Supporting Information

Ruthenium(II)-Catalyzed *C*–H Activation/*C*–N Bond Formation *via* in situ Generated Iminophosphorane as the Directing Group: Construction of Annulated Pyridin-2(1*H*)-ones

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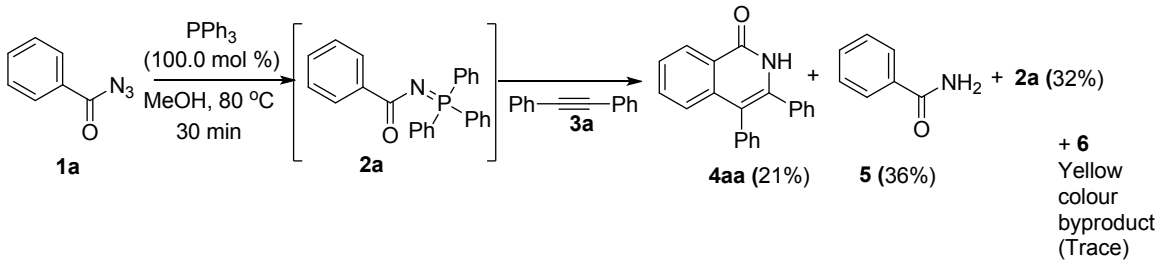
Experimental Section

I. Mechanistic observation reactions

A Isolation of intermediates iminophosphorane and benzamide during the transformation of 1a in MeOH

Scheme 1. Quenching the reaction after 5h

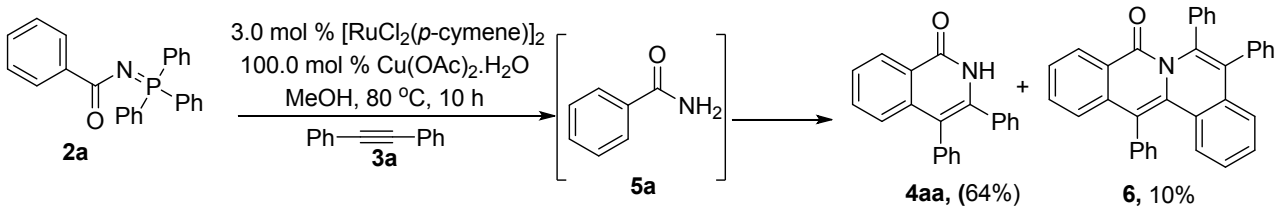


[a] Reaction condition: (1.02 mmol) of **1a**, (0.81 mmol) of **3a**, 3.0 mol % [Ru(*p*-cymene)Cl_2]$_2$, (1.02 mmol) of $Cu(OAc)_2 \cdot H_2O$ in 5 mL of MeOH at 80 °C after 5h.

In a flame dried round bottomed flask equipped with a stir bar, we added a mixture of Acyl azide **1a** (1.02 mmol) (150 mg), in 5.0 mL solvent followed by the addition of Triphenylphosphine (TPP) (1.02 mmol) (267 mg), we then monitored the formation of iminophosphorane **2a** by tlc after 30 min of stirring at 80 °C. Next we added alkyne **3a** (0.816 mmol) (145 mg), [$RuCl_2$(*p*-cymene)]$_2$ (3.0 mol%) and $Cu(OAc)_2 \cdot H_2O$ (1.02 mmol) (204 mg). After 5 h of reaction monitored by tlc. The resulting mixture was evaporated to remove MeOH. After that diluted with H_2O (10 mL) and mixture was extracted with EtOAc (3x20 mL). The combined organic layers were washed with brine (20 mL) and dried over Na_2SO_4. The solvent was evaporated in vacuo and the remaining residue was purified by column chromatography on silica gel (*n*-hexanes/EtOAc 5%-60%) to yield products **4aa** (21%, 63 mg)**,** benzamide **5a** (36%, 44 mg)**,** unreacted imniophosphorane **2a** (32%, 124 mg) along with traces of yellow colour byproduct **6.**

B. Treatment of presynthesized iminophosphorane 2a with unactivated internal alkyne 3a in MeOH

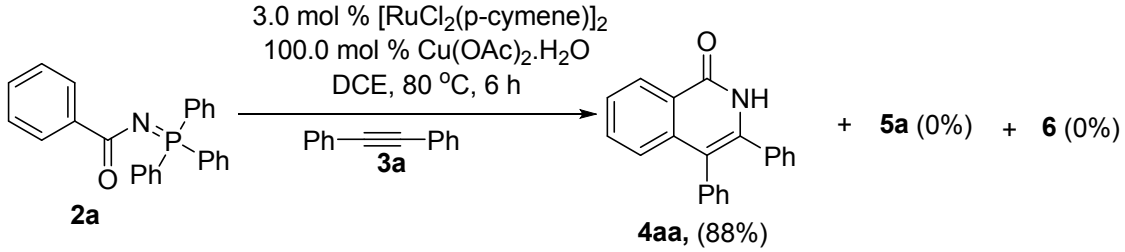
Scheme 2: Treatment of presynthesized iminophosphorane **2a** with unactivated internal alkyne **3a** in MeOH for 10 h



In a flame dried round bottomed flask equipped with a stir bar, we added a mixture of iminophosphorane **2a** (0.39 mmol) (150 mg), in 5.0 mL solvent followed by the addition of alkyne **3** (0.312 mmol), $[RuCl_2(p\text{-cymene})]_2$ (3.0 mol%) and $Cu(OAc)_2{\cdot}H_2O$ (0.39 mmol) (71 mg) at 80 °C. After completion of the reaction in 10 h, monitored by tlc, the resulting mixture was evaporated to remove MeOH. After that dilluted with H_2O (10 mL) and mixture was extracted with EtOAc (3x20 mL). The combined organic layers were washed with brine (20 mL) and dried over Na_2SO_4. The solvent was evaporated in vacuo and the remaining residue was purified by column chromatography on silica gel (*n*-hexanes/EtOAc 5%-40%) to yield products **4aa** (64%, 74 mg) and **6** (10%, 18 mg).

C. Treatment of presynthesized iminophosphorane 2a with unactivated internal alkyne 3a in DCE

Scheme 3. Synthesis of **4aa** from iminophosphorane **2a** in DCE solvent

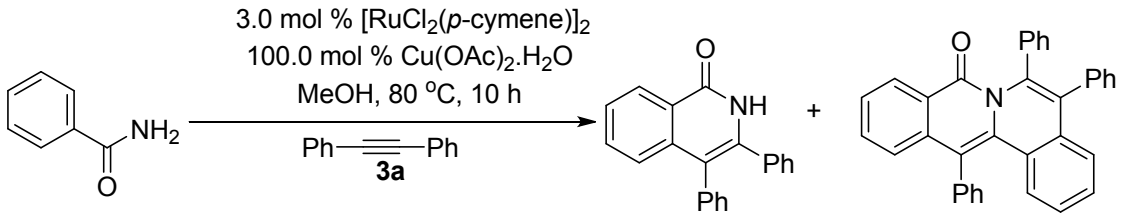


In an flame dried round bottomed flask equipped with a stir bar, we added a mixture of iminophospharane **2a** (0.39 mmol) (150 mg), in 5.0 mL solvent followed by the addition alkyne **3a** (0.312 mmol) (56 mg), $[RuCl_2(p\text{-cymene})_2]$ (3.0 mol %) and $Cu(OAc)_2{\cdot}H_2O$ (0.39 mmol) (71 mg) at 80 °C. After completion of the reaction in 6 h, monitored by tlc, the resulting mixture was evaporated to remove DCE. After that diluted with H_2O (10 mL) and mixture was extracted with EtOAc (3x20 mL). The combined organic layers were washed

with brine (20 mL) and dried over Na_2SO_4. The solvent was evaporated in vacuo and the remaining residue was purified by column chromatography on silica gel (*n*-hexanes/EtOAc 30-40%) to yield product **4aa** (88%, 102 mg).

D. Treatment of presynthesized benzamide 5 with unactivated internal alkyne 3a in MeOH

Scheme 4. Synthesis of **4aa** from benzamide **5** in MeOH solvent

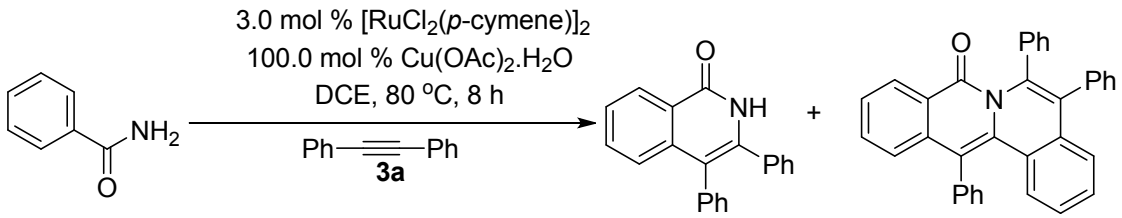


5 **4aa,** (68%) **6,** (8.0%)

In a flame dried round bottomed flask equipped with a stir bar, we added a mixture of benzamide **5** (1.23 mmol) (150 mg), in 5.0 mL solvent followed by the addition of alkyne **3a** (0.99 mmol) (176 mg), $[RuCl_2(p\text{-cymene})]_2$ (3.0 mol%) and $Cu(OAc)_2{\cdot}H_2O$ (1.23 mmol) (223 mg). After completion of the reaction in 10 h, monitored by tlc, the resulting mixture was evaporated to remove MeOH. After that dilluted with H_2O (10 mL) and mixture was extracted with EtOAc (3x20 mL). The combined organic layers were washed with brine (20 mL) and dried over Na_2SO_4. The solvent was evaporated in vacuo and the remaining residue was purified by column chromatography on silica gel (*n*-hexanes/EtOAc 5% - 40%) to yield products **4aa (**68%, 249 mg**)** and **6** (8.0%, 46 mg)**.**

E. Treatment of presynthesized benzamide with unactivated internal alkyne 3a in DCE

Scheme 5. Synthesis of **4aa** from benzamide **5** in DCE solvent

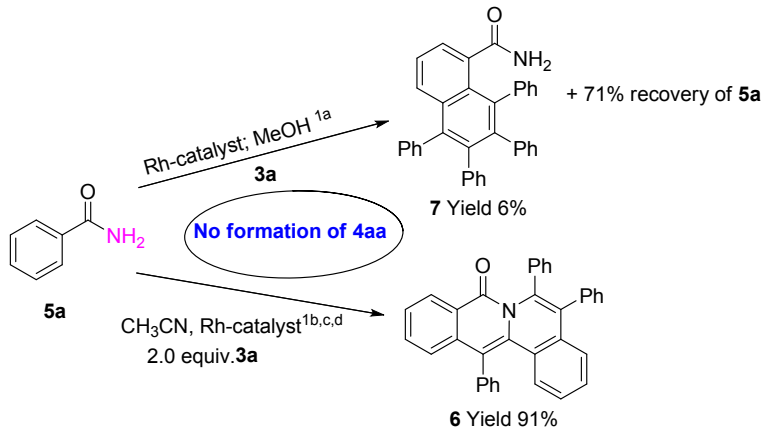


5 **4aa,** (75%) **6,** (5.0%)

In a flame dried round bottomed flask equipped with a stir bar, we added a mixture of benzamide **5** (1.23 mmol) (150 mg), in 5.0 mL solvent followed by the addition of alkyne **3a**

(0.99 mmol) (176 mg), $[RuCl_2(p\text{-cymene})]_2$ (3.0 mol%) and $Cu(OAc)_2{\cdot}H_2O$ (1.23 mmol) (223 mg). After completion of the reaction in 8 h, monitored by tlc, the resulting mixture was evaporated to remove DCE. After that dilluted with H_2O (10 mL) and mixture was extracted with EtOAc (3x20 mL). The combined organic layers were washed with brine (20 mL) and dried over Na_2SO_4. The solvent was evaporated in vacuo and the remaining residue was purified by column chromatography on silica gel (*n*-hexanes/EtOAc 5% - 40%) to yield products **4aa (**75%, 276 mg**)** and **6** (5.0%, 29 mg**).**

Scheme 6. Literature reports dealing with transformation of primary benzamide 5a to undesired products 6 and 7[1]



Literature reports on the transformation of primary benzamide **5** to undesired products **6** and **7** with no formation of **4aa**

Formation of **4aa** from **5a** as depicted in (Scheme 6) was in contrast to literature reports[1] where pre-synthesized **5a** in general has been demonstrated to be resistant towards oxidative annulation affording either **7** or a tricyclic compound **6** as the major product (Scheme 6). Notably, Jaganmohan et al[2] have demonstrated formation of quinlinones from benzonitrile via benzamide with no detectable formation of either **6** or **7**.

II. 1H and 31P NMR Experiments

Experimental evidence for the role and stability of the in situ generated iminophosphoranes during the transformation of **1a** in DCE and to rule out involvement of in situ benzamide was established by ^1H and ^{31}P experiments. Initially **1a** was allowed to react with **3d** in DCE for 2 h at 80 ^oC in the presence of (1.0 equiv) PPh_3, (3.0 mol %) of $[Ru(p\text{-cymene})Cl_2]_2$, (1.0 equiv) $Cu(OAc)_2{\cdot}H_2O$ and the reaction mixture after passing through a small celite bed was

evaporated to complete dryness. The ^{1}H NMR of the crude product was recorded in $CDCl_3$ and compared with presynthesized purified iminophosphorane **2a** and **4ad** (Figure 2)

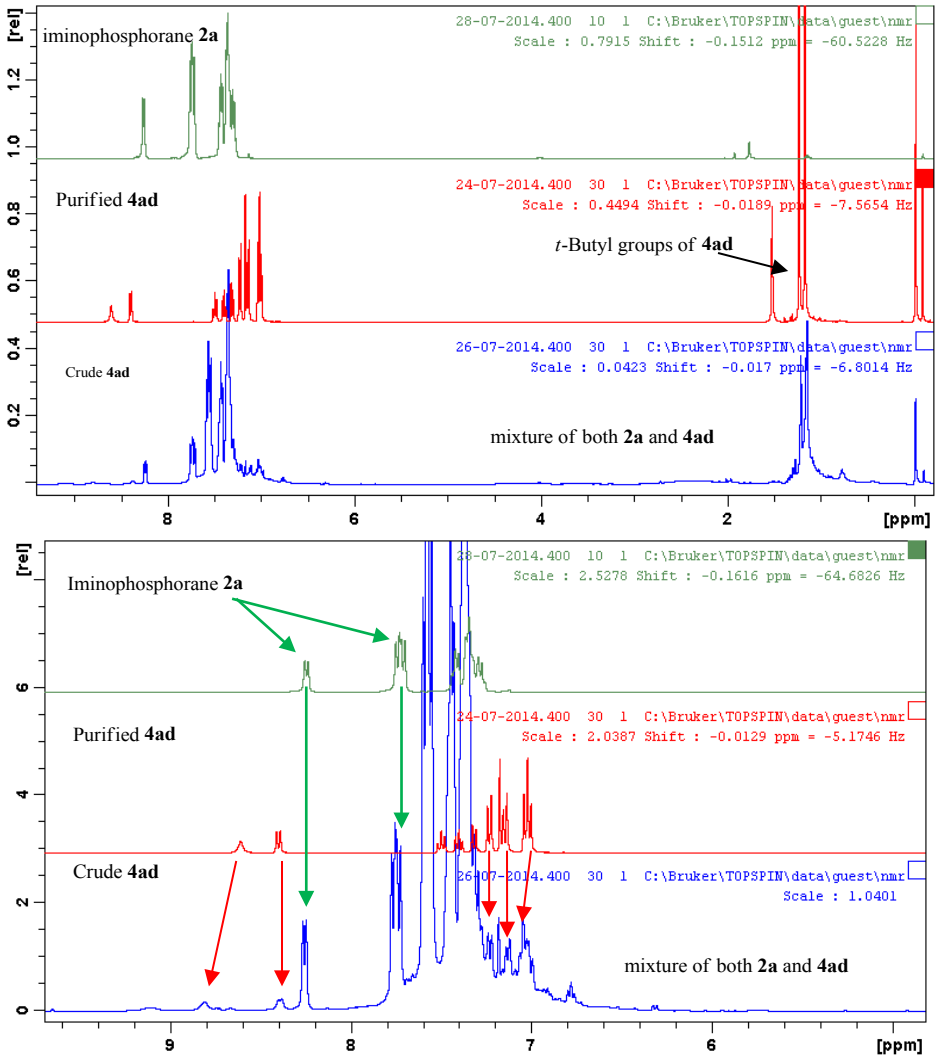


Fig 2: Comparative ^{1}H spectra of purified **2a** and **4ad** with crude **4ad**

As is evident, NMR peaks corresponding to the iminophosphorane **2a** and **4ad** can be seen in the crude **4ad**.

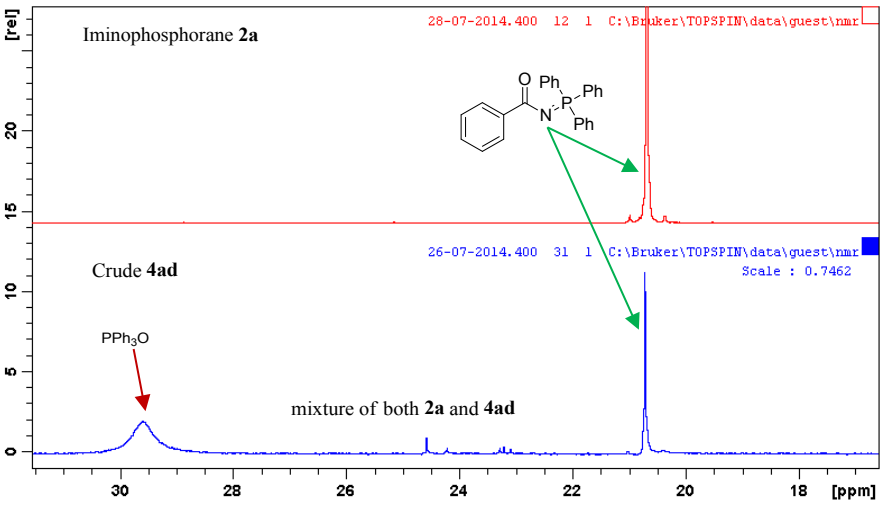
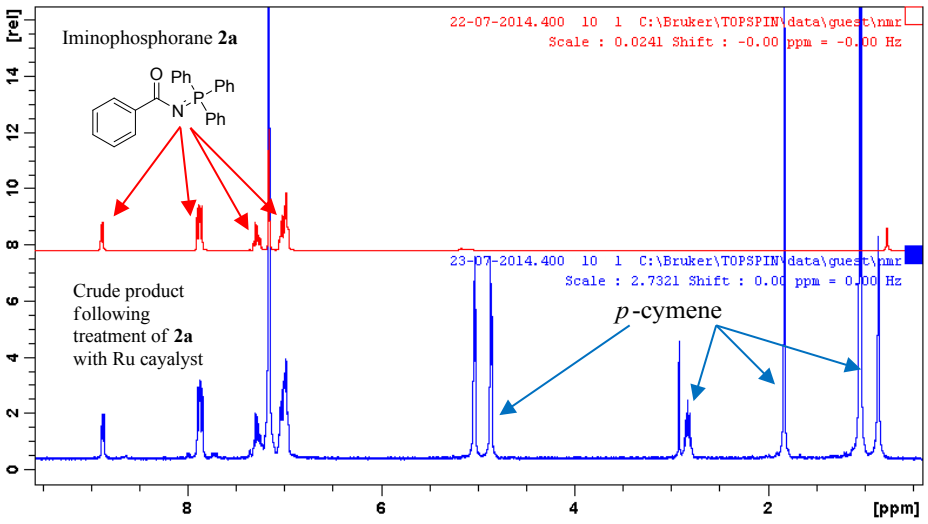


Fig 3: ^{31}P NMR comparison of **2a** with crude product **4ad**

Next, the ^{31}P NMR was recorded for the crude reaction mixture and presynthesized iminophosphorane **2a** in $CDCl_3$ and a comparative profile has been depicted in Figure 3. As is evident, a peak corresponding to the P present in **2a** at 20.0 ppm can be seen in the crude **4ad** at 20.68 ppm along with formation of triphenyl phosphine oxide (PPh_3O) as a byproduct at 29.5 ppm. The mass spectrum of the crude reaction mixture also showed the presence of iminophosphorane **2a** corresponding to 382 Da, **4ad** corresponding to 410 Da and PPh_3O corresponding to 279 Da (for mass spectrum see below). The findings suggest that in DCE transformation of **1a to 4ad** proceeds via in situ formation of iminophosphorane **2a**.

Next in order to check the stability of the N-P bond of **2a**, it was exposed alone (in the absence of **3d**) to [Ru(*p*-cymene)Cl_2]$_2$ 1.0 equiv for 36 h at 80 ^{o}C in DCE.[16] After this, the reaction mixture was evaporated to dryness and both ^{1}H and ^{31}P NMR of the crude reaction mixture was recorded in C_6D_6 solvent and a comparative profile has been depicted in Figure 4.



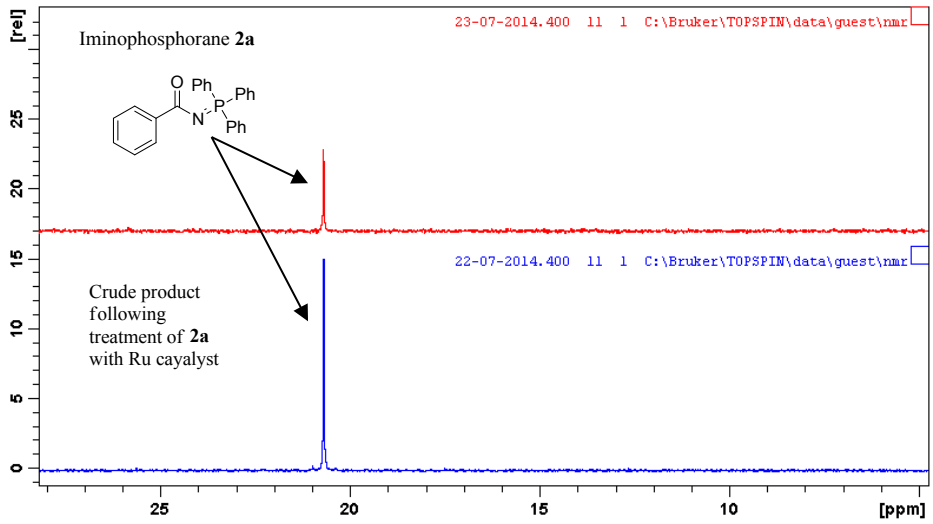


Fig 4: Comparative ^{1}H NMR and ^{31}P NMR for the **s**tability profile of **2a** with the crude product obtained following treatment of **2a** with Ru-catalyst

As is evident, in situ formation of benzamide **5** was not observed instead ^{1}H and ^{31}P signals can be seen due to the unchanged iminophosphorane **2a** even after 36 h of prolonged heating. The findings yet again rule out involvement of in situ benzamide and confirm involvement of the in situ generated iminophosphorane **2a** as the exclusive intermediate during the transformation of **1a** to **4ad** in DCE.

