Electronic Supplementary Material (ESI) for ChemComm.

Supporting Information

Visible-Light Driven Synthesis of Polycyclic Benzo[d][1,3]oxazocine From 2-Aminochalcone via Tandem Aromatization/Dearomatization Process

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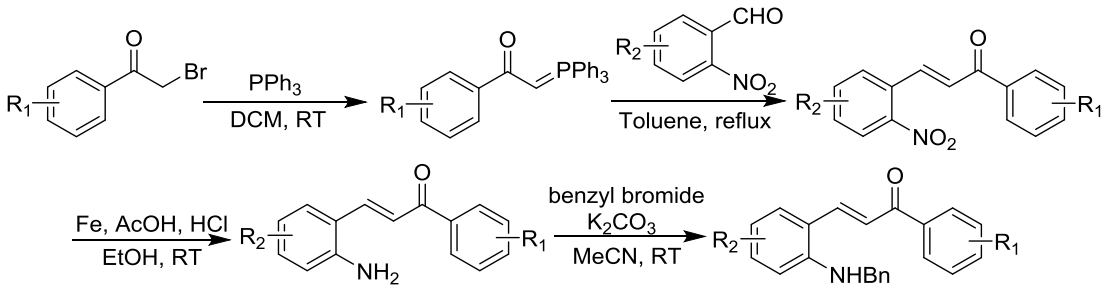
1.General Information

Unless otherwise noted, all reagents were obtained from commercial sources and used directly without further purification. Non-aqueous reaction was conducted under an inert atmosphere of argon in flame-dried glassware. Anhydrous solvents were treated as follow: dichloromethane and toluene were distilled from calcium hydride under argon atmosphere; chloroform and carbon tetrachloride were distilled from phosphorus pentoxide under argon atmosphere; tetrahydrofuran and diethyl ether were distilled from sodium under argon atmosphere. Anhydrous 1,2-dichloroethane (Adamas-beta, SafeDry, with molecular sieves) was commercial available. Thin layer chromatography was conducted on Merck 60 F254 pre-coated silica gel plates. Column chromatography was carried out by normal silica gel (40-60 μm, 200-400 mesh, Silicycle P60). NMR data including ^{1}H NMR or ^{13}C NMR spectra were recorded on Bruker AVANCE III 500MHz. All of the ^{13}C NMR spectra were broad band proton-decoupled. ^{1}H NMR Chemical shifts were reported in ppm relative to residual signals of the solvents ($CDCl_3$: 7.26 ppm; $(CD_3)_2CO$: 2.09 ppm; CD_2Cl_2: 5.32 ppm). ^{13}C NMR chemical shifts were reported in ppm relative to the solvent ($CDCl_3$:77.36 ppm; $(CD_3)_2CO$: 30.6 ppm; CD_2Cl_2: 53.84 ppm). Multiplicities are reported using the following abbreviations: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, br = broad resonance. High resolution mass spectra were obtained from IonSpec 4.7 Tesla FTMS mass spectrometer (MALDI), Bruker APEXIII 7.0 TESLA FTMS (ESI). IR spectra were obtained using a Bruker Tensor 27 FT-IR spectrometer with KBr pellets. The melting points of the products were determined on an SGW® X-4 apparatus (Shanghai INESA Physico-Optical Instrument Co., Ltd.). Photoirradiation was carried out with 24 W blue LED.

2. Preparation of Substrates

General Procedure for Synthesis of 2-Aminochalcone 4a-4o[1][2][3].

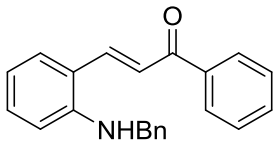


To a reaction tube equipped with a magnetic stir bar and 2-bromoacetophenone (1.0 equiv., 30 mmol) dissolved in CH_2Cl_2 (1 M), a solution of triphenylphosphine (1.2 equiv.) in CH_2Cl_2 (0.5 M) was added dropwise and the mixture was stirred at room temperature for 24 h. After 2-bromoacetophenone was consumed completely, diethyl ether (100 mL) was added and stirred for a further hour. The crude triphenylphosphonium bromide salt was suspended in a mixture of water/methanol (100 mL, 1:1) and stirred for 1 h. Aqueous NaOH (2 M) was then added until pH reached 7-8 and the mixture was stirred at room temperature for another 5 h. Methanol was removed by rotary evaporator and the aqueous layer was extracted 3x with CH_2Cl_2. The combined organic extracts were then dried with Na_2SO_4 and concentrated by rotary evaporator to afford the wittig reagent as a white solid.

2-Nitrobenzaldehyde (1.0 equiv., 10 mmol), phosphoris ylide (1.2 equiv.) and toluene (0.2 M) were added to a reaction tube equipped with a magnetic stir bar. The mixture was stirred at 90 ℃ until 2-Nitrobenzaldehyde completely consumed. The solvent was removed by rotary evaporator and the residue was purified by column chromatography on silica gel (EtOAc/petroleum ether = 1: 7) to provide 2-nitrochalcone.

To a solution of 2-nitrochalcon (1.0 equiv.) in ethanol (0.1 M), iron powder (7.0 equiv.), acetic acid (1.0 equiv.) and hydrochloric acid (1.5 equiv.) were added and the mixture was stirred at room temperature for 4h. After 2-nitrochalcon was consumed completely, the mixture was filtered and saturated sodium carbonate was added to basify the filtrate until pH reached 7-8. After an evaporation of ethanol, the residue was exacted 3x with CH_2Cl_2, and the combined organic extracts were washed with water, saturated brine and dried over anhydrous Na_2SO_4. The organic solvent was removed by rotary evaporator and the crude residue was recrystallized using Ethyl acetate/Petroleum ether to afford the 2-aminochalcones.

To a solution of 2-aminochalcone (1.0 equiv.) in acetonitrile (1 M), potassium carbonate (1.0 equiv.) and benzyl bromide (1.0 equiv.) were added and stirred at room temperature overnight. After 2-aminochalcone was consumed completely, the potassium carbonate was filter out and the solvent was evaporated under reduced pressure. The residue was purified by column chromatography on silica gel (EtOAc/petroleum ether = 1: 7) to give the desired product.



4a

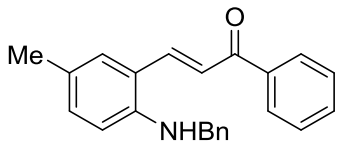
Following the general procedure, compound **4a** was isolated as a yellow solid in 42% yield (1.32 g).

M.p. 113.6-114.3 °C; **IR (KBr)** V_{max}: 3448, 3018, 2852, 1653, 1576, 1505, 1444, 1334, 1207, 1011, 728, 684 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 8.10 – 7.98 (m, 3H), 7.64 – 7.45 (m, 5H), 7.43 – 7.34 (m, 4H), 7.33 – 7.23 (m, 2H), 6.78 (t, *J* = 7.5 Hz, 1H), 6.70 (d, *J* = 8.3 Hz, 1H), 4.63 (t, *J* = 5.5 Hz, 1H), 4.42 (d, *J* = 5.3 Hz, 2H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 190.36, 147.45, 140.31, 138.93, 138.66, 133.05, 132.28, 129.09, 128.93, 128.74, 128.62, 127.77, 127.73, 122.27, 120.73, 117.90, 112.26, 48.45.

HRMS (ESI): exact mass calcd for $C_{22}H_{20}NO$: m/z 314.1545 $[M+H]^+$, found: m/z 314.1539.



4b

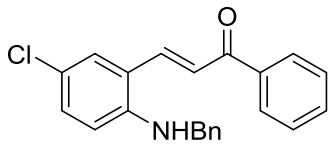
Following the general procedure, compound **4b** was isolated as a yellow solid in 40% yield (1.31 g).

M.p. 101.2-101.6 °C; **IR (KBr)** V_{max}: 3355, 3026, 2854, 1658, 1563, 1509, 1452, 1319, 1223, 1168, 1072, 821, 738, 695, 465 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 8.07 – 7.97 (m, 3H), 7.64 – 7.55 (m, 1H), 7.54 – 7.47 (m, 3H), 7.42 – 7.32 (m, 5H), 7.32 – 7.27 (m, 1H), 7.08 (dd, *J* = 8.5, 2.0 Hz, 1H), 6.61 (d, *J* = 8.3 Hz, 1H), 4.48 (t, *J* = 5.6 Hz, 1H), 4.40 (d, *J* = 5.5 Hz, 2H), 2.29 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 190.40, 145.45, 140.39, 139.15, 138.73, 133.15, 133.02, 129.07, 128.93, 128.80, 128.75, 127.73, 127.71, 127.04, 121.97, 120.70, 112.56, 48.67, 20.65.

HRMS (ESI): exact mass calcd for $C_{23}H_{22}NO$: m/z 328.1701 $[M+H]^+$, found: m/z 328.1696.



4c

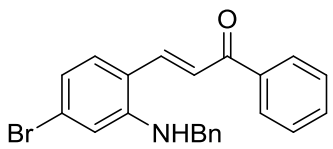
Following the general procedure, compound **4c** was isolated as a yellow solid in 43% yield (1.50 g).

M.p. 111.4-111.8 °C; **IR (KBr)** V_{max}: 3367, 3055, 2858, 1658, 1593, 1497, 1313, 1179, 1020, 822, 740, 693, 466 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 8.02 (d, *J* = 7.6 Hz, 2H), 7.96 (d, *J* = 15.2 Hz, 1H), 7.64 – 7.56 (m, 1H), 7.53 – 7.46 (m, 4H), 7.39 – 7.33 (m, 4H), 7.33 – 7.27 (m, 1H), 7.18 (dd, *J* = 8.9, 2.5 Hz, 1H), 6.60 (d, *J* = 8.8 Hz, 1H), 4.63 (t, *J* = 5.4 Hz, 1H), 4.40 (d, *J* = 5.3 Hz, 2H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 189.97, 145.88, 138.58, 138.49, 138.34, 133.30, 131.73, 129.16, 129.01, 128.80, 127.90, 127.69, 127.65, 123.26, 122.76, 122.02, 113.54, 48.50.

HRMS (ESI): exact mass calcd for $C_{22}H_{19}ClNO$: m/z 348.1155 $[M+H]^+$, found: m/z 348.1150.



4d

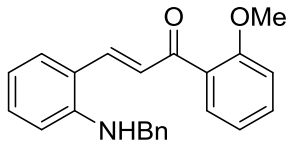
Following the general procedure, compound **4d** was isolated as a yellow solid in 39% yield (1.53 g).

M.p. 105.4-106.0 °C; **IR (KBr)** V_{max}: 3370, 3027, 2918, 1650, 1572, 1503, 1446, 1341, 1269, 1217, 1031, 858, 782, 696, 464 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 8.00 (d, *J* = 7.7 Hz, 2H), 7.92 (d, *J* = 15.2 Hz, 1H), 7.63 – 7.55 (m, 1H), 7.54 – 7.44 (m, 3H), 7.44 – 7.29 (m, 6H), 6.93 – 6.81 (m, 2H), 4.61 (t, *J* = 5.4 Hz, 1H), 4.37 (d, *J* = 5.1 Hz, 2H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 190.07, 148.19, 139.11, 138.43, 138.10, 133.23, 129.71, 129.25, 128.99, 128.74, 128.08, 127.88, 126.67, 122.57, 120.93, 119.60, 114.98, 48.43.

HRMS (ESI): exact mass calcd for $C_{22}H_{19}BrNO$: m/z 392.0650 $[M+H]^+$, found: m/z 392.0645.



4e

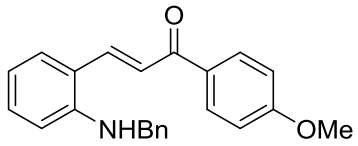
Following the general procedure, compound **4e** was isolated as a yellow solid in 42% yield (1.44 g).

M.p. 67.3-67.6 °C; **IR (KBr)** V_{max}: 3405, 3018, 2931, 1648, 1596, 1456, 1333, 1246, 1198, 1022, 975, 747 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.95 – 7.80 (m, 1H), 7.68 – 7.62 (m, 1H), 7.50 – 7.43 (m, 2H), 7.40 – 7.28 (m, 6H), 7.25 – 7.20 (m, 1H), 7.04 (t, *J* = 7.5 Hz, 1H), 6.97 (d, *J* = 8.4 Hz, 1H), 6.75 (t, *J* = 7.5 Hz, 1H), 6.67 (d, *J* = 8.3 Hz, 1H), 4.63 – 4.55 (m, 1H), 4.41 (d, *J* = 5.4 Hz, 2H), 3.83 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 192.77, 158.48, 147.30, 139.03, 138.73, 133.28, 131.88, 130.87, 129.79, 129.09, 128.89, 127.74, 127.54, 121.14, 120.97, 117.84, 112.06, 111.96, 56.00, 48.47.

HRMS (ESI): exact mass calcd for $C_{23}H_{22}NO_2$: m/z 344.1651 $[M+H]^+$, found: m/z 344.1645.



4f

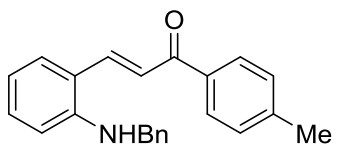
Following the general procedure, compound **4f** was isolated as a yellow solid in 40% yield (1.37 g).

M.p. 114.6-115.0 °C; **IR (KBr)** V_{max}: 3436, 2922, 1650, 1599, 1510, 1454, 1342, 1266, 1222, 1166, 1027, 831, 745 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 8.10 – 7.97 (m, 3H), 7.57 – 7.49 (m, 2H), 7.41 – 7.22 (m, 6H), 6.97 (d, *J* = 8.4 Hz, 2H), 6.77 (t, *J* = 7.5 Hz, 1H), 6.68 (d, *J* = 8.3 Hz, 1H), 4.60 (t, *J* = 5.7 Hz, 1H), 4.42 (d, *J* = 5.4 Hz, 2H), 3.89 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 188.67, 163.71, 147.31, 139.48, 138.96, 132.04, 131.50, 131.05, 129.09, 128.52, 127.75, 122.31, 120.93, 117.84, 114.16, 112.14, 55.82, 48.44.

HRMS (ESI): exact mass calcd for $C_{23}H_{22}NO_2$: m/z 344.1651 $[M+H]^+$, found: m/z 344.1645.



4g

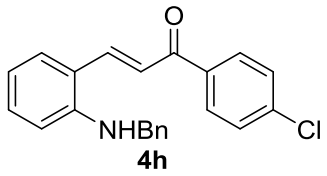
Following the general procedure, compound **4g** was isolated as a yellow solid in 45% yield (1.47 g).

M.p. 108.0-108.2 °C; **IR (KBr)** V_{max}: 3428, 3026, 2916, 1651, 1576, 1511, 1454, 1338, 1173, 1030, 818, 747 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 8.03 (d, *J* = 15.2 Hz, 1H), 7.96 – 7.90 (m, 2H), 7.57 – 7.48 (m, 2H), 7.43 – 7.33 (m, 4H), 7.32 – 7.23 (m, 4H), 6.77 (t, *J* = 7.5 Hz, 1H), 6.69 (d, *J* = 8.2 Hz, 1H), 4.59 (t, *J* = 5.7 Hz, 1H), 4.42 (d, *J* = 5.4 Hz, 2H), 2.44 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 189.92, 147.39, 143.91, 139.91, 138.97, 136.10, 132.15, 129.66, 129.11, 128.91, 128.61, 127.78, 127.76, 122.46, 120.88, 117.90, 112.21, 48.49, 22.01.

HRMS (ESI): exact mass calcd for $C_{23}H_{22}NO$: m/z 328.1701 $[M+H]^+$, found: m/z 328.1696.



4h

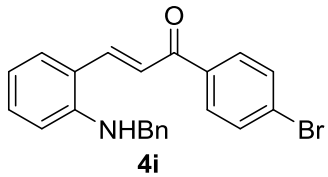
Following the general procedure, compound **4h** was isolated as a yellow solid in 48% yield (1.67 g).

M.p. 129.0-129.4 °C; **IR (KBr)** V_{max}: 3399, 3021, 2919, 1651, 1587, 1510, 1338, 1217, 1086, 1035, 827, 743, 482 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 8.10 – 7.99 (m, 1H), 7.98 – 7.91 (m, 2H), 7.54 (d, *J* = 7.8 Hz, 1H), 7.50 – 7.40 (m, 3H), 7.40 – 7.24 (m, 6H), 6.76 (t, *J* = 7.5 Hz, 1H), 6.69 (d, *J* = 8.0 Hz, 1H), 4.60 (t, *J* = 5.1 Hz, 1H), 4.42 (d, *J* = 5.0 Hz, 2H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 189.02, 147.52, 140.81, 139.48, 138.83, 136.94, 132.54, 130.15, 129.25, 129.13, 128.63, 127.84, 127.76, 121.54, 120.49, 117.94, 112.32, 48.45.

HRMS (ESI): exact mass calcd for $C_{22}H_{19}ClNO$: m/z 348.1155 $[M+H]^+$, found: m/z 348.1150.



4i

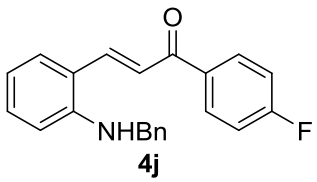
Following the general procedure, compound **4i** was isolated as a yellow solid in 43% yield (1.69 g).

M.p. 135.0-135.3 °C; **IR (KBr)** V_{max}: 3432, 3025, 2920, 1650, 1584, 1512, 1338, 1218, 1034, 824, 750, 470 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 8.05 (d, *J* = 15.1 Hz, 1H), 7.89 – 7.84 (m, 2H), 7.70 – 7.58 (m, 2H), 7.57 – 7.51 (m, 1H), 7.44 (d, *J* = 15.4 Hz, 1H), 7.41 – 7.19 (m, 6H), 6.76 (t, *J* = 7.5 Hz, 1H), 6.69 (d, *J* = 8.3 Hz, 1H), 4.60 (t, *J* = 5.4 Hz, 1H), 4.41 (d, *J* = 5.4 Hz, 2H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 189.23, 147.56, 140.91, 138.86, 137.40, 132.54, 132.24, 130.26, 129.13, 128.67, 128.16, 127.84, 127.76, 121.54, 120.53, 117.97, 112.36, 48.49.

HRMS (ESI): exact mass calcd for $C_{22}H_{19}BrNO$: m/z 392.0650 $[M+H]^+$, found: m/z 392.0645.



4j

Following the general procedure, compound **4j** was isolated as a yellow solid in 38% yield (1.26 g).

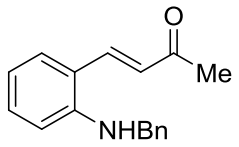
M.p. 100.3-100.6 °C; **IR (KBr)** V_{max}: 3434, 3024, 2909, 1651, 1569, 1506, 1337, 1215, 1029, 832, 750 cm^{-1}.

^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 8.32 – 8.23 (m, 2H), 8.18 (dd, *J* = 15.2, 2.8 Hz, 1H), 7.78 – 7.71 (m, 2H), 7.57 – 7.42 (m, 2H), 7.41 – 7.25 (m, 5H), 7.24 – 7.18 (m, 1H), 6.75 – 6.65 (m, 2H), 6.35 – 6.08 (m, 1H), 4.59 – 4.55 (m, 2H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 189.01, 167.01 (d, *J* = 251.5 Hz), 149.46, 141.61, 141.56, 136.78, 133.38, 132.83, 132.76, 130.02, 129.61, 128.72, 128.41, 122.24, 121.80, 118.36, 117.19, 117.01, 113.72, 48.62.

^{19}F NMR (470 MHz, $(CD_3)_2CO$): δ -108.40.

HRMS (ESI): exact mass calcd for $C_{22}H_{19}FNO$: m/z 332.1451 $[M+H]^+$, found: m/z 332.1445.



4k

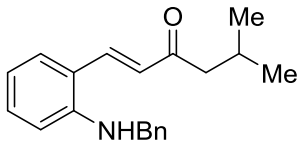
Following the general procedure, compound **4k** was isolated as a yellow solid in 30% yield (0.75 g).

M.p. 101.7-102.5 °C; **IR (KBr)** V_{max}: 3416, 3025, 2926, 1640, 1600, 1513, 1453, 1361, 1266, 1172, 971, 734, 483 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.72 (d, *J* = 15.8 Hz, 1H), 7.41 (dd, *J* = 7.7, 1.7 Hz, 1H), 7.39 – 7.27 (m, 5H), 7.25 – 7.20 (m, 1H), 6.77 – 6.72 (m, 1H), 6.72 – 6.63 (m, 2H), 4.51 – 4.34 (m, 3H), 2.35 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 198.37, 147.15, 138.94, 138.76, 132.14, 129.12, 128.63, 127.79, 127.67, 127.31, 120.31, 118.10, 112.37, 48.52, 28.71.

HRMS (ESI): exact mass calcd for $C_{17}H_{18}NO$: m/z 252.1388 $[M+H]^+$, found: m/z 252.1383.



4l

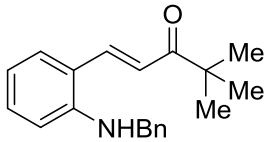
Following the general procedure, compound **4l** was isolated as a yellow solid in 20% yield (0.59 g).

M.p. 74.9-75.2 °C; **IR (KBr)** V_{max}: 3373, 2955, 1633, 1600, 1515, 1453, 1333, 1262, 1164, 977, 739 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.76 (d, *J* = 15.6 Hz, 1H), 7.42 (dd, *J* = 7.8, 1.6 Hz, 1H), 7.40 – 7.33 (m, 4H), 7.33 – 7.27 (m, 1H), 7.24 – 7.20 (m, 1H), 6.76 – 6.68 (m, 2H), 6.66 (dd, *J* = 8.3, 1.1 Hz, 1H), 4.48 (s, 1H), 4.41 (s, 2H), 2.49 (d, *J* = 7.0 Hz, 2H), 2.29 – 2.10 (m, 1H), 0.98 (d, *J* = 6.6 Hz, 6H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 200.38, 147.23, 138.98, 137.77, 132.04, 129.11, 128.51, 127.78, 127.68, 126.68, 120.41, 117.99, 112.28, 51.33, 48.50, 25.67, 23.07.

HRMS (ESI): exact mass calcd for $C_{20}H_{24}NO$: m/z 294.1858 $[M+H]^+$, found: m/z 294.1852.



4m

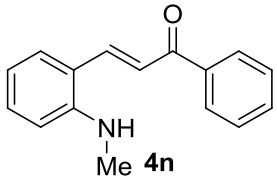
Following the general procedure, compound **4m** was isolated as a yellow solid in 22% yield (0.65 g).

M.p. 94.1-94.5 °C; **IR (KBr)** V_{max}: 3442, 3025, 2964, 1668, 1580, 1511, 1467, 1336, 1083, 981, 752 cm^{-1}.

^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 7.96 (d, *J* = 15.2 Hz, 1H), 7.62 – 7.58 (m, 1H), 7.49 – 7.44 (m, 2H), 7.39 – 7.33 (m, 2H), 7.29 – 7.23 (m, 2H), 7.19 – 7.14 (m, 1H), 6.66 (t, *J* = 7.4 Hz, 2H), 6.06 (t, *J* = 5.7 Hz, 1H), 4.54 (d, *J* = 5.8 Hz, 2H), 1.24 (s, 9H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 204.29, 149.11, 141.62, 139.32, 132.84, 129.99, 129.24, 128.70, 128.36, 122.06, 121.85, 118.24, 113.50, 48.59, 44.27, 27.31.

HRMS (ESI): exact mass calcd for $C_{20}H_{24}NO$: m/z 294.1858 $[M+H]^+$, found: m/z 294.1852.



4n

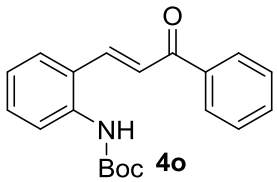
Following the general procedure to afford corresponding 2-aminochalcone. To a solution of 2-aminochalcone (1.0 equiv.) in acetonitrile (1 M), potassium carbonate (1.0 equiv.) and iodomethane (2.0 equiv.) was added and stirred at room temperature overnight. After 2-aminochalcone was consumed completely, the potassium carbonate was filter out and the solvent was evaporated under reduced presure. The residue was purified by column chromatography on silica gel (EtOAc/petroleum ether = 1: 7) to give the desired compound **4n** as a yellow solid in 55% yield (1.31 g).

M.p. 85.6-86.4 °C; **IR (KBr)** V_{max}: 3336, 3226, 2923, 1654, 1577, 1453, 1340, 1211, 1013, 736, 684 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 8.09 – 7.95 (m, 3H), 7.61 – 7.45 (m, 5H), 7.36 – 7.29 (m, 1H), 6.80 – 6.73 (m, 1H), 6.69 (d, *J* = 8.3 Hz, 1H), 4.28 (d, *J* = 6.5 Hz, 1H), 2.92 (d, *J* = 5.1 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 190.51, 148.65, 140.39, 138.72, 133.02, 132.38, 128.94, 128.76, 128.42, 122.10, 120.48, 117.45, 111.26, 30.92.

HRMS (ESI): exact mass calcd for $C_{16}H_{16}NO$: m/z 238.1232 $[M+H]^+$, found: m/z 238.1227.



4o

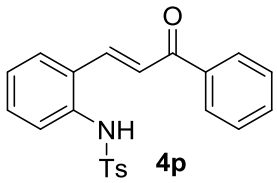
4o was prepared according to references[4] and obtained as a white solid in 60% yield (1.94 g).

M.p. 97.2-97.8 °C; **IR (KBr)** V_{max}: 3259, 2976, 1723, 1653, 1599, 1482, 1333, 1242, 1160, 1015, 751, 689 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 8.06 – 8.02 (m, 2H), 8.00 (d, *J* = 15.3 Hz, 1H), 7.85 (d, *J* = 8.3 Hz, 1H), 7.65 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.63 – 7.57 (m, 1H), 7.56 – 7.48 (m, 3H), 7.40 (td, *J* = 8.3, 7.8, 1.5 Hz, 1H), 7.15 (t, *J* = 7.5 Hz, 1H), 6.63 (s, 1H), 1.53 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 190.18, 153.25, 139.49, 138.28, 137.53, 133.38, 131.46, 129.04, 128.85, 127.58, 126.72, 124.63, 124.32, 123.16, 81.43, 28.63.

HRMS (ESI): exact mass calcd for $C_{20}H_{22}NO_3$: m/z 324.1600 $[M+H]^+$, found: m/z 324.1595.



4p

4p was prepared according to references[4] and obtained as a white solid in 72% yield (2.72 g).

M.p. 171.9-172.9 °C; **IR (KBr)** V_{max}: 3184, 3065, 1655, 1596, 1454, 1339, 1216, 1159, 1020, 758, 689, 553 cm^{-1}.

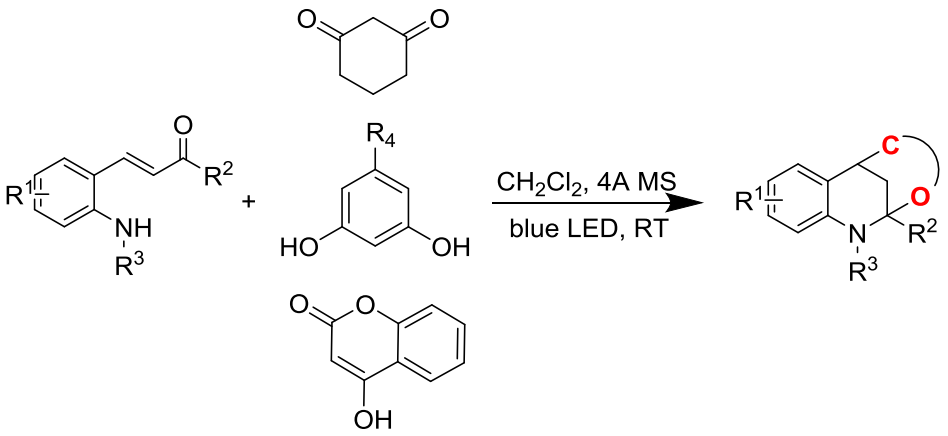
^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 8.94 (s, 1H), 8.15 – 8.08 (m, 2H), 7.96 (dd, *J* = 7.8, 1.6 Hz, 1H), 7.92 (d, *J* = 15.6 Hz, 1H), 7.72 – 7.66 (m, 1H), 7.65 – 7.51 (m, 5H), 7.44 (td, *J* = 7.6, 1.6 Hz, 1H), 7.38 (td, *J* = 7.6, 1.4 Hz, 1H), 7.32 (dd, *J* = 7.9, 1.4 Hz, 1H), 7.27 (d, *J* = 8.0 Hz, 2H), 2.25 (s, 3H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 190.59, 145.12, 140.98, 139.73, 138.66, 137.75, 134.38, 133.83, 132.32, 131.18, 130.29, 130.08, 129.77, 128.92, 128.82, 128.74, 125.09, 22.02.

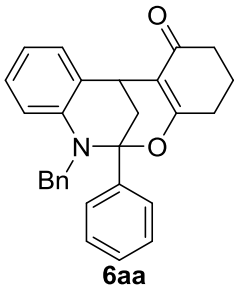
HRMS (ESI): exact mass calcd for $C_{22}H_{20}NO_3S$: m/z 378.1164 $[M+H]^+$, found: m/z 378.1158.

3. Substrate Scope of the Visible-Light Driven Reaction

General Procedure for Visible-light driven Synthesis of flavonoids 11, 12, 14.



2-Aminochalcone (0.1 mmol), bifunctional nucleophile (0.12 mmol), 4Å molecular sieves (100mg) and dichloromethane (3.0 mL) were added to a reaction tube equipped with a magnetic stir bar. The mixture was stirred under the irradiation by blue LED at room temperature under argon overnight and monitored by TLC. After 2-aminochalcone was consumed, the solvent was removed by rotary evaporator. The residue was directly purified by column chromatography on silica gel (**6aa-6am, 6co-6cv, 6ba-6bn**: EtOAc/Petroleum ether = 1: 10; **6ca-6cn**: EtOAc/DCM = 1: 15) to yield the desired products.



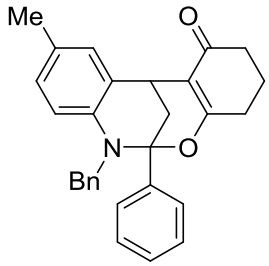
6aa

Following the **general procedure**, compound **6aa** was isolated as a white solid in 99% yield (40.8 mg). **M.p.** 173.0-173.3 ^{o}C; **IR (KBr)** V_{max}: 3024, 2937, 1651, 1615, 1491, 1453, 1379, 1178, 1059, 1025, 992, 861, 819, 753 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.69 – 7.50 (m, 2H), 7.52 – 7.29 (m, 4H), 7.21 – 7.04 (m, 3H), 6.98 (t, *J* = 7.9 Hz, 1H), 6.91 (d, *J* = 6.8 Hz, 2H), 6.76 (t, *J* = 7.5 Hz, 1H), 6.68 (d, *J* = 8.1 Hz, 1H), 4.72 (d, *J* = 17.5 Hz, 1H), 4.34 (d, *J* = 17.5 Hz, 1H), 4.16 (s, 1H), 2.55 – 2.24 (m, 4H), 2.14 – 1.85 (m, 4H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 196.90, 170.14, 142.06, 141.90, 139.42, 128.92, 128.80, 128.51, 128.38, 128.18, 127.20, 126.82, 126.69, 126.50, 118.90, 115.84, 112.97, 92.38, 50.37, 37.73, 37.18, 28.50, 21.17.

HRMS (ESI): exact mass calcd for $C_{28}H_{26}NO_2$: m/z 408.1964 $[M+H]^+$, found: m/z 408.1958.



6ab

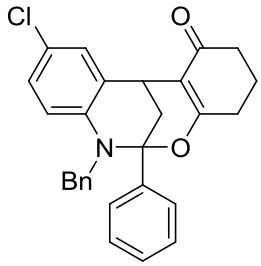
Following the **general procedure**, compound **6ab** was isolated as a yellow solid in 96% yield (40.4 mg).

M.p. 109.3-110.0 °C; **IR (KBr)** V_{max}: 3028, 2934, 1688, 1593, 1492, 1348, 1253, 1156, 1114, 1017, 881, 839, 700, 583 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.55 (d, *J* = 7.5 Hz, 2H), 7.44 – 7.32 (m, 3H), 7.31 – 7.26 (m, 1H), 7.16 – 7.05 (m, 3H), 6.91 (d, *J* = 6.7 Hz, 3H), 6.79 (dd, *J* = 8.2, 2.3 Hz, 1H), 6.58 (d, *J* = 8.2 Hz, 1H), 4.69 (d, *J* = 17.4 Hz, 1H), 4.30 (d, *J* = 17.4 Hz, 1H), 4.11 (t, 1H), 2.53 – 2.26 (m, 4H), 2.25 (s, 3H), 2.14 – 1.86 (m, 4H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 197.01, 170.31, 142.19, 139.63, 139.55, 128.89, 128.86, 128.74, 128.46, 128.37, 128.04, 127.73, 126.84, 126.65, 126.52, 115.81, 112.85, 92.53, 50.37, 37.88, 37.24, 28.53, 28.46, 21.19, 20.75.

HRMS (ESI): exact mass calcd for $C_{29}H_{28}NO_2$: m/z 422.2120 $[M+H]^+$, found: m/z 422.2115.



6ac

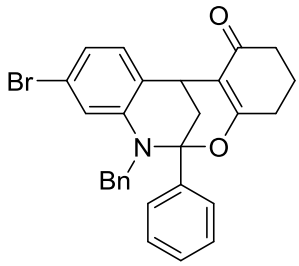
Following the **general procedure**, compound **6ac** was isolated as a white solid in 91% yield (40.1 mg).

M.p. 175.8-176.1 °C; **IR (KBr)** V_{max}: 3056, 2952, 1650, 1616, 1485, 1379, 1179, 1024, 856, 805, 700 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.54 (d, *J* = 7.5 Hz, 2H), 7.46 – 7.35 (m, 4H), 7.20 – 7.07 (m, 3H), 7.01 – 6.82 (m, 3H), 6.56 (d, *J* = 8.8 Hz, 1H), 4.63 (d, *J* = 17.4 Hz, 1H), 4.34 (d, *J* = 17.4 Hz, 1H), 4.11 (t, *J* = 3.1 Hz, 1H), 2.56 – 2.21 (m, 4H), 2.16 – 1.88 (m, 4H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 196.73, 170.26, 141.60, 140.45, 138.82, 130.30, 129.03, 128.67, 128.50, 127.90, 126.95, 126.89, 126.72, 126.38, 123.58, 115.19, 114.02, 92.14, 50.50, 37.46, 37.12, 28.47, 28.37, 21.12.

HRMS (ESI): exact mass calcd for $C_{28}H_{24}ClNNaO_2$: m/z 464.1393 $[M+Na]^+$, found: m/z 464.1388.



6ad

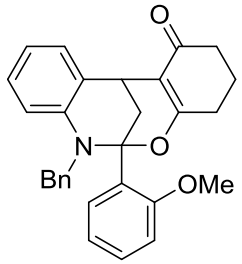
Following the **general procedure**, compound **6ad** was isolated as a white solid in 90% yield (43.7 mg).

M.p. 167.8-168.2 ^{o}C; **IR (KBr)** V_{max}: 3028, 2940, 1653, 1619, 1484, 1376, 1174, 1024, 818, 757, 696 cm^{-1}.

^{1}H NMR (500 MHz, CDCl$_3$): δ 7.54 (d, *J* = 7.5 Hz, 2H), 7.45 – 7.34 (m, 3H), 7.31 (d, *J* = 7.9 Hz, 1H), 7.21 – 7.06 (m, 3H), 6.97 – 6.79 (m, 4H), 4.63 (d, *J* = 17.4 Hz, 1H), 4.31 (d, *J* = 17.4 Hz, 1H), 4.10 (t, *J* = 3.0 Hz, 1H), 2.52 – 2.19 (m, 4H), 2.09 – 1.84 (m, 4H).

^{13}C NMR (126 MHz, CDCl$_3$): δ 196.81, 170.03, 143.37, 141.49, 138.68, 129.32, 129.03, 128.71, 128.55, 127.77, 126.99, 126.85, 126.39, 121.69, 120.87, 115.90, 115.44, 91.89, 50.33, 37.49, 37.10, 28.37, 28.15, 21.10.

HRMS (ESI): exact mass calcd for $C_{28}H_{25}BrNO_2$: m/z 486.1069 $[M+H]^+$, found: m/z 486.1063.



6ae

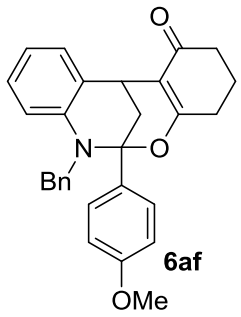
Following the **general procedure**, compound **6ae** was isolated as a red solid in 95% yield (41.5 mg).

M.p. 136.5-136.8 ^{o}C; **IR (KBr)** V_{max}: 3036, 2937, 1650, 1611, 1490, 1380, 1247, 1176, 1117, 1024, 815, 749 cm^{-1}.

^{1}H NMR (500 MHz, CDCl$_3$): δ 7.84 (d, *J* = 7.3 Hz, 1H), 7.44 (dd, *J* = 7.4, 1.7 Hz, 1H), 7.39 – 7.32 (m, 1H), 7.15 – 7.00 (m, 4H), 6.95 – 6.89 (m, 4H), 6.71 (t, *J* = 7.3 Hz, 1H), 6.49 (d, *J* = 8.1 Hz, 1H), 4.53 – 4.40 (m, 2H), 4.14 (t, *J* = 3.0 Hz, 1H), 3.68 (s, 3H), 2.67 (dd, *J* = 12.9, 2.6 Hz, 1H), 2.61 – 2.51 (m, 1H), 2.46 – 2.26 (m, 3H), 2.06 – 1.87 (m, 3H).

^{13}C NMR (126 MHz, CDCl$_3$): δ 197.01, 169.60, 156.42, 141.52, 139.72, 129.99, 129.08, 128.87, 128.37, 127.63, 126.90, 126.72, 126.54, 120.80, 118.10, 115.97, 112.25, 111.61, 91.63, 55.91, 49.27, 37.30, 33.09, 28.81, 28.65, 21.31.

HRMS (ESI): exact mass calcd for $C_{29}H_{28}NO_3$: m/z 438.2069 $[M+H]^+$, found: m/z 438.2064.

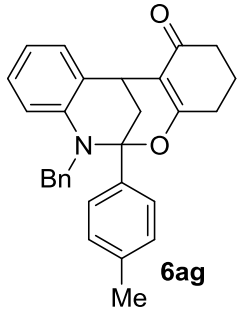


Following the **general procedure**, compound **6af** was isolated as a white solid in 87% yield (38.3 mg). **M.p.** 172.8-173.5 °C; **IR (KBr)** V_{max}: 3042, 2948, 1650, 1612, 1501, 1381, 1250, 1173, 1028, 846, 749 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.51 – 7.39 (m, 3H), 7.16 – 7.07 (m, 3H), 7.00 – 6.85 (m, 6H), 6.79 – 6.69 (m, 1H), 6.66 (d, *J* = 8.2 Hz, 1H), 4.69 (d, *J* = 17.5 Hz, 1H), 4.36 (d, *J* = 17.5 Hz, 1H), 4.13 (t, *J* = 3.1 Hz, 1H), 3.83 (s, 19H), 2.51 – 2.23 (m, 4H), 2.12 – 1.84 (m, 4H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 196.93, 170.26, 141.90, 139.49, 139.14, 138.29, 129.61, 128.81, 128.37, 128.15, 127.15, 126.81, 126.65, 126.39, 118.81, 115.79, 112.93, 92.43, 50.26, 37.77, 37.19, 28.54, 28.51, 21.44, 21.18.

HRMS (ESI): exact mass calcd for $C_{29}H_{28}NO_3$: m/z 438.2069 $[M+H]^+$, found: m/z 438.2064.

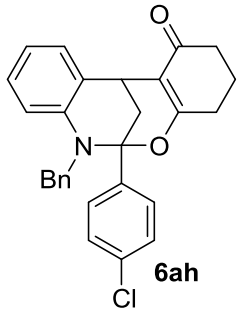


Following the **general procedure**, compound **6ag** was isolated as a white solid in 79% yield (33.2 mg). **M.p.** 196.5-197.0 °C; **IR (KBr)** V_{max}: 3036, 2950, 1648, 1614, 1491, 1381, 1180, 1111, 1026, 814, 738 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.53 – 7.35 (m, 3H), 7.22 (d, *J* = 7.9 Hz, 2H), 7.17 – 7.06 (m, 4H), 6.98 (t, *J* = 7.8 Hz, 1H), 6.91 (d, *J* = 7.1 Hz, 2H), 6.75 (t, *J* = 7.3 Hz, 1H), 6.67 (d, *J* = 8.1 Hz, 1H), 4.70 (d, *J* = 17.5 Hz, 1H), 4.36 (d, *J* = 17.5 Hz, 1H), 4.15 (s, 1H), 2.48 (dt, *J* = 17.4, 5.9 Hz, 1H), 2.39 (s, 5H), 2.30 (ddd, *J* = 27.2, 11.1, 3.8 Hz, 2H), 2.14 – 1.86 (m, 3H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 196.93, 170.26, 141.90, 139.49, 139.14, 138.29, 129.61, 128.81, 128.37, 128.15, 127.15, 126.81, 126.65, 126.39, 118.81, 115.79, 112.93, 92.43, 50.26, 37.77, 37.19, 28.54, 28.51, 21.44, 21.18.

HRMS (ESI): exact mass calcd for $C_{29}H_{28}NO_2$: m/z 422.2120 $[M+H]^+$, found: m/z 422.2115.



6ah

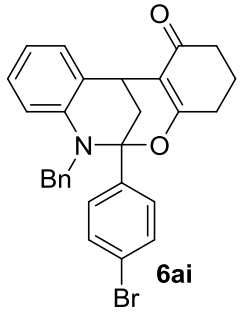
Following the **general procedure**, compound **6ah** was isolated as a white solid in 82% yield (36.3 mg).

M.p. 177.6-177.9 °C; **IR (KBr)** V_{max}: 3054, 2952, 1654, 1620, 1489, 1380, 1180, 1105, 1023, 853, 745 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.54 – 7.41 (m, 3H), 7.37 (d, *J* = 8.4 Hz, 2H), 7.20 – 7.06 (m, 3H), 7.02 – 6.96 (m, 1H), 6.93 – 6.85 (m, 2H), 6.76 (t, *J* = 7.4 Hz, 1H), 6.70 (d, *J* = 8.1 Hz, 1H), 4.71 (d, *J* = 17.4 Hz, 1H), 4.29 (d, *J* = 17.4 Hz, 1H), 4.15 (s, 1H), 2.53 – 2.34 (m, 2H), 2.35 – 2.22 (m, 2H), 2.09 – 1.84 (m, 4H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 196.84, 169.84, 141.79, 140.68, 139.24, 134.47, 129.11, 128.71, 128.45, 128.25, 128.04, 127.30, 126.82, 126.80, 119.15, 115.88, 113.09, 91.98, 50.36, 37.64, 37.13, 28.41, 28.39, 21.12.

HRMS (ESI): exact mass calcd for $C_{28}H_{25}ClNO_2$: m/z 442.1574 $[M+H]^+$, found: m/z 442.1568.



6ai

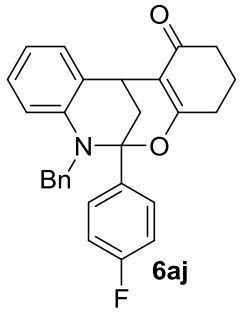
Following the **general procedure**, compound **6ai** was isolated as a white solid in 85% yield (41.3 mg).

M.p. 187.8-188.0 °C; **IR (KBr)** V_{max}: 3052, 2949, 1653, 1617, 1487, 1379, 1174, 1108, 1061, 996, 817, 738, 615 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.68 – 7.37 (m, 5H), 7.20 – 7.07 (m, 3H), 6.99 (t, *J* = 7.8 Hz, 1H), 6.96 – 6.85 (m, 2H), 6.76 (t, *J* = 7.4 Hz, 1H), 6.69 (d, *J* = 8.2 Hz, 1H), 4.71 (d, *J* = 17.4 Hz, 1H), 4.29 (d, *J* = 17.4 Hz, 1H), 4.15 (s, 1H), 2.51 – 2.22 (m, 4H), 2.09 – 1.85 (m, 4H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 196.84, 169.83, 141.73, 141.21, 139.18, 132.07, 128.65, 128.44, 128.36, 128.23, 127.29, 126.81, 126.77, 122.64, 119.14, 115.84, 113.06, 91.99, 50.35, 37.58, 37.13, 28.38, 21.11.

HRMS (ESI): exact mass calcd for $C_{28}H_{25}BrNO_2$: m/z 486.1069 $[M+H]^+$, found: m/z 486.1063.



6aj

Following the **general procedure**, compound **6aj** was isolated as a white solid in 96% yield (40.8 mg).

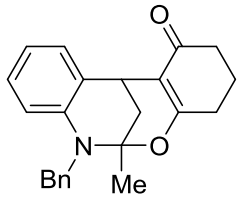
M.p. 164.5-165.2 °C; **IR (KBr)** V_{max}: 3037, 2936, 1651, 1613, 1498, 1381, 1220, 1174, 1109, 1060, 1024, 990, 804, 743 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.64 – 7.49 (m, 2H), 7.46 (d, *J* = 7.3 Hz, 1H), 7.19 – 7.04 (m, 5H), 7.03 – 6.88 (m, 3H), 6.76 (t, *J* = 7.5 Hz, 1H), 6.69 (d, *J* = 8.2 Hz, 1H), 4.71 (d, *J* = 17.4 Hz, 1H), 4.32 (d, *J* = 17.4 Hz, 1H), 4.15 (s, 1H), 2.53 – 2.24 (m, 4H), 2.13 – 1.84 (m, 4H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 196.87, 169.93, 162.78 (d, *J* = 247.5 Hz), 141.85, 139.27, 137.82 (d, *J* = 2.9 Hz), 128.68, 128.41, 128.35, 128.21, 127.26, 126.77, 119.06, 115.85, 115.68, 113.05, 91.99, 50.28, 37.70, 37.12, 28.41, 21.12.

^{19}F NMR (470 MHz, $CDCl_3$): δ -113.96.

HRMS (ESI): exact mass calcd for $C_{28}H_{25}BrNO_2$: m/z 426.1869 $[M+H]^+$, found: m/z 426.1864.



6ak

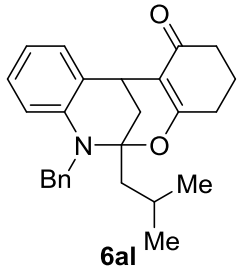
Following the **general procedure**, compound **6ak** was isolated as a white solid in 93% yield (32.1 mg).

M.p. 182.0-182.4 °C; **IR (KBr)** V_{max}: 2947, 1644, 1609, 1493, 1383, 1289, 1160, 1114, 1057, 850, 745 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.41 (dd, *J* = 7.4, 1.9 Hz, 1H), 7.38 – 7.31 (m, 2H), 7.31 – 7.22 (m, 3H), 7.04 – 6.88 (m, 1H), 6.72 (t, *J* = 7.4 Hz, 1H), 6.52 (d, *J* = 8.1 Hz, 1H), 5.05 (d, *J* = 18.3 Hz, 1H), 4.46 (d, *J* = 18.3 Hz, 1H), 4.14 (t, *J* = 2.9 Hz, 1H), 2.46 – 2.23 (m, 5H), 2.06 – 1.90 (m, 3H), 1.68 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 196.64, 170.28, 143.51, 140.04, 128.91, 128.30, 128.07, 127.32, 126.96, 126.23, 118.74, 116.05, 112.60, 88.65, 50.22, 36.94, 34.77, 28.68, 27.37, 27.07, 21.20.

HRMS (ESI): exact mass calcd for $C_{23}H_{24}NO_2$: m/z 346.1807 $[M+H]^+$, found: m/z 346.1802.



6al

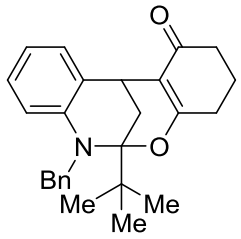
Following the **general procedure**, compound **6al** was isolated as a white solid in 92% yield (35.7 mg).

M.p. 114.0-114.5 °C; **IR (KBr)** V_{max}: 2957, 1645, 1610, 1493, 1455, 1381, 1241, 1122, 1032, 783cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.39 (dd, *J* = 7.5, 1.7 Hz, 1H), 7.32 – 7.25 (m, 2H), 7.24 – 7.20 (m, 1H), 7.17 (d, *J* = 7.5 Hz, 2H), 7.01 – 6.89 (m, 1H), 6.71 (t, *J* = 7.3 Hz, 1H), 6.57 (d, *J* = 8.1 Hz, 1H), 4.99 (d, *J* = 18.0 Hz, 1H), 4.50 (d, *J* = 18.0 Hz, 1H), 4.11 (t, *J* = 3.0 Hz, 1H), 2.39 – 2.21 (m, 3H), 2.21 – 2.06 (m, 3H), 2.00 – 1.84 (m, 4H), 1.81 – 1.69 (m, 1H), 0.95 (d, *J* = 6.6 Hz, 3H), 0.83 (d, *J* = 6.7 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 155.59, 154.34, 145.45, 140.44, 134.00, 130.39, 128.25, 127.67, 126.80, 126.27, 124.70, 119.14, 117.83, 117.47, 108.80, 104.42, 91.72, 53.16, 40.74, 35.29, 32.64, 27.92.

HRMS (ESI): exact mass calcd for $C_{26}H_{30}NO_2$: m/z 388.2277 $[M+H]^+$, found: m/z 388.2271.



6am

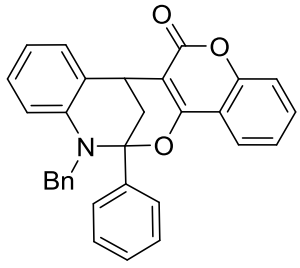
Following the **general procedure**, compound **6am** was isolated as a white solid in 92% yield (35.8 mg).

M.p. 151.8-152.3 °C; **IR (KBr)** V_{max}: 2954, 1651, 1614, 1490, 1382, 1249, 1118, 1035, 993, 803, 737 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.36 (d, *J* = 7.2 Hz, 1H), 7.25 – 7.12 (m, 3H), 7.08 (d, *J* = 7.4 Hz, 2H), 6.87 (t, *J* = 7.7 Hz, 1H), 6.71 (d, *J* = 8.1 Hz, 2H), 4.97 (d, *J* = 17.2 Hz, 1H), 4.62 (d, *J* = 17.2 Hz, 1H), 3.96 (s, 1H), 2.48 – 2.31 (m, 2H), 2.28 – 2.19 (m, 1H), 2.18 – 2.02 (m, 3H), 2.01 – 1.84 (m, 2H), 1.21 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 197.04, 170.23, 145.44, 140.76, 131.87, 128.50, 127.38, 127.23, 126.79, 126.60, 119.78, 116.53, 115.12, 94.38, 53.08, 40.44, 37.15, 31.70, 28.49, 28.16, 27.80, 21.16.

HRMS (ESI): exact mass calcd for $C_{26}H_{30}NO_2$: m/z 388.2277 $[M+H]^+$, found: m/z 388.2271.



6ba

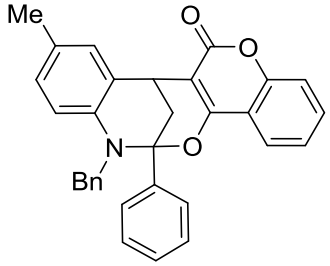
Following the **general procedure**, compound **6ba** was isolated as a yellow solid in 99% yield (45.3 mg).

M.p. 159.8-160.1 °C; **IR (KBr)** V_{max}: 3032, 2897, 1701, 1617, 1489, 1386, 1167, 1037, 978, 920, 852, 793, 753 cm^{-1}.

^{1}H NMR (500 MHz, CD_2Cl_2): δ 7.85 (dd, *J* = 7.9, 1.7 Hz, 1H), 7.73 (d, *J* = 7.5 Hz, 2H), 7.57 – 7.40 (m, 5H), 7.33 (d, *J* = 8.3 Hz, 1H), 7.29 – 7.23 (m, 1H), 7.03 – 6.97 (m, 1H), 6.95 – 6.81 (m, 5H), 6.78 (t, *J* = 7.4 Hz, 1H), 6.71 (d, *J* = 8.2 Hz, 1H), 4.71 (d, *J* = 17.2 Hz, 1H), 4.48 (d, *J* = 17.2 Hz, 1H), 4.28 (t, *J* = 3.0 Hz, 1H), 2.55 (dd, *J* = 13.4, 2.6 Hz, 1H), 2.36 (dd, *J* = 13.4, 3.4 Hz, 1H).

^{13}C NMR (126 MHz, CD_2Cl_2): δ 162.10, 159.00, 152.68, 141.89, 141.53, 138.77, 132.00, 129.16, 128.87, 128.33, 128.23, 127.70, 127.57, 126.86, 126.71, 126.63, 124.12, 123.14, 119.07, 116.78, 116.06, 113.42, 105.75, 93.50, 51.14, 37.27, 30.37.

HRMS (ESI): exact mass calcd for $C_{31}H_{24}NO_3$: m/z 458.1756 $[M+H]^+$, found: m/z 458.1751.



6bb

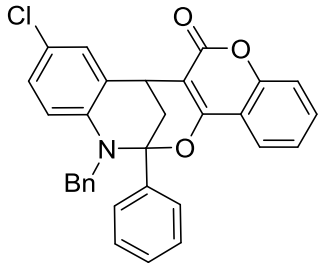
Following the **general procedure**, compound **6bb** was isolated as an orange solid in 84% yield (39.6 mg).

M.p. 138.2-138.6 °C; **IR (KBr)** V_{max}: 3028, 2853, 1720, 1628, 1495, 1385, 1168, 1027, 978, 747, 692 cm^{-1}.

^{1}H NMR (500 MHz, CD_2Cl_2): δ 7.84 (dd, *J* = 7.9, 1.7 Hz, 1H), 7.79 – 7.61 (m, 2H), 7.57 – 7.39 (m, 4H), 7.37 – 7.29 (m, 2H), 7.29 – 7.22 (m, 1H), 6.98 – 6.67 (m, 6H), 6.59 (d, *J* = 8.3 Hz, 1H), 4.67 (d, *J* = 17.2 Hz, 1H), 4.45 (d, *J* = 17.2 Hz, 1H), 4.23 (t, *J* = 3.0 Hz, 1H), 2.52 (dd, *J* = 13.4, 2.6 Hz, 1H), 2.34 (dd, *J* = 13.3, 3.4 Hz, 1H), 2.25 (s, 3H).

^{13}C NMR (126 MHz, CD_2Cl_2): δ 162.16, 159.11, 152.70, 141.71, 139.46, 139.00, 131.96, 129.14, 128.82, 128.79, 128.42, 128.31, 128.17, 127.55, 126.89, 126.66, 124.10, 123.16, 116.77, 116.13, 113.35, 105.72, 93.72, 51.12, 37.47, 30.38, 20.43.

HRMS (ESI): exact mass calcd for $C_{32}H_{26}NO_3$: m/z 472.1913 $[M+H]^+$, found: m/z 472.1907.



6bc

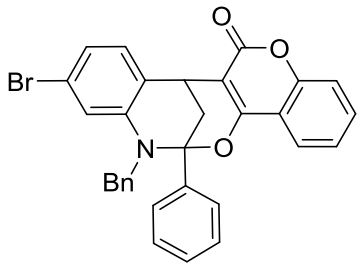
Following the **general procedure**, compound **6bc** was isolated as a pink solid in 99% yield (48.6 mg).

M.p. 134.2-134.6 °C; **IR (KBr)** V_{max}: 3030, 2865, 1706, 1622, 1488, 1388, 1170, 1028, 980, 798, 759, 698 cm^{-1}.

^{1}H NMR (500 MHz, CD_2Cl_2): δ 7.84 (dd, *J* = 7.9, 1.6 Hz, 1H), 7.71 (d, *J* = 7.6 Hz, 2H), 7.58 – 7.40 (m, 5H), 7.39 – 7.30 (m, 1H), 7.29 – 7.22 (m, 1H), 6.96 (dd, *J* = 8.7, 2.6 Hz, 1H), 6.94 – 6.76 (m, 5H), 6.62 (d, *J* = 8.7 Hz, 1H), 4.65 (d, *J* = 17.3 Hz, 1H), 4.48 (d, *J* = 17.2 Hz, 1H), 4.24 (t, *J* = 3.0 Hz, 1H), 2.52 (dd, *J* = 13.5, 2.6 Hz, 1H), 2.36 (dd, *J* = 13.5, 3.4 Hz, 1H).

^{13}C NMR (126 MHz, CD_2Cl_2): δ 162.00, 159.17, 152.75, 141.14, 140.68, 138.26, 132.22, 129.27, 129.24, 129.05, 128.44, 127.79, 127.38, 126.89, 126.83, 126.58, 124.23, 123.68, 123.17, 116.89, 115.91, 114.68, 105.09, 93.30, 51.26, 37.02, 30.27.

HRMS (ESI): exact mass calcd for $C_{31}H_{23}ClNO_3$: m/z 492.1366 $[M+H]^+$, found: m/z 492.1361.



6bd

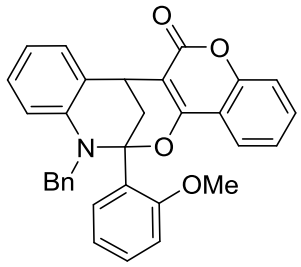
Following the **general procedure**, compound **6bd** was isolated as a yellow solid in 95% yield (51.0 mg).

M.p. 137.6-137.9 °C; **IR (KBr)** V_{max}: 3071, 2941, 1713, 1623, 1486, 1387, 1166, 1028, 979, 864, 756, 696 cm^{-1}.

^{1}H NMR (500 MHz, CD_2Cl_2): δ 7.81 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.78 – 7.59 (m, 2H), 7.57 – 7.41 (m, 4H), 7.37 (d, *J* = 7.9 Hz, 1H), 7.32 (d, *J* = 8.3 Hz, 1H), 7.28 – 7.23 (m, 1H), 6.94 – 6.77 (m, 7H), 4.63 (d, *J* = 17.2 Hz, 1H), 4.45 (d, *J* = 17.2 Hz, 1H), 4.24 (t, *J* = 3.0 Hz, 1H), 2.50 (dd, *J* = 13.5, 2.5 Hz, 1H), 2.36 (dd, *J* = 13.5, 3.5 Hz, 1H).

^{13}C NMR (126 MHz, CD_2Cl_2): δ 161.97, 158.92, 152.69, 143.38, 140.97, 137.97, 132.17, 129.40, 129.26, 129.05, 128.45, 126.96, 126.87, 126.63, 126.54, 124.21, 123.11, 121.78, 121.28, 116.84, 116.35, 115.86, 105.28, 92.94, 51.09, 37.00, 29.97.

HRMS (ESI): exact mass calcd for $C_{31}H_{23}BrNO_3$: m/z 536.0861 $[M+H]^+$, found: m/z 536.0856.



6be

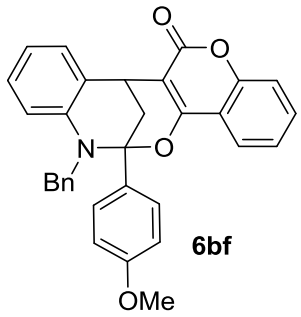
Following the **general procedure**, compound **6be** was isolated as an orange solid in 75% yield (36.6 mg).

M.p. 116.9-117.3 °C; **IR (KBr)** V_{max}: 2944, 1714, 1626, 1491, 1387, 1249, 1165, 1025, 977, 750 cm^{-1}.

^{1}H NMR (500 MHz, CD_2Cl_2): δ 8.08 (dd, *J* = 7.9, 1.8 Hz, 1H), 7.94 (dd, *J* = 8.0, 1.7 Hz, 1H), 7.58 – 7.53 (m, 1H), 7.49 – 7.41 (m, 2H), 7.36 – 7.27 (m, 2H), 7.15 – 7.10 (m, 1H), 7.04 – 6.90 (m, 3H), 6.90 – 6.80 (m, 4H), 6.77 – 6.72 (m, 1H), 6.56 (d, *J* = 8.2 Hz, 1H), 4.59 (d, *J* = 16.9 Hz, 1H), 4.49 (d, *J* = 16.9 Hz, 1H), 4.25 (t, *J* = 2.9 Hz, 1H), 3.74 (s, 3H), 2.90 (dd, *J* = 13.2, 2.6 Hz, 1H), 2.21 (dd, *J* = 13.1, 3.4 Hz, 1H).

^{13}C NMR (126 MHz, CD_2Cl_2): δ 162.22, 158.66, 156.52, 152.84, 141.62, 139.24, 131.92, 130.46, 128.82, 128.61, 128.38, 127.91, 127.73, 127.50, 126.94, 126.67, 124.14, 123.14, 121.07, 118.40, 116.87, 116.39, 112.71, 111.96, 105.85, 92.92, 56.05, 49.98, 32.84, 30.60.

HRMS (ESI): exact mass calcd for $C_{32}H_{26}NO_4$: m/z 488.1862 $[M+H]^+$, found: m/z 488.1856.



6bf

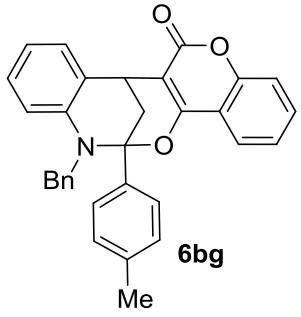
Following the **general procedure**, compound **6bf** was isolated as a yellow solid in 97% yield (47.3 mg).

M.p. 119.8-120.2 °C; **IR (KBr)** V_{max}: 2940, 2848, 1705, 1620, 1500, 1389, 1254, 1169, 1031, 978, 754 cm^{-1}.

^{1}H NMR (500 MHz, CD_2Cl_2): δ 7.83 (dd, *J* = 7.8, 1.7 Hz, 1H), 7.63 (d, *J* = 8.2 Hz, 2H), 7.56 – 7.50 (m, 1H), 7.48 (dd, *J* = 7.4, 1.7 Hz, 1H), 7.38 – 7.28 (m, 1H), 7.28 – 7.22 (m, 1H), 7.02 – 6.96 (m, 3H), 6.94 – 6.80 (m, 5H), 6.80 – 6.74 (m, 1H), 6.69 (d, *J* = 8.2 Hz, 1H), 4.69 (d, *J* = 17.2 Hz, 1H), 4.51 (d, *J* = 17.2 Hz, 1H), 4.26 (t, *J* = 2.9 Hz, 1H), 3.84 (s, 3H), 2.53 (dd, *J* = 13.4, 2.6 Hz, 1H), 2.33 (dd, *J* = 13.4, 3.4 Hz, 1H).

^{13}C NMR (126 MHz, CD_2Cl_2): δ 162.14, 160.11, 159.08, 152.68, 141.97, 138.92, 133.45, 131.96, 128.33, 128.22, 127.91, 127.67, 127.57, 126.86, 126.68, 124.09, 123.14, 119.00, 116.78, 116.10, 114.38, 113.42, 105.75, 93.45, 55.74, 50.91, 37.28, 30.43.

HRMS (ESI): exact mass calcd for $C_{32}H_{26}NO_4$: m/z 488.1862 $[M+H]^+$, found: m/z 488.1856.



6bg

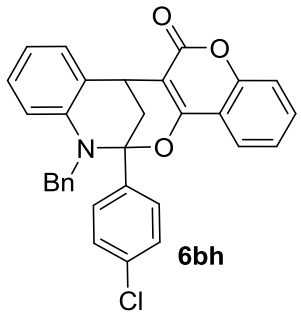
Following the **general procedure**, compound **6bg** was isolated as a white solid in 94% yield (44.4 mg).

M.p. 117.5-118.0 °C; **IR (KBr)** V_{max}: 3033, 2930, 1706, 1622, 1491, 1454, 1388, 1169, 1036, 979, 750 cm^{-1}.

^{1}H NMR (500 MHz, CD_2Cl_2): δ 7.84 (dd, *J* = 7.9, 1.7 Hz, 1H), 7.60 (d, *J* = 7.8 Hz, 2H), 7.56 – 7.50 (m, 1H), 7.48 (dd, *J* = 7.4, 1.7 Hz, 1H), 7.37 – 7.19 (m, 4H), 7.01 – 6.96 (m, 1H), 6.95 – 6.80 (m, 5H), 6.79 – 6.74 (m, 1H), 6.68 (d, *J* = 8.1 Hz, 1H), 4.68 (d, *J* = 17.2 Hz, 1H), 4.49 (d, *J* = 17.2 Hz, 1H), 4.26 (t, *J* = 3.0 Hz, 1H), 2.52 (dd, *J* = 13.4, 2.6 Hz, 1H), 2.41 (s, 3H), 2.33 (dd, *J* = 13.4, 3.4 Hz, 1H).

^{13}C NMR (126 MHz, CD_2Cl_2): δ 162.14, 159.09, 152.69, 141.90, 138.87, 138.57, 131.97, 129.81, 128.33, 128.21, 127.66, 127.60, 126.86, 126.69, 126.51, 124.10, 123.17, 119.00, 116.78, 116.10, 113.40, 105.73, 93.57, 51.04, 37.31, 30.42, 21.25.

HRMS (ESI): exact mass calcd for $C_{32}H_{26}NO_3$: m/z 472.1913 $[M+H]^+$, found: m/z 472.1907.



6bh

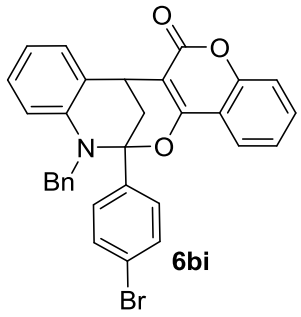
Following the **general procedure**, compound **6bh** was isolated as an orange solid in 99% yield (48.6 mg).

M.p. 123.9-124.2 °C; **IR (KBr)** V_{max}: 3029, 2937, 1709, 1622, 1489, 1387, 1167, 1036, 979, 755 cm^{-1}.

^{1}H NMR (500 MHz, CD_2Cl_2): δ 7.80 (dd, *J* = 7.9, 1.5 Hz, 1H), 7.67 (d, *J* = 8.2 Hz, 2H), 7.56 – 7.51 (m, 1H), 7.49 (dd, *J* = 7.4, 1.7 Hz, 1H), 7.47 – 7.41 (m, 2H), 7.32 (d, *J* = 8.3 Hz, 1H), 7.27 – 7.22 (m, 1H), 7.04 – 6.98 (m, 1H), 6.94 – 6.76 (m, 6H), 6.73 (d, *J* = 8.2 Hz, 1H), 4.71 (d, *J* = 17.2 Hz, 1H), 4.44 (d, *J* = 17.2 Hz, 1H), 4.28 (t, *J* = 3.0 Hz, 1H), 2.52 (dd, *J* = 13.4, 2.7 Hz, 1H), 2.34 (dd, *J* = 13.4, 3.5 Hz, 1H).

^{13}C NMR (126 MHz, CD_2Cl_2): δ 162.01, 158.81, 152.69, 141.86, 140.25, 138.65, 134.74, 132.08, 129.32, 128.40, 128.30, 127.82, 127.52, 126.87, 126.82, 124.16, 123.07, 119.34, 116.83, 115.95, 113.56, 105.82, 93.14, 51.14, 37.19, 30.32.

HRMS (ESI): exact mass calcd for $C_{31}H_{23}ClNO_3$: m/z 492.1366 $[M+H]^+$, found: m/z 492.1361.



6bi

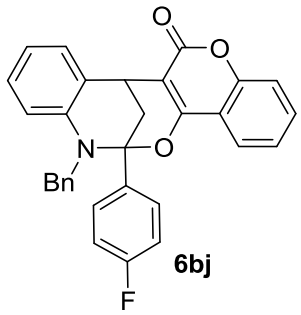
Following the **general procedure**, compound **6bi** was isolated as a pink solid in 95% yield (50.9 mg).

M.p. 121.6-122.1 °C; **IR (KBr)** V_{max}: 3031, 2938, 1712, 1626, 1489, 1389, 1167, 1034, 978, 752 cm^{-1}.

^{1}H NMR (500 MHz, CD_2Cl_2): δ 7.80 (dd, *J* = 8.0, 1.7 Hz, 1H), 7.67 – 7.57 (m, 4H), 7.56 – 7.48 (m, 2H), 7.32 (d, *J* = 8.3 Hz, 1H), 7.25 (t, *J* = 7.6 Hz, 1H), 7.04 – 6.98 (m, 1H), 6.98 – 6.75 (m, 6H), 6.72 (d, *J* = 8.2 Hz, 1H), 4.71 (d, *J* = 17.1 Hz, 1H), 4.45 (d, *J* = 17.1 Hz, 1H), 4.28 (t, *J* = 3.0 Hz, 1H), 2.52 (dd, *J* = 13.4, 2.6 Hz, 1H), 2.34 (dd, *J* = 13.4, 3.4 Hz, 1H).

^{13}C NMR (126 MHz, CD_2Cl_2): δ 161.99, 158.77, 152.64, 141.77, 140.74, 138.59, 132.28, 132.07, 128.57, 128.38, 128.27, 127.79, 127.46, 126.83, 126.80, 124.14, 123.04, 122.90, 119.31, 116.81, 115.89, 113.52, 105.78, 93.14, 51.12, 37.10, 30.26.

HRMS (ESI): exact mass calcd for $C_{31}H_{23}BrNO_3$: m/z 536.0861 $[M+H]^+$, found: m/z 536.0856.



6bj

Following the **general procedure**, compound **6bj** was isolated as a white solid in 98% yield (46.5 mg).

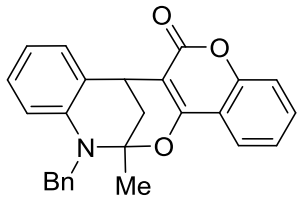
M.p. 171.8-172.0 °C; **IR (KBr)** V_{max}: 3033, 2936, 1708, 1623, 1496, 1387, 1227, 1037, 981, 847, 754 cm^{-1}.

^{1}H NMR (500 MHz, CD_2Cl_2): δ 7.81 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.77 – 7.59 (m, 2H), 7.56 – 7.51 (m, 1H), 7.49 (dd, *J* = 7.4, 1.7 Hz, 1H), 7.32 (dd, *J* = 8.4, 1.1 Hz, 1H), 7.29 – 7.23 (m, 1H), 7.19 – 7.12 (m, 2H), 7.04 – 6.97 (m, 1H), 6.94 – 6.76 (m, 6H), 6.72 (d, *J* = 8.2 Hz, 1H), 4.71 (d, *J* = 17.2 Hz, 1H), 4.46 (d, *J* = 17.2 Hz, 1H), 4.28 (t, *J* = 3.0 Hz, 1H), 2.54 (dd, *J* = 13.4, 2.6 Hz, 1H), 2.34 (dd, *J* = 13.4, 3.4 Hz, 1H).

^{13}C NMR (126 MHz, CD_2Cl_2): δ163.05 (d, *J* = 247.1 Hz), 162.03, 158.85, 152.67, 141.92, 138.71, 137.45 (d, *J* = 3.2 Hz), 132.05, 128.72, 128.65, 128.37, 128.27, 127.78, 127.51, 126.85, 126.78, 124.14, 123.06, 119.26, 116.82, 116.04, 115.97, 115.87, 113.53, 105.81, 93.15, 51.06, 37.27, 30.33.

^{19}F NMR (470 MHz, CD_2Cl_2): δ -114.35.

HRMS (ESI): exact mass calcd for $C_{31}H_{23}FNO_3$: m/z 476.1662 $[M+H]^+$, found: m/z 476.1656.



6bk

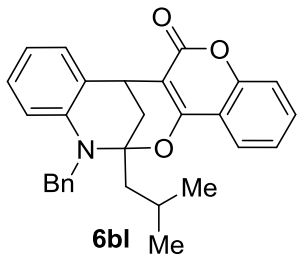
Following the **general procedure**, compound **6bk** was isolated as a white solid in 88% yield (34.8 mg).

