Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry.

–Electronic Supporting Information –

Metal-free switchable *ortho*/*ipso*-cyclization of *N*-aryl alkynamides: divergent synthesis of 3-selenyl quinolin-2-ones and azaspiro[4,5]trienones

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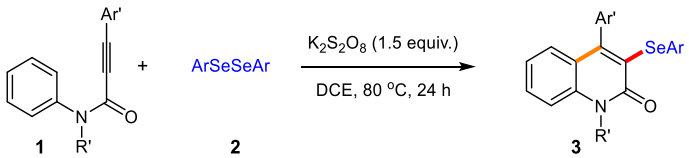
General Information:

All non-aqueous reactions were carried out under an atmosphere of nitrogen in flame-dried glass ware and were stirred using a magnetic stir plate. All reactions were carried out using anhydrous solvent unless otherwise noted. DCE, MeCN, and DMSO were dried over calcium hydride. Dry toluene, and THF were prepared by distilling over sodium ketyl. Dried DMC and MeOH were purchased from FINAR. $K_2S_2O_8$, $Na_2S_2O_8$, $(NH_4)_2S_2O_8$ and DTBP were procured from Sigma Aldrich Company.

All reactions were monitored by thin layer chromatography (TLC) on WhatmanPartisil® K6F TLC plates (silica gel 60 Å, 0.25 mm thickness) and visualized using a UV lamp (366 or 254 nm) or by use of one of the following visualization reagents: PMA: 10 g phosphomolybdic acid/ 100 mL ethanol, $KMnO_4$: 0.75 g potassium permanganate, 5 g K_2CO_3,/100mL water. Products were isolated by column chromatography (Merck silica gel 100-200μm). Yields refer to chromatographically and spectroscopically homogenous materials unless noted otherwise. ^{13}C and ^{1}H NMR spectra were recorded on a Bruker 400 or Bruker 500 MHz spectrometers. Chemical shift values (δ) are reported in ppm and calibrated to the residual solvent peak $CDCl_3$ δ = 7.2600 ppm for ^{1}H, δ = 77.16 ppm for ^{13}C and or calibrated to tetramethylsilane (δ = 0.00). All NMR spectra were recorded at ambient temperature (290 K) unless otherwise noted. ^{1}H NMR spectra are reported as follows: chemical shift (multiplicity, coupling constant, integration). The following abbreviations are used to indicate multiplicities: s, singlet; d, doublet; t, triplet; q, quartet; quint, quintet, sext, sextet, sept, septet, m, multiplet; dd, doublet of doublet; dt, doublet of triplet; dq, doublet of quartet; td, triplet of doublet; tt, triplet of triplet; dq, doublet of quartet; br, broad; app, apparent.
Mass spectra were recorded by electron spray ionization (ESI) method on a Q-TOF Micro with lock spray source. The crystal data were collected and integrated using a BrukerAxs kappa apex2 CCD diffractometer, with graphite monochromated Mo-Kα radiation.

The *N*-arylpropiolamides **1** were synthesized following the previously published procedures (*Chem. Eur. J.* **2015**, *21*, 1468). Diselenide derivatives were prepared following the know procedure (*Org. Biomol. Chem*. **2014**, *12*, 9557).

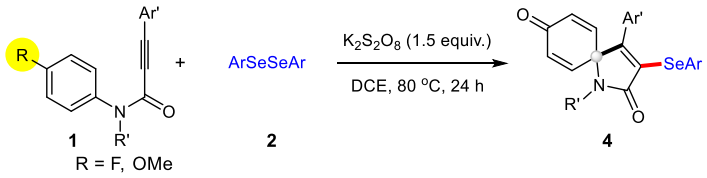
General Procedure for the Synthesis of 3-Selenyl Quinolin-2-ones:



The *N*-arylpropiolamides **1** (0.20 mmol), diaryl diselenide derivatives **2** (0.30 mmol) and $K_2S_2O_8$ (0.30 mmol) were taken in an oven dried reaction tube with a magnetic stir. Then DCE (1.5 mL) was added with a syringe and the reaction tube was purged with nitrogen. The reaction mixture was allowed to stir at 80 °C

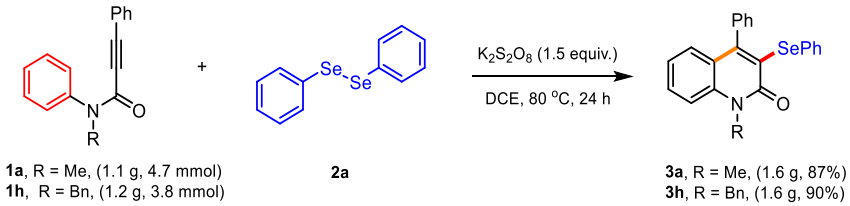
for 24 h. After completion of the reaction (TLC monitored), it was transferred to a round bottom flask after dilution with CH_2Cl_2. Volatiles were evaporated under reduced pressure and the resulting residue was purified by column chromatography on silica gel with a gradient eluent of hexane and ethyl acetate to get pure products **3**.

General Procedure for Selenylative Spirocyclization of *N*-arylpropiolamides:



The *N*-arylpropiolamides **1** (0.20 mmol), diaryl diselenide derivatives **2** (0.30 mmol) and $K_2S_2O_8$ (0.30 mmol) were taken in an oven dried reaction tube with a magnetic stir. Then DCE (1.5 mL) was added with a syringe and the reaction tube was purged with nitrogen. The reaction mixture was allowed to stir at 80 °C for 24 h. After completion of the reaction (TLC monitored), it was transferred to a round bottom flask after dilution with CH_2Cl_2. Volatiles were evaporated under reduced pressure and the resulting residue was purified by column chromatography on silica gel with a gradient eluent of hexane and ethyl acetate to get pure products **4**.

Gram Scale Synthesis of Product 3a/3h:

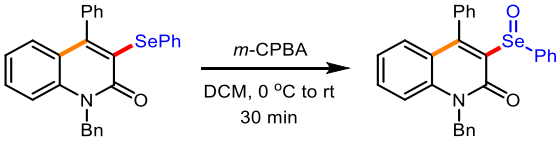


Synthesis of 3a: The *N*-methyl-*N*,3-diphenylpropiolamide **1a** (1.1 g, 4.7 mmol), diphenyl diselenide **2a** (2.2 g, 7.0 mmol) and $K_2S_2O_8$ (7.0 mmol) were taken in an oven dried Schlenk tube with a magnetic stir. Then DCE (30 mL) was added with a syringe and the reaction tube was purged with nitrogen. The reaction mixture was allowed to stir at 80 °C for 24 h. After completion of the reaction (TLC monitored), it was transferred to a round bottom flask after dilution with CH_2Cl_2. Volatiles were evaporated under reduced pressure and the resulting residue was purified by silica gel column chromatography (hexane : ethyl acetate, 85 : 15) to provide pure 1-methyl-4-phenyl-3-(phenylselanyl)quinolin-2(1H)-one **3a** in 87% yield (1.6 g).

Synthesis of 3h: The *N*-benzyl-*N*,3-diphenylpropiolamide **1h** (1.2 g, 3.8 mmol), diphenyl diselenide **2a** (1.8 g, 5.7 mmol) and $K_2S_2O_8$ (5.7 mmol) were taken in an oven dried Schlenk tube with a magnetic stir. Then DCE (30 mL) was added with a syringe and the reaction tube was purged with nitrogen. The reaction mixture was allowed to stir at 80 °C for 24 h. After completion of the reaction (TLC monitored), it was transferred to a round bottom flask after dilution with CH_2Cl_2. Volatiles were evaporated under reduced pressure and the resulting residue was purified by silica gel column chromatography (hexane : ethyl acetate, 85 : 15) to provide pure 1-benzyl-4-phenyl-3-(phenylselanyl)quinolin-2(1H)-one **3h** in 90% yield (1.6 g).

Post-functionalization:

Synthesis of compound 5:

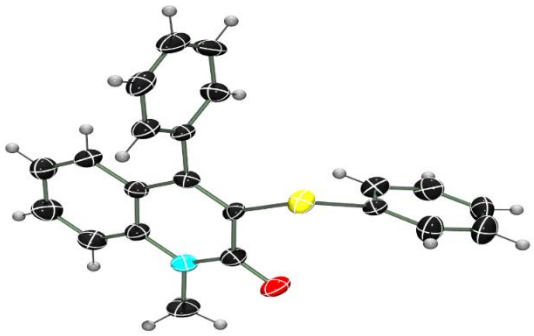


3h **5**, 58%

The compound **3h** (0.2 mmol) was taken in a dried reaction tube with a magnetic stir bar. Then DCM (2 mL) was added and cooled at 0 °C. After that, a solution of *m*-CPBA (2.2 equiv.) in DCM was added to the reaction mixture, and allowed to stir for 30 min at room temperature. After completion of the reaction (TLC monitored), the reaction was quenched with 10 mL of saturated Na_2SO_3 solution. The reaction mixture was washed with $NaHCO_3$. The organic layer was dried with $MgSO_4$ and evaporated to dryness. The crude reaction mixture was directly purified by silica gel column chromatography (DCM : MeOH, 95 : 5) to provide product **5** (60 mg, 58%) as colorless solid.

Crystallographic Experimental Section:

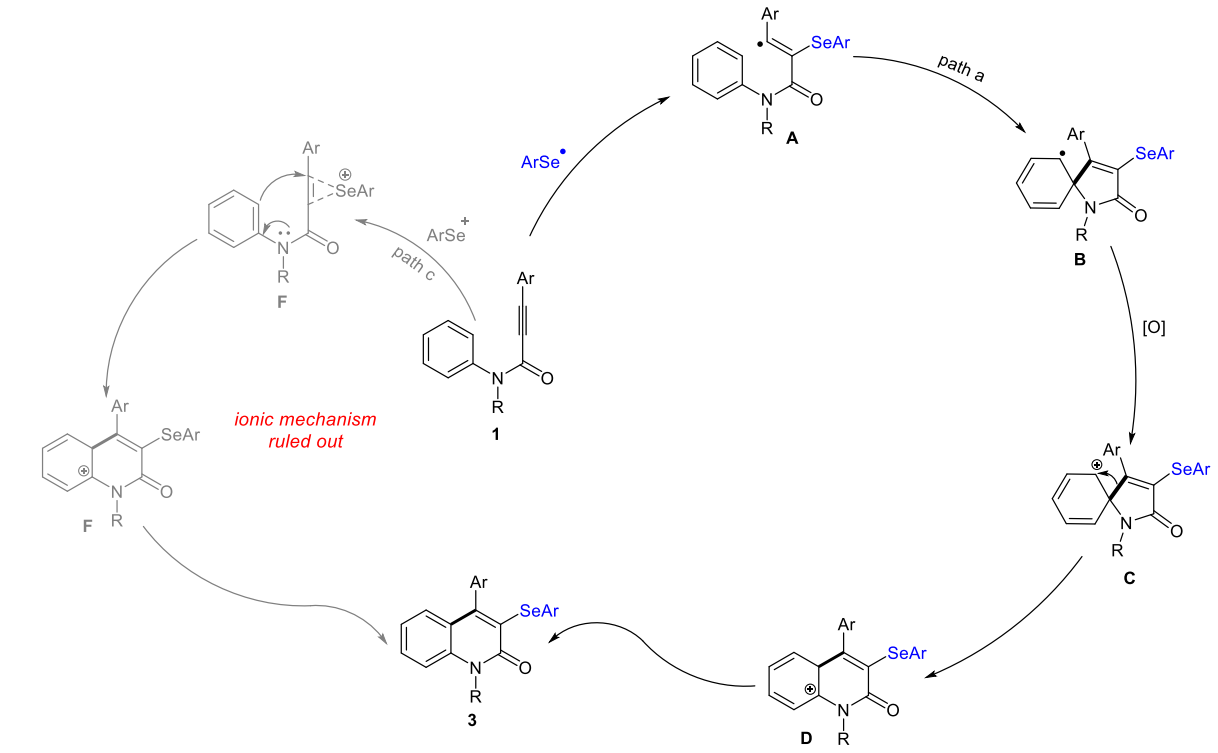
*ORTEP diagram of compound **3a** at 35% ellipsoid probability CCDC 1957705*



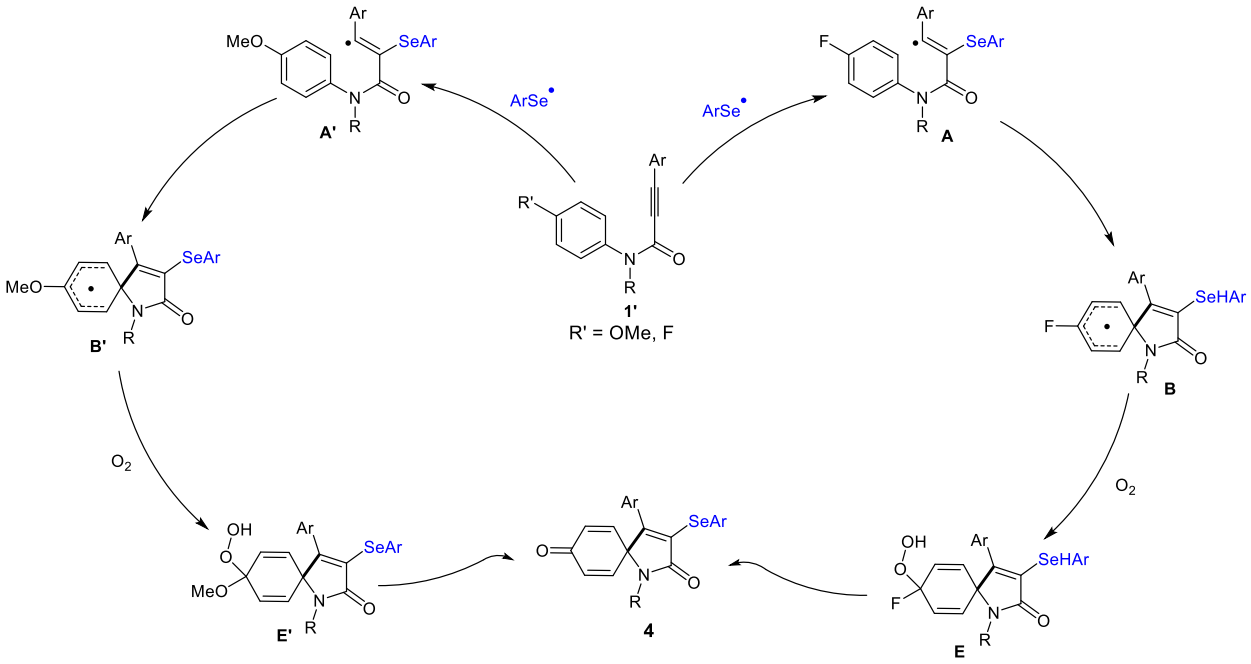
Identification code	3a
Empirical formula	$C_{26}H_{17}Cl_2Se_2$
Formula weight	558.21

Temperature	296(2) K
Wavelength	0.71073 A
Crystal system, space group	Monoclinic, P2(1)/c
Unit cell dimensions	a = 22.670(5) A alpha = 90 deg.
	b = 6.1798(10) A beta = 112.748(8) deg.
	c = 17.778(4) A gamma = 90 deg.
Volume	2297.0(8) A^3
Z, Calculated density	4, 1.614 Mg/m^3
Absorption coefficient	3.463 mm^-1
F(000)	1100
Crystal size	0.250 x 0.220 x 0.100 mm
Theta range for data collection	1.948 to 24.995 deg.
Limiting indices	-24<=h<=26, -5<=k<=7, -21<=l<=21
Reflections collected / unique	13517 / 4041 [R(int) = 0.0659]
Completeness to theta = 24.995	99.9 %
Absorption correction	None
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	4041 / 0 / 271
Goodness-of-fit on F^2	1.052
Final R indices [I>2sigma(I)]	R1 = 0.0586, wR2 = 0.1527
R indices (all data)	R1 = 0.1196, wR2 = 0.1955
Extinction coefficient	n/a
Largest diff. peak and hole	0.912 and -0.761 e.A^-3

Plausible Reaction Mechanism



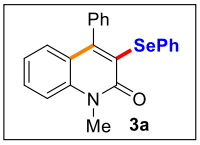
Plausible reaction mechanism for the cascade cyclization of *N*-aryl alkynamide with ArSeSeAr for the formation of 3-selenyl quinolin-2-ones



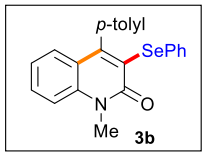
Plausible reaction mechanism for the spiro-cyclization process of *N*-aryl alkynamide

Spectroscopic Data:

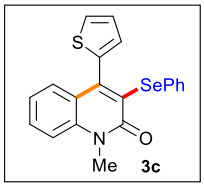
1-Methyl-4-phenyl-3-(phenylselanyl)quinolin-2(1H)-one (**3a**): Pale yellow solid, Mp (148-150 °C), eluent (15% ethyl acetate in hexane). Yield: 94% (74 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.57 – 7.51 (m, 1H), 7.45 – 7.34 (m, 4H), 7.31 – 7.24 (m, 2H), 7.19 – 7.04 (m, 7H), 3.82 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.7, 155.1, 140.0, 138.1, 132.3, 131.8, 131.0, 128.9, 128.8 (2×C), 128.3, 128.1, 126.8 , 126.3, 122.1, 121.6, 114.3, 31.0 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+Na]^+$ Calcd for $C_{22}H_{17}NOSeNa^+$ 414.0373; Found 414.0369.



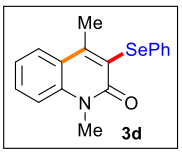
1-Methyl-3-(phenylselanyl)-4-(p-tolyl)quinolin-2(1H)-one (**3b**): Yellow solid, Mp (116-118 °C), eluent (15% ethyl acetate in hexane). Yield: 88% (71 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.54 (t, *J* = 7.8 Hz, 1H), 7.39 (d, *J* = 8.5 Hz, 1H), 7.28 (d, *J* = 7.4 Hz, 2H), 7.24 – 7.16 (m, 3H), 7.14 – 6.96 (m, 6H), 3.80 (s, 3H), 2.41 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.6, 155.2, 139.9, 137.9, 135.2, 132.1, 131.9, 130.9, 129.0, 128.9, 128.8, 128.7, 126.7, 126.2, 122.0, 121.7, 114.2, 30.9, 21.5 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{23}H_{19}NOSeH^+$ 406.0710; Found 406.0737.



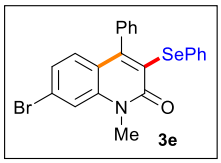
1-Methyl-3-(phenylselanyl)-4-(thiophen-2-yl)quinolin-2(1H)-one (**3c**): Yellow solid, Mp (182-184 °C), eluent (15% ethyl acetate in hexane). Yield: 81% (64 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.57 (t, *J* = 7.7 Hz, 1H), 7.46 (d, *J* = 5.0 Hz, 1H), 7.41 – 7.35 (m, 4H), 7.20 – 7.11 (m, 4H), 7.10 – 7.02 (m, 1H), 6.88 (d, *J* = 2.6 Hz, 1H), 3.79 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.2, 147.8, 139.6, 137.9, 132.5, 131.4, 131.1, 129.6, 128.9, 128.7, 128.5, 127.0 (2×C), 126.8, 122.3, 122.0, 114.2, 31.0 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{20}H_{15}NOSSeH^+$ 398.0118; Found 398.0118.

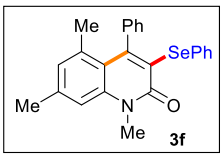


1,4-Dimethyl-3-(phenylselanyl)quinolin-2(1H)-one (**3d**): Pale yellow solid, Mp (96-98 °C), eluent (15% ethyl acetate in hexane). Yield: 73% (48 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.79 (dd, *J* = 8.1, 1.4 Hz, 1H), 7.60 (ddd, *J* = 8.6, 7.2, 1.4 Hz, 1H), 7.43 – 7.34 (m, 3H), 7.29 – 7.24 (m, 1H), 7.22 – 7.13 (m, 3H), 3.77 (s, 3H), 2.73 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.8, 151.4, 139.6, 132.2, 131.1, 131.0, 129.3, 126.6, 126.4, 126.3, 122.3, 121.2, 114.6, 30.9, 21.1 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+Na]^+$ Calcd for $C_{17}H_{15}NOSeNa^+$ 352.0217; Found 352.0201.

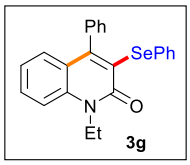


7-Bromo-1-methyl-4-phenyl-3-(phenylselanyl)quinolin-2(1H)-one (**3e**): White solid, Mp (160-162 °C), eluent (15% ethyl acetate in hexane). Yield: 58% (54 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.48 (d, *J* = 7.6 Hz, 1H), 7.44 – 7.26 (m, 7H), 7.19 – 7.15 (m, 5H), 3.77 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 159.5, 153.4, 142.2, 140.2, 132.1, 132.0, 130.7, 130.5, 130.3, 129.8, 129.0, 128.4, 128.1, 126.9, 122.4, 119.3, 114.4, 32.0 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{22}H_{16}BrNOSeH^+$ 469.9659; Found 469.9660.

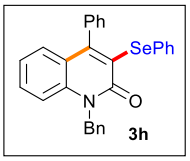


1,5,7-Trimethyl-4-phenyl-3-(phenylselanyl)quinolin-2(1H)-one (**3f**): Pale yellow solid, eluent (15% ethyl acetate in hexane). Yield: 72% (60 mg); 

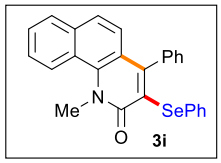
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33 – 7.27 (m, 3H), 7.23 – 7.18 (m, 2H), 7.08 – 7.04 (m, 6H), 6.72 (s, 1H), 3.71 (s, 3H), 2.36 (s, 3H), 1.65 (s, 3H) ppm. **^{13}C NMR** (125 MHz, $CDCl_3$) δ 160.1, 155.8, 142.6, 141.5, 141.1, 138.2, 132.9, 131.2, 128.9, 128.7, 128.6, 128.2, 128.1, 126.4, 126.1, 117.7, 113.5, 31.9, 24.6, 21.9 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+Na]^+$ Calcd for $C_{24}H_{21}NOSeNa^+$ 442.0686; Found 442.0699.

1-Ethyl-4-phenyl-3-(phenylselanyl)quinolin-2(1H)-one (**3g**): Pale yellow solid, Mp (117-119 °C), eluent (15% ethyl acetate in hexane). Yield: 91% (74 mg); 

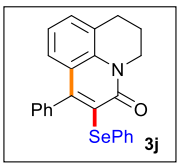
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (t, *J* = 7.5 Hz, 1H), 7.46 – 7.33 (m, 4H), 7.27 (d, *J* = 5.9 Hz, 2H), 7.20 – 7.01 (m, 7H), 4.44 (q, *J* = 6.9 Hz, 2H), 1.40 (t, *J* = 6.8 Hz, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.0, 154.8, 138.9, 138.1, 132.3, 131.8, 130.8, 129.0, 128.8 (2×C), 128.3, 128.1, 126.7, 126.4, 121.9, 121.8, 114.1, 38.7, 12.7 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+Na]^+$ Calcd for $C_{23}H_{19}NOSeNa^+$ 428.0530; Found 428.0554.

1-Benzyl-4-phenyl-3-(phenylselanyl)quinolin-2(1H)-one (**3h**): Yellow solid, Mp (134-136 °C), eluent (15% ethyl acetate in hexane). Yield: 93% (87 mg); 

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 – 7.37 (m, 4H), 7.35 – 7.24 (m, 14H), 7.02 (t, *J* = 6.9 Hz, 1H), 5.63 (s, 2H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.8, 155.6, 139.4, 138.2, 136.5, 132.3, 131.9, 130.9 (2×C), 128.9 (3×C), 128.4, 128.3, 127.4, 127.0, 126.9, 126.5, 122.2, 121.9, 115.1, 47.4 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{28}H_{21}NOSeH^+$ 468.0867; Found 468.0886.

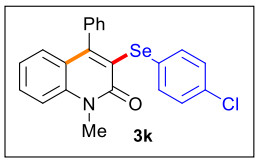
1-Methyl-4-phenyl-3-(phenylselanyl)benzo[h]quinolin-2(1H)-one (**3i**): Pale yellow solid, Mp (176-178 °C), eluent (15% ethyl acetate in hexane). Yield: 63% (55 mg); 

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.44 (d, *J* = 8.2 Hz, 1H), 7.92 – 7.81 (m, 1H), 7.62 – 7.52 (m, 2H), 7.47 – 7.39 (m, 4H), 7.33 – 7.28 (m, 2H), 7.18 – 7.08 (m, 6H), 4.12 (s, 3H) ppm. **^{13}C NMR** (125 MHz, $CDCl_3$) δ 163.1, 154.9, 139.8, 138.5, 135.5, 132.6, 131.7, 129.0 (2×C), 128.7, 128.5, 128.3, 127.7, 126.9, 126.1, 125.7, 125.3, 124.5, 123.7, 123.5, 119.2, 41.8 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{26}H_{19}NOSeH^+$ 442.0710; Found 442.0706.

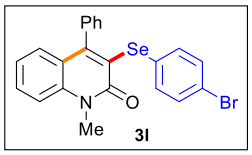
7-Phenyl-6-(phenylselanyl)-2,3-dihydro-1H,5H-pyrido[3,2,1-ij]quinolin-5-one (**3j**): White solid, Mp (178-180 °C), eluent (15% ethyl acetate in hexane). Yield: 60% (50 mg); 

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.39 – 7.35 (m, 3H), 7.31 – 7.25 (m, 3H), 7.16 – 7.06 (m, 5H), 6.99 – 6.94 (m, 2H), 4.26 (t, *J* = 4.4 Hz, 2H), 3.01 (t, *J* = 6.2 Hz, 2H), 2.14 (quint, *J* = 6.1 Hz, 2H) ppm. **^{13}C NMR** (125 MHz, $CDCl_3$) δ 160.2, 155.0, 138.4, 136.8, 132.3, 131.9, 130.3, 128.9, 128.8, 128.3, 128.0, 126.8, 126.7, 125.8, 124.9, 121.6, 121.5, 43.7, 27.9, 20.9 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{24}H_{19}NOSeH^+$ 418.0710; Found 418.0738.

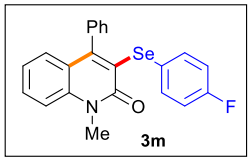
3-((4-Chlorophenyl)selanyl)-1-methyl-4-phenylquinolin-2(1H)-one (**3k**): Pale yellow solid, Mp (155-157 °C), eluent (15% ethyl acetate in hexane). Yield: 95% (81 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.60 – 7.54 (m, 1H), 7.44 – 7.40 (m, 4H), 7.22 – 7.02 (m, 8H), 3.82 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.6, 155.1, 139.9, 138.0, 133.7, 133.0, 131.1, 129.9, 129.1, 128.8 (2×C), 128.4, 128.3, 126.1, 122.3, 121.5, 114.4, 31.0 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+Na]^+$ Calcd for $C_{22}H_{16}ClNOSeNa^+$ 447.9983; Found 447.9950.



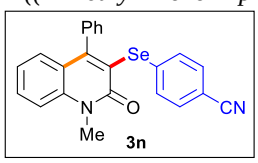
3-((4-Bromophenyl)selanyl)-1-methyl-4-phenylquinolin-2(1H)-one (**3l**): Yellow solid, Mp (168-170 °C), eluent (15% ethyl acetate in hexane). Yield: 69% (65 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.59 – 7.55 (m, 1H), 7.45 – 7.38 (m, 4H), 7.24 – 7.18 (m, 2H), 7.18 – 7.06 (m, 6H), 3.82 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.5, 155.2, 140.0, 138.0, 133.9, 132.0, 131.2, 130.7, 128.9, 128.8, 128.4, 128.3, 126.0, 122.3, 121.5, 121.1, 114.4, 31.0 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{22}H_{16}BrNOSeH^+$ 469.9659; Found 469.9675.



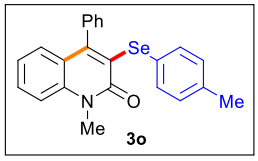
3-((4-Fluorophenyl)selanyl)-1-methyl-4-phenylquinolin-2(1H)-one (**3m**): White solid, Mp (119-121 °C), eluent (15% ethyl acetate in hexane). Yield: 87% (78 mg); **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.58 – 7.53 (m, 1H), 7.42 – 7.39 (m, 4H), 7.30 – 7.23 (m, 2H), 7.15 – 7.07 (m, 4H), 6.83 – 6.76 (m, 2H), 3.82 (s, 3H) ppm. **^{13}C NMR** (125 MHz, $CDCl_3$) δ 163.2, 161.0 (d, J = 75.8 Hz), 154.4, 139.8, 137.9, 135.1 (d, J = 7.8 Hz), 131.0, 128.8, 128.7, 128.4, 128.2, 126.6, 125.9 (d, J = 3.3 Hz), 122.2, 121.6, 116.0 (d, J = 21.6 Hz), 114.3, 30.9 ppm. **^{19}F NMR** (471 MHz, $CDCl_3$) δ -115.0 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{22}H_{16}FNOSeH^+$ 410.0459; Found 410.0458.



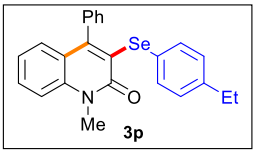
4-((1-Methyl-2-oxo-4-phenyl-1,2-dihydroquinolin-3-yl)selanyl)benzonitrile **(3n)**: Brown solid, Mp (163-165 °C), eluent (15% ethyl acetate in hexane). Yield: 57% (52 mg); **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.63 – 7.60 (m, 1H), 7.49 – 7.41 (m, 4H), 7.37 (d, J = 8.3 Hz, 2H), 7.34 – 7.29 (m, 2H), 7.20 (dd, J = 8.1, 1.4 Hz, 1H), 7.17 – 7.11 (m, 3H), 3.84 (s, 3H) ppm. **^{13}C NMR** (125 MHz, $CDCl_3$) δ 160.2, 156.7, 140.3, 140.0, 137.9, 132.2, 131.7, 131.0, 129.2, 128.7, 128.6 (2×C), 124.4, 122.5, 121.4, 119.0, 114.5, 109.7, 31.1 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{23}H_{16}N_2OSeH^+$ 417.0506; Found 417.0486.



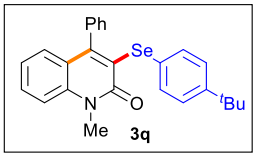
1-Methyl-4-phenyl-3-(p-tolylselanyl)quinolin-2(1H)-one (**3o**): Pale yellow solid, Mp (130-131 °C), eluent (15% ethyl acetate in hexane). Yield: 98% (87 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.56 – 7.52 (m, 1H), 7.43 – 7.36 (m, 4H), 7.21 – 7.11 (m, 5H), 7.11 – 7.03 (m, 1H), 6.92 (d, J = 7.9 Hz, 2H), 3.80 (s, 3H), 2.25 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.7, 154.7, 139.9, 138.2, 136.8, 132.7, 130.8, 129.7, 128.8 (2×C), 128.3, 128.1, 127.9, 126.6, 122.1, 121.6, 114.3, 30.9, 21.2 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+Na]^+$ Calcd for $C_{23}H_{19}NOSeNa^+$ 428.0530; Found 428.0536.



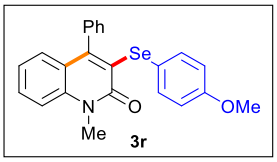
3-((4-Ethylphenyl)selanyl)-1-methyl-4-phenylquinolin-2(1H)-one (**3p**): Pale yellow solid, Mp (115-117 °C), eluent (15% ethyl acetate in hexane). Yield: 78% (72 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.57 – 7.52 (m, 1H), 7.43 – 7.35 (m, 4H), 7.22 – 7.17 (m, 2H), 7.16 – 7.03 (m, 4H), 6.94 (d, *J* = 8.2 Hz, 2H), 3.82 (s, 3H), 2.55 (q, *J* = 7.6 Hz, 2H), 1.18 (t, *J* = 7.6 Hz, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.8, 154.6, 143.1, 139.9, 138.1, 132.8, 130.8, 128.9, 128.7, 128.6, 128.3, 128.1 (2×C), 126.7, 122.1, 121.7, 114.3, 31.0, 28.6, 15.6 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{24}H_{21}NOSeH^+$ 420.0867; Found 420.0878.



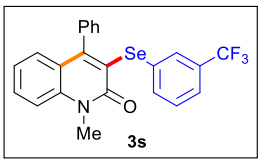
3-((4-(tert-Butyl)phenyl)selanyl)-1-methyl-4-phenylquinolin-2(1H)-one (**3q**): Pale yellow solid, Mp (219-221 °C), eluent (15% ethyl acetate in hexane). Yield: 93% (83 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.56 – 7.52 (m, 1H), 7.43 – 7.31 (m, 4H), 7.22 – 7.16 (m, 2H), 7.15 – 7.03 (m, 6H), 3.82 (s, 3H), 1.25 (s, 9H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.8, 154.4, 149.9, 139.8, 138.0, 132.6, 130.8, 128.9, 128.6, 128.3, 128.0, 127.9, 126.8, 126.0, 122.1, 121.7, 114.2, 34.5, 31.4, 30.9 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{26}H_{25}NOSeH^+$ 448.1180; Found 448.1205.



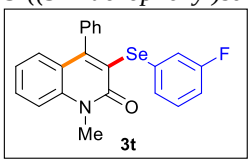
3-((4-Methoxyphenyl)selanyl)-1-methyl-4-phenylquinolin-2(1H)-one (**3r**): Brown solid, Mp (108-110 °C), eluent (15% ethyl acetate in hexane). Yield: 92% (77 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.55 – 7.51 (m, 1H), 7.44 – 7.36 (m, 4H), 7.28 – 7.23 (m, 2H), 7.17 – 7.02 (m, 4H), 6.70 – 6.61 (m, 2H), 3.80 (s, 3H), 3.74 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.8, 159.1, 153.9, 139.7, 138.1, 135.3, 130.7, 128.9, 128.6, 128.3, 128.1, 127.2, 122.1, 121.7, 121.5, 114.6, 114.2, 55.3, 30.9 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+Na]^+$ Calcd for $C_{23}H_{19}NO_2SeNa^+$ 444.0479; Found 444.0452.



