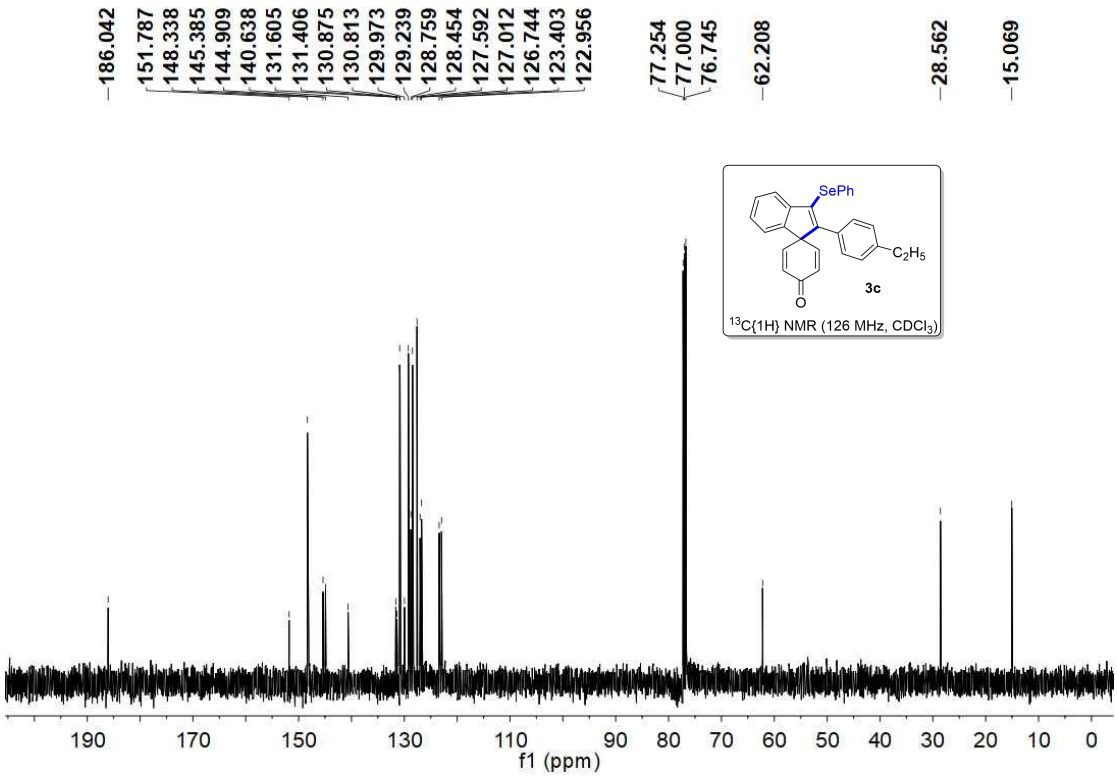
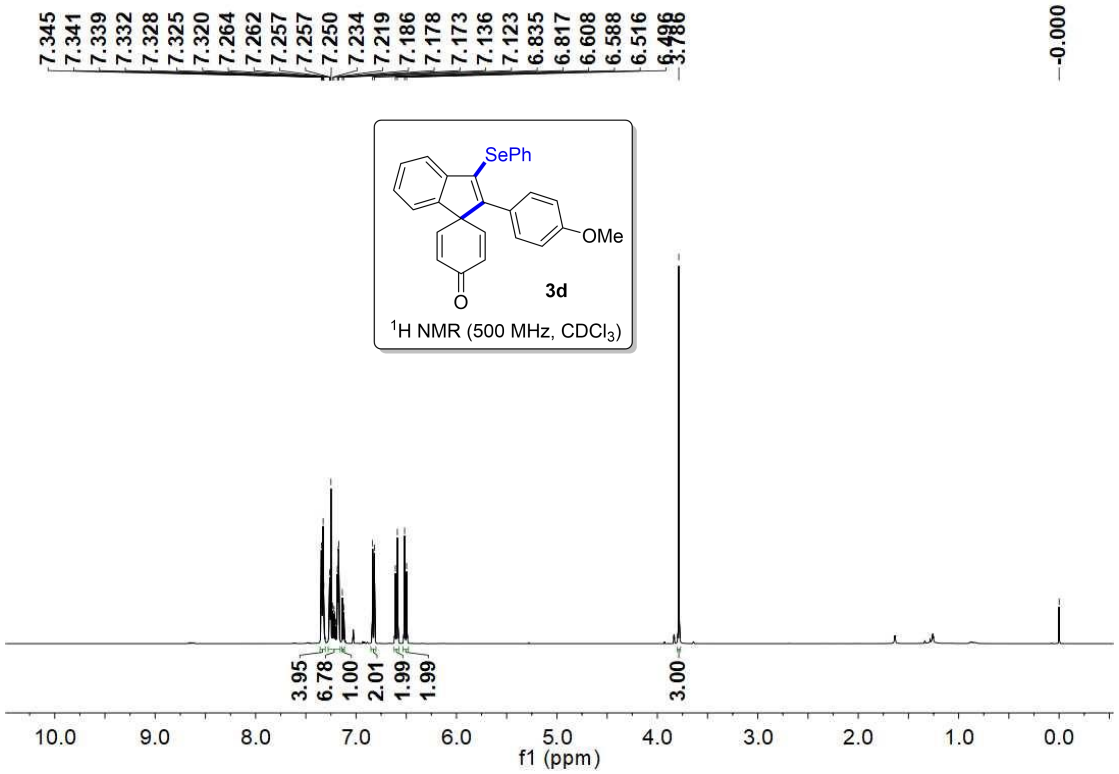
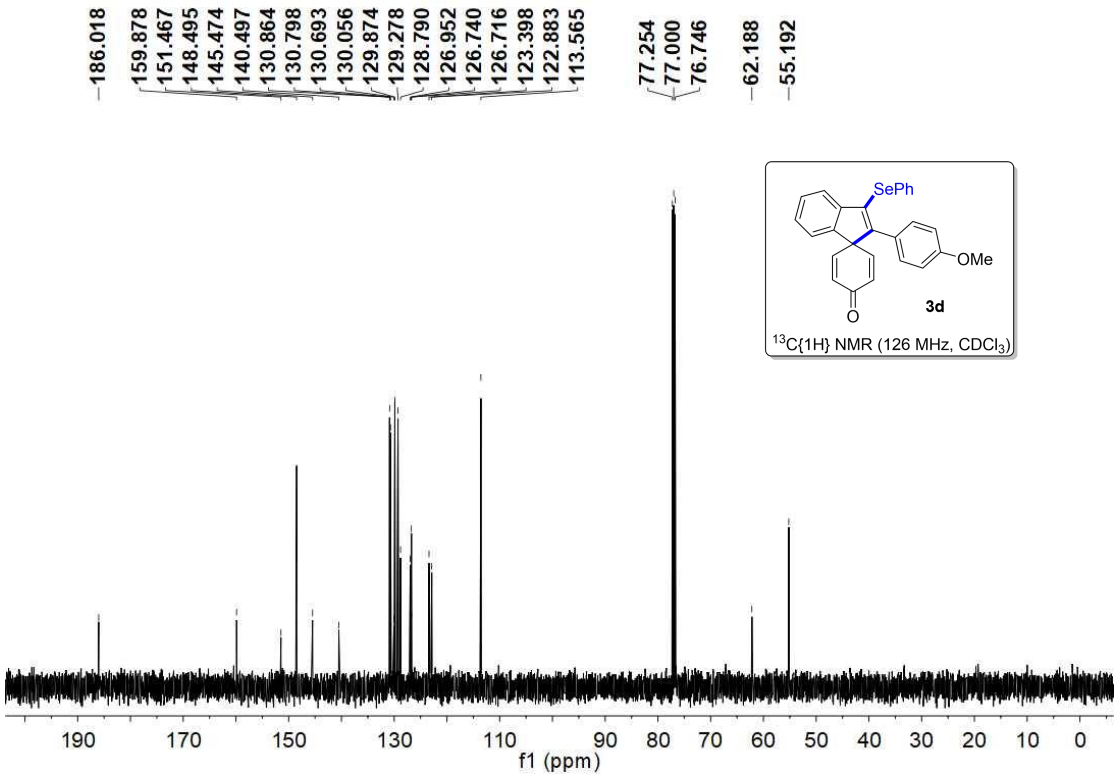
0.0
f1 (ppm)

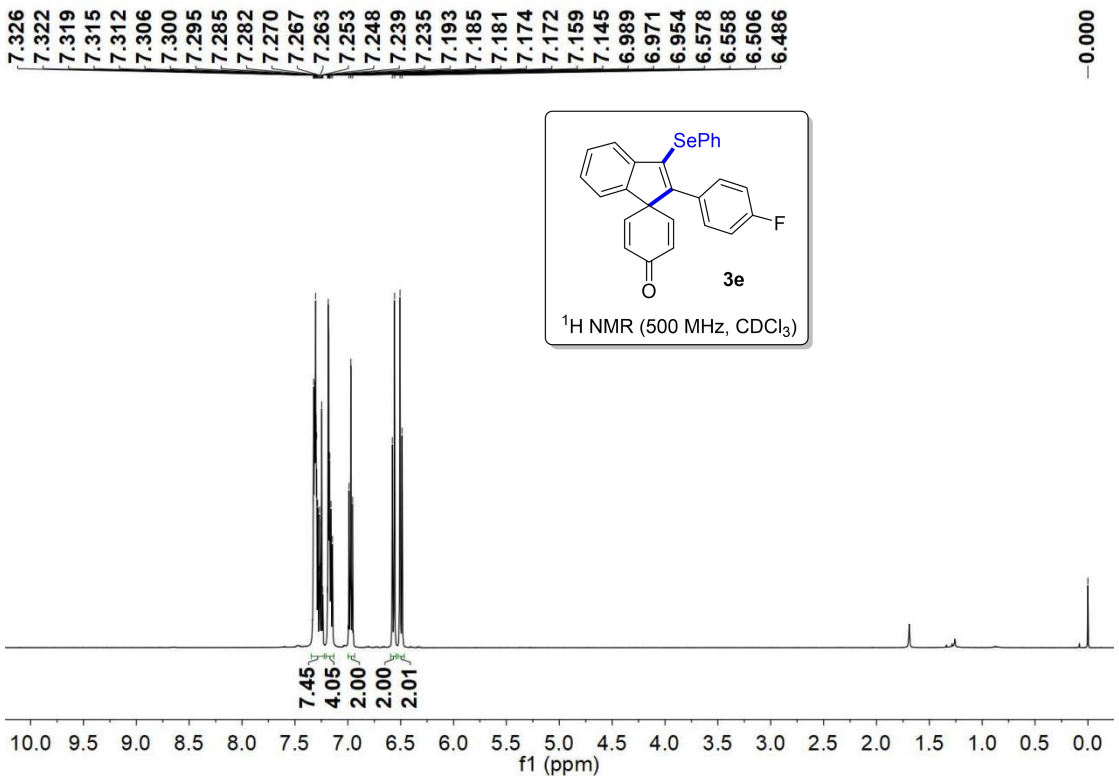

185.971
151.867
148.217
145.328
140.666
138.739
131.454
131.378
130.874
130.775
129.964
129.231
128.823
128.751
128.397
127.010
126.733
123.402
122.944
77.254
77.000
76.747
62.192
21.272
SePh
O
3b
13C{1H} NMR (126 MHz, CDCl3)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

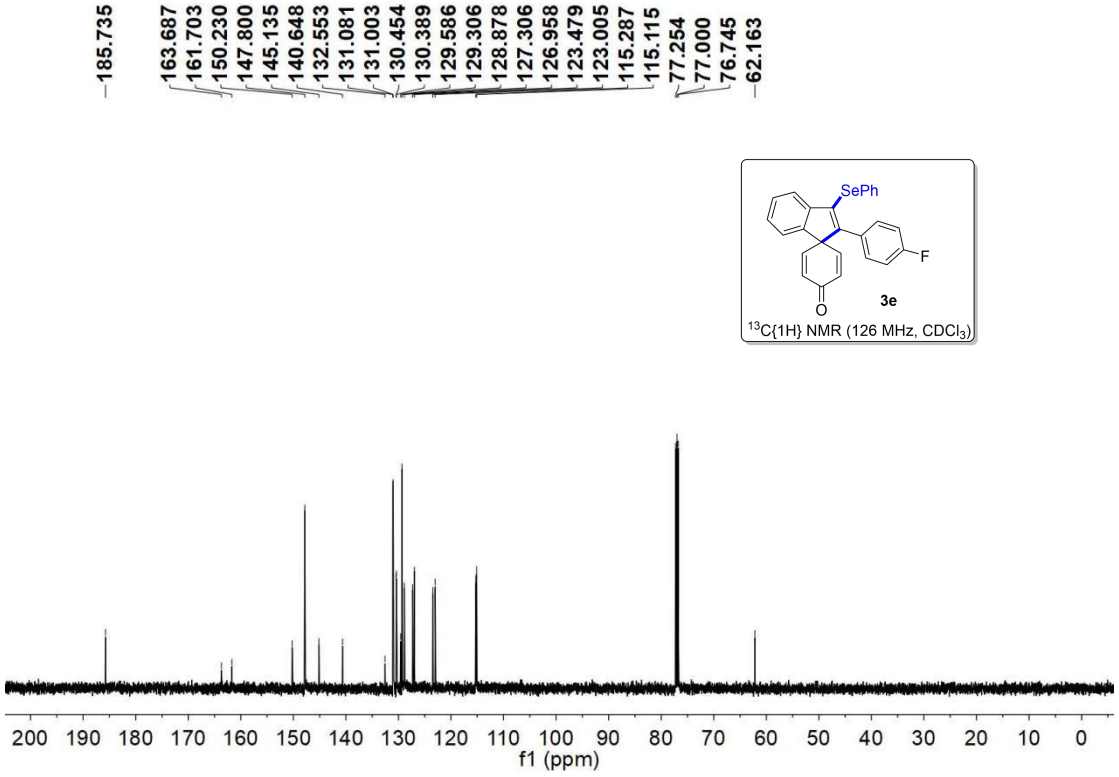

7.353
7.350
7.316
7.300
7.272
7.200
7.163
6.639
6.619
6.537
6.517
2.662
1.262
1.247
1.232
SePh
C2H5
3c
1H NMR (500 MHz, CDCl3)
13.66
1.93
1.92
2.00
3.04
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

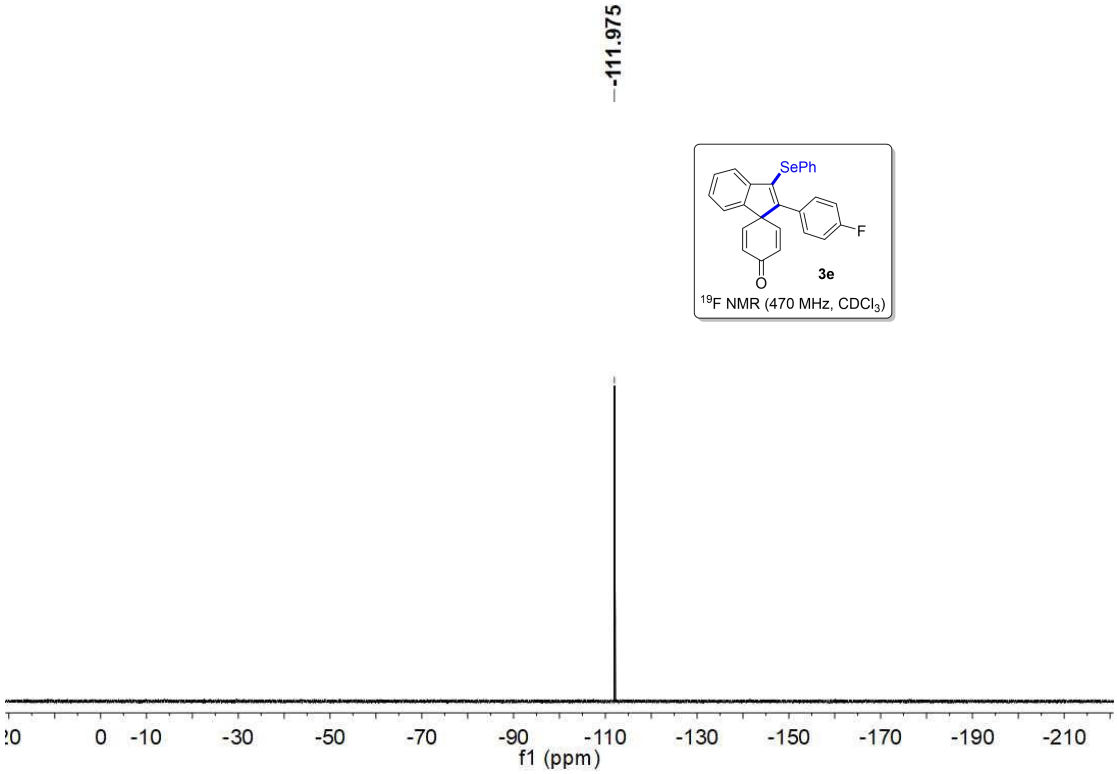

186.042
151.787
148.338
145.385
144.909
140.638
131.605
131.406
130.875
130.813
129.973
129.239
128.759
128.454
127.592
127.012
126.744
123.403
122.956
77.254
77.000
76.745
62.208
28.562
15.069
SePh
C2H5
3c
13C{1H} NMR (126 MHz, CDCl3)
190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

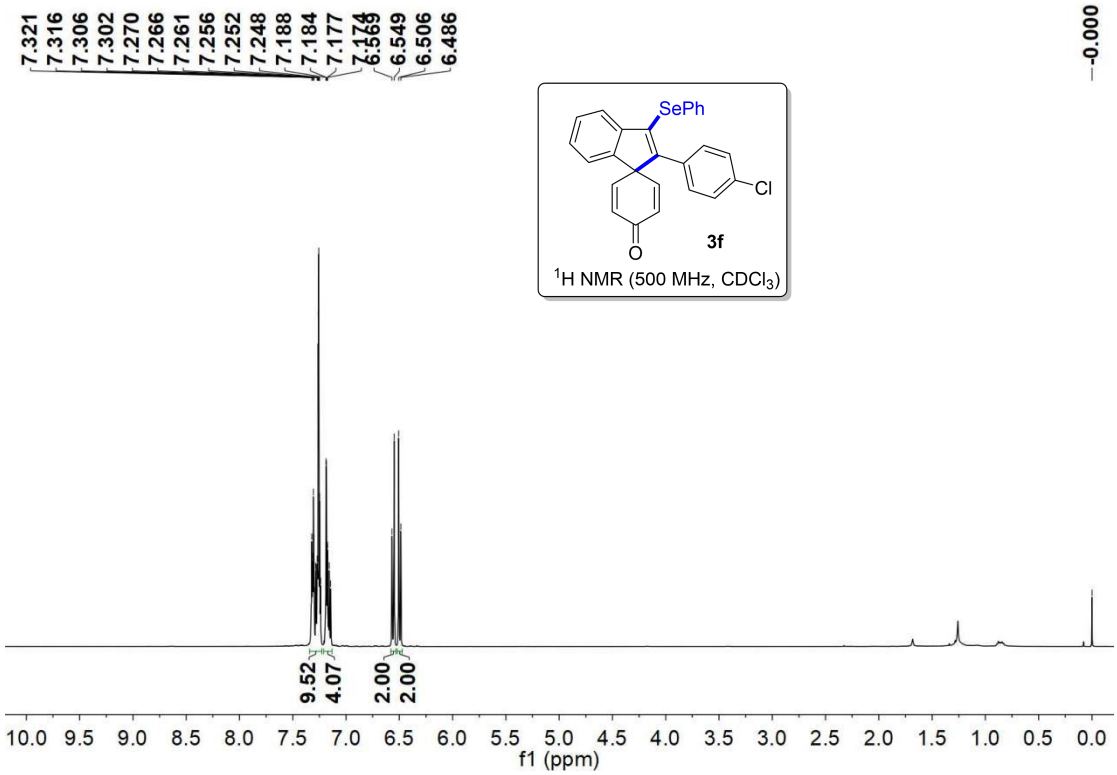

7.345
7.341
7.339
7.332
7.328
7.325
7.320
7.264
7.262
7.257
7.257
7.250
7.234
7.219
7.186
7.178
7.173
7.136
7.123
6.835
6.817
6.608
6.588
6.516
-0.000
SePh
OMe
O
3d
^{1}H NMR (500 MHz, CDCl$_3$)
3.95
6.78
1.00
2.01
1.99
1.99
3.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

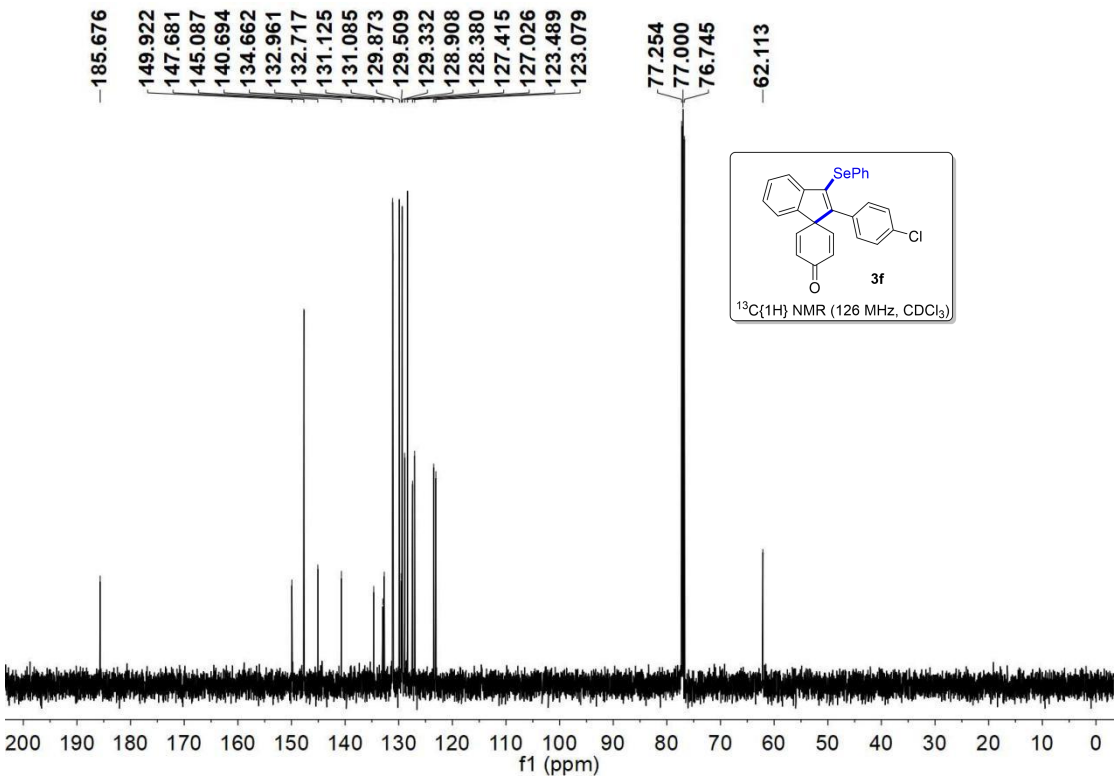

186.018
159.878
151.467
148.495
145.474
140.497
130.864
130.798
130.693
130.056
129.874
129.278
128.790
126.952
126.740
126.716
123.398
122.883
113.565
77.254
77.000
76.746
62.188
55.192
SePh
OMe
O
3d
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

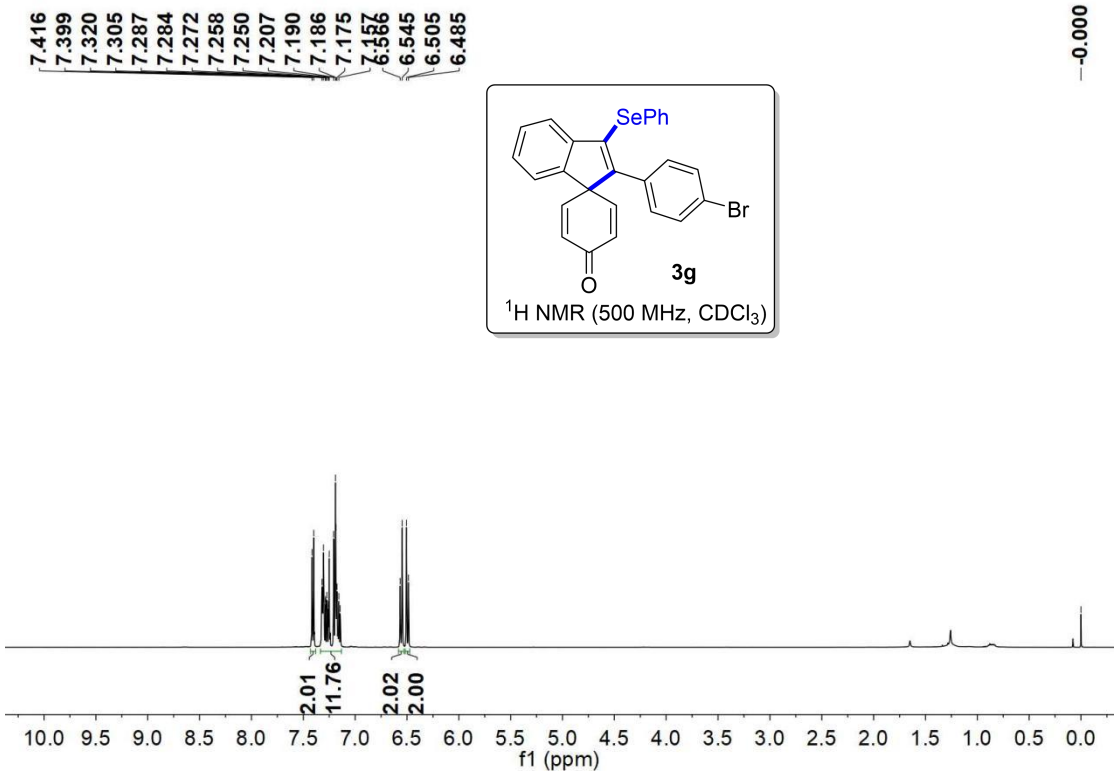

7.326
7.322
7.319
7.315
7.312
7.306
7.300
7.295
7.285
7.282
7.270
7.267
7.263
7.253
7.248
7.239
7.235
7.193
7.185
7.181
7.174
7.172
7.159
7.145
6.989
6.971
6.954
6.578
6.558
6.506
6.486
0.000
SePh
F
O
3e
^{1}H NMR (500 MHz, CDCl$_3$)
7.45
4.05
2.00
2.00
2.01
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

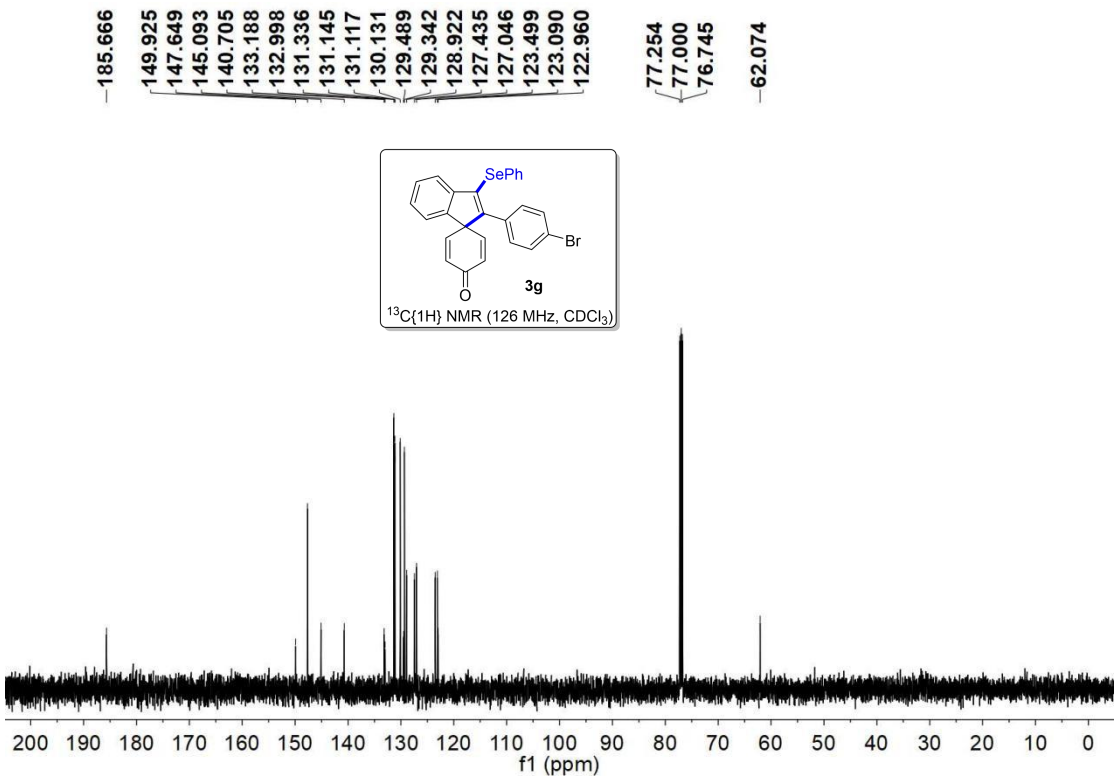

185.735
163.687
161.703
150.230
147.800
145.135
140.648
132.553
131.081
131.003
130.454
130.389
129.586
129.306
128.878
127.306
126.958
123.479
123.005
115.287
115.115
77.254
77.000
76.745
62.163
SePh
F
O
3e
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

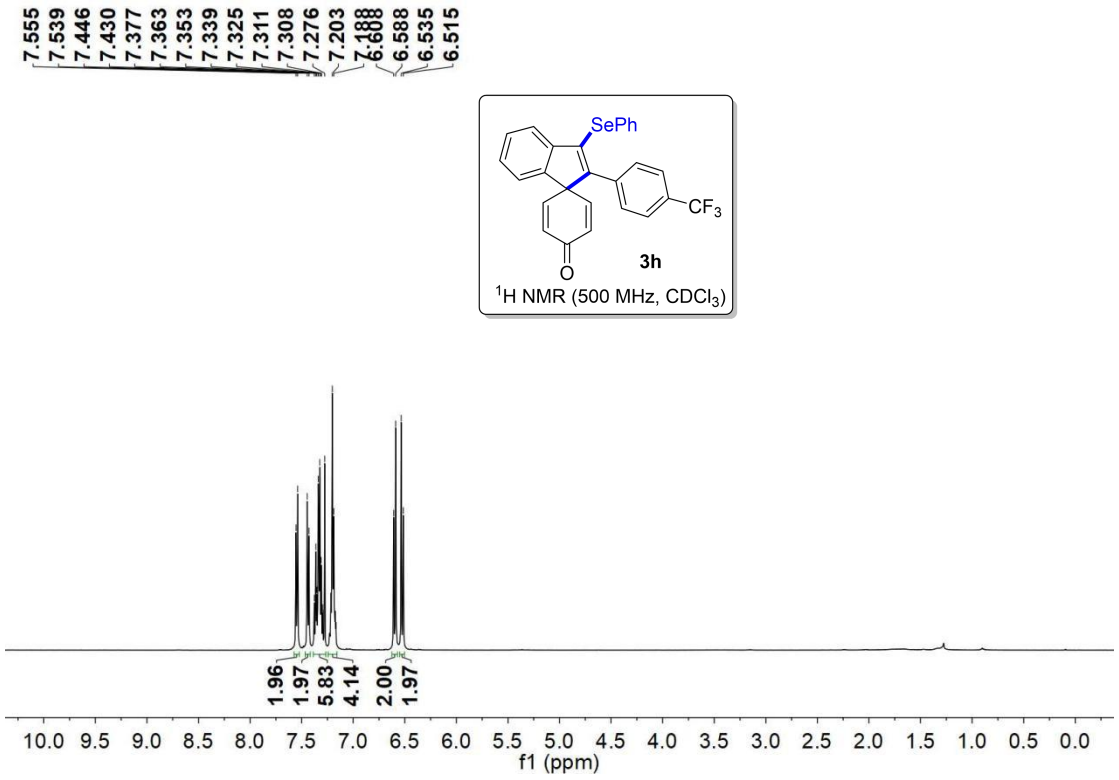

-111.975
SePh
F
O
3e
^{19}F NMR (470 MHz, $CDCl_3$)
0 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210
f1 (ppm)

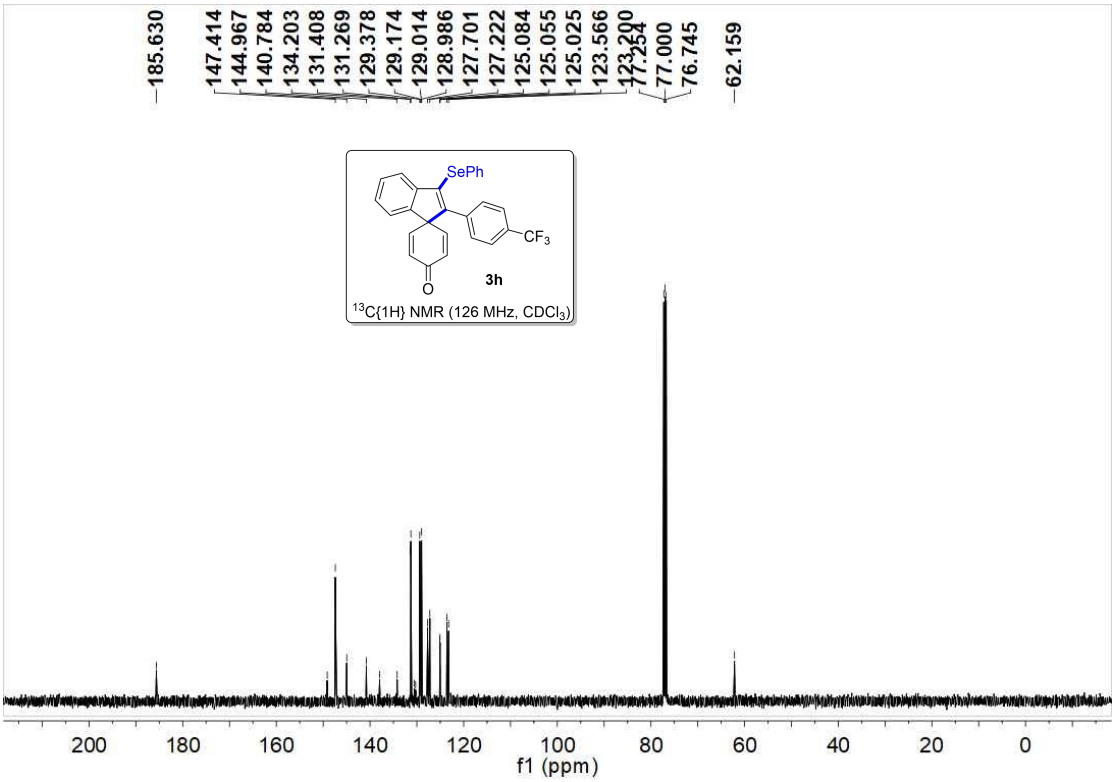

7.321
7.316
7.306
7.302
7.270
7.266
7.261
7.256
7.252
7.248
7.188
7.184
7.177
7.174
6.569
6.549
6.506
6.486
-0.000
SePh
Cl
O
3f
^{1}H NMR (500 MHz, $CDCl_3$)
9.52
4.07
2.00
2.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

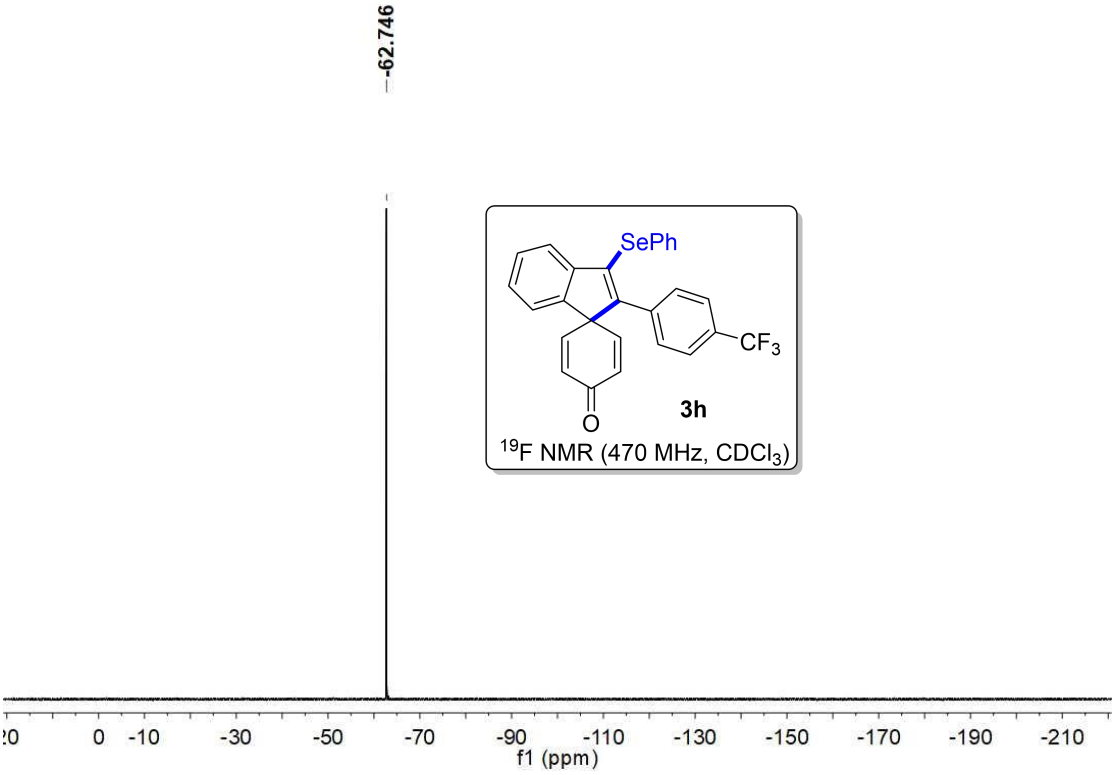

185.676
149.922
147.681
145.087
140.694
134.662
132.961
132.717
131.125
131.085
129.873
129.509
129.332
128.908
128.380
127.415
127.026
123.489
123.079
77.254
77.000
76.745
62.113
SePh
Cl
O
3f
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

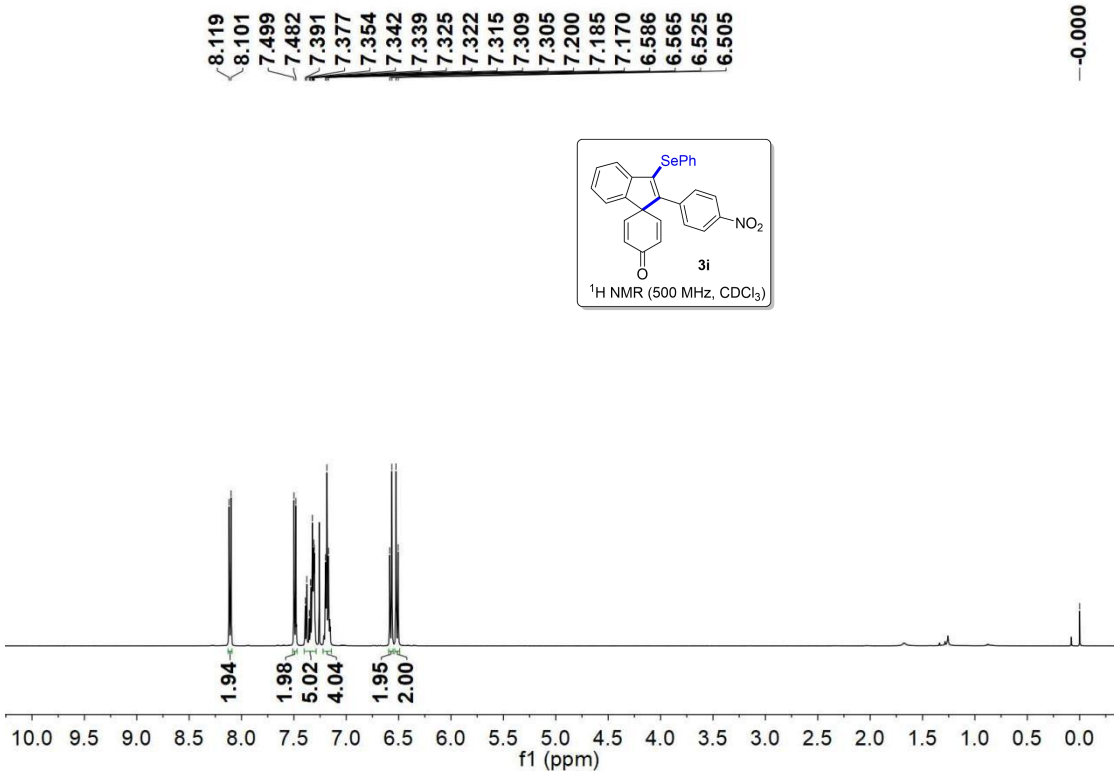

7.416
7.399
7.320
7.305
7.287
7.284
7.272
7.258
7.250
7.207
7.190
7.186
7.175
6.566
6.545
6.505
6.485
-0.000
SePh
Br
O
3g
^{1}H NMR (500 MHz, CDCl$_3$)
2.01
11.76
2.02
2.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

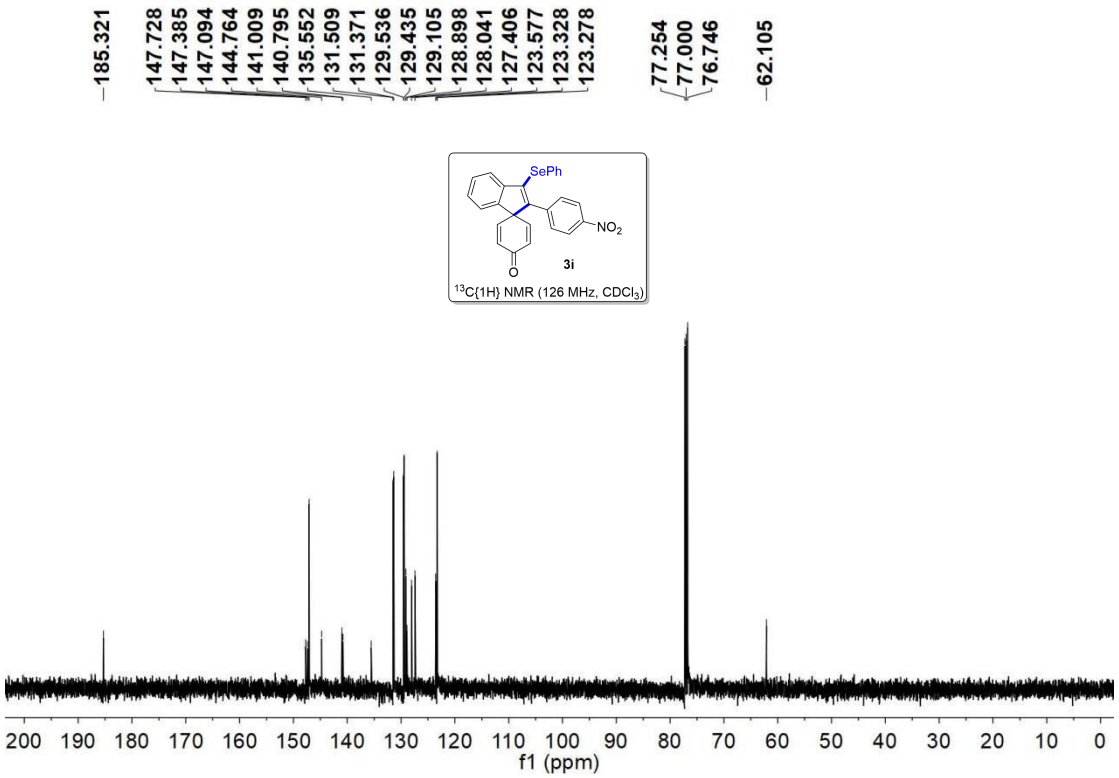

185.666
149.925
147.649
145.093
140.705
133.188
132.998
131.336
131.145
131.117
130.131
129.489
129.342
128.922
127.435
127.046
123.499
123.090
122.960
77.254
77.000
76.745
62.074
SePh
Br
O
3g
13C{1H} NMR (126 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

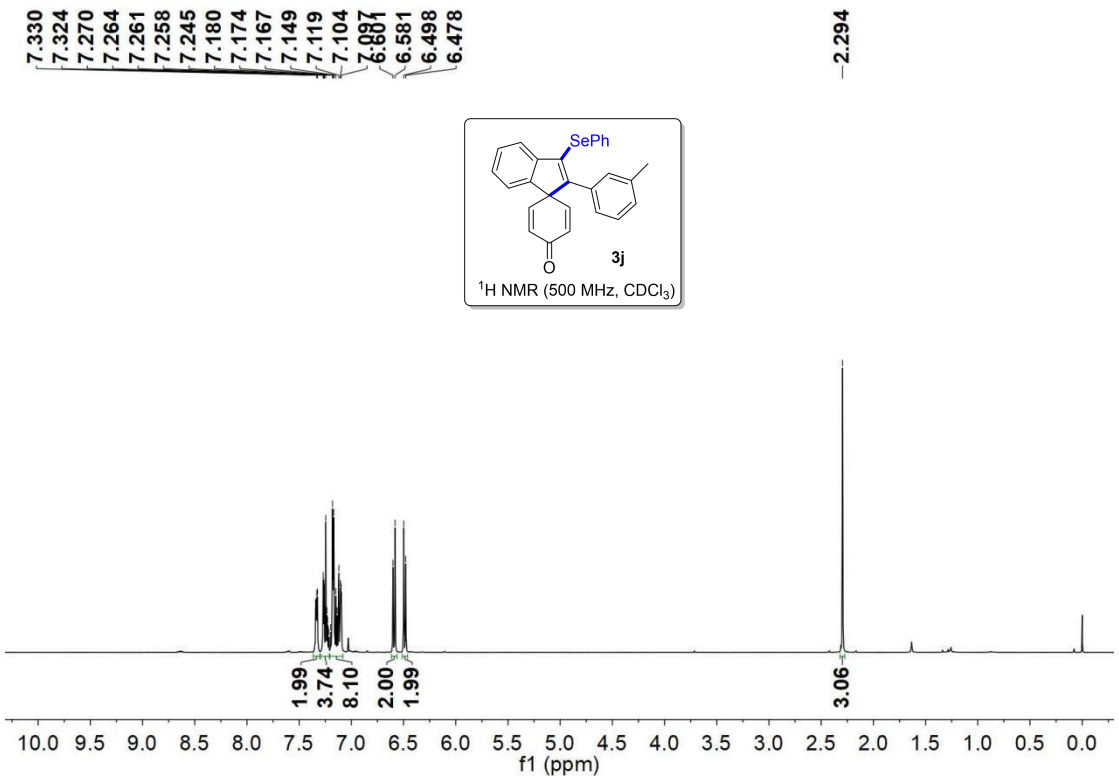

7.555
7.539
7.446
7.430
7.377
7.363
7.353
7.339
7.325
7.311
7.308
7.276
7.203
6.588
6.535
6.515
SePh
CF3
O
3h
1H NMR (500 MHz, CDCl3)
1.96
1.97
5.83
4.14
2.00
1.97
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

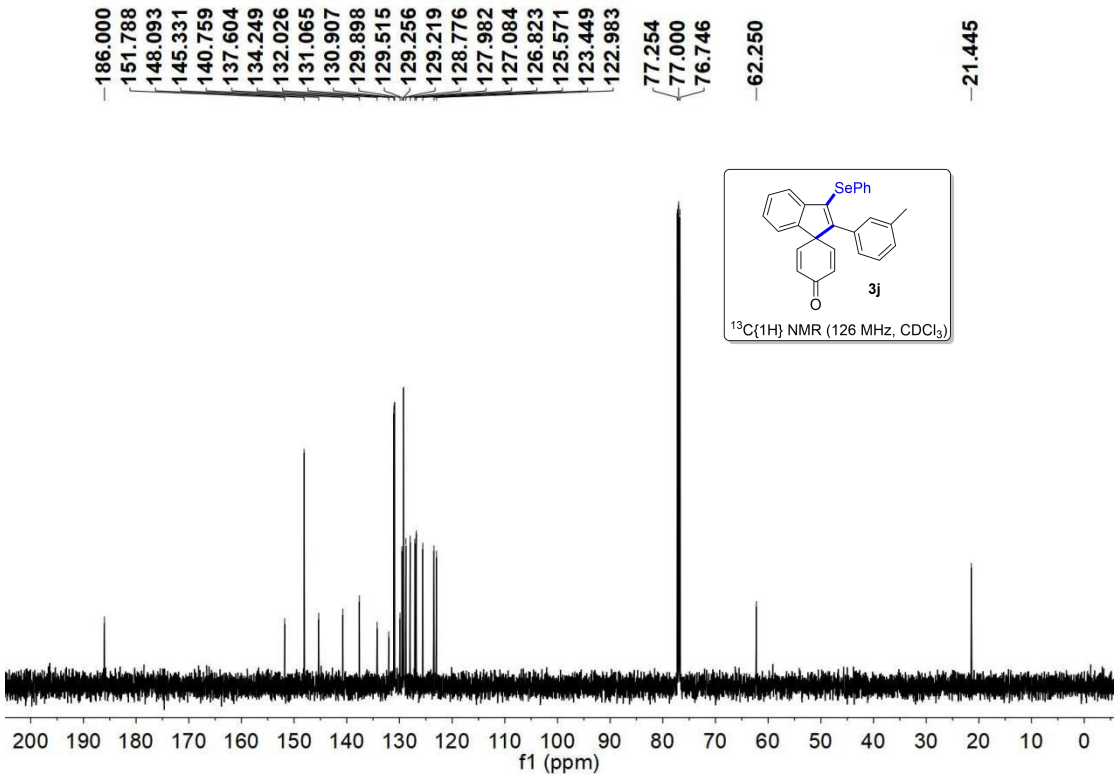

185.630
147.414
144.967
140.784
134.203
131.408
131.269
129.378
129.174
129.014
128.986
127.701
127.222
125.084
125.055
125.025
123.566
123.200
77.254
77.000
76.745
62.159
SePh
CF3
O
3h
13C{1H} NMR (126 MHz, CDCl3)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

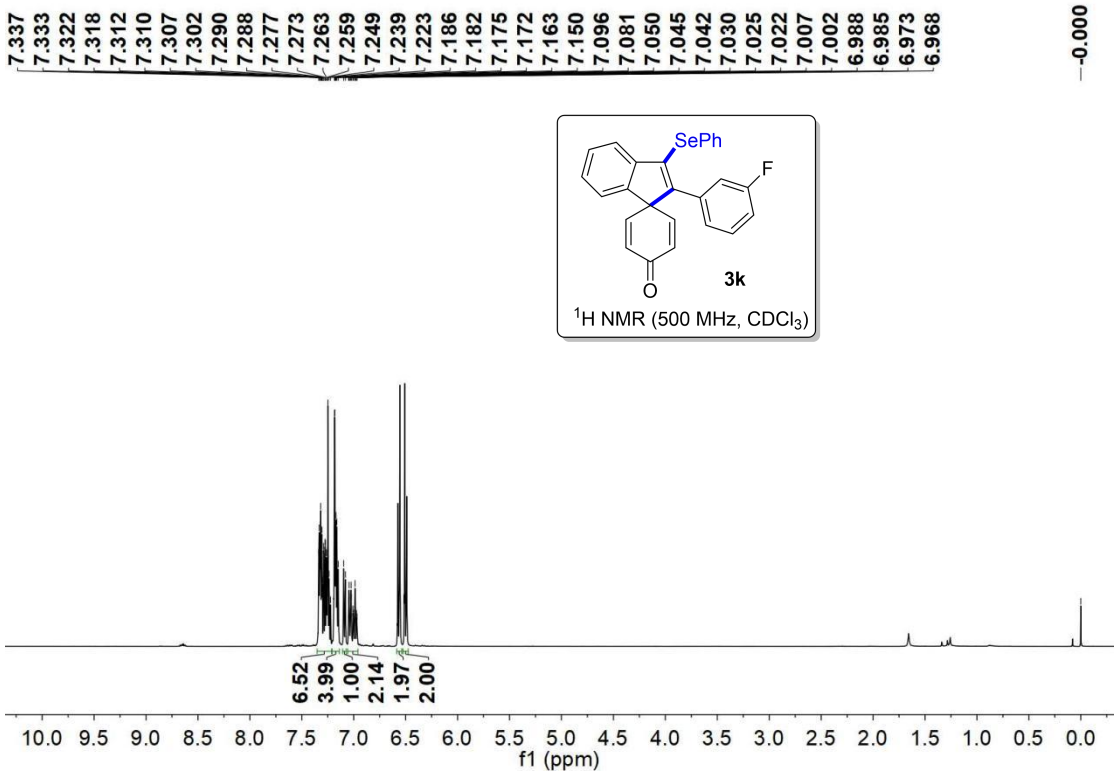

-62.746
SePh
CF3
O
3h
19F NMR (470 MHz, CDCl3)
0
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
f1 (ppm)

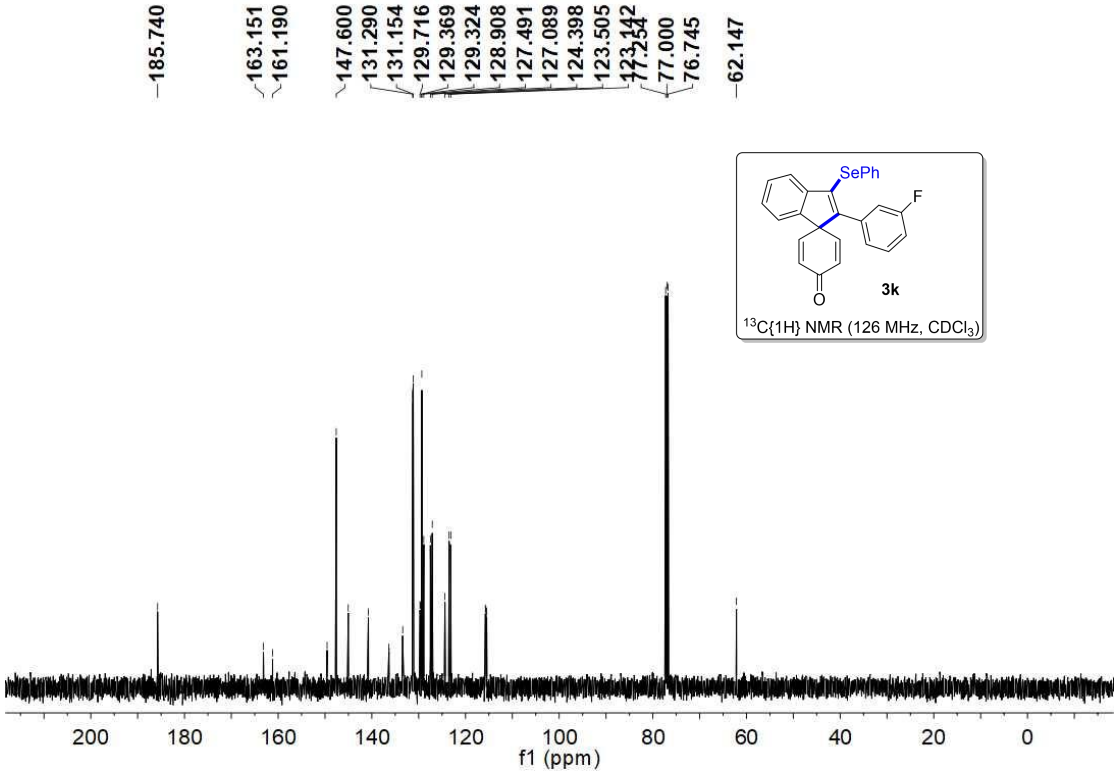

8.119
8.101
7.499
7.482
7.391
7.377
7.354
7.342
7.339
7.325
7.322
7.315
7.309
7.305
7.200
7.185
7.170
6.586
6.565
6.525
6.505
-0.000
SePh
NO2
O
3i
1H NMR (500 MHz, CDCl3)
1.94
1.98
5.02
4.04
1.95
2.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

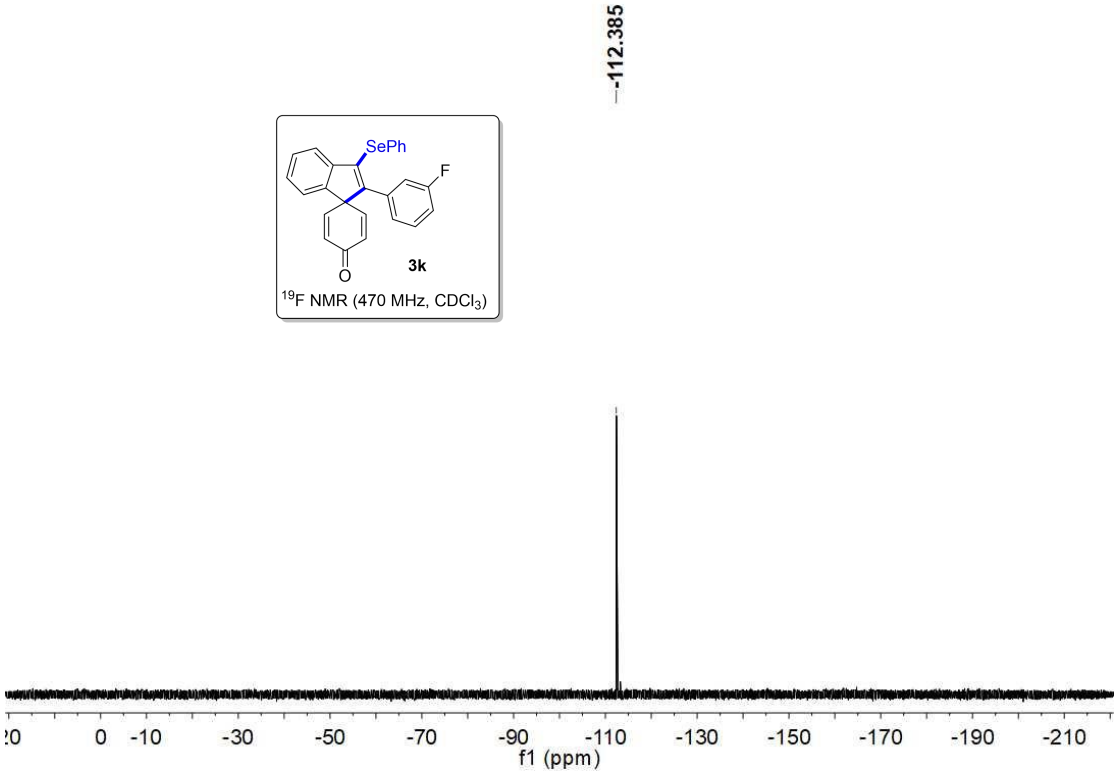

185.321
147.728
147.385
147.094
144.764
141.009
140.795
135.552
131.509
131.371
129.536
129.435
129.105
128.898
128.041
127.406
123.577
123.328
123.278
77.254
77.000
76.746
62.105
SePh
NO2
O
3i
13C{1H} NMR (126 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

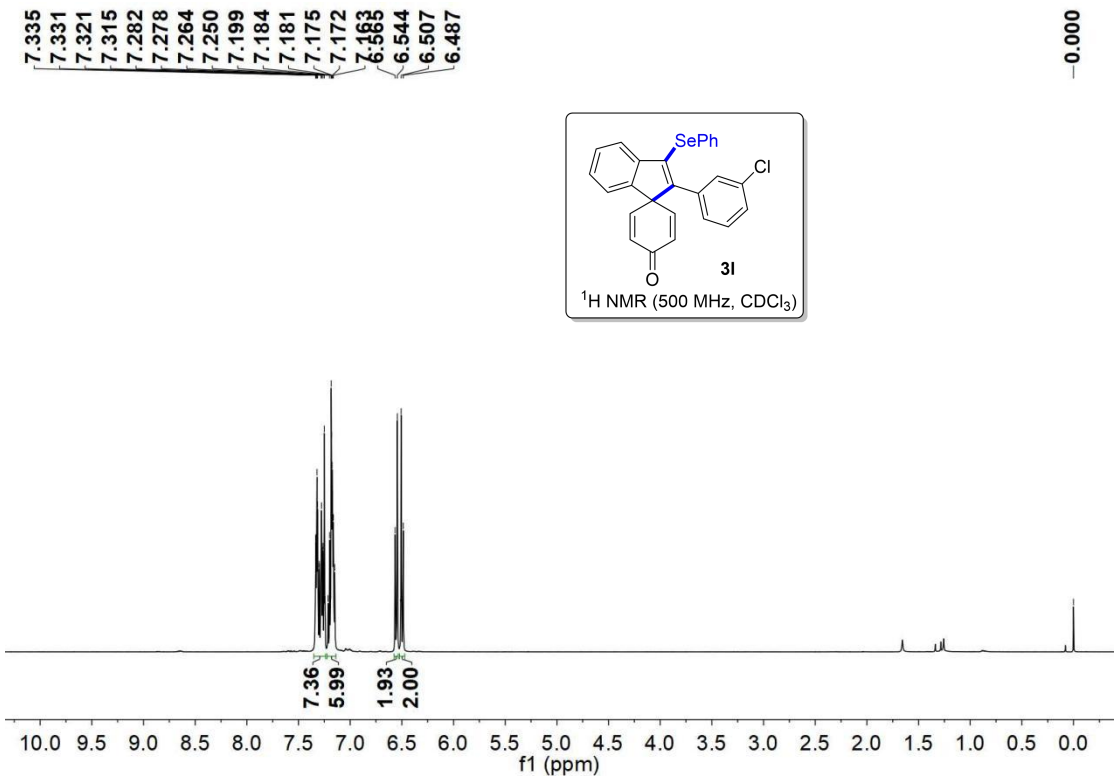

7.330
7.324
7.270
7.264
7.261
7.258
7.245
7.180
7.174
7.167
7.149
7.119
7.104
7.097
6.581
6.498
6.478
2.294
SePh
O
3j
^{1}H NMR (500 MHz, CDCl$_3$)
1.99
3.74
8.10
2.00
1.99
3.06
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

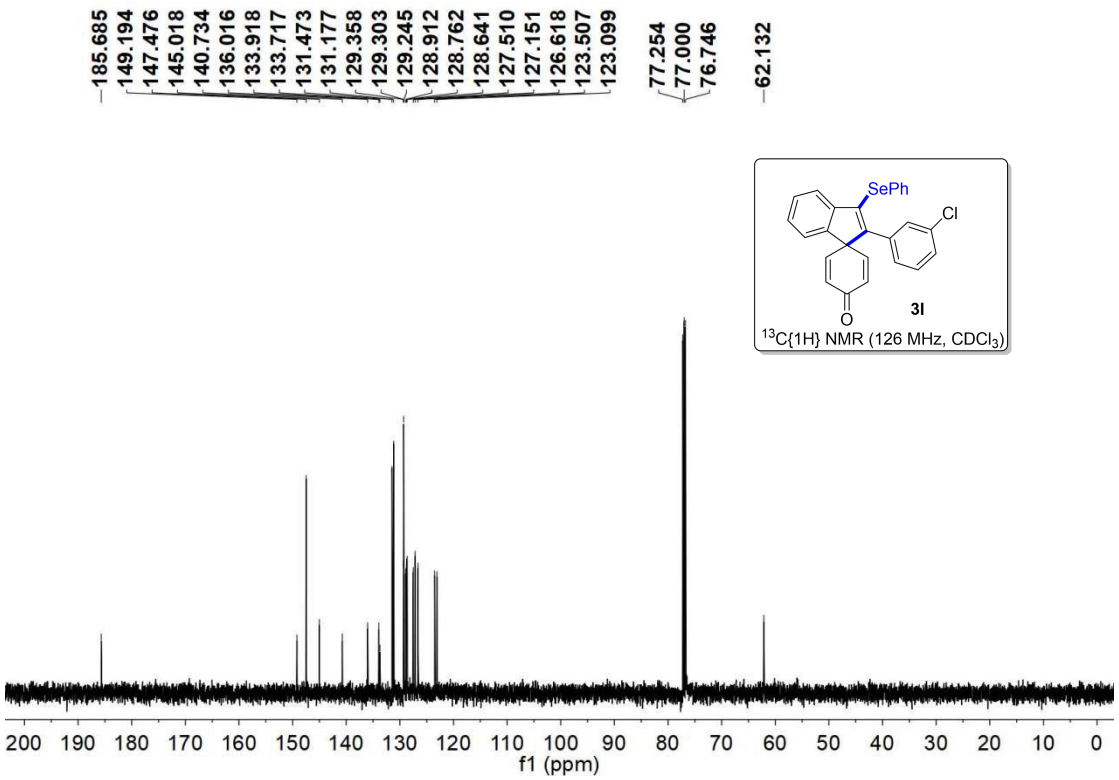

186.000
151.788
148.093
145.331
140.759
137.604
134.249
132.026
131.065
130.907
129.898
129.515
129.256
129.219
128.776
127.982
127.084
126.823
125.571
123.449
122.983
77.254
77.000
76.746
62.250
21.445
SePh
O
3j
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

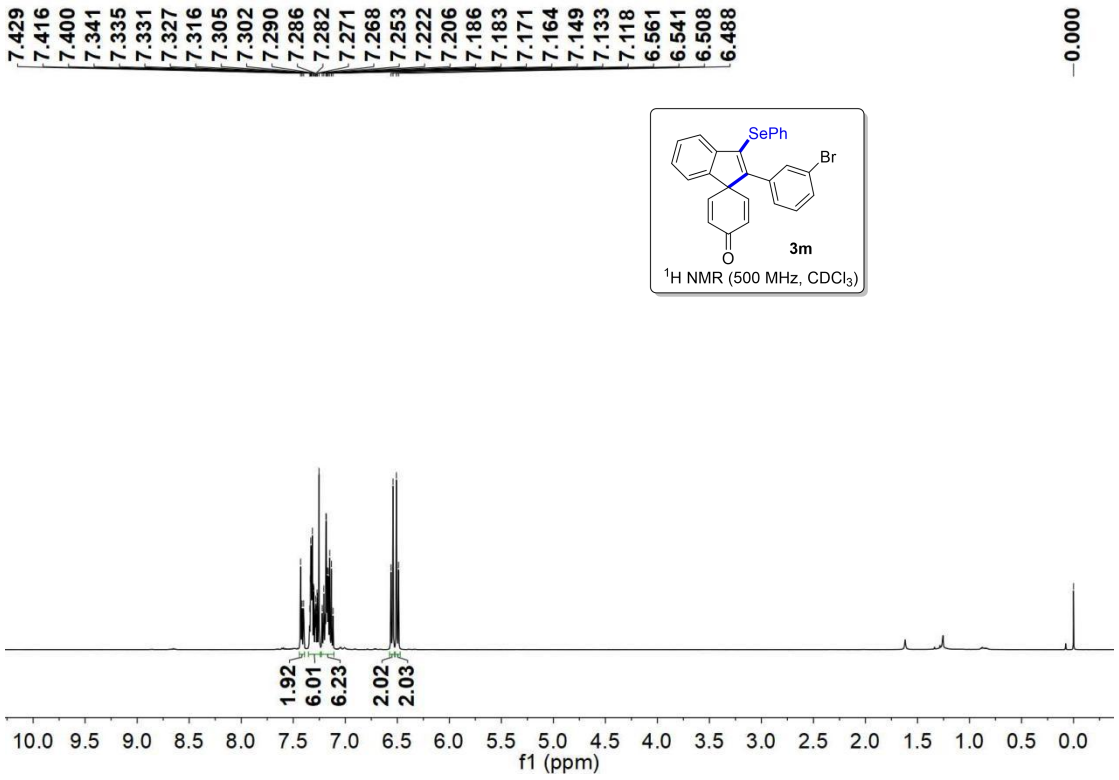

7.337
7.333
7.322
7.318
7.312
7.310
7.307
7.302
7.290
7.288
7.277
7.273
7.263
7.259
7.249
7.239
7.223
7.186
7.182
7.175
7.172
7.163
7.150
7.096
7.081
7.050
7.045
7.042
7.030
7.025
7.022
7.007
7.002
6.988
6.985
6.973
6.968
-0.000
SePh
F
O
3k
1H NMR (500 MHz, CDCl3)
6.52
3.99
1.00
2.14
1.97
2.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

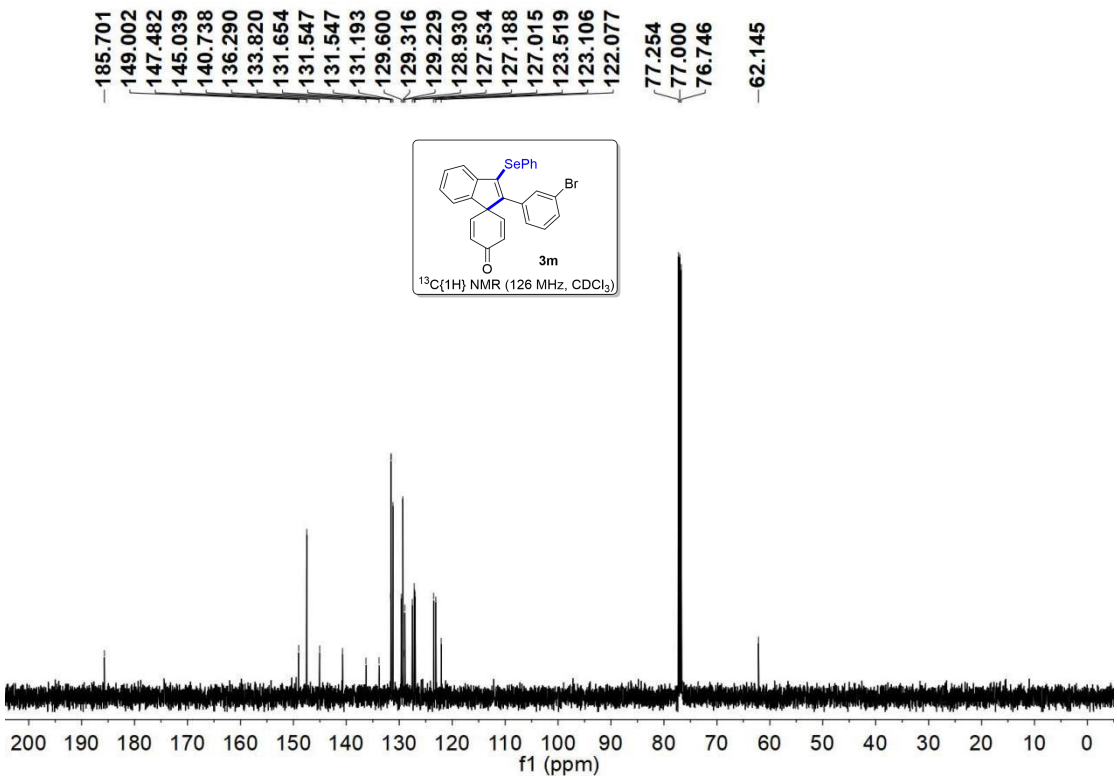

185.740
163.151
161.190
147.600
131.290
131.154
129.716
129.369
129.324
128.908
127.491
127.089
124.398
123.505
123.142
77.254
77.000
76.745
62.147
SePh
F
O
3k
13C{1H} NMR (126 MHz, CDCl3)
200 180 160 140 120 100 80 60 40 20 0
f1 (ppm)

