Cu(II)-Catalyzed [3 + 2] Cycloaddition of Enaminones and *N*-Tosylaziridines Leading to 2,3-Dihydropyrroles

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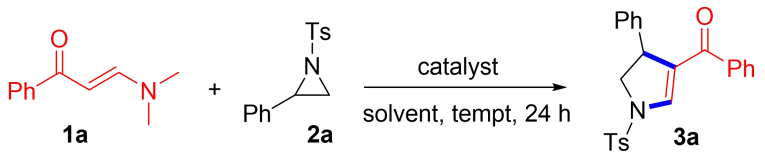
General Methods and Materials

$Ni(OAc)_2$, $Ni(OAc)_2 \cdot 4H_2O$, $Cu(OAc)_2$, $CuBr \cdot SMe_2$, $Cu(OAc)_2 \cdot H_2O$, $Cu(OTf)_2$, CuOTf, CuCl, CuBr, CuI, $Cu(acac)_2$, $CuCl_2$, and $CuBr_2$ were purchased from Energy Chemical and used without further purification. Other chemicals were purchased from commercial suppliers, further dried and purified if necessary. The water used was re-distillated and ion-free. ^1H and ^{13}C NMR spectra were achieved on a Bruker AVANCE 400 MHz spectrometer (^1H 400 MHz; ^{13}C 100 MHz) in $CDCl_3$. Abbreviations for data quoted are *s*-singlet; *brs*-broad singlet; *d*-doublet; *t*-triplet; *dd*-doublet of doublets; m-multiplet. High-resolution mass spectra were measured on a Waters Micromass GCT facility. Thin-layer chromatographies were done on pre-coated silica gel 60F254 plates (Merck). Silica gel 60H (200-300 mesh) manufactured by Qingdao Haiyang Chemical Group Co. (China) was used for general chromatography.

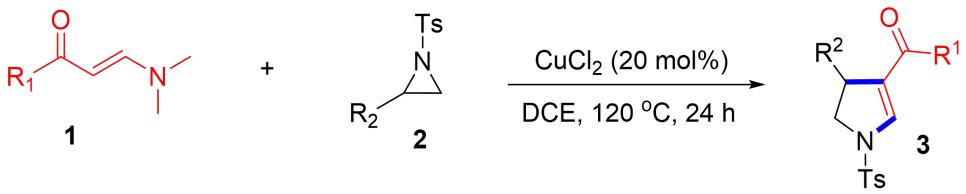
Table 1 Screening of Reaction Conditions[a]



entry	Catalyst (x mol%)	solvent	tempt	yield (%)[b]
1	$Cu(OAc)_2$ (10 mol%)	toluene	100	14
2	$Cu(OAc)_2$ (20 mol%)	toluene	100	34
3	$Cu(OAc)_2$ (50 mol%)	toluene	100	32
4	$Cu(OAc)_2$ (100 mol%)	toluene	100	21
5	$Cu(OAc)_2$ (20 mol%)	toluene	120	76
6	$Cu(acac)_2$ (20 mol%)	toluene	120	56
7	$CuCl_2$ (20 mol%)	toluene	120	81
8	$CuBr_2$ (20 mol%)	toluene	120	53
9	CuCl (20 mol%)	toluene	120	64
10	CuBr (20 mol%)	toluene	120	66
11	CuI (20 mol%)	toluene	120	43
12	$Cu(OTf)_2$ (20 mol%)	toluene	120	58
13	CuOTf (20 mol%)	toluene	120	trace
14	$Cu(OAc)_2 \cdot H_2O$ (20 mol%)	toluene	120	72
15	$CuBr \cdot SMe_2$ (20 mol%)	toluene	120	0
16	$CuCl_2$ (20 mol%)	DMF	120	0
17	$CuCl_2$ (20 mol%)	DMSO	120	0
18	$CuCl_2$ (20 mol%)	CH_3CN	120	0
19	$CuCl_2$ (20 mol%)	DCE	120	83
20	$CuCl_2$ (20 mol%)	THF	120	11
21	$CuCl_2$ (20 mol%)	dioxane	120	trace
22	$CuCl_2$ (20 mol%)	MeOH	120	0
23[c]		DCE	120	0
21[d]	$CuCl_2$	DCE	120	82

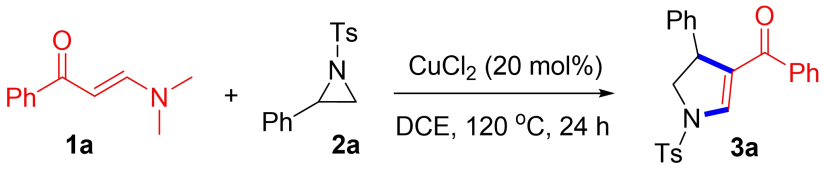
[a]Reaction conditions: 3-(dimethylamino)-1-phenylprop-2-en-1-one **1a** (0.2 mmol), 2-phenyl-1-tosylaziridine **2a** (0.2 mmol), copper catalyst (x mol%), solvent (2 mL) at 120 °C for 24 h under air atmosphere; [b]Isolated yield; [c]The reaction was performed in the absence of $CuCl_2$; [d]The reaction was performed under argon atmosphere.

General Catalytic Procedure for Cu(II)-Catalyzed [3 + 2] Cycloaddition of Enaminones and *N*-Tosylaziridines Leading to 2,3-Dihydropyrroles



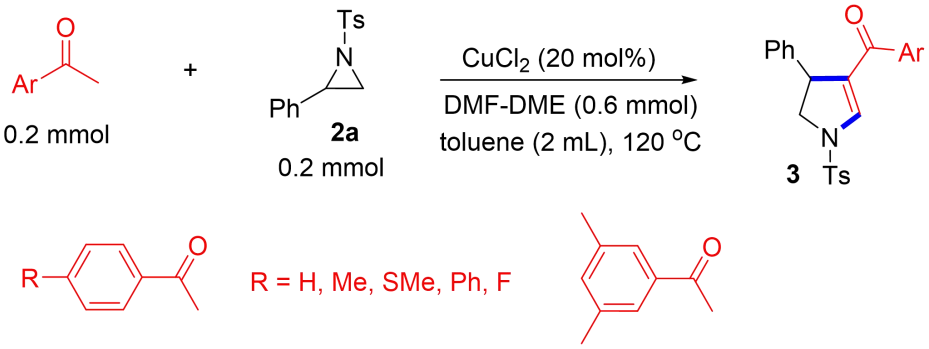
To a dry thick walled pressure resistant tube (25 mL) was charged with enaminones **1** (0.2 mmol), *N*-tosylaziridines **2** (0.2 mmol), $CuCl_2$ (13.4 mg, 20 mol%), then the DCE (2 mL) was added. The tube was closed with a PTFE thread sealing cap. The mixture was stirred at 120 °C in oil bath for 24 hours under an atmosphere of air. After the reaction finished, the resulted mixtures were diluted with 20 mL of dichloromethane and washed with 20 mL of H_2O. The aqueous layer was extracted twice with dichloromethane (10 mL) and the combined organic phase was dried over Na_2SO_4. After evaporation of the solvents, the residue was purified by silica gel chromatography (hexane/AcOEt = 5 : 1) to yield product.

Procedure Gram-scale for the Synthesis of 3a.



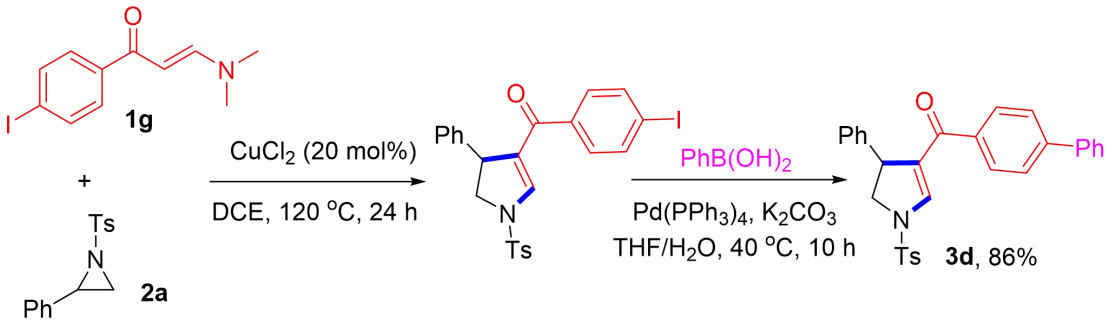
To a dry thick walled pressure resistant tube (250 mL) was charged with (*E*)-3-dimethylamino-1-phenylprop-2-en-1-one **1a** (5.0 mmol), 2-phenyl-1-tosylaziridine **2a** (5.0 mmol), $CuCl_2$ (335.1 mg, 20 mol%), then the DCE (50 mL) was added. The tube was closed with a PTFE thread sealing cap. The mixture was stirred at 120 °C in oil bath for 24 hours under an atmosphere of air. After the reaction finished, the resulted mixtures were diluted with 200 mL of dichloromethane and washed with 200 mL of H_2O. The aqueous layer was extracted twice with dichloromethane (100 mL) and the combined organic phase was dried over Na_2SO_4. After evaporation of the solvents, the residue was purified by silica gel chromatography (hexane/AcOEt = 5 : 1) to yield product 1450.8 mg.

General Catalytic Procedure for Cu(II)-Catalyzed Cycloaddition of Aromatic Ketones and *N*-Tosylaziridines Leading to 2,3-Dihydropyrroles

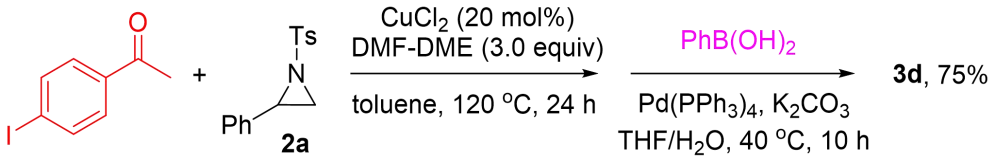


To a dry thick walled pressure resistant tube (25 mL) was charged with aromatic ketones (0.2 mmol), *N*-tosylaziridines **2** (0.2 mmol), DME-DME (0.6 mmol), $CuCl_2$ (13.4 mg, 20 mol%), then the toluene (2 mL) was added. The tube was closed with a PTFE thread sealing cap. The mixture was stirred at 120 °C in oil bath for 24 hours under an atmosphere of air. After the reaction finished, the resulted mixtures were diluted with 20 mL of dichloromethane and washed with 20 mL of H_2O. The aqueous layer was extracted twice with dichloromethane (10 mL) and the combined organic phase was dried over Na_2SO_4. After evaporation of the solvents, the residue was purified by silica gel chromatography (hexane/AcOEt = 5 : 1) to yield product.

Synthetic Utility

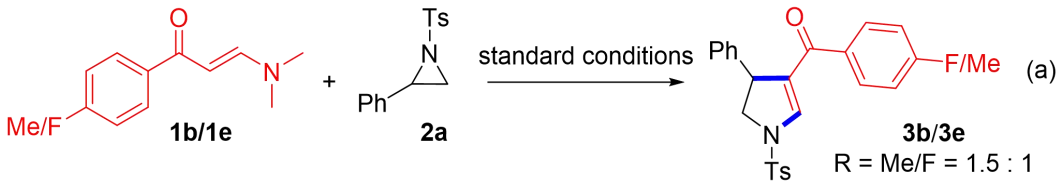


A reaction flask (25 mL) was charged with (*E*)-3-dimethylamino-1-phenylprop-2-en-1-one **1g** (0.2 mmol), 2-phenyl-1-tosylaziridine **2a** (0.2 mmol), $CuCl_2$ (13.4 mg, 20 mol%), then the DCE (2 mL) was added. The tube was closed with a PTFE thread sealing cap. The mixture was stirred at 120 °C in oil bath for 24 hours under an atmosphere of air. After the reaction finished, the resulted mixtures were diluted with 20 mL of dichloromethane and washed with 20 mL of H_2O. The aqueous layer was extracted twice with dichloromethane (10 mL) and the combined organic phase was dried over Na_2SO_4. After evaporation of the solvents, the residue was afforded without further purification. The Phenylboronic acid (0.3 mmol, 36.6 mg), $Pd(PPh_3)_4$ (11.6 mg, 5.0 mol%), K_2CO_3 (55.2 mg, 2.0 equiv) was added in 50 mL reaction flask, then the $V_{THF/H2O}$ = 5 : 1 (3 mL) was added. The mixture was stirred at 40 °C in the oil bath for 10 hours under an atmosphere of nitrogen. After the reaction finished, the resulted mixtures were diluted with 100 mL of dichloromethane and washed with 100 mL of H_2O. The aqueous layer was extracted twice with dichloromethane (30 mL) and the combined organic phase was dried over Na_2SO_4. After evaporation of the solvents, the residue was purified by silica gel chromatography (hexane/AcOEt = 5 : 1) to yield product of **3d** (86% yield, 82.4 mg).

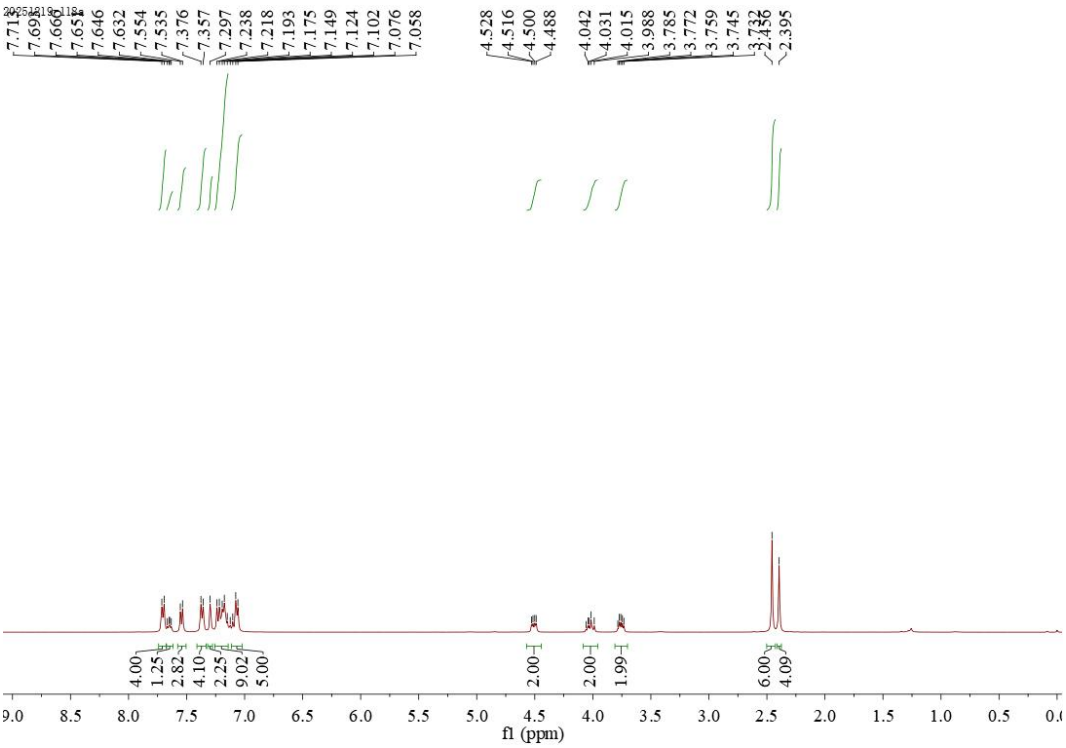


A reaction flask (50 mL) was charged with acetophenone (0.2 mmol, 24 mg), 2-phenyl-1-tosylaziridine **2a** (0.2 mmol), DME-DME (0.6 mmol), $CuCl_2$ (13.4 mg, 20 mol%), then the toluene (2 mL) was added. The tube was closed with a PTFE thread sealing cap. The mixture was stirred at 120 °C in oil bath for 24 hours under an atmosphere of air. After the reaction finished, the resulted mixtures were diluted with 20 mL of dichloromethane and washed with 20 mL of H_2O. The aqueous layer was extracted twice with dichloromethane (10 mL) and the combined organic phase was dried over Na_2SO_4. After evaporation of the solvents, the residue was afforded without further purification. The Phenylboronic acid (0.3 mmol, 36.6 mg), $Pd(PPh_3)_4$ (11.6 mg, 5.0 mol%), K_2CO_3 (55.2 mg, 2.0 equiv) was added in 50 mL reaction flask, then the $V_{THF/H2O}$ = 5 : 1 (3 mL) was added. The mixture was stirred at 40 °C in the oil bath for 10 hours under an atmosphere of nitrogen. After the reaction finished, the resulted mixtures were diluted with 100 mL of dichloromethane and washed with 100 mL of H_2O. The aqueous layer was extracted twice with dichloromethane (30 mL) and the combined organic phase was dried over Na_2SO_4. After evaporation of the solvents, the residue was purified by silica gel chromatography (hexane/AcOEt = 5 : 1) to yield product of **3d** (75% yield, 71.9 mg).

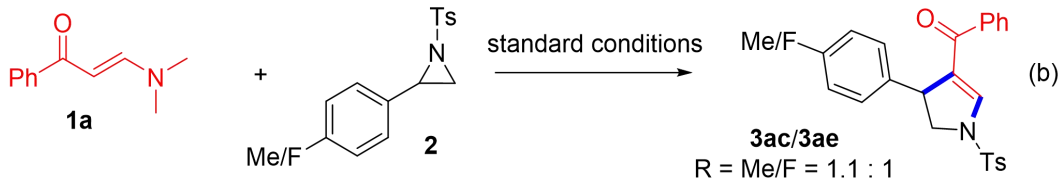
Competitive Reaction



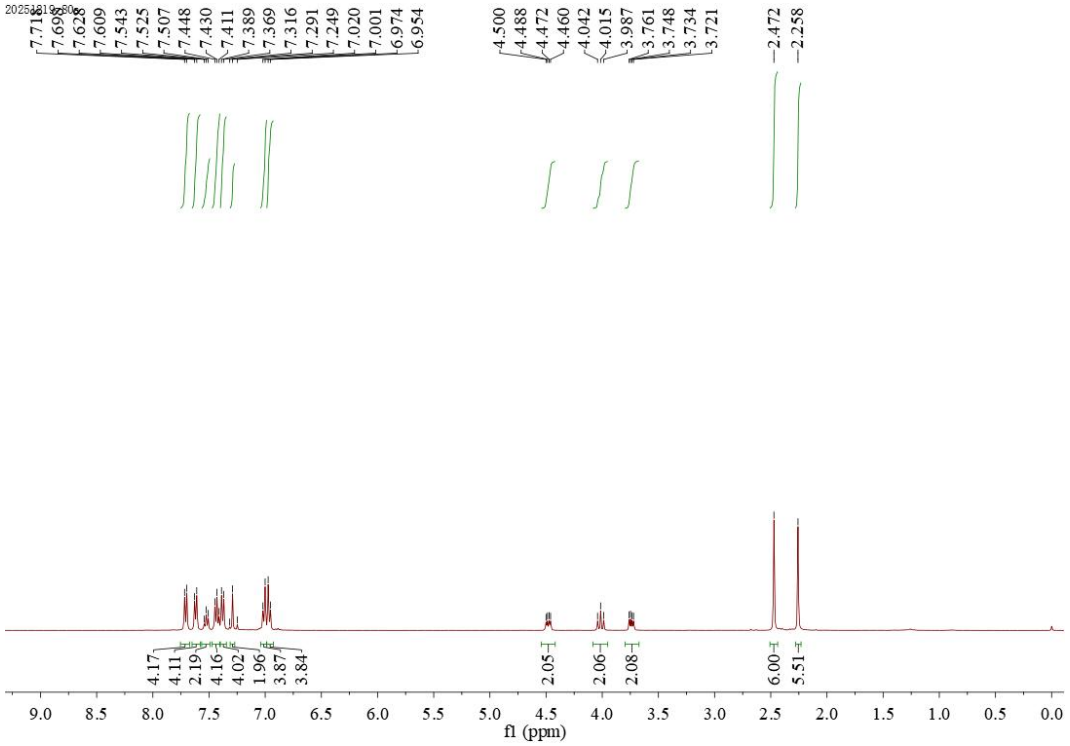
To a dry thick walled pressure resistant tube (25 mL) was charged with (*E*)-3-(dimethylamino)-1-(*p*-tolyl)prop-2-en-1-one **1b** (0.1 mmol, 18.9 mg), (*E*)-3-(dimethylamino)-1-(4-fluorophenyl)prop-2-en-1-one **1e** (0.1 mmol, 19.3 mg), *N*-tosylaziridines **2** (0.2 mmol), and $CuCl_2$ (13.4 mg, 20 mol%), then the DCE (2 mL) was added. The tube was closed with a PTFE thread sealing cap. The mixture was stirred at 120 °C in oil bath for 24 hours under an atmosphere of air. After the reaction finished, the resulted mixtures were diluted with 20 mL of dichloromethane and washed with 20 mL of H_2O. The aqueous layer was extracted twice with dichloromethane (10 mL) and the combined organic phase was dried over Na_2SO_4. After evaporation of the solvents, the residue was purified by silica gel chromatography (hexane/AcOEt = 5 : 1) to yield product.



6/4.09 = 1.5 : 1

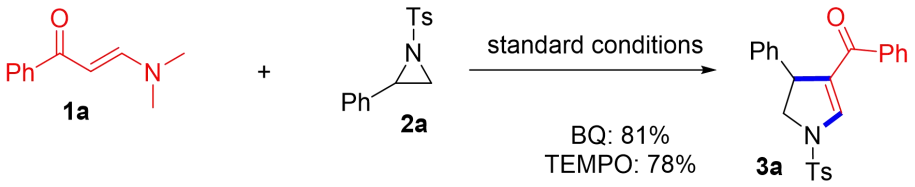


To a dry thick walled pressure resistant tube (25 mL) was charged with (*E*)-3-(dimethylamino)-1-phenylprop-2-en-1-one **1a** (0.2 mmol, 35 mg), 2-(*p*-tolyl)-1-tosylaziridine **2ac** (0.1 mmol, 28.7 mg), 2-(4-fluorophenyl)-1-tosylaziridine **2ae** (0.1 mmol, 29.1 mg), $CuCl_2$ (13.4 mg, 20 mol%), then the DCE (2 mL) was added. The tube was closed with a PTFE thread sealing cap. The mixture was stirred at 120 °C in oil bath for 24 hours under an atmosphere of air. After the reaction finished, the resulted mixtures were diluted with 20 mL of dichloromethane and washed with 20 mL of H_2O. The aqueous layer was extracted twice with dichloromethane (10 mL) and the combined organic phase was dried over Na_2SO_4. After evaporation of the solvents, the residue was purified by silica gel chromatography (hexane/AcOEt = 5 : 1) to yield product.



6/5.51 = 1.1 : 1

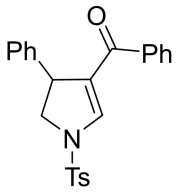
Radical Scavenger Experiments



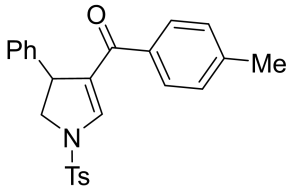
(c)

To a dry thick walled pressure resistant tube (250 mL) was charged with (*E*)-3-dimethylamino-1-phenylprop-2-en-1-one **1a** (0.2 mmol, 35 mg), 2-phenyl-1-tosylaziridine **2a** (0.2 mmol, 54.6 mg), $CuCl_2$ (13.4 mg, 20 mol%), BQ (0.6 mmol, 3.0 equiv, 64.8 mg) or TEMPO (0.6 mmol, 3.0 equiv, 93.6 mg), then the DCE (2 mL) was added. The tube was closed with a PTFE thread sealing cap. The mixture was stirred at 120 ºC in oil bath for 24 hours under an atmosphere of air. After the reaction finished, the resulted mixtures were diluted with 20 mL of dichloromethane and washed with 20 mL of H_2O. The aqueous layer was extracted twice with dichloromethane (10 mL) and the combined organic phase was dried over Na_2SO_4. After evaporation of the solvents, the residue was purified by silica gel chromatography (hexane/AcOEt = 5 : 1) to yield product.

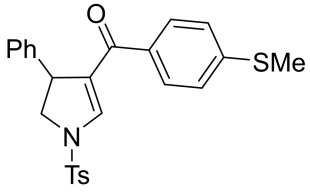
Characterization Data for the Products



Phenyl(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)methanone (**3a**): Obtained as a light yellow liquid (66.9 mg, 83% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, J = 8.4 Hz, 2H), 7.61 - 7.63 (m, 2H), 7.50 - 7.54 (m, 1H), 7.41 - 7.45 (t, J = 7.6 Hz, 2H), 7.37 (d, J = 8.4 Hz, 2H), 7.31 (d, J = 0.8 Hz, 1H), 7.14 - 7.22 (m, 3H), 7.06 - 7.08 (m, 2H), 4.49 - 4.53 (q, J = 4.2, 11.2 Hz, 1H), 4.03 (t, J = 10.8 Hz, 1H), 3.74 - 3.78 (q, J = 4.2, 10.8 Hz, 1H), 2.46 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.1, 145.0, 142.6, 142.1, 138.8, 132.9, 131.9, 130.2, 128.6, 128.4, 128.2, 127.4, 127.1, 126.9, 126.5, 56.6, 46.9, 21.6; HRMS (ESI-TOF) m/z calcd for $C_{24}H_{22}NO_3S$ $[M + H]^+$ 404.1315, found 404.1317.

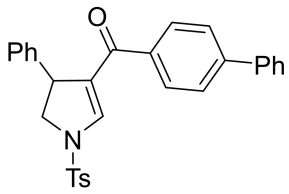


(4-Phenyl-1-tosyl-4,5-dihydro-1*H*-pyrrol-3-yl)(*p*-tolyl)methanone (**3b**): Obtained as a light yellow liquid (71.7 mg, 86% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, J = 8.0 Hz, 2H), 7.54 (d, J = 8.0 Hz, 2H), 7.37 (d, J = 8.0 Hz, 2H), 7.29 (s, 1H), 7.15 - 7.24 (m, 5H), 7.07 (t, J = 6.8 Hz, 2H), 4.49 - 4.53 (q, J = 4.2, 11.2 Hz, 1H), 4.02 (t, J = 10.8 Hz, 1H), 3.73 - 3.77 (q, J = 4.2, 10.8 Hz, 1H), 2.46 (s, 3H), 2.40 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 189.9, 145.0, 142.6, 142.1, 136.1, 132.9, 130.2, 129.1, 128.6, 128.4, 127.4, 127.0, 126.9, 126.7, 56.6, 47.0, 21.6, 21.5; HRMS (ESI-TOF) m/z calcd for $C_{25}H_{24}NO_3S$ $[M + H]^+$ 418.1471, found 418.1473.

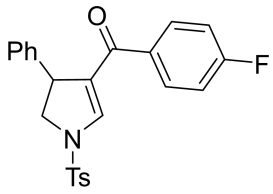


(4-(Methylthio)phenyl)(4-phenyl-1-tosyl-4,5-dihydro-1*H*-pyrr

ol-3-yl)methanone (**3c**): Obtained as a light yellow liquid (70.0 mg, 78% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, J = 8.0 Hz, 2H), 7.57 (d, J = 8.4 Hz, 2H), 7.37 (d, J = 8.0 Hz, 2H), 7.29 (s, 1H), 7.25 (t, J = 8.4 Hz, 2H), 7.16 - 7.22 (m, 3H), 7.07 (t, J = 6.8 Hz, 2H), 4.49 - 4.53 (q, J = 4.2, 11.2 Hz, 1H), 4.02 (t, J = 11.2 Hz, 1H), 3.74 - 3.78 (q, J = 4.2, 10.8 Hz, 1H), 2.51 (s, 3H), 2.47 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 189.1, 145.0, 144.5, 142.1, 141.9, 135.0, 132.9, 130.2, 128.8, 128.7, 127.4, 127.1, 126.9, 126.5, 125.1, 56.5, 47.0, 21.6, 14.9; HRMS (ESI-TOF) m/z calcd for $C_{25}H_{24}NO_3S_2$ $[M + H]^+$ 450.1192, found 450.1193.

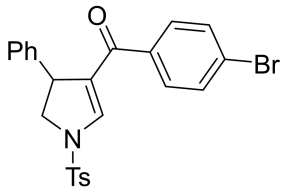


[1,1'-Biphenyl]-4-yl(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)methanone (**3d**): Obtained as a light yellow liquid (87.2 mg, 91% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 - 7.73 (m, 4H), 7.61 - 7.66 (m, 4H), 7.47 (t, J = 7.2 Hz, 2H), 7.36 - 7.41 (m, 4H), 7.17 - 7.23 (m, 3H), 7.09 (d, J = 6.8 Hz, 2H), 4.48 - 4.52 (q, J = 4.8, 10.8 Hz, 1H), 4.04 (t, J = 10.8 Hz, 1H), 3.76 - 3.80 (q, J = 5.2, 10.8 Hz, 1H), 2.46 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 189.7, 145.1, 144.8, 142.5, 142.1, 139.8, 137.5, 133.0, 130.2, 128.9, 128.8, 128.7, 128.0, 127.4, 127.2, 127.1, 127.0, 126.9, 126.6, 56.6, 47.0, 21.6; HRMS (ESI-TOF) m/z calcd for $C_{30}H_{26}NO_3S$ $[M + H]^+$ 480.1628, found 480.1627.

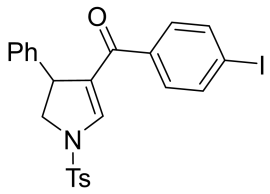


(4-Fluorophenyl)(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl) methanone (**3e**): Obtained as a light yellow liquid (59.8 mg, 71% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, J = 7.2 Hz, 2H), 7.57 - 7.59 (m, 2H), 7.31 (d, J = 7.2 Hz, 2H), 7.21 (s, 1H), 7.12 - 7.13 (m, 3H), 6.99 - 7.06 (m, 4H), 4.42 - 4.45 (q, J = 4.0, 10.0 Hz, 1H), 3.96 (t, J = 10.4 Hz, 1H), 3.68 - 3.72 (q, J = 4.4, 10.0 Hz, 1H), 2.40 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$)

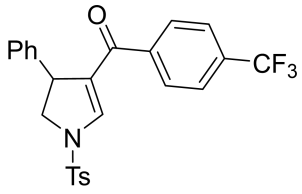
δ 188.7, 165.0 (d, J = 251.7 Hz), 145.2, 142.4, 142.0, 135.1 (d, J = 3.1 Hz), 133.0, 130.7 (d, J = 8.9 Hz), 130.3, 128.7, 127.4, 127.2, 126.9, 126.4, 115.6 (d, J = 21.7 Hz), 56.6, 47.0, 21.6; ^{19}F NMR (400 MHz, $CDCl_3$) δ -106.7; HRMS (ESI-TOF) m/z calcd for $C_{24}H_{21}NO_3SF$ $[M + H]^+$ 422.1221, found 422.1222.



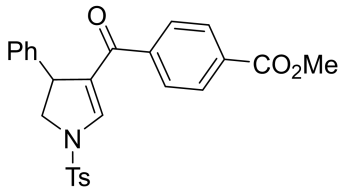
(4-Bromophenyl)(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl) methanone (**3f**): Obtained as a light yellow liquid (70.2 mg, 73% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, J = 8.4 Hz, 2H), 7.61 - 7.64 (m, 1H), 7.56 - 7.59 (m, 2H), 7.48 - 7.50 (m, 2H), 7.38 (d, J = 8.0 Hz, 2H), 7.28 - 7.30 (m, 1H), 7.17 - 7.23 (m, 3H), 7.05 - 7.07 (m, 1H), 4.48 - 4.52 (q, J = 4.8, 10.8 Hz, 1H), 4.04 (t, J = 11.2 Hz, 1H), 3.76 - 3.79 (q, J = 4.8, 10.4 Hz, 1H), 2.48 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 189.0, 145.2, 142.8, 142.0, 137.6, 132.9, 131.9, 131.7, 130.3, 130.2, 129.7, 128.7, 127.4, 127.2, 126.8, 126.7, 126.2, 56.6, 46.9, 21.6; HRMS (ESI-TOF) m/z calcd for $C_{24}H_{21}BrNO_3S$ $[M + H]^+$ 482.0420, found 482.0421.



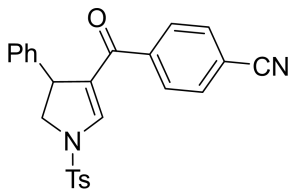
(4-Iodophenyl)(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)met hanone (**3g**): Obtained as a light yellow liquid (76.2 mg, 72% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.78 (d, J = 8.0 Hz, 2H), 7.71 (d, J = 8.0 Hz, 2H), 7.28 - 7.39 (m, 6H), 7.15 - 7.22 (m, 2H), 7.05 (d, J = 7.2 Hz, 2H), 4.47 - 4.51 (q, J = 4.8, 10.8 Hz, 1H), 4.04 (t, J = 10.8 Hz, 1H), 3.74 - 3.78 (q, J = 4.8, 10.4 Hz, 1H), 2.47 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 189.2, 145.1, 142.8, 141.9, 137.7, 137.7, 132.9, 130.2, 129.7, 128.7, 127.4, 127.2, 126.8, 119.3, 99.1, 56.6, 46.8, 21.6; HRMS (ESI-TOF) m/z calcd for $C_{24}H_{21}NIO_3S$ $[M + H]^+$ 530.0281, found 530.0282.