M.p. 176.2-176.7 °C; **IR (KBr)** V_{max}: 3038, 2937, 1696, 1622, 1491, 1387, 1283, 1159, 1044, 996, 755 cm^{-1}.

^{1}H NMR (500 MHz, CD_2Cl_2): δ 7.85 (dd, *J* = 7.8, 1.7 Hz, 1H), 7.54 – 7.47 (m, 1H), 7.43 (dd, *J* = 7.4, 1.7 Hz, 1H), 7.37 – 7.22 (m, 7H), 6.99 – 6.92 (m, 1H), 6.76 – 6.67 (m, 1H), 6.52 (d, *J* = 8.2 Hz, 1H), 5.13 (d, *J* = 18.3 Hz, 1H), 4.46 (d, *J* = 18.3 Hz, 1H), 4.21 (t, *J* = 3.1 Hz, 1H), 2.49 (dd, *J* = 13.2, 2.8 Hz, 1H), 2.31 (dd, *J* = 13.2, 3.4 Hz, 1H), 1.86 (s, 3H).

^{13}C NMR (126 MHz, CD_2Cl_2): δ 162.10, 159.19, 152.66, 143.59, 139.84, 131.84, 128.98, 127.93, 127.89, 127.10, 127.07, 126.33, 124.01, 123.03, 119.02, 116.73, 116.24, 113.01, 105.65, 90.06, 50.40, 34.56, 29.63, 26.73.

HRMS (ESI): exact mass calcd for $C_{26}H_{22}NO_3$: m/z 396.1600 $[M+H]^+$, found: m/z 396.1594.



6bl

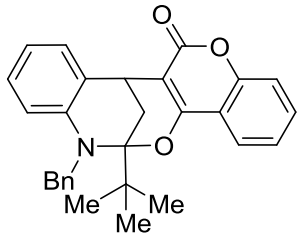
Following the **general procedure**, compound **6bl** was isolated as a yellow solid in 80% yield (35.1 mg).

M.p. 157.2-157.5 °C; **IR (KBr)** V_{max}: 3032, 2962, 1710, 1622, 1493, 1456, 1389, 1108, 1037, 984, 759 cm^{-1}.

^{1}H NMR (500 MHz, CD_2Cl_2): δ 7.78 (dd, *J* = 8.1, 1.6 Hz, 1H), 7.53 – 7.47 (m, 1H), 7.43 (dd, *J* = 7.4, 1.7 Hz, 1H), 7.29 – 7.15 (m, 7H), 6.99 – 6.90 (m, 1H), 6.77 – 6.70 (m, 1H), 6.57 (d, *J* = 8.2 Hz, 1H), 5.08 (d, *J* = 18.1 Hz, 1H), 4.51 (d, *J* = 18.1 Hz, 1H), 4.22 (t, *J* = 3.1 Hz, 1H), 2.42 (dd, *J* = 13.2, 3.5 Hz, 1H), 2.35 (dd, *J* = 13.2, 2.8 Hz, 1H), 2.22 (dd, *J* = 14.8, 8.0 Hz, 1H), 2.07 (dd, *J* = 14.8, 4.0 Hz, 1H), 1.93 – 1.82 (m, 1H), 1.02 (d, *J* = 6.6 Hz, 3H), 0.89 (d, *J* = 6.7 Hz, 3H).

^{13}C NMR (126 MHz, CD_2Cl_2): δ 162.12, 159.15, 152.69, 143.75, 139.94, 131.82, 128.80, 127.86, 127.79, 127.70, 126.96, 126.64, 124.04, 123.05, 119.12, 116.73, 116.27, 113.74, 105.60, 92.60, 50.37, 47.19, 31.61, 29.31, 25.22, 24.70, 23.92.

HRMS (ESI): exact mass calcd for $C_{29}H_{28}NO_3$: m/z 438.2069 $[M+H]^+$, found: m/z 438.2064.



6bm

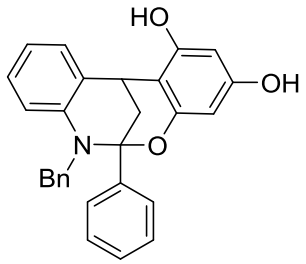
Following the **general procedure**, compound **6bm** was isolated as an orange solid in 97% yield (42.5 mg).

M.p. 164.3-164.7 °C; **IR (KBr)** V_{max}: 2964, 1709, 1619, 1490, 1455, 1388, 1160, 1114, 1038, 980, 808, 747 cm^{-1}.

^{1}H NMR (500 MHz, CD_2Cl_2): δ 7.83 (dd, *J* = 7.9, 1.6 Hz, 1H), 7.54 – 7.49 (m, 1H), 7.39 (dd, *J* = 7.4, 1.7 Hz, 1H), 7.33 – 7.22 (m, 2H), 7.10 – 7.00 (m, 5H), 6.95 – 6.90 (m, 1H), 6.82 – 6.75 (m, 2H), 5.04 (d, *J* = 17.2 Hz, 1H), 4.58 (d, *J* = 17.2 Hz, 1H), 4.07 (t, *J* = 3.1 Hz, 1H), 2.44 (dd, *J* = 13.3, 3.9 Hz, 1H), 2.29 (dd, *J* = 13.3, 2.5 Hz, 1H), 1.34 (s, 9H).

^{13}C NMR (126 MHz, CD_2Cl_2): δ 162.14, 159.03, 152.76, 145.87, 140.29, 131.87, 130.79, 128.41, 127.49, 127.41, 127.19, 126.65, 124.10, 122.88, 120.08, 117.00, 116.78, 116.31, 104.92, 95.68, 53.69, 40.94, 31.69, 29.79, 27.99.

HRMS (ESI): exact mass calcd for $C_{29}H_{28}NO_3$: m/z 438.2069 $[M+H]^+$, found: m/z 438.2064.



6ca

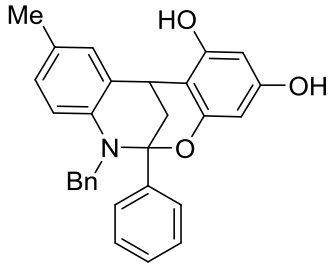
Following the **general procedure**, compound **6ca** was isolated as a brown solid in 83% yield (35.0 mg).

M.p. 95.7-96.1 °C; **IR (KBr)** V_{max}: 3353, 3061, 2936, 1703, 1606, 1458, 1345, 1261, 1140, 1054, 1004, 877, 753, 699 cm^{-1}.

^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 8.45 (s, 1H), 8.11 (s, 1H), 7.71 (d, *J* = 7.7 Hz, 2H), 7.51 – 7.45 (m, 2H), 7.44 – 7.36 (m, 2H), 7.05 – 6.96 (m, 5H), 6.90 – 6.84 (m, 1H), 6.67 – 6.62 (m, 1H), 6.59 (d, *J* = 8.1 Hz, 1H), 6.14 (d, *J* = 2.4 Hz, 1H), 6.12 (d, *J* = 2.3 Hz, 1H), 4.59 (d, *J* = 17.1 Hz, 1H), 4.42 – 4.34 (m, 2H), 2.35 (dd, *J* = 12.9, 2.6 Hz, 1H), 2.25 (dd, *J* = 12.9, 3.6 Hz, 1H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 158.68, 157.48, 155.71, 145.01, 143.60, 140.67, 131.45, 130.12, 129.38, 129.35, 128.80, 128.67, 127.83, 127.66, 118.86, 114.39, 106.59, 97.33, 97.15, 90.92, 52.25, 39.51, 31.16.

HRMS (ESI): exact mass calcd for $C_{28}H_{24}NO_3$: m/z 422.1756 $[M+H]^+$, found: m/z 422.1751.



6cb

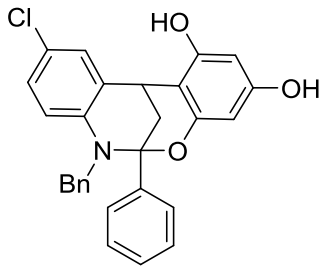
Following the **general procedure**, compound **6cb** was isolated as a brown solid in 51% yield (22.3 mg).

M.p. 127.3-127.6 °C; **IR (KBr)** V_{max}: 3326, 3061, 2860, 1688, 1608, 1502, 1254, 1136, 1056, 1001, 853, 763 cm^{-1}.

^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 8.46 (s, 1H), 8.12 (s, 1H), 7.70 (d, *J* = 7.7 Hz, 2H), 7.51 – 7.45 (m, 2H), 7.42 – 7.36 (m, 1H), 7.23 (d, *J* = 2.1 Hz, 1H), 7.07 – 6.96 (m, 5H), 6.68 (dd, *J* = 8.2, 2.1 Hz, 1H), 6.47 (d, *J* = 8.2 Hz, 1H), 6.15 – 6.09 (m, 2H), 4.56 (d, *J* = 17.0 Hz, 1H), 4.36 (d, *J* = 17.0 Hz, 1H), 4.31 (t, *J* = 3.1 Hz, 1H), 2.34 (dd, *J* = 12.9, 2.6 Hz, 1H), 2.23 (dd, *J* = 12.9, 3.5 Hz, 1H), 2.19 (s, 3H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 158.64, 157.43, 155.79, 145.17, 141.26, 140.87, 131.39, 130.08, 129.39, 129.32, 128.82, 128.24, 127.83, 127.60, 127.44, 114.29, 106.65, 97.25, 97.14, 90.99, 52.25, 39.63, 31.14, 21.27.

HRMS (ESI): exact mass calcd for $C_{29}H_{26}NO_3$: m/z 436.1913 $[M+H]^+$, found: m/z 436.1907.



6cc

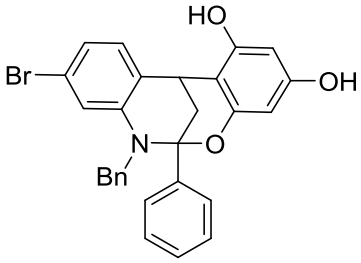
Following the **general procedure**, compound **6cc** was isolated as a brown solid in 45% yield (20.6 mg).

M.p. 94.3-94.7 ^{o}C; **IR (KBr)** V_{max}: 3348, 3062, 2934, 1689, 1609, 1487, 1348, 1258, 1138, 1057, 1006, 884, 813, 700 cm^{-1}.

^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 8.59 (s, 1H), 8.18 (s, 1H), 7.71 (d, *J* = 7.7 Hz, 2H), 7.52 – 7.47 (m, 2H), 7.43 – 7.38 (m, 2H), 7.06 – 7.00 (m, 3H), 6.98 – 6.93 (m, 2H), 6.87 (dd, *J* = 8.7, 2.6 Hz, 1H), 6.56 (d, *J* = 8.7 Hz, 1H), 6.17 – 6.12 (m, 2H), 4.55 (d, *J* = 17.0 Hz, 1H), 4.40 (d, *J* = 17.0 Hz, 1H), 4.34 (t, *J* = 3.1 Hz, 1H), 2.37 (dd, *J* = 13.1, 2.6 Hz, 1H), 2.27 (dd, *J* = 13.1, 3.6 Hz, 1H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 158.98, 157.50, 155.65, 144.54, 142.52, 140.11, 133.34, 130.20, 129.54, 129.45, 128.80, 128.18, 127.85, 127.80, 127.32, 123.04, 115.75, 105.78, 97.47, 97.25, 90.81, 52.30, 39.07, 31.04.

HRMS (ESI): exact mass calcd for $C_{28}H_{23}ClNO_3$: m/z 456.1366 $[M+H]^+$, found: m/z 456.1361.



6cd

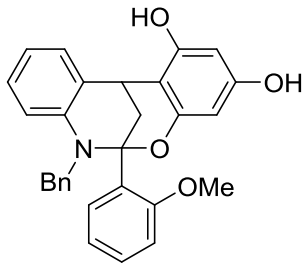
Following the **general procedure**, compound **6cd** was isolated as a brown oil in 42% yield (21.1 mg).

IR (KBr) V_{max}: 3343, 3064, 2942, 1703, 1601, 1484, 1357, 1221, 1142, 1057, 881, 822, 701, 537 cm^{-1}.

^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 8.55 (s, 1H), 8.19 (s, 1H), 7.73 (d, *J* = 7.7 Hz, 2H), 7.54 – 7.47 (m, 2H), 7.44 – 7.38 (m, 1H), 7.31 (d, *J* = 7.9 Hz, 1H), 7.09 – 6.97 (m, 5H), 6.79 (dd, *J* = 7.9, 1.9 Hz, 1H), 6.75 (d, *J* = 1.9 Hz, 1H), 6.16 (d, *J* = 2.3 Hz, 1H), 6.13 (d, *J* = 2.3 Hz, 1H), 4.55 (d, *J* = 17.0 Hz, 1H), 4.41 (d, *J* = 17.0 Hz, 1H), 4.34 (t, *J* = 3.1 Hz, 1H), 2.34 (dd, *J* = 13.1, 2.5 Hz, 1H), 2.27 (dd, *J* = 13.1, 3.6 Hz, 1H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 158.92, 157.54, 155.47, 145.14, 144.40, 139.84, 130.76, 130.23, 129.92, 129.58, 129.51, 128.86, 127.97, 127.81, 121.39, 121.06, 117.20, 105.90, 97.48, 97.19, 90.65, 52.22, 39.13, 30.72.

HRMS (ESI): exact mass calcd for $C_{28}H_{23}BrNO_3$: m/z 500.0861 $[M+H]^+$, found: m/z 500.0856.



6ce

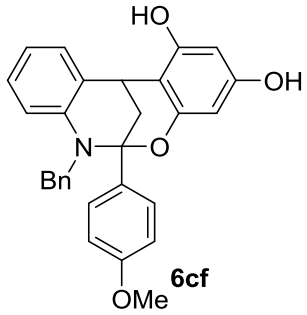
Following the **general procedure**, compound **6ce** was isolated as a brown solid in 65% yield (29.4 mg).

M.p. 119.7-120.2 °C; **IR (KBr)** V_{max}: 3323, 3062, 2938, 1688, 1605, 1459, 1343, 1249, 1137, 1055, 872, 750 cm^{-1}.

^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 8.38 (s, 1H), 8.09 (s, 1H), 8.04 (dd, *J* = 7.6, 1.8 Hz, 1H), 7.45 – 7.33 (m, 2H), 7.16 – 7.06 (m, 2H), 7.05 – 6.90 (m, 5H), 6.89 – 6.80 (m, 1H), 6.66 – 6.54 (m, 1H), 6.49 (d, *J* = 8.1 Hz, 1H), 6.17 (d, *J* = 2.3 Hz, 1H), 6.12 (d, *J* = 2.4 Hz, 1H), 4.49 (d, *J* = 16.8 Hz, 1H), 4.39 (d, *J* = 16.7 Hz, 1H), 4.32 (t, *J* = 3.1 Hz, 1H), 3.74 (s, 3H), 2.69 (dd, *J* = 12.5, 2.6 Hz, 1H), 2.09 – 2.04 (m, 1H, overlapped).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 158.62, 157.89, 157.58, 155.60, 143.60, 141.30, 131.80, 131.62, 131.04, 129.99, 129.37, 128.78, 128.29, 127.57, 127.53, 122.05, 118.19, 113.72, 113.23, 106.64, 97.31, 97.26, 89.95, 56.90, 50.86, 34.93, 31.45.

HRMS (ESI): exact mass calcd for $C_{29}H_{26}NO_4$: m/z 452.1862 $[M+H]^+$, found: m/z 452.1856.



6cf

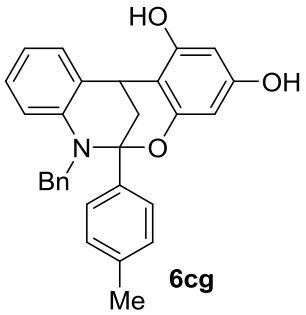
Following the **general procedure**, compound **6cf** was isolated as a brown solid in 80% yield (36.1 mg).

M.p. 118.7-119.0 °C; **IR (KBr)** V_{max}: 3310, 3062, 2939, 1689, 1606, 1502, 1457, 1346, 1254, 1136, 1055, 1003, 829, 748 cm^{-1}.

^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 8.44 (s, 1H), 8.10 (s, 1H), 7.62 (d, *J* = 8.3 Hz, 2H), 7.40 (dd, *J* = 7.4, 1.7 Hz, 1H), 7.07 – 6.94 (m, 7H), 6.89 – 6.82 (m, 1H), 6.73 – 6.59 (m, 1H), 6.57 (d, *J* = 8.2 Hz, 1H), 6.15 – 6.08 (m, 2H), 4.58 (d, *J* = 17.1 Hz, 1H), 4.43 (d, *J* = 17.1 Hz, 1H), 4.34 (t, *J* = 3.2 Hz, 1H), 3.86 (s, 3H), 2.35 (dd, *J* = 13.0, 2.7 Hz, 1H), 2.22 (dd, *J* = 13.0, 3.5 Hz, 1H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 160.99, 158.64, 157.46, 155.80, 143.70, 140.82, 136.90, 131.42, 129.35, 129.08, 128.78, 128.67, 127.79, 127.61, 118.77, 115.37, 114.36, 106.65, 97.25, 97.13, 90.78, 56.33, 52.04, 39.47, 31.19.

HRMS (ESI): exact mass calcd for $C_{29}H_{26}NO_4$: m/z 452.1862 $[M+H]^+$, found: m/z 452.1856.



6cg

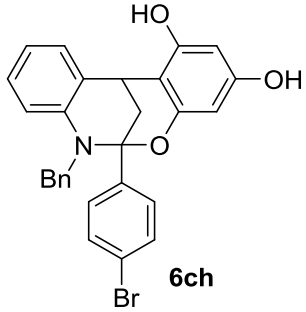
Following the **general procedure**, compound **6cg** was isolated as a brown solid in 82% yield (35.7 mg).

M.p. 123.2-123.5 ^{o}C; **IR (KBr)** V_{max}: 3314, 3028, 2945, 1690, 1607, 1499,1459, 1345, 1258, 1140, 1059, 1006, 822, 743 cm^{-1}.

^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 8.44 (s, 1H), 8.10 (s, 1H), 7.58 (d, *J* = 7.8 Hz, 2H), 7.41 (dd, *J* = 7.4, 1.7 Hz, 1H), 7.29 (d, *J* = 8.0 Hz, 2H), 7.05 – 6.96 (m, 5H), 6.89 – 6.83 (m, 1H), 6.66 – 6.60 (m, 1H), 6.57 (d, *J* = 8.2 Hz, 1H), 6.15 – 6.08 (m, 2H), 4.57 (d, *J* = 17.1 Hz, 1H), 4.41 (d, *J* = 17.1 Hz, 1H), 4.34 (t, *J* = 3.1 Hz, 1H), 2.39 (s, 3H), 2.33 (dd, *J* = 13.0, 2.6 Hz, 1H), 2.23 (dd, *J* = 12.9, 3.6 Hz, 1H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 158.66, 157.48, 155.79, 143.61, 142.10, 140.75, 138.92, 131.45, 130.73, 129.35, 128.80, 128.66, 127.79, 127.76, 127.63, 118.79, 114.35, 106.62, 97.29, 97.15, 90.92, 52.18, 39.54, 31.19, 21.85.

HRMS (ESI): exact mass calcd for $C_{29}H_{26}NO_3$: m/z 436.1913 $[M+H]^+$, found: m/z 436.1907.



6ch

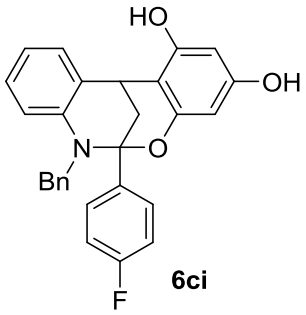
Following the **general procedure**, compound **6ch** was isolated as a brown oil in 62% yield (30.9 mg).

IR (KBr) V_{max}: 3325, 3062, 2936, 1687, 1606, 1488, 1345, 1256, 1140, 1058, 1005, 823, 744 cm^{-1}.

^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 8.48 (s, 1H), 8.13 (s, 1H), 7.70 – 7.60 (m, 4H), 7.41 (dd, *J* = 7.3, 1.6 Hz, 1H), 7.06 – 6.95 (m, 5H), 6.91 – 6.84 (m, 1H), 6.68 – 6.62 (m, 1H), 6.59 (d, *J* = 8.2 Hz, 1H), 6.15 – 6.09 (m, 2H), 4.61 (d, *J* = 17.1 Hz, 1H), 4.40 – 4.34 (m, 2H), 2.36 (dd, *J* = 13.0, 2.6 Hz, 1H), 2.25 (dd, *J* = 12.9, 3.6 Hz, 1H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 158.70, 157.46, 155.45, 144.41, 143.51, 140.52, 133.14, 131.38, 130.15, 129.37, 128.77, 128.70, 127.88, 127.71, 122.95, 119.08, 114.53, 106.53, 97.44, 97.11, 90.63, 52.22, 39.22, 31.03.

HRMS (ESI): exact mass calcd for $C_{28}H_{23}BrNO_3$: m/z 500.0861 $[M+H]^+$, found: m/z 500.0856.



6ci

Following the **general procedure**, compound **6ci** was isolated as a brown solid in 69% yield (30.3 mg).

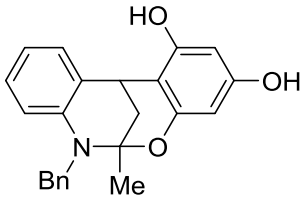
M.p. 155.4-155.7 °C; **IR (KBr)** V_{max}: 3256, 3060, 2937, 1687, 1600, 1498, 1458, 1344, 1254, 1142, 1057, 1006, 829, 730 cm^{-1}.

^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 8.46 (s, 1H), 8.11 (s, 1H), 7.79 – 7.70 (m, 2H), 7.41 (dd, *J* = 7.3, 1.6 Hz, 1H), 7.25 – 7.19 (m, 2H), 7.05 – 6.96 (m, 5H), 6.91 – 6.85 (m, 1H), 6.68 – 6.62 (m, 1H), 6.59 (d, *J* = 8.1 Hz, 1H), 6.15 – 6.09 (m, 2H), 4.61 (d, *J* = 17.1 Hz, 1H), 4.41 – 4.34 (m, 2H), 2.38 (dd, *J* = 12.9, 2.7 Hz, 1H), 2.24 (dd, *J* = 13.0, 3.5 Hz, 1H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ163.89 (d, *J* = 244.6 Hz), 158.69, 157.45, 155.55, 143.66, 141.06 (d, *J* = 3.2 Hz), 140.63, 131.40, 130.10, 130.03, 129.36, 128.78, 128.71, 127.87, 127.69, 119.03, 116.79, 116.61, 114.52, 106.61, 97.40, 97.13, 90.58, 52.14, 39.35, 31.08.

^{19}F NMR (470 MHz, $(CD_3)_2CO$): δ -116.51.

HRMS (ESI): exact mass calcd for $C_{28}H_{23}FNO_3$: m/z 440.1662 $[M+H]^+$, found: m/z 440.1656.



6cj

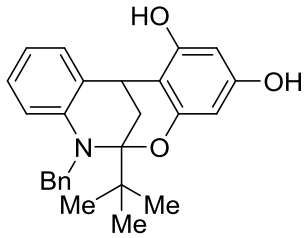
Following the **general procedure**, compound **6cj** was isolated as a brown solid in 33% yield (11.9 mg).

M.p. 153.2-153.6 °C; **IR (KBr)** V_{max}: 3285, 3065, 2936, 1604, 1463, 1358, 1218, 1151, 1055, 1008, 818, 747 cm^{-1}.

^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 8.42 (s, 1H), 8.03 (s, 1H), 7.35 (dq, *J* = 13.0, 7.3, 6.6 Hz, 5H), 7.29 – 7.23 (m, 1H), 6.93 – 6.81 (m, 1H), 6.62 (t, *J* = 7.3 Hz, 1H), 6.42 (d, *J* = 8.1 Hz, 1H), 5.99 (d, *J* = 2.3 Hz, 1H), 5.94 (d, *J* = 2.3 Hz, 1H), 5.12 (d, *J* = 18.3 Hz, 1H), 4.39 (d, *J* = 18.3 Hz, 1H), 4.30 (t, *J* = 3.2 Hz, 1H), 2.34 (dd, *J* = 12.9, 2.8 Hz, 1H), 2.21 (dd, *J* = 12.8, 3.5 Hz, 1H), 1.69 (s, 3H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 158.26, 157.04, 155.70, 145.68, 142.10, 130.74, 129.97, 128.47, 128.05, 127.91, 127.73, 118.81, 113.63, 107.26, 96.67, 96.64, 86.63, 50.94, 36.05, 30.19, 28.48.

HRMS (ESI): exact mass calcd for $C_{23}H_{22}NO_3$: m/z 360.1600 $[M+H]^+$, found: m/z 360.1594.



6ck

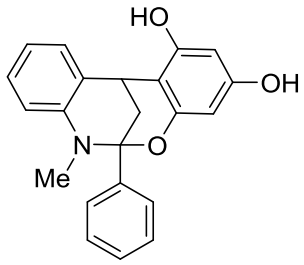
Following the **general procedure**, compound **6ck** was isolated as a brown oil in 62% yield (25.0 mg).

IR (KBr) V_{max}: 3278, 2962, 1687, 1618, 1487, 1255, 1145, 1060, 822, 745 cm^{-1}.

^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 8.31 (s, 1H), 7.99 (s, 1H), 7.28 (dd, *J* = 7.6, 1.7 Hz, 1H), 7.08 – 7.01 (m, 3H), 6.88 – 6.83 (m, 2H), 6.76 – 6.71 (m, 1H), 6.62 – 6.57 (m, 2H), 6.10 (d, *J* = 2.4 Hz, 1H), 6.04 (d, *J* = 2.4 Hz, 1H), 4.90 (d, *J* = 16.3 Hz, 1H), 4.71 (d, *J* = 16.2 Hz, 1H), 4.16 – 4.12 (m, 1H), 2.35 (dd, *J* = 12.9, 4.0 Hz, 1H), 2.12 – 2.09 (m, 1H, overlapped), 1.28 (s, 9H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 158.72, 157.86, 156.31, 146.67, 142.05, 135.23, 129.33, 127.49, 127.39, 127.20, 119.80, 118.48, 105.85, 97.22, 97.20, 92.71, 54.02, 41.82, 34.10, 30.98, 28.65.

HRMS (ESI): exact mass calcd for $C_{26}H_{28}NO_3$: m/z 402.2069 $[M+H]^+$, found: m/z 402.2064.



6cn

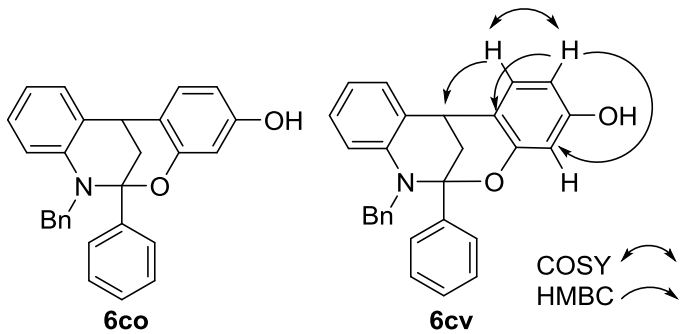
Following the **general procedure**, compound **6cn** was isolated as a yellow solid in 59% yield (20.4 mg).

M.p. 112.1-112.5 °C; **IR (KBr)** V_{max}: 3309, 2940, 1692, 1605, 1485, 1342, 1262, 1143, 1066, 1019, 880, 821, 755, 699 cm^{-1}.

^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 8.41 (s, 1H), 8.04 (s, 1H), 7.67 – 7.60 (m, 2H), 7.52 – 7.46 (m, 2H), 7.43 – 7.36 (m, 2H), 7.11 – 7.05 (m, 1H), 6.81 (d, *J* = 8.0 Hz, 1H), 6.69 (td, *J* = 7.3, 1.1 Hz, 1H), 6.13 (d, *J* = 2.3 Hz, 1H), 6.04 (d, *J* = 2.2 Hz, 1H), 4.28 (t, *J* = 3.0 Hz, 1H), 2.77 (s, 3H), 2.23 – 2.15 (m, 2H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 158.48, 157.24, 155.69, 146.10, 145.02, 131.11, 130.08, 129.28, 128.45, 128.38, 127.79, 118.75, 113.07, 107.06, 97.11, 97.01, 90.18, 39.27, 34.94, 31.02.

HRMS (ESI): exact mass calcd for $C_{22}H_{20}NO_3$: m/z 346.1443 $[M+H]^+$, found: m/z 346.1438.



6co **6cv**

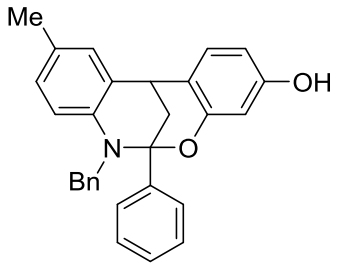
Following the **general procedure**, compound **6co** was isolated as a brown solid in 95% yield (38.5 mg).

M.p. 158.4-158.9 °C; **IR (KBr)** V_{max}: 3523, 3028, 1595, 1495, 1452, 1291, 1113, 1009, 872, 763, 696 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.67 (d, *J* = 7.6 Hz, 2H), 7.46 – 7.38 (m, 2H), 7.37 – 7.31 (m, 1H), 7.28 – 7.25 (m, 1H), 7.12 (d, *J* = 8.1 Hz, 1H), 7.03 – 6.98 (m, 3H), 6.95 (td, *J* = 7.8, 1.6 Hz, 1H), 6.80 – 6.70 (m, 3H), 6.56 (d, *J* = 8.1 Hz, 1H), 6.47 – 6.40 (m, 2H), 4.55 (d, *J* = 17.2 Hz, 1H), 4.43 (d, *J* = 17.2 Hz, 1H), 4.02 (t, *J* = 3.0 Hz, 1H), 2.44 – 2.34 (m, 2H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 155.51, 153.84, 143.02, 142.30, 138.95, 130.21, 130.11, 128.79, 128.26, 128.20, 127.42, 127.09, 126.65, 126.44, 126.09, 118.41, 118.30, 113.48, 108.91, 104.40, 89.84, 51.11, 38.04, 36.09.

HRMS (ESI): exact mass calcd for $C_{28}H_{24}NO_2$: m/z 406.1807 $[M+H]^+$, found: m/z 406.1802.



6cp

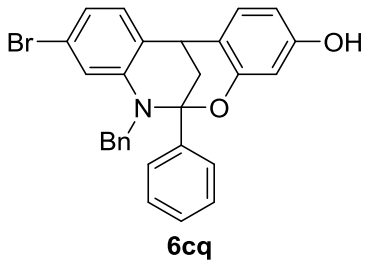
Following **the general procedure**, compound **6cp** was isolated as a red oil in 98% yield (41.1 mg).

IR (KBr) V_{max}: 3333, 3025, 2927, 1701, 1618, 1500, 1452, 1352, 1228, 1156, 1010, 874, 806, 698 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.67 (d, *J* = 7.6 Hz, 2H), 7.44 – 7.37 (m, 2H), 7.37 – 7.32 (m, 1H), 7.13 (d, *J* = 8.1 Hz, 1H), 7.09 (d, *J* = 2.1 Hz, 1H), 7.06 – 6.97 (m, 3H), 6.84 – 6.75 (m, 3H), 6.52 – 6.39 (m, 3H), 4.54 (d, *J* = 17.2 Hz, 1H), 4.41 (d, *J* = 17.2 Hz, 1H), 3.98 (t, *J* = 3.0 Hz, 1H), 2.46 – 2.33 (m, 2H), 2.27 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 155.45, 153.93, 143.16, 139.93, 139.19, 130.09, 130.02, 128.75, 128.24, 128.15, 127.88, 127.40, 127.10, 126.87, 126.66, 126.39, 118.54, 113.35, 108.81, 104.38, 89.95, 51.12, 38.15, 36.09, 20.73.

HRMS (ESI): exact mass calcd for $C_{29}H_{26}NO_2$: m/z 420.1964 $[M+H]^+$, found: m/z 420.1958.



6cq

Following the **general procedure**, compound **6cq** was isolated as a yellow solid in 96% yield (46.4 mg).

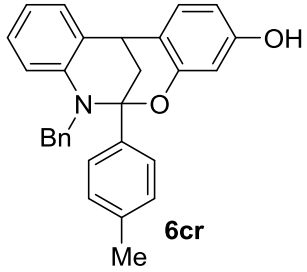
M.p. 98.0-98.5 °C; **IR (KBr)** V_{max}: 3288, 3026, 2933, 1687, 1594, 1489, 1452, 1320, 1155, 1115, 1017, 880, 698 cm^{-1}.

^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 8.32 (s, 1H), 7.70 (d, *J* = 7.6 Hz, 2H), 7.49 – 7.43 (m, 2H), 7.41 – 7.34 (m, 1H), 7.25 (d, *J* = 7.9 Hz, 1H), 7.14 (d, *J* = 8.2 Hz, 1H), 7.05 – 6.95 (m, 3H), 6.93 – 6.85 (m,

2H), 6.78 (dd, *J* = 7.9, 1.8 Hz, 1H), 6.70 (d, *J* = 1.8 Hz, 1H), 6.53 (d, *J* = 2.4 Hz, 1H), 6.47 (dd, *J* = 8.3, 2.5 Hz, 1H), 4.53 (d, *J* = 17.1 Hz, 1H), 4.37 (d, *J* = 17.1 Hz, 1H), 4.08 (t, *J* = 3.0 Hz, 1H), 2.39 – 2.28 (m, 2H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 158.98, 154.73, 144.92, 144.11, 139.67, 131.46, 131.41, 130.24, 129.65, 129.51, 128.75, 128.69, 127.99, 127.82, 121.89, 121.50, 117.90, 117.41, 110.66, 105.43, 90.63, 52.17, 39.07, 36.37.

HRMS (ESI): exact mass calcd for $C_{28}H_{23}BrNO_2$: m/z 484.0912 $[M+H]^+$, found: m/z 484.0907.



6cr

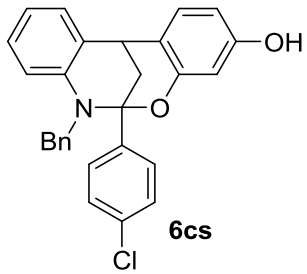
Following the **general procedure**, compound **6cr** was isolated as a brown solid in 86% yield (36.2 mg).

M.p. 192.9-193.3 °C; **IR (KBr)** V_{max}: 3516, 3025, 2929, 1596, 1496, 1453, 1345, 1290, 1148, 1112, 1063, 1014, 877, 763 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.55 (d, *J* = 7.8 Hz, 2H), 7.27 – 7.24 (m, 1H), 7.22 (d, *J* = 8.0 Hz, 2H), 7.12 (d, *J* = 8.1 Hz, 1H), 7.05 – 6.97 (m, 3H), 6.94 (td, *J* = 7.8, 1.6 Hz, 1H), 6.81 – 6.74 (m, 2H), 6.73 – 6.69 (m, 1H), 6.54 (d, *J* = 8.1 Hz, 1H), 6.46 – 6.39 (m, 2H), 4.53 (d, *J* = 17.3 Hz, 1H), 4.45 (d, *J* = 17.2 Hz, 1H), 4.01 (t, *J* = 3.1 Hz, 1H), 2.42 – 2.33 (m, 5H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 155.49, 153.94, 142.27, 140.13, 139.03, 137.93, 130.23, 130.12, 129.49, 128.25, 127.37, 127.09, 126.55, 126.40, 126.06, 118.42, 118.20, 113.45, 108.84, 104.40, 89.87, 51.01, 38.10, 36.14, 21.46.

HRMS (ESI): exact mass calcd for $C_{29}H_{26}NO2$: m/z 420.1964 $[M+H]^+$, found: m/z 420.1958.



6cs

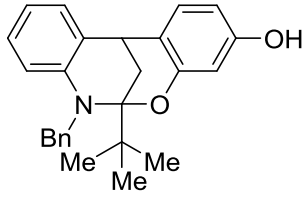
Following the **general procedure**, compound **6cs** was isolated as a brown solid in 93% yield (40.9 mg).

M.p. 180.7-181.0 °C; **IR (KBr)** V_{max}: 3518, 3023, 2928, 1595, 1493, 1452, 1288, 1111, 1061, 1010, 875, 767 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.60 (d, *J* = 8.1 Hz, 2H), 7.40 – 7.33 (m, 2H), 7.28 – 7.24 (m, 1H), 7.15 – 7.10 (m, 1H), 7.06 – 6.99 (m, 3H), 6.96 (td, *J* = 7.8, 1.6 Hz, 1H), 6.79 – 6.71 (m, 3H), 6.57 (d, *J* = 8.2 Hz, 1H), 6.45 – 6.40 (m, 2H), 4.54 (d, *J* = 17.2 Hz, 1H), 4.40 (d, *J* = 17.2 Hz, 1H), 4.01 (t, *J* = 3.0 Hz, 1H), 2.42 – 2.31 (m, 2H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 155.52, 153.57, 142.18, 141.60, 138.75, 134.11, 130.09, 130.07, 128.95, 128.31, 128.18, 127.51, 127.04, 126.55, 126.15, 118.57, 118.32, 113.60, 109.07, 104.36, 89.50, 51.09, 37.92, 35.97.

HRMS (ESI): exact mass calcd for $C_{28}H_{23}ClNO_2$: m/z 440.1417 $[M+H]^+$, found: m/z 440.1412.



6ct

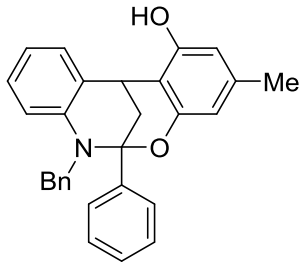
Following the **general procedure**, compound **6ct** was isolated as a brown oil in 90% yield (34.8 mg).

IR (KBr) V_{max}: 3359, 2967, 1702, 1597, 1495, 1456, 1358, 1226, 1154, 1115, 1077, 1027, 848, 745 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.16 (dd, *J* = 7.3, 1.6 Hz, 1H), 7.10 – 7.04 (m, 4H), 6.82 (td, *J* = 7.8, 1.6 Hz, 1H), 6.72 – 6.65 (m, 3H), 6.58 (d, *J* = 8.1 Hz, 1H), 6.45 – 6.39 (m, 2H), 4.85 (d, *J* = 16.6 Hz, 1H), 4.67 (d, *J* = 16.6 Hz, 1H), 3.86 (t, *J* = 3.1 Hz, 1H), 2.44 (dd, *J* = 12.8, 4.0 Hz, 1H), 2.17 (dd, *J* = 12.9, 2.3 Hz, 1H), 1.25 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 155.51, 154.36, 145.45, 140.44, 134.00, 130.41, 128.26, 127.68, 126.82, 126.28, 124.70, 119.16, 117.91, 117.48, 108.80, 104.43, 91.74, 53.16, 40.75, 35.29, 32.65, 27.93.

HRMS (ESI): exact mass calcd for $C_{26}H_{28}NO_2$: m/z 386.2120 $[M+H]^+$, found: m/z 386.2115.



6cu

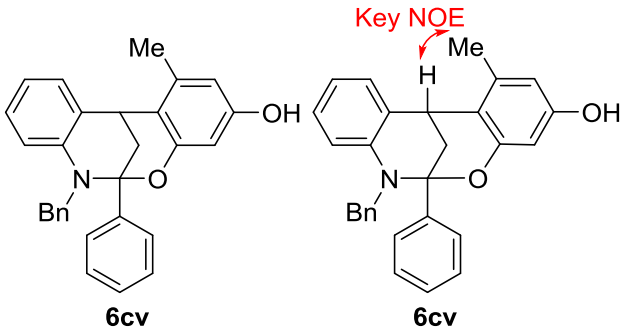
Following the **general procedure**, compound **6cu** was isolated as a brown oil in 57% yield (23.9 mg).

IR (KBr) V_{max}: 3379, 3031, 2939, 1704, 1593, 1491, 1454, 1343, 1208, 1058, 879, 751, 698 cm^{-1}.

^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 8.45 (s, 1H), 7.73 (d, *J* = 7.6 Hz, 2H), 7.51 – 7.37 (m, 4H), 7.05 – 6.92 (m, 5H), 6.92 – 6.84 (m, 2H), 6.65 (td, *J* = 7.4, 1.2 Hz, 1H), 6.60 (d, *J* = 8.2 Hz, 1H), 6.43 (s, 1H), 6.37 (s, 1H), 4.60 (d, *J* = 17.1 Hz, 1H), 4.43 – 4.35 (m, 2H), 2.39 (dd, *J* = 13.0, 2.5 Hz, 1H), 2.28 – 2.25 (m, 1H), 2.24 (s, 3H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 156.64, 154.95, 144.94, 143.81, 140.66, 138.73, 131.06, 130.11, 129.40, 129.30, 128.83, 128.79, 127.94, 127.84, 127.65, 118.90, 114.41, 112.03, 110.73, 109.73, 90.73, 52.20, 39.20, 31.34, 22.13.

HRMS (ESI): exact mass calcd for $C_{29}H_{26}NO_2$: m/z 420.1964 $[M+H]^+$, found: m/z 420.1958.



6cv **6cv**

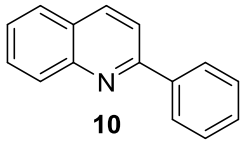
Following the **general procedure**, compound **6cv** was isolated as a brown oil in 42% yield (17.6 mg).

IR (KBr) V_{max}: 3377, 3029, 2935, 1701, 1596, 1488, 1455, 1350, 1216, 1134, 1055, 986, 885, 751, 696 cm^{-1}.

^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 8.19 (s, 1H), 7.69 (d, *J* = 7.6 Hz, 2H), 7.53 – 7.46 (m, 2H), 7.43 – 7.36 (m, 2H), 7.05 – 6.97 (m, 3H), 6.97 – 6.89 (m, 3H), 6.70 (td, *J* = 7.4, 1.2 Hz, 1H), 6.63 (d, *J* = 8.1 Hz, 1H), 6.45 (d, *J* = 2.5 Hz, 1H), 6.40 (d, *J* = 2.5 Hz, 1H), 4.54 (d, *J* = 17.0 Hz, 1H), 4.39 (d, *J* = 17.0 Hz, 1H), 4.25 (t, *J* = 3.1 Hz, 1H), 2.46 (s, 3H), 2.35 – 2.28 (m, 2H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 158.11, 155.21, 144.80, 143.75, 140.51, 139.73, 130.86, 130.18, 129.43, 129.39, 128.81, 128.23, 128.16, 127.75, 118.95, 116.46, 114.71, 112.28, 103.40, 90.30, 52.07, 40.27, 34.02, 20.66.

HRMS (ESI): exact mass calcd for $C_{29}H_{26}NO_2$: m/z 420.1964 $[M+H]^+$, found: m/z 420.1958.



10

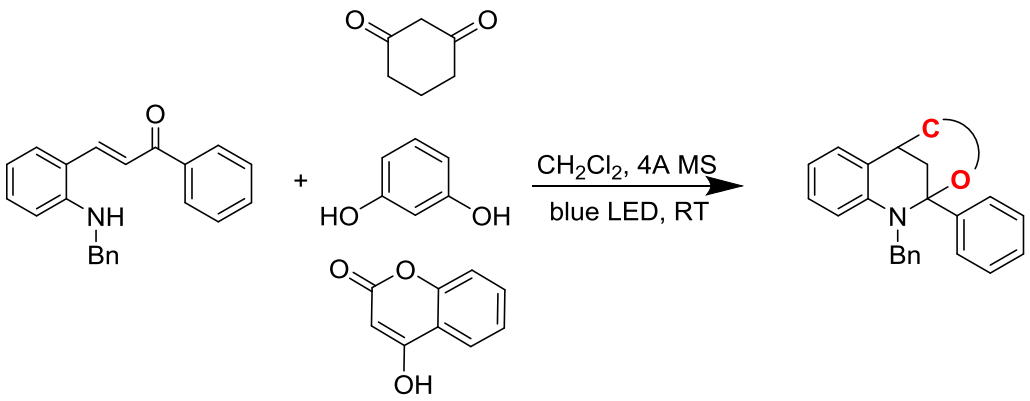
2-Aminochalcone **4o** (0.1 mmol, 32.3 mg), phloroglucinol (0.12 mmol, 15.1 mg), 4Å molecular sieves (100mg) and dichloromethane (3.0 mL) were added to a reaction tube equipped with a magnetic stir bar. The mixture was stirred under the irradiation by Blue compact fluorescence lamp (CFL) at room temperature under argon overnight and monitored by TLC. After 2-aminochalcone was consumed, the solvent was removed by rotary evaporator. The residue was directly purified by column chromatography on silica gel to yield 2-phenylquinoline **10** as a white solid in 88% yield (18.1 mg).

The spectrum data of **10** were consistent with the reference[5].

^{1}H NMR (500 MHz, $CDCl_3$): δ 8.22 (d, *J* = 8.6 Hz, 1H), 8.21 – 8.15 (m, 3H), 7.88 (d, *J* = 8.5 Hz, 1H), 7.83 (d, *J* = 8.1 Hz, 1H), 7.76 – 7.71 (m, 1H), 7.58 – 7.52 (m, 3H), 7.51 – 7.45 (m, 1H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 157.69, 148.62, 140.02, 137.09, 130.08, 129.97, 129.64, 129.17, 127.90, 127.78, 127.51, 126.60, 119.33.

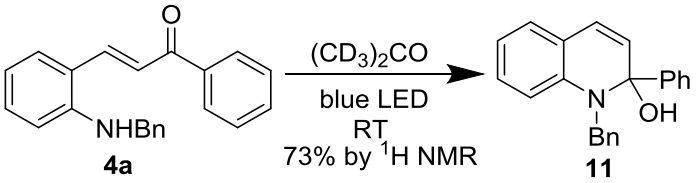
4. Procedure for 1 mmol Scale Synthesis of 6aa, 6ba, 6co



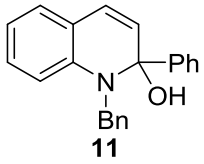
To a 50 ml round-bottom flask equipped with a magnetic stir bar was added 2-aminochalcone (1.0 mmol), bifunctional nucleophile (1.2 mmol), 4Å molecular sieves (1.0 g) and dichloromethane (30 mL). The mixture was stirred under the irradiation by Blue compact fluorescence lamp (CFL) at room temperature under argon overnight and monitored by TLC. After 2-aminochalcone was consumed, the solvent was removed by rotary evaporator. The residue was directly purified by column chromatography on silica gel to yield **6aa** (99%, 403.4 mg), **6ba** (89%, 407.2 mg) and **6co** (93%, 377.1 mg) respectively.

5. Mechanistic Studies

The synthesis of quinolinium salt

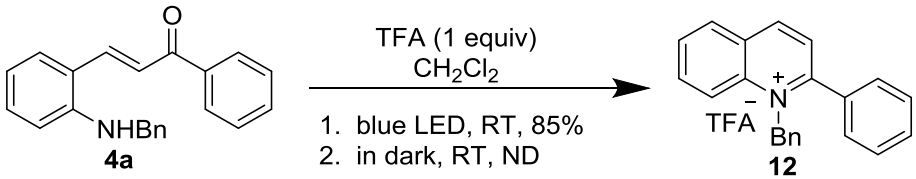


The 2-aminochalcone **4a** (0.03 mmol, 9.4 mg) and $(CD_3)_2CO$ (0.6 mL) were added to a NMR tube. The mixture was irradiated by blue LED at room temperature for 40 minutes and monitored by ^1H NMR. After the 2-aminochalcone was consumed, the novel compound was identified to be **11** by the NMR spectrum, and the yield of **11** was confirmed to be 73% through adding dimethyl sulfone as the interior label.

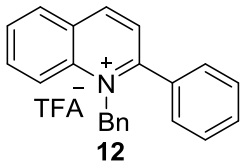


^{1}H NMR (500 MHz, $(CD_3)_2CO$): δ 7.62 (d, *J* = 7.6 Hz, 2H), 7.35 (t, *J* = 7.6 Hz, 2H), 7.31 (d, *J* = 7.6 Hz, 2H), 7.27 (d, *J* = 7.4 Hz, 1H), 7.25 – 7.20 (m, 2H), 7.16 (d, *J* = 7.4 Hz, 2H), 6.99 (t, *J* = 7.7 Hz, 1H), 6.73 – 6.64 (m, 2H), 6.44 (d, *J* = 8.3 Hz, 1H), 5.71 (d, *J* = 9.7 Hz, 1H), 4.58 (s, 2H).

^{13}C NMR (126 MHz, $(CD_3)_2CO$): δ 148.26, 143.56, 141.02, 130.38, 129.65, 129.50, 129.01, 128.91, 128.08, 128.02, 127.82, 127.79, 125.33, 120.94, 118.20, 113.62, 88.23, 50.79.



To a solution of 2-aminochalcone **4a** (0.3 mmol, 93.9 mg) in DCM (6 ml), TFA (0.3 mmol, 22.5 μL) was added. After stirred for 1h with irradiation by blue LED at room temperature under argon, After the 2-aminochalcone was consumed completely, the solvent was removed by rotary evaporator to afford the desired quinolinium salt **12** as a brown oil in 85% yield (104.3 mg).

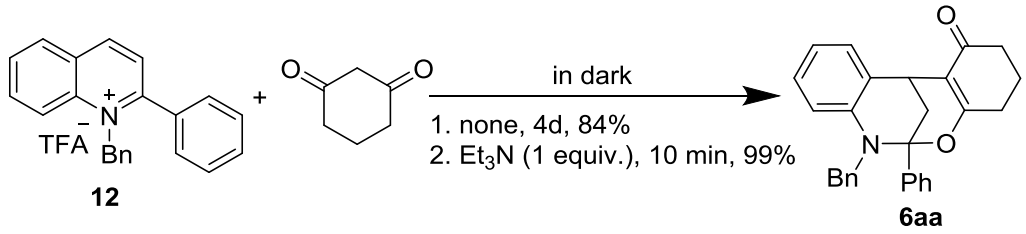


IR (KBr) V_{max}: 3420, 3060, 1687, 1600, 1520, 1352, 1197, 762 cm^{-1}.

^{1}H NMR (500 MHz, $CDCl_3$): δ 9.42 (d, *J* = 8.2 Hz, 1H), 8.40 (d, *J* = 8.0 Hz, 1H), 8.30 (d, *J* = 8.9 Hz, 1H), 8.02 (d, *J* = 8.0 Hz, 1H), 7.96 (t, *J* = 7.9 Hz, 1H), 7.78 (t, *J* = 7.5 Hz, 1H), 7.60 – 7.53 (m, 3H), 7.52 – 7.46 (m, 2H), 7.26 – 7.19 (m, 3H), 6.94 – 6.88 (m, 2H), 6.41 (s, 2H).

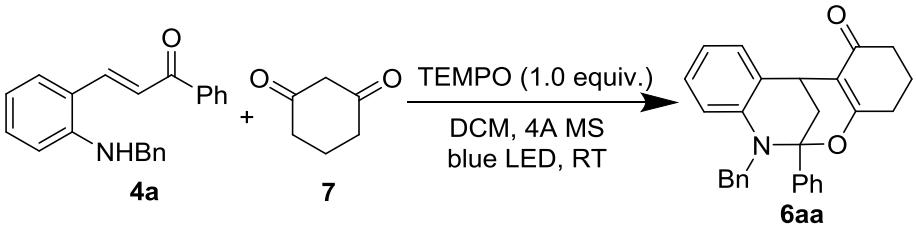
^{13}C NMR (126 MHz, $CDCl_3$): δ 160.59, 148.71, 139.40, 136.77, 134.34, 132.93, 132.18, 131.55, 130.27, 129.86, 129.81, 129.68, 128.80, 128.77, 125.77, 125.57, 120.91, 57.71.

^{19}F NMR (470 MHz, $CDCl_3$): δ -74.80.



To a reaction tube equipped with a magnetic stir bar was added the quinolinium salt (0.1 mmol, 40.9 mg), 1,3-cyclohexanedione (0.12 mmol, 13.5 mg) and DCM (3.0 mL). The mixture was stirred in dark, using aluminium foil to wrap up the reaction flask, at room temperature under argon for 4 days and monitored by TLC. After quinolinium salt was consumed, the solvent was removed by rotary evaporator. The residue was directly purified by column chromatography on silica gel (EtOAc/petroleum ether = 1: 8) to afford **6aa** in 84% yield (34.2 mg).

To a reaction tube equipped with a magnetic stir bar was added the quinolinium salt (0.1 mmol, 40.9 mg), 1,3-cyclohexanedione (0.12 mmol, 13.5 mg), Et_3N(0.1 mmol, 16.7 μL) and DCM (3.0 mL). The mixture was stirred in dark, using aluminium foil to wrap up the reaction flask, at room temperature under argon for 10 min and monitored by TLC. After quinolinium salt was consumed, the solvent was removed by rotary evaporator. The residue was directly purified by column chromatography on silica gel (EtOAc/petroleum ether = 1: 8) to afford **6aa** in 99% yield (40.3 mg).



2-Aminochalcone **4a** (0.1 mmol, 31.3 mg), 1,3-cyclohexanedione **7**(0.12 mmol, 13.5 mg), 2,2,6,6-tetramethylpiperidinooxy (0.1 mmol, 15.6 mg), 4Å molecular sieves (100mg) and dichloromethane (3.0 mL) were added to a reaction tube equipped with a magnetic stir bar. The mixture was stirred under the irradiation by blue LED at room temperature under argon overnight and monitored by TLC. After **4a** was consumed, the solvent was removed by rotary evaporator. The residue was directly purified by column chromatography on silica gel to yield **6aa** in 96% yield (39.2 mg).

6. Reference

[1] Ryan J., Siauciulis M., Gomm A., Macia B., O'Reilly E., Caprio V.. *J. Am. Chem. Soc*. **2016**, 138, 15798-15800.

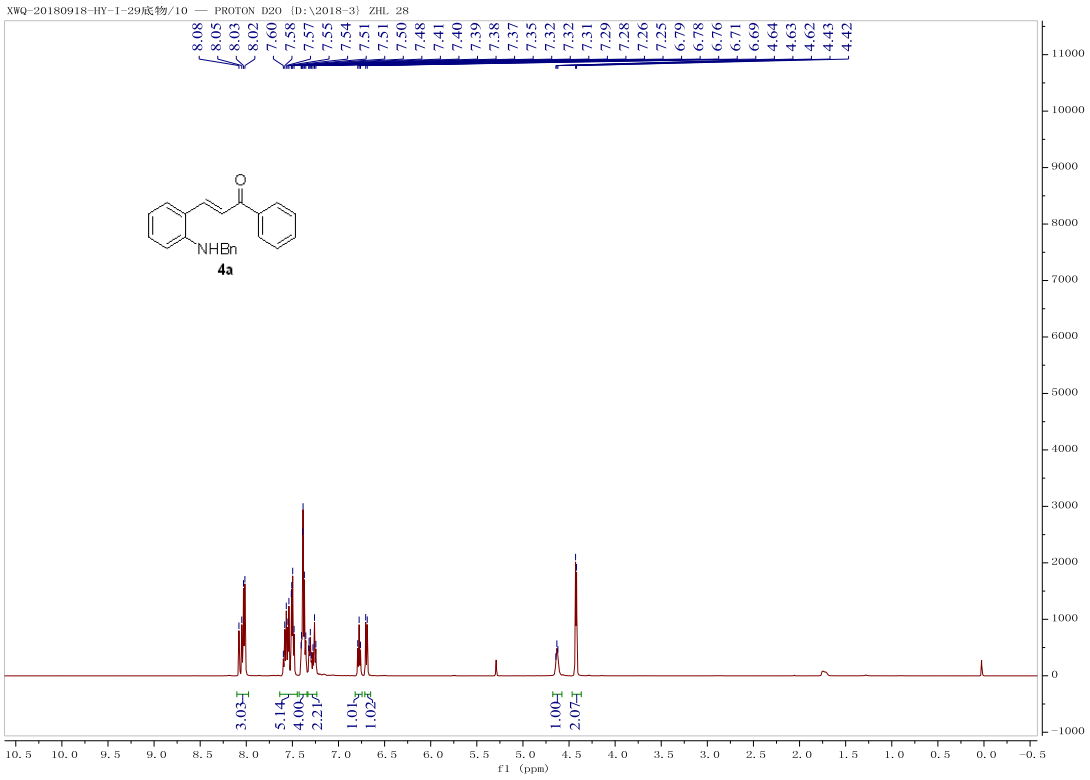
[2] Zhu Y., Li B., Wang C., Dong Z., Zhong X., Wang K., Yan W., Wang R.. *Org. Biomol. Chem*., **2017**,15, 4544-4547.

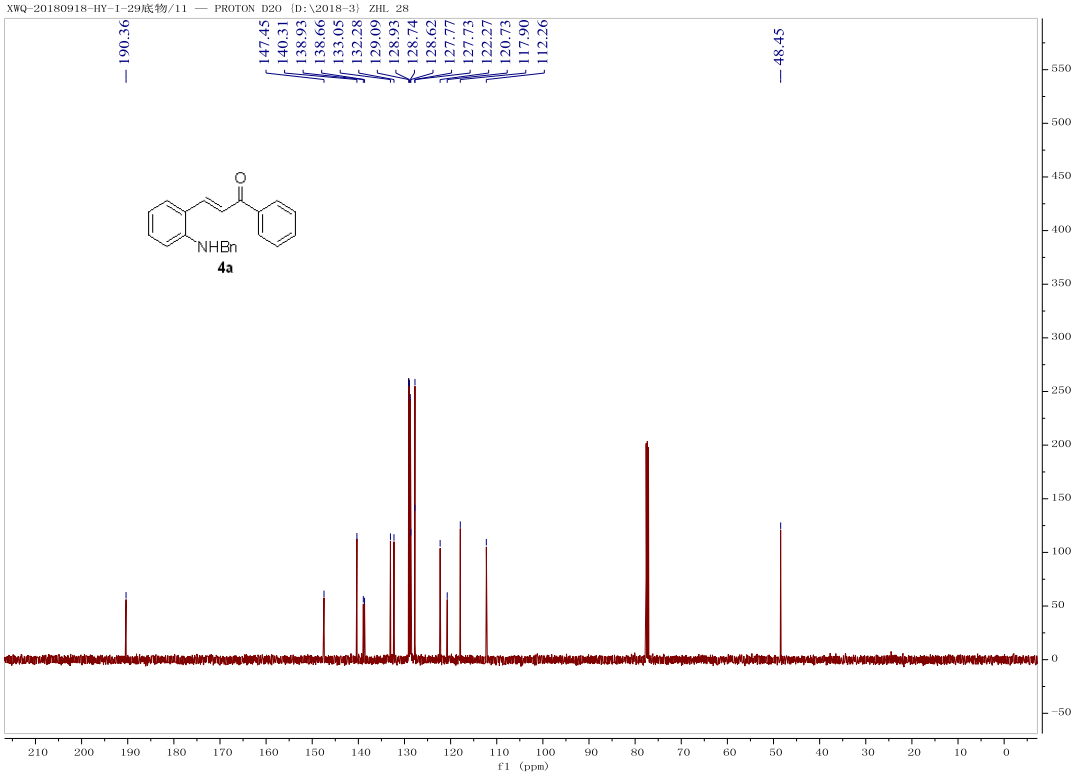
[3] Wei W., Dong X., Nie S., Chen Y., Zhang X., Yan M.. *Org. Lett*. **2013**, 15, 6018-6021.

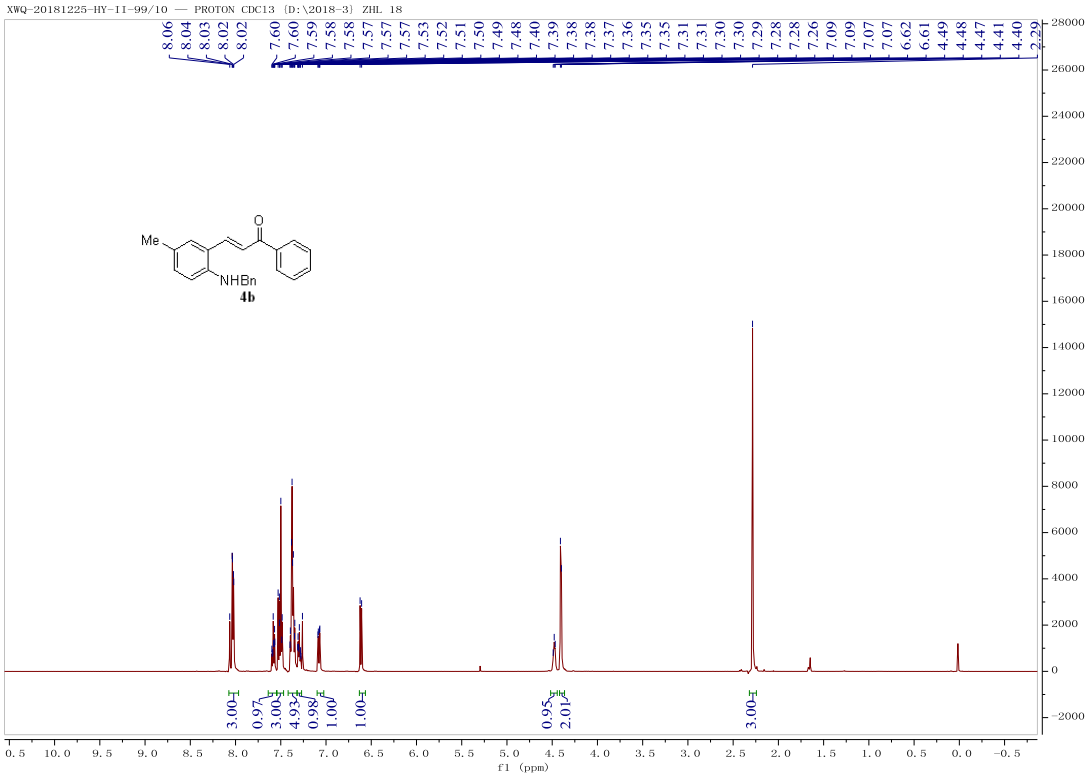
[4] Lee Y. T., Jang Y. J., Syu S. E., Chou S. C., Lee C. J., Lin W. W.. *Chem. Commun*.. **2012**, 48, 8135-8137.

[5] Wu S. Q., Liu C. Y., Luo G. Y., Jin Z. C., Zheng P. C., Chi Y. G. R.. *Angew. Chem. Int. Ed*. **2019**, 58, 18410-18413.

