Supporting Information

Cinchona Alkaloid Thiourea Mediated Asymmetric Mannich Reaction of Isocyanoacetates with Isatin-Derived Ketimines and Subsequent Cyclization: Enantioselective Synthesis of Spirooxindole Imidazolines

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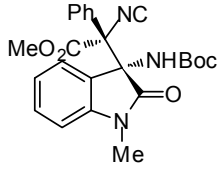
1. General Methods

NMR spectra were recorded with a Bruker AVANCE 400 MHz spectrometer in $CDCl_3$ with tetramethylsilane (TMS) as the internal standard; *J* values are given in Hz. IR spectra were recorded with a Bruker tensor 27 infrared spectrometer. Chiral HPLC was performed with a Shimadzu SPD-10A series instrument with chiral columns. HRMS (ESI) were recorded with a Waters LCT Premier XE spectrometer. Optical rotations were determined using a PolAAr 3005 High Accuracy Polarimeter; $[\alpha]_D$-values are given in units of 10^{-1} deg cm^2 g^{-1}. Flash column chromatography was performed on silica gel (300-400 mesh). Melting points were measured with a digital apparatus. Unless otherwise noted, all commercially obtained reagents were used without further purification. All reactions were carried out in air in a closed system. All reactions were carried out under air in a closed system. Isocyanoacetates **2**[1], isatinimines **3**[2] and catalysts **1a-f**[3] were prepared using literature method. Racemic Mannich adducts **4** for chiral HPLC analysis were prepared from the corresponding isocyanoacetates **2** (0.24 mmol) and isatinimine **3** (0.20 mmol) in the presence of DABCO (0.02 mmol) in 1.0 mL of $CHCl_3$ at -15ºC. Racemic spirooxindole imidazolines **5** were obtained from the cyclization of the above corresponding racemic Mannich adducts **4** catalyzed by DABCO (10 mol%) in 0.5 mL of $CHCl_3$ at the room temperature.

2. General procedure for the asymmetric Mannich reaction of isocyanoacetates 1 with isatin derived ketimines 2 and characterization data of 4

To the solution of isocyanoacetates **2** (0.30 mmol) and isatin derived ketimines **3** (0.20 mmol) in $CHCl_3$ (0.5 mL) was added cat. **1d** (11.9 mg, 0.02 mmol), the resulting mixture was stirred at -15ºC for 24h until the reaction completed (monitored by TLC). After concentration, the residue was directly subjected to flash column chromatography on silica gel (petroleum ether / ethyl acetate = 4:1 as eluent) to furnish the corresponding products **4**.

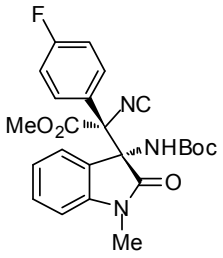
(*R*)-Methyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-1-methyl-2-oxoindolin-3-yl)-2-isocyano-2-phenylacetate 4a:



Yield: 76.0 mg (87 %). >20:1 *dr*. White solid, Mp: 154.4-154.8 ºC. $[\alpha]_D^{25}$ = -52.6 (*c* =1.0, CH_2Cl_2) (92 % *ee*); Chiralcel OD-H, Hexane/ isopropanol = 90/10, 0.5 mL/min, 254 nm, t_{major} = 13.56 min, t_{minor} = 15.83 min; ^1H NMR (400 MHz,

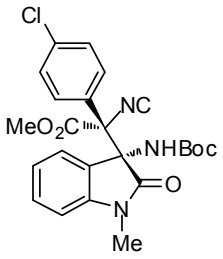
$CDCl_3$) δ 7.54 (d, J = 7.6 Hz, 2H), 7.49-7.45 (m, 1H), 7.42-7.38 (m, 2H), 7.30 (td, J = 8.0, 1.2 Hz, 1H), 7.06 (s, 1H), 6.81-6.79 (m, 2H), 6.18 (s, 1H), 3.92 (s, 3H), 3.19 (s, 3H), 1.21 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.2, 166.5, 165.1, 153.7, 144.9, 130.2, 129.9, 128.6, 128.1, 127.6, 125.4, 123.9, 121.8, 108.2, 80.7, 71.2, 67.3, 54.5, 27.8, 26.3. IR (film) ν 3366, 2136, 1725, 1614, 1473, 1371, 1353, 1255, 1163 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{24}H_{25}N_3NaO_5$ $[M+Na]^+$: 458.1692; found: 458.1715.

(*R*)-Methyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-1-methyl-2-oxoindolin-3-yl)-2-(4-fluorophenyl)-2-isocyanoacetate 4b:



Yield: 68.6 mg (76 %). >20:1 *dr*. White solid. Mp: 128.2-129.4 ºC; $[\alpha]_D^{25}$ = -37.4 (c = 0.25, CH_2Cl_2) (98 % *ee*); Chiralcel OD-H, Hexane/ isopropanol = 95/5, 0.5 mL/min, 254 nm, t_{major} = 21.33 min, t_{minor} = 26.64 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54-7.50 (m, 2H), 7.32 (t, J = 8.0 Hz, 1H), 7.08 (t, J = 8.4 Hz, 2H), 6.97 (s, 1H), 6.85 (t, J = 8.0 Hz, 1H), 6.81 (d, J = 7.6 Hz, 1H), 6.26 (s, br., 1H), 3.93 (s, 3H), 3.19 (s, 3H), 1.22 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.0, 166.5, 165.6, 163.5 (J = 249.6 Hz), 153.7, 145.0, 130.4, 129.9 (d, J = 8.5 Hz), 125.4, 124.6 (J = 3.3 Hz), 123.7, 122.0, 115.1 (J = 21.6 Hz), 108.4, 80.9, 70.8, 67.3, 54.7, 27.9, 26.4; ^{19}F NMR (376 MHz, $CDCl_3$) δ -111.1 ppm. IR (film) ν 3365, 2138, 1728, 1614, 1510, 1473, 1371, 1255, 1168 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{24}H_{24}FN_3NaO_5$ $[M+Na]^+$: 476.1598; found: 476.1635.

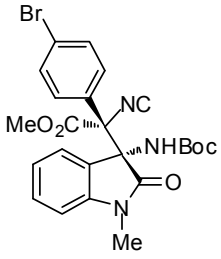
(*R*)-Methyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-1-methyl-2-oxoindolin-3-yl)-2-(4-chloro phenyl)-2-isocyanoacetate 4c:



Yield: 70.0 mg (75 %). >20:1 *dr*. White solid. Mp: 127.6-128.4 ºC; $[\alpha]_D^{25}$ = -52.2 (c = 0.25, CH_2Cl_2) (90 % *ee*); Chiralcel OD-H, Hexane/isopropanol = 95/5, 0.5 mL/min, 254 nm, t_{major} = 21.33 min, t_{minor} = 26.64 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 (d, J = 8.0 Hz, 1H), 7.37 (d, J = 8.8 Hz, 2H), 7.33 (t, J = 8.0 Hz, 1H), 6.97 (s, 1H), 6.86 (t, J = 7.6 Hz, 1H), 6.82 (d, J = 7.6 Hz, 1H), 6.27 (s, br., 1H), 3.93 (s, 3H), 3.19 (s, 3H), 1.22 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.0, 166.4, 165.7, 153.7, 145.0, 136.4, 130.5, 129.2, 128.3, 127.3, 125.4, 123.7, 122.0, 108.4, 80.9, 70.8, 67.2, 54.7, 27.9, 26.4; IR (film) ν 3371, 2137, 1729, 1614, 1494, 1371, 1257, 1163, 1099 cm^{-1}; HRMS

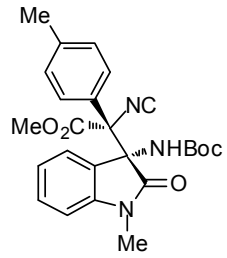
(TOF-ESI) Calcd. for $C_{24}H_{24}ClN_3NaO_5$ $[M+Na]^+$: 492.1302; found: 492.1344.

(*R*)-Methyl 2-(4-bromophenyl)-2-((*R*)-3-((tert-butoxycarbonyl)amino)-1-methyl-2-oxoindolin-3-yl)-2-isocyanoacetate 4d:



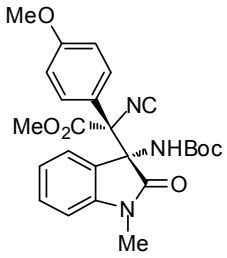
Yield: 73.0 mg (71 %). >20:1 *dr*. White solid. Mp: 97.5-98.2 ºC; $[\alpha]_D^{25}$ = -67.3 (*c* = 0.25, CH_2Cl_2) (90 % *ee*); Chiralpak IC-H, Hexane/isopropanol = 80/20, 0.5 mL/min, 254 nm, t_{major} = 40.72 min, t_{minor} = 36.23 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 (d, *J* = 8.4 Hz, 2H), 7.40 (d, *J* = 8.0 Hz, 2H), 7.33 (t, *J* = 8.0 Hz, 1H), 6.97 (s, 1H), 6.86 (t, *J* = 7.6 Hz, 1H), 6.82 (d, *J* = 8.0 Hz, 1H), 6.27 (s, br., 1H), 3.92 (s, 3H), 3.19 (s, 3H), 1.21 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.9, 166.2, 165.7, 153.6, 144.9, 131.2, 130.4, 129.4, 127.8, 125.3, 124.7, 123.6, 122.0, 108.4, 80.8, 70.9, 67.1, 54.7, 27.8, 26.4; IR (film) ν 3365, 2138, 1729, 1614, 1492, 1371, 1260, 1162 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{24}H_{25}BrN_3NaO_5$ $[M+H]^+$: 514.0978; found: 514.0975.

(*R*)-Methyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-1-methyl-2-oxoindolin-3-yl)-2-isocyano-2-(p-tolyl)acetate 4e:



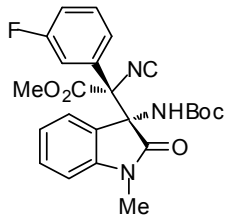
Yield: 74.8 mg (83 %). >20:1 *dr*. White solid. Mp: 139.9-140.5 ºC; $[\alpha]_D^{25}$ = -59.3 (*c* = 0.25, CH_2Cl_2) (88 % *ee*); Chiralcel OD-H, Hexane/isopropanol = 95/5, 0.7 mL/min, 254 nm, t_{major} =14.14 min, t_{minor} = 16.64 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 (d, *J* = 8.2 Hz, 2H), 7.31 (t, *J* = 7.6 Hz, 1H), 7.21 (d, *J* = 8.4 Hz, 2H), 7.06 (s, 1H), 6.82 (t, *J* = 7.2 Hz, 2H), 6.18 (s, br., 1H), 3.91 (s, 3H), 3.22 (s, 3H), 2.40 (s, 3H), 1.20 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.3, 166.7, 164.8, 153.7, 145.0, 140.1, 130.2, 128.9, 127.6, 125.7, 125.5, 124.0, 121.8, 108.2, 80.6, 71.2, 67.3, 54.5, 27.9, 26.4, 21.0; IR (film) ν 3363, 2130, 1726, 1614, 1472, 1371, 1258, 1162, 1091 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{25}H_{27}N_3NaO_5$ $[M+Na]^+$: 472.1848; found: 472.1842

(*R*)-Methyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-1-methyl-2-oxoindolin-3-yl)-2-isocyano-2-(4-methoxyphenyl)acetate 4f:



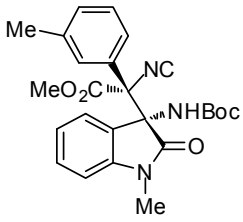
Yield: 83.0 mg (90 %). >20:1 *dr*. White solid. Mp: 134.4-135.2 ºC; $[\alpha]_D^{25}$ = -71.7 (*c* = 1.0, CH_2Cl_2) (81 % *ee*); Chiralpak AD-H, Hexane/isopropanol = 80/20, 0.5 mL/min, 254 nm, t_{major} = 15.86 min, t_{minor} = 22.34 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 (d, *J* = 8.8 Hz, 2H), 7.31 (t, *J* = 7.6 Hz, 1H), 7.04 (s, 1H), 6.91 (d, *J* = 8.8 Hz, 2H), 6.85-6.80 (m, 2H), 6.22 (s, br., 1H), 3.91 (s, 3H), 3.85 (s, 3H), 3.21 (s, 3H), 1.20 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.3, 166.7, 164.7, 160.7, 153.7, 145.0, 130.2, 129.1, 125.4, 124.1, 121.8, 120.4, 113.4, 108.2, 80.6, 70.9, 67.4, 55.3, 54.4, 27.9, 26.4; IR (film) ν 3363, 2137, 1720, 1611, 1512, 1471, 1369, 1253, 1160 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{25}H_{27}N_3NaO_6$ $[M+Na]^+$: 488.1798; found: 488.1791.

(*R*)-Methyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-1-methyl-2-oxoindolin-3-yl)-2-(3-fluoro phenyl)-2-isocyanoacetate 4g:



Yield: 46.5 mg (51 %). >20:1 *dr*. White solid. Mp: 113.2-113.6 ºC; $[\alpha]_D^{25}$ = -39.0 (*c* = 1.0, CH_2Cl_2) (95 % *ee*); Chiralcel OD-H, Hexane/isopropanol = 95/5, 0.5 mL/min, 254 nm, t_{major} = 17.45 min, t_{minor} = 21.72 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42-7.26 (m, 4H), 7.20-7.16 (m, 1H), 6.98 (s, 1H), 6.86 (t, *J* = 8.0 Hz, 1H), 6.82 (d, *J* = 8.0 Hz, 1H), 6.28-6.25 (m, 1H), 3.93 (s, 3H), 3.20 (s, 3H), 1.23 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.0, 166.3, 165.8, 160.2 (d, *J* = 245.7 Hz), 153.7, 145.0, 131.2 (d, *J* = 8.6 Hz), 130.5, 129.6 (d, *J* = 7.9 Hz), 125.4, 123.6 (d, *J* = 3.3 Hz), 122.0, 117.0 (d, *J* = 21.3 Hz), 115.4 (d, *J* = 26.0 Hz), 108.4, 80.9, 70.8, 67.2, 54.8, 27.9, 26.4; ^{19}F NMR (376 MHz, $CDCl_3$) δ -111.2 ppm. IR (film) ν 3364, 2134, 1724, 1613, 1592, 1490, 1370, 1251, 1161 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{24}H_{25}FN_3O_5$ $[M+H]^+$: 454.1778; found: 454.1768

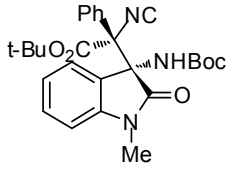
(*R*)-Methyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-1-methyl-2-oxoindolin-3-yl)-2-isocyano-2-(m-tolyl)acetate 4h:



Yield: 75.0 mg (84 %). >20:1 *dr*. White solid. Mp: 149.0-149.4 ºC; $[\alpha]_D^{25}$ = -28.0 (*c* = 0.25, CH_2Cl_2) (87 % *ee*); Chiralpak AD-H, Hexane/isopropanol = 80/20, 0.5 mL/min, 254 nm, t_{major} = 12.35 min, t_{minor} = 16.03 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34-7.26 (m, 5H), 7.03 (s, 1H), 6.83 (d, *J* = 7.6 Hz, 1H), 6.79 (d, *J* = 7.2 Hz, 1H), 6.22 (s, br., 1H), 3.91 (s, 3H), 3.19 (s, 3H), 2.36 (s, 3H), 1.22 (s, 9H); ^{13}C

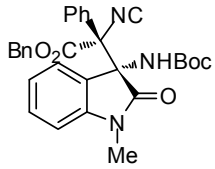
NMR (100 MHz, $CDCl_3$) δ 173.2, 166.6, 164.9, 153.7, 145.0, 138.0, 130.6, 130.3, 128.5, 128.3, 128.0, 125.6, 124.8, 124.0, 121.7, 108.2, 80.7, 71.3, 67.3, 54.5, 27.9, 26.4, 21.5; IR (film) ν 3368, 2137, 1728, 1614, 1472, 1373, 1258, 1165 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{25}H_{28}N_3O_5$ $[M+H]^+$: 450.2029; found: 450.2020.

(*R*)-tert-Butyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-1-methyl-2-oxoindolin-3-yl)-2-isocyano-2- henylacetate 4j:



Yield: 88.3 mg (93 %). >20:1 *dr*. White solid. Mp: 113.4-113.9 ºC; $[\alpha]_D^{25}$ = -50.3 (*c* = 0.94, CH_2Cl_2) (93 % *ee*); Chiralcel OD-H, Hexane/isopropanol = 99/1, 0.5 mL/min, 254 nm, t_{major} = 23.35 min, t_{minor} = 27.80 min; ^1H NMR (400 MHz, $CDCl_3$) δ 7.49-7.46 (m, 5H), 7.30 (d, *J* = 8.0 Hz, 1H), 7.14 (s, 1H), 6.81 (t, *J* = 7.6 Hz, 1H), 6.76 (d, *J* = 7.6 Hz, 1H), 6.27 (s, br., 1H), 3.17 (s, 3H), 1.52 (s, 9H), 1.19 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.1, 164.4, 164.2, 153.8, 145.0, 130.1, 129.6, 129.2, 127.9, 127.6, 125.3, 124.5, 121.7, 108.1, 86.4, 80.5, 71.8, 66.9, 27.9, 27.5, 26.3; IR (film) ν 3352, 2136, 1729, 1614, 1474, 1372, 1281, 1257, 1157 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{27}H_{31}N_3NaO_5$ $[M+Na]^+$: 500.2161; found: 500.2169.

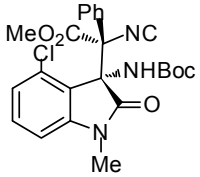
(*R*)-Benzyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-1-methyl-2-oxoindolin-3-yl)-2-isocyano-2-phenylacetate 4k:



Yield: 70.8 mg (70 %). >20:1 *dr*. White solid. Mp: 110.7-111.3 ºC; $[\alpha]_D^{25}$ = -24.4 (*c* = 1.0, CH_2Cl_2) (87 % *ee*); ChiralpakAD-H, Hexane/isopropanol = 90/10, 0.5 mL/min, 254 nm, t_{major} = 33.02 min, t_{minor} = 40.98 min; ^1H NMR (400 MHz, $CDCl_3$) δ 7.48 (d, *J* = 7.6 Hz, 2H), 7.44 (d, *J* = 7.2 Hz, 1H), 7.37 (d, *J* = 8.0 Hz, 2H), 7.34-7.26 (m, 6H), 6.97 (s, 1H), 6.82 (t, *J* = 7.6 Hz, 1H), 6.77 (d, *J* = 7.6 Hz, 1H), 6.26 (s, br., 1H), 5.34 (s, 2H), 3.16 (s, 3H), 1.21 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.0, 165.7, 165.2, 153.7, 145.0, 134.0, 130.3, 129.9, 128.6, 128.1, 128.0, 127.7, 125.5, 124.1, 121.9, 108.2, 80.7, 71.7, 69.4, 67.1, 27.9, 26.3; IR (film) ν 3367, 2135, 1721, 1613, 1472, 1370, 1252, 1160 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{30}H_{29}N_3NaO_5$ $[M+Na]^+$: 534.2005; found: 534.2001

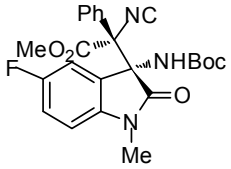
(*R*)-Methyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-4-chloro-1-methyl-2-oxoindolin-3-yl)-2-

isocyano-2-phenylacetate 4m:



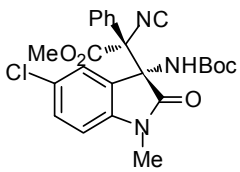
Yield: 61.8 mg (65 %). >20:1 *dr*. White solid. Mp: 164.8-165.4 ºC; $[\alpha]_D^{25}$ = +31.8 (*c* = 1.0, CH_2Cl_2) (85 % *ee*); Chiralpak AD-H, Hexane/isopropanol = 95/5, 0.5 mL/min, 254 nm, t_{major} = 49.11 min, t_{minor} = 43.44 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 (d, *J* = 7.6 Hz, 2H), 7.43 (t, *J* = 7.6 Hz, 1H), 7.36 (d, *J* = 8.0 Hz, 2H), 7.23 (d, *J* = 8.0 Hz, 1H), 7.01 (s, br., 1H), 6.82 (d, *J* = 8.4 Hz, 1H), 6.70 (d, *J* = 8.0 Hz, 1H), 3.95 (s, 3H), 3.11 (s, 3H), 1.25 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.5, 165.7, 165.6, 153.41, 153.39, 146.9, 132.6, 131.1, 130.1, 128.8, 128.6, 127.8, 124.2, 107.0, 80.8, 71.5, 69.2, 54.7, 27.9, 26.6; IR (film) ν 3385, 2135, 1732, 1610, 1488, 1460, 1367, 1258, 1165, 1115 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{24}H_{25}ClN_3O_5$ $[M+H]^+$: 470.1483; found: 470.1484.

(*R*)-Methyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-5-fluoro-1-methyl-2-oxoindolin-3-yl)-2-isocyano-2-phenylacetate 4n:



Yield: 66.6 mg (74 %). >20:1 *dr*. White solid. Mp: 135.6-136.8 ºC; $[\alpha]_D^{25}$ = -55.0 (*c* = 1.0, CH_2Cl_2) (90 % *ee*); Chiralcel OD-H, Hexane/isopropanol = 95/5, 0.5 mL/min, 254 nm, t_{major} = 17.93 min, t_{minor} = 23.23 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 (d, *J* = 7.6 Hz, 2H), 7.49 (d, *J* = 6.8 Hz, 1H), 7.44 (d, *J* = 8.0 Hz, 2H), 7.12 (s, 1H), 7.01 (td, *J* = 8.8, 2.8 Hz, 1H), 6.72 (dd, *J* = 8.4, 4.0 Hz, 1H), 5.89 (s, br., 1H), 3.93 (s, 3H), 3.19 (s, 3H), 1.25 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.1, 166.5, 165.6, 158.4 (d, *J* = 239.5 Hz), 153.8, 141.1 (d, *J* = 1.5 Hz), 130.2, 128.4, 128.3, 127.6, 125.6 (d, *J* = 7.8 Hz), 116.5 (d, *J* = 23.4 Hz), 113.7 (d, *J* = 25.1 Hz), 108.7 (d, *J* = 8.0 Hz), 81.0, 71.1, 67.5, 54.7, 28.0, 26.5; ^{19}F NMR (376 MHz, $CDCl_3$) δ -120.5 ppm. IR (film) ν 3365, 2135, 1724, 1622, 1496, 1368, 1256, 1162 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{24}H_{25}FN_3O_5$ $[M+H]^+$: 454.1778; found: 454.1766.

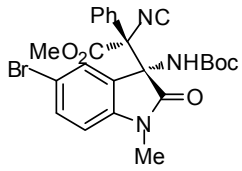
(*R*)-Methyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-5-chloro-1-methyl-2-oxoindolin-3-yl)-2-isocyano-2-phenylacetate 4o:



Yield: 49.8 mg (55 %). >20:1 *dr*. White solid. Mp: 152.2-153.4 ºC; $[\alpha]_D^{25}$ = -23.8 (*c* = 1.0, CH_2Cl_2) (90 % *ee*); Chiralcel OD-H, Hexane/isopropanol = 90/10, 0.5 mL/min, 254 nm, t_{major} = 12.83 min, t_{minor} = 15.79 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54-7.50 (m, 3H), 7.47-7.43 (m, 2H), 7.28 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.13 (s,

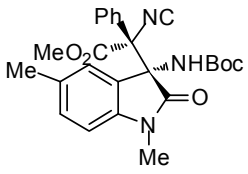
1H), 6.73 (d, *J* = 8.4 Hz, 1H), 6.04 (s, 1H), 3.93 (s, 3H), 3.20 (s, 3H), 1.25 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.0, 166.4, 165.6, 153.8, 143.6, 130.3, 130.1, 128.3, 127.6, 127.3, 125.9, 125.6, 109.1, 81.1, 71.0, 67.4, 54.7, 28.0, 26.5; IR (film) ν 3369, 2136, 1731, 1613, 1490, 1367, 1264, 1163, 1104 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{24}H_{25}ClN_3O_5$ $[M+H]^+$: 470.1483; found: 470.1478.

(*R*)-Methyl 2-((*R*)-5-bromo-3-((tert-butoxycarbonyl)amino)-1-methyl-2-oxoindolin-3-yl)-2-isocyano-2-phenylacetate 4p:



Yield: 66.0 mg (65 %). >20:1 *dr*. White solid. Mp:156.2-157.0 ºC; $[\alpha]_D^{25}$ = -22.0 (*c* =1.0, CH_2Cl_2) (92 % *ee*); Chiralcel OD-H, Hexane/isopropanol = 90/10, 0.5 mL/min, 254 nm, t_{major} = 12.96 min, t_{minor} = 15.93 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54-7.51 (m, 3H), 7.46 (d, *J* = 7.2 Hz, 2H), 7.43 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.13 (s, 1H), 6.79 (d, *J* = 8.4 Hz, 1H), 6.13 (s, 1H), 3.93 (s, 3H), 3.19 (s, 3H), 1.25 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.8, 166.4, 165.6, 153.8, 144.0, 132.9, 130.2, 128.5, 128.3, 128.2, 127.5, 125.9, 114.5, 109.6, 81.0, 71.0, 67.3, 54.7, 27.9, 26.5; IR (film) ν 3364, 2136, 1732, 1610, 1488, 1366, 1264, 1163 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{24}H_{25}BrN_3O_5$ $[M+H]^+$: 514.0978; found: 514.0987.

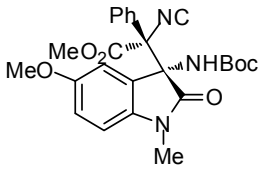
(*R*)-Methyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-1,5-dimethyl-2-oxoindolin-3-yl)-2-isocyano-2-phenylacetate 4q:



Yield: 81.2 mg (90 %). >20:1 *dr*. White solid. Mp: 134.5-135.2 ºC; $[\alpha]_D^{25}$ = -29.8 (*c* = 1.0, CH_2Cl_2) (93 % *ee*); Chiralcel OD-H, Hexane/isopropanol = 95/5, 0.5 mL/min, 254 nm, t_{major} = 17.15 min, t_{minor} = 20.31 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (d, *J* = 7.6 Hz, 2H), 7.48 (d, *J* = 7.2 Hz, 1H), 7.42 (d, *J* = 8.0 Hz, 2H), 7.09 (d, *J* = 7.2 Hz, 2H), 6.69 (d, *J* = 8.0 Hz, 1H), 5.86 (s, 1H), 3.92 (s, 3H), 3.18 (s, 3H), 2.10 (s, 3H), 1.22 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.2, 166.7, 165.1, 153.8, 142.6, 131.2, 130.4, 129.9, 128.8, 128.0, 127.8, 126.3, 123.8, 107.9, 80.6, 71.2, 67.5, 54.5, 27.9, 26.4, 20.9; IR (film) ν 3367, 2136, 1723, 1623, 1501, 1367, 1255, 1164 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{25}H_{28}N_3O_5$ $[M+H]^+$: 450.2029; found: 450.2024.

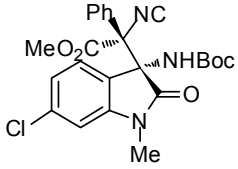
(*R*)-Methyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-5-methoxy-1-methyl-2-oxoindolin-3-yl)-2-

isocyano-2-phenylacetate 4r:



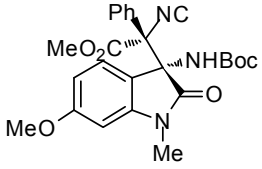
Yield: 76.4 mg (82 %). >20:1 *dr*. White solid. Mp: 77.5-78.2 ºC; $[\alpha]_D^{25}$ = -35.2 (*c* = 1.0, CH_2Cl_2) (83 % *ee*); Chiralcel OD-H, Hexane/isopropanol = 90/10, 0.5 mL/min, 254 nm, t_{major} = 15.58 min, t_{minor} = 18.54 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 (d, *J* = 7.6 Hz, 2H), 7.50-7.41 (m, 1H), 7.44 (d, *J* = 7.6 Hz, 2H), 7.15 (s, 1H), 6.83 (dd, *J* = 8.8, 2.8 Hz, 1H), 6.71 (d, *J* = 8.8 Hz, 1H), 5.69 (s, 1H), 3.92 (s, 3H), 3.52 (s, 3H), 3.19 (s, 3H), 1.22 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.0, 166.7, 165.2, 155.0, 153.8, 138.5, 130.0, 128.7, 128.2, 127.8, 125.0, 115.2, 112.2, 108.7, 80.8, 71.1, 67.7, 55.5, 54.6, 27.9, 26.5; IR (film) ν 3362, 2136, 1720, 1606, 1498, 1367, 1255, 1162, 1128 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{25}H_{28}lN_3O_6$ $[M+H]^+$: 466.1978; found: 466.1974.

(*R*)-Methyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-6-chloro-1-methyl-2-oxoindolin-3-yl)-2-isocyano-2-phenylacetate 4s:



Yield: 57.3 mg (65 %). >20:1 *dr*. White solid. Mp: 156.3-156.9 ºC; $[\alpha]_D^{25}$ = -56.8 (*c* = 1.0, CH_2Cl_2) (90 % *ee*); Chiralcel OD-H, Hexane/isopropanol = 95/5, 0.5 mL/min, 254 nm, t_{major} = 15.95 min, t_{minor} = 18.84 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (d, *J* = 7.6 Hz, 2H), 7.51-7.40 (m, 1H), 7.43 (d, *J* = 7.6 Hz, 2H), 7.09 (s, 1H), 6.80-6.78 (m, 2H), 6.04 (s, br., 1H), 3.92 (s, 3H), 3.19 (s, 3H), 1.25 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.3, 166.4, 165.5, 153.7, 146.2, 136.2, 130.1, 128.4, 128.3, 127.6, 126.3, 122.3, 121.8, 109.1, 81.0, 71.1, 67.0, 54.6, 27.9, 26.5; IR (film) ν 3365, 2135, 1734, 1610, 1495, 1371, 1264, 1164, 1039 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{24}H_{25}ClN_3O_5$ $[M+H]^+$: 470.1483; found: 470.1477.

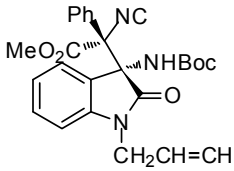
(*R*)-Methyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-6-methoxy-1-methyl-2-oxoindolin-3-yl)-2-isocyano-2-phenylacetate 4t:



Yield: 77.7 mg (83 %). >20:1 *dr*. White solid. Mp: 143.6-144.9 ºC; $[\alpha]_D^{25}$ = -54.0 (*c* = 1.0, CH_2Cl_2) (82 % *ee*); Chiralcel OD-H, Hexane/isopropanol = 90/10, 0.5 mL/min, 254 nm, t_{major} = 15.67 min, t_{minor} = 18.09 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 (d, *J* = 7.6 Hz, 2H), 7.48-7.38 (m, 1H), 7.41 (d, *J* = 7.6 Hz, 2H), 7.00 (s, 1H), 6.37 (s, 1H), 6.30 (d, *J* = 8.4 Hz, 1H), 6.10 (s, br., 1H), 3.91 (s, 3H), 3.79 (s, 3H), 3.17 (s, 3H), 1.24 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.7, 166.7, 164.9, 161.6, 153.8, 146.4, 129.9, 128.9,

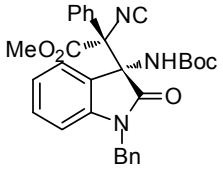
128.1, 127.7, 126.5, 115.5, 105.8, 96.1, 80.6, 71.5, 67.1, 55.3, 54.5, 28.0, 26.4; IR (film) ν 3367, 2136, 1725, 1626, 1508, 1474, 1376, 1254, 1163, 1092 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{25}H_{28}lN_3O_6$ $[M+H]^+$: 466.1978; found: 466.1978.

(*R*)-Methyl 2-((*R*)-1-allyl-3-((tert-butoxycarbonyl)amino)-2-oxoindolin-3-yl)-2-isocyano-2-phenylacetate 4u:



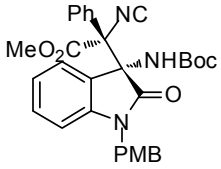
Yield: 77.6 mg (84 %). >20:1 *dr*. White solid. Mp: 138.7-139.8 ºC; $[\alpha]_D^{25}$ = -33.8 (*c* = 1.0, CH_2Cl_2) (83 % *ee*); Chiralcel OD-H, Hexane/isopropanol = 90/10, 0.5 mL/min, 254 nm, t_{major} = 10.83 min, t_{minor} = 12.99 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 (d, *J* = 7.6 Hz, 2H), 7.47 (t, *J* = 7.2 Hz, 1H), 7.41 (d, *J* = 7.6 Hz, 2H), 7.27 (t, J = 8.0 Hz, 1H), 7.08 (s, 1H), 6.83-6.79 (m, 2H), 6.22 (s, 1H), 5.75 (s, br., 1H), 5.37 (d, *J* = 17.2 Hz, 1H), 5.22 (d, *J* = 10.4 Hz, 1H), 4.41 (dd, *J* = 16.0, 5.2 Hz, 1H), 4.24 (dd, *J* = 16.0, 5.2 Hz, 1H), 3.92 (s, 3H), 1.23 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.0, 166.6, 165.6, 153.8, 144.4, 131.1, 130.2, 129.9, 128.8, 128.2, 127.8, 125.6, 123.9, 121.8, 118.2, 109.2, 80.7, 71.3, 67.0, 54.6, 43.1, 27.9; IR (film) ν 3365, 2136, 1726, 1613, 1488, 1368, 1263, 1163 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{26}H_{28}N_3O_5$ $[M+H]^+$: 462.2029; found: 462.2027.

(*R*)-Methyl 2-((*R*)-1-benzyl-3-((tert-butoxycarbonyl)amino)-2-oxoindolin-3-yl)-2-isocyano-2-phenylacetate 4v:



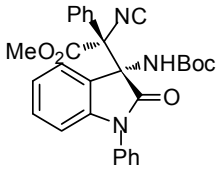
Yield: 58.1 mg (57 %). >20:1 *dr*. White solid. Mp: 142.3-143.1 ºC; $[\alpha]_D^{25}$ = -57.7 (*c* = 1.0, CH_2Cl_2) (74 % *ee*); Chiralcel OD-H, Hexane/isopropanol = 95/5, 0.5 mL/min, 254 nm, t_{major} = 14.89 min, t_{minor} = 21.92 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 (d, *J* = 7.6 Hz, 2H), 7.50 (t, *J* = 7.6 Hz, 1H), 7.43 (t, *J* = 7.6 Hz, 2H), 7.37 (d, *J* = 7.2 Hz, 2H), 7.31 (t, *J* = 7.6 Hz, 2H), 7.28-7.24 (m, 1H), 7.22-7.18 (m, 2H), 6.80 (t, *J* = 8.0 Hz, 1H), 6.69 (d, *J* = 8.0 Hz, 1H), 6.22 (s, br., 1H), 5.10 (d, *J* = 16.0 Hz, 1H), 4.77 (d, *J* = 16.0 Hz, 1H), 3.96 (s, 3H), 1.24 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.6, 166.7, 165.6, 153.9, 144.4, 135.1, 130.1, 129.9, 128.7, 128.6, 128.2, 127.8, 127.5, 125.5, 123.9, 121.9, 109.4, 80.7, 71.2, 67.1, 54.6, 44.5, 27.9; IR (film) ν 3359, 2136, 1725, 1614, 1488, 1369, 1264, 1162 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{30}H_{30}N_3O_5$ $[M+H]^+$: 512.2185; found: 512.2182.

(*R*)-Methyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-1-(4-methoxybenzyl)-2-oxoindolin-3-yl)-2-isocyano-2-phenylacetate 4w:



Yield: 86.5 mg (80 %). >20:1 *dr*. White solid. Mp: 121.6-122.8 ºC; $[\alpha]_D^{25}$ = -61.3 (*c* = 1.0, CH_2Cl_2) (69 % *ee*); Chiralpak AD-H, Hexane/isopropanol = 80/20, 0.8 mL/min, 254 nm, t_{major} = 21.47 min, t_{minor} = 16.07 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 (d, *J* = 7.6 Hz, 2H), 7.48 (t, *J* = 7.2 Hz, 1H), 7.41 (t, *J* = 7.6 Hz, 2H), 7.28 (d, *J* = 8.4 Hz, 2H), 7.18 (t, *J* = 7.6 Hz, 2H), 6.82 (d, *J* = 8.4 Hz, 2H), 6.77 (t, *J* = 7.6 Hz, 1H), 6.69 (d, *J* = 7.6 Hz, 1H), 6.16 (s, br., 1H), 5.02 (d, *J* = 15.2 Hz, 1H), 4.69 (d, *J* = 15.6 Hz, 1H), 3.94 (s, 3H), 3.77 (s, 3H), 1.21 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.6, 166.7, 165.5, 159.0, 153.9, 144.4, 130.1, 129.9, 128.9, 128.7, 128.2, 127.8, 127.1, 125.5, 124.0, 121.8, 114.0, 109.4, 80.7, 71.2, 67.1, 55.1, 54.6, 44.0, 27.9; IR (film) ν 3360, 2136, 1721, 1612, 1514, 1486, 1368, 1248, 1160 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{31}H_{32}N_3O_6$ $[M+H]^+$: 542.2291; found: 542.2287.

(*R*)-Methyl 2-((*R*)-3-((tert-butoxycarbonyl)amino)-2-oxo-1-phenylindolin-3-yl)-2-isocyano-2-phenylacetate 4x:



Yield: 89.3 mg (90 %). >20:1 *dr*. White solid. Mp: 155.7-156.5 ºC; $[\alpha]_D^{25}$ = -66.8 (*c* = 1.0, CH_2Cl_2) (95 % *ee*); Chiralpak AD-H, Hexane/isopropanol = 90/10, 0.5 mL/min, 254 nm, t_{major} = 23.02 min, t_{minor} = 14.57 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 (d, *J* = 7.2 Hz, 2H), 7.52 (d, *J* = 8.0 Hz, 1H), 7.50 (d, *J* = 7.2 Hz, 2H), 7.45-7.39 (m, 5H), 7.24-7.18 (m, 2H), 6.84 (t, *J* = 7.6 Hz, 1H), 6.74 (d, *J* = 8.0 Hz, 1H), 6.23 (s, br., 1H), 3.90 (s, 3H), 1.26 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.8, 166.6, 165.7, 154.0, 145.3, 133.9, 130.1, 130.0, 129.6, 128.7, 128.29, 128.26, 127.8, 126.6, 125.7, 123.8, 122.3, 109.4, 80.9, 71.3, 67.3, 54.6, 28.0; IR (film) ν 3364, 2135, 1728, 1612, 1499, 1481, 1371, 1254, 1162 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{29}H_{28}N_3O_5$ $[M+H]^+$: 498.2029; found: 498.2023.

3. Optimization reaction conditions for cyclization of adduct 4a[a]

To investigate the chirality match relationship between the Mannich adduct **4** and the catalysts, the cyclization of Mannich adduct **4a** and ***ent*-4**a were carried out in the presence of different catalyst, the results were summerized in Table S1. It was found that quinine-derived thiourea **1a** was the best catalyst for the adduct **4a**, high yield and remained enantioselectivity were obtained. In contrast,

quinidine-derived thiourea **1d** was effective to ***ent*-4a** to afford the good yield and higher enantioselectivity.

Table S1. Optimization of cyclization conditions of Mannich adduct **4a** and *ent*-**4a**[a]

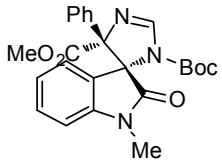
Entry	Mannich adduct	Catalyst	Time (h)	Yield (%)[b]	*ee* (%)[c]
1	**4a** (92% *ee*)	--	120	trace	n.d.
2	**4a** (92% *ee*)	DABCO	24	53	21
3	**4a** (92% *ee*)	**1d**	4	67	77
4	**4a** (92% *ee*)	**1d**	8	71	82
5	**4a** (92% *ee*)	**1a**	4	67	92
6	**4a** (92% *ee*)	**1a**	8	95	92
7	**4a** (92% *ee*)	**1a**	16	95	92
8	***ent*-4a** (-70% *ee*)[d]	**1a**	8	76	-64
9	***ent*-4a** (-70% *ee*)[d]	**1d**	8	79	-80

[a] All reactions were carried out with Mannich adduct **4a** (0.10 mmol) or ***ent*-4a** (0.10 mmol) and cat. (10 mol%) in $CHCl_3$ (0.5 mL) at room temperature. [b] Isolated yields. [c] Determined by chiral HPLC analysis. [d] ***ent*-4a** was prepared by cat. **1a** under the optimized Mannich reaction conditions.

4. General procedure for the cyclization of adduct 4 and characterization data of 5

To the solution of Mannich adducts **4** (0.10 mmol) in $CHCl_3$ (0.5 mL) was added cat. **1a** (5.9 mg, 0.01 mmol), the resulting mixture was stirred at room temperature for 8h until the reaction completed (monitored by TLC). After concentration, the residue was directly subjected to flash column chromatography on silica gel (petroleum ether / ethyl acetate = 4:1 as eluent) to furnish the corresponding spirooxindole imidazolines **5**.

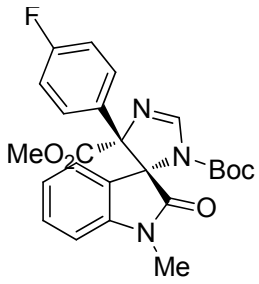
(*3'R,5R*)-3-tert-Butyl 5-methyl 1'-methyl-2'-oxo-5-phenylspiro[imidazole-4,3'-indoline]-3,5(5H)-dicarboxylate 5a



Yield: 95 %. >20:1 *dr*. White solid. Mp: 173.3-174.5 ºC; $[\alpha]_D^{25}$ = -75.7 (*c* = 1.0, CH_2Cl_2) (92 % *ee*); Chiralpak AD-H, Hexane/isopropanol = 60/40, 0.5 mL/min, 254 nm, t_{major} = 13.66 min, t_{minor} = 22.64 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.22 (s, 0.7H), 8.08 (s, 0.3H), 7.42-7.38 (m, 1H), 7.39 (t, *J* = 8.0 Hz, 2H), 7.28-7.21 (m, 3H), 7.21 (d, *J* = 7.2 Hz, 1H), 7.08 (t, *J* = 7.6 Hz, 1H), 6.85 (d, *J* = 7.6 Hz, 1H), 3.59 (s, 3H), 2.91 (s, 3H), 1.43 (s, 2.6H), 1.03 (s, 6.4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.1, 168.4, 151.6, 149.0, 144.4, 136.1, 130.2, 128.2, 127.5, 127.3, 126.7, 123.5, 122.5, 108.7, 108.3, 88.9, 83.8, 83.1, 72.9, 52.8, 27.9, 27.3, 25.9; IR (film) ν 1732, 1640, 1613, 1494, 1471, 1354, 1292, 1256, 1217, 1147, 1086

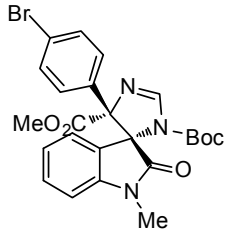
cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{24}H_{26}N_3O_5$ $[M+H]^+$: 436.1872; found: 436.1865.

(*3'R,5R*)-3-tert-Butyl 5-methyl 5-(4-fluorophenyl)-1'-methyl-2'-oxospiro[imidazole-4,3'-indoline]-3,5(5H)-dicarboxylate 5b:



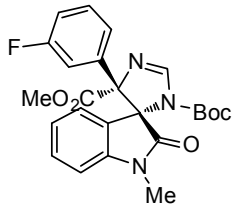
Yield: 89 %. >20:1 *dr*. White solid. Mp: 187.6-188.6 ºC; $[\alpha]_D^{25}$ = -54.4 (*c* = 1.0, CH_2Cl_2) (97 % *ee*); Chiralpak AD-H, Hexane/isopropanol = 60/40, 0.5 mL/min, 254 nm, t_{major} = 14.47 min, t_{minor} = 21.04 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.21 (s, 0.7H), 8.07 (s, 0.3H), 7.40 (t, *J* = 7.6 Hz, 3H), 7.19 (d, *J* = 7.6 Hz, 1H), 7.08 (t, *J* = 7.6 Hz, 1H), 6.94 (t, *J* = 8.4 Hz, 2H), 6.85 (d, *J* = 7.6 Hz, 1H), 3.60 (s, 3H), 2.93 (s, 3H), 1.43 (s, 2.6H), 1.03 (s, 6.4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.1, 168.2, 162.4 (d, *J* = 246.0 Hz), 151.8, 148.9, 144.2, 131.9, 130.3, 129.4 (d, *J* = 8.0 Hz), 126.4, 123.4, 122.6, 114.2 (d, *J* = 21.2 Hz), 108.7, 108.4, 88.3, 83.9, 83.2, 72.9, 52.8, 27.9, 27.2, 25.9; ^{19}F NMR (376 MHz, $CDCl_3$) δ -113.8 ppm. IR (film) ν 1734, 1639, 1613, 1509, 1471, 1371, 1355, 1293, 1224, 1148 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{24}H_{25}FN_3O_5$ $[M+H]^+$: 454.1778; found: 454.1771.

(*3'R,5R*)-3-tert-Butyl 5-methyl 5-(4-bromophenyl)-1'-methyl-2'-oxospiro[imidazole-4,3'-indoline]-3,5(5H)-dicarboxylate 5c:



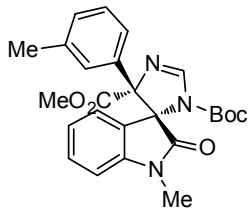
Yield: 87 %. >20:1 *dr*. White solid. Mp: 185.3-186.1 ºC; $[\alpha]_D^{25}$ = +37.5 (*c* = 1.0, CH_2Cl_2) (90 % *ee*); Chiralpak AD-H, Hexane/isopropanol = 60/40, 0.5 mL/min, 254 nm, t_{major} = 15.14 min, t_{minor} = 26.51 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.21 (s, 0.7H), 8.07 (s, 0.3H), 7.42-7.37 (m, 3H), 7.29 (d, *J* = 7.6 Hz, 2H), 7.19 (d, *J* = 7.2 Hz, 1H), 7.09 (t, *J* = 7.6 Hz, 1H), 6.85 (d, *J* = 7.2 Hz, 1H), 3.59 (s, 3H), 2.94 (s, 3H), 1.42 (s, 2.6H), 1.03 (s, 6.4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.1, 168.1, 152.1, 151.8, 148.9, 144.3, 135.3, 130.5, 129.4, 129.2, 126.4, 123.6, 122.8, 108.8, 108.5, 88.4, 83.4, 83.3, 72.9, 52.9, 27.9, 27.3, 26.0; IR (film) ν 1732, 1639, 1613, 1493, 1471, 1353, 1292, 1257, 1148 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{24}H_{25}BrN_3O$ $[M+H]^+$: 514.0978; found: 514.0968.

(*3'R,5R*)-3-tert-Butyl 5-methyl 5-(3-fluorophenyl)-1'-methyl-2'-oxospiro[imidazole-4,3'-indoline]-3,5(5H)-dicarboxylate 5d:



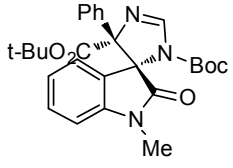
Yield: 76 %. >20:1 *dr*. White solid. Mp: 178.9-179.8 ºC; $[\alpha]_D^{25}$ = -63.0 (*c* = 1.00, CH_2Cl_2) (93 % *ee*); Chiralpak AD-H, Hexane/isopropanol = 60/40, 0.5 mL/min, 254 nm, t_{major} = 13.62 min, t_{minor} = 24.29 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.21 (s, 0.7H), 8.07 (s, 0.3H), 7.41 (t, *J* = 7.6 Hz, 1H), 7.26-7.16 (m, 4H), 7.09 (t, *J* = 7.6 Hz, 1H), 7.00-6.93 (m, 1H), 6.87 (d, *J* = 7.2 Hz, 1H), 3.59 (s, 3H), 2.95 (s, 3H), 1.43 (s, 2.6H), 1.03 (s, 6.4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.0, 168.0, 162.1 (d, *J* = 243.0 Hz), 151.9, 148.9, 144.2, 138.6 (d, *J* = 6.5 Hz), 130.4, 128.6 (d, *J* = 7.7 Hz), 126.4, 123.5, 123.3, 122.7, 115.1 (d, *J* = 20.7 Hz), 115.0 (d, *J* = 23.9 Hz), 108.8, 108.5, 88.4, 84.0, 83.3, 72.9, 52.9, 27.9, 27.3, 25.9; ^{19}F NMR (376 MHz, $CDCl_3$) δ -113.5 ppm. IR (film) ν 1732, 1640, 1613, 1589, 1471, 1371, 1354, 1293, 1234, 1147 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{24}H_{25}FN_3O_5$ $[M+H]^+$: 454.1778; found: 454.1780.

