Supporting Information

Visible Light Catalyzed Reaction of *α*-Bromochalcones with Chalcones: Direct Access to the Urundeuvine Scaffold

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1. Experimental Section

1.1 General experimental information

All reactions were monitored by TLC, visualization was effected with UV and/or by developing in iodine. Melting points were recorded on a Precision melting point apparatus and are uncorrected. NMR spectra were recorded on a Brucker Avance spectrometer at 400 or 500 MHz (^{1}H) and 100 MHz (^{13}C). Chemical shifts are reported in δ (ppm) relative to TMS as the internal standard. To describe spin multiplicity, standard abbreviations such as s, d, t, q, m, dd referring to singlet, doublet, triplet, quartet, multiplet and doublet of doublet respectively, are used. The ESI-HRMS spectra were recorded on Agilent 6520-Q-Tof LC/MS system. The NMR yields of products were calculated through ^{1}H NMR of crude reaction mixture using dibromo methane as internal standard and isolated yields were calculated after purification by column chromatography. Preparative HPLC was conducted on a 1200 infinity series system (Pumps, 1260 Prep. Pumps; Diode Array Detector, 1260 DAD VL; Fraction collector, 1260 FC-PS; Sampler, 1260 manual injector and Open LAB CDS software) from Agilent Technologies. Reverse phase column (Agilent 10 Prep-C18, 150 x 30 mm) was used and acetonitrile (Pump A, flow rate 20 ml/min) and water with 0.1 % TFA (Pump B, flow rate 4 ml/min) were used as mobile phase with isocratic elution.

All the chemicals and catalysts were purchased from commercial sources and used as received except DMSO which was freshly distilled over CaH_2 before the reaction. The chalcones **1a-1s** are known compounds and were synthesized following literature protocols.[1] Similarly, all the α-bromochalcones except **2c** and **2f** are known compounds and were synthesized according to the reported procedure.[2]

1.2 General procedure for the photoredox catalyzed reaction

In an oven dried 5 mL snap vial equipped with a magnetic stirring bar, the *α*-bromochalcone **2** (0.3 mmol), chalcone **1** (0.6 mmol, 2.0 equiv), K_3PO_4 (0.13 g, 0.6 mmol, 2.0 equiv) and photocatalyst *fac*-Ir(ppy_3) (0.002 g, 0.003 mmol, 1.0 mol%) were dissolved in anhydrous DMSO (3 mL). The resulting reaction mixture was degassed by three "pump-freeze-thaw" cycles via a syringe needle. The vial was irradiated using 450 nm blue LEDs with a cooling device maintaining the temperature around 25 ^{o}C. After 36 h of irradiation (TLC monitoring), the reaction mixture was diluted with water (10 mL) and extracted with ethyl acetate (3 x 10 mL). The combined organic layers were dried (Na_2SO_4) and concentrated under reduced pressure. The residue was purified by column chromatography on silica gel using hexane/ethyl acetate as eluent to afford the pure product **3**.

1.3 General procedure for the oxidation of dihydronaphthalenes

The dihydronaphthalene **3** (0.1 mmol) and ammonium acetate (0.31 g, 0.4 mmol, 4.0 equiv) were dissolved in acetic acid (5 mL) and the reaction mixture was refluxed for 9-12 h (TLC monitoring). The reaction mixture was diluted with water (10 mL) and extracted with ethyl acetate (3 x 10 mL). The combined organic layers were dried (Na_2SO_4) and concentrated under reduced pressure. The residue was purified by column chromatography on silica gel using hexane/ethyl acetate as eluent to afford the pure product **4**.

2. Spectroscopic Data

(Z)-2-bromo-1-(5-bromo-2,4-dimethoxyphenyl)-3-(2-bromo-4,5-dimethoxyphenyl) prop-2-en-1-one (2c).

Yellow solid; R_f 0.50 (25% EtOAc/hexane); Mp 163-164 ^oC; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.79 (s, 1H), 7.68 (s, 1H), 7.58 (s, 1H), 7.00 (s, 1H), 6.44 (s, 1H), 3.91 (s, 3H), 3.84 (s, 3H),, 3.85 (s, 3H), 3.79 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 188.78, 159.21, 158.57, 150.94, 147.81, 141.81, 134.32, 126.06, 125.16, 120.56, 117.11, 115.31, 112.99, 102.23, 96.34, 56.47, 56.25, 56.23, 56.15; **HRMS** for $C_{19}H_{17}Br_3O_5$: calcd. $(M+H)^+$: 562.8699, found: 562.8697

(Z)-2-bromo-3-phenyl-1-(thiophen-2-yl)prop-2-en-1-one (2f).

Yellow oil; R_f 0.50 (5% EtOAc/hexane); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.77-7.80 (m, 3H), 7.74 (dd, J = 3.8 Hz, 1.1 Hz, 1H), 7.68 (dd, J = 5.0 Hz, 1.2 Hz, 1H), 7.36-7.40 (m, 3H), 7.10 (dd, J = 5.0 Hz, 3.8 Hz, 1H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 183.03, 141.35, 140.02, 135.12, 134.81, 133.68, 130.25, 130.13, 128.57, 128.15, 120.78; **HRMS** for $C_{13}H_9BrOS$: calcd. $(M+H)^+$: 292.9630, found: 292.9633

(1-(4-Methoxyphenyl)-1,2-dihydronaphthalene-2,3-diyl)bis(phenylmethanone) (3a).

White solid; isolated yield 75% (69 mg). R_f 0.50 (10% EtOAc/hexane); Mp 123-125 ^oC; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.90-7.92 (m, 2H), 7.64-7.66 (m, 2H), 7.46-7.49 (m, 2H), 7.39 (d, J = 7.9 Hz, 3H), 7.36 (d, J = 3.2 Hz, 2H), 7.14-7.23 (m, 3H), 7.00-7.04 (m, 2H), 6.90-6.94 (m, 1H), 6.69-6.73 (m, 2H), 5.16 (d, J = 4.0 Hz, 1H), 4.43 (d, J = 4.0 Hz, 1H), 3.67 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.91, 196.36, 158.60, 142.07, 137.84, 137.31, 136.18, 135.04, 134.67, 132.92, 131.94, 131.61, 130.83, 129.49, 129.43, 129.07, 128.78, 128.74, 128.64, 128.28, 127.59, 114.19, 55.26, 49.68, 46.27; **HRMS** for $C_{31}H_{24}O_3$: calcd. $(M+H)^+$: 445.1798, found: 445.1804

(1-Phenyl-1,2-dihydronaphthalene-2,3-diyl)bis(phenylmethanone) (3b). Yellow solid; isolated yield 72% (89 mg). R_f 0.50 (10% EtOAc/hexane); Mp 97-98 ^oC; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.99 (d, J = 7.6 Hz, 2H), 7.72 (d, J = 7.0 Hz, 2H), 7.53-7.57 (m, 2H), 7.44-

7.47 (m, 5H), 7.24-7.31 (m, 5H), 7.17-7.20 (m, 3H), 6.99-7.01 (m, 1H), 5.25 (d, *J* = 3.9 Hz, 1H), 4.54 (d, *J* = 3.8 Hz, 1H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.76, 196.31, 142.88, 142.12, 137.82, 136.88, 136.12, 134.61, 132.95, 131.95, 131.73, 130.85, 129.51, 129.42, 129.16, 128.82, 128.80, 128.65, 128.28, 127.74, 127.70, 127.11, 49.51, 47.02; **HRMS** for $C_{30}H_{22}O_2$: calcd. $(M+H)^+$: 415.1693, found: 415.1688

(3-Benzoyl-1-(p-tolyl)-1,2-dihydronaphthalen-2-yl)(4-methoxyphenyl)methanone (3c). White solid; isolated yield 51% (70 mg). R_f 0.50 (10% EtOAc/hexane); Mp 112-113 ^oC; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.92-7.95 (m, 2H), 7.64-7.66 (m, 2H), 7.45-7.49 (m, 1H), 7.35-7.39 (m, 3H), 7.14-7.22 (m, 3H), 7.00 (br s, 4H), 6.92-6.94 (m, 1H), 6.86-6.88 (m, 2H), 5.12 (d, *J* = 3.3 Hz, 1H), 4.41 (d, *J* = 3.3 Hz, 1H), 3.80 (s, 3H), 2.21 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 196.96, 196.40, 163.52, 142.12, 140.36, 137.97, 137.25, 136.66, 134.56, 131.86, 131.66, 131.19, 130.77, 129.50, 129.45, 129.16, 128.68, 128.25, 127.53, 127.47, 113.89, 55.49, 48.99, 46.78, 20.99; **HRMS** for $C_{32}H_{26}O_3$: calcd. $(M+H)^+$: 459.1955, found: 459.1960

(3-Benzoyl-1-(4-methoxyphenyl)-1,2-dihydronaphthalen-2-yl)(p-tolyl)methanone (3d). Yellow gummy solid; isolated yield 55% (75 mg). R_f 0.50 (15% EtOAc/hexane); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.6 Hz, 2H), 7.63-7.67 (m, 2H), 7.46-7.50 (m, 1H), 7.35-7.40 (m, 3H), 7.14-7.23 (m, 5H), 7.01-7.05 (m, 2H), 6.91-6.93 (m, 1H), 6.71-6.74 (m, 2H), 5.14 (d, *J* = 3.6 Hz, 1H), 4.42 (d, *J* = 3.3 Hz, 1H), 3.69 (s, 3H), 2.35 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.26, 196.38, 158.56, 143.76, 142.04, 137.93, 137.33, 135.32, 134.61, 133.42, 131.88, 131.63, 130.77, 129.44, 129.38, 129.10, 128.97, 128.66, 128.25, 127.55, 114.18, 55.26, 49.41, 46.28, 21.65; **HRMS** for $C_{32}H_{26}O_3$: calcd. $(M+H)^+$: 459.1955, found: 459.1958

(3-Benzoyl-1-(4-methoxyphenyl)-1,2-dihydronaphthalen-2-yl)(2-methoxyphenyl) methanone (3e). Yellow gummy solid; isolated yield 45% (64 mg). R_f 0.50 (20% EtOAc/hexane); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.56-7.58 (m, 2H), 7.43-7.47 (m, 1H), 7.32-7.39 (m, 4H), 7.21 (s, 1H), 7.17-7.19 (m, 3H), 6.95-7.01 (m, 3H), 6.85-6.90 (m, 2H), 6.67-6.70 (m, 2H), 5.27 (d, *J* = 2.3 Hz, 1H), 4.53 (d, *J* = 1.9 Hz, 1H), 3.74 (s, 3H), 3.67 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 200.60, 196.21, 158.24, 157.70, 140.85, 138.11, 137.68, 135.52, 134.66, 132.98, 131.88, 131.68, 130.50, 130.41, 129.41, 129.29, 129.21, 128.45, 128.13, 127.91, 127.47, 120.79, 113.79, 111.46, 55.60, 55.21, 52.99, 44.87; **HRMS** for $C_{32}H_{26}O_4$: calcd. $(M+H)^+$: 475.1904, found: 475.1902

(3-Benzoyl-1-(4-methoxyphenyl)-1,2-dihydronaphthalen-2-yl)(3-methoxyphenyl) methanone (3f). Yellow gummy solid; isolated yield 50% (71 mg). R_f 0.50 (20% EtOAc/hexane); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.65-7.67 (m, 2H), 7.58 (d, *J* = 7.6 Hz, 1H),

7.46-7.50 (m, 1H), 7.37-7.40 (m, 4H), 7.31 (t, J = 8.0 Hz, 1H), 7.16-7.24 (m, 3H), 7.02-7.05 (m, 3H), 6.93-6.95 (m, 1H), 6.73 (d, J = 8.6 Hz, 2H), 5.13 (d, J = 3.7 Hz, 1H), 4.45 (d, J = 3.5 Hz, 1H), 3.74 (s, 3H), 3.68 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.58, 196.30, 159.91, 158.63, 142.00, 137.87, 137.52, 137.33, 135.11, 134.59, 131.94, 131.62, 130.84, 129.60,129.48, 129.42, 129.12, 128.72, 128.28, 127.60, 121.36, 119.82, 114.22, 112.85, 55.40, 55.26, 49.84, 46.26; **HRMS** for $C_{32}H_{26}O_4$: calcd. $(M+H)^+$: 475.1904, found: 475.1898

(3-Benzoyl-1-(4-methoxyphenyl)-1,2-dihydronaphthalen-2-yl)(4-methoxyphenyl) methanone (3g). Yellow gummy solid; isolated yield 62% (88 mg). R_f 0.50 (15% EtOAc/hexane); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.93 (d, J = 8.8 Hz, 2H), 7.66 (d, J = 7.1 Hz, 2H), 7.46-7.49 (m, 1H), 7.34-7.40 (m, 3H), 7.15-7.22 (m, 3H), 7.03 (d, J = 8.6 Hz, 2H), 6.91-6.93 (m, 1H), 6.87 (d, J = 8.8 Hz, 2H), 6.72 (d, J = 8.6 Hz, 2H), 5.12 (d, J = 3.8 Hz, 1H), 4.42 (d, J = 3.7 Hz, 1H), 3.80 (s, 3H), 3.68 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 197.25, 196.45, 163.50, 158.56, 142.00, 137.94, 137.46, 135.39, 134.73, 131.89, 131.61, 131.15, 130.76, 129.46, 129.07, 128.82, 128.69, 128.26, 127.51, 114.19, 113.88, 55.49, 55.26, 49.19, 46.50; **HRMS** for $C_{32}H_{26}O_4$: calcd. $(M+H)^+$: 475.1904, found: 475.1894

(3-Benzoyl-1-(4-(methylthio)phenyl)-1,2-dihydronaphthalen-2-yl)(4-methoxyphenyl) methanone (3h). Yellow solid; isolated yield 60% (88 mg). R_f 0.50 (15% EtOAc/hexane); Mp 108-109 ^{o}C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.92 (d, J = 8.9 Hz, 2H), 7.66 (d, J = 7.1 Hz, 2H), 7.46-7.49 (m, 1H), 7.34-7.40 (m, 3H), 7.15-7.22 (m, 3H), 7.06 (dd, J = 21.1 Hz, 8.4 Hz, 4H), 6.91-6.93 (m, 1H), 6.82-6.88 (m, 2H), 5.12 (d, J = 3.6 Hz, 1H), 4.41 (d, J = 3.6 Hz, 1H), 3.79 (s, 3H), 2.36 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 197.00, 196.36, 163.56, 141.93, 140.18, 137.88, 137.13, 136.92, 134.60, 131.93, 131.63, 131.14, 130.81, 129.51, 129.45, 129.08, 128.72, 128.28, 128.16, 127.67, 127.18, 113.92, 55.49, 48.91, 46.72, 15.96; **HRMS** for $C_{32}H_{26}O_3S$: calcd. $(M+H)^+$: 491.1675, found: 491.1674

(3-Benzoyl-1-(4-fluorophenyl)-1,2-dihydronaphthalen-2-yl)(4-ethoxyphenyl)methanone (3i). White solid; isolated yield 57% (79 mg). R_f 0.50 (10% EtOAc/hexane); Mp 99-101 ^{o}C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.89 (d, J = 8.8 Hz, 2H), 7.65 (d, J = 7.2 Hz, 2H), 7.45-7.49 (m, 1H), 7.33-7.39 (m, 3H), 7.16-7.22 (m, 3H), 7.05-7.08 (m, 2H), 6.84-6.90 (m, 5H), 5.10 (d, J = 4.2 Hz, 1H), 4.45 (d, J = 4.1 Hz, 1H), 3.78 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 197.24, 196.36, 163.58, 161.81 (d, J = 244.5 Hz), 141.73, 138.82 (d, J = 3.5 Hz), 137.81, 136.98, 134.77, 132.00, 131.61, 131.06, 130.84, 129.53, 129.44, 129.32 (d, J = 7.9 Hz), 128.96, 128.87, 128.29, 127.74, 115.64 (d, J = 21.3 Hz), 113.92, 55.48, 49.16, 46.60; **HRMS** for $C_{31}H_{23}FO_3$: calcd. $(M+H)^+$: 463.1704, found: 463.1705

(3-Benzoyl-1-(4-fluorophenyl)-1,2-dihydronaphthalen-2-yl)(4-fluorophenyl)methanone (3j). White solid; isolated yield 45% (60 mg). R_f 0.50 (15% EtOAc/hexane); Mp 136-138 ^oC; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.89 (dd, *J* = 8.6 Hz, 5.4 Hz, 2H), 7.65 (d, *J* = 7.2 Hz, 2H), 7.49 (t, *J* = 7.5 Hz, 1H), 7.39 (t, *J* = 7.6 Hz, 2H), 7.34 (s, 1H), 7.19-7.22 (m, 3H), 7.01-7.08 (m, 4H), 6.85-6.91 (m, 3H), 5.10 (d, *J* = 5.2 Hz, 1H), 4.46 (d, *J* = 5.2 Hz, 1H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 197.98, 196.31, 165.70 (d, *J* = 253.4 Hz), 161.87 (d, *J* = 244.5 Hz), 141.92, 138.16, 137.55, 136.91, 134.86, 132.78, 132.7, 131.48, 131.27 (d, *J* = 9.3 Hz), 131.01, 129.60, 129.54, 129.46, 129.40, 128.81, 128.37, 127.83, 115.72 (d, *J* = 21.1 Hz), 49.78, 46.73; **HRMS** for $C_{30}H_{20}F_2O_2$: calcd. $(M+H)^+$: 451.1504, found: 451.1503

(1-(4-Chlorophenyl)-1,2-dihydronaphthalene-2,3-diyl)bis(phenylmethanone) (3k). White solid; isolated yield 65% (87 mg). R_f 0.50 (10% EtOAc/hexane); Mp 119-120 ^oC; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.86-7.88 (m, 2H), 7.60-7.62 (m, 2H), 7.45-7.49 (m, 2H), 7.35-7.39 (m, 4H), 7.33 (s, 1H), 7.12-7.20 (m, 5H), 7.01 (d, *J* = 8.9 Hz, 2H), 6.88-6.90 (m, 1H), 5.12 (d, *J* = 4.0 Hz, 1H), 4.43 (d, *J* = 4.0 Hz, 1H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.58, 196.21, 141.87, 141.29, 137.67, 136.43, 136.09, 134.42, 133.07, 132.95, 132.06, 131.60, 130.97, 129.63, 129.40, 129.11, 129.02, 128.96, 128.71, 128.32, 127.91, 49.33, 46.34; **HRMS** for $C_{30}H_{21}ClO_2$: calcd. $(M+H)^+$: 449.1303, found: 449.1313

(3-Benzoyl-1-(3-nitrophenyl)-1,2-dihydronaphthalen-2-yl)(4-methoxyphenyl) methanone (3l). Yellow gummy solid; isolated yield 52% (76 mg). R_f 0.50 (20% EtOAc/hexane); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.99-8.00 (m, 2H), 7.89 (d, *J* = 8.7 Hz, 2H), 7.65 (d, *J* = 7.3 Hz, 2H), 7.45-7.49 (m, 2H), 7.37-7.41 (m, 4H), 7.19-7.28 (m, 4H), 6.92 (br d, *J* = 6.8 Hz, 1H), 6.86 (br d, *J* = 8.7 Hz, 2H), 5.13 (d, *J* = 3.7 Hz, 1H), 4.59 (d, *J* = 3.5 Hz, 1H), 3.79 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 196.45, 196.18, 163.75, 148.55, 144.99, 141.74, 137.56, 135.68, 134.26, 133.93, 132.18, 131.59, 131.15, 131.04, 129.89, 129.83, 129.43, 128.88, 128.55, 128.38, 128.29, 122.79, 122.24, 114.05, 55.53, 48.65, 46.82; **HRMS** for $C_{31}H_{23}NO_5$: calcd. $(M+H)^+$: 490.1649, found: 490.1646

(3-Benzoyl-1-phenyl-1,2-dihydronaphthalen-2-yl)(pyridin-2-yl)methanone (3m). White solid; isolated yield 60% (74 mg). R_f 0.50 (15% EtOAc/hexane); Mp 135-136 ^oC; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.69-8.71 (m, 1H), 7.90-7.92 (m, 1H), 7.71-7.75 (m, 1H), 7.58-7.61 (m, 2H), 7.43-7.48 (m, 1H), 7.38-7.41 (m, 1H), 7.33-7.37 (m, 3H), 7.16-7.25 (m, 7H), 7.08-7.12 (m, 1H), 6.90-6.92 (m, 1H), 5.78 (d, *J* = 4.0 Hz, 1H), 4.74 (d, *J* = 4.0 Hz, 1H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.58, 196.08, 152.32, 148.79, 142.80, 141.86, 137.82, 136.93, 135.29, 132.51, 131.80, 130.61, 129.43, 129.29, 129.22, 128.39, 128.26, 128.20, 127.66, 127.02,

126.73, 122.92, 48.92, 46.35; **HRMS** for $C_{29}H_{21}NO_2$: calcd. $(M+H)^+$: 416.1645, found: 416.1641

(3-Benzoyl-1-phenyl-1,2-dihydronaphthalen-2-yl)(thiophen-2-yl)methanone (3n). Yellow solid; isolated yield 47% (60 mg). R_f 0.50 (15% EtOAc/hexane); Mp 97-98 ^oC; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.77 (dd, *J* = 3.8 Hz, 1.0 Hz, 1H), 7.64-7.66 (m, 2H), 7.57 (dd, *J* = 5.0 Hz, 1.1 Hz, 1H), 7.46-7.50 (m, 1H), 7.36-7.40 (m, 3H), 7.18-7.24 (m, 5H), 7.13-7.15 (m, 3H), 7.06 (dd, *J* = 5.0 Hz, 3.8 Hz, 1H), 6.96-6.98 (m, 1H), 4.97 (d, *J* = 4.1 Hz, 1H), 4.56 (d, *J* = 4.2 Hz, 1H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 196.22, 191.25, 142.96, 142.91, 142.27, 137.75, 136.94, 134.09, 133.91, 132.67, 132.01, 131.68, 130.96, 129.54, 129.44, 129.17, 128.85, 128.31, 128.26, 127.85, 127.70, 127.16, 51.44, 47.65; **HRMS** for $C_{28}H_{20}O_2S$: calcd. $(M+H)^+$: 421.1257, found: 421.1260

1-(3-Benzoyl-1-phenyl-1,2-dihydronaphthalen-2-yl)butan-1-one (3o). Yellow gummy solid; isolated yield 52% (59 mg). R_f 0.50 (10% EtOAc/hexane); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.62 (d, *J* = 7.1 Hz, 2H), 7.47-7.50 (m, 1H), 7.37-7.40 (m, 2H), 7.15-7.23 (m, 7H), 7.07 (d, *J* = 7.1 Hz, 2H), 7.00 (d, *J* = 7.0 Hz, 1H), 4.57 (d, *J* = 5.5 Hz, 1H), 4.23 (d, *J* = 5.5 Hz, 1H), 2.47-2.55 (m, 1H), 2.14-2.25 (m, 1H), 1.38-1.45 (m, 2H), 0.71 (t, *J* = 7.4 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 209.68, 196.71, 142.26, 141.40, 137.84, 137.67, 135.01, 132.02, 131.62, 130.95, 129.31, 129.26, 128.93, 128.74, 128.36, 128.10, 127.59, 127.04, 54.92, 46.45, 44.12, 16.78, 13.58; **HRMS** for $C_{27}H_{24}O_2$: calcd. $(M+H)^+$: 381.1849, found: 381.1853

(3-Benzoyl-1-phenyl-1,2-dihydronaphthalen-2-yl)(cyclopropyl)methanone (3p). White solid; isolated yield 45% (51 mg). R_f 0.50 (10% EtOAc/hexane); Mp 147-148 ^oC; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.63-7.65 (m, 2H), 7.47-7.51 (m, 1H), 7.37-7.41 (m, 2H), 7.13-7.24 (m, 7H), 7.05-7.09 (m, 3H), 4.67 (d, *J* = 4.4 Hz, 1H), 4.52 (d, *J* = 4.5 Hz, 1H), 1.92-1.99 (m, 1H), 0.83-0.92 (s, 1H), 0.63-0.82 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 208.64, 196.67, 142.52, 141.36, 137.98, 137.83, 134.25, 131.99, 131.47, 130.98, 129.37, 129.30, 129.05, 128.66, 128.34, 127.97, 127.53, 126.93, 55.20, 45.94, 20.09, 11.40, 11.28; **HRMS** for $C_{27}H_{22}O_2$: calcd. $(M+H)^+$: 379.1693, found: 379.1686

Ethyl 3-benzoyl-1-phenyl-1,2-dihydronaphthalene-2-carboxylate (3q). White gummy solid; isolated yield 52% (59 mg). R_f 0.50 (15% EtOAc/hexane); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.65 (d, *J* = 7.0 Hz, 2H), 7.46-7.50 (m, 1H), 7.36-7.40 (m, 2H), 7.16-7.23 (m, 6H), 7.13 (d, *J* = 7.1 Hz, 1H), 7.09 (d, *J* = 7.0 Hz, 1H), 7.04 (d, *J* = 7.1 Hz, 2H), 4.75 (d, *J* = 4.0 Hz, 1H), 4.29 (d, *J* = 4.1 Hz, 1H), 3.98 (q, *J* = 7.1 Hz, 2H), 1.00 (t, *J* = 7.1 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 192.52, 168.54, 138.41, 136.01, 134.26, 133.56, 129.95, 128.22,

127.85, 127.08, 125.69, 125.51, 124.87, 124.57, 124.13, 123.96, 123.23, 57.47, 43.39, 42.38, 10.28; **HRMS** for $C_{26}H_{22}O_3$: calcd. $(M+H)^+$: 383.1642, found: 383.1638

(3-Benzoyl-6-methyl-4-phenyl-3,4-dihydronaphthalen-2-yl)(p-tolyl)methanone (3r). Yellow oil; isolated yield 56% (74 mg). R_f 0.50 (10% EtOAc/hexane); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.95 (d, J = 7.3 Hz, 2H), 7.55 (d, J = 8.0 Hz, 2H), 7.47-7.51 (m, 1H), 7.41 (d, J = 7.8 Hz, 2H), 7.37-7.38 (poorly resolved m, 1H), 7.17-7.22 (m, 5H), 7.11-7.15 (m, 4H), 6.99-7.01 (poorly resolved m, 1H), 6.76 (br s, 1H), 5.14 (d, J = 3.6 Hz, 1H), 4.42 (d, J = 3.5 Hz, 1H), 2.36 (s, 3H), 2.19 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.70, 196.01, 143.16, 142.46, 141.92, 141.23, 136.77,136.13, 135.20, 133.57, 132.88, 130.00, 129.56, 129.44, 129.23, 128.92, 128.83, 128.79, 128.62, 128.44, 127.70, 127.02, 49.57, 46.98, 21.61; **HRMS** for $C_{32}H_{26}O_2$: calcd. $(M+H)^+$: 443.2006, found: 443.2010

(1-(4-Methoxyphenyl)-7-methyl-1,2-dihydronaphthalene-2,3-diyl)bis(p-tolylmethanone) (3s). Yellow solid; isolated yield 66% (92 mg). R_f 0.50 (15% EtOAc/hexane); Mp 120-121 ^{o}C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.85 (d, J = 8.2 Hz, 2H), 7.55 (d, J = 8.0 Hz, 2H), 7.34 (s, 1H), 7.16-7.20 (m, 4H), 7.10 (br d, J = 7.7 Hz, 1H), 7.01-7.03 (m, 2H), 6.96 (br d, J = 7.7 Hz, 1H), 6.71-6.73 (m, 3H), 5.08 (d, J = 3.3 Hz, 1H), 4.35 (d, J = 3.2 Hz, 1H), 3.68 (s, 3H), 2.35 (s, 3H), 2.34 (s, 3H), 2.17 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.21, 196.07, 158.51, 143.65,142.38,141.83, 141.12, 137.22, 135.60, 135.32, 133.60, 133.45, 129.93, 129.59, 129.39, 129.35, 129.14, 129.00, 128.90, 128.63, 128.30, 114.16, 55.25, 49.48, 46.27, 21.64, 21.60; **HRMS** for $C_{34}H_{30}O_3$: calcd. $(M+H)^+$: 487.2268, found: 487.2267

(3-(2-Methoxybenzoyl)-4-(4-methoxyphenyl)-6-methyl-3,4-dihydronaphthalen-2-yl)(p-tolyl) methanone (3t). Brown solid; isolated yield 60% (90 mg). R_f 0.50 (20% EtOAc/hexane); Mp 145-146 ^{o}C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.45 (d, J = 7.2 Hz, 2H), 7.38-7.40 (m, 1H), 7.30-7.35 (m, 1H), 7.19 (s merged with $CDCl_3$ peak, 1H), 7.13 (d, J = 7.6 Hz, 2H), 7.07 (d, J = 7.6 Hz, 1H), 6.96 (d, J = 8.3 Hz, 3H), 6.83-6.89 (m, 3H), 6.68 (d, J = 7.6 Hz, 2H), 5.21 (br s, 1H), 4.49 (br s, 1H), 3.72 (s, 3H), 3.67 (s, 3H), 2.33 (s, 3H), 2.20 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 200.67, 195.90, 158.21, 157.68, 142.16, 140.81, 140.64, 137.72, 135.81, 135.46, 133.67, 132.86, 130.40, 130.01,129.55, 129.32, 129.20, 128.77, 128.48, 128.19, 128.05, 120.73, 113.78, 111.44, 55.57, 55.21, 53.08, 44.86, 21.62, 21.58; **HRMS** for $C_{34}H_{30}O_4$: calcd. $(M+H)^+$: 503.2217, found: 503.2213

(3-(3-Methoxybenzoyl)-4-(4-methoxyphenyl)-6-methyl-3,4-dihydronaphthalen-2-yl)(p-tolyl)methanone (3u). Yellow solid; isolated yield 53% (80 mg). R_f 0.50 (20% EtOAc/hexane); Mp 98-101 ^{o}C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.57 (d, J = 7.8 Hz, 1H), 7.54 (d, J = 8.1 Hz, 2H), 7.40 (t, J = 2.2 Hz, 1H), 7.34 (s, 1H), 7.30 (t, J = 8.0 Hz, 1H), 7.17 (d, J =

8.0 Hz, 2H), 7.11 (d, *J* = 7.7 Hz, 1H), 7.02 (d, *J* = 8.8 Hz, 3H), 6.98 (d, *J* = 7.3 Hz, 1H), 6.71-6.76 (m, 3H), 5.06 (d, *J* = 3.4 Hz, 1H), 4.38 (d, *J* = 3.4 Hz, 1H), 3.74 (s, 3H), 3.68 (s, 3H), 2.35 (s, 3H), 2.18 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.51, 196.02, 159.87, 158.55, 142.47, 141.82, 141.22, 137.49, 137.20, 135.38, 135.23, 133.54, 129.95, 129.57, 129.41, 129.10, 128.93, 128.68, 128.35, 121.41, 119.83, 114.17, 112.80, 55.40, 55.25, 49.88, 46.21, 21.63, 21.61; **HRMS** for $C_{34}H_{30}O_4$: calcd. $(M+H)^+$: 503.2217, found: 503.2218

(3-(4-Methoxybenzoyl)-6-methyl-4-(4-(methylthio)phenyl)-3,4-dihydronaphthalen-2-yl)(p-tolyl)methanone (3v). Yellow solid; isolated yield 82% (127 mg). R_f 0.50 (15% EtOAc/hexane); Mp 98-100 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.8 Hz, 2H), 7.55 (d, *J* = 8.0 Hz, 2H), 7.33 (s, 1H), 7.17 (d, *J* = 8.0 Hz, 2H), 7.02-7.12 (m, 5H), 6.98 (d, *J* = 7.8 Hz, 1H), 6.87 (d, *J* = 8.8 Hz, 2H), 6.74 (s, 1H), 5.07 (d, *J* = 3.2 Hz, 1H), 4.35 (d, *J* = 3.0 Hz, 1H), 3.80 (s, 3H), 2.35, 2.37 (2s merged, 6H), 2.17 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 197.00, 196.06, 163.51, 142.45, 141.73, 141.18, 140.46, 137.00, 136.84, 135.28, 133.60, 131.17, 129.93, 129.59, 129.45. 129.13, 128.93, 128.77, 128.41, 128.15, 127.18, 113.89, 55.48, 48.98, 46.72, 21.61, 15.98; **HRMS** for $C_{34}H_{30}O_3S$: calcd. $(M+H)^+$: 519.1988, found: 519.1992

(3-Benzoyl-4-(4-fluorophenyl)-6-methyl-3,4-dihydronaphthalen-2-yl)(p-tolyl) methanone (3w). White solid; isolated yield 45% (62 mg). R_f 0.50 (10% EtOAc/hexane); Mp 92-94 °C; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.90 (d, *J* = 7.4 Hz, 2H), 7.54 (d, *J* = 8.0 Hz, 2H), 7.47 (t, *J* = 7.6 Hz, 1H), 7.37 (t, *J* = 7.8 Hz, 2H), 7.33 (s, 1H), 7.17 (d, *J* = 8.0 Hz, 2H), 7.12 (d, *J* = 7.7 Hz, 1H), 7.04-7.07 (m, 2H), 7.00 (d, *J* = 7.5 Hz, 1H), 6.86 (t, *J* = 8.6 Hz, 2H), 6.72 (s, 1H), 5.10 (d, *J* = 4.0 Hz, 1H), 4.41 (d, *J* = 4.0 Hz, 1H), 2.35 (s, 3H), 2.17 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.88, 195.99, 161.78 (d, *J* = 244.0 Hz), 142.60, 141.65, 141.35, 138.75 (d, *J* = 2.7 Hz), 136.75, 136.25, 135.08, 133.61, 132.94, 129.81, 129.55, 129.51, 129.31 (d, *J* = 8.0 Hz),129.09, 128.96, 128.72, 128.64, 128.55, 115.60 (d, *J* = 21.2 Hz), 49.69, 46.31, 21.62, 21.61; **HRMS** for $C_{32}H_{25}FO_2$: calcd. $(M+H)^+$: 461.1911, found: 461.1907

(5-Bromo-2,4-dimethoxyphenyl)(8-bromo-3-(2,4-dimethoxybenzoyl)-5,6-dimethoxy-4-(4-methoxyphenyl)-3,4-dihydronaphthalen-2-yl)methanone (3x). Yellow solid; isolated yield 40% (93 mg). R_f 0.50 (50% EtOAc/hexane); Mp 120-121 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.62-7.64 (m, 1H), 7.57 (s, 1H), 7.51 (s, 1H), 7.14 (d, *J* = 8.6 Hz, 2H), 7.00 (s, 1H), 6.77 (d, *J* = 8.7 Hz, 2H), 6.50-6.53 (m, 3H), 5.40 (s, 1H), 4.91 (s, 1H), 3.98 (s, 3H), 3.88 (s, 3H), 3.87 (s, 3H), 3.85 (s, 3H), 3.77 (s, 6H), 3.43 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 197.66, 193.33, 164.19, 160.15, 158.45, 158.30, 158.23, 154.85, 145.87, 140.26, 135.16, 135.03, 134.55, 134.29, 132.96, 128.54, 125.00, 122.31, 120.23, 119.90, 114.99, 113.61, 105.29,

101.86, 98.52, 96.60, 60.36, 56.35, 56.08, 55.91, 55.73, 55.50, 55.21, 50.46, 39.45; **HRMS** for $C_{37}H_{34}Br_2O_9$: calcd. $(M+H)^+$: 781.0642, found: 781.0643

(7-Chloro-1-(4-chlorophenyl)-1,2-dihydronaphthalene-2,3-diyl)bis(phenylmethanone) (3y). Yellow solid; isolated yield 50% (72 mg). R_f 0.50 (15% EtOAc/hexane); Mp 115-117 ^oC; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.87-7.89 (m, 2H), 7.60-7.62 (m, 2H), 7.47-7.52 (m, 2H), 7.36-7.41 (m, 4H), 7.30 (s, 1H), 7.16-7.19 (m, 4H), 7.00-7.03 (m, 2H), 6.91 (br s, 1H), 5.13 (d, J = 3.9 Hz, 1H), 4.42 (d, J = 3.9 Hz, 1H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.24, 195.94, 140.50, 140.45, 138.24, 137.44, 136.54, 135.83, 134.70, 133.26, 132.21, 130.59, 130.13, 129.37, 129.24, 129.15, 129.01, 128.79, 128.73, 128.38, 128.14, 49.05, 46.19; **HRMS** for $C_{30}H_{20}Cl_2O_2$: calcd. $(M+H)^+$: 483.0913, found: 483.0914

(7-Fluoro-1-phenyl-1,2-dihydronaphthalene-2,3-diyl)bis(phenylmethanone) (3z). White solid; isolated yield 54% (70 mg). R_f 0.50 (10% EtOAc/hexane); Mp 90-92 ^oC; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.91 (d, J = 7.6 Hz, 2H), 7.63 (d, J = 7.5 Hz, 2H), 7.48 (t, J = 7.5 Hz, 2H), 7.38 (t, J = 7.7 Hz, 4H), 7.33 (s, 1H), 7.13-7.23 (m, 4H), 7.09-7.11 (m, 2H), 6.85-6.90 (m, 1H), 6.66 (dd, J = 9.2 Hz, 2.4 Hz, 1H), 5.17 (d, J = 4.2 Hz, 1H), 4.45 (d, J = 4.1 Hz, 1H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.81, 196.13, 164.03 (d, J = 250.2 Hz), 142.07, 140.91, 139.83 (d, J = 7.9 Hz), 137.70, 136.02, 134.21 (d, J = 2.4 Hz), 133.08, 132.01, 131.24 (d, J = 8.6 Hz), 129.37, 128.97, 128.77, 128.68, 128.32, 128.01 (d, J = 3.1 Hz), 127.69, 127.40, 116.51 (d, J = 22.4 Hz), 114.70 (d, J = 21.8 Hz), 49.10, 47.22; **HRMS** for $C_{30}H_{21}FO_2$: calcd. $(M+H)^+$: 433.1598, found: 433.1603

(3-Benzoyl-7-fluoro-1-phenyl-1,2-dihydronaphthalen-2-yl)(thiophen-2-yl)methanone (3za). Yellow gummy solid; isolated yield 58% (76 mg). R_f 0.50 (15% EtOAc/hexane); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.75 (d, J = 3.6 Hz, 1H), 7.62 (d, J = 7.3 Hz, 2H), 7.57 (d, J = 4.8 Hz, 1H), 7.46-7.49 (m, 1H), 7.35-7.39 (m, 2H), 7.31 (s, 1H), 7.10-7.23 (m, 6H), 7.05 (t, J = 4.6 Hz, 1H), 6.85-6.92 (m, 1H), 6.69 (dd, J = 9.2 Hz, 2.2 Hz, 1H), 4.95 (d, J = 4.2 Hz, 1H), 4.52 (d, J = 4.2 Hz, 1H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 196.03, 191.25, 164.10 (d, J = 250.8 Hz), 142.86, 142.10, 141.04, 139.89 (d, J = 7.9 Hz), 137.64, 134.28, 133.48, 132.79, 132.06, 131.26 (d, J = 8.7 Hz), 129.39, 128.98, 128.33, 127.98, 127.78, 127.44, 116.54 (d, J = 22.7 Hz), 114.69 (d, J = 21.7 Hz), 50.98, 47.78; **HRMS** for $C_{28}H_{19}FO_2S$: calcd. $(M+H)^+$: 439.1163, found: 439.1161

(3-Benzoyl-4-phenyl-3,4-dihydronaphthalen-2-yl)(thiophen-2-yl)methanone (3zb). Yellow solid; isolated yield 55% (69 mg). R_f 0.50 (10% EtOAc/hexane); Mp 111-113 ^oC; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.88-7.90 (m, 2H), 7.68 (dd, J = 3.8 Hz, 1.1 Hz, 1H), 7.66 (s, 1H), 7.57 (dd, J = 5.0 Hz, 1.1 Hz, 1H), 7.44-7.48 (m, 1H), 7.34-7.38 (m, 2H), 7.30-7.32 (m,

1H), 7.15-7.23 (m, 4H), 7.06-7.11 (m, 4H), 6.93 (br d, J = 6.8 Hz, 1H), 5.12 (d, J = 4.2 Hz, 1H), 4.45 (d, J = 4.2 Hz, 1H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.56, 187.30, 142.75, 142.71, 140.04, 136.89, 136.10, 134.82, 133.34, 133.28, 132.93, 131.69, 130.77, 129.45, 129.12, 128.80, 128.78, 128.60, 127.77, 127.73, 127.12, 50.03, 47.08; **HRMS** for $C_{28}H_{20}O_2S$: calcd. $(M+H)^+$: 421.1257, found: 421.1257

Ethyl 3-benzoyl-4-phenyl-3,4-dihydronaphthalene-2-carboxylate (3zc). White solid; isolated yield 57% (65 mg). R_f 0.50 (15% EtOAc/hexane); Mp 101-102 ^{o}C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.94-7.66 (m, 2H), 7.85 (s, 1H), 7.52-7.56 (m, 1H), 7.42-7.46 (m, 2H), 7.34-7.36 (m, 1H), 7.14-7.23 (m, 5H), 7.05-7.08 (m, 2H), 6.88 (d, J = 7.3 Hz, 1H), 4.98 (d, J = 3.0 Hz, 1H), 4.35 (d, J = 3.0 Hz, 1H), 4.10 (q, J = 7.1 Hz, 2H), 1.15 (t, J = 7.1 Hz, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.28, 166.58, 143.51, 138.98, 136.23, 135.84, 133.06, 131.57, 130.46, 129.33, 129.12, 128.83, 128.82, 128.73, 127.69, 127.54, 127.05, 126.11, 60.90, 49.18, 46.93, 14.08; **HRMS** for $C_{26}H_{22}O_3$: calcd. $(M+H)^+$: 383.1642, found: 383.1644

(6,7-Dimethoxy-1-(4-methoxyphenyl)-1,2-dihydronaphthalene-2,3-diyl)bis((2,4-dimethoxy phenyl)methanone) (3zd). Yellow solid; R_f 0.50 (50% EtOAc/hexane); Mp 185-187 ^{o}C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.65 (d, J = 8.6 Hz, 1H), 7.21 (d, J = 8.4 Hz, 1H), 7.16 (s, 1H), 7.06 (d, J = 8.3 Hz, 2H), 6.71 (d, J = 8.3 Hz, 2H), 6.48 (s, 1H), 6.42-6.46 (m, 4H), 5.26 (s, 1H), 4.31 (s, 1H), 3.79 (s, 6H), 3.76 (s, 3H), 3.74 (s, 3H), 3.70 (2 s merged, 6H), 3.65 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 197.67, 195.04, 164.23, 162.36, 160.35, 158.94, 158.19, 150.59, 147.86, 141.75, 136.84, 134.59, 133.59, 131.62, 131.37, 128.42, 124.86, 122.06, 120.07, 113.65, 112.10, 105.35, 104.15, 98.88, 98.52, 55.91, 55.88, 55.71, 55.68, 55.51, 55.45, 55.24, 51.58, 45.50; **HRMS** for $C_{37}H_{36}O_9$: calcd. $(M+H)^+$: 625.2432, found: 625.2431

(7,8-Dimethoxy-1-(4-methoxyphenyl)-1,2-dihydronaphthalene-2,3-diyl)bis((2,4-dimethoxy phenyl)methanone) (3ze). White solid; R_f 0.50 (50% EtOAc/hexane); Mp 125-127 ^{o}C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.56 (d, J = 8.9 Hz, 1H), 7.02-7.09 (m, 4H), 6.71 (s, 1H), 6.65 (d, J = 8.5 Hz, 2H), 6.51 (s, 1H), 6.39-6.48 (m, 4H), 4.93 (s, 1H), 4.58 (s, 1H), 3.81 (s, 9H), 3.77 (s, 3H), 3.73 (s, 3H), 3.67 (s, 3H), 3.61 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 199.01, 195.34, 164.33, 162.31, 159.76, 158.90, 158.24, 150.50, 148.17, 140.10, 137.10, 135.09, 133.26, 130.97, 128.63, 127.78, 126.34, 122.33, 120.14, 113.54, 112.78, 111.80, 105.56, 104.13, 98.91, 98.44, 57.55, 55.90, 55.84, 55.66, 55.57, 55.44, 55.14, 39.58; **HRMS** for $C_{37}H_{36}O_9$: calcd. $(M+H)^+$: 625.2432, found: 625.2431

(3-Benzoyl-1-(p-tolyl)naphthalen-2-yl)(4-methoxyphenyl)methanone (4a). Yellow solid; isolated yield 56% (25 mg). R_f 0.50 (20% EtOAc/hexane); Mp 138-140 ^{o}C; **^{1}H NMR** (400

MHz, $CDCl_3$) δ 8.11 (s, 1H), 7.93 (d, *J* = 8.4 Hz, 1H), 7.85-7.88 (m, 2H), 7.68 (d, *J* = 8.4 Hz, 1H), 7.51-7.61 (m, 5H), 7.43-7.47 (m, 2H), 7.04, 7.11 (ABq, *J* = 7.9 Hz, 4H), 6.67-6.71 (m, 2H), 3.76 (s, 3H), 2.28 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 196.77, 196.25, 162.90, 138.98, 137.55, 137.46, 137.26, 135.04, 133.78, 133.44, 132.88, 131.97, 131.54, 131.16, 130.68, 130.50, 129.12, 128.69, 128.54, 128.30, 127.40, 126.99, 113.14, 55.33, 21.22; **HRMS** for $C_{32}H_{24}O_3$: calcd. $(M+H)^+$: 457.1798, found: 457.1796

(3-Benzoyl-1-(4-methoxyphenyl)naphthalen-2-yl)(3-methoxyphenyl)methanone (4b). Yellow solid; isolated yield 60% (28 mg). R_f 0.50 (25% EtOAc/hexane); Mp 169-171 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.06 (s, 1H), 7.87 (d, *J* = 7.5 Hz, 1H), 7.80-7.82 (m, 2H), 7.63 (d, *J* = 8.3 Hz, 1H), 7.46-7.55 (m, 3H), 7.38-7.42 (m, 2H), 7.00-7.07 (m, 5H), 6.81-6.84 (m, 1H), 6.68-6.72 (m, 2H), 3.69 (s, 3H), 3.64 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.17, 196.07, 159.21, 159.03, 140.01, 138.95, 137.72, 137.40, 134.96, 133.98, 132.88, 132.10, 132.04, 131.45, 130.48, 129.20, 128.85, 128.80, 128.48, 128.33, 127.51, 126.93, 122.50, 119.21, 113.37, 112.65, 55.30, 55.20; **HRMS** for $C_{32}H_{24}O_4$: calcd. $(M+H)^+$: 473.1747, found: 473.1752

(3-Benzoyl-1-(4-methoxyphenyl)naphthalen-2-yl)(4-methoxyphenyl)methanone (4c). White solid; isolated yield 30% (14 mg). R_f 0.50 (15% EtOAc/hexane); Mp 194-195 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.04 (s, 1H), 7.86 (d, *J* = 7.9 Hz, 1H), 7.80 (d, *J* = 7.3 Hz, 2H), 7.63 (d, *J* = 8.2 Hz, 1H), 7.46-7.54 (m, 5H), 7.39 (t, *J* = 7.7 Hz, 2H), 7.07 (d, *J* = 8.2 Hz, 2H), 6.70 (d, *J* = 8.5 Hz, 2H), 6.62 (d, *J* = 8.8 Hz, 2H), 3.69, 3.70 (2 s, 6H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 196.91, 196.25, 162.89, 158.97, 138.56, 137.79, 137.44, 135.08, 133.91, 132.89, 132.01, 131.91, 131.51, 131.14, 130.52, 129.15, 128.70, 128.63, 128.30, 127.38, 126.90, 113.35, 113.18, 55.32, 55.19; **HRMS** for $C_{32}H_{24}O_4$: calcd. $(M+H)^+$: 473.1747, found: 473.1747

(3-(3-Methoxybenzoyl)-4-(4-methoxyphenyl)-6-methylnaphthalen-2-yl)(p-tolyl)methanone (4d). White solid; isolated yield 50% (25 mg). R_f 0.50 (25% EtOAc/hexane); Mp 130-132 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.02 (s, 1H), 7.77 (d, *J* = 8.7 Hz, 1H), 7.71 (d, *J* = 7.8 Hz, 2H), 7.37 (br d, *J* = 5.2 Hz, 2H), 7.19 (d merged with $CDCl_3$ peak, *J* = 7.6 Hz, 2H), 7.00-7.06 (m, 5H), 6.82 (d, *J* = 6.8 Hz, 1H), 6.70 (d, *J* = 8.4 Hz, 2H), 3.71 (s, 3H), 3.64 (s, 3H), 2.37 (s, 6H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.33, 195.75, 159.18, 158.91, 143.59, 140.13, 139.09, 138.18, 137.91, 134.90, 134.29, 134.12, 132.11, 131.23, 130.64, 130.23, 129.68, 129.04, 128.99, 128.74, 128.68, 125.84, 122.50, 119.16, 113.32, 112.55, 55.28, 55.18, 22.16, 21.70; **HRMS** for $C_{34}H_{28}O_4$: calcd. $(M+H)^+$: 501.2060, found: 501.2067

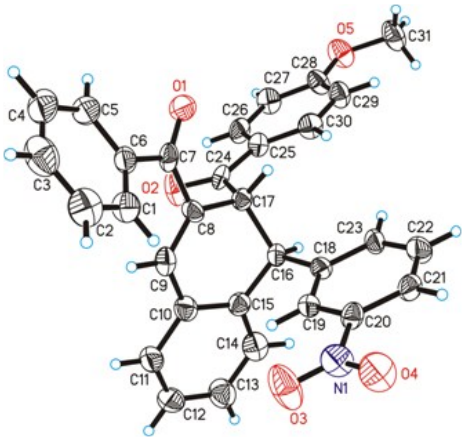
(3-(4-Methoxybenzoyl)-6-methyl-4-(4-(methylthio)phenyl)naphthalen-2-yl)(p-tolyl) methanone (4e). White solid; isolated yield 26% (13 mg). R_f 0.50 (20% EtOAc/hexane); Mp 205-207 ^oC; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.01 (s, 1H), 7.76 (d, *J* = 8.3 Hz, 1H), 7.69 (d, *J* = 8.2 Hz, 2H), 7.45-7.48 (m, 2H), 7.35-7.37 (m, 1H), 7.33 (br s, 1H), 7.18 (d, *J* = 7.9 Hz, 2H), 7.05 (s, 4H), 6.60-6.64 (m, 2H), 3.70 (s, 3H), 2.36, 2.37, 2.38 (3s merged, 9H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 196.85, 195.83, 162.88, 143.65, 139.09, 137.86, 137.50, 134.91, 134.34, 133.77, 133.32, 132.01, 131.47, 131.23, 131.12, 130.66, 130.18, 129.66, 129.02, 128.98, 125.69, 113.17, 55.33, 22.16, 21.71, 15.56; **HRMS** for $C_{34}H_{28}O_3S$: calcd. $(M+H)^+$: 517.1832, found: 517.1829

(6,7-Dimethoxy-1-(4-methoxyphenyl)naphthalene-2,3-diyl)bis((2,4-dimethoxyphenyl) methanone) (4f). White solid; isolated yield 14% (9 mg). R_f 0.50 (60% EtOAc/hexane); Mp 138-140 ^oC; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 7.80 (s, 1H), 7.36 (d, *J* = 8.7 Hz, 1H), 7.32 (d, *J* = 8.1 Hz, 1H), 7.09 (s, 1H), 7.04 (d, *J* = 7.7 Hz, 2H), 6.80 (s, 1H), 6.70 (d, *J* = 7.7 Hz, 2H), 6.38-6.40 (br m, 2H), 6.22 (d, *J* = 8.4 Hz, 1H), 6.13 (s, 1H), 3.92 (s, 3H), 3.78 (s, 3H), 3.70 (s, 6H), 3.67 (s, 3H), 3.63 (s, 3H), 3.42 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 195.07, 194.53, 164.02, 163.57, 160.64, 160.35, 158.57, 150.99, 149.91, 139.07, 135.42, 135.11, 133.69, 133.40, 131.59, 130.30, 129.83, 129.33, 127.88, 122.37, 121.86, 113.22, 107.33, 105.63, 104.47, 104.37, 98.79, 98.06, 55.95, 55.80, 55.72, 55.48, 55.42, 55.35, 55.15; **HRMS** for $C_{37}H_{34}O_9$: calcd. $(M+H)^+$: 623.2276, found: 623.2270

(7,8-Dimethoxy-1-(4-methoxyphenyl)naphthalene-2,3-diyl)bis((2,4-dimethoxyphenyl) methanone) (4g). White solid; isolated yield 13% (8 mg). R_f 0.50 (60% EtOAc/hexane); Mp 147-149 ^oC; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.86 (s, 1H), 7.09-7.19 (m, 4H), 6.82 (d, *J* = 7.8 Hz, 2H), 6.37 (d, *J* = 8.3 Hz, 2H), 6.16-6.19 (m, 1H), 6.10-6.13 (m, 1H), 6.07 (br s, 2H), 3.95 (s, 3H), 3.80 (s, 3H), 3.68 (s, 3H), 3.66 (s, 3H), 3.55 (s, 3H), 3.48 (s, 3H), 3.41 (s, 3H); **^{13}C NMR** (100 MHz, $CDCl_3$) δ 197.17, 196.70, 164.38, 163.87, 160.76, 160.02, 158.19, 151.14, 149.81, 139.07, 138.43, 133.75, 133.46, 132.99, 131.37, 130.78, 127.79, 127.38, 127.02, 122.29, 122.23, 112.61, 107.03, 104.40, 104.15, 104.09, 98.22, 98.11, 55.96, 55.91, 55.58, 55.40, 55.11; **HRMS** for $C_{37}H_{34}O_9$: calcd. $(M+H)^+$: 623.2276, found: 623.2274

3. Crystallographic Data

3.1 Crystallographic data for 3l



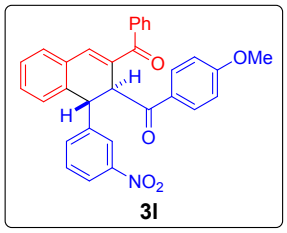


Figure 1. ORTEP diagram drawn with 30% ellipsoid probability for non-H atoms of the crystal structure of compound **3l** determined at 293 K.