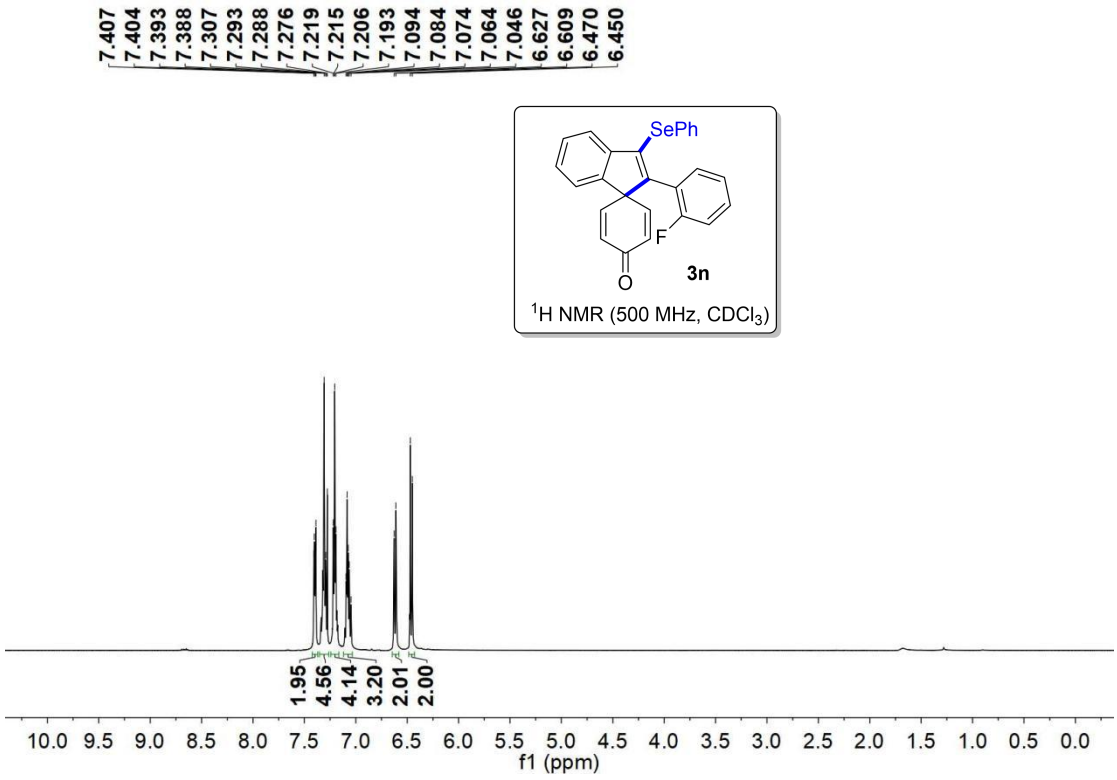

-112.385
SePh
F
O
3k
^{19}F NMR (470 MHz, $CDCl_3$)
f1 (ppm)

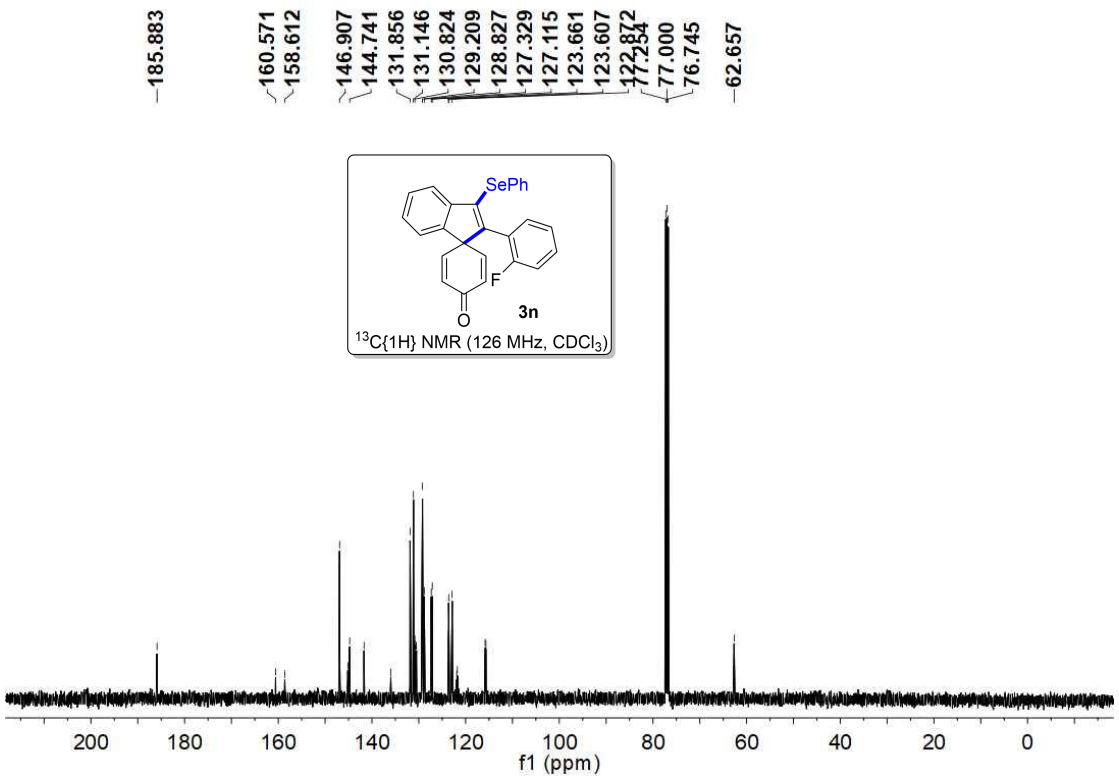

7.335
7.331
7.321
7.315
7.282
7.278
7.264
7.250
7.199
7.184
7.181
7.175
7.172
6.544
6.507
6.487
0.000
SePh
Cl
O
3l
^{1}H NMR (500 MHz, $CDCl_3$)
7.36
5.99
1.93
2.00
f1 (ppm)

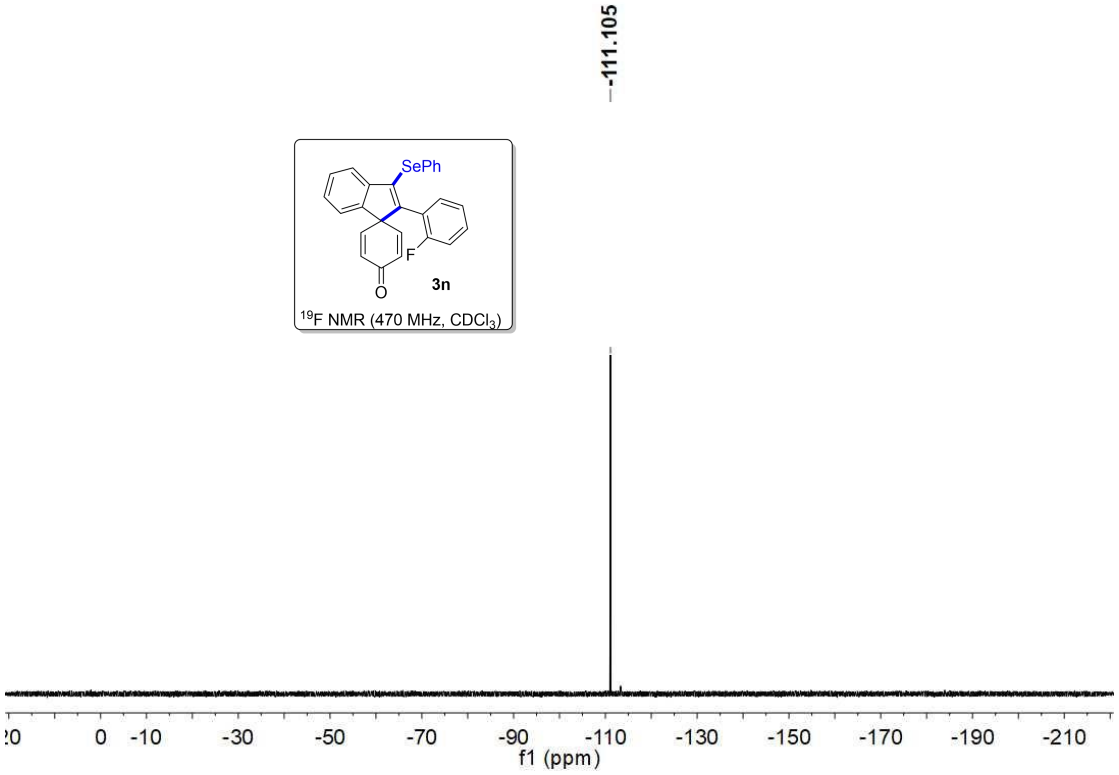

185.685
149.194
147.476
145.018
140.734
136.016
133.918
133.717
131.473
131.177
129.358
129.303
129.245
128.912
128.762
128.641
127.510
127.151
126.618
123.507
123.099
77.254
77.000
76.746
62.132
SePh
Cl
O
3l
13C{1H} NMR (126 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

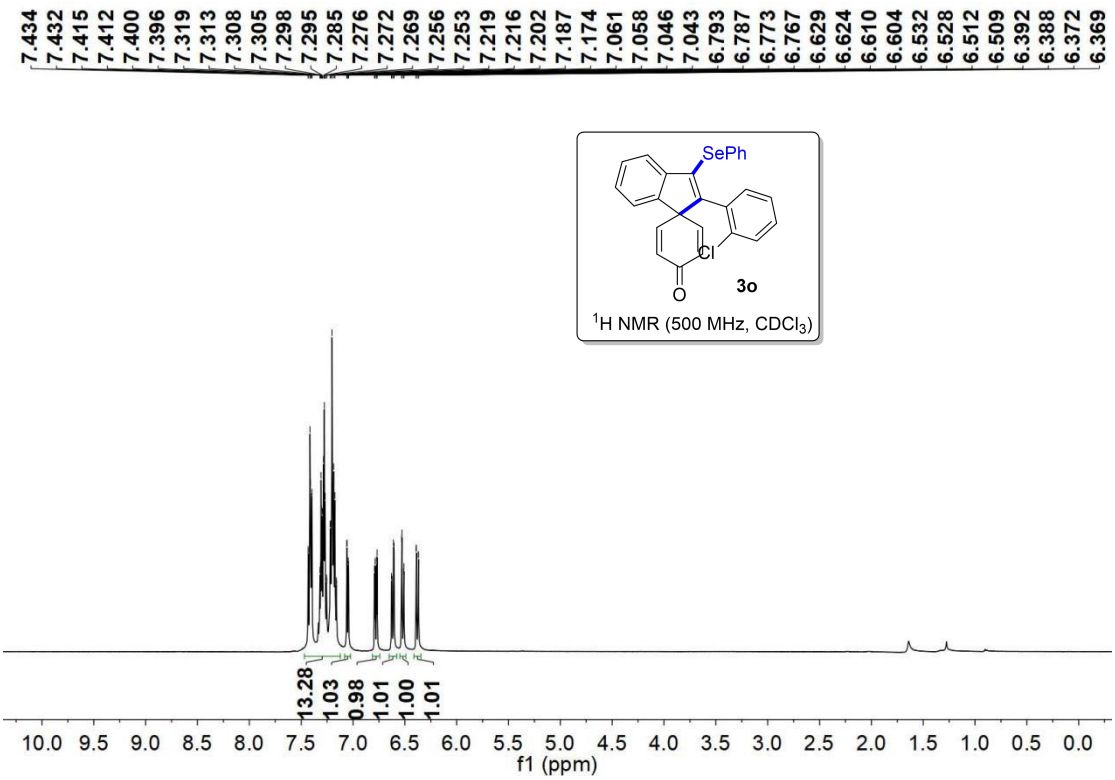

7.429
7.416
7.400
7.341
7.335
7.331
7.327
7.316
7.305
7.302
7.290
7.286
7.282
7.271
7.268
7.253
7.222
7.206
7.186
7.183
7.171
7.164
7.149
7.133
7.118
6.561
6.541
6.508
6.488
0.000
SePh
Br
O
3m
1H NMR (500 MHz, CDCl3)
1.92
6.01
6.23
2.02
2.03
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

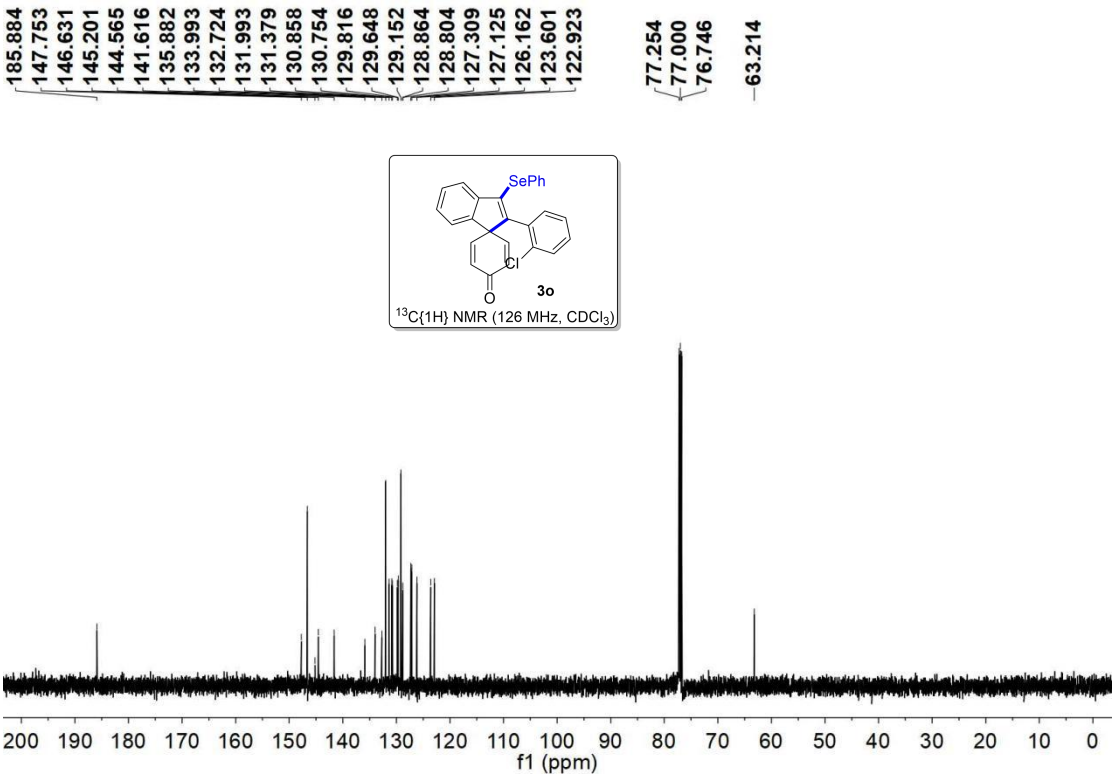

185.701
149.002
147.482
145.039
140.738
136.290
133.820
131.654
131.547
131.547
131.193
129.600
129.316
129.229
128.930
127.534
127.188
127.015
123.519
123.106
122.077
77.254
77.000
76.746
62.145
SePh
Br
O
3m
13C{1H} NMR (126 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

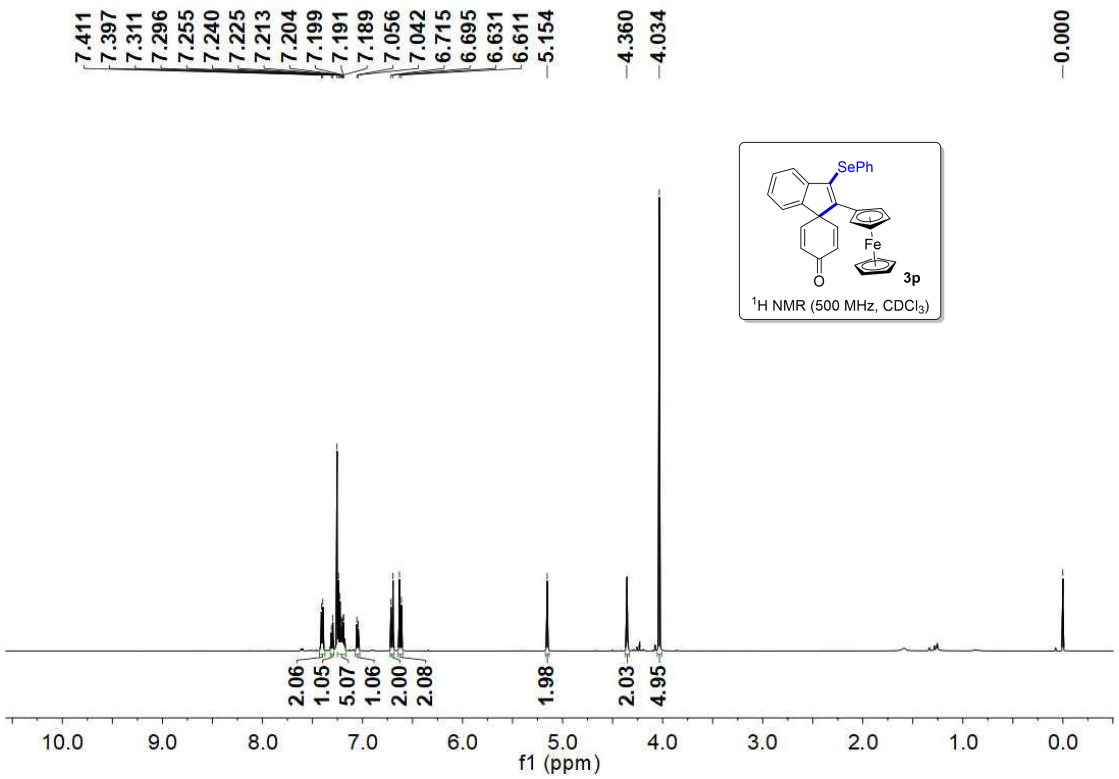

7.407
7.404
7.393
7.388
7.307
7.293
7.288
7.276
7.219
7.215
7.206
7.193
7.094
7.084
7.074
7.064
7.046
6.627
6.609
6.470
6.450
SePh
F
O
3n
1H NMR (500 MHz, CDCl3)
1.95
4.56
4.14
3.20
2.01
2.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

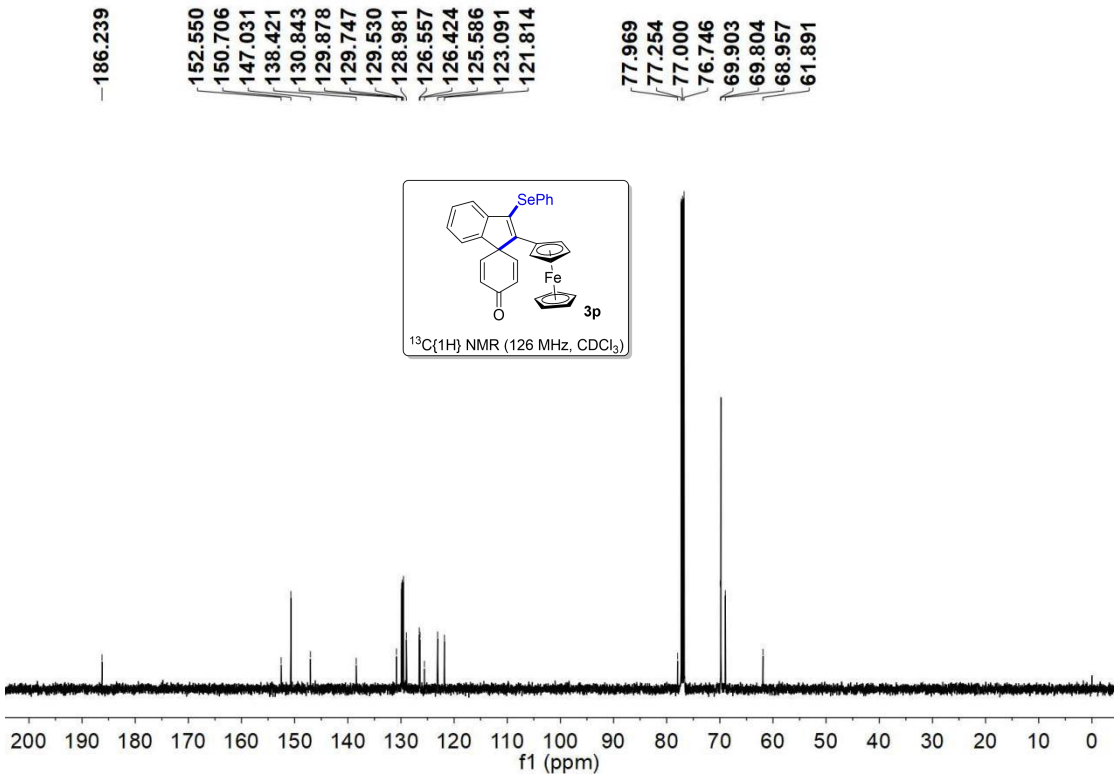

185.883
160.571
158.612
146.907
144.741
131.856
131.146
130.824
129.209
128.827
127.329
127.115
123.661
123.607
122.872
77.254
77.000
76.745
62.657
SePh
F
O
3n
13C{1H} NMR (126 MHz, CDCl3)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

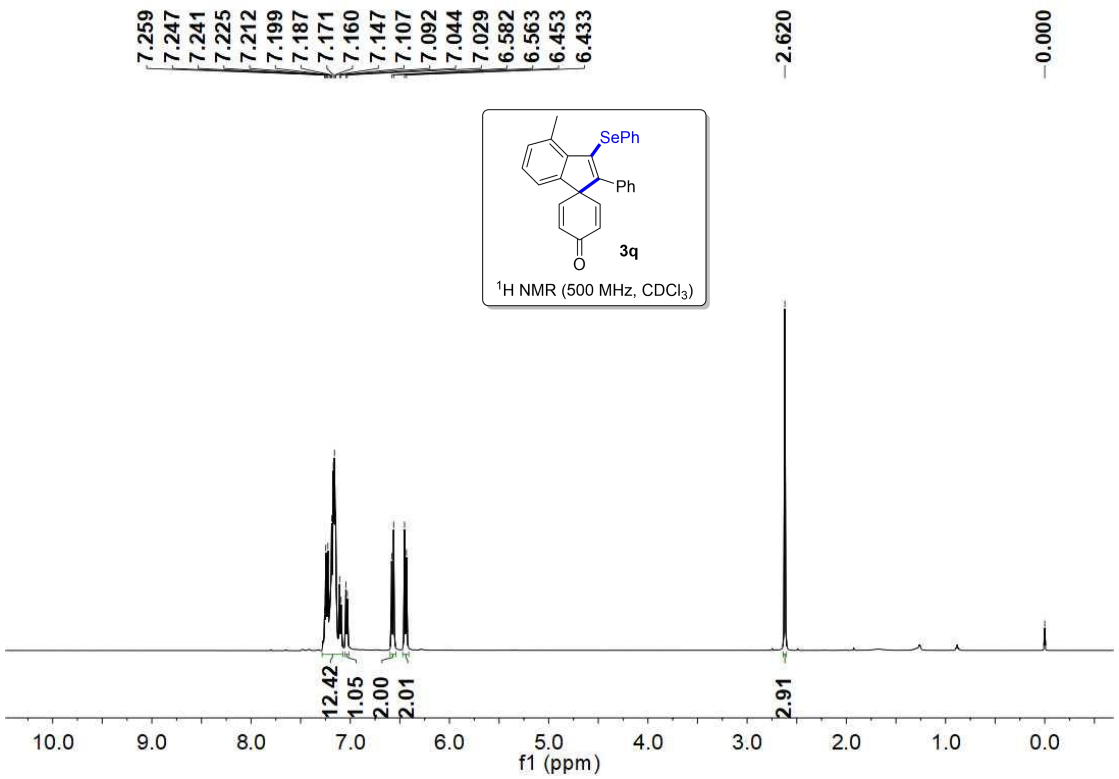

-111.105
SePh
F
O
3n
19F NMR (470 MHz, CDCl3)
0
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
f1 (ppm)

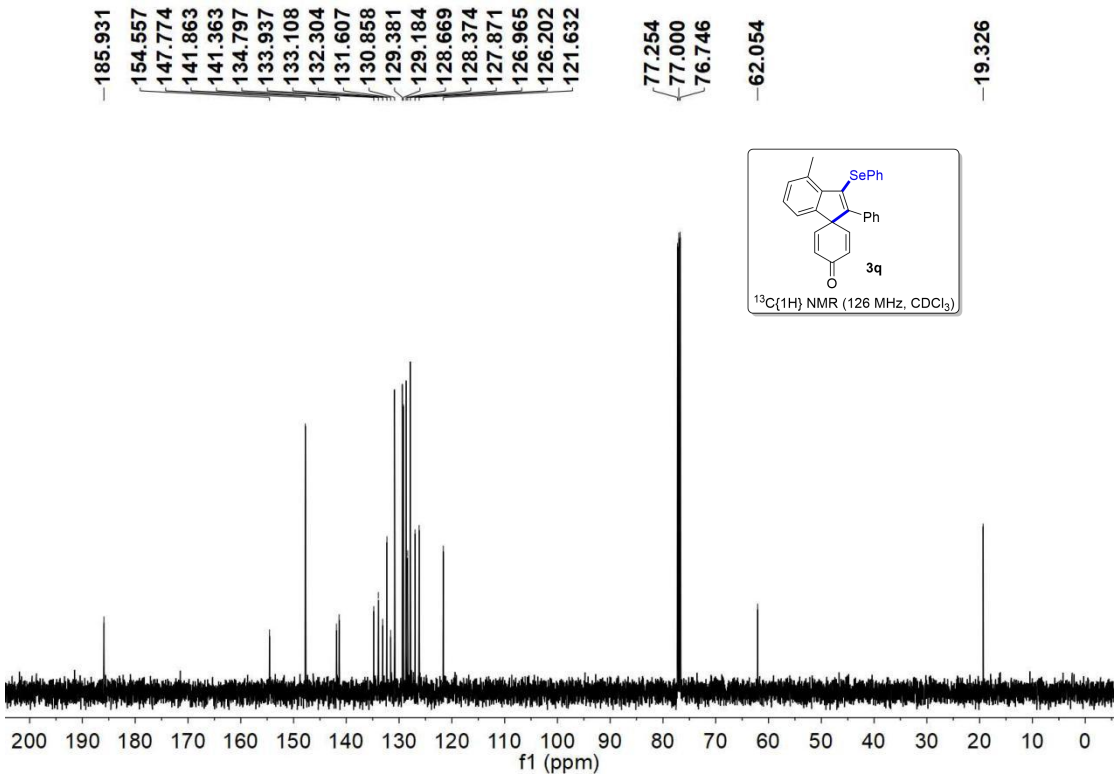

7.434
7.432
7.415
7.412
7.400
7.396
7.319
7.313
7.308
7.305
7.298
7.295
7.285
7.276
7.272
7.269
7.256
7.253
7.219
7.216
7.202
7.187
7.174
7.061
7.058
7.046
7.043
6.793
6.787
6.773
6.767
6.629
6.624
6.610
6.604
6.532
6.528
6.512
6.509
6.392
6.388
6.372
6.369
SePh
Cl
O
3o
^{1}H NMR (500 MHz, $CDCl_3$)
13.28
1.03
0.98
1.01
1.00
1.01
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

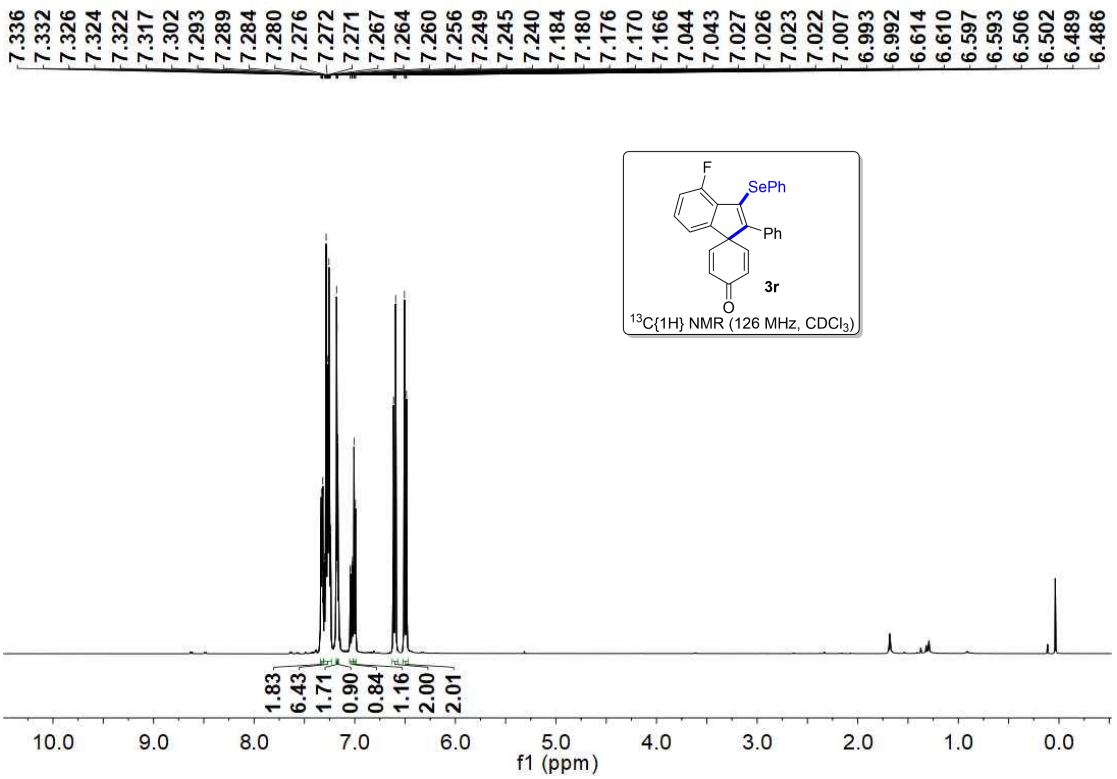

185.884
147.753
146.631
145.201
144.565
141.616
135.882
133.993
132.724
131.993
131.379
130.858
130.754
129.816
129.648
129.152
128.864
128.804
127.309
127.125
126.162
123.601
122.923
77.254
77.000
76.746
63.214
SePh
Cl
O
3o
^{13}C{1H} NMR (126 MHz, $CDCl_3$)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

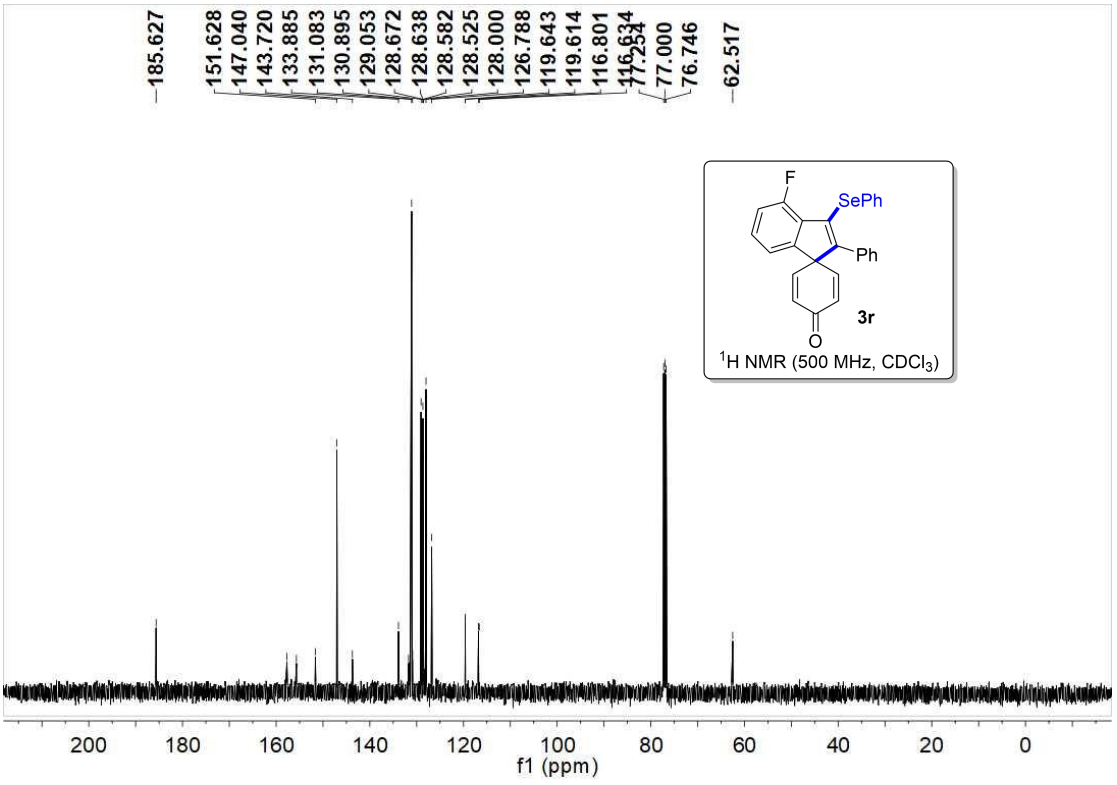

7.411
7.397
7.311
7.296
7.255
7.240
7.225
7.213
7.204
7.199
7.191
7.189
7.056
7.042
6.715
6.695
6.631
6.611
5.154
4.360
4.034
0.000
SePh
Fe
O
3p
^{1}H NMR (500 MHz, CDCl$_3$)
2.06
1.05
5.07
1.06
2.00
2.08
1.98
2.03
4.95
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

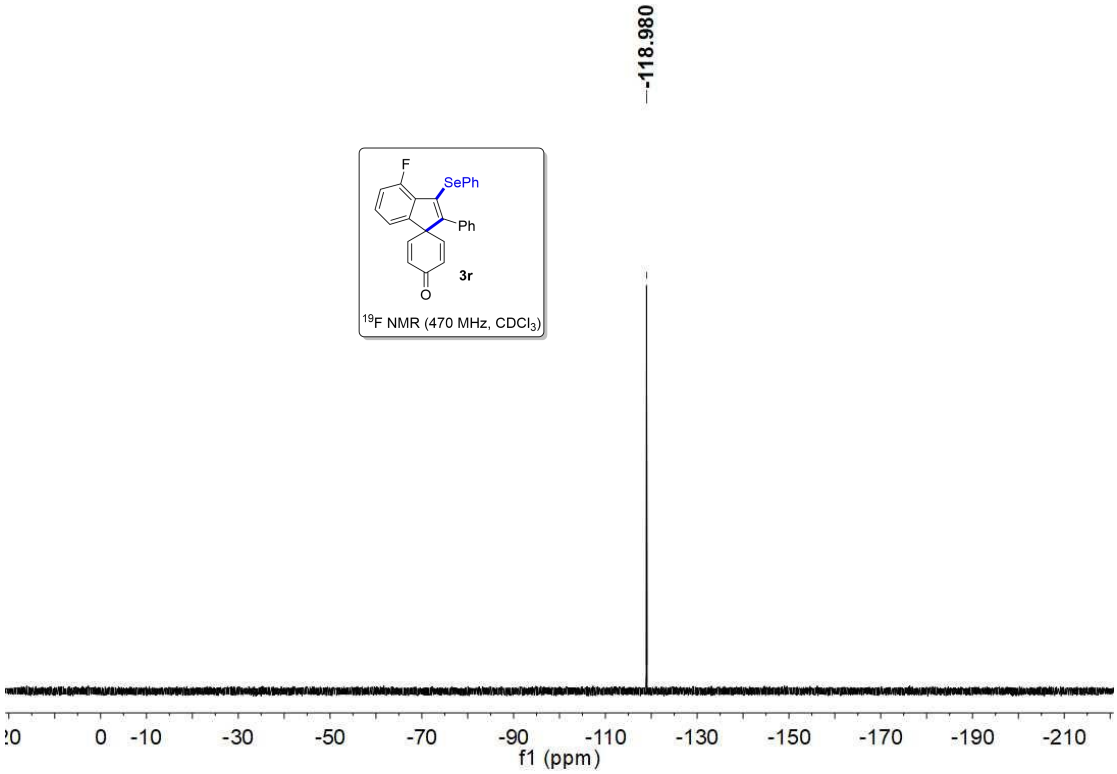

186.239
152.550
150.706
147.031
138.421
130.843
129.878
129.747
129.530
128.981
126.557
126.424
125.586
123.091
121.814
77.969
77.254
77.000
76.746
69.903
69.804
68.957
61.891
SePh
Fe
O
3p
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

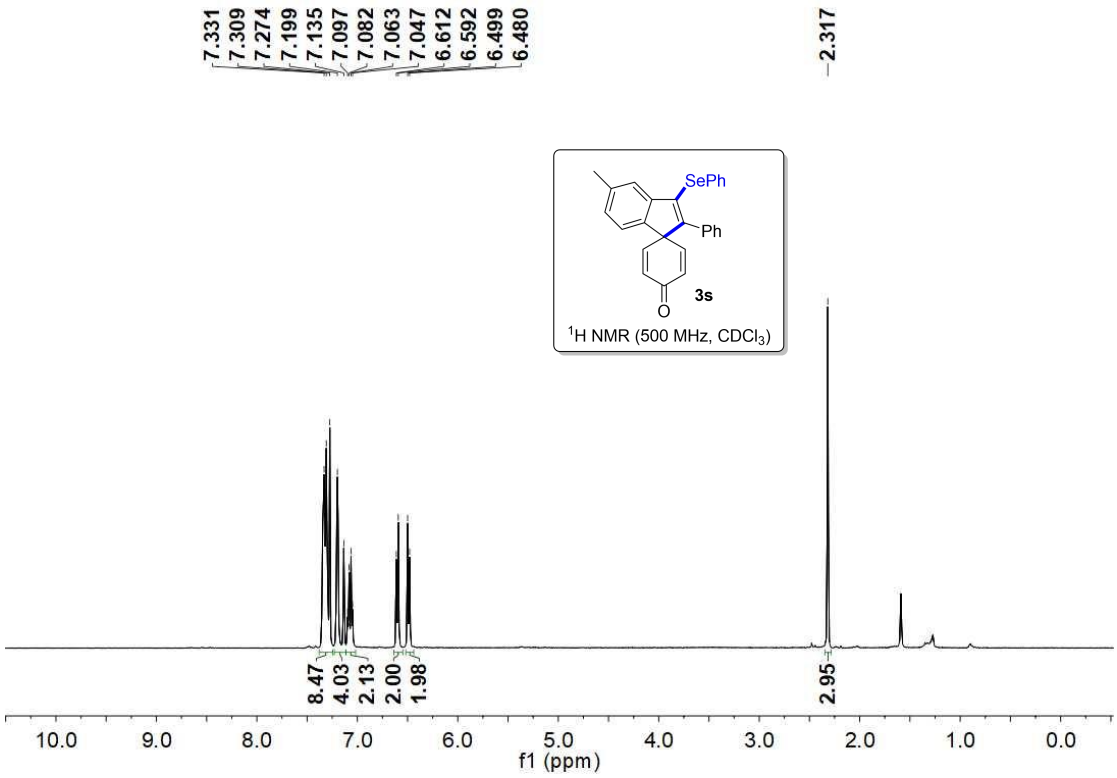

7.259
7.247
7.241
7.225
7.212
7.199
7.187
7.171
7.160
7.147
7.107
7.092
7.044
7.029
6.582
6.563
6.453
6.433
2.620
0.000
SePh
Ph
O
3q
^{1}H NMR (500 MHz, CDCl$_3$)
12.42
1.05
2.00
2.01
2.91
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

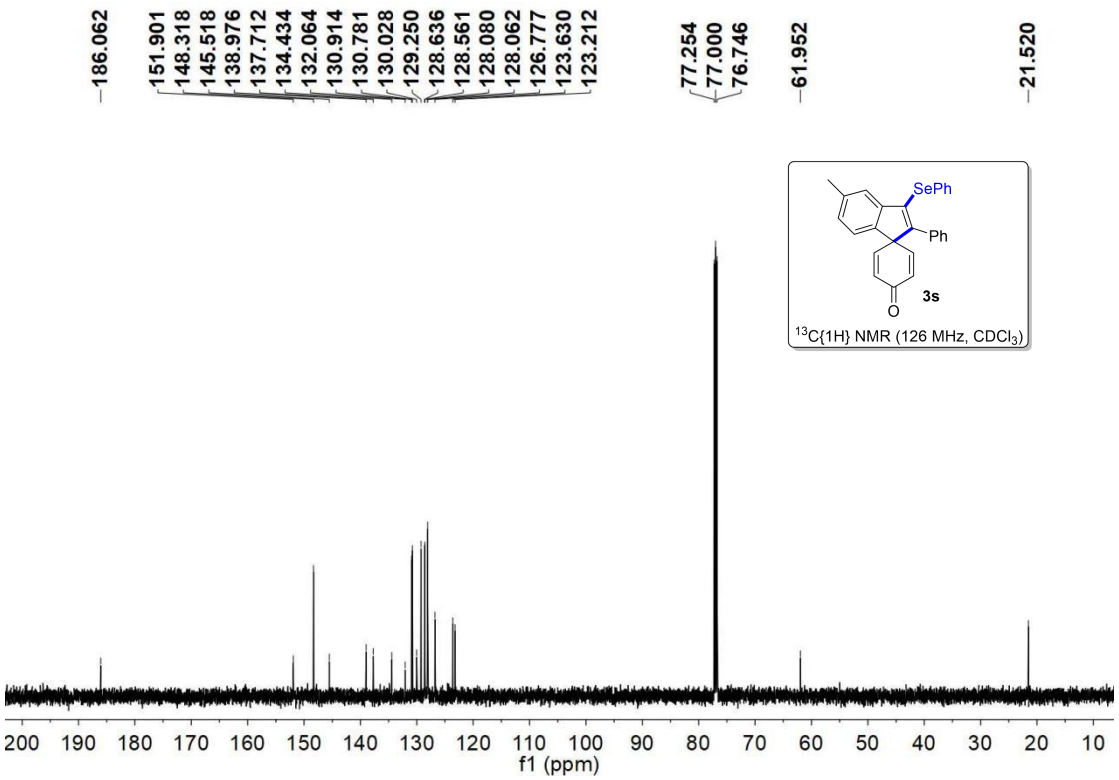

185.931
154.557
147.774
141.863
141.363
134.797
133.937
133.108
132.304
131.607
130.858
129.381
129.184
128.669
128.374
127.871
126.965
126.202
121.632
77.254
77.000
76.746
62.054
19.326
SePh
Ph
O
3q
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

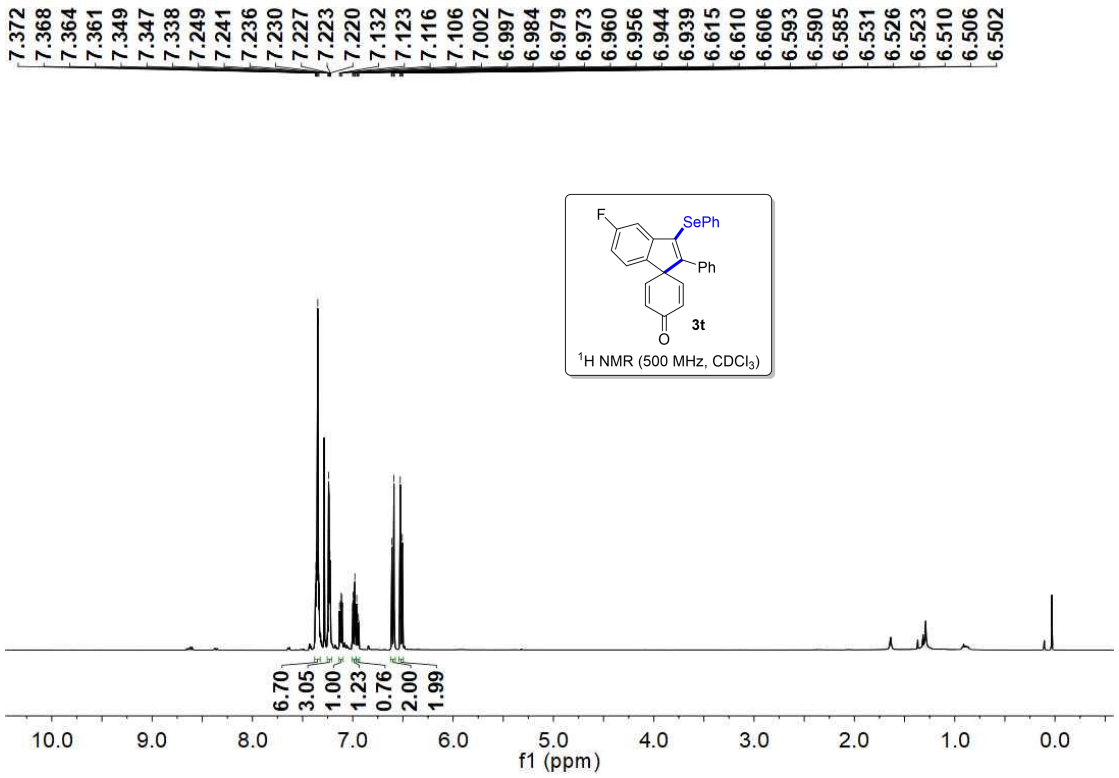

7.336
7.332
7.326
7.324
7.322
7.317
7.302
7.293
7.289
7.284
7.280
7.276
7.272
7.271
7.267
7.264
7.260
7.256
7.249
7.245
7.240
7.184
7.180
7.176
7.170
7.166
7.044
7.043
7.027
7.026
7.023
7.022
7.007
6.993
6.992
6.614
6.610
6.597
6.593
6.506
6.502
6.489
6.486
F
SePh
Ph
3r
O
13C{1H} NMR (126 MHz, CDCl3)
1.83
6.43
1.71
0.90
0.84
1.16
2.00
2.01
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

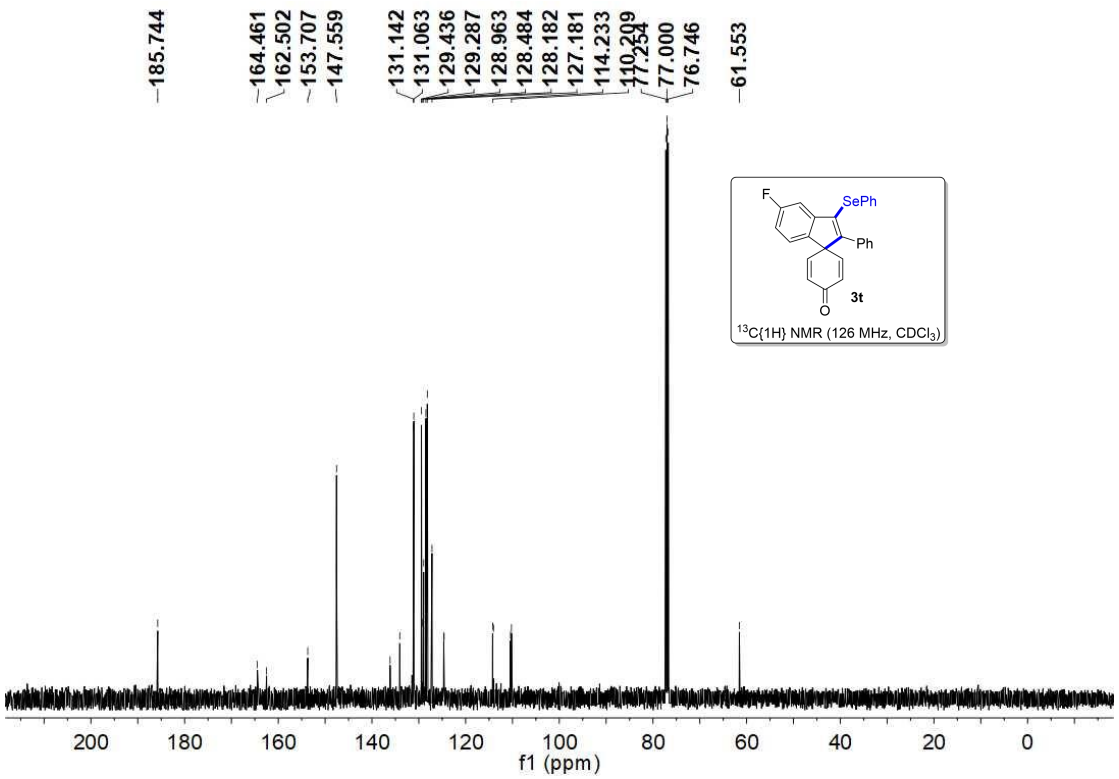

185.627
151.628
147.040
143.720
133.885
131.083
130.895
129.053
128.672
128.638
128.582
128.525
128.000
126.788
119.643
119.614
116.801
116.634
77.254
77.000
76.746
62.517
F
SePh
Ph
3r
O
1H NMR (500 MHz, CDCl3)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

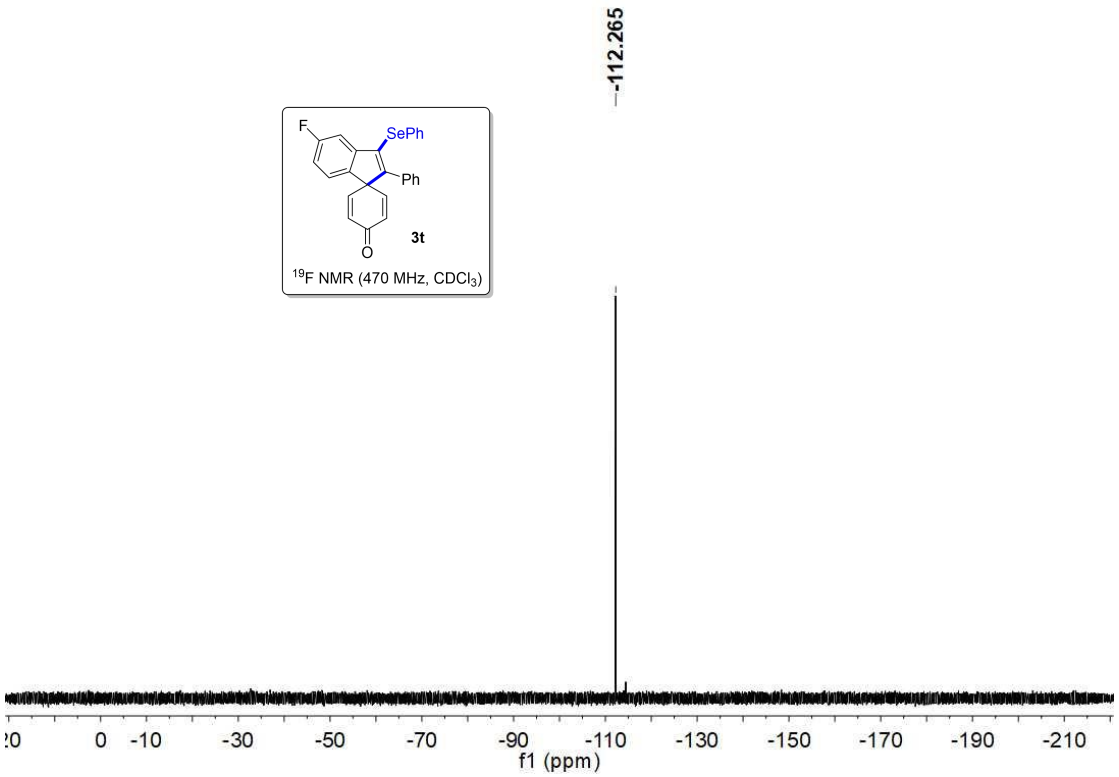

-118.980
F
SePh
Ph
3r
O
^{19}F NMR (470 MHz, CDCl$_3$)
0
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
f1 (ppm)

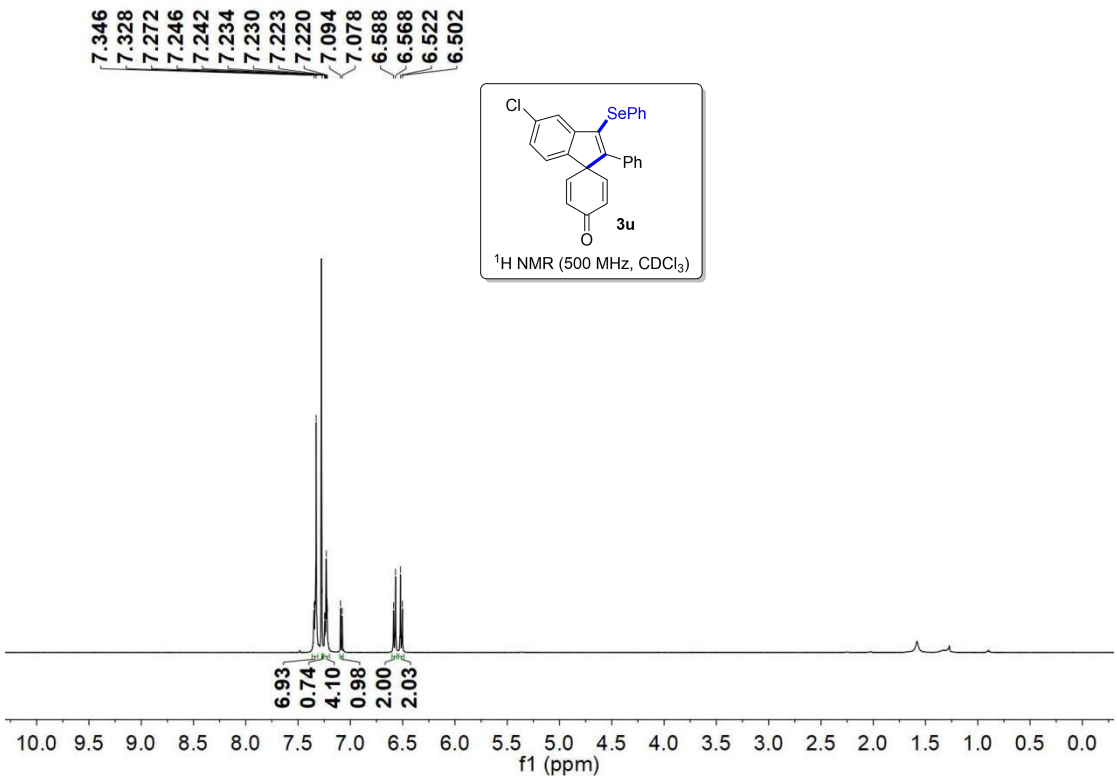

7.331
7.309
7.274
7.199
7.135
7.097
7.082
7.063
7.047
6.612
6.592
6.499
6.480
2.317
SePh
Ph
3s
O
^{1}H NMR (500 MHz, CDCl$_3$)
8.47
4.03
2.13
2.00
1.98
2.95
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

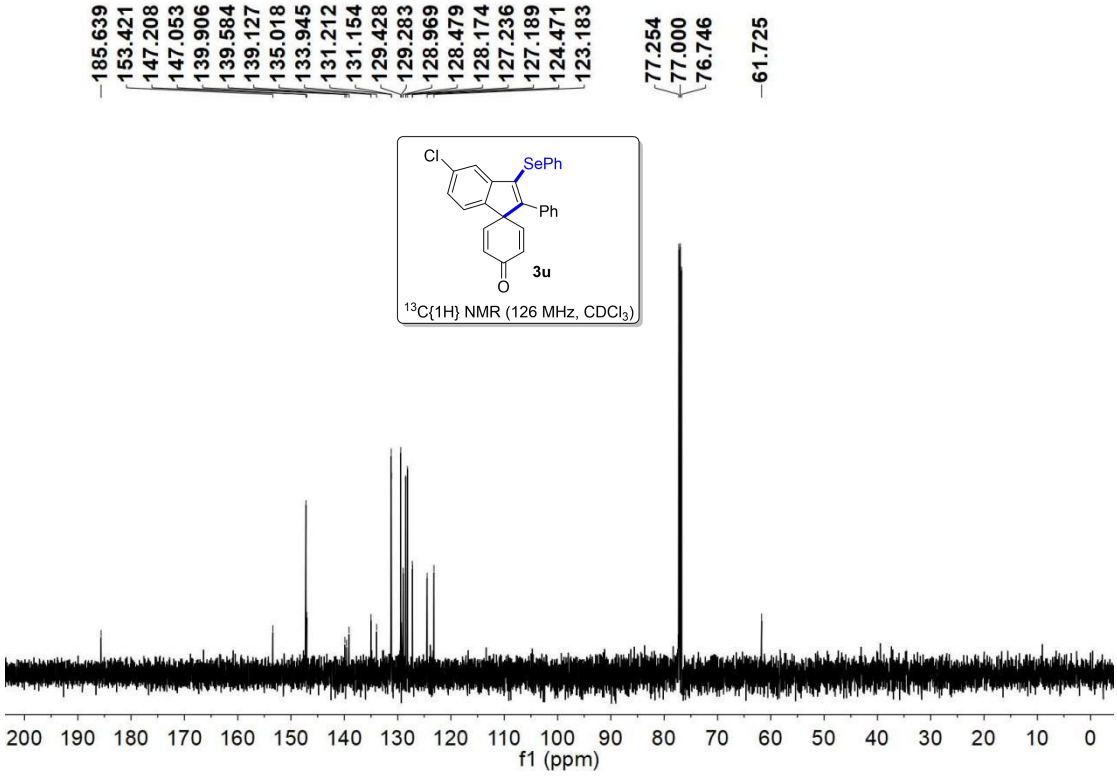

186.062
151.901
148.318
145.518
138.976
137.712
134.434
132.064
130.914
130.781
130.028
129.250
128.636
128.561
128.080
128.062
126.777
123.630
123.212
77.254
77.000
76.746
61.952
21.520
SePh
Ph
3s
O
13C{1H} NMR (126 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

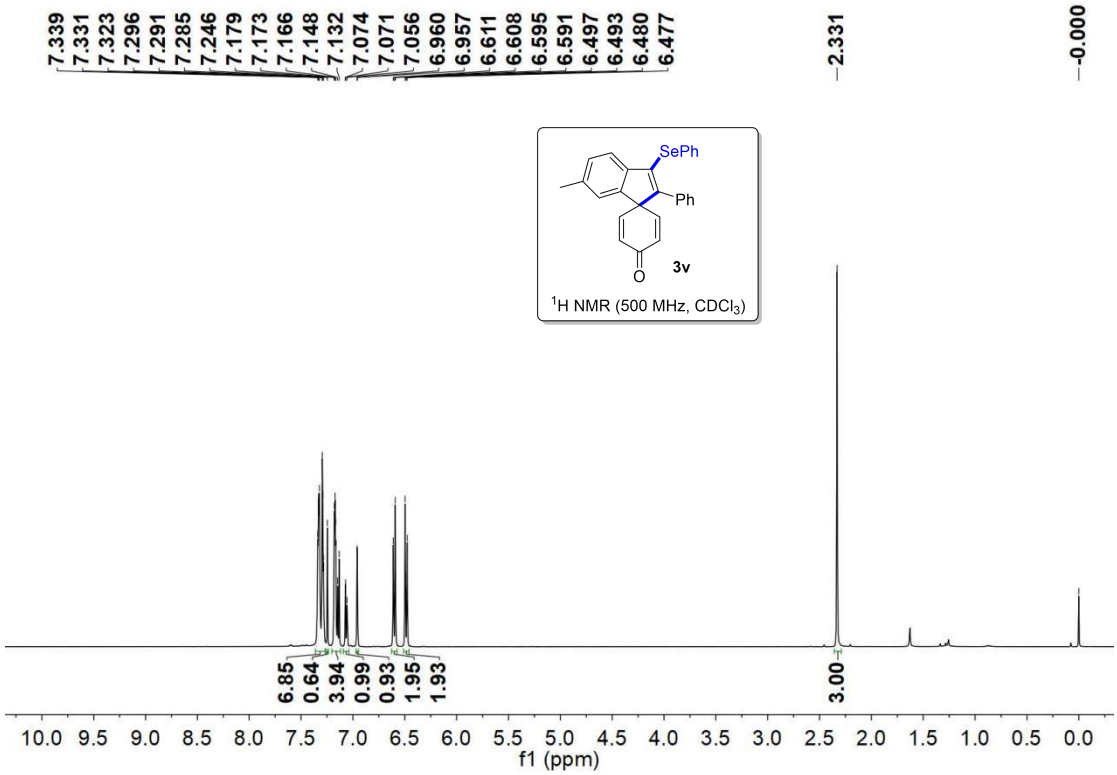

7.372
7.368
7.364
7.361
7.349
7.347
7.338
7.249
7.241
7.236
7.230
7.227
7.223
7.220
7.132
7.123
7.116
7.106
7.002
6.997
6.984
6.979
6.973
6.960
6.956
6.944
6.939
6.615
6.610
6.606
6.593
6.590
6.585
6.531
6.526
6.523
6.510
6.506
6.502
F
SePh
Ph
3t
O
1H NMR (500 MHz, CDCl3)
6.70
3.05
1.00
1.23
0.76
2.00
1.99
10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)

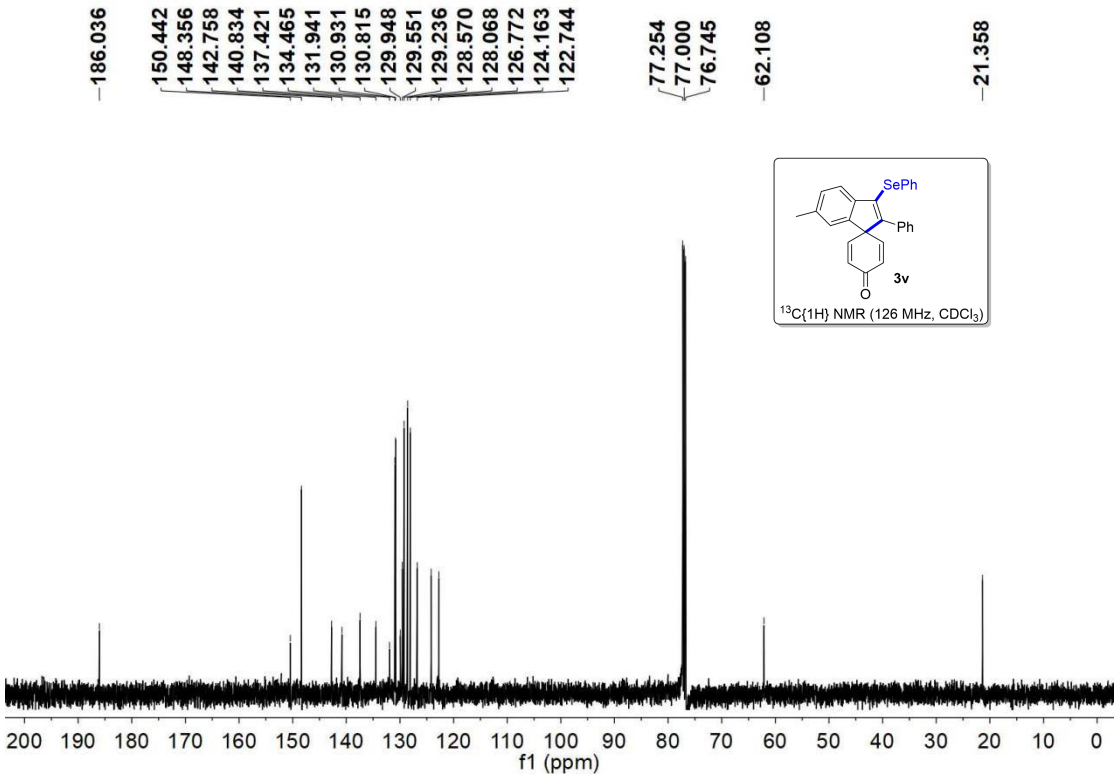

185.744
164.461
162.502
153.707
147.559
131.142
131.063
129.436
129.287
128.963
128.484
128.182
127.181
114.233
110.209
77.254
77.000
76.746
61.553
F
SePh
Ph
O
3t
$^{13}C\{1H\}$ NMR (126 MHz, $CDCl_3$)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

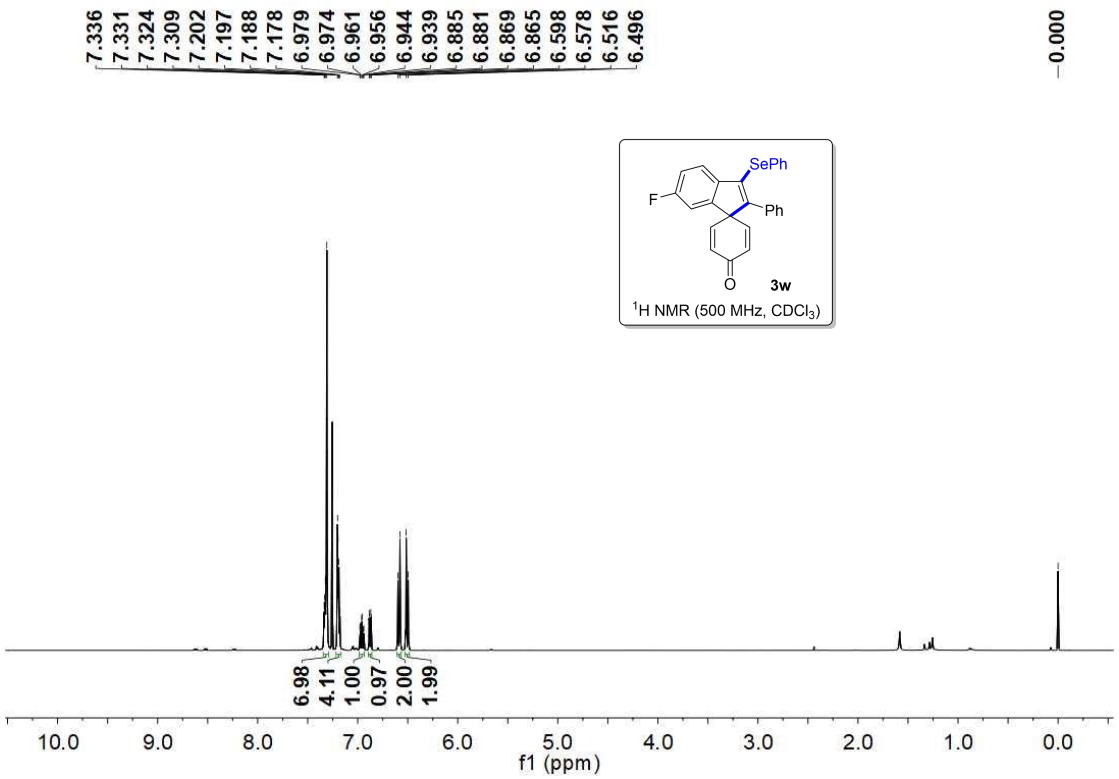

-112.265
F
SePh
Ph
O
3t
^{19}F NMR (470 MHz, $CDCl_3$)
0
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
f1 (ppm)

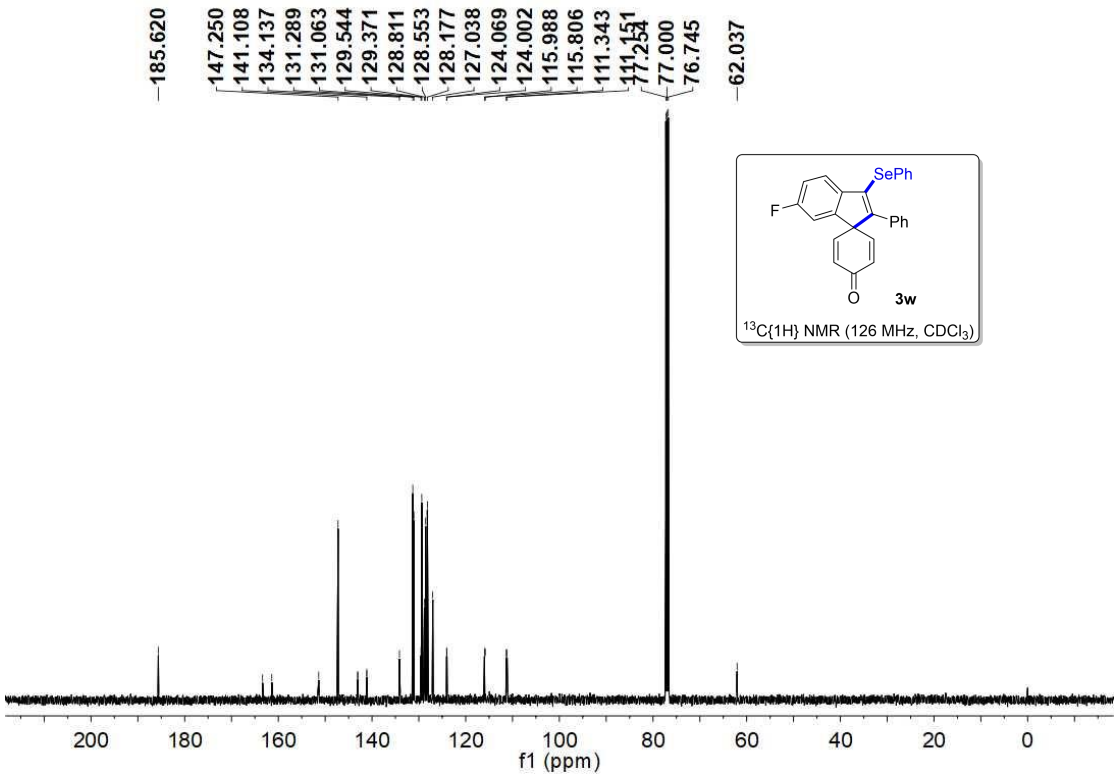

7.346
7.328
7.272
7.246
7.242
7.234
7.230
7.223
7.220
7.094
7.078
6.588
6.568
6.522
6.502
Cl
SePh
Ph
O
3u
^{1}H NMR (500 MHz, CDCl$_3$)
6.93
0.74
4.10
0.98
2.00
2.03
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