(*3'R,5R*)-3-tert-Butyl 5-methyl 1'-methyl-2'-oxo-5-(m-tolyl)spiro[imidazole-4,3'-indoline]-3,5(5H)-dicarboxylate 5e:



Yield: 86 %. >20:1 *dr*. White solid. Mp: 180.2-181.2 ºC; $[\alpha]_D^{25}$ = -57.9 (*c* = 1.00, CH_2Cl_2) (90 % *ee*); Chiralpak AD-H, Hexane/isopropanol = 60/40, 0.5 mL/min, 254 nm, t_{major} = 11.64 min, t_{minor} = 22.55 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.21 (s, 0.7H), 8.07 (s, 0.3H), 7.39 (t, *J* = 7.6 Hz, 1H), 7.30 (s, 1H), 7.20 (d, *J* = 7.2 Hz, 1H), 7.13 (t, *J* = 7.6 Hz, 2H), 7.09-7.05 (m, 2H), 6.85 (d, *J* = 7.2 Hz, 1H), 3.58 (s, 3H), 2.93 (s, 3H), 2.30 (s, 3H), 1.42 (s, 2.6H), 1.03 (s, 6.4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.1, 168.4, 151.4, 149.0, 144.3, 136.9, 136.1, 130.2, 128.9, 128.1, 127.1, 126.7, 124.5, 123.4, 122.5, 108.6, 108.2, 88.9, 87.4, 83.7, 83.1, 72.9, 52.7, 27.9, 27.3, 25.8, 21.4; IR (film) ν 1731, 1640, 1612, 1494, 1471, 1353, 1293, 1259, 1147 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{25}H_{28}N_3O_5$ $[M+H]^+$: 450.2029; found: 450.2020

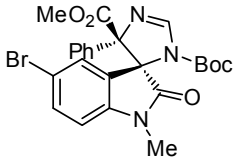
(3'S,5S)-Di-tert-butyl 1'-methyl-2'-oxo-5-phenylspiro[imidazole-4,3'-indoline]-3,5(5H)-dicarboxylate 5f:



Yield: 68 %. >20:1 dr. White solid. Mp: 180.7-181.7 ºC; $[\alpha]_D^{25}$ = -90.1 (*c* = 1.0, CH_2Cl_2) (95 % *ee*); Chiralpak AD-H, Hexane/isopropanol = 60/40, 0.5 mL/min,

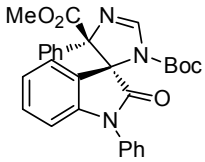
254 nm, t_{major} = 11.11 min, t_{minor} = 16.70 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.22 (s, 0.7H), 8.06 (s, 0.3H), 7.40-7.36 (m, 4H), 7.23-7.29 (m, 3H), 7.05 (t, J = 7.6 Hz, 1H), 6.82 (d, J = 7.2 Hz, 1H), 2.96 (s, 2.1H), 2.92 (s, 0.9H), 1.41 (s, 2.5H), 1.23 (s, 9H), 1.02 (s, 6.5H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 172.2, 166.7, 151.0, 149.2, 144.5, 136.1, 130.0, 128.1, 127.6, 127.3, 127.1, 124.3, 122.5, 107.8, 89.3, 83.3, 83.0, 72.6, 29.7, 28.0, 27.6, 27.4, 26.0; IR (film) ν 1726, 1640, 1613, 1494, 1472, 1371, 1357, 1297, 1250, 1150 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{27}H_{32}N_3O_5$ $[M+H]^+$: 478.2342; found: 478.2348.

(3'S,5S)-3-tert-Butyl 5-methyl 5'-bromo-1'-methyl-2'-oxo-5-phenylspiro[imidazole-4,3'-indoline]-3,5(5H)-dicarboxylate 5g:



Yield: 89 %. >20:1 *dr*. White solid. Mp: 181.6-182.3 ºC; $[\alpha]_D^{25}$ = -8.5 (c = 1.0, CH_2Cl_2) (92 % *ee*); Chiralpak AD-H, Hexane/isopropanol = 60/40, 0.5 mL/min, 254 nm, t_{major} = 13.43 min, t_{minor} = 33.68 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.20 (s, 0.6H), 8.05 (s, 0.4H), 7.52 (d, J = 8.0 Hz, 1H), 7.40-7.35 (m, 3H), 7.30-7.24 (m, 3H), 6.75 (d, J = 8.0 Hz, 1H), 3.66 (s, 3H), 2.89 (s, 3H), 1.44 (s, 3H), 1.07 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.6, 168.2, 151.5, 151.3, 148.7, 143.3, 135.7, 133.0, 132.8, 128.7, 128.4, 127.4, 126.8, 115.1, 110.1, 109.7, 89.2, 87.7, 84.3, 83.5, 72.8, 52.9, 27.9, 27.3, 25.9; IR (film) ν 1734, 1640, 1610, 1489, 1355, 1292, 1267, 1216, 1148 cm^{-1}; HRMS (TOF-ESI) Calcd. for $C_{24}H_{25}BrN_3O$ $[M+H]^+$: 514.0978; found: 514.0988.

(3'S,5S)-3-tert-Butyl 5-methyl 2'-oxo-1',5-diphenylspiro[imidazole-4,3'-indoline]-3,5(5H)-dicarboxylate 5h



Yield: 99 %. >20:1 dr. White solid. Mp: 169.2-170.4 ºC; $[\alpha]_D^{25}$ = -26.3 (c = 1.0, CH_2Cl_2) (95 % *ee*); Chiralpak AD-H, Hexane/isopropanol = 60/40, 0.5 mL/min, 254 nm, t_{major} = 20.84 min, t_{minor} = 22.62 min; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.24 (s, 0.65H), 8.08 (s, 0.35H), 7.50-7.47 (m, 2H), 7.42-7.35 (m, 2H), 7.29-7.19 (m, 6H), 7.12-7.06 (m, 1H), 7.02 (d, J = 7.6 Hz, 2H), 6.90 (d, J = 7.2 Hz, 0.65H), 6.80-6.82 (m, 0.35H), 3.63 (s, 3H), 1.41 (s, 3H), 1.06 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.2, 168.4, 152.2, 151.8, 149.2, 144.1, 135.8, 133.5, 130.1, 129.4, 128.3, 127.9, 127.8, 127.6, 126.2, 126.0, 125.2, 124.1, 123.1, 109.9, 89.2, 83.4, 73.3, 52.9, 28.0, 27.5; IR (film) ν 1736, 1639, 1611, 1501, 1467, 1371, 1355, 1294, 1235, 1146 cm^{-1};

HRMS (TOF-ESI) Calcd. for $C_{29}H_{28}N_3O_5$ $[M+H]^+$: 498.2029; found: 498.2012.

References:

1. (a) For the synthesis of α-phenyl isocyanoacetates **2a**, **2j-k** and α-alkyl substituted isocyanoacetates **2l**, see: (a) R. S. Bon, C. Hong, M. J. Bouma, R. F. Schmitz, F. J. J. de Kanter, M. Lutz, A. L. Spek, R. V. A. Orru, *Org. Lett.* **2003**, *5*, 3759; For the synthesis of α-aryl isocyanoacetates **2b-i**, see: (b) E. J. Jacobsen, L. S. Stelzer, K. L. Belonga, D. B. Carter, W. B. Im, V. H. Sethy, A. H. Tang, P. F. VonVoigtlander, J. D. Petke, *J. Med. Chem.* **1996**, *39*, 3820; (c) K. Matsumoto, M. Suzuki, M. Miyoshi, *J. Org. Chem.* **1978**, *38*, 2094.
2. W. Yan, D.Wang, J. Feng, P. Li, D. Zhao and R. Wang, *Org. Lett.* **2012**, *14*, 2512.
3. For the synthesis of cinchona alkaloid derived thiourea catalysts **1a-e**, see: (a) J. Ye, D. J. Dixon,P. S. Hynes, *Chem. Commun.* **2005**, 4481. (b) B. Vakulya, S. Varga, A. Csampai and T. Soós, *Org. Lett.* **2005**, *7*, 1967-1969; For the synthesis of quinine derived squaramide catalyst **1b**, see: (c) J. P. Malerich, K. Hagihara, V. H. Rawal, *J. Am. Chem. Soc.* **2008**, *130*, 14416; (d) L. Dai, S.-X. Wang, F.-E. Chen, *Adv. Synth. Catal.* **2010**, *352*, 2137; (e) W. Yang, D. -M. Du, *Org. Lett.* **2010**, *12*, 5450.

5. X-Ray crystal data of compound 4p and 5g

Table S1. Crystal data and structure refinement for 3116 (**4p**, CCDC number: 1047214).

Identification code	3116	
Empirical formula	$C_{25}H_{26}BrCl_2N_3O_5$	
Formula weight	599.30	
Temperature	296 (2)	
Wavelength	0.71073 Å	
Crystal system	Orthorhombic	
Space group	P2(1)2(1)2(1)	
Unit cell dimensions	a = 9.5000(10) Å	α = 90.00°.
	b = 14.8773(16) Å	β = 90.00°.
	c = 19.875(2) Å	γ = 90.00°.
Volume	2809.0(5) $Å^3$	
Z	4	
Density (calculated)	1.417 Mg/m^3	
Absorption coefficient	1.692 mm^{-1}	
F(000)	1224	
Crystal size	0.48 x 0.41 x 0.26 mm^3	
Theta range for data collection	1.71 to 25.00°.	
Index ranges	-11<=h<=11, -17<=k<=17, -23<=l<=23	
Reflections collected	32871	
Independent reflections	4948 [R(int) = 0.0431]	
Data / restraints / parameters	4948 / 0 / 325	
Goodness-of-fit on F^2	1.030	
Final R indices [I>2sigma(I)]	R1 = 0.0599, wR2 = 0.1654	
R indices (all data)	R1 = 0.0714, wR2 = 0.1774	
Largest diff. peak and hole	0.843 and -1.247 $e.Å^{-3}$	

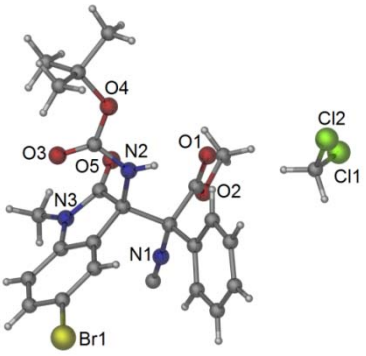


Figure S1

Table S2. Crystal data and structure refinement for 2806 (**5g**, CCDC number: 1021346).

Identification code	2806	
Empirical formula	$C_{24}H_{24}BrN_3O_5$	
Formula weight	514.37	
Temperature	173(2)	
Wavelength	0.71073 Å	
Crystal system	Orthorhombic	
Space group	P2(1)2(1)2(1)	
Unit cell dimensions	a = 8.8260(9) Å	α = 90.00°.
	b = 16.2679(17) Å	β = 90.00°.
	c = 16.3883(17) Å	γ = 90.00°.
Volume	2353.0(4) $Å^3$	
Z	4	
Density (calculated)	1.452 Mg/m^3	
Absorption coefficient	1.787 mm^{-1}	
F(000)	1056	
Crystal size	0.45 x 0.26 x 0.14 mm^3	
Theta range for data collection	1.76 to 25.01°.	
Index ranges	-10<=h<=10, -18<=k<=19, -19<=l<=19	
Reflections collected	27004	
Independent reflections	4152 [R(int) = 0. 1385]	
Data / restraints / parameters	4152 / 0 / 299	
Goodness-of-fit on F^2	0.959	
Final R indices [I>2sigma(I)]	R1 = 0.0508, wR2 = 0.1121	
R indices (all data)	R1 = 0.0747, wR2 = 0.1221	
Largest diff. peak and hole	0.615 and -0.470 $e.Å^{-3}$	

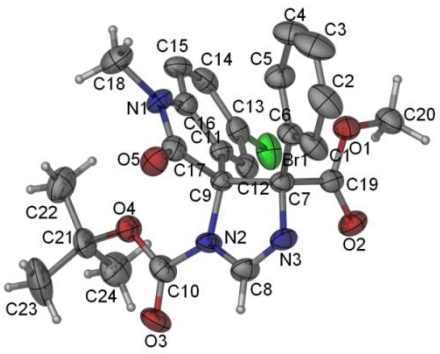
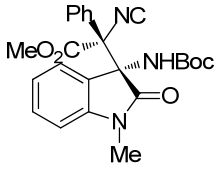


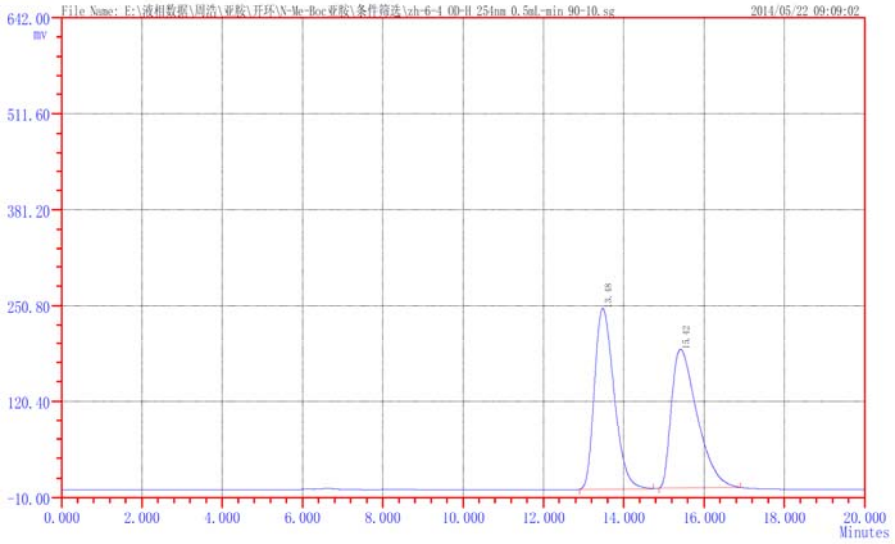
Figure S2

5. Copies of HPLC analysis spectra of compounds 4 and 5

4a (Table 2, Entry 1)

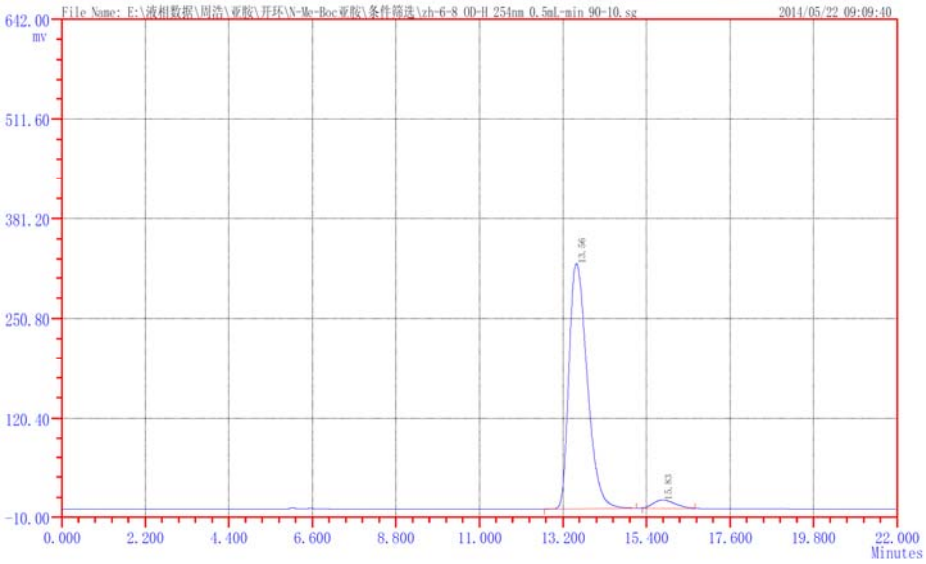


Racemic



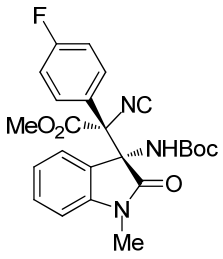
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		13.480	245858	8334692.1	49.9738	1.34	3151
2		15.420	187680	8343447.7	50.0262	1.74	2398
	Σ:		433538	16678139.8	100.0000		

Chiral

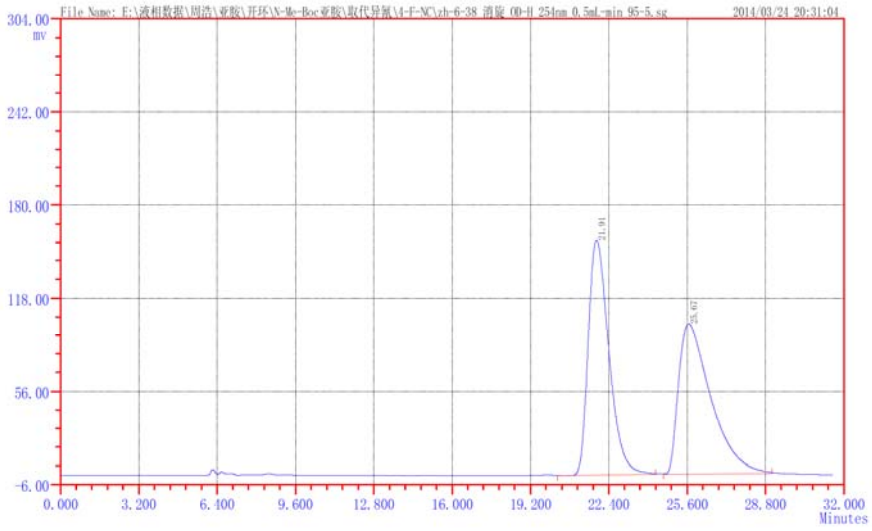


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		13.560	321922	10760964.0	95.9526	1.40	3280
2		15.830	11245	453916.1	4.0474	1.21	3065
	Σ:		333167	11214880.1	100.0000		

4b (Table 2, entry 2)

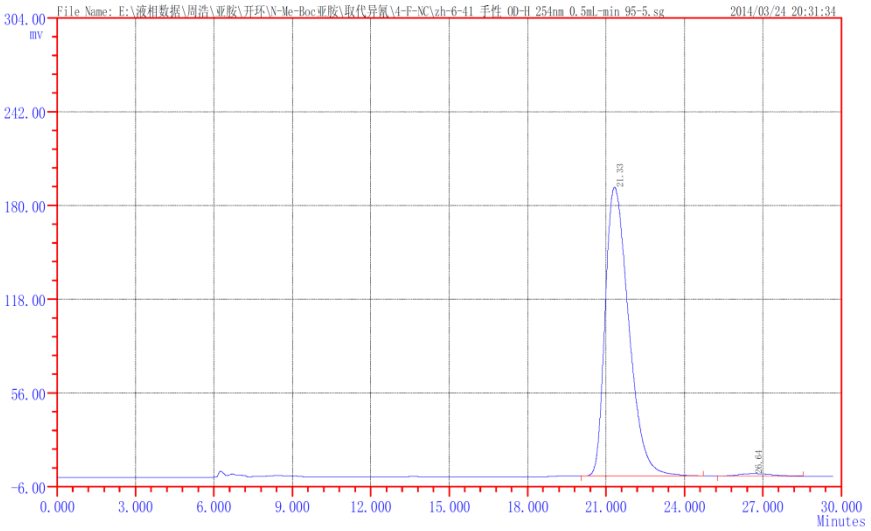


Racemic



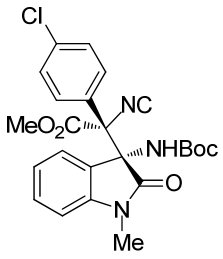
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		21.907	156485	9196306.9	50.0141	1.44	2769
2		25.665	100155	9191119.9	49.9859	2.13	1559
	Σ:		256640	18387426.8	100.0000		

Chiral

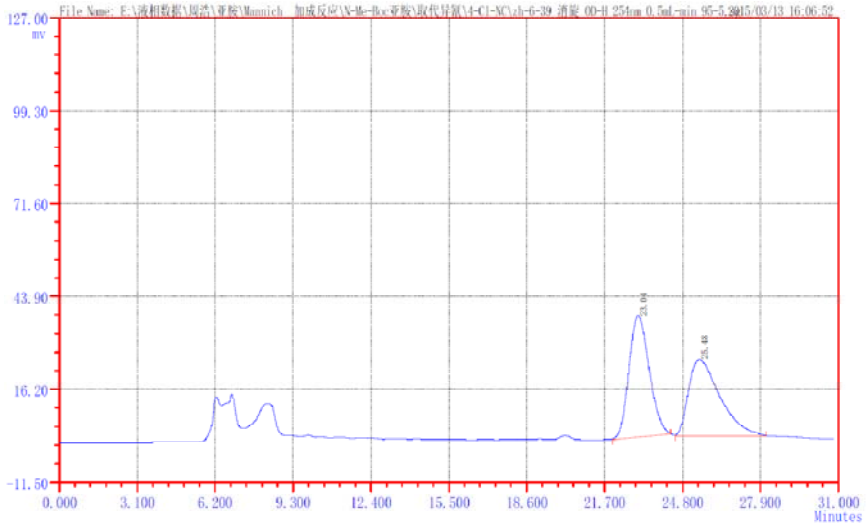


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		21.328	191076	11985703.1	98.8177	1.44	2304
2		26.642	1572	143398.6	1.1823	1.08	1700
	Σ:		192648	12129101.7	100.0000		

4c (Table 2, entry 3)

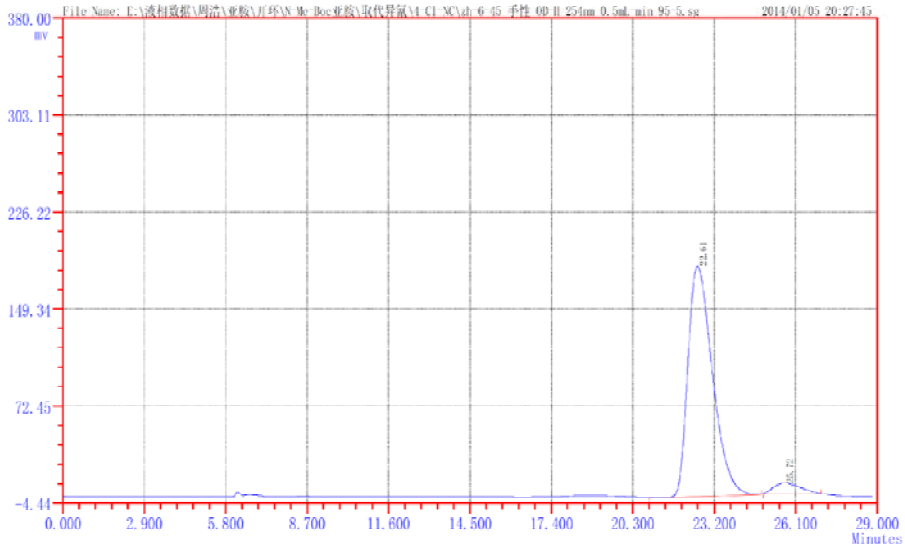


Racemic



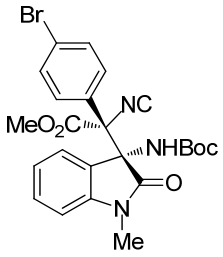
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		23.043	36277	2046338.5	50.6761	1.26	3326
2		25.480	22928	1991734.1	49.3239	1.79	1715
	Σ:		59205	4038072.5	100.0000		

Chiral

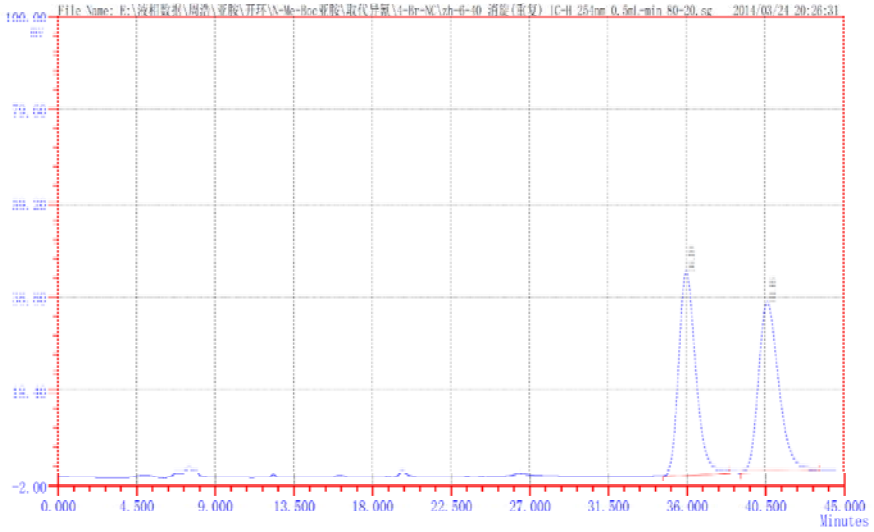


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		22.613	183238	11198350.0	95.0736	1.50	2729
2		25.715	8481	580257.1	4.9264	1.34	2815
	Σ:		191719	11778607.1	100.0000		

4d (Table 2, entry 4)

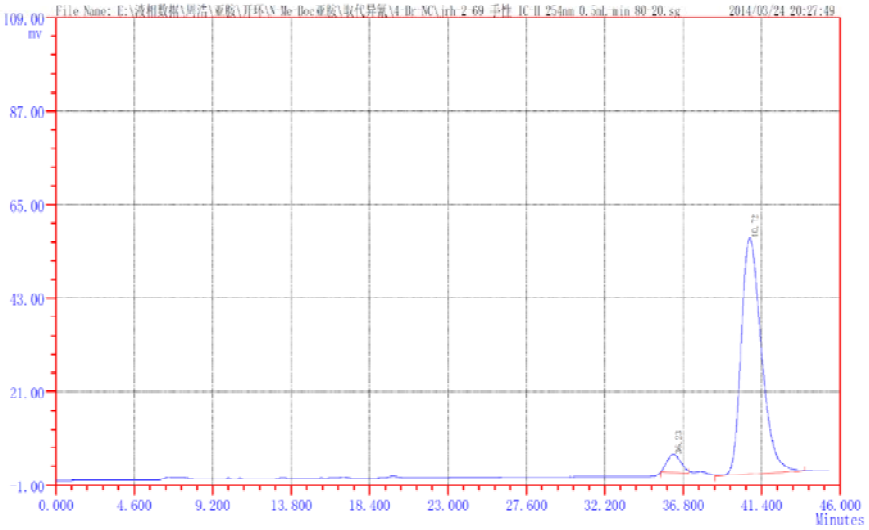


Racemic



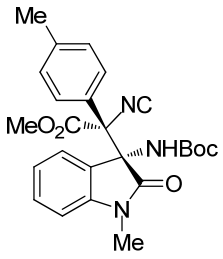
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		36.000	44094	2972982.5	50.0101	1.29	5682
2		40.665	36811	2971779.1	49.9899	1.31	5057
	Σ:		80905	5944761.6	100.0000		

Chiral

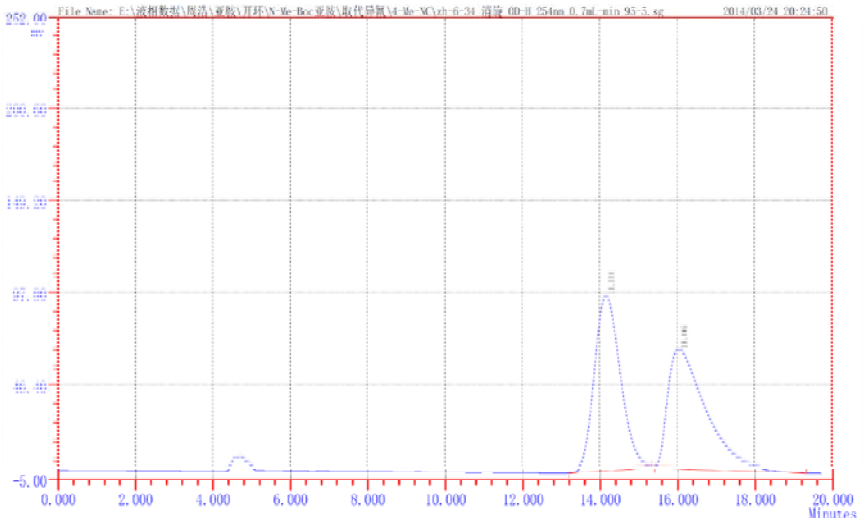


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		36.227	4353	242110.1	5.0218	1.15	8455
2		40.718	55584	4579043.3	94.9782	1.38	4869
	Σ:		59937	4821153.4	100.0000		

4e (Table 2, entry 5)

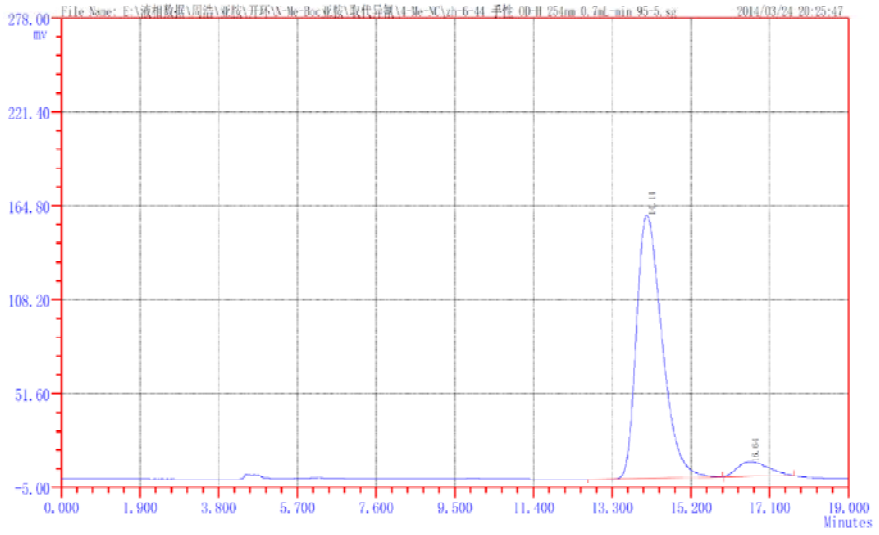


Racemic



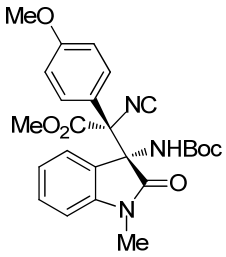
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		14.175	96545	4478126.2	50.1413	1.24	1861
2		16.060	65971	4452883.7	49.8587	2.10	1128
	Σ:		162516	8931009.9	100.0000		

Chiral

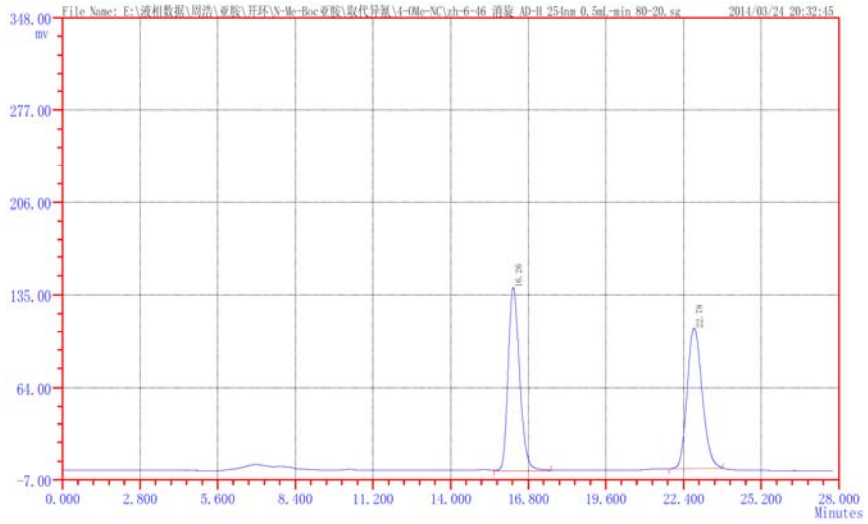


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		14.140	158542	6792541.2	93.9149	1.42	2171
2		16.638	8506	440116.1	6.0851	1.42	2061
	Σ:		167048	7232657.3	100.0000		

4f (Table 2, entry 6)

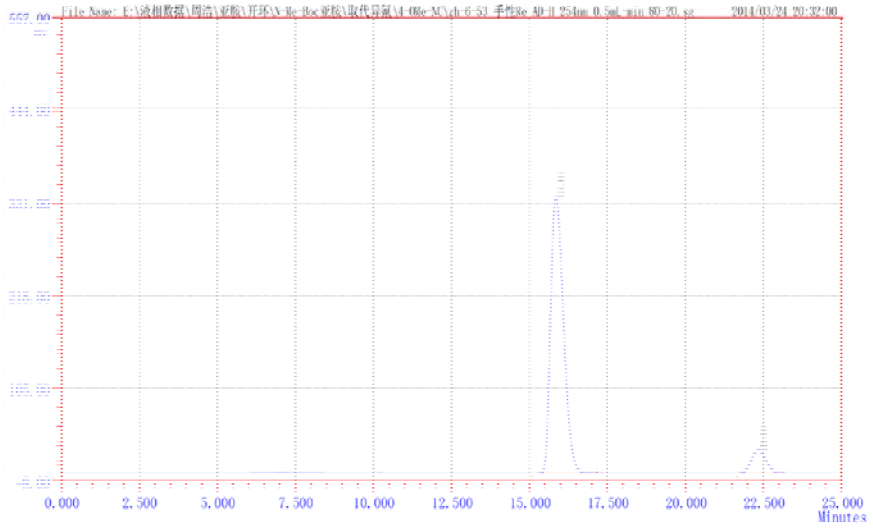


Racemic



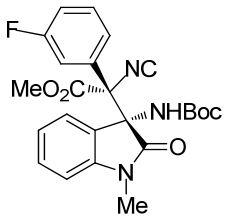
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		16.262	140364	4063021.5	50.0848	1.25	6290
2		22.782	107945	4049260.4	49.9152	1.19	7351
	Σ:		248309	8112282.0	100.0000		

Chiral



ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		15.857	337652	9860950.9	90.5890	1.36	5876
2		22.343	29302	1024424.4	9.4110	1.10	8141
	Σ:		366954	10885375.3	100.0000		

4g (Table 2, entry 7)



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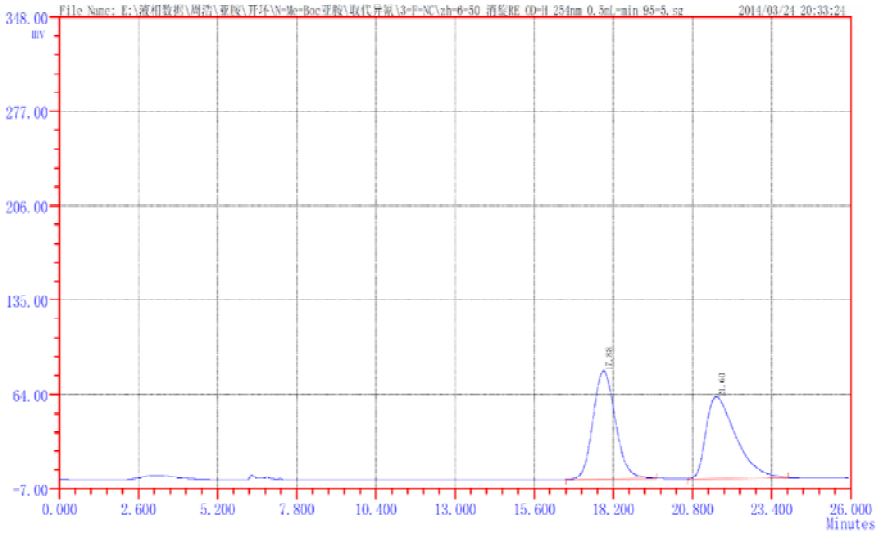
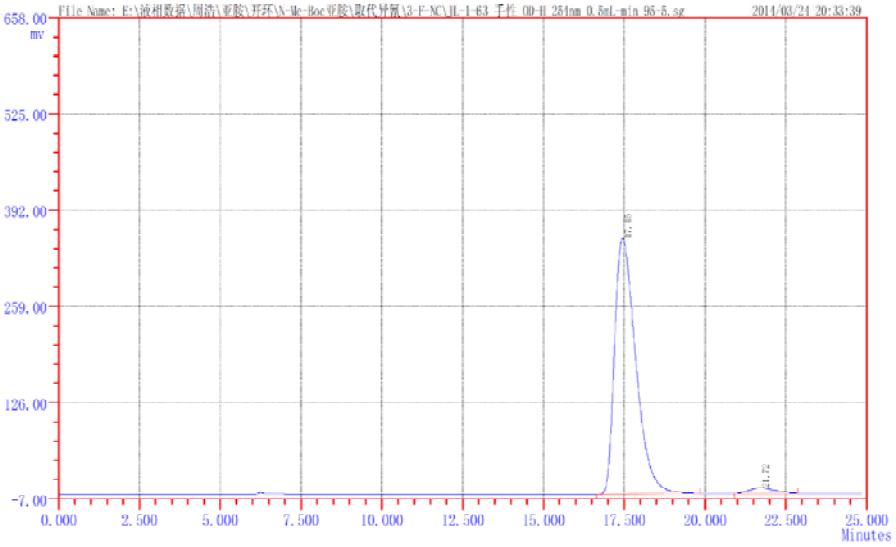


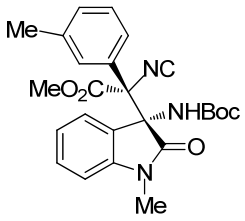
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		17.882	81261	4184320.6	50.0167	1.16	2404
2		21.595	61413	4181534.0	49.9833	1.80	2005
	Σ:		142674	8365854.5	100.0000		

Chiral

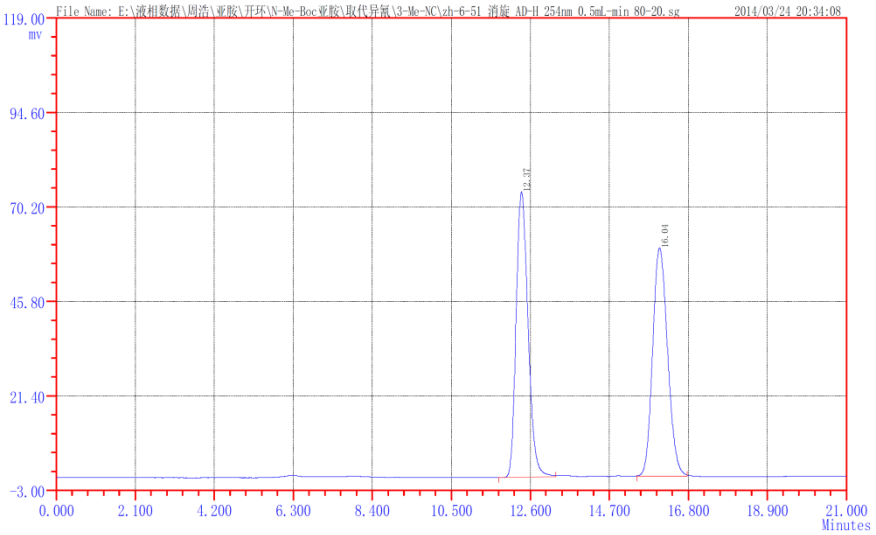


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		17.452	352404	16050985.7	97.5954	1.58	2926
2		21.722	6806	395479.7	2.4046	1.29	2785
	Σ:		359210	16446465.4	100.0000		

4h (Table 2, entry 8)

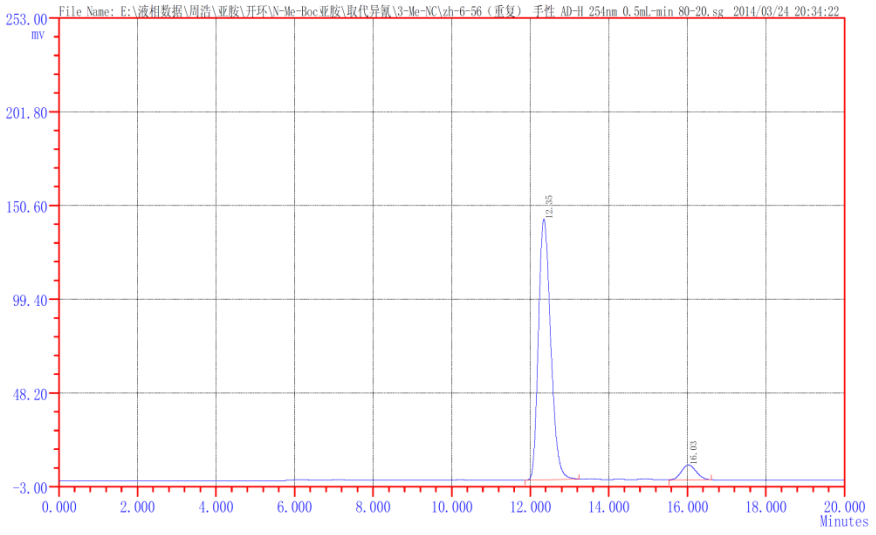


Racemic



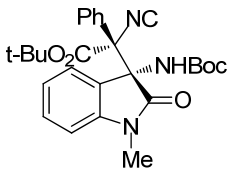
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		12.367	73729	1622028.5	49.9194	1.23	6298
2		16.040	58968	1627265.0	50.0806	1.14	6734
	Σ:		132697	3249293.5	100.0000		

Chiral

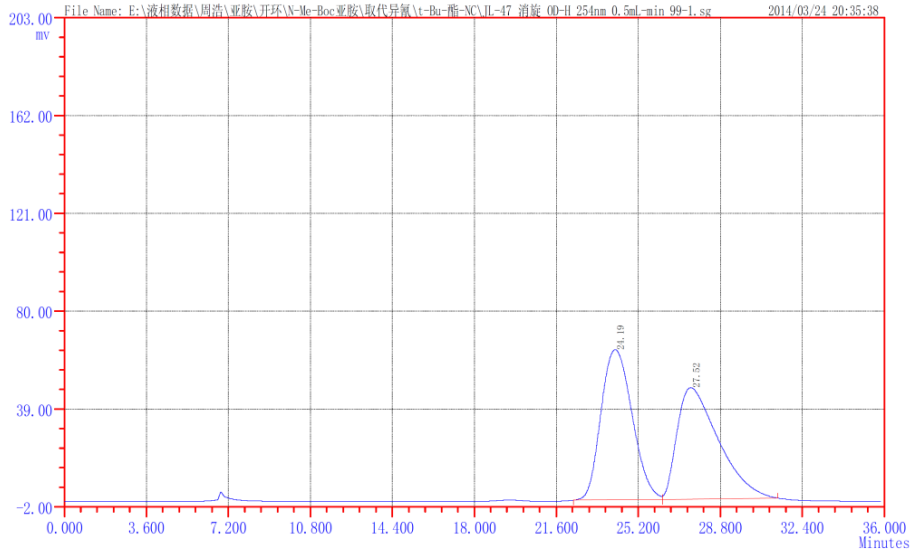


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		12.350	142452	3099975.9	93.5312	1.25	6419
2		16.033	8188	214399.9	6.4688	1.09	7473
	Σ:		150640	3314375.8	100.0000		

4j (Table 2, entry 10)

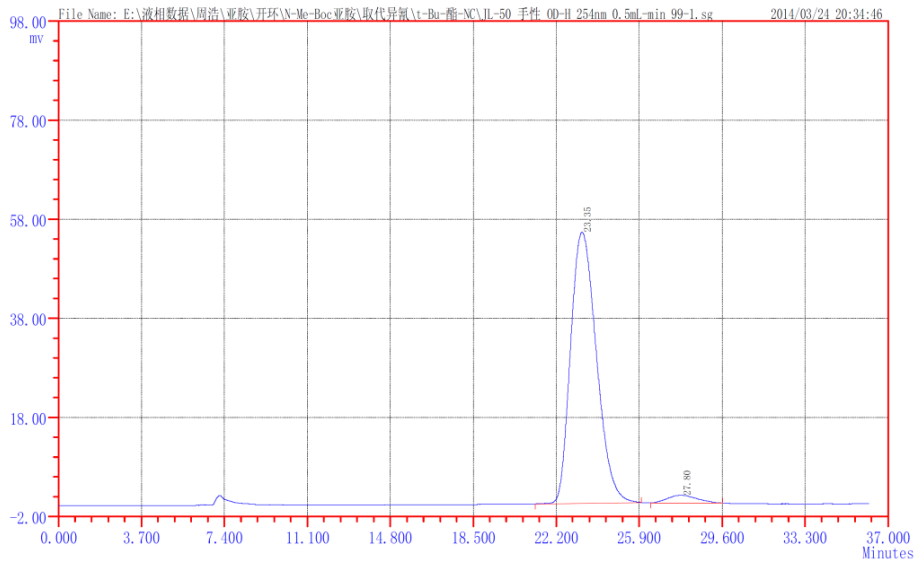


Racemic



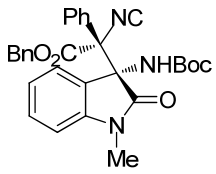
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		24.190	62953	5997790.1	50.4259	1.20	1285
2		27.522	46682	5896477.9	49.5741	1.86	946
	Σ:		109635	11894268.0	100.0000		

Chiral

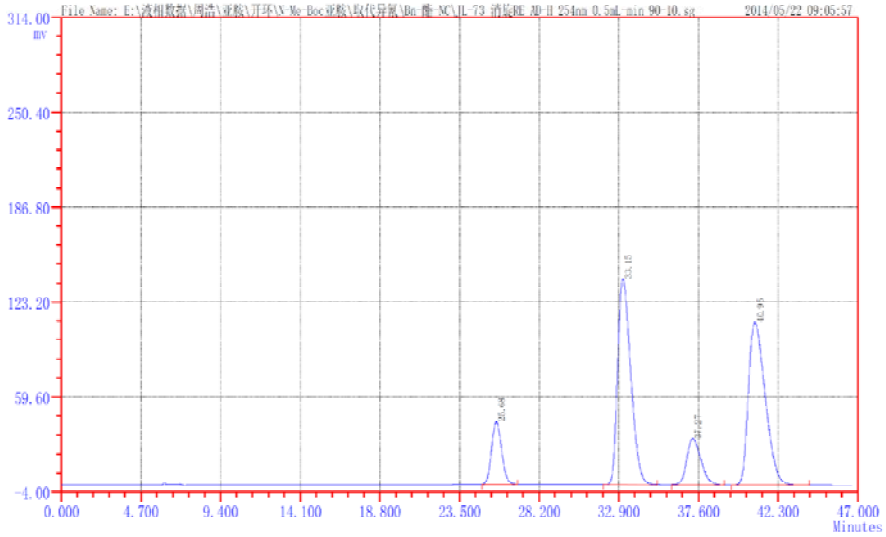


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		23.350	54796	4394765.9	96.7089	1.28	1689
2		27.802	1571	149556.9	3.2911	1.10	1700
	Σ:		56367	4544322.8	100.0000		

4k (Table 2, entry 11)

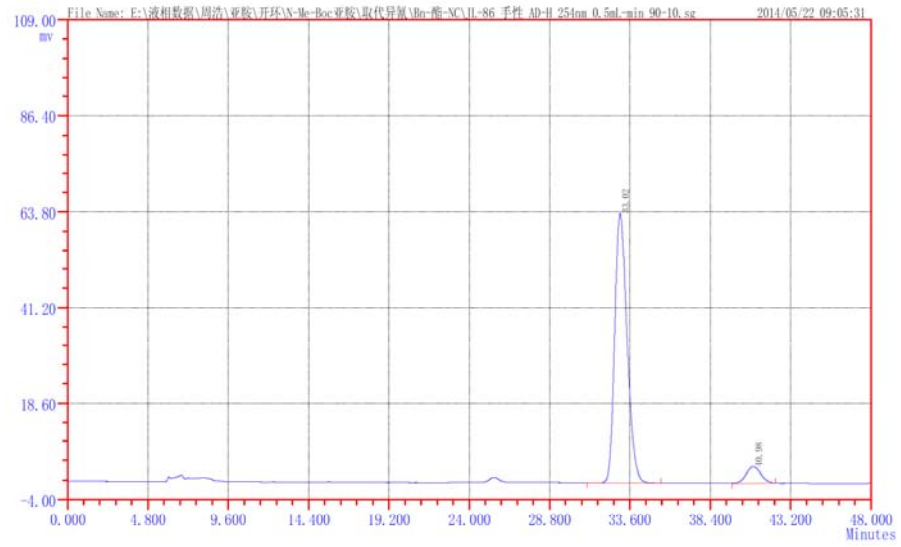


Racemic



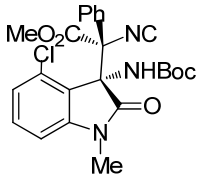
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		25.678	42339	1777574.8	9.5685	1.11	7456
2		33.148	138229	7450171.7	40.1035	1.38	7539
3		37.273	31027	1800954.7	9.6944	1.24	8219
4		40.945	109024	7548659.4	40.6336	1.42	6970
	Σ:		320619	18577360.6	100.0000		

Chiral

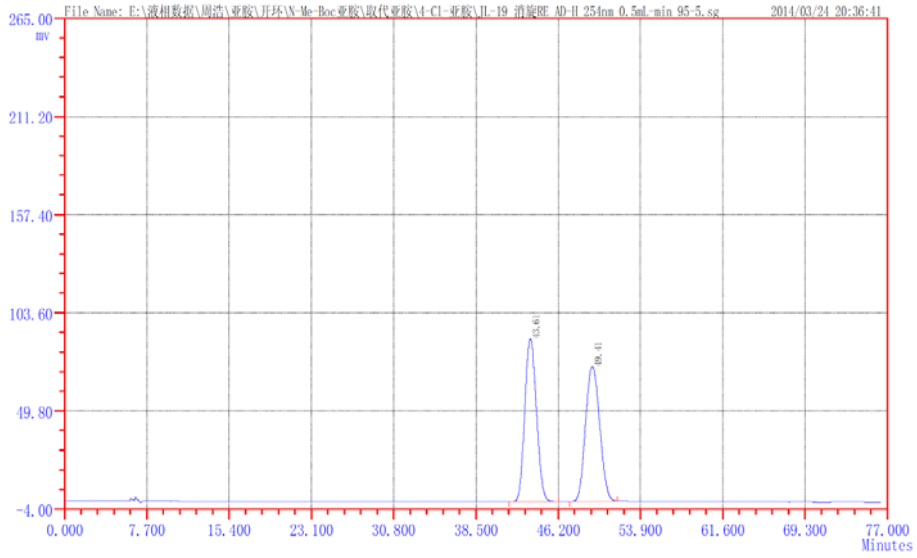


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		33.018	63486	3264242.8	93.3456	1.25	8219
2		40.975	3809	232700.1	6.6544	1.08	8966
	Σ:		67295	3496942.9	100.0000		

