CHEMBIOCHEM

Supporting Information

CHEMBIOCHEM

Supporting Information

for

Extremely Tight Binding of Ruthenium Complex to Glycogen Synthase Kinase 3

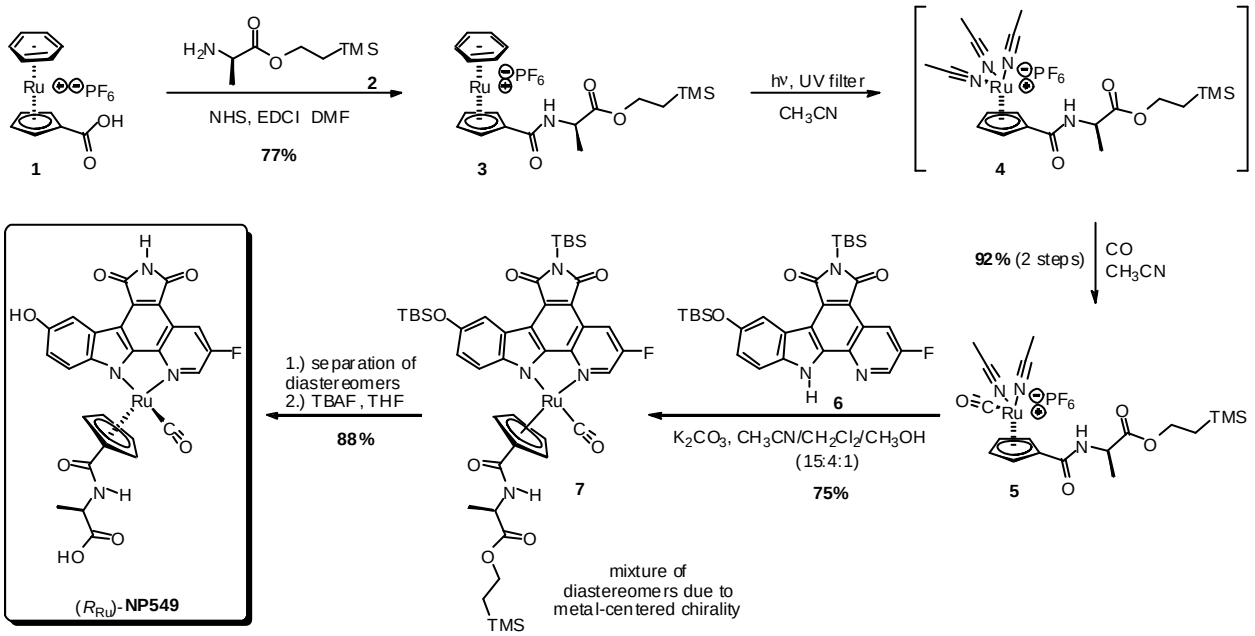
G. Ekin Atilla-Gokcumen, Nicholas Pagano, Craig Streu, Jasna Maksimoska, Panagis Filippakopoulos, Stefan Knapp, and Eric Meggers

Contents

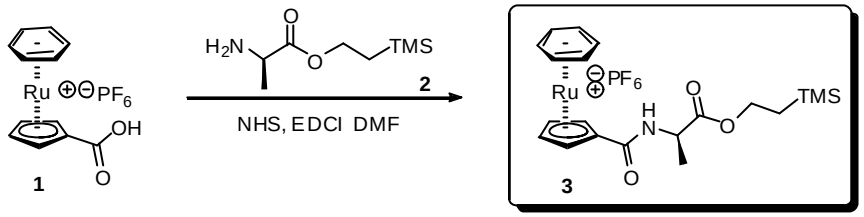
All reactions were carried out using oven-dried glassware and conducted under a positive pressure of argon or nitrogen unless otherwise specified. NMR spectra were recorded on a DMX-360 (360 MHz), DRX-500 (500 MHz) or Bruker AM-500 (500 MHz) spectrometer. Infrared spectra were recorded on a Perkin-Elmer 1600 series FTIR spectrometer or Nicolet 510 FTIR spectrometer. Low-resolution mass spectra were obtained on an LC platform from Micromass using ESI technique. ES-TOF spectra were measured by Waters Micromass MS Technologies. High-resolution mass spectra were obtained with a Micromass AutoSpec instrument or Thermo LTQ-FT instrument using either ES or CI ionization. CD spectra were recorded on a JASCO J-810 spectropolarimeter. Compounds **1**[1], **2**[2,3], **6**[4], **8**[5], **9**[6] and **10**[7] were prepared according to reported literature procedures. Reagents and solvents were used as received from standard suppliers.

A) Synthesis of Ruthenium GSK-3 Inhibitor (R_{Ru})-NP549

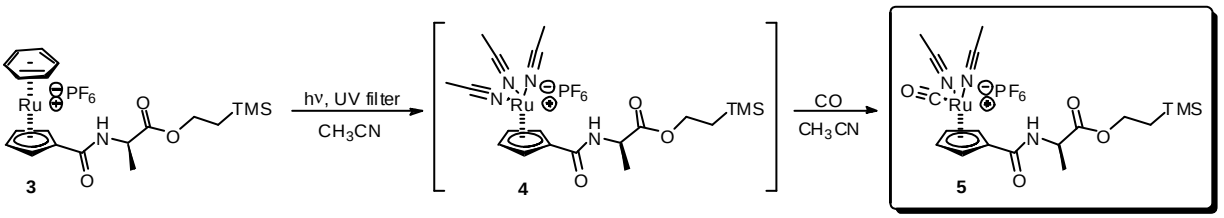
The synthesis of (R_{Ru})-**NP549** is summarized in Scheme S1. Starting from literature reported carboxylic acid **1**, EDCI-coupling using *D*-alanine TMS-ethylester **2** proceeded smoothly (77%) to yield sandwich complex **3**. This was followed by the photochemical replacement of benzene by three acetonitrile ligands (**4**) and a subsequent substitution of one acetonitrile ligand by carbon monoxide to provide precursor complex **5** in excellent yield (92% over two steps). Reaction with ligand **6** in the presence of a weak base furnished half-sandwich complex **7** (75%) as a 1:1 mixture of diastereomers separable by HPLC. Removal of all three silyl protection groups was achieved in high yield (88%) with warm fluoride treatment to provide final GSK-3 inhibitor (R_{Ru})-**NP549**.



Scheme S1. Synthetic Overview of (R_{Ru})-**NP549**.

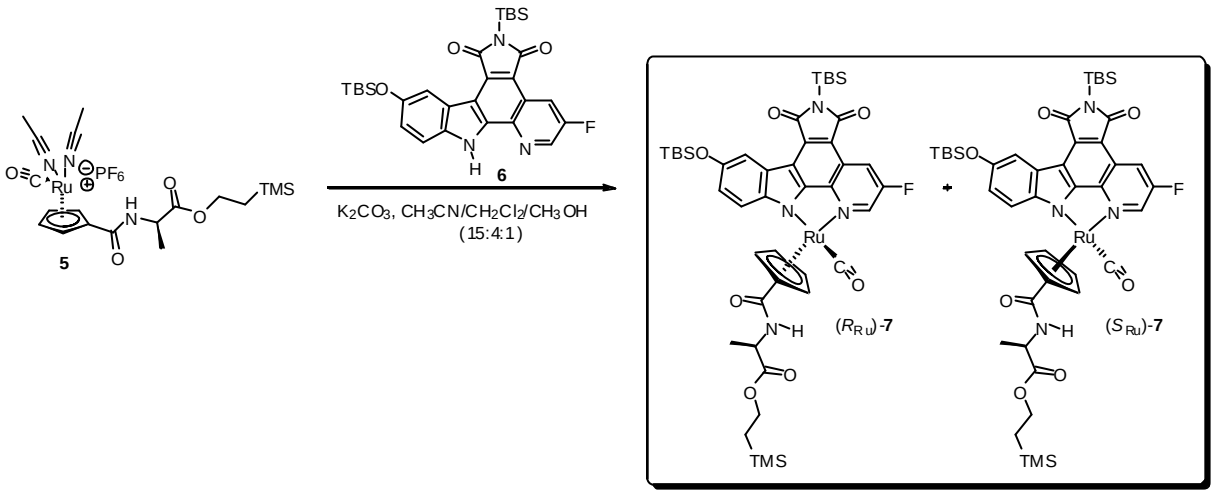


Compound 3. A solution of sandwich complex **1** (383 mg, 0.883 mmol) in DMF (16.1 mL) was purged with argon while cooling to 0°C. *N*-hydroxysuccinimide (135 mg, 1.17 mmol) and *N*-(3-dimethylamino-propyl)-*N*'-ethylcarbodiimide hydrochloride (EDCI) (223 mg, 1.17 mmol) were added respectively and the resulting suspension was allowed to warm to room temperature, stirring for a total of 2 hours. A solution of *D*-alanine TMS-ethylester **2** (200 mg, 1.06 mmol) in DMF (1 mL) was then added and the reaction mixture was stirred at room temperature for an additional 2 hours. The resulting yellow-orange suspension was concentrated under high vacuum and co-evaporated once using CH_3CN. The crude material was subjected to silica gel chromatography with CH_3CN/H_2O:saturated aqueous KNO_3 (50:3:1). The combined product eluents were dried *in vacuo*, re-dissolved in H_2O (30 mL) and excess NH_4PF_6 was added. The resulting white suspension was extracted with CH_2Cl_2 (2x) and the combined organic layers were washed with H_2O (2x), dried using Na_2SO_4, filtered and concentrated to dryness *in vacuo* to provide amide **3** (410 mg, 77%) as a white foam. ^{1}H NMR (360 MHz, acetonitrile-d_3): d (ppm) 7.03 (d, J = 6.6 Hz, 1H), 6.17 (s, 6H), 5.84-5.80 (m, 2H), 5.45-5.41 (m, 2H), 4.40 (quintet, J = 7.3 Hz, 1H), 4.26-4.21 (m, 2H), 1.42 (d, J = 7.4 Hz, 3H), 1.05-1.00 (m, 2H), 0.06 (s, 9H). ^{13}C NMR (90 MHz, acetonitrile-d_3): d (ppm) 173.9, 164.2, 90.5, 88.7, 83.3, 83.1, 81.5, 80.7, 64.9, 50.1, 18.3, 17.5, -1.1. IR (film): n (cm^{-1}) 3416, 3333, 3102, 2954, 2899, 1735, 1668, 1536, 1446, 1390, 1346, 1307, 1251, 1220, 1180, 1148, 1042, 929, 859, 774, 737, 698, 662. HRMS calcd for $C_{20}H_{28}NO_3RuSi$ $(M)^+$ 460.0882, found $(M)^+$ 460.0898.