7. NMR Spectra



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4b
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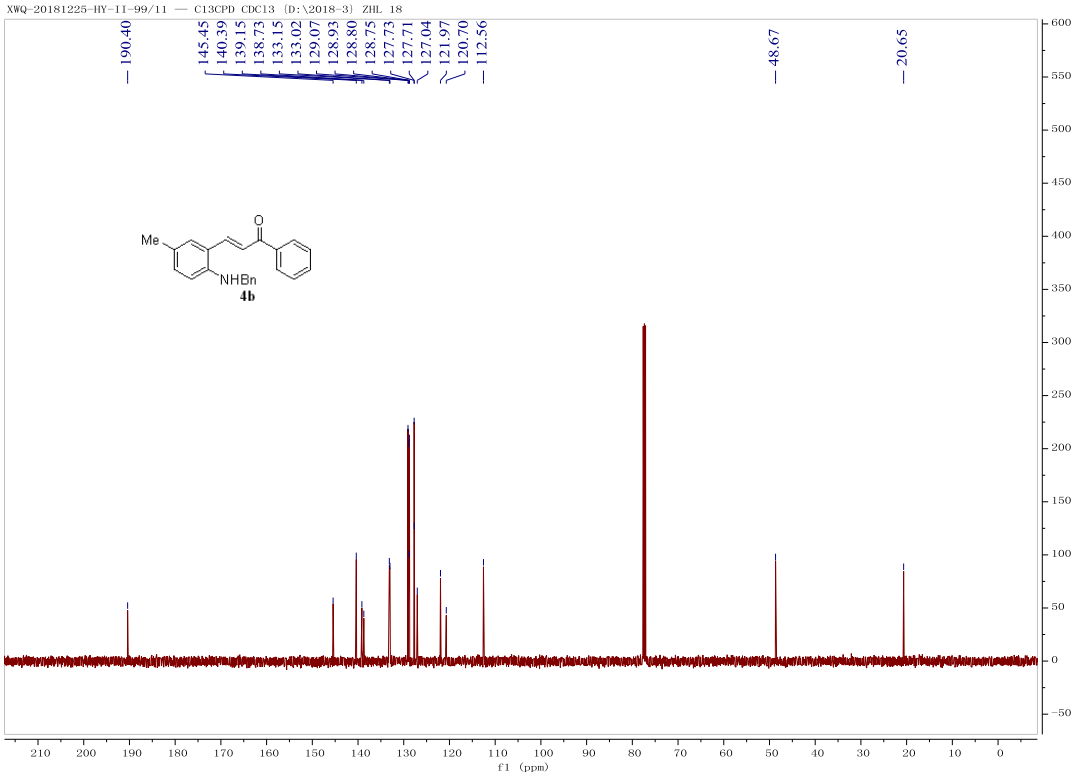
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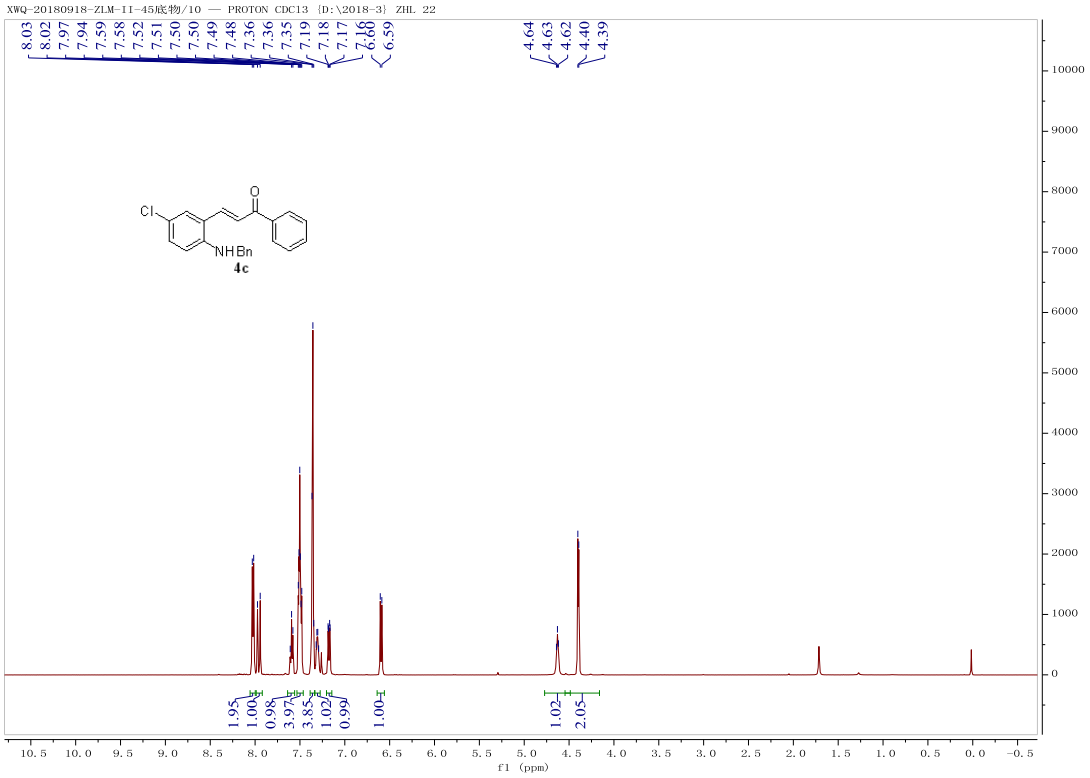
NHBn
4b
f1 (ppm)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7.59
7.58
7.52
7.51
7.50
7.50
7.49
7.48
7.36
7.36
7.35
7.19
7.18
7.17
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6.59
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4.62
4.40
4.39
Cl
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NHBn
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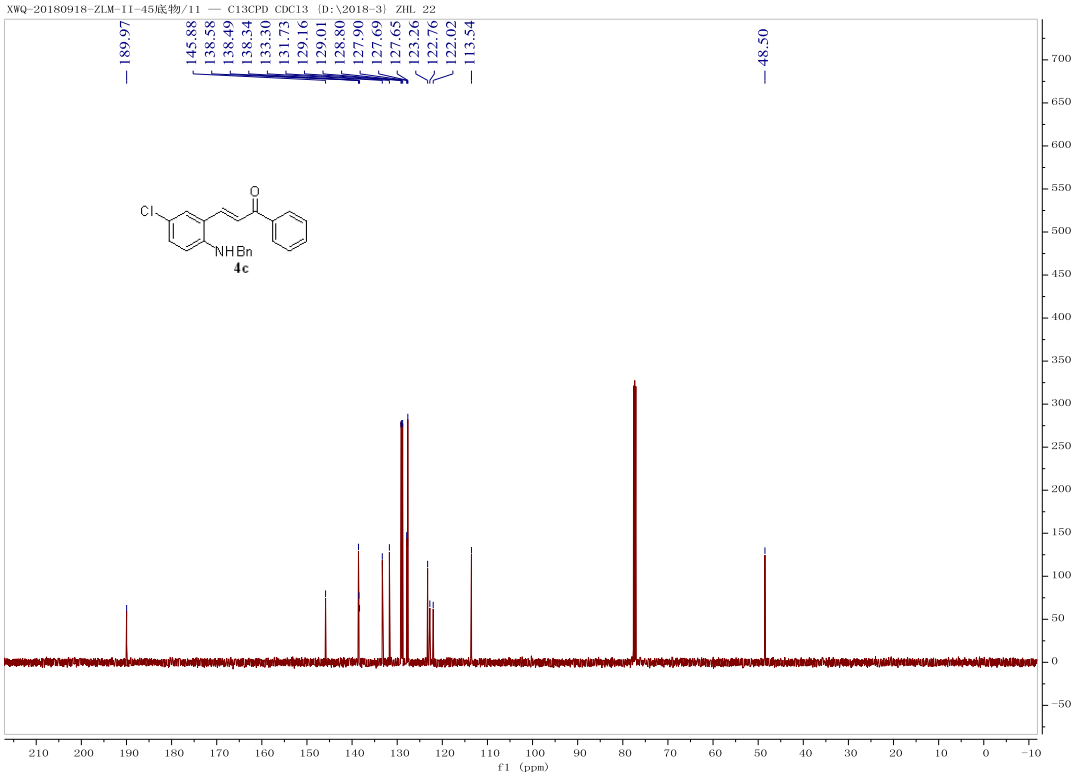
1.00
1.02
2.05
f1 (ppm)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131.73
129.16
129.01
128.80
127.90
127.69
127.65
123.26
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122.02
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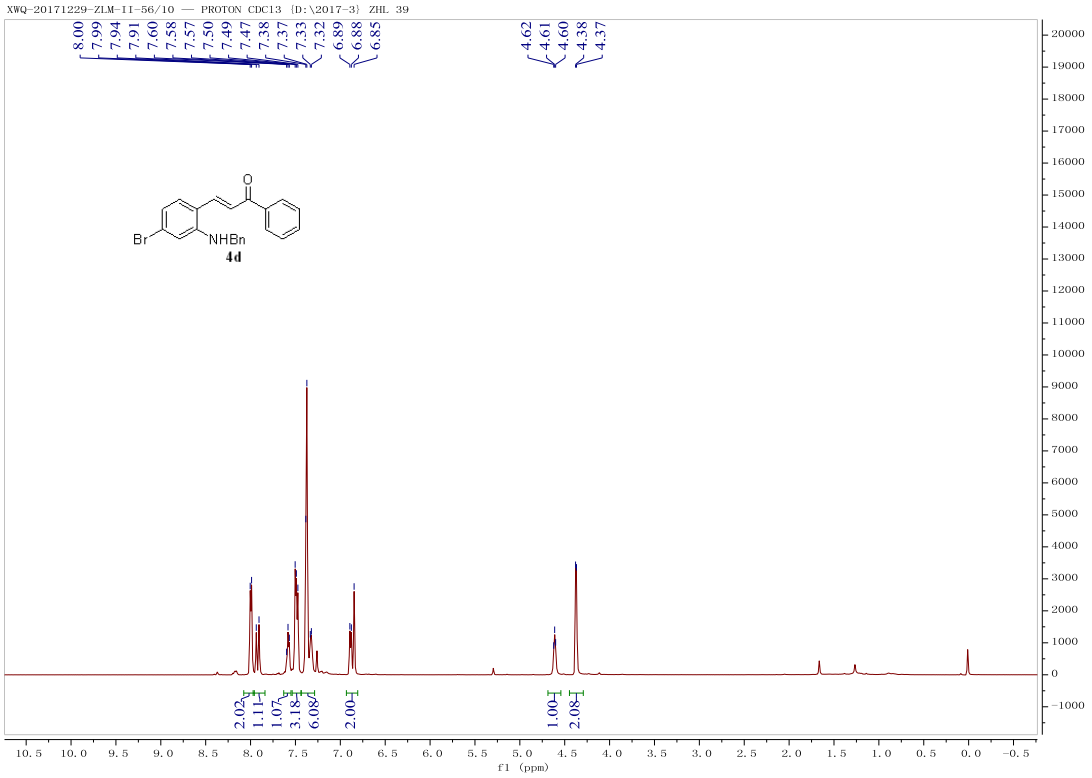
48.50
Cl
O
NHBn
4c
f1 (ppm)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7.38
7.37
7.33
7.32
6.89
6.88
6.85
4.62
4.61
4.60
4.38
4.37
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NHBn
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1.07
3.18
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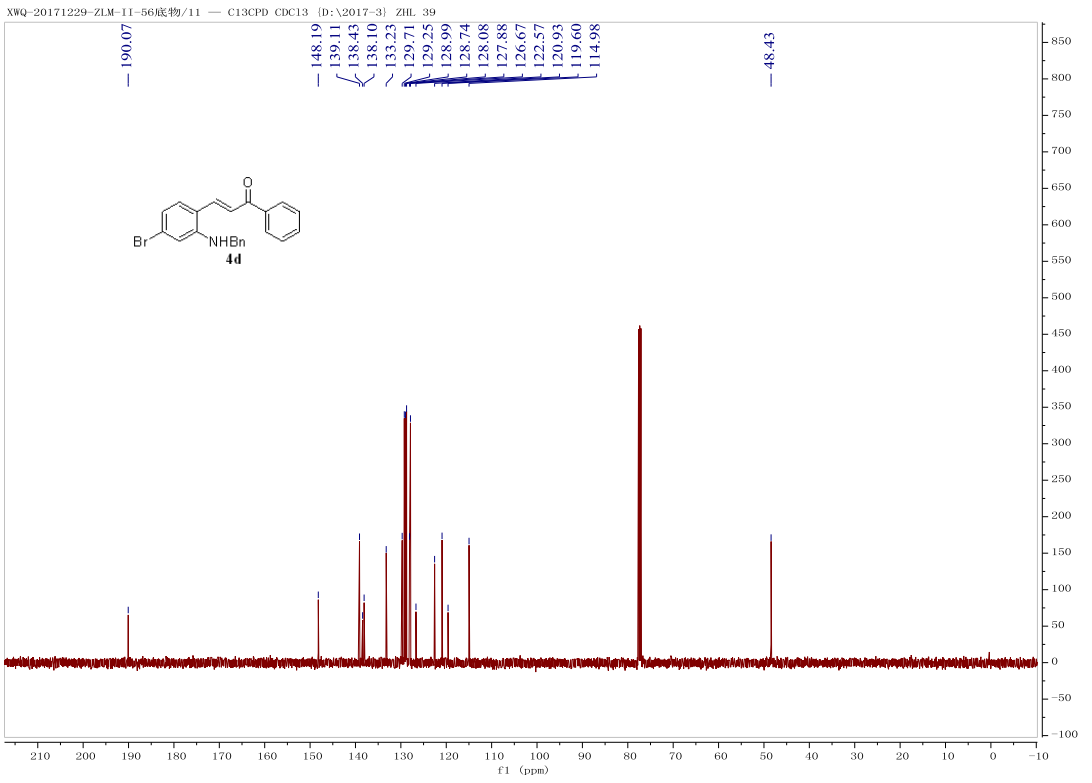
2.00
1.00
2.08
f1 (ppm)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138.10
133.23
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Br
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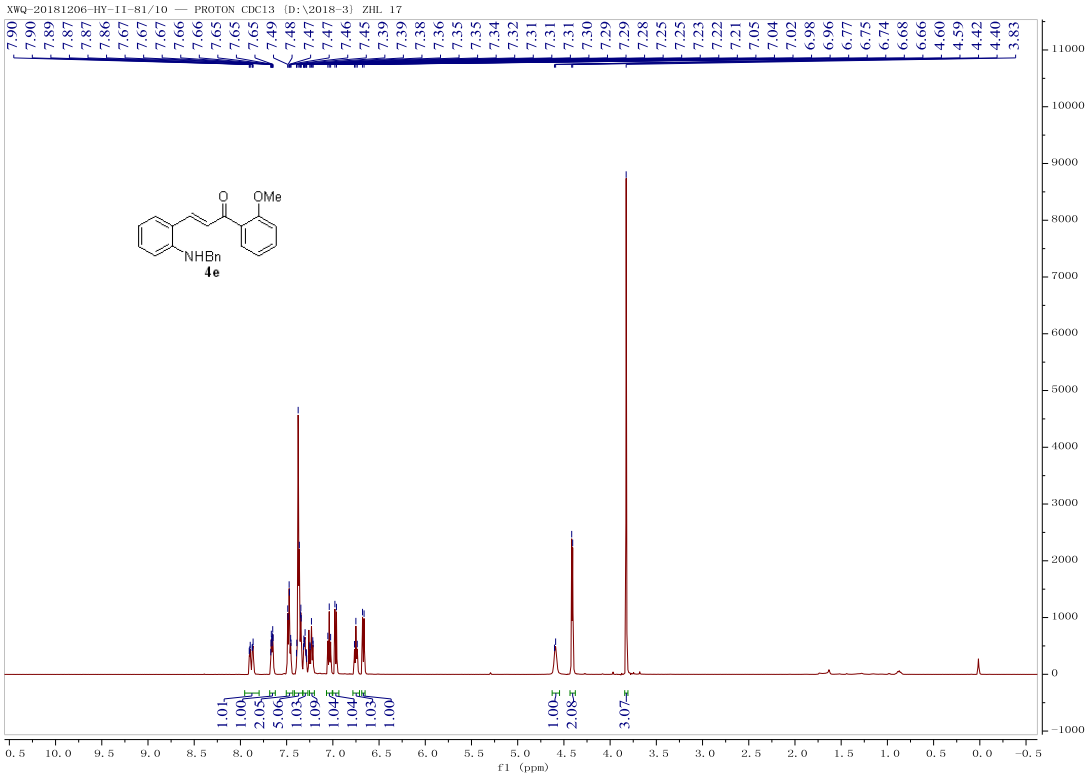
4d
f1 (ppm)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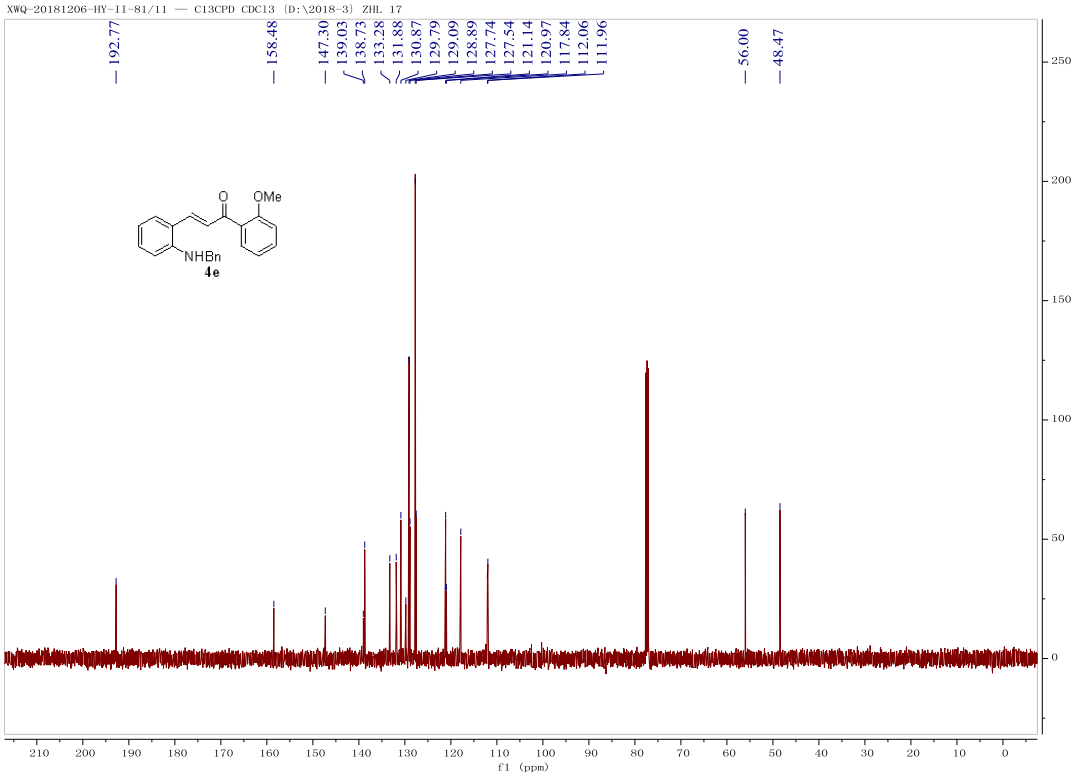
O
OMe
NHBn
4e
1.01 1.00 2.05 5.06 1.03 1.09 1.04 1.04 1.03 1.00 1.00 2.08 3.07
f1 (ppm)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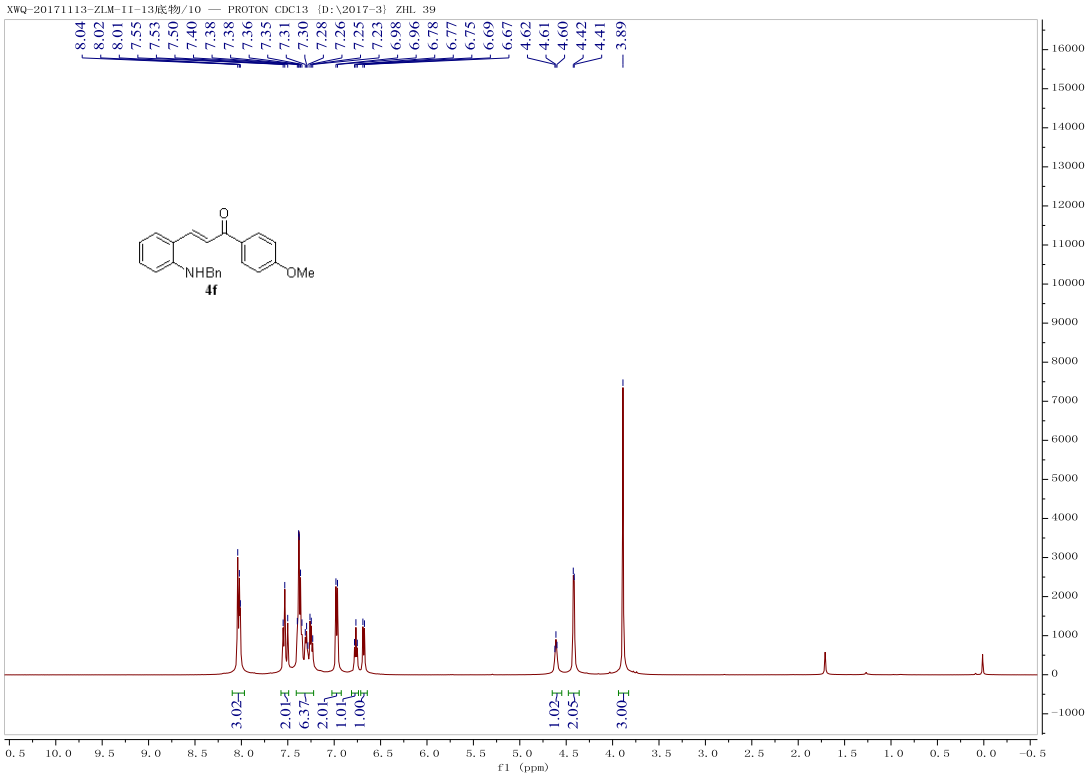
192.77 158.48 147.30 139.03 138.73 133.28 131.88 130.87 129.79 129.09 128.89 127.74 127.54 121.14 120.97 117.84 112.06 111.96 56.00 48.47
O
OMe
NHBn
4e
f1 (ppm)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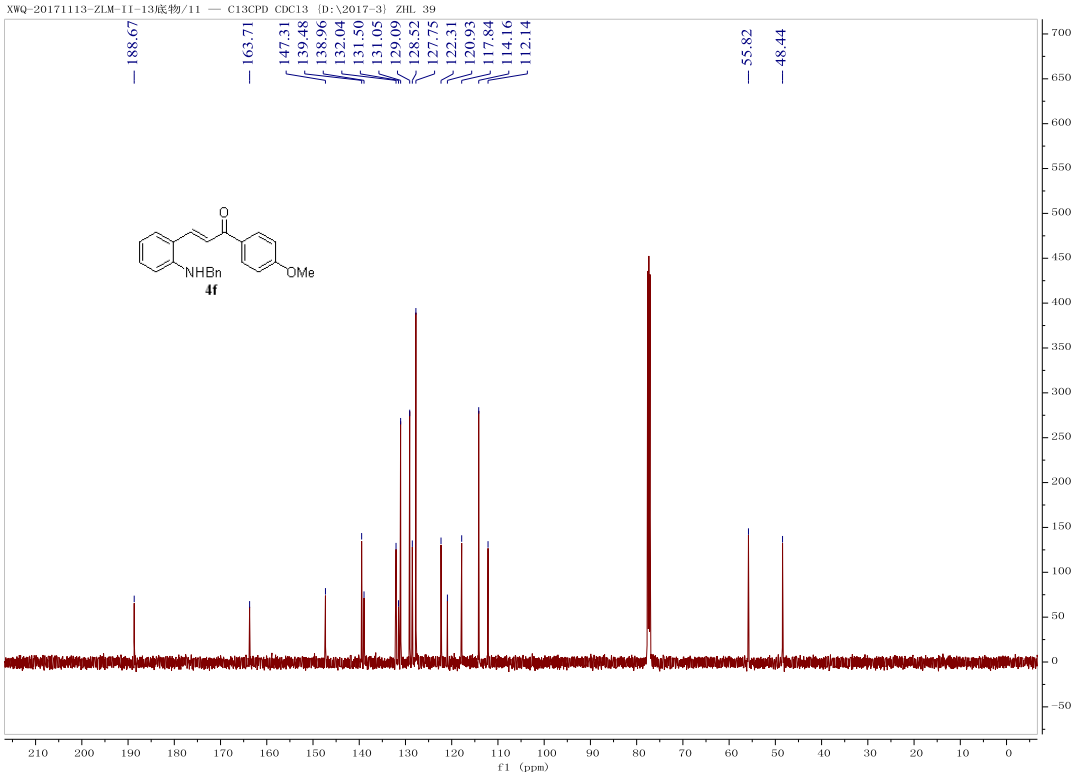
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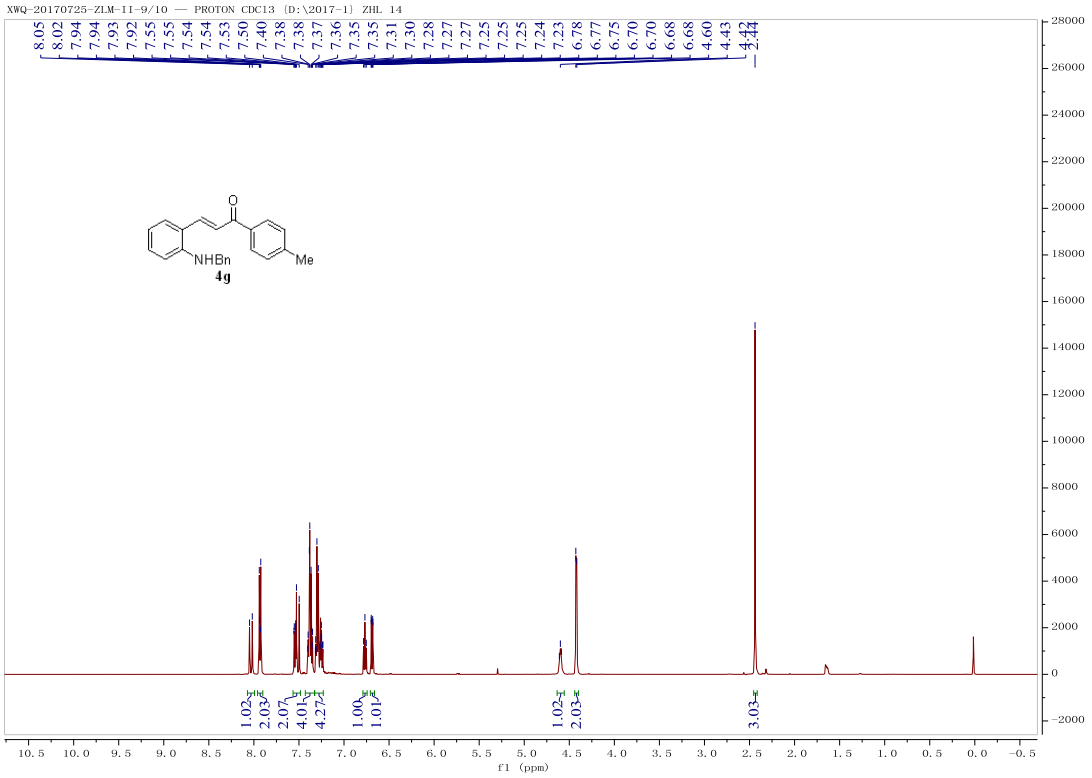
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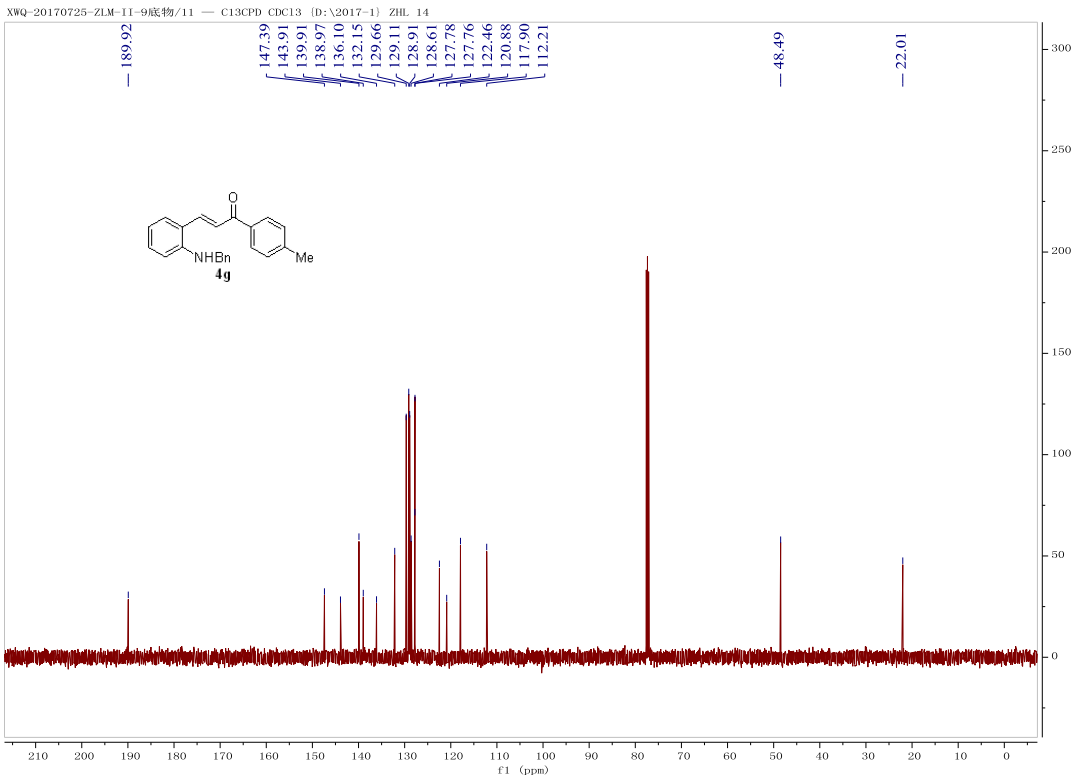
4g
f1 (ppm)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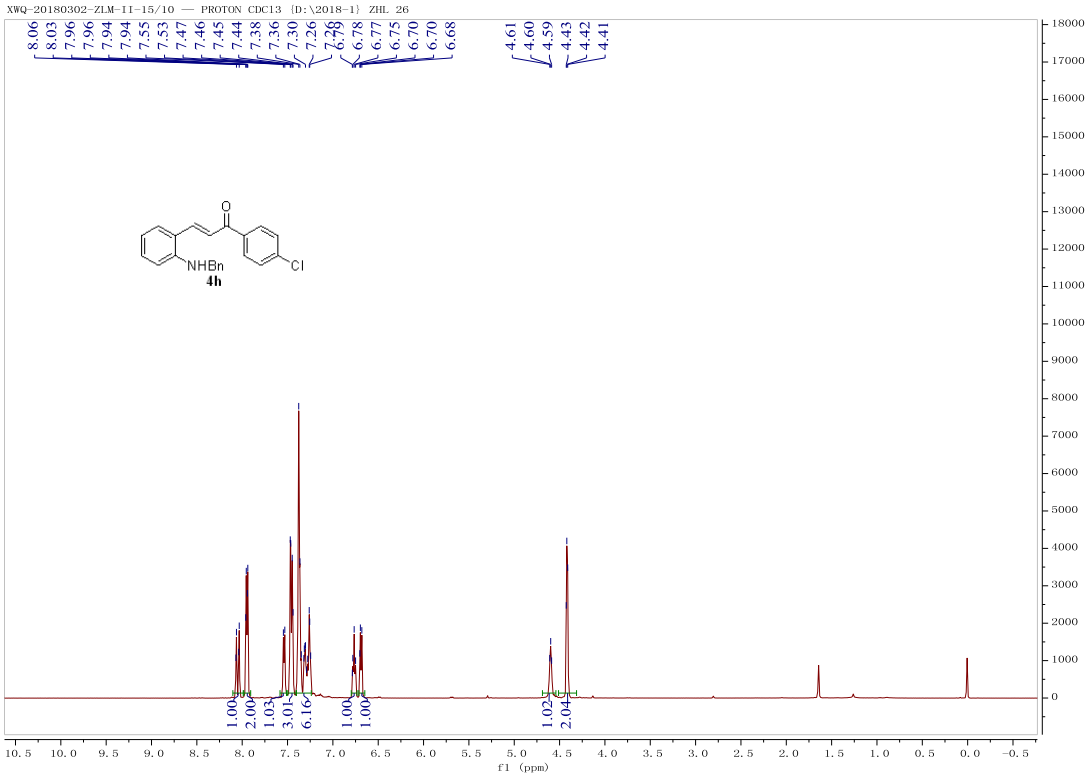
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7.44
7.38
7.36
7.30
7.26
6.78
6.77
6.75
6.70
6.70
6.68
4.61
4.60
4.59
4.43
4.42
4.41
O
NHBn
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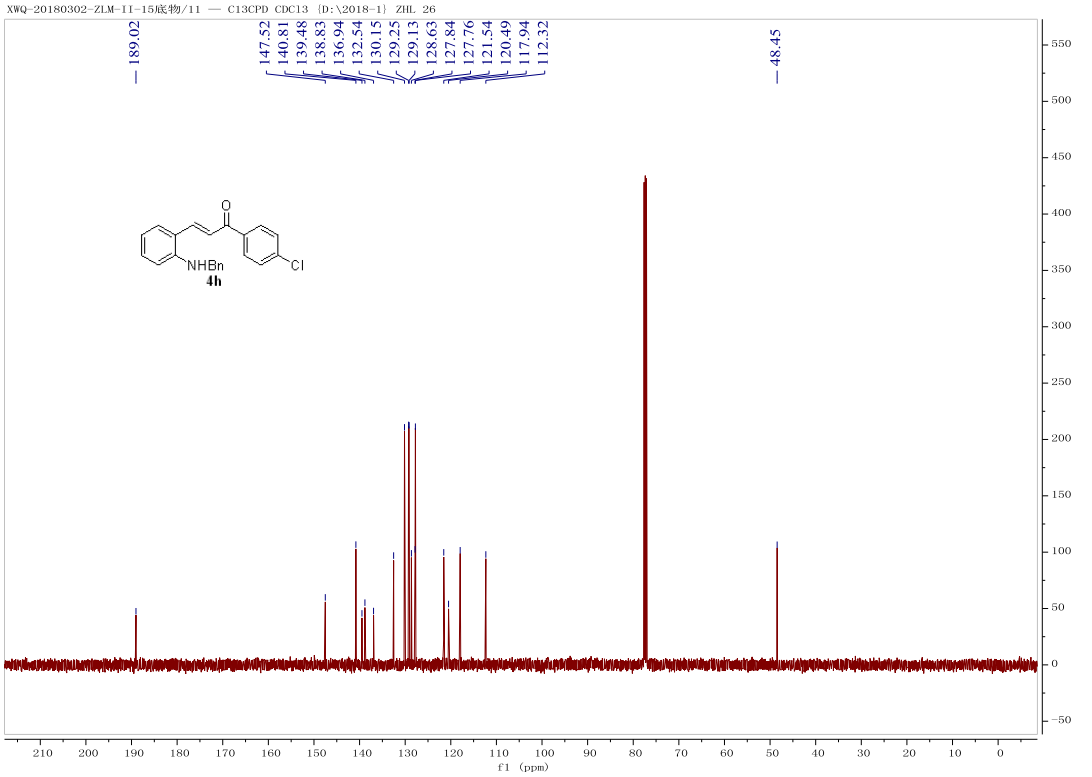
f1 (ppm)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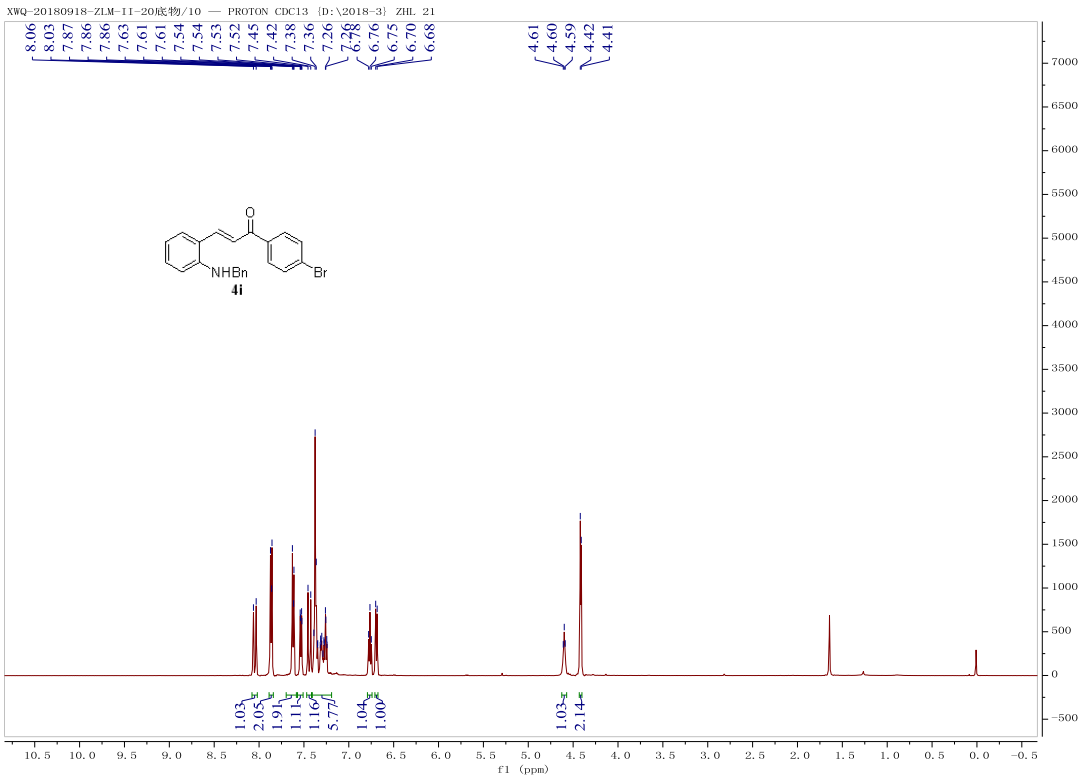
Cl
4h
f1 (ppm)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4.59
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Br
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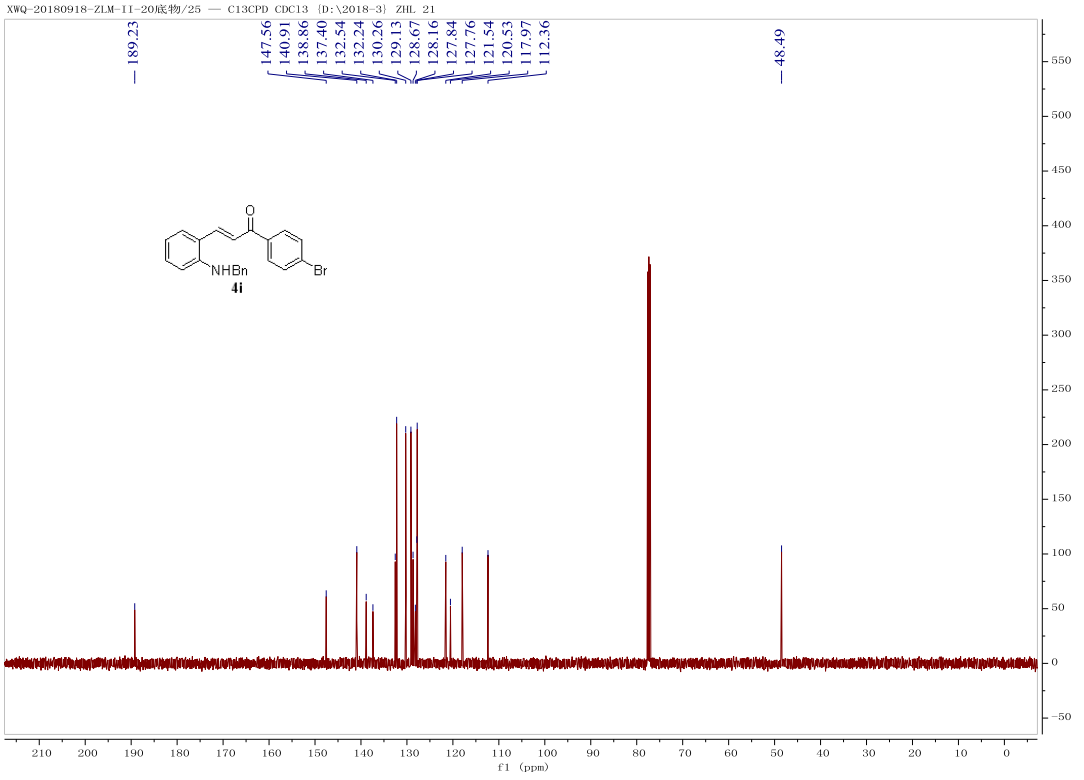
f1 (ppm)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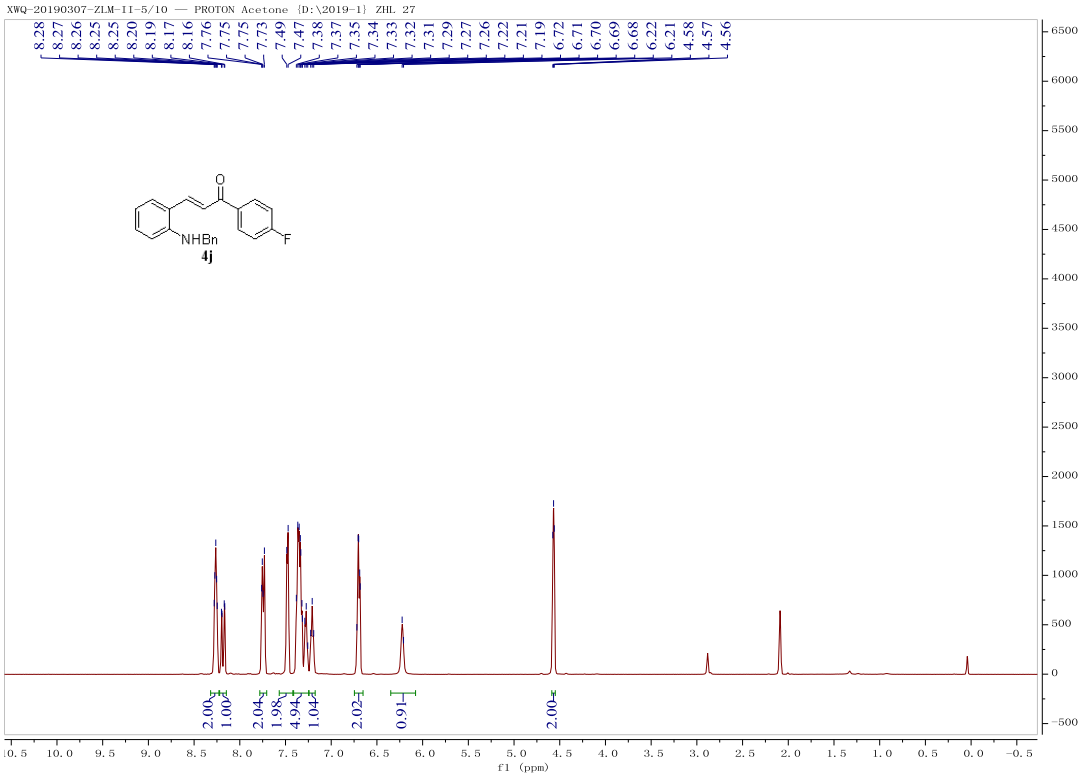
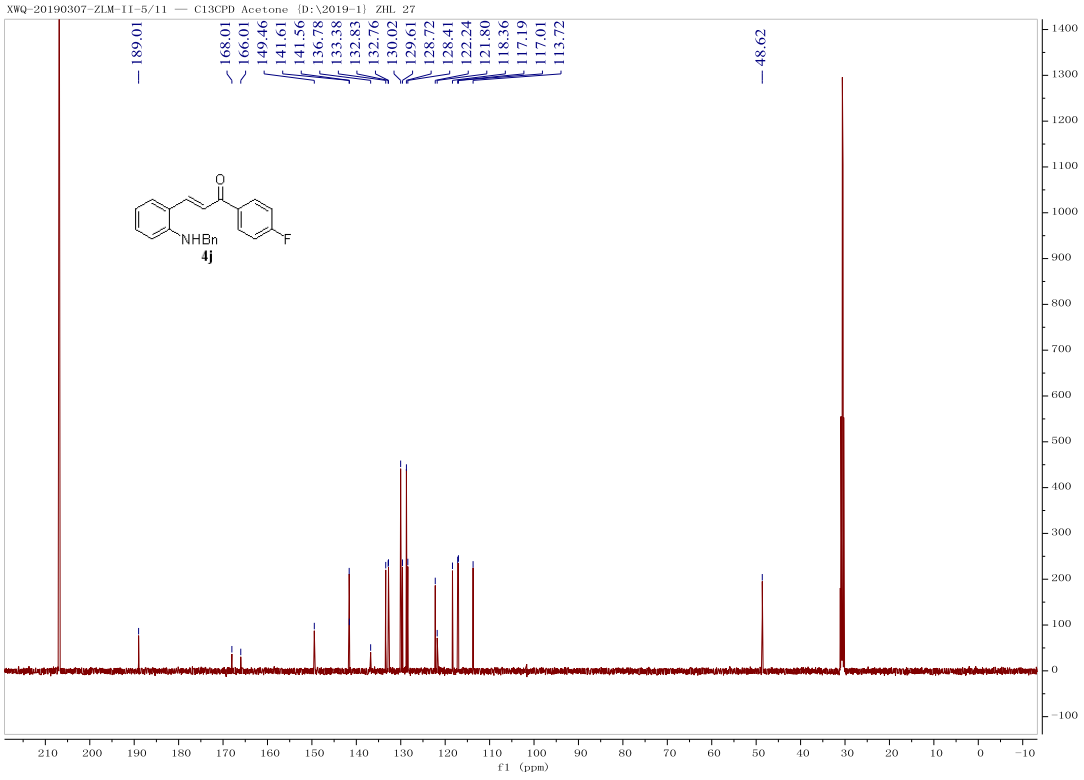
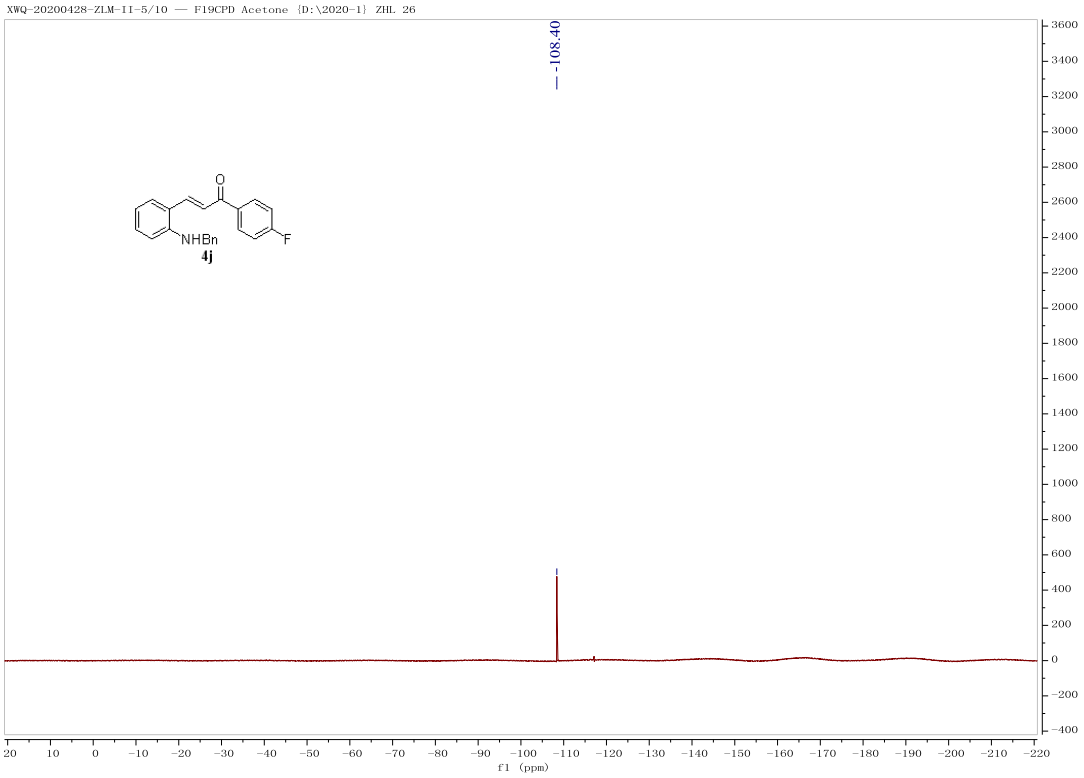
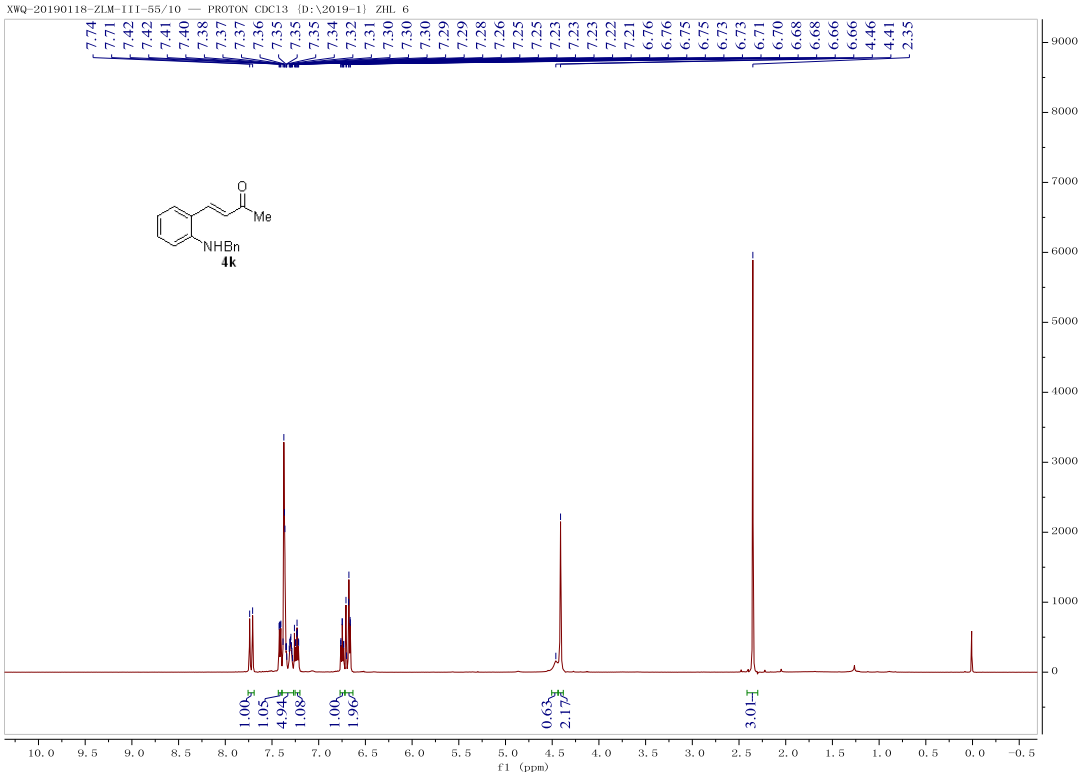
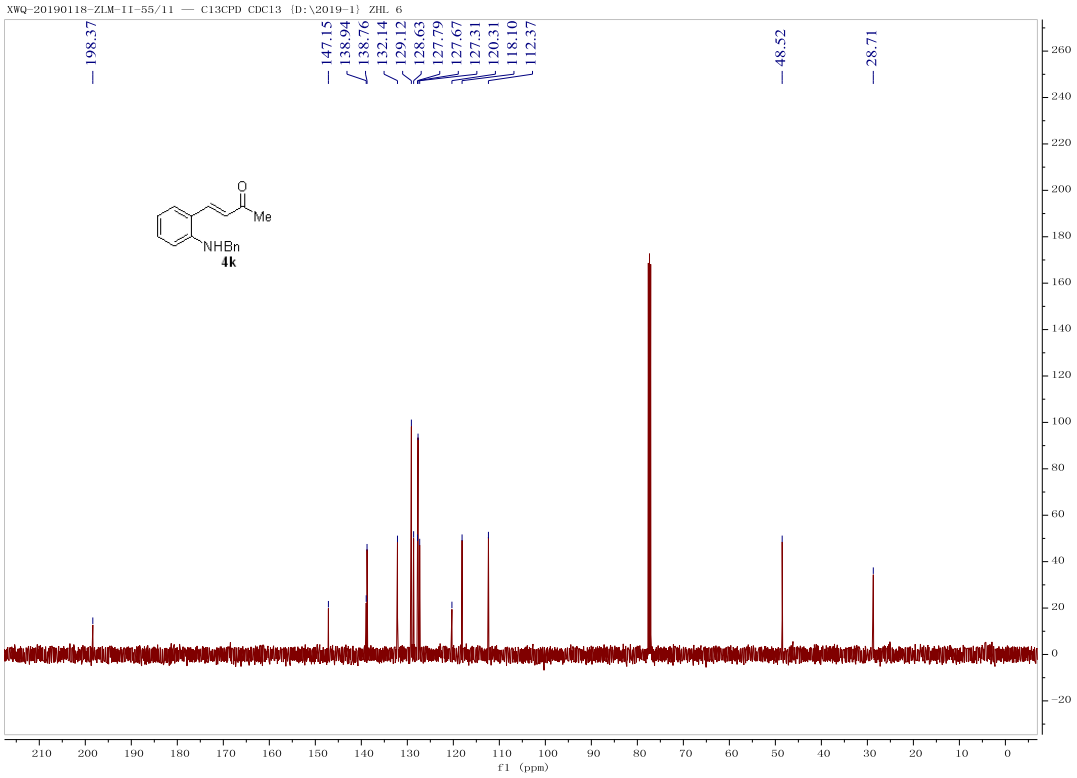
120.53
117.97
112.36
48.49
O
NHBn
Br
4i
f1 (ppm)

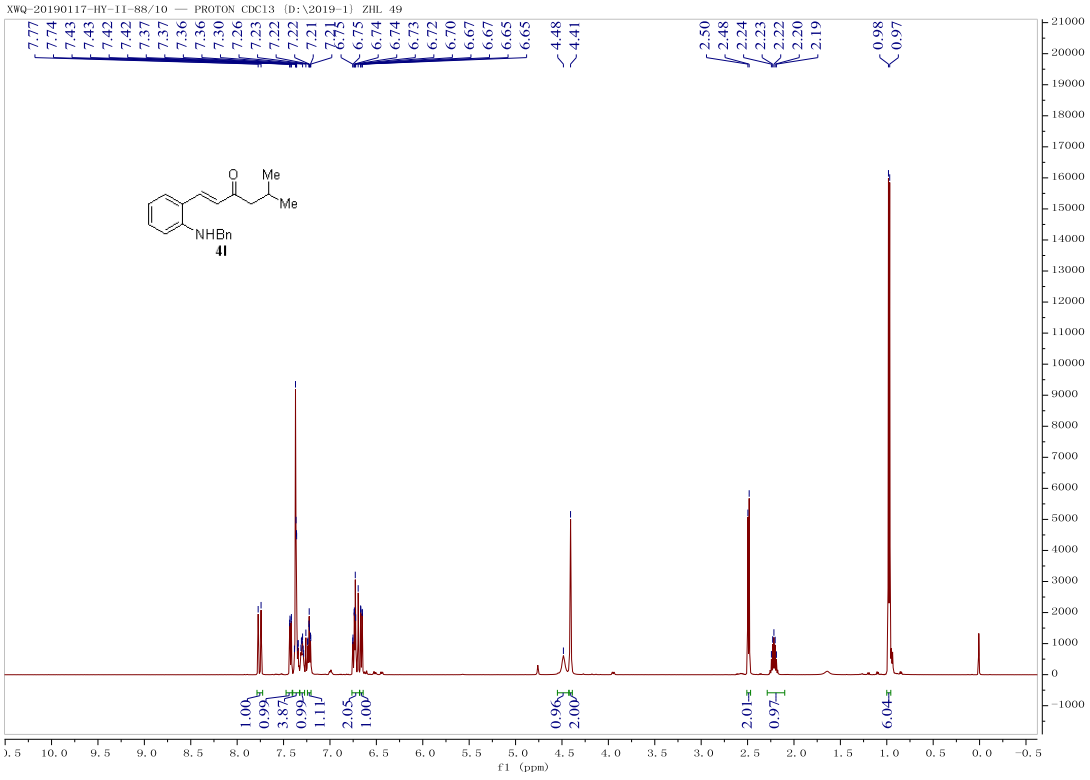

XWQ-20190307-ZLM-II-5/10 — PROTON Acetone {D:\2019-1} ZHL 27
8.28 8.27 8.26 8.25 8.25 8.20 8.19 8.17 8.16 7.76 7.75 7.75 7.73 7.49 7.47 7.38 7.37 7.35 7.34 7.33 7.32 7.31 7.29 7.27 7.26 7.22 7.21 7.19 6.72 6.71 6.70 6.69 6.68 6.22 6.21 4.58 4.57 4.56
O
NHBn
F
4j
2.00 1.00 2.04 1.98 4.94 1.04 2.02 0.91 2.00
f1 (ppm)

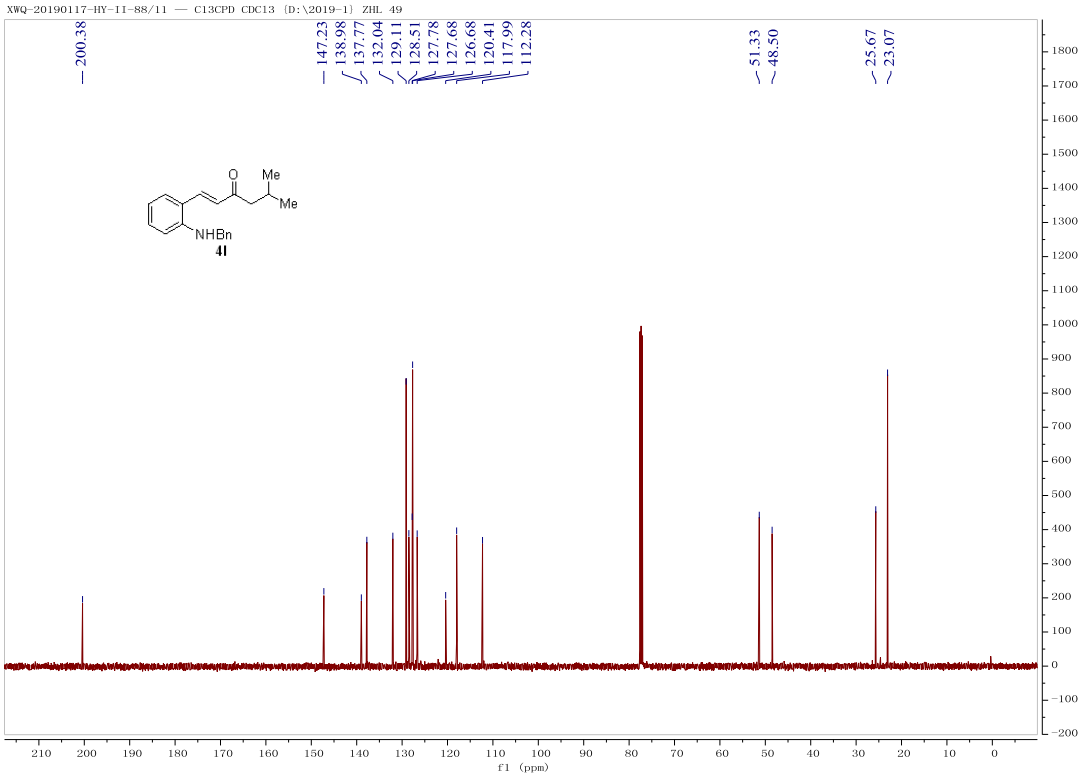

XWQ-20190307-ZLM-II-5/11 — C13CPD Acetone {D:\2019-1} ZHL 27
189.01 168.01 166.01 149.46 141.61 141.56 136.78 133.38 132.83 132.76 130.02 129.61 128.72 128.41 122.24 121.80 118.36 117.19 117.01 113.72 48.62
O
NHBn
F
4j
f1 (ppm)

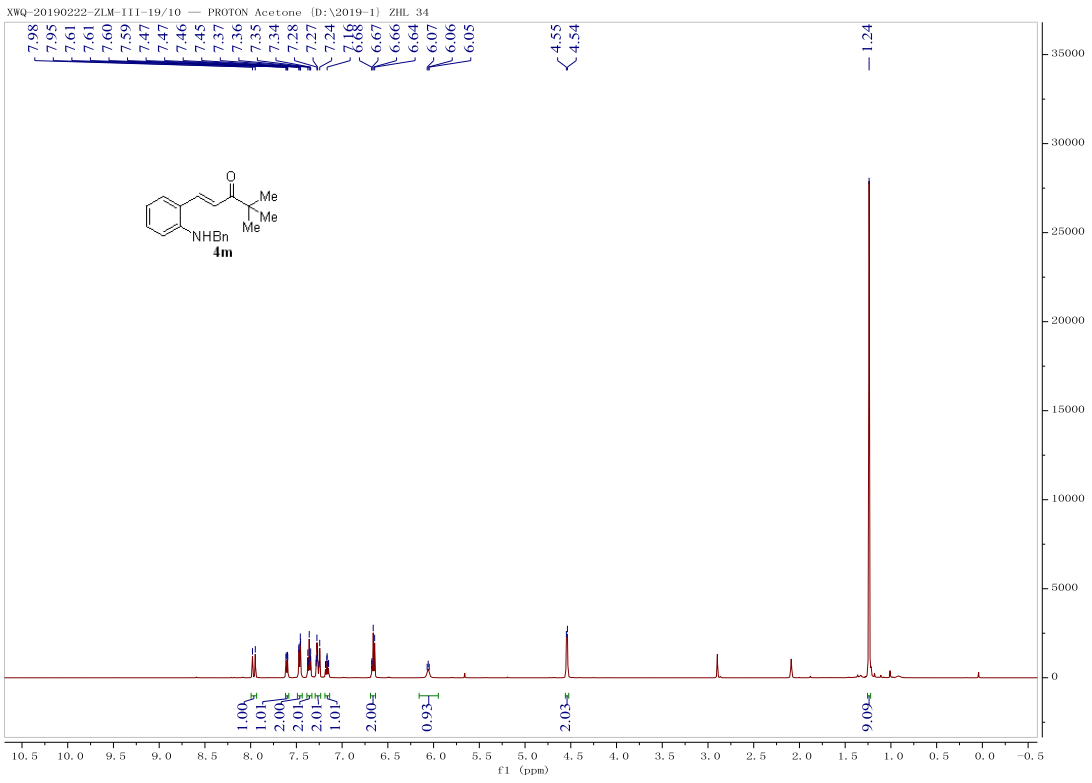

XWQ-20200428-ZLM-II-5/10 — F19CPD Acetone {D:\2020-1} ZHL 26
-108.40
O
NHBn
F
4j
f1 (ppm)

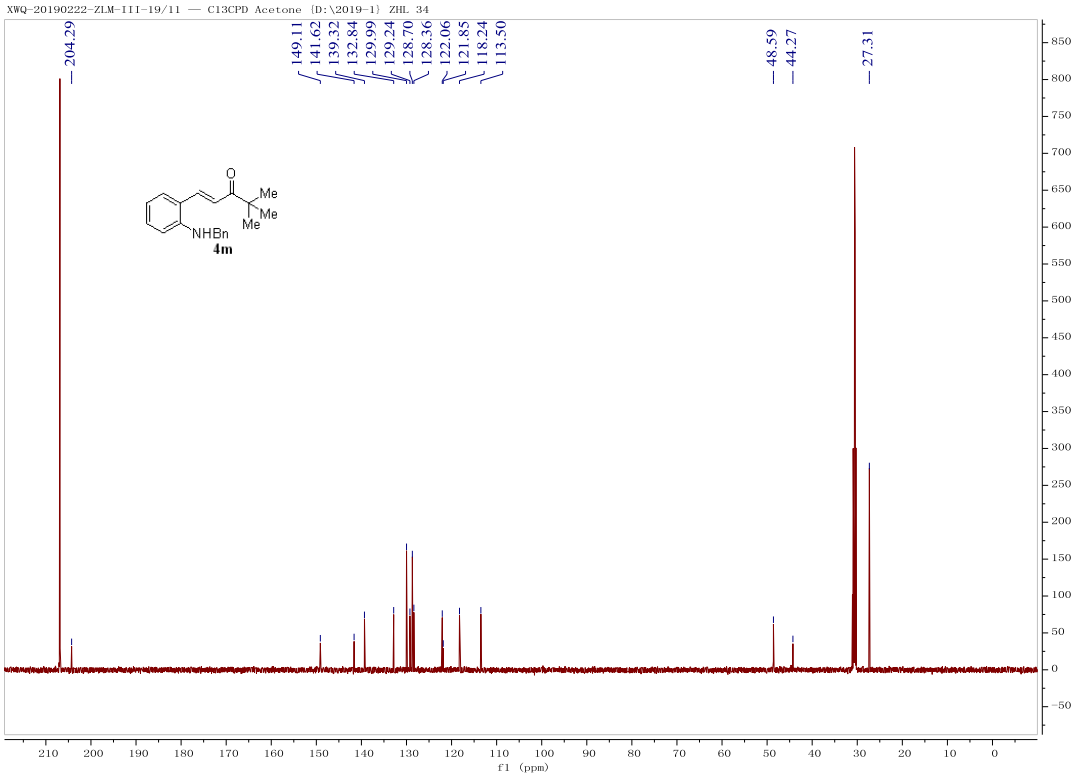

XWQ-20190118-ZLM-III-55/10 — PROTON CDCl3 {D:\2019-1} ZHL 6
7.74 7.71 7.42 7.42 7.41 7.40 7.38 7.37 7.37 7.36 7.35 7.35 7.35 7.34 7.32 7.31 7.30 7.30 7.30 7.29 7.29 7.28 7.26 7.25 7.25 7.23 7.23 7.23 7.22 7.21 6.76 6.76 6.75 6.75 6.73 6.73 6.71 6.70 6.68 6.68 6.66 6.66 4.46 4.41 2.35
O
Me
NHBn
4k
1.00 1.05 4.94 1.08 1.00 1.96 0.63 2.17 3.01
f1 (ppm)

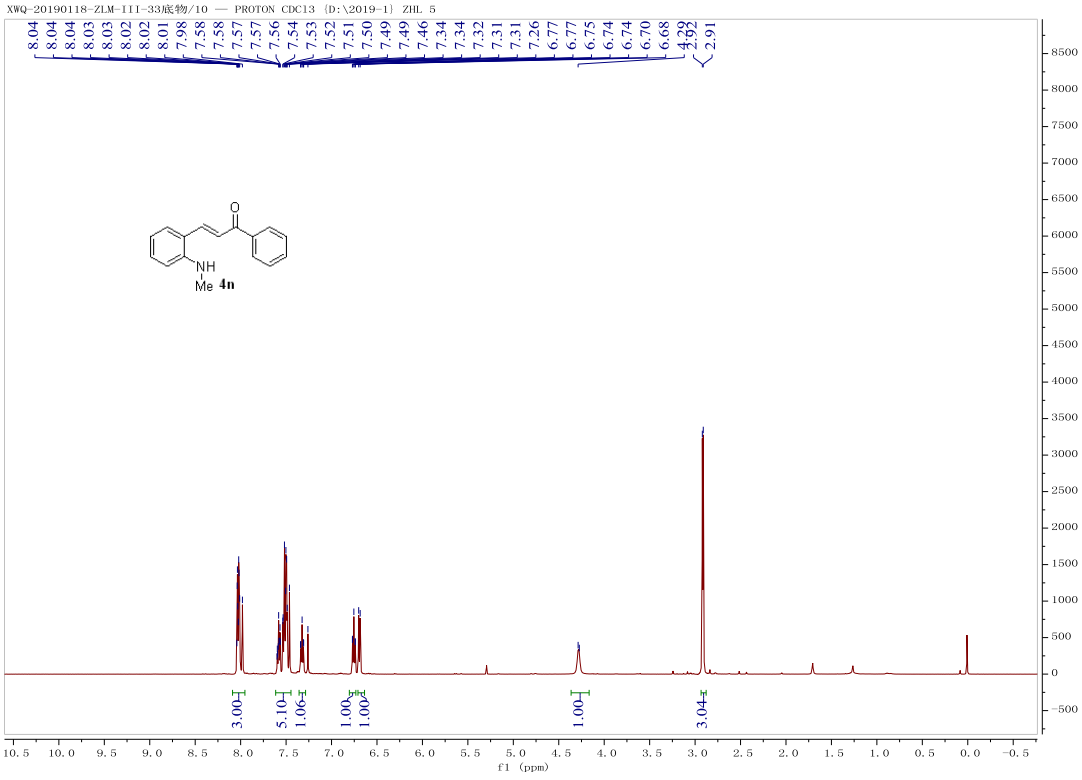

XWQ-20190118-ZLM-II-55/11 — C13CPD CDC13 {D:\2019-1} ZHL 6
198.37
147.15
138.94
138.76
132.14
129.12
128.63
127.79
127.67
127.31
120.31
118.10
112.37
48.52
28.71
O
Me
NHBn
4k
f1 (ppm)

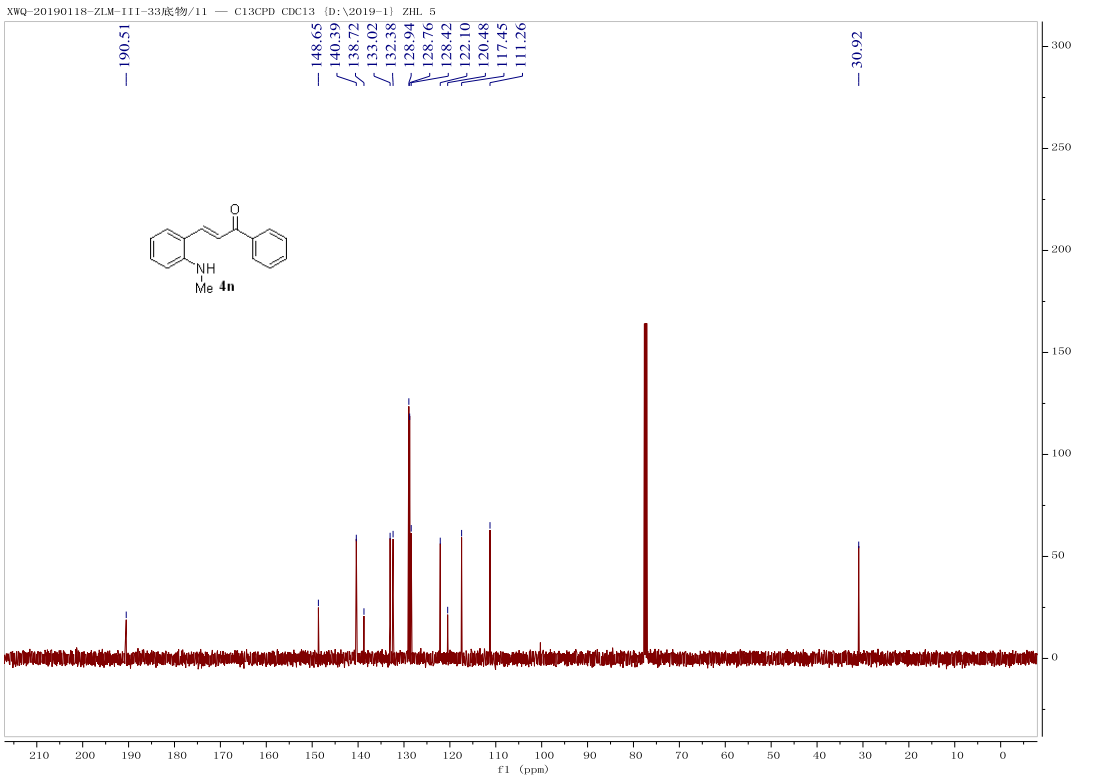

XWQ-20190117-HY-II-88/10 — PROTON CDC13 {D:\2019-1} ZHL 49
7.77
7.74
7.43
7.43
7.42
7.42
7.37
7.37
7.36
7.36
7.30
7.26
7.23
7.22
7.22
7.21
7.21
6.75
6.75
6.74
6.74
6.73
6.72
6.70
6.67
6.67
6.65
6.65
4.48
4.41
2.50
2.48
2.24
2.23
2.22
2.20
2.19
0.98
0.97
O
Me
Me
NHBn
4l
1.00
0.99
3.87
0.99
1.11
2.05
1.00
0.96
2.00
2.01
0.97
6.04
f1 (ppm)

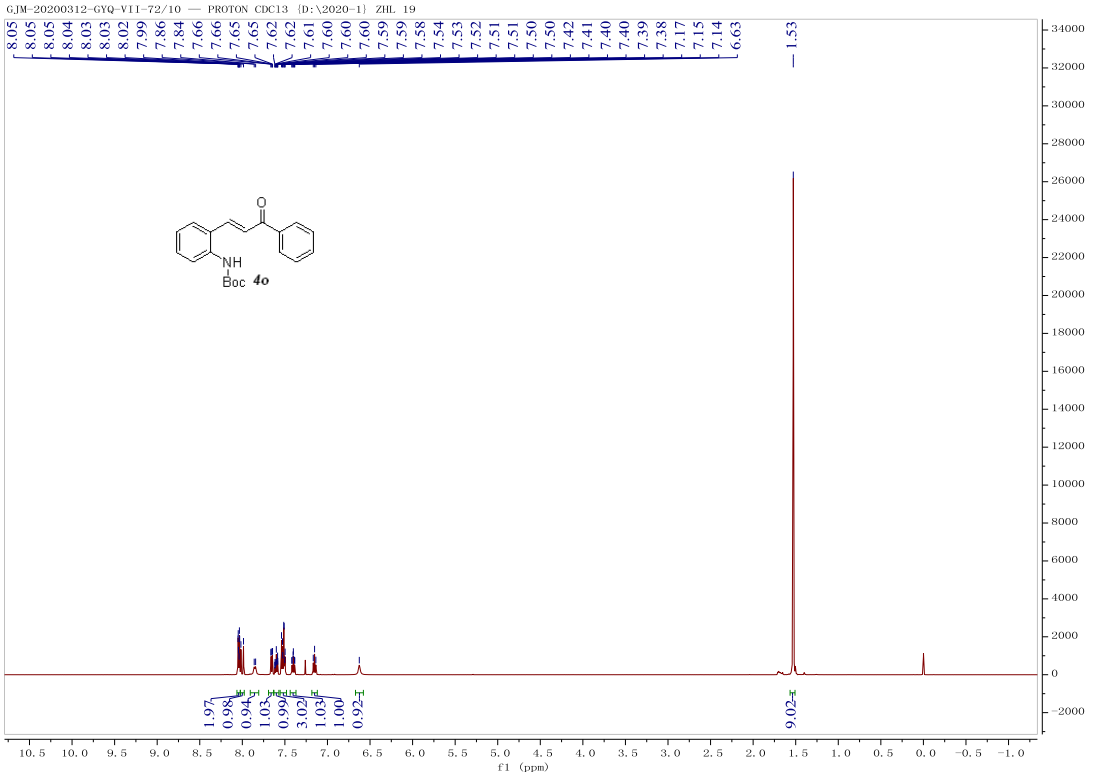

XWQ-20190117-HY-II-88/11 — C13CPD CDC13 (D:\2019-1) ZHL 49
200.38
147.23
138.98
137.77
132.04
129.11
128.51
127.78
127.68
126.68
120.41
117.99
112.28
51.33
48.50
25.67
23.07
O
Me
Me
NHBn
4l
f1 (ppm)

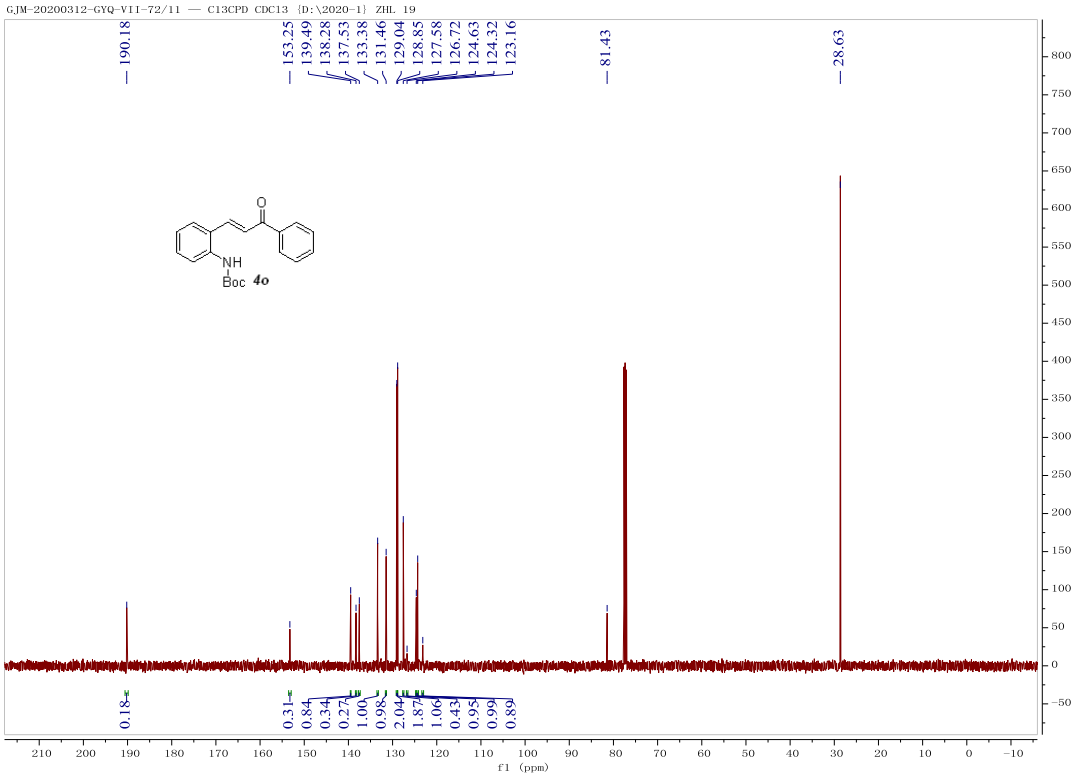

XWQ-20190222-ZLM-III-19/10 — PROTON Acetone (D:\2019-1) ZHL 34
7.98
7.95
7.61
7.61
7.60
7.59
7.47
7.47
7.46
7.45
7.37
7.36
7.35
7.34
7.28
7.27
7.24
7.16
6.68
6.67
6.66
6.64
6.07
6.06
6.05
4.55
4.54
1.24
O
Me
Me
Me
NHBn
4m
1.00
1.01
2.00
2.01
2.01
1.01
2.00
0.93
2.03
9.09
f1 (ppm)

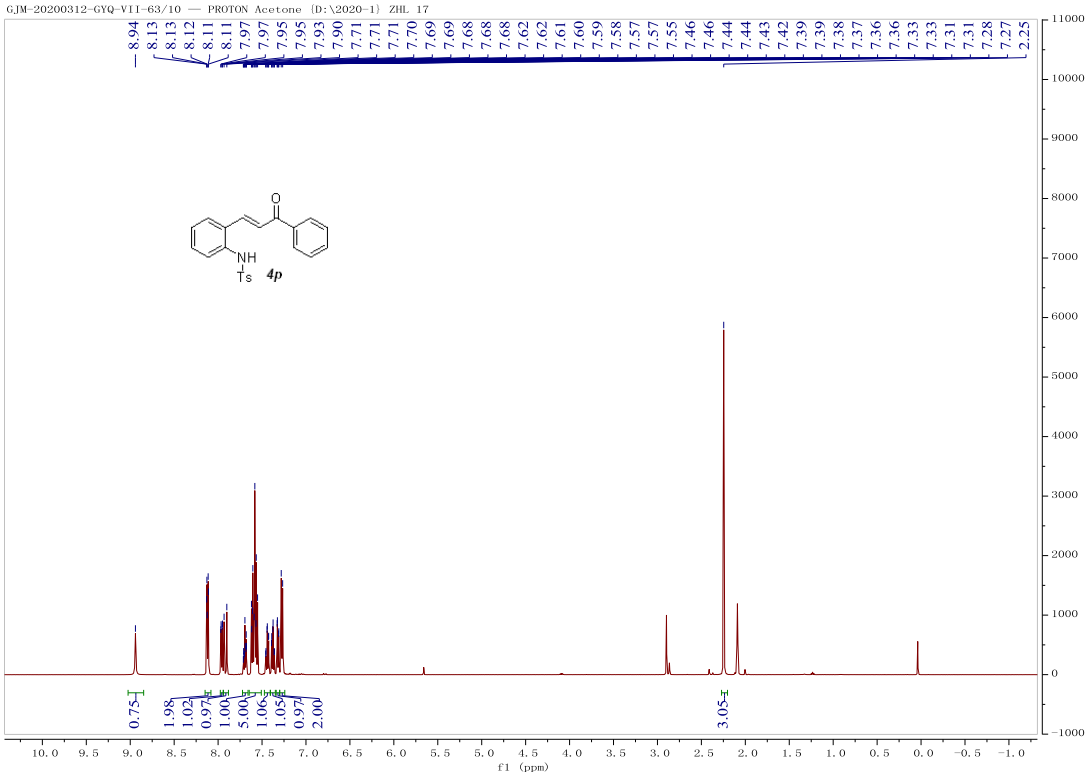

XWQ-20190222-ZLM-III-19/11 — C13CPD Acetone (D:\2019-1) ZHL 34
204.29
149.11
141.62
139.32
132.84
129.99
129.24
128.70
128.36
122.06
121.85
118.24
113.50
48.59
44.27
27.31
O
Me
Me
Me
NHBn
4m
f1 (ppm)