4m (Table 2, entry 13)

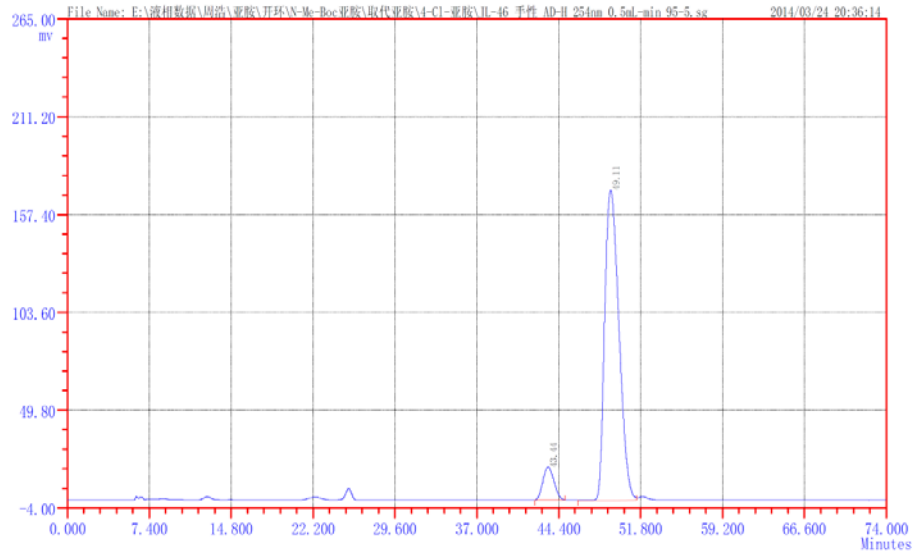


Racemic



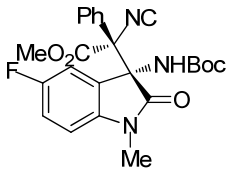
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		43.610	89316	6794923.6	49.9350	1.09	6549
2		49.410	74234	6812610.5	50.0650	1.09	5777
	Σ:		163550	13607534.1	100.0000		

Chiral

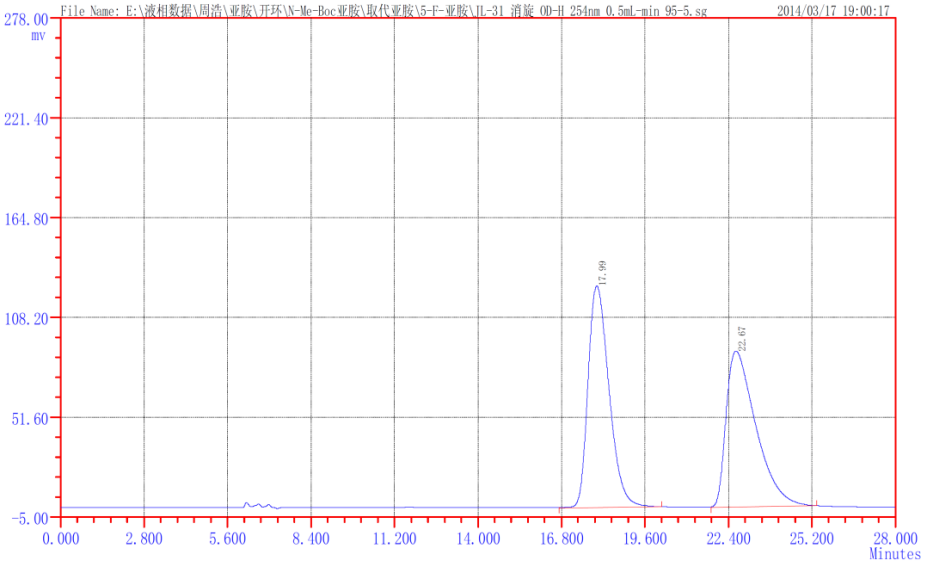


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		43.442	18013	1276111.9	7.7097	1.13	7494
2		49.108	170537	15275971.6	92.2903	1.32	5990
	Σ:		188550	16552083.5	100.0000		

4n (Table 2, entry 14)

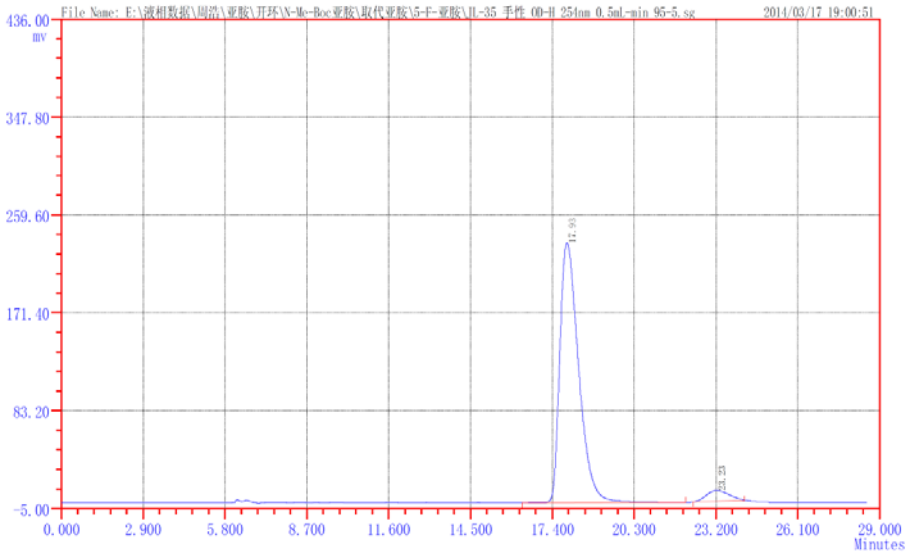


Racemic



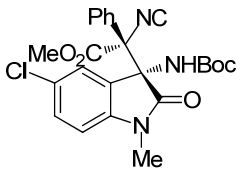
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		17.987	125653	6152902.2	49.9927	1.36	2689
2		22.665	88442	6154699.8	50.0073	1.90	2114
	Σ:		214095	12307602.0	100.0000		

Chiral

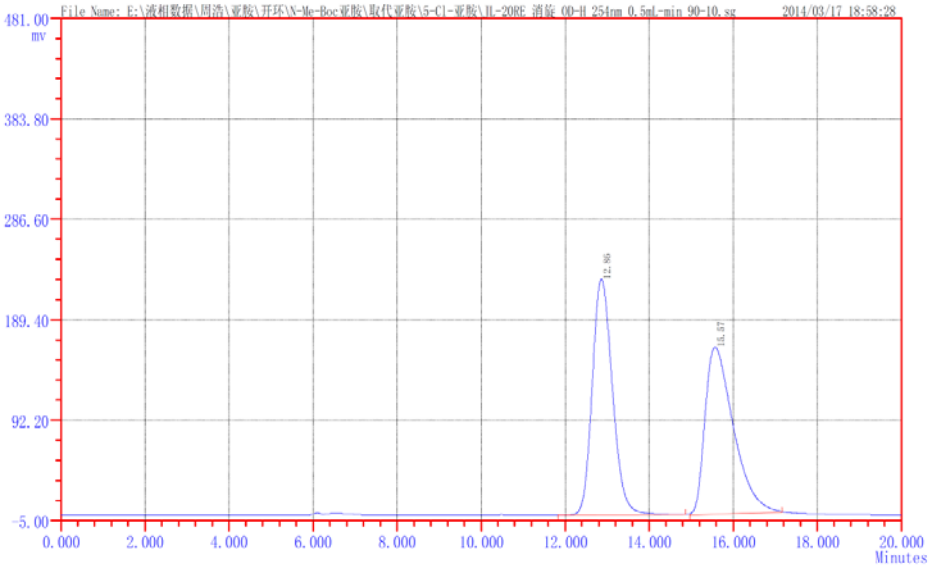


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		17.927	234019	10838940.7	95.1481	1.54	2986
2		23.227	9793	552708.0	4.8519	1.22	3376
	Σ:		243812	11391648.7	100.0000		

4o (Table 2, entry 15)

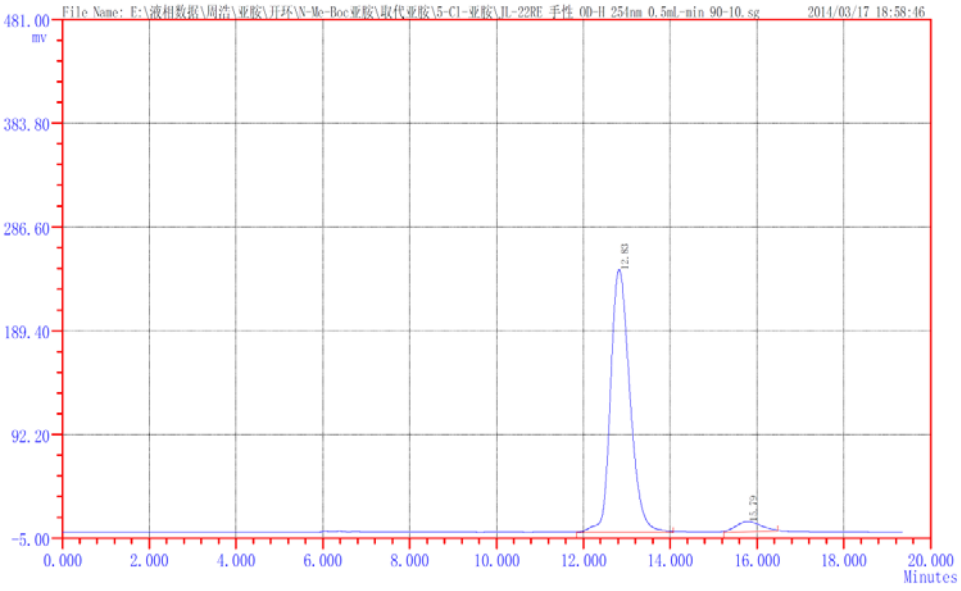


Racemic



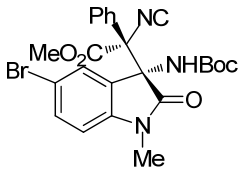
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		12.863	228161	7609063.5	50.0041	1.19	2965
2		15.573	161768	7607815.6	49.9959	1.77	2186
	Σ:		389929	15216879.1	100.0000		

Chiral

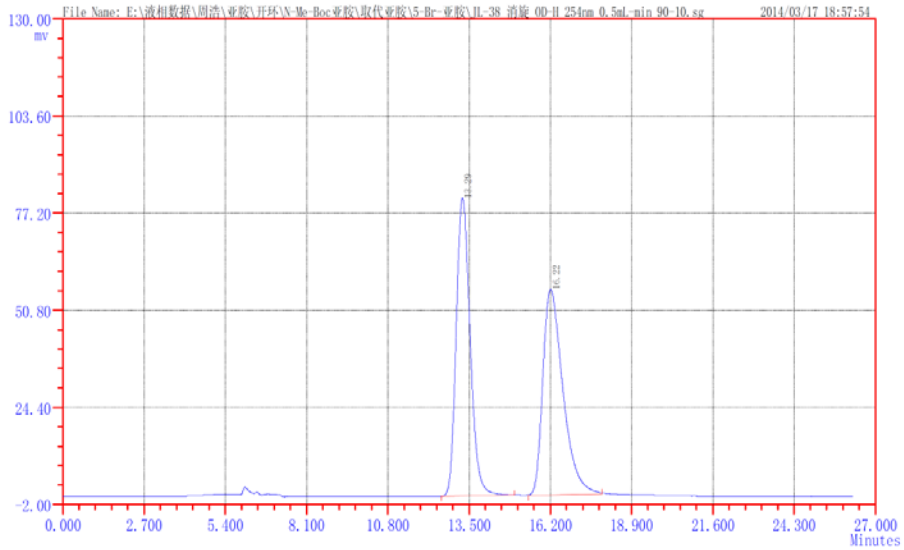


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		12.827	246756	7672077.8	95.1260	1.25	3392
2		15.790	9679	393098.0	4.8740	1.13	3013
	Σ:		256435	8065175.8	100.0000		

4p (Table 2, entry 16)

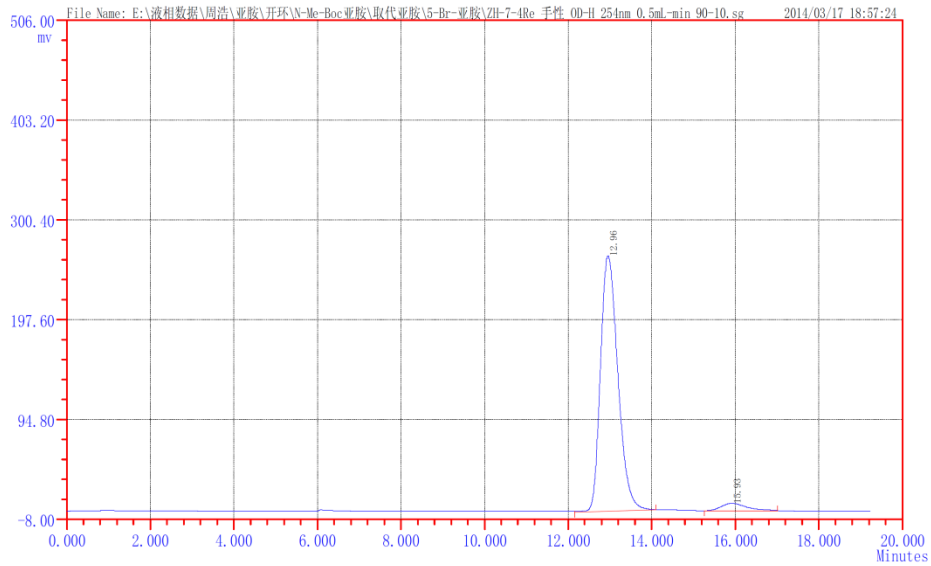


Racemic



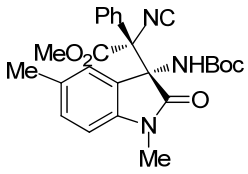
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		13.285	81040	2609554.8	50.0426	1.21	3392
2		16.218	55932	2605112.3	49.9574	1.55	2417
	Σ:		136972	5214667.1	100.0000		

Chiral

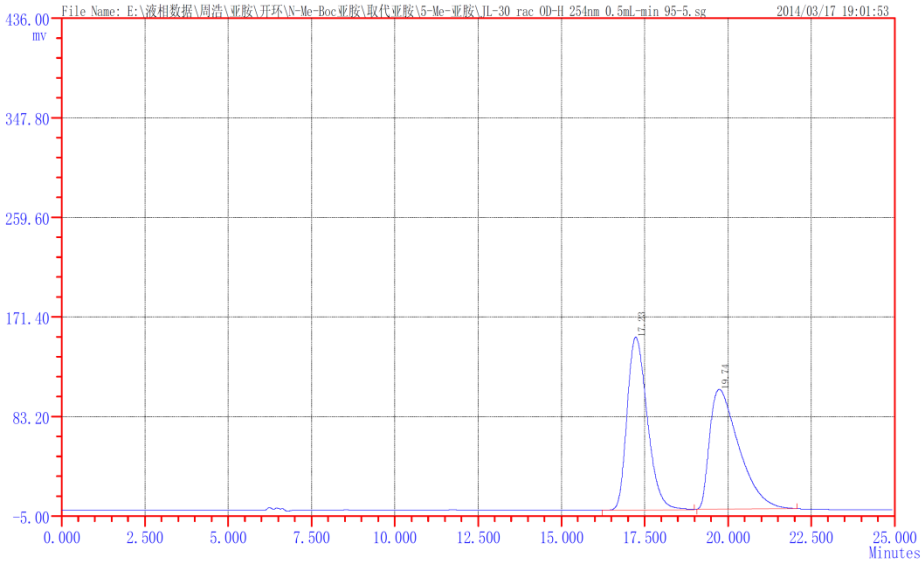


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		12.955	263017	7620042.8	95.9728	1.31	3985
2		15.925	7494	319752.9	4.0272	1.45	2776
	Σ:		270511	7939795.7	100.0000		

4q (Table 2, entry 17)

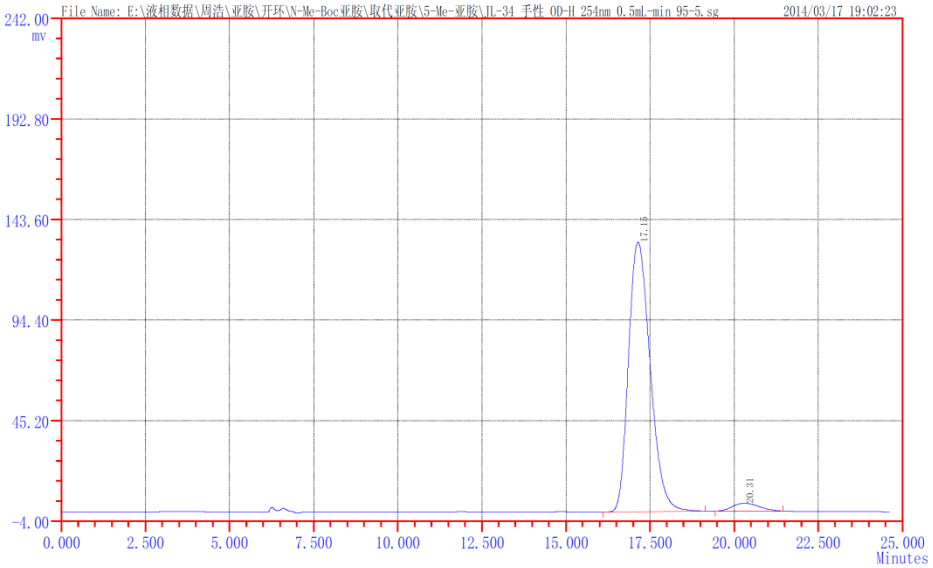


Racemic



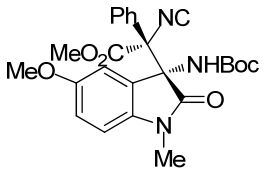
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		17.235	153060	6458881.4	49.8989	1.31	3325
2		19.743	106154	6485057.5	50.1011	1.93	2082
	Σ:		259214	12943938.9	100.0000		

Chiral

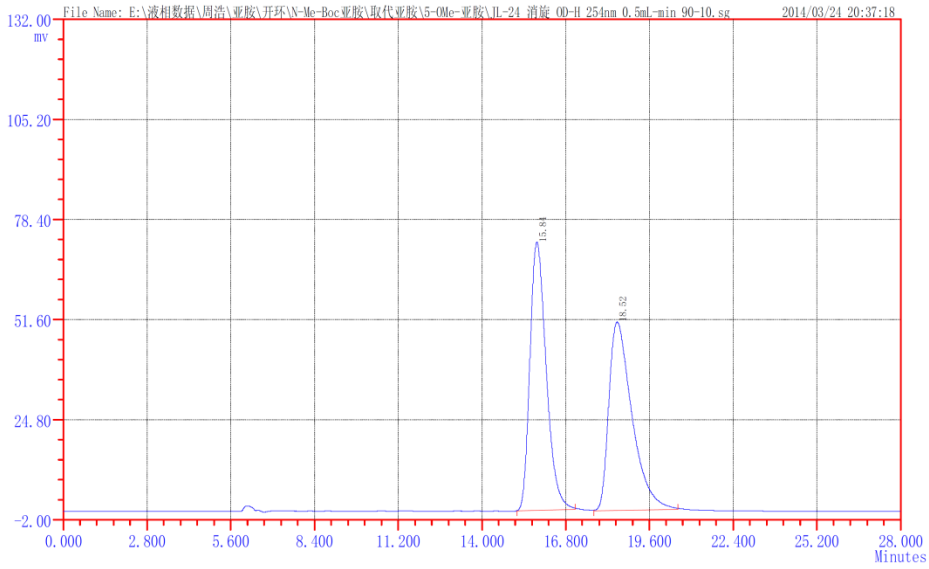


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		17.147	131970	5936681.7	96.4054	1.26	2896
2		20.310	3999	221358.7	3.5946	1.20	2683
	Σ:		135969	6158040.4	100.0000		

4r (Table 2, entry 18)

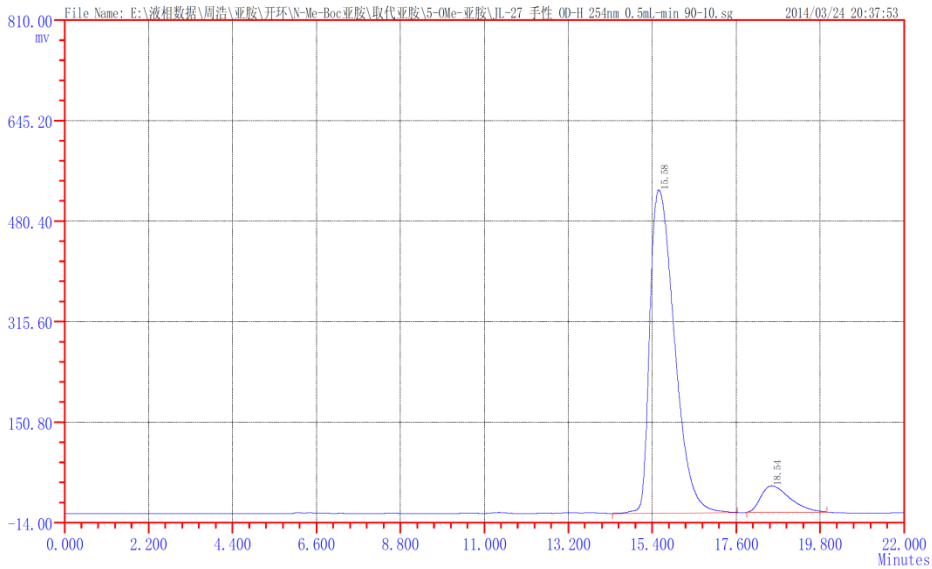


Racemic



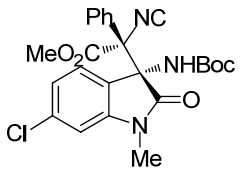
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		15.842	71814	2716552.7	50.1064	1.34	3495
2		18.520	50435	2705013.7	49.8936	1.76	2376
	Σ:		122249	5421566.4	100.0000		

Chiral

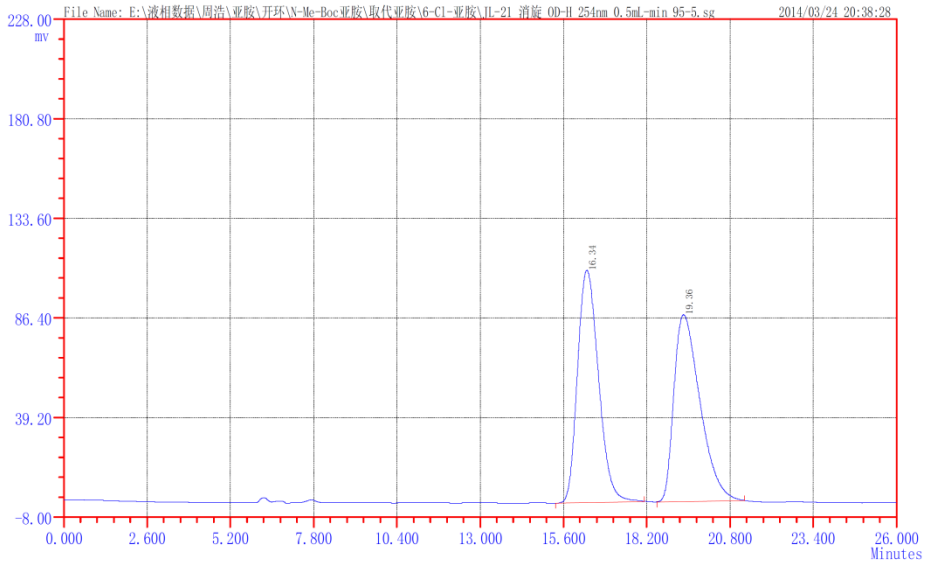


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		15.580	529438	23781000.1	91.2691	1.61	2398
2		18.543	43308	2274927.4	8.7309	1.58	2484
	Σ:		572746	26055927.5	100.0000		

4s (Table 2, entry 19)

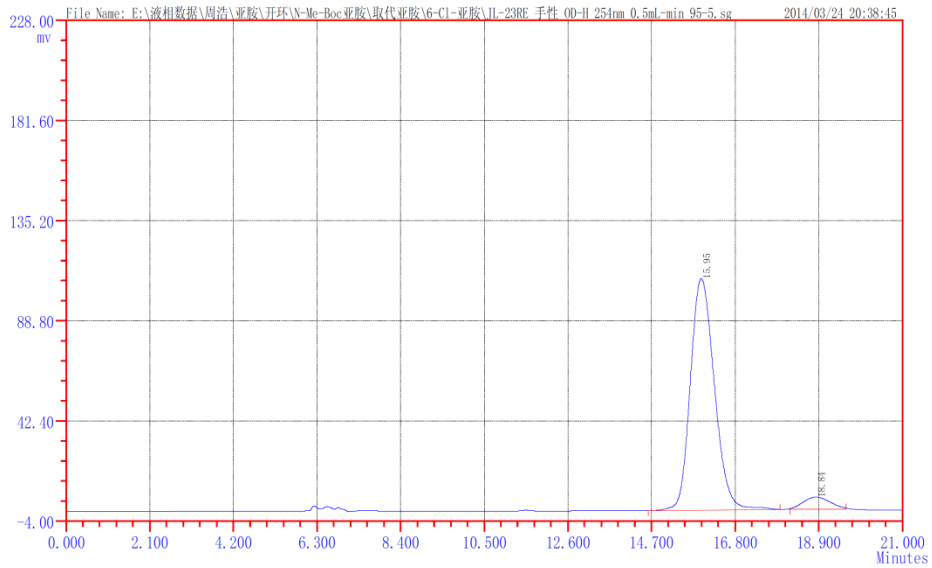


Racemic



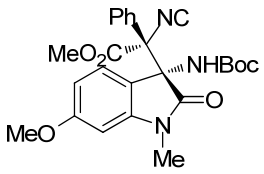
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		16.338	110149	5030071.5	50.0329	1.24	2551
2		19.358	88562	5023452.3	49.9671	1.61	2321
	Σ:		198711	10053523.8	100.0000		

Chiral

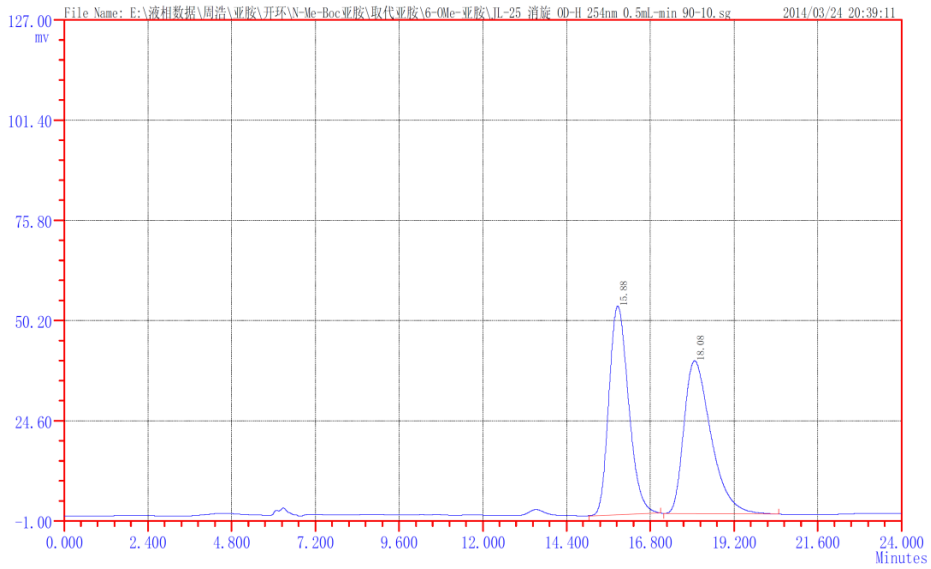


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		15.948	107297	4523842.8	94.7713	1.20	2852
2		18.835	5456	249587.1	5.2287	1.11	3379
	Σ:		112753	4773429.9	100.0000		

4t (Table 2, entry 20)

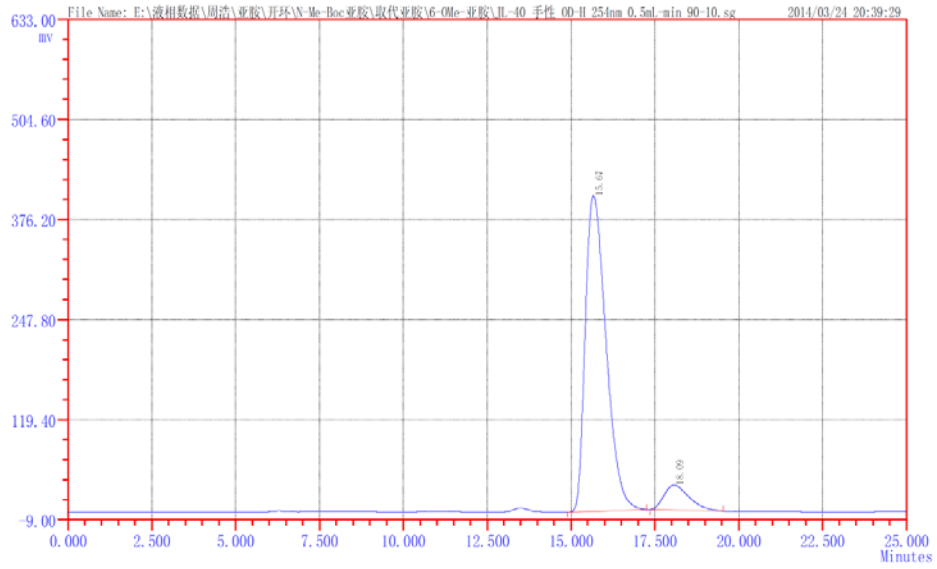


Racemic



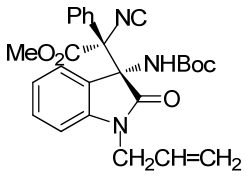
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		15.875	53388	2100273.6	49.8024	1.25	3246
2		18.083	39109	2116937.7	50.1976	1.48	2224
	Σ:		92497	4217211.3	100.0000		

Chiral

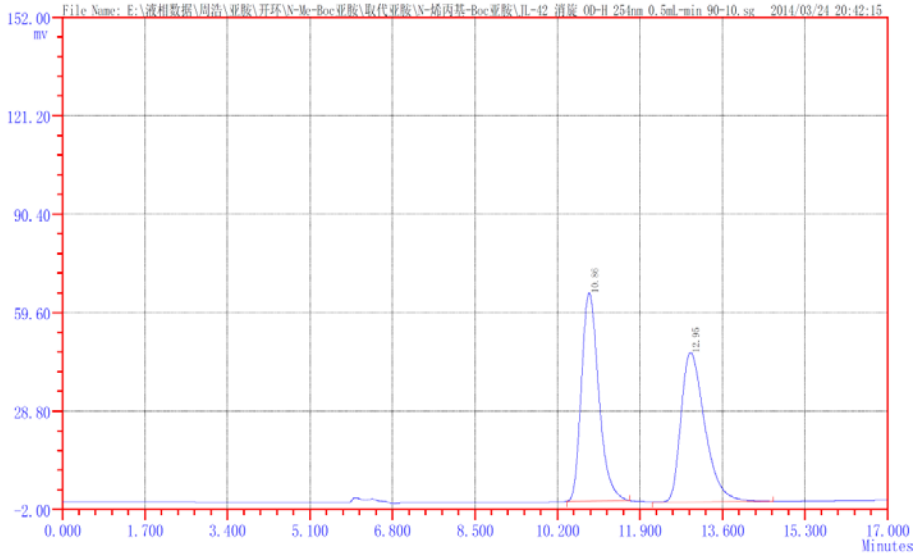


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		15.673	405157	17458520.6	91.1666	1.48	2637
2		18.085	32429	1691603.5	8.8334	1.29	2396
	Σ:		437586	19150124.1	100.0000		

4u (Table 2, entry 21)

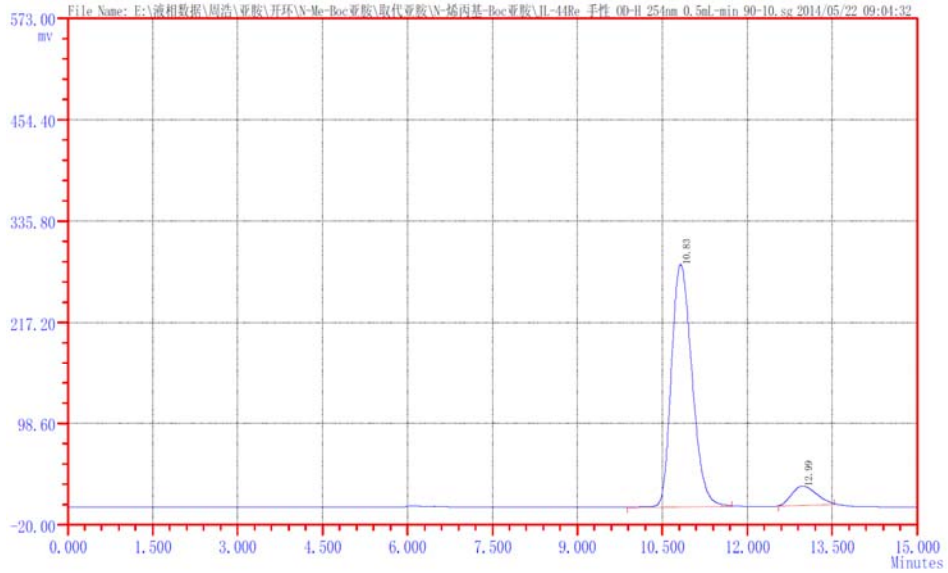


Racemic



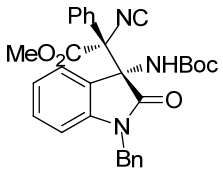
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		10.857	65133	1624723.6	50.3010	1.31	3775
2		12.947	46858	1605279.0	49.6990	1.46	2846
	Σ:		111991	3230002.6	100.0000		

Chiral

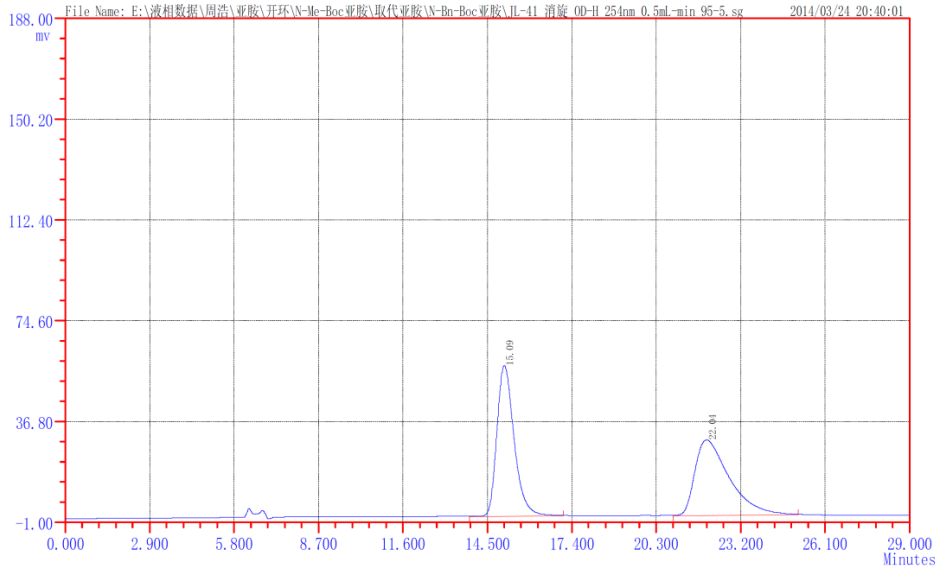


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		10.825	284508	7242775.3	91.3830	1.25	3604
2		12.985	22492	682961.8	8.6170	1.24	3645
	Σ:		307000	7925737.0	100.0000		

4v (Table 2, entry 22)

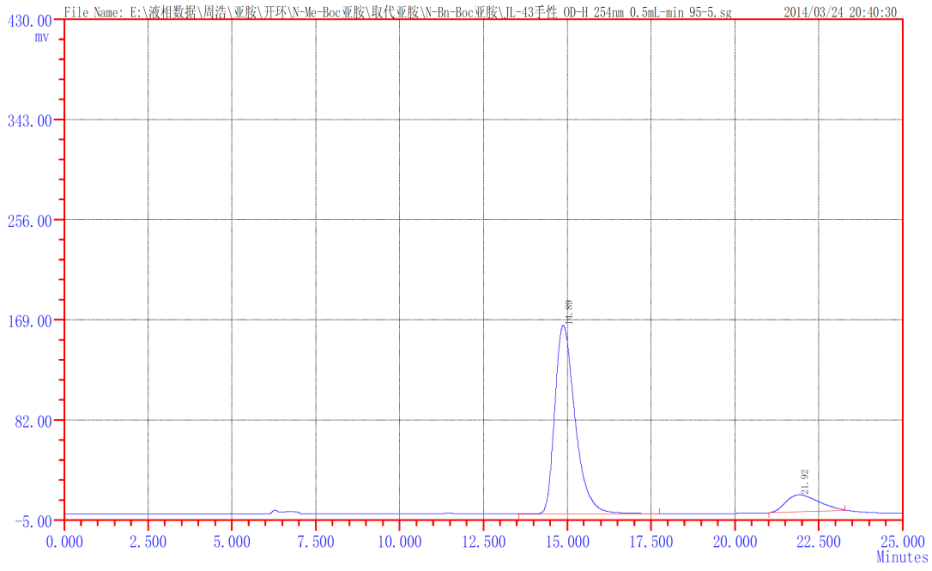


Racemic



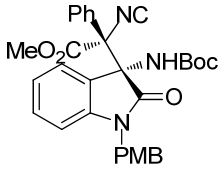
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		15.088	56565	2329126.0	50.0008	1.33	2676
2		22.037	28332	2329055.2	49.9992	1.93	1432
	Σ:		84897	4658181.2	100.0000		

Chiral

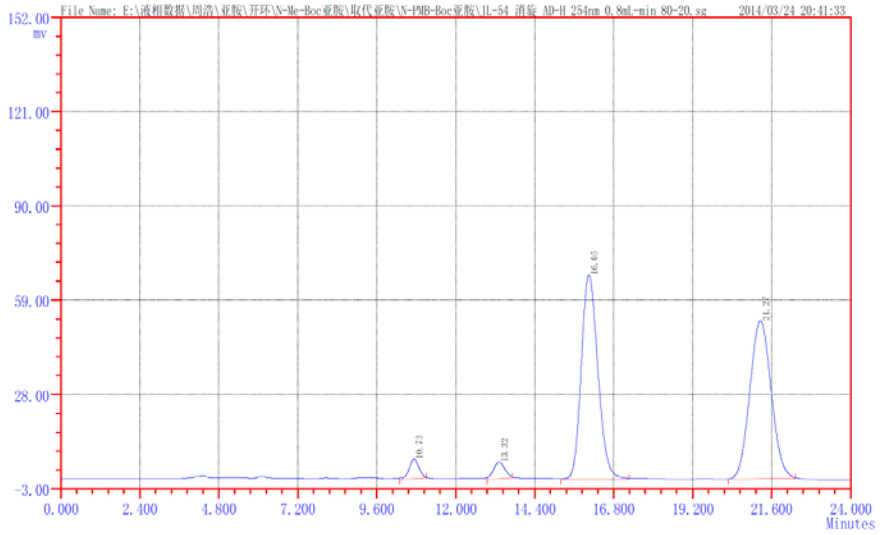


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		14.887	163593	6884652.9	87.1260	1.41	2494
2		21.922	14895	1017298.9	12.8740	1.45	2053
	Σ:		178488	7901951.8	100.0000		

4w (Table 2, entry 23)

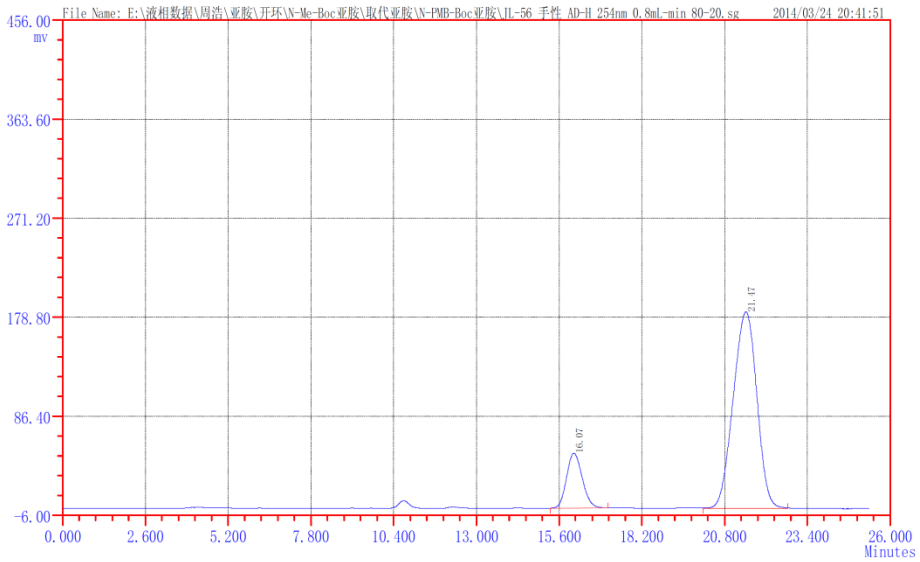


Racemic



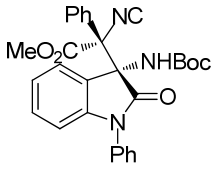
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		10.733	6417	134342.4	2.6945	1.07	5239
2		13.320	5546	136046.4	2.7286	1.05	5876
3		16.050	67310	2365384.8	47.4419	1.17	4157
4		21.265	51980	2350079.4	47.1350	1.06	4409
	Σ:		131253	4985853.1	100.0000		

Chiral

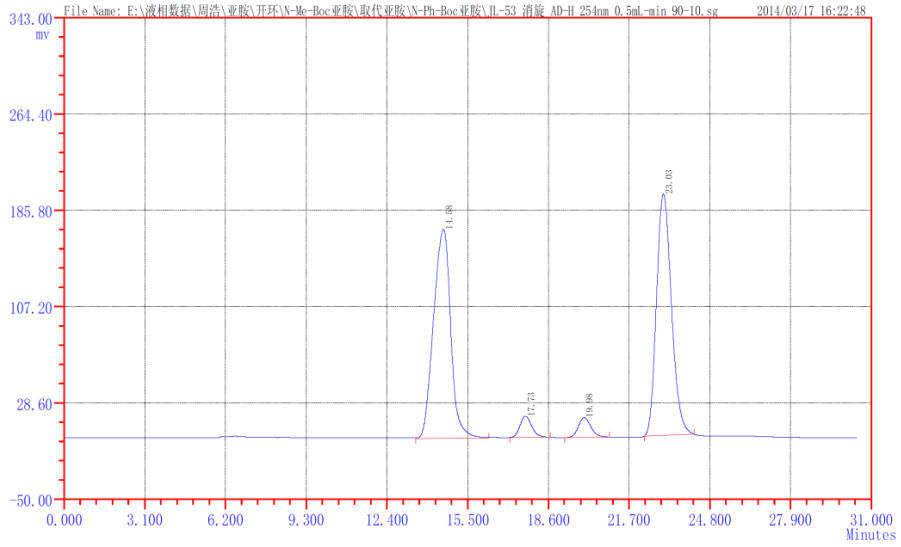


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		16.068	51299	1758585.9	15.6648	1.14	4379
2		21.472	183138	9467751.5	84.3352	0.96	3438
	Σ:		234437	11226337.4	100.0000		

4x (Table 2, entry 24)



Racemic

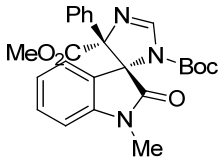


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		14.575	170533	7862309.9	46.7334	0.98	1992
2		17.725	17273	537338.1	3.1939	1.19	6470
3		19.978	16088	535093.0	3.1806	1.23	7191
4		23.025	197144	7889025.8	46.8921	1.20	6598
	Σ:		401038	16823766.8	100.0000		

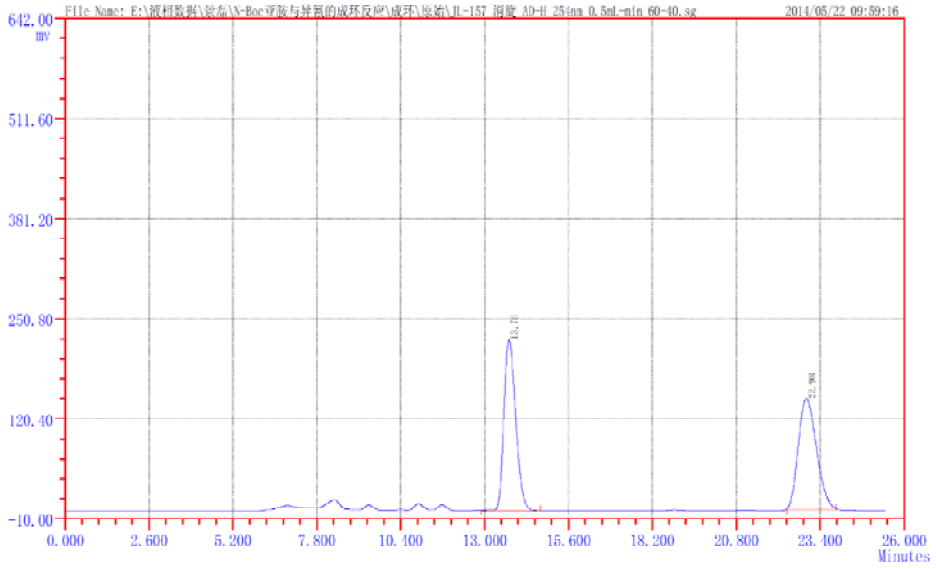
Chiral

ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		14.573	3174	135370.7	2.3471	0.86	2327
2		23.023	136386	5632264.5	97.6529	1.25	6195
	Σ:		139560	5767635.2	100.0000		

5a (Table 3, entry 1)

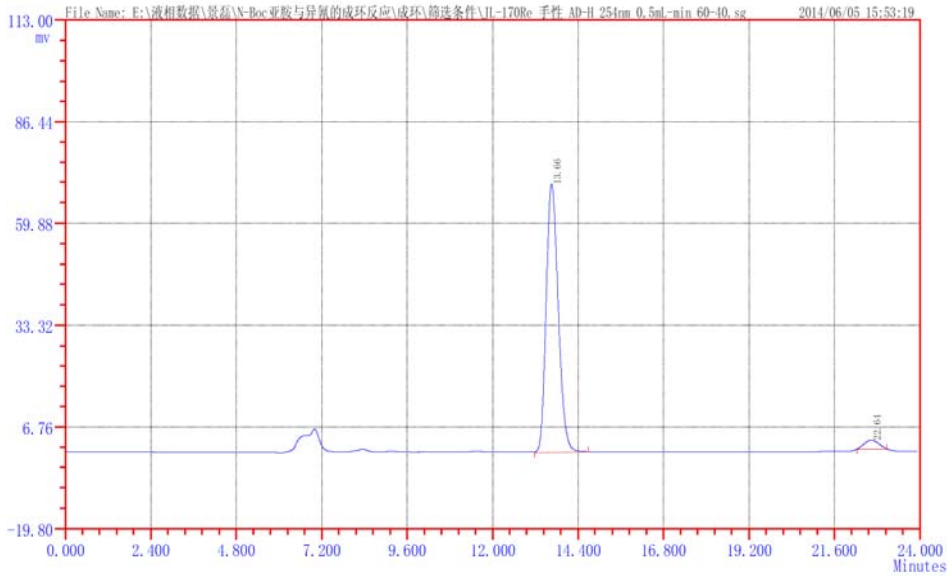


Racemic



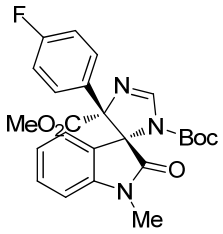
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		13.760	222070	5663865.0	50.0102	1.26	5801
2		22.980	144143	5661547.0	49.9898	1.21	6822
	Σ:		366213	11325412.0	100.0000		

Chiral

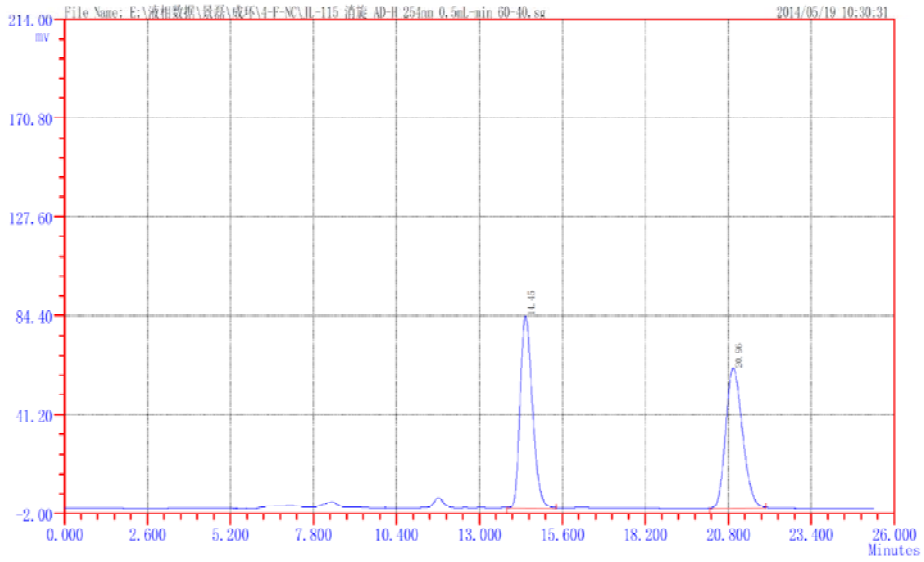


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		13.662	69943	1647809.0	96.0940	1.20	6702
2		22.640	2357	66979.5	3.9060	1.06	12651
	Σ:		72300	1714788.5	100.0000		