(4-Phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)(4-(trifluoromethyl)phenyl)methanone (**3h**): Obtained as a light yellow liquid (61.2 mg, 65% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 - 7.73 (m, 6H), 7.39 (d, J = 8.0 Hz, 2H), 7.31 (s, 1H), 7.16 - 7.23 (m, 3H), 7.07 (d, J = 7.2 Hz, 2H), 4.49 - 4.53 (q, J = 4.8, 11.2 Hz, 1H), 4.07 (t, J = 11.2 Hz, 1H), 3.77 - 3.80 (q, J = 4.8, 10.8 Hz, 1H), 2.47 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 189.0, 146.6, 145.3, 143.5, 142.0, 141.9, 140.7, 134.6, 130.3, 129.7 (q, J = 223.6 Hz), 128.7, 128.4, 127.4, 127.2, 127.0, 126.8, 125.5 (q, J = 7.1 Hz), 119.4, 56.7, 46.8, 21.6; ^{19}F NMR (400 MHz, $CDCl_3$) δ -62.9; HRMS (ESI-TOF) m/z calcd for $C_{25}H_{21}NO_3SF_3$ [M + H] $^{+}$ 472.1189, found 472.1188.

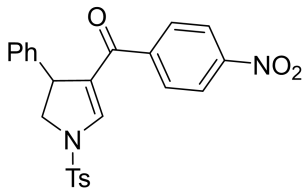


Methyl 4-(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrole-2-carbonyl)benzoate (**3i**): Obtained as a light yellow liquid (62.8 mg, 68% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.10 (d, J = 8.0 Hz, 2H), 7.71 (d, J = 8.4 Hz, 2H), 7.65 (d, J = 8.0 Hz, 2H), 7.40 (d, J = 8.0 Hz, 2H), 7.29 (s, 1H), 7.17 - 7.22 (m, 3H), 7.07 (t, J = 6.8 Hz, 2H), 4.49 - 4.53 (q, J = 4.8, 11.2 Hz, 1H), 4.06 (t, J = 10.8 Hz, 1H), 3.96 (s, 3H), 3.76 - 3.80 (q, J = 5.2, 10.8 Hz, 1H), 2.49 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 189.5, 166.2, 145.3, 143.5, 142.6, 142.0, 133.0, 132.9, 130.3, 129.7, 128.8, 128.1, 127.4, 127.3, 126.9, 126.4, 56.8, 52.5, 46.9, 21.7; HRMS (ESI-TOF) m/z calcd for $C_{26}H_{24}NO_5S$ [M + H] $^{+}$ 462.1370, found 462.1372.

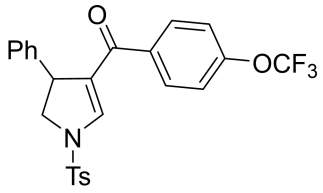


4-(4-Phenyl-1-tosyl-4,5-dihydro-1H-pyrrole-2-carbonyl)benzo

nitrile (**3j**): Obtained as a light yellow liquid (53.1 mg, 62% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 - 7.44 (m, 6H), 7.40 (d, J = 8.0 Hz, 2H), 7.30 (s, 1H), 7.17 - 7.23 (m, 3H), 7.06 (d, J = 6.8 Hz, 2H), 4.48 - 4.52 (q, J = 4.8, 10.8 Hz, 1H), 4.04 - 4.15 (m, 1H), 3.77 - 3.81 (q, J = 4.8, 10.4 Hz, 1H), 2.48 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 188.4, 145.4, 143.7, 142.5, 141.8, 132.9, 132.3, 130.3, 128.8, 128.6, 127.4, 127.3, 126.8, 125.9, 117.9, 115.1, 56.7, 46.7, 21.6; HRMS (ESI-TOF) m/z calcd for $C_{25}H_{21}N_2O_3S$ $[M + H]^+$ 429.1267, found 429.1268.

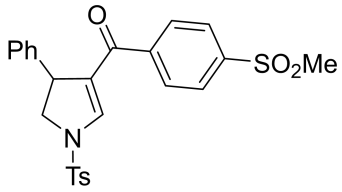


(4-Nitrophenyl)(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl) methanone (**3k**): Obtained as a light yellow liquid (52.9 mg, 59% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.29 (d, J = 8.0 Hz, 2H), 7.71 - 7.74 (dd, J = 5.6, 8.0 Hz, 4H), 7.40 (d, J = 8.0 Hz, 2H), 7.31 (s, 1H), 7.18 - 7.24 (m, 3H), 7.07 (d, J = 7.2 Hz, 2H), 4.50 - 4.53 (q, J = 4.8, 10.8 Hz, 1H), 4.09 (t, J = 10.8 Hz, 1H), 3.79 - 3.83 (q, J = 4.8, 10.4 Hz, 1H), 2.49 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 188.2, 149.5, 145.4, 144.2, 144.0, 141.8, 132.9, 130.4, 129.0, 128.8, 127.4, 127.3, 126.8, 126.0, 123.8, 56.8, 46.8, 21.7; HRMS (ESI-TOF) m/z calcd for $C_{24}H_{21}N_2O_5S$ $[M + H]^+$ 449.1166, found 449.1167.

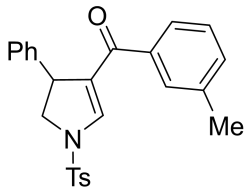


(4-Phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)(4-(trifluorom ethoxy)phenyl)methanone (**3l**): Obtained as a light yellow liquid (52.6 mg, 54% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (d, J = 7.6 Hz, 2H), 7.67 (d, J = 8.4 Hz, 2H), 7.39 (d, J = 8.0 Hz, 2H), 7.26 - 7.31 (m, 3H), 7.16 - 7.23 (m, 3H), 7.07 (d, J = 7.2 Hz, 2H), 4.49 - 4.53 (q, J = 5.2, 11.2 Hz, 1H), 4.05 (t, J = 11.2 Hz, 1H), 3.77 - 3.81 (q, J = 5.2, 10.8 Hz, 1H), 2.48 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 188.6, 151.7, 145.2, 142.8, 142.0, 137.2, 133.0, 130.3,

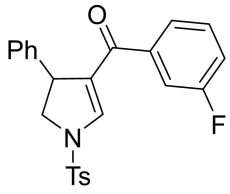
130.1, 128.8, 127.4, 127.3, 126.9, 126.2, 120.6, 56.6, 47.0, 21.7; ^{19}F NMR (400 MHz, $CDCl_3$) δ -57.6; HRMS (ESI-TOF) m/z calcd for $C_{25}H_{21}F_3NO_4S$ [M + H] $^+$ 488.1138, found 488.1140.



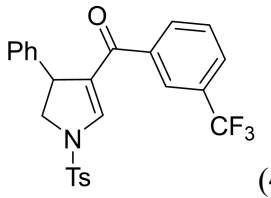
(4-(Methylsulfonyl)phenyl)(4-phenyl-1-tosyl-4,5-dihydro-1 H-pyrrol-3-yl)methanone (**3m**): Obtained as a light yellow liquid (62.5 mg, 65% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (d, J = 8.0 Hz, 2H), 7.73 (t, J = 8.8 Hz, 4H), 7.40 (d, J = 8.0 Hz, 2H), 7.32 (s, 1H), 7.17 - 7.22 (m, 3H), 7.06 (d, J = 7.2 Hz, 2H), 4.49 - 4.53 (q, J = 4.8, 10.8 Hz, 1H), 4.09 (t, J = 11.2 Hz, 1H), 3.77 - 3.81 (q, J = 5.2, 10.8 Hz, 1H), 3.09 (s, 3H), 2.48 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 188.6, 145.4, 144.0, 143.6, 142.9, 141.8, 132.9, 130.3, 128.9, 128.85, 127.6, 127.4, 127.3, 126.8, 126.0, 56.8, 46.7, 44.3, 21.6; HRMS (ESI-TOF) m/z calcd for $C_{25}H_{24}NO_5S_2$ [M + H] $^+$ 482.1090, found 482.1092.



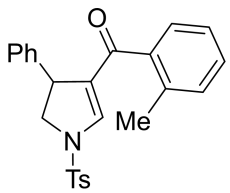
(4-Phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)(m-tolyl)methanone (**3n**): Obtained as a light yellow liquid (73.4 mg, 88% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, J = 8.0 Hz, 2H), 7.37 - 7.41 (m, 4H), 7.30 - 7.35 (m, 3H), 7.14 - 7.22 (m, 3H), 7.06 (d, J = 7.2 Hz, 2H), 4.48 - 4.52 (q, J = 4.8, 10.8 Hz, 1H), 4.03 (t, J = 10.8 Hz, 1H), 3.74 - 3.78 (q, J = 4.8, 10.8 Hz, 1H), 2.47 (s, 3H), 2.40 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.4, 145.0, 142.6, 142.1, 138.9, 138.3, 132.9, 132.7, 130.2, 128.7, 128.6, 128.2, 127.4, 127.1, 126.9, 126.7, 125.4, 56.6, 46.9, 21.6, 21.4; HRMS (ESI-TOF) m/z calcd for $C_{25}H_{24}NO_3S$ [M + H] $^+$ 418.1471, found 418.1470.



(3-Fluorophenyl)(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)methanone (**3o**): Obtained as a light yellow liquid (58.1 mg, 69% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, J = 8.0 Hz, 2H), 7.41 - 7.47 (m, 1H), 7.33 - 7.39 (m, 3H), 7.28 (s, 1H), 7.10 - 7.19 (m, 5H), 7.01 (d, J = 7.2 Hz, 2H), 4.45 - 4.49 (q, J = 4.8, 11.2 Hz, 1H), 4.07 (t, J = 10.8 Hz, 1H), 3.65 - 3.69 (q, J = 4.8, 10.8 Hz, 1H), 2.46 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 186.5, 159.1 (d, J = 248.6 Hz), 145.1, 144.6 (d, J = 3.9 Hz), 142.0, 132.8, 132.4 (d, J = 8.2 Hz), 130.2, 129.9 (d, J = 3.0 Hz), 128.6, 127.4, 127.0, 126.9, 124.4 (d, J = 3.5 Hz), 116.2 (d, J = 22.0 Hz), 57.1, 46.4, 21.6; ^{19}F NMR (400 MHz, $CDCl_3$) δ -113.4; HRMS (ESI-TOF) m/z calcd for $C_{24}H_{21}NO_3SF$ $[M + H]^+$ 422.1221, found 422.1223.

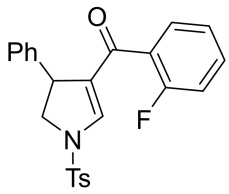


(4-Phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)(3-(trifluoromethyl)phenyl)methanone (**3p**): Obtained as a light yellow liquid (57.5 mg, 61% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.78 - 7.82 (m, 3H), 7.73 (d, J = 8.0 Hz, 2H), 7.58 (t, J = 7.6 Hz, 1H), 7.41 (d, J = 8.0 Hz, 2H), 7.28 (s, 1H), 7.16 - 7.23 (m, 3H), 7.03 (d, J = 7.6 Hz, 2H), 4.49 - 4.53 (q, J = 5.2, 10.8 Hz, 1H), 4.09 (t, J = 10.8 Hz, 1H), 3.74 - 3.78 (q, J = 5.6, 10.8 Hz, 1H), 2.50 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 188.7, 145.3, 143.5, 141.8, 139.5, 131.1, 130.9 (q, J = 251.7 Hz), 130.8, 128.8, 128.3 (q, J = 7.0 Hz), 127.4, 127.3, 126.9, 126.2, 125.0 (q, J = 7.4 Hz), 122.3, 56.8, 46.9, 21.7; ^{19}F NMR (400 MHz, $CDCl_3$) δ -62.7; HRMS (ESI-TOF) m/z calcd for $C_{25}H_{21}NO_3SF_3$ $[M + H]^+$ 472.1189, found 472.1191.

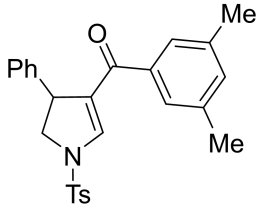


(4-Phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)(o-tolyl)methanone

(**3q**): Obtained as a light yellow liquid (70.1 mg, 84% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, J = 7.6 Hz, 2H), 7.38 (d, J = 8.0 Hz, 2H), 7.32 (t, J = 8.0 Hz, 1H), 7.16 - 7.23 (m, 6H), 7.07 (s, 1H), 7.04 (d, J = 7.2 Hz, 2H), 4.43 - 4.47 (q, J = 4.4, 10.8 Hz, 1H), 4.06 (t, J = 10.8 Hz, 1H), 3.72 - 3.76 (q, J = 4.4, 10.8 Hz, 1H), 2.48 (s, 3H), 2.18 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 192.5, 145.1, 144.0, 142.2, 138.9, 135.9, 133.0, 131.0, 130.2, 129.9, 128.6, 128.4, 127.4, 127.2, 127.1, 126.8, 125.2, 57.1, 46.2, 21.6, 19.3; HRMS (ESI-TOF) m/z calcd for $C_{25}H_{24}NO_3S$ $[M + H]^+$ 418.1471, found 418.1473.

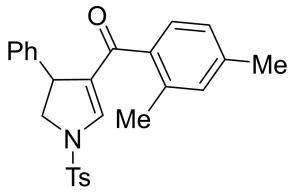


(2-Fluorophenyl)(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)methanone (**3r**): Obtained as a light yellow liquid (55.6 mg, 66% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, J = 8.0 Hz, 2H), 7.43 - 7.48 (m, 1H), 7.39 (d, J = 8.0 Hz, 2H), 7.32 - 7.36 (m, 1H), 7.28 (s, 1H), 7.11 - 7.21 (m, 5H), 7.02 (d, J = 7.6 Hz, 2H), 4.46 - 4.50 (q, J = 5.2, 11.2 Hz, 1H), 4.07 (t, J = 11.2 Hz, 1H), 3.66 - 3.70 (q, J = 5.2, 10.8 Hz, 1H), 2.48 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 186.5, 159.2 (d, J = 248.6 Hz), 145.1, 144.6 (d, J = 3.9 Hz), 142.0, 132.9, 132.5 (d, J = 8.2 Hz), 130.2, 129.9 (d, J = 3.0 Hz), 129.8, 128.9, 128.6, 127.5, 127.1, 127.0, 126.9, 126.8, 124.4 (d, J = 3.5 Hz), 116.3 (d, J = 22.0 Hz), 57.1, 46.4, 21.6; ^{19}F NMR (400 MHz, $CDCl_3$) δ -113.4; HRMS (ESI-TOF) m/z calcd for $C_{24}H_{21}NO_3SF$ $[M + H]^+$ 422.1221, found 422.1222.

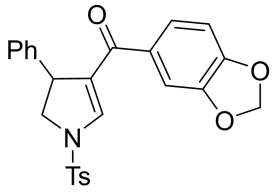


(3,5-Dimethylphenyl)(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)methanone (**3s**): Obtained as a light yellow liquid (76.7 mg, 89% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, J = 8.0 Hz, 2H), 7.38 (d, J = 8.0 Hz, 2H), 7.28 (s, 1H), 7.14- 7.21 (m, 6H), 7.06 (d, J =

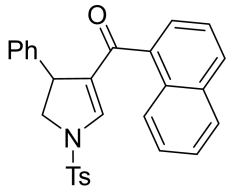
7.2 Hz, 2H), 4.47 - 4.51 (q, *J* = 5.2, 11.2 Hz, 1H), 4.02 (t, *J* = 11.2 Hz, 1H), 3.73 - 3.77 (q, *J* = 4.8, 10.4 Hz, 1H), 2.48 (s, 3H), 2.37 (s, 6H); ^{13}C NMR (101 MHz, $CDCl_3$) *δ* 190.6, 145.0, 142.6, 142.1, 139.0, 138.1, 133.6, 132.9, 130.2, 128.6, 127.4, 127.0, 126.9, 126.8, 126.0, 56.7, 46.9, 21.6, 21.3; HRMS (ESI-TOF) m/z calcd for $C_{26}H_{26}NO_3S$ $[M + H]^+$ 432.1628, found 432.1626.



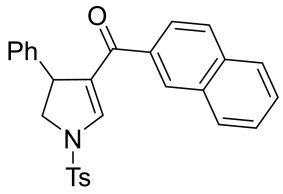
(2,4-Dimethylphenyl)(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)methanone (**3t**): Obtained as a light yellow liquid (75.0 mg, 87% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) *δ* 7.68 (d, *J* = 8.0 Hz, 2H), 7.39 (d, *J* = 8.0 Hz, 2H), 7.17 - 7.22 (m, 3H), 7.12 (d, *J* = 8.4 Hz, 1H), 7.01 - 7.07 (m, 5H), 4.43 - 4.47 (q, *J* = 4.8, 11.2 Hz, 1H), 4.04 (t, *J* = 11.2 Hz, 1H), 3.72 - 3.76 (q, *J* = 4.8, 10.8 Hz, 1H), 2.49 (s, 3H), 2.35 (s, 3H), 2.17 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) *δ* 192.5, 145.1, 143.6, 142.2, 140.2, 136.2, 136.1, 133.0, 131.9, 130.2, 128.7, 128.6, 127.7, 127.4, 127.1, 126.8, 125.8, 57.1, 46.3, 21.7, 21.3, 19.4; HRMS (ESI-TOF) m/z calcd for $C_{26}H_{26}NO_3S$ $[M + H]^+$ 432.1628, found 432.1629.



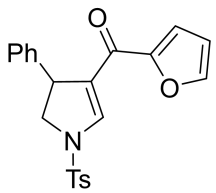
Benzo[d][1,3]dioxol-5-yl(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)methanone (**3u**): Obtained as a light yellow liquid (68.8 mg, 77% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) *δ* 7.71 (d, *J* = 8.0 Hz, 2H), 7.37 (d, *J* = 7.6 Hz, 2H), 7.29 (s, 1H), 7.15 - 7.25 (m, 4H), 7.12 (s, 1H), 7.04 - 7.06 (m, 2H), 6.82 (d, *J* = 8.0 Hz, 1H), 6.00 (s, 2H), 4.48 - 4.52 (q, *J* = 4.8, 10.8 Hz, 1H), 4.01 (t, *J* = 10.8 Hz, 1H), 3.72 - 3.76 (q, *J* = 5.2, 10.4 Hz, 1H), 2.46 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) *δ* 188.4, 151.0, 147.9, 145.0, 142.0, 141.6, 133.1, 132.8, 130.2, 128.6, 127.4, 127.0, 126.9, 126.4, 124.0, 108.4, 107.8, 101.7, 56.4, 47.1, 21.6; HRMS (ESI-TOF) m/z calcd for $C_{25}H_{22}NO_5S$ $[M + H]^+$ 448.1213, found 448.1214.



Naphthalen-1-yl(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)methanone (**3v**): Obtained as a light yellow liquid (59.8 mg, 66% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 - 7.85 (m, 1H), 7.76 - 7.78 (m, 2H), 7.54 (d, J = 8.0 Hz, 2H), 7.33 - 7.43 (m, 4H), 7.25 (d, J = 8.0 Hz, 2H), 7.12 - 7.17 (m, 3H), 7.01 - 7.04 (m, 3H), 4.45 - 4.49 (q, J = 4.4, 11.2 Hz, 1H), 4.00 (t, J = 11.2 Hz, 1H), 3.68 - 3.72 (q, J = 4.8, 10.8 Hz, 1H), 2.36 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 191.7, 145.1, 144.2, 142.2, 136.9, 133.6, 132.9, 130.8, 130.2, 130.2, 128.7, 128.7, 128.3, 127.4, 127.1, 126.9, 126.8, 126.4, 125.9, 125.1, 124.4, 57.1, 46.4, 21.6; HRMS (ESI-TOF) m/z calcd for $C_{28}H_{24}NO_3S$ [M + H] $^{+}$ 454.1471, found 454.1472.

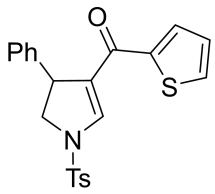


Naphthalen-2-yl(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl) methanone (**3w**): Obtained as a light yellow liquid (84.3 mg, 93% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.12 (s, 1H), 7.92 - 7.95 (m, 1H), 7.86 - 7.88 (m, 2H), 7.70 - 7.72 (m, 3H), 7.54 - 7.60 (m, 2H), 7.36 - 7.38 (m, 3H), 7.17 - 7.24 (m, 3H), 7.12 (d, J = 7.6 Hz, 2H), 4.54 - 4.58 (q, J = 4.8, 10.8 Hz, 1H), 4.06 (t, J = 10.8 Hz, 1H), 3.79 - 3.82 (q, J = 4.8, 10.4 Hz, 1H), 2.46 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.1, 145.1, 142.7, 142.1, 136.1, 134.9, 132.9, 132.2, 130.2, 129.1, 128.7, 128.5, 128.0, 127.7, 127.4, 127.1, 126.9, 126.8, 126.8, 124.6, 56.7, 47.0, 21.6; HRMS (ESI-TOF) m/z calcd for $C_{28}H_{24}NO_3S$ [M + H] $^{+}$ 454.1471, found 454.1473.

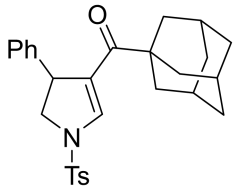


Furan-2-yl(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)methanone

(**3x**): Obtained as a light yellow liquid (66.8 mg, 85% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.09 (s, 1H), 7.76 (t, J = 8.0 Hz, 2H), 7.58 (s, 1H), 7.38 (t, J = 8.0 Hz, 2H), 7.14 - 7.18 (m, 3H), 7.10 (d, J = 3.2 Hz, 1H), 7.01 (d, J = 7.2 Hz, 2H), 6.49 - 6.50 (m, 1H), 4.46 - 4.50 (q, J = 4.4, 11.2 Hz, 1H), 3.98 (t, J = 10.8 Hz, 1H), 3.67 - 3.70 (q, J = 4.4, 10.8 Hz, 1H), 2.46 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 175.5, 153.3, 145.3, 145.0, 142.4, 142.3, 133.0, 130.2, 128.5, 127.4, 127.0, 126.8, 125.1, 116.7, 112.1, 56.0, 46.9, 21.6; HRMS (ESI-TOF) m/z calcd for $C_{22}H_{20}NO_4S$ $[M + H]^+$ 394.1108, found 394.1107.

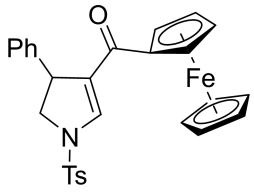


(4-Phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)(thiophen-2-yl)methanone (**3y**): Obtained as a light yellow liquid (68.7 mg, 84% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74 (t, J = 8.4 Hz, 2H), 7.56 - 7.62 (m, 3H), 7.38 (t, J = 8.0 Hz, 2H), 7.15 - 7.20 (m, 3H), 7.10 (t, J = 4.0 Hz, 1H), 7.03 - 7.05 (m, 2H), 4.50 - 4.54 (q, J = 5.2, 11.2 Hz, 1H), 4.03 (t, J = 11.2 Hz, 1H), 3.70 - 3.74 (q, J = 5.2, 10.8 Hz, 1H), 2.47 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 180.8, 145.1, 143.5, 141.9, 140.9, 132.9, 132.4, 131.2, 130.2, 128.6, 127.8, 127.4, 127.1, 126.9, 126.4, 56.4, 47.2, 21.6; HRMS (ESI-TOF) m/z calcd for $C_{22}H_{20}NO_3S_2$ $[M + H]^+$ 410.0879, found 410.0877.

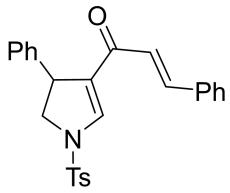


Adamantan-1-yl)(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)methanone (**3z**): Obtained as a light yellow liquid (71.9 mg, 78% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (d, J = 8.0 Hz, 2H), 7.59 (s, 1H), 7.38 (d, J = 8.0 Hz, 2H), 7.14 - 7.18 (m, 3H), 6.91 - 6.93 (m, 2H), 4.29 - 4.33 (q, J = 4.4, 11.2 Hz, 1H), 3.80 (d, J = 10.8 Hz, 1H), 3.49 - 3.53 (q, J = 4.4, 10.4 Hz, 1H), 2.48 (s, 3H), 2.04 (s, 3H), 1.67 - 1.84 (m, 12H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 201.2, 144.9, 142.9, 137.6, 132.9, 130.1, 128.5, 127.5, 126.8, 126.7, 124.5,

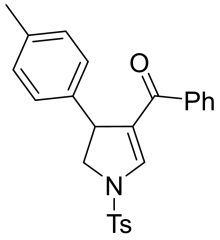
54.9, 48.4, 46.6, 39.7, 36.6, 28.1, 21.6; HRMS (ESI-TOF) m/z calcd for $C_{28}H_{32}NO_3S$ $[M + H]^+$ 462.2097, found 462.2099.



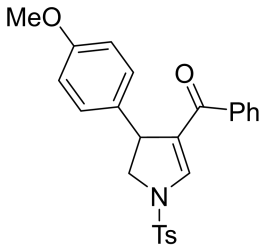
(Ferrocen-1-yl)(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)methanone (**3aa**): Obtained as a light yellow liquid (75.6 mg, 74% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 (d, J = 7.6 Hz, 2H), 7.51 (s, 1H), 7.38 (d, J = 8.0 Hz, 2H), 7.23 - 7.26 (m, 2H), 7.19 (d, J = 6.8 Hz, 1H), 7.13 - 7.15 (m, 2H), 4.86 (s, 1H), 4.68 (s, 1H), 4.46 - 4.50 (m, 3H), 3.79 - 3.94 (m, 7H), 2.47 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 191.3, 144.9, 142.4, 137.7, 132.7, 130.2, 128.7, 128.3, 127.5, 127.3, 127.2, 79.5, 72.1, 71.6, 71.3, 69.9, 68.6, 55.9, 47.3, 21.6; HRMS (ESI-TOF) m/z calcd for $C_{28}H_{26}FeNO_3S$ $[M + H]^+$ 512.0977, found 512.0978.



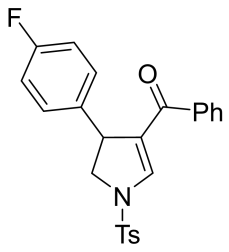
3-Phenyl-1-(4-phenyl-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)prop-2-en-1-one (**3ab**): Obtained as a light yellow liquid (72.9 mg, 85% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.76 (d, J = 8.0 Hz, 2H), 7.71 (s, 1H), 7.51 - 7.55 (m, 3H), 7.36 - 7.38 (m, 5H), 7.14 - 7.18 (m, 3H), 6.99 - 7.06 (m, 3H), 4.40 - 4.44 (q, J = 4.4, 10.8 Hz, 1H), 4.02 (d, J = 10.8 Hz, 1H), 3.69 - 3.73 (q, J = 4.4, 10.8 Hz, 1H), 2.46 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 184.0, 145.0, 142.3, 142.0, 140.4, 134.6, 133.0, 130.2, 128.8, 128.7, 128.6, 128.2, 127.4, 127.0, 126.8, 121.7, 56.8, 46.6, 21.6; HRMS (ESI-TOF) m/z calcd for $C_{26}H_{24}NO_3S$ $[M + H]^+$ 430.1471, found 430.1472.



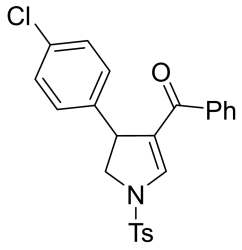
Phenyl(4-(*p*-tolyl)-1-tosyl-4,5-dihydro-1*H*-pyrrol-3-yl)methanone (**3ac**): Obtained as a light yellow liquid (71.7 mg, 86% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 - 7.72 (m, 2H), 7.60 - 7.63 (m, 2H), 7.50 - 7.54 (m, 1H), 7.41 - 7.45 (t, J = 7.6 Hz, 2H), 7.38 (d, J = 8.0 Hz, 2H), 7.29 (d, J = 0.8 Hz, 1H), 4.46 - 4.50 (q, J = 4.8, 11.2 Hz, 1H), 4.02 (t, J = 10.8 Hz, 1H), 3.72 - 3.76 (q, J = 5.2, 10.8 Hz, 1H), 2.47 (s, 3H), 2.26 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.2, 145.0, 142.5, 139.1, 138.9, 136.7, 133.0, 131.9, 130.2, 129.3, 128.4, 128.3, 127.4, 126.8, 126.7, 56.7, 46.6, 21.6, 21.0; HRMS (ESI-TOF) m/z calcd for $C_{25}H_{24}NO_3S$ $[M + H]^+$ 418.1471, found 418.1472.



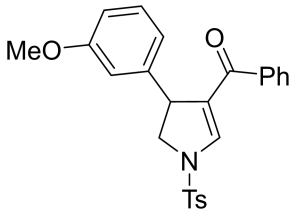
(4-(4-Methoxyphenyl)-1-tosyl-4,5-dihydro-1*H*-pyrrol-3-yl)(phenyl)methanone (**3ad**): Obtained as a light yellow liquid (70.1 mg, 81% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, J = 8.0 Hz, 2H), 7.62 (d, J = 8.0 Hz, 2H), 7.42 - 7.46 (t, J = 7.6 Hz, 2H), 7.39 (d, J = 8.4 Hz, 2H), 7.33 (s, 1H), 7.28 (s, 1H), 6.99 (d, J = 8.4 Hz, 2H), 6.74 (d, J = 8.8 Hz, 2H), 4.45 - 4.49 (q, J = 4.8, 10.8 Hz, 1H), 4.00 (t, J = 10.8 Hz, 1H), 3.72 - 3.76 (m, 4H), 2.48 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.3, 158.6, 145.1, 142.4, 139.0, 133.0, 131.9, 130.2, 128.8, 128.5, 128.5, 128.3, 127.9, 127.5, 114.1, 56.7, 55.2, 46.2, 21.7; HRMS (ESI-TOF) m/z calcd for $C_{25}H_{24}NO_4S$ $[M + H]^+$ 434.1421, found 434.1422.



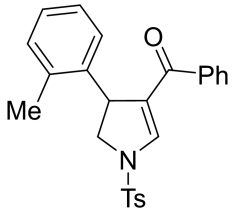
(4-(4-Fluorophenyl)-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)(phenyl)methanone (**3ae**): Obtained as a light yellow liquid (62.3 mg, 74% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, J = 8.0 Hz, 2H), 7.61 (d, J = 7.2 Hz, 2H), 7.55 (d, J = 7.2 Hz, 1H), 7.45 (d, J = 7.6 Hz, 2H), 7.39 (d, J = 8.0 Hz, 2H), 7.31 (s, 1H), 7.03 - 7.06 (m, 2H), 6.89 (t, J = 8.4 Hz, 2H), 4.48 - 4.52 (q, J = 4.8, 11.2 Hz, 1H), 4.02 (t, J = 10.8 Hz, 1H), 3.72 - 3.76 (q, J = 4.8, 10.8 Hz, 1H), 2.49 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.2, 161.8 (d, J = 244.1 Hz), 145.2, 142.8, 138.8, 138.0 (d, J = 3.2 Hz), 133.0, 132.1, 130.3, 128.6, 128.4 (d, J = 8.0 Hz), 128.2, 127.5, 126.4, 115.6 (d, J = 21.4 Hz), 56.6, 46.3, 21.7; ^{19}F NMR (400 MHz, $CDCl_3$) δ -115.4; HRMS (ESI-TOF) m/z calcd for $C_{24}H_{21}NO_3SF$ $[M + H]^+$ 422.1221, found 422.1223.



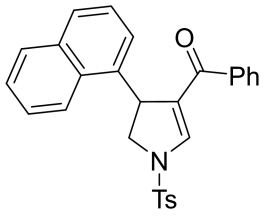
(4-(4-Chlorophenyl)-1-tosyl-4,5-dihydro-1*H*-pyrrol-3-yl)(phenyl)methanone (**3af**): Obtained as a light yellow liquid (65.6 mg, 75% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, J = 8.0 Hz, 2H), 7.60 - 7.62 (m, 2H), 7.53 - 7.57 (m, 1H), 7.43 - 7.47 (t, J = 7.6 Hz, 2H), 7.39 (d, J = 8.4 Hz, 2H), 7.32 (s, 1H), 7.17 (d, J = 8.4 Hz, 2H), 7.01 (d, J = 8.4 Hz, 2H), 4.46 - 4.50 (q, J = 4.8, 11.2 Hz, 1H), 4.03 (t, J = 11.2 Hz, 1H), 3.71 - 3.74 (q, J = 4.8, 10.8 Hz, 1H), 2.49 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.1, 145.3, 142.9, 140.7, 138.8, 132.9, 132.9, 132.1, 130.3, 128.9, 128.6, 128.3, 128.2, 127.4, 126.2, 56.4, 46.4, 21.7; HRMS (ESI-TOF) m/z calcd for $C_{24}H_{21}ClNO_3S$ $[M + H]^+$ 438.0925, found 438.0924.



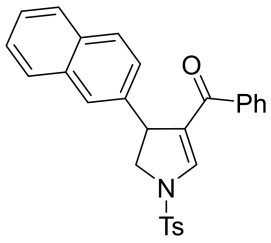
(4-(3-Methoxyphenyl)-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)(phenyl)methanone (**3ag**): Obtained as a light yellow liquid (65.8 mg, 76% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, J = 8.0 Hz, 2H), 7.63 (d, J = 8.0 Hz, 2H), 7.52 - 7.59 (m, 1H), 7.44 (t, J = 7.6 Hz, 2H), 7.38 (d, J = 8.0 Hz, 2H), 7.30 (s, 1H), 7.12 (d, J = 8.0 Hz, 1H), 6.71 (d, J = 7.6 Hz, 1H), 6.66 (d, J = 7.6 Hz, 1H), 6.63 (s, 1H), 4.48 - 4.52 (q, J = 5.2, 11.2 Hz, 1H), 4.03 (t, J = 11.2 Hz, 1H), 3.69 - 3.77 (m, 4H), 2.47 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.2, 159.7, 145.1, 143.7, 142.8, 138.8, 132.9, 132.0, 130.2, 129.7, 128.5, 128.3, 127.4, 126.3, 119.2, 112.9, 112.3, 56.6, 55.1, 46.9, 21.6; HRMS (ESI-TOF) m/z calcd for $C_{25}H_{24}NO_4S$ $[M + H]^+$ 434.1421, found 434.1422.