1-Methyl-4-phenyl-3-((3-(trifluoromethyl)phenyl)selanyl) quinolin-2(1H)-one (**3s**): Yellow solid, Mp (100-102 °C), eluent (15% ethyl acetate in hexane). Yield: 62% (57 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.61 – 7.57 (m, 1H), 7.48 – 7.42 (m, 3H), 7.41 – 7.31 (m, 4H), 7.23 – 7.14 (m, 2H), 7.13 – 7.06 (m, 3H), 3.85 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.6, 155.0, 140.0, 137.6, 135.8, 132.7, 131.2, 131.0 (d, *J* = 32.1 Hz), 129.2, 129.1 (q, *J* = 3.9 Hz), 128.8 (2×C), 128.4 (2×C), 126.0, 123.8 (q, *J* = 272.3 Hz), 123.7 (q, *J* = 3.5 Hz), 122.4, 121.6, 114.4, 31.0 ppm. **^{19}F NMR** (471 MHz, $CDCl_3$) δ -62.7 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{23}H_{16}F_3NOSeH^+$ 460.0427; Found 460.0446.

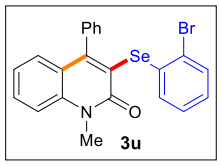


3-((3-Fluorophenyl)selanyl)-1-methyl-4-phenylquinolin-2(1H)-one (**3t**): Yellow solid, Mp (110-112 °C), eluent (15% ethyl acetate in hexane). Yield: 84% (69 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.60 – 7.56 (m, 1H), 7.46 – 7.36 (m, 4H), 7.21 – 7.04 (m, 6H), 6.94 – 6.90 (m, 1H), 6.86 – 6.78 (m, 1H), 3.84 (s, 3H) ppm. **^{13}C NMR** (125 MHz, $CDCl_3$) δ 162.5 (d, *J* = 248.7 Hz), 160.5, 155.6, 140.1, 138.0, 133.7 (d, *J* = 6.9 Hz), 131.3, 130.1 (d, *J* = 8.1 Hz), 129.0, 128.8, 128.4 (2×C), 127.5 (d, *J* = 3.0 Hz),



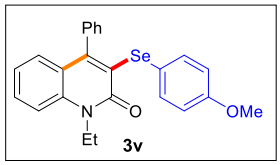
125.7, 122.3, 121.6, 118.7 (d, *J* = 22.4 Hz), 114.4, 113.8 (d, *J* = 21.2 Hz), 31.1 ppm. **^{19}F NMR** (471 MHz, $CDCl_3$) δ -112.7 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{22}H_{16}FNOSeH^+$ 410.0459; Found 410.0478.

3-((2-Bromophenyl)selanyl)-1-methyl-4-phenylquinolin-2(1H)-one (**3u**): Brown solid, Mp (117-119 °C),



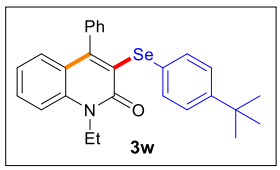
eluent (15% ethyl acetate in hexane). Yield: 68% (64 mg); **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.60 (ddd, *J* = 8.5, 7.2, 1.5 Hz, 1H), 7.46 – 7.42 (m, 1H), 7.42 – 7.34 (m, 4H), 7.21 – 7.09 (m, 4H), 7.07 – 7.00 (m, 2H), 6.98 – 6.94 (m, 1H), 3.84 (s, 3H) ppm. **^{13}C NMR** (125 MHz, $CDCl_3$) δ 160.4, 156.3, 140.3, 137.9, 135.3, 132.7, 131.4, 131.3, 129.1, 128.5 (2×C), 127.7, 127.5, 125.5, 124.6, 122.3, 121.6, 114.4, 31.1 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{22}H_{16}BrNOSeH^+$ 469.9659; Found 469.9658.

1-Ethyl-3-((4-methoxyphenyl)selanyl)-4-phenylquinolin-2(1H)-one (**3v**): Yellow solid, Mp (106-108 °C),



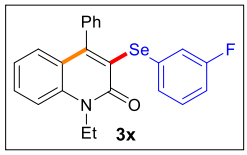
eluent (15% ethyl acetate in hexane). Yield: 89% (77 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.52 (t, *J* = 7.7 Hz, 1H), 7.42 – 7.35 (m, 4H), 7.25 (d, *J* = 8.1 Hz, 2H), 7.15 – 7.08 (m, 3H), 7.04 (t, *J* = 7.3 Hz, 1H), 6.64 (d, *J* = 8.2 Hz, 2H), 4.43 (q, *J* = 6.9 Hz, 2H), 3.73 (s, 3H), 1.40 (t, *J* = 7.4 Hz, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.1, 159.1, 153.7, 138.7, 138.1, 135.2, 130.5, 128.9, 128.7, 128.3, 128.0, 127.3, 121.9, 121.8, 121.4, 114.5, 114.0, 55.2, 38.6, 12.7 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+Na]^+$ Calcd for $C_{24}H_{21}NO_2SeNa^+$ 458.0635; Found 458.0629.

3-((4-(tert-Butyl)phenyl)selanyl)-1-ethyl-4-phenylquinolin-2(1H)-one (**3w**): Yellow solid, Mp (169-171 °C), eluent



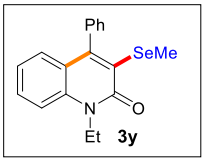
(15% ethyl acetate in hexane). Yield: 91% (84 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.52 (t, *J* = 6.7 Hz, 1H), 7.41 (d, *J* = 8.3 Hz, 1H), 7.34 (s, 3H), 7.19 (d, *J* = 7.7 Hz, 2H), 7.16 – 7.07 (m, 5H), 7.04 (t, *J* = 7.0 Hz, 1H), 4.45 (d, *J* = 6.6 Hz, 2H), 1.41 (s, 3H), 1.25 (s, 9H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.2, 154.2, 149.8, 138.8, 138.0, 132.7, 130.6, 128.9, 128.8, 128.2, 127.9 (2×C), 126.9, 125.9, 122.0, 121.8, 114.1, 38.7, 34.5, 31.3, 12.8 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{27}H_{27}NOSeH^+$ 462.1336; Found 462.1348.

1-Ethyl-3-((3-fluorophenyl)selanyl)-4-phenylquinolin-2(1H)-one (**3x**): Yellow solid, Mp (140-142 °C), eluent (15%

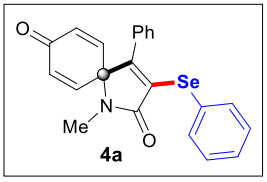


ethyl acetate in hexane). Yield: 80% (68 mg); **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.57 (t, *J* = 7.8 Hz, 1H), 7.45 (d, *J* = 8.6 Hz, 1H), 7.42 – 7.38 (m, 3H), 7.18 (d, *J* = 8.1 Hz, 1H), 7.14 (dd, *J* = 6.0, 2.2 Hz, 2H), 7.11 – 7.02 (m, 3H), 6.96 – 6.88 (m, 1H), 6.82 (dd, *J* = 8.5, 6.9 Hz, 1H), 4.46 (q, *J* = 7.1 Hz, 2H), 1.42 (t, *J* = 7.1 Hz, 3H) ppm. **^{13}C NMR** (125 MHz, $CDCl_3$) δ 162.6 (d, *J* = 248.7 Hz), 159.9, 155.4, 139.1, 138.0, 133.7 (d, *J* = 7.0 Hz), 131.2, 130.0 (d, *J* = 8.1 Hz), 129.2, 128.8, 128.4, 128.3, 127.6 (d, *J* = 3.0 Hz), 125.9, 122.1, 121.8, 118.8 (d, *J* = 22.4 Hz), 114.2, 113.8 (d, *J* = 21.3 Hz), 38.9, 12.8 ppm. **^{19}F NMR** (471 MHz, $CDCl_3$) δ -112.8 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{23}H_{18}FNOSeH^+$ 424.0616; Found 424.0616.

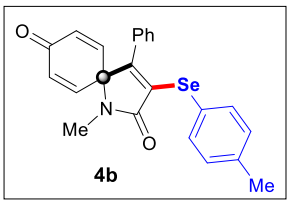
1-Ethyl-3-(methylselanyl)-4-phenylquinolin-2(1H)-one (**3y**): Yellow solid, Mp (97-98 °C), eluent (15% ethyl acetate in hexane). Yield: 77% (53 mg); **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.54 – 7.46 (m, 4H), 7.42 (d, *J* = 8.4 Hz, 1H), 7.29 – 7.25 (m, 2H), 7.14 (dd, *J* = 8.1, 1.5 Hz, 1H), 7.10 – 7.04 (m, 1H), 4.47 (q, *J* = 7.1 Hz, 2H), 2.16 (s, 3H), 1.44 (t, *J* = 7.2 Hz, 3H) ppm. **^{13}C NMR** (125 MHz, $CDCl_3$) δ 160.3, 151.9, 138.3 (2×C), 130.1, 129.1, 128.6, 128.4, 128.3, 125.9, 121.9 (2×C), 114.1, 38.6, 12.8, 8.3 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{18}H_{17}NOSeH^+$ 344.0554; Found 344.0552.



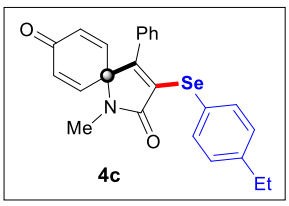
1-Methyl-4-phenyl-3-(phenylselanyl)-1-azaspiro[4.5]deca-3,6,9-triene-2,8-dione (**4a**): White solid, eluent (30% ethyl acetate in hexane). Yield: 80% (65 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.37 – 7.33 (m, 2H), 7.30 – 7.21 (m, 1H), 7.21 – 7.15 (m, 3H), 7.13 – 7.07 (m, 4H), 6.51 (d, *J* = 10.2 Hz, 2H), 6.43 (d, *J* = 10.2 Hz, 2H), 2.90 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 184.0, 168.8, 154.2, 145.1, 133.9, 133.1, 131.2, 130.2, 129.5, 129.1, 128.2, 128.0, 127.9, 127.2, 69.1, 26.5 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+Na]^+$ Calcd for $C_{22}H_{17}NO_2SeNa^+$ 430.0322; Found 430.0350.



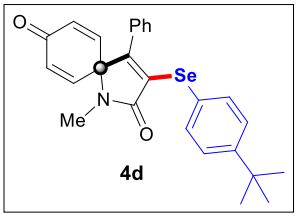
1-Methyl-4-phenyl-3-(p-tolylselanyl)-1-azaspiro[4.5]deca-3,6,9-triene-2,8-dione (**4b**): Yellow solid, Mp (170-172 °C), eluent (30% ethyl acetate in hexanes). Yield: 73% (61 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.30 – 7.24 (m, 3H), 7.22 – 7.16 (m, 2H), 7.11 – 7.05 (m, 2H), 6.92 (d, *J* = 7.8 Hz, 2H), 6.49 (d, *J* = 10.2 Hz, 2H), 6.42 (d, *J* = 10.2 Hz, 2H), 2.89 (s, 3H), 2.25 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 184.2, 169.0, 153.5, 145.3, 138.3, 134.5, 133.2, 131.4, 130.6, 129.9, 129.4, 128.3, 128.2, 123.2, 69.1, 26.5, 21.3 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{23}H_{19}NO_2SeH^+$ 422.0659; Found 422.0636.



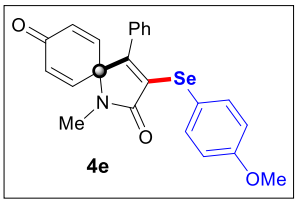
3-((4-Ethylphenyl)selanyl)-1-methyl-4-phenyl-1-azaspiro[4.5]deca-3,6,9-triene-2,8-dione (**4c**): Yellow solid, eluent (30% ethyl acetate in hexanes). Yield: 69% (60 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.32 – 7.26 (m, 2H), 7.25 – 7.21 (m, 1H), 7.19 – 7.13 (m, 2H), 7.09 – 7.03 (m, 2H), 6.92 (d, *J* = 8.1 Hz, 2H), 6.50 (d, *J* = 10.2 Hz, 2H), 6.42 (d, *J* = 10.2 Hz, 2H), 2.90 (s, 3H), 2.54 (q, *J* = 7.6 Hz, 2H), 1.16 (t, *J* = 7.6 Hz, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 184.2, 169.1, 153.3, 145.3, 144.5, 134.6, 133.2, 131.3, 130.7, 129.3, 128.7, 128.2 (2×C), 123.3, 69.2, 28.6, 26.5, 15.5 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+Na]_+$ Calcd for $C_{24}H_{21}NO_2SeNa_+$ 458.0635; Found 458.0667.



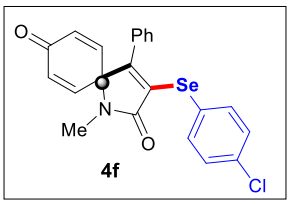
3-((4-(tert-Butyl)phenyl)selanyl)-1-methyl-4-phenyl-1-azaspiro[4.5]deca-3,6,9-triene-2,8-dione (**4d**): Yellow solid, eluent (30% ethyl acetate in hexanes). Yield: 76% (70 mg); **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.28 – 7.24 (m, 2H), 7.21 – 7.16 (m, 1H), 7.11 (t, *J* = 7.6 Hz, 2H), 7.07 (d, *J* = 8.5 Hz, 2H), 7.03 – 6.99 (m, 2H), 6.50 (d, *J* = 10.1 Hz, 2H), 6.41 (d, *J* = 10.2 Hz, 2H), 2.91 (s, 3H), 1.23 (s, 9H) ppm. **^{13}C NMR** (125 MHz, $CDCl_3$) δ 184.2, 169.2, 152.9, 151.3, 145.3, 134.2, 133.2, 131.1, 130.7, 129.3, 128.2, 128.1, 126.2, 123.0, 69.4, 34.6, 31.3, 26.6 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{26}H_{25}NO_2SeH^+$ 464.1129; Found 464.1148.



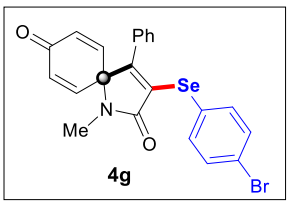
3-((4-Methoxyphenyl)selanyl)-1-methyl-4-phenyl-1-azaspiro[4.5]deca-3,6,9-triene-2,8-dione (**4e**): Yellow solid, eluent (30% ethyl acetate in hexanes). Yield: 61% (53 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.36 – 7.30 (m, 2H), 7.27-7.22 (m, 1H), 7.22 – 7.16 (m, 2H), 7.07 – 7.03 (m, 2H), 6.65 – 6.60 (m, 2H), 6.48 (d, *J* = 10.4 Hz, 2H), 6.41 (d, *J* = 10.3 Hz, 2H), 3.74 (s, 3H), 2.89 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 184.2, 169.1, 160.0, 152.7, 145.3, 136.8, 133.2, 131.3, 131.0, 129.3, 128.3 (2×C), 116.6, 114.7, 69.2, 55.3, 26.5 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{23}H_{19}NO_3SeH^+$ 438.0608; Found 438.0625.



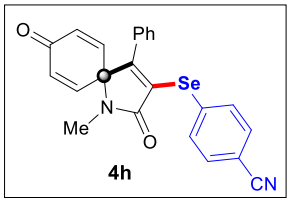
3-((4-Chlorophenyl)selanyl)-1-methyl-4-phenyl-1-azaspiro[4.5]deca-3,6,9-triene-2,8-dione (**4f**): Brown solid, eluent (30% ethyl acetate in hexanes). Yield: 74% (65 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.32 – 7.27 (m, 3H), 7.21 (t, *J* = 7.5 Hz, 2H), 7.12 – 7.00 (m, 4H), 6.49 (d, *J* = 10.2 Hz, 2H), 6.43 (d, *J* = 10.2 Hz, 2H), 2.90 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 184.0, 168.7, 154.2, 144.9, 135.7, 134.6, 133.3, 131.1, 130.1, 129.7, 129.3, 128.4, 128.1, 125.0, 69.3, 26.6 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+Na]^+$ Calcd for $C_{22}H_{16}ClNO_2SeNa^+$ 463.9932; Found 463.9901.



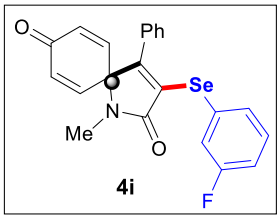
3-((4-Bromophenyl)selanyl)-1-methyl-4-phenyl-1-azaspiro[4.5]deca-3,6,9-triene-2,8-dione (**4g**): Yellow solid, eluent (30% ethyl acetate in hexanes). Yield: 69% (67 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.33 – 7.25 (m, 2H), 7.25 – 7.20 (m, 5H), 7.10 – 7.04 (m, 2H), 6.49 (d, *J* = 10.3 Hz, 2H), 6.43 (d, *J* = 10.3 Hz, 2H), 2.91 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 184.0, 168.6, 154.3, 144.9, 135.9, 133.3, 132.2, 131.1, 130.0, 129.7, 128.4, 128.1, 125.8, 122.8, 69.3, 26.6 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{22}H_{16}BrNO_2SeH^+$ 485.9608; Found 485.9610.



4-((1-Methyl-2,8-dioxo-4-phenyl-1-azaspiro[4.5]deca-3,6,9-trien-3-yl)selanyl)benzonitrile (**4h**): Yellow solid, Mp (158-160 °C), eluent (30% ethyl acetate in hexanes). Yield: 53% (46 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.47 – 7.42 (m, 2H), 7.42 – 7.37 (m, 2H), 7.36 – 7.30 (m, 1H), 7.27 – 7.20 (m, 2H), 7.15 (dd, *J* = 8.5, 1.1 Hz, 2H), 6.55 (d, *J* = 10.2 Hz, 2H), 6.48 (d, *J* = 10.3 Hz, 2H), 2.92 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 183.7, 168.1, 156.6, 144.4, 134.9, 133.4, 132.9, 132.3, 130.9, 130.0, 128.6, 128.5, 127.9, 118.4, 111.1, 69.2, 26.5 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{23}H_{16}N_2O_2SeH^+$ 433.0455; Found 433.0461.

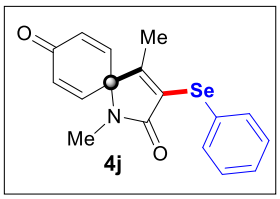


3-((3-Fluorophenyl)selanyl)-1-methyl-4-phenyl-1-azaspiro[4.5]deca-3,6,9-triene-2,8-dione (**4i**): Yellow solid, Mp (122-124 °C), eluent (30% ethyl acetate in hexanes). Yield: 56% (47 mg); **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.29 – 7.25 (m, 1H), 7.22 – 7.19 (m, 2H), 7.18 – 7.14 (m, 1H), 7.12 – 7.07 (m, 3H), 7.06 – 7.02 (m, 1H), 6.90 – 6.82 (m, 1H), 6.52 (d, *J* = 10.2 Hz, 2H), 6.45 (d, *J* = 10.2 Hz, 2H), 2.92 (s, 3H) ppm. **^{13}C NMR** (125 MHz, $CDCl_3$) δ 184.0, 168.7, 162.4 (d, *J* = 250.0 Hz), 154.9, 144.9, 133.3 (2×C), 131.1, 130.3 (d, *J* = 8.1 Hz), 129.8, 129.3 (d, *J* = 3.3 Hz), 128.7 (d, *J* = 7.1 Hz), 128.4, 128.0, 120.7 (d, *J* = 22.5 Hz), 115.1 (d, *J* = 21.1 Hz), 69.3, 26.6 ppm. **^{19}F NMR** (471 MHz, $CDCl_3$) δ -111.8 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{22}H_{16}NFO_2SeH^+$ 426.0409; Found 426.0401.



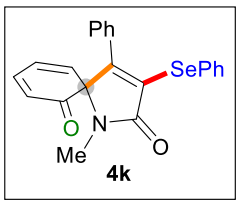
4i

1,4-dimethyl-3-(phenylselanyl)-1-azaspiro[4.5]deca-3,6,9-triene-2,8-dione (**4j**): White solid, eluent (30% ethyl acetate in hexanes). Yield: 61% (42 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.63 – 7.41 (m, 2H), 7.33 – 7.21 (m, 3H), 6.55 (d, *J* = 10.1 Hz, 2H), 6.36 (d, *J* = 10.1 Hz, 2H), 2.89 (s, 3H), 1.79 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 184.2, 169.3, 155.7, 145.7, 133.4, 133.0, 129.5, 128.4, 128.3, 127.9, 69.4, 26.9, 13.1 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+Na]^+$ Calcd for $C_{17}H_{15}NO_2SeNa^+$ 368.0166; Found 368.0191.



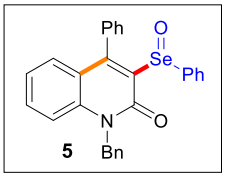
4j

1-Methyl-4-phenyl-3-(phenylselanyl)-1-azaspiro[4.5]deca-3,7,9-triene-2,6-dione (**4k**): Brown solid, Mp (109-111 °C), eluent (30% ethyl acetate in hexanes). Yield: 52% (42 mg); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.40 – 7.32 (m, 2H), 7.23 – 7.08 (m, 8H), 6.97 – 6.81 (m, 1H), 6.55 – 6.38 (m, 1H), 6.13 (t, *J* = 11.3 Hz, 2H), 2.78 (s, 3H) ppm. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 195.2, 170.3, 155.9, 142.2, 137.7, 132.6, 131.3, 129.3, 129.0, 128.9, 128.4, 128.0, 127.9, 127.4, 127.2, 127.0, 76.6, 27.0. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{22}H_{17}NO_2SeH^+$ 408.0503; Found 408.0505.



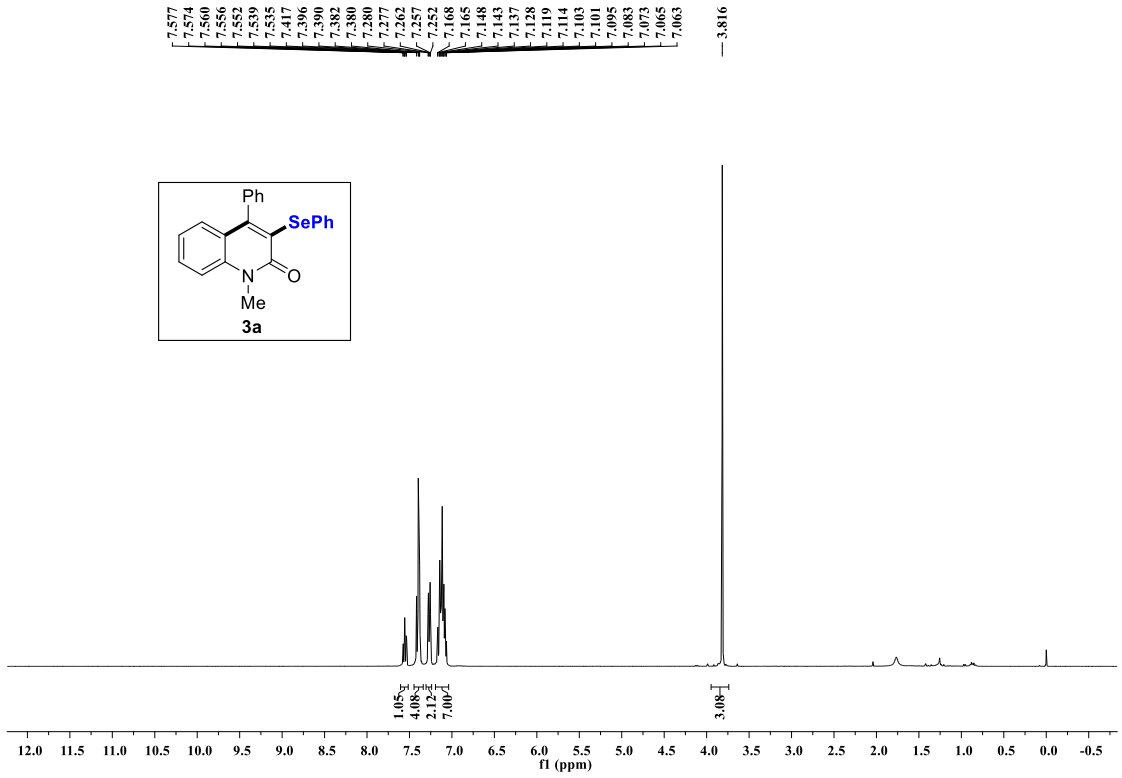
4k

1-Benzyl-4-phenyl-3-(phenylseleninyl)quinolin-2(1H)-one (**5**): White solid, eluent (5% methanol in DCM). Yield: 58% (56 mg); **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.78 (d, *J* = 5.1 Hz, 2H), 7.58 – 7.49 (m, 2H), 7.48 – 7.37 (m, 6H), 7.31 (t, *J* = 7.6 Hz, 3H), 7.26 (t, *J* = 3.3 Hz, 1H), 7.21 – 7.15 (m, 3H), 7.11 – 6.97 (m, 2H), 5.57 (d, *J* = 18.6 Hz, 2H) ppm. **^{13}C NMR** (125 MHz, $CDCl_3$) δ 160.1, 155.5, 139.8, 135.7, 132.4, 131.6, 130.7, 129.7, 129.2 (2×C), 129.0 (2×C), 128.9, 128.1, 128.0, 127.7, 126.8, 126.7, 122.8, 122.1, 115.3, 46.5 ppm. **HRMS** (ESI/TOF-Q) m/z: $[M+H]^+$ Calcd for $C_{28}H_{21}NO_2SeH^+$ 484.0816; Found 484.0804.