5b (Table 3, entry 2)

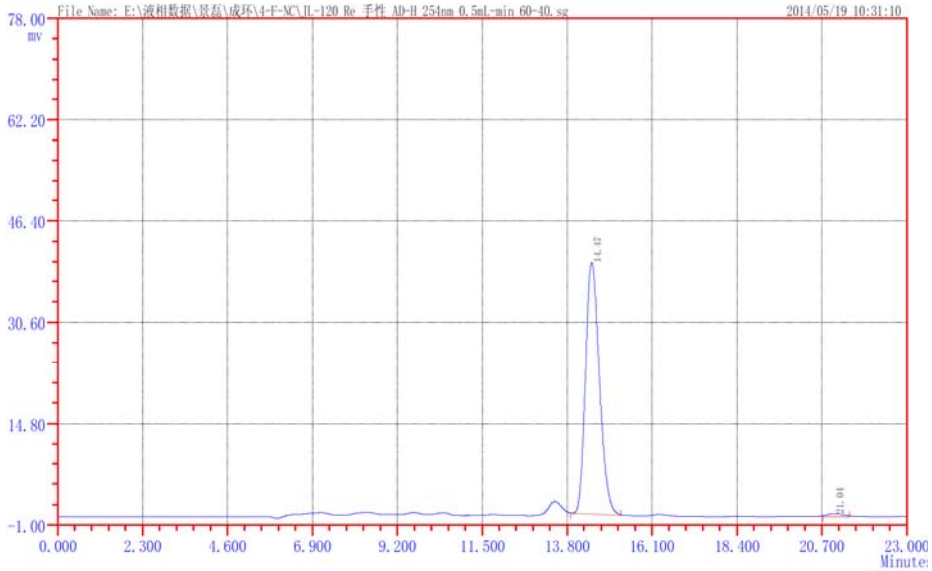


Racemic



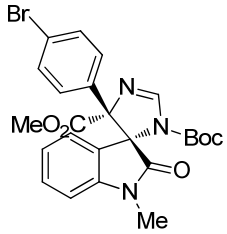
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		14.448	84013	2245696.4	49.9148	1.27	5823
2		20.963	61288	2253366.6	50.0852	1.20	6479
	Σ:		145301	4499063.0	100.0000		

Chiral

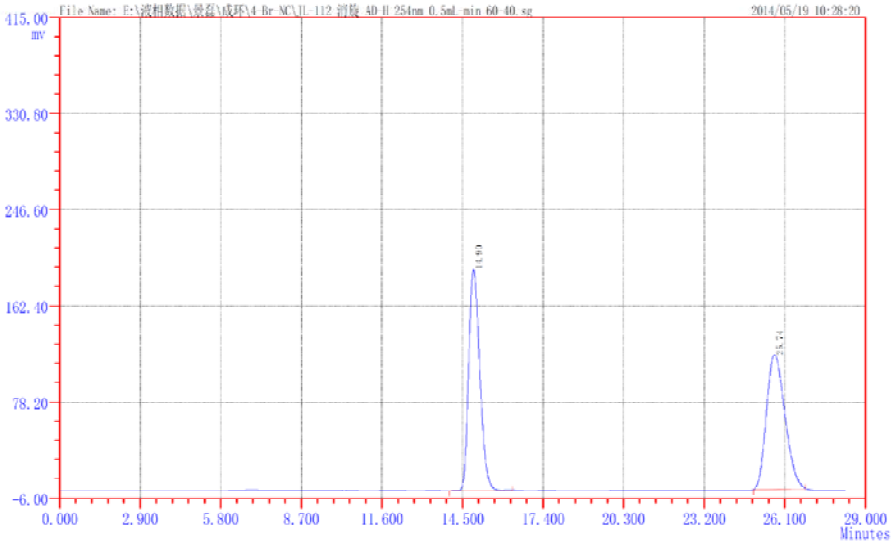


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		14.473	39286	1029937.4	98.5316	1.20	6075
2		21.038	484	15348.6	1.4684	1.18	8772
	Σ:		39770	1045286.0	100.0000		

5c (Table 3, entry 3)

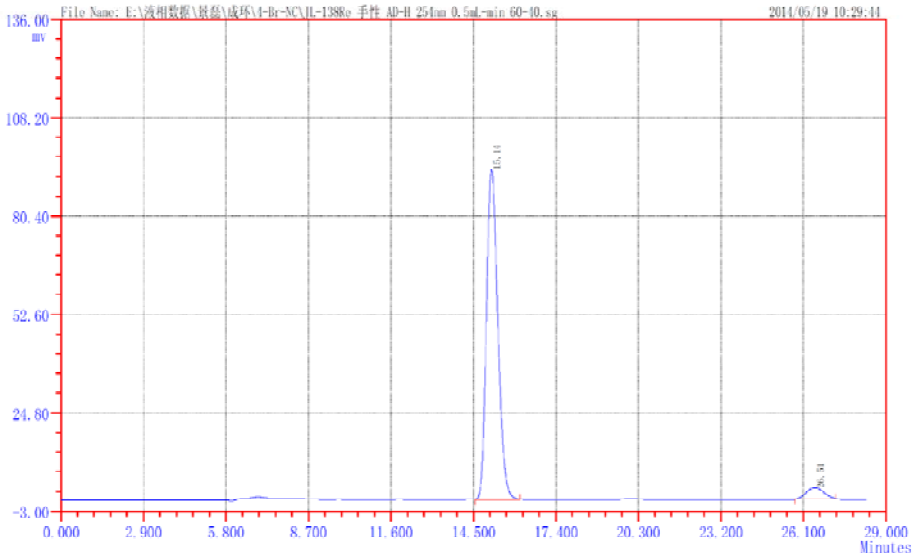


Racemic



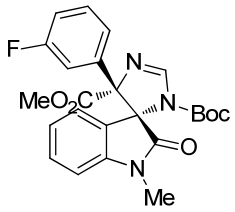
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		14.902	193812	5444460.7	49.8939	1.26	5608
2		25.742	117903	5467611.9	50.1061	1.24	6141
	Σ:		311715	10912072.6	100.0000		

Chiral

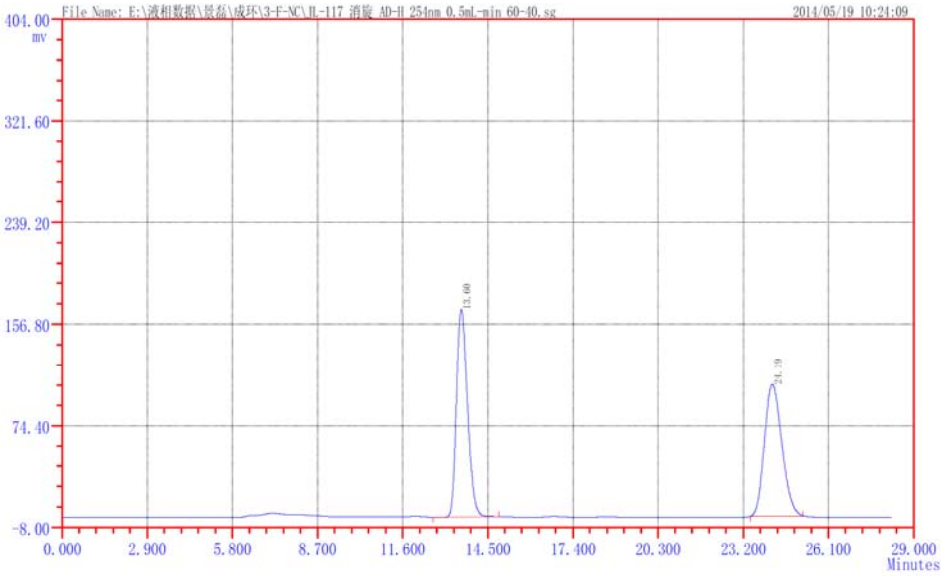


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		15.140	93225	2592469.7	95.0294	1.21	5908
2		26.512	3178	135602.7	4.9706	1.09	7694
	Σ:		96403	2728072.4	100.0000		

5d (Table 3, entry 4)

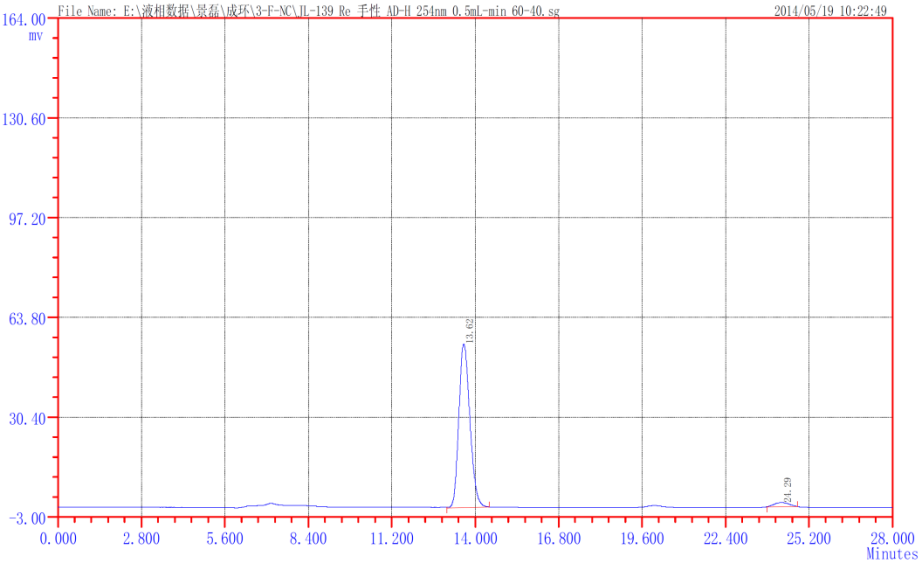


Racemic



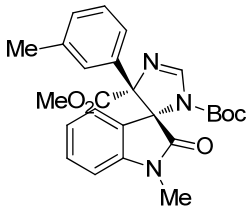
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		13.598	168214	4415727.3	49.8613	1.25	5348
2		24.192	107319	4440299.4	50.1387	1.20	6814
	Σ:		275533	8856026.7	100.0000		

Chiral

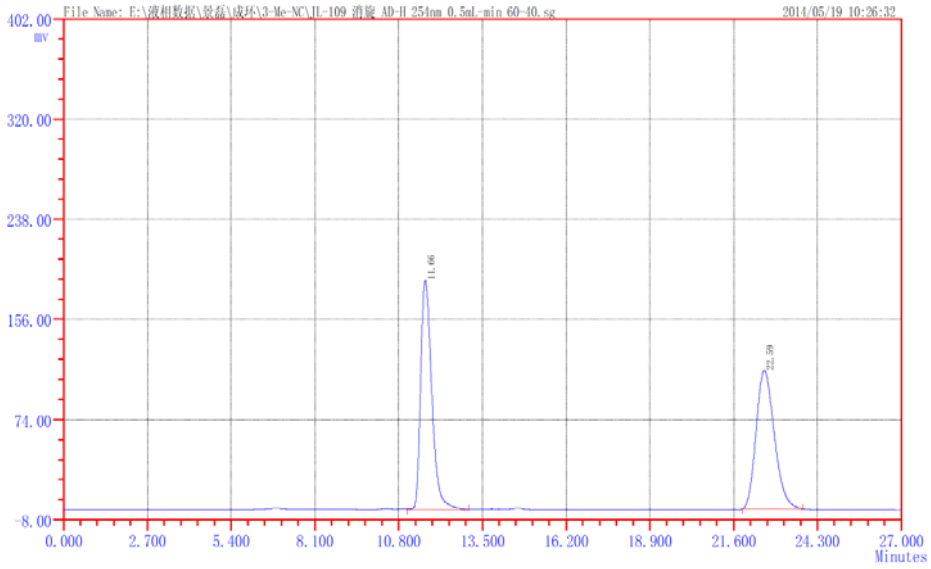


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		13.620	54747	1418027.4	96.6845	1.22	5511
2		24.292	1407	48626.2	3.3155	1.04	9847
	Σ:		56154	1466653.7	100.0000		

5e (Table 3, entry 5)

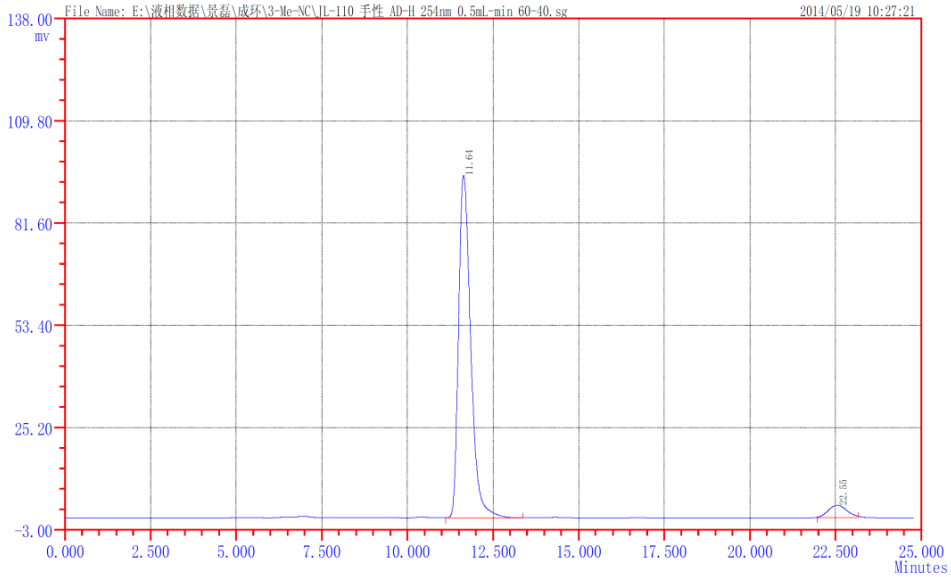


Racemic



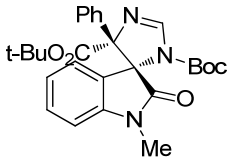
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		11.662	187434	4657563.0	49.9689	1.41	4390
2		22.585	113409	4663369.2	50.0311	1.24	6013
	Σ:		300843	9320932.2	100.0000		

Chiral



ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		11.643	94524	2345067.7	94.8999	1.39	4390
2		22.553	3363	126029.6	5.1001	1.06	7219
	Σ:		97887	2471097.3	100.0000		

5f (Table 3, entry 6)



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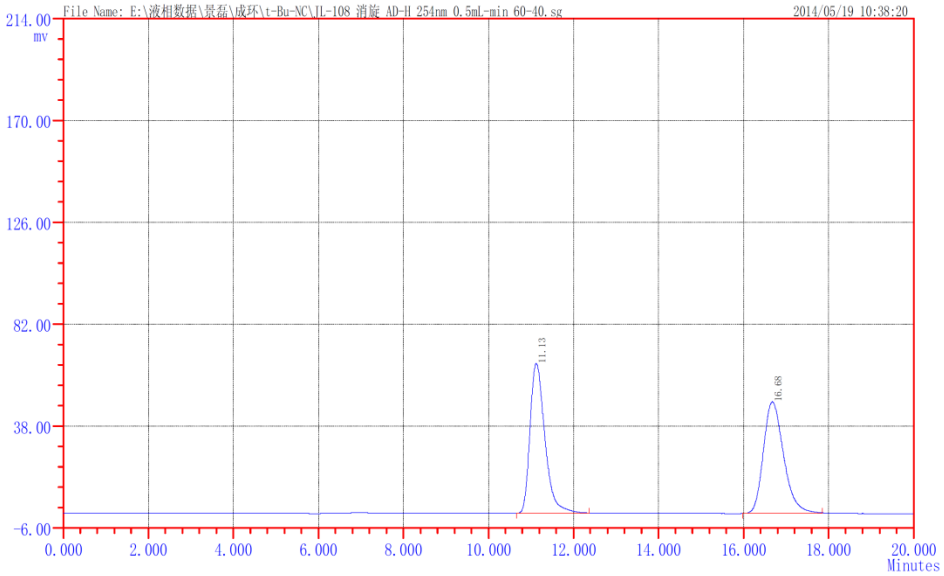
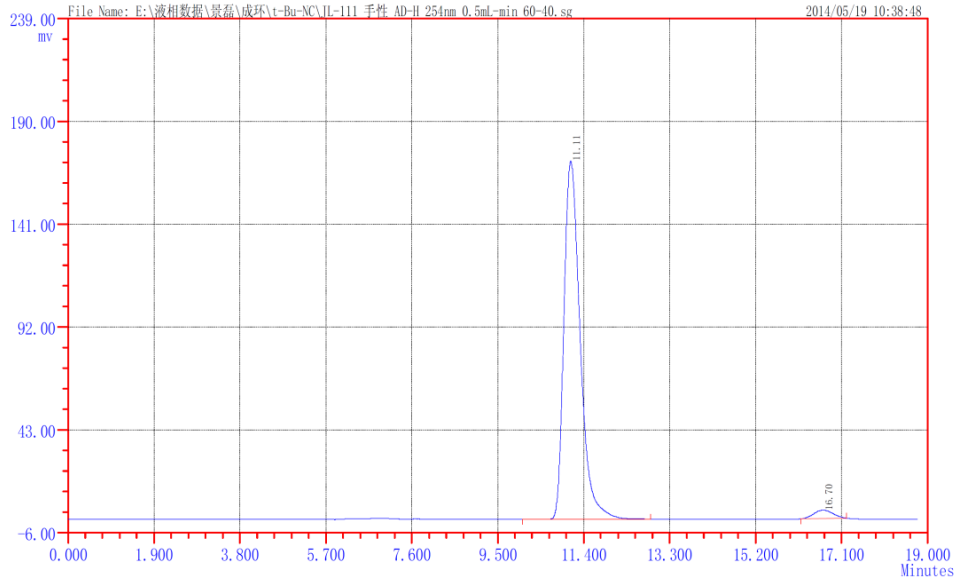


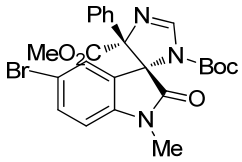
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		11.127	64784	1584080.0	49.9261	1.40	4127
2		16.683	48142	1588766.4	50.0739	1.26	5094
	Σ:		112926	3172846.4	100.0000		

Chiral



ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		11.113	170705	4260899.3	97.2642	1.42	3951
2		16.697	4045	119846.8	2.7358	1.12	6329
	Σ:		174750	4380746.1	100.0000		

5g (Table 3, entry 7)



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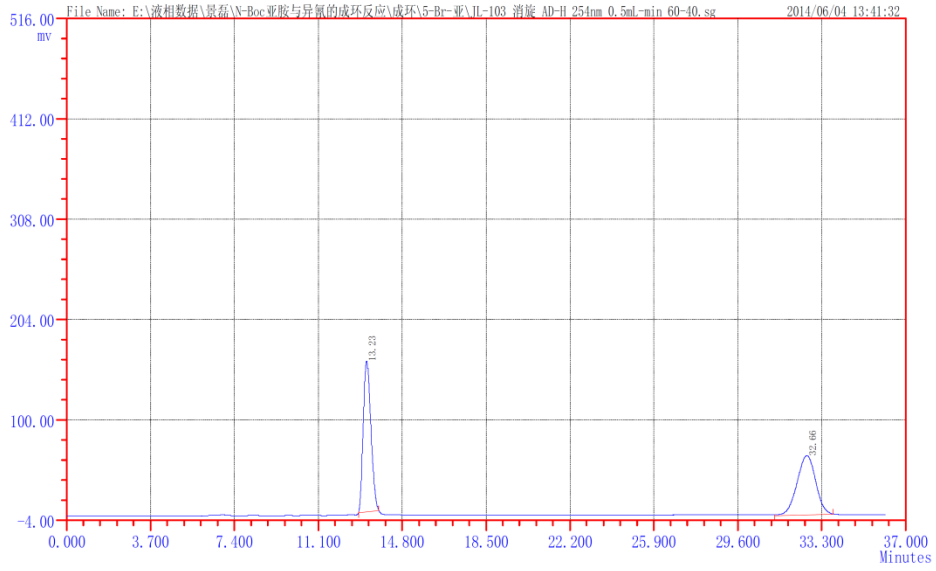
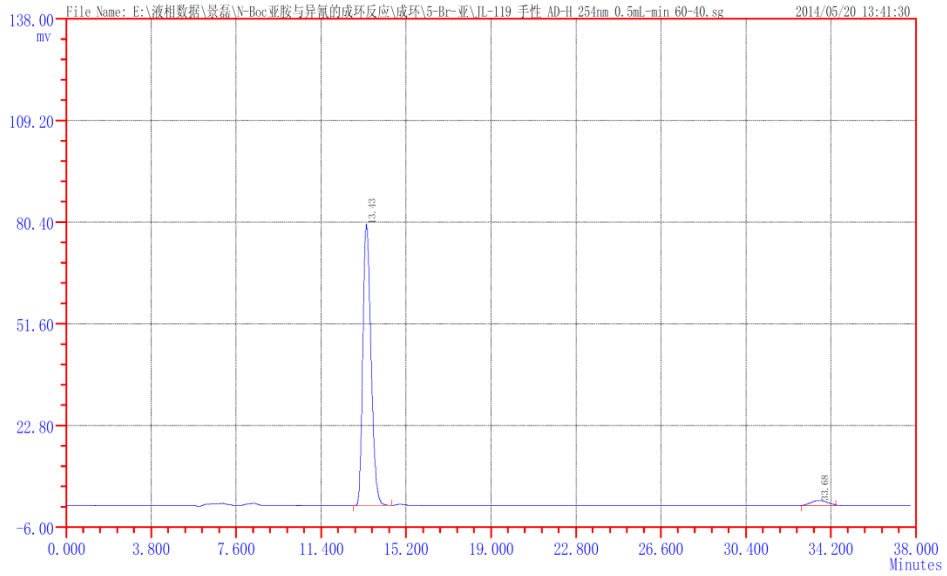


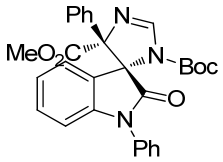
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		13.232	156221	3683998.3	50.9652	1.25	6275
2		32.657	61597	3544463.5	49.0348	0.99	6419
	Σ:		217818	7228461.9	100.0000		

Chiral

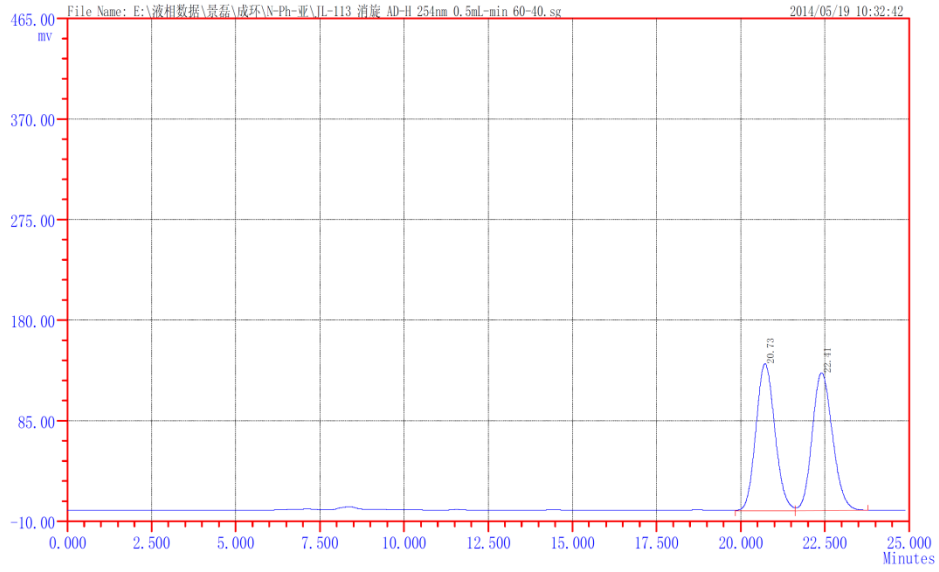


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		13.428	79810	2031873.2	95.9276	1.27	5545
2		33.677	1554	86259.4	4.0724	0.97	7336
	Σ:		81364	2118132.6	100.0000		

5h (Table 3, entry 8)

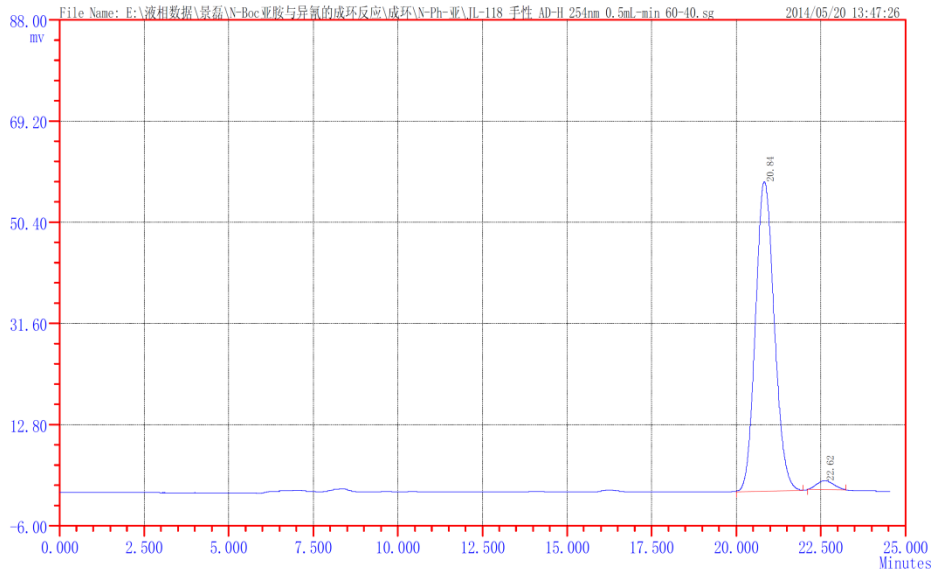


Racemic



ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		20.728	139038	5457668.6	49.9693	1.10	5558
2		22.408	130048	5464364.4	50.0307	1.15	5669
	Σ:		269086	10922033.0	100.0000		

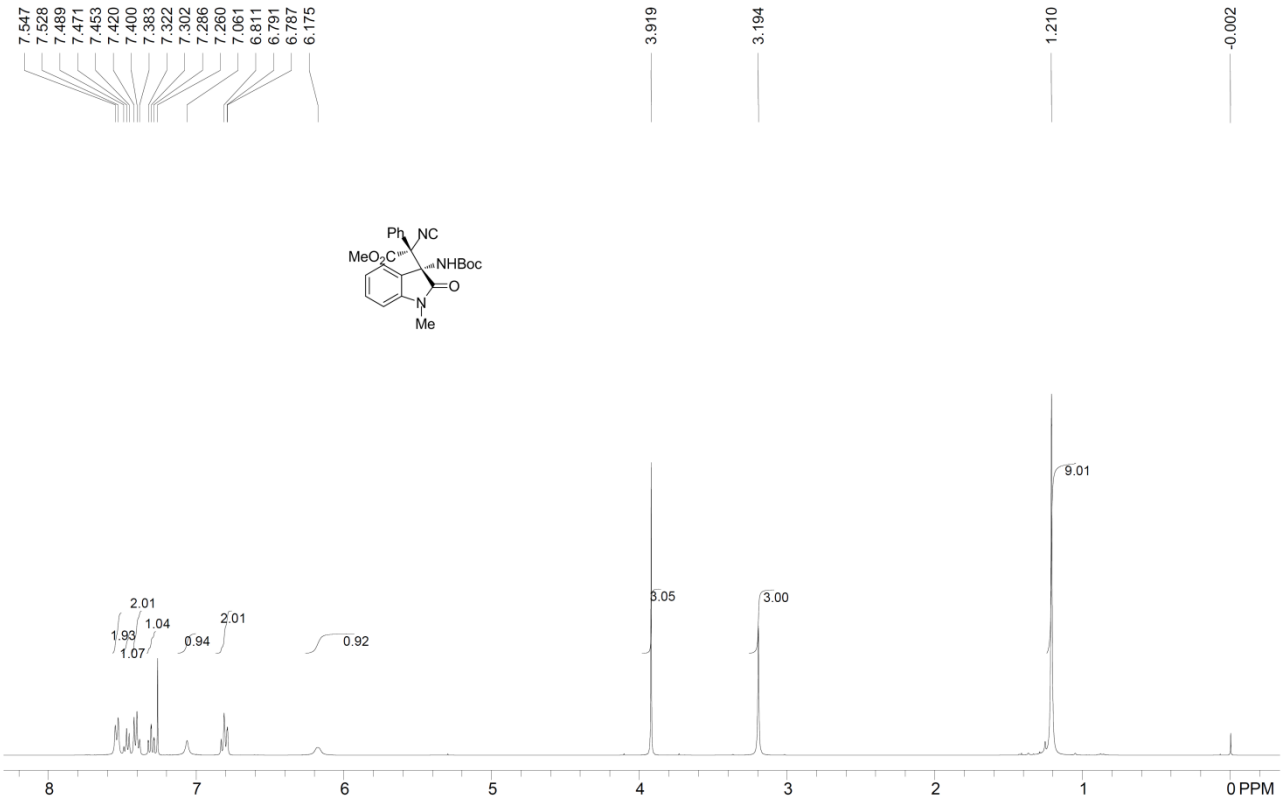
Chiral



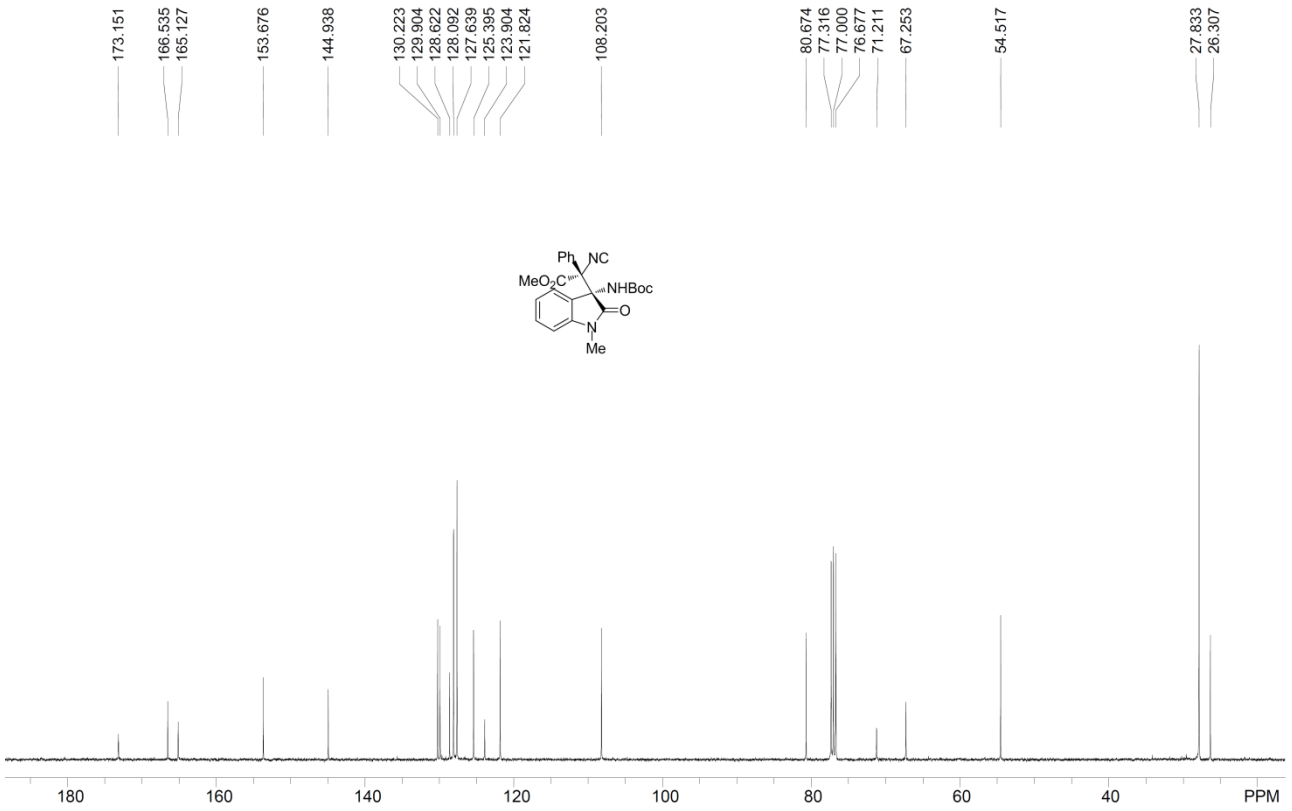
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		20.842	57482	2223762.3	97.5234	1.12	5785
2		22.622	1620	56471.8	2.4766	1.07	8393
	Σ:		59102	2280234.1	100.0000		