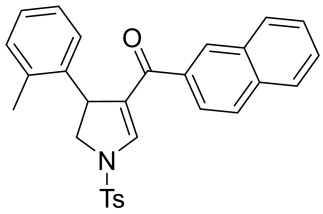
Phenyl(4-(o-tolyl)-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)methanone (**3ah**): Obtained as a light yellow liquid (71.7 mg, 86% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, J = 8.0 Hz, 2H), 7.66 (d, J = 7.2 Hz, 2H), 7.54 (t, J = 7.2 Hz, 1H), 7.45 (t, J = 7.6 Hz, 2H), 7.35 - 7.38 (m, 3H), 7.04 - 7.11 (m, 2H), 6.98 (t, J = 7.2 Hz, 1H), 6.81 (d, J = 7.6 Hz, 1H), 4.74 - 4.78 (q, J = 5.6, 11.6 Hz, 1H), 4.08 (t, J = 10.8 Hz, 1H), 3.61 - 3.65 (q, J = 5.6, 10.4 Hz, 1H), 2.46 (s, 3H), 2.40 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.2, 145.0, 143.1, 140.5, 138.8, 135.4, 133.0, 132.0, 130.4, 130.2, 128.5, 128.3, 127.4, 126.9, 126.6, 126.5, 125.6, 56.3, 42.7, 21.6, 19.7; HRMS (ESI-TOF) m/z calcd for $C_{25}H_{24}NO_3S$ $[M + H]^+$ 418.1471, found 418.1472.



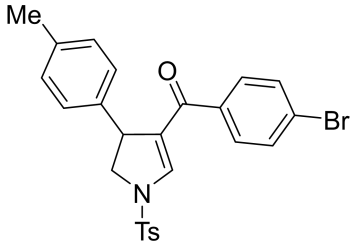
(4-(Naphthalen-1-yl)-1-tosyl-4,5-dihydro-1*H*-pyrrol-3-yl)(phenyl) methanone (**3ai**): Obtained as a light yellow liquid (73.4 mg, 81% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, J = 8.4 Hz, 1H), 7.81 - 7.83 (m, 1H), 7.74 (d, J = 7.2 Hz, 2H), 7.64 - 7.69 (m, 3H), 7.52 - 7.56 (m, 1H), 7.44 - 7.47 (m, 5H), 7.30 (d, J = 8.0 Hz, 2H), 7.24 (d, J = 8.0 Hz, 1H), 7.07 (d, J = 6.8 Hz, 1H), 5.29 - 5.33 (q, J = 5.6, 11.6 Hz, 1H), 4.24 (t, J = 11.2 Hz, 1H), 3.68 - 3.72 (q, J = 5.2, 10.0 Hz, 1H), 2.41 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.2, 145.0, 143.8, 138.8, 134.0, 133.1, 132.0, 130.9, 130.1, 128.9, 128.5, 128.3, 127.7, 127.3, 126.2, 125.6, 125.4, 125.3, 122.9, 21.6; HRMS (ESI-TOF) m/z calcd for $C_{28}H_{24}NO_3S$ $[M + H]^+$ 454.1471, found 454.1472.



(4-(Naphthalen-2-yl)-1-tosyl-4,5-dihydro-1*H*-pyrrol-3-yl)(pheny l)methanone (**3aj**): Obtained as a light yellow liquid (81.5 mg, 90% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 - 7.76 (m, 3H), 7.69 (d, J = 8.4 Hz, 1H), 7.62 - 7.68 (m, 3H), 7.50 - 7.54 (m, 2H), 7.37 - 7.45 (m, 7H), 7.21 (d, J = 8.8 Hz, 1H), 4.67 - 4.71 (q, J = 4.8, 11.2 Hz, 1H), 4.12 (t, J = 10.8 Hz, 1H), 3.84 - 3.88 (q, J = 4.8, 10.8 Hz, 1H), 2.47 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.2, 145.1, 142.7, 139.5, 138.9, 133.3, 133.1, 132.5, 132.0, 130.3, 128.6, 128.5, 128.3, 127.8, 127.5, 127.5, 126.5, 126.1, 125.8, 125.7, 125.0, 56.6, 47.1, 21.7; HRMS (ESI-TOF) m/z calcd for $C_{28}H_{24}NO_3S$ $[M + H]^+$ 454.1471, found 454.1470.



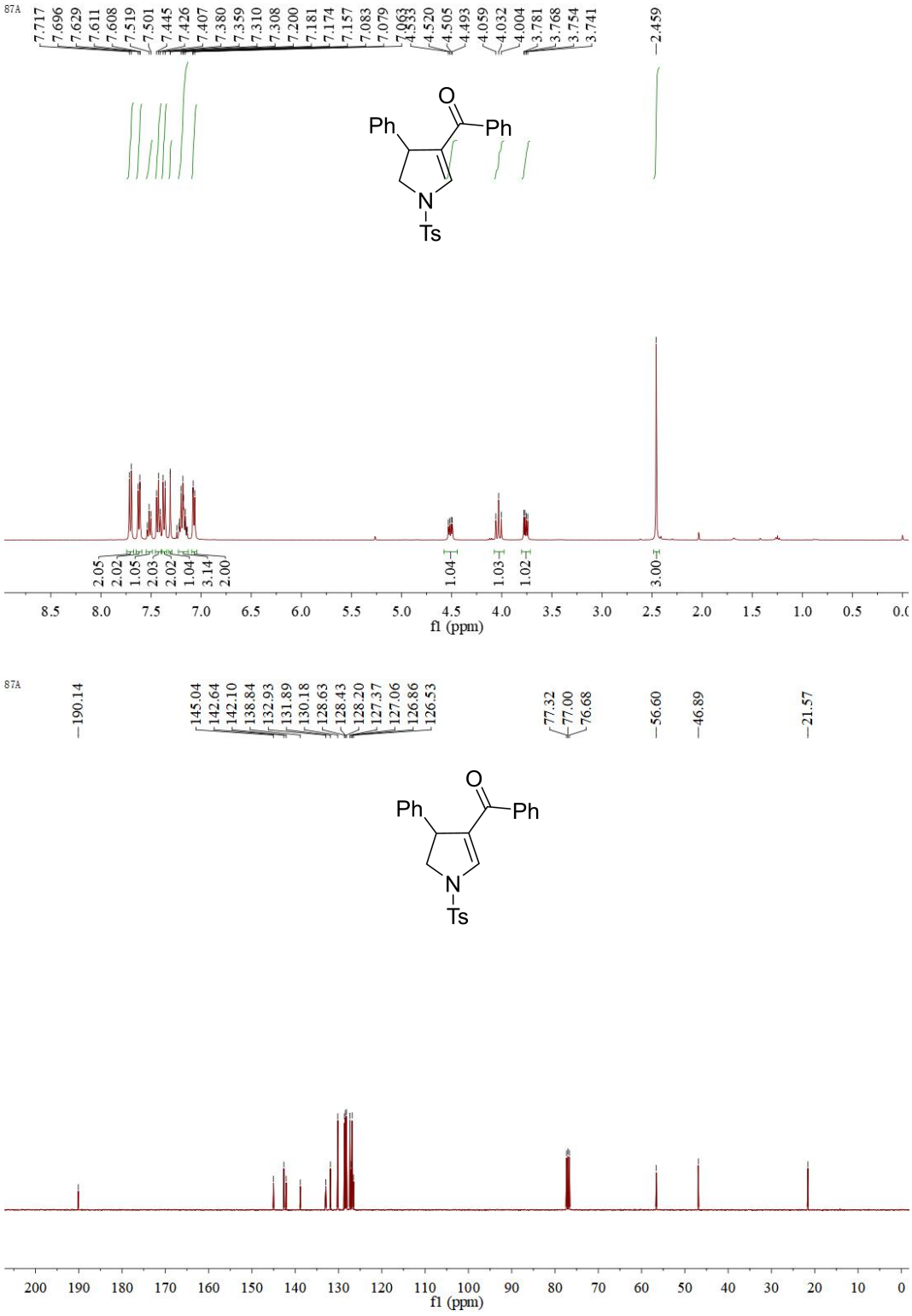
Naphthalen-2-yl(4-(o-tolyl)-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)methanone (**3ak**): Obtained as a light yellow liquid (82.2 mg, 88% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.27 (d, J = 8.4 Hz, 2H), 7.70 - 7.77 (m, 6H), 7.65 - 7.67 (m, 1H), 7.49 (s, 1H), 7.39 - 7.45 (m, 4H), 7.37 (s, 1H), 7.20 (d, J = 8.4 Hz, 1H), 4.66 - 4.70 (q, J = 4.8, 11.2 Hz, 1H), 4.17 (t, J = 11.2 Hz, 1H), 3.88 - 3.91 (q, J = 4.8, 10.8 Hz, 1H), 2.49 (s, 3H), 1.42 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 188.2, 149.4, 145.5, 144.1, 144.0, 139.1, 133.3, 132.9, 132.6, 130.4, 129.0, 128.8, 127.7, 127.6, 127.4, 126.3, 126.0, 125.9, 125.7, 124.7, 123.8, 56.7, 46.9, 26.9, 21.7; HRMS (ESI-TOF) m/z calcd for $C_{29}H_{26}NO_3S$ $[M + H]^+$ 468.1628, found 468.1626.



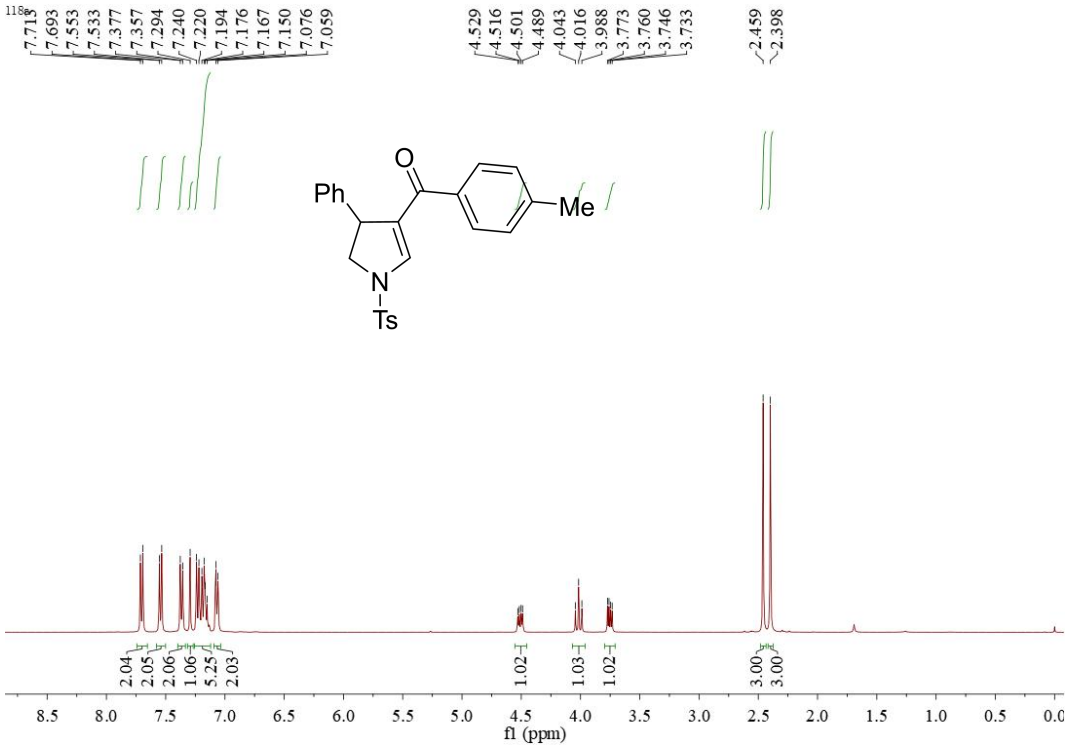
(4-Bromophenyl)(4-(p-tolyl)-1-tosyl-4,5-dihydro-1H-pyrrol-3-yl)methanone (**3al**): Obtained as a light yellow liquid (84.2 mg, 85% yield), eluting with 15% EtOAc in PE (elution gradient); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 - 7.72 (m, 2H), 7.60 - 7.63 (m, 2H), 7.50 - 7.54 (m, 1H), 7.41 - 7.45 (t, J = 7.6 Hz, 2H), 7.38 (d, J = 8.0 Hz, 2H), 7.29 (d, J = 0.8 Hz, 1H), 4.46 - 4.50 (q, J = 4.8, 11.2 Hz, 1H), 4.02 (t, J = 10.8 Hz, 1H), 3.72 - 3.76 (q, J = 5.2, 10.8 Hz, 1H), 2.47 (s, 3H), 2.26 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 189.0, 145.1, 142.6, 139.0, 137.7, 136.8, 133.0, 131.7, 130.2, 129.8, 129.4, 127.4, 126.7, 126.7, 126.4, 56.7, 46.6, 26.9, 21.6; HRMS (ESI-TOF) m/z calcd for $C_{25}H_{23}BrNO_3S$ $[M + H]^+$ 496.0577, found 496.0578.

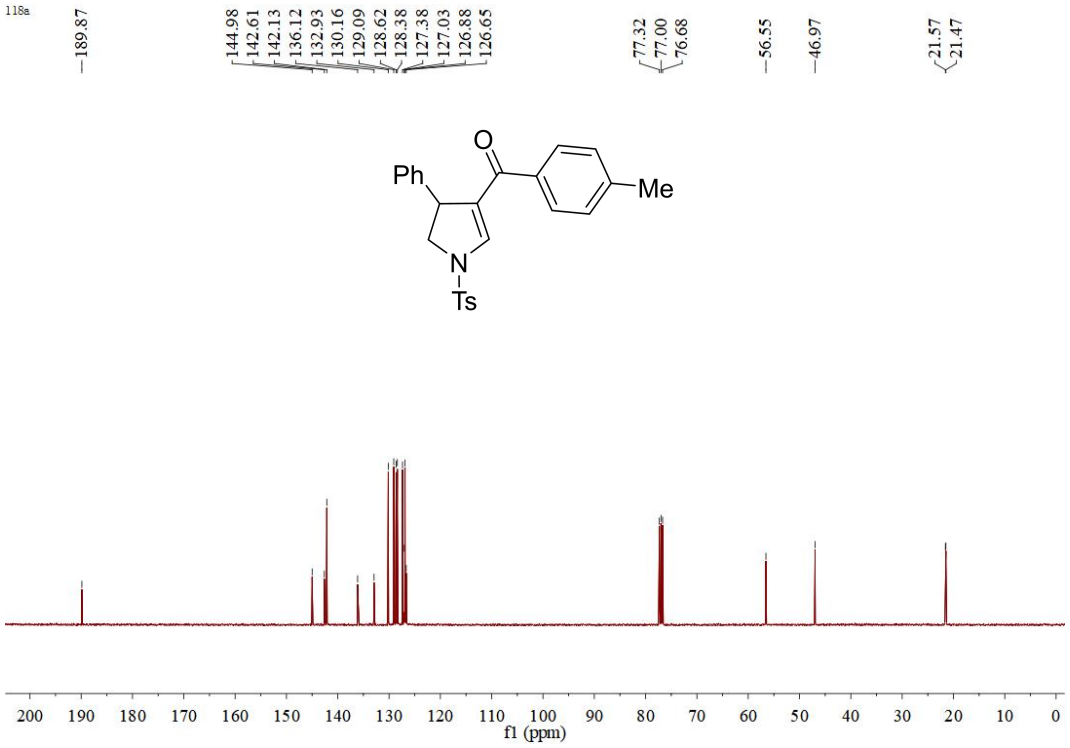
Copies of ^{1}H and ^{13}C NMR Spectra of Products

^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of 3**a**

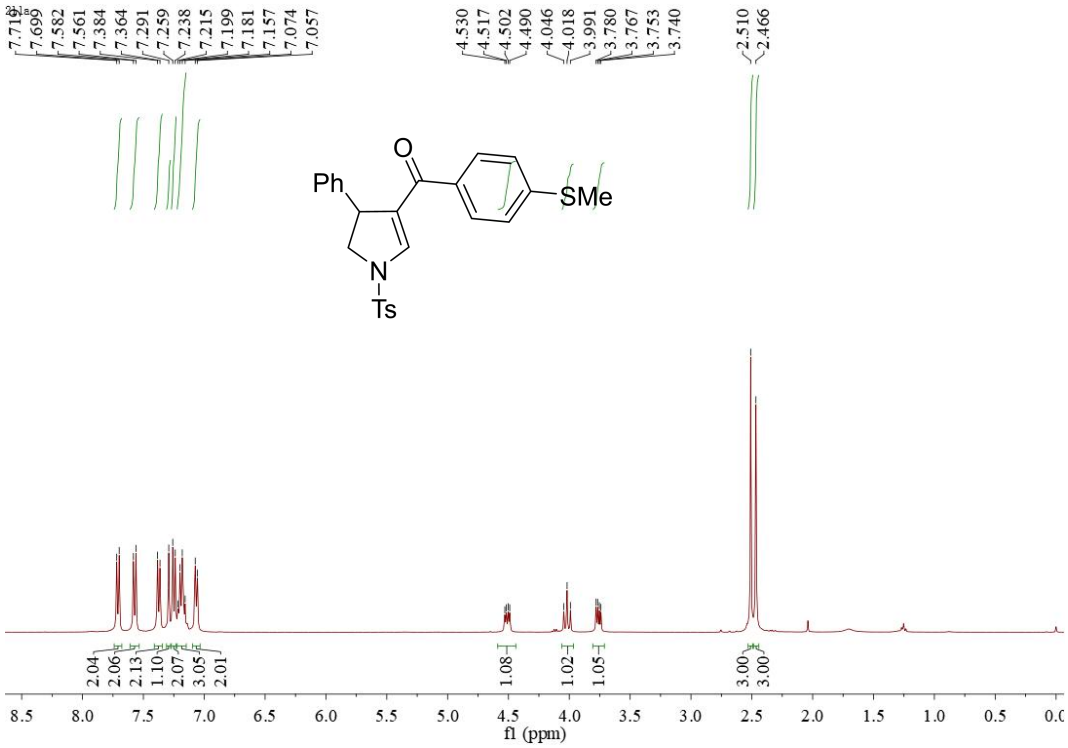


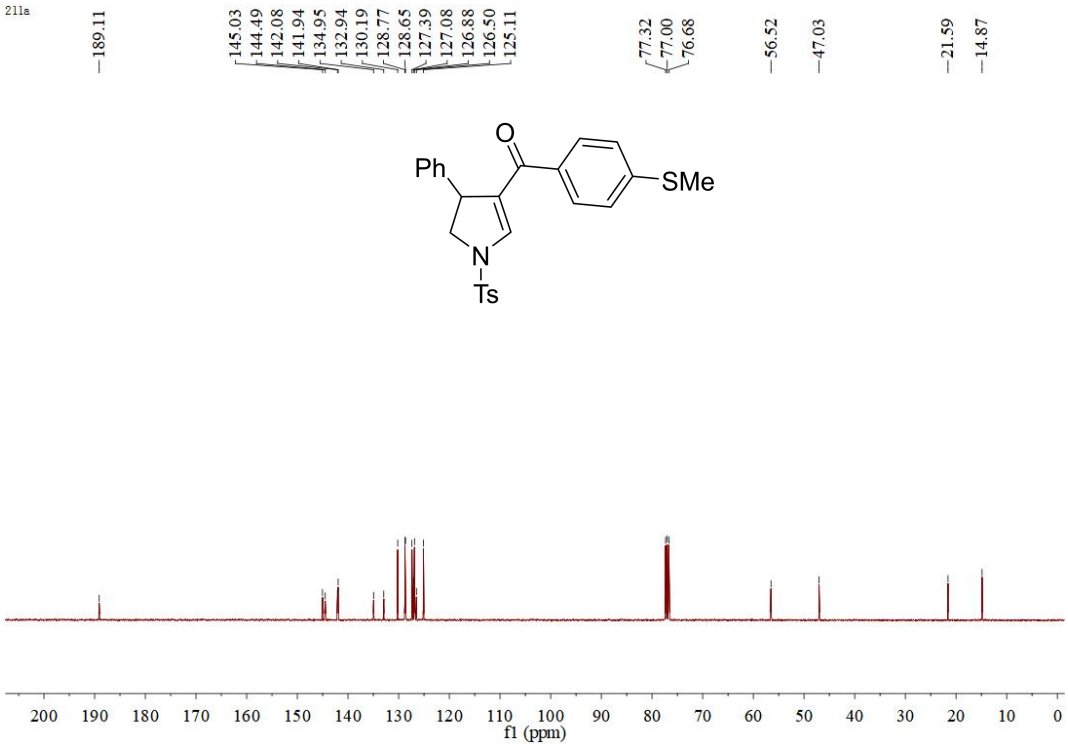
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3b**



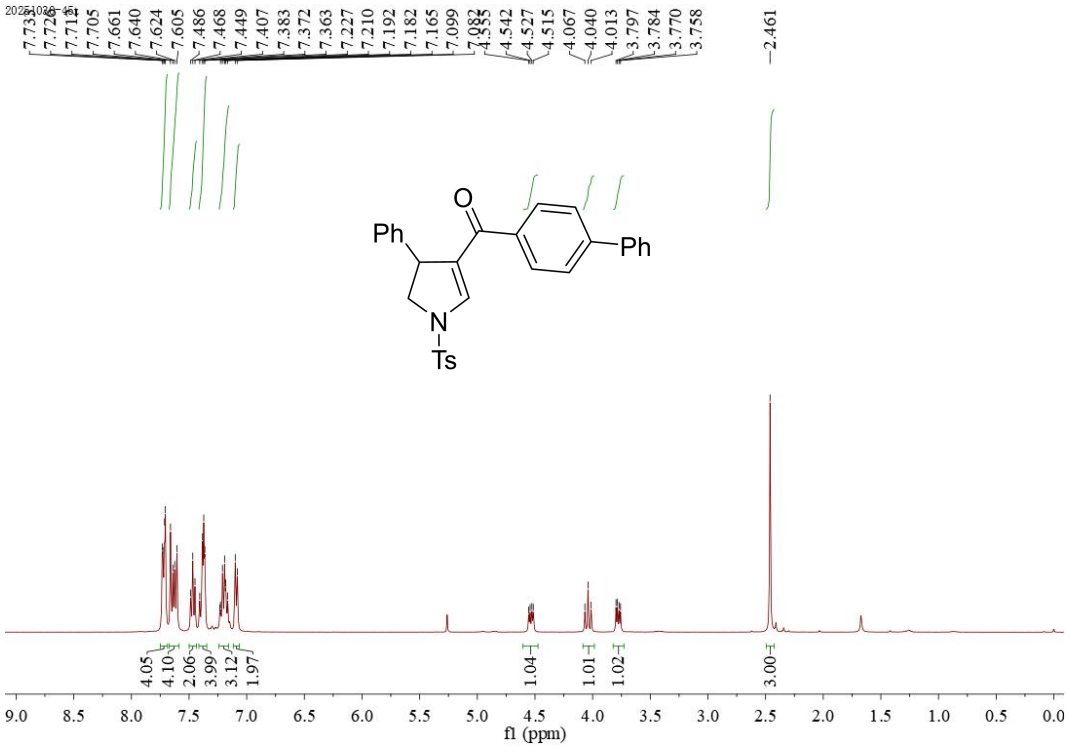


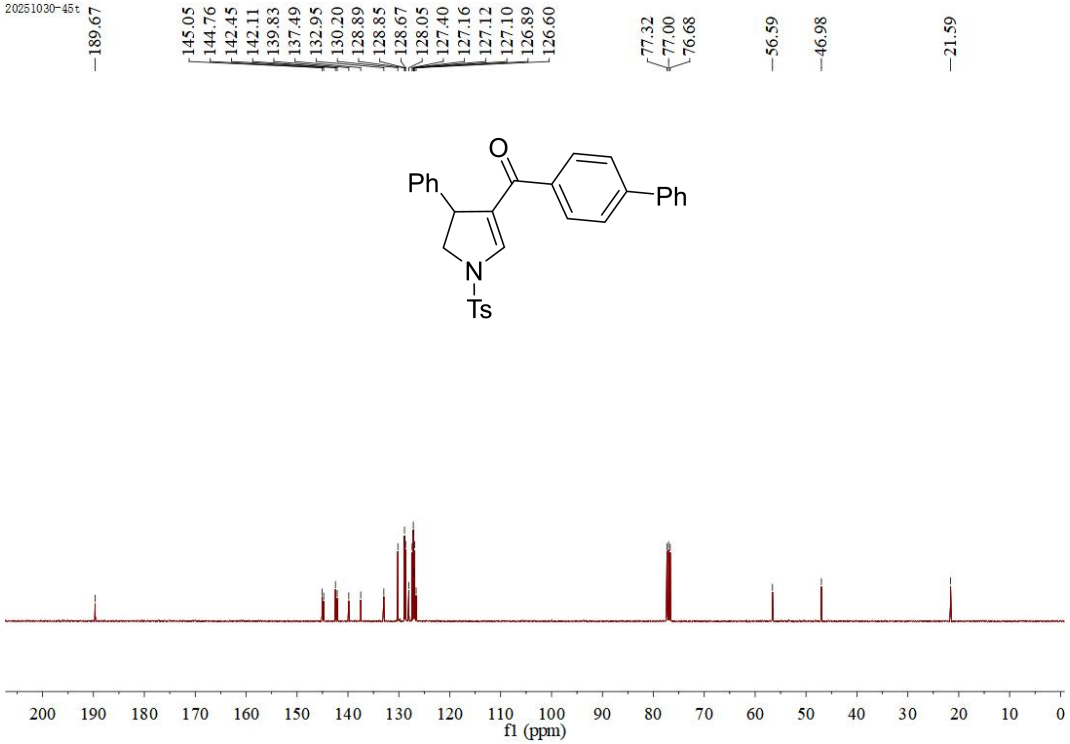
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3c**



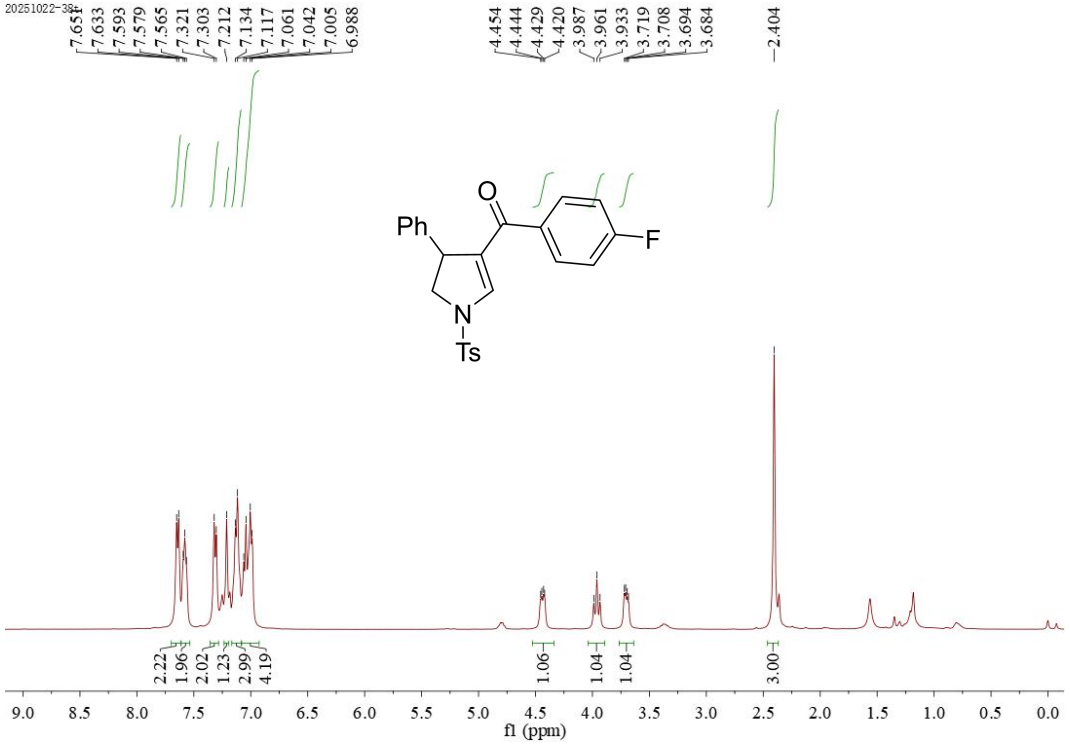


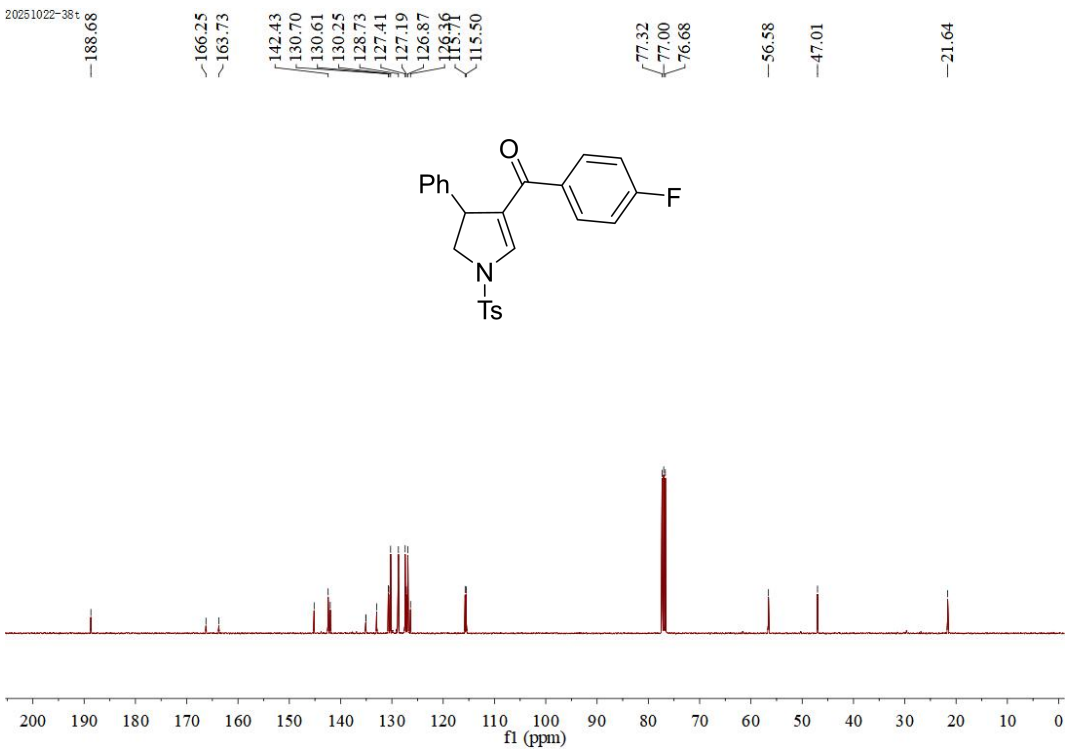
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3d**

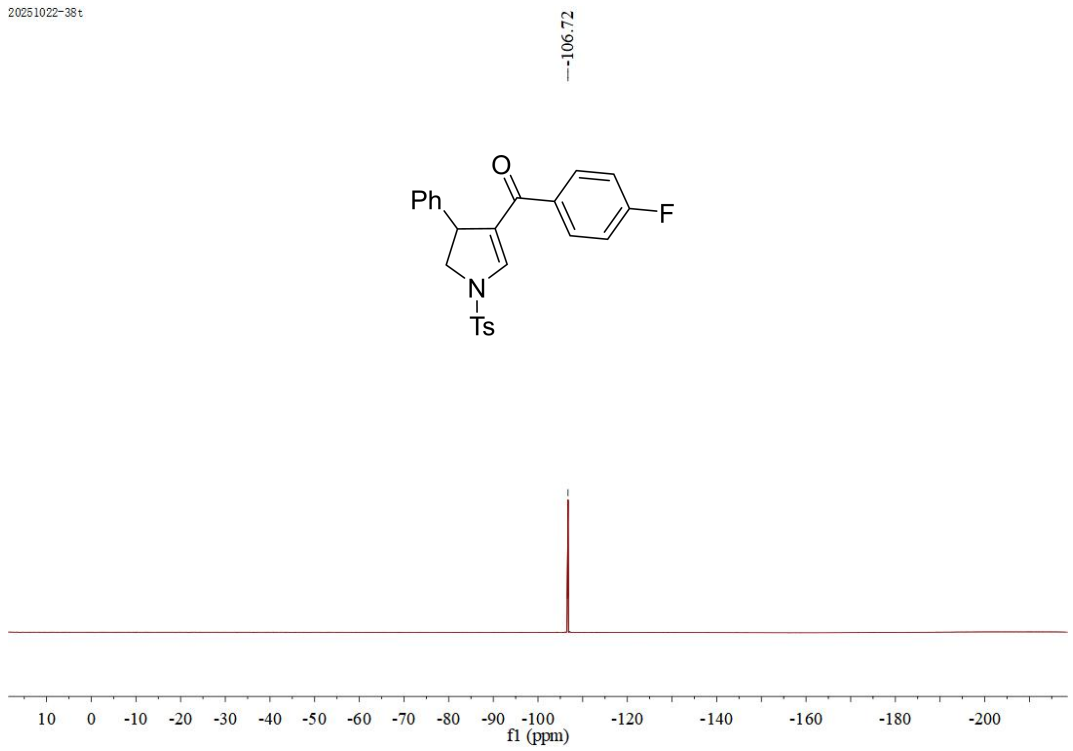




^{1}H NMR ($CDCl_3$, 400 MHz), **^{13}C NMR** (100 MHz, $CDCl_3$) and **^{19}F NMR** (400 MHz, $CDCl_3$) Spectrum of **3e**