Compound 5. A clear solution of sandwich complex **3** (307 mg, 0.507 mmol) in CH_3CN (250 mL) was irradiated with a medium pressure Hg lamp using an uranium filter (50% transmission at 350 nm) for 5 hours with constant argon flow through the solution. The resulting yellow solution was concentrated to dryness *in vacuo*, re-dissolved in CH_3CN (30.7 mL) and purged with argon. The solution was then purged with carbon monoxide gas for 5 minutes and stirred at room temperature under an atmosphere of carbon monoxide overnight. The resulting yellow-orange solution was concentrated to dryness *in vacuo* to provide half-sandwich complex **5** (299 mg, 92%) as an orange foam. ^{1}H NMR (360 MHz, acetonitrile-d_3): d (ppm) 6.97 (d, J = 6.9 Hz, 1H), 5.81-5.80 (m, 2H), 5.18-5.09 (m, 2H), 4.43 (quintet, J

= 7.3 Hz, 1H), 4.22-4.17 (m, 2H), 2.40 (s, 3H), 2.39 (s, 3H), 1.40 (d, *J* = 7.3 Hz, 3H), 1.02-0.98 (m, 2H), 0.05 (s, 9H). ^{13}C NMR (90 MHz, acetonitrile-d_3): *d* (ppm) 198.6, 173.8, 163.8, 130.8, 87.9, 87.7, 86.9, 82.3, 80.5, 64.7, 50.1, 18.3, 17.9, 4.94, -1.1. IR (film): *n* (cm^{-1}) 3420, 3331, 3117, 2953, 2898, 2009, 1738, 1665, 1538, 1456, 1418, 1373, 1341, 1308, 1251, 1220, 1180, 1146, 1042, 934, 842, 770, 696. HRMS calcd for $C_{19}H_{28}N_3O_4RuSi$ $(M)^+$ 492.0893, found $(M)^+$ 492.0910.

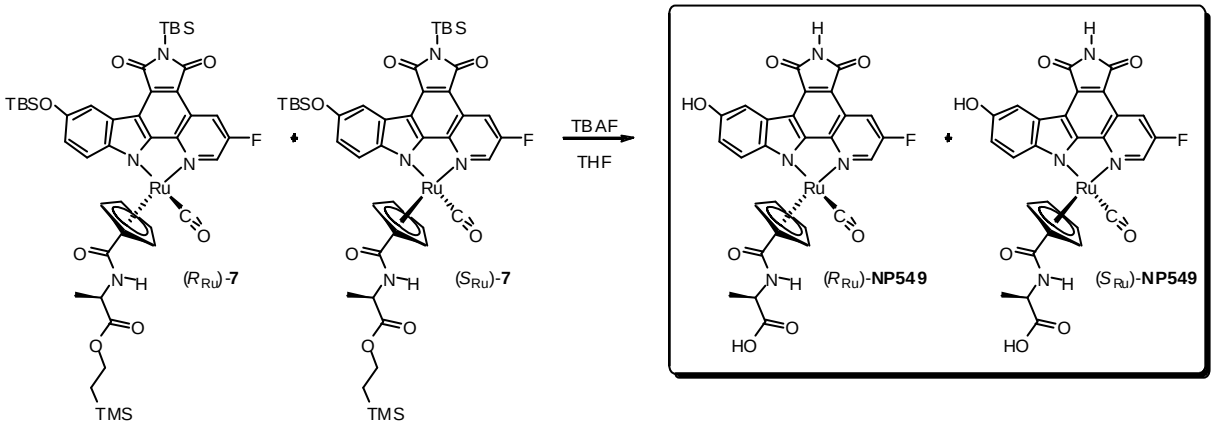


Compound 7 (mixture of diastereomers). A suspension of ligand **6** (50 mg, 0.091 mmol), **5** (64 mg, 0.100 mmol) and K_2CO_3 (14 mg, 0.100 mmol) in $CH_3CN/CH_2Cl_2/CH_3OH$ (15:4:1) (5 mL) was purged with argon and stirred at room temperature overnight. The resulting dark purple reaction mixture was concentrated to dryness *in vacuo* and subjected to silica gel chromatography with toluene:acetone (10:1). The combined product eluents were dried *in vacuo* to provide half-sandwich complex **7** (65 mg, 75%) as a purple solid and as a 1:1 mixture of diastereomers.

HPLC separation of diastereomers 7. Baseline separation of diastereomers was achieved using the Varian Dynamax (250 x 10.0 mm) silica gel column. Each injection was conducted isocratic using hexanes:EtOAc (5:1) with a flow rate of 7.0 mL/min. The absolute configuration of each diastereomer was later assigned by co-crystallization of (R_{Ru})-**NP549** with GSK-3ß and supplemented with circular dichroism measurements.

Diastereomer (S_{Ru})-7. ^{1}H NMR (360 MHz, $CDCl_3$): *d* (ppm) 8.94 (dd, *J* = 9.2, 2.3 Hz, 1H), 8.89 (t, *J* = 2.5 Hz, 1H), 8.37 (d, *J* = 2.5 Hz, 1H), 7.31 (d, *J* = 8.7 Hz, 1H), 7.14 (dd, *J* = 8.7, 2.5 Hz, 1H), 6.34 (d, *J* = 7.2 Hz, 1H), 5.92 (m, 1H), 5.66 (m, 1H), 5.37 (m, 1H), 5.29 (m, 1H), 4.56 (quintet, *J* = 7.2 Hz, 1H), 4.23-4.19 (m, 2H), 1.34 (d, *J* = 7.2 Hz, 3H), 1.07 (s, 9H), 1.05 (s, 9H), 1.01-0.97 (m, 2H), 0.61 (s, 6H), 0.31 (s, 6H), 0.05 (s, 9H). ^{13}C NMR (90 MHz, $CDCl_3$): *d* (ppm) 198.0, 175.5, 174.3, 173.0, 164.3, 157.3 (d_{C-F}, *J* = 250.9 Hz), 155.0, 150.3, 148.4, 143.7 (d_{C-F}, *J* = 34.4 Hz), 142.6, 142.6, 134.1, 124.9, 121.7 (d_{C-F}, J = 8.5 Hz), 120.6, 119.6 (d_{C-F}, *J* = 20.2 Hz), 115.5, 115.0 (d_{C-F}, *J* = 27.4 Hz), 113.5 (d_{C-F}, *J* = 4.9 Hz), 91.5, 85.0, 83.3, 81.4, 74.6, 64.5, 48.7, 26.7, 26.2, 19.3, 18.6, 18.4, 17.6, -1.3, -3.7, -4.0. IR (film): *n* (cm^{-1}) 3335, 3092, 2953, 2859, 1975, 1742, 1688, 1559, 1523, 1461, 1411, 1332, 1304, 1255, 1232, 1198, 1139, 1044, 947, 907, 834, 771, 659. HRMS calcd for $C_{44}H_{58}FN_4O_7RuSi_3$ $(M+H)^+$ 959.2641, found $(M+H)^+$ 959.2633.

Diastereomer (R_{Ru})-7. ^{1}H NMR (360 MHz, $CDCl_3$): *d* (ppm) 8.94 (dd, *J* = 9.2, 2.4 Hz, 1H), 8.84 (t, *J* = 2.5 Hz, 1H), 8.37 (d, *J* = 2.5 Hz, 1H), 7.34 (d, *J* = 8.7 Hz, 1H), 7.15 (dd, *J* = 8.7, 2.5 Hz, 1H), 6.06 (d, *J* = 7.2 Hz, 1H), 5.91 (m, 1H), 5.77 (m, 1H), 5.30 (m, 1H), 5.26 (m, 1H), 4.40 (quintet, *J* = 7.2 Hz, 1H), 4.22-4.16 (m, 2H), 1.07 (s, 9H), 1.05 (s, 9H), 1.01 (d, *J* = 7.1 Hz, 3H), 1.01-0.95 (m, 2H), 0.62 (s, 6H), 0.31 (s, 6H), 0.03 (s, 9H). ^{13}C NMR (90 MHz, $CDCl_3$): *d* (ppm) 198.1, 175.4, 174.3, 172.9, 163.8, 157.2 (d_{C-F}, *J* = 250.9 Hz), 155.0, 150.3, 148.3, 144.0 (d_{C-F}, *J* = 34.3 Hz), 142.5, 142.5, 134.1, 125.0, 121.6 (d_{C-F}, J = 8.4 Hz), 120.7, 119.7 (d_{C-F}, *J* = 20.1 Hz), 115.5, 114.9, 113.6 (d_{C-F}, *J* = 4.9 Hz), 88.3, 84.9, 84.6, 84.1, 73.2, 64.4, 48.5, 26.7, 26.2, 19.3, 18.6, 18.0, 17.5, -1.3, -3.7, -4.0. IR (film): *n* (cm^{-1}) 2952, 2852, 1975, 1741, 1687, 1559, 1460, 1411, 1332, 1304, 1252, 1199, 1140, 1044, 946, 903, 832, 772. HRMS calcd for $C_{44}H_{57}FN_4O_7RuSi_3$ $(M)^+$ 958.2563, found $(M)^+$ 958.2601.



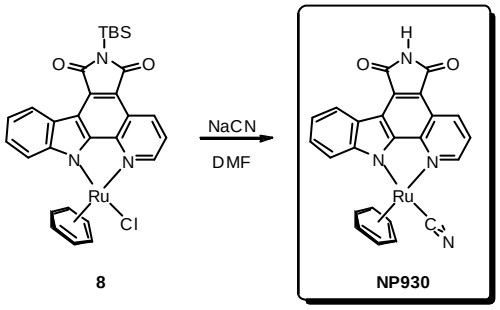
(S_{Ru})-**NP549:**(R_{Ru})-**NP549.** A solution of (S_{Ru})-**7**:(R_{Ru})-**7** (1:1) (65 mg, 0.068 mmol) in THF (6.5 mL) was purged with argon while cooling to 0°C. To the solution was added tetrabutylammonium fluoride (1 M solution in THF) (340 µL, 0.340 mmol) and the reaction mixture was heated to 45 °C for 2 hours. The resulting dark purple reaction mixture was cooled to 0 °C and glacial acetic acid (19.3 µL, 0.340 mmol) was added, allowed to warm to room temperature, concentrated to dryness *in vacuo*, and re-dissolved in EtOAc. The purple solution was washed with 1 M HCl followed by brine, dried using Na_2SO_4, filtered and evaporated. The crude material was subjected to silica gel chromatography with CH_2Cl_2:CH_3OH (3:1). The combined product eluents were dried to provide half-sandwich complexes (S_{Ru})-**NP549:**(R_{Ru})-**NP549** (38 mg, 88%) as a light purple solid and as a 1:1 mixture of diastereomers. This protocol was repeated on the separated diastereomers (S_{Ru})-**7** and (R_{Ru})-**7**, affording the pure stereoisomers (S_{Ru})-**NP549** and (R_{Ru})-**NP549**, respectively.