III General Information and methods. All reagents and solvents were purchased from commercial sources and used without purification. NMR spectra were recorded with a 300, 400 MHz spectrometers for ^{1}H NMR, 75, 100 MHz for ^{13}C NMR, and 161.9 MHz for ^{31}P NMR Chemical shifts δ are given in ppm relative to the residual signals of tetramethylsilane in $CDCl_3$ or deuterated solvent $CDCl_3$/DMSO-d_6 and C_6D_6 for ^{1}H and ^{13}C NMR. Multiplicities are reported as follows: singlet (s), doublet (d), doublet of doublets (dd), doublet of triplets (dt), triplet (t), quartet (q), multiplet (m), broad singlet (bs). HRMS were obtained using the electro spray ionization (ESI) technique and a time-of-flight (TOF) analyzer. Column chromatography was performed using silica gel (100-200 mesh) as the stationary phase. All reactions were monitored by thin layer chromatography (TLC). The purity and characterization of these compounds were further established using HR/ESI Mass

spectroscopy. Melting points were measured on a capillary melting point apparatus and are uncorrected.

IV: General Procedure for the Preparation of Aryl acyl azide (1a-1n)

Starting materials **1a-n** were prepared according to the literature[34] procedure (the yields were not optimised). To a solution of acyl chloride (20 mmol) in acetone (20 mL) at 0 °C added drop wise solution of sodium azide (1.99 g, 30 mmol) in water (10 mL) (over 1 h). The reaction mixture was warmed to room temperature and stirred for 8-12 h. Acetone was removed under reduced pressure and the reaction mixture was extracted with EtOAc (30 mL x 3). The combined organic layers were dried over Na_2SO_4 and solvent was evaporated in vacuo. The residue was purified using silica gel column chromatography (*n*-hexanes/EtOAc 9:1ratio).

Compounds **1a**[3a], **1b**[3a], **1f**[3a], **1h**[3a], **1j**[3a], **1k**[4] are reported and their corresponding data matches well with corresponding literature data.

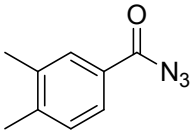
V. General procedure for the ruthenium-catalyzed synthesis of isoquinolone derivatives (4):

In a flame dried round bottomed flask equipped with a stir bar, we added a mixture of acyl azide **1** (1.02 mmol), in 5.0 mL solvent followed by the addition of Triphenylphosphine (TPP) (1.02 mmol), we then monitored the formation of iminophosphorane by tlc after 30 min of stirring at 80 °C. Next we added alkyne **3** (0.81 mmol), $[RuCl_2(p\text{-cymene})]_2$ (3.0 mol%) and $Cu(OAc)_2{\cdot}H_2O$ (1.02 mmol). After completion of reaction monitored by tlc, the resulting mixture was diluted with EtOAc, filtered through a pad of celite, and the solvent

was evaporated. At ambient temperature, H_2O (20 mL) was added and the reaction mixture was extracted with EtOAc (3-20 mL). The combined organic layers were washed with brine (20 mL) and dried over Na_2SO_4. The solvent was evaporated in vacuo and the remaining residue was purified by column chromatography on silica gel (*n*-hexanes/EtOAc 3:2 to 4:1) to yield product **4.**

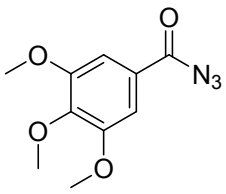
Compounds **4aa, 4ae, 4af, 4ah, 4ag, 4ba, 4fa, 4ga, 4ha, 4ja, 4ka** and **6** were reported.

azido(3,4-dimethylphenyl)methanone.(1c)



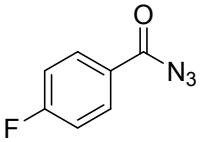
White solid; R_f = 0.56 (10% ethyl acetate/hexane); mp: 48-50 °C; FT-IR (KBr) 3415, 3019, 1669, 1384, 1215 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.81 (s, 1H), 7.78-7.76 (m, 1H), 7.22 (d, *J* = 7.9 Hz, 1H), 2.34 (s, 3H), 2.32 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.5, 144.1, 137.1, 130.4, 129.9, 128.3, 127.1, 20.1, 19.6 ppm; HRMS (ESI) calcd for $C_9H_{10}N_3O$ [M + H] 176.0824 found 176.0824.

azido(3,4,5-trimethoxyphenyl)methanone.(1d)



White solid; R_f = 0.48 (10% ethyl acetate/hexane); mp: 73-75 °C; FT-IR (KBr) 3406, 3020, 1667, 1466, 1384 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.29 (s, *2*H), 3.91 (s, 9H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.8, 153.0, 143.6, 125.5, 106.7, 60.9, 56.3 ppm; HRMS (ESI) calcd for $C_{10}H_{12}N_3O_4$ [M + H] 238.0828 found 238.0836.

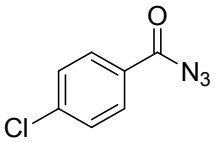
azido(4-fluorophenyl)methanone.(1e)



Colorless oil; R_f = 0.56 (10% ethyl acetate/hexane); FT-IR (Neat) 3414, 2181, 1689, 1409, 1216 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 8.09-8.05 (m, 2H), 7.16-7.12 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.3, 167.9, 165.4, 132.1 (d, *J*

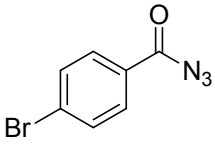
= 10 Hz), 115.9 (d, *J* = 22 Hz) ppm; HRMS (ESI) calcd for $C_7H_5N_3OF$ [M + H] 166.0417 found 166.0417.

azido(4-chlorophenyl)methanone.(1f)



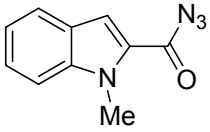
Yellow oil; R_f = 0.58 (10% ethyl acetate/hexane); FT-IR (Neat) 3410, 2401, 1691, 1421, 1280 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.66 (d, *J* = 1.4 Hz, 1H), 7.61-7.59 (m, 1H), 7.20 (d, *J* = 7.9 Hz, 1H), 4.86 (s, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.3, 134.9, 134.2, 132.3, 129.9, 129.4, 127.5 ppm; HRMS (ESI) calcd for $C_7H_5N_3OCl$ [M + H] 182.0121 found 182.0124.

azido(4-bromophenyl)methanone.(1g)



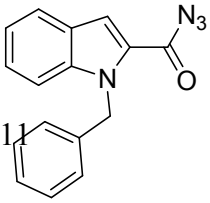
White solid; R_f = 0.56 (10% ethyl acetate/hexane); mp: 58-60 °C; FT-IR (KBr) 3408, 2136, 1686, 1392, 1216 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.90 (d, *J* = 8.7 Hz, 2H), 7.62 (d, *J* = 8.7 Hz, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 171.6, 132.0, 130.8, 129.7, 129.5 ppm; HRMS (ESI) calcd for $C_7H_5N_3OBr$ [M + H] 225.9616 found 225.9619.

azido(1-methyl-1*H*-indol-2-yl)methanone.(1l)



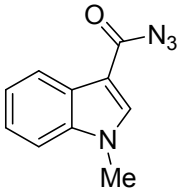
White solid; R_f = 0.62 (10% ethyl acetate/hexane); mp: 62-64 °C; FT-IR (KBr) 3408, 2401, 1677, 1397, 1214 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.64 (d, *J* = 8.0 Hz, 1H), 7.36-7.31 (m, 3H), 7.15-7.11 (m, 1H), 4.02 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 166.4, 140.9, 126.3, 125.8, 123.2, 121.1, 112.7, 110.4, 31.7 ppm; HRMS (ESI) calcd for $C_{10}H_9N_4O$ [M + H] 201.0776 found 201.0785.

azido(1-benzyl-1*H*-indol-2-yl)methanone.(1m)

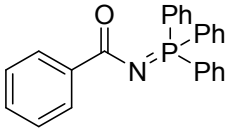


White solid; R_f = 0.58 (10% ethyl acetate/hexane); mp: 68-70 °C; FT-IR (KBr) 3415, 2412, 1682, 1214 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.75 (d, *J* = 8.1 Hz, 1H), 7.49 (s, 1H), 7.40-7.39 (m, 2H), 7.31-7.27 (m, 3H), 7.25-7.19 (m, 1H), 7.10-7.08 (m, 2H), 5.88 (s, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 166.3, 140.9, 137.9, 128.8, 128.7, 127.4, 126.7, 126.4, 123.3, 121.4, 113.7, 111.0, 48.0 ppm; HRMS (ESI) calcd for $C_{16}H_{13}N_4O$ [M + H] 277.1089 found 277.1089.

azido(1-methyl-1*H*-indol-3-yl)methanone.(1n)



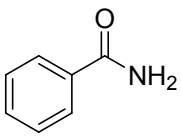
White solid; R_f = 0.58 (10% ethyl acetate/hexane); mp: 84-86 °C; FT-IR (KBr) 3408, 1677, 1214 cm^{-1}; 1H NMR (400 MHz, $CDCl_3$): δ 8.28-8.26 (m, 1H), 7.79 (s, 1H), 7.36-7.31 (m, 3H), 3.84 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.6, 137.5, 136.4, 126.3, 123.3, 122.6, 121.5, 109.9, 108.2, 33.4 ppm; HRMS (ESI) calcd for $C_{10}H_9N_4O$ [M + H] 201.0776 found 201.0785.



***N*-(benzoyl)-triphenyl iminophosphorane (2a)[5]**

White solid, R_f = 0.5 (40% ethyl acetate/hexane); mp 192-194 °C {Lit[5] Rep 196-198 °C}; FT-IR (KBr) 1026, 1112, 1173, 1342, 1437, 1595, 3016 cm^{-1}; ^1H NMR (400 MHz), 8.41 (d, *J* = 8.0 Hz, 2H), 7.91-7.87 (m, 6H), 7.60-7.57 (m, 3H), 7.52-7.42 (m, 9H) ppm; ^{13}C NMR (100 MHz) 176.3 (d, *J* = 6.0 Hz), 138.6 (d, *J* = 15.0 Hz), 133.2 (d, $J_{C\text{-}P}$, 7.5 Hz), 132.2 (d, $J_{C\text{-}P}$, 1.5 Hz), 13.7, 129.6, 128.9, 128.7, 128.6, 127.9, 127.6 ppm; ^{31}P NMR (161.9 MHz) 20.68 ppm ; HRMS (ESI) calcd for $C_{25}H_{20}NOP$ [M + H] 382.1361 Found 381.1363.

Benzamide.(5a)[6]



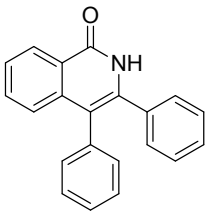
White solid; R_f = 0.50 (50% ethyl acetate/hexane); mp: 108-110 °C {Lit[6] Rep 126-128 °C}; FT-IR (KBr) 3367, 2253, 1673, 1384, 1216 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.83-7.81 (m, 2H), 7.55-7.51 (m, 1H), 7.46-7.43 (m, 2H), 6.22 (brs,

2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 169.8, 133.43, 131.9, 128.6, 127.4 ppm; HRMS (ESI) calcd for C_7H_8NO [M + H] 122.0606 found 122.0606.

VI. Charecterisation data of isoquinolin-1(2*H*)-one (4):

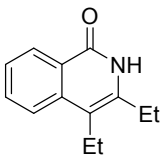
3,4-diphenylisoquinolin-1(2*H*)-one (4aa).[7]

White solid; R_f = 0.54 (40% ethyl acetate/hexane); Yield; 260 mg (86%); mp: 236-238 °C {Lit Rep[7] 242-246 °C }; FT-IR (KBr) 3404, 3018, 1659, 1387, 1215 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6): δ 11.54 (s, 1H), 8.33 (dd, J_1 = 7.9 Hz, J_2 = 1.0 Hz, 1H), 7.89-7.87 (m, 1H), 7.67-7.63 (m, 1H), 7.55-7.51 (m, 1H), 7.47-7.43 (m, 1H), 7.31-7.23 (m, 6H), 7.17-7.15 (m, 3H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6): δ 169.6, 162.9, 138.8, 137.2, 135.8, 135.1, 132.8, 132.1, 131.9, 129.4, 128.7, 128.7, 128.5, 128.4, 127.6 127.5, 127.4, 126.7, 125.8, 125.2, 117.4 ppm; HRMS (ESI) calcd for $C_{21}H_{16}NO$ [M + H] 298.1232 found 298.1231.



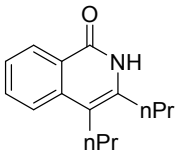
3,4-diethylisoquinolin-1(2*H*)-one (4ae).[7b]

Off-white solid; R_f = 0.56 (40% ethyl acetate/hexane); Yield; 156 mg (76%); mp: 168-170 °C {Lit Rep[7b] 173-175 °C }; FT-IR (KBr) 3399, 3019, 1651, 1384, 1215 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 11.24 (s, 1H), 8.47 (d, J = 7.8 Hz, 1H), 7.71-7.65 (m, 2H), 7.46-7.42 (m, 1H), 2.79-2.71 (m, 4H), 1.34 (t, J = 7.6 Hz, 3H), 1.21 (t, J = 7.5 Hz, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 164.1, 139.4, 138.4, 132.4, 127.8, 125.3, 122.9, 114.0, 24.3, 19.6, 15.0, 14.1 ppm; HRMS (ESI) calcd for $C_{13}H_{16}NO$ [M + H] 202.1232 found 202.1238.



3,4-dipropylisoquinolin-1(2*H*)-one (4af).[7a]

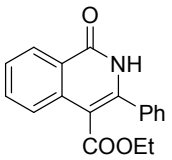
Off-white solid; R_f = 0.54 (40% ethyl acetate/hexane); Yield; 182 mg (78%); mp: 174-176 °C



{Lit Rep[7a] 176-180 °C }; FT-IR (KBr) 3399, 3019, 1654, 1384, 1215 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 10.88 (s, 1H), 8.45 (d, *J* = 8.0 Hz, 1H), 7.67 (d, *J* = 3.7 Hz, 1H), 7.46-7.42 (m, 1H), 2.72-2.65 (m, 4H), 1.79-1.70 (m, 3H), 1.65-1.58 (m, 2H), 1.56-1.04 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 163.9, 138.6, 138.3, 132.4, 127.7, 125.3, 122.2, 123.1, 113.1, 33.0, 28.7, 23.7, 22.9, 14.4, 14.1 ppm; HRMS (ESI) calcd for $C_{15}H_{20}NO$ [M + H] 230.1545 found 230.1545.

ethyl 1-oxo-3-phenyl-1,2-dihydroisoquinoline-4-carboxylate (4ah).[8]

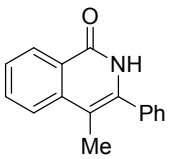
Off-white solid; R_f = 0.50 (40% ethyl acetate/hexane); Yield; 197 mg (66%); mp: 162-164



°C {Lit Rep[8] 165-167 °C}; FT-IR (KBr) 3389, 1711, 1653, 1489, 1278 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 10.23 (s, 1H), 8.37 (dd, J_1 = 8.0 Hz, J_2 = 0.8 Hz, 1H), 7.94 (d, *J* = 8.2 Hz, 1H), 7.75-7.71 (m, 1H), 7.55-7.47 (m, 6H), 4.07 (q, *J* = 14.3 Hz, 2H), 0.91 (t, *J* = 14.3 Hz, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.2, 163.1, 141.9, 135.3, 134.8, 133.5, 129.9, 128.8, 128.2, 1277, 127.2, 124.6, 110.4, 61.3, 13.6 ppm; HRMS (ESI) calcd for $C_{18}H_{16}NO_3$ [M + H] 294.1130 found 294.1130.

4-methyl-3-phenylisoquinolin-1(2*H*)-one (4ag).[7a]

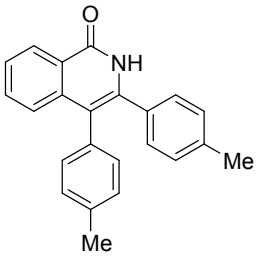
Off-white solid; R_f = 0.48 (40% ethyl acetate/hexane); Yield; 187 mg (78%); mp: 202-204 °C



{Lit Rep[7a] 200-204 °C }; FT-IR (KBr) 3394, 3019, 1651, 1384, 1215 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 9.17 (s, 1H), 8.44 (d, *J* = 7.9 Hz, 1H), 7.64 (d, *J* = 3.6 Hz, 2H), 7.54-7.46 (m, 6H), 2.26 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 162.8, 138.9, 136.9, 135.4, 132.7, 129.5, 129.1, 128.7, 127.8, 126.4,125.5, 123.7, 109.2, 13.9 ppm; HRMS (ESI) calcd for $C_{16}H_{14}NO$ [M + H] 236.1075 found 236.1075.

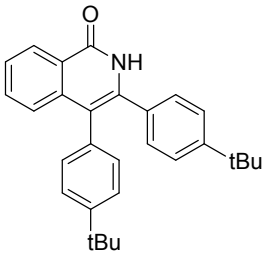
3,4-bis(4-methylphenyl)isoquinolin-1(2*H*)-one (4bb).[7b]

Off-white solid; R_f = 0.50 (40% ethyl acetate/hexane); Yield; 282 mg (85%); mp: 250-252 °C {Lit Rep[7b] 254-256 °C}; FT-IR (KBr) 3392, 3019, 1649, 1388, 1215 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6): δ 11.42 (s, 1H), 8.32-8.29 (m, 1H), 7.65-7.60 (m, 1H), 7.52-7.48 (m, 1H), 7.15-7.12 (m, 5H), 7.05-7.03 (m, 3H), 2.29 (s, 3H), 2.25 (s, 3H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6): δ 162.9,139.1, 138.6, 137.2, 136.9, 132.9, 132.6, 132.4, 131.7, 129.2, 129.1, 127.5, 126.4, 125.8, 125.1, 117.0, 21.4 ppm; HRMS (ESI) calcd for $C_{23}H_{20}NO$ [M + H] 326.1545 found 326.1545.



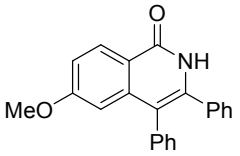
3,4-bis[4-(*tert*-butyl)phenyl]isoquinolin-1(2*H*)-one (4ad).

Off-white solid; R_f = 0.52 (40% ethyl acetate/hexane); Yield; 346 mg (83%); mp: 258-260 °C; FT-IR (KBr) 3398, 3019, 1651, 1384, 1215 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6): δ 11.40 (s, 1H), 8.31 (d, J = 7.9 Hz, 1H), 7.64 (d, J = 7.0 Hz, 1H), 7.50 (t, J = 8.0 Hz, 1H), 7.31 (d, J = 8.2 Hz, 2H), 7.23 (d, J = 8.4 Hz, 2H), 7.17-7.13 (m, 3H), 7.07 (d, J = 8.2 Hz, 2H), 1.26 (s, 9H), 1.21 (s, 9H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6 + $CDCl_3$): δ 161.6, 150.2, 149.0, 138.2, 138.1, 132.7, 132.0, 131.7, 131.2, 129.3, 126.6, 125.7, 124.8, 124.6, 124.1, 115.2, 34.1, 34.0, 30.9, 30.8 ppm; HRMS (ESI) calcd for $C_{29}H_{32}NO$ [M + H] 410.2484 found 410 2484.



6-methoxy-3,4-diphenylisoquinolin-1(2*H*)-one (4ba).[7b]

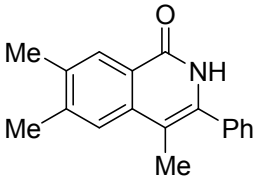
Off-white solid; R_f = 0.50 (40% ethyl acetate/hexane); Yield; 216 mg (78%); mp: 223-225 °C {Lit Rep[7b] 225 °C }; FT-IR (KBr) 3396, 2928, 1644, 1387, 1218 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6): δ 11.36 (s, 1H), 8.26 (d, J = 8.8 Hz, 1H), 7.33-7.28 (m, 3H), 7.23 (s, 5H), 7.17-7.14 (m, 3H), 6.52 (d, J = 2.4



Hz, 1H), 3.69 (s, 3H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6 + $CDCl_3$): δ 162.2, 161.8, 140.1, 135.4, 134.4, 131.2, 129.1, 128.8, 127.8, 127.3, 126.6, 118.6, 115.8, 114.4, 106.8, 54.7 ppm; HRMS (ESI) calcd for $C_{22}H_{18}NO_2$ [M + H] 328.1338 found 328.1338.

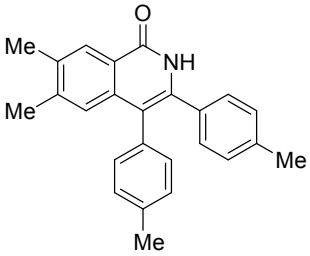
4,6,7-trimethyl-3-phenylisoquinolin-1(2*H*)-one (4bg).

Off-white solid; R_f = 0.52 (40% ethyl acetate/hexane); Yield; 140 mg (62%); mp: 200-202 °C; FT-IR (KBr) 3849, 3394, 1647, 1384, 1215 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.51 (s, 1H), 8.24 (s, 1H), 7.52-7.46 (m, 6H), 2.48 (s, 3H), 2.45 (s, 3H), 2.26 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 162.5, 142.7, 137.1, 135.9, 130.5, 129.3, 128.9, 128.8, 128.4, 127.9, 124.3, 123.5, 109.0, 20.7, 19.8, 13.9 ppm; HRMS (ESI) calcd for $C_{18}H_{18}NO$ [M + H] 264.1388 found 264.1388.



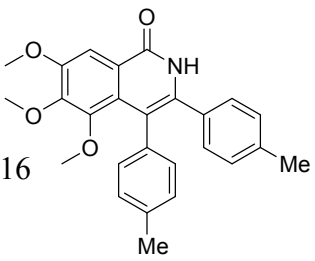
6,7-dimethyl-3,4-bis(4-methylphenyl)isoquinolin-1(2*H*)-one (4cb).

Off-white solid; R_f = 0.48 (40% ethyl acetate/hexane); Yield; 212 mg (70%); mp: 272-274 °C; FT-IR (KBr) 3392, 3019, 1647, 1387, 1215 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6): δ 11.23 (s, 1H), 8.07 (s, 1H), 7.13-7.06 (m, 4H), 7.03-7.00 (m, 4H), 6.91 (s, 1H), 2.37 (s, 3H), 2.30 (s, 3H), 2.24 (s, 3H), 2.22 (s, 3H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6 + $CDCl_3$): δ 162.3, 141.8, 137.6, 137.1, 136.2, 135.3, 133.5, 132.4, 131.8, 129.9, 128.6, 127.2, 125.7, 123.6, 115.5, 21.3, 21.2, 20.5, 19.8 ppm; HRMS (ESI) calcd for $C_{25}H_{24}NO$ [M + H] 354.1858 found 354.1860.



5,6,7-trimethoxy-3,4- bis(4-methylphenyl)isoquinolin-1(2*H*)-one (4db).

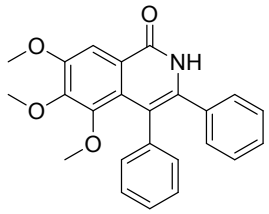
Red solid; R_f = 0.42 (50% ethyl acetate/hexane); Yield; 178 mg (68%); mp: 258-260 °C; FT-IR (KBr) 3395, 3019, 1645, 1474, 1215 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.67 (s, 1H), 7.82 (s, 1H), 7.09-6.99 (m, 8H), 4.03 (s,



3H), 3.91 (s, 3H), 3.15 (s, 3H), 2.32 (s, 3H), 2.29 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 161.7, 153.1, 150.5, 147.9, 138.0, 136.2, 135.6, 135.5, 132.9, 131.1, 129.3, 128.9, 128.8, 127.9, 127.7, 115.0, 104.4, 60.9, 60.8, 56.2, 21.3, 21.3 ppm; HRMS (ESI) calcd for $C_{26}H_{26}NO_4$ [M + H] 416.1862 found 416.1862.