6. Copies of NMR spectra for the compounds 4 and 5

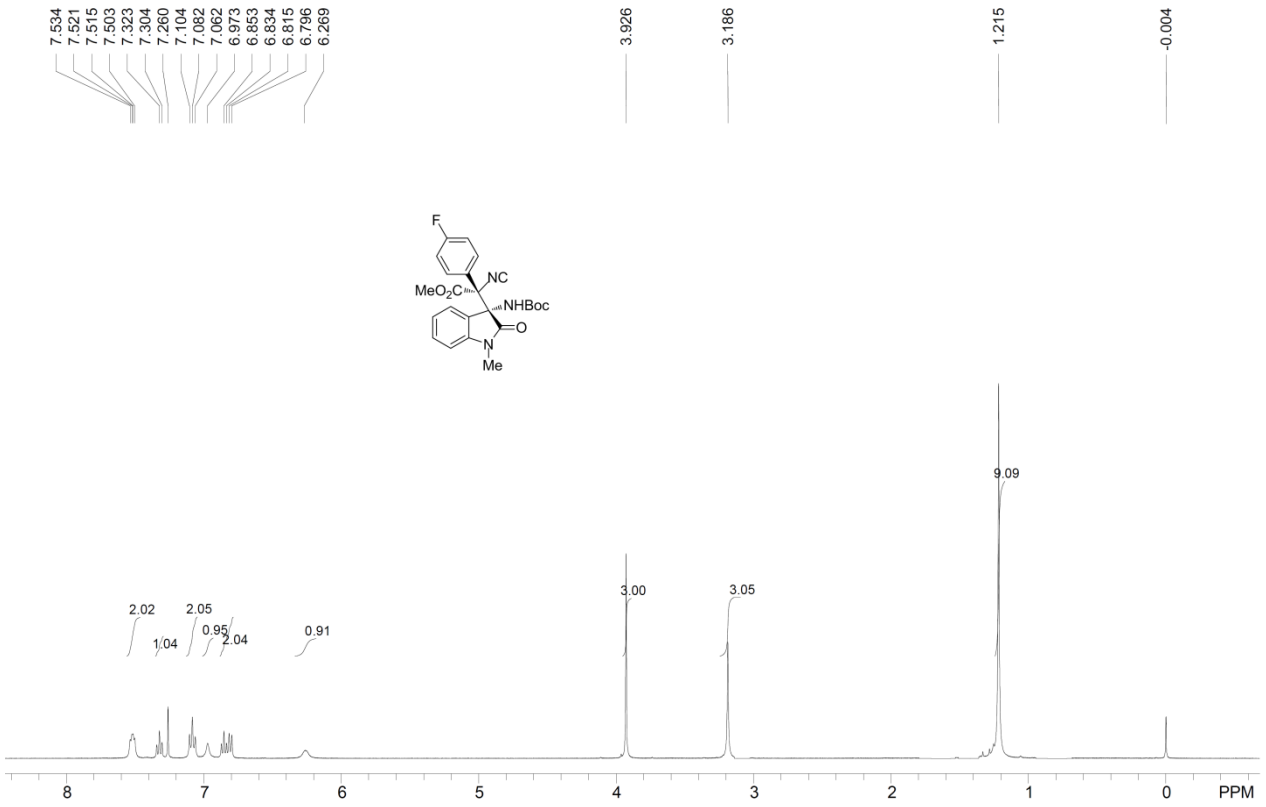
^{1}H NMR of **4a**



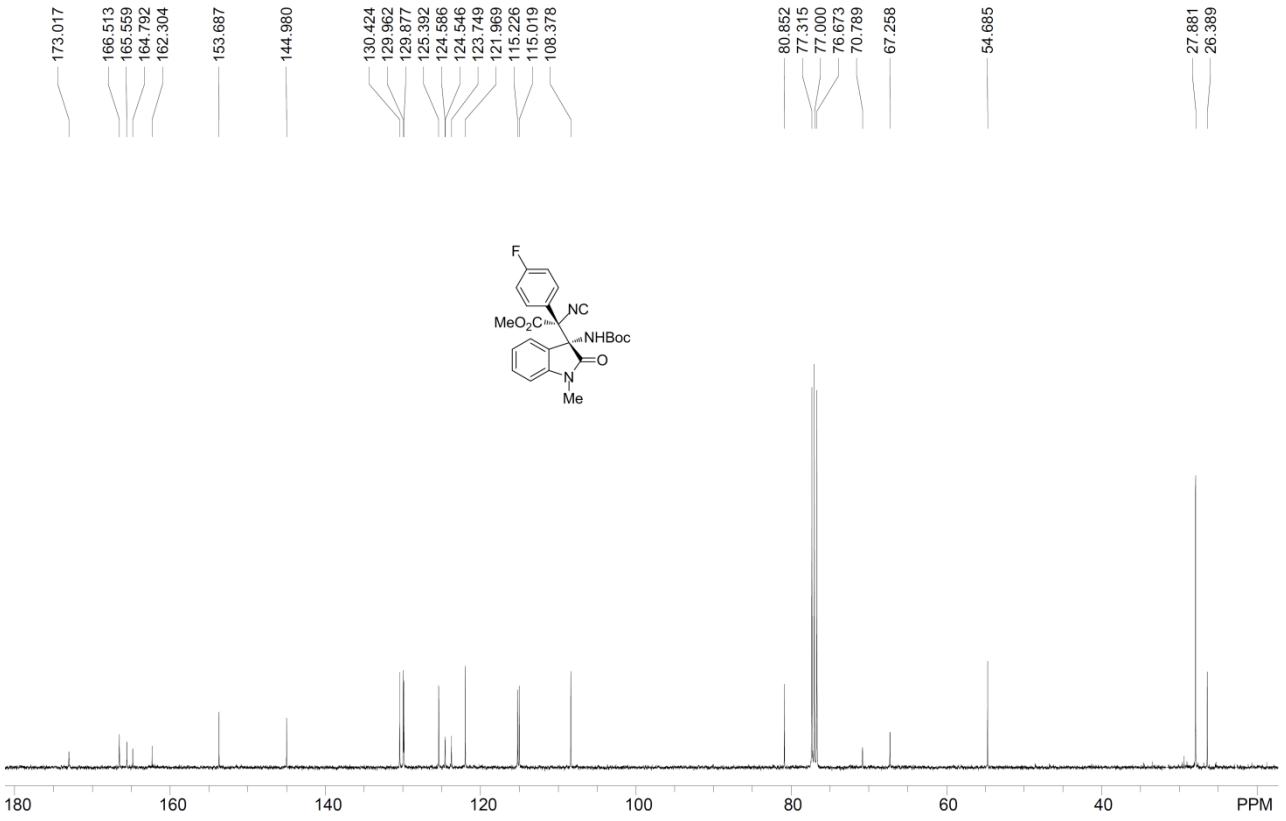
^{13}C NMR of **4a**



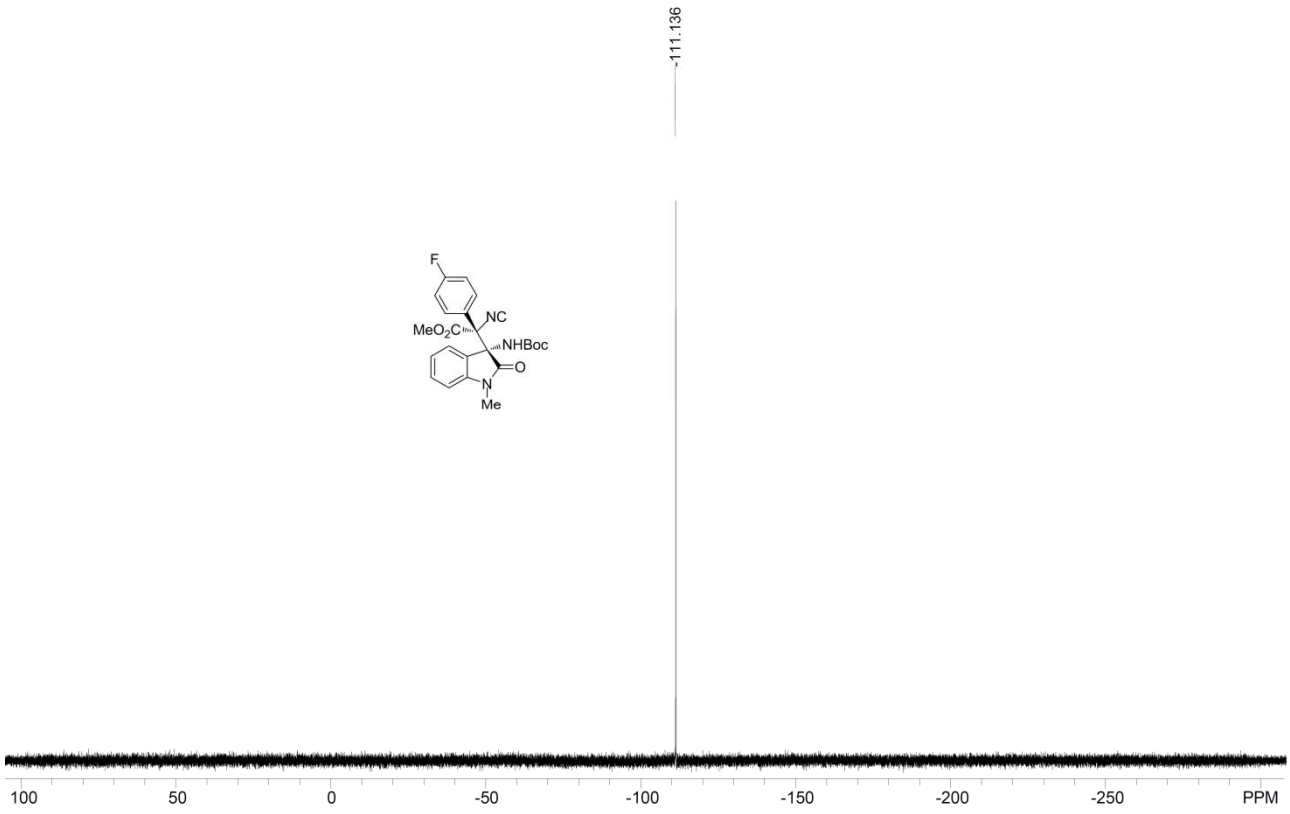
^{1}H NMR of **4b**



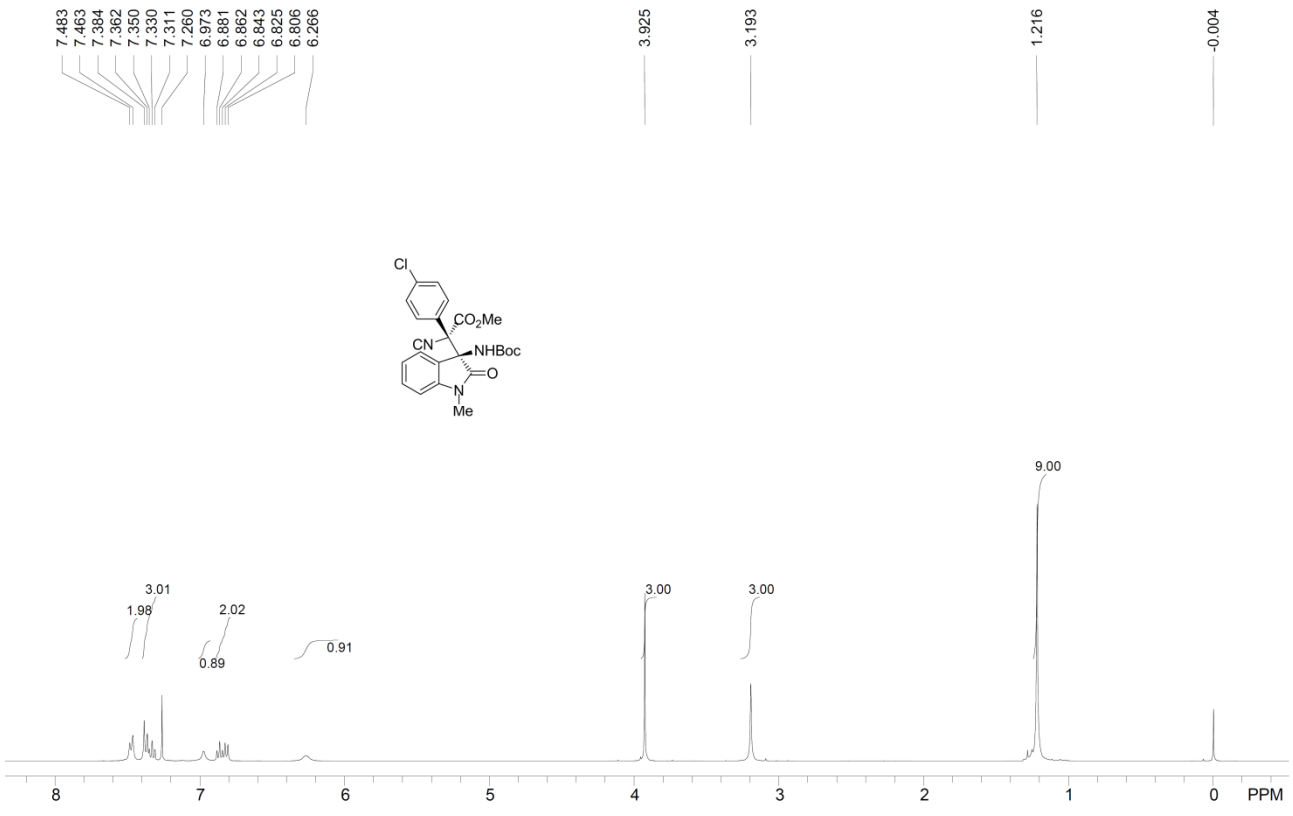
^{13}C NMR of **4b**



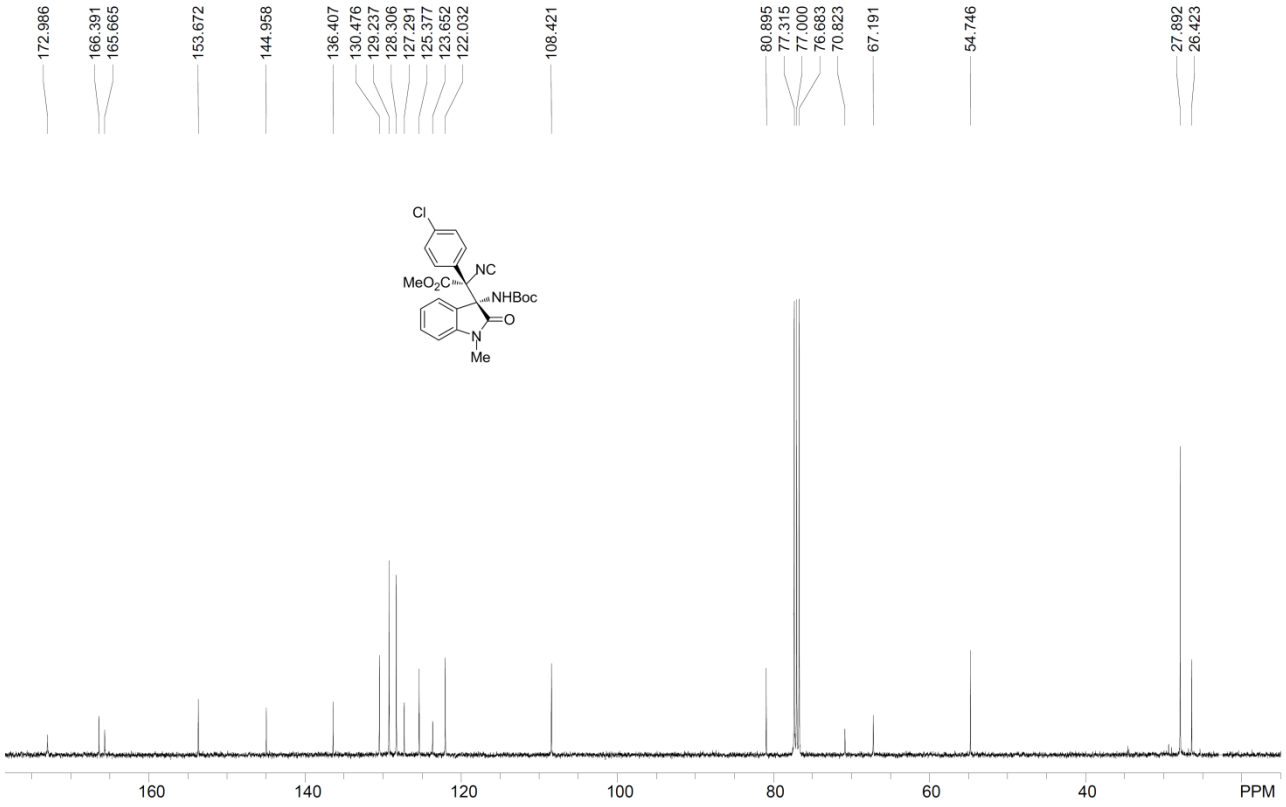
^{19}F NMR of **4b**



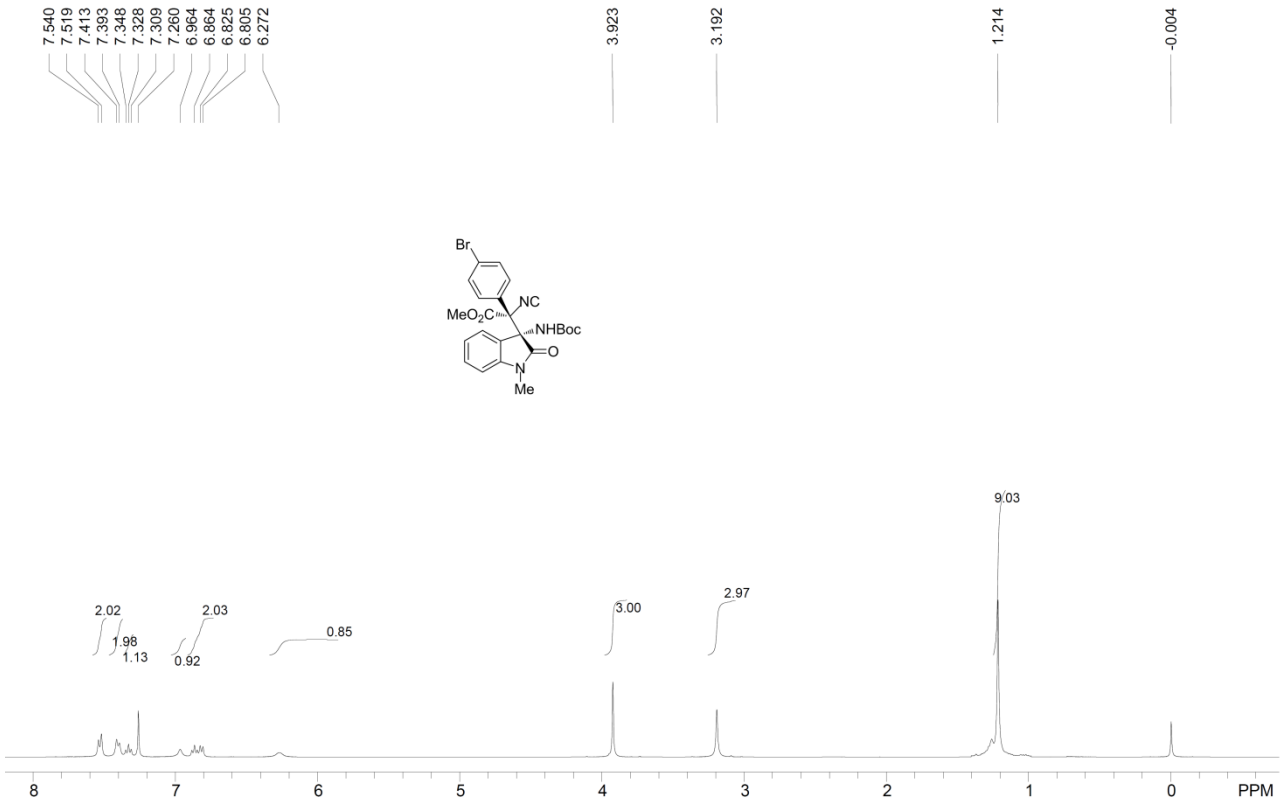
^{1}H NMR of **4c**



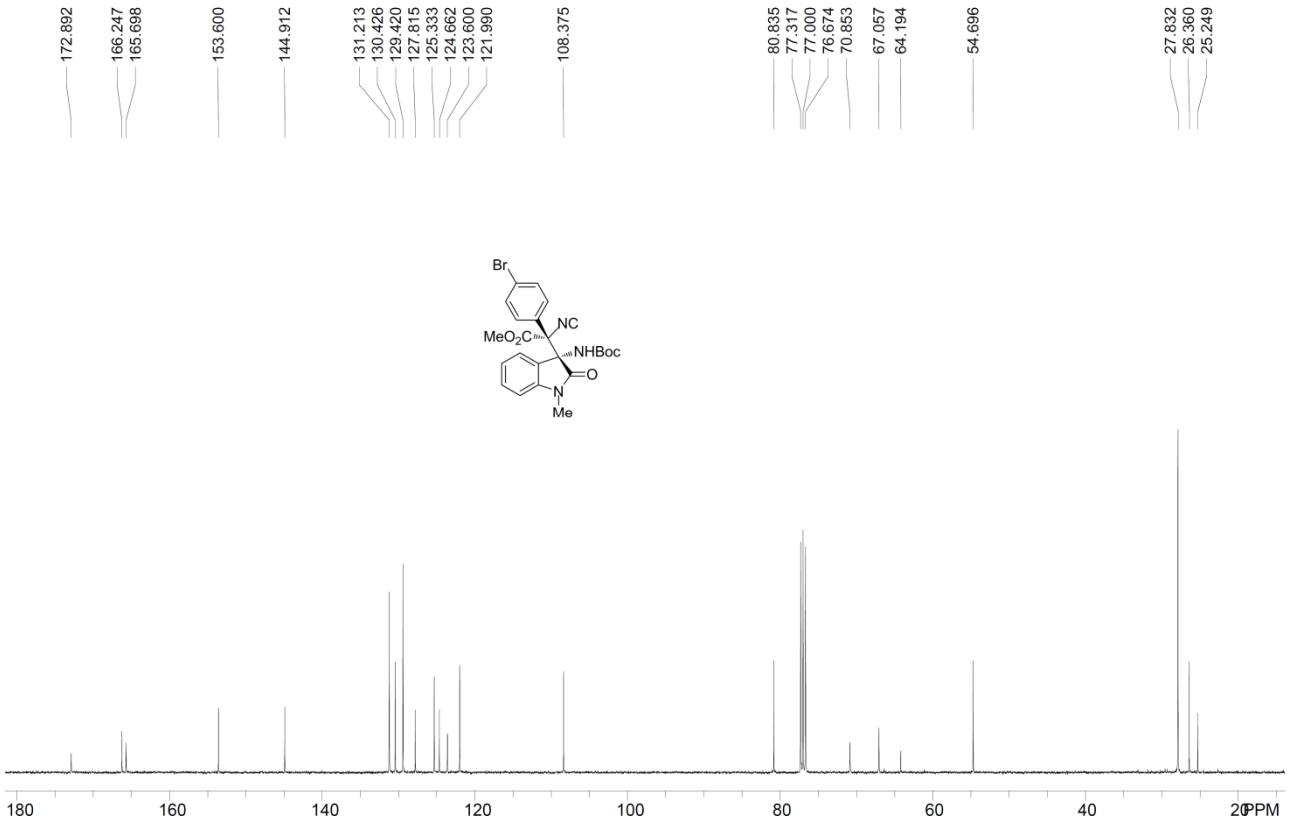
^{13}C NMR of **4c**



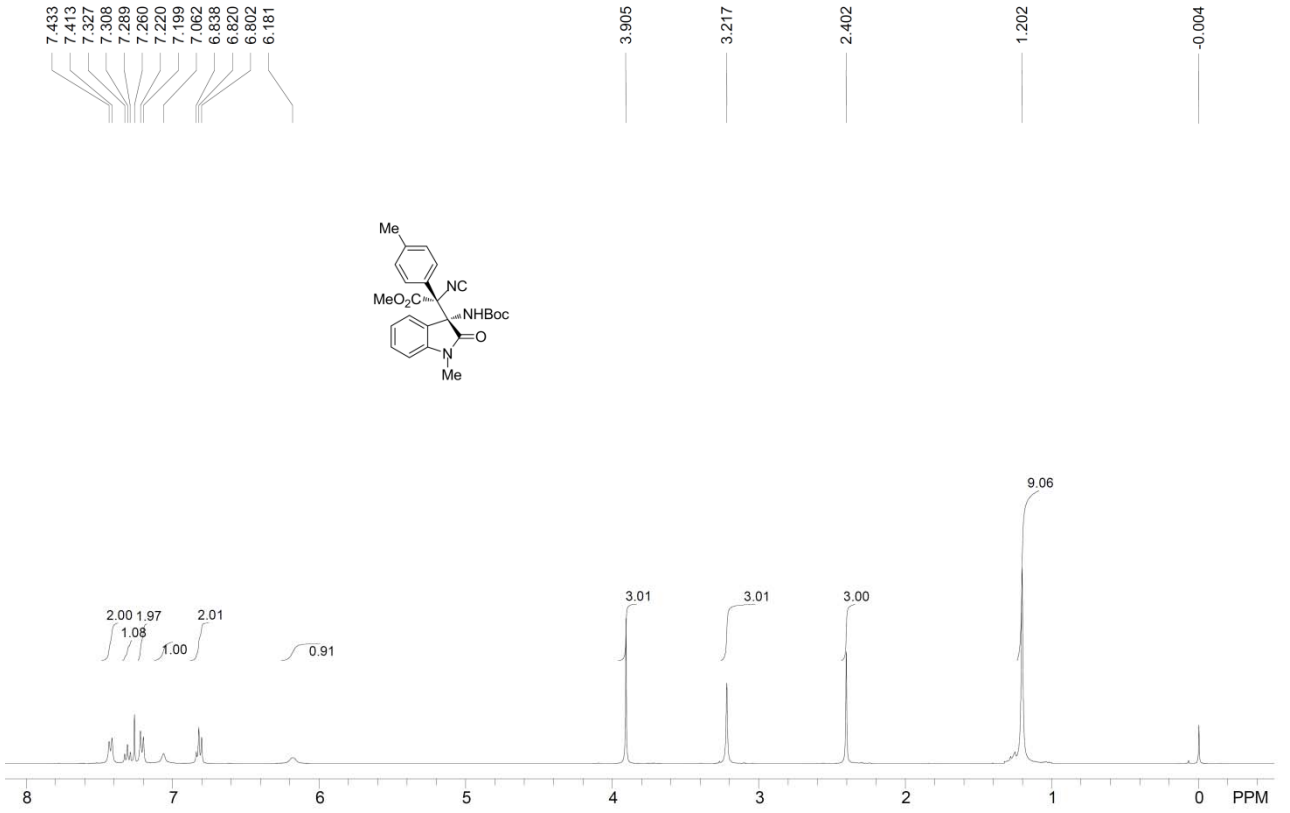
^{1}H NMR of **4d**



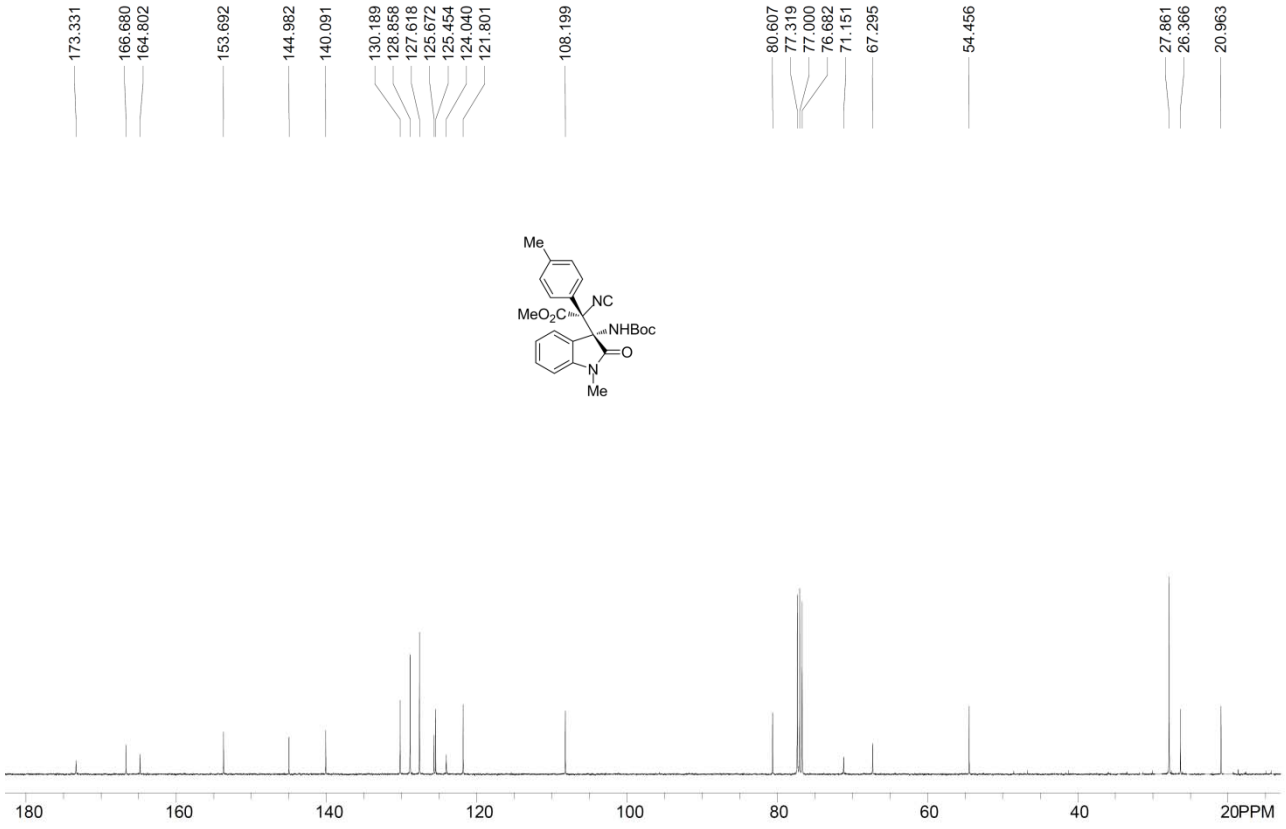
^{13}C NMR of **4d**



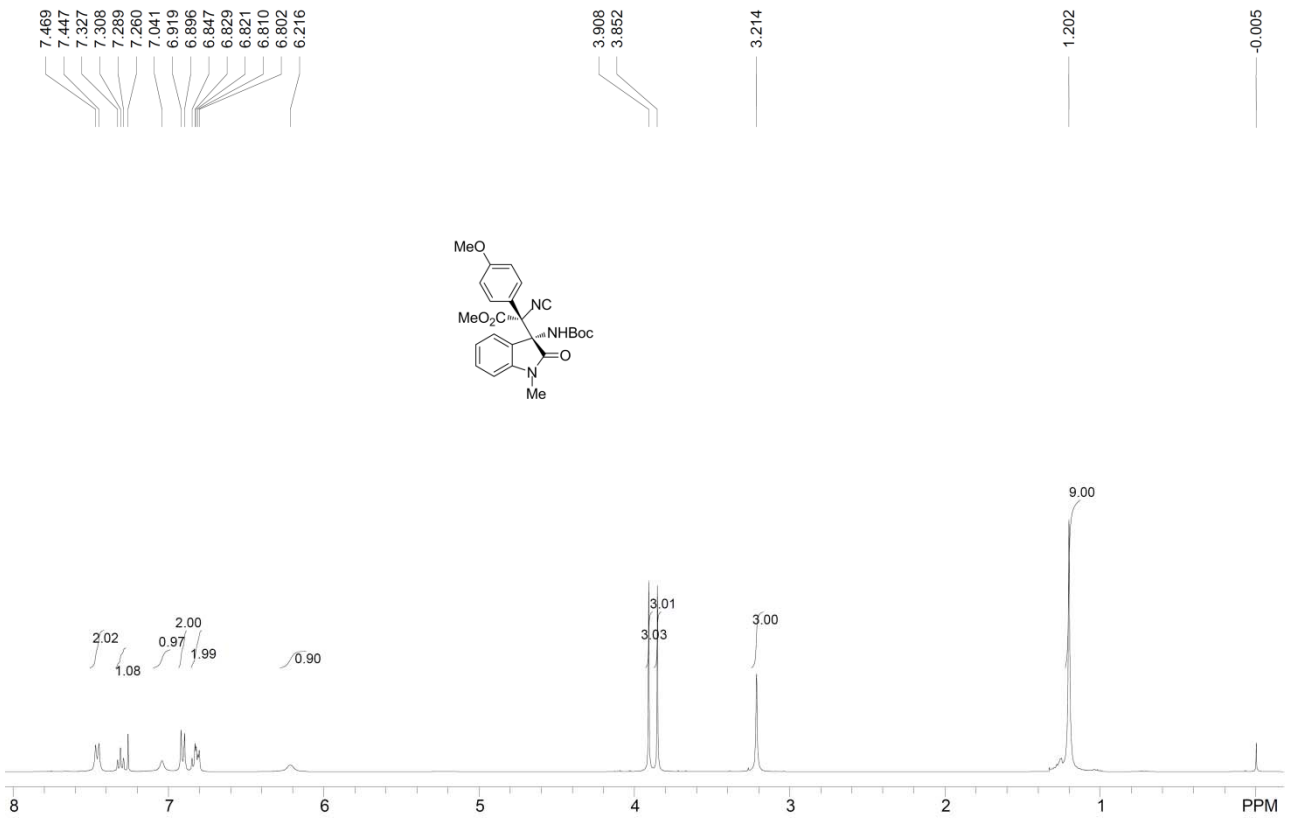
^{1}H NMR of **4e**



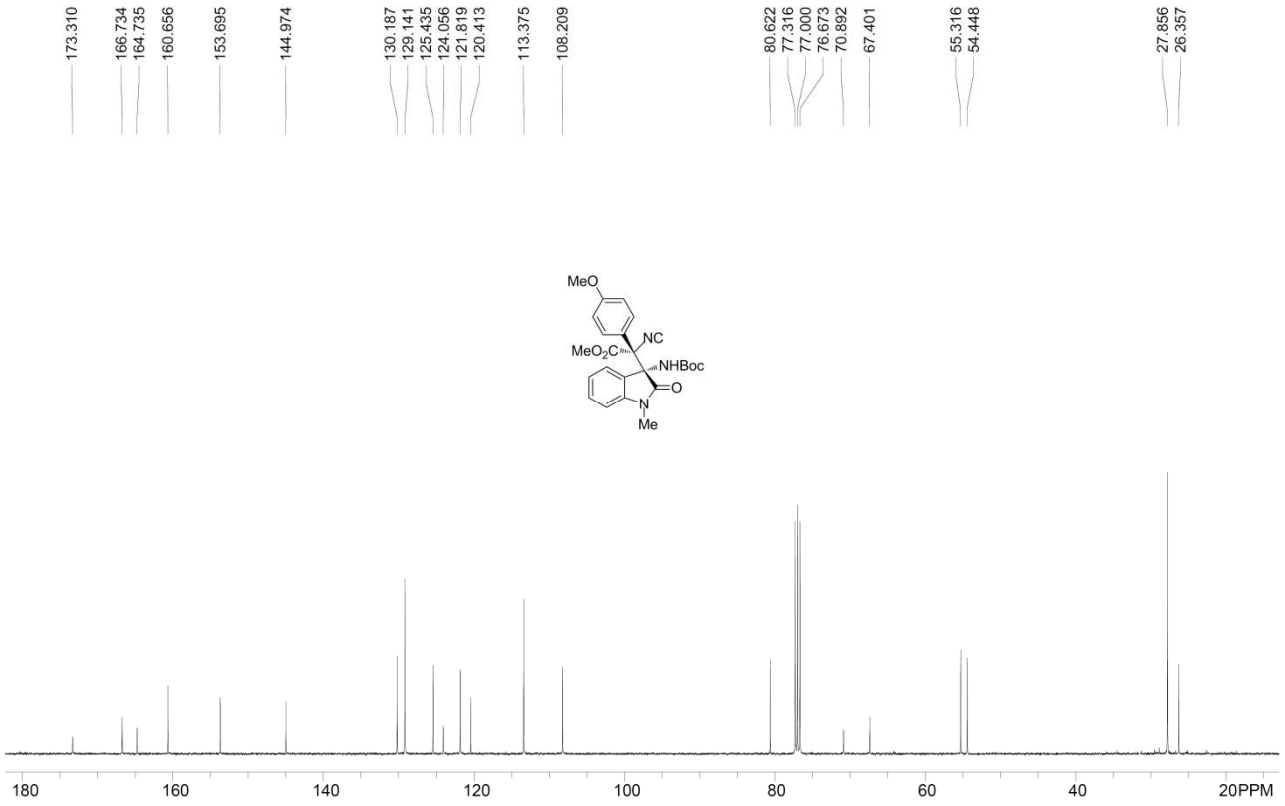
^{13}C NMR of **4e**



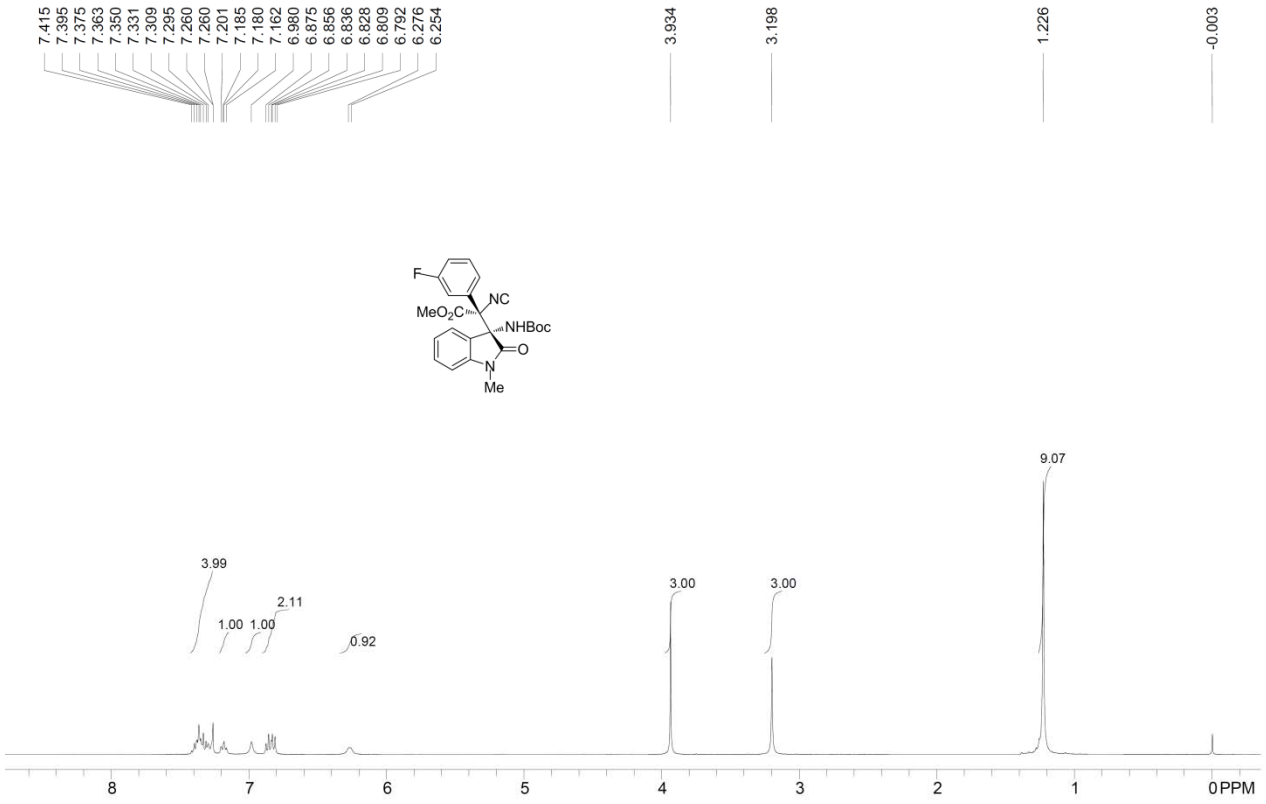
^{1}H NMR of **4f**



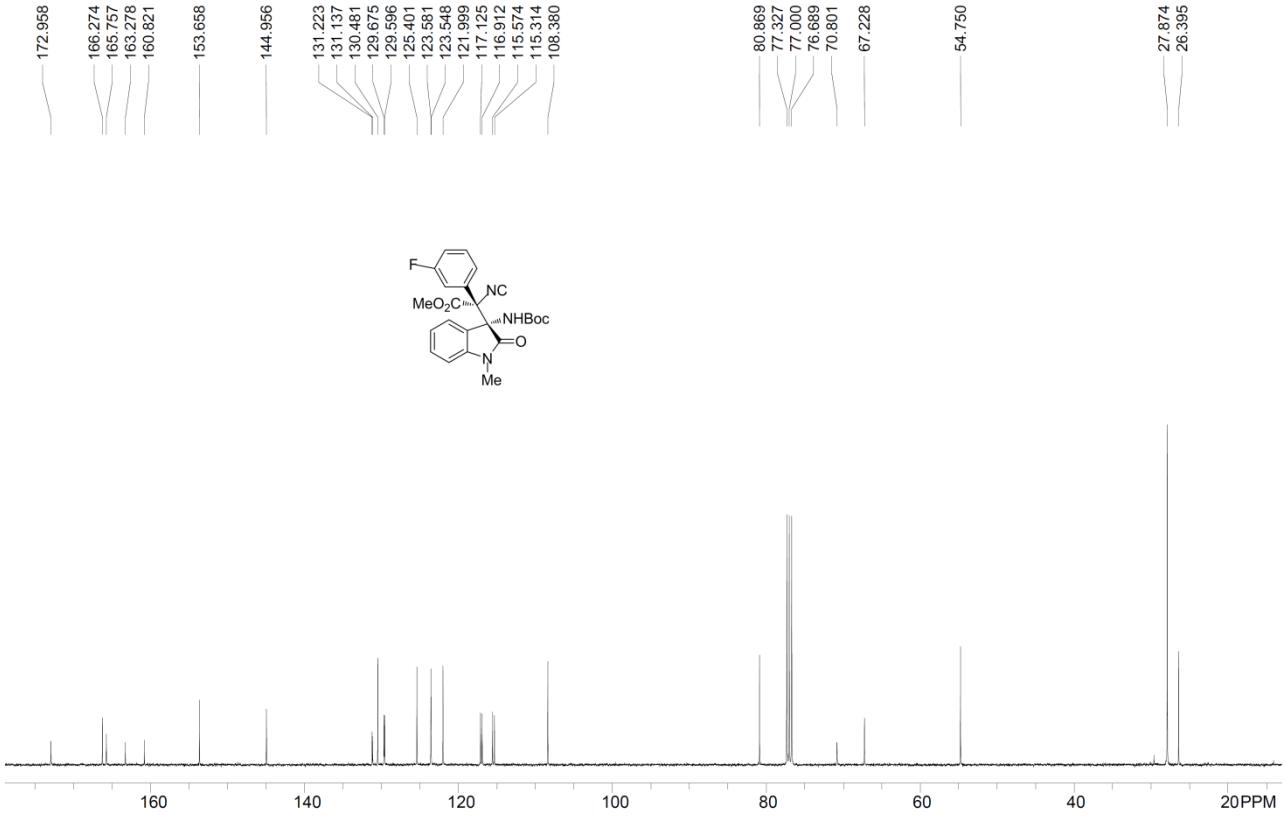
^{13}C NMR of **4f**



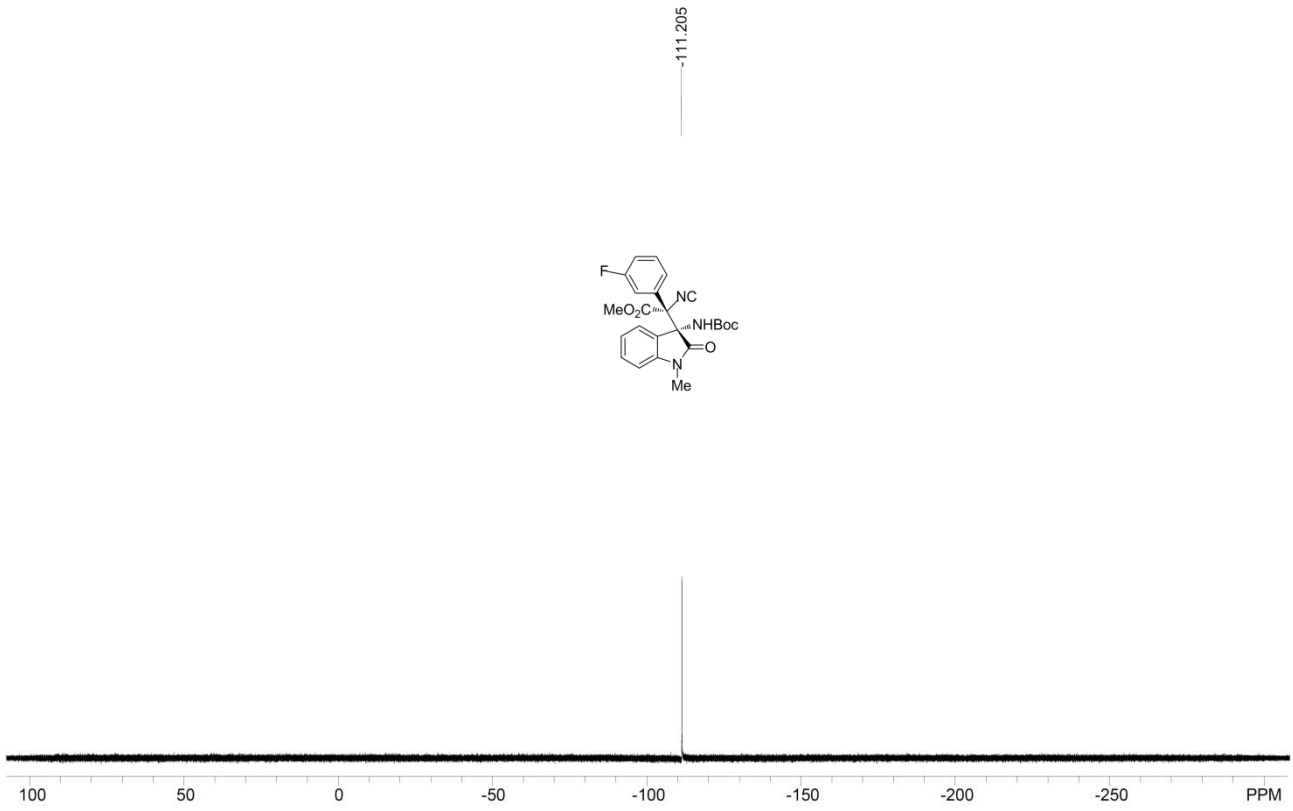
^{1}H NMR of **4g**



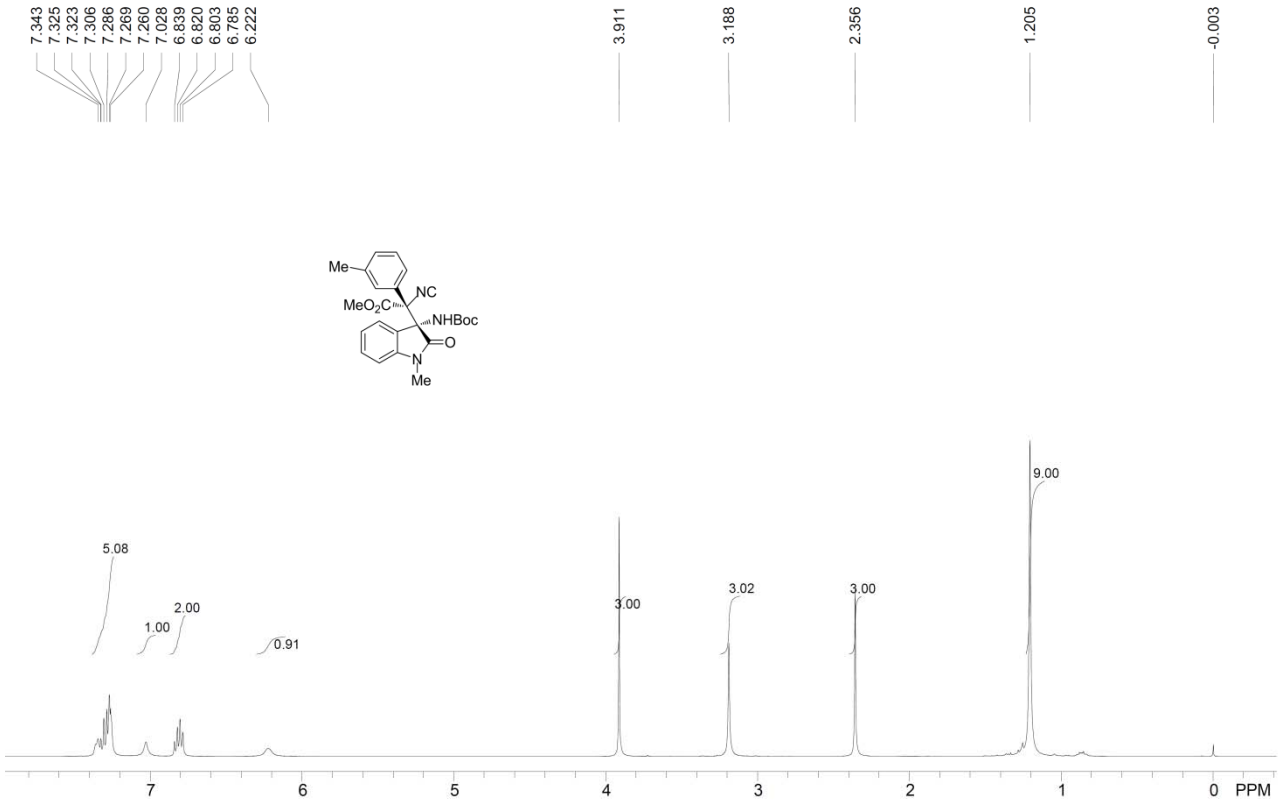
^{13}C NMR of **4g**



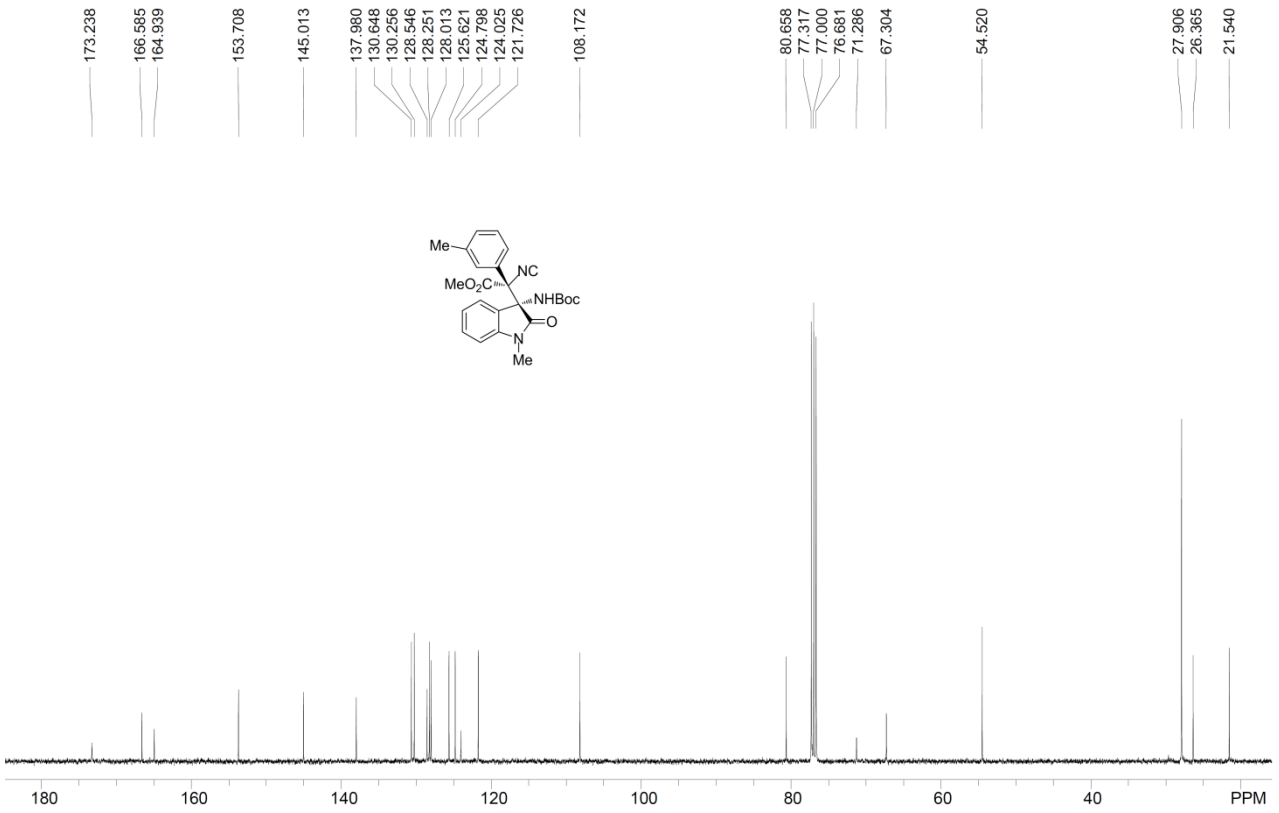
^{19}F NMR of **4g**



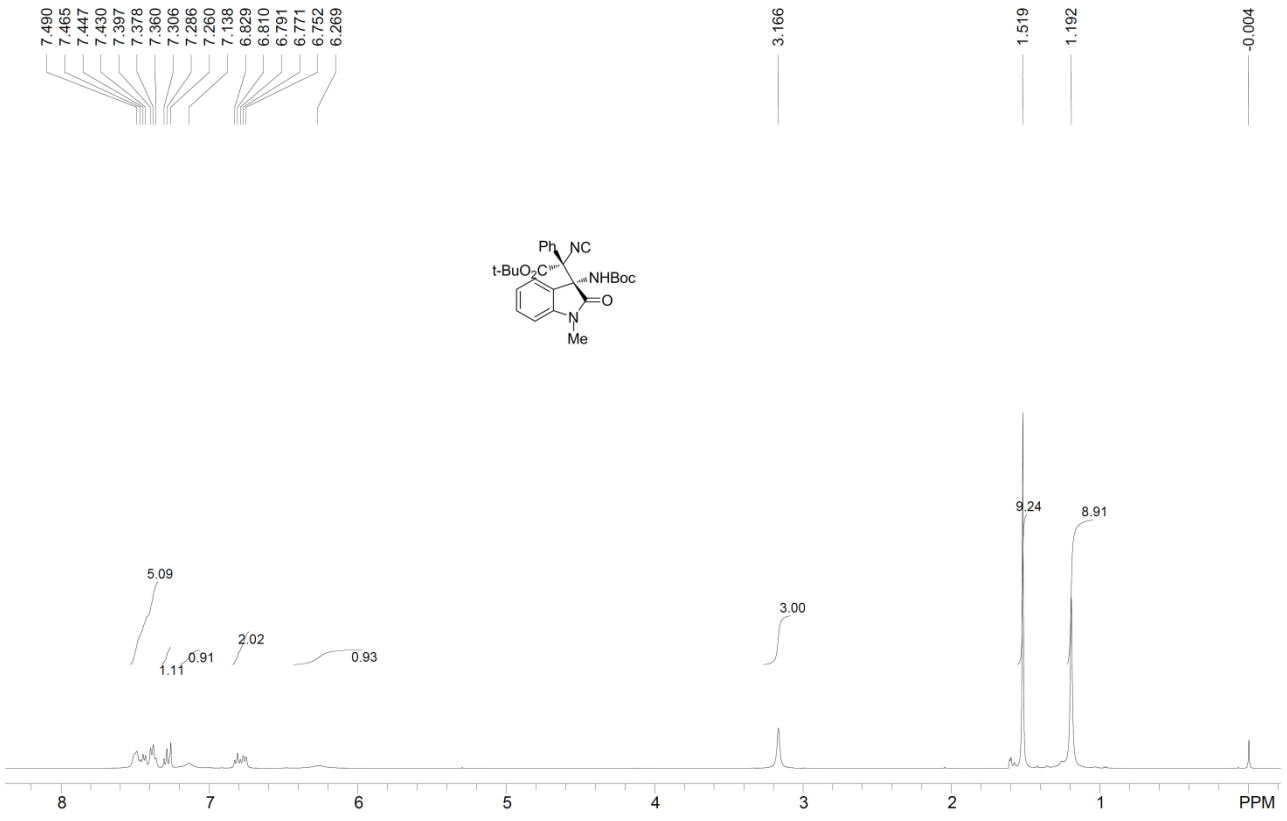
^{1}H NMR of **4h**



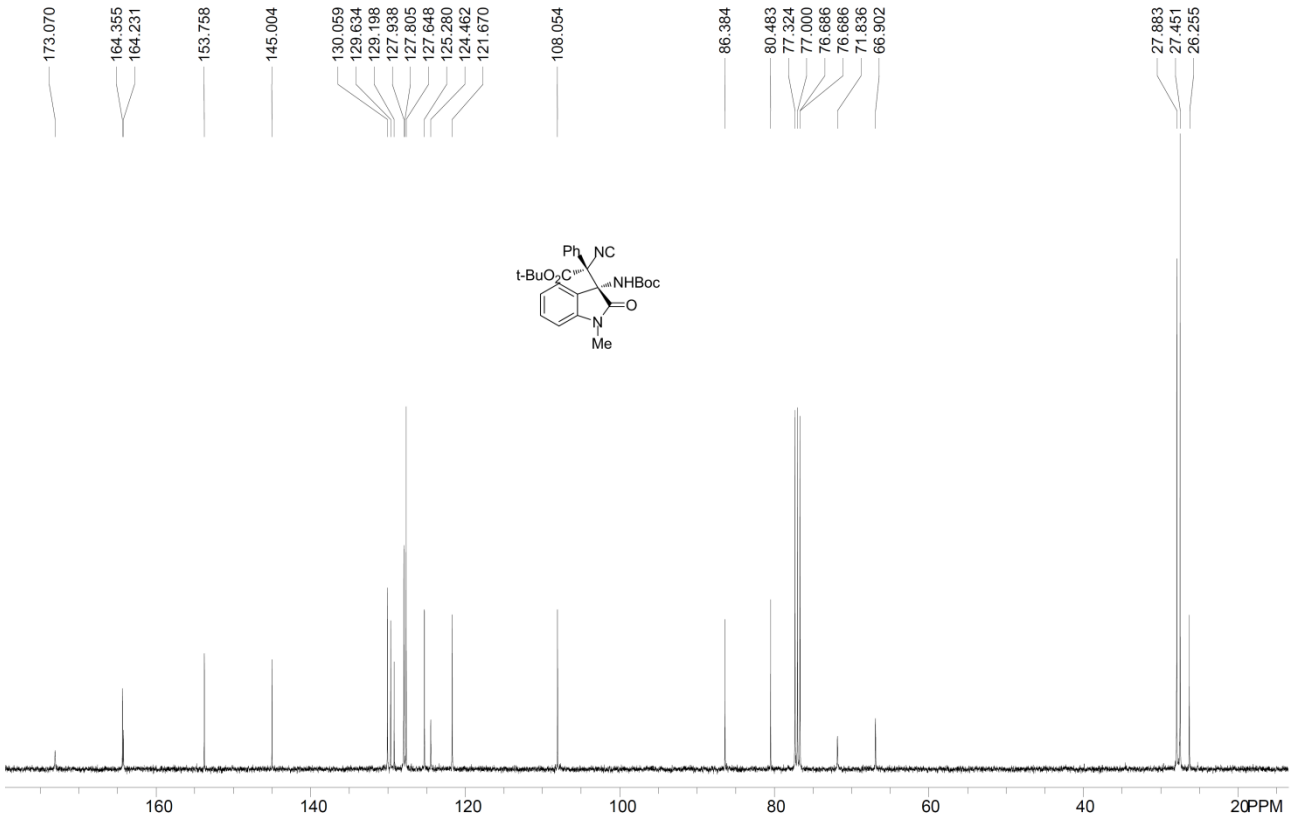