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Ph
F
N
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-10
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-40
-50
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-90
-100
-120
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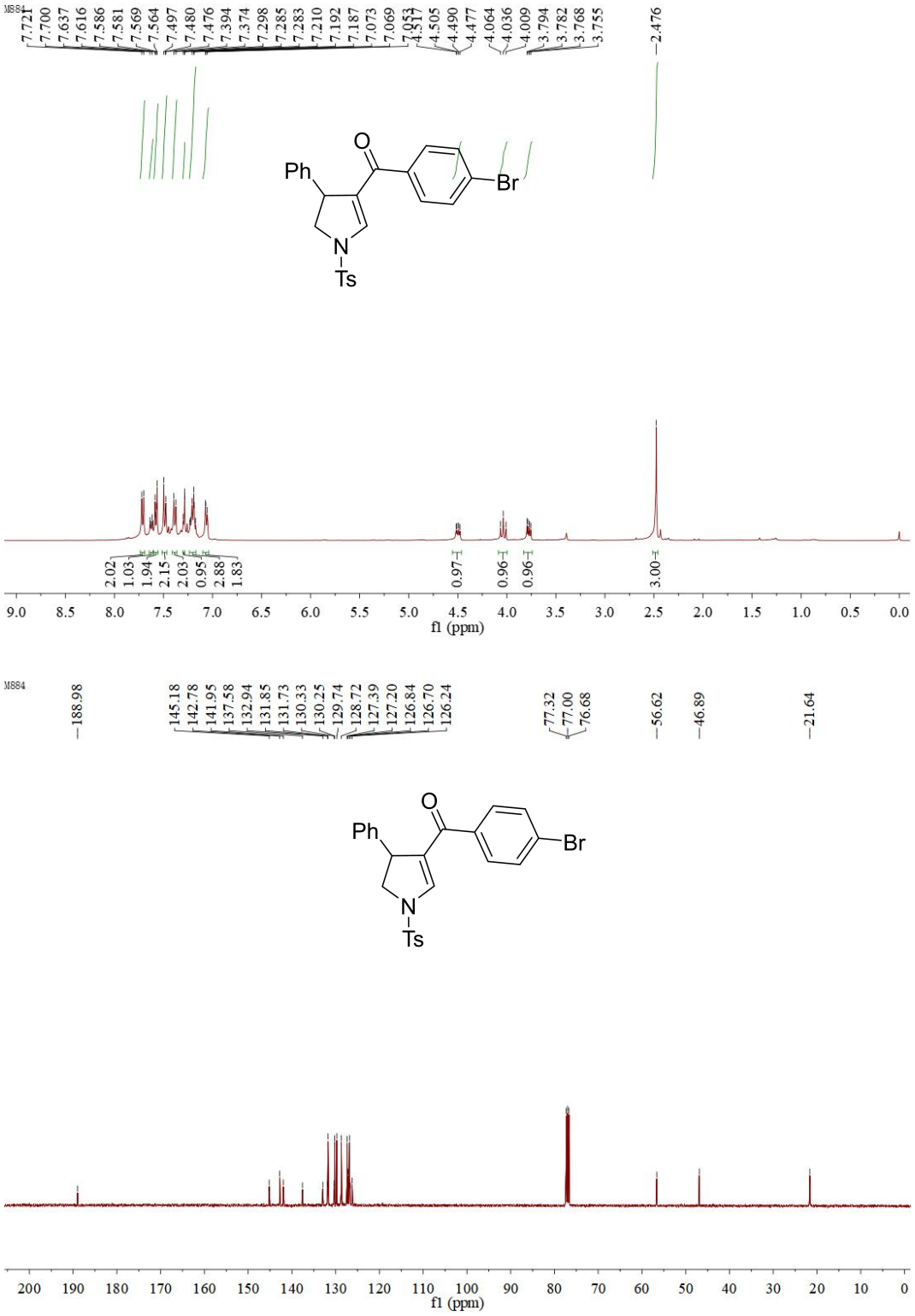
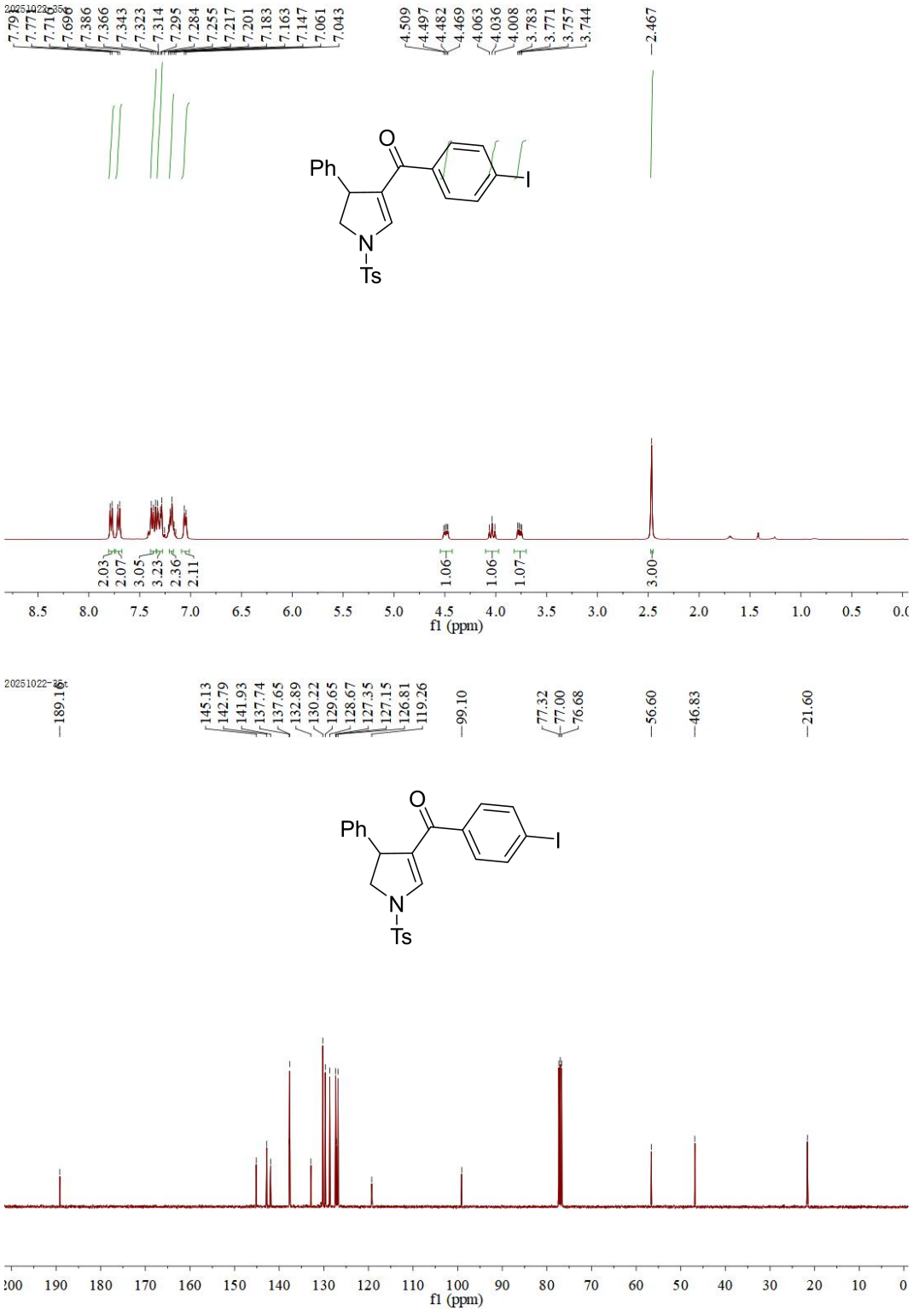
-180
-200
f1 (ppm)

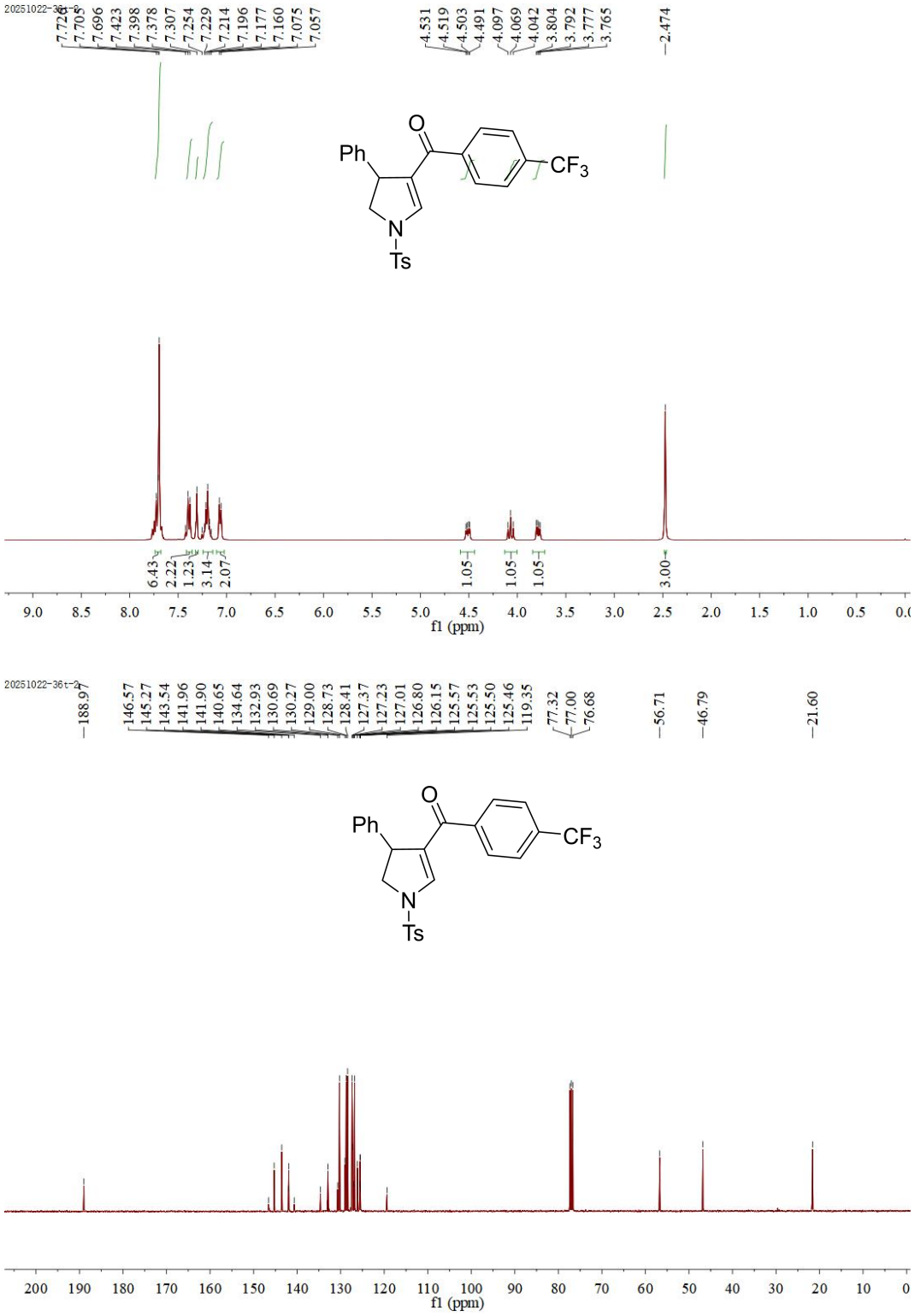
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3f**

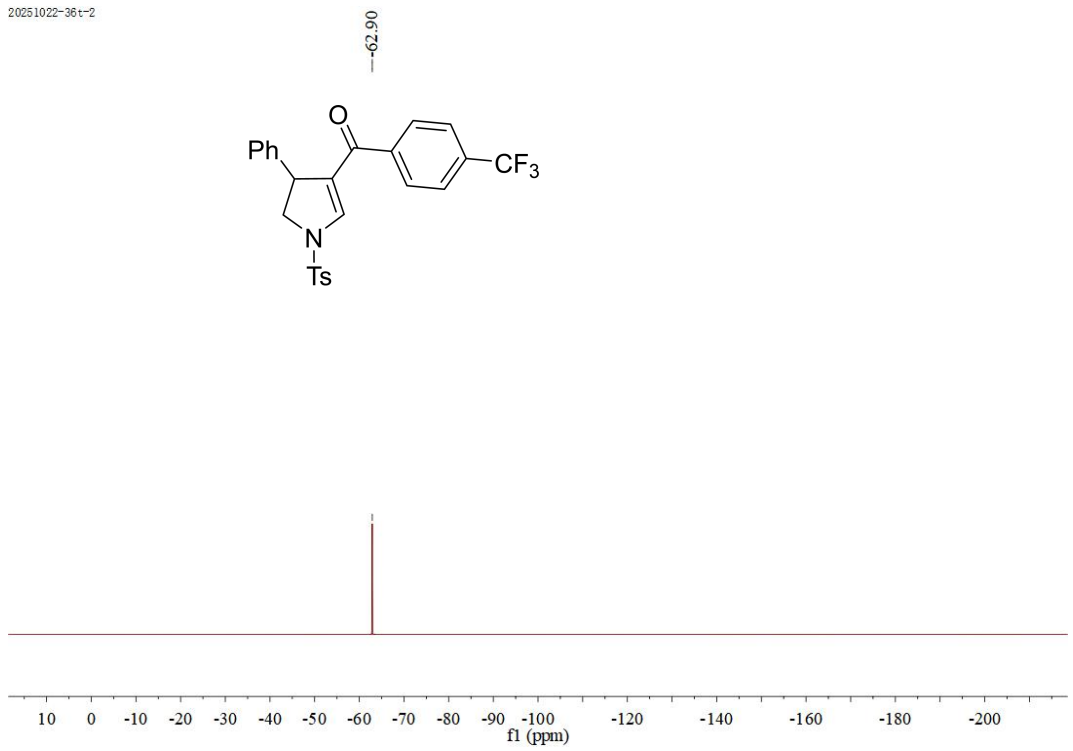


^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3g**



^{1}H NMR ($CDCl_3$, 400 MHz), **^{13}C NMR** (100 MHz, $CDCl_3$) and **^{19}F NMR** (400 MHz, $CDCl_3$) Spectrum of **3h**




20251022-36t-2
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O
Ph
CF3
N
Ts
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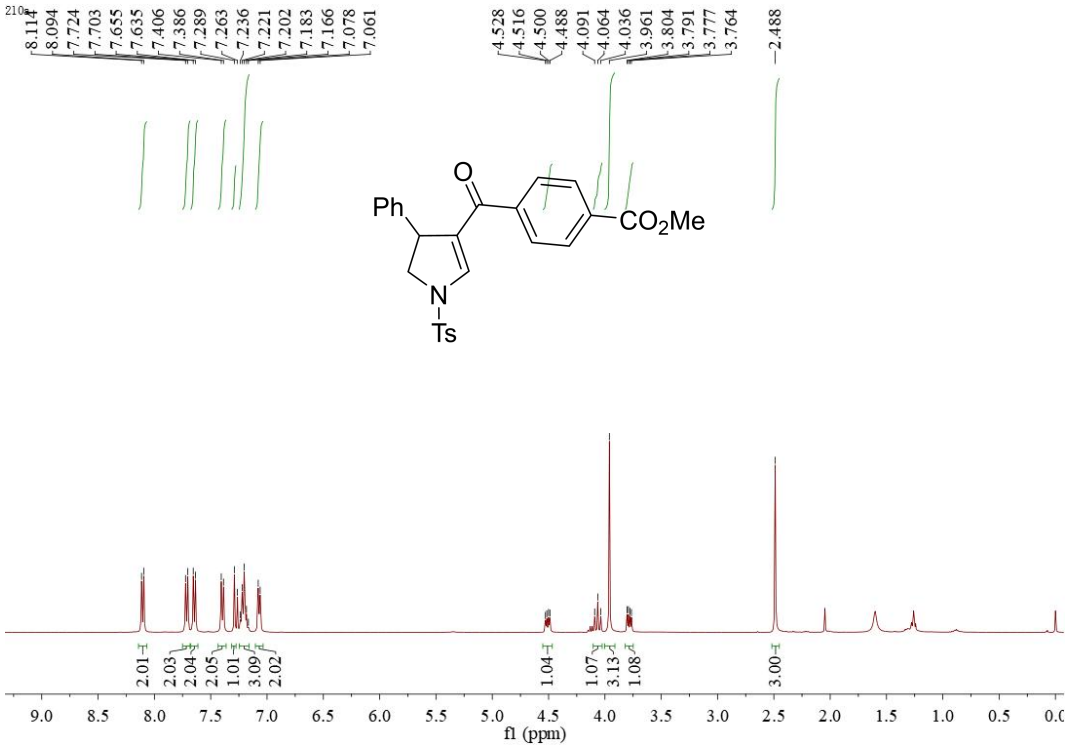
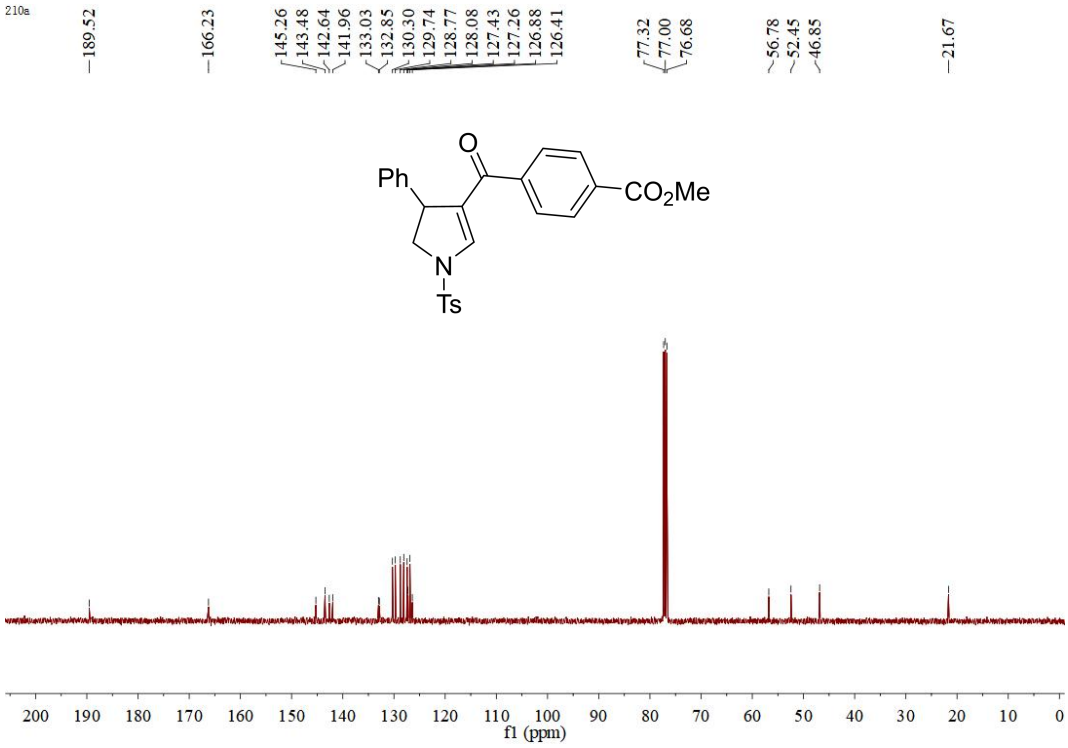
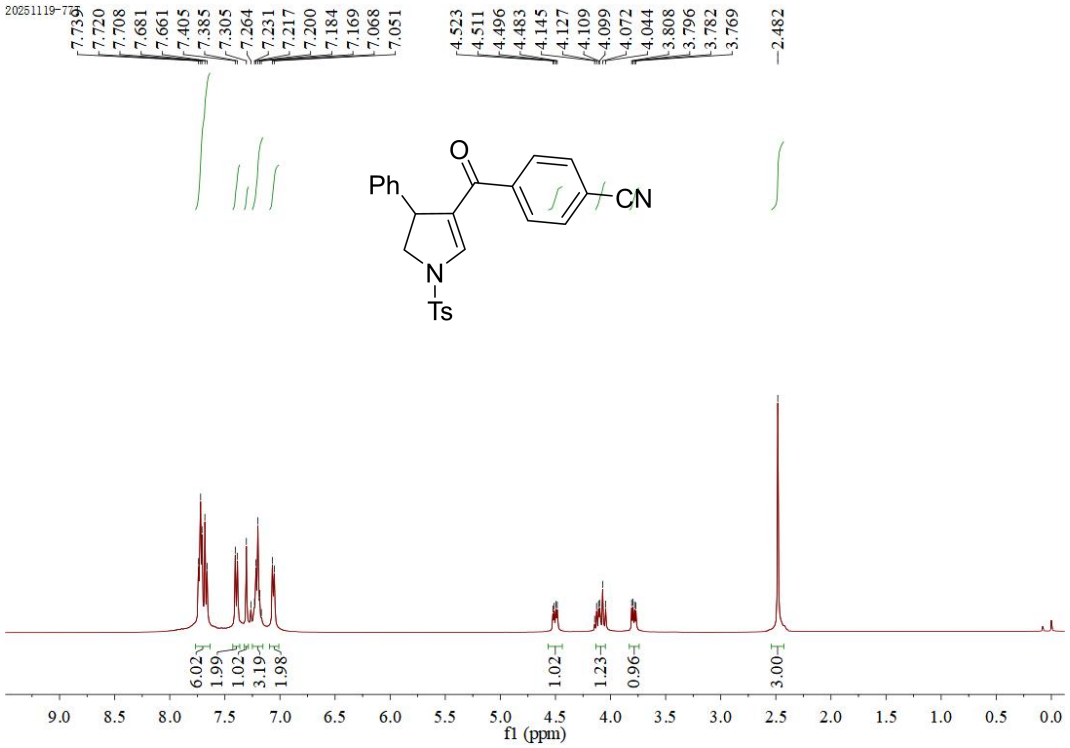
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180
-200
f1 (ppm)

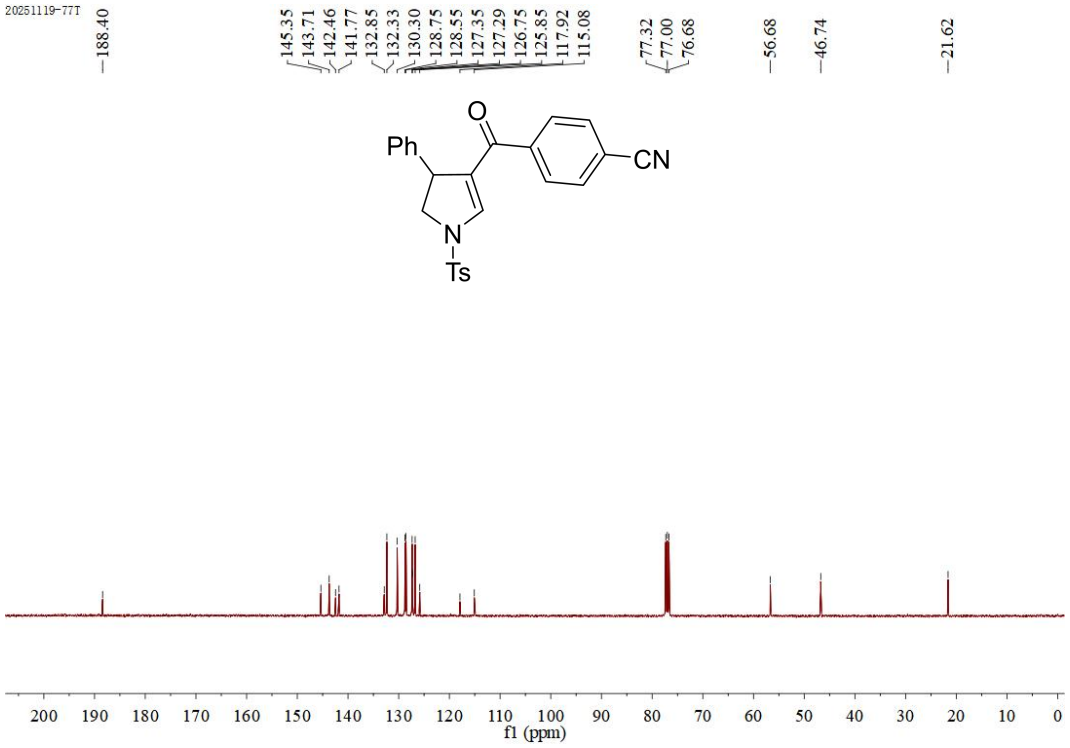
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3i**



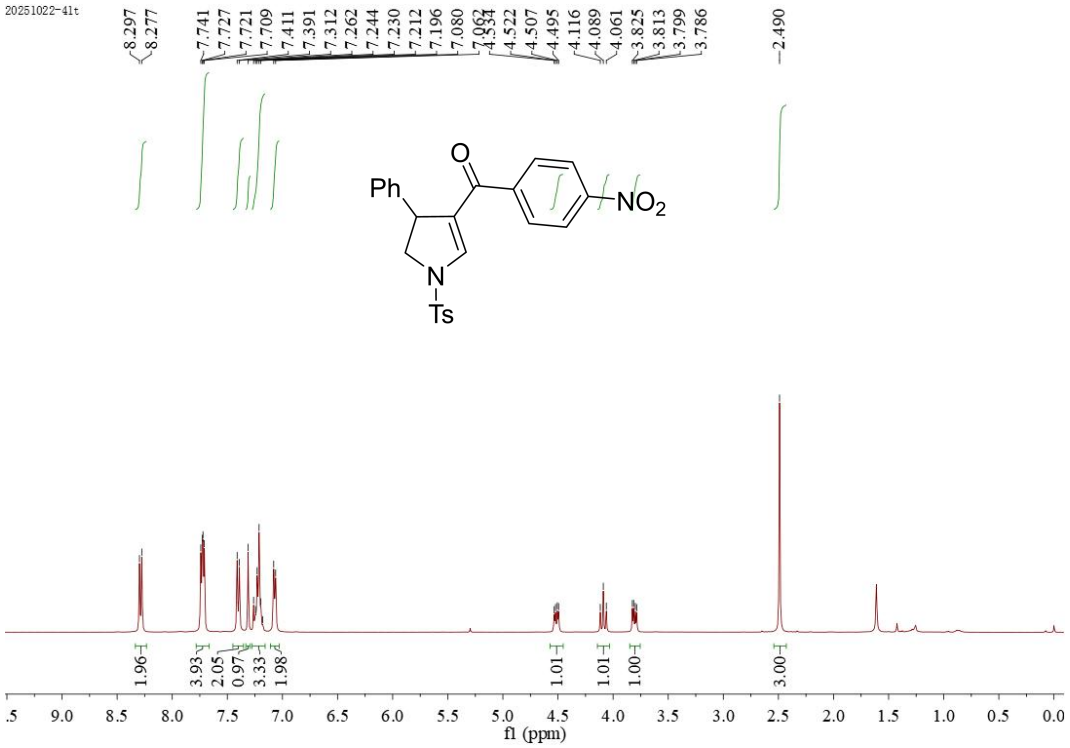


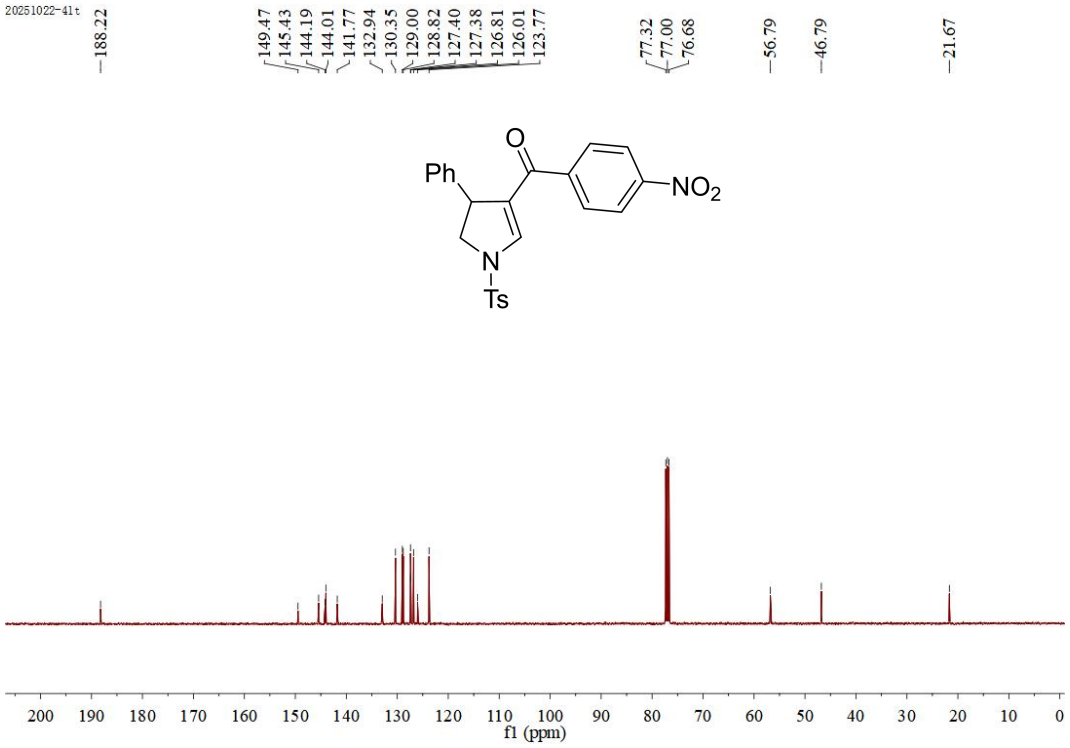
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3j**