Diastereomer (S_{Ru})-NP549. ^{1}H NMR (360 MHz, DMSO-d_6): *d* (ppm) 11.06 (s, 1H), 9.31 (t, *J* = 2.4 Hz, 1H), 9.20 (s, 1H), 8.73 (dd, *J* = 9.4, 2.3 Hz, 1H), 8.43 (d, *J* = 7.4 Hz, 1H), 8.07 (d, *J* = 2.4 Hz, 1H), 7.47 (d, *J* = 8.8 Hz, 1H), 7.05 (dd, *J* = 8.7, 2.4 Hz, 1H), 6.26 (s, 1H), 6.18 (s, 1H), 5.65 (s, 1H), 5.58 (s, 1H), 4.21 (quintet, *J* = 7.4 Hz, 1H), 1.15 (d, *J* = 7.0 Hz, 3H). ^{13}C NMR (90 MHz, DMSO-d_6): *d* (ppm) 199.4, 173.7, 170.5, 170.3, 163.3, 156.6 (d_{C-F}, *J* = 248.9 Hz), 153.7, 151.8, 146.9, 144.9 (d_{C-F}, *J* = 35.1 Hz), 141.4, 131.8, 123.9, 120.5 (d_{C-F}, J = 8.4 Hz), 117.5 (d_{C-F}, *J* = 19.9 Hz), 116.3, 116.2, 114.3, 110.6 (d_{C-F}, *J* = 4.7 Hz), 108.3, 91.8, 84.5, 83.1, 81.1, 79.0, 47.7, 16.7. IR (film): *n* (cm^{-1}) 3275, 1966, 1745, 1710,

1636, 1560, 1500, 1466, 1412, 1336, 1258, 1223, 1202, 1024, 990, 923, 856, 825, 762, 695. HRMS calcd for $C_{27}H_{18}FN_4O_7Ru$ $(M+H)^+$ 631.0197, found $(M+H)^+$ 631.0202.

Diastereomer (R_{Ru})-NP549. ^{1}H NMR (500 MHz, DMSO-d_6): d (ppm) 11.05 (s, 1H), 9.22 (s, 1H), 8.72 (dd, J = 9.3, 2.2 Hz, 1H), 8.31 (d, J = 6.6 Hz, 1H), 8.07 (d, J = 2.3 Hz, 1H), 7.51 (d, J = 8.7 Hz, 1H), 7.07 (dd, J = 8.7, 2.2 Hz, 1H), 6.25 (s, 1H), 6.23 (s, 1H), 5.61 (s, 1H), 5.58 (s, 1H), 4.19 (quintet, J = 7.1 Hz, 1H), 1.16 (d, J = 7.1 Hz, 3H). ^{13}C NMR (125 MHz, DMSO-d_6): d (ppm) 199.5, 173.6, 170.5, 170.3, 163.3, 156.7 (d_{C-F}, J = 248.7 Hz), 153.7, 151.8, 146.9, 141.4, 131.8, 123.9, 120.5 (d_{C-F}, J = 8.6 Hz), 117.6, 116.4, 116.3, 114.3, 110.6 (d_{C-F}, J = 4.6 Hz), 108.3, 90.1, 84.9, 84.2, 83.4, 76.9, 47.9, 16.8, one hidden carbon. IR (film): n (cm^{-1}) 3279, 1967, 1741, 1710, 1634, 1561, 1500, 1464, 1415, 1337, 1263, 1227, 1202, 1024, 995, 923, 856, 825, 762, 700. HRMS calcd for $C_{27}H_{18}FN_4O_7Ru$ $(M+H)^+$ 631.0197, found $(M+H)^+$ 631.0200.

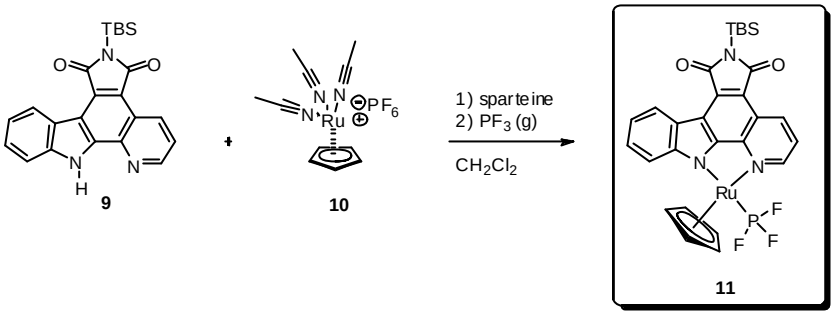
B) Synthesis of Cyanide Complex NP930



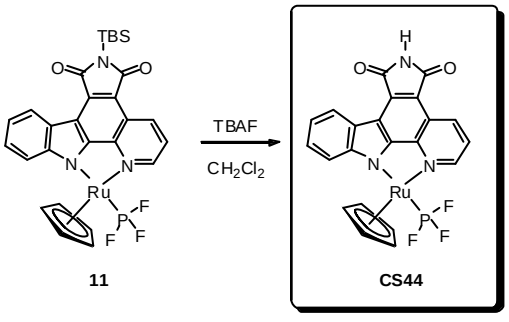
8 **NP930**

Compound NP930. A red solution of **8** (20 mg, 0.033 mmol) in DMF (2 mL) was cooled to 0 °C and sodium cyanide (16 mg, 0.330 mmol) was added. Within 5 minutes, the reaction mixture was blue-purple in color and the DMF was removed using high vacuum. The resulting purple film was transferred to a centrifuge tube, washed with 10 mL of H_2O (2x) and the precipitate collected to provide half-sandwich complex **NP930** (15 mg, 94%) as a light purple solid. ^{1}H NMR (500 MHz, DMSO-d_6): d (ppm) 11.10 (s, 1H), 9.42 (dd, J = 5.1, 0.9 Hz, 1H), 9.12 (dd, J = 8.4, 0.9 Hz, 1H), 8.69 (d, J = 7.8 Hz, 1H), 7.84 (d, J = 8.4 Hz, 1H), 7.83 (d, J = 8.4 Hz, 1H), 7.60 (ddd, J = 8.2, 7.1, 1.1 Hz, 1H), 7.38 (ddd, J = 7.7, 7.2, 0.6 Hz, 1H), 6.29 (s, 6H). ^{13}C NMR (125 MHz, DMSO-d_6): d (ppm) 170.7, 170.4, 154.4, 152.5, 151.6, 142.2, 133.5, 130.7, 128.9, 126.2, 124.0, 123.4, 123.3, 121.0, 119.6, 115.7, 114.1, 112.7, 87.3. IR (KBr): n (cm^{-1}) 3031, 2121, 1748, 1702, 1580, 1523, 1496, 1473, 1417, 1345, 1296, 1266, 1229, 764, 749. HRMS calcd for $C_{24}H_{15}N_4O_2Ru$ $(M+H)^+$ 493.0233, found $(M+H)^+$ 493.0229.

C) Synthesis of PF_3 Complex CS44



Compound 11. Free ligand **9** (17.4 mg, 0.0419 mmol) and complex **10** (20.0 mg, 0.0461 mmol) were added together to a dry 10 mL two-necked round bottomed flask and placed under argon. The flask was cooled to 0 °C and CH_2Cl_2 (4 mL) was added turning the reaction dark maroon. After stirring 5 minutes at 0 °C, sparteine (13.8 µL, 0.060 mmol) was added causing the reaction to become dark purple. After stirring for 45 minutes at 0 °C, the reaction was purged with freshly generated PF_3 gas[8] using argon as a carrier gas, while slowly warming to room temperature. During this time, the reaction became deep red. After 2 hours, the reaction was concentrated and subjected to silica gel chromatography with toluene:acetone (50:1). The product **11** eluted as a bright red band (10.5 mg). Some TBS-deprotected material (**CS44**) could be eluted as a more polar purple band (1.0 mg) resulting in an overall yield of 43%. ^{1}H NMR (360 MHz, $CDCl_3$): *d* (ppm) 9.26 (dt, *J* = 8.3, 1.1 Hz, 1H), 8.88 (m, 2H), 7.57 (ddd, *J* = 8.4, 7.0, 1.3 Hz, 1H), 7.47 (dd, *J* = 8.3, 5.1 Hz, 1H), 7.41 (m, 2H), 5.14 (d, *J* = 1.3 Hz, 5H), 1.06 (s, 9H), 0.62 (s, 6H). ^{13}C NMR (90 MHz, $CDCl_3$): *d* (ppm) 175.7, 175.1, 155.1, 154.4 (d, J_{C-P} = 3.4 Hz), 153.4, 145.2, 134.5, 133.2, 126.3, 125.5, 124.5, 122.1, 122.1, 120.1, 115.9, 115.2, 114.5, 79.0 (d, J_{C-P} = 4.3 Hz), 26.7, 19.4, -3.7. ^{31}P NMR (122 MHz, $CDCl_3$): *d* (ppm) 134 (q, J_{P-F} = 1341 Hz). IR (film): *n* (cm^{-1}) 2926, 2854, 1740, 1688, 1586, 1504, 1416, 1337, 1262, 1229, 1180, 1127, 1046, 849, 747, 663, 576. HRMS calcd for $C_{28}H_{28}F_3N_3O_2PRuSi$ $(M+H)^+$ 656.0679, found $(M+H)^+$ 656.0687.

