Supporting Information

An Efficient Approach to AviCys Analogues via Regio- and Stereoselective Hydrosulfuration of Ynamides

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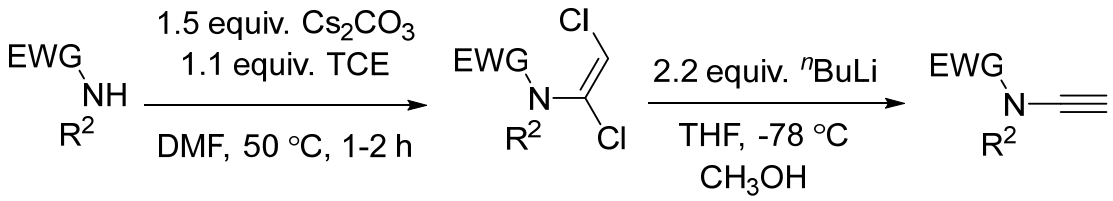
1. General remarks：

All reactions were carried out in oven-dried glassware. All the reactions were monitored by thin-layer chromatography (TLC); All reagents and solvents were obtained from commercial sources. Starting material thiol compounds **2** were purchased from commercial sources. Starting material ynamides were synthesized according literature. Products purification was done using silica gel column chromatography. $^{1}H/^{13}C$ NMR, in $CDCl_3$ unless otherwise stated, using either TMS or the undeuterated solvent residual signal as the reference. ^{1}H NMR spectra were recorded in $CDCl_3$ and referenced to residual $CHCl_3$ at 7.26 ppm, and ^{13}C NMR spectra were referenced to the central peak of $CDCl_3$ at 77.0 ppm. Data for ^{1}H NMR are reported in terms of chemical shift (δ), integration, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet), broad peaks (br), coupling constants (Hz), and assignment. Data for ^{13}C NMR are reported in terms of chemical shift, multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet), and coupling constants (Hz), and no special nomenclature is used for equivalent carbons. High-resolution mass spectra (HRMS) were obtained by the electrospray ionization time-of-flight (ESI-TOF) mass spectrometry. Flash column chromatography purification of compounds was carried out by gradient elution using ethyl acetate (EA) in light petroleum ether (PE).

2. General procedure for the preparation of starting ynamides



General procedure A [1]

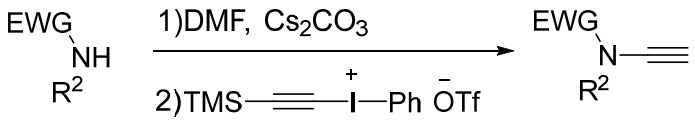
2.1: General procedure for the Cs_2CO_3 promoted synthesis of 1,2-dichloroenamides.

To a stirring suspension of amide (1.0 equiv.), Cs_2CO_3 (1.5 equiv.) and DMF (0.75 mL/mmol of amide substrate), at 50 °C, was added trichloroethylene (1.1 equiv.) dropwise over 10 minutes. The resulting mixture was stirred at 50 ºC until reaction completion, as analysed by TLC (1-2 h). Upon cooling to room temperature, the mixture was partitioned between EtOAc and H_2O (roughly 2:1 of EtOAc:H_2O), the organic layer was separated and further washed with water (×3). The organic layer was then dried (Na_2SO_4), filtered and concentrated in vacuo. Purification was then performed as described for each compound. Note: The use of an inert atmosphere or rigorously dried solvent is not necessary for this transformation.

2.2: General procedure for the synthesis of ynamides using *n*-butyllithium.

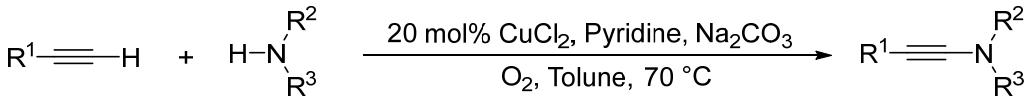
To an oven-dried, argon flushed flask was added 1,2-dichloroenamide (1.0 equiv.) and anhydrous THF (4 mL/mmol of enamide substrate), and cooled to -78 °C whilst stirring. A solution of *n*-butyllithium (2.5 M solution in hexanes, 1.2 equiv.) was then added dropwise over 10 minutes, such that the reaction does not exceed -70 °C, and the resulting mixture was then stirred at-78 °C for 5 minutes, followed by warming to -41 °C for 30 minutes. Upon cooling to -78 °C, another portion of *n*-butyllithium (2.5 M solution in hexanes, 1.0 equiv.) was added dropwise over 10 minutes, and stirred for a further 10 minutes. Next, the electrophile (1.2 equiv.) was added at -78 °C and the stirring mixture was allowed to warm to room temperature. Upon reaction completion, as analysed by TLC (~ 1 h), the reaction mixture was quenched with water, followed by extraction with Et_2O (×2). The organic extracts were combined and dried (Na_2SO_4), filtered and concentrated in vacuo. Purification was then performed as described for each compound.

General procedure B [2]



Cs_2CO_3 (1.5 equiv.) was added to a solution of amide (1.0 equiv.) in absolute toluene under argon at 0 °C. Stirred for a further 2 hours. After the mixture was allowed to warm to room temperature, iodonium salt **2** (1.1 equiv.) was added in small portions. The reaction mixture was stirred for 12 h and then filtered through a plug of silica gel. Purification by column chromatography.

General procedure C [3]



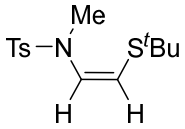
Adding acetylene substrate (1.0 equiv.), $CuCl_2$ (0.2 equiv.), pyridine(2.0 equiv.), Na_2CO_3(2.0 equiv.), and toluene in turn into a schlenk flask, adding an atmospheric pressure of oxygen, using a peristaltic pump to add the amide (5.0 equiv.). TLC monitoring the reaction, after the reaction, removing the toluene. Purifying the products by chromatographic column.

3. General experimental procedure:

To an oven-dried Schlenk tube equipped with a magnetic stir bar was added ynamides (0.2 mmol), Cs_2CO_3 (1.5 equiv.), thiols or thiophenols (0.4 mmol) in *i*-propanol (1.0 mL). The solution was heated at 35 °C and monitored by TLC. Upon the reaction completion, the residue was purified by silica gel chromatography to afford the desired products.

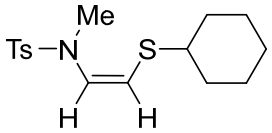
4. Characterization of products:

(Z)-N-(2-(tert-butylthio)vinyl)-N,4-dimethylbenzenesulfonamide (3a)



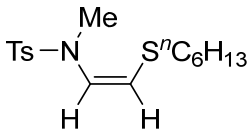
White solid, (57.4 mg, yield 96%); R_f = 0.2 (PE/EA = 10:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, *J* = 8.2 Hz, 2H), 7.31 (d, *J* = 8.0 Hz, 2H), 6.28 (d, *J* = 8.0 Hz, 1H), 5.73 (d, *J* = 8.0 Hz, 1H), 3.08 (s, 3H), 2.42 (s, 3H), 1.31 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.7, 134.9, 129.7, 127.4, 126.2, 113.8, 44.4, 36.0, 30.7, 21.6. HRMS (ESI) m/z calcd. for $C_{14}H_{22}NO_2S_2^+$ $[M + H]^+$: 300.1086, found: 300.1096.

(Z)-N-(2-(cyclohexylthio)vinyl)-N,4-dimethylbenzenesulfonamide (3b)



White solid, (60.5 mg, yield 93%); R_f = 0.2 (PE/EA = 10:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, *J* = 8.3 Hz, 2H), 7.30 (d, *J* = 8.0 Hz, 2H), 6.16 (d, *J* = 7.8 Hz, 1H), 5.65 (d, *J* = 7.8 Hz, 1H), 3.06 (s, 3H), 2.78 – 2.67 (m, 1H), 2.42 (s, 3H), 1.99 – 1.89 (m, 2H), 1.72 (dt, *J* = 6.8, 3.3 Hz, 2H), 1.40 – 1.16 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.6, 134.9, 129.6, 127.4, 125.1, 116.8, 46.7, 35.7, 33.5, 25.9, 25.6, 21.6. HRMS (ESI) m/z calcd. for $C_{16}H_{23}NNaO_2S_2^+$ $[M + Na]^+$: 348.1062, found: 348.1073.

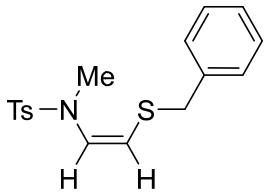
(Z)-N-(2-(hexylthio)vinyl)-N,4-dimethylbenzenesulfonamide (3c)



White solid, (61.5 mg, yield 94%); R_f = 0.2 (PE/EA = 10:1); ^{1}H NMR (400 MHz, $CDCl_3$)

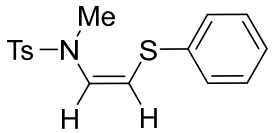
δ 7.69 (d, *J* = 8.2 Hz, 2H), 7.30 (d, *J* = 8.0 Hz, 2H), 6.13 (d, *J* = 7.7 Hz, 1H), 5.58 (d, *J* = 7.7 Hz, 1H), 3.06 (s, 3H), 2.60 (t, *J* = 7.4 Hz, 2H), 2.42 (s, 3H), 1.56 (dt, *J* = 14.9, 7.3 Hz, 2H), 1.31 (m, 8H), 0.87 (t, *J* = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.7, 134.9, 129.7, 127.4, 124.8, 119.0, 35.6, 34.8, 31.3, 30.0, 28.1, 22.5, 21.5, 14.0. HRMS (ESI) m/z calcd. for $C_{16}H_{25}NNaO_2S_2^+$ $[M + Na]^+$: 350.1219, found: 350.1229.

(Z)-N-benzyl-N-(2-(tert-butylthio)vinyl)-4-methylbenzenesulfonamide (3d)



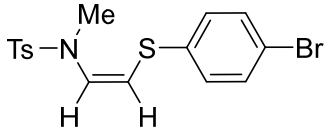
White solid, (57.9 mg, yield 87%); R_f = 0.2 (PE/EA =10:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, *J* = 8.3 Hz, 2H), 7.32 – 7.22 (m, 7H), 6.16 (d, *J* = 7.8 Hz, 1H), 5.53 (d, *J* = 7.8 Hz, 1H), 3.80 (s, 2H), 3.00 (s, 3H), 2.41 (s, 3H).^{13}C NMR (100 MHz, $CDCl_3$) δ 143.7, 137.3, 134.7, 129.7, 128.8, 128.6, 127.3, 127.3, 125.8, 116.1, 38.7, 35.6, 21.5. HRMS (ESI) m/z calcd. for $C_{17}H_{19}NNaO_2S_2^+$ $[M + Na]^+$: 356.0749, found: 356.0757.

(Z)-N,4-dimethyl-N-(2-(phenylthio)vinyl)benzenesulfonamide (3e)



White solid, (59.9 mg, yield 94%); R_f = 0.2 (PE/EA = 10:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (d, *J* = 8.2 Hz, 2H), 7.33 (d, *J* = 8.0 Hz, 2H), 7.29 (d, *J* = 4.3 Hz, 4H), 7.22 (dq, *J* = 8.5, 4.3 Hz, 1H), 6.45 (d, *J* = 7.8 Hz, 1H), 5.79 (d, *J* = 7.8 Hz, 1H), 3.16 (s, 3H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.0, 135.9, 134.8, 129.8, 129.1, 128.9, 128.2, 127.4, 126.7, 113.6, 35.8, 21.6. HRMS (ESI) m/z calcd. for $C_{16}H_{18}NO_2S_2^+$ $[M + H]^+$: 320.0773, found: 320.0783.

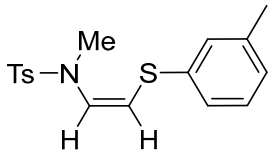
(Z)-N-(2-((4-bromophenyl)thio)vinyl)-N,4-dimethylbenzenesulfonamide (3f)



White solid, (72.0 mg, yield 91%); R_f = 0.2 (PE/EA = 20:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.1 Hz, 2H), 7.38 (d, *J* = 8.3 Hz, 2H), 7.33 (d, *J* = 8.0 Hz, 2H), 7.13 (d, *J* = 8.3 Hz, 2H), 6.49 (d, *J* = 7.8 Hz, 1H), 5.70 (d, *J* = 7.8 Hz, 1H), 3.13 (s, 3H), 2.43 (s,

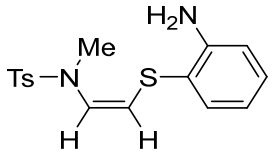
3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.1, 135.3, 134.5, 132.1, 130.1, 129.8, 129.3, 127.3, 120.4, 111.8, 35.8, 21.5. HRMS (ESI) m/z calcd. for $C_{16}H_{16}BrNNaO_2S_2^+$ [M + Na]$^+$: 419.9698, found: 419.9703.

(Z)-N,4-dimethyl-N-(2-(m-tolylthio)vinyl)benzenesulfonamide (3g)



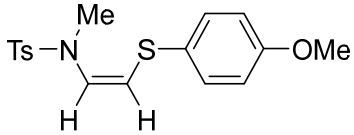
White solid, (63.9 mg, yield 96%); R_f = 0.2 (PE/EA = 20:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (d, *J* = 8.1 Hz, 2H), 7.32 (d, *J* = 7.9 Hz, 2H), 7.27 – 7.23 (m, 1H), 7.13 (m, 3H), 6.47 (d, *J* = 7.8 Hz, 1H), 5.66 (d, *J* = 7.8 Hz, 1H), 3.17 (s, 3H), 2.43 (s, 3H), 2.31 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.9, 137.6, 134.8, 134.7, 130.3, 129.8, 129.4, 128.3, 127.3, 126.9, 126.7, 113.7, 35.7, 21.5, 20.3. HRMS (ESI) m/z calcd. for $C_{16}H_{16}BrNNaO_2S_2^+$ [M + H]$^+$: 334.0940, found: 334.0930.

(Z)-N-(2-((2-aminophenyl)thio)vinyl)-N,4-dimethylbenzenesulfonamide (3h)



White solid, (60.1 mg, yield 90%); R_f = 0.2 (PE/EA = 10:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 8.3 Hz, 2H), 7.33 (d, *J* = 8.0 Hz, 2H), 7.28 (m, 1H), 7.13 (m, 1H), 6.77 – 6.62 (m, 2H), 6.08 (d, *J* = 7.4 Hz, 1H), 5.67 (d, *J* = 7.4 Hz, 1H), 4.23 (s, 2H), 3.10 (s, 3H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.7, 143.9, 134.8, 134.4, 130.3, 129.7, 127.5, 125.9, 121.2, 118.5, 116.5, 115.3, 36.3, 21.5. HRMS (ESI) m/z calcd. for $C_{16}H_{18}N_2NaO_2S_2^+$ [M + Na]$^+$: 357.0702, found: 357.0704.

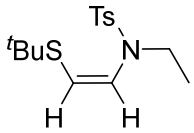
(Z)-N-(2-((4-methoxyphenyl)thio)vinyl)-N,4-dimethylbenzenesulfonamide (3i)



White solid, (66.3 mg, yield 95%); R_f = 0.2 (PE/EA = 20:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (d, *J* = 8.3 Hz, 2H), 7.35 – 7.30 (m, 2H), 7.29 – 7.23 (m, 2H), 6.83 (d, *J* = 8.8 Hz, 2H), 6.21 (d, *J* = 7.7 Hz, 1H), 5.77 (d, *J* = 7.6 Hz, 1H), 3.78 (s, 3H), 3.12 (s, 3H), 2.43 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.2, 143.8, 134.6, 132.1, 129.7, 127.3, 125.9, 125.8, 118.3, 114.8, 55.3, 35.9, 21.5. HRMS (ESI) m/z calcd. for

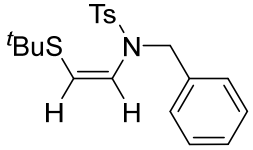
$C_{17}H_{19}NNaO_3S_2^+$ [M + Na]$^+$: 372.0699, found: 372.0710.

(Z)-N-(2-(tert-butylthio)vinyl)-N-ethyl-4-methylbenzenesulfonamide (4a)



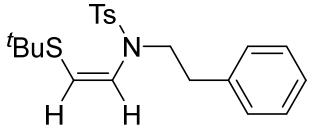
White solid, (57.0 mg, yield 91%); R_f = 0.2 (PE/EA = 20:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.2 Hz, 2H), 7.27 (d, *J* = 8.1 Hz, 2H), 6.04 (d, *J* = 7.8 Hz, 1H), 5.94 (d, *J* = 7.7 Hz, 1H), 3.48 (q, *J* = 7.1 Hz, 2H), 2.41 (s, 3H), 1.32 (s, 9H), 1.12 (t, *J* = 7.1 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.3, 136.5, 129.5, 127.2, 123.1, 118.4, 44.1, 43.2, 30.7, 21.5, 14.0. HRMS (ESI) m/z calcd. for $C_{15}H_{23}NNaO_2S_2^+$ [M + Na]$^+$: 336.1062, found: 336.1064.

(Z)-N-benzyl-N-(2-(tert-butylthio)vinyl)-4-methylbenzenesulfonamide (4b)



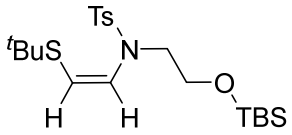
White solid, (69.0 mg, yield 92%); R_f = 0.2 (PE/EA = 20:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (d, *J* = 8.2 Hz, 2H), 7.33 – 7.22 (m, 7H), 5.96 (d, *J* = 7.4 Hz, 1H), 5.90 (d, *J* = 7.4 Hz, 1H), 4.60 (s, 2H), 2.42 (s, 3H), 1.20 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.4, 136.4, 136.4, 129.5, 128.2, 128.2, 127.4, 127.4, 123.3, 121.9, 51.9, 44.2, 30.7, 21.5. HRMS (ESI) m/z calcd. for $C_{20}H_{25}NNaO_2S_2^+$ [M + Na]$^+$: 398.1229, found: 398.1227.

(Z)-N-(2-(tert-butylthio)vinyl)-4-methyl-N-phenethylbenzenesulfonamide (4c)



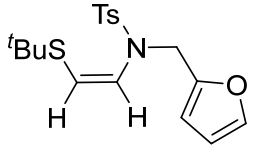
White solid, (75.5 mg, yield 97%); R_f = 0.2 (PE/EA = 20:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, *J* = 8.2 Hz, 2H), 7.28 – 7.15 (m, 7H), 6.15 (d, *J* = 7.8 Hz, 1H), 5.91 (d, *J* = 7.8 Hz, 1H), 3.68 – 3.61 (m, 2H), 2.91 – 2.83 (m, 2H), 2.39 (s, 3H), 1.33 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.4, 138.6, 136.4, 129.6, 129.0, 128.4, 127.2, 126.4, 123.5, 117.4, 49.6, 44.4, 35.3, 30.8, 21.5. HRMS (ESI) m/z calcd. for $C_{21}H_{27}NNaO_2S_2^+$ [M + Na]$^+$: 412.1375, found: 412.1382.

(Z)-N-(2-((tert-butyldimethylsilyl)oxy)ethyl)-N-(2-(tert-butylthio)vinyl)-4-methyl benzenesulfonamide (4d)



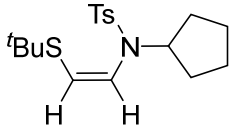
White solid, (80.6 mg, yield 91%); R_f = 0.2 (PE/EA = 20:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, *J* = 7.9 Hz, 2H), 7.22 (d, *J* = 7.9 Hz, 2H), 6.04 (d, *J* = 7.6 Hz, 1H), 5.89 (d, *J* = 7.6 Hz, 1H), 3.70 (t, *J* = 7.0 Hz, 2H), 3.48 (t, *J* = 7.0 Hz, 2H), 2.36 (s, 3H), 1.26 (s, 9H), 0.83 (s, 9H), 0.00 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.3, 136.4, 129.5, 127.2, 123.7, 119.2, 61.3, 50.0, 44.1, 30.7, 25.9, 21.5, 18.2, -5.4. HRMS (ESI) m/z calcd. for $C_{21}H_{37}NNaO_3S_2Si^+$ $[M + Na]^+$: 466.1876, found: 466.1885.

(Z)-N-(2-(tert-butylthio)vinyl)-N-(furan-2-ylmethyl)-4-methylbenzenesulfon-amide (4e)



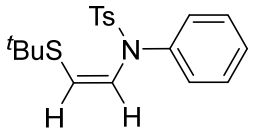
White solid, (70.0 mg, yield 96%); R_f = 0.2 (PE/EA = 20:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 – 7.64 (m, 2H), 7.27 – 7.24 (m, 2H), 6.23 (dt, *J* = 6.9, 2.5 Hz, 2H), 6.06 (d, *J* = 7.2 Hz, 1H), 5.93 (d, *J* = 7.2 Hz, 1H), 4.67 (s, 2H), 2.40 (s, 3H), 1.28 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.9, 143.4, 142.1, 136.2, 129.4, 127.5, 123.0, 122.7, 110.2, 108.9, 44.7, 44.1, 30.7, 21.5. HRMS (ESI) m/z calcd. for $C_{18}H_{23}NNaO_3S_2^+$ $[M + Na]^+$: 388.1012, found: 388.1022.

(Z)-N-(2-(tert-butylthio)vinyl)-N-cyclopentyl-4-methylbenzenesulfonamide (4f)



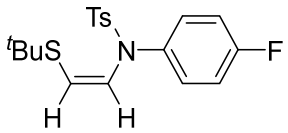
White solid, (40.2 mg, yield 57%); R_f = 0.2 (PE/EA = 20:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 8.0 Hz, 2H), 7.27 (d, *J* = 7.8 Hz, 2H), 6.57 (d, *J* = 6.7 Hz, 1H), 5.64 (d, *J* = 6.7 Hz, 1H), 4.28 (p, *J* = 8.0 Hz, 1H), 2.41 (s, 3H), 1.67 (m, 2H), 1.55 – 1.37 (m, 6H), 1.34 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.1, 136.9, 133.7, 129.3, 127.8, 118.6, 60.6, 43.5, 31.0, 28.7, 23.8, 21.5. HRMS (ESI) m/z calcd. for $C_{18}H_{27}NNaO_2S_2^+$ $[M + Na]^+$: 376.1375, found: 376.1371.

(Z)-N-(2-(tert-butylthio)vinyl)-4-methyl-N-phenylbenzenesulfonamide (4g)



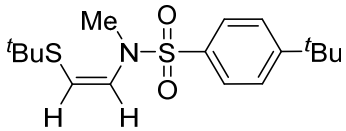
White solid, (57.8 mg, yield 80%); R_f = 0.2 (PE/EA = 20:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 – 7.43 (m, 2H), 7.30 – 7.18 (m, 5H), 7.16 – 7.00 (m, 2H), 6.61 (d, *J* = 7.9 Hz, 1H), 5.73 (d, *J* =7.9 Hz, 1H), 2.40 (s, 3H), 1.18 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.8, 139.0, 135.2, 129.4, 128.7, 128.6, 127.7, 127.4, 124.4, 114.6, 43.9, 30.7, 21.6. HRMS (ESI) m/z calcd. for $C_{19}H_{23}NNaO_2S_2^+$ $[M + Na]^+$: 384.1062, found: 384.1044.

(Z)-N-(2-(tert-butylthio)vinyl)-N-(4-fluorophenyl)-4-methylbenzenesulfonamide (4h)



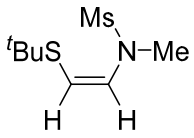
White solid, (60.6 mg, yield 80%); R_f = 0.2 (PE/EA = 20:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 (d, *J* = 8.4 Hz, 2H), 7.24 (d, *J* = 8.1 Hz, 2H), 7.04 (m, 2H), 6.98 – 6.92 (m, 2H), 6.60 (d, *J* = 8.0 Hz, 1H), 5.68 (d, *J* = 8.0 Hz, 1H), 2.41 (s, 3H), 1.18 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.75 (d, ^2J = 247.6 Hz), 144.0, 134.8, 134.74 (d, ^4J= 3.2 Hz), 130.79 (d, ^3J = 8.8 Hz), 129.5, 127.7, 124.2, 115.53 (d, *J* = 22.7 Hz), 113.6, 44.0, 30.6, 21.6. HRMS (ESI) m/z calcd. for $C_{19}H_{22}FNNaO_2S_2^+$ $[M + Na]^+$: 402.0968, found: 402.0699.

(Z)-4-(tert-butyl)-N-(2-(tert-butylthio)vinyl)-N-methylbenzenesulfonamide (4i)



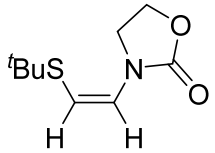
White solid, (66.8 mg, yield 98%); R_f = 0.2 (PE/EA = 20:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 8.5 Hz, 2H), 7.51 (d, *J* = 8.6 Hz, 2H), 6.32 (d, *J* = 8.0 Hz, 1H), 5.72 (d, *J* = 7.9 Hz, 1H), 3.11 (s, 3H), 1.34 (s, 9H), 1.29 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.6, 134.9, 127.2, 126.3, 126.0, 113.5, 44.2, 36.0, 35.1, 31.1, 30.6. HRMS (ESI) m/z calcd. for $C_{17}H_{27}NNaO_2S_2^+$ $[M + Na]^+$: 364.1375, found: 364.1141.

(Z)-N-(2-(tert-butylthio)vinyl)-N-methylmethanesulfonamide (4j)



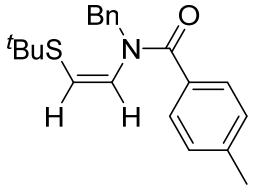
Yellow oil, (41.5 mg, yield 93%); R_f = 0.2 (PE/EA = 10:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.27 (d, *J* = 7.8 Hz, 1H), 5.84 (d, *J* = 7.8 Hz, 1H), 3.17 (s, 3H), 2.87 (s, 3H), 1.36 (s, 9H); ^{13}C NMR (100MHz, $CDCl_3$) δ 125.5, 115.6, 44.5, 37.7, 35.6, 30.7. HRMS (ESI) m/z calcd. for $C_8H_{18}NO_2S_2^+$ $[M + H]^+$: 224.0773, found: 224.0788.

(Z)-3-(2-(tert-butylthio)vinyl)oxazolidin-2-one (4k)



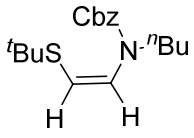
White solid, (39.4 mg, yield 98%); R_f = 0.2 (PE/EA = 8:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.68 (d, *J* = 8.7 Hz, 1H), 5.40 (d, *J* = 8.7 Hz, 1H), 4.36 (t, *J* = 7.9 Hz, 2H), 4.20 (t, *J* = 7.8 Hz, 2H), 1.32 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 156.6, 125.5, 101.9, 62.6, 45.4, 44.8, 30.5. HRMS (ESI) m/z calcd. for $C_9H_{15}NNaO_2S^+$ $[M + Na]^+$: 224.0716, found: 224.0721.

(Z)-N-benzyl-N-(2-(tert-butylthio)vinyl)-4-methylbenzamide (4l)



Yellow oil, (54.2 mg, yield 80%); R_f = 0.2 (PE/EA = 25:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 – 7.69 (m, 2H), 7.35 – 7.22 (m, 7H), 5.97 (d, *J* = 7.3 Hz, 1H), 5.89 (d, *J* = 7.4 Hz, 1H), 4.59 (s, 2H), 2.42 (s, 3H), 1.20 (s, 9H), 1.05 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.4, 136.4, 129.5, 128.2, 128.1, 127.4, 127.4, 123.3, 122.0, 51.9, 44.2, 30.6, 21.5, 17.7, 12.3. HRMS (ESI) m/z calcd. for $C_{21}H_{25}NNaOS^+$ $[M + Na]^+$: 362.1549, found: 362.2410.

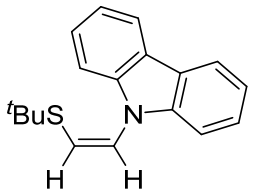
Benzyl (Z)-butyl(2-(tert-butylthio)vinyl)carbamate (4m)



Colorless oil, (50.2 mg, yield 78%); R_f = 0.3 (PE/EA = 20:1); ^{1}H NMR (600 MHz,

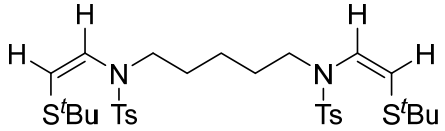
$CDCl_3$) δ 7.39 – 7.33 (m, 4H), 7.33 – 7.29 (m, 1H), 6.49 (s, 1H), 5.56 (d, *J* = 8.5 Hz, 1H), 5.17 (s, 2H), 3.72 – 3.66 (m, 2H), 1.59 – 1.52 (m, 2H), 1.36 (s, 9H), 1.33 – 1.29 (m, 2H), 0.91 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 128.55, 128.55, 128.12, 128.05, 128.05, 67.65, 46.17, 44.34, 30.80, 30.80, 19.95, 13.97. HRMS (ESI) m/z calcd. for $C_{18}H_{28}NO_2S^+$ $[M + H]^+$: 322.1835, found: 322.1829.

(Z)-9-(2-(tert-butylthio)vinyl)-9H-carbazole (4n)



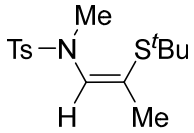
Yellow solid, (48.9 mg, yield 87%); R_f = 0.2 (PE/EA = 50:1); ^1H NMR (400 MHz, $CDCl_3$) δ 8.12 (d, *J* = 7.7 Hz, 2H), 7.50 (m, 2H), 7.38 (d, *J* = 8.1 Hz, 2H), 7.31 (t, *J* = 7.5 Hz, 2H), 6.94 (d, *J* = 7.2 Hz, 1H), 6.65 (d, *J* = 7.3 Hz, 1H), 1.43 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.8, 125.7, 123.7, 123.5, 120.3, 120.2, 119.9, 110.8, 44.4, 31.0. HRMS (ESI) m/z calcd. for $C_{21}H_{25}NNaOS^+$ $[M + Na]^+$: 362.1549, found: 362.2410.

N-((Z)-2-(tert-butylthio)vinyl)-N-(5-((N-((Z)-2-(tert-butylthio)vinyl)-4-methyl phenyl)sulfonamido)pentyl)-4-methylbenzenesulfonamide (4o)



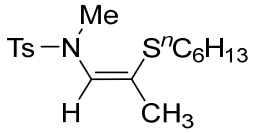
White solid, (54.2 mg, yield 80%); R_f = 0.2 (PE/EA =3:1); ^1H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, *J* = 8.2 Hz, 4H), 7.27 (d, *J* = 5.8 Hz, 4H), 5.96 (d, *J* = 1.6 Hz, 4H), 3.32 (t, *J* = 7.2 Hz, 4H), 2.41 (s, 6H), 1.52 (dt, *J* = 14.8, 7.5 Hz, 4H), 1.40 – 1.33 (m, 2H), 1.31 (s, 18H).^{13}C NMR (100 MHz, $CDCl_3$) δ 143.3, 136.3, 129.5, 127.2, 123.4, 119.7, 48.3, 44.1, 30.7, 28.1, 23.6, 21.5. HRMS (ESI) m/z calcd. for $C_{31}H_{46}N_2NaO_4S_4^+$ $[M + Na]^+$: 661.2233, found: 661.2230.

(Z)-N-(2-(tert-butylthio)prop-1-en-1-yl)-N,4-dimethylbenzenesulfonamide (6a)



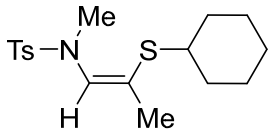
White solid, (57.0 mg, yield 91%); R_f = 0.2 (PE/EA =10:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, *J* = 8.3 Hz, 2H), 7.30 (d, *J* = 8.0 Hz, 2H), 6.36 (d, *J* = 1.4 Hz, 1H), 3.09 (s, 3H), 2.41 (s, 3H), 2.04 (d, *J* = 1.3 Hz, 3H), 1.32 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.6, 135.1, 131.2, 129.7, 127.5, 125.1, 47.1, 37.2, 32.1, 26.3, 21.6. HRMS (ESI) m/z calcd. for $C_{15}H_{23}NNaO_2S_2^+$ $[M + Na]^+$: 336.1056, found: 336.1062.

(Z)-N-(2-(hexylthio)prop-1-en-1-yl)-N,4-dimethylbenzenesulfonamide (6b)



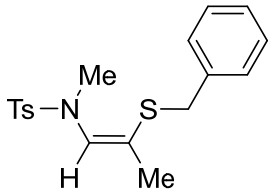
White solid, (62.0 mg, yield 91%); R_f = 0.2 (PE/EA =10:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, *J* = 8.3 Hz, 2H), 7.29 (d, *J* = 8.1 Hz, 2H), 5.70 (d, *J* = 1.7 Hz, 1H), 2.91 (s, 3H), 2.70 – 2.63 (m, 2H), 2.41 (s, 3H), 1.95 (d, *J* = 1.4 Hz, 3H), 1.56 – 1.44 (m, 2H), 1.39 – 1.24 (m, 6H), 0.87 (t, *J* = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.4, 134.6, 134.6, 129.5, 127.6, 123.0, 36.8, 31.4, 30.2, 30.0, 28.5, 22.5, 21.5, 20.3, 14.0. HRMS (ESI) m/z calcd. for $C_{17}H_{27}NNaO_2S_2^+$ $[M + Na]^+$: 364.1375, found: 364.1371.

(Z)-N-(2-(cyclohexylthio)prop-1-en-1-yl)-N,4-dimethylbenzenesulfonamide (6c)



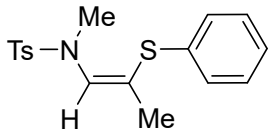
White solid, (63.7 mg, yield 94%); R_f = 0.2 (PE/EA =10:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, *J* = 8.3 Hz, 2H), 7.30 (d, *J* = 8.0 Hz, 2H), 6.16 (d, *J* = 7.8 Hz, 1H), 5.65 (d, *J* = 7.8 Hz, 1H), 3.06 (s, 3H), 2.78 – 2.67 (m, 1H), 2.42 (s, 3H), 1.99 – 1.89 (m, 2H), 1.72 (dt, *J* = 6.8, 3.3 Hz, 2H), 1.40 – 1.16 (m, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.4, 134.8, 132.0, 129.5, 127.5, 124.8, 42.3, 36.9, 33.8, 26.0, 25.6, 21.5, 21.2. HRMS (ESI) m/z calcd. for $C_{17}H_{25}NNaO_2S_2^+$ $[M + Na]^+$: 362.1219, found: 362.1214.

(Z)-N-(2-(benzylthio)prop-1-en-1-yl)-N,4-dimethylbenzenesulfonamide (6d)



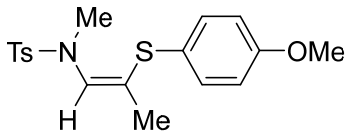
White solid, (63.8 mg, yield 92%); R_f = 0.2 (PE/EA =10:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 – 7.65 (m, 2H), 7.32 – 7.26 (m, 6H), 7.22 (dt, *J* = 8.8, 4.3 Hz, 1H), 5.76 (q, *J* = 1.4 Hz, 1H), 3.93 (s, 2H), 2.84 (s, 3H), 2.42 (s, 3H), 1.97 (d, *J* = 1.5 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.5, 137.6, 134.5, 133.4, 129.6, 128.7, 128.5, 127.6, 127.1, 124.0, 36.7, 35.1, 21.5, 20.8. HRMS (ESI) m/z calcd. for $C_{18}H_{21}NNaO_2S_2^+$ $[M + Na]^+$: 370.0906, found: 370.0903.

(Z)-N,4-dimethyl-N-(2-(phenylthio)prop-1-en-1-yl)benzenesulfonamide (6e)



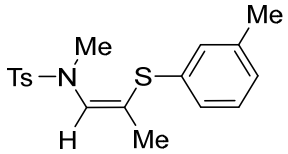
White solid, (55.9 mg, yield 84%); R_f = 0.2 (PE/EA =20:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 8.3 Hz, 2H), 7.34 – 7.25 (m, 7H), 5.97 (d, *J* = 1.5 Hz, 1H), 3.02 (s, 3H), 2.43 (s, 3H), 1.77 (d, *J* = 1.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.7, 134.6, 132.7, 132.4, 131.6, 129.6, 129.2, 128.9, 127.6, 125.7, 37.1, 21.6, 21.1. HRMS (ESI) m/z calcd. for $C_{17}H_{19}NNaO_2S_2^+$ $[M + Na]^+$: 356.0749, found: 356.0745.

(Z)-N-(2-((4-methoxyphenyl)thio)prop-1-en-1-yl)-N,4-dimethylbenzenesulfon amide (6f)



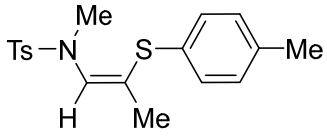
White solid, (60.3 mg, yield 83%); R_f = 0.2 (PE/EA =10:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 8.3 Hz, 2H), 7.35 – 7.27 (m, 4H), 6.82 (d, *J* = 8.7 Hz, 2H), 5.71 (q, *J* = 1.4 Hz, 1H), 3.79 (s, 3H), 2.98 (s, 3H), 2.43 (s, 3H), 1.66 (d, *J* = 1.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.9, 143.6, 136.0, 136.0, 134.5, 129.6, 127.7, 122.8, 122.1, 114.5, 55.3, 37.2, 21.5, 20.6. HRMS (ESI) m/z calcd. for $C_{18}H_{21}NNaO_3S_2^+$ $[M + Na]^+$: 386.0855, found: 386.0851.

(Z)-N,4-dimethyl-N-(2-(m-tolylthio)prop-1-en-1-yl)benzenesulfonamide (6g)



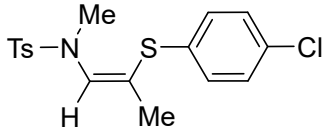
White solid, (61.0 mg, yield 88%); R_f = 0.2 (PE/EA =20:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 8.2 Hz, 2H), 7.32 (d, *J* = 8.1 Hz, 2H), 7.19 – 7.05 (m, 4H), 5.96 (d, *J* = 1.5 Hz, 1H), 3.02 (s, 3H), 2.43 (s, 3H), 2.31 (s, 3H), 1.76 (d, *J* = 1.3 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.6, 138.7, 134.7, 133.4, 132.4, 132.0, 129.8, 129.6, 128.7, 128.5, 127.6, 125.4, 37.1, 21.6, 21.3, 21.1. HRMS (ESI) m/z calcd. for $C_{18}H_{21}NNaO_2S_2^+$ $[M + Na]^+$: 370.0906, found: 370.0903.

(Z)-N,4-dimethyl-N-(2-(p-tolylthio)prop-1-en-1-yl)benzenesulfonamide (6h)



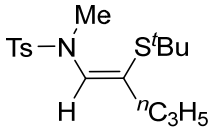
White solid, (61.0 mg, yield 88%); R_f = 0.2 (PE/EA =20:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.77 – 7.70 (m, 2H), 7.32 (dd, *J* = 7.6, 4.9 Hz, 3H), 7.22 – 7.17 (m, 2H), 7.14 – 7.08 (m, 1H), 5.91 (d, *J* = 1.4 Hz, 1H), 3.01 (s, 3H), 2.43 (s, 3H), 2.34 (s, 3H), 1.66 (d, *J* = 1.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.6, 141.1, 134.2, 131.2, 130.3, 129.6, 128.3, 127.7, 126.4, 124.7, 36.9, 21.5, 20.7. HRMS (ESI) m/z calcd. for $C_{18}H_{21}NNaO_2S_2^+$ $[M + Na]^+$: 370.0906, found: 370.0903.

(Z)-N-(2-((4-chlorophenyl)thio)prop-1-en-1-yl)-N,4-dimethylbenzenesulfonamide (6i)



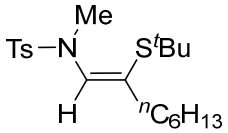
White solid, (61.8 mg, yield 84%); R_f = 0.2 (PE/EA =20:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74 – 7.68 (m, 2H), 7.32 (d, *J* = 8.0 Hz, 2H), 7.24 (s, 4H), 5.94 (d, *J* = 1.4 Hz, 1H), 2.98 (s, 3H), 2.43 (s, 3H), 1.76 (d, *J* = 1.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.8, 134.4, 133.9, 133.8, 131.7, 131.1, 129.7, 129.1, 127.6, 126.3, 37.1, 21.6, 21.1. HRMS (ESI) m/z calcd. for $C_{17}H_{18}ClNNaO_2S_2^+$ $[M + Na]^+$: 390.0360, found: 390.0355.

(Z)-N-(2-(tert-butylthio)hex-1-en-1-yl)-N,4-dimethylbenzenesulfonamide (6j)



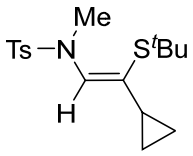
White solid, (67.5 mg, yield 99%); R_f = 0.2 (PE/EA =10:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, *J* = 7.9 Hz, 2H), 7.30 (d, *J* = 7.9 Hz, 2H), 6.50 (s, 1H), 3.13 (s, 3H), 2.42 (s, 3H), 2.22 (t, *J* = 7.4 Hz, 2H), 1.53 (dt, *J* = 14.7, 7.3 Hz, 2H), 1.29 (s, 9H), 0.83 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.6, 134.9, 132.5, 129.7, 127.9, 127.4, 47.5, 41.3, 37.4, 31.9, 21.9, 21.5, 13.3. HRMS (ESI) m/z calcd. for $C_{17}H_{27}NNaO_2S_2^+$ $[M + Na]^+$: 364.1375, found: 364.1369.

(Z)-N-(2-(tert-butylthio)oct-1-en-1-yl)-N,4-dimethylbenzenesulfonamide (6k)



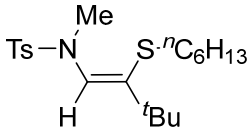
White solid, (75.8 mg, yield 99%); R_f = 0.2 (PE/EA =10:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, *J* = 8.0 Hz, 2H), 7.30 (d, *J* = 7.9 Hz, 2H), 6.50 (s, 1H), 3.13 (s, 3H), 2.41 (s, 3H), 2.24 (t, *J* = 7.5 Hz, 2H), 1.48 (p, *J* = 7.2 Hz, 2H), 1.29 (s, 9H), 1.23 (m, 6H), 0.85 (t, *J* = 6.7 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.6, 135.0, 132.4, 129.7, 128.1, 127.4, 47.5, 39.4, 37.4, 31.9, 31.6, 28.8, 28.5, 22.6, 21.5, 14.1. HRMS (ESI) m/z calcd. for $C_{20}H_{33}NNaO_2S_2^+$ $[M + Na]^+$: 406.1845, found: 406.1840.

(Z)-N-(2-(tert-butylthio)-2-cyclopropylvinyl)-N,4-dimethylbenzenesulfonamide (6l)



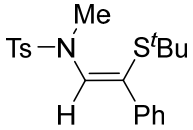
White solid, (62.4 mg, yield 92%); R_f = 0.2 (PE/EA =10:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, *J* = 8.0 Hz, 2H), 7.31 (d, *J* = 8.0 Hz, 2H), 6.56 (s, 1H), 3.15 (s, 3H), 2.43 (s, 3H), 1.34 (s, 9H), 0.74 – 0.67 (m, 2H), 0.59 – 0.52 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.7, 134.9, 131.6, 129.8, 128.2, 127.4, 47.8, 37.0, 31.9, 31.0, 21.6, 19.7, 7.4. HRMS (ESI) m/z calcd. for $C_{17}H_{25}NNaO_2S_2^+$ $[M + Na]^+$: 362.1219, found: 362.1211.

(Z)-N-(2-(hexylthio)-3,3-dimethylbut-1-en-1-yl)-N-methylmethanesulfonamide (6m)



Colorless oil, (48 mg, yield 78%); R_f = 0.2 (PE/EA =20:1); ^{1}H NMR (600 MHz, $CDCl_3$) δ 6.36 (s, 1H), 3.19 (s, 3H), 2.90 (s, 3H), 2.72 (t, *J* = 7.4 Hz, 2H), 1.54 (m, *J* = 7.4 Hz, 2H), 1.39 – 1.35 (m, 2H), 1.27 (m, *J* = 3.3 Hz, 4H), 1.16 (s, 9H), 0.87 (t, *J* = 6.9 Hz, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 141.88, 126.34, 38.08, 36.04, 34.89, 33.88, 31.58, 29.46, 29.42, 28.69, 22.67, 14.16. HRMS (ESI) m/z calcd. for $C_{14}H_{30}NO_2S_2^+$ $[M + H]^+$: 308.1712, found: 308.1705.

(Z)-N-(2-(tert-butylthio)-2-phenylvinyl)-N,4-dimethylbenzenesulfonamide (6n)

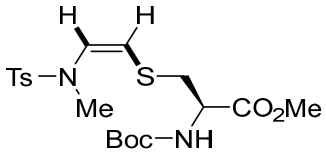


Colorless oil, (32.3 mg, yield 43%); R_f = 0.2 (PE/EA =20:1); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.75 – 7.69 (m, 2H), 7.54 – 7.50 (m, 2H), 7.35 – 7.27 (m, 5H), 6.94 (s, 1H), 3.36 (s, 3H), 2.44 (s, 3H), 1.09 (s, 9H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 143.99, 142.42, 134.98, 134.32, 129.93, 128.38, 128.25, 127.62, 127.41, 47.88, 37.18, 31.76, 21.70. HRMS (ESI) m/z calcd. for $C_{20}H_{25}NNaO_2S_2^+$ $[M + Na]^+$: 398.1219, found: 398.1213.

(E)-N-(2-(tert-butylthio)-2-phenylvinyl)-N,4-dimethylbenzenesulfonamide (6n')

Colorless oil, (30.1 mg, yield 40%); R_f = 0.15 (PE/EA =20:1); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.72 (d, *J* = 8.3 Hz, 2H), 7.53 (d, *J* = 7.3 Hz, 2H), 7.28 – 7.21 (m, 4H), 7.19 – 7.16 (m, 1H), 6.46 (s, 1H), 3.10 (s, 3H), 2.38 (s, 3H), 1.33 (s, 9H). ^{13}C NMR (150 MHz, Chloroform-*d*) δ 143.79 , 136.15 , 135.73 , 129.88 , 129.76 , 128.14 , 128.09 , 128.04 , 49.37 , 37.35 , 31.62 , 21.73 . HRMS (ESI) m/z calcd. for $C_{20}H_{25}NNaO_2S_2^+$ $[M + Na]^+$: 398.1219, found: 398.1214.

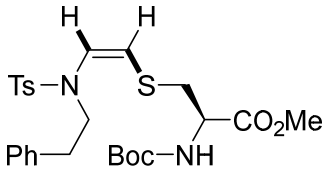
Methyl (Z)-N-(tert-butoxycarbonyl)-S-(2-((N,4-dimethylphenyl) sulfonamido) vinyl)-L-cysteinate (9a)



Colorless oil, (79.9 mg, yield 90%); R_f = 0.2 (PE/EA =4:1); ^{1}H NMR (400 MHz, CDCl3) δ 7.69 – 7.62 (m, 2H), 7.32 – 7.28 (m, 2H), 6.10 (d, *J* = 7.7 Hz, 1H), 5.52 (d, *J* = 7.7

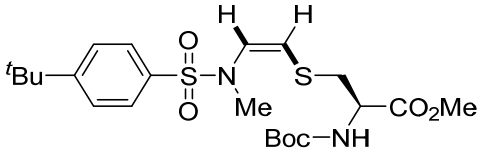
Hz, 1H), 5.31 (d, *J* = 7.9 Hz, 1H), 4.51 (dt, *J* = 9.2, 4.9 Hz, 1H), 3.70 (s, 3H), 3.07 (t, *J* = 5.5 Hz, 2H), 3.01 (s, 3H), 2.41 (s, 3H), 1.42 (s, 2H), 1.41 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.8, 154.9, 143.9, 134.5, 129.7, 127.3, 126.0, 117.7, 80.3, 53.7, 52.6, 37.3, 35.6, 28.3, 21.6. HRMS (ESI) m/z calcd. for $C_{19}H_{28}N_2NaO_6S_2^+$ [M + Na]$^+$: 467.1281, found: 467.1292.

Methyl (Z)-N-(tert-butoxycarbonyl)-S-(2-((4-methyl-N-phenethylphenyl) sulfonamido)vinyl)-L-cysteinate (9b)



Colorless Oil, (66.2 mg, yield 62%); R_f = 0.2 (PE/EA =4:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 – 7.64 (m, 2H), 7.30 – 7.25 (m, 4H), 7.21 (d, *J* = 7.0 Hz, 3H), 5.94 (d, *J* = 7.5 Hz, 1H), 5.79 (d, *J* = 7.3 Hz, 1H), 5.40 – 5.32 (m, 1H), 4.55 (t, *J* = 6.2 Hz, 1H), 3.72 (s, 3H), 3.53 (td, *J* = 7.2, 6.5, 2.1 Hz, 2H), 3.16 (d, *J* = 4.8 Hz, 2H), 2.86 (t, *J* = 8.1 Hz, 2H), 2.41 (s, 3H), 1.43 (d, *J* = 1.6 Hz, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.7, 155.0, 143.7, 138.3, 135.9, 129.7, 128.9, 128.5, 128.5, 127.3, 126.5, 123.5, 80.3, 53.9, 52.6, 50.1, 37.1, 35.3, 28.3, 21.5. HRMS (ESI) m/z calcd. for $C_{26}H_{34}N_2NaO_6S_2^+$ [M + Na]$^+$: 557.1750, found: 557.1750.

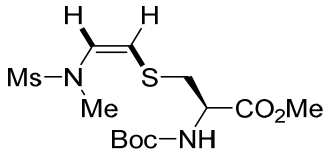
Methyl (Z)-N-(tert-butoxycarbonyl)-S-(2-((4-(tert-butyl)-N-methylphenyl) sulfonamido)vinyl)-L-cysteinate (9c)



Colorless Oil, (89.4 mg, yield 92%); R_f = 0.2 (PE/EA =5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.6 Hz, 2H), 7.51 (d, *J* = 8.6 Hz, 2H), 6.15 (d, *J* = 7.7 Hz, 1H), 5.51 (d, *J* = 7.8 Hz, 1H), 5.35 – 5.27 (m, 1H), 4.57 – 4.47 (m, 1H), 3.71 (s, 3H), 3.09 (dd, *J* = 7.4, 4.9 Hz, 2H), 3.04 (s, 3H), 1.42 (s, 9H), 1.33 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.8, 156.8, 154.9, 134.5, 127.8, 127.2, 126.1, 116.9, 80.3, 53.7, 52.6, 37.4, 35.6, 35.2, 31.1, 28.3. HRMS (ESI) m/z calcd. for $C_{26}H_{34}N_2NaO_6S_2^+$ [M + Na]$^+$: 509.1756, found: 509.1756.

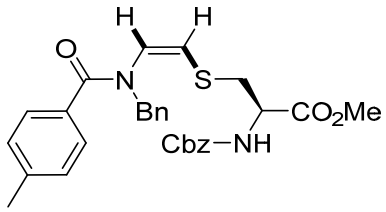
Methyl (Z)-N-(tert-butoxycarbonyl)-S-(2-(N-methylmethylsulfonamido)vinyl)-L-

cysteinate (9d)



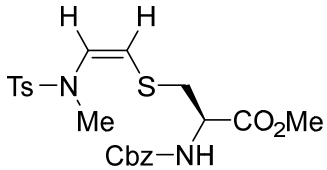
Colorless Oil, (50.0 mg, yield 68%); R_f = 0.2 (PE/EA =3:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.17 (d, *J* = 7.6 Hz, 1H), 5.55 (d, *J* = 7.6 Hz, 1H), 5.37 (d, *J* = 7.9 Hz, 1H), 4.51 (dt, *J* = 8.7, 4.9 Hz, 1H), 3.70 (s, 3H), 3.12 (s, 3H), 3.04 (dd, *J* = 14.0, 5.0 Hz, 2H), 2.85 (s, 3H), 1.38 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.7, 154.9, 125.8, 117.5, 80.2, 53.6, 52.6, 37.5, 37.1, 35.4, 28.2. HRMS (ESI) m/z calcd. for $C_{13}H_{24}N_2NaO_6S_2^+$ $[M + Na]^+$: 391.0968, found: 391.0968.

Methyl (Z)-S-(2-(N-benzyl-4-methylbenzamido)vinyl)-N-((benzyloxy)carbonyl)-L-cysteinate (9e)



White solid, (71.5 mg, yield 69%); R_f = 0.2 (PE/EA =5:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, *J* = 8.0 Hz, 2H), 7.39 – 7.21 (m, 12H), 5.71 (d, *J* = 7.1 Hz, 1H), 5.58 (d, *J* = 7.1 Hz, 1H), 5.37 (d, *J* = 8.0 Hz, 1H), 5.14 – 5.01 (m, 2H), 4.53 (dt, *J* = 8.3, 4.3 Hz, 1H), 4.42 (q, *J* = 14.6 Hz, 2H), 3.69 (s, 3H), 3.14 (dd, *J* = 14.4, 4.0 Hz, 1H), 3.01 (dd, *J* = 14.4, 4.7 Hz, 1H), 2.42 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.1, 155.5, 143.8, 136.2, 135.9, 135.6, 129.7, 128.5, 128.4, 128.3, 128.2, 128.2, 128.2, 127.8, 127.5, 127.2, 123.4, 67.1, 54.3, 52.7, 52.7, 36.8, 21.6. HRMS (ESI) m/z calcd. for $C_{29}H_{31}N_2O_5S^+$ $[M + H]^+$: 519.1948, found: 519.1949.

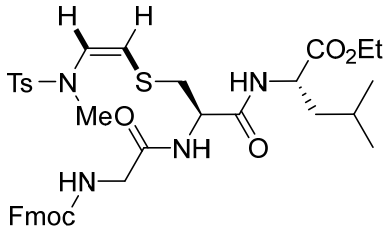
Methyl (Z)-N-((benzyloxy)carbonyl)-S-(2-((N,4-dimethylphenyl) sulfonamido) vinyl)-L-cysteinate (9f)



Colorless Oil, (79.3 mg, yield 83%); R_f = 0.2 (PE/EA =4:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, *J* = 8.1 Hz, 2H), 7.38 – 7.26 (m, 7H), 6.06 (d, *J* = 7.6 Hz, 1H), 5.63 (d, *J* =

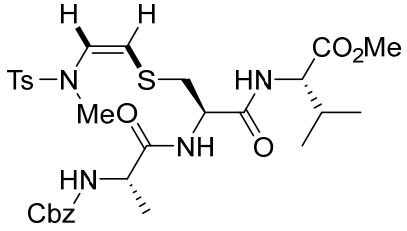
7.9 Hz, 1H), 5.49 (d, *J* = 7.7 Hz, 1H), 5.14 – 5.06 (m, 2H), 4.60 (dt, *J* = 8.7, 4.8 Hz, 1H), 3.72 (s, 3H), 3.11 (t, *J* = 3.9 Hz, 2H), 2.99 (s, 3H), 2.40 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.4, 155.5, 143.8, 136.1, 134.5, 129.7, 128.5, 128.2, 128.1, 127.3, 126.2, 117.4, 67.1, 54.1, 52.7, 37.1, 35.6, 21.5. HRMS (ESI) m/z calcd. for $C_{22}H_{26}N_2NaO_6S_2^+$ $[M + Na]^+$: 501.1124, found: 501.1125.

