Supporting Information

DDQ/$FeCl_3$-mediated tandem oxidative carbon-carbon bond formation to the Synthesis of indole-fluorene hybrid

Abhishek Kar, Baitan Chakraborty, Sandip Kundal, Gopal Rana and Umasish Jana*

[a]Department of Chemistry, Jadavpur University, Kolkata 700032, West Bengal, India

E-mail: jumasish2004@yahoo.co.in.
umasishjana@gmail.com.

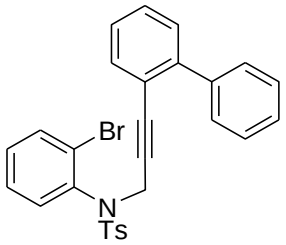
Table of content:

General: All ^{1}H NMR spectral data were recorded by Bruker 300, 400, 500 (300, 400, 500 MHz) spectrometer in $CDCl_3$ solutions expressing chemical shifts in parts per million (ppm, δ) and are referenced to $CHCl_3$ (δ = 7.26 ppm) as an internal standard. All coupling constants are absolute values and are expressed in Hz. The description of the signals include: s = singlet, d = doublet, t = triplet, m = multiplet, dd = doublet of doublets and brs = broad singlet.td = triplet of doublet. ^{13}C NMR spectra were recorded with a Bruker 300, 400, 500 (75, 100, 125 respectively MHz) spectrometer as solutions in $CDCl_3$ with complete proton decoupling. Chemical shifts are expressed in parts per million (ppm, δ) and are referenced to $CDCl_3$ (δ = 77.0 ppm) as an internal standard. High-Resolution Mass Spectra (HRMS) were performed with a Qtof Micro YA263 spectrometer in trichloromethane solvent. The molecular fragments are quoted as the relation between mass and charge (m/z). The routine monitoring of reactions was performed with silica gel coated glass slides (Merck, silica gel G for TLC), and pre-coated Al plate, which were analyzed with iodine and uv light respectively. Solvents, reagents and chemicals were purchased from Aldrich, Fluka, Merck, SRL, Spectrochem and Process Chemicals. All reactions involving moisture sensitive reactants were executed with oven-dried glassware.

Table for crystallographic data and structural refinement parameters for 3a

Empirical formula	$C_{28}H_{21}NO_2S$
Formula weight	435.52
Temperature/K	293
Crystal system	monoclinic
Space group	'P 21/n'
a/Å	9.730(2)
b/Å	20.980(4)
c/Å	11.450(2)
α/°	90
β/°	104.39(3)
γ/°	90
Volume/Å^3	2264.0(8)
Z	4
ρ_{calc}g/cm^3	1.278
μ/mm^{-1}	0.168
F(000)	912
Crystal size/mm^3	.4 × .25 × .1
Radiation	Mo Kα (λ = 0.71073)
θ range/°	1.94 to 27.46
Index ranges	-12 ≤ h ≤ 12, -27 ≤ k ≤ 27, -13 ≤ l ≤ 14
Data/restraints/parameters	5164/0/289
Goodness-of-fit on F^2	0.861
Largest diff. peak/hole/e	0.18/-0.38

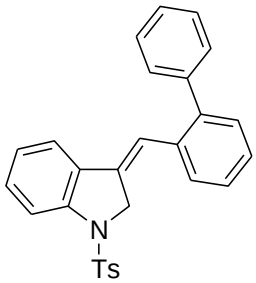
Representative experimental procedure for the synthesis of *N*-(3-(2-phenylphenyl)prop-2-yn-1-yl)-*N*-(2-bromophenyl)-4-methylbenzenesulfonamide (1a):



To a solution of N-(2-bromophenyl)-4-methyl-N-(prop-2-yn-1-yl)benzenesulfonamide (363 mg, 1mmol) in dimethyl sulfoxide (2 mL) and 2-phenyliodobenzene (308 mg, 1.1 mmol), triethylamine (202 mg, 2 mmol), CuI (4 mg, 0.02 mmol) and $Pd(PPh_3)_4$ (12 mg, 0.02 mmol) were added successively. The resulting solution was stirred at room temperature under argon atmosphere for overnight. After the completion of the reaction (monitored by TLC), the crude reaction mixture was extracted with ethyl acetate. The organic extract was washed with brine solution, dried over anhydrous Na_2SO_4 and concentrated. The product was subjected to column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 90:10 (v/v) to afford the product **1a** as a yellow semisolid (463 mg, 0.90mmol, 90%).^{1}H NMR ($CDCl_3$, 300 MHz) δ 2.42 (s, 3H), 4.28 (d, J = 18.0 Hz, 1H), 4.93 (d, J = 18.0 Hz, 1H), 6.99 (d, J = 6.3Hz, 1H), 7.13 (d, J = 6.6 Hz, 1H), 7.18–7.26 (m, 4H), 7.29–7.36 (m, 6H), 7.42 (t, J = 4.2 Hz, 2H), 7.64 (d, J =8.7 Hz, 1H), 7.70 (d, J =8.1 Hz, 2H) ppm. ^{13}C NMR ($CDCl_3$, 75 MHz) δ 21.7, 41.4, 85.3, 85.9, 120.7, 125.8, 127.0, 127.5, 127.9, 128.1, 128.8, 129.1, 129.5, 129.6, 130.2, 132.3, 133.6, 133.8, 137.2, 137.6, 140.3, 143.7, 143.8 ppm.

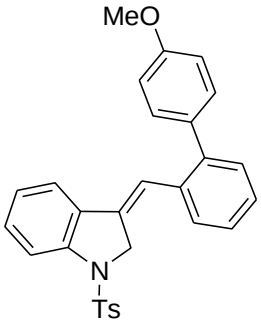
Compounds **1b-1o** were synthesised by the above similar procedure.

Representative experimental procedure for the synthesis of *(z)*-2-((1-tosylindolin-3-ylidene)methyl)bipheny*l*(2a):



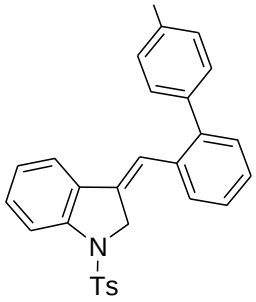
To a solution of *N*-(3-([1,1'-biphenyl]-2-yl)prop-2-yn-1-yl)-*N*-(2-bromophenyl)-4-methylbenzenesulfonamide **1a** (155 mg, 0.3 mmol) in 2.5 M K_2CO_3(2 mL) and 2 mL ethanol-toluene (1:1), PCy_3 (8 mg, 0.03 mmol) and $Pd(OAc)_2$ (4 mg, 0.015 mmol) were added successively. The resulting solution was stirred at 75 °C under argon atmosphere for 3 h. After the completion of the reaction (monitored by TLC), the crude reaction mixture was extracted with ethyl acetate. The organic extract was washed with brine solution, dried over anhydrous Na_2SO_4 and concentrated. The product was subjected to column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 95:5 (v/v) to afford the product **2a** as a greenish white solid (109 mg, 0.25 mmol, 82%); m. p. 116-118 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.37 (s, 3H), 4.80 (d, *J*= 2.8 Hz, 2H) , 6.70 (d, $J = 2.8$ Hz, 1H), 6.96 (t, *J*= 7.6 Hz,1H), 7.16 (d, *J*= 7.6 Hz, 1H), 7.20–7.27 (m, 5H), 7.29–7.44 (m, 7H), 7.72 (t, *J*= 8.0 Hz,3H) ppm. ^{13}C NMR ($CDCl_3$, 100MHz) δ 21.7, 54.5, 115.0, 118.2, 120.6, 123.9, 127.3, 127.4, 127.5, 127.6, 127.7, 128.2, 129.8, 129.9, 130.6, 131.4, 132.8, 134.0, 134.2, 140.9, 141.9, 143.4, 144.4, ppm.

(*z*)-2-(1-(1-tosylindolin-3-ylidene)methyl)-4'-methoxybiphenyl (2b):



To a solution of *N*-(2-bromophenyl)-*N*-(3-(4'-methoxy-[1,1'-biphenyl]-2-yl)prop-2-yn-1-yl)-4-methylbenzenesulfonamide **1b** (164 mg, 0.3 mmol) in 2.5 M K_2CO_3(2 mL) and 2 mL ethanol-toluene (1:1), PCy_3(8 mg, 0.03 mmol) and $Pd(OAc)_2$ (4 mg, 0.015 mmol) were added successively. The resulting solution was stirred at 75 °C under argon atmosphere for 4 h. After the completion of the reaction (monitored by TLC), the crude reaction mixture was extracted with ethyl acetate. The organic extract was washed with brine solution, dried over anhydrous $Na_2SO_4$and concentrated. The product was subjected to column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 95:5 (v/v) to afford the product **2b** as a greenish white solid (117 mg, 0.25 mmol, 83%); m. p. 130-132°C. ^{1}H NMR ($CDCl_3$, 500 MHz) δ 2.39 (s, 3H), 3.84 (s, 3H) 4.78 (d, *J*= 3.0 Hz, 2H) , 6.72 (t, $J = 3.0$Hz, 1H), 6.90 (d, *J*= 8.5 Hz,2H), 6.97 (t, *J*= 7.5 Hz, 1H), 7.16–7.25 (m, 4H), 7.31–7.41 (m, 6H), 7.72 (dd, *J*= 8.5, 12.0, Hz,3H) ppm. ^{13}C NMR (CDC_{l3}, 100 MHz) δ 21.6, 54.5, 55.4 113.7, 115.0, 118.4, 120.5, 123.9, 127.2, 127.3, 127.5, 127.6, 129.7, 129.9, 130.6, 130.9, 131.4, 132.6, 133.2, 134.1, 134.2, 141.5, 143.4, 144.3, 159.0 ppm.

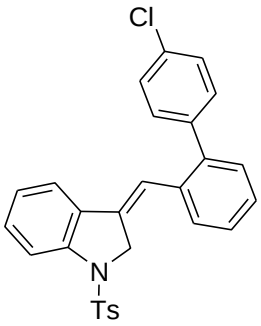
(*z*)-2-((1-tosylindolin-3-ylidene)methyl)-4'-methylbiphenyl (2c):



To a solution of *N*-(2-bromophenyl)-4-methyl-*N*-(3-(4'-methyl-[1,1'-biphenyl]-2-yl)prop-2-yn-1-yl)benzenesulfonamide **1c** (159 mg, 0.3 mmol) in 2.5 M K_2CO_3(2 mL) and 2 mL ethanol-toluene (1:1), PCy_3 (8 mg, 0.03 mmol) and $Pd(OAc)_2$ (4 mg, 0.015 mmol) were added successively. The resulting solution was stirred at 70-75 °C under argon atmosphere for 4 h. After the completion of the reaction (monitored by TLC), the crude reaction mixture was extracted with ethyl acetate. The organic extract was washed with brine solution, dried over anhydrous Na_2SO_4 and concentrated. The product was subjected to column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 95:5 (v/v) to afford the product **2c** as a greenish white solid (106 mg, 0.24mmol, 81%); m. p. 138-140 °C.^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.28 (s, 3H), 2.30 (s, 3H), 4.72 (d, *J*= 3.2 Hz, 2H), 6.63 (t, $J = 3.2$Hz, 1H), 6.88 (t, *J*= 7.6 Hz, 1H), 7.07–7.11 (m, 5H), 7.14–7.17 (m, 3H), 7.22-7.31 (m, 4H), 7.63 (t, *J*= 8.4 Hz,3H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.3, 21.6, 54.5, 114.9, 118.4, 120.6, 123.9, 127.3, 127.4, 127.6, 128.9, 129.7, 129.9, 130.6, 131.4, 132.5, 134.0, 134.1, 137.0, 137.8, 141.8, 143.3, 144.4 ppm.

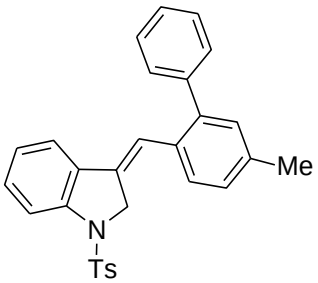
Me

(z)-2-((1-tosylindolin-3-ylidene)methyl)-4'-chlorobiphenyl (2d):



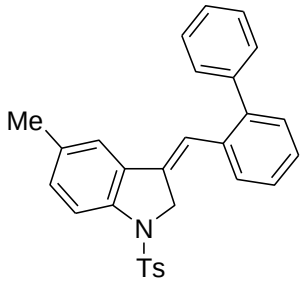
To a solution of *N*-(2-bromophenyl)-*N*-(3-(4'-chloro-[1,1'-biphenyl]-2-yl)prop-2-yn-1-yl)-4-methylbenzenesulfonamide **1d** (165 mg, 0.3 mmol) in 2.5 M K_2CO_3(2 mL) and 2 mL ethanol-toluene (1:1), PCy_3 (8 mg, 0.03 mmol) and $Pd(OAc)_2$ (4 mg, 0.015 mmol) were added successively. The resulting solution was stirred at 70-75 °C under argon atmosphere for 4 h. After the completion of the reaction (monitored by TLC), the crude reaction mixture was extracted with ethyl acetate. The organic extract was washed with brine solution, dried over anhydrous Na_2SO_4 and concentrated. The product was subjected to column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 95:5 (v/v) to afford the product **2d** as a greenish white solid (118 mg, 0.25mmol, 85%); m. p. 142-144 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.26 (s, 3H), 4.66 (d, *J*= 2.8 Hz, 2H), 6.55 (t, *J* = 2.8Hz, 1H), 6.88 (t, *J* = 7.6 Hz, 1H), 7.09 (d, *J*= 8.8 Hz, 3H), 7.15 (t, *J* = 8.0 Hz, 3H), 7.21–7.27 (m, 5H), 7.32 (dd, *J*= 7.6, 2.4 Hz, 1H), 7.62 (dd, *J*= 11.2, 8.4 Hz, 3H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ21.6, 54.3, 114.9, 117.6, 120.5, 123.9, 127.2, 127.5, 127.7, 127.9, 128.4, 129.9, 130.4, 131.0, 133.2, 133.4, 134.0, 139.2, 140.3, 143.3, 144.4. ppm.

(z)-2-((1-tosylindolin-3-ylidene)methyl)-5-methylbiphenyl (2e):



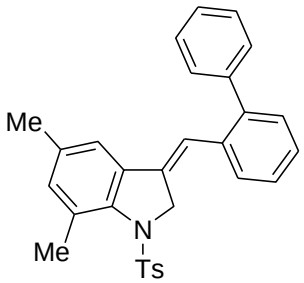
To a solution of *N*-(2-bromophenyl)-4-methyl-*N*-(3-(5-methyl-[1,1'-biphenyl]-2-yl)prop-2-yn-1-yl)benzenesulfonamide **1e** (159 mg, 0.3 mmol) in 2.5 M K_2CO_3(2 mL) and 2 mL ethanol-toluene (1:1), PCy_3 (8 mg, 0.03 mmol) and $Pd(OAc)_2$ (4 mg, 0.015 mmol) were added successively. The resulting solution was stirred at 70-75 °C under argon atmosphere for 4 h. After the completion of the reaction (monitored by TLC), the crude reaction mixture was extracted with ethyl acetate. The organic extract was washed with brine solution, dried over anhydrous Na_2SO_4 and concentrated. The product was subjected to column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 95:5 (v/v) to afford the product **2e** as a yellowish white solid (108 mg, 0.24mmol, 81%); m. p. 126-128 °C.^{1}H NMR ($CDCl_3$, 300 MHz) δ 2.37 (s, 3H), 2.42 (s, 3H), 4.80 (d, *J*= 3.0 Hz, 2H), 6.68 (bs, 1H), 6.95 (t, *J* = 7.5 Hz, 1H), 7.14 (d, *J*= 7.5 Hz, 1H), 7.19–7.26 (m, 8H), 7.32-7.36 (m, 3H), 7.70 (dd, *J*= 7.8, 4.5 Hz, 3H). ppm. ^{13}C NMR ($CDCl_3$, 75 MHz) δ21.4, 21.7, 54.6, 114.9, 118.1, 120.5, 123.9, 127.4, 128.2, 128.4, 129.6, 129.8, 129.9, 131.2, 131.4, 131.6, 131.9, 134.2, 137.5, 141.0, 141.9, 143.3, 144.4. ppm.

(*z*)-2-((5-methyl-1-tosylindolin-3-ylidene)methyl)biphenyl (2f):



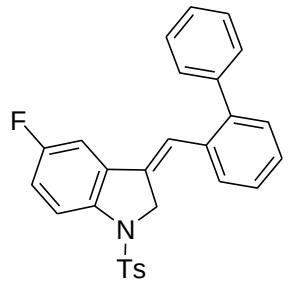
To a solution of *N*-(3-([1,1'-biphenyl]-2-yl)prop-2-yn-1-yl)-*N*-(2-bromo-4-methylphenyl)-4-methylbenzenesulfonamide **1f** (159 mg, 0.3 mmol) in 2.5 M K_2CO_3(2 mL) and 2 mL ethanol-toluene (1:1), PCy_3 (8 mg, 0.03 mmol) and $Pd(OAc)_2$ (4 mg, 0.015 mmol) were added successively. The resulting solution was stirred at 75 °C under argon atmosphere for 4 h. After the completion of the reaction (monitored by TLC), the crude reaction mixture was extracted with ethyl acetate. The organic extract was washed with brine solution, dried over anhydrous Na_2SO_4 and concentrated. The product was subjected to column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 95:5 (v/v) to afford the product **2f** as a yellowish white solid (108 mg, 0.24 mmol, 80%); m. p. 136-138 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.24 (s, 3H), 2.37 (s, 3H), 4.76 (d, *J*= 2.8 Hz, 2H) , 6.65 (t, $J = 2.8$ Hz, 1H), 6.96 (s,1H), 7.05 (d, *J*= 8.4 Hz, 1H), 7.22–7.29 (m, 4H), 7.30–7.44 (m, 7H), 7.62 (d, *J*= 8.0 Hz,1H), 7.68 (d, *J*= 8.4 Hz,2H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.1, 21.7, 54.7, 114.98, 117.94, 120.9, 127.3, 127.4, 127.5, 127.5, 127.6, 128.2, 129.8, 129.9, 130.7, 131.5, 133.1, 133.7, 134.1, 134.2, 140.9, 141.3, 141.7, 144.3 ppm.

(*z*)-2-((5,7-dimethyl-1-tosylindolin-3-ylidene)methyl)biphenyl (2g):



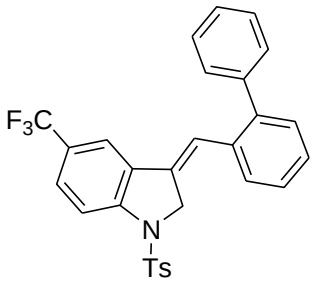
To a solution of *N*-(3-([1,1'-biphenyl]-2-yl)prop-2-yn-1-yl)-*N*-(2-bromo-4,6-dimethylphenyl)-4-methylbenzenesulfonamide **1g** (163 mg, 0.3 mmol) in 2.5 M K_2CO_3(2 mL) and 2 mL ethanol-toluene (1:1), PCy_3 (8 mg, 0.03 mmol) and $Pd(OAc)_2$ (4 mg, 0.015 mmol) were added successively. The resulting solution was stirred at 75 °C under argon atmosphere for 5 h. After the completion of the reaction (monitored by TLC), the crude reaction mixture was extracted with ethyl acetate. The organic extract was washed with brine solution, dried over anhydrous Na_2SO_4 and concentrated. The product was subjected to column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 95:5 (v/v) to afford the product **2g** as a greenish white solid (116 mg, 0.25 mmol, 84%); m. p. 138-140 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.25 (s, 3H), 2.34 (s, 3H), 2.58 (s, 3H), 4.70 (d, *J*= 2.4 Hz, 2H) , 6.32 (d, $J = 2.4$Hz, 1H), 6.71 (s,1H),6.96 (s, 1H),7.00-7.05 (m, 4H), 7.15 (d, *J*= 6.8 Hz,1H), 7.20–7.29 (m, 2H), 7.31 (dd, *J*= 2.0, 4.8 Hz,3H), 7.35-7.38 (m, 3H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ 19.8, 21.2, 21.8, 56.8, 118.3, 118.6, 125.0, 127.2, 127.5, 127.6, 127.7, 128.1, 128.2, 129.2, 129.8, 130.4, 132.3, 133.0, 133.2, 134.1, 135.1, 136.4, 137.7, 140.8, 141.1, 141.4, 143.8 ppm.

(z)-2-((5-fluoro-1-tosylindolin-3-ylidene)methyl)biphenyl (2h):



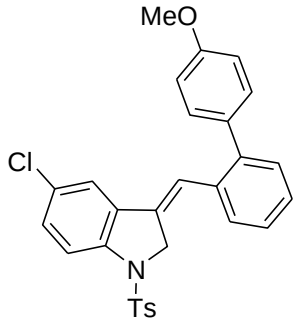
To a solution of*N*-(3-([1,1'-biphenyl]-2-yl)prop-2-yn-1-yl)-*N*-(2-bromo-4-fluorophenyl)-4-methylbenzenesulfonamide **1h** (160 mg, 0.3 mmol) in 2.5 M K_2CO_3(2 mL) and 2 mL ethanol-toluene (1:1), PCy_3 (8 mg, 0.03 mmol) and $Pd(OAc)_2$ (4 mg, 0.015 mmol) were added successively. The resulting solution was stirred at 70-75 °C under argon atmosphere for 4 h. After the completion of the reaction (monitored by TLC), the crude reaction mixture was extracted with ethyl acetate. The organic extract was washed with brine solution, dried over anhydrous Na_2SO_4 and concentrated. The product was subjected to column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 95:5 (v/v) to afford the product **2h** as a greenish white solid (114 mg, 0.25mmol, 83%); m. p. 152-154 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.29 (s, 3H), 4.72 (d, *J*= 2.8 Hz, 2H), 6.54 (t, *J* = 2.8 Hz, 1H), 6.71 (dd, *J* = 8.0, 2.4Hz, 1H), 6.84 (td, *J*= 9.2, 2.8 Hz, 1H), 7.14 (dd, *J* = 7.6, 2.0Hz, 3H), 7.16 (s, 1H), 7.21 (d, *J*= 7.2 Hz, 1H) 7.25–7.30 (m, 5H), 7.32–7.34 (m, 1H), 7.56–7.61 (m, 3H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ21.7, 54.9, 107.2 (d, , $J_{C\text{-}F}$ = 24.0 Hz), 116.4 (d, , $J_{C\text{-}F}$ = 9.0 Hz), 116.5, 119.5, 127.3, 127.4, 127.4, 127.6, 127.9, 128.2, 129.7, 129.9, 130.6, 132.0 (d, , $J_{C\text{-}F}$ = 3.0 Hz), 133.3, 133.4, 133.5, 133.7, 139.4, 140.6, 142.0, 144.5, 160.0 (d, , $J_{C\text{-}F}$ = 241.0 Hz). ppm.

(z)-2-((5-trifluoromethyl-1-tosylindolin-3-ylidene)methyl)biphenyl (2i)



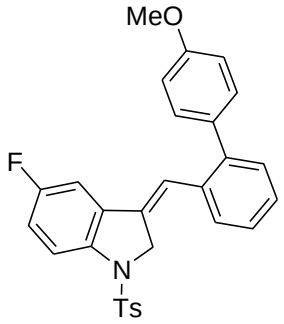
To a solution of *N*-(3-([1,1'-biphenyl]-2-yl)prop-2-yn-1-yl)-*N*-(2-bromo-4-(trifluoromethyl)phenyl)-4-methylbenzenesulfonamide **1i** (175 mg, 0.3 mmol) in 2.5 M K_2CO_3(2 mL) and 2 mL ethanol-toluene (1:1), PCy_3 (8 mg, 0.03 mmol) and $Pd(OAc)_2$ (4 mg, 0.015 mmol) were added successively. The resulting solution was stirred at 70-75 °C under argon atmosphere for 5 h. After the completion of the reaction (monitored by TLC), the crude reaction mixture was extracted with ethyl acetate. The organic extract was washed with brine solution, dried over anhydrous Na_2SO_4 and concentrated. The product was subjected to column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 95:5 (v/v) to afford the product **2i** as a pale greenish solid (116 mg, 0.23mmol, 78%); m. p. 124-126 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.40 (s, 3H), 4.80 (d, *J*= 3.2 Hz, 2H), 6.80 (t, *J* = 3.2Hz, 1H), 7.25–7.29 (m, 4H), 7.32 (d, *J*= 7.2 Hz, 1H), 7.35–7.43 (m, 7H), 7.47 (d, *J*= 8.8 Hz, 1H), 7.72 (d, *J*= 8.0 Hz, 2H), 7.77 (d, *J*= 8.4 Hz, 1H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ21.7, 54.8, 114.4, 117.7, 120.1, 126.8, 127.2, 127.6, 127.6, 128.1, 128.3, 129.7, 130.1, 130.8, 131.2, 133.5, 134.0, 140.5, 142.0, 144.9, 145.8. ppm.

(z)-2-((5-chloro-1-tosylindolin-3-ylidene)methyl)-4'-methoxybiphenyl (2j):



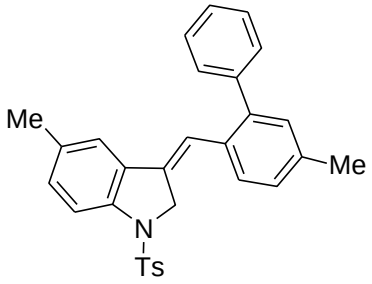
To a solution of *N*-(2-bromo-4-chlorophenyl)-*N*-(3-(4'-methoxy-[1,1'-biphenyl]-2-yl)prop-2-yn-1-yl)-4-methylbenzenesulfonamide **1j** (175 mg, 0.3 mmol) in 2.5 M K_2CO_3(2 mL) and 2 mL ethanol-toluene (1:1), PCy_3 (8 mg, 0.03 mmol) and $Pd(OAc)_2$ (4 mg, 0.015 mmol) were added successively. The resulting solution was stirred at 70-75 °C under argon atmosphere for 4 h. After the completion of the reaction (monitored by TLC), the crude reaction mixture was extracted with ethyl acetate. The organic extract was washed with brine solution, dried over anhydrous Na_2SO_4 and concentrated. The product was subjected to column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 95:5 (v/v) to afford the product **2j** as a white solid (116 mg, 0.23mmol, 75%)as a mixture of non-separable isomers (E:Z=1:1.2); m. p. 144-146 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.28 (s, 3.6H), 2.30 (s, 3H), 3.75 (s, 3.6H), 3.76 (s, 3H), 4.67 (d, *J*= 2.8 Hz, 2H), 4.70 (d, *J*= 3.2 Hz, 2.4H), 6.62 (dt, *J* = 12.0, 3.2 Hz, 2H), 6.80–6.83 (m, 4H), 6.88 (td, *J*= 8.0, 1.0Hz, 1H), 7.05–7.16 (m, 14H), 7.18–7.23 (m, 2H), 7.26–7.30 (m, 6H),7.60 (dt, *J*= 21.6, 9.6Hz, 6H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ21.6, 54.4. 54.8, 55.3, 113.6, 113.8, 114.9, 116.0, 118.4, 119.9, 120.5, 120.5, 123.9, 127.2, 127.3, 127.4, 127.5, 127.6, 128.0, 129.4, 129.5, 129.7, 129.9, 130.0, 130.6, 130.7, 130.8, 130.9, 131.4, 132.5, 133.2, 133.6, 133.7, 134.0, 134.1, 141.4, 141.6, 141.9, 144.3, 144.3, 144.6, 158.9, 159.0. ppm.

(z)-2-((5-fluoro-1-tosylindolin-3-ylidene)methyl)-4'-methoxybiphenyl (2k):



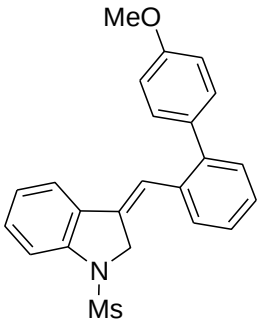
To a solution of*N*-(2-bromo-4-fluorophenyl)-*N*-(3-(4'-methoxy-[1,1'-biphenyl]-2-yl)prop-2-yn-1-yl)-4-methylbenzenesulfonamide **1k** (169 mg, 0.3 mmol) in 2.5 M K_2CO_3(2 mL) and 2 mL ethanol-toluene (1:1), PCy_3 (8 mg, 0.03 mmol) and $Pd(OAc)_2$ (4 mg, 0.015 mmol) were added successively. The resulting solution was stirred at 70-75 °C under argon atmosphere for 4 h. After the completion of the reaction (monitored by TLC), the crude reaction mixture was extracted with ethyl acetate. The organic extract was washed with brine solution, dried over anhydrous Na_2SO_4 and concentrated. The product was subjected to column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 95:5 (v/v) to afford the product **2k** as a greenish white solid (112 mg, 0.23mmol, 78%); m. p. 158-160 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.28 (s, 3H), 3.75 (s, 3H), 4.69 (d, *J*= 3.2 Hz, 2H), 6.56 (t, *J* = 3.2 Hz, 1H), 6.75 (dd, *J*= 8.0, 2.4Hz, 1H), 6.78–6.86 (m, 3H), 7.06 (dt, *J*= 6.8, 2.0 Hz, 2H) 7.14–7.18 (m, 3H), 7.20–7.30 (m, 3H), 7.55–7.60 (m, 3H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ21.6, 54.3, 54.9, 107.2 (d, , $J_{C\text{-}F}$ = 24.0 Hz), 113.7, 116.3 (d, , $J_{C\text{-}F}$ = 7.0 Hz), 116.4 (d, , $J_{C\text{-}F}$ = 9.0 Hz), 119.8, 127.2, 127.3, 127.4, 127.9, 129.9, 130.6, 130.8, 131.8 (d, , $J_{C\text{-}F}$ = 2.0 Hz), 132.9, 133.3, 133.4, 133.5, 133.6, 139.4, 141.6, 144.5, 159.0, 160.0 (d, , $J_{C\text{-}F}$ = 241.0 Hz), ppm.

(z)-2-((5-methyl-1-tosylindolin-3-ylidene)methyl)-5-methylbiphenyl (2l):



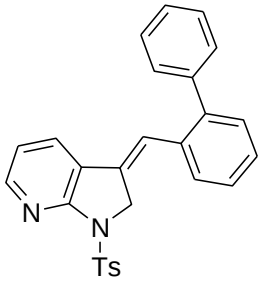
To a solution of *N*-(2-bromo-4-methylphenyl)-4-methyl-*N*-(3-(5-methyl-[1,1'-biphenyl]-2-yl)prop-2-yn-1-yl)benzenesulfonamide **1l** (164 mg, 0.3 mmol) in 2.5 M K_2CO_3(2 mL) and 2 mL ethanol-toluene (1:1), PCy_3 (8 mg, 0.03 mmol) and $Pd(OAc)_2$ (4 mg, 0.015 mmol) were added successively. The resulting solution was stirred at 70-75 °C under argon atmosphere for 5 h. After the completion of the reaction (monitored by TLC), the crude reaction mixture was extracted with ethyl acetate. The organic extract was washed with brine solution, dried over anhydrous Na_2SO_4 and concentrated. The product was subjected to column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 95:5 (v/v) to afford the product **2l** as a greenish solid (112 mg, 0.24mmol, 80%); m. p. 162-164 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.23 (s, 3H), 2.36 (s, 3H),2.41 (s, 3H), 4.76 (d, *J*= 2.8 Hz, 2H), 6.62 (t, J = 3.2Hz, 1H), 6.94 (s, 1H), 7.03 (d, *J*= 8.0 Hz, 1H), 7.18–7.26 (m, 7H), 7.32-7.38 (m, 3H), 7.61 (d, *J*= 8.0 Hz, 1H), 7.67 (d, *J*= 8.0 Hz, 2H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ21.0, 21.3, 21.6, 54.7, 114.9, 117.8, 120.8, 127.2, 127.3, 127.4, 128.2, 128.3, 129.8, 129.8, 130.4, 131.3, 131.4, 131.6, 132.2, 133.6, 134.1, 137.4, 141.0, 141.2, 141.7, 144.2. ppm.

(z)-2-((1-mesylindolin-3-ylidene)methyl)-4'-methoxybiphenyl (2m):



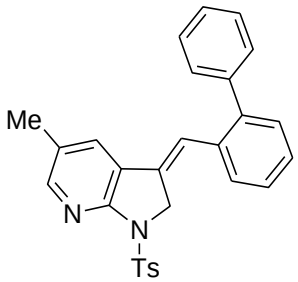
To a solution of*N*-(2-bromophenyl)-*N*-(3-(4'-methoxy-[1,1'-biphenyl]-2-yl)prop-2-yn-1-yl)methanesulfonamide **1m** (141 mg, 0.3 mmol) in 2.5 M K_2CO_3(2 mL) and 2 mL ethanol-toluene (1:1), PCy_3(8 mg, 0.03 mmol) and $Pd(OAc)_2$ (4 mg, 0.015 mmol) were added successively. The resulting solution was stirred at 75 °C under argon atmosphere for 3 h. After the completion of the reaction (monitored by TLC), the crude reaction mixture was extracted with ethyl acetate. The organic extract was washed with brine solution, dried over anhydrous $Na_2SO_4$and concentrated. The product was subjected to column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 95:5 (v/v) to afford the product **2m** as a white solid (102 mg, 0.26 mmol, 85%); m. p. 146-148 °C. ^{1}H NMR ($CDCl_3$, 500 MHz) δ 2.88 (s, 3H), 3.85 (s, 3H) 4.83 (d, *J*= 3.0 Hz, 2H) , 6.88 (t, J = 3.5 Hz, 1H), 6.95 (dd, *J*= 7.0, 2.0 Hz,2H), 7.04 (td, *J*= 7.5, 0.5 Hz, 1H), 7.24 (d, *J*= 7.5 Hz, 1H), 7.27 (dd, *J*= 5.0, 4.5 Hz, 2H), 7.29 (dd, *J*= 6.5, 2.0 Hz, 1H), 7.33 (d, *J*= 7.5 Hz, 1H) 7.34–7.39 (m, 3H), 7.51 (d, *J*= 8.5 Hz,1H) ppm. ^{13}C NMR (CDC_{l3}, 125 MHz) δ 35.3, 54.8, 55.4, 113.7, 113.8, 114.2, 118.8, 120.8, 124.1, 127.3, 127.5, 127.8, 129.9, 130.5, 130.6, 131.0, 131.2, 132.3, 133.3, 134.0, 141.6, 143.2, 159.0 ppm.

(z)-2-((1-tosyl-7-azaindolin-3-ylidene)methyl)biphenyl (2n):



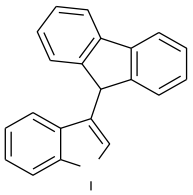
To a solution of *N*-(3-([1,1'-biphenyl]-2-yl)prop-2-yn-1-yl)-*N*-(3-bromopyridin-2-yl)-4-methylbenzenesulfonamide **1n** (155 mg, 0.3 mmol) in 2.5 M K_2CO_3(2 mL) and 2 mL ethanol-toluene (1:1), PCy_3 (8 mg, 0.03 mmol) and $Pd(OAc)_2$ (4 mg, 0.015 mmol) were added successively. The resulting solution was stirred at 75 °C under argon atmosphere for 5 h. After the completion of the reaction (monitored by TLC), the crude reaction mixture was extracted with ethyl acetate. The organic extract was washed with brine solution, dried over anhydrous Na_2SO_4 and concentrated. The product was subjected to column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 90:10 (v/v) to afford the product **2n** as a yellow solid (100 mg, 0.23 mmol, 75%); m. p. 148-150 °C. ^{1}H NMR ($CDCl_3$, 500 MHz) δ 2.39 (s, 3H), 4.95 (d, *J*= 3.0 Hz, 2H) , 6.78 (t, $J = 3.0$Hz, 1H), 6.81 (dd, *J*= 7.5, 5.5 Hz,1H), 7.28 (dd, *J*= 14.5, 7.0 Hz, 2H), 7.31 (dd, *J*= 4.5, 2.0 Hz, 2H), 7.32–7.41 (m, 7H), 7.44 (dd, *J*= 6.0, 3.0 Hz, 1H), 8.01 (dd, *J*= 8.5, 2.0 Hz, 2H), 8.18 (dd, *J*= 5.0, 1.5 Hz, 1H). ppm. ^{13}C NMR ($CDCl_3$, 125 MHz) δ 21.7, 53.3, 118.4, 120.7, 124.4, 127.4, 127.5, 127.7, 128.0, 128.1, 128.2, 128.3, 129.5, 129.6, 129.8, 130.7, 133.4, 135.6, 140.7, 142.0, 144.4, 148.6, 156.5 ppm.

(z)-2-((5-methyl-1-tosyl-7-azaindolin-3-ylidene)methyl)biphenyl (2o):



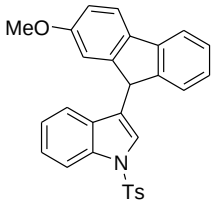
To a solution of *N*-(3-([1,1'-biphenyl]-2-yl)prop-2-yn-1-yl)-*N*-(3-bromo-5-methylpyridin-2-yl)-4-methylbenzenesulfonamide **1o** (159 mg, 0.3 mmol) in 2.5 M K_2CO_3(2 mL) and 2 mL ethanol-toluene (1:1), PCy_3 (8 mg, 0.03 mmol) and $Pd(OAc)_2$ (4 mg, 0.015 mmol) were added successively. The resulting solution was stirred at 75 °C under argon atmosphere for 5 h. After the completion of the reaction (monitored by TLC), the crude reaction mixture was extracted with ethyl acetate. The organic extract was washed with brine solution, dried over anhydrous Na_2SO_4 and concentrated. The product was subjected to column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 90:10 (v/v) to afford the product **2o** as a yellow solid (95 mg, 0.21 mmol, 70%); m. p. 156-158 °C. ^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.21 (s, 3H), 2.40 (s, 3H), 4.94 (d, *J*= 3.2 Hz, 2H) , 6.77 (t, $J = 3.2$Hz, 1H), 7.22 (d, *J*= 1.6 Hz,1H), 7.29 (d, *J*= 8.0 Hz, 2H),7.32–7.35 (m, 2H), 7.38–7.40 (m, 6H),7.42 (dd, *J*= 5.6, 1.6 Hz, 1H), 8.00 (d, *J*= 8.0 Hz, 2H), 8.03 (d, *J*= 1.0 Hz, 1H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ 18.0, 21.7, 53.5, 120.4, 127.4, 127.6, 127.7, 127.9, 128.0, 128.3, 128.9, 129.6, 129.8, 129.8, 130.7, 133.5, 140.8, 141.9, 144.3, 148.8, 154.8 ppm.