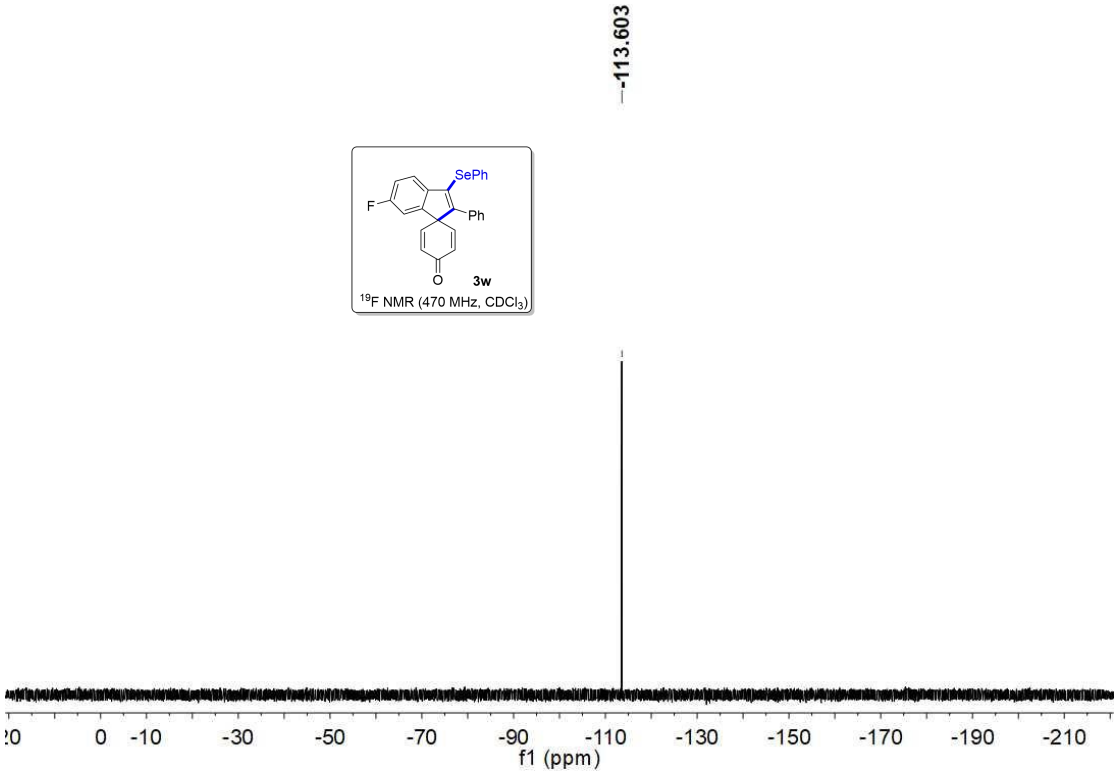

185.639
153.421
147.208
147.053
139.906
139.584
139.127
135.018
133.945
131.212
131.154
129.428
129.283
128.969
128.479
128.174
127.236
127.189
124.471
123.183
77.254
77.000
76.746
61.725
Cl
SePh
Ph
O
3u
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

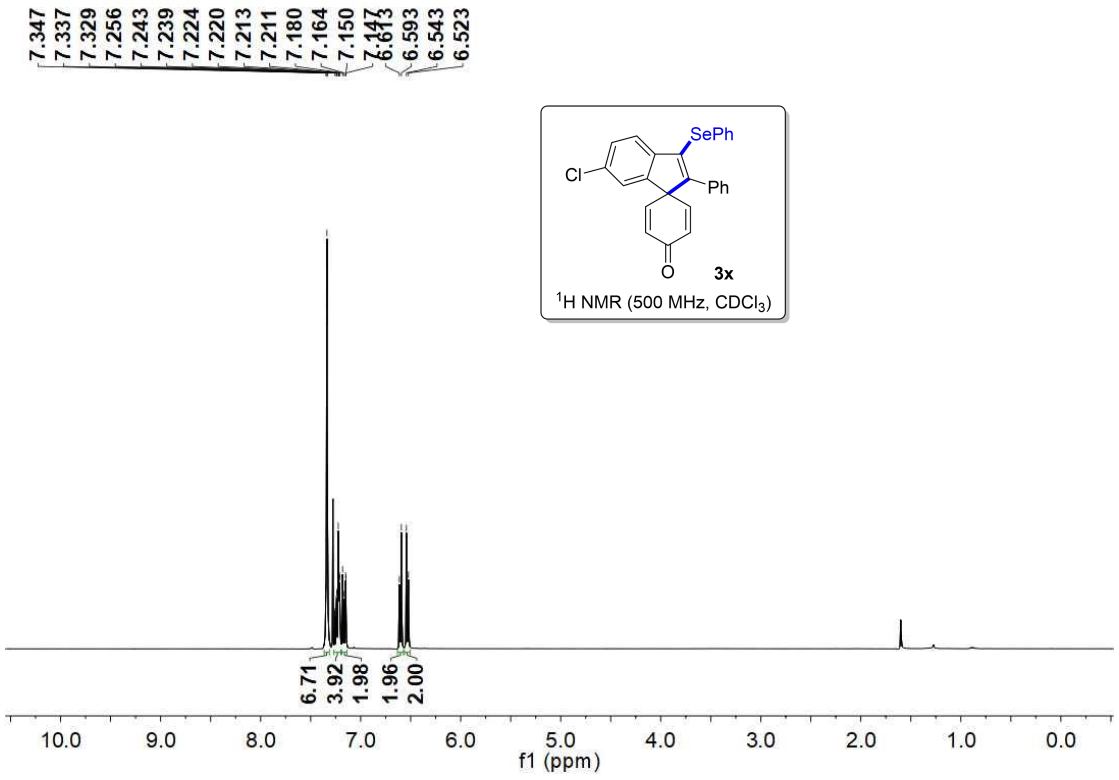

7.339
7.331
7.323
7.296
7.291
7.285
7.246
7.179
7.173
7.166
7.148
7.132
7.074
7.071
7.056
6.960
6.957
6.611
6.608
6.595
6.591
6.497
6.493
6.480
6.477
2.331
0.000
SePh
Ph
O
3v
^{1}H NMR (500 MHz, CDCl$_3$)
6.85
0.64
3.94
0.99
0.93
1.95
1.93
3.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

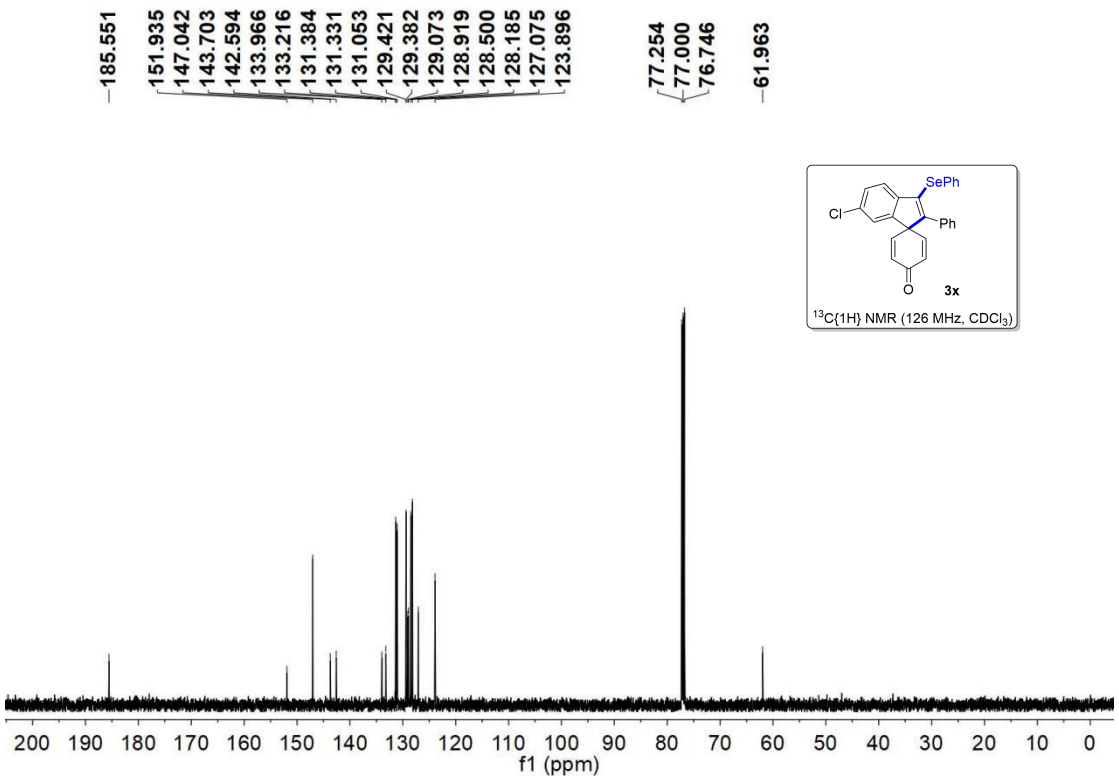

186.036
150.442
148.356
142.758
140.834
137.421
134.465
131.941
130.931
130.815
129.948
129.551
129.236
128.570
128.068
126.772
124.163
122.744
77.254
77.000
76.745
62.108
21.358
SePh
Ph
O
3v
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

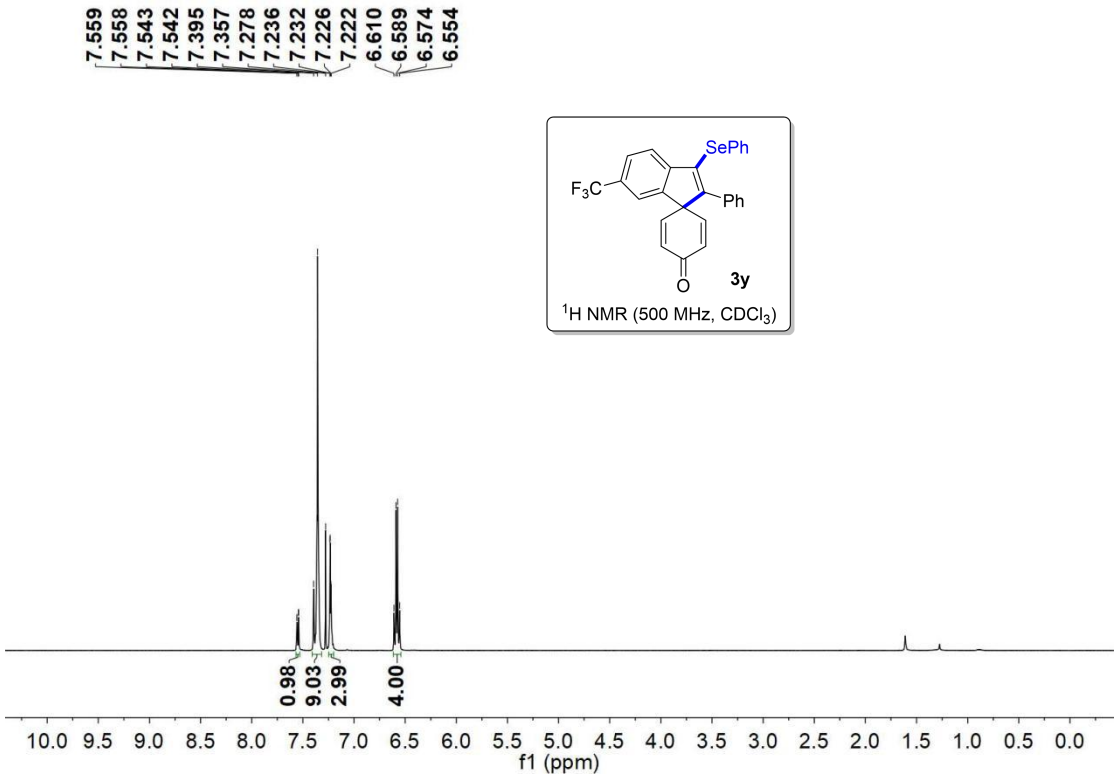

7.336
7.331
7.324
7.309
7.202
7.197
7.188
7.178
6.979
6.974
6.961
6.956
6.944
6.939
6.885
6.881
6.869
6.865
6.598
6.578
6.516
6.496
0.000
SePh
F
Ph
O
3w
1H NMR (500 MHz, CDCl3)
6.98
4.11
1.00
0.97
2.00
1.99
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

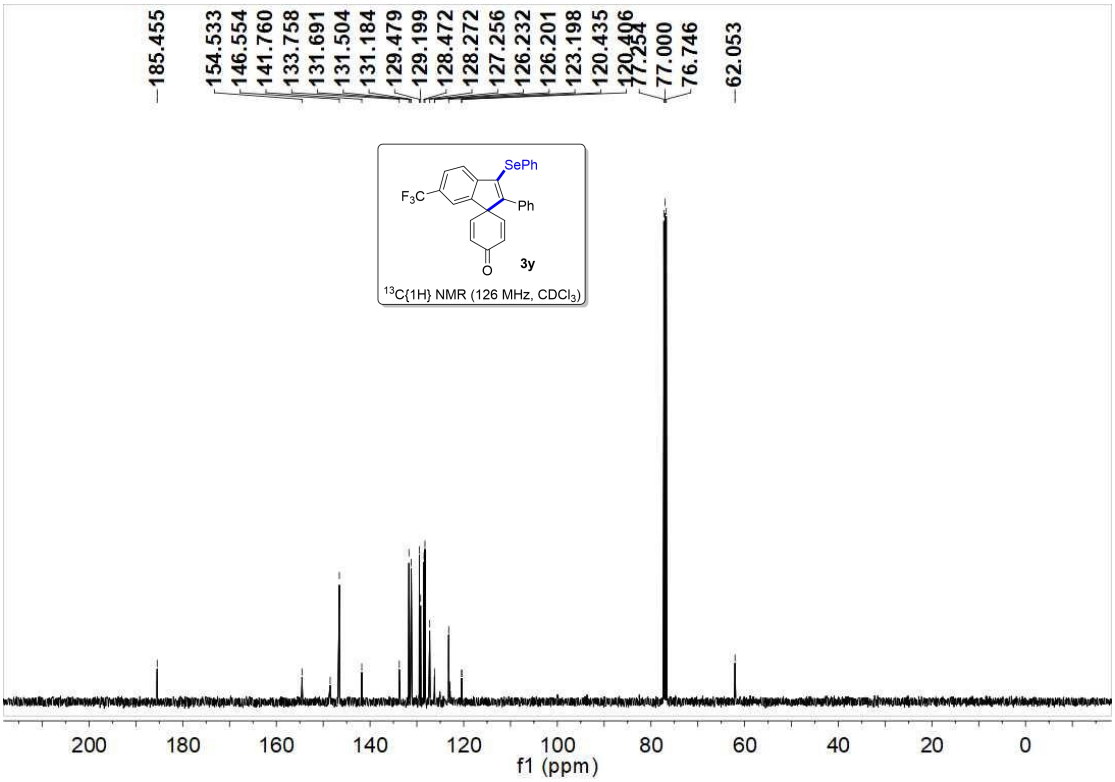

185.620
147.250
141.108
134.137
131.289
131.063
129.544
129.371
128.811
128.553
128.177
127.038
124.069
124.002
115.988
115.806
111.343
111.151
77.254
77.000
76.745
62.037
SePh
F
Ph
O
3w
13C{1H} NMR (126 MHz, CDCl3)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

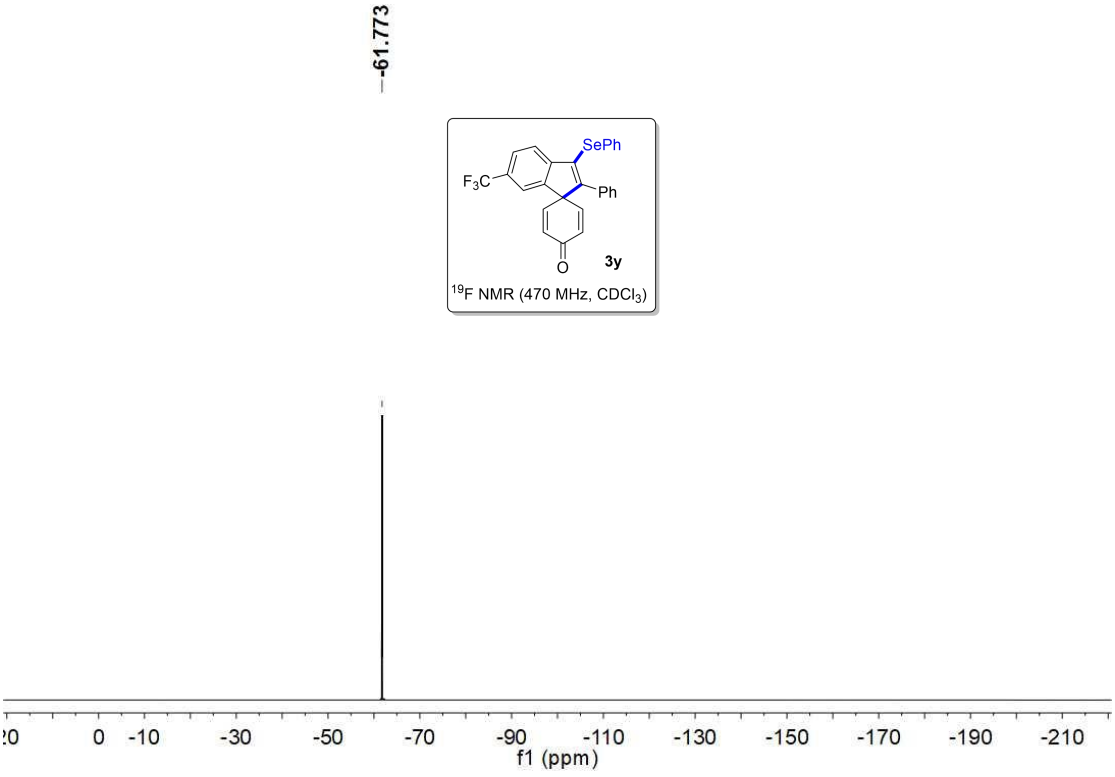

-113.603
SePh
F
Ph
O
3w
^{19}F NMR (470 MHz, CDCl$_3$)
0
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
f1 (ppm)

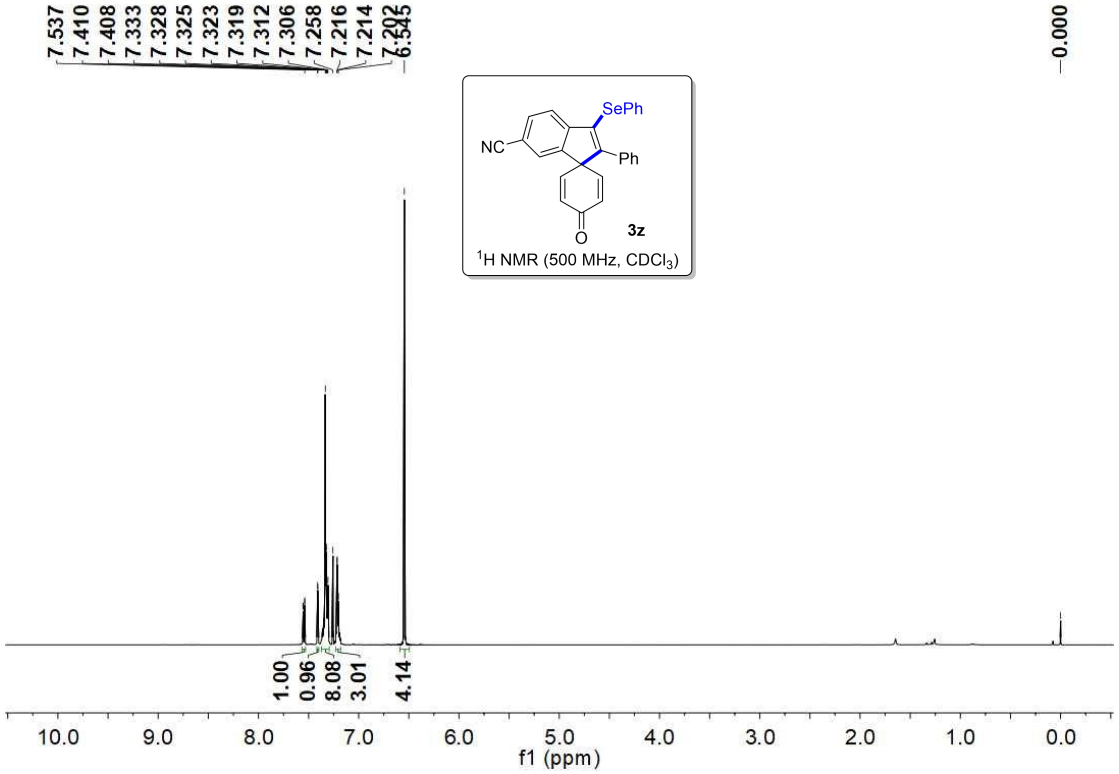

7.347
7.337
7.329
7.256
7.243
7.239
7.224
7.220
7.213
7.211
7.180
7.164
7.150
7.147
6.613
6.593
6.543
6.523
SePh
Cl
Ph
O
3x
^{1}H NMR (500 MHz, CDCl$_3$)
6.71
3.92
1.98
1.96
2.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

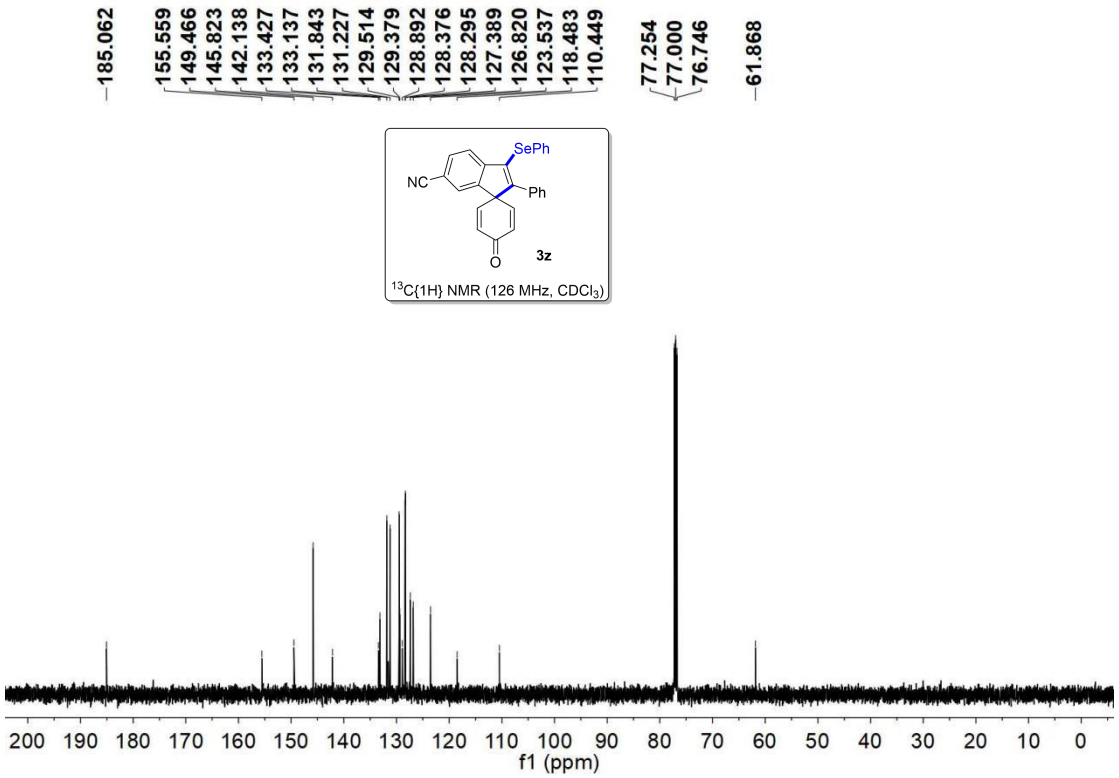

185.551
151.935
147.042
143.703
142.594
133.966
133.216
131.384
131.331
131.053
129.421
129.382
129.073
128.919
128.500
128.185
127.075
123.896
77.254
77.000
76.746
61.963
SePh
Cl
Ph
O
3x
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

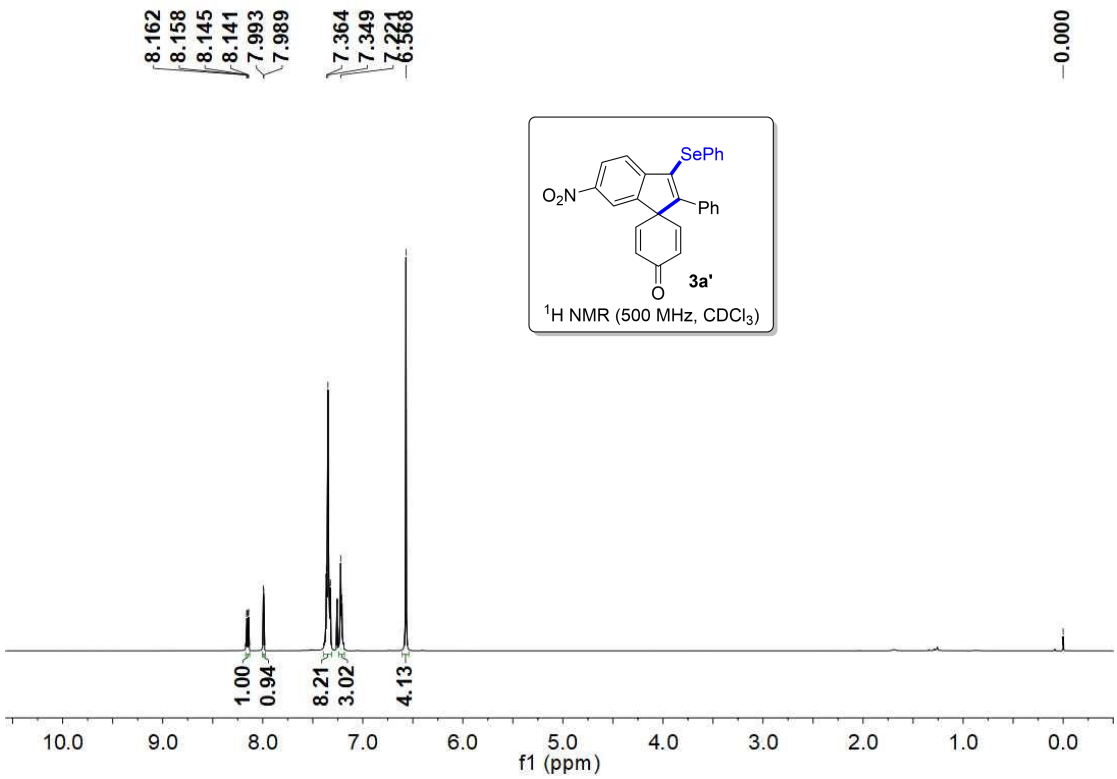

7.559
7.558
7.543
7.542
7.395
7.357
7.278
7.236
7.232
7.226
7.222
6.610
6.589
6.574
6.554
SePh
F$_3$C
Ph
O
3y
^{1}H NMR (500 MHz, CDCl$_3$)
0.98
9.03
2.99
4.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

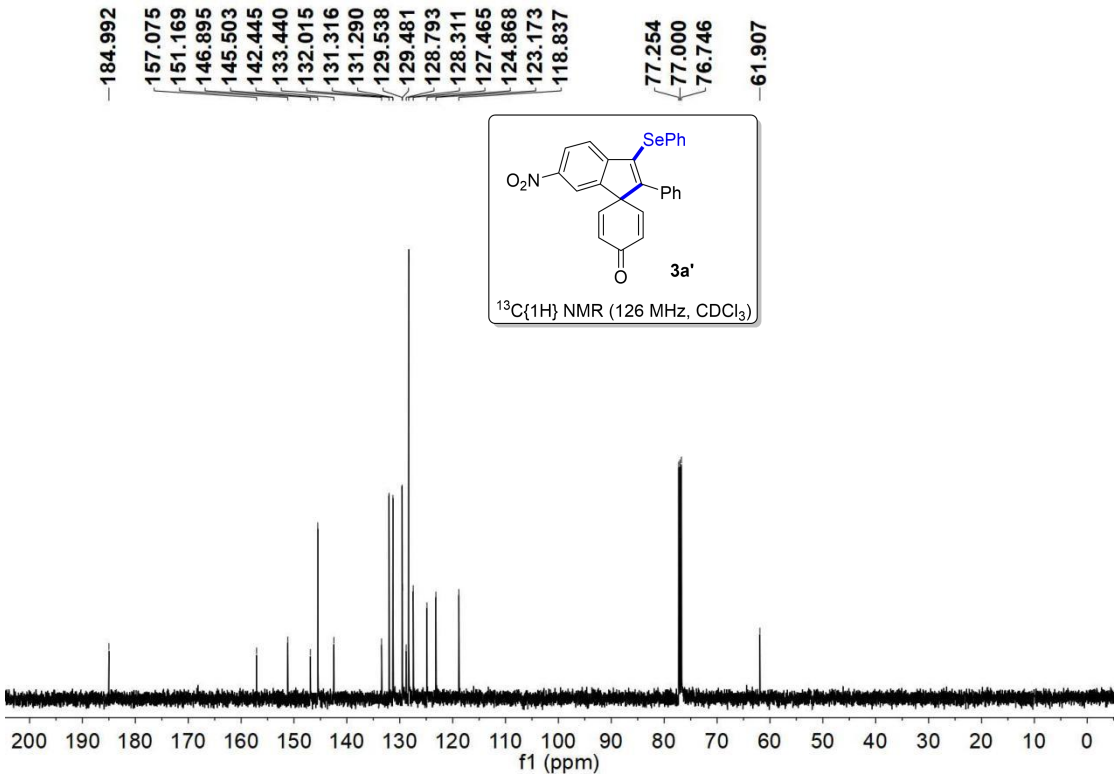

185.455
154.533
146.554
141.760
133.758
131.691
131.504
131.184
129.479
129.199
128.472
128.272
127.256
126.232
126.201
123.198
120.435
120.406
77.254
77.000
76.746
62.053
SePh
F3C
Ph
O
3y
13C{1H} NMR (126 MHz, CDCl3)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

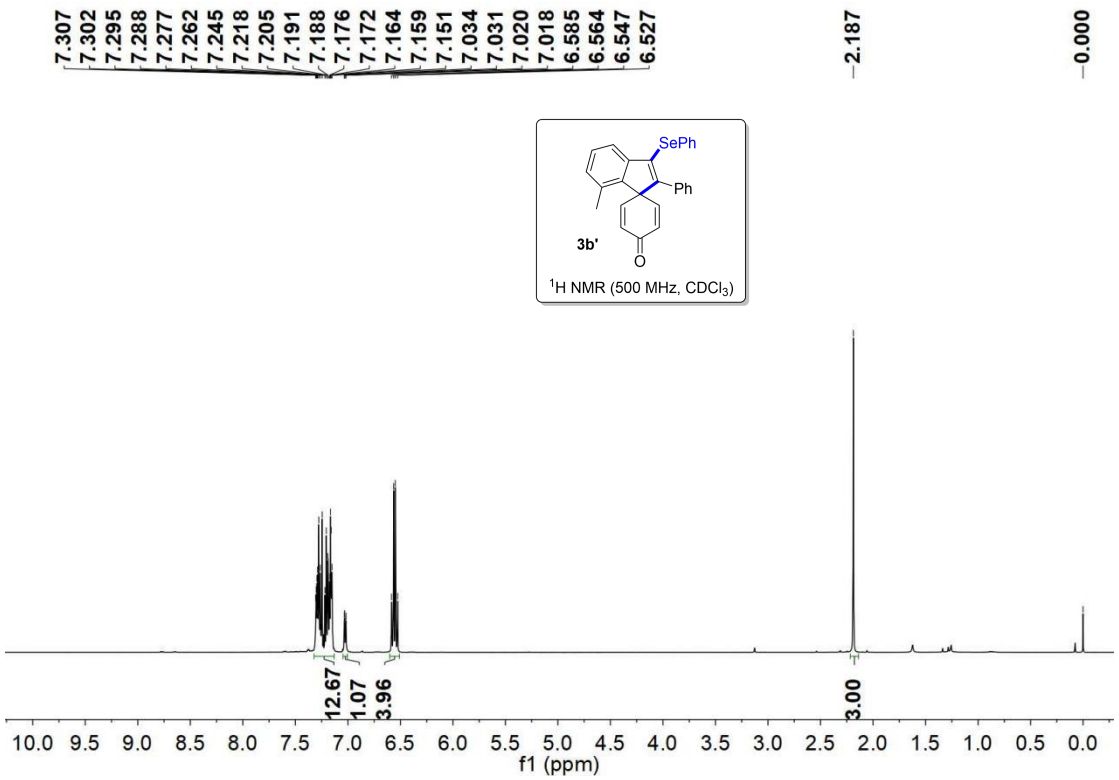

-61.773
SePh
F3C
Ph
O
3y
19F NMR (470 MHz, CDCl3)
0
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
f1 (ppm)

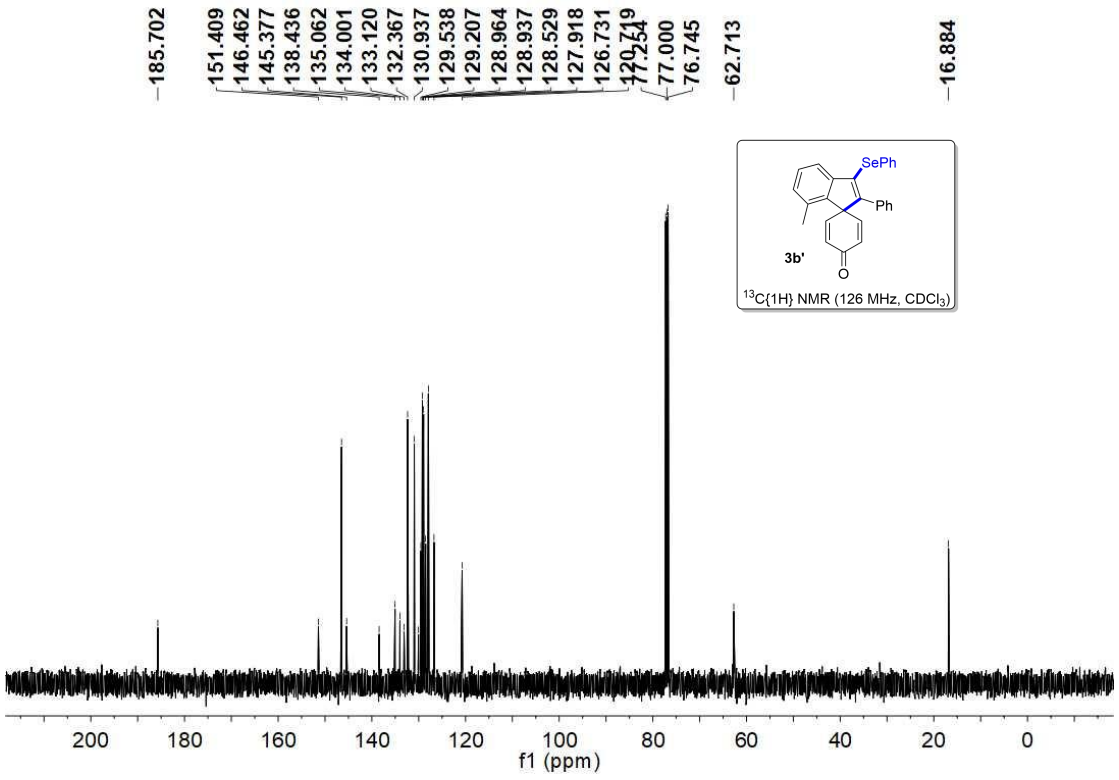

7.537
7.410
7.408
7.333
7.328
7.325
7.323
7.319
7.312
7.306
7.258
7.216
7.214
7.202
6.545
0.000
SePh
NC
Ph
O
3z
^{1}H NMR (500 MHz, CDCl$_3$)
1.00
0.96
8.08
3.01
4.14
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

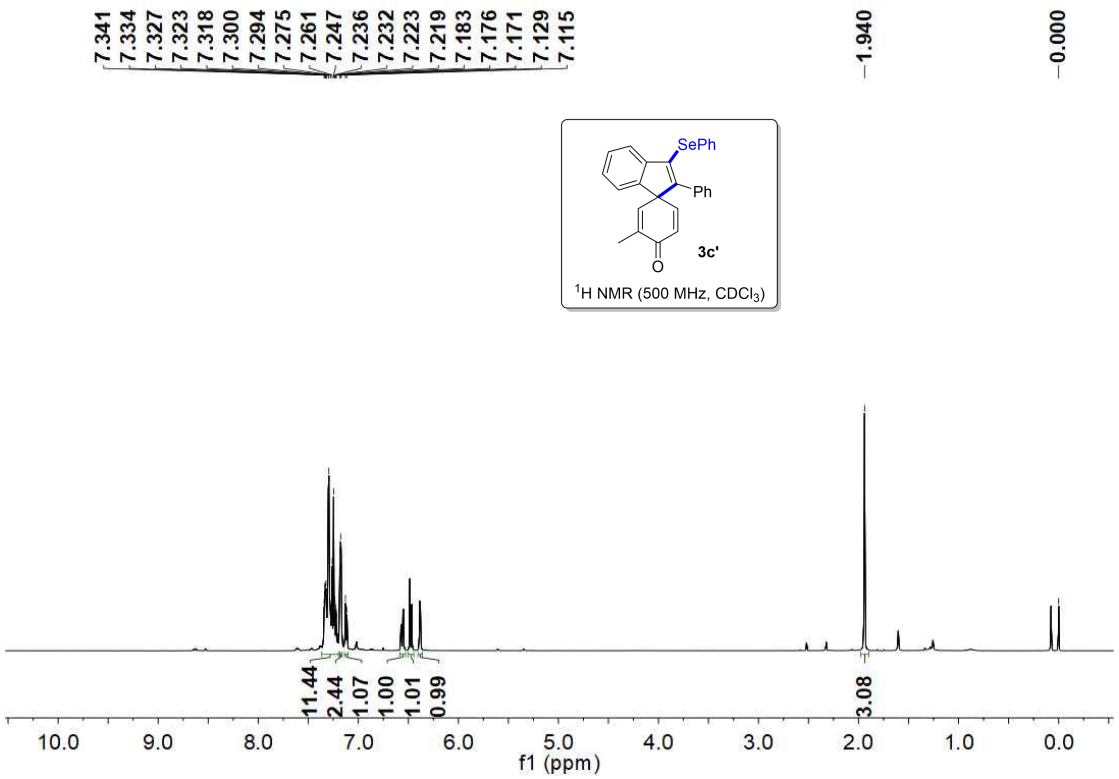

185.062
155.559
149.466
145.823
142.138
133.427
133.137
131.843
131.227
129.514
129.379
128.892
128.376
128.295
127.389
126.820
123.537
118.483
110.449
77.254
77.000
76.746
61.868
SePh
NC
Ph
O
3z
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

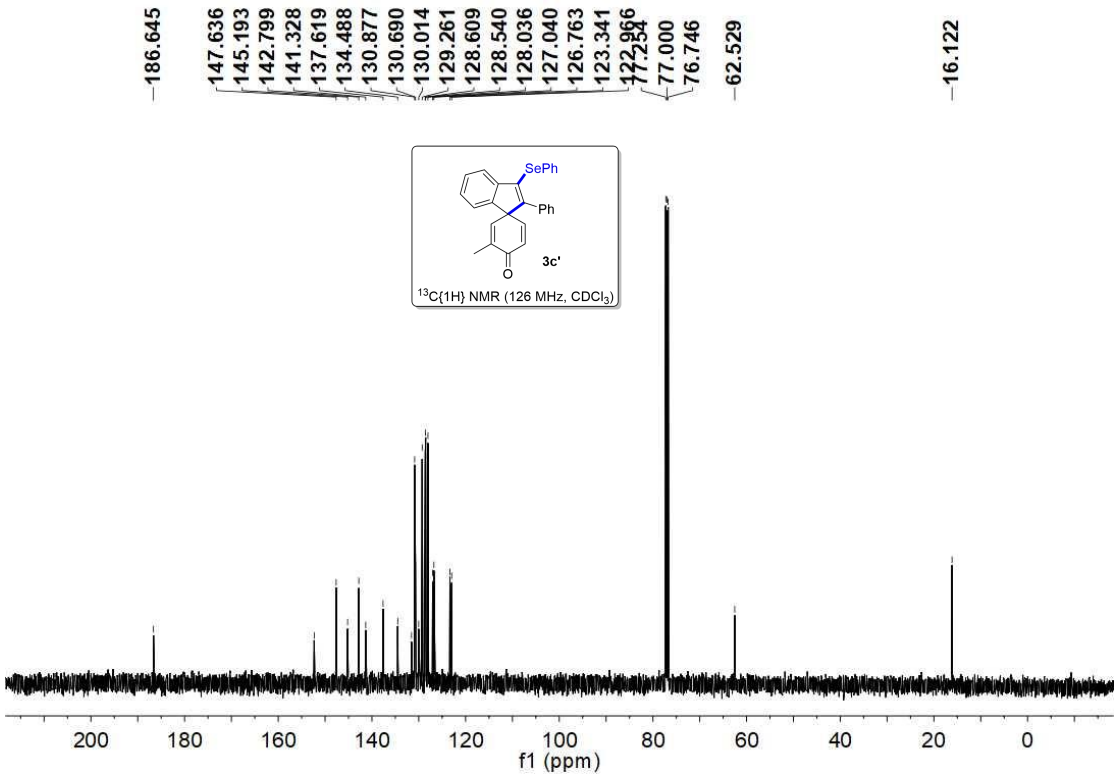

8.162
8.158
8.145
8.141
7.993
7.989
7.364
7.349
7.221
6.568
0.000
SePh
O2N
Ph
O
3a'
1H NMR (500 MHz, CDCl3)
1.00
0.94
8.21
3.02
4.13
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

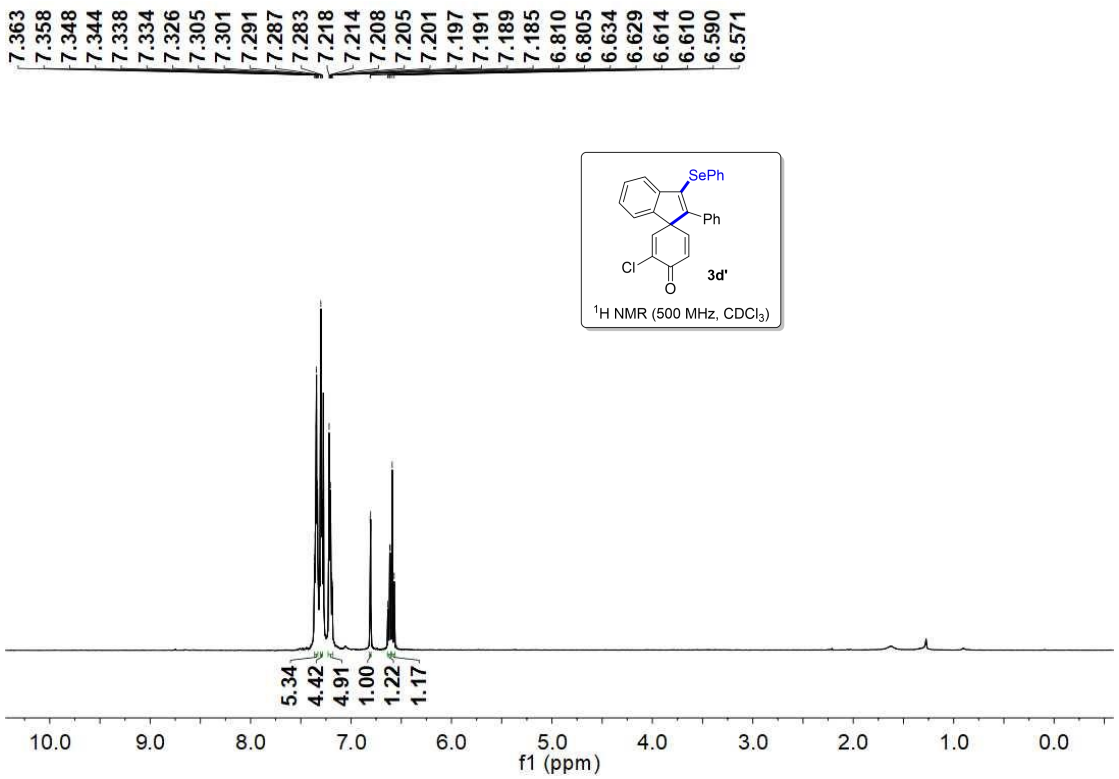

184.992
157.075
151.169
146.895
145.503
142.445
133.440
132.015
131.316
131.290
129.538
129.481
128.793
128.311
127.465
124.868
123.173
118.837
77.254
77.000
76.746
61.907
SePh
O2N
Ph
O
3a'
13C{1H} NMR (126 MHz, CDCl3)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

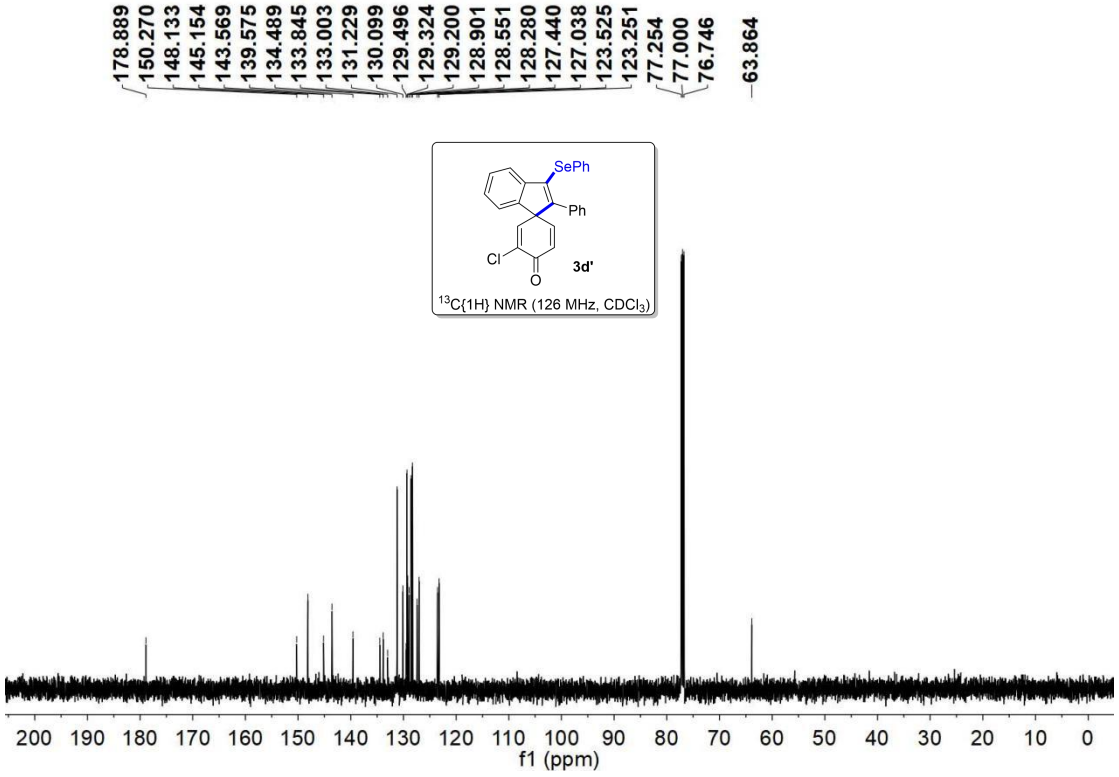

7.307
7.302
7.295
7.288
7.277
7.262
7.245
7.218
7.205
7.191
7.188
7.176
7.172
7.164
7.159
7.151
7.034
7.031
7.020
7.018
6.585
6.564
6.547
6.527
2.187
0.000
SePh
Ph
3b'
O
1H NMR (500 MHz, CDCl3)
12.67
1.07
3.96
3.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

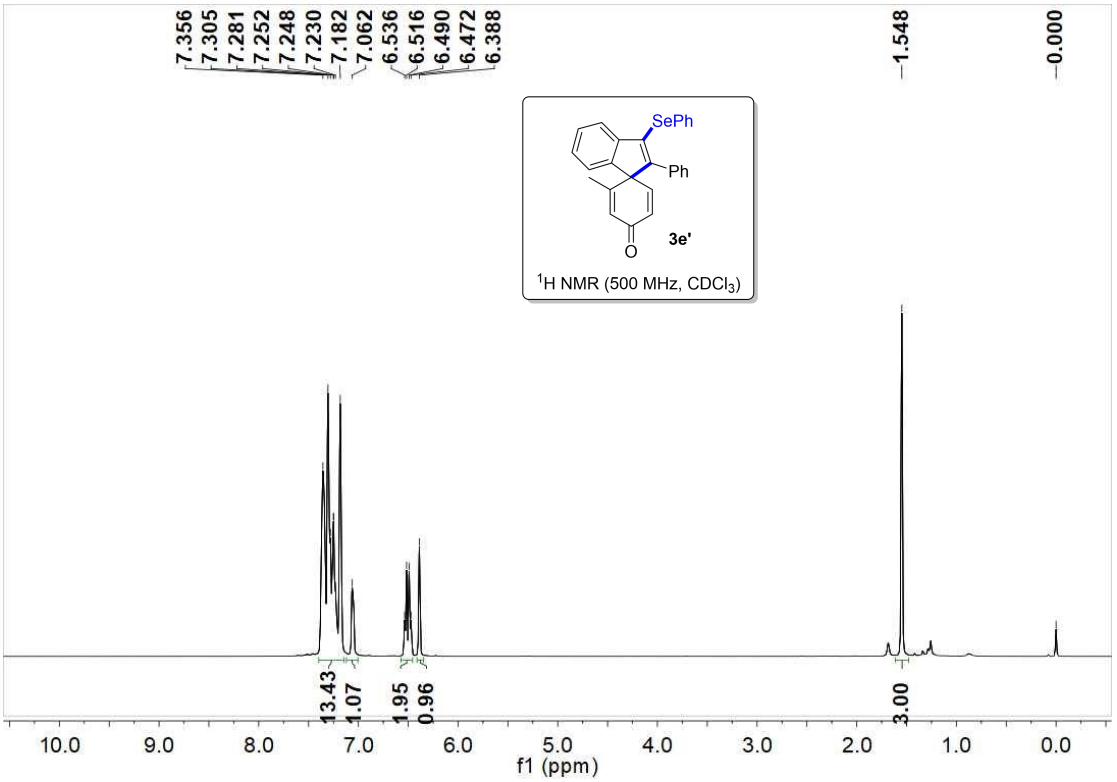

185.702
151.409
146.462
145.377
138.436
135.062
134.001
133.120
132.367
130.937
129.538
129.207
128.964
128.937
128.529
127.918
126.731
120.719
77.254
77.000
76.745
62.713
16.884
SePh
Ph
3b'
O
13C{1H} NMR (126 MHz, CDCl3)
200 180 160 140 120 100 80 60 40 20 0
f1 (ppm)

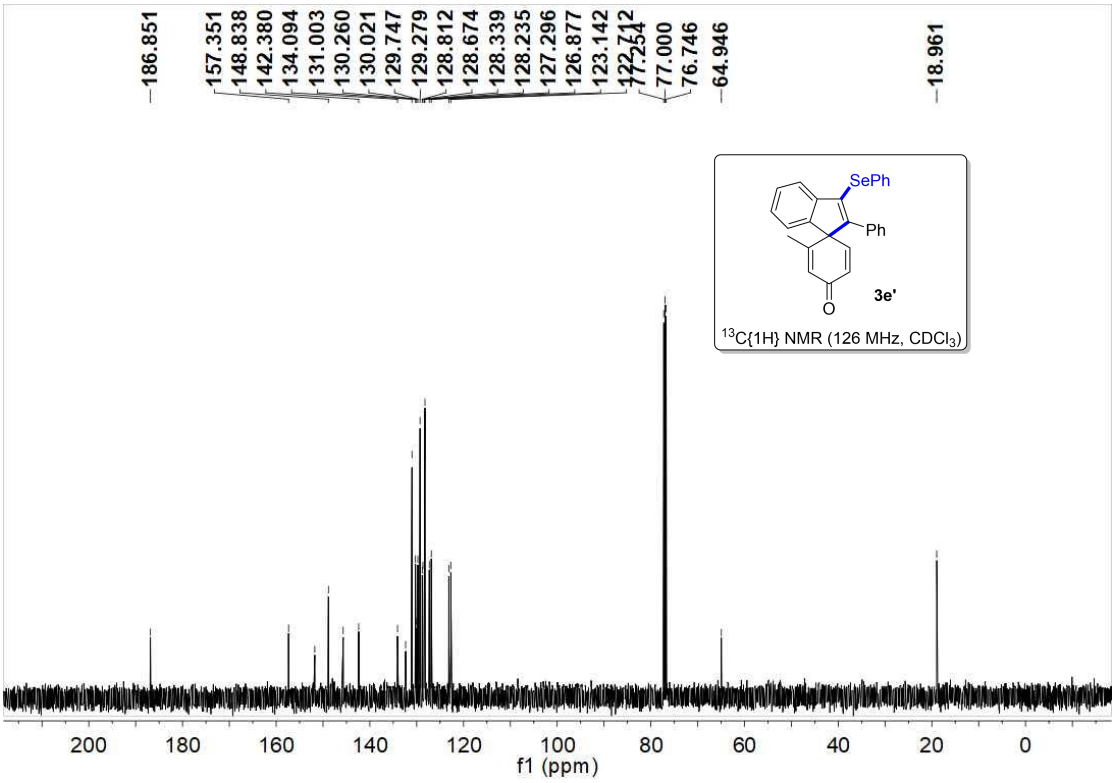

7.341
7.334
7.327
7.323
7.318
7.300
7.294
7.275
7.261
7.247
7.236
7.232
7.223
7.219
7.183
7.176
7.171
7.129
7.115
1.940
0.000
SePh
Ph
O
3c'
^{1}H NMR (500 MHz, CDCl$_3$)
11.44
2.44
1.07
1.00
1.01
0.99
3.08
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

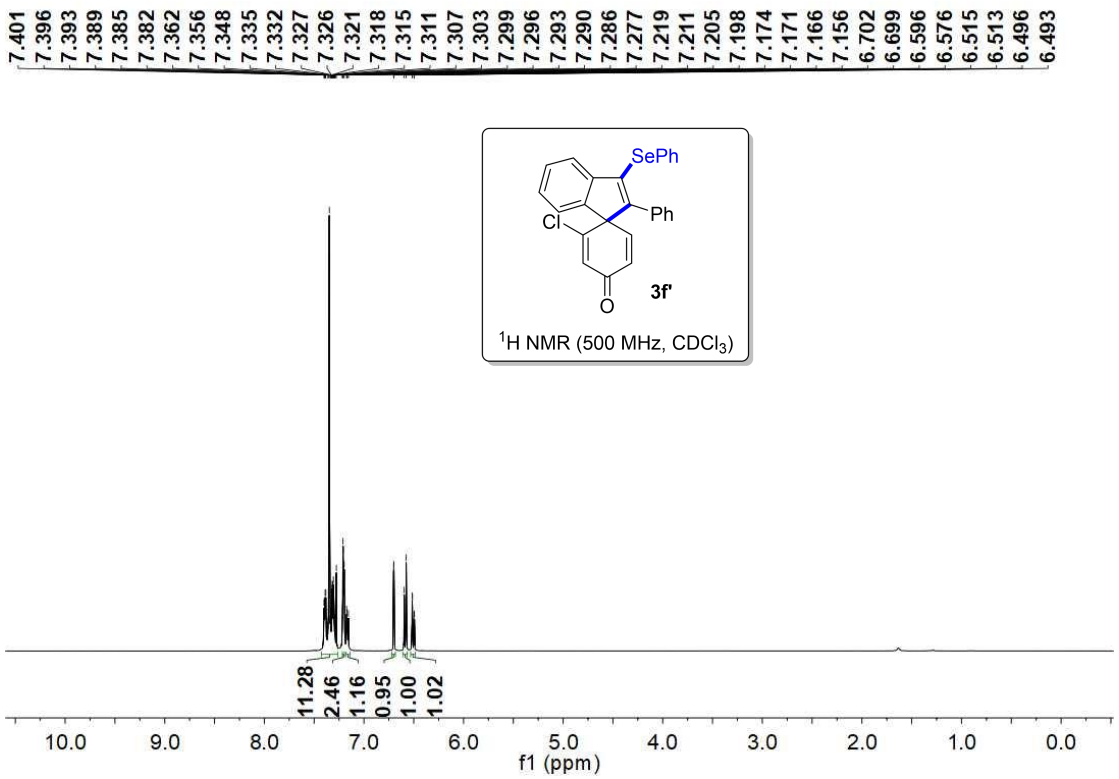

186.645
147.636
145.193
142.799
141.328
137.619
134.488
130.877
130.690
130.014
129.261
128.609
128.540
128.036
127.040
126.763
123.341
122.966
77.254
77.000
76.746
62.529
16.122
SePh
Ph
O
3c'
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

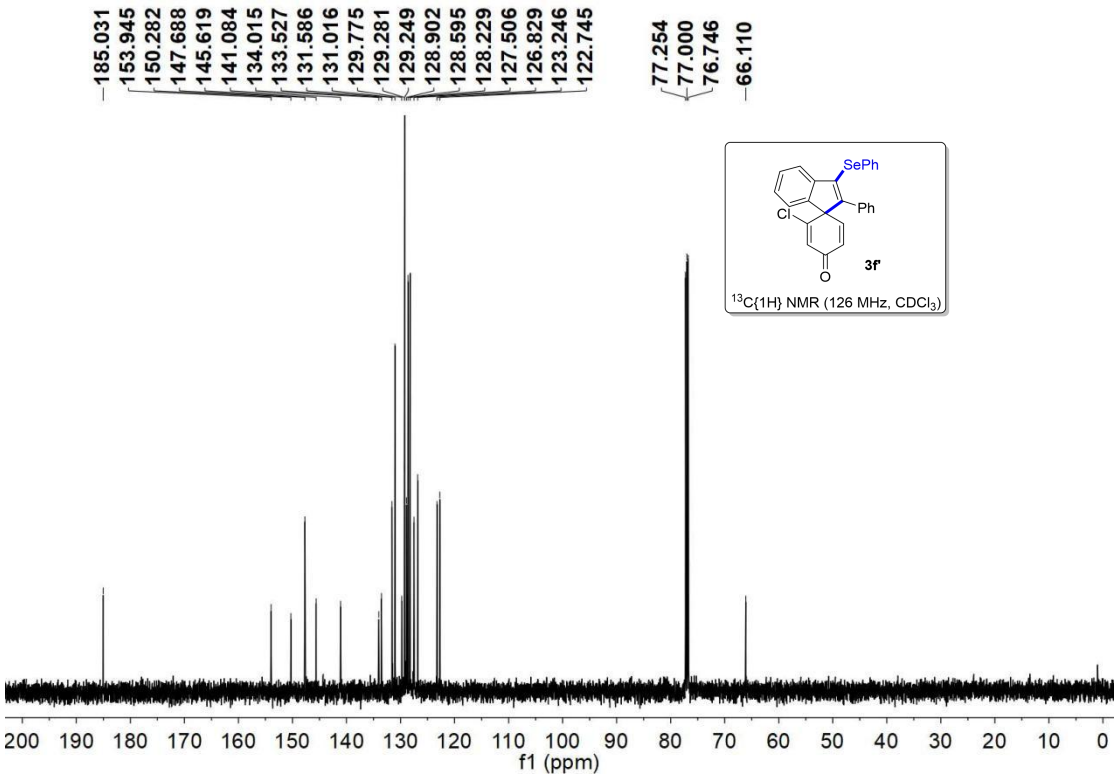

7.363
7.358
7.348
7.344
7.338
7.334
7.326
7.305
7.301
7.291
7.287
7.283
7.218
7.214
7.208
7.205
7.201
7.197
7.191
7.189
7.185
6.810
6.805
6.634
6.629
6.614
6.610
6.590
6.571
SePh
Ph
Cl
O
3d'
^{1}H NMR (500 MHz, CDCl$_3$)
5.34
4.42
4.91
1.00
1.22
1.17
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

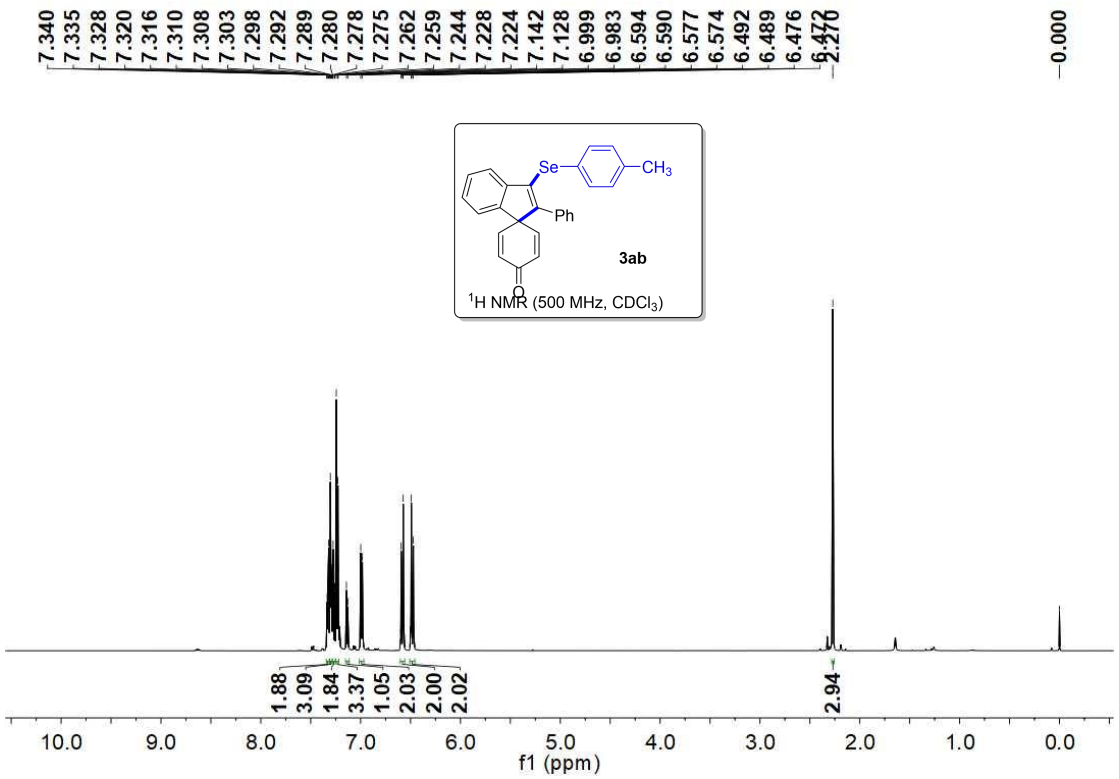

178.889
150.270
148.133
145.154
143.569
139.575
134.489
133.845
133.003
131.229
130.099
129.496
129.324
129.200
128.901
128.551
128.280
127.440
127.038
123.525
123.251
77.254
77.000
76.746
63.864
SePh
Ph
Cl
O
3d'
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

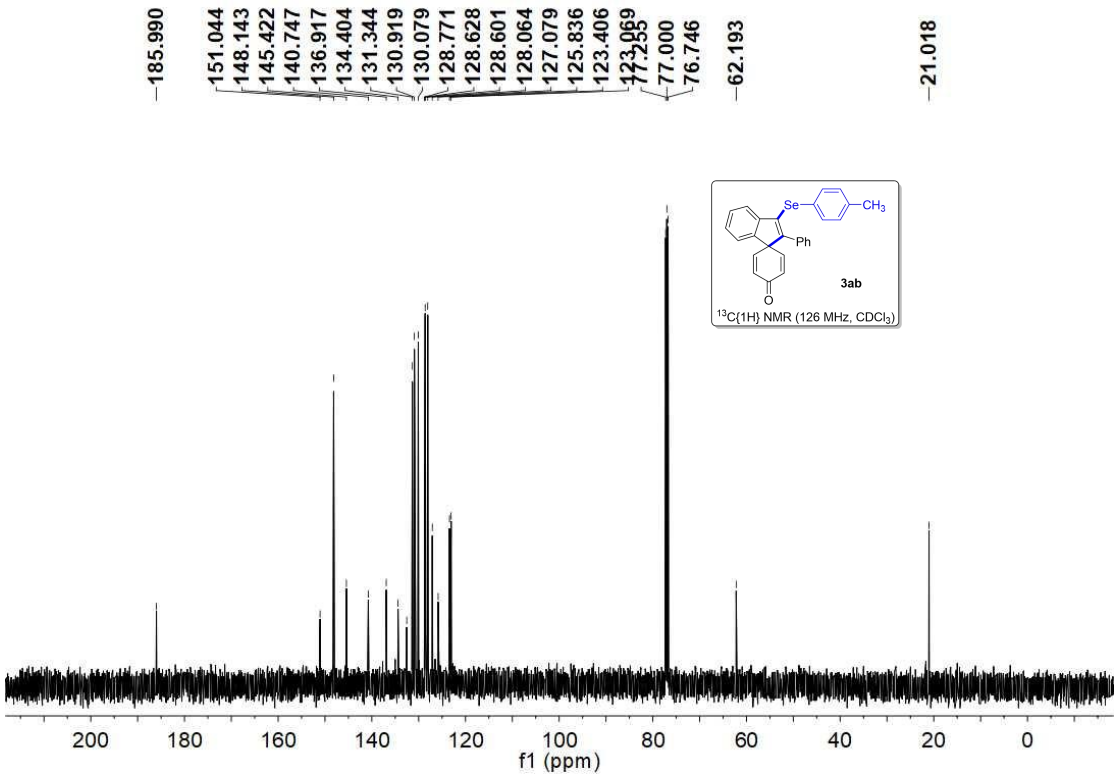

7.356
7.305
7.281
7.252
7.248
7.230
7.182
7.062
6.536
6.516
6.490
6.472
6.388
1.548
0.000
SePh
Ph
O
3e'
^{1}H NMR (500 MHz, CDCl$_3$)
13.43
1.07
1.95
0.96
3.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

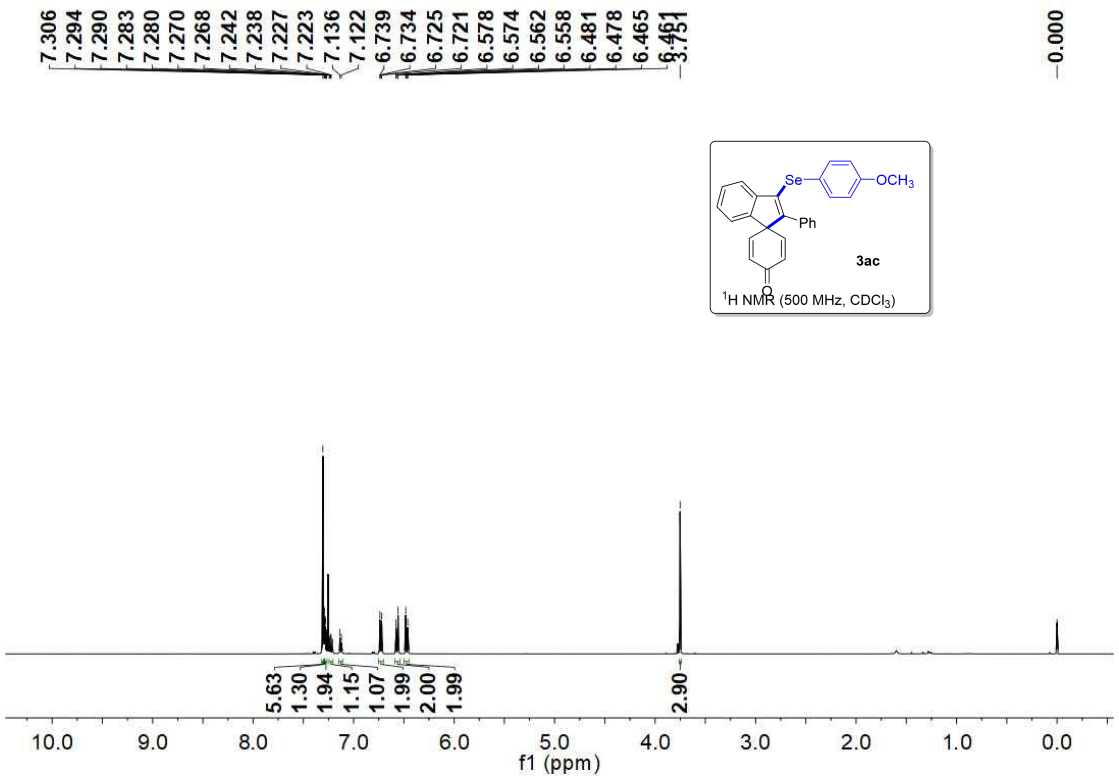

186.851
157.351
148.838
142.380
134.094
131.003
130.260
130.021
129.747
129.279
128.812
128.674
128.339
128.235
127.296
126.877
123.142
122.712
77.254
77.000
76.746
64.946
18.961
SePh
Ph
O
3e'
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