Ethyl N-((((9H-fluoren-9-yl)methoxy)carbonyl)glycyl)-S-((Z)-2-((N,4-dimethyl phenyl)sulfonamido)vinyl)-L-cysteinyl-L-leucinate (9g)



White solid, (148.5 mg, yield 90%); R_f = 0.2 (PE/EA =1:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 (d, *J* = 7.5 Hz, 2H), 7.66 (d, *J* = 8.0 Hz, 2H), 7.59 (d, *J* = 7.5 Hz, 2H), 7.38 (t, *J* = 7.5 Hz, 2H), 7.30 (d, *J* = 7.8 Hz, 4H), 7.27 (d, *J* = 2.7 Hz, 1H), 7.24 (d, *J* = 7.6 Hz, 1H), 7.14 (d, *J* = 8.0 Hz, 1H), 5.99 (d, *J* = 7.1 Hz, 1H), 5.86 (d, *J* = 7.1 Hz, 1H), 5.80 (d, *J* = 5.8 Hz, 1H), 4.67 (q, *J* = 6.7 Hz, 1H), 4.51 (q, *J* = 7.4 Hz, 1H), 4.39 (d, *J* = 7.1 Hz, 2H), 4.26 – 4.17 (m, 2H), 4.14 (ddd, *J* = 10.8, 6.9, 3.3 Hz, 2H), 3.95 (d, *J* = 5.6 Hz, 2H), 3.21 (dd, *J* = 14.2, 4.8 Hz, 1H), 2.97 (dd, *J* = 14.2, 7.1 Hz, 1H), 2.89 (s, 3H), 2.41 (s, 3H), 1.68 (q, *J* = 6.4 Hz, 1H), 1.64 (d, *J* = 6.9 Hz, 2H), 1.26 (d, *J* = 7.2 Hz, 3H), 0.89 (dd, *J* = 6.4, 2.9 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.3, 169.4, 169.2, 156.7, 144.1, 143.8, 141.3, 133.6, 129.8, 127.8, 127.7, 127.6, 127.1, 126.5, 125.1, 123.3, 120.0, 67.3, 61.4, 53.2, 51.5, 47.1, 44.5, 40.7, 36.5, 36.0, 24.8, 22.7, 21.8, 21.6, 14.2. HRMS (ESI) m/z calcd. for $C_{38}H_{47}N_4O_8S_2^+$ $[M + H]^+$: 751.2830, found: 751.2830.

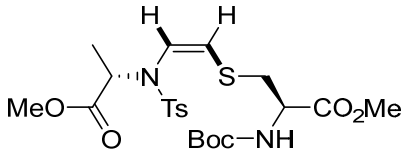
Methyl N-(((benzyloxy)carbonyl)-L-alanyl)-S-((Z)-2-((N,4-dimethylphenyl) sulfonamido)vinyl)-L-cysteinyl-L-valinate (9h)



White solid, (125.7 mg, yield 97%); R_f = 0.2 (PE/EA =2:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, *J* = 8.0 Hz, 2H), 7.45 (d, *J* = 8.0 Hz, 1H), 7.35 – 7.25 (m, 10H), 5.92 (dd, *J* = 14.5, 7.4 Hz, 2H), 5.84 (d, *J* = 7.3 Hz, 1H), 5.16 – 5.05 (m, 2H), 4.76 (q, *J* = 6.6 Hz,

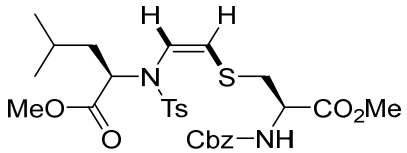
1H), 4.47 (dd, *J* = 8.6, 5.2 Hz, 1H), 4.43 – 4.33 (m, 1H), 3.71 (s, 3H), 3.13 (dd, *J* = 14.3, 5.6 Hz, 1H), 2.99 (dd, *J* = 14.0, 6.7 Hz, 1H), 2.92 (s, 3H), 2.41 (s, 3H), 2.17 (dt, *J* = 13.0, 6.7 Hz, 1H), 1.38 (d, *J* = 7.1 Hz, 3H), 0.91 (t, *J* = 6.3 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.9, 171.8, 169.7, 156.0, 144.0, 136.3, 133.9, 129.8, 128.5, 128.1, 128.0, 127.5, 126.1, 121.5, 66.9, 57.8, 53.2, 52.2, 50.7, 36.2, 36.1, 31.0, 21.5, 18.9, 18.7, 17.9. HRMS (ESI) m/z calcd. for $C_{30}H_{40}N_4NaO_8S2^+$ $[M + Na]^+$: 671.2180, found: 671.2173.

Methyl (6R,12S,Z)-6-(methoxycarbonyl)-2,2,12-trimethyl-4-oxo-11-tosyl-3-oxa-8-thia-5,11-diazatridec-9-en-13-oate (9i)



Yellow Oil, (75.3 mg, yield 73%); R_f = 0.2 (PE/EA =2:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, *J* = 8.1 Hz, 2H), 7.28 (d, *J* = 10.0 Hz, 2H), 6.33 (d, *J* = 6.5 Hz, 1H), 5.93 (d, *J* = 6.5 Hz, 1H), 5.56 (d, *J* = 8.1 Hz, 1H), 4.71 (q, *J* = 7.3 Hz, 1H), 4.59 (dt, *J* = 8.8, 4.6 Hz, 1H), 3.75 (s, 3H), 3.47 (s, 3H), 3.23 (dd, *J* = 14.4, 4.0 Hz, 1H), 3.14 (dd, *J* = 14.3, 5.1 Hz, 1H), 2.42 (s, 3H), 1.46 (s, 9H), 1.40 (d, *J* = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.4, 170.5, 155.0, 143.6, 136.6, 136.1, 129.3, 127.6, 120.2, 80.1, 56.5, 53.9, 52.5, 51.9, 36.5, 28.3, 28.2, 21.5, 16.5. HRMS (ESI) m/z calcd. for $C_{22}H_{32}N_2NaO_8S_2^+$ $[M + Na]^+$: 539.1492, found: 539.1492.

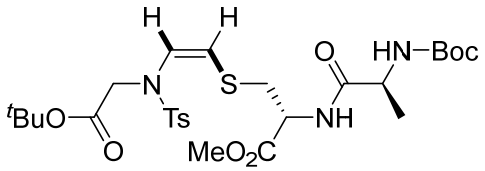
Methyl (5R,11R,Z)-11-isobutyl-5-(methoxycarbonyl)-3-oxo-1-phenyl-10-tosyl-2-oxa-7-thia-4,10-diazadodec-8-en-12-oate (9j)



Yellow Oil, (71.0 mg, yield 60%); R_f = 0.2 (PE/EA =2:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, *J* = 8.0 Hz, 2H), 7.34 (dd, *J* = 12.4, 5.0 Hz, 5H), 7.17 (d, *J* = 8.0 Hz, 2H), 6.26 (d, *J* = 6.7 Hz, 1H), 6.05 (d, *J* = 8.3 Hz, 1H), 5.91 (d, *J* = 6.6 Hz, 1H), 5.15 (q, *J* = 12.4 Hz, 2H), 4.71 (dt, *J* = 8.5, 4.2 Hz, 1H), 4.58 (dd, *J* = 8.4, 6.4 Hz, 1H), 3.76 (s, 3H), 3.37 (s, 3H), 3.32 (dd, *J* = 14.5, 3.7 Hz, 1H), 3.15 (dd, *J* = 14.4, 4.9 Hz, 1H), 2.38 (s, 3H), 1.83 – 1.77 (m, 1H), 1.49 (ddd, *J* = 8.1, 6.0, 4.1 Hz, 2H), 0.92 (d, *J* = 6.6 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.2, 170.3, 155.8, 143.6, 136.5, 136.3, 135.7, 129.3, 128.5, 128.1, 128.1, 127.7, 120.5, 67.1, 58.9, 54.4, 52.7, 51.7, 39.8, 36.6, 24.6, 22.7,

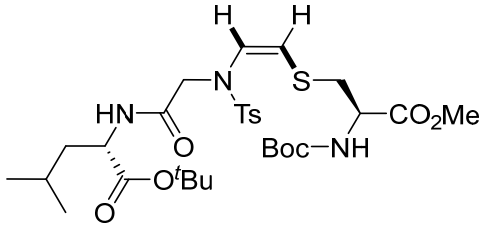
21.6, 21.5. HRMS (ESI) m/z calcd. for $C_{28}H_{36}N_2NaO_8S_2^+$ [M + Na]$^+$: 615.1805, found: 615.1800.

Methyl S-((Z)-2-((N-(2-(tert-butoxy)-2-oxoethyl)-4-methylphenyl) sulfonamido) vinyl)-N-((tert-butoxycarbonyl)-L-alanyl)-L-cysteinate (9k)



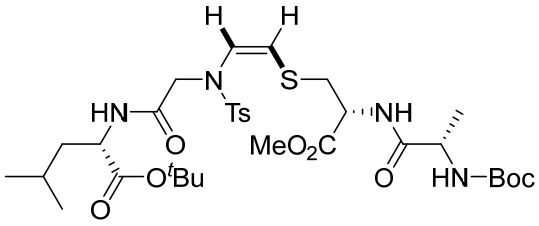
Yellow Oil, (109.5 mg, yield 89%); R_f = 0.2 (PE/EA =1:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, *J* = 8.2 Hz, 2H), 7.34 – 7.26 (m, 2H), 7.13 (d, *J* = 7.6 Hz, 1H), 6.28 (d, *J* = 7.5 Hz, 1H), 5.65 (d, *J* = 7.5 Hz, 1H), 5.35 – 5.25 (m, 1H), 4.80 (dt, *J* = 7.7, 4.7 Hz, 1H), 4.31 (d, *J* = 18.1 Hz, 1H), 4.18 (d, *J* = 18.2 Hz, 2H), 3.73 (s, 3H), 3.15 (d, *J* = 4.7 Hz, 2H), 2.42 (s, 3H), 1.45 (s, 9H), 1.40 (s, 9H), 1.36 (d, *J* = 7.1 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.7, 170.2, 167.5, 155.4, 143.9, 135.9, 129.6, 127.4, 125.2, 119.6, 82.3, 79.9, 52.7, 52.6, 50.1, 49.6, 36.6, 28.3, 27.9, 21.5, 18.2. HRMS (ESI) m/z calcd. for $C_{27}H_{41}N_3NaO_9S_2^+$ [M + Na]$^+$: 638.2176, found: 638.2176.

Tert-butyl ((R,Z)-6-(methoxycarbonyl)-2,2-dimethyl-4-oxo-11-tosyl-3-oxa-8-thia-5,11-diazatridec-9-en-13-oyl)-L-leucinate (9l)



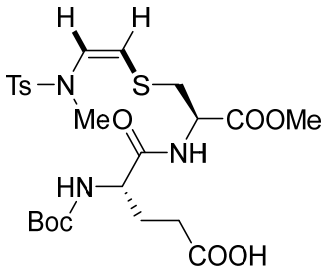
Yellow Oil, (119.6 mg, yield 89%); R_f = 0.2 (PE/EA =1:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, *J* = 7.9 Hz, 2H), 7.33 (d, *J* = 8.0 Hz, 2H), 7.14 (d, *J* = 8.5 Hz, 1H), 6.09 (d, *J* = 6.9 Hz, 1H), 5.78 (d, *J* = 6.9 Hz, 1H), 5.72 (d, *J* = 7.9 Hz, 1H), 4.51 (dp, *J* = 17.8, 6.9, 6.1 Hz, 2H), 4.02 (d, *J* = 17.2 Hz, 1H), 3.74 (s, 3H), 3.17 (d, *J* = 5.3 Hz, 2H), 2.44 (s, 3H), 1.74 (dt, *J* = 13.2, 6.7 Hz, 1H), 1.61 (ddd, *J* = 11.4, 8.1, 5.7 Hz, 2H), 1.46 (d, *J* = 8.6 Hz, 18H), 0.96 (t, *J* = 6.8 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.6, 170.6, 167.0, 155.1, 144.5, 134.1, 129.8, 127.8, 127.5, 124.3, 81.8, 80.1, 53.7, 52.7, 52.5, 51.4, 41.6, 36.4, 28.2, 27.9, 24.7, 22.8, 21.9, 21.5. HRMS (ESI) m/z calcd. for $C_{30}H_{47}N_3NaO_9S_2^+$ [M + Na]$^+$: 680.2646, found: 680.2640.

Tert-butyl N-((Z)-2-(((R)-2-((S)-2-((tert-butoxycarbonyl)amino)propanamido)-3-methoxy-3-oxopropyl)thio)vinyl)-N-tosylglycyl-L-leucinate (9m)



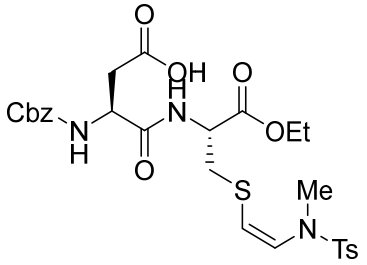
Yellow oil, (111.6 mg, yield 75%); R_f = 0.2 (CH_3OH/CH_2Cl_2 =50:1); ^1H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.3 Hz, 2H), 7.52 (d, *J* = 7.1 Hz, 1H), 7.32 (d, *J* = 8.5 Hz, 2H), 7.22 (d, *J* = 8.5 Hz, 1H), 6.11 (d, *J* = 7.5 Hz, 1H), 5.80 (d, *J* = 7.5 Hz, 1H), 5.47 (d, *J* = 8.2 Hz, 1H), 4.72 – 4.63 (m, 1H), 4.51 (td, *J* = 8.6, 5.5 Hz, 1H), 4.34 – 4.24 (m, 1H), 4.08 (d, *J* = 7.8 Hz, 2H), 3.72 (s, 3H), 3.21 (dd, *J* = 14.2, 4.5 Hz, 1H), 3.10 (dd, *J* = 14.2, 6.1 Hz, 1H), 2.43 (s, 3H), 1.76 – 1.69 (m, 1H), 1.63 – 1.57 (m, 2H), 1.45 (d, *J* = 9.9 Hz, 18H), 0.95 (t, *J* = 6.4 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.2, 172.2, 170.1, 167.5, 155.5, 144.4, 134.6, 129.8, 127.5, 125.5, 121.3, 81.9, 79.8, 52.6, 51.5, 51.2, 49.9, 41.2, 36.0, 28.3, 27.9, 24.8, 22.8, 21.9, 21.5, 18.3. HRMS (ESI) m/z calcd. for $C_{33}H_{52}N_4NaO_{10}S_2^+$ $[M + Na]^+$: 751.3017, found: 751.3019.

(S)-4-((tert-butoxycarbonyl)amino)-5-(((R)-3-(((Z)-2-((N,4-dimethylphenyl) sulfonamido)vinyl)thio)-1-methoxy-1-oxopropan-2-yl)amino)-5-oxopentanoic acid (11a)



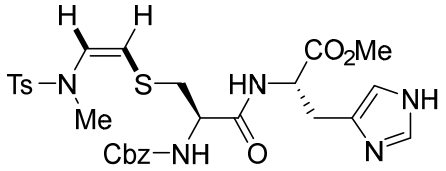
White solid, (92.8 mg, yield 82%); R_f = 0.2 (PE/EA =2:1); ^1H NMR (400 MHz, DMSO-d_6) δ 8.32 (d, *J* = 7.7 Hz, 1H), 7.65 (d, *J* = 7.9 Hz, 2H), 7.43 (d, *J* = 7.9 Hz, 2H), 6.96 (d, *J* = 8.2 Hz, 1H), 6.05 (d, *J* = 7.6 Hz, 1H), 5.89 (d, *J* = 7.6 Hz, 1H), 4.44 (td, *J* = 8.0, 4.9 Hz, 1H), 4.05 (td, *J* = 8.7, 5.3 Hz, 1H), 3.61 (s, 3H), 3.14 – 2.95 (m, 2H), 2.87 (s, 3H), 2.47 – 2.41 (m, 2H), 2.02 (s, 3H), 1.85 – 1.71 (m, 2H), 1.35 (s, 9H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 172.4, 171.0, 155.7, 144.4, 134.1, 130.4, 127.6, 125.9, 119.4, 78.6, 53.8, 52.8, 52.6, 35.9, 35.3, 32.2, 30.0, 28.6, 21.5, 15.1. HRMS (ESI) m/z calcd. for $C_{24}H_{37}N_3NaO_9S_2^+$ $[M + Na]^+$: 598.1863, found: 598.1862.

(S)-3-(((benzyloxy)carbonyl)amino)-4-(((R)-3-(((Z)-2-((N,4-dimethylphenyl)sul fonamido)vinyl)thio)-1-ethoxy-1-oxopropan-2-yl)amino)-4-oxobutanoic acid (11b)



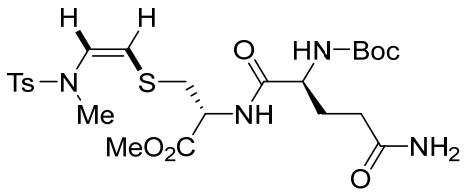
White solid, (86.3 mg, yield 73%); R_f = 0.2 (PE/EA =2:1);^{1}H NMR (400 MHz, DMSO-d_6) δ 12.40 (s, 1H), 8.45 (d, *J* = 7.7 Hz, 1H), 7.70 (d, *J* = 8.0 Hz, 2H), 7.60 (d, *J* = 8.2 Hz, 1H), 7.48 (d, *J* = 8.0 Hz, 2H), 7.39 (m, 5H), 6.09 (d, *J* = 7.6 Hz, 1H), 5.95 (d, *J* = 7.6 Hz, 1H), 5.13 – 4.99 (m, 2H), 4.46 (m, 2H), 4.11 (q, *J* = 7.1 Hz, 2H), 3.14 (dd, *J* = 14.0, 5.3 Hz, 1H), 3.04 (dd, *J* = 14.1, 8.1 Hz, 1H), 2.91 (s, 3H), 2.68 (dd, *J* = 16.7, 4.5 Hz, 1H), 2.44 (s, 3H), 1.28 (s, 1H), 1.21 (t, *J* = 7.1 Hz, 3H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 172.0, 171.6, 170.4, 156.2, 144.4, 137.3, 134.1, 130.4, 128.8, 128.3, 128.2, 127.6, 125.7, 119.7, 66.0, 61.4, 53.2, 51.7, 36.7, 35.9, 35.1, 21.5, 14.4. HRMS (ESI) m/z calcd. for $C_{27}H_{33}N_3NaO_9S_2^+$ $[M + Na]^+$: 630.1550, found: 630.1546.

Methyl N-((benzyloxy)carbonyl)-S-((Z)-2-((N,4-dimethylphenyl) sulfonamido) vinyl)-L-cysteinyl-L-histidinate (11c)



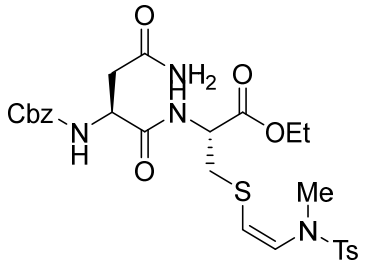
White solid, (97.2 mg, yield 79%); R_f = 0.2 (PE/EA =2:1); ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.52 (d, *J* = 7.4 Hz, 1H), 7.66 (d, *J* = 8.0 Hz, 2H), 7.58 (d, *J* = 8.7 Hz, 1H), 7.53 (s, 1H), 7.43 (d, *J* = 8.0 Hz, 2H), 7.39 – 7.23 (m, 5H), 6.84 (s, 1H), 6.00 (s, 2H), 5.09 – 4.96 (m, 2H), 4.49 (q, *J* = 6.9 Hz, 1H), 4.21 (td, *J* = 9.5, 3.9 Hz, 1H), 3.04 (dd, *J* = 13.9, 3.9 Hz, 1H), 2.94 (h, *J* = 6.7 Hz, 2H), 2.83 (s, 3H), 2.81 – 2.74 (m, 1H), 2.54 (s, 1H), 2.39 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 172.1, 170.6, 156.4, 144.4, 137.3, 135.4, 134.1, 130.4, 128.8, 128.2, 128.1, 127.6, 124.9, 120.6, 66.0, 55.4, 53.1, 52.3, 40.8, 36.3, 35.9, 21.5. HRMS (ESI) m/z calcd. for $C_{28}H_{34}N_5O_7S_2^+$ $[M + H]^+$: 616.1894, found: 616.1894.

Methyl N-((tert-butoxycarbonyl)-L-glutaminyl)-S-((Z)-2-((N,4-dimethylphenyl) sulfonamido)vinyl)-L-cysteinate (11d)



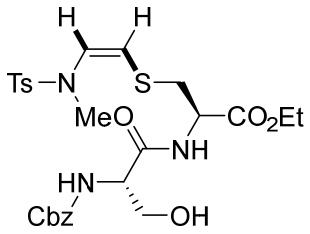
White solid, (98.4 mg, yield 86%); R_f = 0.2 (PE/EA =2:1); ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.31 (d, *J* = 7.8 Hz, 1H), 7.71 – 7.66 (m, 2H), 7.47 (d, *J* = 8.0 Hz, 2H), 7.26 (s, 1H), 6.88 (d, *J* = 8.1 Hz, 1H), 6.77 (s, 1H), 6.09 (d, *J* = 7.6 Hz, 1H), 5.91 (d, *J* = 7.6 Hz, 1H), 4.48 (td, *J* = 7.9, 5.1 Hz, 1H), 3.96 (tt, *J* = 10.5, 5.1 Hz, 1H), 3.64 (s, 3H), 3.12 (dd, *J* = 14.0, 5.1 Hz, 1H), 3.02 (dd, *J* = 13.8, 7.8 Hz, 1H), 2.91 (s, 3H), 2.43 (s, 3H), 2.13 (dt, *J* = 8.9, 6.0 Hz, 2H), 1.39 (s, 9H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 174.3, 172.6, 171.0, 155.7, 144.4, 134.2, 130.4, 127.6, 125.9, 119.3, 78.6, 54.3, 52.8, 52.6, 35.9, 35.4, 31.9, 28.6, 28.2, 21.5. HRMS (ESI) m/z calcd. for $C_{24}H_{36}N_4NaO_8S_2^+$ [M + Na]$^+$: 595.1867, found: 595.1862.

Ethyl N-(((benzyloxy)carbonyl)-L-asparaginyl)-S-((Z)-2-((N,4-dimethylphenyl) sulfonamido)vinyl)-L-cysteinate (11e)



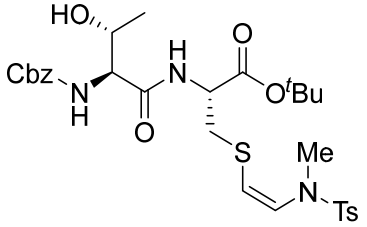
White solid, (86.2 mg, yield 71%); R_f = 0.2 (PE/EA =2:1); ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.35 (d, *J* = 7.7 Hz, 1H), 7.66 (d, *J* = 7.9 Hz, 2H), 7.47 – 7.25 (m, 9H), 6.92 (s, 1H), 6.07 (d, *J* = 7.6 Hz, 1H), 5.89 (d, *J* = 7.6 Hz, 1H), 5.00 (d, *J* = 3.7 Hz, 2H), 4.42 (dd, *J* = 8.4, 4.9 Hz, 2H), 4.07 (q, *J* = 7.1 Hz, 2H), 3.13 – 2.96 (m, 2H), 2.88 (s, 3H), 2.46 (d, *J* = 4.5 Hz, 1H), 2.42 (s, 1H), 2.39 (s, 3H), 1.17 (t, *J* = 7.1 Hz, 3H). ^{13}C NMR (100 MHz, DMSO-d_6) δ 172.1, 171.6, 170.4, 156.1, 144.4, 137.3, 134.1, 130.4, 128.8, 128.3, 128.2, 127.6, 125.8, 119.5, 65.9, 61.4, 53.2, 51.9, 37.7, 35.9, 35.3, 21.5, 14.4. HRMS (ESI) m/z calcd. for $C_{27}H_{34}N_4NaO_8S_2^+$ [M + Na]$^+$: 629.1710, found: 629.1706.

Ethyl N-(((benzyloxy)carbonyl)-L-seryl)-S-((Z)-2-((N,4-dimethylphenyl) sulfonamido)vinyl)-L-cysteinate (11f)



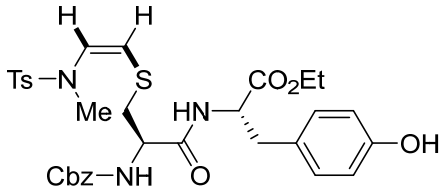
White solid, (90.3 mg, yield 78%); R_f = 0.2 (PE/EA =2:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, *J* = 8.0 Hz, 2H), 7.41 (d, *J* = 7.8 Hz, 1H), 7.37 – 7.27 (m, 7H), 6.03 (d, *J* = 7.5 Hz, 1H), 5.94 (d, *J* = 7.6 Hz, 1H), 5.63 (d, *J* = 7.5 Hz, 1H), 5.12 (d, *J* = 2.5 Hz, 2H), 4.80 (dt, *J* = 8.0, 5.0 Hz, 1H), 4.34 (d, *J* = 8.9 Hz, 1H), 4.19 (q, *J* = 7.1 Hz, 2H), 4.03 (dt, *J* = 10.0, 4.5 Hz, 1H), 3.72 (dt, *J* = 11.9, 6.4 Hz, 1H), 3.28 (t, *J* = 6.3 Hz, 1H), 3.13 (t, *J* = 4.7 Hz, 2H), 2.95 (s, 3H), 2.41 (s, 3H), 1.26 (t, *J* = 7.1 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.7, 169.9, 156.4, 144.0, 136.1, 134.1, 129.8, 128.5, 128.2, 128.0, 127.4, 126.4, 119.1, 67.2, 62.9, 62.2, 55.8, 52.8, 36.3, 35.9, 21.5, 14.1. HRMS (ESI) m/z calcd. for $C_{26}H_{33}N_3NaO_8S_2^+$ $[M + Na]^+$: 602.1601, found: 602.1599.

Tert-butyl N-(((benzyloxy)carbonyl)-L-threonyl)-S-((Z)-2-((N,4-dimethylphenyl) sulfonamido)vinyl)-L-cysteinate (11g)



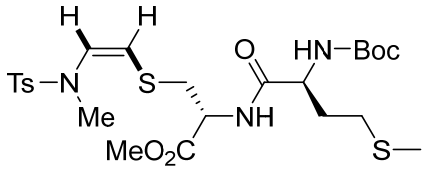
White solid, (93.3 mg, yield 75%); R_f = 0.2 (PE/EA =2:1); ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.67 (d, *J* = 7.9 Hz, 2H), 7.39 (s, 1H), 7.36 – 7.28 (m, 7H), 6.04 (d, *J* = 7.4 Hz, 1H), 5.91 (t, *J* = 7.1 Hz, 1H), 5.67 (d, *J* = 7.5 Hz, 1H), 5.12 (s, 2H), 4.72 (dt, *J* = 7.6, 4.9 Hz, 1H), 4.34 (d, *J* = 6.7 Hz, 1H), 4.24 (m, 1H), 3.39 (d, *J* = 29.2 Hz, 1H), 3.10 (dd, *J* = 7.3, 4.7 Hz, 2H), 2.96 (s, 3H), 2.41 (s, 3H), 1.46 (s, 9H), 1.18 (d, *J* = 6.4 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.5, 168.7, 156.7, 143.9, 136.2, 134.3, 129.8, 128.5, 128.2, 128.0, 127.4, 126.0, 119.6, 83.3, 67.2, 59.0, 53.4, 48.9, 36.6, 35.9, 27.9, 21.5, 18.4. HRMS (ESI) m/z calcd. for $C_{29}H_{39}N_3NaO_8S_2^+$ $[M + Na]^+$: 644.2071, found: 644.2075.

Ethyl N-((benzyloxy)carbonyl)-S-((Z)-2-((N,4-dimethylphenyl) sulfonamido) vinyl)-L-cysteinyl-L-tyrosinate (11h)



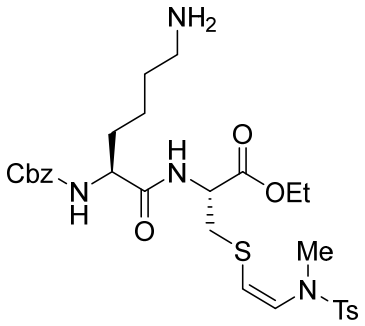
White solid, (107.4 mg, yield 82%); R_f = 0.2 (PE/EA =2:1); ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.29 (s, 1H), 8.38 (d, J = 7.5 Hz, 1H), 7.67 (d, J = 7.9 Hz, 2H), 7.49 (d, J = 8.8 Hz, 1H), 7.43 (d, J = 8.0 Hz, 2H), 7.37 – 7.30 (m, 5H), 6.99 (d, J = 8.1 Hz, 2H), 6.68 (d, J = 8.0 Hz, 2H), 6.00 (s, 2H), 5.02 (q, J = 12.5 Hz, 2H), 4.42 (q, J = 7.3 Hz, 1H), 4.23 (td, J = 9.6, 4.1 Hz, 1H), 3.58 (s, 3H), 3.00 (dd, J = 13.8, 4.0 Hz, 1H), 2.96 – 2.87 (m, 2H), 2.85 (s, 3H), 2.82 – 2.74 (m, 1H), 2.39 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 172.2, 170.6, 156.5, 156.3, 144.4, 137.3, 134.2, 130.5, 130.4, 128.8, 128.3, 128.1, 127.6, 127.3, 124.9, 120.5, 115.6, 66.0, 60.2, 55.3, 54.5, 52.3, 36.3, 35.9, 21.5. HRMS (ESI) m/z calcd. for $C_{32}H_{38}N_3O_8S_2^+$ $[M + H]^+$: 656.2095, found: 656.2094.

Methyl N-((tert-butoxycarbonyl)-L-methionyl)-S-((Z)-2-((N,4-dimethylphenyl) sulfonamido)vinyl)-L-cysteinate (11i)



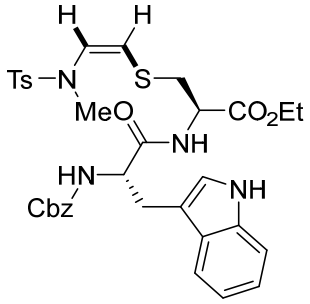
White solid, (105.8 mg, yield 92%); R_f = 0.2 (PE/EA =2:1); ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.25 (d, J = 7.7 Hz, 1H), 7.64 – 7.59 (m, 2H), 7.40 (d, J = 8.1 Hz, 2H), 6.90 (d, J = 8.2 Hz, 1H), 6.02 (d, J = 7.6 Hz, 1H), 5.84 (d, J = 7.7 Hz, 1H), 4.40 (td, J = 8.0, 4.9 Hz, 1H), 4.01 (td, J = 8.4, 5.0 Hz, 1H), 3.57 (s, 3H), 3.06 (dd, J = 14.0, 5.0 Hz, 1H), 2.95 (dd, J = 14.1, 8.3 Hz, 1H), 2.84 (s, 3H), 2.40 (t, J = 7.7 Hz, 2H), 2.36 (s, 3H), 1.98 (s, 3H), 1.75 (ddd, J = 29.5, 13.7, 7.1 Hz, 2H), 1.32 (s, 9H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 172.4, 171.0, 155.7, 144.4, 134.2, 130.4, 127.6, 125.9, 119.3, 78.6, 53.8, 52.8, 52.6, 35.9, 35.3, 32.2, 30.1, 28.6, 21.5, 15.1. HRMS (ESI) m/z calcd. for $C_{24}H_{37}N_3NaO_7S_3^+$ $[M + Na]^+$: 598.1686, found: 598.1680.

Methyl N-(((benzyloxy)carbonyl)-L-lysyl)-S-((Z)-2-((N,4-dimethylphenyl) sulfonamido)vinyl)-L-cysteinate (11j)



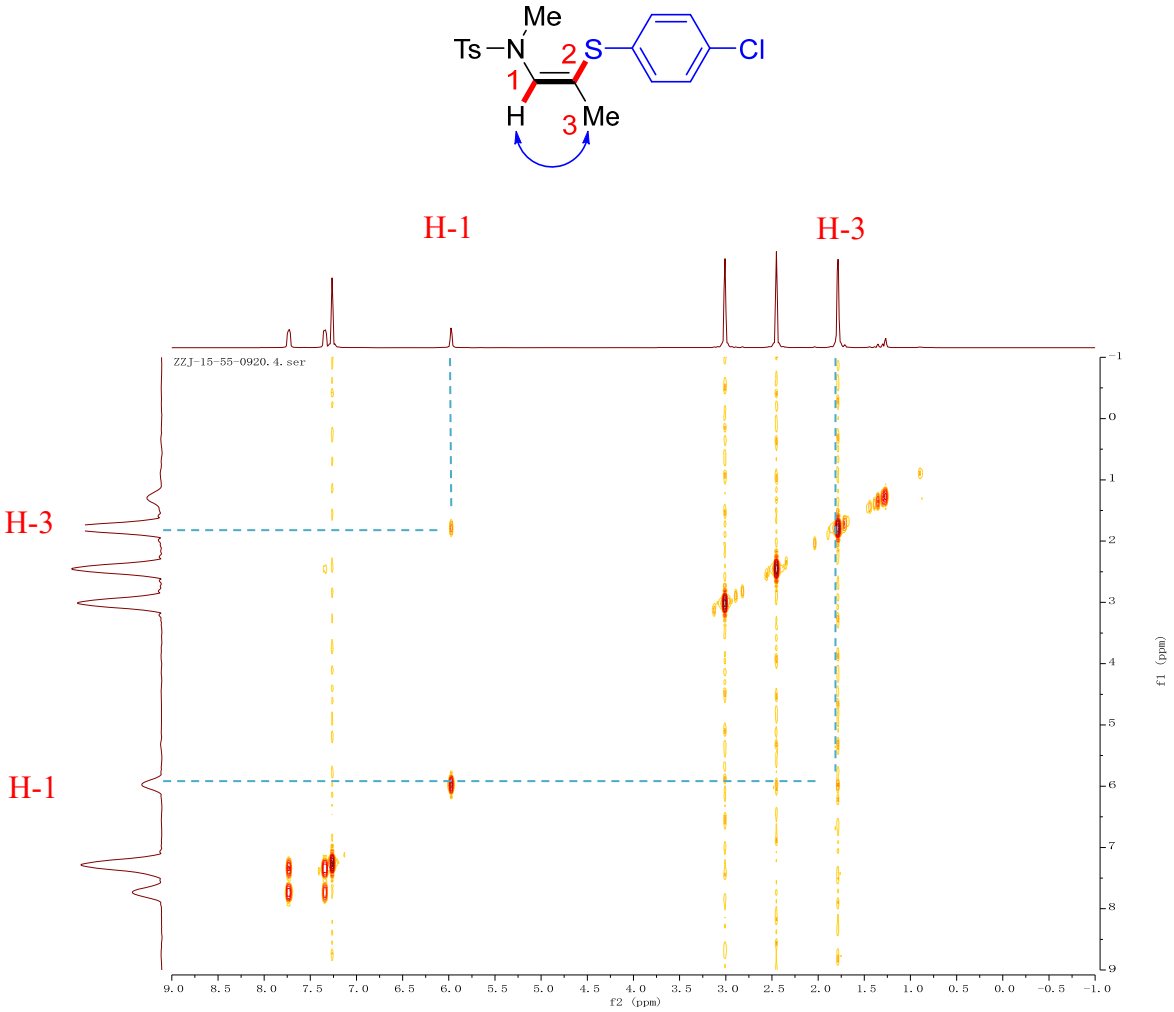
White solid, (90.6 mg, yield 73%); R_f = 0.2 (DCM/MeOH = 5:1); ^{1}H NMR (400 MHz, DMSO-*d*$_6$) δ 8.45 (d, *J* = 7.7 Hz, 1H), 7.63 (d, *J* = 8.1 Hz, 2H), 7.41 (d, *J* = 8.1 Hz, 2H), 7.33 (m, 5H), 6.03 (d, *J* = 7.8 Hz, 1H), 5.90 (d, *J* = 7.6 Hz, 1H), 4.99 (m *J* = 12.8, 7.3 Hz, 2H), 4.39 (m, *J* = 7.2 Hz, 1H), 4.14 – 3.91 (m, 4H), 3.08 – 2.91 (m, 2H), 2.84 (s, 3H), 2.37 (s, 3H), 1.62 – 1.55 (m, 1H), 1.52 – 1.45 (m, 1H), 1.35 – 1.19 (m, 6H), 1.14 (t, *J* = 7.0 Hz, 4H). ^{13}C NMR (100 MHz, DMSO-*D*$_6$) δ 172.3, 170.2, 155.9, 144.0, 137.0, 133.6, 130.0, 128.4, 127.8, 127.7, 127.2, 125.3, 119.3, 65.4, 60.9, 54.5, 52.6, 40.9, 35.5, 34.8, 31.9, 31.8, 22.7, 21.1, 14.0. HRMS (ESI) m/z calcd. for $C_{29}H_{41}N_4O_7S_2^+$ $[M + H]^+$: 621.2411, found: 621.2408.

Ethyl N-(((benzyloxy)carbonyl)-L-tryptophyl)-S-((Z)-2-((N,4-dimethylphenyl) sulfonamido)vinyl)-L-cysteinate (11k)



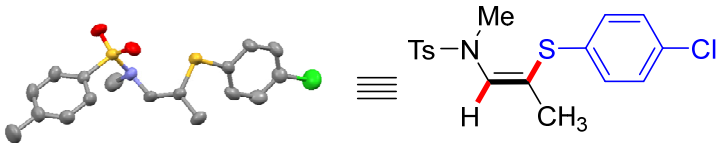
White solid, (118.0 mg, yield 87%); R_f = 0.2 (PE/EA =2:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.71 – 8.64 (m, 1H), 7.63 (d, *J* = 8.0 Hz, 3H), 7.29 (h, *J* = 7.9 Hz, 9H), 7.13 (t, *J* = 7.5 Hz, 1H), 7.11 – 7.02 (m, 2H), 6.75 (d, *J* = 7.5 Hz, 1H), 5.69 (d, *J* = 7.3 Hz, 1H), 5.59 (d, *J* = 7.8 Hz, 1H), 5.38 (d, *J* = 7.4 Hz, 1H), 5.16 – 5.04 (m, 2H), 4.70 (dt, *J* = 8.2, 4.6 Hz, 1H), 4.59 (d, *J* = 6.6 Hz, 1H), 4.10 (qq, *J* = 6.8, 3.7 Hz, 2H), 3.17 (dd, *J* = 14.6, 7.0 Hz, 1H), 3.04 – 2.93 (m, 2H), 2.82 (s, 3H), 2.39 (s, 3H), 1.21 (t, *J* = 7.1 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.4, 169.5, 156.0, 144.0, 136.4, 136.3, 133.9, 129.8, 128.5, 128.1, 128.0, 127.5, 125.6, 123.9, 122.1, 121.4, 119.6, 118.7, 111.5, 109.8, 67.0, 62.0, 55.6, 52.8, 36.4, 36.0, 21.6, 14.1. HRMS (ESI) m/z calcd. for $C_{34}H_{38}N_4NaO_7S_2^+$ $[M + Na]^+$: 701.2074, found: 701.2070.

5. NOESY 2-D NMR analysis of 6i



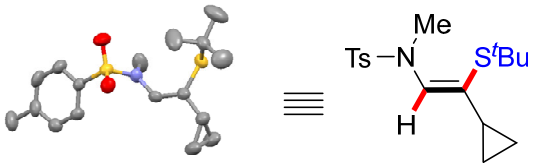
NOESY of **6i,** $CDCl_3$

6. X-ray structure for compound 6i and 6l



CDCC: 2383934 **6i**

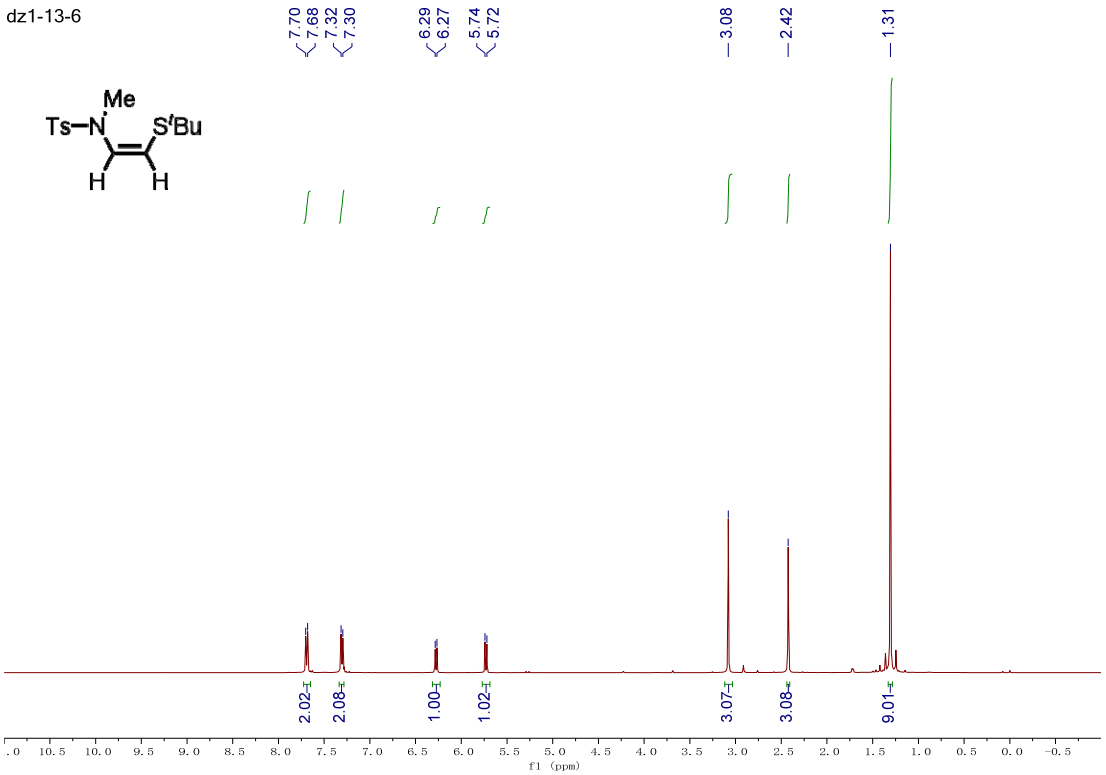
X-Ray crystal structure of **6i**



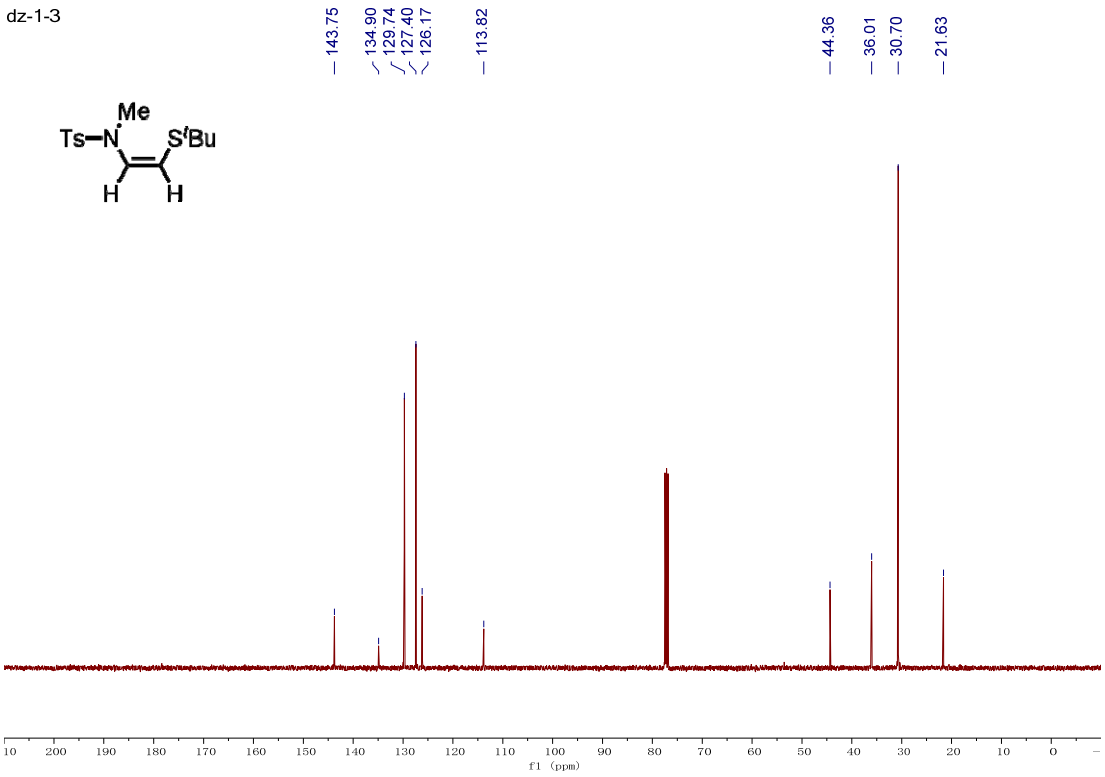
CDCC: 2383935 **6l**

X-Ray crystal structure of **6l**

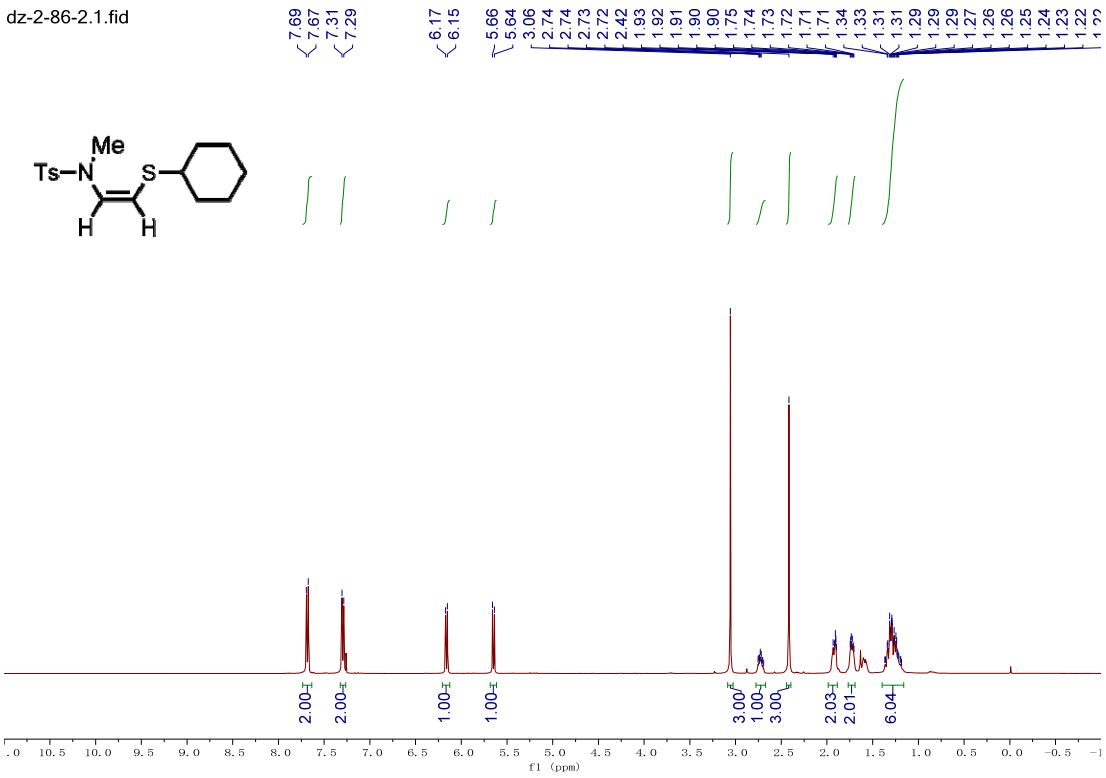
7. Copies of ^{1}H-NMR & ^{13}C-NMR Spectrum