Representative experimental procedure for the synthesis of 3-(9H-fluoren-9-yl)-1-tosyl-1H-indole(3a):



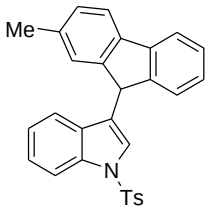
To a solution of **2a** (66 mg, 0.15 mmol) in dry nitromethane (1.5 mL) was added DDQ (0.15 mmol) in presence of anhydrous $FeCl_3$ (5 mg, 0.03 mmol) and 4Å molecular sieves as additive.The reaction mixture was stirred at 60 °C temperature under an argon atmosphere for 3 h. After the completion of the reaction (monitored by TLC),the crude reaction mixture was extracted with DCM. The organic extract was dried over anhydrous Na_2SO_4 and product was purified by column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 97:3 (v/v) to afford the product **3a** as a white solid (56 mg, 0.13 mmol, 85%), m. p. 166-168 °C. . ^{1}H NMR ($CDCl_3$, 300 MHz) δ 2.37 (s, 3H), 5.24 (s, 1H), 6.70 (d, *J*= 7.8 Hz, 1H), 6.95 (t, *J*= 8.1 Hz,1H),7.17–7.23 (m, 5H), 7.24–7.29 (m, 2H), 7.40 (t, *J*= 7.2 Hz,2H),7.57 (s, 1H), 7.76 (d, *J*= 8.1 Hz, 2H),7.84 (d, *J*= 6.9 Hz, 2H), 7.93 (d, *J*= 8.1 Hz, 1H).ppm. ^{13}C NMR ($CDCl_3$, 75MHz) δ 21.7, 45.8, 113.9, 120.2, 120.3, 122.3, 123.2, 124.5, 124.8, 125.1, 126.9, 127.5, 127.7, 129.8, 130.0, 135.3, 135.9, 141.0, 145.0, 146.0 ppm. HRMS: cacld for $C_{28}H_{21}NO_2S$ $[M]^+$ 435.1293; found 435.1292.

3-(2-methoxy-9H-fluoren-9-yl)-1-tosyl-1H-indole (3b):



Compound **2b** (70 mg, 0.15 mmol) was treated with DDQ(0.15 mmol) in combination with anhydrous $FeCl_3$ (5 mg, 0.03 mmol) and 4Å molecular sieves under argon atmosphere at 60°C temperature as described for the synthesis of **3b** for 2 h to afford **3b** as a off white solid (60 mg, 0.13 mmol, 84%), m. p. 147-149 °C.^{1}H NMR ($CDCl_3$, 300 MHz) δ 2.39 (s, 3H), 3.77 (s, 3H), 5.20 (s, 1H), 6.71 (d, *J*= 7.2 Hz,1H), 6.82 (s, 1H), 6.95 (d, *J*= 7.2Hz,2H), 7.15–7.19 (m, 2H),7.22–7.28 (m, 3H), 7.38 (t, *J*= 7.2 Hz, 1H), 7.60 (s, 1H), 7.77 (t, *J*= 8.7 Hz, 4H), 7.95 (d, *J*= 8.4 Hz, 1H).ppm. ^{13}C NMR ($CDCl_3$, 75MHz) δ 21.7, 45.8, 55.5, 110.6, 113.8, 119.3, 120.3, 122.4, 123.2, 124.5, 124.8, 124.9, 126.3, 126.9, 127.7, 129.7, 129.9, 133.9, 135.3, 135.9, 141.0, 145.0, 145.5, 147.8, 159.7 ppm. HRMS: cacld for $C_{29}H_{23}NO_3S$ $[M+H]^+$ 466.1432; found 466.1478.

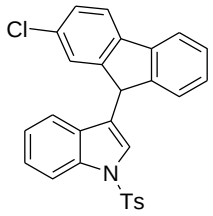
3-(2-methyl-9H-fluoren-9-yl)-1-tosyl-1H-indole (3c):



Compound **2c** (68 mg, 0.15 mmol) was treated with DDQ(0.15 mmol) in combination with anhydrous $FeCl_3$ (5 mg, 0.03 mmol)and 4Å molecular sieves under argon atmosphere at 60 °C temperature as described for the synthesis of **3c** for 2.5 h to afford **3c** as a white solid (58 mg, 0.13 mmol, 90%), m. p. 168-170 °C.^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.32 (s, 3H), 2.37 (s, 3H), 5.20 (s, 1H), 6.70 (d, *J*= 6.0 Hz,1H), 6.95 (t, *J*= 7.2 Hz,1H), 7.08 (s, 1H), 7.17–7.26 (m, 6H), 7.39 (t, *J*= 7.2 Hz, 1H), 7.59 (s, 1H), 7.72–7.81 (m, 4H), 7.96 (d, *J*= 8.4 Hz, 1H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.4, 21.6, 21.7, 45.6, 113.9, 119.8, 120.3, 122.6, 123.2, 124.5, 124.7, 125.0, 125.7, 126.8, 126.9, 127.7, 128.6, 129.0, 129.8, 129.9, 135.3, 135.9, 137.3, 138.3, 141.1, 144.9, 145.8, 146.2 ppm. HRMS: cacld for $C_{29}H_{23}NO_2SNa$ $[M+Na]^+$ 472.1347; found 472.1350.

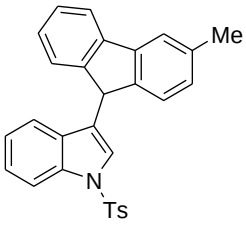
N
Ts

3-(2-chloro-9H-fluoren-9-yl)-1-tosyl-1H-indole (3d):



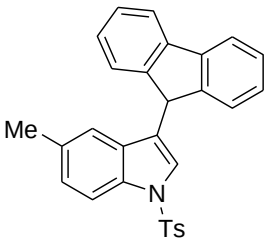
Compound **2d** (71 mg, 0.15 mmol) was treated with DDQ (0.15 mmol) in combination with anhydrous $FeCl_3$ (5 mg, 0.03 mmol) and 4Å molecular sieves under argon atmosphere at 60 °C temperature as described for the synthesis of **3d** for 2 h to afford **3d** as a off white solid (52 mg, 0.11 mmol, 74%), m. p. 158-160 °C.^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.37 (s, 3H), 5.22 (s, 1H), 6.66 (d, *J*= 5.6 Hz,1H), 6.96 (t, *J*= 7.6 Hz,1H),7.21–7.30 (m, 6H), 7.36–7.42 (m, 2H),7.59 (s, 1H), 7.78 (td, *J*= 8.4, 13.2 Hz, 4H), 7.98 (d, *J*= 8.4 Hz,1H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.6, 45.7, 114.0, 120.0, 120.2, 121.0, 121.6, 123.3, 124.7, 124.9, 125.1, 125.3, 126.9, 127.8, 128.1, 129.5, 130.0, 133.1, 135.1, 135.9, 139.5, 139.9, 145.1, 145.8, 147.8ppm. HRMS: cacld for $C_{28}H_{20}ClNO_2SNa$ $[M+Na]^+$ 492.0801; found 492.0800.

3-(3-methyl-9H-fluoren-9-yl)-1-tosyl-1H-indole (3e):



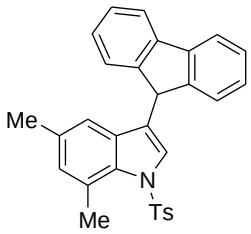
Compound **2e** (68 mg, 0.15 mmol) was treated with DDQ (0.15 mmol) in combination with anhydrous $FeCl_3$ (5 mg, 0.03 mmol) and 4Å molecular sieves under argon atmosphere at 60 °C temperature as described for the synthesis of **3e** for 2 h to afford **3e** as a off white solid (54 mg, 0.12 mmol, 83%), m. p. 156-158 °C.^{1}H NMR ($CDCl_3$, 300 MHz) δ 2.37 (s, 3H), 2.46 (s, 3H), 5.20 (s, 1H), 6.71 (d, *J*= 7.8 Hz,1H), 6.95 (t, *J*= 7.8 Hz,1H),7.04 (d, *J*= 7.8 Hz,1H), 7.19 (dd, *J*= 7.8, 15.6 Hz,2H), 7.25–7.41 (m, 4H), 7.38 (t, *J*= 7.5 Hz, 1H), 7.55 (s, 1H), 7.65 (s, 1H), 7.79 (dd, *J*= 8.4, 15.6 Hz, 3H), 7.93 (d, *J*= 8.4 Hz,1H). ppm. ^{13}C NMR ($CDCl_3$, 125MHz) δ 21.6, 45.4, 113.9, 120.0, 120.3, 120.7, 122.7, 123.2, 124.8, 125.1, 126.9, 127.3, 127.7, 128.4, 129.9, 135.6, 136.0, 137.5, 141.1, 141.2, 143.2, 144.9, 146.5ppm. HRMS: cacld for $C_{29}H_{23}NO_2SNa$ $[M+Na]^+$ 472.1347; found 472.1385.

3-(9H-fluoren-9-yl)-5-methyl-1-tosyl-1H-indole (3f):



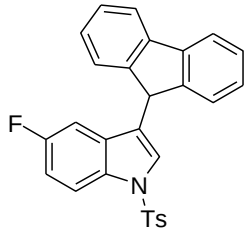
Compound **2f** (68 mg, 0.15 mmol) was treated with DDQ(0.15 mmol) in combination with anhydrous $FeCl_3$ (5 mg, 0.03 mmol) and 4Å molecular sieves under argon atmosphere at 60 °C temperature as described for the synthesis of **3f** for 2 h to afford **3f** as a off white solid (59 mg, 0.13 mmol, 88%), m. p. 183-185 °C.^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.20 (s, 3H), 2.36 (s, 3H), 5.23 (s, 1H), 6.60 (bs, 1H), 7.05 (d, *J*= 8.4 Hz,1H), 7.21–7.26 (m, 4H), 7.29 (d, *J*= 7.2 Hz, 2H), 7.41 (t, *J*= 7.6 Hz, 2H),7.46 (s, 1H), 7.74 (d, *J*= 8.4 Hz, 2H), 7.84 (t, *J*= 8.4 Hz, 3H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.4, 21.6, 45.6, 113.6, 120.0, 120.2, 122.3, 124.5, 125.0, 126.3, 126.9, 127.4, 127.7, 128.3, 129.9, 130.2, 132.9, 134.1, 135.3, 141.0, 144.9, 146.0 ppm. HRMS: cacld for $C_{29}H_{23}NO_2SNa$ $[M+Na]^+$ 472.1347; found 472.1385.

3-(9H-fluoren-9-yl)-5,7-dimethyl-1-tosyl-1H-indole (3g):



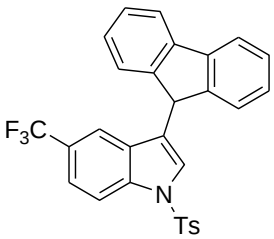
Compound **2g** (70 mg, 0.15 mmol) was treated with DDQ(0.15 mmol) in combination with anhydrous $FeCl_3$ (5 mg, 0.03 mmol)and 4Å molecular sieves under argon atmosphere at 60 °C temperature as described for the synthesis of **3g** for 3.5 h to afford **3g** as a off white solid (57 mg, 0.12 mmol, 82%), m. p. 152-154 °C.^{1}H NMR ($CDCl_3$, 300 MHz) δ 2.16 (s, 3H), 2.37 (s, 3H), 2.54 (s, 3H), 5.21 (s, 1H), 6.51 (bs, 1H), 6.80 (s, 1H),7.16–7.25 (m, 4H), 7.26–7.28 (m, 2H),7.38–7.53 (m, 5H),7.84 (d, *J*= 7.5 Hz, 2H). ppm. ^{13}C NMR ($CDCl_3$, 75MHz) δ 21.1, 21.7, 21.7, 45.4, 117.7, 120.1, 122.6, 124.9, 125.6, 126.6, 127.4, 127.6, 128.2, 129.7, 130.0, 132.7, 133.5, 134.5, 136.3, 141.0, 144.4, 146.1 ppm. HRMS: cacld for $C_{30}H_{25}NO_2SNa$ $[M+Na]^+$ 486.1504; found 486.1502.

3-(9H-fluoren-9-yl)-5-fluoro-1-tosyl-1H-indole (3h):



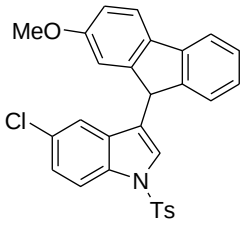
Compound **2h** (68 mg, 0.15 mmol) was treated with DDQ (0.15 mmol) in combination with anhydrous $FeCl_3$ (5 mg, 0.03 mmol) and 4Å molecular sieves under argon atmosphere at 60°C temperature as described for the synthesis of **3h** for 3 h to afford **3h** as a white solid (54 mg, 0.12 mmol, 80%), m. p. 208-210 °C.^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.38 (s, 3H), 5.20 (s, 1H), 6.25 (d, *J*= 8.0 Hz,1H), 6.93 (t, *J*= 8.0 Hz,1H), 7.24–7.28 (m, 6H),7.43 (t, *J*= 8.0 Hz, 2H), 7.66 (s, 1H), 7.76 (d, *J*= 8.8 Hz,2H), 7.88 (dd, *J*= 8.0, 8.0 Hz, 3H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.7, 45.7,106.0 (d, , $J_{C\text{-}F}$ = 24.0 Hz), 112.9 (d, , $J_{C\text{-}F}$ = 26.0 Hz),114.9 (d, , $J_{C\text{-}F}$ = 9.0 Hz), 122.2 (d, , $J_{C\text{-}F}$ = 4.0 Hz), 125.0, 126.8, 126.9, 127.5, 127.9, 128.3, 129.1, 129.9, 130.0, 130.6, 130.7, 132.3, 135.1, 141.0, 145.2, 145.5, 159.3 (d, , $J_{C\text{-}F}$ = 239.0 Hz),ppm. HRMS: cacld for $C_{28}H_{20}FNO_2SNa$ $[M+Na]^+$ 476.1096; found 476.1091.

3-(9H-fluoren-9-yl)-5-(trifluoromethyl)-1-tosyl-1H-indole (3i):



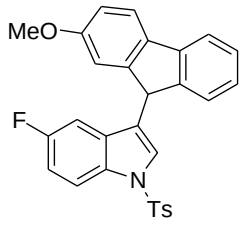
Compound **2i** (76 mg, 0.15 mmol) was treated with DDQ (0.15 mmol) in combination with anhydrous $FeCl_3$ (5 mg, 0.03 mmol) and 4Å molecular sieves under argon atmosphere at 60 °C temperature as described for the synthesis of **3i** for 3.5 h to afford **3i** as a off white solid (55 mg, 0.11 mmol, 75%), m. p. 170-172 °C.^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.38 (s, 3H), 5.27 (s, 1H), 7.06 (s, 1H), 7.22–7.28 (m, 6H), 7.41–7.47 (m, 3H), 7.62 (s, 1H), 7.77 (d, *J*= 8.4 Hz, 2H), 7.86 (d, *J*= 7.6 Hz, 2H), 8.04 (d, *J*= 8.8 Hz, 1H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.7, 45.3, 114.2, 117.7 (q, , $J_{C\text{-}F}$ = 4.0 Hz), 120.3, 121.6 (q, , $J_{C\text{-}F}$ = 4.0 Hz), 122.6, 123.0, 124.9, 125.1, 125.4, 125.7 (d, , $J_{C\text{-}F}$ = 5.0 Hz), 126.9, 127.6, 128.0, 128.4, 129.6, 130.2, 135.0, 137.2, 141.0, 145.5 (d, , $J_{C\text{-}F}$ = 8.0 Hz).ppm. HRMS: cacld for $C_{29}H_{20}F_3NO_2SNa$ $[M+Na]^+$ 526.1065; found 526.1068.

5-chloro-3-(2-methoxy-9H-fluoren-9-yl)-1-tosyl-1H-indole (3j):



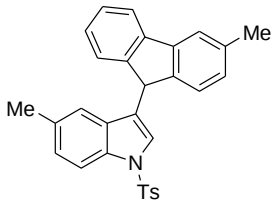
Compound **2j** (75 mg, 0.15 mmol) was treated with DDQ (0.15 mmol) in combination with anhydrous $FeCl_3$ (5 mg, 0.03 mmol) and 4Å molecular sieves under argon atmosphere at 60 °C temperature as described for the synthesis of **3j** for 3 h to afford **3j** as a pale yellow solid (57 mg, 0.11 mmol, 76%, 1:1.7 dr), m. p. 120-122 °C.^{1}H NMR ($CDCl_3$, 300 MHz) δ 2.36 (s, 3H), 2.37 (s, 5H), 3.74 (s, 3H) 3.75 (s, 5H), 5.13 (s, 1.7H), 5.18 (s, 1H)6.63 (s, 1H), 6.70 (d, *J*= 7.8 Hz,1H), 6.79 (dd, *J*= 1.8, 10.8 Hz,3H), 6.95 (dt, *J*= 2.1, 8.4 Hz,3H), 7.11–7.26 (m, 14H),7.33–7.40 (m, 3H), 7.58 (s, 3H), 7.60–7.61 (m, 10H), 7.72 (d, *J*= 3.3 Hz, 2H), 7.75 (d, *J*= 3.3 Hz, 1H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.6, 21.7, 45.5, 45.8, 55.5, 55.5, 110.6, 110.7, 113.8, 114.9, 119.3, 119.5, 119.9, 120.3, 120.8, 121.0, 122.0, 123.2, 124.5, 124.7, 124.8, 124.9, 125.2, 125.8, 126.3, 126.4, 126.9, 126.9, 127.7, 127.9, 129.1, 129.8, 130.0, 130.9, 133.9, 134.0, 134.3, 135.0, 140.9, 145.0, 145.0, 145.3, 145.5, 147.4, 147.9, 159.8, 159.8 ppm. HRMS: cacld for $C_{29}H_{22}ClNO_3SNa$ $[M+Na]^+$ 522.0907; found 522.0908.

5-fluoro-3-(2-methoxy-9H-fluoren-9-yl)-1-tosyl-1H-indole (3k):



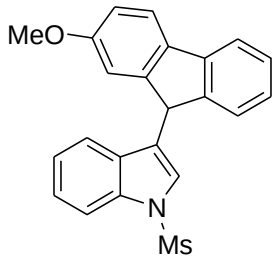
Compound **2k** (73 mg, 0.15 mmol) was treated with DDQ (0.15 mmol) in combination with anhydrous $FeCl_3$ (5 mg, 0.03 mmol) and 4Å molecular sieves under argon atmosphere at 60°C temperature as described for the synthesis of **3k** for 3 h to afford **3k** as a white solid (58 mg, 0.12 mmol, 78%), m. p. 138-140°C.^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.37 (s, 3H), 3.74 (s, 3H), 5.11 (s, 1H), 6.21 (d, *J*= 8.0 Hz,1H), 6.22 (s, 1H), 6.89–6.95 (m, 2H), 7.16 (dd, *J*= 7.6, 13.2 Hz,2H), 7.23–7.25 (m, 2H) 7.36 (t ,*J*= 7.2 Hz, 1H), 7.64 (s, 1H), 7.71–7.75 (m, 4H) 7.86 (dd, *J*= 4.4, 8.8 Hz,1H). ppm. ^{13}C NMR ($CDCl_3$, 125MHz) δ 21.7, 45.7, 55.5, 106.0 (d, , J_{C-F} = 23.7 Hz), 110.7, 112.9 (d, , J_{C-F} = 25.0 Hz), 113.8, 114.9 (d, , J_{C-F} = 8.7 Hz), 119.5, 121.0, 122.4 (d, , J_{C-F} = 3.7 Hz), 124.8, 126.3 (d, , J_{C-F} = 8.7 Hz), 126.9, 127.4, 127.9, 129.9 (d, , J_{C-F} = 26.2 Hz), 130.6 (d, , J_{C-F} = 8.7 Hz), 132.3, 133.9, 135.0, 141.0, 145.1 (d, , J_{C-F} = 26.2 Hz),147.4, 159.8 159.4 (d, , J_{C-F} = 238.7 Hz) ppm. HRMS: cacld for $C_{29}H_{22}FNO_3S$ $[M+H]^+$ 484.1383; found 484.1374.

5-methyl-3-(3-methyl-9H-fluoren-9-yl)-1-tosyl-1H-indole (3l):



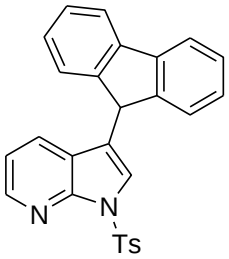
Compound **2l** (70 mg, 0.15 mmol) was treated with DDQ(0.15 mmol) in combination with anhydrous $FeCl_3$ (5 mg, 0.03 mmol) and 4Å molecular sieves under argon atmosphere at 60 °C temperature as described for the synthesis of **3l** for 3 h to afford **3l** as a off white solid (56 mg, 0.12 mmol, 80%), m. p. 168-170 °C.^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.20 (s, 3H), 2.35 (s, 3H), 2.46 (s, 3H), 5.17 (s, 1H), 6.61 (bs, 1H), 7.03–7.05 (m, 2H), 7.15–7.26 (m, 5H), 7.39 (dd, *J*= 8.8 , 15.6 Hz, 2H), 7.65 (s, 1H), 7.72 (d, *J*= 8.0 Hz, 2H), 7.81 (d, *J*= 8.4 Hz, 2H). ppm. ^{13}C NMR ($CDCl_3$, 100MHz) δ 21.4, 21.7, 5.2, 113.6, 120.0, 120.0, 120.7, 122.6, 124.4, 124.7, 125.0, 126.2, 126.9, 127.3, 127.6, 128.4, 129.9, 132.8, 134.1, 135.3, 137.4, 141.1, 143.2, 144.8, 146.4ppm. HRMS: cacld for $C_{30}H_{25}NO_2SNa$ $[M+Na]^+$ 486.1504; found 486.1506.

3-(2-methoxy-9H-fluoren-9-yl)-1-mesyl-1H-indole (3m):



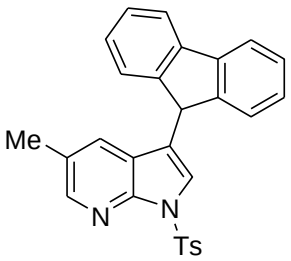
Compound **2m** (59 mg, 0.15 mmol) was treated with DDQ (0.15 mmol) in combination with anhydrous $FeCl_3$ (5 mg, 0.03 mmol) and 4Å molecular sieves under argon atmosphere at 60 °C temperature as described for the synthesis of **3m** for 2 h to afford **3m** as a white solid (47 mg, 0.12 mmol, 81%), m. p. 160-162 °C.^{1}H NMR ($CDCl_3$, 400 MHz) δ 3.13 (s, 3H), 3.80 (s, 3H), 5.26 (s, 1H), 6.91 (d, *J*= 7.6 Hz,1H), 6.95 (s, 1H), 6.99 (d, *J*= 8.4 Hz, 1H), 7.08 (t, *J*= 7.6 Hz, 1H), 7.20 (t, *J*= 7.2 Hz, 1H), 7.28–7.42 (m, 3H), 7.46 (s, 1H), 7.78 (d, *J*= 8.0 Hz, 2H), 7.89 (d, *J*= 8.4 Hz, 1H) .ppm. ^{13}C NMR ($CDCl_3$, 75MHz) δ 40.7, 45.7, 55.6, 110.9, 113.2, 113.7, 119.4, 120.6, 120.9, 122.2, 123.4, 123.9, 125.0, 125.1, 126.4, 127.8, 129.7, 134.0, 135.8, 141.0, 145.5, 147.8, 159.8 ppm. HRMS: cacld for $C_{23}H_{19}NO_3SNa$ $[M+Na]^+$ 412.0983; found 412.0985.

3-(9H-fluoren-9-yl)-1-tosyl-1H-pyrrolo[2,3-b]pyridine (3n):



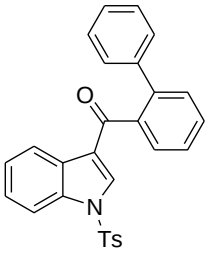
Compound **2n** (66 mg, 0.15 mmol) was treated with DDQ (0.19 mmol) in combination with anhydrous $FeCl_3$ (5 mg, 0.03 mmol) and 4Å molecular sieves under argon atmosphere at 60 °C temperature as described for the synthesis of **3n** for 5 h to afford **3n** as a off white solid (44 mg, 0.10 mmol, 66%),The organic extract was dried over anhydrous Na_2SO_4 and product was purified by column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 97:5 (v/v),m. p. 176-178 °C.^{1}H NMR ($CDCl_3$, 300 MHz) δ 2.38 (s, 3H), 5.21 (s, 1H), 6.75–6.84 (m, 2H), 7.20–7.31 (m, 6H), 7.38–7.43 (m, 2H), 7.84 (t, *J*= 4.2 Hz, 3H), 8.08–8.12 (m, 2H), 8.27 (dd, *J*= 1.8, 4.5 Hz, 1H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.7, 46.0, 118.5, 118.6, 120.2, 121.7, 124.2, 125.2, 127.5, 127.9, 128.2, 128.7, 129.7, 135.6, 140.9, 145.0, 145.2, 145.6, 147.9 ppm. HRMS: cacld for $C_{27}H_{20}N_2O_2S$ $[M+H]^+$ 437.1324; found 437.1322.

3-(9H-fluoren-9-yl)-5-methyl-1-tosyl-1H-pyrrolo[2,3-b]pyridine (3o):



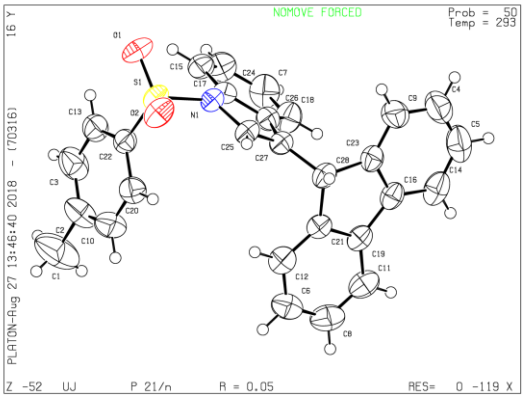
Compound **2o** (68 mg, 0.15 mmol) was treated with DDQ (0.19 mmol) in combination with anhydrous $FeCl_3$ (5 mg, 0.03 mmol) and 4Å molecular sieves under argon atmosphere at 60 °C temperature as described for the synthesis of **3o** for 5 h to afford **3o** as a white solid (45 mg, 0.10 mmol, 68%),The organic extract was dried over anhydrous Na_2SO_4 and product was purified by column chromatography (silica gel, 60-120 mesh), eluting with pet ether/EtOAc 97:5 (v/v),m. p. 194-196 °C.^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.03 (s, 3H), 2.31 (s, 3H), 5.11 (s, 1H), 6.52 (s, 1H), 7.15–7.24 (m, 6H), 7.34 (t, *J*= 7.6 Hz, 2H), 7.68 (s, 1H), 7.77 (d, *J*= 7.6 Hz, 2H), 7.98–8.05 (m, 3H). ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ 18.4, 21.7, 46.0, 118.3, 120.2, 121.7, 124.4, 125.1, 127.5, 127.9, 128.0, 128.1, 128.6, 129.7, 135.7, 141.0, 145.0, 145.7, 145.9, 146.5 ppm. HRMS: cacld for $C_{28}H_{23}N_2O_2SNa$ $[M+Na]^+$ 473.1300; found 473.1303.

NMR data of compound 3-indolyl biphenyl ketone:

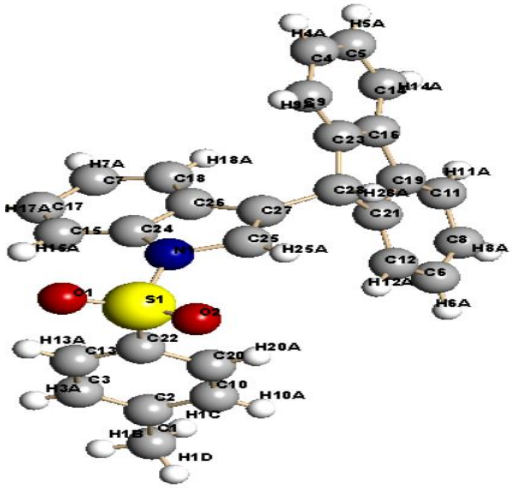


^{1}H NMR ($CDCl_3$, 400 MHz) δ 2.38 (s, 3H), 7.14 (d, *J*= 7.2 Hz, 1H), 7.18–7.26 (m, 4H),7.30 (dd, *J*= 3.2, 3.2 Hz, 2H), 7.37 (d, *J*= 7.2 Hz, 2H), 7.48–7.55 (m, 3H), 7.59 (d, *J*= 8.4 Hz, 3H), 7.62 (s, 1H), 7.75 (dd, *J*= 3.2, 2.4 Hz, 1H), 8.25 (dd, *J*= 2.8, 2.8 Hz, 1H) ppm. ^{13}C NMR ($CDCl_3$, 100 MHz) δ 21.8, 112.9, 121.4, 123.0, 124.8, 125.7, 127.2, 127.3, 127.6, 127.8, 128.6, 128.9 130.2, 130.3, 130.5, 130.6, 134.5, 134.7, 135.0, 139.9,140.2, 140.5 145.8, 193.5 ppm. HRMS: cacld for $C_{28}H_{21}NO_3SNa$ $[M+Na]^+$ 474.1140; found 474.1143.

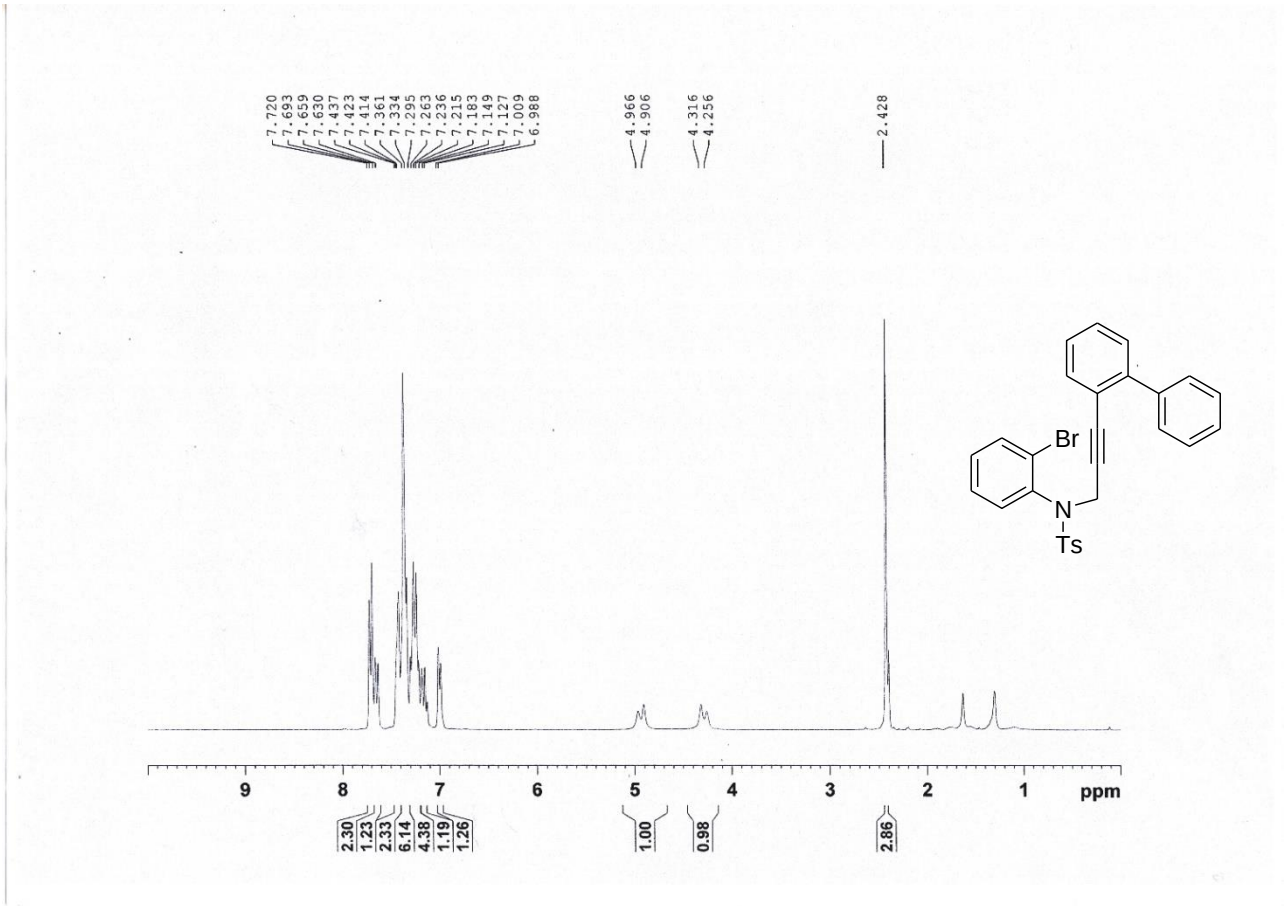
Two view of ortep diagram for the crystal structure of the compound 3a (Thermal ellipsoid contour at 50%probability level)