5, 6, 7-trimethoxy-3,4-diphenylisoquinolin-1(2*H*)-one (4da).

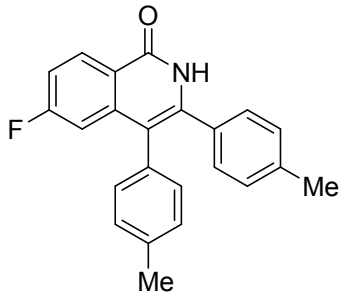
Red solid; R_f = 0.44 (50% ethyl acetate/hexane); Yield; 160 mg (65%); mp: 252-254 °C; FT-



IR (KBr) 3391, 3016, 1642, 1418, 1216 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.63 (s, 1H), 7.81 (s, 1H), 7.26 (s, 1H), 7.20-7.13 (m, 9H), 4.02 (s, 3H), 3.90 (s, 3H), 3.13 (s, 3H), ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 161.8, 153.2, 150.4, 147.9, 138.7, 136.3, 35.6, 131.4, 129.6, 128.2, 128.1, 126.9, 126.2, 115.3, 104.4, 60.9, 60.8, 56.2 ppm; HRMS (ESI) calcd for $C_{24}H_{22}NO_4$ [M + H] 388.1549 found 388.1549.

6-fluoro-3,4-bis(4-methylphenyl)isoquinolin-1(2*H*)-one (4eb).

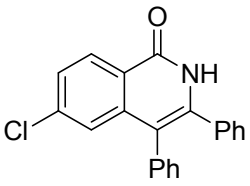
Off-white solid; R_f = 0.46 (40% ethyl acetate/hexane); Yield; 240 mg (77%); mp: 252-254



°C; FT-IR (KBr) 3402, 2923, 1651, 1446, 1216 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.94 (s, 1H), 8.49-8.45 (m, 1H), 7.19-7.09 (m, 5H), 7.06-6.96 (m, 5H), 2.36 (s, 3H), 2.30 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 166.9, 164.4, 162.5, 141.7 (d, J = 10 Hz), 138.7 (d, J = 12 Hz), 137.2, 132.4, 131.9, 131.5, 130.9 (d, J = 10 Hz), 129.4, 129.2 (d, J = 13 Hz), 121.7, 116.6, 115.0 (d, J = 24 Hz), 110.9 (d, J = 23 Hz), 21.4 ppm; HRMS (ESI) calcd for $C_{23}H_{19}NOF$ [M + H] 344.1451 found 344.1451.

6-chloro-3,4-diphenylisoquinolin-1(2*H*)-one (4fa).[7b]

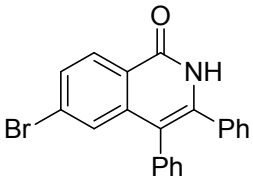
Off-white solid; R_f = 0.50 (40% ethyl acetate/hexane); Yield; 225 mg (82%); mp: 242-244 °C



{Lit Rep[7b] 246-248 °C }; FT-IR (KBr) 3401, 3021, 1652, 1441, 1215 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6): δ 11.71 (s, 1H), 8.32 (d, J = 8.4 Hz, 1H), 7.57-7.54 (m, 1H), 7.36-7.29 (m, 4H), 7.24 (s, 4H), 7.18-7.16 (m, 2H), 7.05 (d, J = 2.0 Hz, 1H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6): δ 161.4, 140.3, 139.6, 137.6, 135.1, 134.1, 131.6, 129.7, 129.3, 128.4, 127.7, 127.3, 126.4, 123.7, 123.6, 114.5 ppm; HRMS (ESI) calcd for $C_{21}H_{15}NOCl$ [M + H] 332.0842 found 332.0842.

6-bromo-3,4-diphenylisoquinolin-1(2*H*)-one (4ga).[7a]

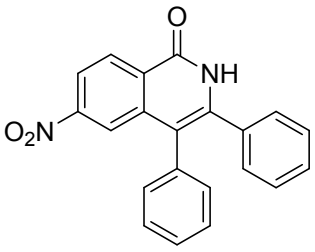
Off-white solid; R_f = 0.46 (40% ethyl acetate/hexane); Yield; 200 mg (80%); mp: 246-248 °C



{Lit Rep[7a] 250 °C }; FT-IR (KBr) 3410, 2997, 1655, 1389, 1216 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6): δ 11.71 (s, 1H), 8.24 (d, J = 8.5 Hz, 1H), 7.87 (d, J = 8.5 Hz, 1H), 7.72-7.67 (m, 2H), 7.35-7.31 (m, 3H), 7.91-7.22 (m, 5H), 7.22-7.16 (m, 2H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6 + $CDCl_3$): δ 161.2, 140.1, 139.8, 135.0, 134.1, 131.6, 131.5, 129.6, 129.2, 129.0, 128.3, 127.6, 127.3, 126.8, 126.7, 126.7, 123.8, 114.3 ppm; HRMS (ESI) calcd for $C_{21}H_{15}NOBr$ [M + H] 376.0337 found 376.0337.

6-nitro-3,4-diphenylisoquinolin-1(2*H*)-one (4ha).[7a]

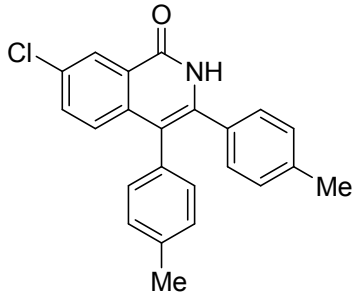
Off-white solid; R_f = 0.42 (40% ethyl acetate/hexane); Yield; 220 mg (82%); mp 251-252 °C



{Lit Rep[7a] 251-252 °C }; FT-IR (KBr) 3388, 1659, 1531, 1387, 1215 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 9.99 (s, 1H), 8.58 (d, J = 8.7 Hz, 1H), 8.22 (s, 2H), 7.36-7.28 (m, 8H), 7.18 (s, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 161.8, 150.8, 139.8, 139.7, 134.4, 134.3, 131.7, 129.7, 129.3, 129.0, 128.6, 128.2, 121.3, 120.2, 117.3 ppm; HRMS (ESI) calcd for $C_{21}H_{15}N_2O_3$ [M + H] 343.1083 found 343.1083.

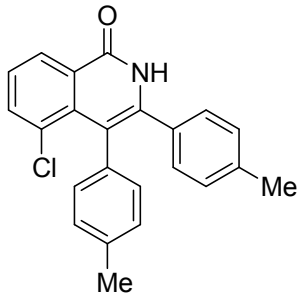
7-chloro-3,4-bis(4-methylphenyl)isoquinolin-1(2*H*)-one (4ib).

White solid; R_f = 0.65 (40% ethyl acetate/hexane); Yield; (produced in 1:1 ratio); mp: 150-152 °C; FT-IR (KBr) 3400, 3019, 1632, 1384, 1215 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 9.99 (s, 1H), 8.46 (s, 1H), 7.51 (d, *J* = 8.8 Hz, 1H), 7.31 (d, *J* = 8.8 Hz, 1H), 7.14-7.11 (m, 4H), 7.07-7.03 (m, 4H), 2.34 (s, 3H), 2.31 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 162.6, 138.8, 137.6, 133.2, 133.0, 132.6, 132.4, 131.6, 131.5, 129.7, 129.4, 129.3, 129.1, 127.6, 126.8, 117.2, 21.4 ppm; HRMS (ESI) calcd for $C_{23}H_{19}NOCl$ [M + H] 360.1155 found 360.1157.



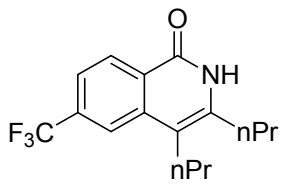
5-chloro-3,4-bis(4-methylphenyl)isoquinolin-1(2*H*)-one (4ib').

White solid; R_f = 0.56 (50% ethyl acetate/hexane); mp: 200-202 °C; FT-IR (KBr) 3400, 3019, 1632, 1384, 1215 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 9.30 (s, 1H), 8.45 (d, *J* = 7.9 Hz, 1H), 7.64-7.62 (m, 1H),7.39-7.35 (m, 1H), 7.02-6.98 (m, 8H), 2.31 (s, 3H), 2.28 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 162.1, 139.7, 138.4, 136.6, 135.1, 134.3, 132.5, 132.1, 131.3, 129.3, 129.2, 128.8, 128.2, 127.2, 126.8, 115.6, 21.4, 21.3 ppm; HRMS (ESI) calcd for $C_{23}H_{19}NOCl$ [M + H] 360.1155 found 360.1157.



3,4-dipropyl-6-(trifluoromethyl)isoquinolin-1(2*H*)-one (4cf).

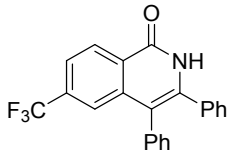
Off-white solid; R_f = 0.48 (40% ethyl acetate/hexane); Yield; 149 mg (72%); mp: 120-122 °C; FT-IR (KBr) 3430, 1650, 1384, 1217 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 11.27 (s, 1H), 8.55 (d, *J* = 8.3 Hz, 1H), 7.92 (s, 1H), 7.64 (d, *J* = 8.3, 1H), 7.02 (s, 1H), 2.75-2.69 (m, 4H), 1.82-1.72 (m, 2H), 1.64-1.57 (m, 2H), 1.09-1.01 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 163.3, 140.2,



138.6, 134.0 (d, J = 29.0 Hz), 128.8, 127.2, 125.5, 122.8, 121.4, 120.5, 113.1, 33.1, 28.5, 23.7, 22.9, 14.2 (d, J = 21.0 Hz) ppm; HRMS (ESI) calcd for $C_{16}H_{19}NOF_3$ [M + H] 298.1419 found 298.1419.

3,4-diphenyl-6-(trifluoromethyl)isoquinolin-1(2*H*)-one (4ja).[7a,7b]

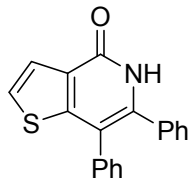
Off-white solid; R_f = 0.62 (50% ethyl acetate/hexane); Yield; 224 mg (88%); mp 228-230 °C



{Lit Rep[7a] 225 °C }; FT-IR (KBr) 3390, 3019, 1660, 1382, 1223 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.01 (s, 1H), 8.59 (d, J = 8.0 Hz, 1H), 7.71-7.69 (m, 1H), 7.62 (s, 1H), 7.35 -7.34 (m, 3H), 7.3-7.26 (m, 3H), 7.24 – 7.21 (m, 2H), 7.18-7.16 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 162.5, 138.9 (d, J = 5.0 Hz), 134.74 (d, J = 25.0 Hz), 131.8, 129.4, 129.1, 128.8 (d, J = 7.0 Hz), 128.5, 127.7, 127.3, 122.9, 122.7, 117.1 ppm; HRMS (ESI) calcd for $C_{22}H_{15}NOF_3$ [M + H] 366.1106 found 366.1106.

4,5-Diphenylthieno[2,3-*c*]pyridin-7(*6H*)-one (4ka).[7b]

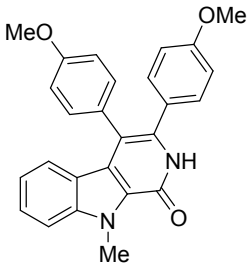
White solid; R_f = 0.56 (50% ethyl acetate/hexane); Yield; 179 mg (60%); mp 263-265 °C;



{Lit Rep[7b] 265-267 °C }FT-IR (KBr) 3390, 3019, 1660, 1384, 1216 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d^6): δ 11.76 (s, 1H), 8.03 (d, J = 5.2 Hz, 1H), 7.28-7.23 (m, 8H), 7.16-7.14 (m, 2H), 6.93 (d, J = 5.2 Hz, 1H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6): δ 158.0, 146.7, 139.8, 136.3, 134.1, 133.9, 130.7, 130.0, 128.3, 128.2, 128.0, 127.8, 126.9, 124.5, 114.7 ppm; HRMS (ESI) calcd for $C_{19}H_{14}NOS$ [M + H] 304.0796 found 304.0796.

3,4-bis(4-methoxyphenyl)-9-methyl-2,9-dihydro-1*H*-β-carbolin-1-one (4lc).

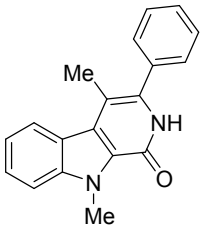
Light-brown solid; R_f = 0.30 (50% ethyl acetate/hexane); Yield; 199 mg (65%); mp: 271-273



°C; FT-IR (KBr) 3421, 3019, 1640, 1384, 1215 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6): δ 11.48 (s, 1H), 7.62 (d, *J* = 8.4 Hz, 1H), 7.42-7.39 (m, 1H), 7.18-7.16 (m, 4H), 6.96-6.93 (m, 3H), 6.79 (d, *J* = 8.8 Hz, 1H), 6.67 (d, *J* = 8.1 Hz, 1H), 4.31 (s, 3H), 3.79 (s, 3H), 3.72 (s, 3H) ppm; ^{13}C NMR of this compound was not obtained due to its very very low solubility; HRMS (ESI) calcd for $C_{26}H_{23}N_2O_3$ [M + H] 411.1709 found 411.1709.

4,9-dimethyl-3-phenyl-2,9-dihydro-1*H*-β-carbolin-1-one (4lg).

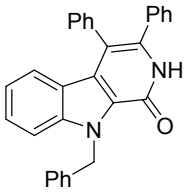
Orange solid; R_f = 0.50 (50% ethyl acetate/hexane); Yield; 114 mg (58%); mp: 268-270 °C;



FT-IR (KBr) 3420, 1644, 1215 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6): δ 11.36 (s, 1H), 8.18 (d, *J* = 7.9 Hz, 1H), 7.68 (d, *J* = 8.4 Hz, 1H), 7.55-7.46 (m, 6H), 7.26(t, *J* = 7.3 Hz, 1H), 4.30 (s, 3H), 2.45 (s, 3H) ppm; ^{13}C NMR (100 MHz, DMSO-d_6): 155.6, 140.6, 134.2, 133.9, 129.9, 128.6, 128.3, 126.7, 126.0, 125.8, 122.9, 122.0, 120.4, 110.0, 107.9, 31.5, 15.6 ppm; HRMS (ESI) calcd for $C_{19}H_{19}N_2O$ [M + H] 289.1341 found 289.1340.

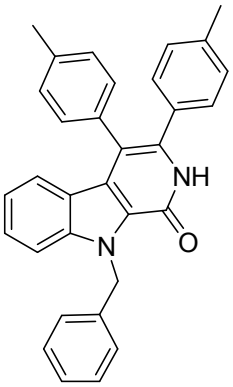
9-benzyl-3,4-diphenyl-2,9-dihydro-1*H*-β-carbolin -1-one (4ma).

Light- Yellow solid; R_f = 0.60 (50% ethyl acetate/hexane); Yield; 157 mg (68%); mp: 298-

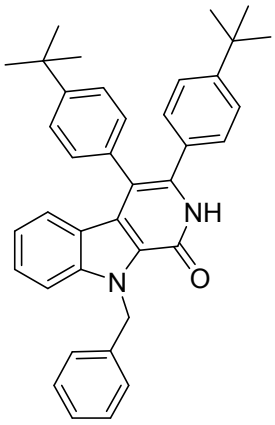


300 °C; FT-IR (KBr) 3427, 2989, 1644, 1386, 1219 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6): δ 11.73 (s, 1H), 7.64 (d, *J* = 8.5 Hz, 1H), 7.38-7.36 (m, 3H), 7.32-7.28 (m, 8H), 7.28-7.23 (m, 4H), 6.88 (t, *J* = 7.9 Hz, 1H), 6.58 (d, *J* = 8.2 Hz, 1H), 6.18 (s, 2H) ppm; ^{13}C NMR of this compound was not obtained due to its very very low solubility; HRMS (ESI) calcd for $C_{30}H_{23}N_2O$ [M + H] 427.1810 found 427.1810.

9-benzyl-3,4-bis(4-methylphenyl)-2,9-dihydro-1H-pyrido[3,4-b]indol-1-one (4mb)



Brown solid; R_f = 0.48 (50% ethyl acetate/hexane); Yield; 167 mg (68%); mp: 188-190 °C; FT-IR (KBr) 3402, 2926, 1389 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6): δ 11.62 (s, 1H), 7.62 (d, *J* = 8.0 Hz, 1H),7.35-7.33 (m, 1H), 7.30-7.29 (m, 4H), 7.24-7.21 (m, 2H), 7.18-7.15 (m, 5H), 7.06-7.04 (m, 2H), 6.88 (t, *J* = 8.0 Hz, 1H), 6.62 (d, *J* = 8.0 Hz, 1H) 6.17 (s, 2H), 2.36 (s, 3H), 2.25 (s, 3H) ppm; ^{13}C NMR of this compound was not obtained due to its very very low solubility; HRMS (ESI) calcd for $C_{32}H_{27}N_2O$ [M + H] 455.2123 found 455.2130.

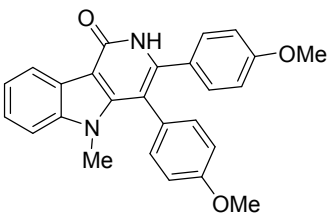


9-benzyl-3,4-bis(4-(*tert*-butyl)phenyl)-2,9-dihydro-1H-pyrido[3,4-b]indol-1-one (4md)

Brown solid; R_f = 0.55 (50% ethyl acetate/hexane); Yield; 210 mg (72%); mp 278-280 °C; FT-IR (KBr) 3401, 3020, 1639 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6): δ 11.58 (s, 1H), 7.62 (d, *J* = 8.0 Hz, 1H), 7.39-7.38 (m, 2H), 7.30-7.29 (m, 5H), 7.23-7.20 (m, 7H), 6.85 (t, *J* = 8.0 Hz, 1H), 6.52 (d, *J* = 8.0 Hz, 1H) 6.16 (s, 2H), 1.31 (s, 9H), 1.23 (s, 9H) ppm; ^{13}C NMR of this compound was not obtained due to its very very low solubility; HRMS (ESI) calcd for $C_{38}H_{39}N_2O$ [M + H] 539.3062 found 539.3062.

5-methyl-3,4-bis[4-methoxyphenyl]-2,5-dihydro-1*H*-pyrido[4,3-*b*]indol-1-one (4nc).

Brown solid; R_f = 0.30 (50% ethyl acetate/hexane); Yield; 230 mg (72%); mp: 268-270 °C;

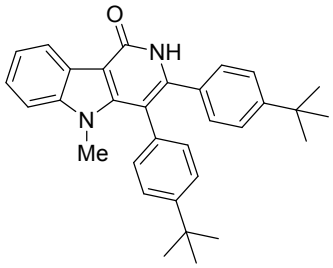


FT-IR (KBr) 3426, 2992, 1634, 1387, 1218 cm^{-1}; ^1H NMR (400 MHz, DMSO-d_6): δ 11.30 (s, 1H), 8.26 (d, *J* = 7.2 Hz, 1H), 7.49 (d, *J* = 8.2 Hz, 1H), 7.38-7.34 (m, 1H), 7.29-7.25 (m, 1H), 7.22-

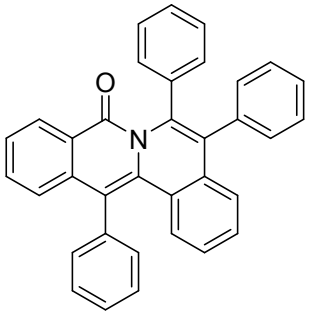
7.16 (m, 1H), 6.89 (d, *J* = 8.7 Hz, 2H), 6.79 (d, *J* = 8.8 Hz, 1H), 3.76 (s, 3H), 3.72 (s, 3H), 3.16 (s, 3H) ppm; ^{13}C NMR of this compound was not obtained due to its very very low solubility; HRMS (ESI) calcd for $C_{27}H_{26}NO_3$ [M + H] 411.1709 found 411.1709.

5-methyl-3,4-bis[4-(*tert*-butyl)phenyl]-2,5-dihydro-1*H*-pyrido[4,3-*b*]indol-1-one (4nd).

Light-brown solid; R_f = 0.48 (50% ethyl acetate/hexane); Yield; 200 mg (58%); mp >300 °C;



FT-IR (KBr) 3421, 2993, 1646, 1387, 1218 cm^{-1}; ^{1}H NMR (400 MHz, DMSO-d_6): δ 11.33 (s, 1H), 8.26 (d, *J* = 7.6 Hz, 1H), 7.49 (d, *J* = 8.2 Hz, 1H), 7.38-7.34 (m, 1H), 7.31-7.26 (m, 3H), 7.23-7.19 (m, 4H), 7.14 (d, *J* = 8.4 Hz, 2H), 3.17 (s, 3H), 1.26 (s, 9H), 1.21 (s, 9H) ppm; ^{13}C NMR of this compound was not due to its very very low solubility; HRMS (ESI) calcd for $C_{32}H_{35}N_2O$ [M + H] 463.2749 found 463.2747.



5,6,13-triphenyl-13, 13a-dihydro-8*H*-isoquinolino[3,2-*a*]isoquinolin-8-one (6)[9]

Light-Yellow solid; R_f = 0.65 (20% ethyl acetate/hexane); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.25-8.23 (m, 1H), 7.61-7.59 (m, 1H), 7.58-7.52 (m, 5H), 7.50-7.40 (m, 1H), 7.35-7.33 (m, 1H), 7.28-7.25 (m, 4H), 7.24-7.23 (m, 3H), 7.22-7.14 (m, 2H), 7.12-7.01 (m, 4H), 6.89-6.85 (m, 1H) ppm; 13C NMR (100 MHz, $CDCl_3$): 162.2, 138.6, 137.1, 136.3, 136.2, 133.8, 133.1, 132.3, 132.2, 131.5, 129.1, 129.0, 128.5, 128.1, 128.0, 127.6, 127.5, 127.1, 126.8, 126.7, 126.5, 126.3, 125.8, 125.7, 125.6, 117.0 ppm; HRMS (ESI) calcd for $C_{35}H_{24}NO$ [M + H] 474.1858 found 474.1863.