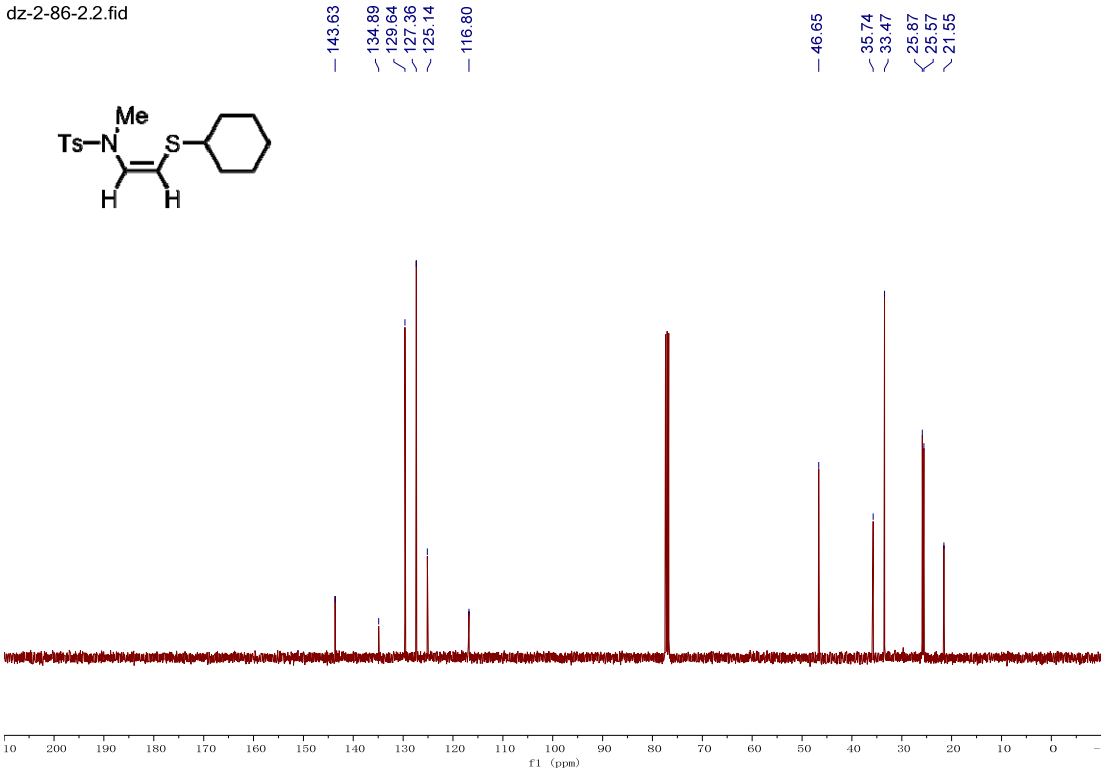
^{1}H NMR of **3a**



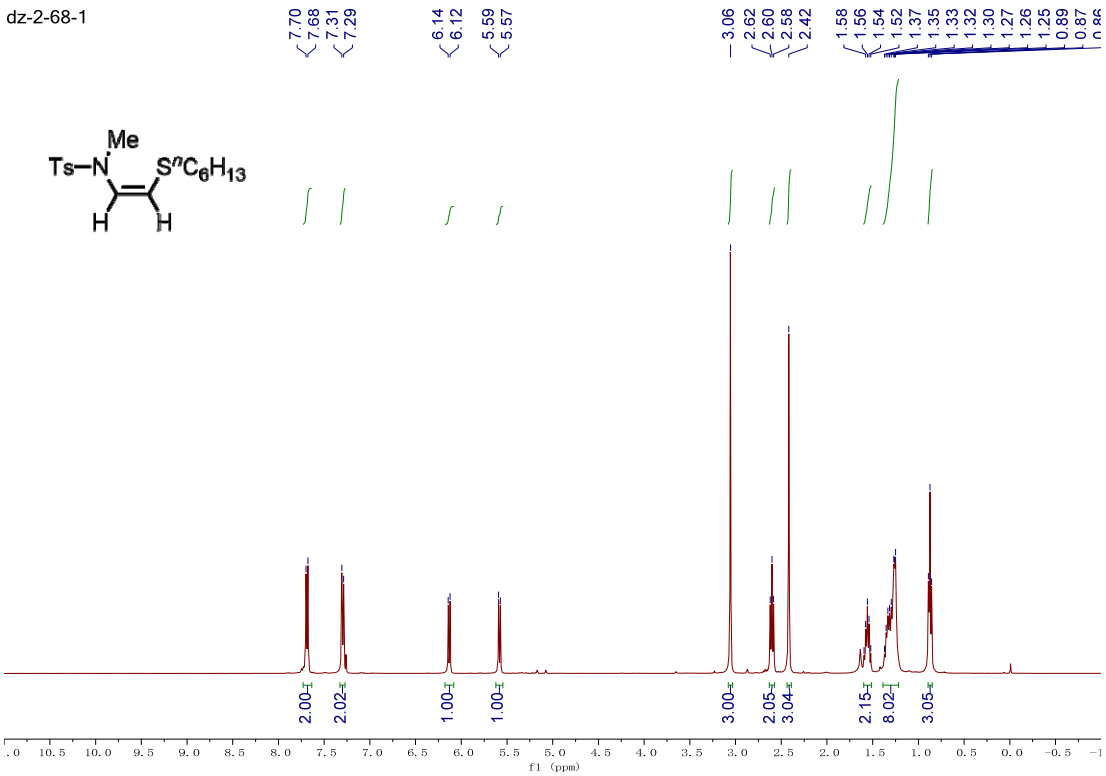
^{13}C NMR of **3a**



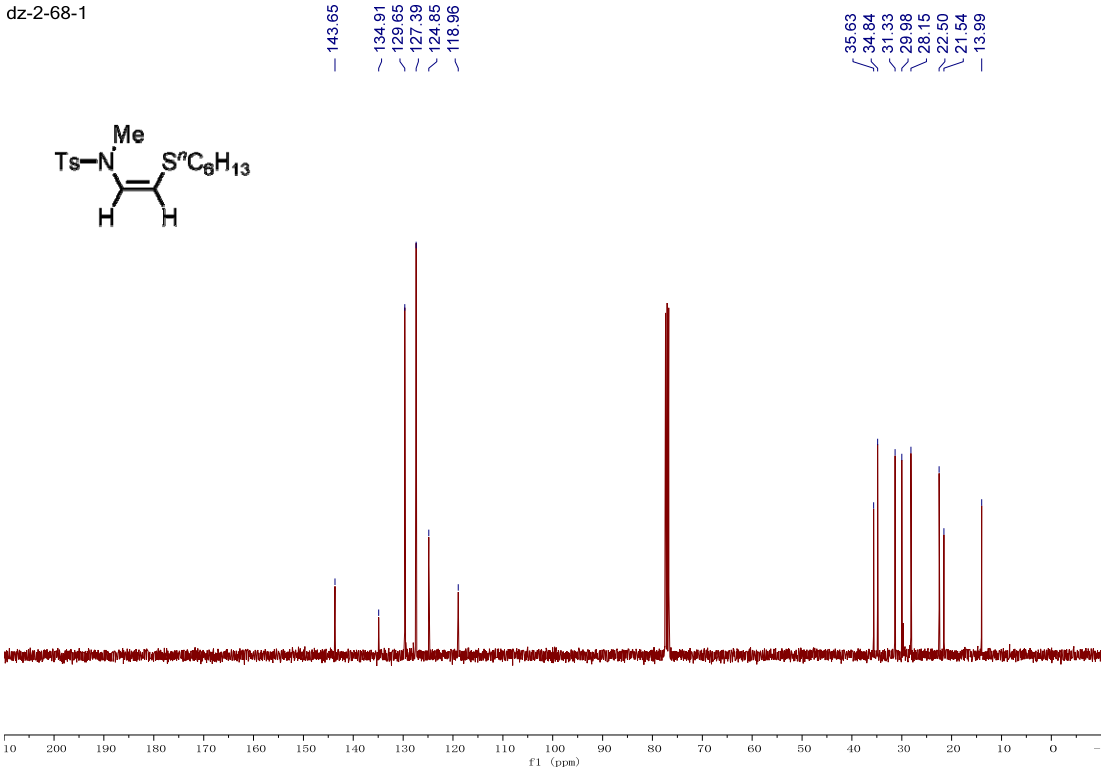
^{1}H NMR of **3b**



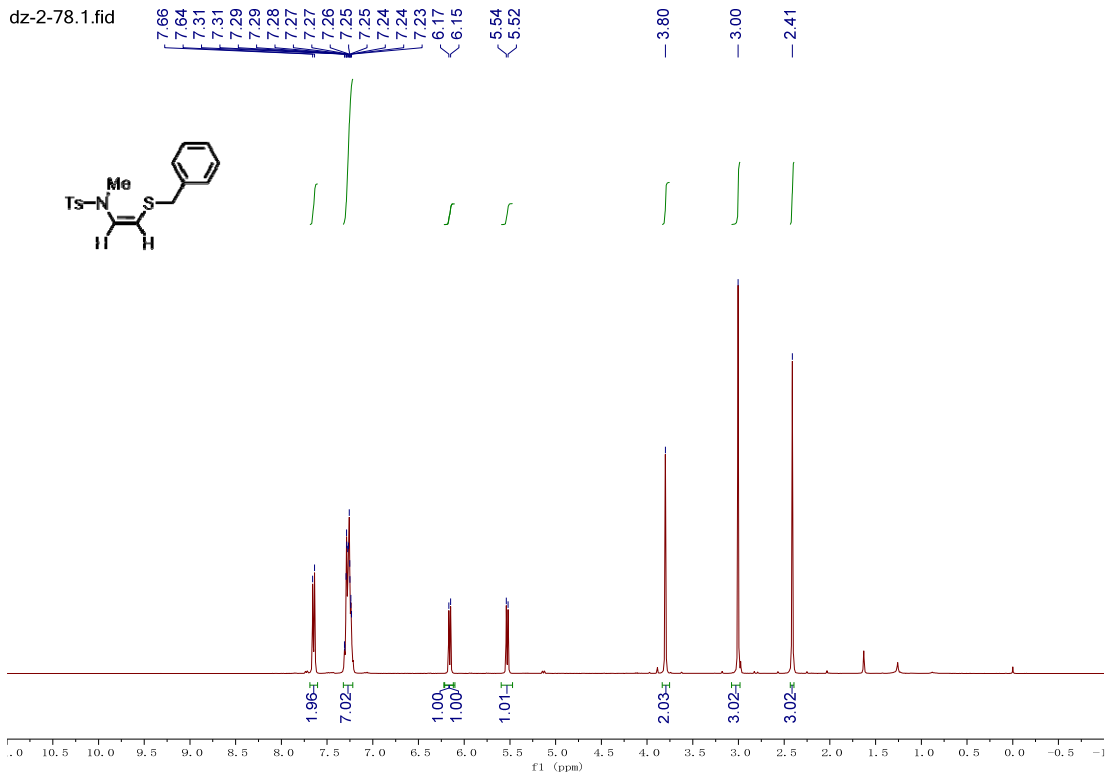
^{13}C NMR of **3b**



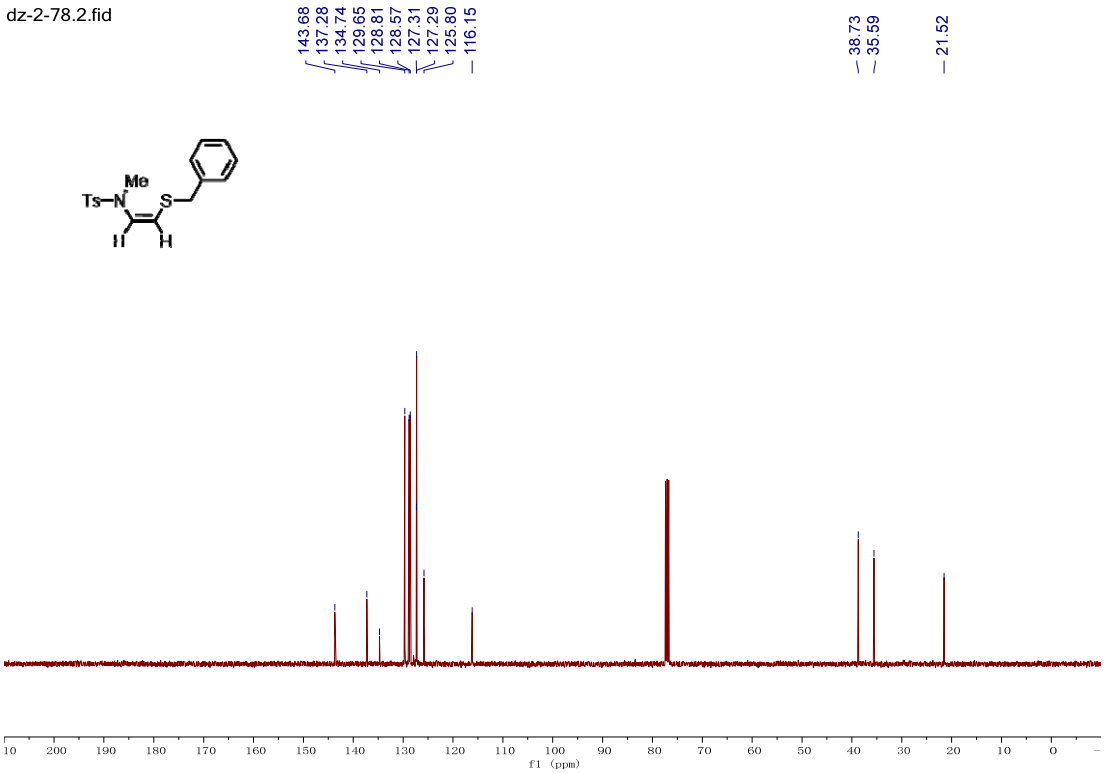
^{1}H NMR of **3c**



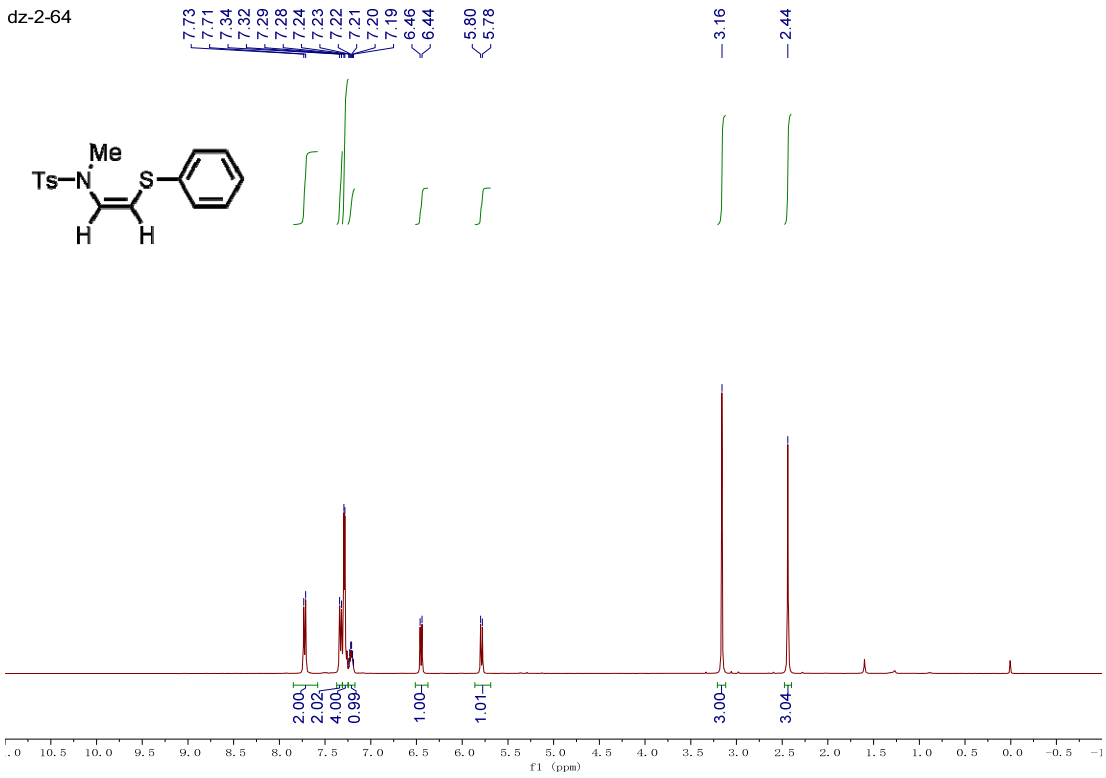
^{13}C NMR of **3c**



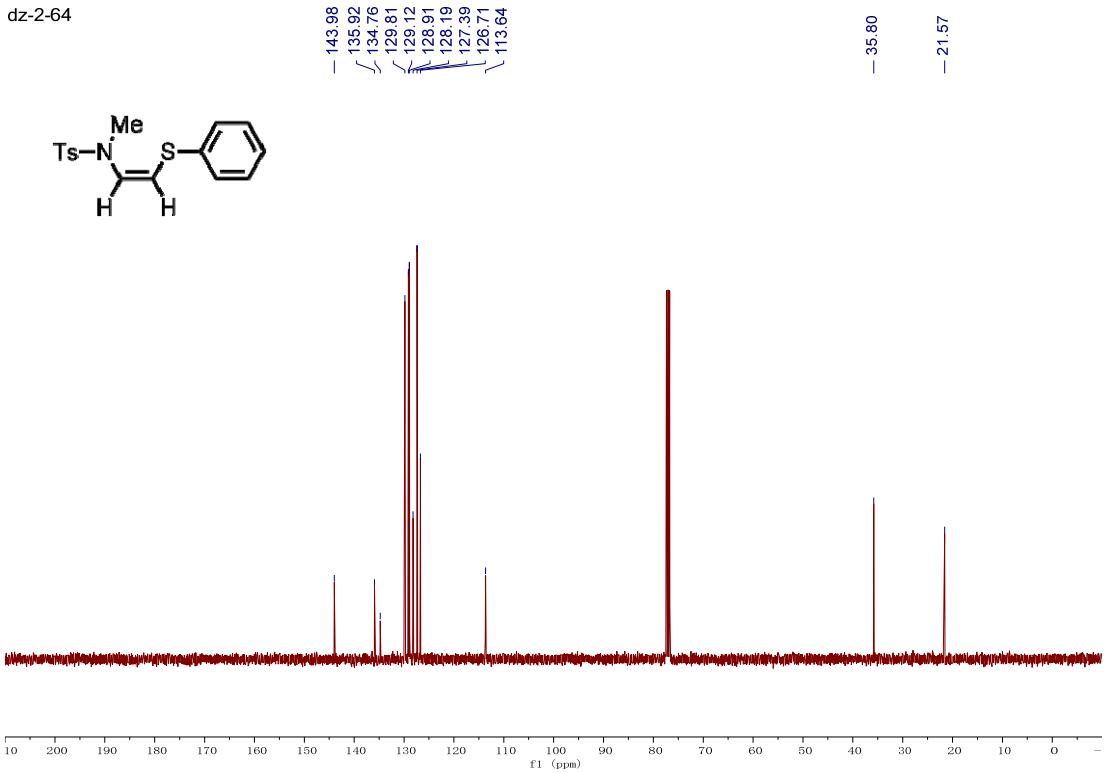
^{1}H NMR of **3d**



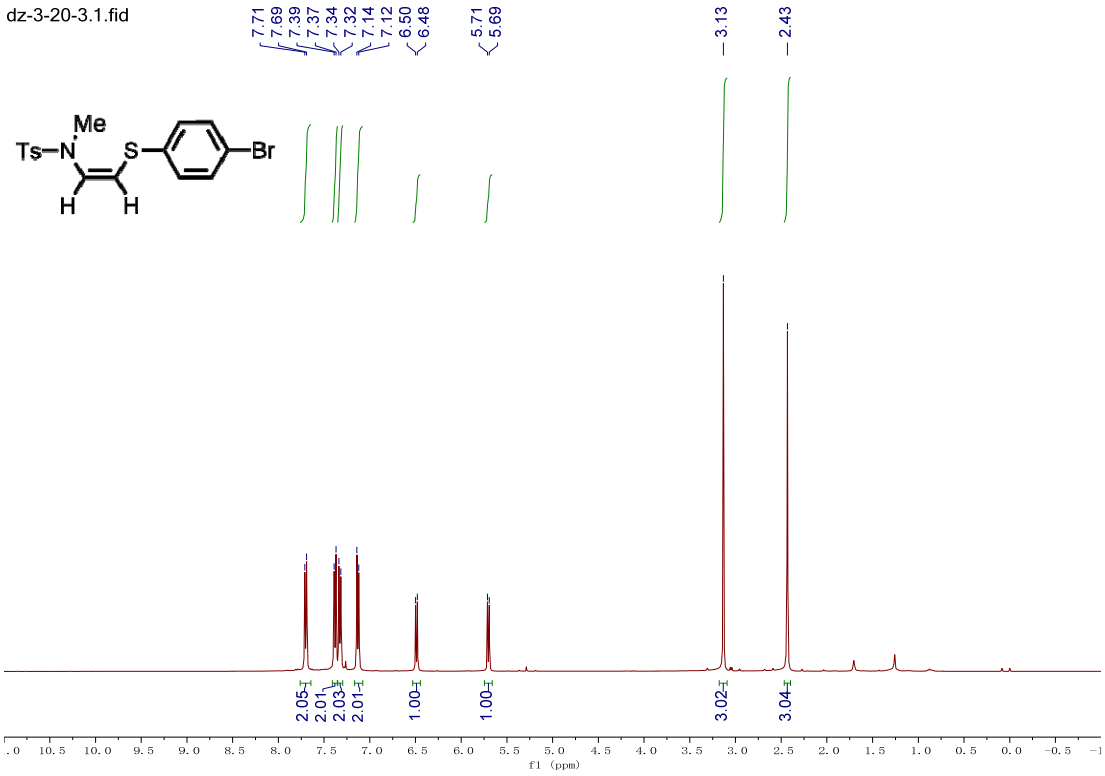
^{13}C NMR of **3d**



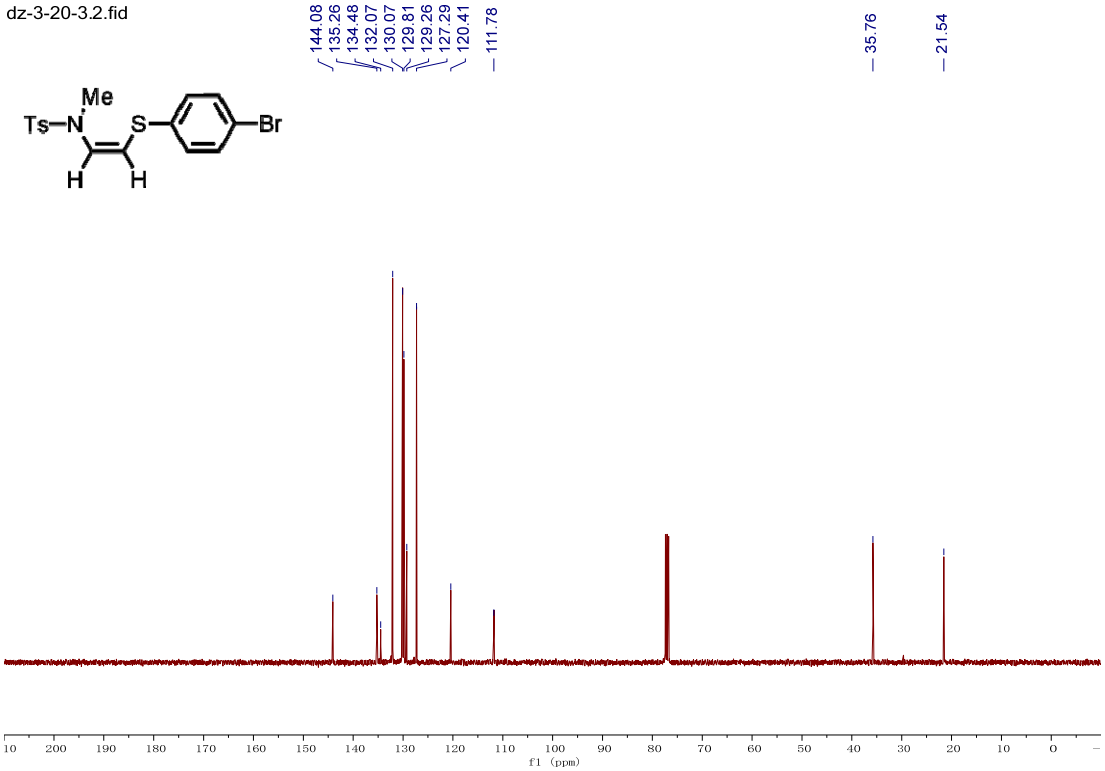
^{1}H NMR of **3e**



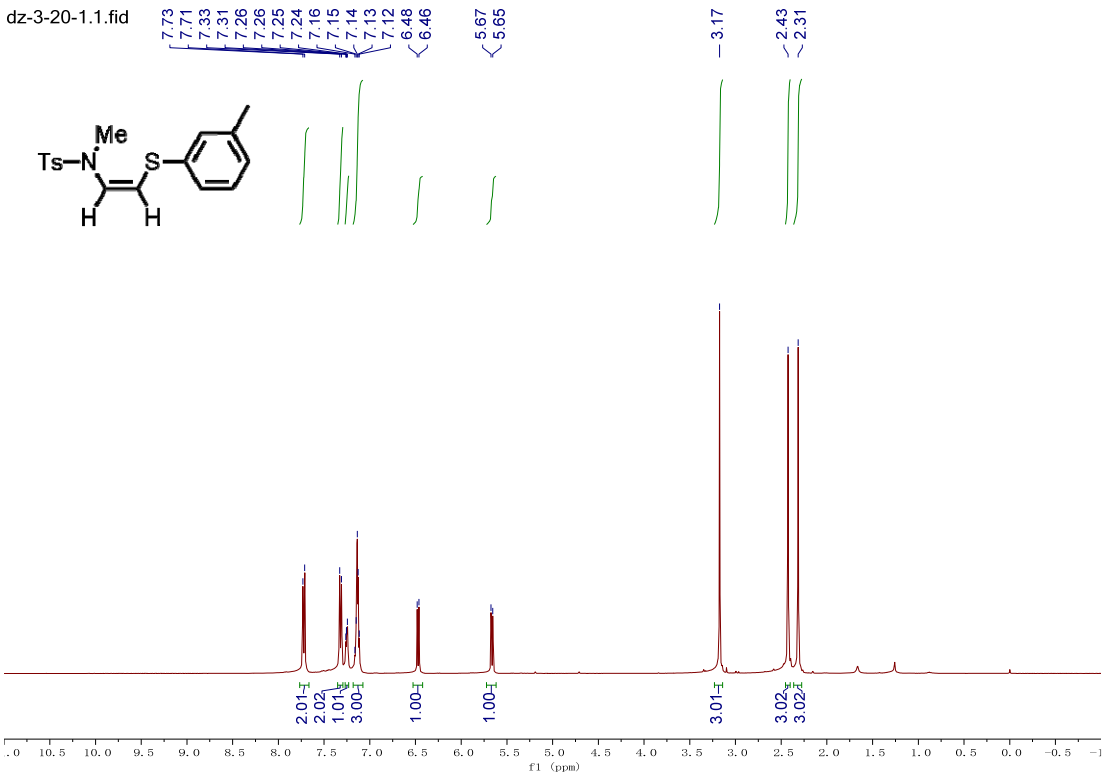
^{13}C NMR of **3e**



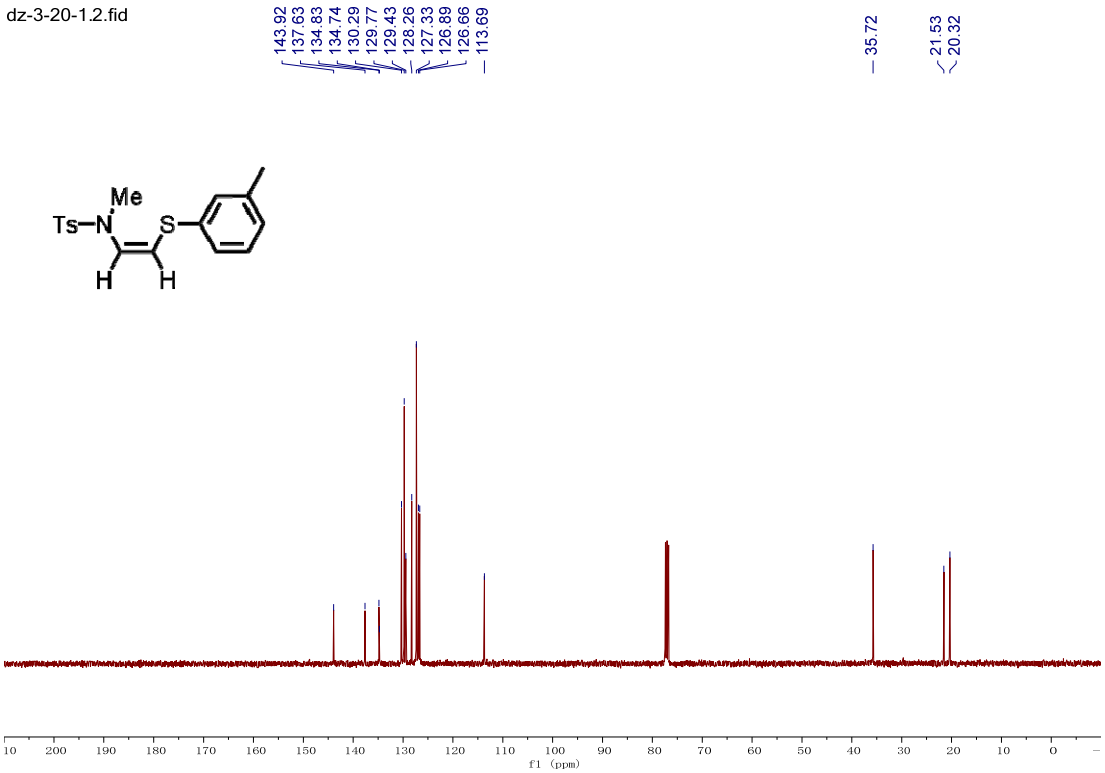
^{1}H NMR of **3f**



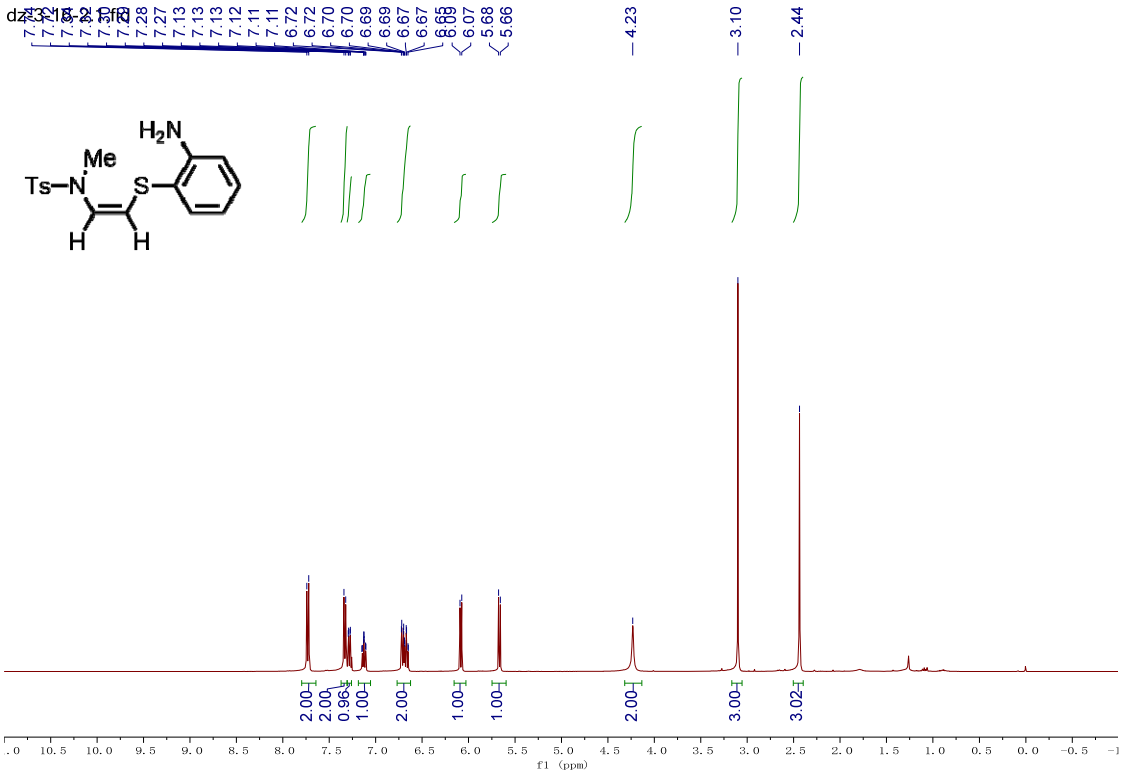
^{13}C NMR of **3f**



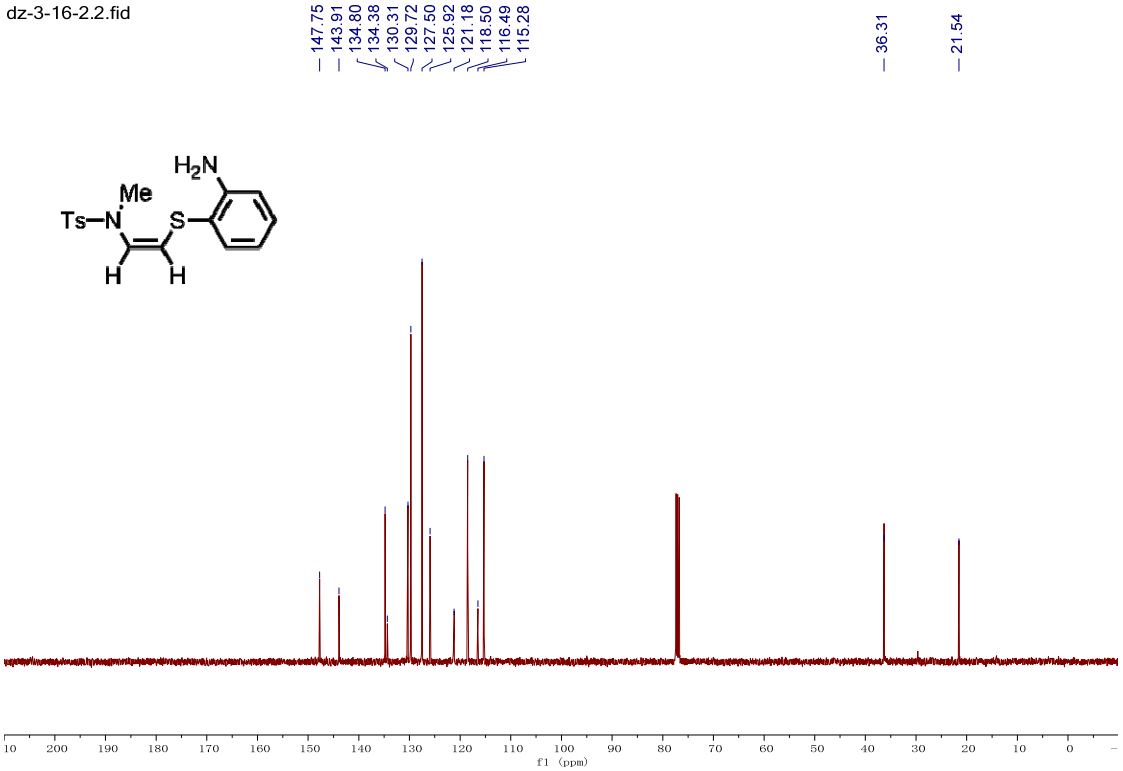
^{1}H NMR of **3g**



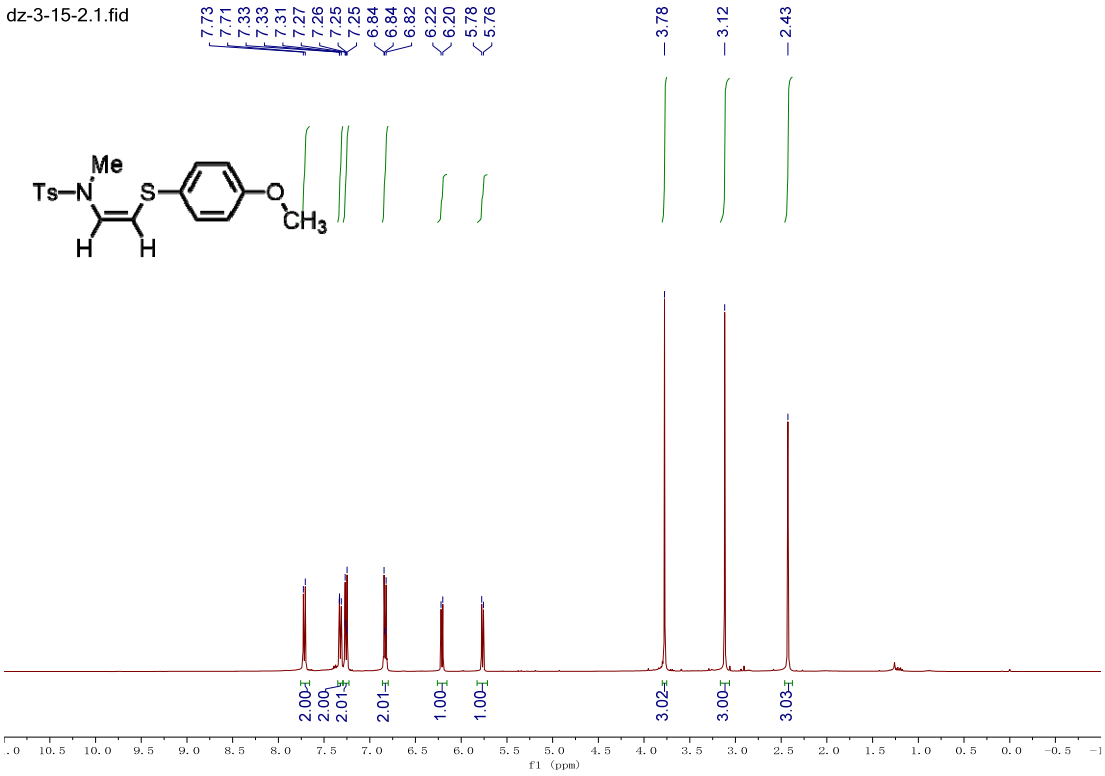
^{13}C NMR of **3g**



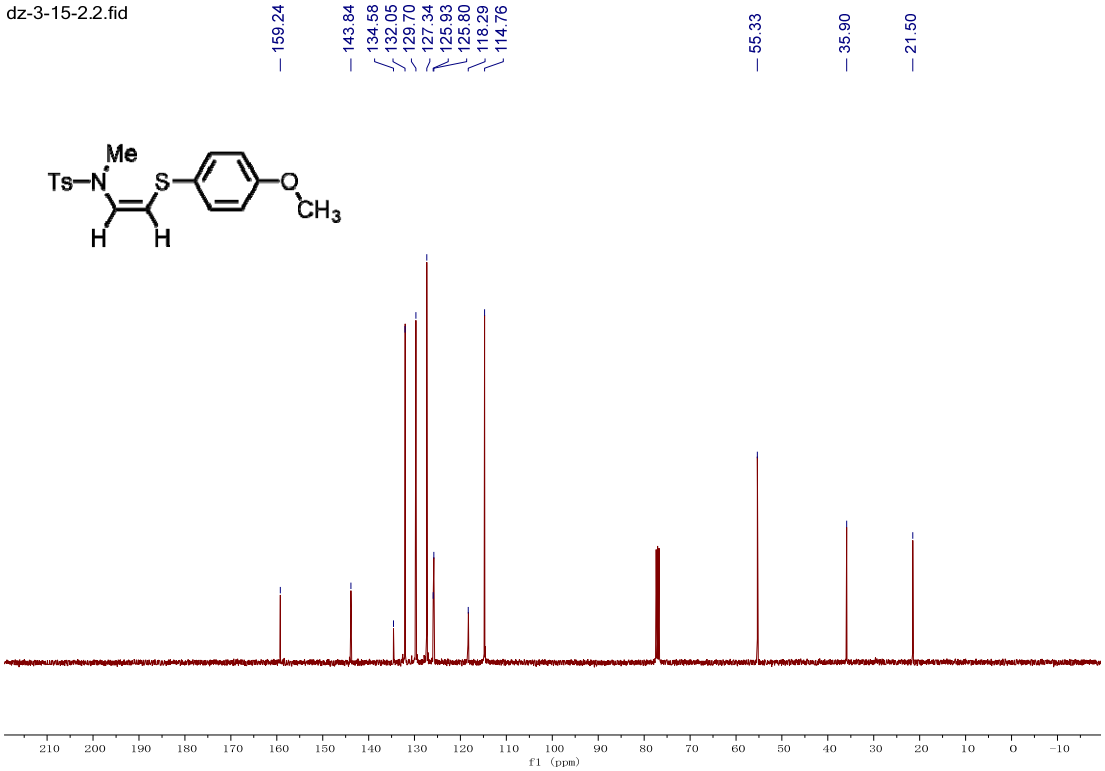
^{1}H NMR of **3h**



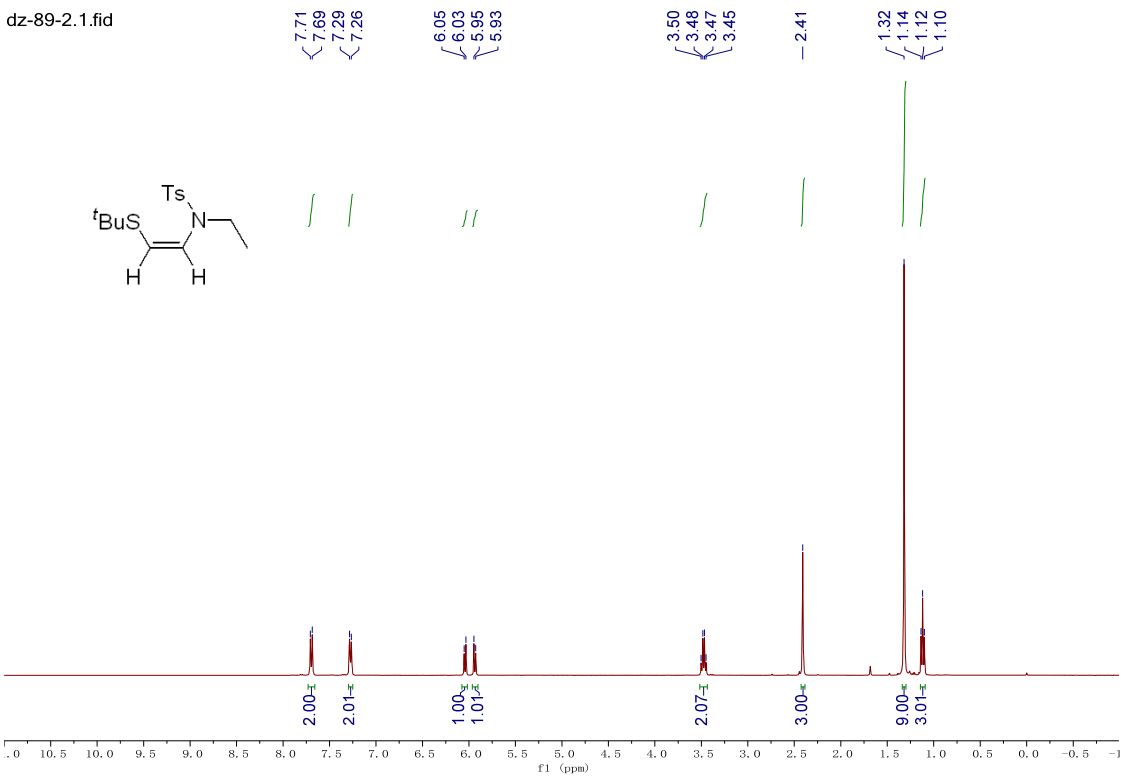
^{13}C NMR of **3h**



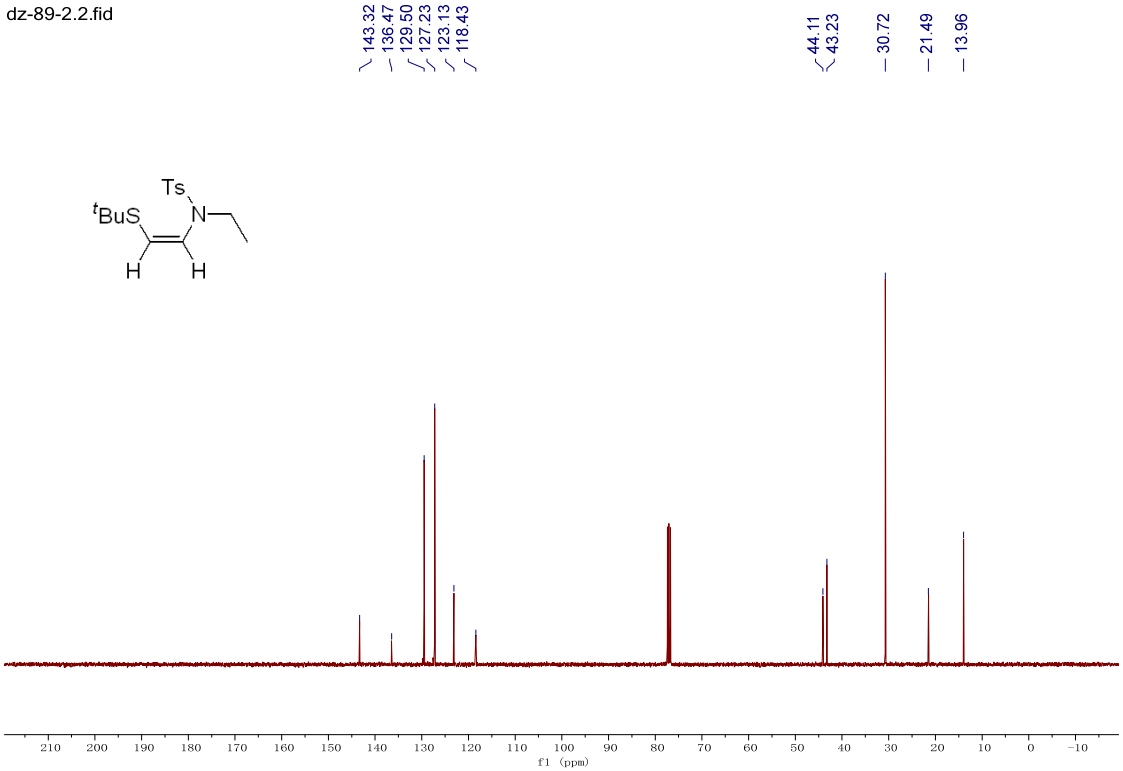
^{1}H NMR of **3i**



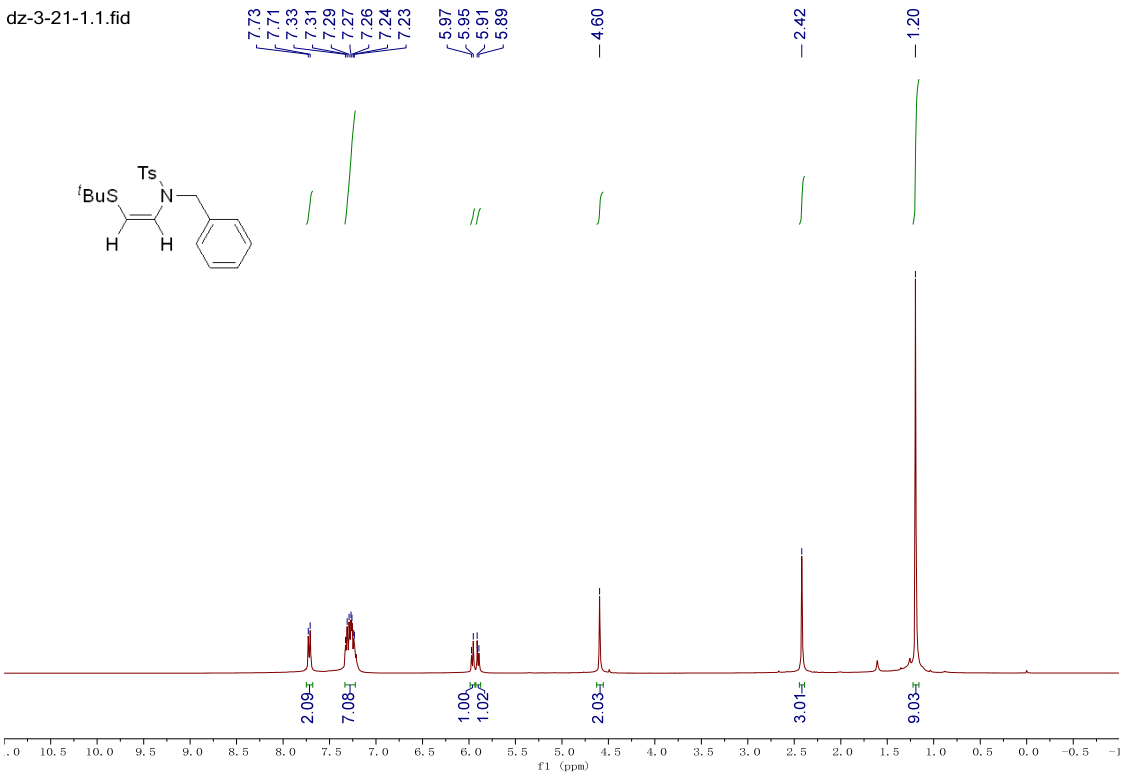
^{13}C NMR of **3i**



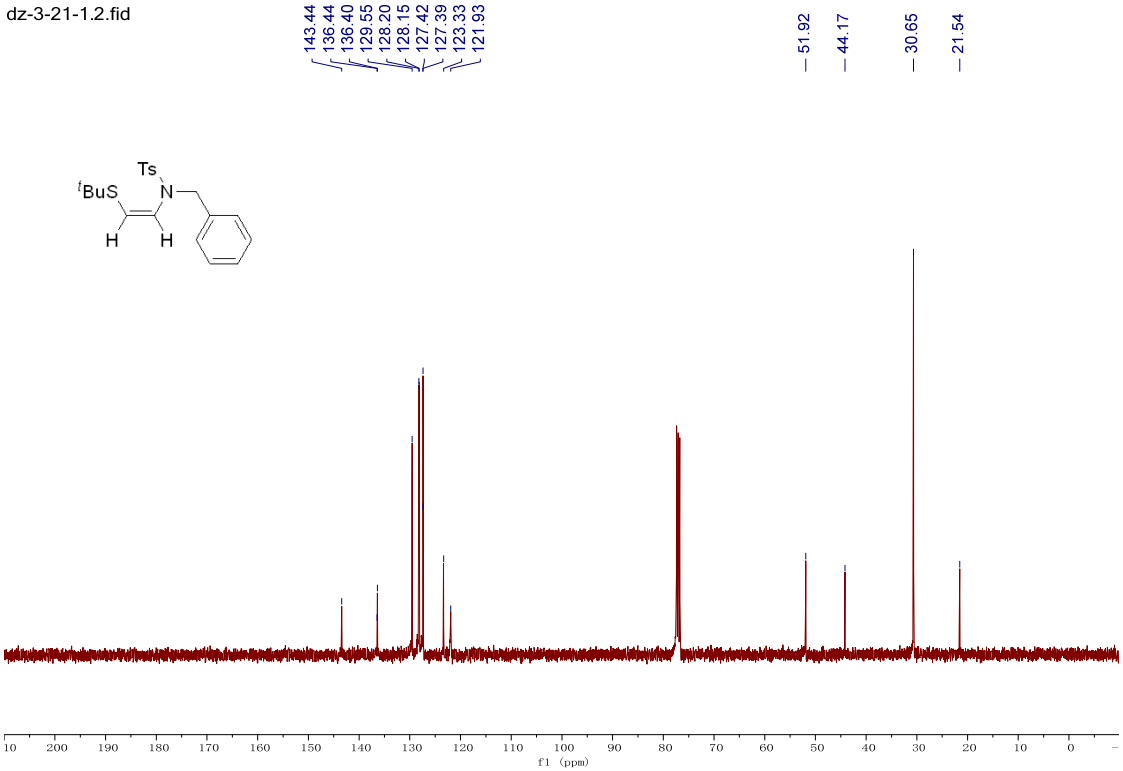
^{1}H NMR of **4a**



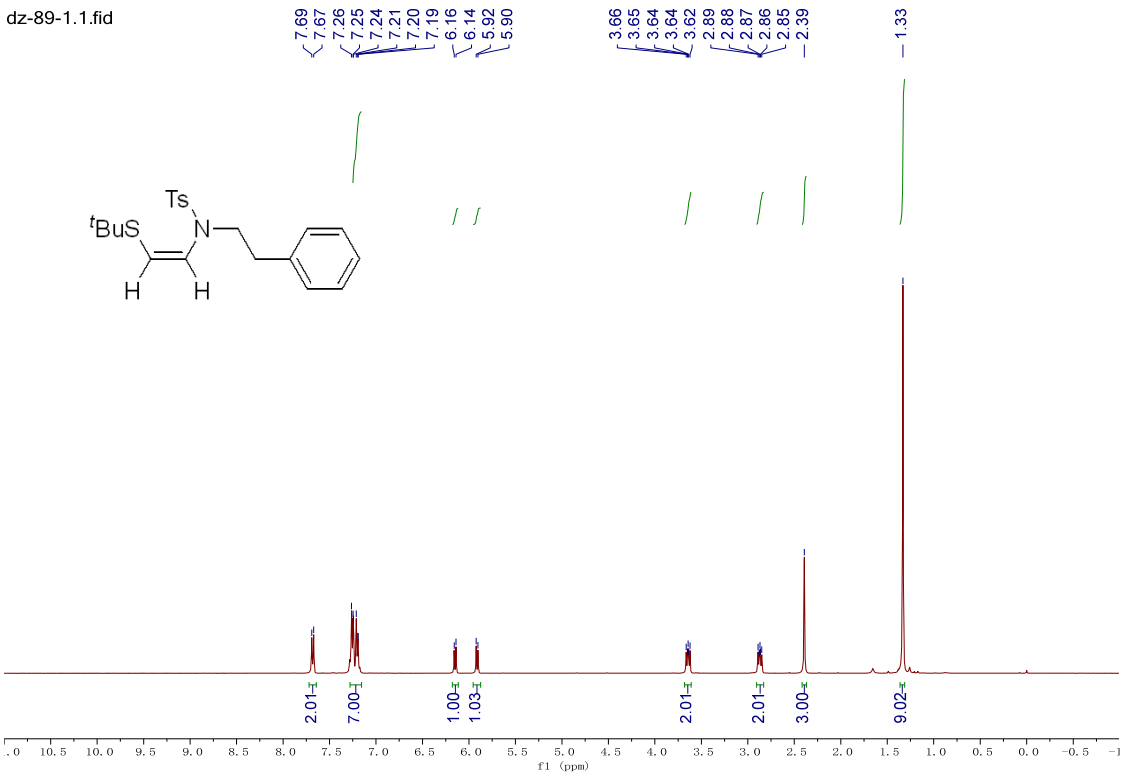