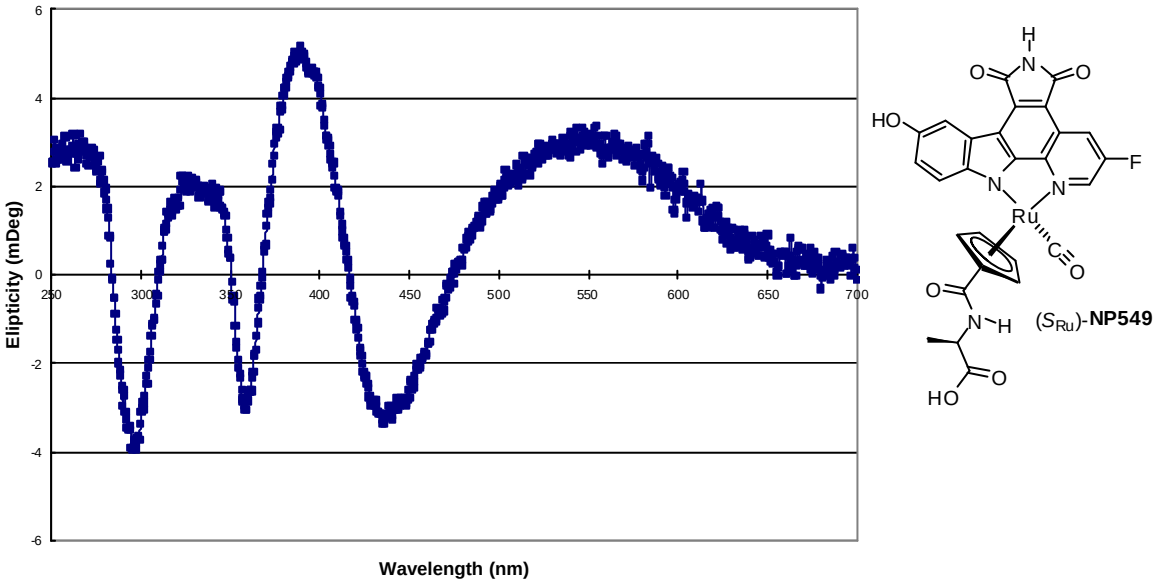


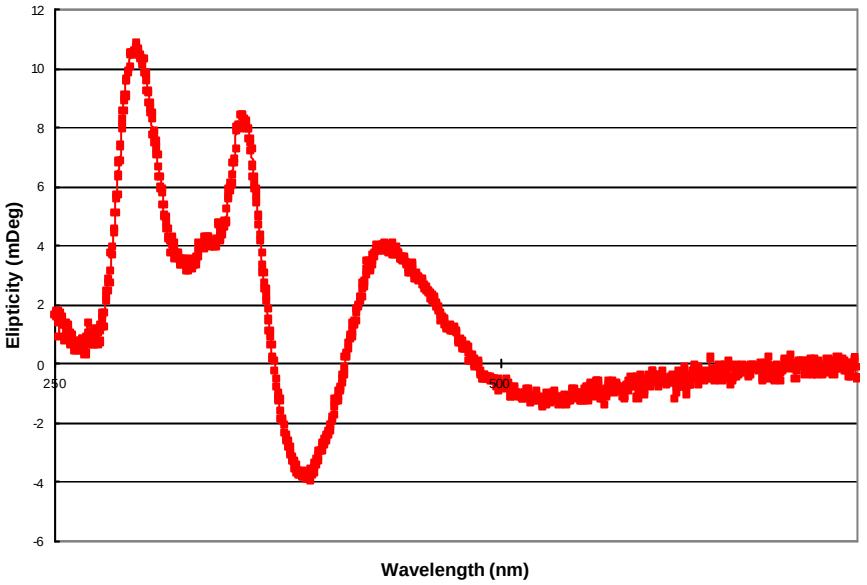
Compound CS44. TBS-protected complex **11** (10.5 mg, 0.016 mmol) was taken up in dry CH_2Cl_2 (2 mL) and cooled to 0 °C. To this was added tetrabutylammonium fluoride (1 M solution in THF) (17.6 µL, 0.018 mmol) causing the reaction to immediately turn purple. After stirring for 3 minutes at 0 °C, the reaction was quenched with one equivalent of glacial acidic acid. The reaction was then concentrated and subjected to silica gel chromatography with toluene:acetone (10:1). **CS44** eluted as

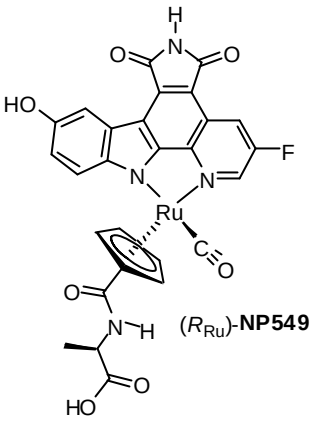
a light purple band (4.0 mg, 46%). ^{1}H NMR (500 MHz, DMSO-d_6): d (ppm) 11.07 (s, 1H), 9.28 (d, J = 5.0 Hz, 1H), 9.09 (d, J = 8.2 Hz, 1H), 8.66 (d, 7.9 Hz, 1H), 7.75 (dd, J = 8.4, 5.1 Hz, 1H), 7.55 (m, 2H), 7.35 (ddd, 8.0, 5.5, 2.5 Hz, 1H), 5.44 (s, 5H). ^{13}C NMR (125 MHz, $CDCl_3$): d (ppm) 169.9, 169.6, 155.3, 154.6 (d, J = 2.6 Hz), 153.5, 144.8, 134.2, 131.5, 126.7, 125.4, 124.3, 122.4, 122.3, 120.5, 116.5, 115.3, 112.2, 79.0 (d, $J_{C\text{-}P}$ = 3.8 Hz). ^{31}P NMR (122 MHz, $CDCl_3$): d (ppm) 134 (q, $J_{P\text{-}F}$ = 1341 Hz). IR (film): n (cm^{-1}) 3192, 2920, 2854, 1746, 1700, 1654, 1581, 1538, 1519, 1494, 1460, 1417, 1343, 1291, 1262, 1229, 1151, 1011, 854, 741. HRMS calcd for $C_{22}H_{14}F_3N_3O_2PRu$ $(M+H)^+$ 541.9814, found $(M+H)^+$ 541.9816.

D) Circular Dichroism Spectroscopy of (S_{Ru})-NP549 & (R_{Ru})-NP549

The following CD spectra were measured at a concentration of 1 mM in DMSO. The results were then compared to reference half-sandwich compounds.[1,9]







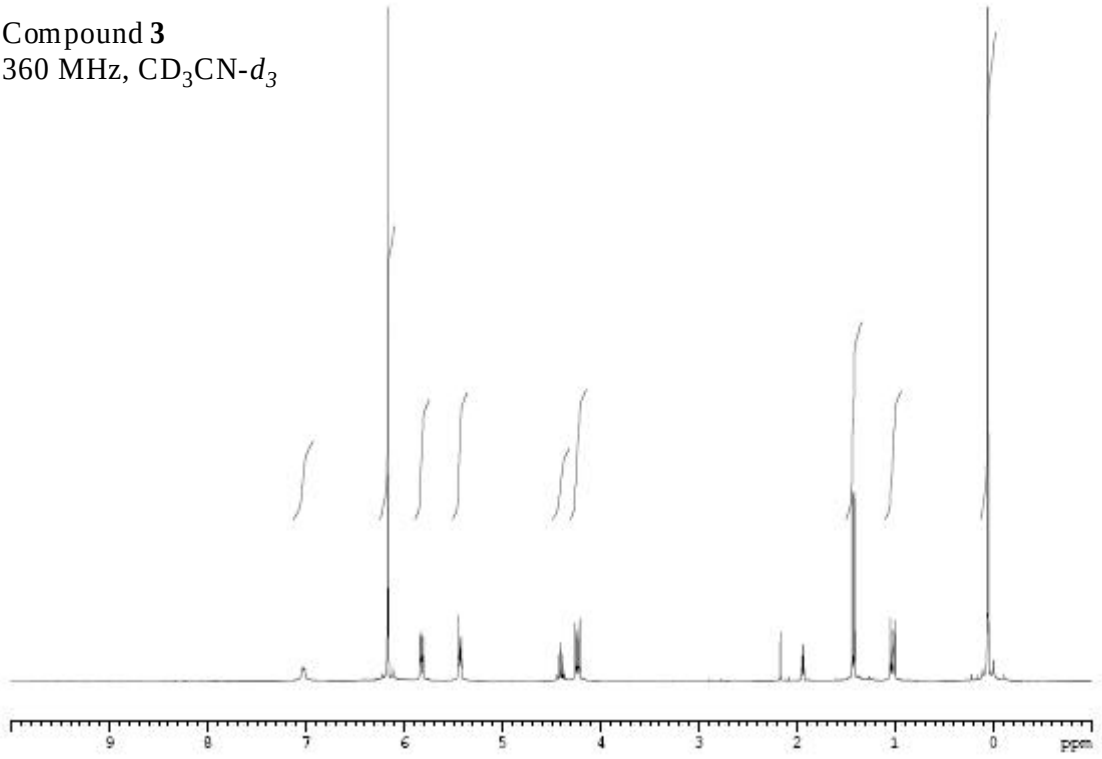
(R_{Ru})-**NP549**

References

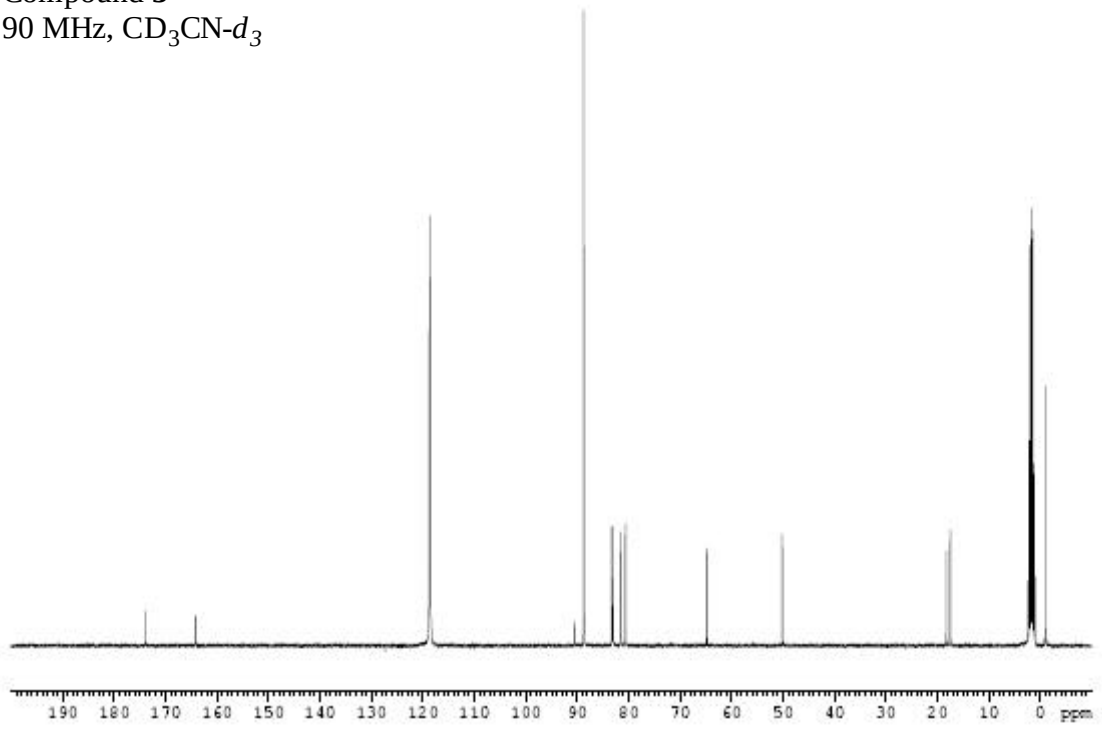
1. Bregman, H.; Meggers, E. *Org. Lett.* **2006**, *8*, 5465-5468.
2. Gerlach, H. *Helvetica Chimica Acta* **1977**, *60*, 3039-3044.
3. Sieber, P. *Helvetica Chimica Acta* **1977**, *60*, 2711-2716.
4. Pagano, N.; Maksimoska, J.; Bregman, H.; Williams, D. S.; Webster, R. D.; Xue, F.; Meggers, E. *Org. Biomol. Chem.* **2007**, *5*, 1218-1227.
5. Bregman, H.; Carroll, P. J.; Meggers, E. *J. Am. Chem. Soc.* **2006**, *128*, 877-884.
6. Bregman, H.; Williams, D. S.; Atilla, G. E.; Carroll, P. J.; Meggers, E. *J. Am. Chem. Soc.* **2004**, *126*, 13594-13595.
7. Gill, T. P.; Mann, K. R. *Organometallics* **1982**, *I*, 485-488.
8. Clark, R. J.; Belefant, H. *Inorg. Synth.*, **1989**, *26*, 12-17.
9. Debreczeni, J. É.; Bullock, A. N.; Atilla, G. E.; Williams, D. S.; Bregman, H.; Knapp, S.; Meggers, E. *Angew. Chem. Int. Ed.* **2006**, *45*, 1580-1585.