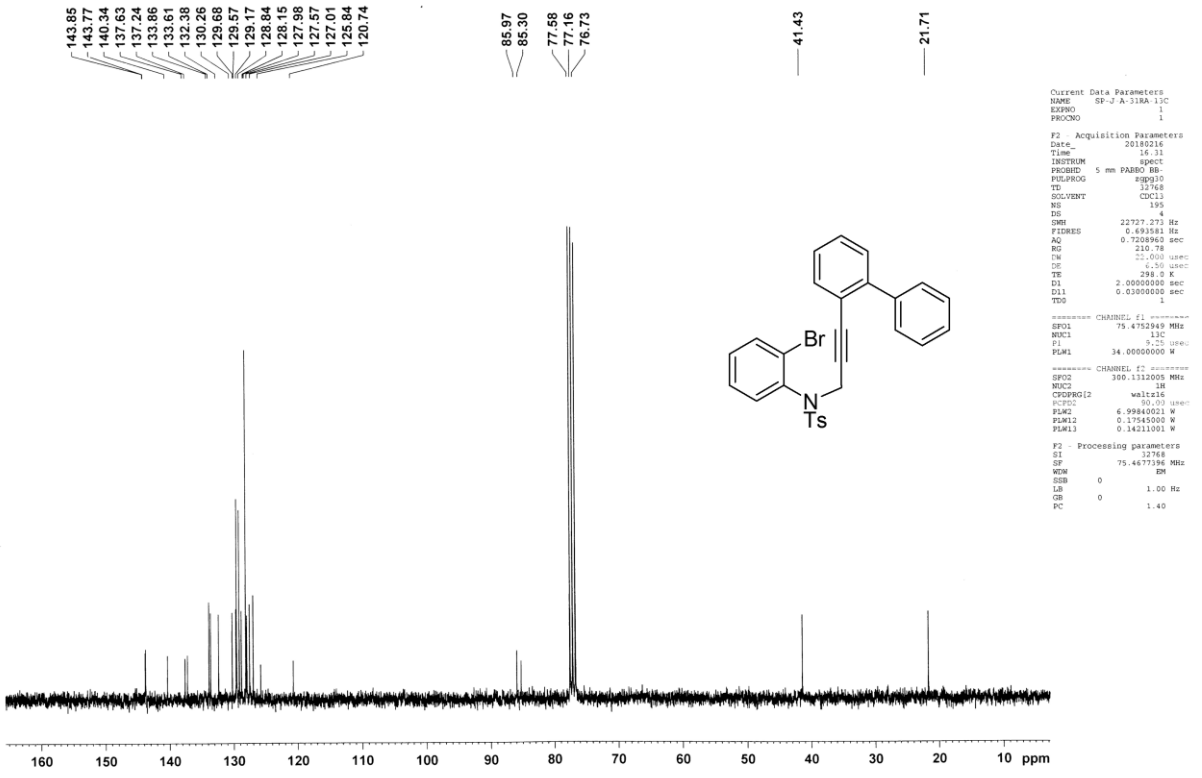
CCDC no.1964540



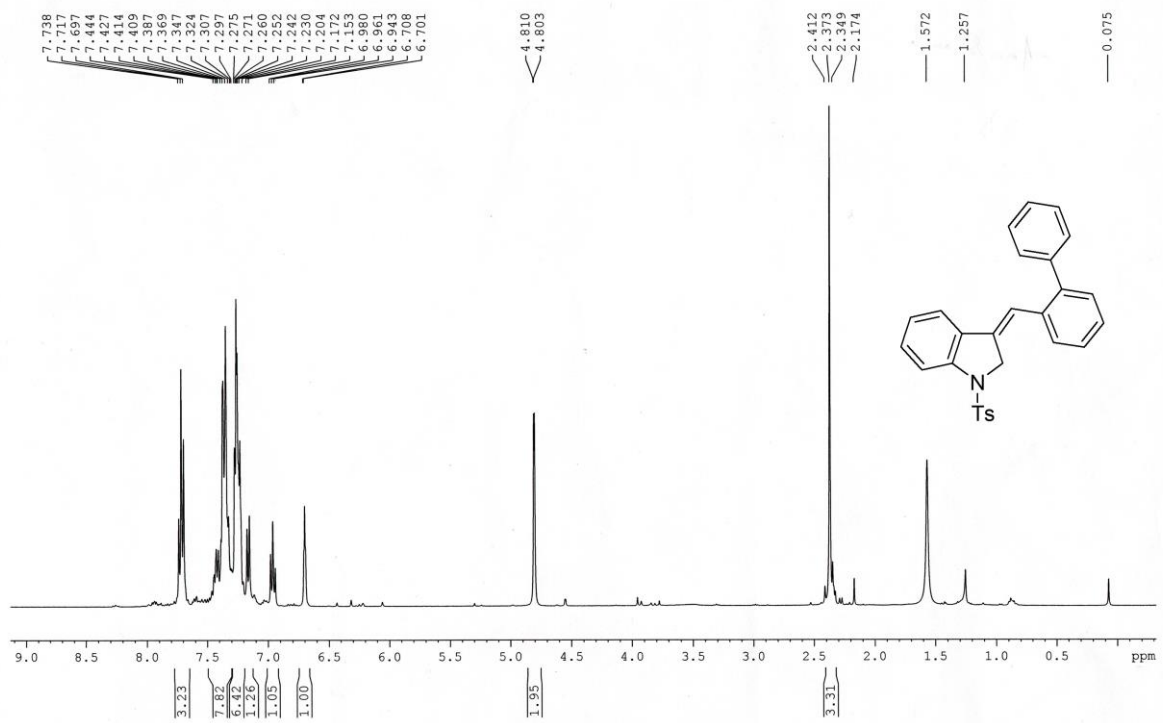
^{1}H NMR of 1a, $CDCl_3$, 300 MHz



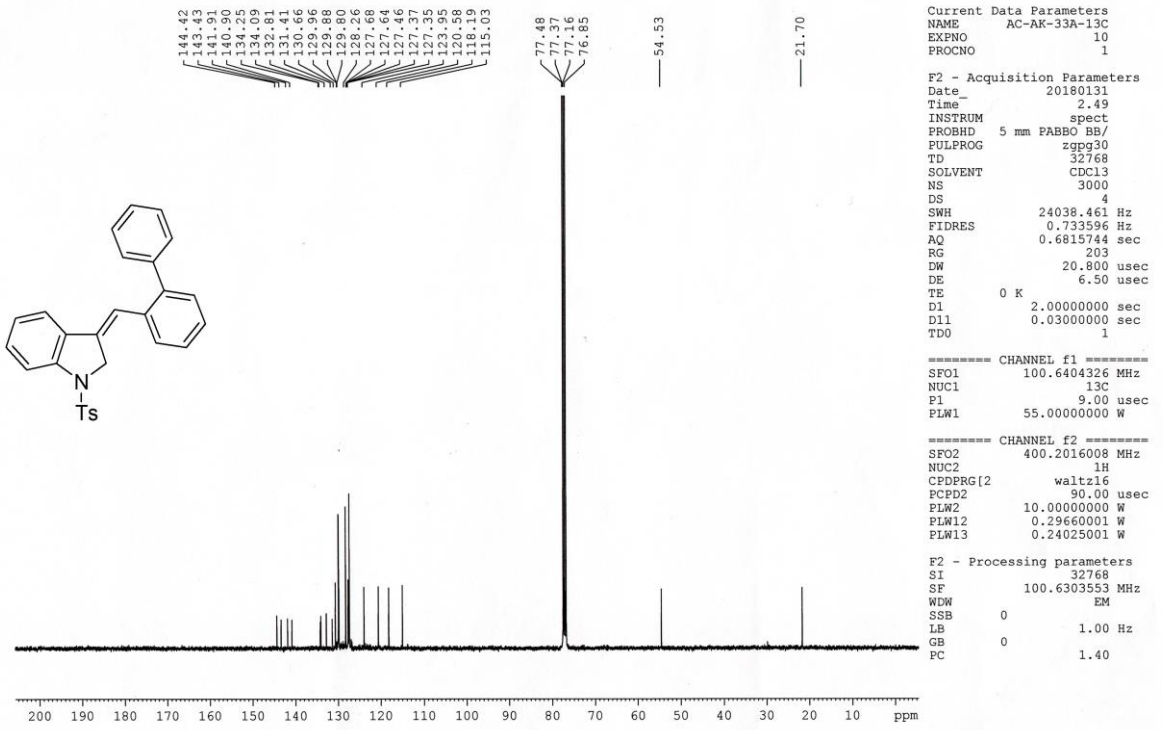
^{13}CNMR of 1a, $CDCl_3$, 75 MHz



^{1}H NMR of 2a, $CDCl_3$, 400 MHz

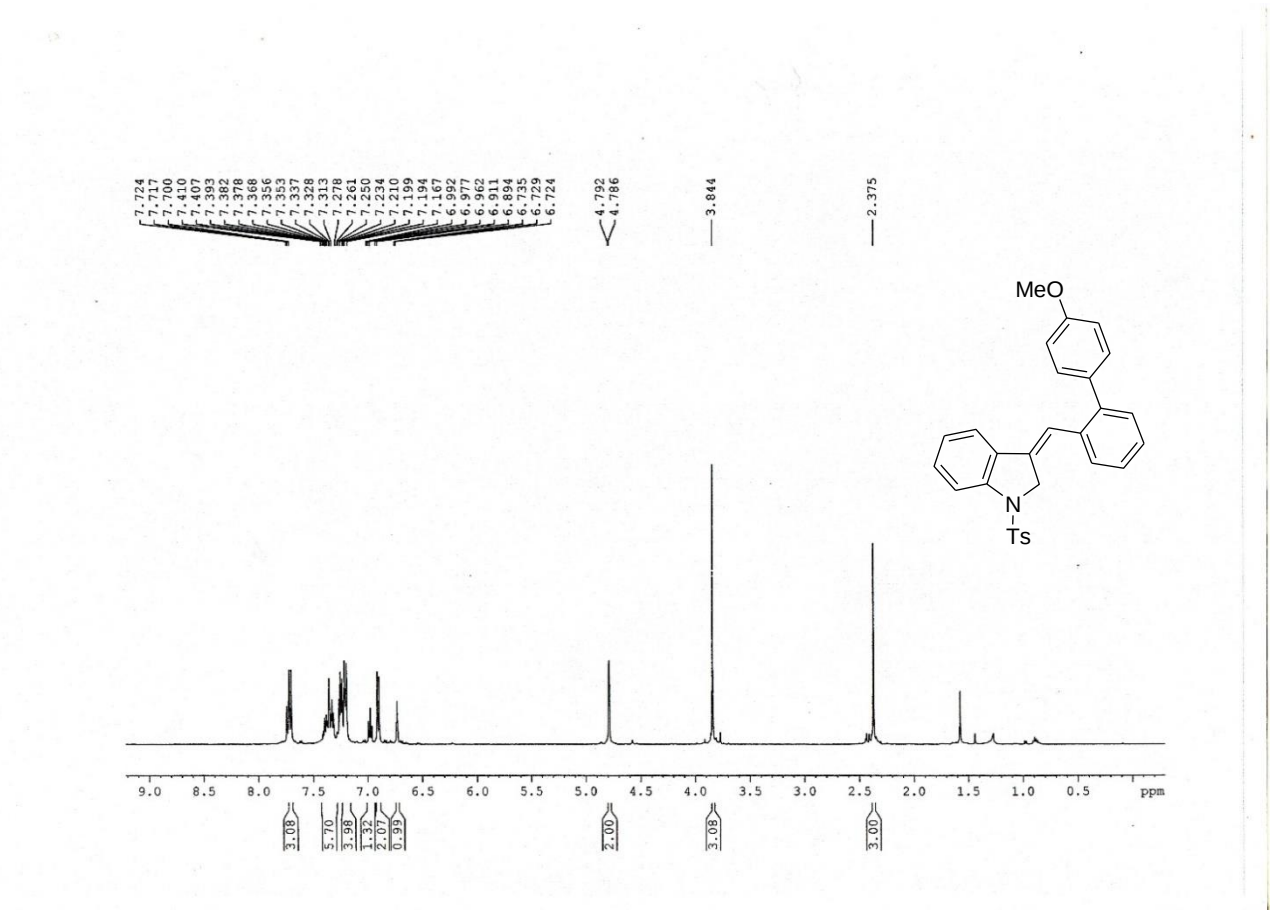


^{13}C NMR of 2a, $CDCl_3$, 100 MHz

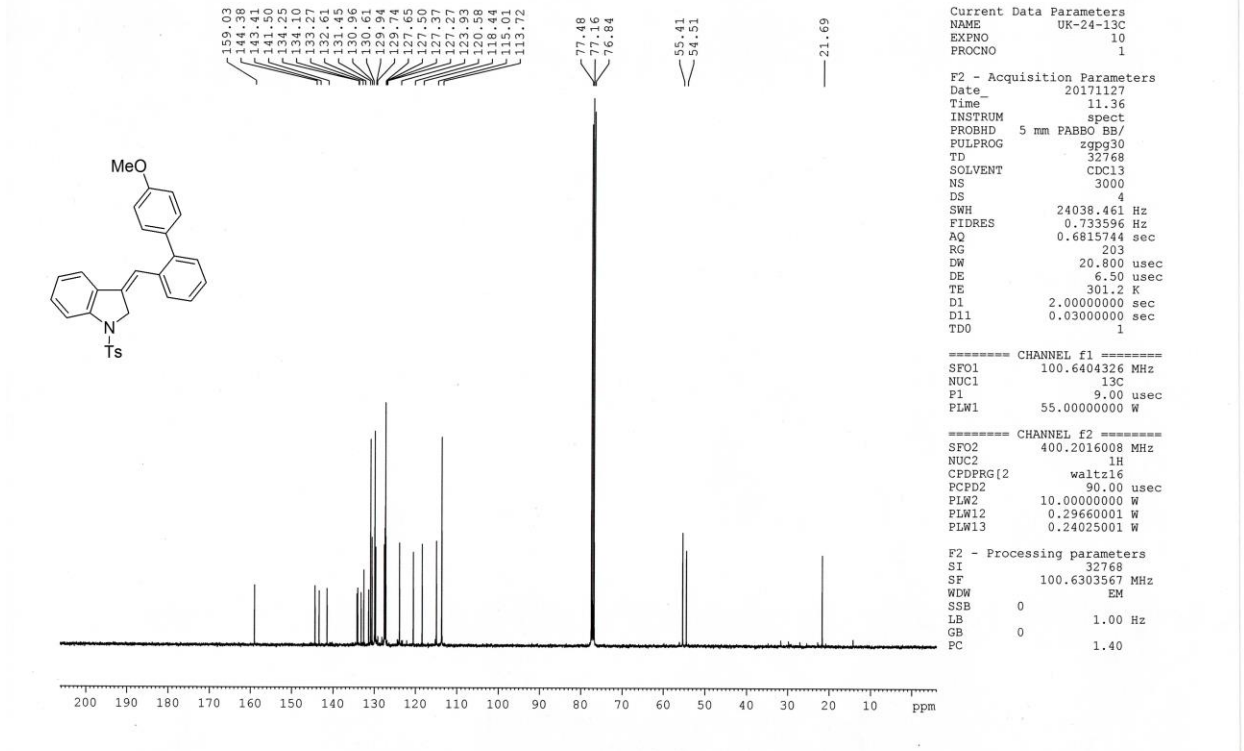



```
Current Data Parameters
NAME       AC-AK-33A-13C
EXPNO                 10
PROCNO                 1

F2 - Acquisition Parameters
Date_           20180131
Time               2.49
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG         zgpg30
TD              32768
SOLVENT           CDCl3
NS                 3000
DS                    4
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ             0.6815744 sec
RG                  203
DW                20.800 usec
DE                 6.50 usec
TE        0 K
D1          2.00000000 sec
D11         0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1       100.6404326 MHz
NUC1               13C
P1                9.00 usec
PLW1        55.00000000 W

======== CHANNEL f2 ========
SFO2       400.2016008 MHz
NUC2               1H
CPDPRG[2        waltz16
PCPD2             90.00 usec
PLW2        10.00000000 W
PLW12        0.29660001 W
PLW13        0.24025001 W

F2 - Processing parameters
SI                32768
SF           100.6303553 MHz
WDW                EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```

^{1}H NMR of 2b, $CDCl_3$, 500 MHz

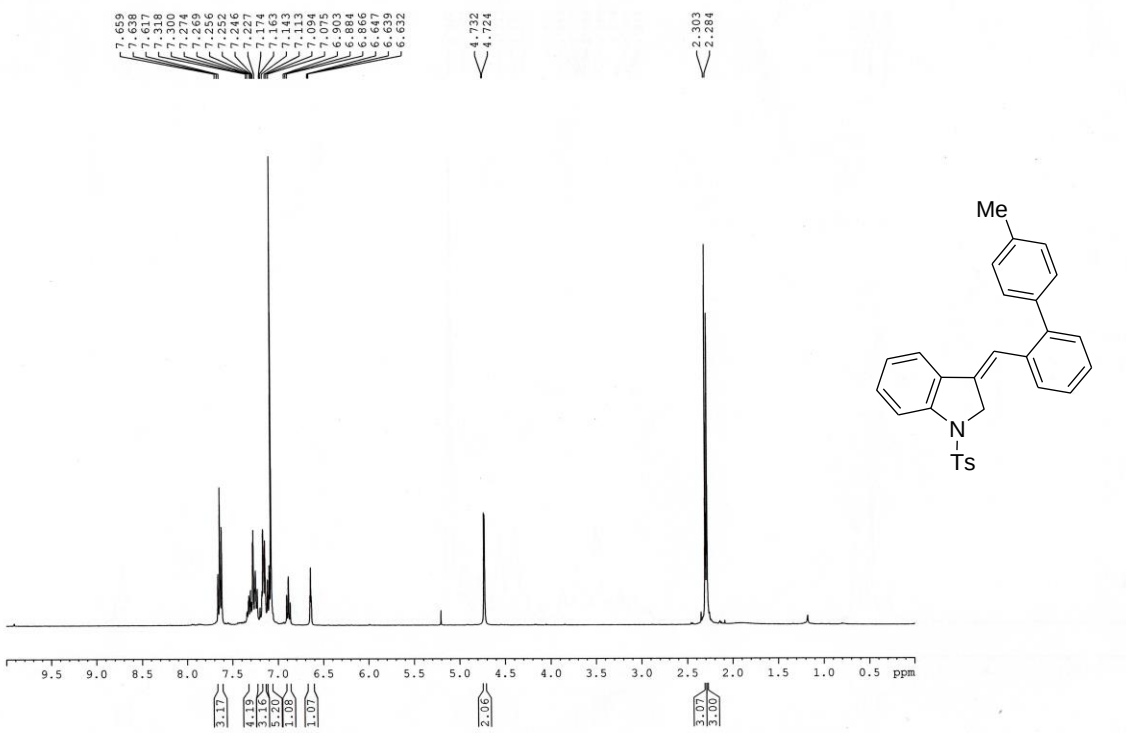


^{13}C NMR of 2b, $CDCl_3$, 100 MHz

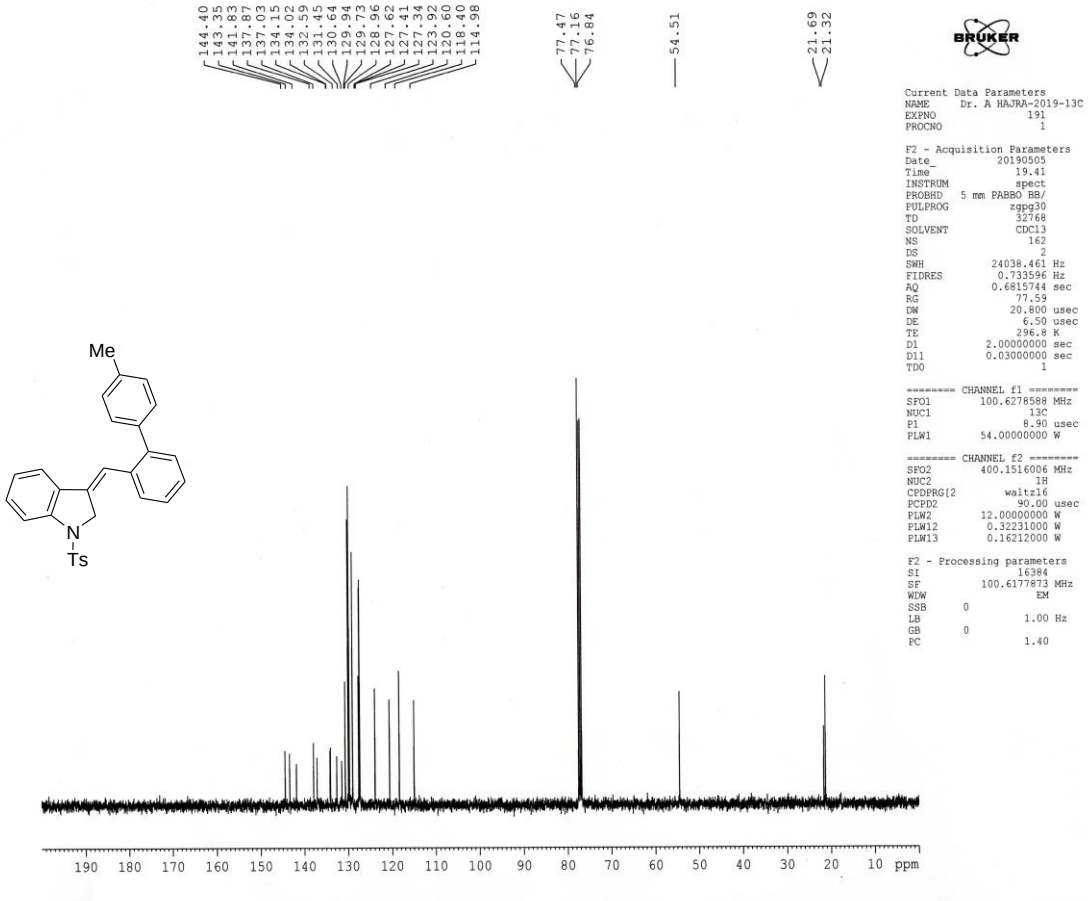



```
Current Data Parameters
NAME            UK-24-13C
EXPNO                  10
PROCNO                  1

F2 - Acquisition Parameters
Date_           20171127
Time               11.36
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                 32768
SOLVENT            CDCl3
NS                  3000
DS                     4
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ              0.6815744 sec
RG                   203
DW                20.800 usec
DE                 6.50 usec
TE                301.2 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6404326 MHz
NUC1                 13C
P1                  9.00 usec
PLW1         55.00000000 W

======== CHANNEL f2 ========
SFO2         400.2016008 MHz
NUC2                 1H
CPDPRG[2          waltz16
PCPD2              90.00 usec
PLW2         10.00000000 W
PLW12         0.29660001 W
PLW13         0.24025001 W

F2 - Processing parameters
SI                 32768
SF           100.6303567 MHz
WDW                  EM
SSB       0
LB                  1.00 Hz
GB        0
PC                  1.40
```

^{1}H NMR of 2c, $CDCl_3$, 400 MHz

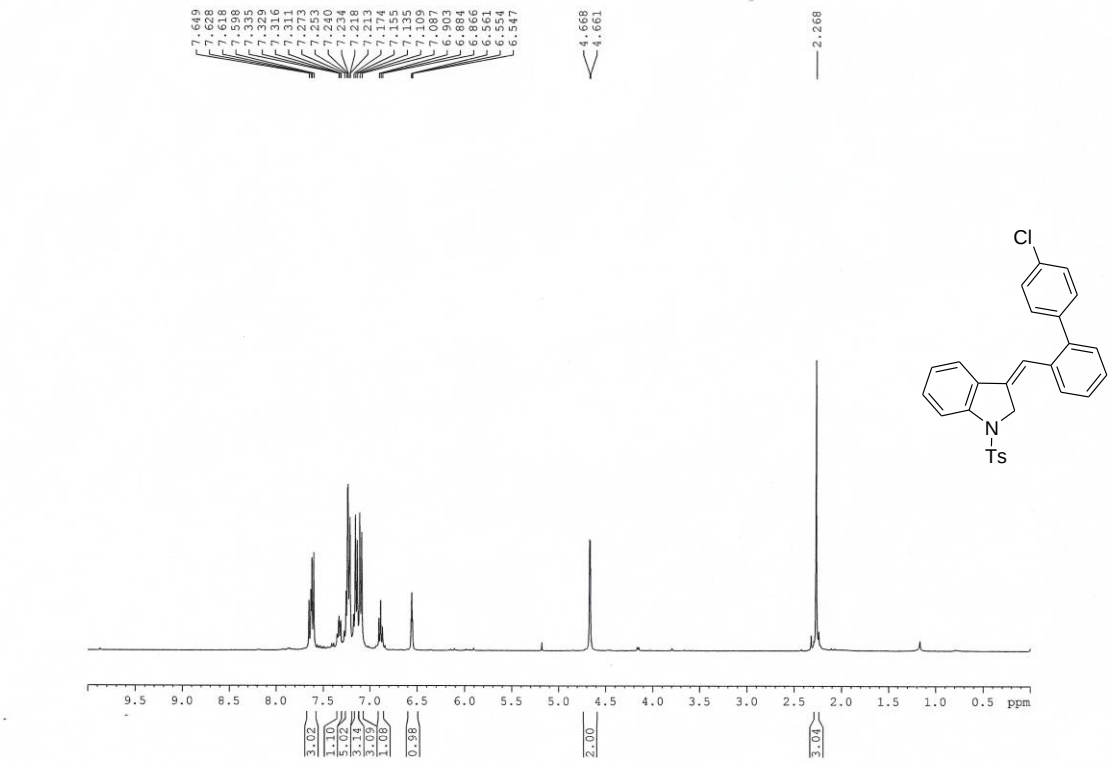


^{13}C NMR of 2c, $CDCl_3$, 100 MHz

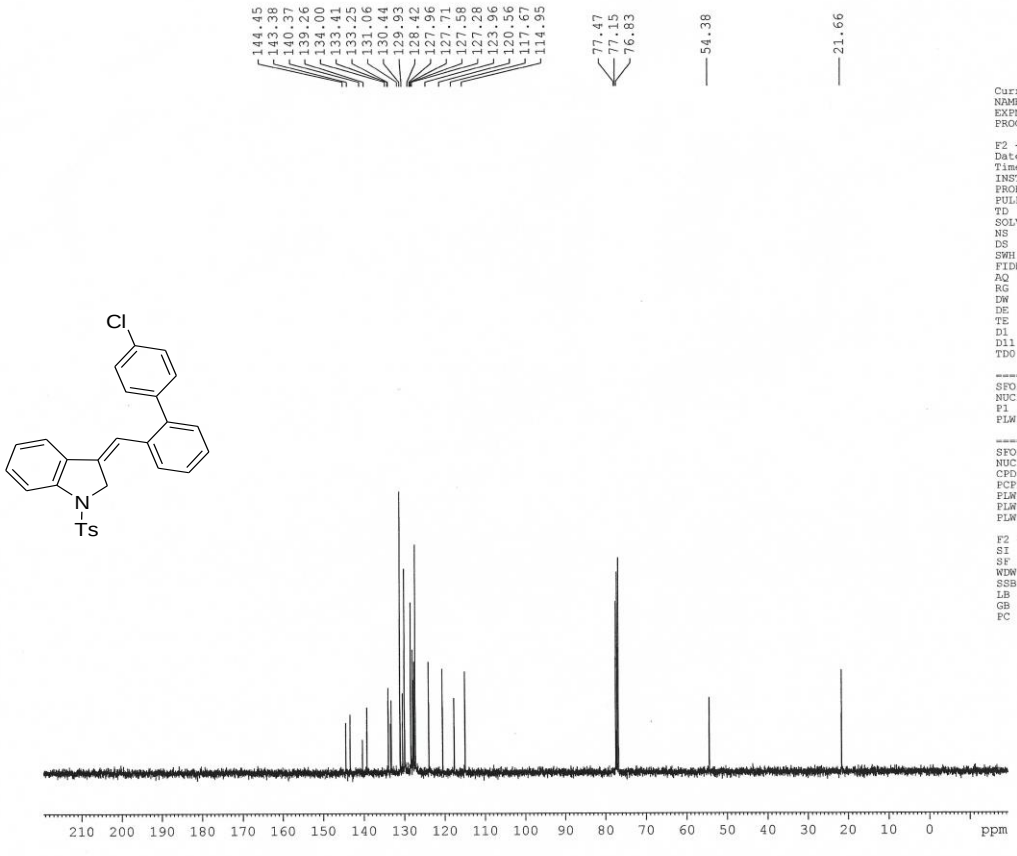



```
Current Data Parameters
NAME      Dr. A HAJRA-2019-13C
EXPNO              191
PROCNO               1

F2 - Acquisition Parameters
Date_          20190505
Time               19.41
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                32768
SOLVENT           CDCl3
NS                  162
DS                    2
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ             0.6815744 sec
RG                77.59
DW               20.800 usec
DE                6.50 usec
TE                296.8 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1         100.6278588 MHz
NUC1               13C
P1                8.90 usec
PLW1         54.00000000 W

======== CHANNEL f2 ========
SFO2         400.1516006 MHz
NUC2               1H
CPDPRG[2          waltz16
PCPD2             90.00 usec
PLW2         12.00000000 W
PLW12         0.32231000 W
PLW13         0.16212000 W

F2 - Processing parameters
SI                16384
SF           100.6177873 MHz
WDW                  EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```

^{1}H NMR of 2d, $CDCl_3$, 400 MHz

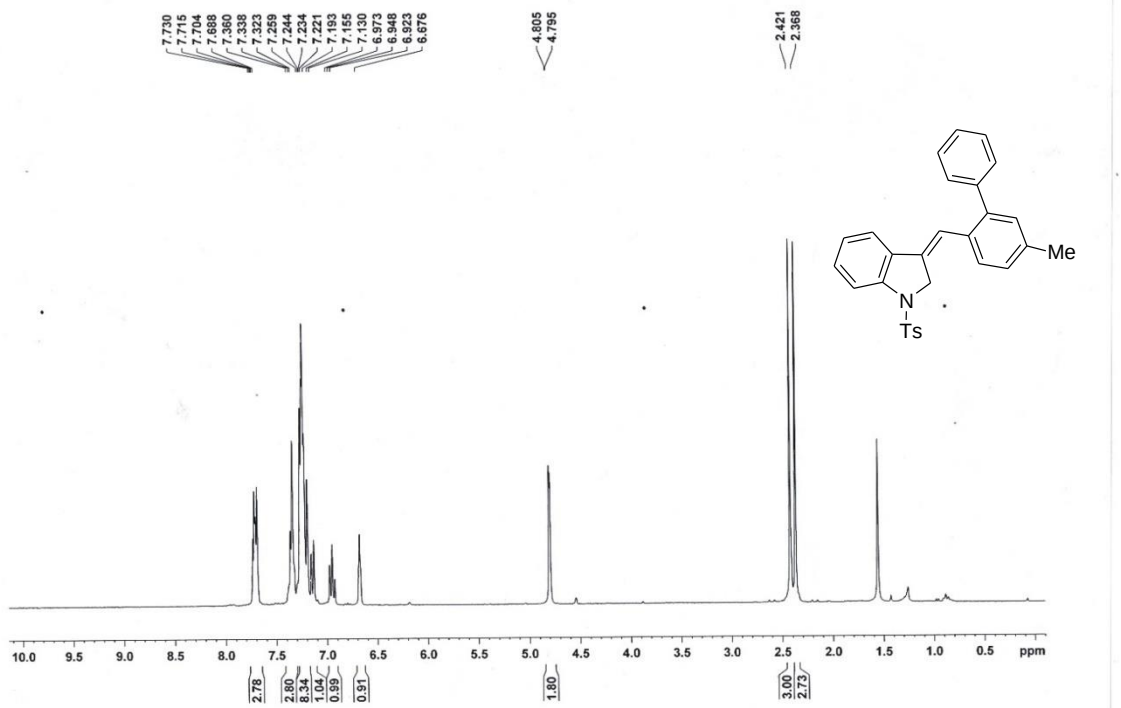


^{13}C NMR of 2d, $CDCl_3$, 100 MHz

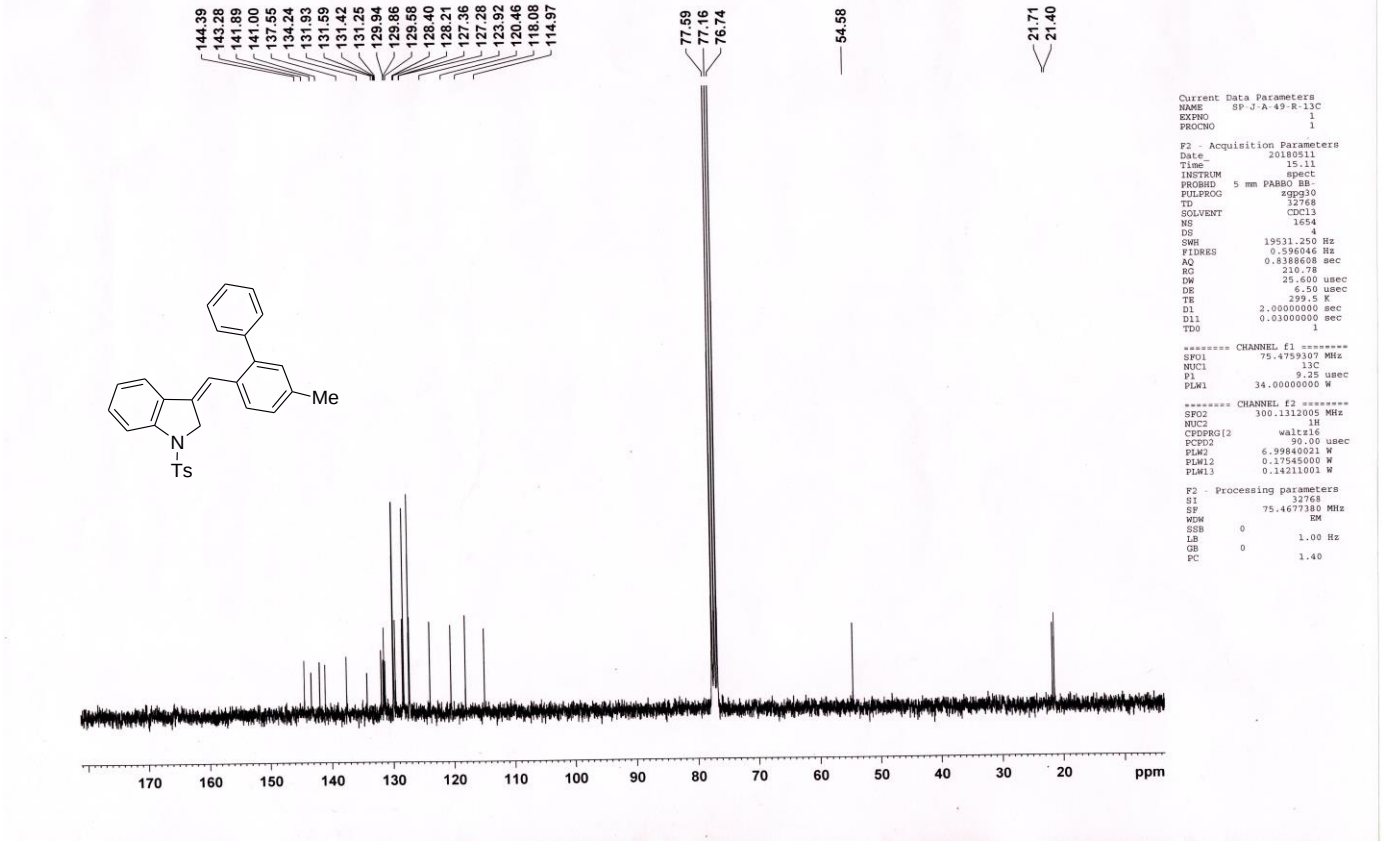



```
Current Data Parameters
NAME        Dr. A HAJRA-2019-13C
EXPNO                        192
PROCNO                         1

F2 - Acquisition Parameters
Date_                   20190505
Time                       19.53
INSTRUM                    spect
PROBHD     5 mm PABBO BB/
PULPROG                 zgpg30
TD                         32768
SOLVENT                    CDCl3
NS                            50
DS                             2
SWH                    24038.461 Hz
FIDRES                 0.733596 Hz
AQ                     0.6815744 sec
RG                         77.59
DW                        20.800 usec
DE                         6.50 usec
TE                        296.7 K
D1                     2.00000000 sec
D11                    0.03000000 sec
TD0                            1

======== CHANNEL f1 ========
SFO1                 100.6278588 MHz
NUC1                         13C
P1                          8.90 usec
PLW1                54.00000000 W

======== CHANNEL f2 ========
SFO2                 400.1516006 MHz
NUC2                         1H
CPDPRG[2                waltz16
PCPD2                      90.00 usec
PLW2                12.00000000 W
PLW12                0.32231000 W
PLW13                0.16212000 W

F2 - Processing parameters
SI                         16384
SF                   100.6177931 MHz
WDW                           EM
SSB                 0
LB                          1.00 Hz
GB                  0
PC                          1.40
```