Triphenylphosphine Oxide

White solid; R_f = 0.35 (50% ethyl acetate/hexane); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.71-7.60 (m, 6H), 7.56-7.54 (m, 3H), 7.50-7.45 (m, 6H) ppm; 13C NMR (100 MHz, $CDCl_3$): 133.0, 132.1, 132.0, 131.9, 131.9, 128.5, 128.4 ppm

VII. Spectral Copies of Starting and Final Compounds

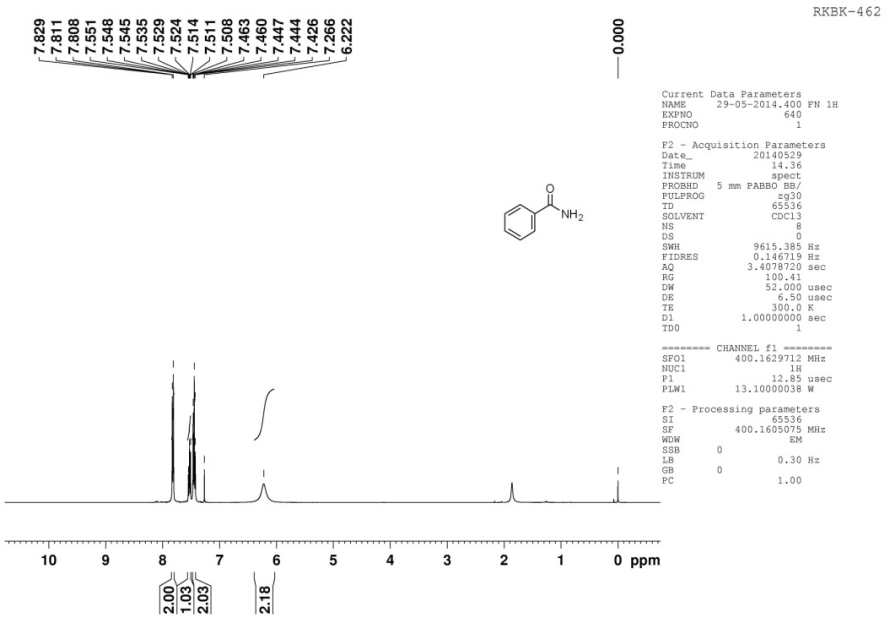


Fig. 5: ^{1}H NMR of 5

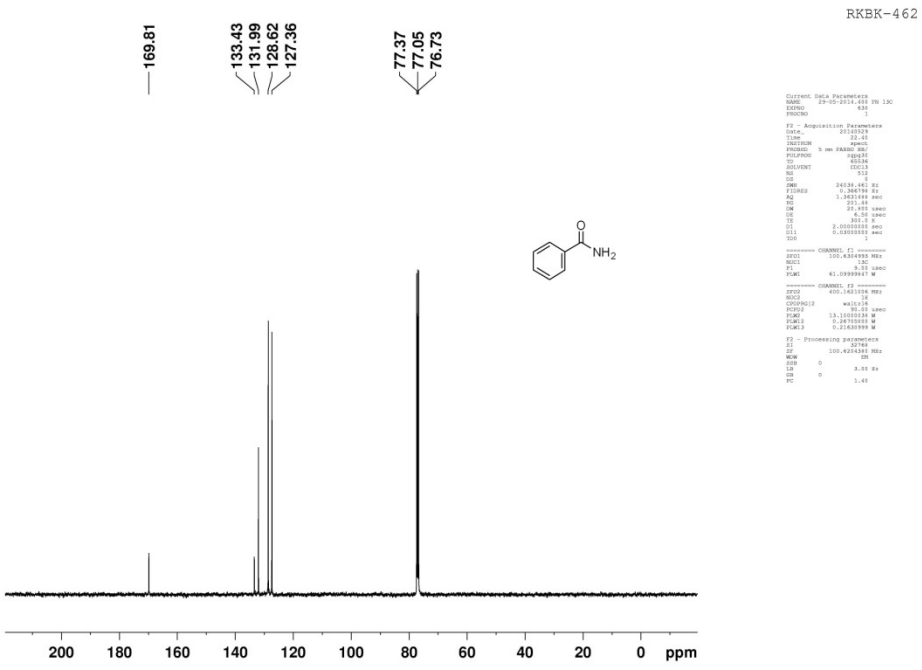


Fig. 6: ^{13}C NMR of 5

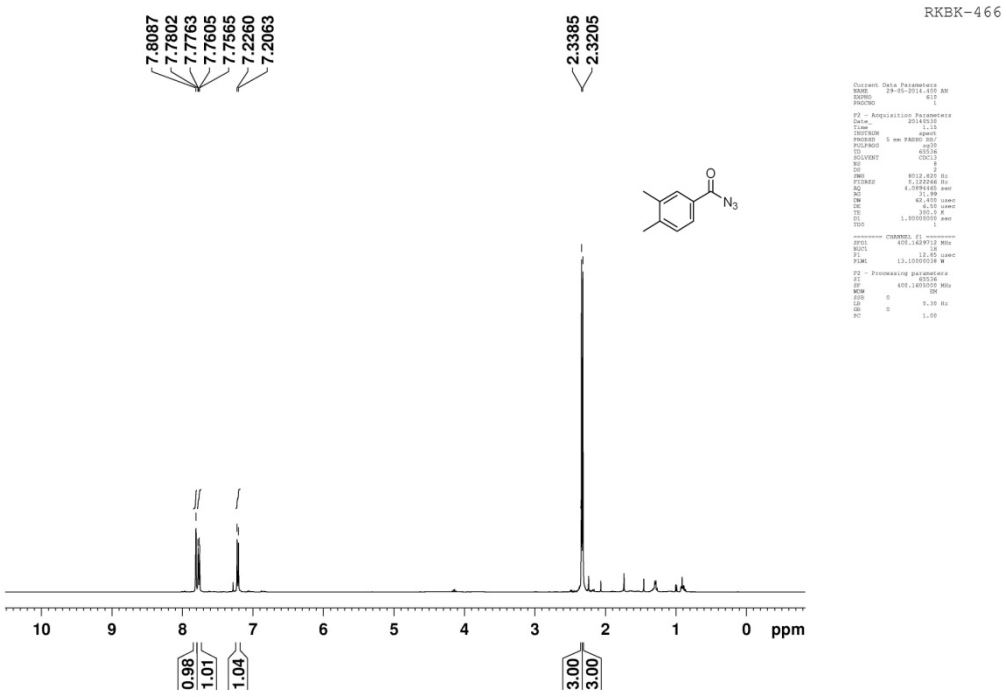


Fig. 7: ^{1}H NMR of 1c

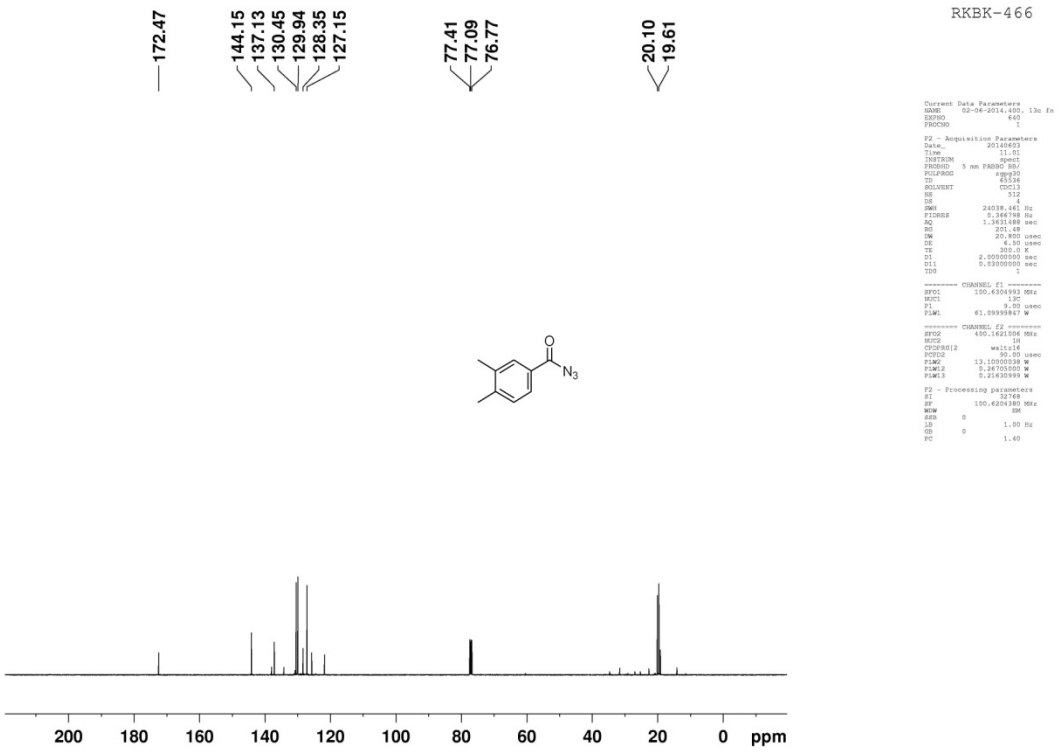


Fig. 8: ^{13}C NMR of 1c

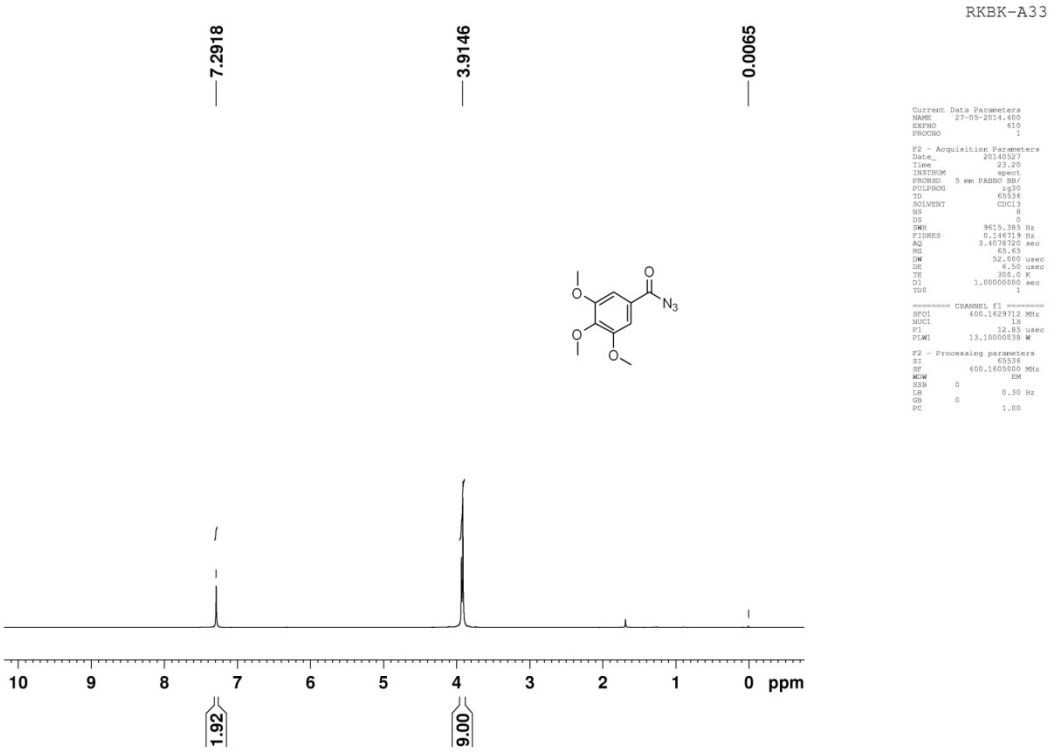


Fig. 9: ^{1}H NMR of 1d

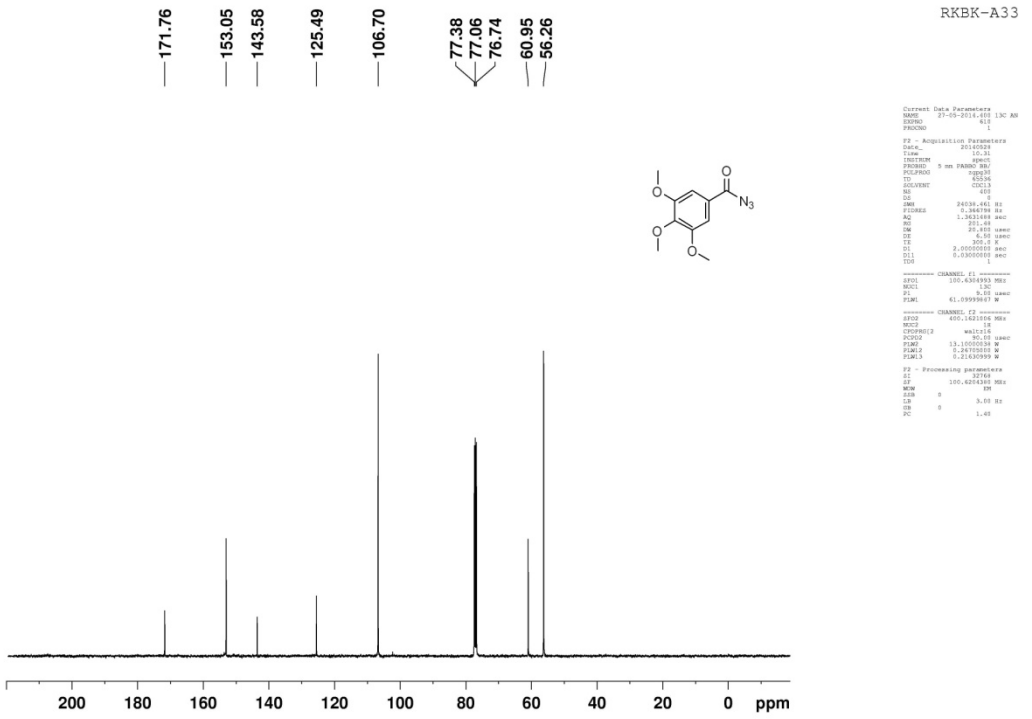


Fig. 10: ^{13}C NMR of 1d