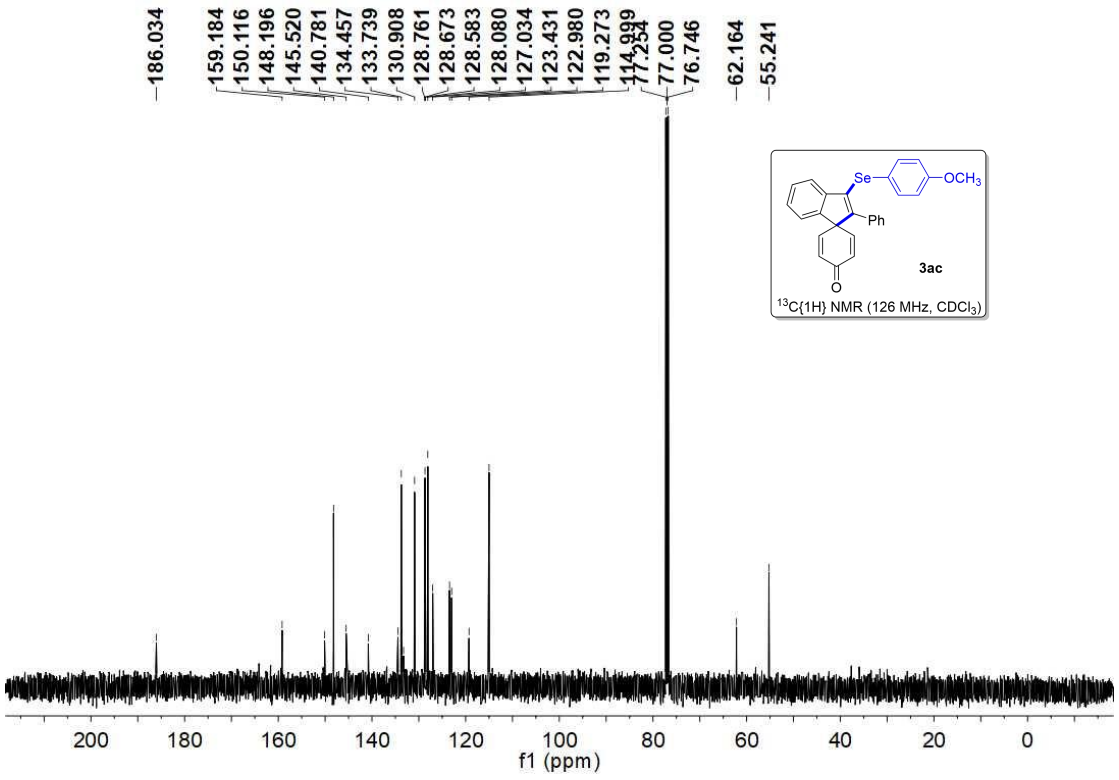

7.401
7.396
7.393
7.389
7.385
7.382
7.362
7.356
7.348
7.335
7.332
7.327
7.326
7.321
7.318
7.315
7.311
7.307
7.303
7.299
7.296
7.293
7.290
7.286
7.277
7.219
7.211
7.205
7.198
7.174
7.171
7.166
7.156
6.702
6.699
6.596
6.576
6.515
6.513
6.496
6.493
SePh
Ph
Cl
O
3f'
^{1}H NMR (500 MHz, CDCl$_3$)
11.28
2.46
1.16
0.95
1.00
1.02
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

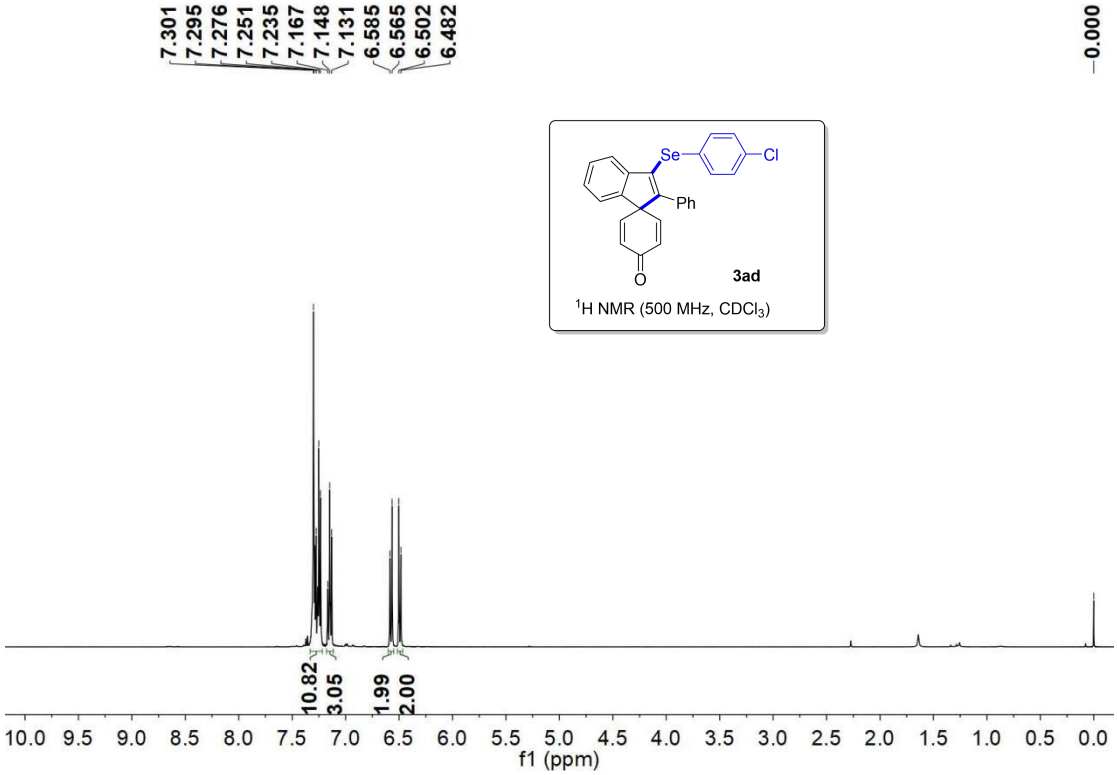

185.031
153.945
150.282
147.688
145.619
141.084
134.015
133.527
131.586
131.016
129.775
129.281
129.249
128.902
128.595
128.229
127.506
126.829
123.246
122.745
77.254
77.000
76.746
66.110
SePh
Ph
Cl
O
3f'
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

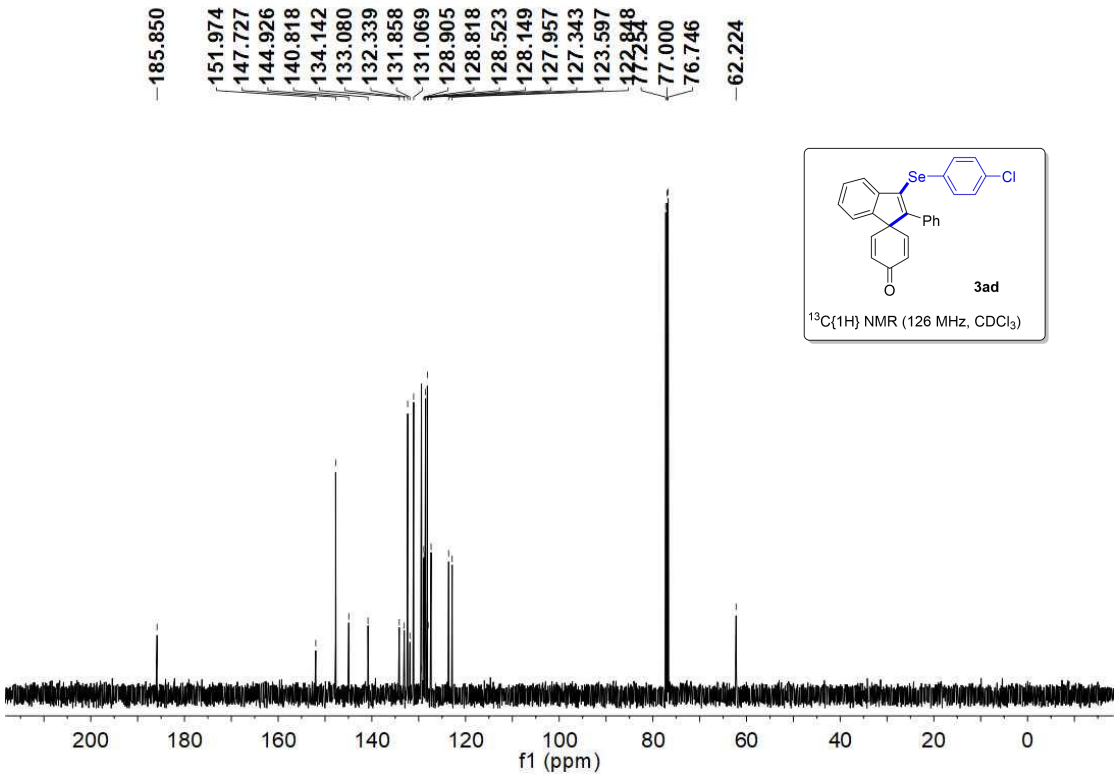

7.340
7.335
7.328
7.320
7.316
7.310
7.308
7.303
7.298
7.292
7.289
7.280
7.278
7.275
7.262
7.259
7.244
7.228
7.224
7.142
7.128
6.999
6.983
6.594
6.590
6.577
6.574
6.492
6.489
6.476
6.472
2.270
0.000
Se
CH3
Ph
O
3ab
1H NMR (500 MHz, CDCl3)
1.88
3.09
1.84
3.37
1.05
2.03
2.00
2.02
2.94
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

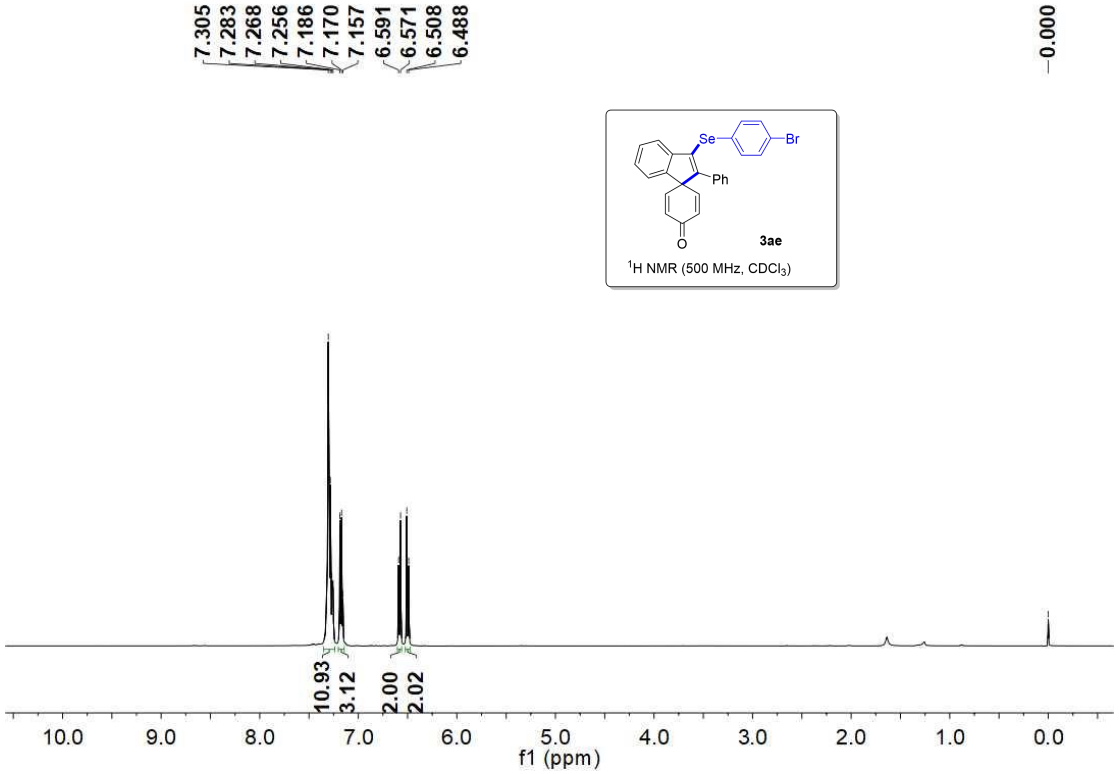

185.990
151.044
148.143
145.422
140.747
136.917
134.404
131.344
130.919
130.079
128.771
128.628
128.601
128.064
127.079
125.836
123.406
123.069
77.253
77.000
76.746
62.193
21.018
Se
CH3
Ph
O
3ab
13C{1H} NMR (126 MHz, CDCl3)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

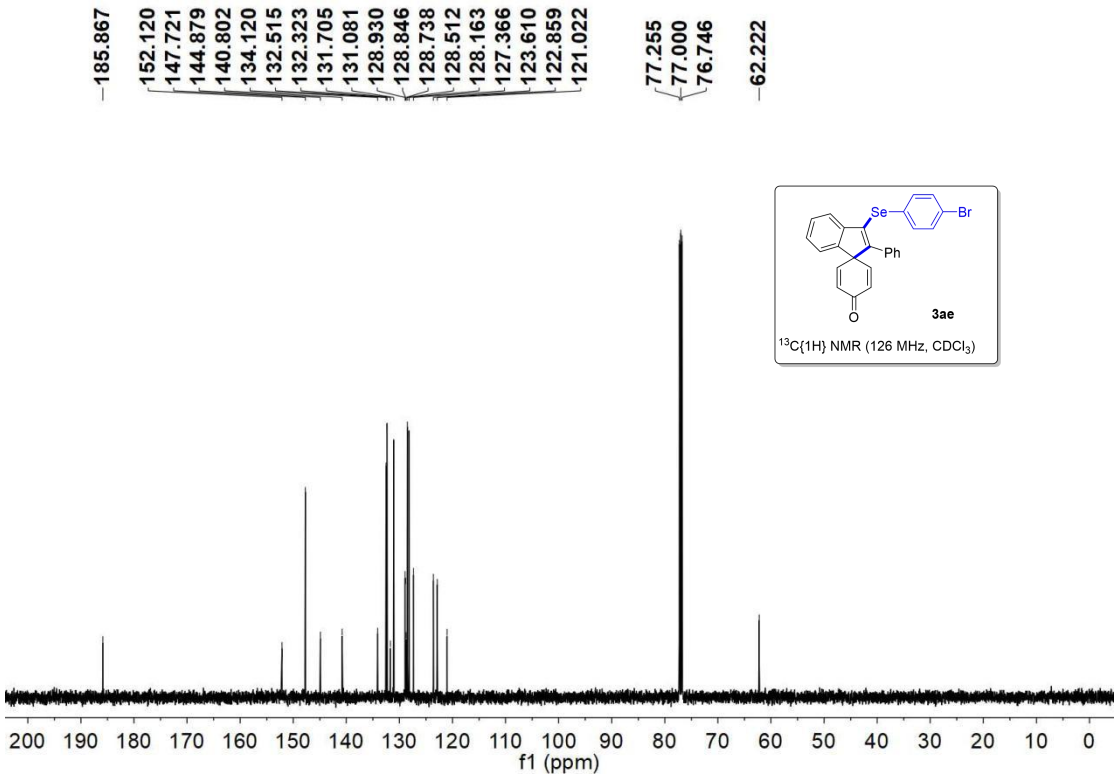

7.306
7.294
7.290
7.283
7.280
7.270
7.268
7.242
7.238
7.227
7.223
7.136
7.122
6.739
6.734
6.725
6.721
6.578
6.574
6.562
6.558
6.481
6.478
6.465
6.461
3.751
0.000
Se
OCH3
Ph
O
3ac
1H NMR (500 MHz, CDCl3)
5.63
1.30
1.94
1.15
1.07
1.99
2.00
1.99
2.90
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

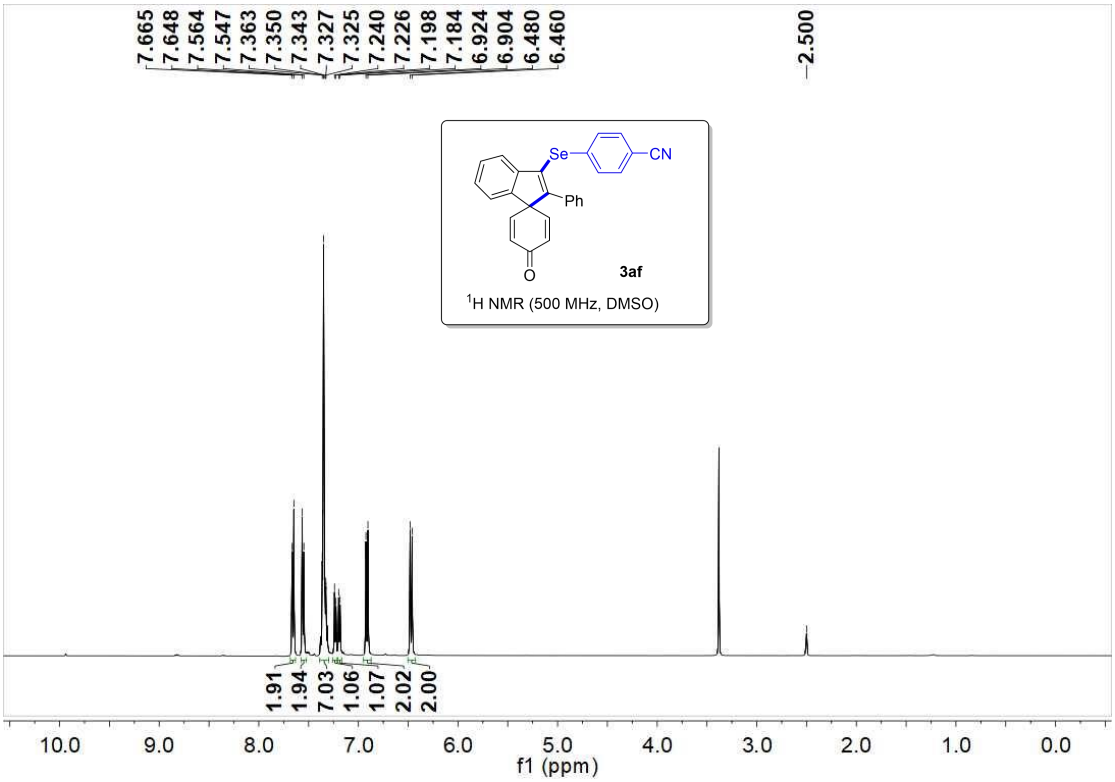

186.034
159.184
150.116
148.196
145.520
140.781
134.457
133.739
130.908
128.761
128.673
128.583
128.080
127.034
123.431
122.980
119.273
114.999
77.254
77.000
76.746
62.164
55.241
Se
OCH3
Ph
O
3ac
13C{1H} NMR (126 MHz, CDCl3)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

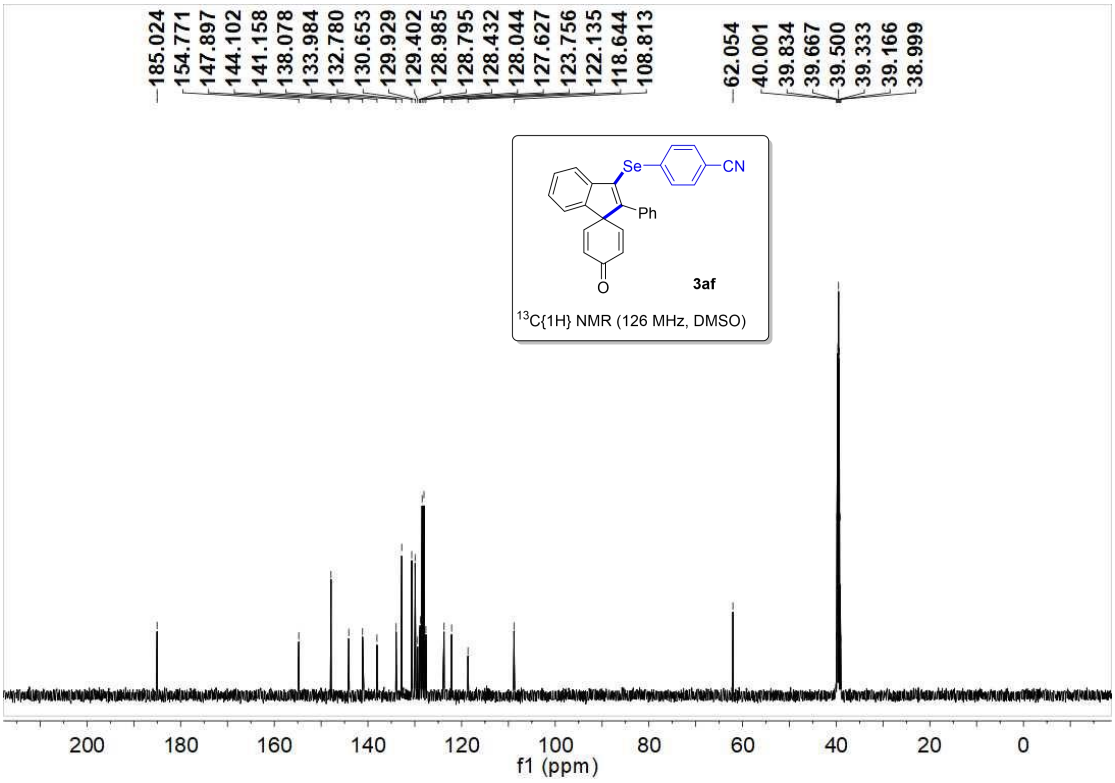

7.301
7.295
7.276
7.251
7.235
7.167
7.148
7.131
6.585
6.565
6.502
6.482
0.000
Se
Cl
Ph
O
3ad
^{1}H NMR (500 MHz, $CDCl_3$)
10.82
3.05
1.99
2.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

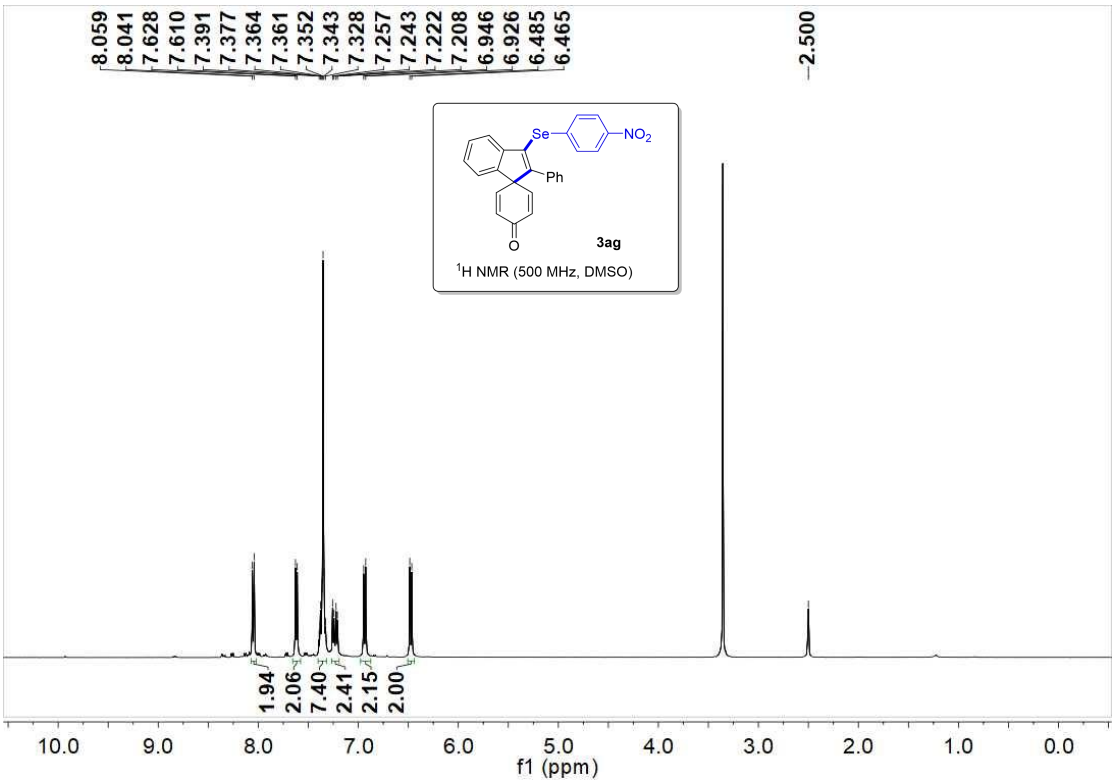

185.850
151.974
147.727
144.926
140.818
134.142
133.080
132.339
131.858
131.069
128.905
128.818
128.523
128.149
127.957
127.343
123.597
122.848
77.254
77.000
76.746
62.224
Se
Cl
Ph
O
3ad
^{13}C{1H} NMR (126 MHz, $CDCl_3$)
200 180 160 140 120 100 80 60 40 20 0
f1 (ppm)

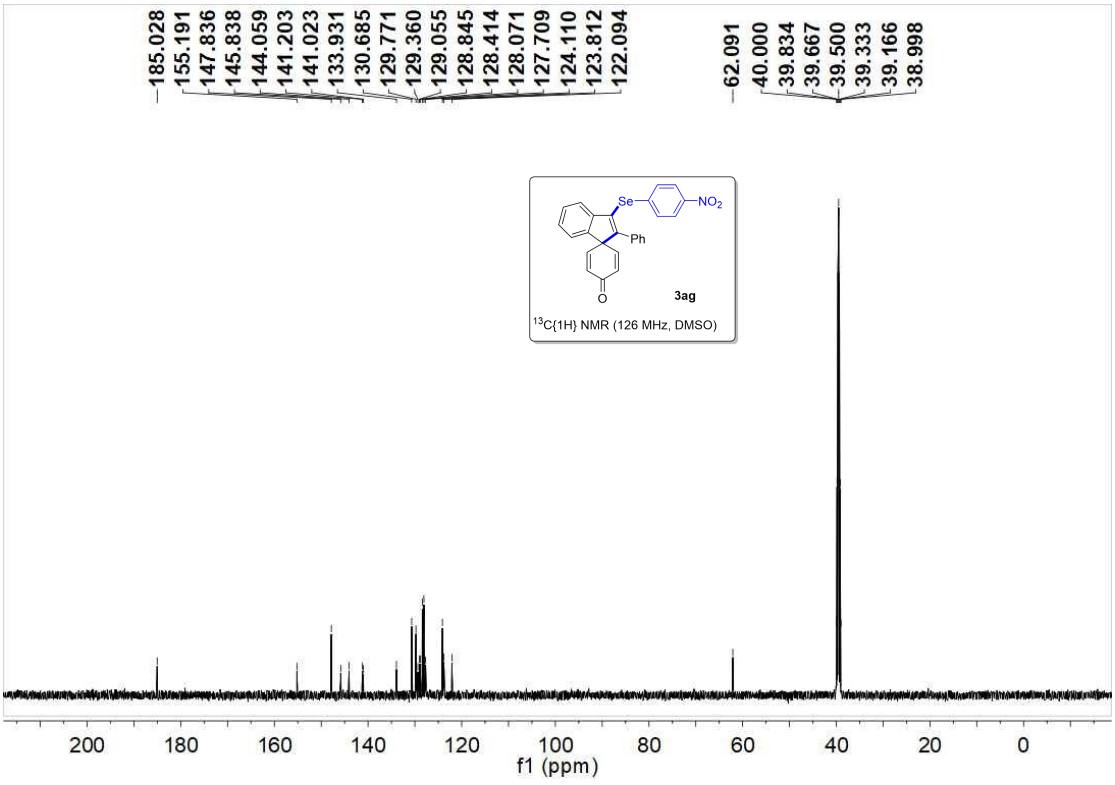

7.305
7.283
7.268
7.256
7.186
7.170
7.157
6.591
6.571
6.508
6.488
0.000
Se
Br
Ph
O
3ae
^{1}H NMR (500 MHz, CDCl$_3$)
10.93
3.12
2.00
2.02
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

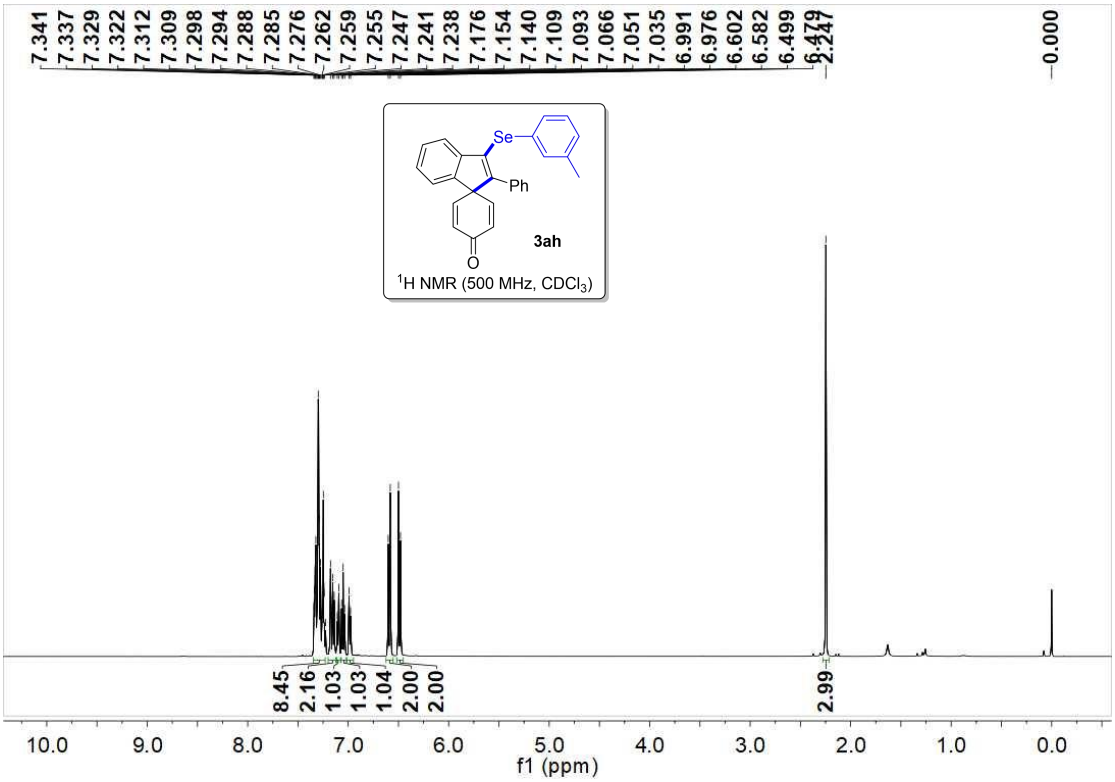

185.867
152.120
147.721
144.879
140.802
134.120
132.515
132.323
131.705
131.081
128.930
128.846
128.738
128.512
128.163
127.366
123.610
122.859
121.022
77.255
77.000
76.746
62.222
Se
Br
Ph
O
3ae
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

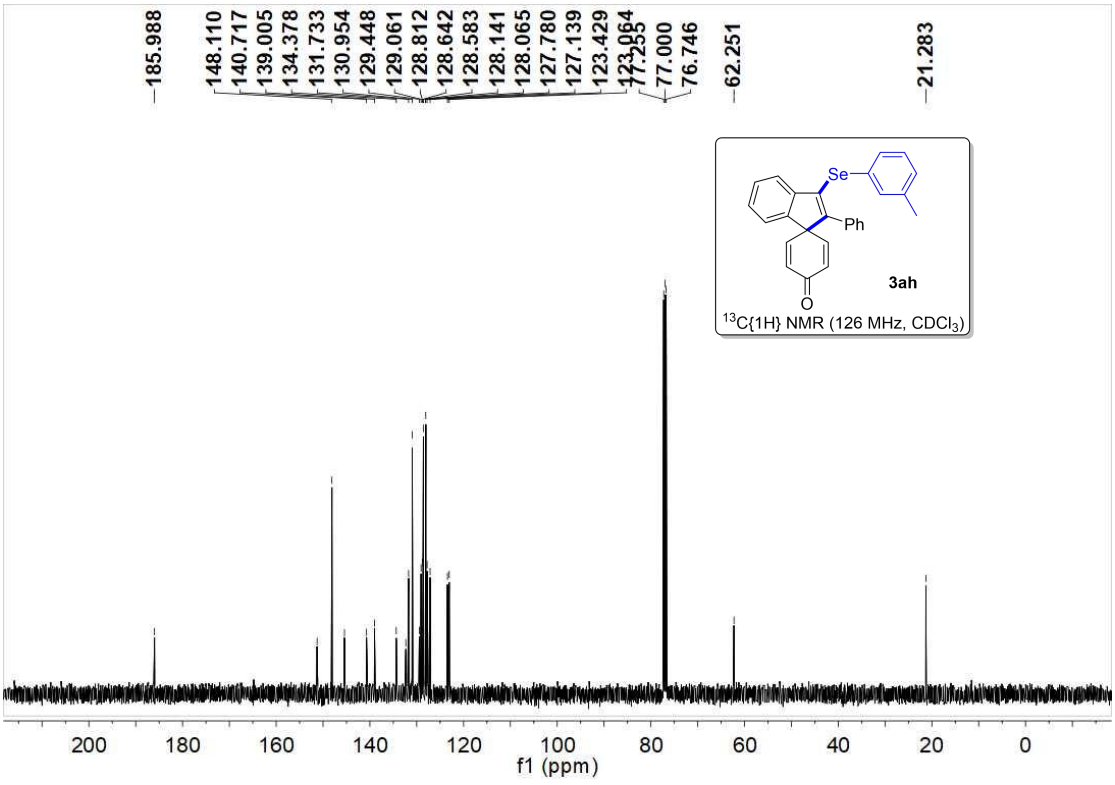

7.665
7.648
7.564
7.547
7.363
7.350
7.343
7.327
7.325
7.240
7.226
7.198
7.184
6.924
6.904
6.480
6.460
2.500
Se
CN
Ph
O
3af
1H NMR (500 MHz, DMSO)
1.91
1.94
7.03
1.06
1.07
2.02
2.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

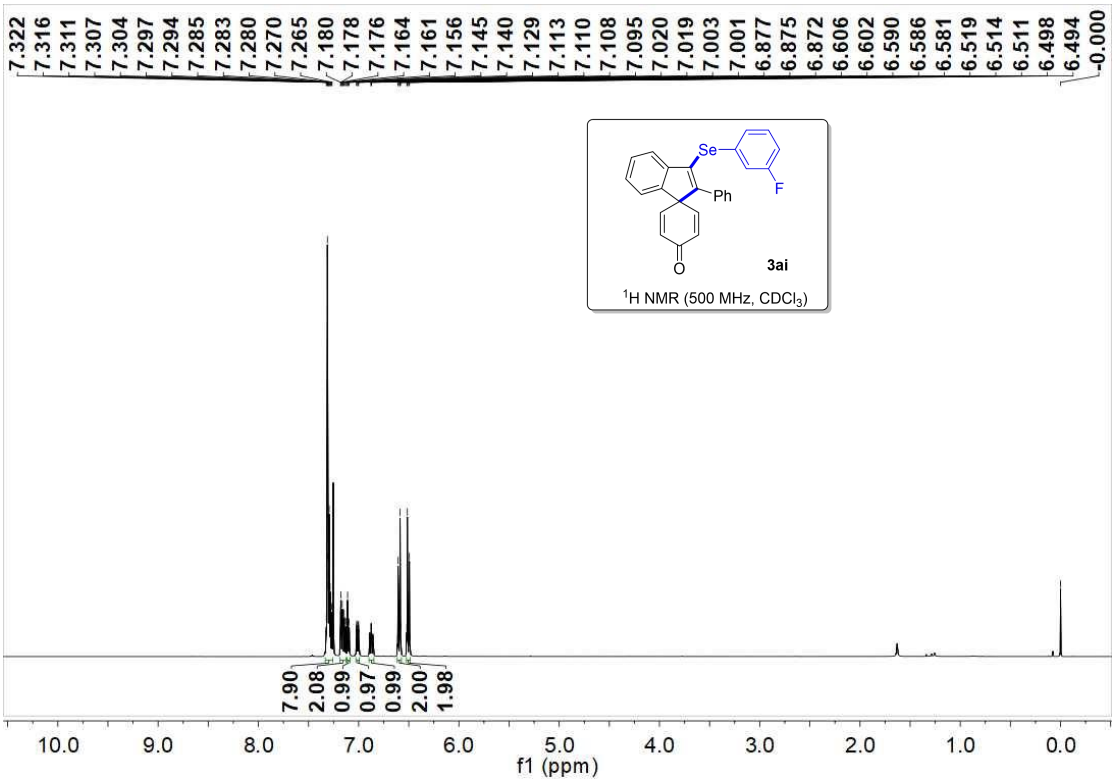

185.024
154.771
147.897
144.102
141.158
138.078
133.984
132.780
130.653
129.929
129.402
128.985
128.795
128.432
128.044
127.627
123.756
122.135
118.644
108.813
62.054
40.001
39.834
39.667
39.500
39.333
39.166
38.999
Se
CN
Ph
O
3af
13C{1H} NMR (126 MHz, DMSO)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

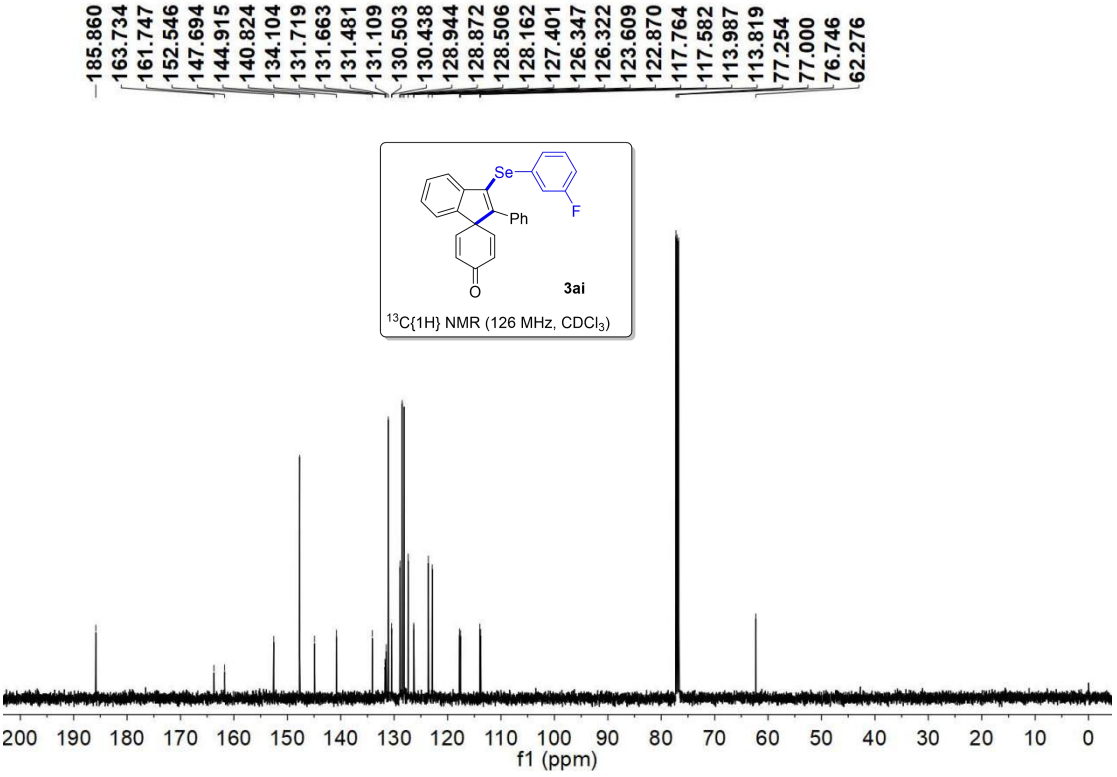

8.059
8.041
7.628
7.610
7.391
7.377
7.364
7.361
7.352
7.343
7.328
7.257
7.243
7.222
7.208
6.946
6.926
6.485
6.465
2.500
Se
NO2
Ph
O
3ag
1H NMR (500 MHz, DMSO)
1.94
2.06
7.40
2.41
2.15
2.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

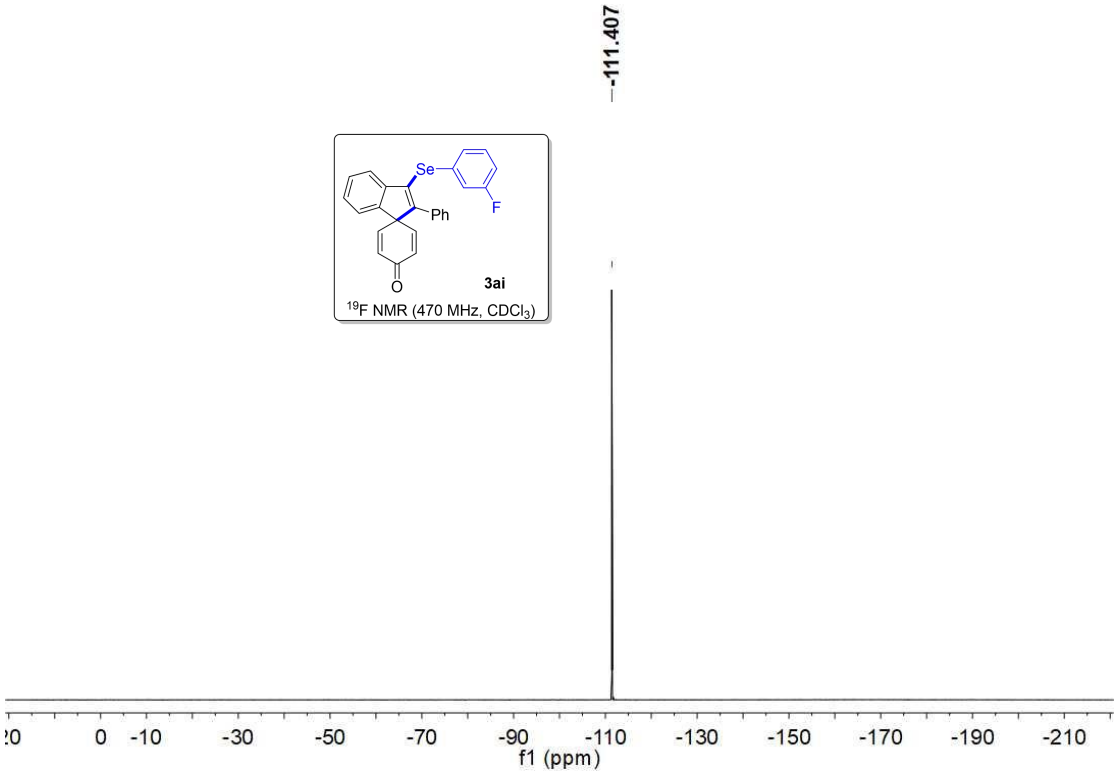

185.028
155.191
147.836
145.838
144.059
141.203
141.023
133.931
130.685
129.771
129.360
129.055
128.845
128.414
128.071
127.709
124.110
123.812
122.094
62.091
40.000
39.834
39.667
39.500
39.333
39.166
38.998
Se
NO2
Ph
O
3ag
13C{1H} NMR (126 MHz, DMSO)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

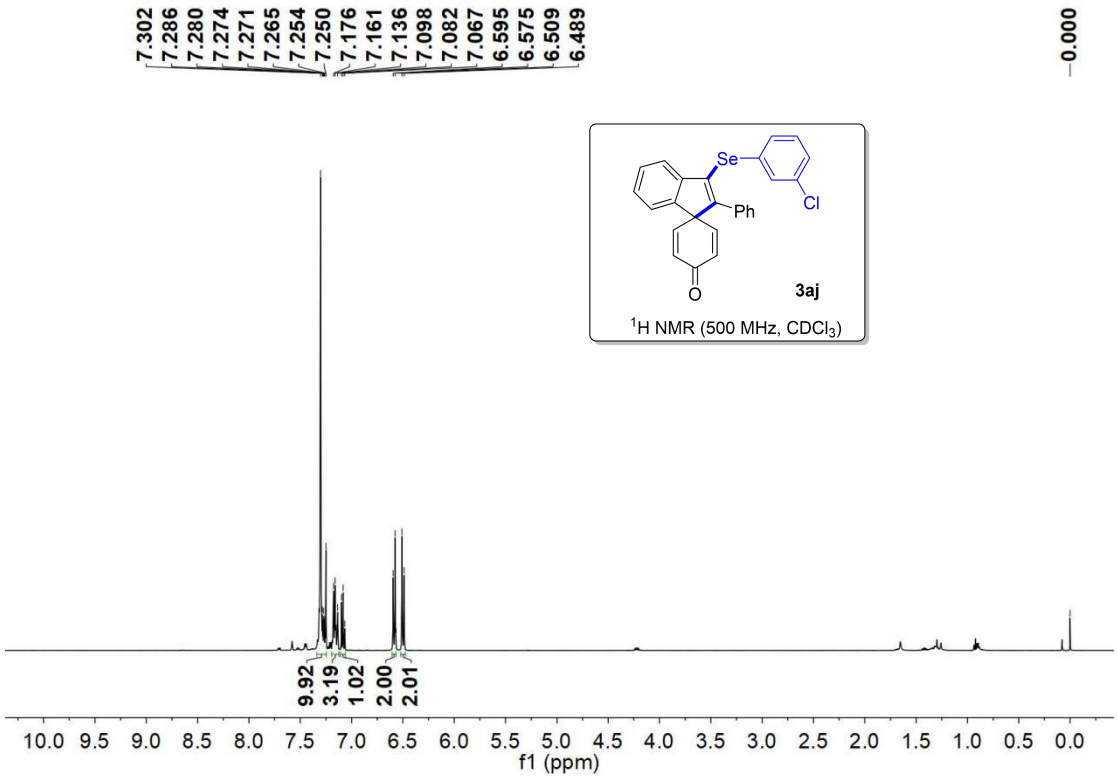

7.341
7.337
7.329
7.322
7.312
7.309
7.298
7.294
7.288
7.285
7.276
7.262
7.259
7.255
7.247
7.241
7.238
7.176
7.154
7.140
7.109
7.093
7.066
7.051
7.035
6.991
6.976
6.602
6.582
6.499
6.479
2.247
0.000
Se
Ph
O
3ah
^{1}H NMR (500 MHz, CDCl$_3$)
8.45
2.16
1.03
1.03
1.04
2.00
2.00
2.99
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

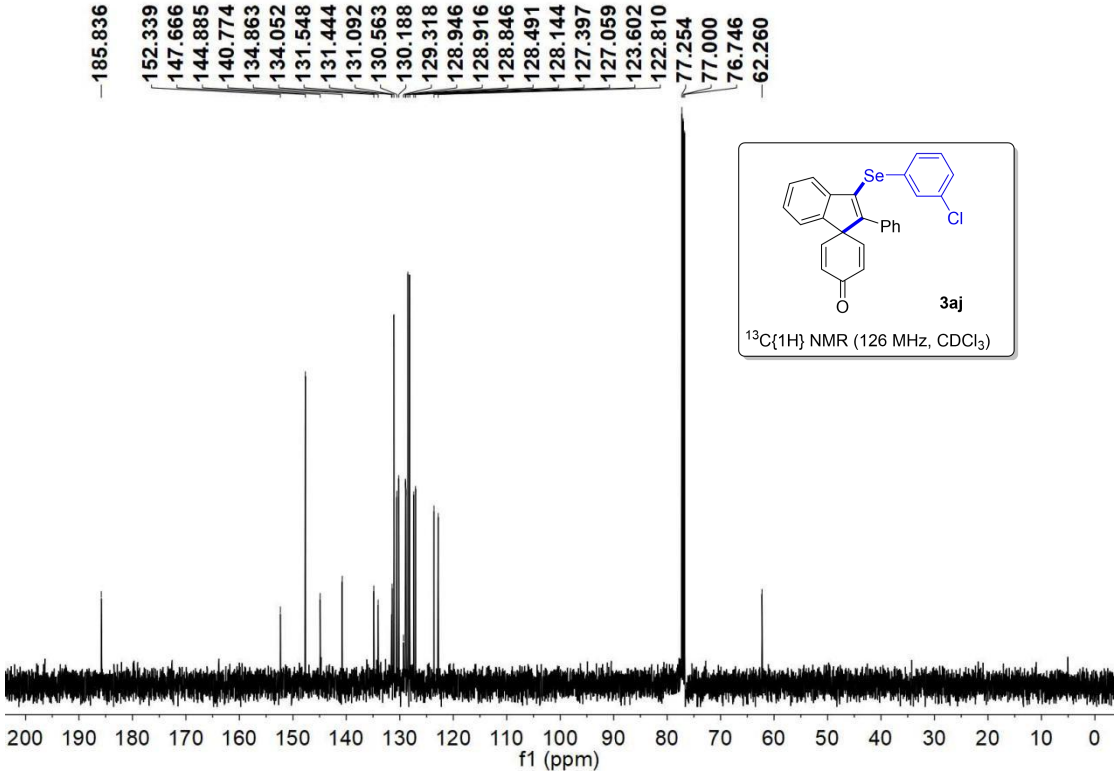

185.988
148.110
140.717
139.005
134.378
131.733
130.954
129.448
129.061
128.812
128.642
128.583
128.141
128.065
127.780
127.139
123.429
123.064
77.253
77.000
76.746
62.251
21.283
Se
Ph
O
3ah
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

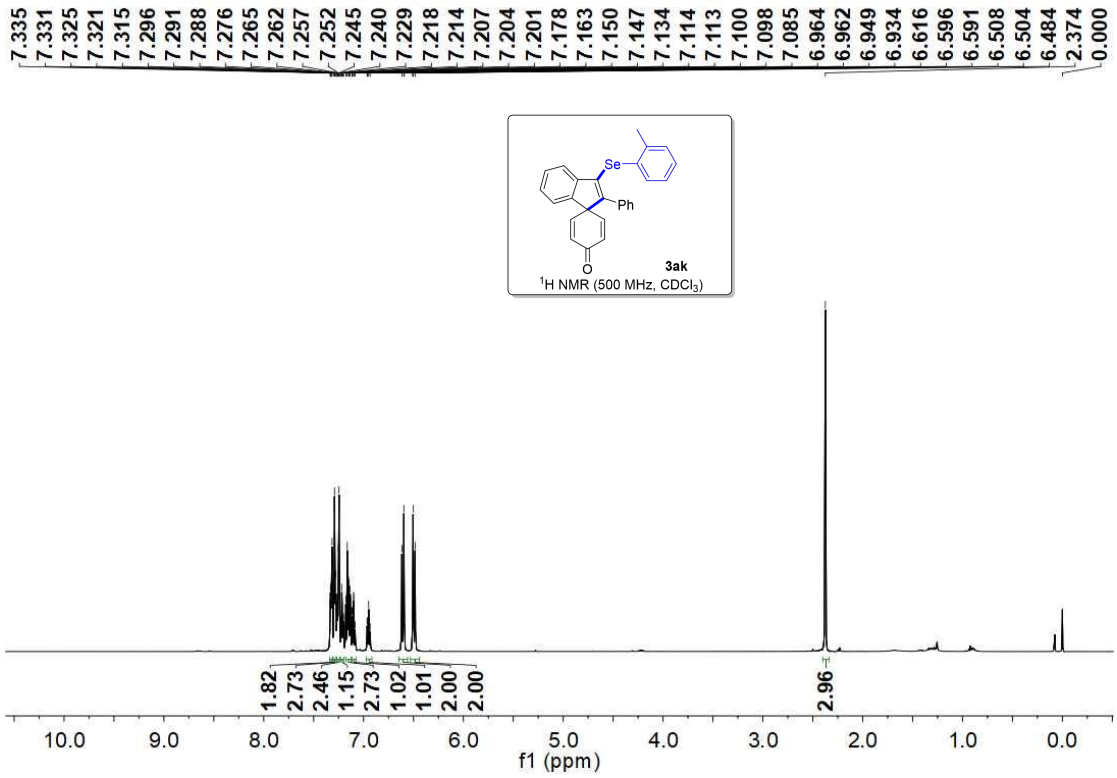

7.322
7.316
7.311
7.307
7.304
7.297
7.294
7.285
7.283
7.280
7.270
7.265
7.180
7.178
7.176
7.164
7.161
7.156
7.145
7.140
7.129
7.113
7.110
7.108
7.095
7.020
7.019
7.003
7.001
6.877
6.875
6.872
6.606
6.602
6.590
6.586
6.581
6.519
6.514
6.511
6.498
6.494
0.000
Se
F
Ph
O
3ai
1H NMR (500 MHz, CDCl3)
7.90
2.08
0.99
0.97
0.99
2.00
1.98
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

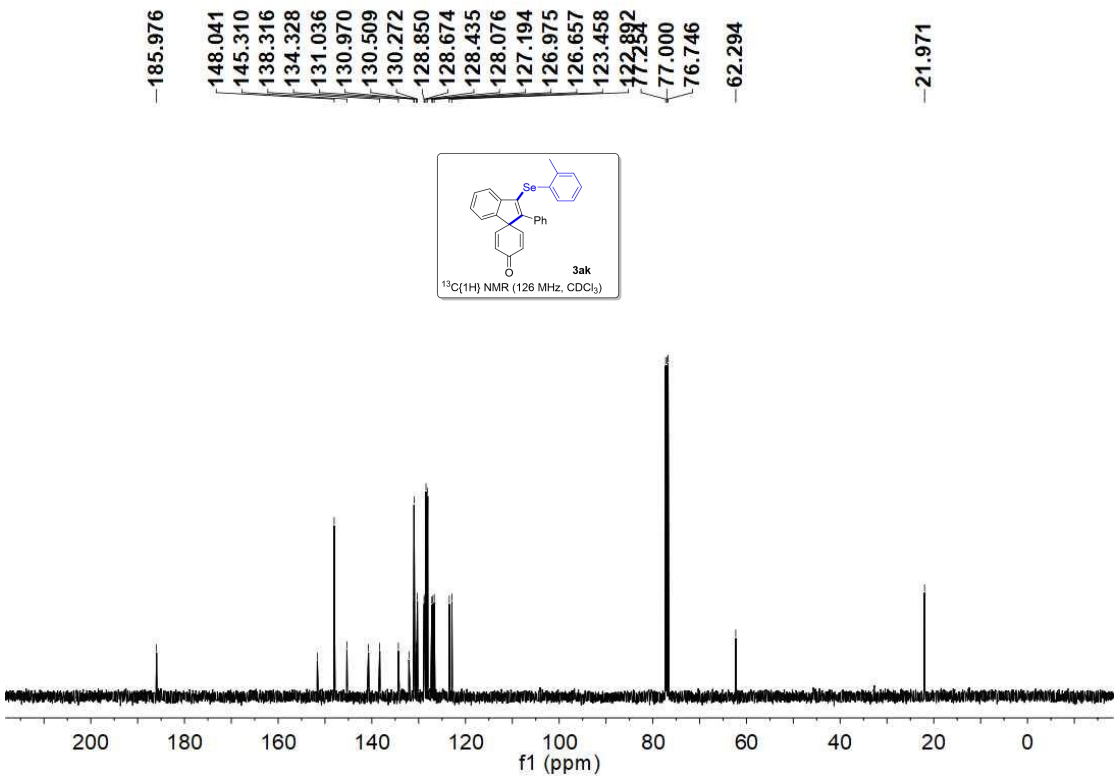

185.860
163.734
161.747
152.546
147.694
144.915
140.824
134.104
131.719
131.663
131.481
131.109
130.503
130.438
128.944
128.872
128.506
128.162
127.401
126.347
126.322
123.609
122.870
117.764
117.582
113.987
113.819
77.254
77.000
76.746
62.276
Se
F
Ph
O
3ai
13C{1H} NMR (126 MHz, CDCl3)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

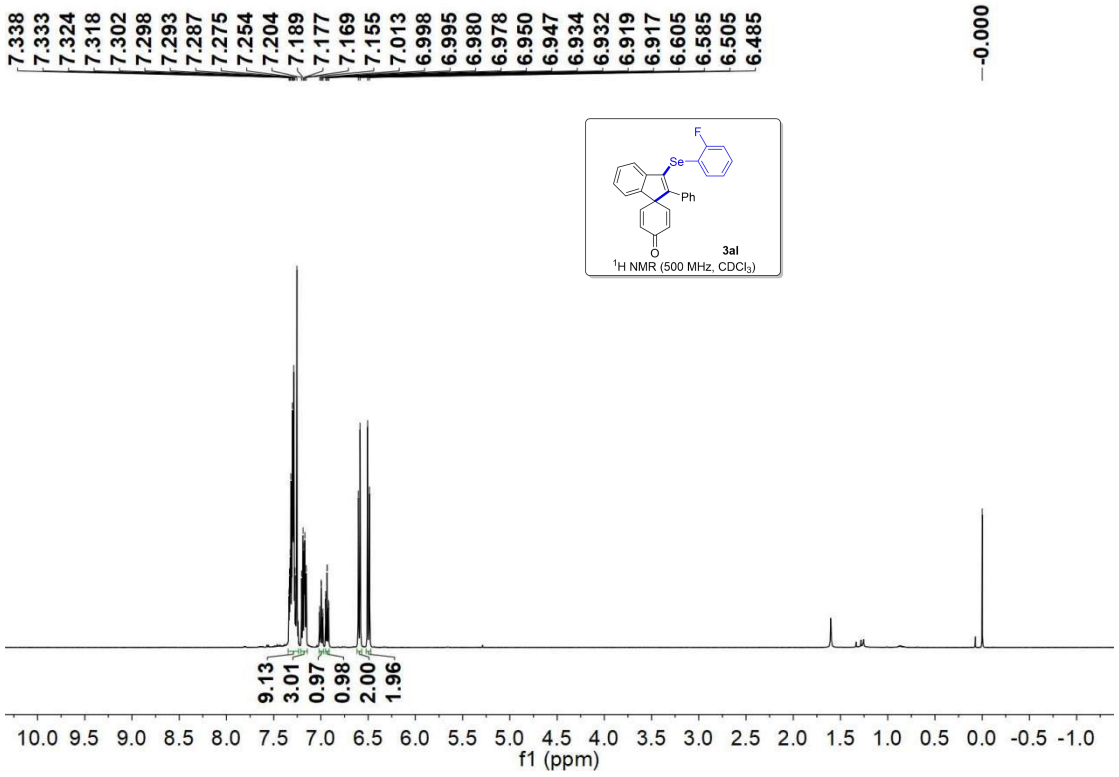

-111.407
Se
Ph
F
O
3ai
^{19}F NMR (470 MHz, $CDCl_3$)
f1 (ppm)

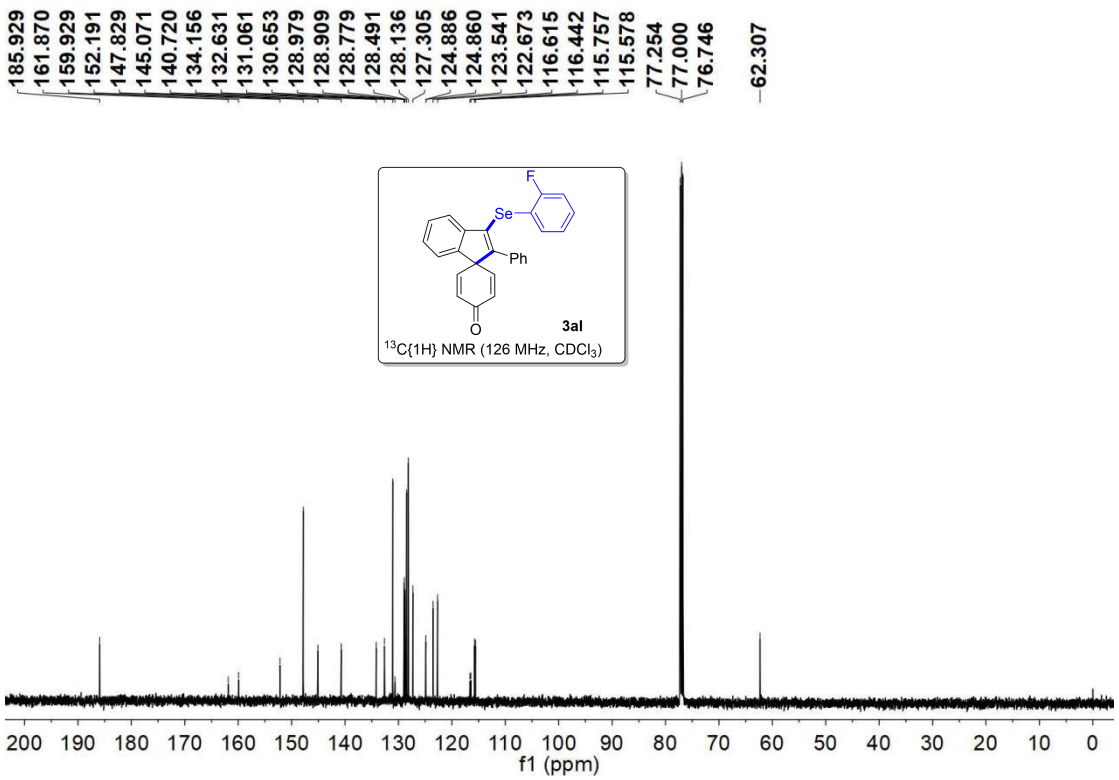

7.302
7.286
7.280
7.274
7.271
7.265
7.254
7.250
7.176
7.161
7.136
7.098
7.082
7.067
6.595
6.575
6.509
6.489
0.000
Se
Ph
Cl
O
3aj
^{1}H NMR (500 MHz, $CDCl_3$)
9.92
3.19
1.02
2.00
2.01
f1 (ppm)

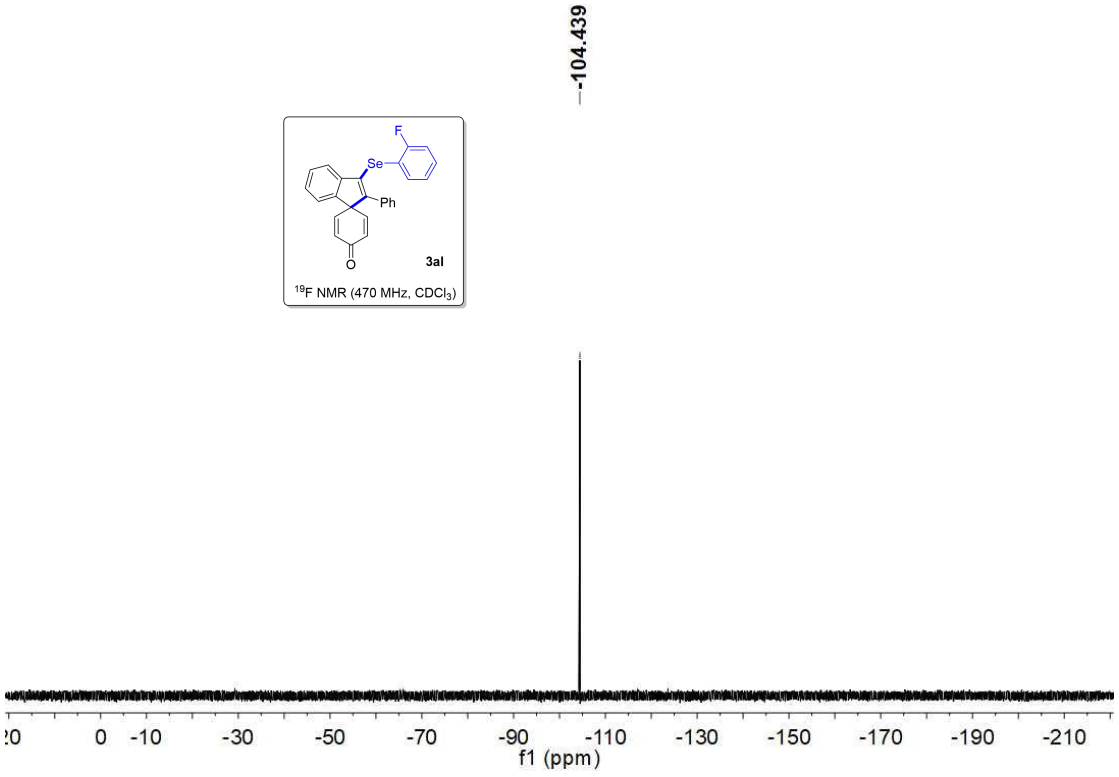

185.836
152.339
147.666
144.885
140.774
134.863
134.052
131.548
131.444
131.092
130.563
130.188
129.318
128.946
128.916
128.846
128.491
128.144
127.397
127.059
123.602
122.810
77.254
77.000
76.746
62.260
Se
Cl
Ph
O
3aj
$^{13}C\{1H\}$ NMR (126 MHz, $CDCl_3$)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

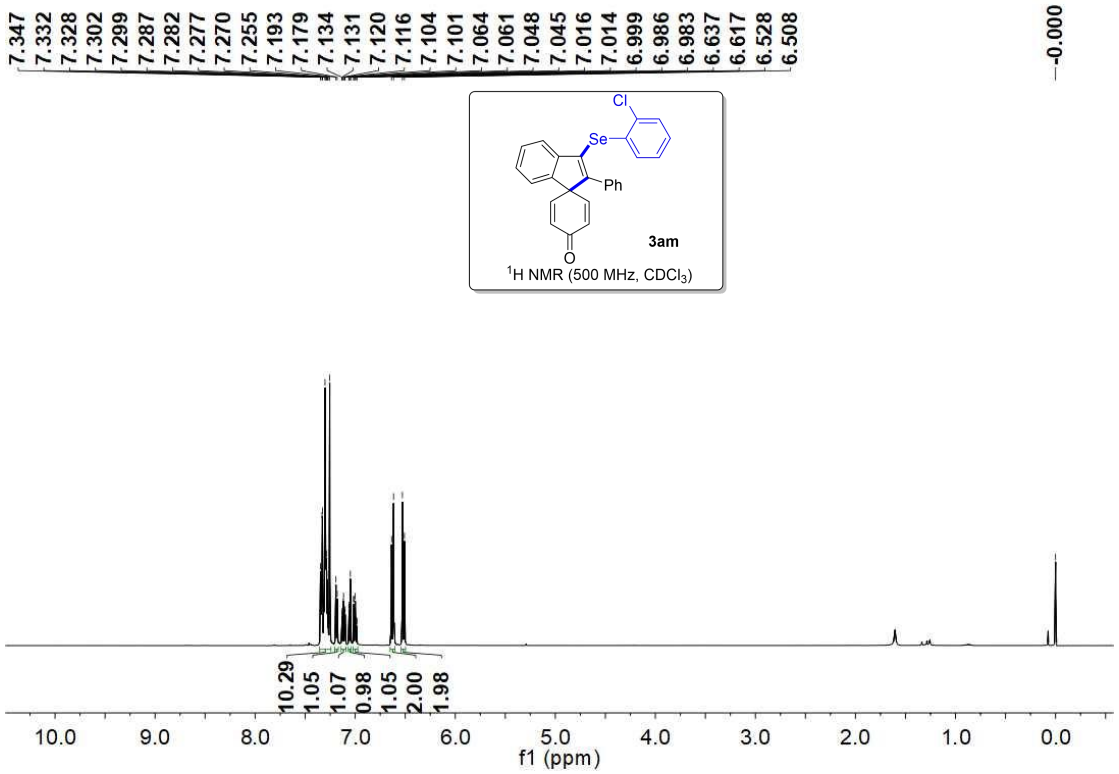

7.335
7.331
7.325
7.321
7.315
7.296
7.291
7.288
7.276
7.265
7.262
7.257
7.252
7.245
7.240
7.229
7.218
7.214
7.207
7.204
7.201
7.178
7.163
7.150
7.147
7.134
7.114
7.113
7.100
7.098
7.085
6.964
6.962
6.949
6.934
6.616
6.596
6.591
6.508
6.504
6.484
2.374
0.000
Se
Ph
O
3ak
^{1}H NMR (500 MHz, $CDCl_3$)
1.82
2.73
2.46
1.15
2.73
1.02
1.01
2.00
2.00
2.96
10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)

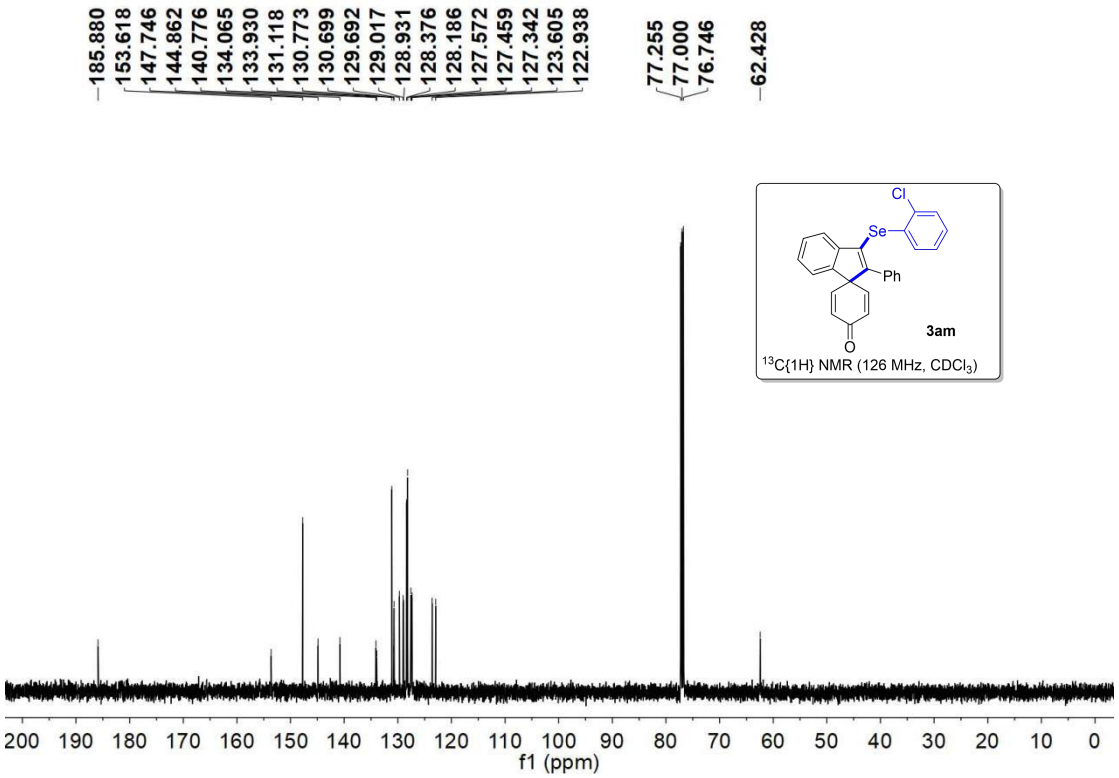

185.976
148.041
145.310
138.316
134.328
131.036
130.970
130.509
130.272
128.850
128.674
128.435
128.076
127.194
126.975
126.657
123.458
122.892
77.254
77.000
76.746
62.294
21.971
Se
Ph
O
3ak
13C{1H} NMR (126 MHz, CDCl3)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