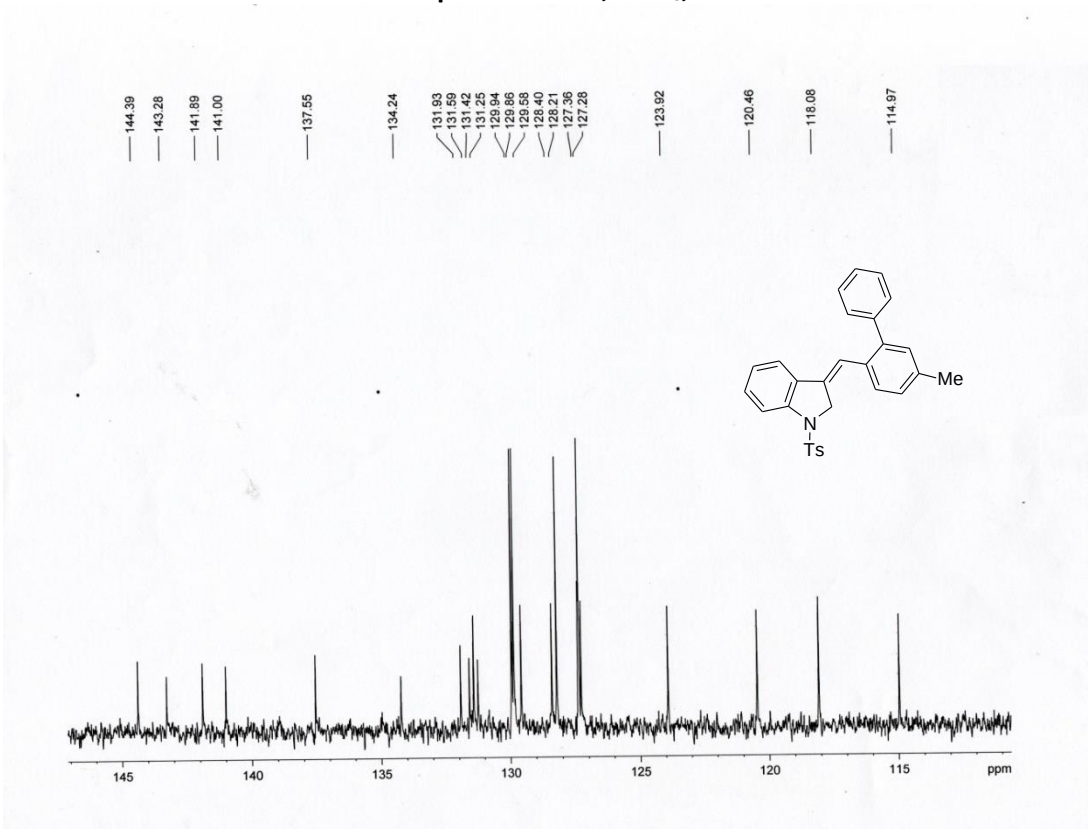
^{1}H NMR of 2e, $CDCl_3$, 300 MHz



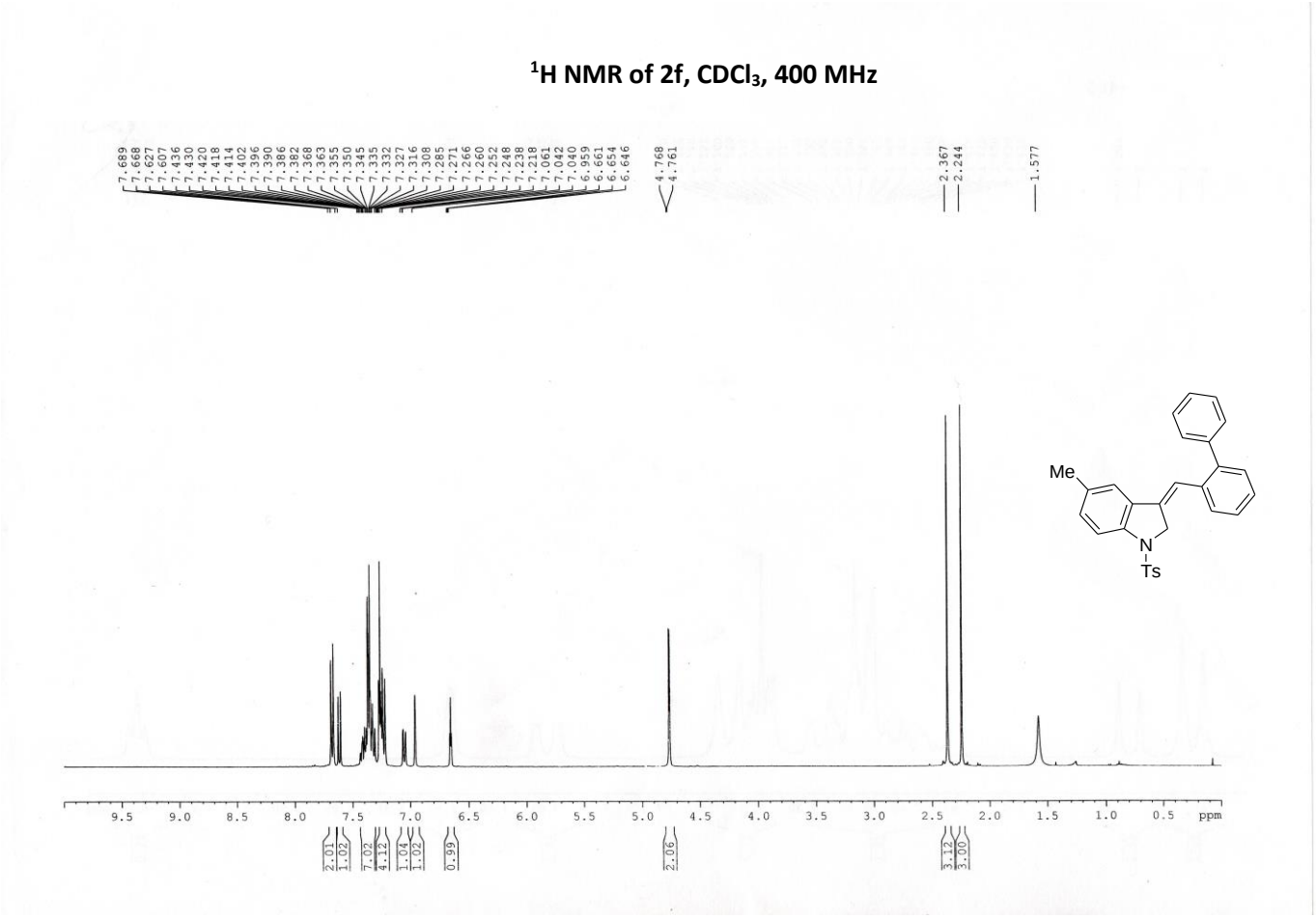
^{13}C NMR of 2e, $CDCl_3$, 75 MHz



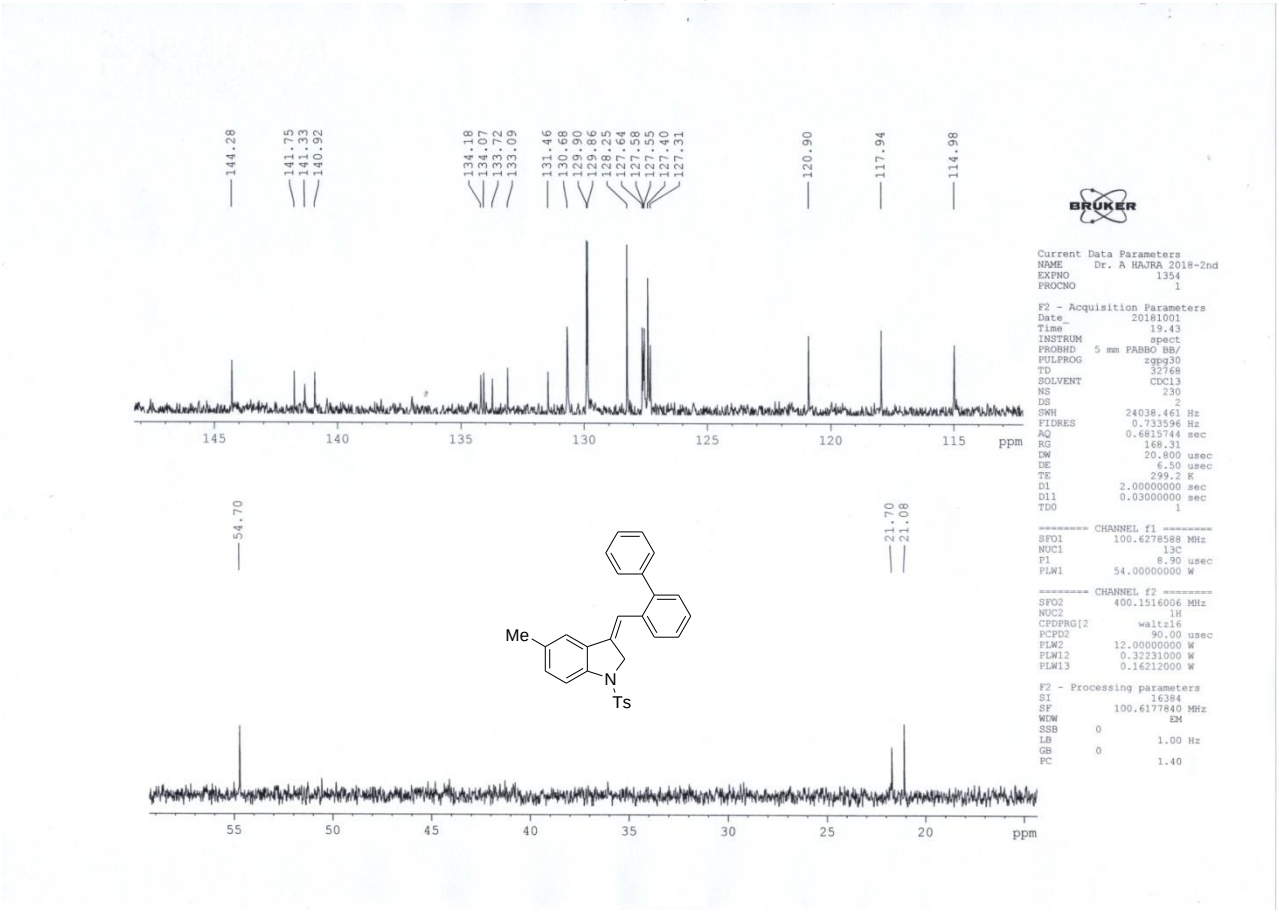
^{13}C NMR expansion of 2e, $CDCl_3$, 75 MHz



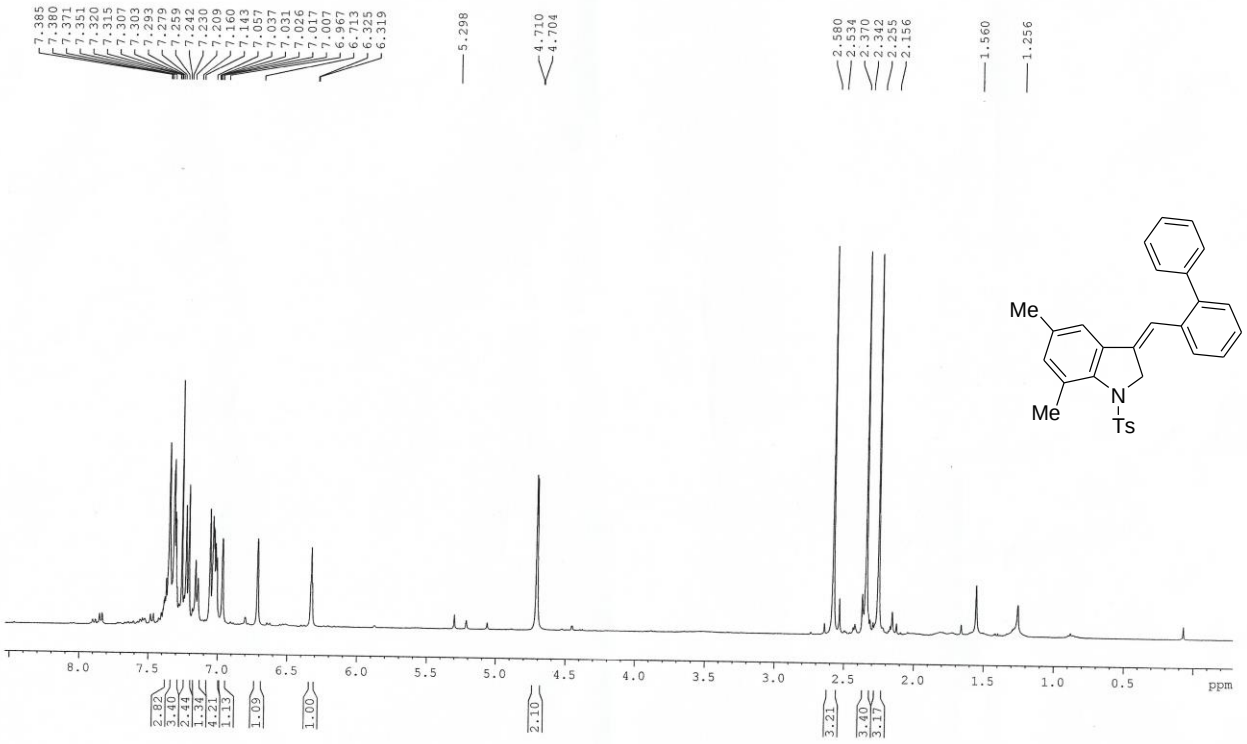
^{1}H NMR of 2f, $CDCl_3$, 400 MHz



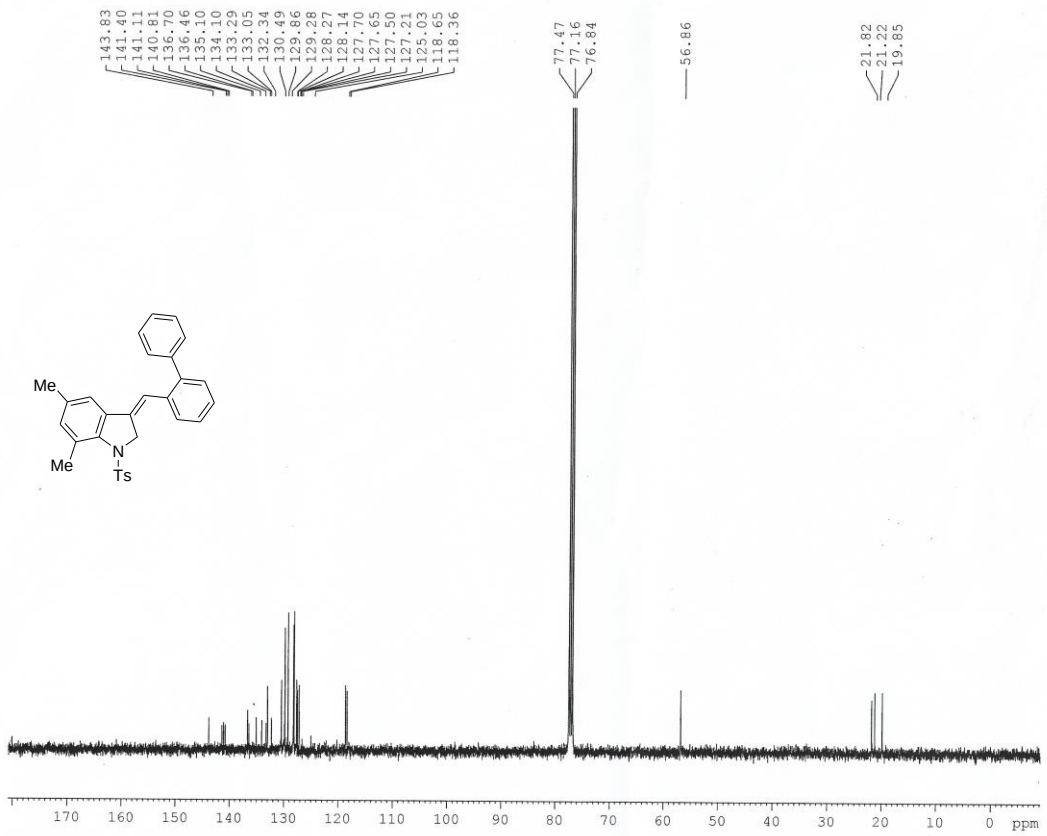
^{13}C NMR of 2f, $CDCl_3$, 300 MHz



^{1}H NMR of 2g, $CDCl_3$, 400 MHz

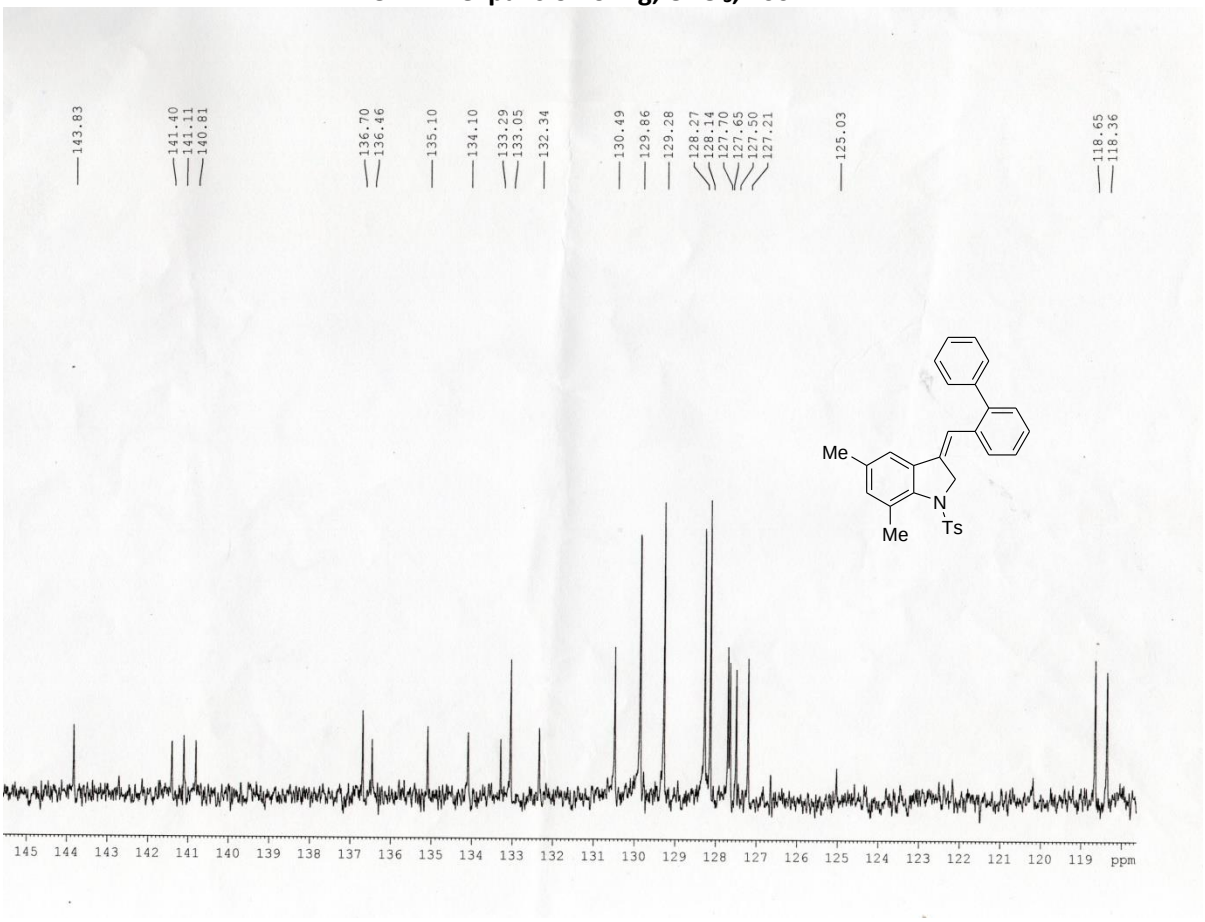


^{13}C NMR of 2g, $CDCl_3$, 100 MHz

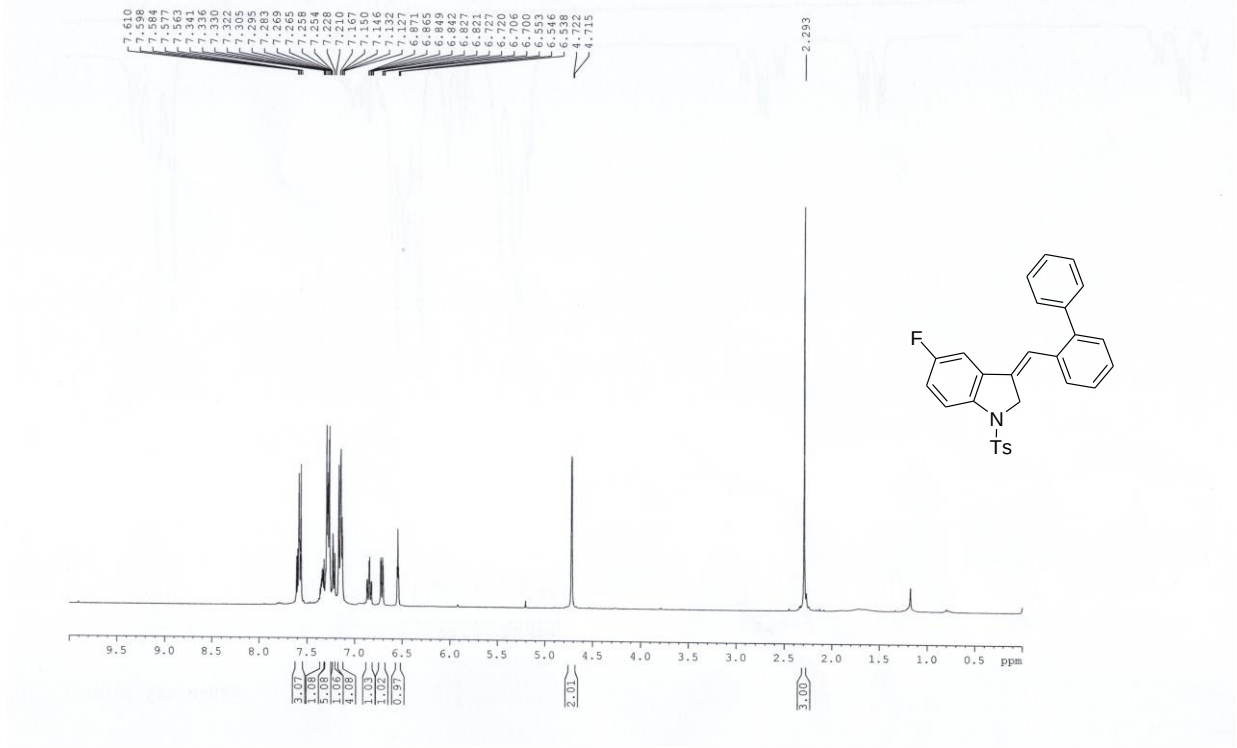



```
Current Data Parameters
NAME      BCR-SJ-AK-96-13C
EXPNO                   10
PROCNO                   1

F2 - Acquisition Parameters
Date_           20181011
Time              17.38
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG         zgpg30
TD              32768
SOLVENT           CDCl3
NS                 1656
DS                    4
SWH           24038.461 Hz
FIDRES        0.733596 Hz
AQ            0.6815744 sec
RG                  203
DW             20.800 usec
DE              6.50 usec
TE        0 K
D1          2.00000000 sec
D11         0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        100.6404326 MHz
NUC1                13C
P1                11.00 usec
PLW1        55.00000000 W

======== CHANNEL f2 ========
SFO2        400.2016008 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        10.00000000 W
PLW12        0.36736000 W
PLW13        0.29756001 W

F2 - Processing parameters
SI                 32768
SF          100.6303531 MHz
WDW                   EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
```

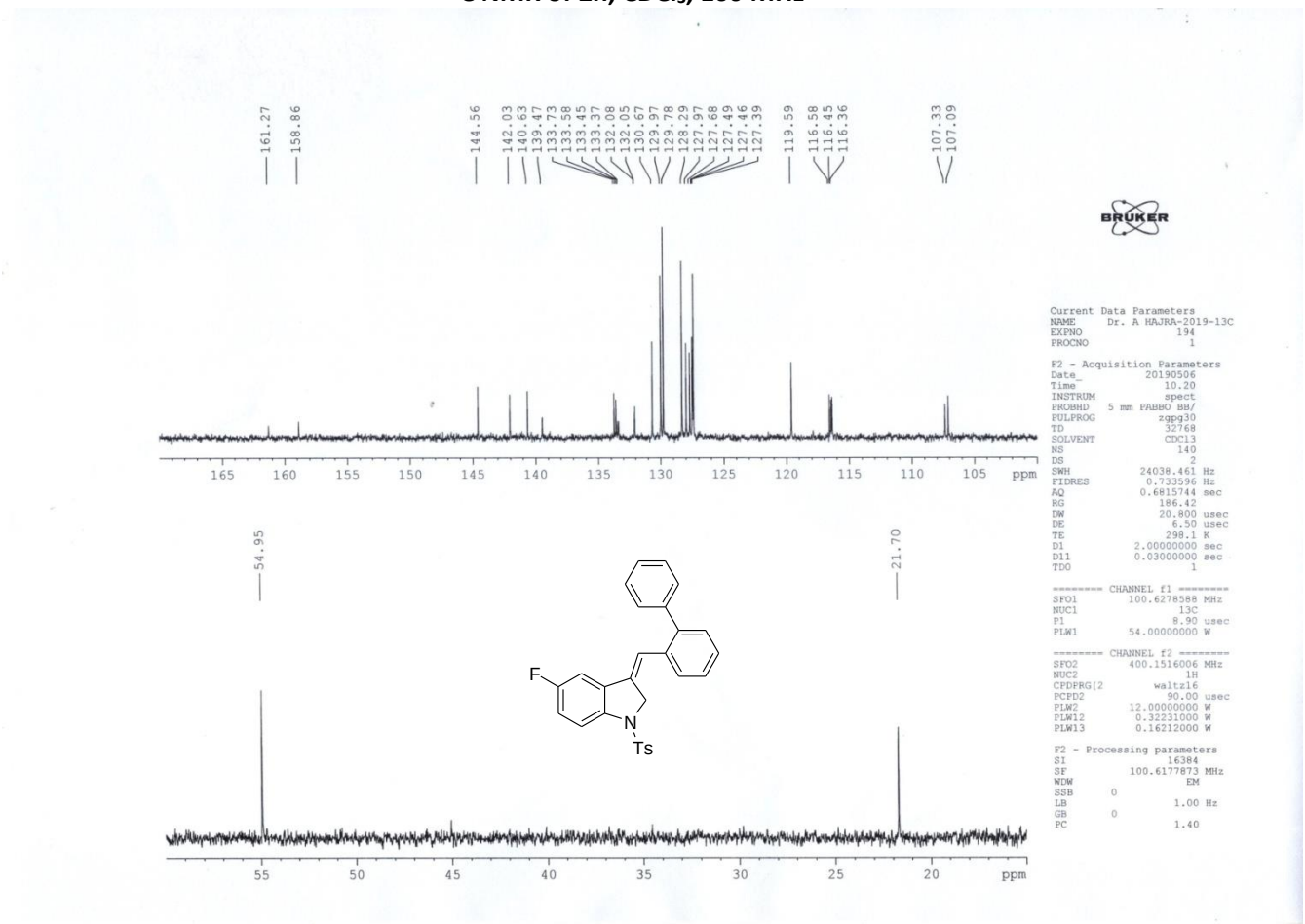
^{13}C NMR expansion of 2g, $CDCl_3$, 100 MHz



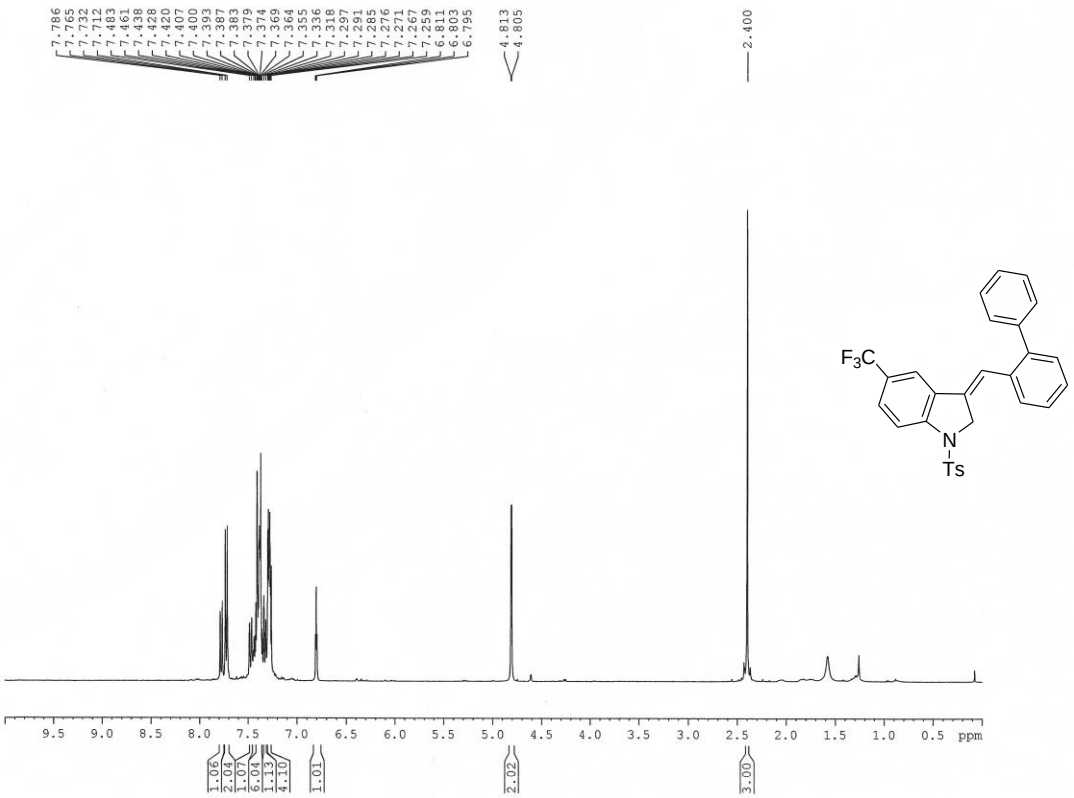
^{1}H NMR of 2h, $CDCl_3$, 400 MHz



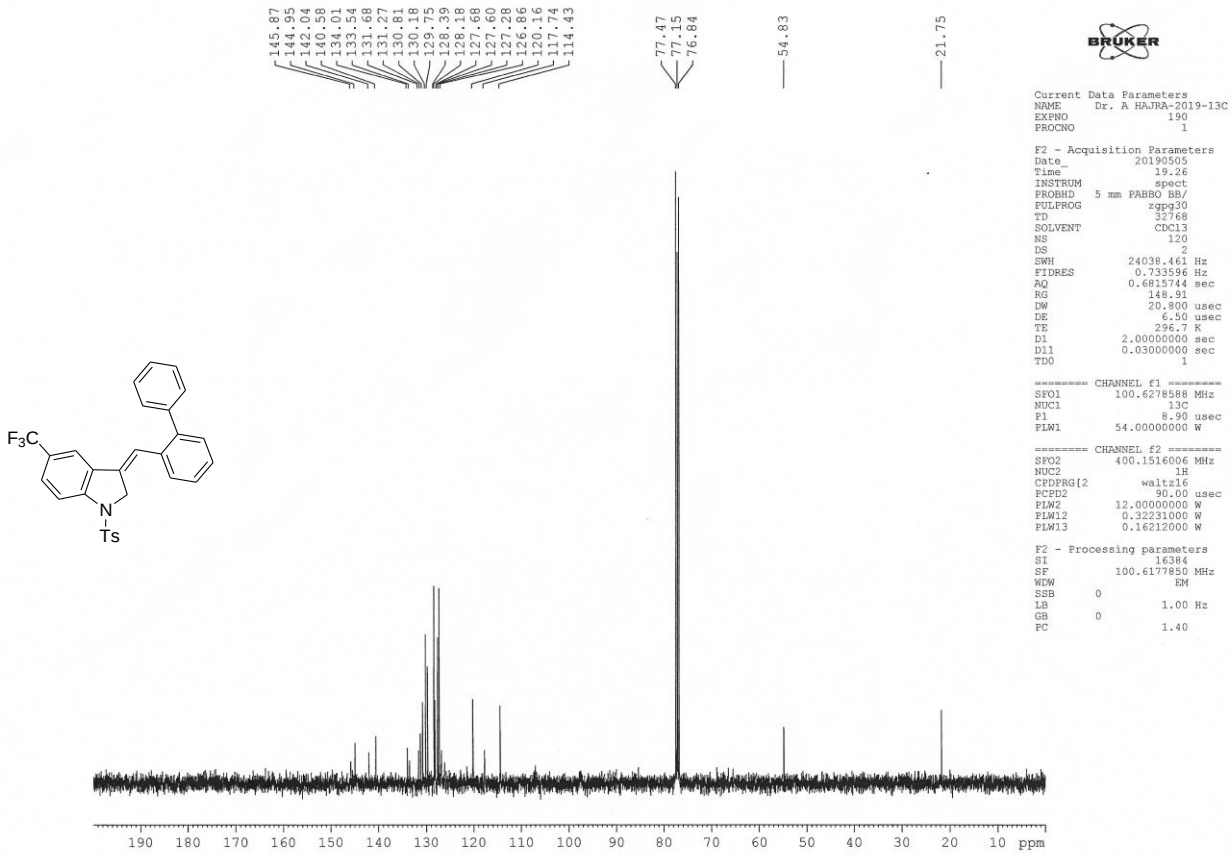
^{13}C NMR of 2h, $CDCl_3$, 100 MHz



^{1}H NMR of 2i, $CDCl_3$, 400 MHz

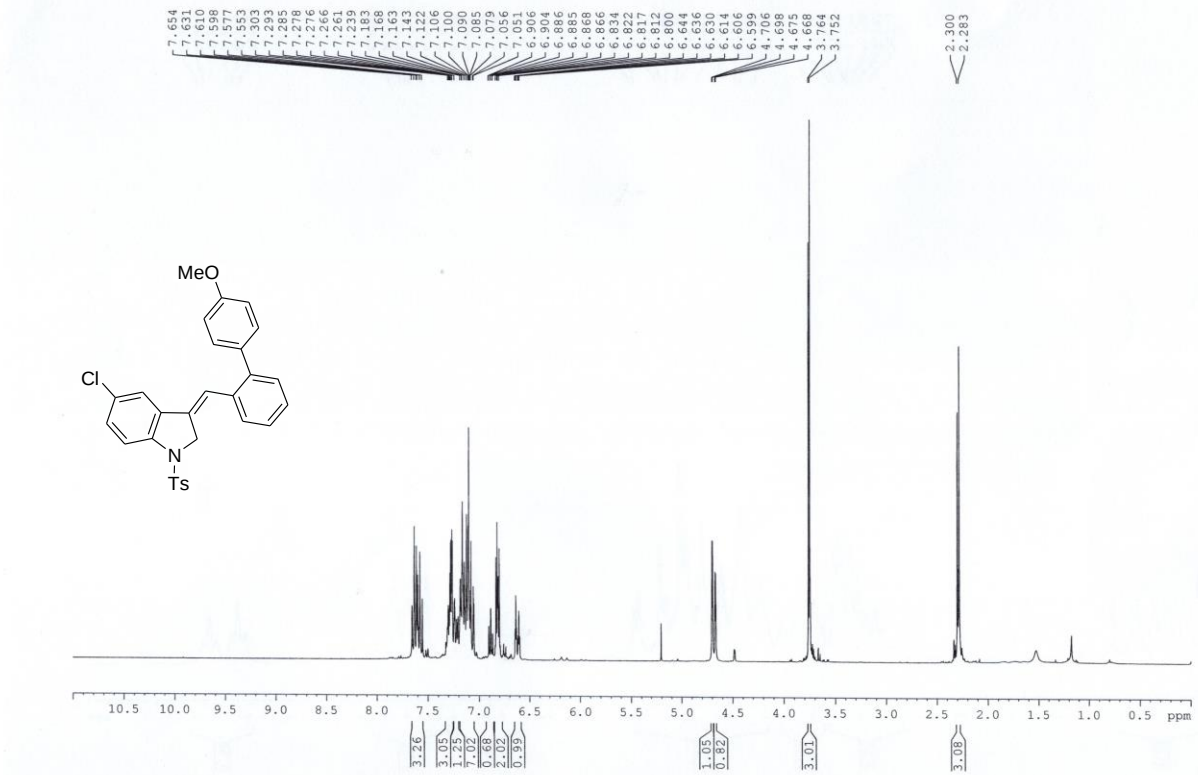


^{13}C NMR of 2i, $CDCl_3$, 100 MHz

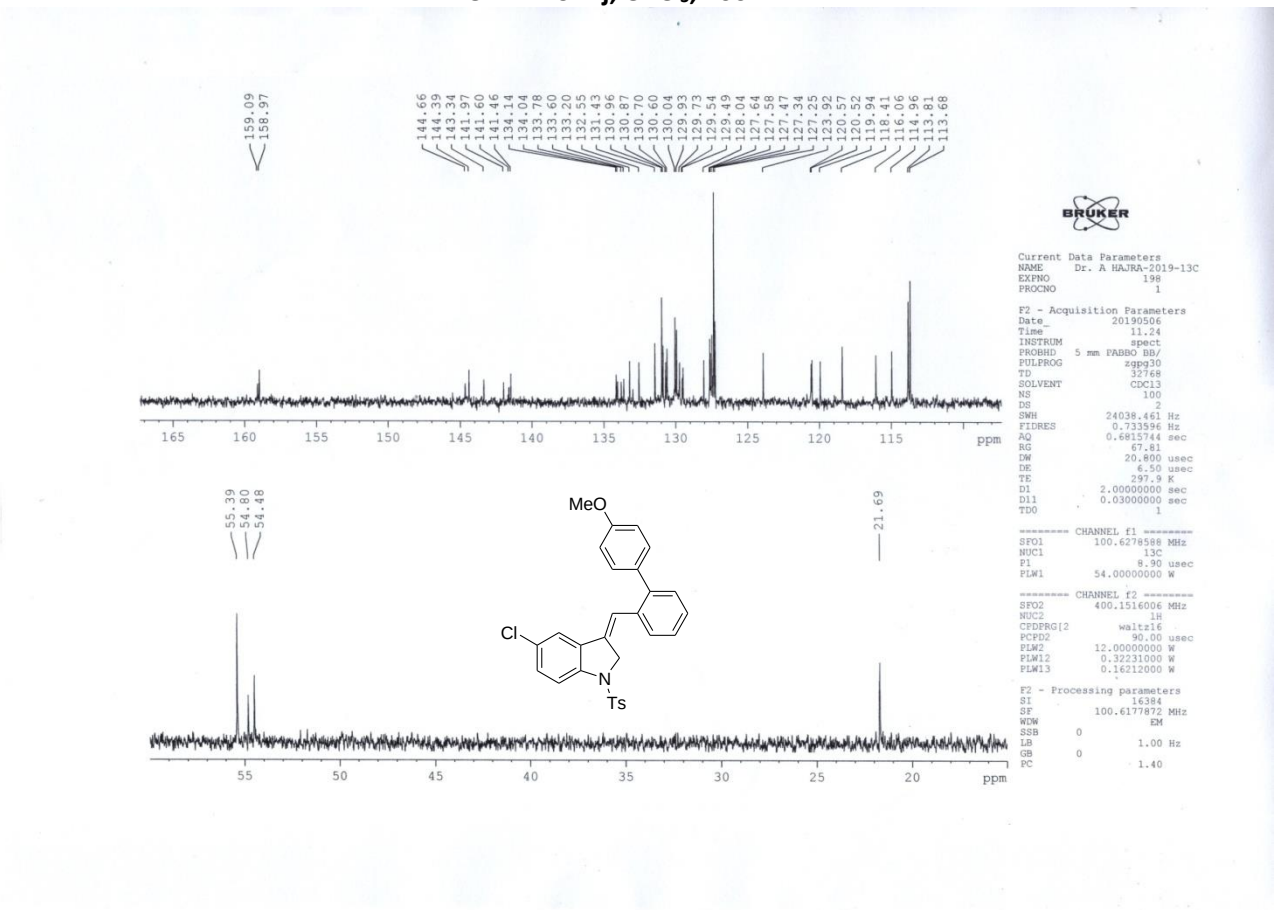



```
Current Data Parameters
NAME      Dr. A HAJRA-2019-13C
EXPNO                  190
PROCNO                   1

F2 - Acquisition Parameters
Date_              20190505
Time                 19.26
INSTRUM              spect
PROBHD    5 mm PABBO BB/
PULPROG            zgpg30
TD                  32768
SOLVENT             CDCl3
NS                    120
DS                      2
SWH              24038.461 Hz
FIDRES           0.733596 Hz
AQ               0.6815744 sec
RG                  148.91
DW                 20.800 usec
DE                  6.50 usec
TE                 296.7 K
D1              2.00000000 sec
D11             0.03000000 sec
TD0                     1

======== CHANNEL f1 ========
SFO1          100.6278588 MHz
NUC1                    13C
P1                   8.90 usec
PLW1          54.00000000 W

======== CHANNEL f2 ========
SFO2          400.1516006 MHz
NUC2                    1H
CPDPRG[2          waltz16
PCPD2               90.00 usec
PLW2          12.00000000 W
PLW12          0.32231000 W
PLW13          0.16212000 W

F2 - Processing parameters
SI                    16384
SF            100.6177850 MHz
WDW                     EM
SSB       0
LB                   1.00 Hz
GB        0
PC                   1.40
```