5

NMR Spectra: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7.539
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7.417
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7.390
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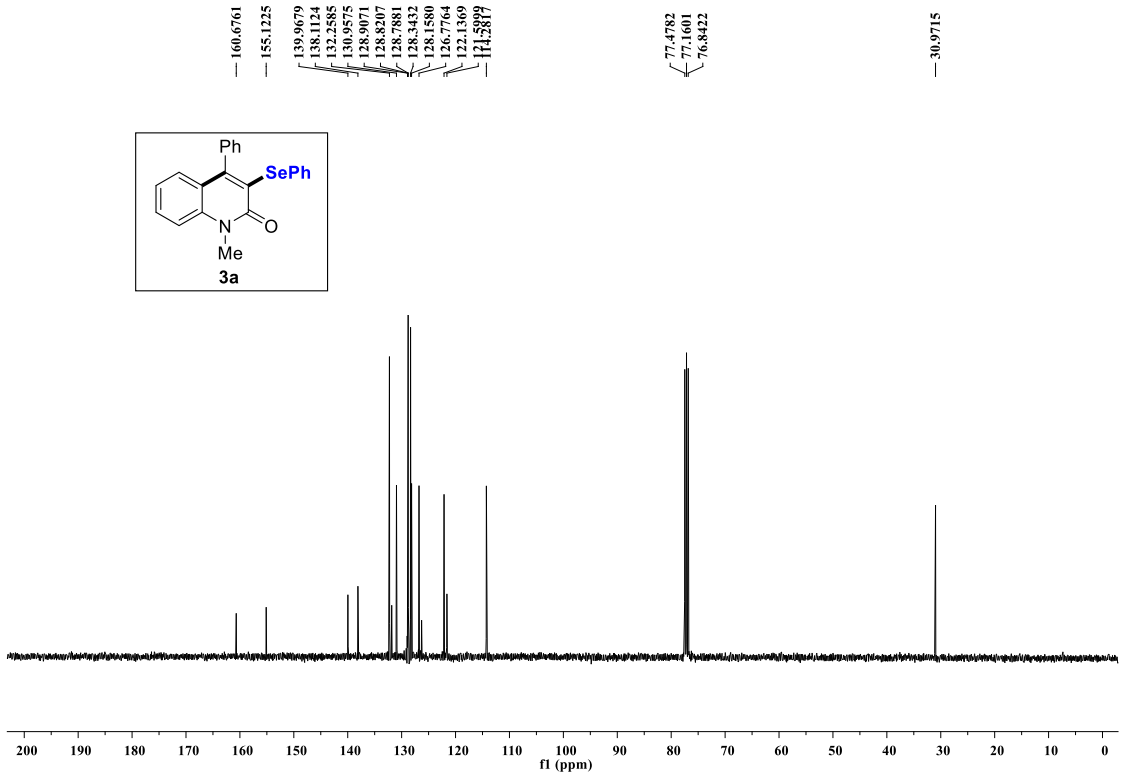
7.280
7.277
7.262
7.257
7.252
7.168
7.165
7.148
7.143
7.137
7.128
7.119
7.114
7.103
7.101
7.095
7.083
7.073
7.065
7.063
3.816
Ph
SePh
N
O
Me
3a
1.05
4.08
2.12
7.00
3.08
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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128.1580
126.7764
122.1369
77.4782
77.1601
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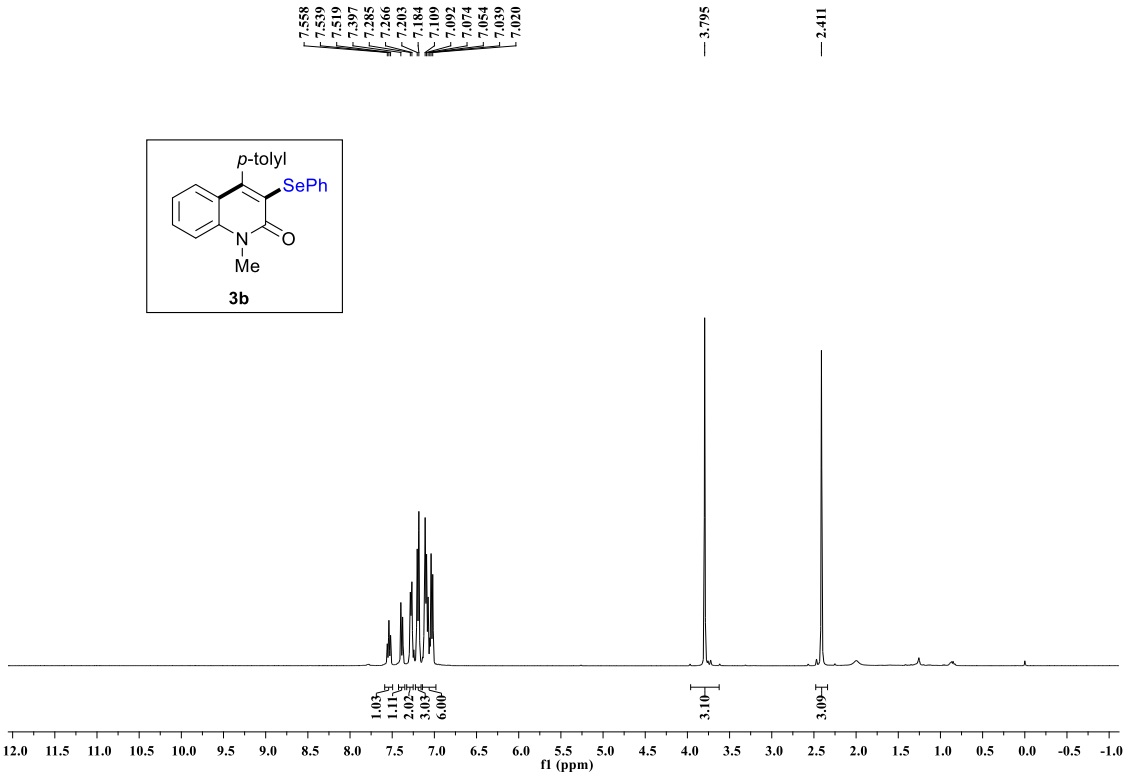
Ph
SePh
N
O
Me
3a
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.184
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7.092
7.074
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7.039
7.020
3.795
2.411
p-tolyl
SePh
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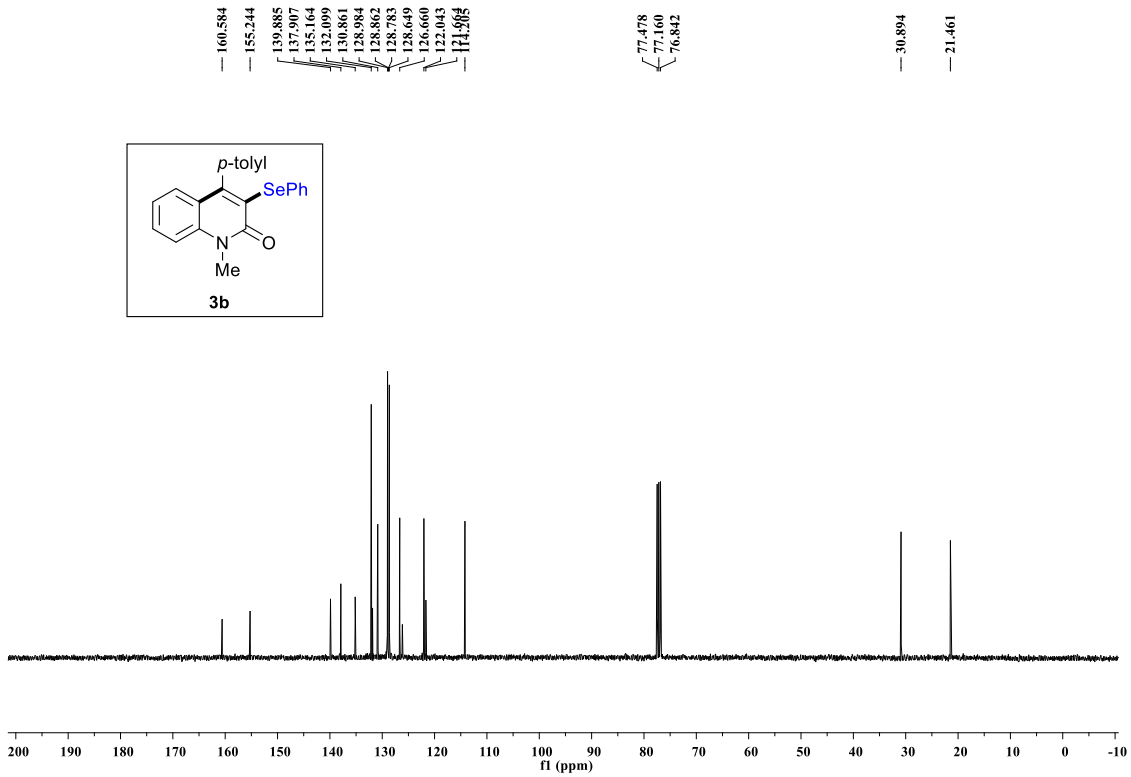
O
Me
3b
1.03
1.11
2.02
3.03
6.00
3.10
3.09
f1 (ppm)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SePh
N
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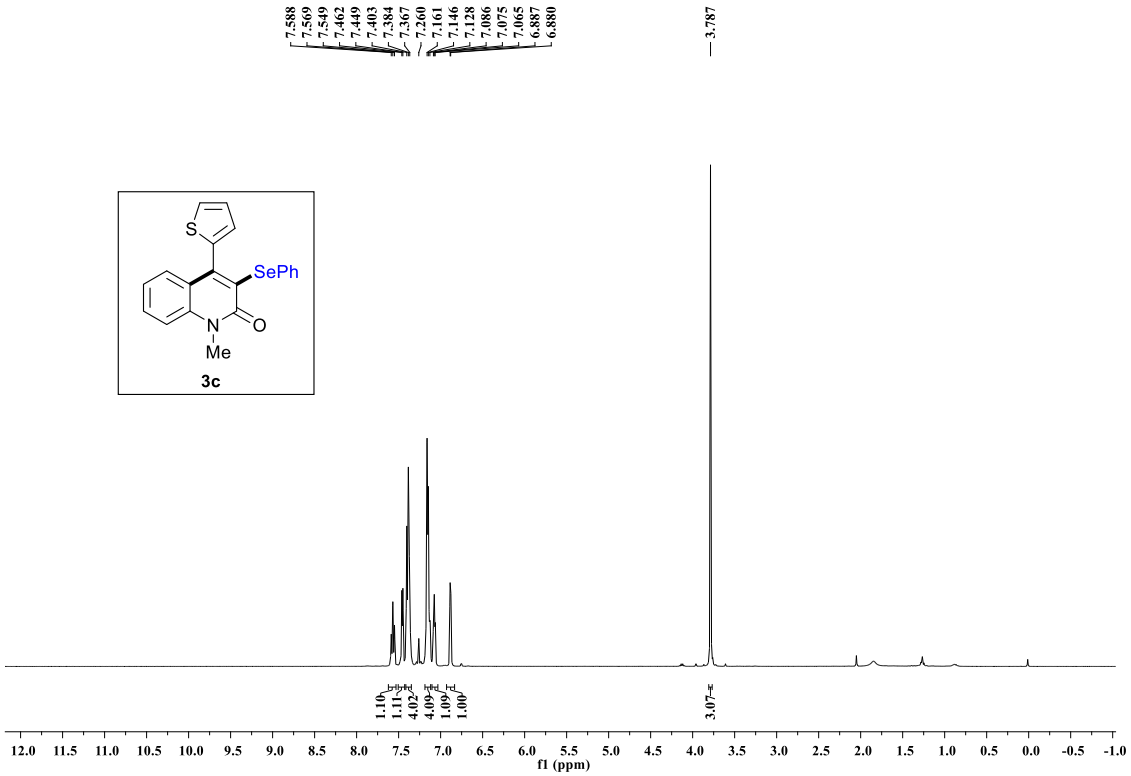
3b
f1 (ppm)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7.075
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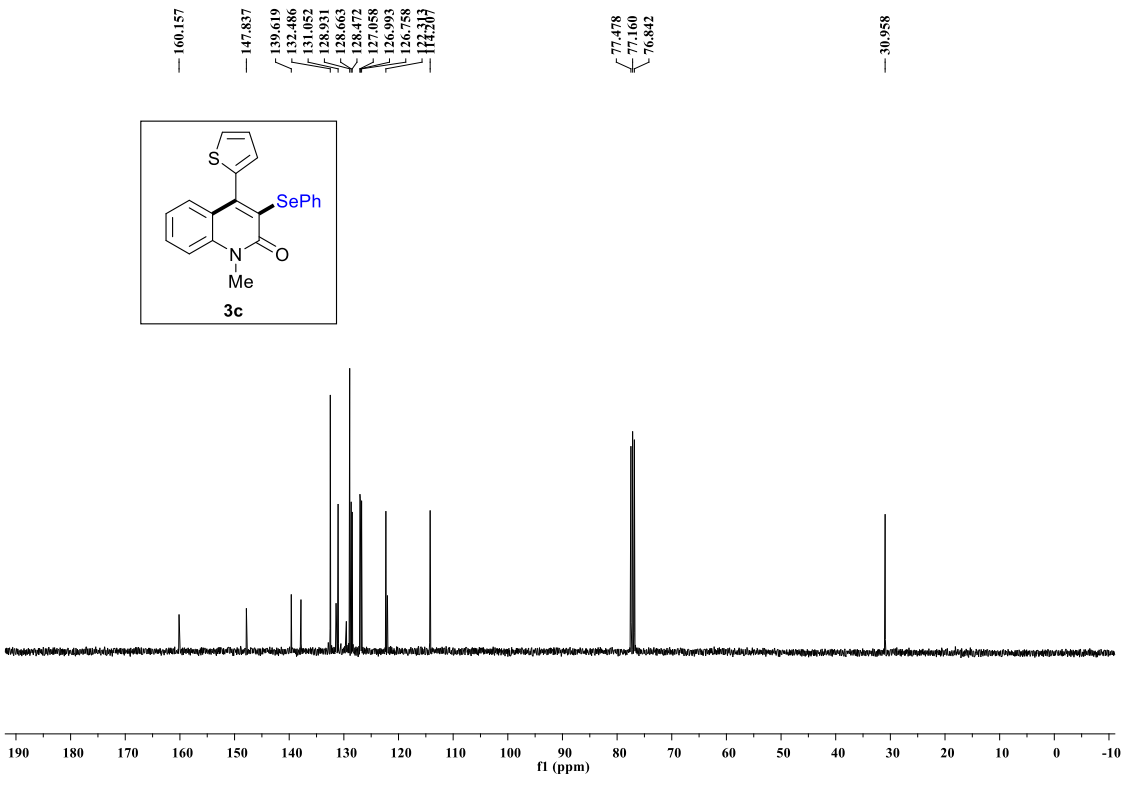
6.880
3.787
S
SePh
N
O
Me
3c
1.10
1.11
4.02
4.09
1.09
1.00
3.07
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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131.052
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128.663
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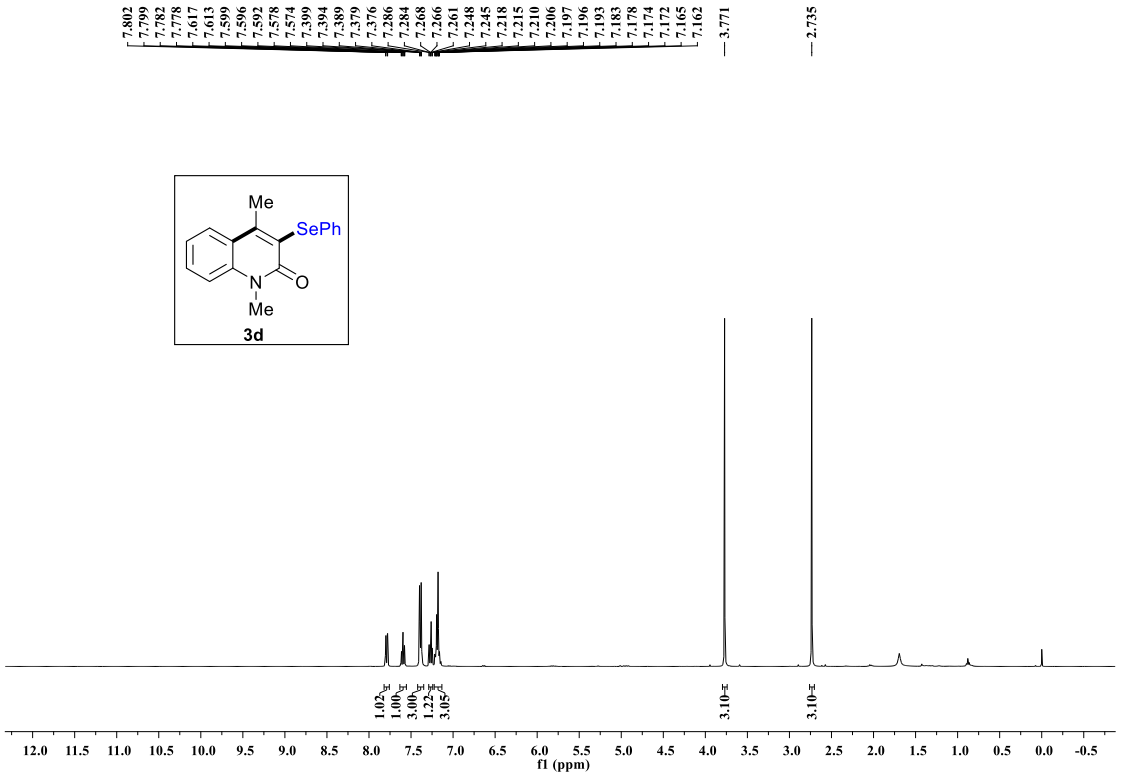
127.058
126.993
126.758
77.478
77.160
76.842
30.958
S
SePh
N
O
Me
3c
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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7.376
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7.284
7.268
7.266
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7.248
7.245
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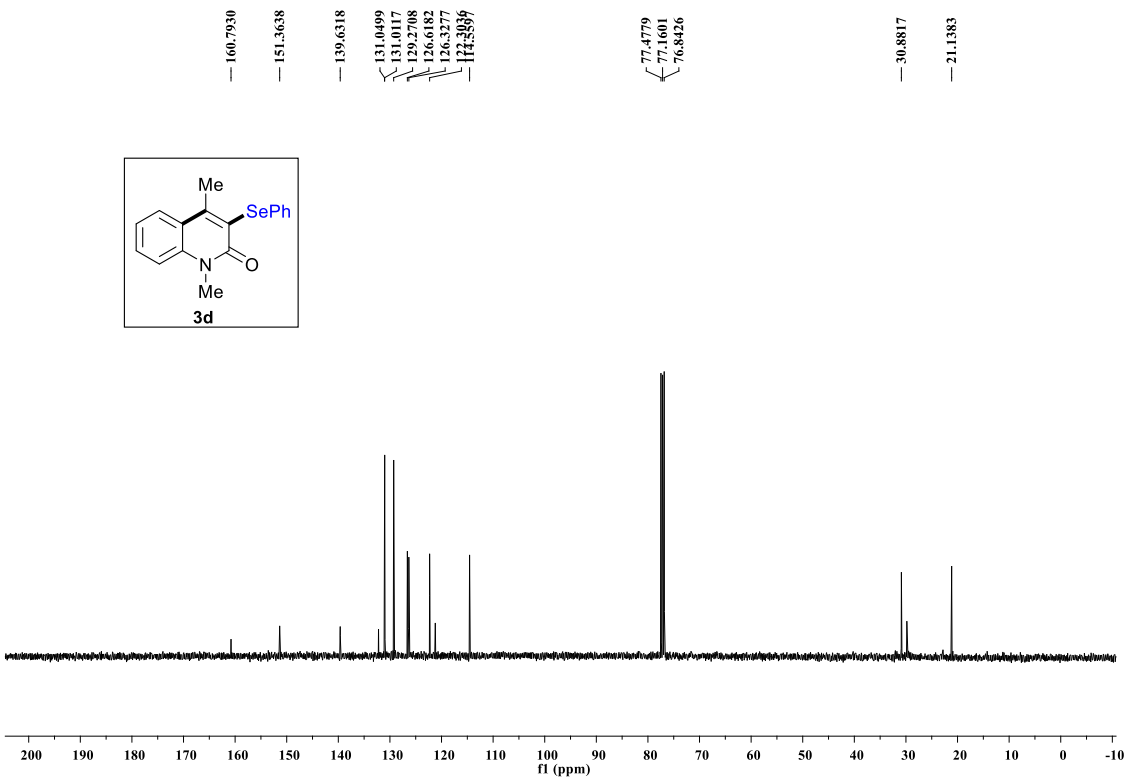
7.215
7.210
7.206
7.197
7.196
7.193
7.183
7.178
7.174
7.172
7.165
7.162
3.771
2.735
Me
SePh
N
O
Me
3d
1.02
1.00
3.00
1.22
3.05
3.10
3.10
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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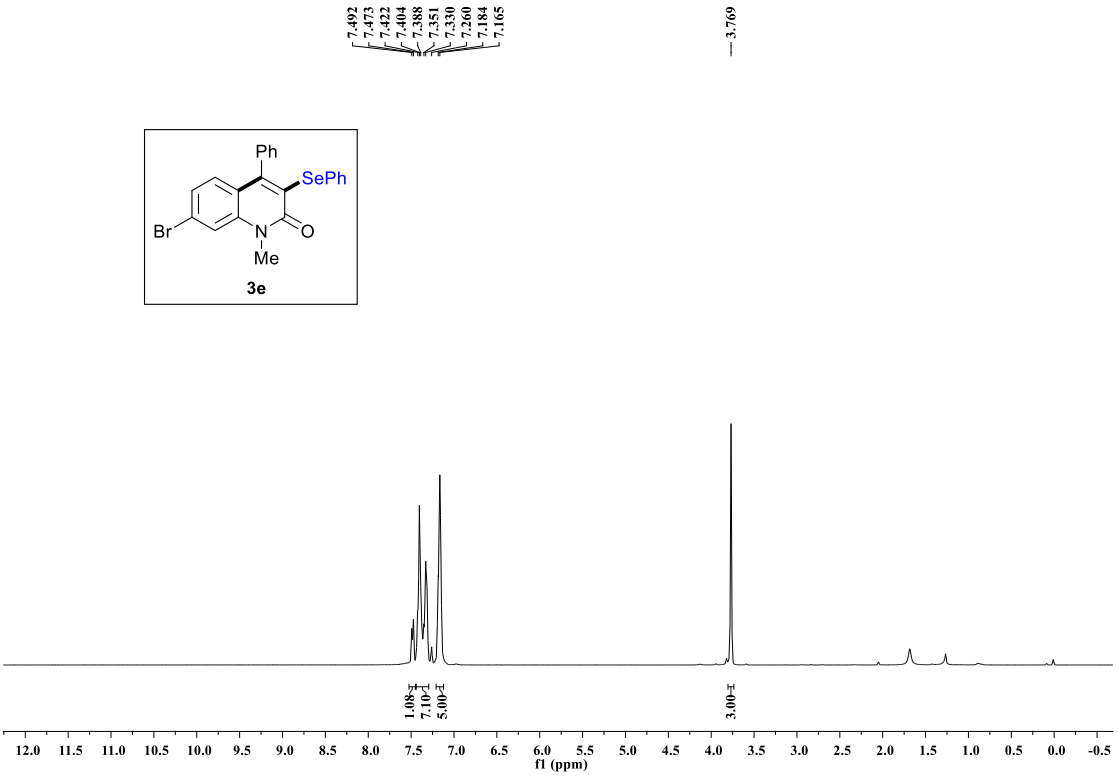
21.1383
Me
SePh
N
O
Me
3d
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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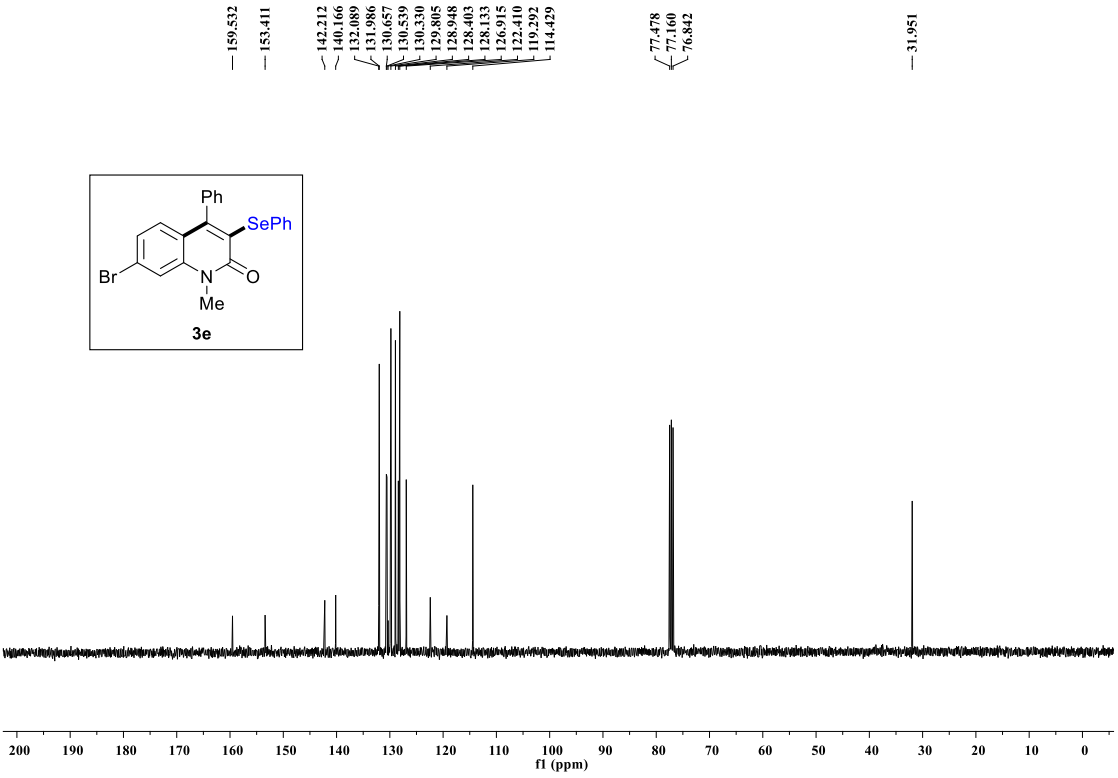
Br
N
O
Me
3e
1.08
7.10
5.00
3.00
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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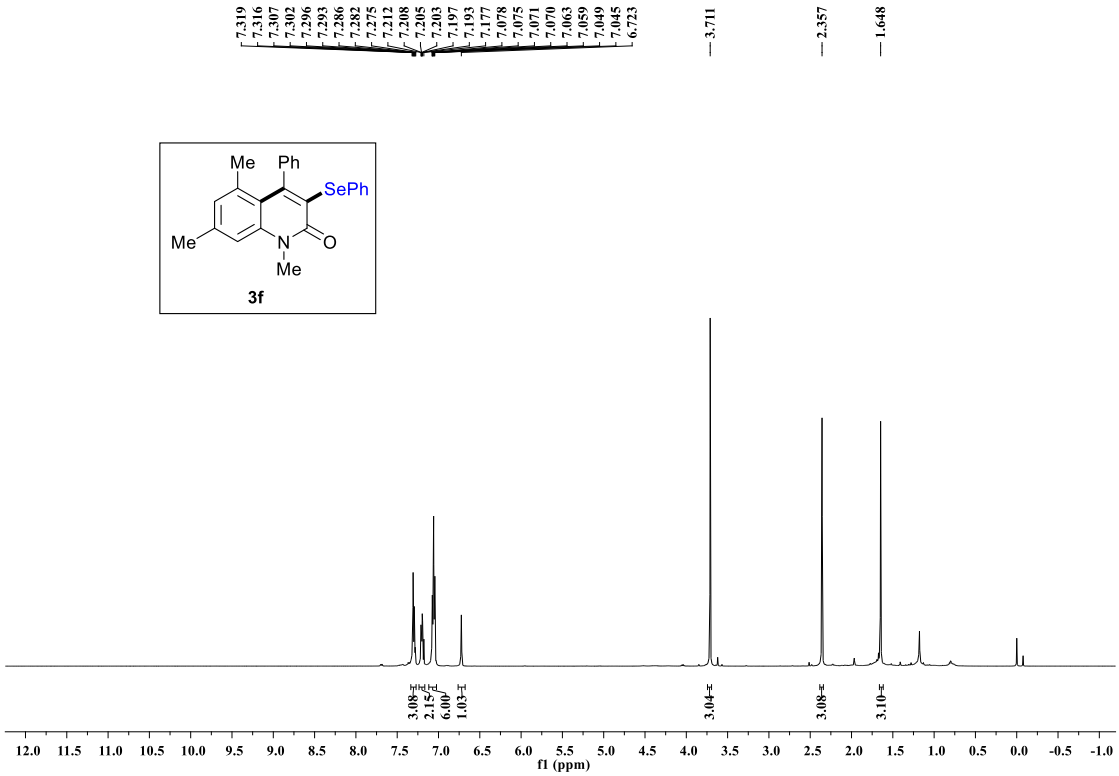
153.411
142.212
140.166
132.089
131.986
130.657
130.539
130.330
129.805
128.948
128.403
128.133
126.915
122.410
119.292
114.429
77.478
77.160
76.842
31.951
Ph
SePh
Br
N
O
Me
3e
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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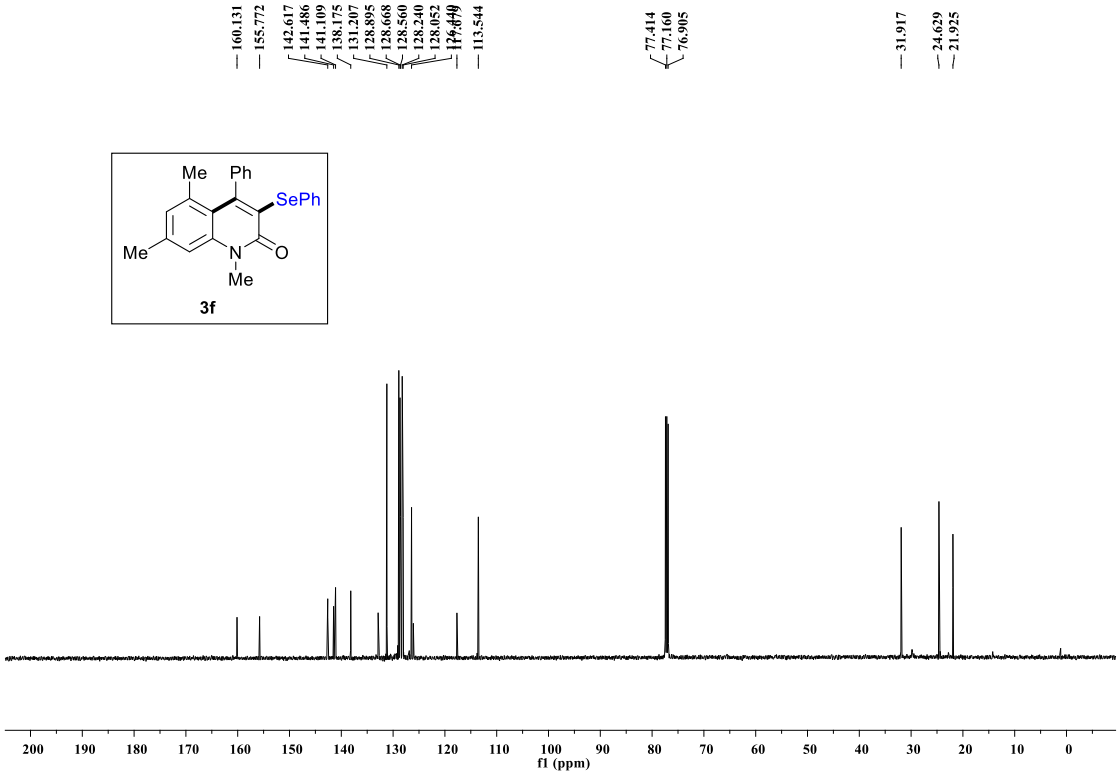
7.307
7.302
7.296
7.293
7.286
7.282
7.275
7.212
7.208
7.205
7.203
7.197
7.193
7.177
7.078
7.075
7.071
7.070
7.063
7.059
7.049
7.045
6.723
3.711
2.357
1.648
Me
Ph
SePh
Me
N
O
Me
3f
3.08
2.15
6.00
1.03
3.04
3.08
3.10
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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142.617
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131.207
128.895
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128.560
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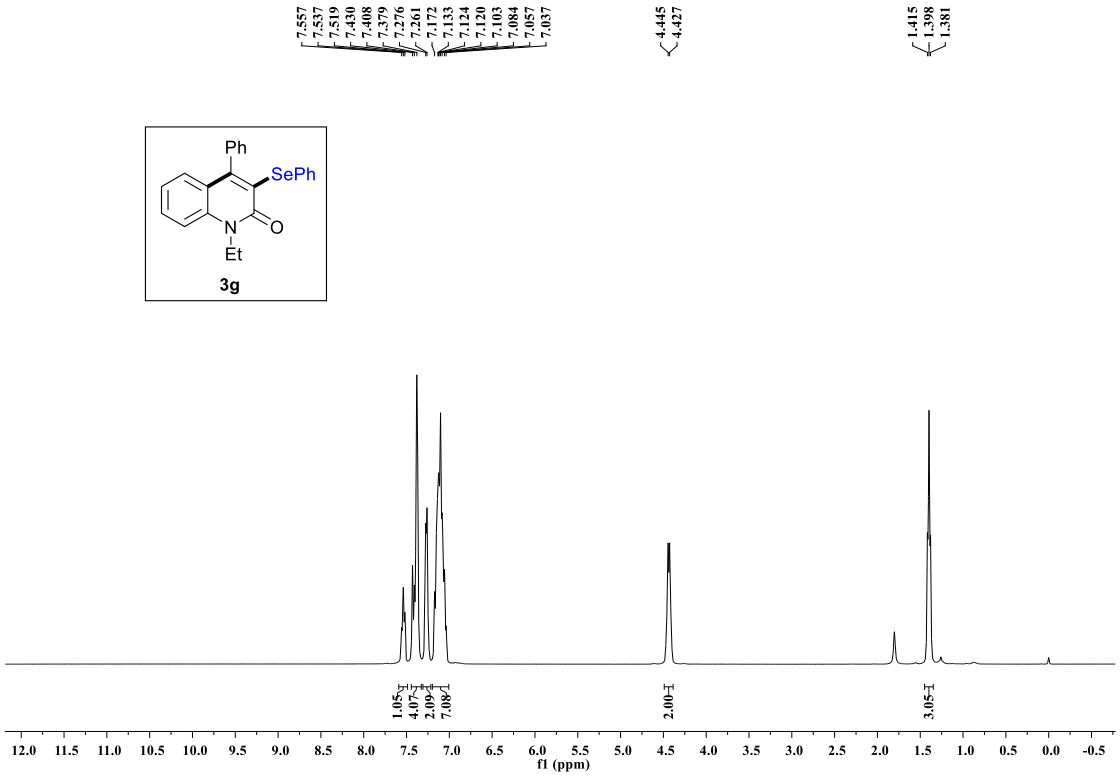
128.052
113.544
77.414
77.160
76.905
31.917
24.629
21.925
Me
Ph
SePh
Me
N
O
Me
3f
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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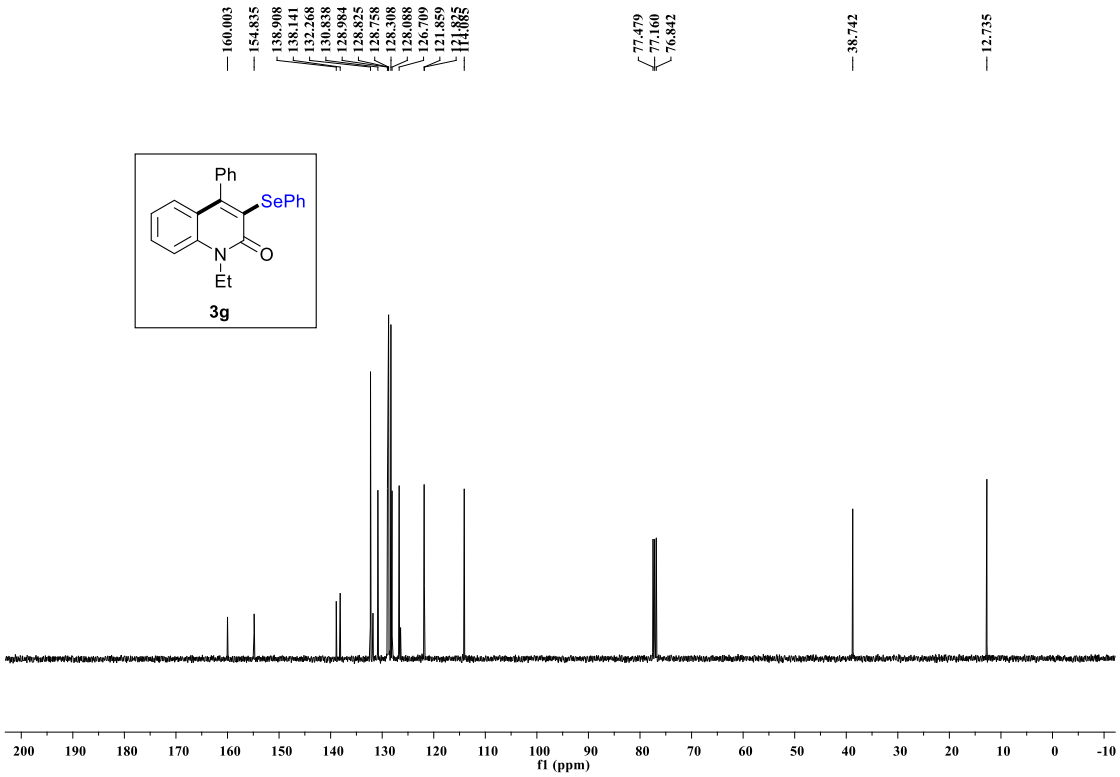
7.537
7.519
7.430
7.408
7.379
7.276
7.261
7.172
7.133
7.124
7.120
7.103
7.084
7.057
7.037
4.445
4.427
1.415
1.398
1.381
Ph
SePh
N
O
Et
3g
1.05
4.07
2.09
7.09
2.00
3.05
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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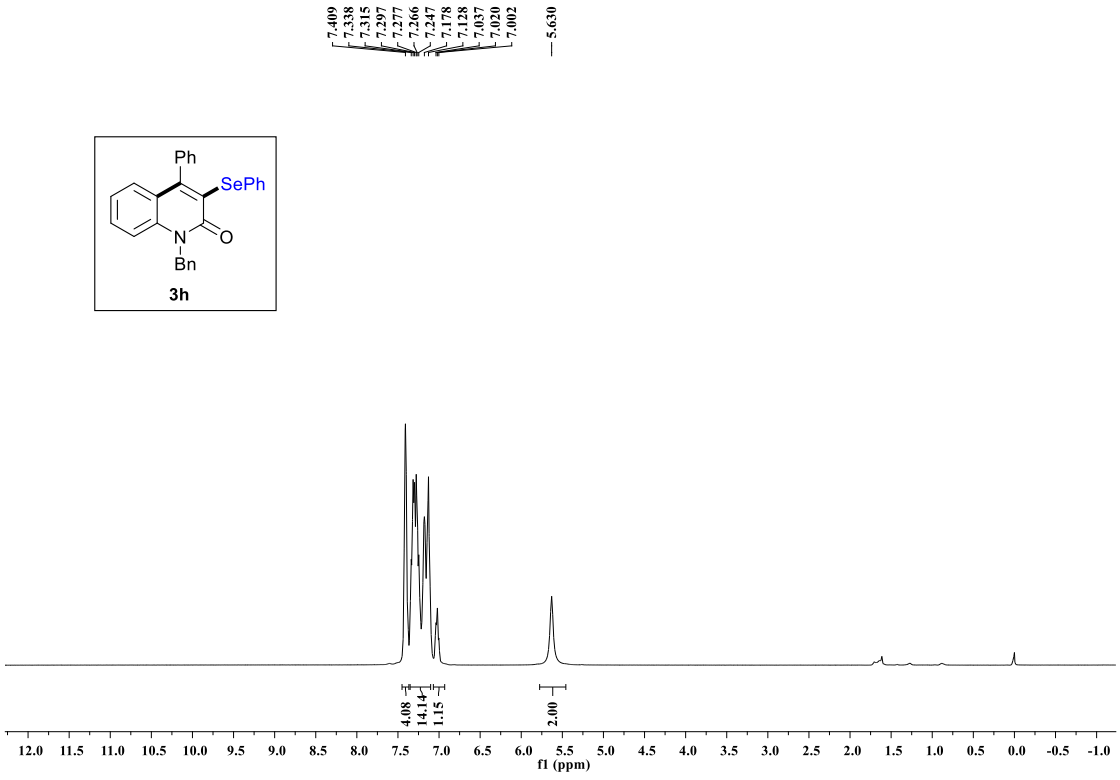
138.908
138.141
132.268
130.838
128.984
128.825
128.758
128.308
128.088
126.709
121.859
77.479
77.160
76.842
38.742
12.735
Ph
SePh
N
O
Et
3g
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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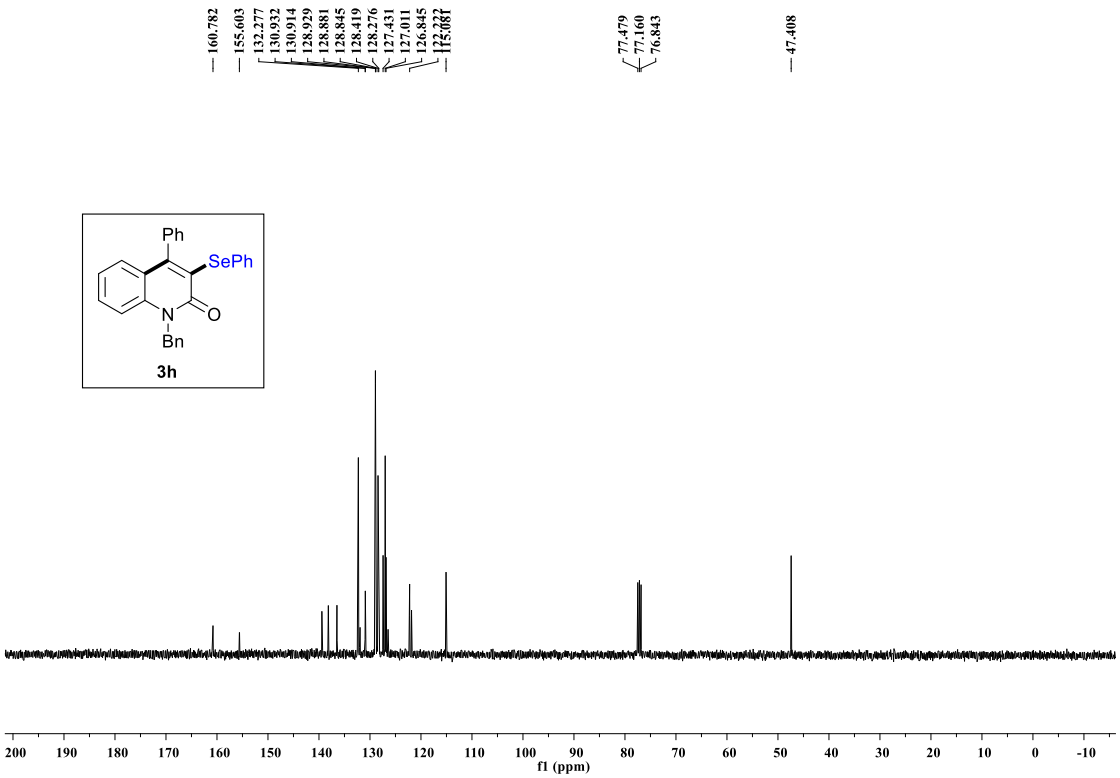
7.338
7.315
7.297
7.277
7.266
7.247
7.178
7.128
7.037
7.020
7.002
5.630
Ph
SePh
N
O
Bn
3h
4.08
14.14
1.15
2.00
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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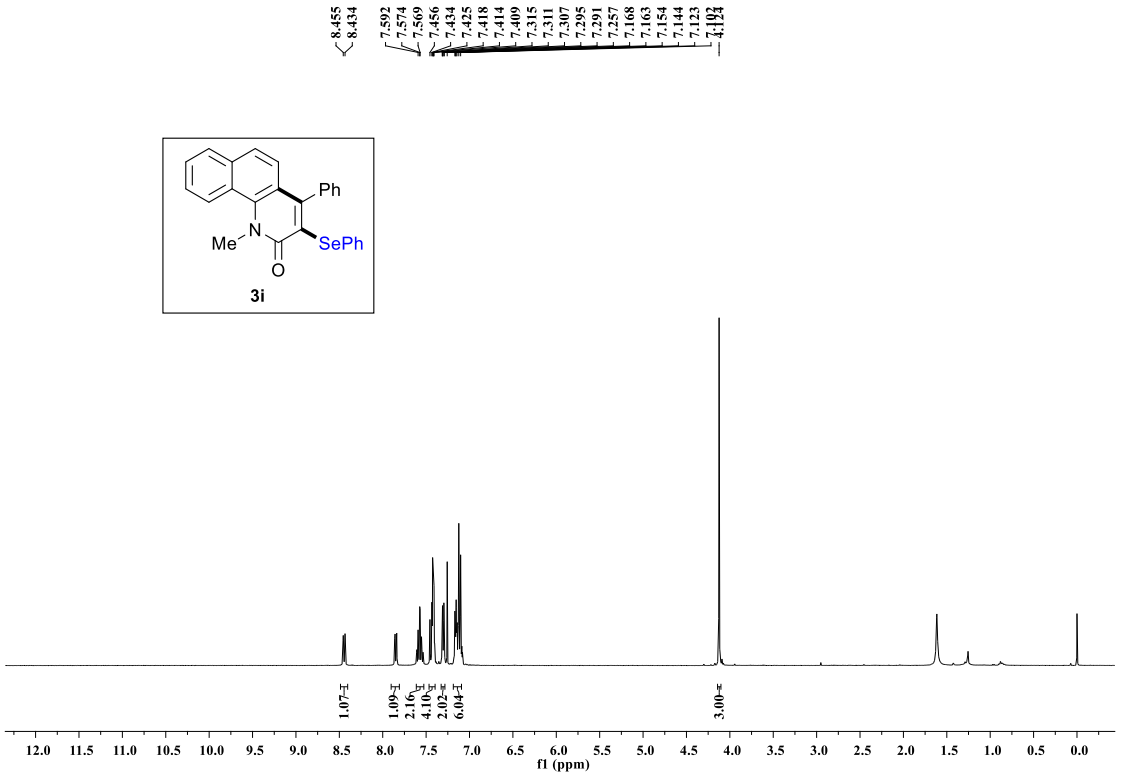
155.603
132.277
130.932
130.914
128.929
128.881
128.845
128.419
128.276
127.431
127.011
126.845
77.479
77.160
76.843
47.408
Ph
SePh
N
O
Bn
3h
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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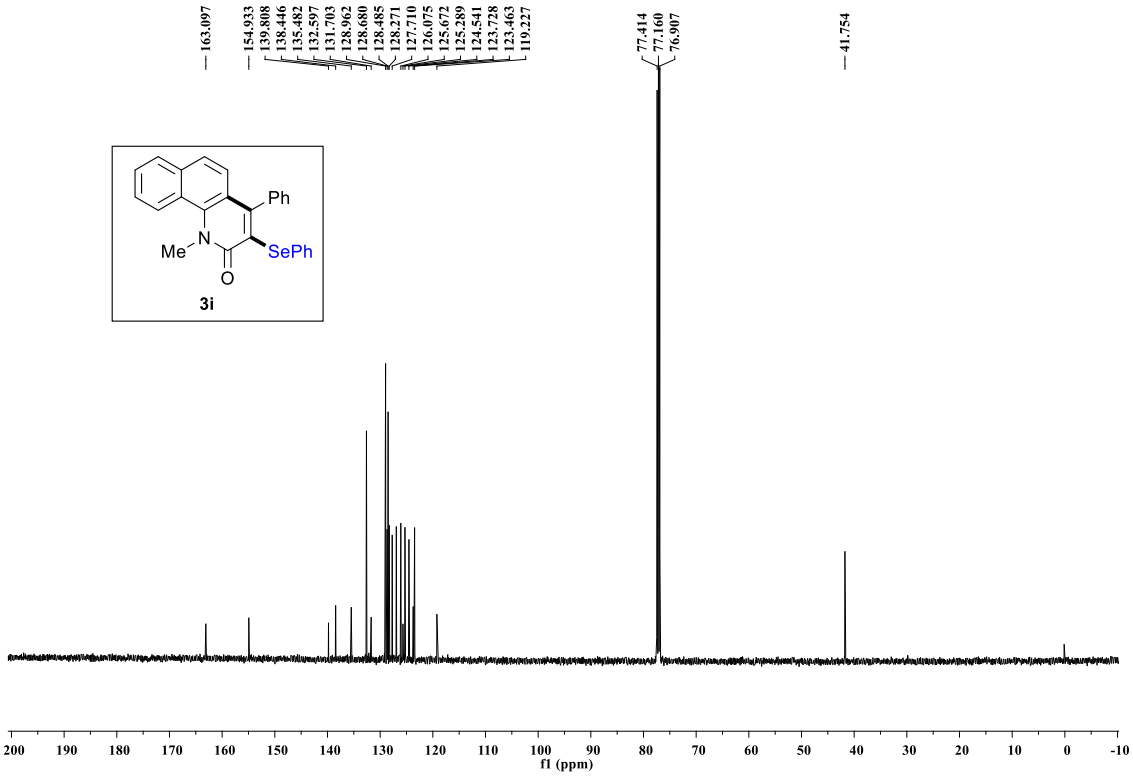
8.434
7.592
7.574
7.569
7.456
7.434
7.425
7.418
7.414
7.409
7.315
7.311
7.307
7.295
7.291
7.257
7.168
7.163
7.154
7.144
7.123
7.102
4.124
Ph
Me
N
O
SePh
3i
1.07
1.09
2.16
4.10
2.02
6.04
3.00
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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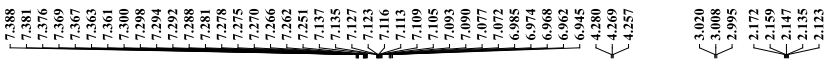
139.808
138.446
135.482
132.597
131.703
128.962
128.680
128.485
128.271
127.710
126.075
125.672
125.289
124.541
123.728
123.463
119.227
77.414
77.160
76.907
41.754
Ph
Me
N
O
SePh
3i
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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7.363
7.361
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7.294
7.292
7.288
7.281
7.278
7.275
7.270
7.266
7.262
7.251
7.137
7.135
7.127
7.123
7.116
7.113
7.109
7.105
7.093
7.090
7.077
7.072
6.985
6.974
6.968
6.962
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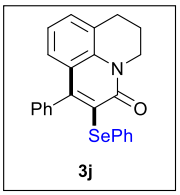
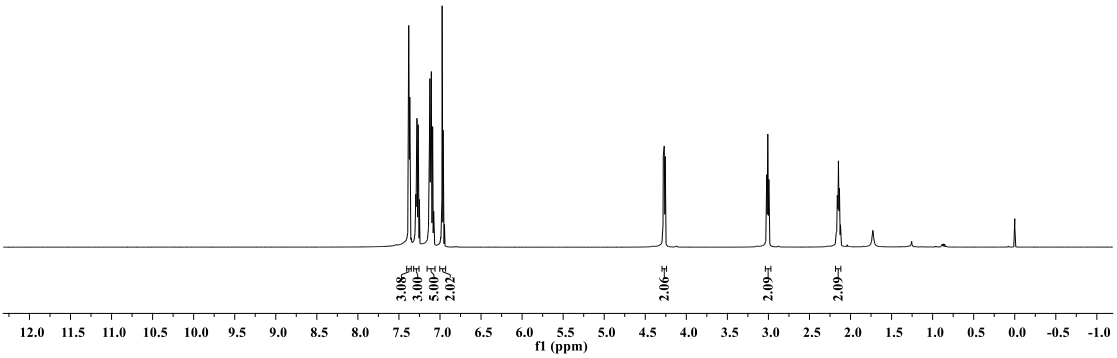
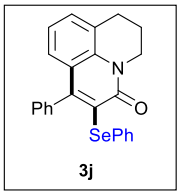
2.995
2.172
2.159
2.147
2.135
2.123