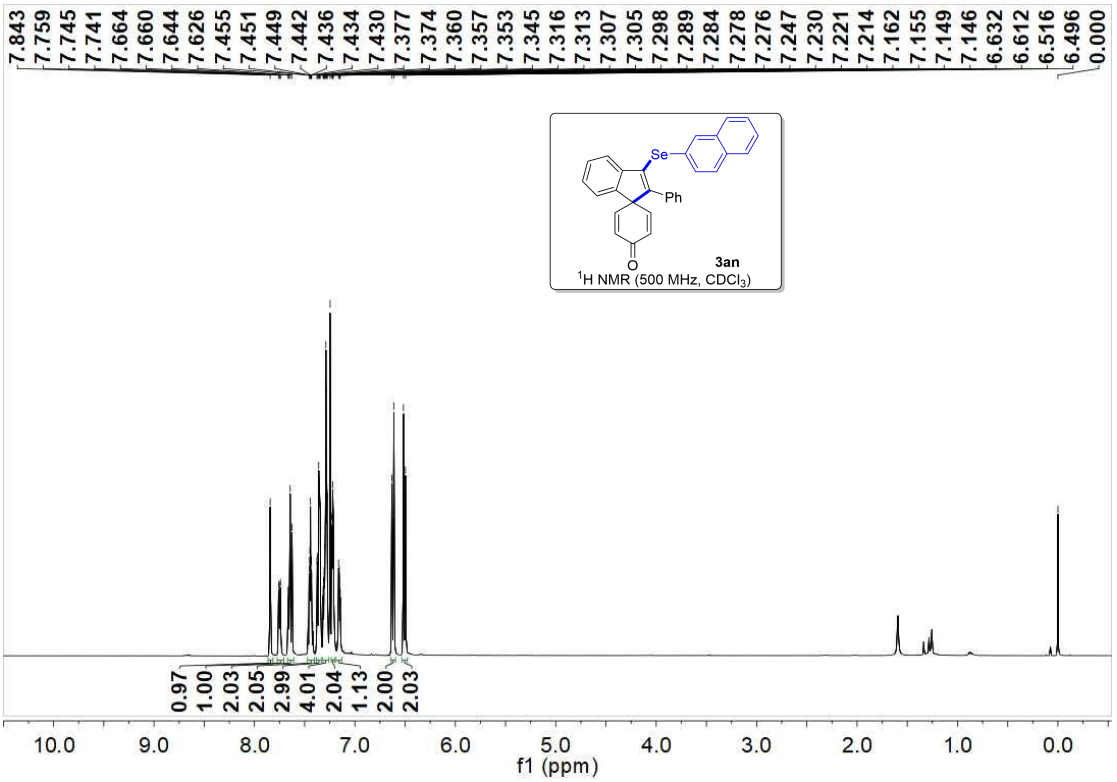

7.338
7.333
7.324
7.318
7.302
7.298
7.293
7.287
7.275
7.254
7.204
7.189
7.177
7.169
7.155
7.013
6.998
6.995
6.980
6.978
6.950
6.947
6.934
6.932
6.919
6.917
6.605
6.585
6.505
6.485
-0.000
F
Se
Ph
O
3al
1H NMR (500 MHz, CDCl3)
9.13
3.01
0.97
0.98
2.00
1.96
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

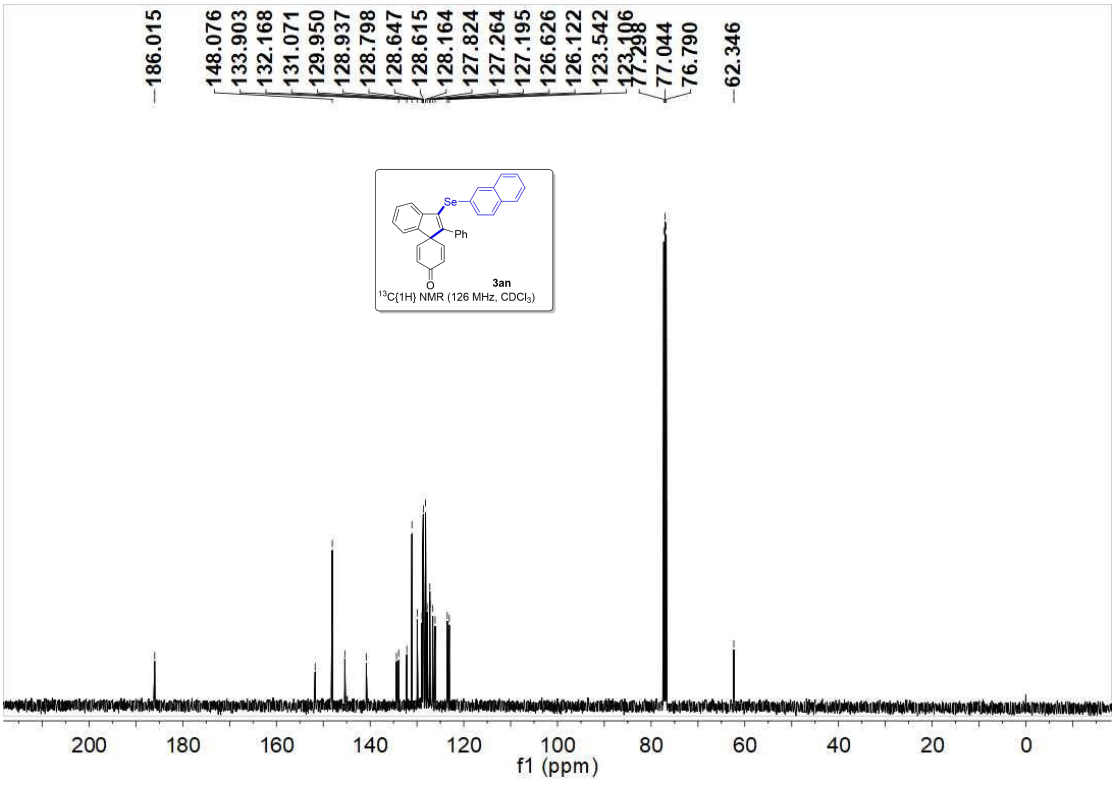

185.929
161.870
159.929
152.191
147.829
145.071
140.720
134.156
132.631
131.061
130.653
128.979
128.909
128.779
128.491
128.136
127.305
124.886
124.860
123.541
122.673
116.615
116.442
115.757
115.578
77.254
77.000
76.746
62.307
F
Se
Ph
O
3al
13C{1H} NMR (126 MHz, CDCl3)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

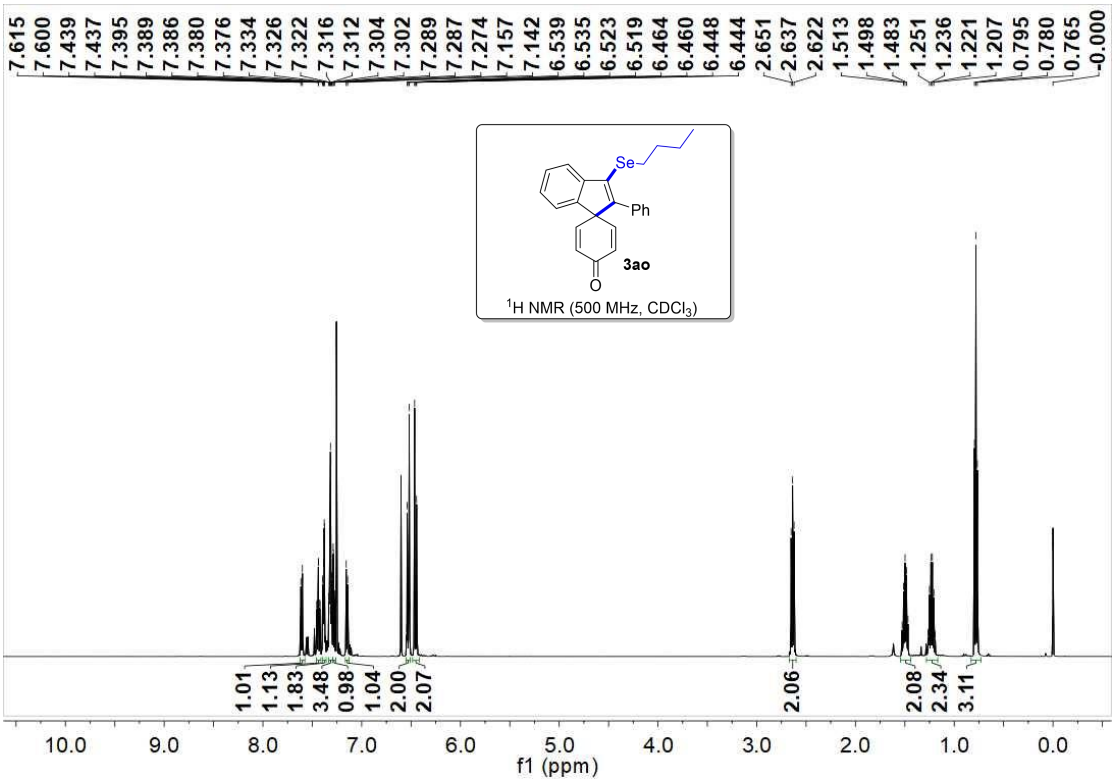

-104.439
F
Se
Ph
O
3al
19F NMR (470 MHz, CDCl3)
0 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210
f1 (ppm)

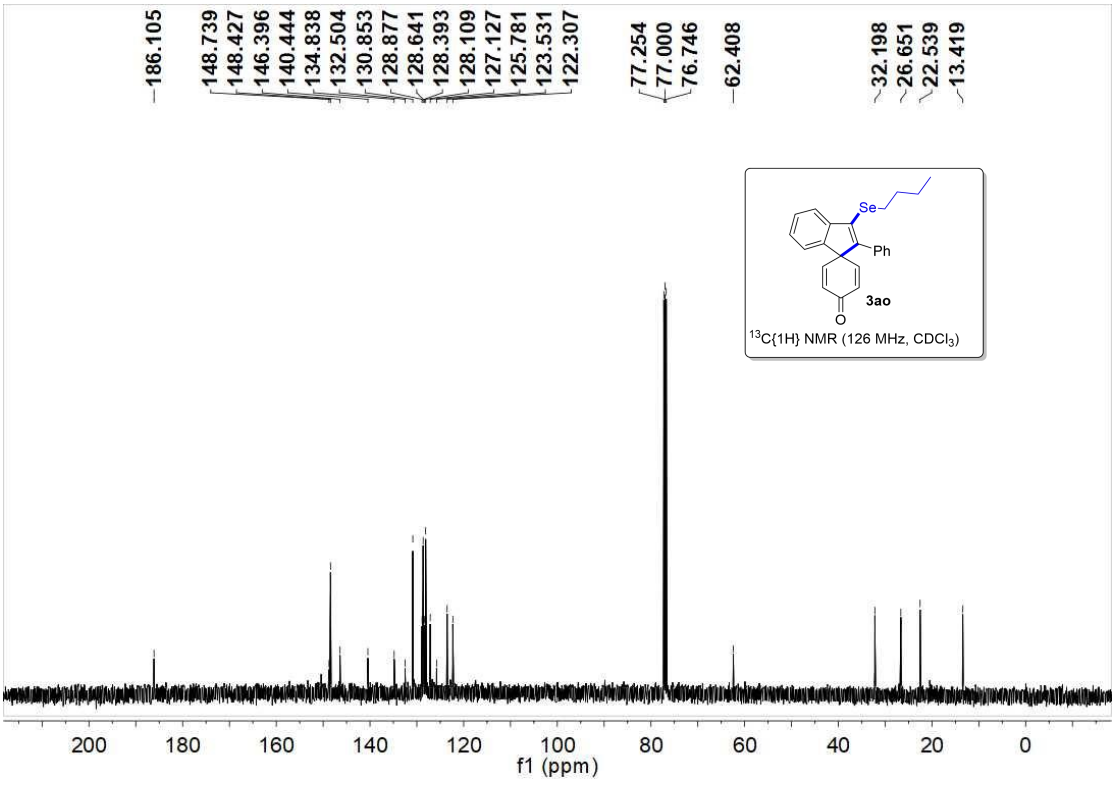

7.347
7.332
7.328
7.302
7.299
7.287
7.282
7.277
7.270
7.255
7.193
7.179
7.134
7.131
7.120
7.116
7.104
7.101
7.064
7.061
7.048
7.045
7.016
7.014
6.999
6.986
6.983
6.637
6.617
6.528
6.508
-0.000
Cl
Se
Ph
O
3am
1H NMR (500 MHz, CDCl3)
10.29
1.05
1.07
0.98
1.05
2.00
1.98
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

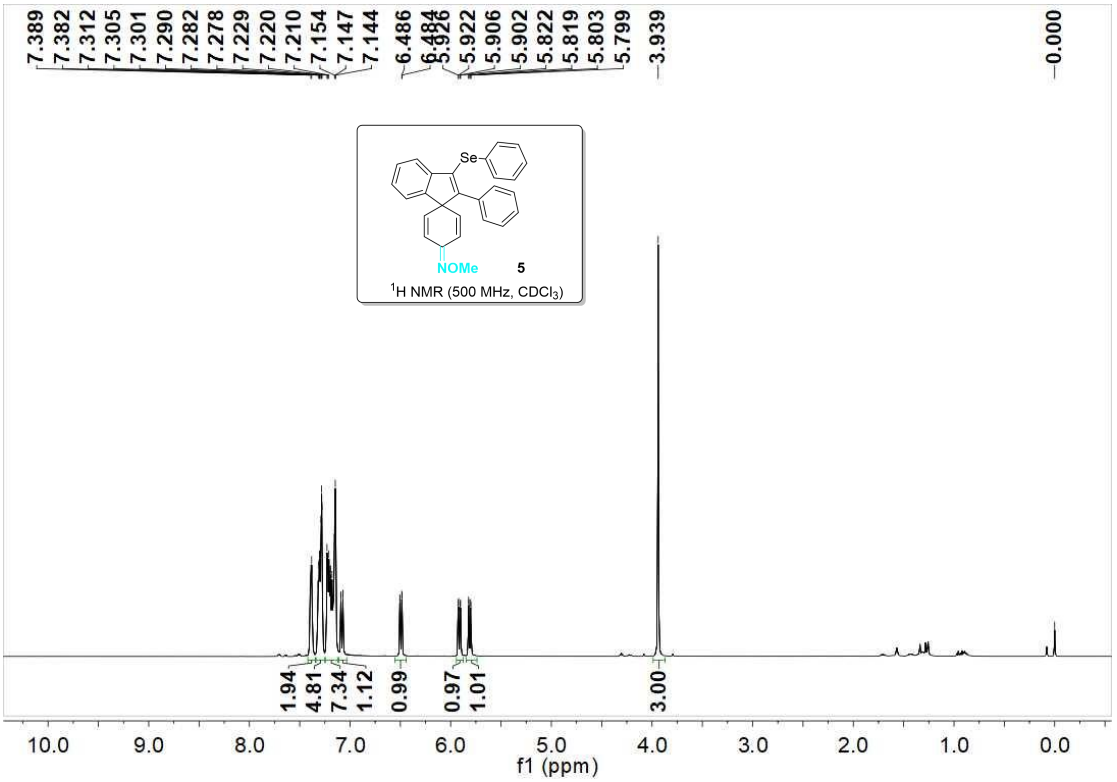

185.880
153.618
147.746
144.862
140.776
134.065
133.930
131.118
130.773
130.699
129.692
129.017
128.931
128.376
128.186
127.572
127.459
127.342
123.605
122.938
77.255
77.000
76.746
62.428
Cl
Se
Ph
O
3am
13C{1H} NMR (126 MHz, CDCl3)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

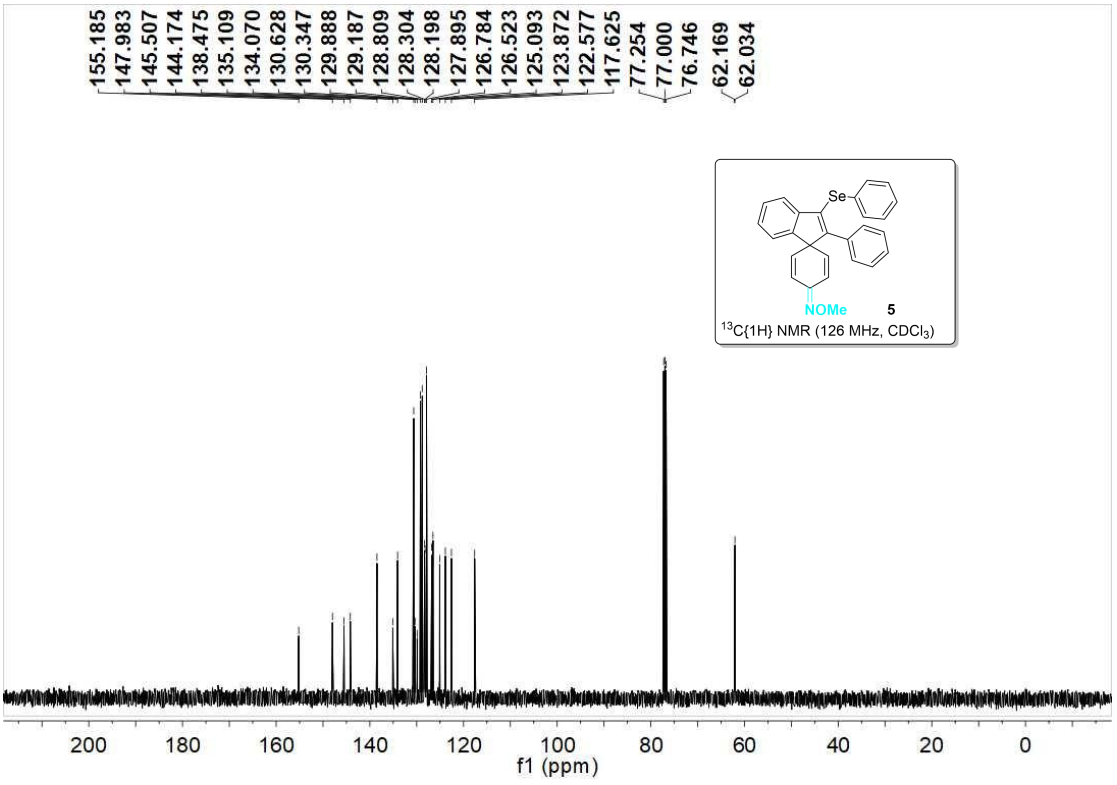

7.843
7.759
7.745
7.741
7.664
7.660
7.644
7.626
7.455
7.451
7.449
7.442
7.436
7.434
7.430
7.377
7.374
7.360
7.357
7.353
7.345
7.316
7.313
7.307
7.305
7.298
7.289
7.284
7.278
7.276
7.247
7.230
7.221
7.214
7.162
7.155
7.149
7.146
6.632
6.612
6.516
6.496
0.000
Se
Ph
O
3an
1H NMR (500 MHz, CDCl3)
0.97
1.00
2.03
2.05
2.99
4.01
2.04
1.13
2.00
2.03
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

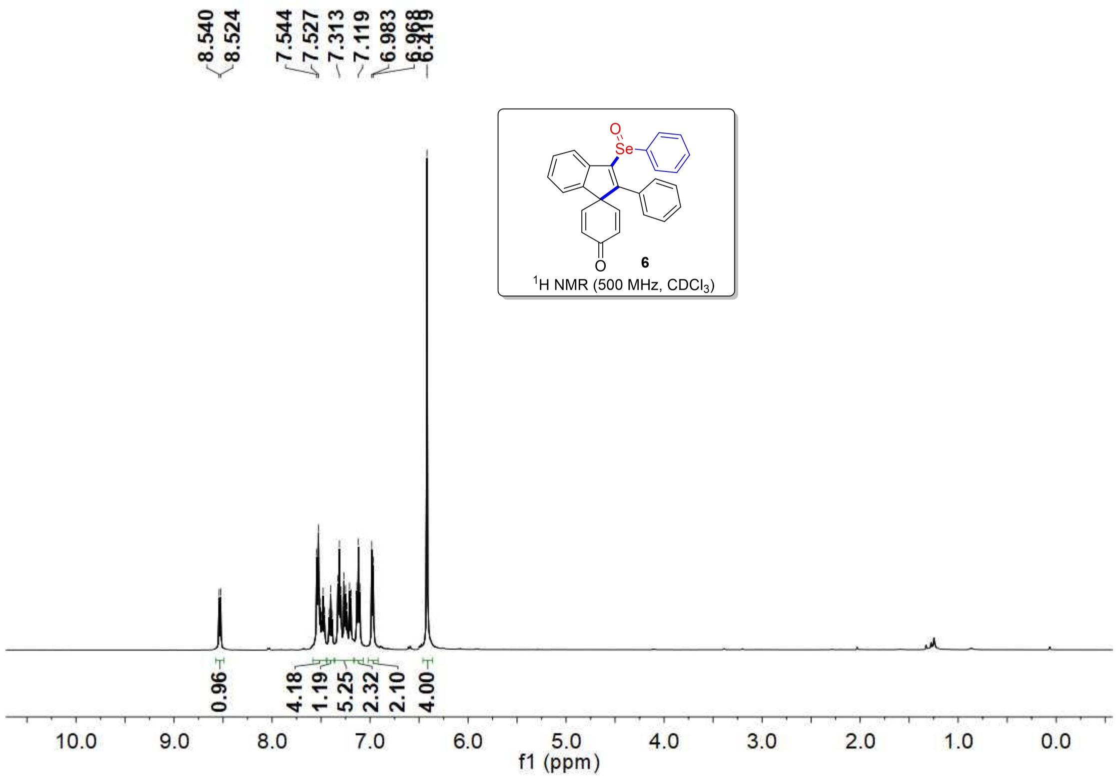

186.015
148.076
133.903
132.168
131.071
129.950
128.937
128.798
128.647
128.615
128.164
127.824
127.264
127.195
126.626
126.122
123.542
123.106
77.298
77.044
76.790
62.346
Se
Ph
O
3an
13C{1H} NMR (126 MHz, CDCl3)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)


7.615
7.600
7.439
7.437
7.395
7.389
7.386
7.380
7.376
7.334
7.326
7.322
7.316
7.312
7.304
7.302
7.289
7.287
7.274
7.157
7.142
6.539
6.535
6.523
6.519
6.464
6.460
6.448
6.444
2.651
2.637
2.622
1.513
1.498
1.483
1.251
1.236
1.221
1.207
0.795
0.780
0.765
0.000
Se
Ph
3ao
O
1H NMR (500 MHz, CDCl3)
1.01
1.13
1.83
3.48
0.98
1.04
2.00
2.07
2.06
2.08
2.34
3.11
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

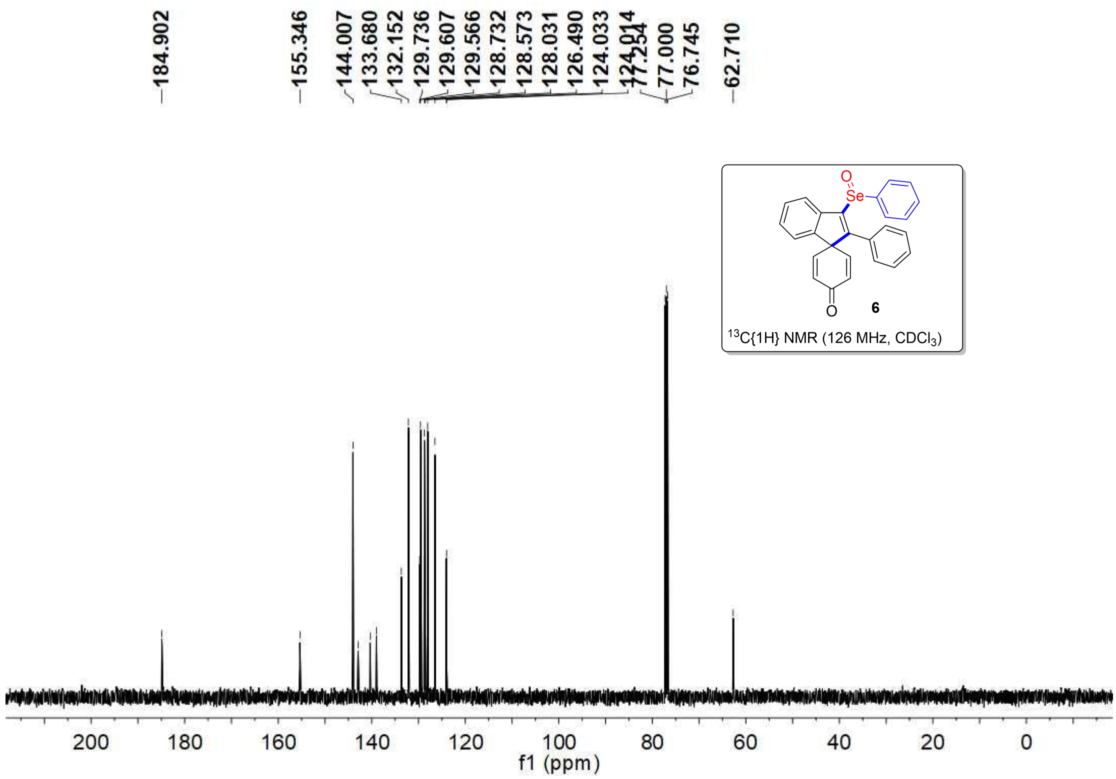

186.105
148.739
148.427
146.396
140.444
134.838
132.504
130.853
128.877
128.641
128.393
128.109
127.127
125.781
123.531
122.307
77.254
77.000
76.746
62.408
32.198
26.651
22.539
13.419
Se
Ph
3ao
O
13C{1H} NMR (126 MHz, CDCl3)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)


7.389
7.382
7.312
7.305
7.301
7.290
7.282
7.278
7.229
7.220
7.210
7.154
7.147
7.144
6.486
6.484
5.926
5.922
5.906
5.902
5.822
5.819
5.803
5.799
3.939
0.000
Se
NOMe
5
1H NMR (500 MHz, CDCl3)
1.94
4.81
7.34
1.12
0.99
0.97
1.01
3.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

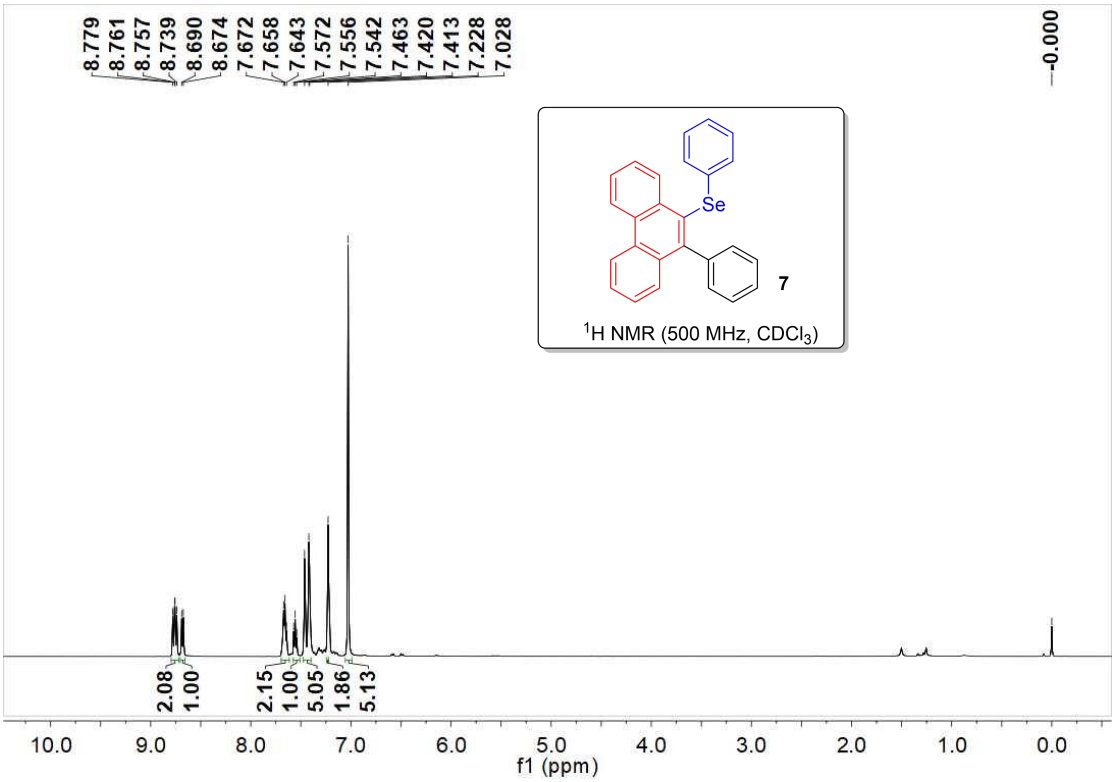

155.185
147.983
145.507
144.174
138.475
135.109
134.070
130.628
130.347
129.888
129.187
128.809
128.304
128.198
127.895
126.784
126.523
125.093
123.872
122.577
117.625
77.254
77.000
76.746
62.169
62.034
Se
NOMe
5
13C{1H} NMR (126 MHz, CDCl3)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

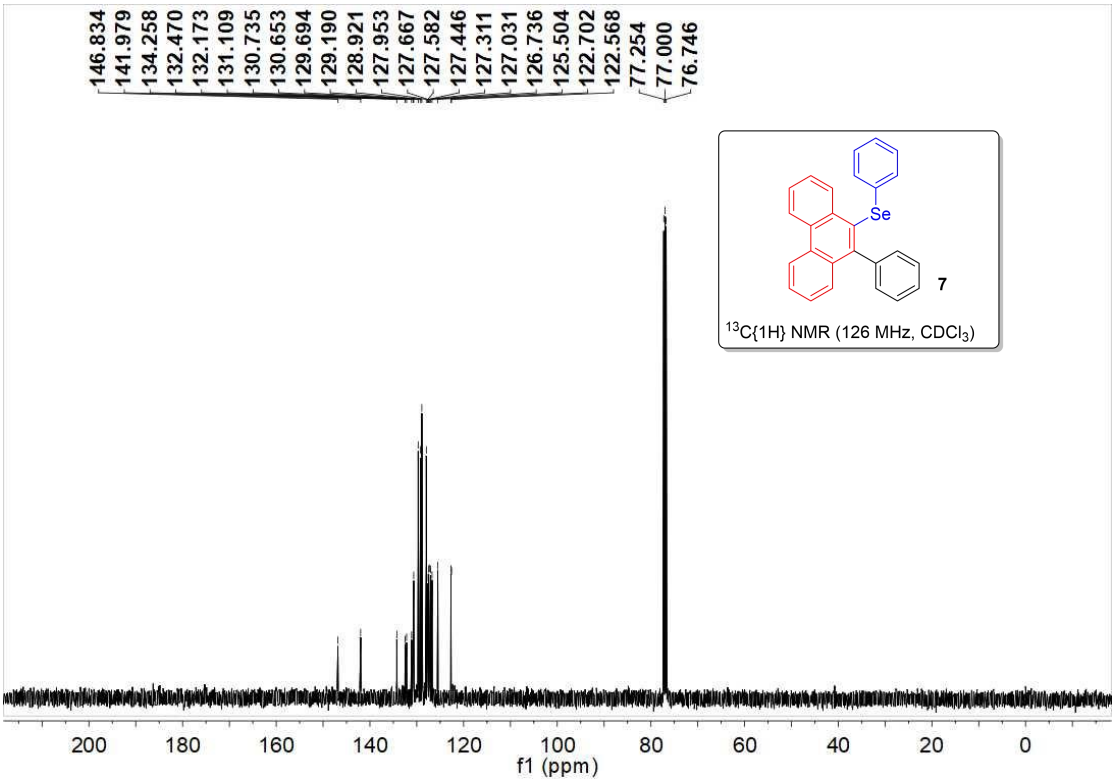


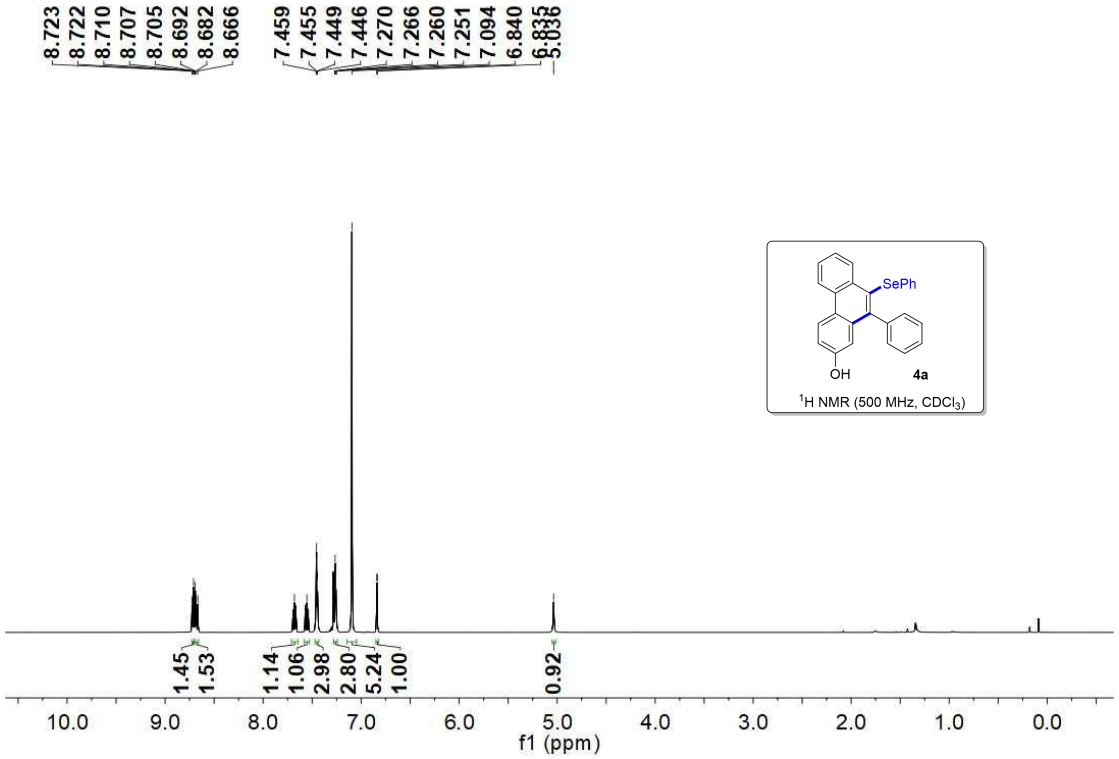
8.540
8.524
7.544
7.527
7.313
7.119
6.983
6.968
6.419
6
^{1}H NMR (500 MHz, $CDCl_3$)
0.96
4.18
1.19
5.25
2.32
2.10
4.00
10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0
f1 (ppm)

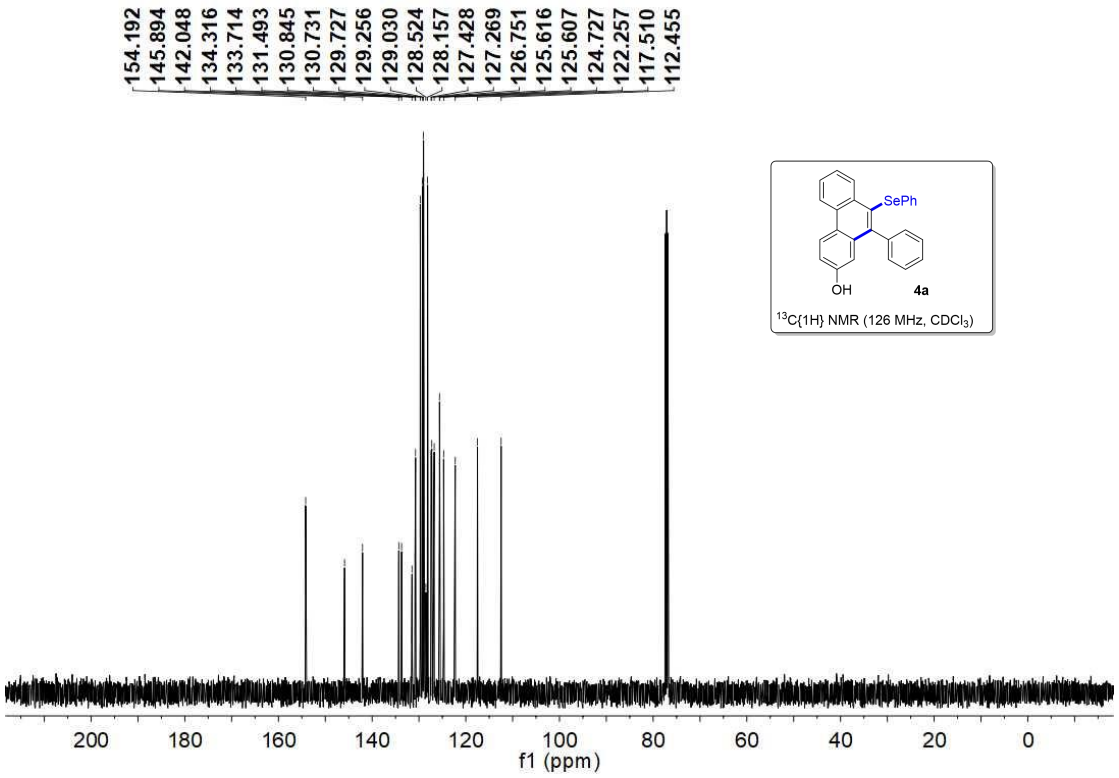


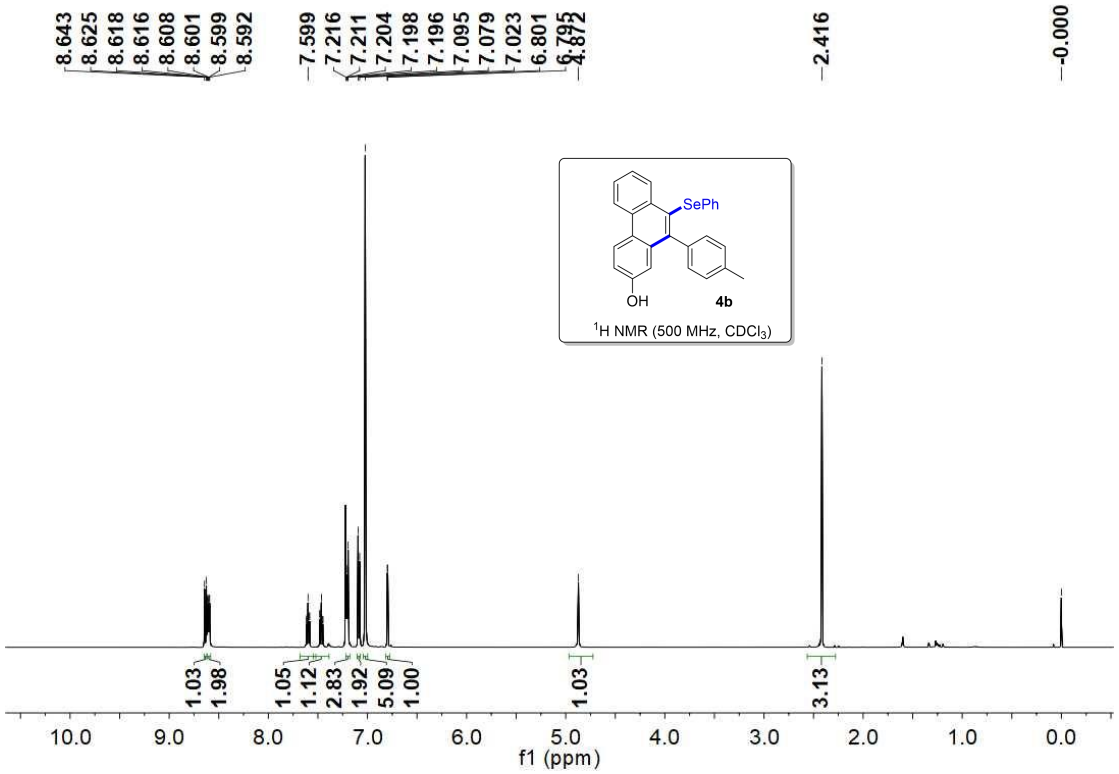
184.902
155.346
144.007
133.680
132.152
129.736
129.607
129.566
128.732
128.573
128.031
126.490
124.033
124.014
77.254
77.000
76.745
62.710
6
^{13}C{1H} NMR (126 MHz, $CDCl_3$)
200 180 160 140 120 100 80 60 40 20 0
f1 (ppm)

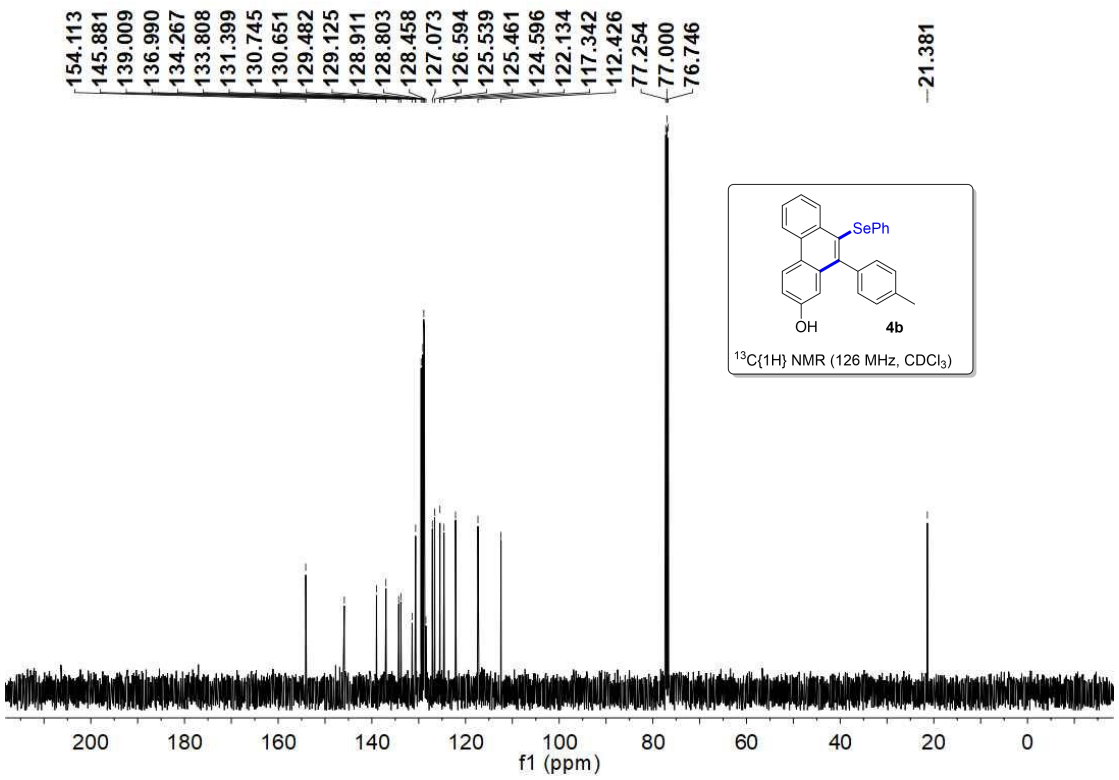

8.779
8.761
8.757
8.739
8.690
8.674
7.672
7.658
7.643
7.572
7.556
7.542
7.463
7.420
7.413
7.228
7.028
-0.000
Se
7
^{1}H NMR (500 MHz, CDCl$_3$)
2.08
1.00
2.15
1.00
5.05
1.86
5.13
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

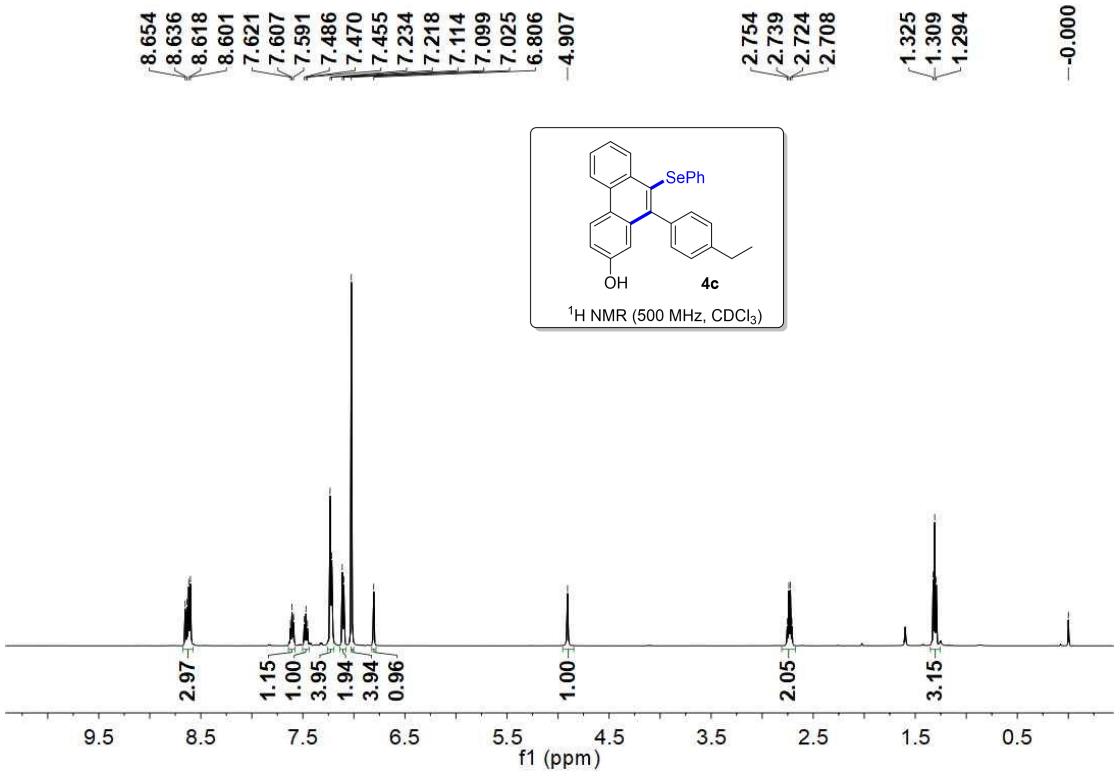

146.834
141.979
134.258
132.470
132.173
131.109
130.735
130.653
129.694
129.190
128.921
127.953
127.667
127.582
127.446
127.311
127.031
126.736
125.504
122.702
122.568
77.254
77.000
76.746
Se
7
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

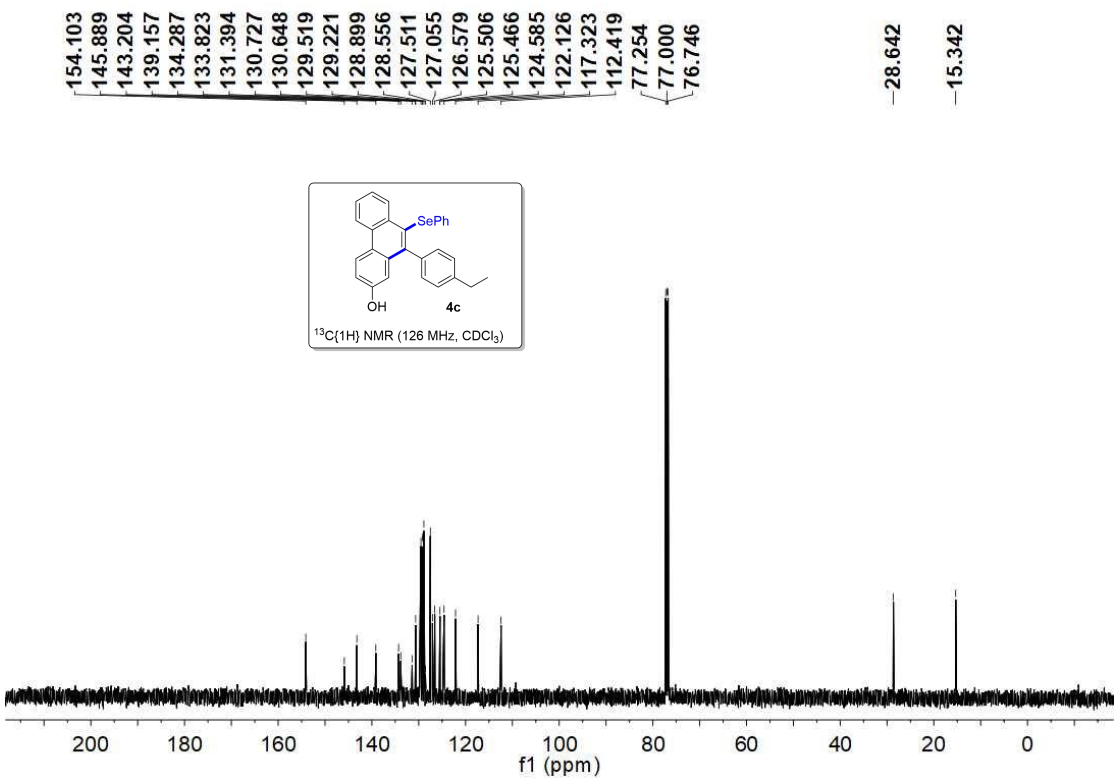

8.723
8.722
8.710
8.707
8.705
8.692
8.682
8.666
7.459
7.455
7.449
7.446
7.270
7.266
7.260
7.251
7.094
6.840
6.835
5.038
SePh
OH
4a
^{1}H NMR (500 MHz, CDCl$_3$)
1.45
1.53
1.14
1.06
2.98
2.80
5.24
1.00
0.92
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

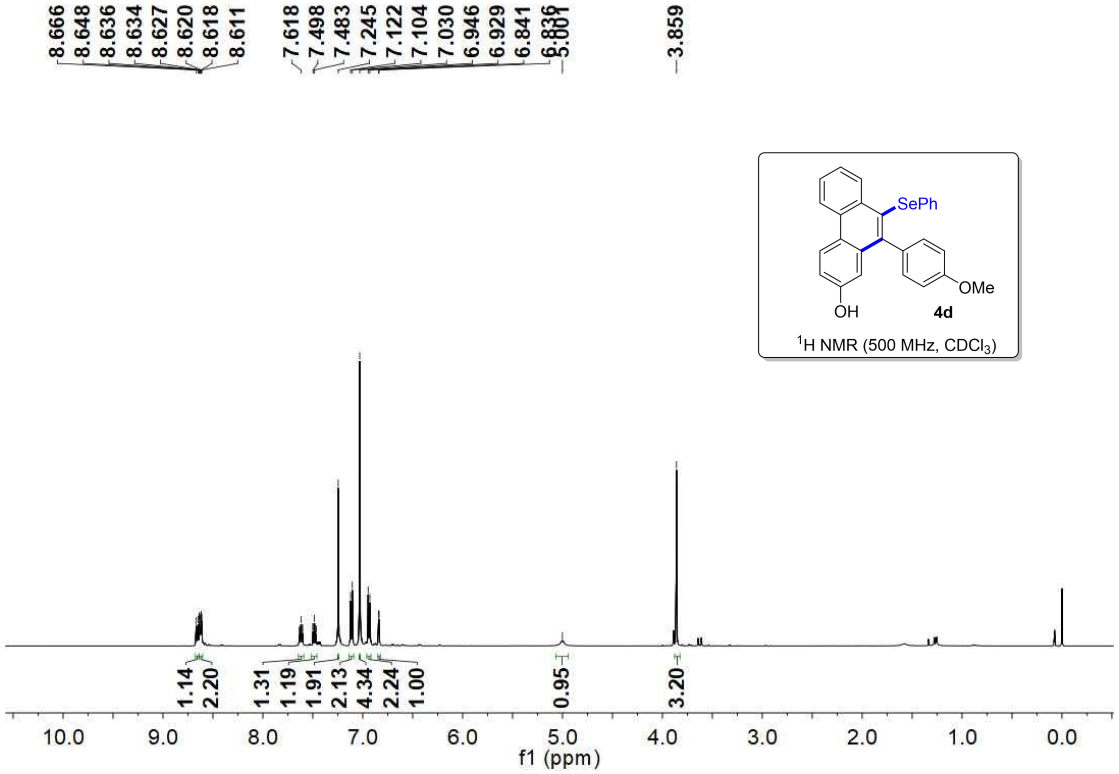

154.192
145.894
142.048
134.316
133.714
131.493
130.845
130.731
129.727
129.256
129.030
128.524
128.157
127.428
127.269
126.751
125.616
125.607
124.727
122.257
117.510
112.455
SePh
OH
4a
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

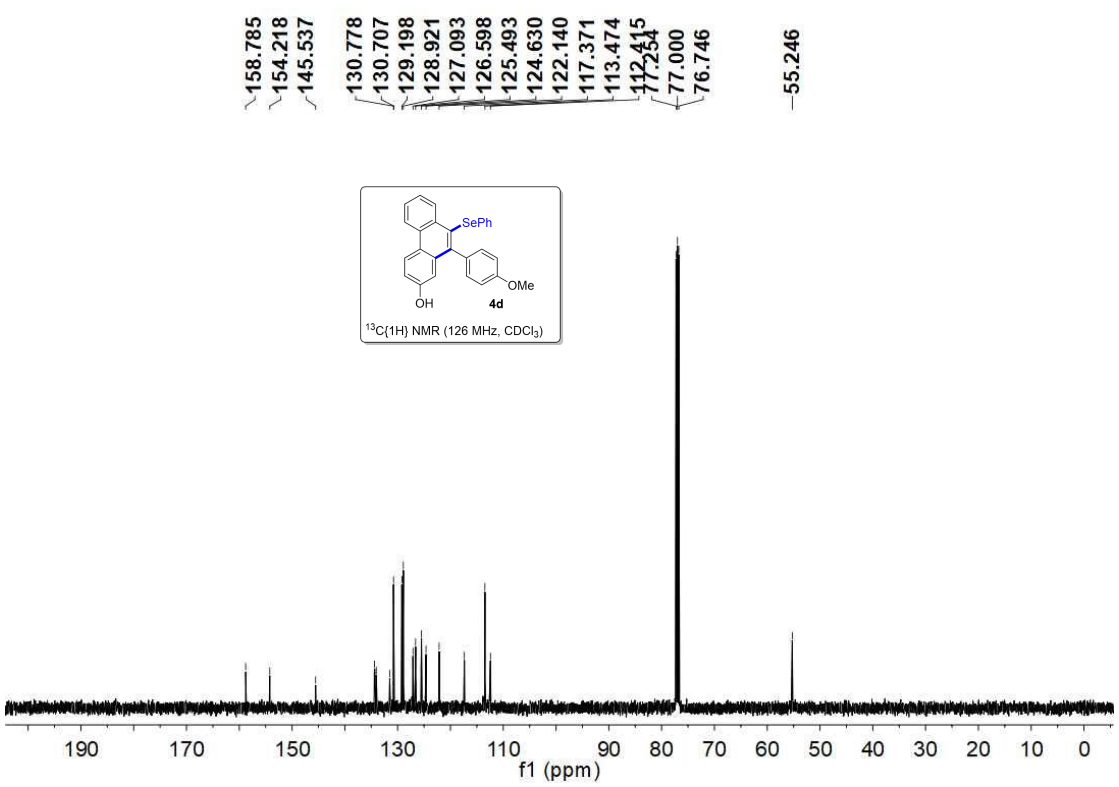

8.643
8.625
8.618
8.616
8.608
8.601
8.599
8.592
7.599
7.216
7.211
7.204
7.198
7.196
7.095
7.079
7.023
6.801
6.795
4.872
2.416
-0.000
SePh
OH
4b
^{1}H NMR (500 MHz, CDCl$_3$)
1.03
1.98
1.05
1.12
2.83
1.92
5.09
1.00
1.03
3.13
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

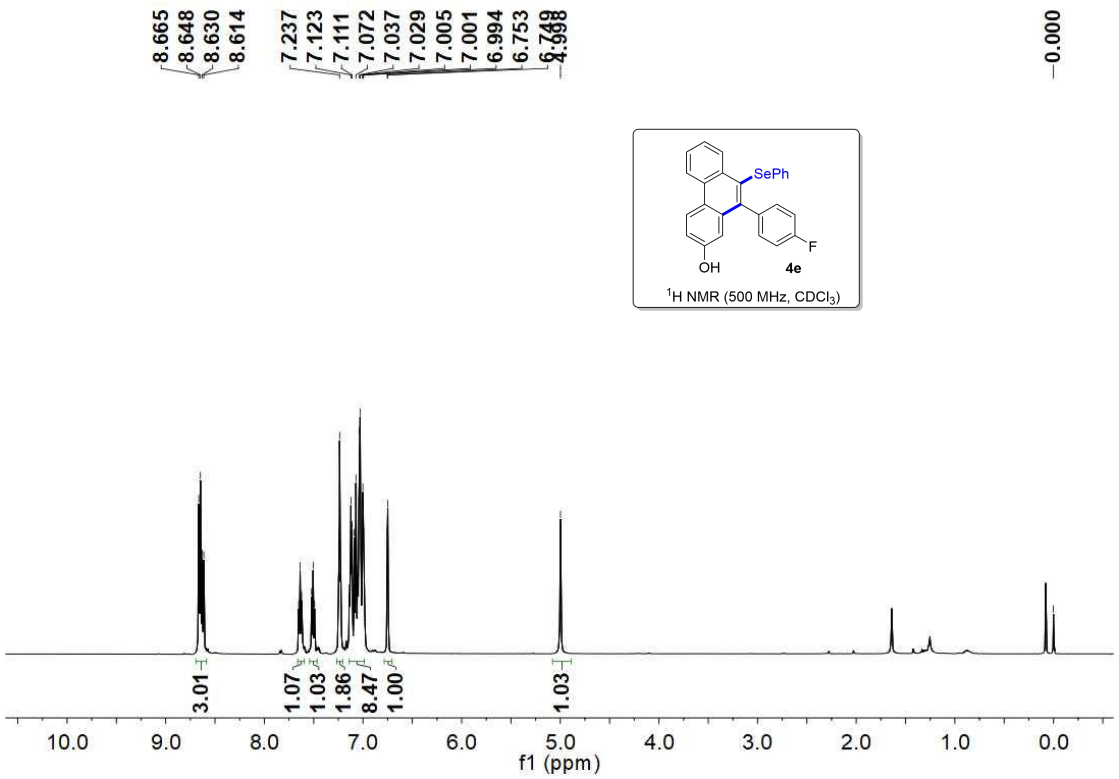

154.113
145.881
139.009
136.990
134.267
133.808
131.399
130.745
130.651
129.482
129.125
128.911
128.803
128.458
127.073
126.594
125.539
125.461
124.596
122.134
117.342
112.426
77.254
77.000
76.746
21.381
SePh
OH
4b
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

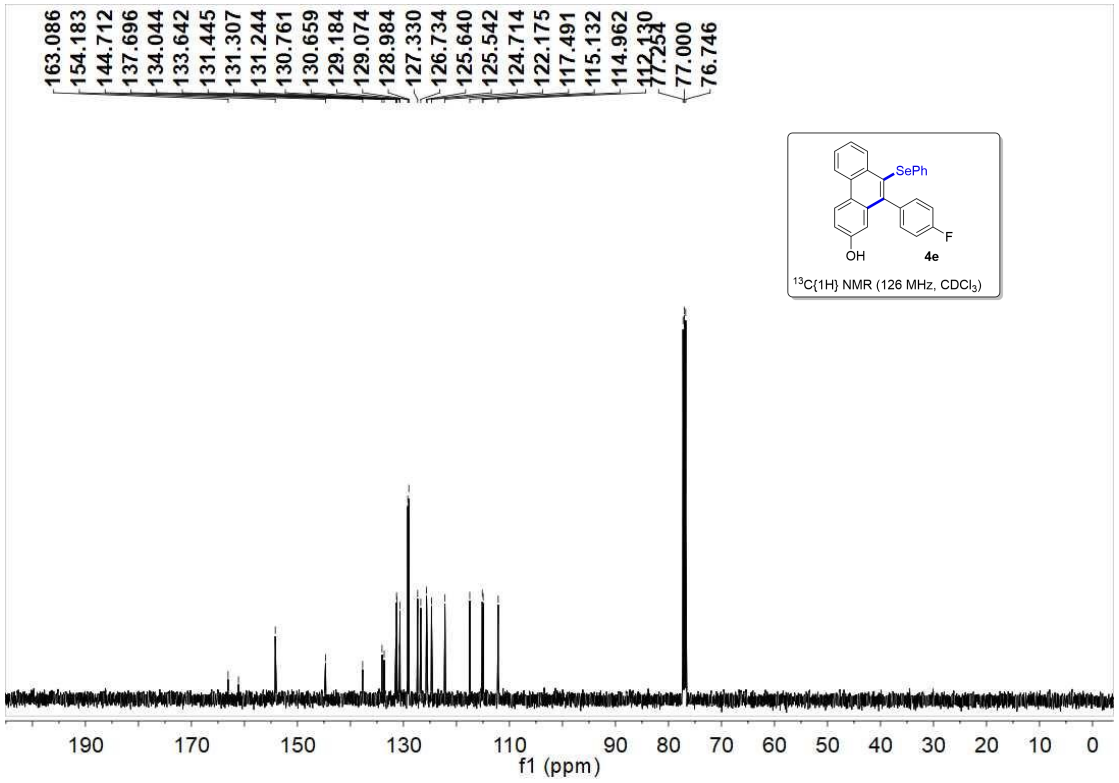

8.654
8.636
8.618
8.601
7.621
7.607
7.591
7.486
7.470
7.455
7.234
7.218
7.114
7.099
7.025
6.806
4.907
2.754
2.739
2.724
2.708
1.325
1.309
1.294
0.000
SePh
OH
4c
^{1}H NMR (500 MHz, CDCl$_3$)
2.97
1.15
1.00
3.95
1.94
3.94
0.96
1.00
2.05
3.15
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)

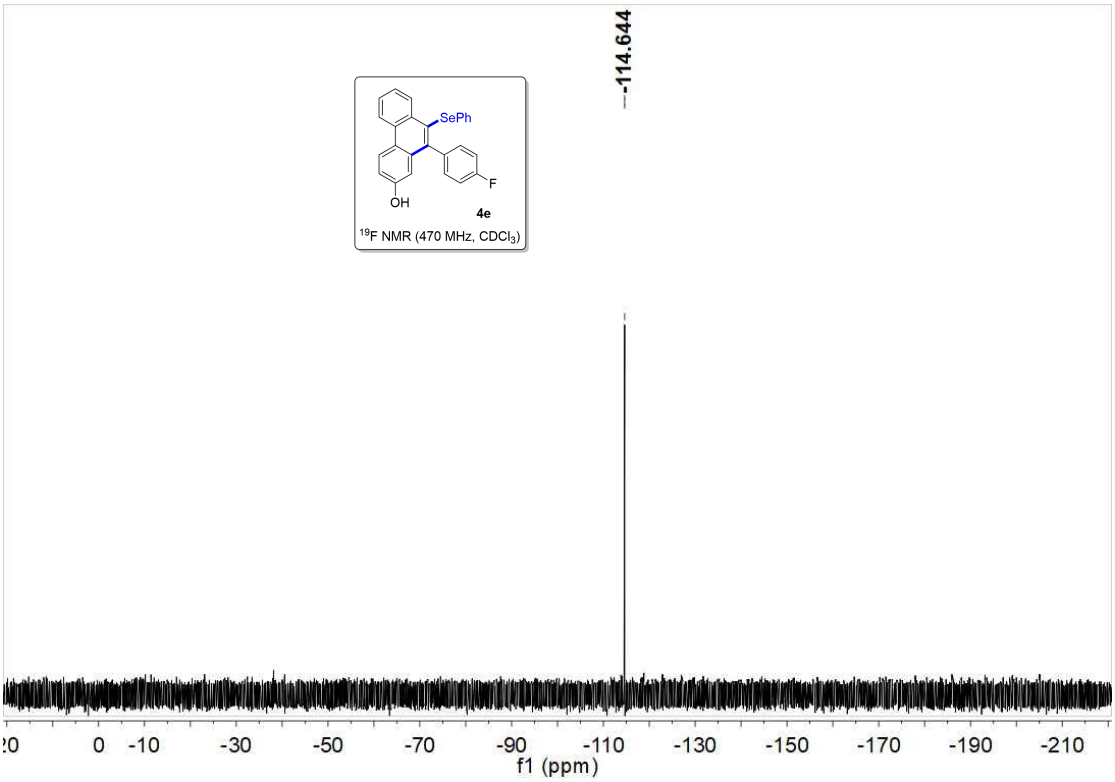

154.103
145.889
143.204
139.157
134.287
133.823
131.394
130.727
130.648
129.519
129.221
128.899
128.556
127.511
127.055
126.579
125.506
125.466
124.585
122.126
117.323
112.419
77.254
77.000
76.746
28.642
15.342
SePh
OH
4c
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

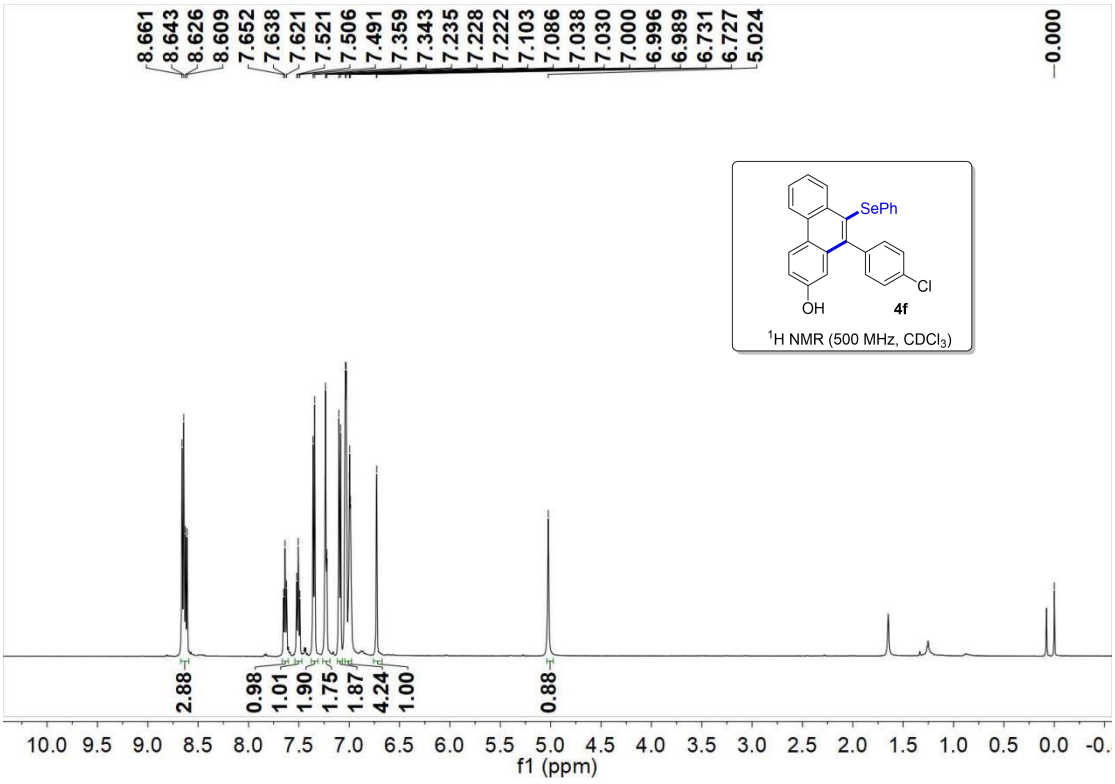

8.666
8.648
8.636
8.634
8.627
8.620
8.618
8.611
7.618
7.498
7.483
7.245
7.122
7.104
7.030
6.946
6.929
6.841
6.836
5.001
3.859
SePh
OMe
OH
4d
^{1}H NMR (500 MHz, CDCl$_3$)
1.14
2.20
1.31
1.19
1.91
2.13
4.34
2.24
1.00
0.95
3.20
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

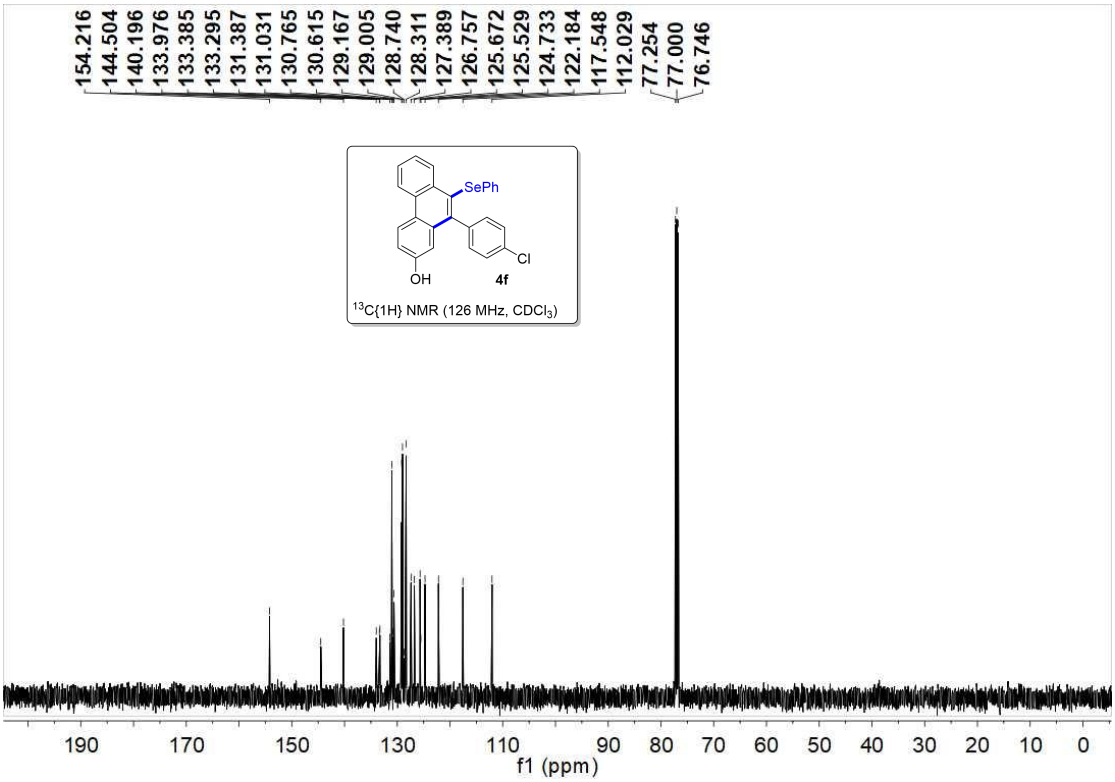

158.785
154.218
145.537
130.778
130.707
129.198
128.921
127.093
126.598
125.493
124.630
122.140
117.371
113.474
112.415
77.254
77.000
76.746
55.246
SePh
OMe
OH
4d
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