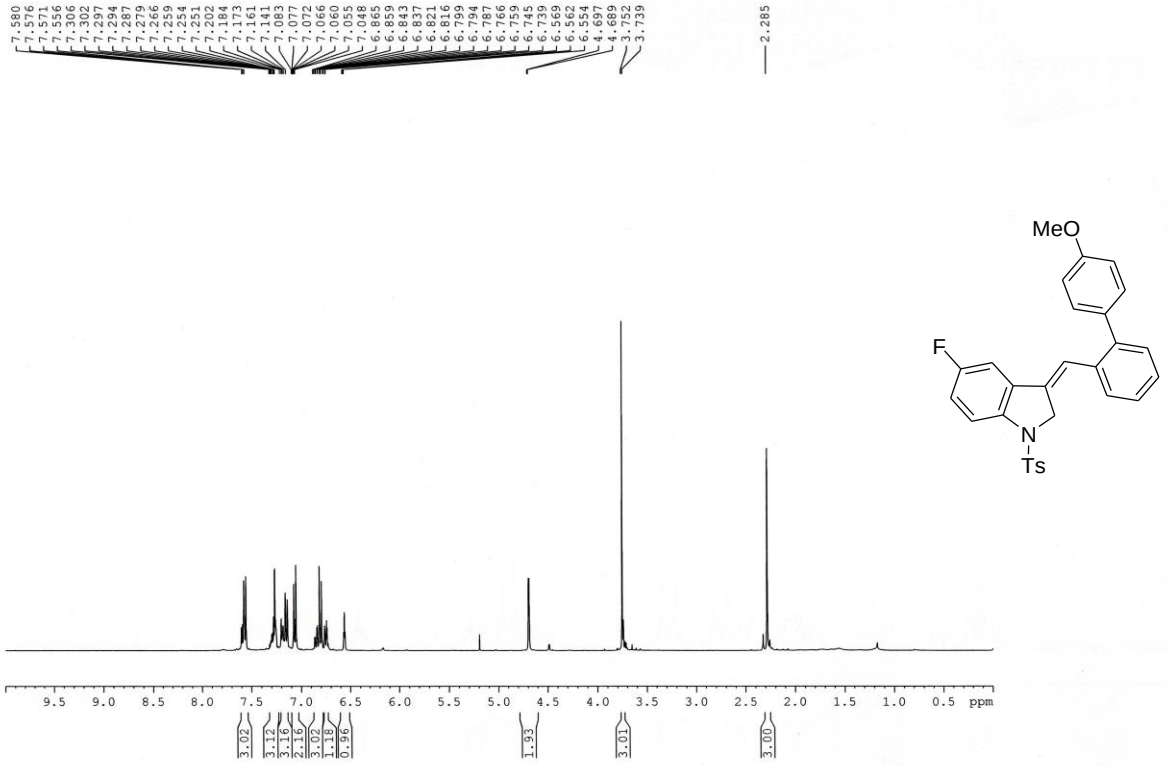
^{1}H NMR of 2j, $CDCl_3$, 400 MHz



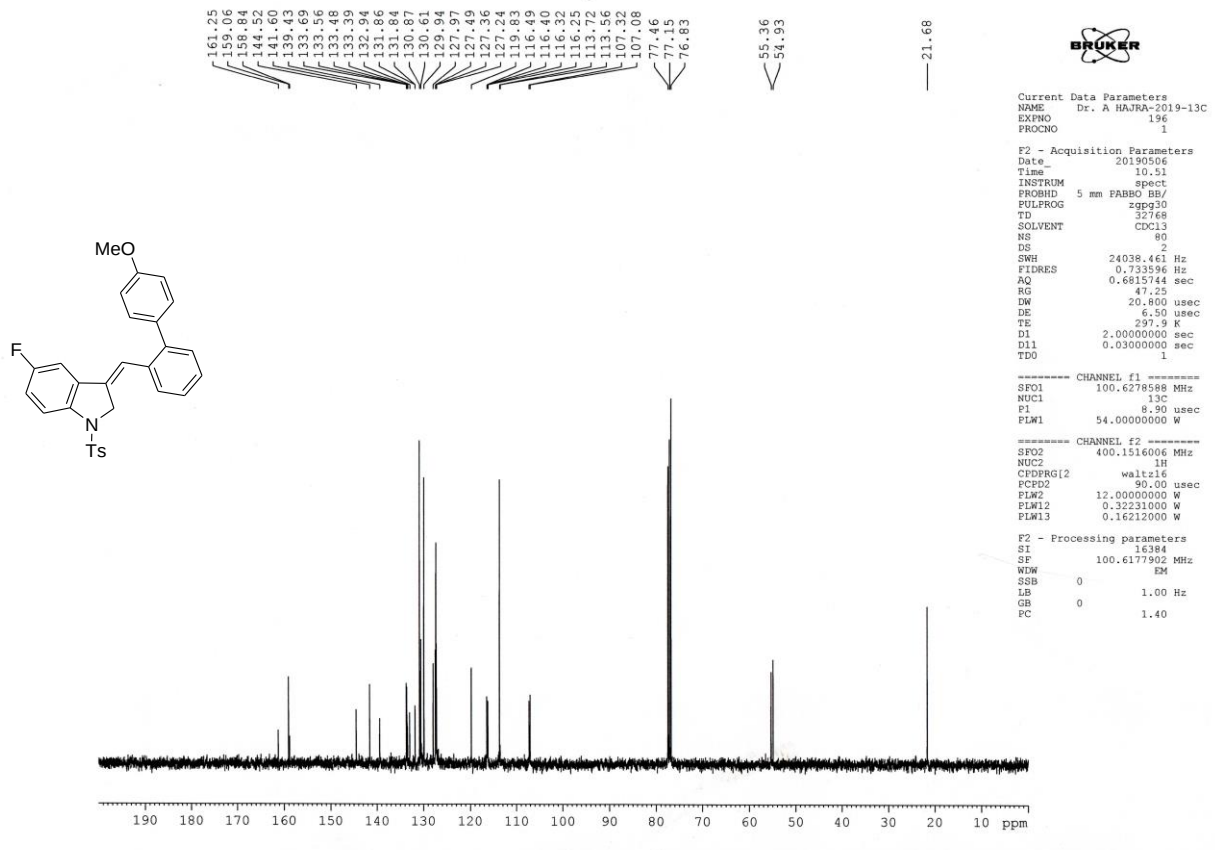
^{13}C NMR of 2j, $CDCl_3$, 100 MHz



^{1}H NMR of 2k, $CDCl_3$, 400 MHz

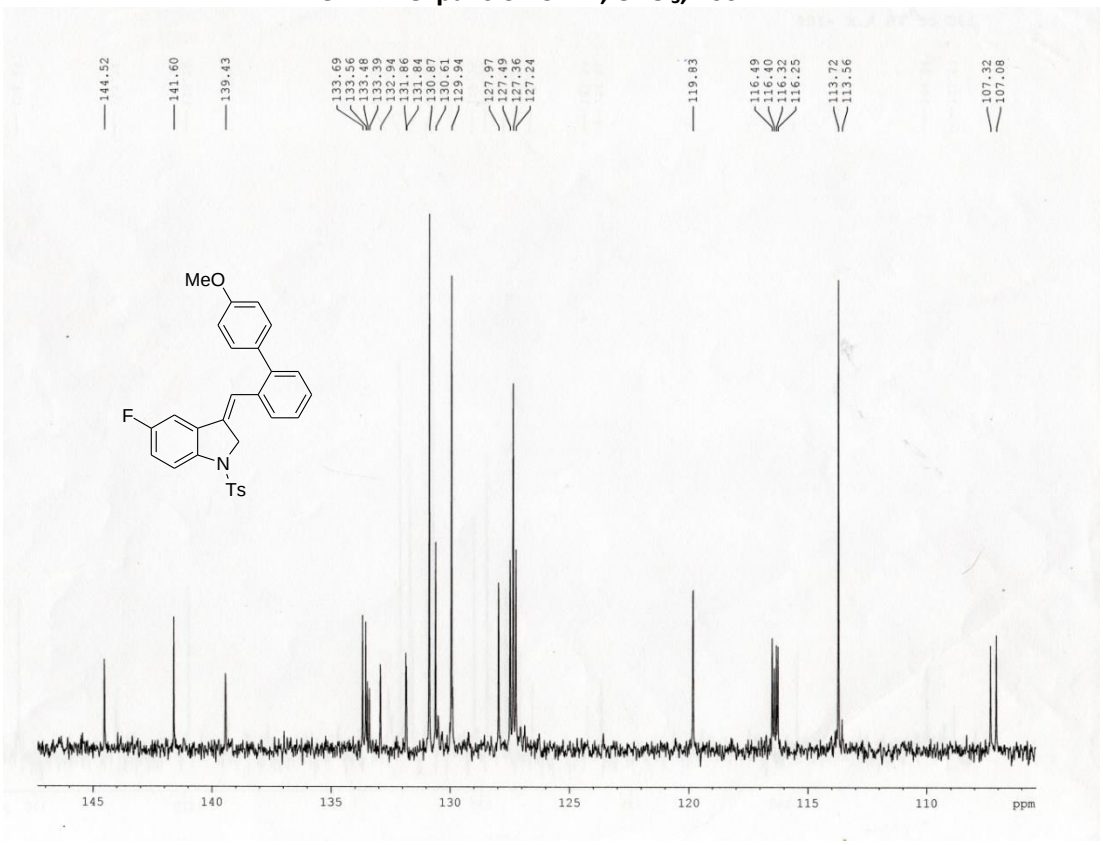


^{13}C NMR of 2k, $CDCl_3$, 100 MHz

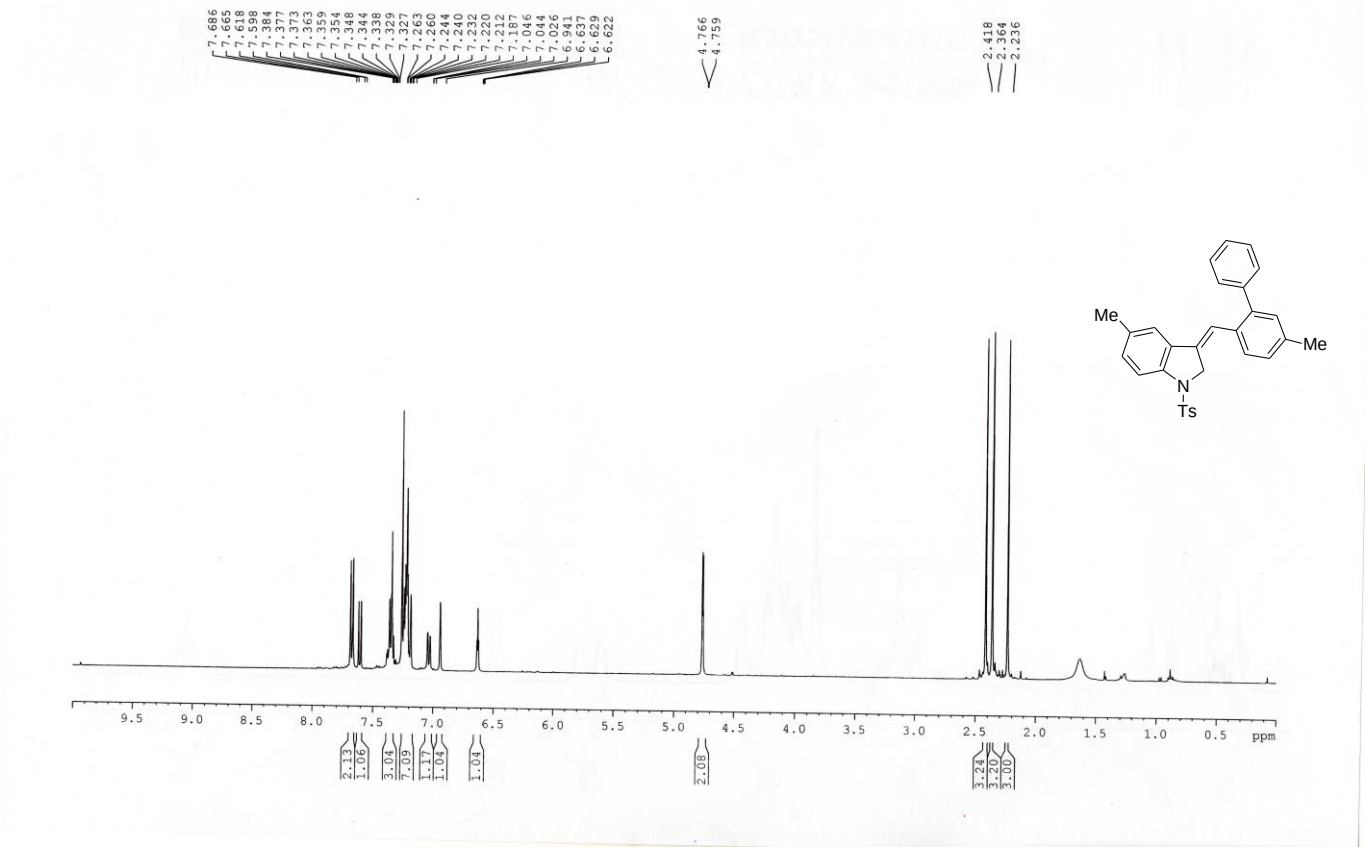



```
Current Data Parameters
NAME      Dr. A HAJRA-2019-13C
EXPNO              196
PROCNO               1

F2 - Acquisition Parameters
Date_          20190506
Time             10.51
INSTRUM          spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD              32768
SOLVENT          CDCl3
NS                  80
DS                   2
SWH          24038.461 Hz
FIDRES         0.733596 Hz
AQ             0.6815744 sec
RG                47.25
DW                20.800 usec
DE                 6.50 usec
TE                297.9 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1         100.6278588 MHz
NUC1               13C
P1                 8.90 usec
PLW1        54.00000000 W

======== CHANNEL f2 ========
SFO2         400.1516006 MHz
NUC2               1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.00000000 W
PLW12        0.32231000 W
PLW13        0.16212000 W

F2 - Processing parameters
SI                32768
SF           100.6177902 MHz
WDW                  EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```

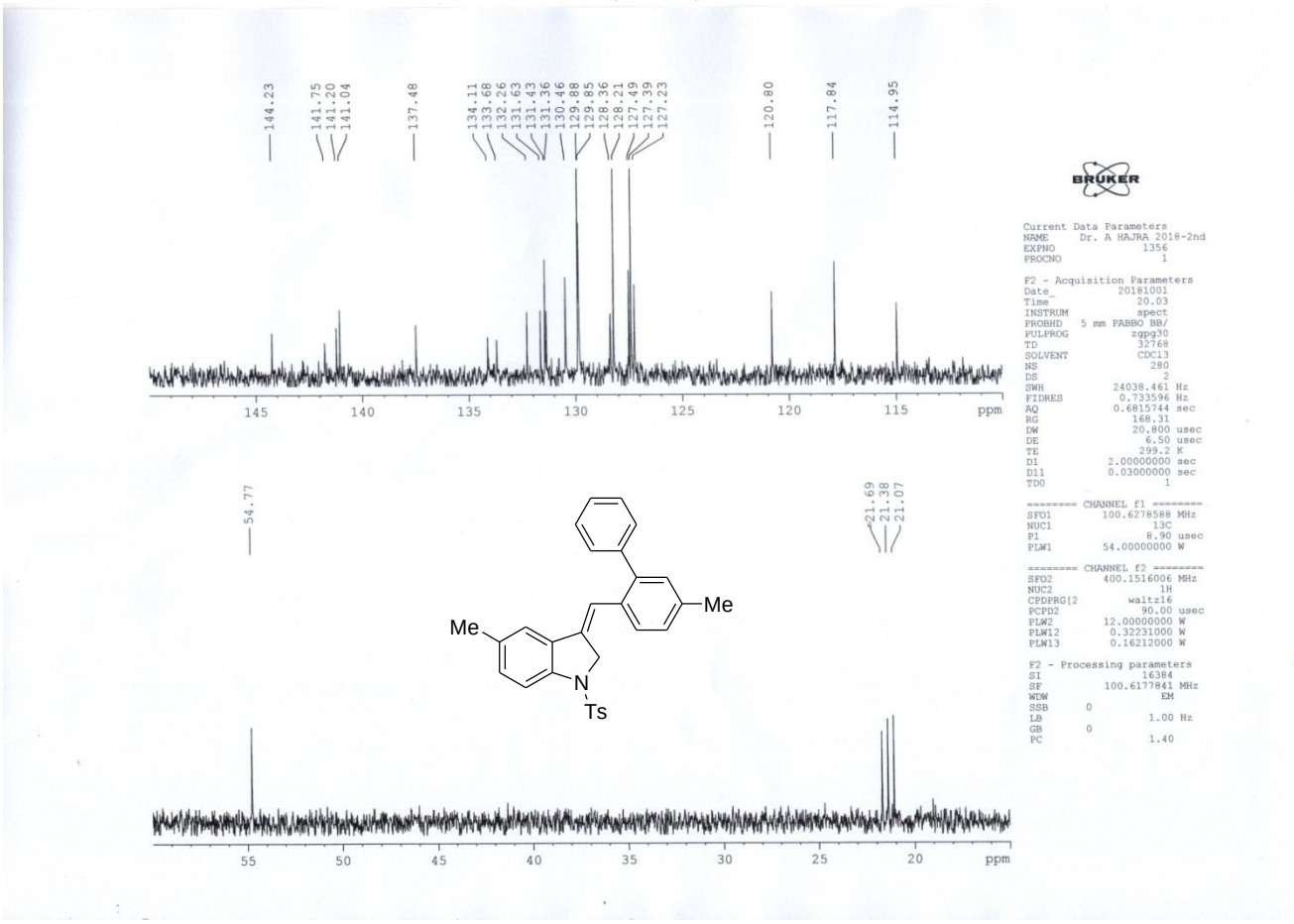
^{13}C NMR expansion of 2k, $CDCl_3$, 100 MHz



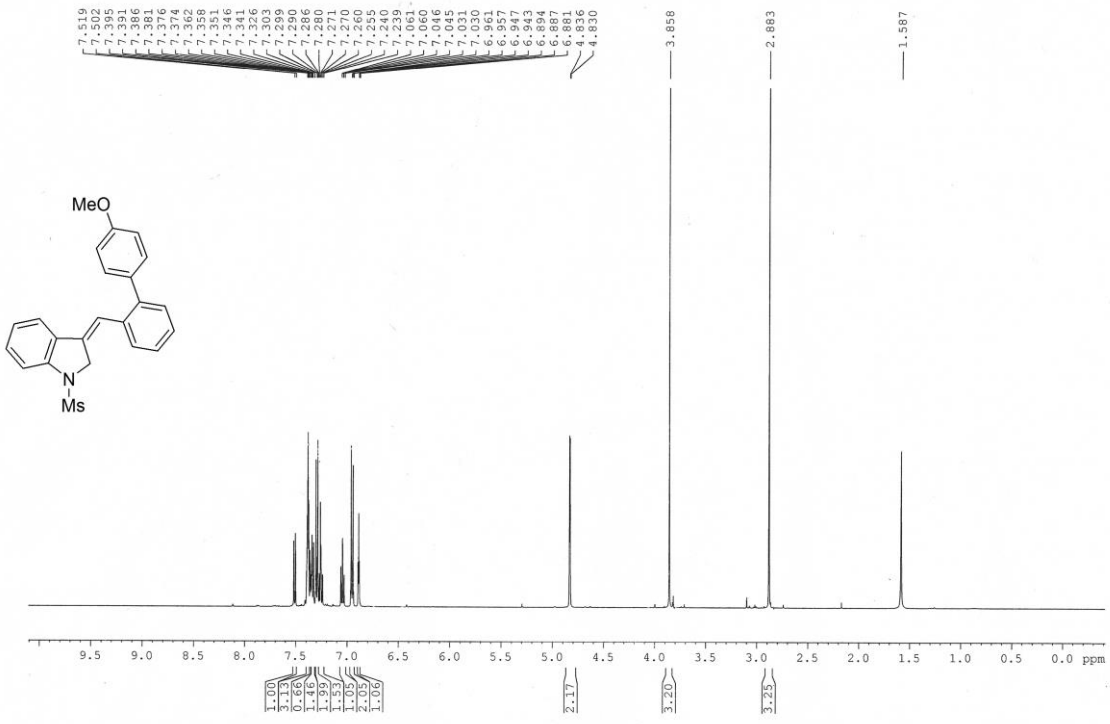
^{1}H NMR of 2l, $CDCl_3$, 400 MHz



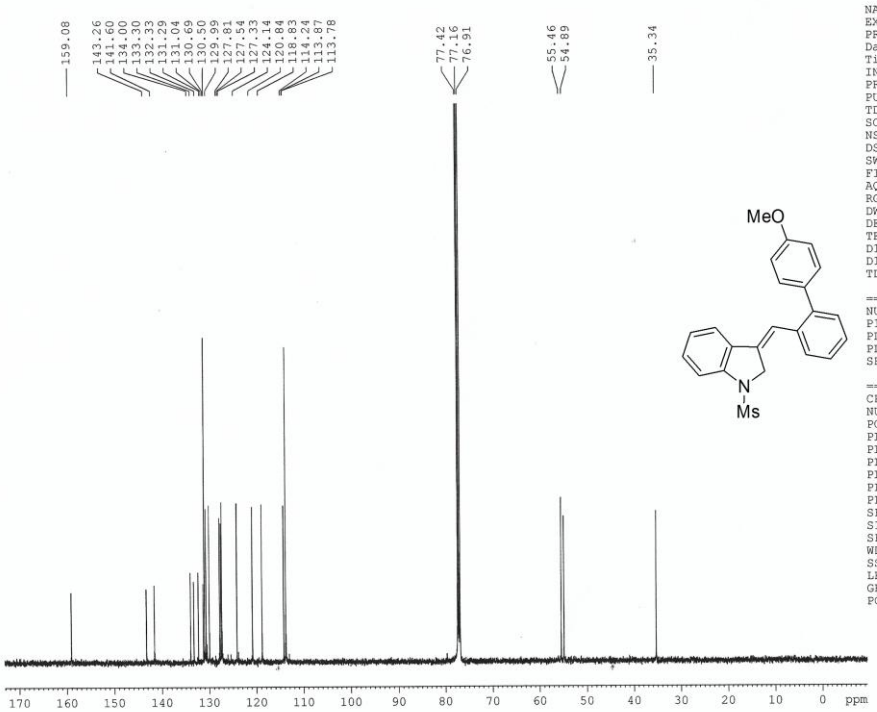
^{13}C NMR of 2l, $CDCl_3$, 100 MHz



^{1}H NMR of 2m, $CDCl_3$, 500 MHz

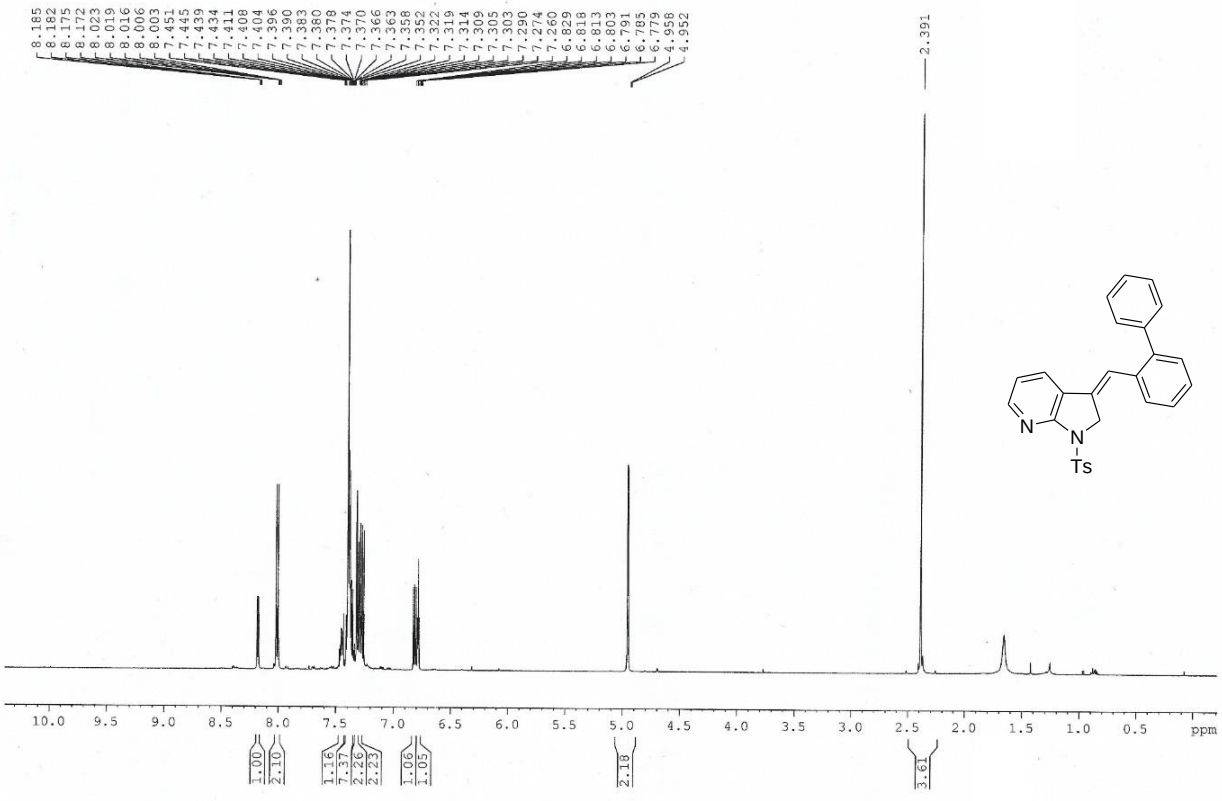


^{13}CNMR of 2m, $CDCl_3$, 125 MHz

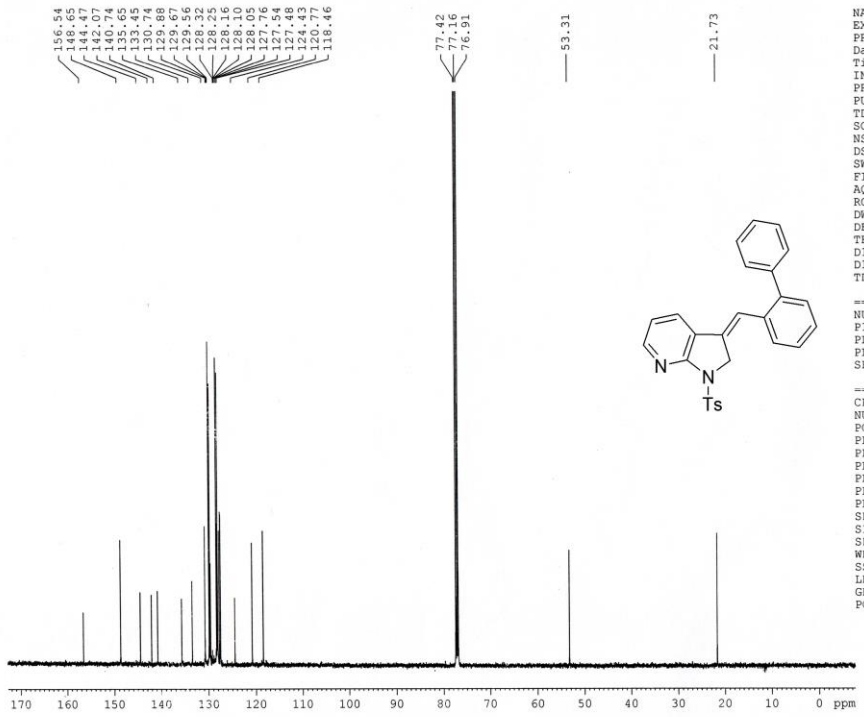



```
NAME          TG-AK-135R-13C
EXPNO                      1
PROCNO                     1
Date_               20190706
Time                   19.28
INSTRUM                spect
PROBHD   5 mm SEI 1H/D-
PULPROG                zgpg30
TD                      32768
SOLVENT                CDCl3
NS                      4000
DS                         2
SWH                29761.904 Hz
FIDRES                 0.908261 Hz
AQ                     0.5505524 sec
RG                        32
DW                        16.800 usec
DE                         6.50 usec
TE                       299.3 K
D1                     2.00000000 sec
D11                    0.03000000 sec
TD0                        1

======== CHANNEL f1 ========
NUC1                      13C
P1                        15.00 usec
PL1                        0.00 dB
PL1W                  92.18623352 W
SFO1                 125.7955118 MHz