Crystallization: Crystals of compound **3l** were grown from the solvent DCM:EtOH (1:3) by slow evaporation method.

Table 1. Crystal data and structure refinement details for **3l**

Compound	**3l**
Empirical formula	$C_{31}H_{23}NO_5$
Formula weight	489.50
Crystal System	Monoclinic
Space group	$P2_1/c$
a (Å)	13.541(8)
b (Å)	9.928(6)
c (Å)	20.222(15)
α (°)	90.00
β (°)	90.670(14)
γ (°)	90.00
V (Å^3)	2718(3)
Z	4
D_c (g/cm^3)	1.196
F_{000}	1024
μ (mm^{-1})	0.081
θ_{max} (°)	25.40
Total reflections	13071
Unique reflections	4683
Reflections [$I > 2\sigma(I)$]	1282
Parameters	335
R_{int}	0.1222
Goodness-of-fit	0.859
R [$F^2 > 2\sigma(F^2)$]	0.0936
wR (F^2, all data)	0.2884
CCDC No.	1816363

3.2 Crystallographic data for 3x

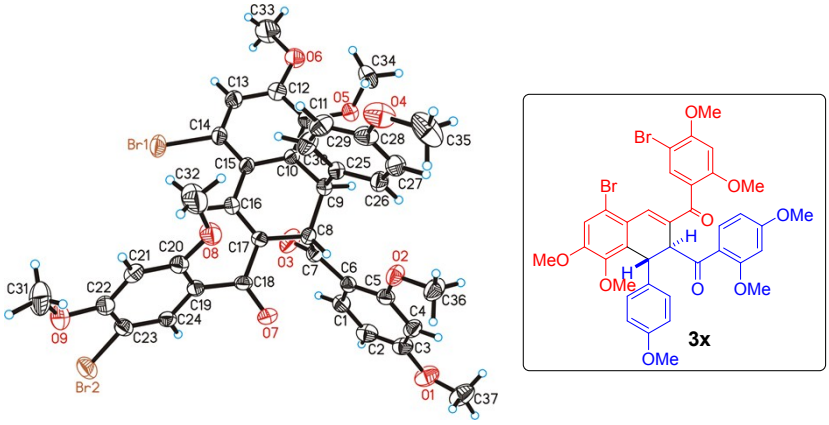


Figure 2 ORTEP diagram drawn with 30% ellipsoid probability for non-H atoms of the crystal structure of compound **3x** determined at 293 K.

Crystallization: Crystals of compound **3x** were grown from the solvent DCM:EtOH (1:3) by slow evaporation method.

Table 2 Crystal data and structure refinement details for **3x**

Compound	**3x**
Empirical formula	$C_{38}H_{34}Br_2O_{10}$
Formula weight	810.47
Crystal System	Monoclinic
Space group	$P2_1/c$
a (Å)	17.651(4)
b (Å)	11.598(3)
c (Å)	18.625(5)
α (°)	90.00
β (°)	98.778(5)
γ (°)	90.00
V (Å^3)	3768.2(16)
Z	4
D_c (g/cm^3)	1.429
F_{000}	1648
μ (mm^{-1})	2.206
θ_{max} (°)	25.38
Total reflections	23722
Unique reflections	6762
Reflections [$I > 2\sigma(I)$]	3424
Parameters	458
R_{int}	0.0752
Goodness-of-fit	0.999
R [$F^2 > 2\sigma(F^2)$]	0.0647
wR (F^2, all data)	0.1871
CCDC No.	1816362

4. Experimental HPLC Chromatogram of the Product Mixture of Reaction between 1s & 2h

```
Data File C:\CHEM32\1\DATA\MANISHA-28-02-2018-1 2018-02-28 12-40-34\069-0101.D
Sample Name: NAM-1

======================================================================
Acq. Operator   : Dr. Anil Kumar K.S.          Seq. Line :   1
Acq. Instrument : Instrument 1                  Location : Vial 69
Injection Date  : 2/28/2018 12:42:25 PM              Inj :   1
                                               Inj Volume : 5.000 µl
Acq. Method     : C:\CHEM32\1\DATA\MANISHA-28-02-2018-1 2018-02-28 12-40-34\ACN-METH-WATER-35
                  -35-30.M
Last changed    : 2/28/2018 11:52:20 AM by Dr. Anil Kumar K.S.
Analysis Method : C:\CHEM32\1\METHODS\ACN-METH-WATER-35-35-30.M
Last changed    : 2/28/2018 11:52:20 AM by Dr. Anil Kumar K.S.
Method Info     : OSDD

Additional Info : Peak(s) manually integrated
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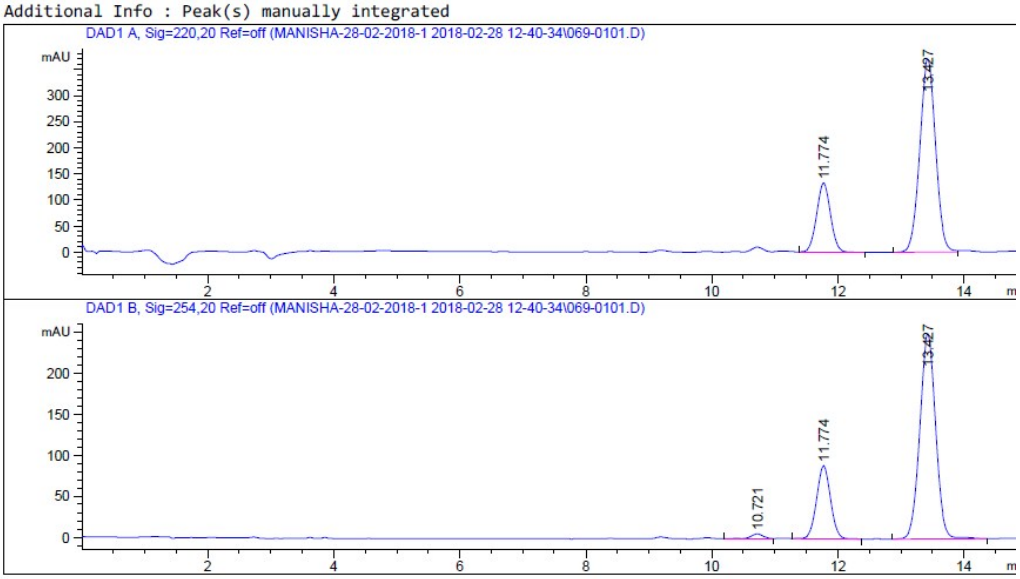


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======================================================================
                        Area Percent Report
======================================================================

Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: DAD1 A, Sig=220,20 Ref=off

Peak RetTime Type  Width     Area      Height     Area
  #   [min]        [min]   [mAU*s]     [mAU]       %
----|-------|----|-------|----------|----------|--------|
   1  11.774 VB    0.2420 2053.78418  133.10472  24.1867
   2  13.427 BV    0.2710 6437.61035  370.04031  75.8133

Totals :                  8491.39453  503.14503
Signal 2: DAD1 B, Sig=254,20 Ref=off

Peak RetTime Type  Width     Area      Height     Area
  #   [min]        [min]   [mAU*s]     [mAU]       %
----|-------|----|-------|----------|----------|--------|
   1  10.721 BV    0.2118   79.16134    5.77861   1.3644
   2  11.774 BB    0.2407 1362.77673   88.97102  23.4882
   3  13.427 BB    0.2718 4360.01416  249.59172  75.1474

Totals :                  5801.95223  344.34136


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                        *** End of Report ***
```

5. References

(1) For **1a**: (a) P. Ahmad, H. Woo, K. Jun, A. A. Kadi, H. A. Abdel-Aziz, K. Kwon and A. F. M. M. Rahman, *Bioorg. Med. Chem.*, 2016, **24**, 1898-1908; For **1b**, **1d**, **1g**: (b) I. Kazi, S. Guha and G. Sekar, *Org. lett.*, 2017, **19**, 1244-1247; For **1c**, **1i**, **1k**: (c) L. Zhang, A. Wang, W. Wang, Y. Huang, X. Liu, S. Miao, J. Liu and T. Zhang, *ACS Catal.*, 2015, **5**, 6563-6572; For **1e**: (d) S. M. Stevenson, R. F. Higgins, M. P. Shores and E. M. Ferreira, *Chem. Sci.*, 2017, **8**, 654-660; For **1f**: (e) M. D. Bowman, M. M. Jacobson and H. E. Blackwell, *Org. Lett.*, 2016, **8**, 1645-1648; For **1h**: (f) B. Umesha and Y. B. Basavaraju, *Russ. J. Bioorg. Chem*., 2014, **40***,* 467-476; For **1j**, **1r**: (g) C. Chan, Y. Tsai and M. Y. Chang, *Tetrahedron*, 2017, **73**, 3368-3376; For **1l**: (h) P. Gao, K. Zhang, M. Yang, S. Xu, H. Sun, J. Zhang, Z. Gao, W. Zhang and L. Xu, *Chem. Commun.*, 2018, **54**, 5074-5077; For **1m**: (i) M. Li, V. Carreras, A. Jalba and T. Ollevier, *Org. Lett*., 2018, **20**, 995-998; For **1n**: (j) B. Liu, Y. Bao, F. Du, H. Wang, J. Tian and R. Bai, *Chem. Commun.*, 2011, **47**, 1731-1733; For **1o**: (k) A. Ueda, T. Umeno, M. Doi, K. Akagawa, K. Kudo and M. Tanaka, *J. Org. Chem.*, 2016, **81**, 6343-6356; For **1p**: (l) D. Wang, Y. Zhang, A. Harris, L. N. S. Gautam, Y. Chen and X. Shi, *Adv. Synth. Catal.*, 2011, **353**, 2584-2588; For **1q**: (m) P. Gao, K. Zhang, M. Yang, S. Xu, H. Sun, J. Zhang, Z. Gao, W. Zhang and L. Xu, *Chem. Commun.*, 2018, **54**, 5074-5077; For **1s**: (n) A. Bianco, C. Cavarischia and M. Guis, *Eur. J. Org. Chem.*, 2004, 2894-2898.

(2) S. Paria and O. Reiser, *Adv. Synth. Catal.*, 2014, **356**, 557-562.

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

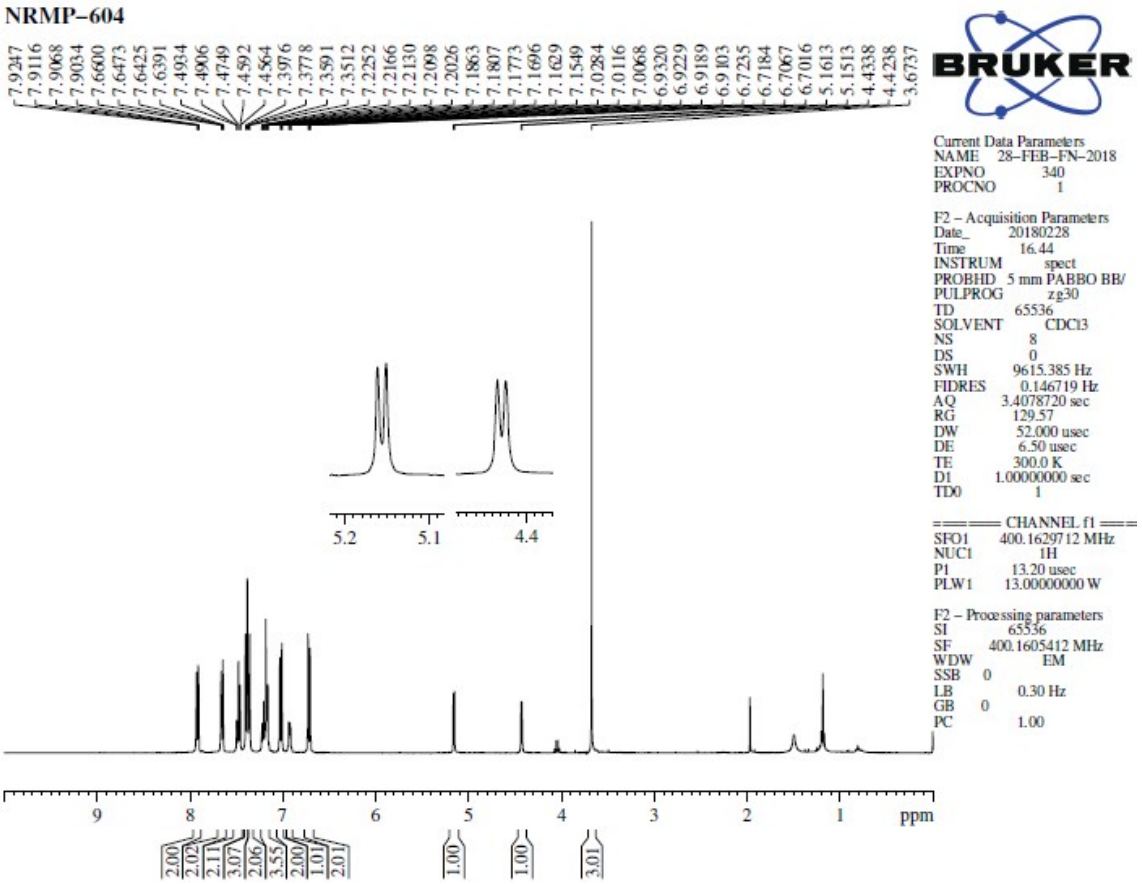

Figure 1: ^{1}H NMR spectrum of 3a

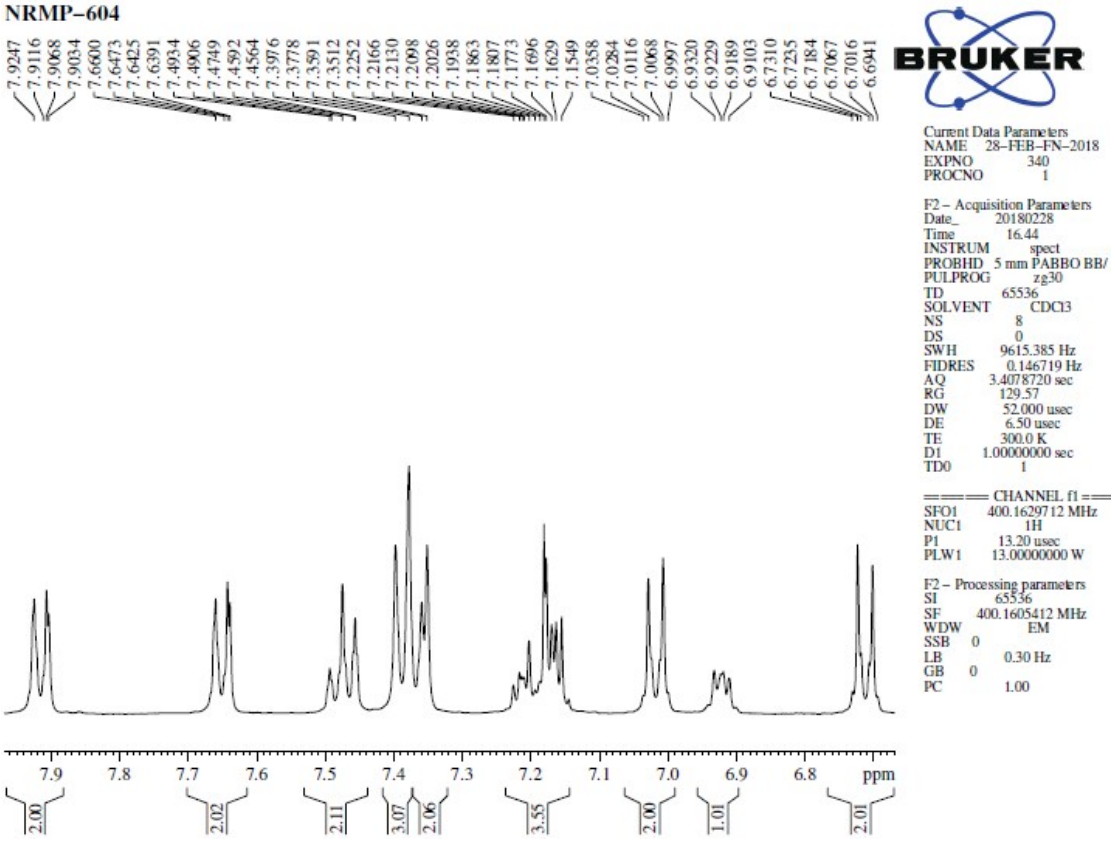

Figure 2: ^{1}H NMR spectrum of 3a (expansion)

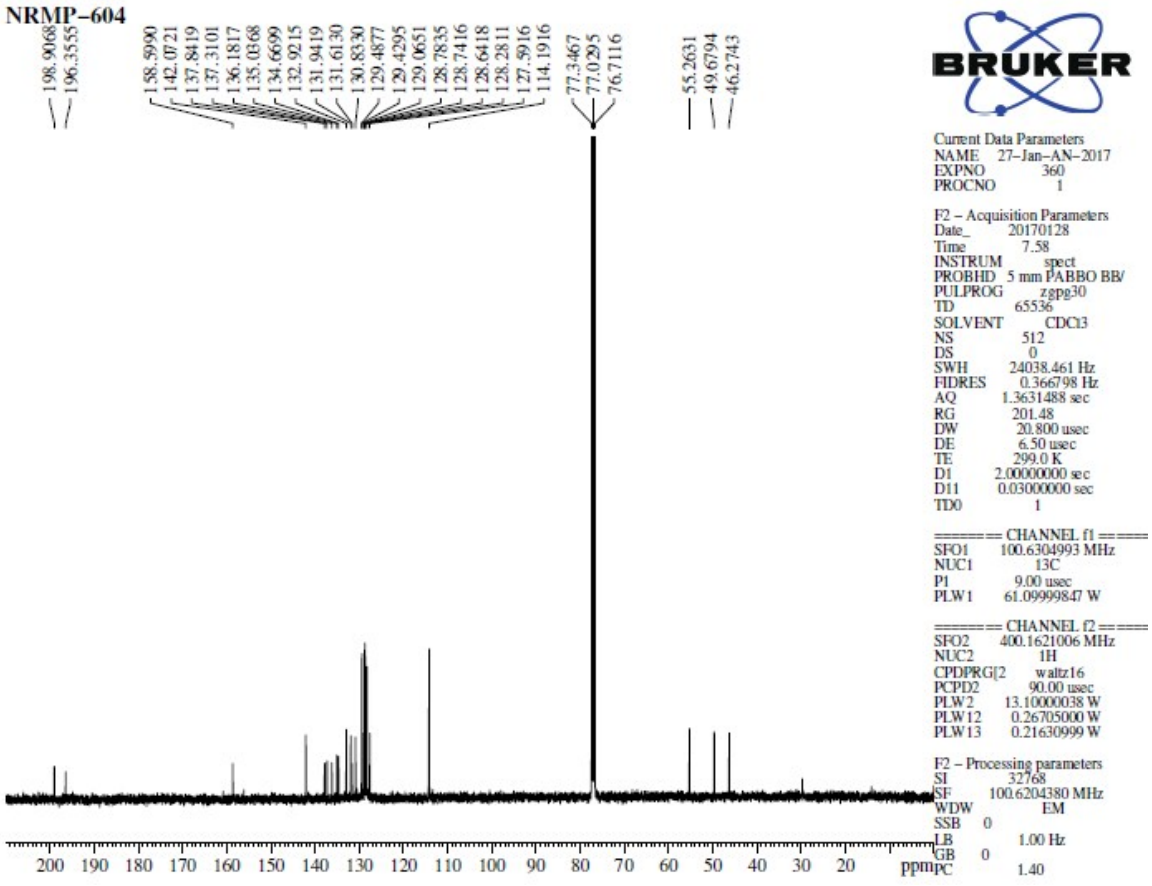

Figure 3: ^{13}C NMR spectrum of 3a

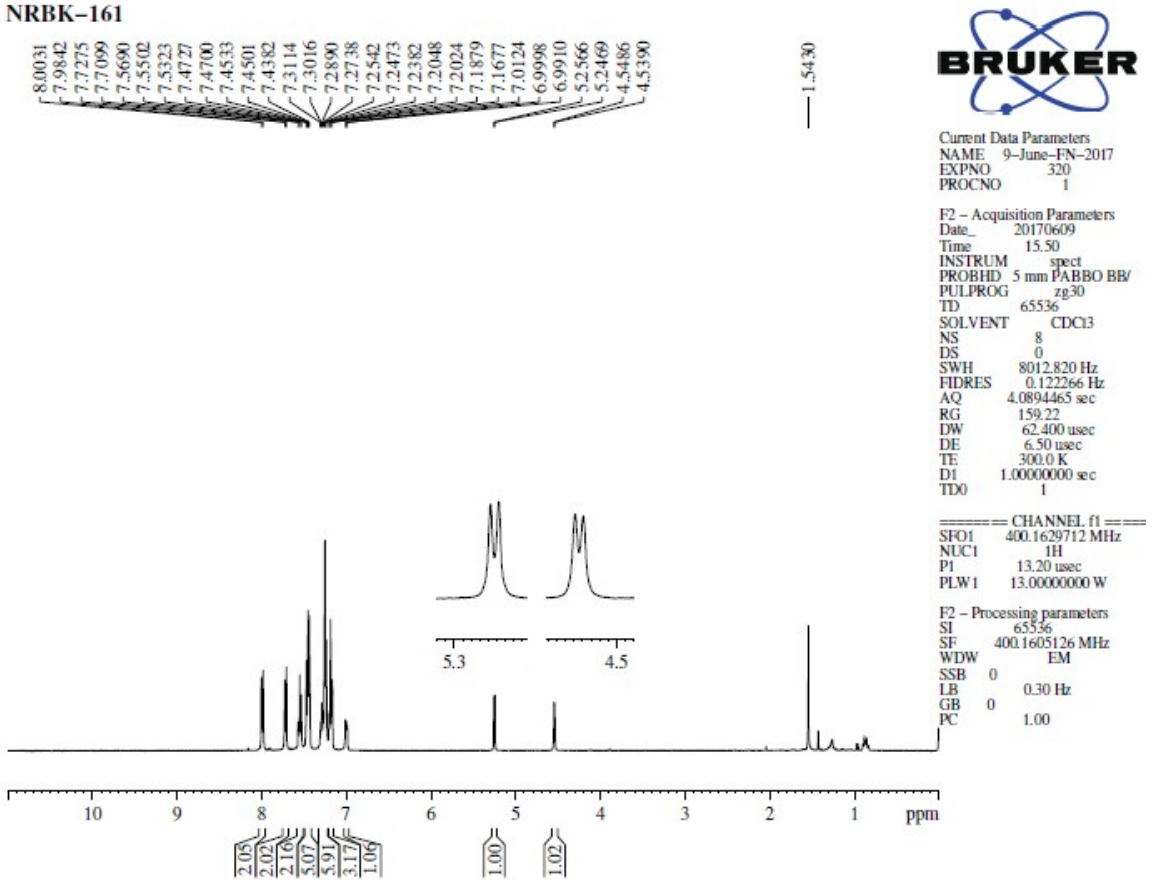

Figure 4: ^{1}H NMR spectrum of 3b

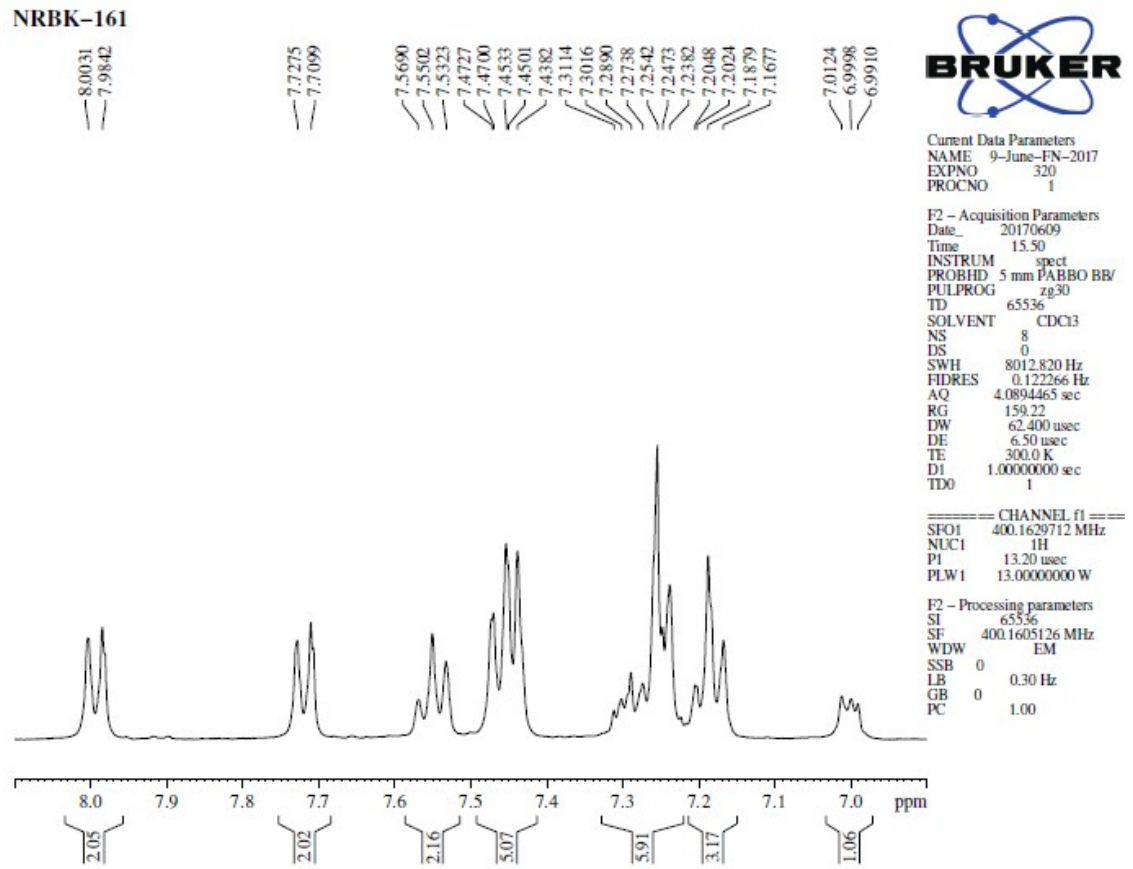

Figure 5: ^{1}H NMR spectrum of 3b (expansion)

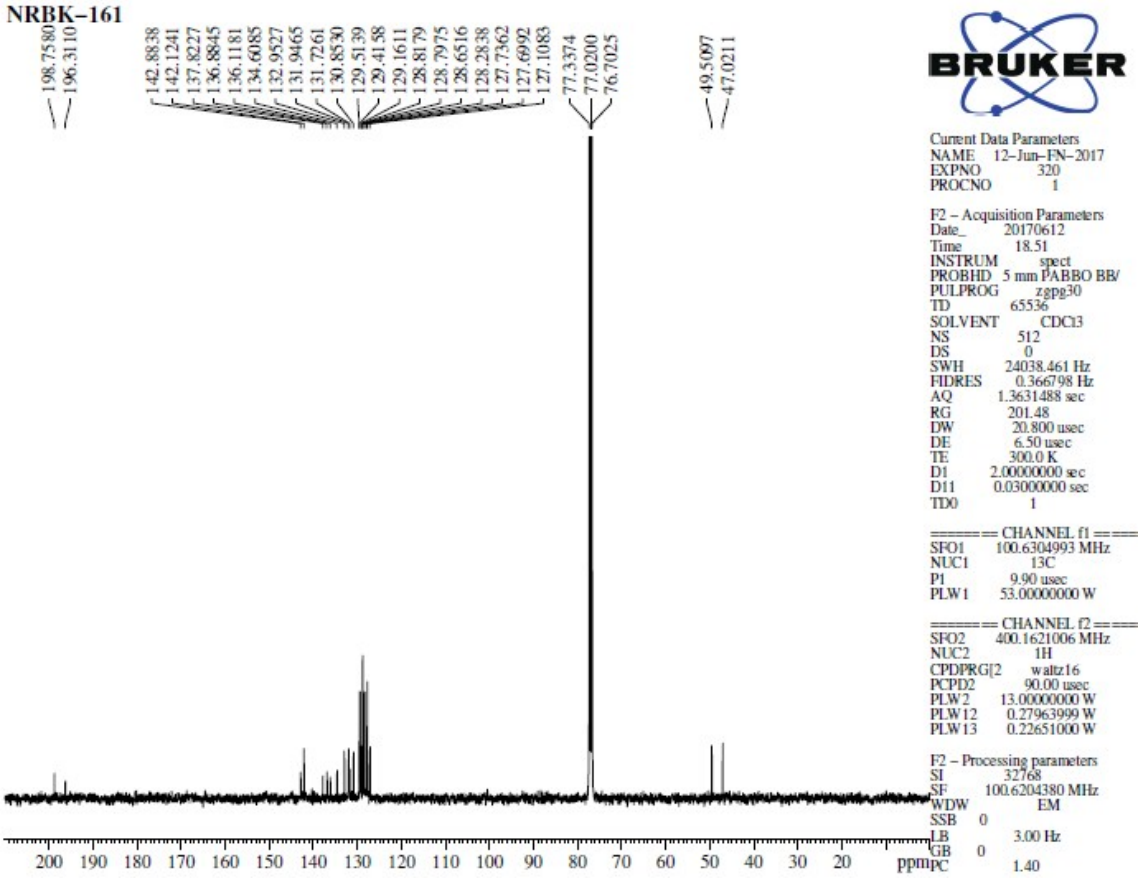

Figure 6: ^{13}C NMR spectrum of 3b

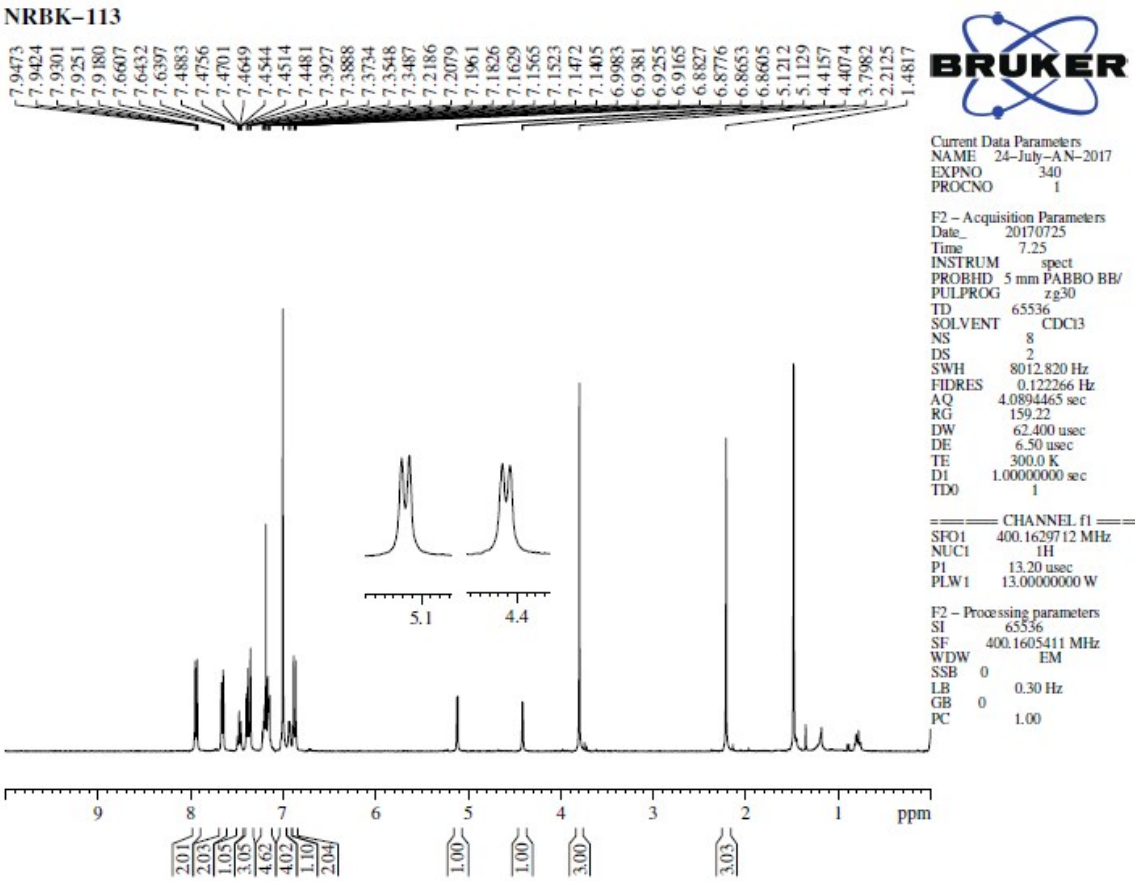

Figure 7: ^{1}H NMR spectrum of 3c

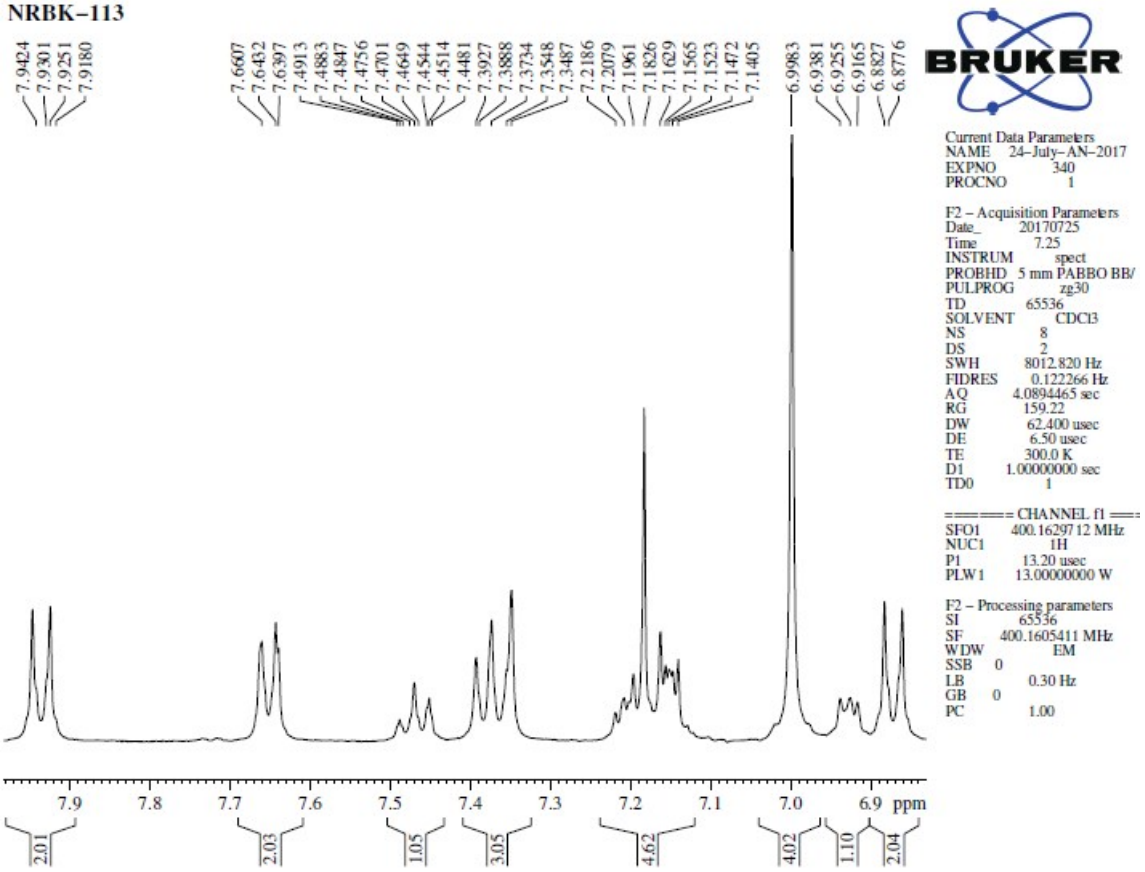

Figure 8: ^{1}H NMR spectrum of 3c (expansion)

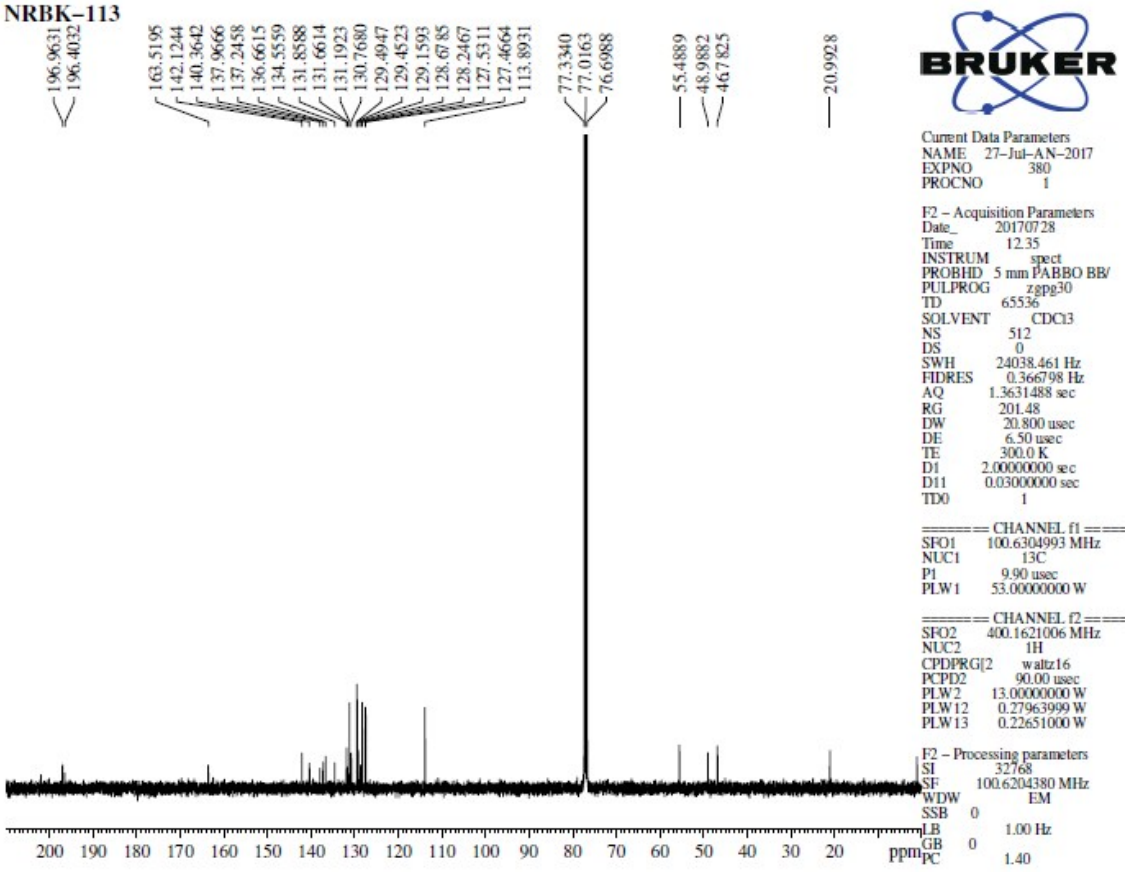

Figure 9: ^{13}C NMR spectrum of 3c

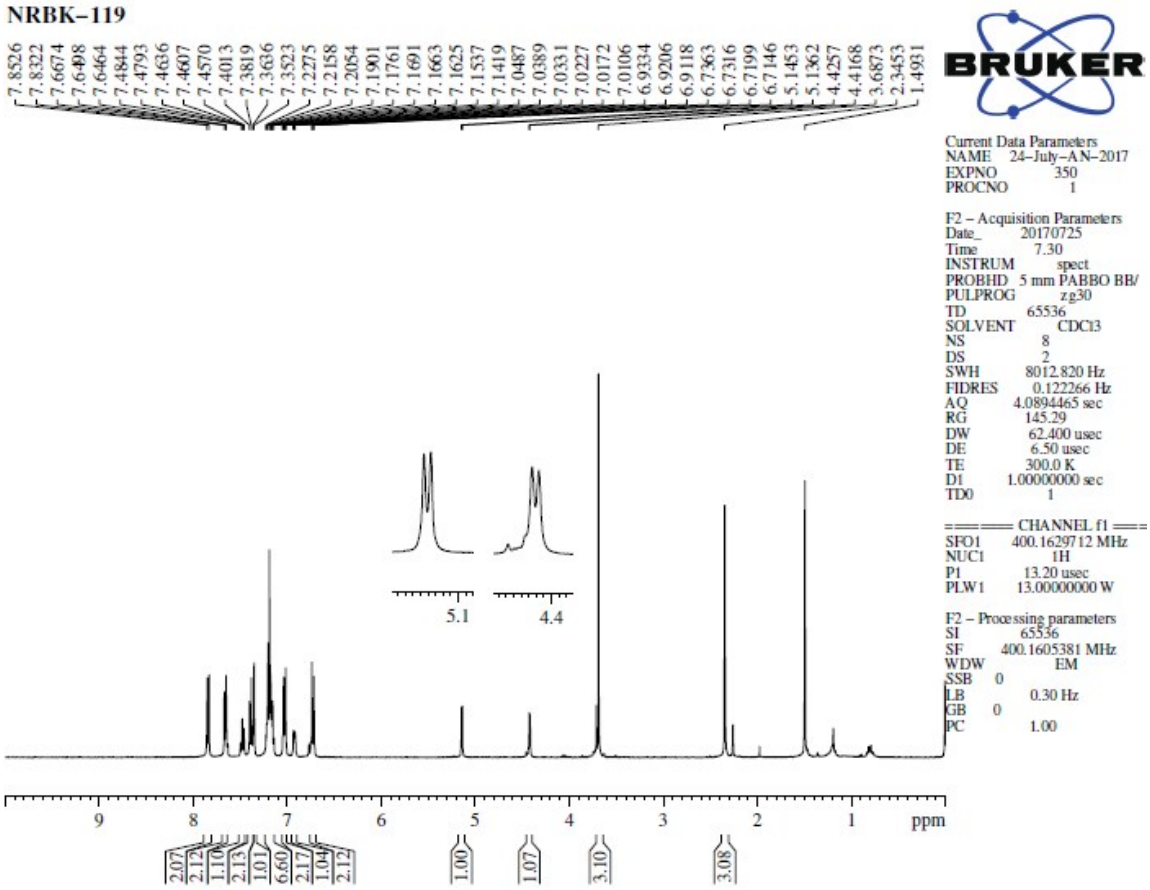

Figure 10: ^{1}H NMR spectrum of 3d

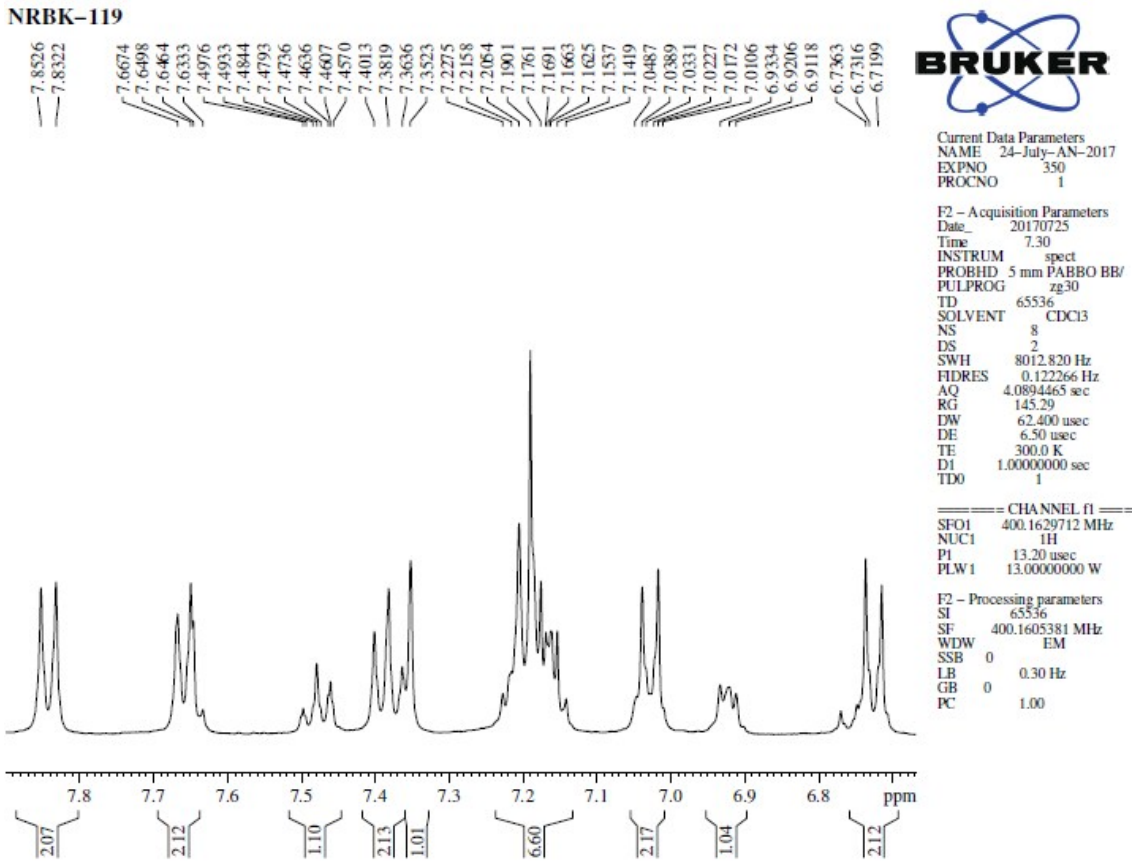

Figure 11: ^{1}H NMR spectrum of 3d (expansion)

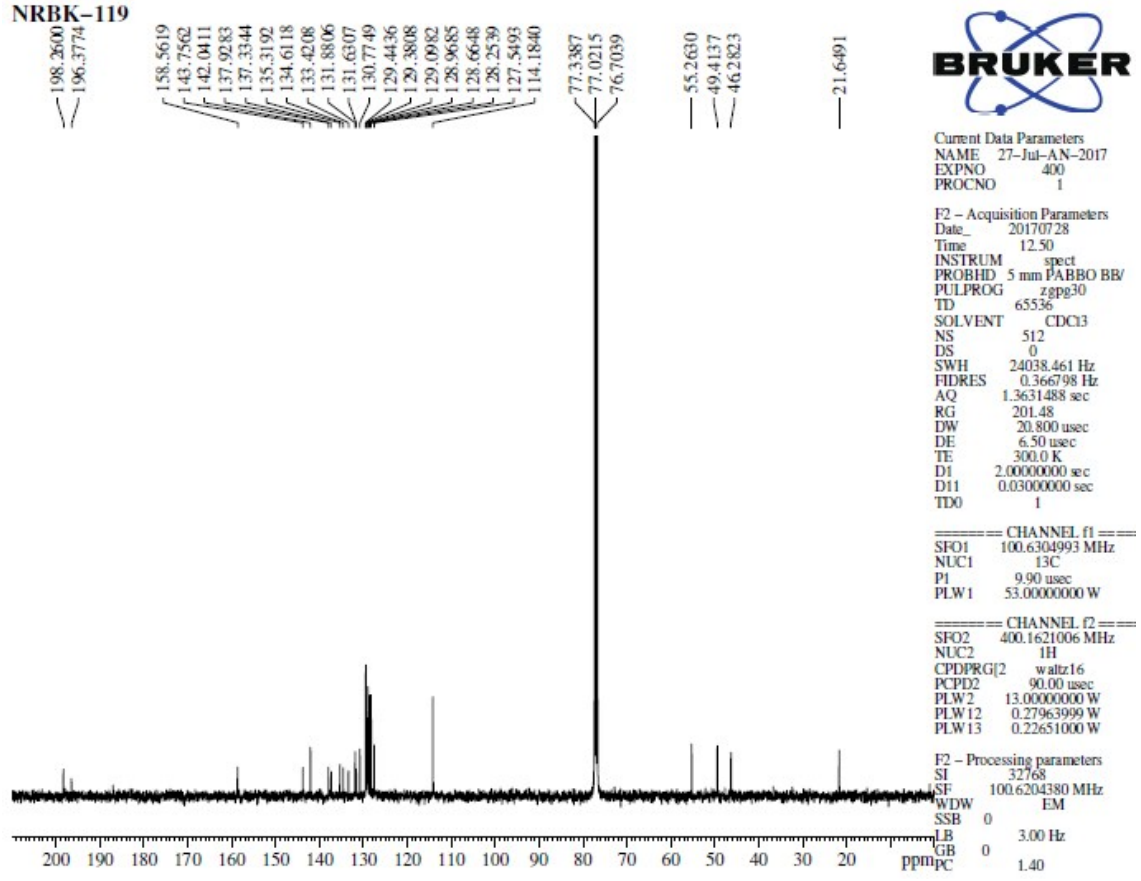

Figure 12: ^{13}C NMR spectrum of 3d

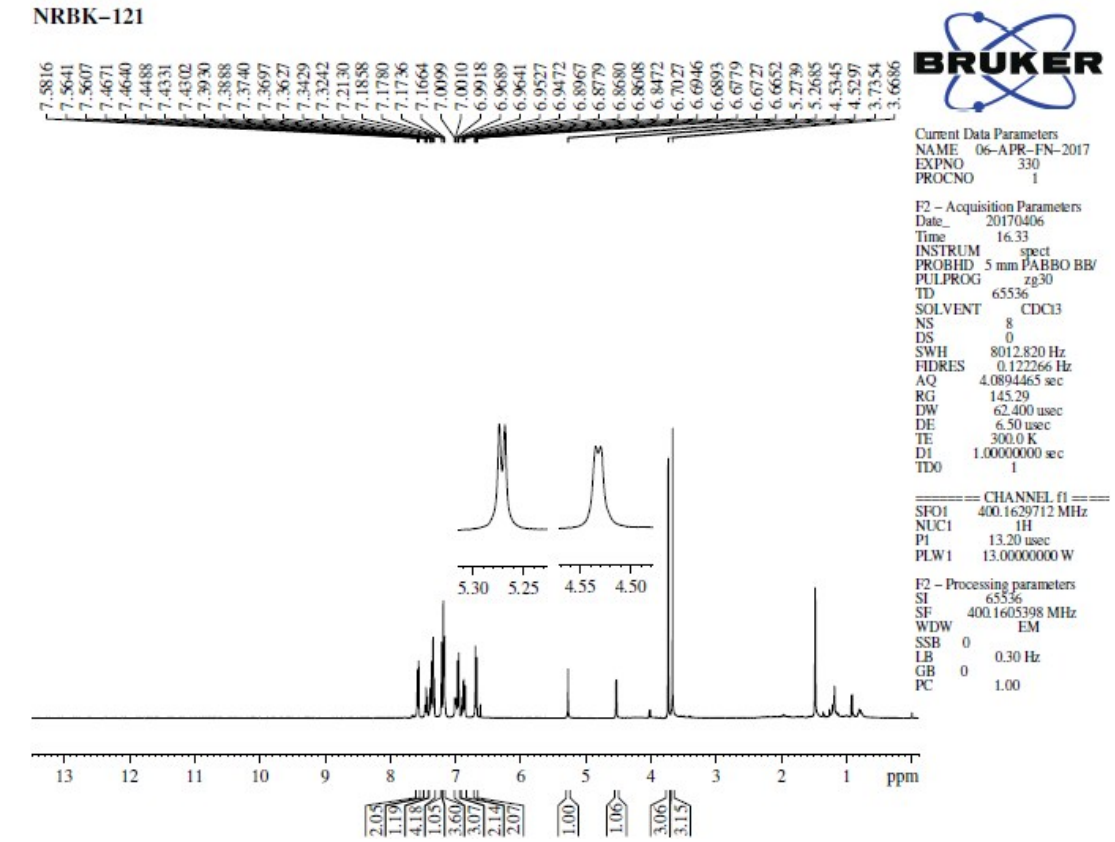

Figure 13: ^{1}H NMR spectrum of 3e

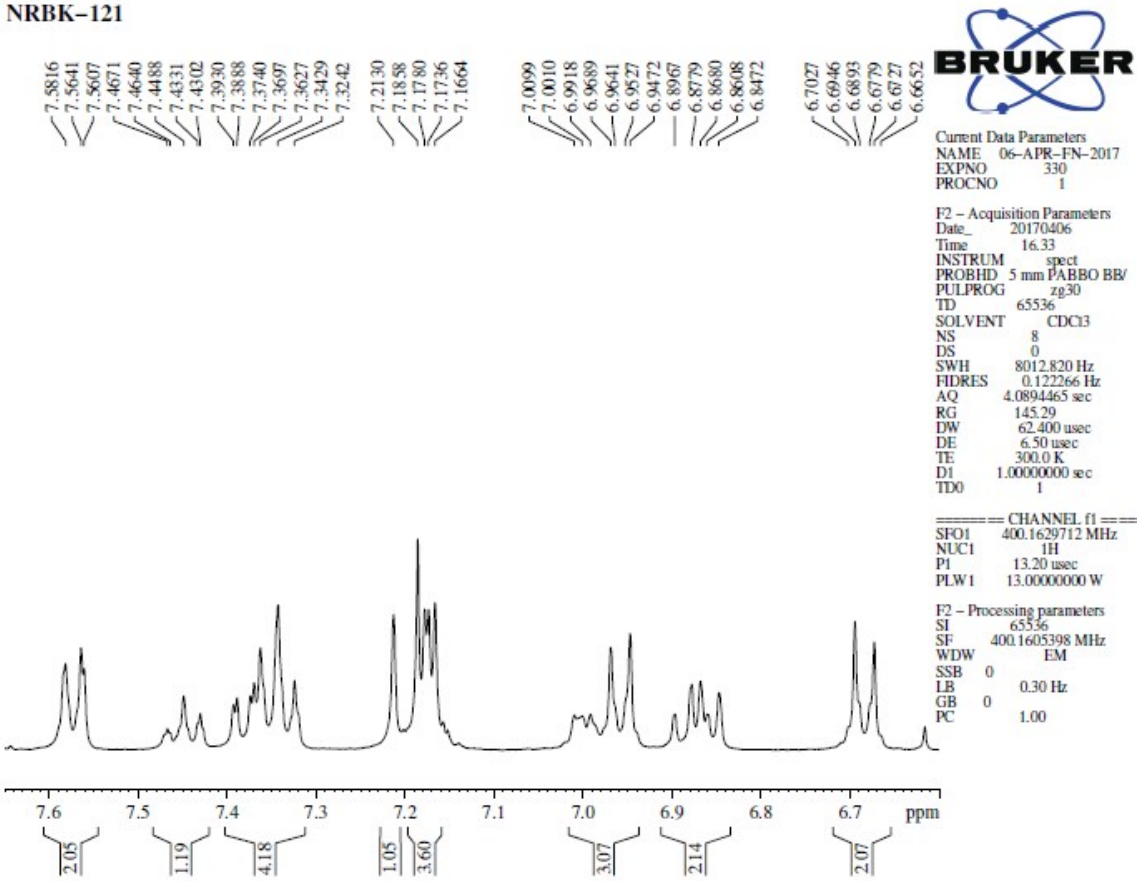

Figure 14: ^{1}H NMR spectrum of 3e (expansion)