^{13}C NMR of **4a**



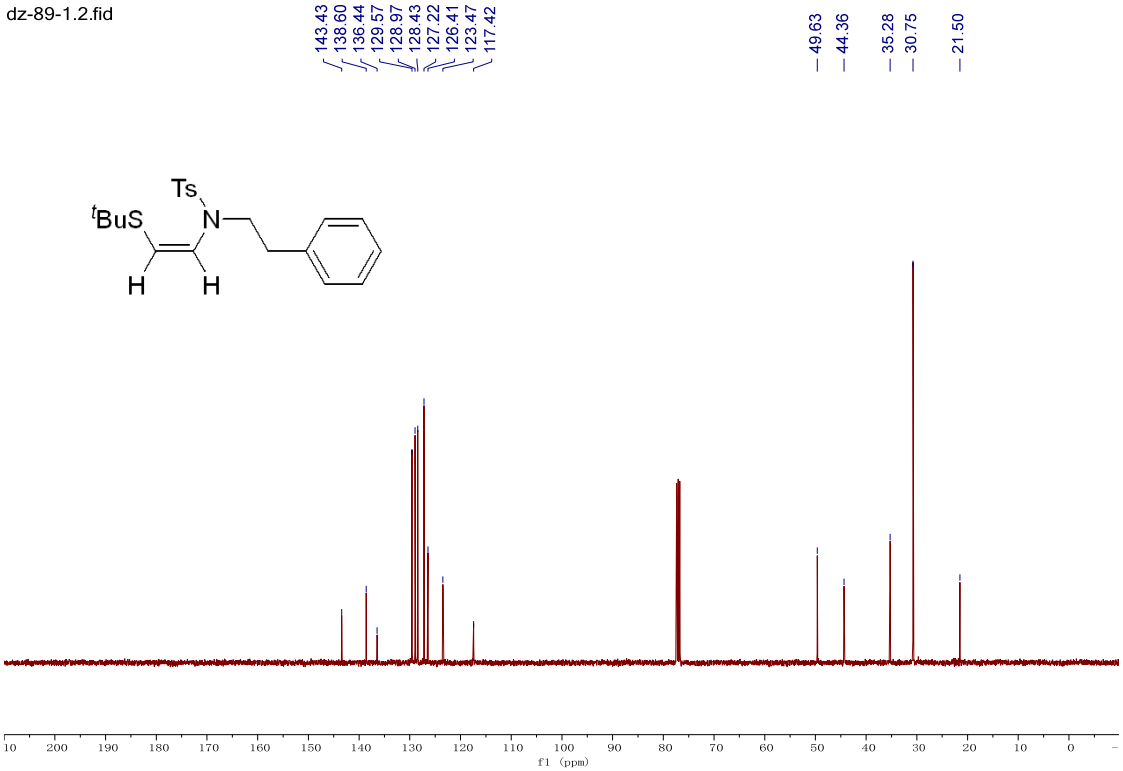
^{1}H NMR of **4b**



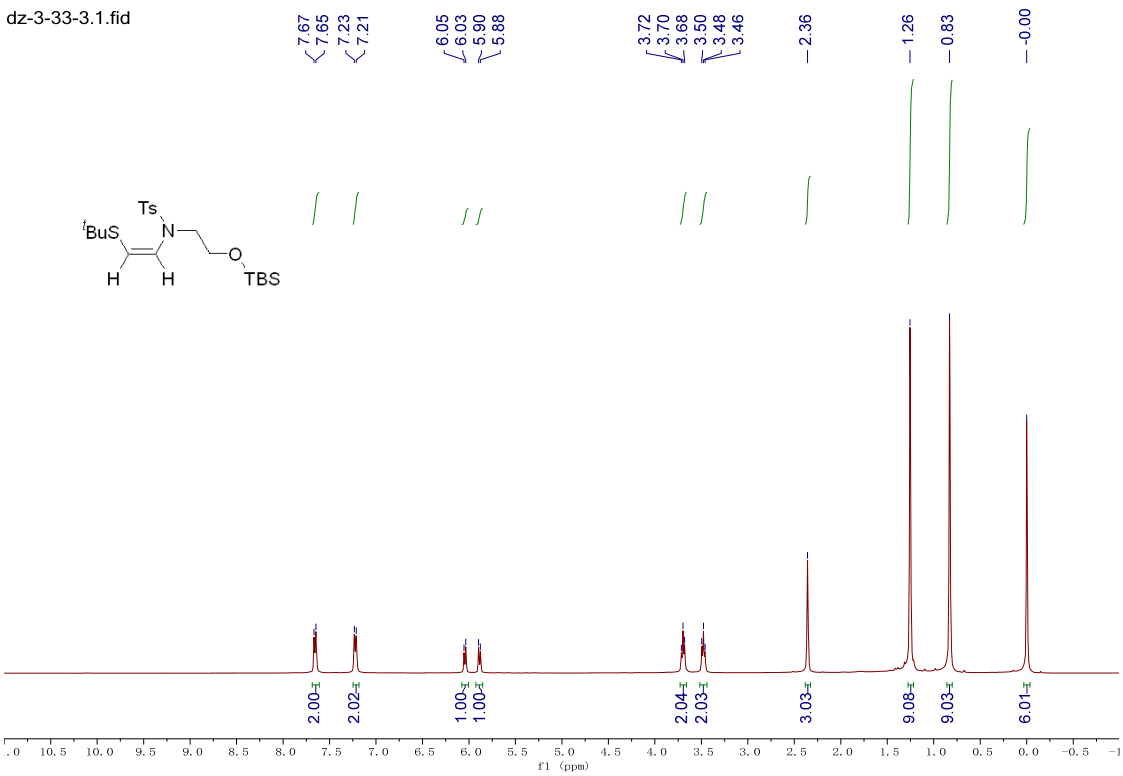
^{13}C NMR of **4b**



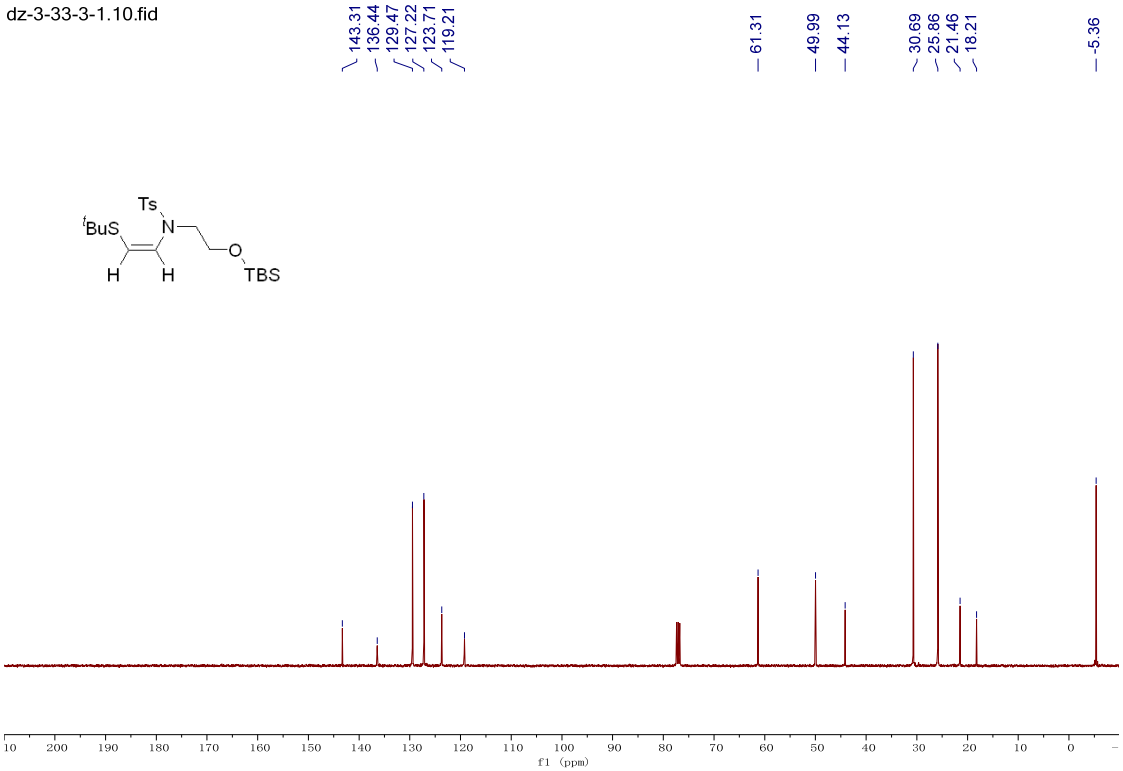
^{1}H NMR of **4c**



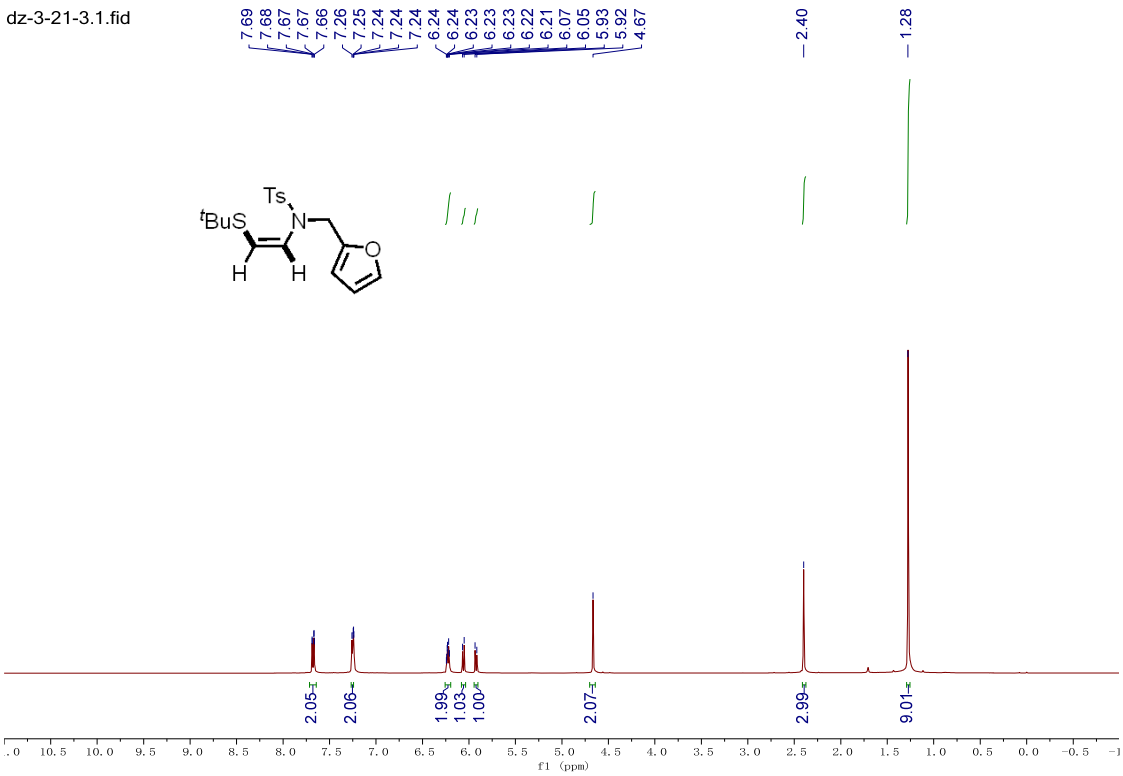
^{13}C NMR of **4c**



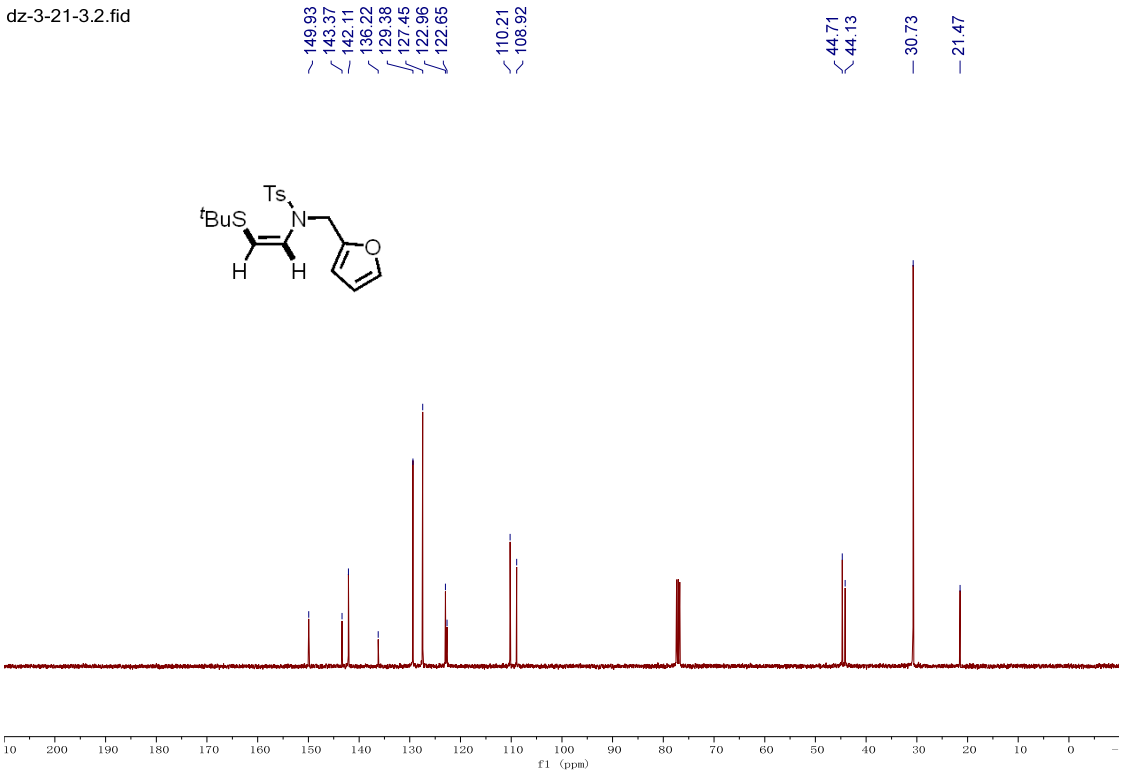
^{1}H NMR of **4d**



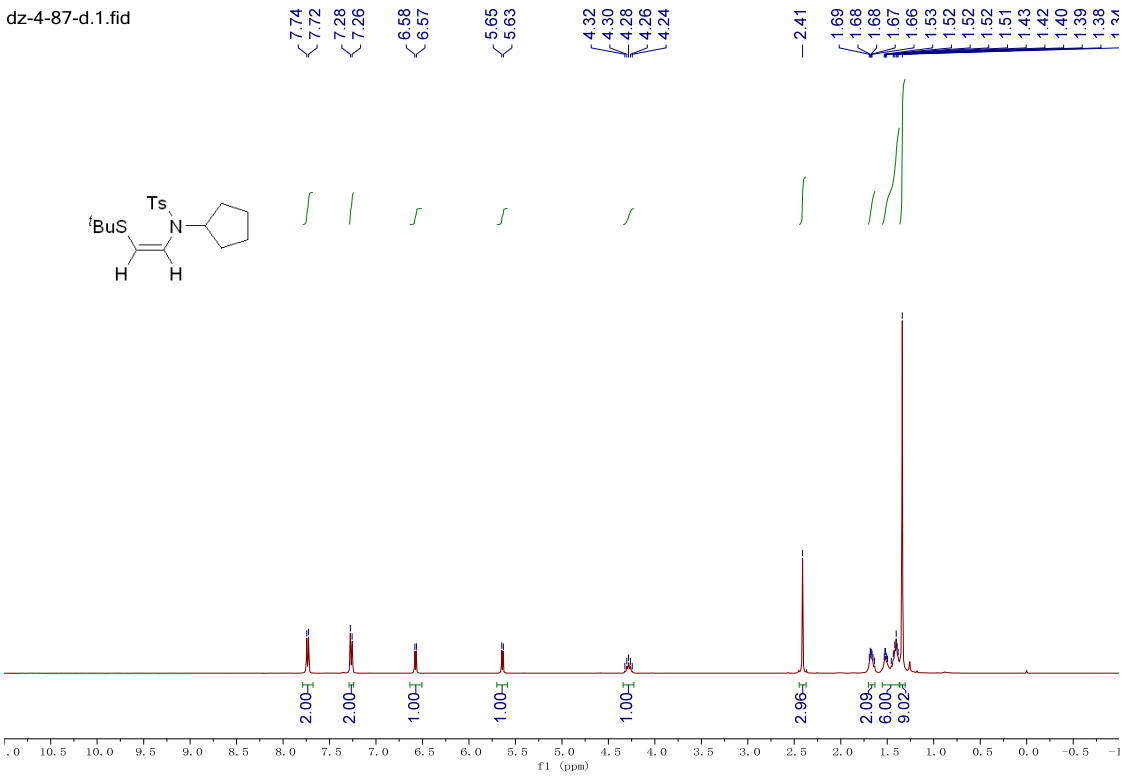
^{13}C NMR of **4d**



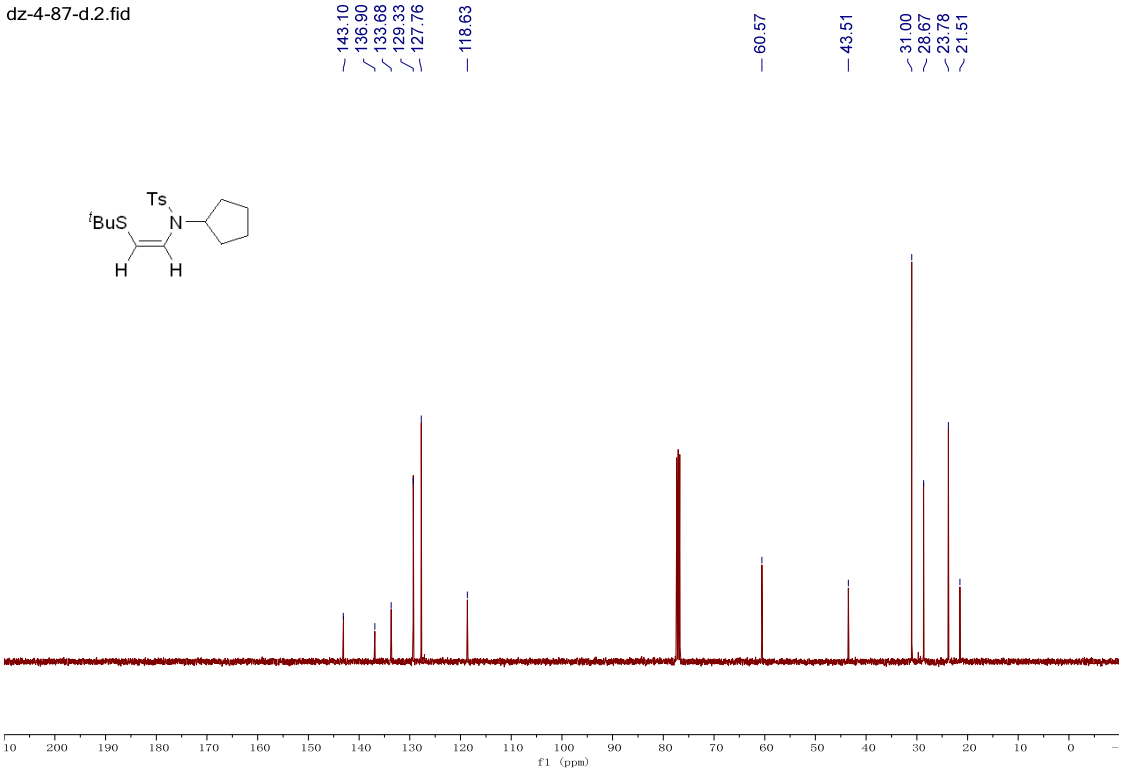
^{1}H NMR of **4e**



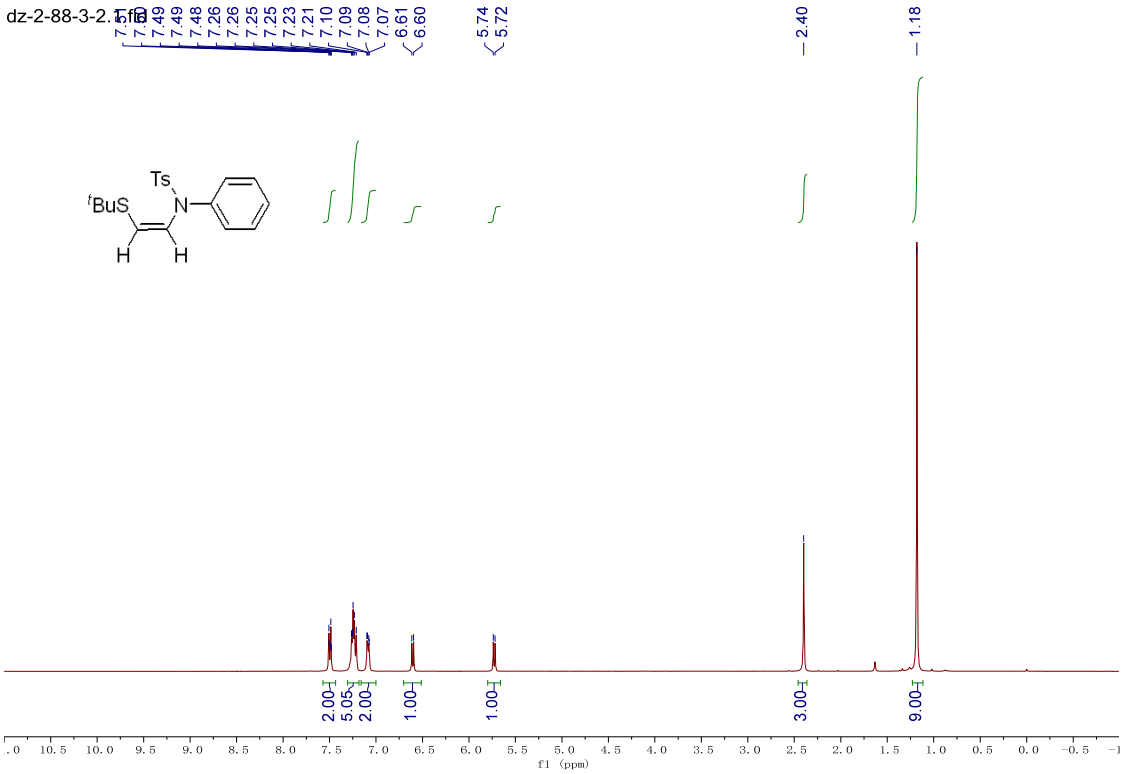
^{13}C NMR of **4e**



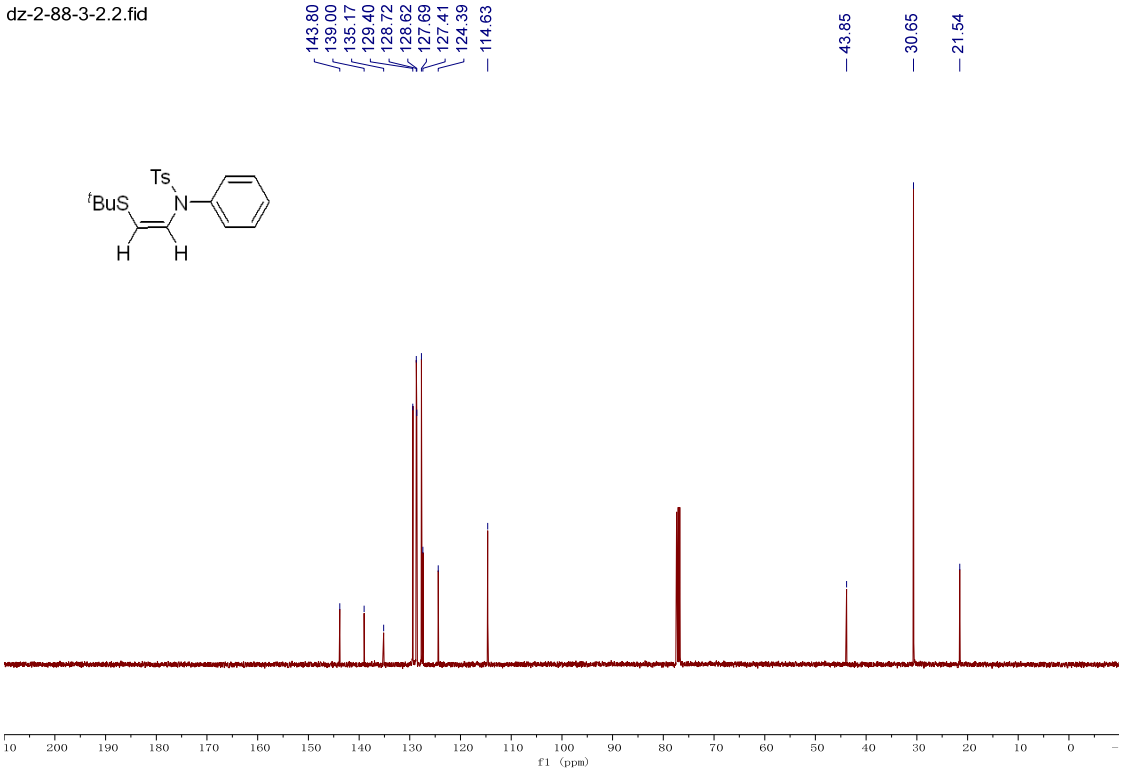
^{1}H NMR of **4f**



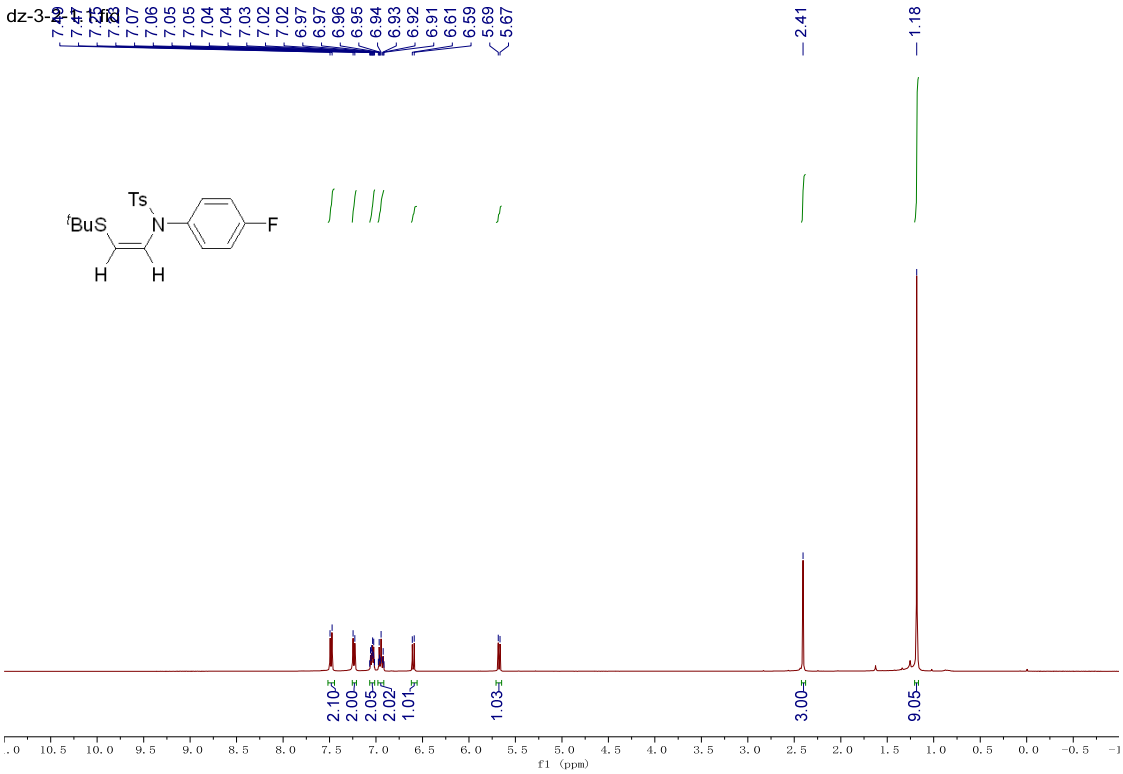
^{13}C NMR of **4f**



^{1}H NMR of **4g**



^{13}C NMR of **4g**



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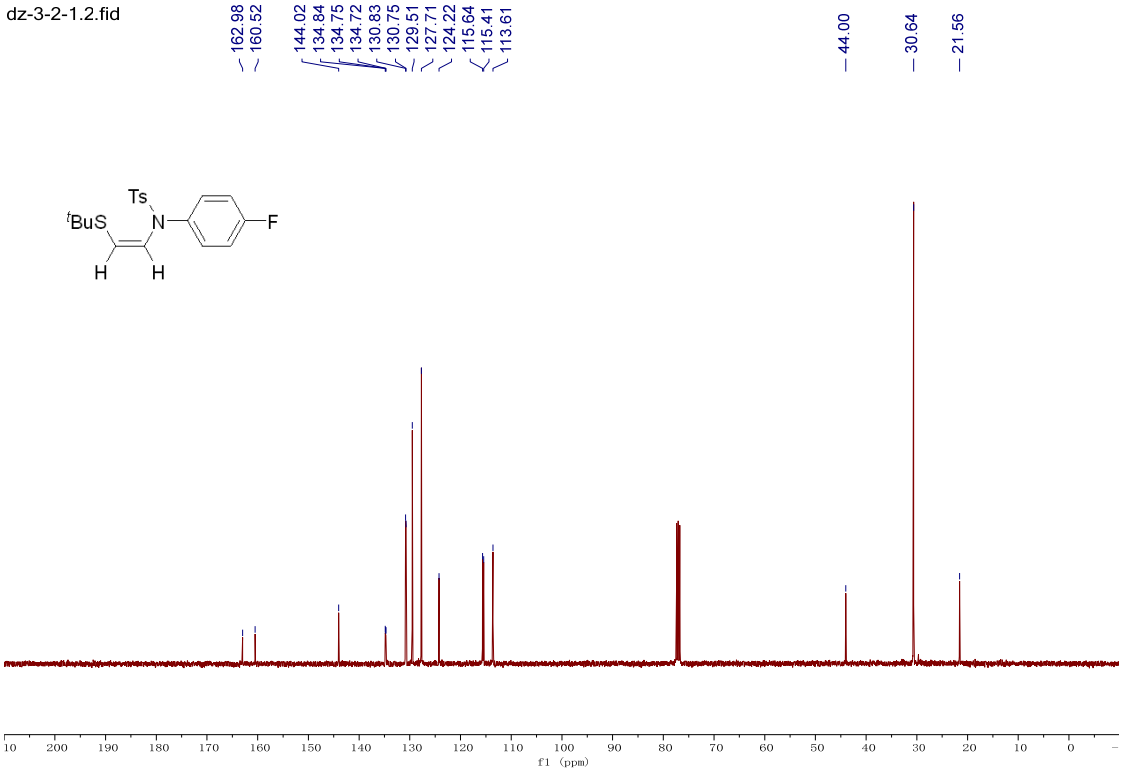

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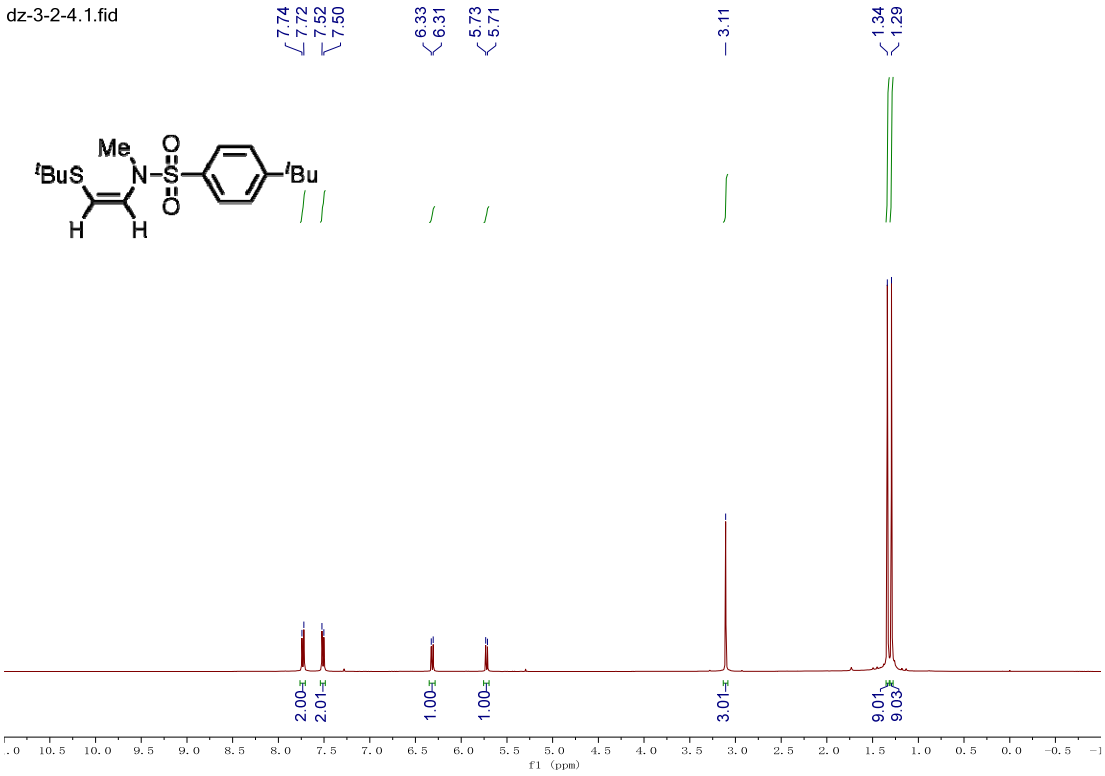
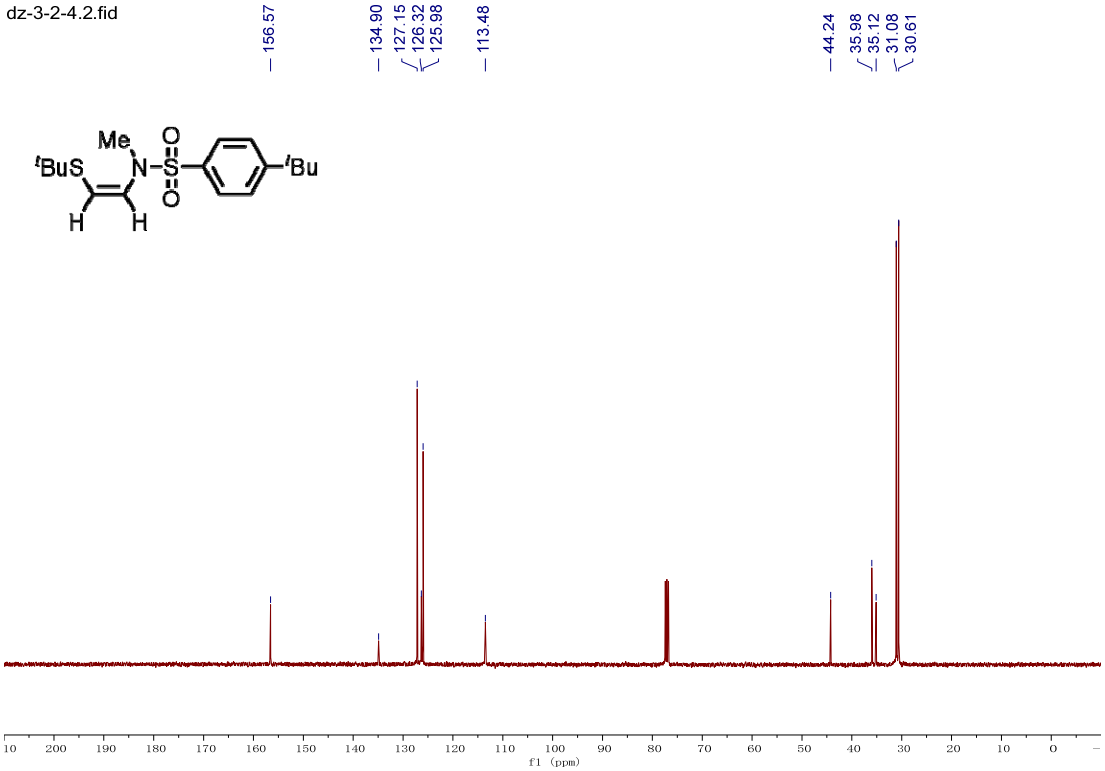


^{1}H NMR of **4i**



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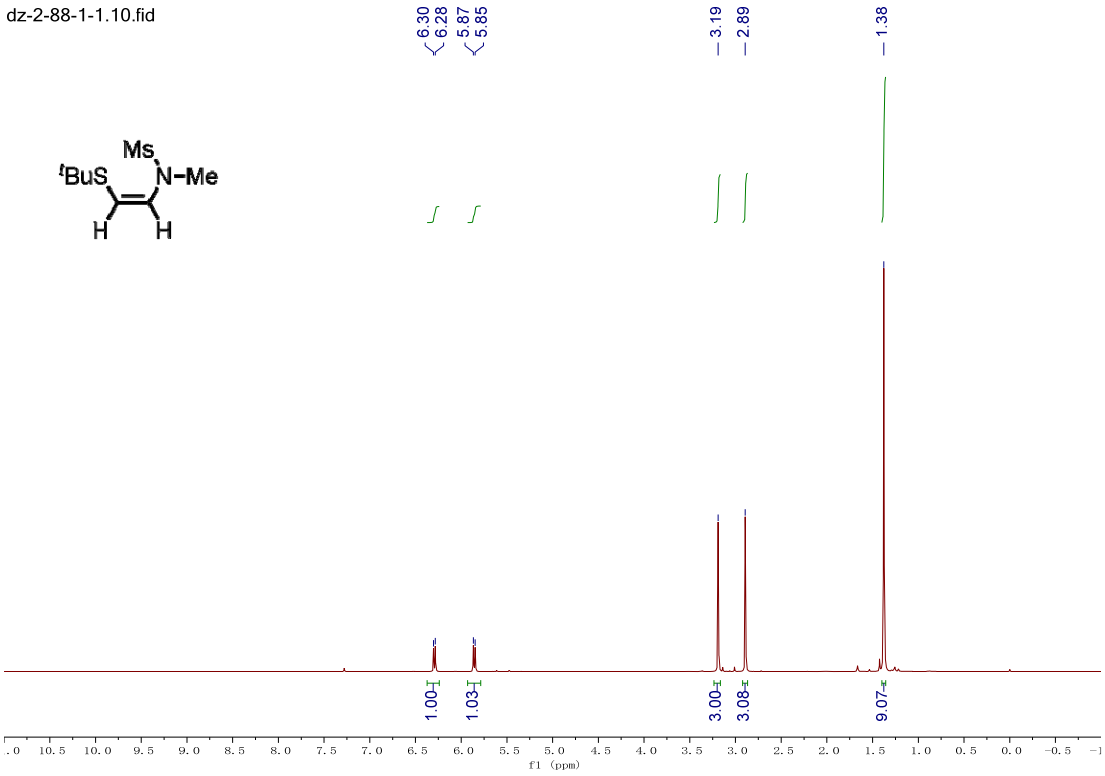

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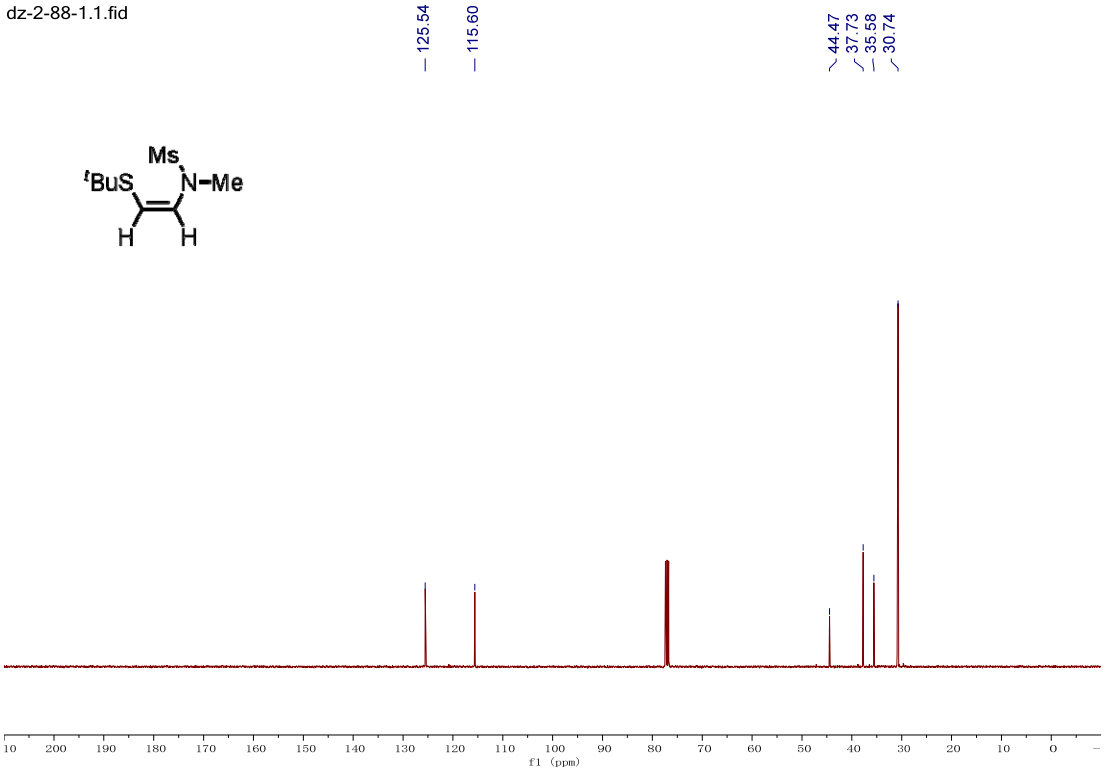
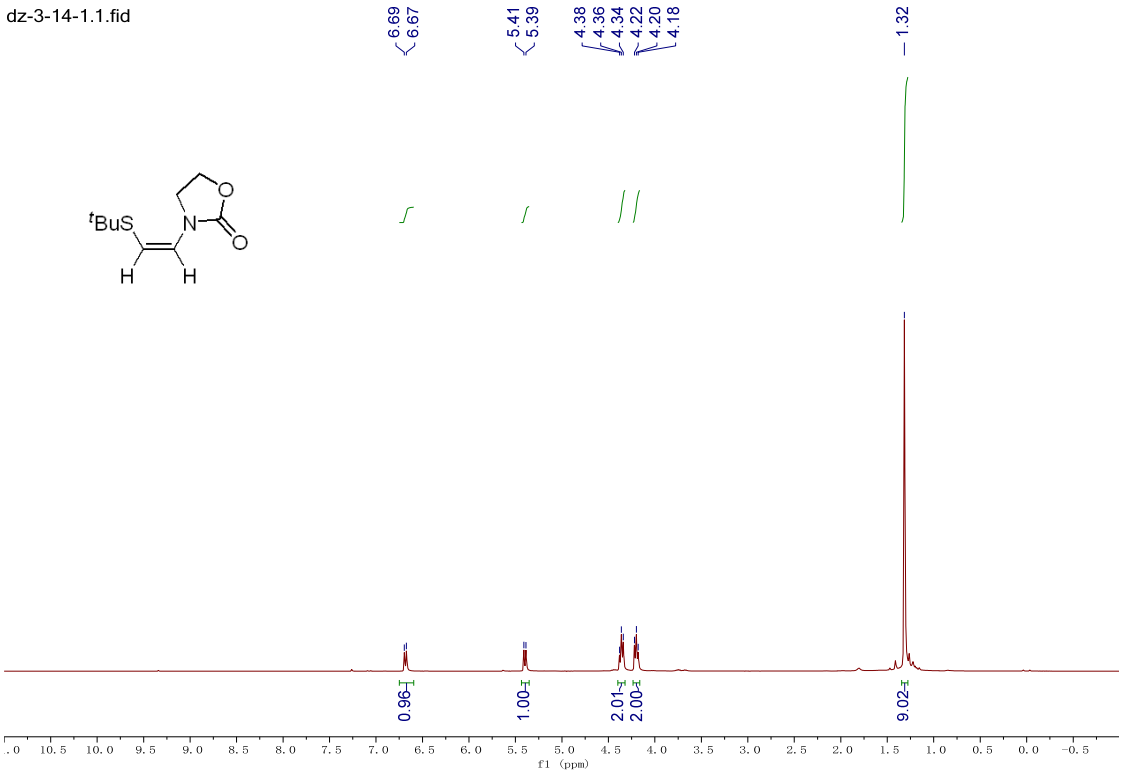
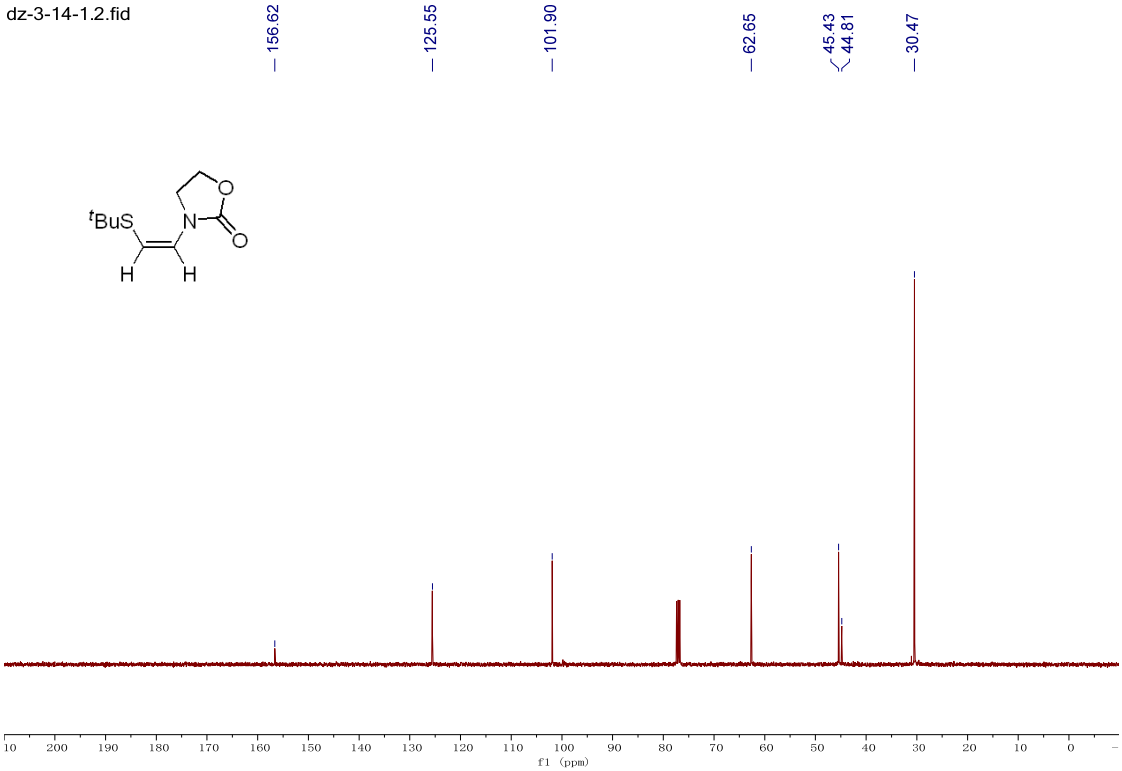