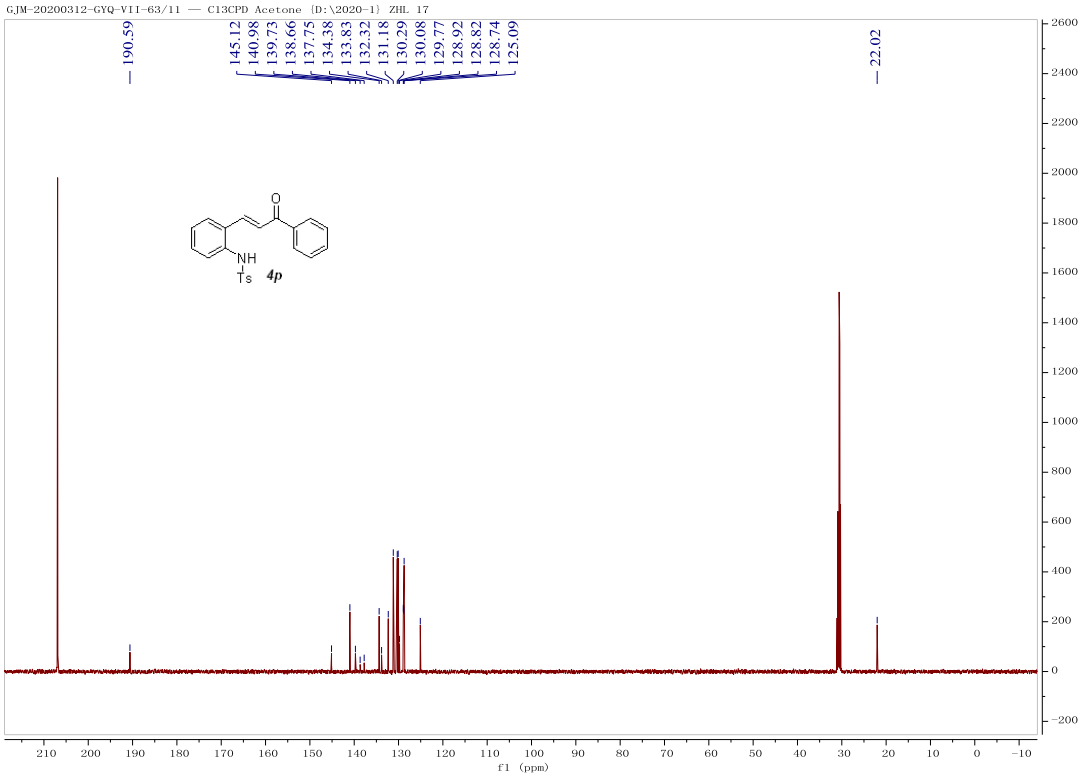

XWQ-20190118-ZLM-III-33底物/10 — PROTON CDCl3 (D:\2019-1) ZHL 5
8.04
8.04
8.04
8.03
8.03
8.02
8.02
8.01
7.98
7.58
7.58
7.57
7.57
7.56
7.54
7.53
7.52
7.51
7.50
7.49
7.49
7.46
7.34
7.34
7.32
7.31
7.31
7.26
6.77
6.77
6.75
6.74
6.74
6.70
6.68
4.29
2.92
2.91
O
NH
Me
4n
3.00
5.10
1.06
1.00
1.00
1.00
3.04
f1 (ppm)

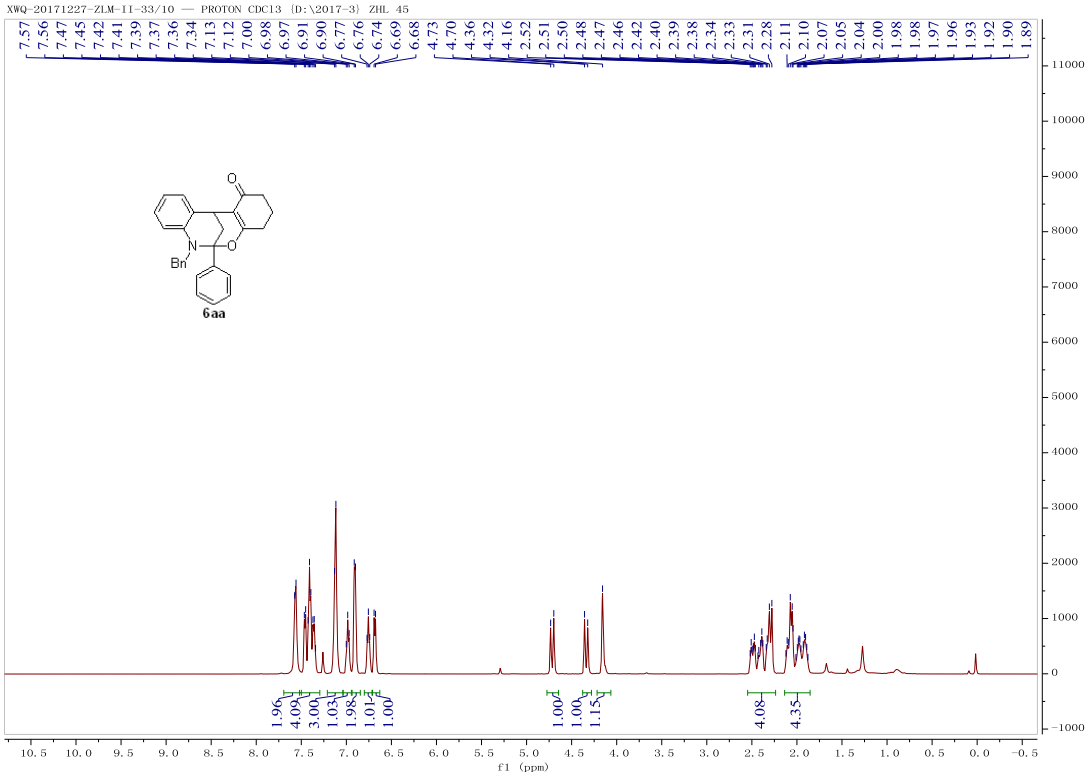

XWQ-20190118-ZLM-III-33/底物/11 — C13CPD CDC13 {D:\2019-1} ZHL 5
190.51
148.65
140.39
138.72
133.02
132.38
128.94
128.76
128.42
122.10
120.48
117.45
111.26
30.92
O
NH
Me 4n
f1 (ppm)

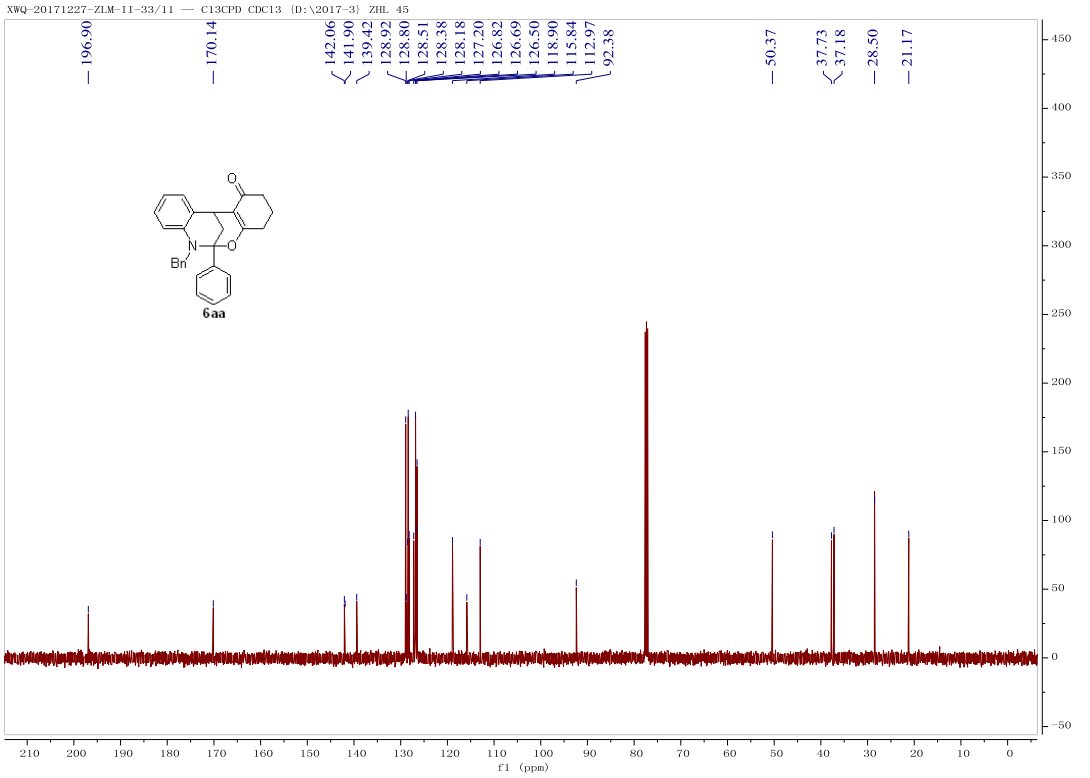

GJM-20200312-GYQ-VII-72/10 — PROTON CDC13 {D:\2020-1} ZHL 19
8.05
8.05
8.05
8.04
8.03
8.03
8.02
7.99
7.86
7.84
7.66
7.66
7.65
7.65
7.62
7.62
7.61
7.60
7.60
7.60
7.59
7.59
7.58
7.54
7.53
7.52
7.51
7.51
7.50
7.50
7.42
7.41
7.40
7.40
7.39
7.38
7.17
7.15
7.14
6.63
1.53
1.97
0.98
0.94
1.03
0.99
3.02
1.03
1.00
0.92
9.02
O
NH
Boc 4o
f1 (ppm)

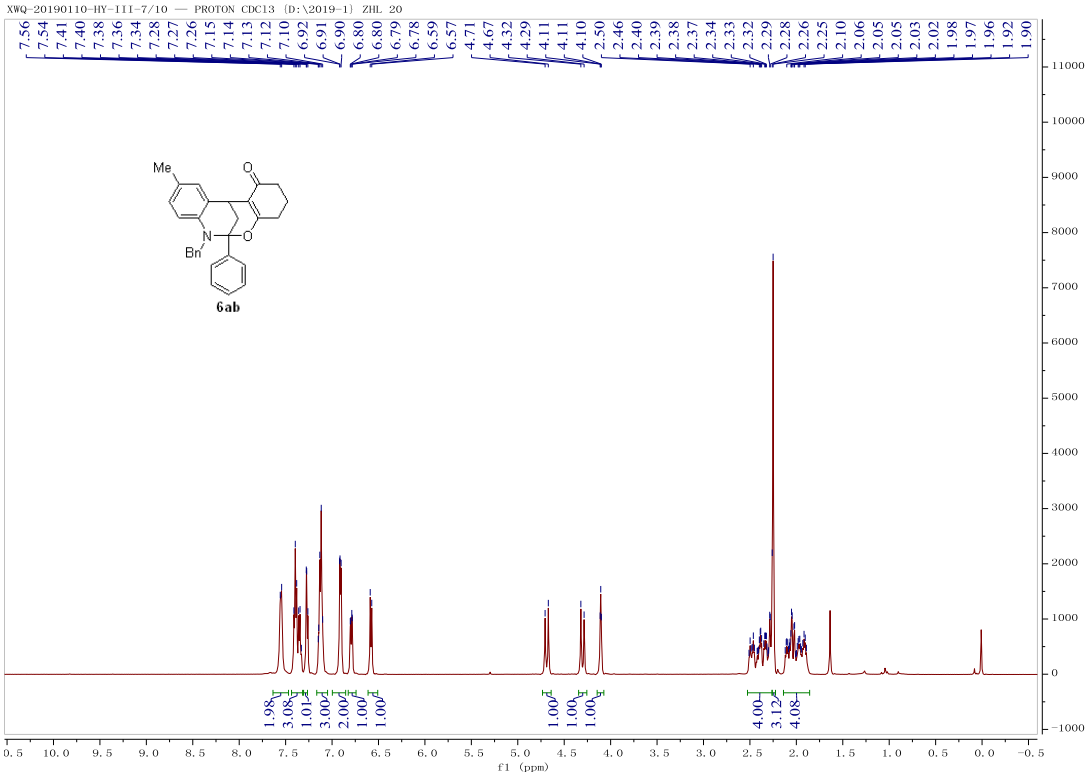

GJM-20200312-GYQ-VII-72/11 — C13CPD CDCl3 (D:\2020-1) ZHL 19
190.18
153.25
139.49
138.28
137.53
133.38
131.46
129.04
128.85
127.58
126.72
124.63
124.32
123.16
81.43
28.63
NH
Boc 4o
f1 (ppm)

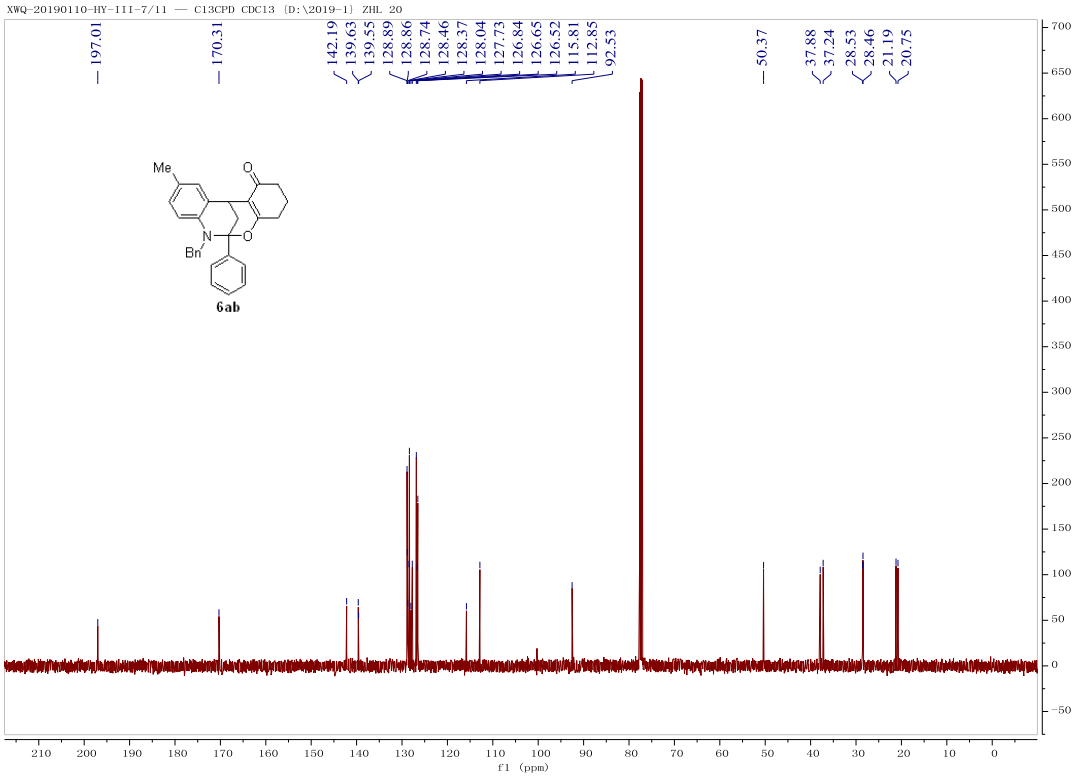

GJM-20200312-GYQ-VII-63/10 — PROTON Acetone (D:\2020-1) ZHL 17
8.94
8.13
8.13
8.12
8.11
8.11
7.97
7.97
7.95
7.95
7.93
7.90
7.71
7.71
7.71
7.70
7.69
7.69
7.68
7.68
7.68
7.62
7.62
7.61
7.60
7.59
7.58
7.57
7.57
7.55
7.46
7.46
7.44
7.44
7.43
7.42
7.39
7.39
7.38
7.37
7.36
7.36
7.33
7.33
7.31
7.31
7.28
7.27
2.25
NH
Ts 4p
f1 (ppm)

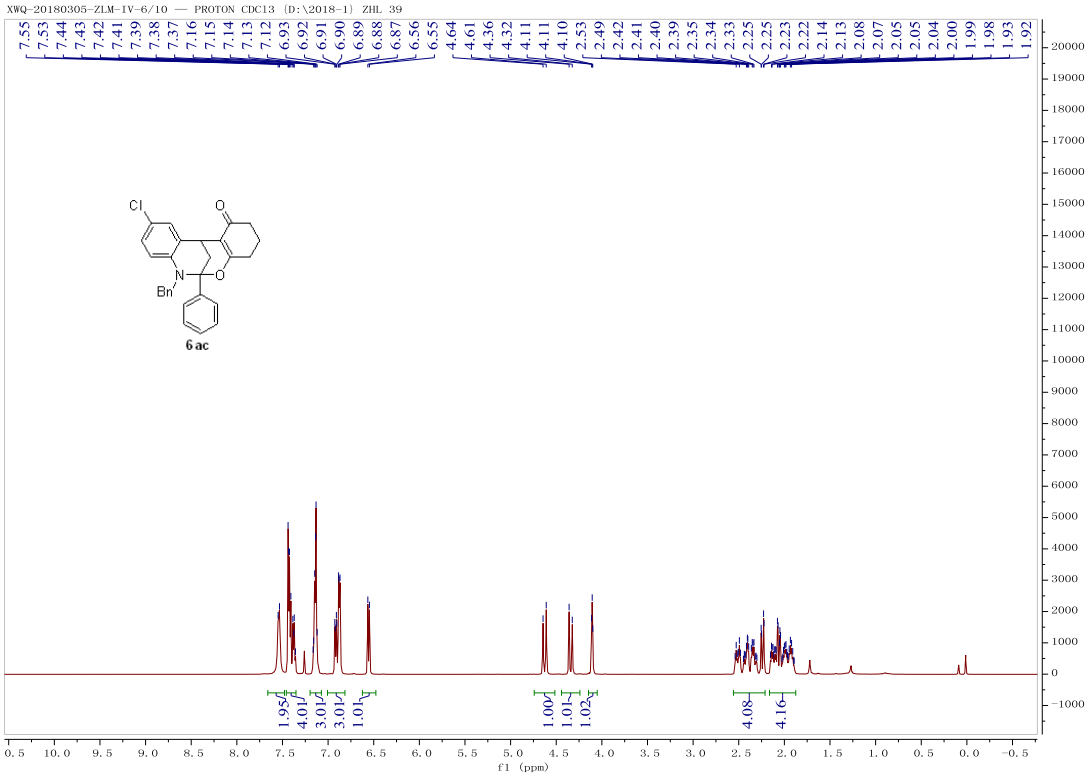

GJM-20200312-GYQ-VII-63/11 — C13CPD Acetone {D:\2020-1} ZHL 17
190.59
145.12
140.98
139.73
138.66
137.75
134.38
133.83
132.32
131.18
130.29
130.08
129.77
128.92
128.82
128.74
125.09
22.02
NH
Ts
4p
f1 (ppm)

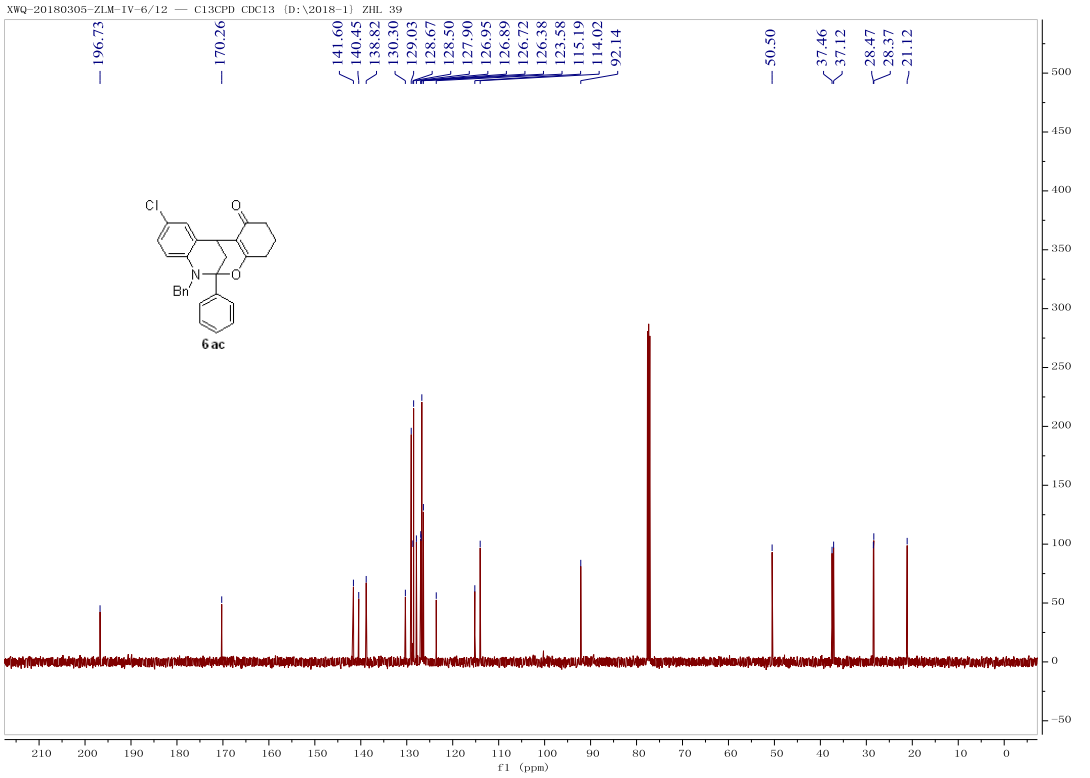

XWQ-20171227-ZLM-II-33/10 — PROTON CDCl3 {D:\2017-3} ZHL 45
7.57
7.56
7.47
7.45
7.42
7.41
7.39
7.37
7.36
7.34
7.13
7.12
7.00
6.98
6.97
6.91
6.90
6.77
6.76
6.74
6.69
6.68
4.73
4.70
4.36
4.32
4.16
2.52
2.51
2.50
2.48
2.47
2.46
2.42
2.40
2.39
2.38
2.34
2.33
2.31
2.28
2.11
2.10
2.07
2.05
2.04
2.00
1.98
1.97
1.96
1.93
1.92
1.90
1.89
1.96
4.09
3.00
1.03
1.98
1.01
1.00
1.00
1.00
1.15
4.08
4.35
N
Bn
O
6aa
f1 (ppm)

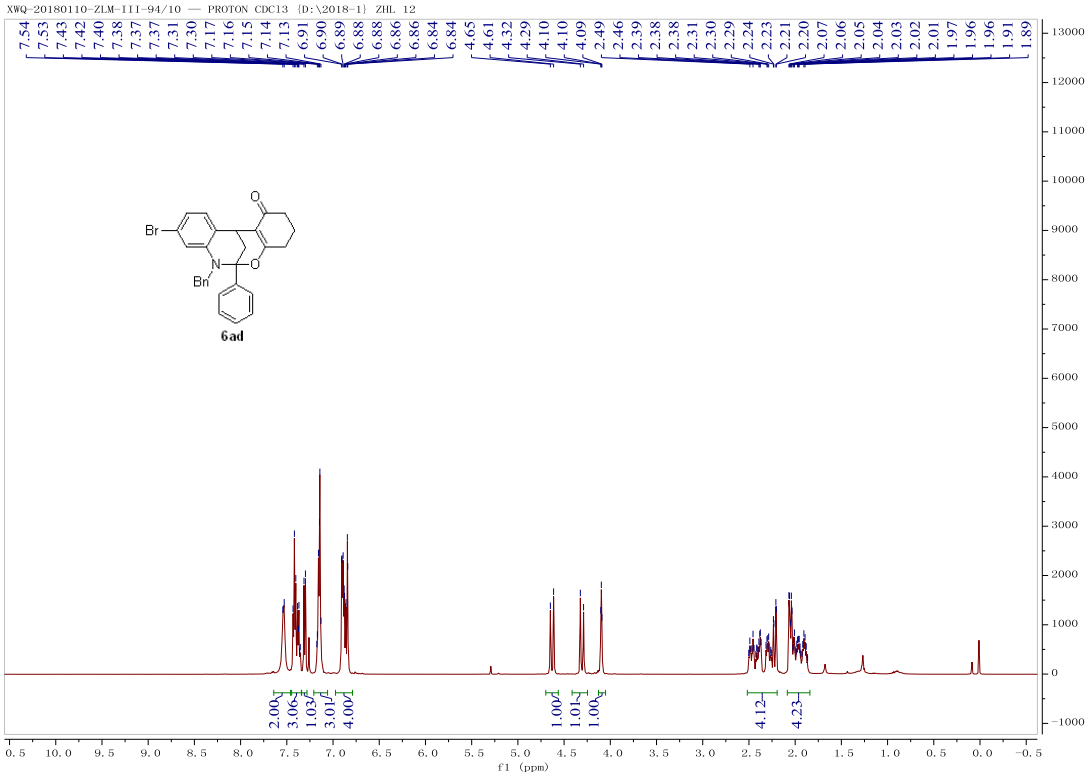

XWQ-20171227-ZLM-II-33/11 — C13CPD CDC13 {D:\2017-3} ZHL 45
196.90
170.14
142.06
141.90
139.42
128.92
128.80
128.51
128.38
128.18
127.20
126.82
126.69
126.50
118.90
115.84
112.97
92.38
50.37
37.73
37.18
28.50
21.17
O
N
O
Bn
6aa
f1 (ppm)

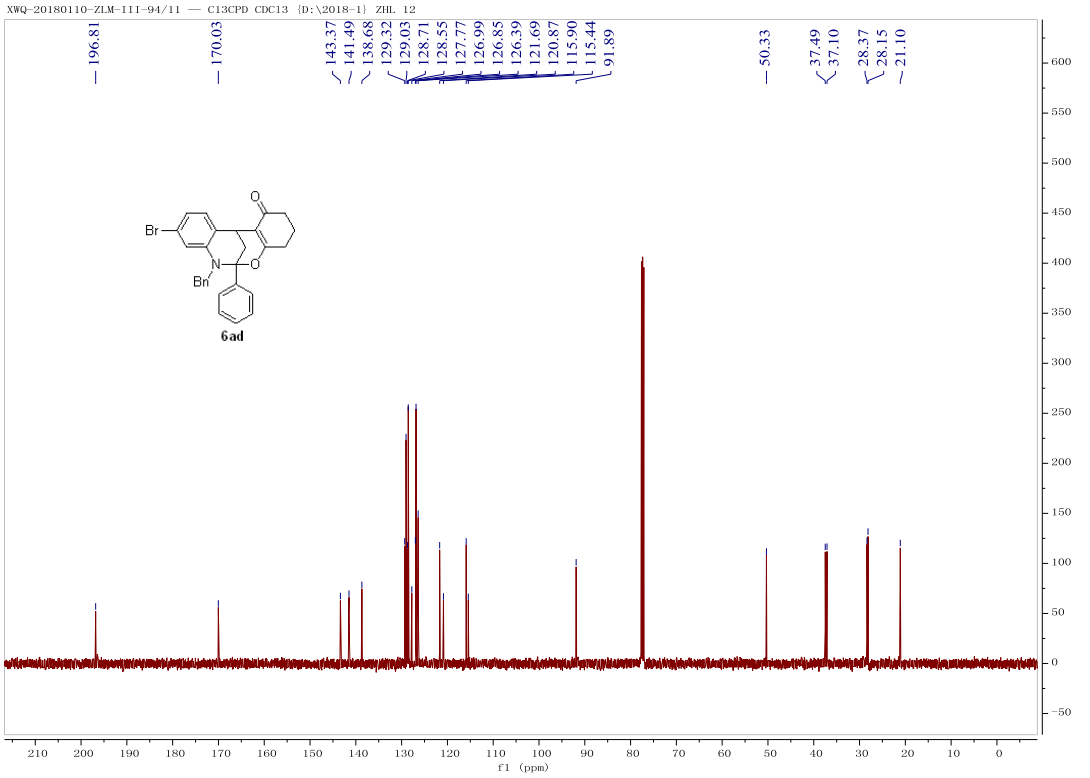

XWQ-20190110-HY-III-7/10 — PROTON CDC13 {D:\2019-1} ZHL 20
7.56
7.54
7.41
7.40
7.38
7.36
7.34
7.28
7.27
7.26
7.15
7.14
7.13
7.12
7.10
6.92
6.91
6.90
6.80
6.80
6.79
6.78
6.59
6.57
4.71
4.67
4.32
4.29
4.11
4.11
4.10
2.50
2.46
2.40
2.39
2.38
2.37
2.34
2.33
2.32
2.29
2.28
2.26
2.25
2.10
2.06
2.05
2.05
2.03
2.02
1.98
1.97
1.96
1.92
1.90
Me
O
N
O
Bn
6ab
1.98
3.08
1.01
3.00
2.00
1.00
1.00
1.00
1.00
1.00
4.00
3.12
4.08
f1 (ppm)

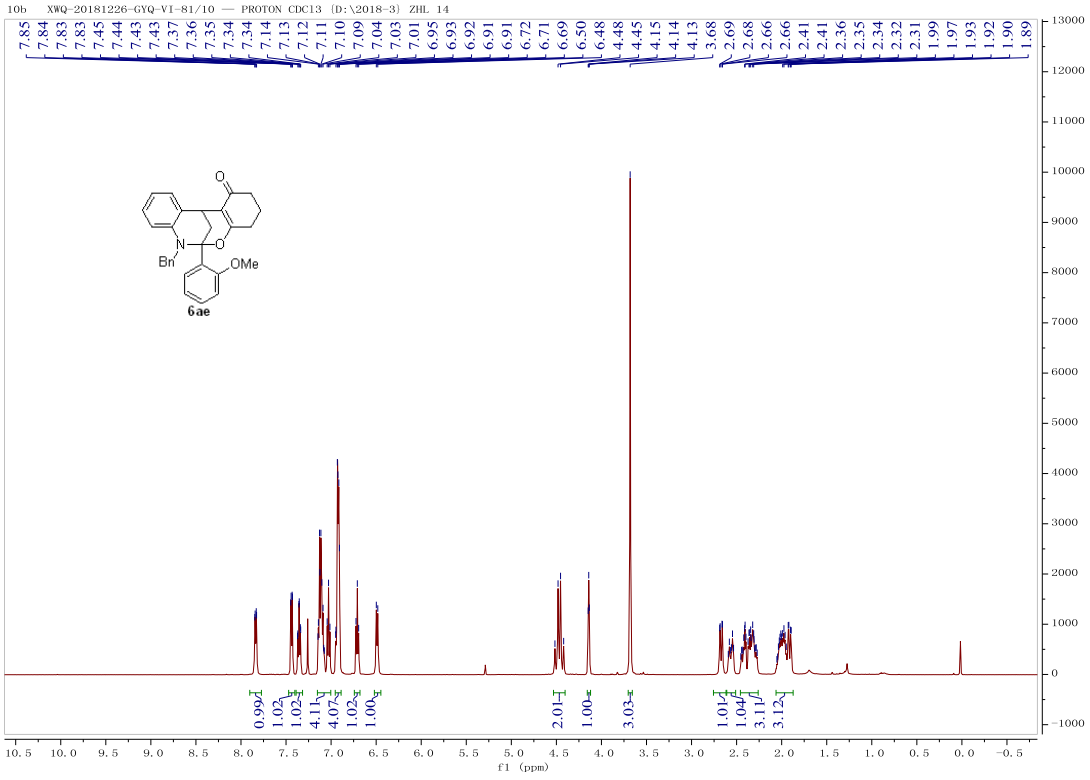

XWQ-20190110-HY-III-7/11 — C13CPD CDC13 (D:\2019-1) ZHL 20
197.01
170.31
142.19
139.63
139.55
128.89
128.86
128.74
128.46
128.37
128.04
127.73
126.84
126.65
126.52
115.81
112.85
92.53
50.37
37.88
37.24
28.53
28.46
21.19
20.75
Me
O
N
Bn
O
6ab
f1 (ppm)

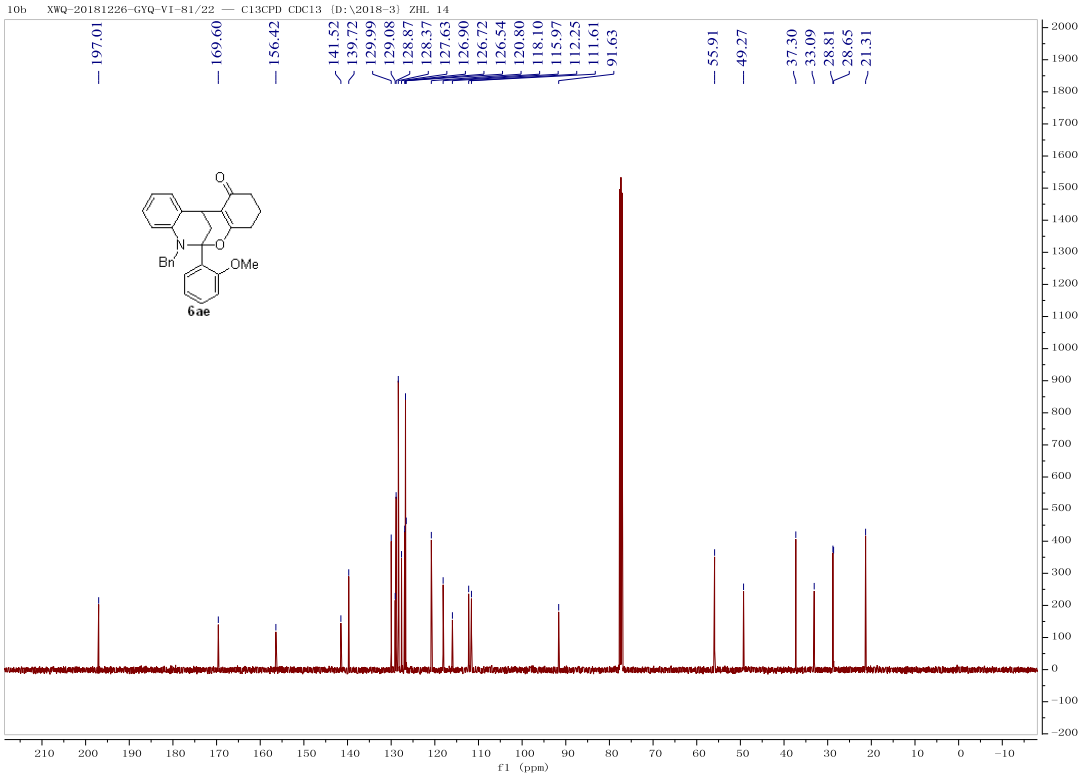

XWQ-20180305-ZLM-IV-6/10 — PROTON CDC13 (D:\2018-1) ZHL 39
7.55
7.53
7.44
7.43
7.42
7.41
7.39
7.38
7.37
7.16
7.15
7.14
7.13
7.12
6.93
6.92
6.91
6.90
6.89
6.88
6.87
6.56
6.55
4.64
4.61
4.36
4.32
4.11
4.11
4.10
2.53
2.49
2.42
2.41
2.40
2.39
2.35
2.34
2.33
2.25
2.25
2.23
2.22
2.14
2.13
2.08
2.07
2.05
2.05
2.04
2.00
1.99
1.98
1.93
1.92
Cl
O
N
Bn
O
6ac
1.95
4.01
3.01
3.01
1.01
1.00
1.01
1.02
4.08
4.16
f1 (ppm)

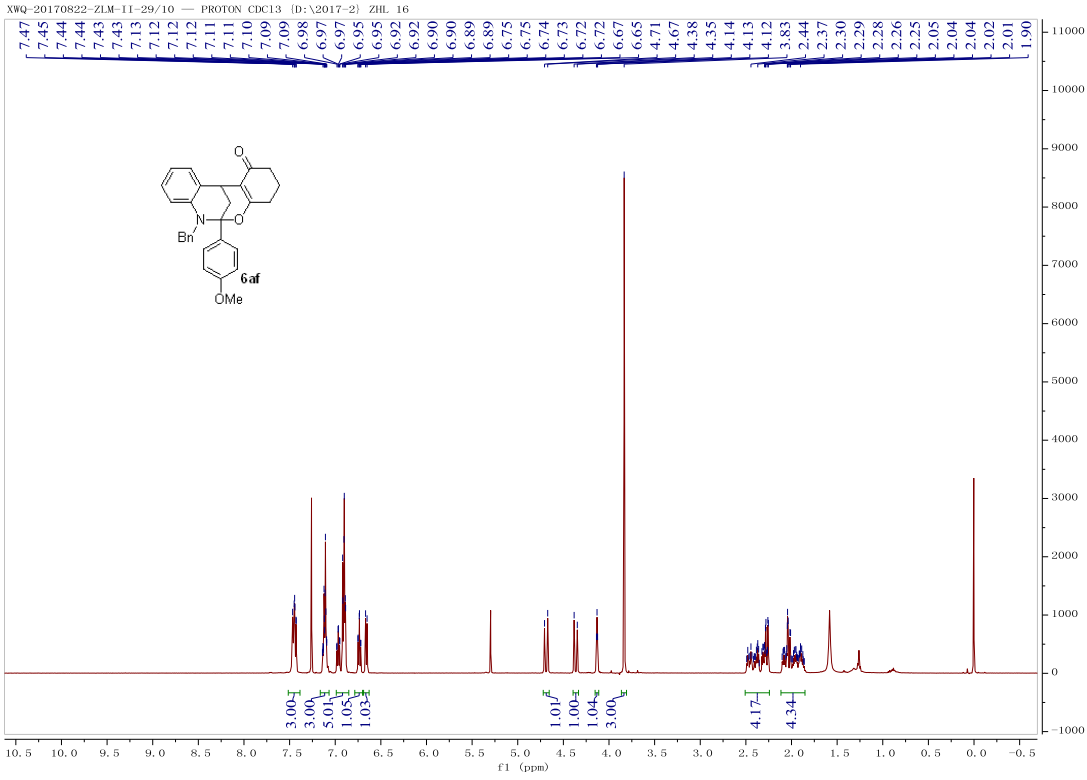

XWQ-20180305-ZLM-IV-6/12 — C13CPD CDC13 {D:\2018-1} ZHL 39
196.73
170.26
141.60
140.45
138.82
130.30
129.03
128.67
128.50
127.90
126.95
126.89
126.72
126.38
123.58
115.19
114.02
92.14
50.50
37.46
37.12
28.47
28.37
21.12
Cl
O
N
O
Bn
6ac
f1 (ppm)

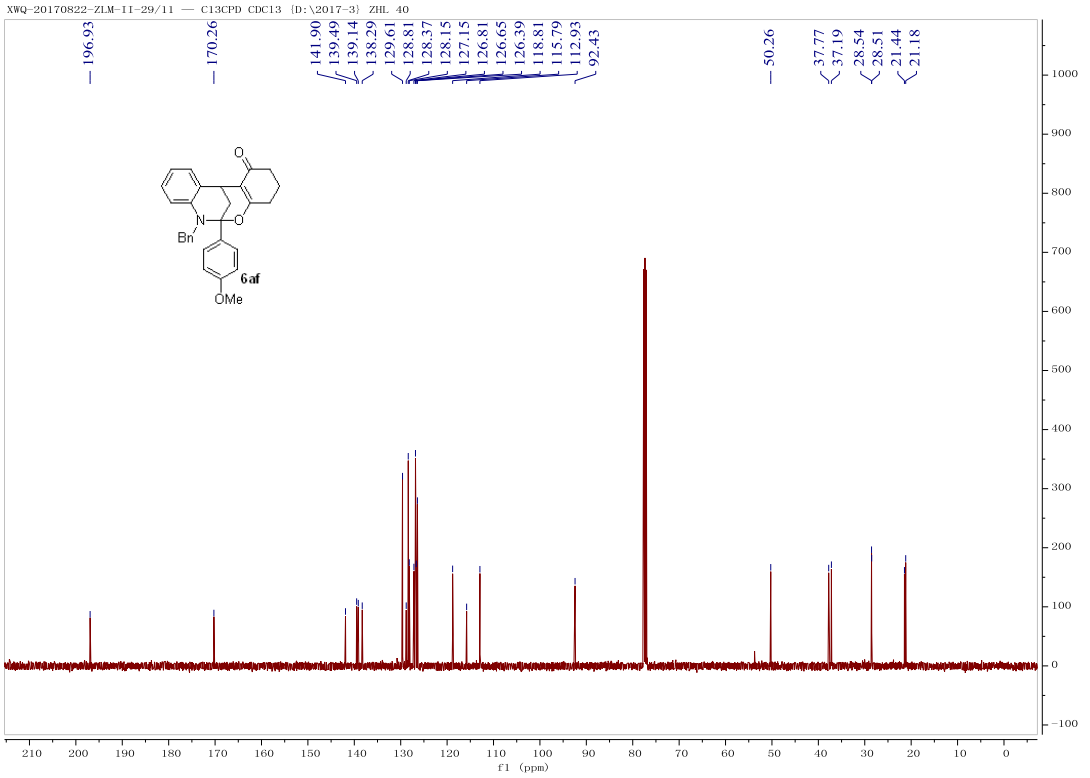

XWQ-20180110-ZLM-III-94/10 — PROTON CDC13 {D:\2018-1} ZHL 12
7.54
7.53
7.43
7.42
7.40
7.38
7.37
7.37
7.31
7.30
7.17
7.16
7.15
7.14
7.13
6.91
6.90
6.89
6.88
6.88
6.86
6.86
6.84
6.84
4.65
4.61
4.32
4.29
4.10
4.10
4.09
2.49
2.46
2.39
2.38
2.38
2.31
2.30
2.29
2.24
2.23
2.21
2.20
2.07
2.06
2.05
2.04
2.03
2.02
2.01
1.97
1.96
1.96
1.91
1.89
Br
O
N
O
Bn
6ad
2.00
3.06
1.03
3.01
4.00
1.00
1.01
1.00
4.12
4.23
f1 (ppm)

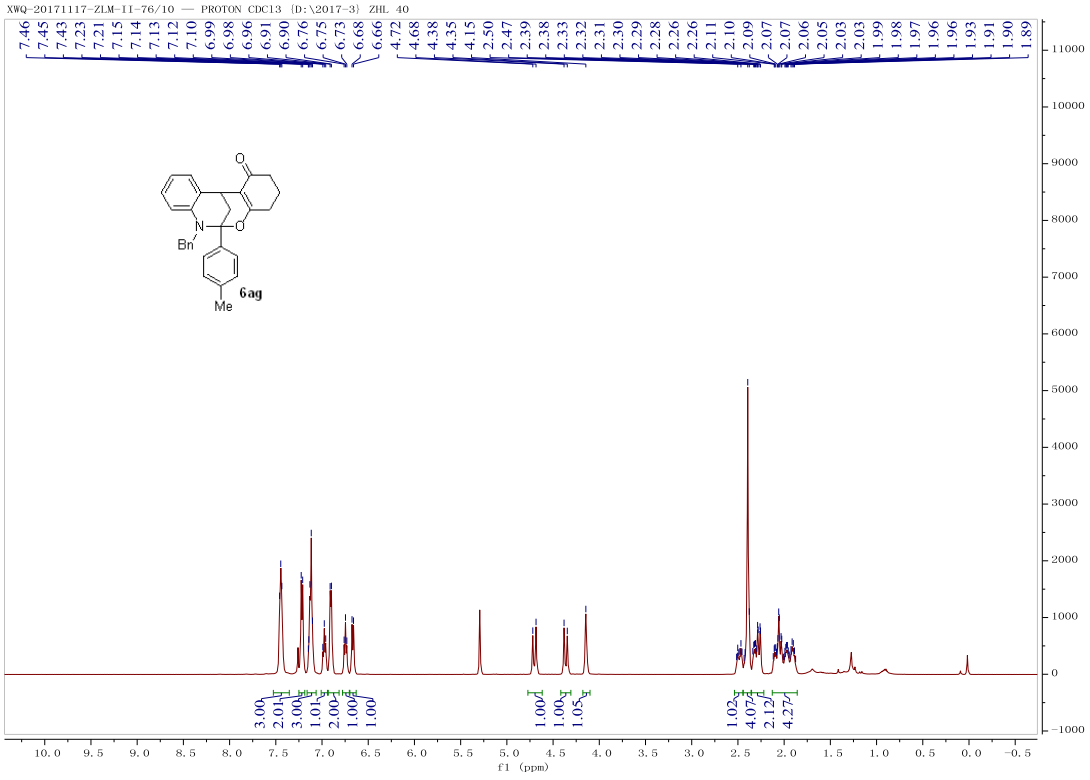

XWQ-20180110-ZLM-III-94/11 — C13CPD CDCl3 (D:\2018-1) ZHL 12
196.81
170.03
143.37
141.49
138.68
129.32
129.03
128.71
128.55
127.77
126.99
126.85
126.39
121.69
120.87
115.90
115.44
91.89
50.33
37.49
37.10
28.37
28.15
21.10
Br
N
O
Bn
6ad
f1 (ppm)

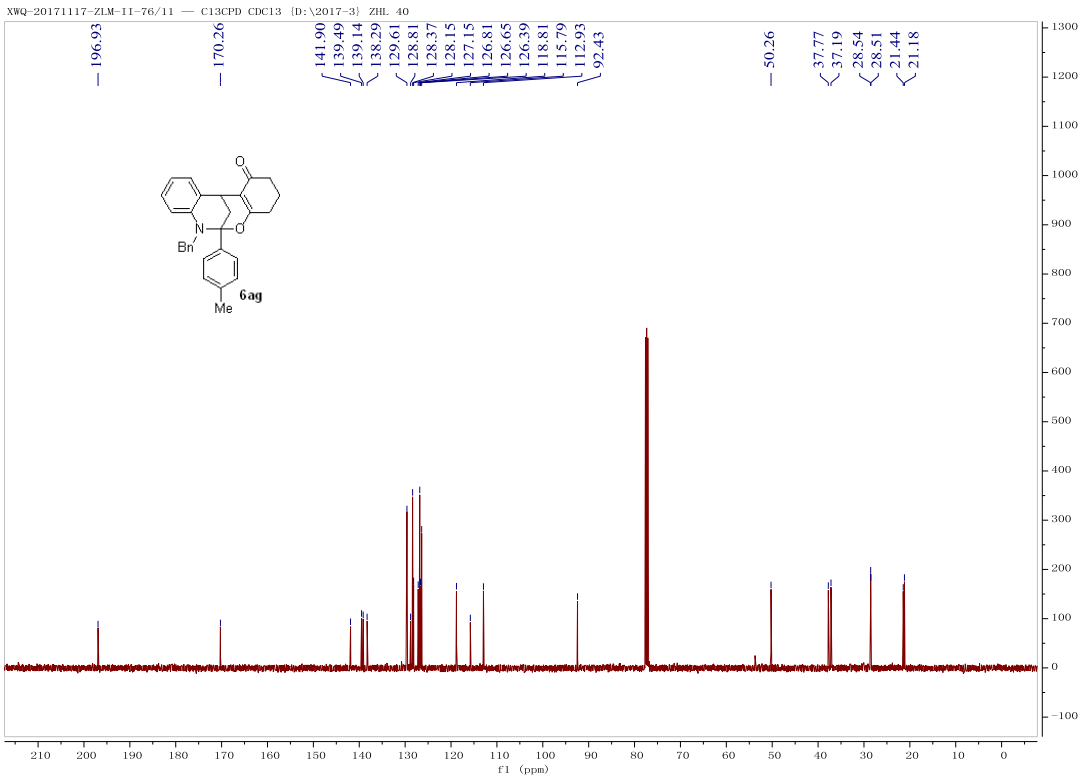

10b XWQ-20181226-GYQ-VI-81/10 — PROTON CDCl3 (D:\2018-3) ZHL 14
7.85
7.84
7.83
7.83
7.45
7.44
7.43
7.43
7.37
7.36
7.35
7.34
7.34
7.14
7.13
7.12
7.11
7.10
7.09
7.04
7.03
7.01
6.95
6.93
6.92
6.91
6.91
6.72
6.71
6.69
6.50
6.48
4.48
4.45
4.15
4.14
4.13
3.68
2.69
2.68
2.66
2.66
2.41
2.41
2.36
2.35
2.34
2.32
2.31
1.99
1.97
1.93
1.92
1.90
1.89
N
O
Bn
OMe
6ae
0.99
1.02
1.02
4.11
4.07
1.02
1.00
2.01
1.00
3.03
1.01
1.04
3.11
3.12
f1 (ppm)

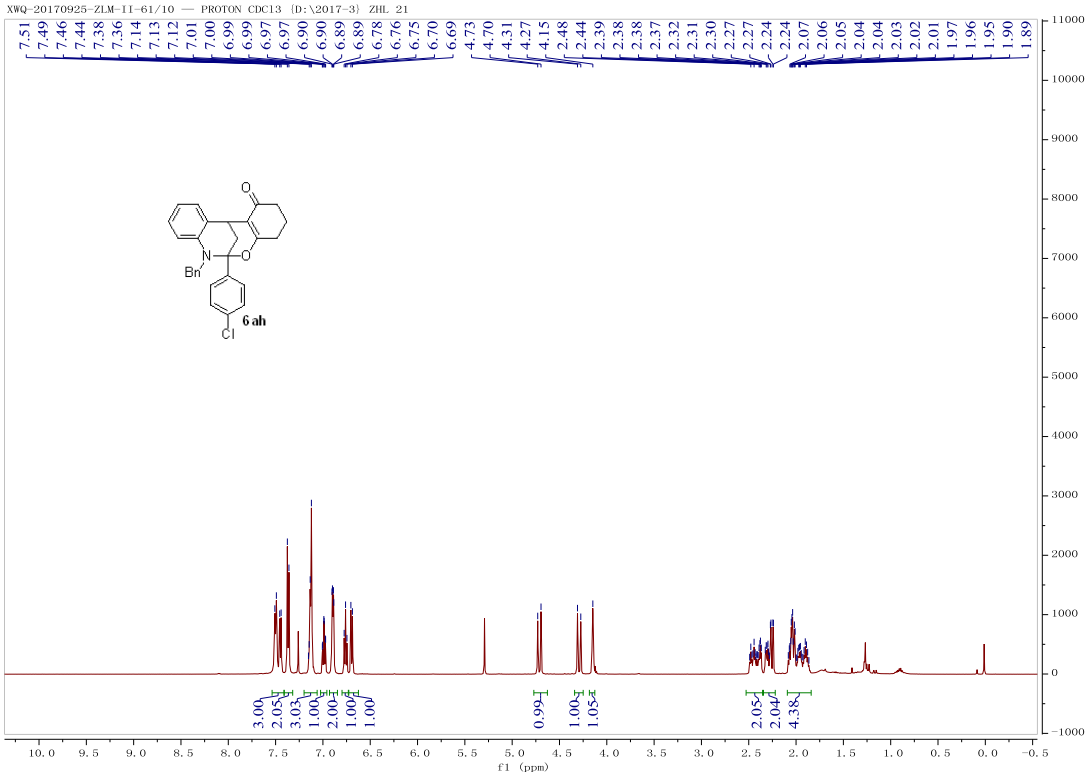

10b XWQ-20181226-GYQ-VI-81/22 — C13CPD CDC13 (D:\2018-3) ZHL 14
197.01
169.60
156.42
141.52
139.72
129.99
129.08
128.87
128.37
127.63
126.90
126.72
126.54
120.80
118.10
115.97
112.25
111.61
91.63
55.91
49.27
37.30
33.09
28.81
28.65
21.31
O
N
Bn
O
OMe
6ae
f1 (ppm)

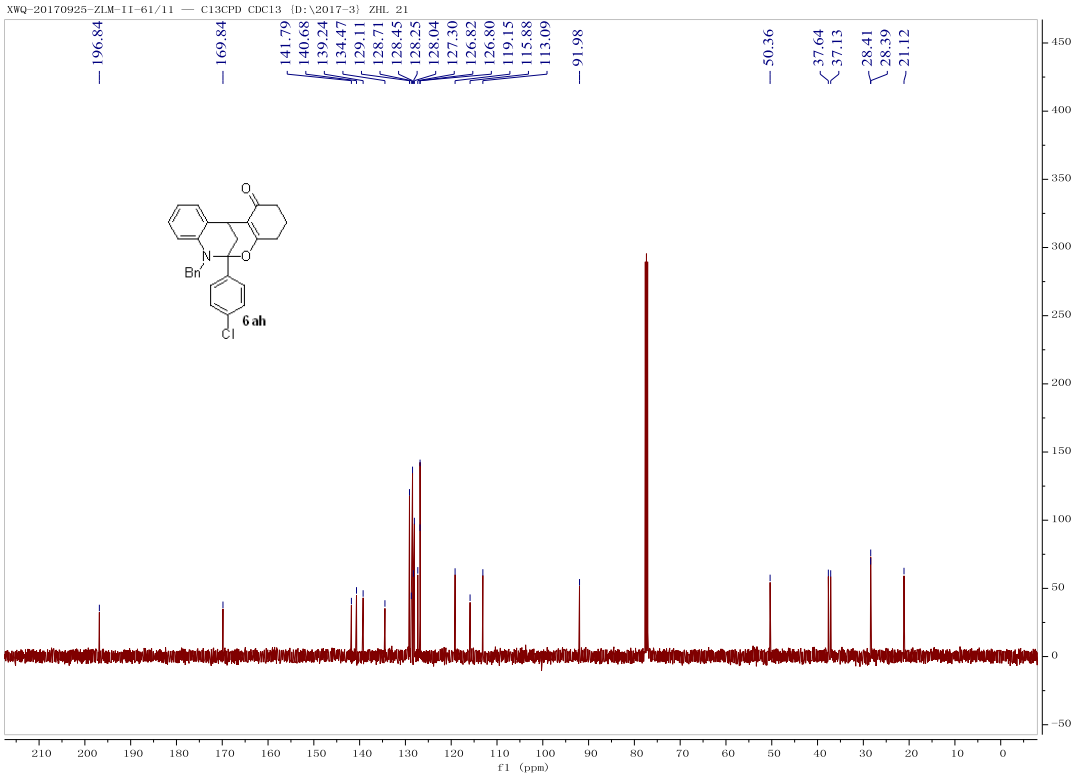

XWQ-20170822-ZLM-II-29/10 — PROTON CDC13 (D:\2017-2) ZHL 16
7.47
7.45
7.44
7.44
7.43
7.43
7.13
7.12
7.12
7.12
7.11
7.11
7.10
7.09
7.09
6.98
6.97
6.97
6.95
6.95
6.92
6.92
6.90
6.90
6.89
6.89
6.75
6.75
6.74
6.73
6.72
6.72
6.67
6.65
4.71
4.67
4.38
4.35
4.14
4.13
4.12
3.83
2.44
2.37
2.30
2.29
2.28
2.26
2.25
2.05
2.04
2.04
2.02
2.01
1.90
O
N
Bn
O
6af
OMe
3.00
3.00
5.01
1.05
1.03
1.01
1.00
1.04
3.00
4.17
4.34
f1 (ppm)

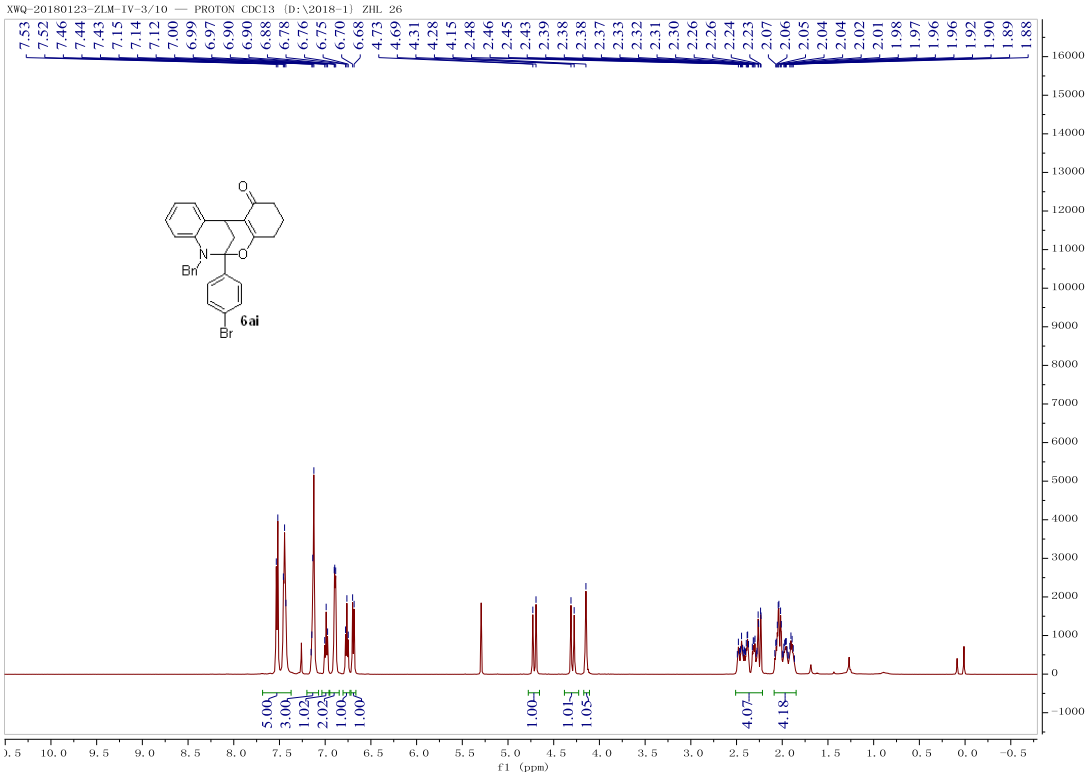

XWQ-20170822-ZLM-II-29/11 — C13CPD CDC13 {D:\2017-3} ZHL 40
196.93
170.26
141.90
139.49
139.14
138.29
129.61
128.81
128.37
128.15
127.15
126.81
126.65
126.39
118.81
115.79
112.93
92.43
50.26
37.77
37.19
28.54
28.51
21.44
21.18
Bn
6af
OMe
f1 (ppm)

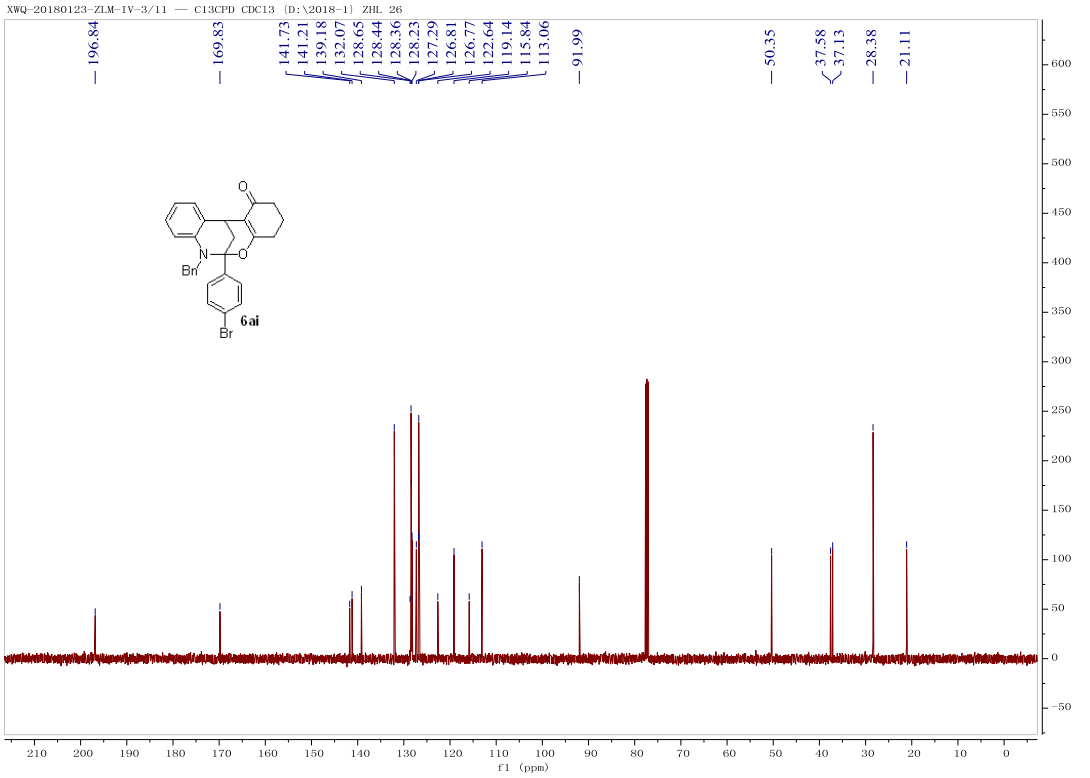

XWQ-20171117-ZLM-II-76/10 — PROTON CDC13 {D:\2017-3} ZHL 40
7.46
7.45
7.43
7.23
7.21
7.15
7.14
7.13
7.12
7.10
6.99
6.98
6.96
6.91
6.90
6.76
6.75
6.73
6.68
6.66
4.72
4.68
4.38
4.35
4.15
2.50
2.47
2.39
2.38
2.33
2.32
2.31
2.30
2.29
2.28
2.26
2.26
2.11
2.10
2.09
2.07
2.07
2.06
2.05
2.03
2.03
1.99
1.98
1.97
1.96
1.96
1.93
1.91
1.90
1.89
3.00
2.01
3.00
1.01
2.00
1.00
1.00
1.00
1.00
1.05
1.02
4.07
2.12
4.27
Bn
6ag
Me
f1 (ppm)

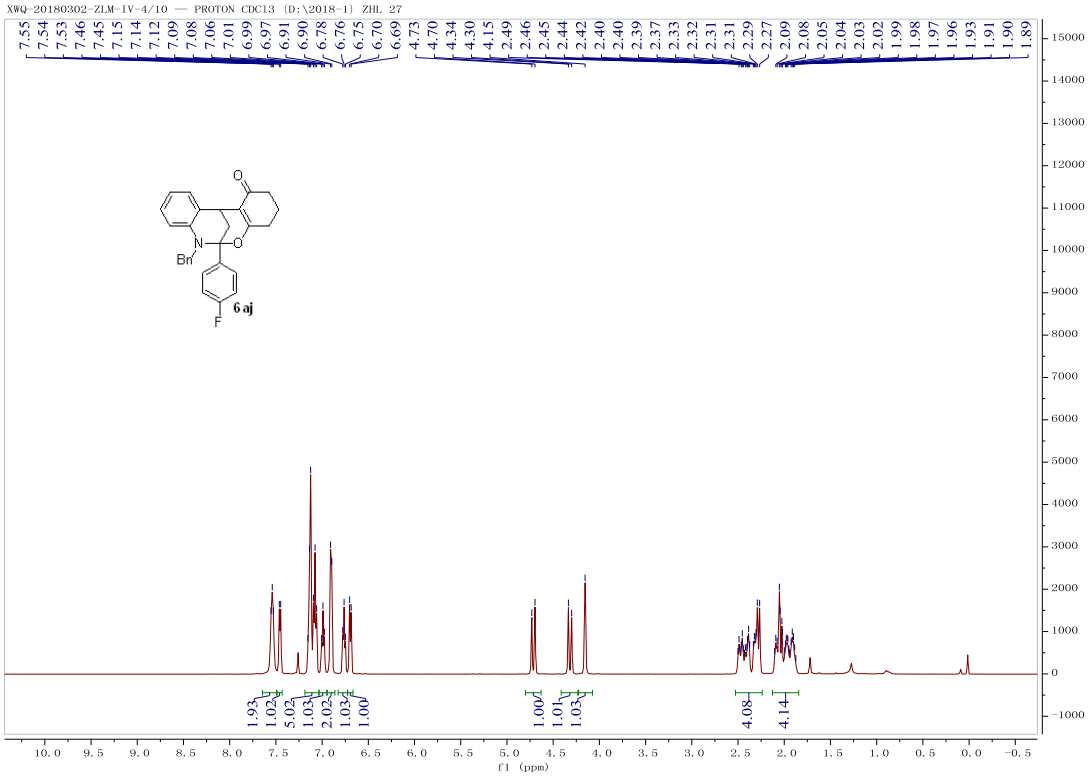

XWQ-20171117-ZLM-II-76/11 — C13CPD CDC13 {D:\2017-3} ZHL 40
196.93
170.26
141.90
139.49
139.14
138.29
129.61
128.81
128.37
128.15
127.15
126.81
126.65
126.39
118.81
115.79
112.93
92.43
50.26
37.77
37.19
28.54
28.51
21.44
21.18
Bn
Me
6ag
f1 (ppm)

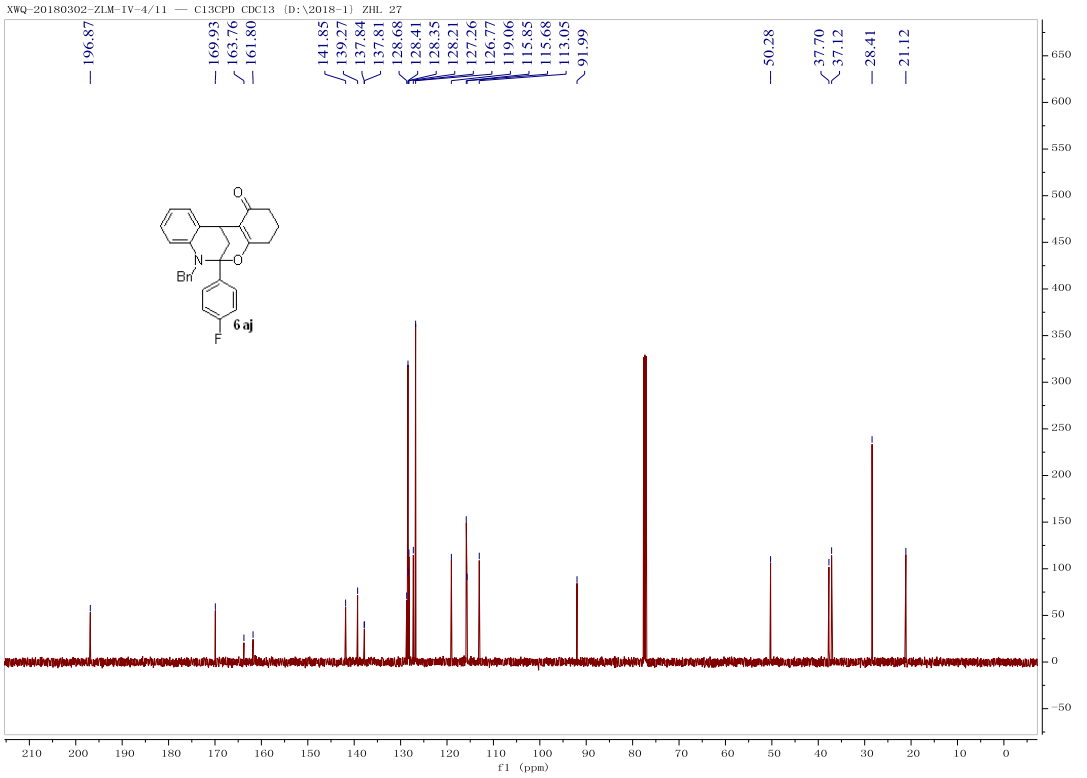

XWQ-20170925-ZLM-II-61/10 — PROTON CDC13 {D:\2017-3} ZHL 21
7.51
7.49
7.46
7.44
7.38
7.36
7.14
7.13
7.12
7.01
7.00
6.99
6.99
6.97
6.97
6.90
6.90
6.89
6.89
6.78
6.76
6.75
6.70
6.69
4.73
4.70
4.31
4.27
4.15
2.48
2.44
2.39
2.38
2.38
2.37
2.32
2.31
2.30
2.27
2.27
2.24
2.24
2.07
2.06
2.05
2.04
2.04
2.03
2.02
2.01
1.97
1.96
1.95
1.90
1.89
3.00
2.05
3.03
1.00
2.00
1.00
1.00
0.99
1.00
1.05
2.05
2.04
4.38
Bn
Cl
6ah
f1 (ppm)

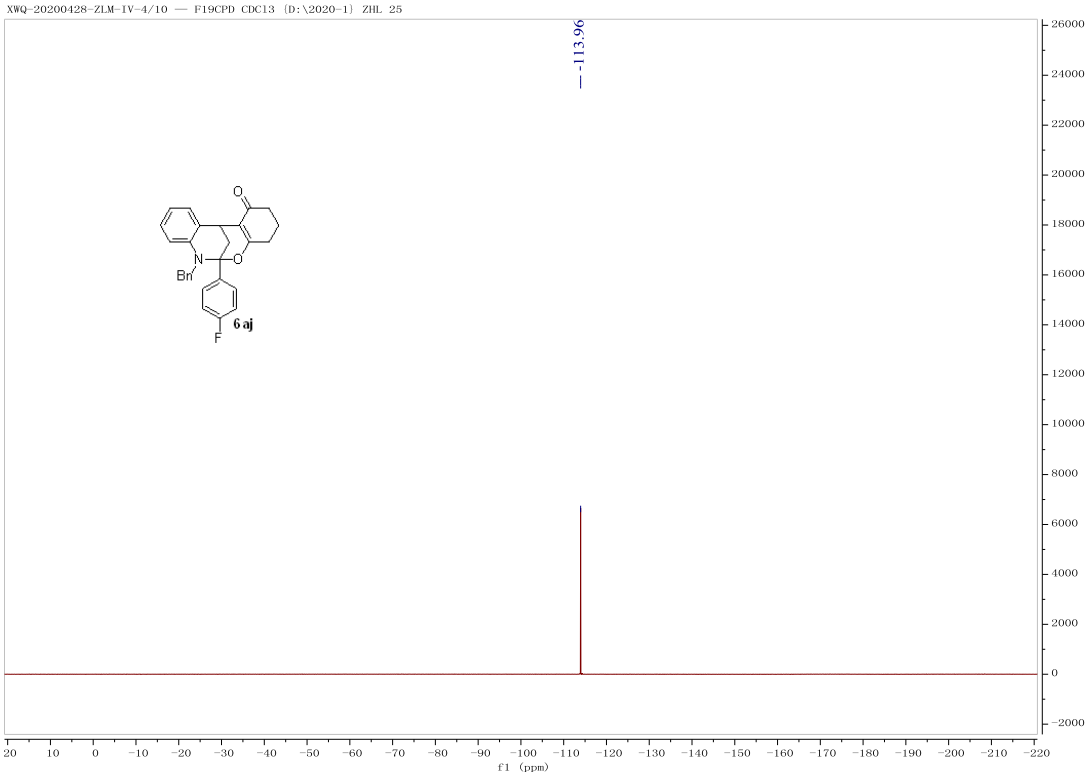

XWQ-20170925-ZLM-II-61/11 — C13CPD CDC13 (D:\2017-3) ZHL 21
196.84
169.84
141.79
140.68
139.24
134.47
129.11
128.71
128.45
128.25
128.04
127.30
126.82
126.80
119.15
115.88
113.09
91.98
50.36
37.64
37.13
28.41
28.39
21.12
6 ah
f1 (ppm)