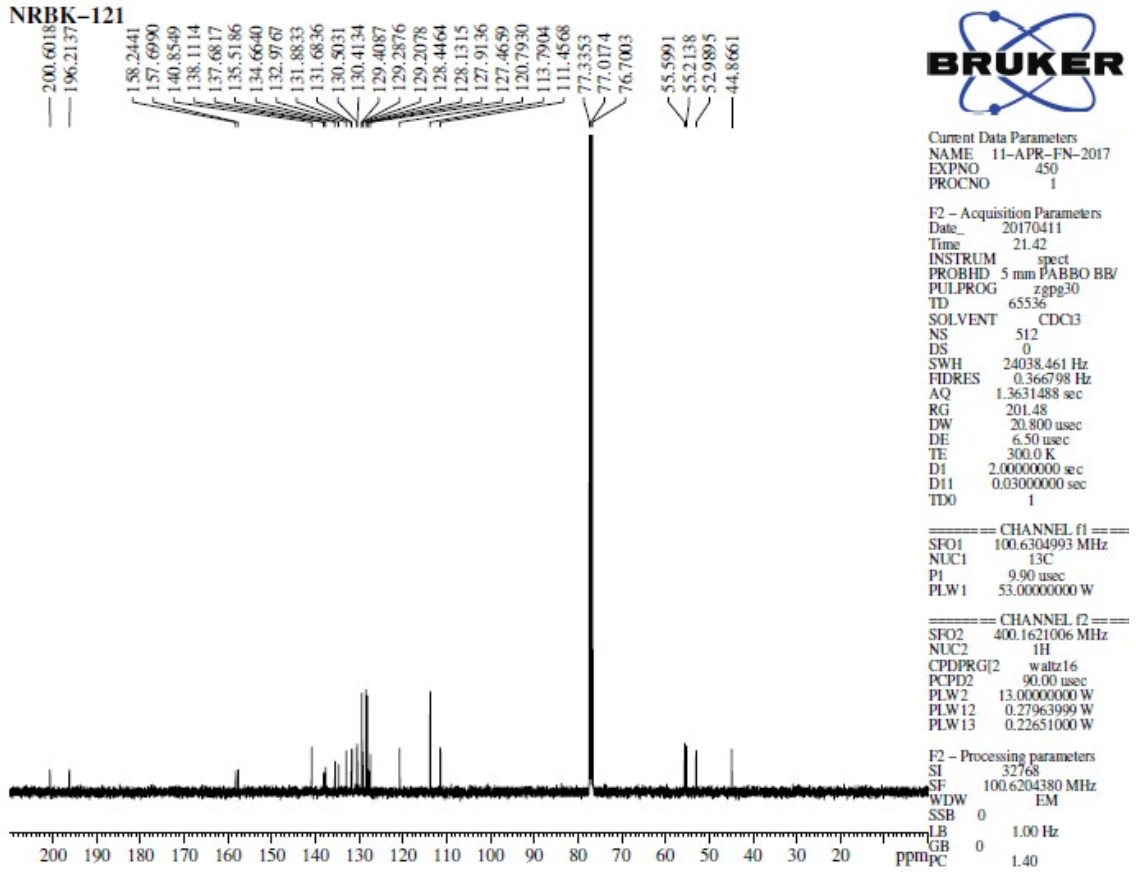

Figure 15: ^{13}C NMR spectrum of 3e

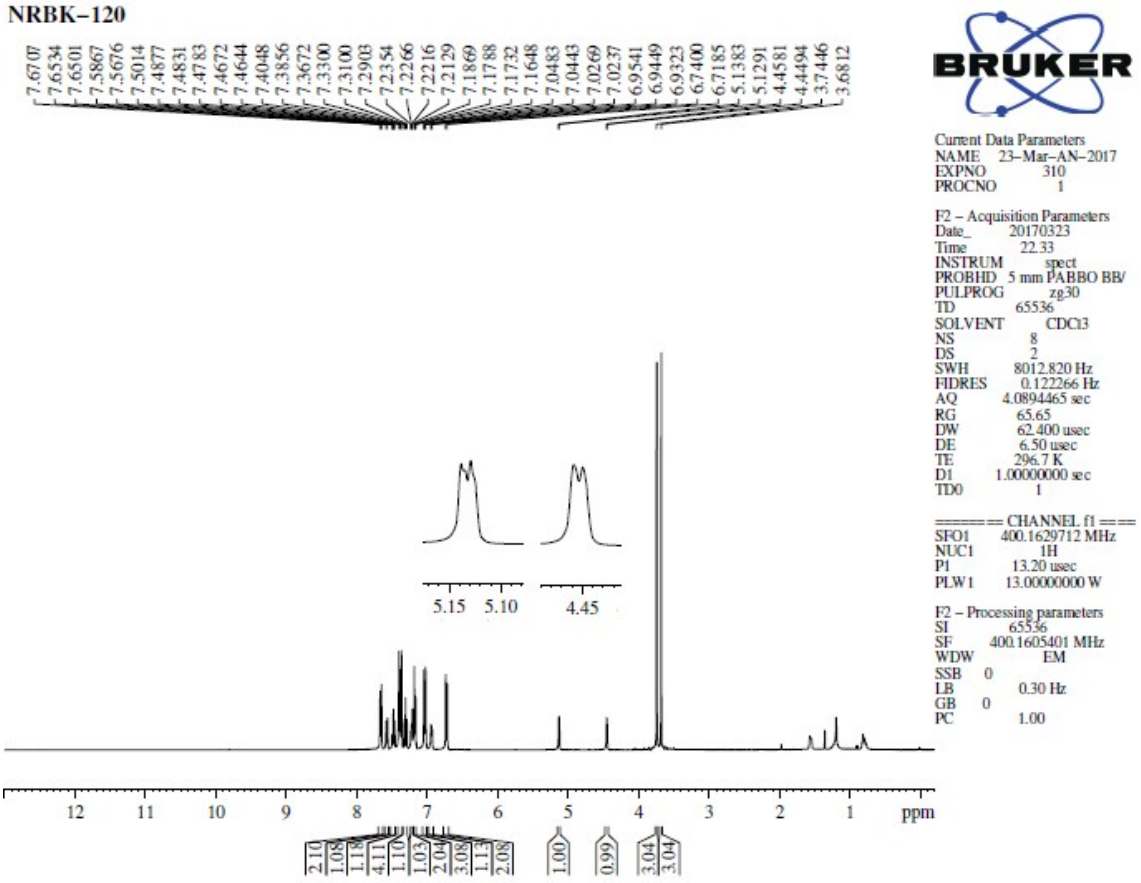

Figure 16: ^{1}H NMR spectrum of 3f

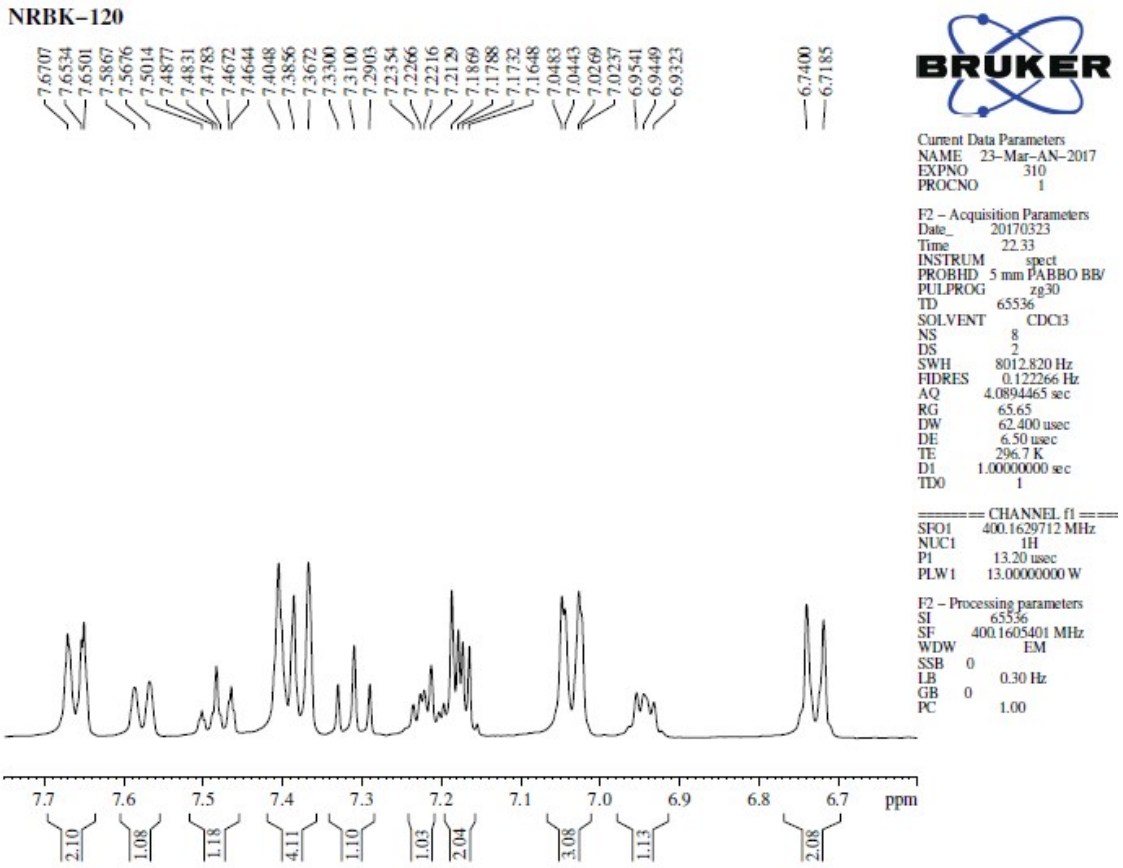

Figure 17: ^{1}H NMR spectrum of 3f (expansion)

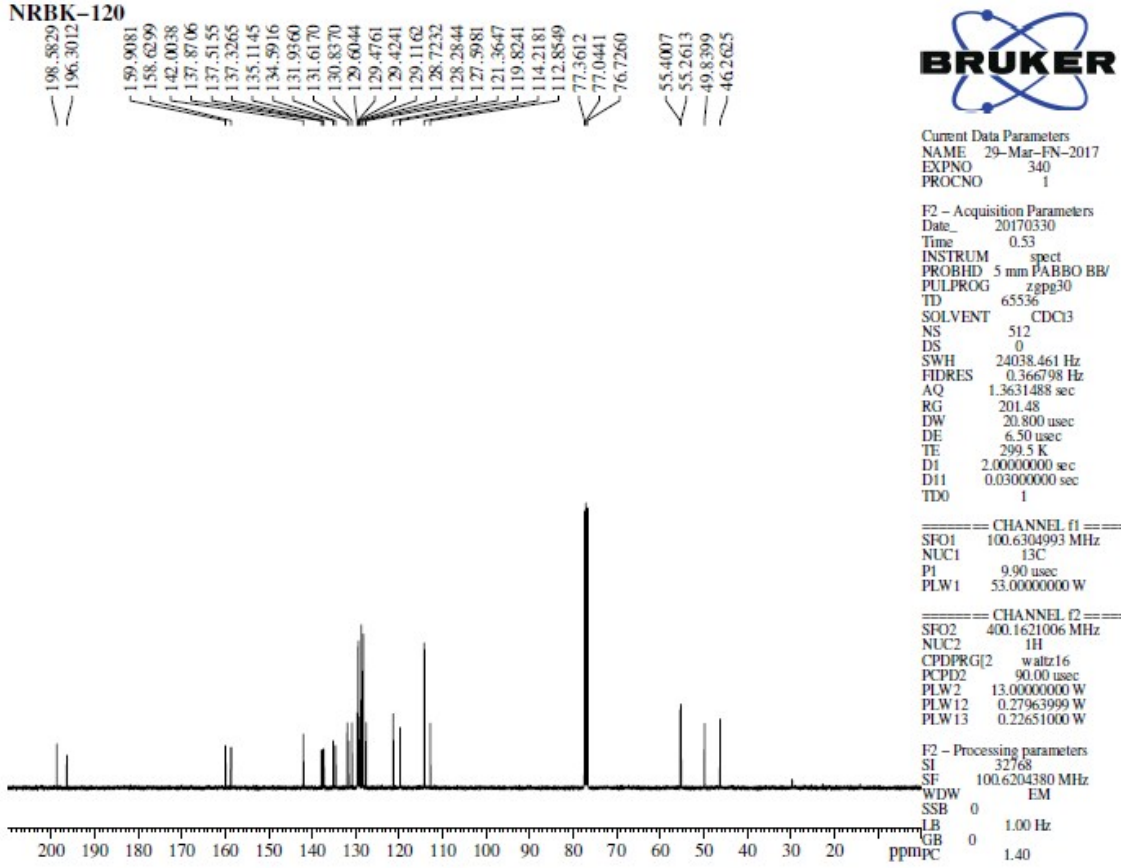

Figure 18: ^{13}C NMR spectrum of 3f

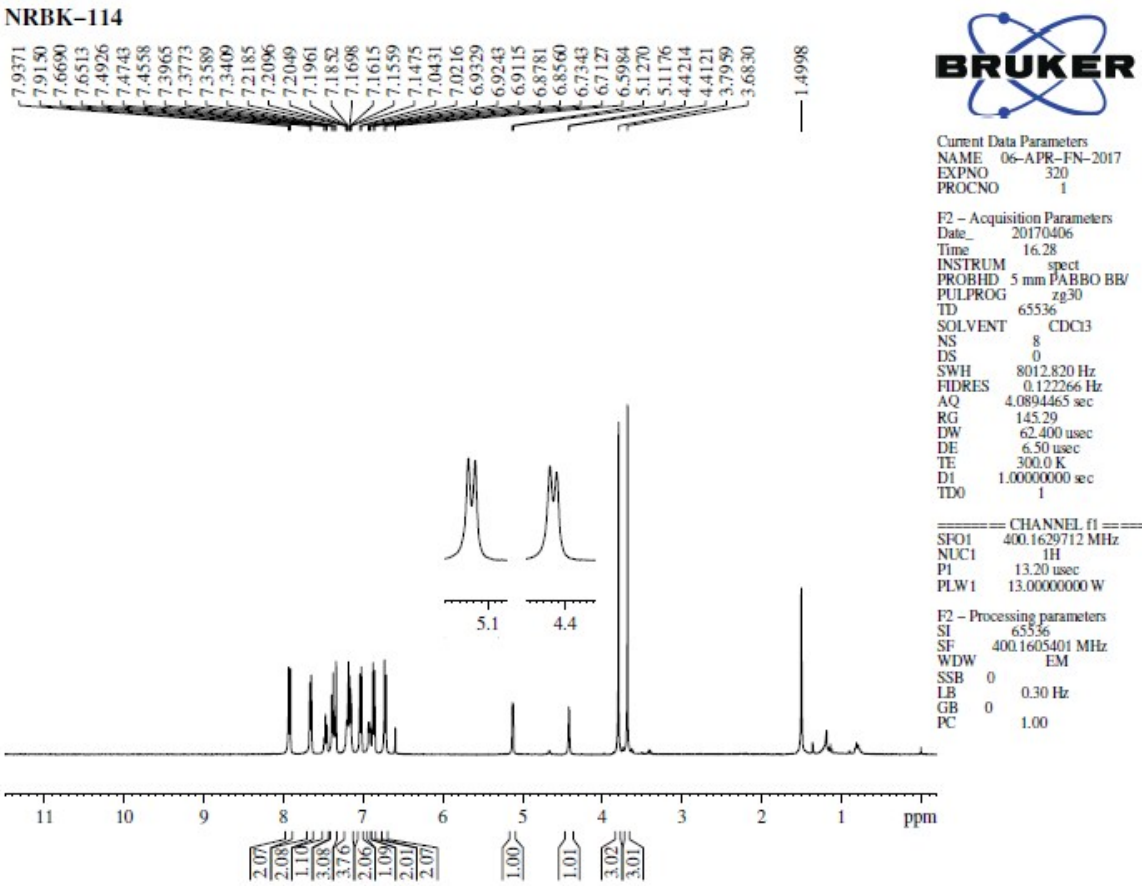

Figure 19: ^{1}H NMR spectrum of 3g

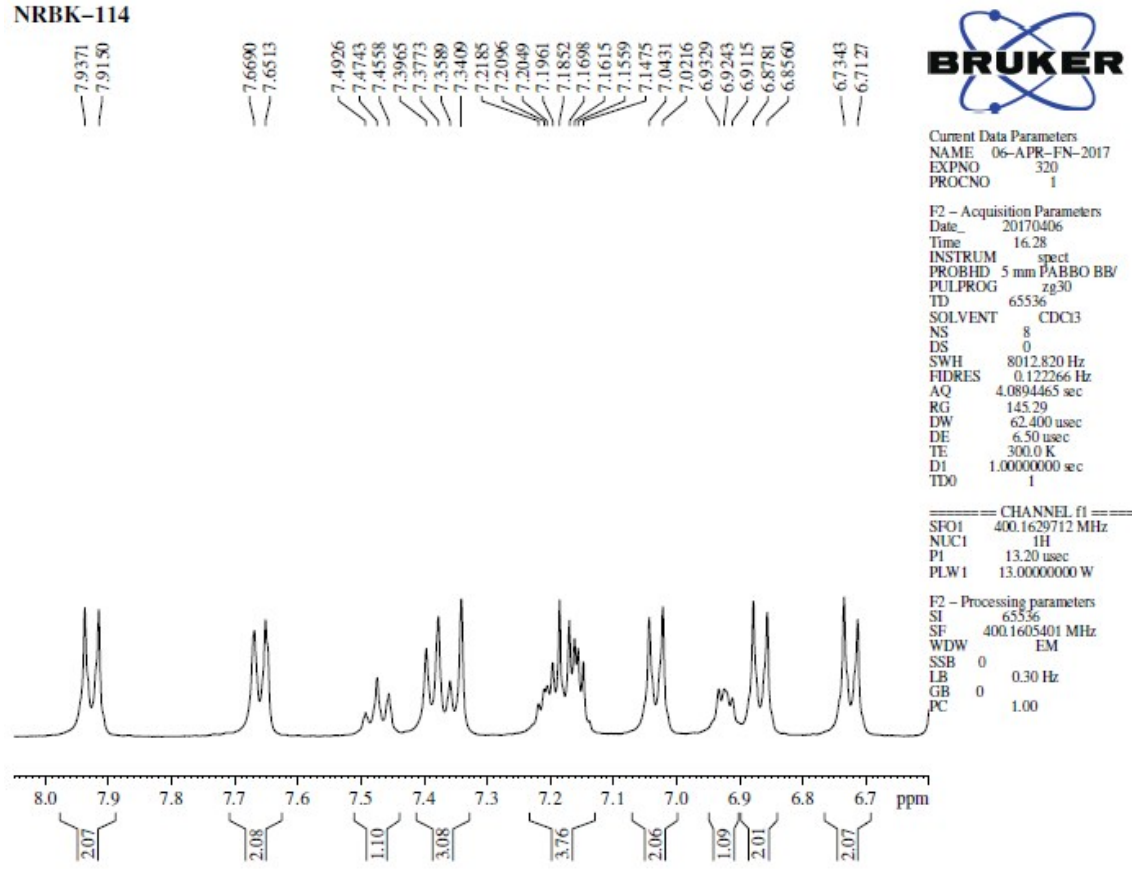

Figure 20: ^{1}H NMR spectrum of 3g (expansion)

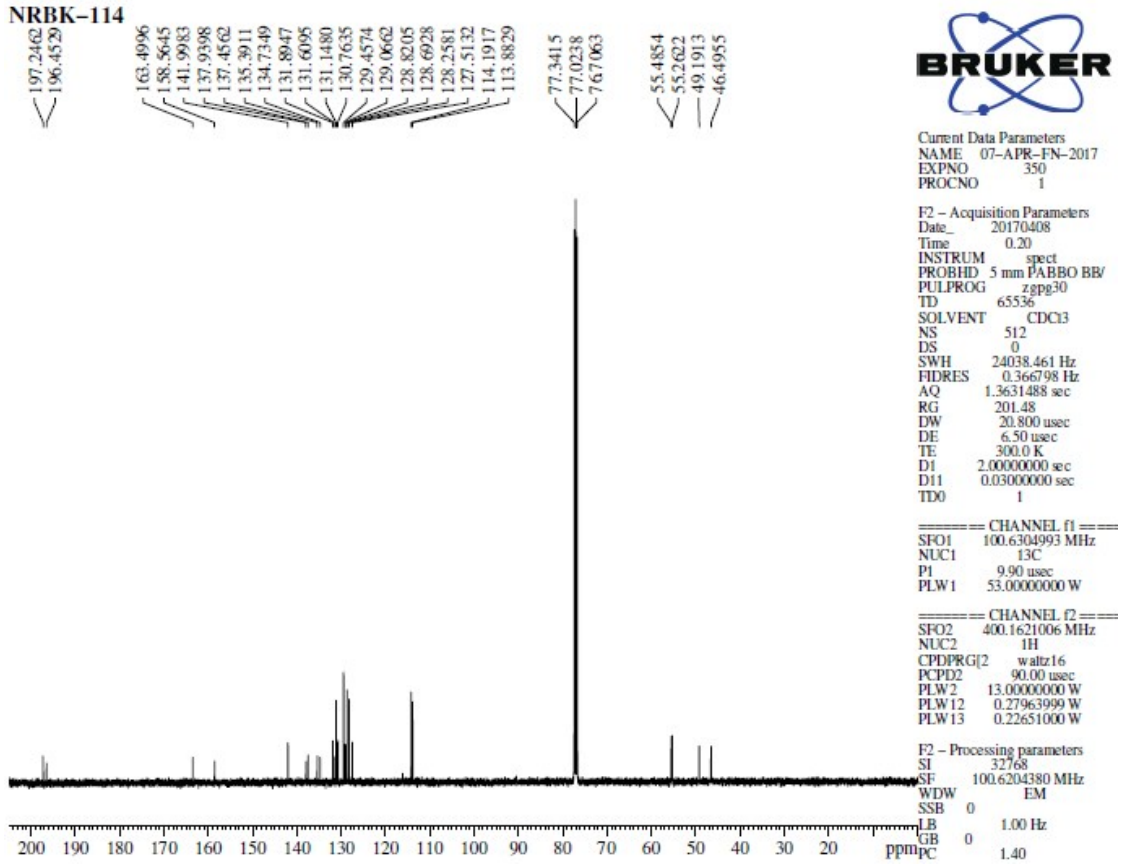

Figure 21: ^{13}C NMR spectrum of 3g

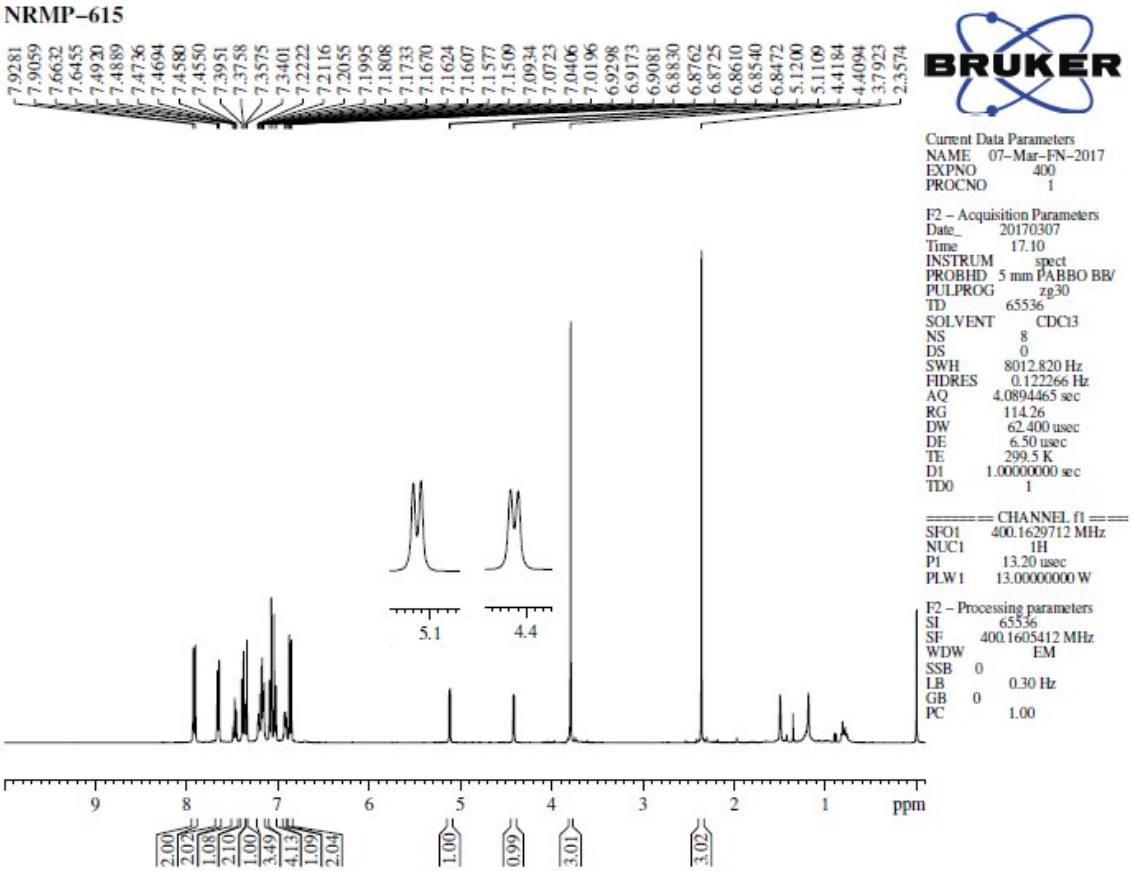

Figure 22: ^{1}H NMR spectrum of 3h

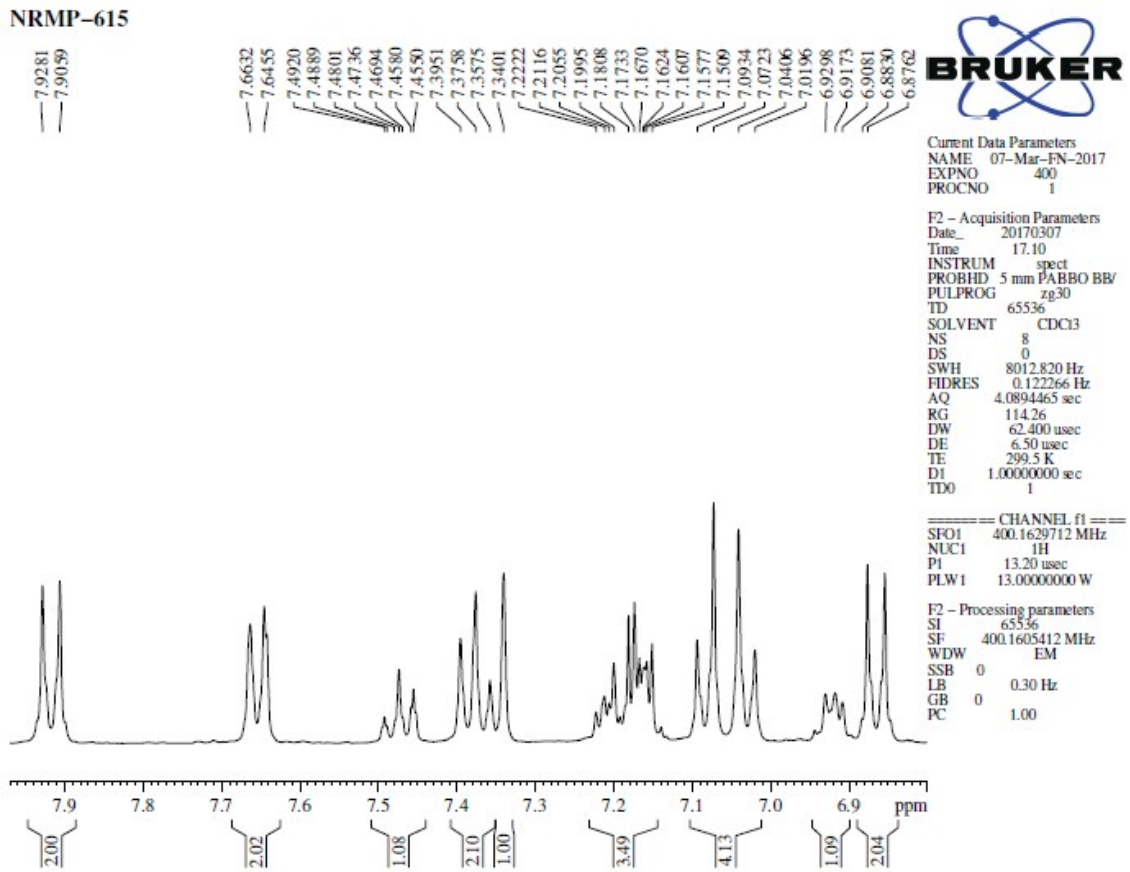

Figure 23: ^{1}H NMR spectrum of 3h (expansion)

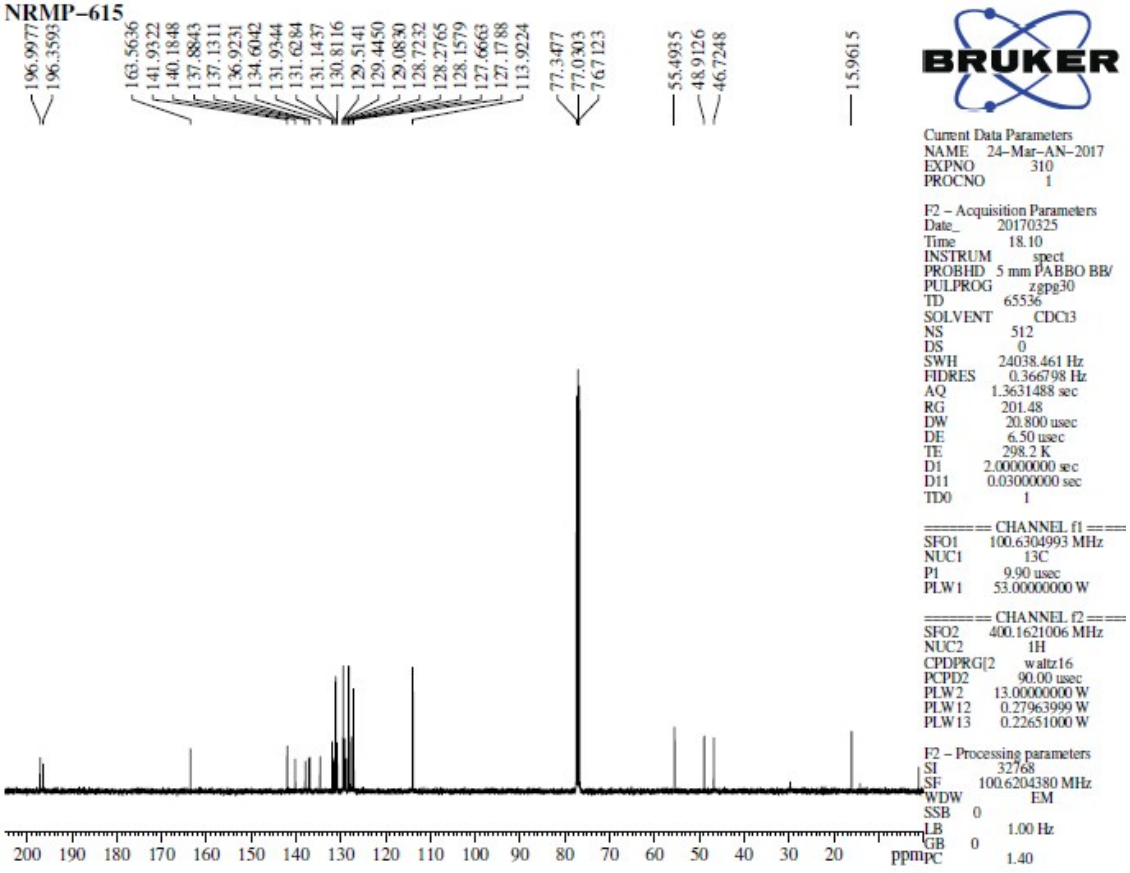

Figure 24: ^{13}C NMR spectrum of 3h

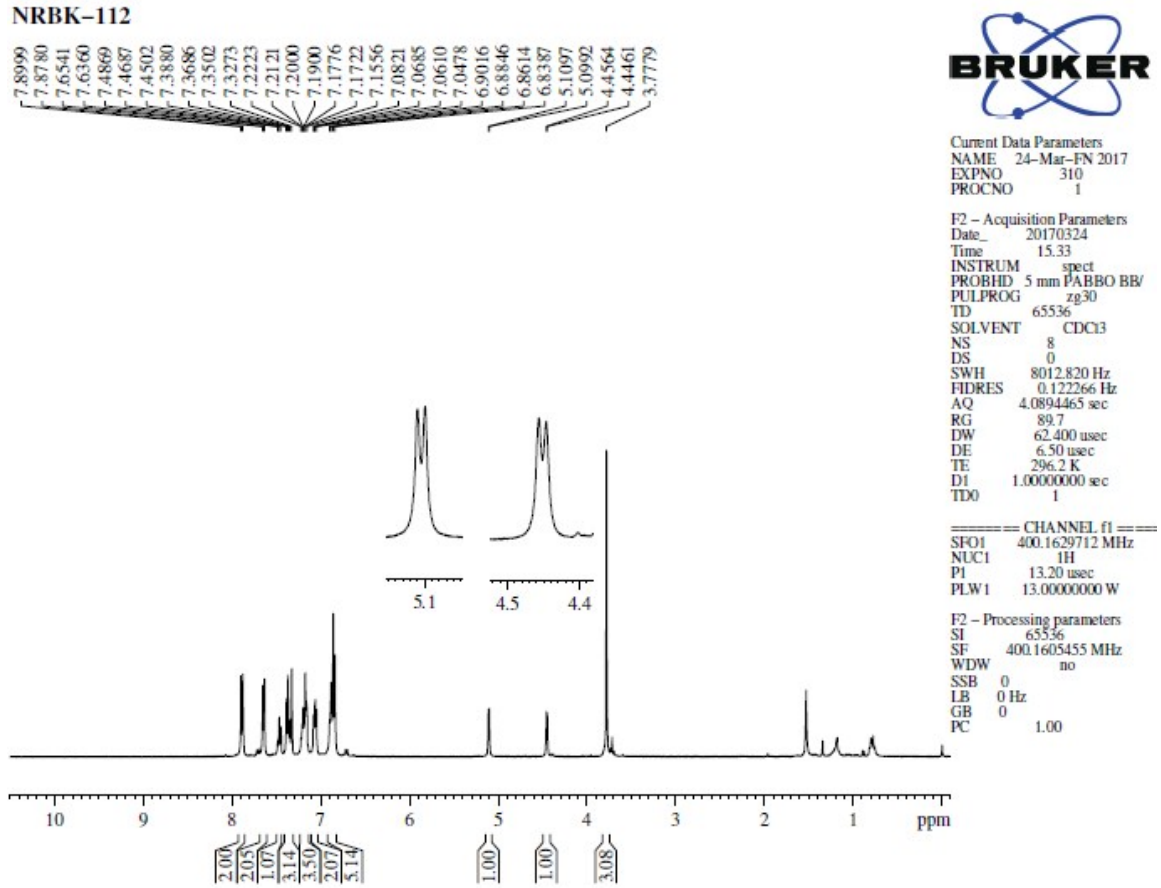

Figure 25: ^{1}H NMR spectrum of 3i

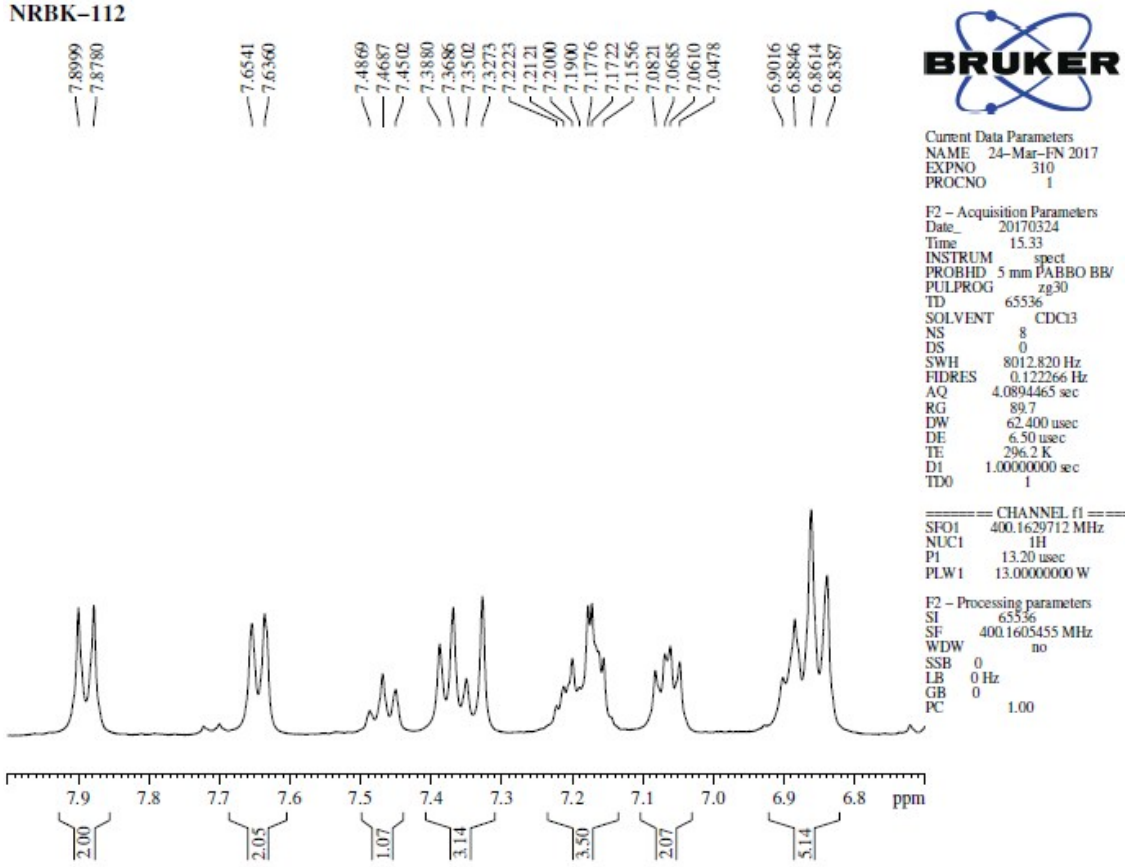

Figure 26: ^{1}H NMR spectrum of 3i (expansion)

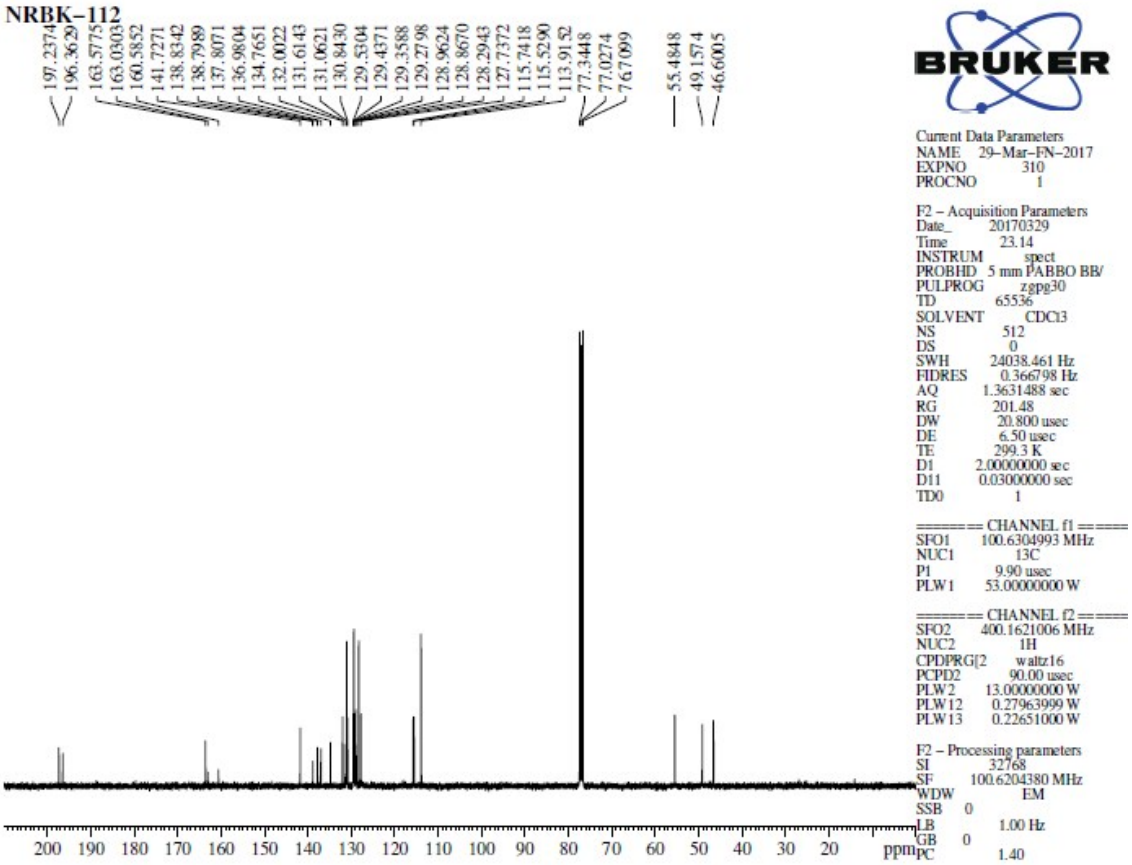

Figure 27: ^{13}C NMR spectrum of 3i

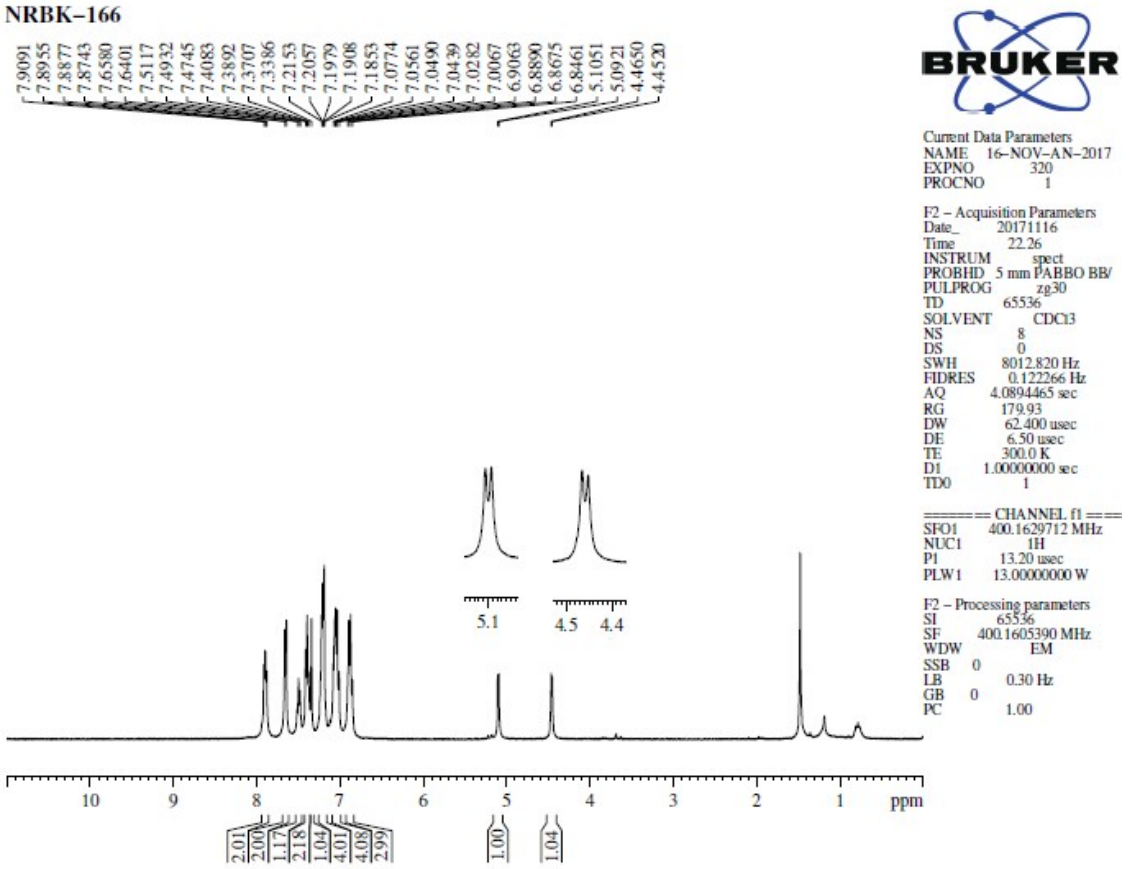

Figure 28: ^{1}H NMR spectrum of 3j

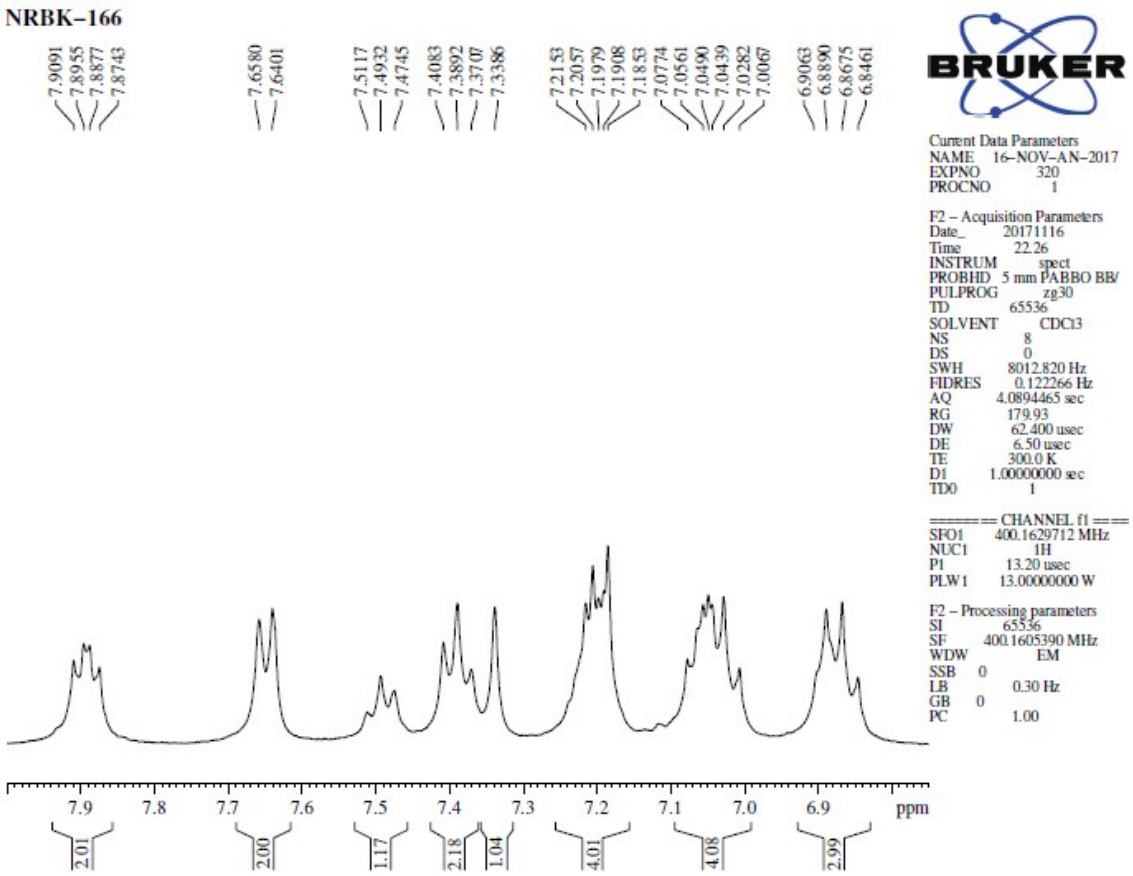

Figure 29: ^{1}H NMR spectrum of 3j (expansion)