======== CHANNEL f2 ========
CPDPRG2                waltz16
NUC2                      1H
PCPD2                     80.00 usec
PL2                        1.00 dB
PL12                      21.86 dB
PL13                      25.00 dB
PL2W                  15.50318813 W
PL12W                  0.12718062 W
PL13W                  0.06171930 W
SFO2                 500.2320009 MHz
SI                        32768
SF                   125.7829180 MHz
WDW                          EM
SSB                           0
LB                         1.00 Hz
GB                            0
PC                         1.40
```

^{1}H NMR of 2n, $CDCl_3$, 500 MHz

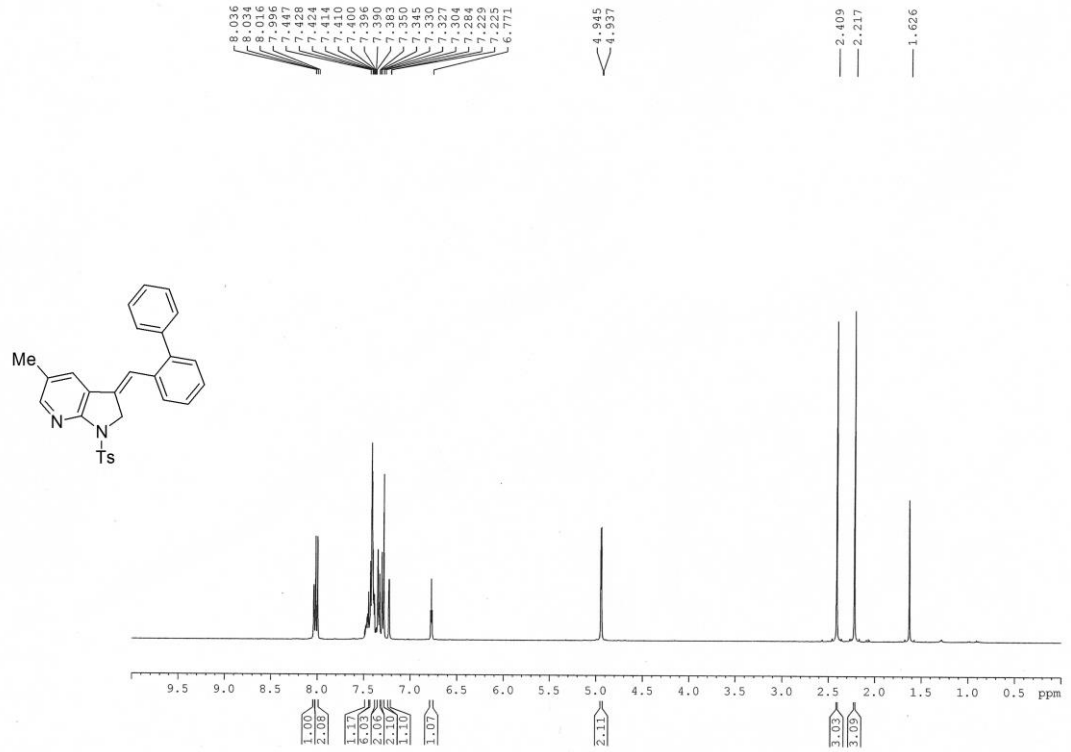


^{13}C NMR of 2n, $CDCl_3$, 125 MHz

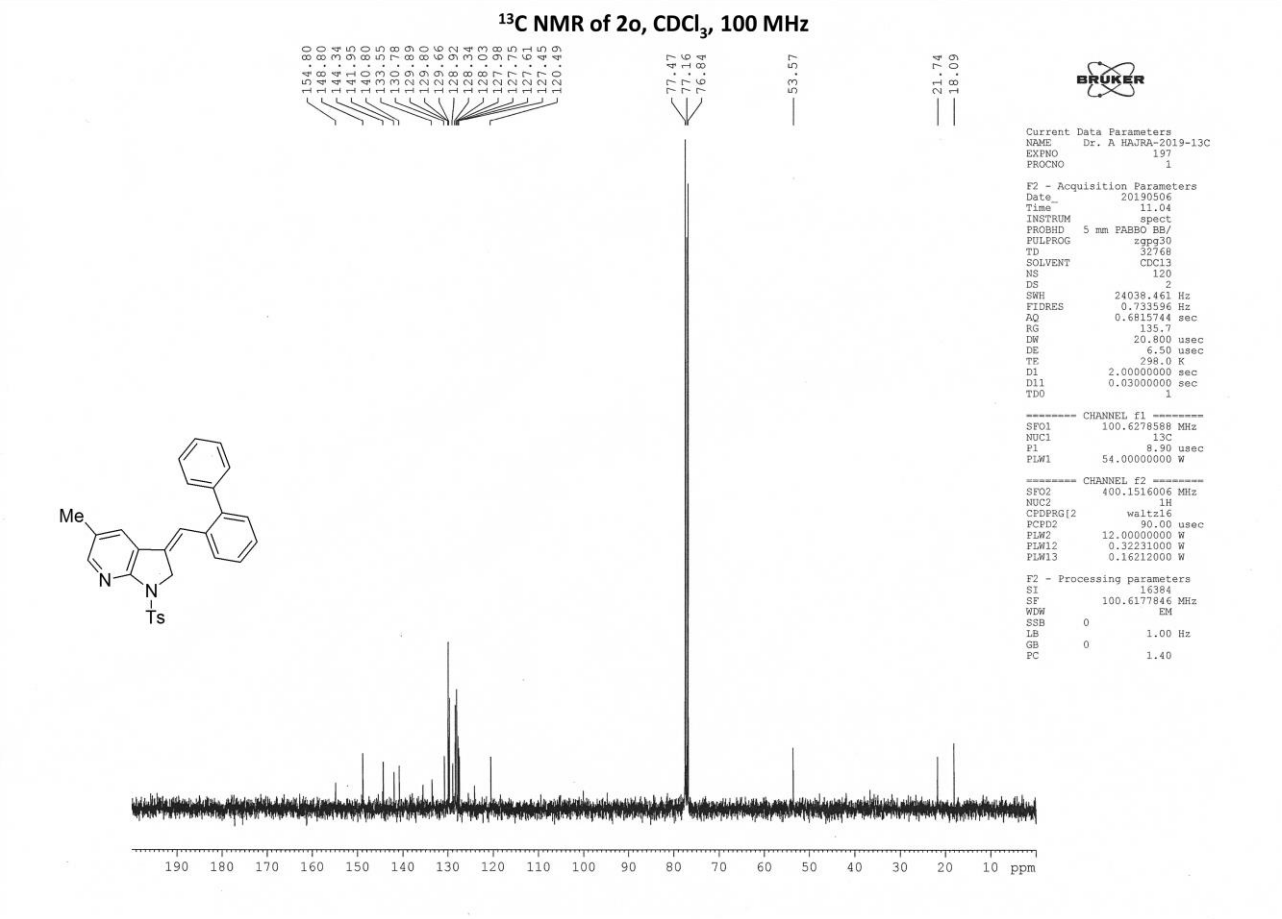


NAME	TG-AJ-123BR-13C
EXPNO	1
PROCNO	1
Date_	20190706
Time	16.30
INSTRUM	spect
PROBHD	5 mm SEI 1H/D-
PULPROG	zgpg30
TD	32768
SOLVENT	CDCl3
NS	4000
DS	2
SWH	29761.904 Hz
FIDRES	0.908261 Hz
AQ	0.5505524 sec
RG	32
DW	16.800 usec
DE	6.50 usec
TE	298.7 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	13C
P1	15.00 usec
PL1	0.00 dB
PL1W	92.18623352 W
SFO1	125.7955118 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.00 dB
PL12	21.86 dB
PL13	25.00 dB
PL2W	15.50318813 W
PL12W	0.12718062 W
PL13W	0.06171930 W
SFO2	500.2320009 MHz
SI	32768
SF	125.7829193 MHz
WDW	EM
SSB	0
LB	1.00 Hz
GB	0
PC	1.40

^{1}H NMR of 2o, $CDCl_3$, 400 MHz



^{13}C NMR of 2o, $CDCl_3$, 100 MHz



Current Data Parameters
NAME Dr. A HAJRA-2019-13C
EXPNO 197
PROCNO 1

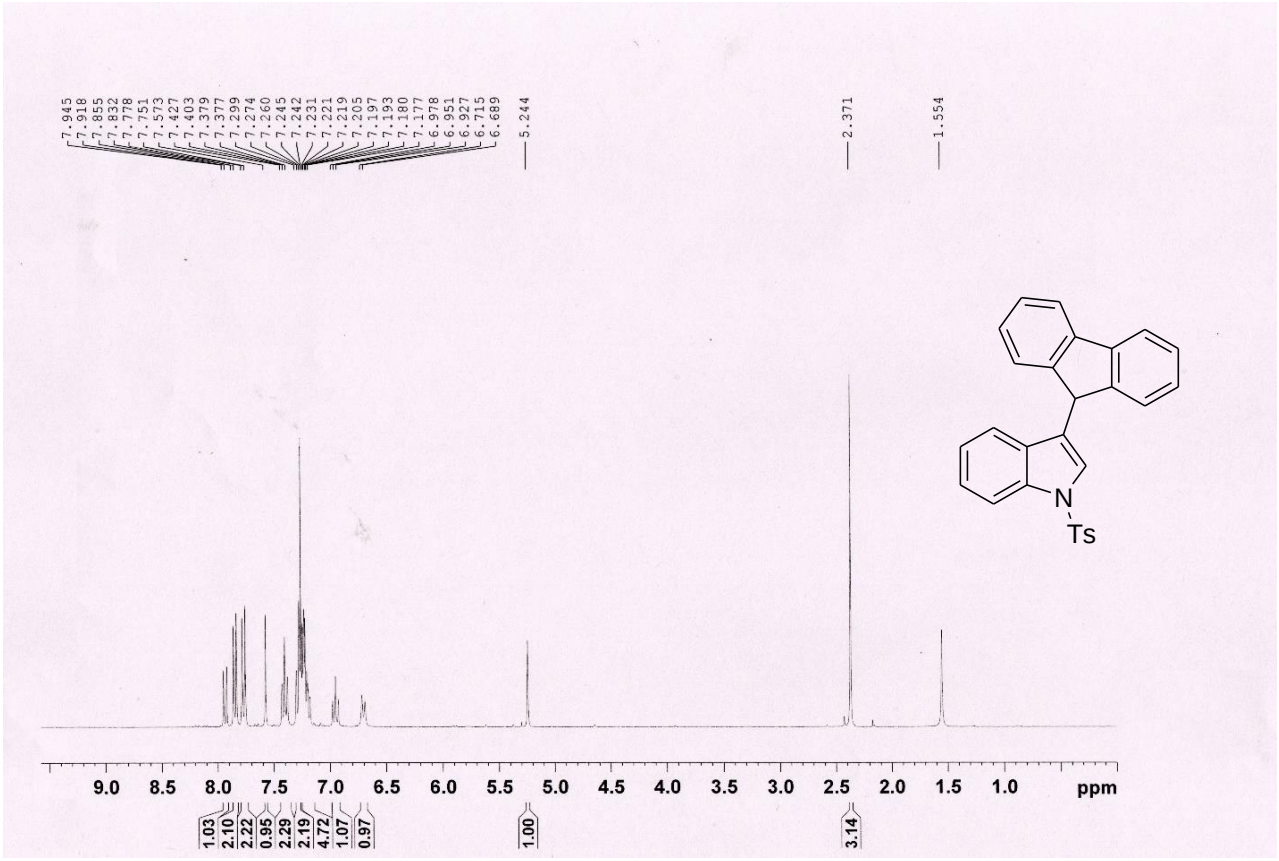
F2 - Acquisition Parameters
Date_ 20190506
Time 11.04
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 120
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 135.7
DW 20.800 usec
DE 6.50 usec
TE 298.0 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

======== CHANNEL f1 ========
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W

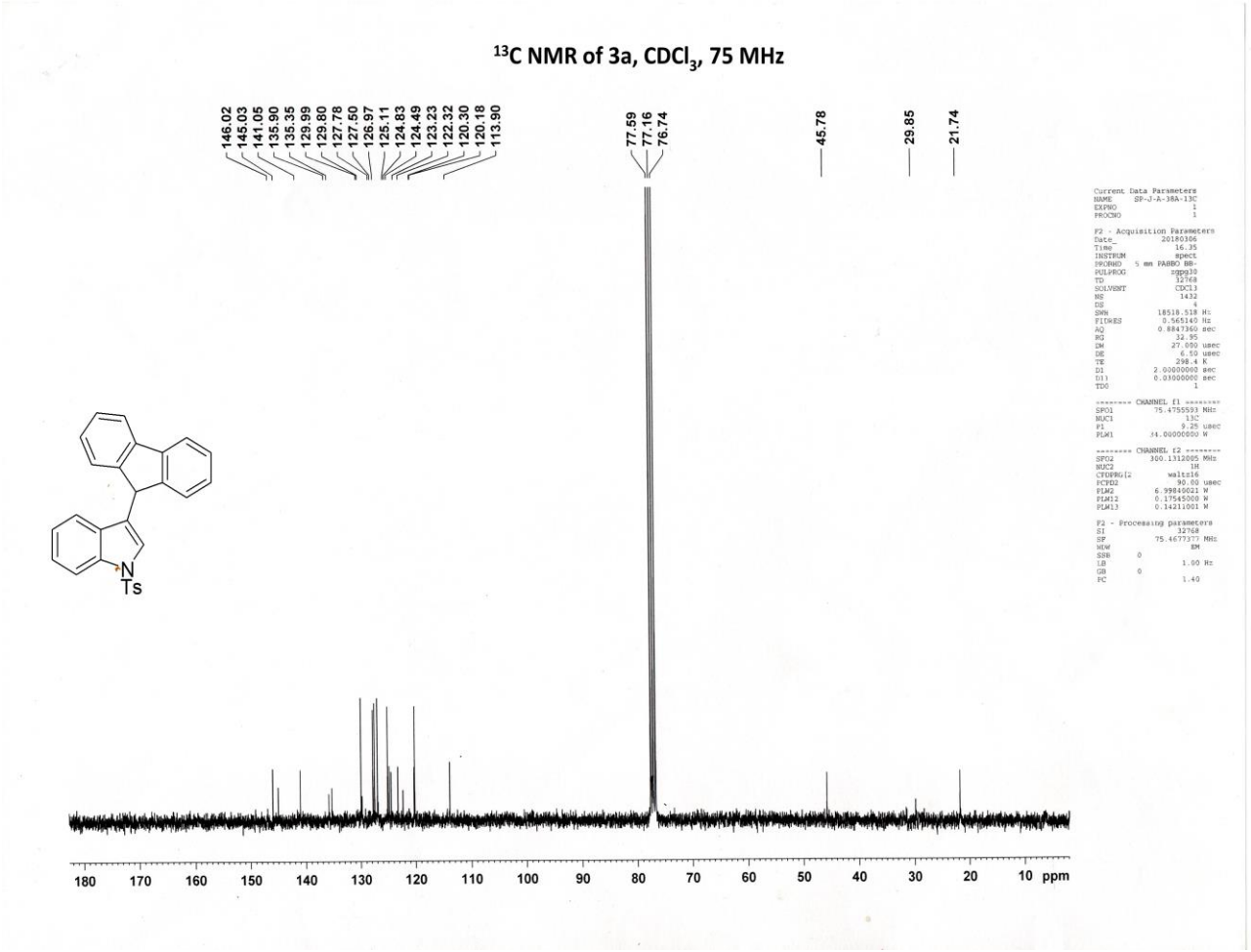
======== CHANNEL f2 ========
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W

F2 - Processing parameters
SI 16384
SF 100.6177846 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

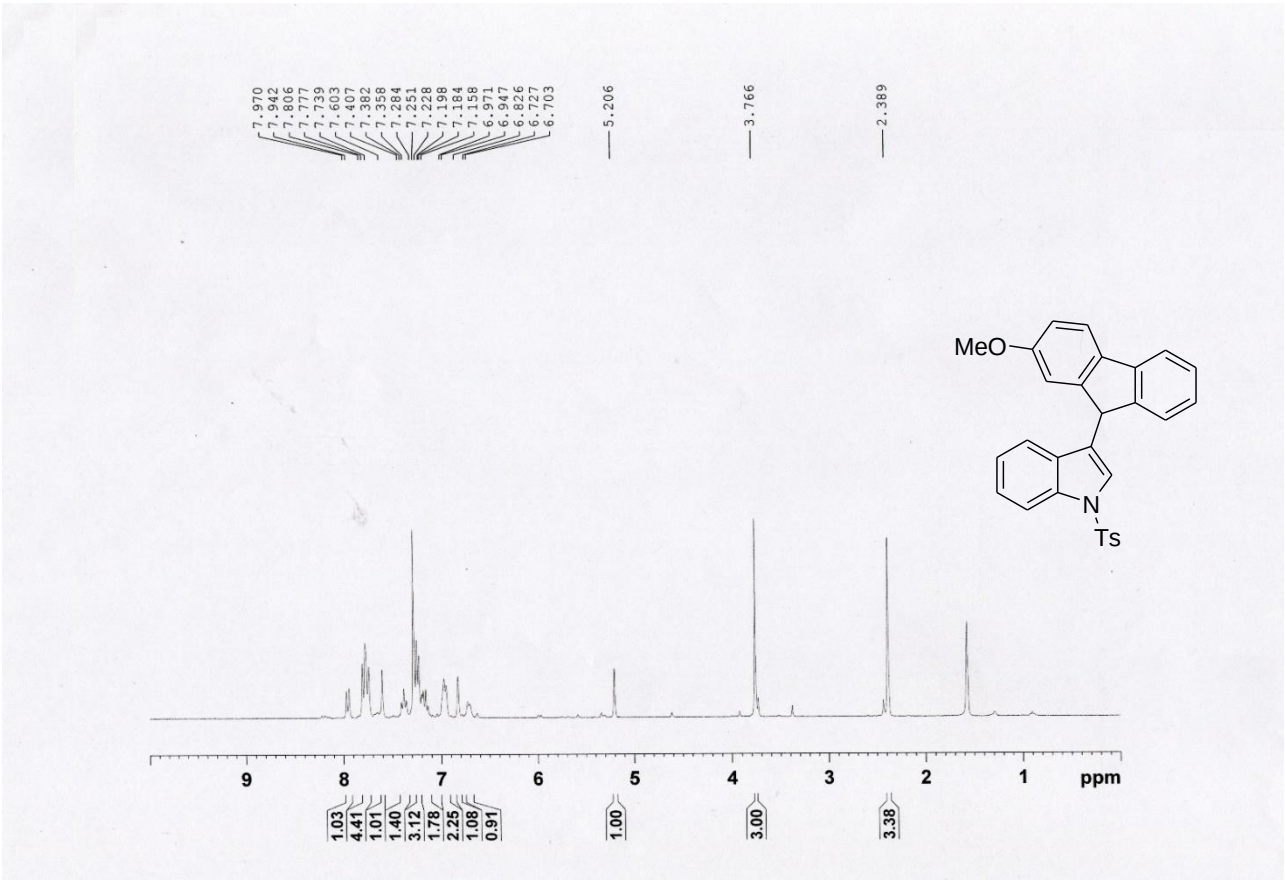
^{1}H NMR of 3a, $CDCl_3$, 300 MHz



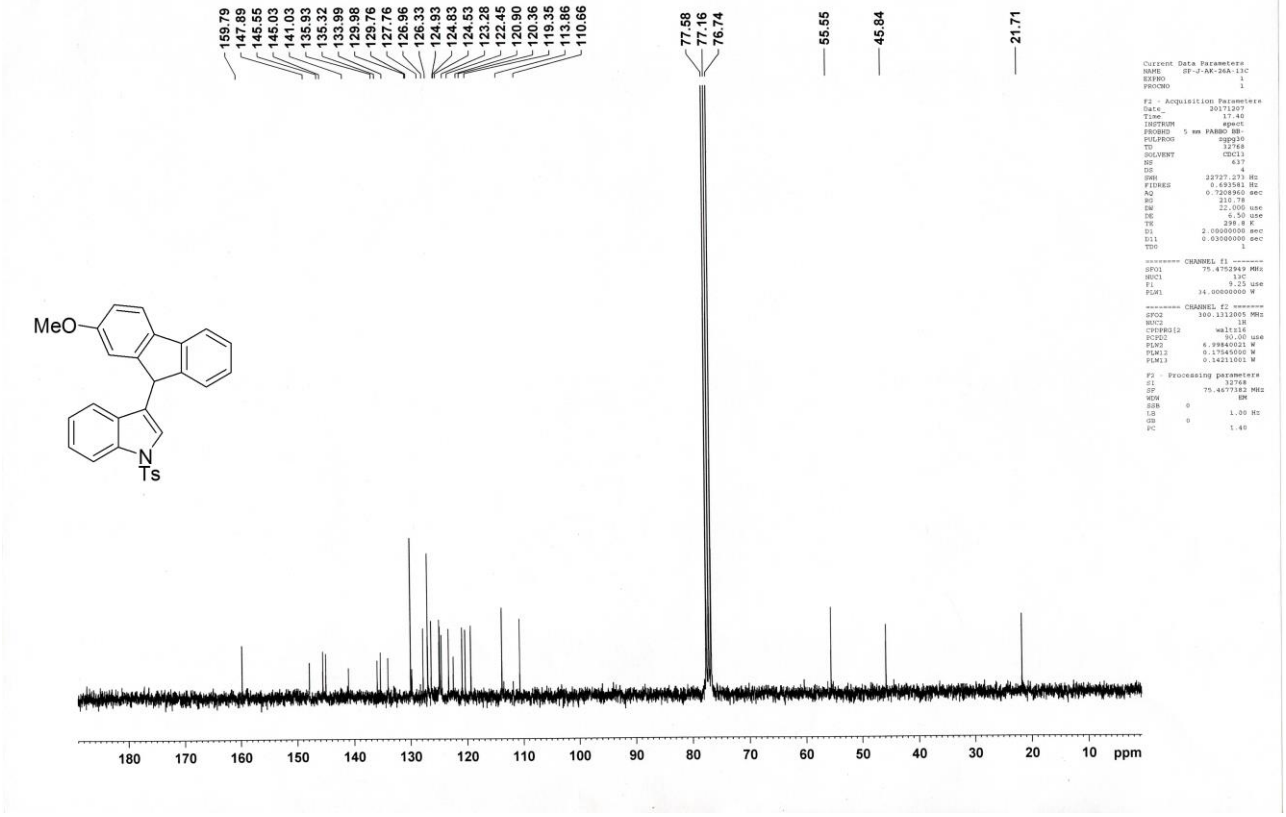
^{13}C NMR of 3a, $CDCl_3$, 75 MHz



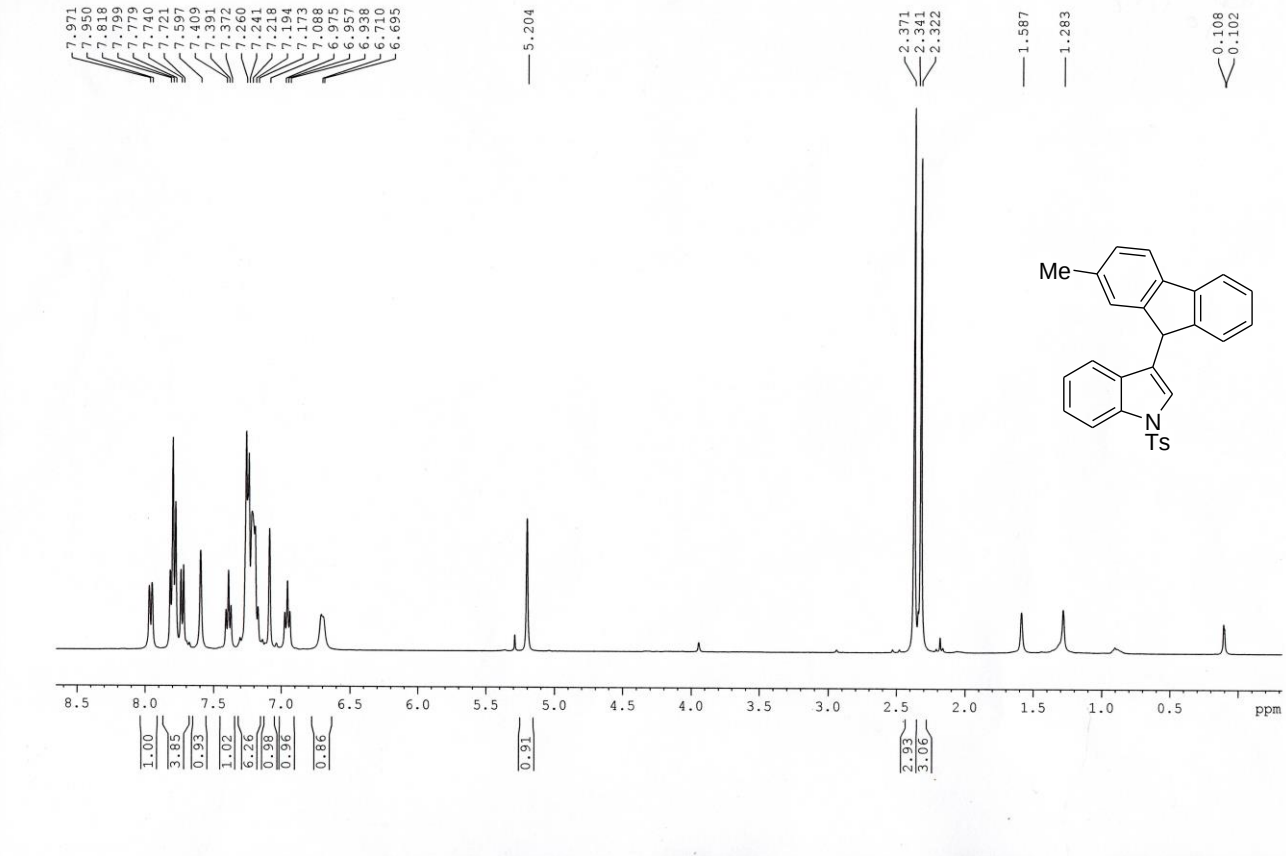
^{1}H NMR of 3b, $CDCl_3$, 300 MHz



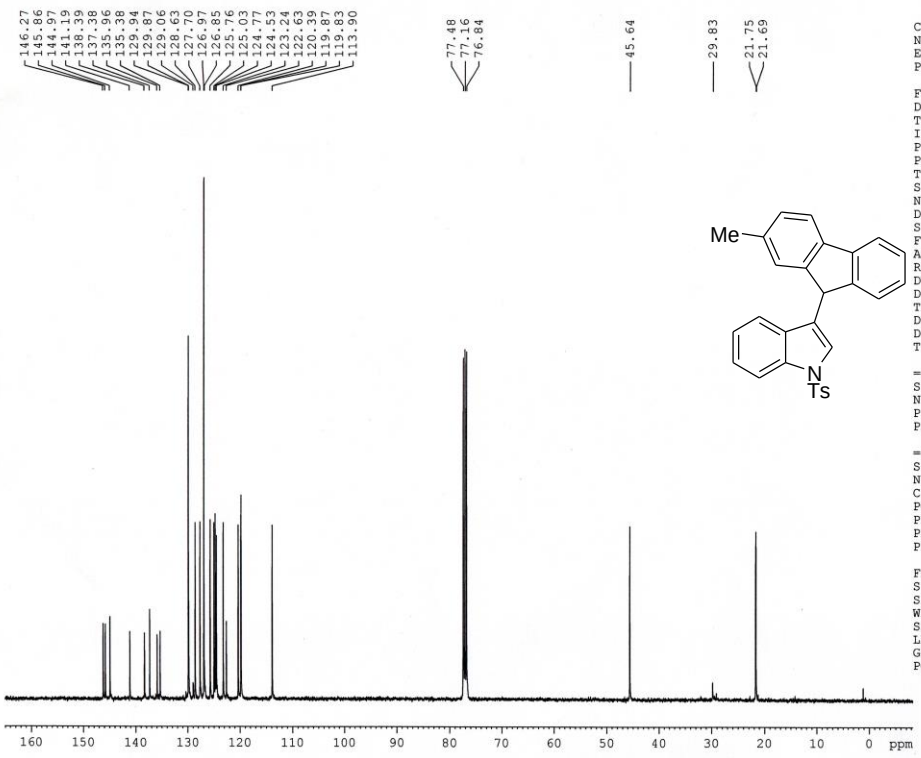
^{13}C NMR of 3b, $CDCl_3$, 75 MHz



^{1}H NMR of 3c, $CDCl_3$, 400 MHz

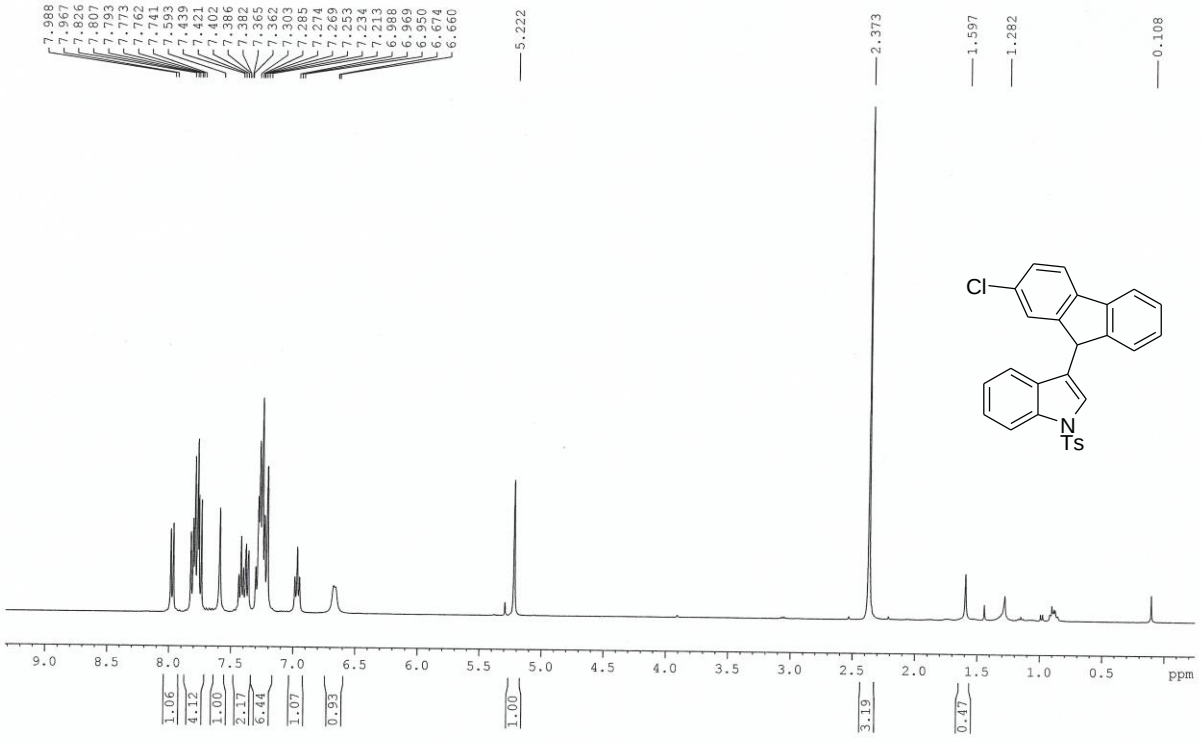


^{13}C NMR of 3c, $CDCl_3$, 100 MHz

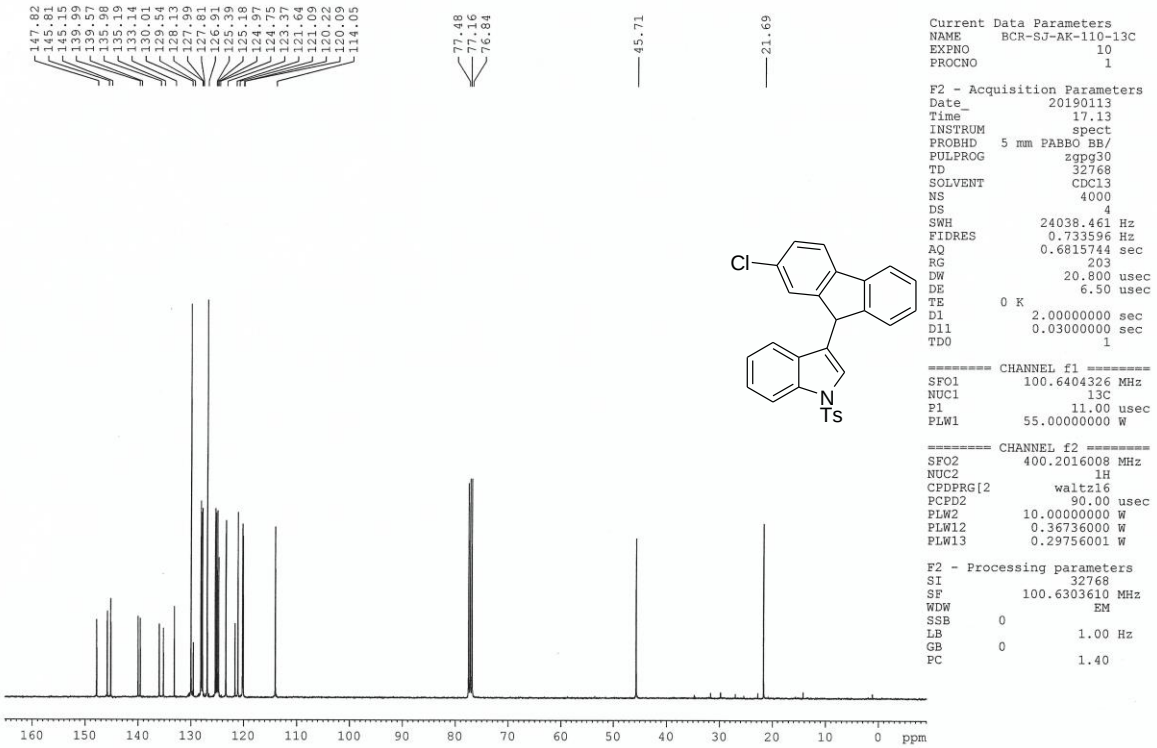



```
Current Data Parameters
NAME      BCR-SJ-AK-102-13C
EXPNO                    10
PROCNO                    1

F2 - Acquisition Parameters
Date_           20190113
Time               4.21
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                32768
SOLVENT            CDC13
NS                 4000
DS                    4
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ             0.6815744 sec
RG                  203
DW               20.800 usec
DE                6.50 usec
TE        0 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1         100.6404326 MHz
NUC1               13C
P1               11.00 usec
PLW1        55.00000000 W

======== CHANNEL f2 ========
SFO2         400.2016008 MHz
NUC2               1H
CPDPRG[2          waltz16
PCPD2             90.00 usec
PLW2        10.00000000 W
PLW12        0.36736000 W
PLW13        0.29756001 W

F2 - Processing parameters
SI                32768
SF           100.6303591 MHz
WDW                EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```

^{1}H NMR of 3d, $CDCl_3$, 400 MHz

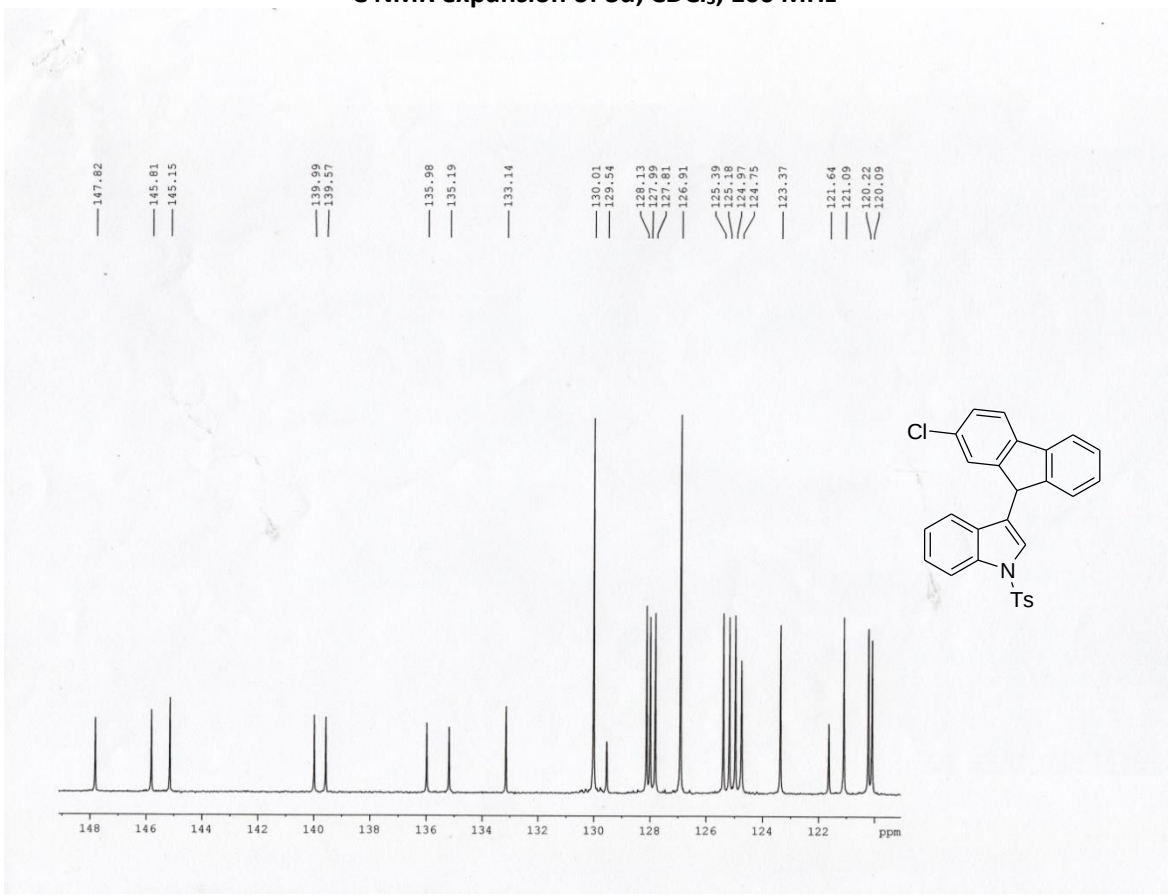


^{13}C NMR of 3d, $CDCl_3$, 100 MHz

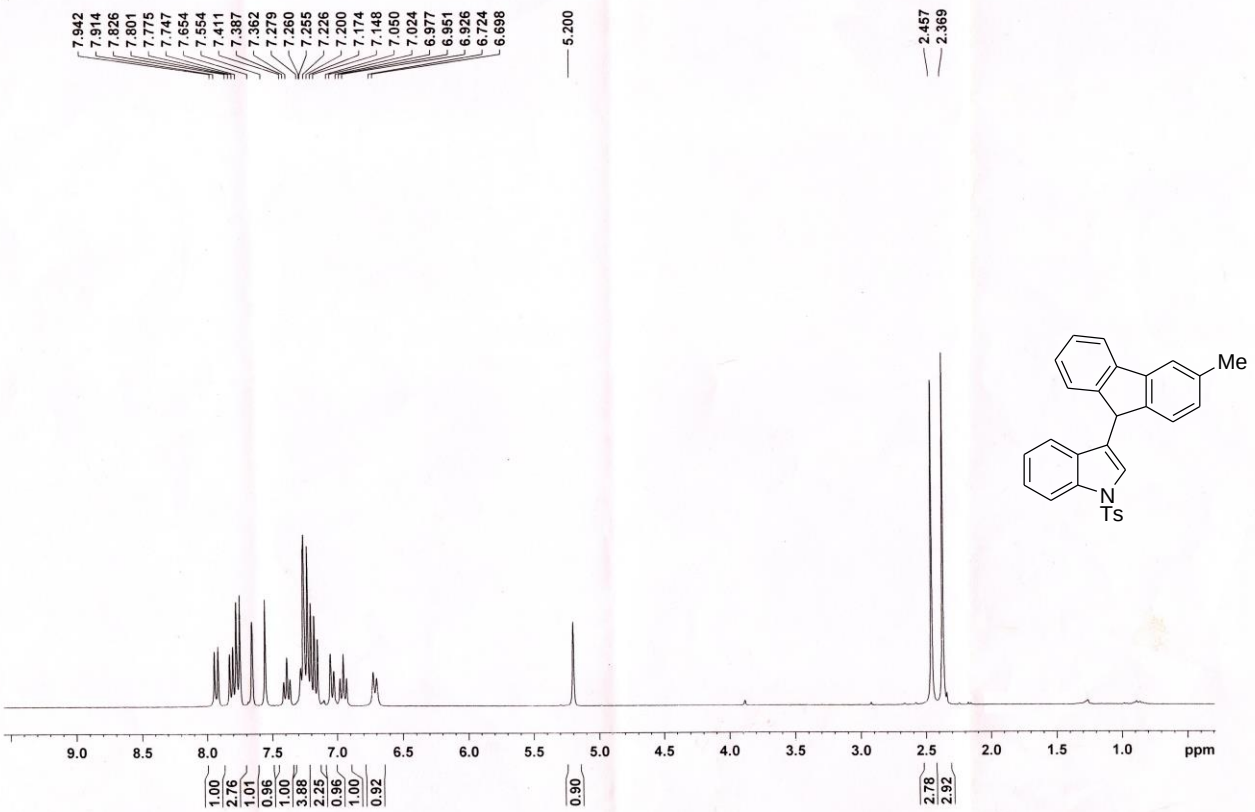



```
Current Data Parameters
NAME       BCR-SJ-AK-110-13C
EXPNO                     10
PROCNO                     1

F2 - Acquisition Parameters
Date_               20190113
Time                   17.13
INSTRUM                spect
PROBHD    5 mm PABBO BB/
PULPROG              zgpg30
TD                    32768
SOLVENT               CDCl3
NS                     4000
DS                        4
SWH                24038.461 Hz
FIDRES             0.733596 Hz
AQ                 0.6815744 sec
RG                      203
DW                   20.800 usec
DE                    6.50 usec
TE                  0 K
D1                 2.00000000 sec
D11                0.03000000 sec
TD0                        1

======== CHANNEL f1 ========
SFO1             100.6404326 MHz
NUC1                     13C
P1                    11.00 usec
PLW1              55.00000000 W

======== CHANNEL f2 ========
SFO2             400.2016008 MHz
NUC2                     1H
CPDPRG[2              waltz16
PCPD2                 90.00 usec
PLW2              10.00000000 W
PLW12              0.36736000 W
PLW13              0.29756001 W

F2 - Processing parameters
SI                       32768
SF               100.6303610 MHz
WDW                        EM
SSB          0
LB                     1.00 Hz
GB           0
PC                     1.40
```

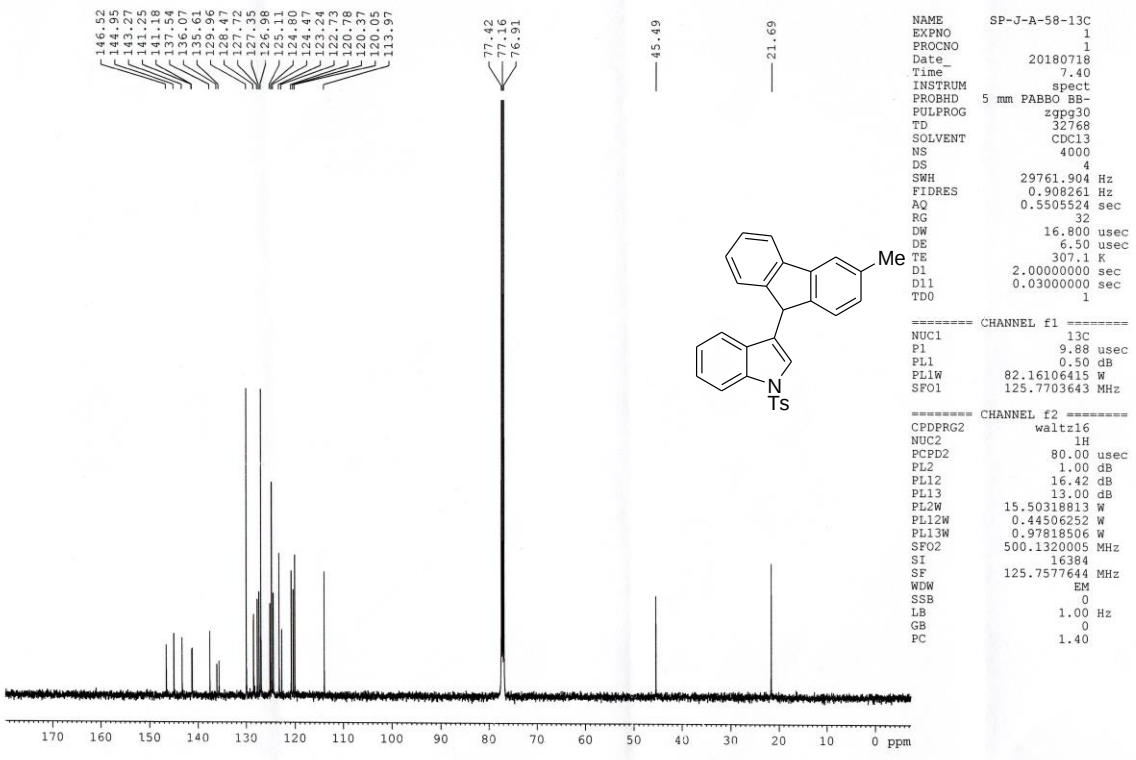
^{13}C NMR expansion of 3d, $CDCl_3$, 100 MHz