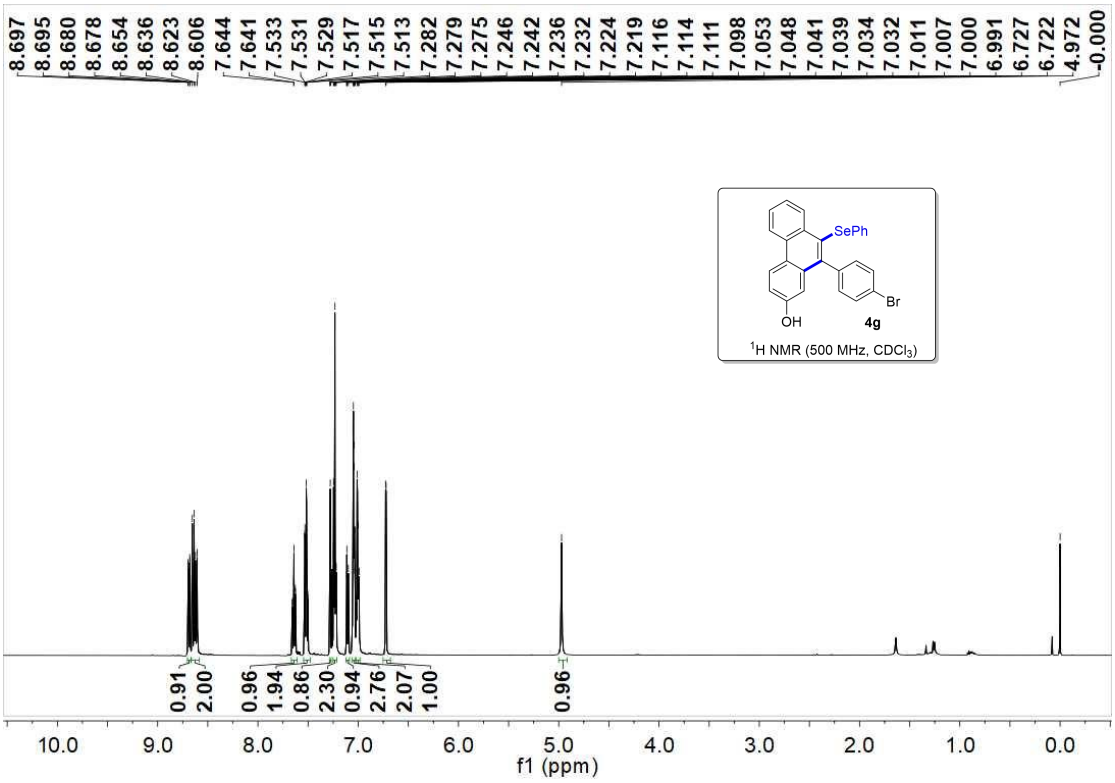

8.665
8.648
8.630
8.614
7.237
7.123
7.111
7.072
7.037
7.029
7.005
7.001
6.994
6.753
0.000
SePh
F
OH
4e
^{1}H NMR (500 MHz, CDCl$_3$)
3.01
1.07
1.03
1.86
8.47
1.00
1.03
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

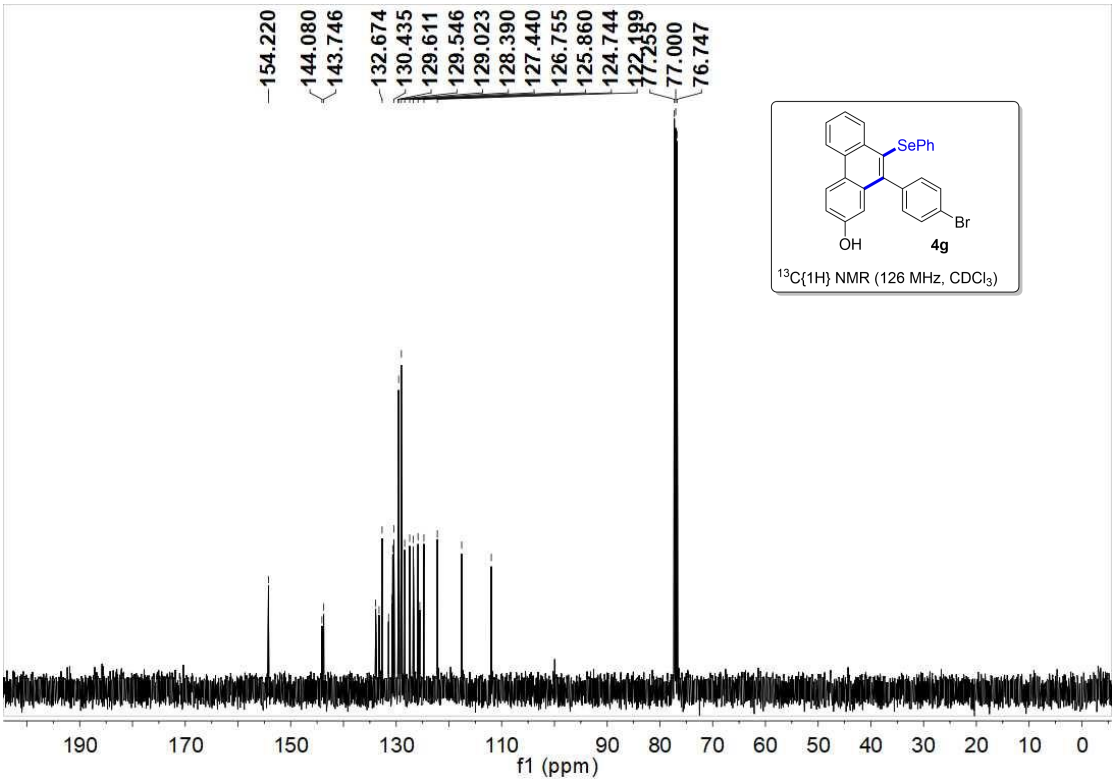

163.086
154.183
144.712
137.696
134.044
133.642
131.445
131.307
131.244
130.761
130.659
129.184
129.074
128.984
127.330
126.734
125.640
125.542
124.714
122.175
117.491
115.132
114.962
112.130
77.254
77.000
76.746
SePh
F
OH
4e
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

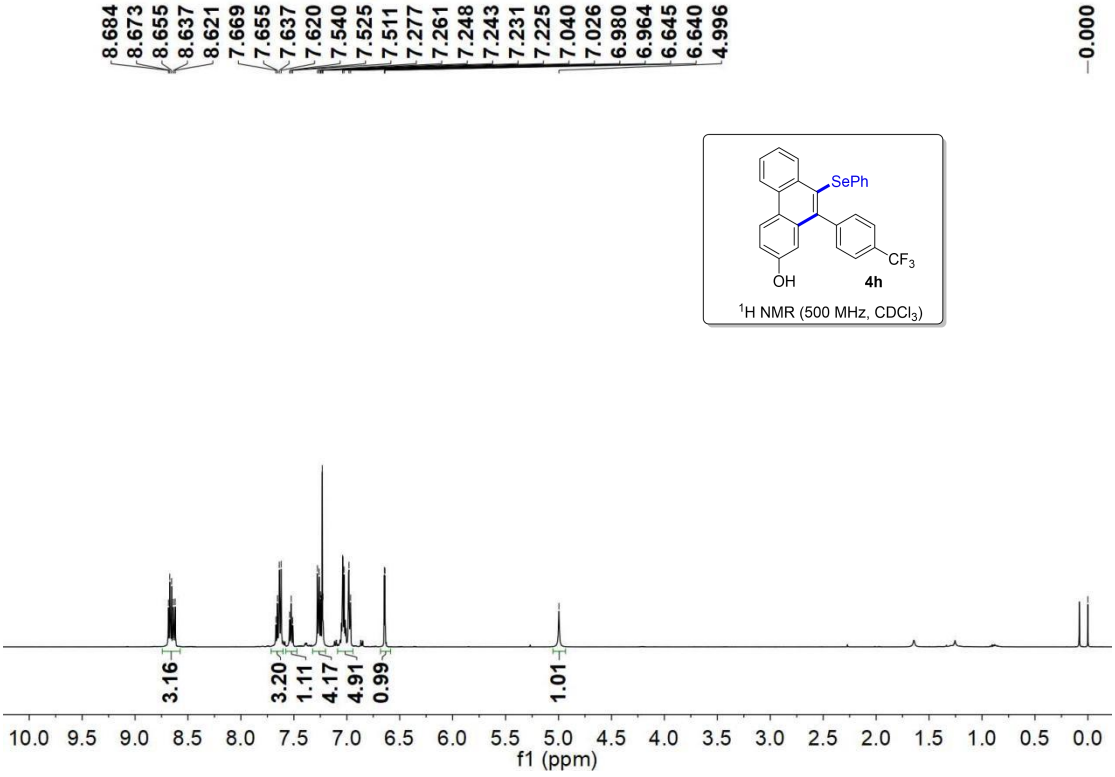

-114.644
SePh
F
OH
4e
^{19}F NMR (470 MHz, $CDCl_3$)
0 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210
f1 (ppm)

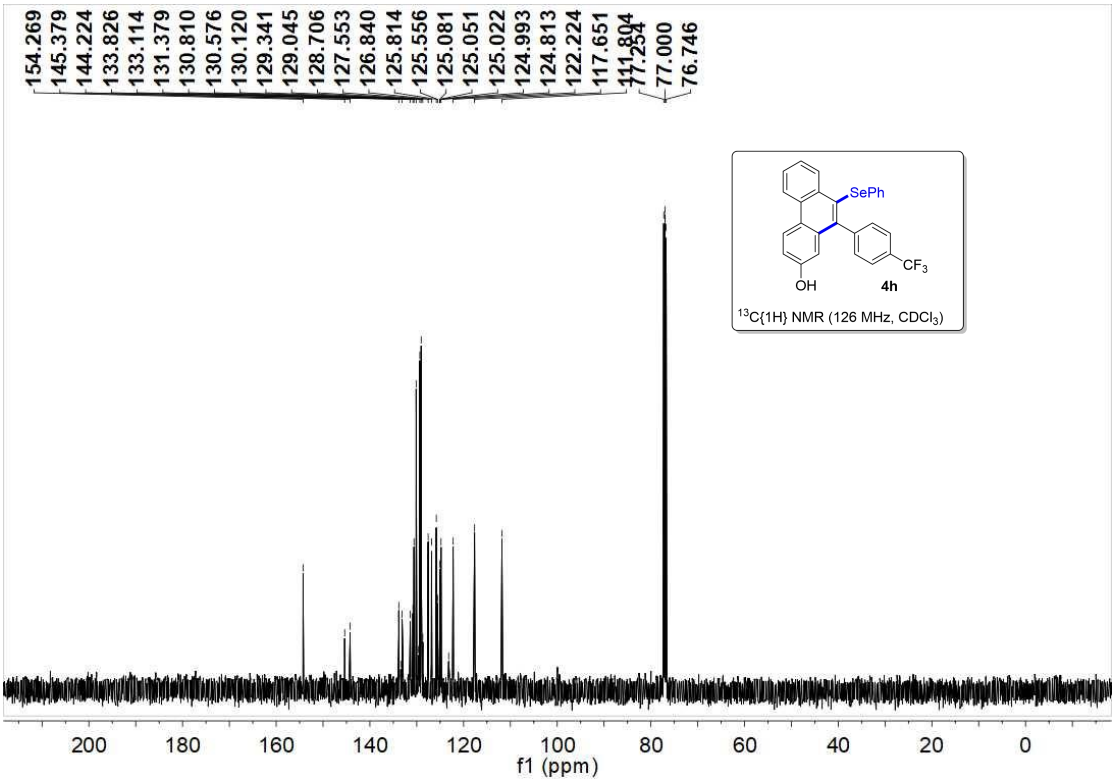

8.661
8.643
8.626
8.609
7.652
7.638
7.621
7.521
7.506
7.491
7.359
7.343
7.235
7.228
7.222
7.103
7.086
7.038
7.030
7.000
6.996
6.989
6.731
6.727
5.024
0.000
SePh
Cl
OH
4f
^{1}H NMR (500 MHz, $CDCl_3$)
2.88
0.98
1.01
1.90
1.75
1.87
4.24
1.00
0.88
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

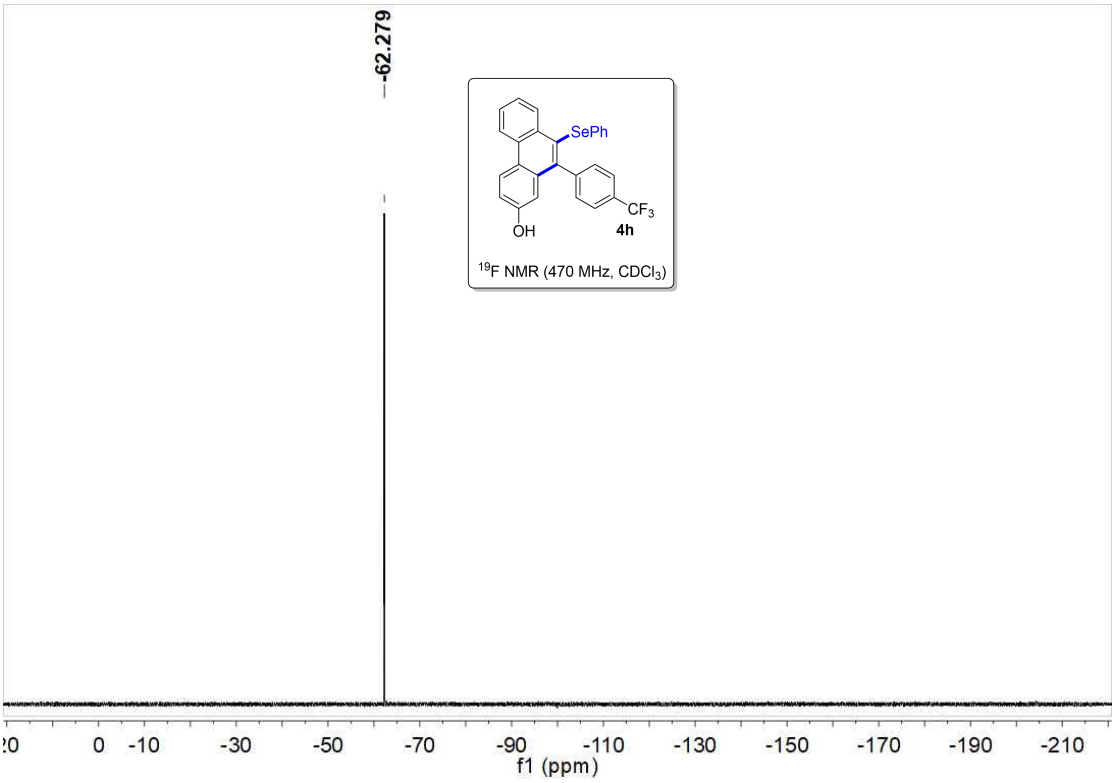

154.216
144.504
140.196
133.976
133.385
133.295
131.387
131.031
130.765
130.615
129.167
129.005
128.740
128.311
127.389
126.757
125.672
125.529
124.733
122.184
117.548
112.029
77.254
77.000
76.746
SePh
Cl
OH
4f
13C{1H} NMR (126 MHz, CDCl3)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

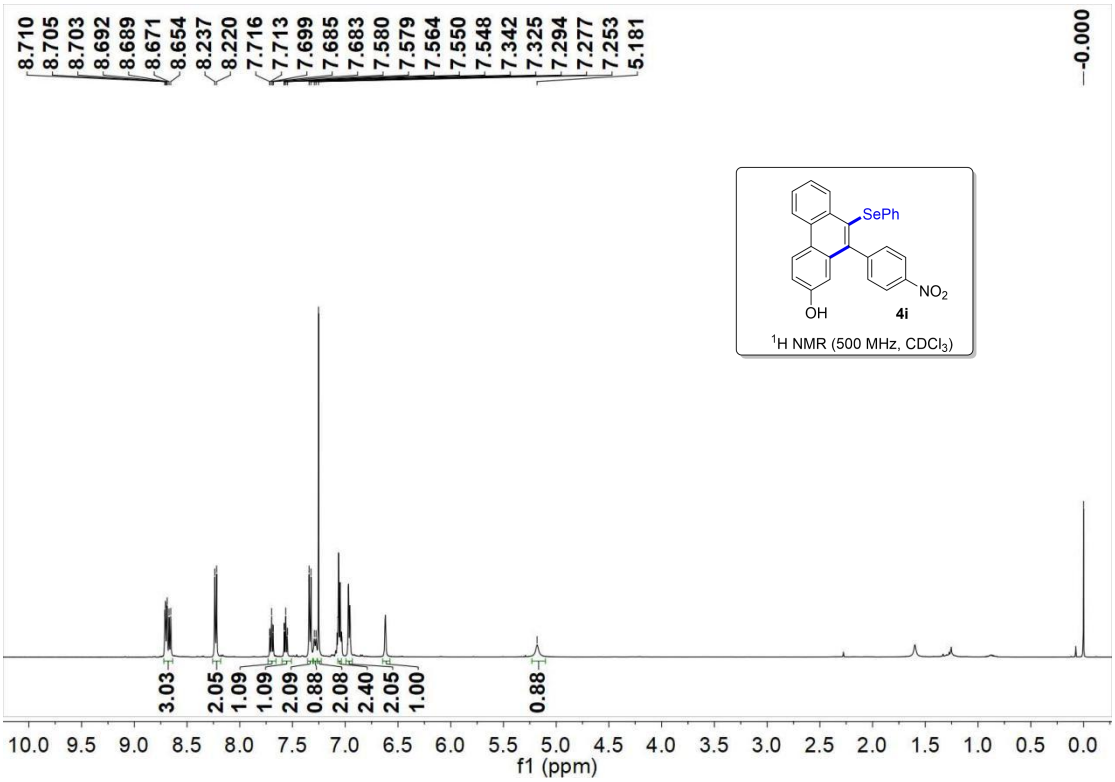

8.697
8.695
8.680
8.678
8.654
8.636
8.623
8.606
7.644
7.641
7.533
7.531
7.529
7.517
7.515
7.513
7.282
7.279
7.275
7.246
7.242
7.236
7.232
7.224
7.219
7.116
7.114
7.111
7.098
7.053
7.048
7.041
7.039
7.034
7.032
7.011
7.007
7.000
6.991
6.727
6.722
4.972
-0.000
SePh
Br
OH
4g
1H NMR (500 MHz, CDCl3)
0.91
2.00
0.96
1.94
0.86
2.30
0.94
2.76
2.07
1.00
0.96
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

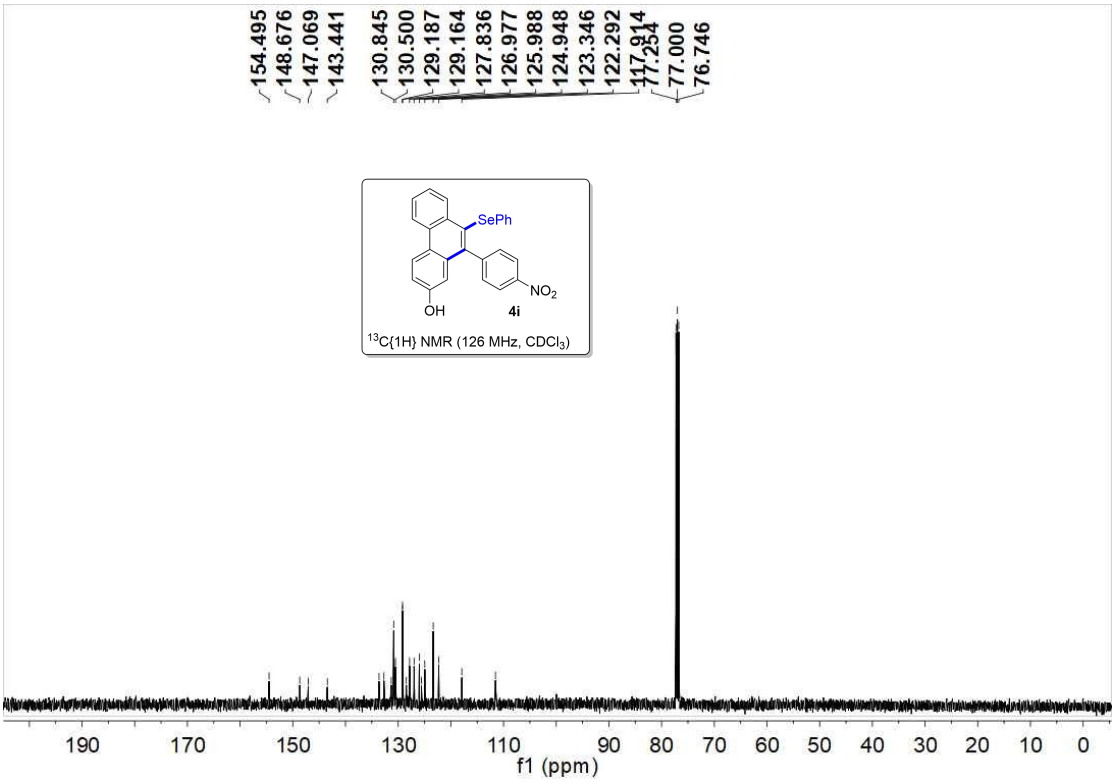

154.220
144.080
143.746
132.674
130.435
129.611
129.546
129.023
128.390
127.440
126.755
125.860
124.744
122.199
77.255
77.000
76.747
SePh
Br
OH
4g
$^{13}C\{1H\}$ NMR (126 MHz, $CDCl_3$)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

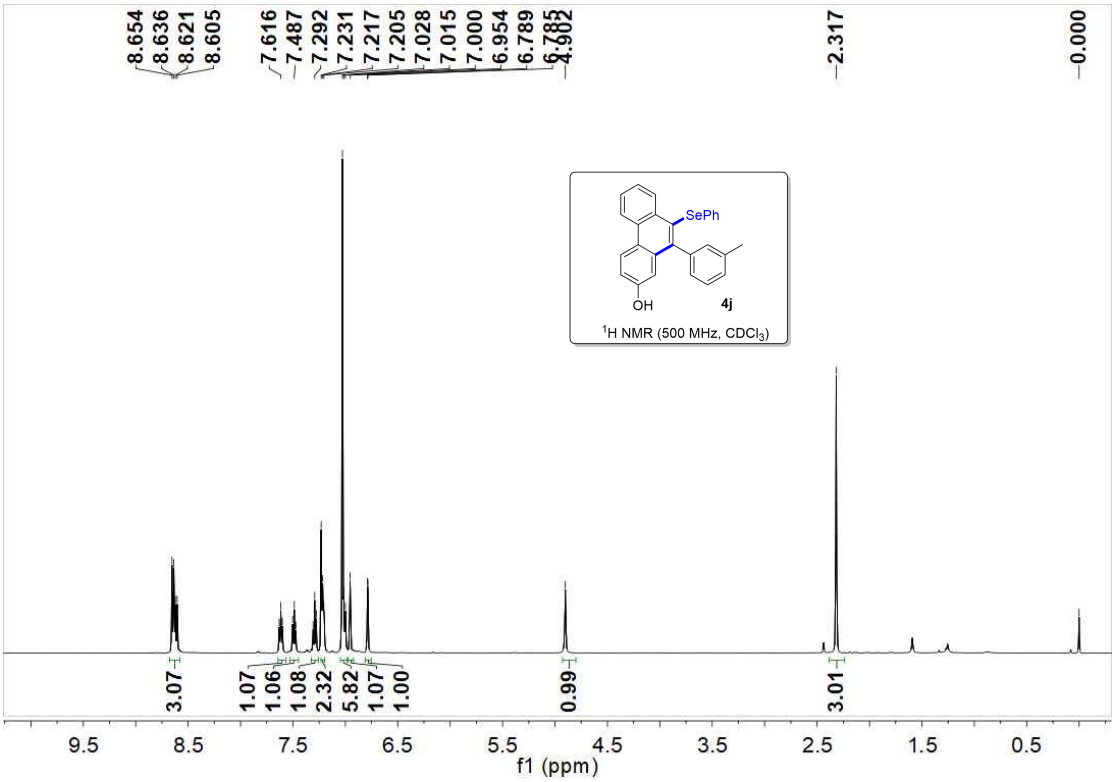

8.684
8.673
8.655
8.637
8.621
7.669
7.655
7.637
7.620
7.540
7.525
7.511
7.277
7.261
7.248
7.243
7.231
7.225
7.040
7.026
6.980
6.964
6.645
6.640
4.996
0.000
SePh
CF3
OH
4h
^{1}H NMR (500 MHz, $CDCl_3$)
3.16
3.20
1.11
4.17
4.91
0.99
1.01
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

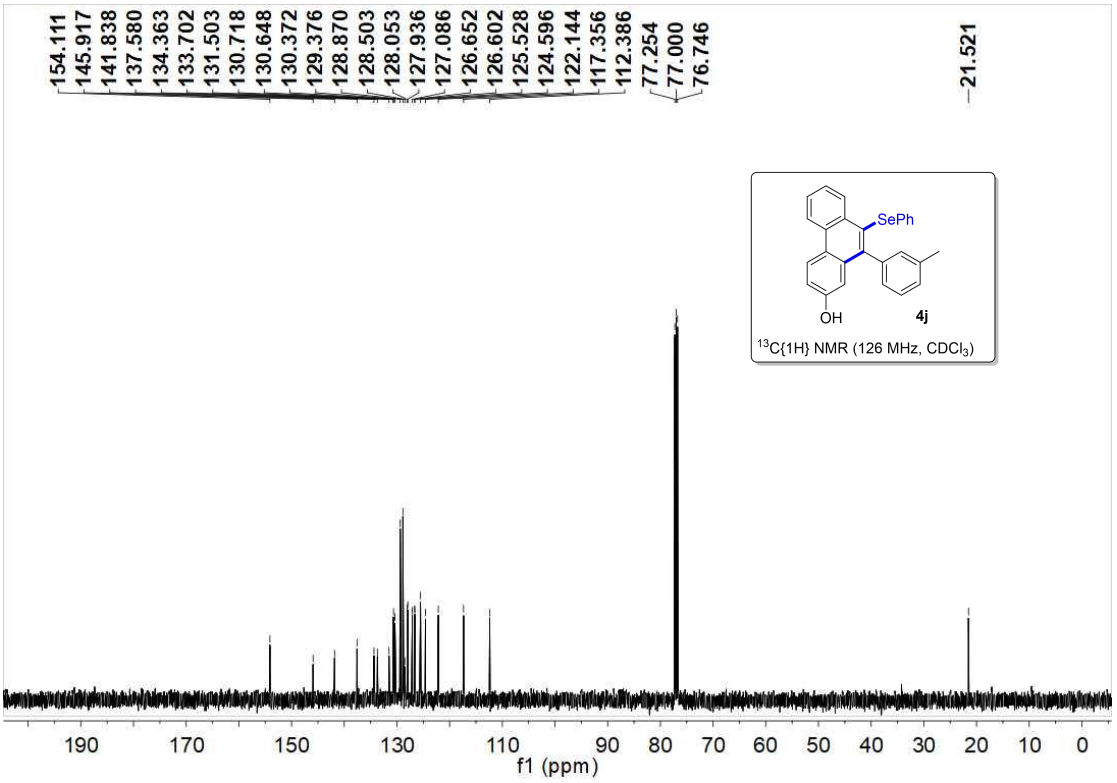

154.269
145.379
144.224
133.826
133.114
131.379
130.810
130.576
130.120
129.341
129.045
128.706
127.553
126.840
125.814
125.556
125.081
125.051
125.022
124.993
124.813
122.224
117.651
111.804
77.254
77.000
76.746
SePh
CF3
OH
4h
13C{1H} NMR (126 MHz, CDCl3)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

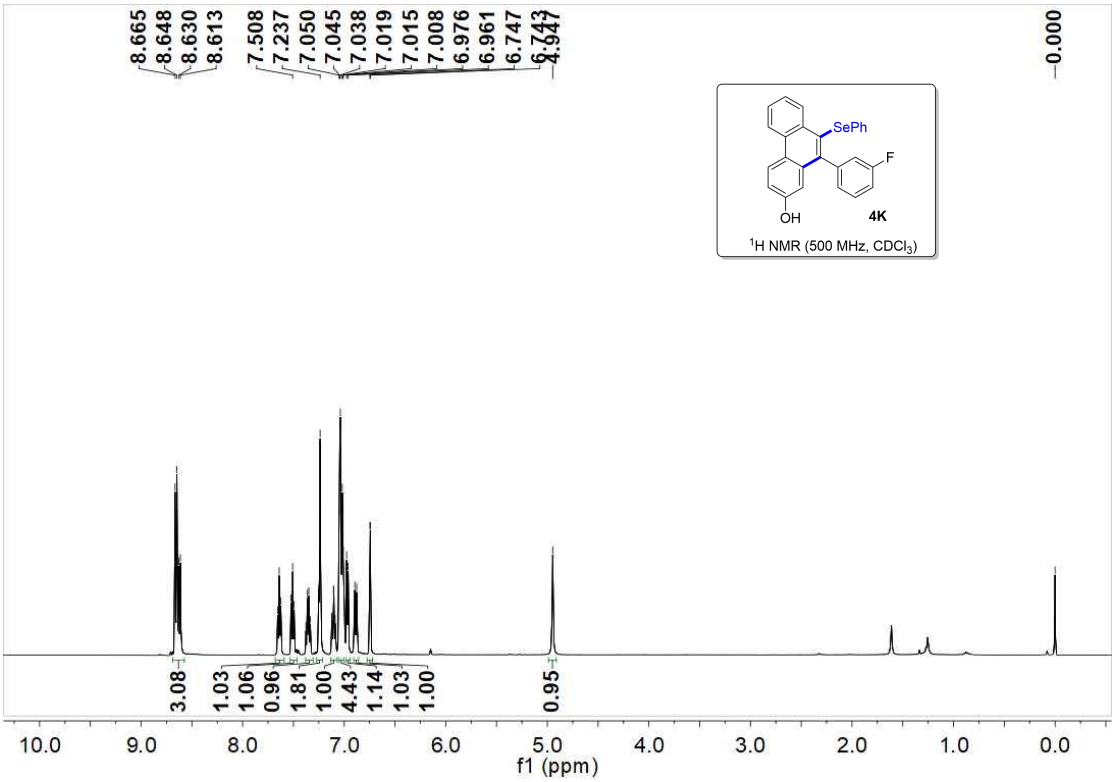

-62.279
SePh
CF3
OH
4h
19F NMR (470 MHz, CDCl3)
0
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
f1 (ppm)

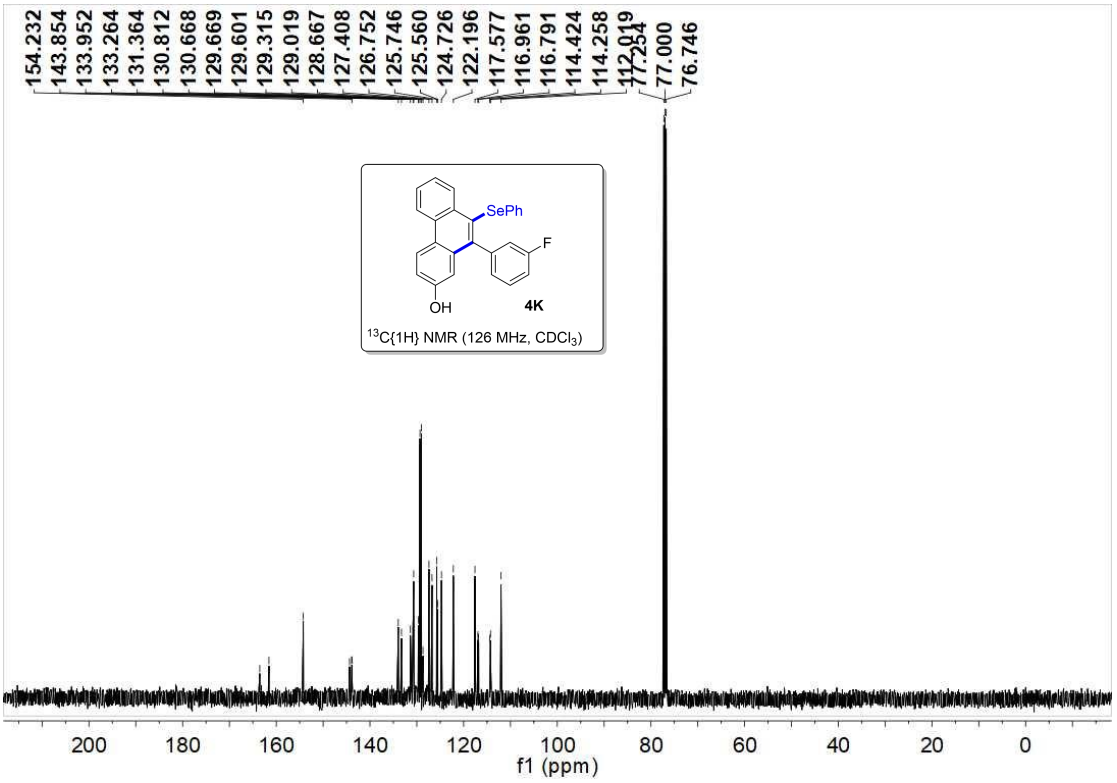

8.710
8.705
8.703
8.692
8.689
8.671
8.654
8.237
8.220
7.716
7.713
7.699
7.685
7.683
7.580
7.579
7.564
7.550
7.548
7.342
7.325
7.294
7.277
7.253
5.181
-0.000
SePh
NO2
OH
4i
1H NMR (500 MHz, CDCl3)
3.03
2.05
1.09
1.09
2.09
0.88
2.08
2.40
2.05
1.00
0.88
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

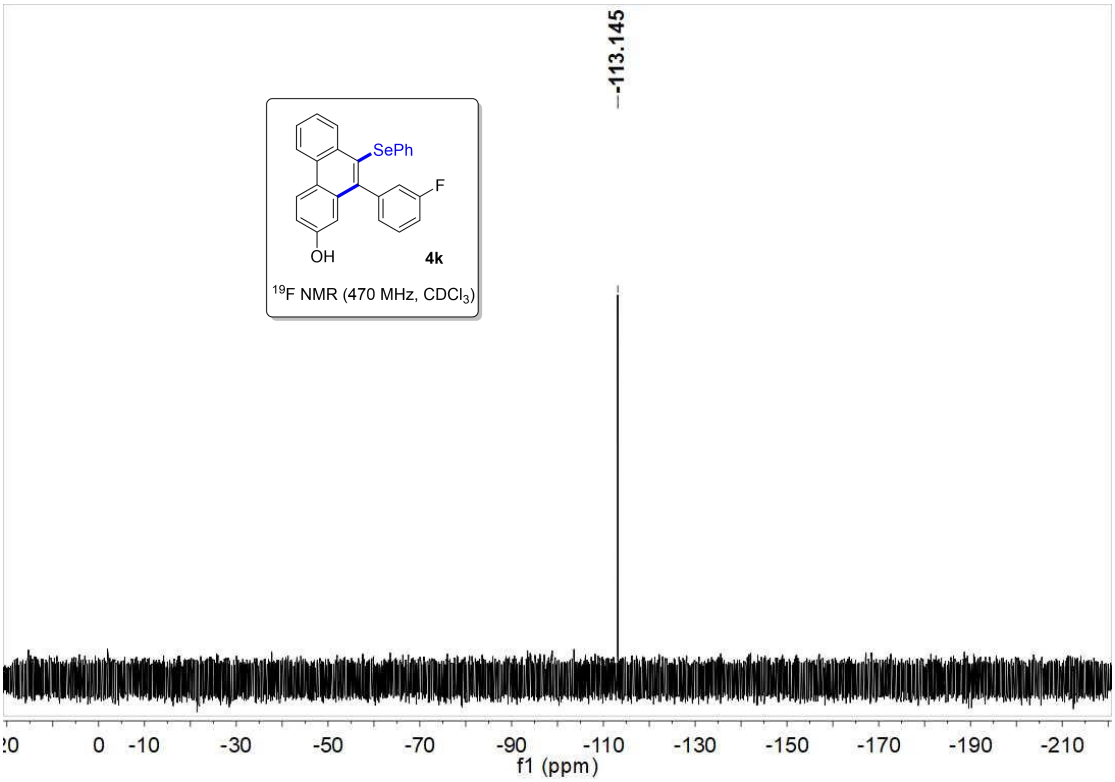

154.495
148.676
147.069
143.441
130.845
130.500
129.187
129.164
127.836
126.977
125.988
124.948
123.346
122.292
117.914
77.254
77.000
76.746
SePh
NO2
OH
4i
13C{1H} NMR (126 MHz, CDCl3)
190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

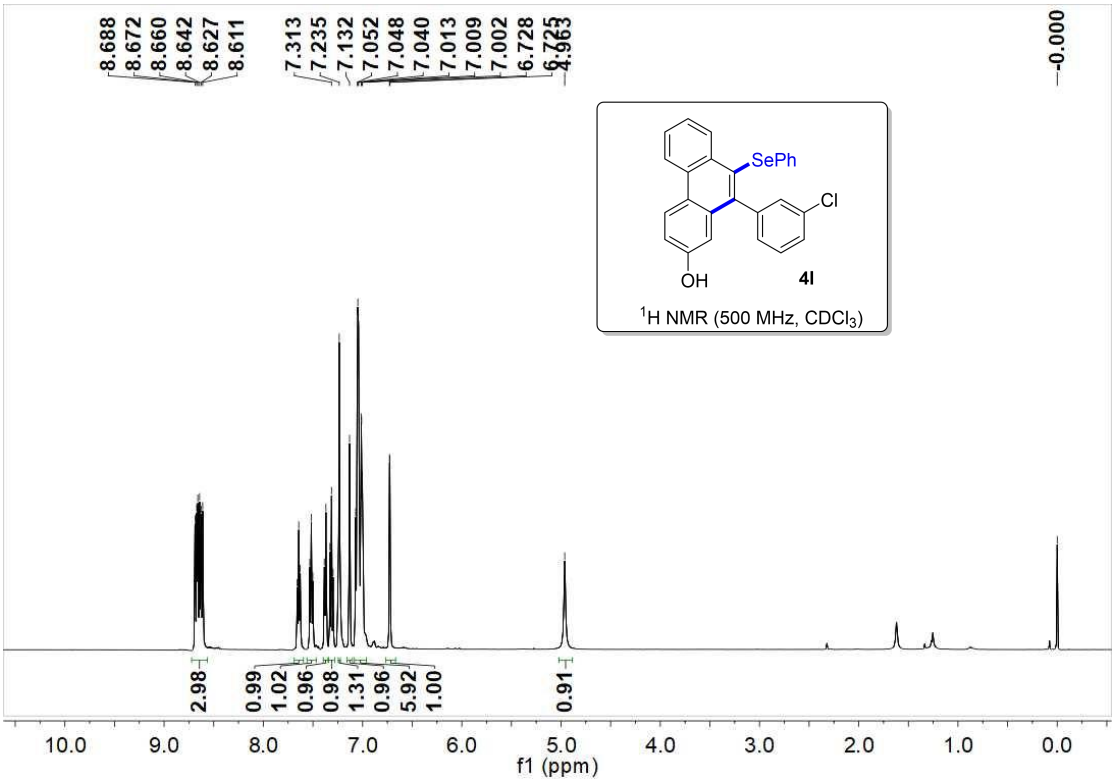

8.654
8.636
8.621
8.605
7.616
7.487
7.292
7.231
7.217
7.205
7.028
7.015
7.000
6.954
6.789
6.785
6.782
4.902
2.317
0.000
SePh
OH
4j
^{1}H NMR (500 MHz, CDCl$_3$)
3.07
1.07
1.06
1.08
2.32
5.82
1.07
1.00
0.99
3.01
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)

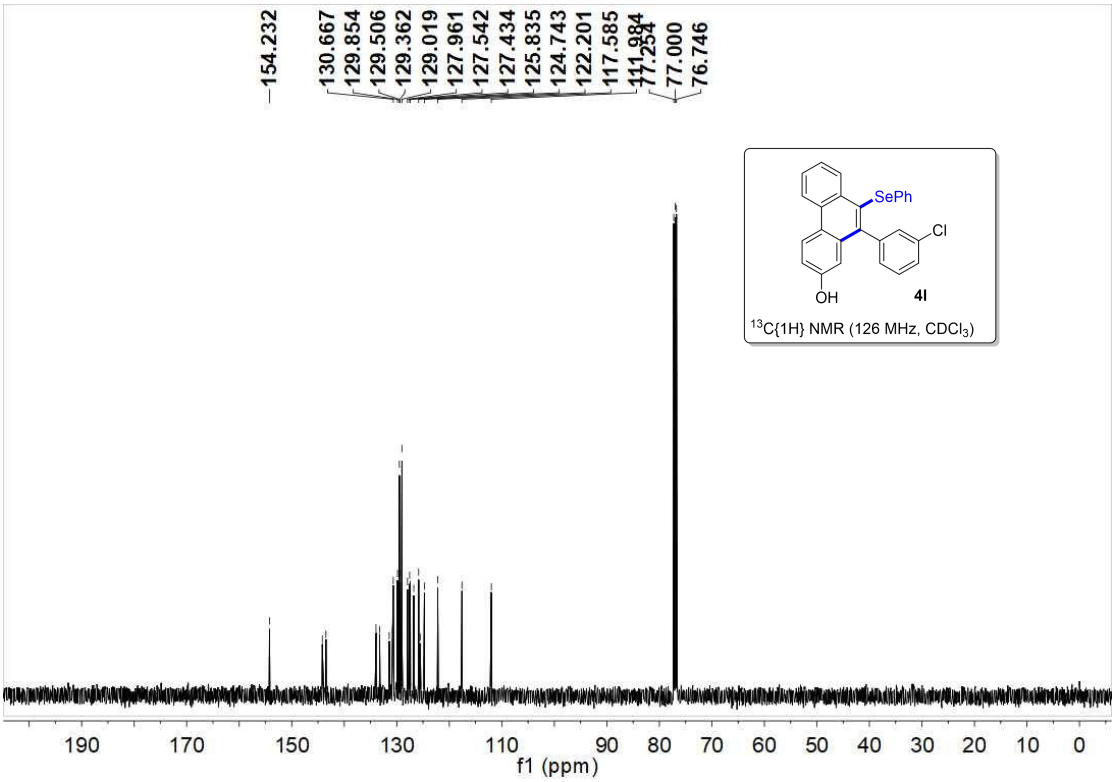

154.111
145.917
141.838
137.580
134.363
133.702
131.503
130.718
130.648
130.372
129.376
128.870
128.503
128.053
127.936
127.086
126.652
126.602
125.528
124.596
122.144
117.356
112.386
77.254
77.000
76.746
21.521
SePh
OH
4j
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

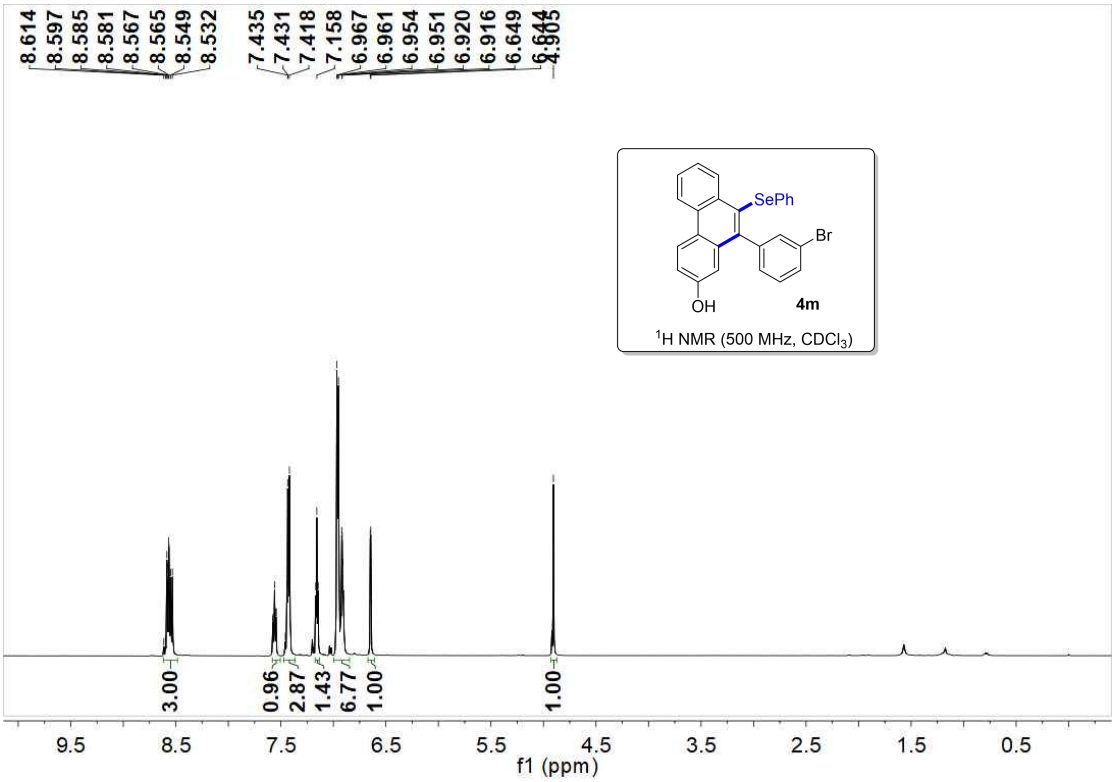

8.665
8.648
8.630
8.613
7.508
7.237
7.050
7.045
7.038
7.019
7.015
7.008
6.976
6.961
6.747
6.743
4.947
0.000
SePh
F
OH
4K
^{1}H NMR (500 MHz, CDCl$_3$)
3.08
1.03
1.06
0.96
1.81
1.00
4.43
1.14
1.03
1.00
0.95
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

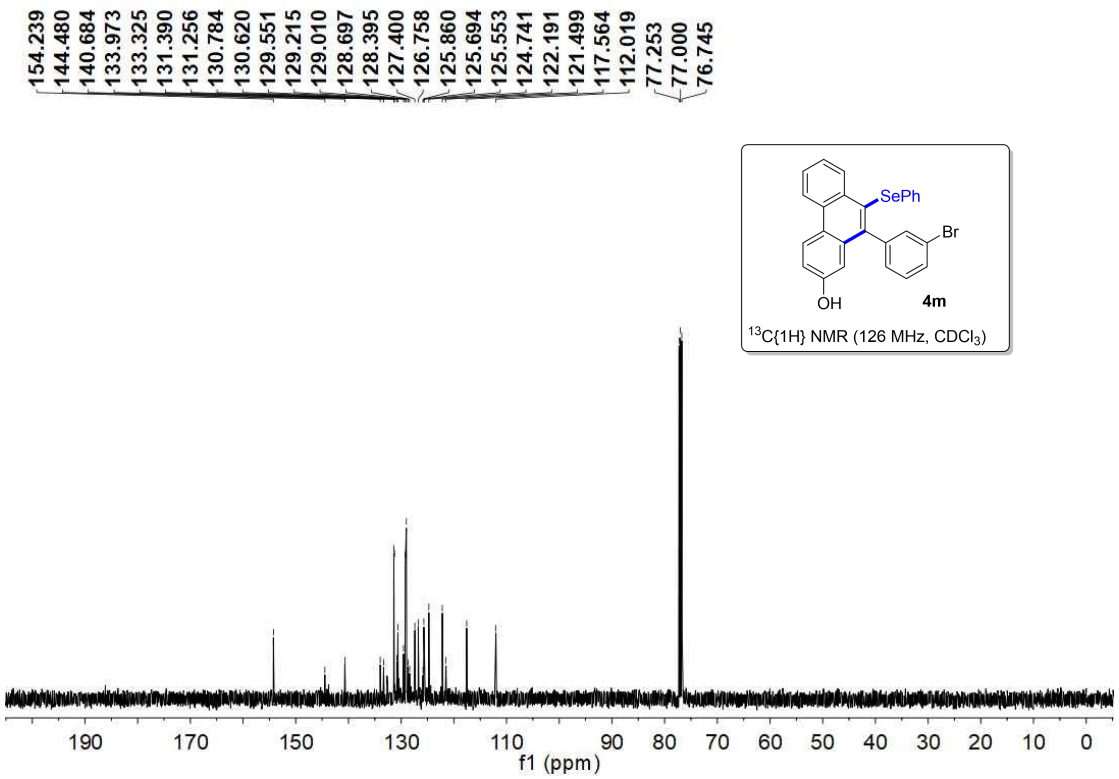

154.232
143.854
133.952
133.264
131.364
130.812
130.668
129.669
129.601
129.315
129.019
128.667
127.408
126.752
125.746
125.560
124.726
122.196
117.577
116.961
116.791
114.424
114.258
112.019
77.254
77.000
76.746
SePh
F
OH
4K
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

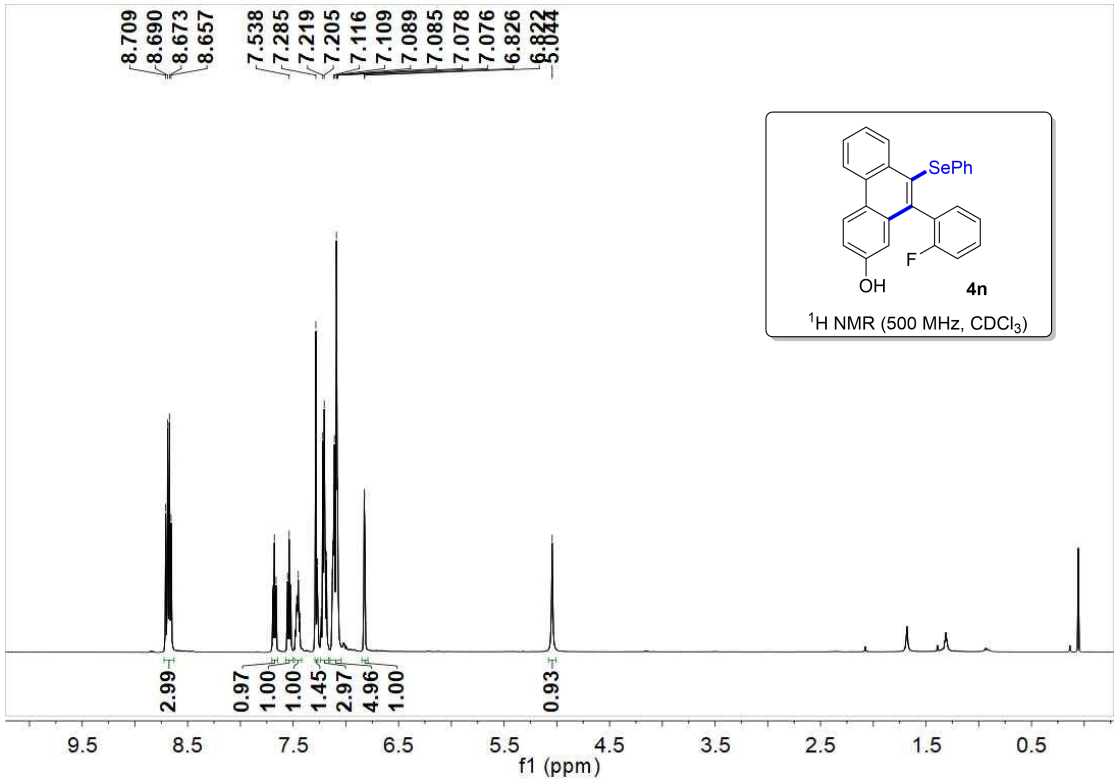

-113.145
SePh
F
OH
4k
19F NMR (470 MHz, CDCl3)
0
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
f1 (ppm)

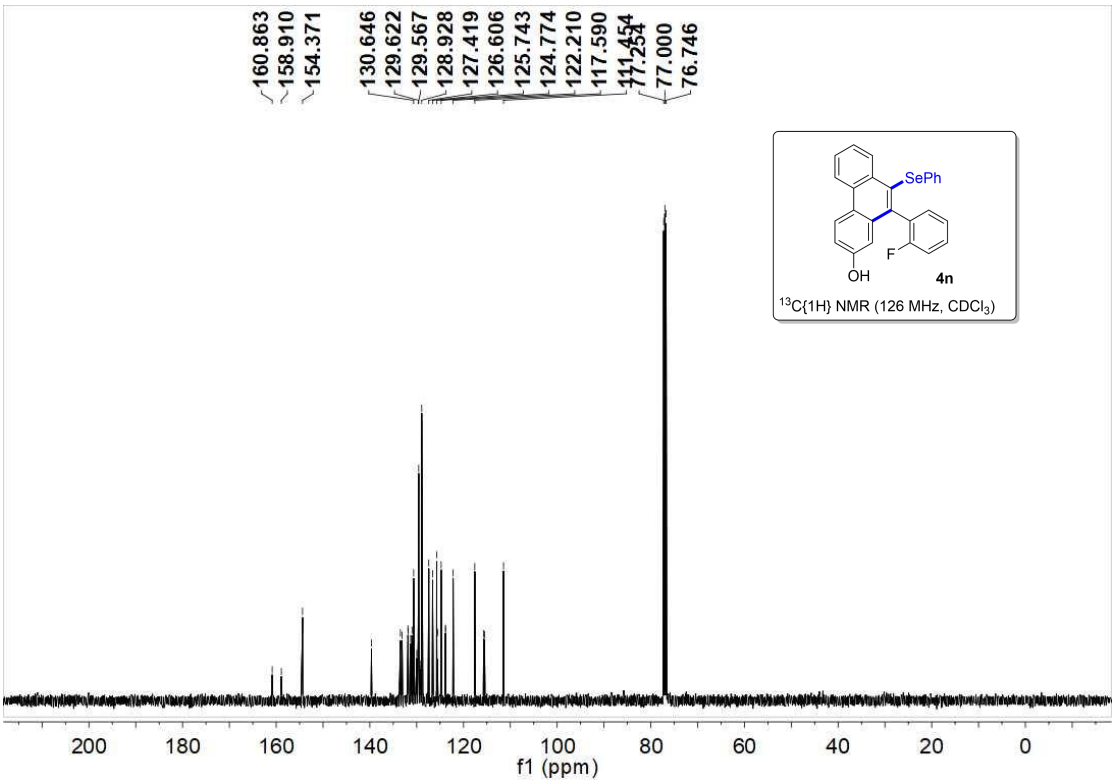

8.688
8.672
8.660
8.642
8.627
8.611
7.313
7.235
7.132
7.052
7.048
7.040
7.013
7.009
7.002
6.728
6.725
4.963
-0.000
SePh
Cl
OH
4l
1H NMR (500 MHz, CDCl3)
2.98
0.99
1.02
0.96
0.98
1.31
0.96
5.92
1.00
0.91
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

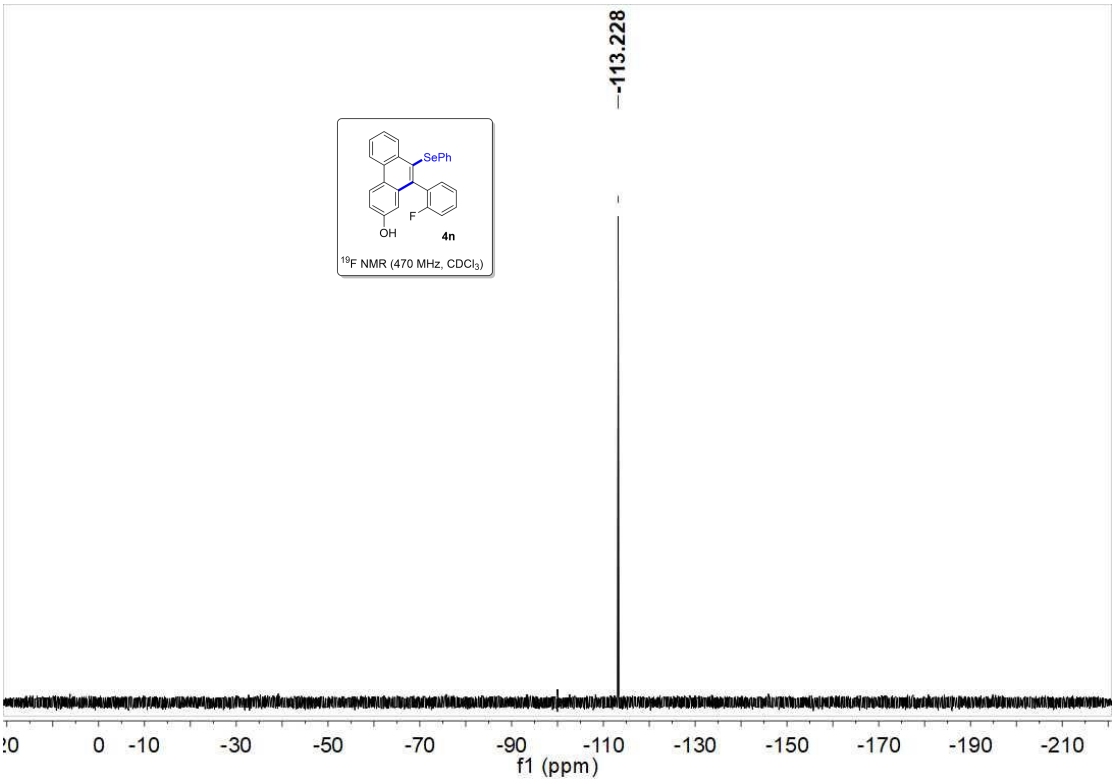

154.232
130.667
129.854
129.506
129.362
129.019
127.961
127.542
127.434
125.835
124.743
122.201
117.585
111.984
77.254
77.000
76.746
SePh
Cl
OH
4l
13C{1H} NMR (126 MHz, CDCl3)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

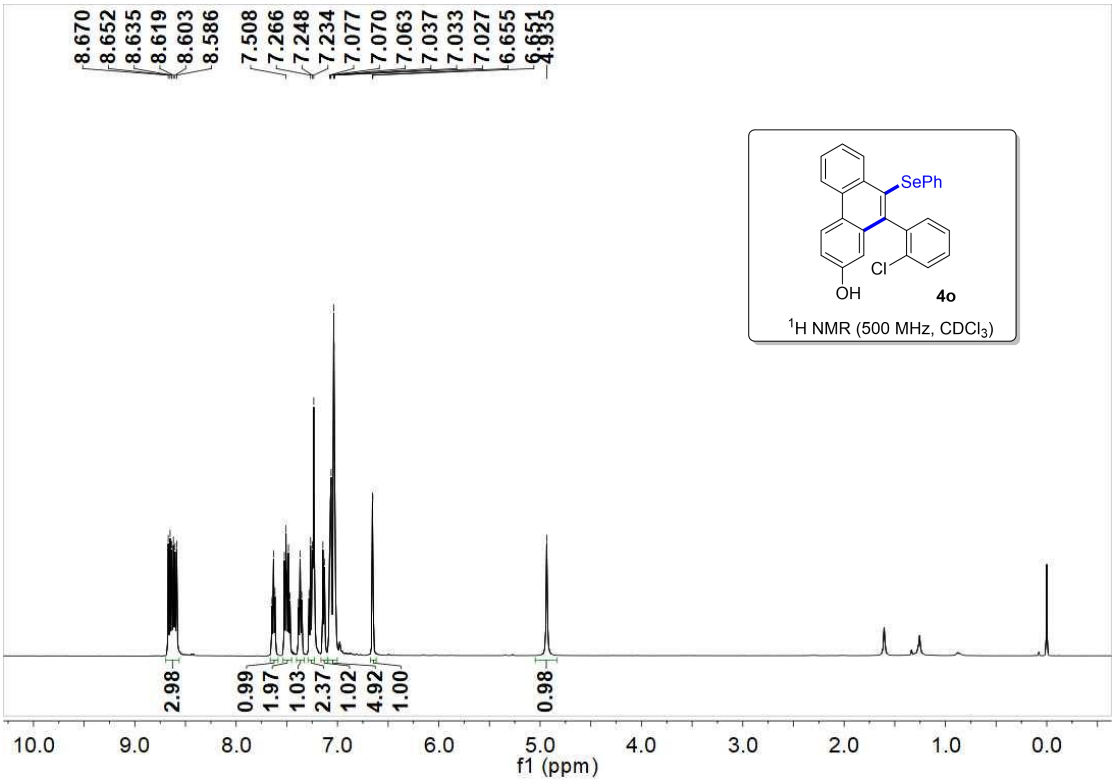

8.614
8.597
8.585
8.581
8.567
8.565
8.549
8.532
7.435
7.431
7.418
7.158
6.967
6.961
6.954
6.951
6.920
6.916
6.649
6.644
4.905
SePh
Br
OH
4m
1H NMR (500 MHz, CDCl3)
3.00
0.96
2.87
1.43
6.77
1.00
1.00
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)

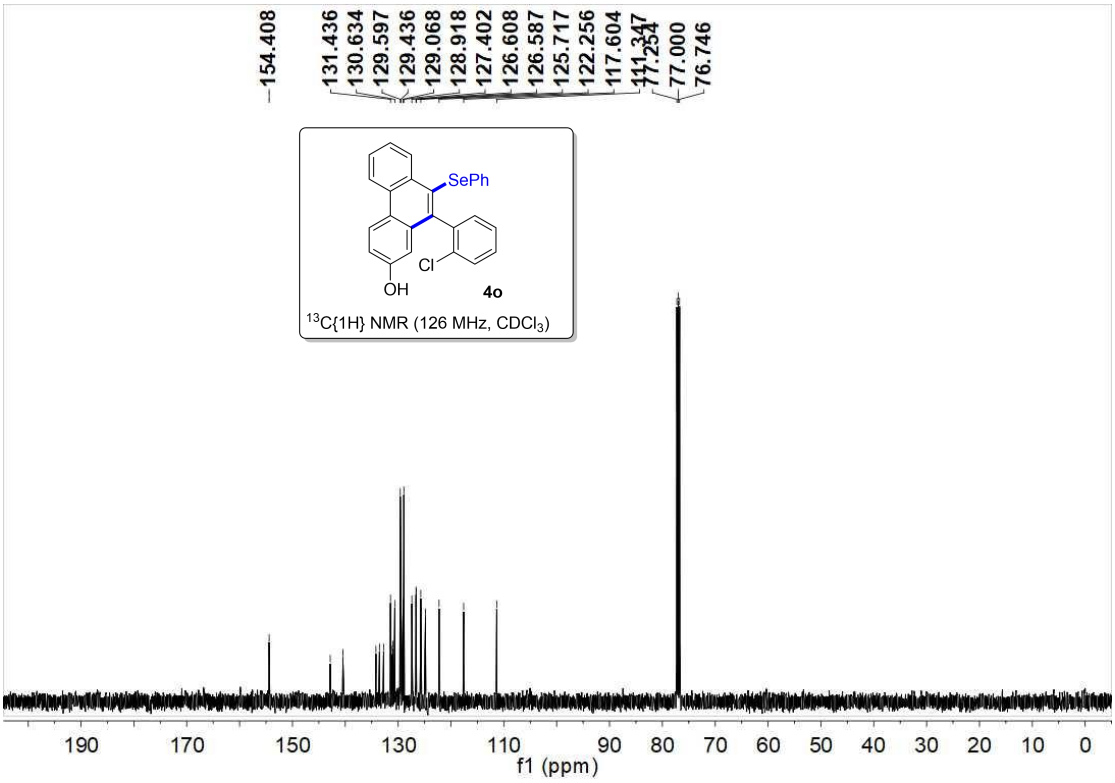

154.239
144.480
140.684
133.973
133.325
131.390
131.256
130.784
130.620
129.551
129.215
129.010
128.697
128.395
127.400
126.758
125.860
125.694
125.553
124.741
122.191
121.499
117.564
112.019
77.253
77.000
76.745
SePh
Br
OH
4m
13C{1H} NMR (126 MHz, CDCl3)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

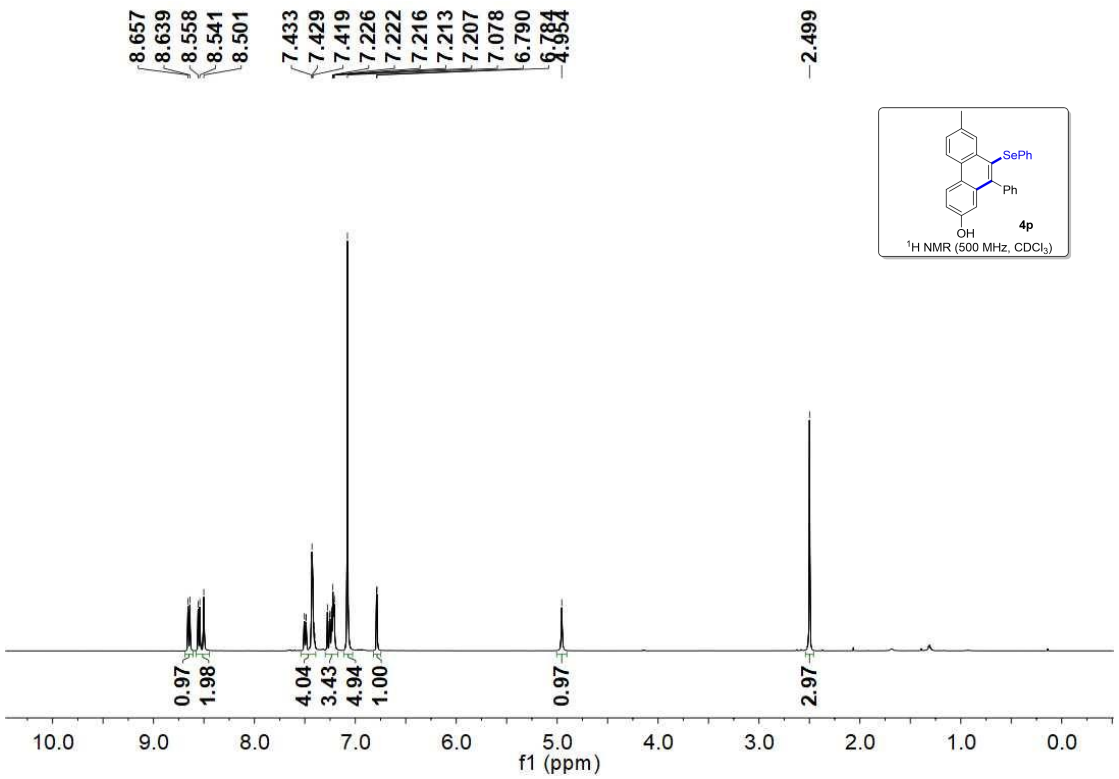

8.709
8.690
8.673
8.657
7.538
7.285
7.219
7.205
7.116
7.109
7.089
7.085
7.078
7.076
6.826
6.822
5.044
SePh
F
OH
4n
1H NMR (500 MHz, CDCl3)
2.99
0.97
1.00
1.00
1.45
2.97
4.96
1.00
0.93
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)

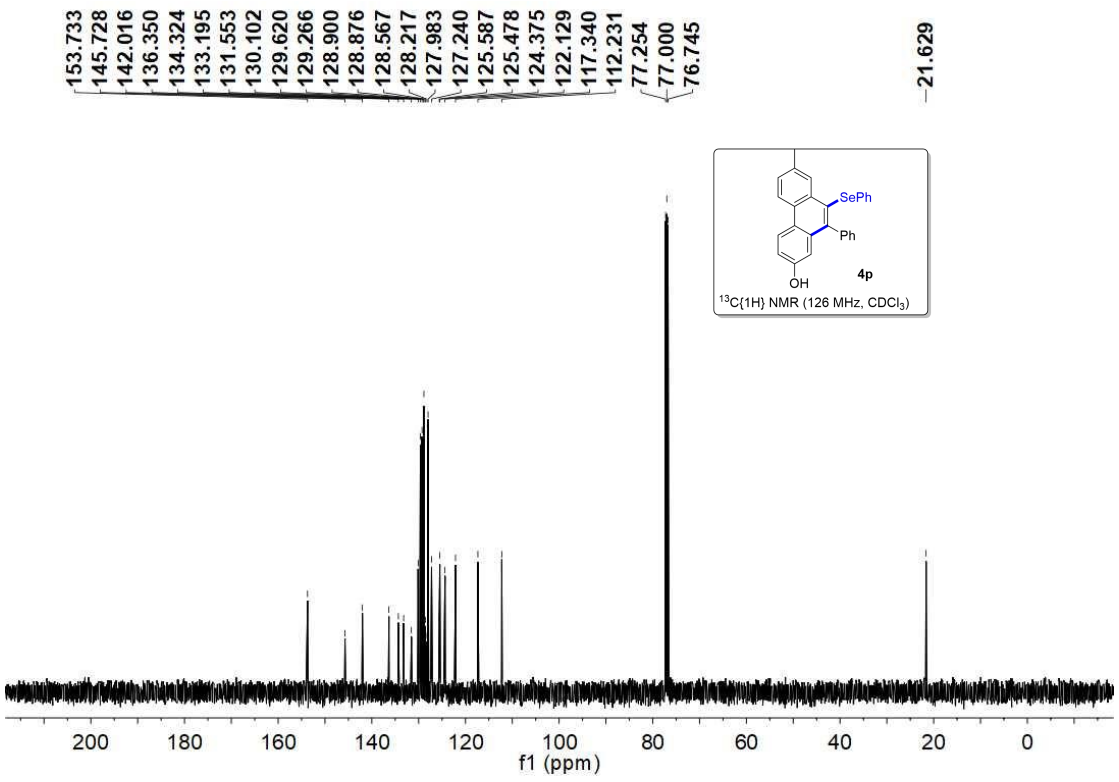

160.863
158.910
154.371
130.646
129.622
129.567
128.928
127.419
126.606
125.743
124.774
122.210
117.590
111.454
111.254
77.000
76.746
SePh
F
OH
4n
$^{13}C\{1H\}$ NMR (126 MHz, $CDCl_3$)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

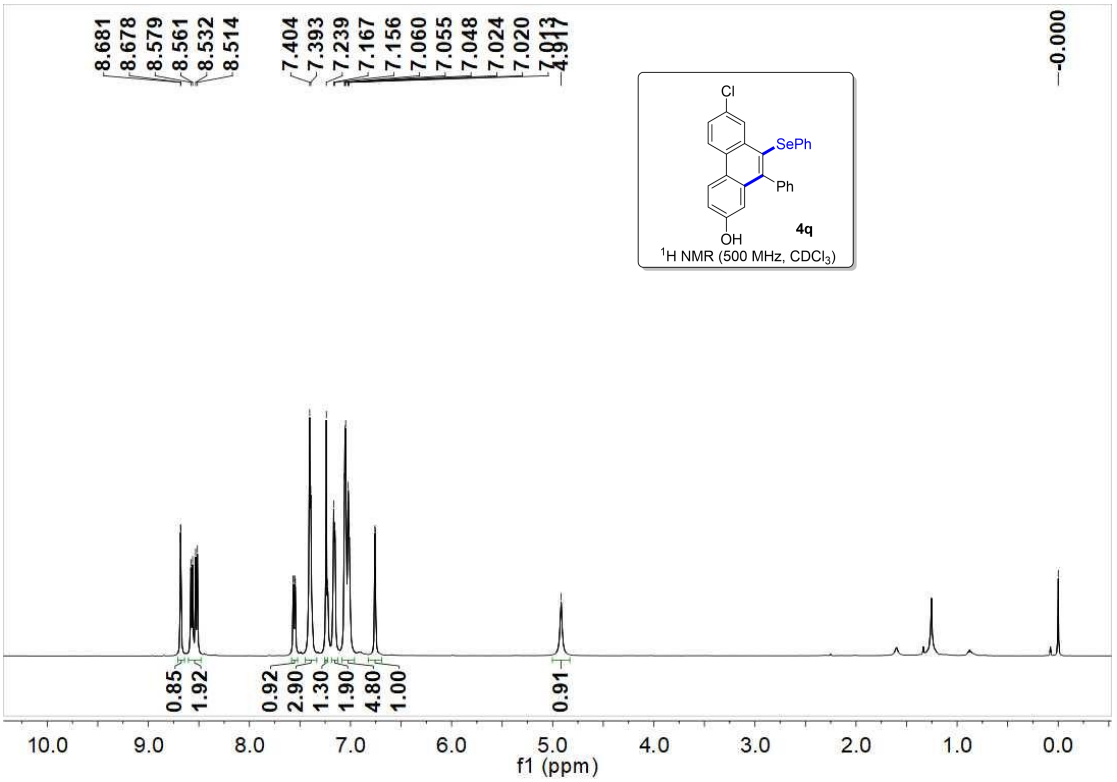

-113.228
SePh
F
OH
4n
^{19}F NMR (470 MHz, $CDCl_3$)
0
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
f1 (ppm)