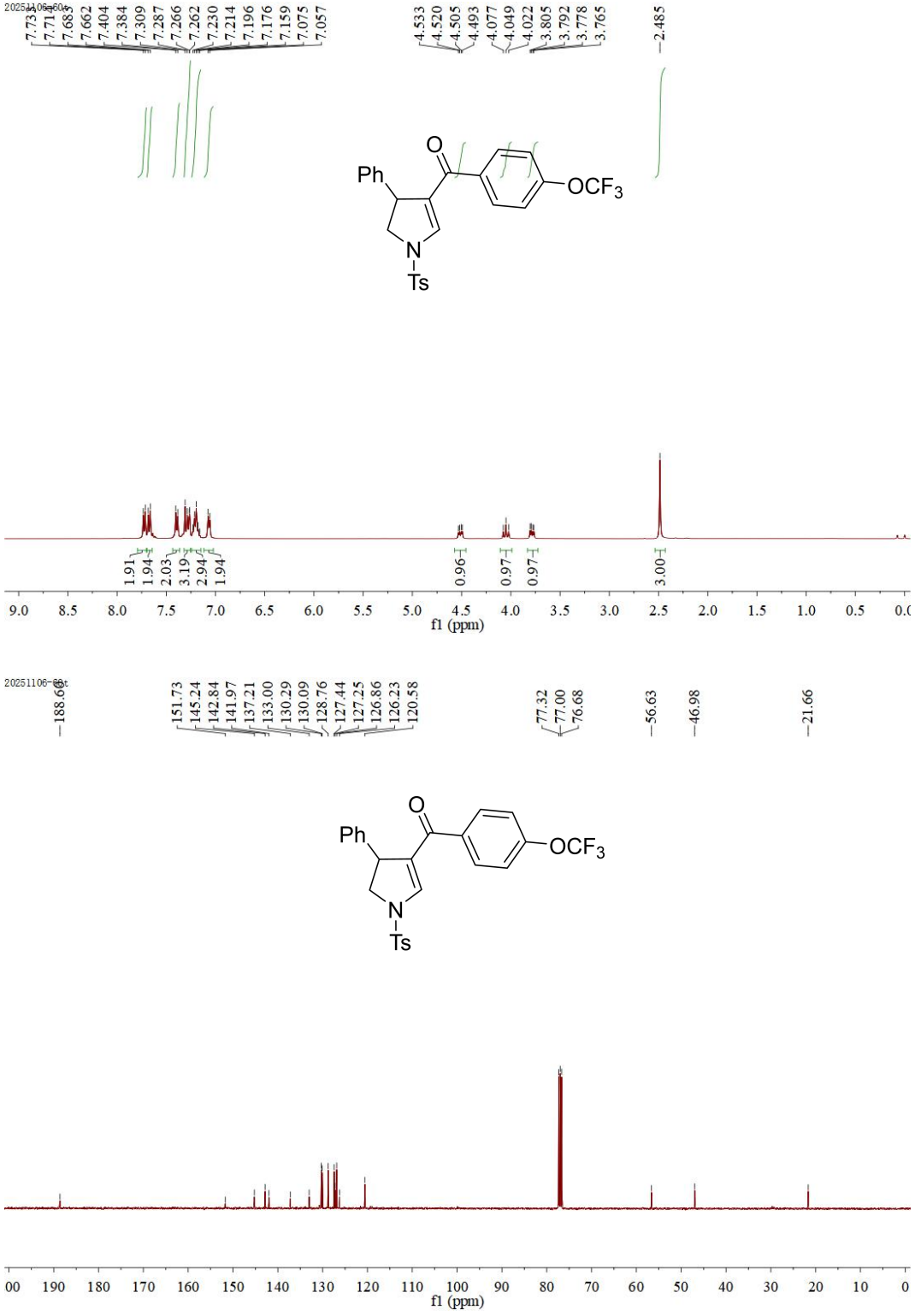


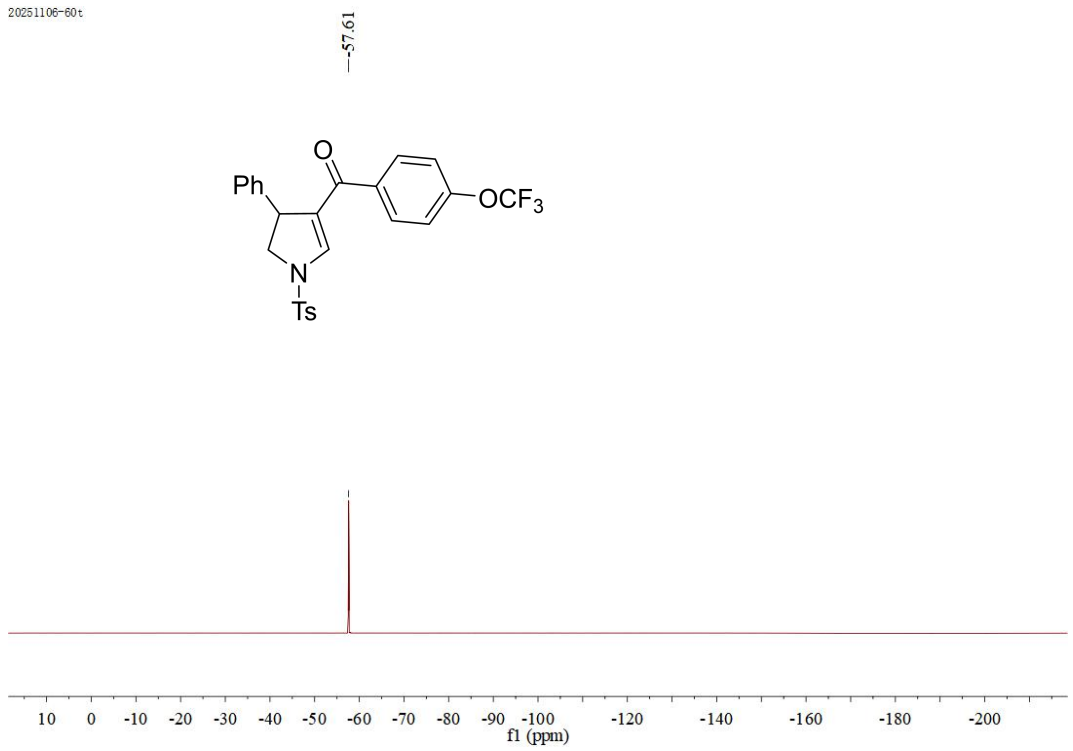
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3k**





^{1}H NMR ($CDCl_3$, 400 MHz), **^{13}C NMR** (100 MHz, $CDCl_3$) and **^{19}F NMR** (400 MHz, $CDCl_3$) Spectrum of **3l**

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Ph
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Ts
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0
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-90
-100
-120
-140
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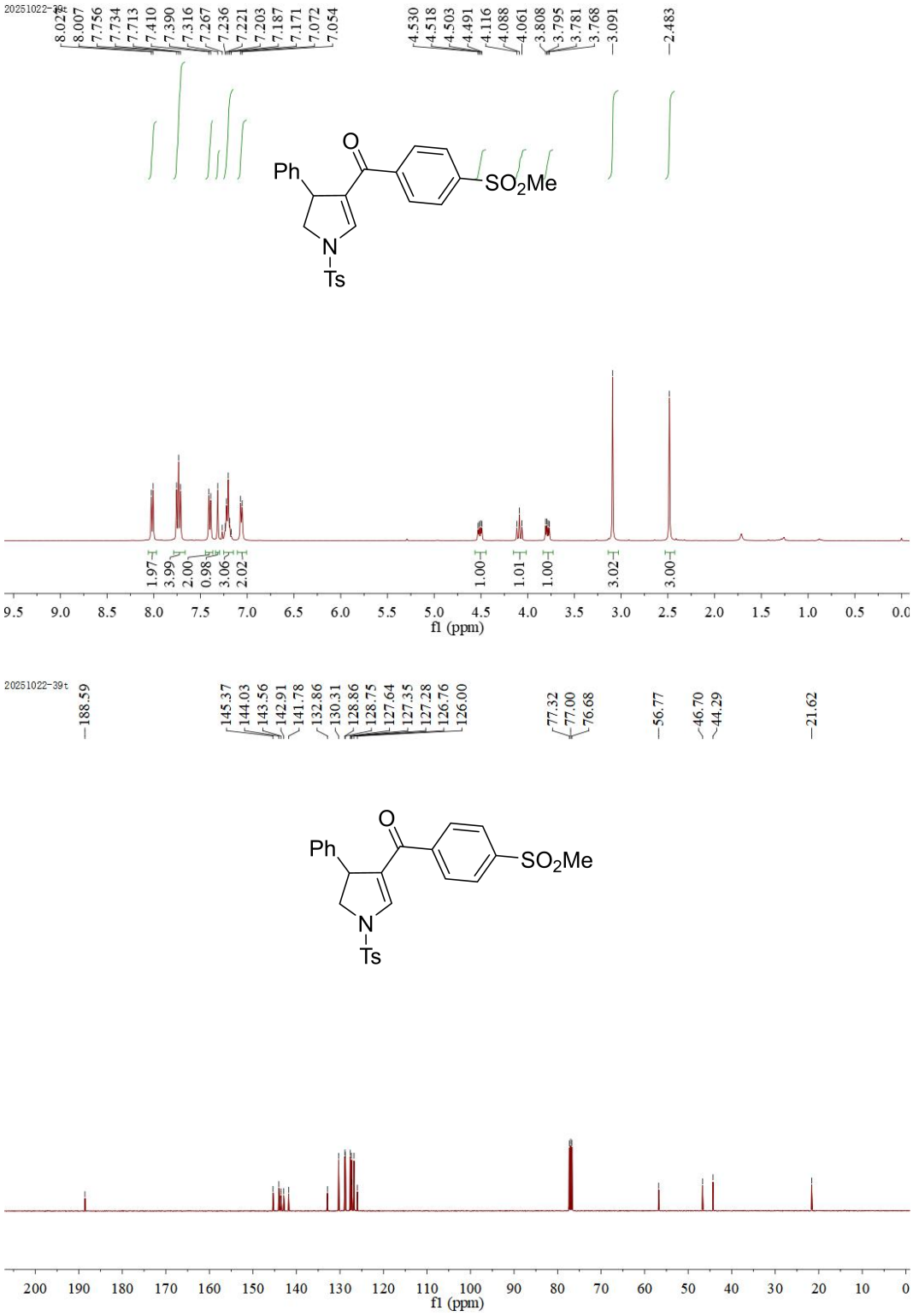
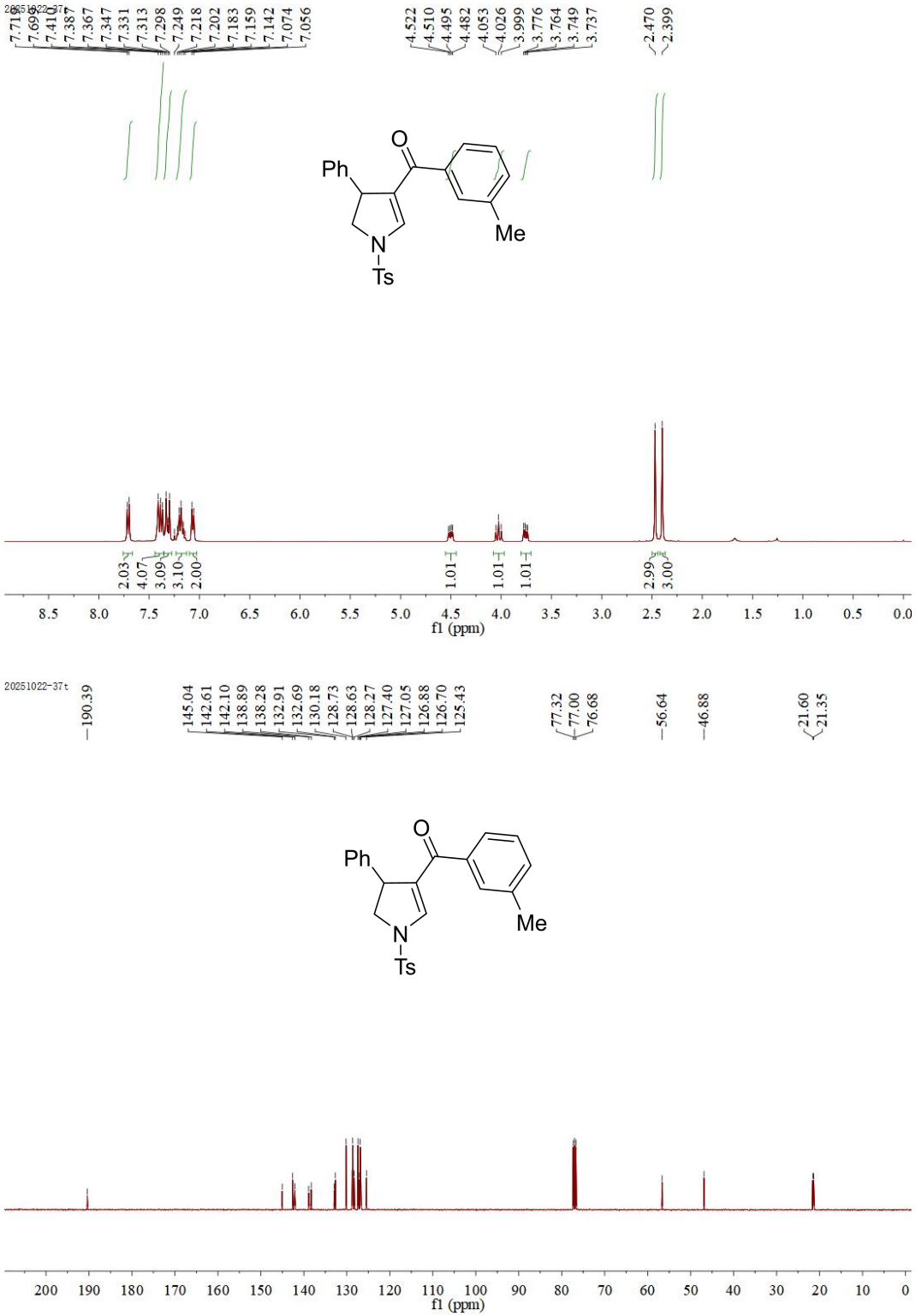
-200
f1 (ppm)

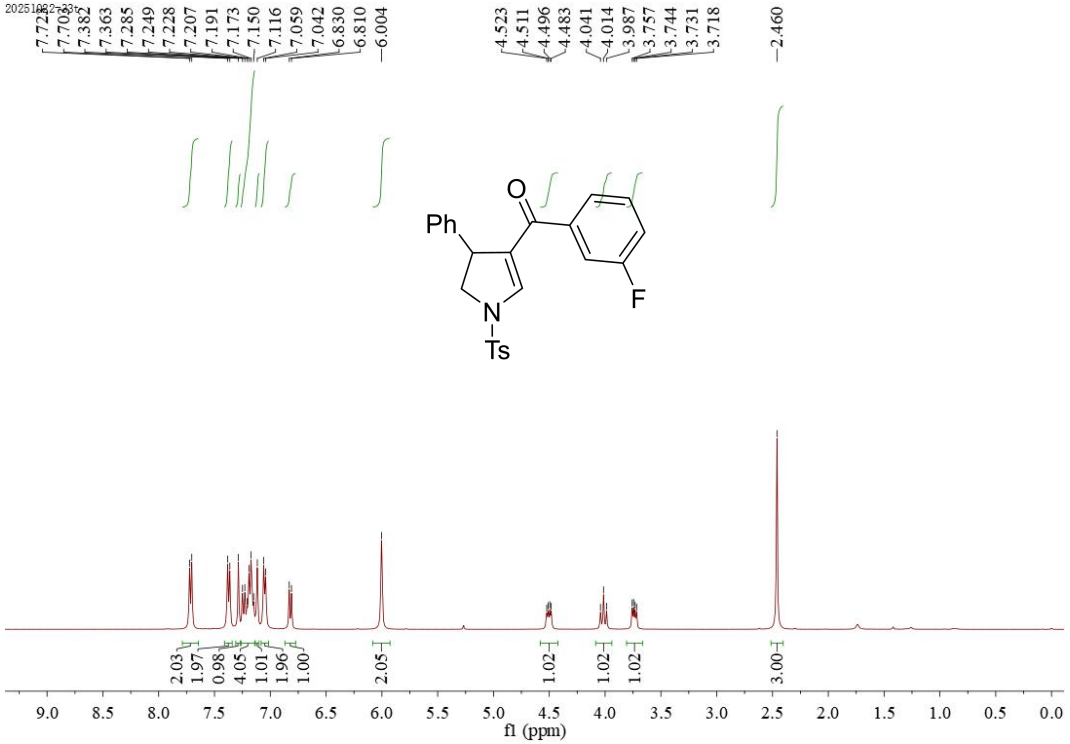
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3m**

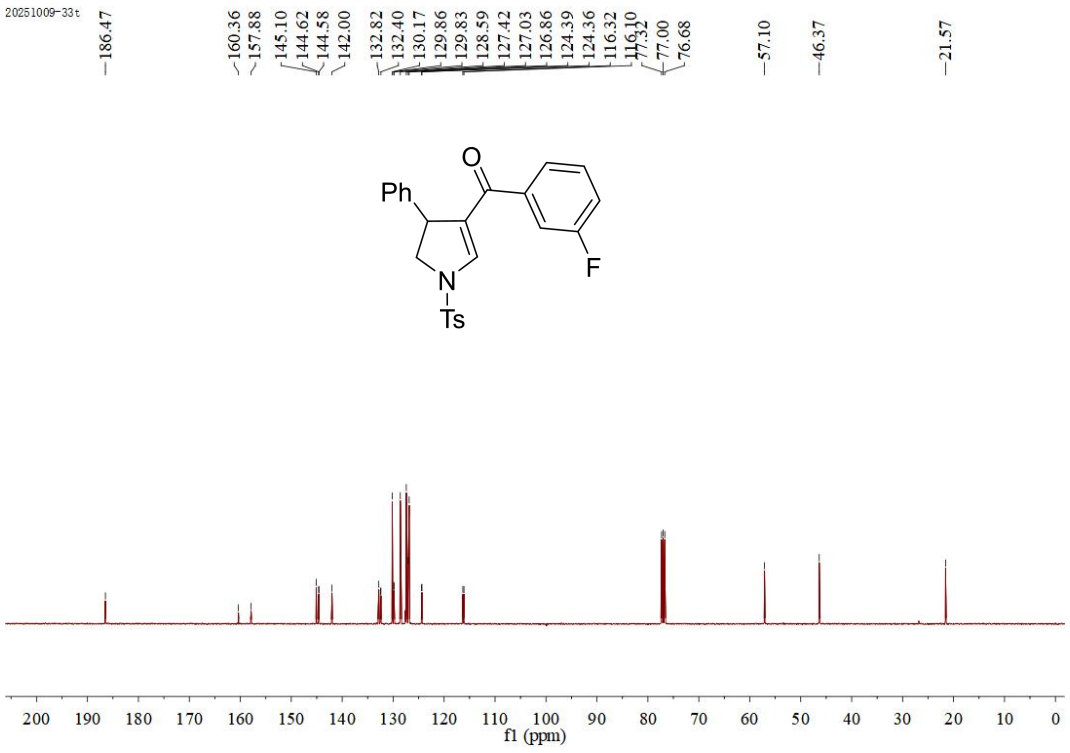


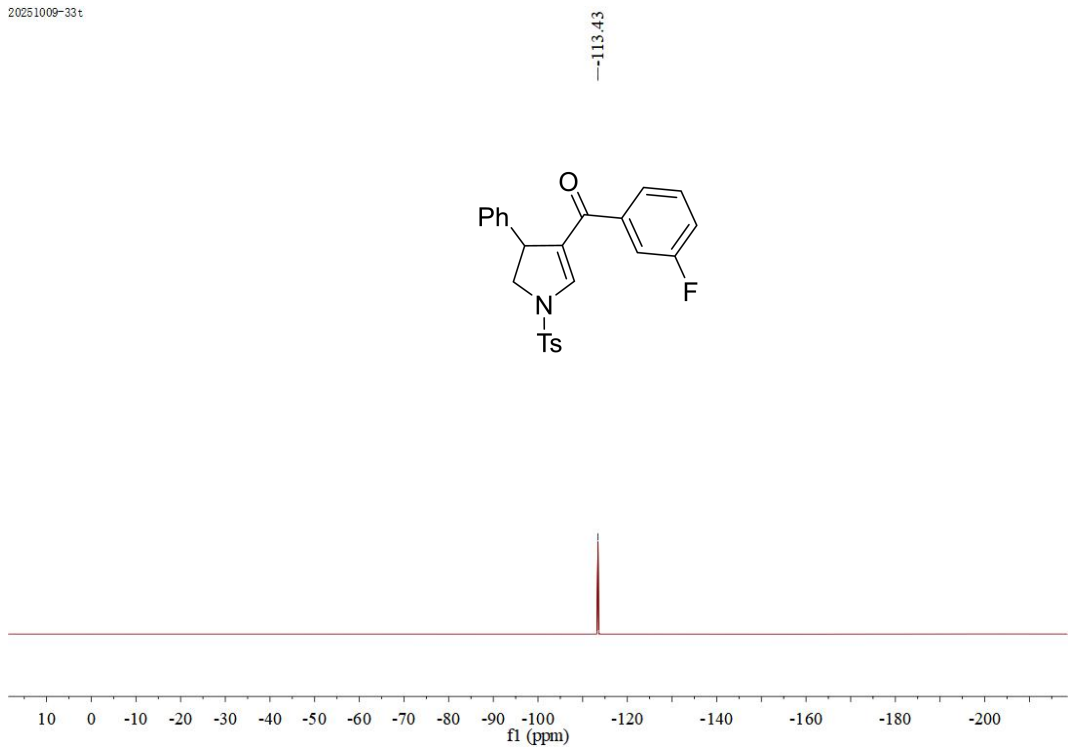
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3n**



^{1}H NMR ($CDCl_3$, 400 MHz), **^{13}C NMR** (100 MHz, $CDCl_3$) and **^{19}F NMR** (400 MHz, $CDCl_3$) Spectrum of **3o**






20251009-33t
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O
Ph
F
N
Ts
10
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-10
-20
-30
-40
-50
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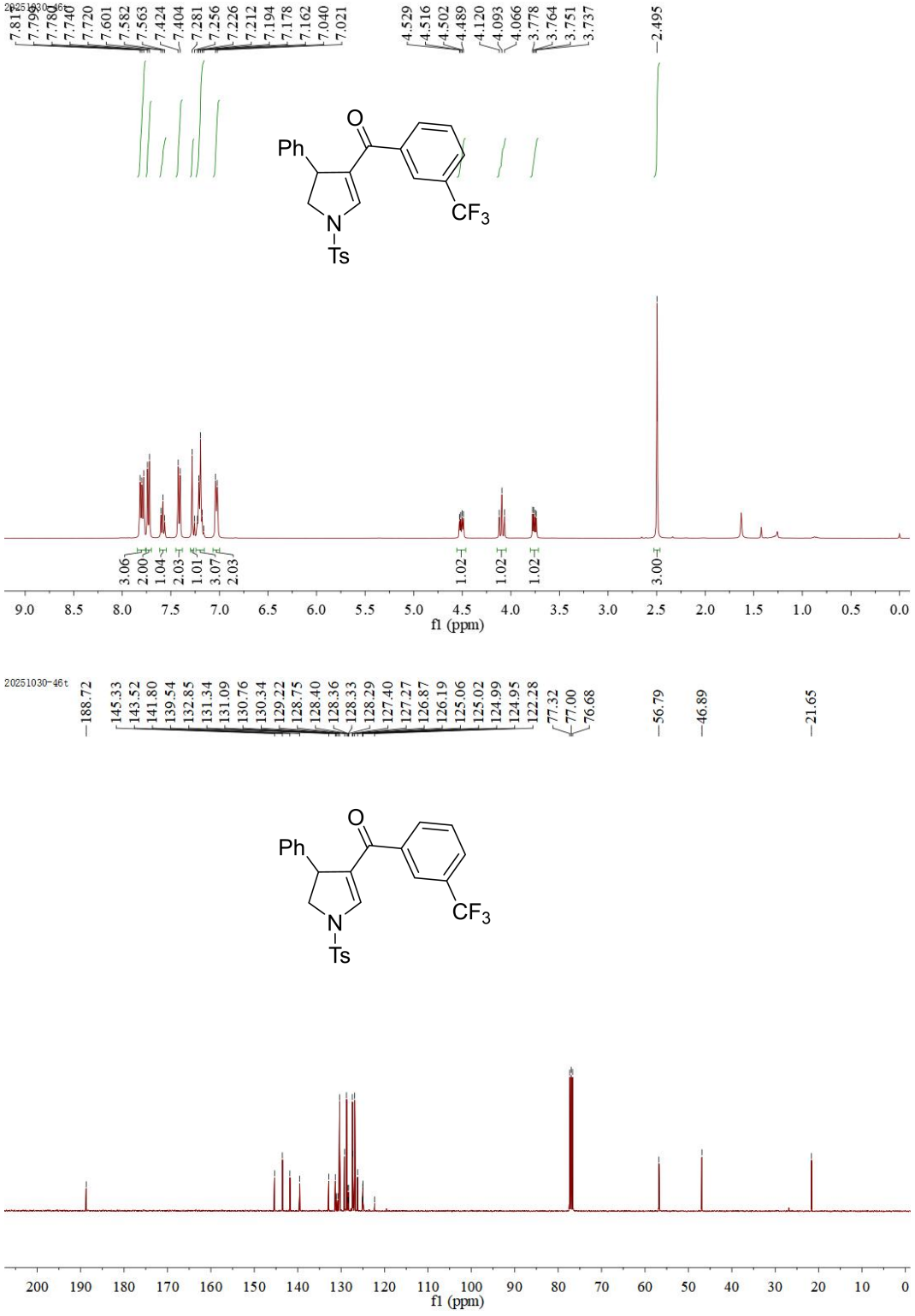
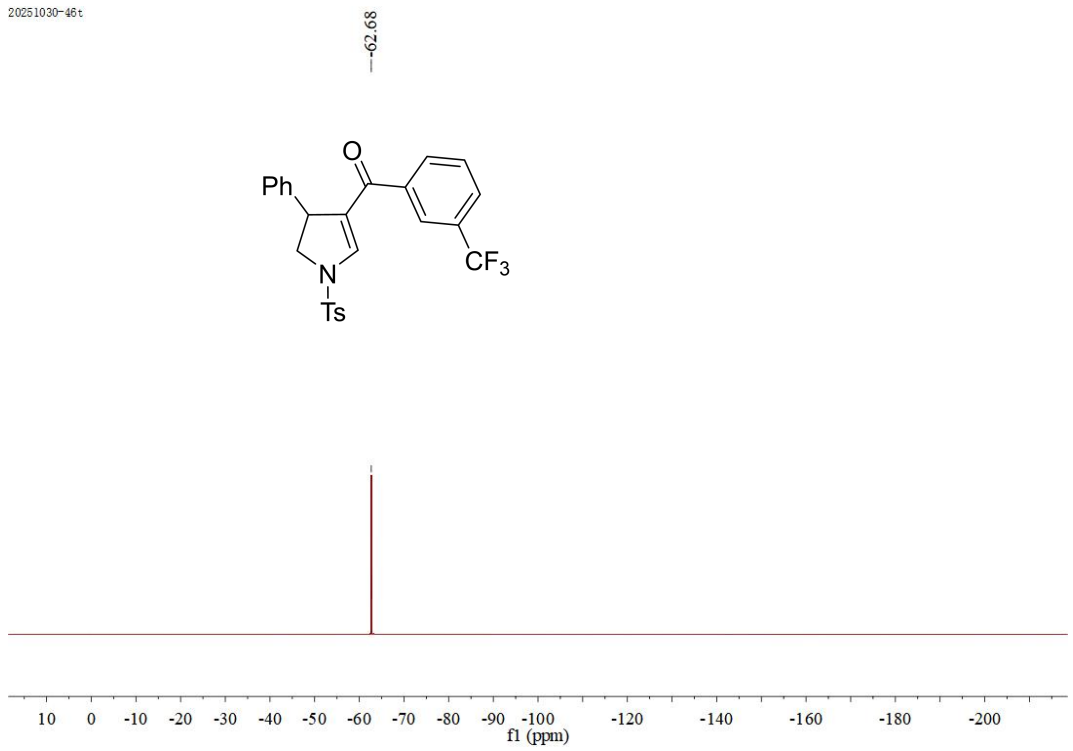
-70
-80
-90
-100
-120
-140
-160
-180
-200
f1 (ppm)

^{1}H NMR ($CDCl_3$, 400 MHz), **^{13}C NMR** (100 MHz, $CDCl_3$) and **^{19}F NMR** (400 MHz, $CDCl_3$) Spectrum of **3p**




20251030-46t
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Ph
N
Ts
CF3
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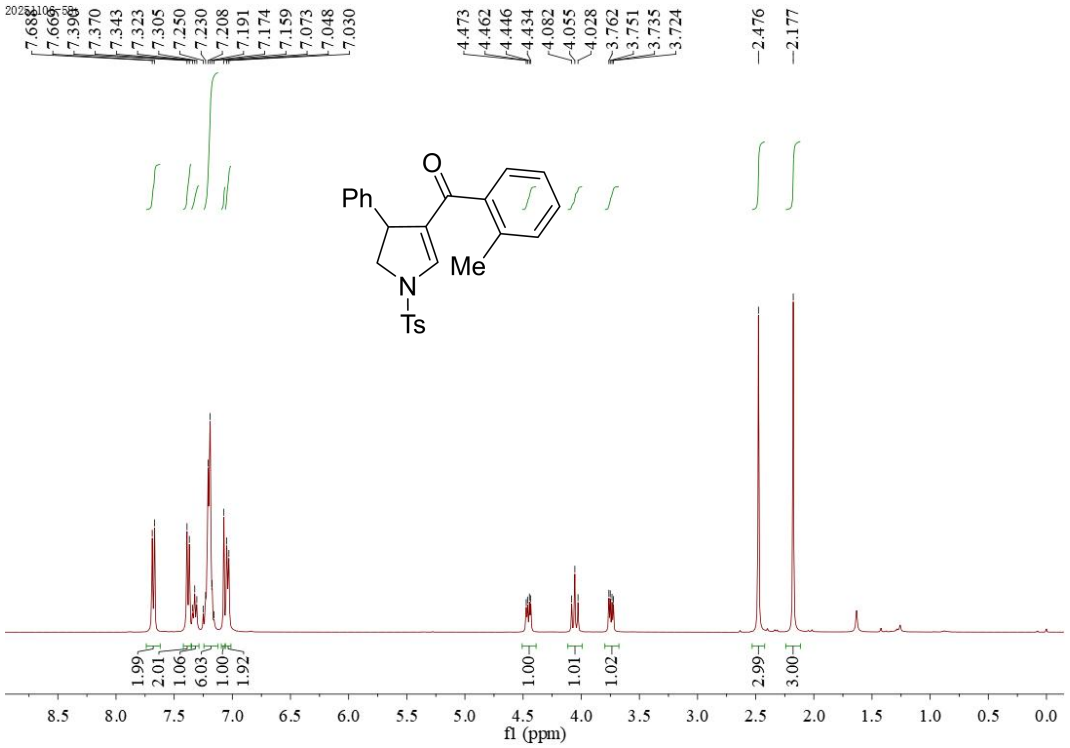
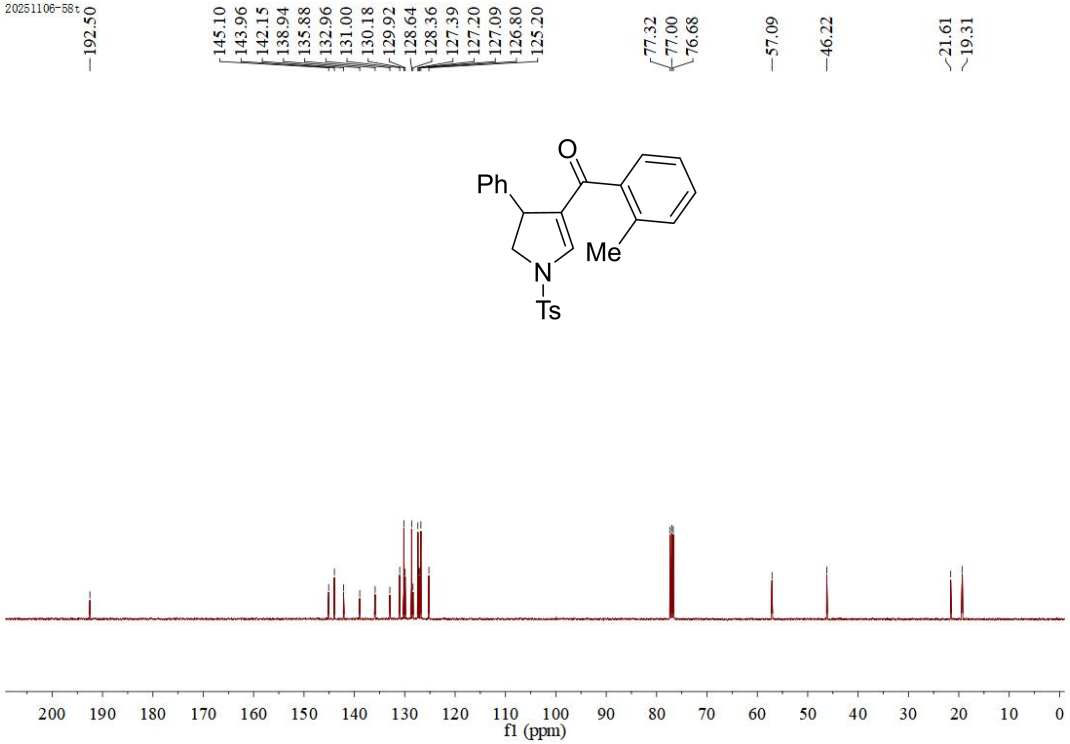
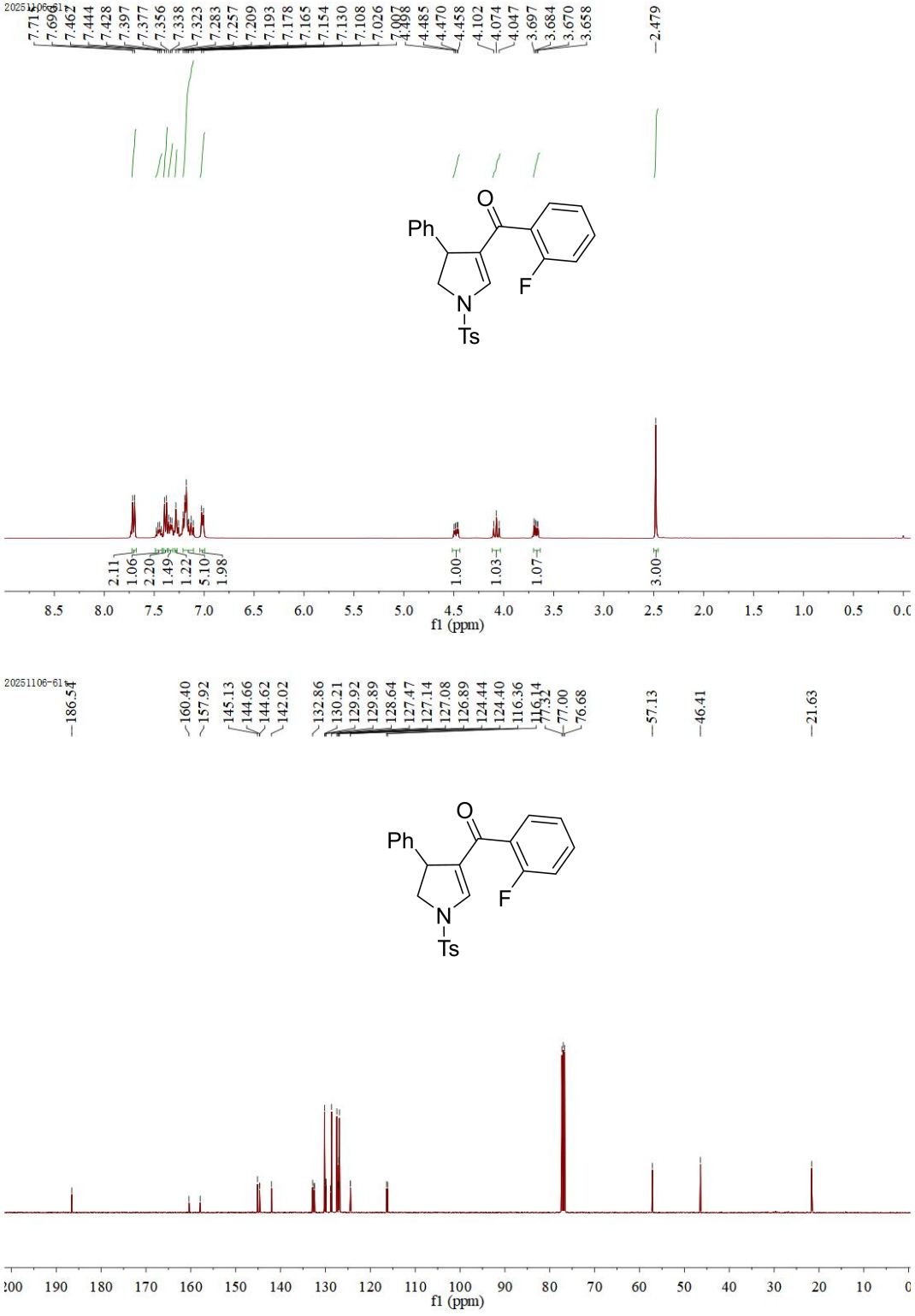
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180
-200
f1 (ppm)