E) NMR Spectra

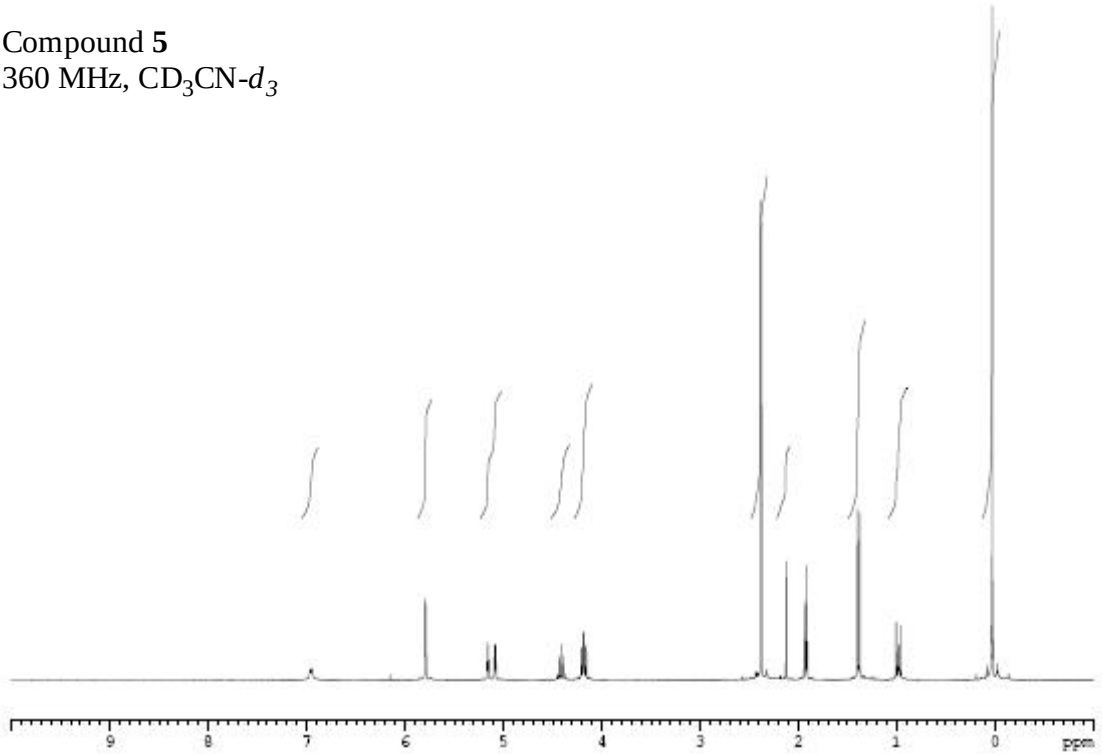
Compound **3**
360 MHz, CD_3CN-d_3



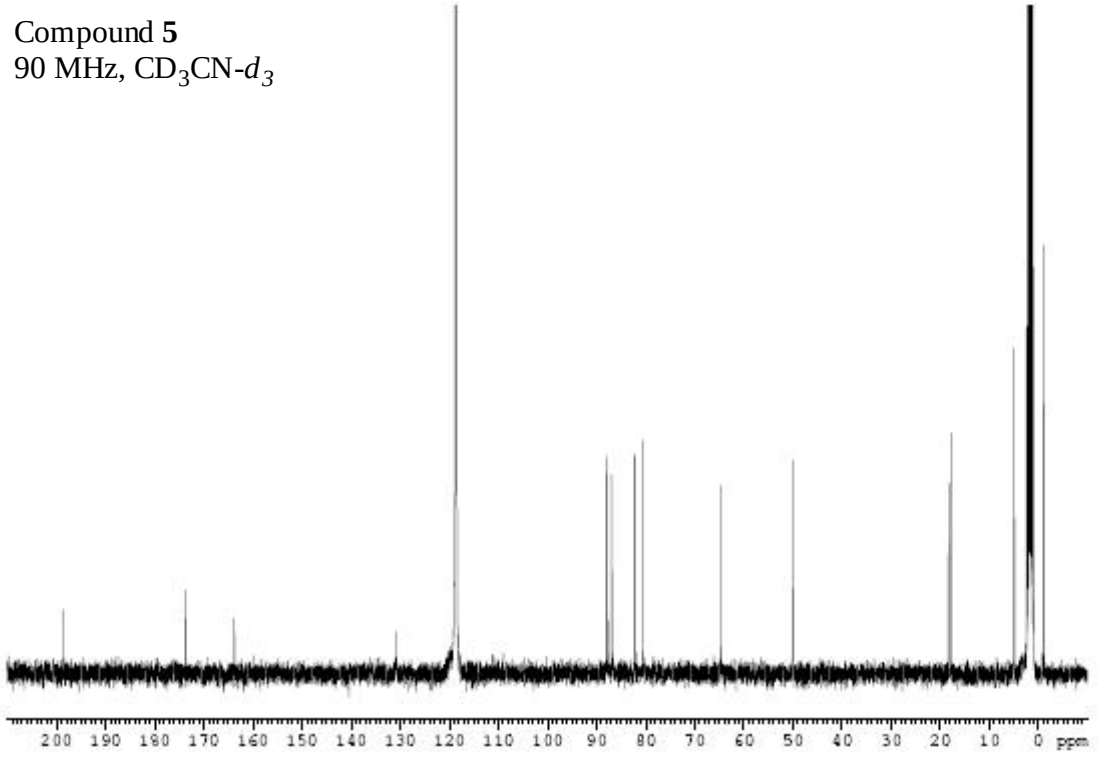
Compound **3**
90 MHz, CD_3CN-d_3



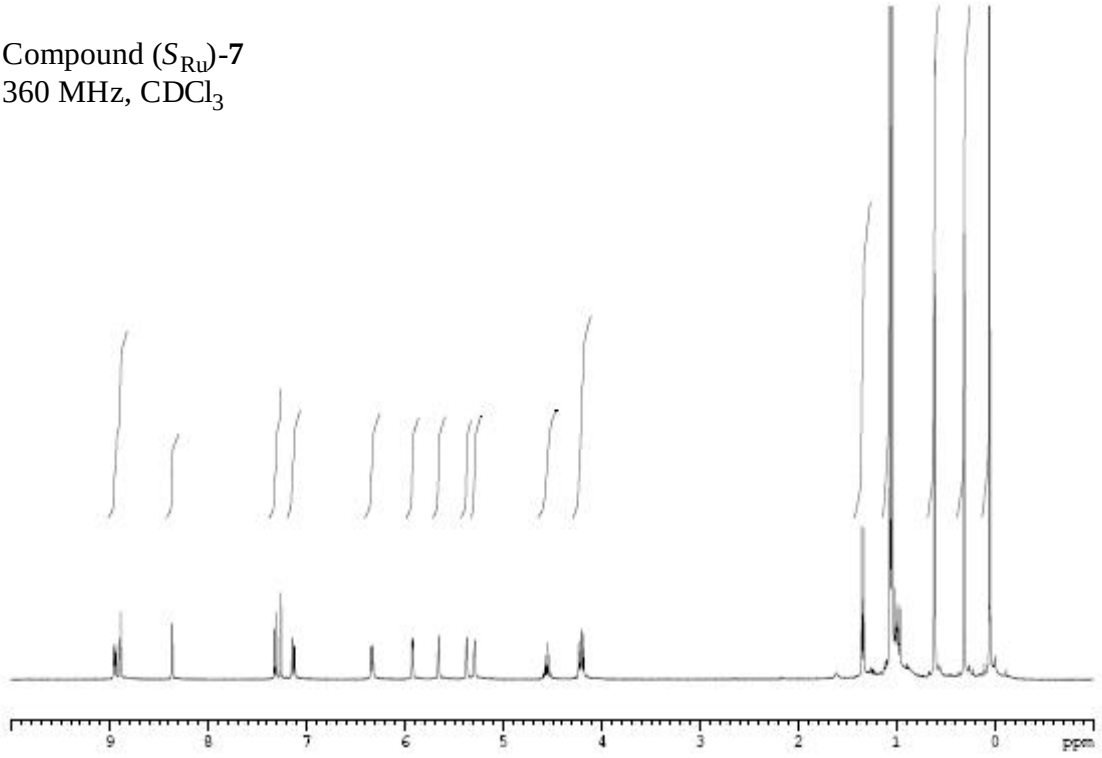
Compound **5**
360 MHz, CD_3CN-d_3



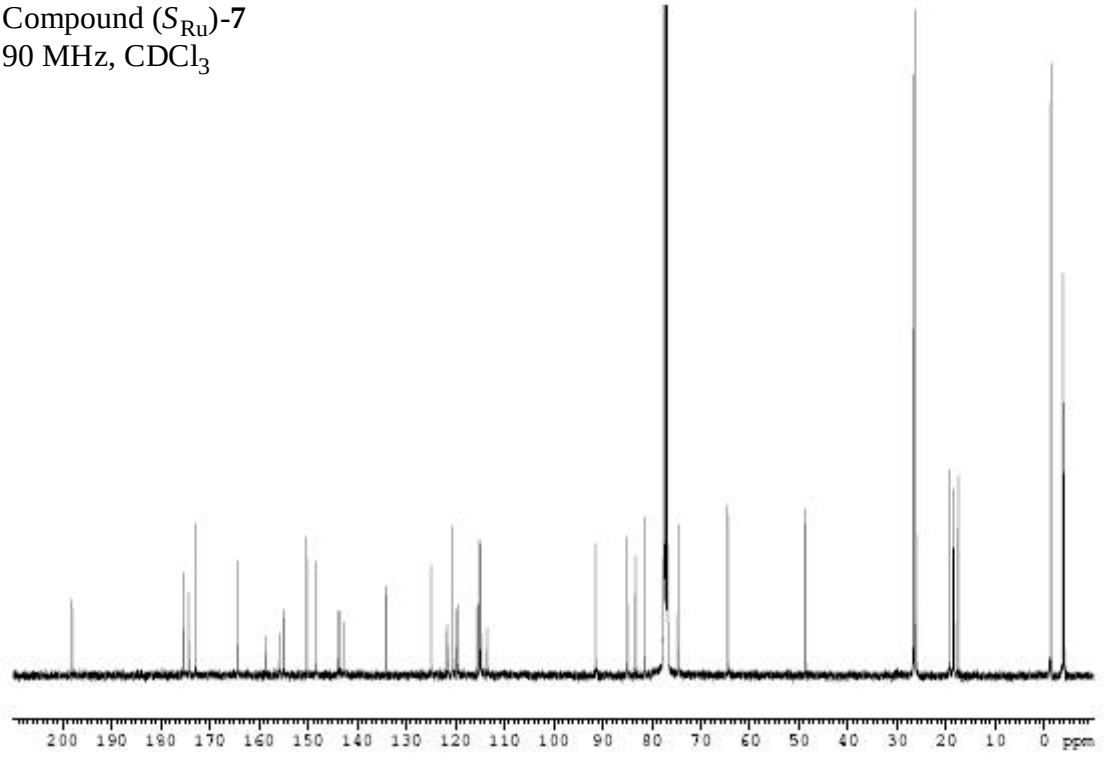