^{13}C NMR of **4h**



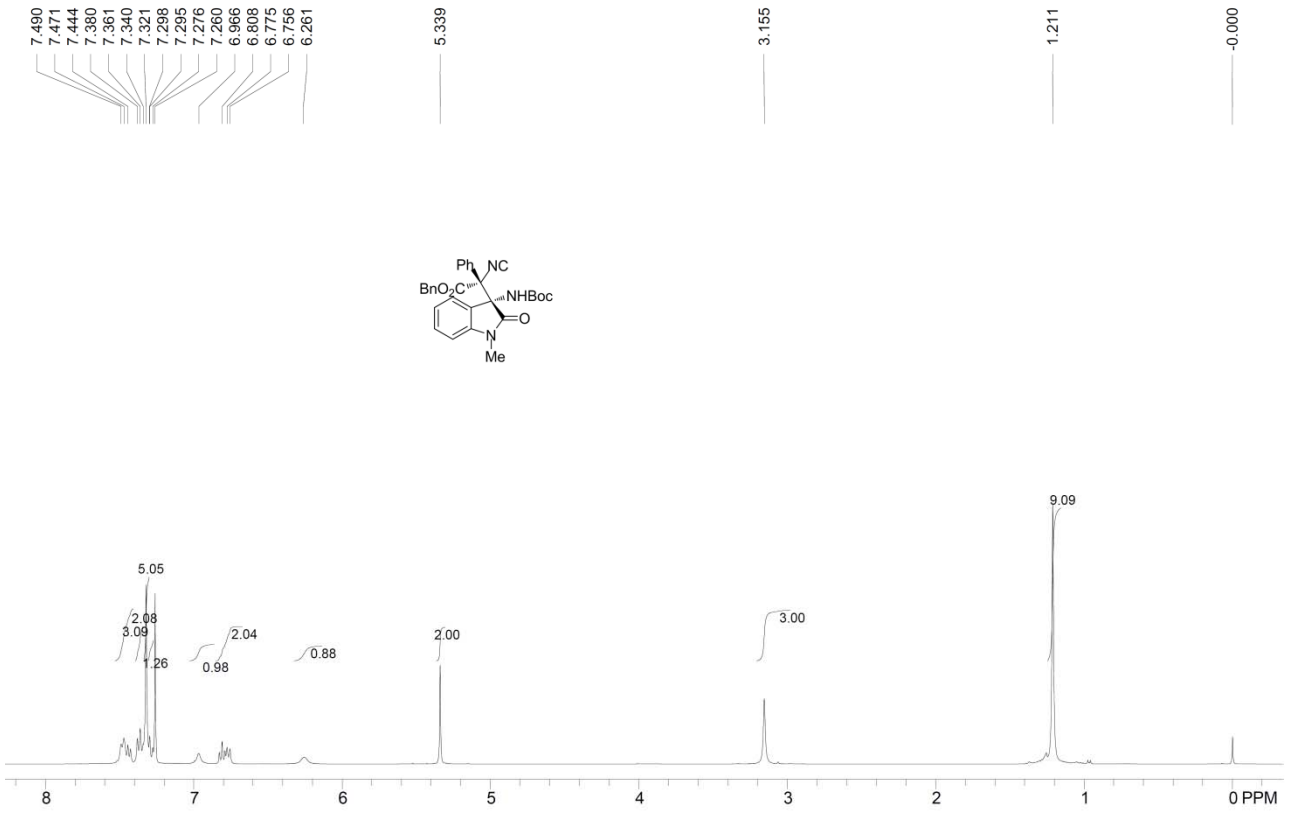
^{1}H NMR of **4j**



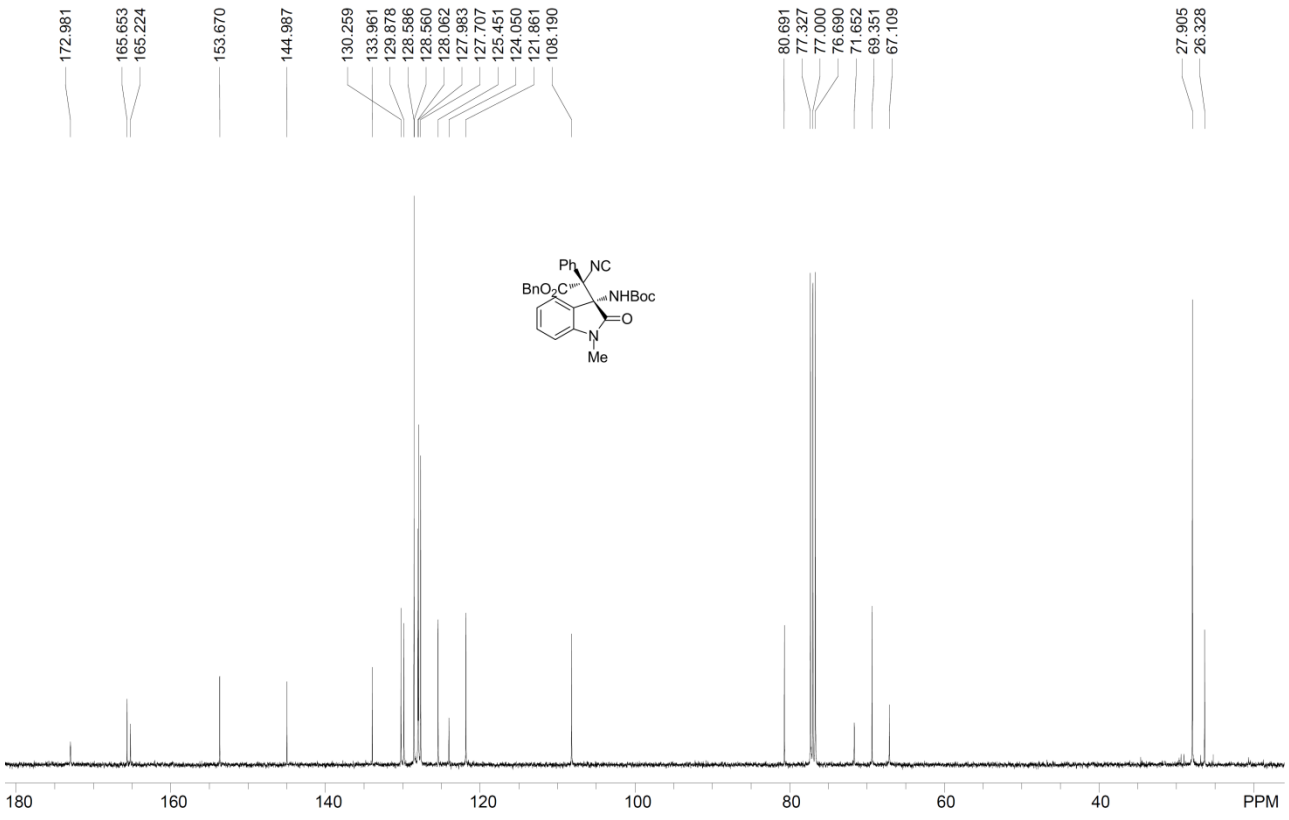
^{13}C NMR of **4j**



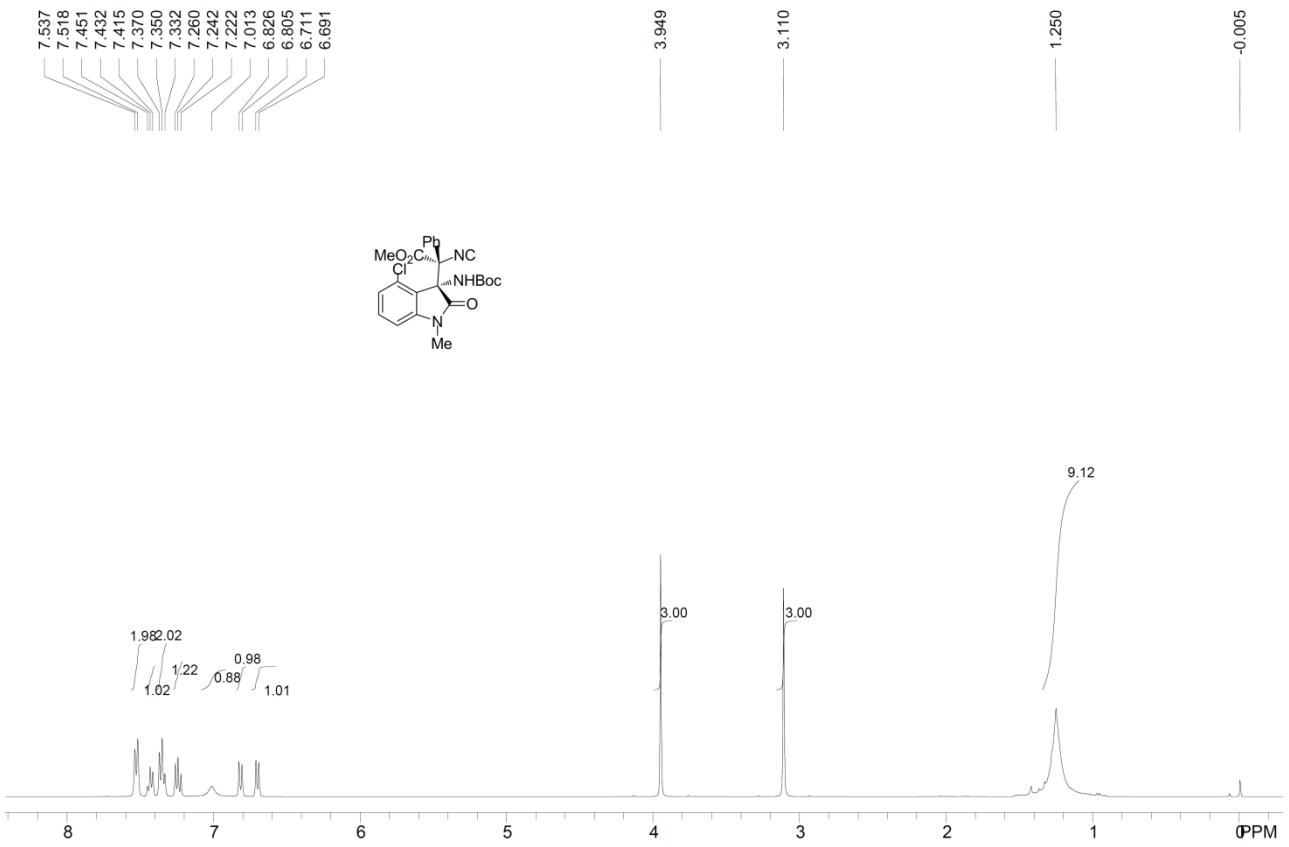
^{1}H NMR of **4k**



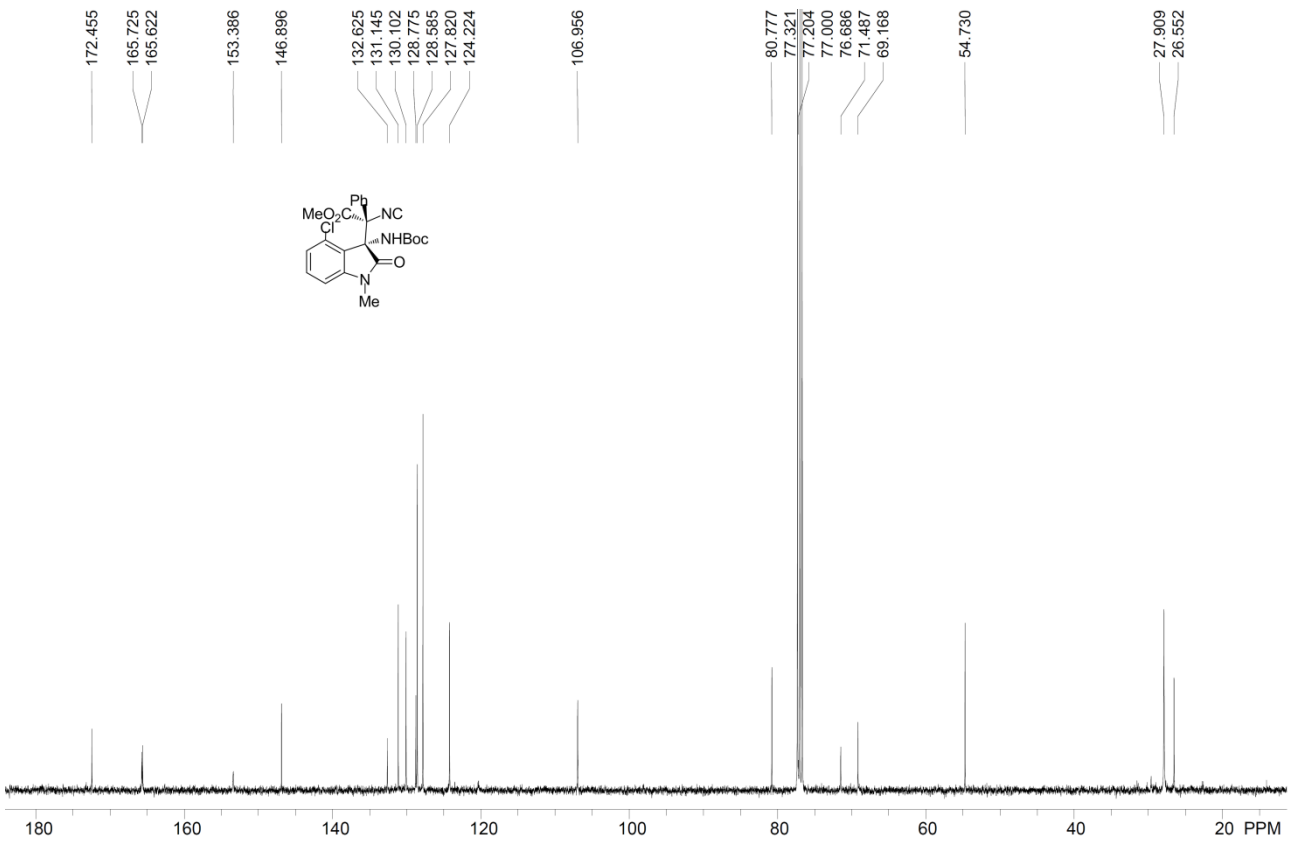
^{13}C NMR of **4k**



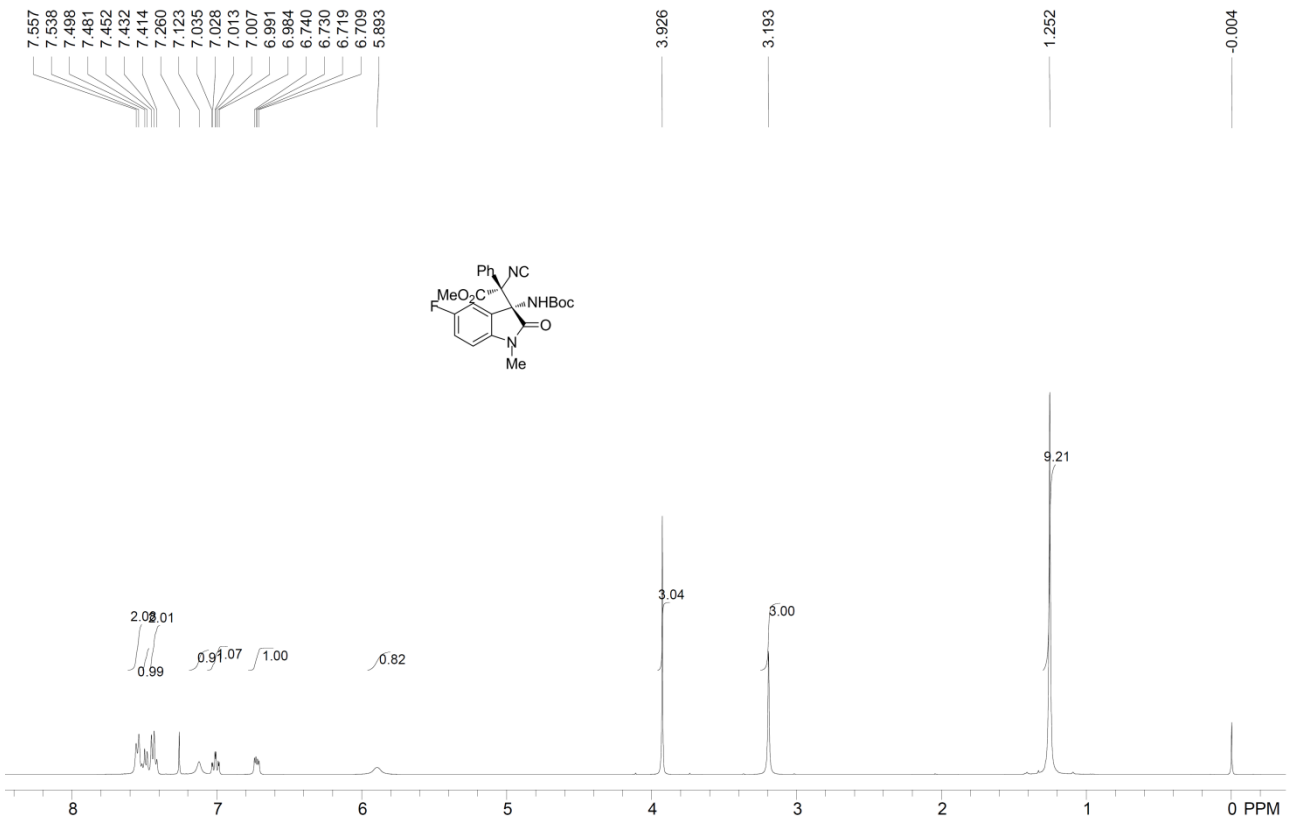
^{1}H NMR of **4m**



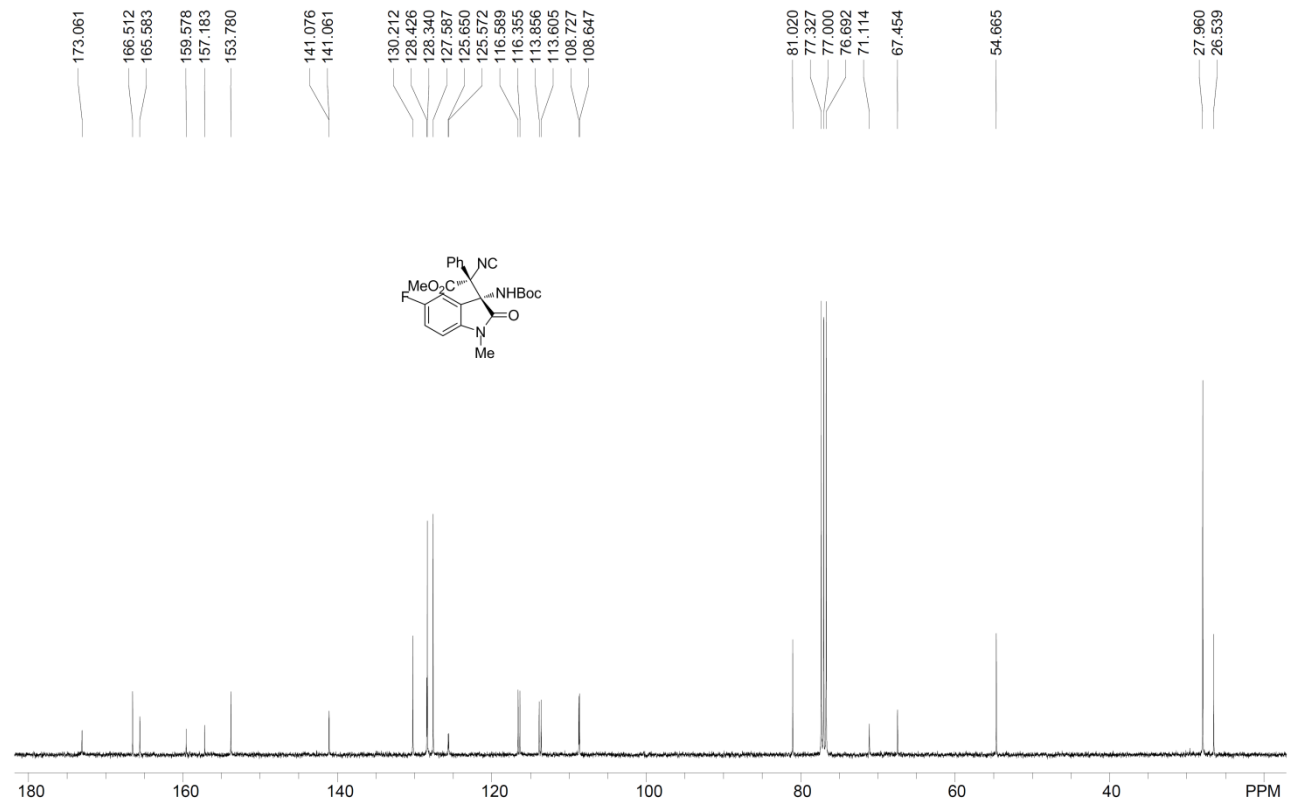
^{13}C NMR of **4m**



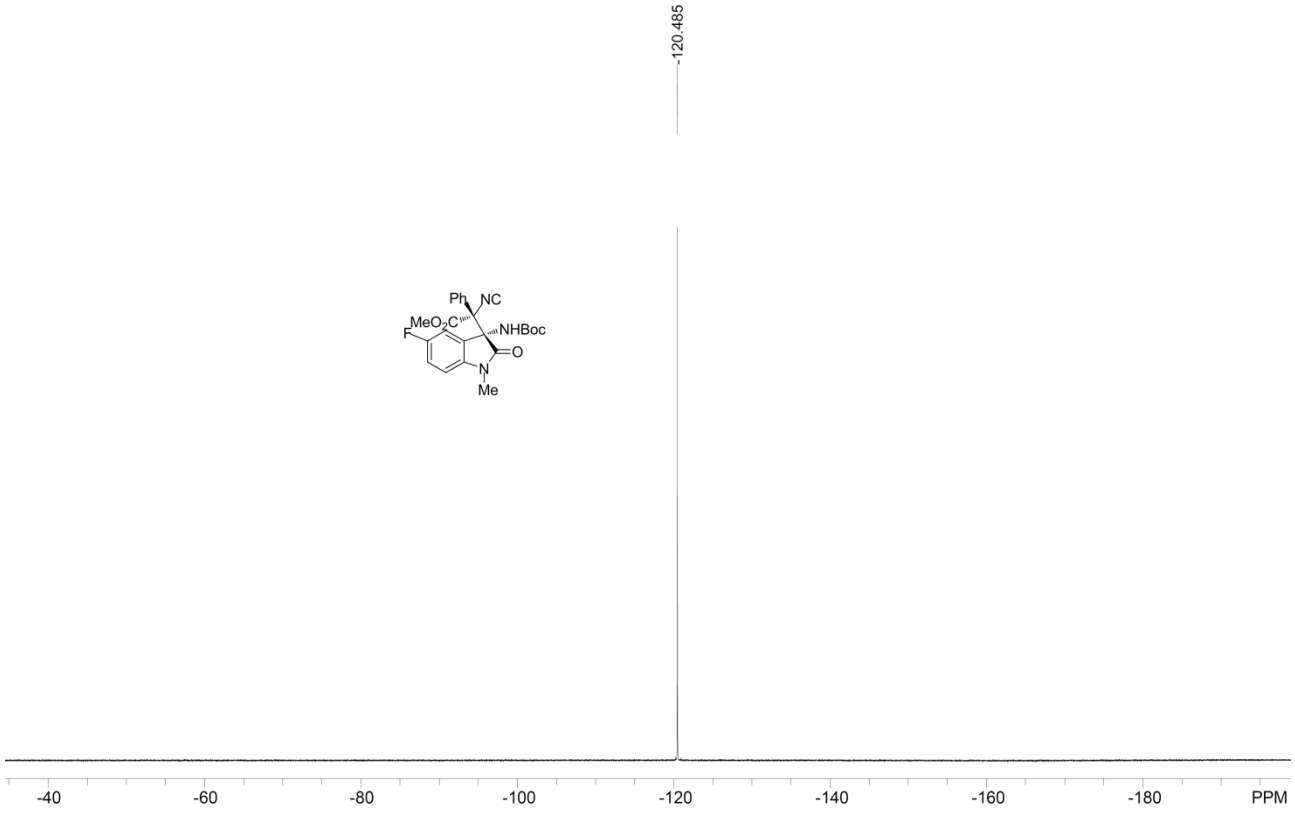
^{1}H NMR of **4n**



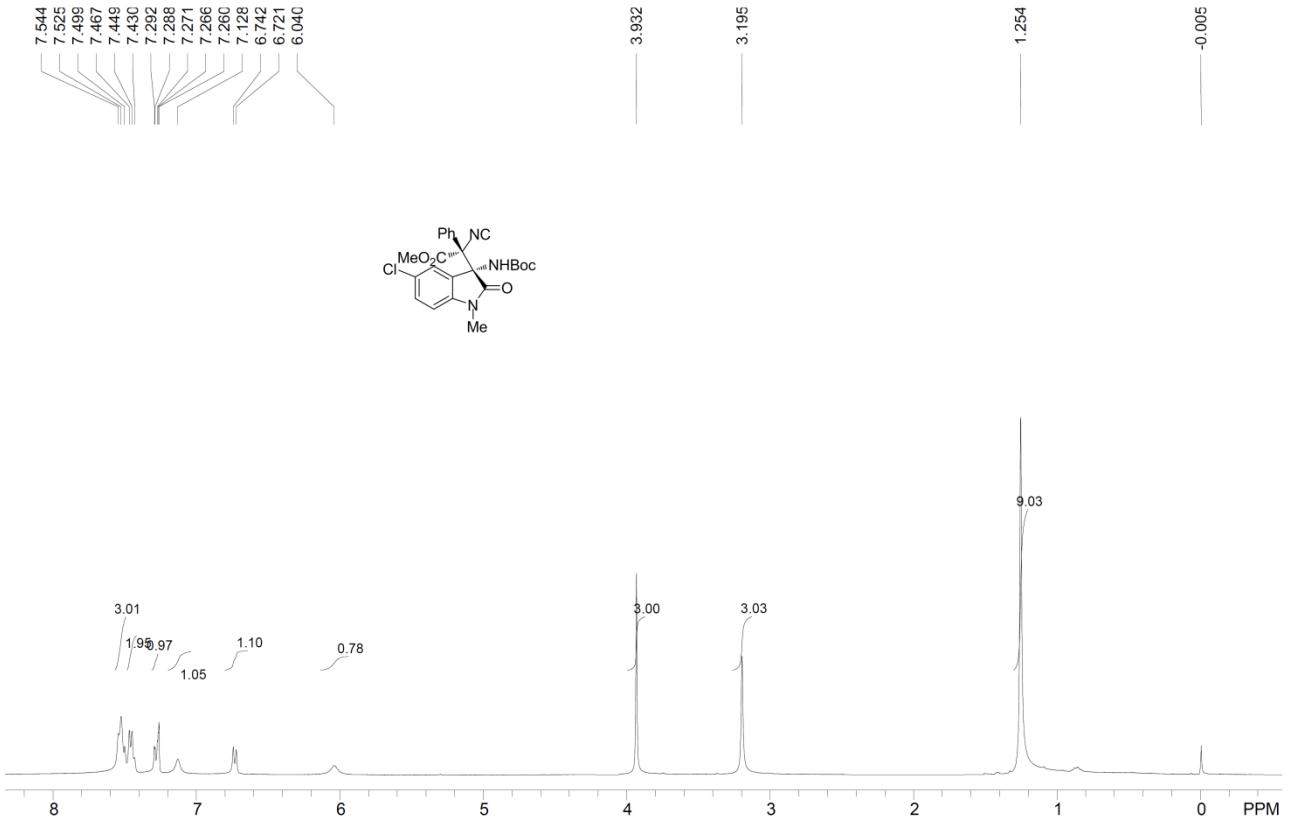
^{13}C NMR of **4n**



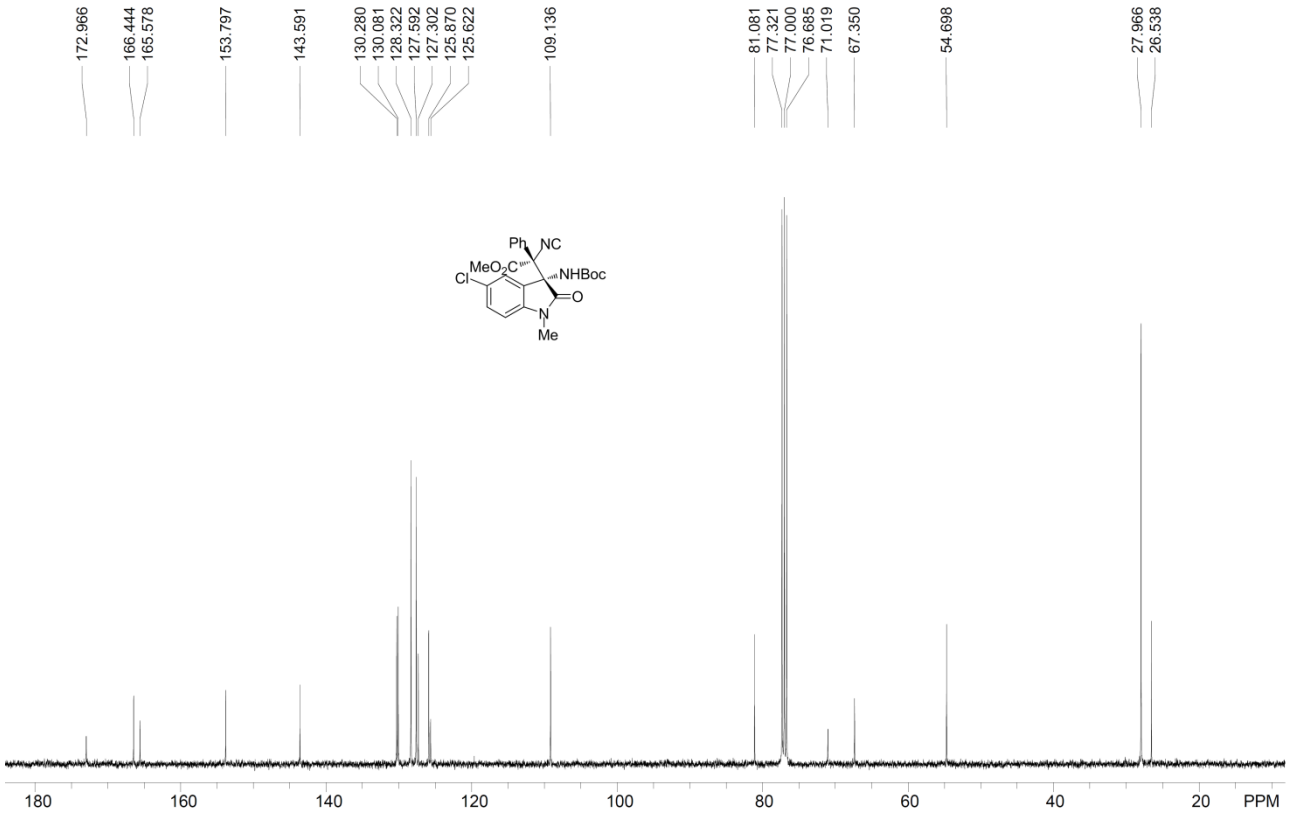
^{19}F NMR of **4n**



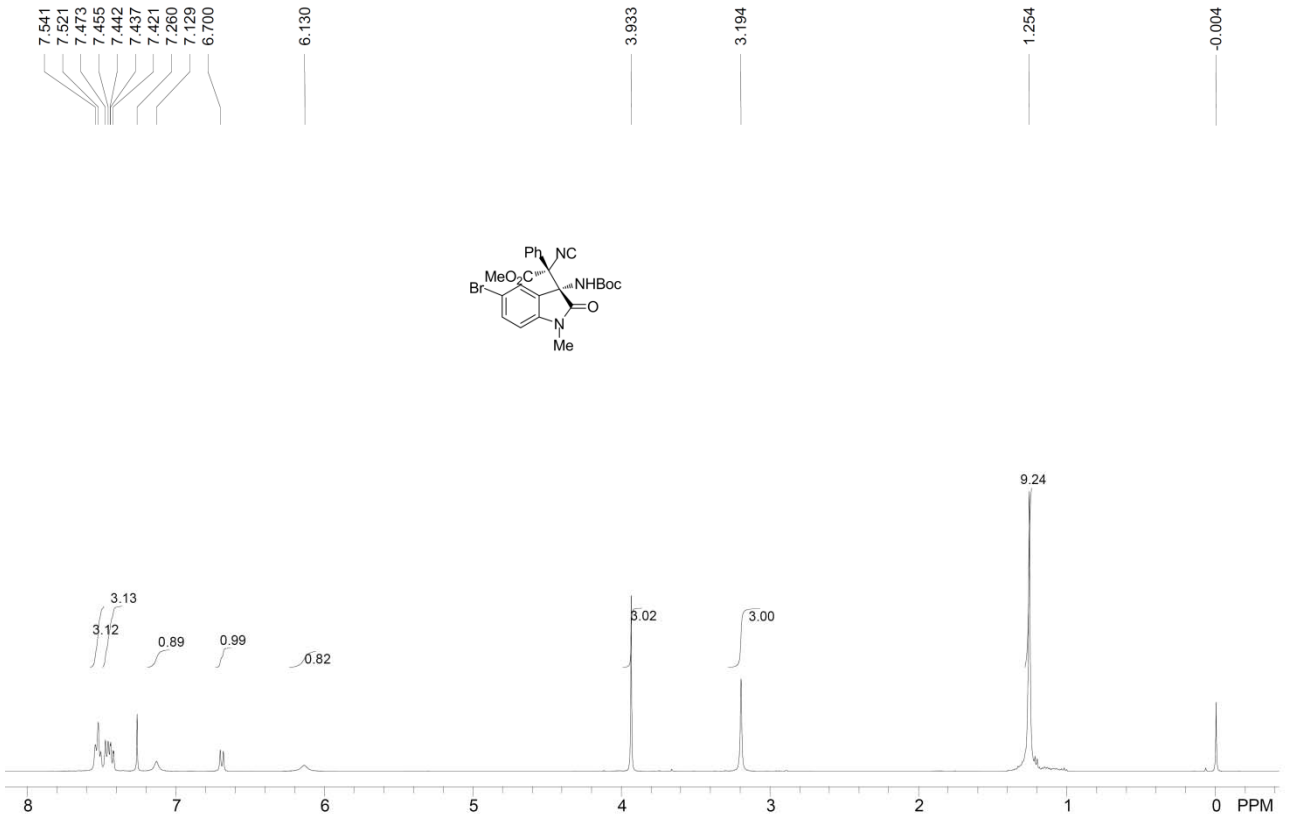
^{1}H NMR of **4o**



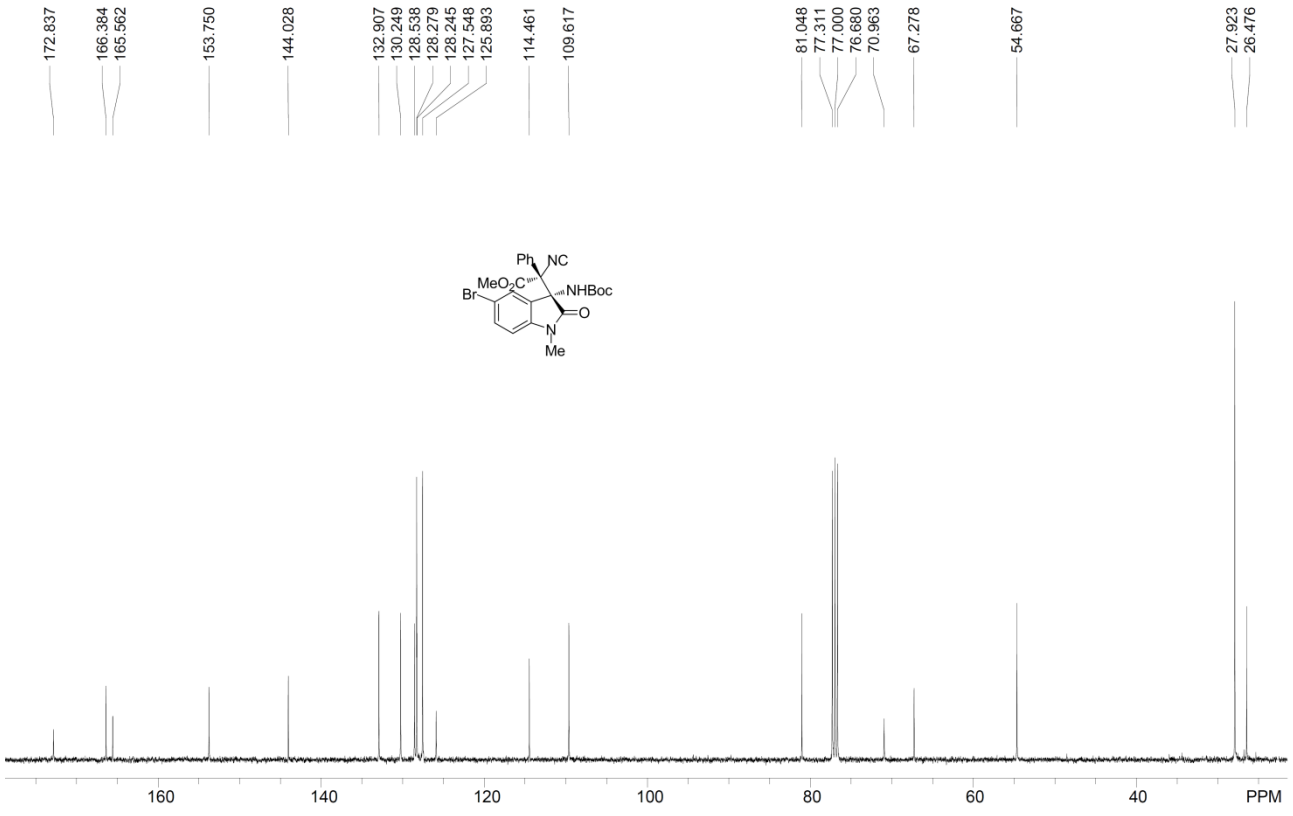
^{13}C NMR of **4o**



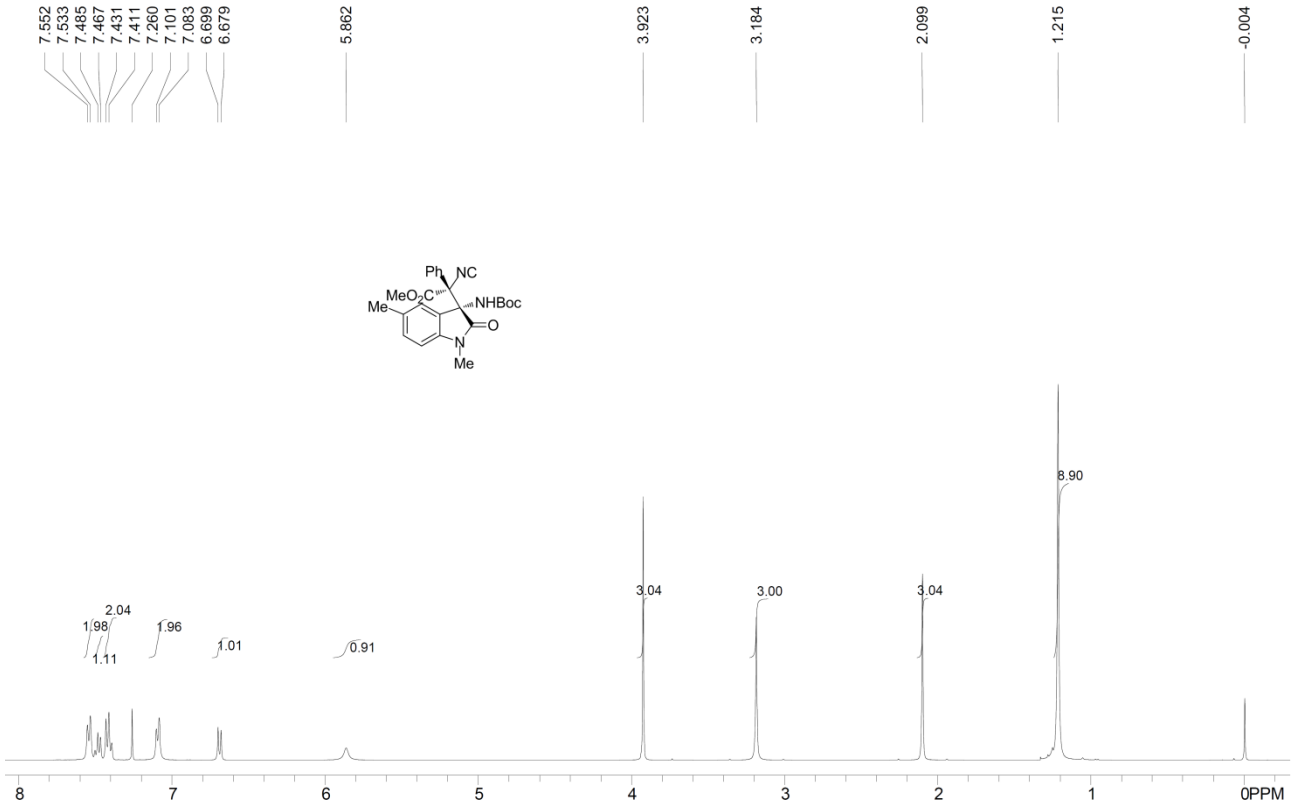
^{1}H NMR of **4p**



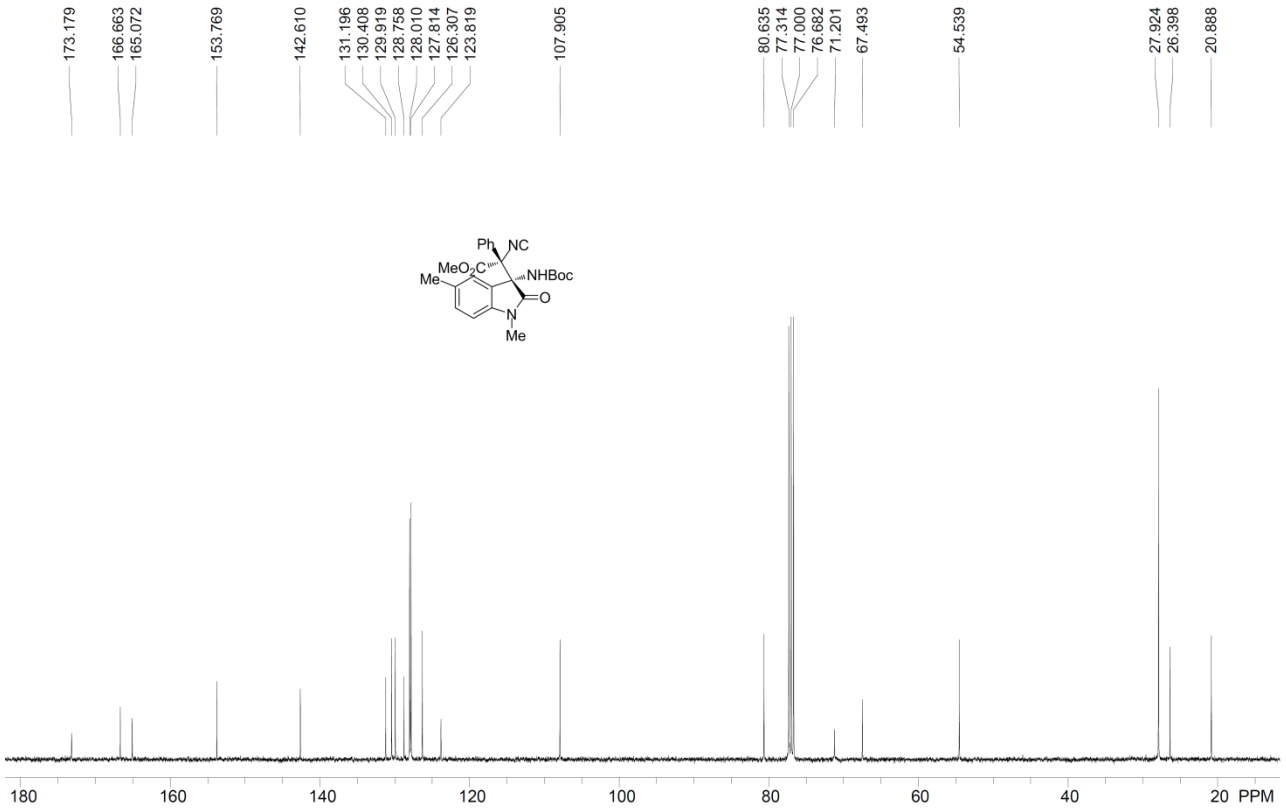
^{13}C NMR of **4p**



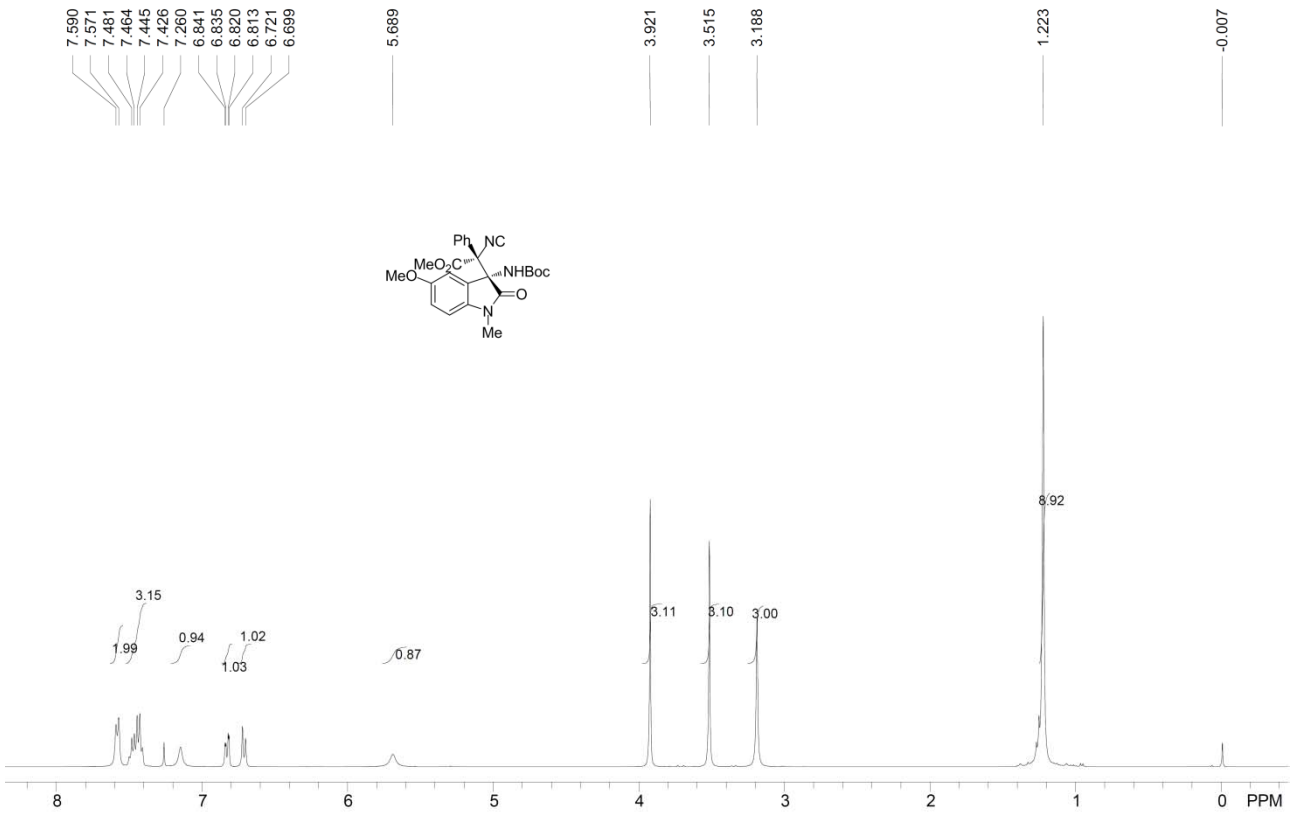
^{1}H NMR of **4q**



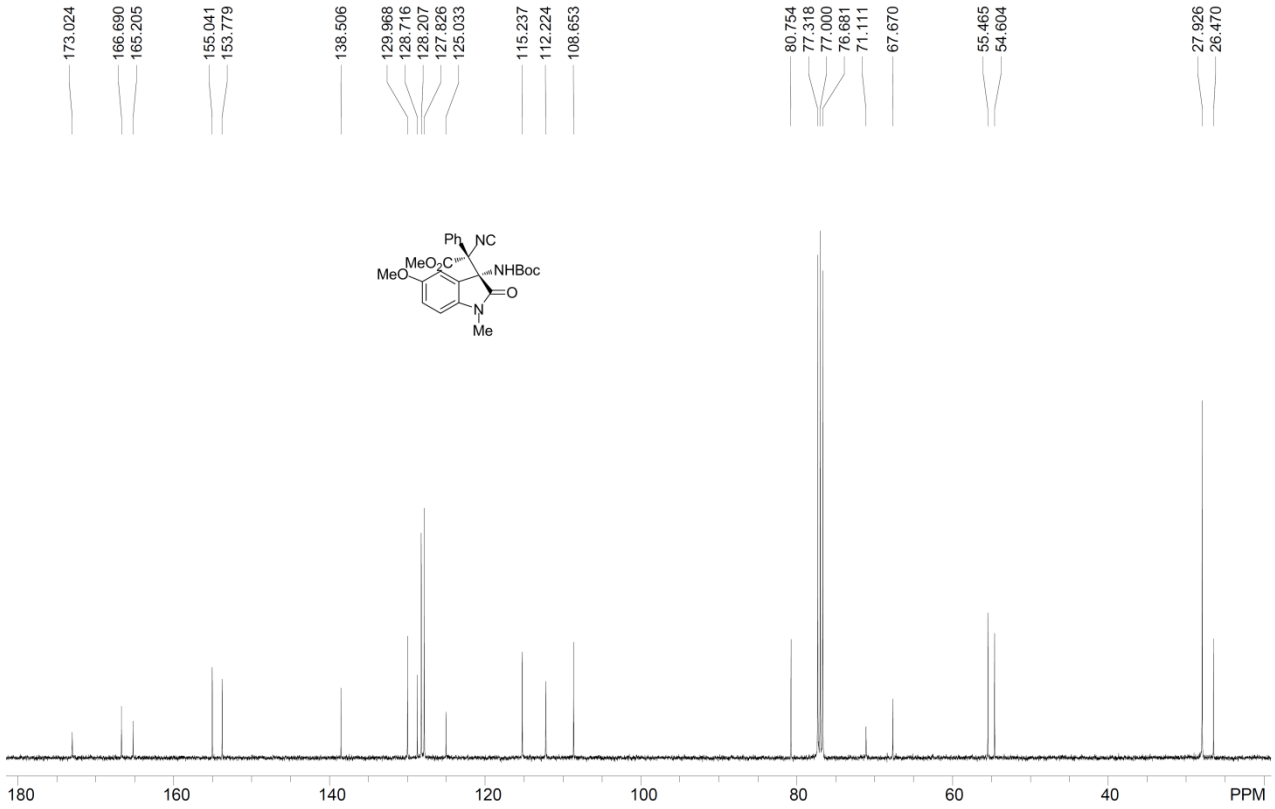
^{13}C NMR of **4q**



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



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



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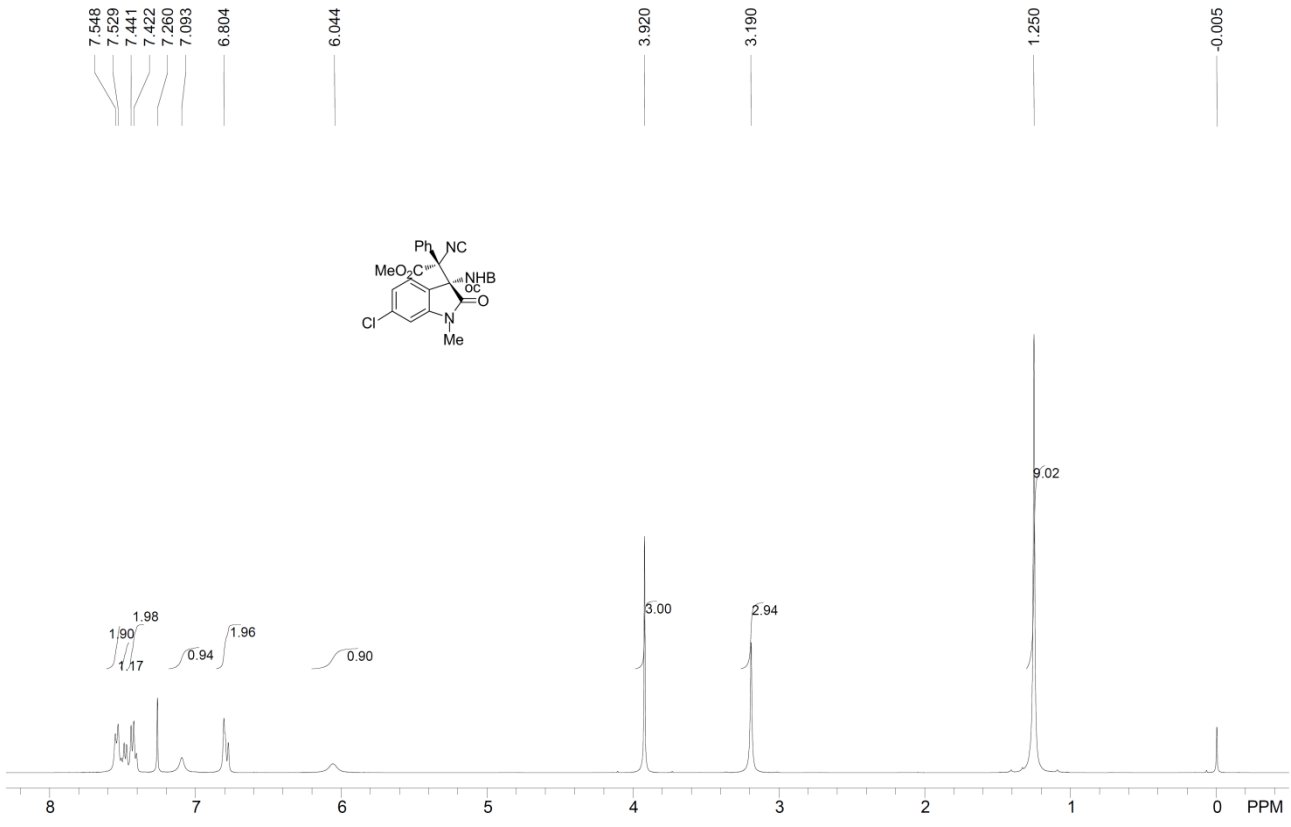