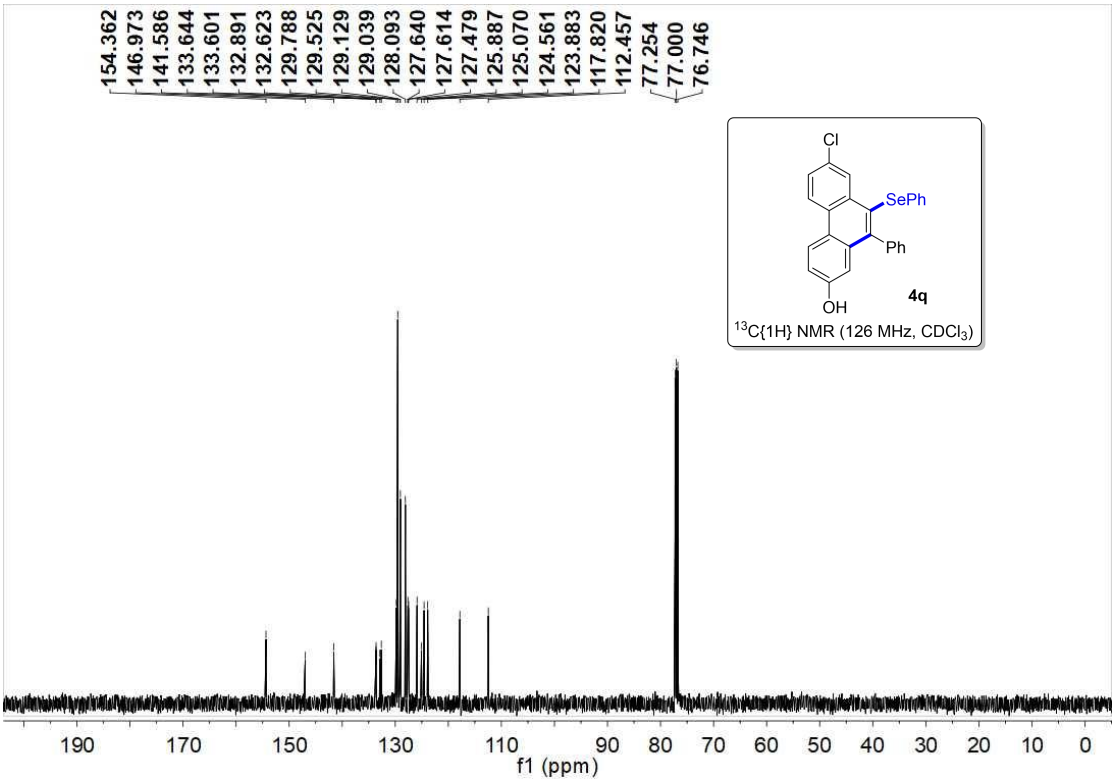

8.670
8.652
8.635
8.619
8.603
8.586
7.508
7.266
7.248
7.234
7.077
7.070
7.063
7.037
7.033
7.027
6.655
6.651
4.935
SePh
Cl
OH
4o
^{1}H NMR (500 MHz, CDCl$_3$)
2.98
0.99
1.97
1.03
2.37
1.02
4.92
1.00
0.98
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

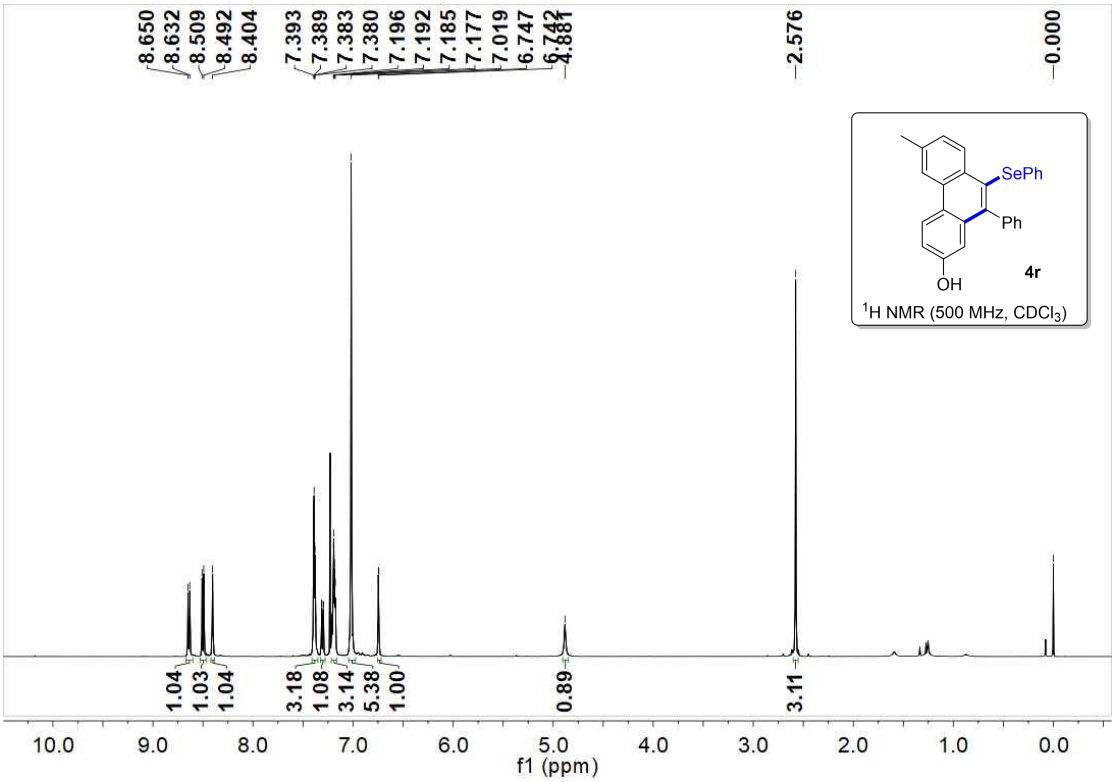

154.408
131.436
130.634
129.597
129.436
129.068
128.918
127.402
126.608
126.587
125.717
122.256
117.604
111.347
77.254
77.000
76.746
SePh
Cl
OH
4o
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

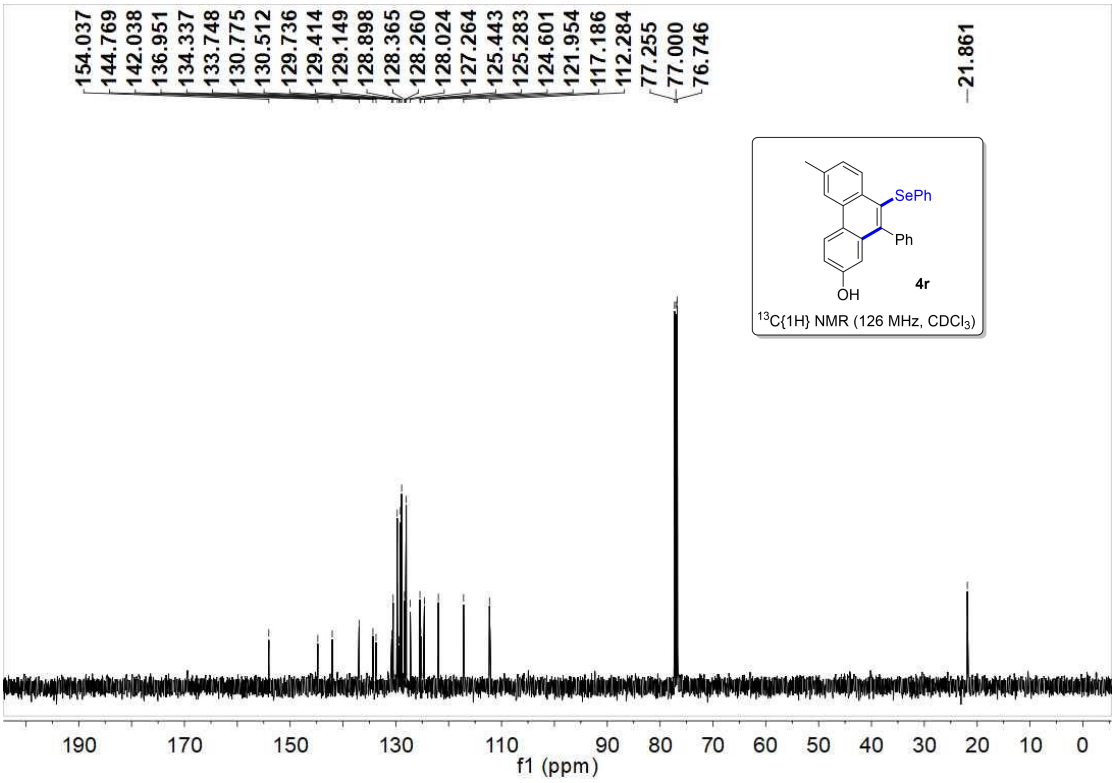

8.657
8.639
8.558
8.541
8.501
7.433
7.429
7.419
7.226
7.222
7.216
7.213
7.207
7.078
6.790
6.784
4.954
2.499
SePh
Ph
OH
4p
^{1}H NMR (500 MHz, CDCl$_3$)
0.97
1.98
4.04
3.43
4.94
1.00
0.97
2.97
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

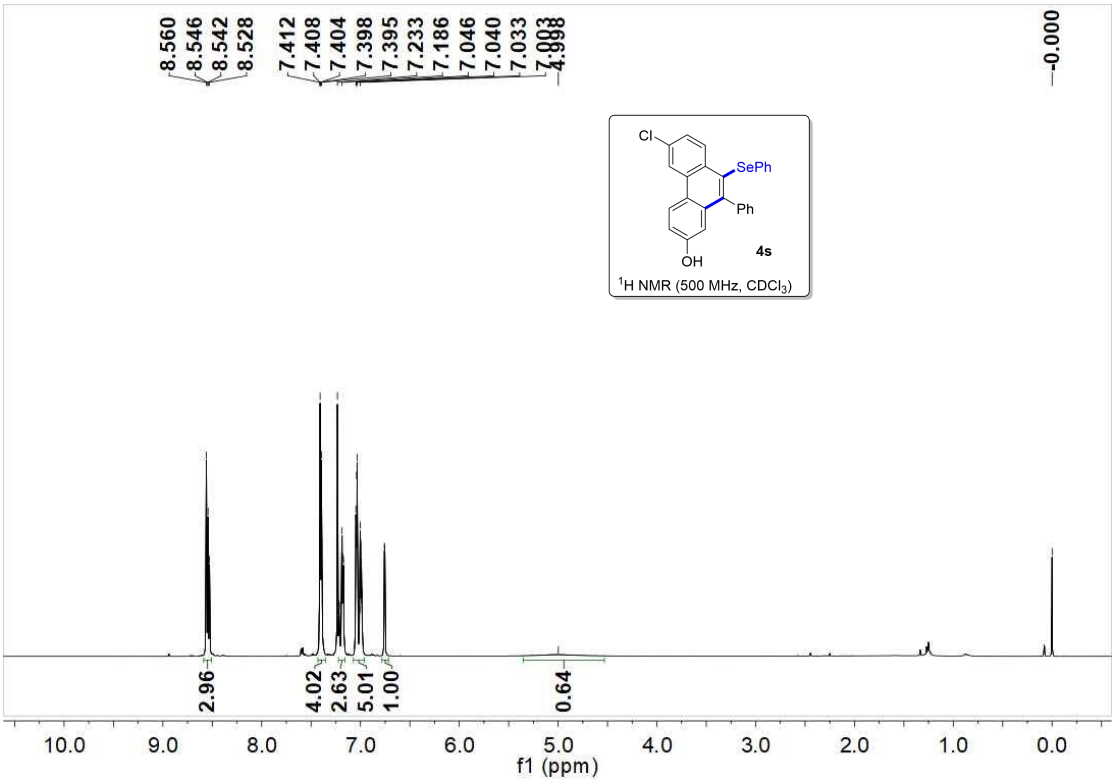

153.733
145.728
142.016
136.350
134.324
133.195
131.553
130.102
129.620
129.266
128.900
128.876
128.567
128.217
127.983
127.240
125.587
125.478
124.375
122.129
117.340
112.231
77.254
77.000
76.745
21.629
SePh
Ph
OH
4p
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

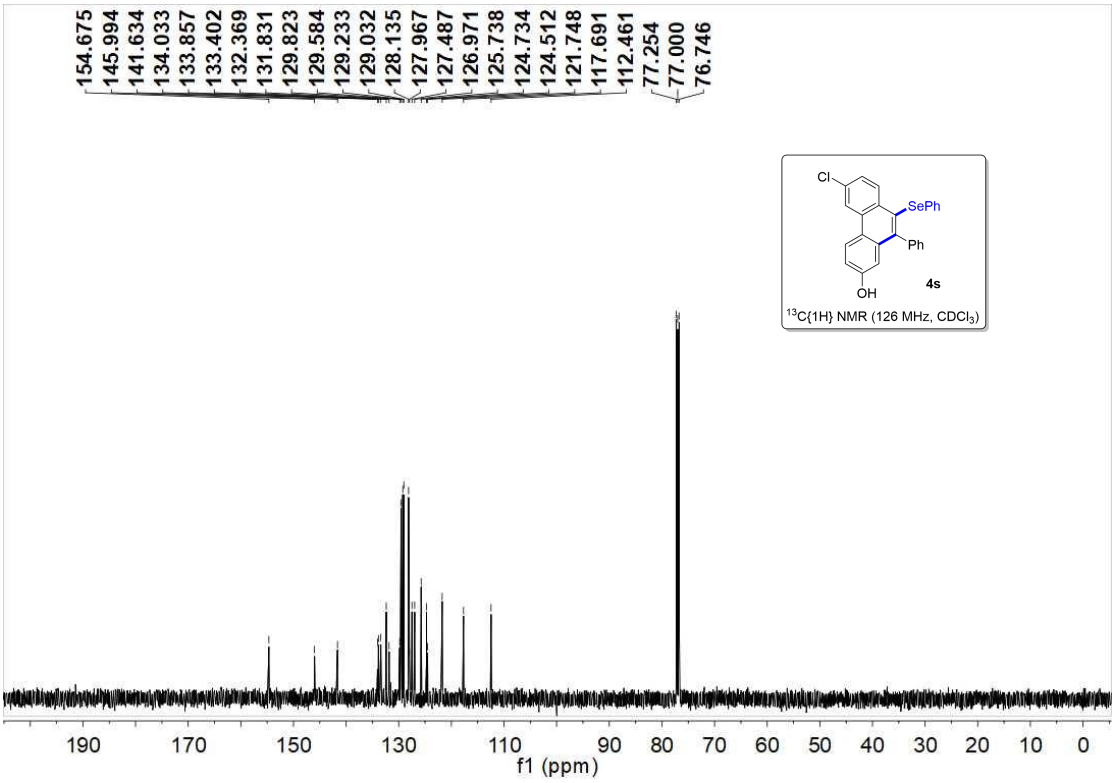

8.681
8.678
8.579
8.561
8.532
8.514
7.404
7.393
7.239
7.167
7.156
7.060
7.055
7.048
7.024
7.020
4.917
-0.000
Cl
SePh
Ph
OH
4q
^{1}H NMR (500 MHz, CDCl$_3$)
0.85
1.92
0.92
2.90
1.30
1.90
4.80
1.00
0.91
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

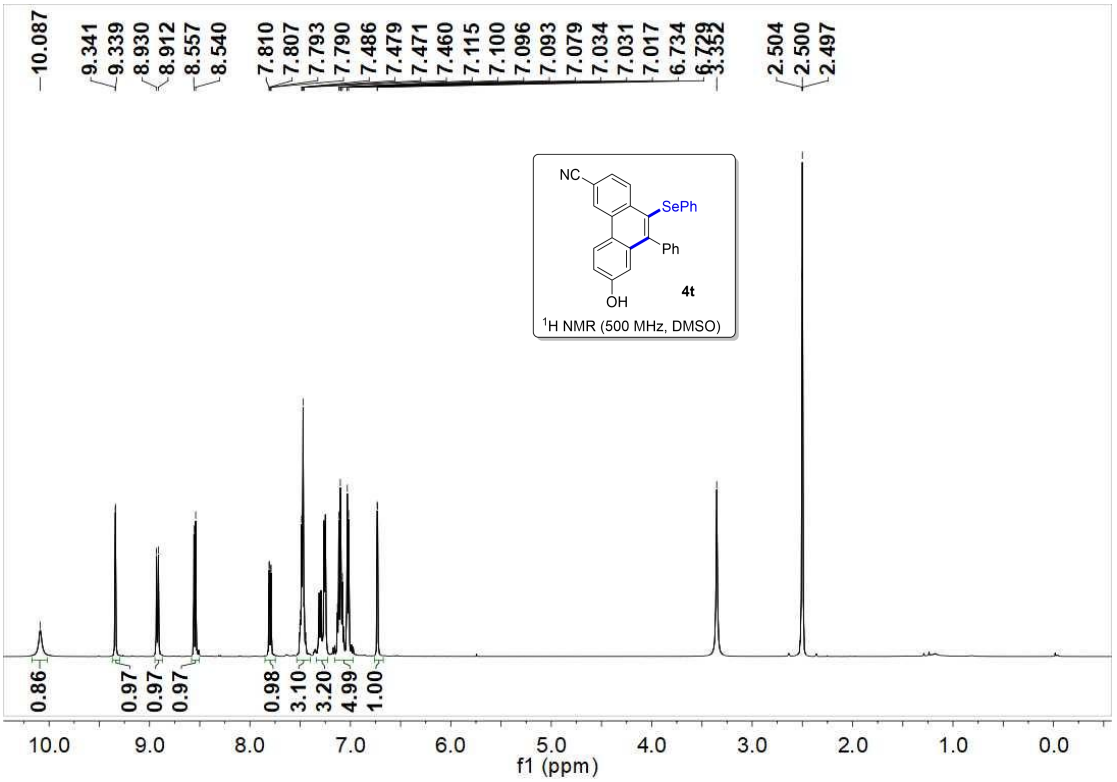

154.362
146.973
141.586
133.644
133.601
132.891
132.623
129.788
129.525
129.129
129.039
128.093
127.640
127.614
127.479
125.887
125.070
124.561
123.883
117.820
112.457
77.254
77.000
76.746
Cl
SePh
Ph
OH
4q
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

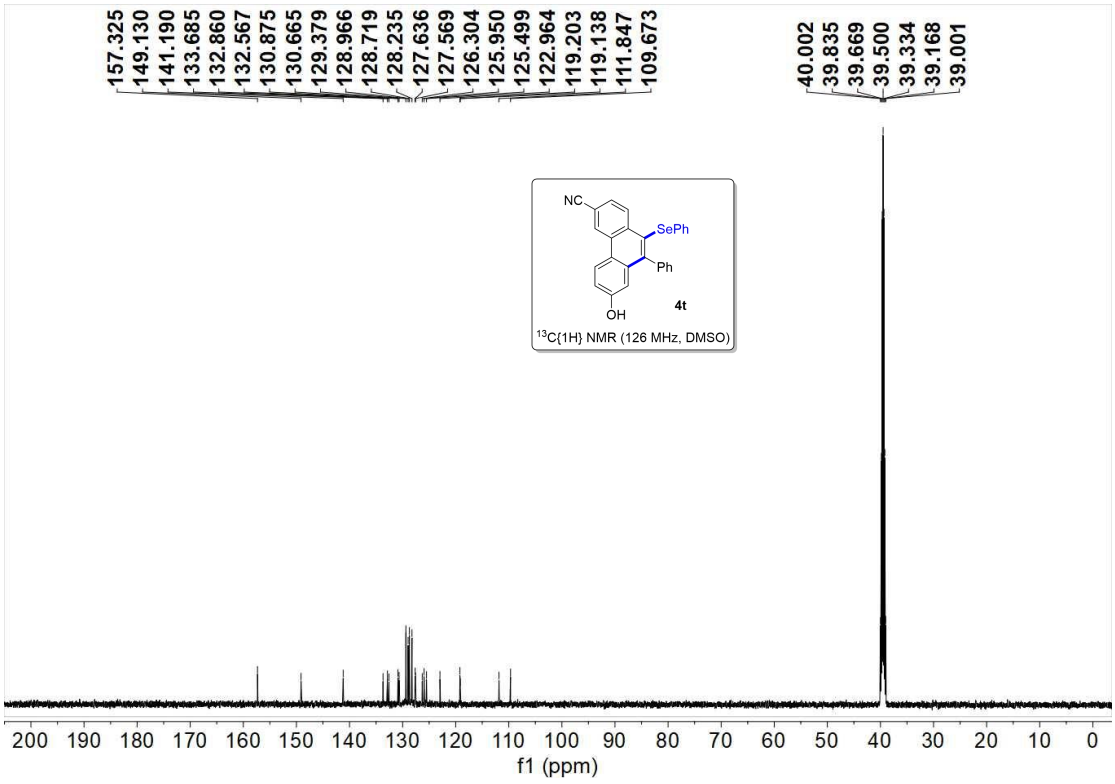

8.650
8.632
8.509
8.492
8.404
7.393
7.389
7.383
7.380
7.196
7.192
7.185
7.177
7.019
6.747
6.742
4.881
2.576
0.000
SePh
Ph
OH
4r
^{1}H NMR (500 MHz, CDCl$_3$)
1.04
1.03
1.04
3.18
1.08
3.14
5.38
1.00
0.89
3.11
f1 (ppm)

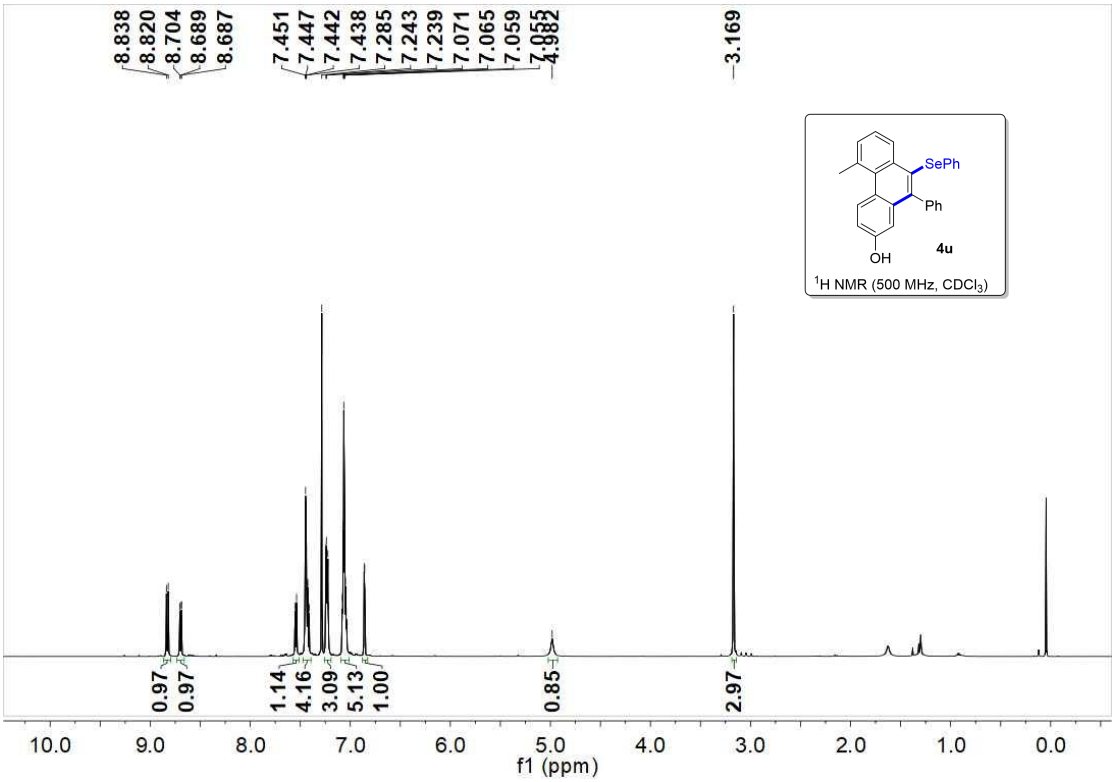

154.037
144.769
142.038
136.951
134.337
133.748
130.775
130.512
129.736
129.414
129.149
128.898
128.365
128.260
128.024
127.264
125.443
125.283
124.601
121.954
117.186
112.284
77.255
77.000
76.746
21.861
SePh
Ph
OH
4r
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
f1 (ppm)

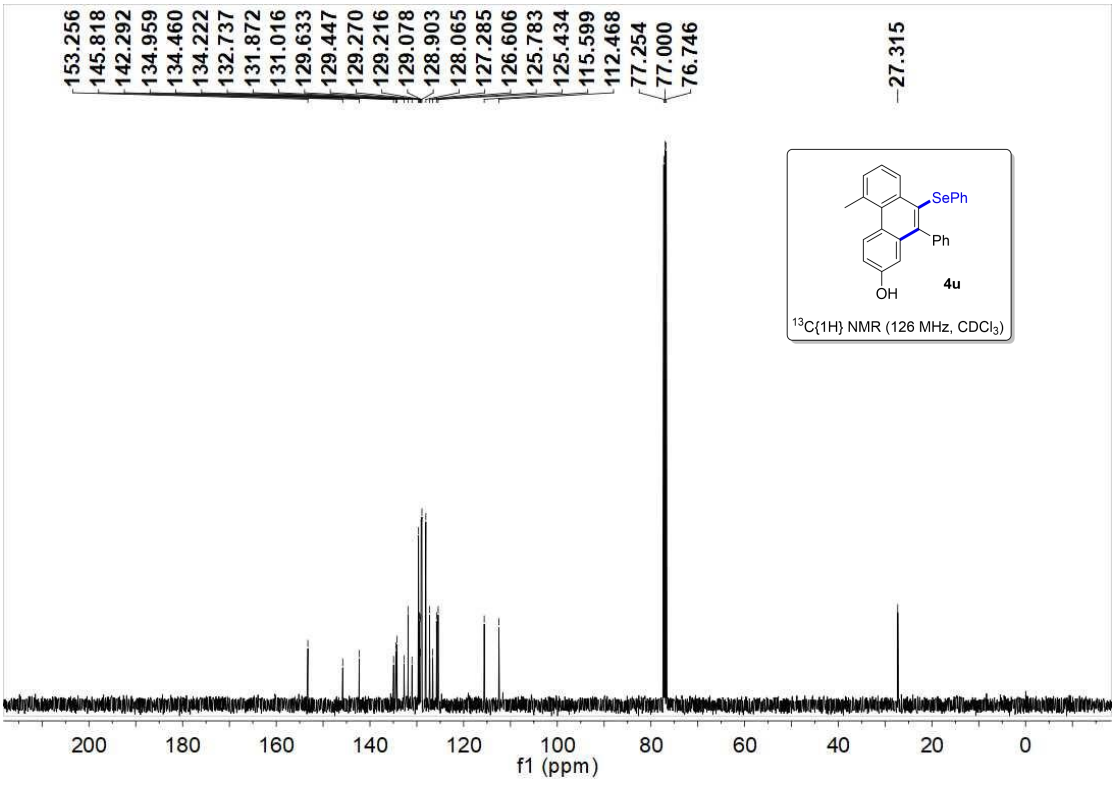

8.560
8.546
8.542
8.528
7.412
7.408
7.404
7.398
7.395
7.233
7.186
7.046
7.040
7.033
7.003
4.998
-0.000
Cl
SePh
Ph
OH
4s
^{1}H NMR (500 MHz, CDCl$_3$)
2.96
4.02
2.63
5.01
1.00
0.64
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

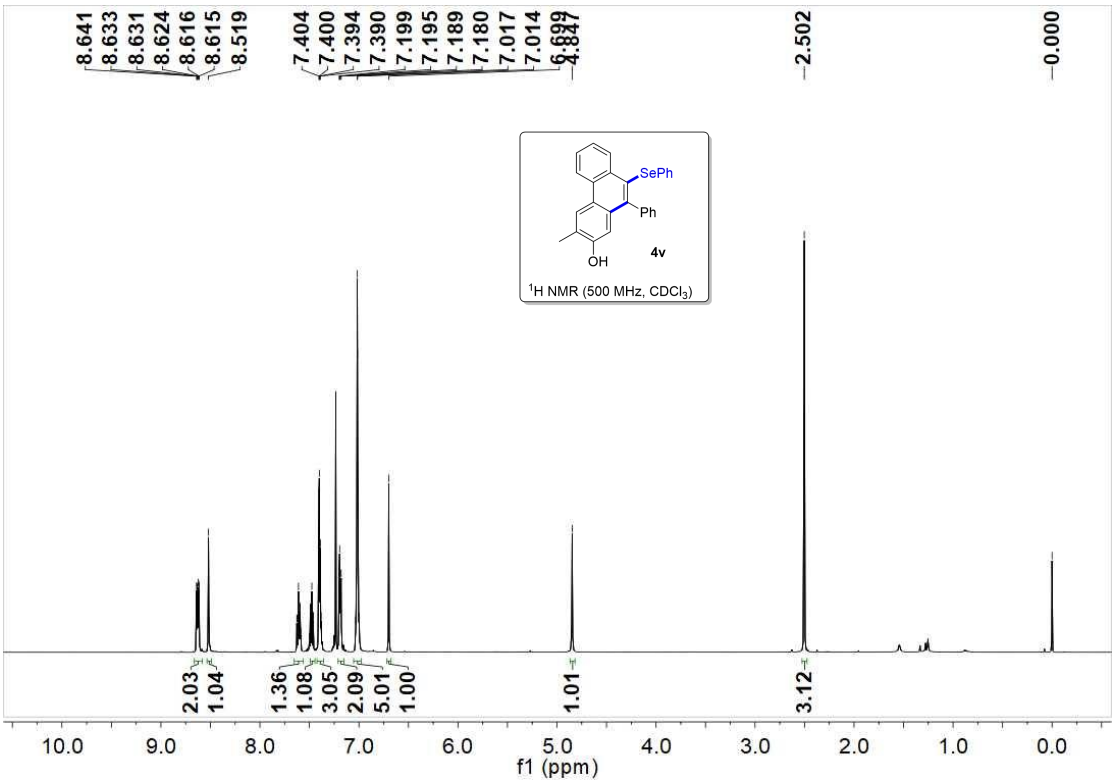

154.675
145.994
141.634
134.033
133.857
133.402
132.369
131.831
129.823
129.584
129.233
129.032
128.135
127.967
127.487
126.971
125.738
124.734
124.512
121.748
117.691
112.461
77.254
77.000
76.746
Cl
SePh
Ph
OH
4s
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

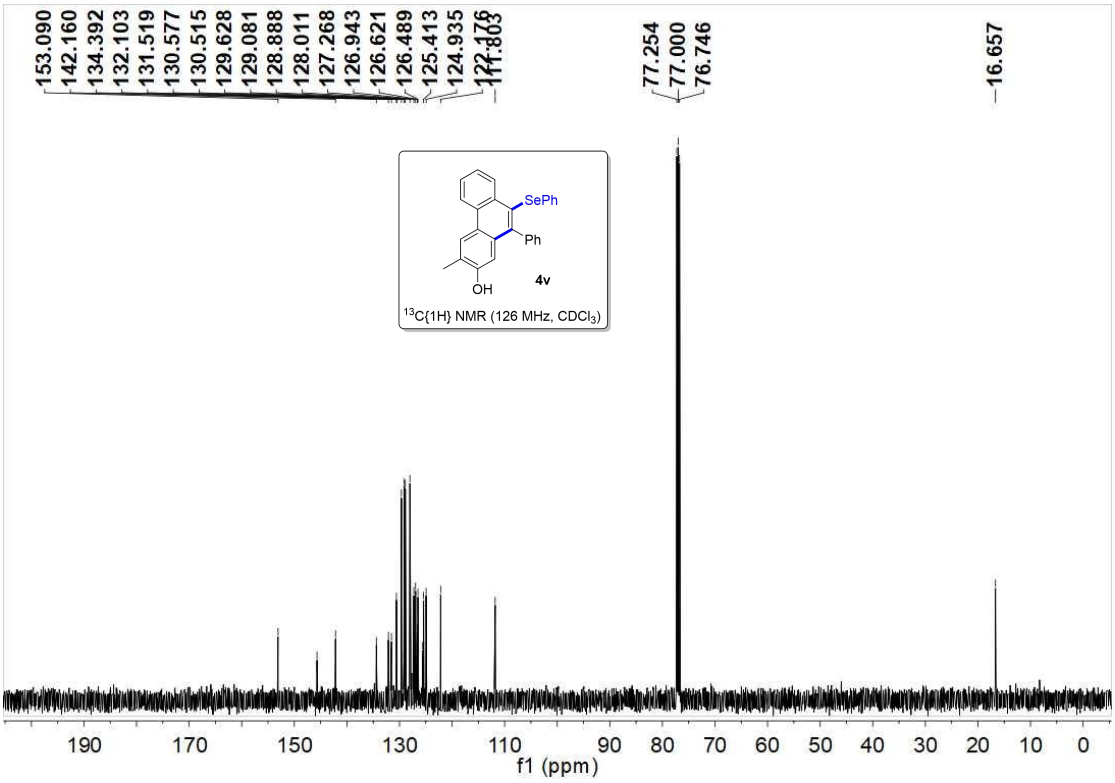

10.087
9.341
9.339
8.930
8.912
8.557
8.540
7.810
7.807
7.793
7.790
7.486
7.479
7.471
7.460
7.115
7.100
7.096
7.093
7.079
7.034
7.031
7.017
6.734
6.729
3.352
2.504
2.500
2.497
NC
SePh
Ph
OH
4t
1H NMR (500 MHz, DMSO)
0.86
0.97
0.97
0.97
0.98
3.10
3.20
4.99
1.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

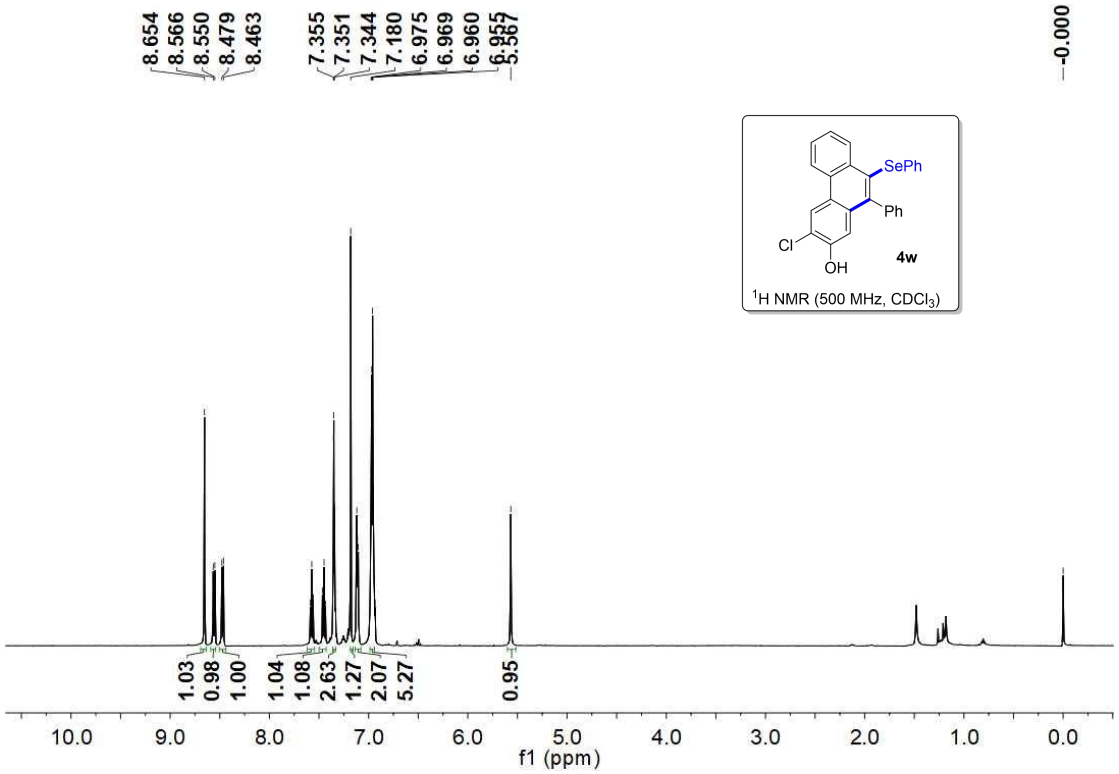

157.325
149.130
141.190
133.685
132.860
132.567
130.875
130.665
129.379
128.966
128.719
128.235
127.636
127.569
126.304
125.950
125.499
122.964
119.203
119.138
111.847
109.673
40.002
39.835
39.669
39.500
39.334
39.168
39.001
NC
SePh
Ph
OH
4t
13C{1H} NMR (126 MHz, DMSO)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

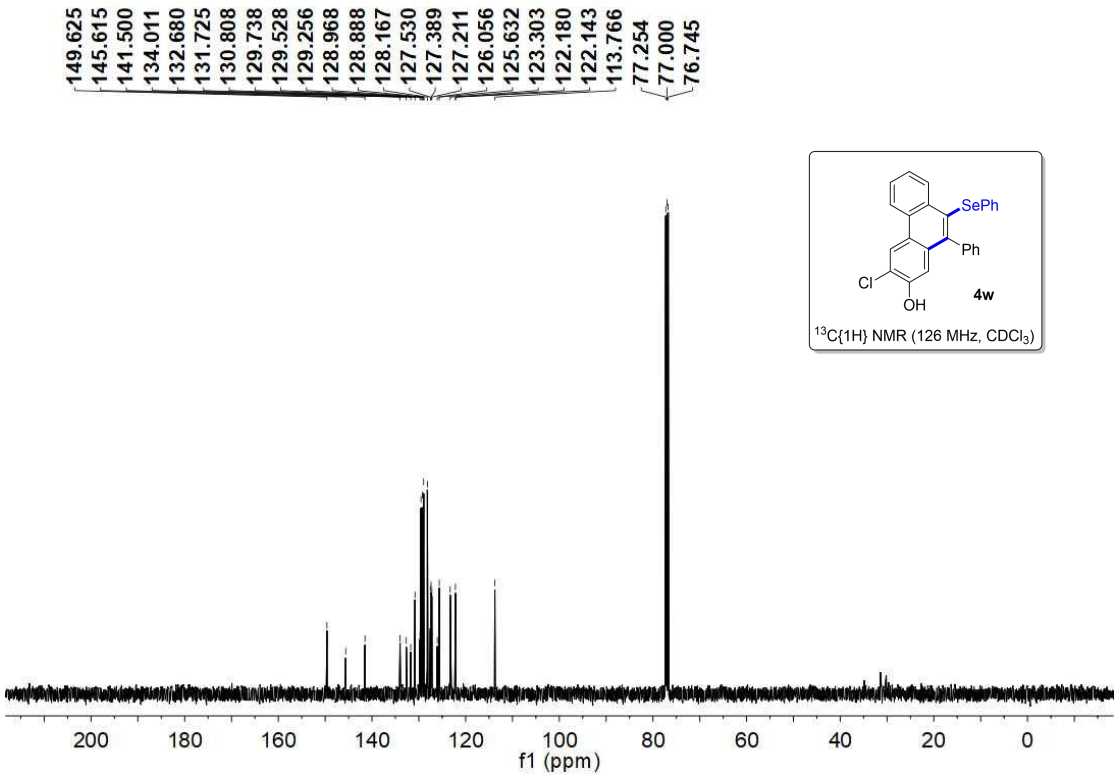

8.838
8.820
8.704
8.689
8.687
7.451
7.447
7.442
7.438
7.285
7.243
7.239
7.071
7.065
7.059
7.055
4.982
3.169
SePh
Ph
OH
4u
^{1}H NMR (500 MHz, CDCl$_3$)
0.97
0.97
1.14
4.16
3.09
5.13
1.00
0.85
2.97
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

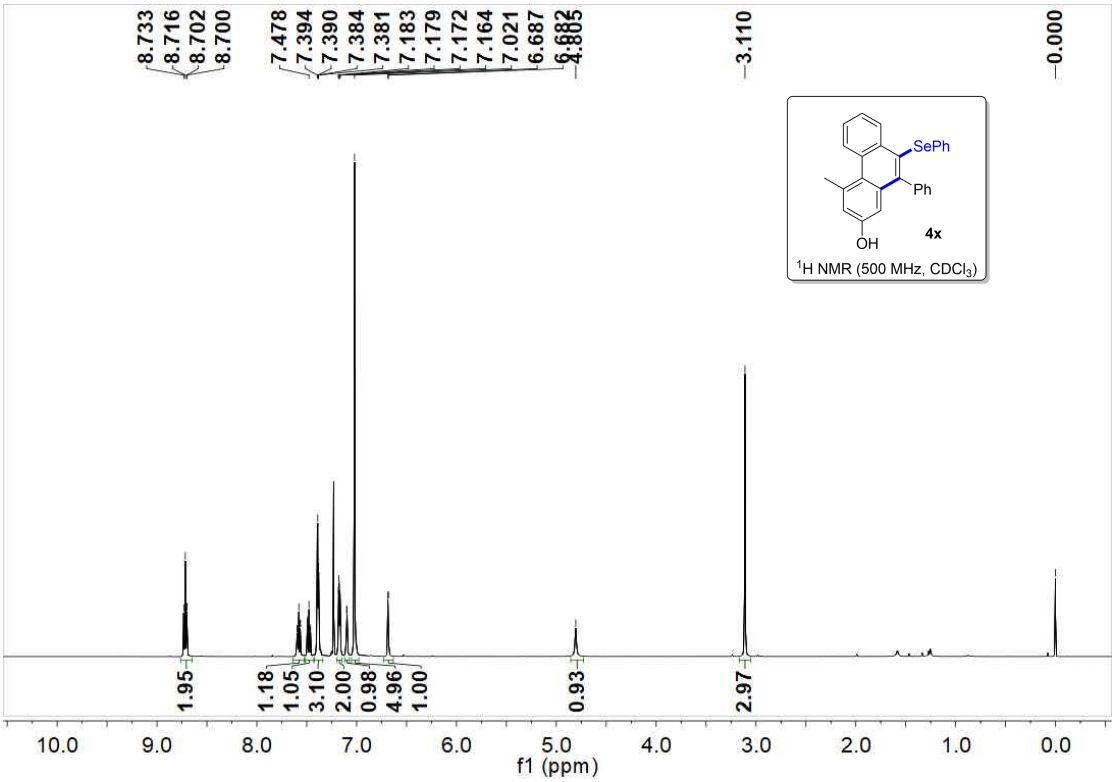

153.256
145.818
142.292
134.959
134.460
134.222
132.737
131.872
131.016
129.633
129.447
129.270
129.216
129.078
128.903
128.065
127.285
126.606
125.783
125.434
115.599
112.468
77.254
77.000
76.746
27.315
SePh
Ph
OH
4u
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

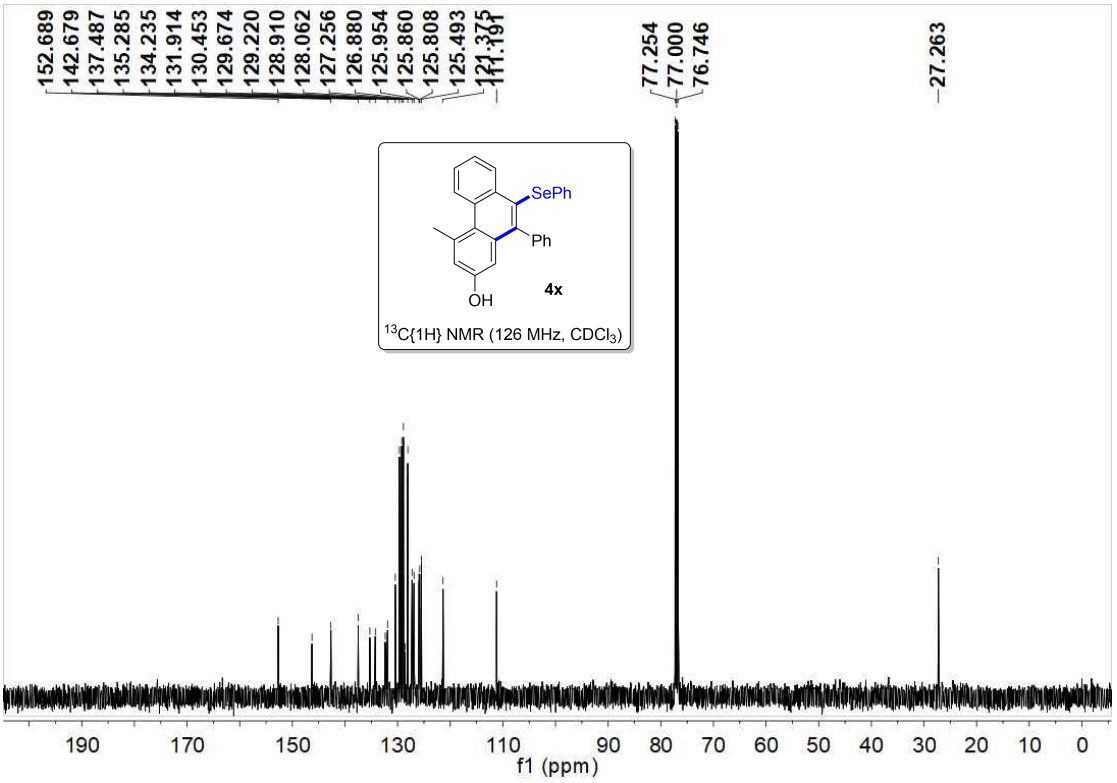

8.641
8.633
8.631
8.624
8.616
8.615
8.519
7.404
7.400
7.394
7.390
7.199
7.195
7.189
7.180
7.017
7.014
6.699
6.697
4.847
2.502
0.000
SePh
Ph
OH
4v
^{1}H NMR (500 MHz, CDCl$_3$)
2.03
1.04
1.36
1.08
3.05
2.09
5.01
1.00
1.01
3.12
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

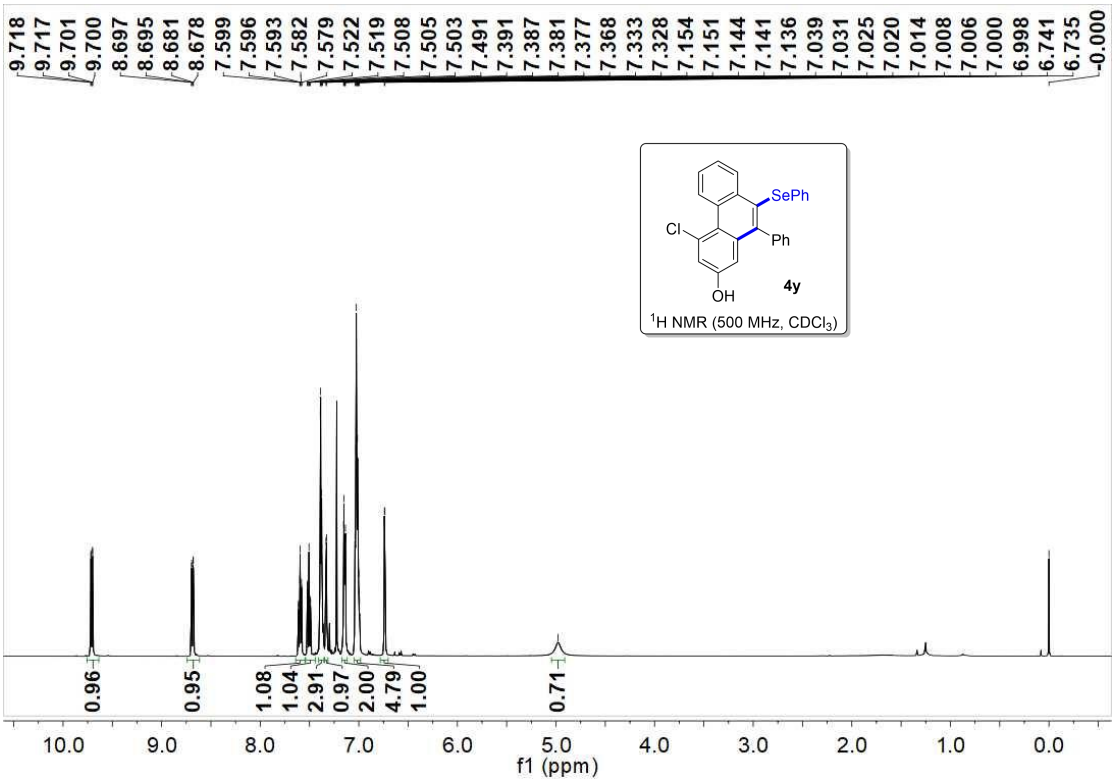

153.090
142.160
134.392
132.103
131.519
130.577
130.515
129.628
129.081
128.888
128.011
127.268
126.943
126.621
126.489
125.413
124.935
77.254
77.000
76.746
16.657
SePh
Ph
OH
4v
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

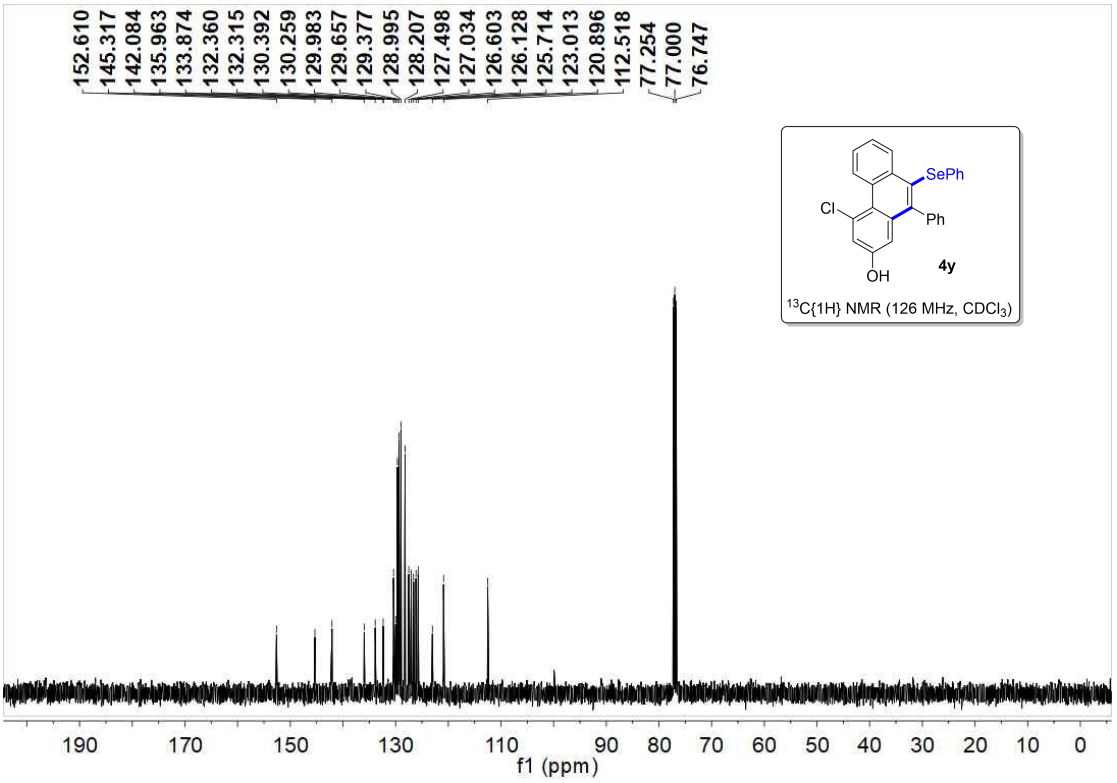

8.654
8.566
8.550
8.479
8.463
7.355
7.351
7.344
7.180
6.975
6.969
6.960
6.955
5.567
-0.000
SePh
Ph
Cl
OH
4w
^{1}H NMR (500 MHz, CDCl$_3$)
1.03
0.98
1.00
1.04
1.08
2.63
1.27
2.07
5.27
0.95
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

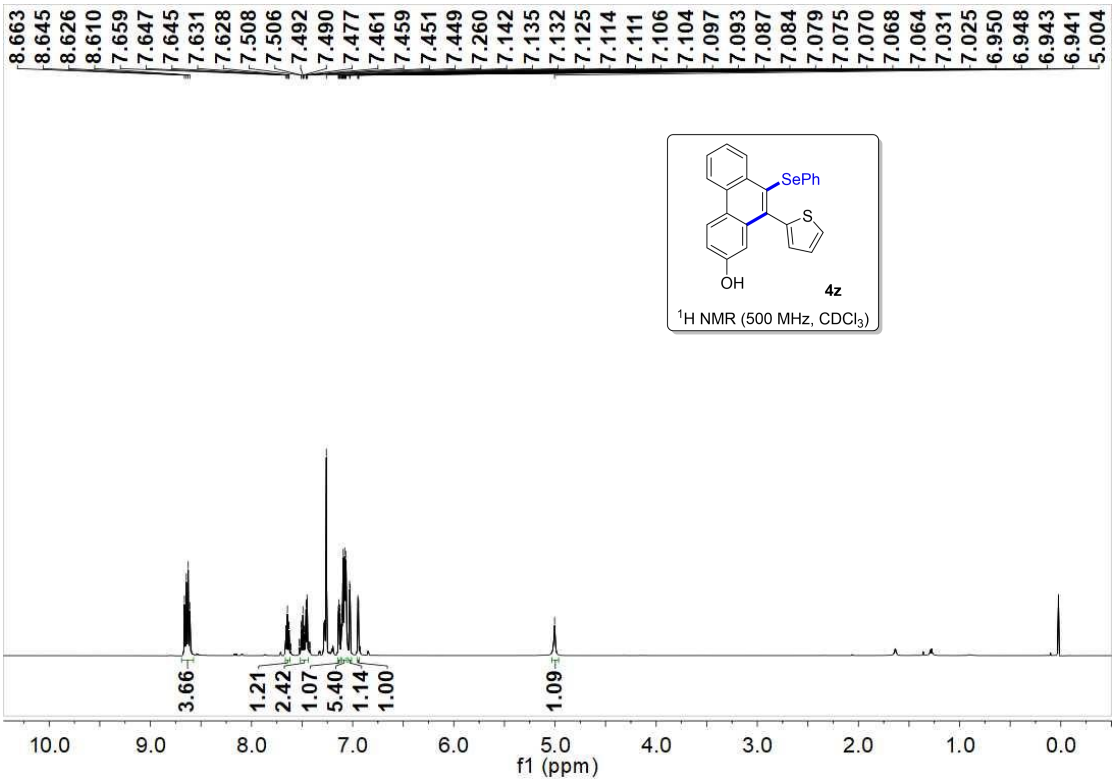

149.625
145.615
141.500
134.011
132.680
131.725
130.808
129.738
129.528
129.256
128.968
128.888
128.167
127.530
127.389
127.211
126.056
125.632
123.303
122.180
122.143
113.766
77.254
77.000
76.745
SePh
Ph
Cl
OH
4w
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

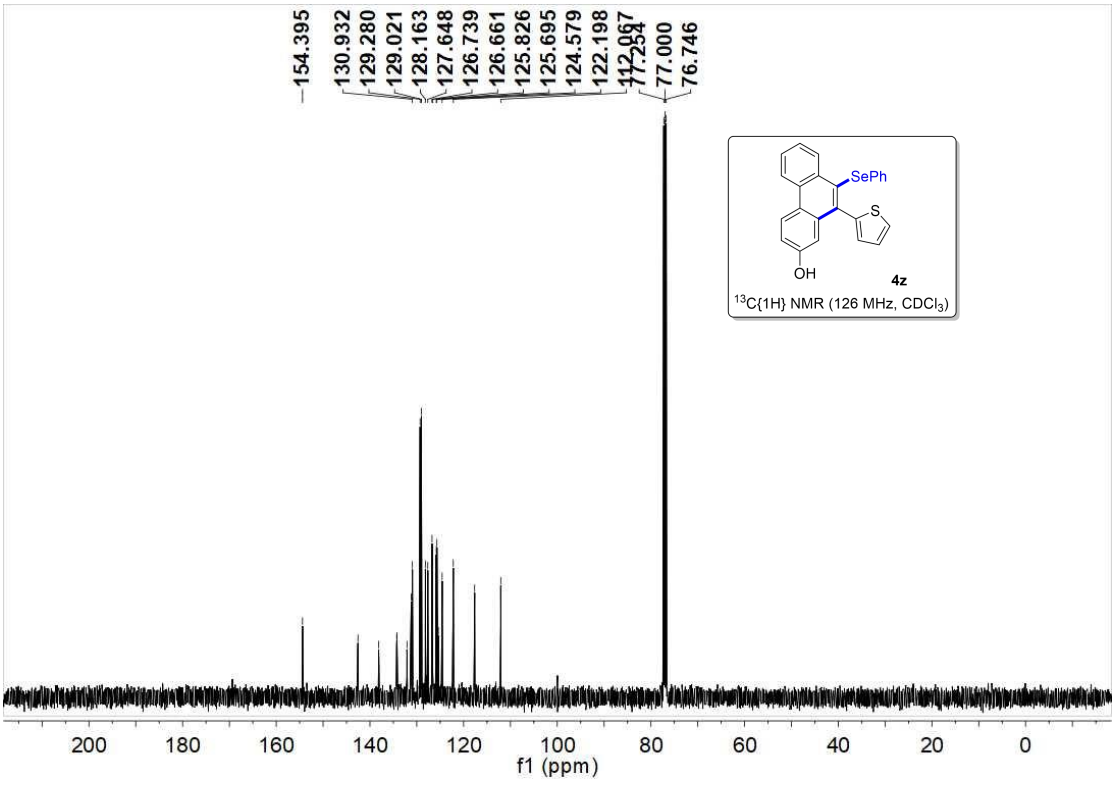

8.733
8.716
8.702
8.700
7.478
7.394
7.390
7.384
7.381
7.183
7.179
7.172
7.164
7.021
6.687
4.805
3.110
0.000
SePh
Ph
OH
4x
^{1}H NMR (500 MHz, CDCl$_3$)
1.95
1.18
1.05
3.10
2.00
0.98
4.96
1.00
0.93
2.97
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

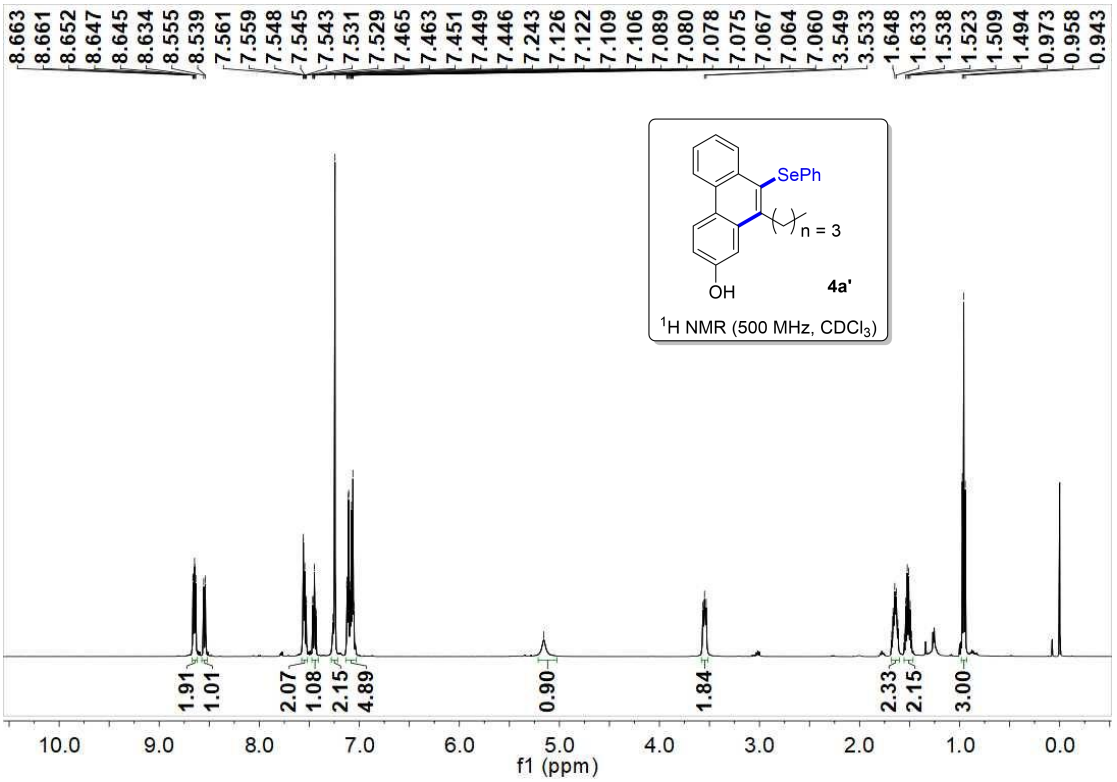

152.689
142.679
137.487
135.285
134.235
131.914
130.453
129.674
129.220
128.910
128.062
127.256
126.880
125.954
125.860
125.808
125.493
121.375
111.191
77.254
77.000
76.746
27.263
SePh
Ph
OH
4x
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

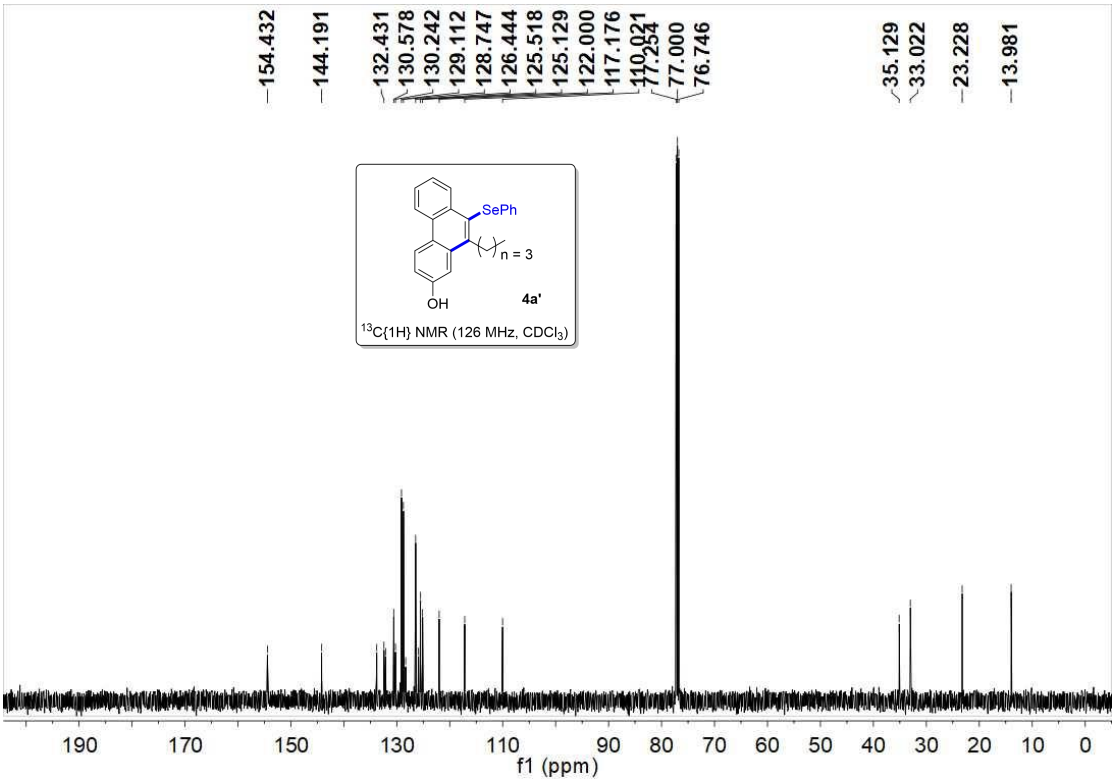

9.718
9.717
9.701
9.700
8.697
8.695
8.681
8.678
7.599
7.596
7.593
7.582
7.579
7.522
7.519
7.508
7.505
7.503
7.491
7.391
7.387
7.381
7.377
7.368
7.333
7.328
7.154
7.151
7.144
7.141
7.136
7.039
7.031
7.025
7.020
7.014
7.008
7.006
7.000
6.998
6.741
6.735
-0.000
SePh
Cl
Ph
OH
4y
^{1}H NMR (500 MHz, CDCl$_3$)
0.96
0.95
1.08
1.04
2.91
0.97
2.00
4.79
1.00
0.71
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

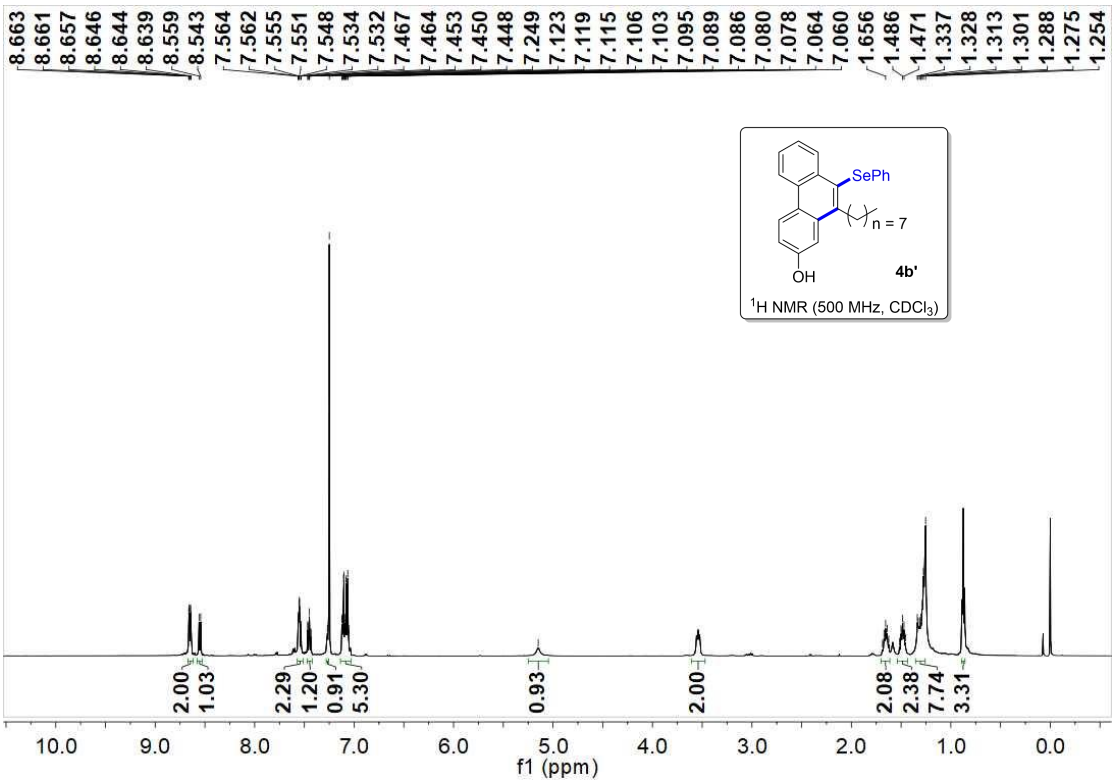

152.610
145.317
142.084
135.963
133.874
132.360
132.315
130.392
130.259
129.983
129.657
129.377
128.995
128.207
127.498
127.034
126.603
126.128
125.714
123.013
120.896
112.518
77.254
77.000
76.747
SePh
Cl
Ph
OH
4y
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

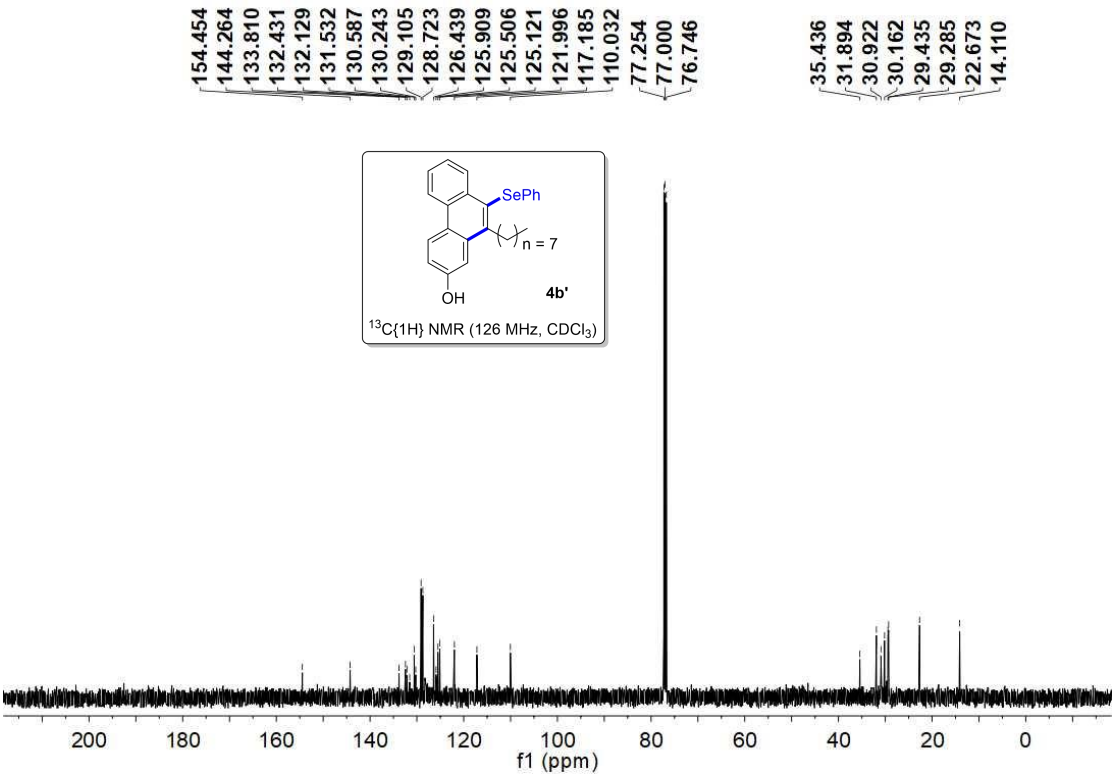

8.663
8.645
8.626
8.610
7.659
7.647
7.645
7.631
7.628
7.508
7.506
7.492
7.490
7.477
7.461
7.459
7.451
7.449
7.260
7.142
7.135
7.132
7.125
7.114
7.111
7.106
7.104
7.097
7.093
7.087
7.084
7.079
7.075
7.070
7.068
7.064
7.031
7.025
6.950
6.948
6.943
6.941
5.004
SePh
S
OH
4z
^{1}H NMR (500 MHz, CDCl$_3$)
3.66
1.21
2.42
1.07
5.40
1.14
1.00
1.09
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