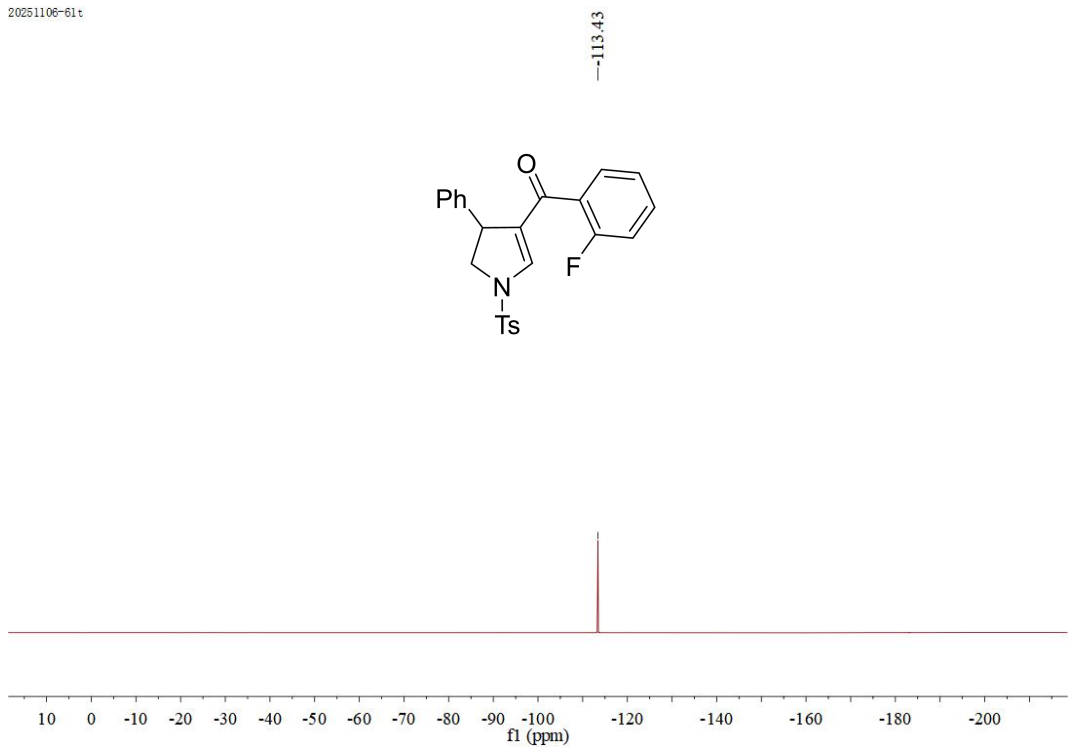
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3q**





^{1}H NMR ($CDCl_3$, 400 MHz), **^{13}C NMR** (100 MHz, $CDCl_3$) and **^{19}F NMR** (400 MHz, $CDCl_3$) Spectrum of **3r**

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Ph
F
N
Ts
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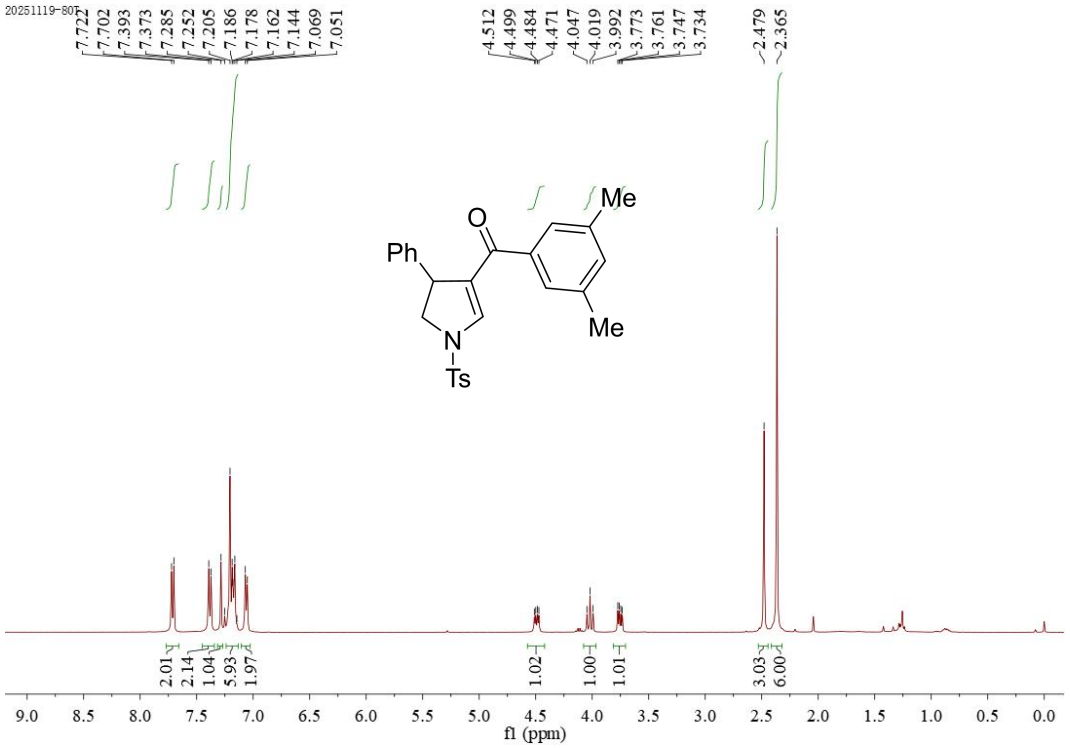
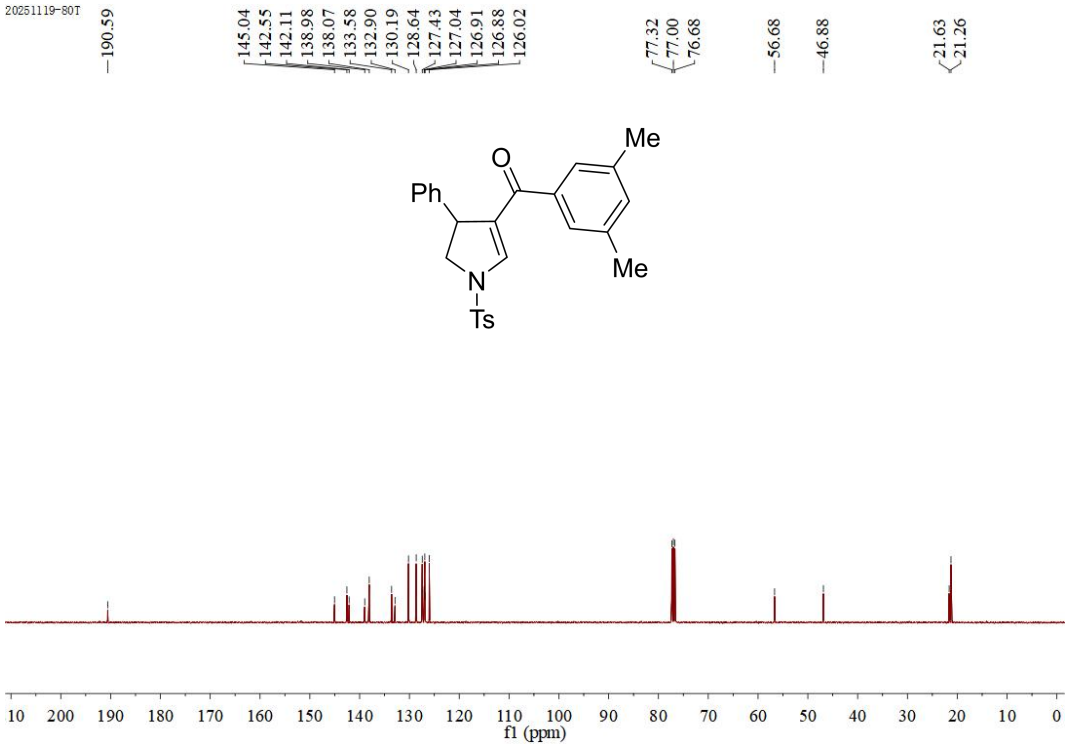
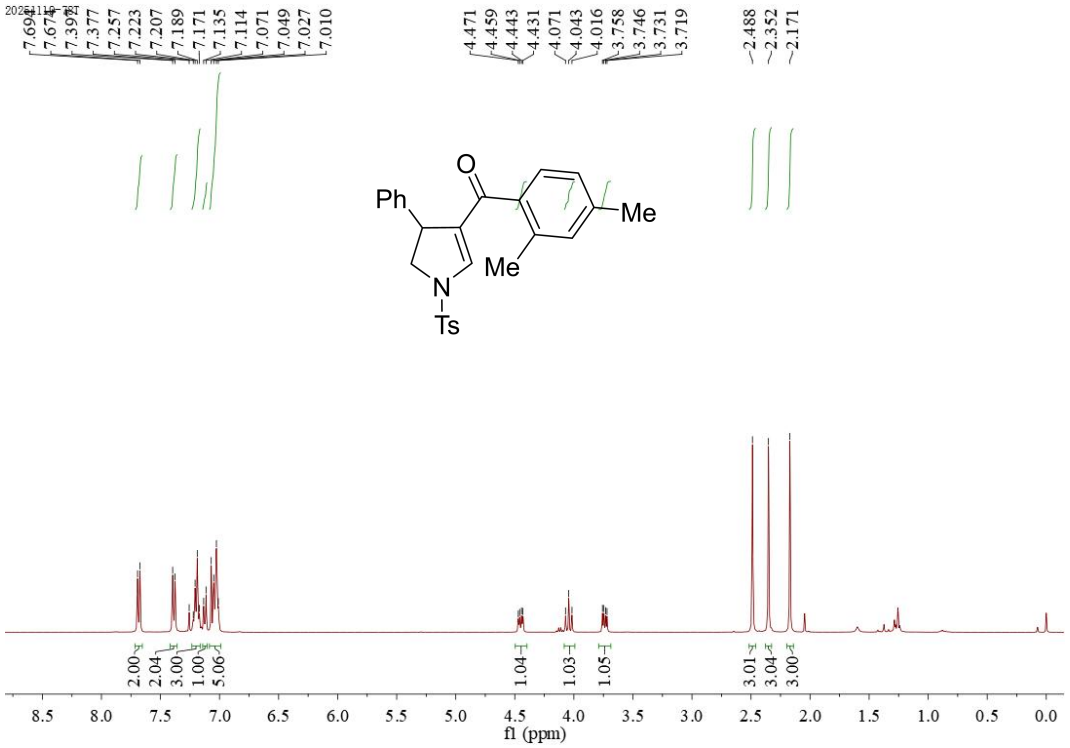
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180
-200
f1 (ppm)

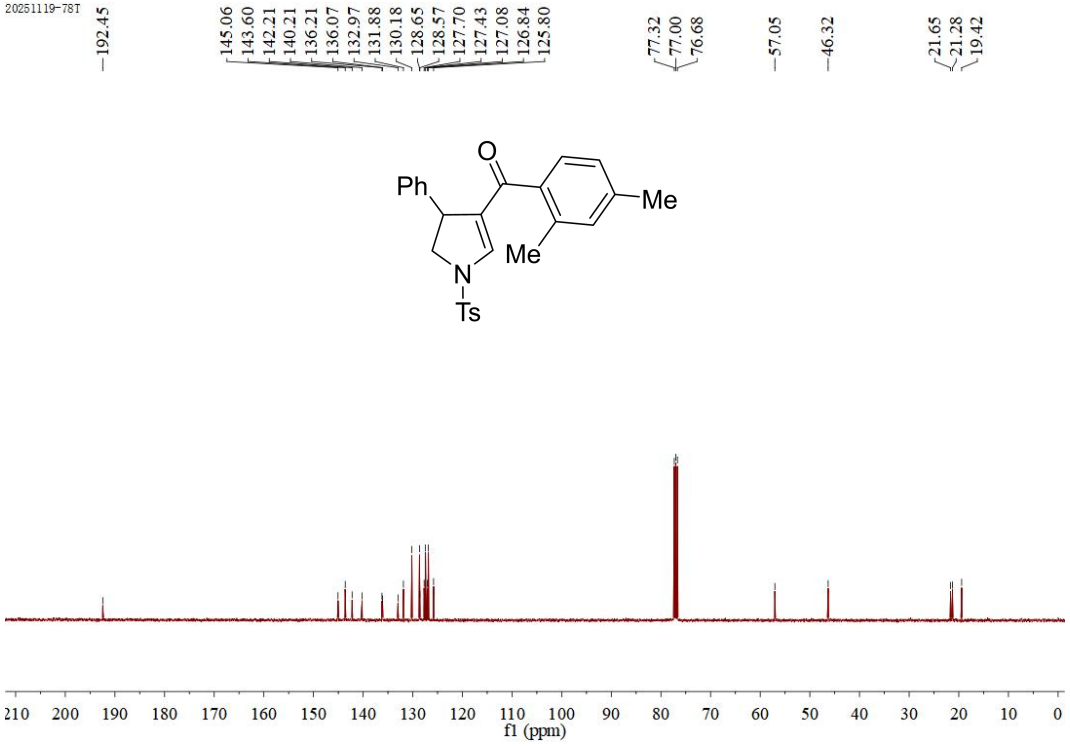
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3s**



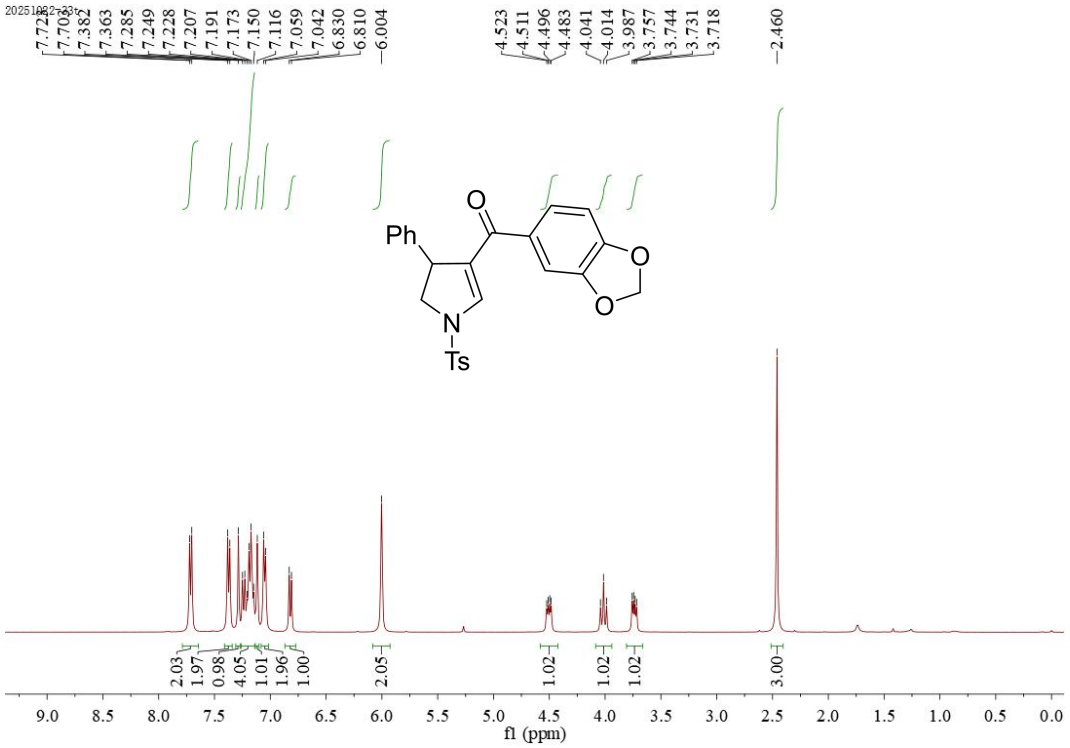


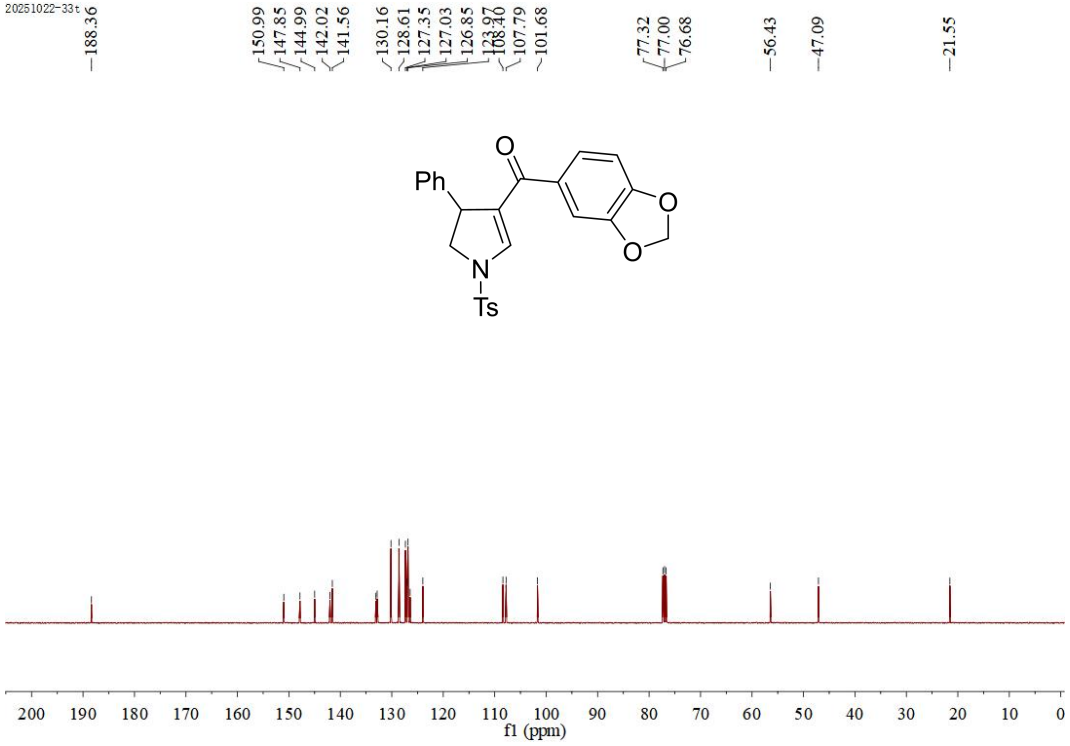
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3t**



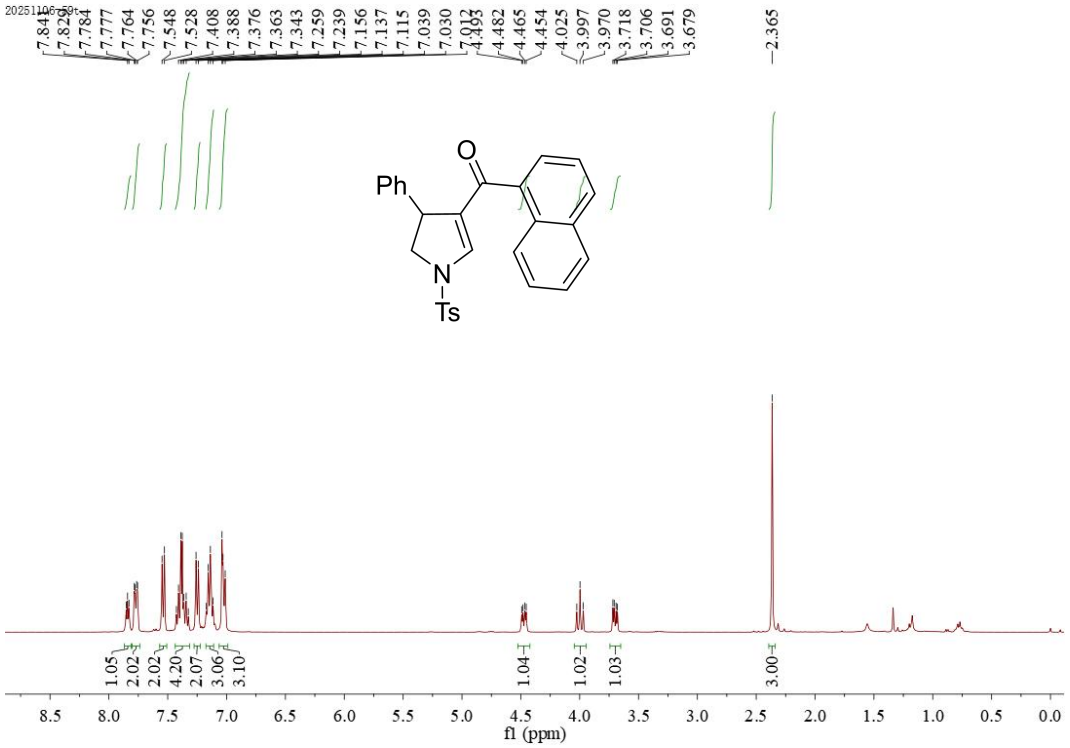


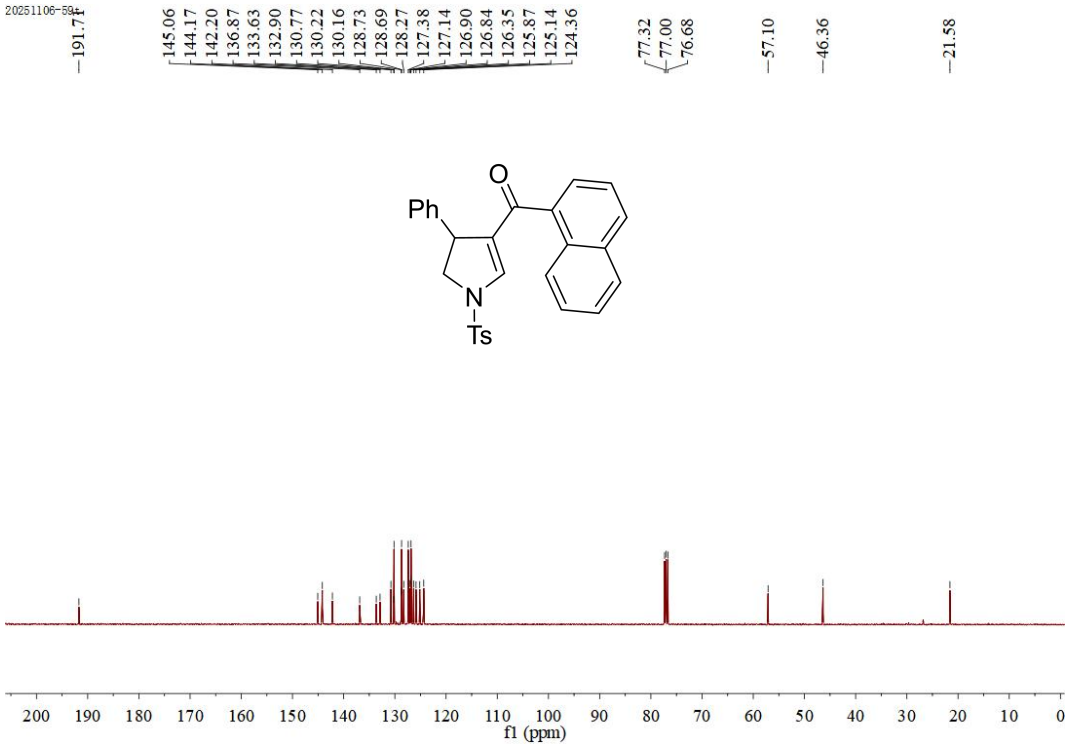
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3u**



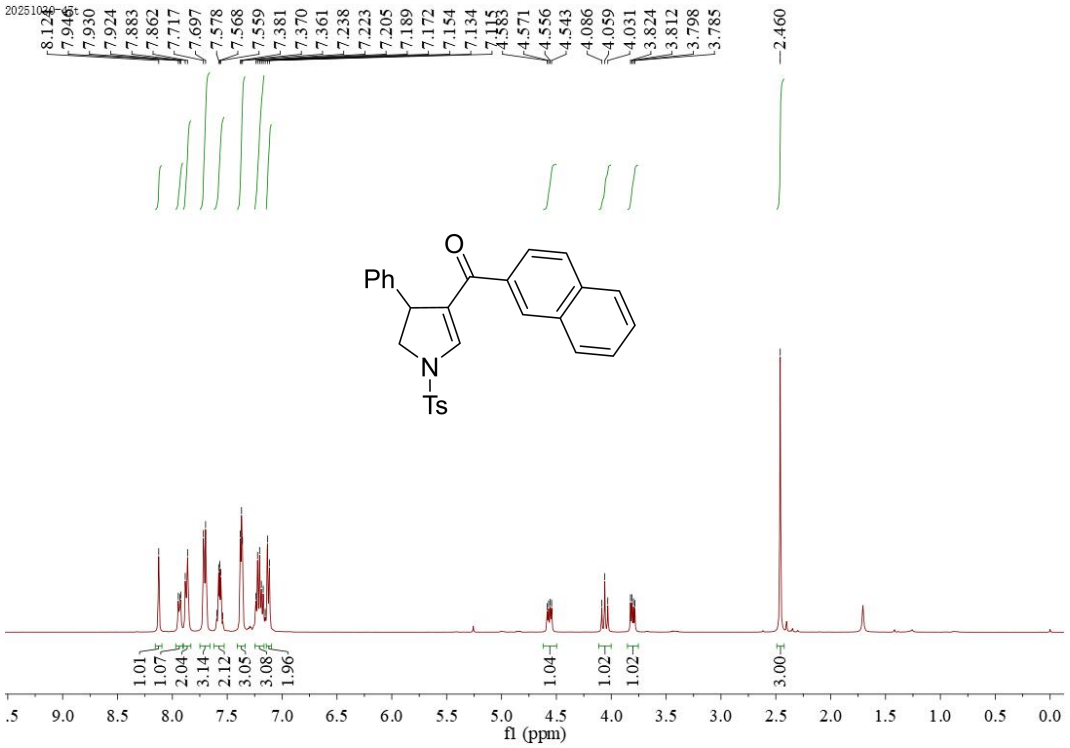


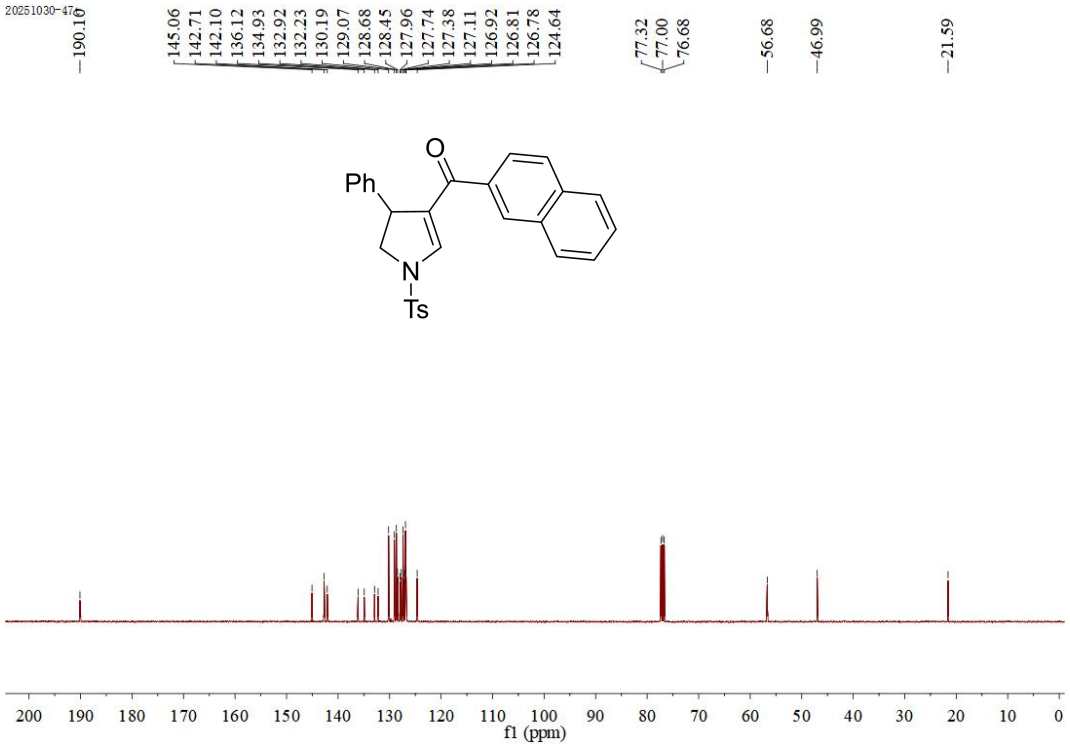
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3v**



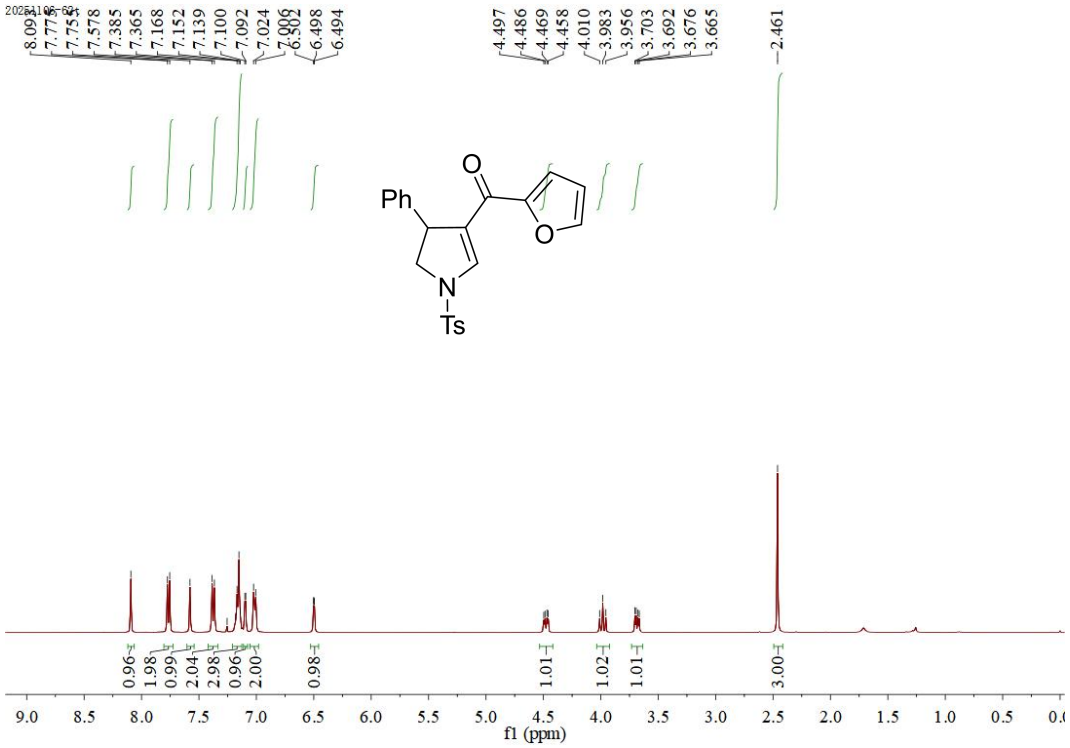


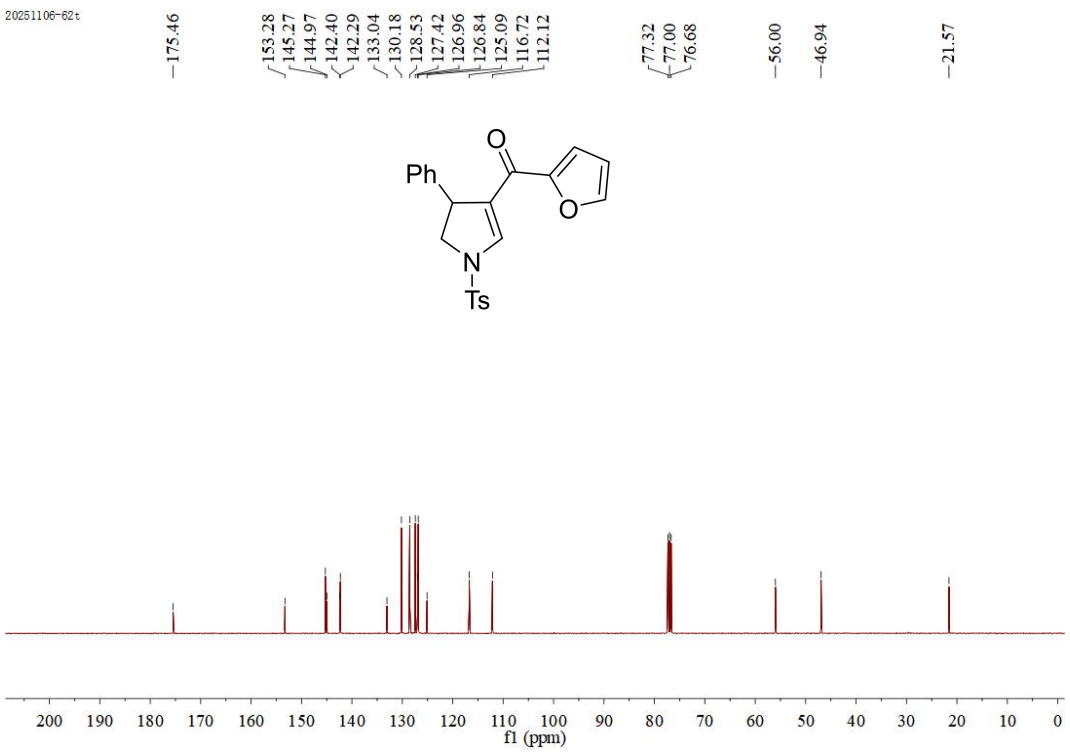
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3w**