Compound **5**
90 MHz, CD_3CN-d_3



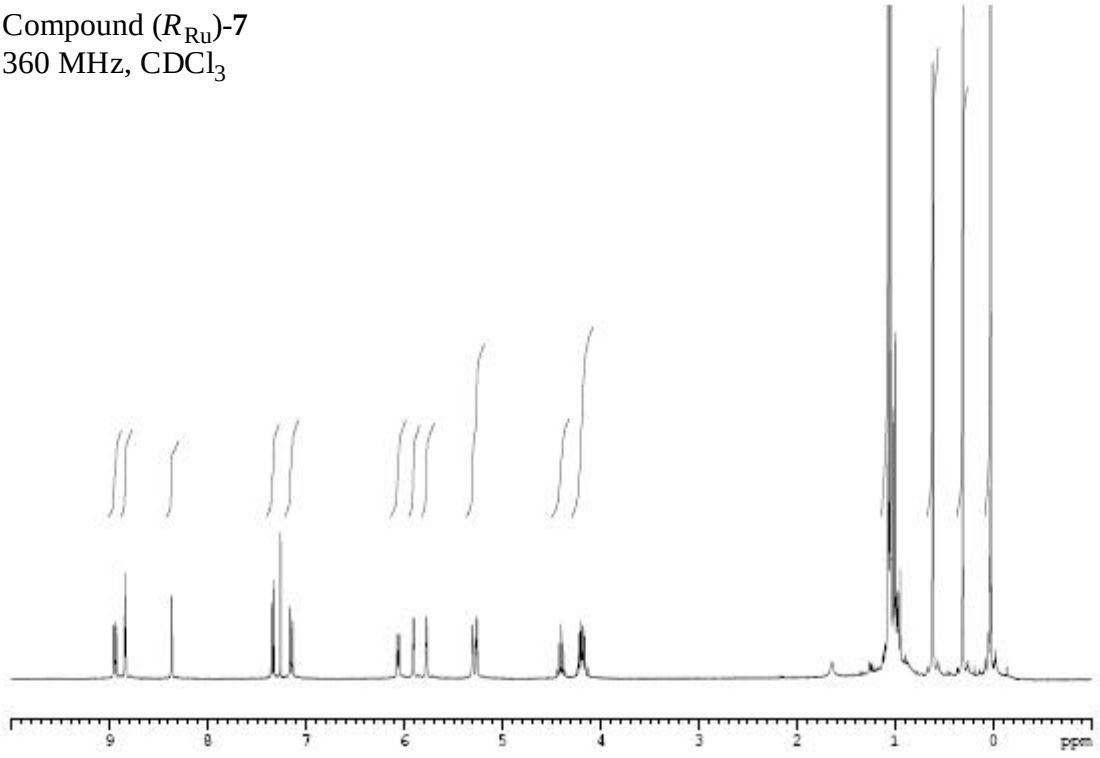
Compound (S_{Ru})-**7**
360 MHz, $CDCl_3$



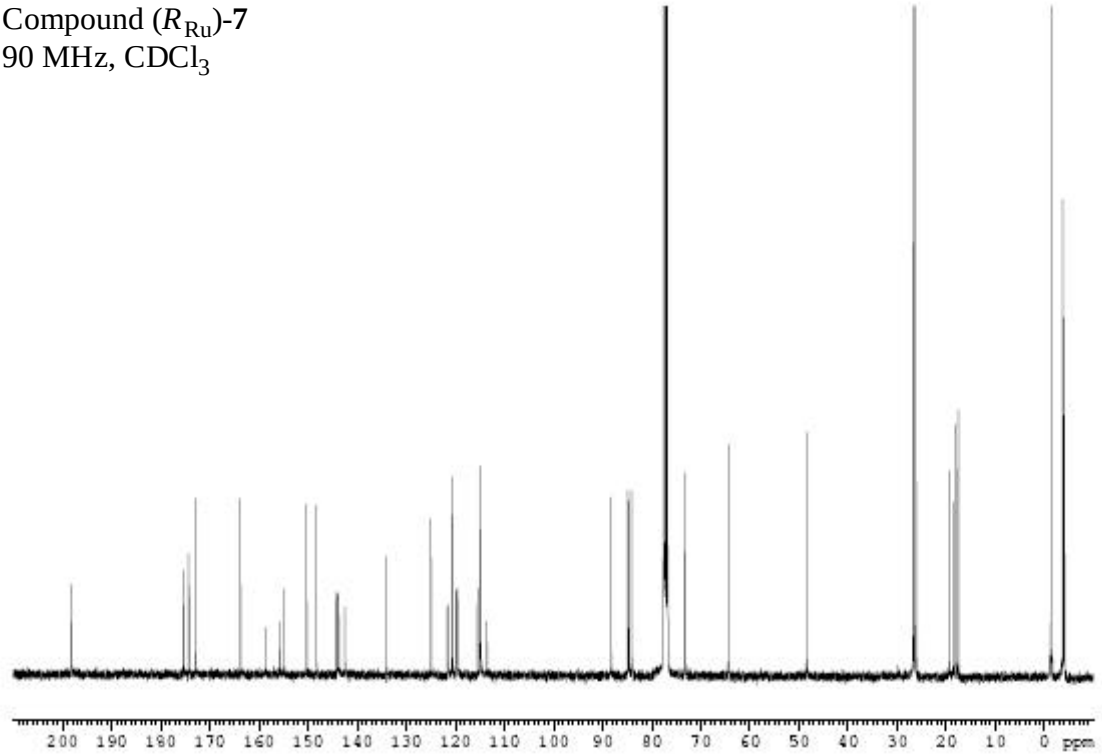
Compound (S_{Ru})-**7**
90 MHz, $CDCl_3$



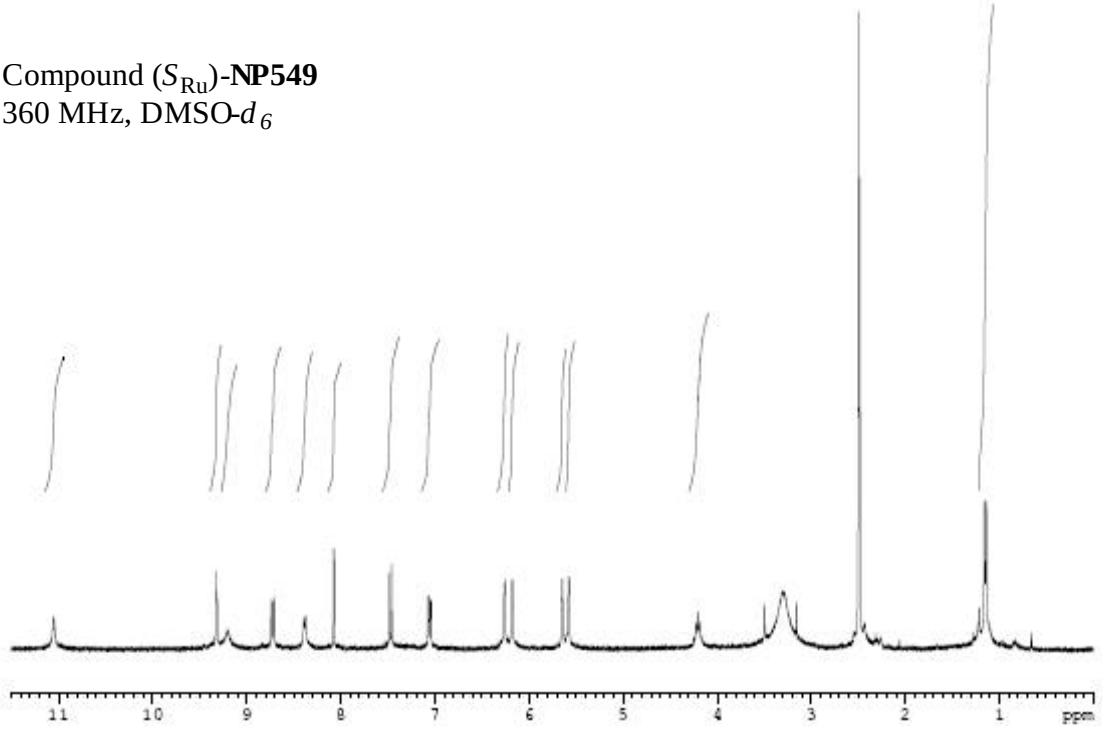
Compound (R_{Ru})-**7**
360 MHz, $CDCl_3$