N
Ph
O
SePh

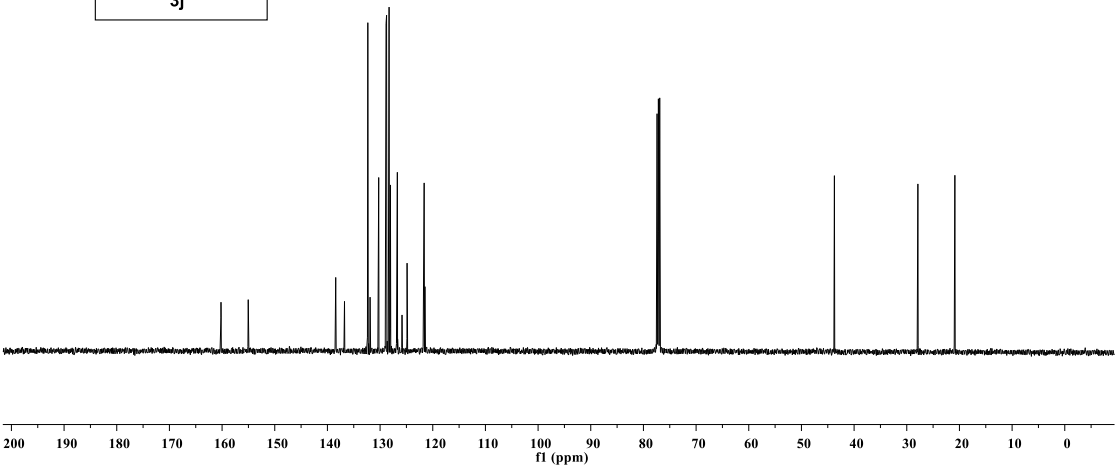
3j

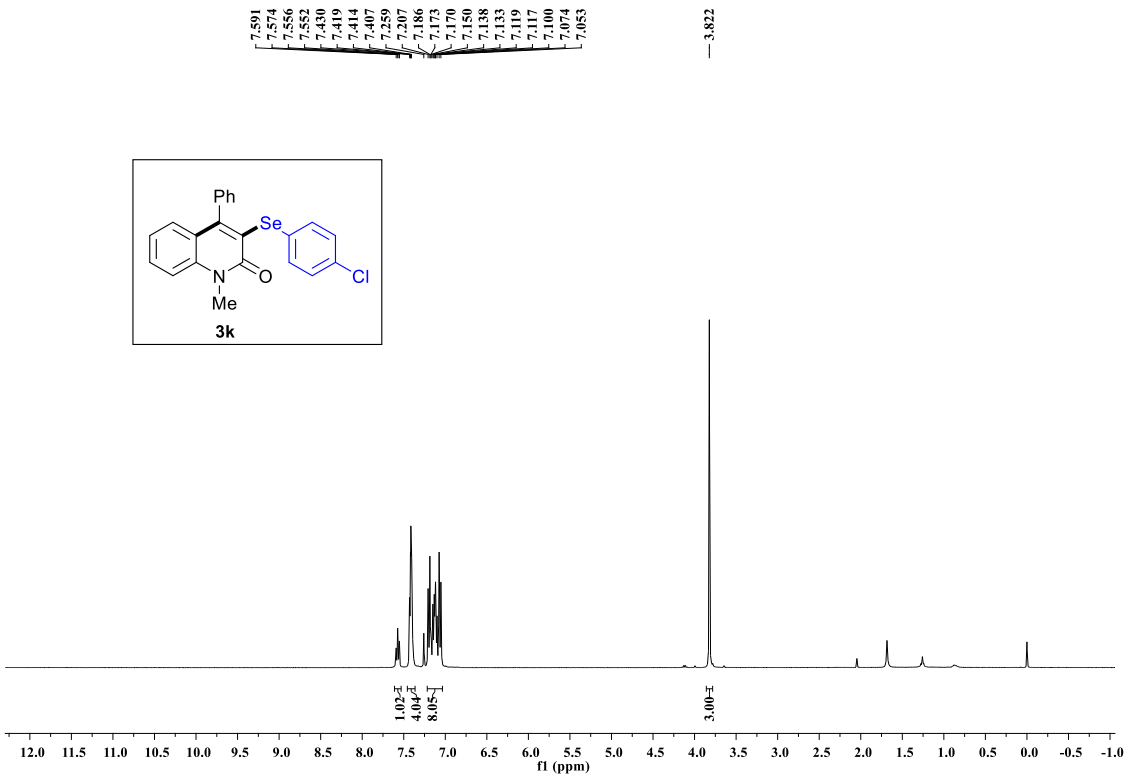

3.08
3.00
5.00
2.02
2.06
2.09
2.09
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


160.207
155.039
138.424
136.759
132.329
131.901
130.263
128.867
128.766
128.290
128.041
126.771
126.725
125.839
124.875
121.631
121.480
77.414
77.160
76.906
43.741
27.891
20.868


N
Ph
O
SePh

3j


200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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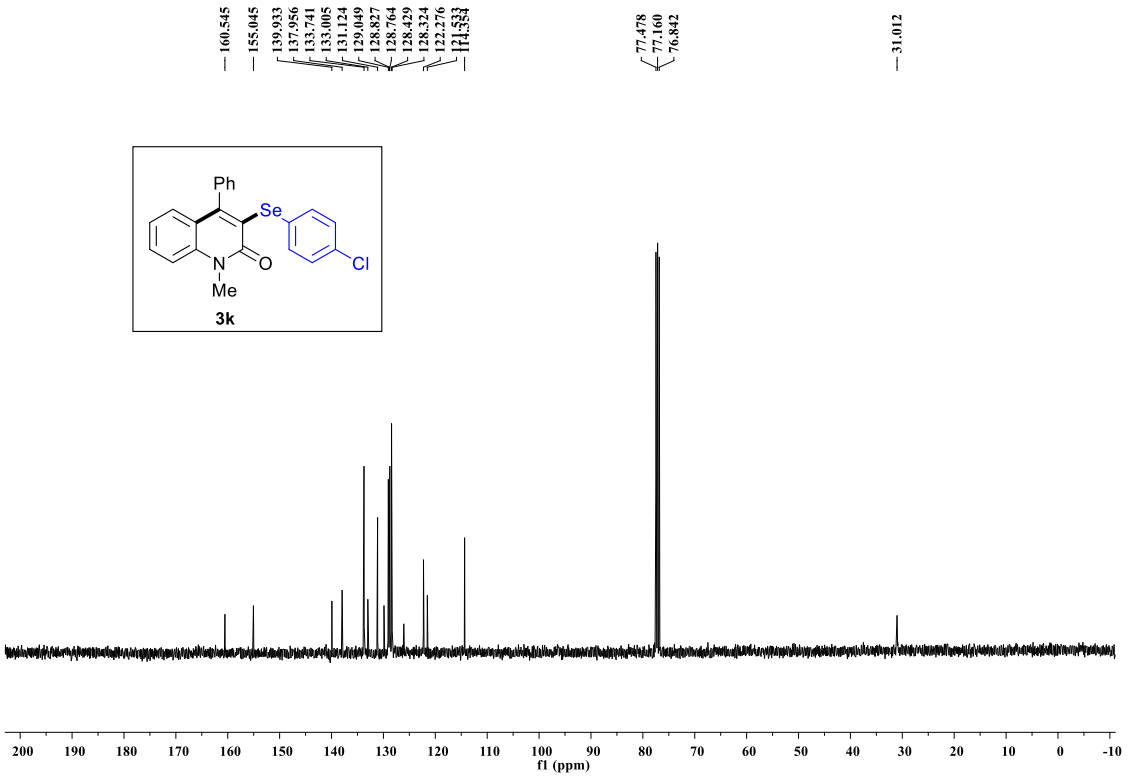
7.552
7.430
7.419
7.414
7.407
7.259
7.207
7.186
7.173
7.170
7.150
7.138
7.133
7.119
7.117
7.100
7.074
7.053
3.822
Ph
Se
Cl
N
O
Me
3k
1.02
4.04
8.05
3.00
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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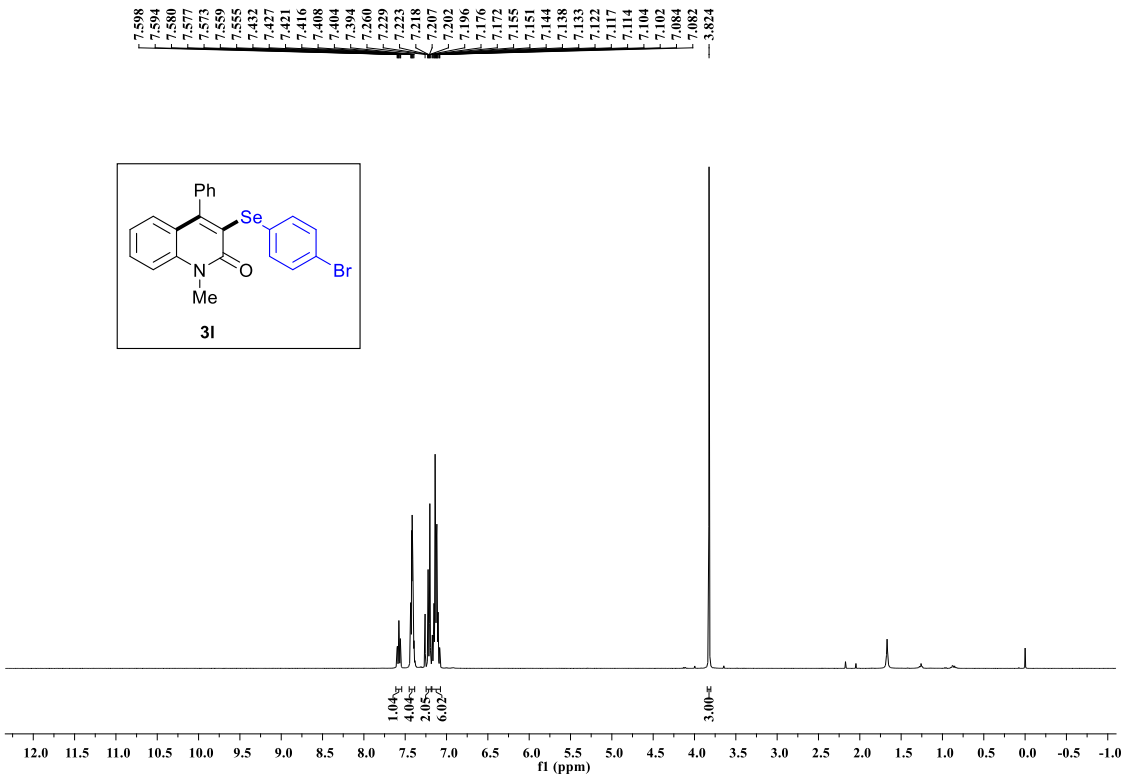
139.933
137.956
133.741
133.005
131.124
129.049
128.827
128.764
128.429
128.324
122.276
121.533
114.354
77.478
77.160
76.842
31.012
Ph
Se
Cl
N
O
Me
3k
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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7.594
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7.577
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7.555
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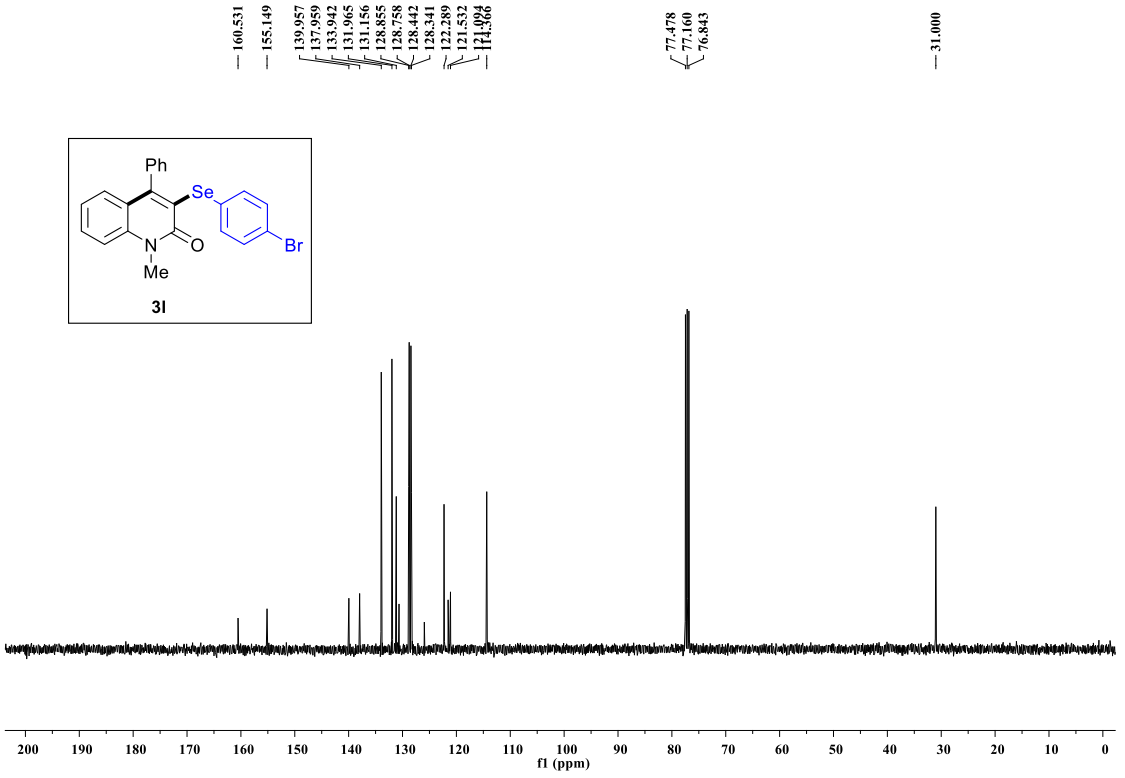
7.427
7.421
7.416
7.408
7.404
7.394
7.260
7.229
7.223
7.218
7.207
7.202
7.196
7.176
7.172
7.155
7.151
7.144
7.138
7.133
7.122
7.117
7.114
7.104
7.102
7.084
7.082
3.824
Ph
Se
Br
N
O
Me
3l
1.04
4.04
2.05
6.02
3.00
f1 (ppm)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137.959
133.942
131.965
131.156
128.855
128.758
128.442
128.341
122.289
121.532
77.478
77.160
76.843
31.000
Ph
Se
Br
N
O
Me
3l
f1 (ppm)


7.573
7.570
7.559
7.556
7.553
7.542
7.539
7.415
7.410
7.405
7.397
7.274
7.270
7.263
7.261
7.258
7.256
7.250
7.246
7.154
7.151
7.138
7.135
7.125
7.121
7.116
7.113
7.111
7.109
7.106
7.102
7.100
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7.086
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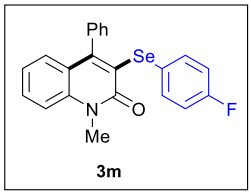
6.780
3.818


Ph
Se
F
N
O
Me

3m

1.13
4.09
2.09
4.04
2.00
3.09
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


163.219
161.260
160.657
154.441
139.806
137.920
135.077
135.015
130.951
128.818
128.671
128.386
128.224
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125.934
125.907
122.214
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116.081
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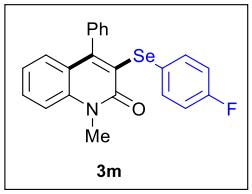
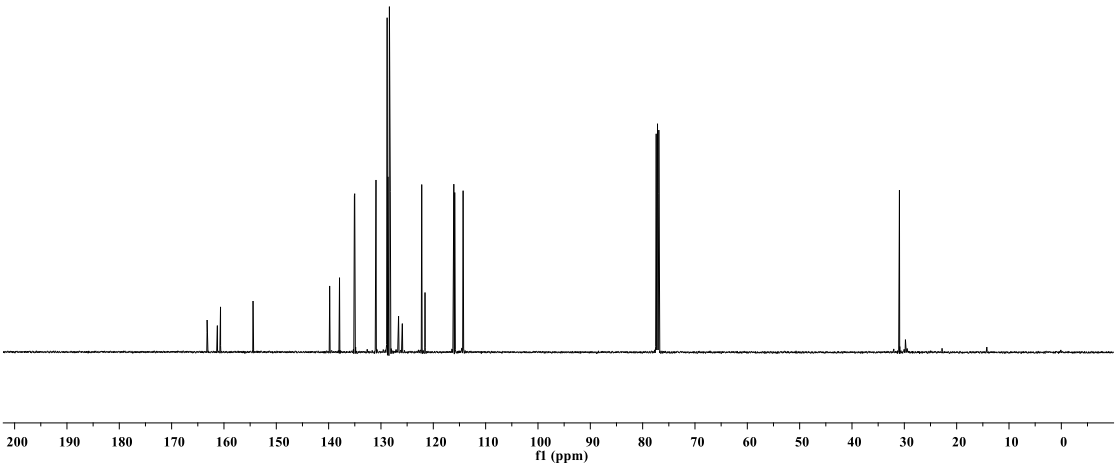
114.300
77.414
77.160
76.906
30.928


Ph
Se
F
N
O
Me

3m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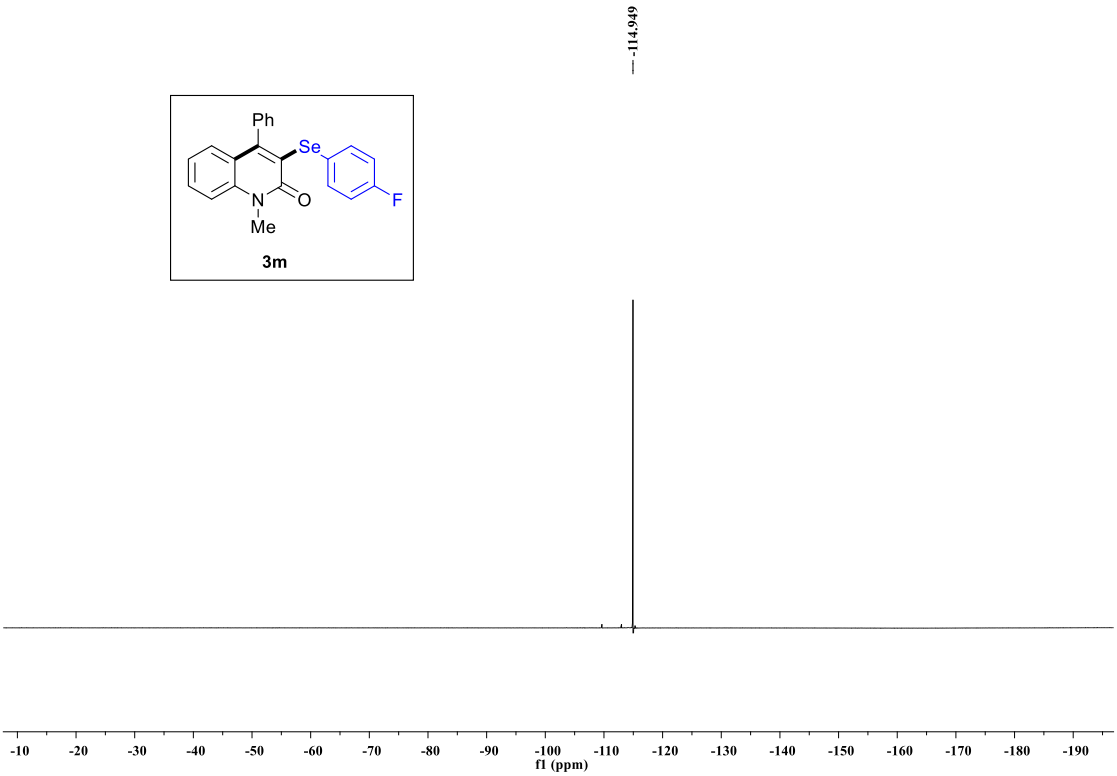
f1 (ppm)