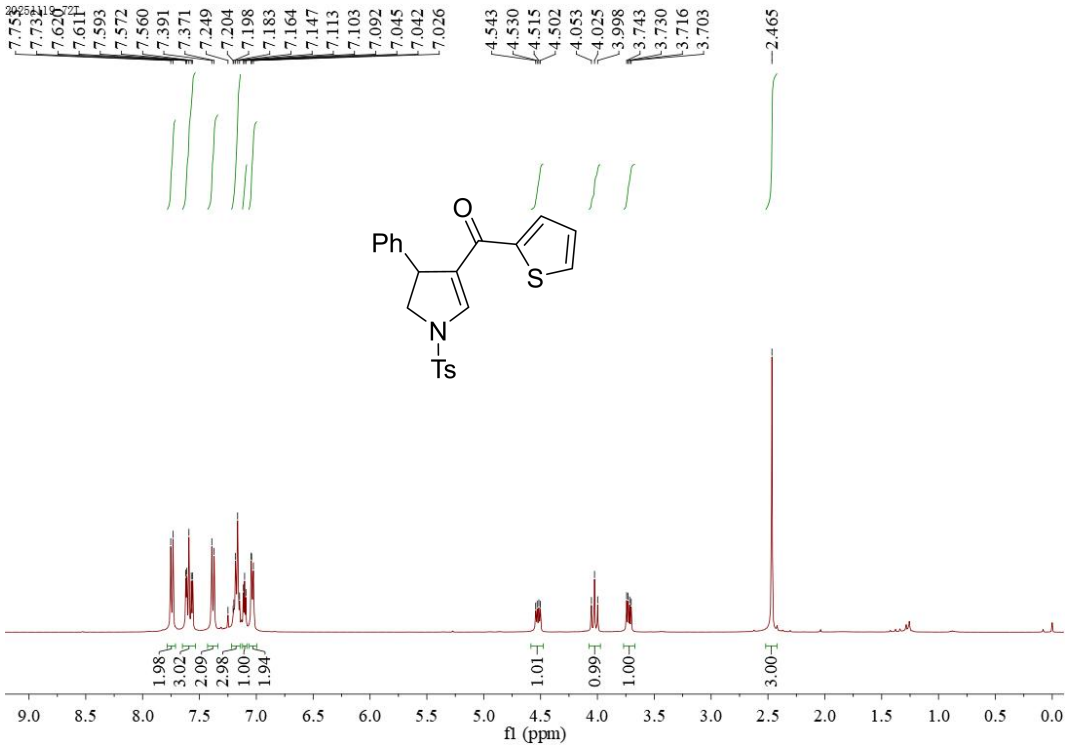


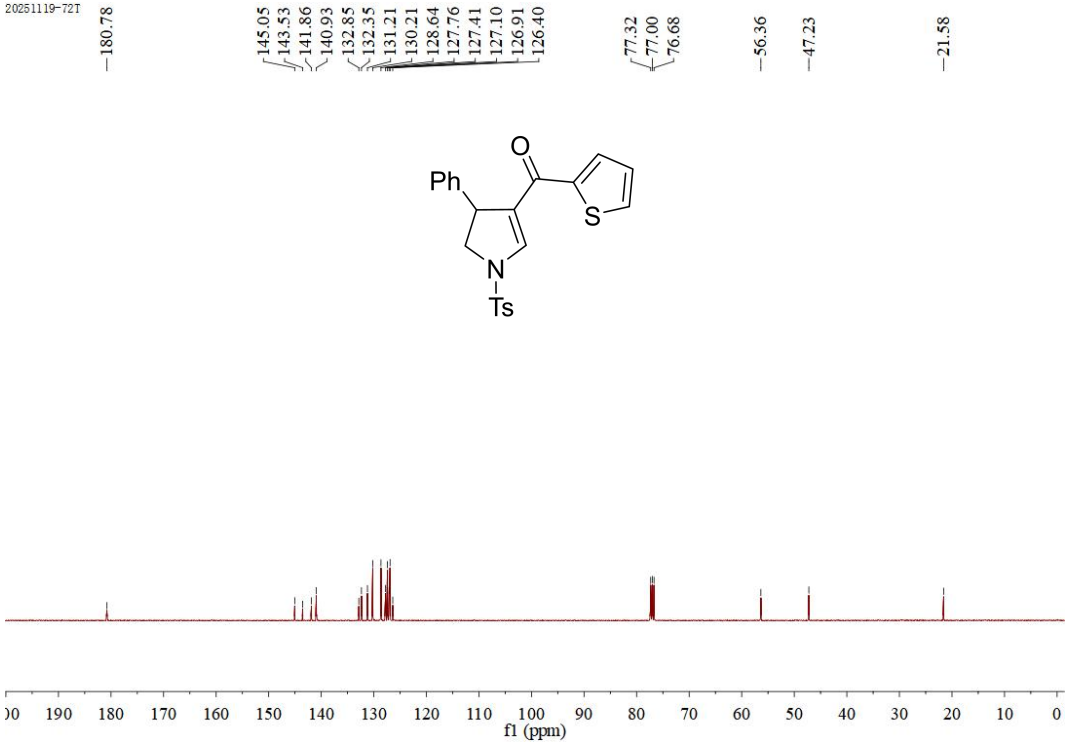
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3x**



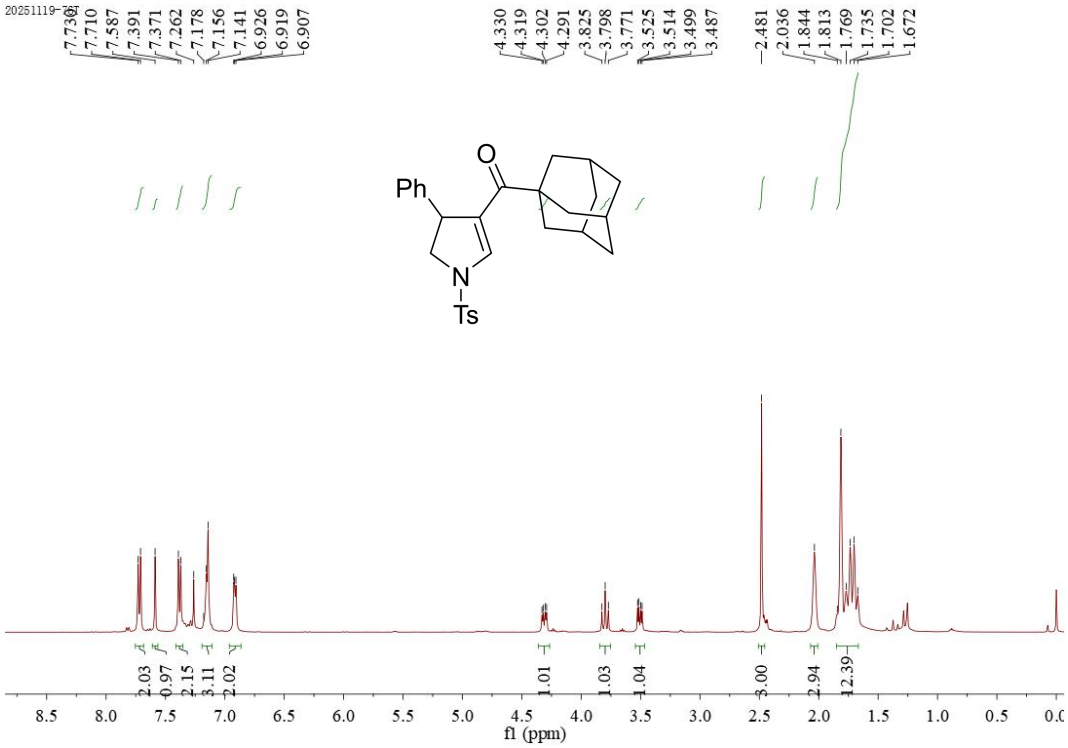


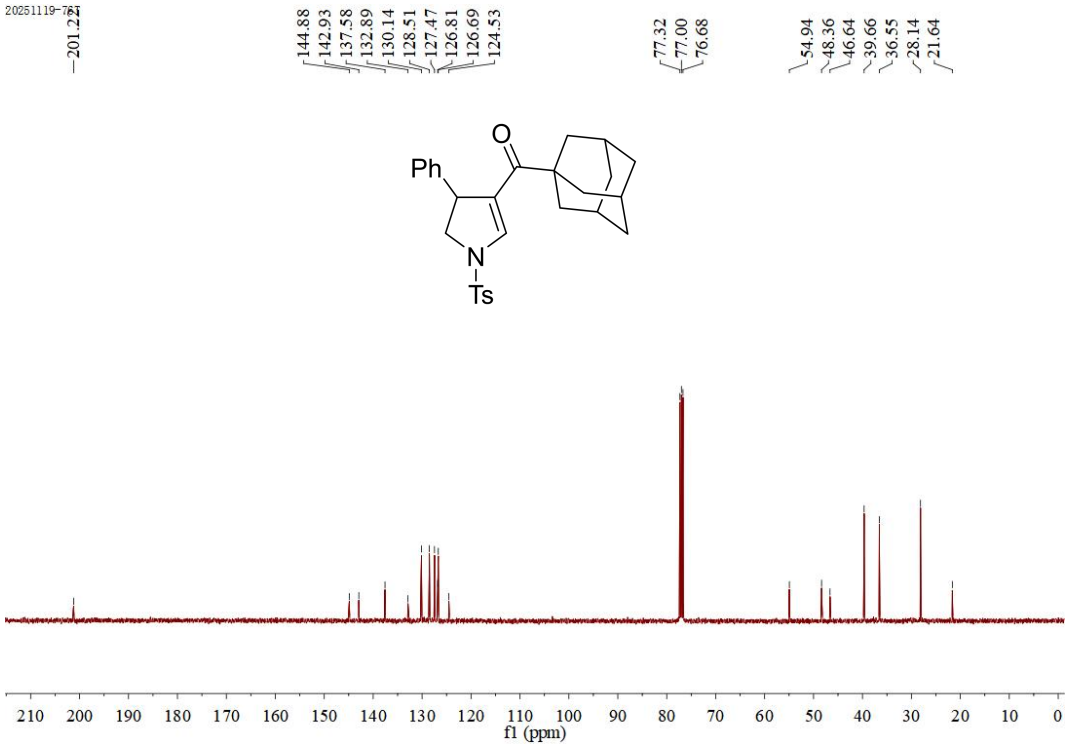
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3y**



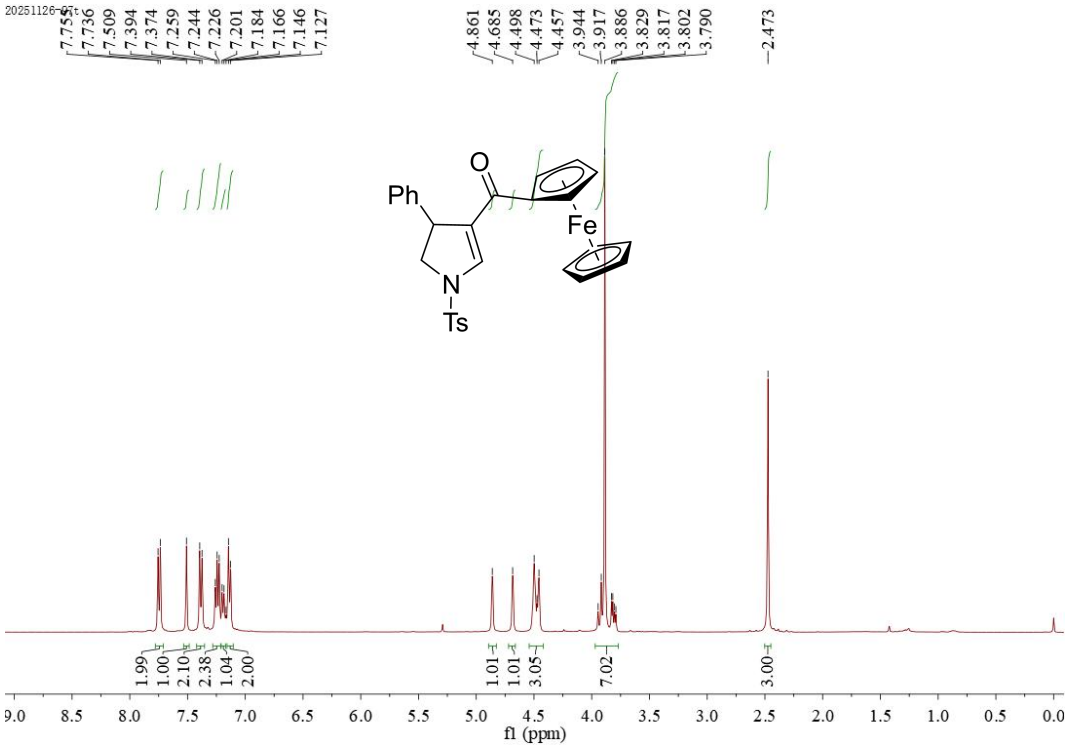


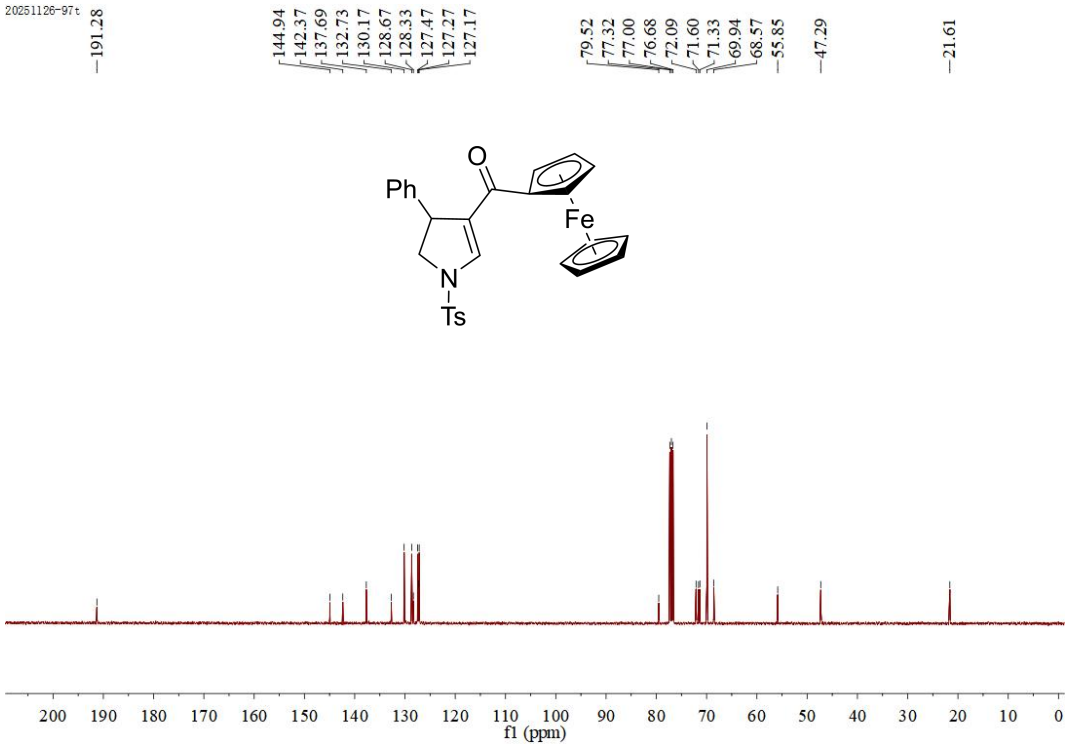
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3z**



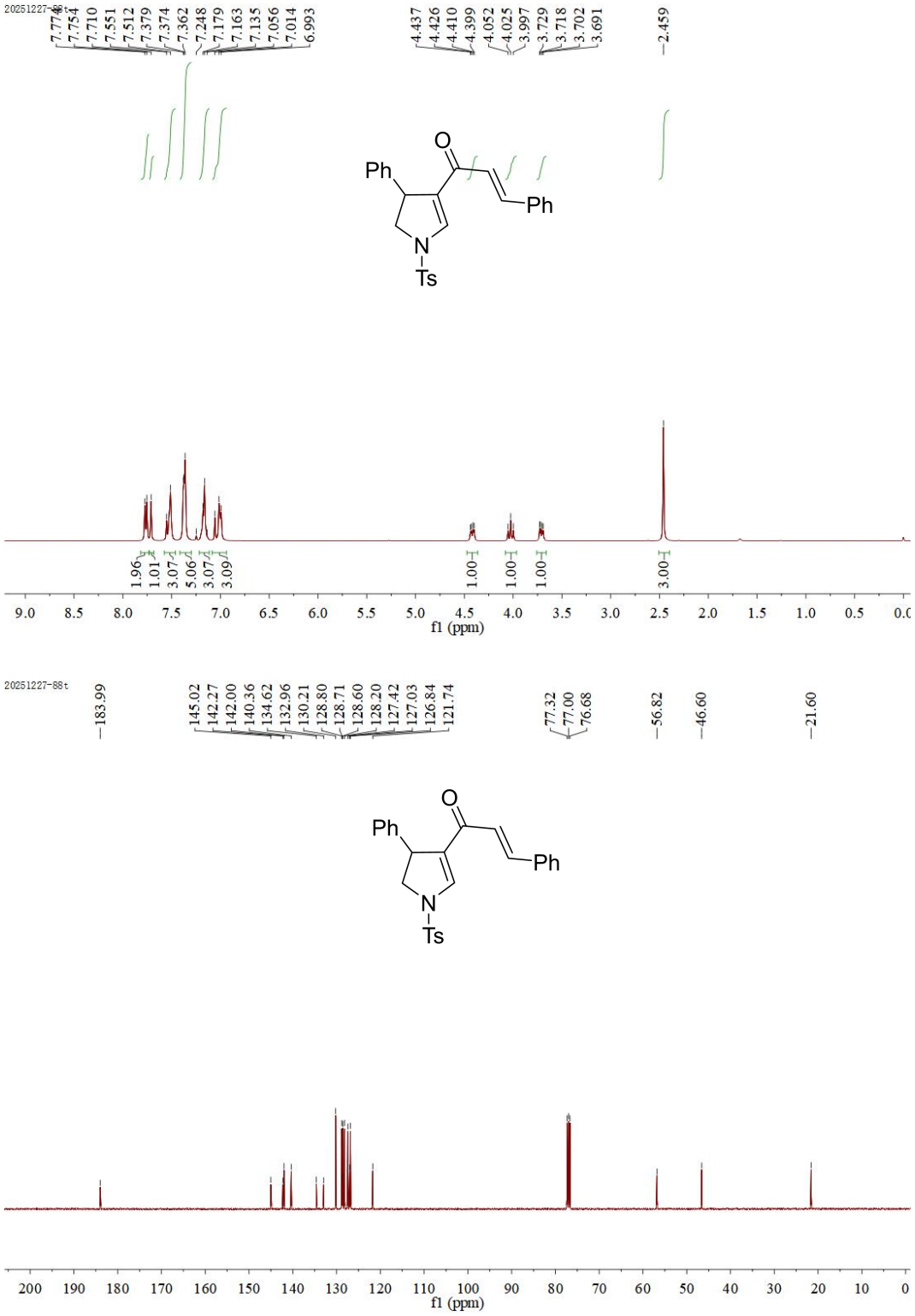


^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3aa**

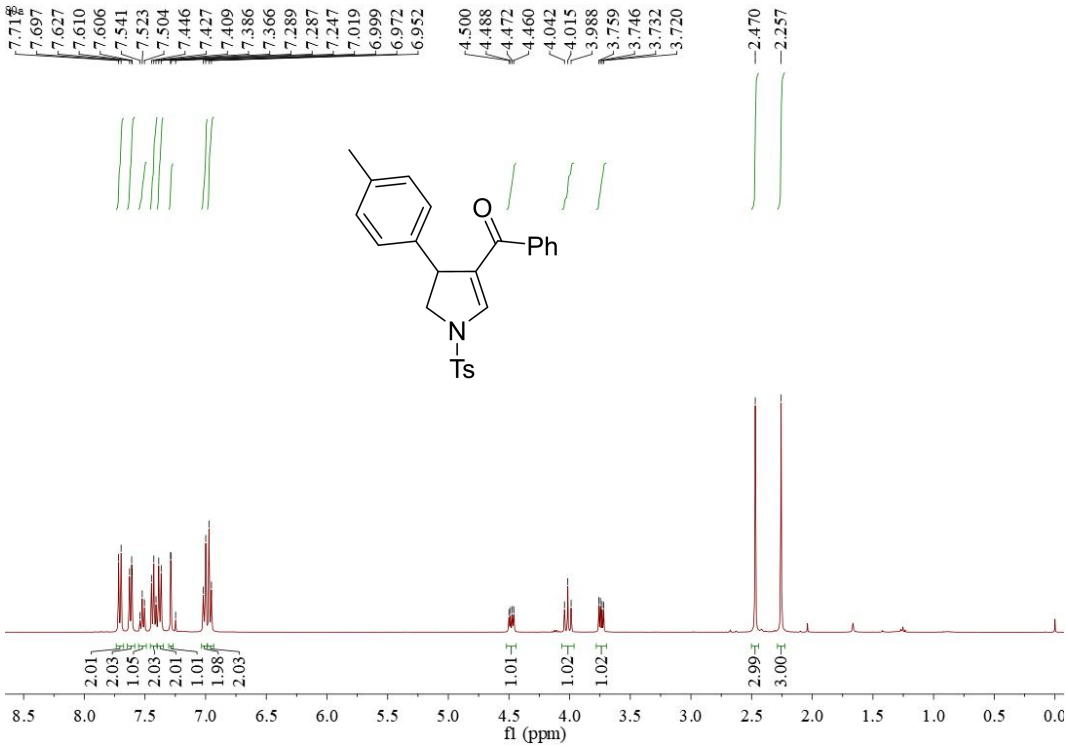


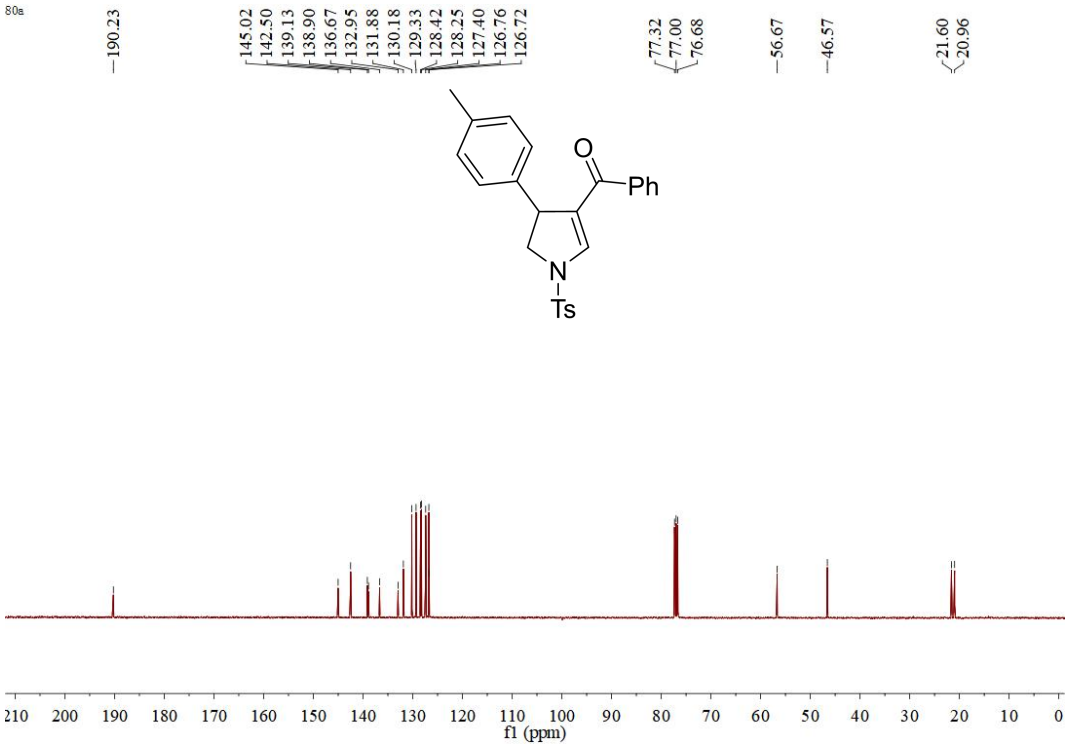


^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3ab**

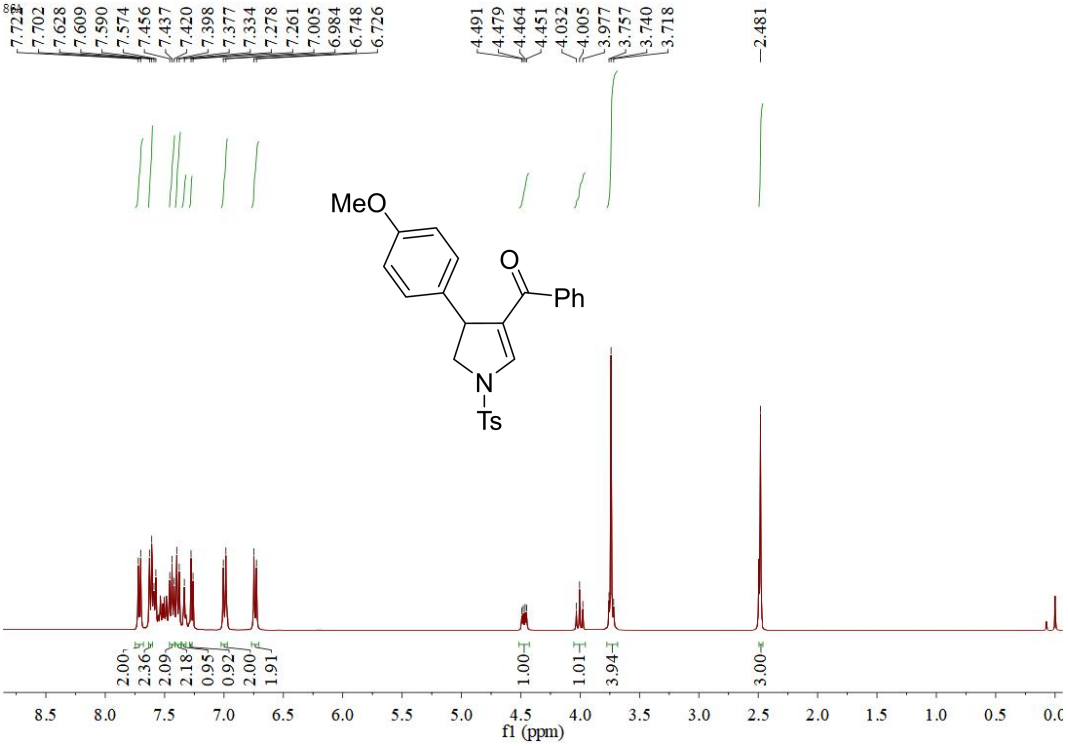


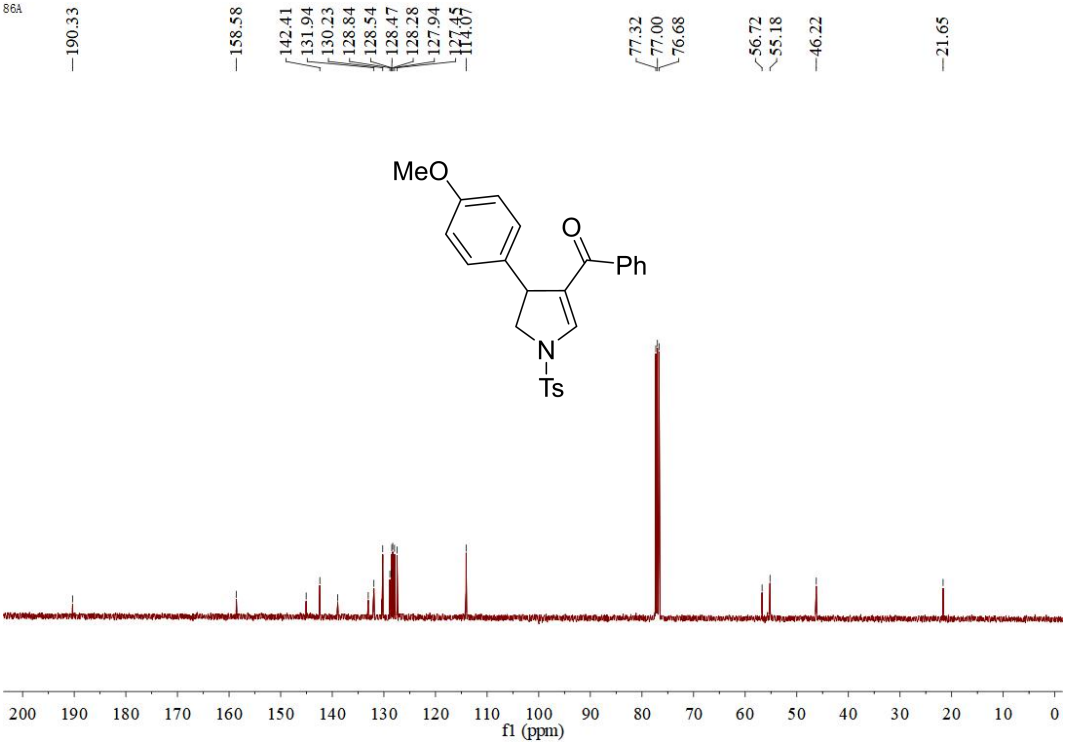
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3ac**



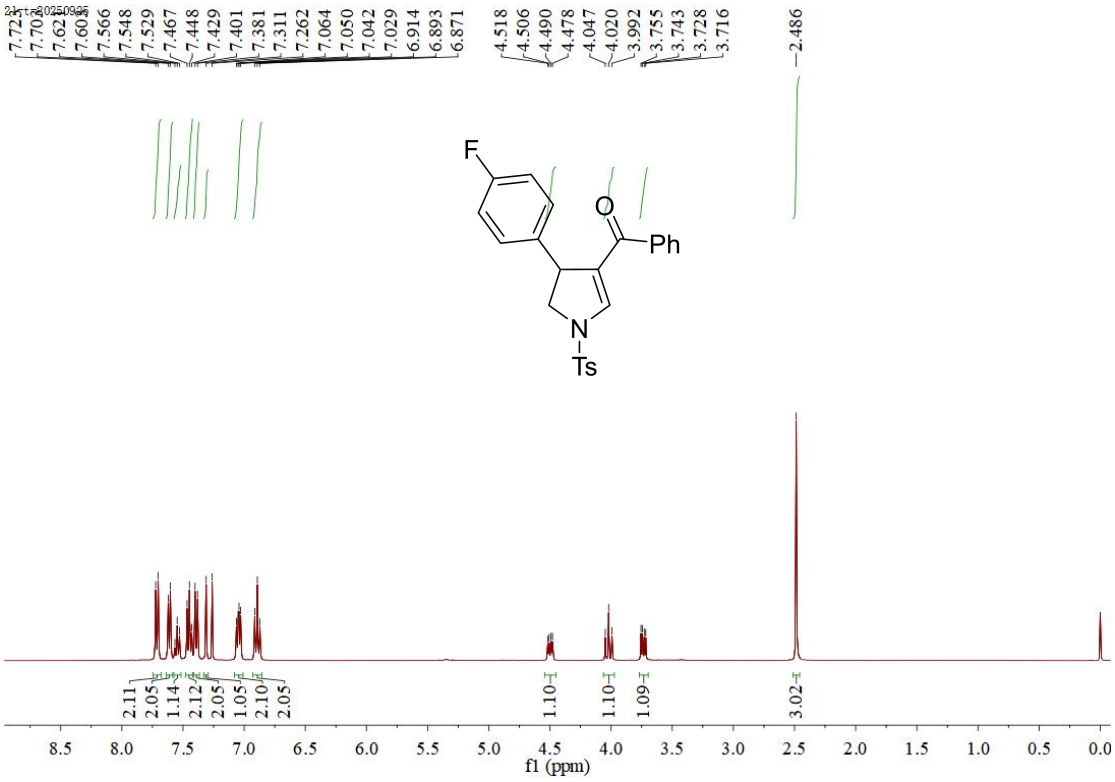


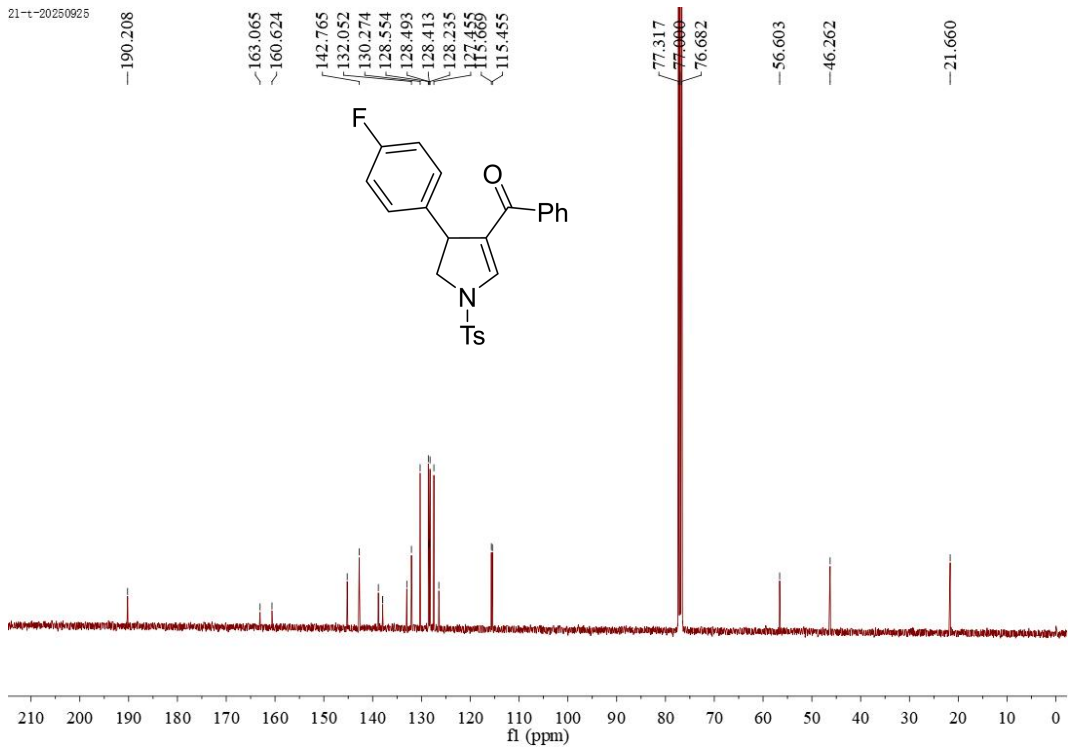
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3ad**