^{1}H NMR of 3e, $CDCl_3$, 300 MHz

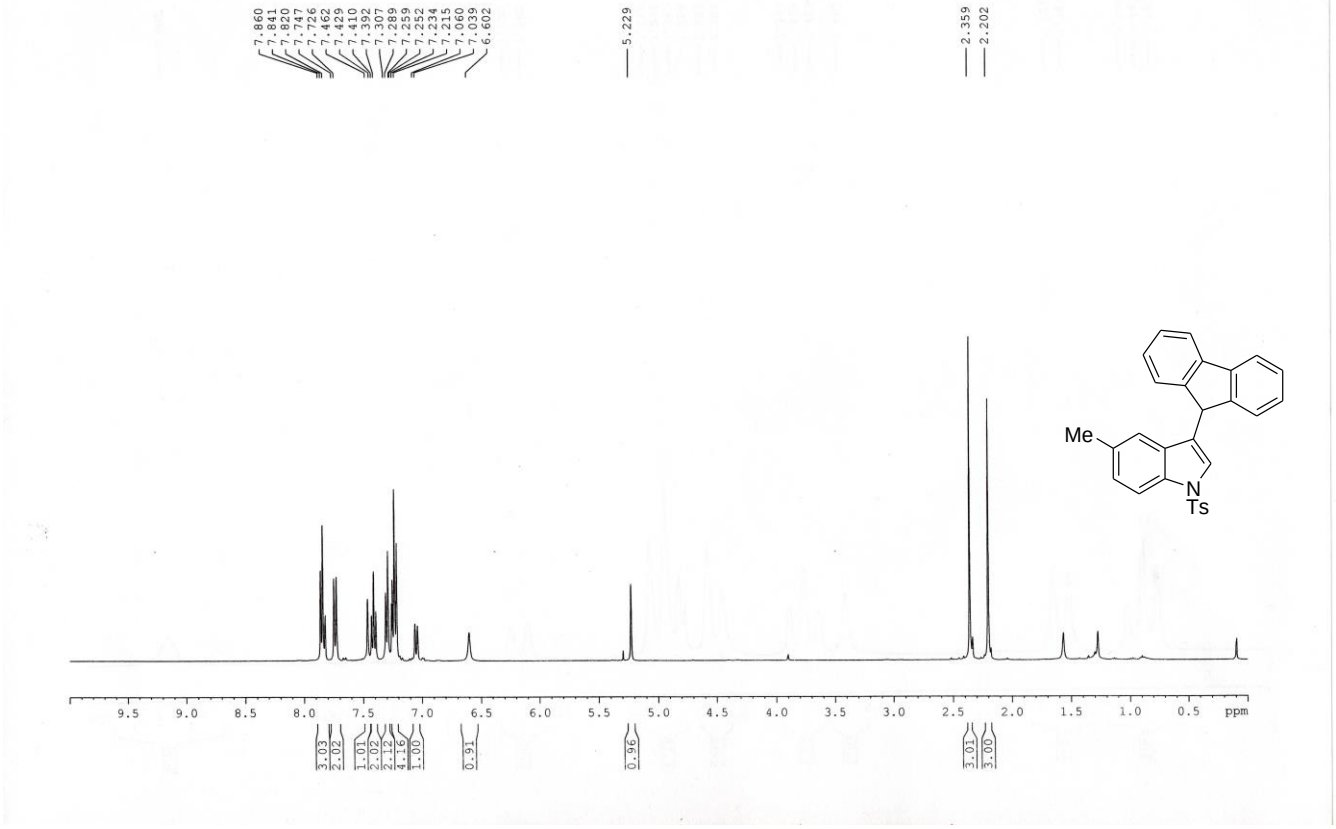


^{13}C NMR of 3e, $CDCl_3$, 125 MHz

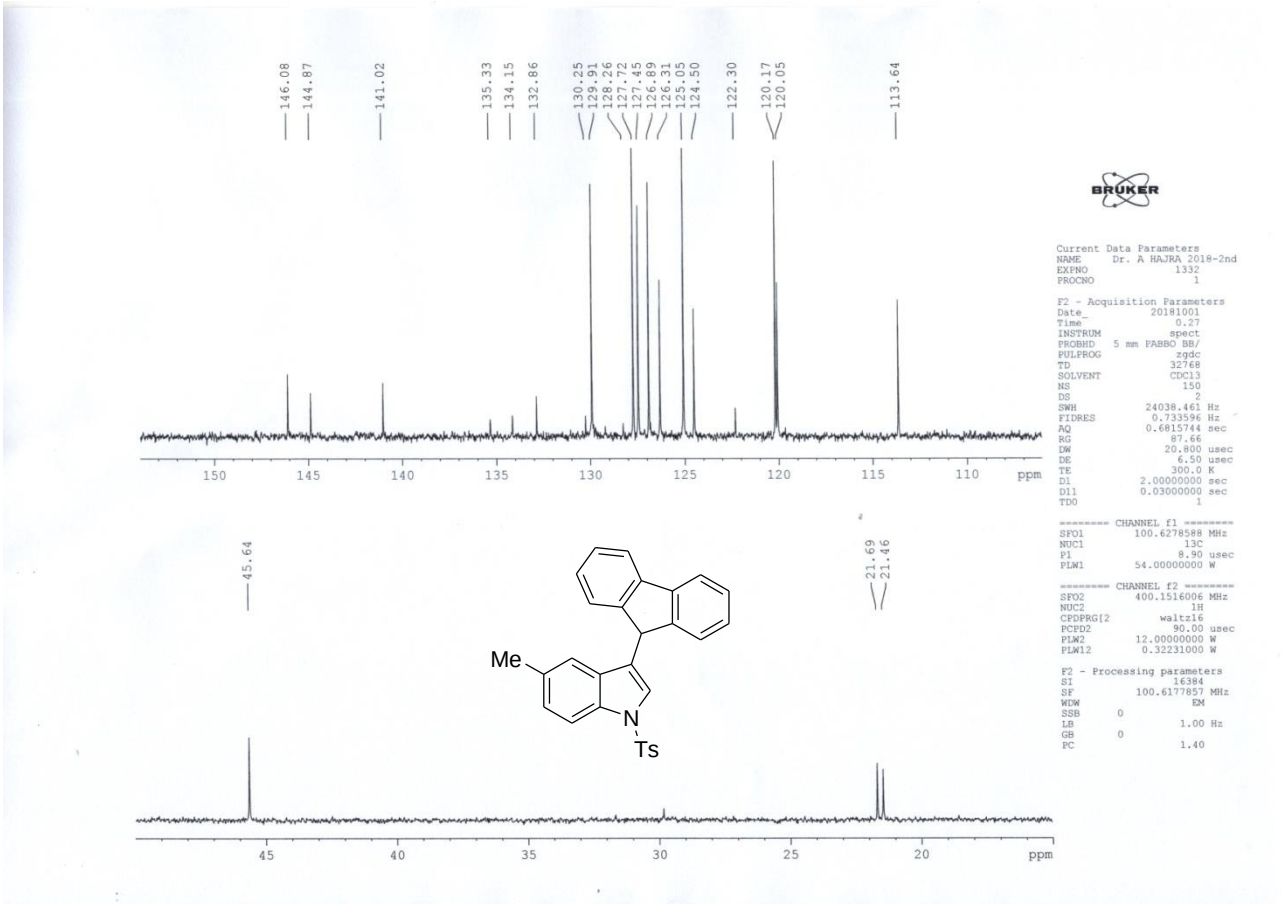


NAME	SP-J-A-58-13C
EXPNO	1
PROCNO	1
Date_	20180718
Time	7.40
INSTRUM	spect
PROBHD	5 mm PABBO BB-
PULPROG	zgpg30
TD	32768
SOLVENT	CDC13
NS	4000
DS	4
SWH	29761.904 Hz
FIDRES	0.908261 Hz
AQ	0.5505524 sec
RG	32
DW	16.800 usec
DE	6.50 usec
TE	307.1 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	13C
P1	9.88 usec
PL1	0.50 dB
PL1W	82.16106415 W
SFO1	125.7703643 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.00 dB
PL12	16.42 dB
PL13	13.00 dB
PL2W	15.50318813 W
PL12W	0.44506252 W
PL13W	0.97818506 W
SFO2	500.1320005 MHz
SI	16384
SF	125.7577644 MHz
WDW	EM
SSB	0
LB	1.00 Hz
GB	0
PC	1.40

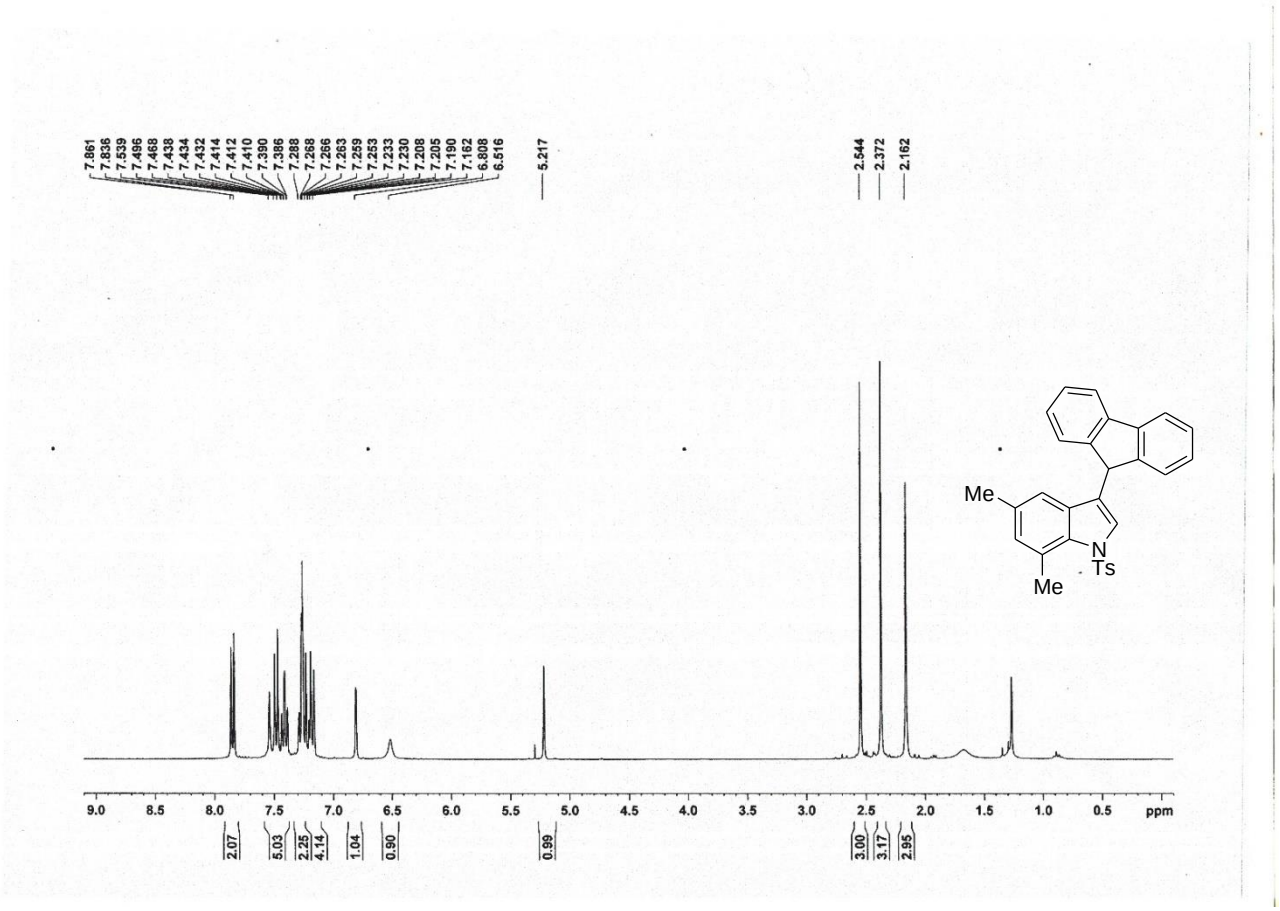
^{1}H NMR of 3f, $CDCl_3$, 400 MHz



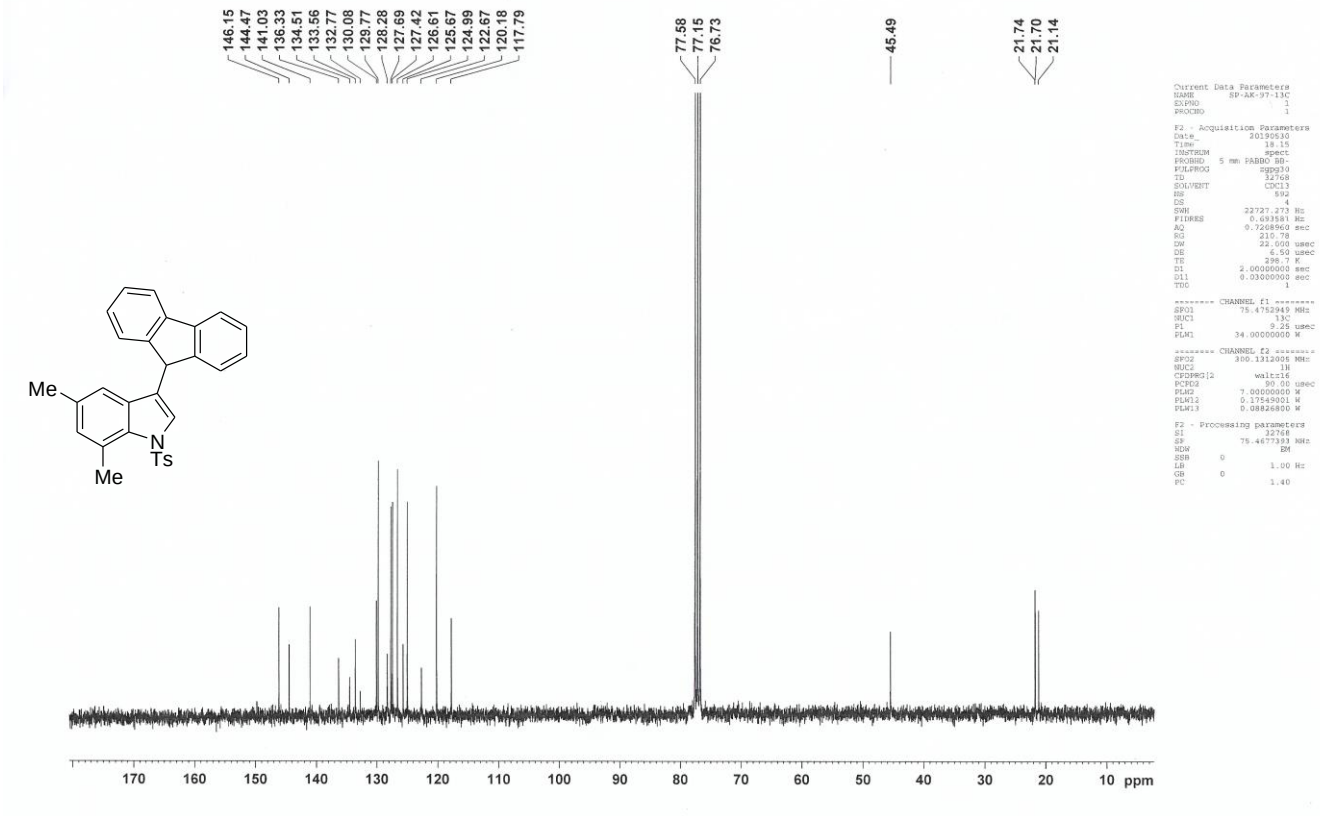
^{13}C NMR of 3f, $CDCl_3$, 100 MHz



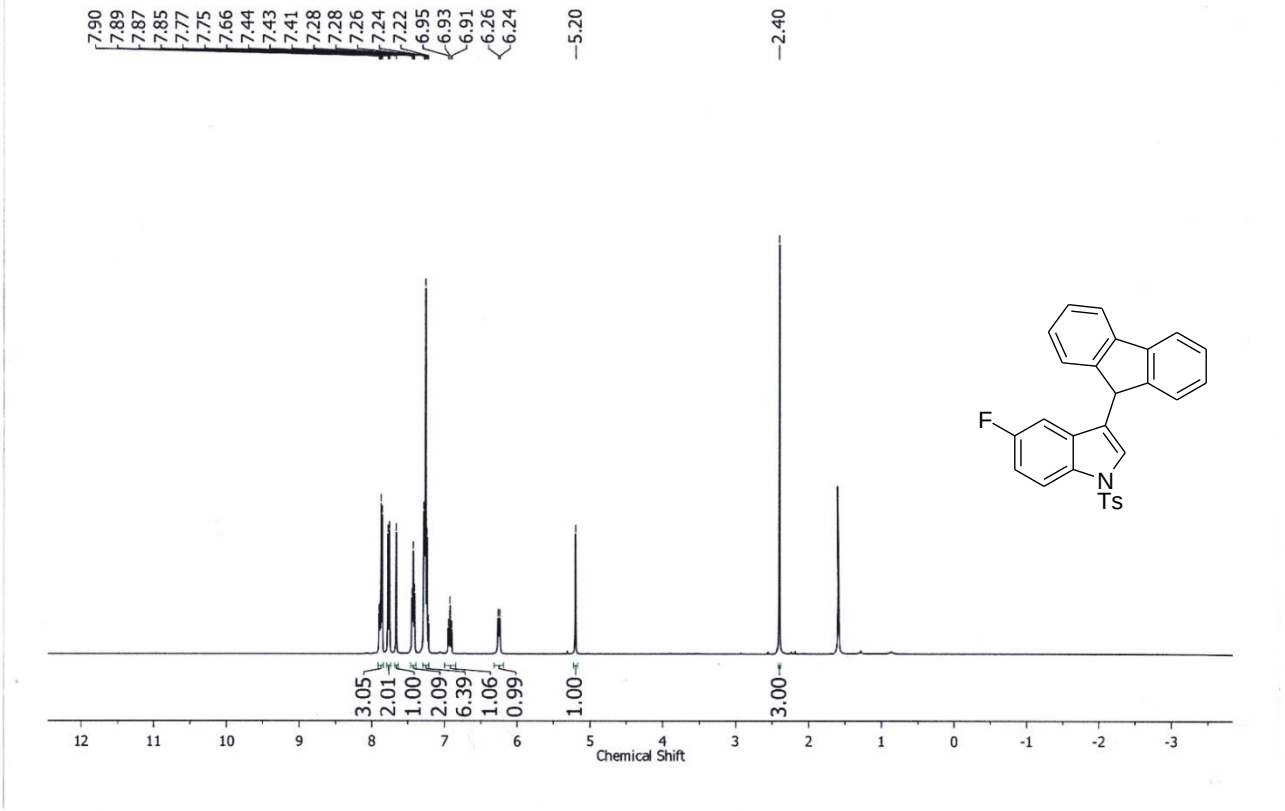
^{1}H NMR of 3g, $CDCl_3$, 300 MHz



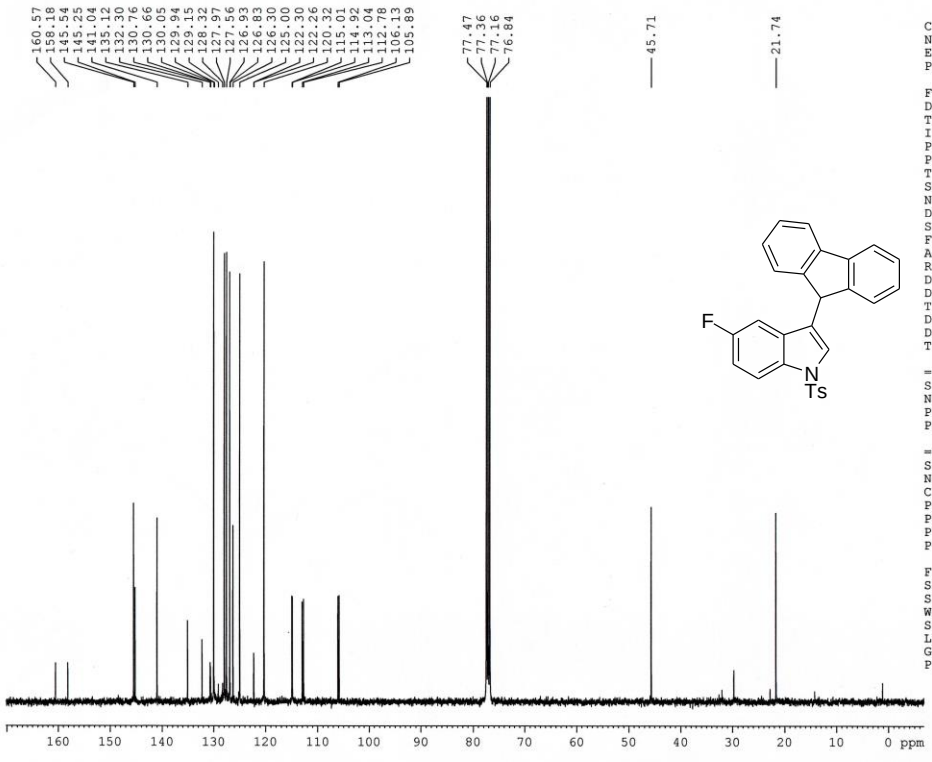
^{13}C NMR of 3g, $CDCl_3$, 75 MHz



^{1}H NMR of 3h, $CDCl_3$, 400 MHz

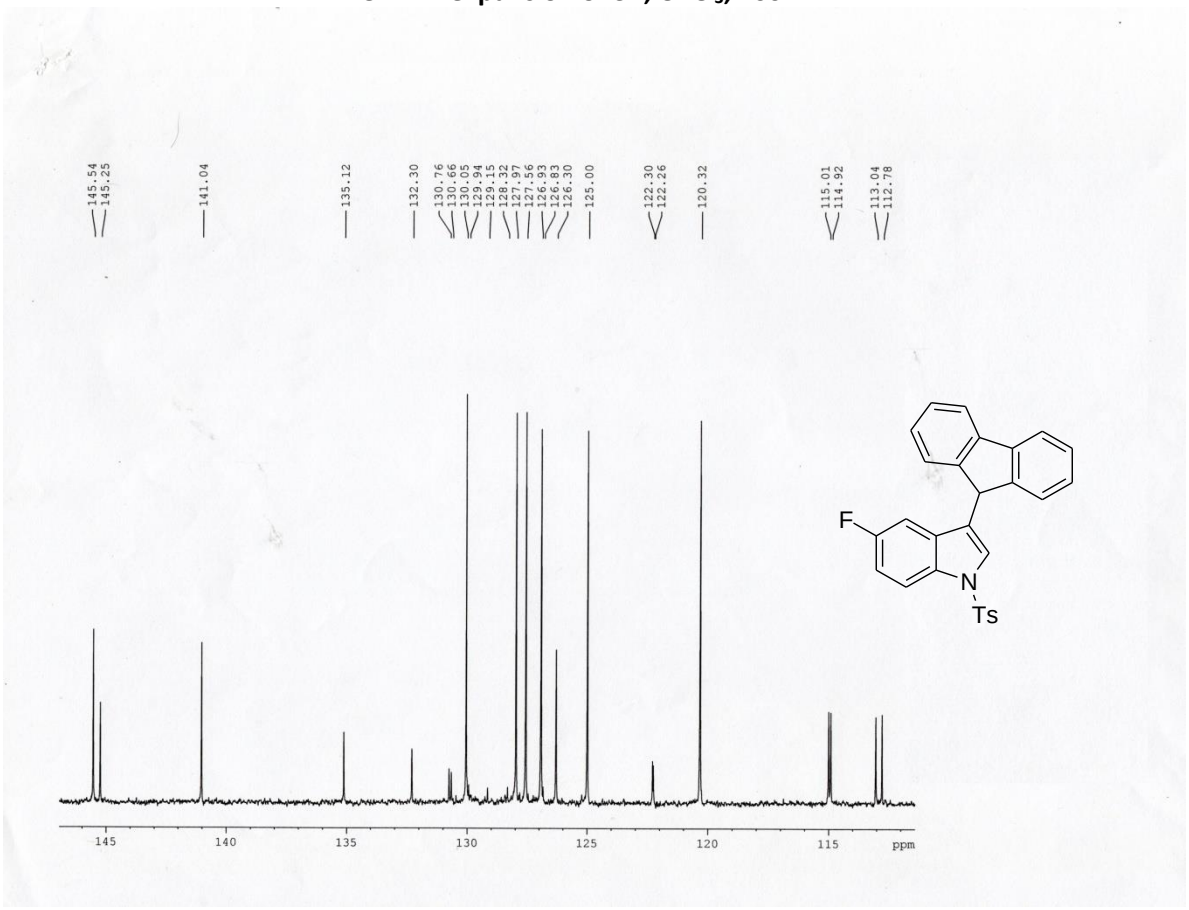


^{13}C NMR of 3h, $CDCl_3$, 100 MHz

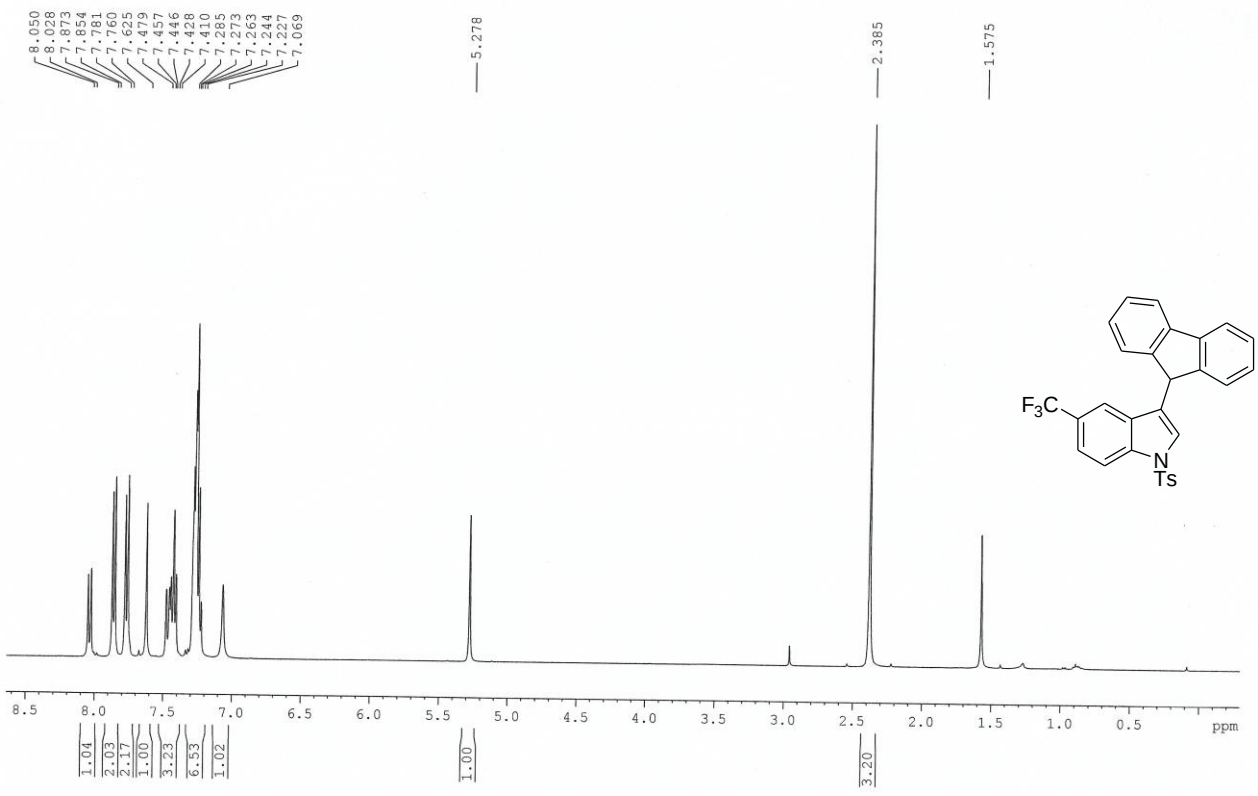



```
Current Data Parameters
NAME      BCR-J-AK-101-13C
EXPNO                   10
PROCNO                   1

F2 - Acquisition Parameters
Date_           20190113
Time              20.19
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                32768
SOLVENT           CDCl3
NS                 4000
DS                    4
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ             0.6815744 sec
RG                  203
DW               20.800 usec
DE                6.50 usec
TE        0 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        100.6404326 MHz
NUC1                13C
P1                11.00 usec
PLW1        55.00000000 W

======== CHANNEL f2 ========
SFO2        400.2016008 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        10.00000000 W
PLW12        0.36736000 W
PLW13        0.29756001 W

F2 - Processing parameters
SI                32768
SF          100.6303560 MHz
WDW                 EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```

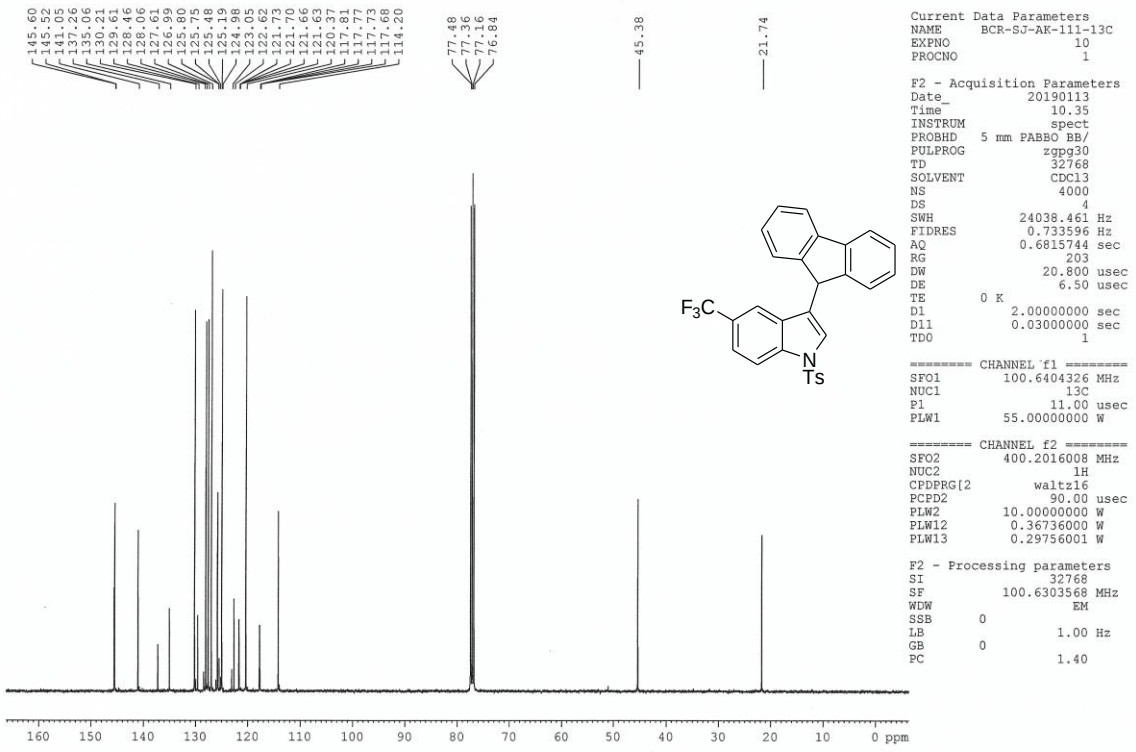
^{13}C NMR expansion of 3h, $CDCl_3$, 100 MHz



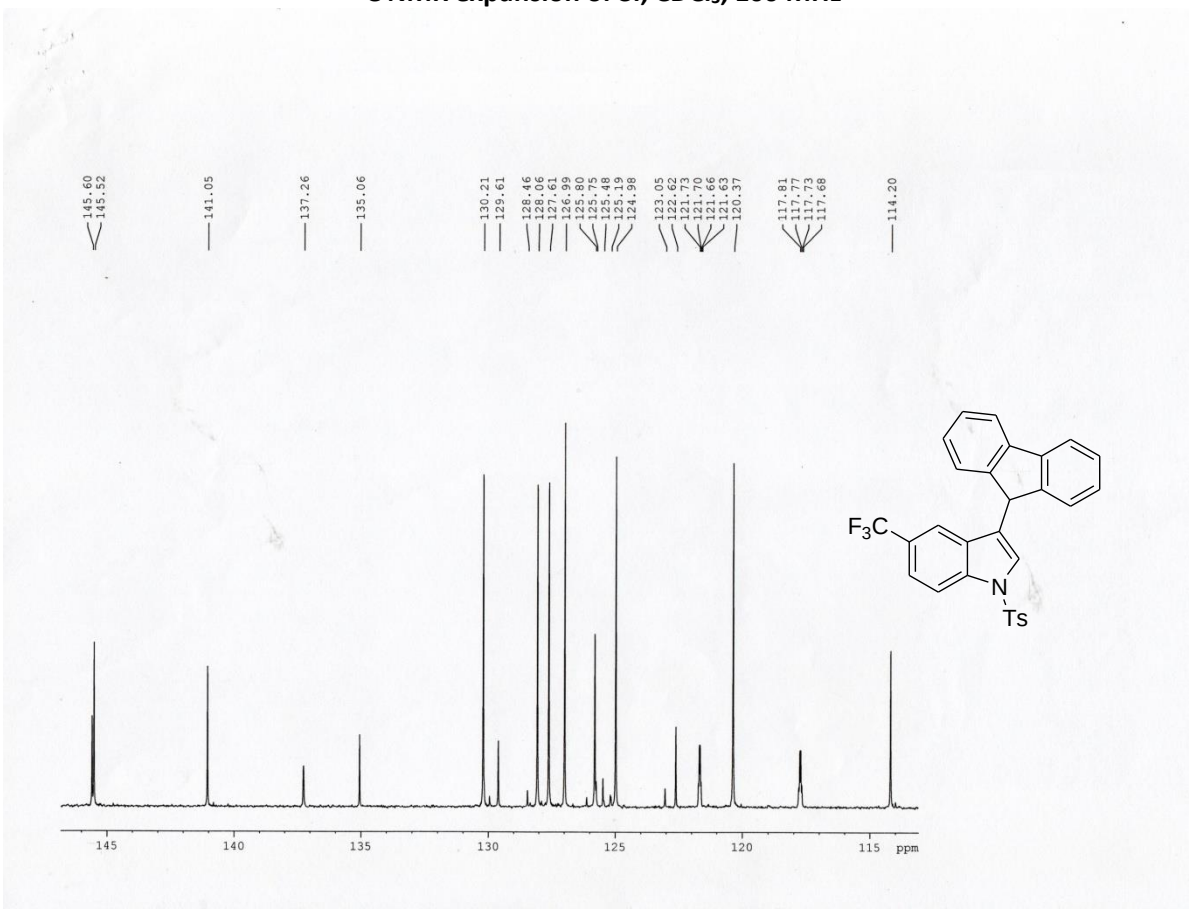
^{1}H NMR of 3i, $CDCl_3$, 400 MHz



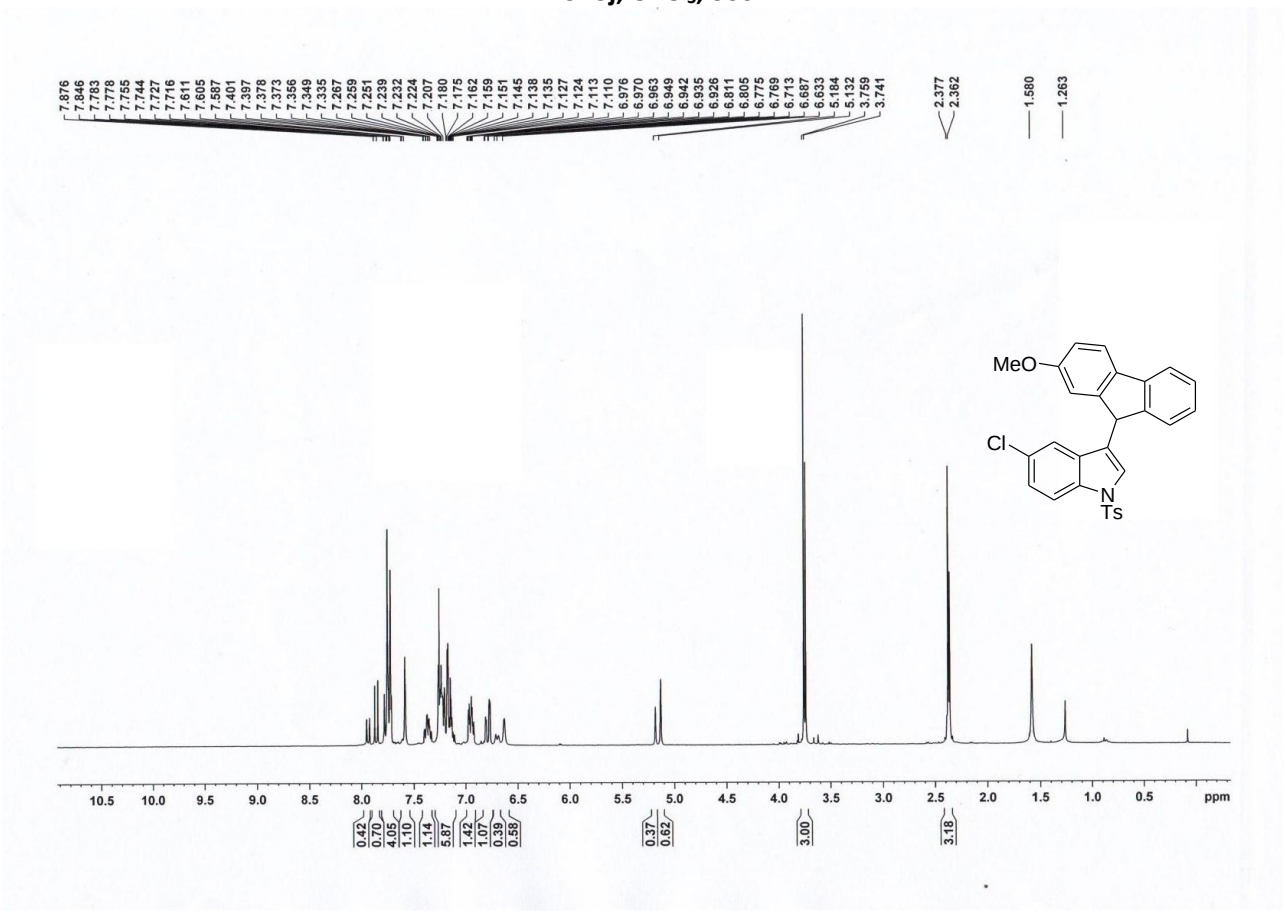
^{13}C NMR of 3i, $CDCl_3$, 100 MHz



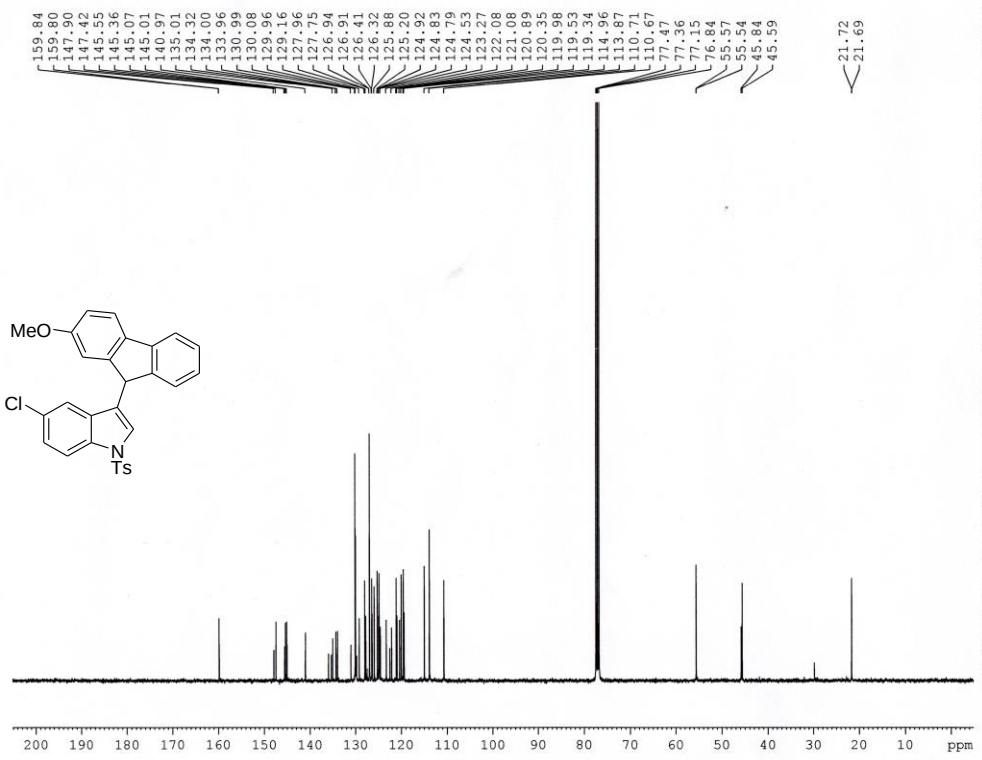
^{13}C NMR expansion of 3i, $CDCl_3$, 100 MHz



^{1}H NMR of 3j, $CDCl_3$, 300 MHz

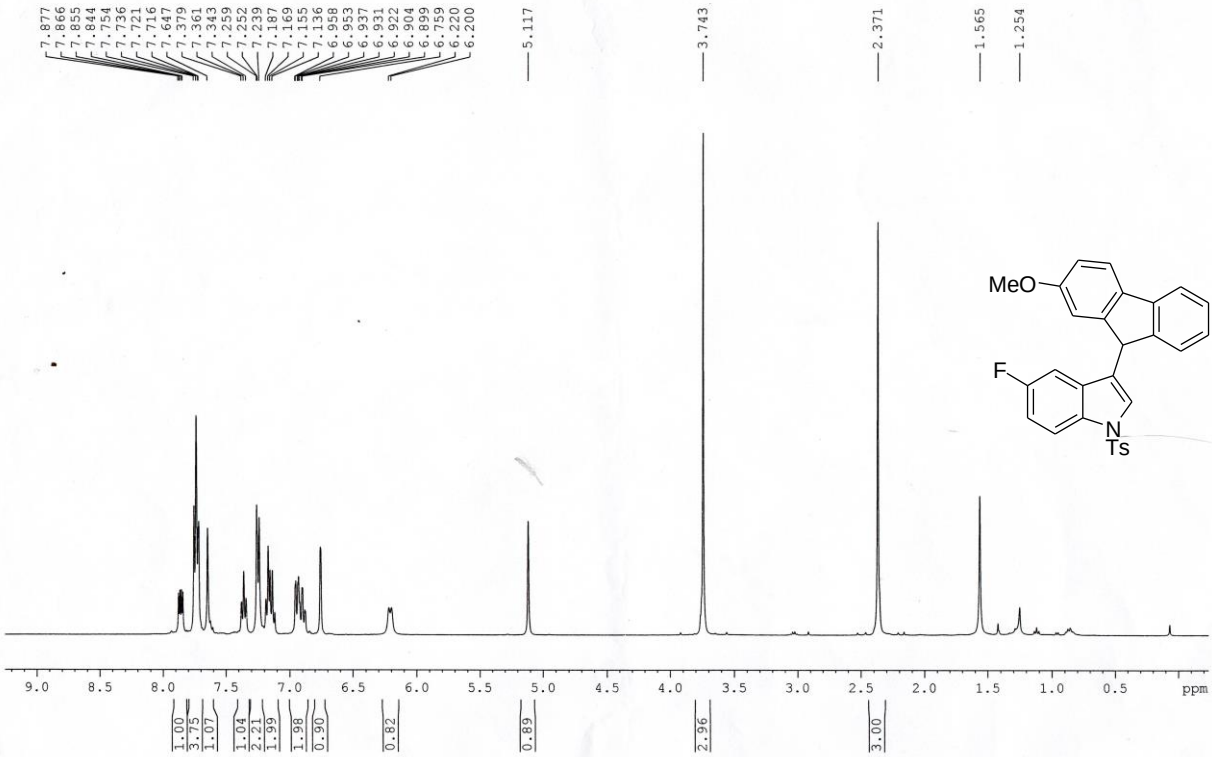


^{13}C NMR of 3j, $CDCl_3$, 100 MHz

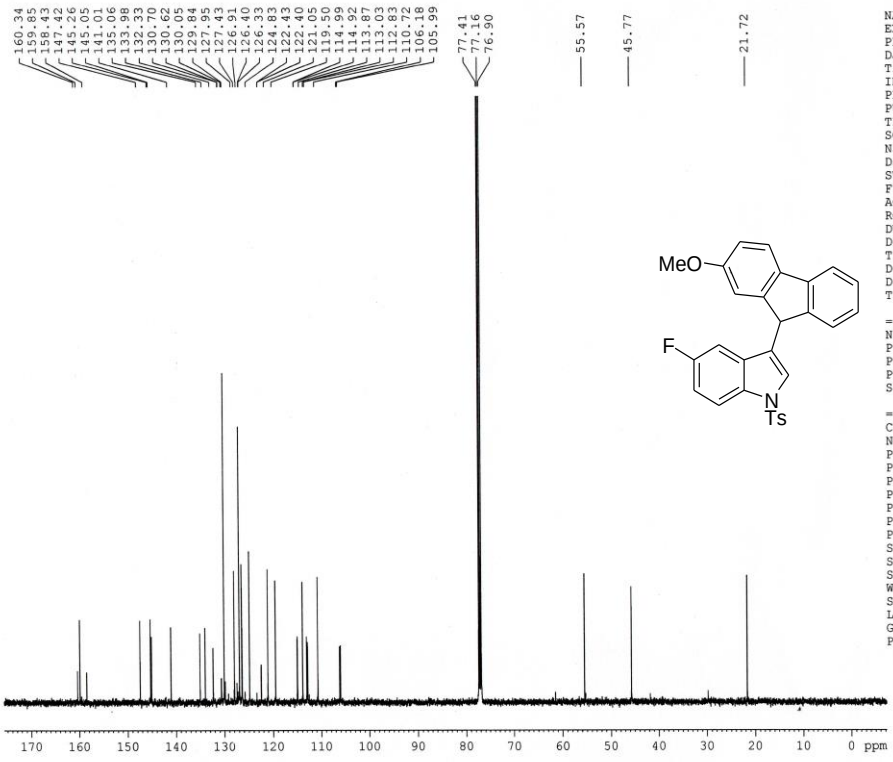