-114.949
Ph
Se
F
N
O
Me
3m
-10
-20
-30
-40
-50
-60
-70
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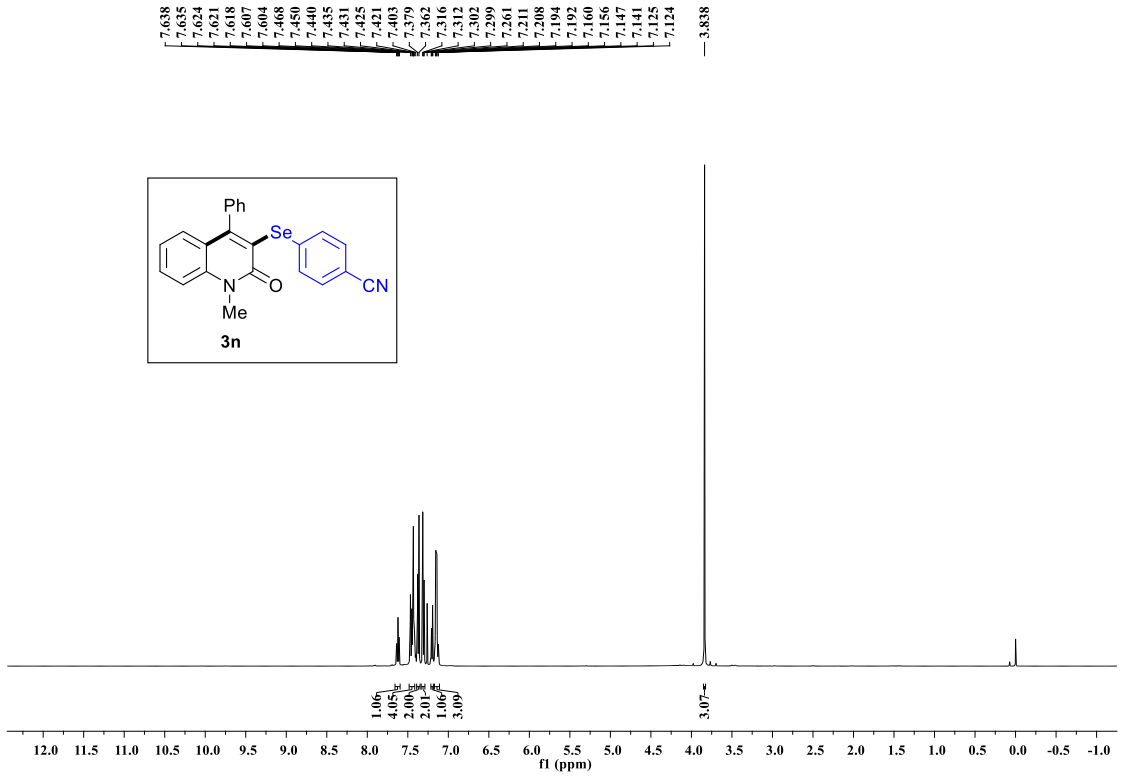
-150
-160
-170
-180
-190
f1 (ppm)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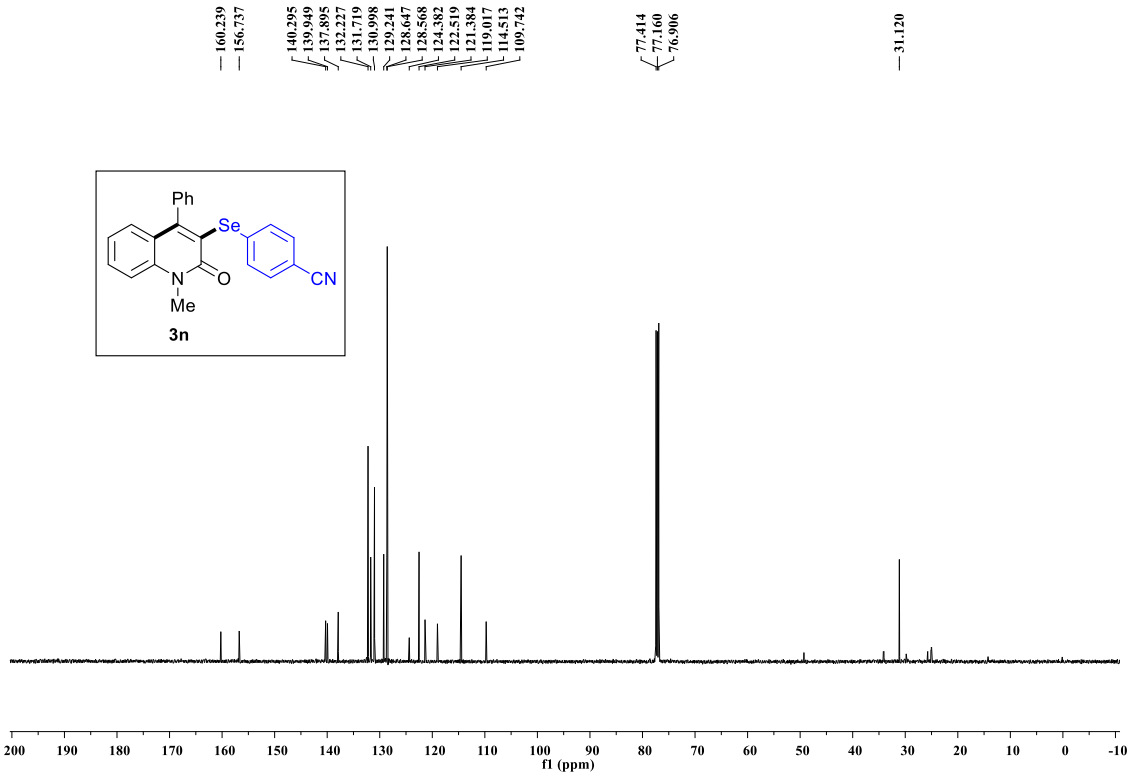
7.468
7.450
7.440
7.435
7.431
7.425
7.421
7.403
7.379
7.362
7.316
7.312
7.302
7.299
7.261
7.211
7.208
7.194
7.192
7.160
7.156
7.147
7.141
7.125
7.124
3.838
Ph
Se
CN
N
O
Me
3n
1.06
4.05
2.00
2.01
1.06
3.09
3.07
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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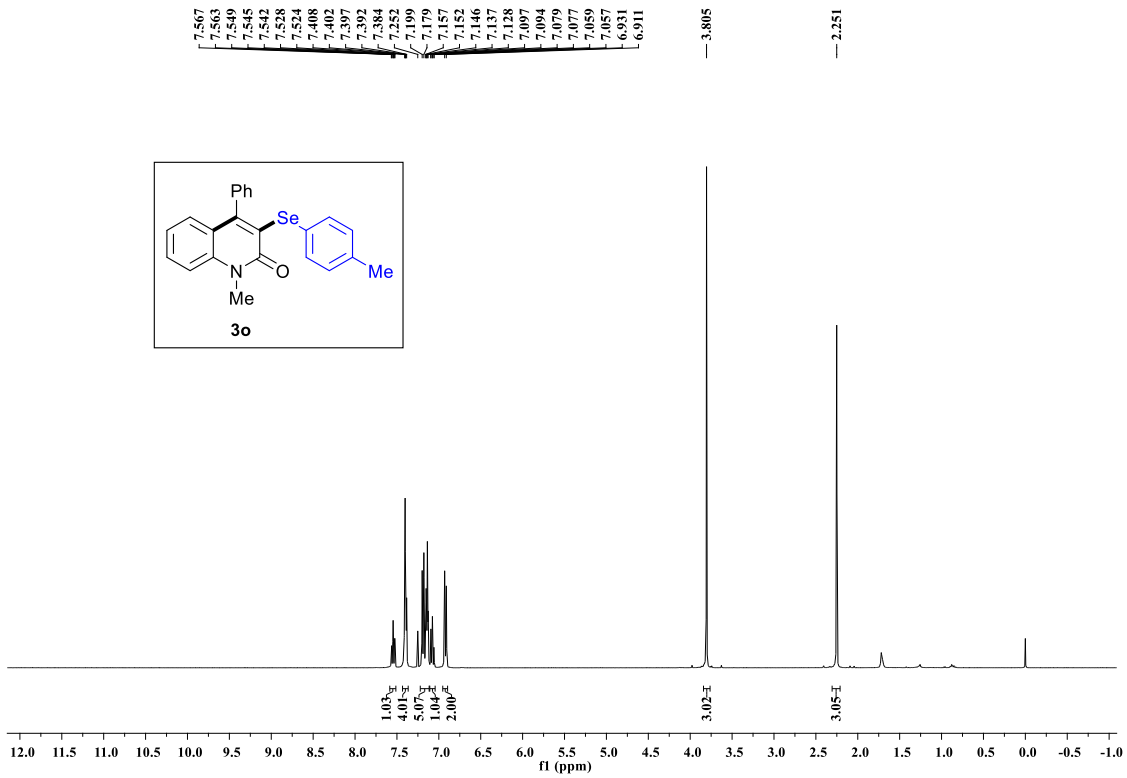
130.998
129.241
128.647
128.568
124.382
122.519
121.384
119.017
114.513
109.742
77.414
77.160
76.906
31.120
Ph
Se
CN
N
O
Me
3n
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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7.549
7.545
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7.528
7.524
7.408
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7.397
7.392
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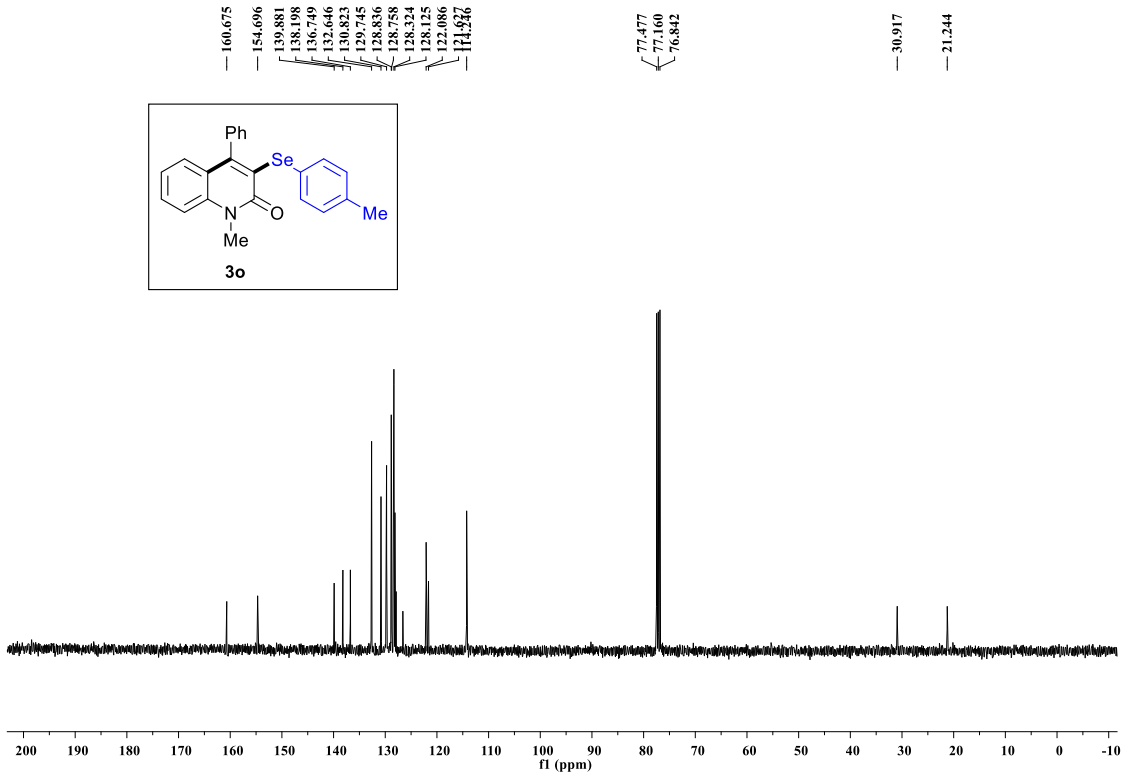
7.252
7.199
7.179
7.157
7.152
7.146
7.137
7.128
7.097
7.094
7.079
7.077
7.059
7.057
6.931
6.911
3.805
2.251
Ph
Se
Me
N
O
Me
3o
1.03
4.01
5.07
1.04
2.00
3.02
3.05
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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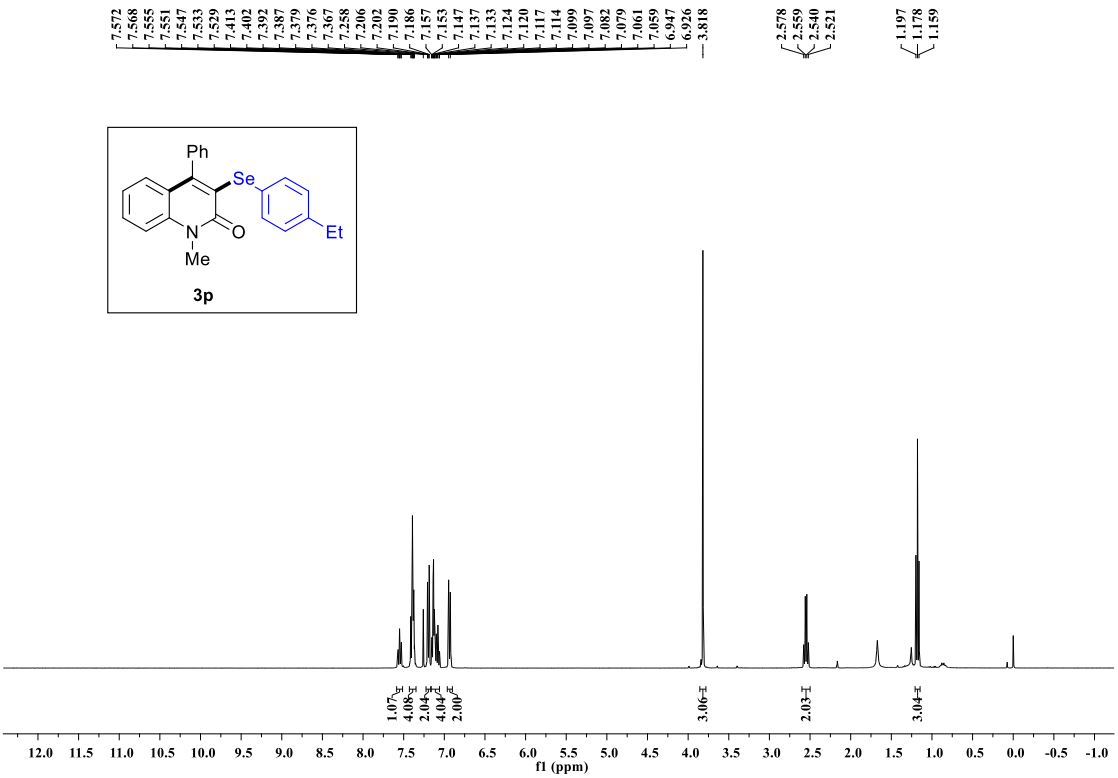
139.881
138.198
136.749
132.646
130.823
129.745
128.836
128.758
128.324
128.125
122.086
121.627
114.246
77.477
77.160
76.842
30.917
21.244
Ph
Se
Me
N
O
Me
3o
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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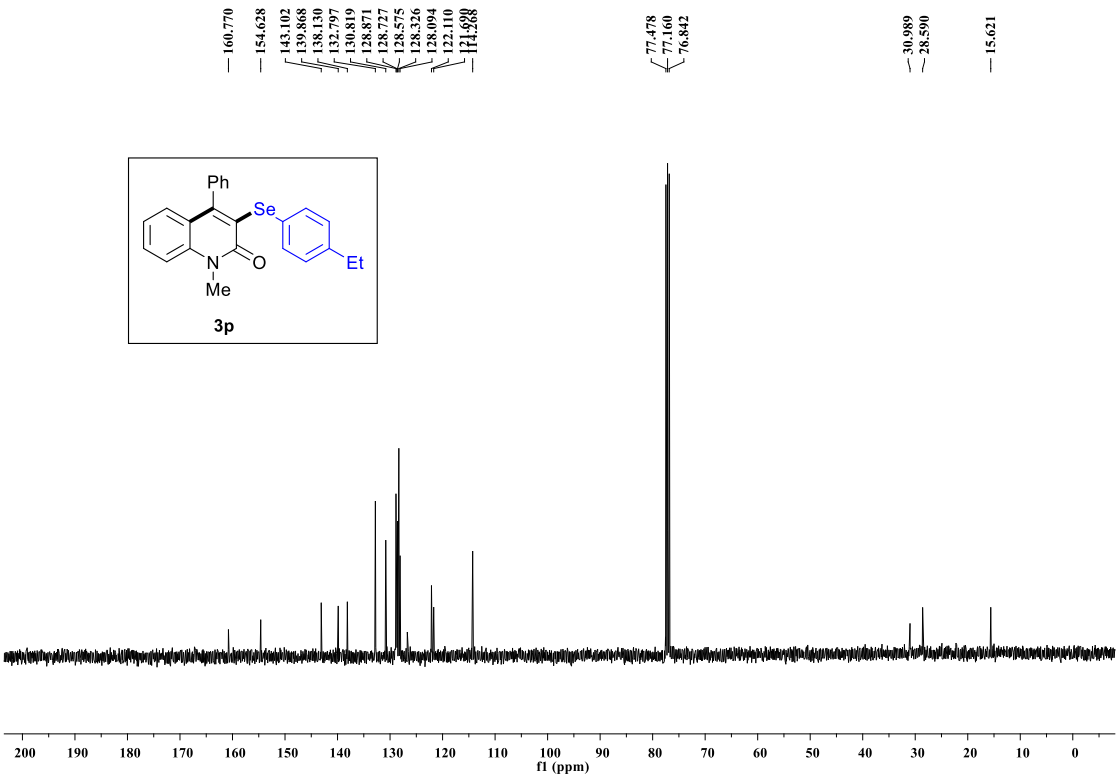
7.413
7.402
7.392
7.387
7.379
7.376
7.367
7.258
7.206
7.202
7.190
7.186
7.157
7.153
7.147
7.137
7.133
7.124
7.120
7.117
7.114
7.099
7.097
7.082
7.079
7.061
7.059
6.947
6.926
3.818
2.578
2.559
2.540
2.521
1.197
1.178
1.159
Ph
Se
Et
N
O
Me
3p
1.07
4.08
2.04
4.04
2.00
3.06
2.03
3.04
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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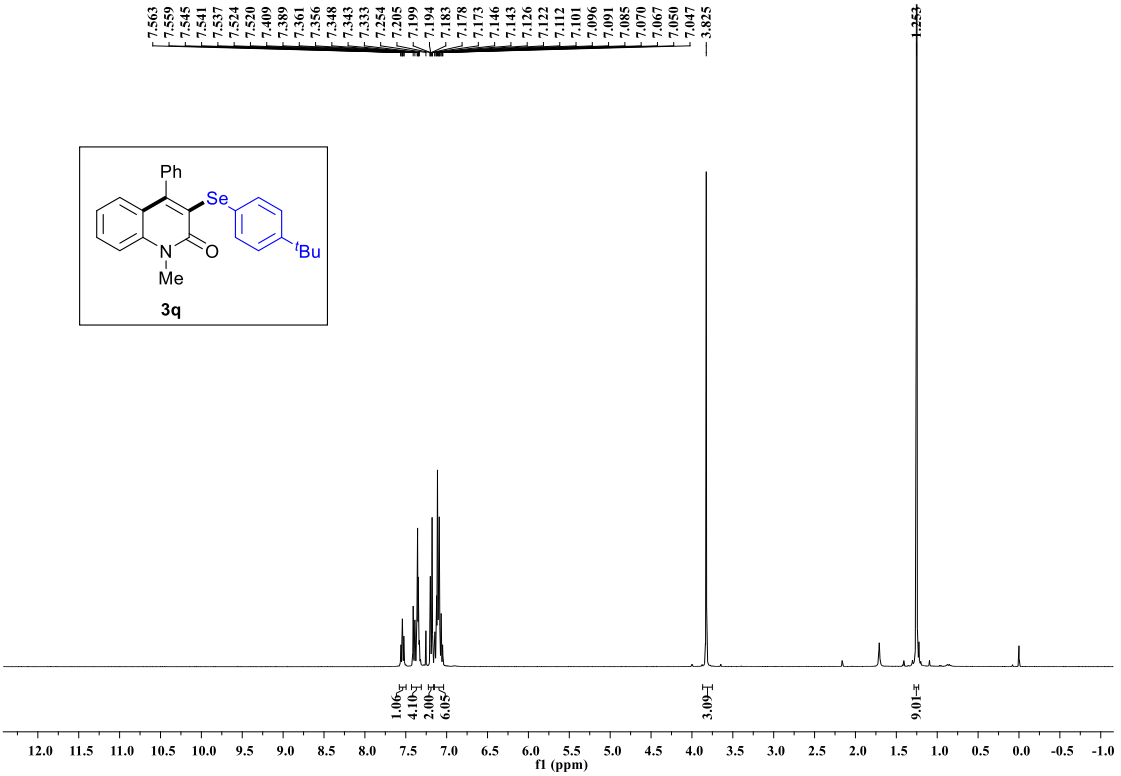
128.575
128.326
128.094
122.110
77.478
77.160
76.842
30.989
28.590
15.621
Ph
Se
Et
N
O
Me
3p
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.545
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7.409
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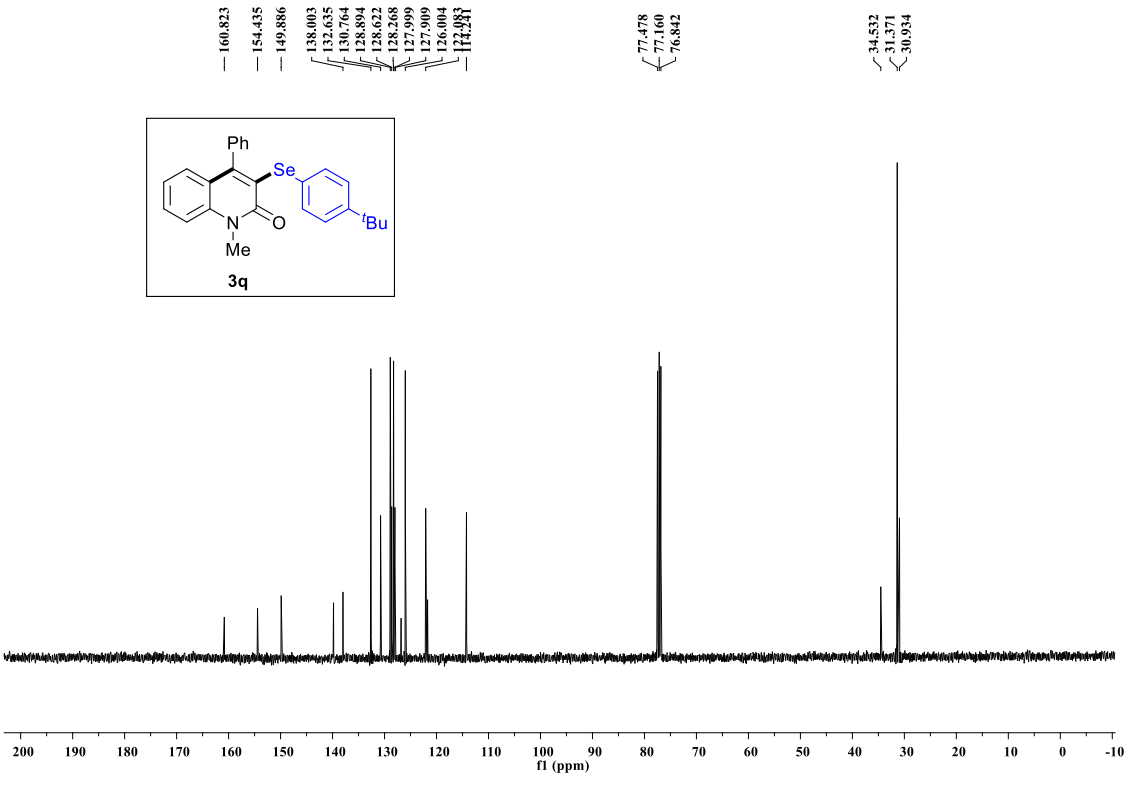
7.356
7.348
7.343
7.333
7.254
7.205
7.199
7.194
7.183
7.178
7.173
7.146
7.143
7.126
7.122
7.112
7.101
7.096
7.091
7.085
7.070
7.067
7.050
7.047
3.825
1.252
Ph
Se
tBu
N
O
Me
3q
1.06
4.10
2.00
6.05
3.09
9.01
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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128.622
128.268
127.999
127.909
126.004
122.083
114.241
77.478
77.160
76.842
34.532
31.371
30.934
Ph
Se
tBu
N
O
Me
3q
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.552
7.548
7.535
7.531
7.527
7.514
7.510
7.409
7.400
7.393
7.383
7.373
7.269
7.261
7.258
7.245
7.239
7.232
7.133
7.125
7.123
7.120
7.116
7.112
7.103
7.084
7.081
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7.064
7.046
7.044
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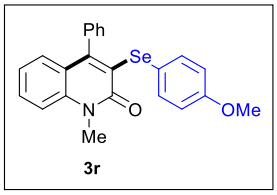
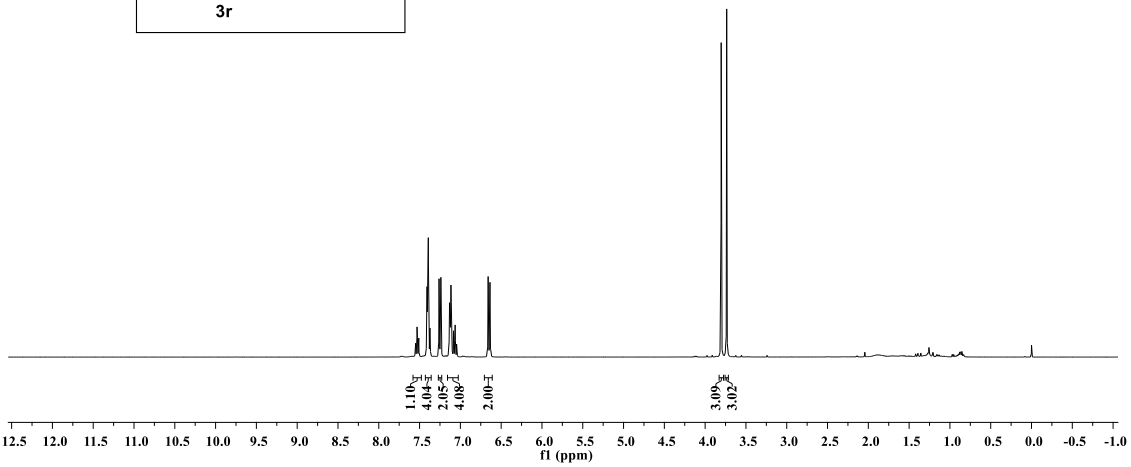
6.659
6.654
6.642
6.637
6.630
3.803
3.736


Ph
Se
O
N
Me
OMe
3r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4.04
2.05
4.08
2.00
3.09
3.02
12.5 12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


160.802
159.131
153.933
139.733
138.074
135.310
130.684
128.914
128.580
128.324
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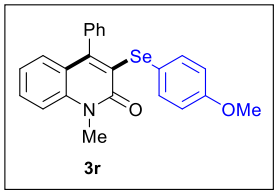
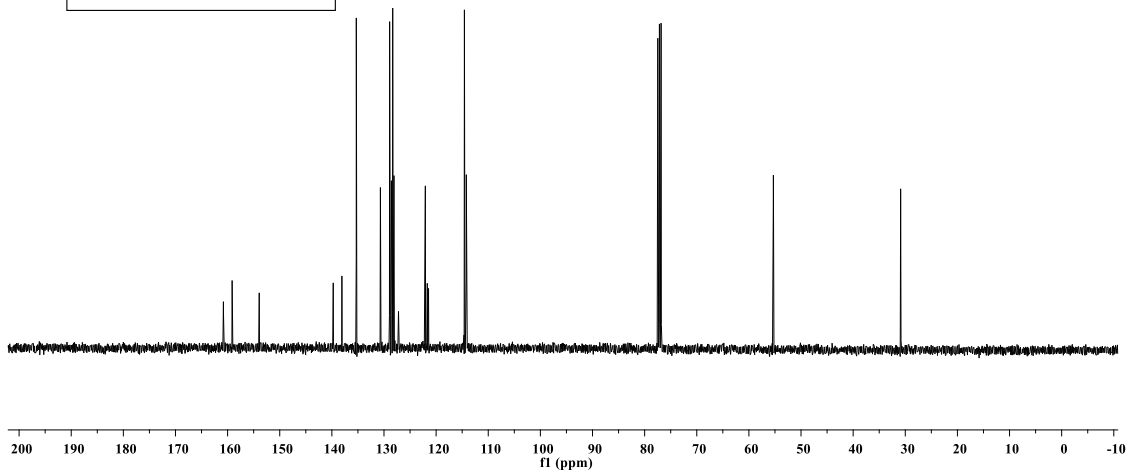
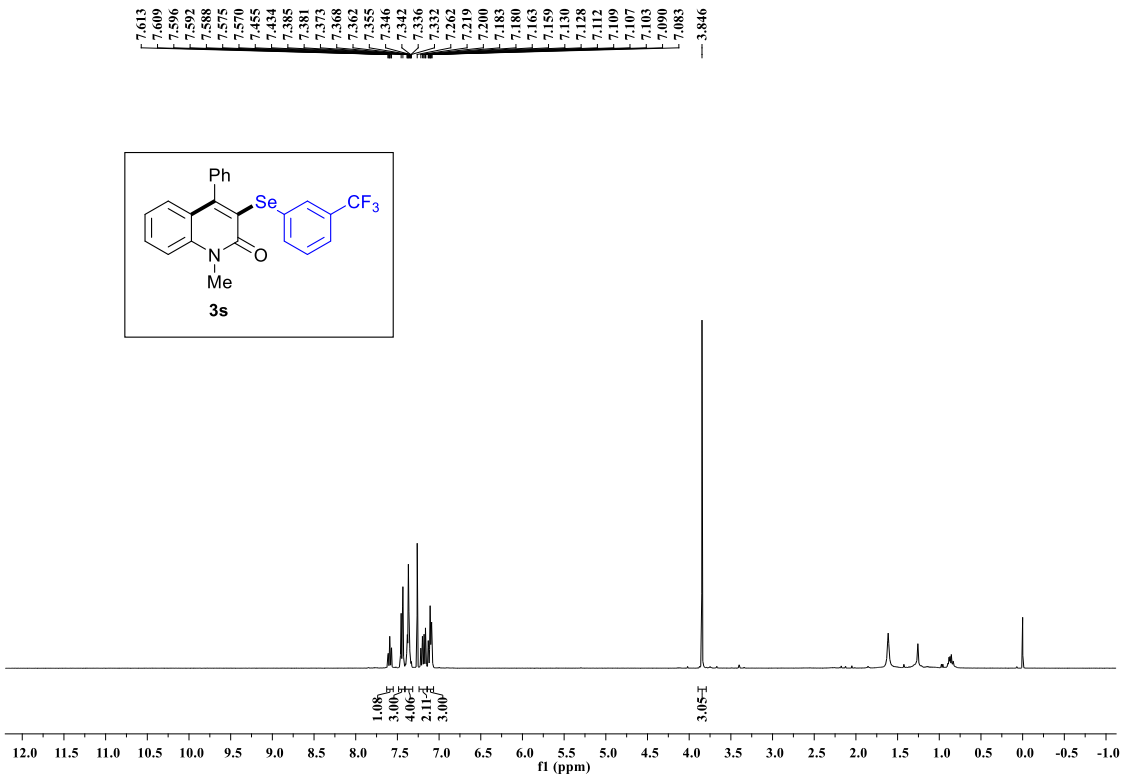
114.210
77.478
77.160
76.842
55.303
30.887


Ph
Se
O
N
Me
OMe
3r


200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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7.596
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7.575
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7.455
7.434
7.385
7.381
7.373
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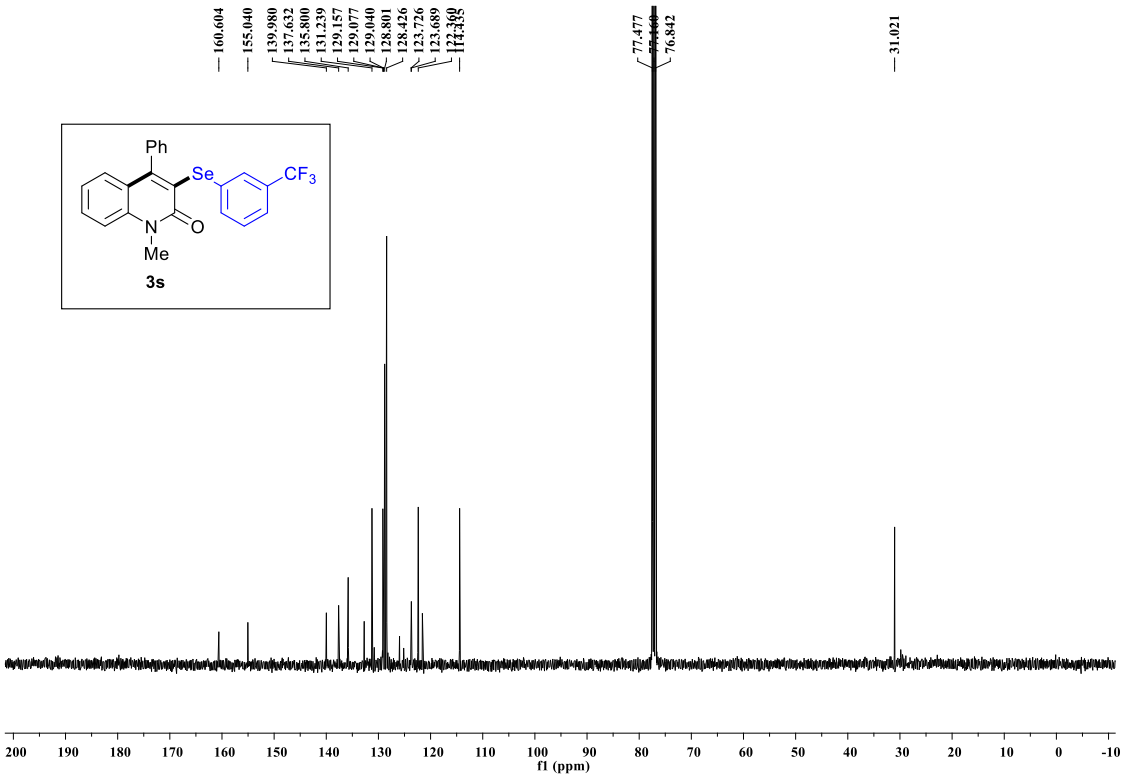
7.362
7.355
7.346
7.342
7.336
7.332
7.262
7.219
7.200
7.183
7.180
7.163
7.159
7.130
7.128
7.112
7.109
7.107
7.103
7.090
7.083
3.846
Ph
Se
CF3
N
O
Me
3s
1.08
3.00
4.06
2.11
3.00
3.05
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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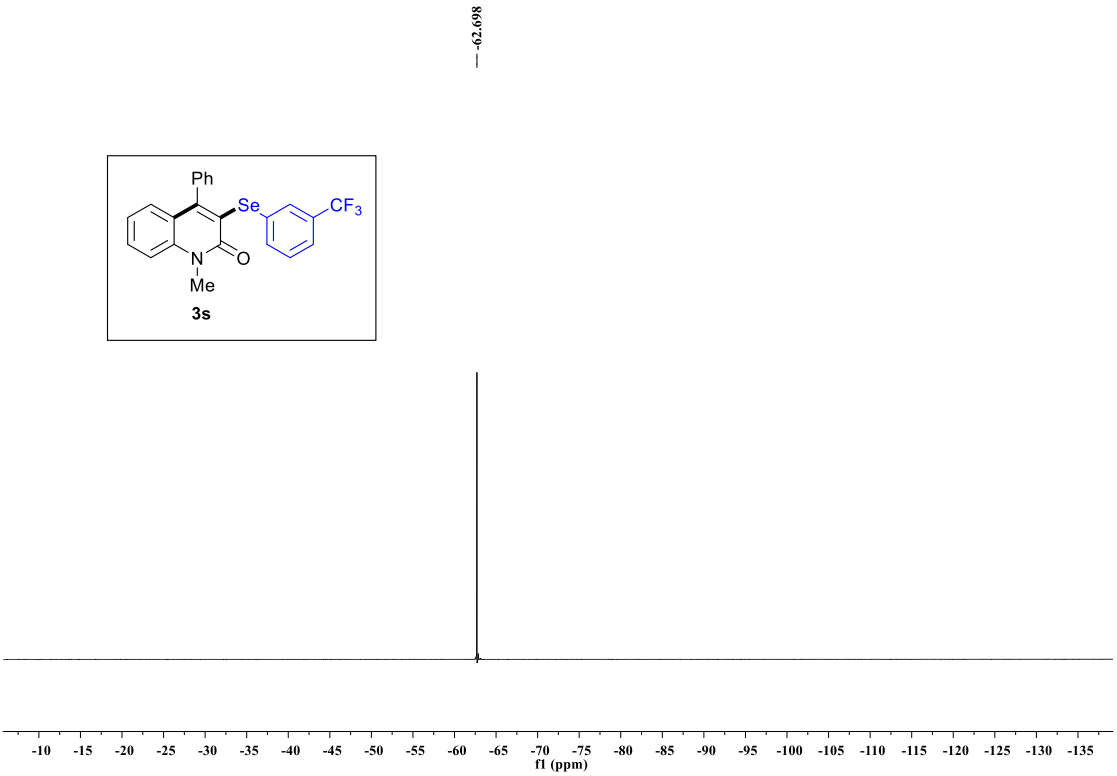
139.980
137.632
135.800
131.239
129.157
129.077
129.040
128.801
128.426
123.726
123.689
77.477
76.842
31.021
Ph
Se
CF3
N
O
Me
3s
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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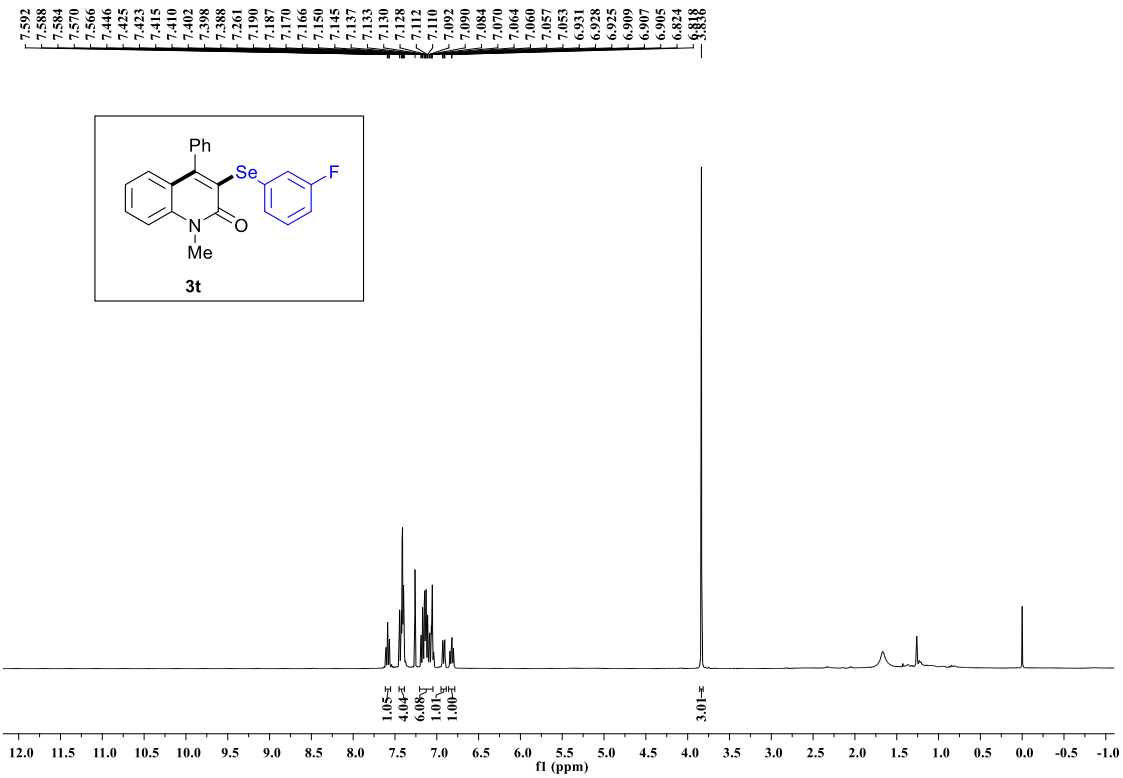
Se
CF3
N
O
Me
3s
-10 -15 -20 -25 -30 -35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85 -90 -95 -100 -105 -110 -115 -120 -125 -130 -135
f1 (ppm)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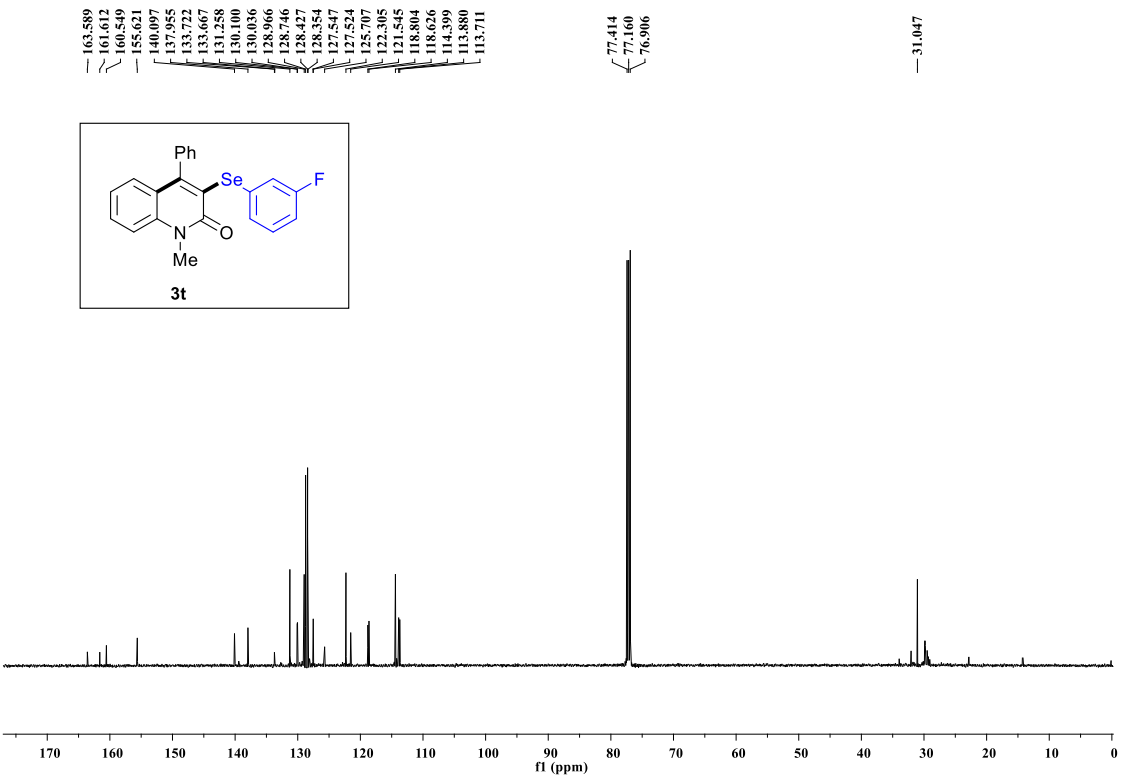
7.415
7.410
7.402
7.398
7.388
7.261
7.190
7.187
7.170
7.166
7.150
7.145
7.137
7.133
7.130
7.128
7.112
7.110
7.092
7.090
7.084
7.070
7.064
7.060
7.057
7.053
6.931
6.928
6.925
6.909
6.907
6.905
6.824
6.818
3.838
Ph
Se
F
N
O
Me
3t
1.05
4.04
6.08
1.01
1.00
3.01
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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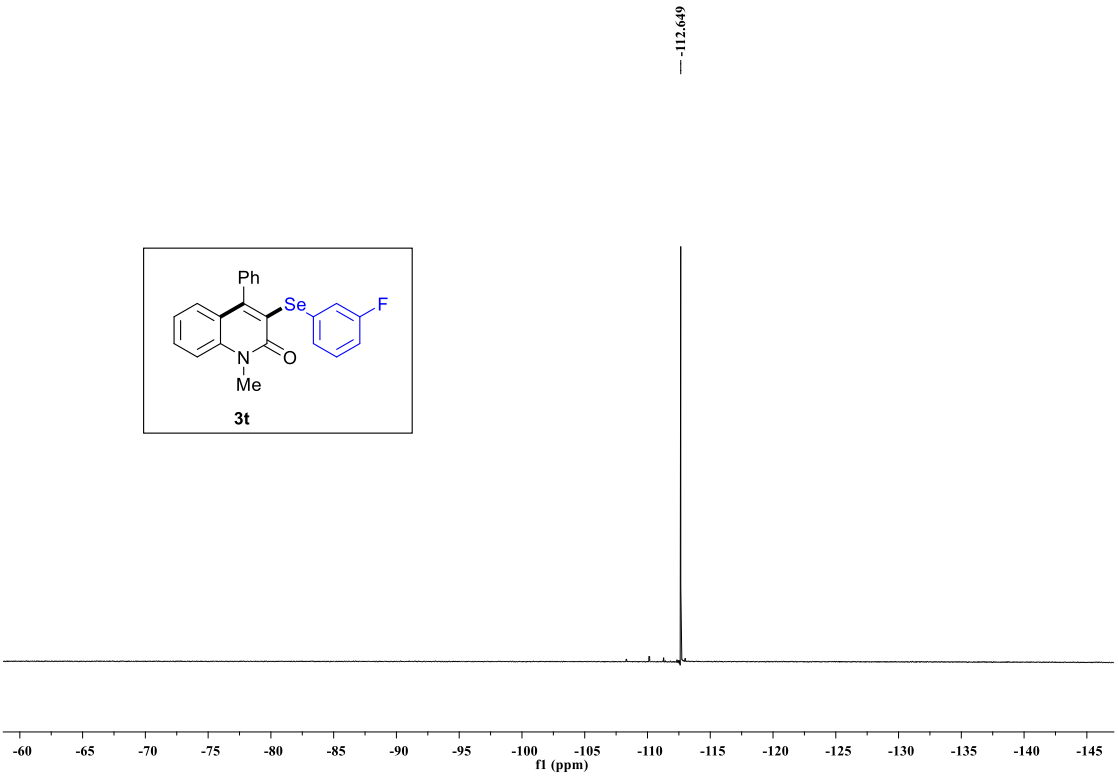
160.549
155.621
140.097
137.955
133.722
133.667
131.258
130.100
130.036
128.966
128.746
128.427
128.354
127.547
127.524
125.707
122.305
121.545
118.804
118.626
114.399
113.880
113.711
77.414
77.160
76.906
31.047
Ph
Se
F
N
O
Me
3t
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