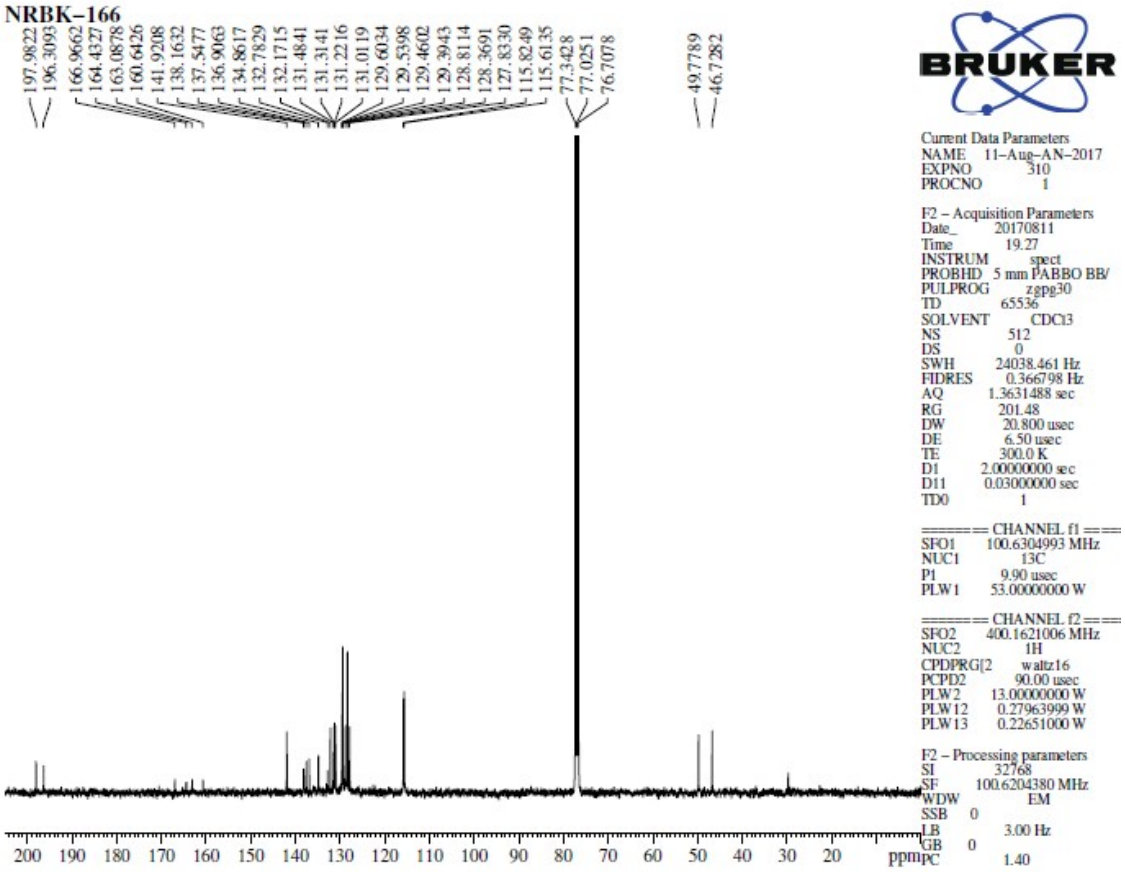

Figure 30: ^{13}C NMR spectrum of 3j

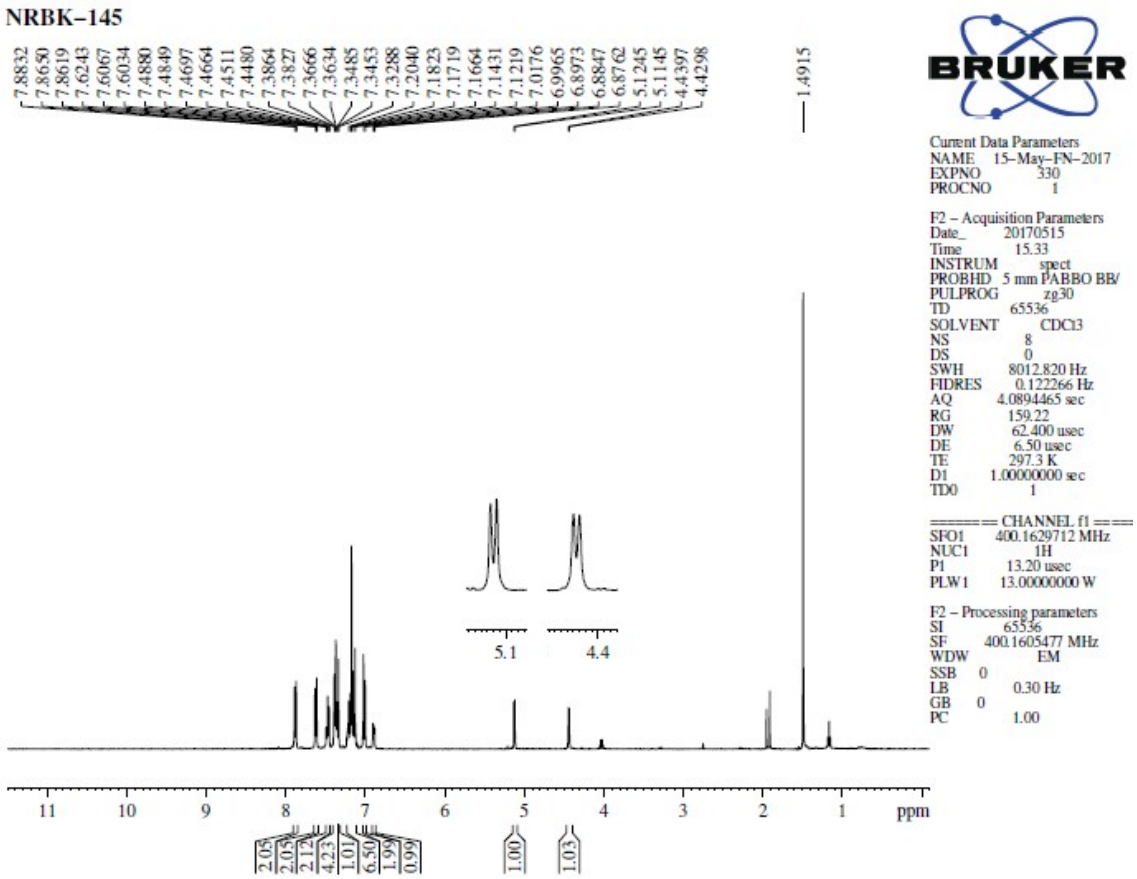

Figure 31: ^{1}H NMR spectrum of 3k

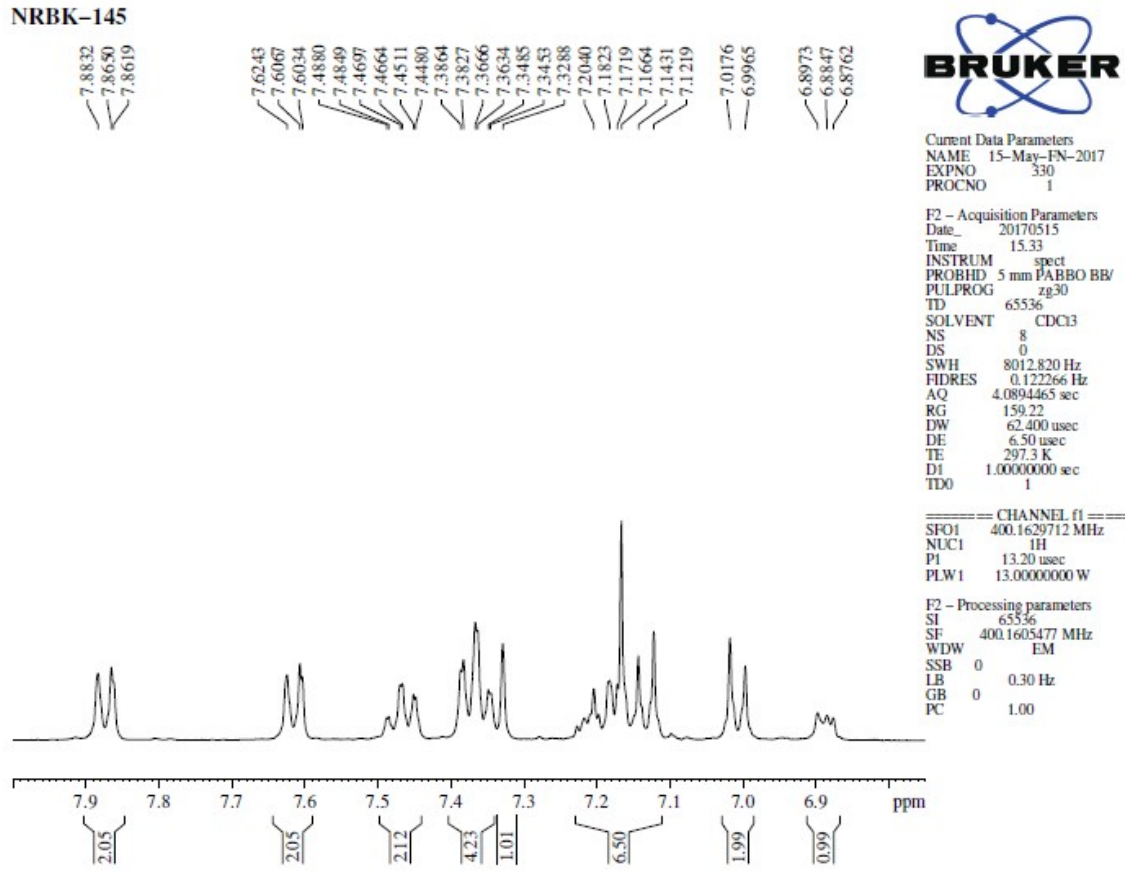

Figure 32: ^{1}H NMR spectrum of 3k (expansion)

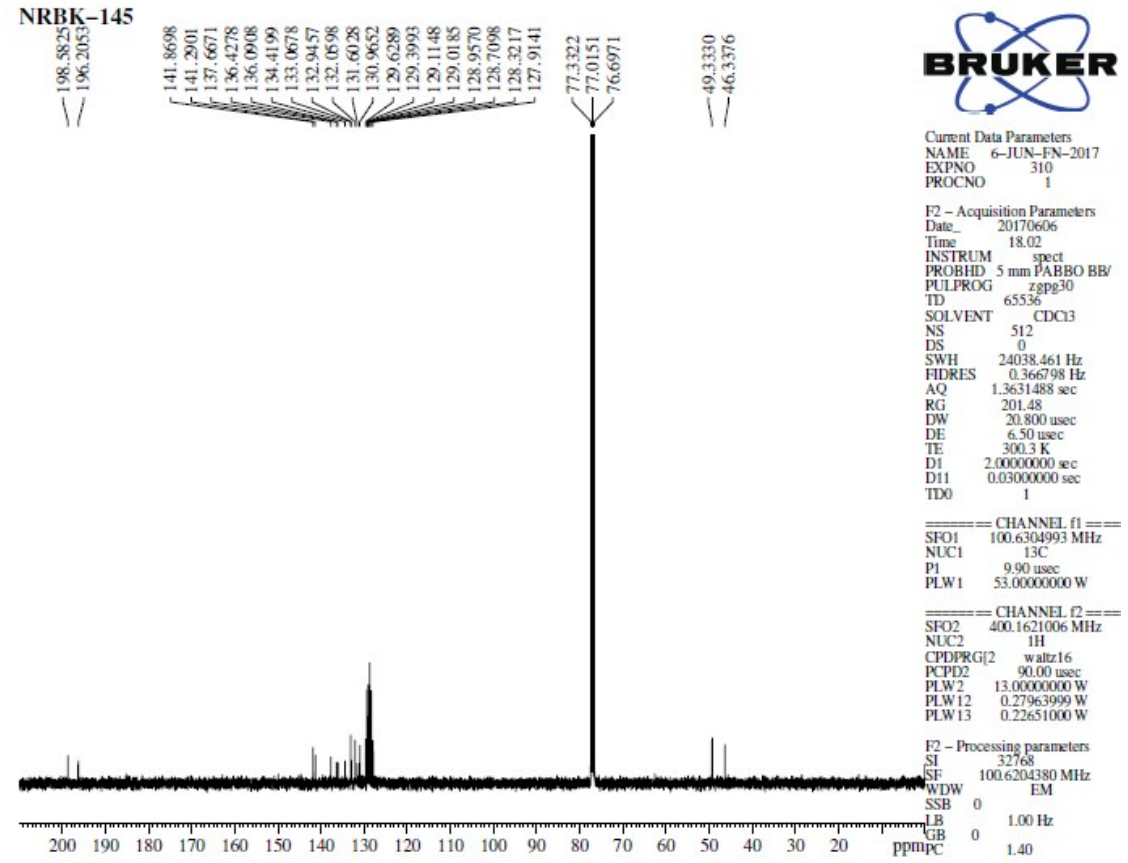

Figure 33: ^{13}C NMR spectrum of 3k

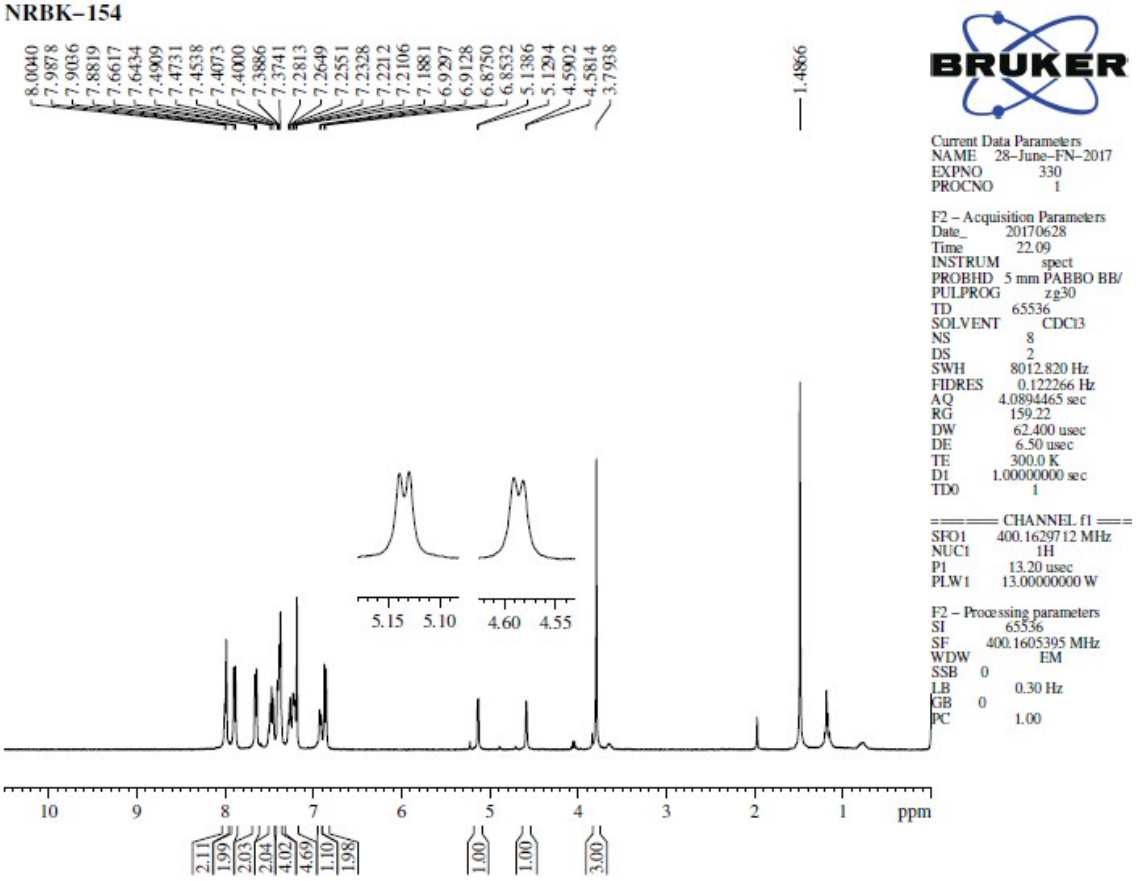

Figure 34: ^{1}H NMR spectrum of 3l

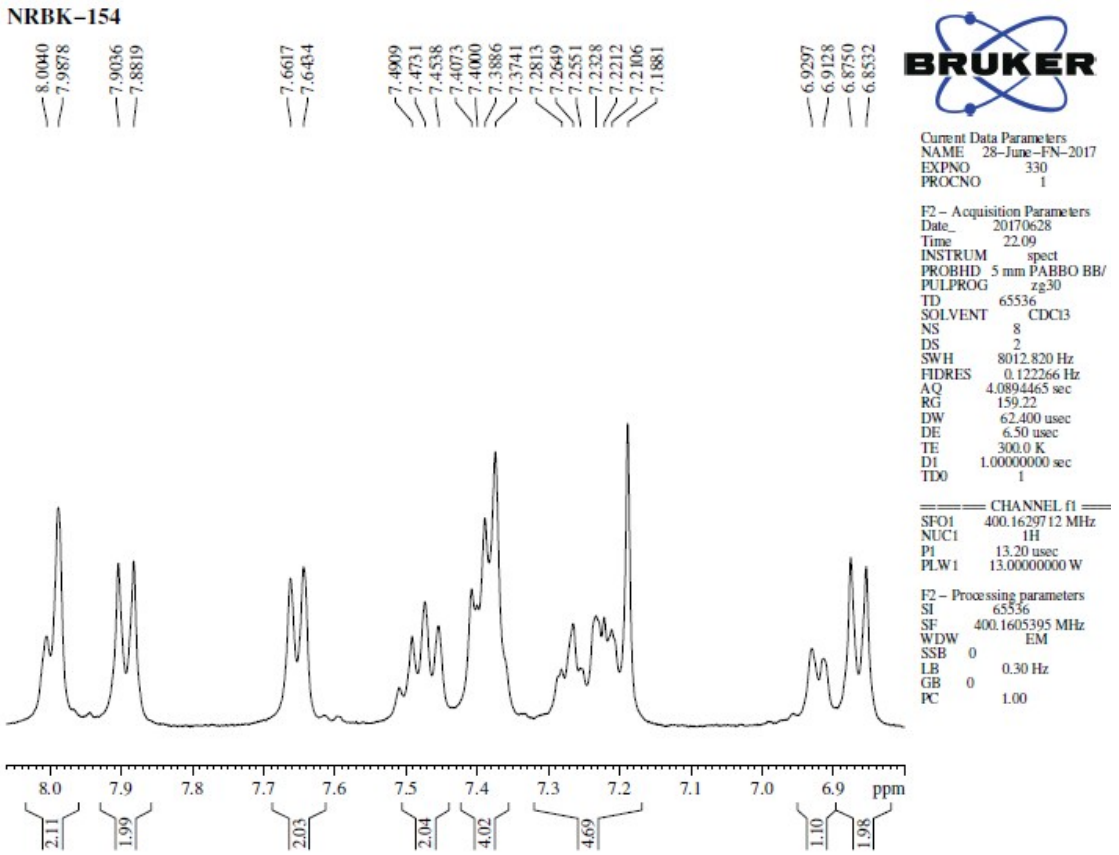

Figure 35: ^{1}H NMR spectrum of 3l (expansion)

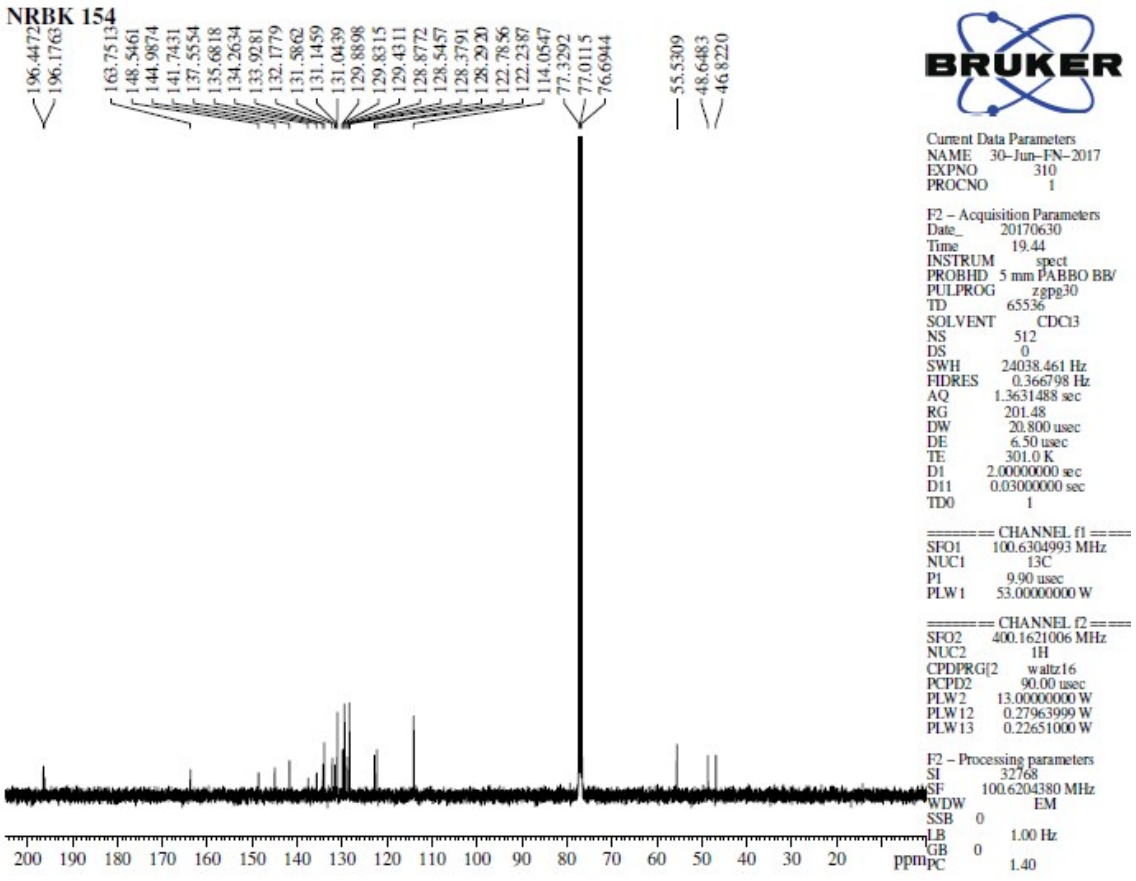

Figure 36: ^{13}C NMR spectrum of 3l

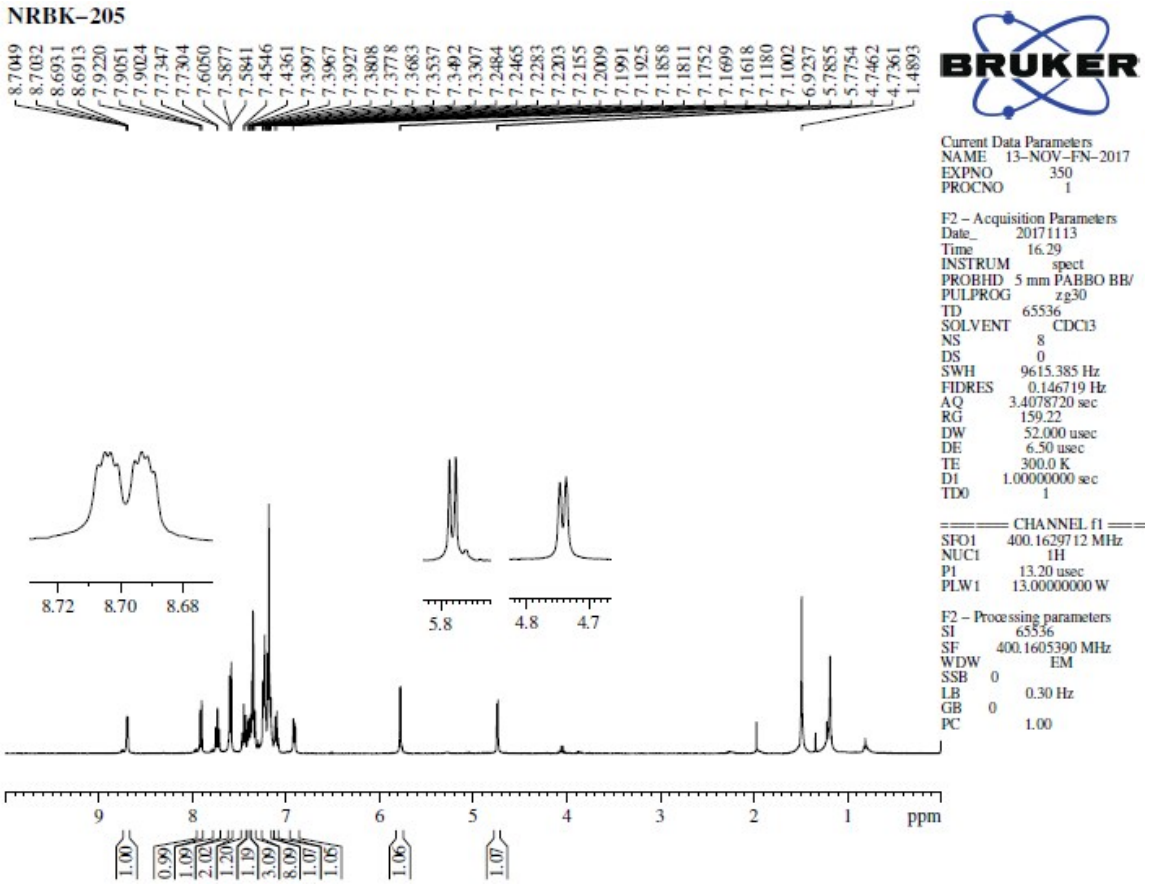

Figure 37: ^{1}H NMR spectrum of 3m

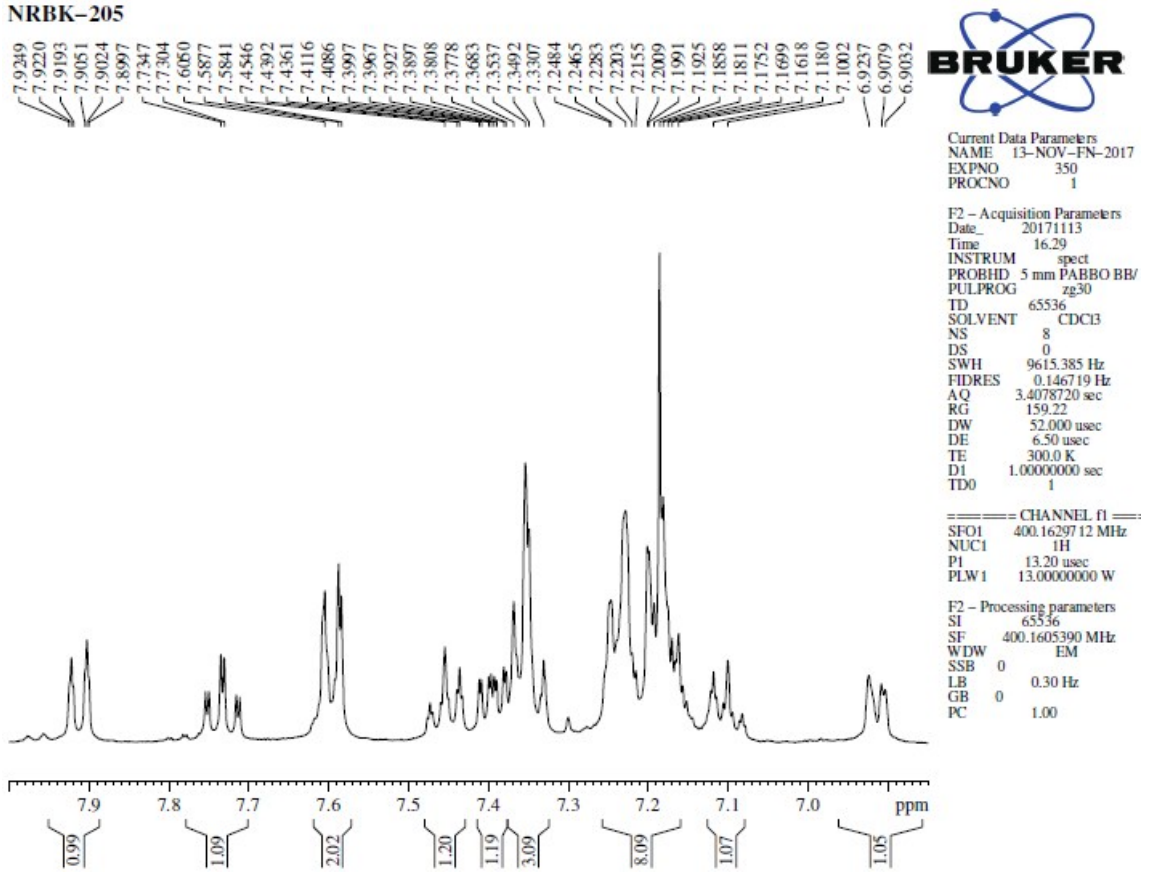

Figure 38: ^{1}H NMR spectrum of 3m (expansion)

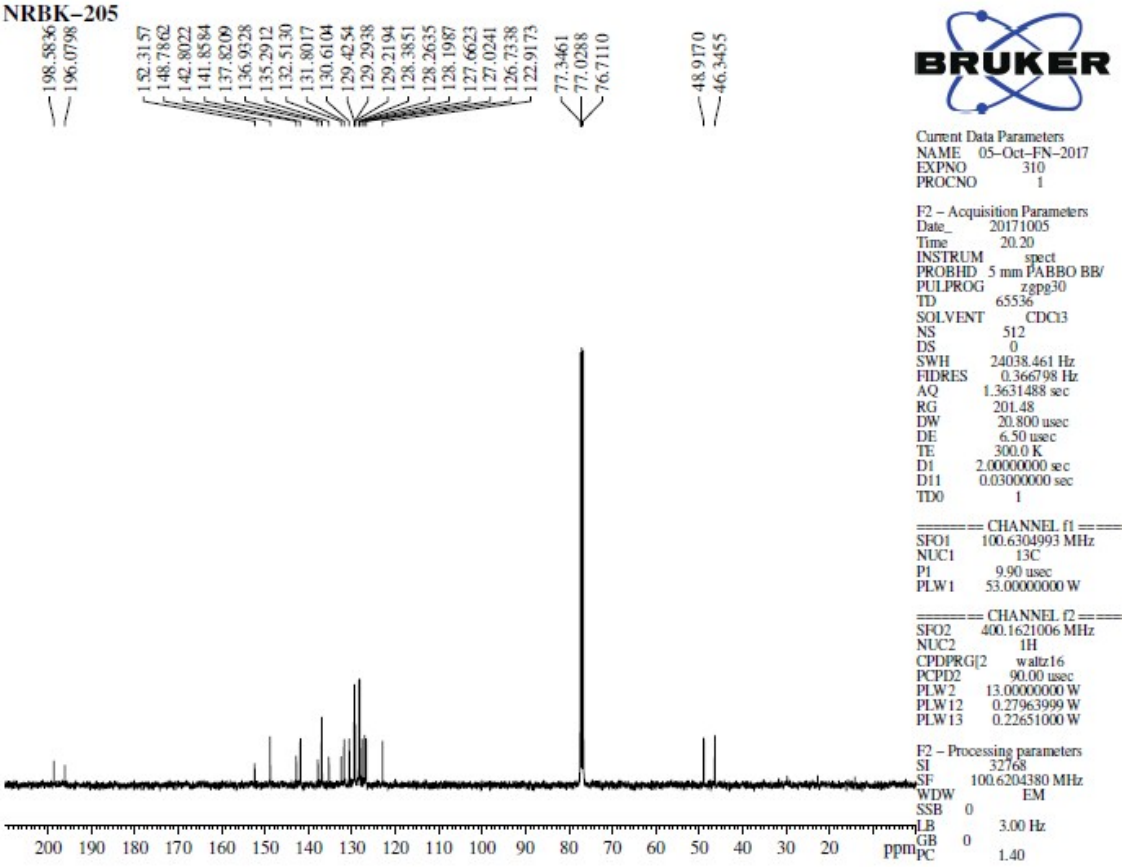

Figure 39: ^{13}C NMR spectrum of 3m

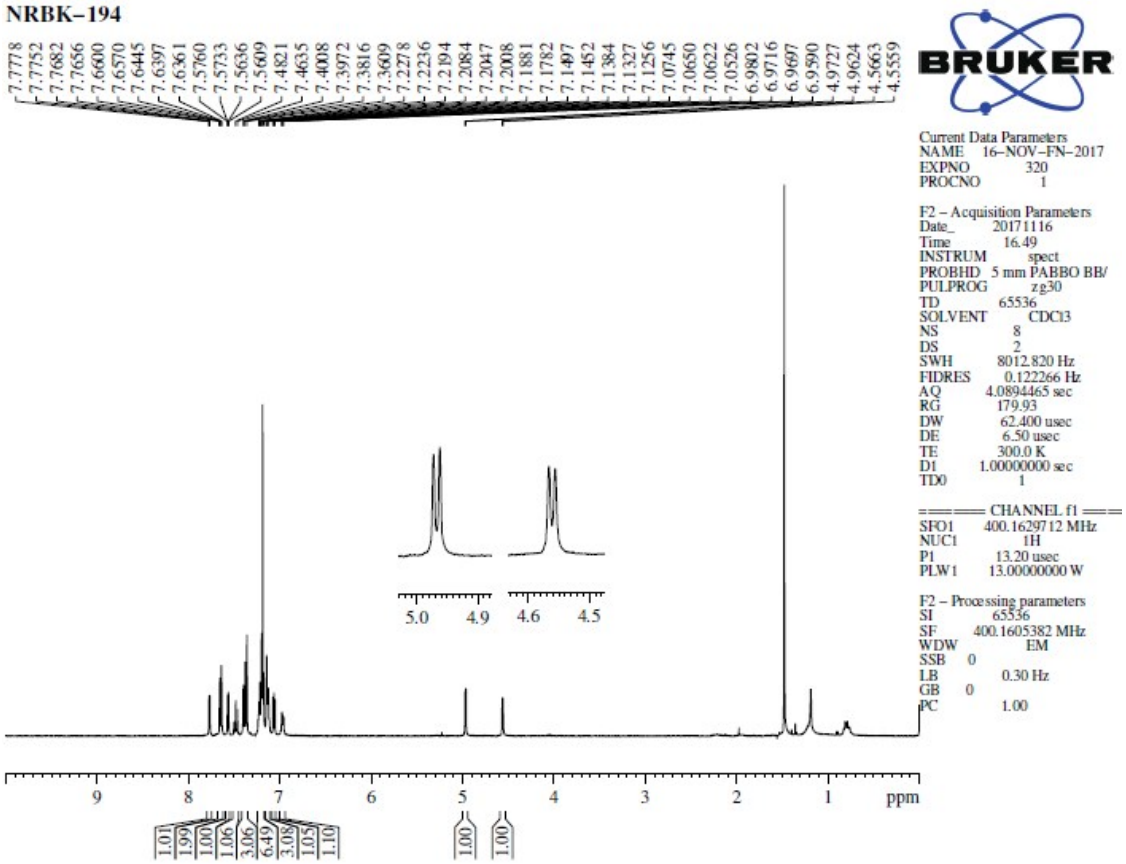

Figure 40: ^{1}H NMR spectrum of 3n

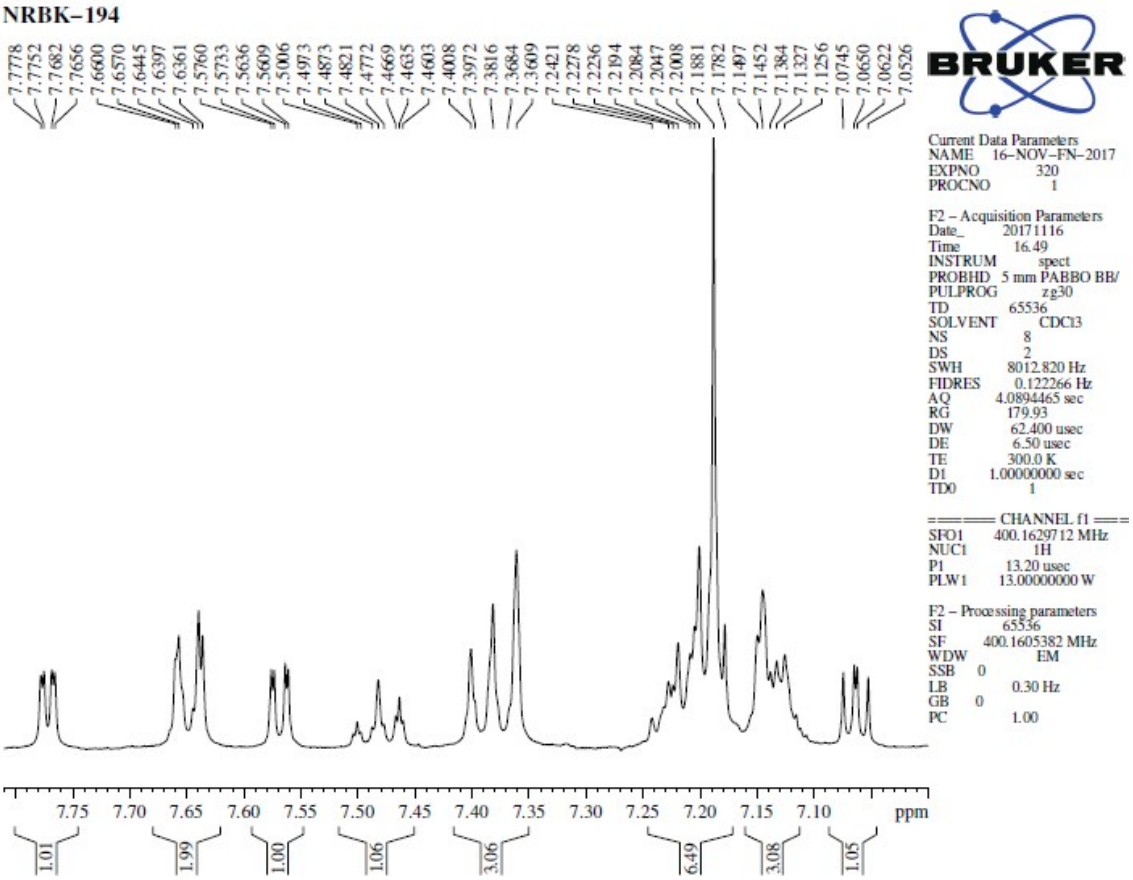

Figure 41: ^{1}H NMR spectrum of 3n (expansion)

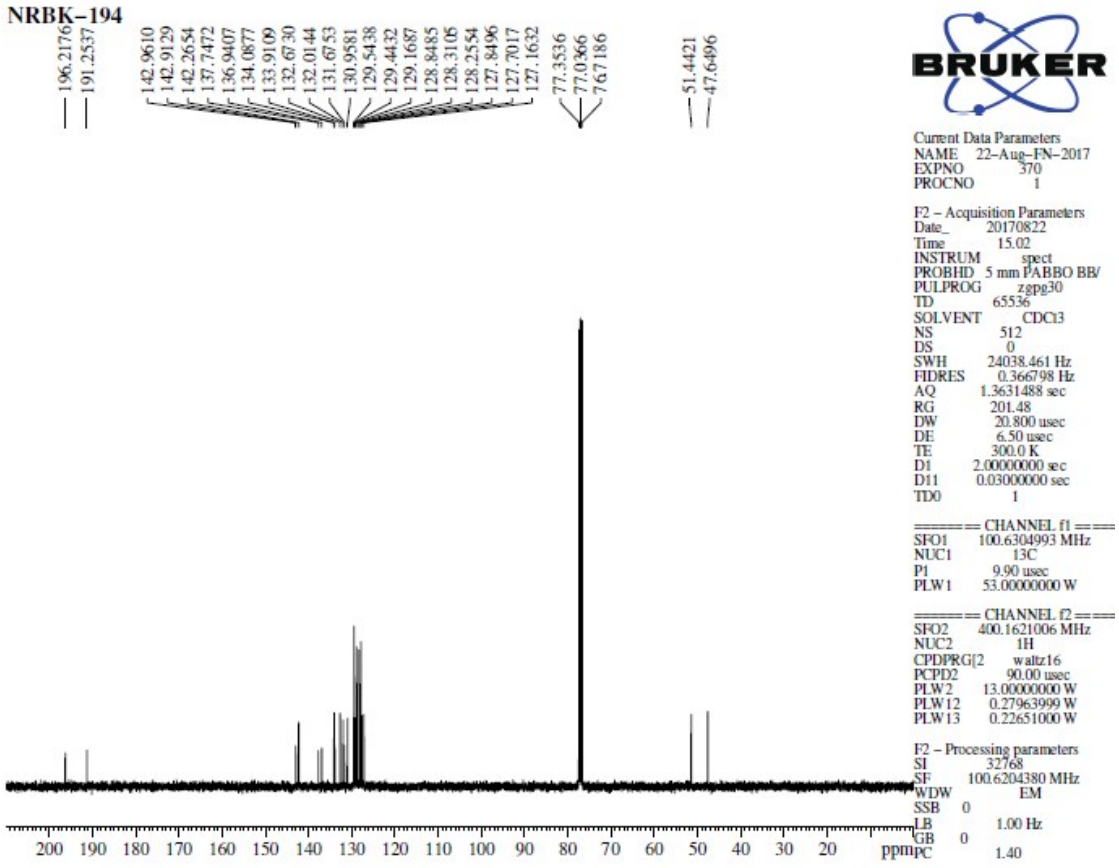

Figure 42: ^{13}C NMR spectrum of 3n

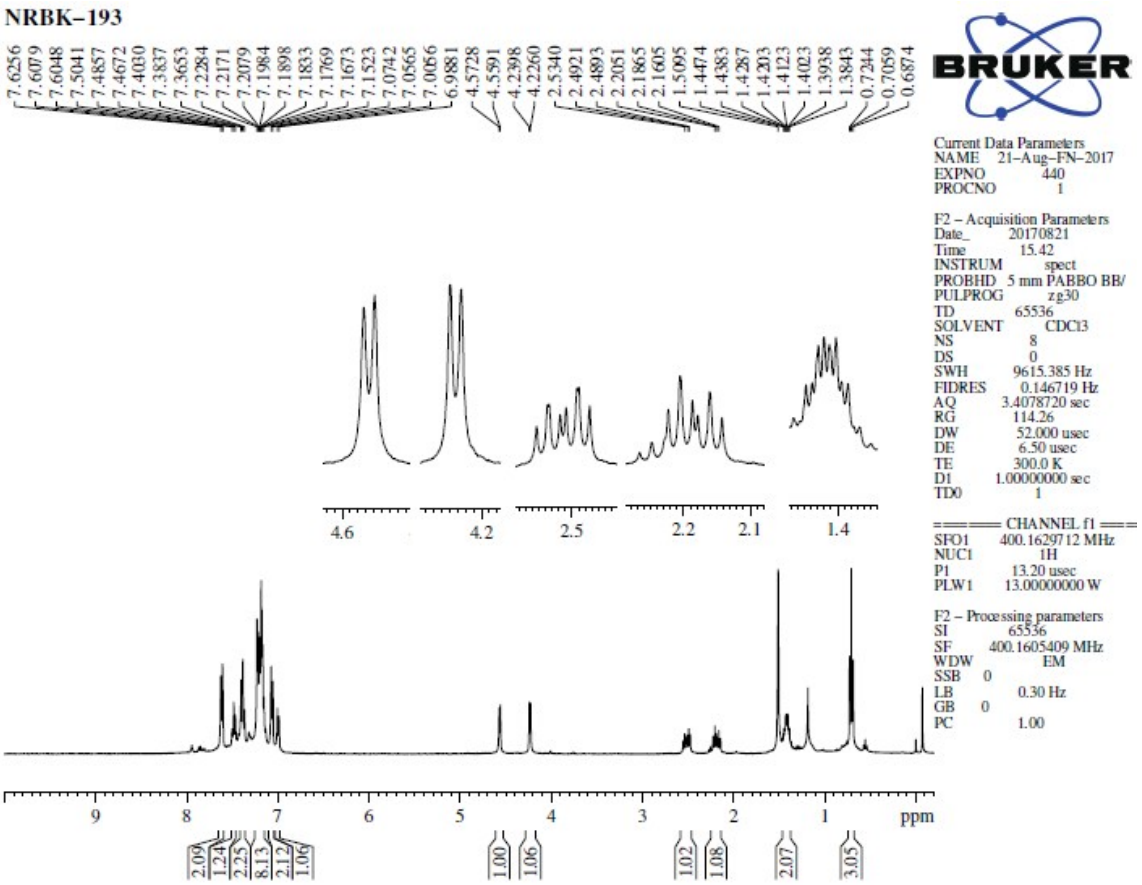

Figure 43: ^{1}H NMR spectrum of 3o

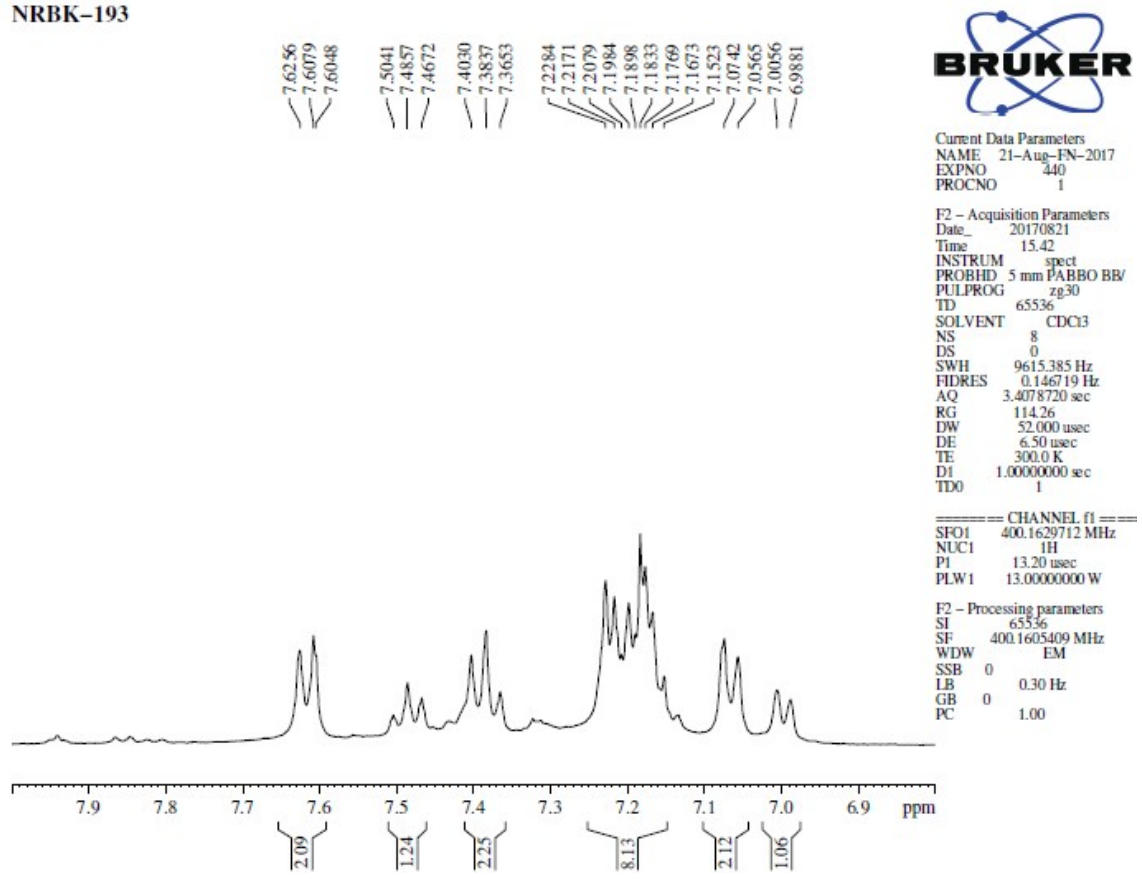

Figure 44: ^{1}H NMR spectrum of 3o (expansion)

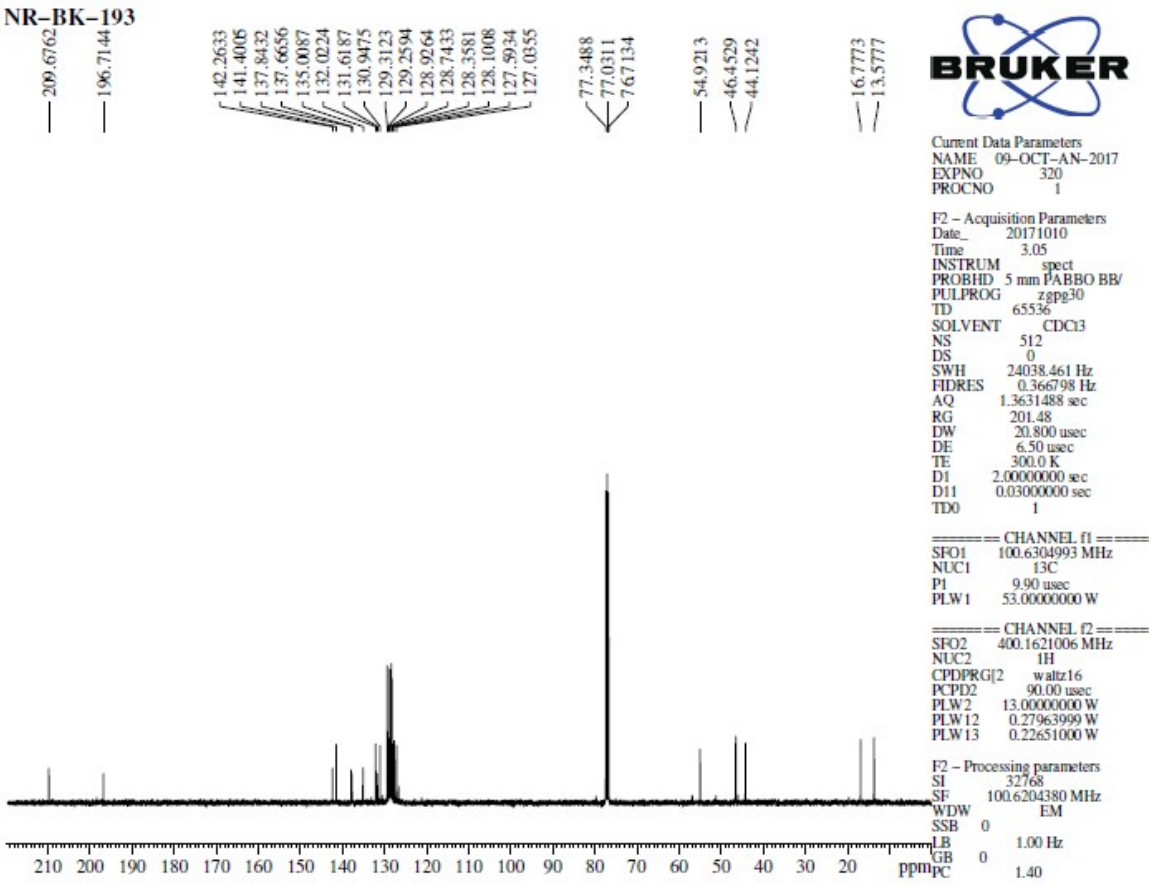

Figure 45: ^{13}C NMR spectrum of 3o

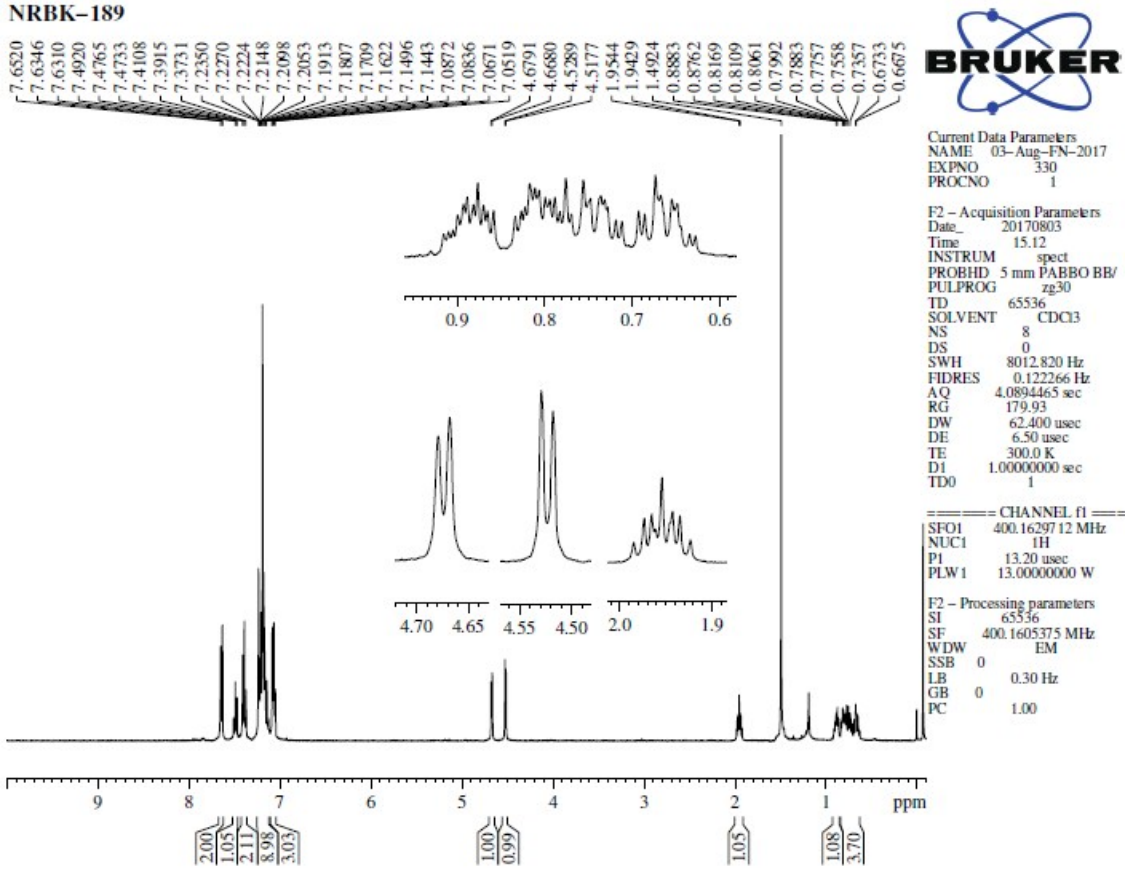

Figure 46: ^{1}H NMR spectrum of 3p

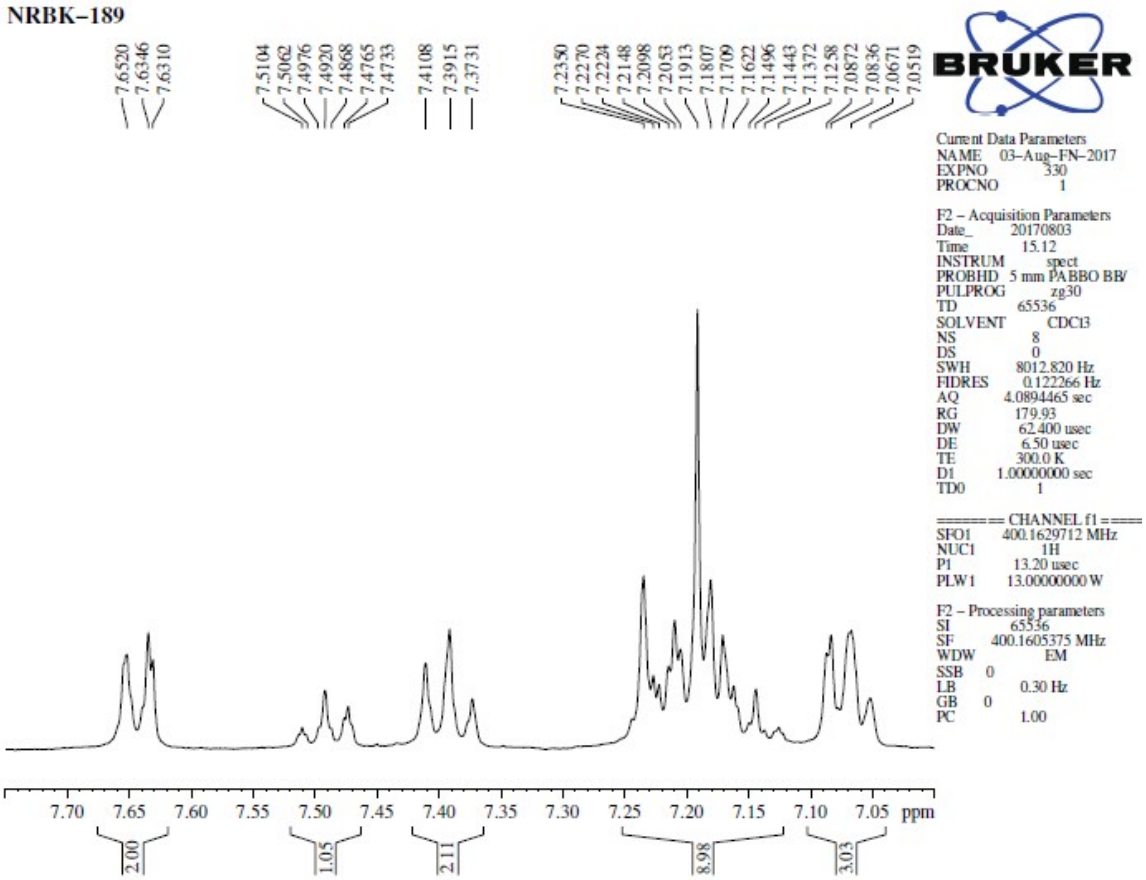

Figure 47: ^{1}H NMR spectrum of 3p (expansion)