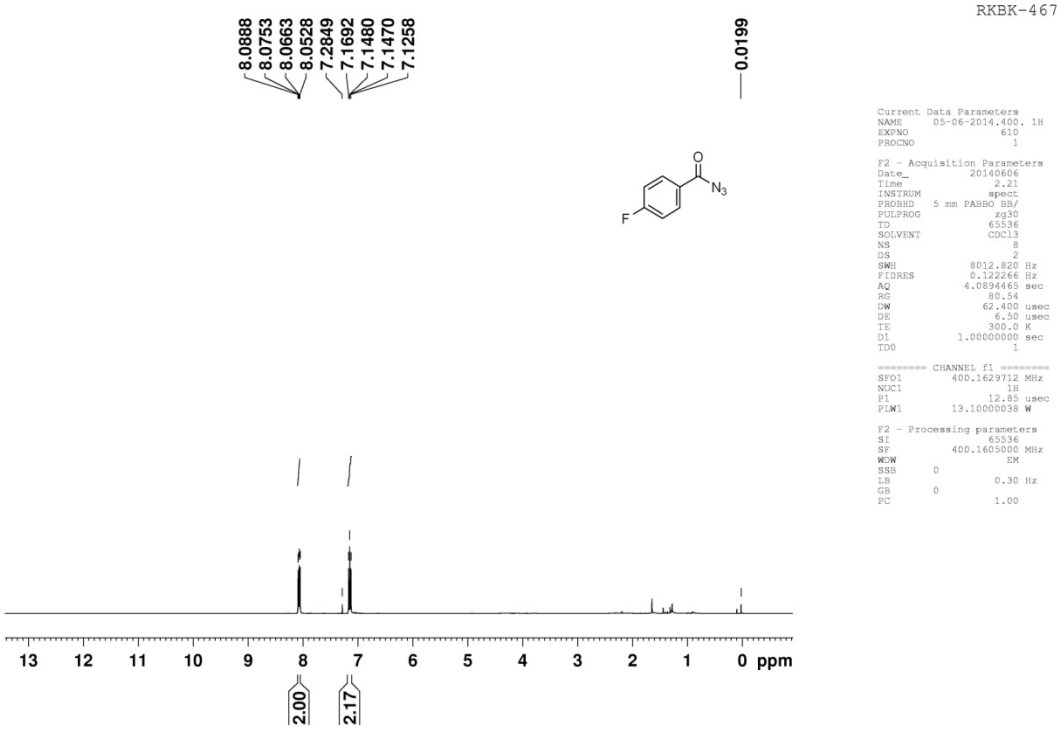


Fig. 11: ^{1}H NMR of 1e

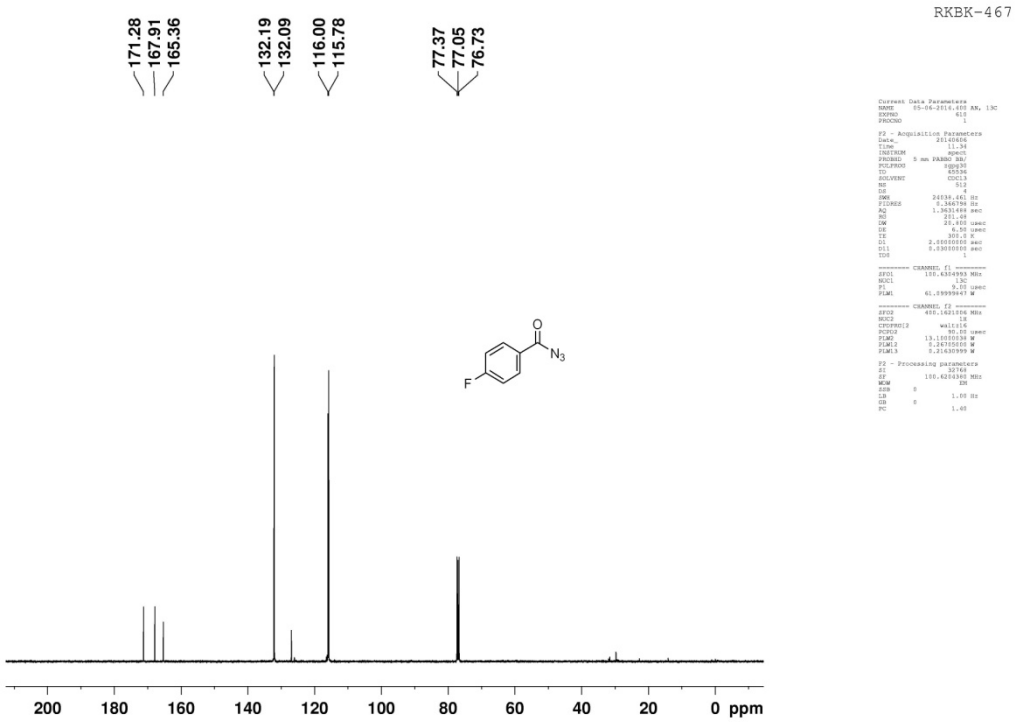


Fig. 12: ^{13}C NMR of 1e

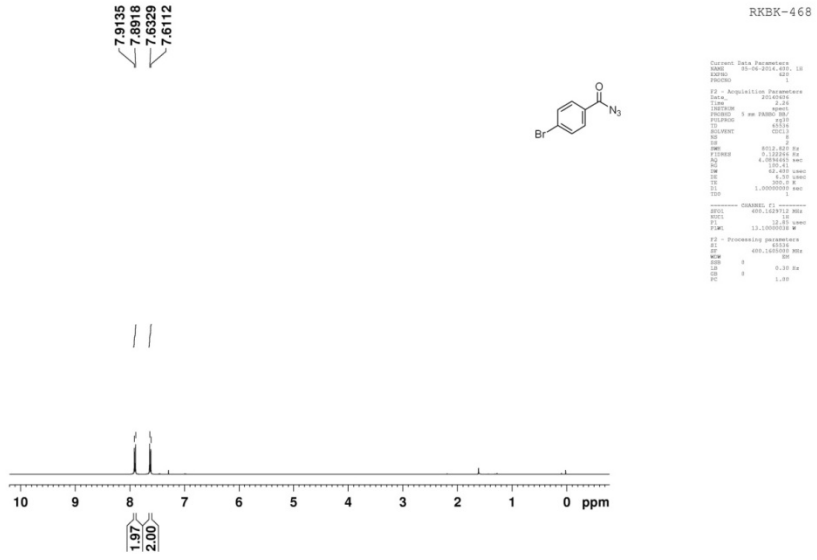


Fig. 13: ^{1}H NMR of 1f

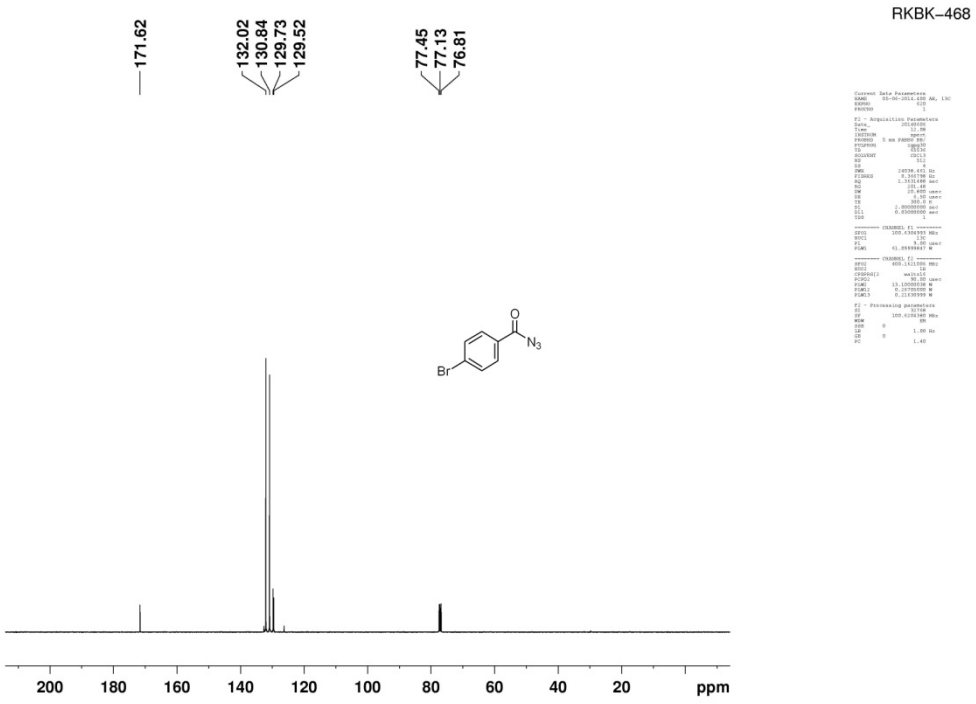


Fig. 14: ^{13}C NMR of 1f

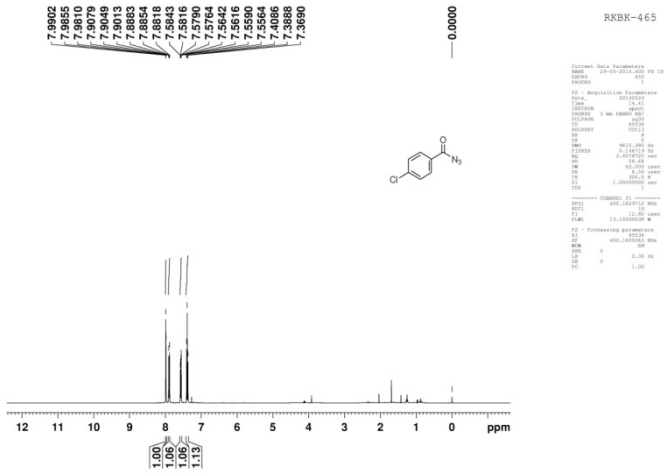


Fig. 15: ^{1}H NMR of 1g

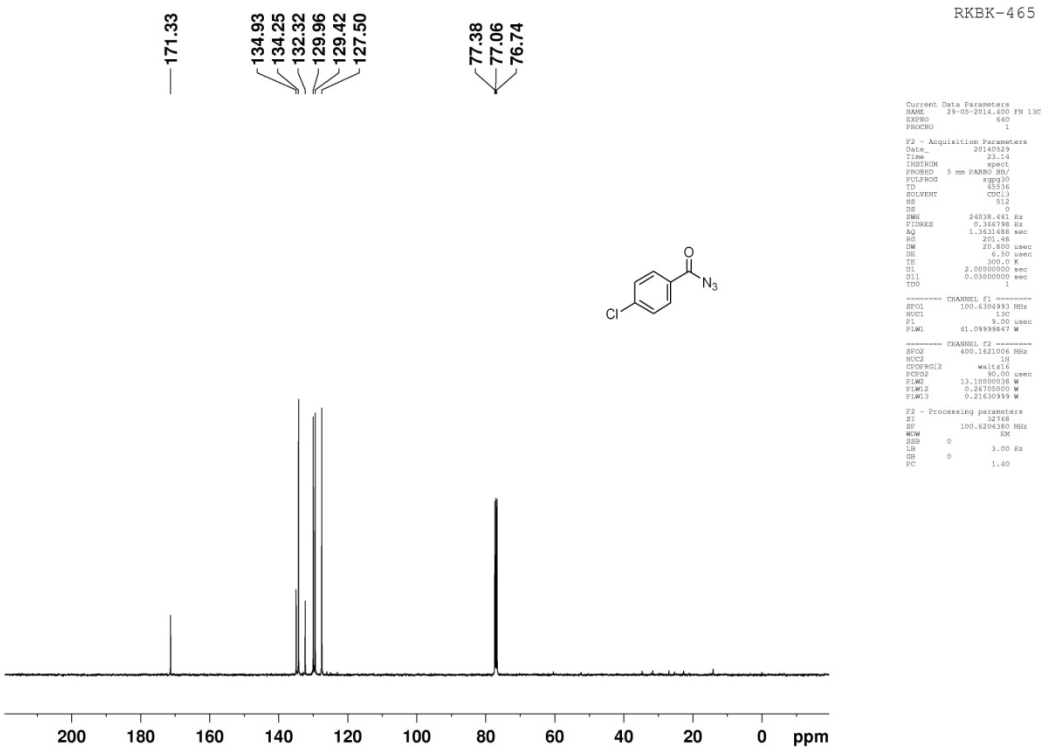


Fig. 16: ^{13}C NMR of 1g

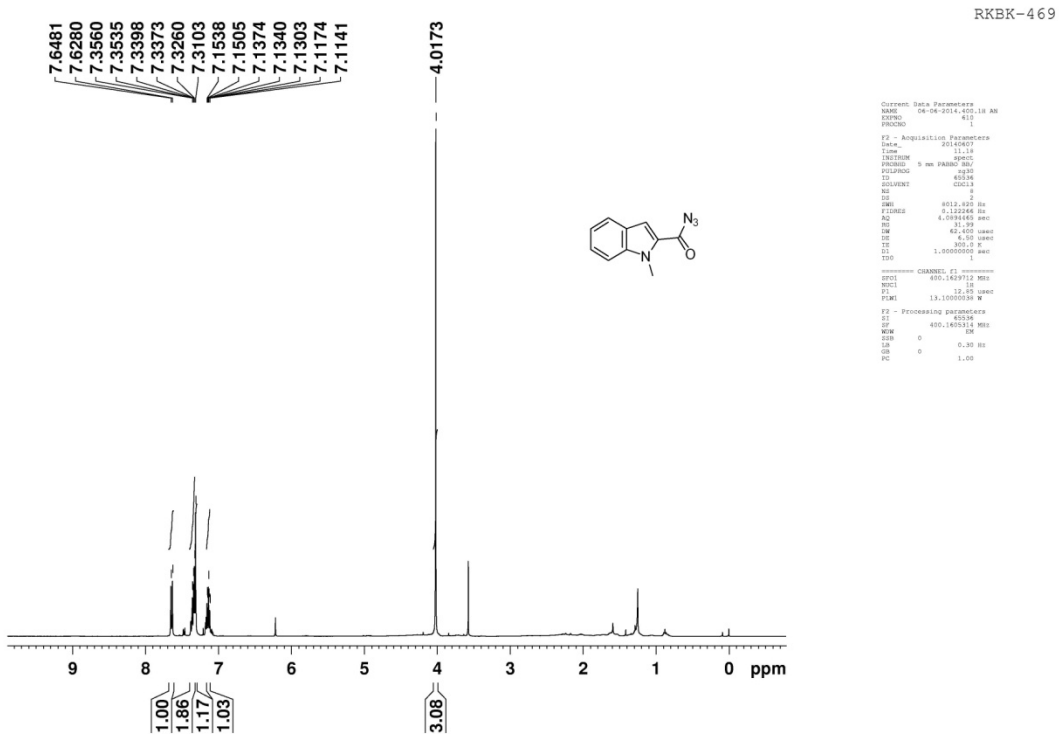


Fig. 17: ^{1}H NMR of 1l

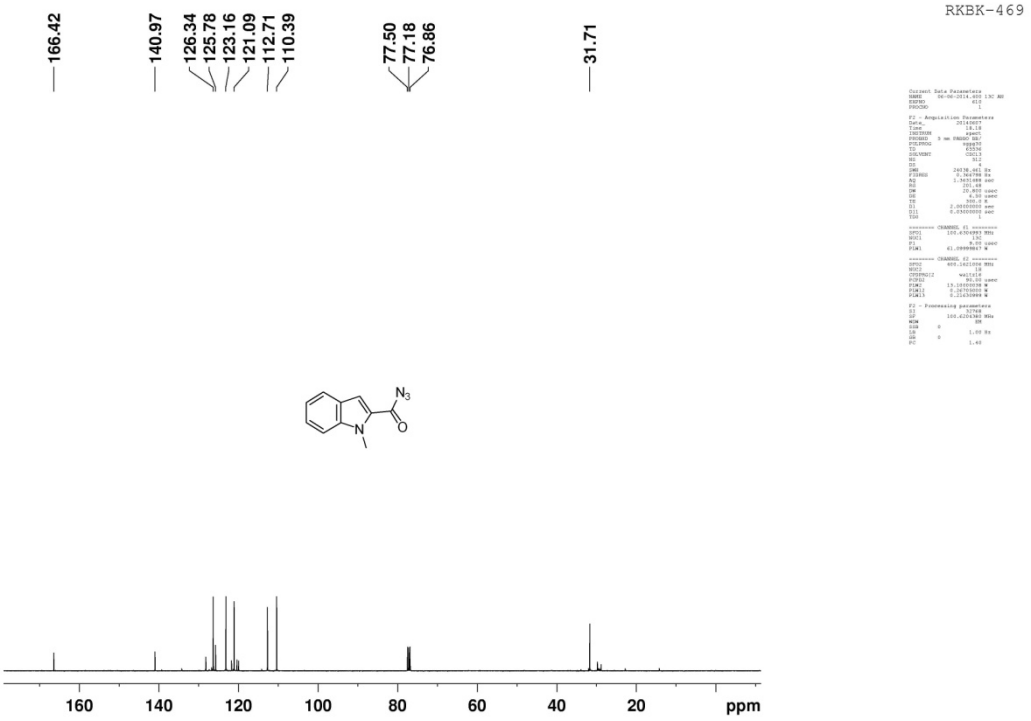


Fig. 18: ^{13}C NMR of 1l

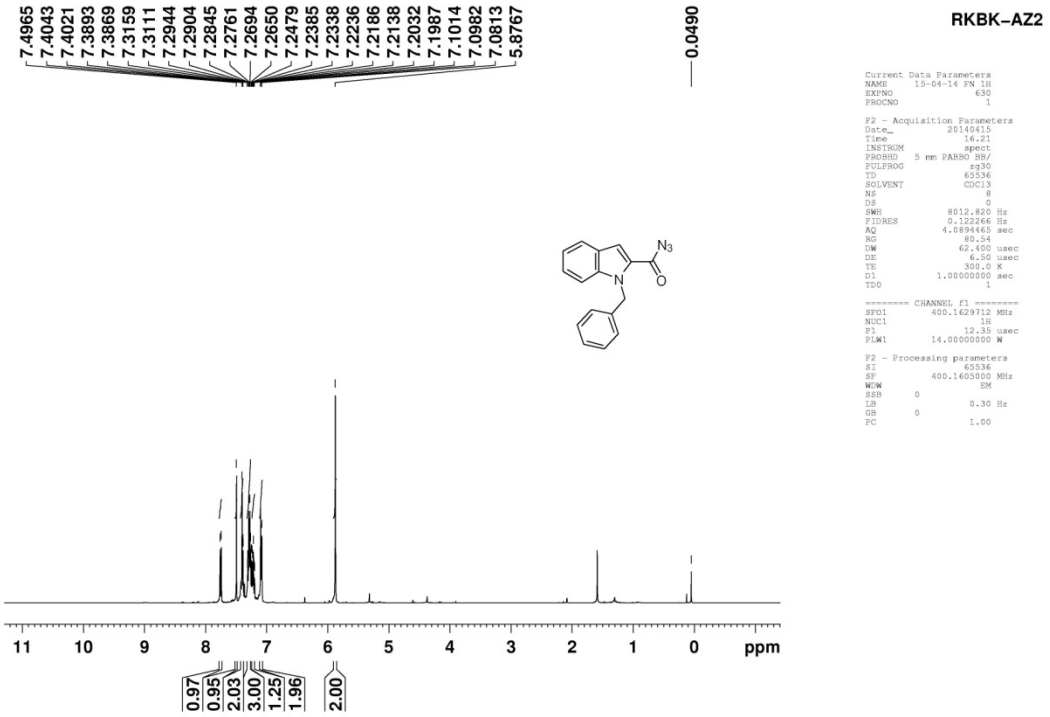


Fig. 19: ^{1}H NMR of 1m

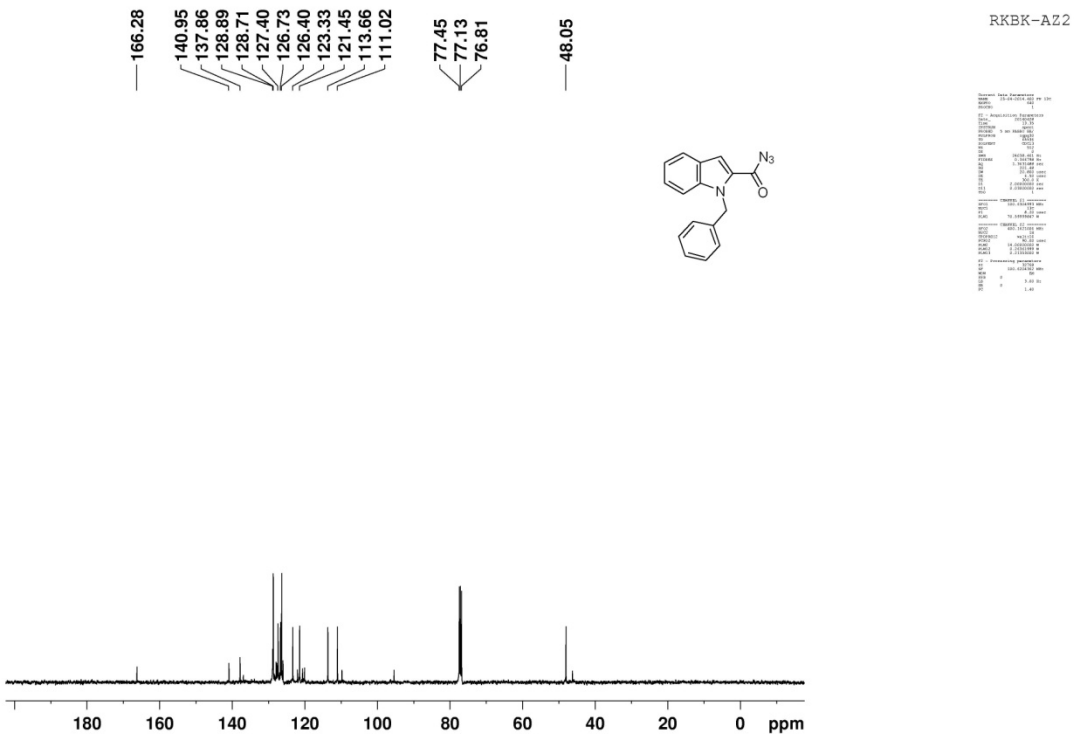


Fig. 20: ^{13}C NMR of 1m

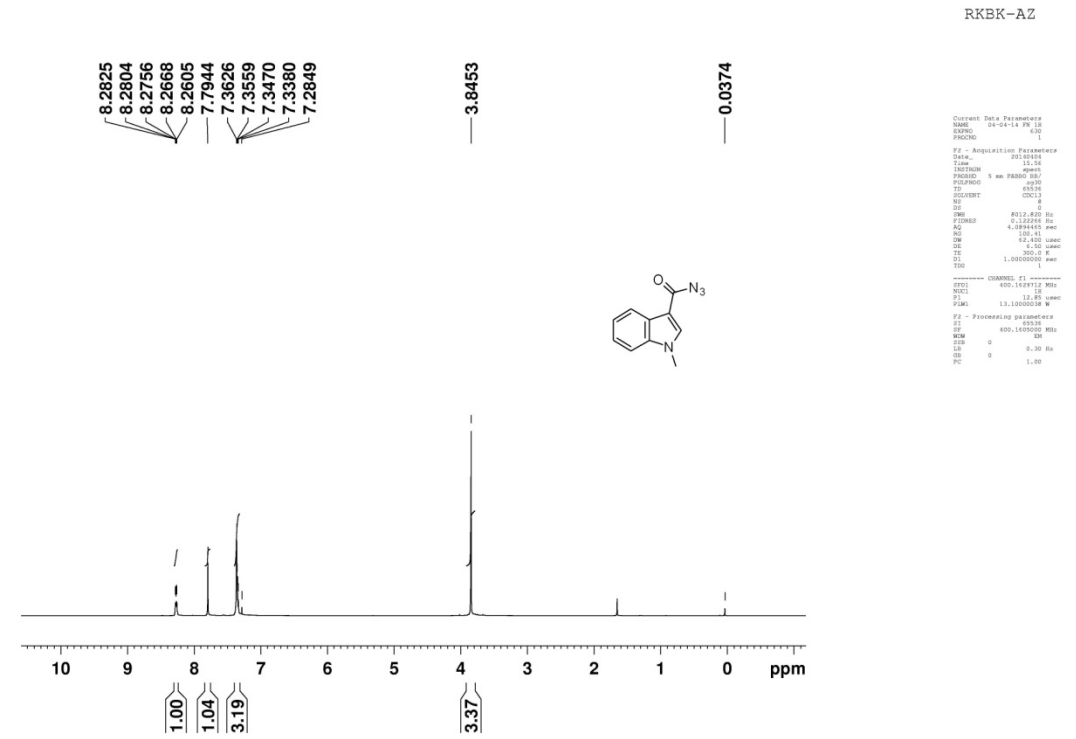


Fig. 21: ^{1}H NMR of 1n