-112.649
Ph
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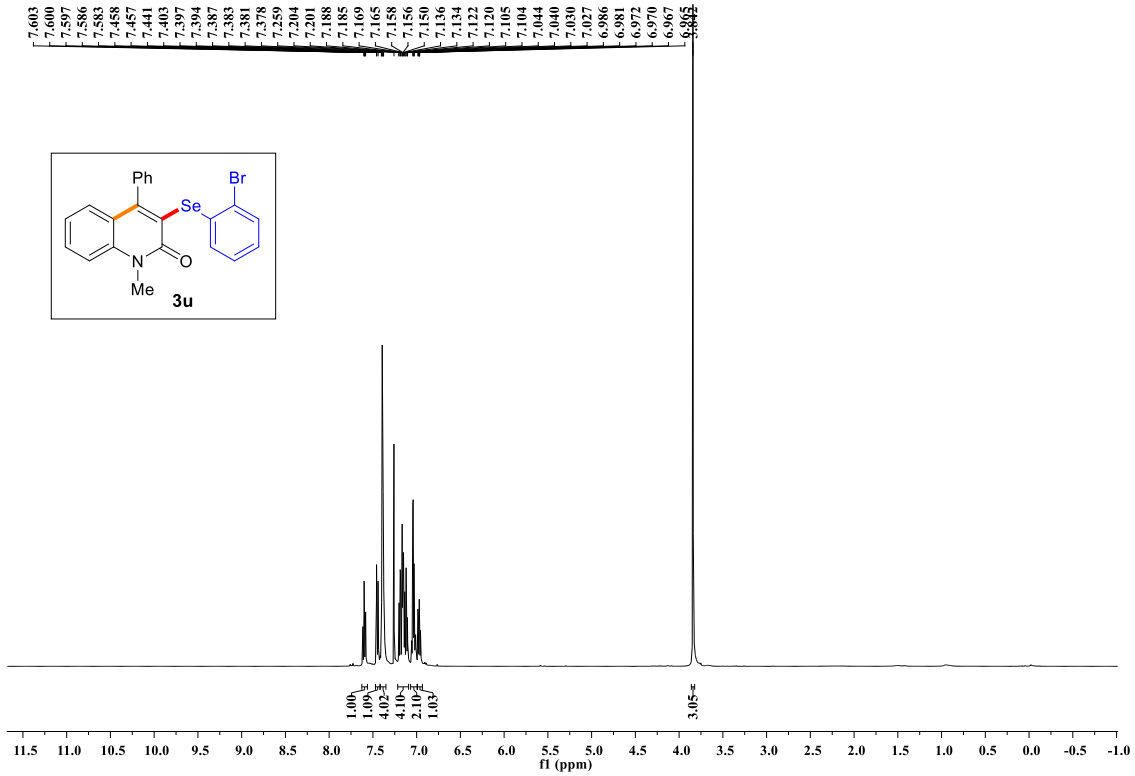
F
N
O
Me
3t
-60
-65
-70
-75
-80
-85
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
-145
f1 (ppm)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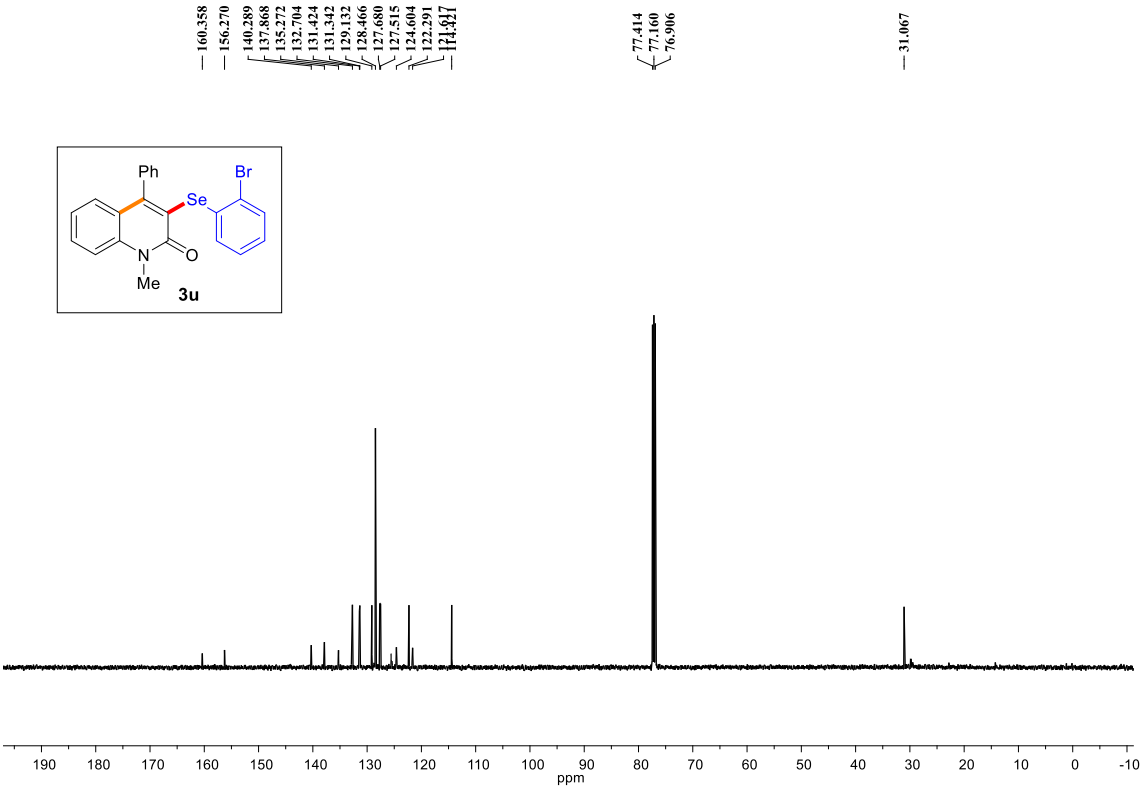
7.394
7.387
7.383
7.381
7.378
7.259
7.204
7.201
7.188
7.185
7.169
7.165
7.158
7.156
7.150
7.136
7.134
7.122
7.120
7.105
7.104
7.044
7.040
7.030
7.027
6.986
6.981
6.972
6.970
6.967
6.965
3.842
Ph
Br
Se
N
O
Me
3u
1.00
1.09
4.02
4.10
2.10
1.03
3.05
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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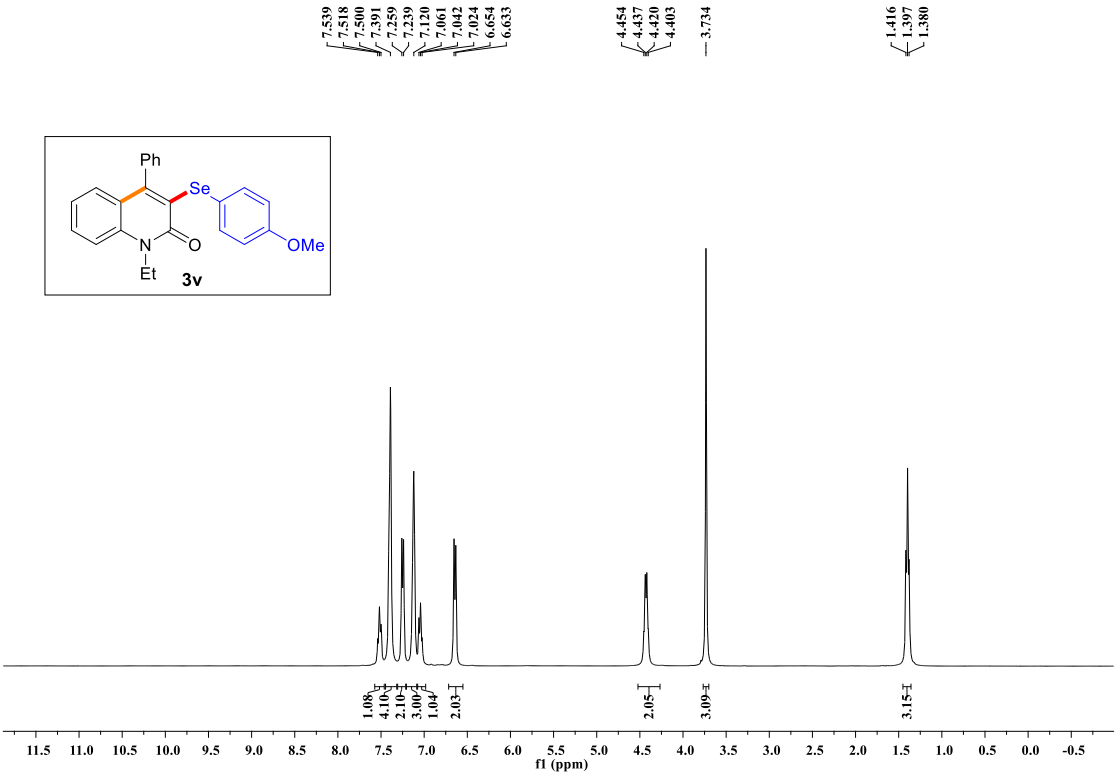
131.342
129.132
128.466
127.680
127.515
124.604
122.291
77.414
77.160
76.906
31.067
Ph
Br
Se
N
O
Me
3u
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
ppm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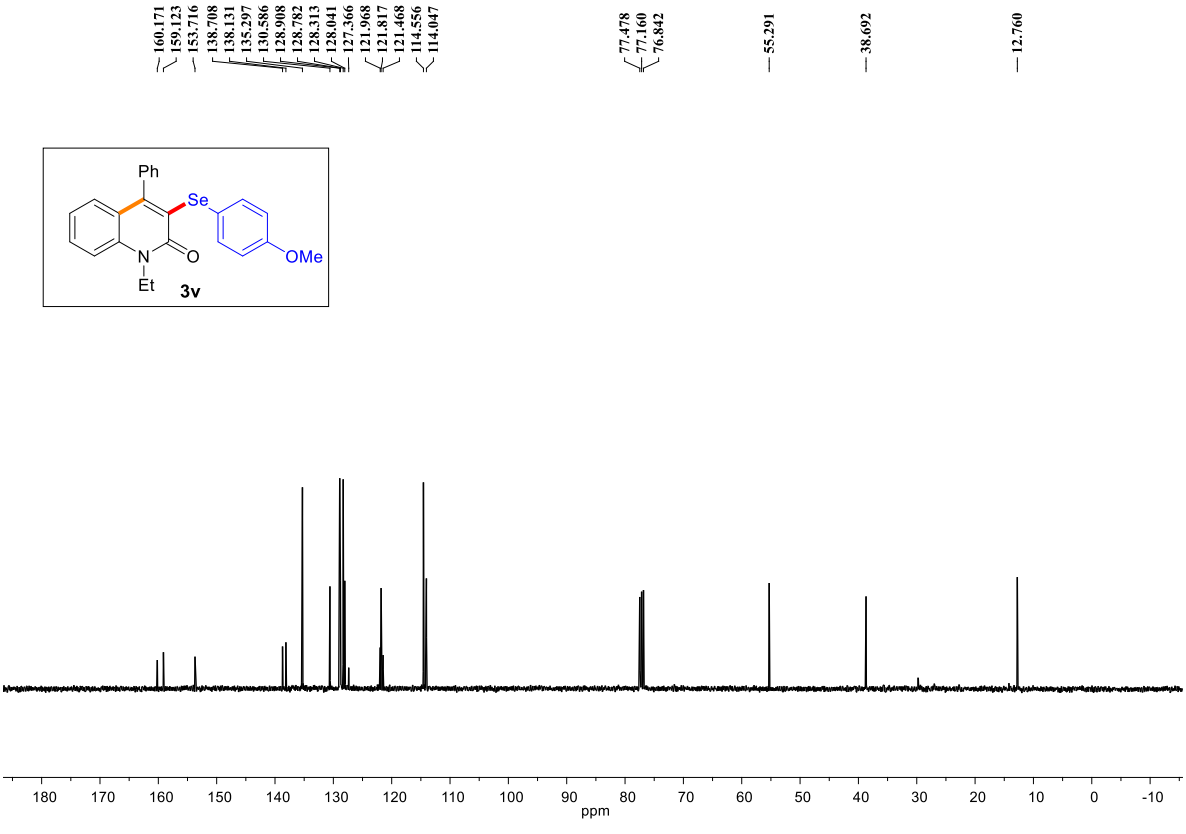
7.259
7.239
7.120
7.061
7.042
7.024
6.654
6.633
4.454
4.437
4.420
4.403
3.734
1.416
1.397
1.380
Ph
Se
OMe
N
O
Et
3v
1.08
4.10
2.10
3.00
1.04
2.03
2.05
3.09
3.15
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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130.586
128.908
128.782
128.313
128.041
127.366
121.968
121.817
121.468
114.556
114.047
77.478
77.160
76.842
55.291
38.692
12.760
Ph
Se
OMe
N
O
Et
3v
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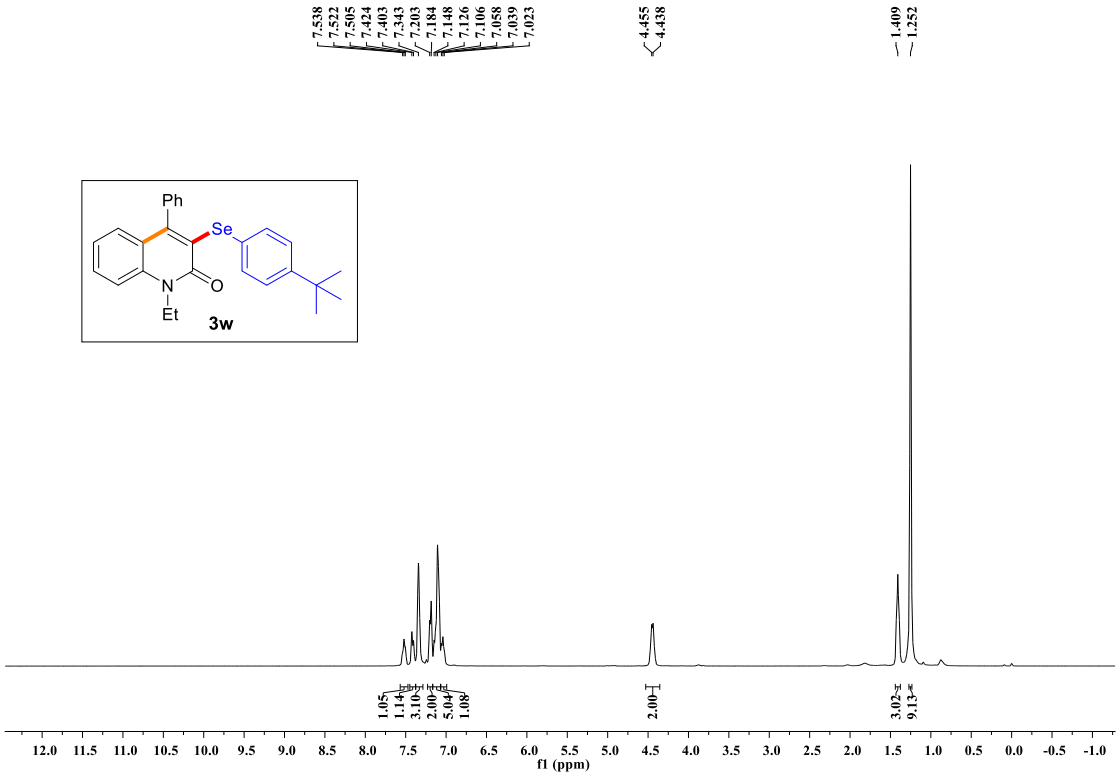
ppm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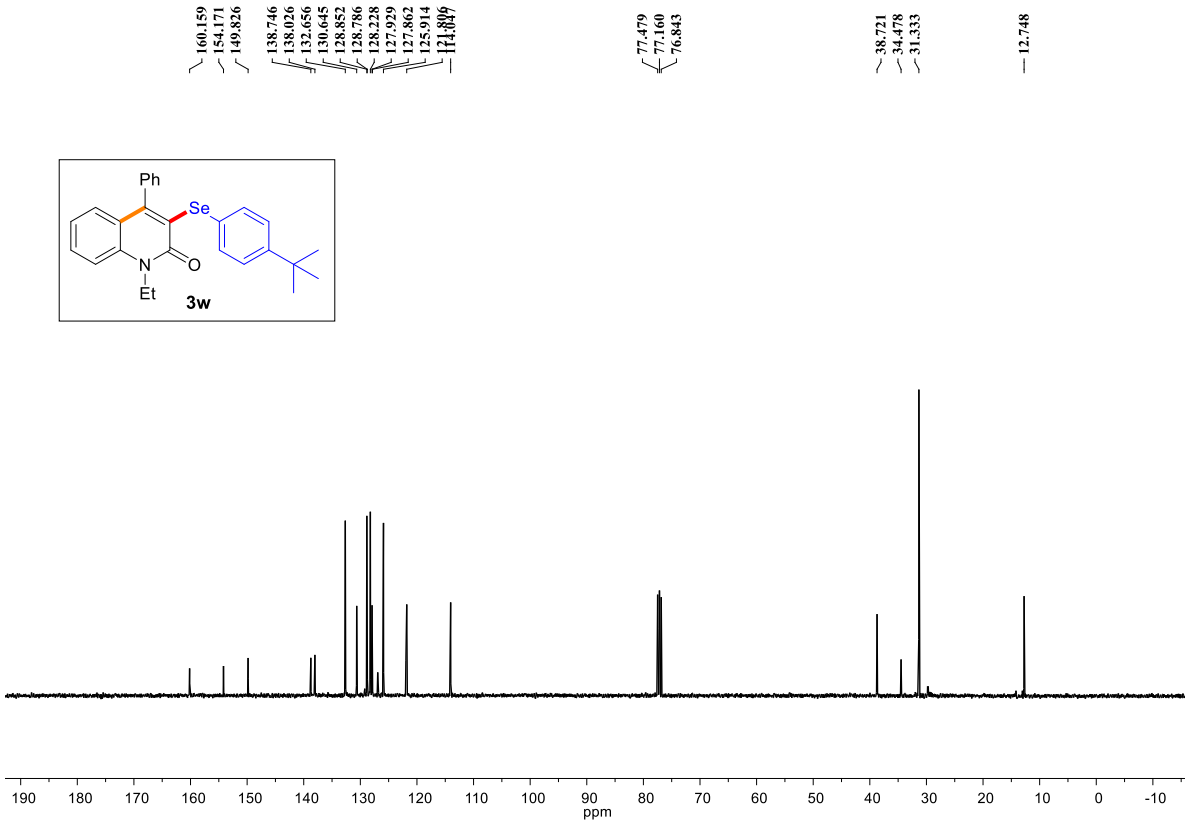
7.505
7.424
7.403
7.343
7.203
7.184
7.148
7.126
7.106
7.058
7.039
7.023
4.455
4.438
1.409
1.252
Ph
Se
N
O
Et
3w
1.05
1.14
3.10
2.00
5.04
1.08
2.00
3.02
9.13
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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128.228
127.929
127.862
125.914
77.479
77.160
76.843
38.721
34.478
31.333
12.748
Ph
Se
N
O
Et
3w
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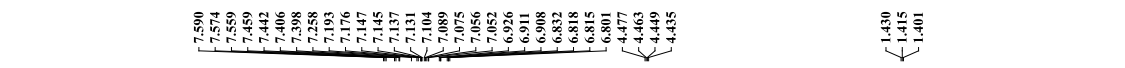
ppm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7.406
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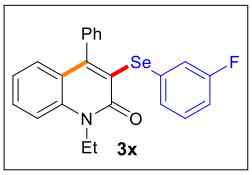
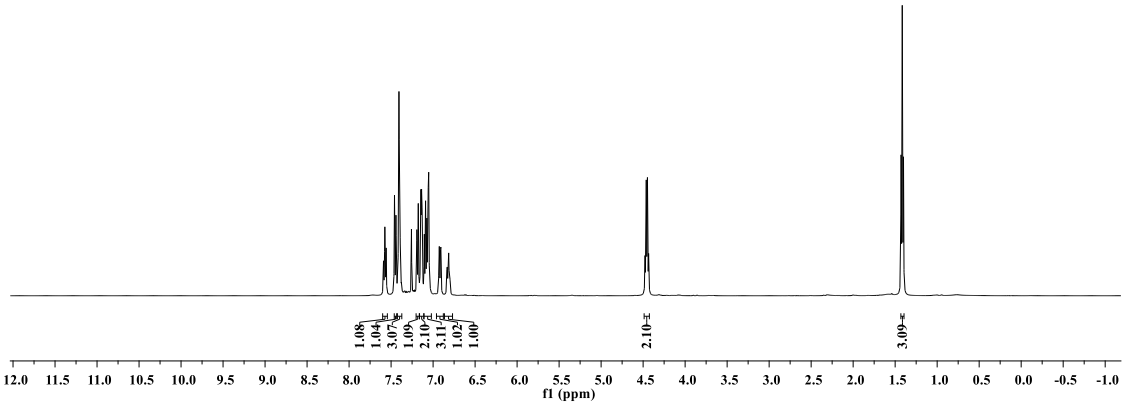
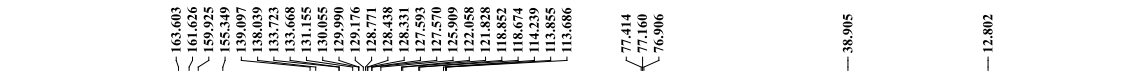
7.258
7.193
7.176
7.147
7.145
7.137
7.131
7.104
7.089
7.075
7.056
7.052
6.926
6.911
6.908
6.832
6.818
6.815
6.801
4.477
4.463
4.449
4.435
1.430
1.415
1.401


Ph
Se
F
N
O
Et
3x


1.08
1.04
3.07
1.09
2.10
3.11
1.02
1.00
2.10
3.09
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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133.723
133.668
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128.438
128.331
127.593
127.570
125.909
122.058
121.828
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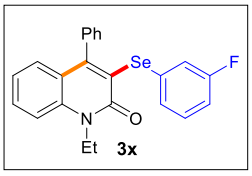
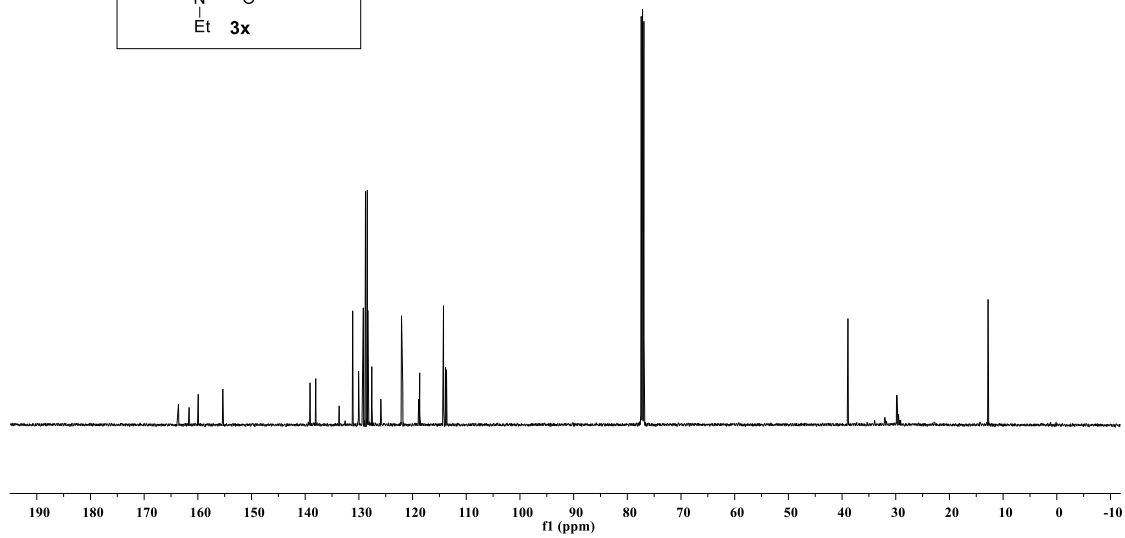
113.855
113.686
77.414
77.160
76.906
38.905
12.802


Ph
Se
F
N
O
Et
3x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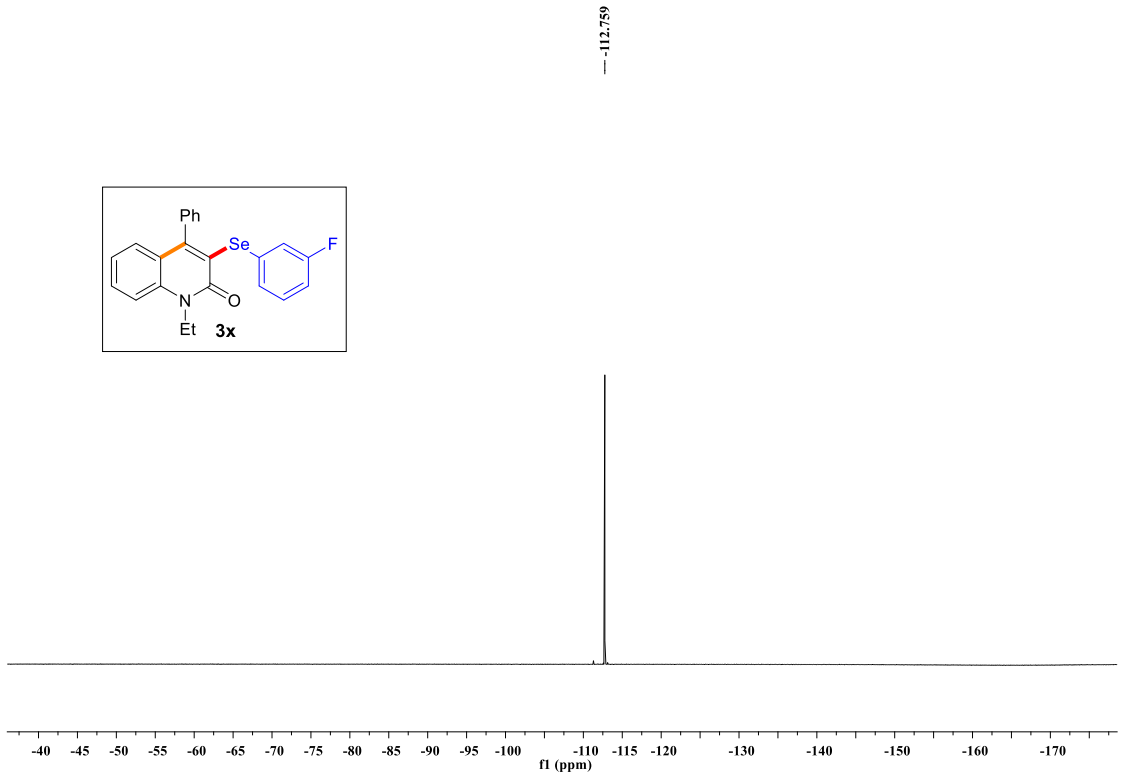
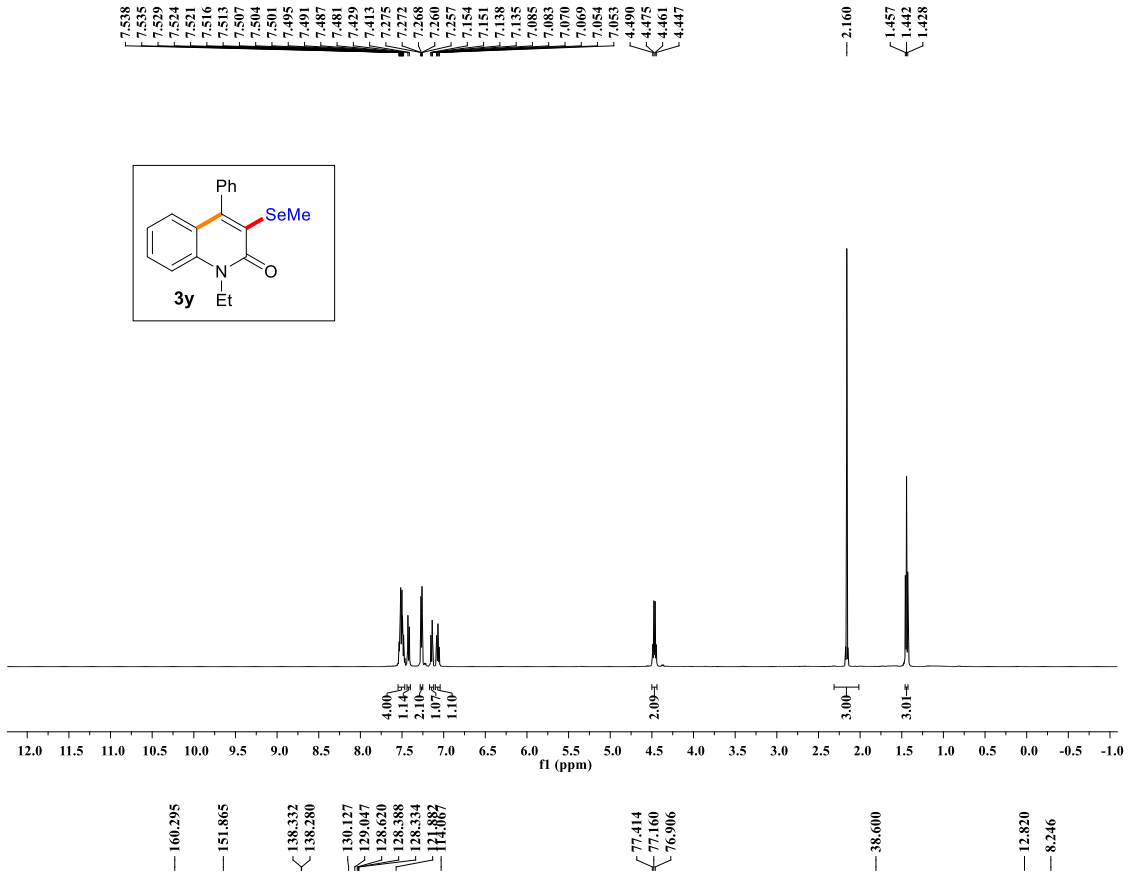
f1 (ppm)