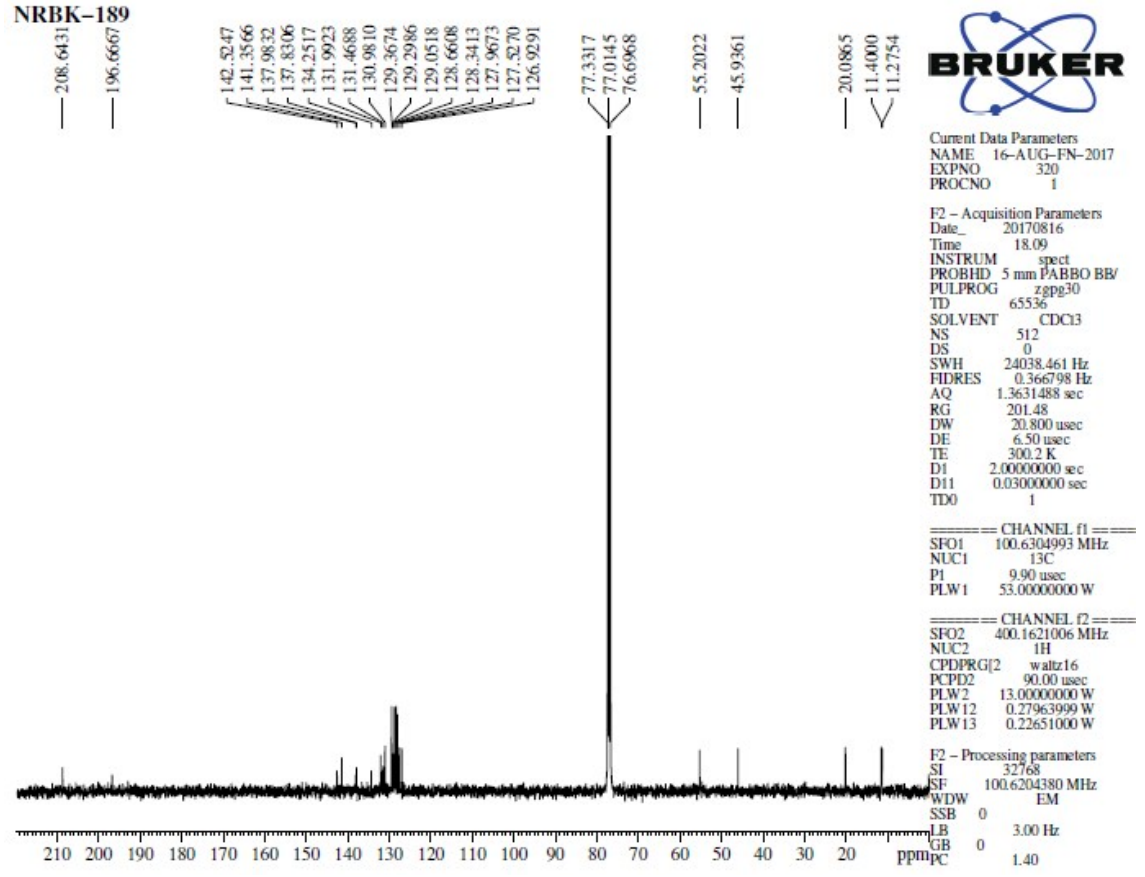

Figure 48: ^{13}C NMR spectrum of 3p

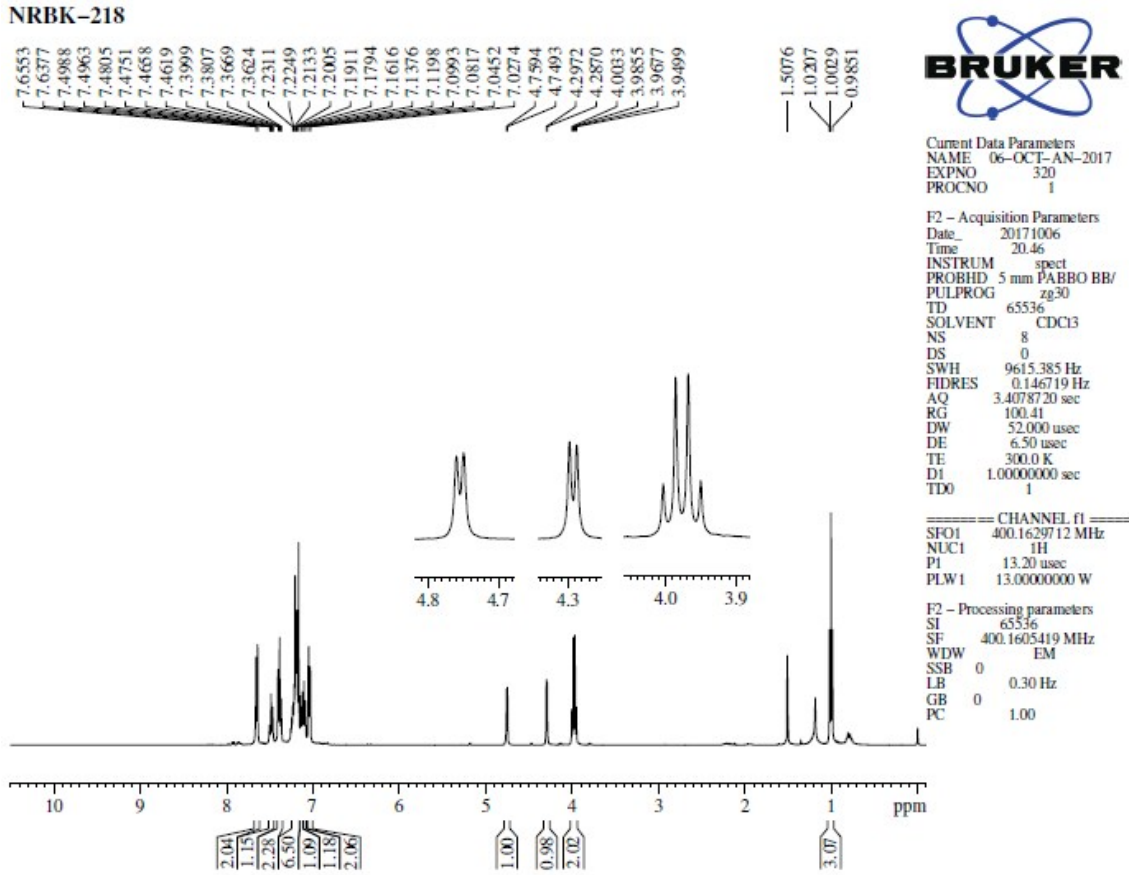

Figure 49: ^{1}H NMR spectrum of 3q

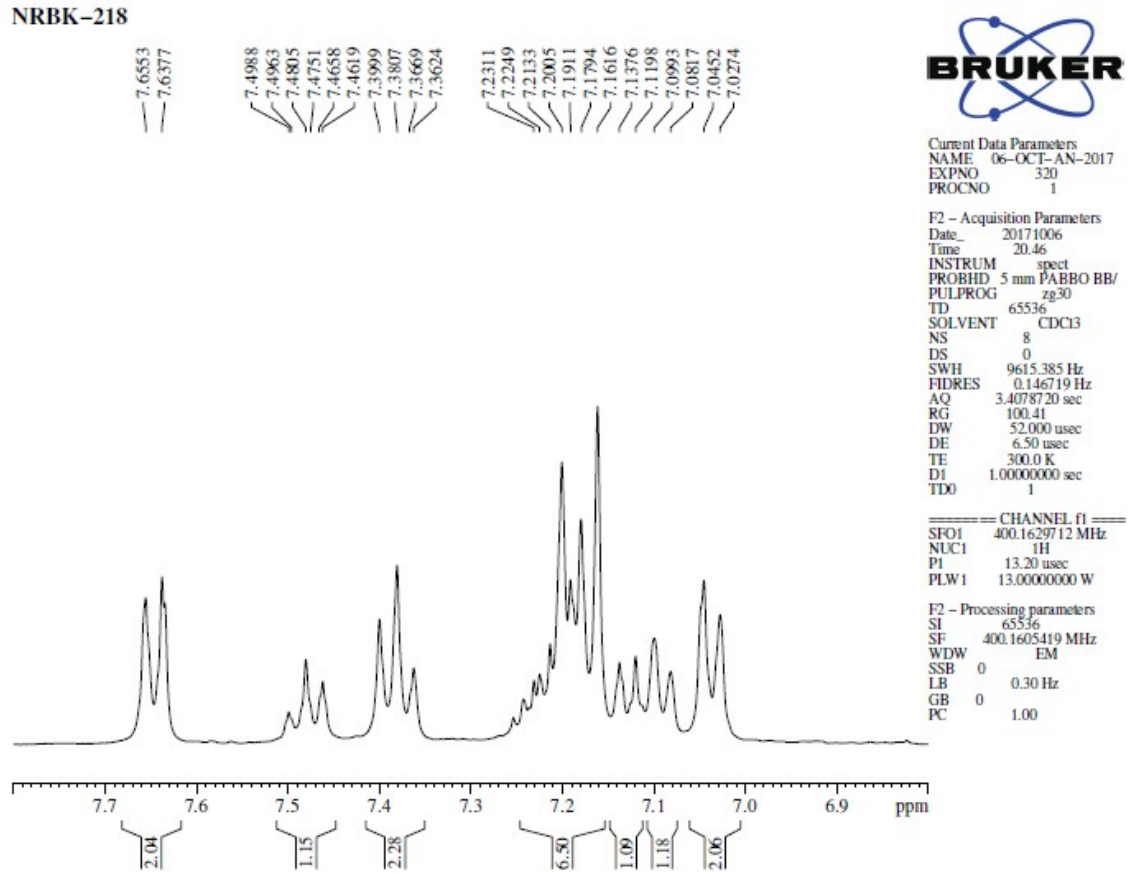

Figure 50: ^{1}H NMR spectrum of 3q (expansion)

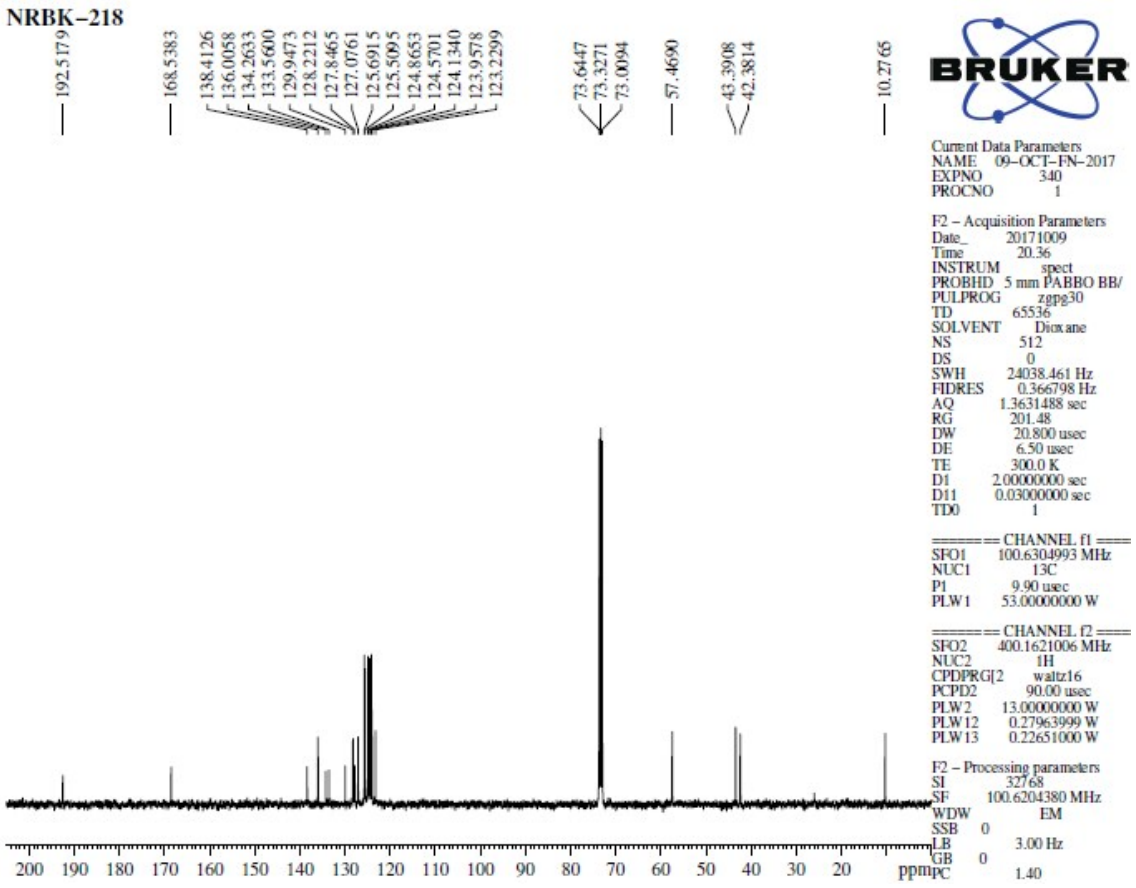

Figure 51: ^{13}C NMR spectrum of 3q

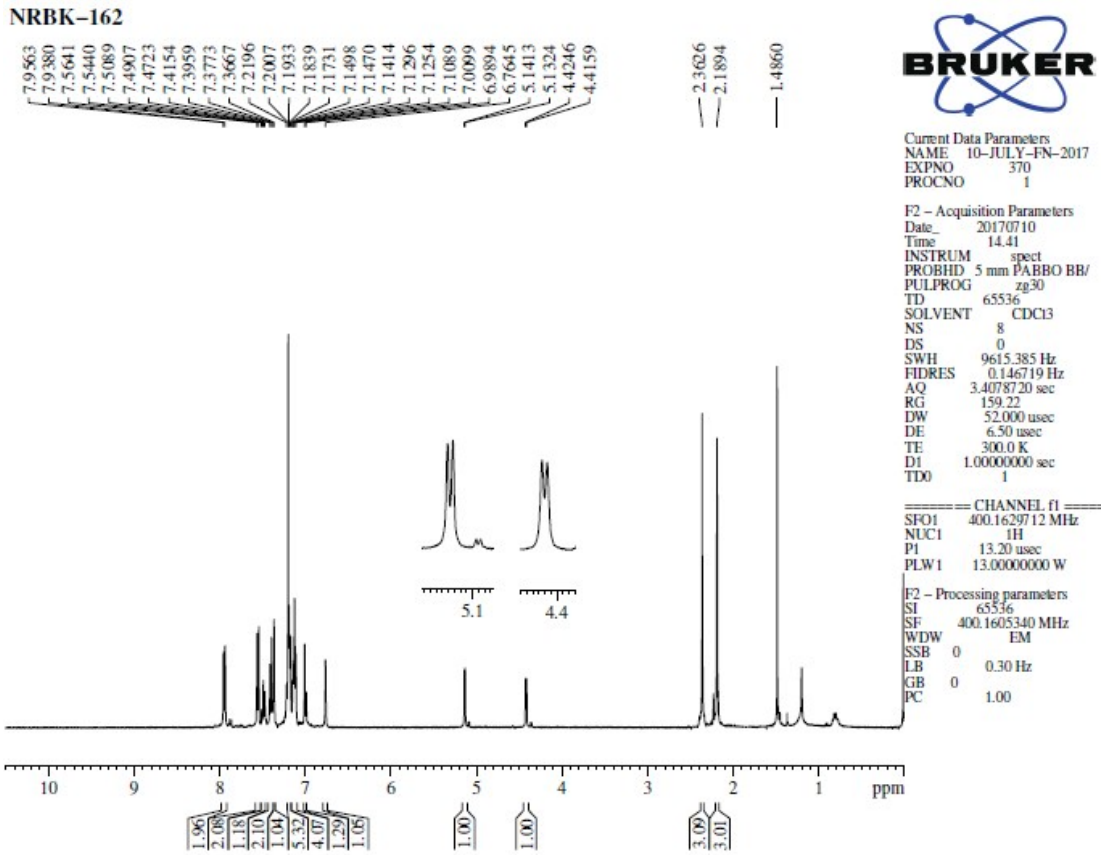

Figure 52: ^{1}H NMR spectrum of 3r

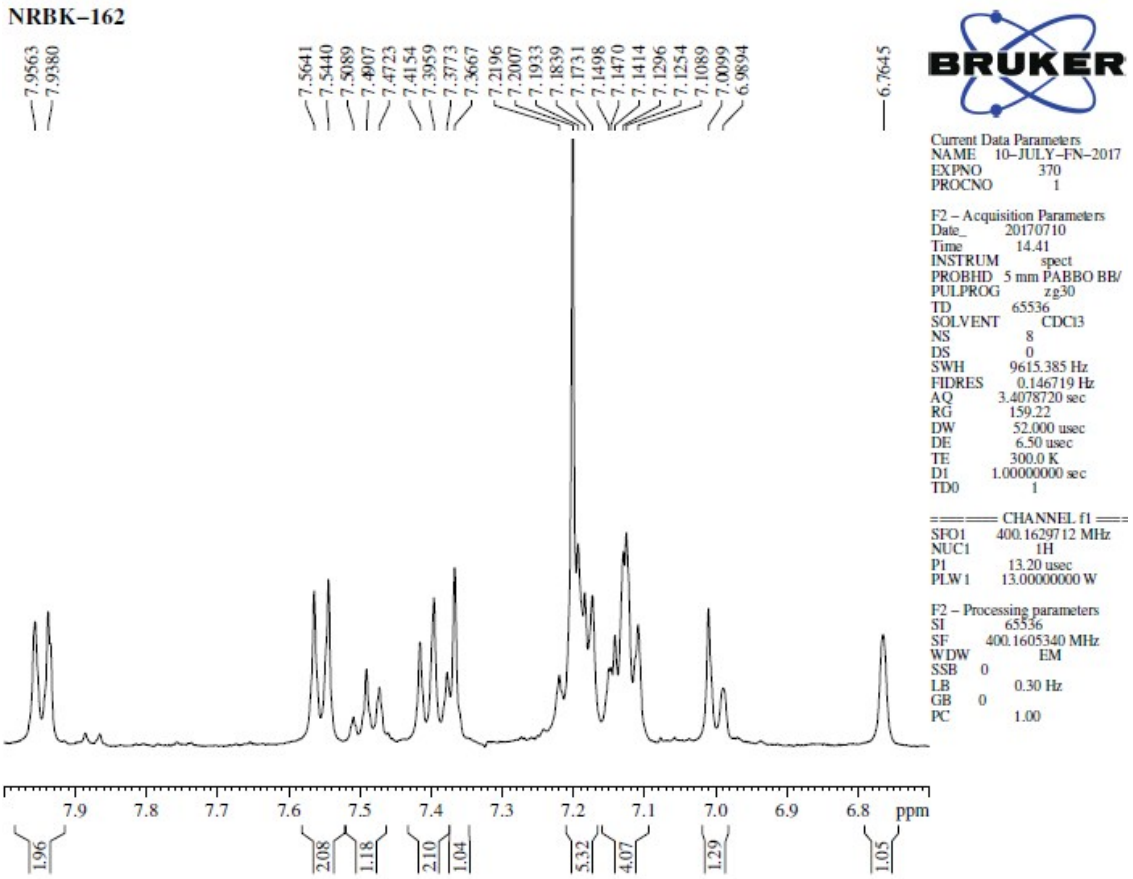

Figure 53: ^{1}H NMR spectrum of 3r (with expansion)

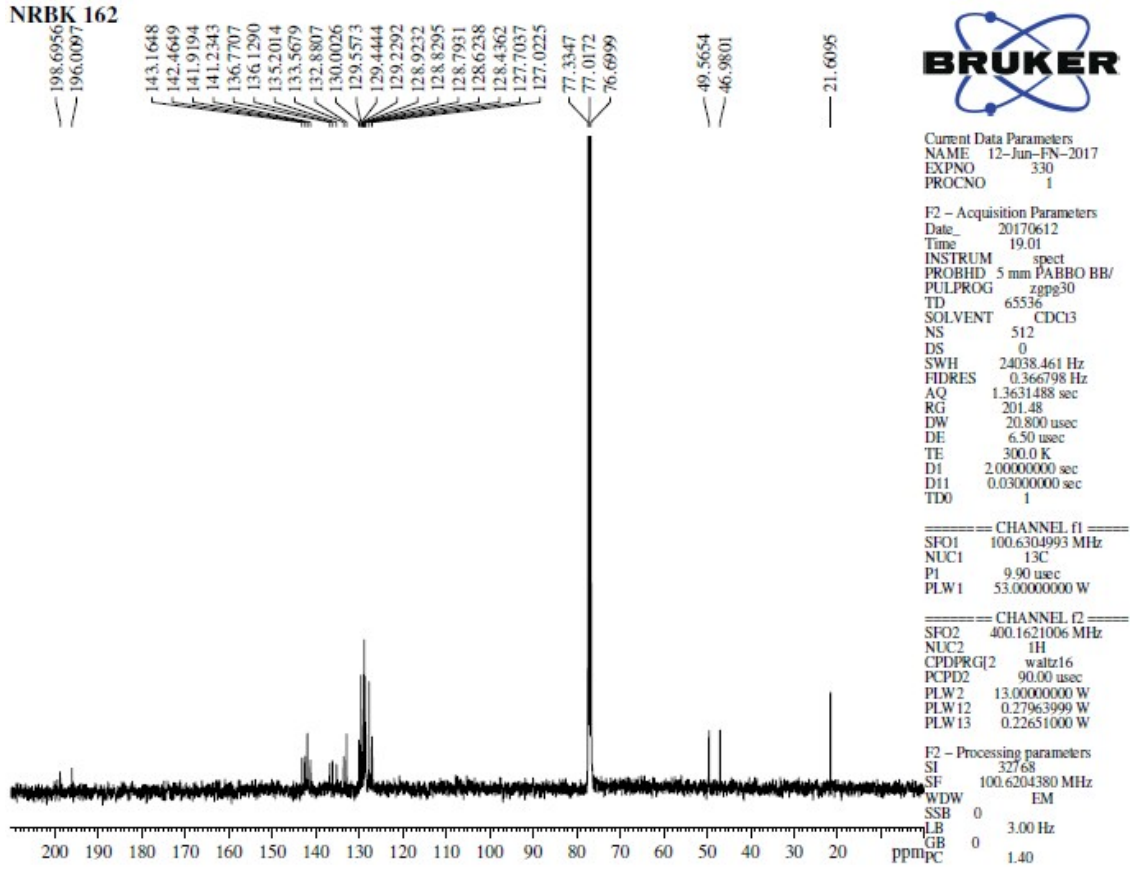

Figure 54: ^{13}C NMR spectrum of 3r

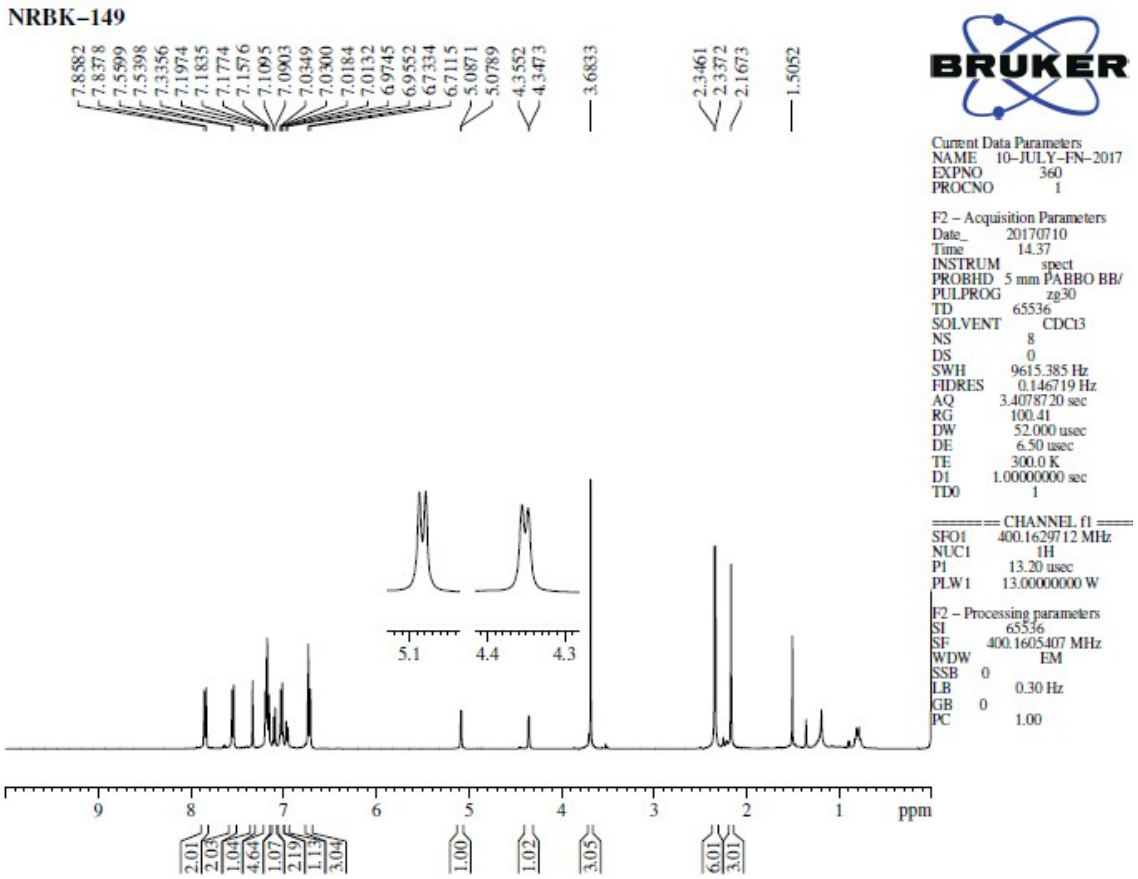

Figure 55: ^{1}H NMR spectrum of 3s

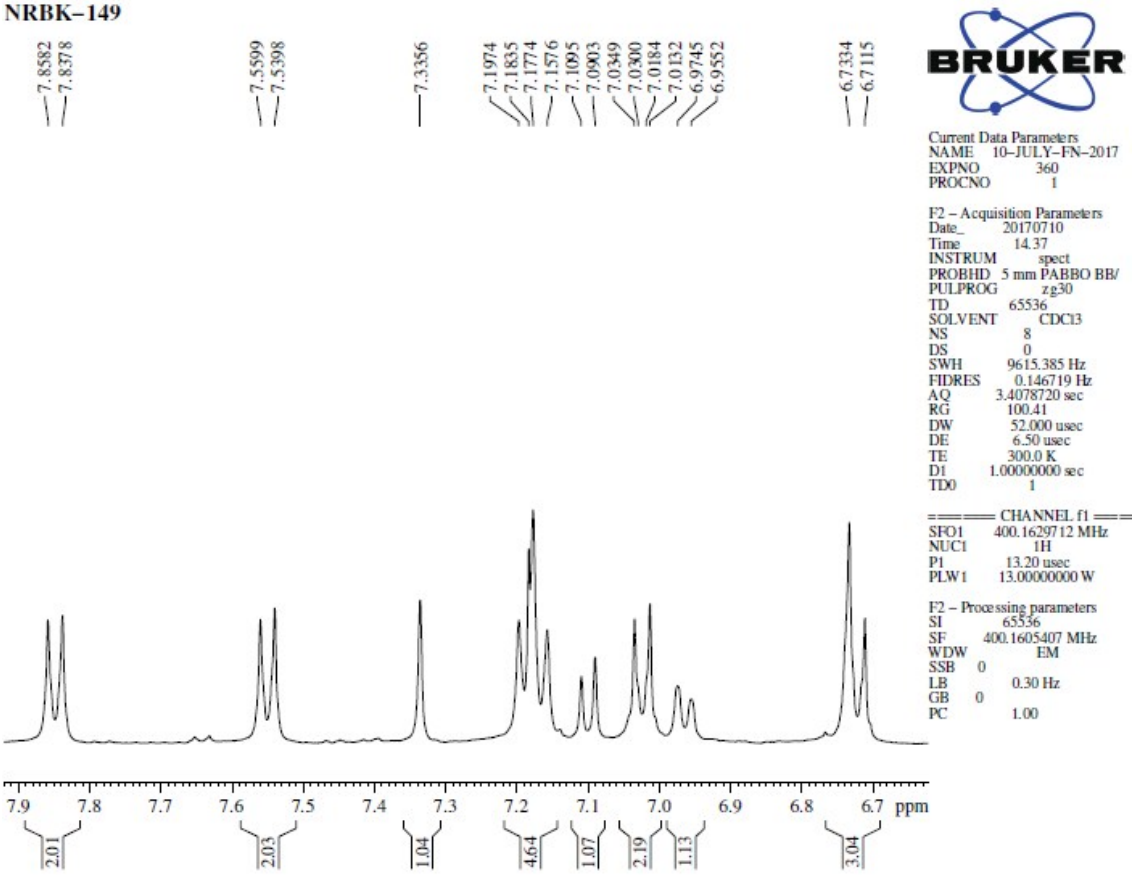

Figure 56: ^{1}H NMR spectrum of 3s (expansion)

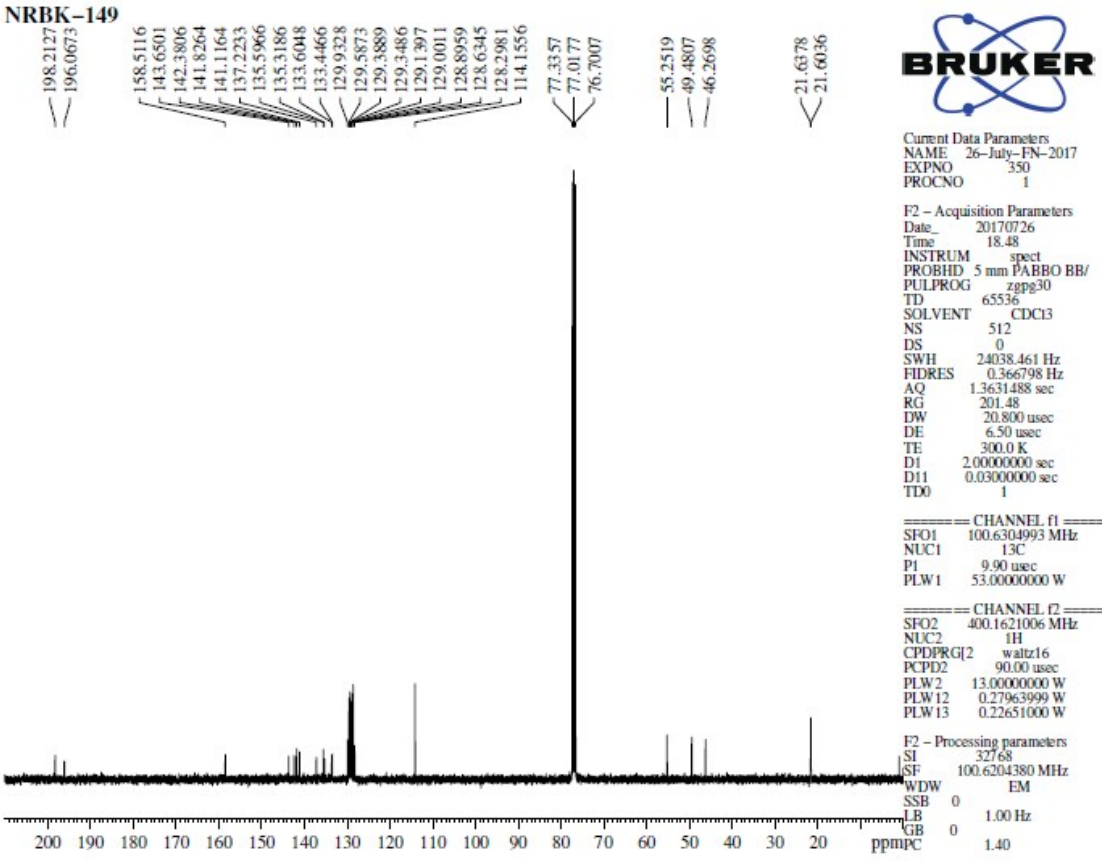

Figure 57: ^{13}C NMR spectrum of 3s

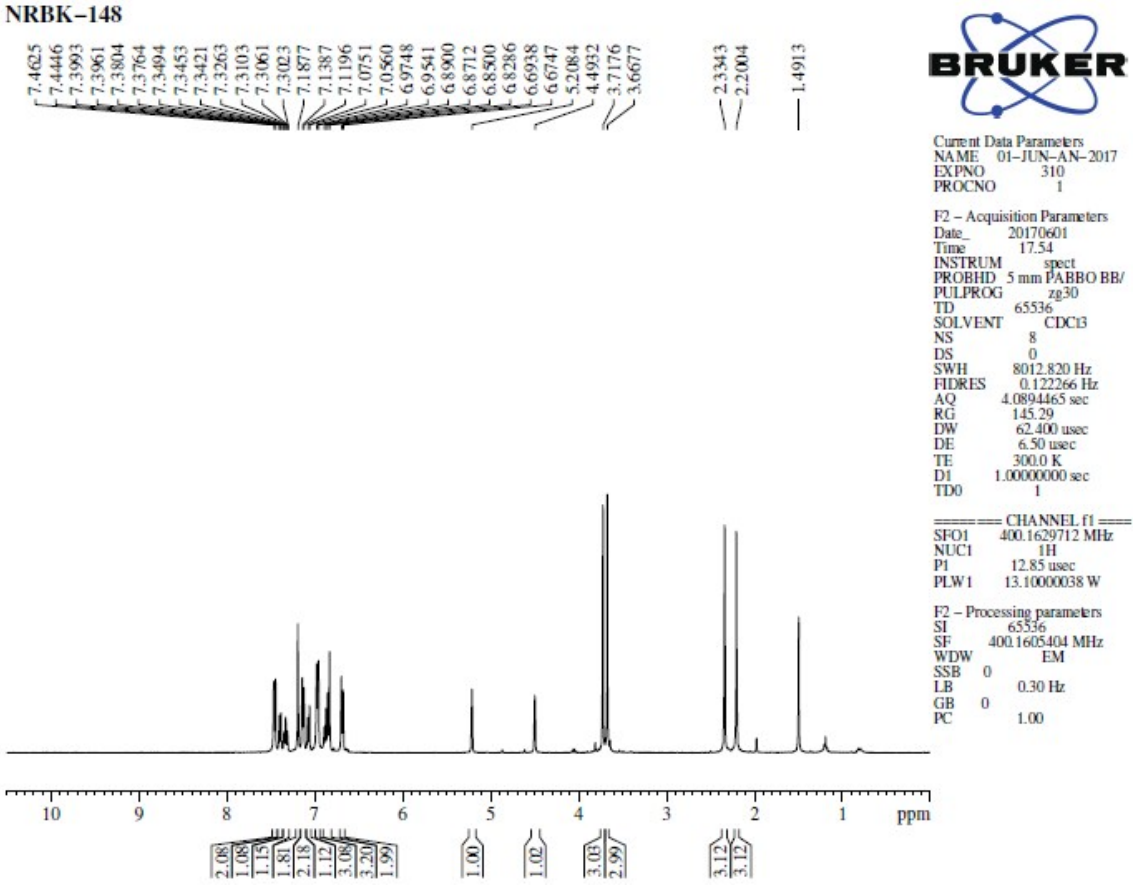

Figure 58: ^{1}H NMR spectrum of 3t

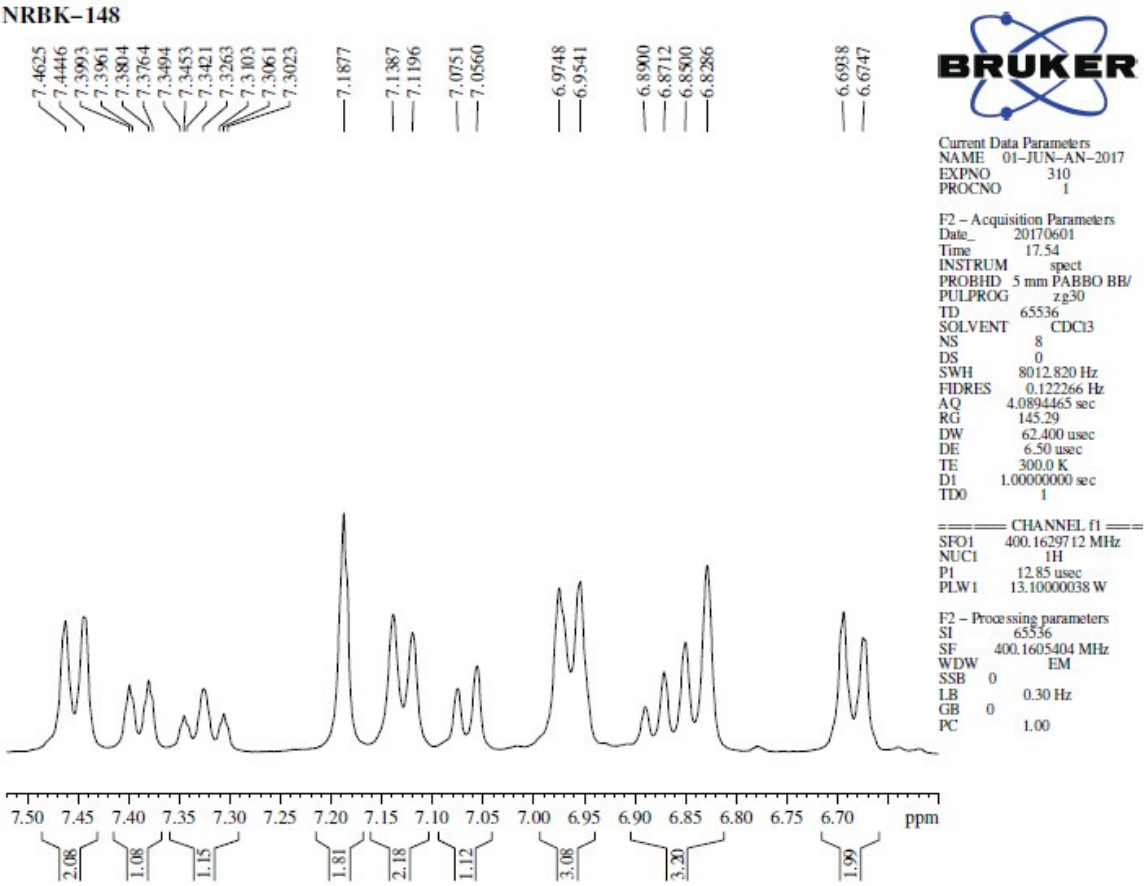

Figure 59: ^{1}H NMR spectrum of 3t (expansion)

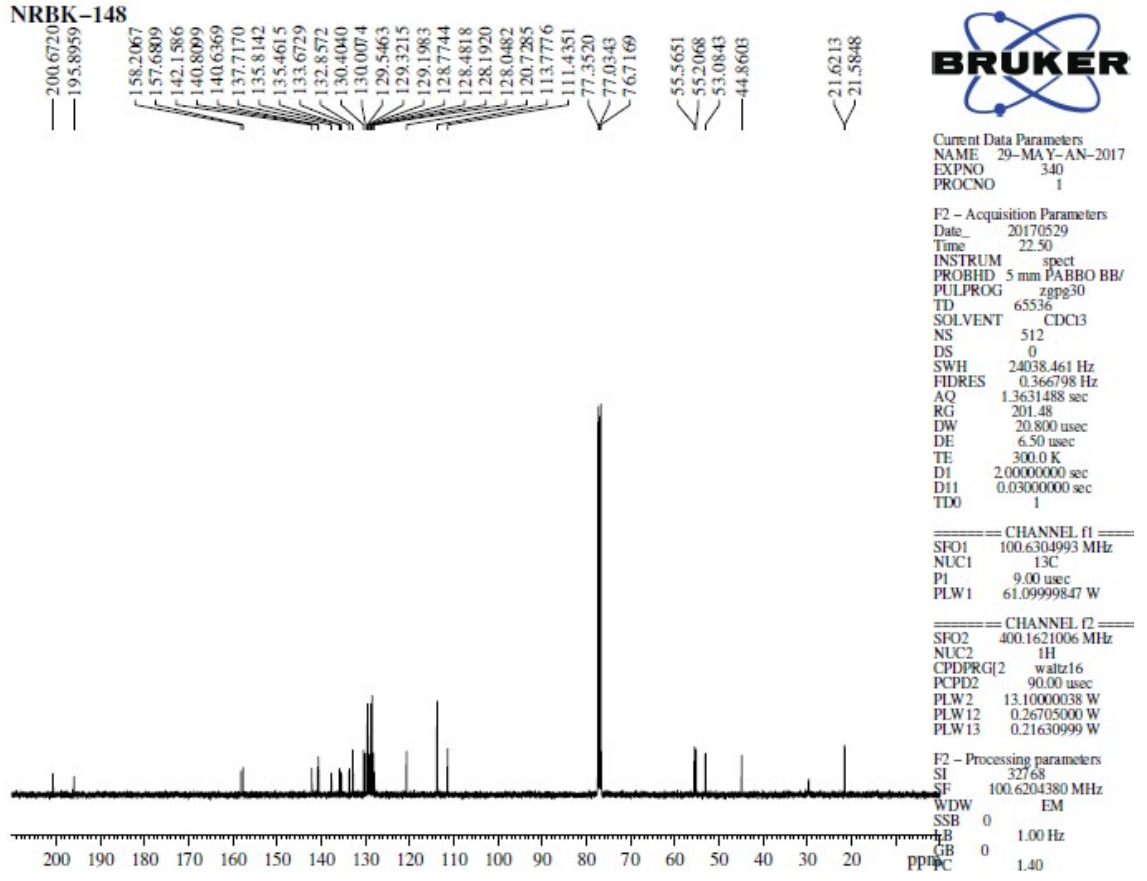

Figure 60: ^{13}C NMR spectrum of 3t

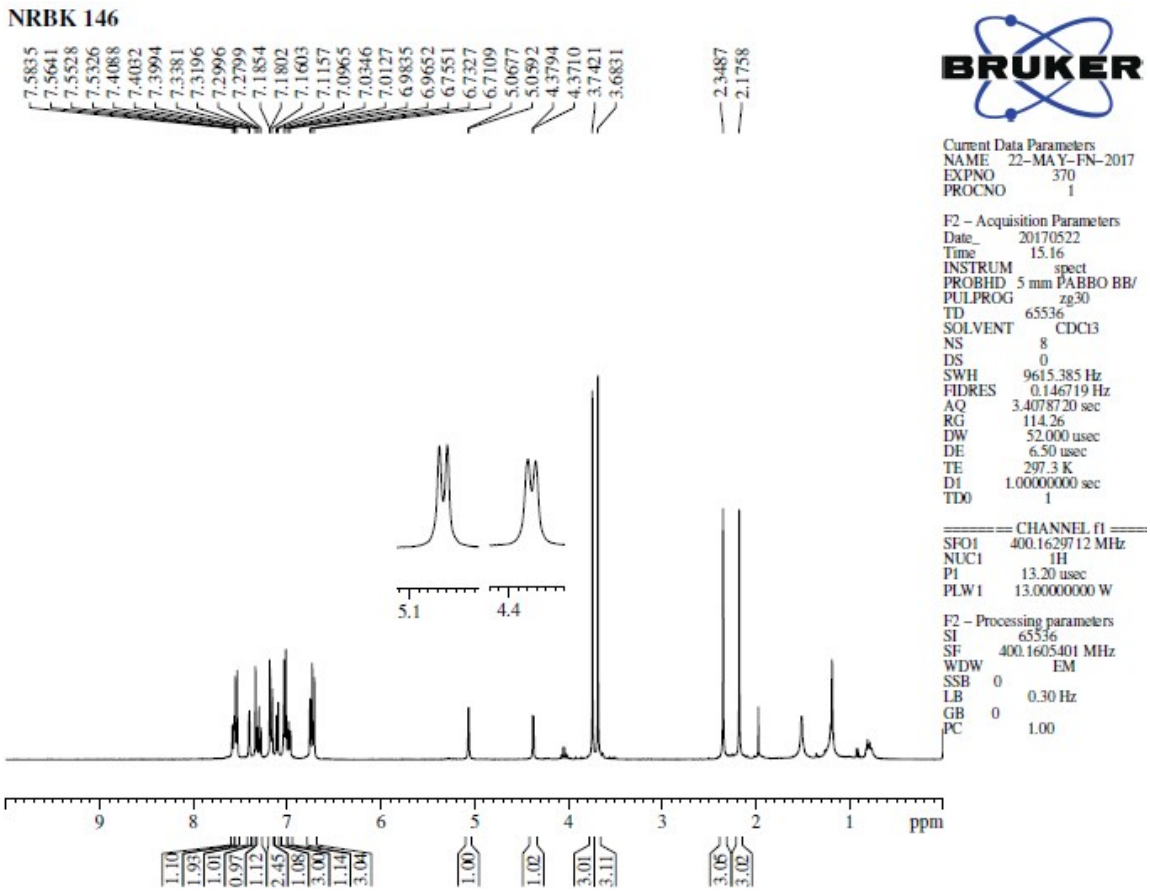

Figure 61: ^{1}H NMR spectrum of 3u

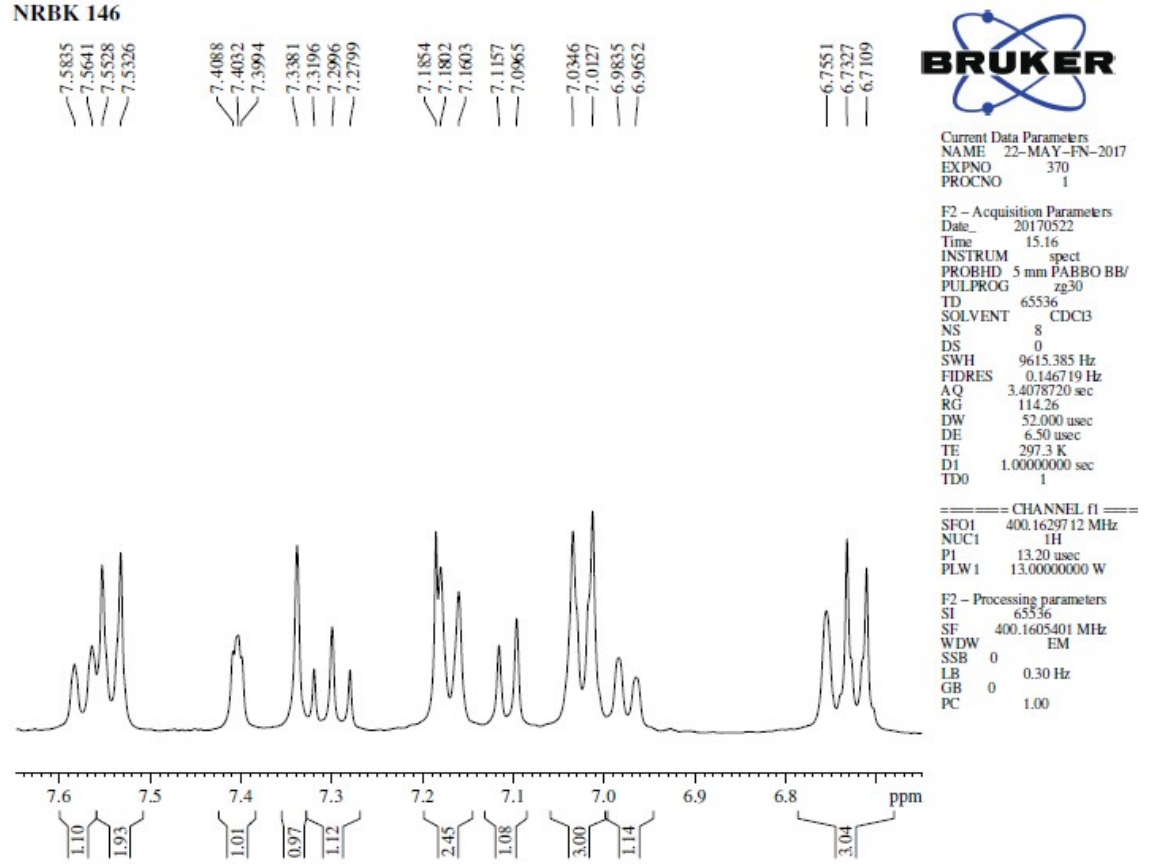

Figure 62: ^{1}H NMR spectrum of 3u (expansion)

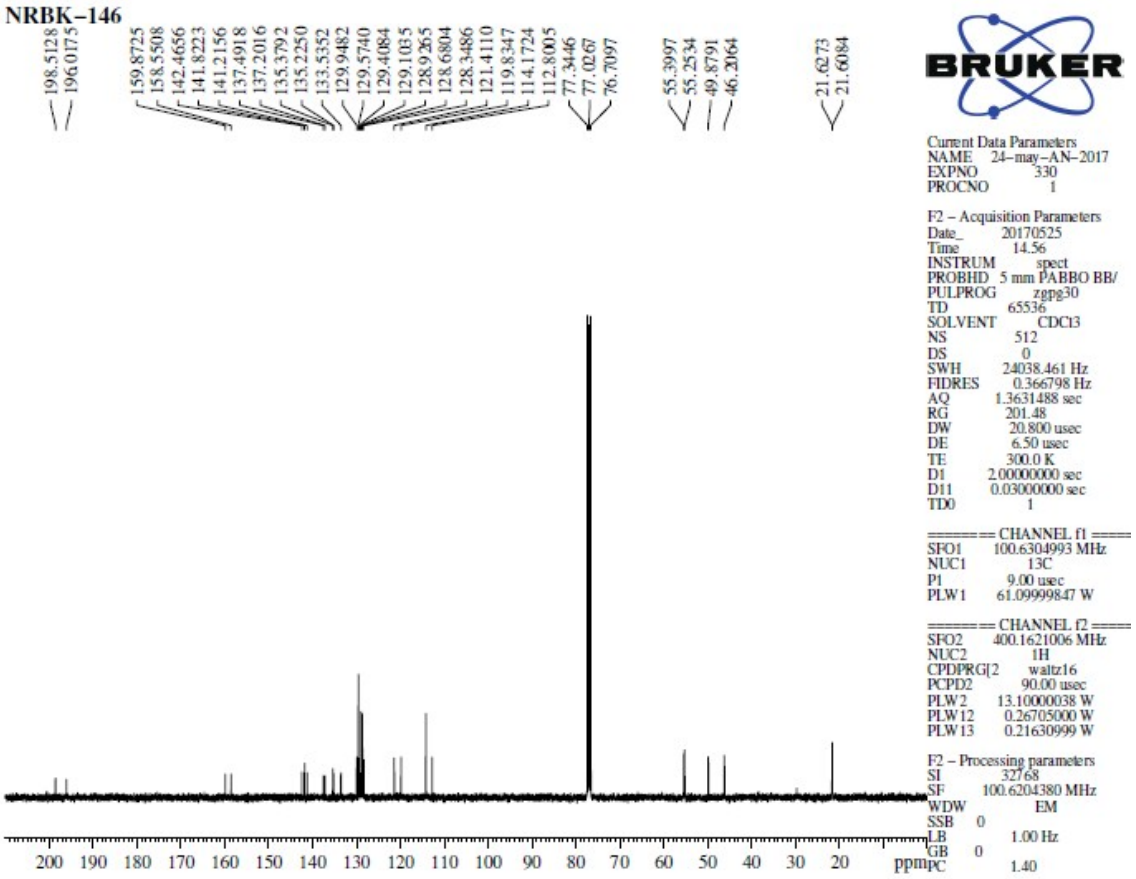

Figure 63: ^{13}C NMR spectrum of 3u

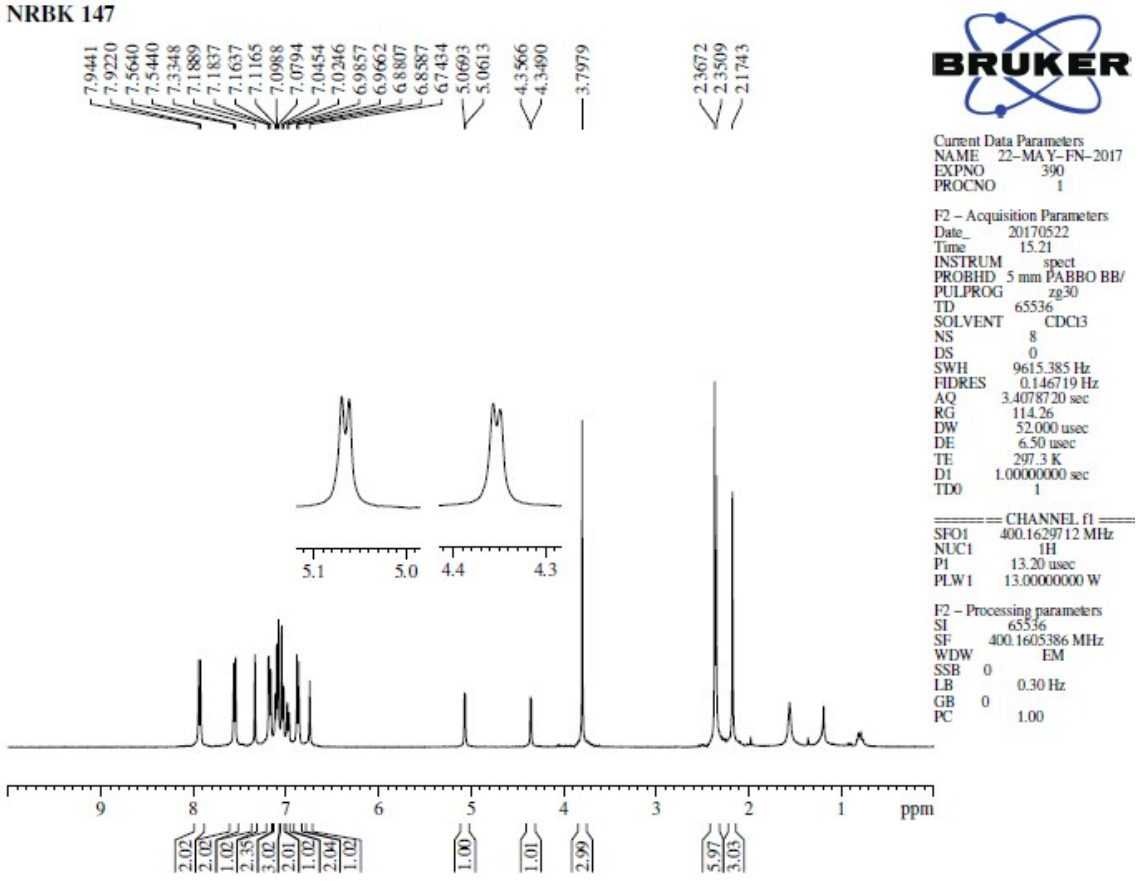

Figure 64: ^{1}H NMR spectrum of 3v

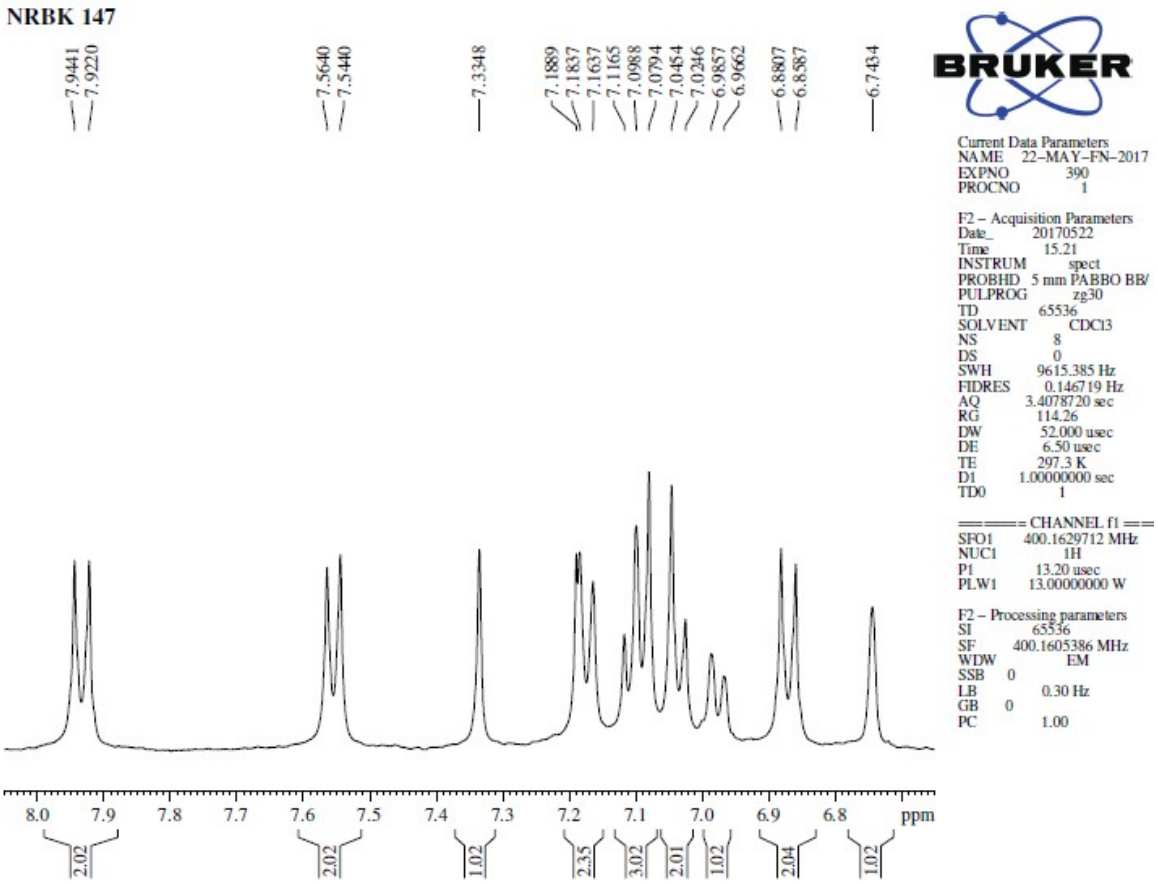

Figure 65: ^{1}H NMR spectrum of 3v (expansion)