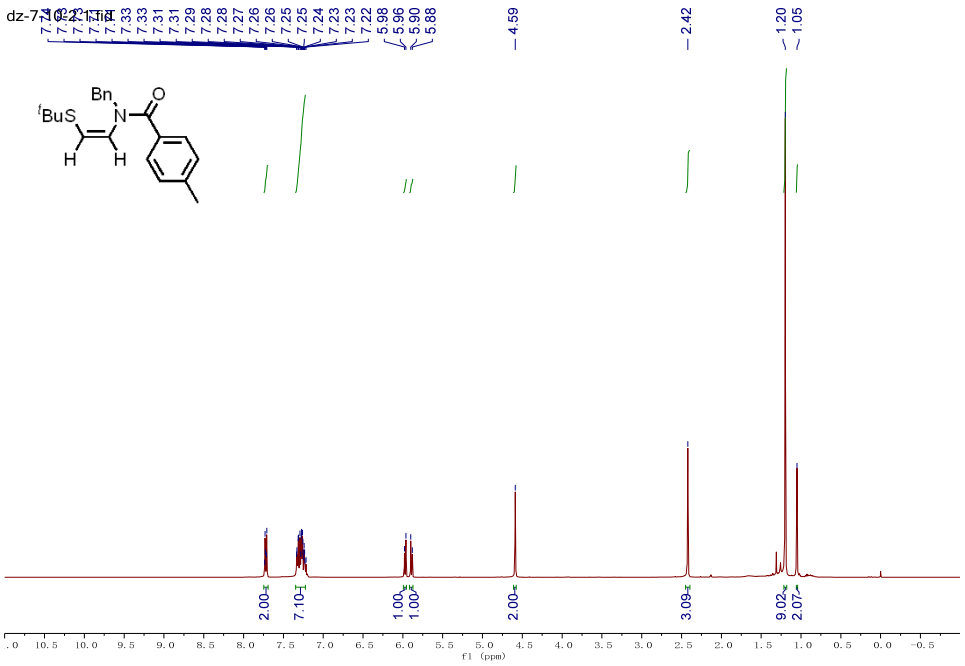
^{13}C NMR of **4j**



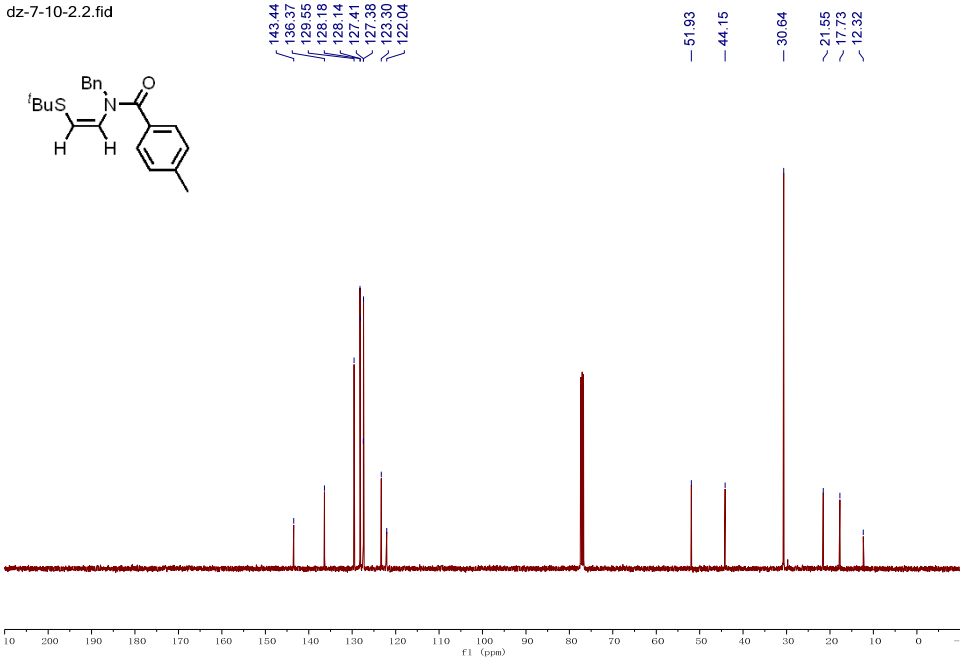
^{1}H NMR of **4k**



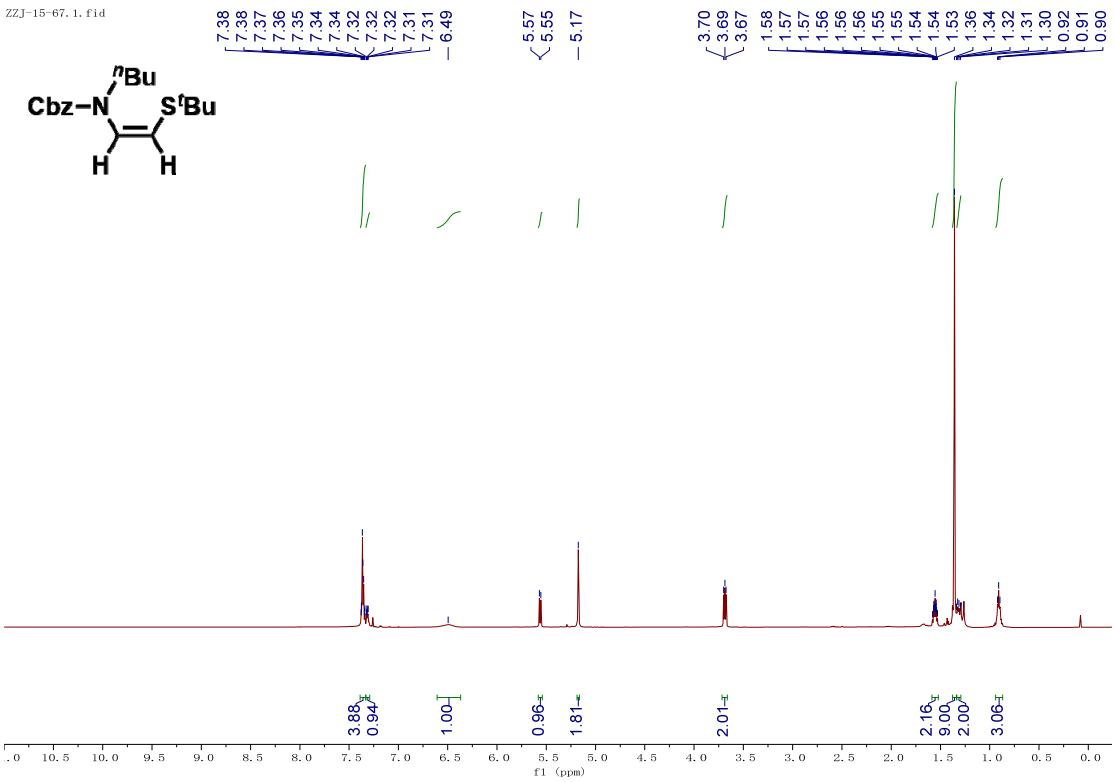
^{13}C NMR of **4k**



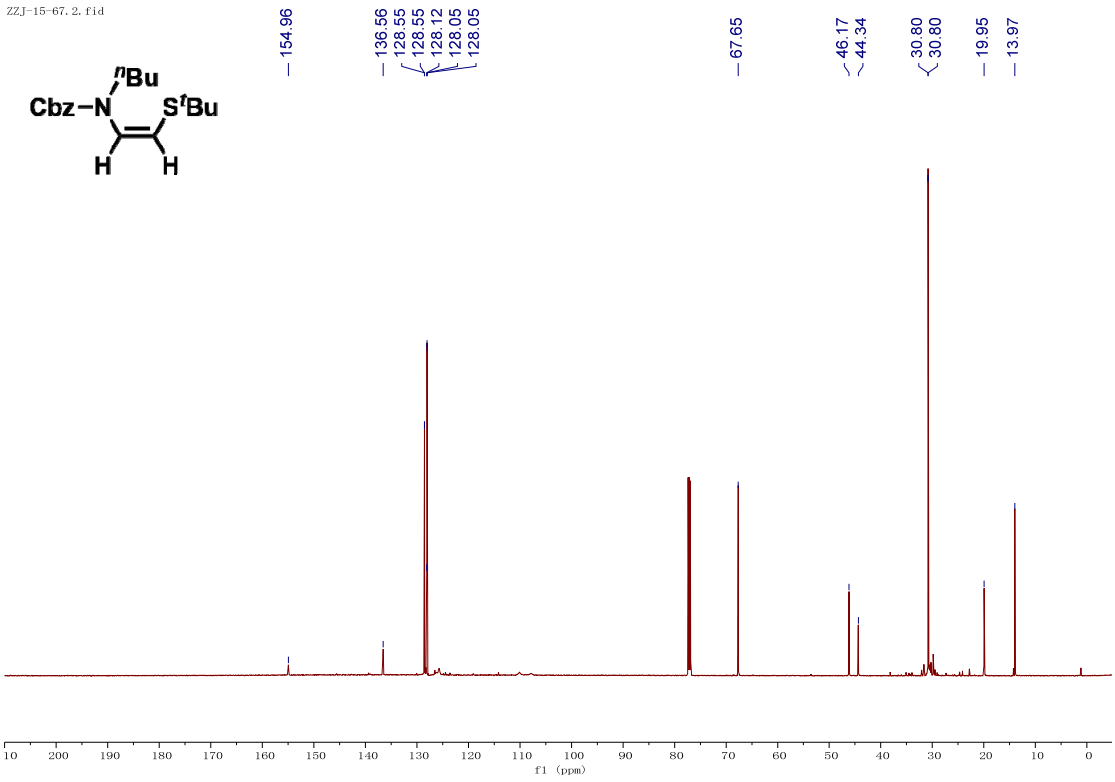
^{1}H NMR of **4l**



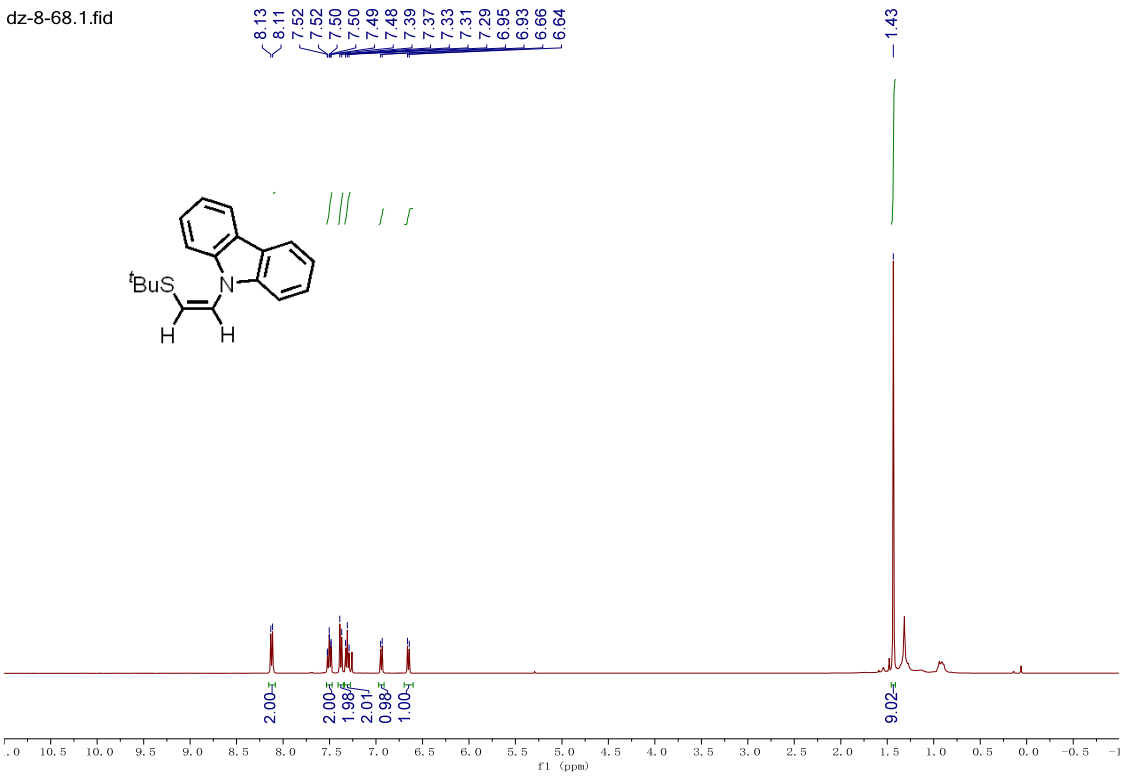
^{13}C NMR of **4l**



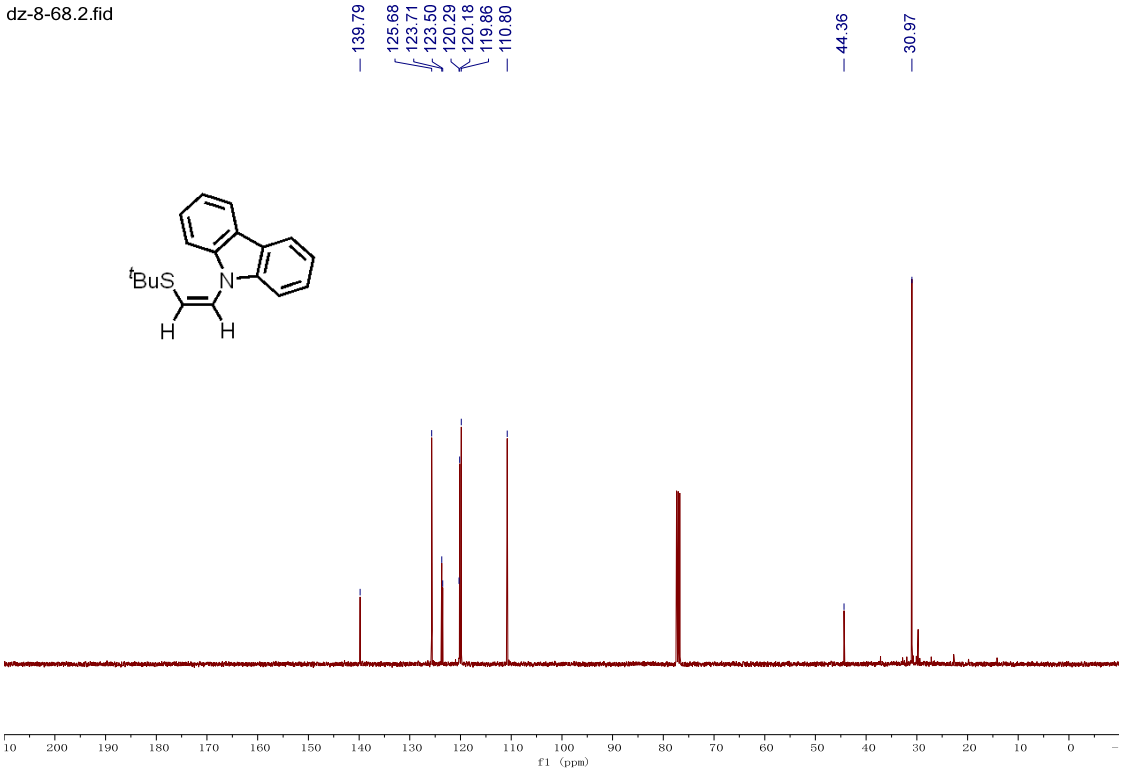
^{1}H NMR of **4m**



^{13}C NMR of **4m**



^{1}H NMR of **4n**



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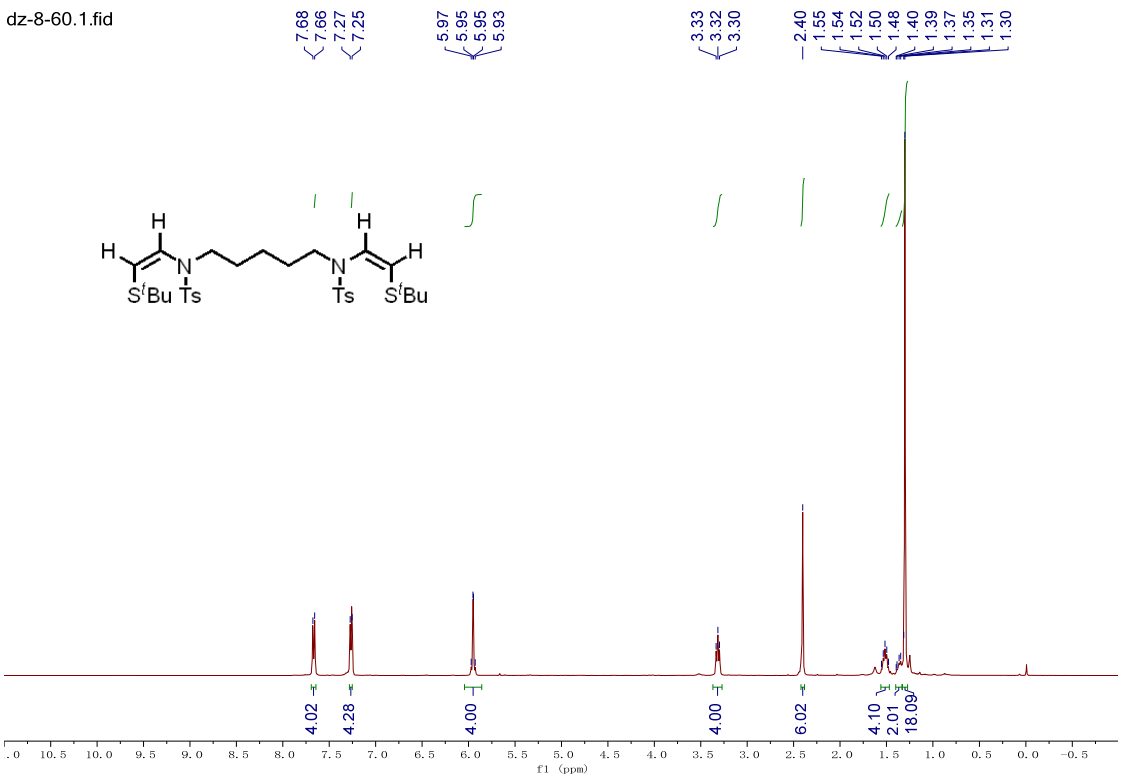
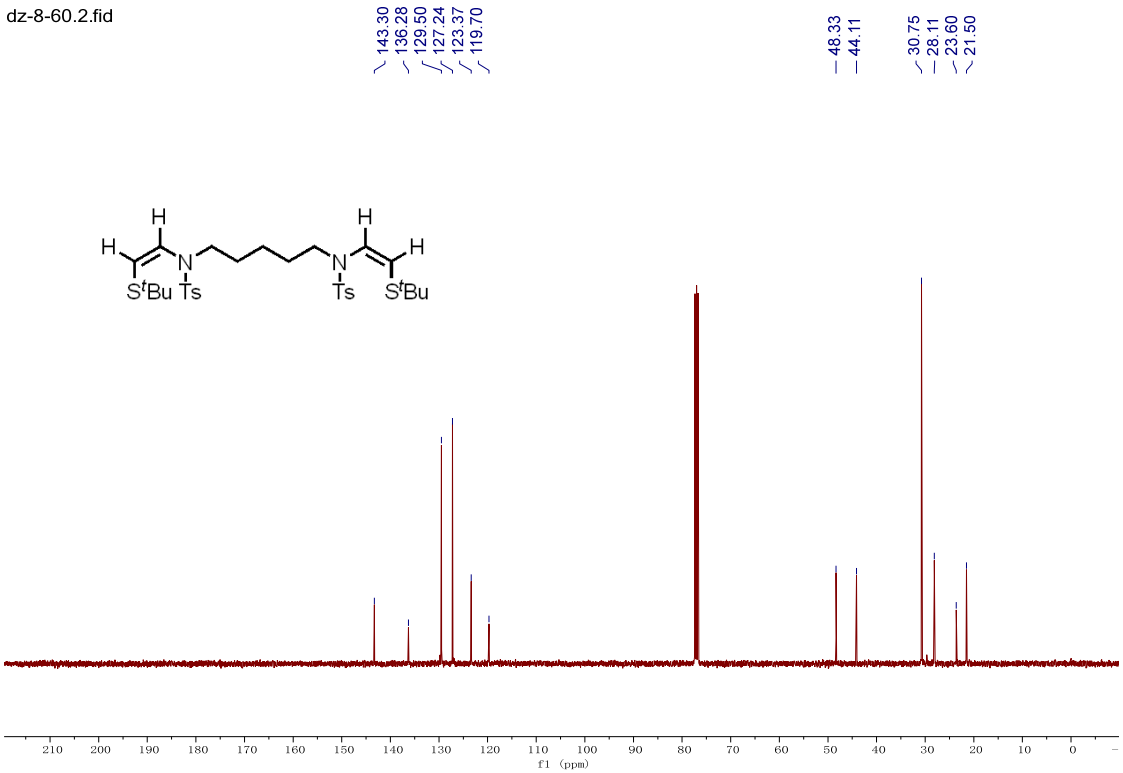
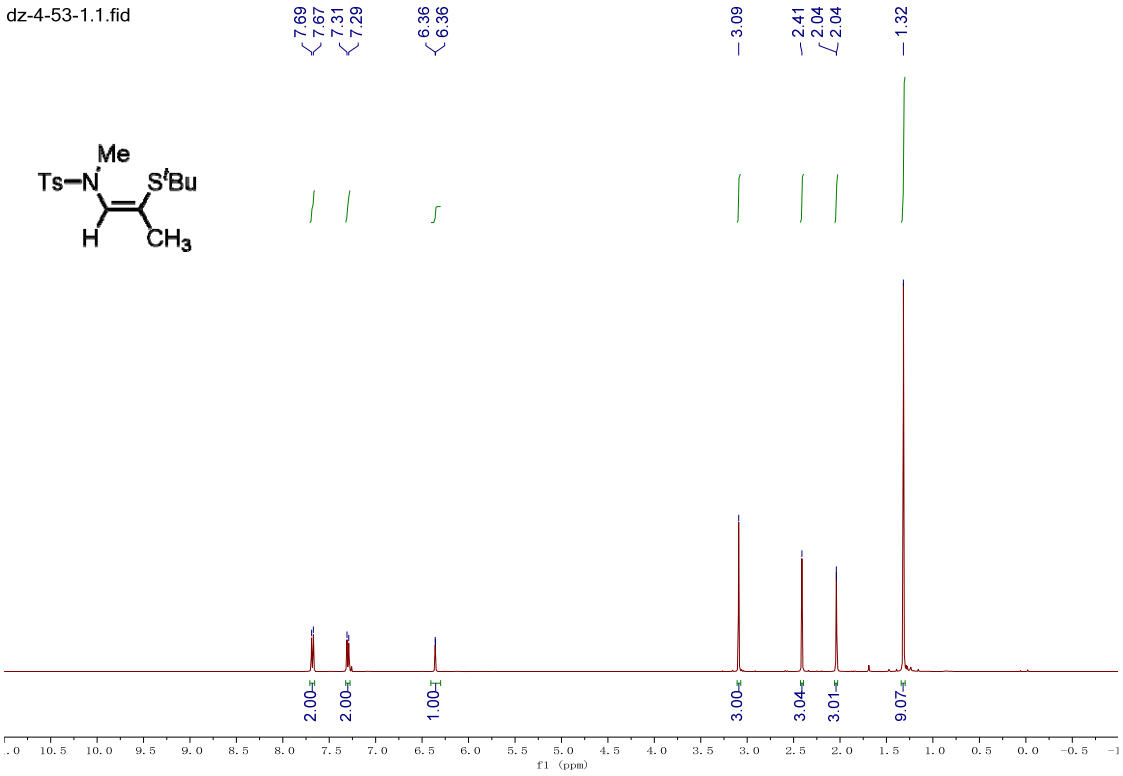


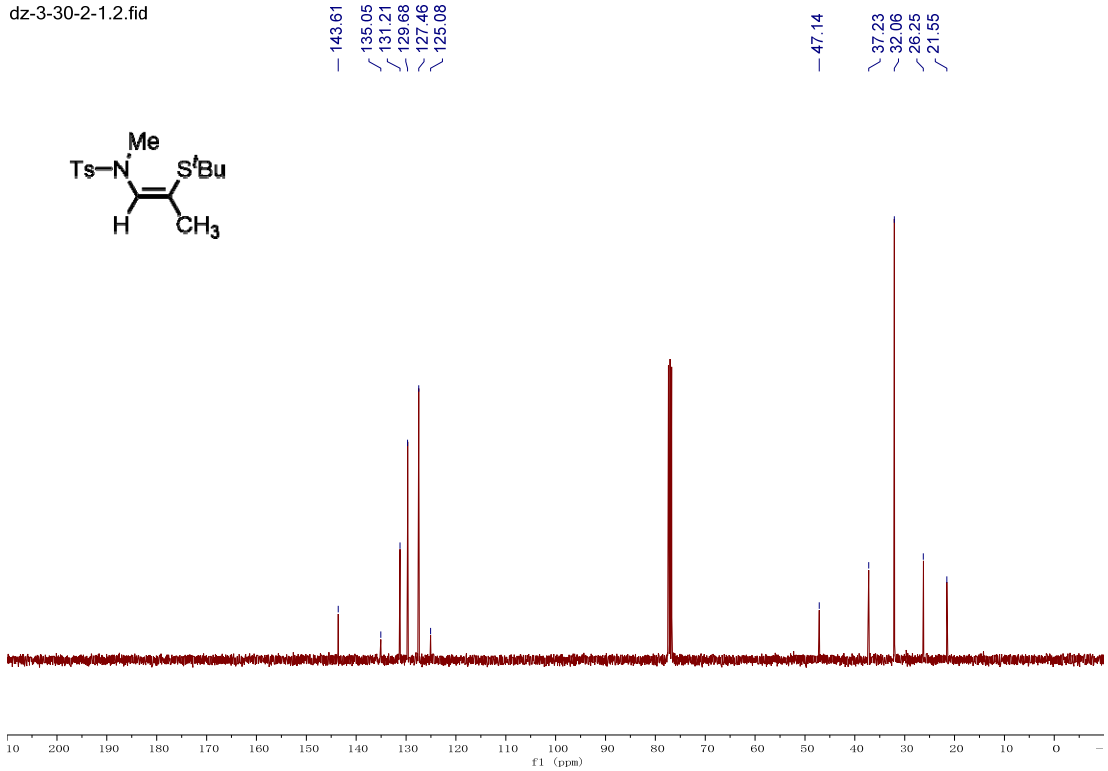
^{1}H NMR of **4o**



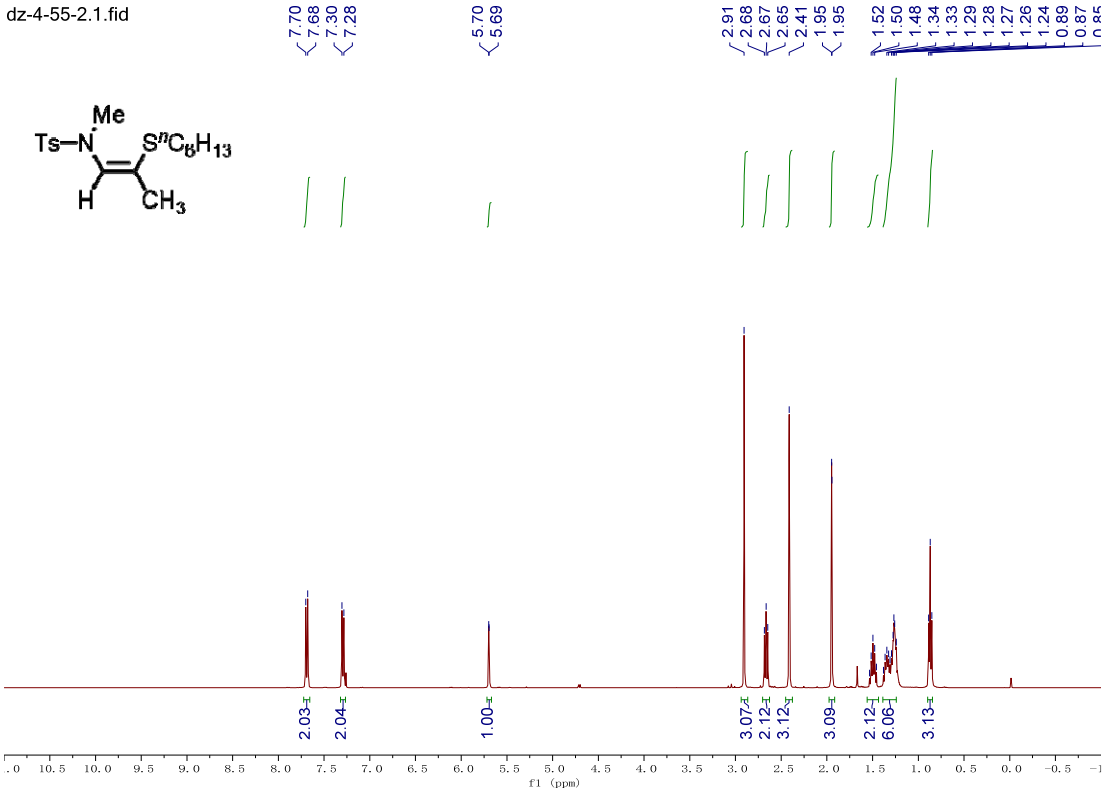
^{13}C NMR of **4o**



^{1}H NMR of **6a**



^{13}C NMR of **6a**



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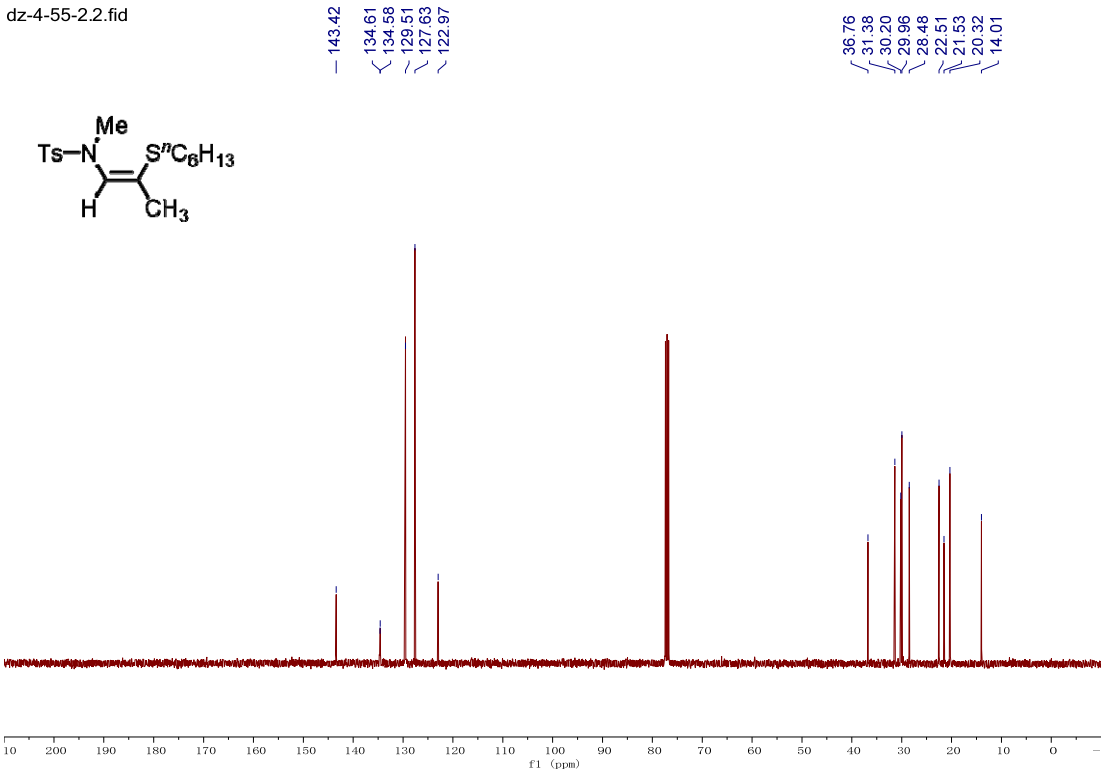

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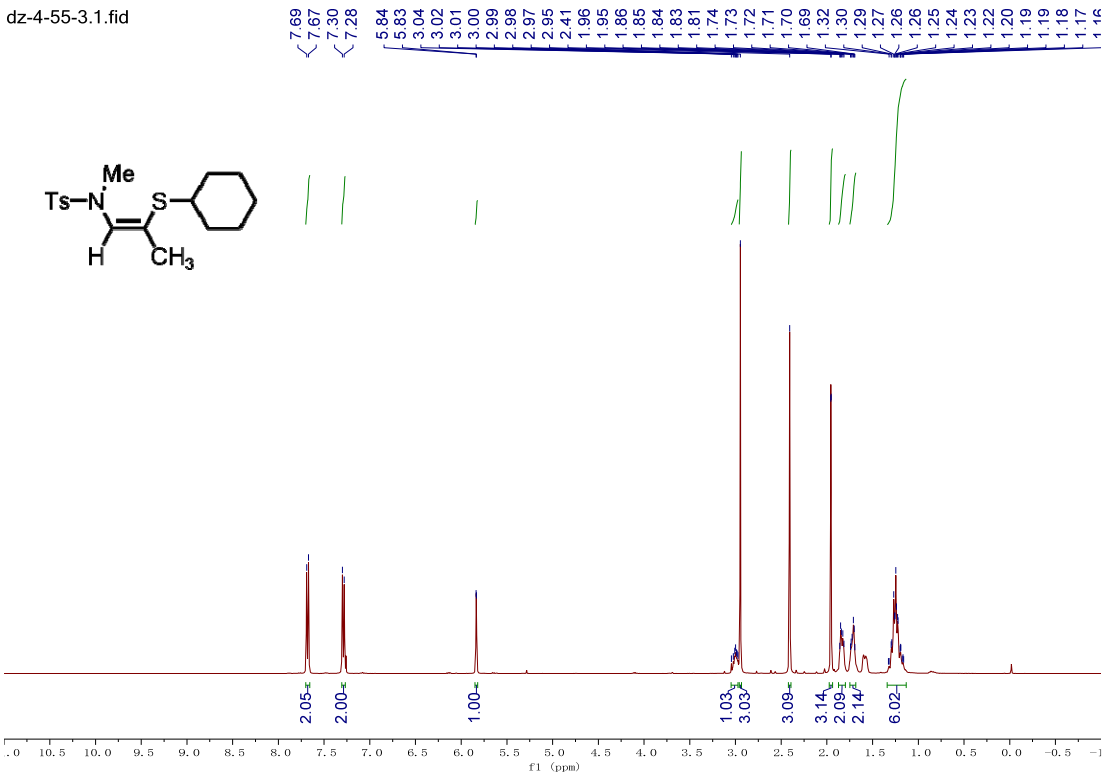
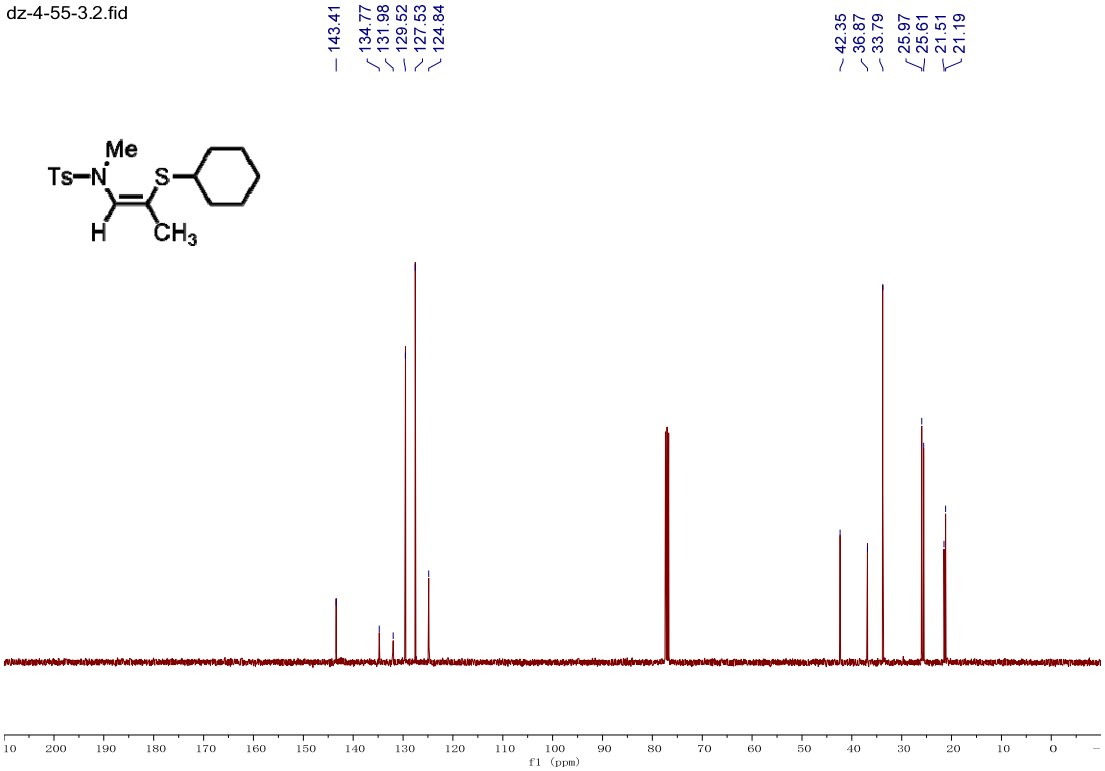


^{1}H NMR of **6c**



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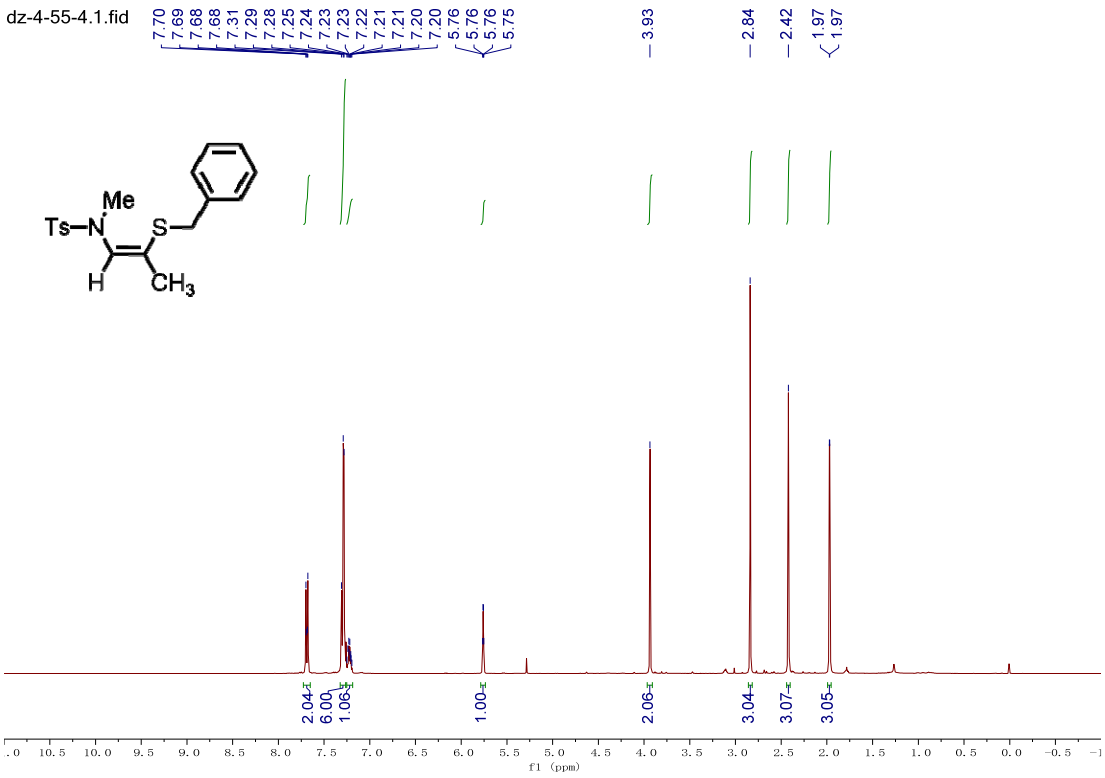

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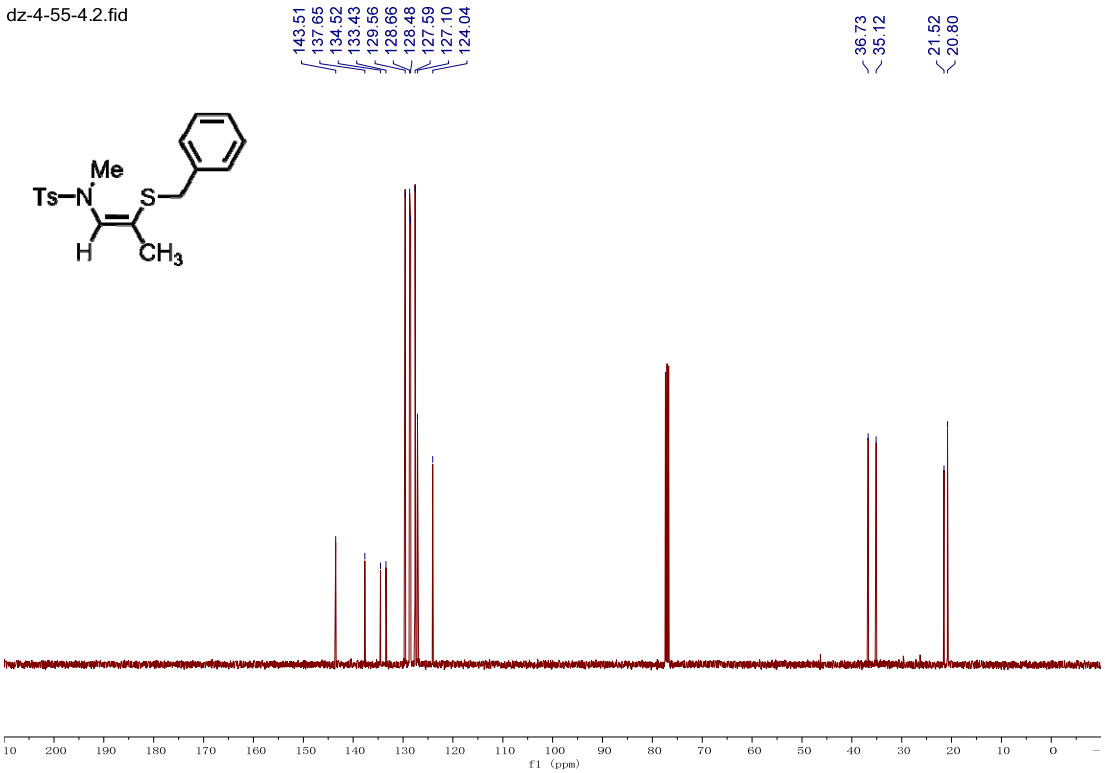
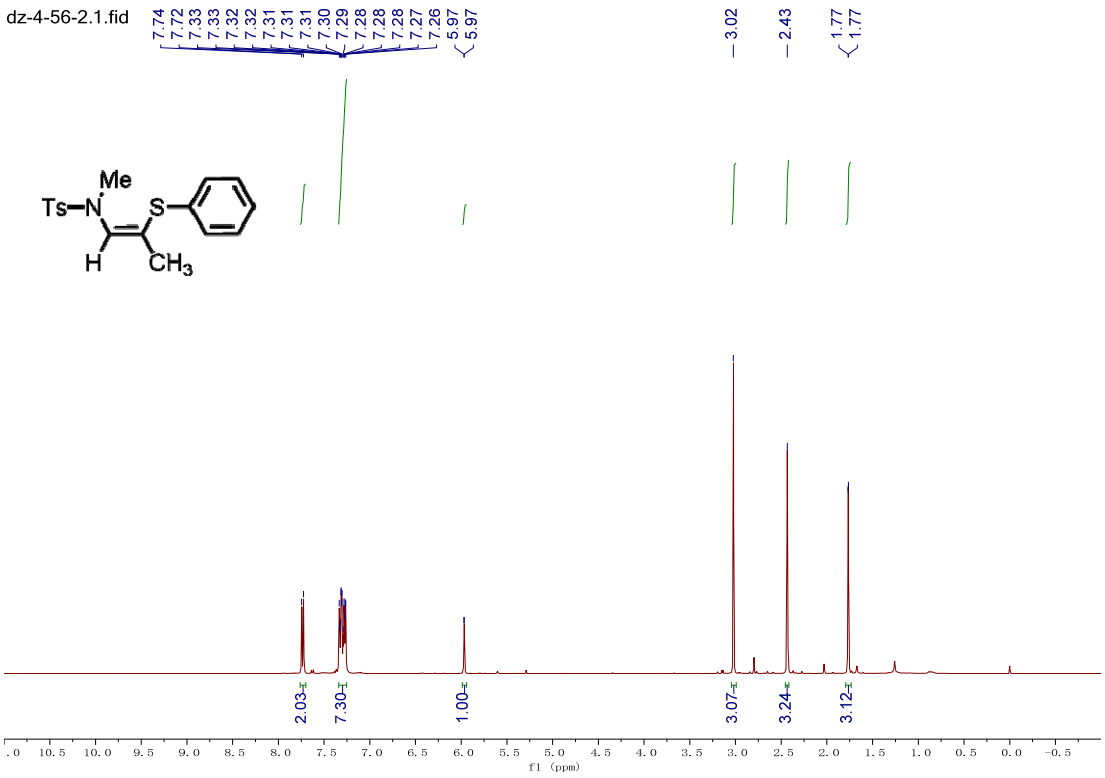
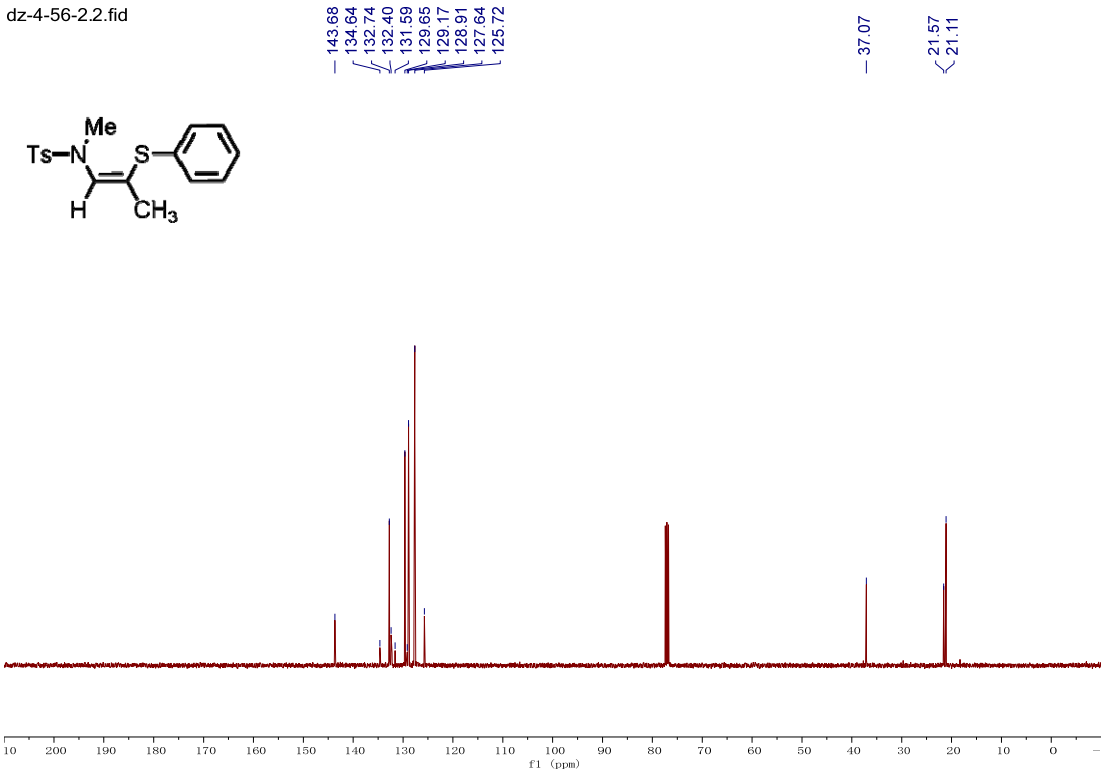