-112.759
Ph
Se
F
N
O
Et
3x
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
-90
-95
-100
-110
-115
-120
-130
-140
-150
-160
-170
f1 (ppm)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7.507
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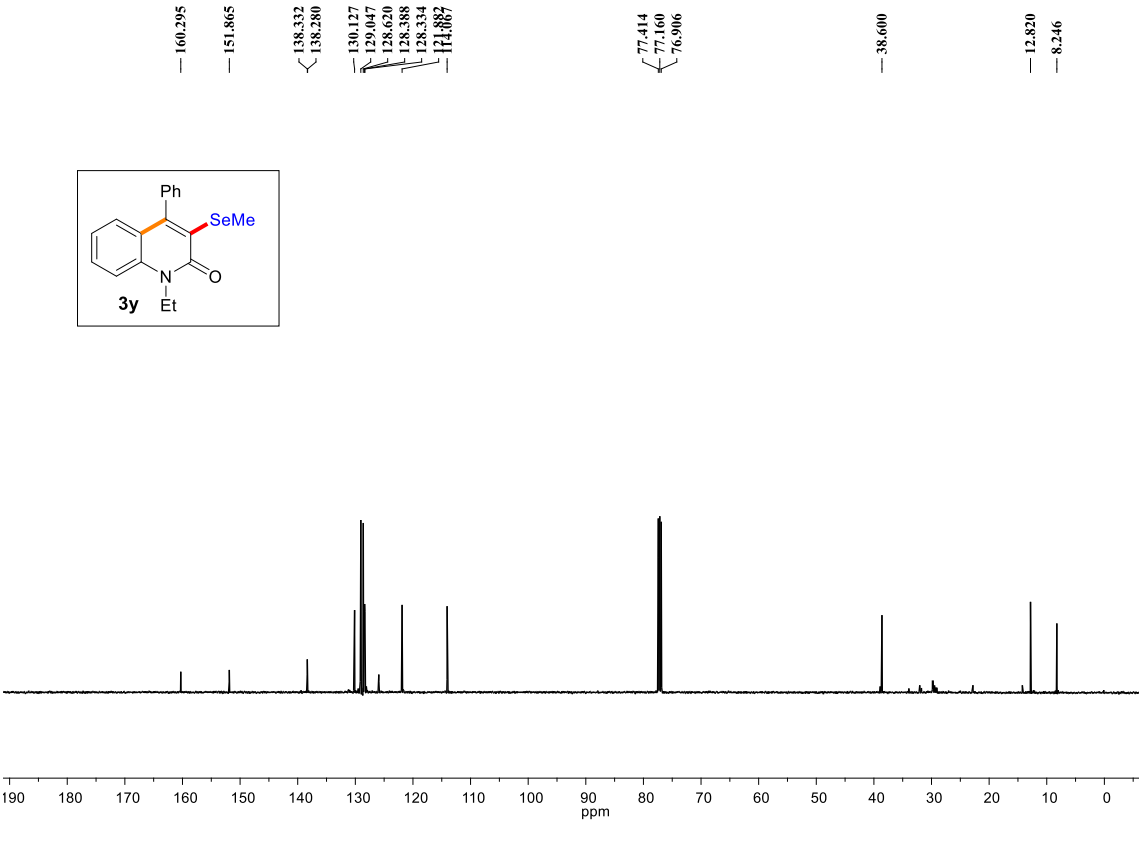
7.501
7.495
7.491
7.487
7.481
7.429
7.413
7.275
7.272
7.268
7.260
7.257
7.154
7.151
7.138
7.135
7.085
7.083
7.070
7.069
7.054
7.053
4.490
4.475
4.461
4.447
2.160
1.457
1.442
1.428
Ph
SeMe
N
O
3y
Et
4.00
1.14
2.10
1.07
1.10
2.09
3.00
3.01
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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128.620
128.388
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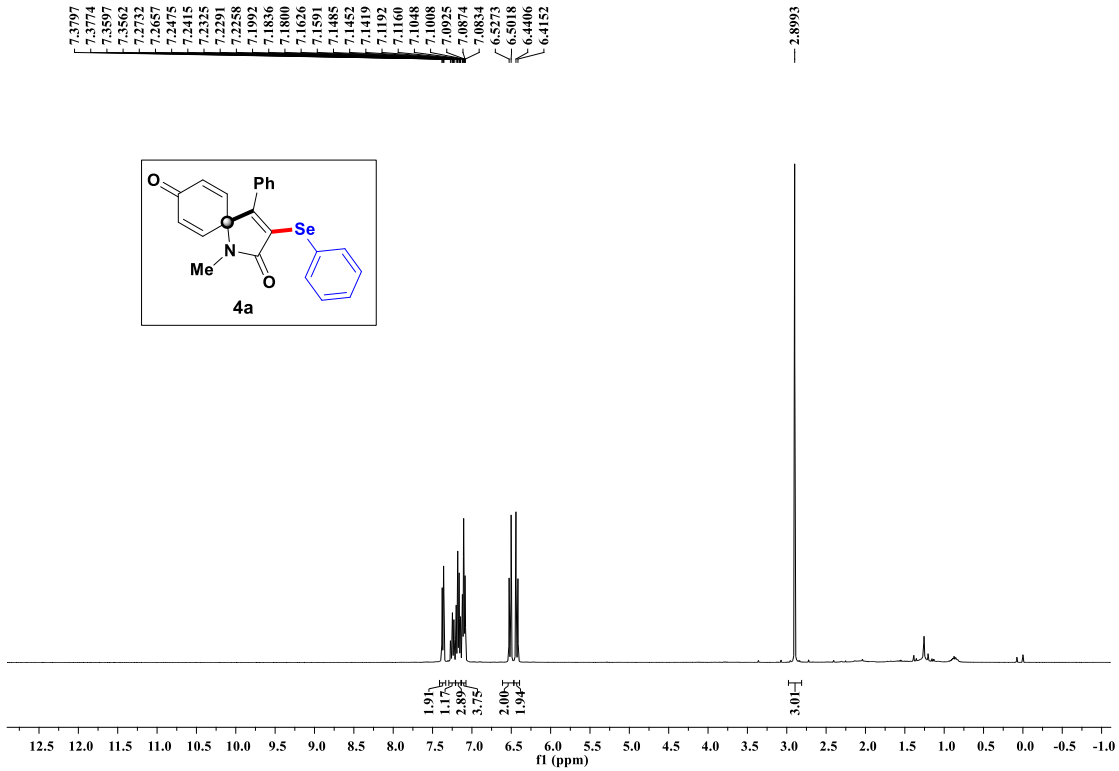
114.867
77.414
77.160
76.906
38.600
12.820
8.246
Ph
SeMe
N
O
3y
Et
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
ppm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7.2325
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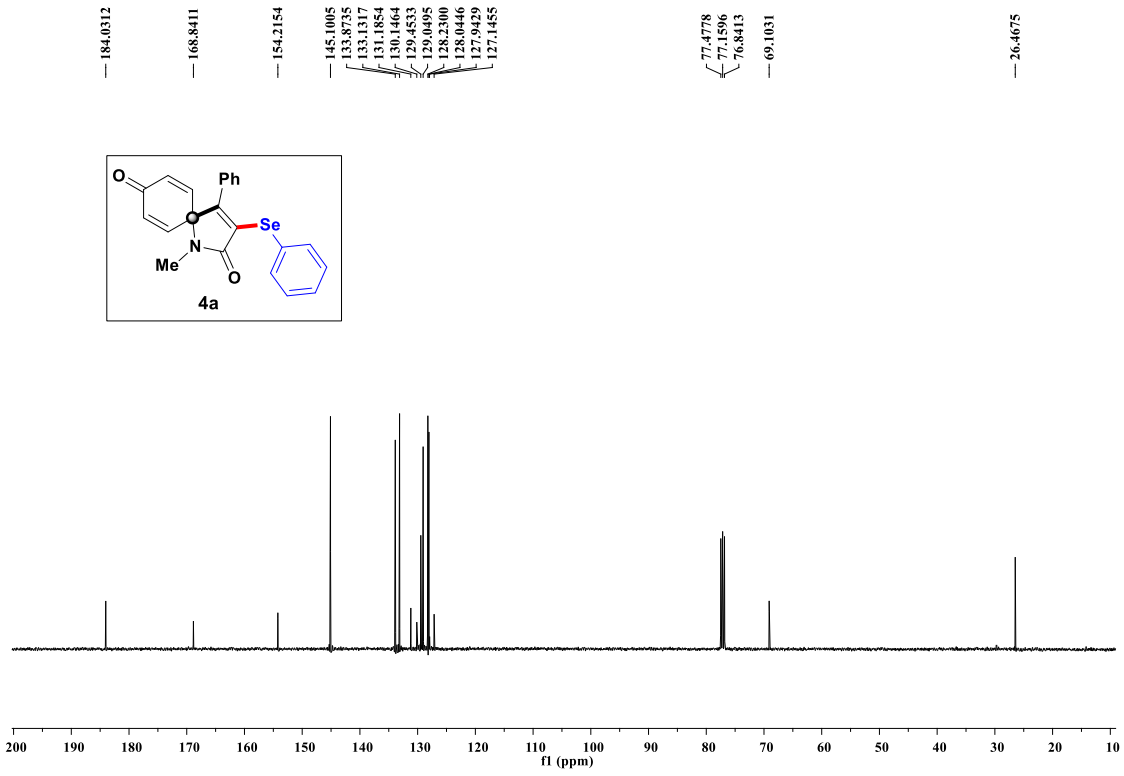
7.2258
7.1992
7.1836
7.1800
7.1626
7.1591
7.1485
7.1452
7.1419
7.1192
7.1160
7.1048
7.1008
7.0925
7.0874
7.0834
6.5273
6.5018
6.4406
6.4152
2.8993
O
Ph
Se
N
Me
O
4a
1.91
1.17
2.89
3.75
2.00
1.94
3.01
12.5 12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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154.2154
145.1005
133.8735
133.1317
131.1854
130.1464
129.4533
129.0495
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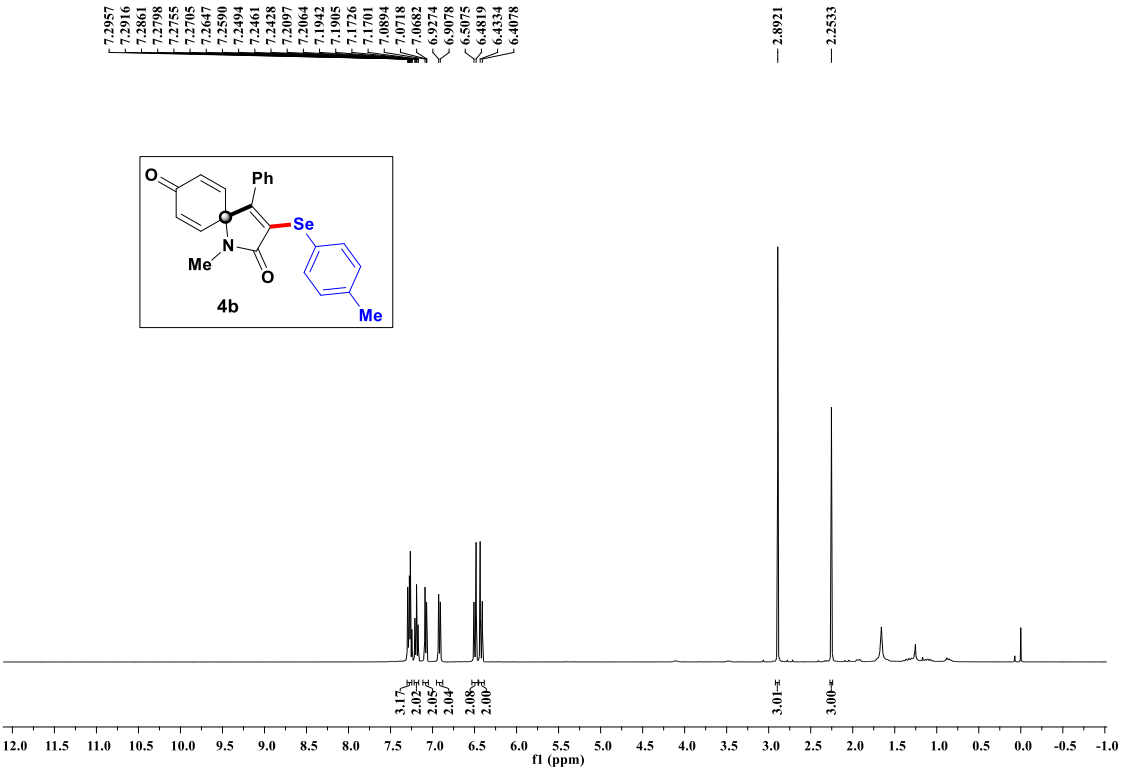
128.0446
127.9429
127.1455
77.4778
77.1596
76.8413
69.1031
26.4675
O
Ph
Se
N
Me
O
4a
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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7.2705
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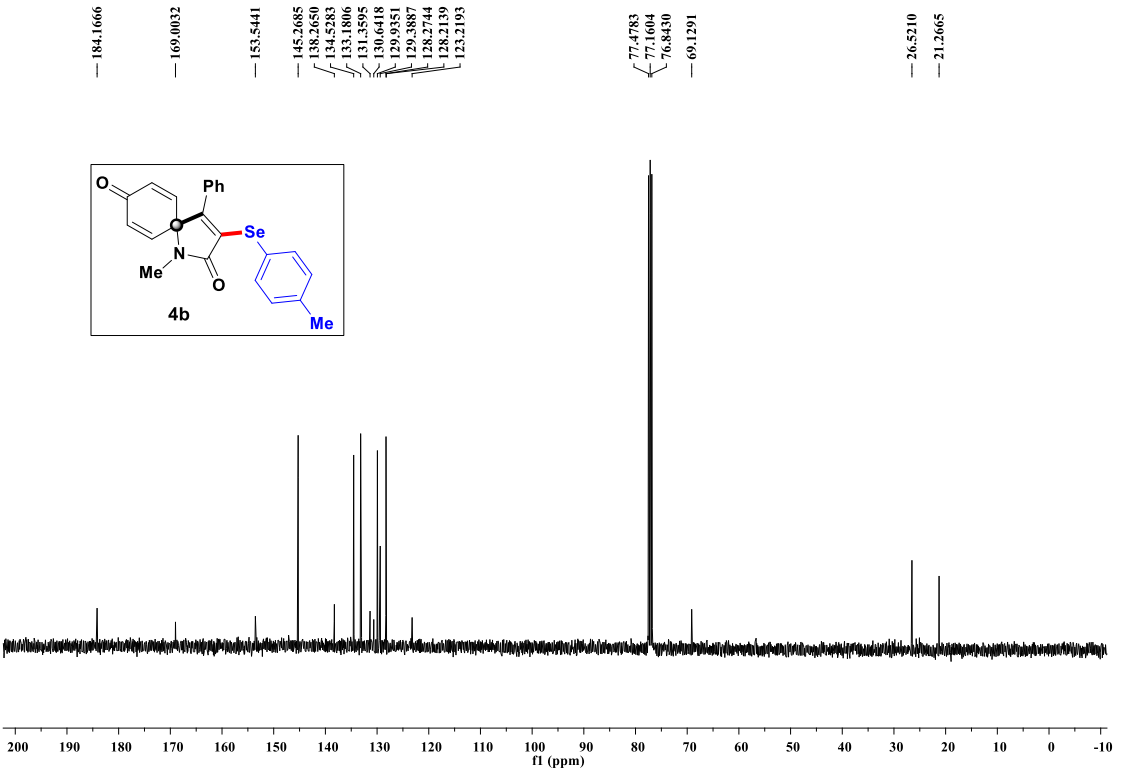
7.2494
7.2461
7.2428
7.2097
7.2064
7.1942
7.1905
7.1726
7.1701
7.0894
7.0718
7.0682
6.9274
6.9078
6.5075
6.4819
6.4334
6.4078
2.8921
2.2533
O
Ph
Se
N
Me
O
4b
Me
3.17
2.02
2.05
2.04
2.08
2.00
3.01
3.00
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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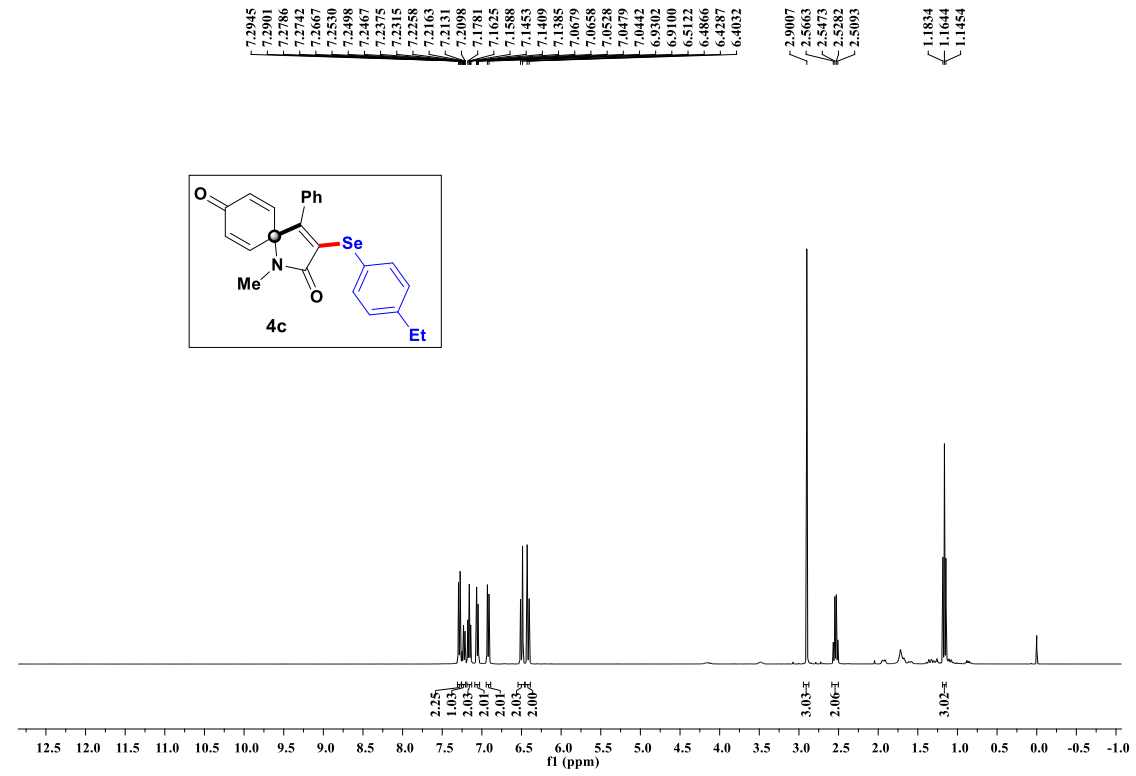
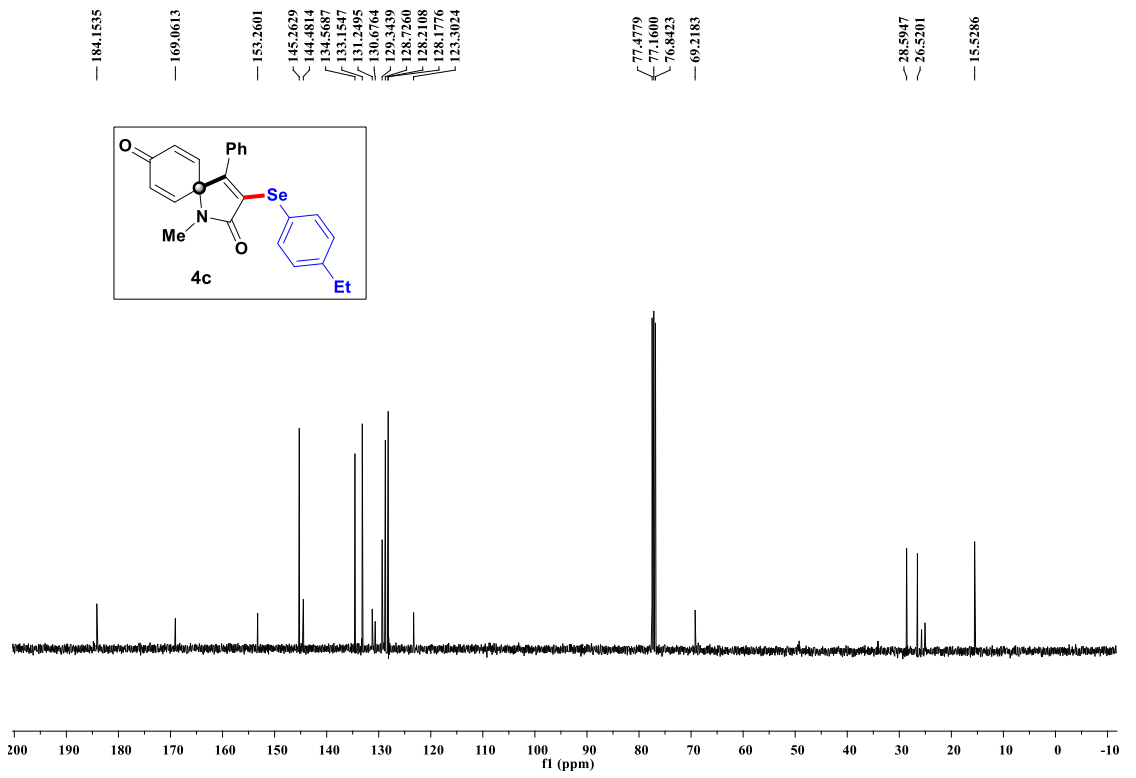
153.5441
145.2685
138.2650
134.5283
133.1806
131.3595
130.6418
129.9351
129.3887
128.2744
128.2139
123.2193
77.4783
77.1604
76.8430
69.1291
26.5210
21.2665
O
Ph
Se
N
Me
O
4b
Me
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.2945
7.2901
7.2786
7.2742
7.2667
7.2530
7.2498
7.2467
7.2375
7.2315
7.2258
7.2163
7.2131
7.2098
7.1781
7.1625
7.1588
7.1453
7.1409
7.1385
7.0679
7.0658
7.0528
7.0479
7.0442
6.9302
6.9100
6.5122
6.4866
6.4287
6.4032
2.9007
2.5663
2.5473
2.5282
2.5093
1.1834
1.1644
1.1454
O
Ph
Se
N
Me
O
4c
Et
2.25
1.03
2.03
2.01
2.01
2.03
2.00
3.03
2.06
3.02
12.5 12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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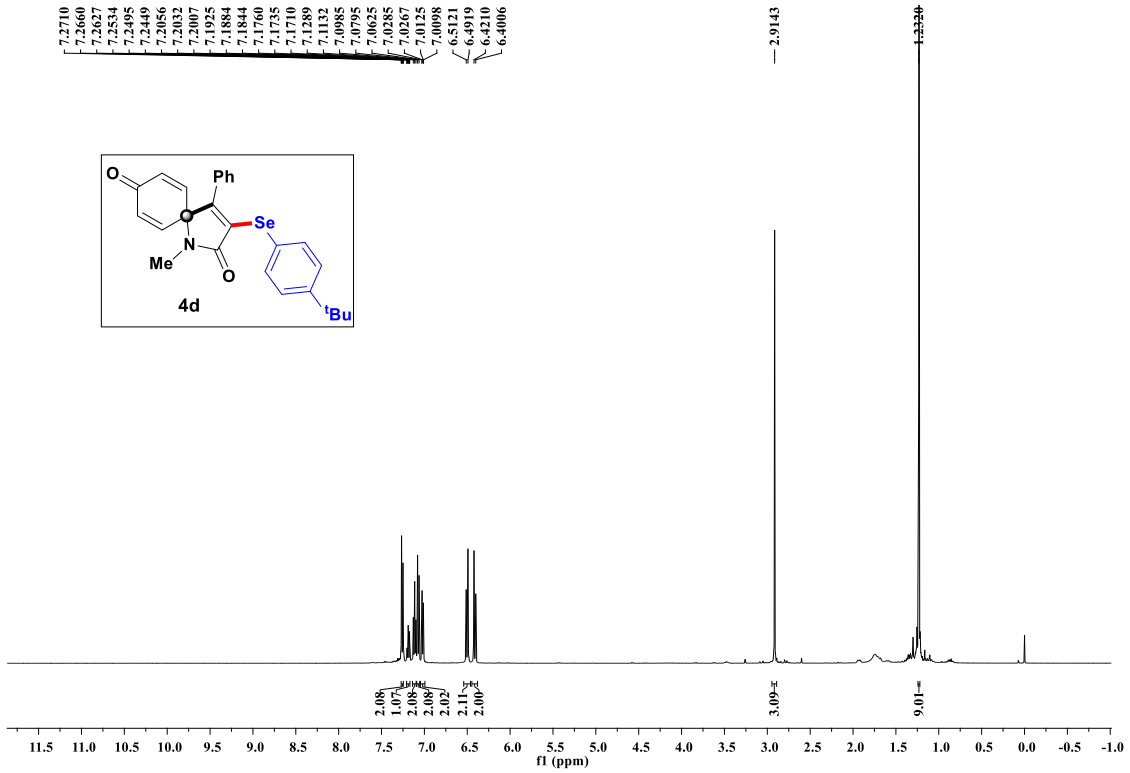
153.2601
145.2629
144.4814
134.5687
133.1547
131.2495
130.6764
129.3439
128.7260
128.2108
128.1776
123.3024
77.4779
77.1600
76.8423
69.2183
28.5947
26.5201
15.5286
O
Ph
Se
N
Me
O
4c
Et
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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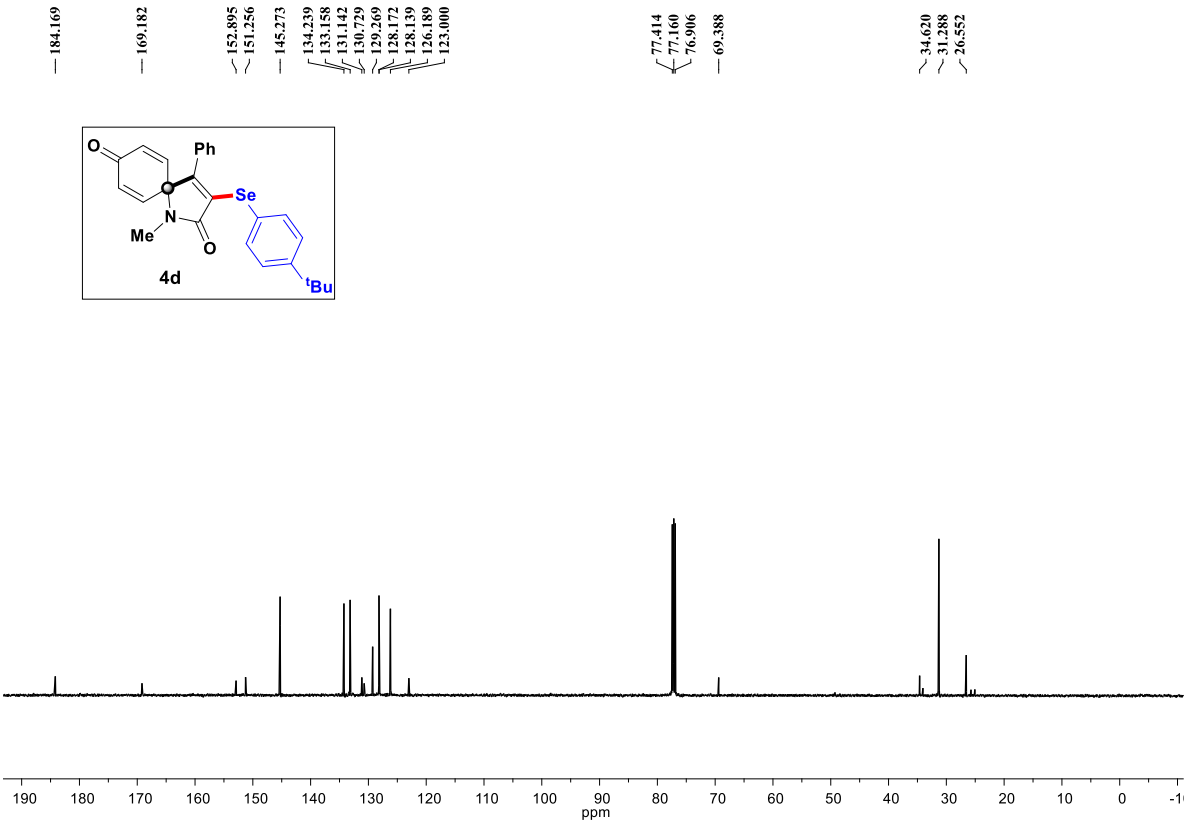
7.2627
7.2534
7.2495
7.2449
7.2056
7.2032
7.2007
7.1925
7.1884
7.1844
7.1760
7.1735
7.1710
7.1289
7.1132
7.0985
7.0795
7.0625
7.0285
7.0267
7.0125
7.0098
6.5121
6.4919
6.4210
6.4006
2.9143
1.3320
O
Ph
Se
N
Me
O
4d
tBu
2.08
1.07
2.08
2.08
2.07
2.11
2.00
3.09
9.01
11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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152.895
151.256
145.273
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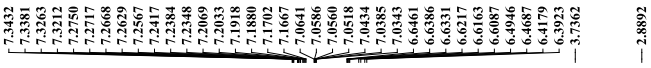
133.158
131.142
130.729
129.269
128.172
128.139
126.189
123.000
77.414
77.160
76.906
69.388
34.620
31.288
26.552
O
Ph
Se
N
Me
O
4d
tBu
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
ppm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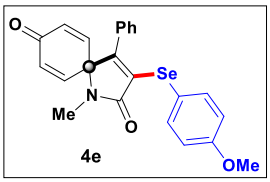
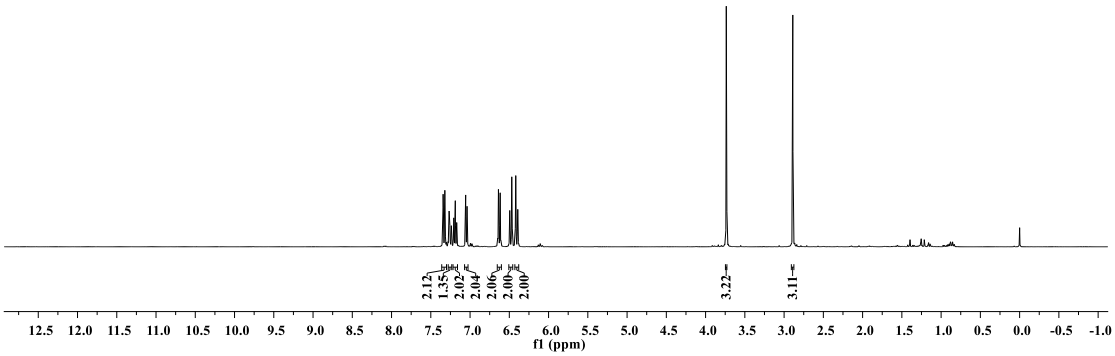
7.3263
7.3212
7.2750
7.2717
7.2668
7.2629
7.2567
7.2417
7.2384
7.2348
7.2069
7.2033
7.1918
7.1880
7.1702
7.1667
7.0641
7.0586
7.0560
7.0518
7.0434
7.0385
7.0343
6.6461
6.6386
6.6331
6.6217
6.6163
6.6087
6.4946
6.4687
6.4179
6.3923
3.7362
2.8892