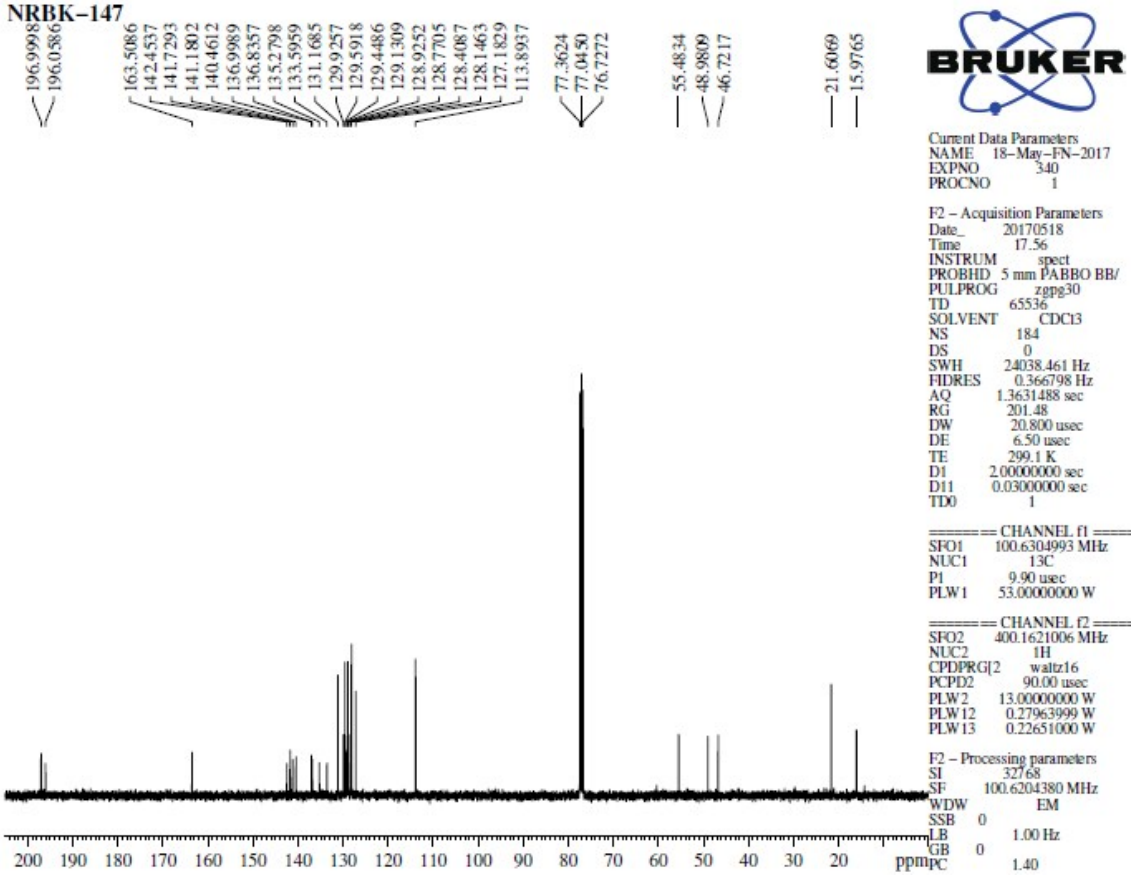

Figure 66: ^{13}C NMR spectrum of 3v

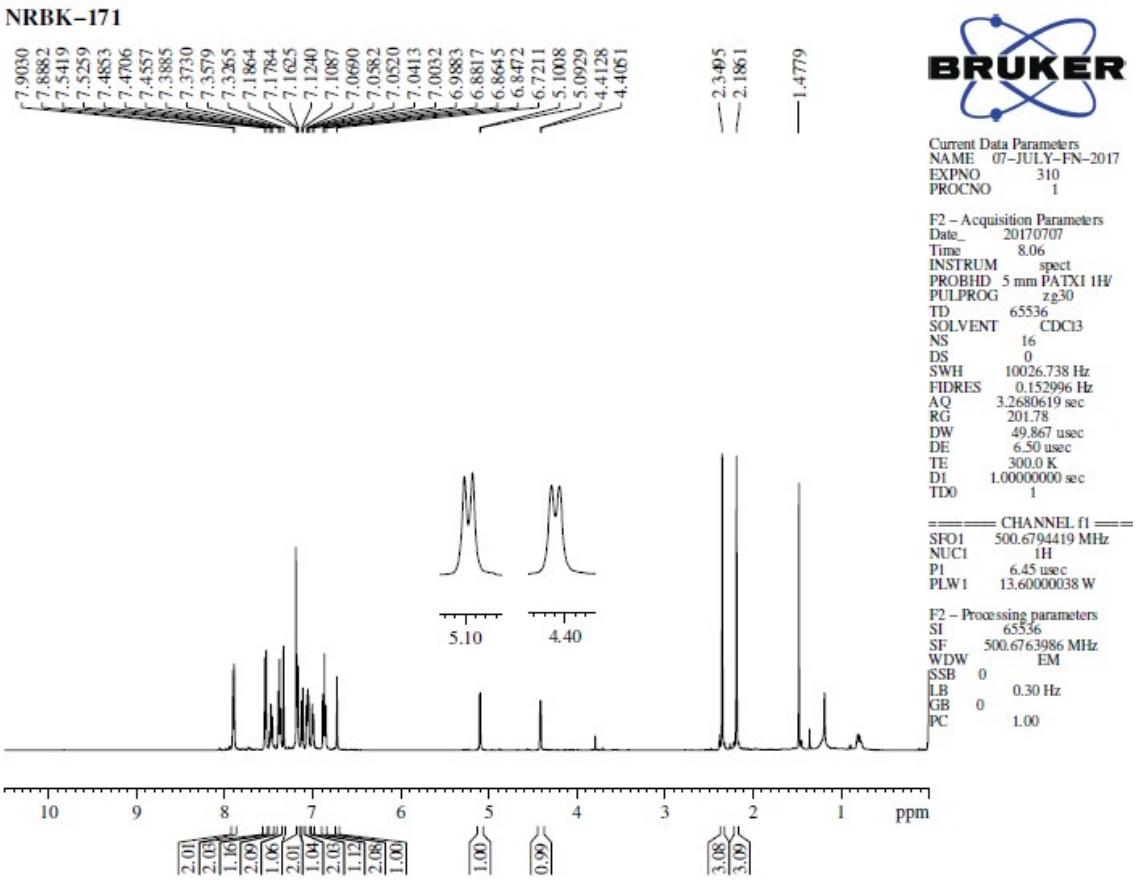

Figure 67: ^{1}H NMR spectrum of 3w

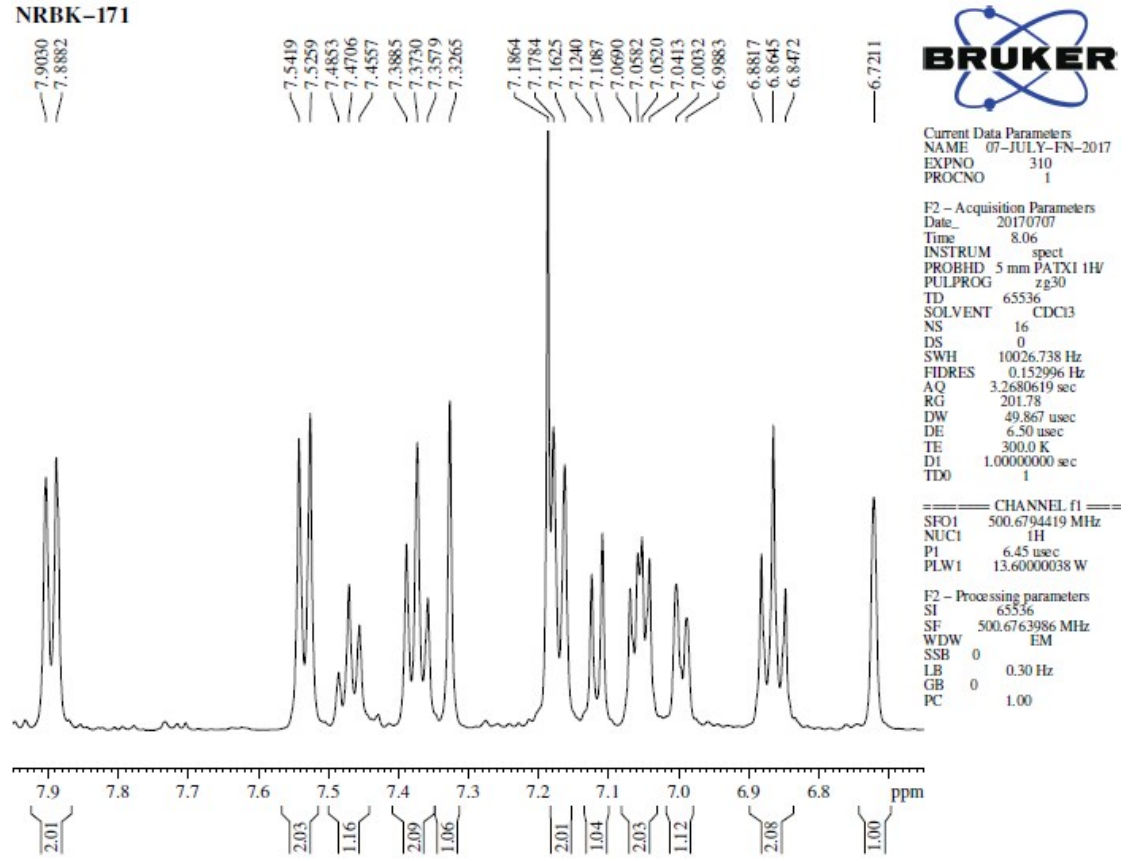

Figure 68: ^{1}H NMR spectrum of 3w (expansion)

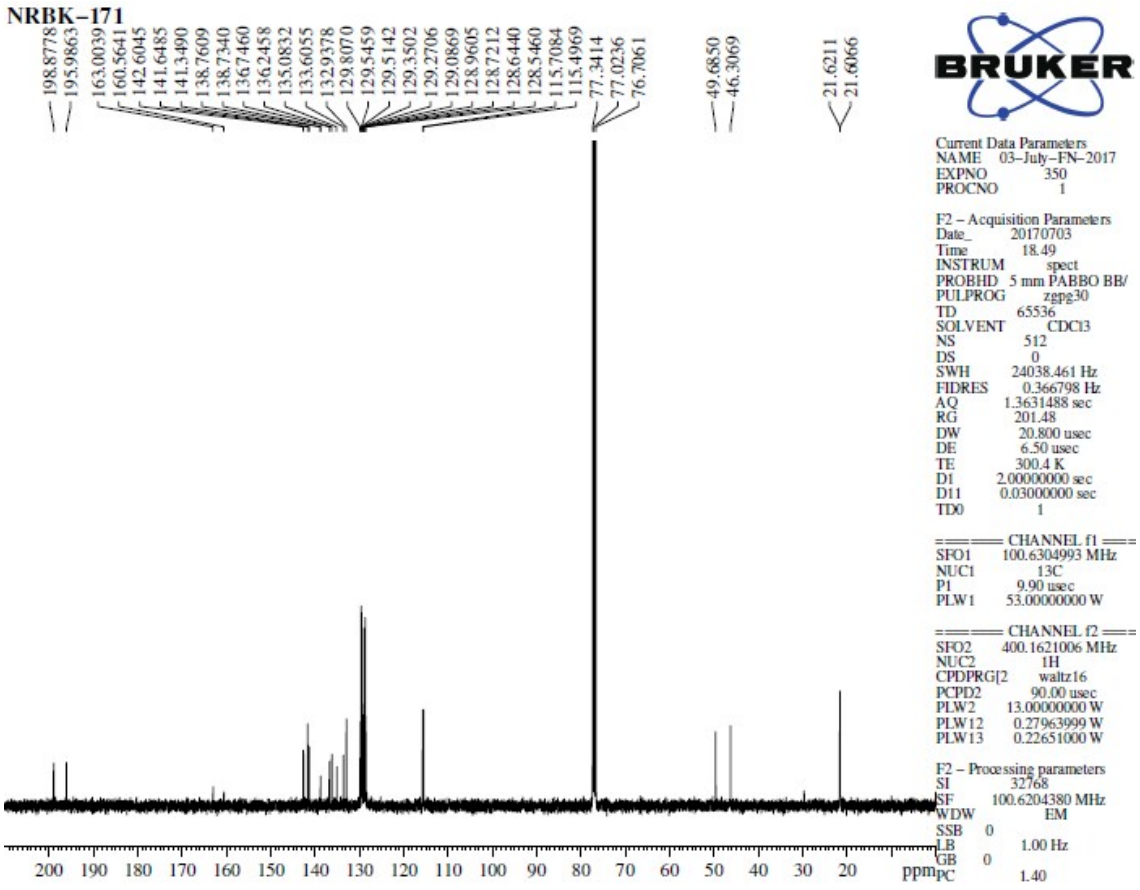

Figure 69: ^{13}C NMR spectrum of 3w

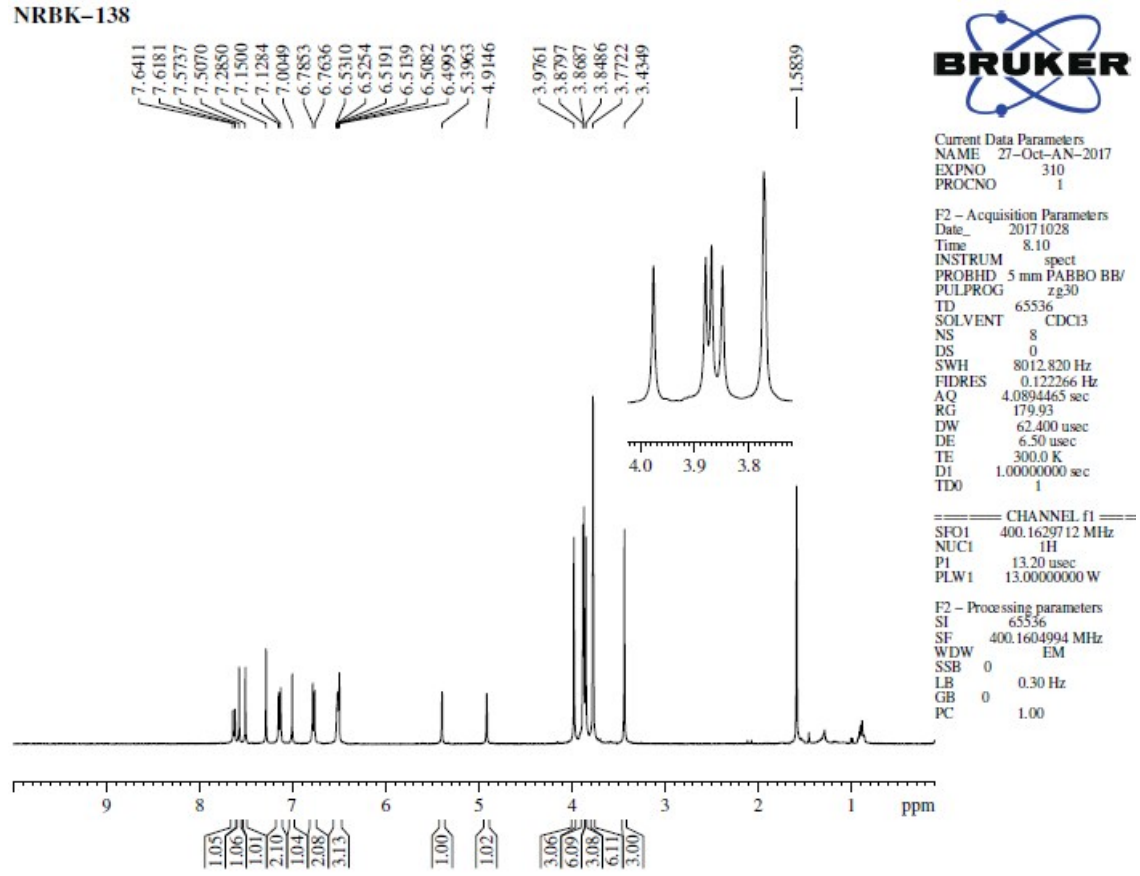

Figure 70: ^{1}H NMR spectrum of 3x

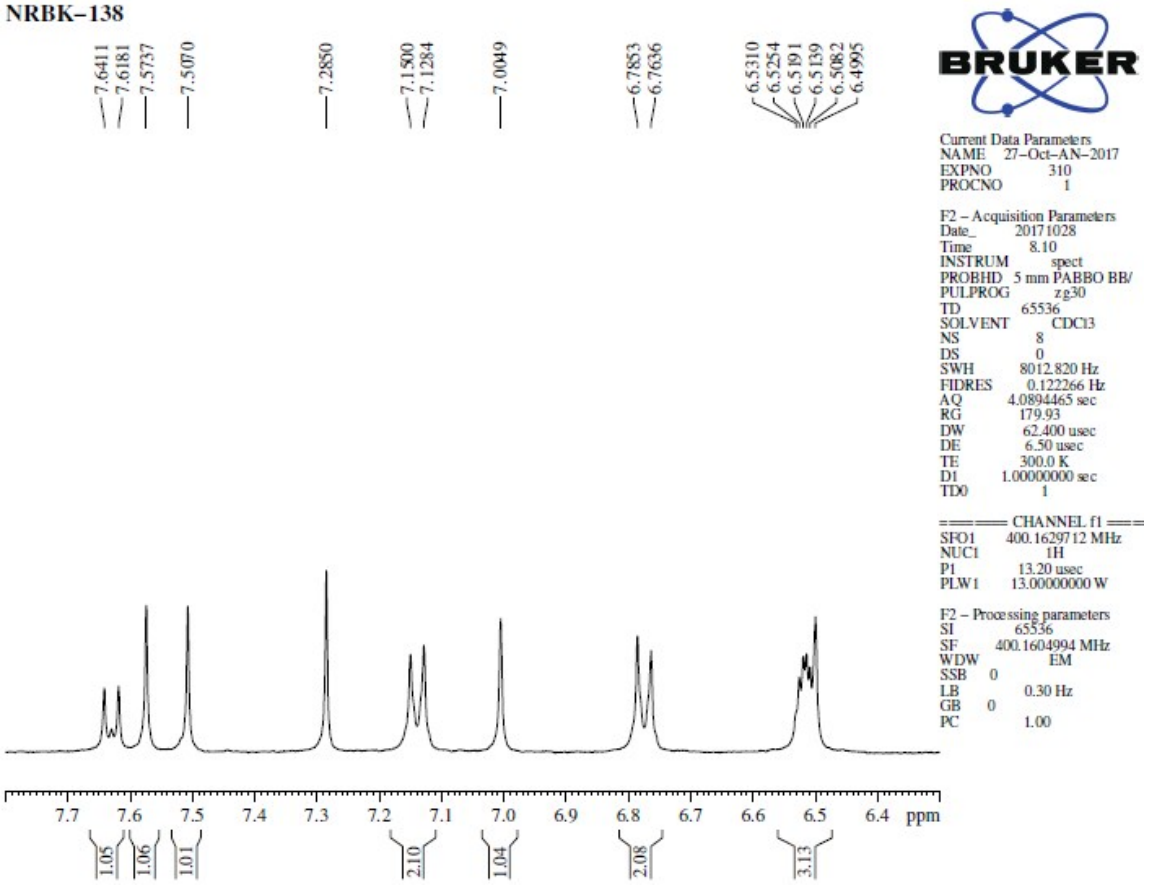

Figure 71: ^{1}H NMR spectrum of 3x (expansion)

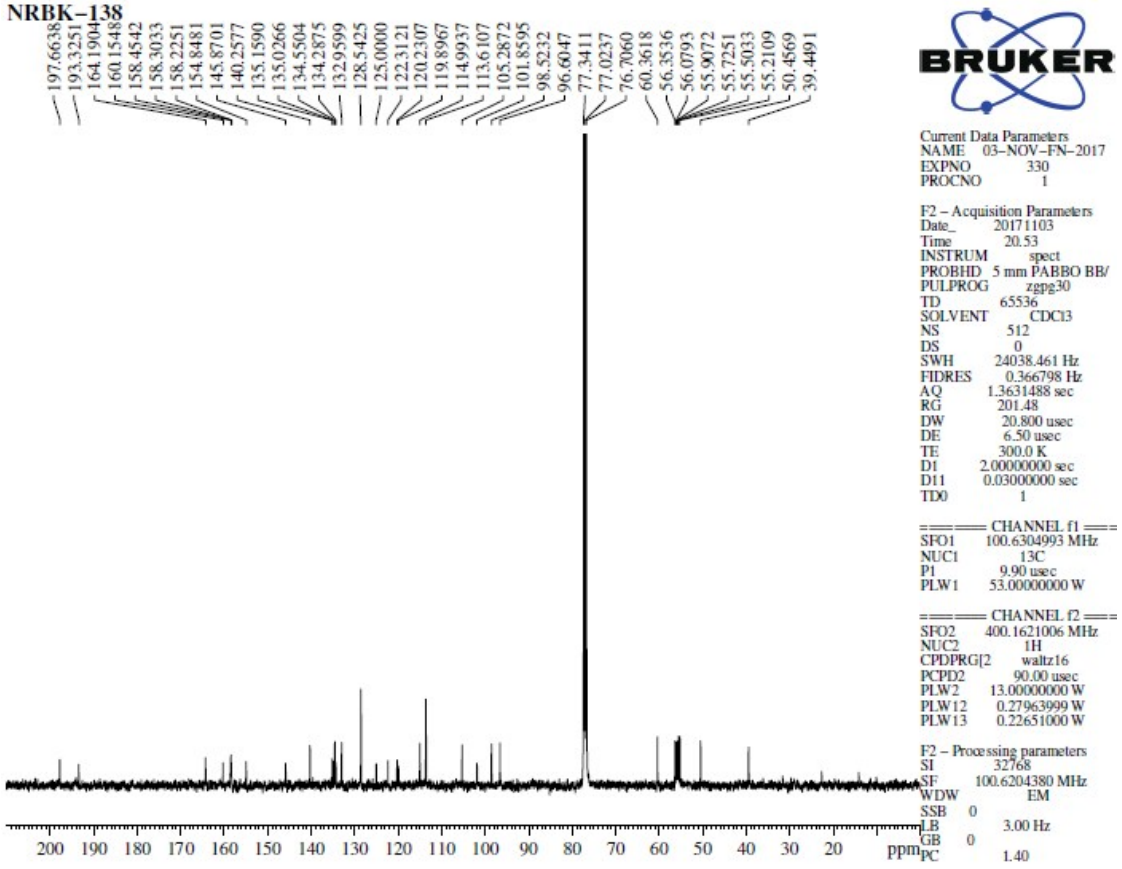

Figure 72: ^{13}C NMR spectrum of 3x

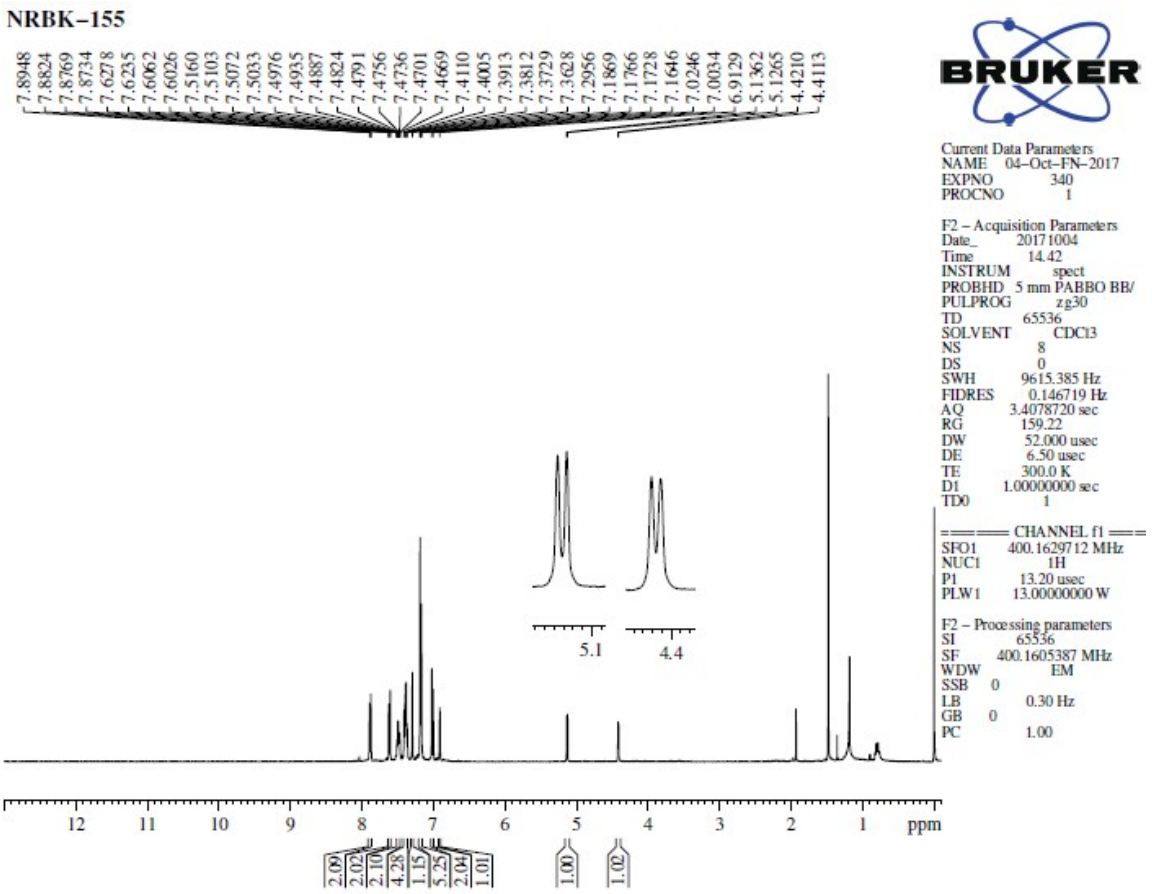

Figure 73: ^{1}H NMR spectrum of 3y

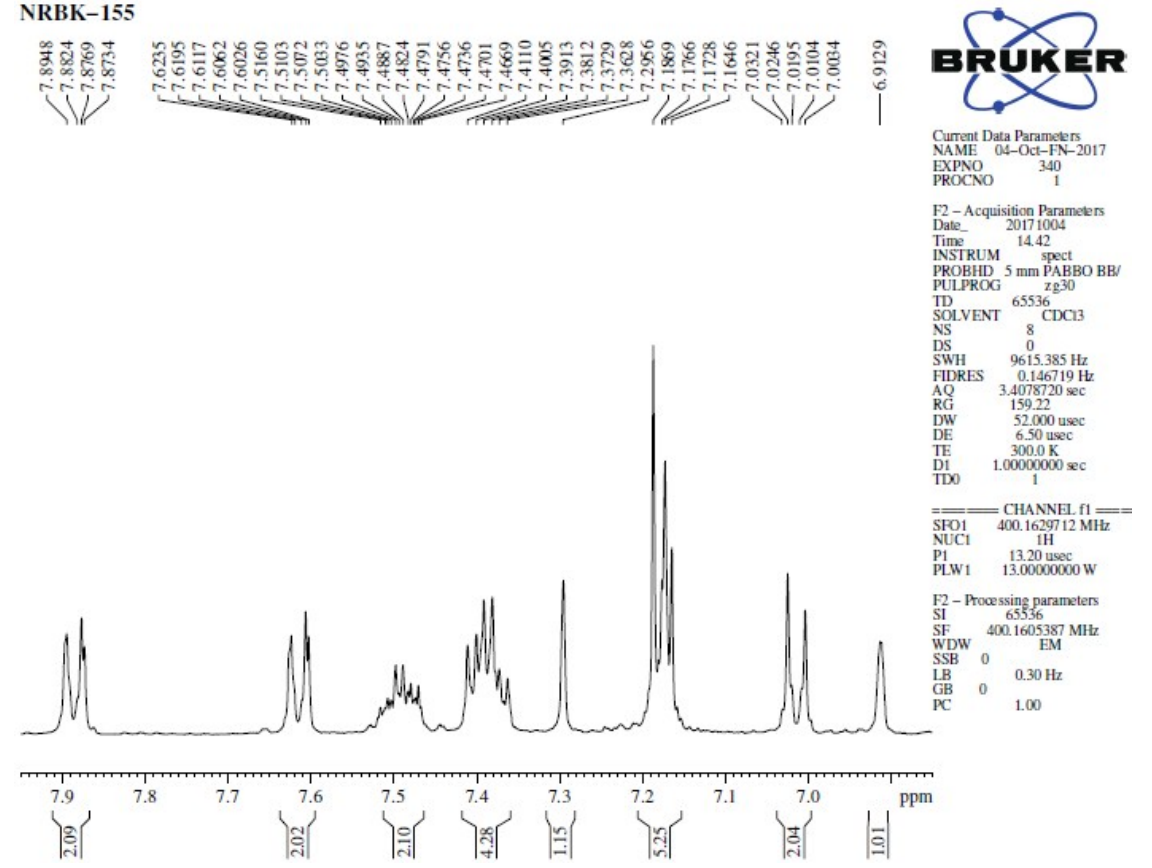

Figure 74: ^{1}H NMR spectrum of 3y (expansion)

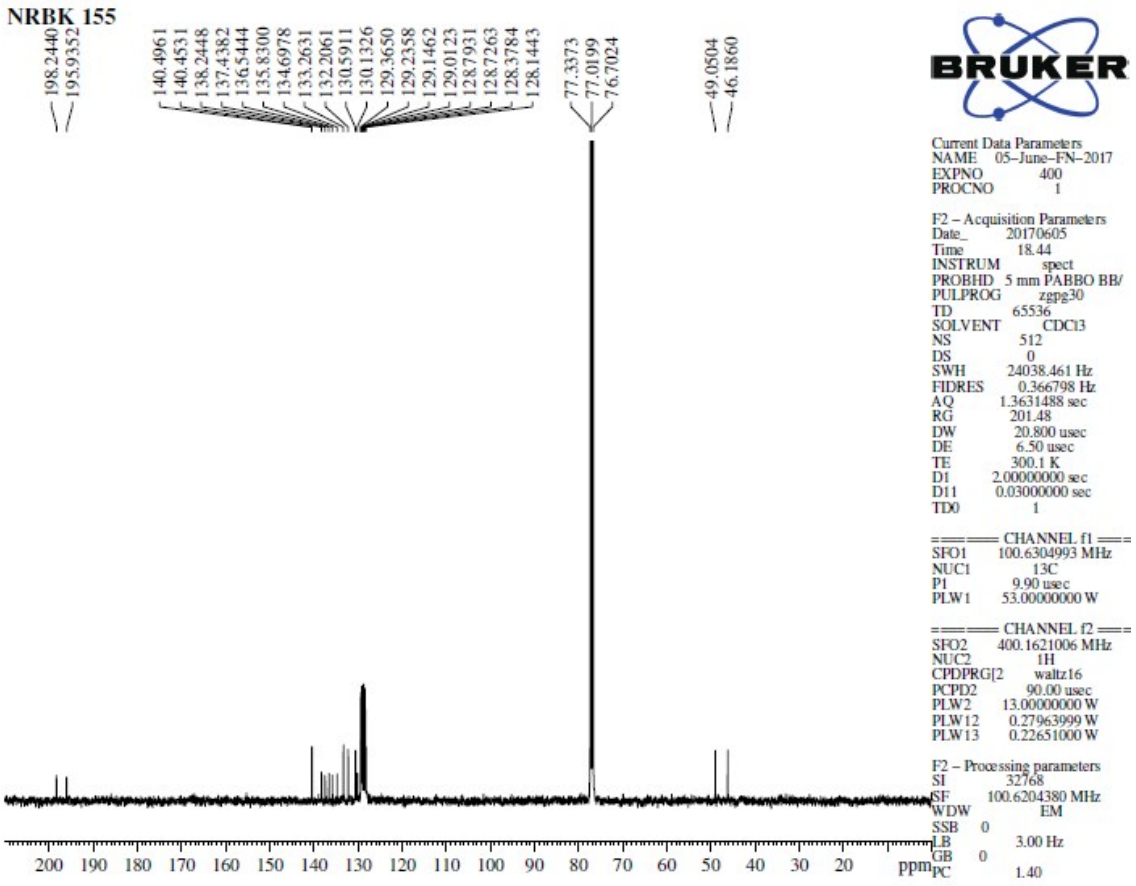

Figure 75: ^{13}C NMR spectrum of 3y

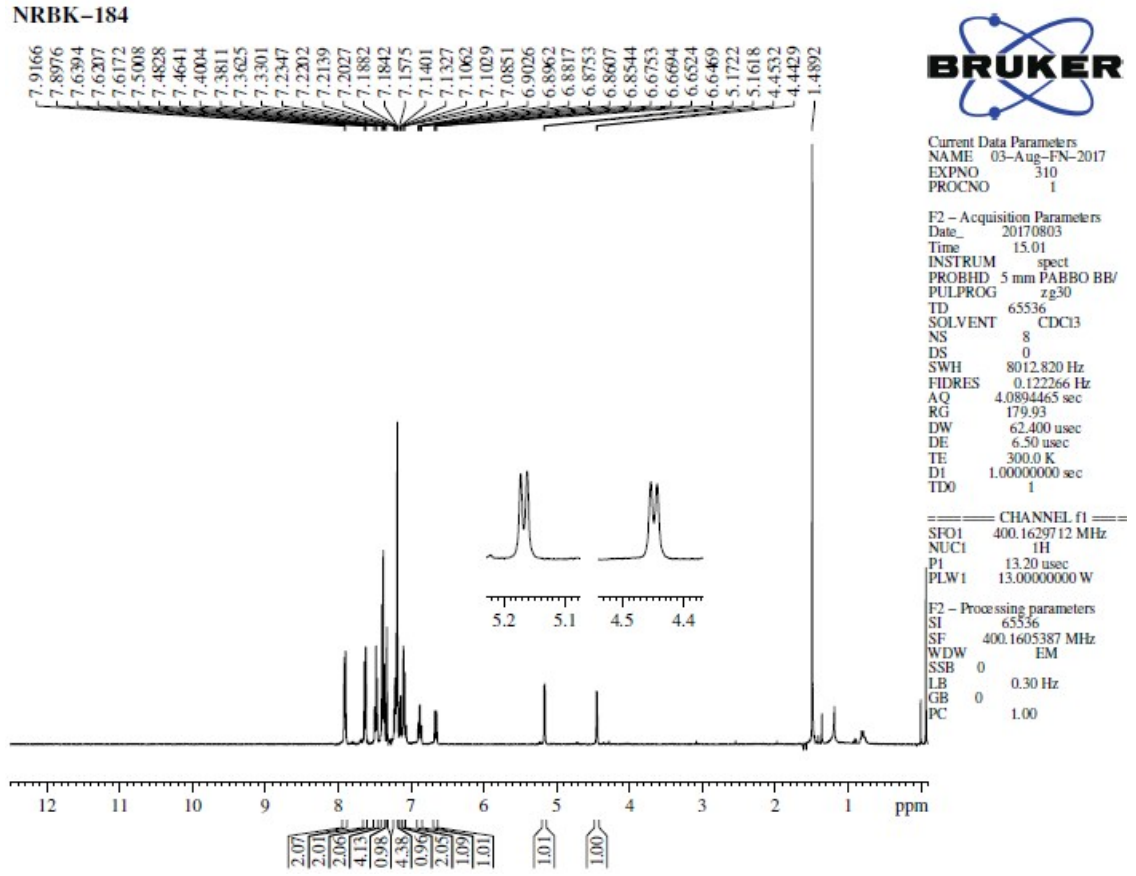

Figure 76: ^{1}H NMR spectrum of 3z

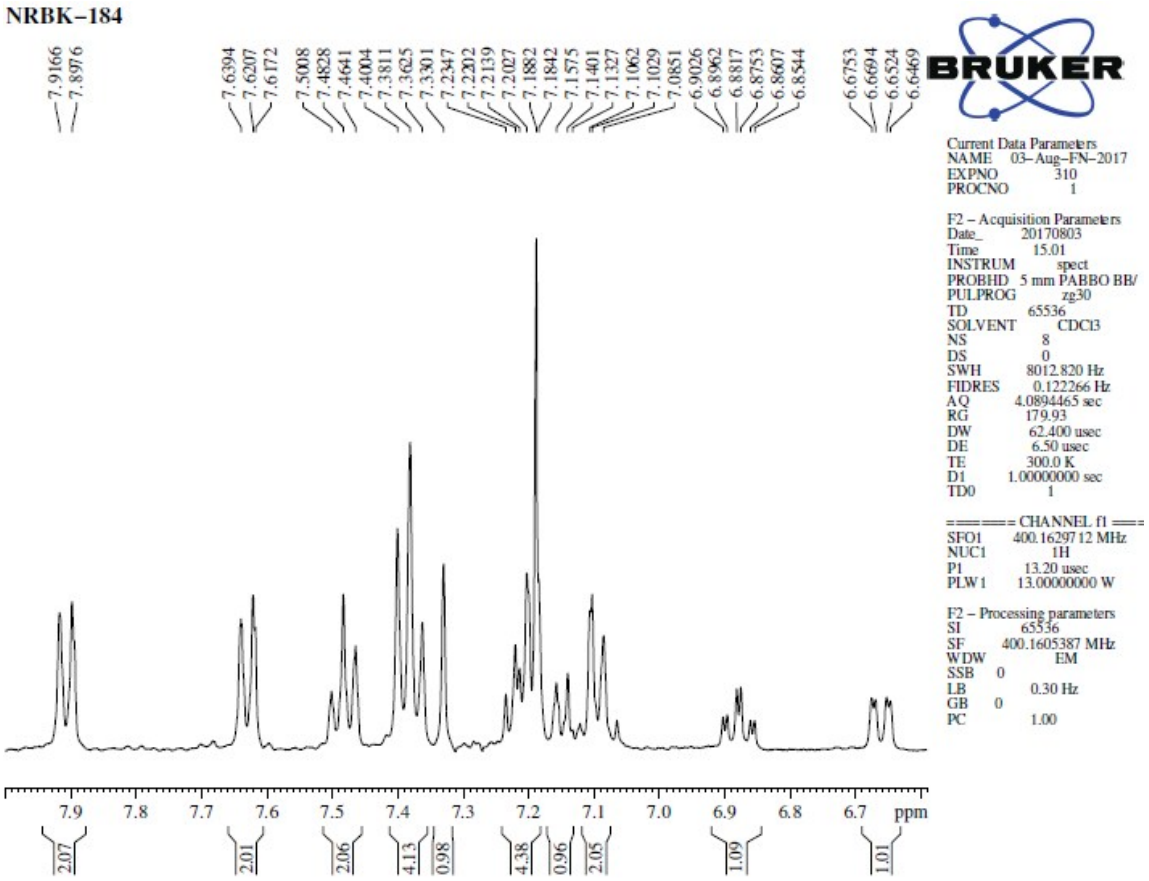

Figure 77: ^{1}H NMR spectrum of 3z (expansion)

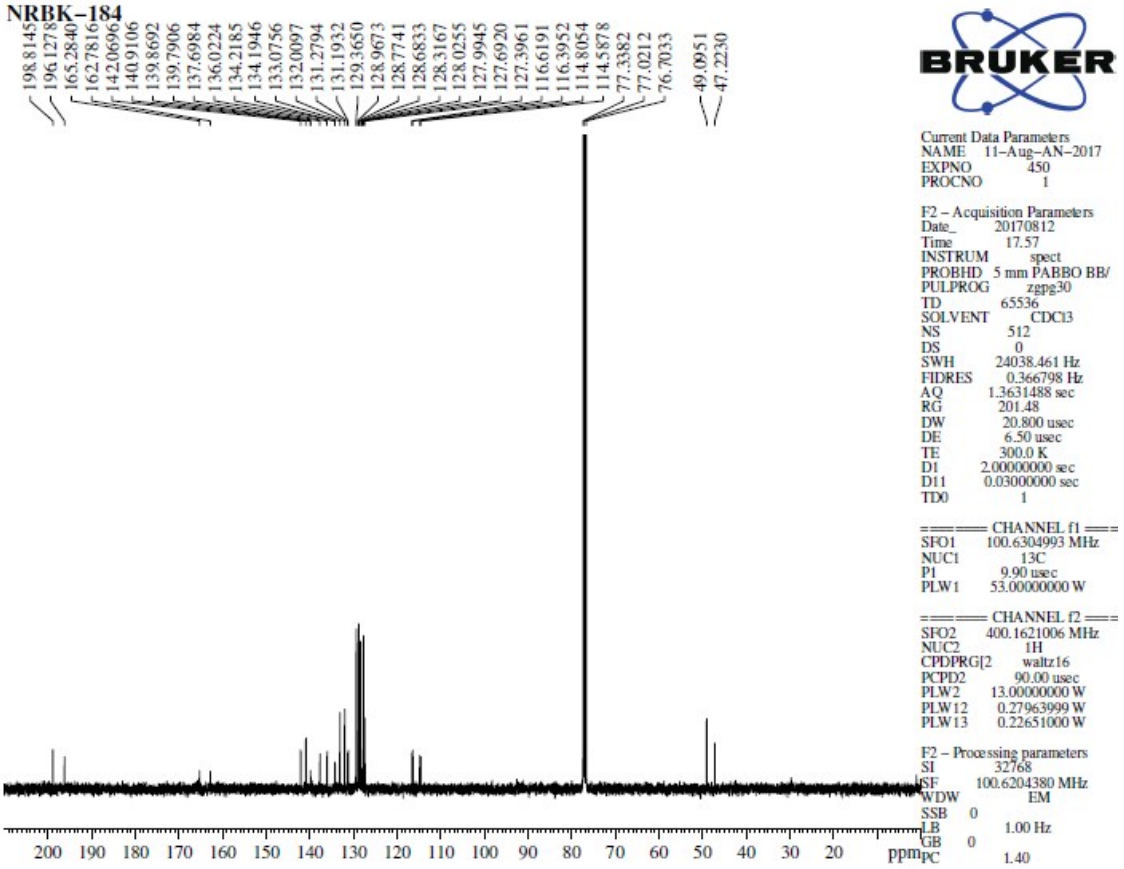

Figure 78: ^{13}C NMR spectrum of 3z

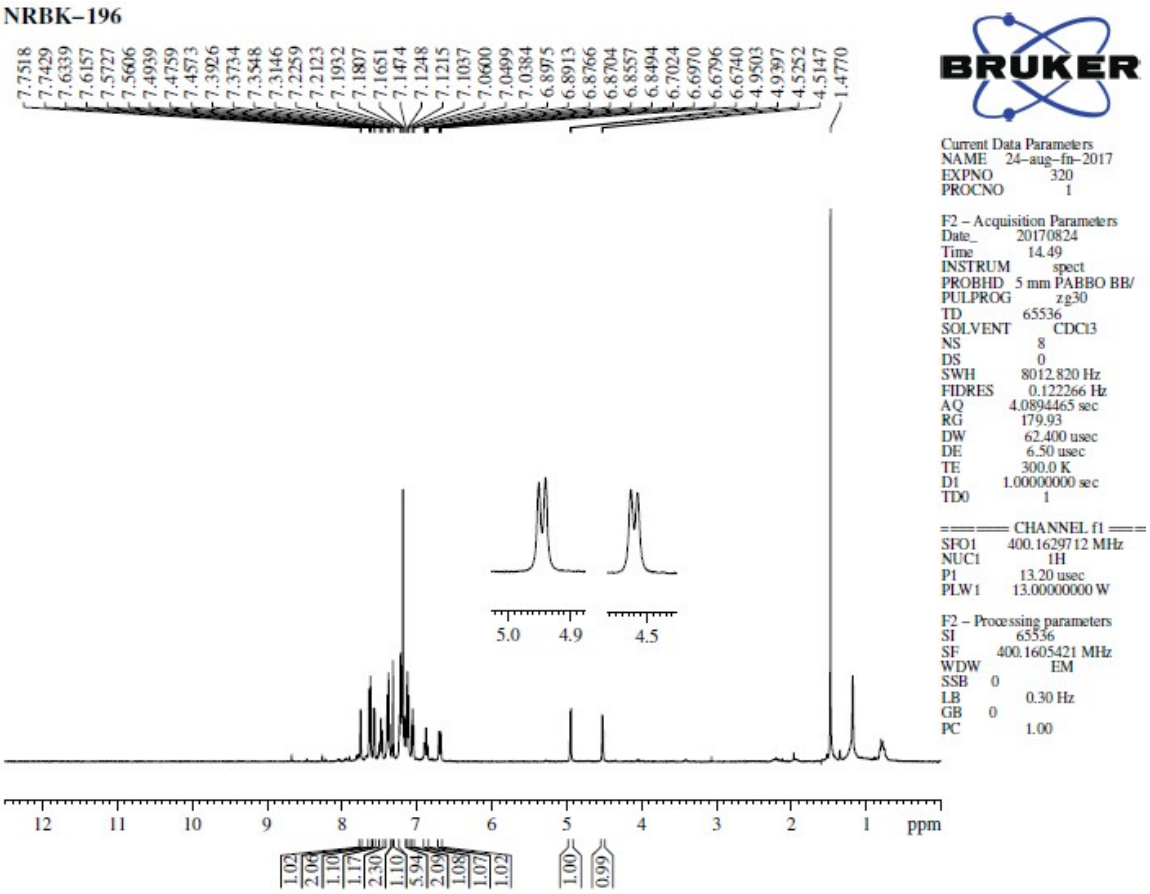

Figure 79: ^{1}H NMR spectrum of 3za

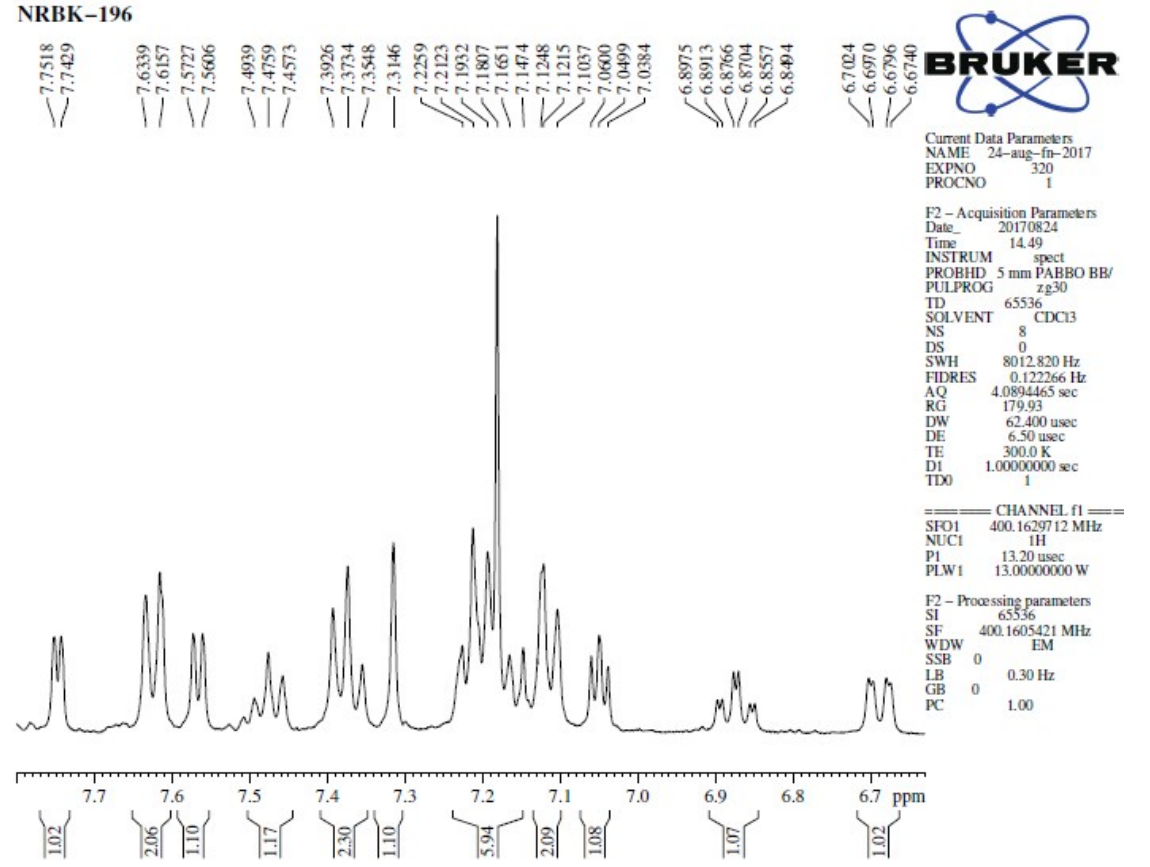

Figure 80: ^{1}H NMR spectrum of 3za (expansion)