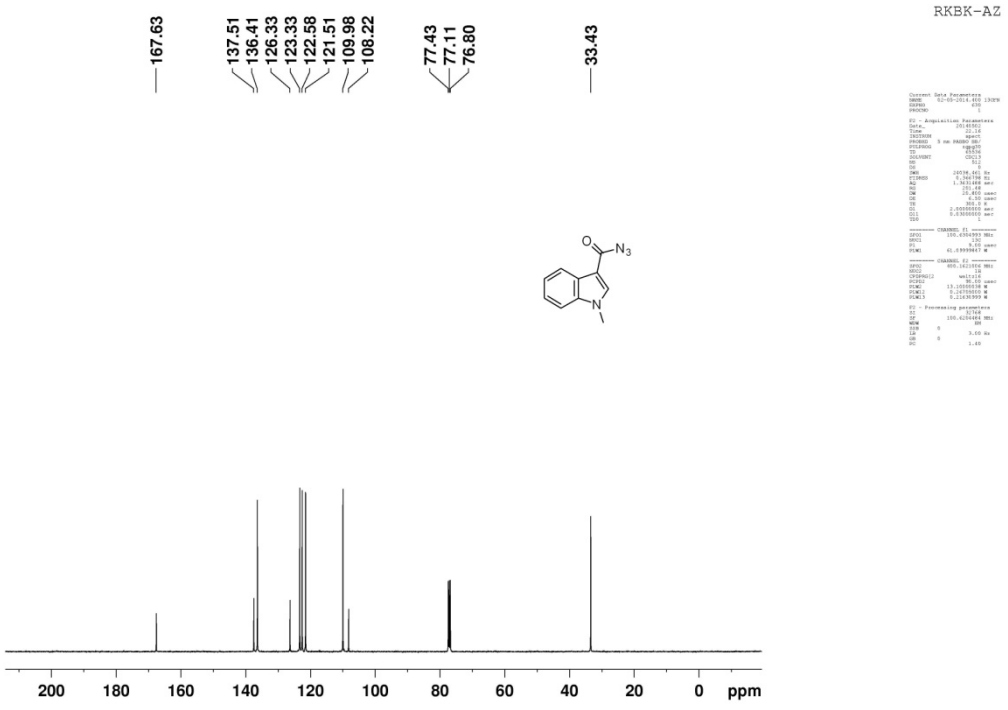


Fig. 22: ^{13}C NMR of 1n

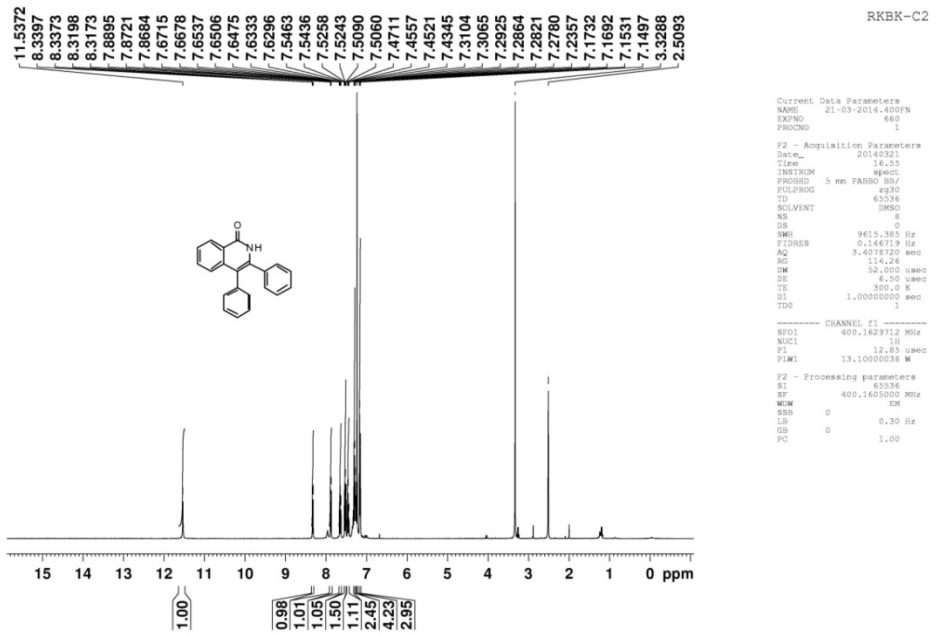


Fig. 23: ^{1}H NMR of 4aa

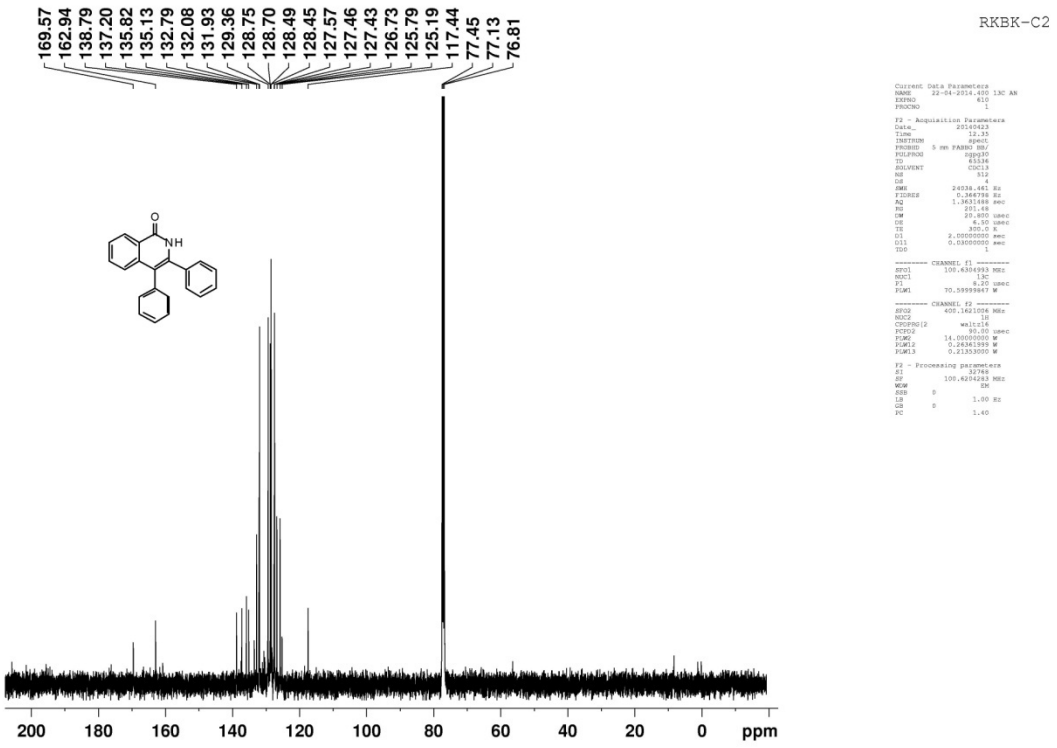


Fig. 24: ^{13}C NMR of 4aa

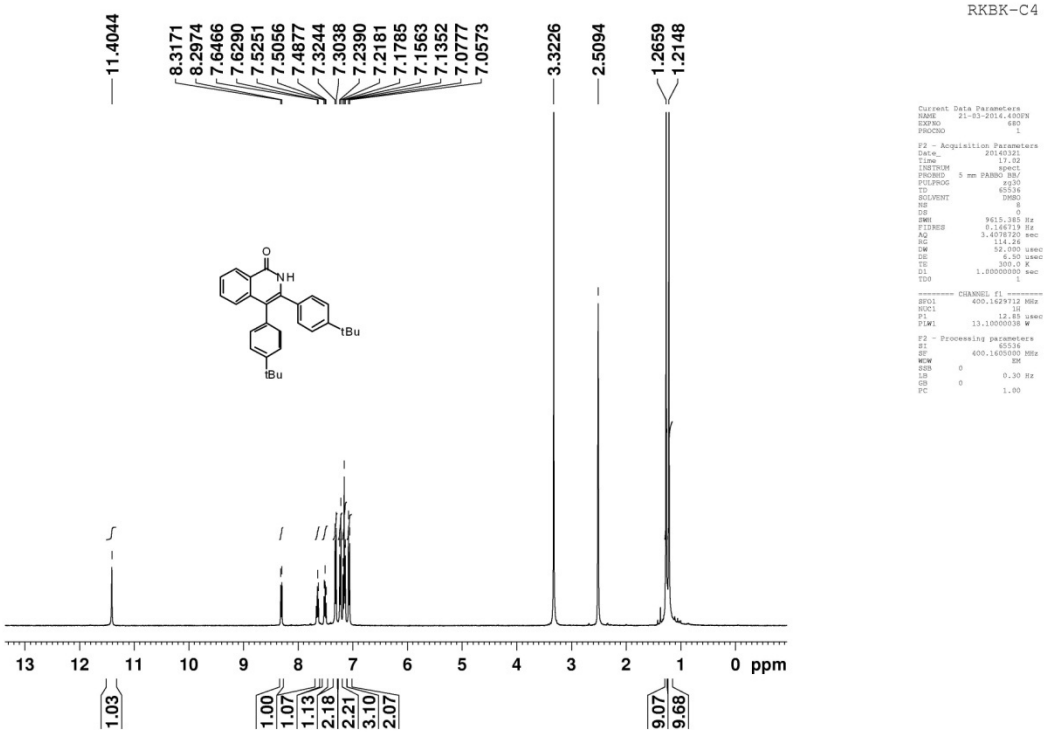


Fig. 25: ^{1}H NMR of 4ad

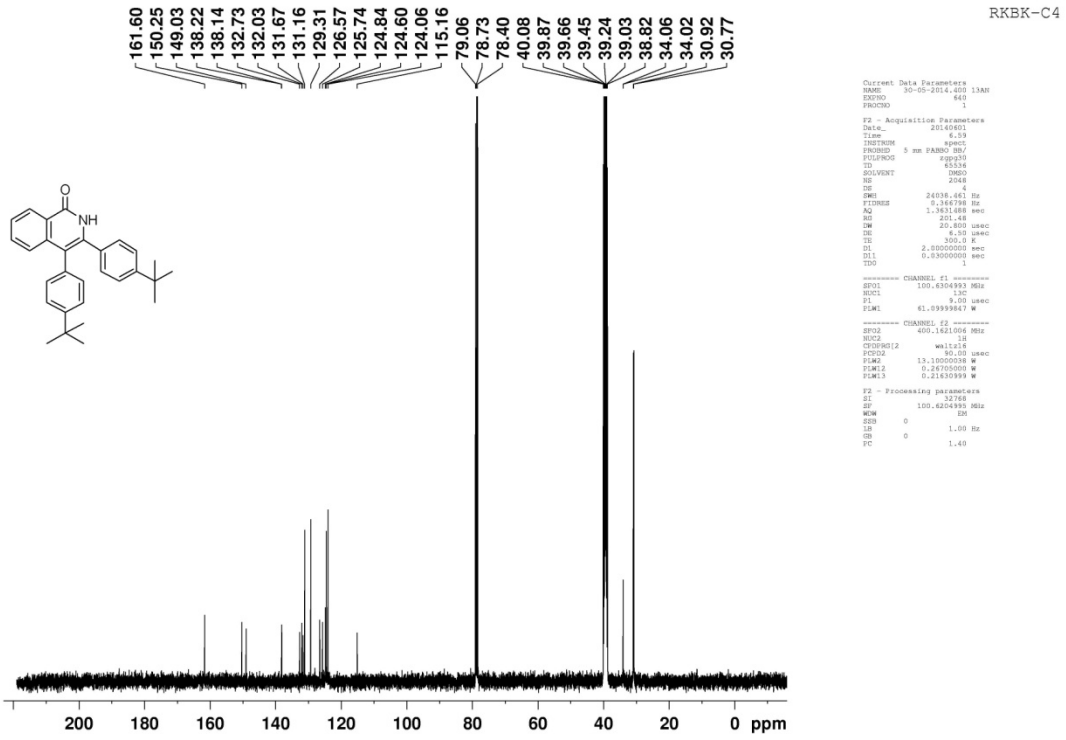


Fig. 26: ^{13}C NMR of 4ad

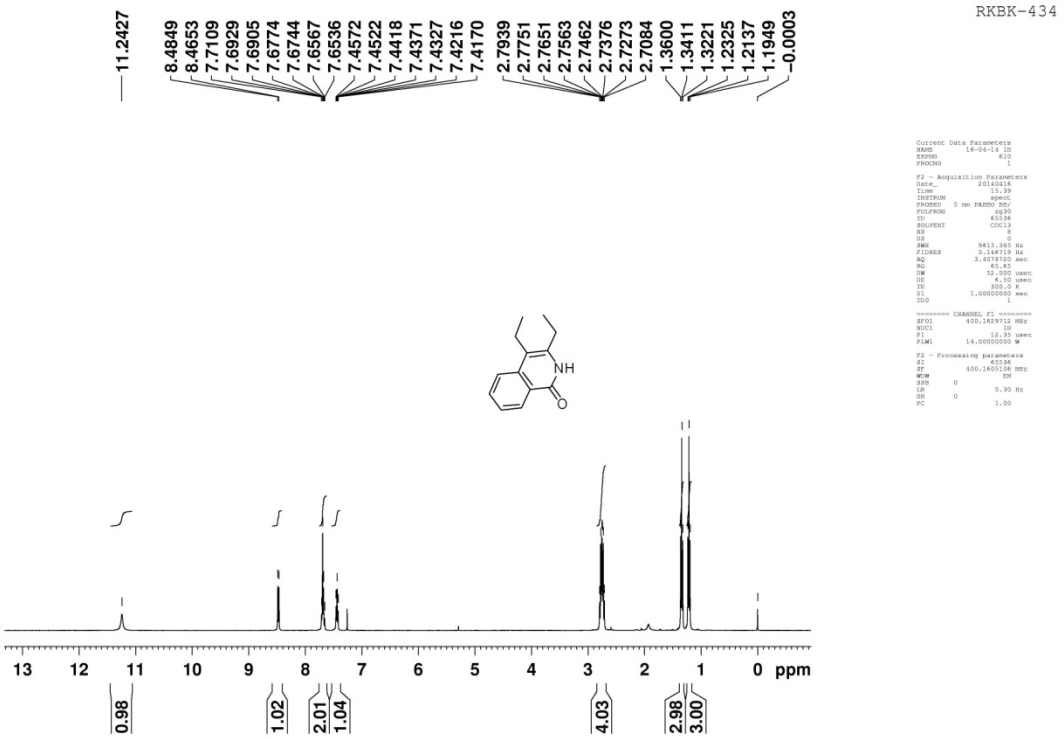


Fig. 27: ^{1}H NMR of 4ae

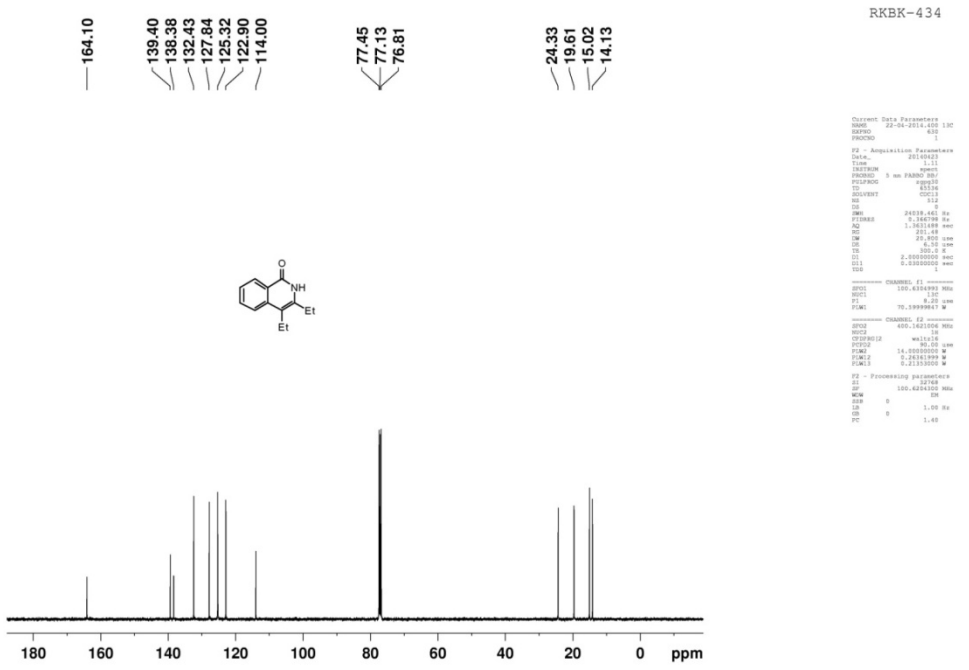


Fig. 28: ^{13}C NMR of 4ae

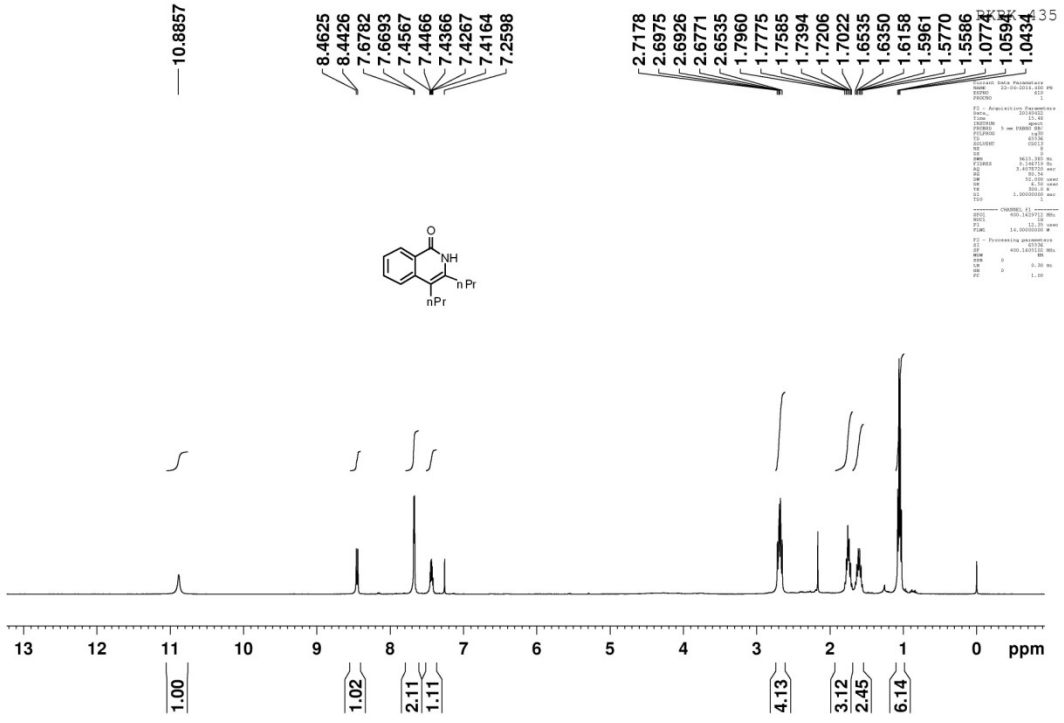


Fig. 29: ^{1}H NMR of 4af

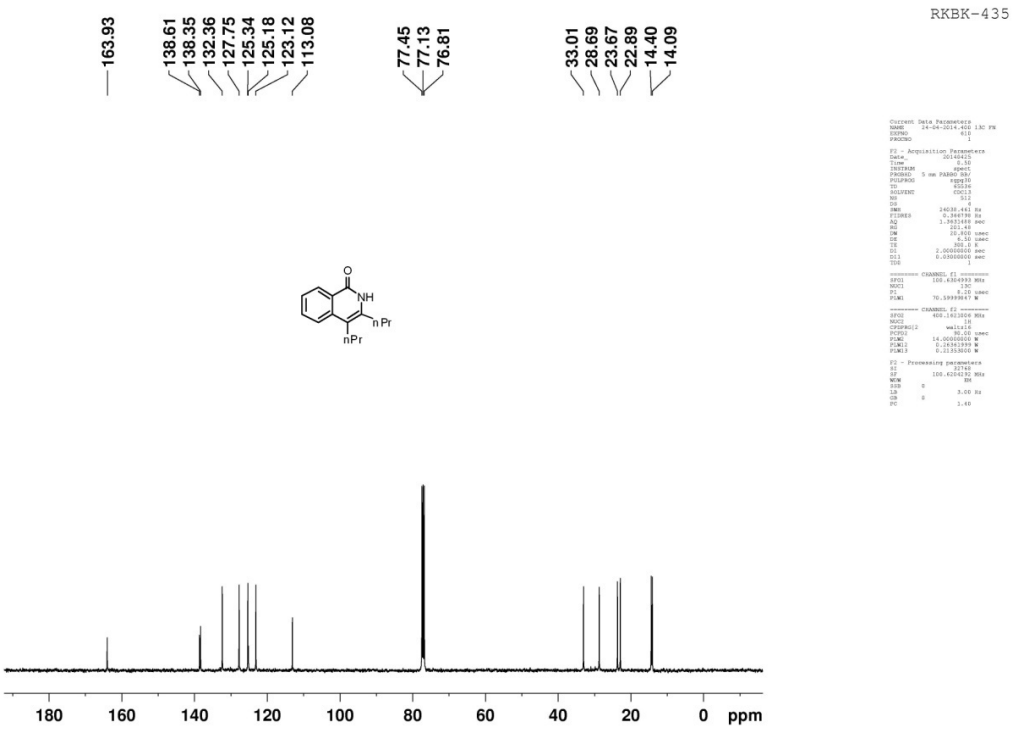


Fig. 30: ^{13}C NMR of 4af

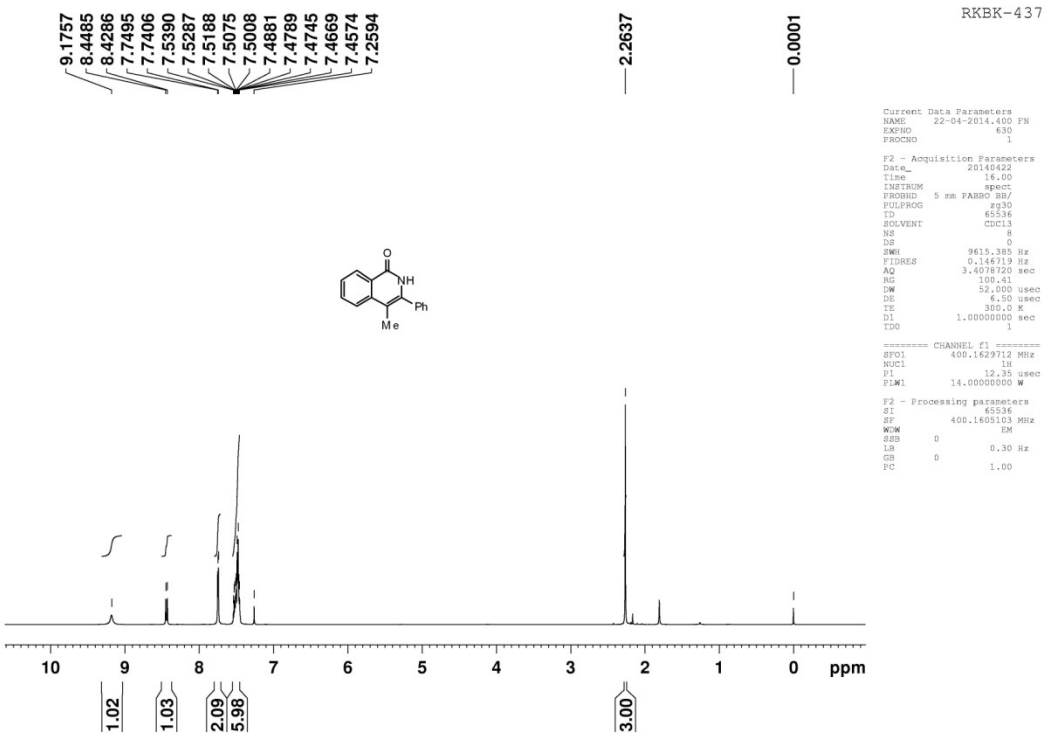


Fig. 31: ^{1}H NMR of 4ag

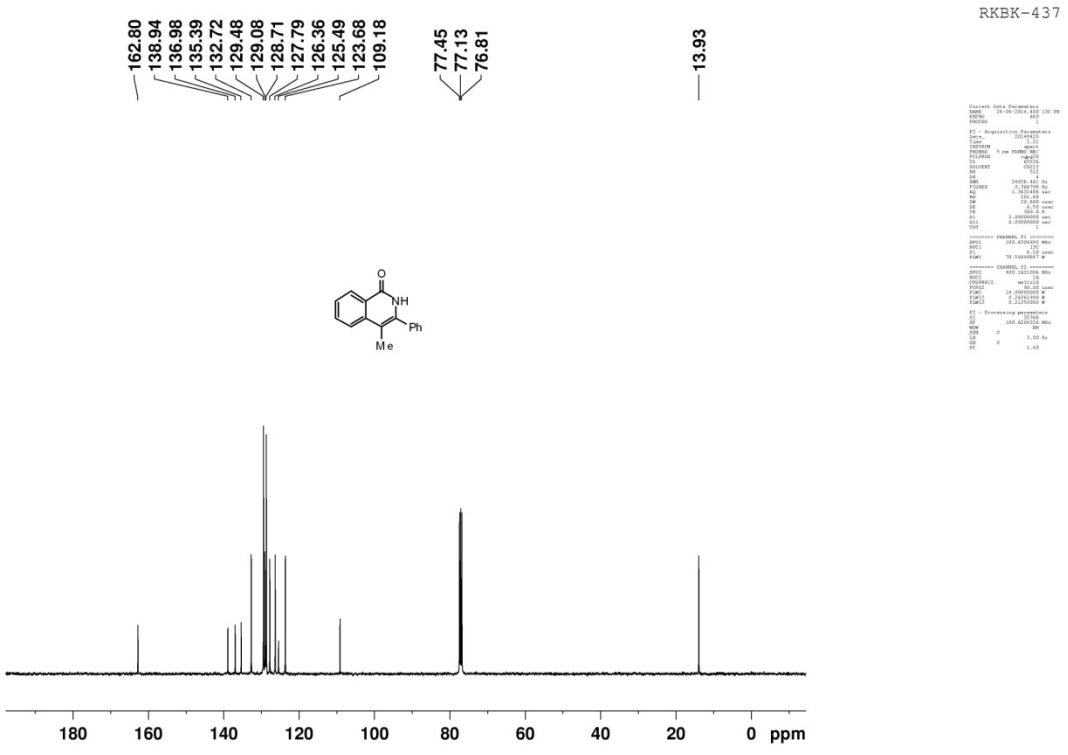