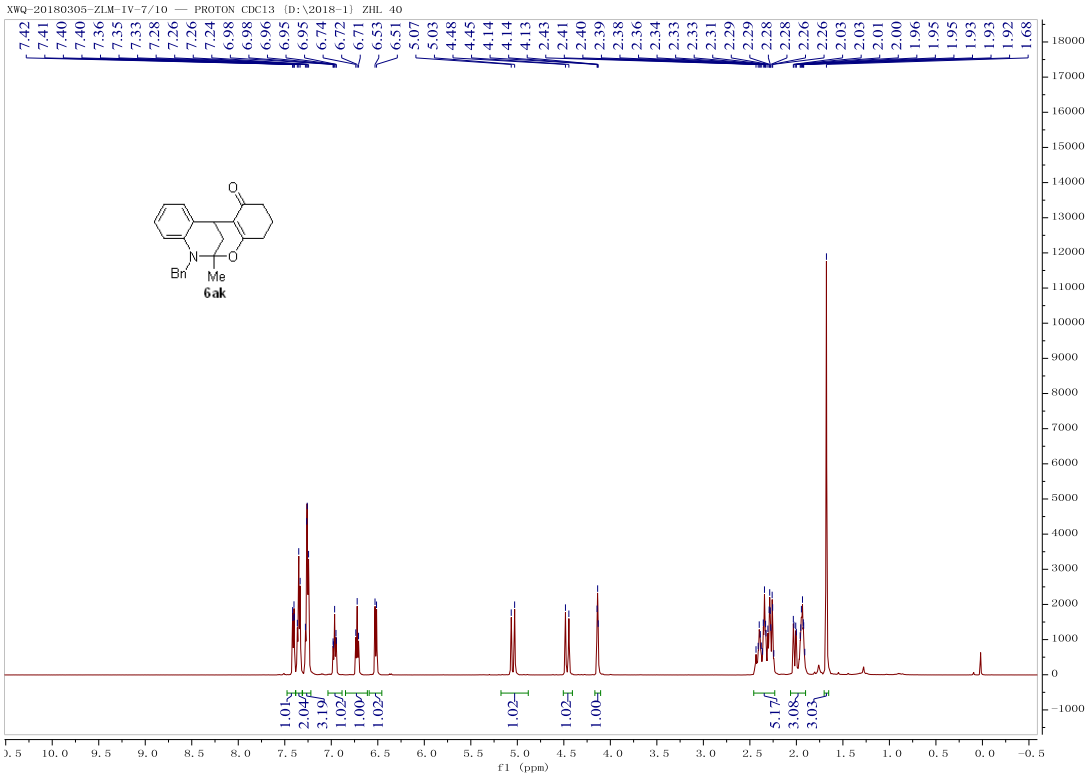

XWQ-20180123-ZLM-IV-3/10 — PROTON CDC13 (D:\2018-1) ZHL 26
7.53
7.52
7.46
7.44
7.43
7.15
7.14
7.12
7.00
6.99
6.97
6.90
6.90
6.88
6.78
6.76
6.75
6.70
6.68
4.73
4.69
4.31
4.28
4.15
2.48
2.46
2.45
2.43
2.39
2.38
2.38
2.37
2.33
2.32
2.31
2.30
2.26
2.26
2.24
2.23
2.07
2.06
2.05
2.04
2.04
2.02
2.01
1.98
1.97
1.96
1.96
1.92
1.90
1.89
1.88
5.00
3.00
1.02
2.02
1.00
1.00
1.00
1.01
1.05
4.07
4.18
6ai
f1 (ppm)

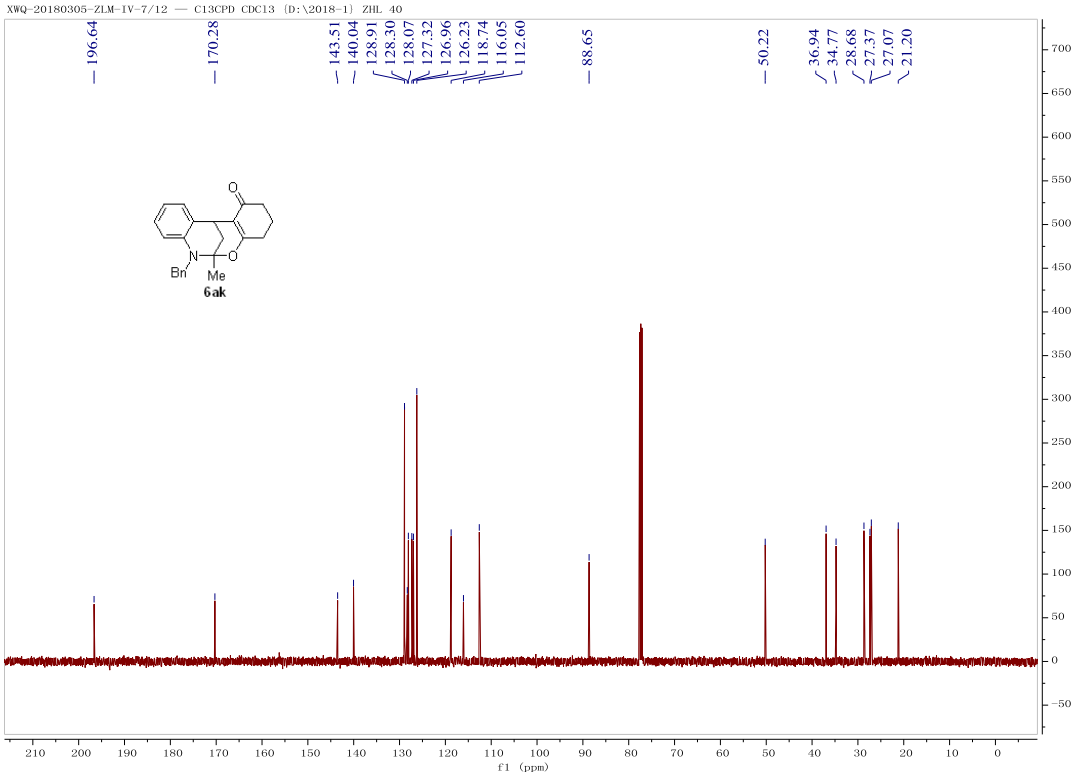

XWQ-20180123-ZLM-IV-3/11 — C13CPD CDCl3 (D:\2018-1) ZHL 26
196.84
169.83
141.73
141.21
139.18
132.07
128.65
128.44
128.36
128.23
127.29
126.81
126.77
122.64
119.14
115.84
113.06
91.99
50.35
37.58
37.13
28.38
21.11
Bn
Br
6ai
f1 (ppm)

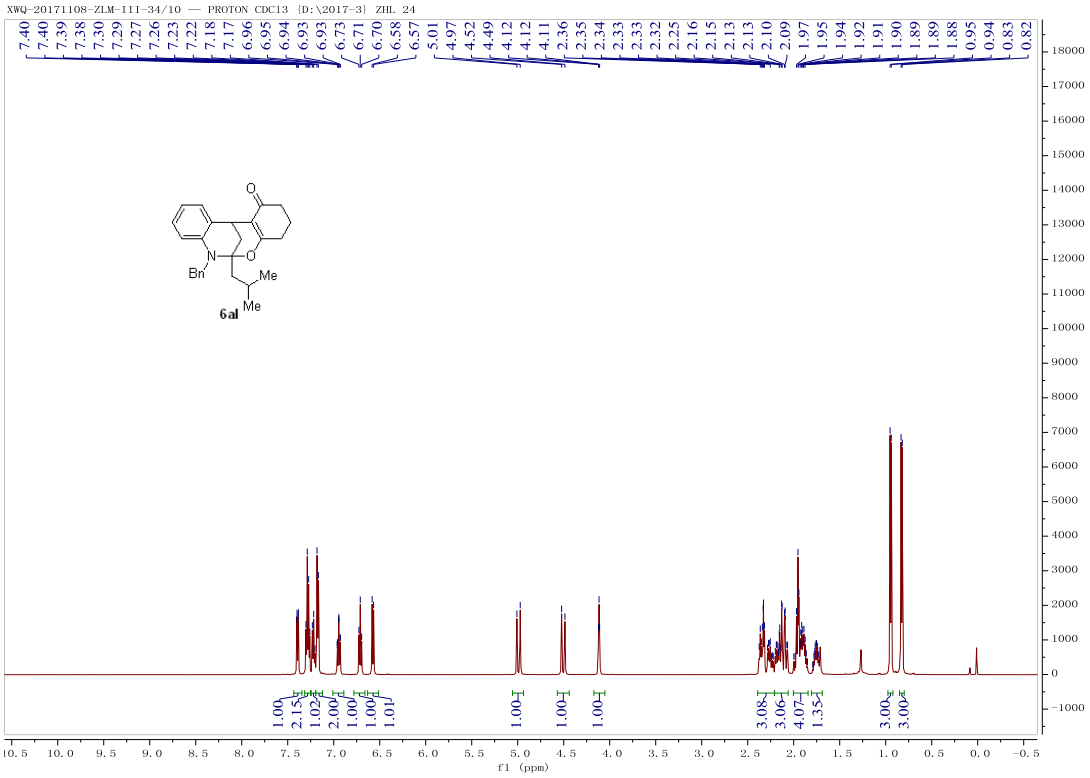

XWQ-20180302-ZLM-IV-4/10 — PROTON CDCl3 (D:\2018-1) ZHL 27
Bn
F
6aj
1.93
1.02
5.02
1.03
2.02
1.03
1.00
1.00
1.01
1.03
4.08
4.14
f1 (ppm)

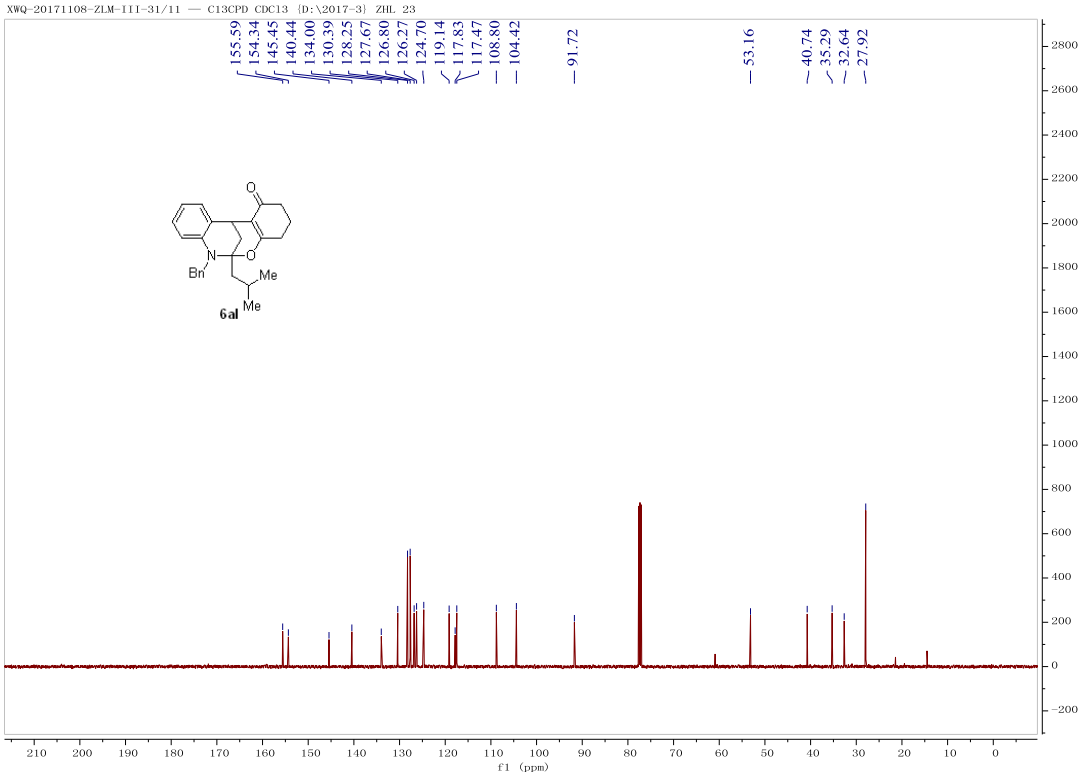

XWQ-20180302-ZLM-IV-4/11 — C13CPD CDC13 (D:\2018-1) ZHL 27
196.87
169.93
163.76
161.80
141.85
139.27
137.84
137.81
128.68
128.41
128.35
128.21
127.26
126.77
119.06
115.85
115.68
113.05
91.99
50.28
37.70
37.12
28.41
21.12
Bn
6 aj
F
f1 (ppm)

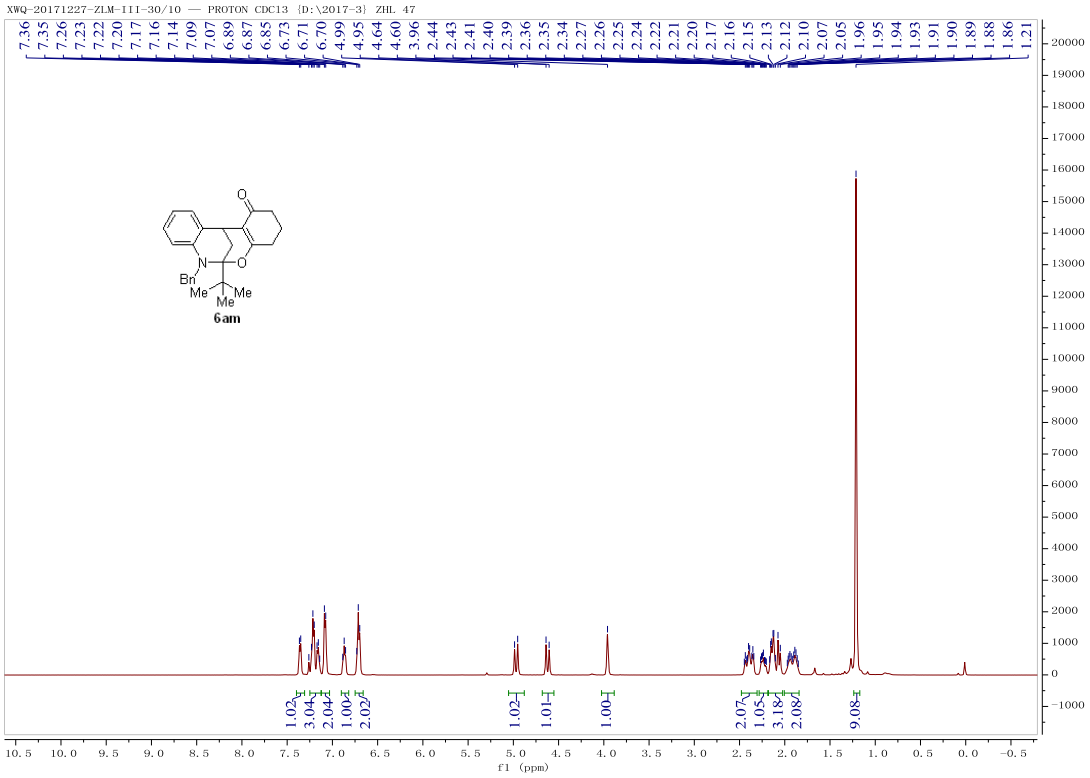

XWQ-20200428-ZLM-IV-4/10 — F19CPD CDC13 (D:\2020-1) ZHL 25
-113.96
Bn
6 aj
F
f1 (ppm)

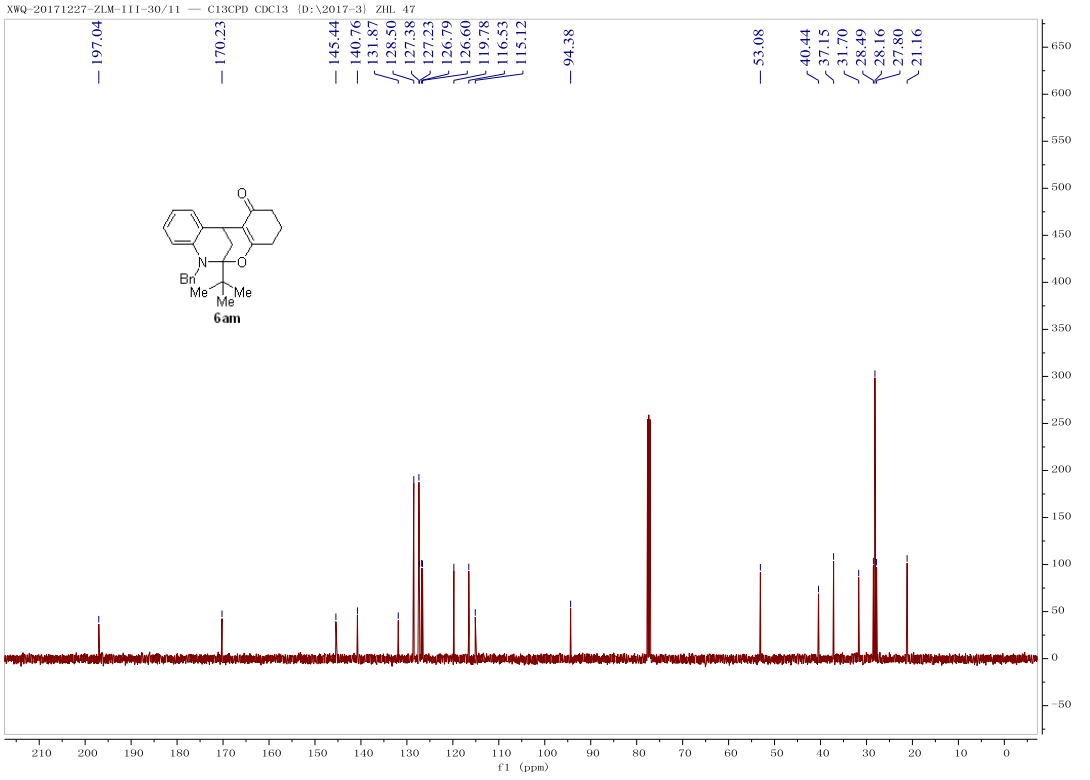

XWQ-20180305-ZLM-IV-7/10 — PROTON CDC13 (D:\2018-1) ZHL 40
7.42 7.41 7.40 7.40 7.36 7.35 7.33 7.28 7.26 7.26 7.24 6.98 6.96 6.95 6.74 6.72 6.71 6.53 6.51 5.07 5.03 4.48 4.45 4.14 4.14 4.13 2.43 2.41 2.40 2.39 2.38 2.36 2.34 2.33 2.33 2.31 2.29 2.29 2.28 2.28 2.26 2.26 2.03 2.01 2.00 1.96 1.95 1.95 1.93 1.93 1.92 1.68
1.01 2.04 3.19 1.02 1.00 1.02 1.02 1.02 1.00 5.17 3.08 3.03
f1 (ppm)
Bn
Me
6ak

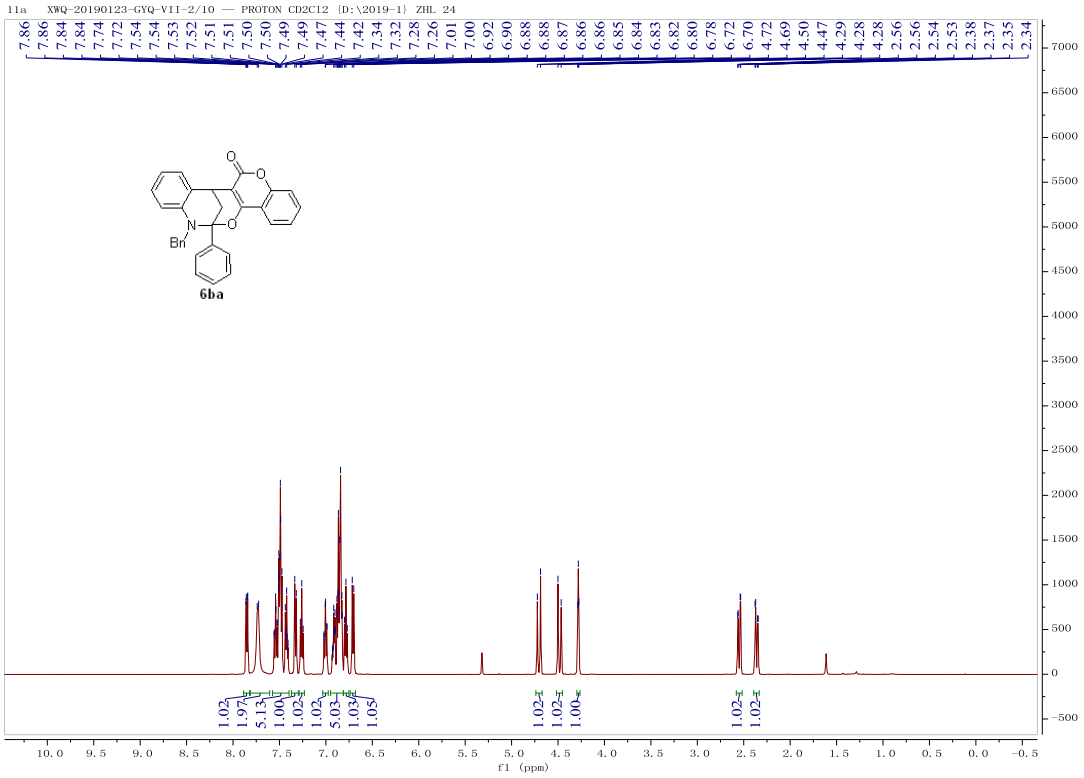

XWQ-20180305-ZLM-IV-7/12 — C13CPD CDC13 (D:\2018-1) ZHL 40
196.64 170.28 143.51 140.04 128.91 128.30 128.07 127.32 126.96 126.23 118.74 116.05 112.60 88.65 50.22 36.94 34.77 28.68 27.37 27.07 21.20
f1 (ppm)
Bn
Me
6ak

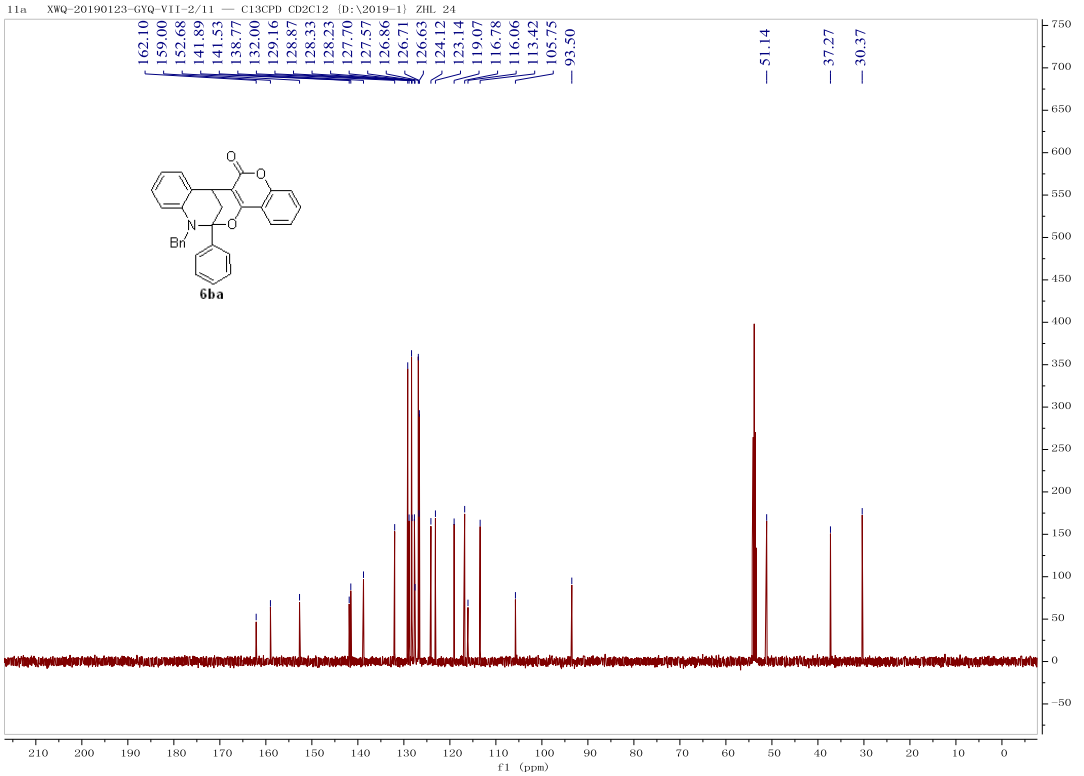

XWQ-20171108-ZLM-III-34/10 — PROTON CDC13 {D:\2017-3} ZHL 24
7.40 7.40 7.39 7.38 7.30 7.29 7.27 7.26 7.23 7.22 7.18 7.17 6.96 6.95 6.94 6.93 6.93 6.73 6.71 6.70 6.58 6.57 5.01 4.97 4.52 4.49 4.12 4.12 4.11 2.36 2.35 2.34 2.33 2.33 2.32 2.25 2.16 2.15 2.13 2.13 2.10 2.09 1.97 1.95 1.94 1.92 1.91 1.90 1.89 1.89 1.88 0.95 0.94 0.83 0.82
1.00 2.15 1.02 2.00 1.00 1.00 1.01 1.00 1.00 1.00 3.08 3.06 4.07 1.35 3.00 3.00
f1 (ppm)
6al

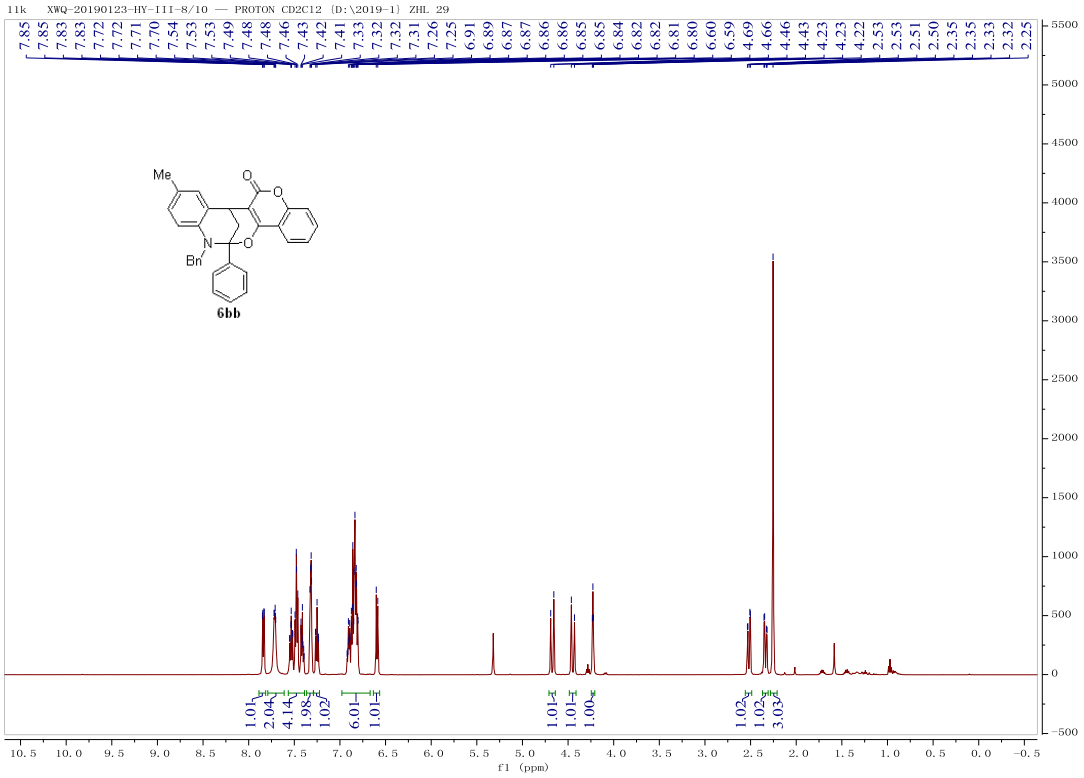

XWQ-20171108-ZLM-III-31/11 — C13CPD CDC13 {D:\2017-3} ZHL 23
155.59 154.34 145.45 140.44 134.00 130.39 128.25 127.67 126.80 126.27 124.70 119.14 117.83 117.47 108.80 104.42 91.72 53.16 40.74 35.29 32.64 27.92
f1 (ppm)
6al

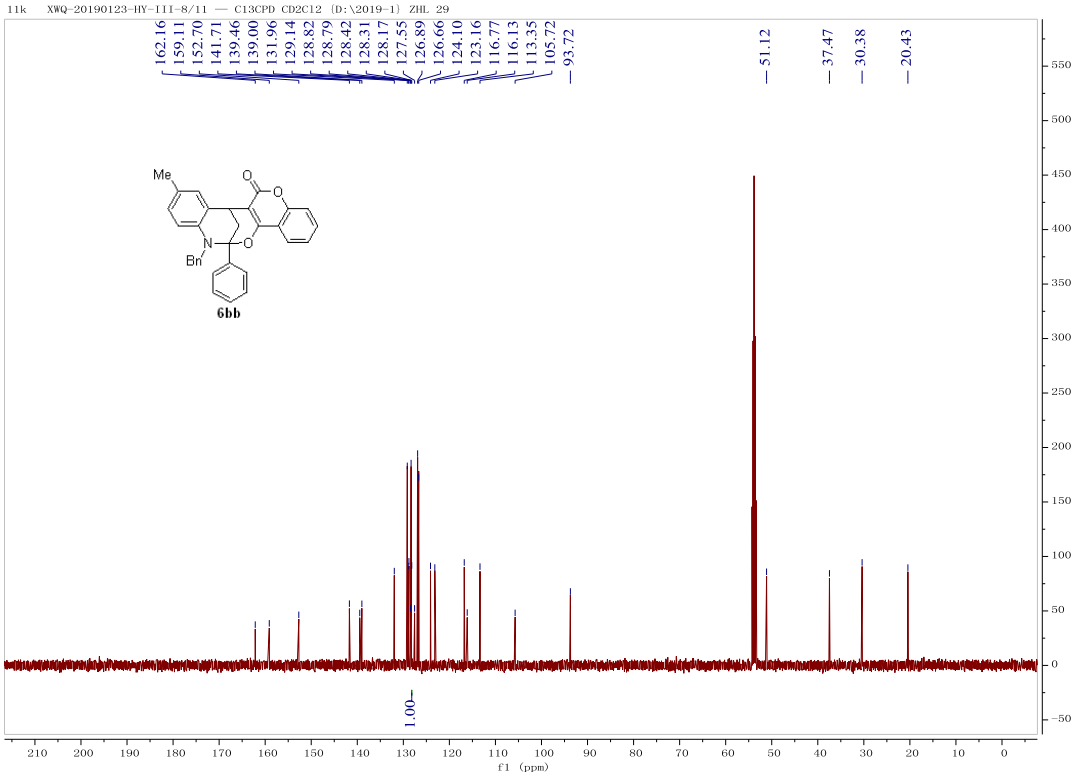

XWQ-20171227-ZLM-III-30/10 — PROTON CDCl3 {D:\2017-3} ZHL 47
7.36 7.35 7.26 7.23 7.22 7.20 7.17 7.16 7.14 7.09 7.07 6.89 6.87 6.85 6.73 6.71 6.70 4.99 4.95 4.64 4.60 3.96 2.44 2.43 2.41 2.40 2.39 2.36 2.35 2.34 2.27 2.26 2.25 2.24 2.22 2.21 2.20 2.17 2.16 2.15 2.13 2.12 2.10 2.07 2.05 1.96 1.95 1.94 1.93 1.91 1.90 1.89 1.88 1.86 1.21
1.02 3.04 2.04 1.00 2.02 1.02 1.01 1.00 2.07 1.05 3.18 2.08 9.08
f1 (ppm)
O
N
O
Bn
Me
Me
Me
6am

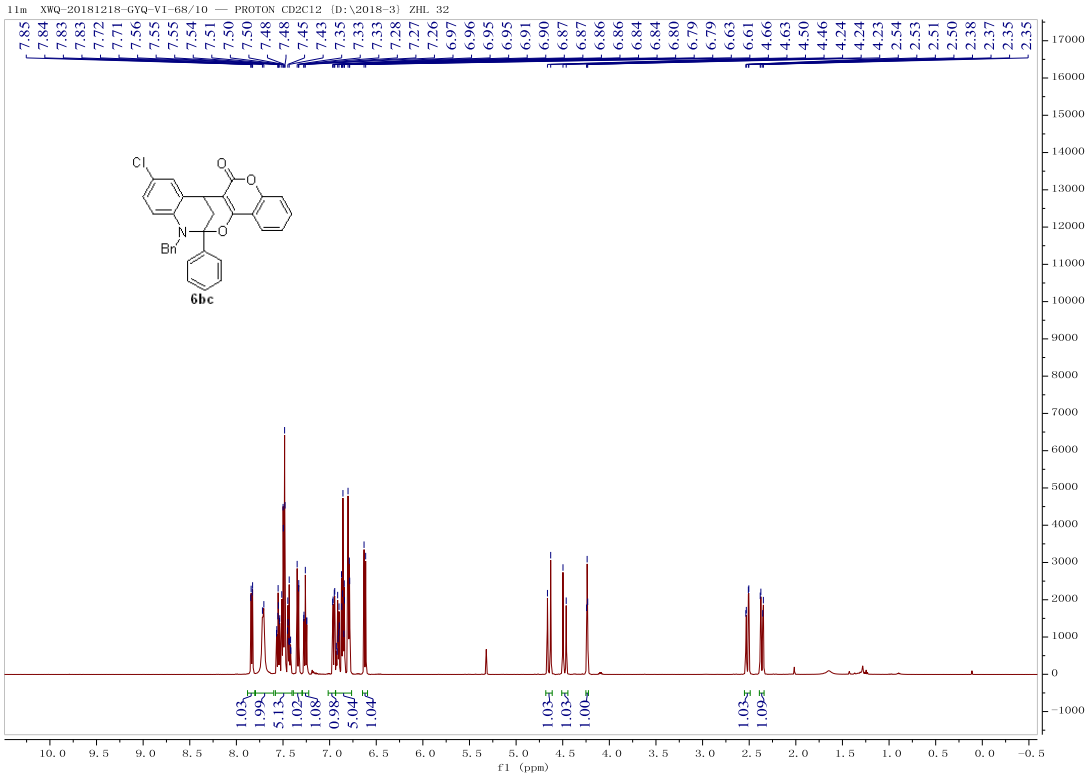

XWQ-20171227-ZLM-III-30/11 — C13CPD CDCl3 {D:\2017-3} ZHL 47
197.04 170.23 145.44 140.76 131.87 128.50 127.38 127.23 126.79 126.60 119.78 116.53 115.12 94.38 53.08 40.44 37.15 31.70 28.49 28.16 27.80 21.16
f1 (ppm)
O
N
O
Bn
Me
Me
Me
6am

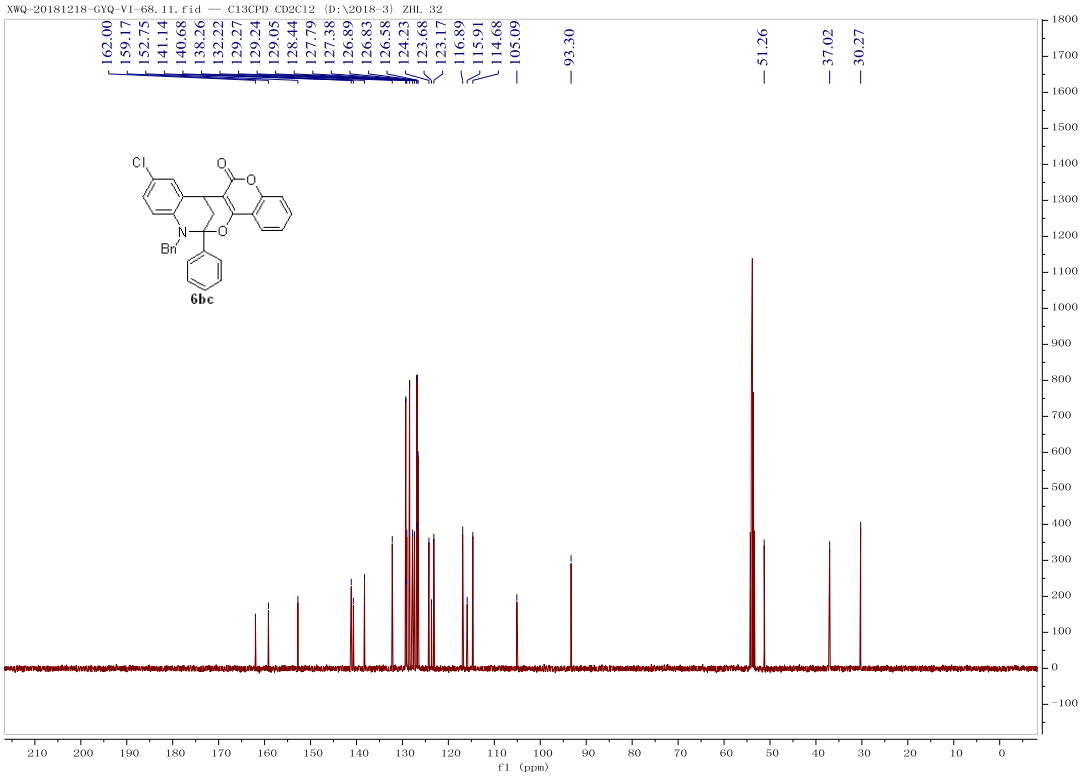

11a XWQ-20190123-GYQ-VII-2/10 — PROTON CD2C12 {D:\2019-1} ZHL 24
7.86 7.86 7.84 7.84 7.84 7.74 7.72 7.54 7.54 7.53 7.52 7.51 7.51 7.50 7.50 7.49 7.49 7.47 7.44 7.42 7.34 7.32 7.28 7.26 7.01 7.00 6.92 6.90 6.88 6.88 6.87 6.86 6.86 6.85 6.84 6.83 6.82 6.80 6.78 6.72 6.70 4.72 4.69 4.50 4.47 4.29 4.28 4.28 2.56 2.54 2.53 2.38 2.37 2.35 2.34
6ba
1.02 1.97 5.13 1.00 1.02 1.02 5.03 1.03 1.05 1.02 1.02 1.00 1.02 1.02
f1 (ppm)

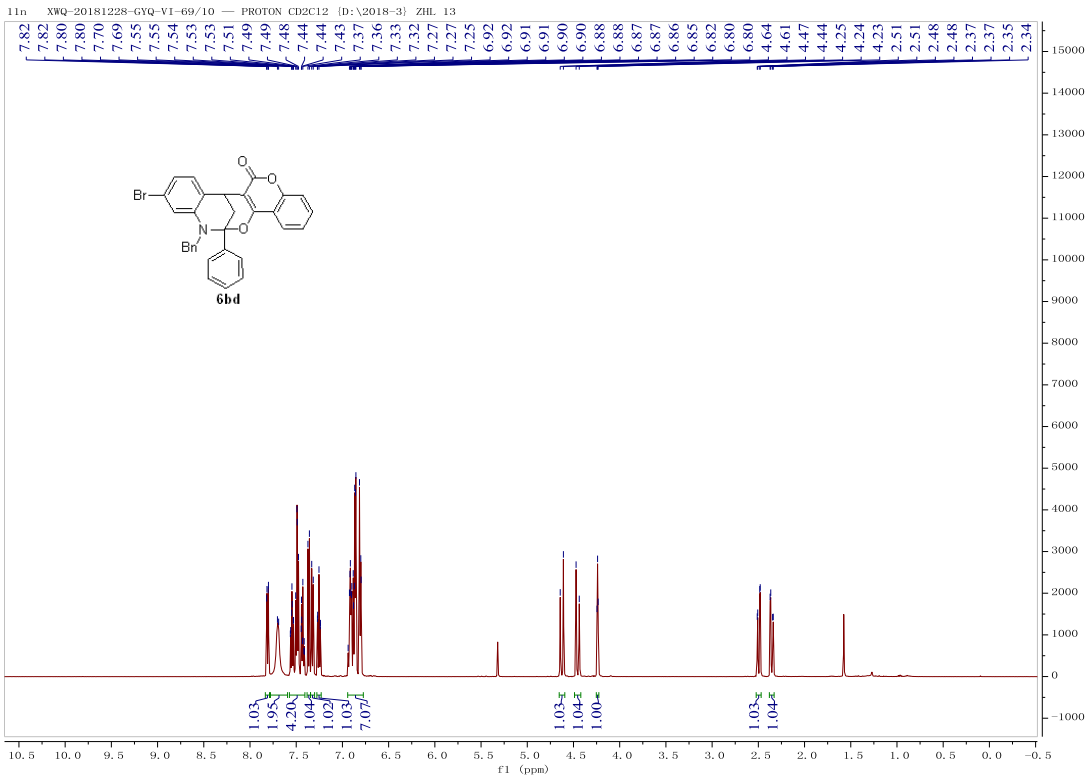

11a XWQ-20190123-GYQ-VII-2/11 — C13CPD CD2C12 {D:\2019-1} ZHL 24
162.10 159.00 152.68 141.89 141.53 138.77 132.00 129.16 128.87 128.33 128.23 127.70 127.57 126.86 126.71 126.63 124.12 123.14 119.07 116.78 116.06 113.42 105.75 93.50 51.14 37.27 30.37
6ba
f1 (ppm)

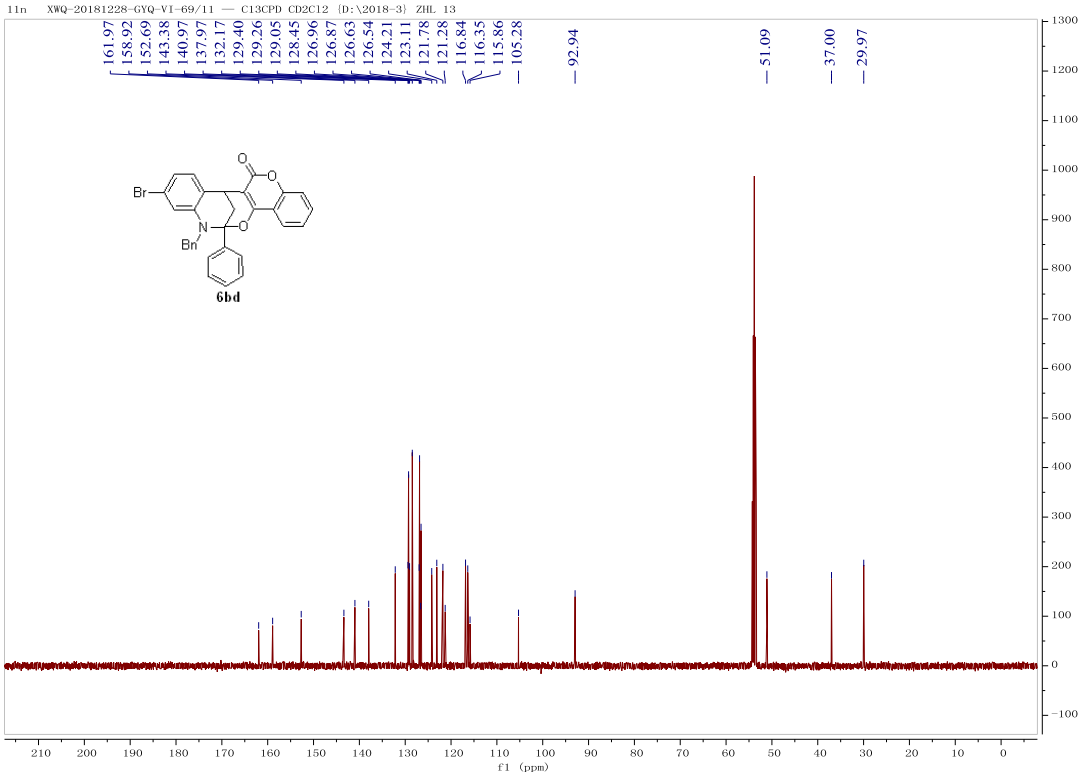

11k XWQ-20190123-HY-III-8/10 — PROTON CD2Cl2 (D:\2019-1) ZHL 29
7.85 7.85 7.83 7.83 7.72 7.72 7.71 7.70 7.54 7.53 7.53 7.49 7.48 7.48 7.46 7.43 7.42 7.41 7.33 7.32 7.32 7.31 7.26 7.25 6.91 6.89 6.87 6.87 6.86 6.86 6.85 6.85 6.84 6.82 6.82 6.81 6.80 6.60 6.59 4.69 4.66 4.46 4.43 4.23 4.23 4.22 2.53 2.53 2.51 2.50 2.35 2.35 2.33 2.32 2.25
Me
O
O
N
O
Bn
6bb
1.01 2.04 4.14 1.98 1.02 6.01 1.01 1.01 1.01 1.00 1.02 1.02 3.03
f1 (ppm)

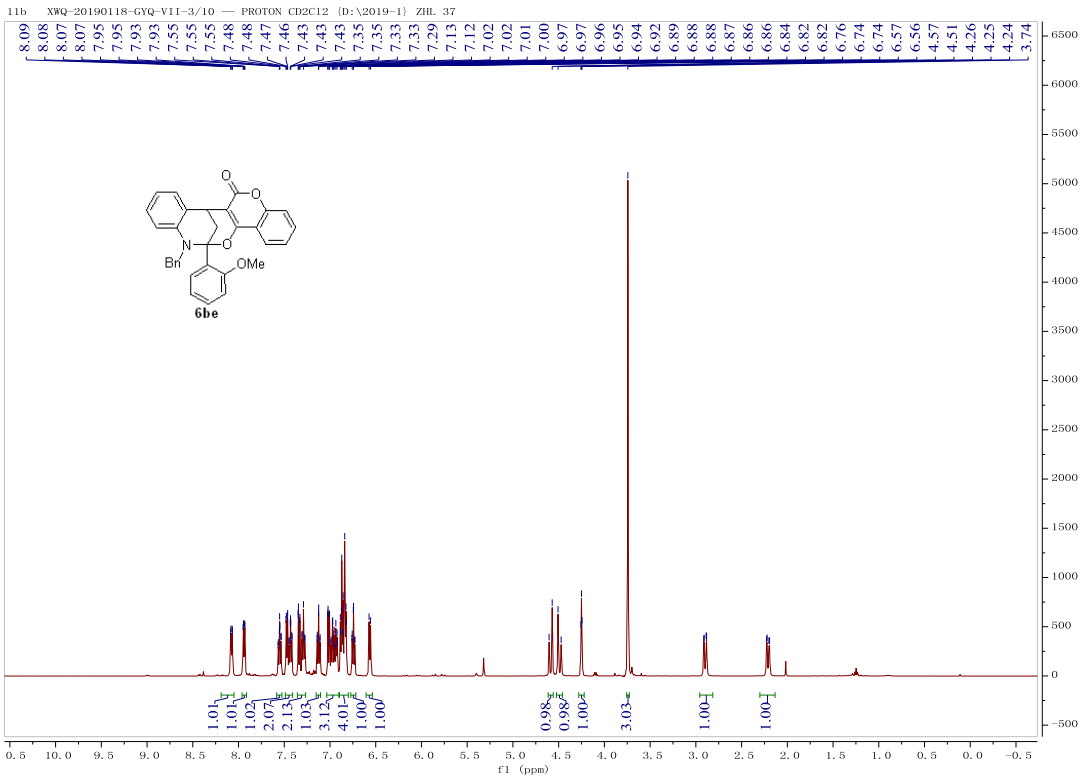

11k XWQ-20190123-HY-III-8/11 — C13CPD CD2Cl2 (D:\2019-1) ZHL 29
162.16 159.11 152.70 141.71 139.46 139.00 131.96 129.14 128.82 128.79 128.42 128.31 128.17 127.55 126.89 126.66 124.10 123.16 116.77 116.13 113.35 105.72 93.72 51.12 37.47 30.38 20.43
Me
O
O
N
O
Bn
6bb
1.00
f1 (ppm)

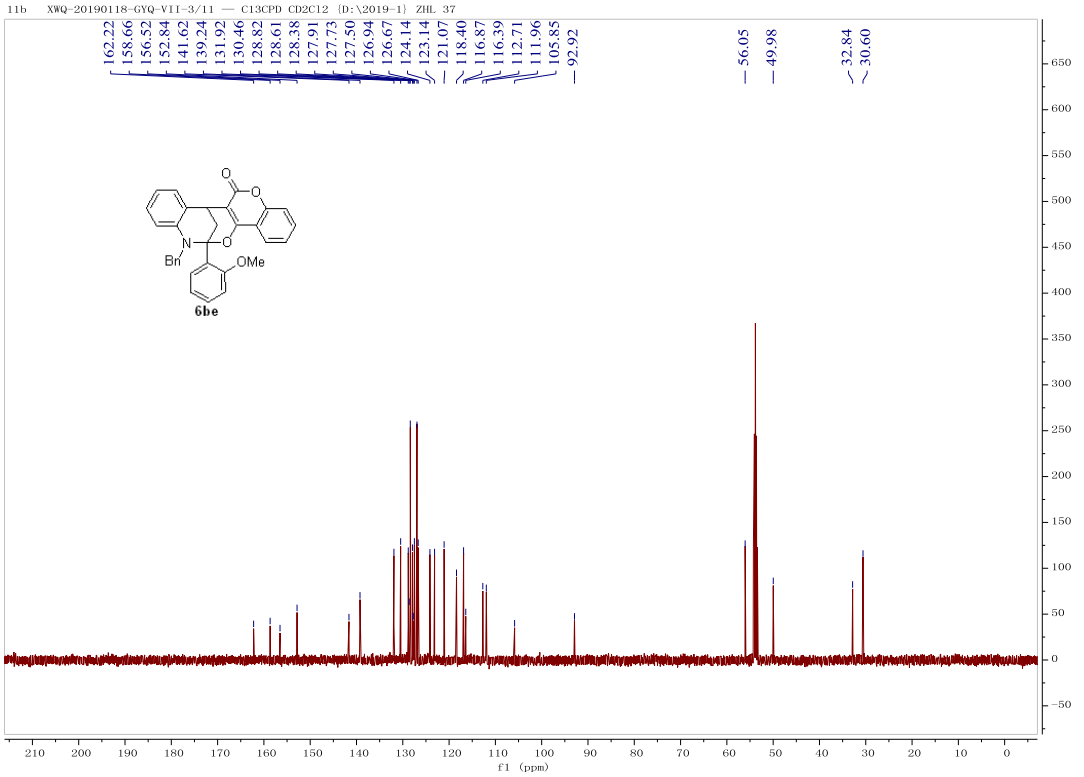

11m XWQ-20181218-GYQ-VI-68/10 — PROTON CD2Cl2 (D:\2018-3) ZHL 32
7.85 7.84 7.83 7.83 7.72 7.71 7.56 7.55 7.55 7.54 7.51 7.50 7.50 7.48 7.48 7.45 7.43 7.35 7.33 7.33 7.28 7.27 7.26 6.97 6.96 6.95 6.95 6.91 6.90 6.87 6.87 6.86 6.86 6.84 6.84 6.80 6.79 6.79 6.63 6.61 4.66 4.63 4.50 4.46 4.24 4.24 4.23 2.54 2.53 2.51 2.50 2.38 2.37 2.35 2.35
Cl
O
O
N
O
Bn
6bc
1.03 1.99 5.13 1.02 1.08 0.98 5.04 1.04 1.03 1.03 1.00 1.03 1.09
f1 (ppm)

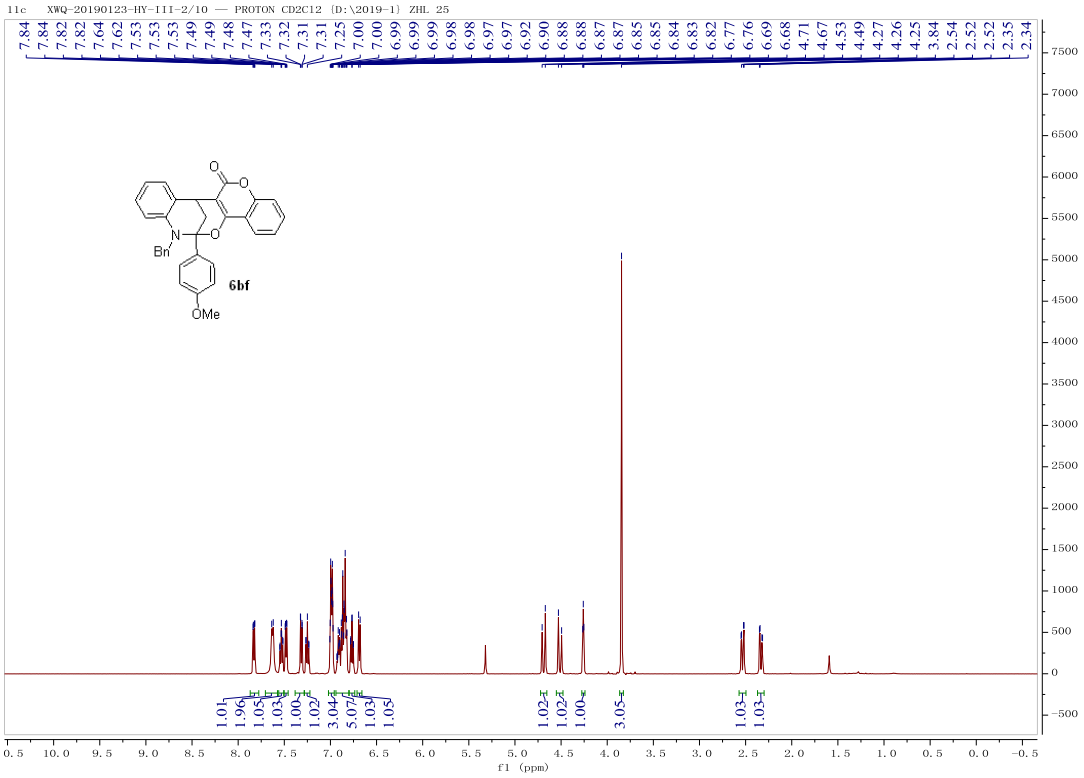

XWQ-20181218-GYQ-VI-68.11.fid — C13CPD CD2Cl2 (D:\2018-3) ZHL 32
162.00 159.17 152.75 141.14 140.68 138.26 132.22 129.27 129.24 129.05 128.44 127.79 127.38 126.89 126.83 126.58 124.23 123.68 123.17 116.89 115.91 114.68 105.09 93.30 51.26 37.02 30.27
Cl
O
O
N
O
Bn
6bc
f1 (ppm)

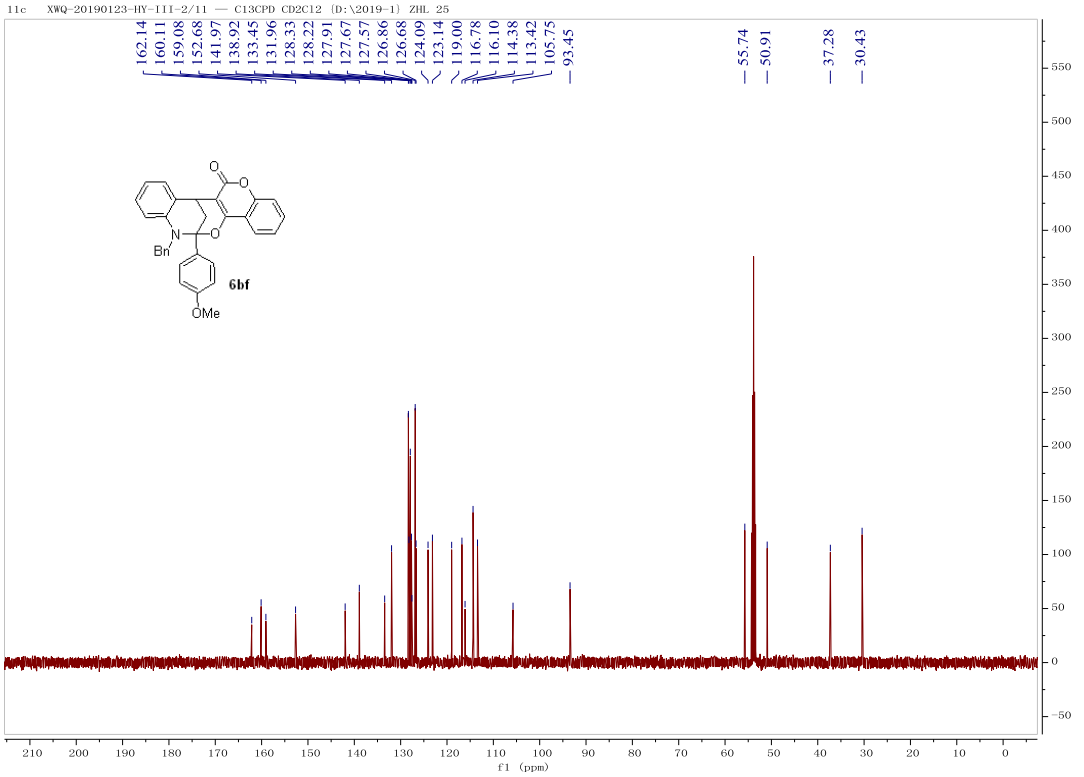

11n XWQ-20181228-GYQ-VI-69/10 — PROTON CD2C12 (D:\2018-3) ZHL 13
7.82 7.82 7.80 7.80 7.70 7.69 7.55 7.55 7.54 7.53 7.53 7.51 7.49 7.49 7.48 7.44 7.44 7.43 7.37 7.36 7.33 7.32 7.27 7.27 7.25 6.92 6.92 6.91 6.91 6.90 6.90 6.88 6.88 6.87 6.87 6.86 6.85 6.82 6.80 6.80 4.64 4.61 4.47 4.44 4.25 4.24 4.23 2.51 2.51 2.48 2.48 2.37 2.37 2.35 2.34
Br
O
O
N
O
Bn
6bd
1.03 1.95 4.20 1.04 1.02 1.03 7.07 1.03 1.04 1.00 1.03 1.04
f1 (ppm)

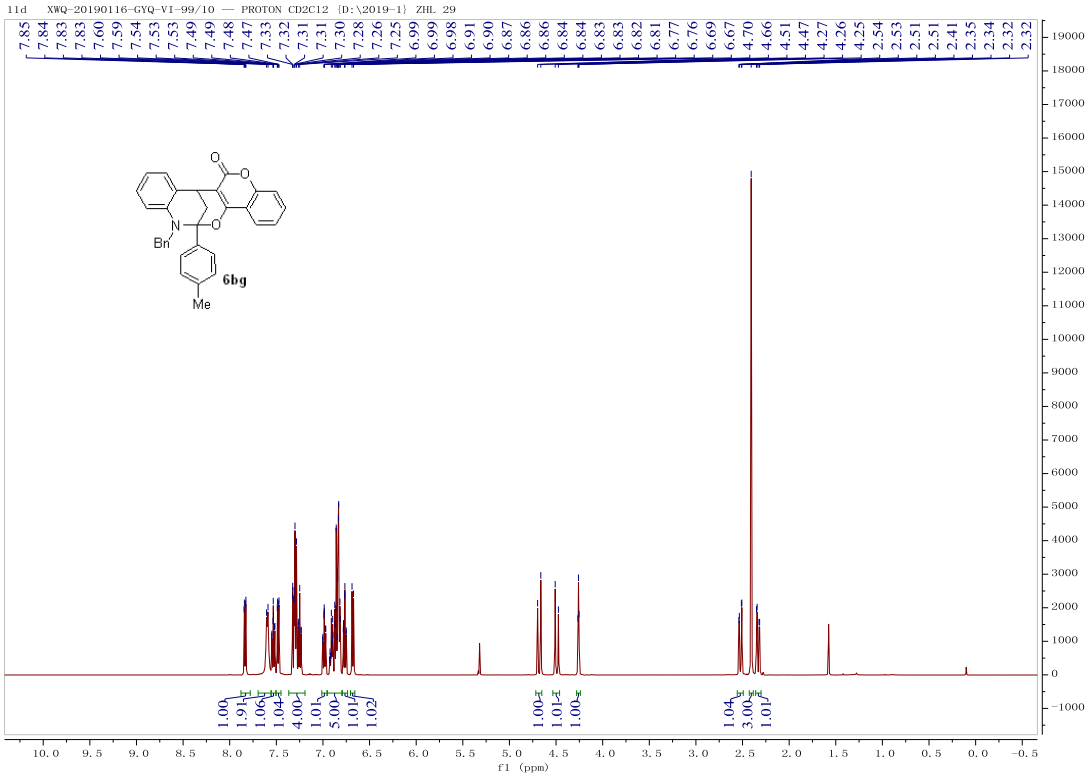

11n XWQ-20181228-GYQ-VI-69/11 — C13CPD CD2C12 (D:\2018-3) ZHL 13
161.97 158.92 152.69 143.38 140.97 137.97 132.17 129.40 129.26 129.05 128.45 126.96 126.87 126.63 126.54 124.21 123.11 121.78 121.28 116.84 116.35 115.86 105.28 92.94 51.09 37.00 29.97
Br
O
O
N
O
Bn
6bd
f1 (ppm)

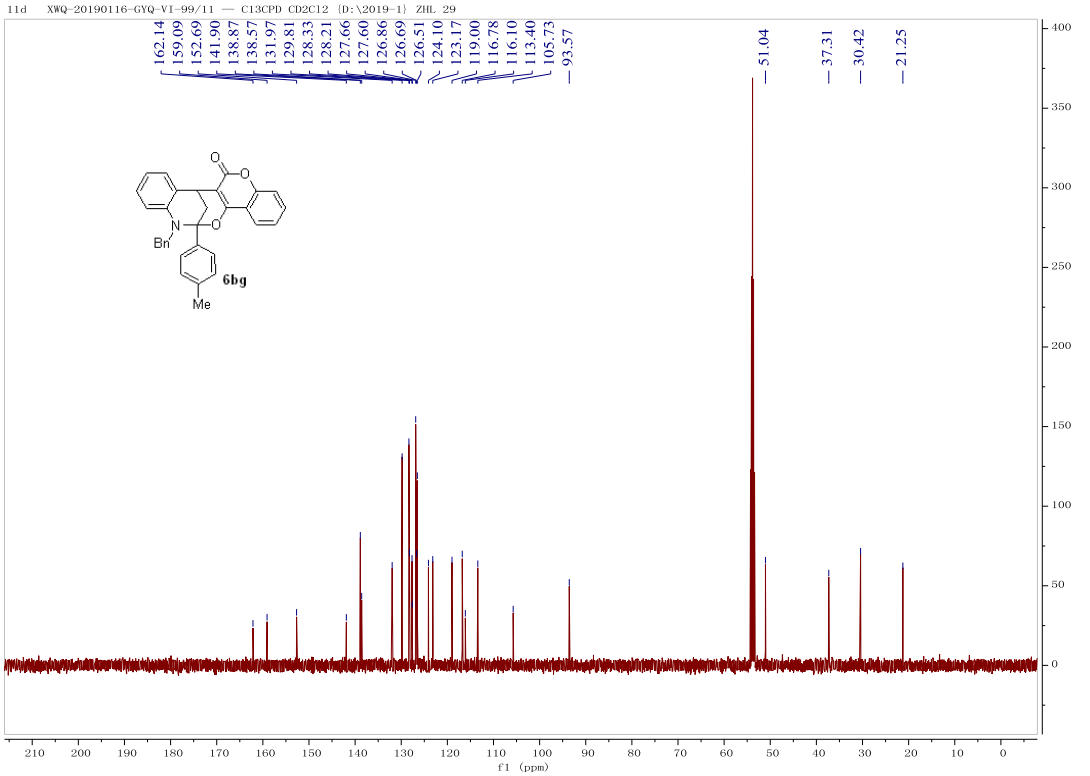

11b XWQ-20190118-GYQ-VII-3/10 — PROTON CD2C12 {D:\2019-1} ZHL 37
8.09 8.08 8.07 8.07 7.95 7.95 7.93 7.93 7.55 7.55 7.48 7.47 7.46 7.43 7.43 7.43 7.35 7.33 7.29 7.13 7.12 7.02 7.02 7.01 7.00 6.97 6.96 6.95 6.94 6.92 6.89 6.88 6.88 6.87 6.86 6.86 6.84 6.82 6.82 6.76 6.74 6.74 6.57 6.56 4.57 4.51 4.26 4.25 4.24 3.74
1.01 1.01 1.02 2.07 2.13 1.03 3.12 4.01 1.00 1.00 0.98 0.98 1.00 3.03 1.00 1.00
f1 (ppm)
6be

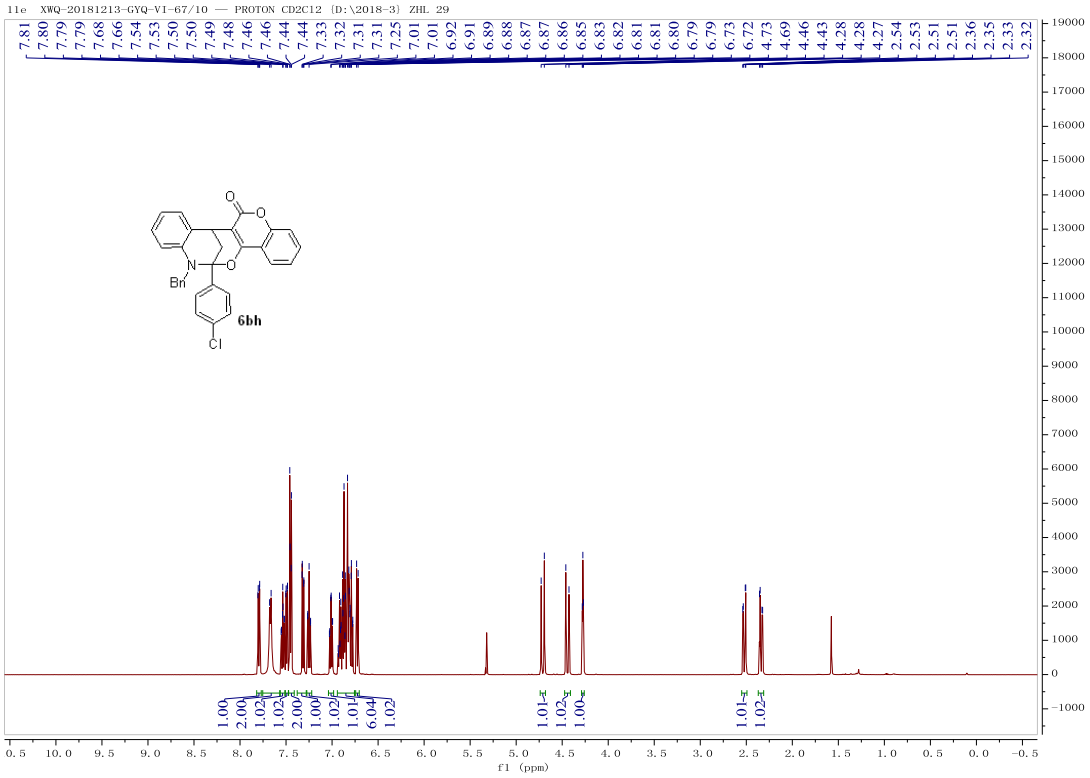

11b XWQ-20190118-GYQ-VII-3/11 — C13CPD CD2C12 {D:\2019-1} ZHL 37
162.22 158.66 156.52 152.84 141.62 139.24 131.92 130.46 128.82 128.61 128.38 127.91 127.73 127.50 126.94 126.67 124.14 123.14 121.07 118.40 116.87 116.39 112.71 111.96 105.85 92.92 56.05 49.98 32.84 30.60
f1 (ppm)
6be

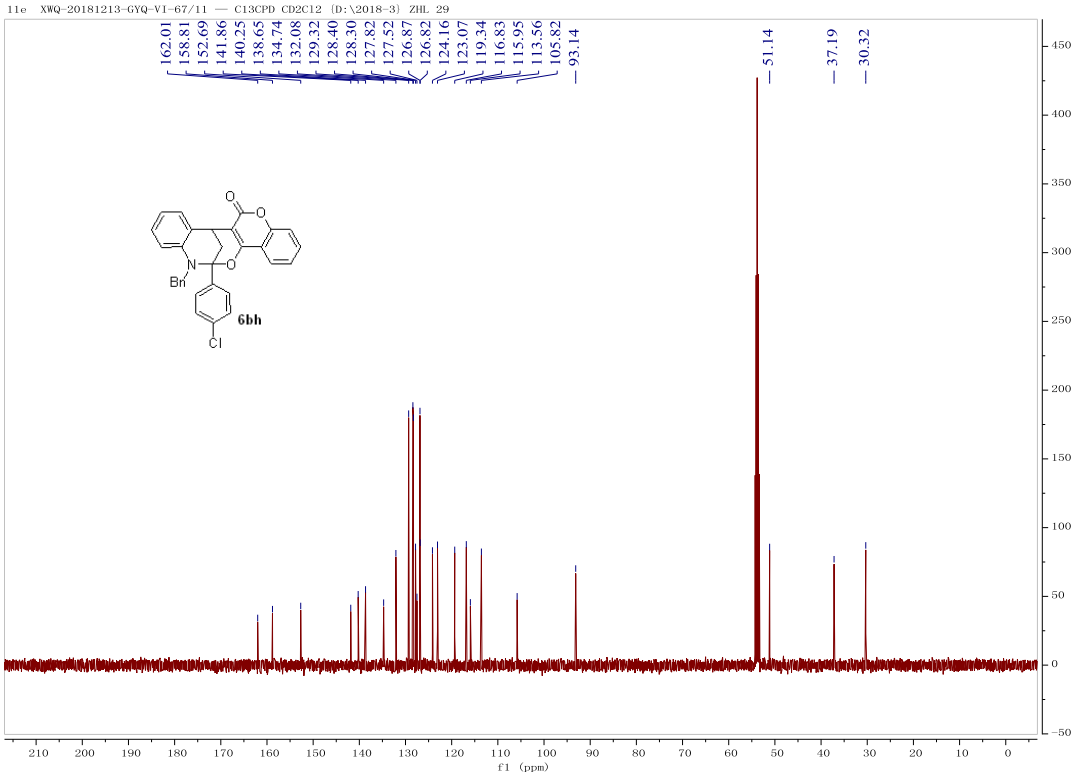

11c XWQ-20190123-HY-III-2/10 — PROTON CD2Cl2 (D:\2019-1) ZHL 25
7.84 7.84 7.82 7.82 7.64 7.62 7.53 7.53 7.53 7.49 7.49 7.48 7.47 7.33 7.32 7.31 7.31 7.25 7.00 7.00 6.99 6.99 6.98 6.98 6.97 6.97 6.92 6.90 6.88 6.88 6.87 6.87 6.85 6.85 6.84 6.83 6.82 6.77 6.76 6.69 6.68 4.71 4.67 4.53 4.49 4.27 4.26 4.25 3.84 2.54 2.52 2.52 2.35 2.34
Bn
6bf
OMe
1.01 1.96 1.05 1.03 1.00 1.02 3.04 5.07 1.03 1.05 1.02 1.02 1.00 3.05 1.03 1.03
f1 (ppm)

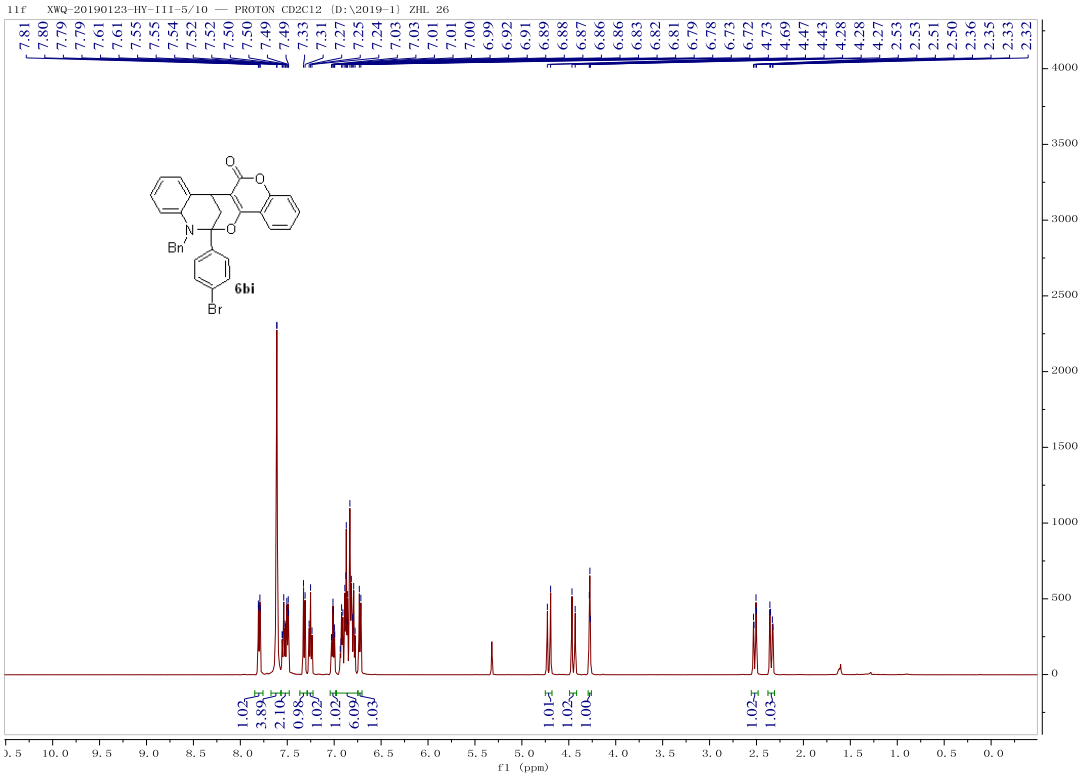

11c XWQ-20190123-HY-III-2/11 — C13CPD CD2Cl2 (D:\2019-1) ZHL 25
162.14 160.11 159.08 152.68 141.97 138.92 133.45 131.96 128.33 128.22 127.91 127.67 127.57 126.86 126.68 124.09 123.14 119.00 116.78 116.10 114.38 113.42 105.75 93.45 55.74 50.91 37.28 30.43
Bn
6bf
OMe
f1 (ppm)