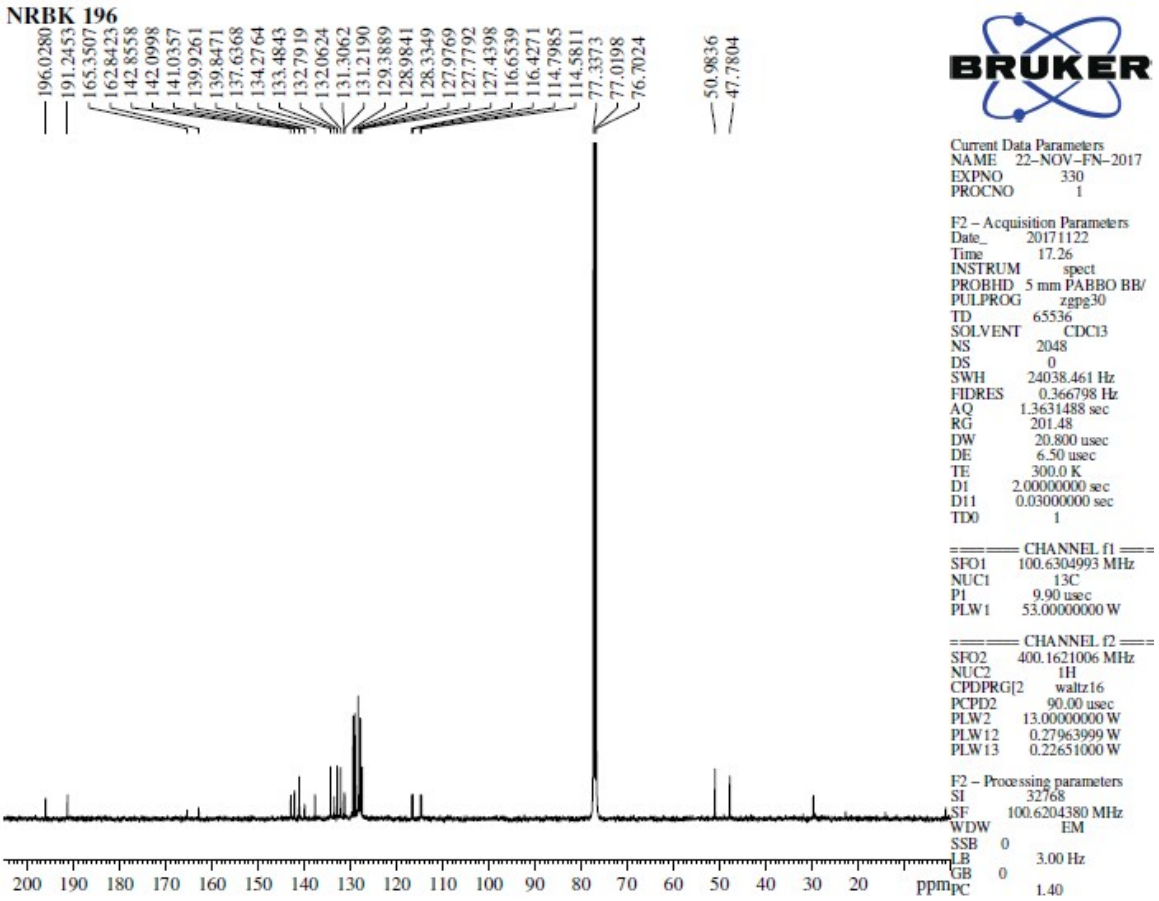

Figure 81: ^{13}C NMR spectrum of 3za

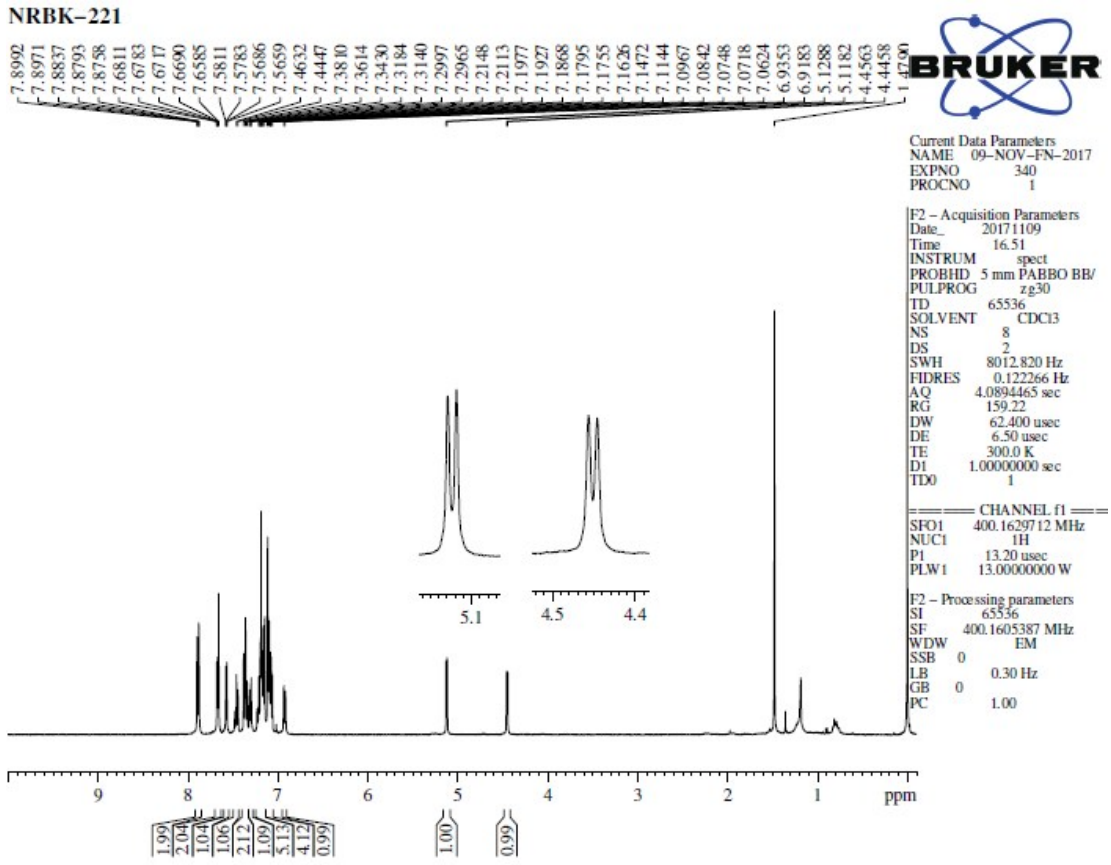

Figure 82: ^{1}H NMR spectrum of 3zb

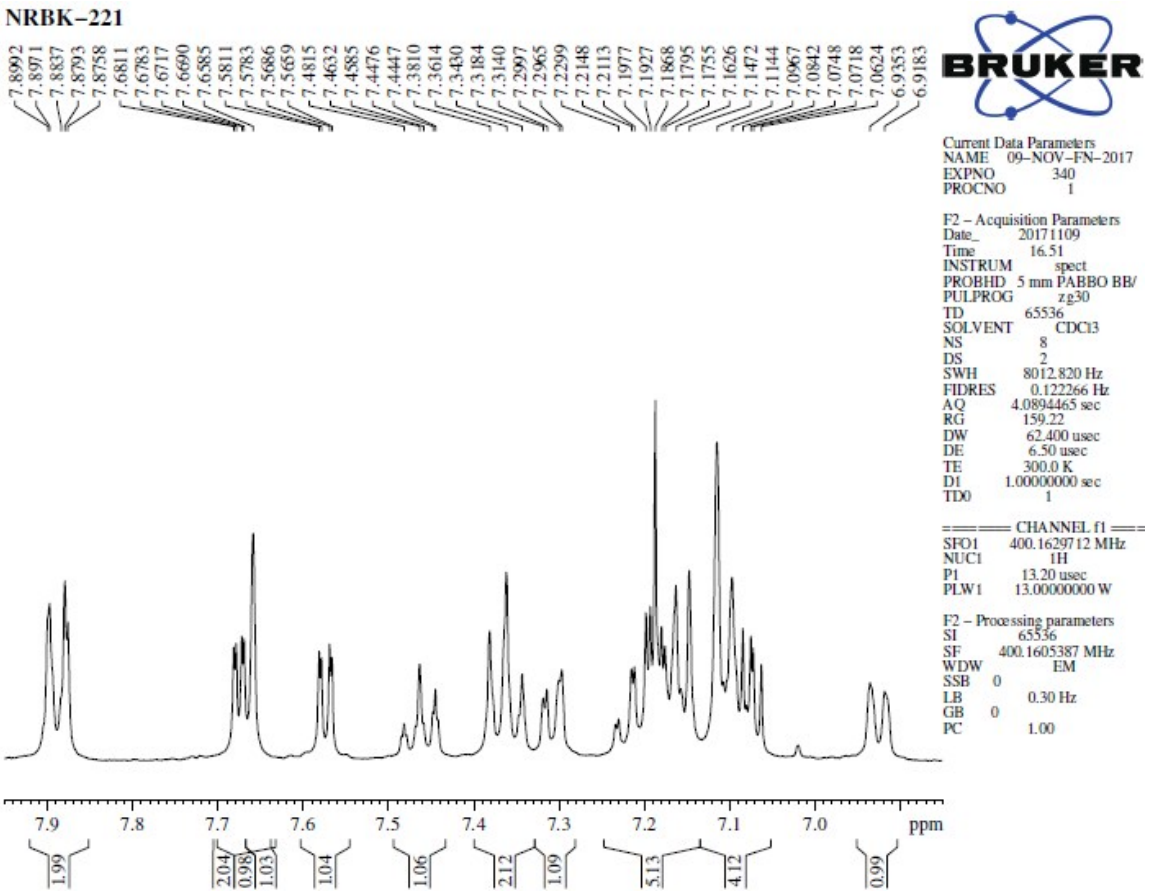

Figure 83: ^{1}H NMR spectrum of 3zb (expansion)

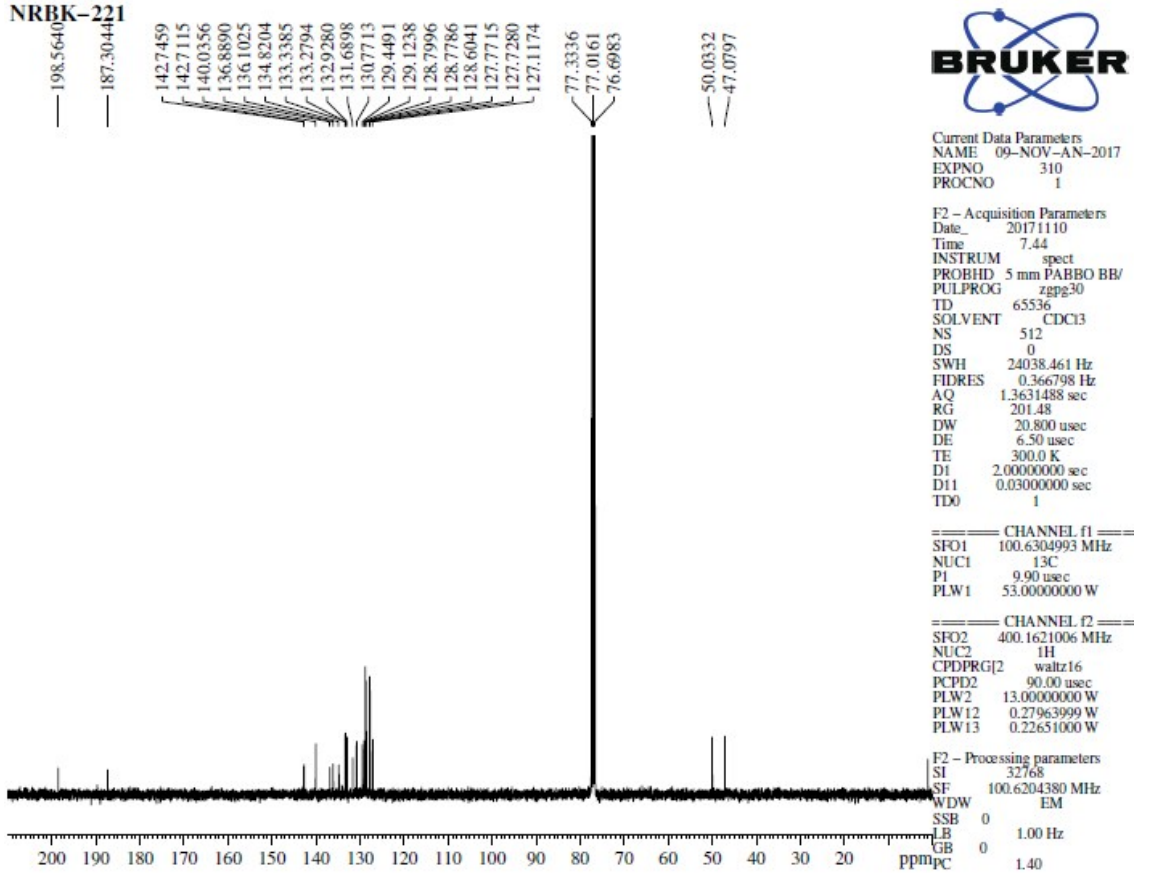

Figure 84: ^{13}C NMR spectrum of 3zb

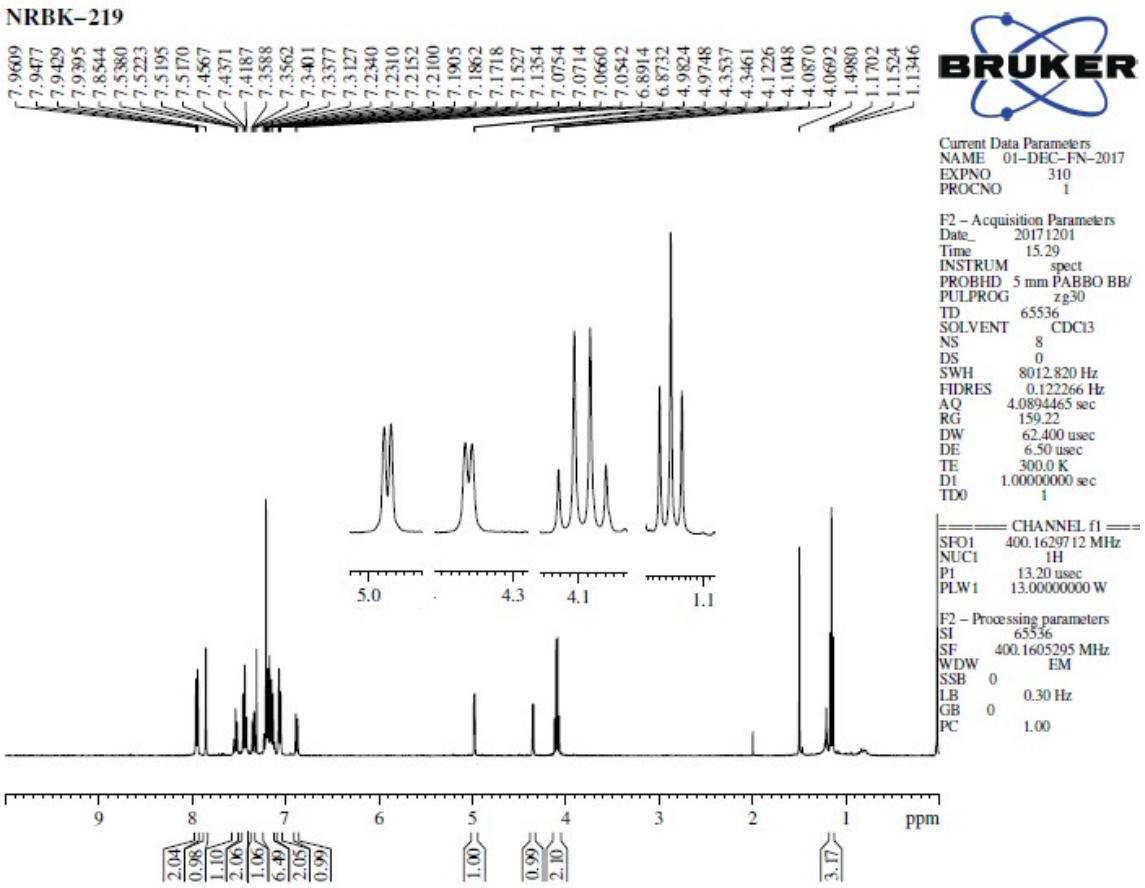

Figure 85: ^{1}H NMR spectrum of 3zc

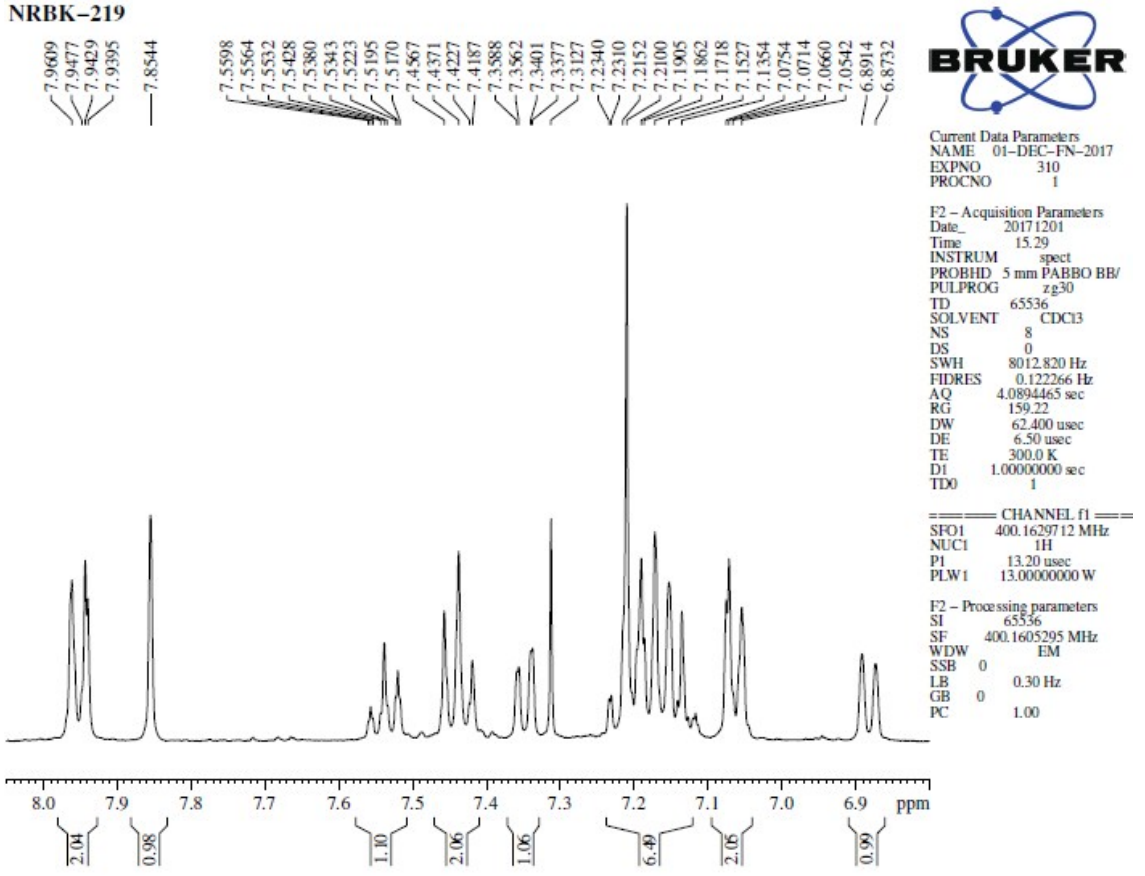

Figure 86: ^{1}H NMR spectrum of 3zc (expansion)

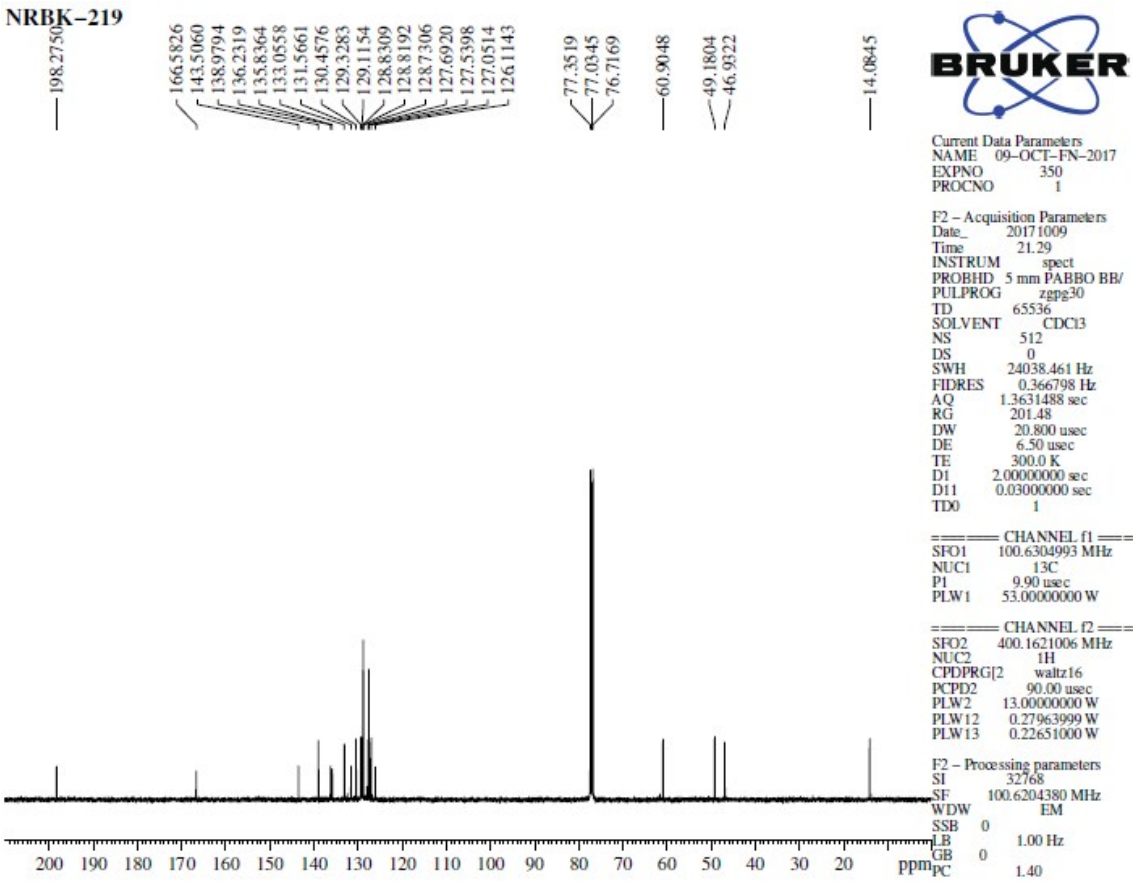

Figure 87: ^{13}C NMR spectrum of 3zc

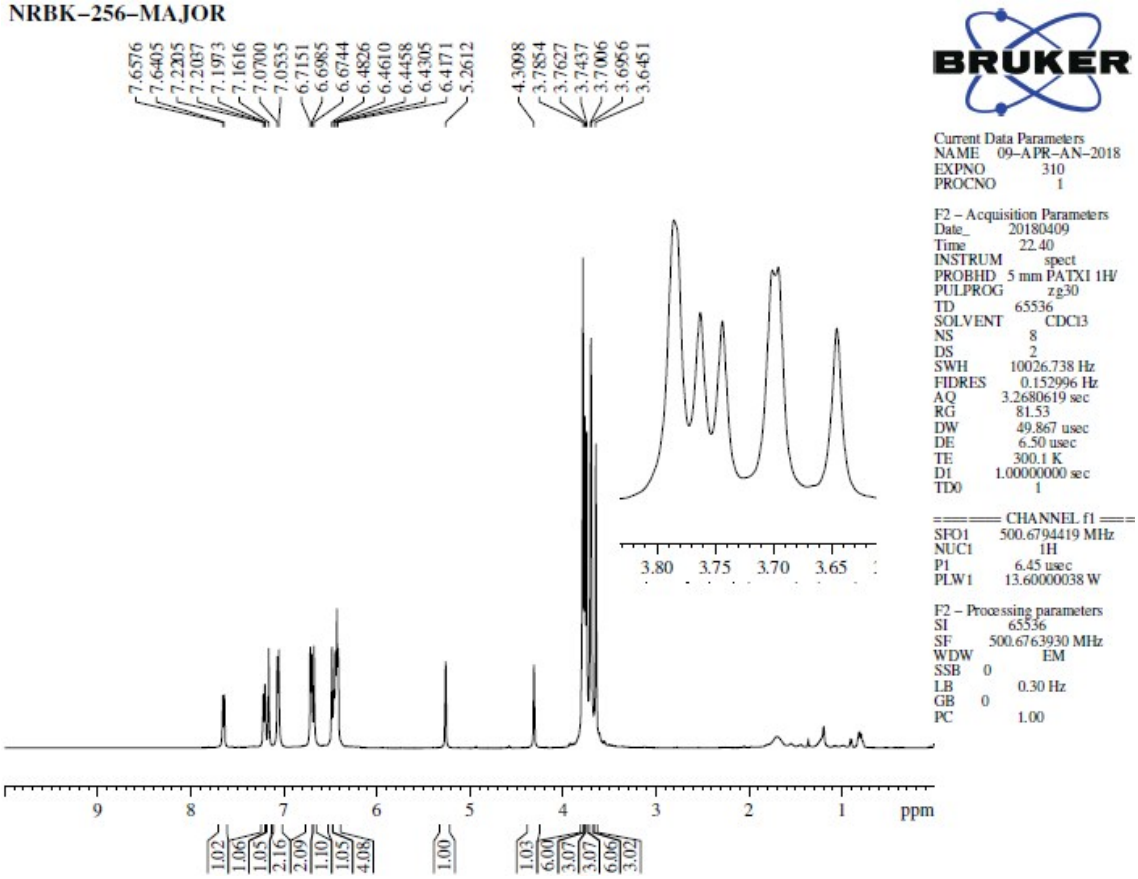

Figure 88: ^{1}H NMR spectrum of 3zd

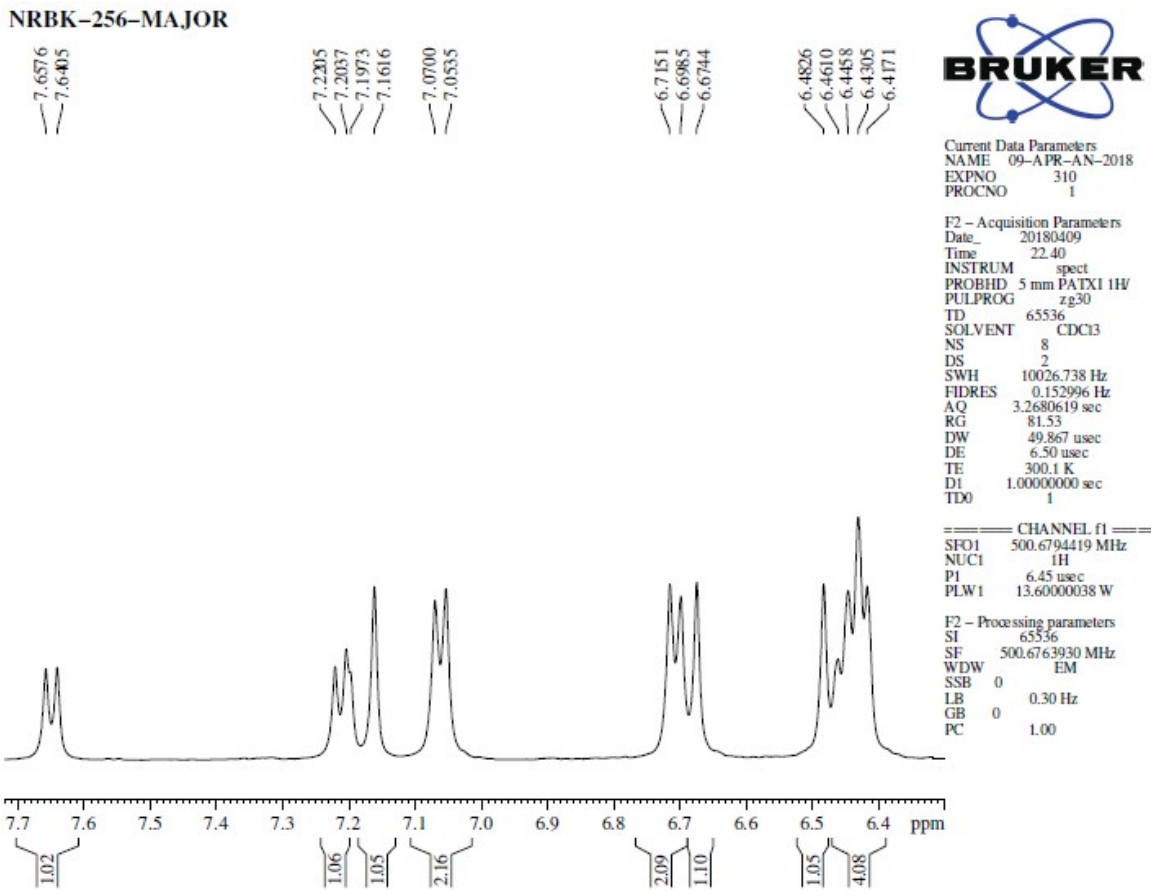

Figure 89: ^{1}H NMR spectrum of 3zd (expansion)

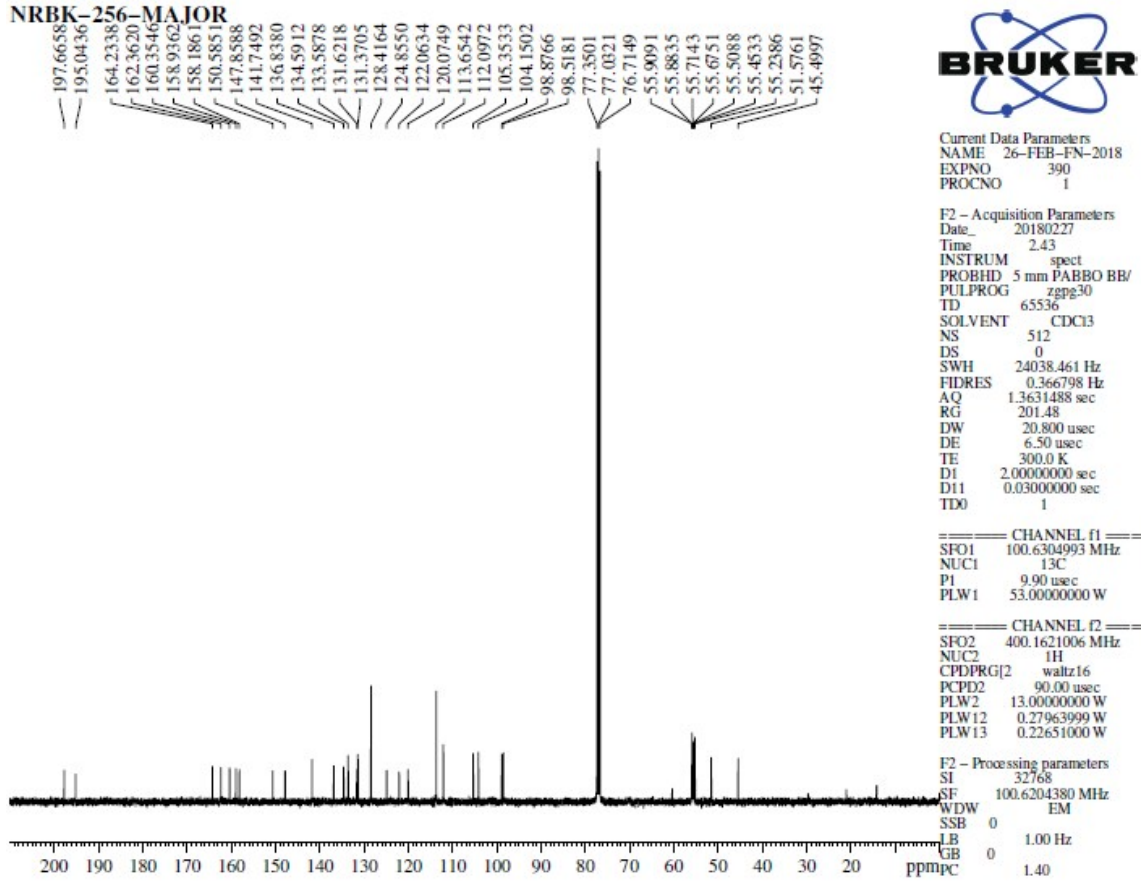

Figure 90: ^{13}C NMR spectrum of 3zd

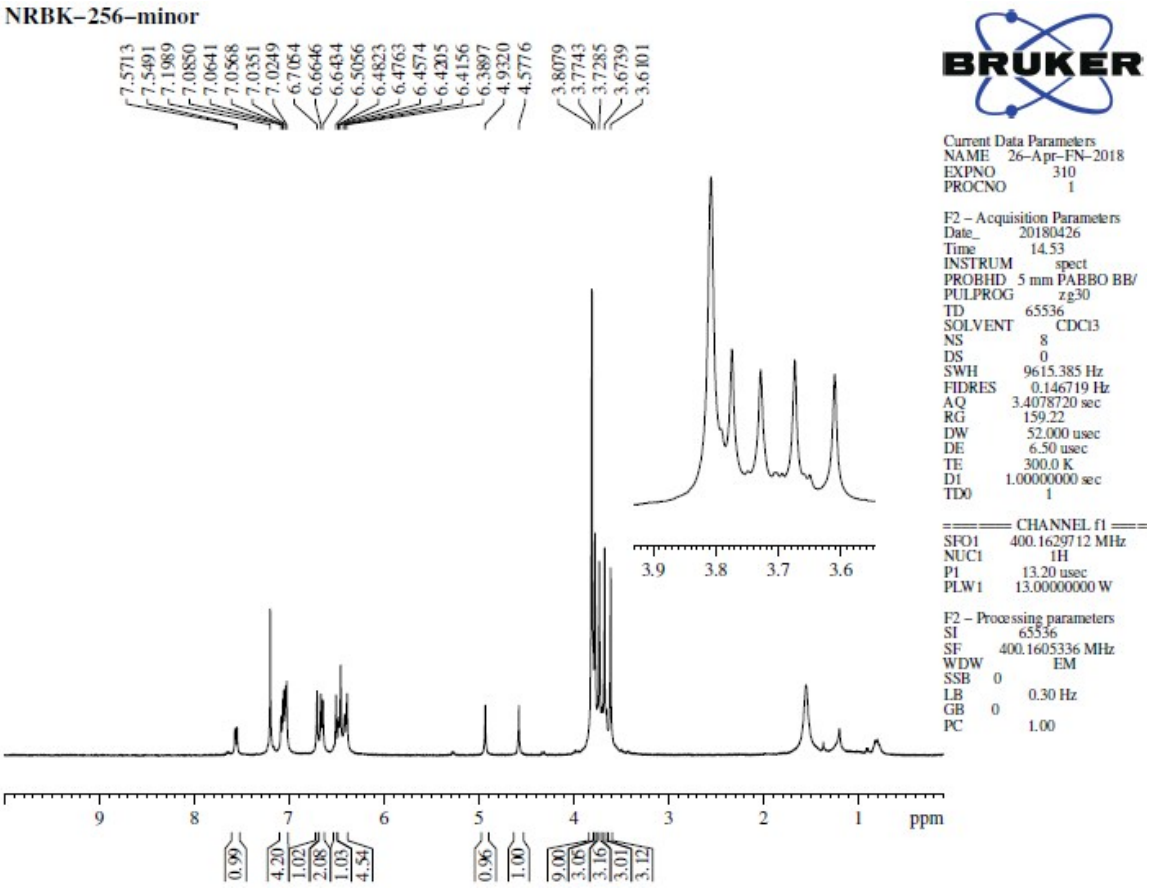

Figure 91: ^{1}H NMR spectrum of 3ze

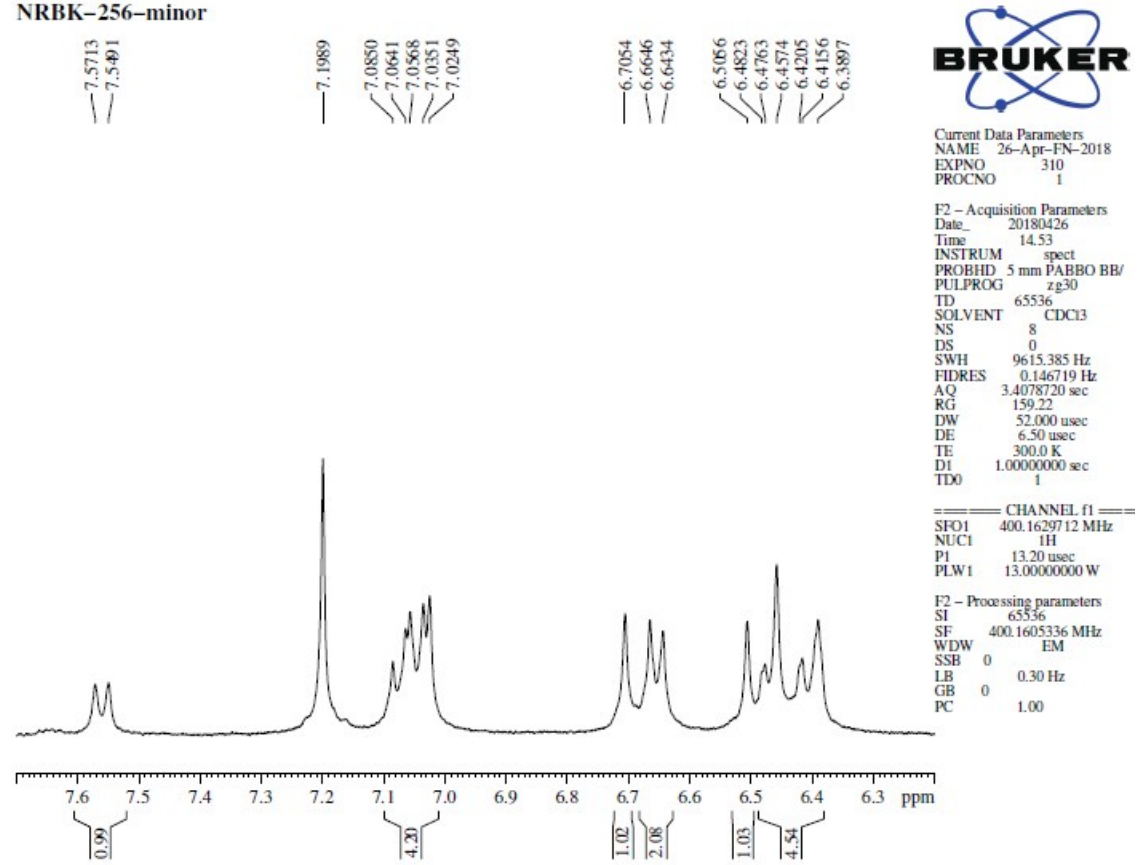

Figure 92: ^{1}H NMR spectrum of 3ze (expansion)

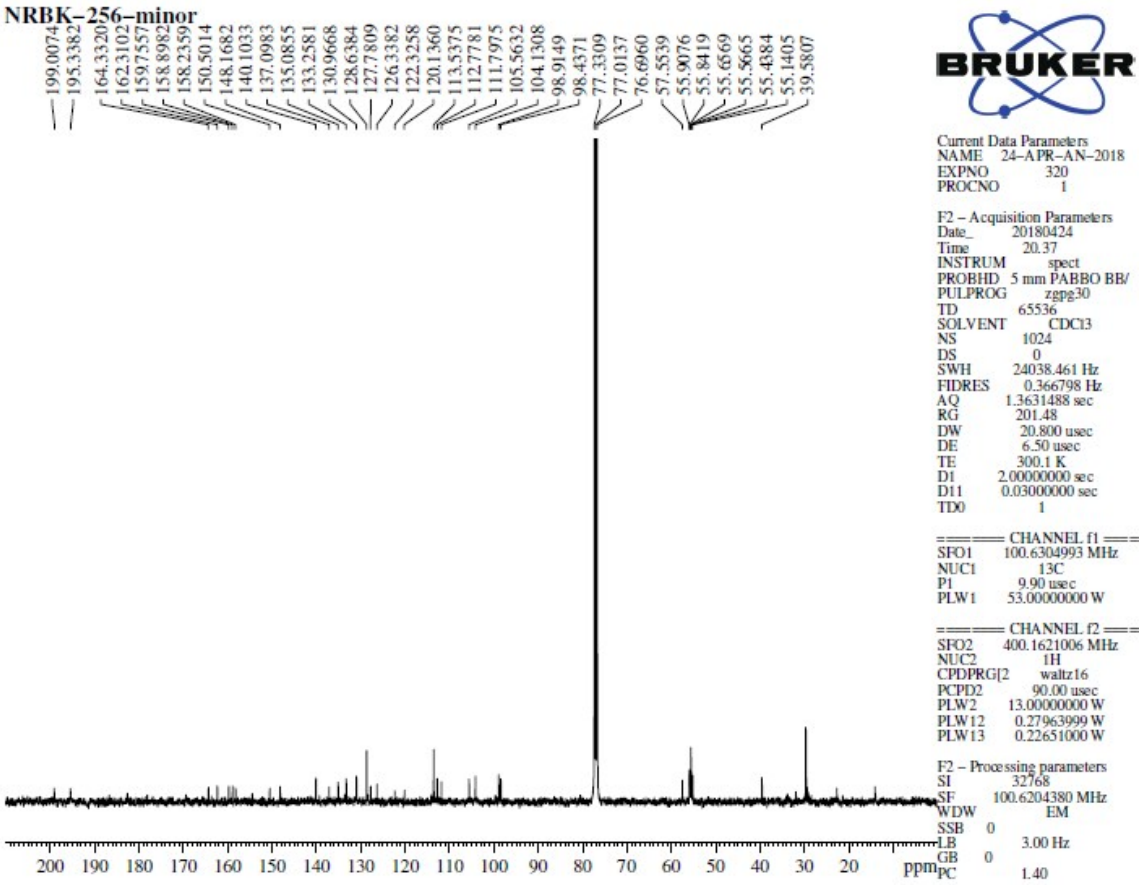

Figure 93: ^{13}C NMR spectrum of 3ze

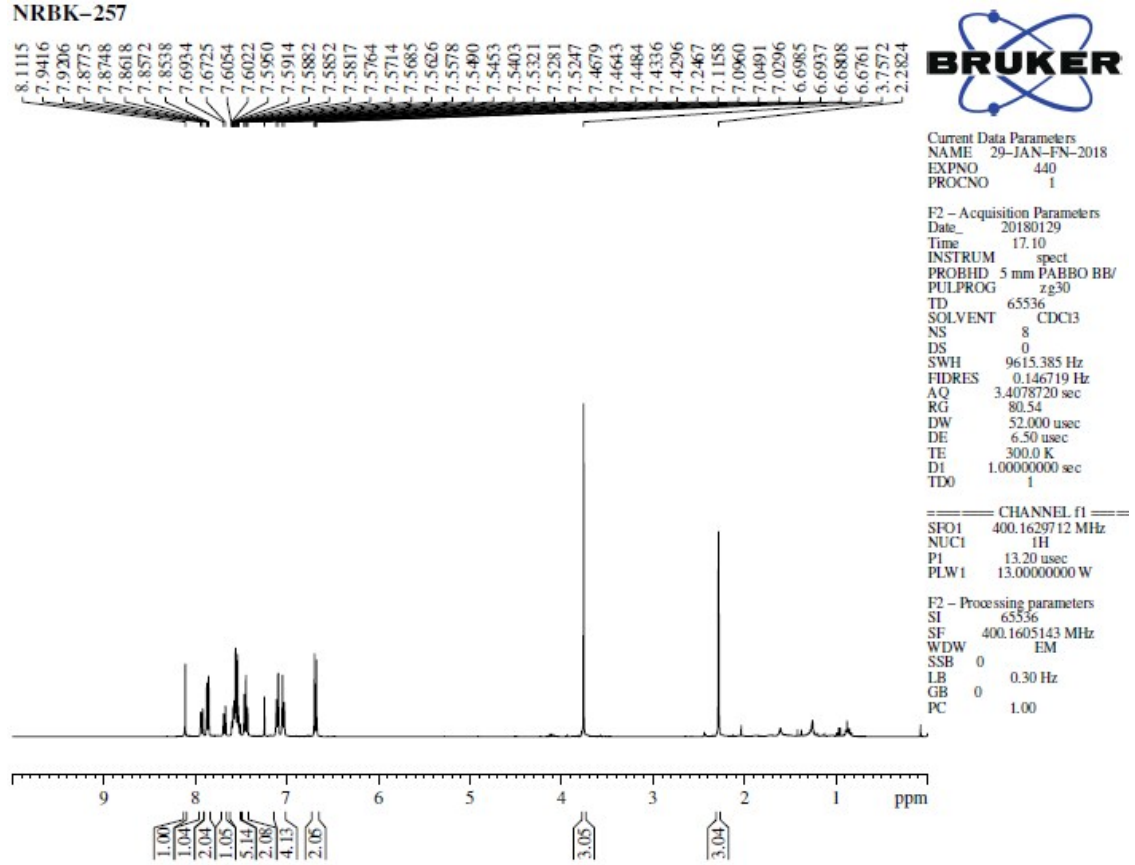

Figure 94: ^{1}H NMR spectrum of 4a

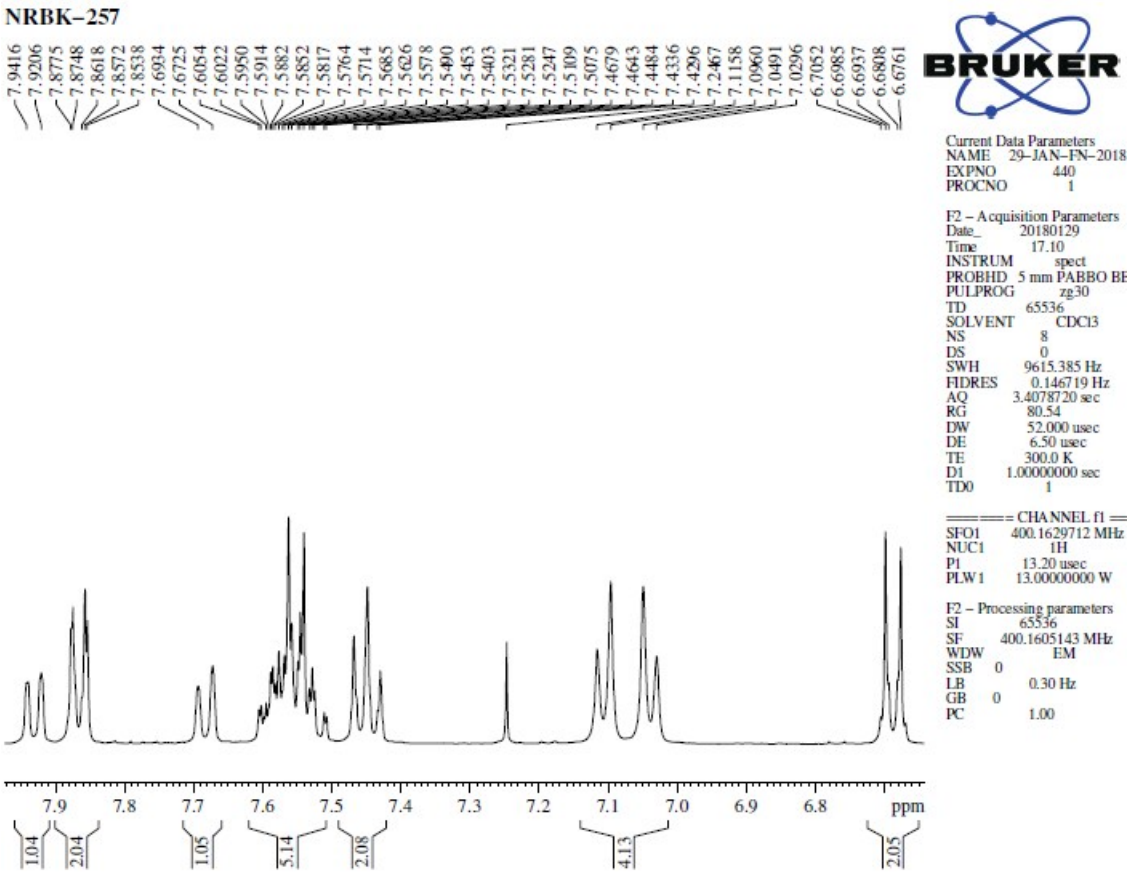

Figure 95: ^{1}H NMR spectrum of 4a (expansion)

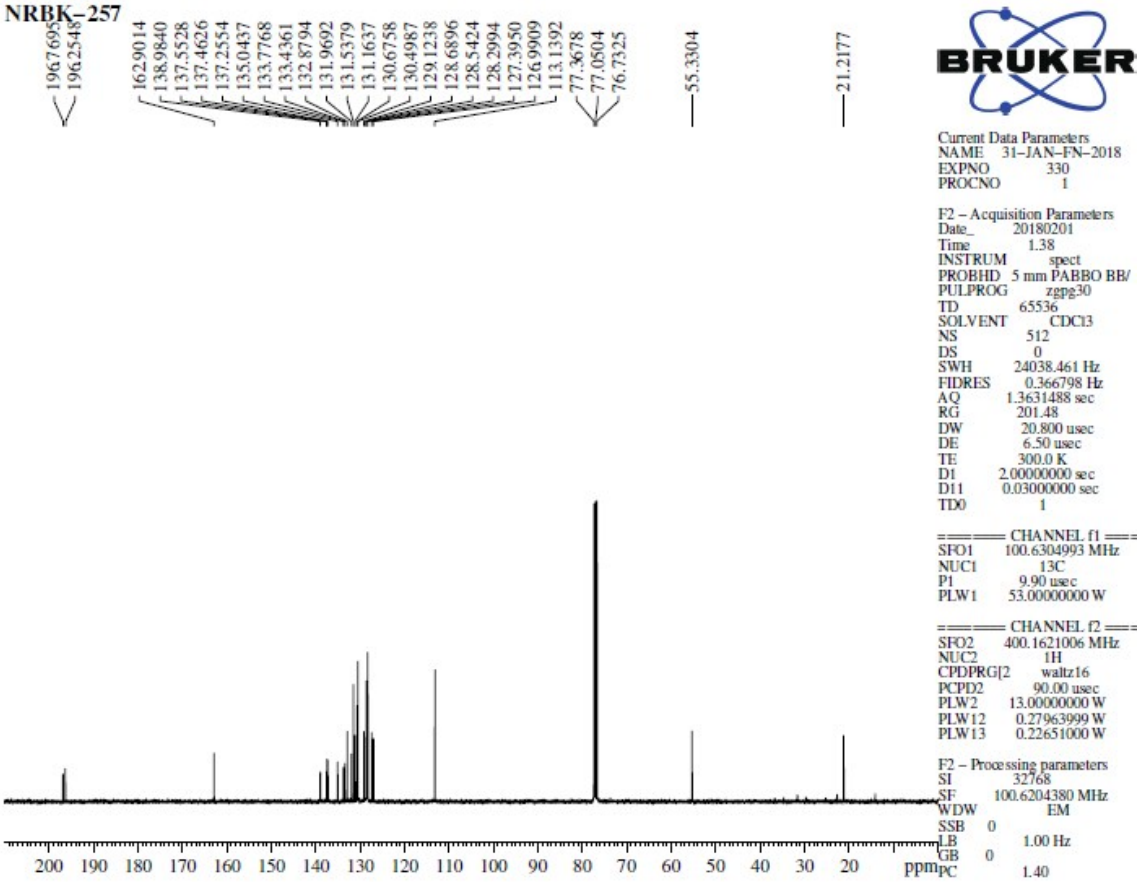

Figure 96: ^{13}C NMR spectrum of 4a

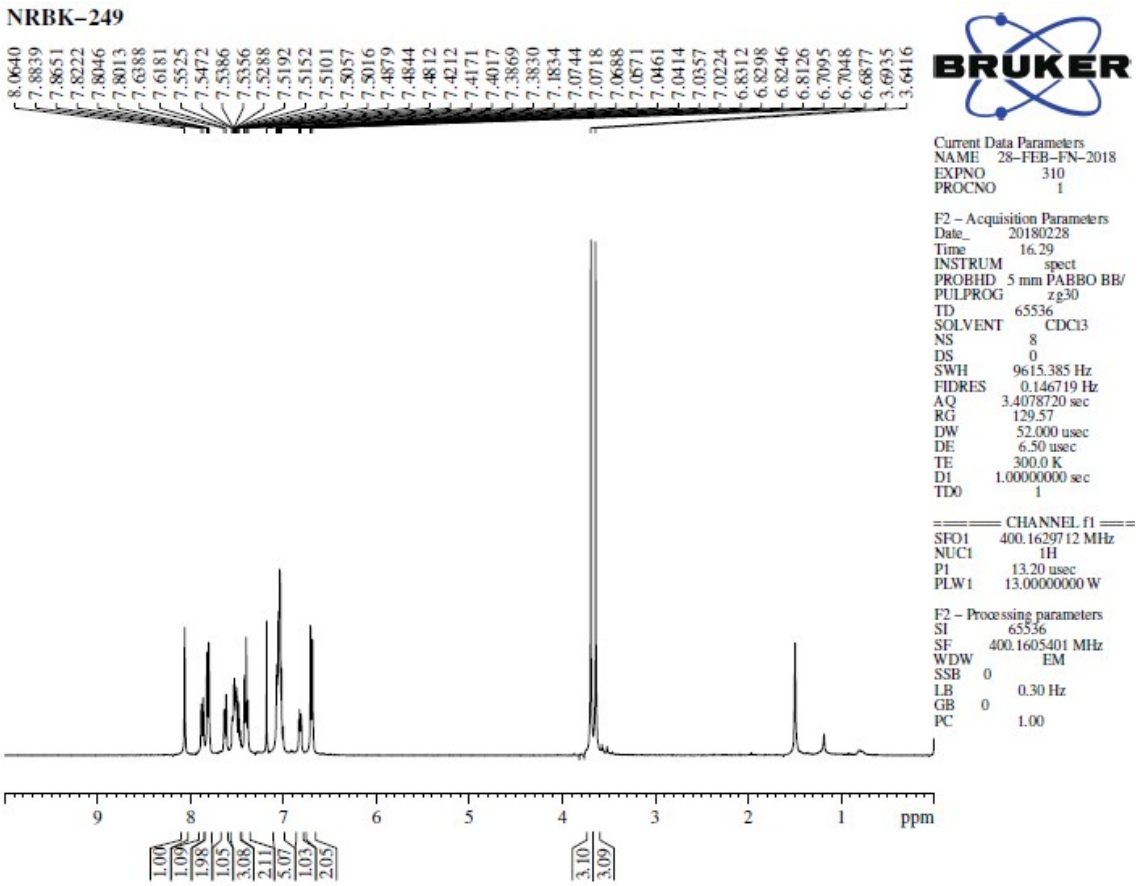

Figure 97: ^{1}H NMR spectrum of 4b

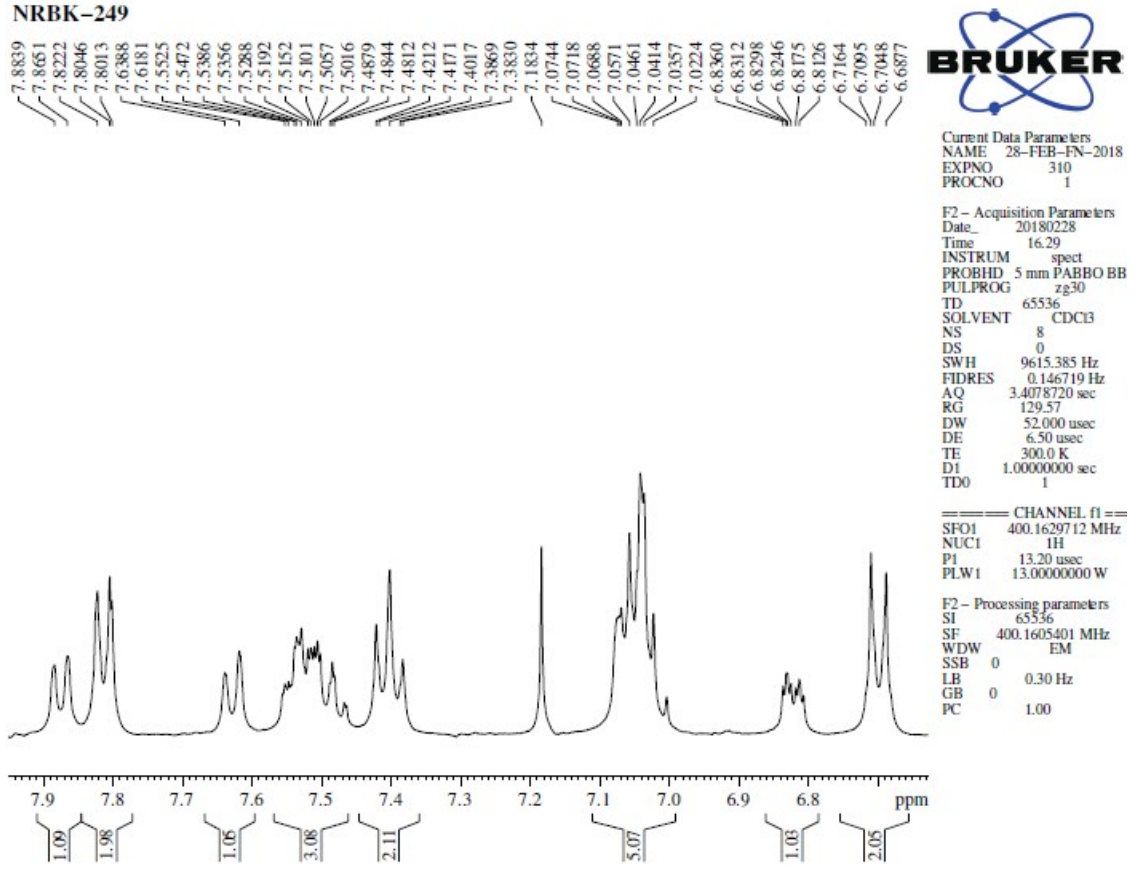

Figure 98: ^{1}H NMR spectrum of 4b (expansion)