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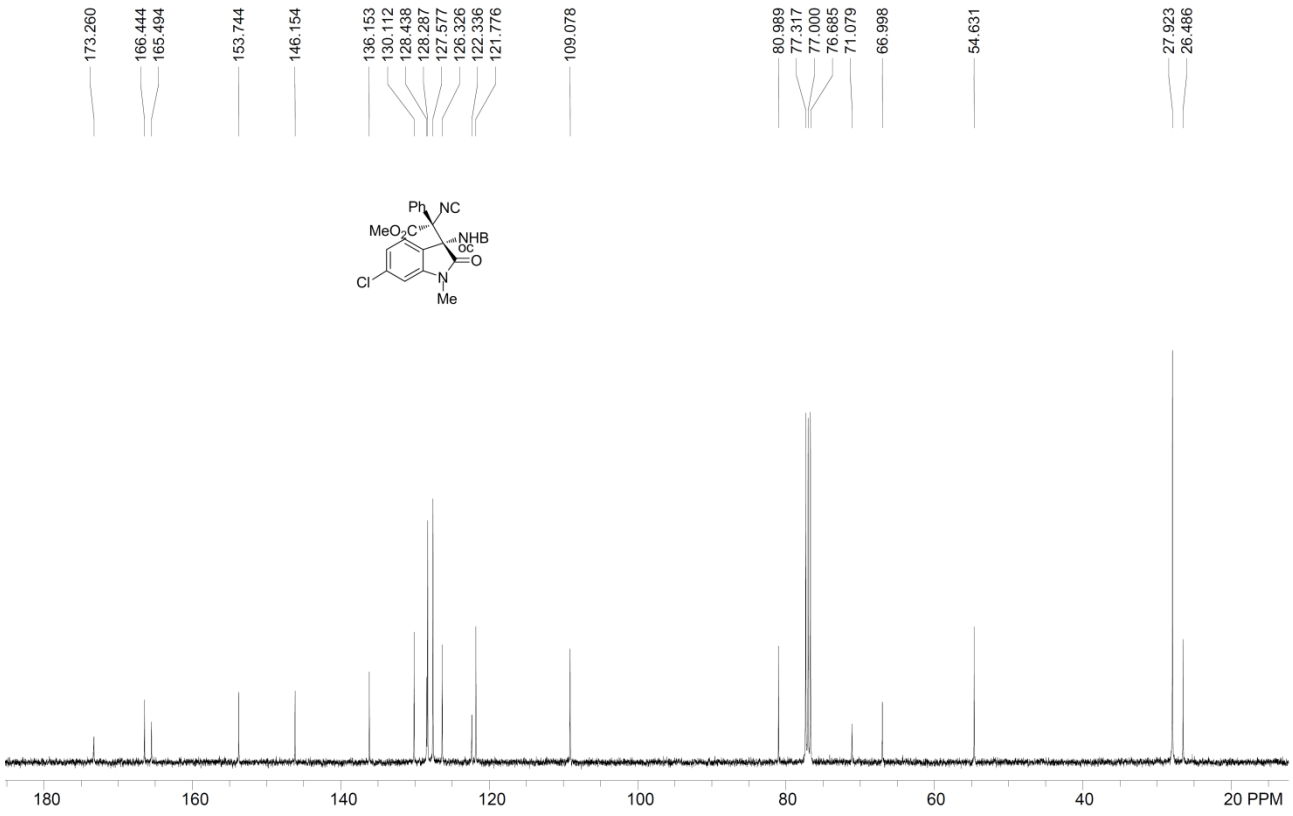
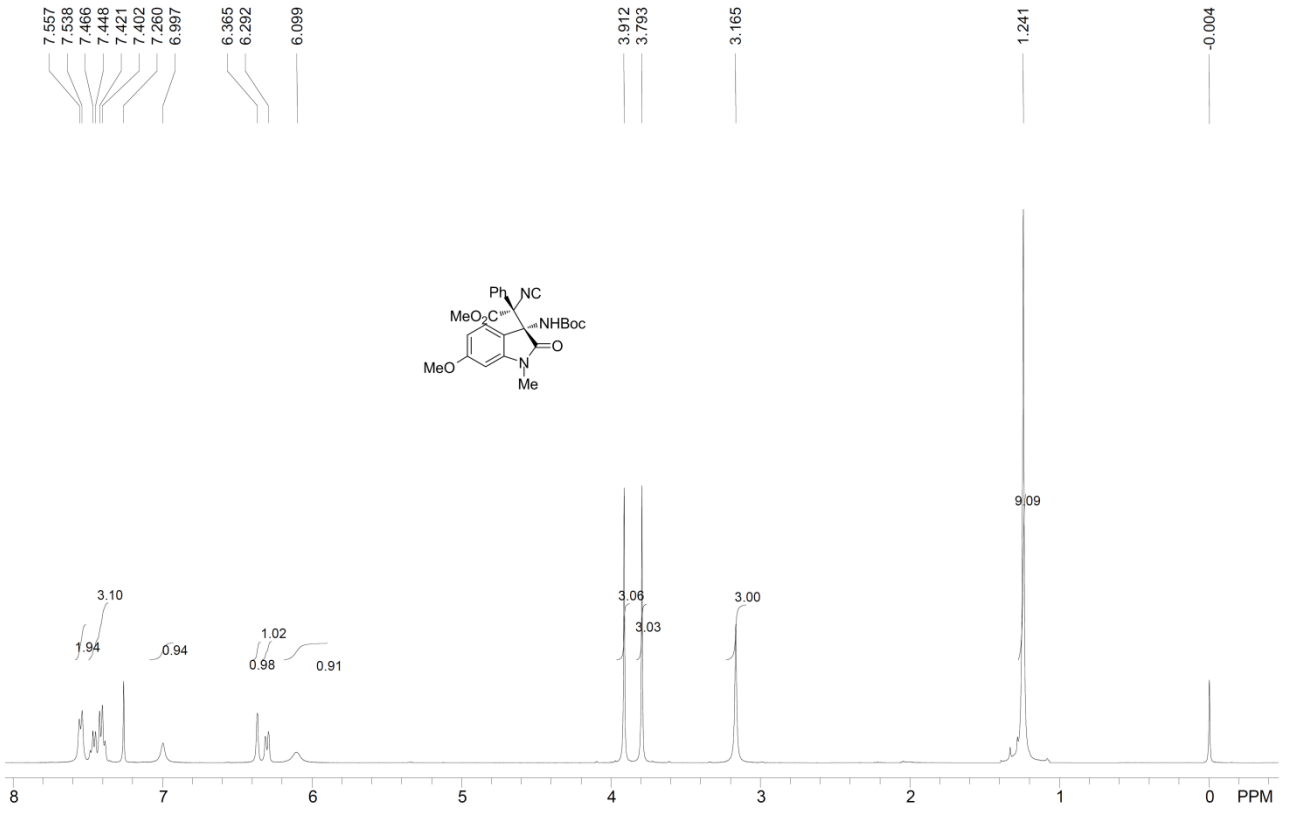


^{1}H NMR of **4t**



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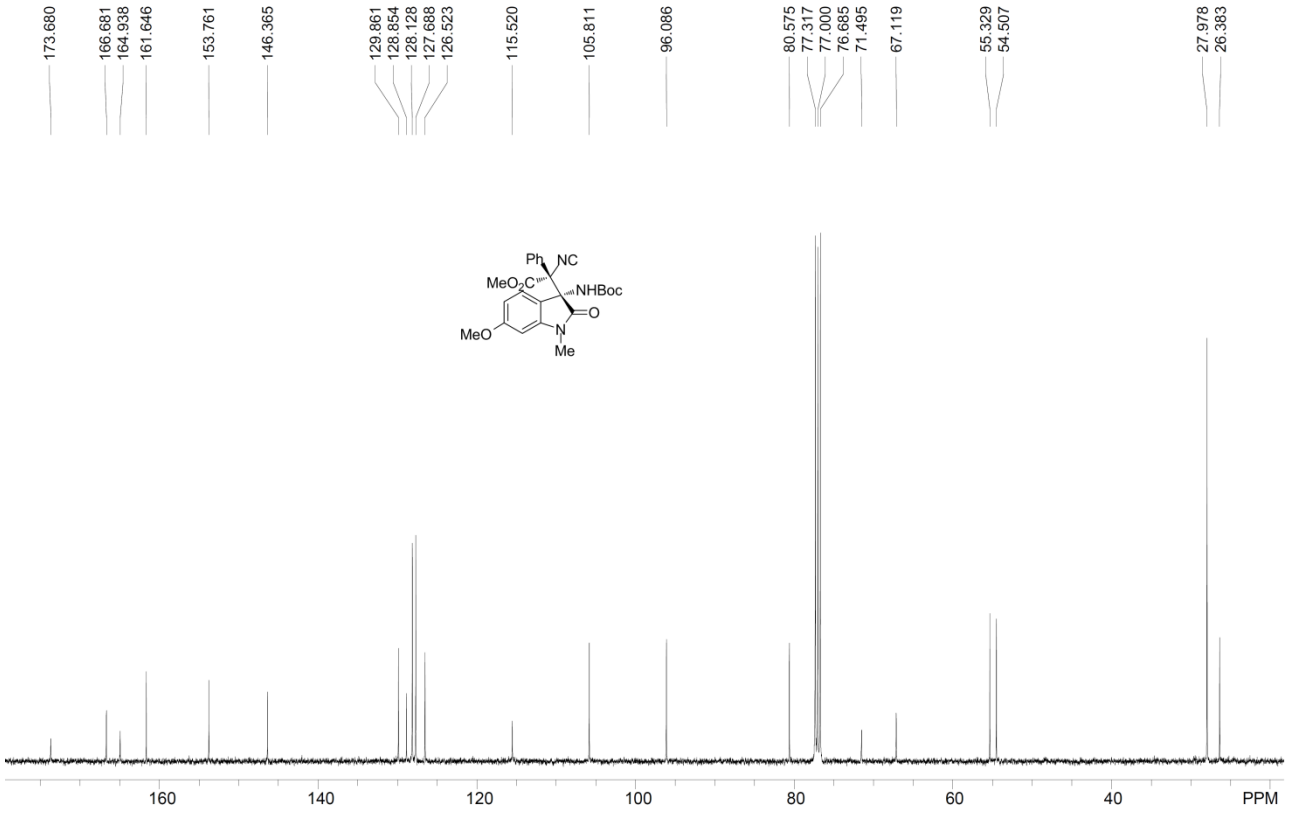
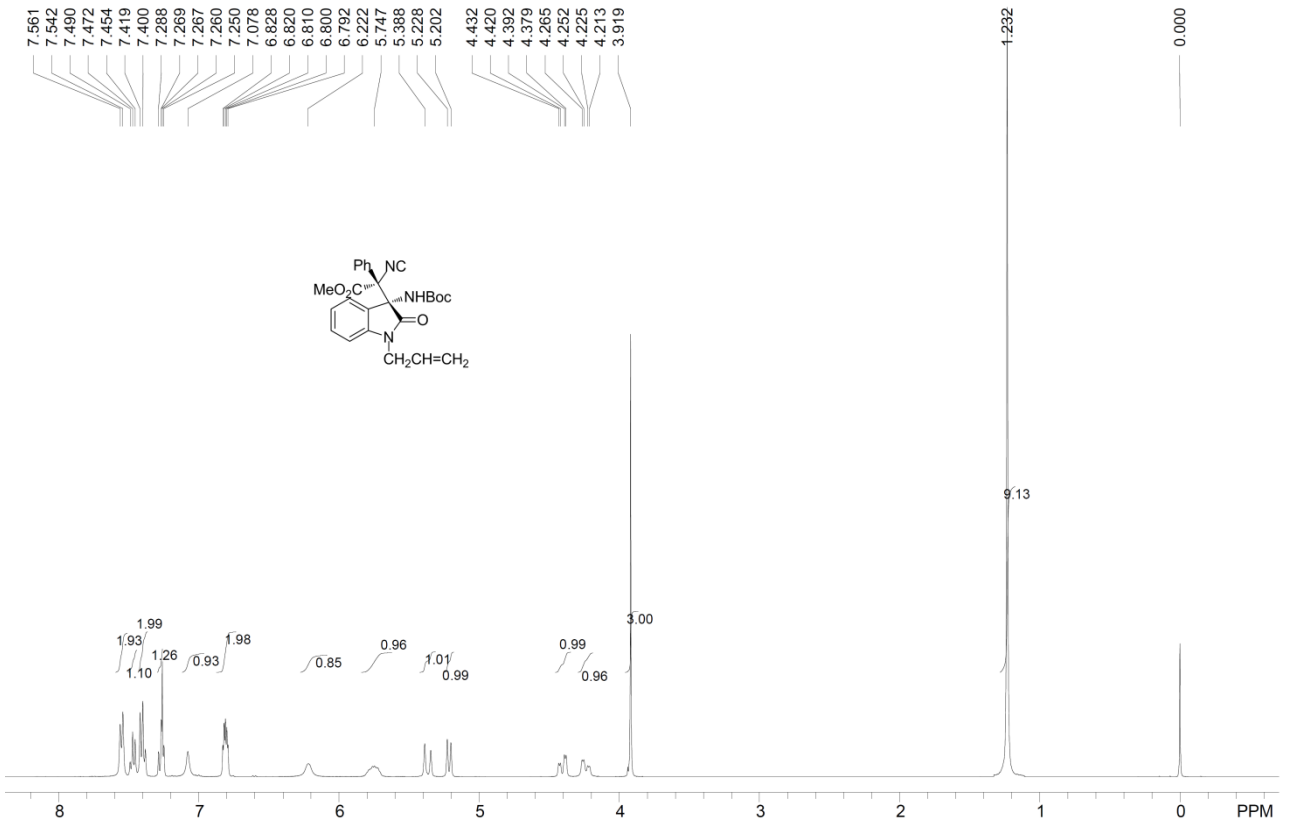
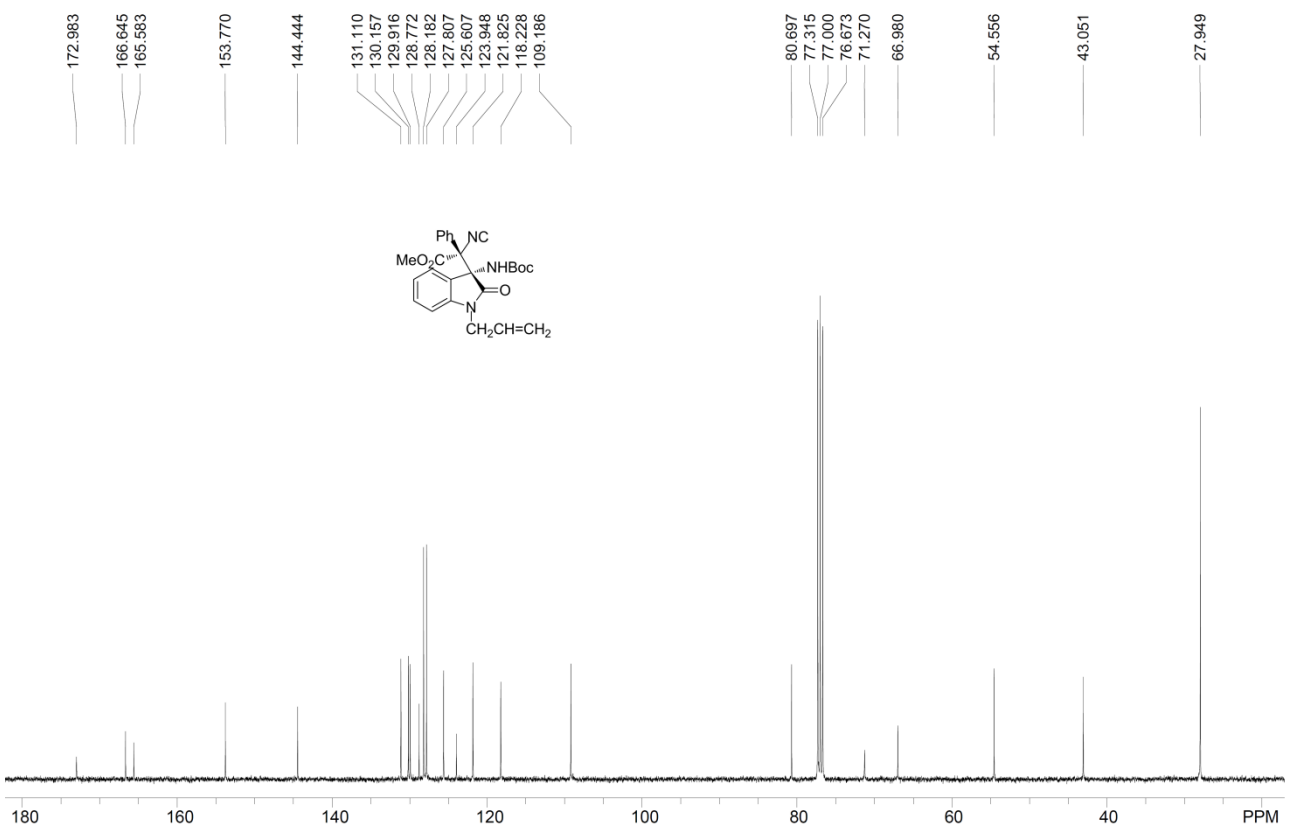