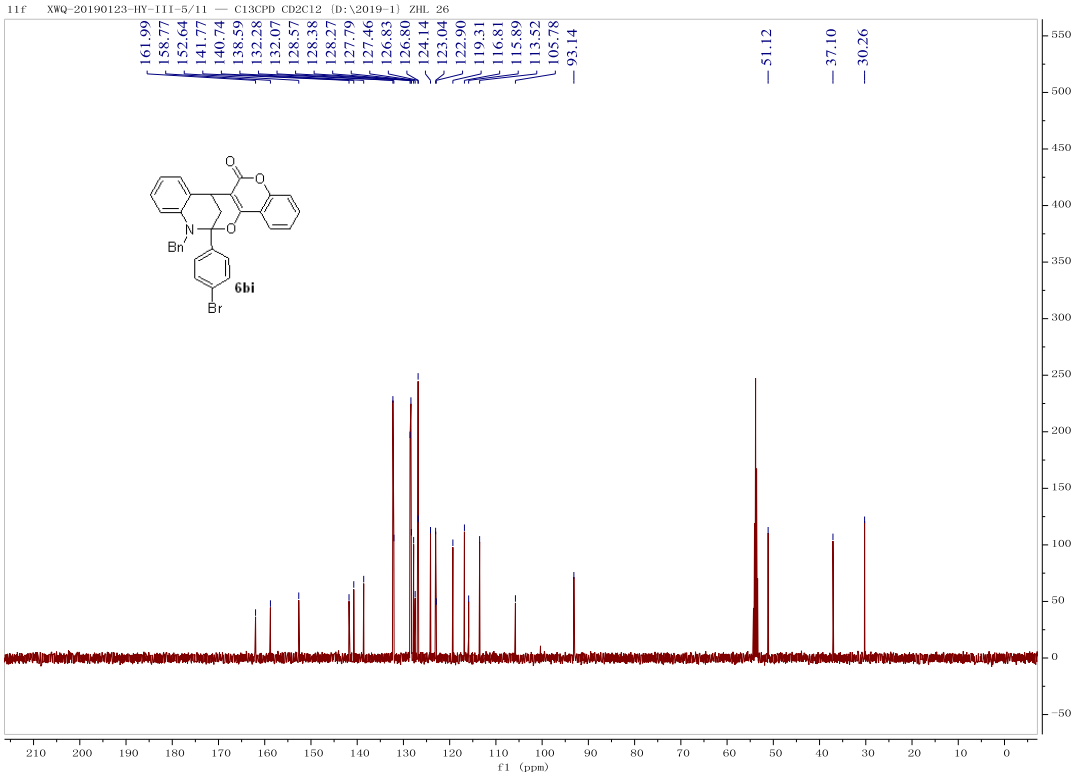

11d XWQ-20190116-GYQ-VI-99/10 — PROTON CD2C12 {D:\2019-1} ZHL 29
7.85 7.84 7.83 7.83 7.60 7.59 7.54 7.53 7.53 7.49 7.49 7.48 7.47 7.33 7.32 7.31 7.31 7.30 7.28 7.26 7.25 6.99 6.99 6.98 6.91 6.90 6.87 6.86 6.86 6.84 6.84 6.83 6.83 6.82 6.81 6.77 6.76 6.69 6.67 4.70 4.66 4.51 4.47 4.27 4.26 4.25 2.54 2.53 2.51 2.51 2.41 2.35 2.34 2.32 2.32
O
O
N
Bn
O
6bg
Me
1.00 1.91 1.06 1.04 4.00 1.01 5.00 1.01 1.02 1.00 1.01 1.00 1.04 3.00 1.01
f1 (ppm)

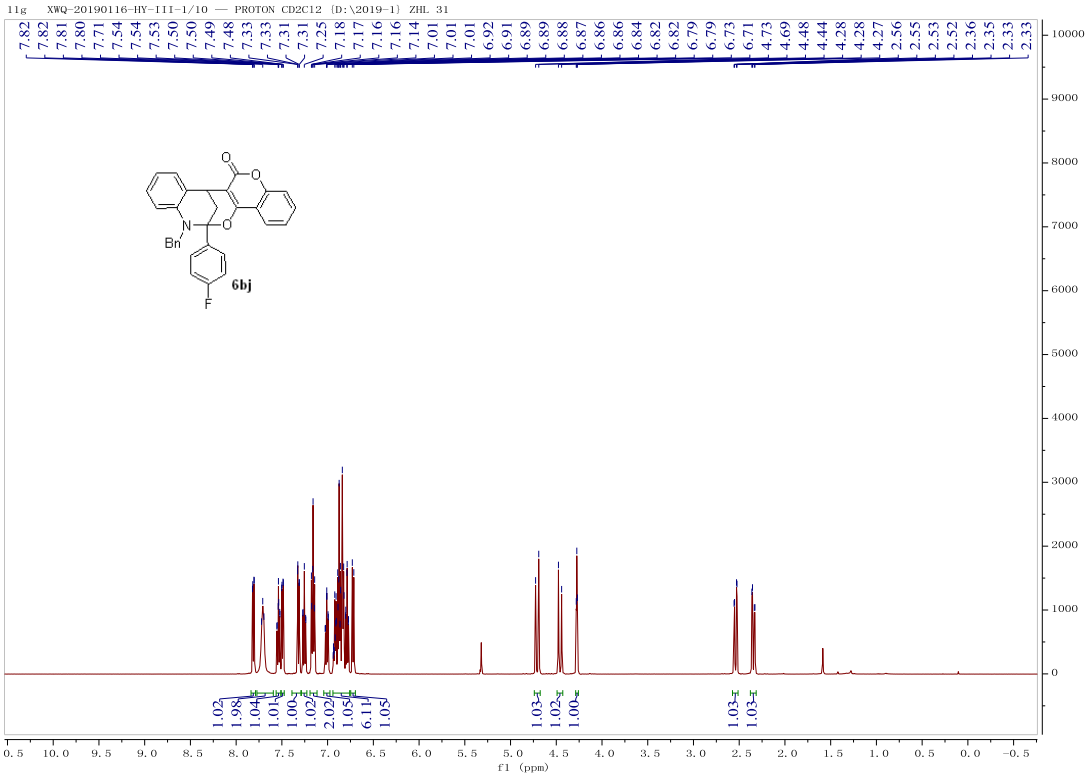

11d XWQ-20190116-GYQ-VI-99/11 — C13CPD CD2C12 {D:\2019-1} ZHL 29
162.14 159.09 152.69 141.90 138.87 138.57 131.97 129.81 128.33 128.21 127.66 127.60 126.86 126.69 126.51 124.10 123.17 119.00 116.78 116.10 113.40 105.73 93.57 51.04 37.31 30.42 21.25
O
O
N
Bn
O
6bg
Me
f1 (ppm)

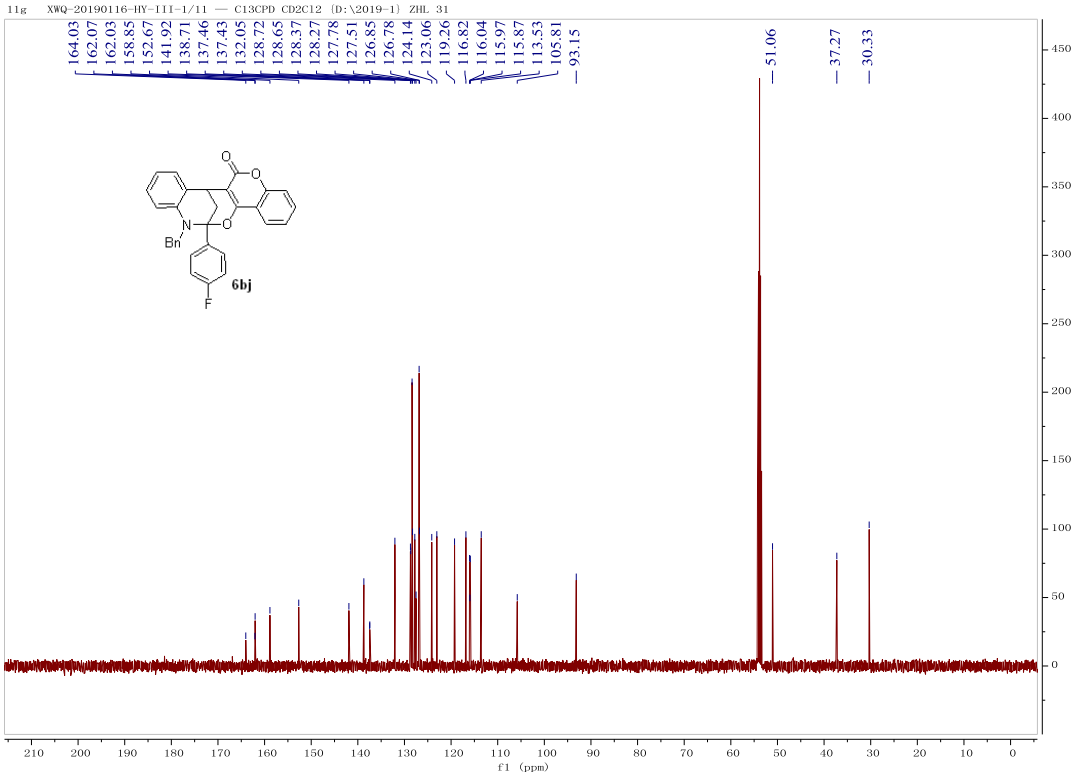

11e XWQ-20181213-GYQ-VI-67/10 — PROTON CD2Cl2 (D:\2018-3) ZHL 29
7.81 7.80 7.79 7.79 7.68 7.66 7.54 7.53 7.50 7.50 7.49 7.48 7.46 7.46 7.44 7.44 7.33 7.32 7.31 7.31 7.25 7.01 7.01 6.92 6.91 6.89 6.88 6.87 6.87 6.86 6.85 6.83 6.82 6.81 6.81 6.80 6.79 6.79 6.73 6.72 4.73 4.69 4.46 4.43 4.28 4.28 4.27 2.54 2.53 2.51 2.51 2.36 2.35 2.33 2.32
1.00 2.00 1.02 1.02 2.00 1.00 1.02 1.01 6.04 1.02 1.01 1.02 1.00 1.01 1.02
f1 (ppm)

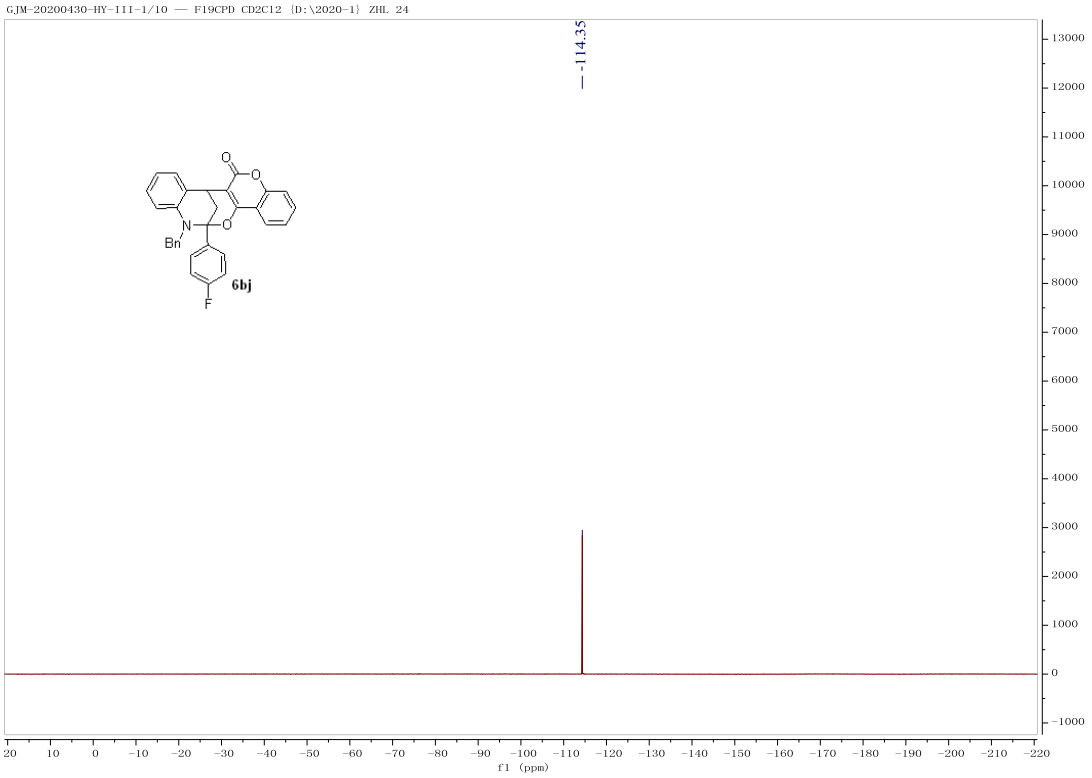

11e XWQ-20181213-GYQ-VI-67/11 — C13CPD CD2Cl2 (D:\2018-3) ZHL 29
162.01 158.81 152.69 141.86 140.25 138.65 134.74 132.08 129.32 128.40 128.30 127.82 127.52 126.87 126.82 124.16 123.07 119.34 116.83 115.95 113.56 105.82 93.14 51.14 37.19 30.32
f1 (ppm)

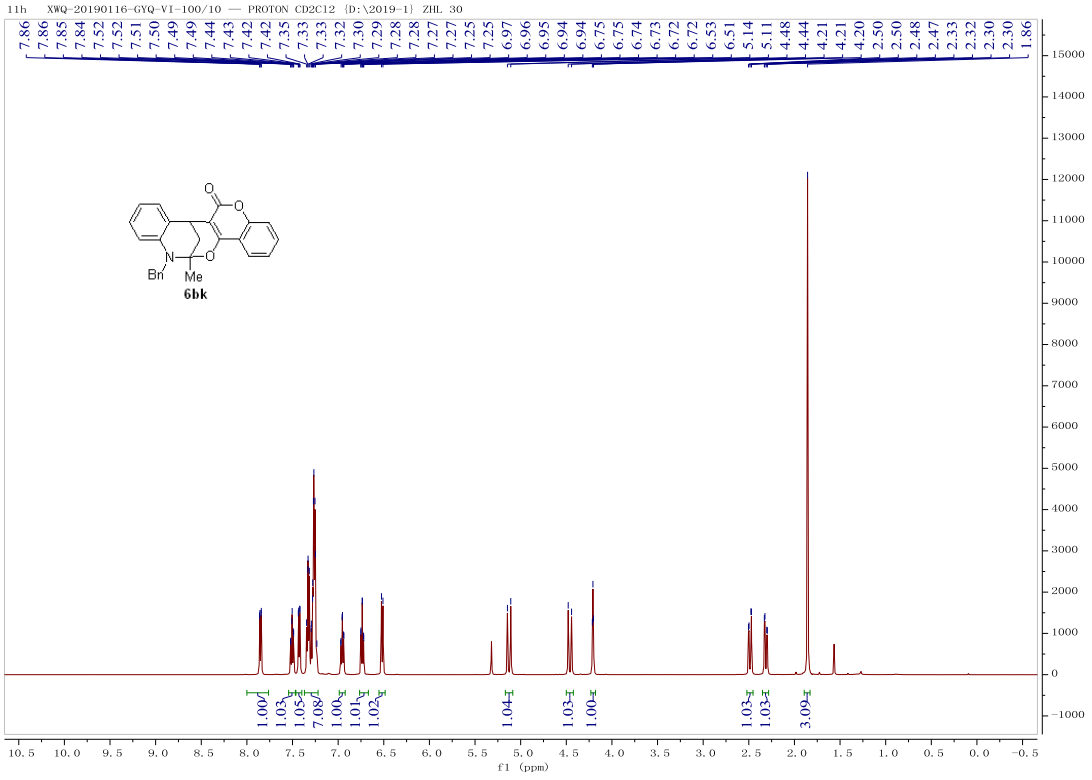

11f XWQ-20190123-HY-III-5/10 — PROTON CD2Cl2 (D:\2019-1) ZHL 26
7.81 7.80 7.79 7.79 7.61 7.61 7.55 7.55 7.54 7.52 7.52 7.50 7.50 7.49 7.49 7.33 7.31 7.27 7.25 7.24 7.03 7.01 7.01 7.00 6.99 6.92 6.91 6.89 6.88 6.87 6.86 6.86 6.83 6.82 6.81 6.79 6.78 6.73 6.72 4.73 4.69 4.47 4.43 4.28 4.27 2.53 2.51 2.50 2.36 2.35 2.33 2.32
Bn
6bi
Br
1.02 3.89 2.10 0.98 1.02 1.02 6.09 1.03 1.01 1.02 1.00 1.02 1.03
f1 (ppm)

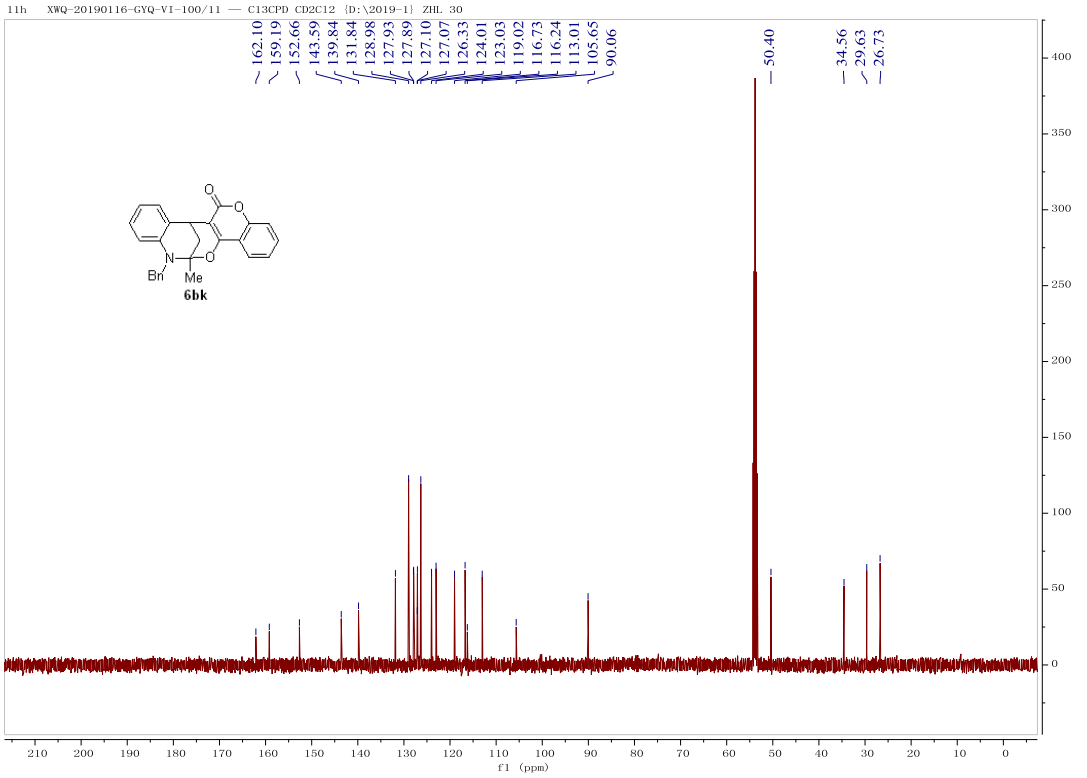

11f XWQ-20190123-HY-III-5/11 — C13CPD CD2Cl2 (D:\2019-1) ZHL 26
161.99 158.77 152.64 141.77 140.74 138.59 132.28 132.07 128.57 128.38 128.27 127.79 127.46 126.83 126.80 124.14 123.04 122.90 119.31 116.81 115.89 113.52 105.78 93.14 51.12 37.10 30.26
Bn
6bi
Br
f1 (ppm)

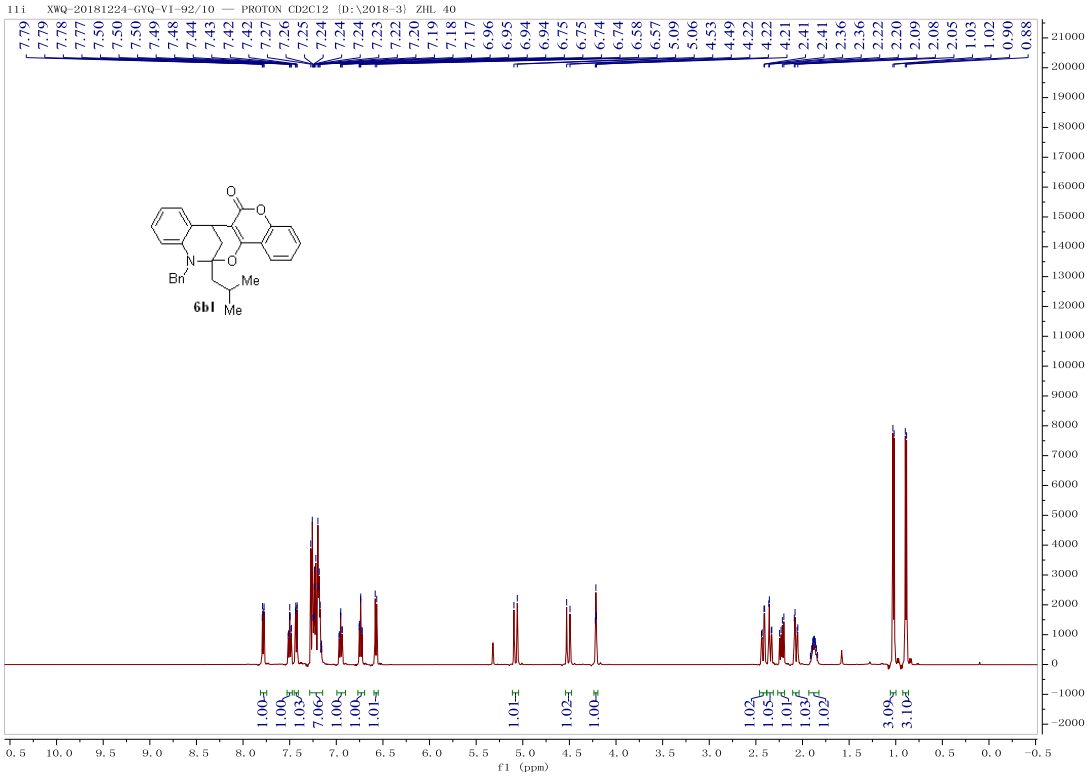

11g XWQ-20190116-HY-III-1/10 — PROTON CD2Cl2 (D:\2019-1) ZHL 31
7.82 7.82 7.81 7.80 7.71 7.54 7.53 7.50 7.50 7.49 7.48 7.33 7.33 7.31 7.31 7.25 7.18 7.17 7.16 7.16 7.14 7.01 7.01 6.92 6.91 6.89 6.89 6.88 6.87 6.86 6.86 6.84 6.82 6.82 6.79 6.79 6.73 6.71 4.73 4.69 4.48 4.44 4.28 4.28 4.27 2.56 2.55 2.53 2.52 2.36 2.35 2.33 2.33
Bn
6bj
F
1.02 1.98 1.04 1.01 1.00 1.02 2.02 1.05 6.11 1.05 1.03 1.02 1.00 1.03 1.03
f1 (ppm)

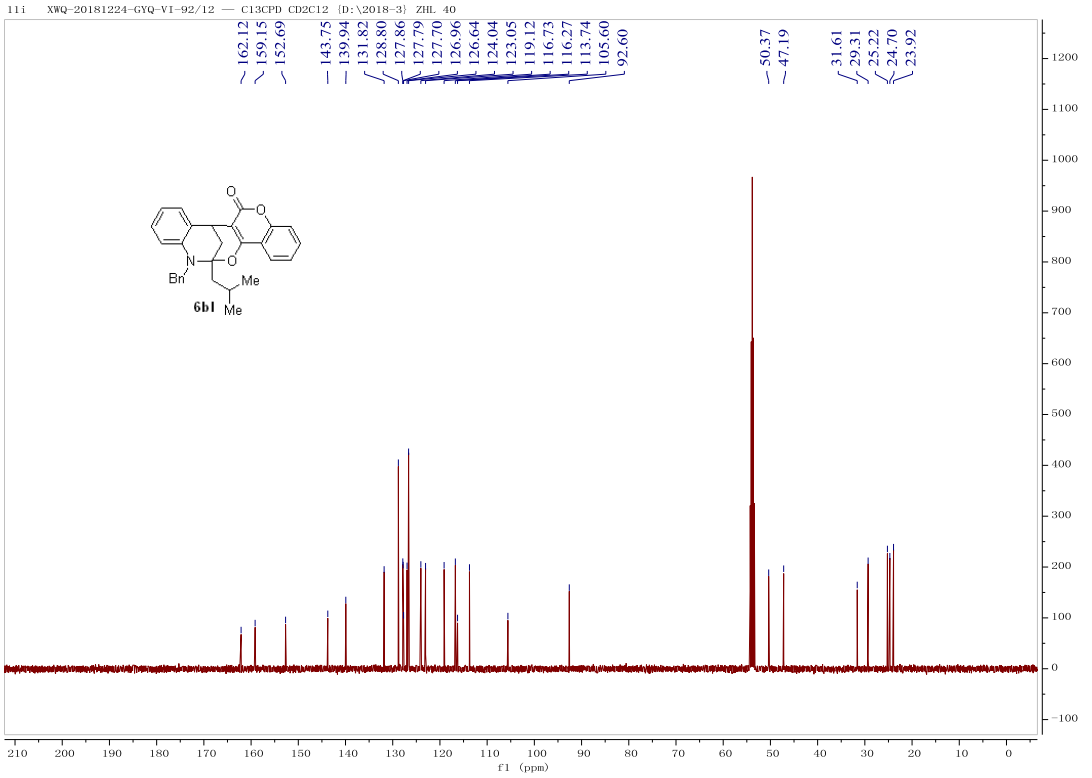

11g XWQ-20190116-HY-III-1/11 — C13CPD CD2Cl2 (D:\2019-1) ZHL 31
164.03 162.07 162.03 158.85 152.67 141.92 138.71 137.46 137.43 132.05 128.72 128.65 128.37 128.27 127.78 127.51 126.85 126.78 124.14 123.06 119.26 116.82 116.04 115.97 115.87 113.53 105.81 93.15 51.06 37.27 30.33
Bn
6bj
F
f1 (ppm)

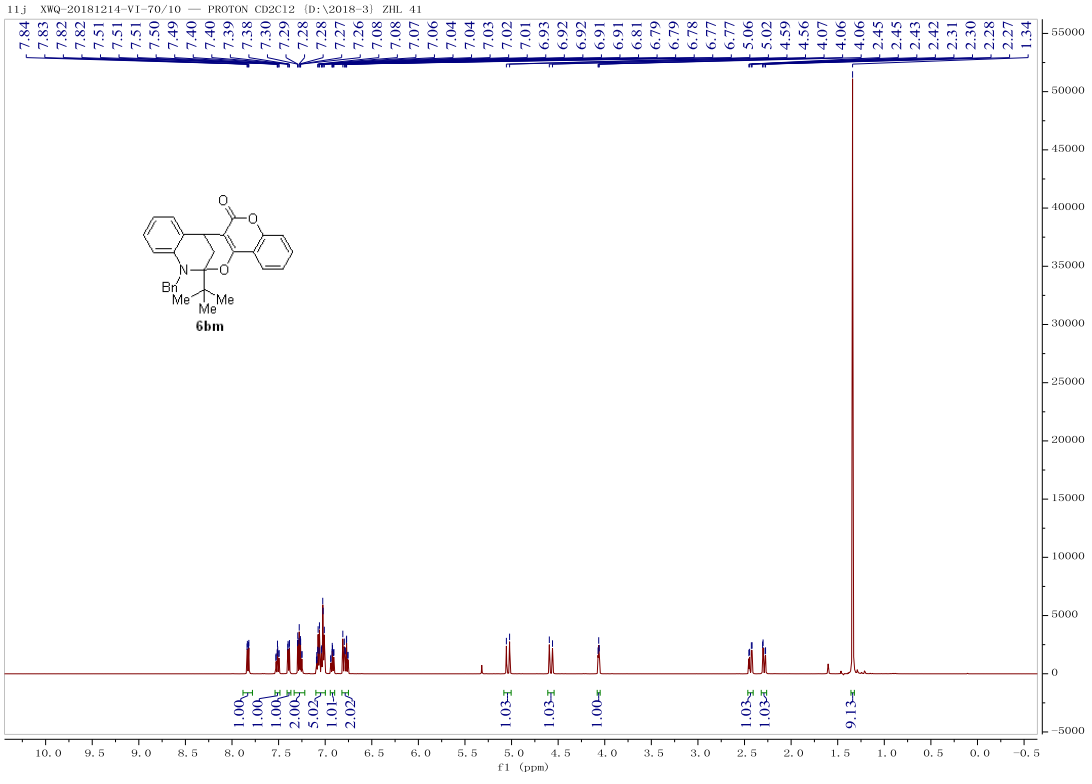

GJM-20200430-HY-III-1/10 — F19CPD CD2Cl2 {D:\2020-1} ZHL 24
-114.35
6bj
f1 (ppm)

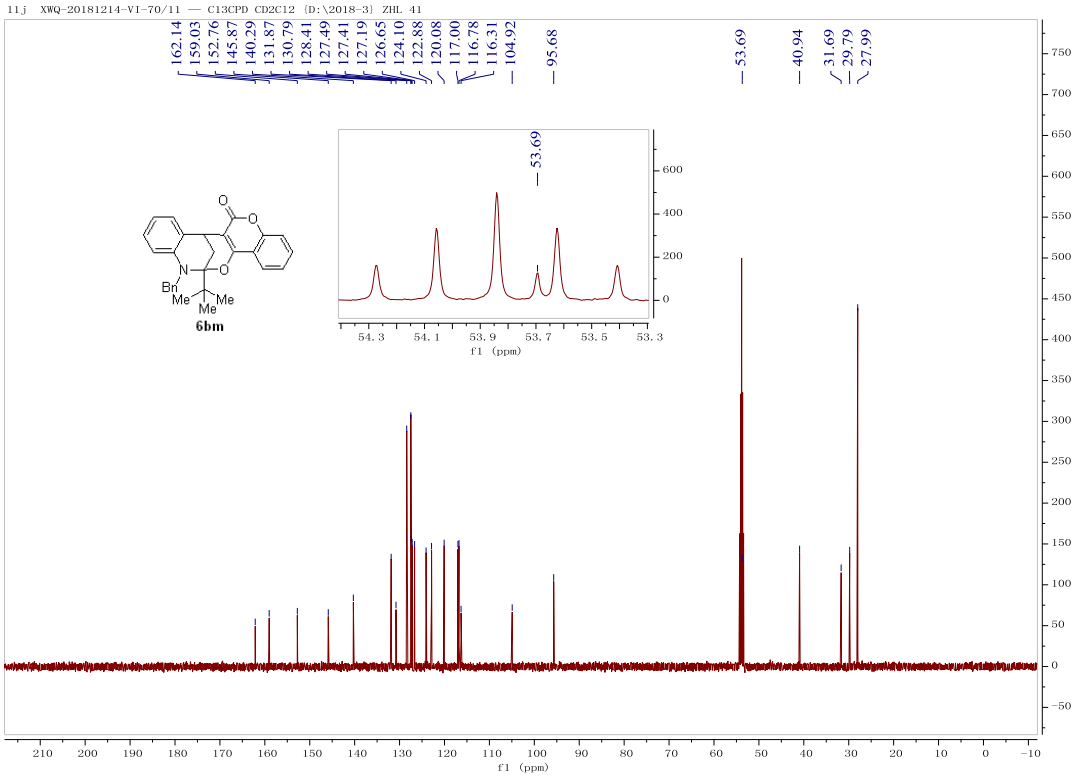

11h XWQ-20190116-GYQ-VI-100/10 — PROTON CD2Cl2 {D:\2019-1} ZHL 30
6bk
f1 (ppm)


11h XWQ-20190116-GYQ-VI-100/11 — C13CPD CD2Cl2 {D:\2019-1} ZHL 30
162.10
159.19
152.66
143.59
139.84
131.84
128.98
127.93
127.89
127.10
127.07
126.33
124.01
123.03
119.02
116.73
116.24
113.01
105.65
90.06
50.40
34.56
29.63
26.73
Bn
Me
6bk
f1 (ppm)


11i XWQ-20181224-GYQ-VI-92/10 — PROTON CD2Cl2 {D:\2018-3} ZHL 40
7.79
7.78
7.77
7.50
7.49
7.48
7.44
7.43
7.42
7.27
7.26
7.25
7.24
7.23
7.22
7.20
7.19
7.18
7.17
6.96
6.95
6.94
6.75
6.74
6.58
6.57
5.09
5.06
4.53
4.49
4.22
4.21
2.41
2.36
2.22
2.20
2.09
2.08
2.05
1.03
1.02
0.90
0.88
Bn
Me
Me
6bl
1.00
1.00
1.03
7.06
1.00
1.00
1.01
1.01
1.02
1.00
1.02
1.05
1.01
1.03
1.02
3.09
3.10
f1 (ppm)


11i XWQ-20181224-GYQ-VI-92/12 — C13CPD CD2C12 {D:\2018-3} ZHL 40
162.12
159.15
152.69
143.75
139.94
131.82
128.80
127.86
127.79
127.70
126.96
126.64
124.04
123.05
119.12
116.73
116.27
113.74
105.60
92.60
50.37
47.19
31.61
29.31
25.22
24.70
23.92
O
O
O
N
Bn
Me
Me
6bl
f1 (ppm)


11j XWQ-20181214-VI-70/10 — PROTON CD2C12 {D:\2018-3} ZHL 41
7.84
7.83
7.82
7.82
7.51
7.51
7.51
7.50
7.49
7.40
7.40
7.39
7.38
7.30
7.29
7.28
7.28
7.27
7.26
7.08
7.08
7.07
7.06
7.04
7.04
7.03
7.02
7.01
6.93
6.92
6.92
6.91
6.91
6.81
6.79
6.79
6.78
6.77
6.77
5.06
5.02
4.59
4.56
4.07
4.06
4.06
2.45
2.45
2.43
2.42
2.31
2.30
2.28
2.27
1.34
1.00
1.00
1.00
2.00
5.02
1.01
2.02
1.03
1.03
1.00
1.03
1.03
9.13
O
O
O
N
Bn
Me
Me
Me
6bm
f1 (ppm)


11j XWQ-20181214-VI-70/11 — C13CPD CD2C12 (D:\2018-3) ZHL 41
162.14
159.03
152.76
145.87
140.29
131.87
130.79
128.41
127.49
127.41
127.19
126.65
124.10
122.88
120.08
117.00
116.78
116.31
104.92
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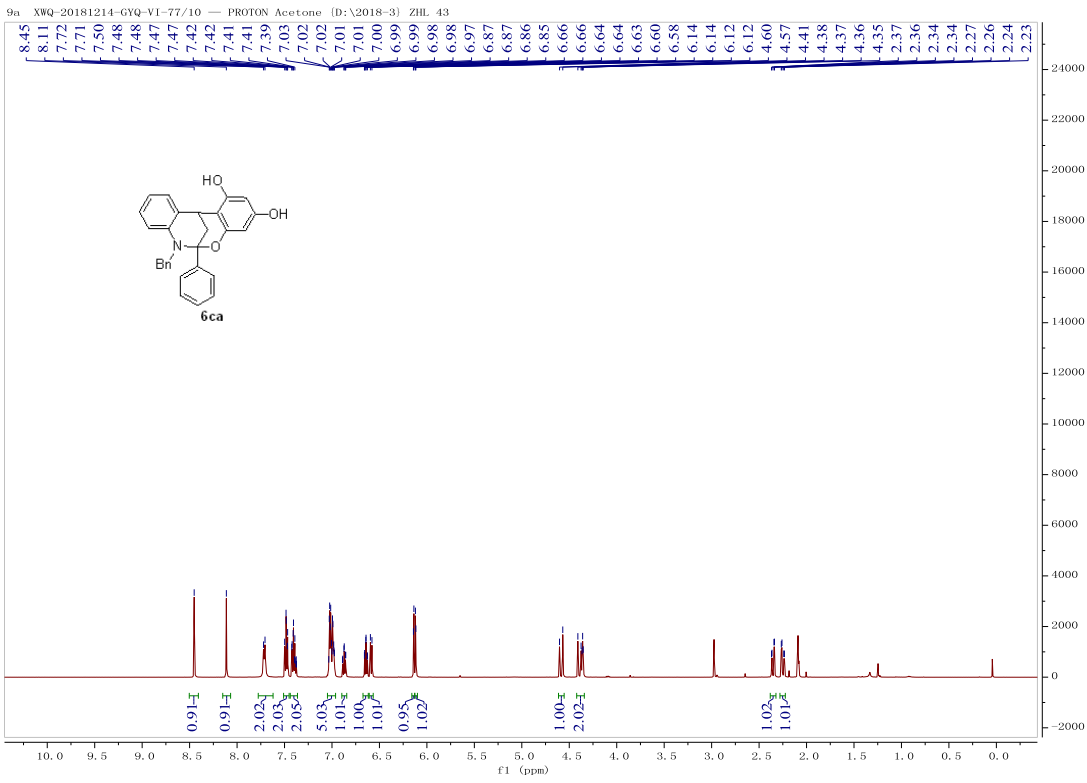
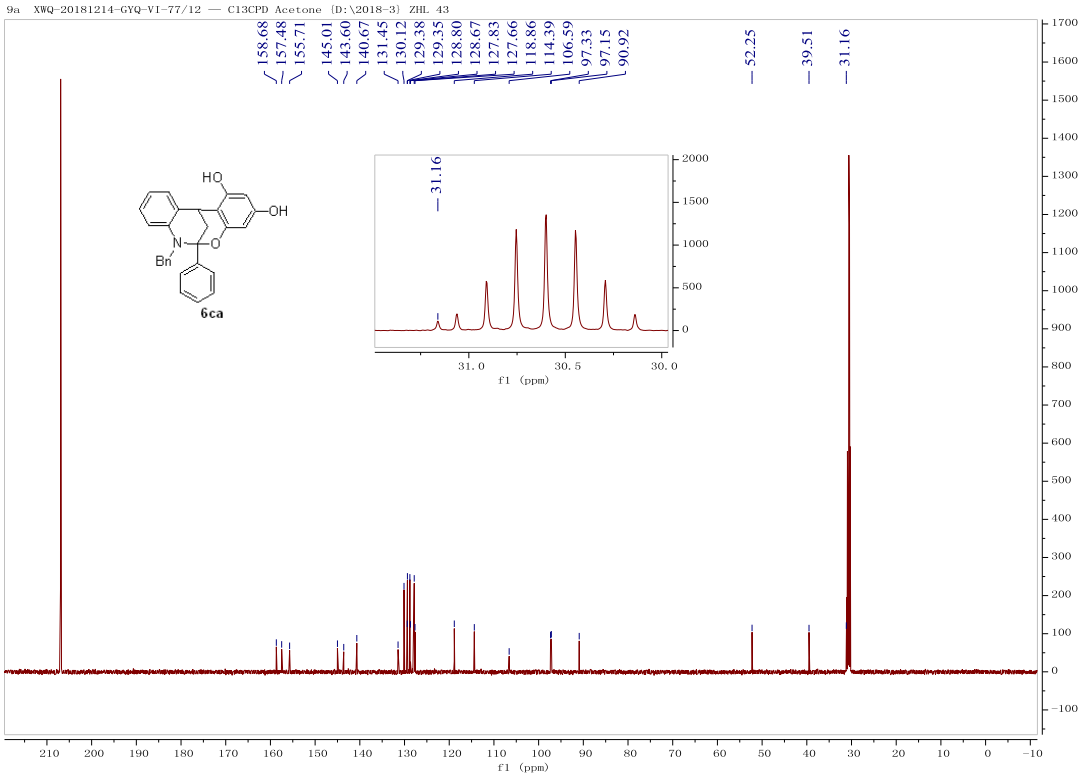
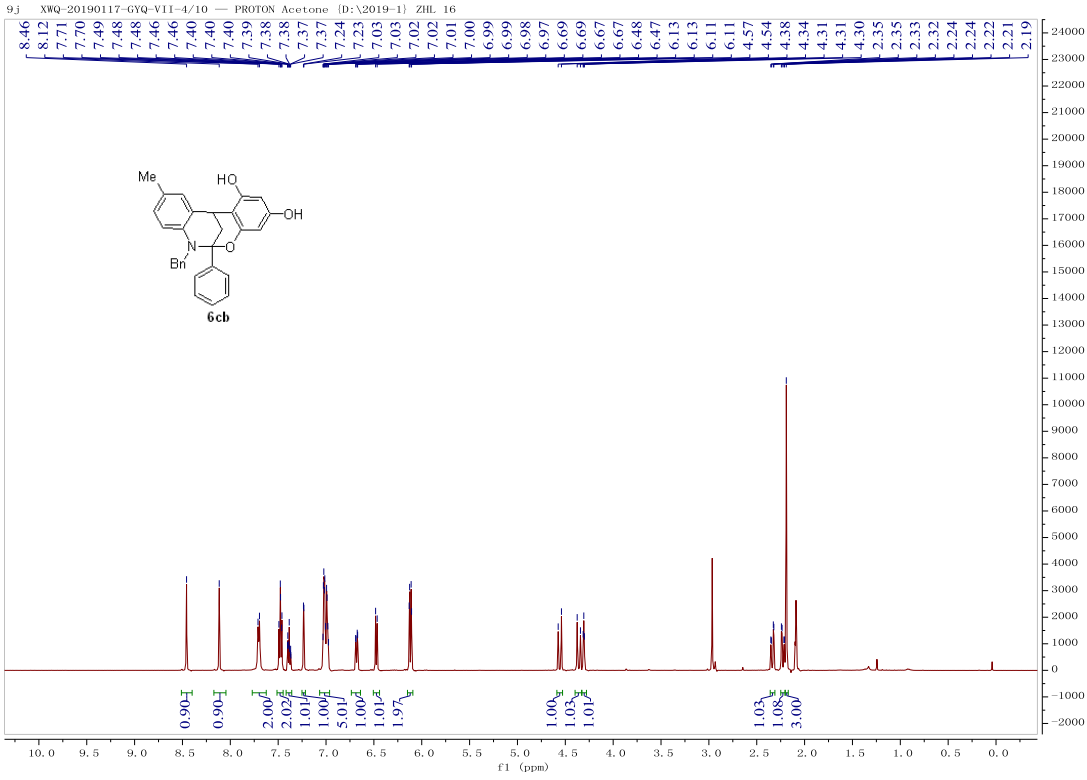
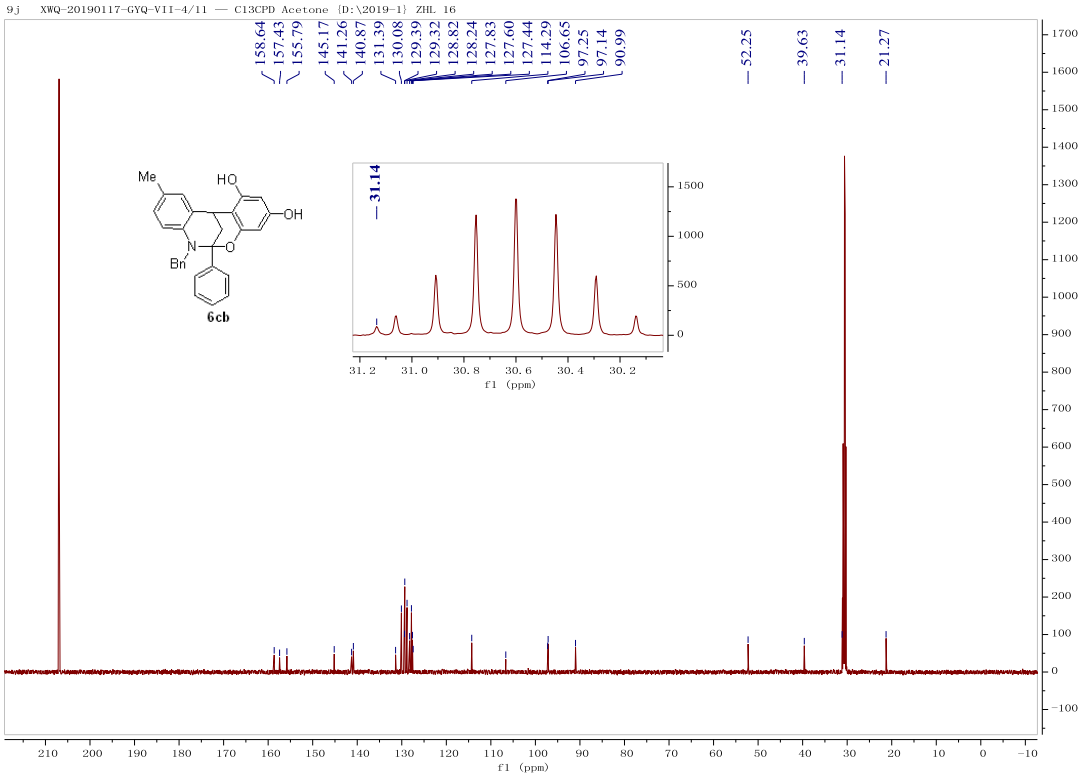
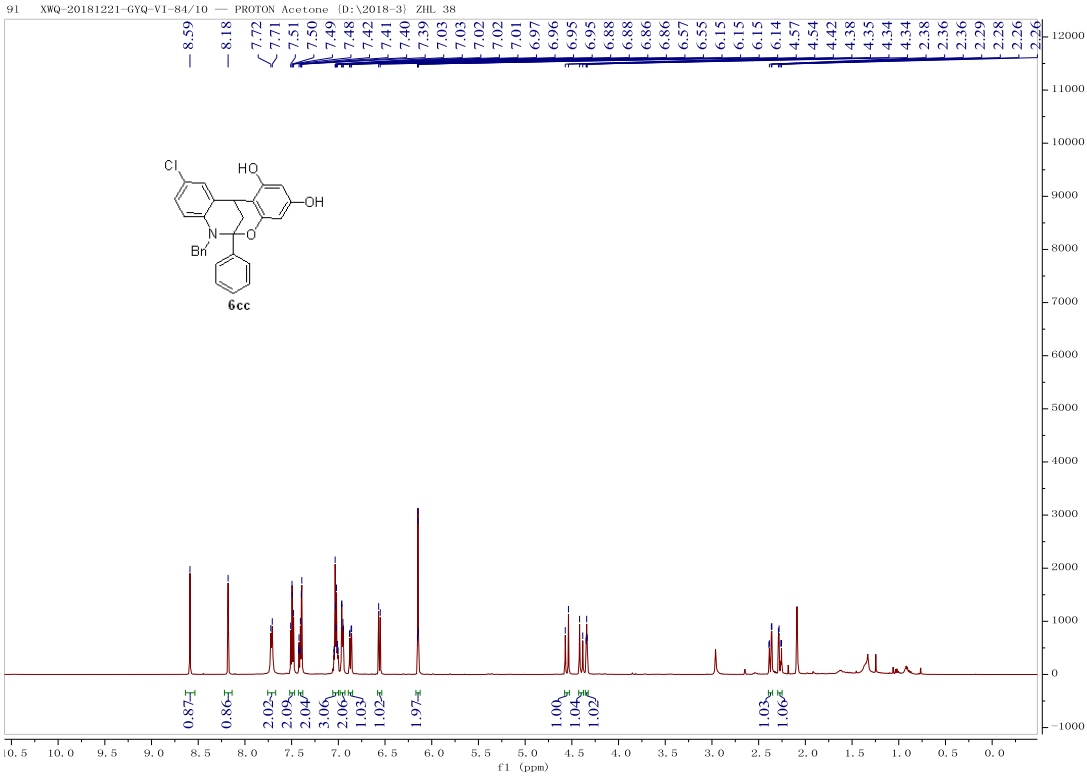
53.69
40.94
31.69
29.79
27.99
6bm
f1 (ppm)

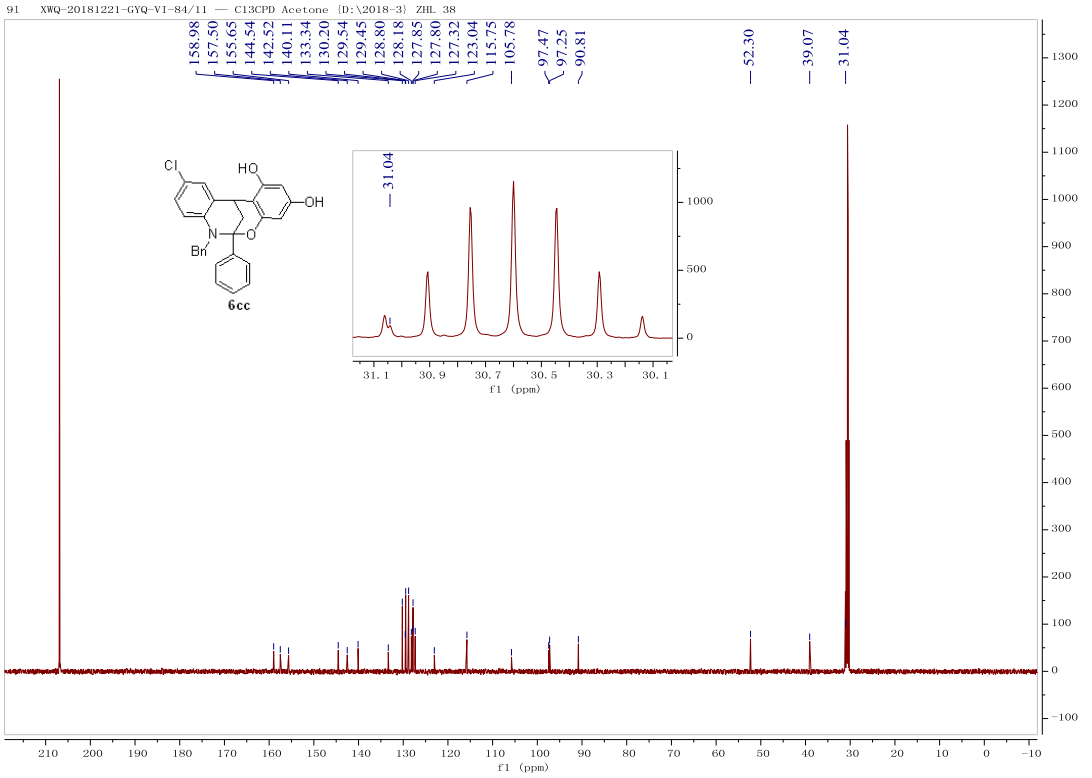

9a XWQ-20181214-GYQ-VI-77/10 — PROTON Acetone (D:\2018-3) ZHL 43
8.45
8.11
7.72
7.71
7.50
7.48
7.48
7.47
7.47
7.42
7.42
7.41
7.41
7.39
7.03
7.02
7.02
7.01
7.01
7.00
6.99
6.99
6.98
6.98
6.97
6.87
6.87
6.86
6.85
6.66
6.66
6.64
6.64
6.63
6.60
6.58
6.14
6.14
6.12
6.12
4.60
4.57
4.41
4.38
4.37
4.36
4.35
2.37
2.36
2.34
2.34
2.27
2.26
2.24
2.23
6ca
0.91
0.91
2.02
2.03
2.05
5.03
1.01
1.00
1.01
0.95
1.02
1.00
2.02
1.02
1.01
f1 (ppm)

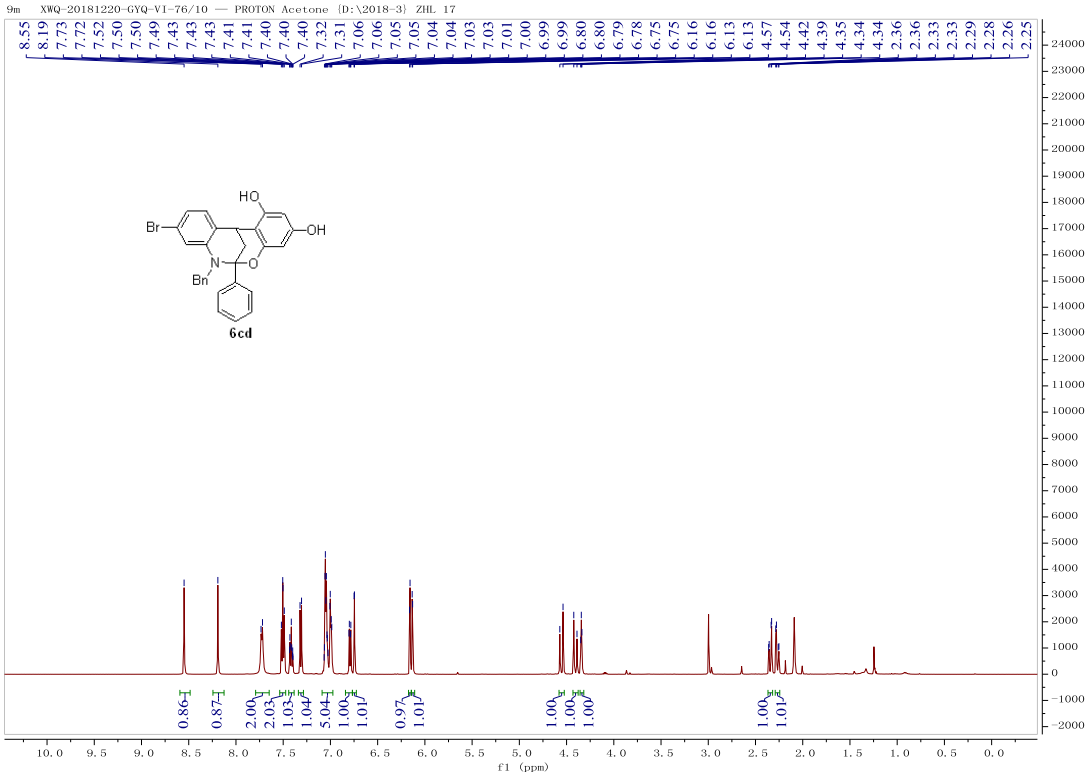

9a XWQ-20181214-GYQ-VI-77/12 — C13CPD Acetone (D:\2018-3) ZHL 43
158.68
157.48
155.71
145.01
143.60
140.67
131.45
130.12
129.38
129.35
128.80
128.67
127.83
127.66
118.86
114.39
106.59
97.33
97.15
90.92
52.25
39.51
31.16
HO
OH
N
O
Bn
6ca
f1 (ppm)

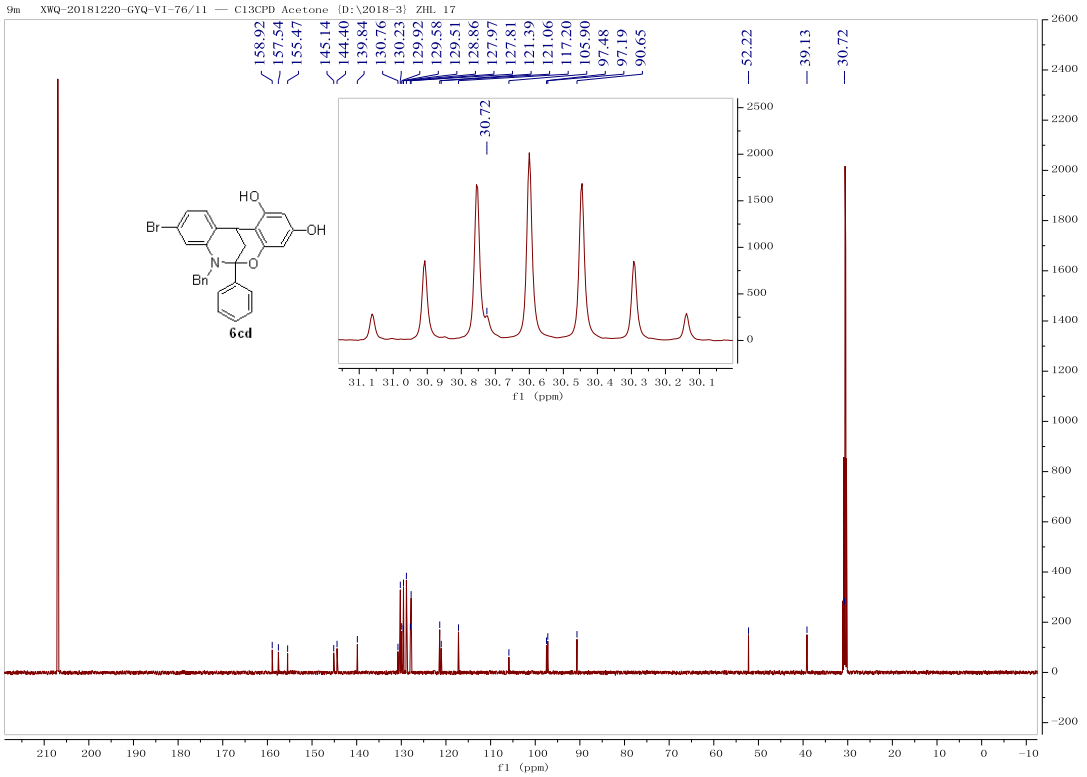

9j XWQ-20190117-GYQ-VII-4/10 — PROTON Acetone (D:\2019-1) ZHL 16
8.46
8.12
7.71
7.70
7.49
7.48
7.48
7.46
7.46
7.40
7.40
7.40
7.39
7.38
7.38
7.37
7.37
7.24
7.23
7.03
7.03
7.02
7.02
7.01
7.00
6.99
6.99
6.98
6.97
6.69
6.69
6.67
6.67
6.48
6.47
6.13
6.13
6.11
6.11
4.57
4.54
4.38
4.34
4.31
4.31
4.30
2.35
2.35
2.33
2.32
2.24
2.24
2.22
2.21
2.19
Me
HO
OH
N
O
Bn
6cb
0.90
0.90
2.00
2.02
1.01
1.00
5.01
1.00
1.01
1.97
1.00
1.03
1.01
1.03
1.08
3.00
f1 (ppm)

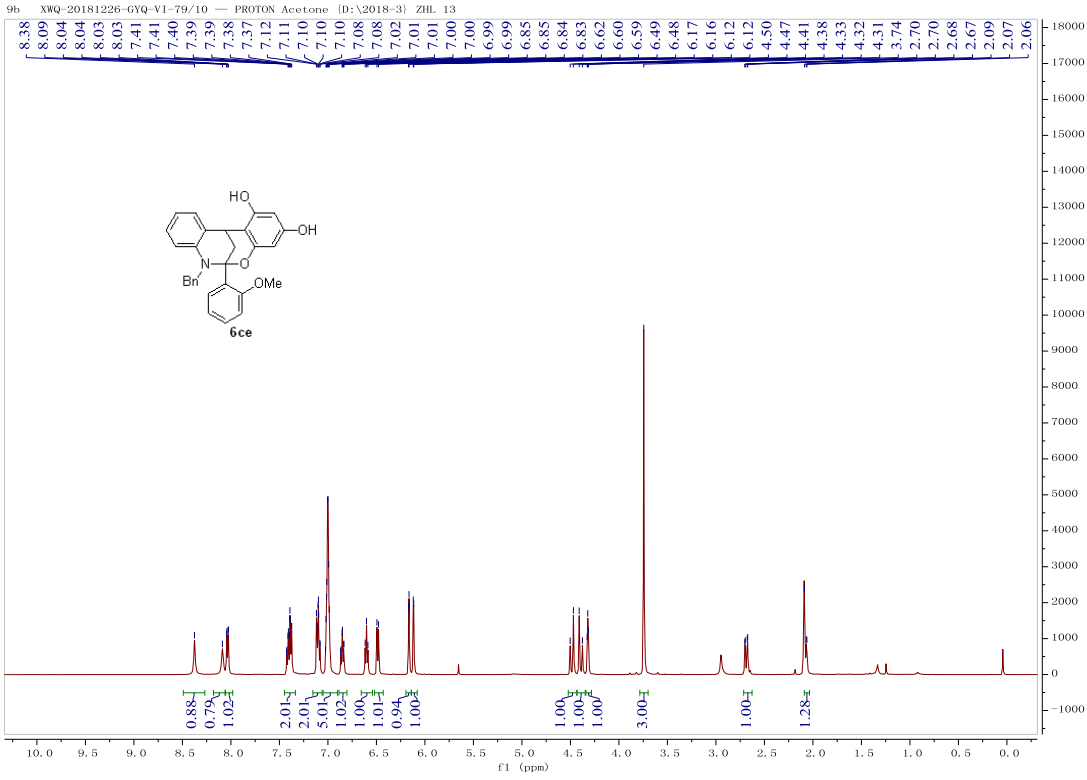

9j XWQ-20190117-GYQ-VII-4/11 — C13CPD Acetone {D:\2019-1} ZHL 16
158.64
157.43
155.79
145.17
141.26
140.87
131.39
130.08
129.39
129.32
128.82
128.24
127.83
127.60
127.44
114.29
106.65
97.25
97.14
90.99
52.25
39.63
31.14
21.27
Me
HO
OH
N
O
Bn
6cb
31.14
f1 (ppm)

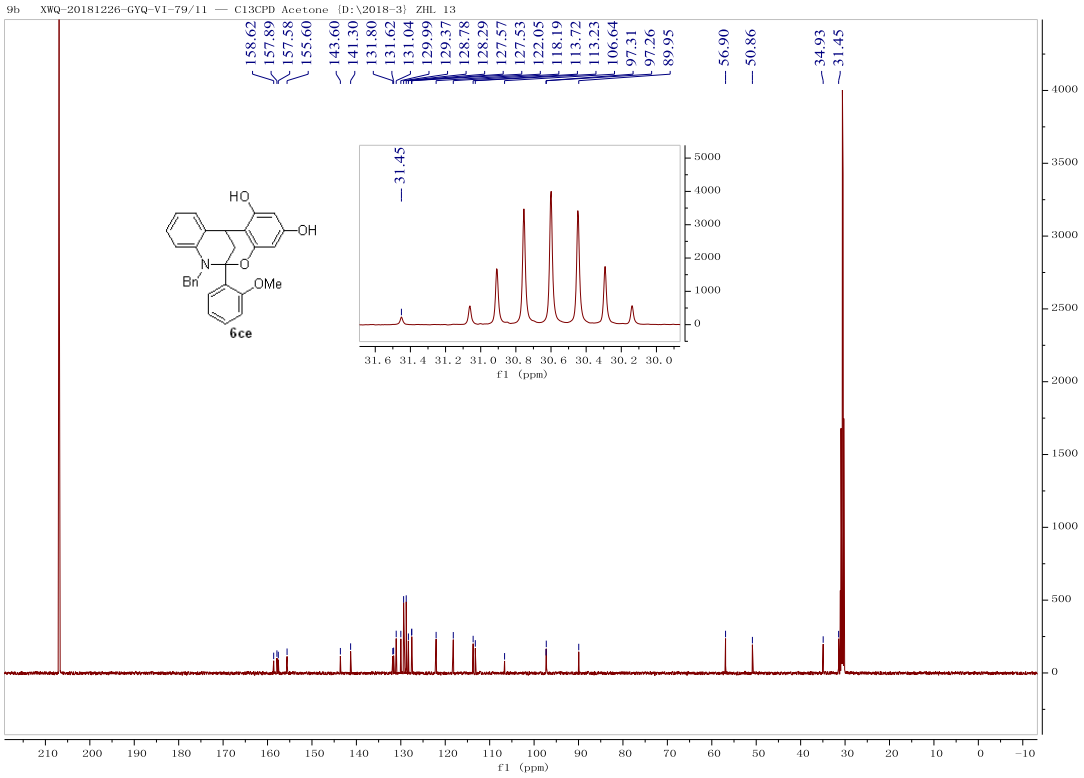

91 XWQ-20181221-GYQ-VI-84/10 — PROTON Acetone {D:\2018-3} ZHL 38
8.59
8.18
7.72
7.71
7.51
7.50
7.49
7.48
7.42
7.41
7.40
7.39
7.03
7.03
7.02
7.02
7.01
6.97
6.96
6.95
6.95
6.88
6.88
6.86
6.86
6.57
6.55
6.15
6.15
6.15
6.14
4.57
4.54
4.42
4.38
4.35
4.34
4.34
2.38
2.36
2.36
2.29
2.28
2.26
2.26
2.26
Cl
HO
OH
N
O
Bn
6cc
0.87
0.86
2.02
2.09
2.04
3.06
2.06
1.03
1.02
1.97
1.00
1.04
1.02
1.03
1.06
f1 (ppm)

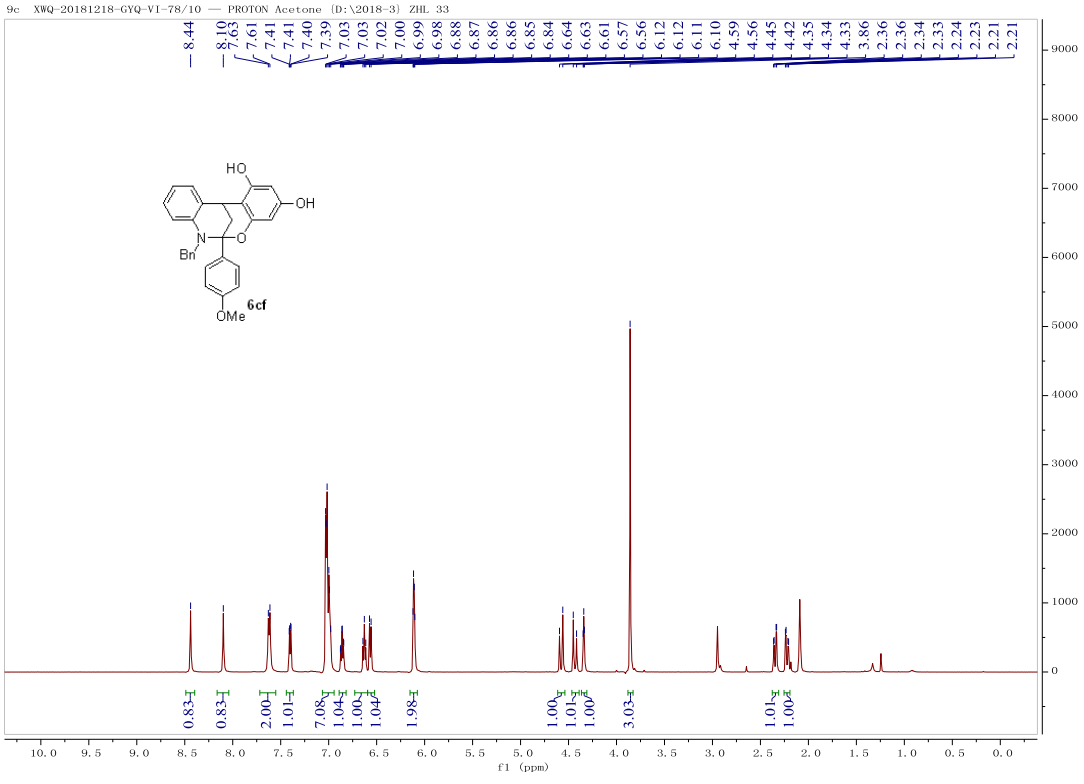

91 XWQ-20181221-GYQ-VI-84/11 — C13CPD Acetone {D:\2018-3} ZHL 38
158.98
157.50
155.65
144.54
142.52
140.11
133.34
130.20
129.54
129.45
128.80
128.18
127.85
127.80
127.32
123.04
115.75
105.78
97.47
97.25
90.81
52.30
39.07
31.04
Cl
HO
OH
N
O
Bn
6cc
f1 (ppm)

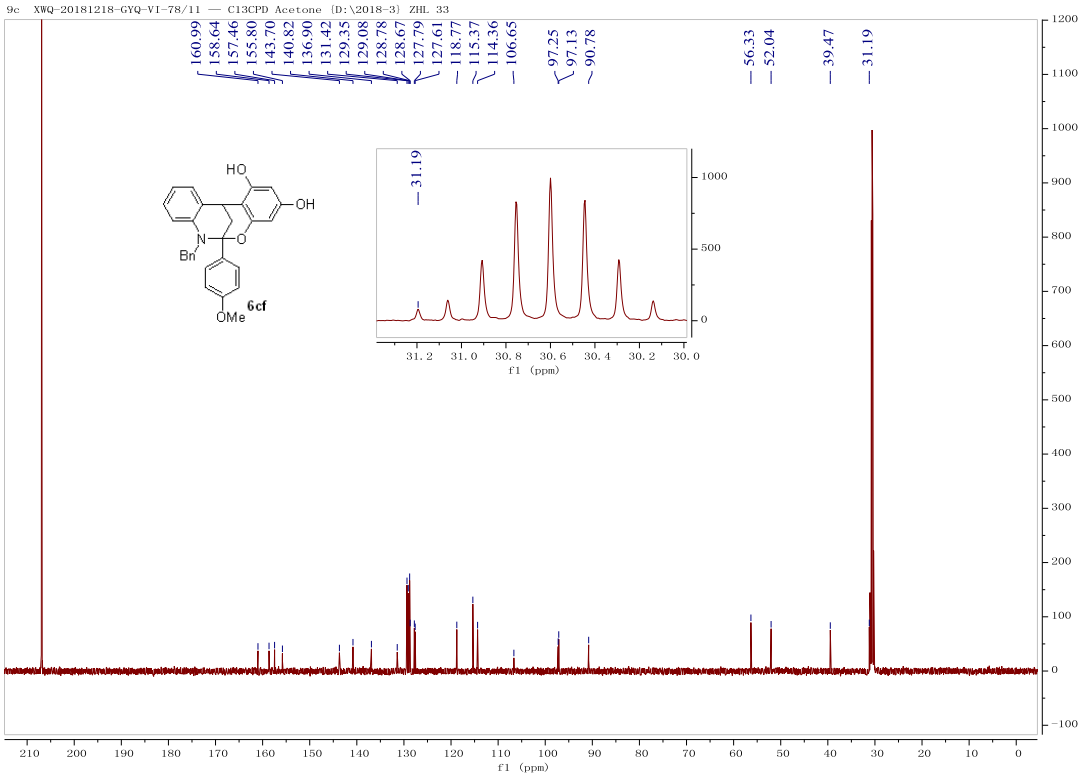

9m XWQ-20181220-GYQ-VI-76/10 — PROTON Acetone {D:\2018-3} ZHL 17
8.55
8.19
7.73
7.72
7.52
7.50
7.50
7.49
7.43
7.43
7.43
7.41
7.41
7.40
7.40
7.40
7.32
7.31
7.06
7.06
7.05
7.05
7.04
7.04
7.03
7.03
7.01
7.00
6.99
6.99
6.80
6.80
6.79
6.78
6.75
6.75
6.16
6.16
6.13
4.57
4.54
4.42
4.39
4.35
4.34
4.34
2.36
2.33
2.33
2.29
2.28
2.26
2.25
HO
Br
OH
N
O
Bn
6cd
0.86
0.87
2.00
2.03
1.03
1.04
5.04
1.00
1.01
0.97
1.01
1.00
1.00
1.00
1.00
1.01
f1 (ppm)