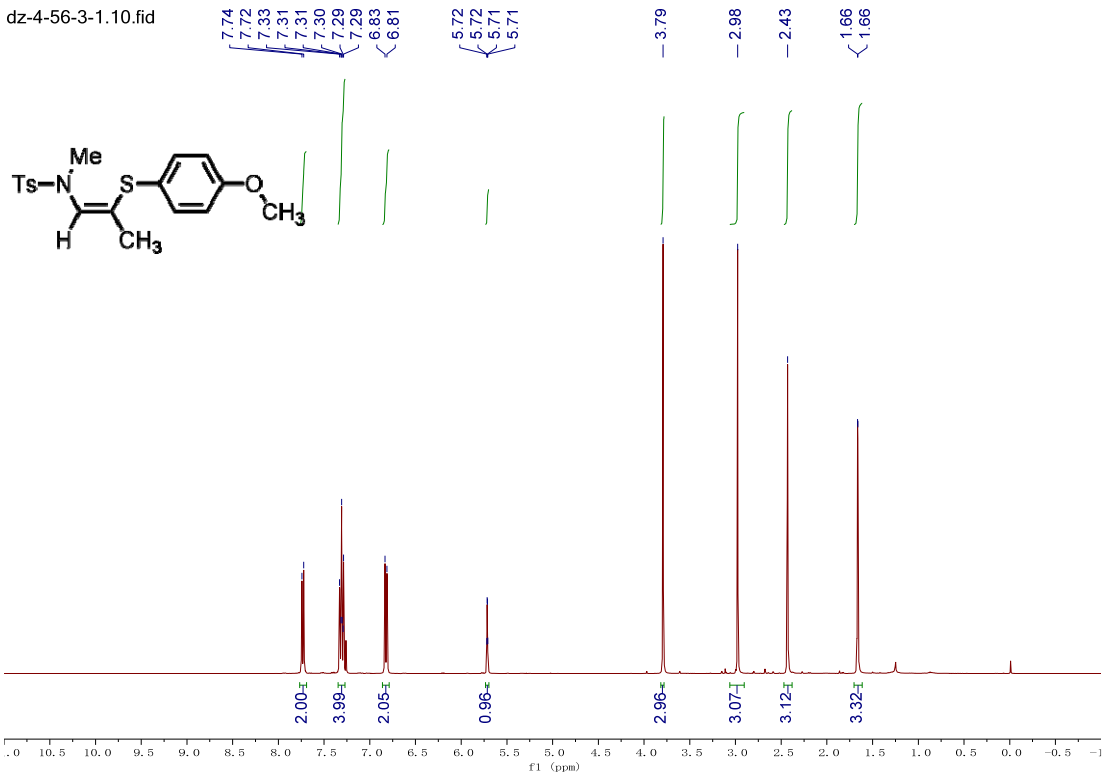
^{13}C NMR of **6d**



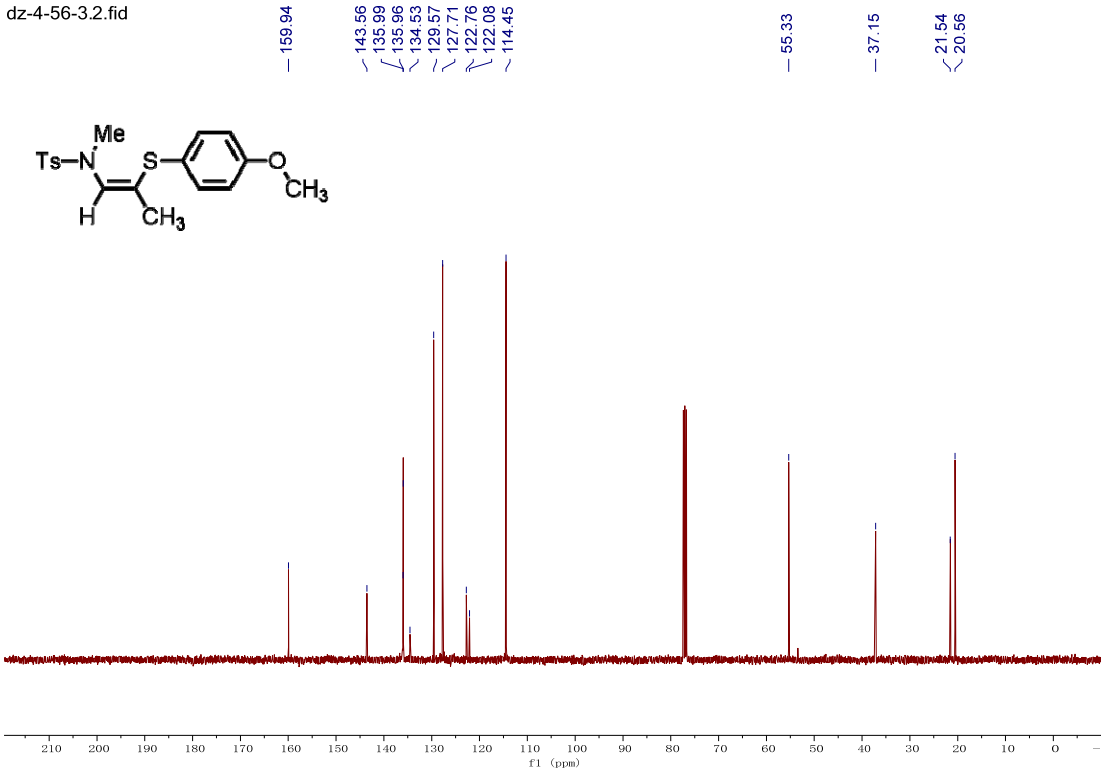
^{1}H NMR of **6e**



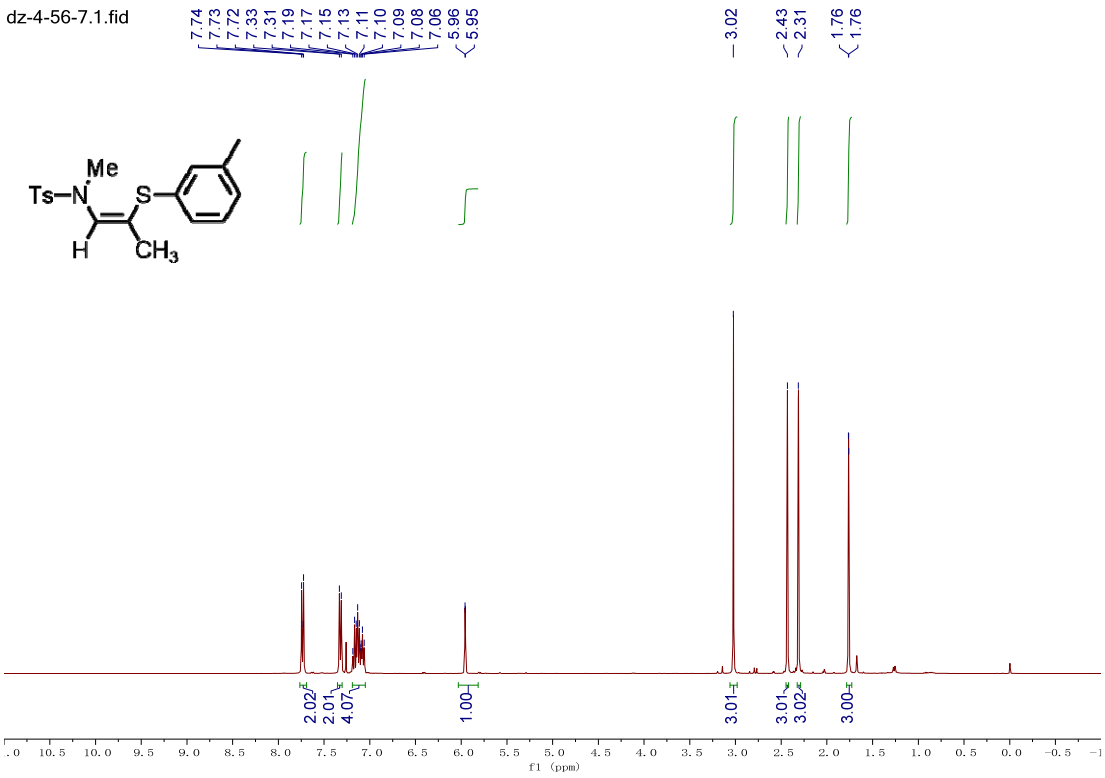
^{13}C NMR of **6e**



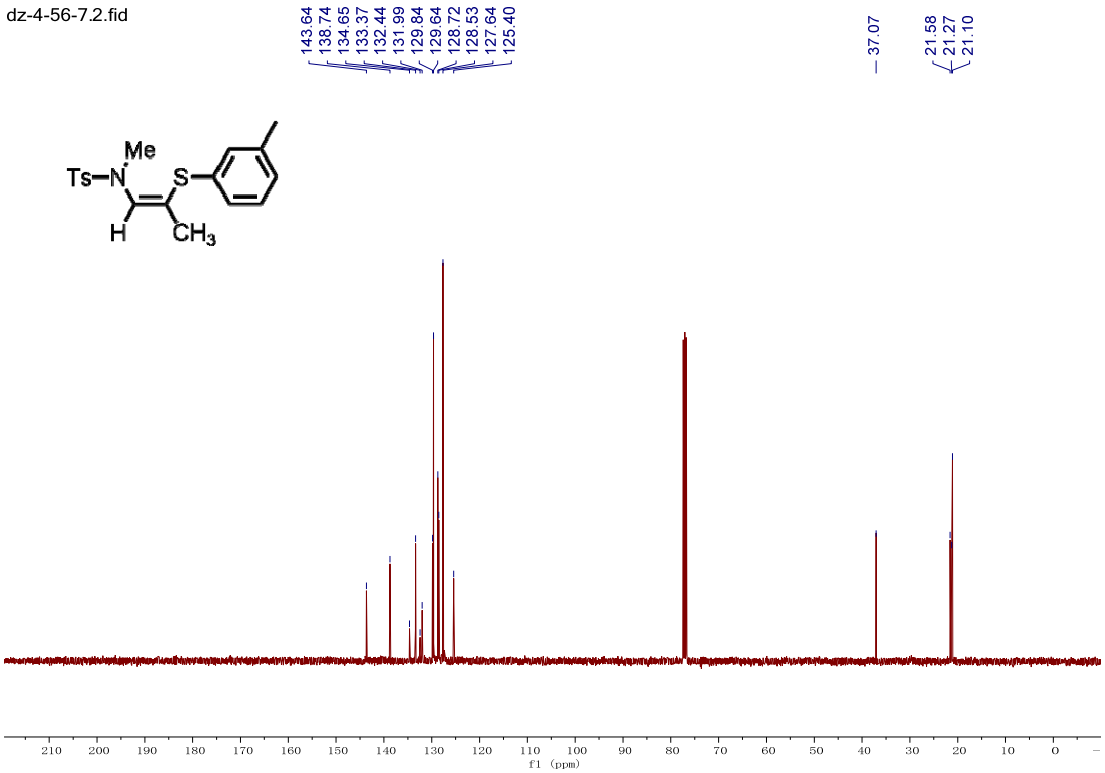
^{1}H NMR of **6f**



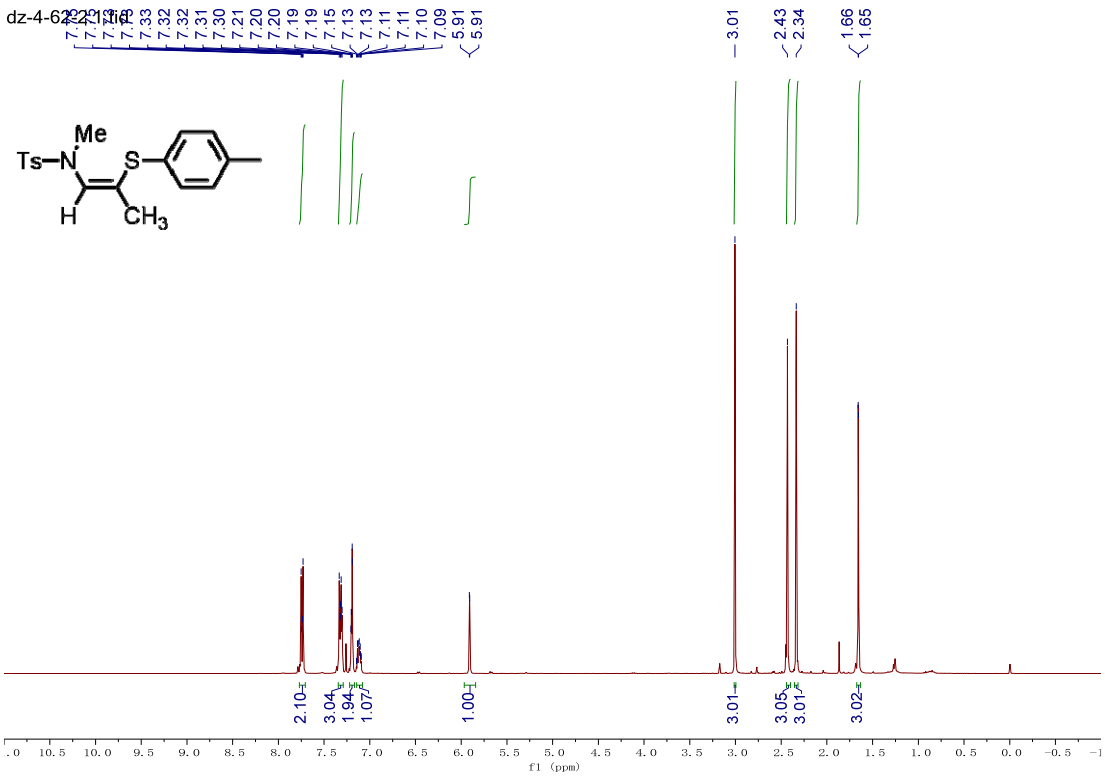
^{13}C NMR of **6f**



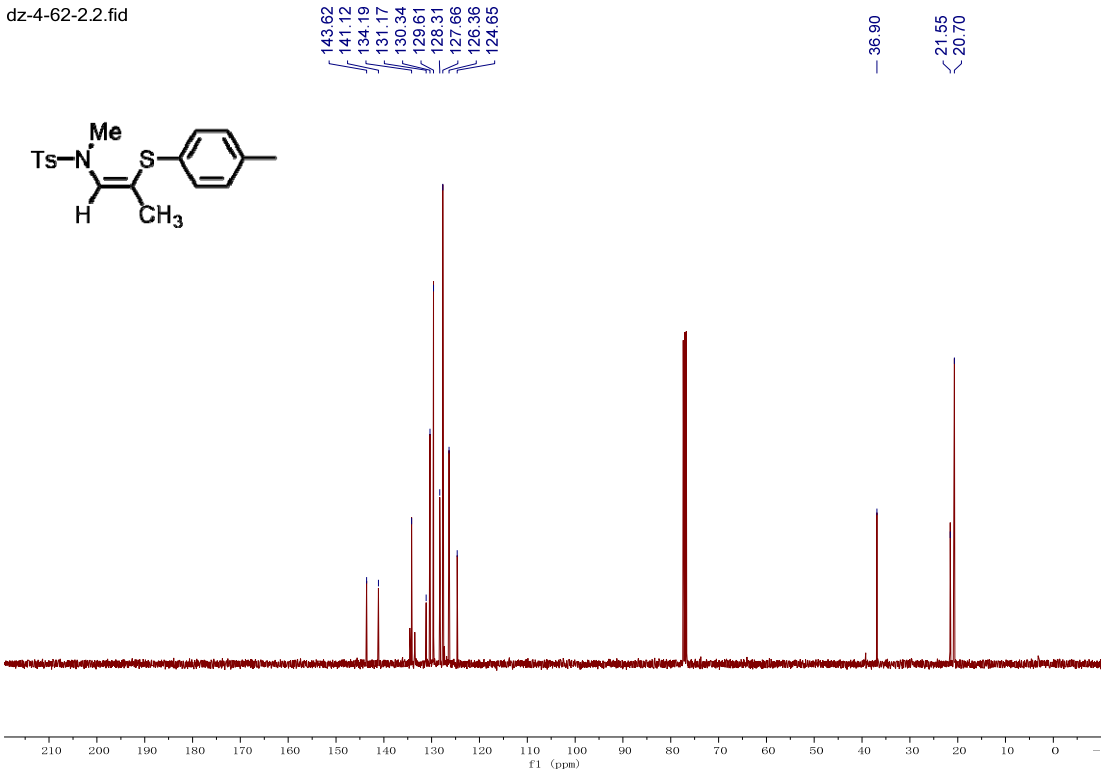
^{1}H NMR of **6g**



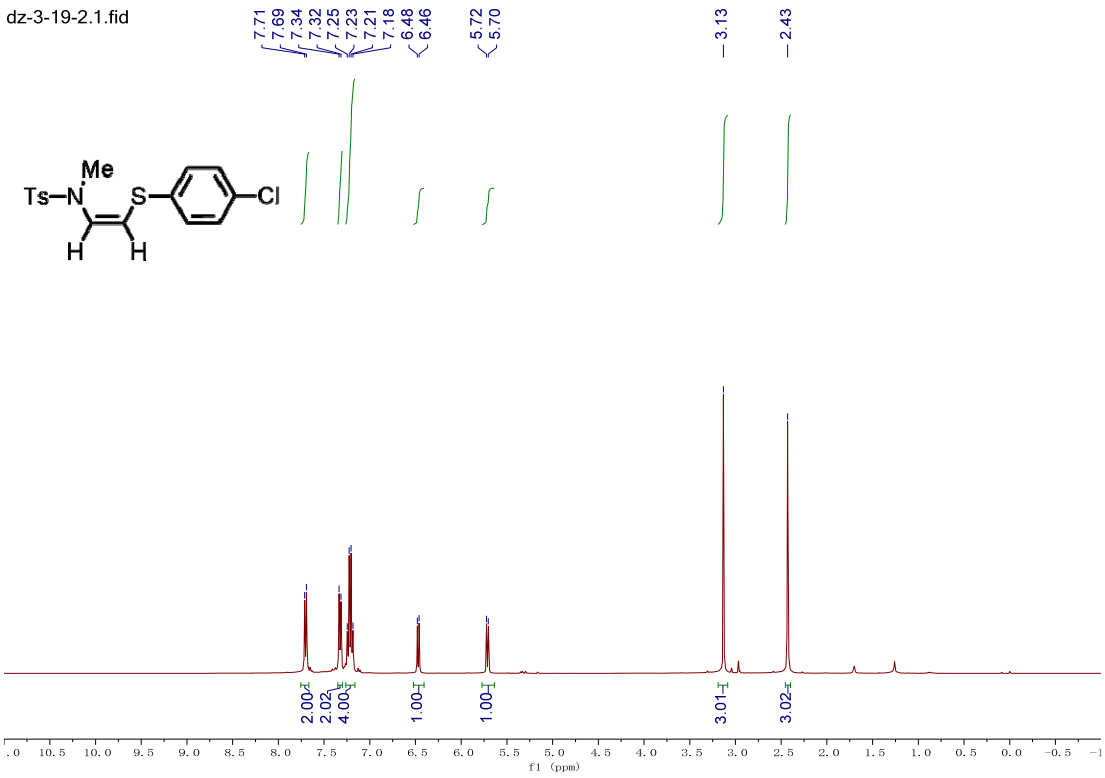
^{13}C NMR of **6g**



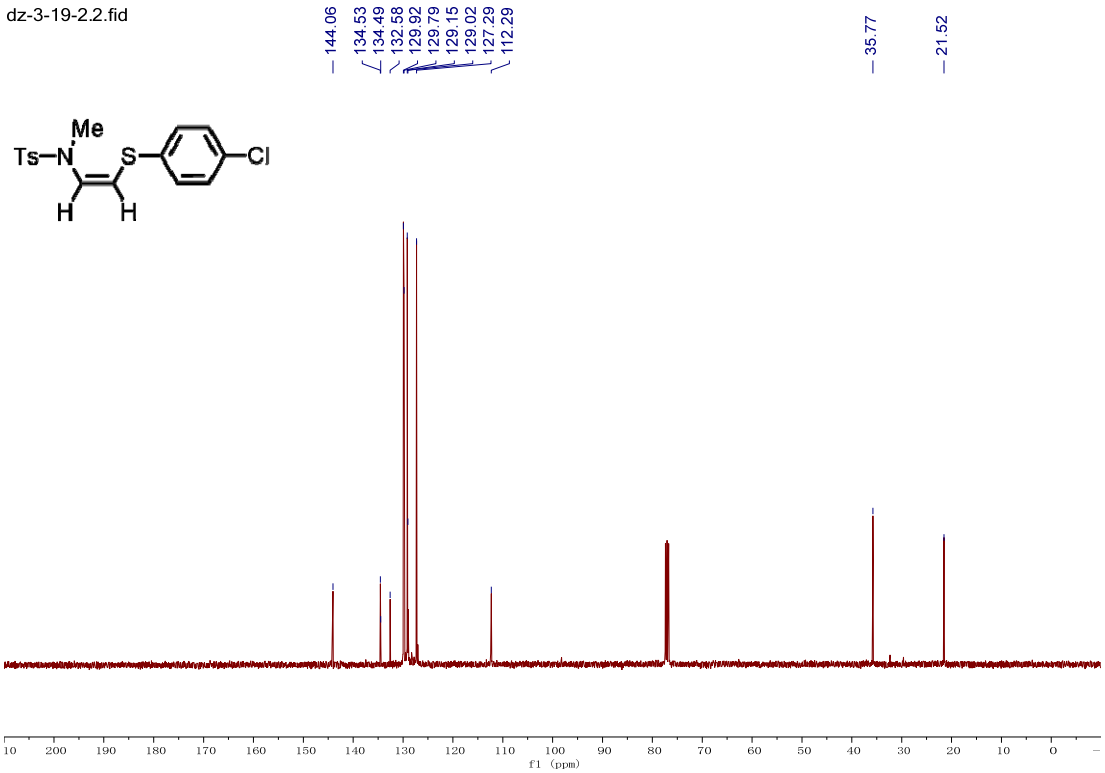
^{1}H NMR of **6h**



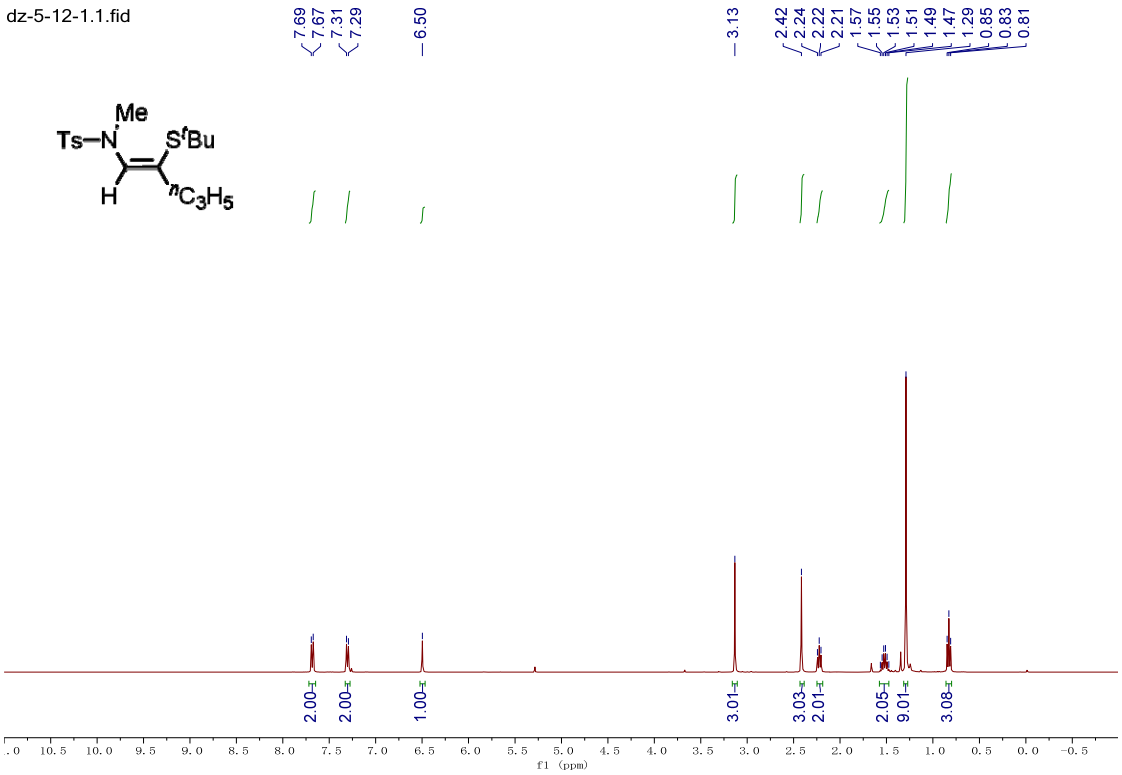
^{13}C NMR of **6h**



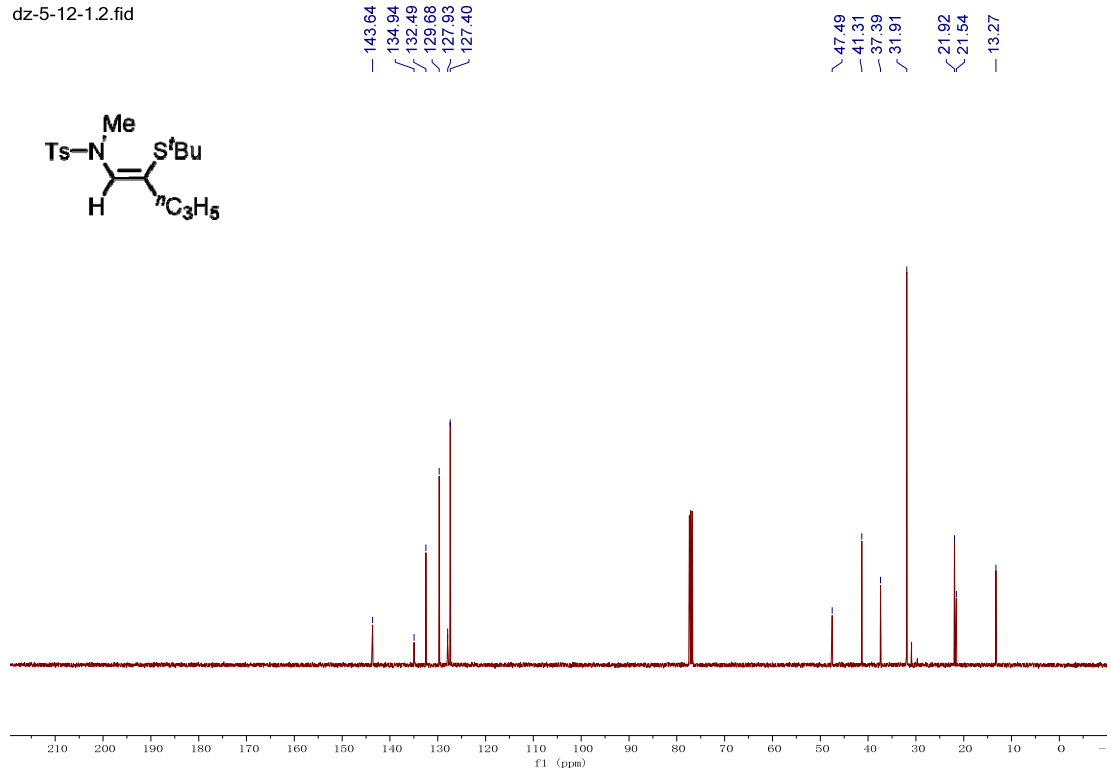
^{1}H NMR of **6i**



^{13}C NMR of **6i**



^{1}H NMR of **6j**



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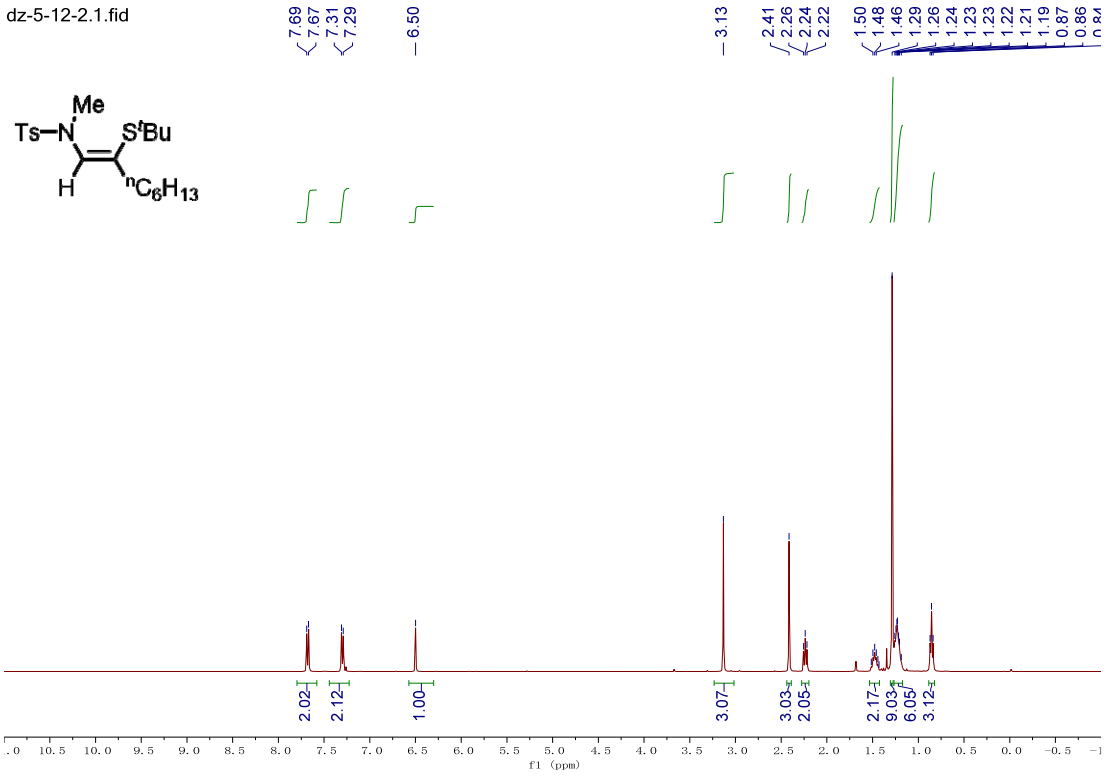

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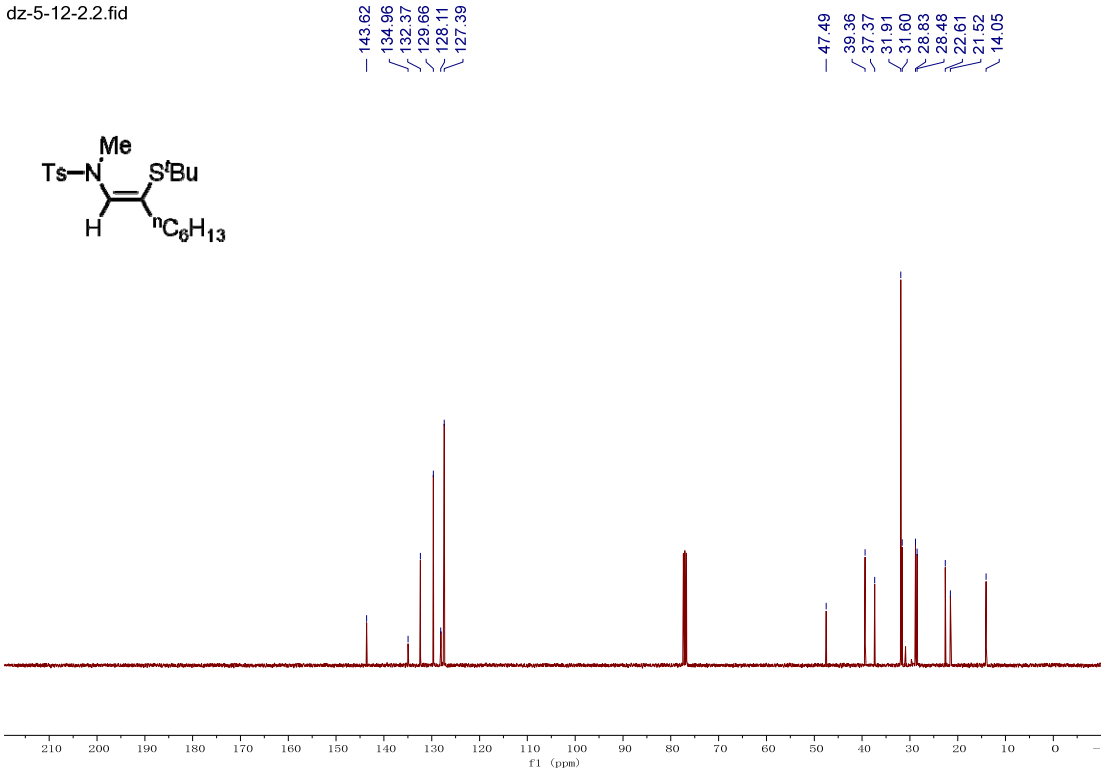
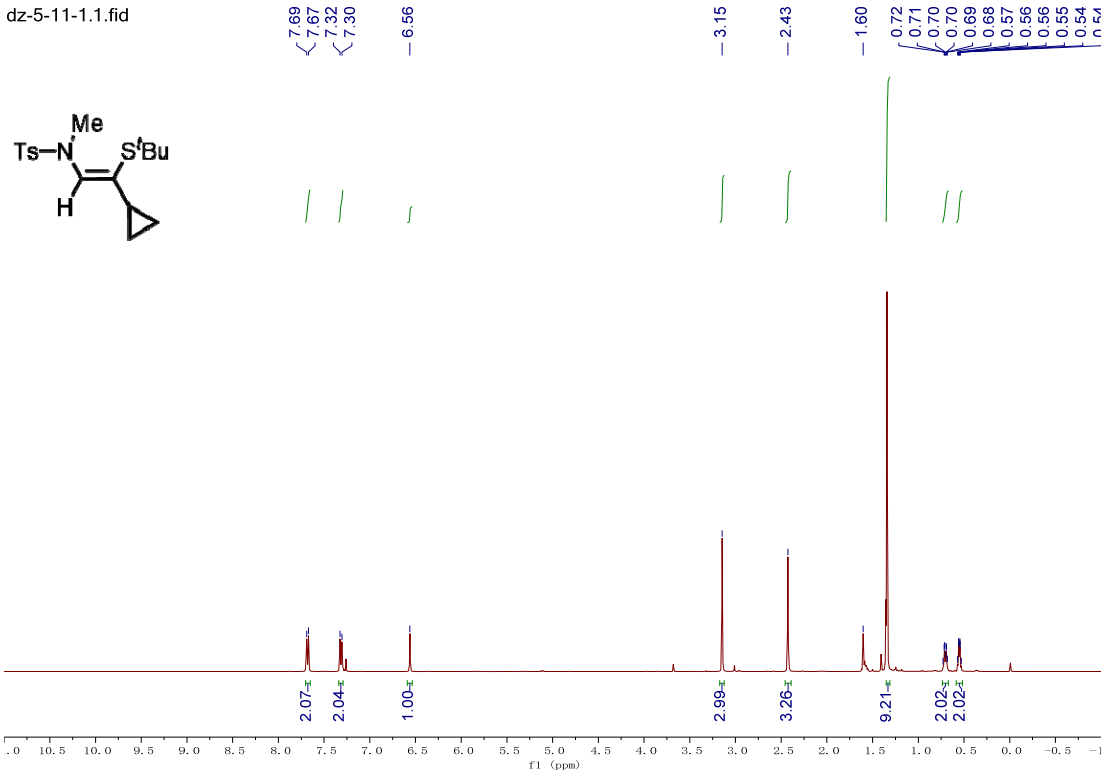
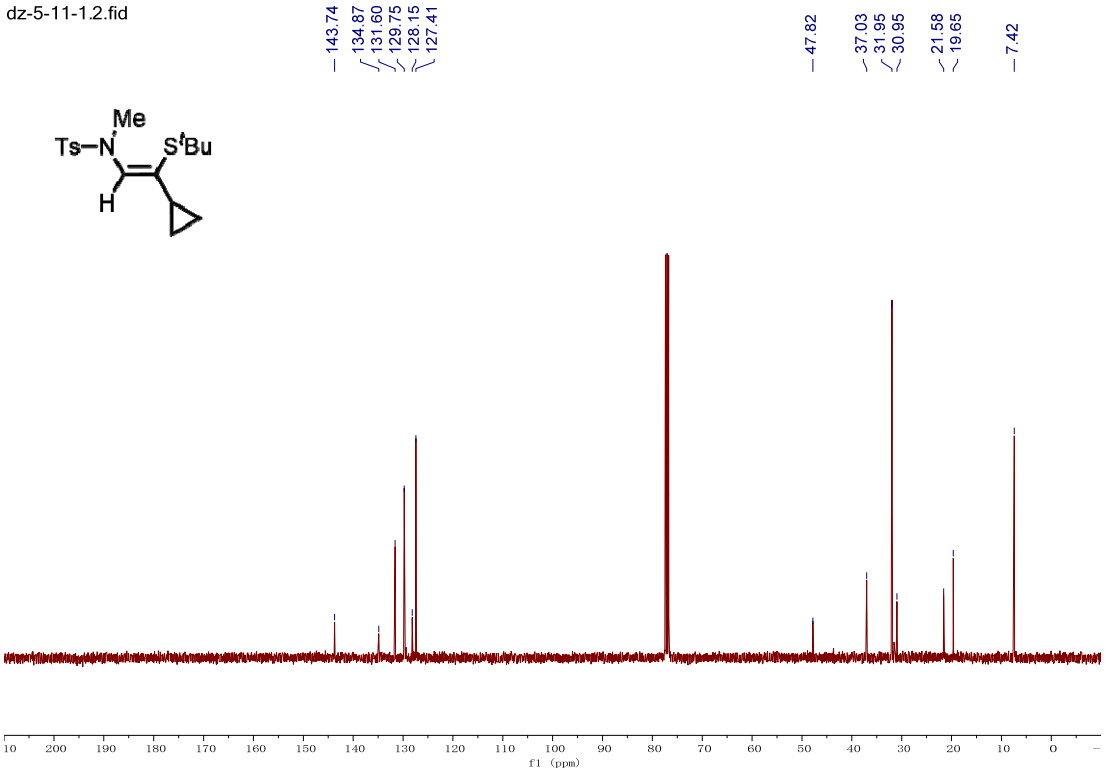


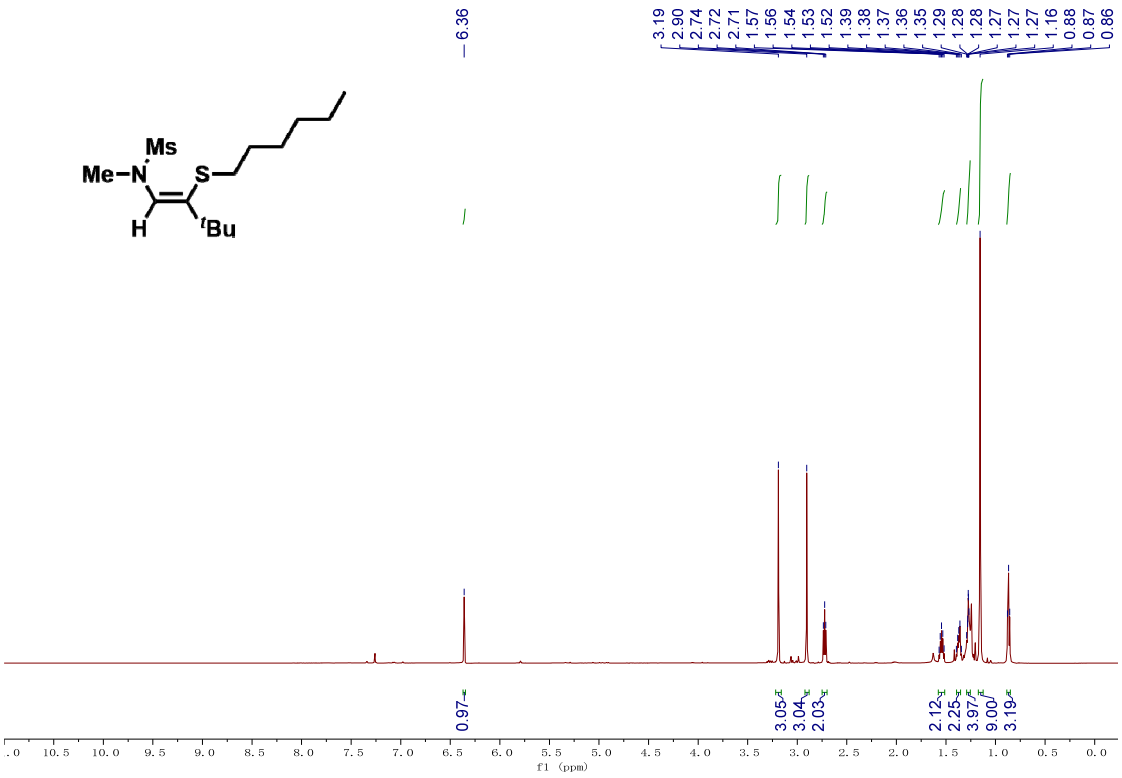
^{13}C NMR of **6k**



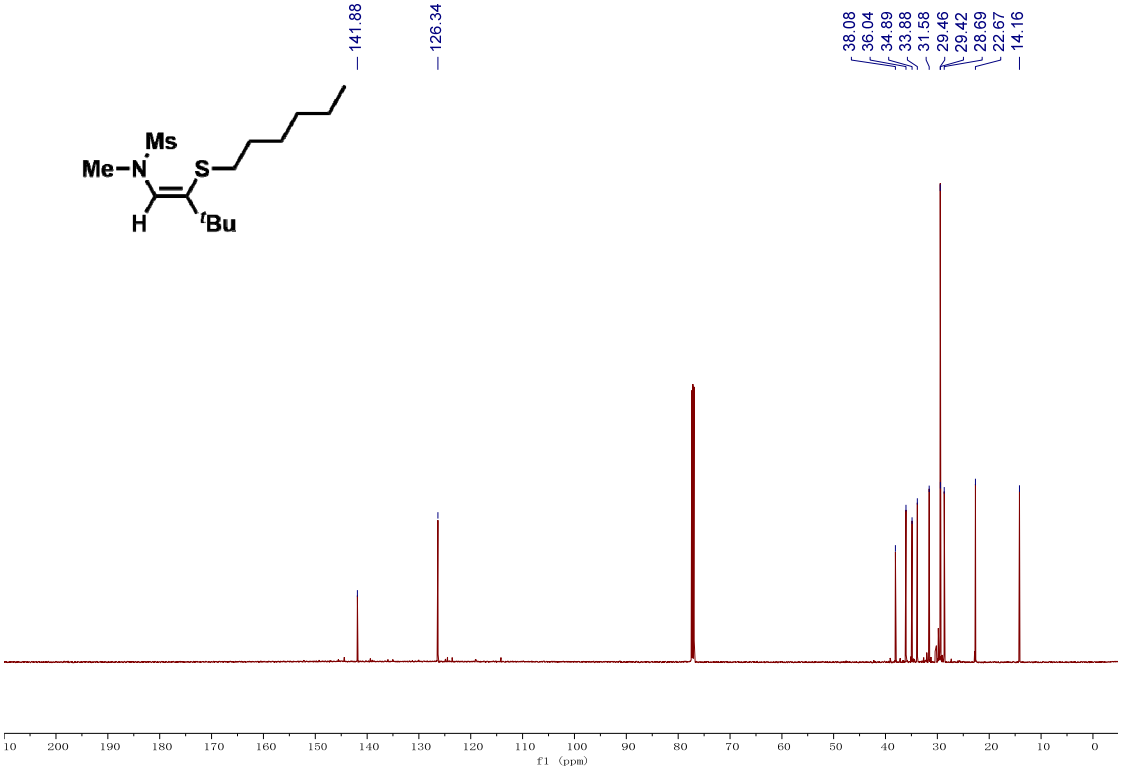
^{1}H NMR of **6l**



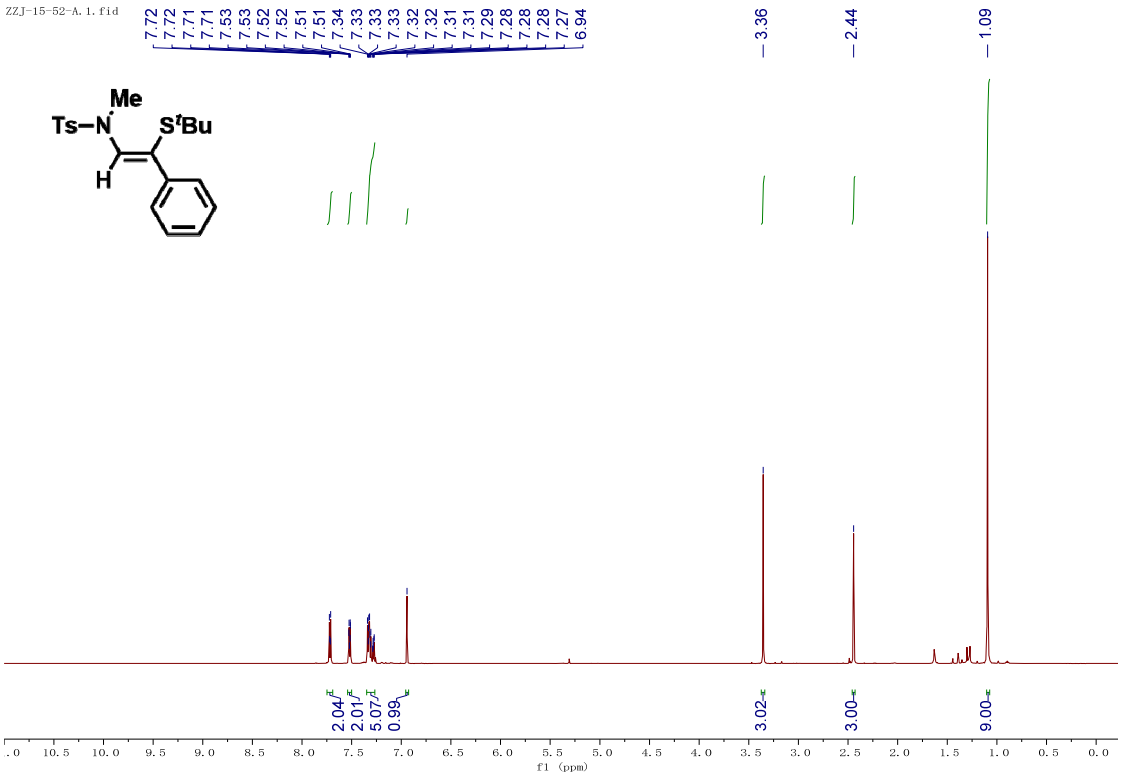
^{13}C NMR of **6l**



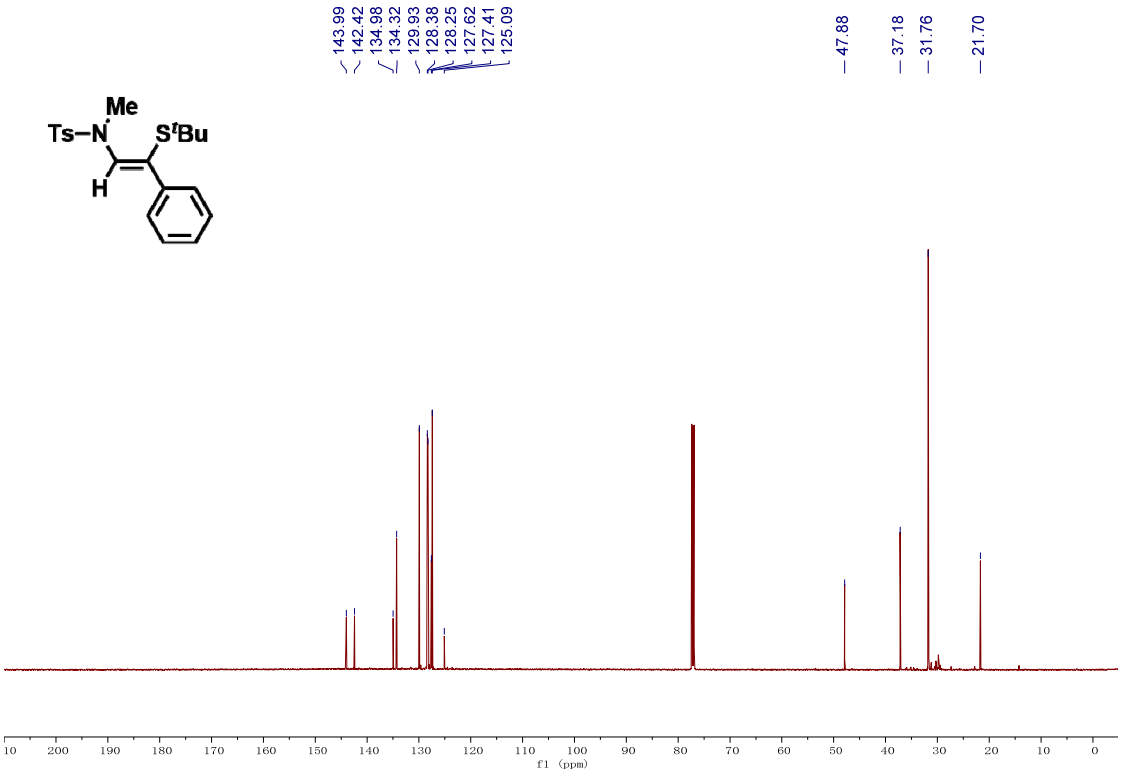
^{1}H NMR of **6m**



^{13}C NMR of **6m**



^{1}H NMR of **6n**



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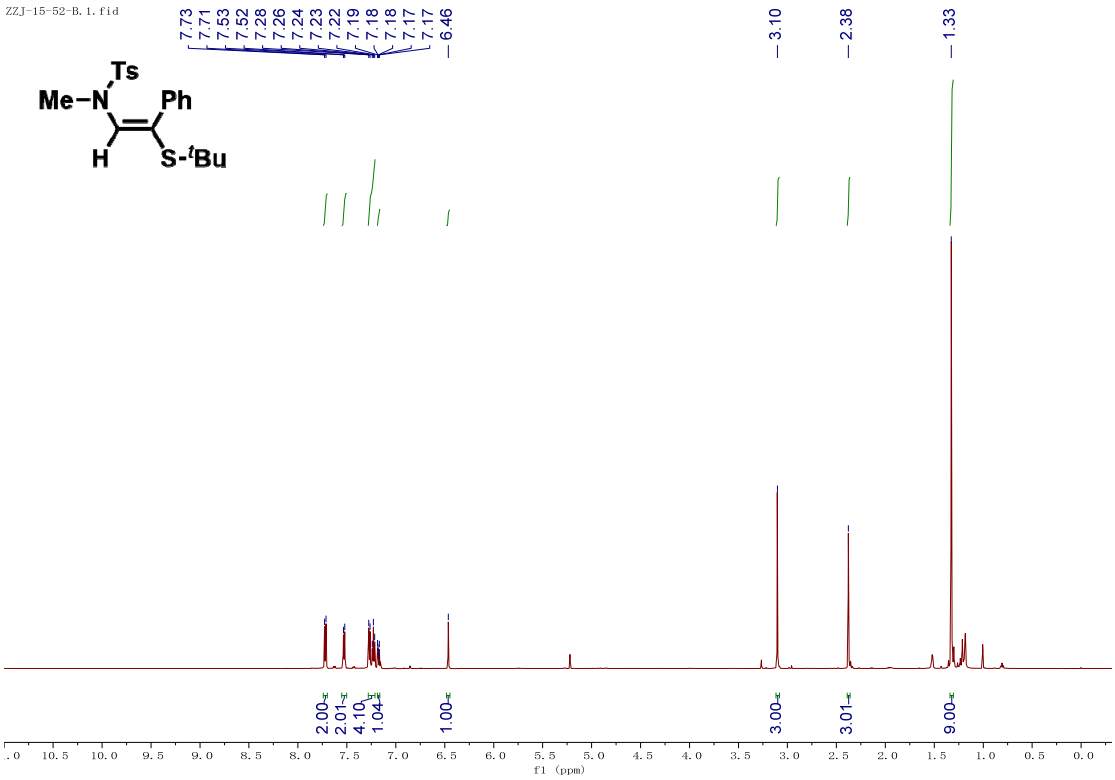
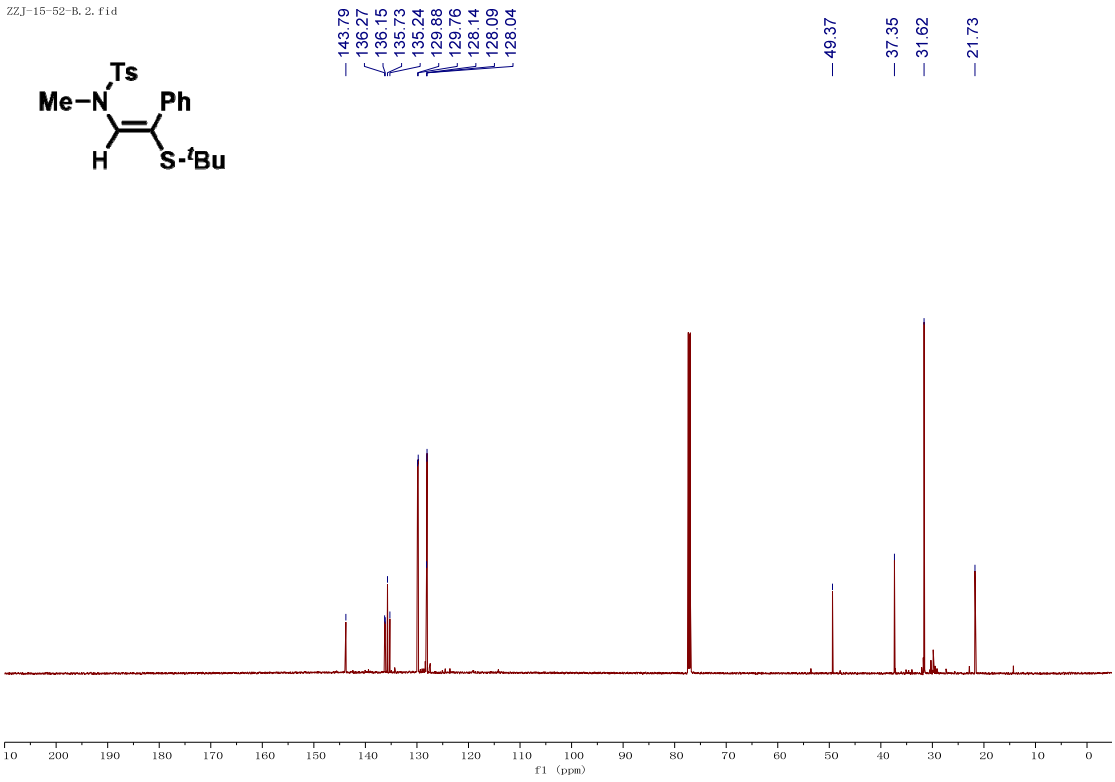
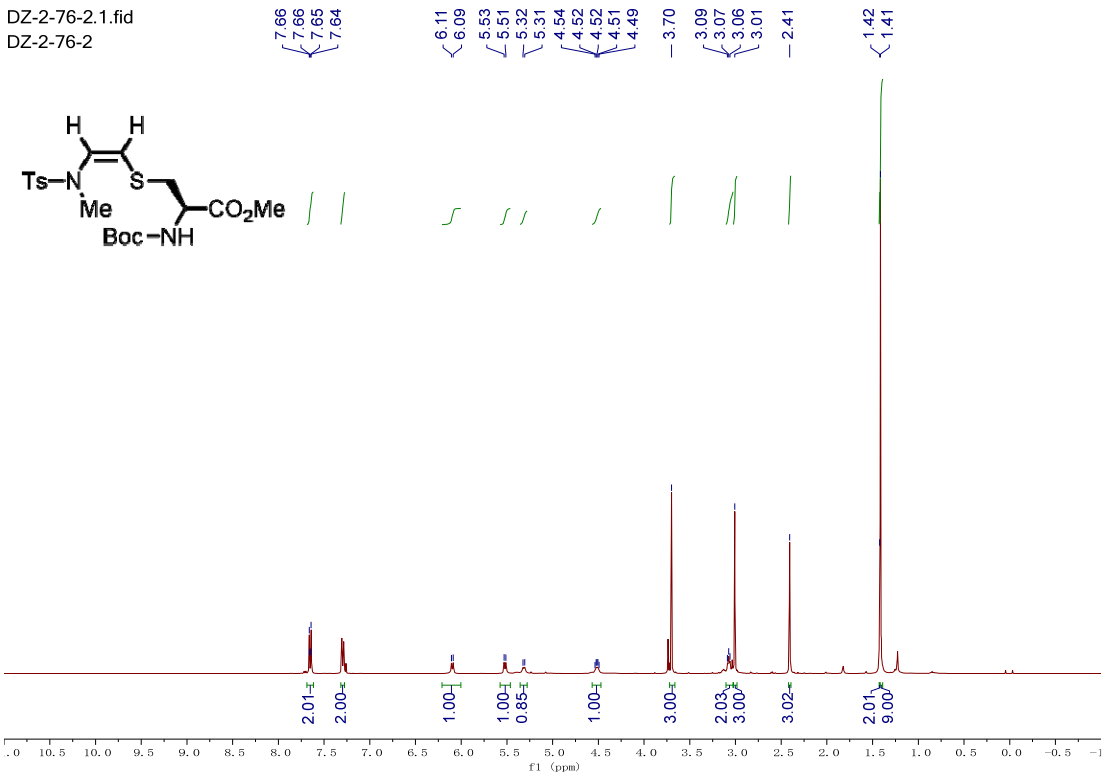