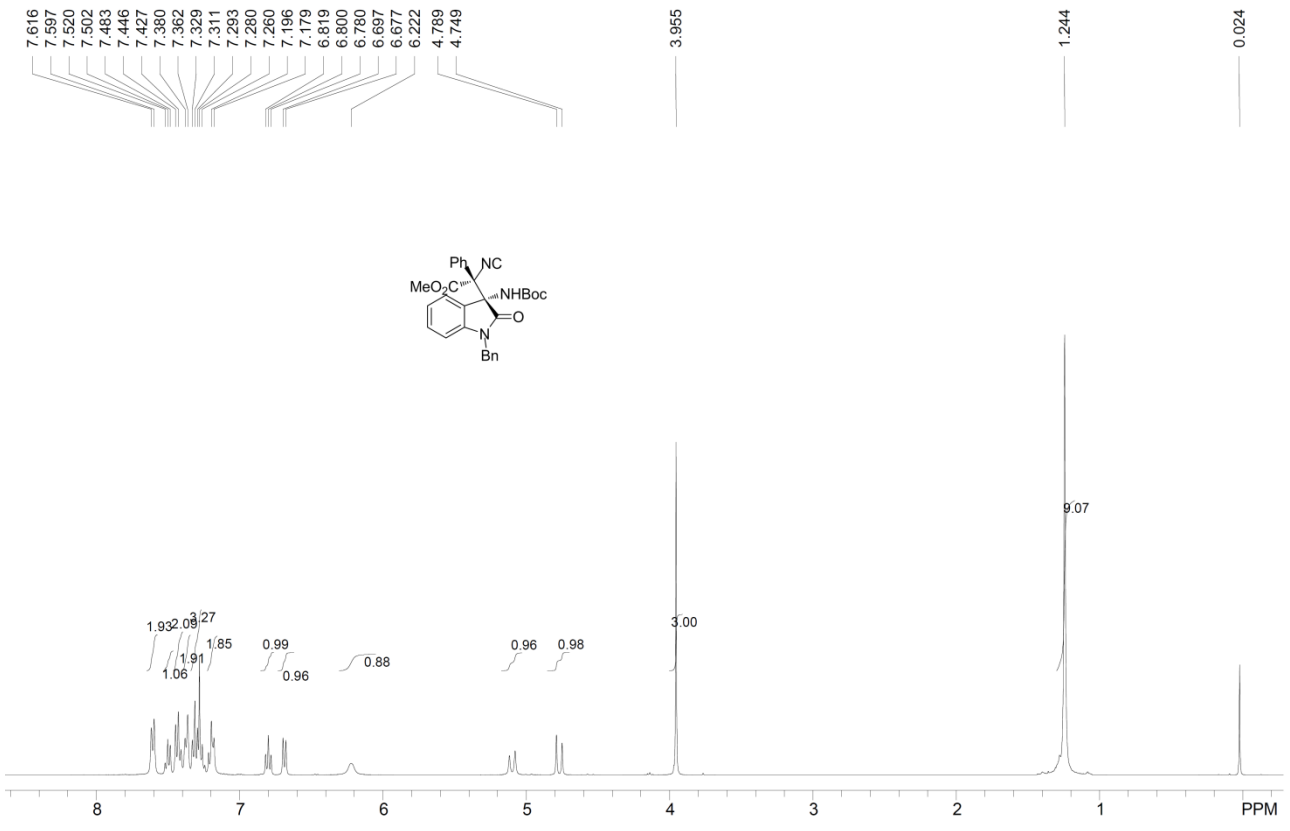
^{1}H NMR of **4u**



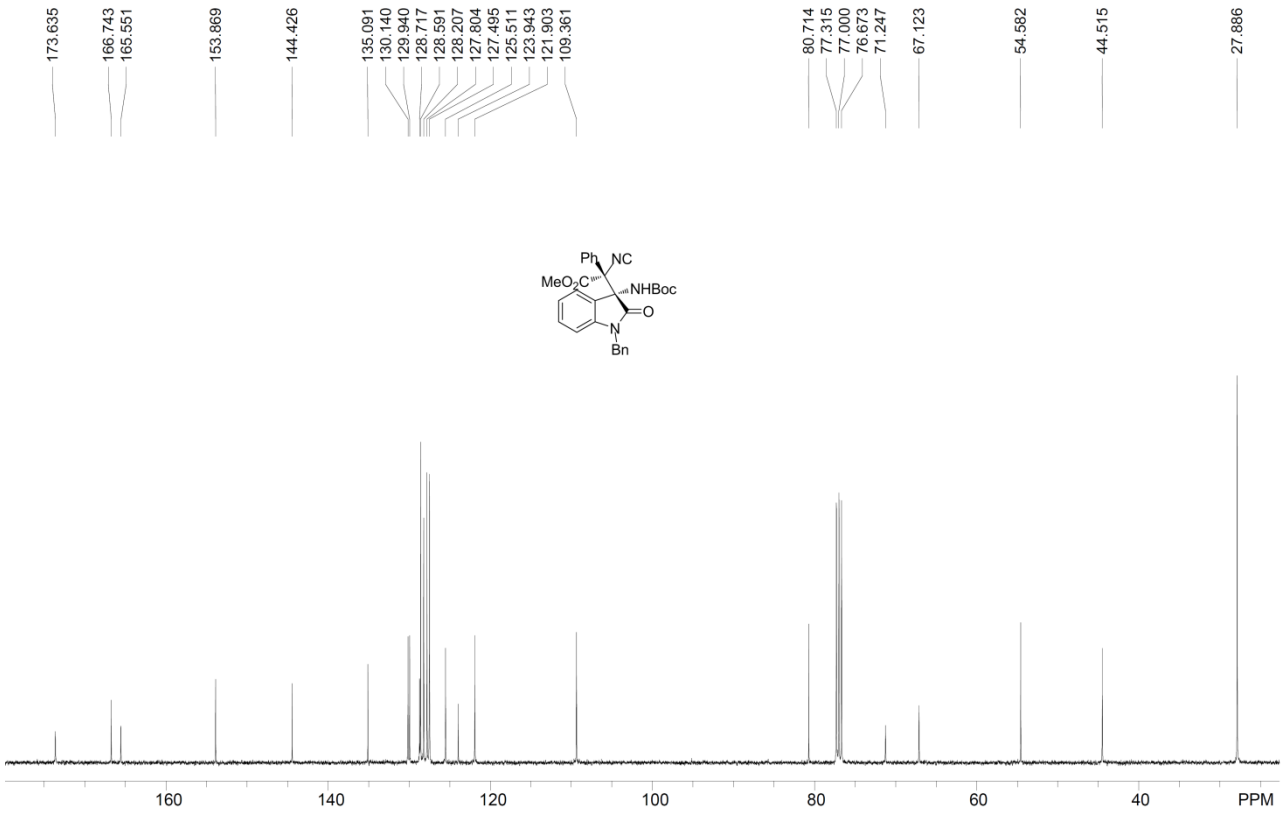
^{13}C NMR of **4u**



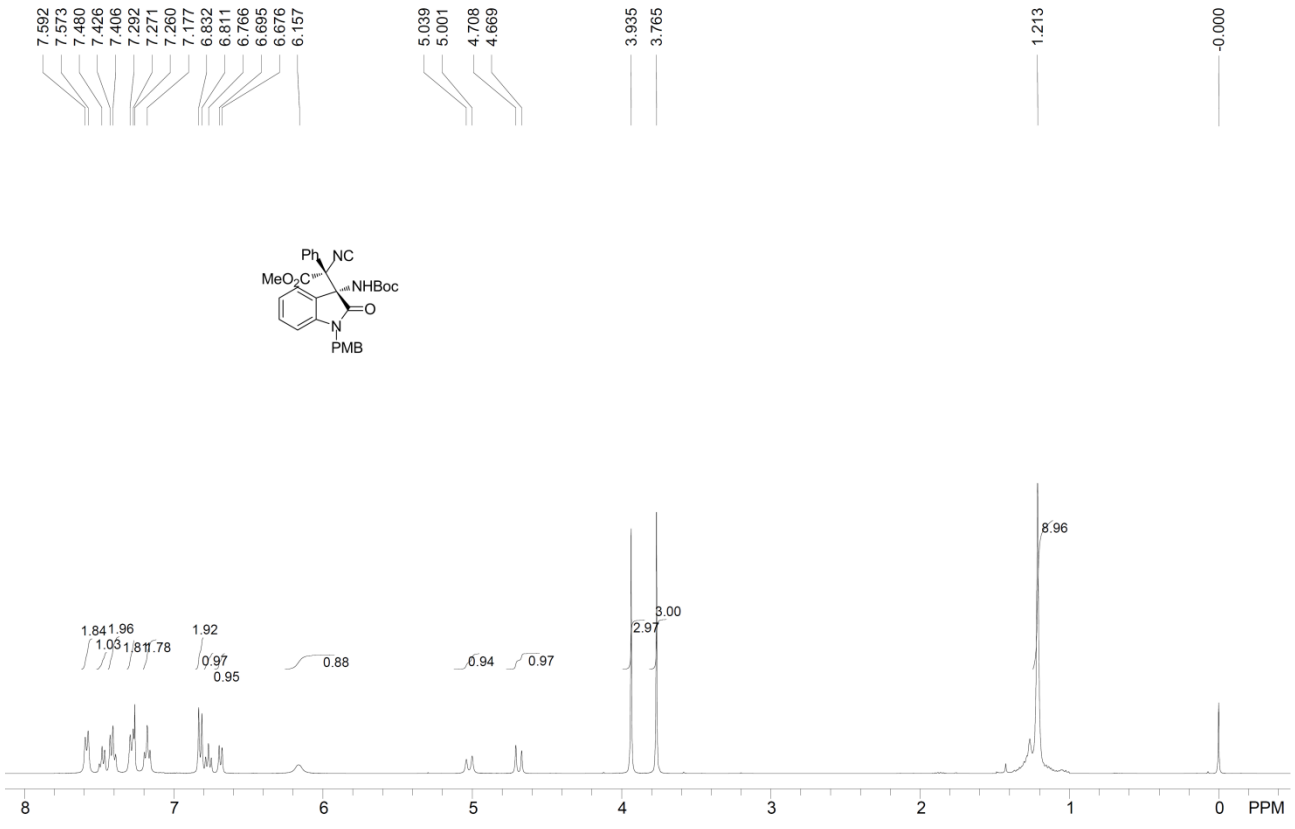
^{1}H NMR of **4v**



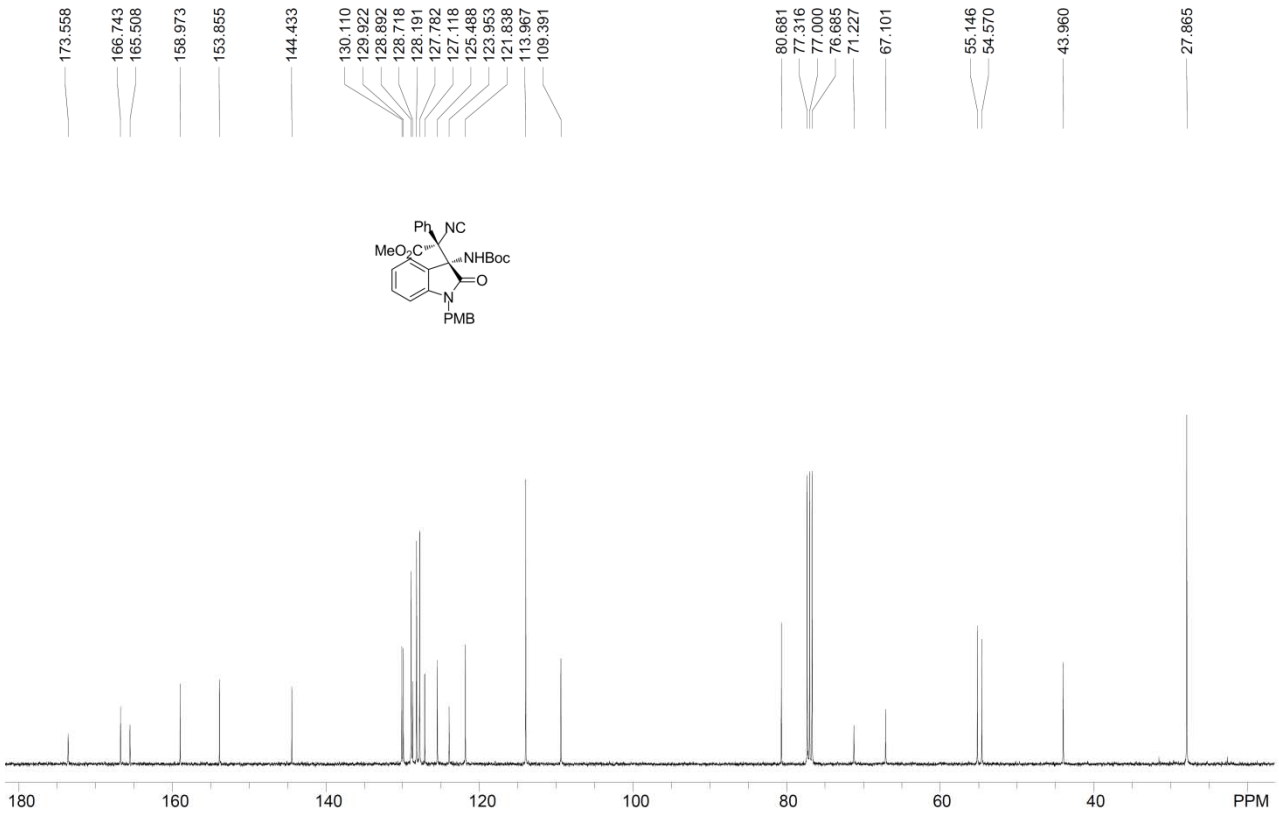
^{13}C NMR of **4v**



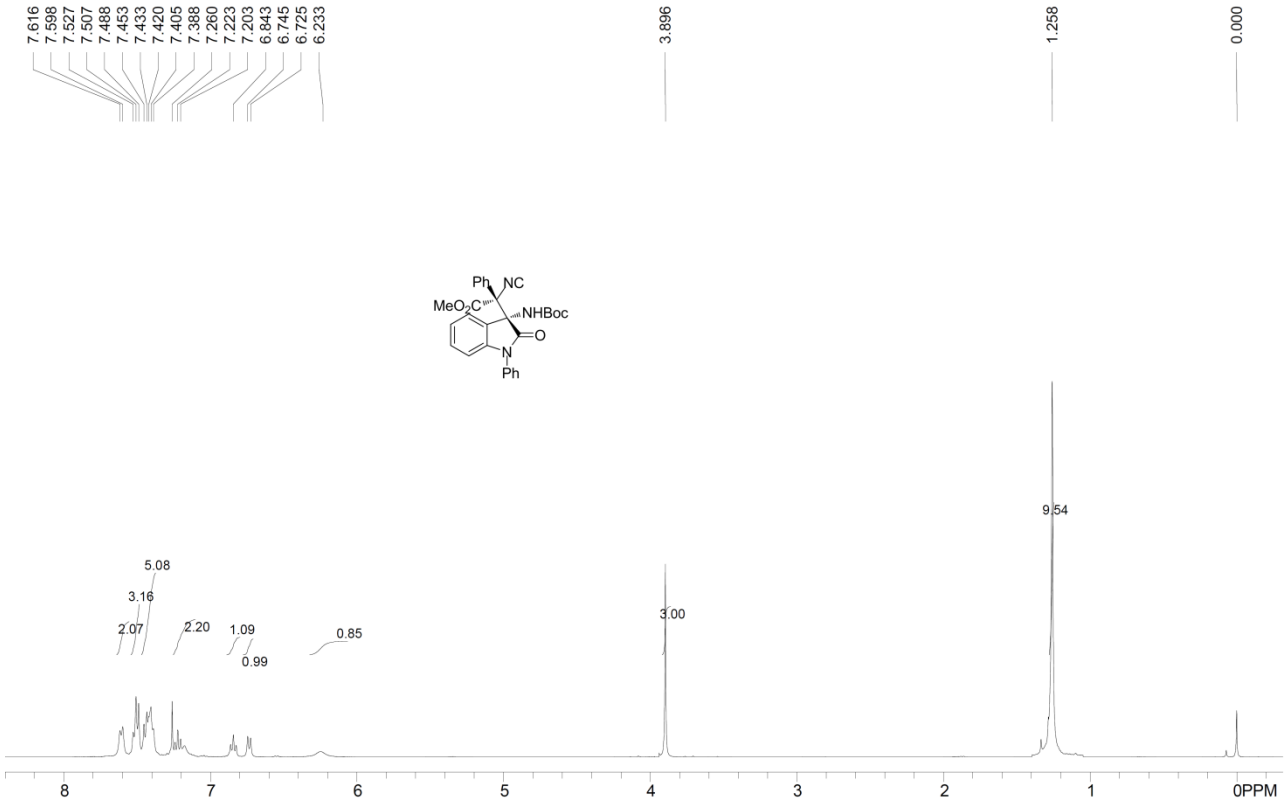
^{1}H NMR of **4w**



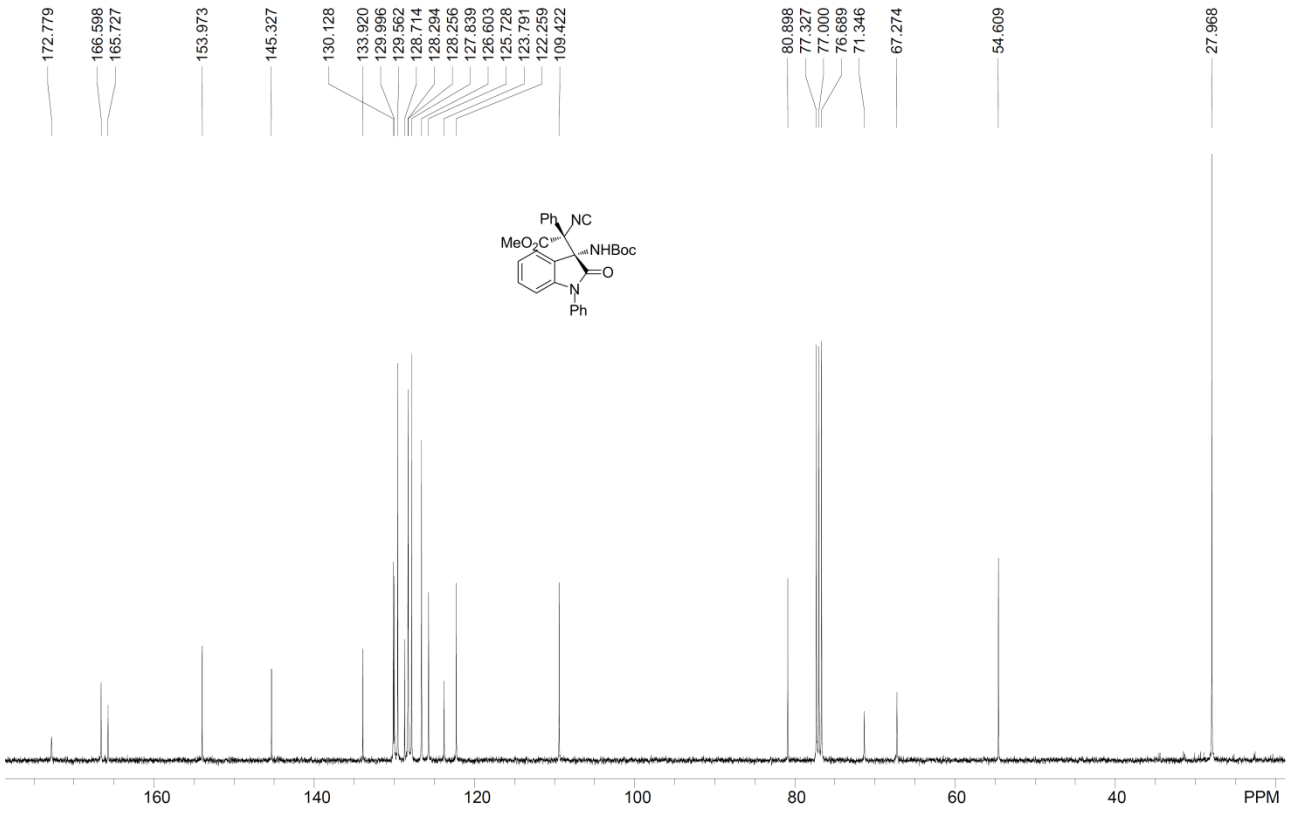
^{13}C NMR of **4w**



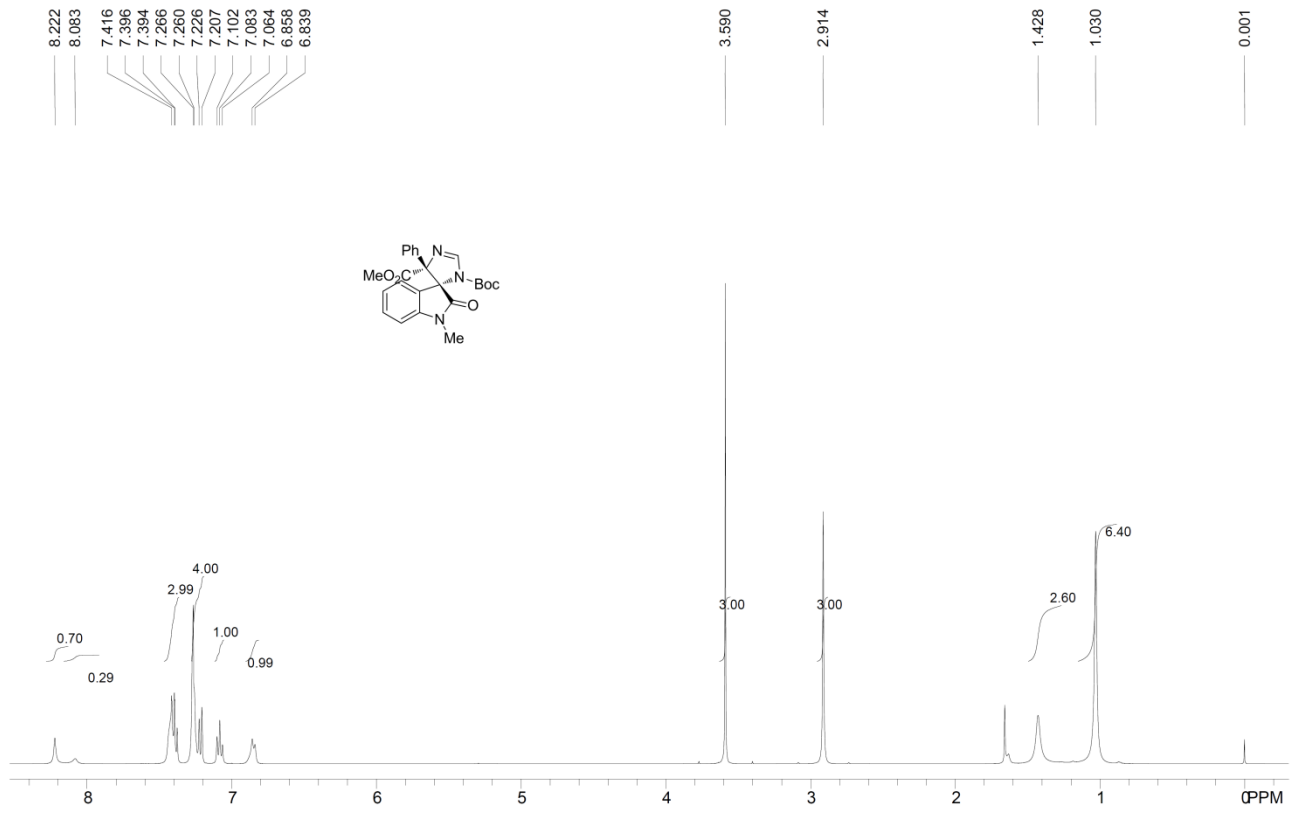
^{1}H NMR of **4x**



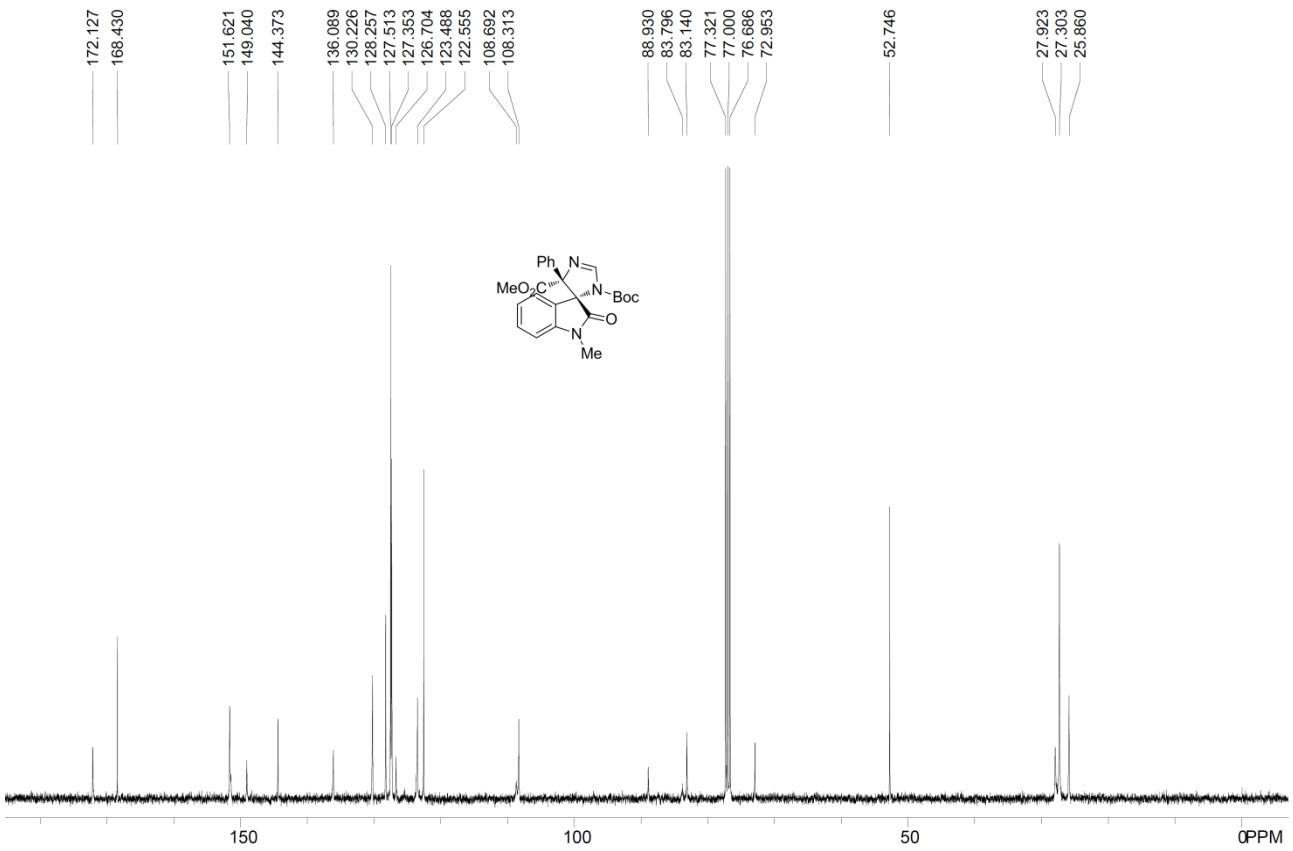
^{13}C NMR of **4x**



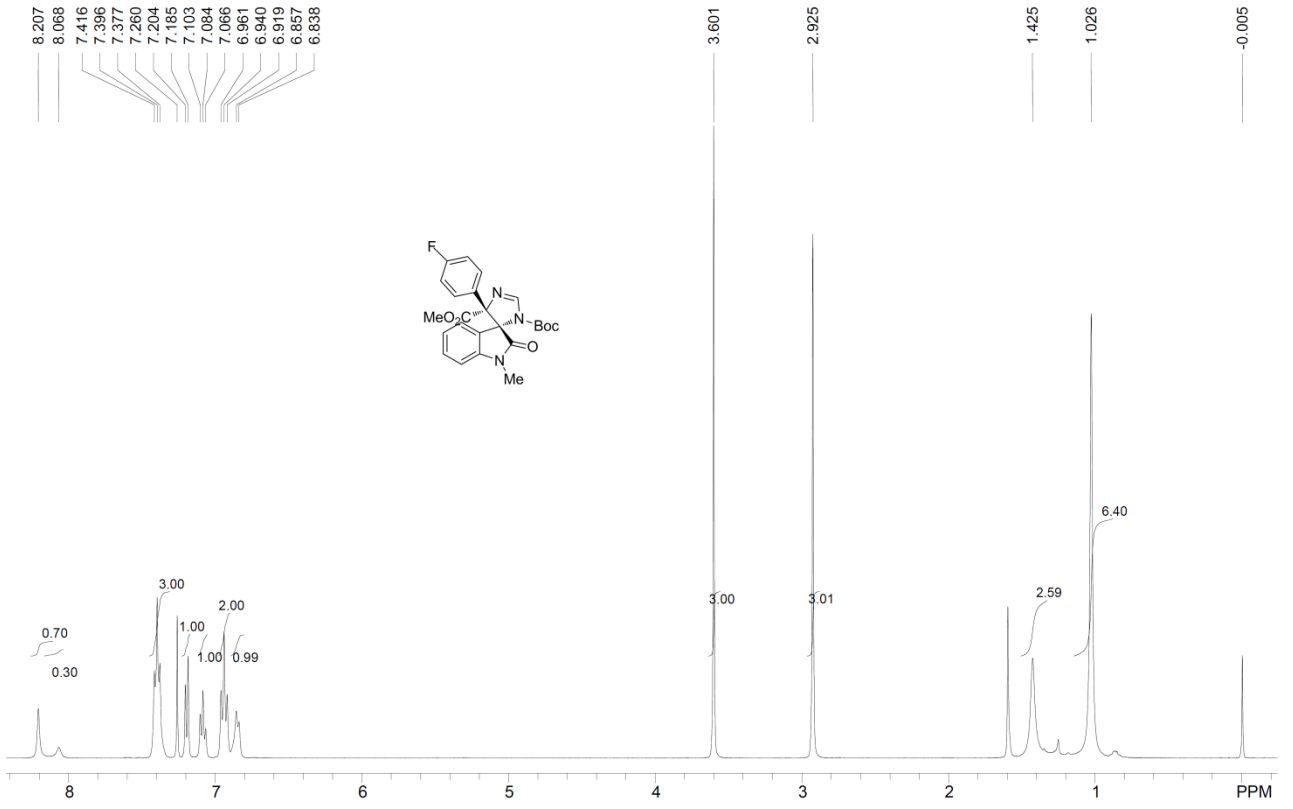
^{1}H NMR of **5a**



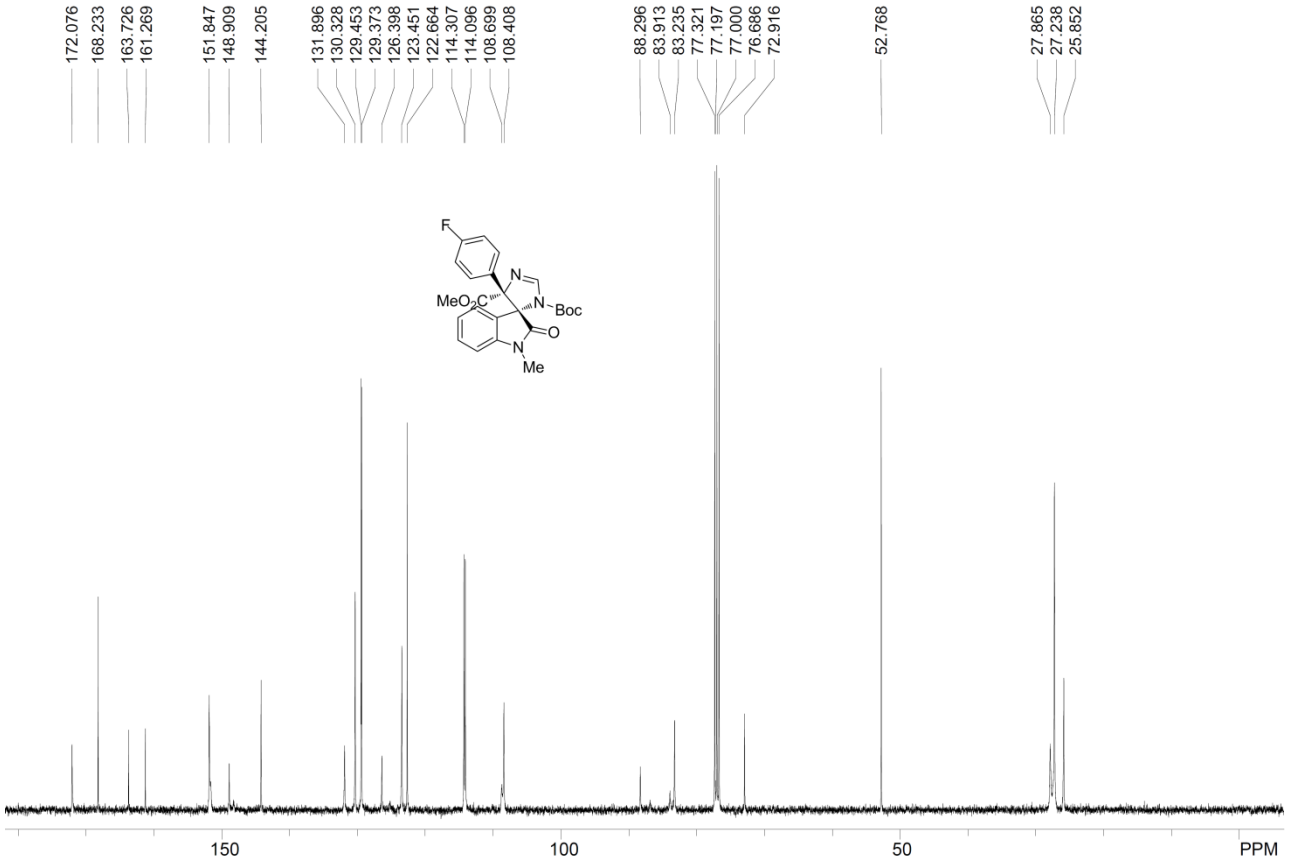
^{13}C NMR of **5a**



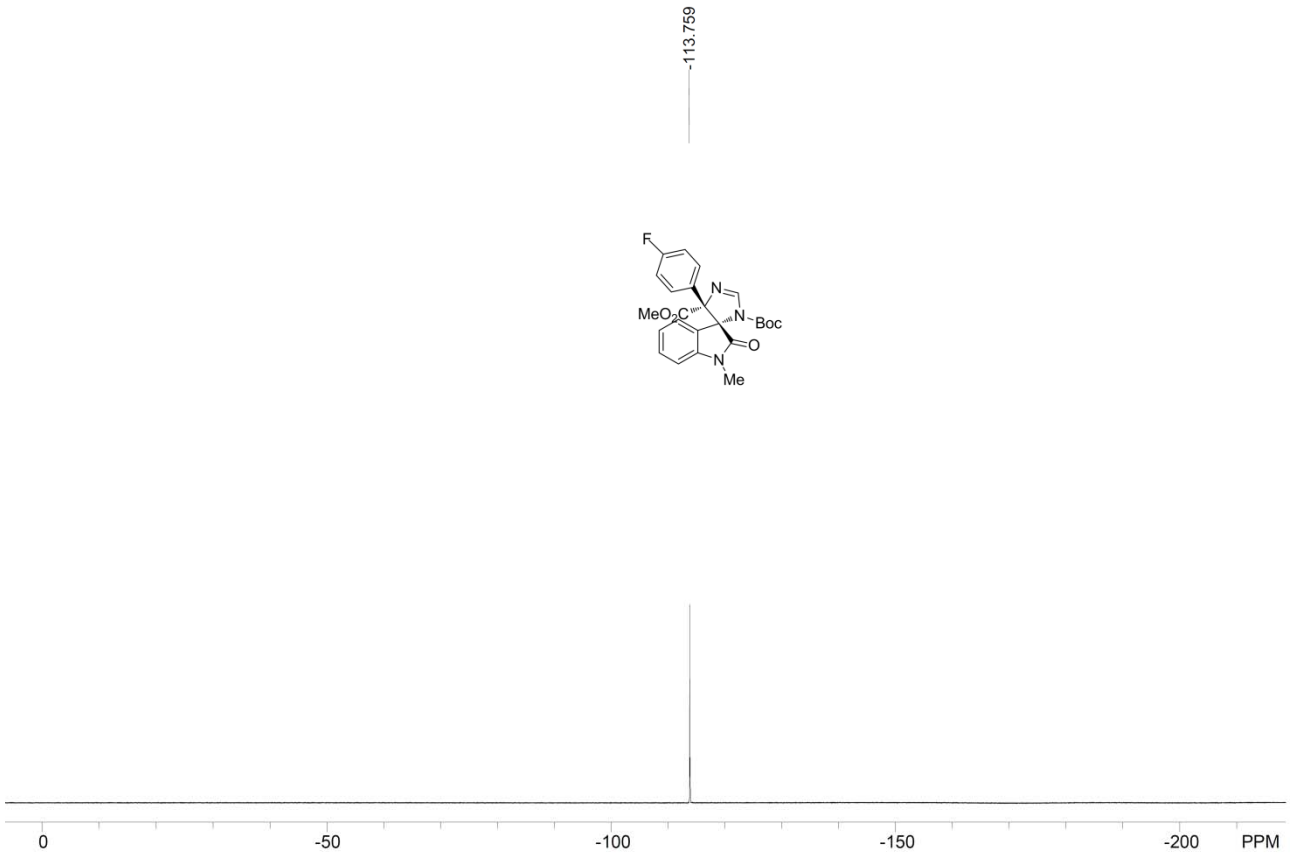
^{1}H NMR of **5b**



^{13}C NMR of **5b**



^{19}F NMR of **5b**



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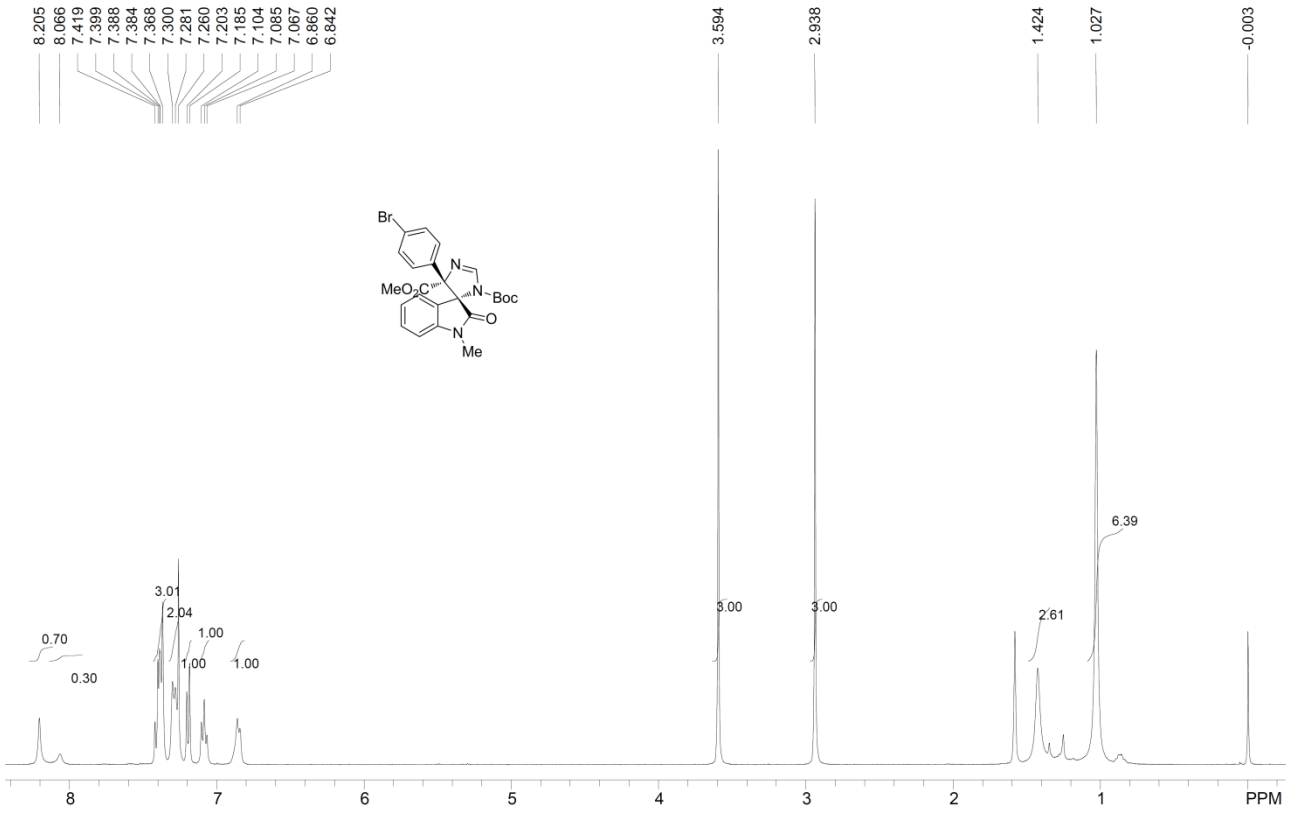

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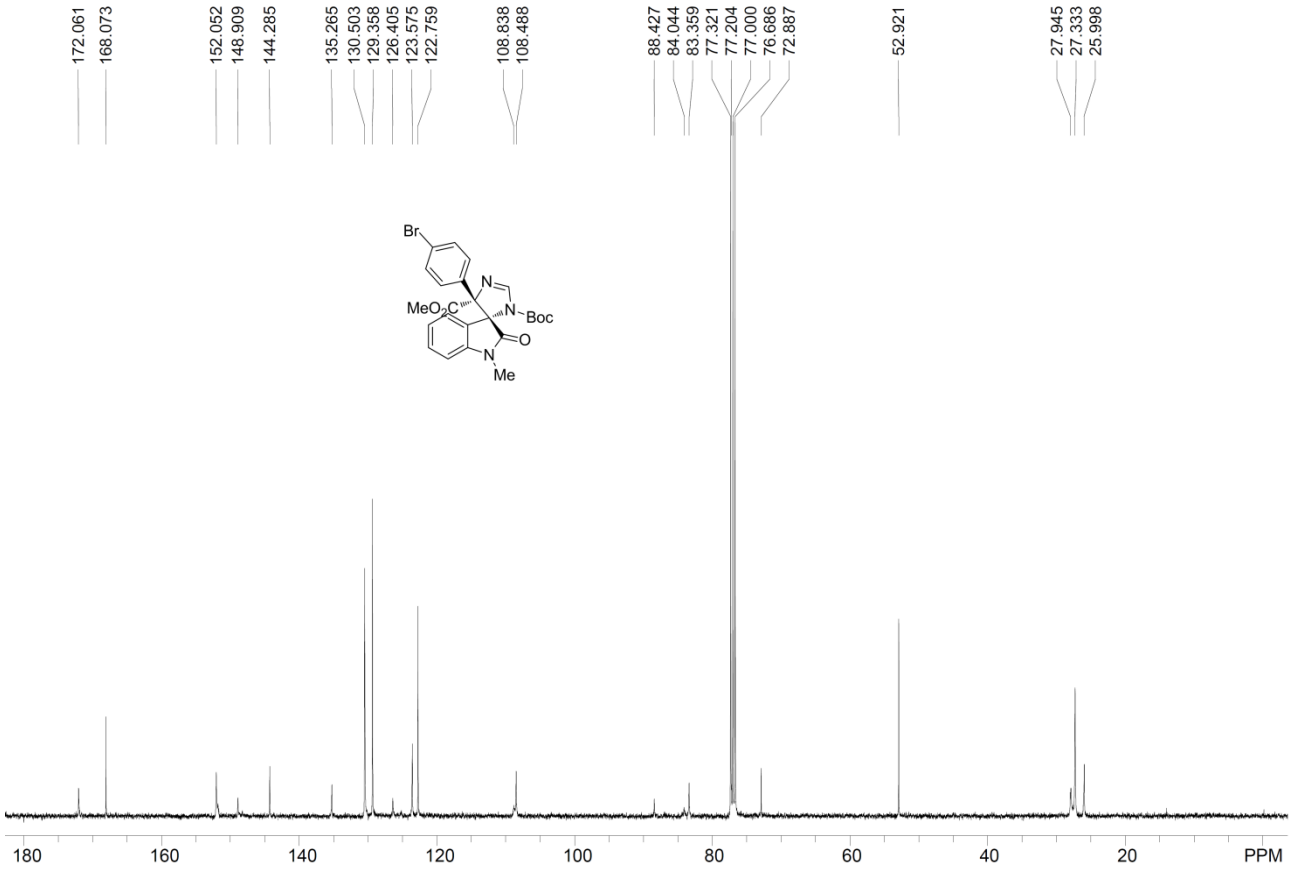

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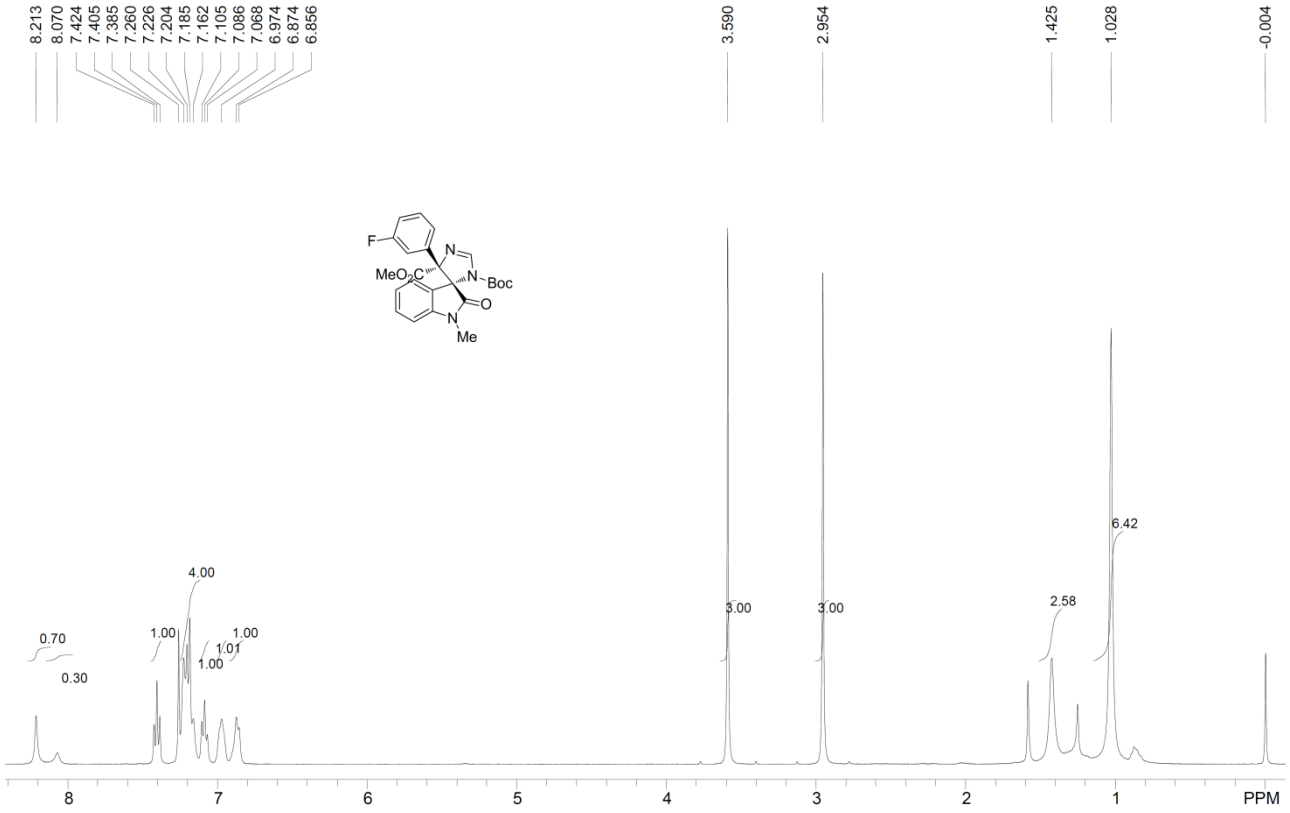

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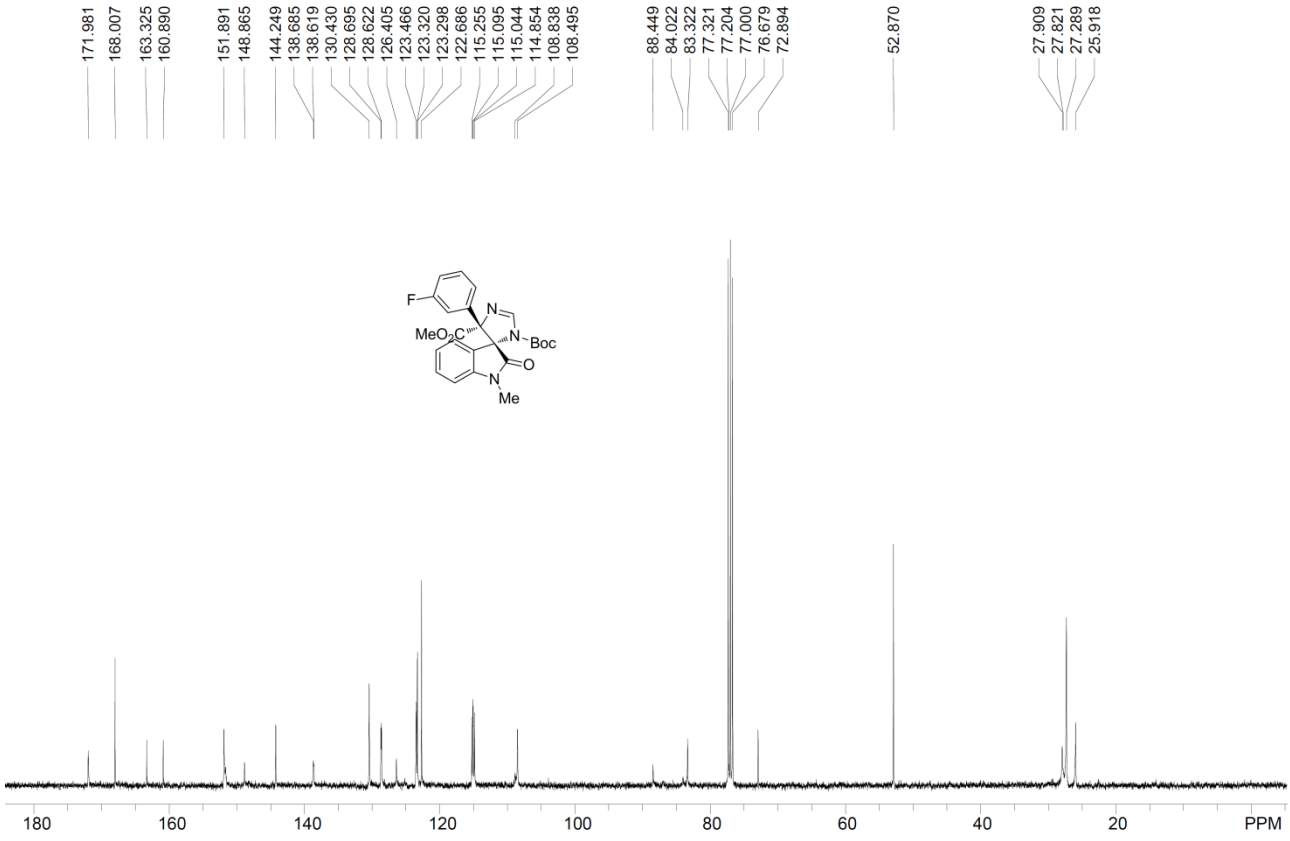

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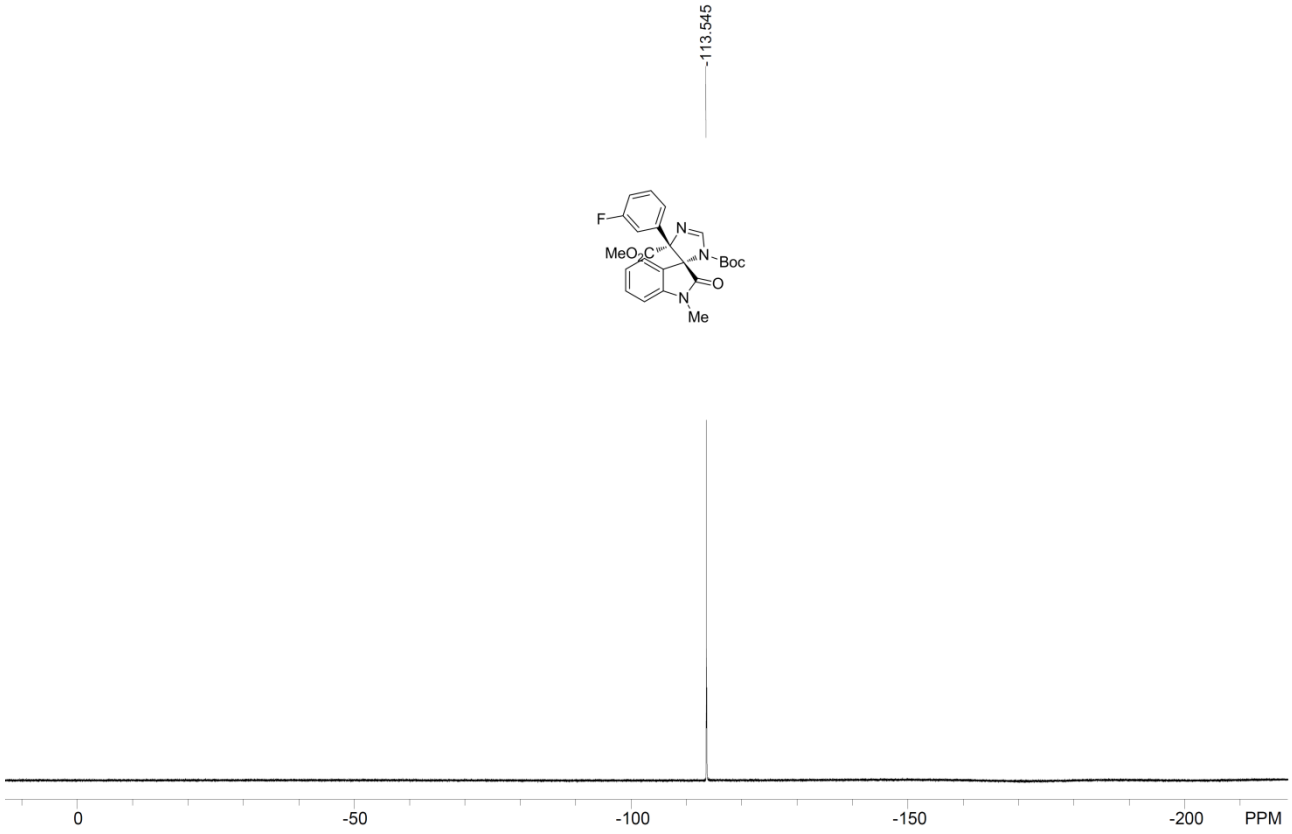
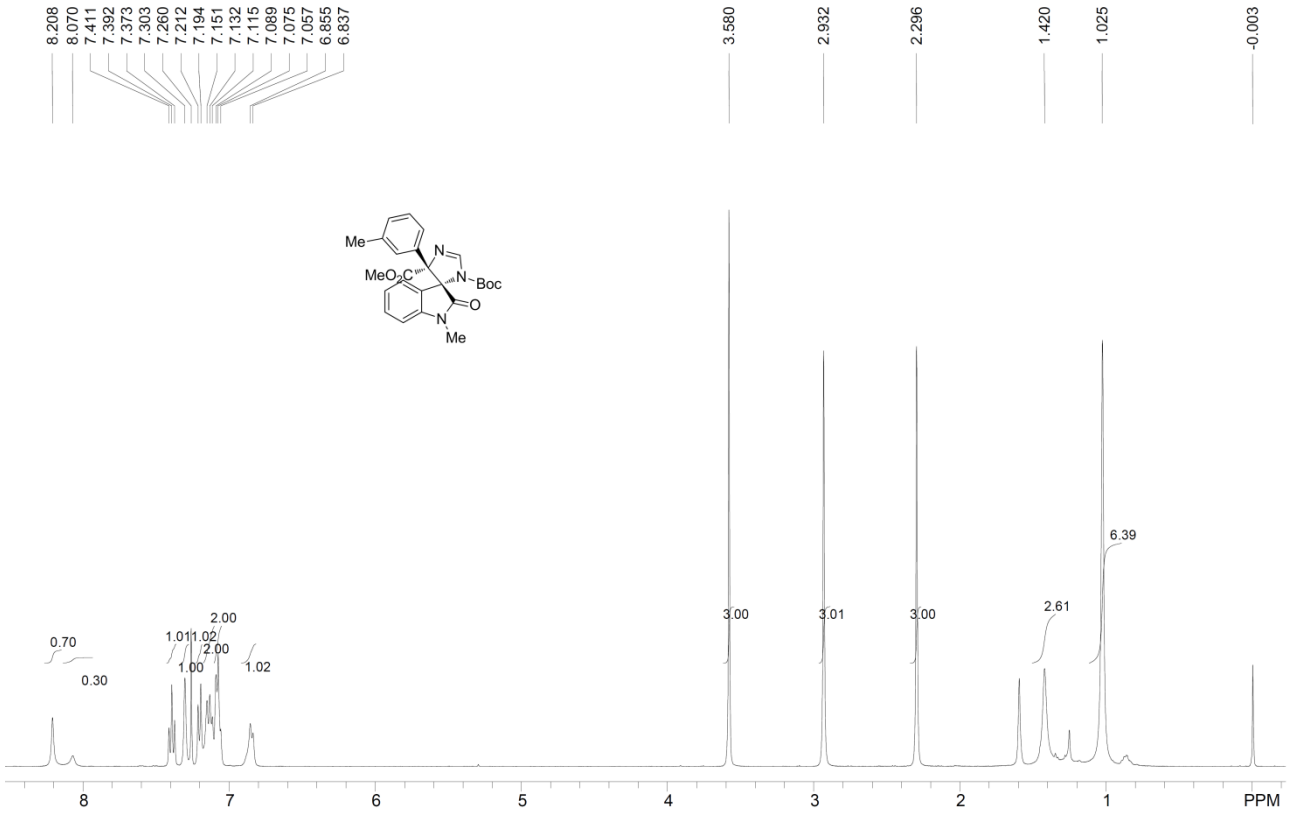
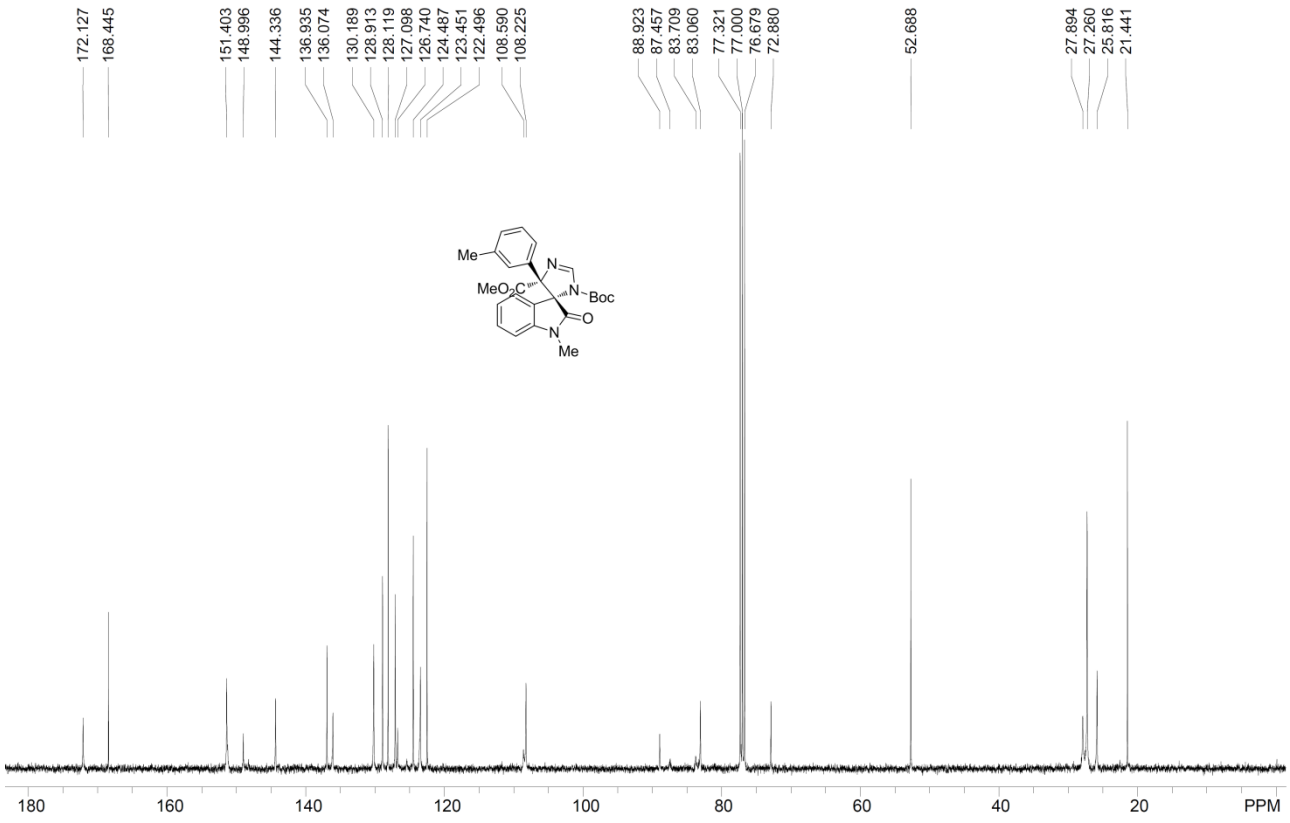


^{1}H NMR of **5e**



^{13}C NMR of **5e**



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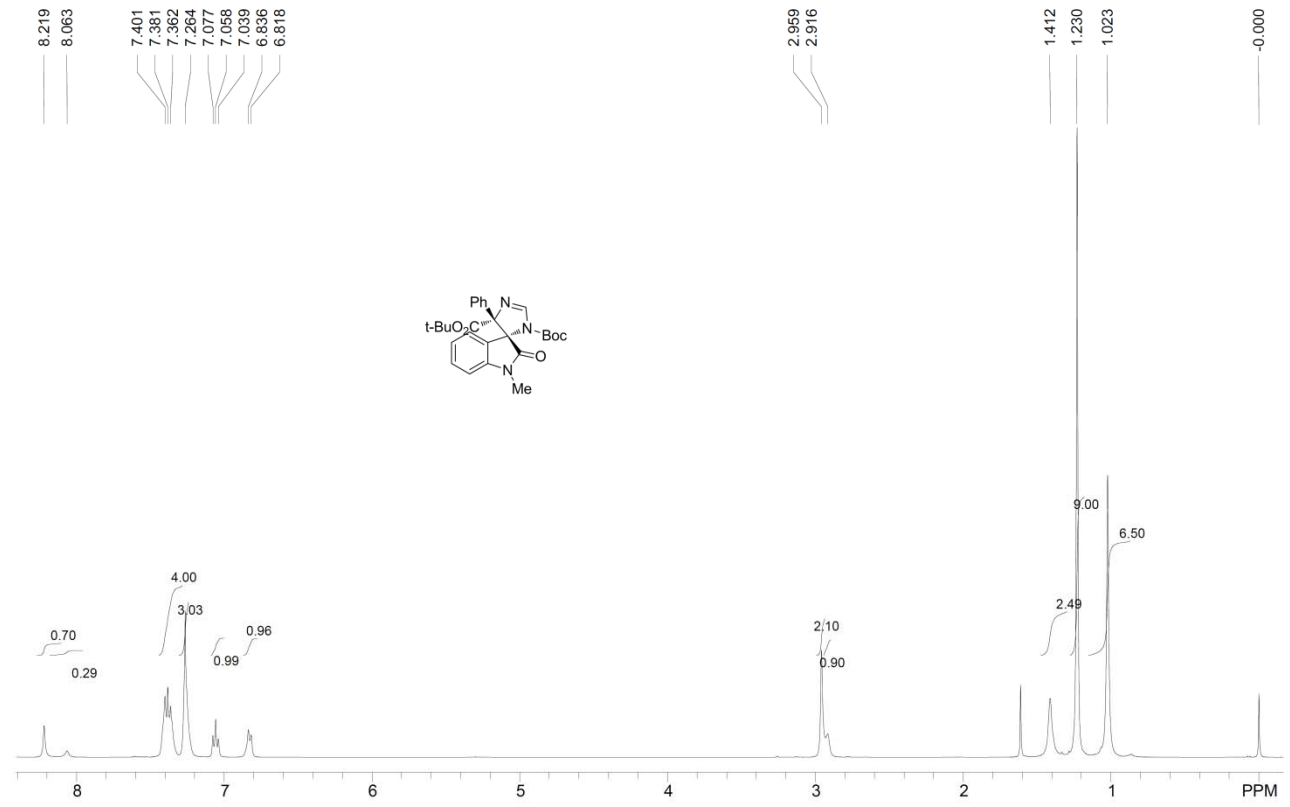

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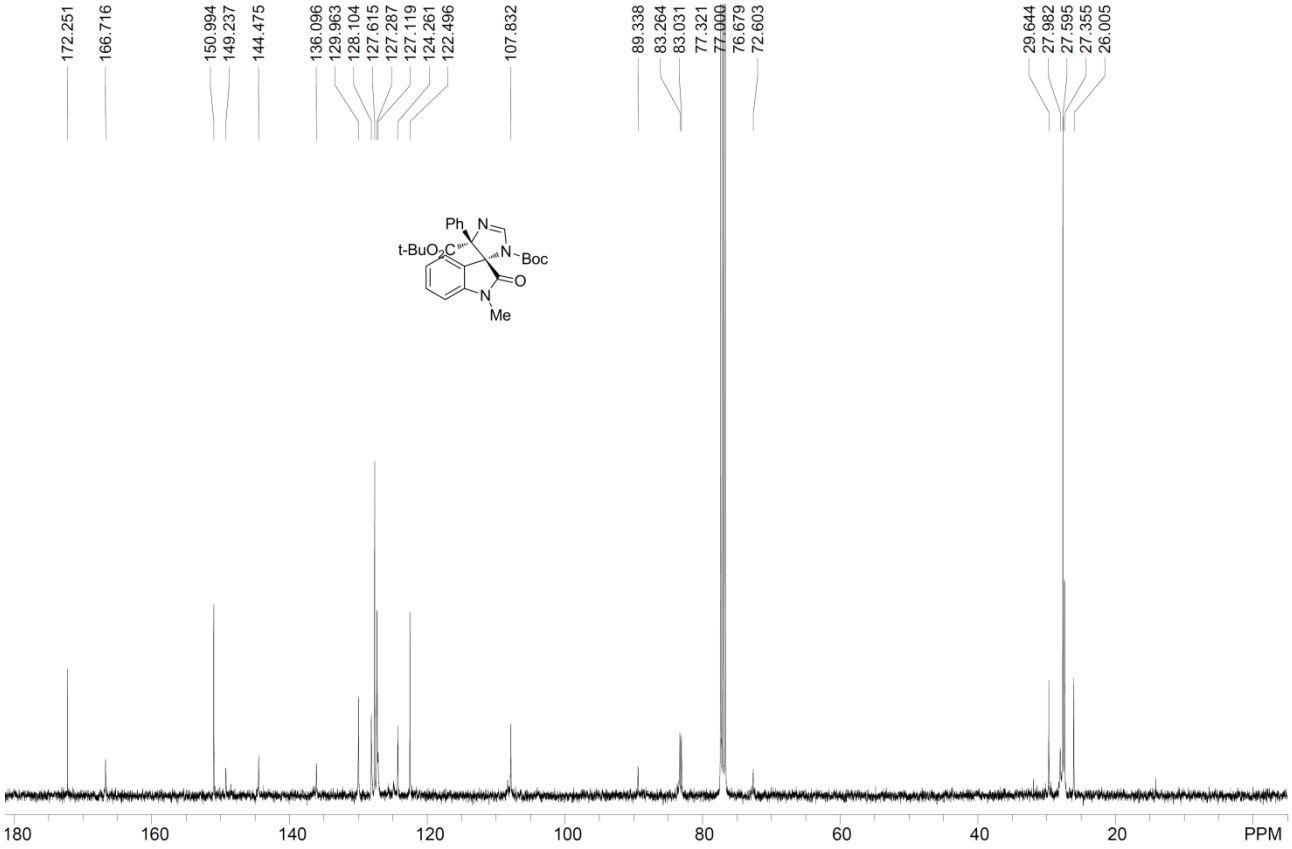
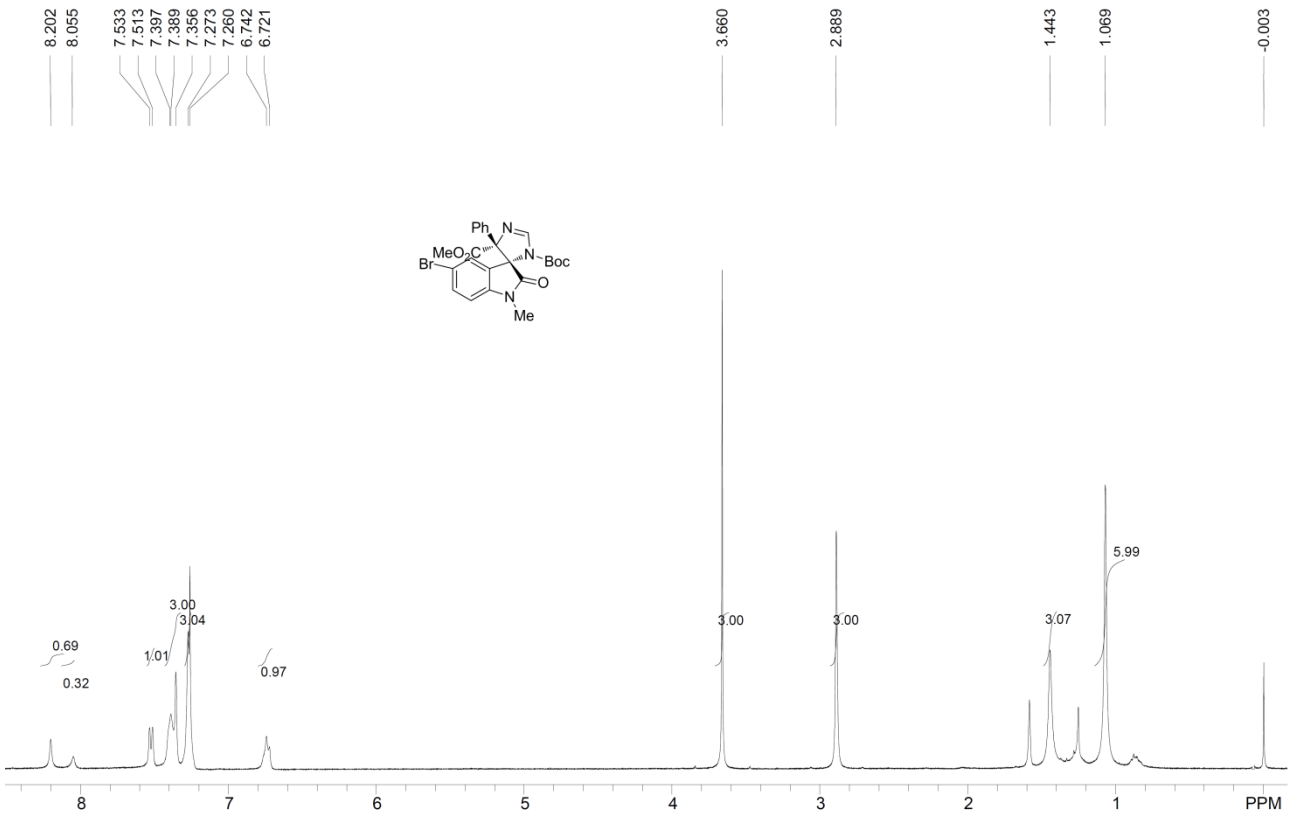


^{1}H NMR of **5g**



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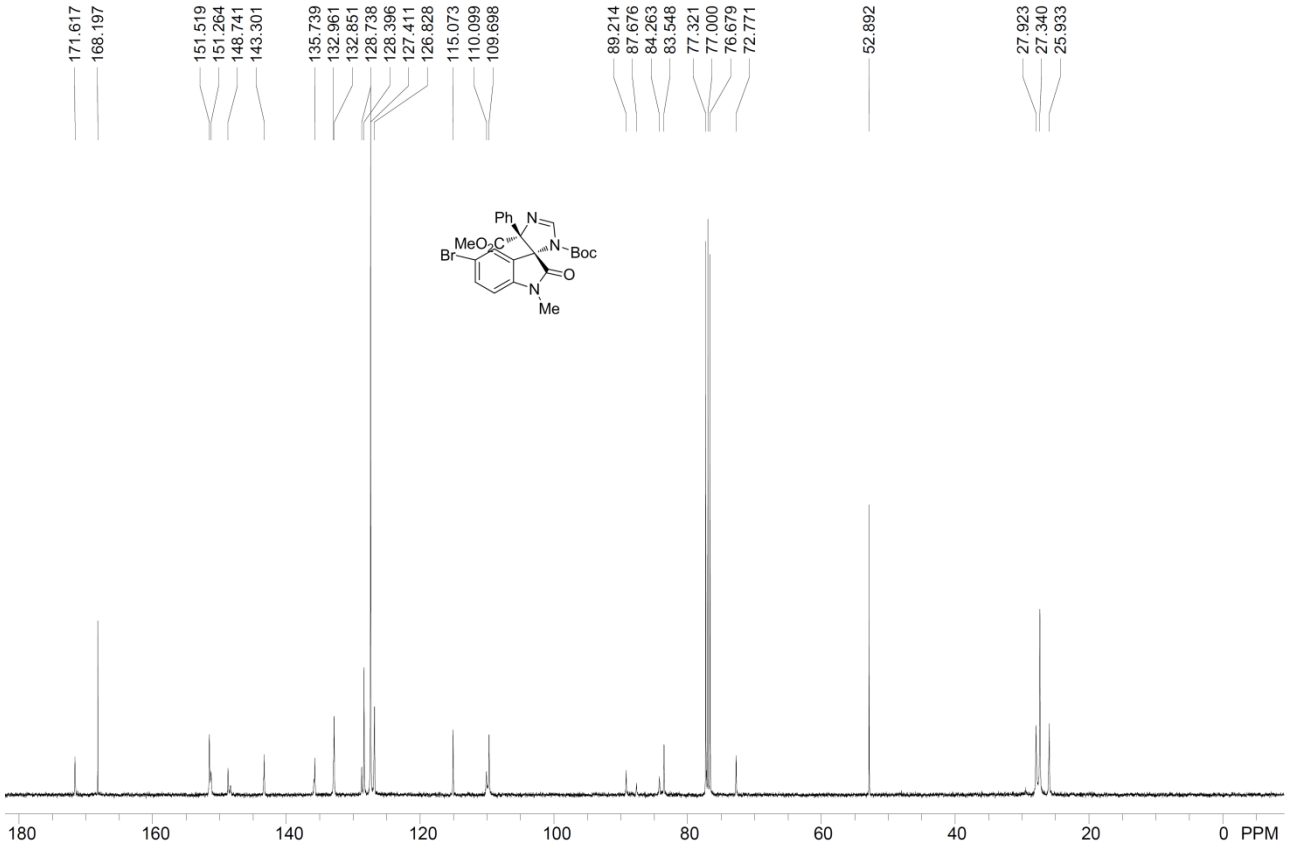
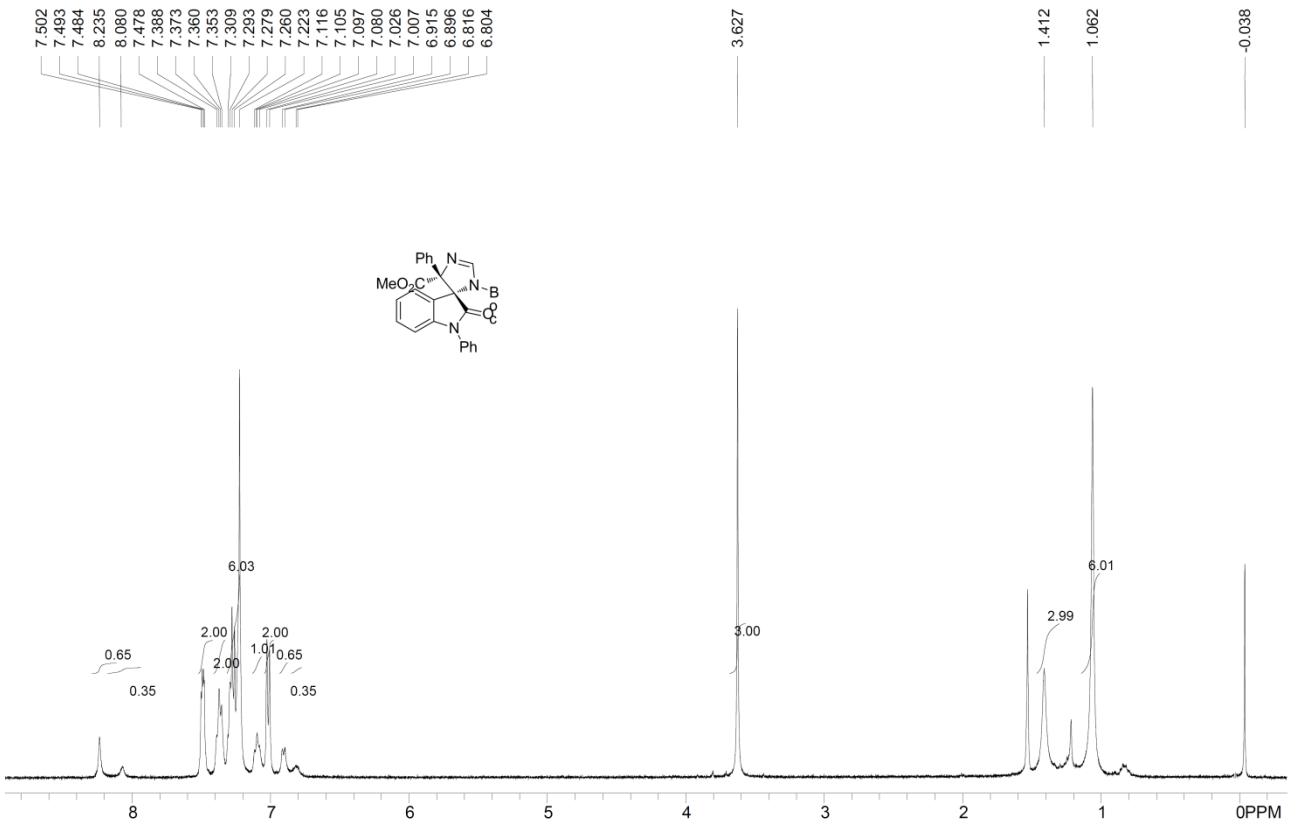
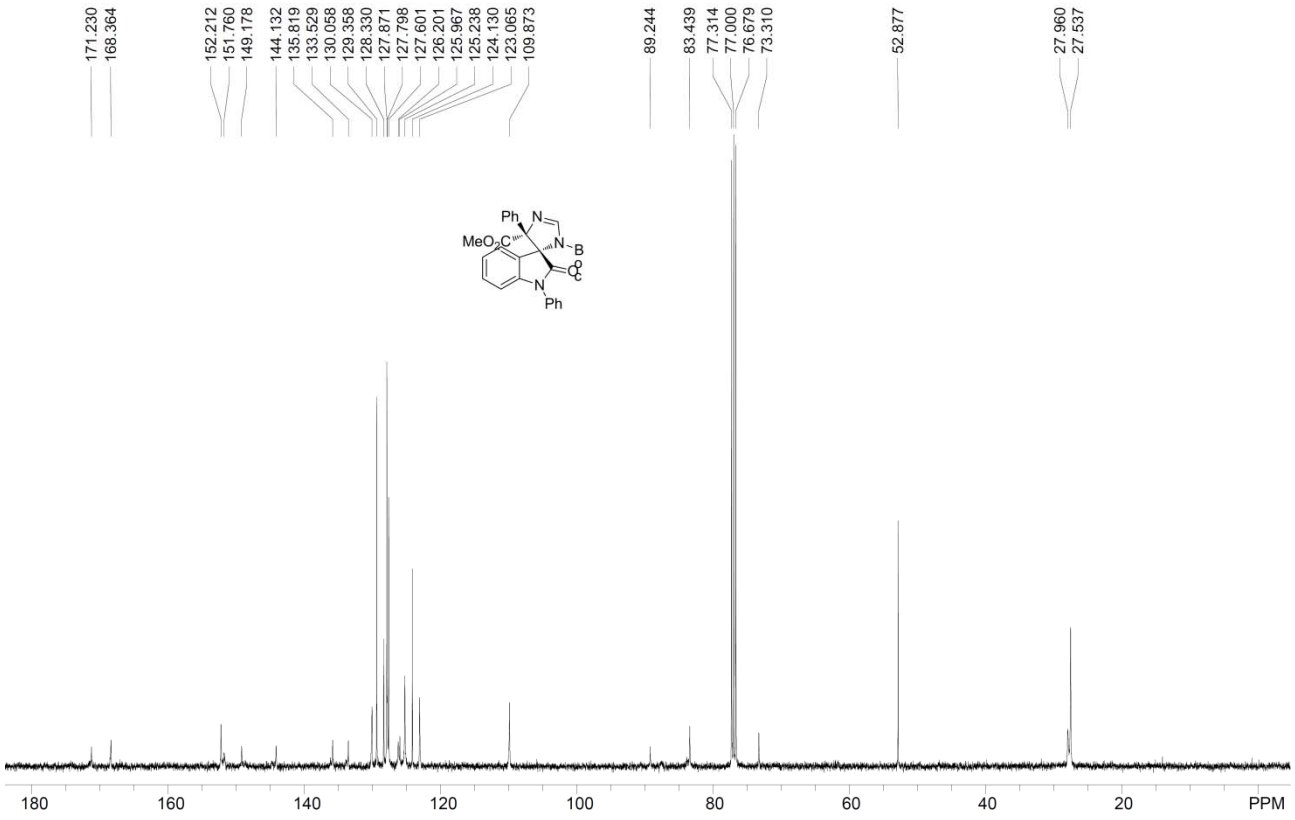


^{1}H NMR of **5h**



^{13}C NMR of **5h**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73.310
52.877
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27.537
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Ph
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PPM