Fig. 32: ^{13}C NMR of 4ag

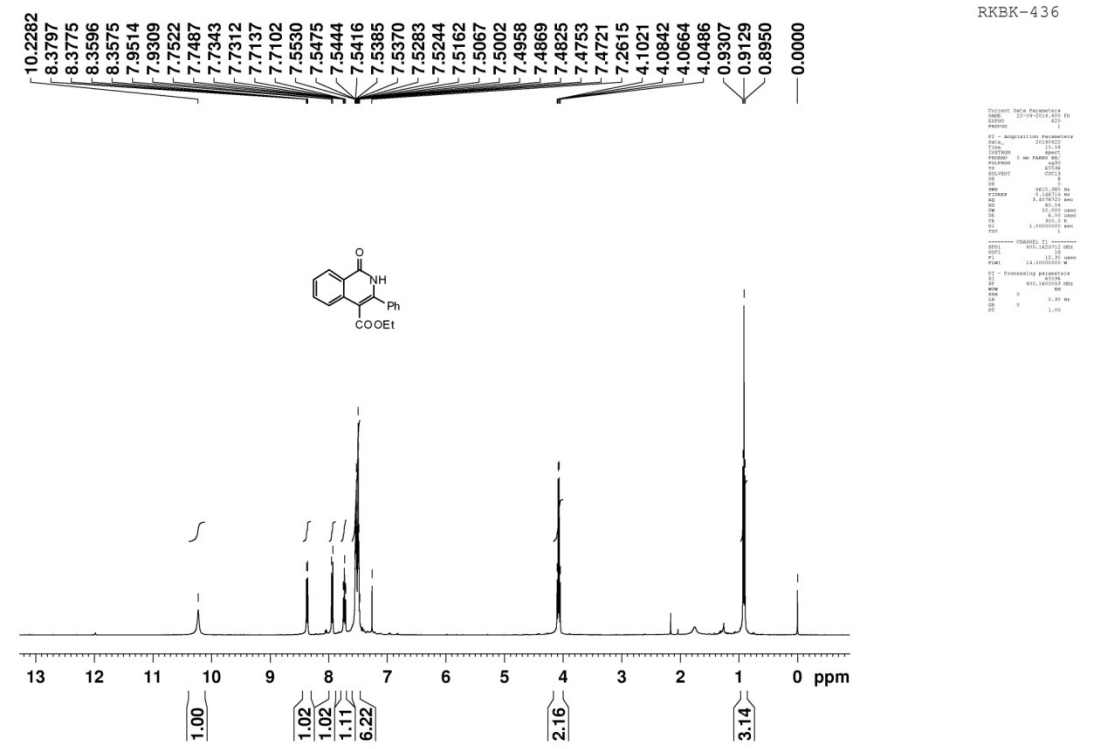


Fig. 33: ^{1}H NMR of 4ah

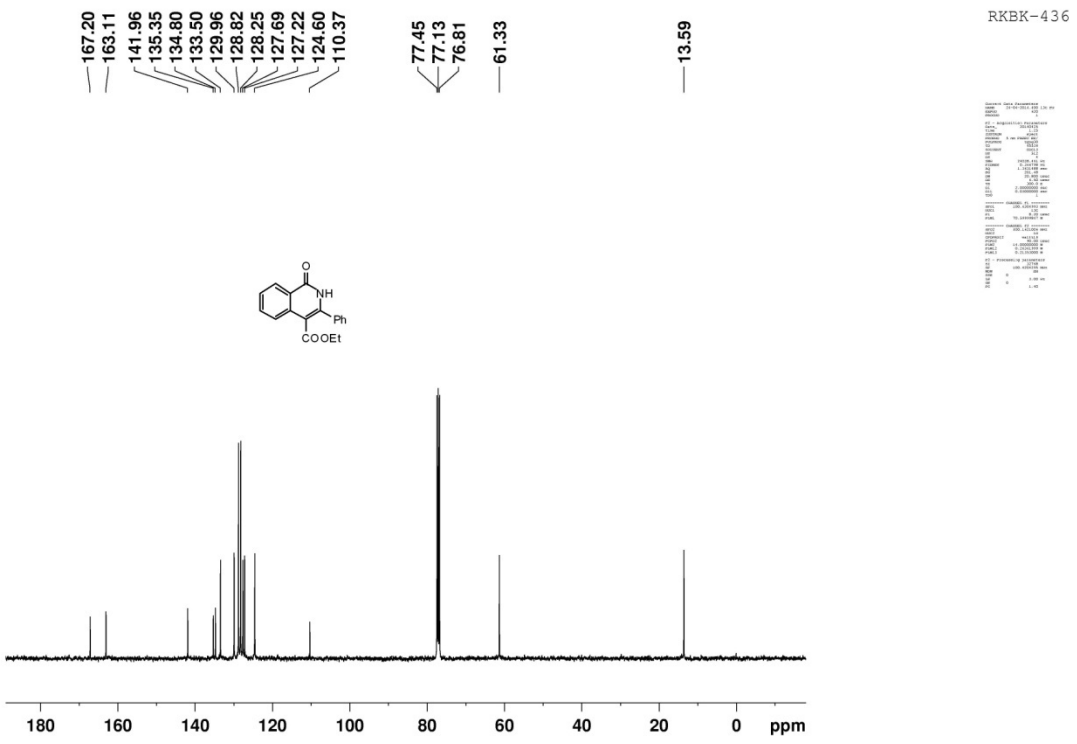


Fig. 34: ^{13}C NMR of 4ah

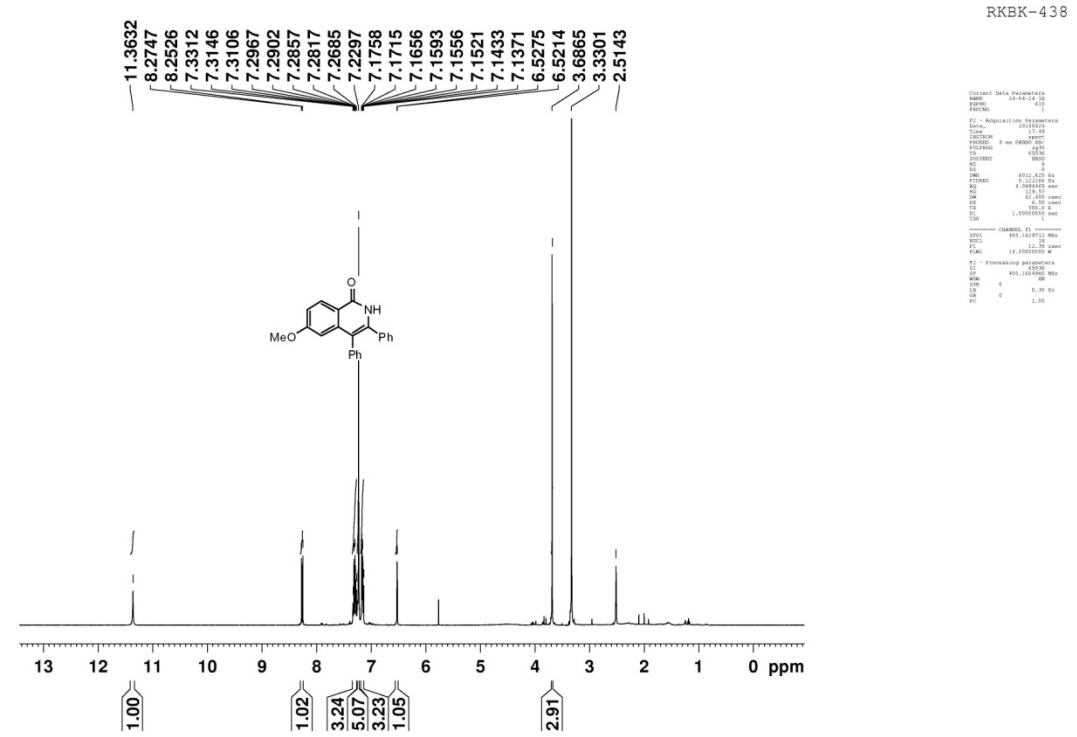


Fig. 35: ^{1}H NMR of 4ba

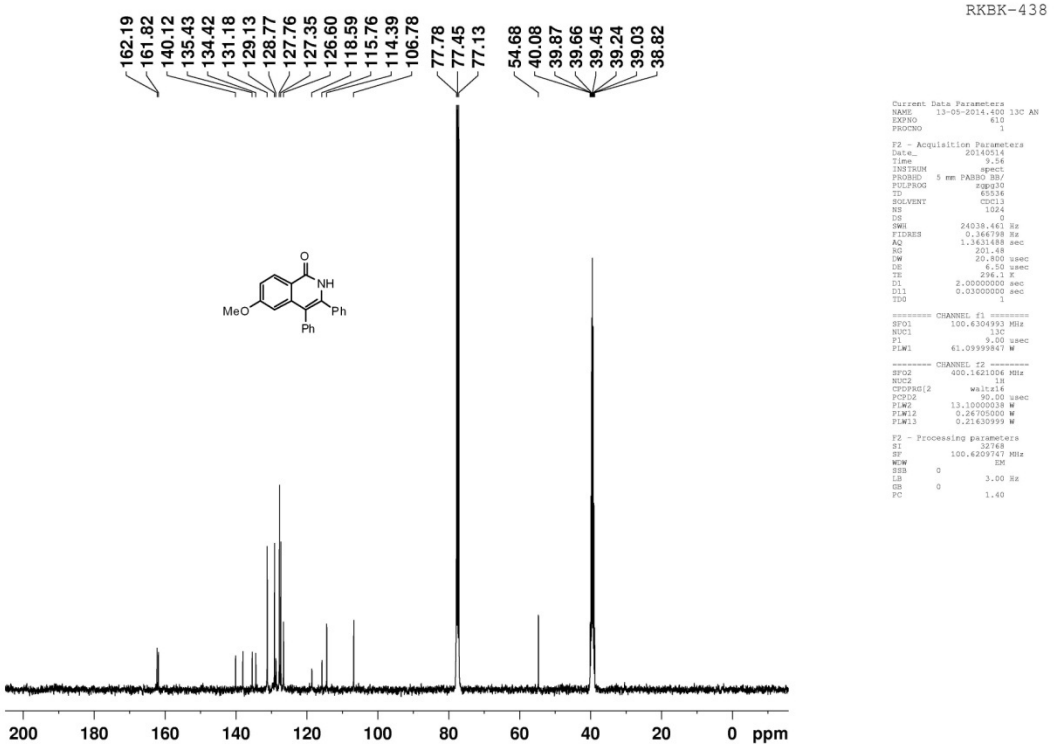


Fig. 36: ^{13}C NMR of 4ba

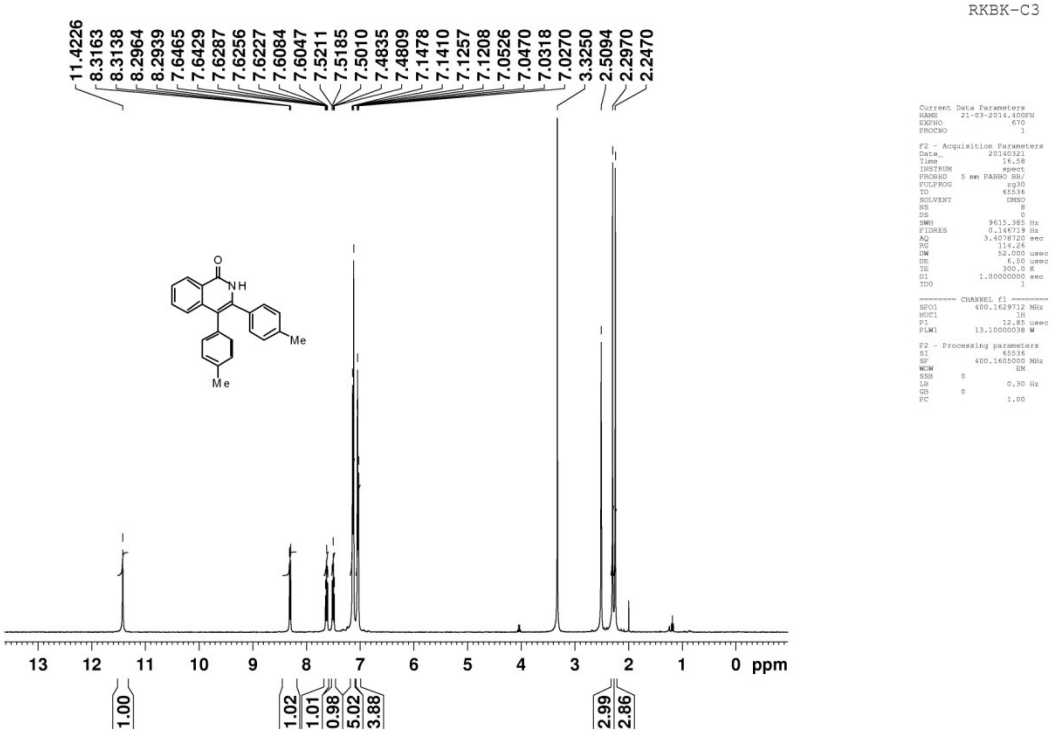


Fig. 37: ^{1}H NMR of 4ab

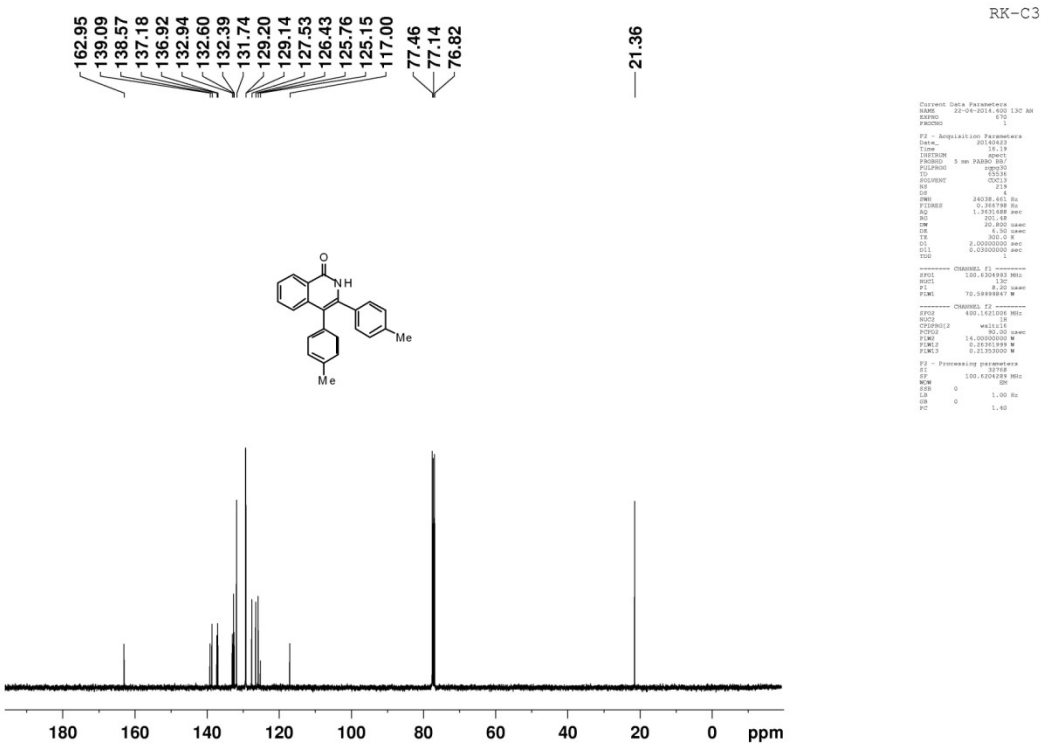


Fig. 38: ^{13}C NMR of 4ab

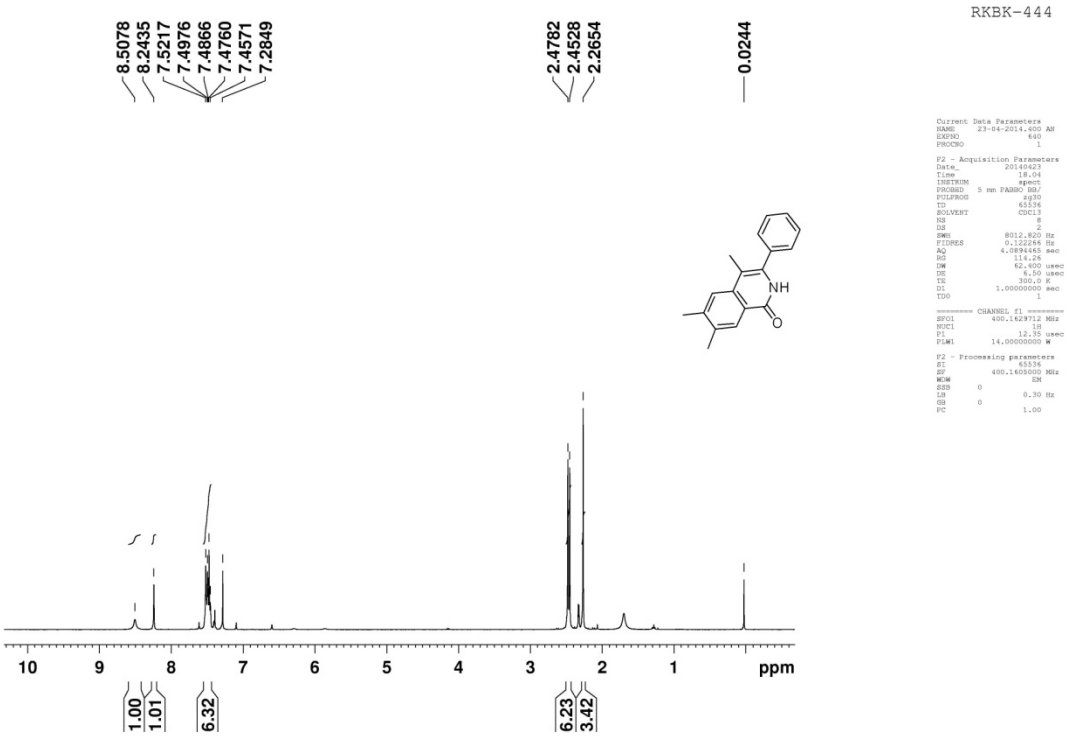


Fig. 39: ^{1}H NMR of 4bg

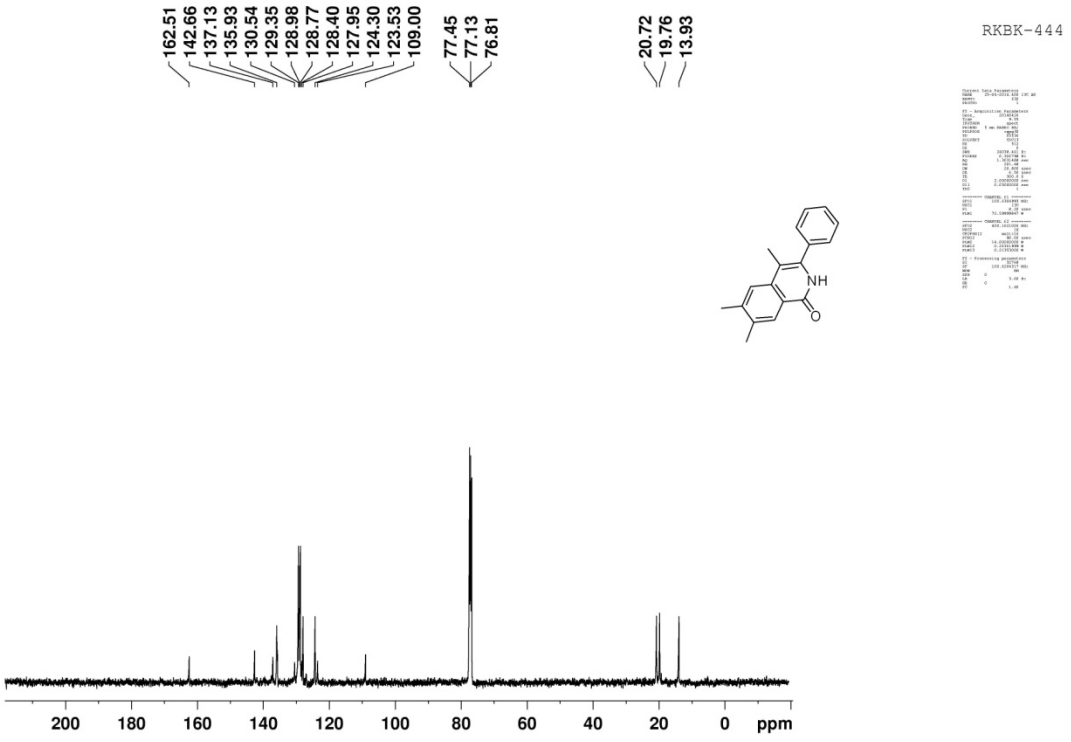


Fig. 40: ^{13}C NMR of 4bg

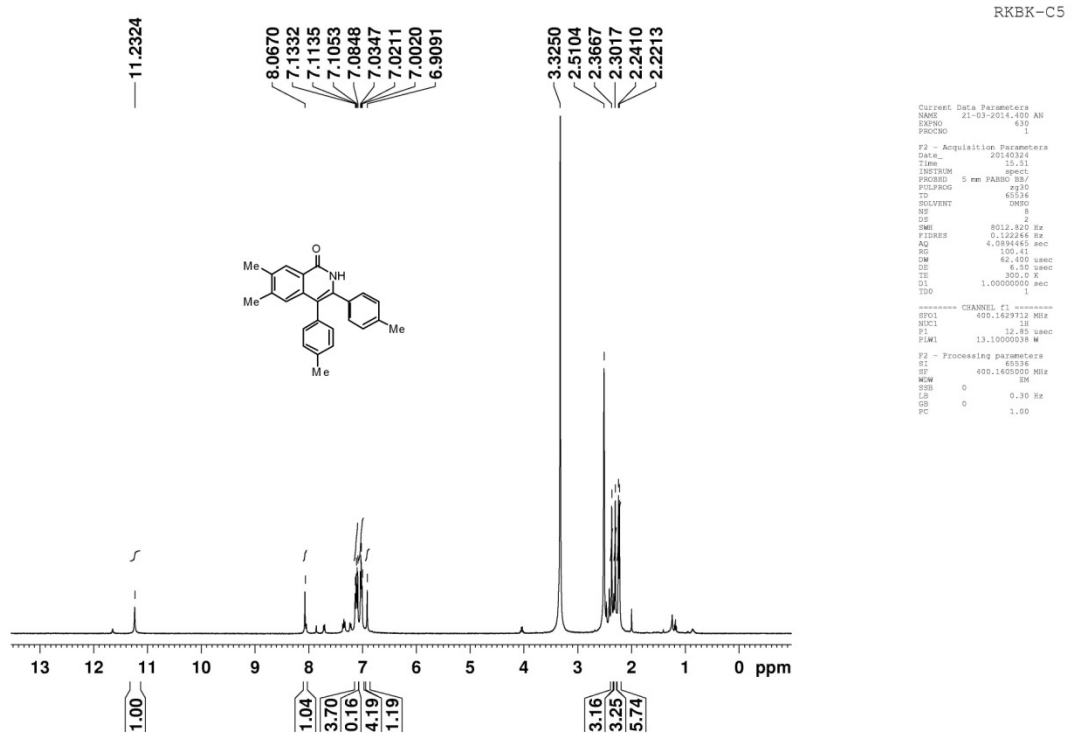


Fig. 41: ^{1}H NMR of 4cb

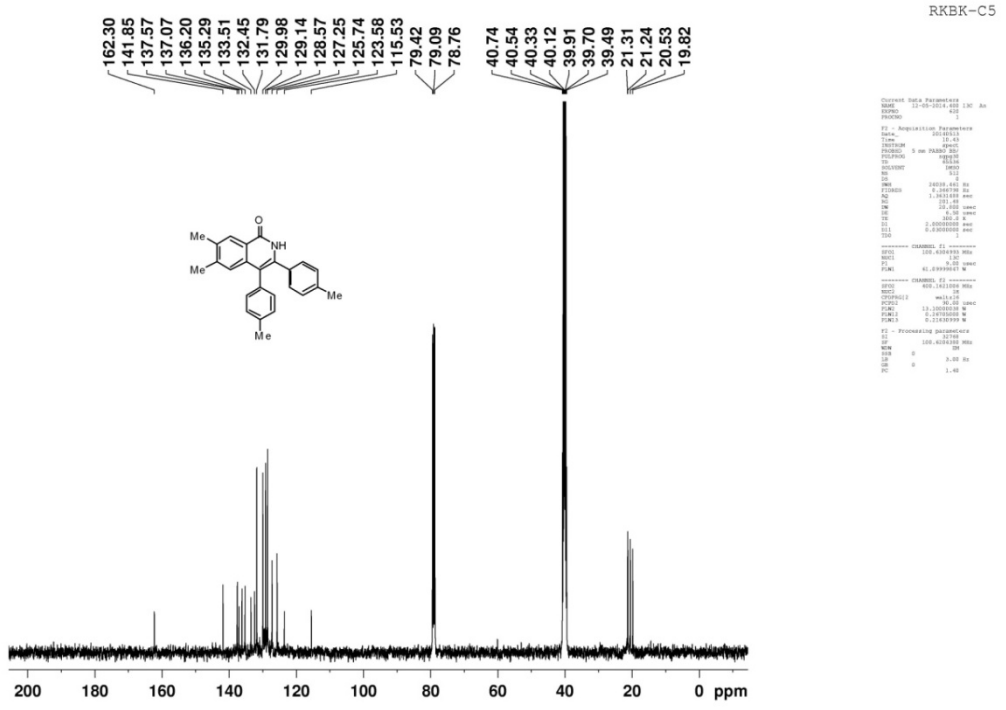


Fig. 42: ^{13}C NMR of 4cb

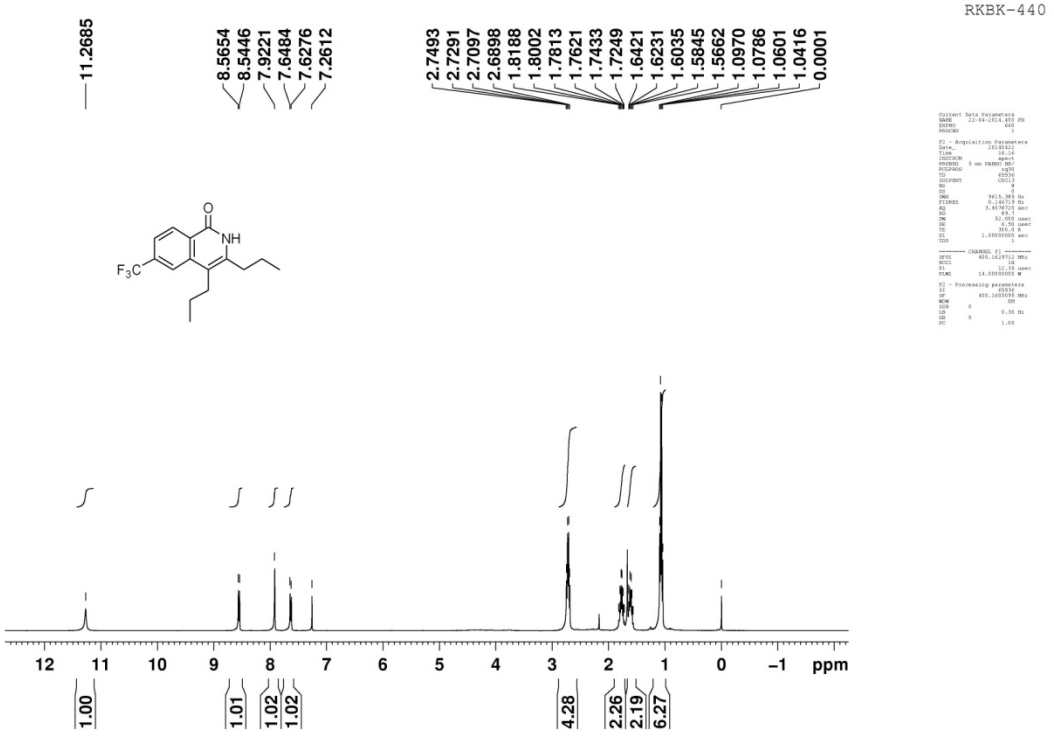