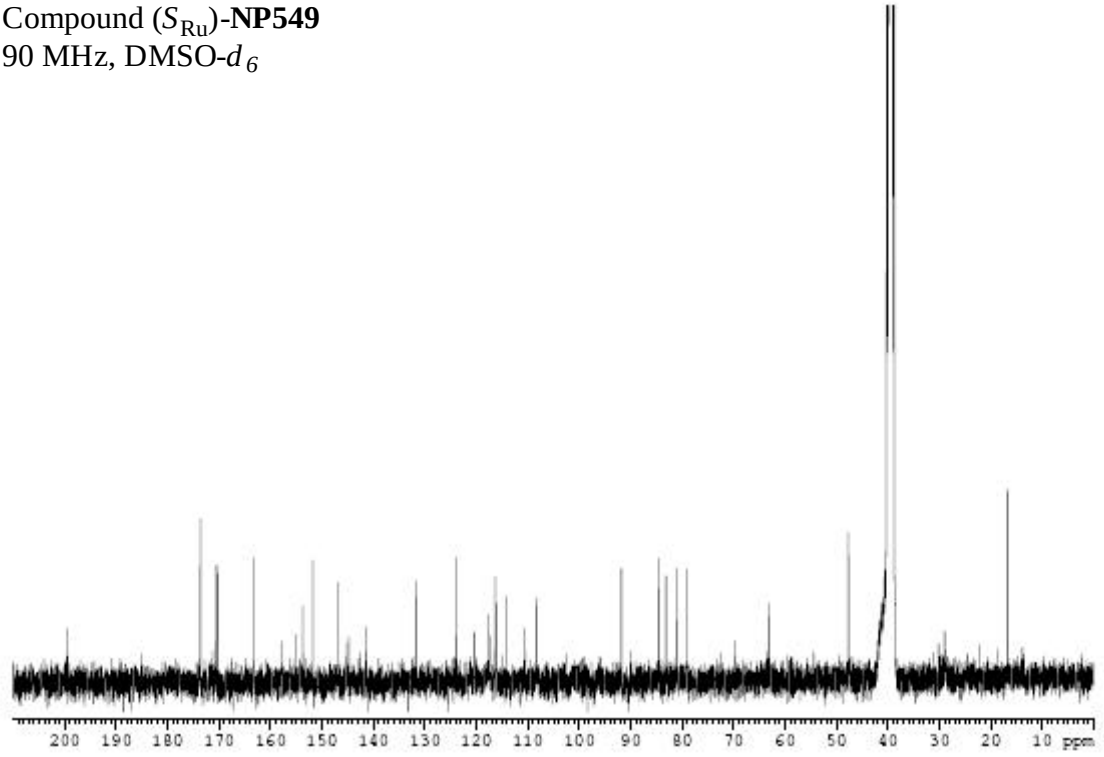
Compound (R_{Ru})-**7**
90 MHz, $CDCl_3$



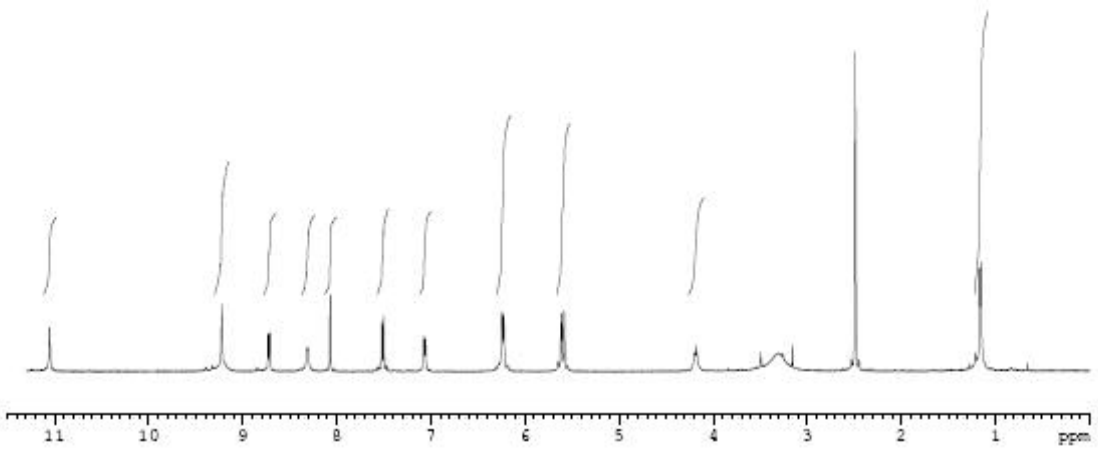
Compound (S_{Ru})-**NP549**
360 MHz, DMSO-d_6



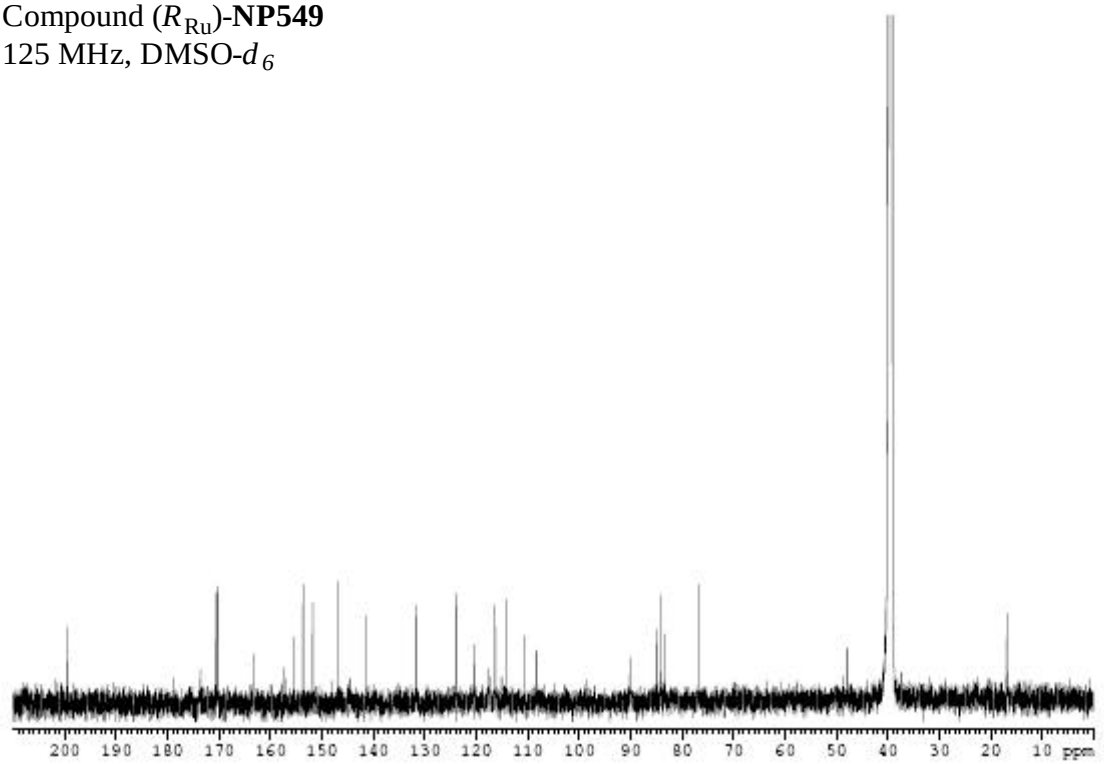
Compound (S_{Ru})-**NP549**
90 MHz, DMSO-d_6



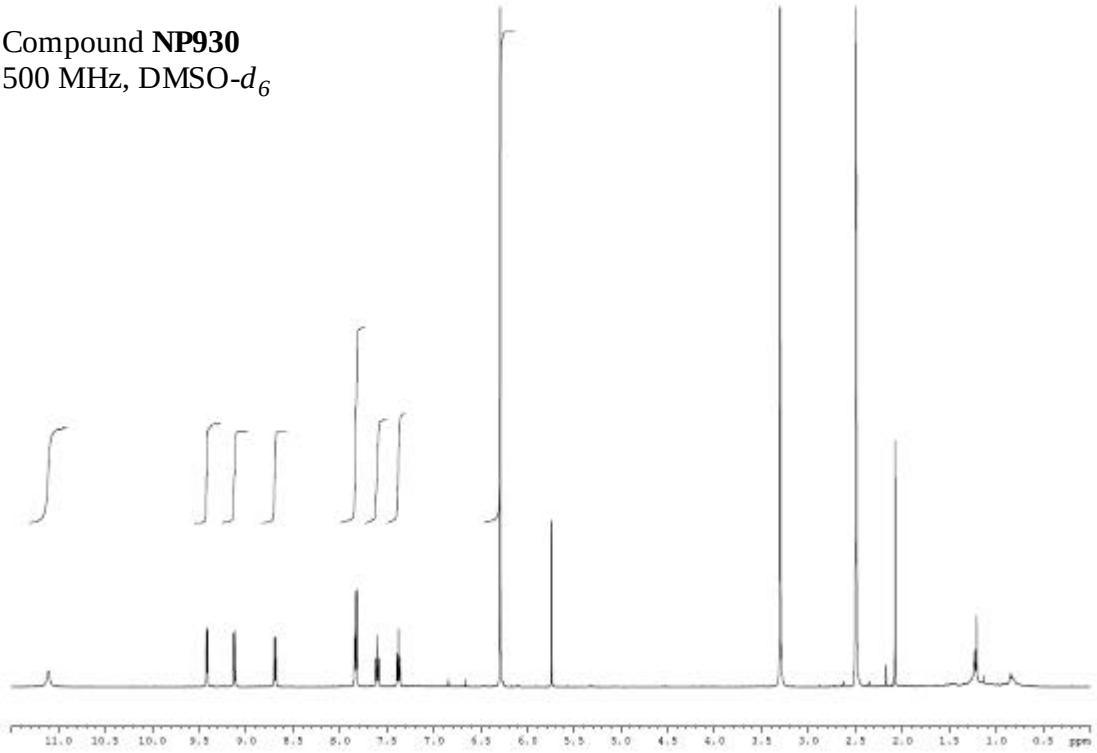
Compound (R_{Ru})-**NP549**
500 MHz, DMSO-d_6