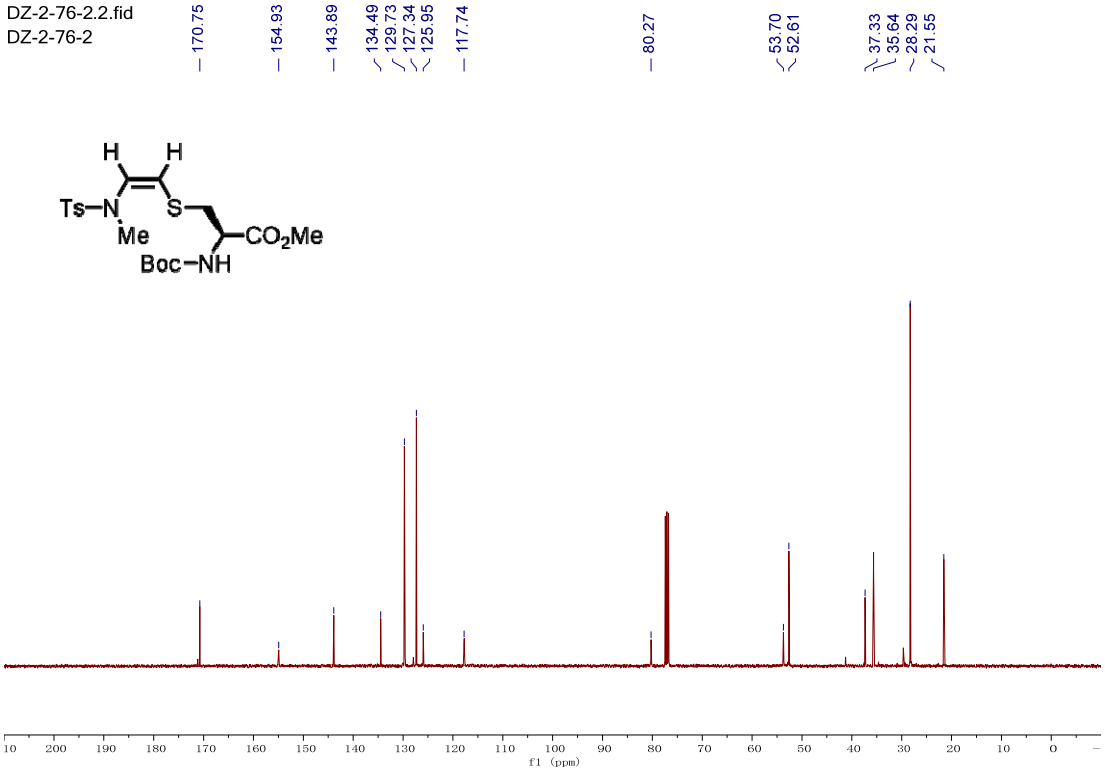
^{1}H NMR of **6n'**



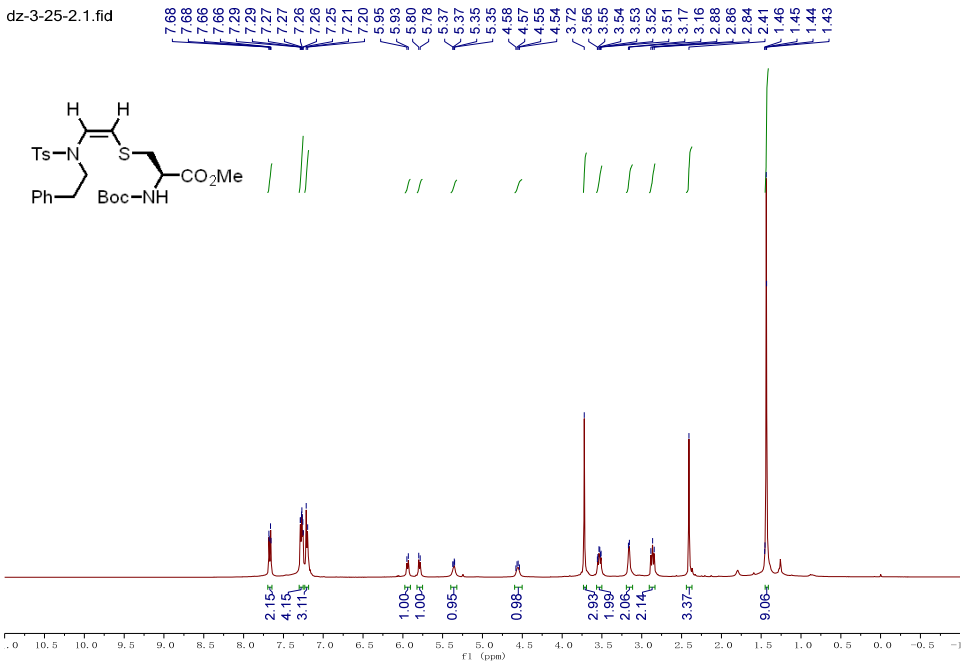
^{13}C NMR of **6n'**



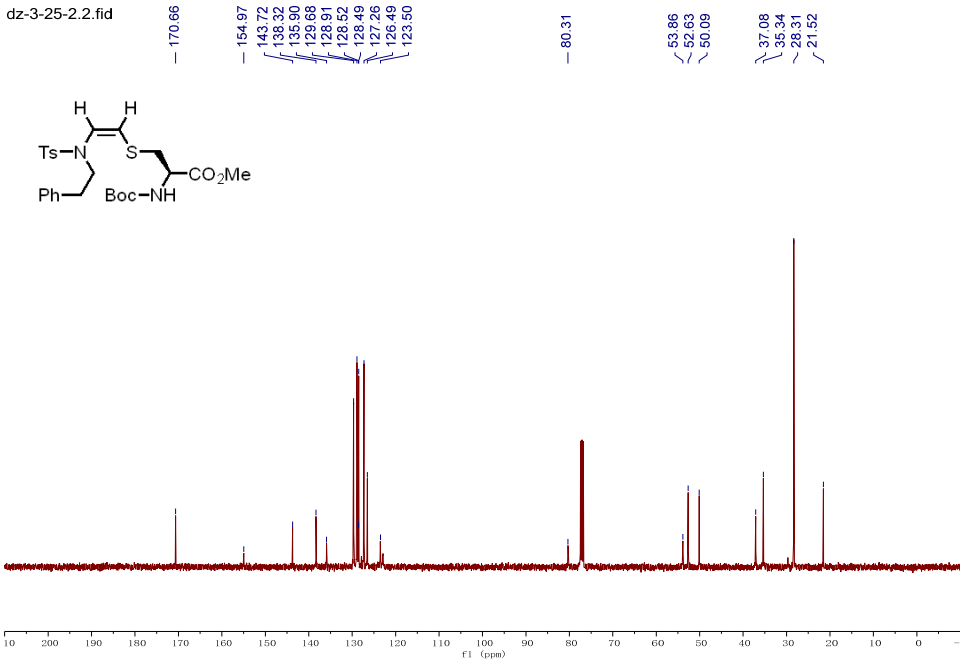
^{1}H NMR of **9a**



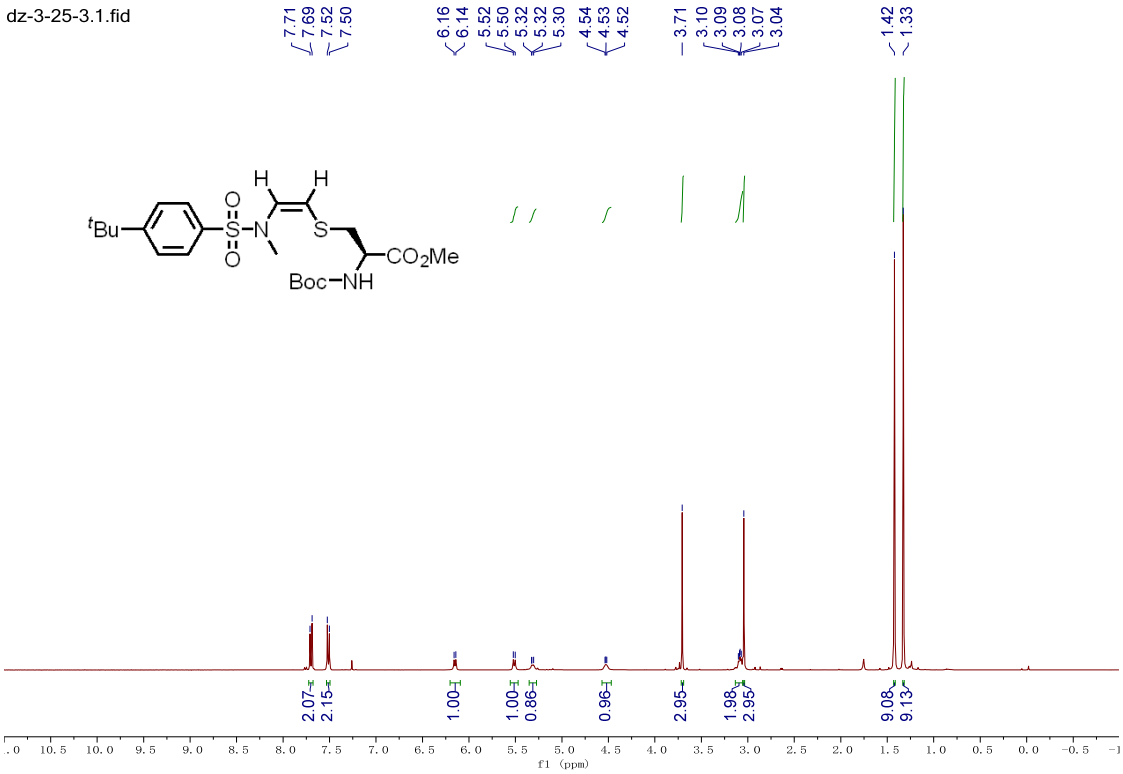
^{13}C NMR of **9a**



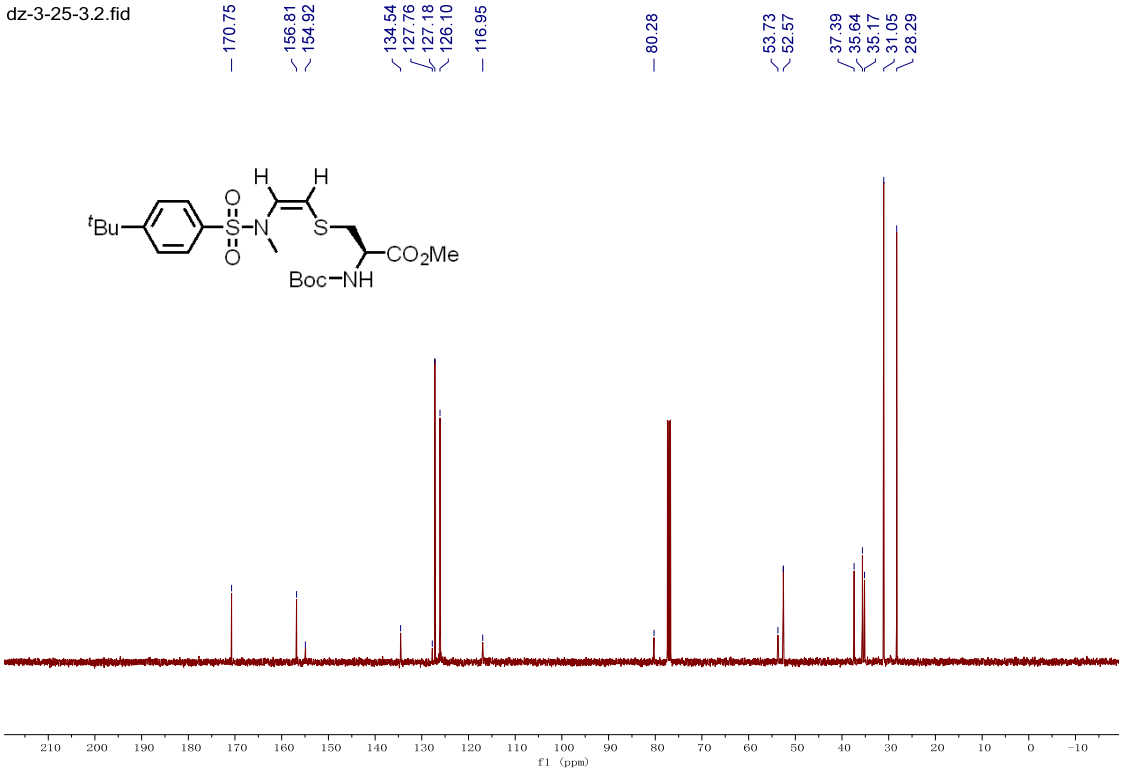
^{1}H NMR of **9b**



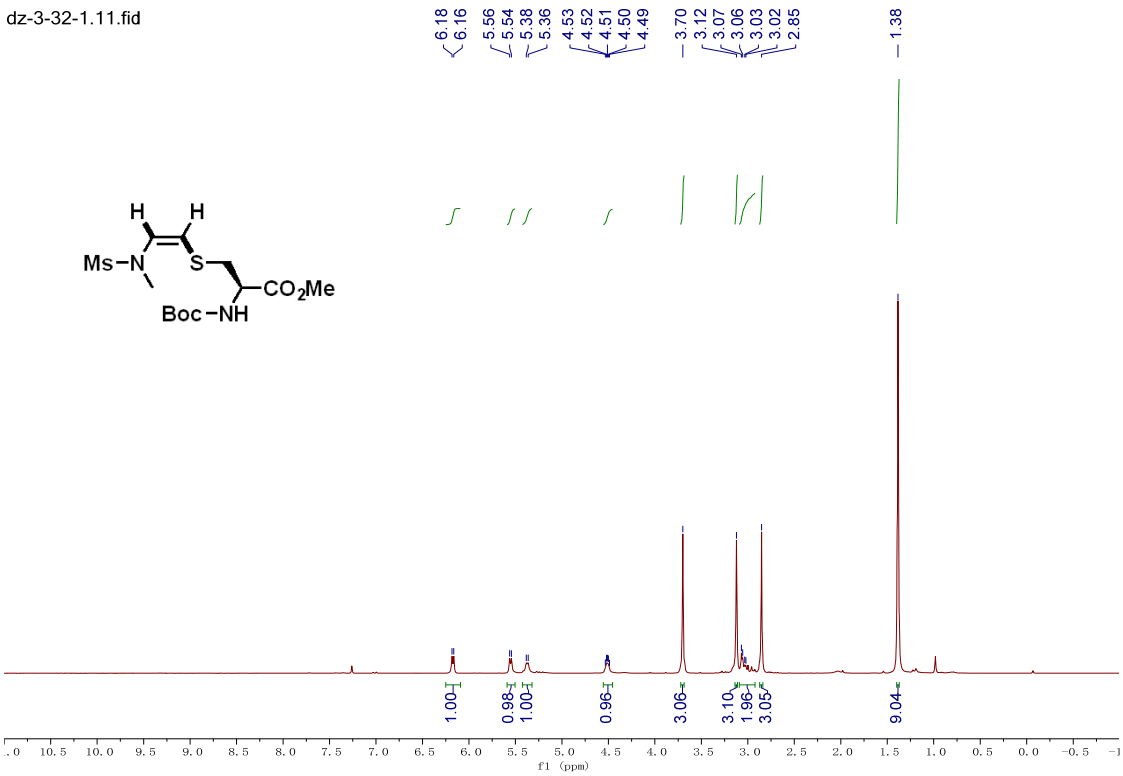
^{13}C NMR of **9b**



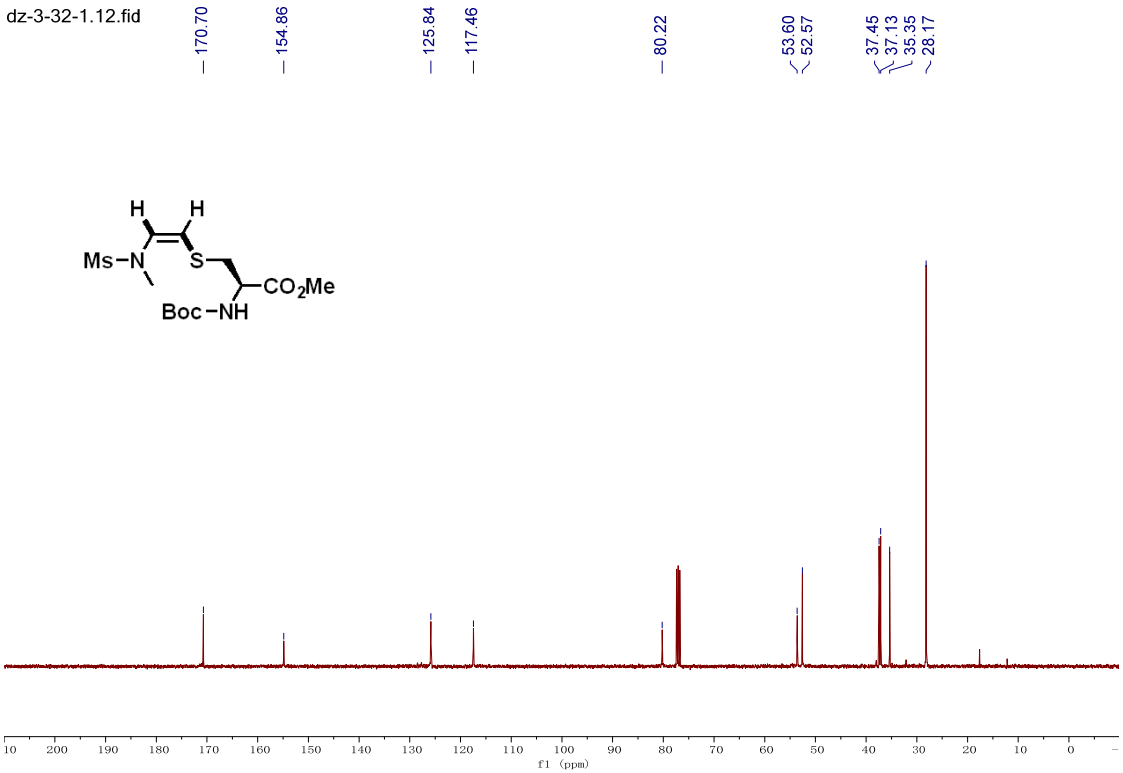
^{1}H NMR of **9c**



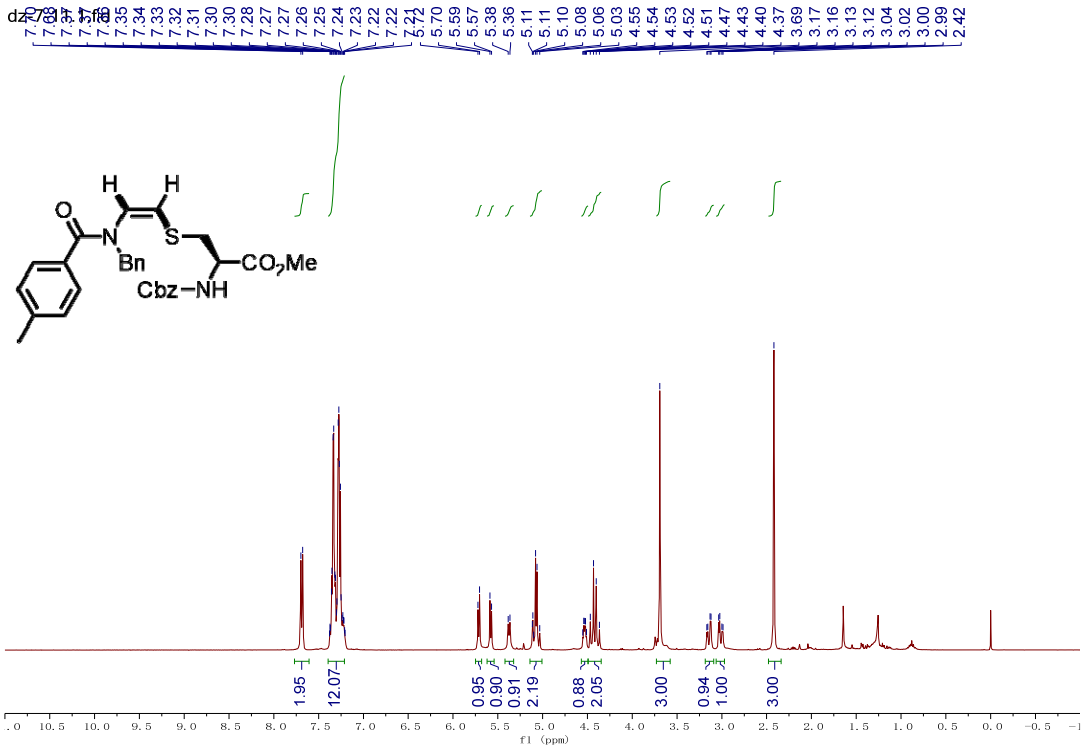
^{13}C NMR of **9c**



^{1}H NMR of **9d**



^{13}C NMR of **9d**



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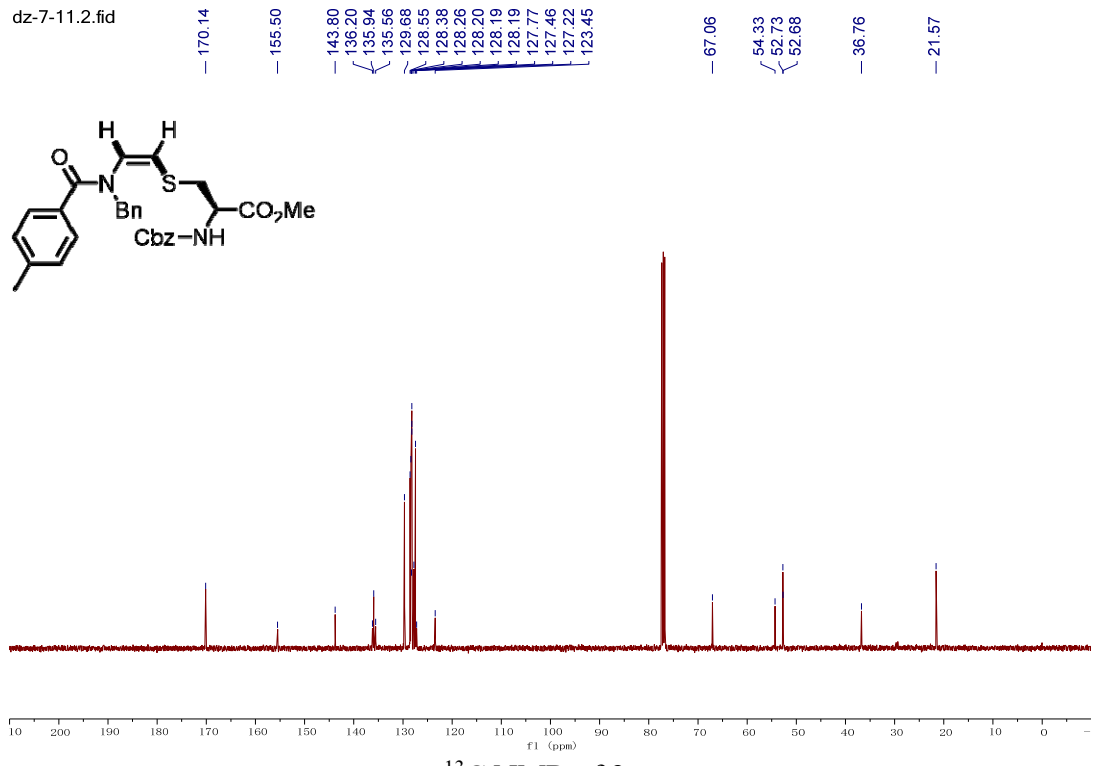
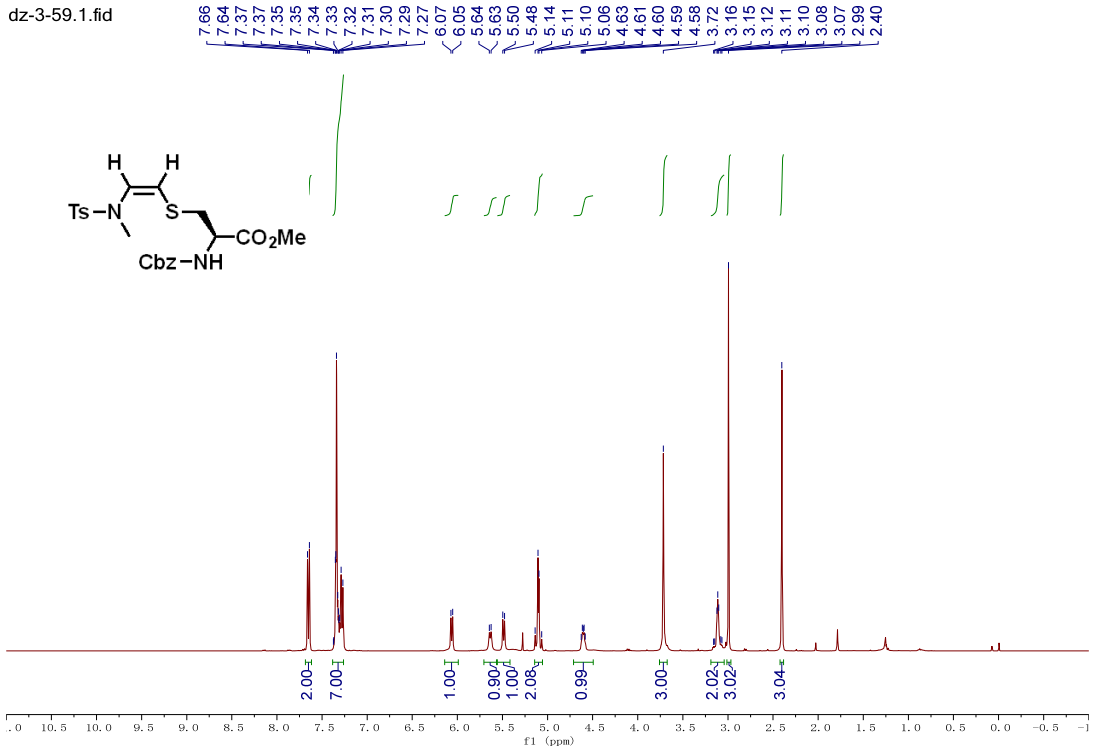
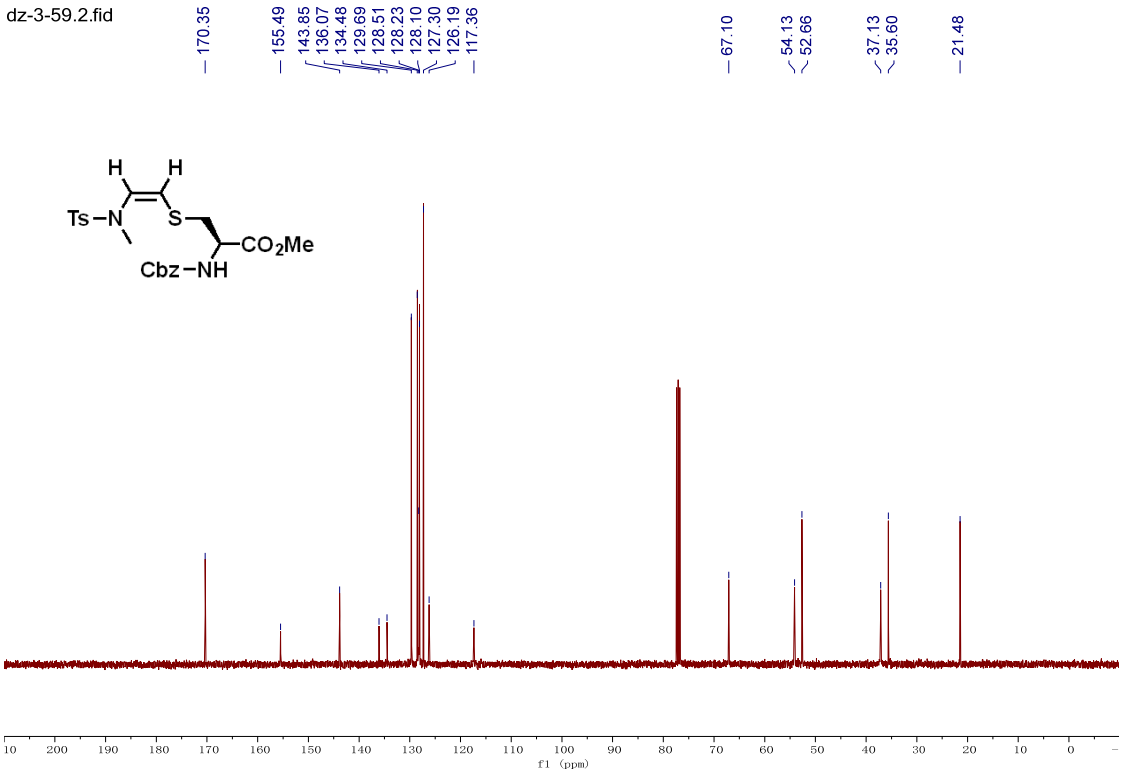


^{13}C NMR of **9e**



^{1}H NMR of **9f**



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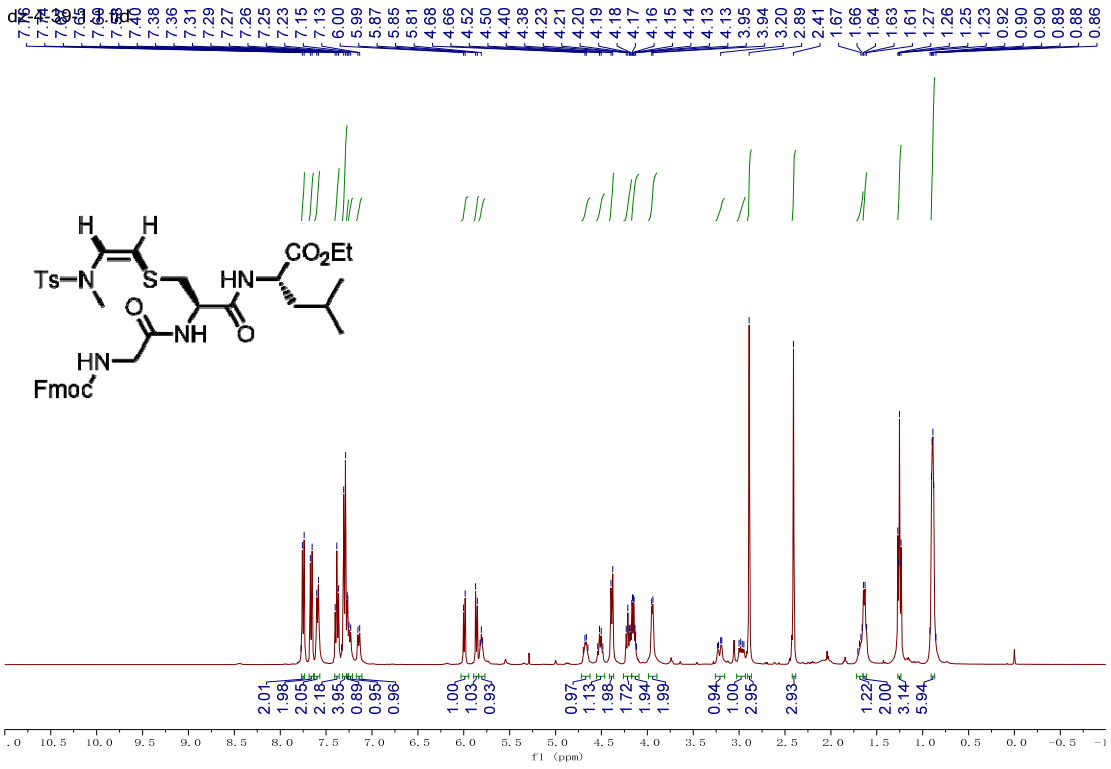

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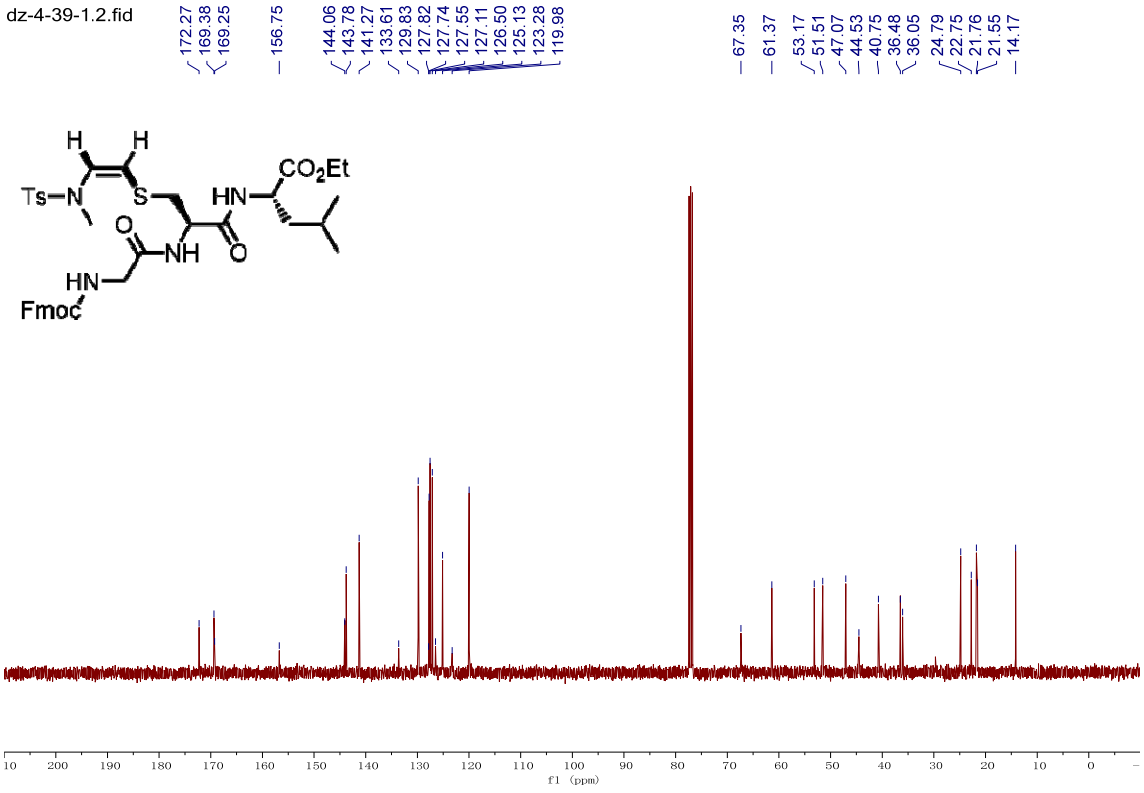
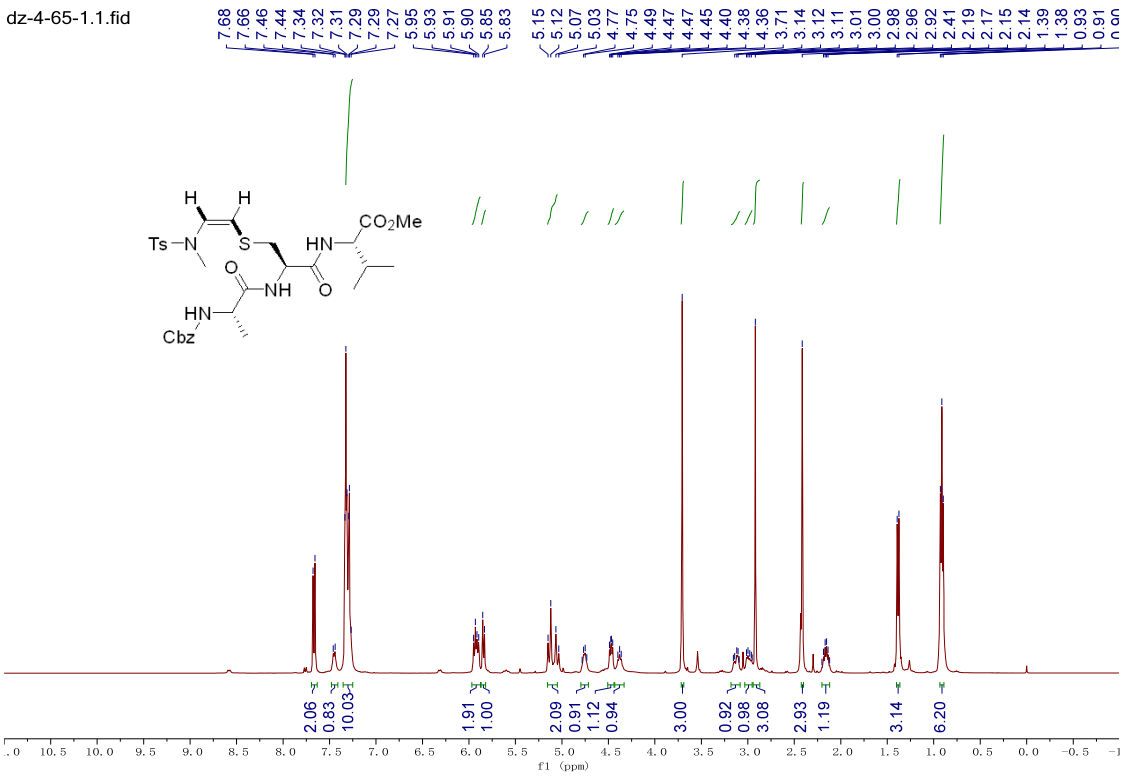


^{13}C NMR of **9g**



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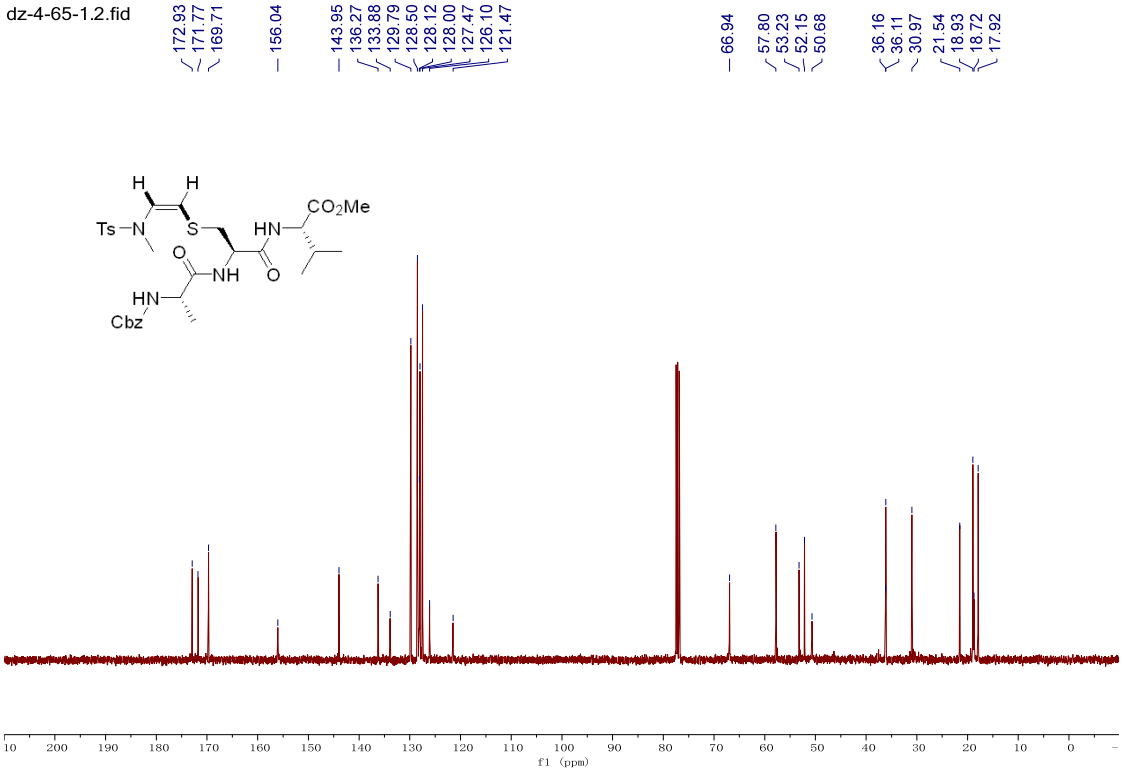

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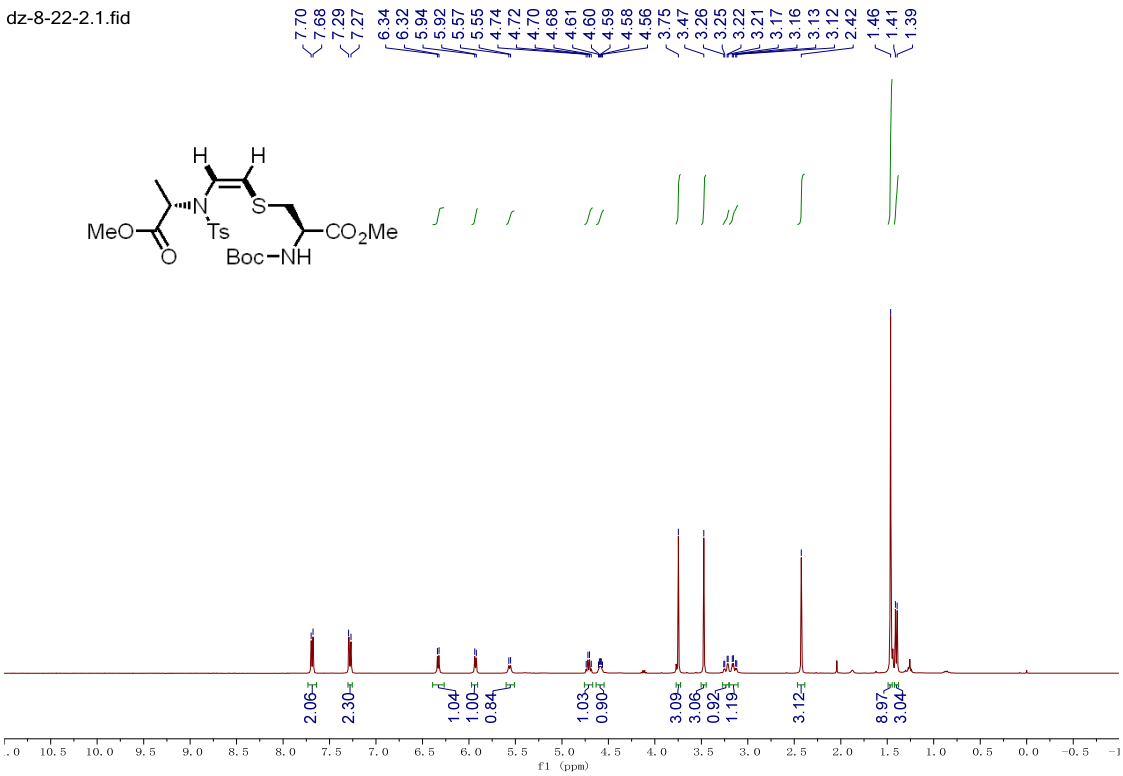
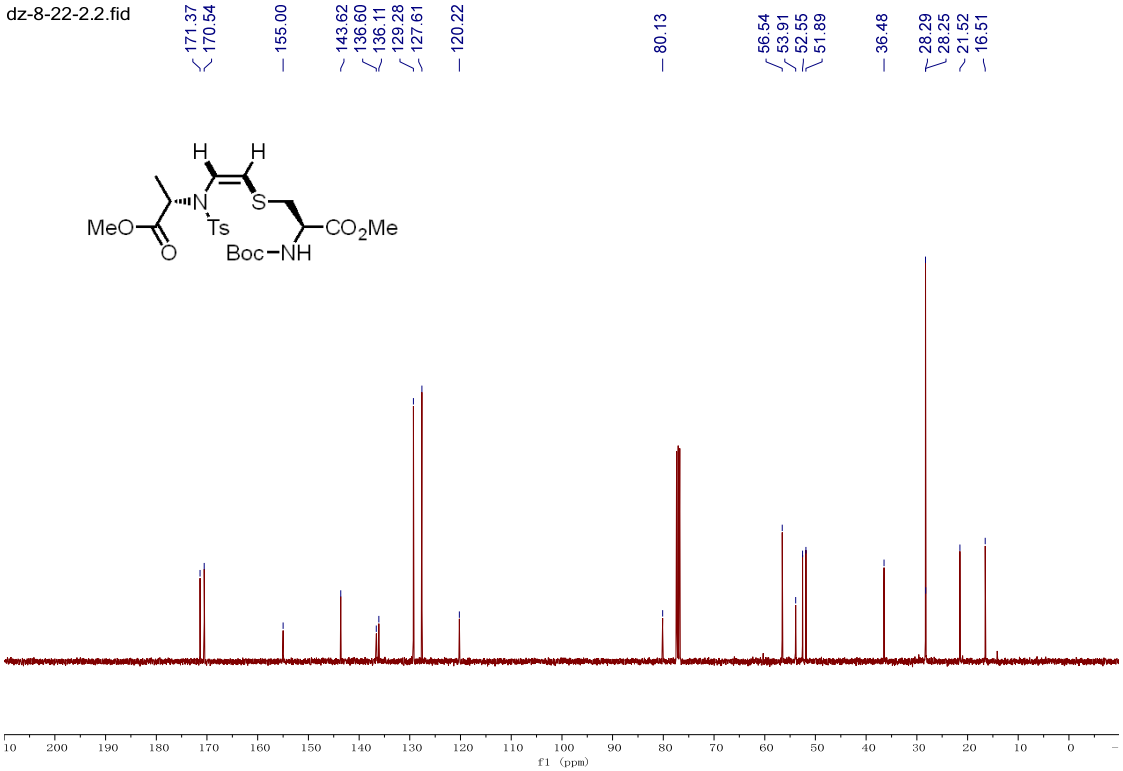


^{1}H NMR of **9i**



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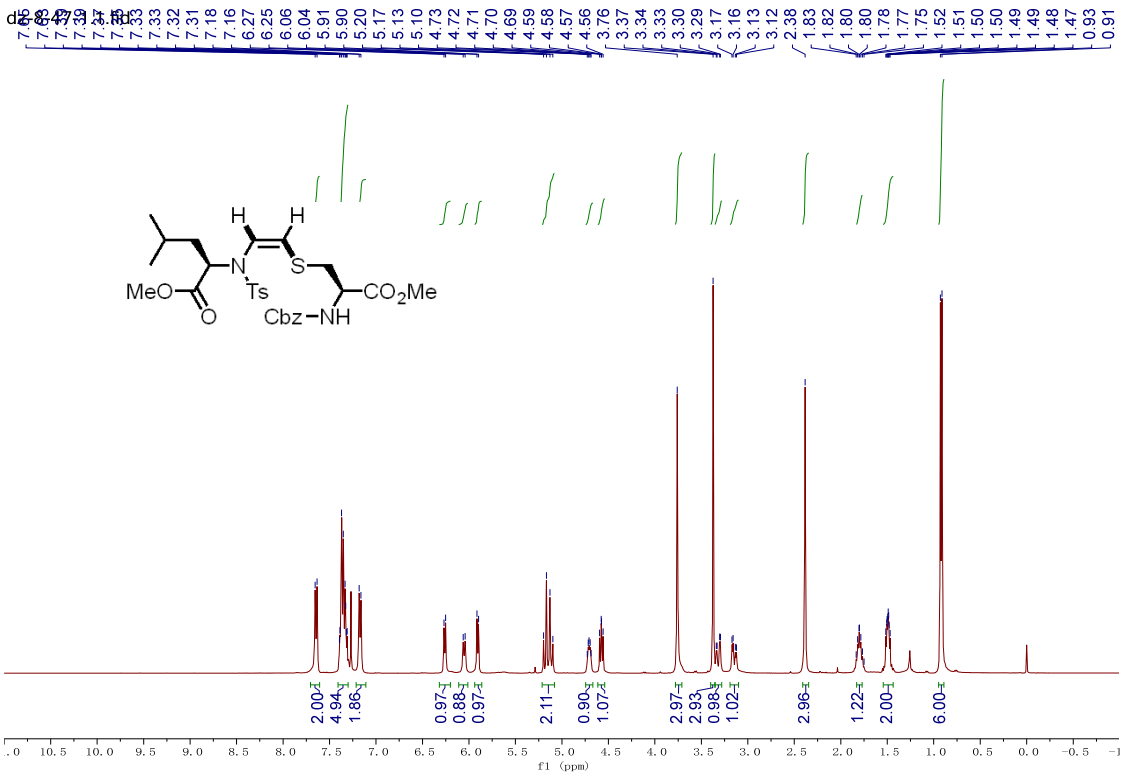

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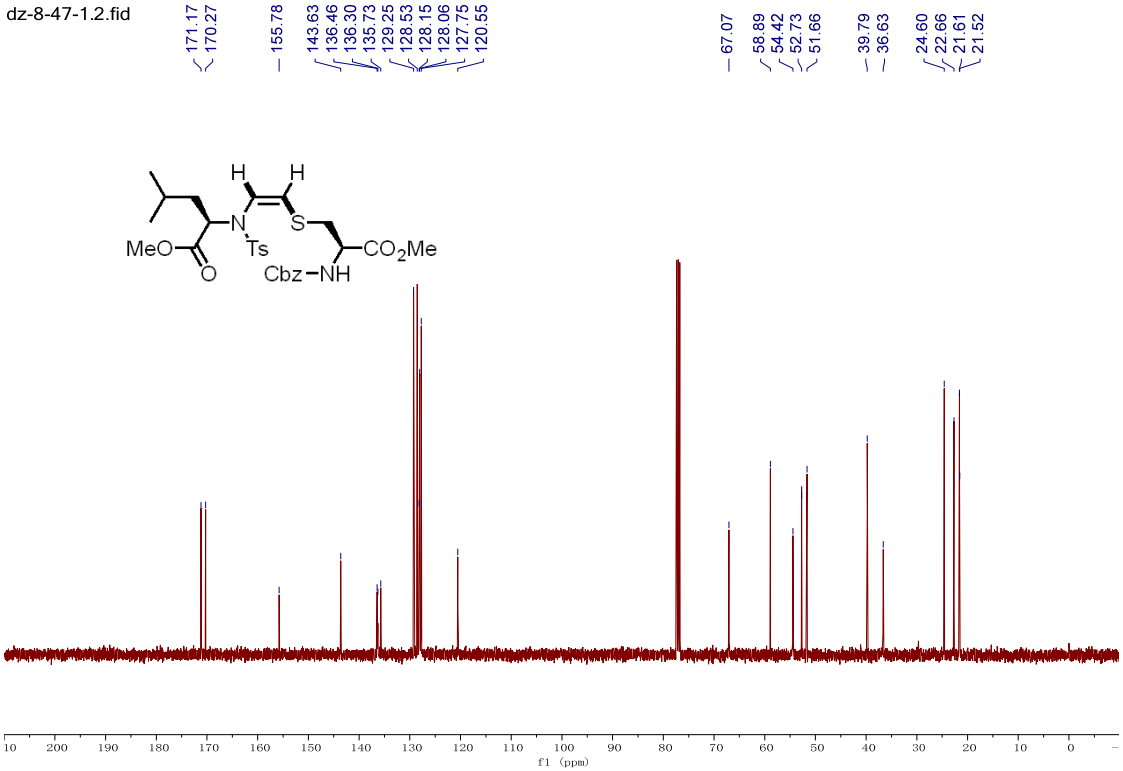

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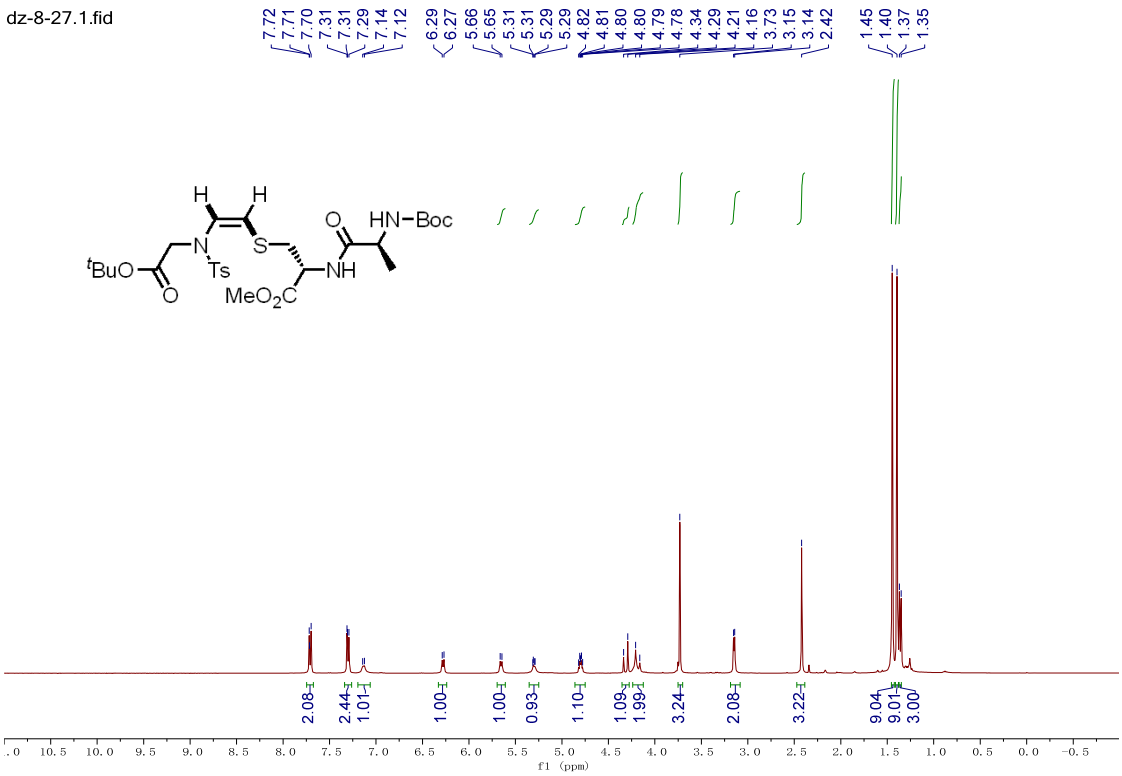

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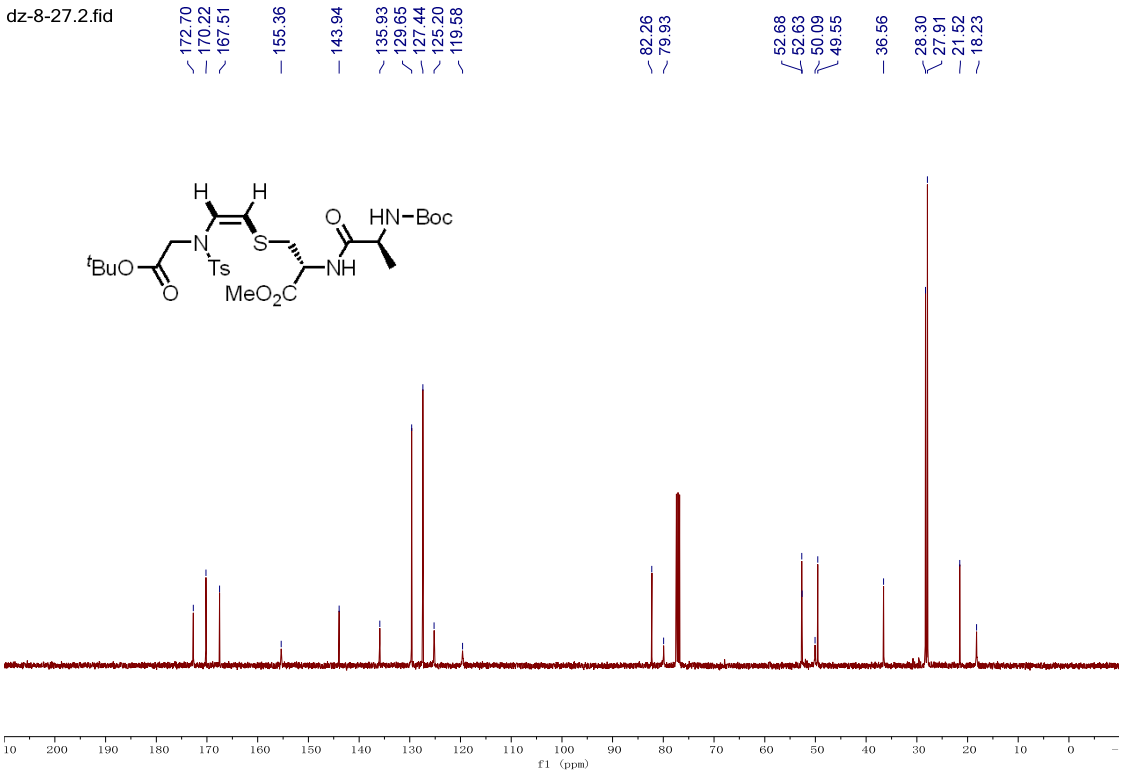

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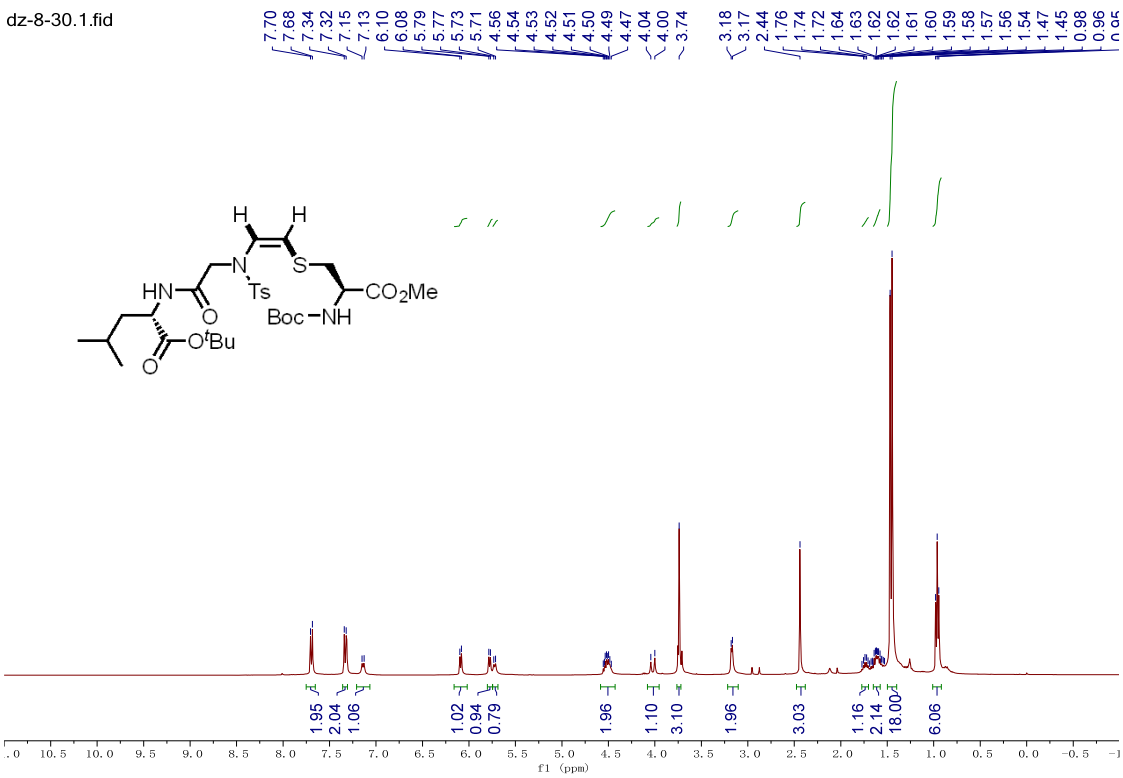

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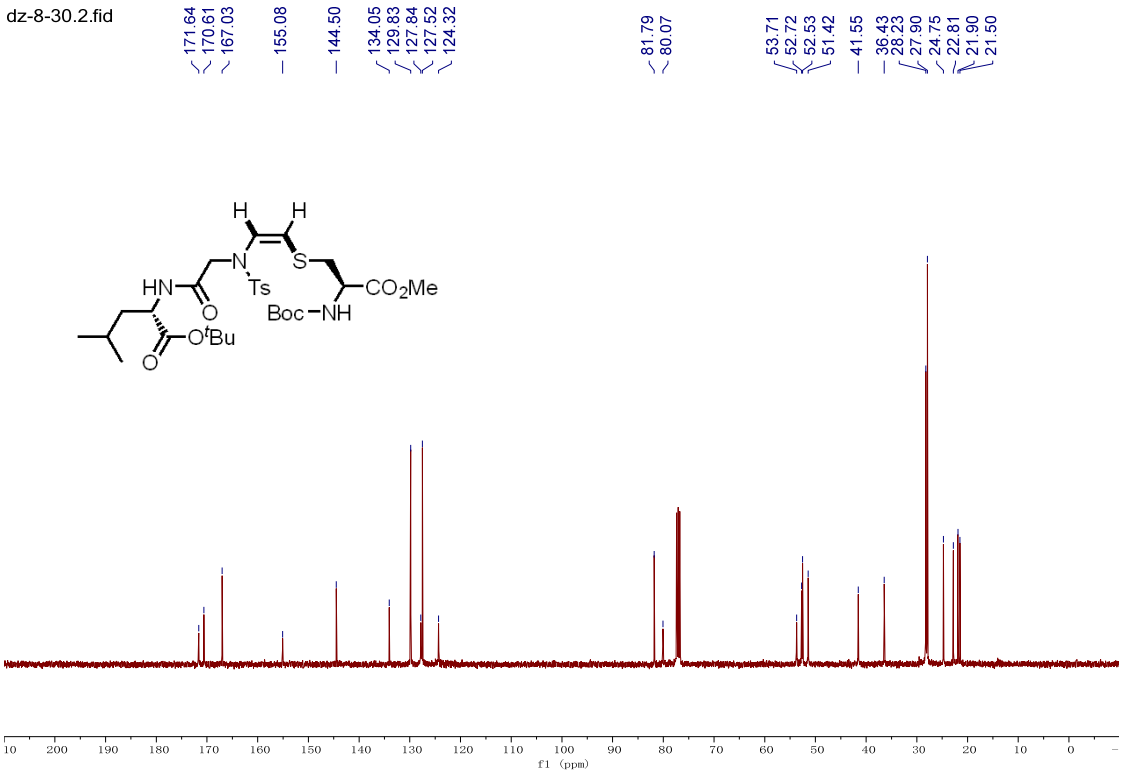

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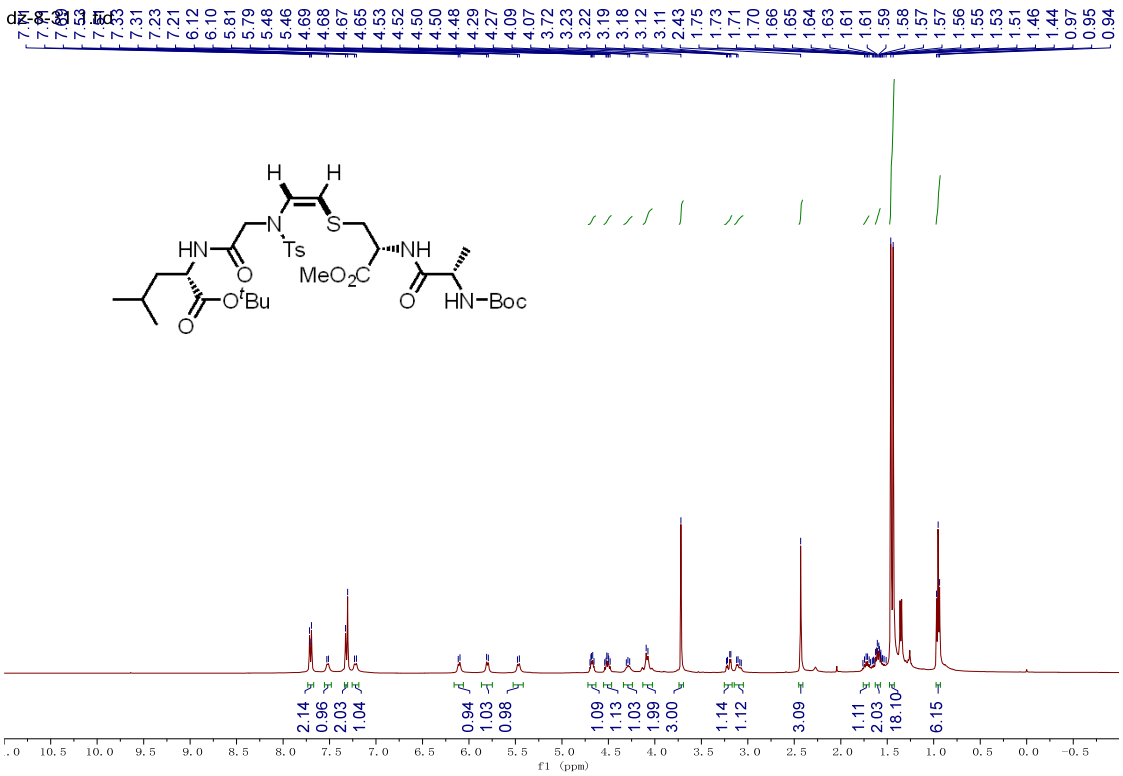
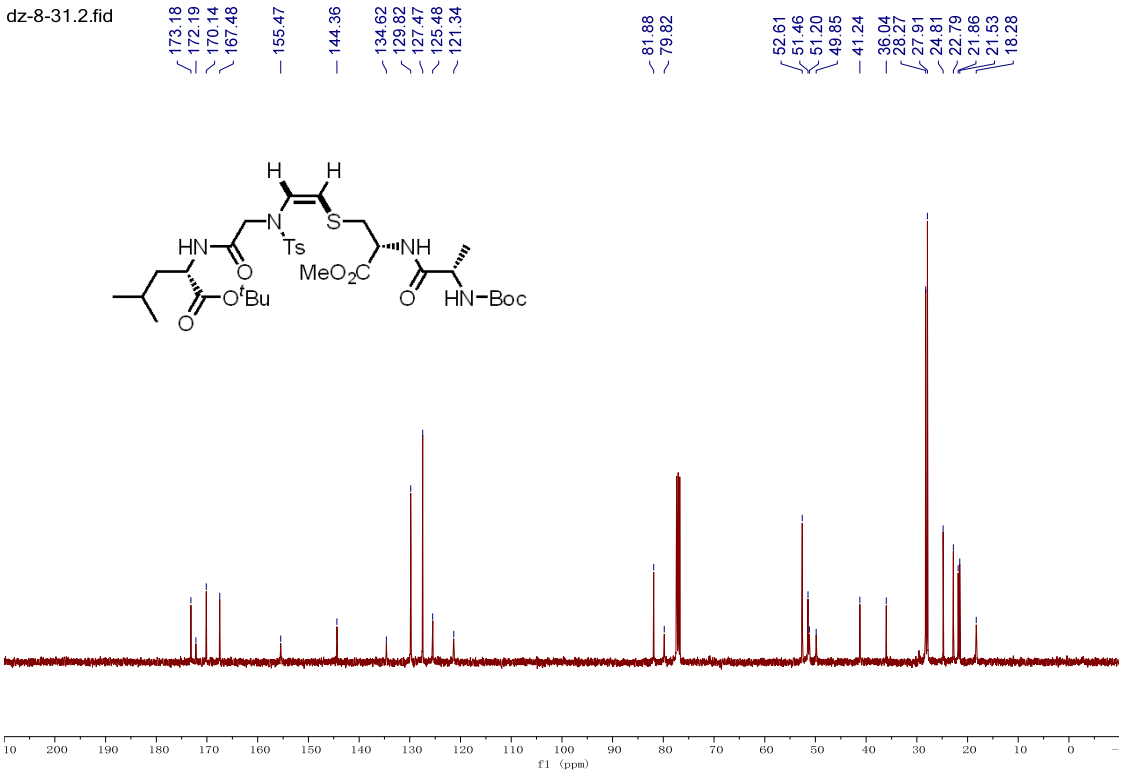
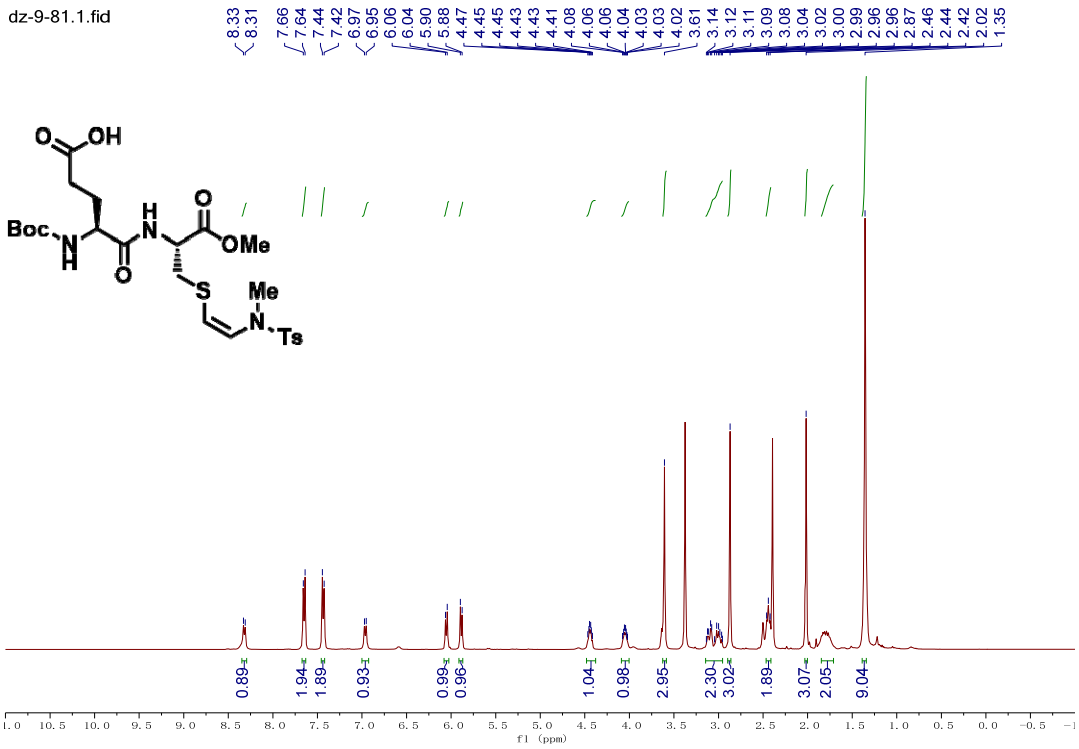