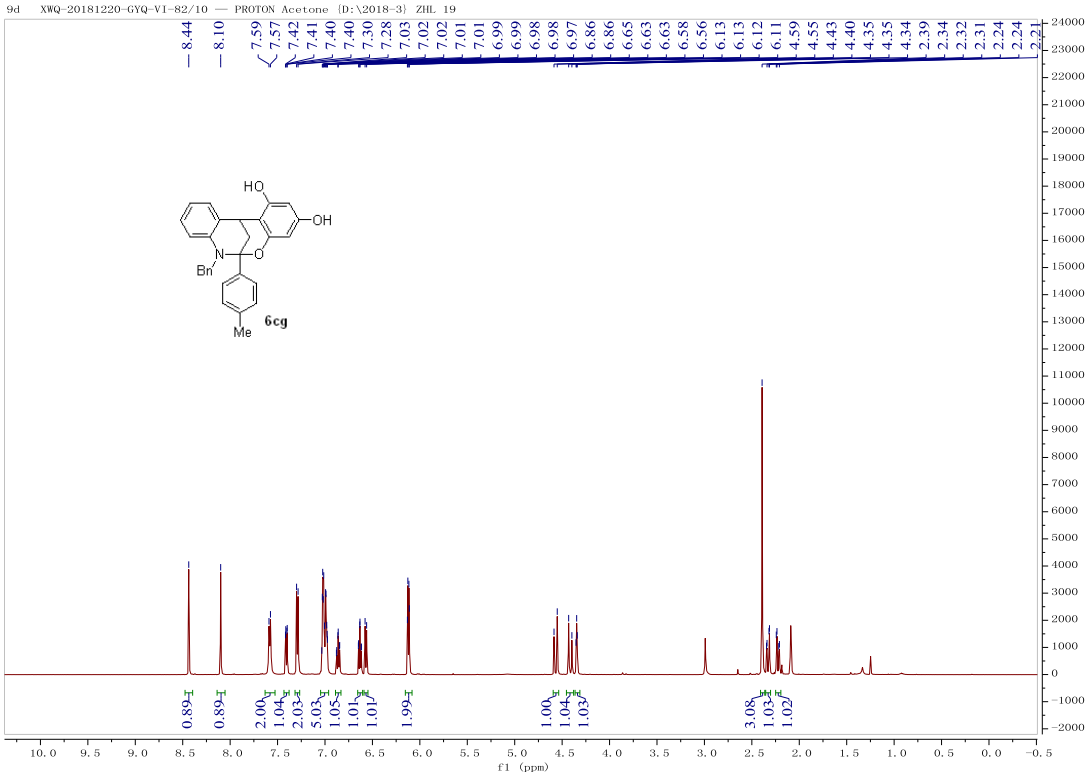

9m XWQ-20181220-GYQ-VI-76/11 — C13CPD Acetone {D:\2018-3} ZHL 17
158.92
157.54
155.47
145.14
144.40
139.84
130.76
130.23
129.92
129.58
129.51
128.86
127.97
127.81
121.39
121.06
117.20
105.90
97.48
97.19
90.65
52.22
39.13
30.72
HO
Br
OH
N
O
Bn
6cd
f1 (ppm)

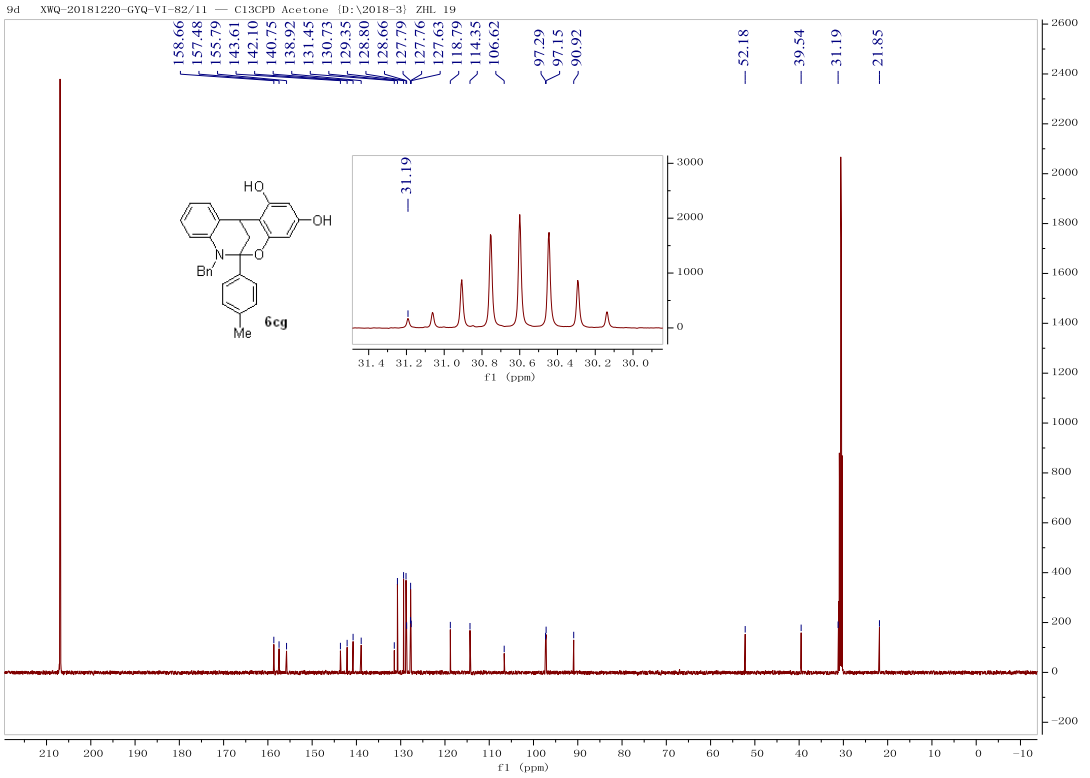

9b XWQ-20181226-GYQ-VI-79/10 — PROTON Acetone {D:\2018-3} ZHL 13
HO
OH
N
O
Bn
OMe
6ce
f1 (ppm)

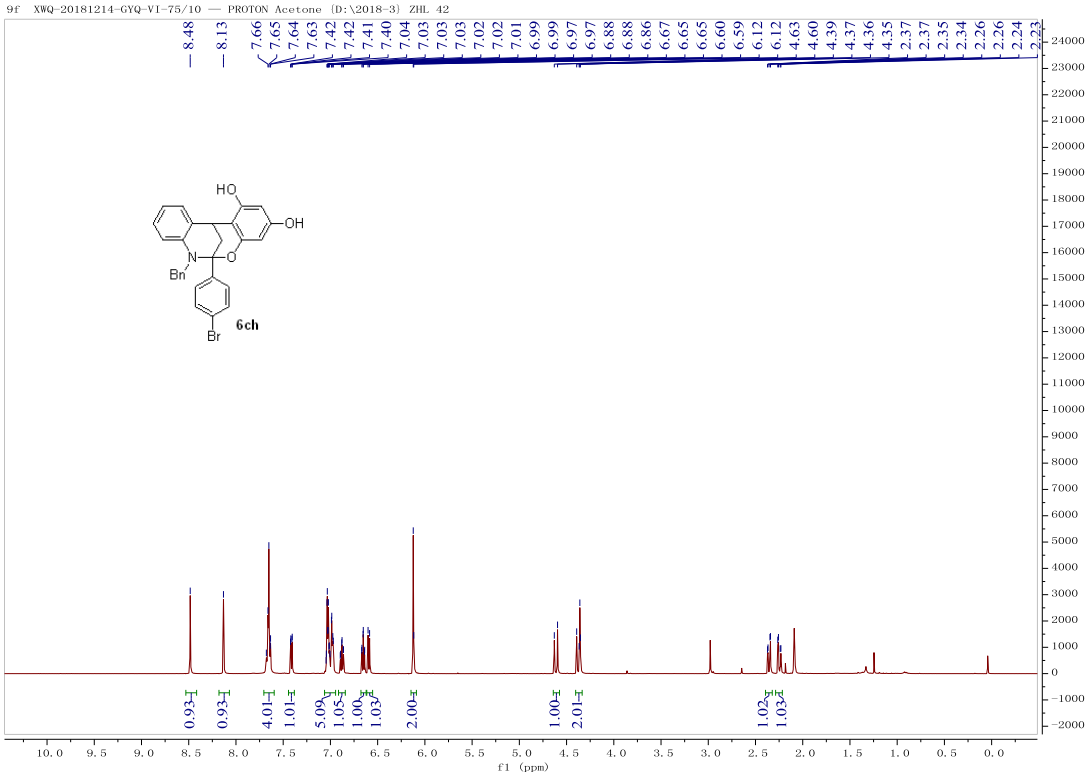

9b XWQ-20181226-GYQ-VI-79/11 — C13CPD Acetone (D:\2018-3) ZHL 13
158.62
157.89
157.58
155.60
143.60
141.30
131.80
131.62
131.04
129.99
129.37
128.78
128.29
127.57
127.53
122.05
118.19
113.72
113.23
106.64
97.31
97.26
89.95
56.90
50.86
34.93
31.45
HO
OH
N
O
Bn
OMe
6ce
f1 (ppm)

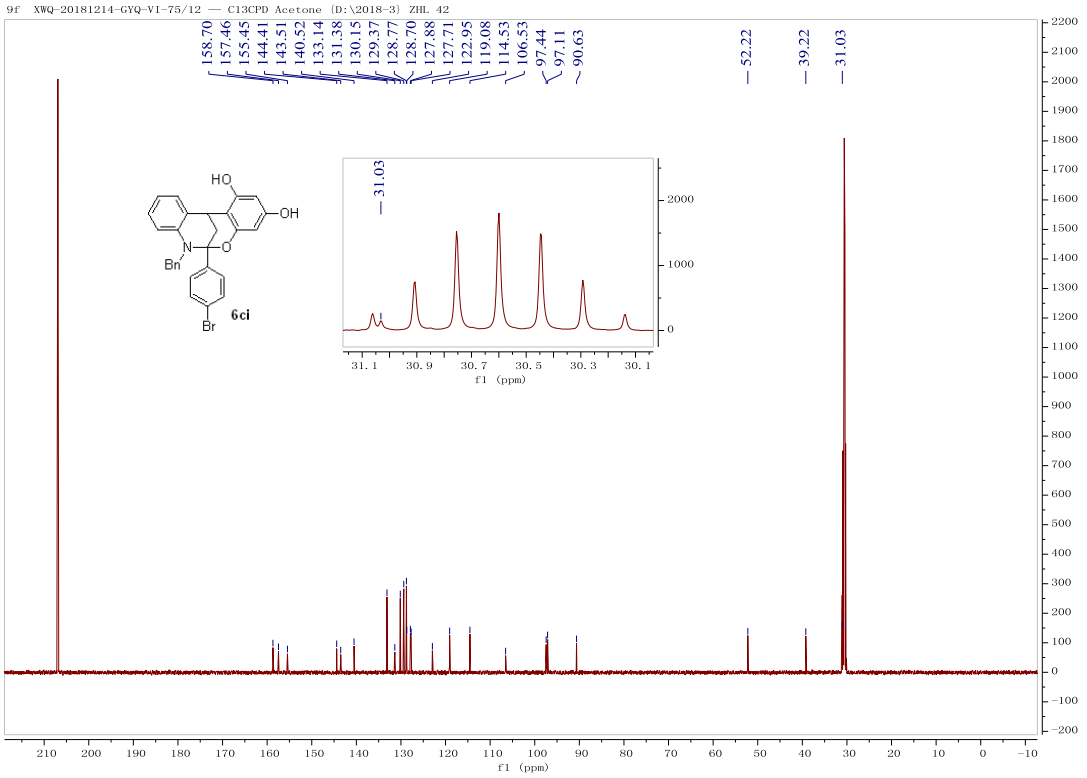

9c XWQ-20181218-GYQ-VI-78/10 — PROTON Acetone (D:\2018-3) ZHL 33
8.44
8.10
7.63
7.61
7.41
7.41
7.40
7.39
7.03
7.03
7.02
7.00
6.99
6.98
6.88
6.87
6.86
6.86
6.85
6.84
6.64
6.63
6.61
6.57
6.56
6.12
6.12
6.11
6.10
4.59
4.56
4.45
4.42
4.35
4.34
4.33
3.86
2.36
2.36
2.34
2.33
2.24
2.23
2.21
2.21
0.83
0.83
2.00
1.01
7.08
1.04
1.00
1.04
1.98
1.00
1.01
1.00
3.03
1.01
1.00
HO
OH
N
O
Bn
OMe
6cf
f1 (ppm)

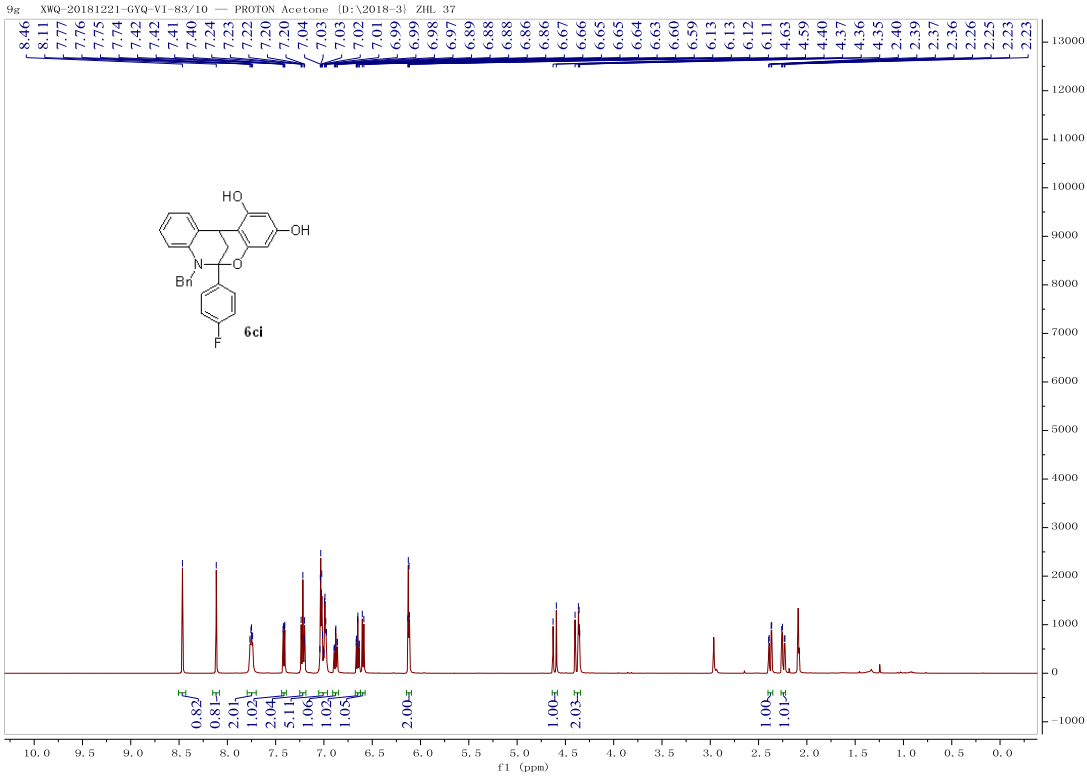

9c XWQ-20181218-GYQ-VI-78/11 — C13CPD Acetone (D:\2018-3) ZHL 33
160.99
158.64
157.46
155.80
143.70
140.82
136.90
131.42
129.35
129.08
128.78
128.67
127.79
127.61
118.77
115.37
114.36
106.65
97.25
97.13
90.78
56.33
52.04
39.47
31.19
HO
OH
N
O
Bn
OMe
6cf
f1 (ppm)

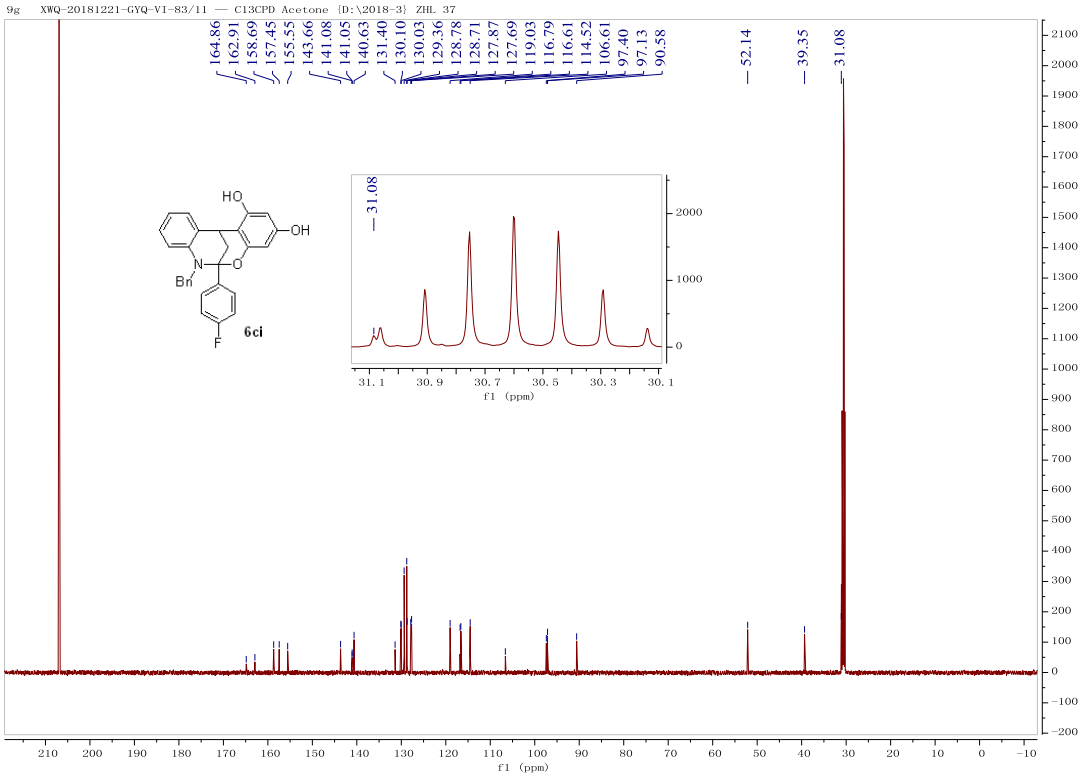

9d XWQ-20181220-GYQ-VI-82/10 — PROTON Acetone (D:\2018-3) ZHL 19
8.44
8.10
7.59
7.57
7.42
7.41
7.40
7.40
7.30
7.28
7.03
7.02
7.02
7.01
7.01
6.99
6.99
6.98
6.98
6.97
6.86
6.86
6.65
6.63
6.63
6.58
6.56
6.13
6.13
6.12
6.11
4.59
4.55
4.43
4.40
4.35
4.34
2.39
2.34
2.32
2.31
2.24
2.24
2.21
0.89
0.89
2.00
1.04
2.03
5.03
1.05
1.01
1.01
1.99
1.00
1.04
1.03
3.08
1.03
1.02
HO
OH
N
O
Bn
Me
6cg
f1 (ppm)

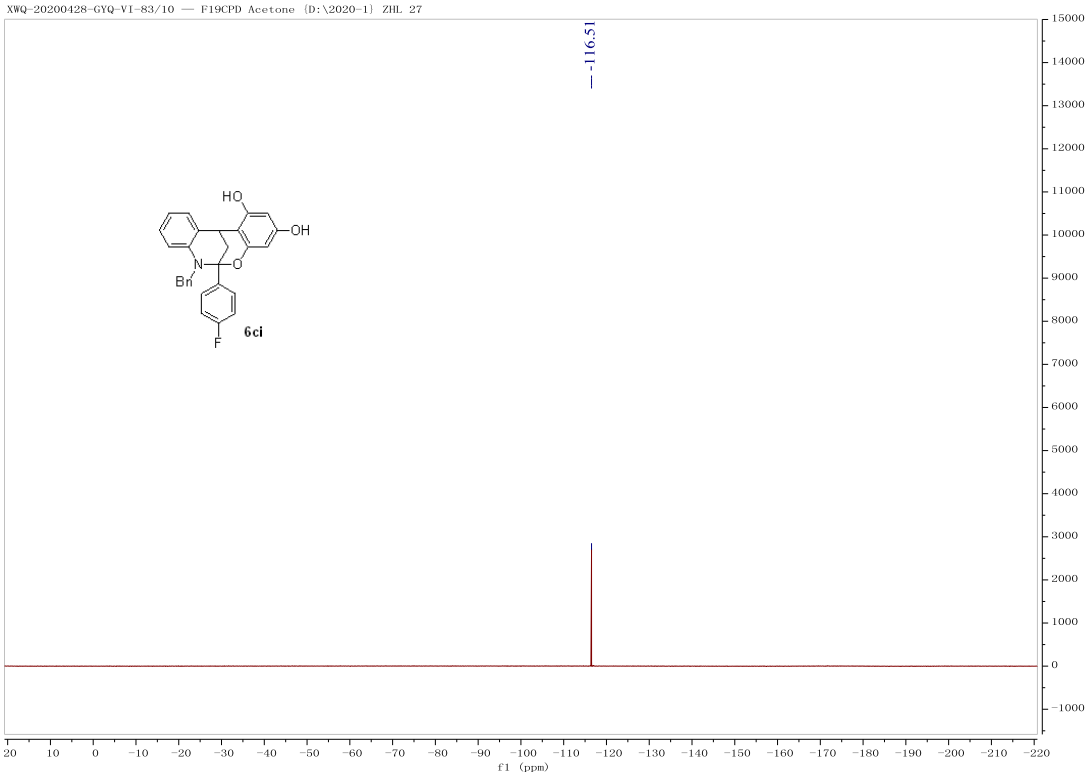

9d XWQ-20181220-GYQ-VI-82/11 — C13CPD Acetone (D:\2018-3) ZHL 19
158.66
157.48
155.79
143.61
142.10
140.75
138.92
131.45
130.73
129.35
128.80
128.66
127.79
127.76
127.63
118.79
114.35
106.62
97.29
97.15
90.92
52.18
39.54
31.19
21.85
HO
OH
N
Bn
O
Me
6cg
f1 (ppm)

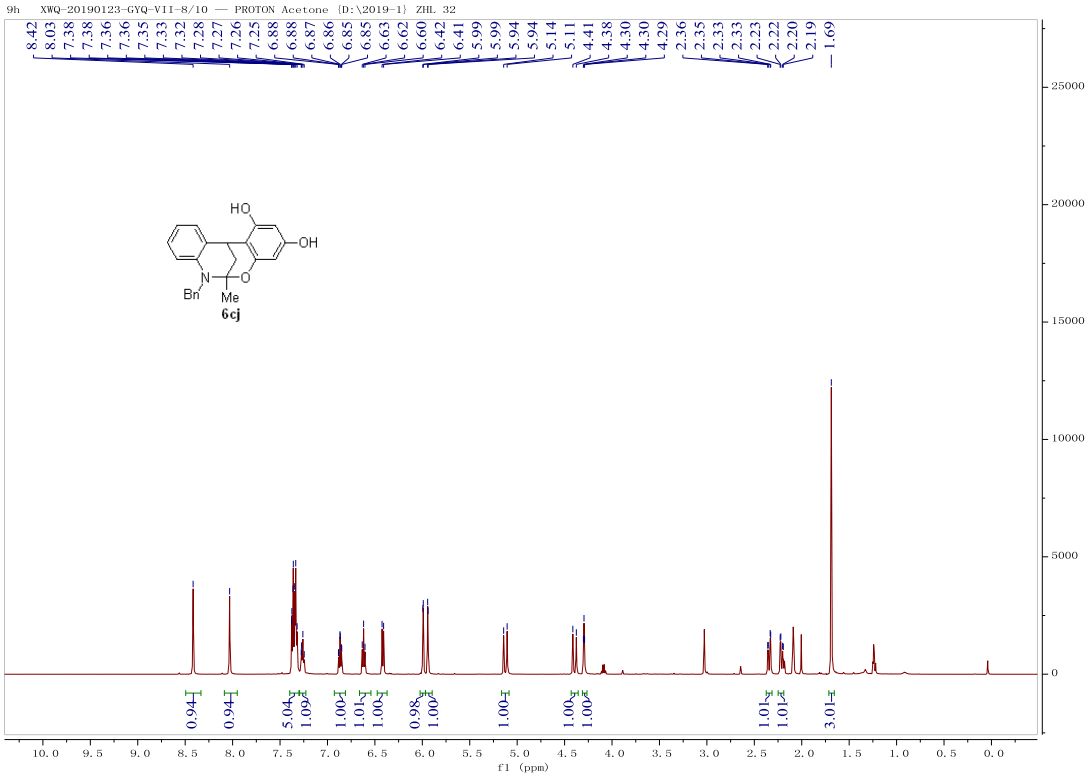

9f XWQ-20181214-GYQ-VI-75/10 — PROTON Acetone (D:\2018-3) ZHL 42
8.48
8.13
7.66
7.65
7.64
7.63
7.42
7.42
7.41
7.40
7.04
7.03
7.03
7.03
7.02
7.02
7.01
6.99
6.99
6.97
6.97
6.88
6.88
6.86
6.67
6.65
6.65
6.60
6.59
6.12
4.63
4.60
4.39
4.37
4.36
4.35
2.37
2.37
2.35
2.34
2.26
2.26
2.24
2.23
HO
OH
N
Bn
O
Br
6ch
0.93
0.93
4.01
1.01
5.09
1.05
1.00
1.03
2.00
1.00
2.01
1.02
1.03
f1 (ppm)

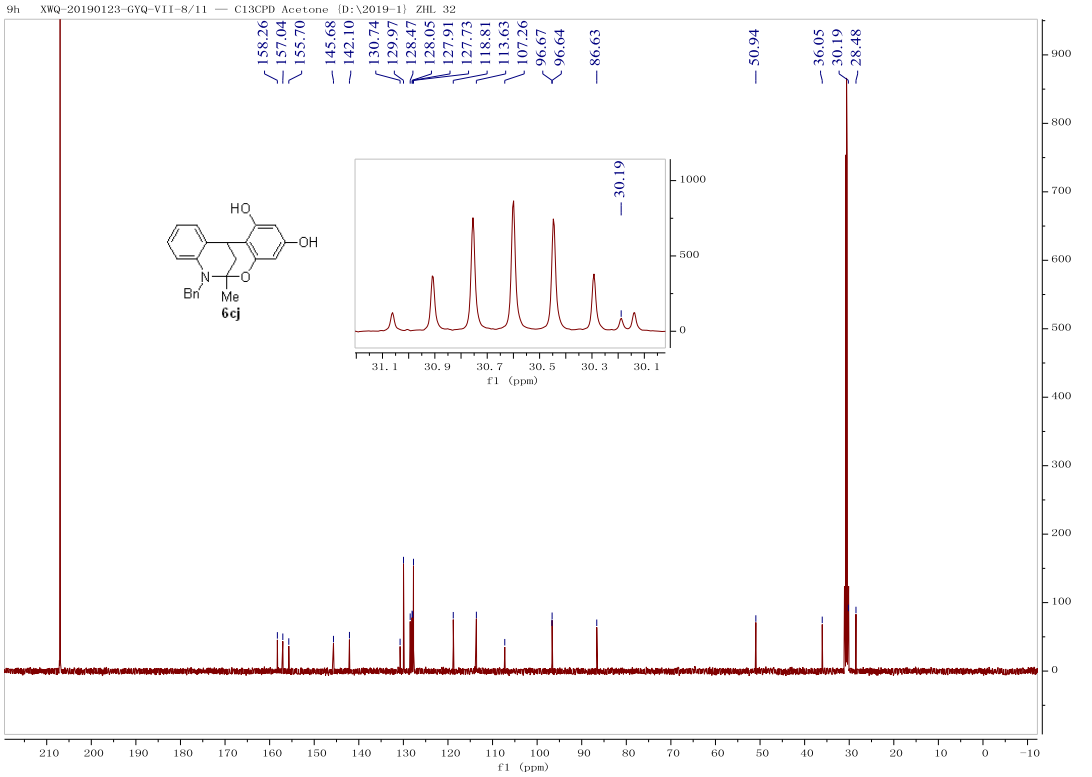

9f XWQ-20181214-GYQ-VI-75/12 — C13CPD Acetone (D:\2018-3) ZHL 42
158.70
157.46
155.45
144.41
143.51
140.52
133.14
131.38
130.15
129.37
128.77
128.70
127.88
127.71
122.95
119.08
114.53
106.53
97.44
97.11
90.63
52.22
39.22
31.03
HO
OH
N
O
Bn
Br
6ci
f1 (ppm)

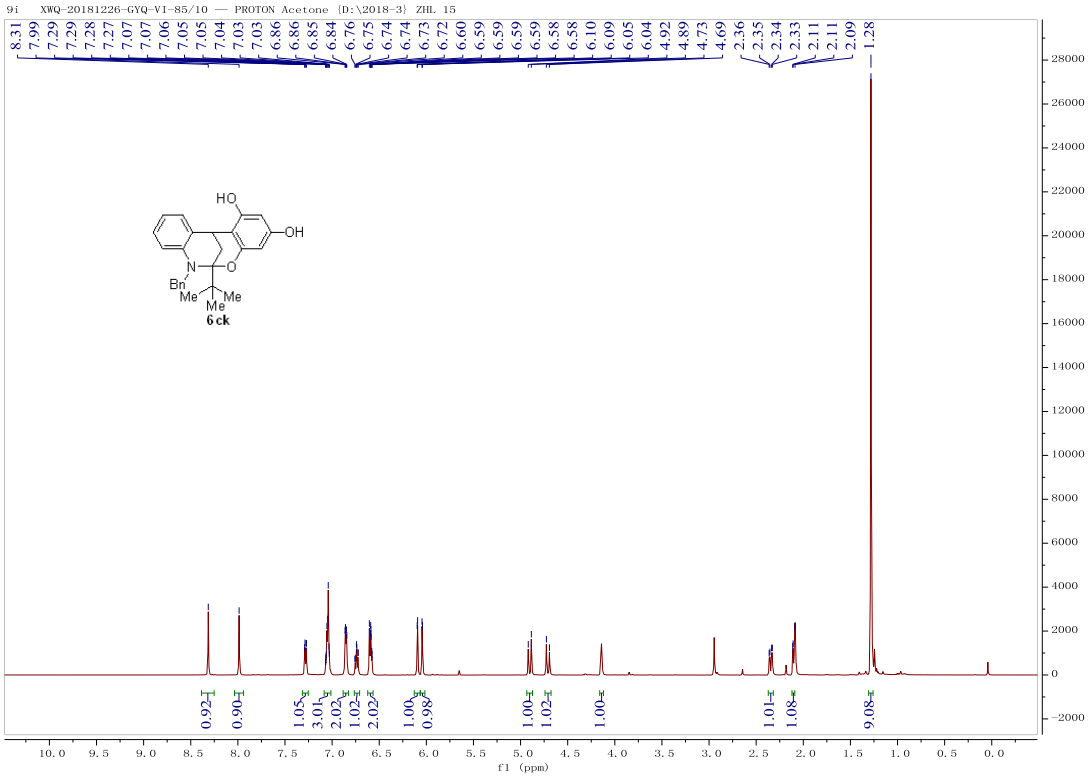

9g XWQ-20181221-GYQ-VI-83/10 — PROTON Acetone (D:\2018-3) ZHL 37
8.46
8.11
7.77
7.76
7.75
7.74
7.42
7.42
7.41
7.40
7.24
7.23
7.22
7.20
7.20
7.04
7.03
7.03
7.02
7.01
6.99
6.99
6.98
6.97
6.89
6.88
6.88
6.86
6.86
6.67
6.66
6.65
6.65
6.64
6.63
6.60
6.59
6.13
6.13
6.12
6.11
4.63
4.59
4.40
4.37
4.36
4.35
2.40
2.39
2.37
2.36
2.26
2.25
2.23
2.23
HO
OH
N
O
Bn
F
6ci
0.82
0.81
2.01
1.02
2.04
5.11
1.06
1.02
1.05
2.00
1.00
2.03
1.00
1.01
f1 (ppm)

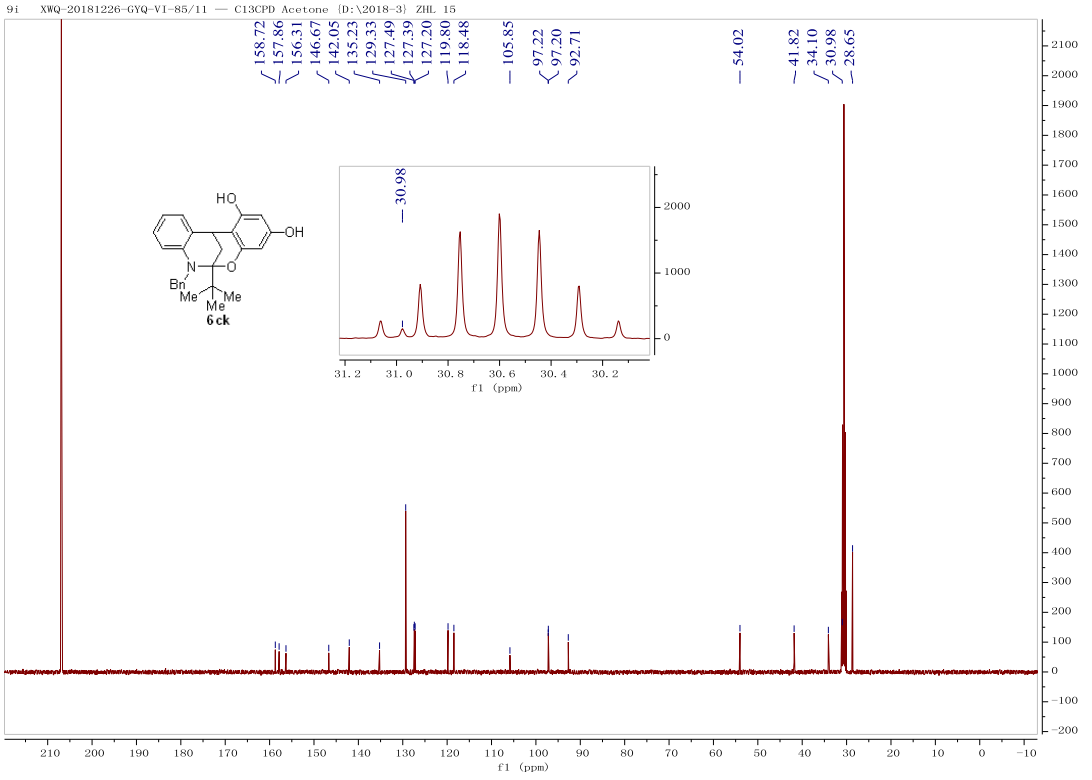

9g XWQ-20181221-GYQ-VI-83/11 — C13CPD Acetone (D:\2018-3) ZHL 37
164.86
162.91
158.69
157.45
155.55
143.66
141.08
141.05
140.63
131.40
130.10
130.03
129.36
128.78
128.71
127.87
127.69
119.03
116.79
116.61
114.52
106.61
97.40
97.13
90.58
52.14
39.35
31.08
HO
OH
N
O
Bn
F
6ci
f1 (ppm)

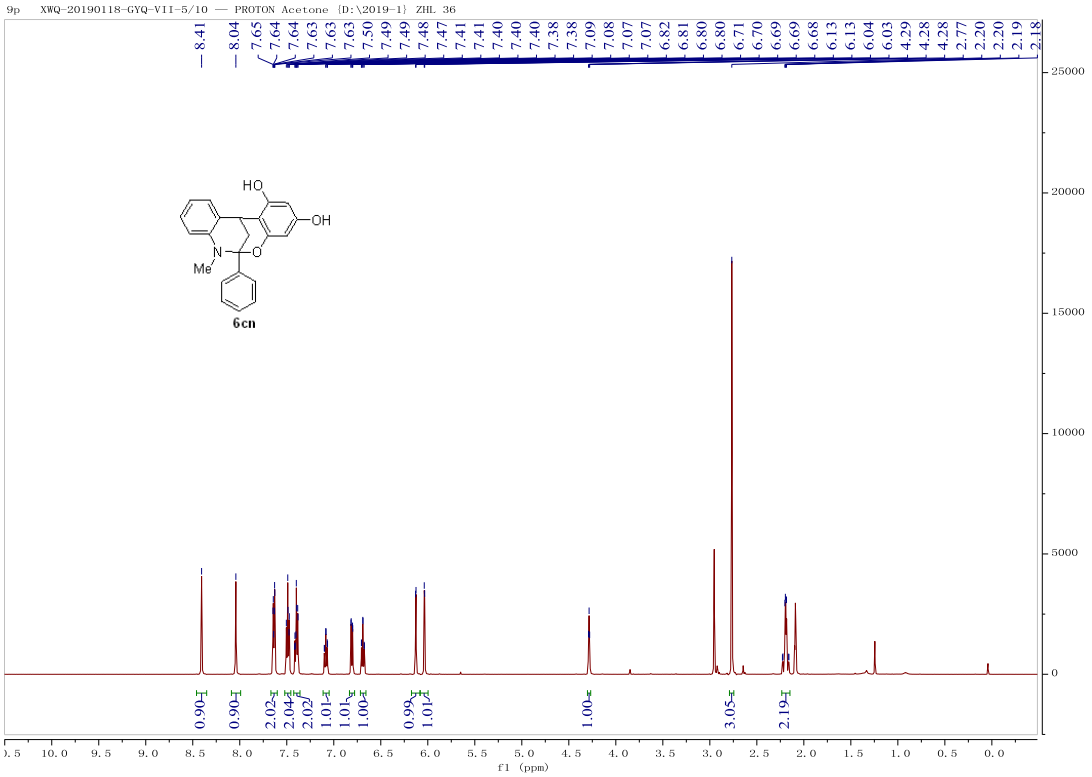

XWQ-20200428-GYQ-VI-83/10 — F19CPD Acetone (D:\2020-1) ZHL 27
-116.51
HO
OH
N
O
Bn
F
6ci
f1 (ppm)

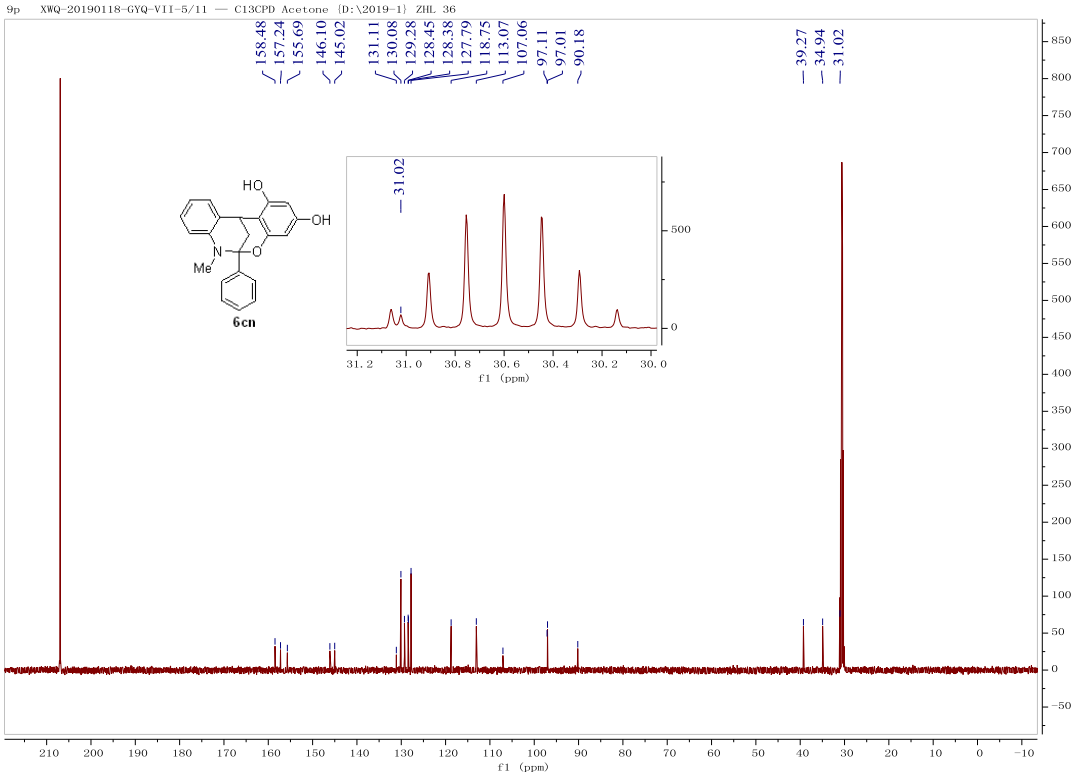

9h XWQ-20190123-GYQ-VII-8/10 — PROTON Acetone (D:\2019-1) ZHL 32
8.42 8.03 7.38 7.38 7.36 7.36 7.35 7.33 7.32 7.28 7.27 7.26 7.25 6.88 6.88 6.87 6.86 6.85 6.85 6.63 6.62 6.60 6.42 6.41 5.99 5.99 5.94 5.94 5.14 5.11 4.41 4.38 4.30 4.30 4.29 2.36 2.35 2.33 2.33 2.23 2.22 2.20 2.19 1.69
HO
OH
N
O
Bn
Me
6cj
0.94 0.94 5.04 1.09 1.00 1.01 1.00 0.98 1.00 1.00 1.00 1.00 1.01 1.01 3.01
f1 (ppm)

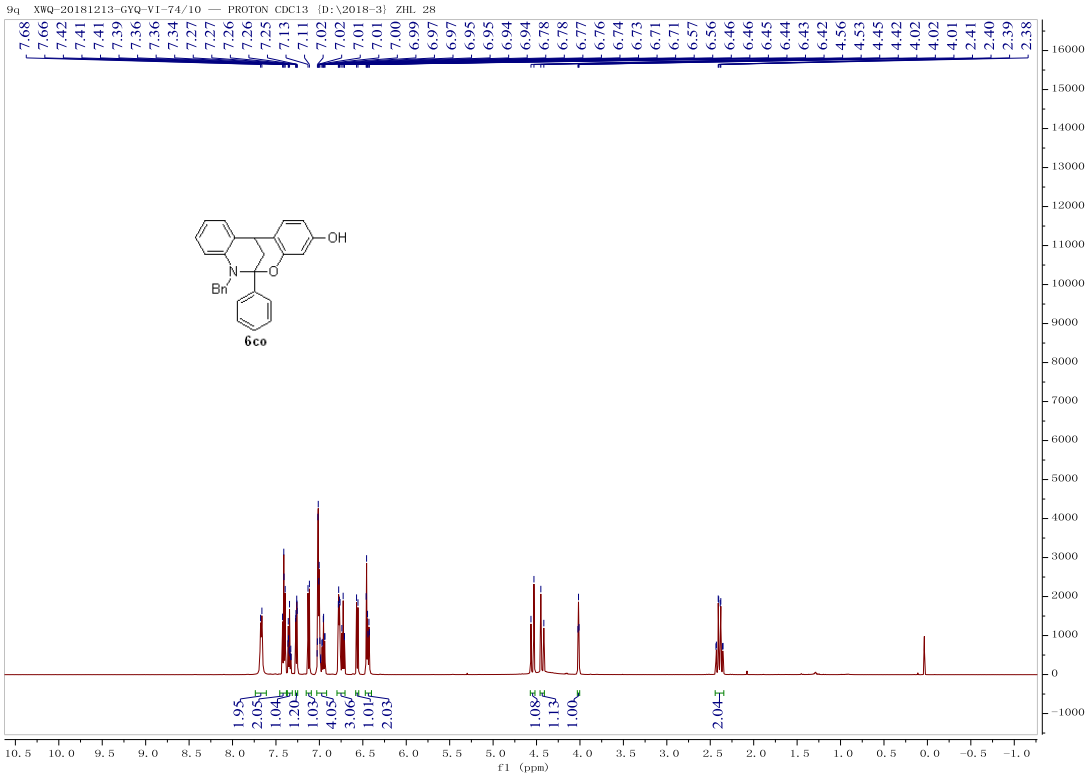

9h XWQ-20190123-GYQ-VII-8/11 — C13CPD Acetone (D:\2019-1) ZHL 32
158.26 157.04 155.70 145.68 142.10 130.74 129.97 128.47 128.05 127.91 127.73 118.81 113.63 107.26 96.67 96.64 86.63 50.94 36.05 30.19 28.48
30.19
HO
OH
N
O
Bn
Me
6cj
f1 (ppm)

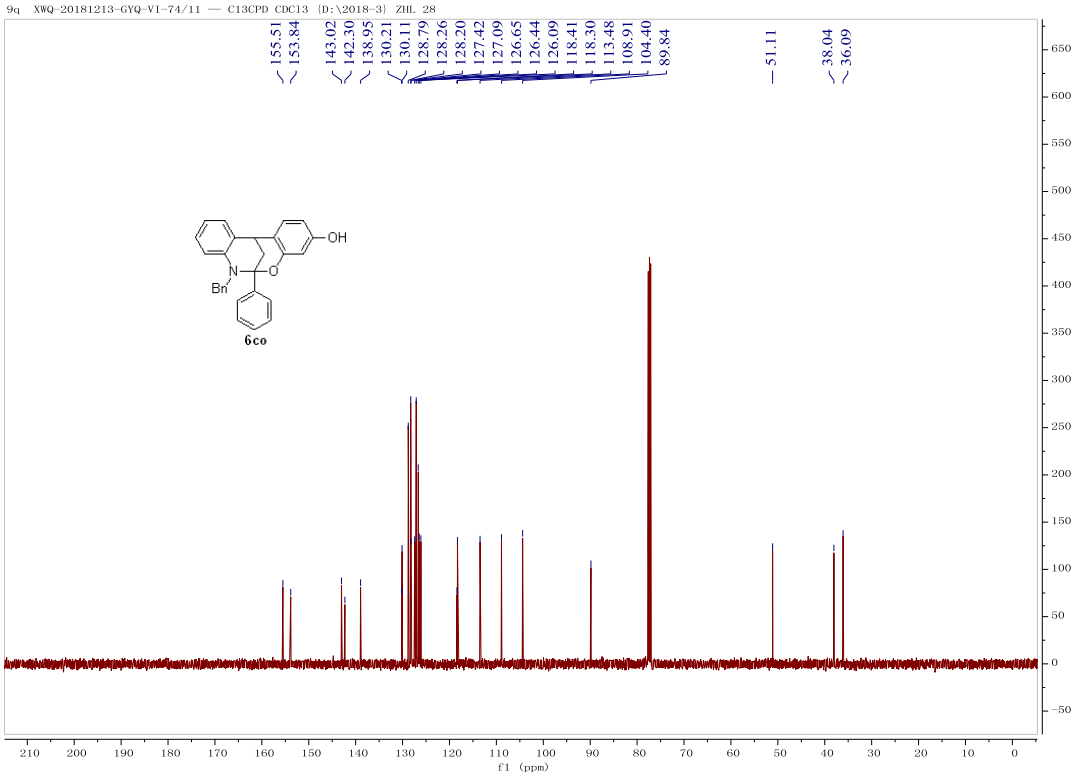

9i XWQ-20181226-GYQ-VI-85/10 — PROTON Acetone (D:\2018-3) ZHL 15
8.31 7.99 7.29 7.29 7.28 7.27 7.07 7.07 7.06 7.05 7.05 7.04 7.03 7.03 6.86 6.86 6.85 6.84 6.76 6.75 6.74 6.74 6.73 6.72 6.60 6.59 6.59 6.59 6.59 6.58 6.10 6.09 6.05 6.04 4.92 4.89 4.73 4.69 2.36 2.35 2.34 2.33 2.11 2.11 2.09 1.28
HO
OH
N
O
Bn
Me
Me
Me
6ck
0.92 0.90 1.05 3.01 2.02 1.02 2.02 1.00 0.98 1.00 1.02 1.00 1.01 1.08 9.08
f1 (ppm)

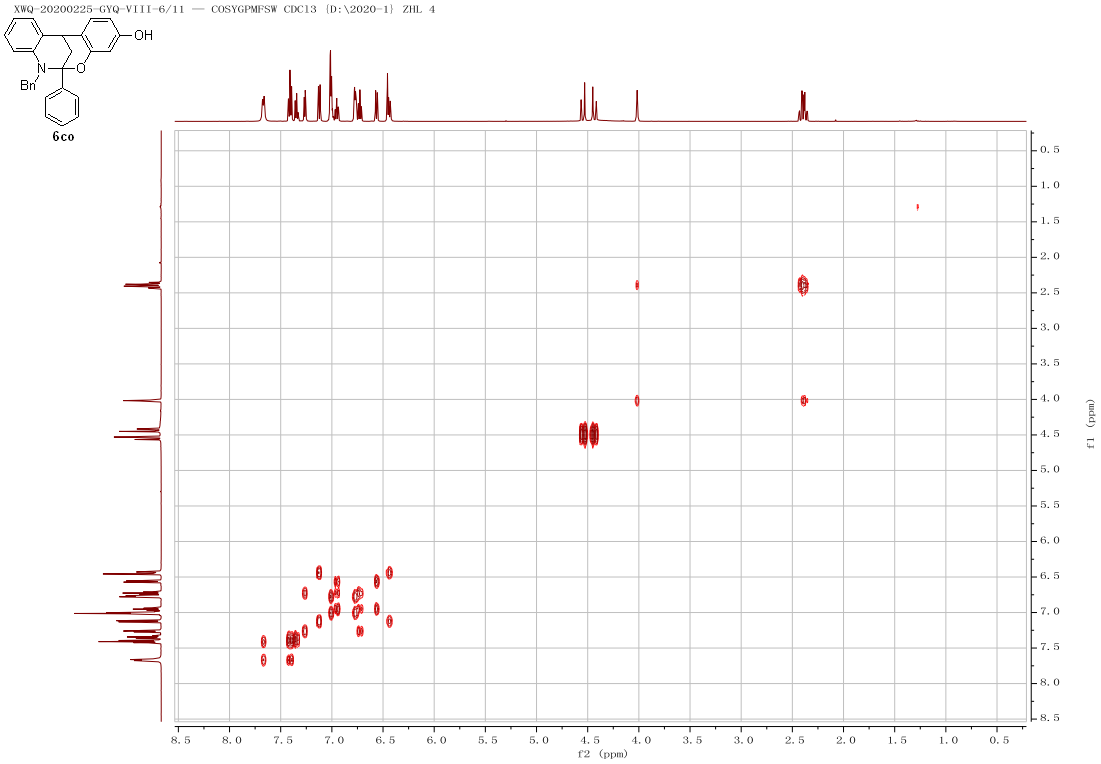

9i XWQ-20181226-GYQ-VI-85/11 — C13CPD Acetone (D:\2018-3) ZHL 15
158.72 157.86 156.31 146.67 142.05 135.23 129.33 127.49 127.39 127.20 119.80 118.48 105.85 97.22 97.20 92.71 54.02 41.82 34.10 30.98 28.65
HO
OH
N
O
Bn
Me
Me
Me
6ck
30.98
f1 (ppm)

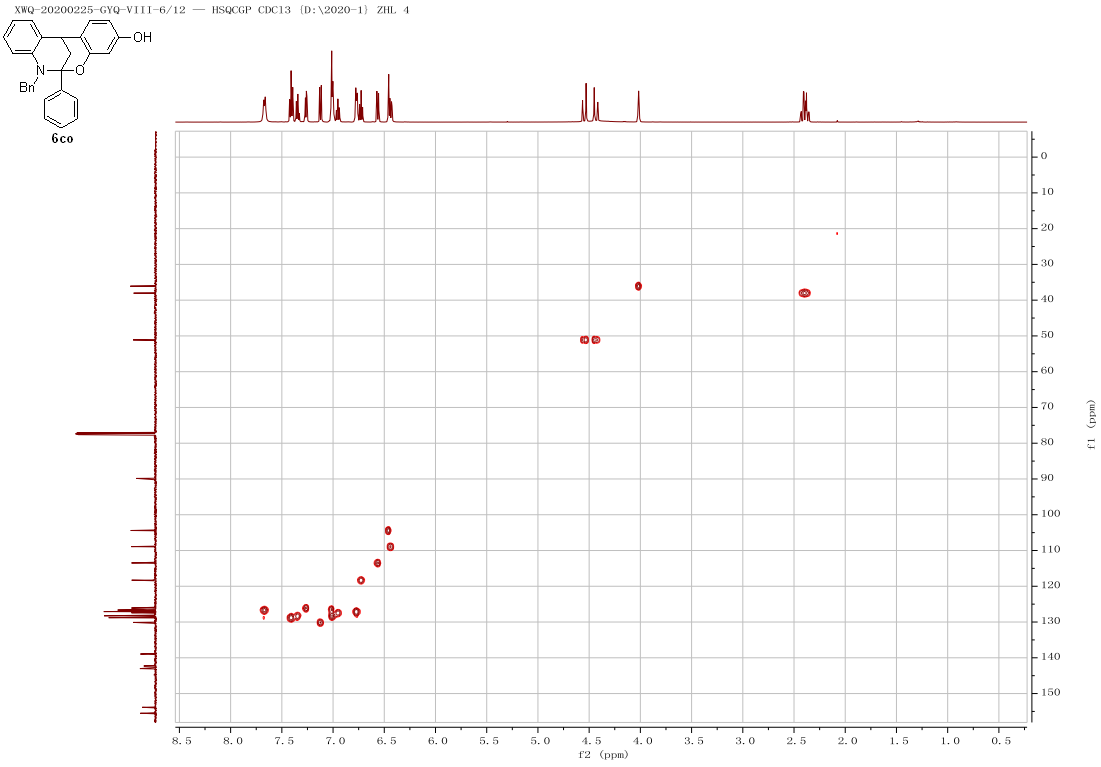

9p XWQ-20190118-GYQ-VII-5/10 — PROTON Acetone {D:\2019-1} ZHL 36
8.41
8.04
7.65
7.64
7.64
7.63
7.63
7.63
7.50
7.49
7.49
7.48
7.47
7.41
7.41
7.40
7.40
7.40
7.40
7.38
7.09
7.08
7.07
7.07
6.82
6.81
6.80
6.80
6.71
6.70
6.69
6.69
6.68
6.13
6.04
6.03
4.29
4.28
4.28
2.77
2.20
2.20
2.19
2.18
HO
OH
N
Me
O
6cn
0.90
0.90
2.02
2.04
2.02
1.01
1.01
1.00
0.99
1.01
1.00
3.05
2.19
f1 (ppm)

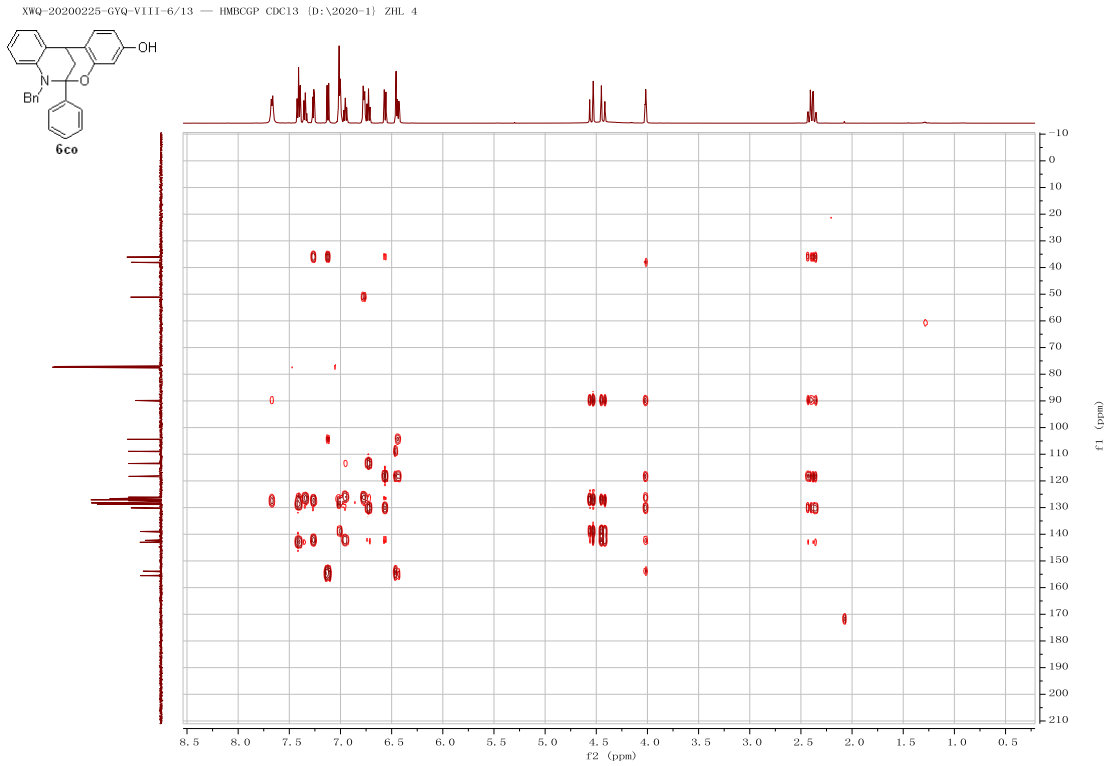

9p XWQ-20190118-GYQ-VII-5/11 — C13CPD Acetone {D:\2019-1} ZHL 36
158.48
157.24
155.69
146.10
145.02
131.11
130.08
129.28
128.45
128.38
127.79
118.75
113.07
107.06
97.11
97.01
90.18
39.27
34.94
31.02
HO
OH
N
Me
O
6cn
31.02
f1 (ppm)

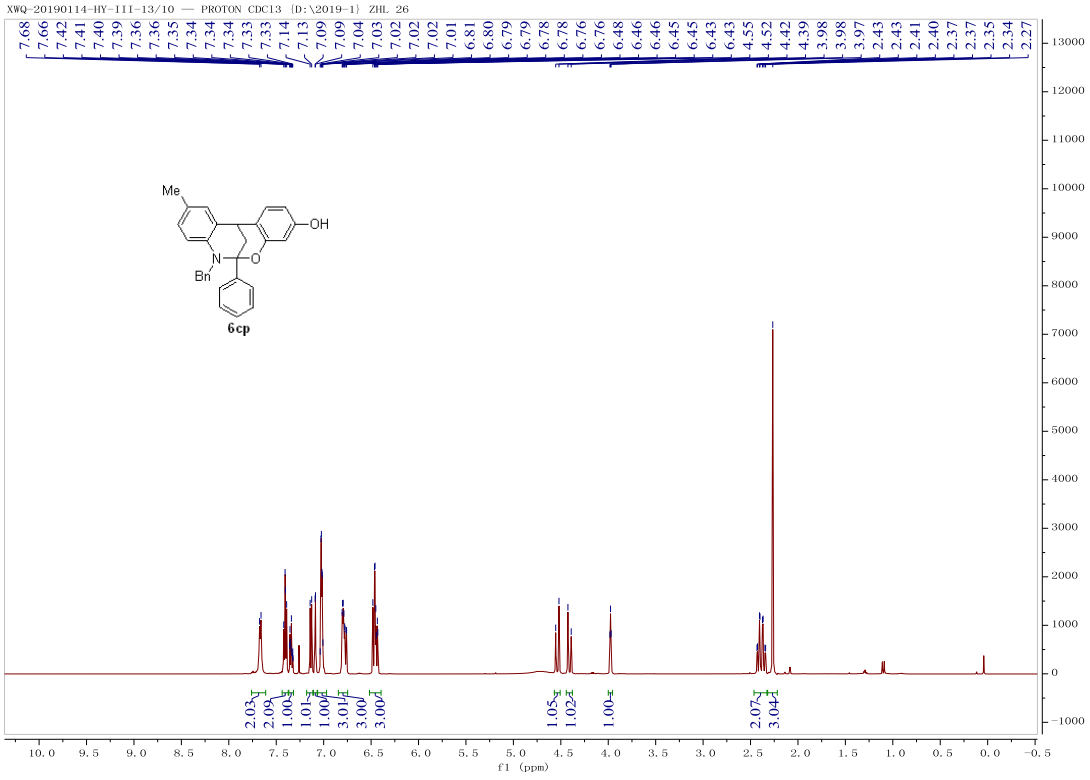

9q XWQ-20181213-GYQ-VI-74/10 — PROTON CDC13 {D:\2018-3} ZHL 28
7.68 7.66 7.42 7.41 7.41 7.39 7.36 7.36 7.34 7.27 7.27 7.26 7.26 7.25 7.13 7.11 7.02 7.02 7.01 7.01 7.00 6.99 6.97 6.97 6.95 6.95 6.94 6.94 6.78 6.78 6.77 6.76 6.74 6.73 6.71 6.71 6.57 6.56 6.46 6.46 6.45 6.44 6.43 6.42 4.56 4.53 4.45 4.42 4.02 4.02 4.01 2.41 2.40 2.39 2.38
OH
N
O
Bn
6co
1.95 2.05 1.04 1.20 1.03 4.05 3.06 1.01 2.03 1.08 1.13 1.00 2.04
f1 (ppm)

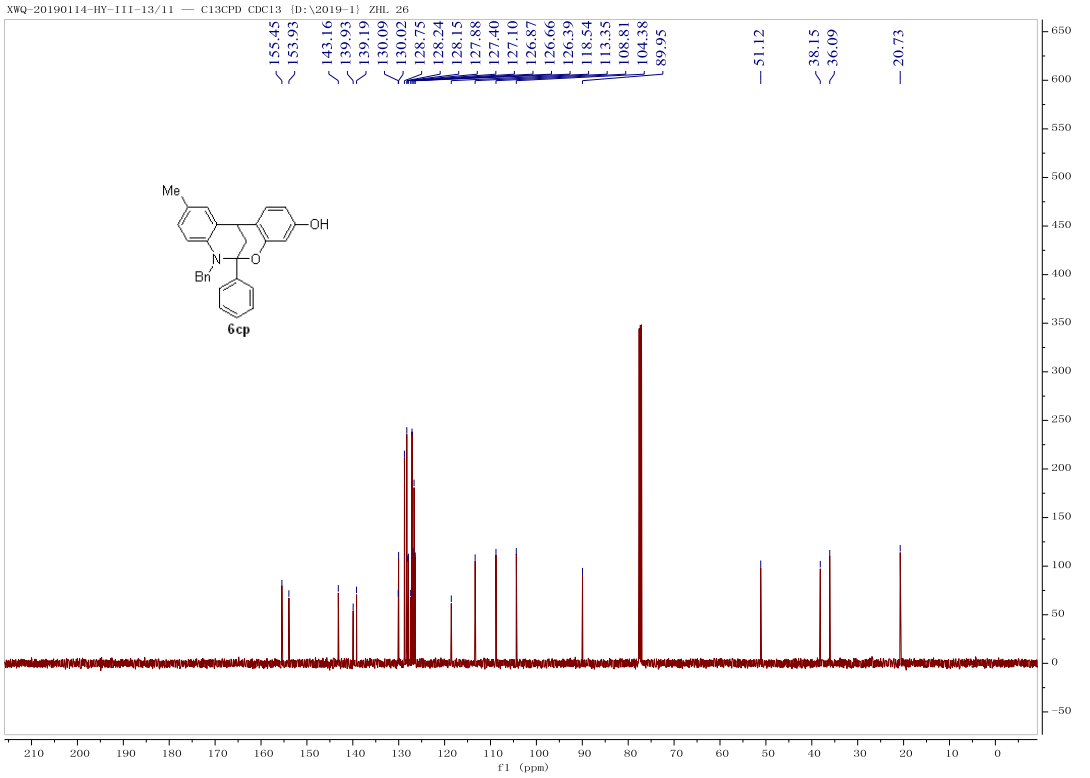

9q XWQ-20181213-GYQ-VI-74/11 — C13CPD CDC13 {D:\2018-3} ZHL 28
155.51 153.84 143.02 142.30 138.95 130.21 130.11 128.79 128.26 128.20 127.42 127.09 126.65 126.44 126.09 118.41 118.30 113.48 108.91 104.40 89.84 51.11 38.04 36.09
OH
N
O
Bn
6co
f1 (ppm)

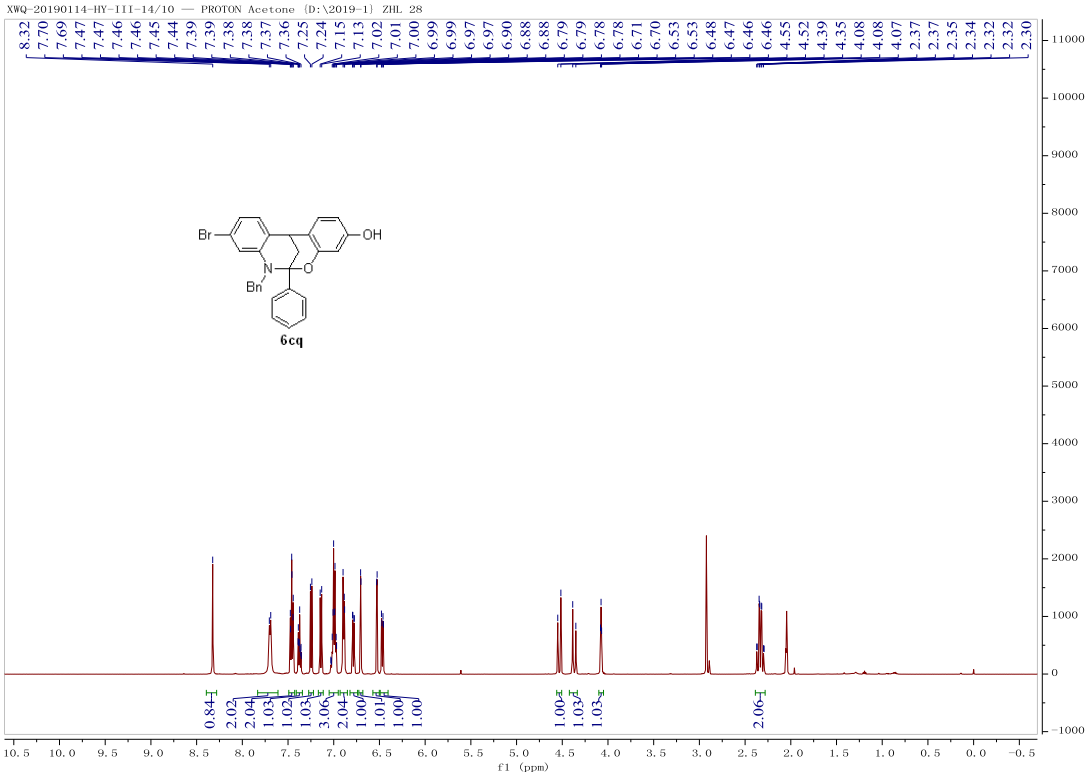

XWQ-20200225-GYQ-VIII-6/11 — COSYGPMFSW CDCl3 (D:\2020-1) ZHL 4
OH
N
O
Bn
6co
f2 (ppm)
f1 (ppm)

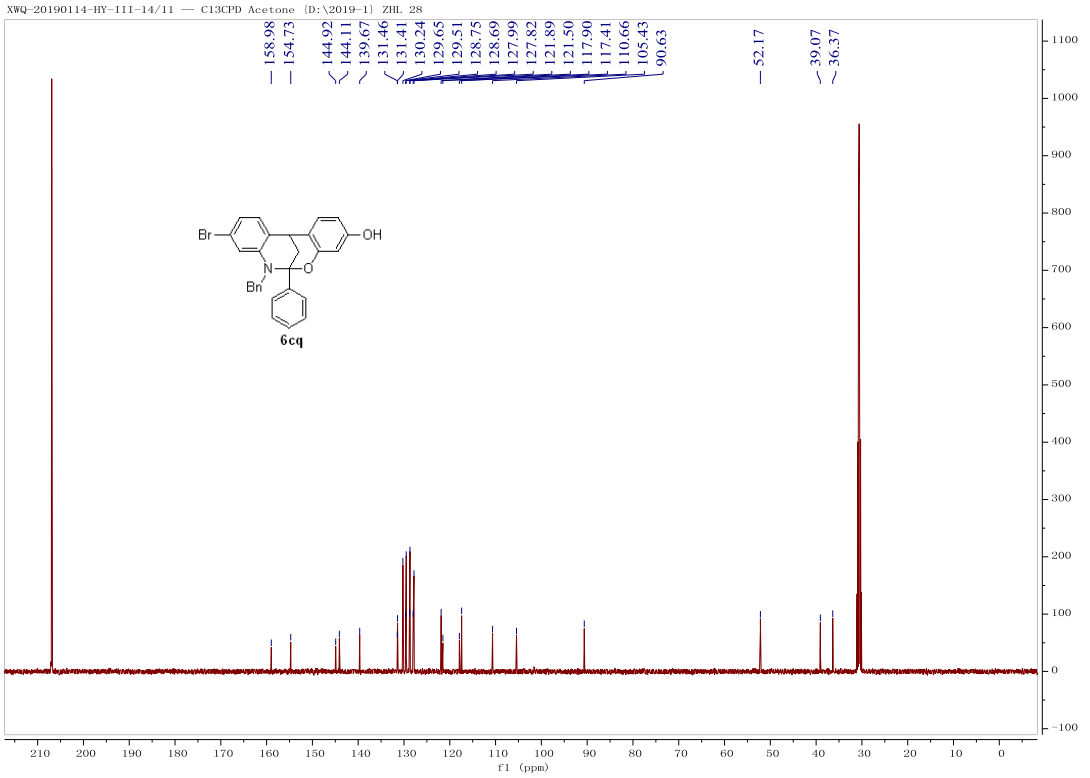

XWQ-20200225-GYQ-VIII-6/12 — HSQCGP CDCl3 (D:\2020-1) ZHL 4
OH
N
O
Bn
6co
f2 (ppm)
f1 (ppm)

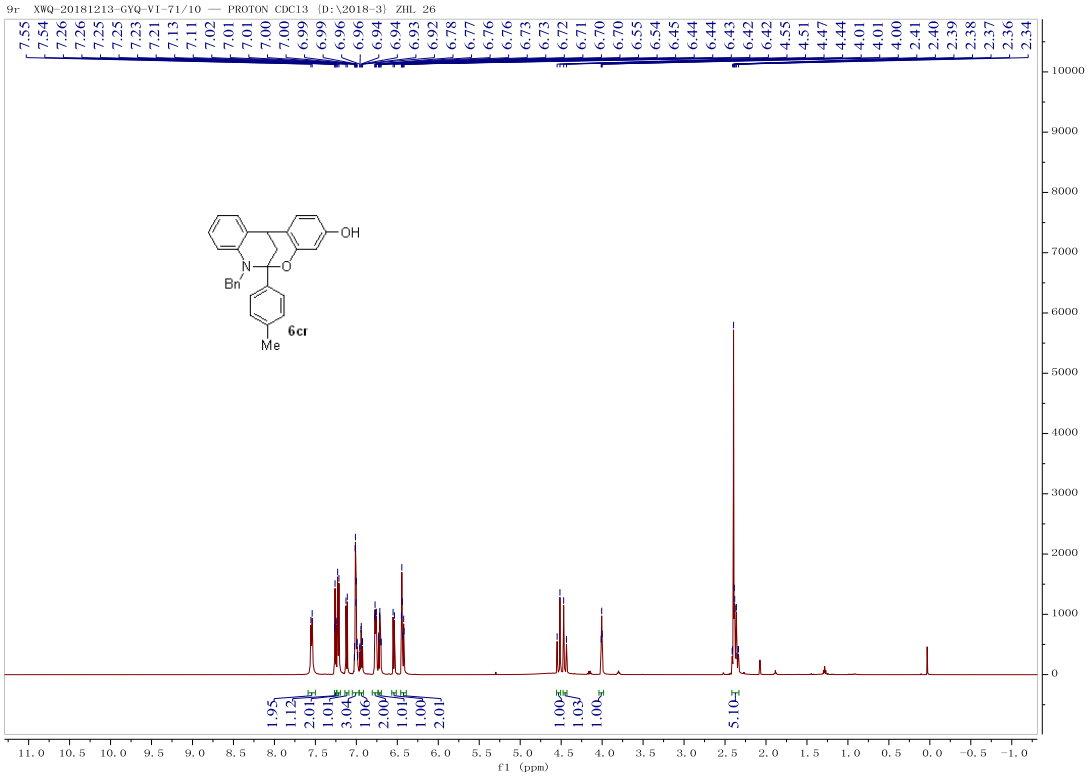

XWQ-20200225-GYQ-VIII-6/13 — HMBCGP CDCl3 (D:\2020-1) ZHL 4
OH
N
O
Bn
6co
f2 (ppm)
f1 (ppm)