O
Ph
Se
N
Me
O
4e
OMe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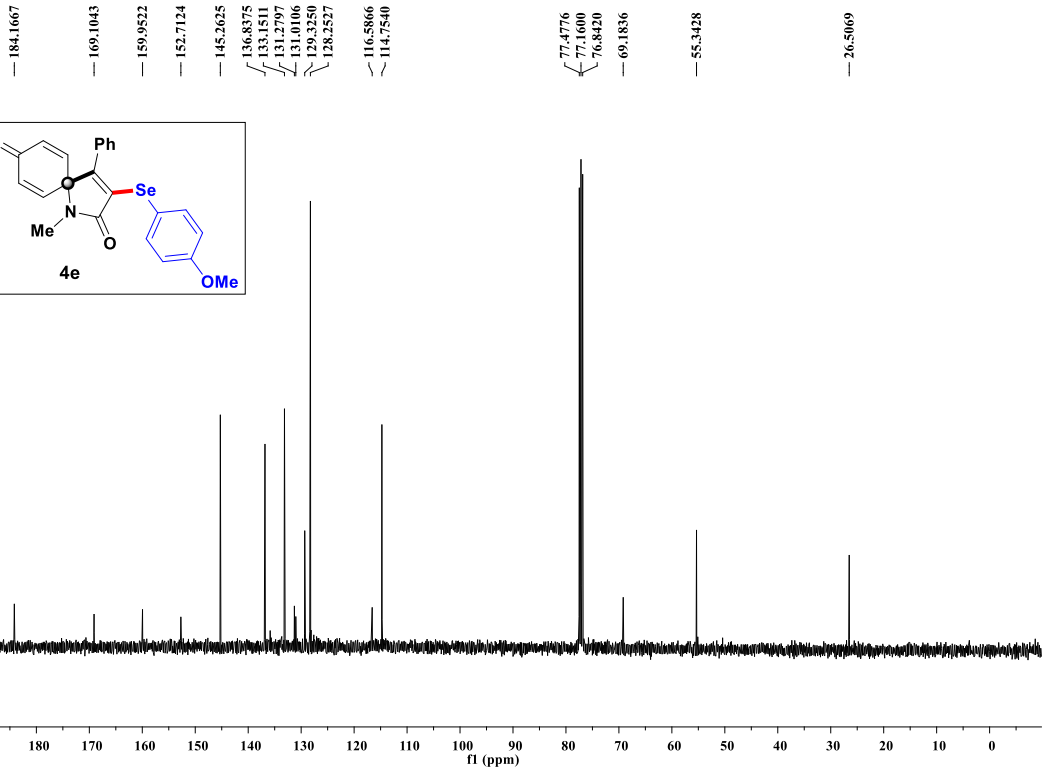
1.35
2.02
2.04
2.06
2.00
2.00
3.22
3.11
12.5 12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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145.2625
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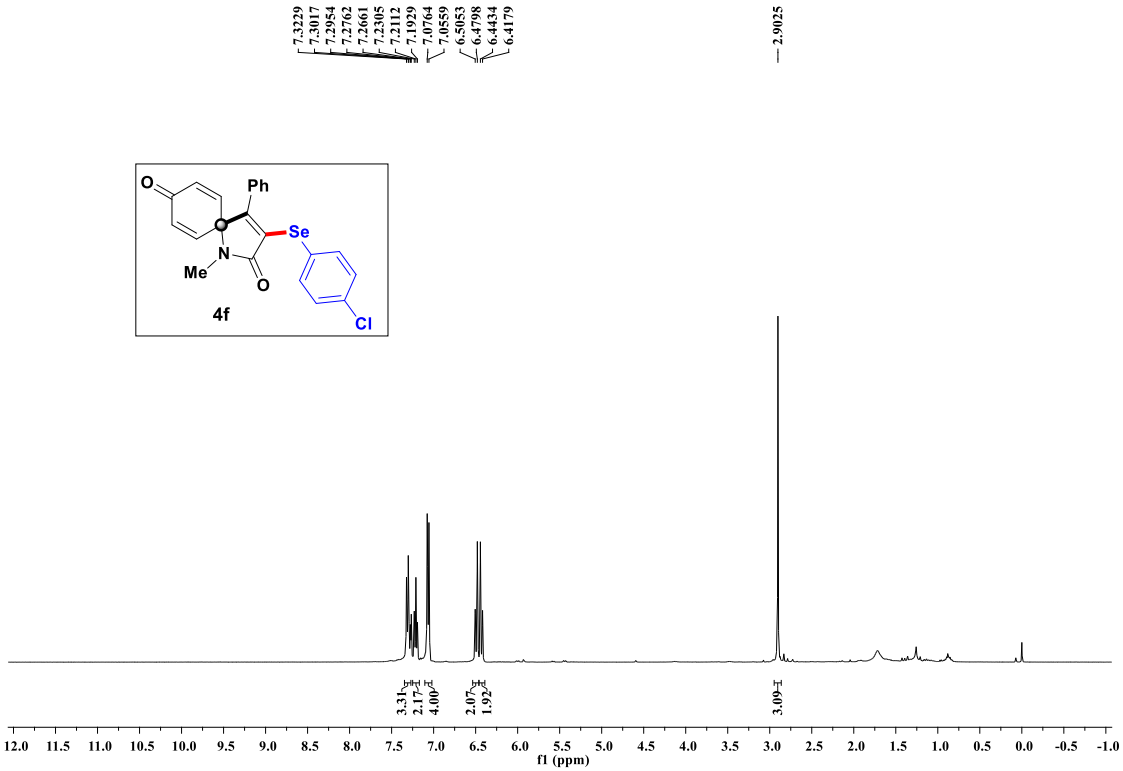
131.2797
131.0106
129.3250
128.2527
116.5866
114.7540
77.4776
77.1600
76.8420
69.1836
55.3428
26.5069
O
Ph
Se
N
Me
O
4e
OMe
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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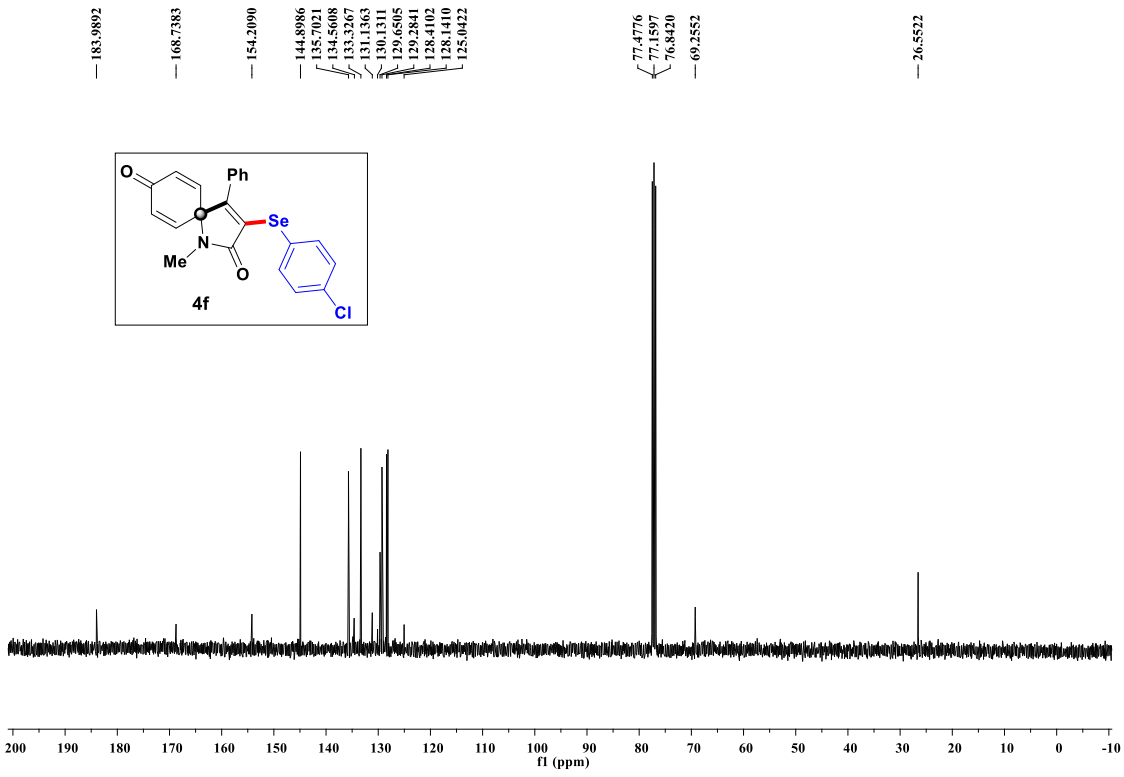
7.2112
7.1929
7.0764
7.0559
6.5053
6.4798
6.4434
6.4179
2.9025
O
Ph
Se
N
Me
O
4f
Cl
3.31
2.17
4.00
2.07
1.92
3.09
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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135.7021
134.5608
133.3267
131.1363
130.1311
129.6505
129.2841
128.4102
128.1410
125.0422
77.4776
77.1597
76.8420
69.2552
26.5522
O
Ph
Se
N
Me
O
4f
Cl
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.3210
7.3077
7.3023
7.2974
7.2869
7.2838
7.2809
7.2668
7.2594
7.2534
7.2373
7.2295
7.2258
7.2183
7.2147
7.2040
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7.0708
7.0530
7.0496
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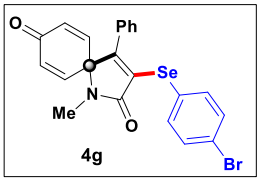
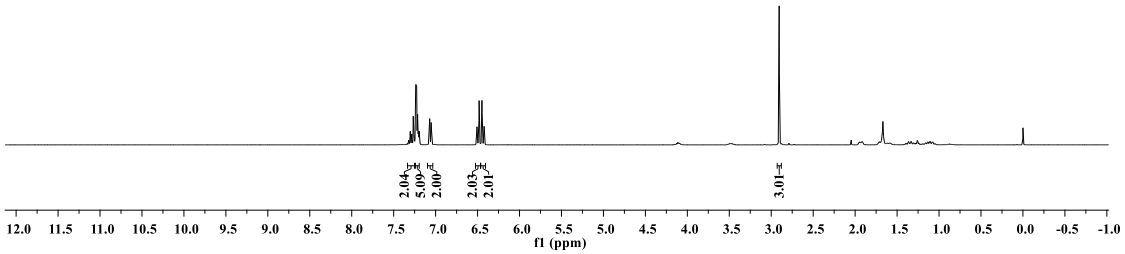
6.4814
6.4476
6.4218
2.9052


O
Ph
Se
N
Me
O
4g
Br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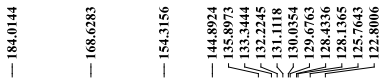
5.09
2.00
2.03
2.01
3.01
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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135.8973
133.3444
132.2245
131.1118
130.0354
129.6763
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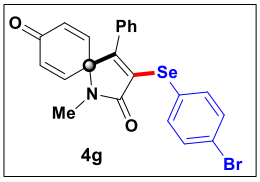
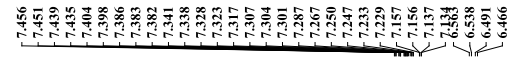
128.1365
125.7643
122.8006
77.4774
77.1601
76.8422
69.2652
26.5737


O
Ph
Se
N
Me
O
4g
Br

200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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7.323
7.317
7.307
7.304
7.301
7.287
7.267
7.250
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7.156
7.137
7.134
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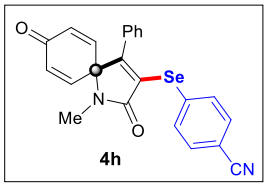
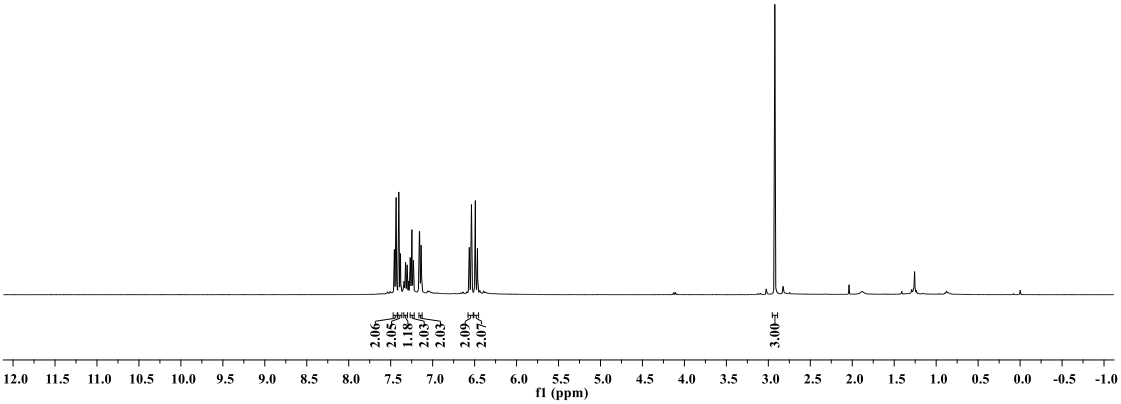
6.491
6.466
2.923


O
Ph
Se
N
Me
O
CN
4h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2.05
1.18
2.03
2.03
2.09
2.07
3.00
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


183.702
168.121
156.577
144.435
133.415
132.849
132.274
130.012
128.491
127.891
127.382
111.107
77.479
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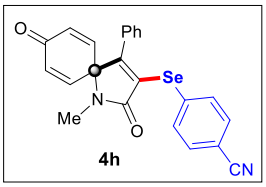
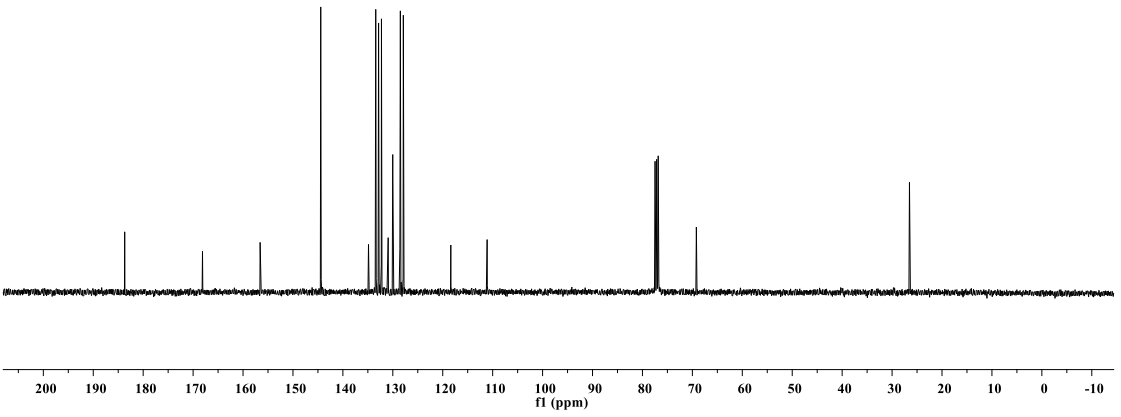
69.202
26.521


O
Ph
Se
N
Me
O
CN
4h


200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.290
7.288
7.280
7.275
7.271
7.268
7.261
7.259
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7.210
7.199
7.196
7.168
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7.152
7.109
7.098
7.094
7.082
7.078
7.066
7.055
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7.047
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7.033
7.030
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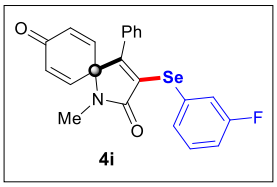
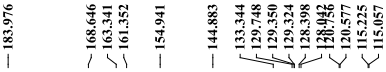
6.458
6.438
2.917


O
Ph
Se
N
Me
O
F
4i

1.11
2.10
1.07
3.08
0.98
1.00
2.09
2.05
3.00
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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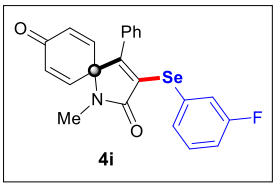
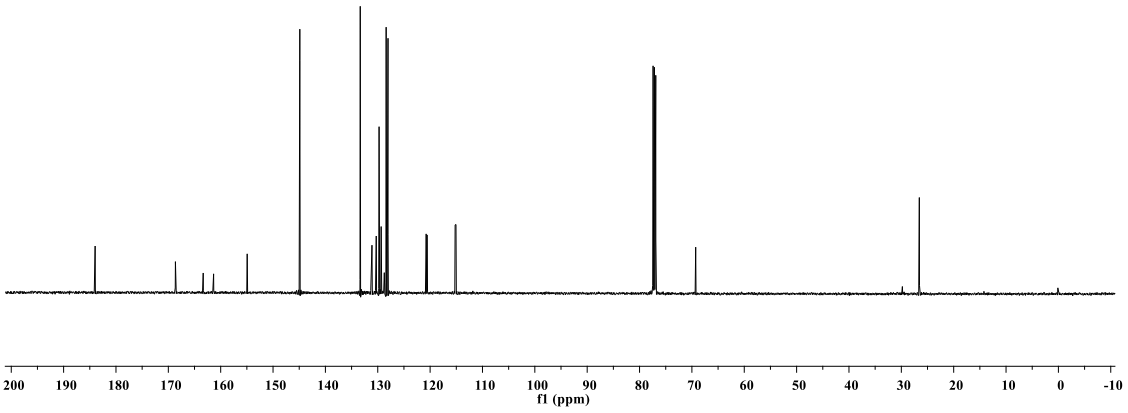
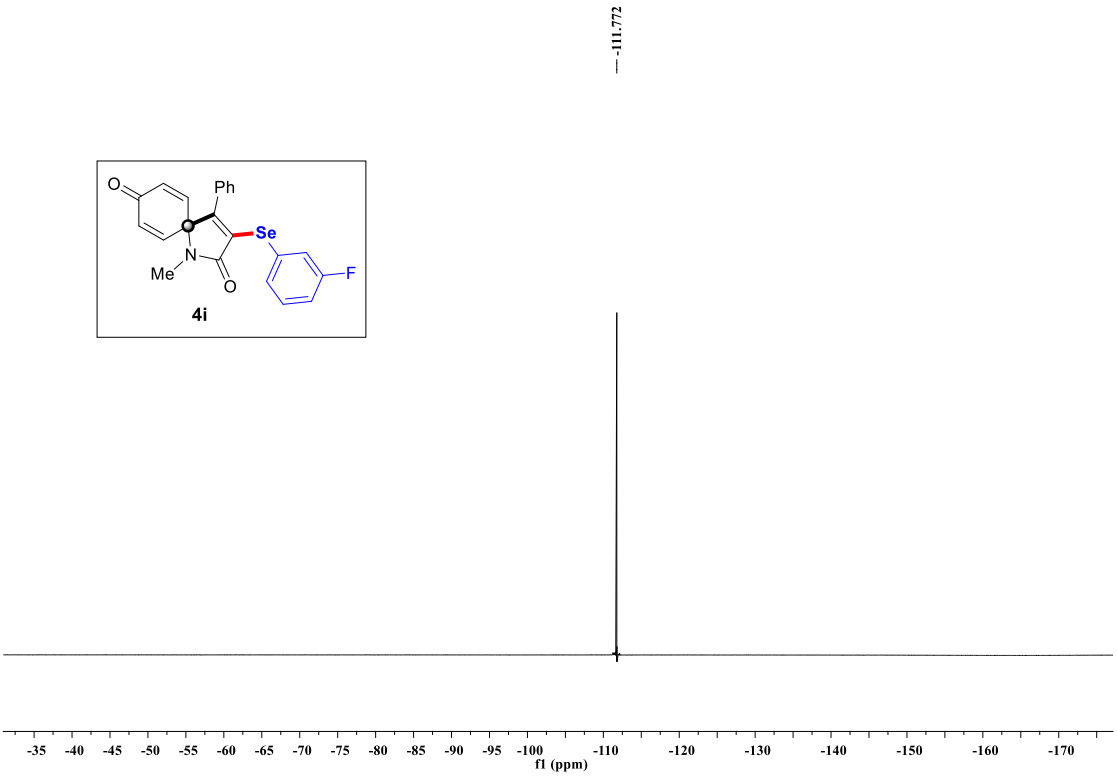
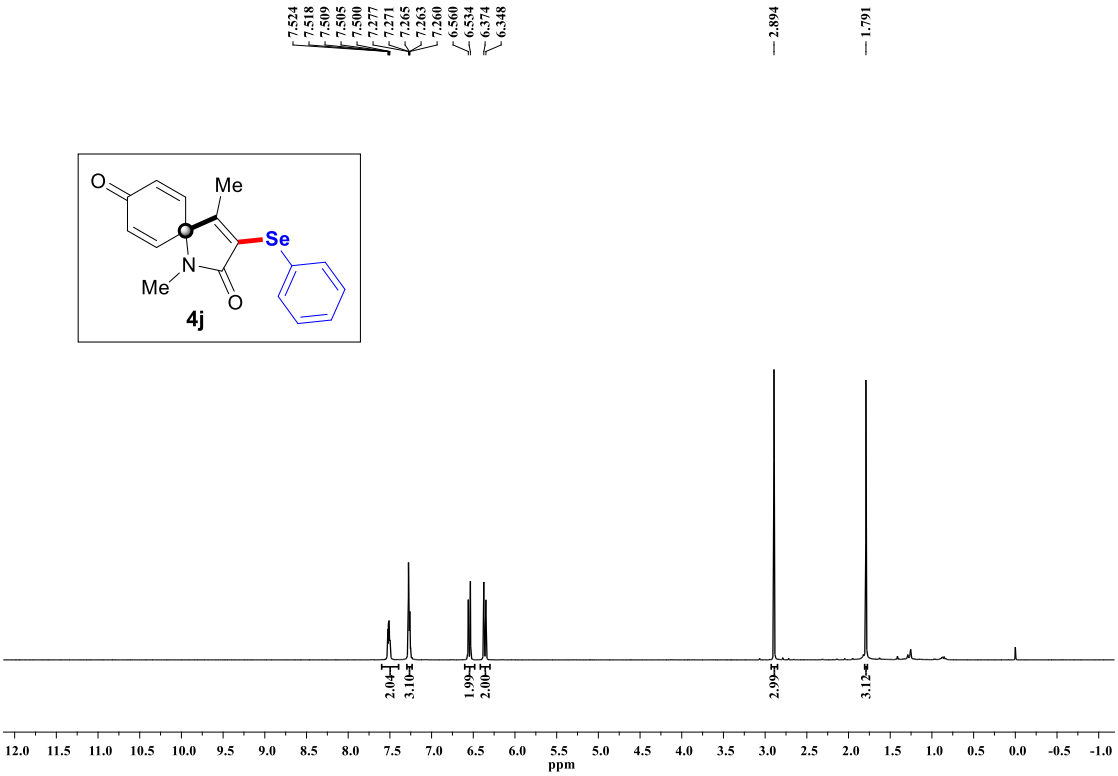
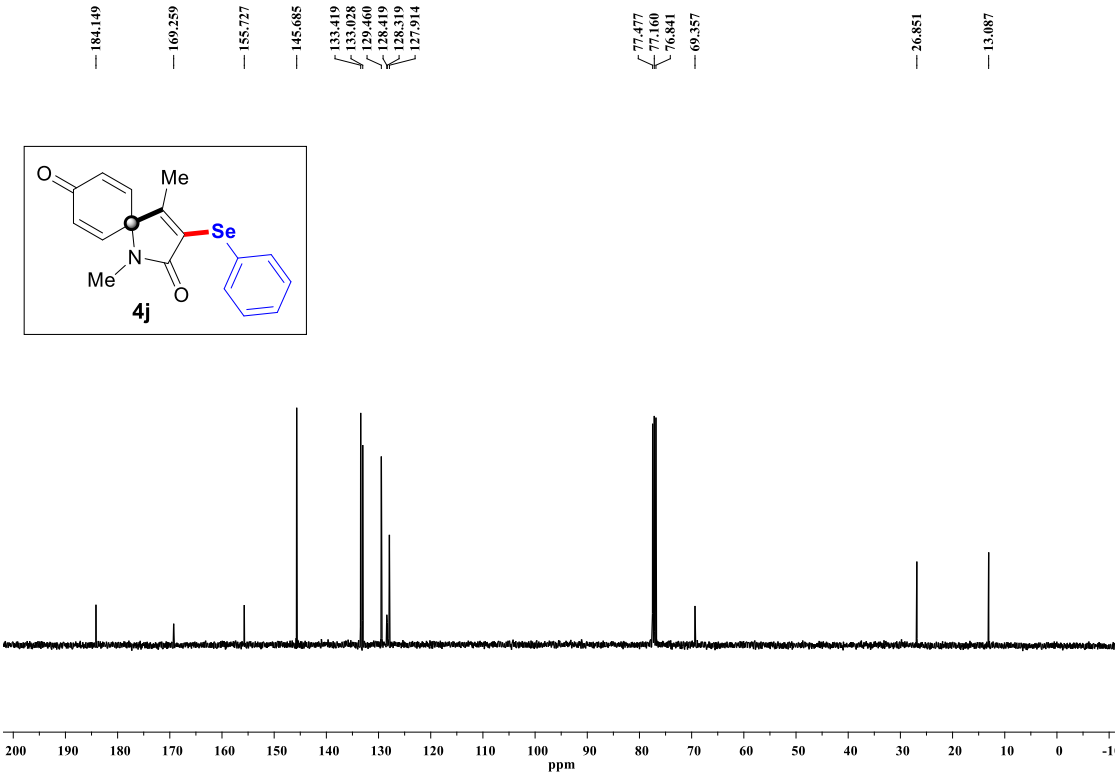
168.646
163.341
161.352
154.941
144.883
133.344
129.748
129.350
129.324
128.398
120.577
115.225
115.057
77.414
77.160
76.906
69.275
26.566

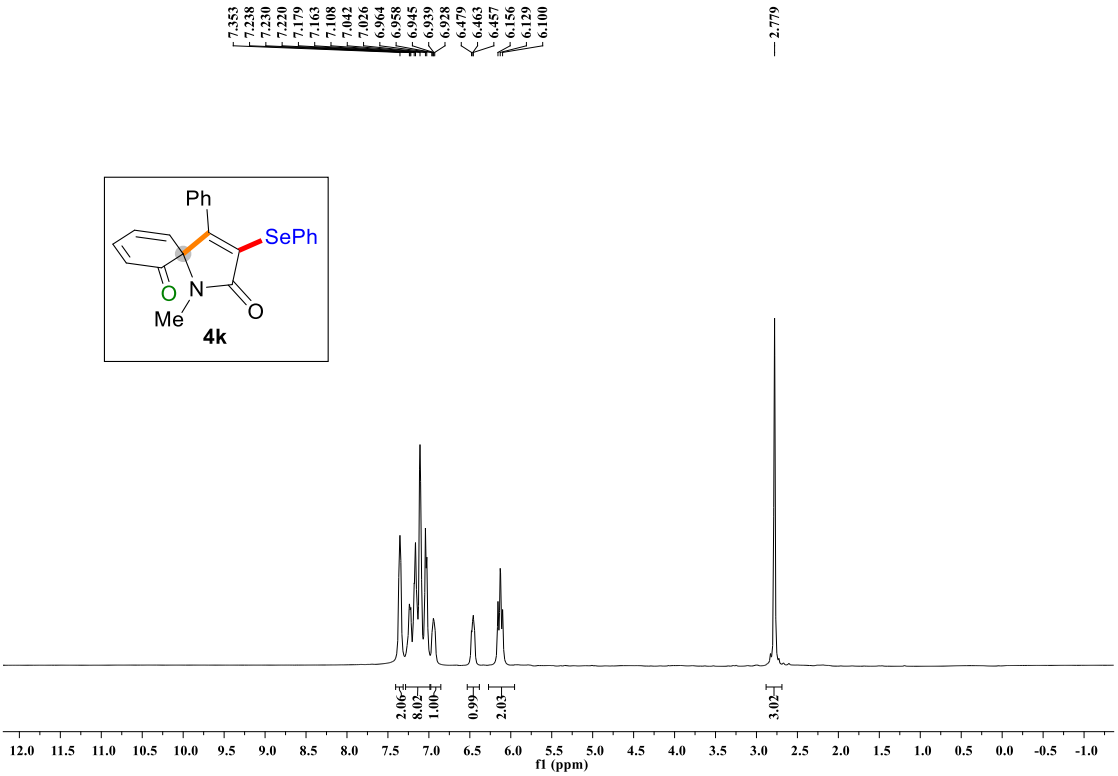

O
Ph
Se
N
Me
O
F
4i

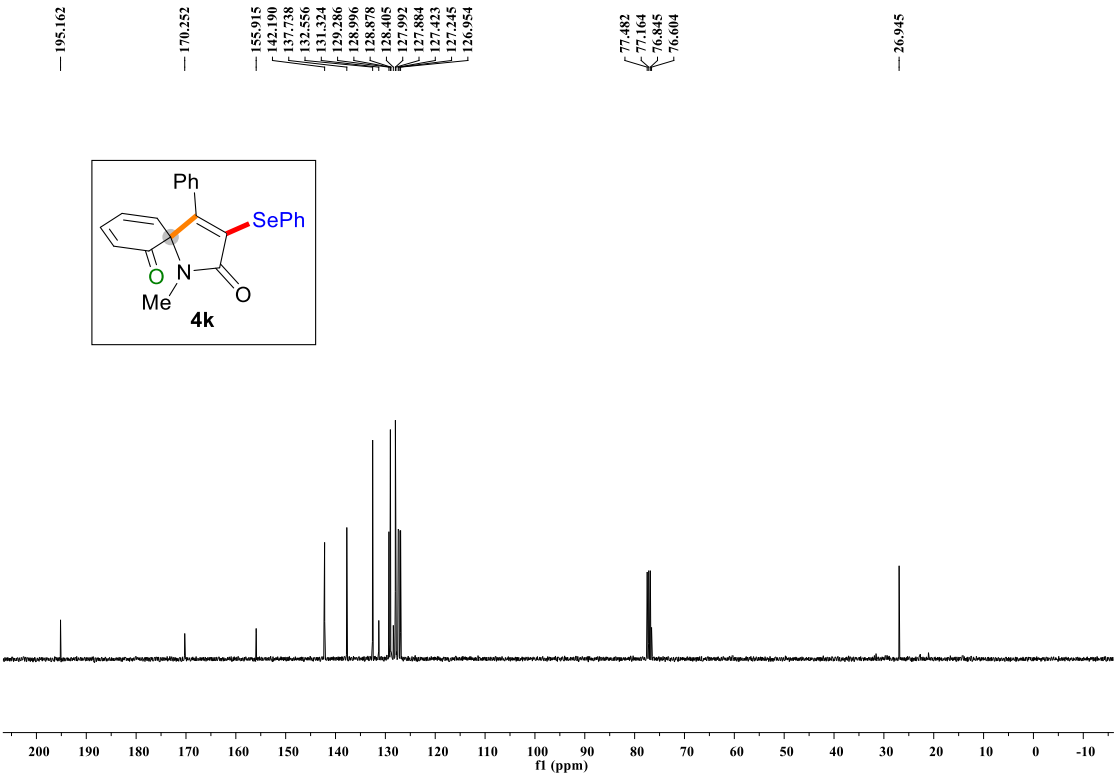

200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

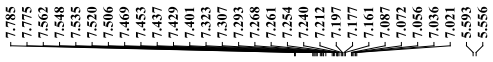

-111.772
O
Ph
Se
N
Me
O
F
4i
-35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85 -90 -95 -100 -110 -120 -130 -140 -150 -160 -170
f1 (ppm)

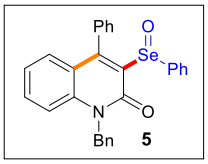

7.524
7.518
7.509
7.505
7.500
7.277
7.271
7.265
7.263
7.260
6.560
6.534
6.374
6.348
2.894
1.791
O
Me
Se
N
Me
O
4j
2.04
3.10
1.99
2.00
2.99
3.12
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
ppm

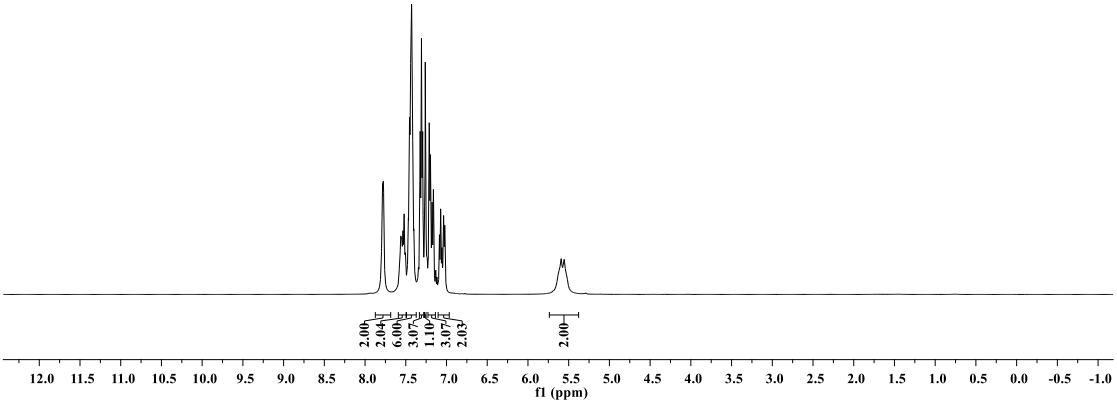

184.149
169.259
155.727
145.685
133.419
133.028
129.460
128.419
128.319
127.914
77.477
77.160
76.841
69.357
26.851
13.087
O
Me
Se
N
Me
O
4j
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
ppm

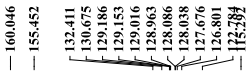

7.353
7.238
7.230
7.220
7.179
7.163
7.108
7.042
7.026
6.964
6.958
6.945
6.939
6.928
6.479
6.463
6.457
6.156
6.129
6.100
2.779
Ph
SePh
O
N
Me
O
4k
2.06
8.02
1.00
0.99
2.03
3.02
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

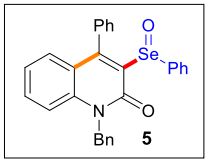

195.162
170.252
155.915
142.190
137.738
132.556
131.324
129.286
128.996
128.878
128.405
127.992
127.884
127.423
127.245
126.954
77.482
77.164
76.845
76.604
26.945
Ph
SePh
O
N
Me
O
4k
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

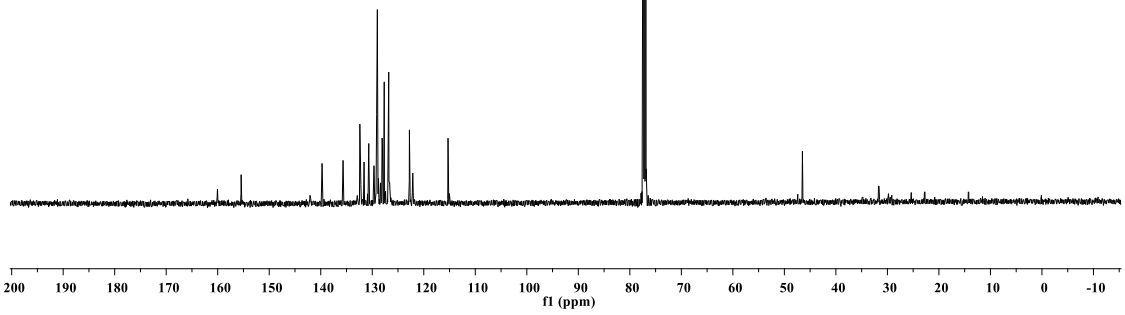

7.785
7.775
7.562
7.548
7.535
7.520
7.506
7.469
7.453
7.437
7.429
7.401
7.323
7.307
7.293
7.268
7.261
7.254
7.240
7.212
7.197
7.177
7.161
7.087
7.072
7.056
7.036
7.021
5.593
5.556


Ph
O
Se
Ph
N
O
Bn
5


2.00
2.04
6.00
3.07
1.10
3.07
2.03
2.00
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


160.046
155.452
132.411
130.675
129.186
129.153
129.016
128.963
128.086
128.038
127.676
126.801
77.414
77.160
76.905
46.494


Ph
O
Se
Ph
N
O
Bn
5


200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)