```
Current Data Parameters
NAME          AK-137-13C
EXPNO                 10
PROCNO                 1

F2 - Acquisition Parameters
Date_           20190709
Time                2.07
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                 32768
SOLVENT            CDCl3
NS                  4000
DS                     4
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ            0.6815744 sec
RG                   203
DW               20.800 usec
DE                6.50 usec
TE        0 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1        100.6404326 MHz
NUC1                 13C
P1                 11.00 usec
PLW1        55.00000000 W

======== CHANNEL f2 ========
SFO2        400.2016008 MHz
NUC2                 1H
CPDPRG[2         waltz16
PCPD2              90.00 usec
PLW2        10.00000000 W
PLW12        0.36736000 W
PLW13        0.18478000 W

F2 - Processing parameters
SI                 32768
SF          100.6303578 MHz
WDW                   EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
```

^{1}H NMR of 3k, $CDCl_3$, 400 MHz

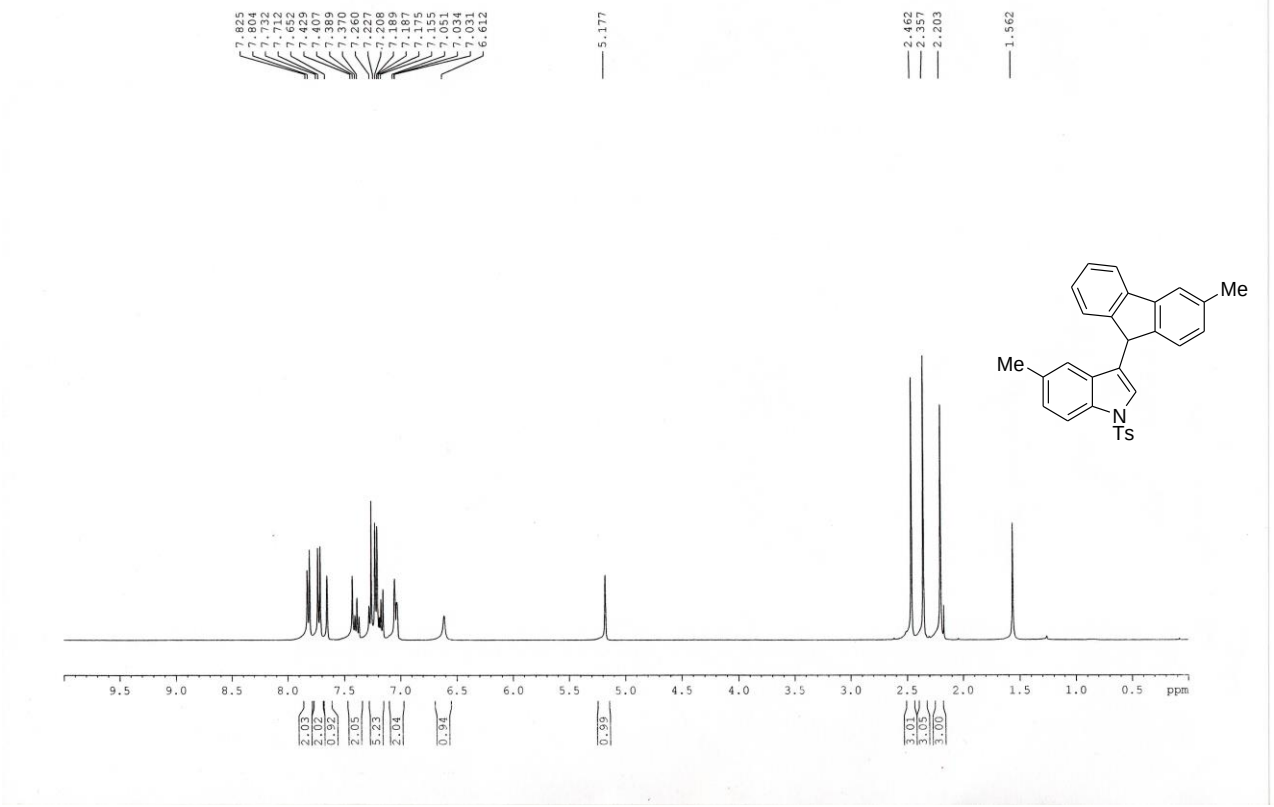


^{13}C NMR of 3k, $CDCl_3$, 125 MHz

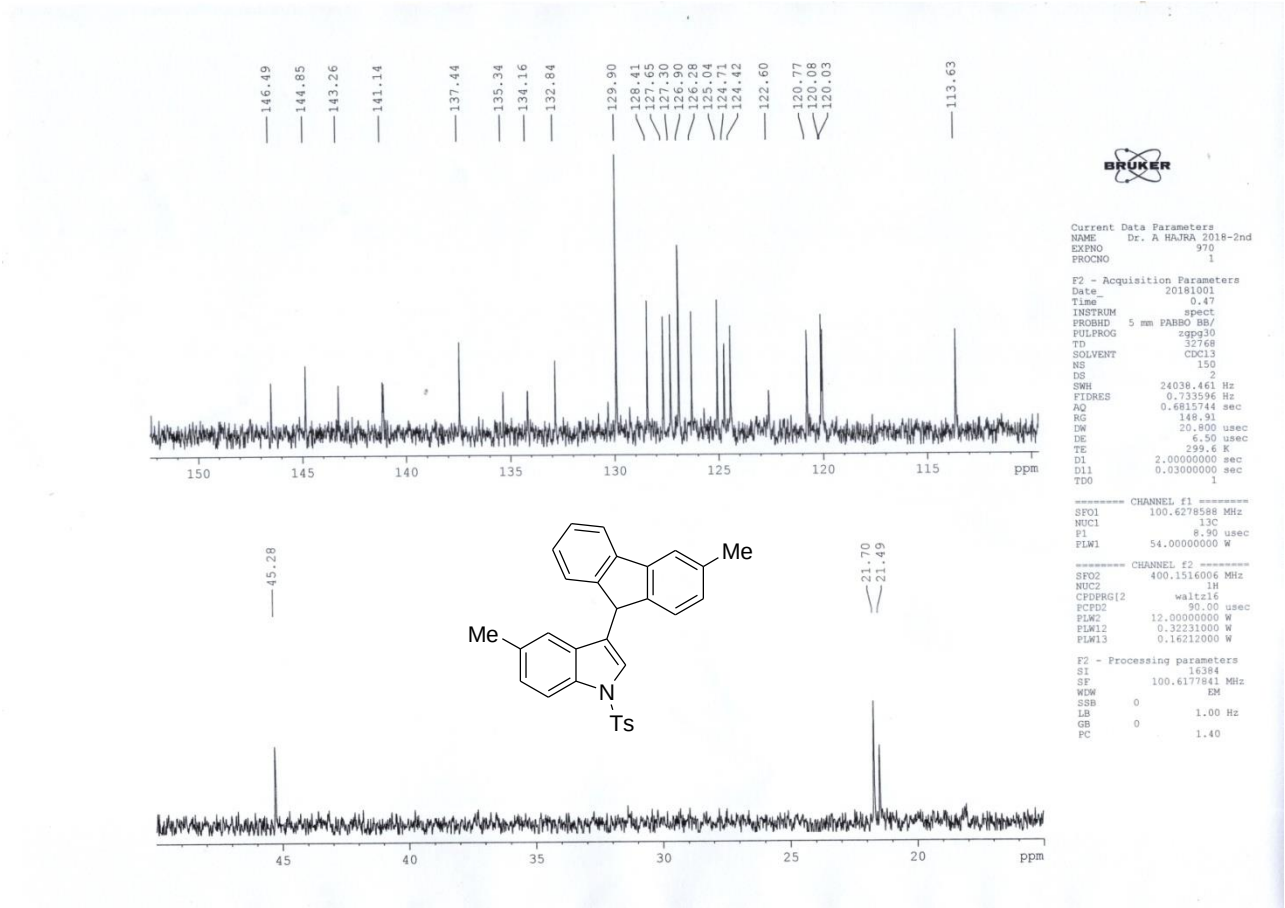


NAME	TG-AK-129-13C
EXPNO	1
PROCNO	1
Date_	20190706
Time	22.25
INSTRUM	spect
PROBHD	5 mm SEI 1H/D-
PULPROG	zgpg30
TD	32768
SOLVENT	CDCl3
NS	4000
DS	2
SWH	29761.904 Hz
FIDRES	0.908261 Hz
AQ	0.5505524 sec
RG	32
DW	16.800 usec
DE	6.50 usec
TE	299.9 K
D1	2.00000000 sec
D11	0.03000000 sec
TD0	1
======== CHANNEL f1 ========	
NUC1	13C
P1	15.00 usec
PL1	0.00 dB
PL1W	92.18623352 W
SFO1	125.7955118 MHz
======== CHANNEL f2 ========	
CPDPRG2	waltz16
NUC2	1H
PCPD2	80.00 usec
PL2	1.00 dB
PL12	21.86 dB
PL13	25.00 dB
PL2W	15.50318813 W
PL12W	0.12718062 W
PL13W	0.06171930 W
SFO2	500.2320009 MHz
SI	32768
SF	125.7829177 MHz
WDW	EM
SSB	0
LB	1.00 Hz
GB	0
PC	1.40

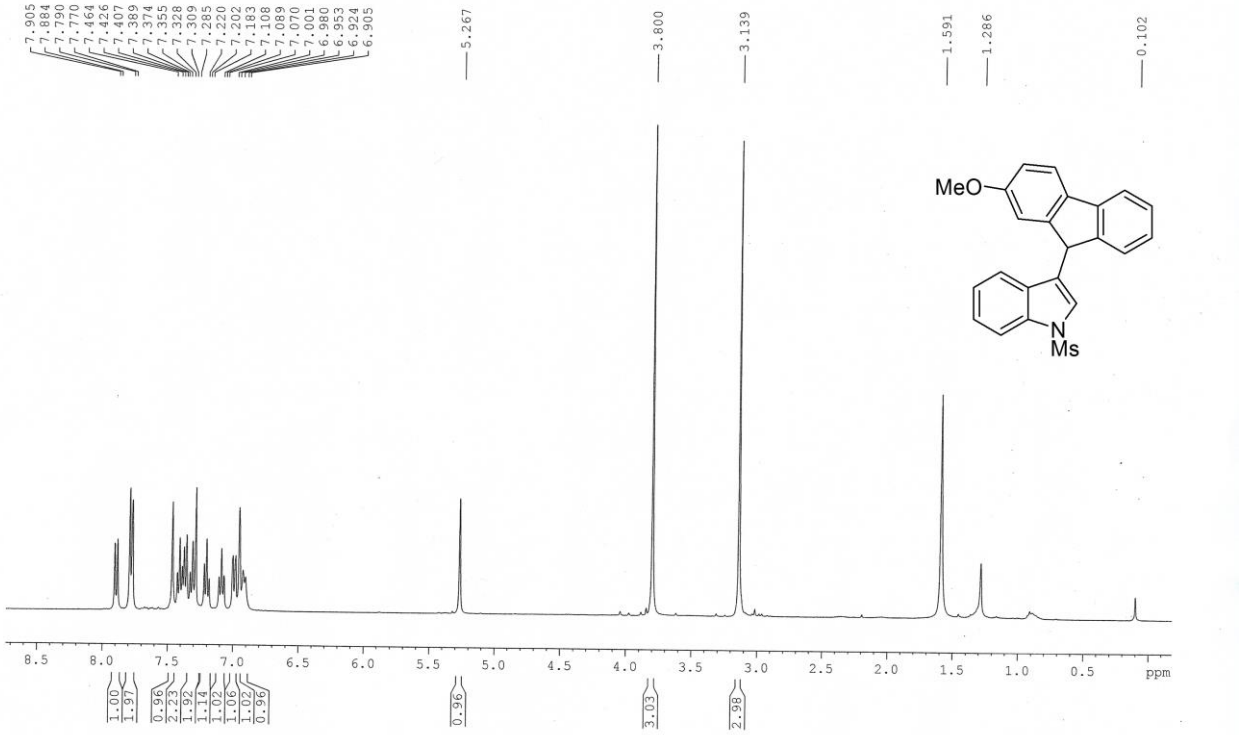
^{1}H NMR of 3l, $CDCl_3$, 400 MHz



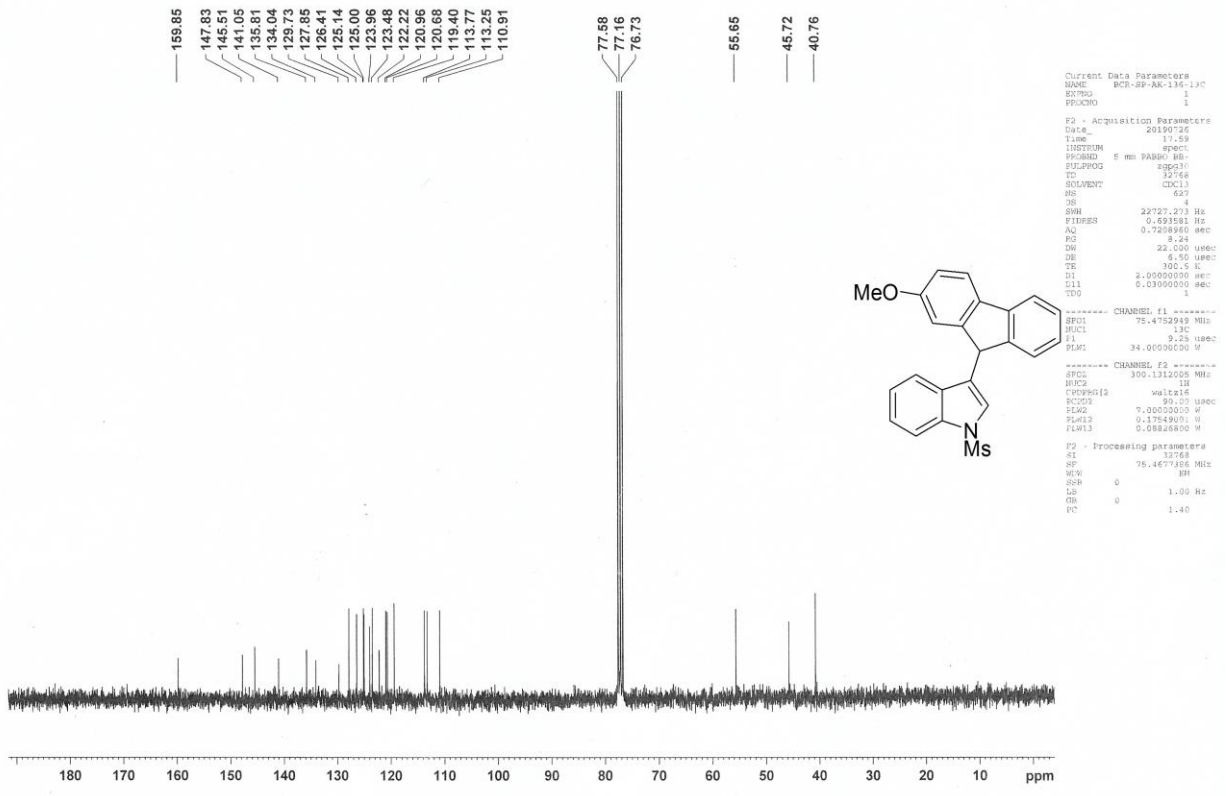
^{13}C NMR of 3l, $CDCl_3$, 100 MHz



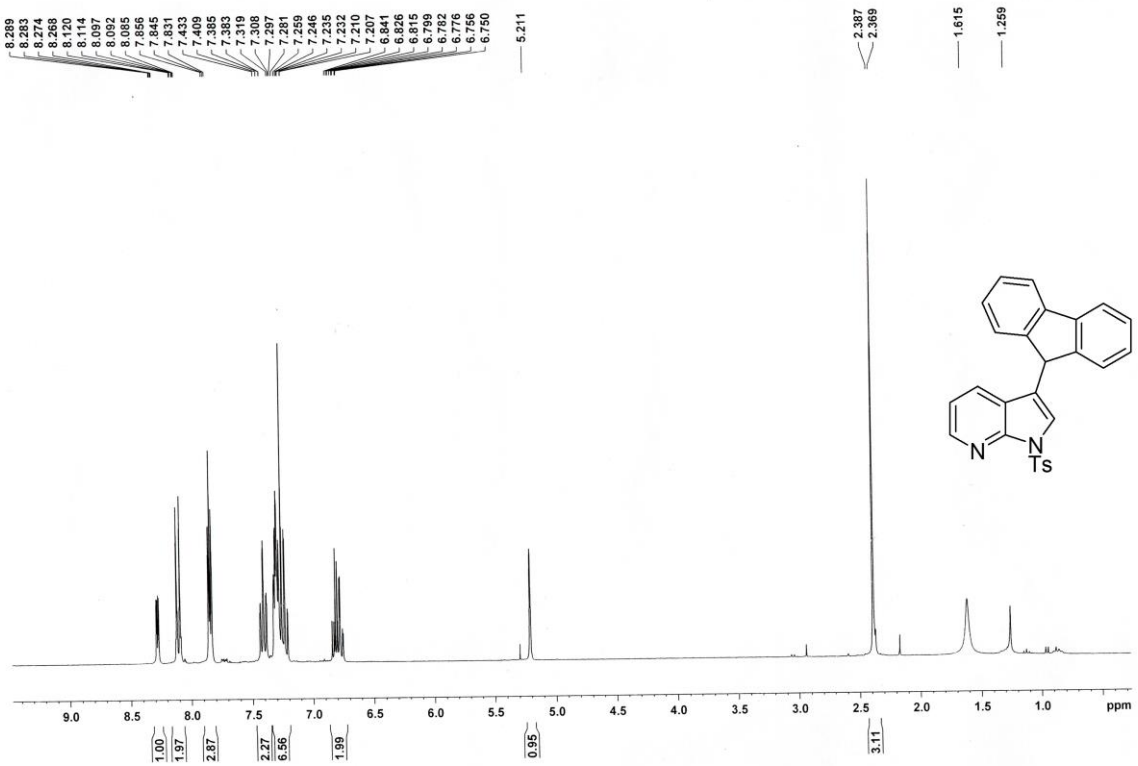
^{1}H NMR of 3m, $CDCl_3$, 400 MHz



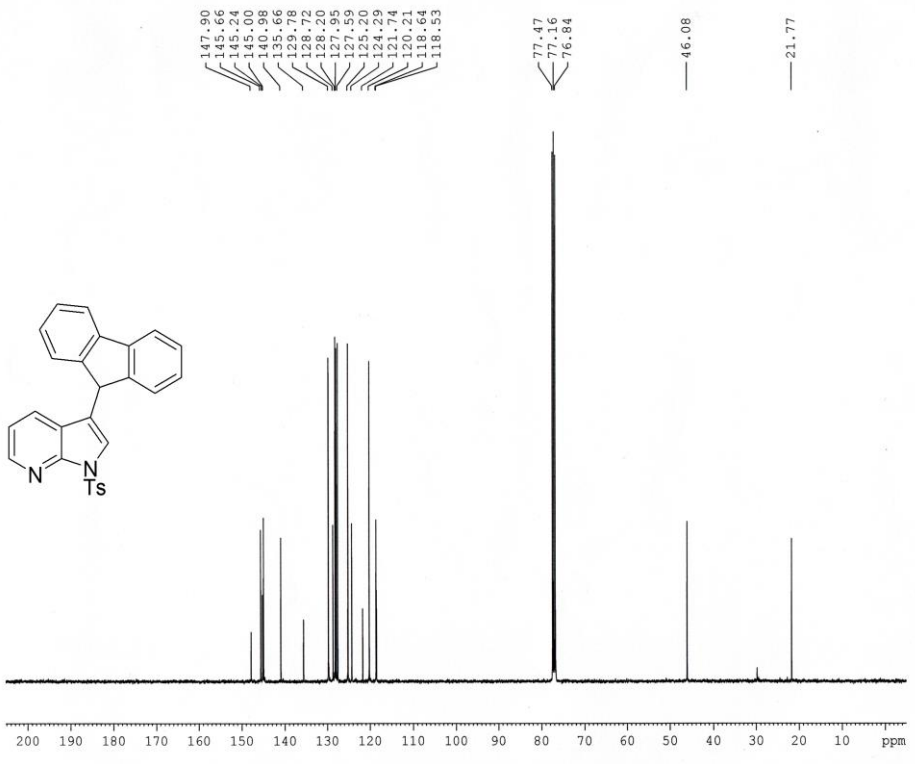
^{13}C NMR of 3m, $CDCl_3$, 75 MHz



^{1}H NMR of 3n, $CDCl_3$, 300 MHz

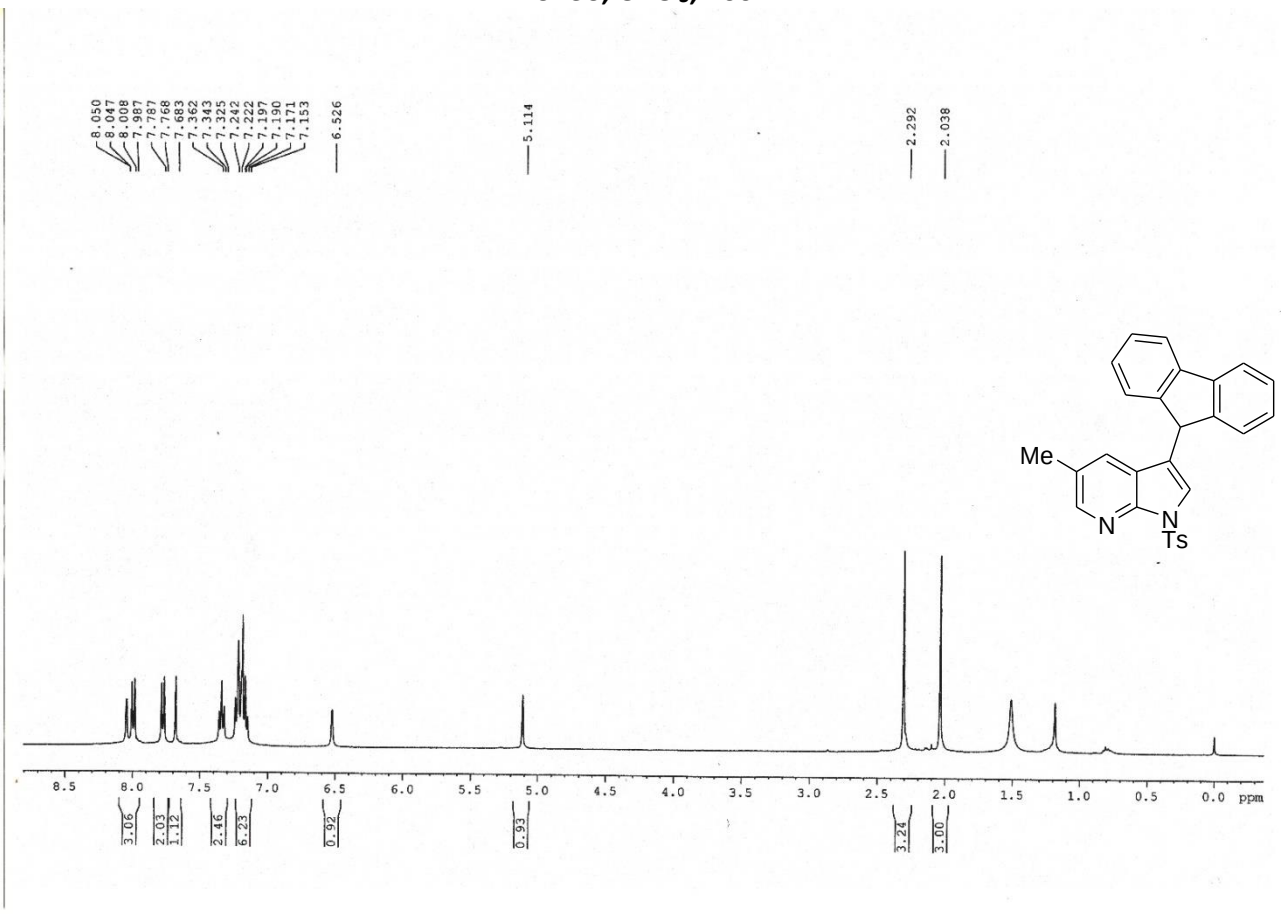


^{13}C NMR of 3n, $CDCl_3$, 100 MHz

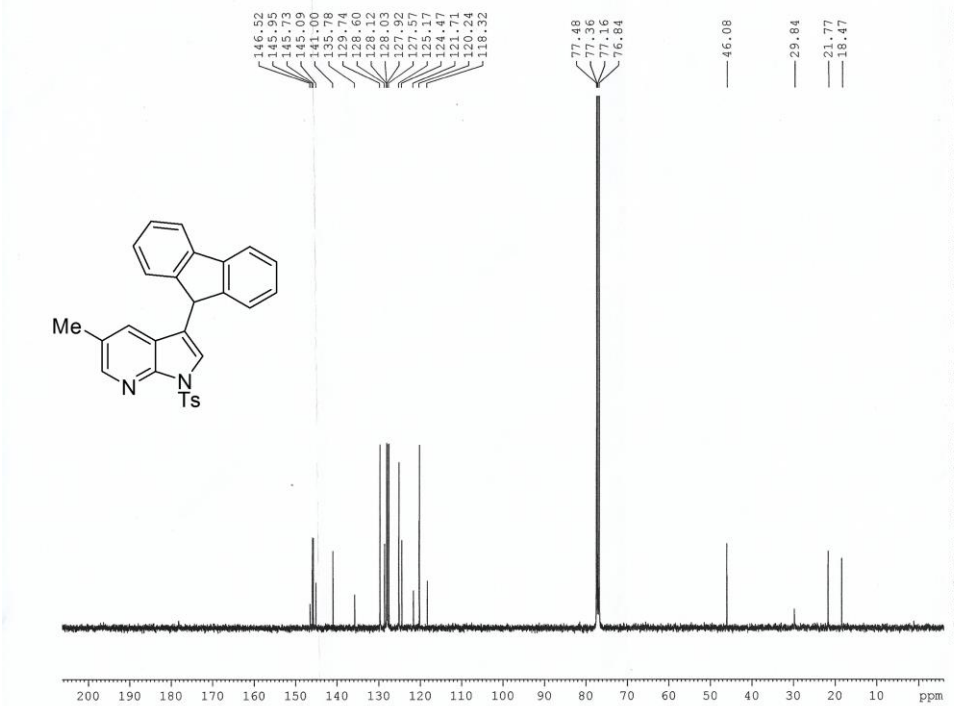



```
Current Data Parameters
NAME          AK-130-13C
EXPNO                 10
PROCNO                 1

F2 - Acquisition Parameters
Date_              20190708
Time                 23.01
INSTRUM              spect
PROBHD   5 mm PABBO BB/
PULPROG           zgpg30
TD                 32768
SOLVENT             CDCl3
NS                  4000
DS                     4
SWH            24038.461 Hz
FIDRES          0.733596 Hz
AQ             0.6815744 sec
RG                   203
DW                20.800 usec
DE                 6.50 usec
TE        0 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         100.6404326 MHz
NUC1                 13C
P1                11.00 usec
PLW1         55.00000000 W

======== CHANNEL f2 ========
SFO2         400.2016008 MHz
NUC2                 1H
CPDPRG[2          waltz16
PCPD2             90.00 usec
PLW2         10.00000000 W
PLW12         0.36736000 W
PLW13         0.18478000 W

F2 - Processing parameters
SI                 32768
SF           100.6303579 MHz
WDW                  EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```

^{1}NMR of 3o, $CDCl_3$, 400 MHz

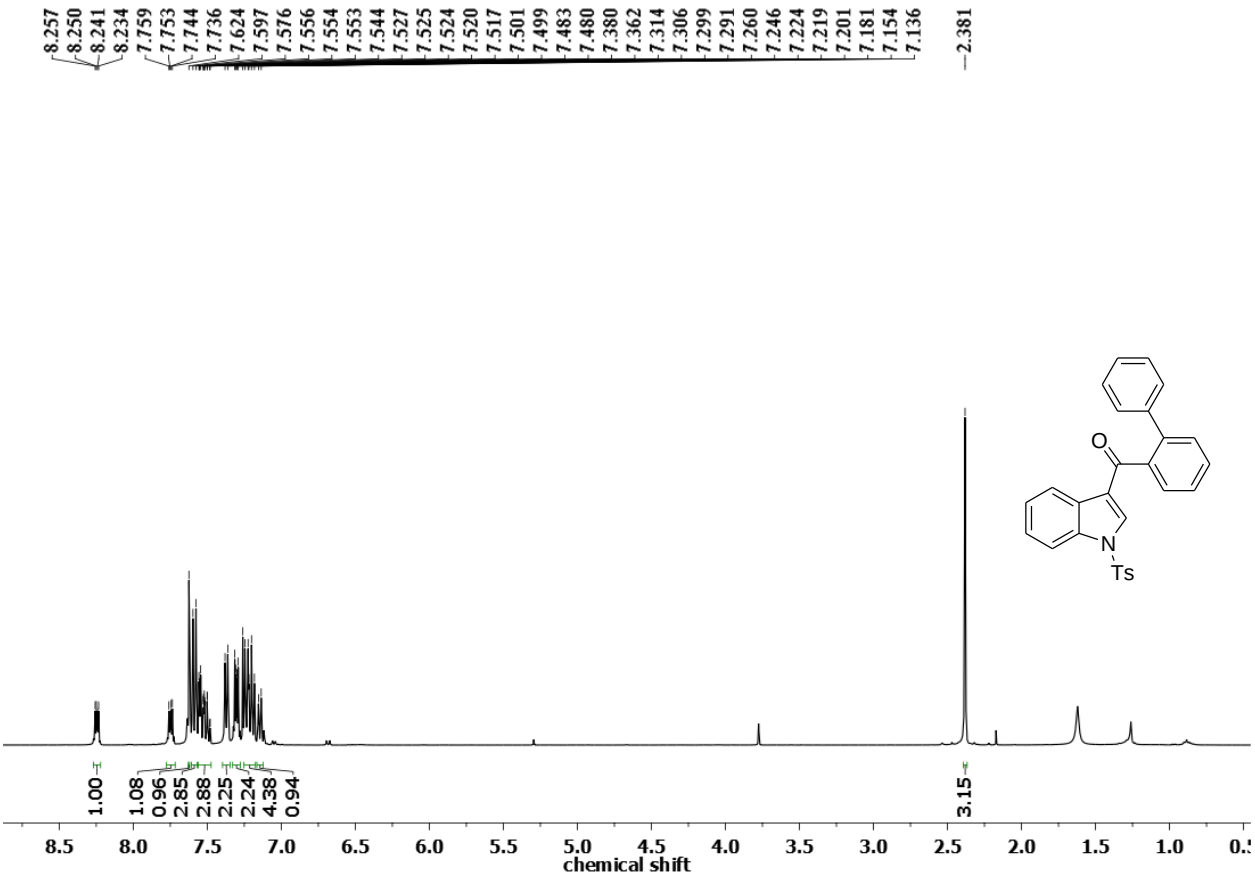


^{13}C NMR of 3o, $CDCl_3$, 100 MHz




```
Current Data Parameters
NAME      SP-J-A-119-13C
EXPNO                 10
PROCNO                 1

F2 - Acquisition Parameters
Date_           20190221
Time                0.50
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG         zgpg30
TD               32768
SOLVENT          CDCl3
NS                3000
DS                   4
SWH          24038.461 Hz
FIDRES        0.733596 Hz
AQ            0.6815744 sec
RG                 203
DW               20.800 usec
DE                6.50 usec
TE        0 K
D1          2.00000000 sec
D11         0.03000000 sec
TD0                1

======== CHANNEL f1 ========
SFO1       100.6404326 MHz
NUC1              13C
P1              11.00 usec
PLW1       55.00000000 W

======== CHANNEL f2 ========
SFO2       400.2016008 MHz
NUC2              1H
CPDPRG[2       waltz16
PCPD2           90.00 usec
PLW2       10.00000000 W
PLW12       0.36736000 W
PLW13       0.18478000 W

F2 - Processing parameters
SI               32768
SF         100.6303549 MHz
WDW                EM
SSB       0
LB               1.00 Hz
GB        0
PC               1.40
```

^{1}H NMR of 3-Indolyl biphenyl ketone, $CDCl_3$, 400 MHz



^{13}C NMR of 3-Indolyl biphenyl ketone, $CDCl_3$, 100 MHz