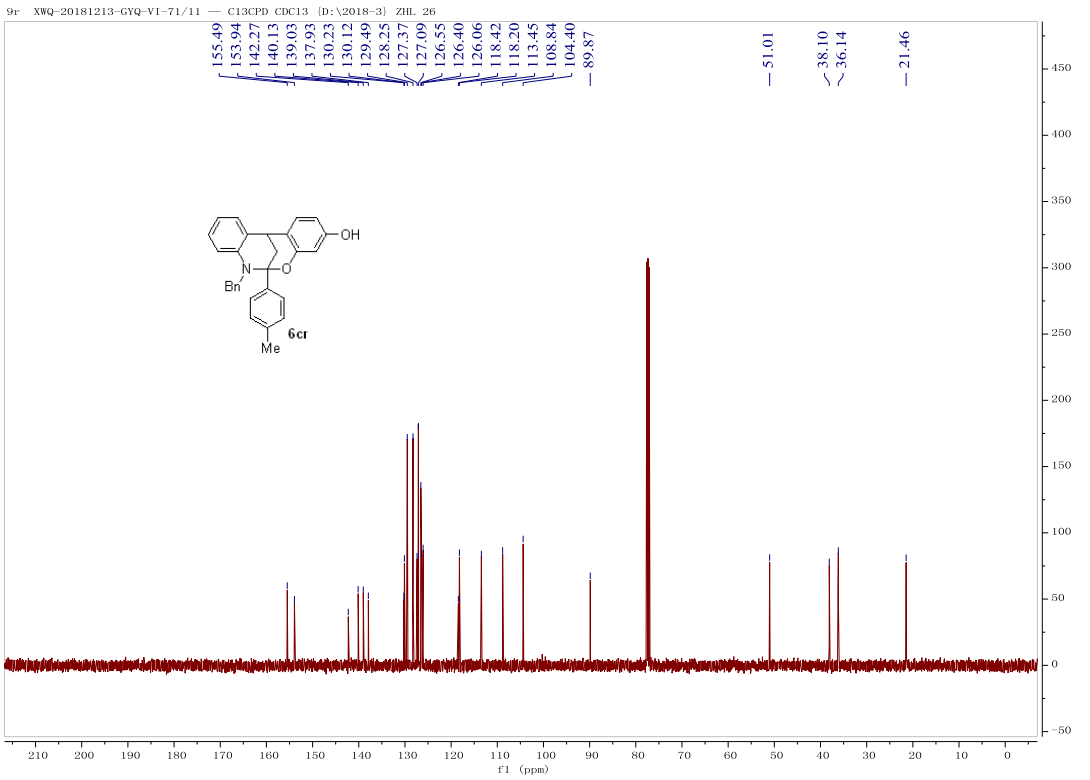

XWQ-20190114-HY-III-13/10 — PROTON CDCl3 (D:\2019-1) ZHL 26
Me
OH
N
O
Bn
6cp
2.03
2.09
1.00
1.01
1.00
3.01
3.00
3.00
1.05
1.02
1.00
2.07
3.04
f1 (ppm)

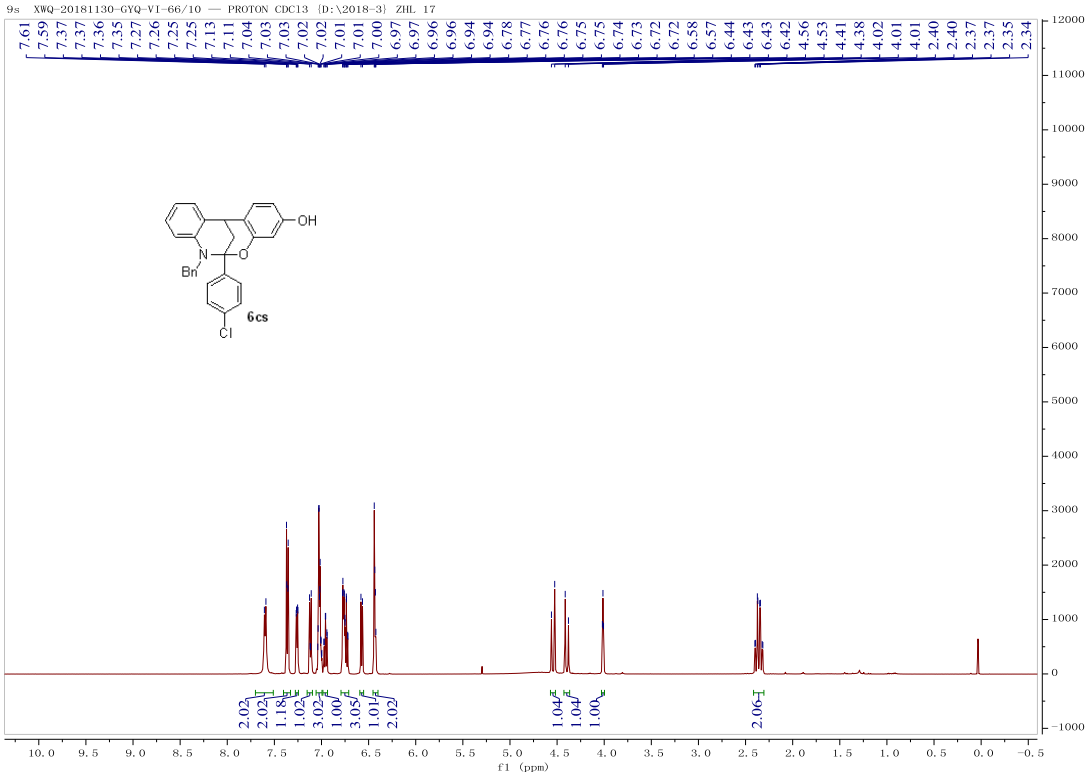

XWQ-20190114-HY-III-13/11 — C13CPD CDC13 (D:\2019-1) ZHL 26
155.45
153.93
143.16
139.93
139.19
130.09
130.02
128.75
128.24
128.15
127.88
127.40
127.10
126.87
126.66
126.39
118.54
113.35
108.81
104.38
89.95
51.12
38.15
36.09
20.73
Me
OH
N
O
Bn
6cp
f1 (ppm)

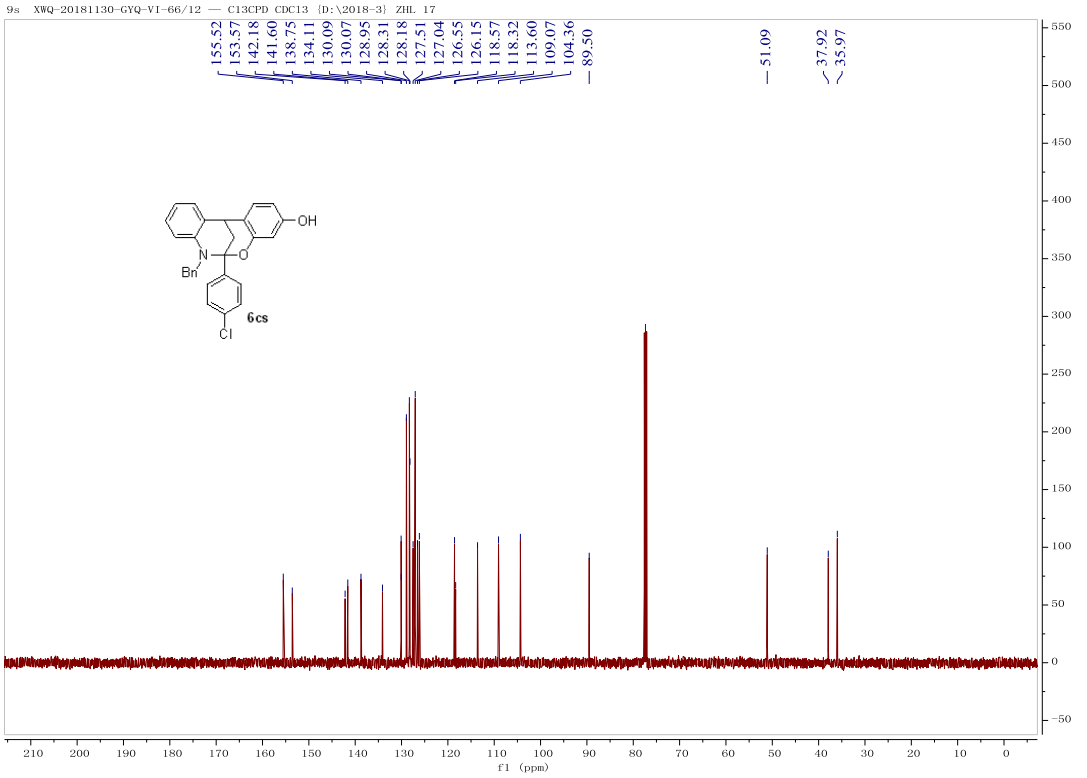

XWQ-20190114-HY-III-14/10 — PROTON Acetone (D:\2019-1) ZHL 28
8.32
7.70
7.69
7.47
7.47
7.46
7.46
7.45
7.44
7.39
7.39
7.38
7.38
7.37
7.36
7.25
7.24
7.15
7.13
7.02
7.01
7.00
6.99
6.99
6.97
6.97
6.90
6.88
6.88
6.79
6.79
6.78
6.78
6.71
6.70
6.53
6.53
6.48
6.47
6.46
6.46
4.55
4.52
4.39
4.35
4.08
4.08
4.07
2.37
2.37
2.35
2.34
2.32
2.32
2.30
Br
OH
N
O
Bn
6cq
0.84
2.02
2.04
1.03
1.02
1.03
3.06
2.04
1.00
1.01
1.00
1.00
1.00
1.03
1.03
2.06
f1 (ppm)

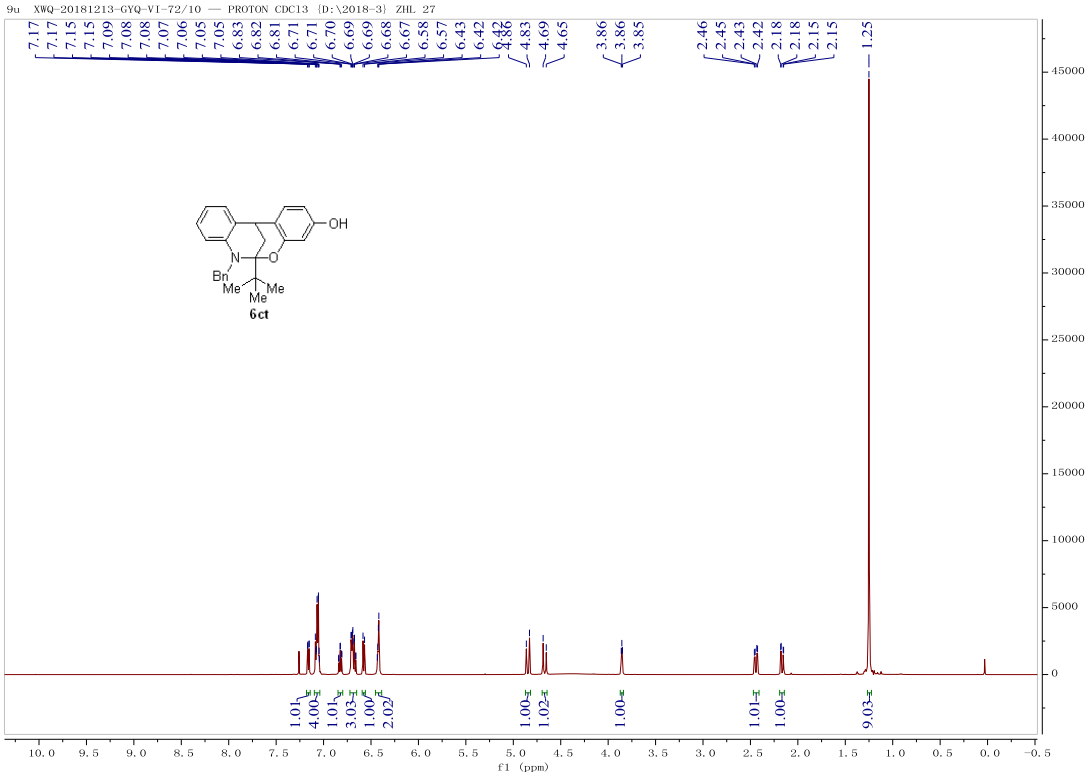

XWQ-20190114-HY-III-14/11 — C13CPD Acetone {D:\2019-1} ZHL 28
158.98
154.73
144.92
144.11
139.67
131.46
131.41
130.24
129.65
129.51
128.75
128.69
127.99
127.82
121.89
121.50
117.90
117.41
110.66
105.43
90.63
52.17
39.07
36.37
Br
OH
N
O
Bn
6cq
f1 (ppm)

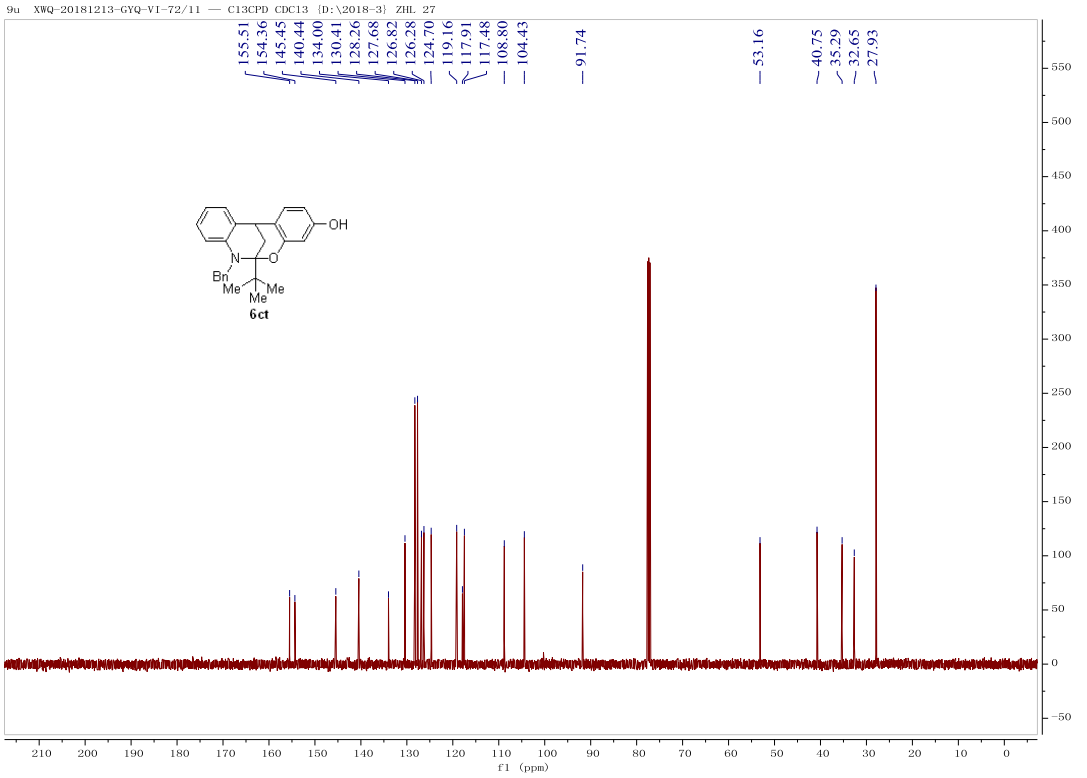

9r XWQ-20181213-GYQ-VI-71/10 — PROTON CDCl3 {D:\2018-3} ZHL 26
7.55
7.54
7.26
7.26
7.25
7.25
7.25
7.23
7.21
7.13
7.11
7.02
7.01
7.01
7.00
7.00
7.00
6.99
6.99
6.96
6.96
6.94
6.94
6.93
6.92
6.78
6.77
6.76
6.76
6.76
6.73
6.73
6.72
6.71
6.70
6.70
6.55
6.54
6.45
6.44
6.44
6.43
6.42
6.42
4.55
4.51
4.47
4.44
4.01
4.01
4.00
2.41
2.40
2.39
2.38
2.37
2.36
2.34
OH
N
O
Bn
Me
6cr
1.95
1.12
2.01
1.01
3.04
1.06
2.00
1.01
1.00
2.01
1.00
1.03
1.00
5.10
f1 (ppm)

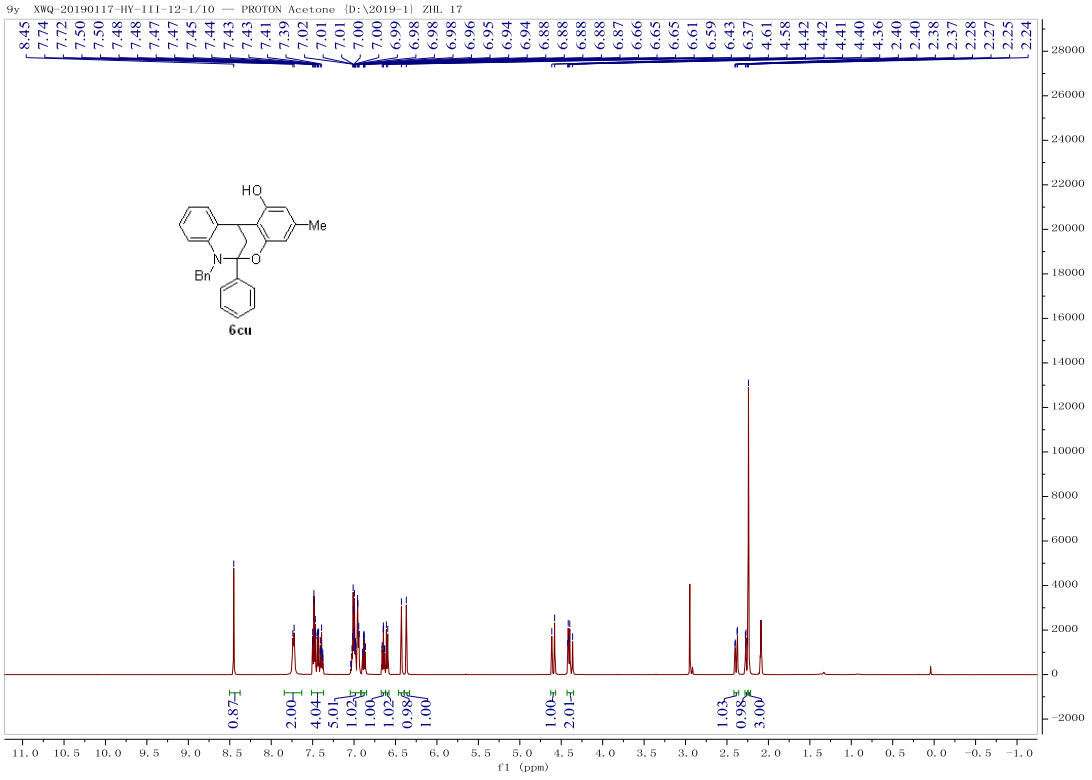

9r XWQ-20181213-GYQ-VI-71/11 — C13CPD CDC13 {D:\2018-3} ZHL 26
155.49
153.94
142.27
140.13
139.03
137.93
130.23
130.12
129.49
128.25
127.37
127.09
126.55
126.40
126.06
118.42
118.20
113.45
108.84
104.40
89.87
51.01
38.10
36.14
21.46
OH
N
O
Bn
Me
6cr
f1 (ppm)

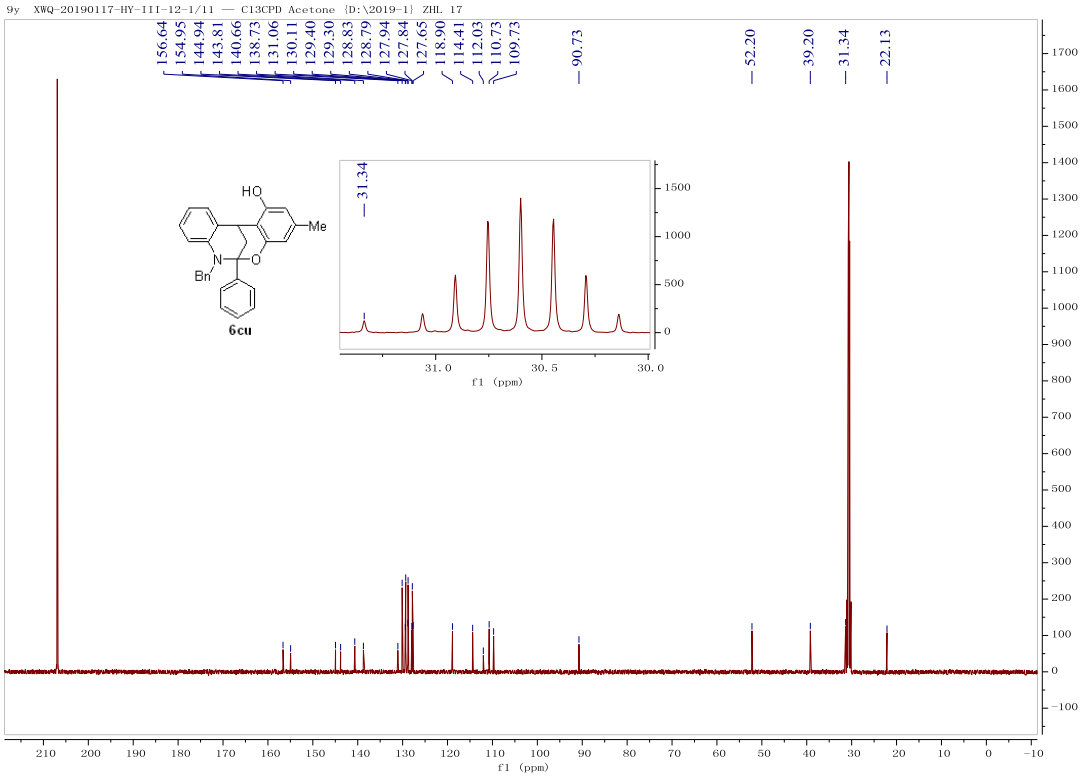

9s XWQ-20181130-GYQ-VI-66/10 — PROTON CDC13 {D:\2018-3} ZHL 17
7.61
7.59
7.37
7.37
7.36
7.35
7.27
7.26
7.25
7.25
7.13
7.11
7.04
7.03
7.03
7.02
7.02
7.01
7.01
7.00
6.97
6.97
6.96
6.96
6.94
6.94
6.78
6.77
6.76
6.76
6.76
6.75
6.75
6.74
6.73
6.72
6.72
6.58
6.57
6.44
6.43
6.43
6.42
4.56
4.53
4.41
4.38
4.02
4.01
4.01
2.40
2.40
2.37
2.37
2.35
2.34
2.02
2.02
1.18
1.02
3.02
1.00
3.05
1.01
2.02
1.04
1.04
1.00
2.06
OH
N
O
Bn
Cl
6cs
f1 (ppm)

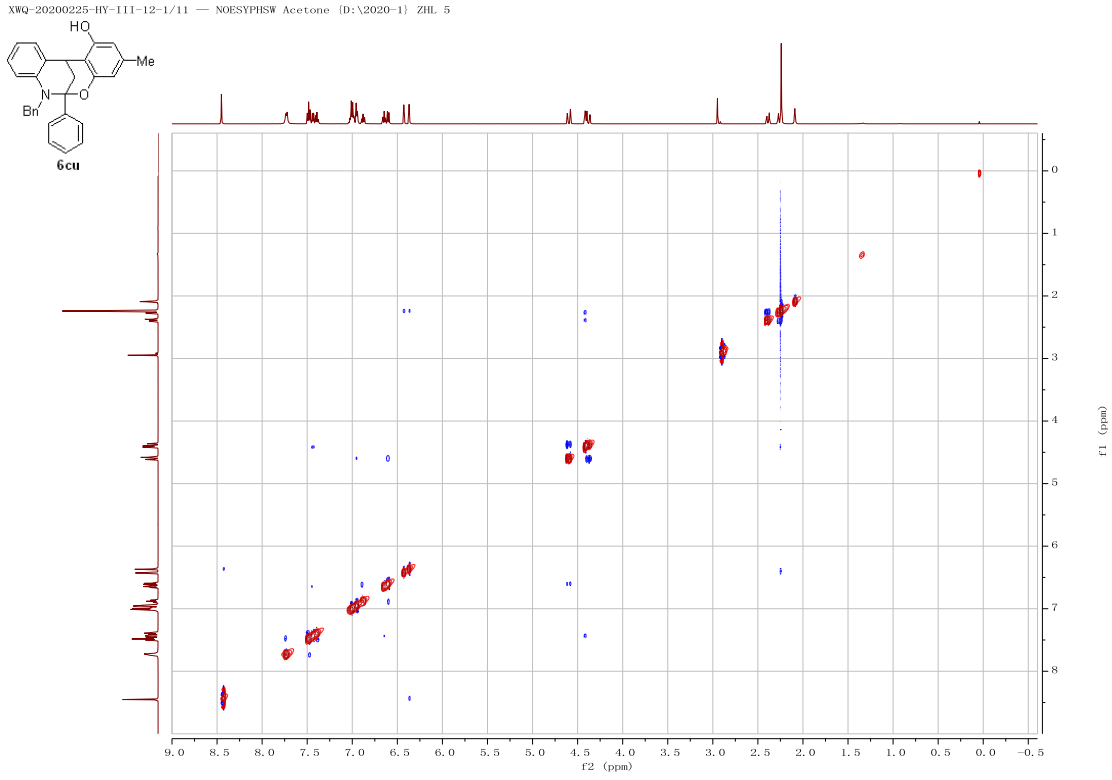

9s XWQ-20181130-GYQ-VI-66/12 — C13CPD CDC13 {D:\2018-3} ZHL 17
155.52
153.57
142.18
141.60
138.75
134.11
130.09
130.07
128.95
128.31
128.18
127.51
127.04
126.55
126.15
118.57
118.32
113.60
109.07
104.36
89.50
51.09
37.92
35.97
OH
N
O
Bn
Cl
6cs
f1 (ppm)

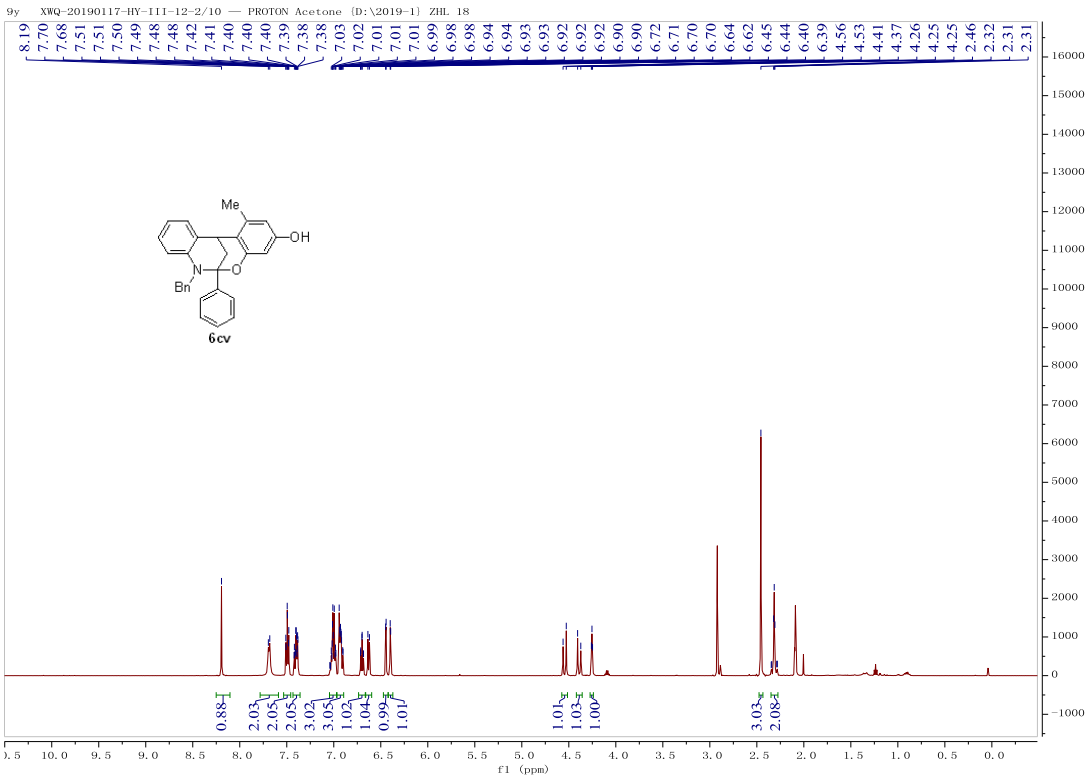

9u XWQ-20181213-GYQ-VI-72/10 — PROTON CDC13 {D:\2018-3} ZHL 27
7.17
7.17
7.15
7.15
7.09
7.08
7.08
7.07
7.06
7.05
7.05
6.83
6.82
6.81
6.71
6.71
6.70
6.69
6.69
6.68
6.67
6.58
6.57
6.43
6.42
4.86
4.83
4.69
4.65
3.86
3.86
3.85
2.46
2.45
2.43
2.42
2.18
2.18
2.15
2.15
1.25
OH
N
O
Bn
Me
Me
Me
6ct
1.01
4.00
1.01
3.03
1.00
2.02
1.00
1.02
1.00
1.01
1.00
9.03
f1 (ppm)

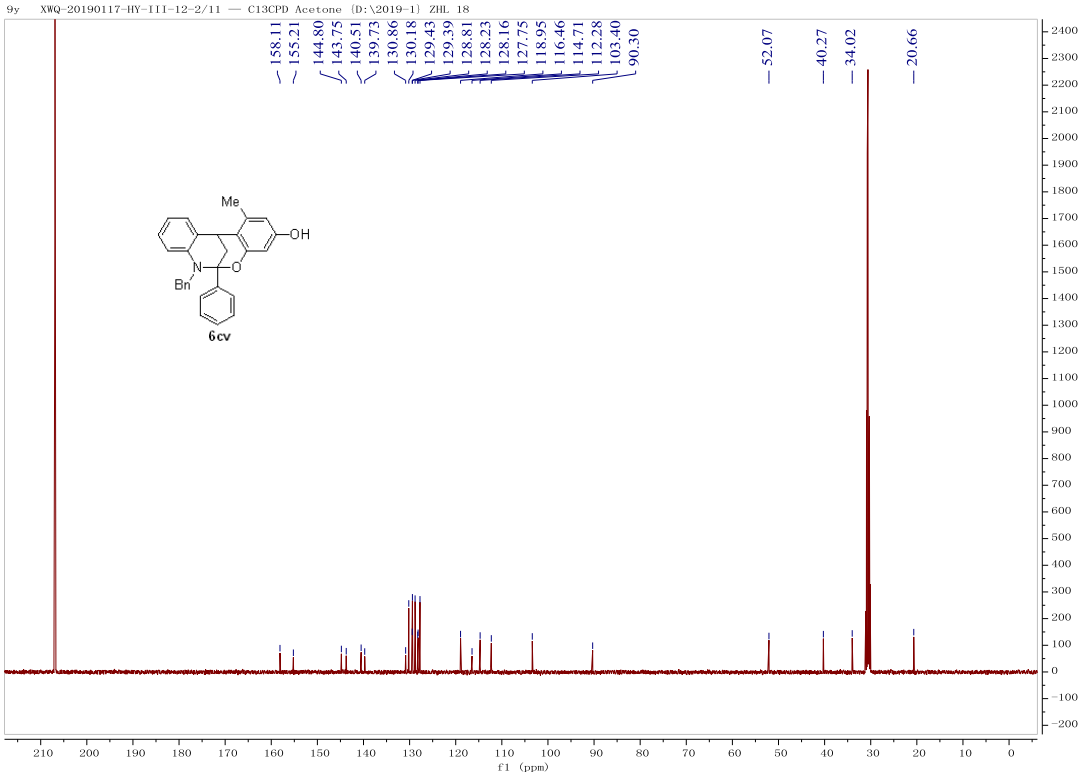

9u XWQ-20181213-GYQ-VI-72/11 — C13CPD CDC13 {D:\2018-3} ZHL 27
155.51
154.36
145.45
140.44
134.00
130.41
128.26
127.68
126.82
126.28
124.70
119.16
117.91
117.48
108.80
104.43
91.74
53.16
40.75
35.29
32.65
27.93
OH
N
O
Bn
Me
Me
Me
6ct
f1 (ppm)

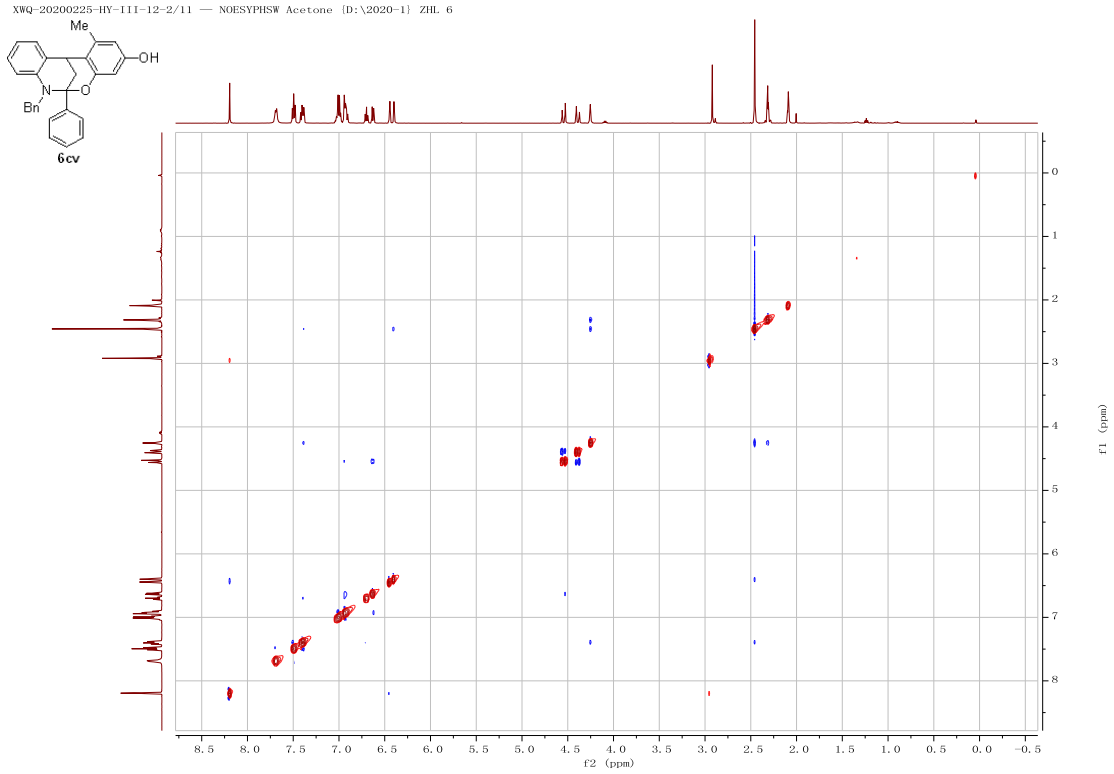

9y XWQ-20190117-HY-III-12-1/10 — PROTON Acetone {D:\2019-1} ZHL 17
8.45
7.74
7.72
7.50
7.50
7.48
7.48
7.47
7.47
7.45
7.44
7.43
7.43
7.41
7.39
7.02
7.01
7.01
7.00
7.00
6.99
6.98
6.98
6.98
6.96
6.95
6.94
6.94
6.88
6.88
6.88
6.88
6.87
6.66
6.65
6.65
6.61
6.59
6.43
6.37
4.61
4.58
4.42
4.42
4.41
4.40
4.36
2.40
2.40
2.38
2.37
2.28
2.27
2.25
2.24
HO
Me
N
O
Bn
6cu
0.87
2.00
4.04
5.01
1.02
1.00
1.02
0.98
1.00
1.00
2.01
1.03
0.98
3.00
f1 (ppm)

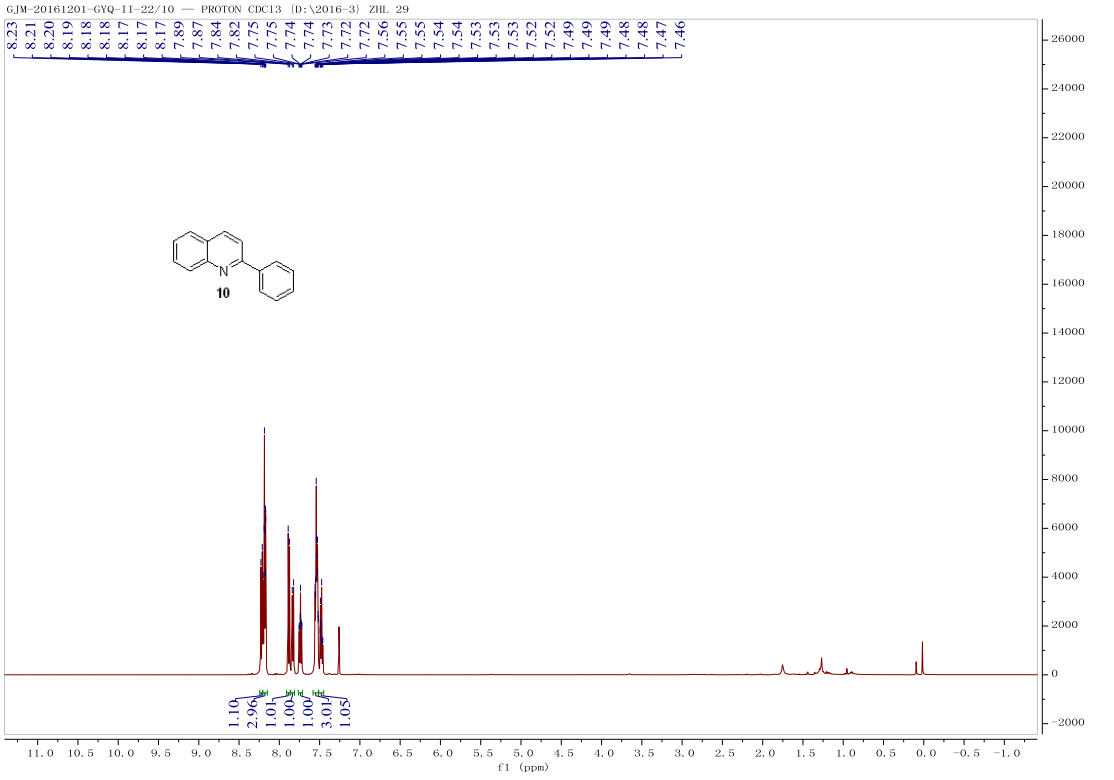

9y XWQ-20190117-HY-III-12-1/11 — C13CPD Acetone {D:\2019-1} ZHL 17
156.64
154.95
144.94
143.81
140.66
138.73
131.06
130.11
129.40
129.30
128.83
128.79
127.94
127.84
127.65
118.90
114.41
112.03
110.73
109.73
90.73
52.20
39.20
31.34
22.13
HO
Me
N
Bn
O
6cu
f1 (ppm)

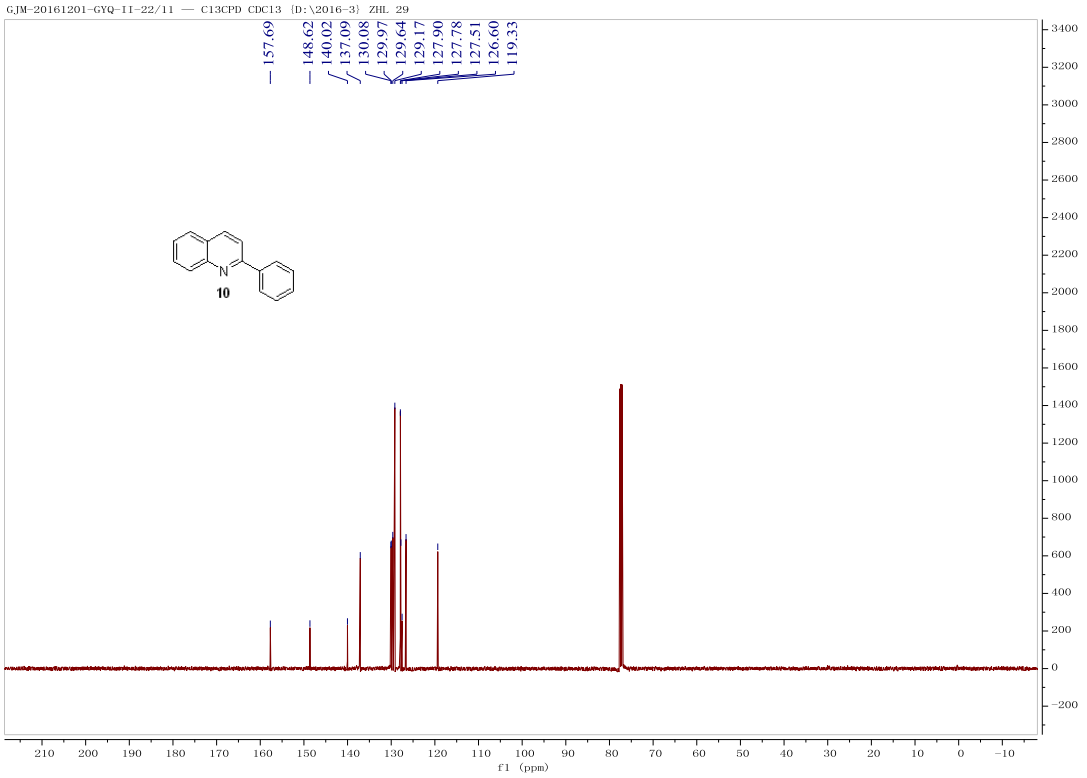

XWQ-20200225-HY-III-12-1/11 — NOESYPHSW Acetone {D:\2020-1} ZHL 5
HO
Me
N
Bn
O
6cu
f2 (ppm)
f1 (ppm)

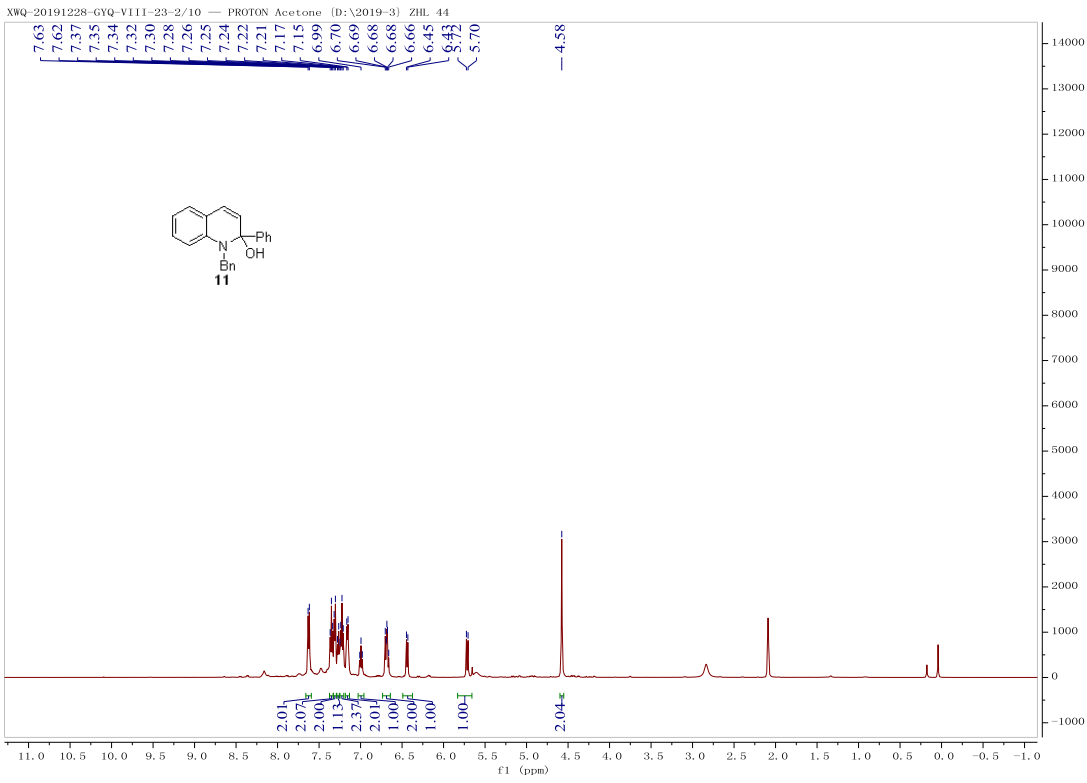

9y XWQ-20190117-HY-III-12-2/10 — PROTON Acetone (D:\2019-1) ZHL 18
8.19 7.70 7.68 7.51 7.51 7.50 7.49 7.48 7.48 7.42 7.41 7.40 7.40 7.40 7.39 7.38 7.38 7.03 7.02 7.01 7.01 7.01 6.99 6.98 6.94 6.94 6.93 6.93 6.92 6.92 6.92 6.90 6.90 6.72 6.71 6.70 6.70 6.64 6.62 6.45 6.44 6.40 6.39 4.56 4.53 4.41 4.37 4.26 4.25 4.25 2.46 2.32 2.31 2.31
Me
OH
N
O
Bn
6cv
0.88 2.03 2.05 2.05 3.02 3.05 1.02 1.04 0.99 1.01 1.01 1.03 1.00 3.03 2.08
f1 (ppm)

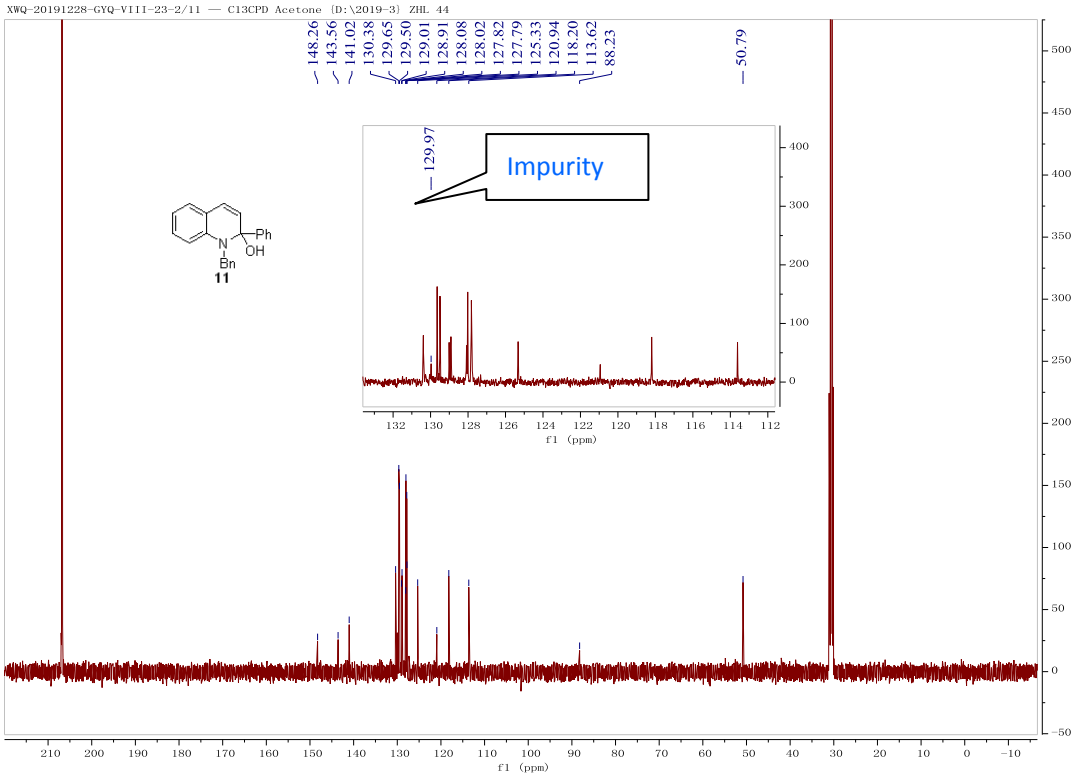

9y XWQ-20190117-HY-III-12-2/11 — C13CPD Acetone (D:\2019-1) ZHL 18
158.11 155.21 144.80 143.75 140.51 139.73 130.86 130.18 129.43 129.39 128.81 128.23 128.16 127.75 118.95 116.46 114.71 112.28 103.40 90.30 52.07 40.27 34.02 20.66
Me
OH
N
O
Bn
6cv
f1 (ppm)

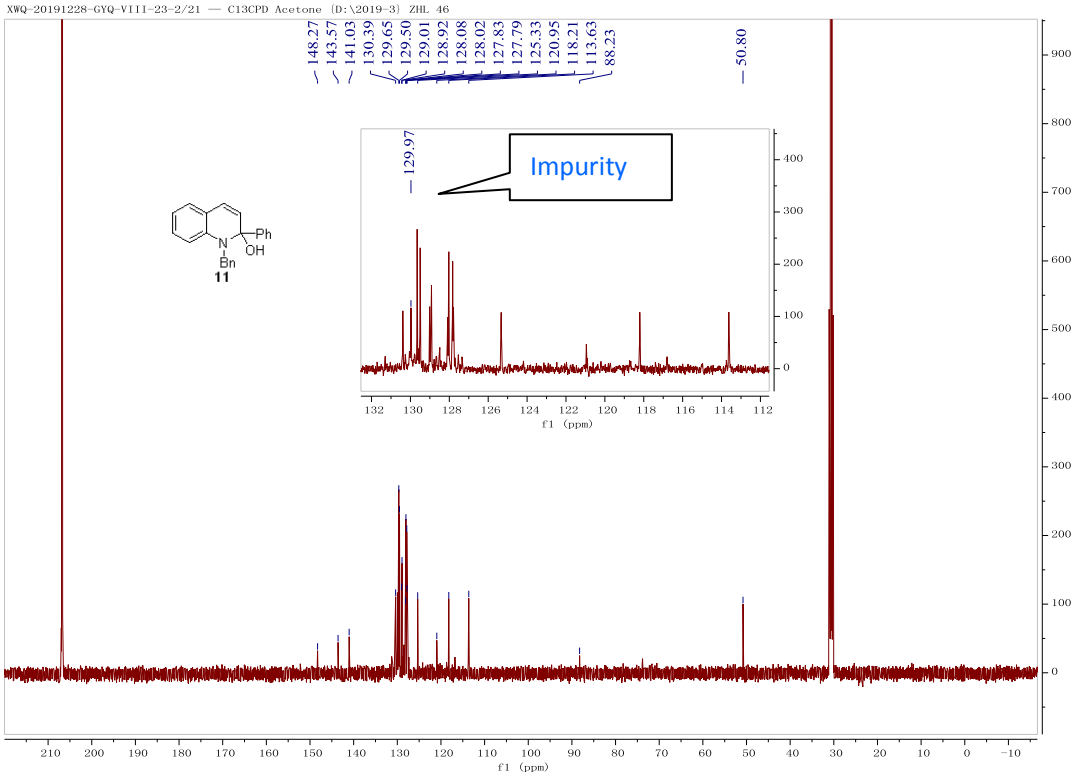

XWQ-20200225-HY-III-12-2/11 — NOESYPHSW Acetone {D:\2020-1} ZHL 6
Me
OH
N
O
Bn
6cv
f2 (ppm)
f1 (ppm)

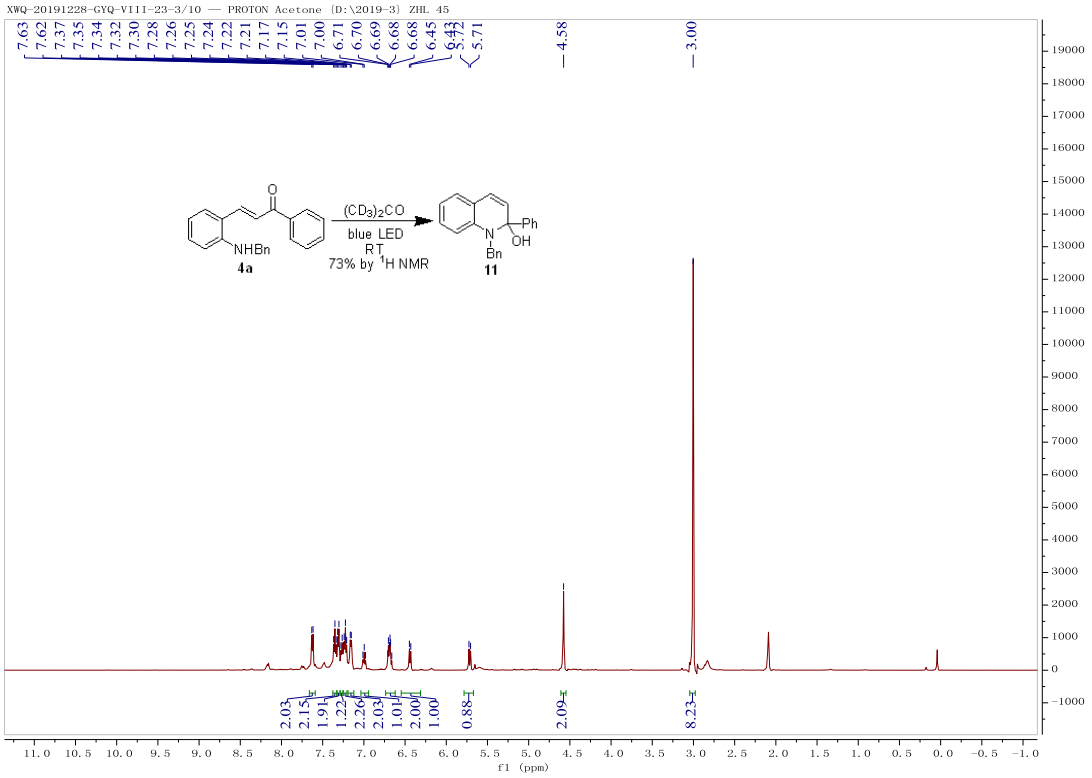

GJM-20161201-GYQ-II-22/10 — PROTON CDCl3 {D:\2016-3} ZHL 29
8.23
8.21
8.20
8.19
8.18
8.18
8.18
8.17
8.17
8.17
8.17
7.89
7.87
7.84
7.82
7.75
7.75
7.74
7.74
7.74
7.73
7.72
7.72
7.72
7.56
7.55
7.55
7.55
7.54
7.54
7.53
7.53
7.53
7.52
7.52
7.49
7.49
7.49
7.48
7.48
7.47
7.46
N
10
1.10
2.96
1.01
1.00
1.00
3.01
1.05
f1 (ppm)

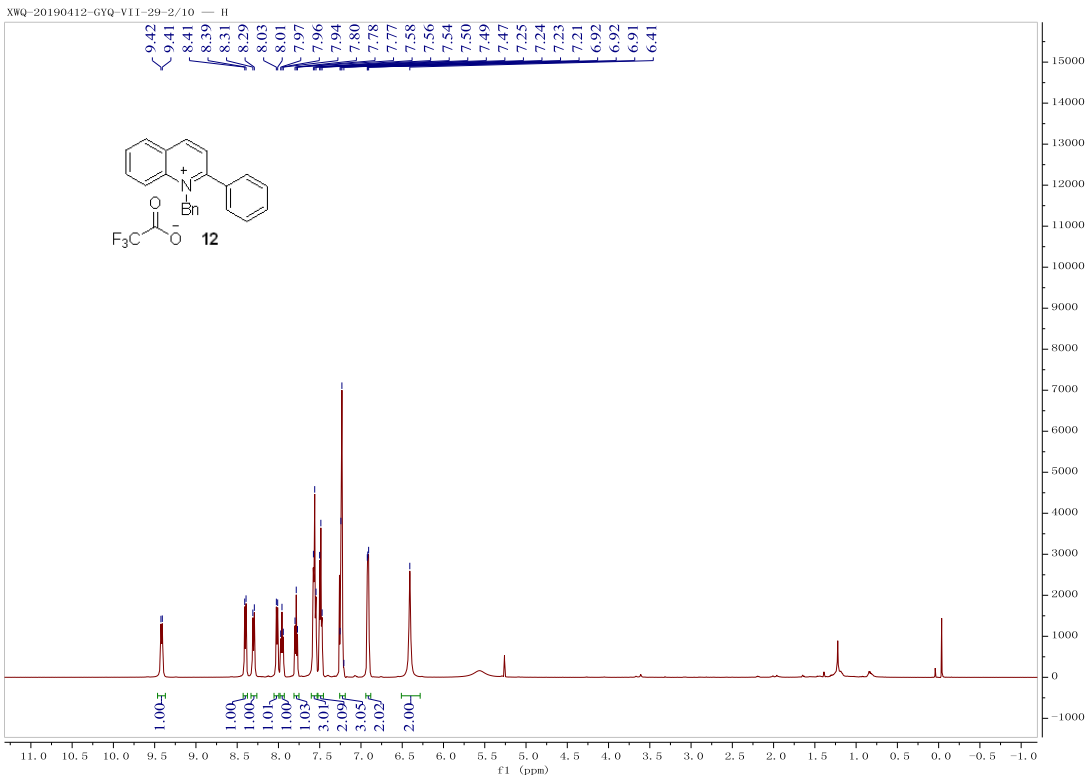

GJM-20161201-GYQ-II-22/11 — C13CPD CDC13 {D:\2016-3} ZHL 29
157.69
148.62
140.02
137.09
130.08
129.97
129.64
129.17
127.90
127.78
127.51
126.60
119.33
10
f1 (ppm)

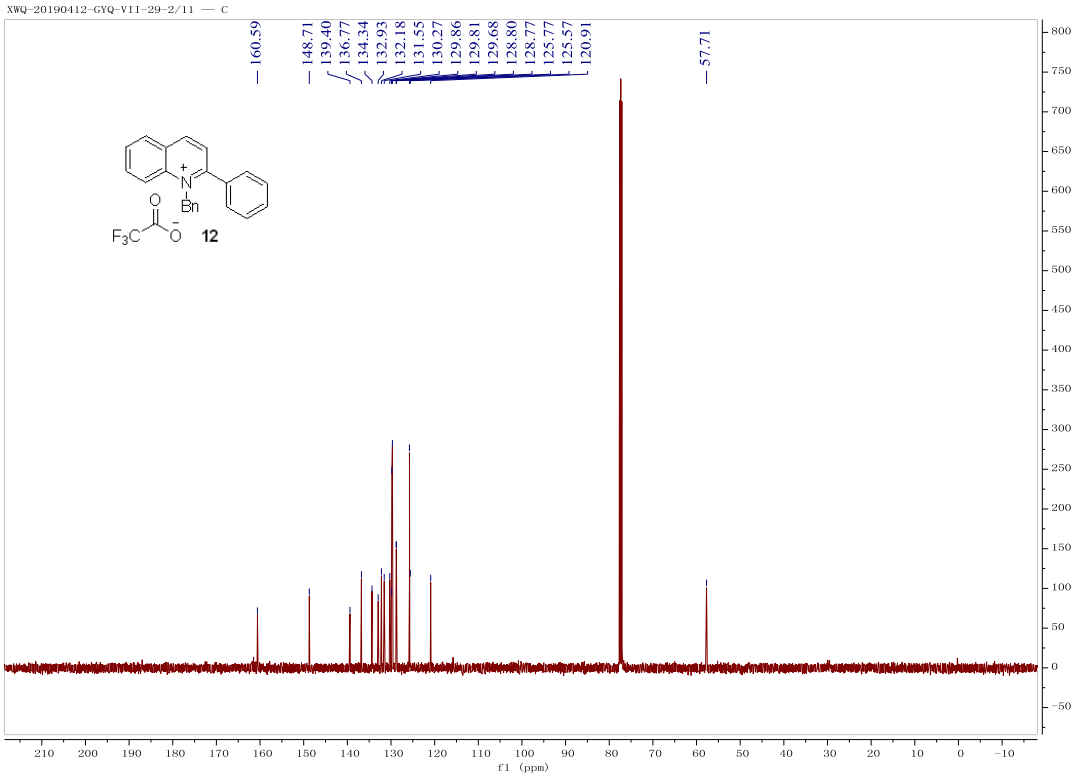

XWQ-20191228-GYQ-VIII-23-2/10 — PROTON Acetone {D:\2019-3} ZHL 44
7.63
7.62
7.37
7.35
7.34
7.32
7.30
7.28
7.26
7.25
7.24
7.22
7.21
7.17
7.15
6.99
6.70
6.69
6.68
6.68
6.66
6.45
6.43
5.72
5.70
4.58
Ph
OH
N
Bn
11
2.01
2.07
2.00
1.12
2.37
2.01
1.00
2.00
1.00
1.00
2.04
f1 (ppm)

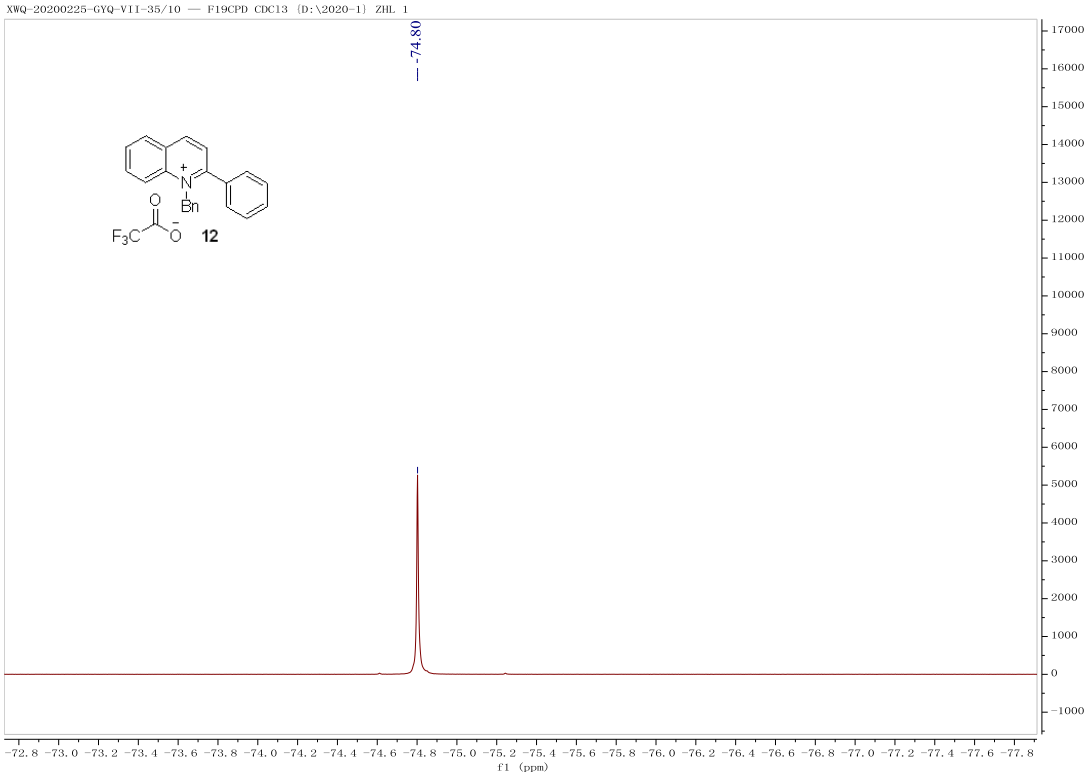

XWQ-20191228-GYQ-VIII-23-2/11 — C13CPD Acetone (D:\2019-3) ZHL 44
148.26
143.56
141.02
130.38
129.65
129.50
129.01
128.91
128.08
128.02
127.82
127.79
125.33
120.94
118.20
113.62
88.23
50.79
129.97
Impurity
Ph
OH
N
Bn
11
f1 (ppm)


XWQ-20191228-GYQ-VIII-23-2/21 — C13CPD Acetone (D:\2019-3) ZHL 46
148.27
143.57
141.03
130.39
129.65
129.50
129.01
128.92
128.08
128.02
127.83
127.79
125.33
120.95
118.21
113.63
88.23
50.80
129.97
Impurity
Ph
OH
N
Bn
11
f1 (ppm)


XWQ-20191228-GYQ-VIII-23-3/10 — PROTON Acetone (D:\2019-3) ZHL 45
7.63 7.62 7.37 7.35 7.34 7.32 7.30 7.28 7.26 7.25 7.24 7.22 7.21 7.17 7.15 7.01 7.00 6.71 6.70 6.69 6.68 6.68 6.45 6.43 5.72 5.71
4.58
3.00
(CD3)2CO
blue LED
RT
73% by 1H NMR
NHBn
4a
Ph
OH
N
Bn
11
2.03 2.15 1.91 1.22 2.26 2.03 1.01 2.00 1.00 0.88 2.09 8.23
f1 (ppm)


XWQ-20190412-GYQ-VII-29-2/10 — H
9.42 9.41 8.41 8.39 8.31 8.29 8.03 8.01 7.97 7.96 7.94 7.80 7.78 7.77 7.58 7.56 7.54 7.50 7.49 7.47 7.25 7.24 7.23 7.21 6.92 6.92 6.91 6.41
N
Bn
O
F3C
O
12
1.00 1.00 1.00 1.01 1.00 1.03 3.01 2.09 3.05 2.02 2.00
f1 (ppm)


XWQ-20190412-GYQ-VII-29-2/11 — C
160.59
148.71
139.40
136.77
134.34
132.93
132.18
131.55
130.27
129.86
129.81
129.68
128.80
128.77
125.77
125.57
120.91
57.71
Bn
12
f1 (ppm)


XWQ-20200225-GYQ-VII-35/10 — F19CPD CDCl3 (D:\2020-1) ZHL 1
-74.80
Bn
12
f1 (ppm)

8. OTEP Drawing of 6aa, 6ba, 6co

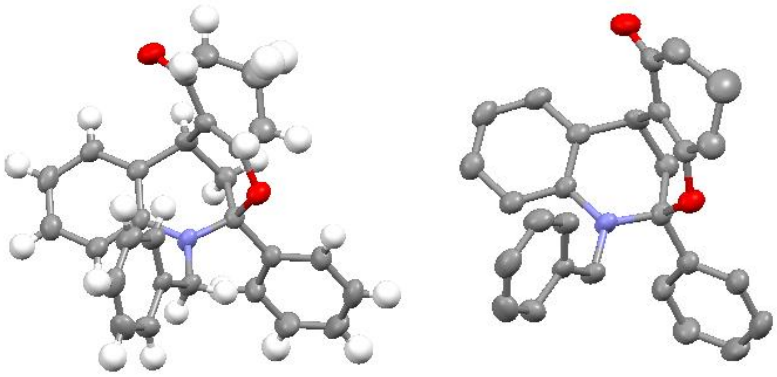


Figure S1 compound 6aa

Table 1 Crystal data and structure refinement for compound 6aa.

Identification code	**6aa**
Empirical formula	$C_{28}H_{25}NO_2$
Formula weight	407.49
Temperature/K	296.(2)
Crystal system	monoclinic
Space group	$P2_1/c$
a/Å	12.1612(13)
b/Å	11.5968(12)
c/Å	14.9705(14)
α/°	90
β/°	90.2700(5)
γ/°	90
Volume/Å^3	2111.3(4)
Z	4
ρ_{calc}g/cm^3	1.282
μ/mm^{-1}	0.080
F(000)	864.0
Crystal size/mm^3	0.250 × 0.230 × 0.230
Radiation	MoKα (λ = 0.71073)
2Θ range for data collection/°	4.86 to 50.28
Index ranges	-14 ≤ h ≤ 13, -11 ≤ k ≤ 13, -16 ≤ l ≤ 17
Reflections collected	14169
Independent reflections	3732 [R_{int} = 0.0692, R_{sigma} = 0.0822]
Data/restraints/parameters	3732/0/280
Goodness-of-fit on F^2	1.014
Final R indexes [I>=2σ (I)]	R_1 = 0.0602, wR_2 = 0.1274
Final R indexes [all data]	R_1 = 0.1296, wR_2 = 0.1546
Largest diff. peak/hole / e Å^{-3}	0.56/-0.24

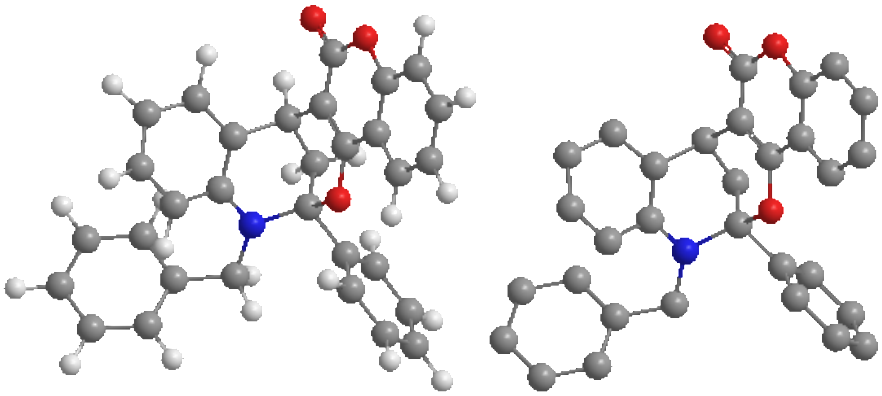


Figure S2 compound 6ba

Table 2 Crystal data and structure refinement for compound 6ba.

Identification code	**6ba**
Empirical formula	$C_{31}H_{23}NO_3$
Formula weight	457.50
Temperature/K	293(2)
Wavelength	1.54178 A
Crystal system, space group	Monoclinic, P2(1)/n
Unit cell dimensions	a = 14.9496(3) Å alpha = 90 deg. b = 9.5237(2) Å beta = 111.831(1) deg. c = 17.4300(4) Å gamma = 90 deg.
Volume	2303.64(9) A^3
Z, Calculated density	4, 1.319 Mg/m^3
Absorption coefficient	0.675 mm^-1
F(000)	960
Crystal size	0.28 x 0.24 x 0.22 mm
Theta range for data collection	3.337 to 72.627 deg.
Limiting indices	-18<=h<=18, -11<=k<=11, -21<=l<=21
Reflections collected / unique	25350 / 4535 [R(int) = 0.0736]
Completeness to theta = 67.679	99.8 %
Absorption correction	None
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	4535 / 0 / 317
Goodness-of-fit on F^2	1.068
Final R indices [I>2sigma(I)]	R_1 = 0.0490, wR_2 = 0.1288
R indices (all data)	R_1 = 0.0848, wR_2 = 0.1590
Extinction coefficient	0.0015(2)
Largest diff. peak and hole	0.203 and -0.221 e.A^-3

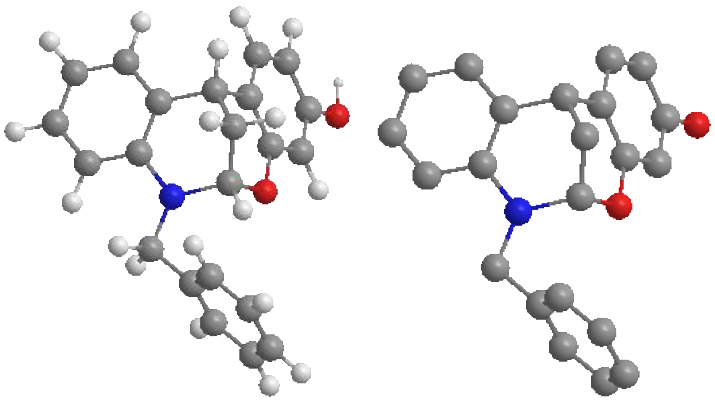


Figure S3 compound 6co

Table 3 Crystal data and structure refinement for compound 6co.

Identification code	**6co**
Empirical formula	$C_{28}H_{23}NO_2$
Formula weight	405.47
Temperature/K	293(2)
Wavelength	1.54178 A
Crystal system, space group	Monoclinic, P2(1)/n
Unit cell dimensions	a = 10.1842(6) Å alpha = 90 deg. b = 20.0153(11) Å beta = 95.242(4) deg. c = 10.5231(6) Å gamma = 90 deg.
Volume	2136.1(2) A^3
Z, Calculated density	4, 1.261 Mg/m^3
Absorption coefficient	0.620 mm^-1
F(000)	856
Crystal size	0.220 x 0.160 x 0.080 mm
Theta range for data collection	4.418 to 73.078 deg.
Limiting indices	-12<=h<=12, -24<=k<=23, -12<=l<=12
Reflections collected / unique	17833 / 4023 [R(int) = 0.1281]
Completeness to theta = 67.679	96.3 %
Absorption correction	None
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	4023 / 0 / 285
Goodness-of-fit on F^2	0.948
Final R indices [I>2sigma(I)]	R_1 = 0.0880, wR_2 = 0.2222
R indices (all data)	R_1 = 0.2382, wR_2 = 0.3359
Extinction coefficient	0.0059(9)
Largest diff. peak and hole	0.200 and -0.264 e.A^-3