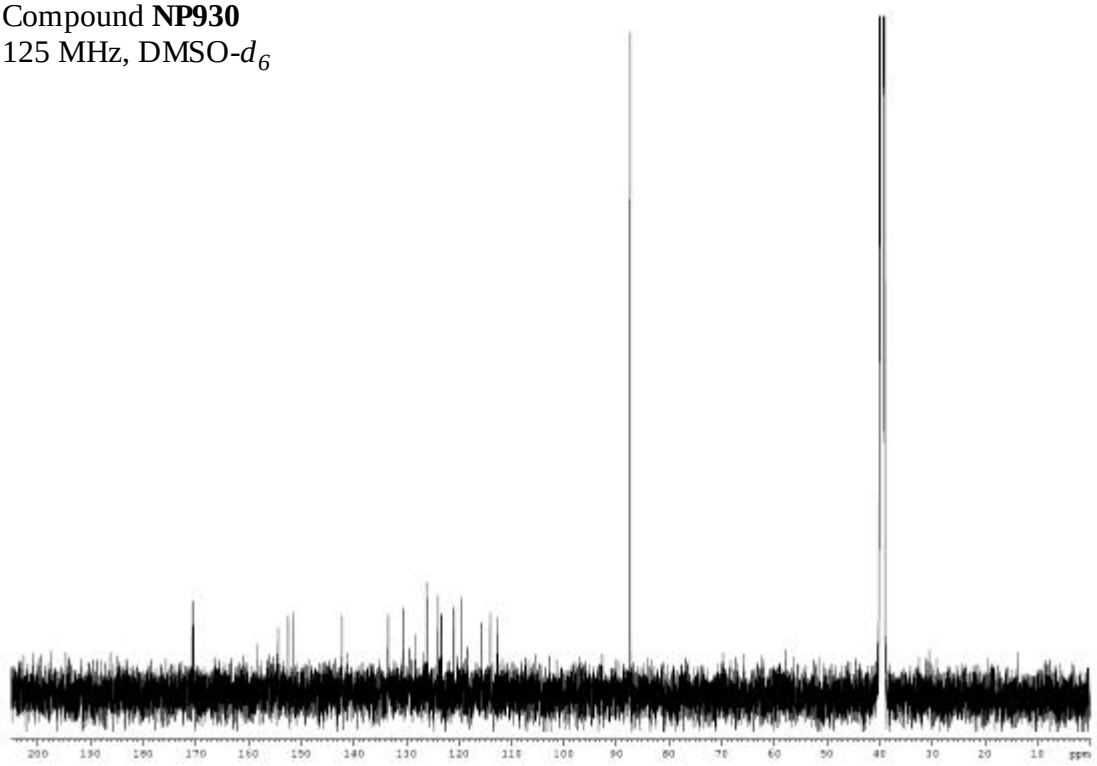
Compound (R_{Ru})-**NP549**
125 MHz, DMSO-d_6



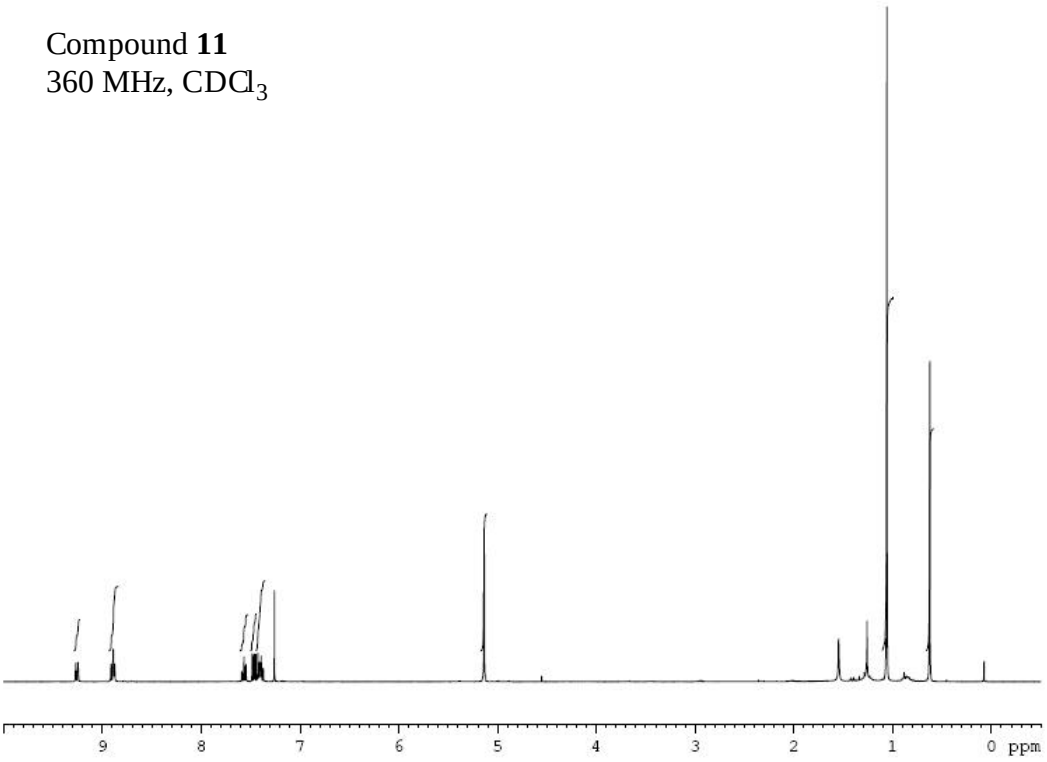
Compound **NP930**
500 MHz, DMSO-d_6



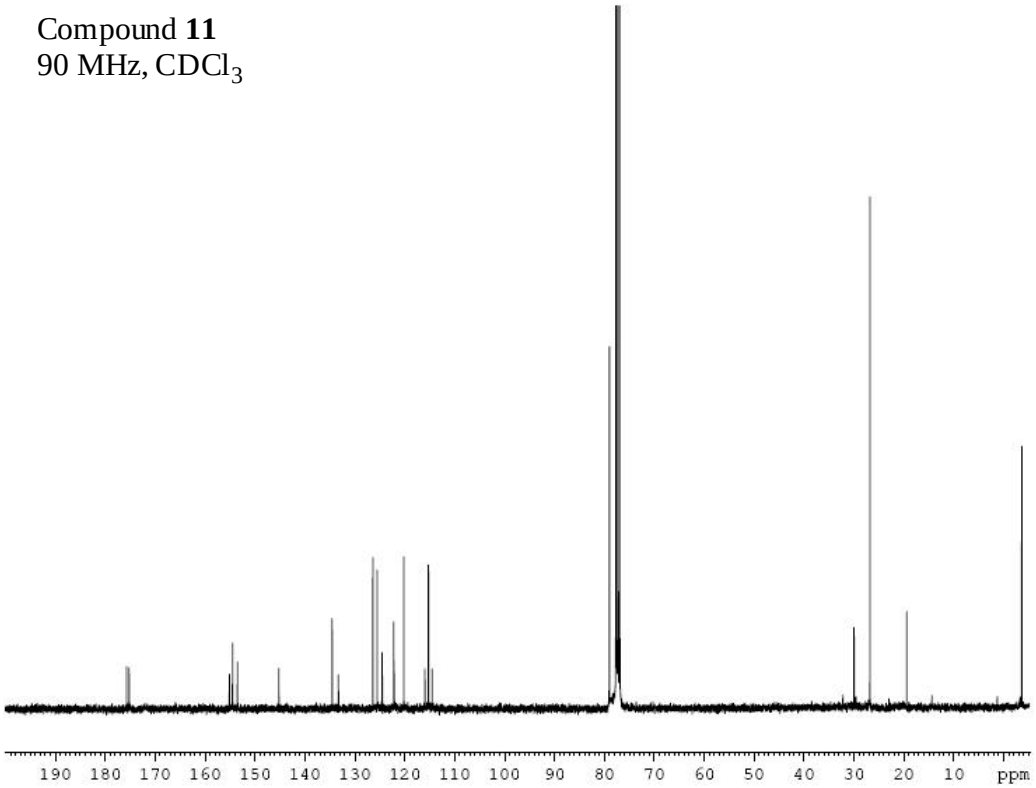
Compound **NP930**
125 MHz, DMSO-d_6



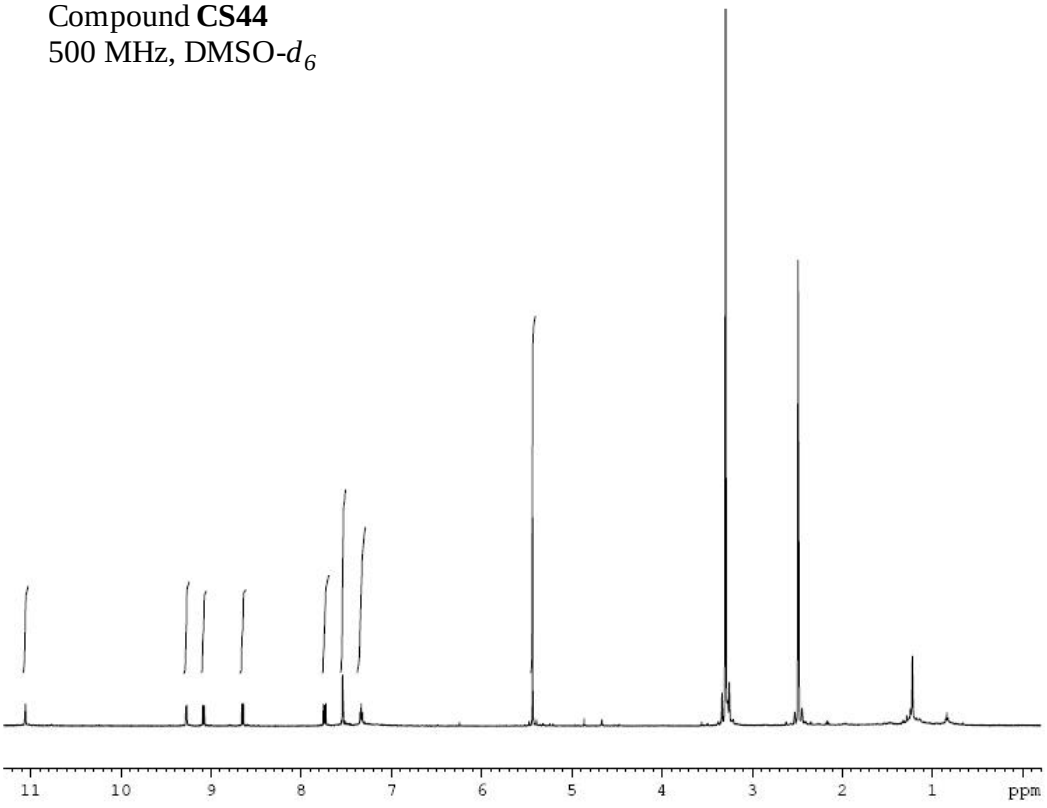
Compound **11**
360 MHz, $CDCl_3$



Compound **11**
90 MHz, $CDCl_3$



Compound **CS44**
500 MHz, DMSO-d_6



Compound **CS44**
125 MHz, $CDCl_3$