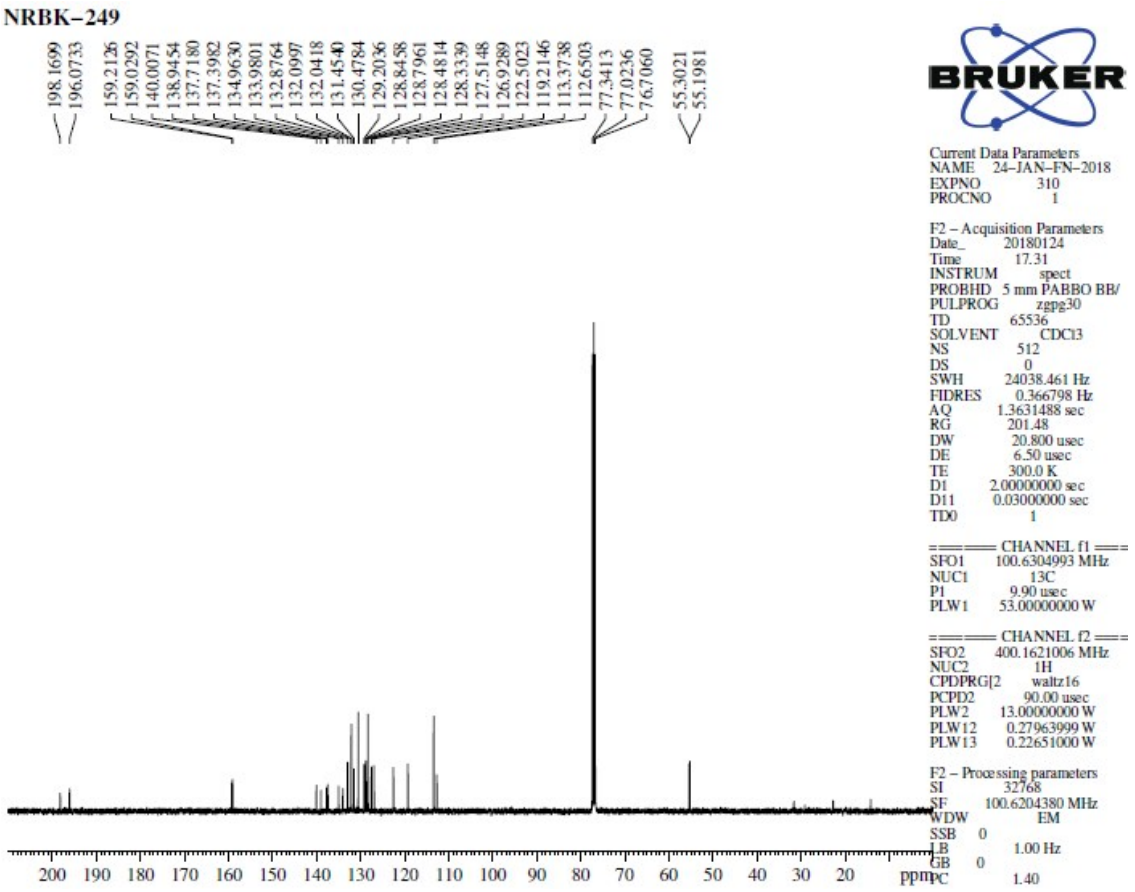

Figure 99: ^{13}C NMR spectrum of 4b

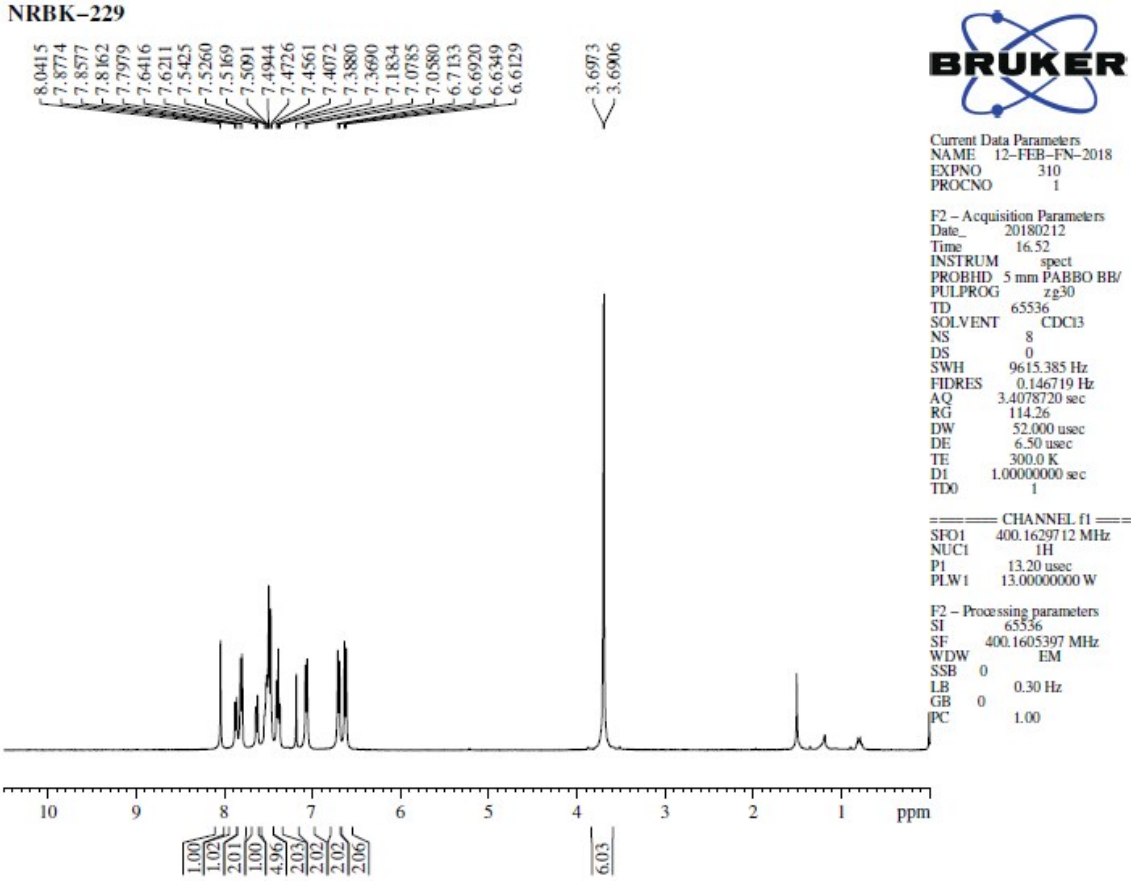

Figure 100: ^{1}H NMR spectrum of 4c

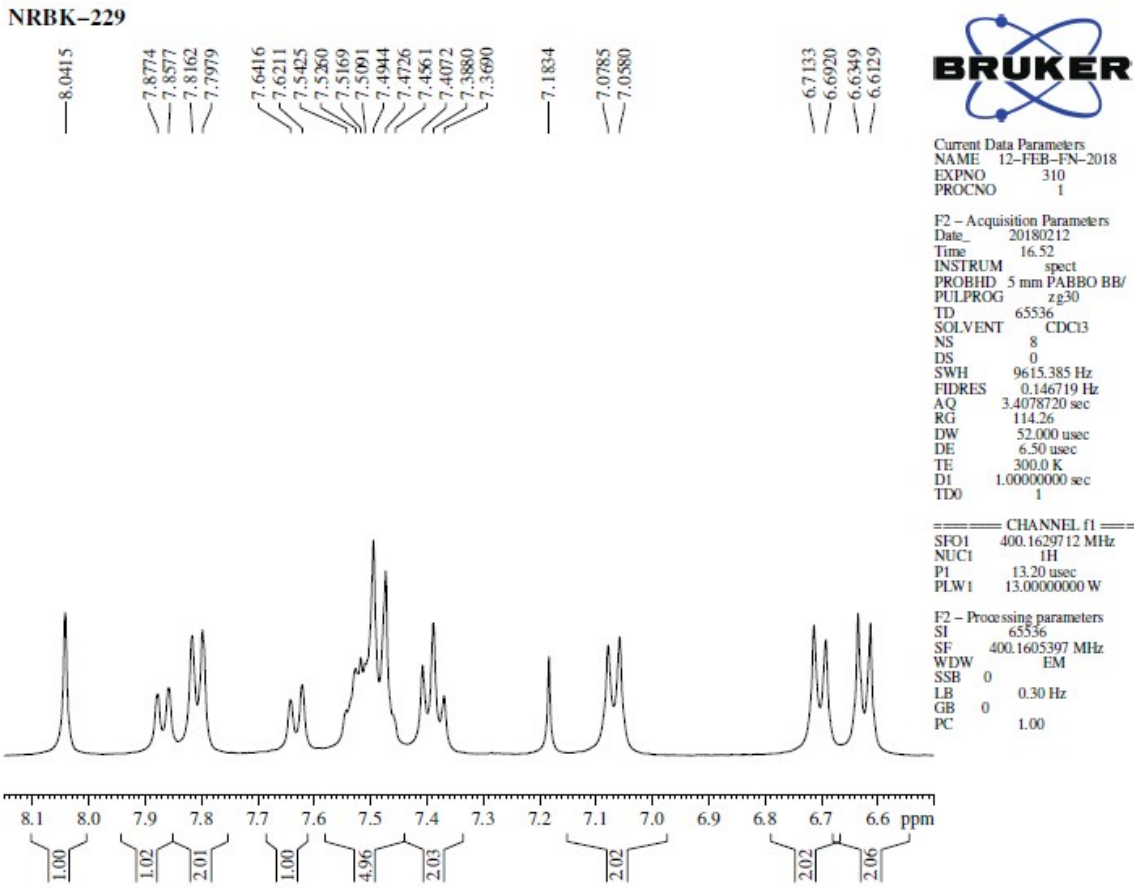

Figure 101: ^{1}H NMR spectrum of 4c (expansion)

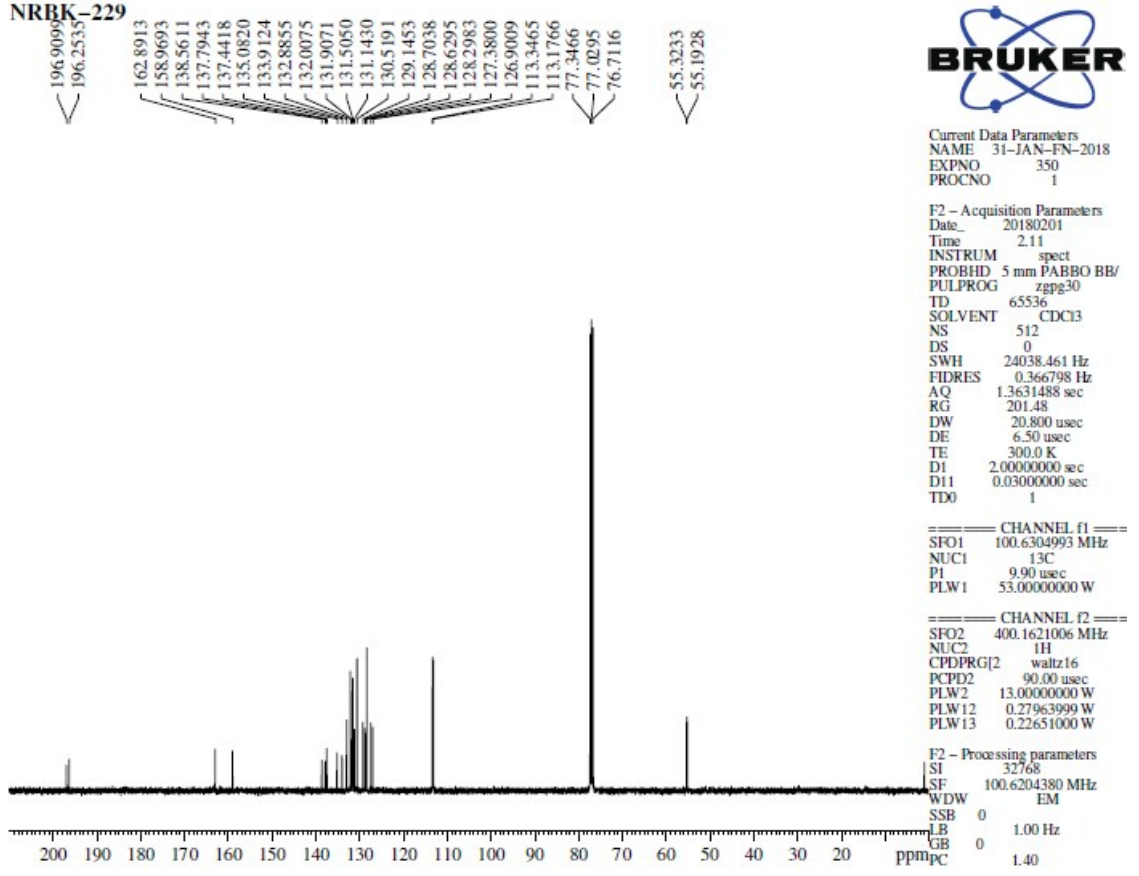

Figure 102: ^{13}C NMR spectrum of 4c

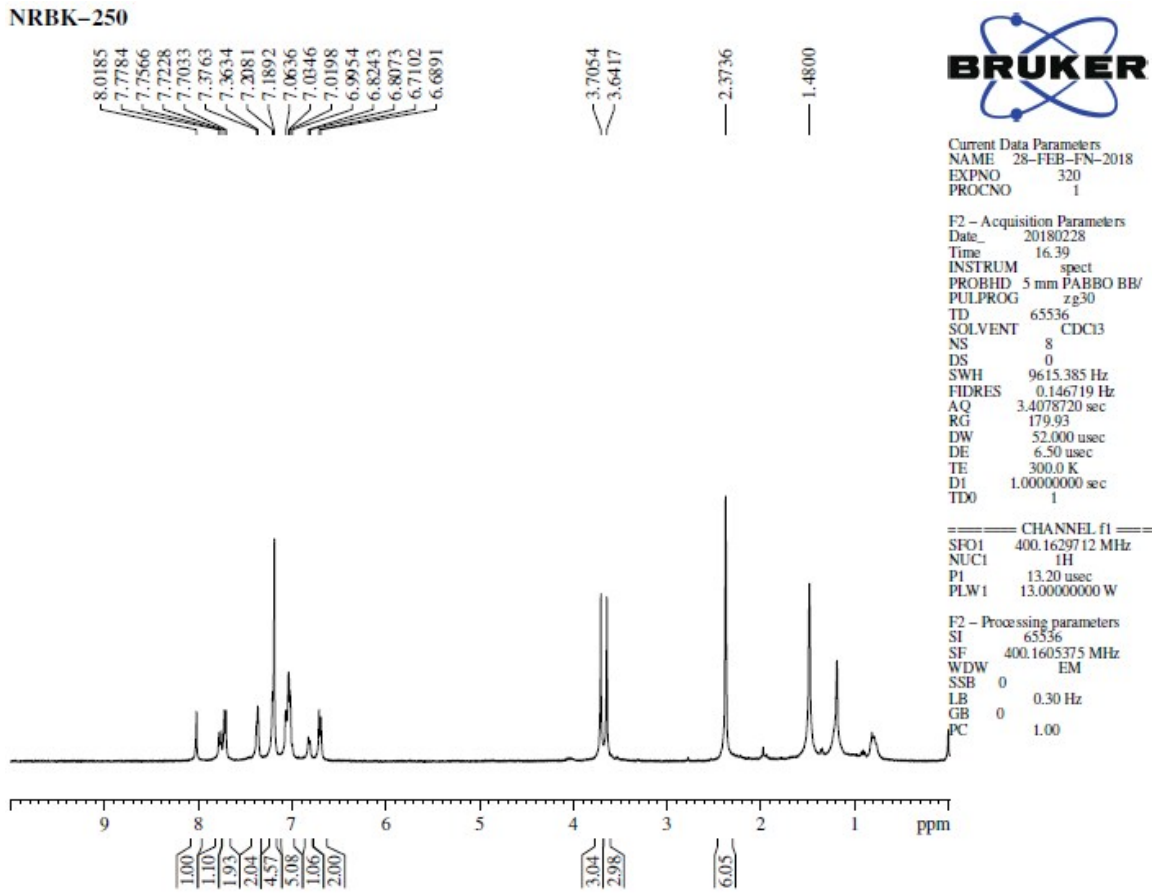

Figure 103: ^{1}H NMR spectrum of 4d

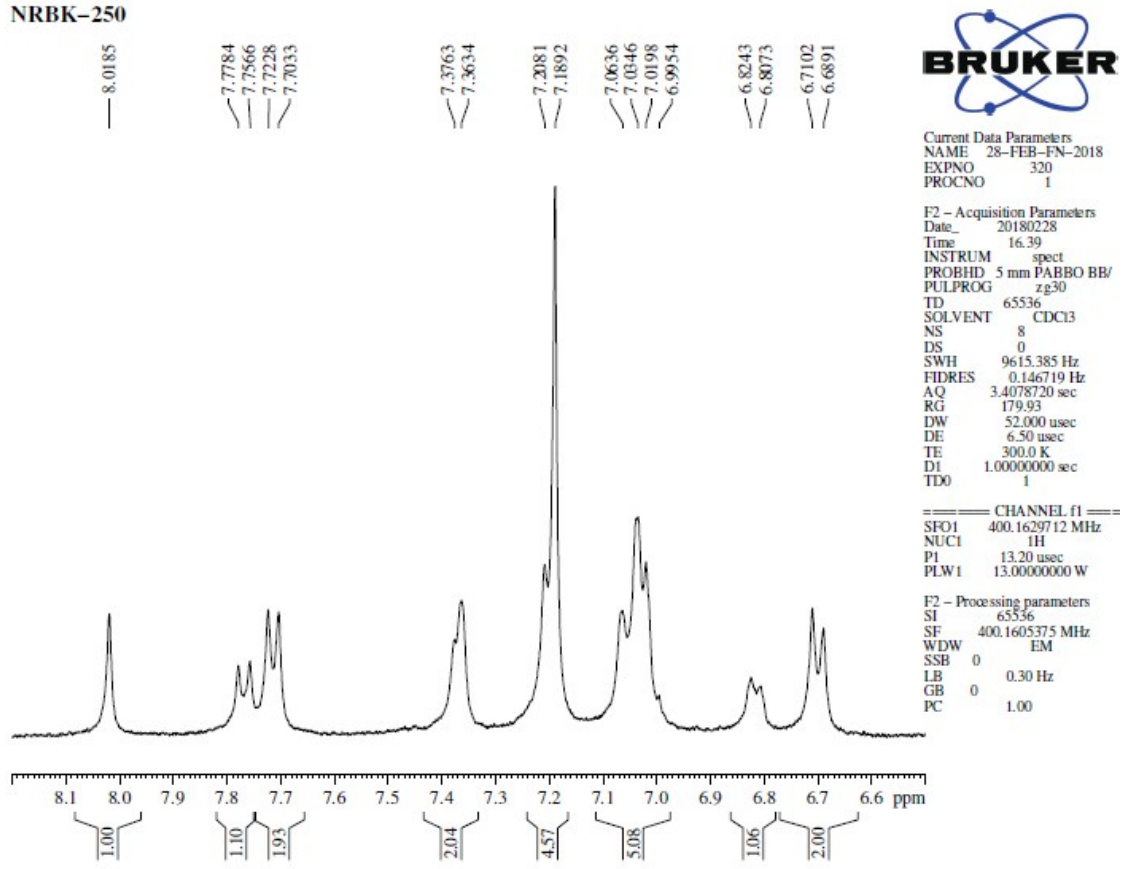

Figure 104: ^{1}H NMR spectrum of 4d (expansion)

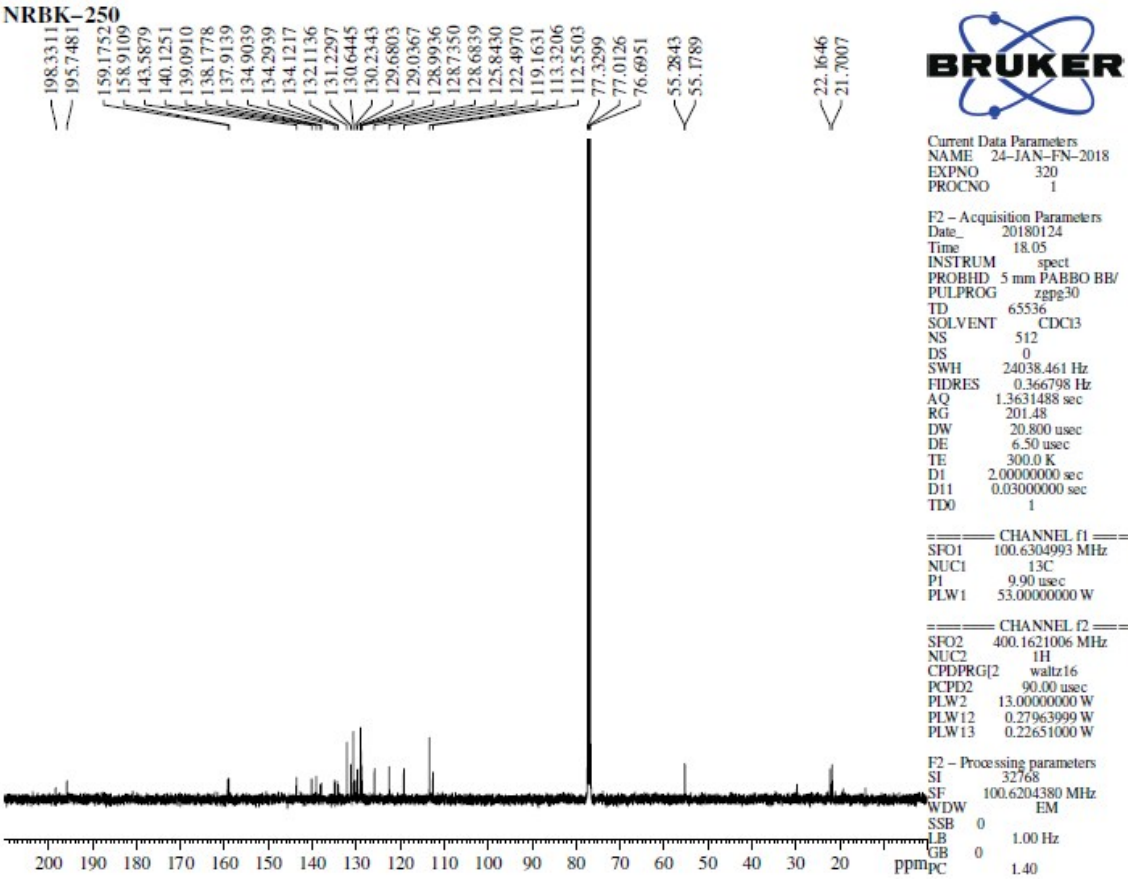

Figure 105: ^{13}C NMR spectrum of 4d

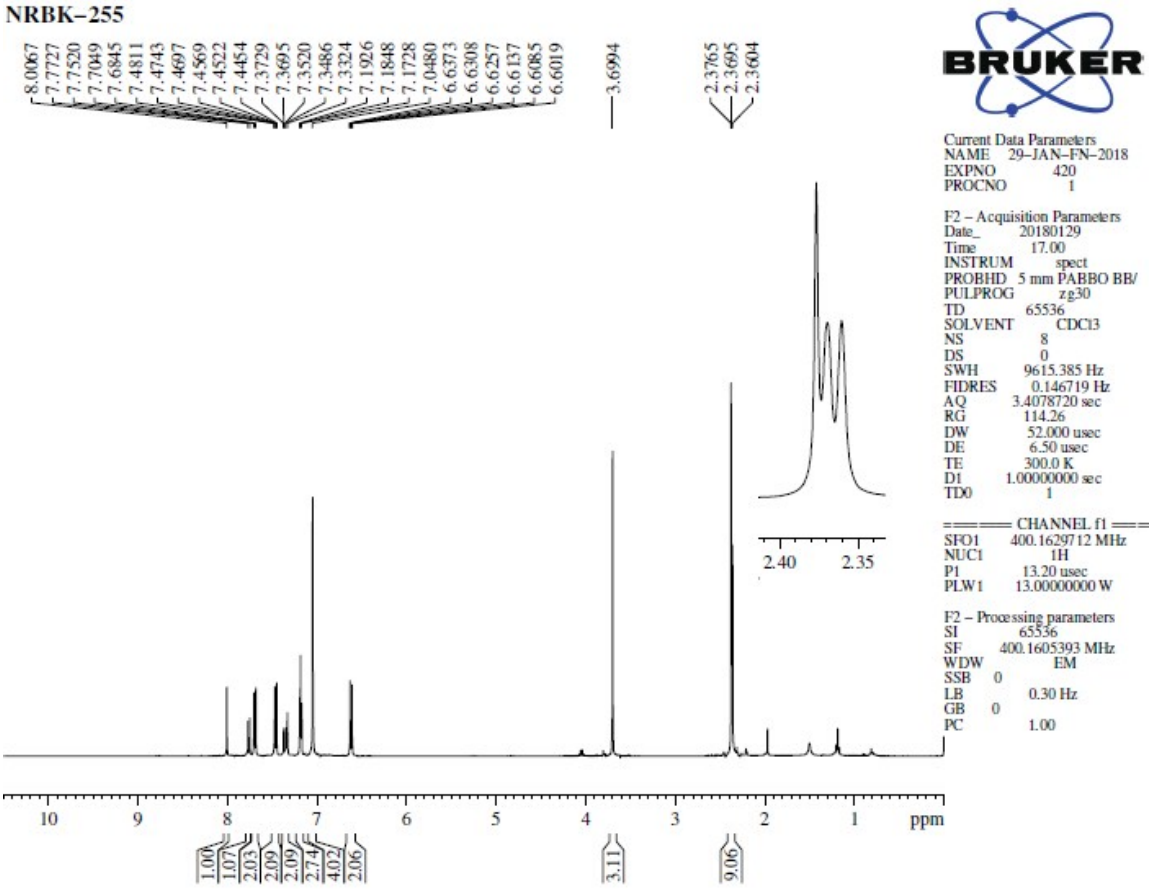

Figure 106: ^{1}H NMR spectrum of 4e

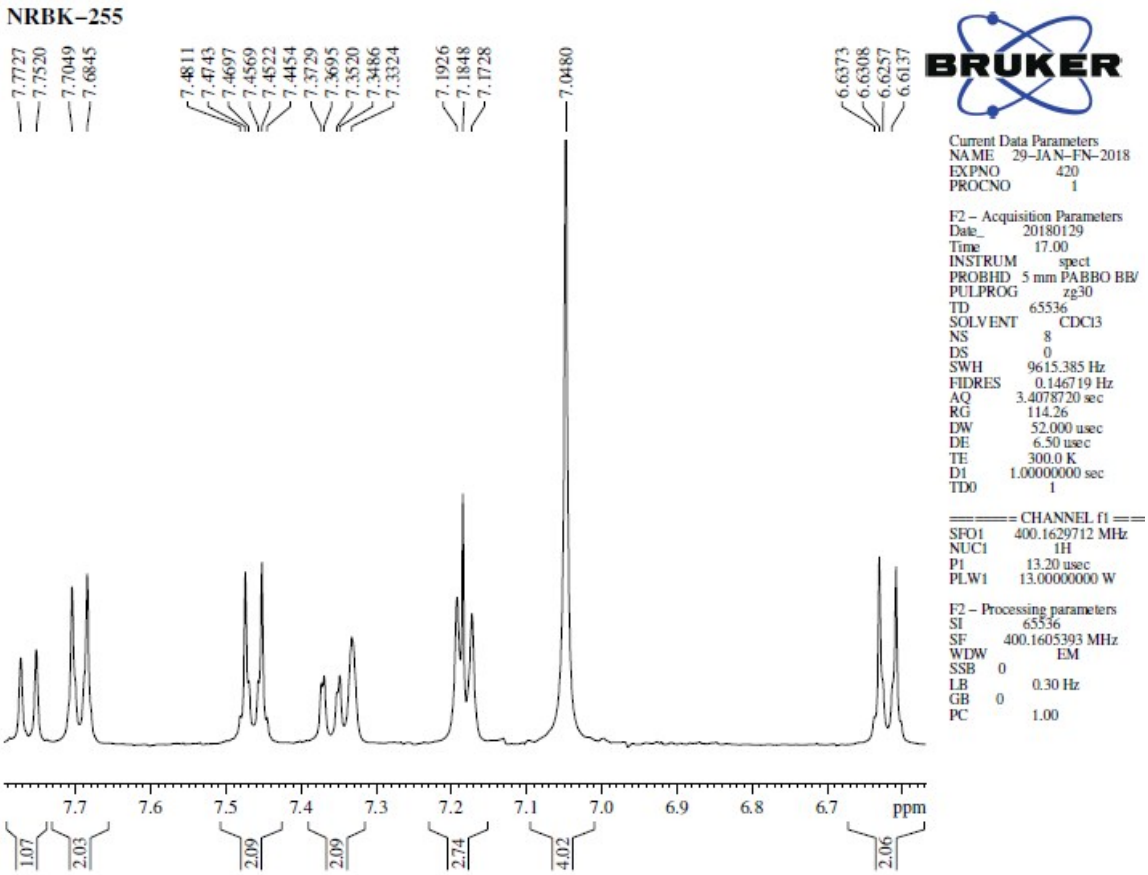

Figure 107: ^{1}H NMR spectrum of 4e (expansion)

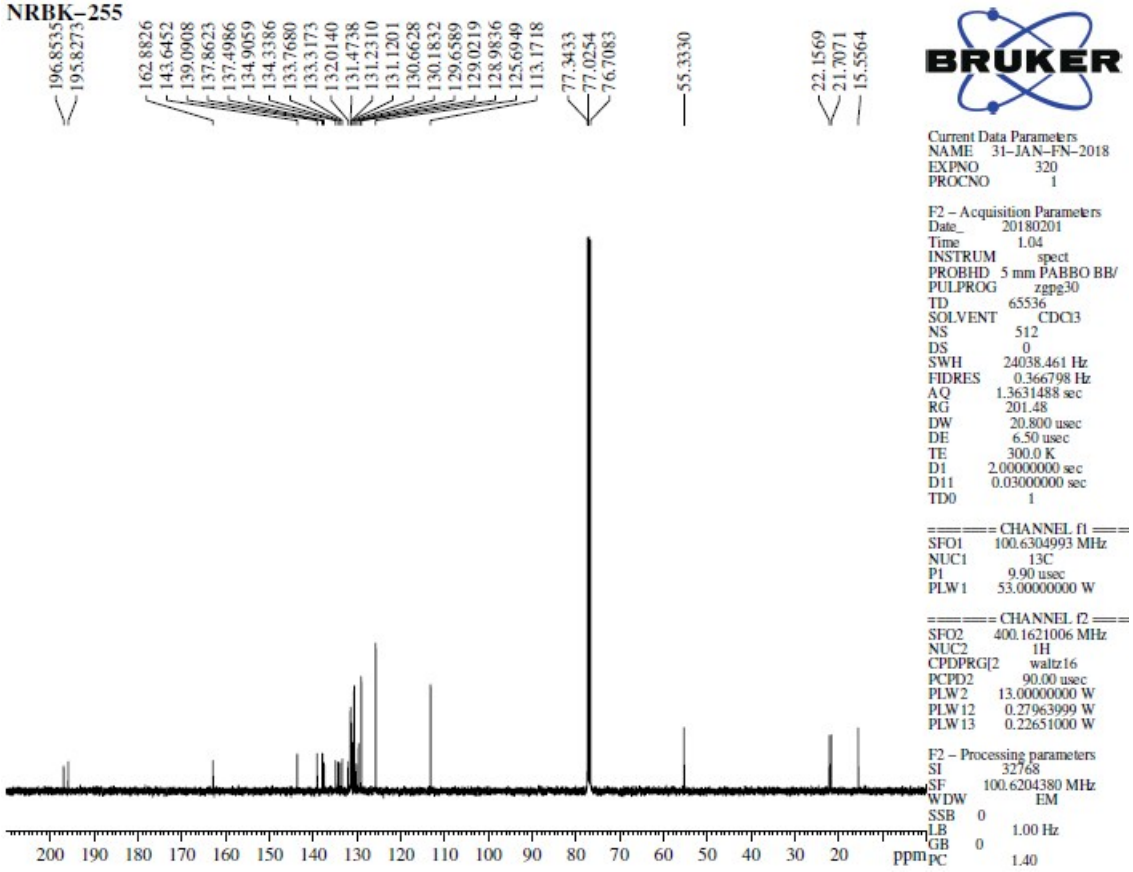

Figure 108: ^{13}C NMR spectrum of 4e

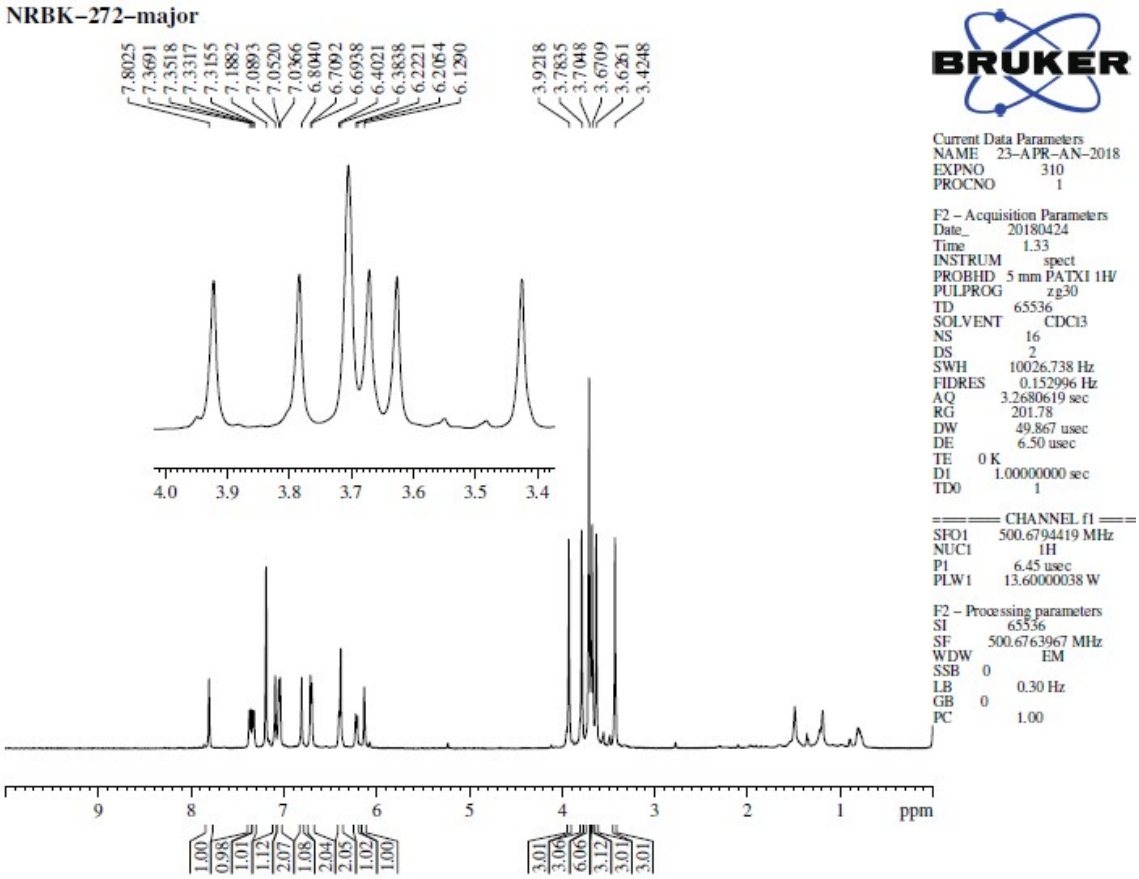

Figure 109: ^{1}H NMR spectrum of 4f

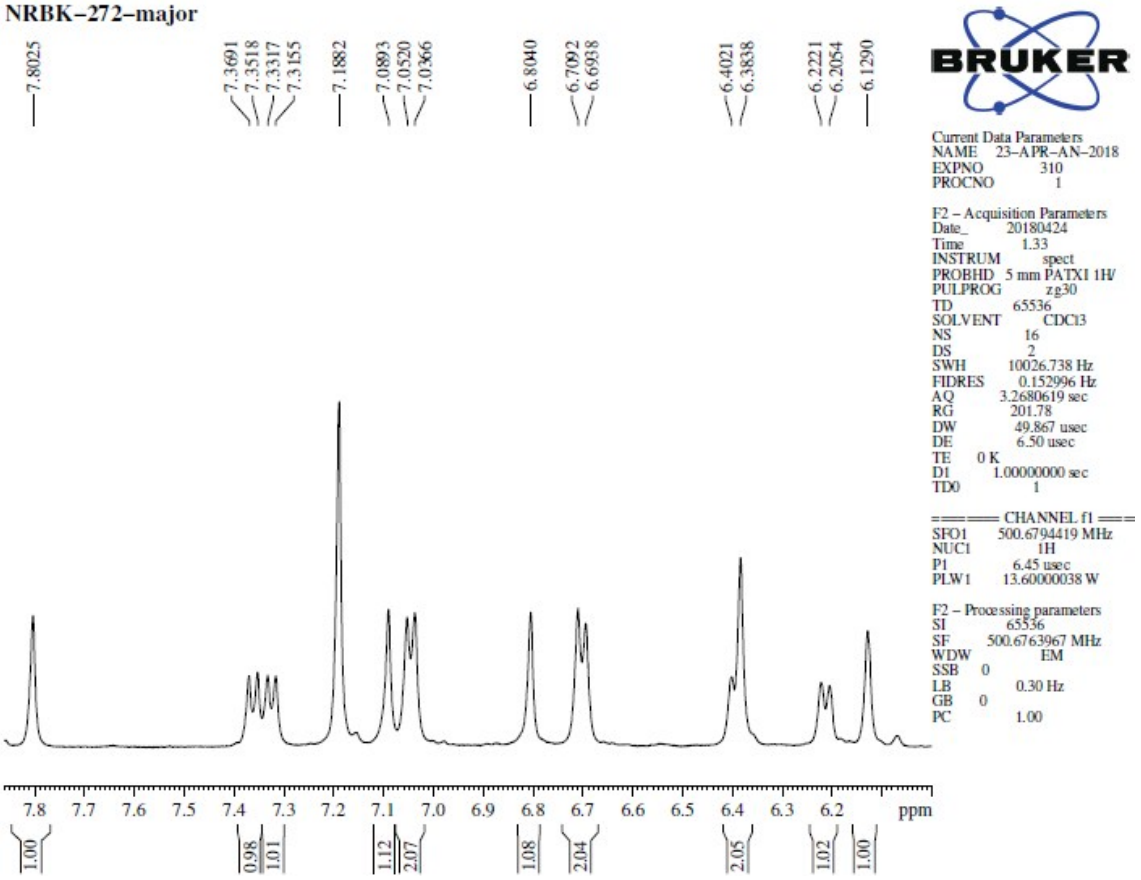

Figure 110: ^{1}H NMR spectrum of 4f (expansion)

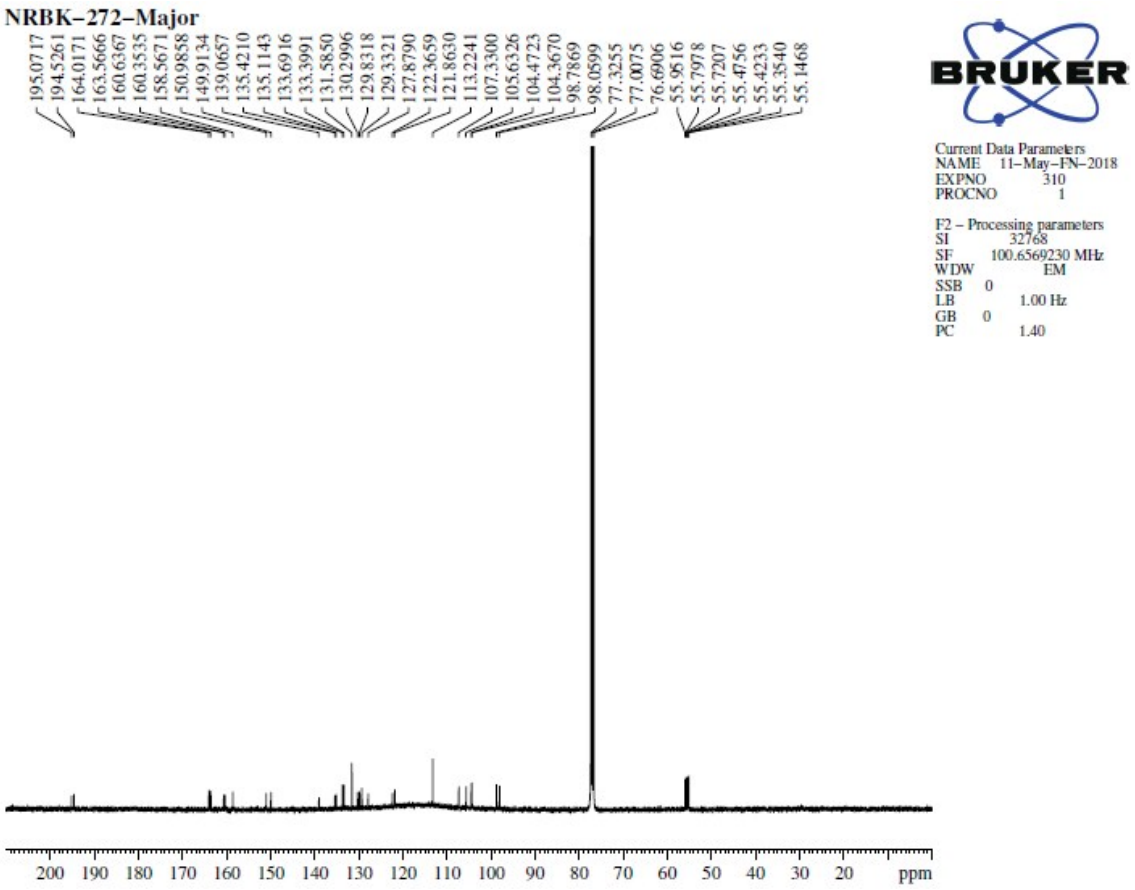

Figure 111: ^{13}C NMR spectrum of 4f

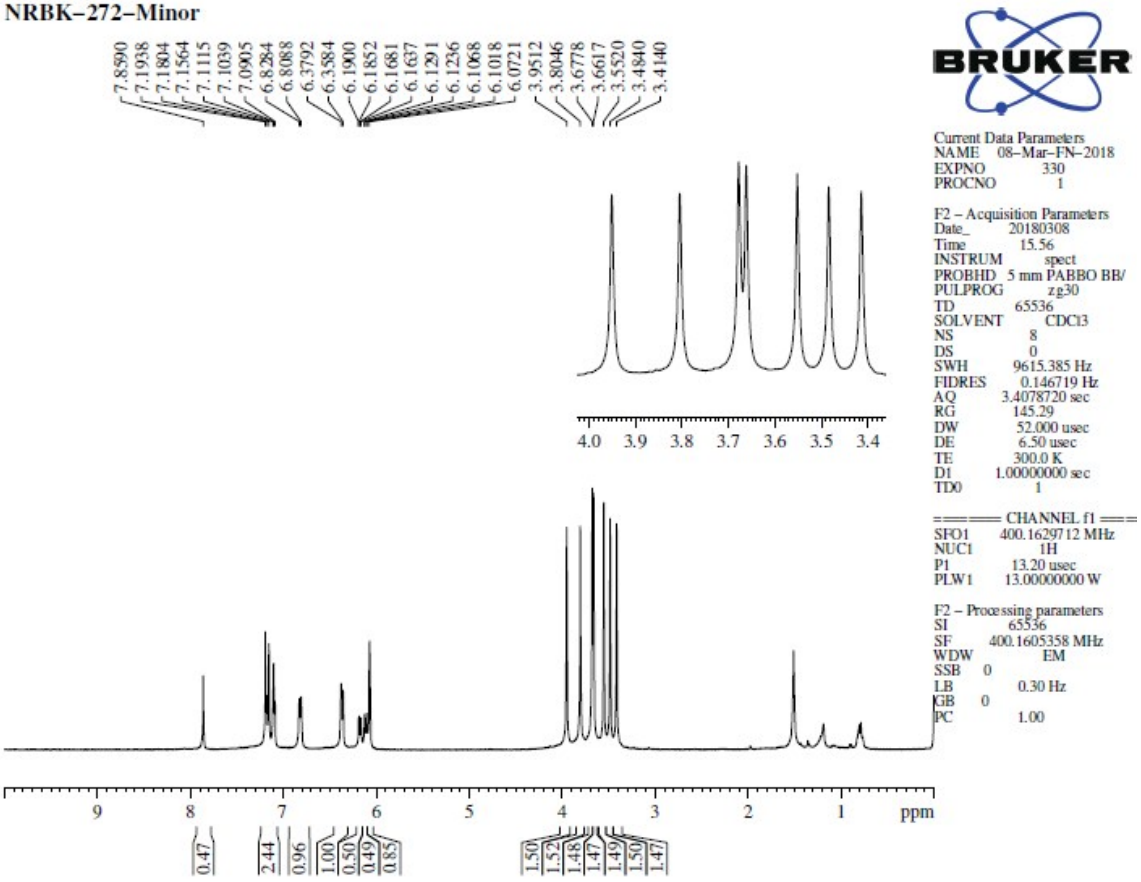

Figure 112: ^{1}H NMR spectrum of 4g

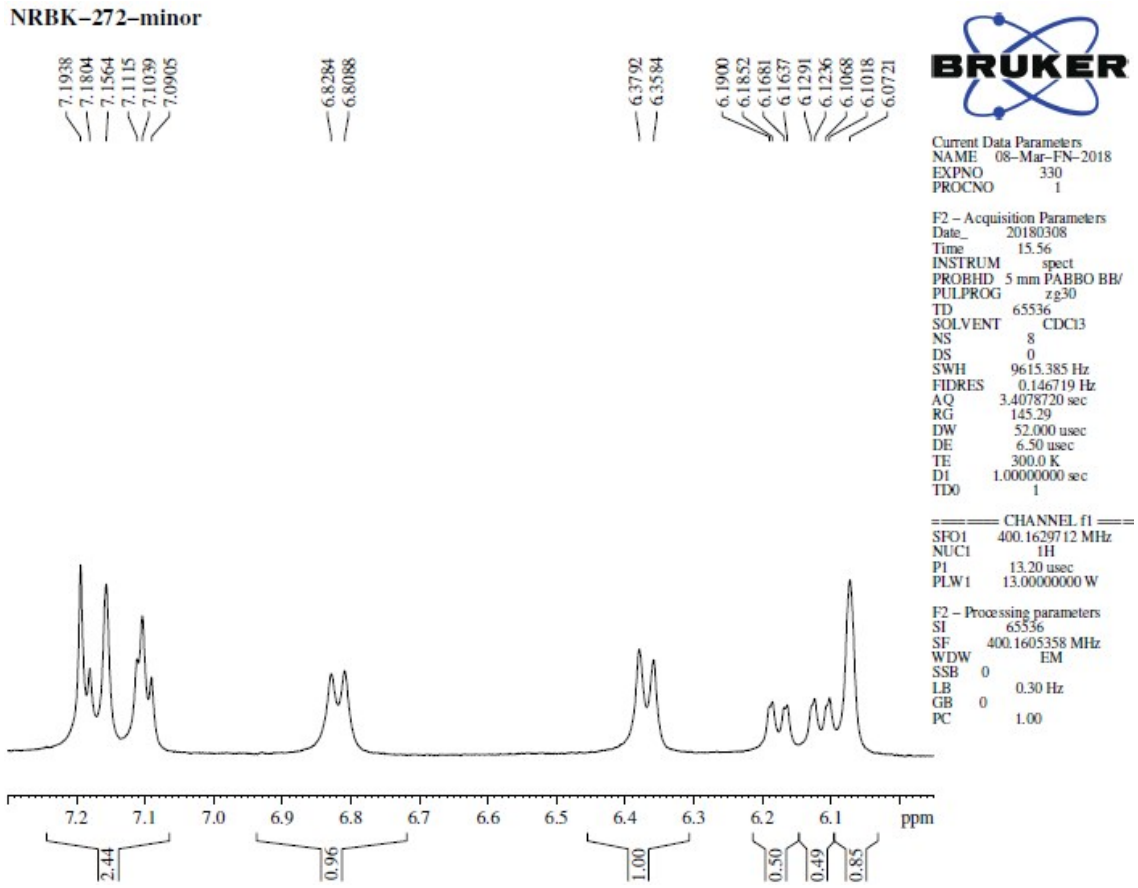

Figure 113: ^{1}H NMR spectrum of 4g (expansion)

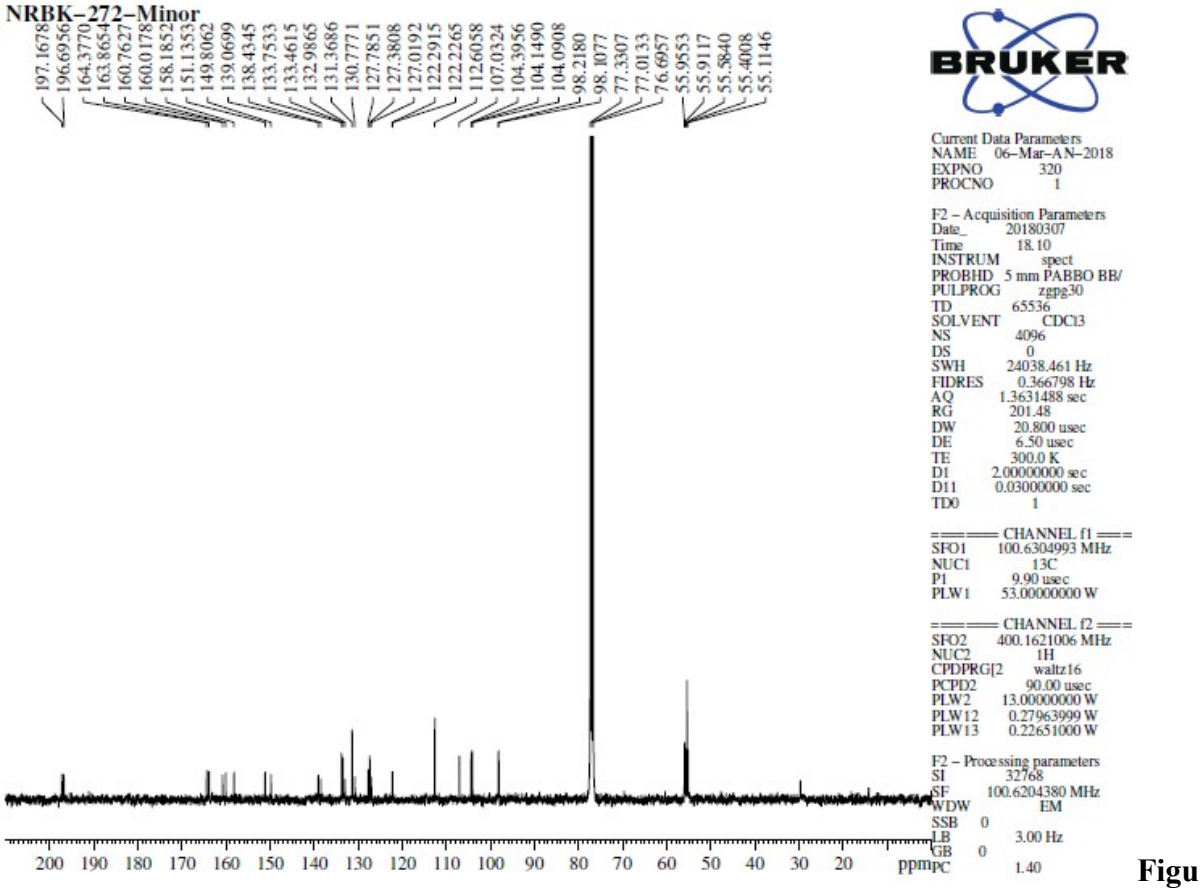

Figure 114: ^{13}C NMR spectrum of 4g