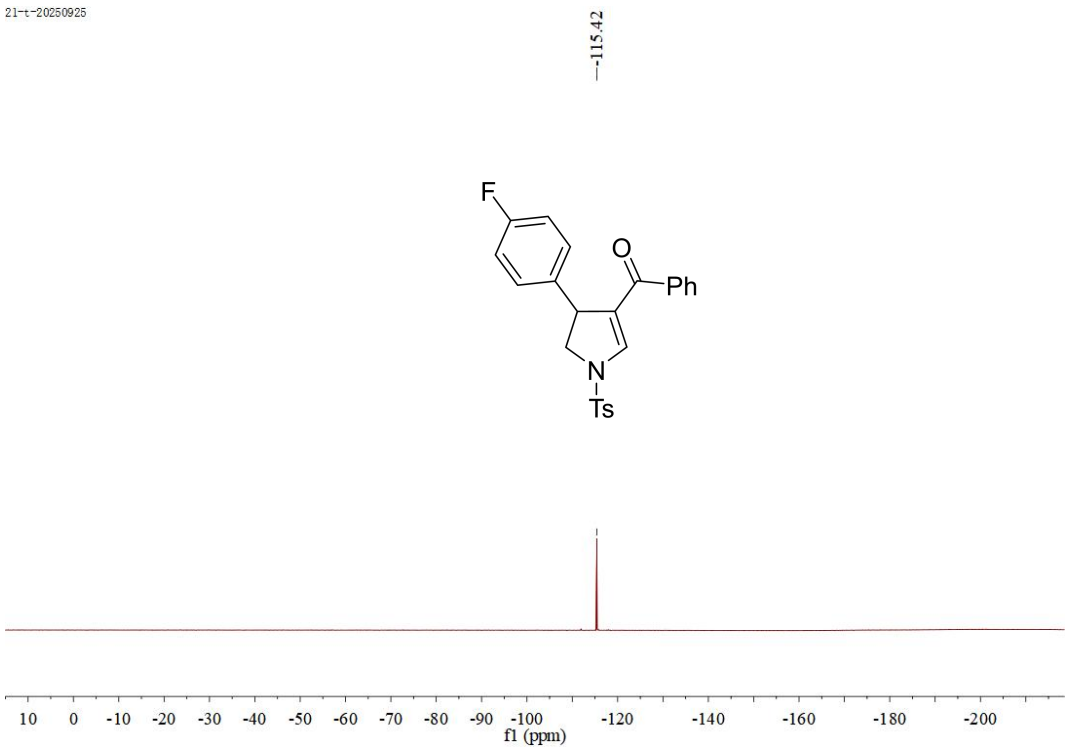




^{1}H NMR ($CDCl_3$, 400 MHz), **^{13}C NMR** (100 MHz, $CDCl_3$) and **^{19}F NMR** (400 MHz, $CDCl_3$) Spectrum of **3ae**






21-t-20250925
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Ph
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-40
-50
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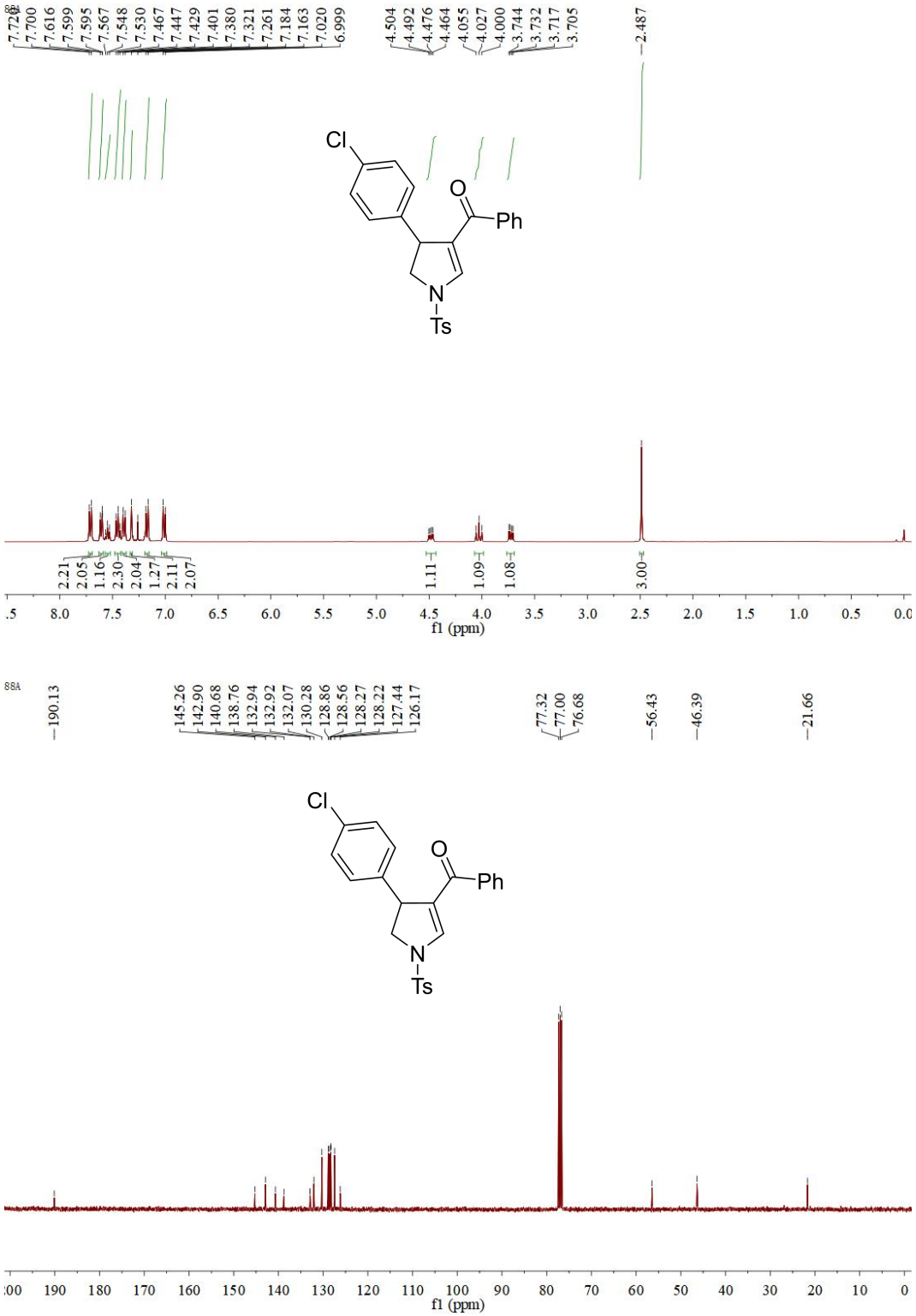
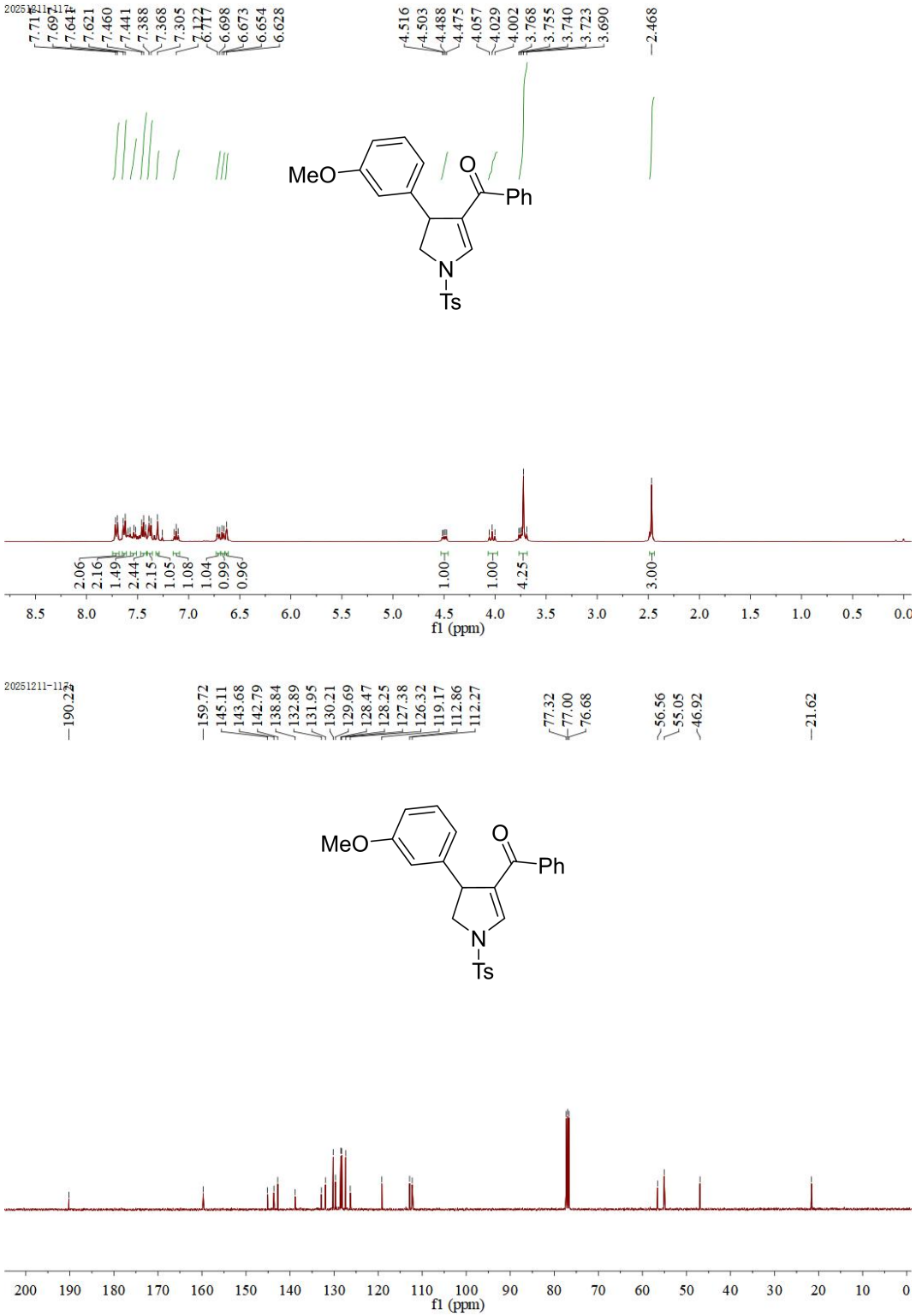
-90
-100
-120
-140
-160
-180
-200
f1 (ppm)

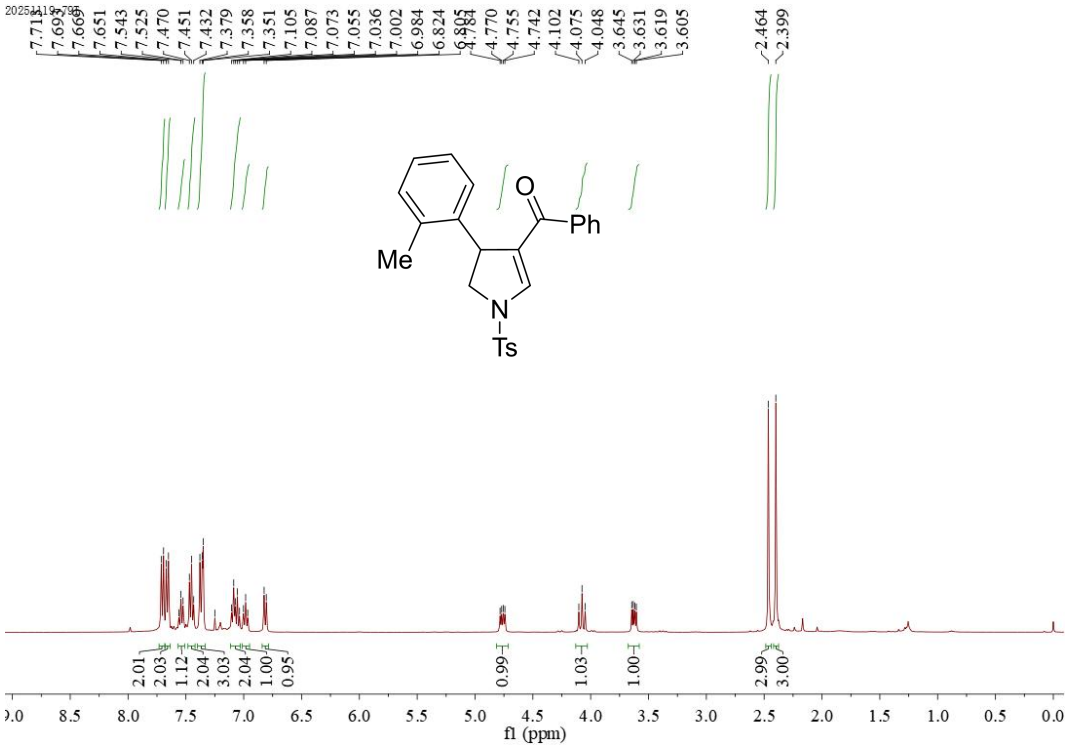
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3af**

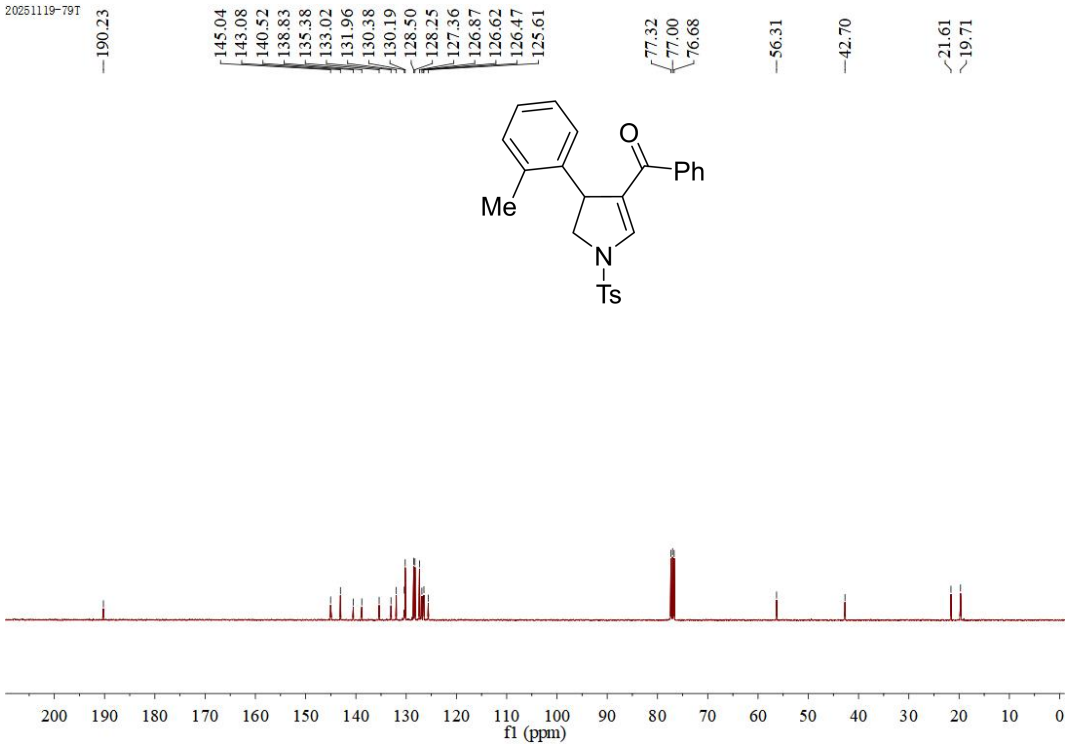


^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3ag**

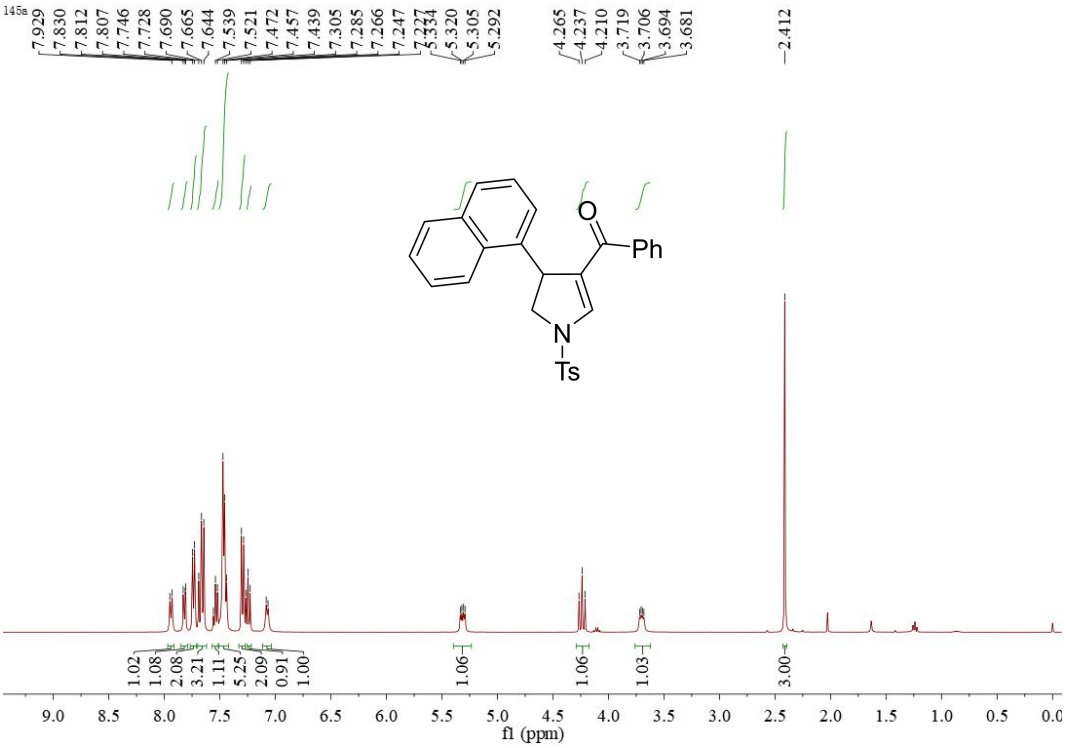


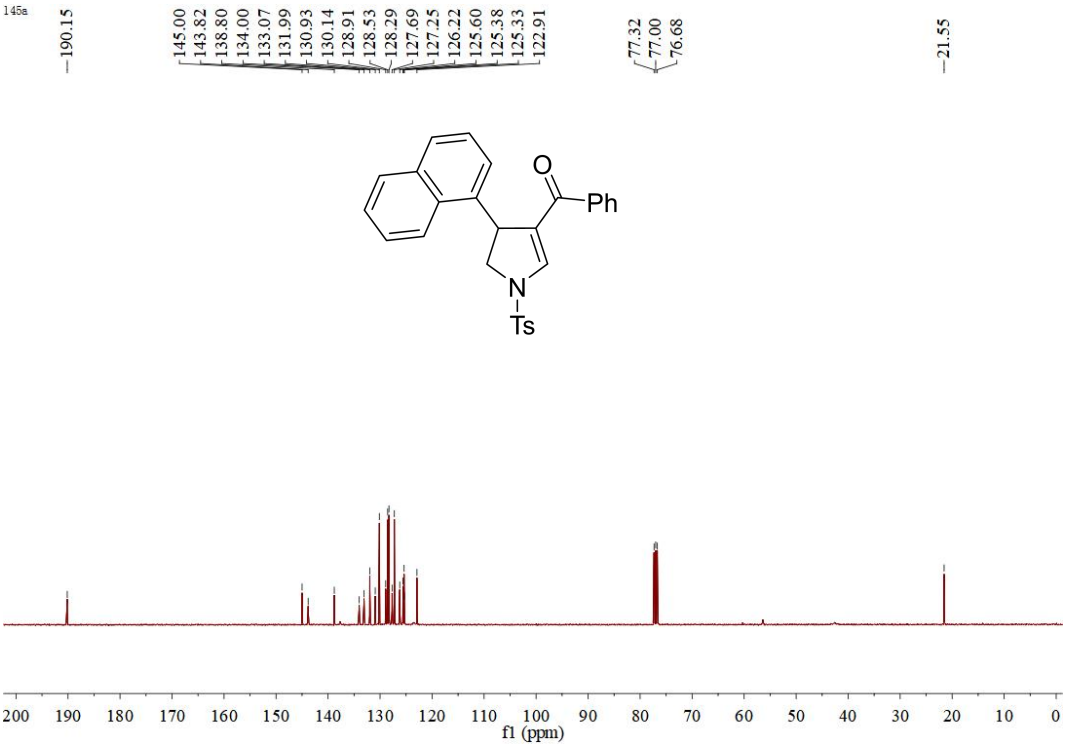
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3ah**



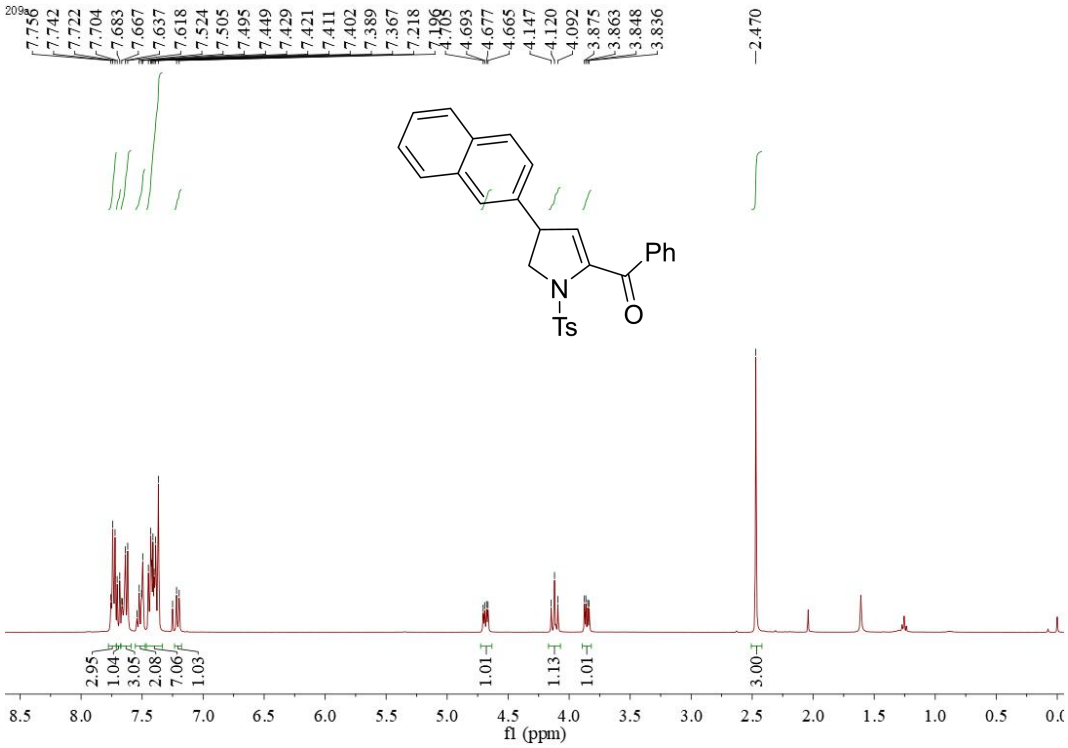


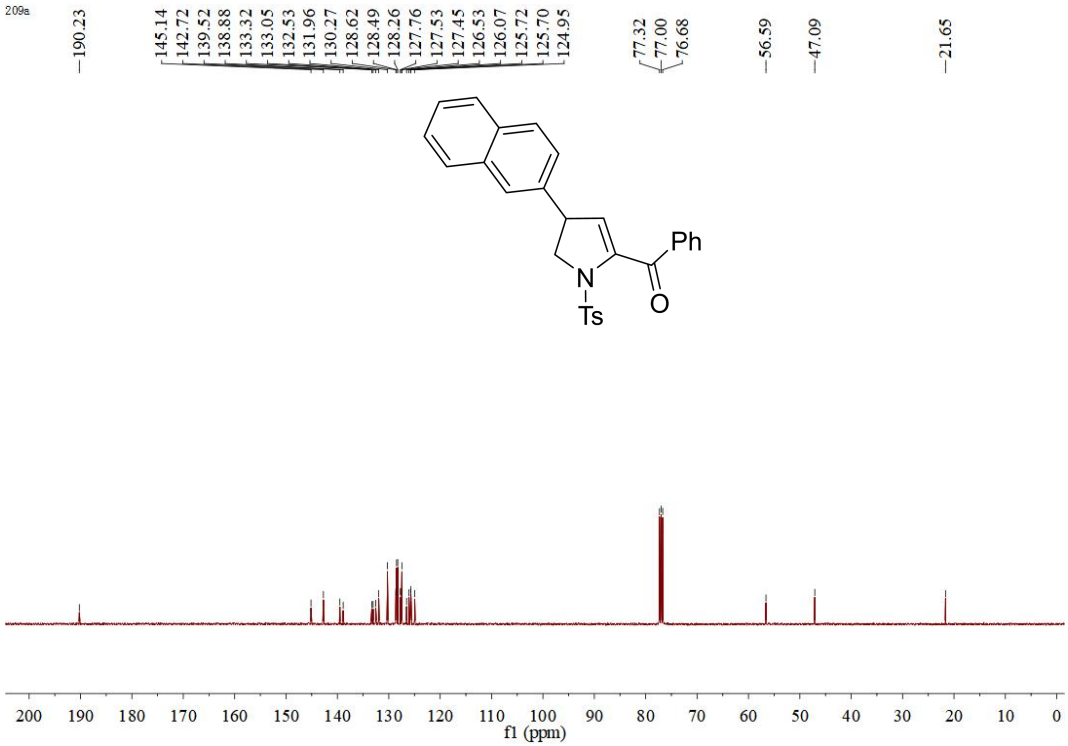
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3ai**



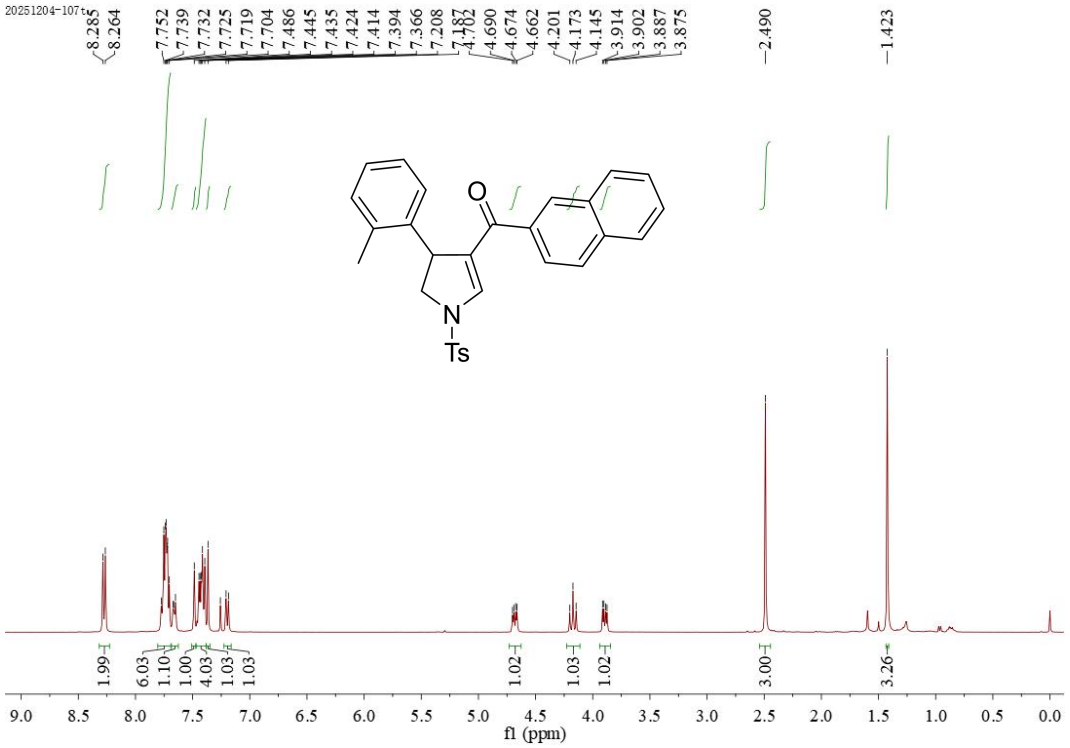


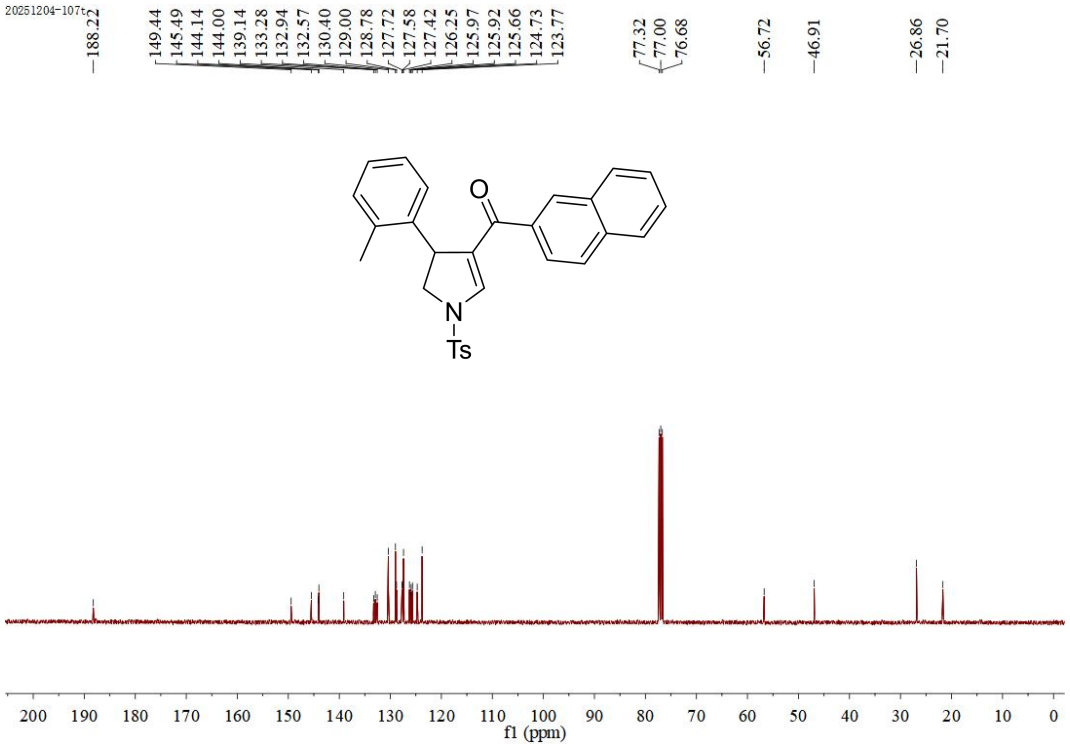
^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3aj**





^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3ak**





^{1}H NMR ($CDCl_3$, 400 MHz) and **^{13}C NMR** (100 MHz, $CDCl_3$) Spectrum of **3al**