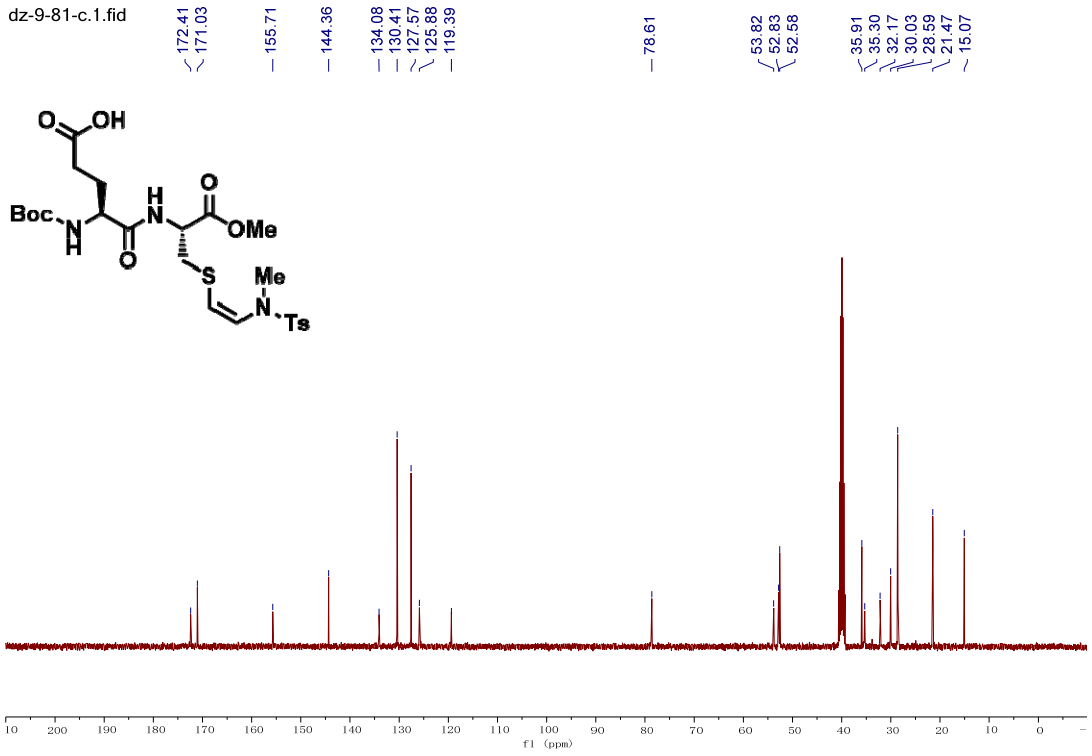
^{1}H NMR of **9m**



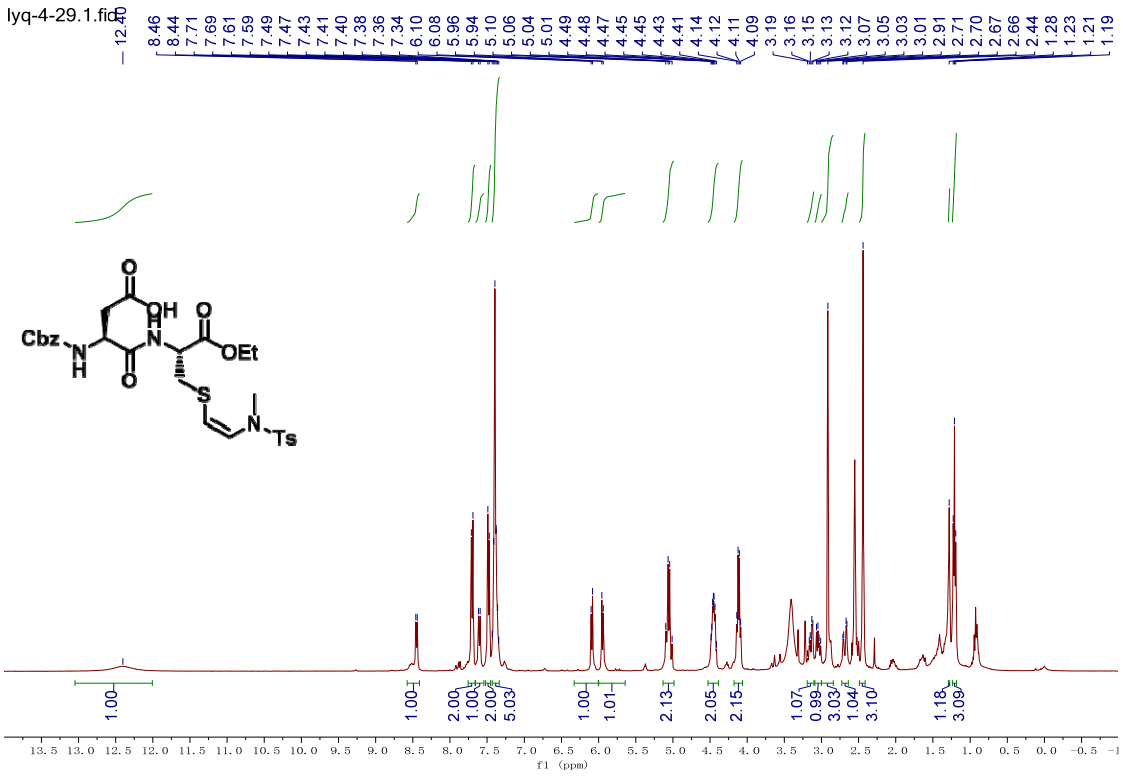
^{13}C NMR of **9m**



^{1}H NMR of **11a**



^{13}C NMR of **11a**



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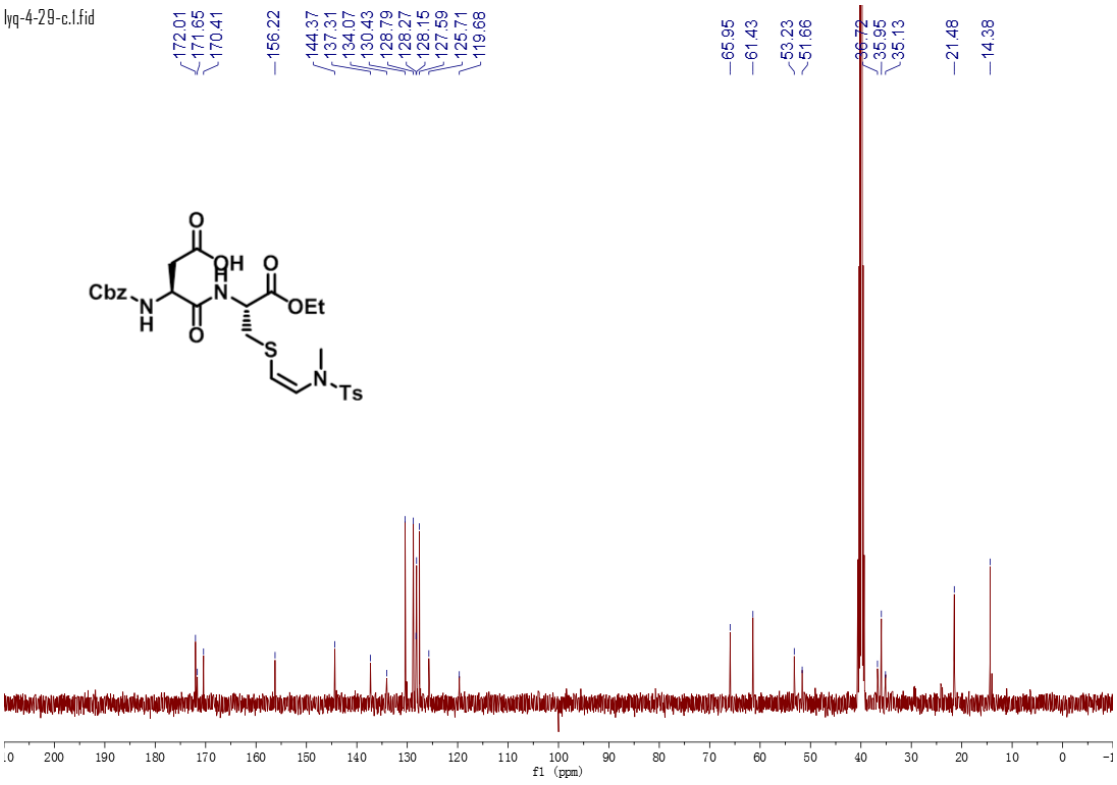

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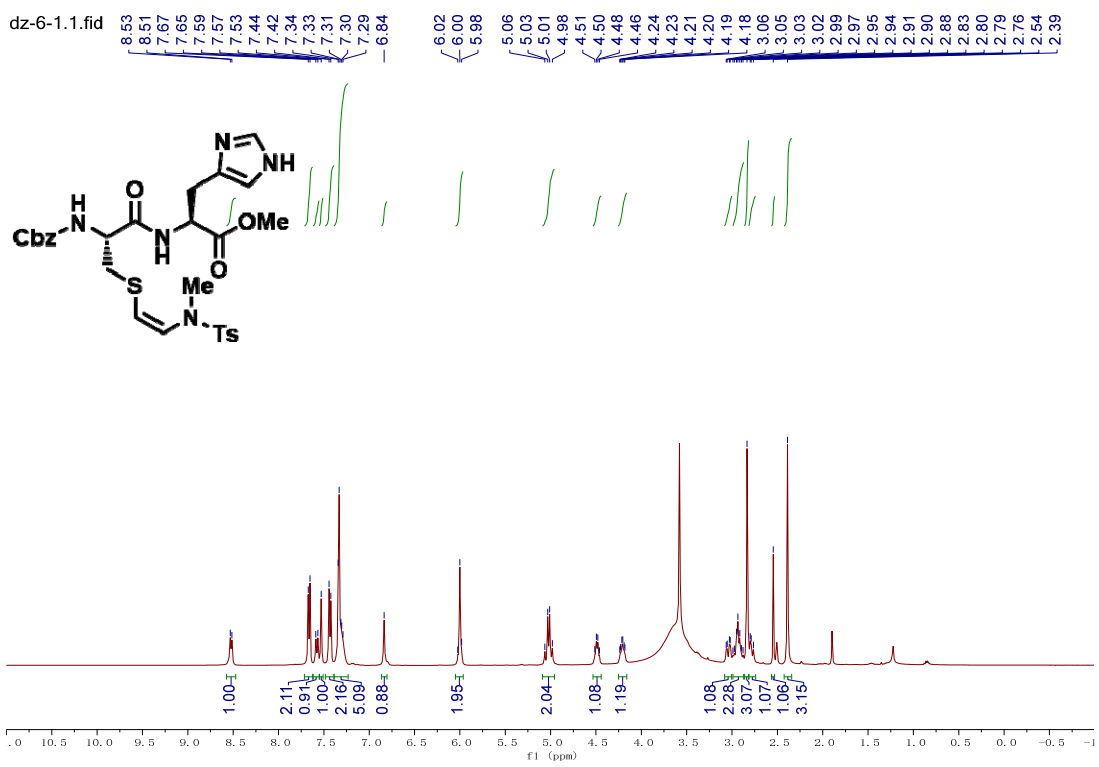
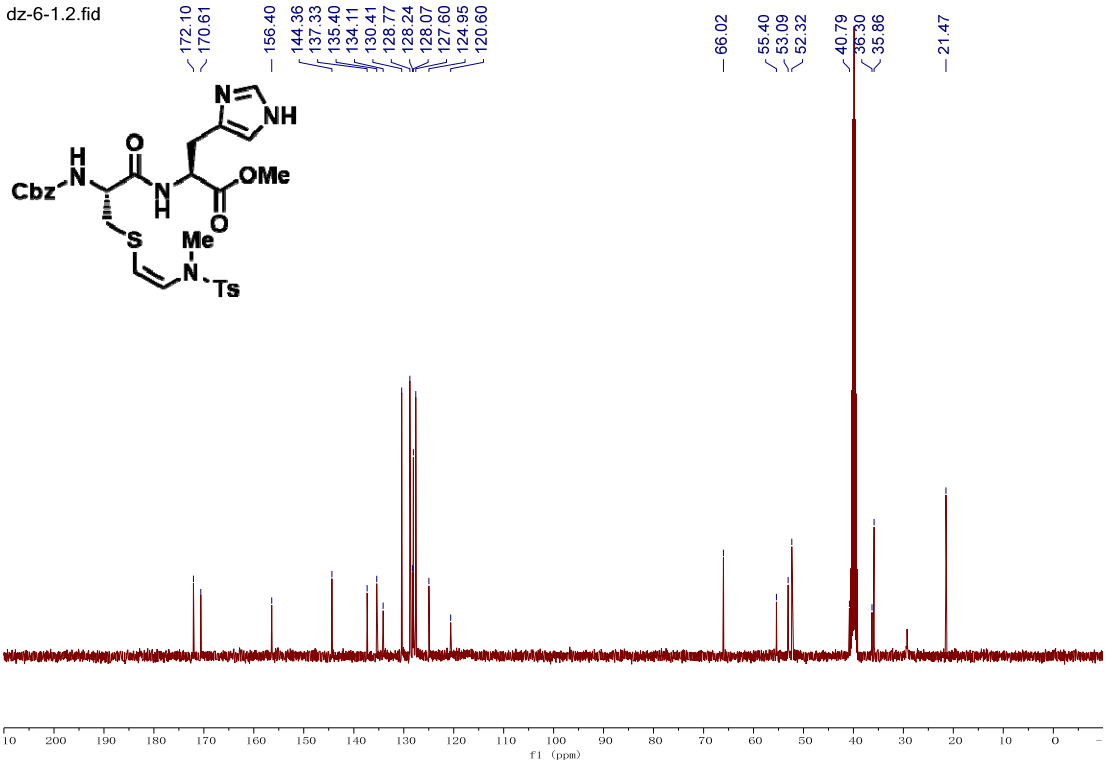


^{1}H NMR of **11c**



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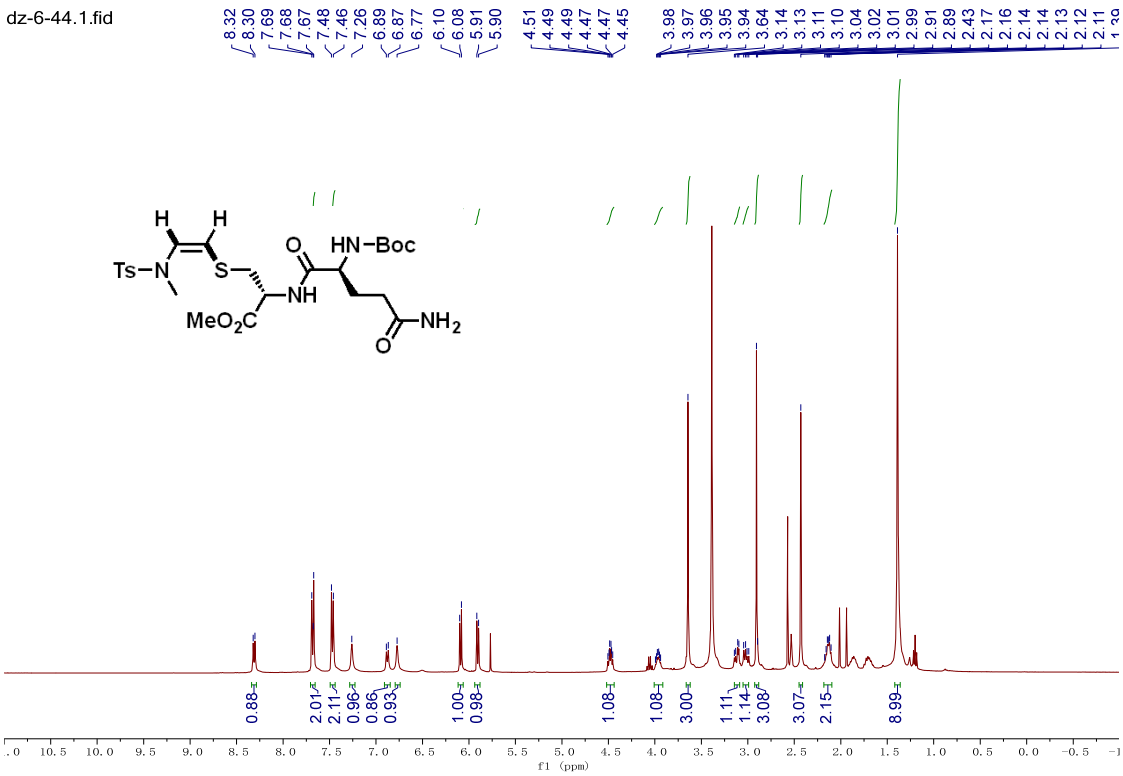

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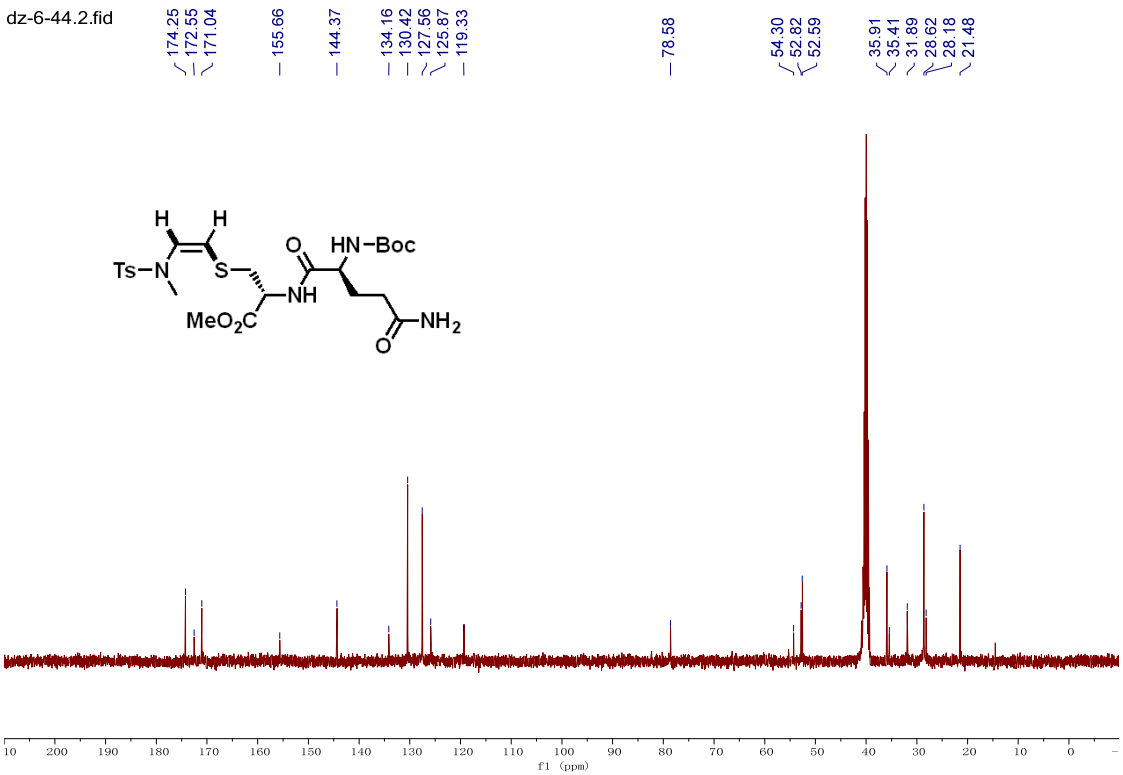
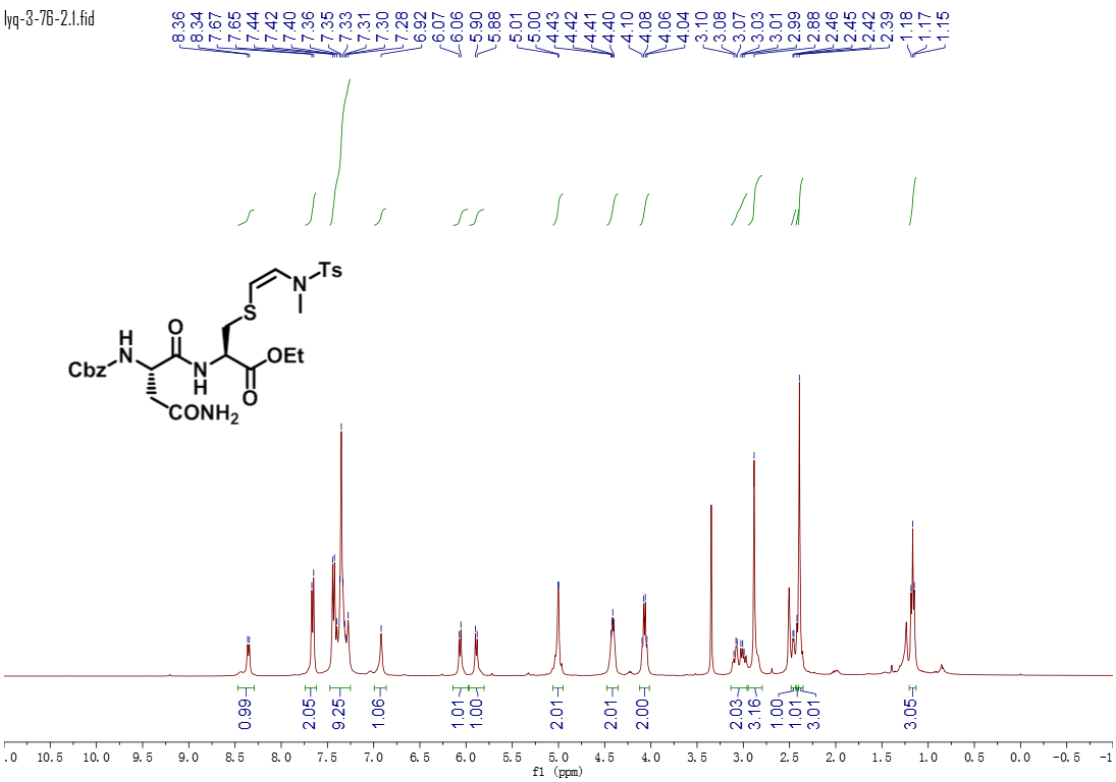


^{13}C NMR of **11d**



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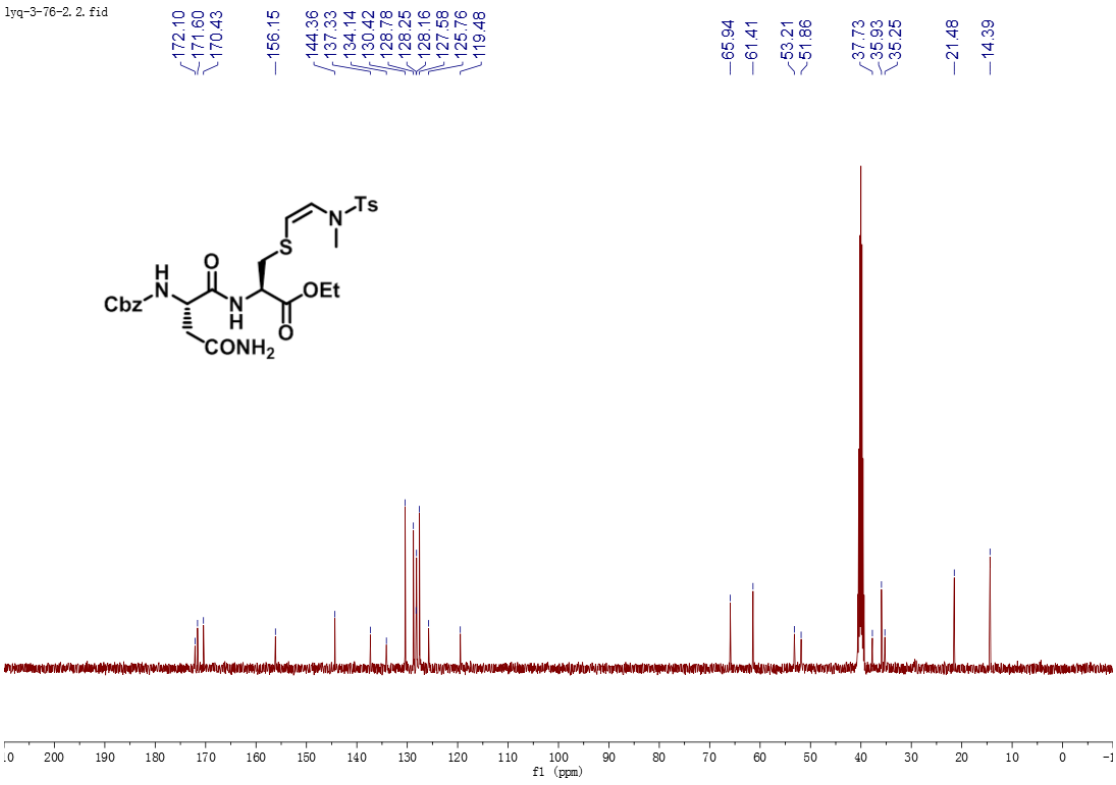

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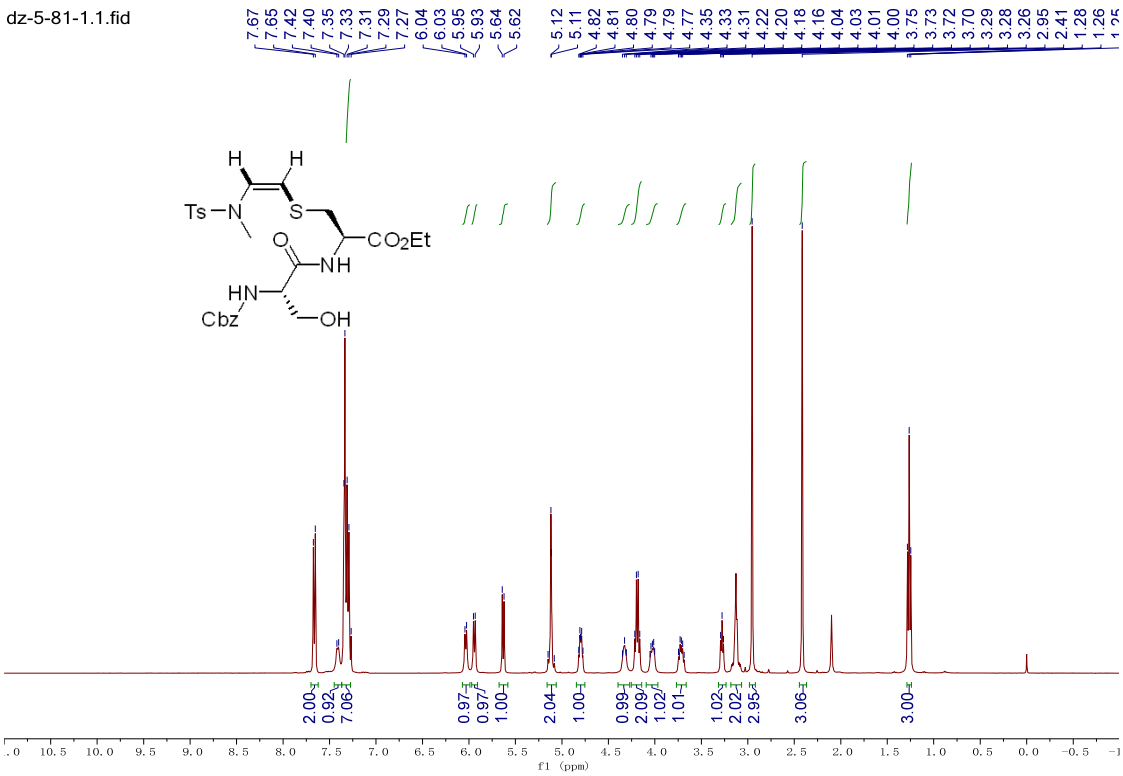
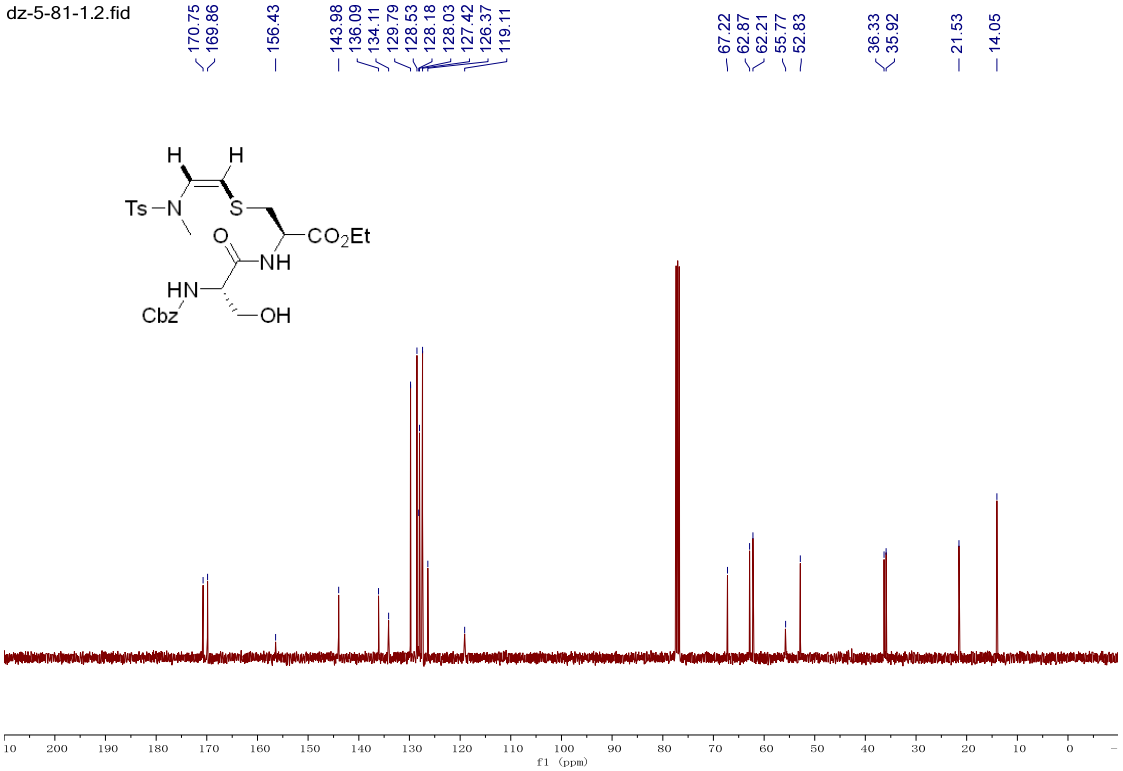


^{1}H NMR of **11f**



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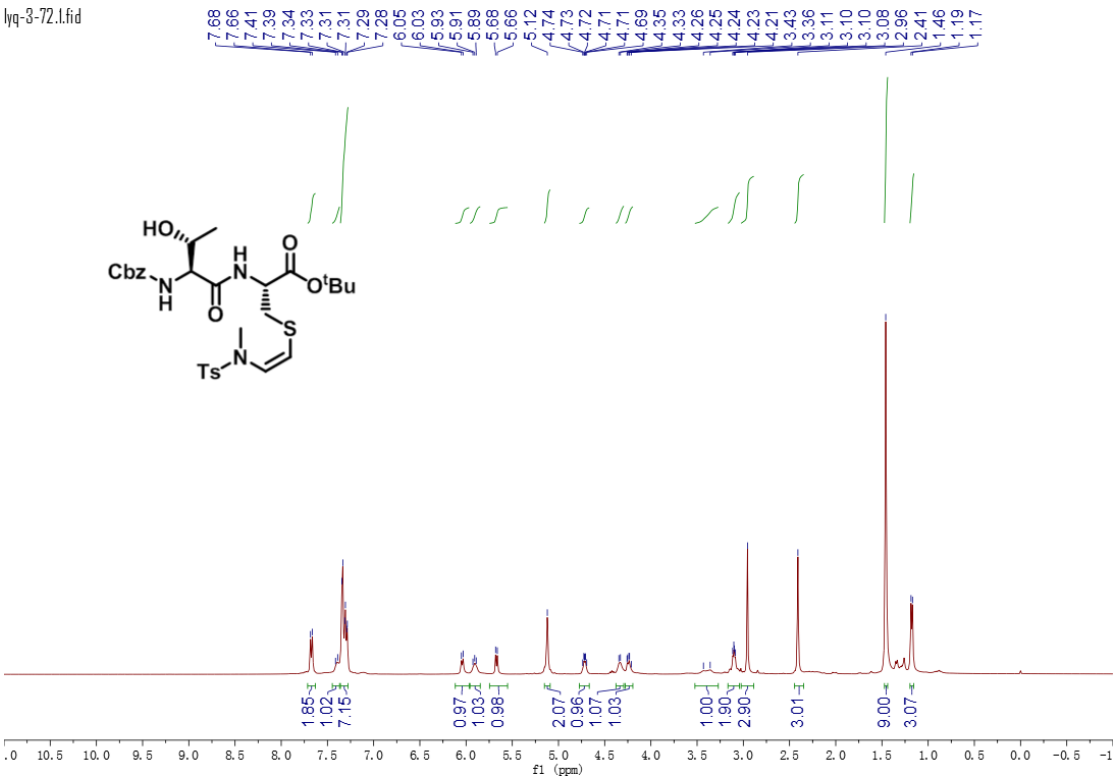

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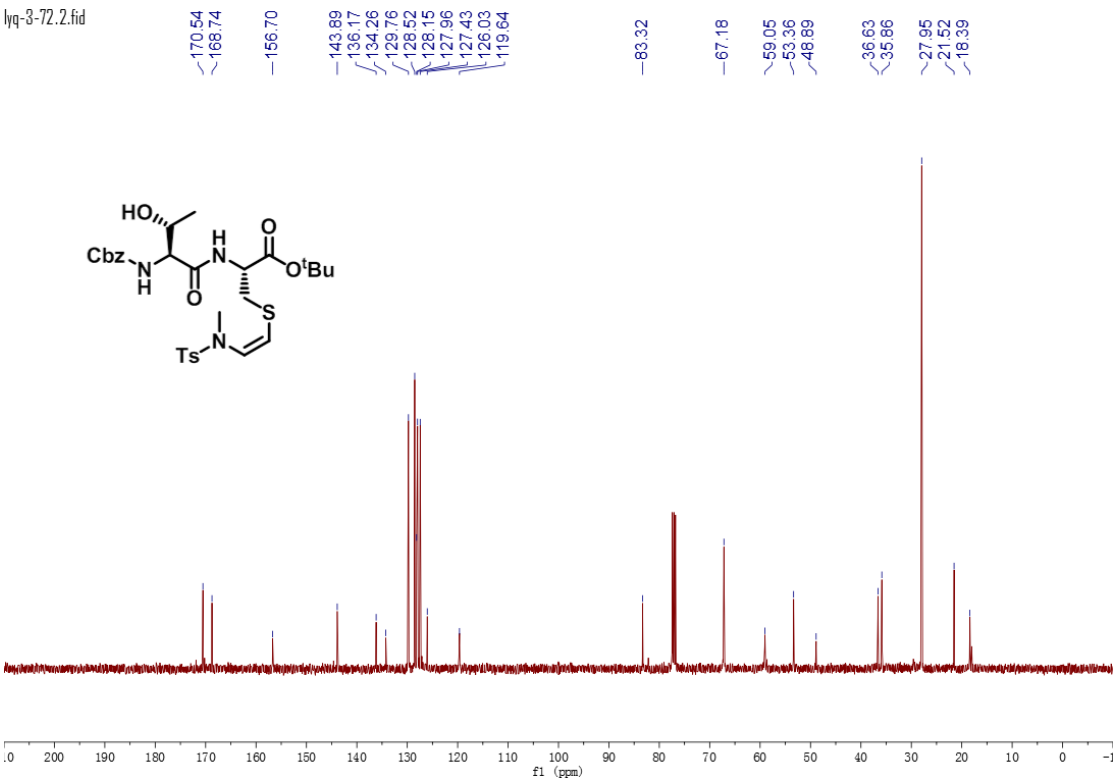
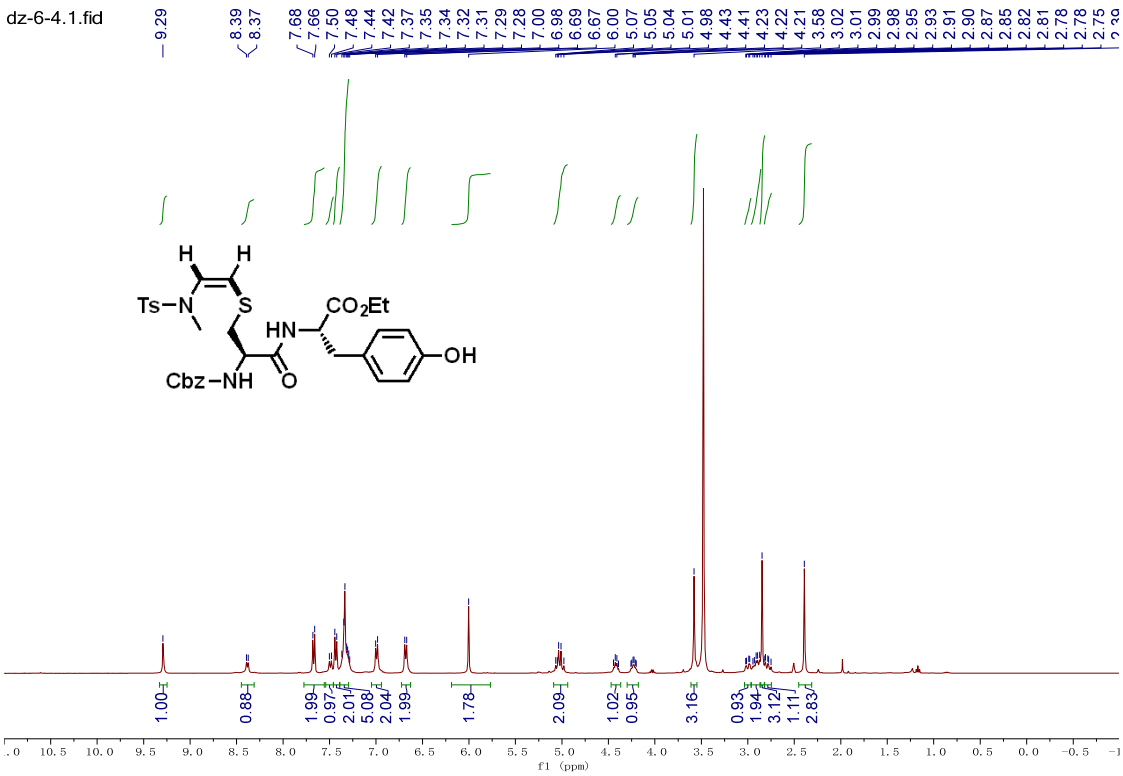


^{13}C NMR of **11g**



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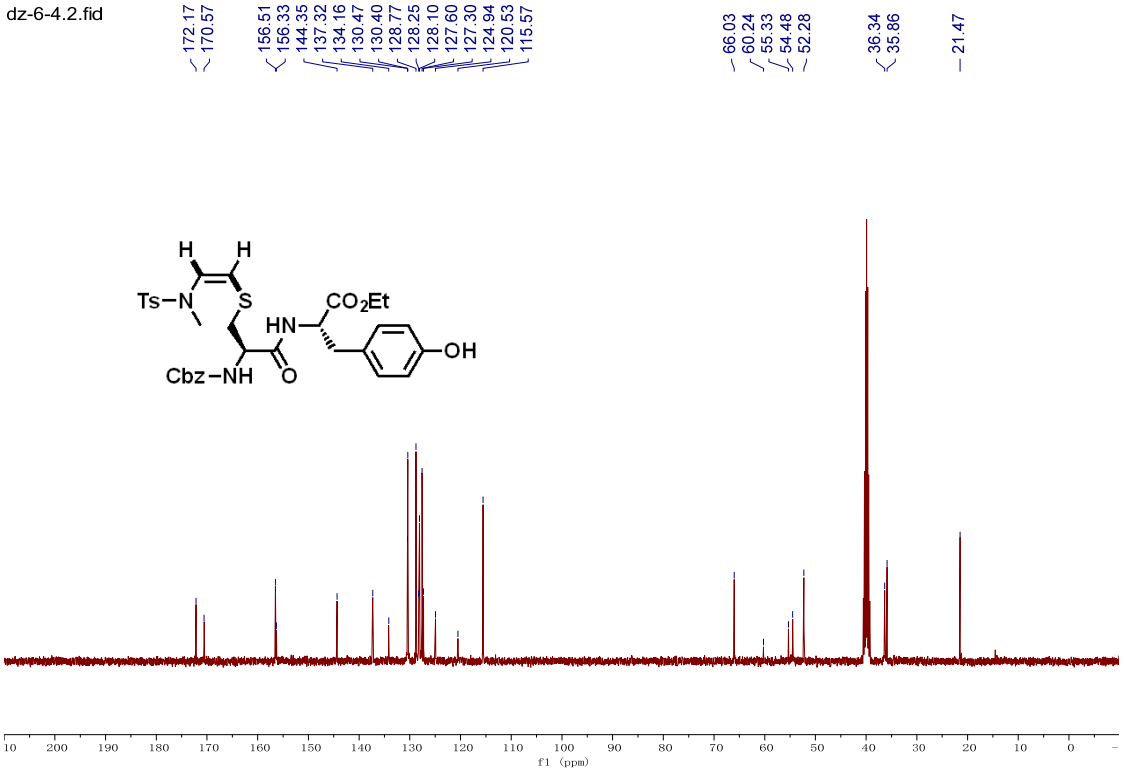
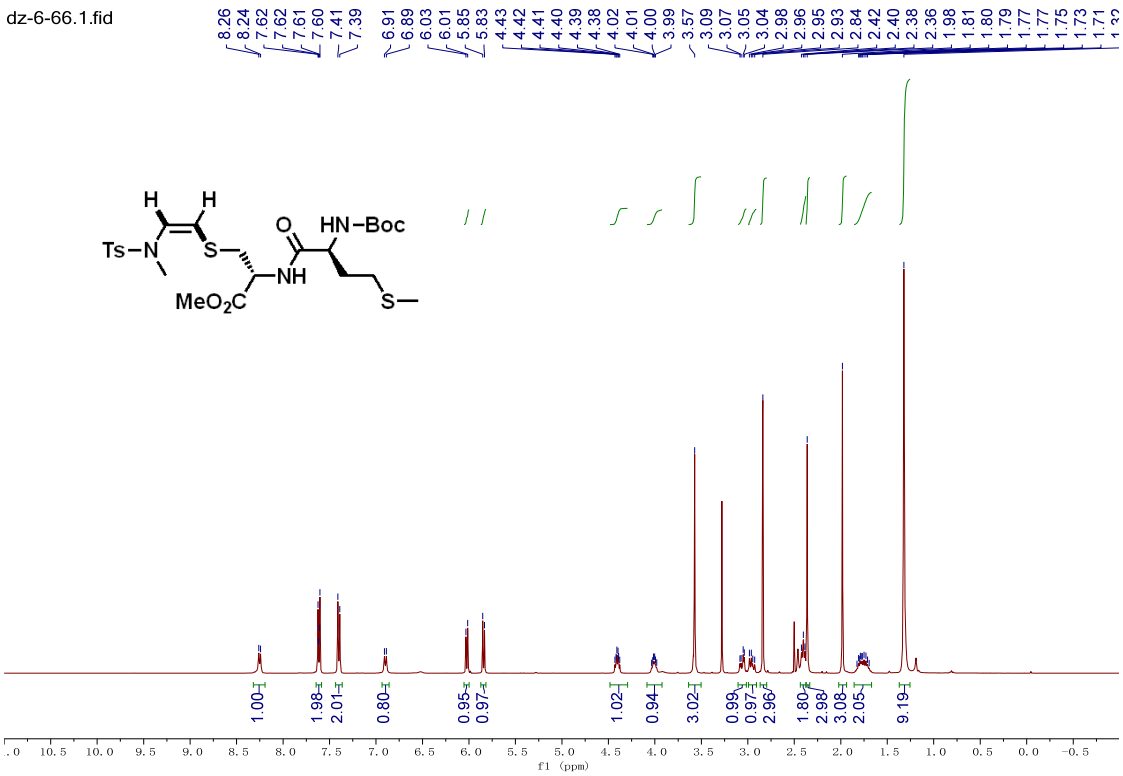
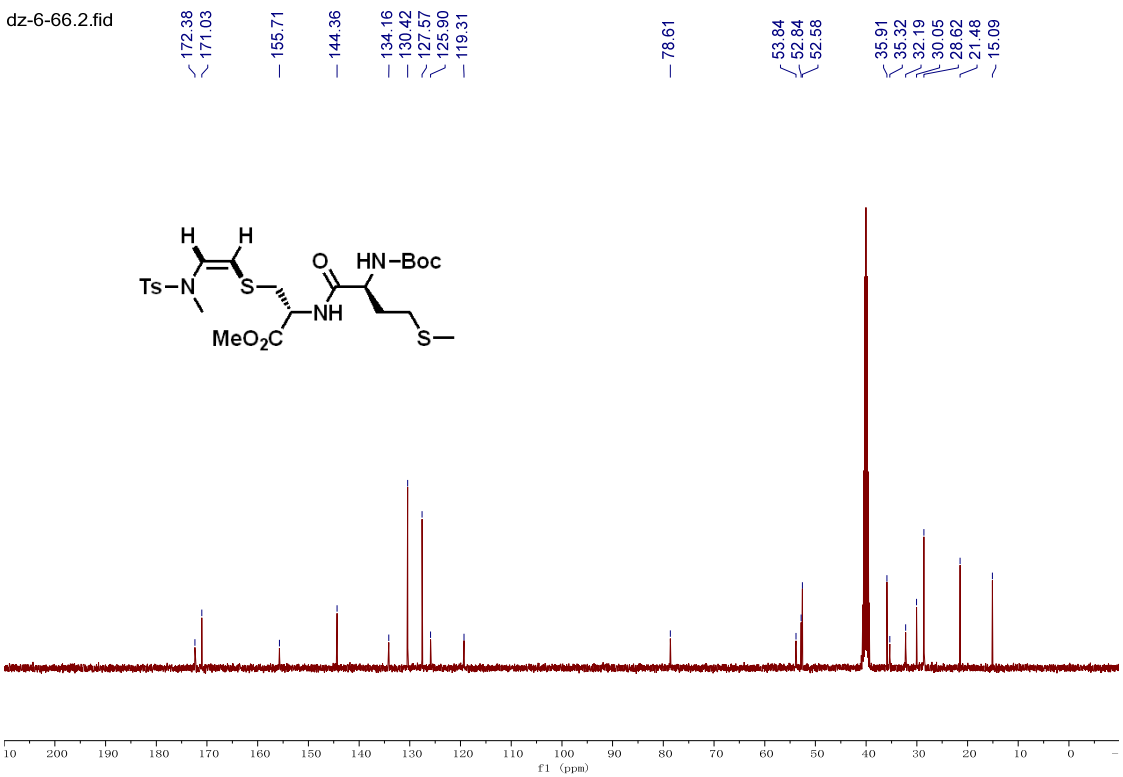


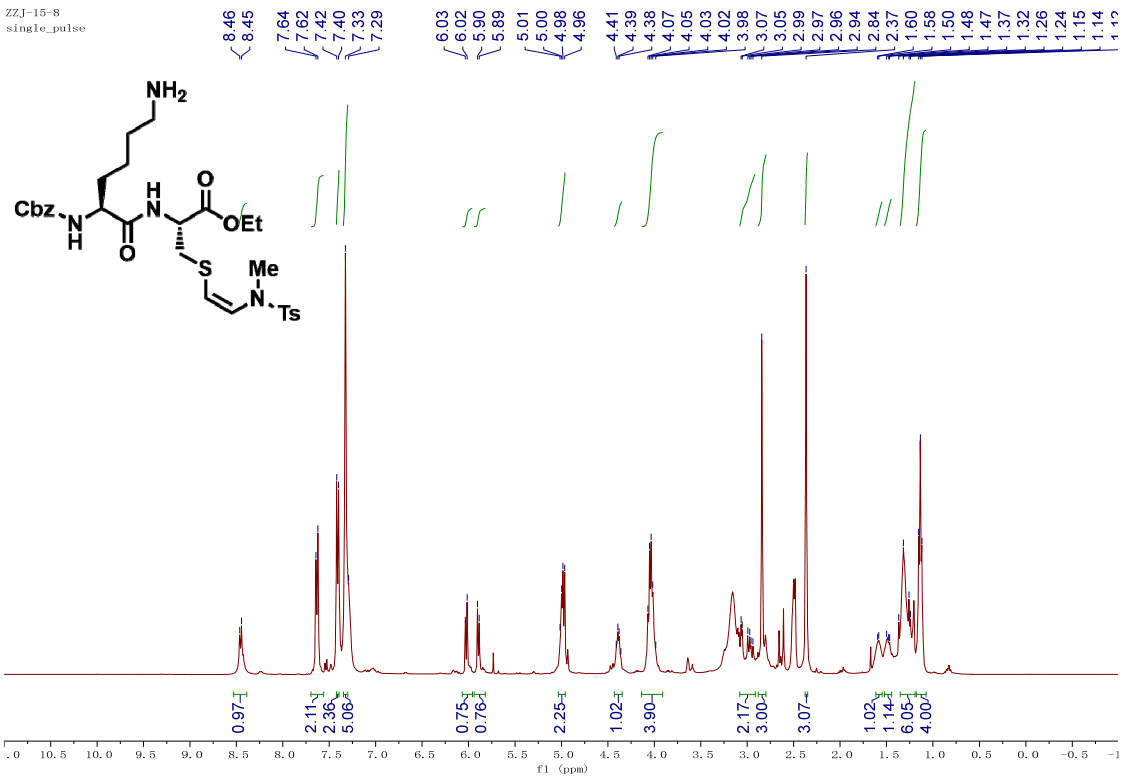
^{13}C NMR of **11h**



^{1}H NMR of **11i**



^{13}C NMR of **11i**



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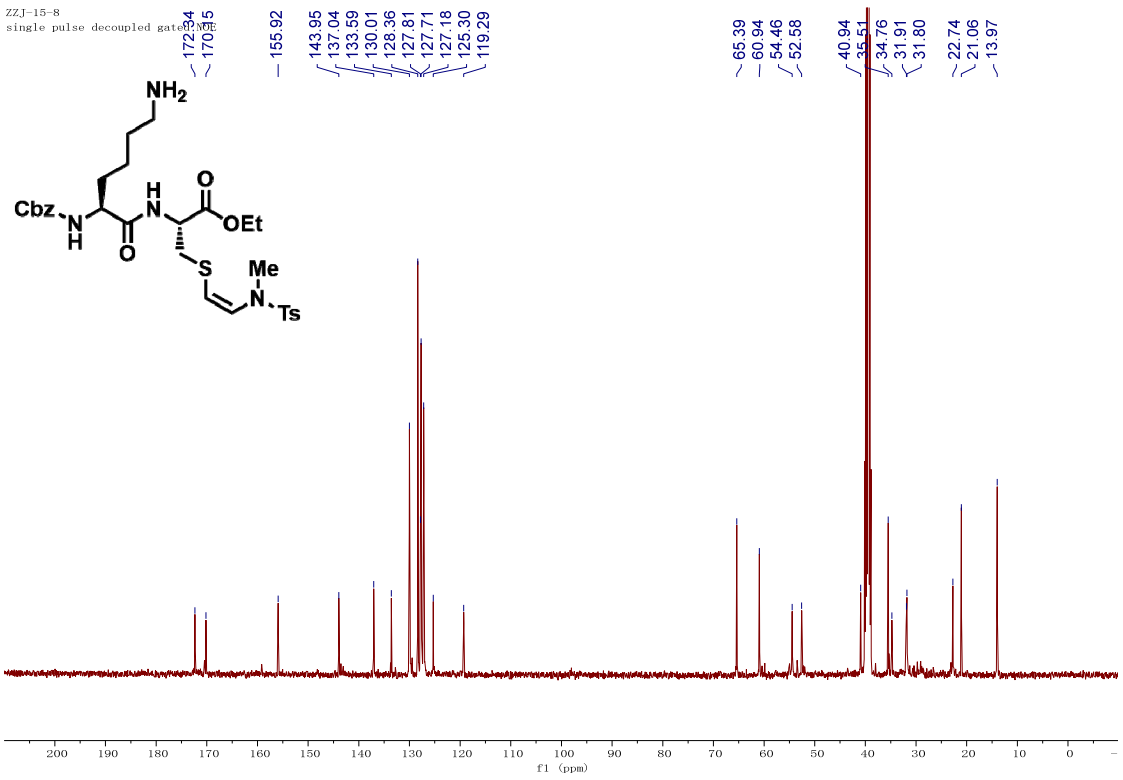

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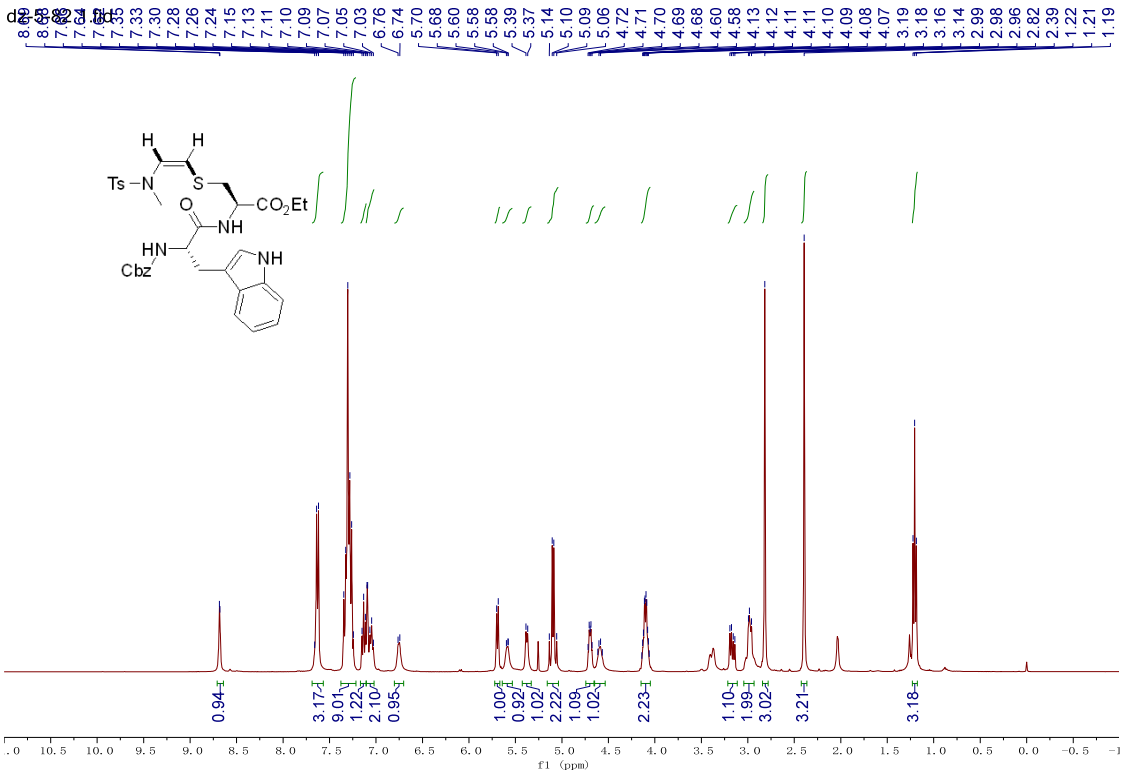
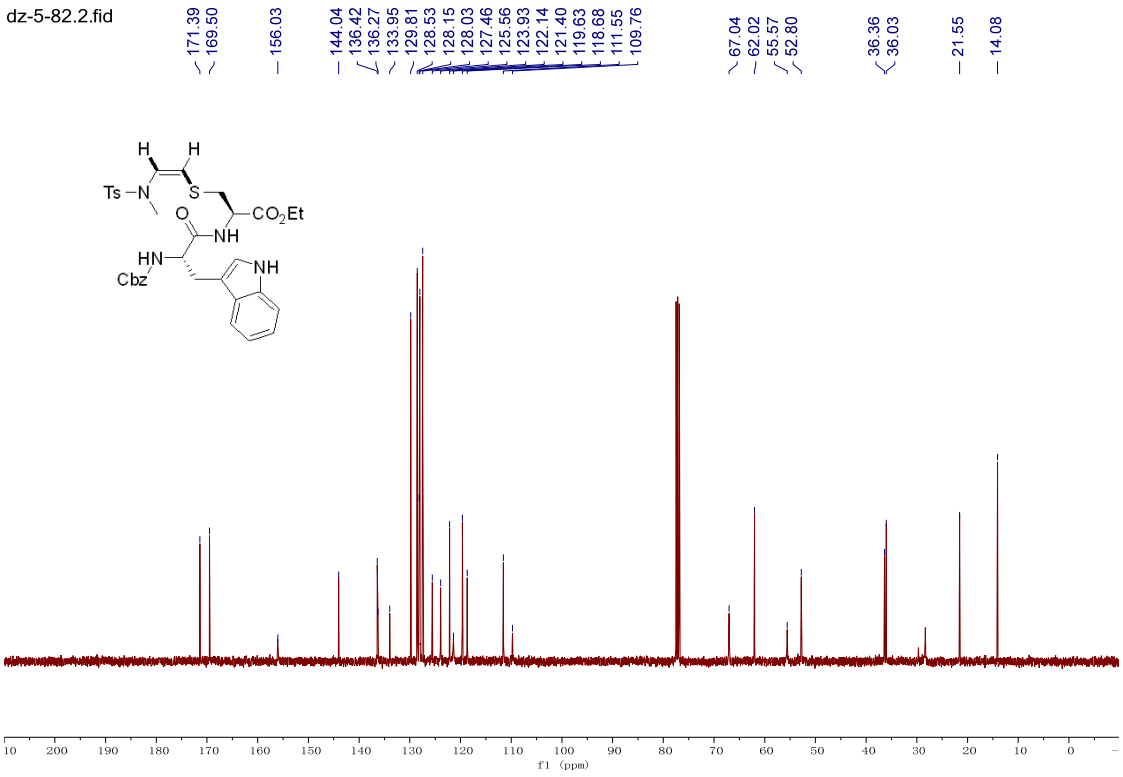


^{1}H NMR of **11k**



^{13}C NMR of **11k**

8. References:

1. S. J. Mansfield, C. D. Campbell, M. W. Jones and E. A. Anderson, A robust and modular synthesis of ynamides, *Chem. Commun.*, 2015, **51**, 3316.
2. B. Witulski and M. Gößmann, Stereospecific synthesis of chiral N-(ethynyl)allylglycines and their use in highly stereoselective intramolecular Pauson–Khand reactions, *Chem. Commun.*, 1999, DOI: 10.1039/A905898B, 1879.
3. T. Hamada, X. Ye and S. S. Stahl, Copper-Catalyzed Aerobic Oxidative Amidation of Terminal Alkynes: Efficient Synthesis of Ynamides, *J. Am. Chem. Soc.*, 2008, **130**, 833.