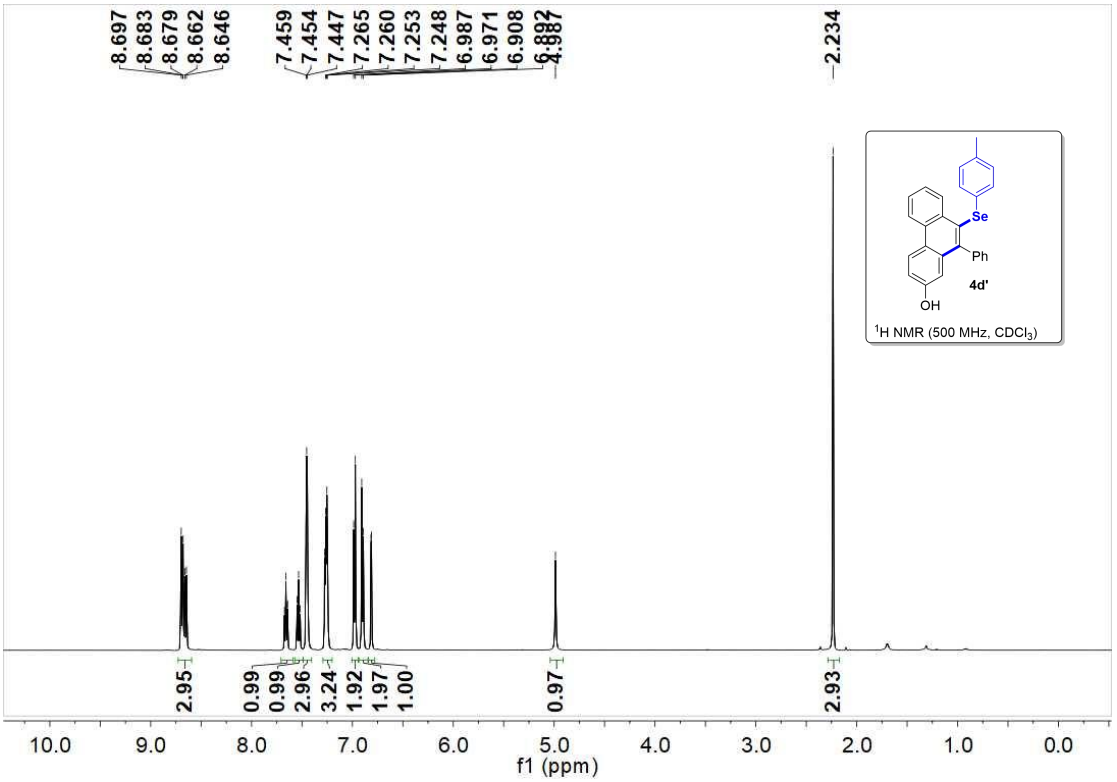

154.395
130.932
129.280
129.021
128.163
127.648
126.739
126.661
125.826
125.695
124.579
122.198
112.067
77.254
77.000
76.746
SePh
S
OH
4z
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

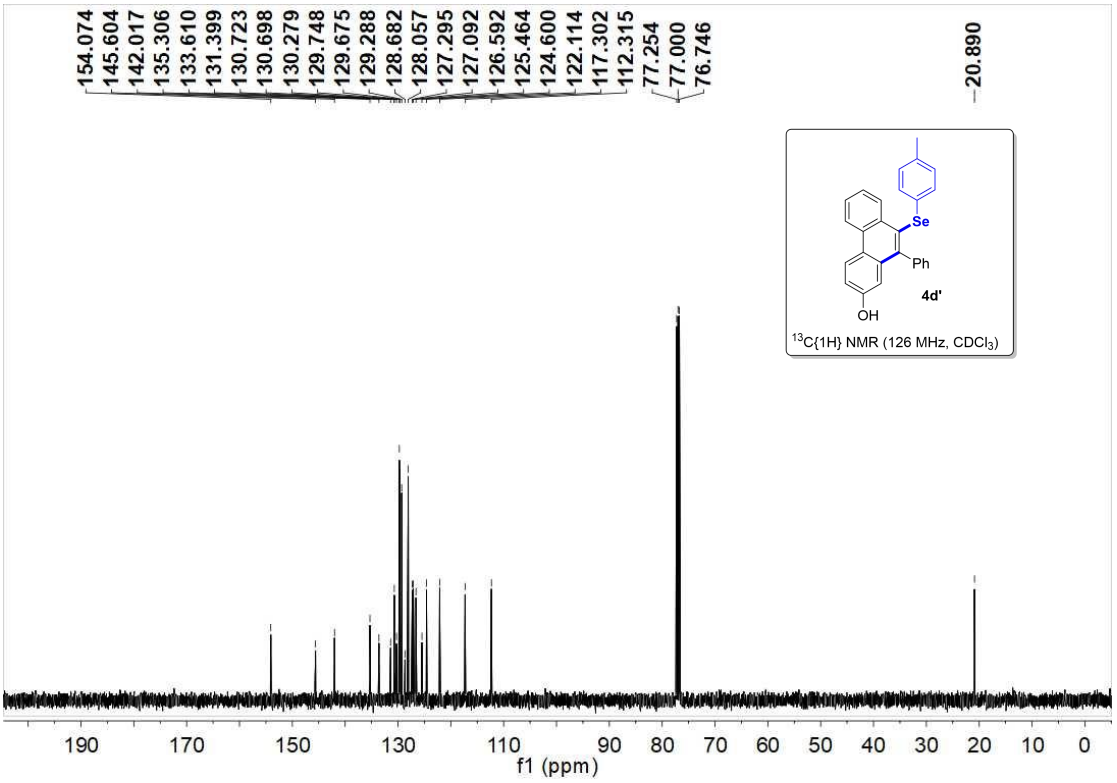

8.663
8.661
8.652
8.647
8.645
8.634
8.555
8.539
7.561
7.559
7.548
7.545
7.543
7.531
7.529
7.465
7.463
7.451
7.449
7.446
7.243
7.126
7.122
7.109
7.106
7.089
7.080
7.078
7.075
7.067
7.064
7.060
3.549
3.533
1.648
1.633
1.538
1.523
1.509
1.494
0.973
0.958
0.943
SePh
n = 3
OH
4a'
^{1}H NMR (500 MHz, CDCl$_3$)
1.91
1.01
2.07
1.08
2.15
4.89
0.90
1.84
2.33
2.15
3.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

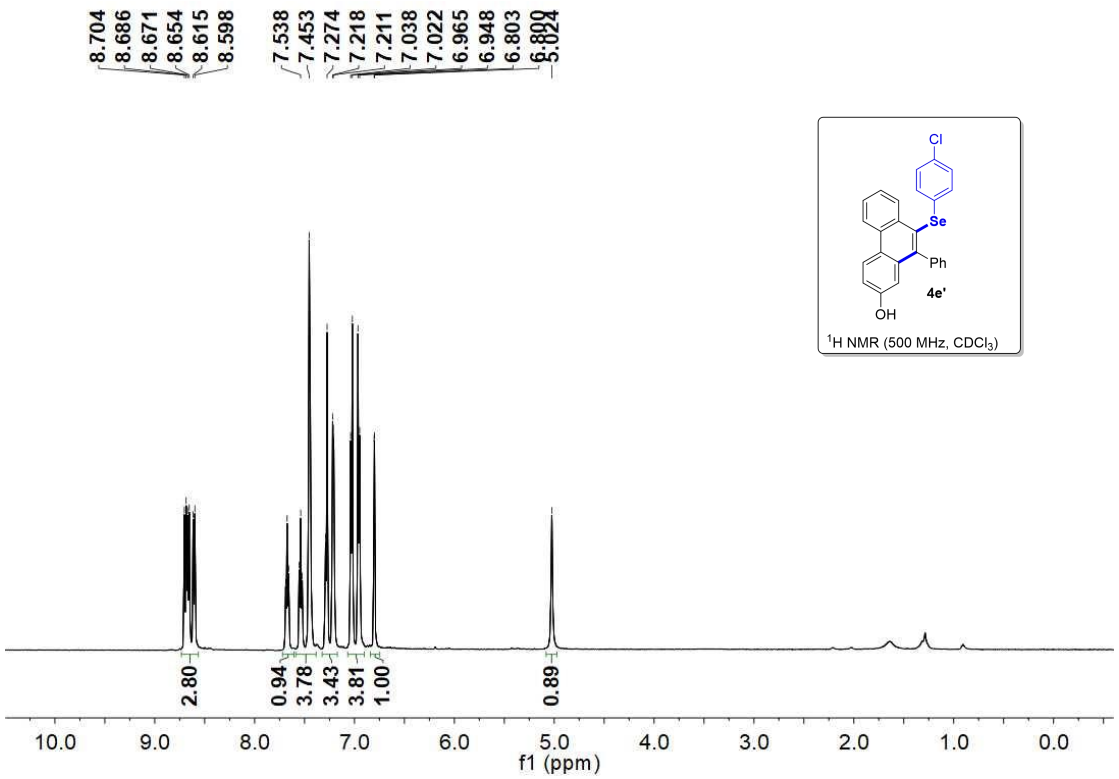

154.432
144.191
132.431
130.578
130.242
129.112
128.747
126.444
125.518
125.129
122.000
117.176
110.021
77.254
77.000
76.746
35.129
33.022
23.228
13.981
SePh
n = 3
OH
4a'
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

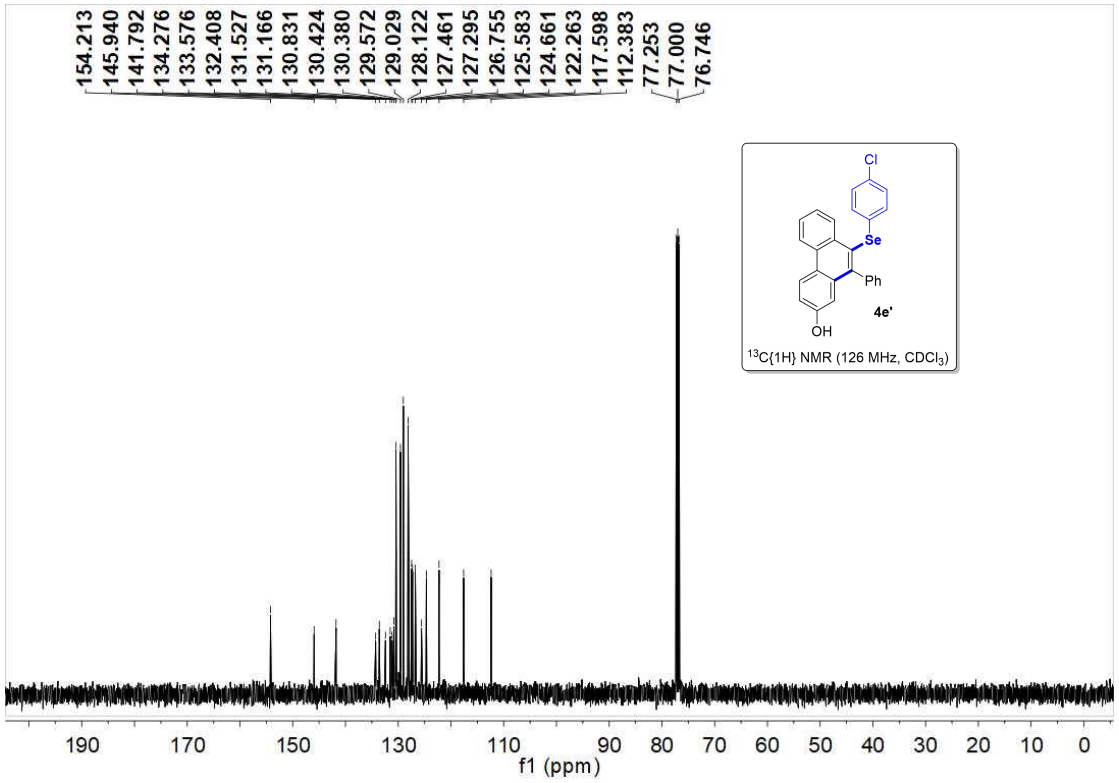

8.663
8.661
8.657
8.646
8.644
8.639
8.559
8.543
7.564
7.562
7.555
7.551
7.548
7.534
7.532
7.467
7.464
7.453
7.450
7.448
7.249
7.123
7.119
7.115
7.106
7.103
7.095
7.089
7.086
7.080
7.078
7.064
7.060
1.656
1.486
1.471
1.337
1.328
1.313
1.301
1.288
1.275
1.254
SePh
n = 7
OH
4b'
1H NMR (500 MHz, CDCl3)
2.00
1.03
2.29
1.20
0.91
5.30
0.93
2.00
2.08
2.38
7.74
3.31
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

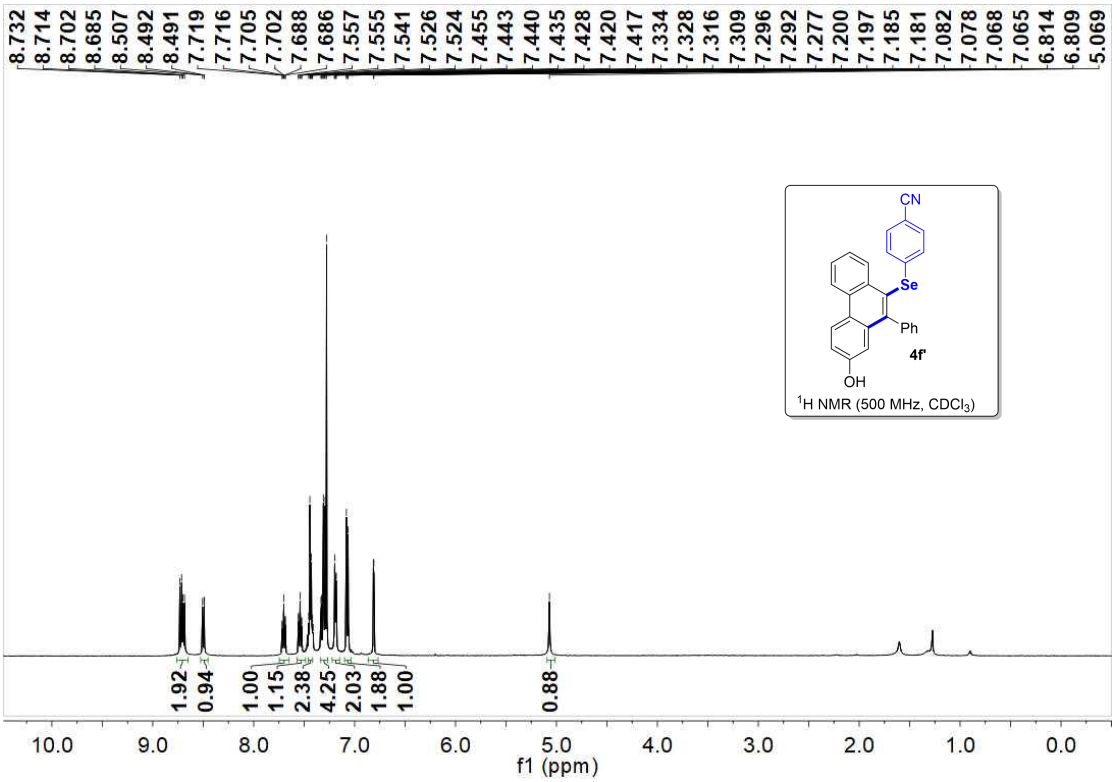

154.454
144.264
133.810
132.431
132.129
131.532
130.587
130.243
129.105
128.723
126.439
125.909
125.506
125.121
121.996
117.185
110.032
77.254
77.000
76.746
35.436
31.894
30.922
30.162
29.435
29.285
22.673
14.110
SePh
n = 7
OH
4b'
13C{1H} NMR (126 MHz, CDCl3)
200
180
160
140
120
100
80
60
40
20
0
f1 (ppm)

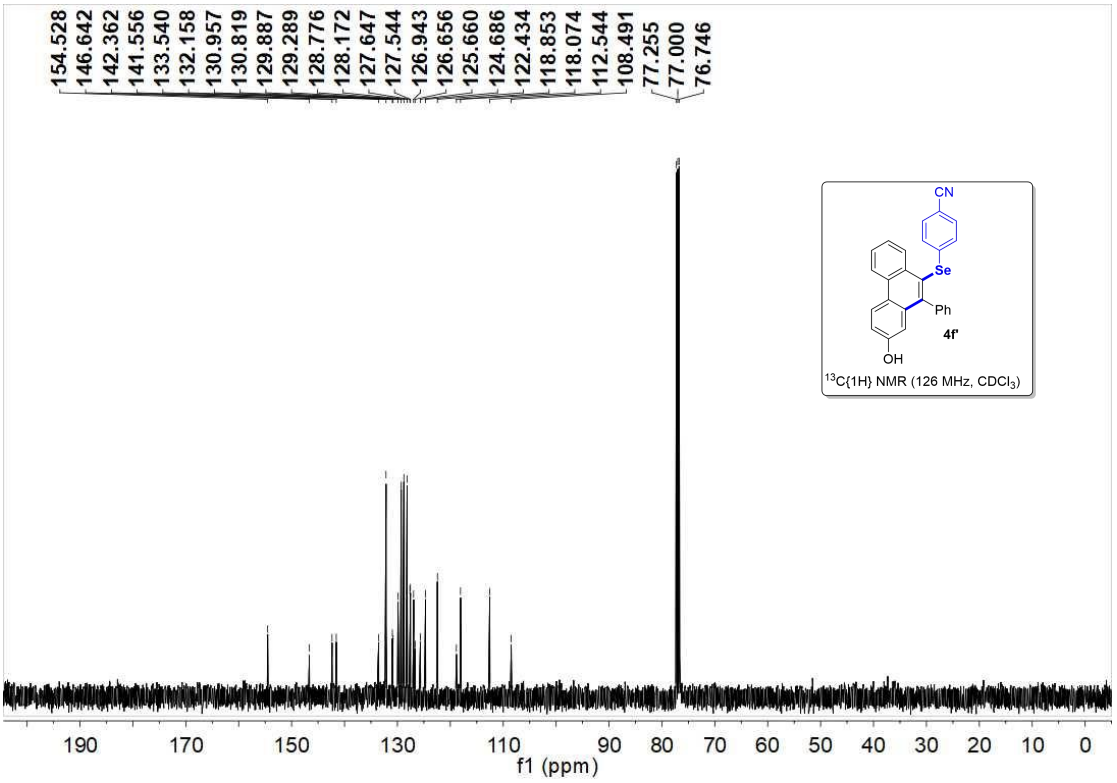

8.697
8.683
8.679
8.662
8.646
7.459
7.454
7.447
7.265
7.260
7.253
7.248
6.987
6.971
6.908
2.234
Se
Ph
4d'
OH
1H NMR (500 MHz, CDCl3)
2.95
0.99
0.99
2.96
3.24
1.92
1.97
1.00
0.97
2.93
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


154.074
145.604
142.017
135.306
133.610
131.399
130.723
130.698
130.279
129.748
129.675
129.288
128.682
128.057
127.295
127.092
126.592
125.464
124.600
122.114
117.302
112.315
77.254
77.000
76.746
20.890
Se
Ph
4d'
OH
13C{1H} NMR (126 MHz, CDCl3)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


8.704
8.686
8.671
8.654
8.615
8.598
7.538
7.453
7.274
7.218
7.211
7.038
7.022
6.965
6.948
6.803
6.800
5.024
Cl
Se
Ph
4e'
OH
^{1}H NMR (500 MHz, CDCl$_3$)
2.80
0.94
3.78
3.43
3.81
1.00
0.89
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


154.213
145.940
141.792
134.276
133.576
132.408
131.527
131.166
130.831
130.424
130.380
129.572
129.029
128.122
127.461
127.295
126.755
125.583
124.661
122.263
117.598
112.383
77.253
77.000
76.746
Cl
Se
Ph
4e'
OH
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


8.732
8.714
8.702
8.685
8.507
8.492
8.491
7.719
7.716
7.705
7.702
7.688
7.686
7.557
7.555
7.541
7.526
7.524
7.455
7.443
7.440
7.435
7.428
7.420
7.417
7.334
7.328
7.316
7.309
7.296
7.292
7.277
7.200
7.197
7.185
7.181
7.082
7.078
7.068
7.065
6.814
6.809
5.069
1.92
0.94
1.00
1.15
2.38
4.25
2.03
1.88
1.00
0.88
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)
CN
Se
Ph
4f'
OH
^{1}H NMR (500 MHz, CDCl$_3$)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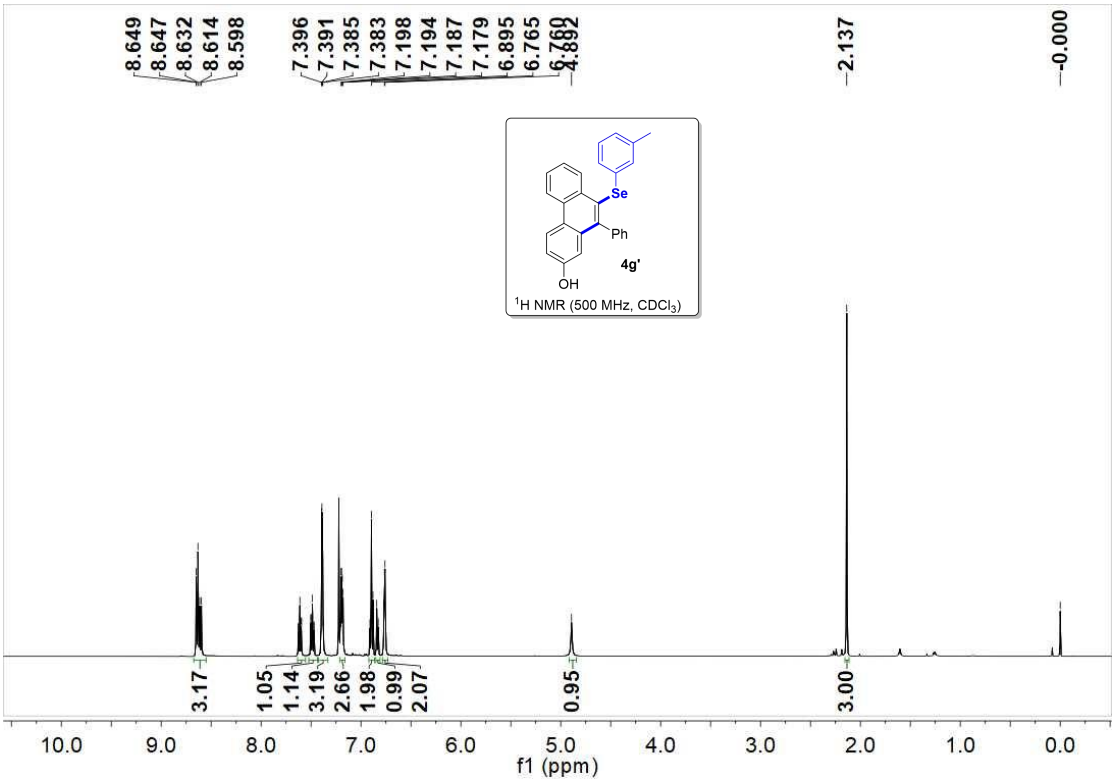
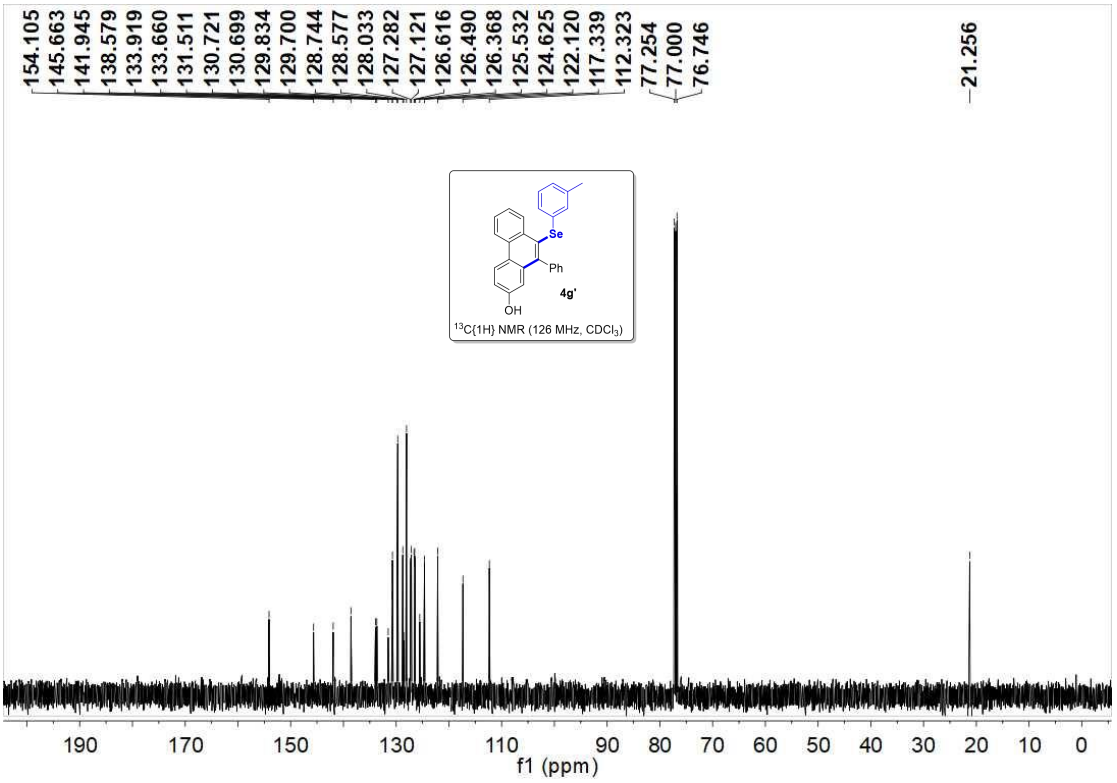
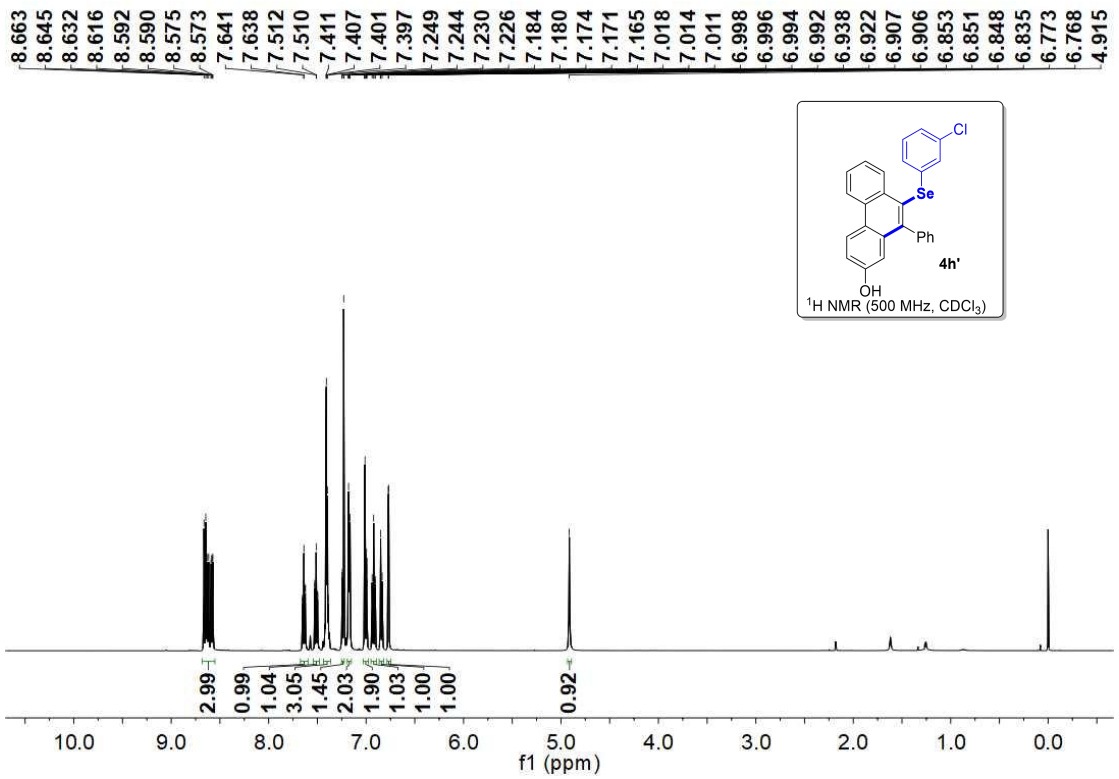
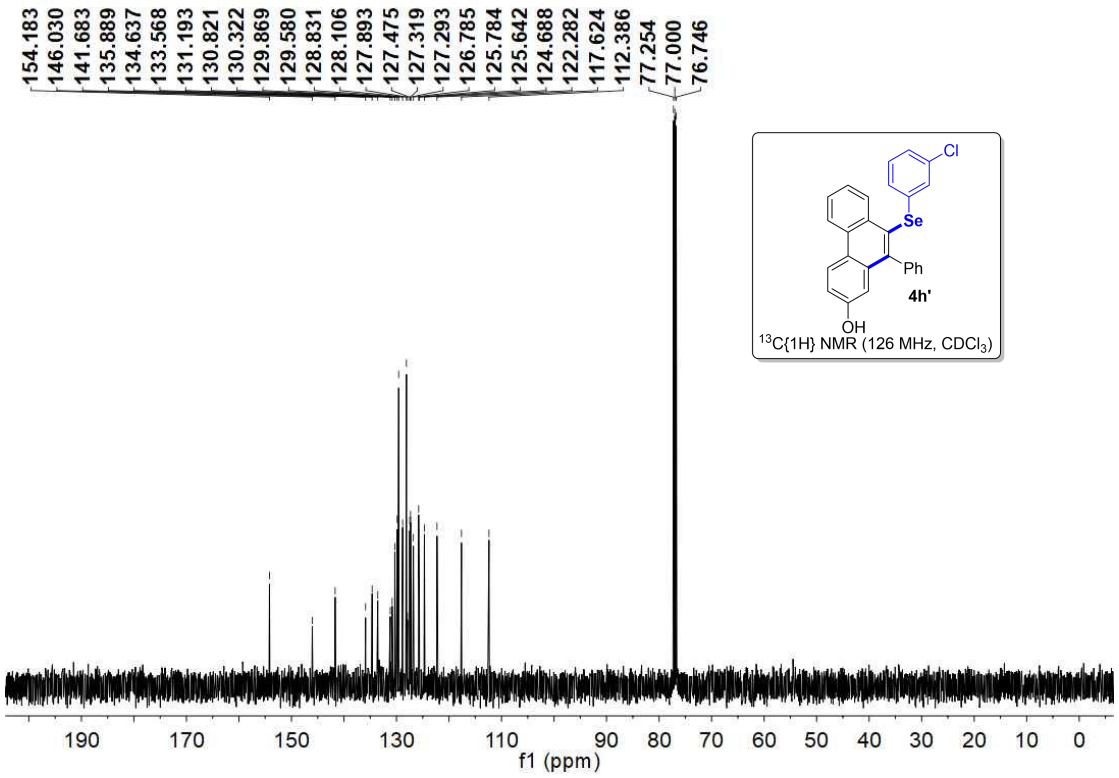
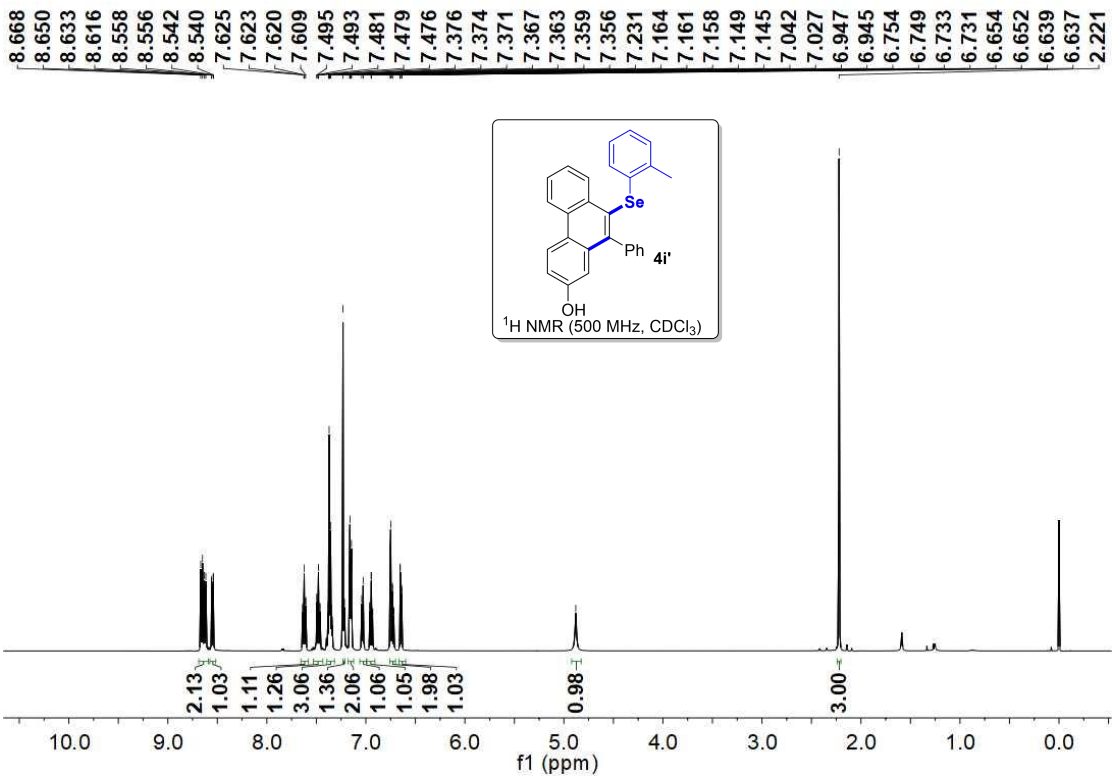
146.642
142.362
141.556
133.540
132.158
130.957
130.819
129.887
129.289
128.776
128.172
127.647
127.544
126.943
126.656
125.660
124.686
122.434
118.853
118.074
112.544
108.491
77.255
77.000
76.746
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)
CN
Se
Ph
4f'
OH
^{13}C{1H} NMR (126 MHz, CDCl$_3$)

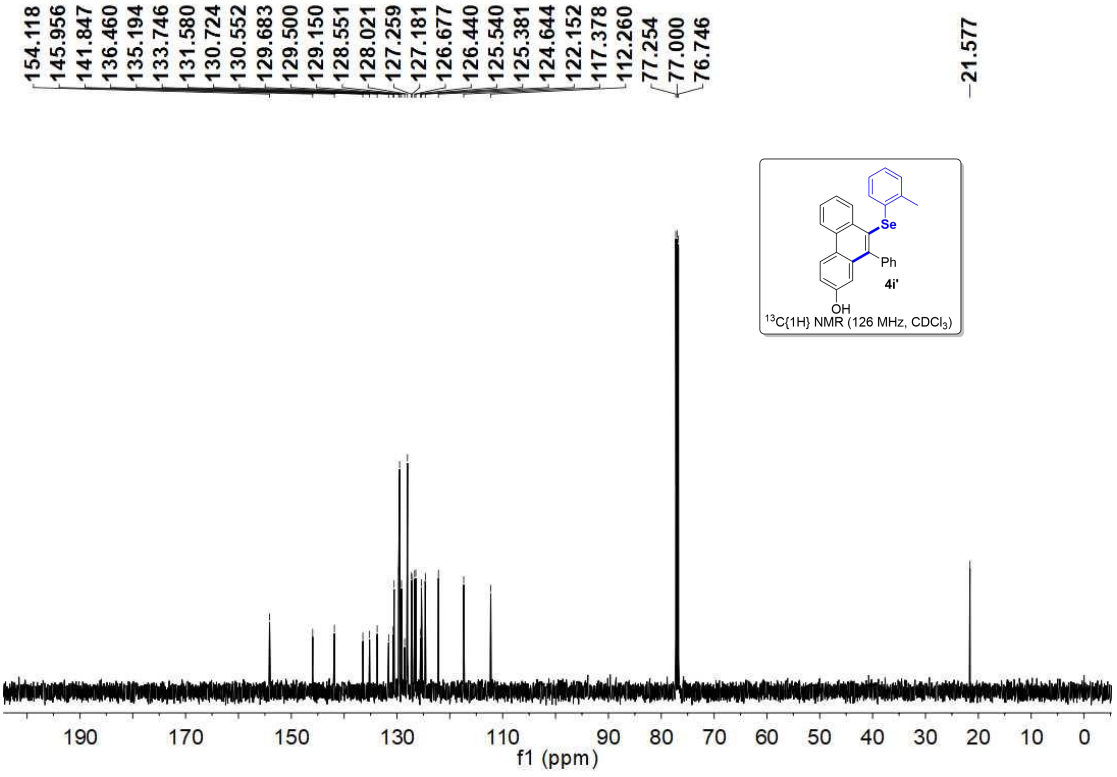

8.649
8.647
8.632
8.614
8.598
7.396
7.391
7.385
7.383
7.198
7.194
7.187
7.179
6.895
6.765
6.760
4.892
2.137
0.000
Se
Ph
OH
4g'
^{1}H NMR (500 MHz, CDCl$_3$)
3.17
1.05
1.14
3.19
2.66
1.98
0.99
2.07
0.95
3.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

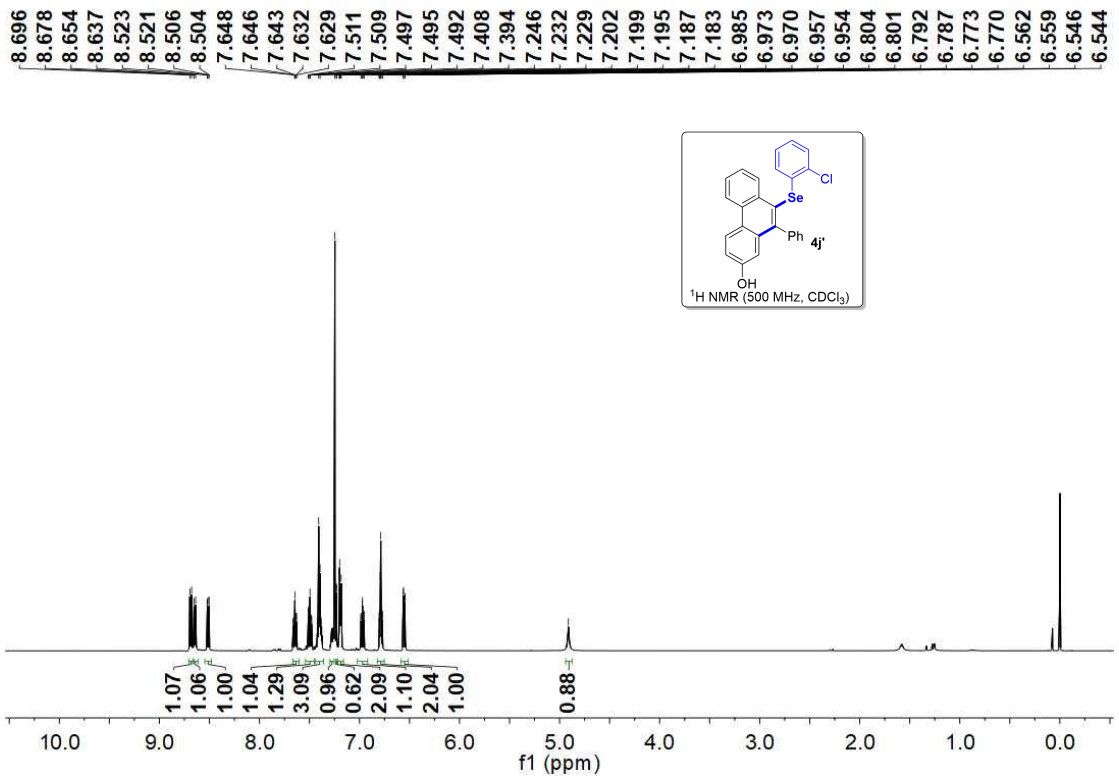

154.105
145.663
141.945
138.579
133.919
133.660
131.511
130.721
130.699
129.834
129.700
128.744
128.577
128.033
127.282
127.121
126.616
126.490
126.368
125.532
124.625
122.120
117.339
112.323
77.254
77.000
76.746
21.256
Se
Ph
OH
4g'
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

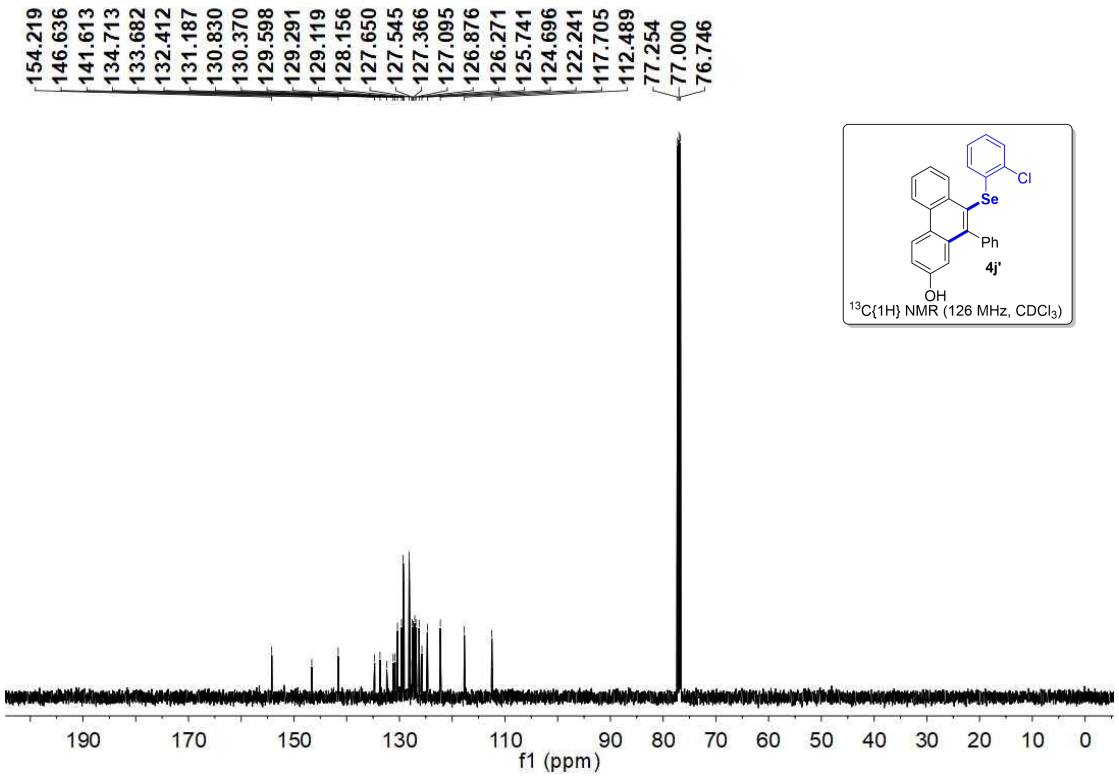

8.663
8.645
8.632
8.616
8.592
8.590
8.575
8.573
7.641
7.638
7.512
7.510
7.411
7.407
7.401
7.397
7.249
7.244
7.230
7.226
7.184
7.180
7.174
7.171
7.165
7.018
7.014
7.011
6.998
6.996
6.994
6.992
6.938
6.922
6.907
6.906
6.853
6.851
6.848
6.835
6.773
6.768
4.915
Cl
Se
Ph
4h'
OH
1H NMR (500 MHz, CDCl3)
2.99
0.99
1.04
3.05
1.45
2.03
1.90
1.03
1.00
1.00
0.92
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

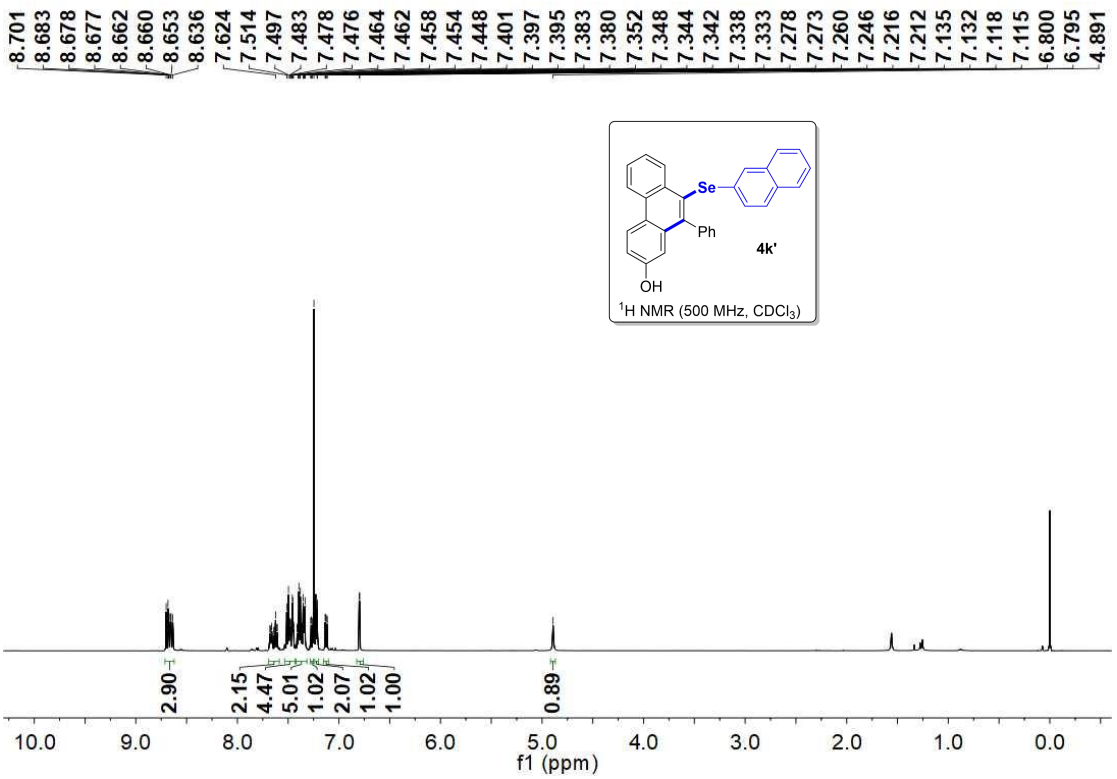

154.183
146.030
141.683
135.889
134.637
133.568
131.193
130.821
130.322
129.869
129.580
128.831
128.106
127.893
127.475
127.319
127.293
126.785
125.784
125.642
124.688
122.282
117.624
112.386
77.254
77.000
76.746
Cl
Se
Ph
4h'
OH
13C{1H} NMR (126 MHz, CDCl3)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

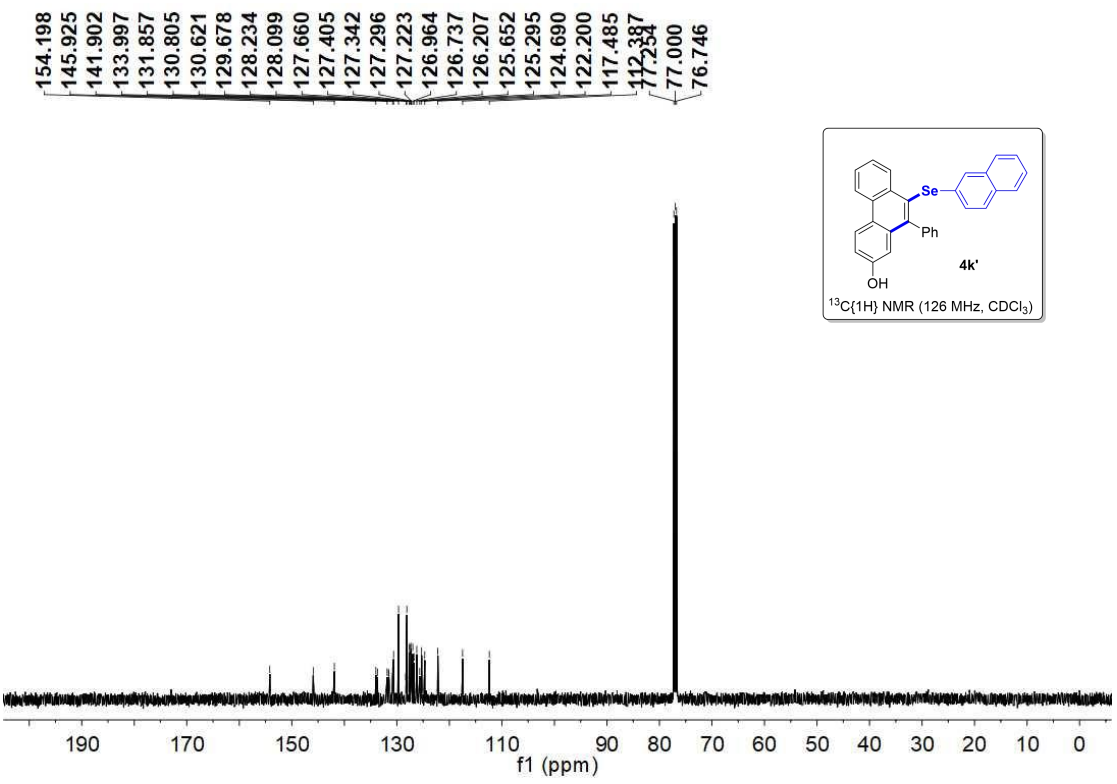

8.668
8.650
8.633
8.616
8.558
8.556
8.542
8.540
7.625
7.623
7.620
7.609
7.495
7.493
7.481
7.479
7.476
7.376
7.374
7.371
7.367
7.363
7.359
7.356
7.231
7.164
7.161
7.158
7.149
7.145
7.042
7.027
6.947
6.945
6.754
6.749
6.733
6.731
6.654
6.652
6.639
6.637
2.221
Se
Ph
4i'
OH
1H NMR (500 MHz, CDCl3)
2.13
1.03
1.11
1.26
3.06
1.36
2.06
1.06
1.05
1.98
1.03
0.98
3.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

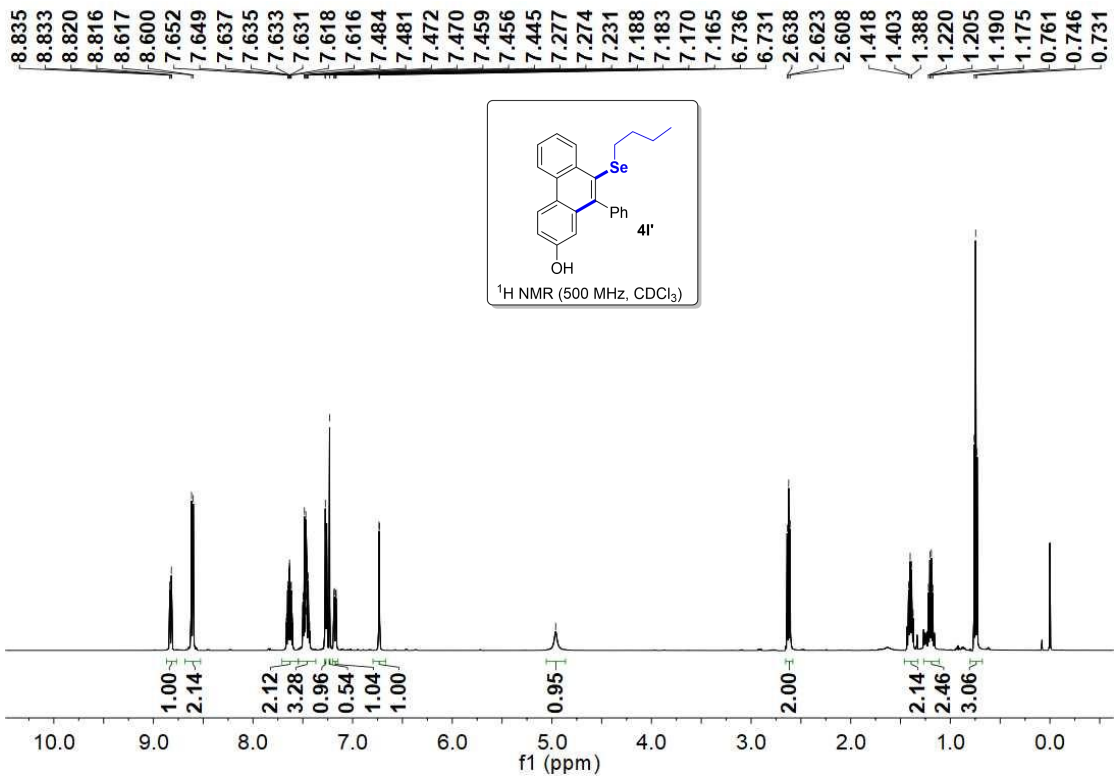

154.118
145.956
141.847
136.460
135.194
133.746
131.580
130.724
130.552
129.683
129.500
129.150
128.551
128.021
127.259
127.181
126.677
126.440
125.540
125.381
124.644
122.152
117.378
112.260
77.254
77.000
76.746
21.577
Se
Ph
4i'
OH
13C{1H} NMR (126 MHz, CDCl3)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

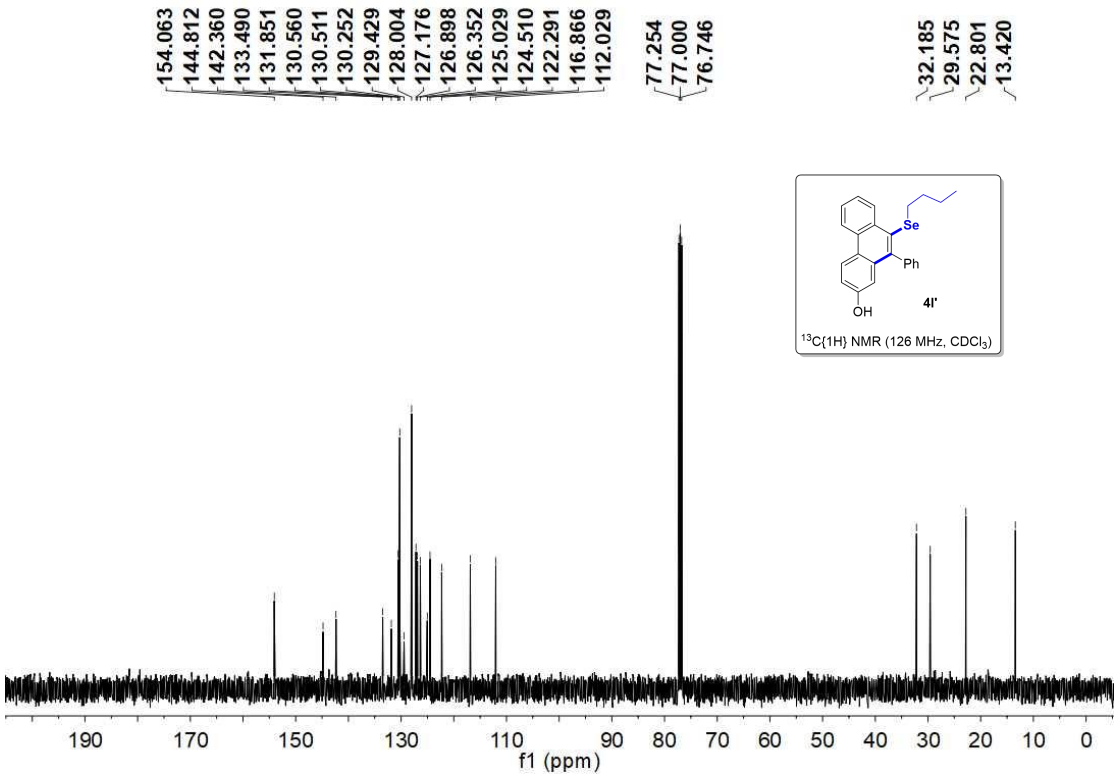

8.696
8.678
8.654
8.637
8.523
8.521
8.506
8.504
7.648
7.646
7.643
7.632
7.629
7.511
7.509
7.497
7.495
7.492
7.408
7.394
7.246
7.232
7.229
7.202
7.199
7.195
7.187
7.183
6.985
6.973
6.970
6.957
6.954
6.804
6.801
6.792
6.787
6.773
6.770
6.562
6.559
6.546
6.544
Cl
Se
Ph
4j'
OH
1H NMR (500 MHz, CDCl3)
1.07
1.06
1.00
1.04
1.29
3.09
0.96
0.62
2.09
1.10
2.04
1.00
0.88
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

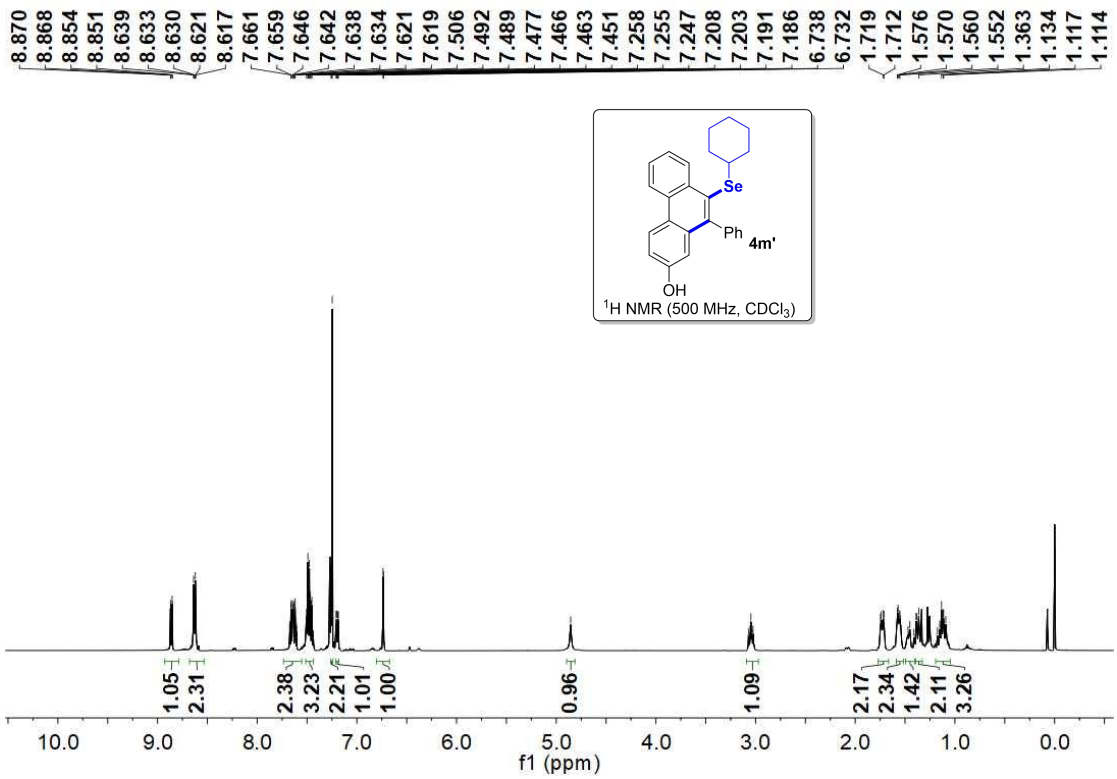

154.219
146.636
141.613
134.713
133.682
132.412
131.187
130.830
130.370
129.598
129.291
129.119
128.156
127.650
127.545
127.366
127.095
126.876
126.271
125.741
124.696
122.241
117.705
112.489
77.254
77.000
76.746
Cl
Se
Ph
4j'
OH
13C{1H} NMR (126 MHz, CDCl3)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

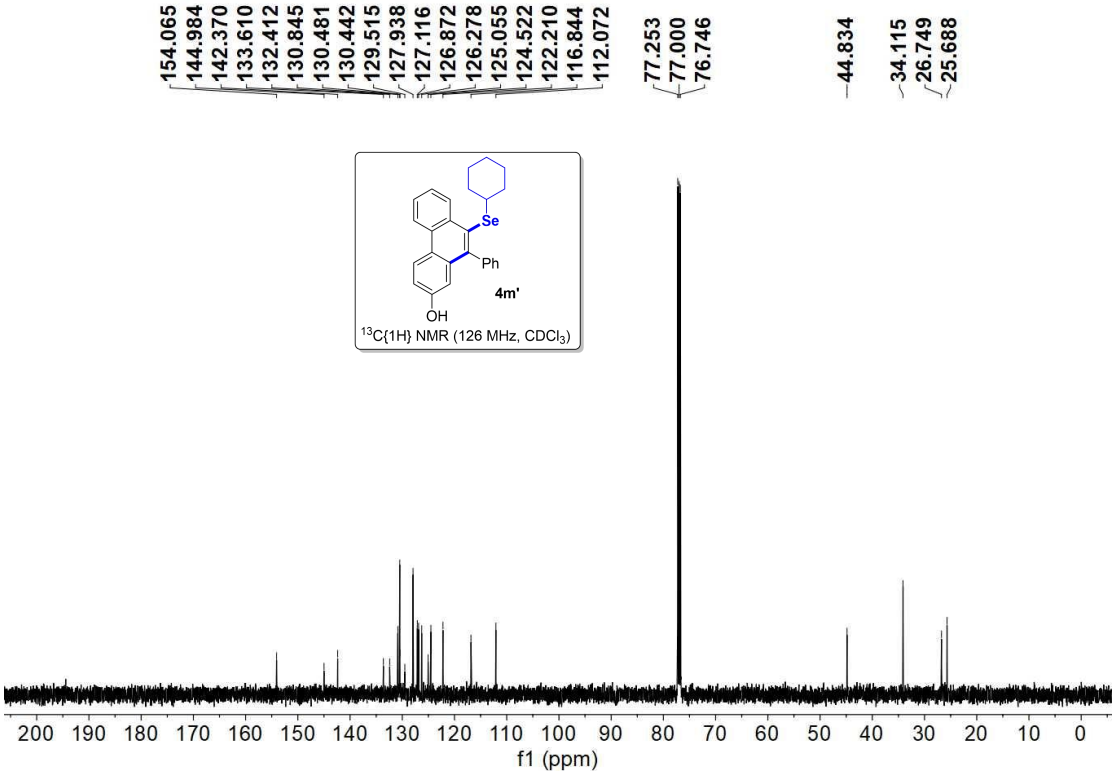

8.701
8.683
8.678
8.677
8.662
8.660
8.653
8.636
7.624
7.514
7.497
7.483
7.478
7.476
7.464
7.462
7.458
7.454
7.448
7.401
7.397
7.395
7.383
7.380
7.352
7.348
7.344
7.342
7.338
7.333
7.278
7.273
7.260
7.246
7.216
7.212
7.135
7.132
7.118
7.115
6.800
6.795
4.891
Se
Ph
OH
4k'
^{1}H NMR (500 MHz, CDCl$_3$)
2.90
2.15
4.47
5.01
1.02
2.07
1.02
1.00
0.89
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


154.198
145.925
141.902
133.997
131.857
130.805
130.621
129.678
128.234
128.099
127.660
127.405
127.342
127.296
127.223
126.964
126.737
126.207
125.652
125.295
124.690
122.200
117.485
112.387
77.254
77.000
76.746
Se
Ph
OH
4k'
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


8.835
8.833
8.820
8.816
8.617
8.600
7.652
7.649
7.637
7.635
7.633
7.631
7.618
7.616
7.484
7.481
7.472
7.470
7.459
7.456
7.445
7.277
7.274
7.231
7.188
7.183
7.170
7.165
6.736
6.731
2.638
2.623
2.608
1.418
1.403
1.388
1.220
1.205
1.190
1.175
0.761
0.746
0.731
Se
Ph
OH
4l'
^{1}H NMR (500 MHz, CDCl$_3$)
1.00
2.14
2.12
3.28
0.96
0.54
1.04
1.00
0.95
2.00
2.14
2.46
3.06
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


154.063
144.812
142.360
133.490
131.851
130.560
130.511
130.252
129.429
128.004
127.176
126.898
126.352
125.029
124.510
122.291
116.866
112.029
77.254
77.000
76.746
32.185
29.575
22.801
13.420
Se
Ph
OH
4l'
^{13}C{1H} NMR (126 MHz, CDCl$_3$)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


8.870
8.868
8.854
8.851
8.639
8.633
8.630
8.621
8.617
7.661
7.659
7.646
7.642
7.638
7.634
7.621
7.619
7.506
7.492
7.489
7.477
7.466
7.463
7.451
7.258
7.255
7.247
7.208
7.203
7.191
7.186
6.738
6.732
1.719
1.712
1.576
1.570
1.560
1.552
1.363
1.134
1.117
1.114
Se
Ph
4m'
OH
1H NMR (500 MHz, CDCl3)
1.05
2.31
2.38
3.23
2.21
1.01
1.00
0.96
1.09
2.17
2.34
1.42
2.11
3.26
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


154.065
144.984
142.370
133.610
132.412
130.845
130.481
130.442
129.515
127.938
127.116
126.872
126.278
125.055
124.522
122.210
116.844
112.072
77.253
77.000
76.746
44.834
34.115
26.749
25.688
Se
Ph
4m'
OH
13C{1H} NMR (126 MHz, CDCl3)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

Single-crystal X-ray structure of 3t and 4a

The crystal of products **3t** and **4a** were obtained by slow evaporation in *n*-hexane and dichloromethane. The single crystal X-ray analysis determined the structure of products **3t** and **4a** as expected (Figure S1 and S2).

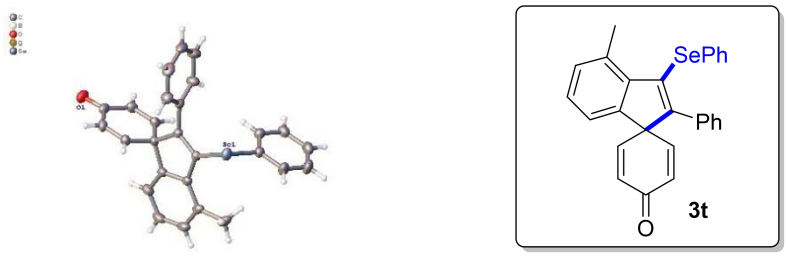


Figure S1. ORTEP illustration of compound 3t with thermal ellipsoids drawn at 50% probability level.

Bond precision:	C-C = 0.0029 A		Wavelength=1.54184
Cell:	a=10.2238(3)	b=10.1572(3)	c=21.0271(8)
	alpha=90	beta=104.016(4)	gamma=90
Temperature:	250 K		

	Calculated	Reported
Volume	2118.55(12)	2118.56(13)
Space group	P 21/n	P 1 21/n 1
Hall group	-P 2yn	-P 2yn
Moiety formula	C27 H20 O Se	C27 H20 O Se
Sum formula	C27 H20 O Se	C27 H20 O Se
Mr	439.39	439.39
Dx,g cm-3	1.378	1.378
Z	4	4
Mu (mm-1)	2.501	2.501
F000	896.0	896.0
F000’	894.85	
h,k,lmax	12,12,26	12,12,25

Nref	4275	4179
Tmin,Tmax	0.759,0.779	0.789,1.000
Tmin’	0.688	

Correction method= # Reported T Limits: Tmin=0.789 Tmax=1.000
AbsCorr = MULTI-SCAN

Data completeness= 0.978 Theta(max)= 73.626

R(reflections)= 0.0308(3798) wR2(reflections)= 0.0838(4179)

S = 1.065 Npar= 263

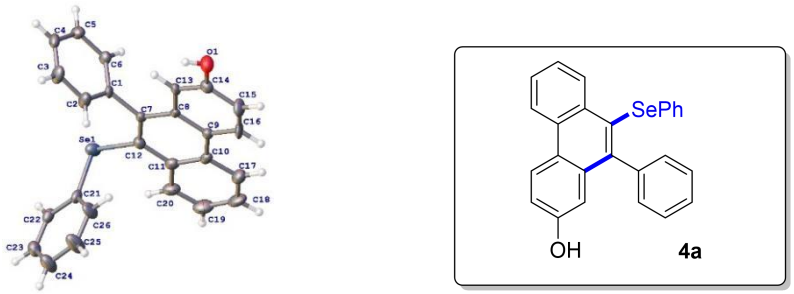


Figure S2. ORTEP illustration of compound 4a with thermal ellipsoids drawn at 50% probability level.

Bond precision: C-C = 0.0091 A Wavelength=0.71073

Cell: a=26.615(3) b=9.7502(10) c=35.915(6)
alpha=90 beta=112.221(16) gamma=90

Temperature: 220 K

	Calculated	Reported
Volume	8628(2)	8628(2)
Space group	C 2/c	C 1 2/c 1
Hall group	-C 2yc	-C 2yc
Moiety formula	C26 H18 O Se [+ solvent]	C26 H18 O Se
Sum formula	C26 H18 O Se [+ solvent]	C26 H18 O Se
Mr	425.36	425.36
Dx,g cm-3	1.310	1.310
Z	16	16

Mu (mm-1)	1.753	1.753
F000	3456.0	3456.0
F000’	3455.71	
h,k,lmax	31,11,42	31,11,42
Nref	7604	7580
Tmin,Tmax	0.810,0.854	0.579,1.000
Tmin’	0.810	

Correction method= # Reported T Limits: Tmin=0.579 Tmax=1.000
AbsCorr = MULTI-SCAN

Data completeness= 0.997 Theta(max)= 24.999

R(reflections)= 0.0634(3699) wR2(reflections)=

0.1417(7580)

S = 1.000 Npar = 506