Fig. 43: ^{1}H NMR of 4cf

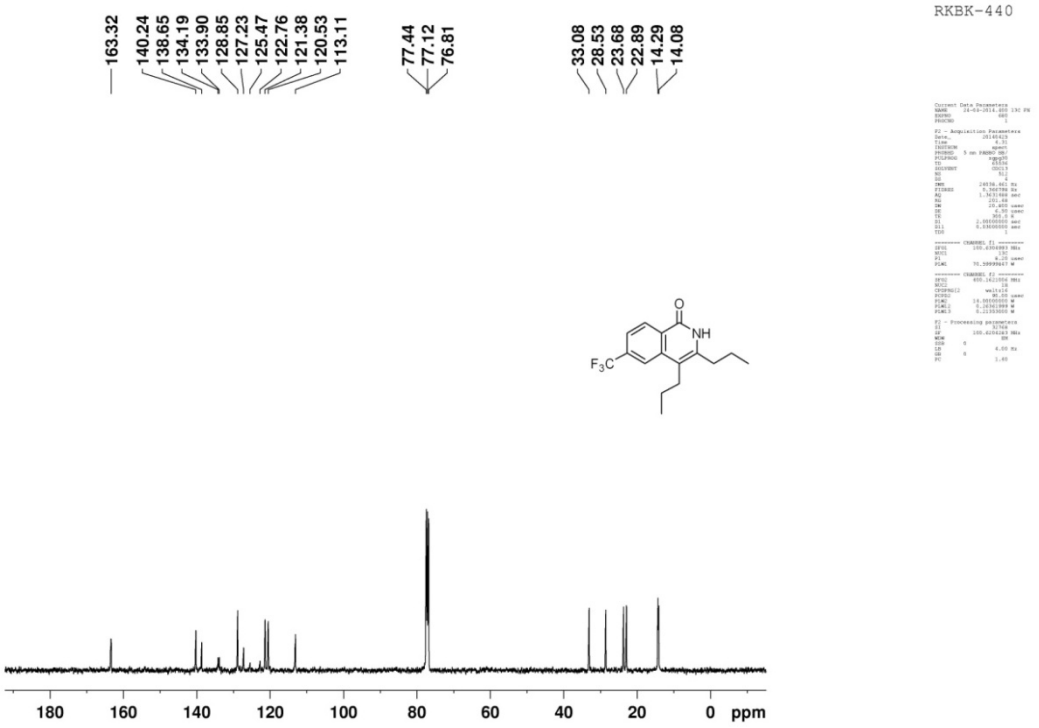


Fig. 44: ^{13}C NMR of 4cf

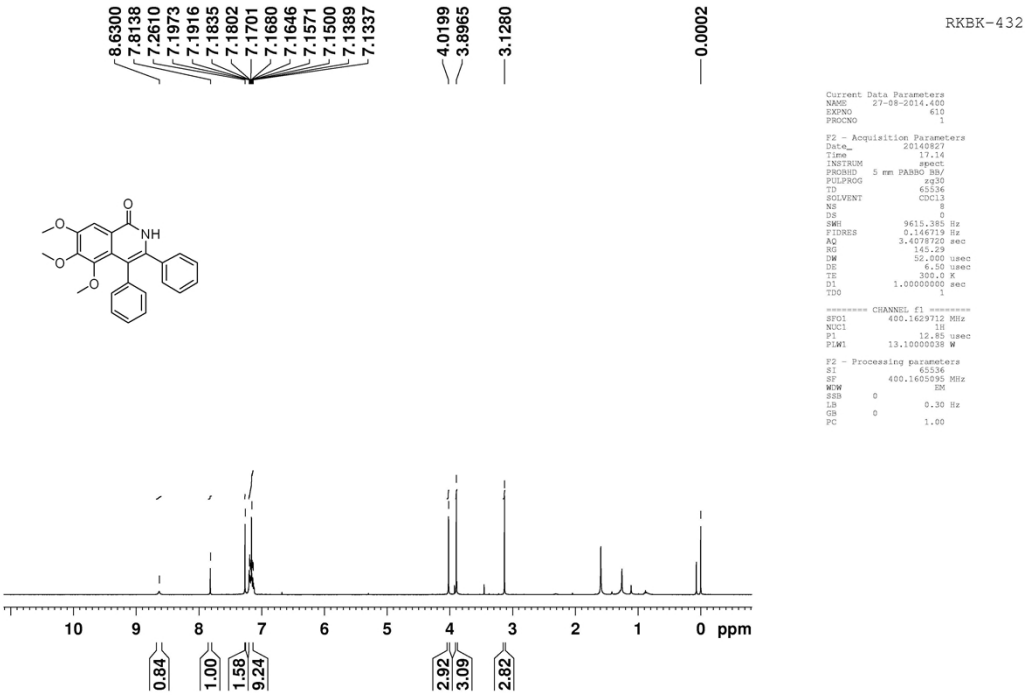


Fig. 45: ^{1}H NMR of 4da

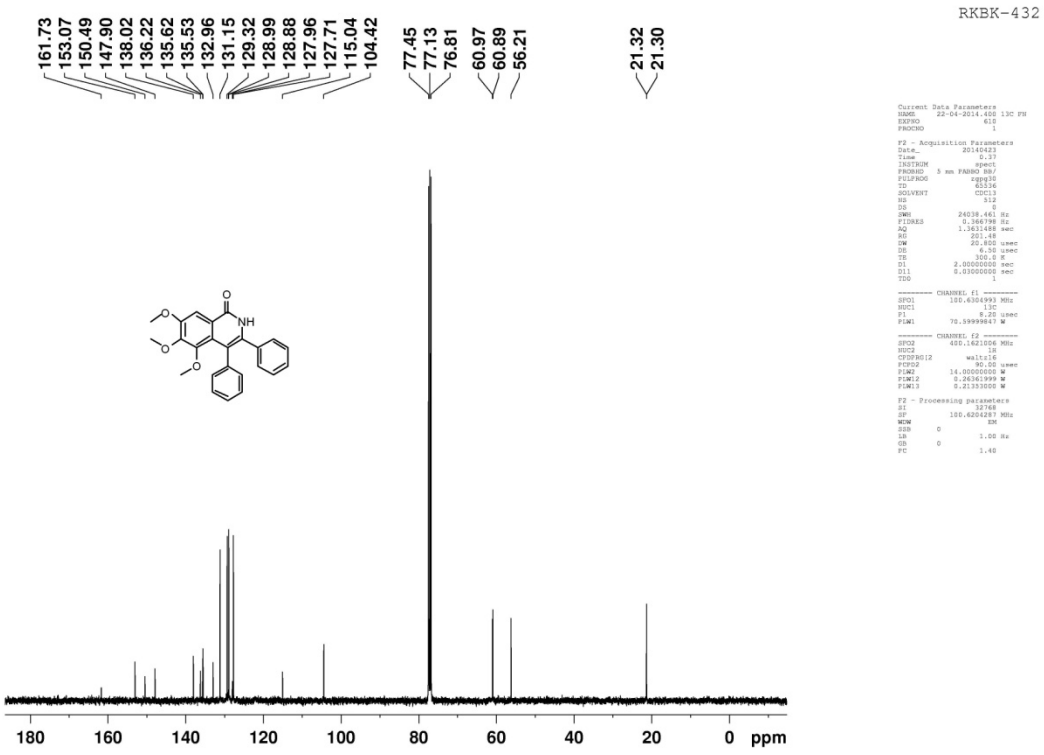


Fig. 46: ^{13}C NMR of 4da

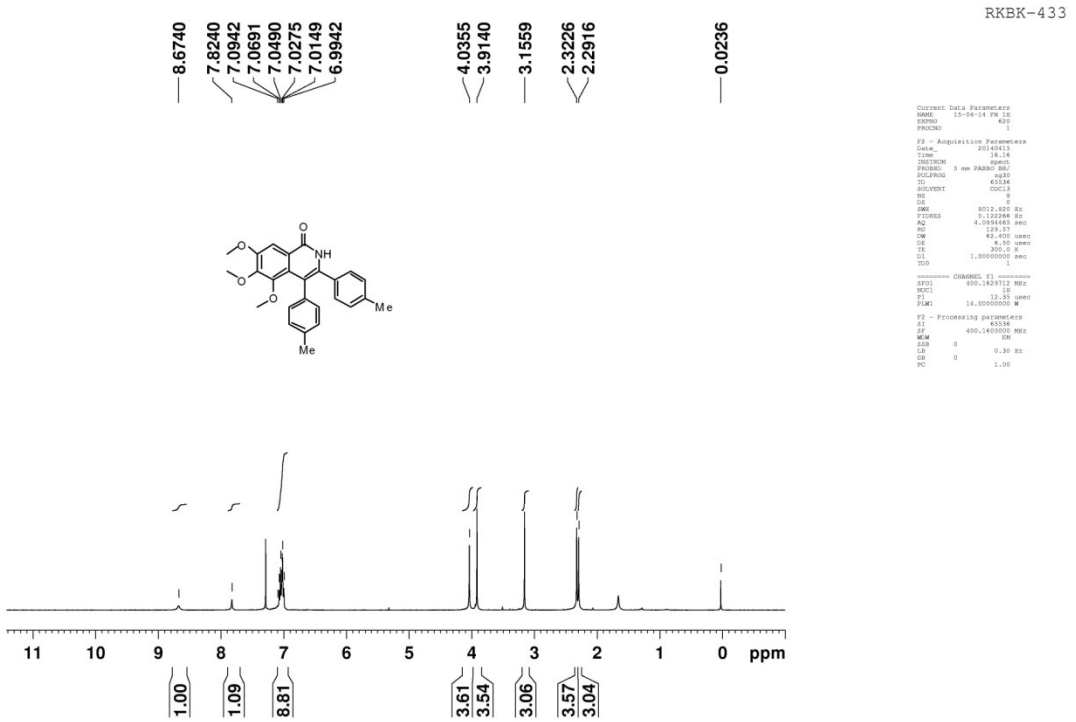


Fig. 47: ^{1}H NMR of 4db

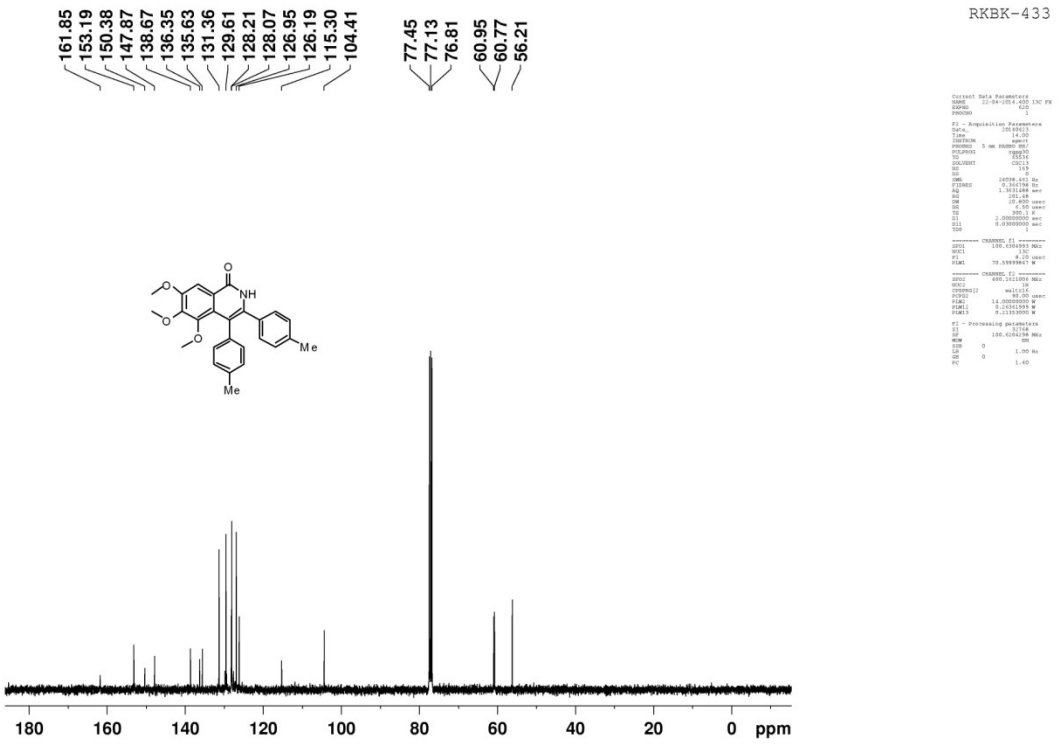


Fig. 48: ^{1}H NMR of 4db

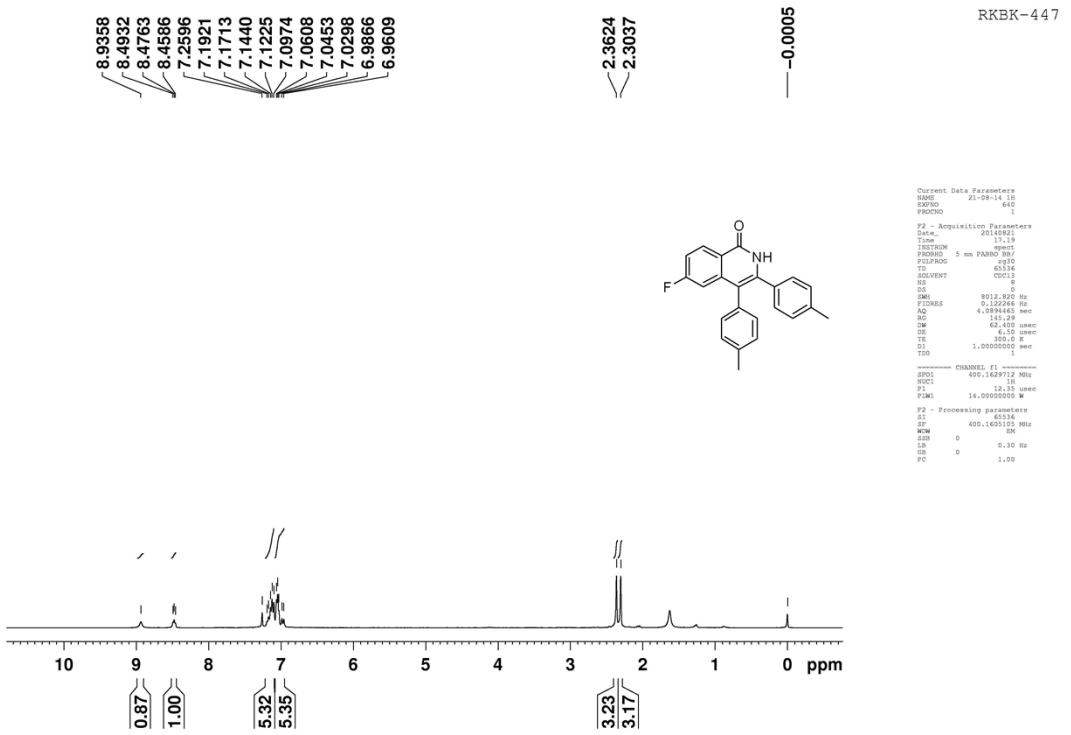


Fig. 49: ^{1}H NMR of 4eb

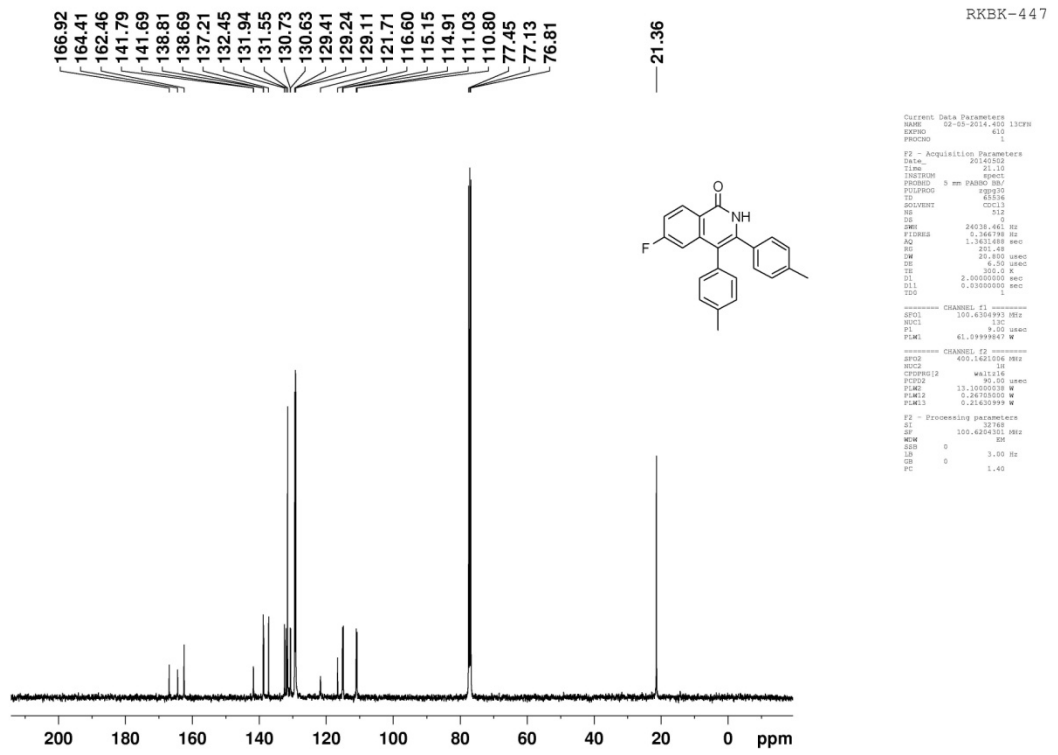


Fig. 50: ^{13}C NMR of 4eb

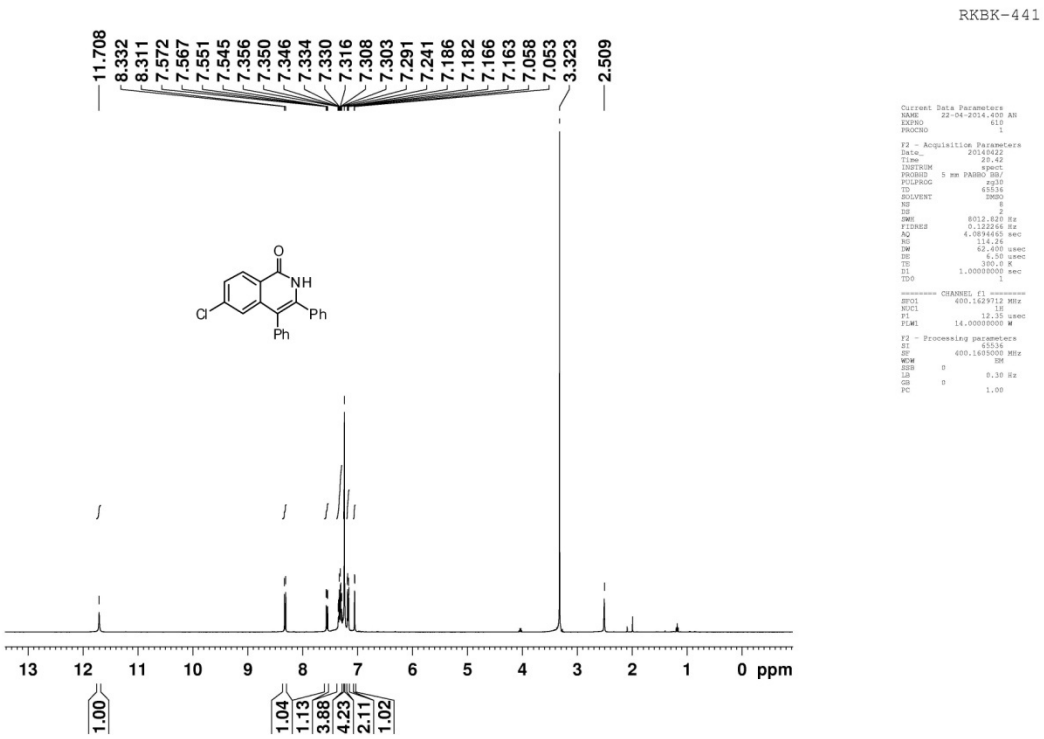


Fig. 51: ^{1}H NMR of 4fa

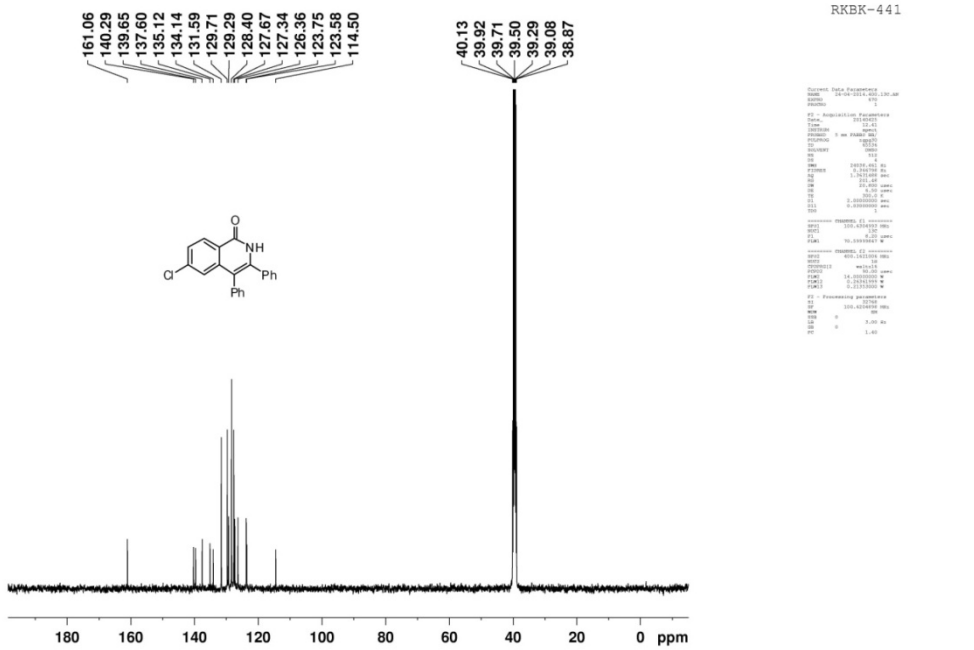


Fig. 52: ^{13}C NMR of 4fa

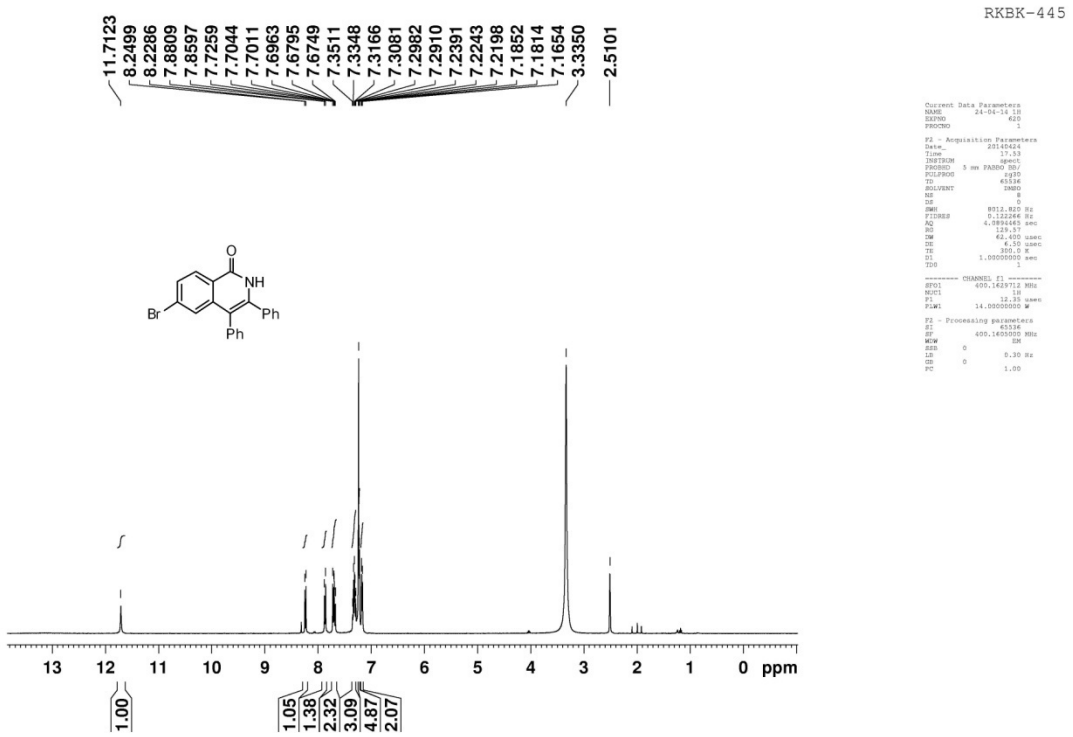


Fig. 53: ^{1}H NMR of 4ga

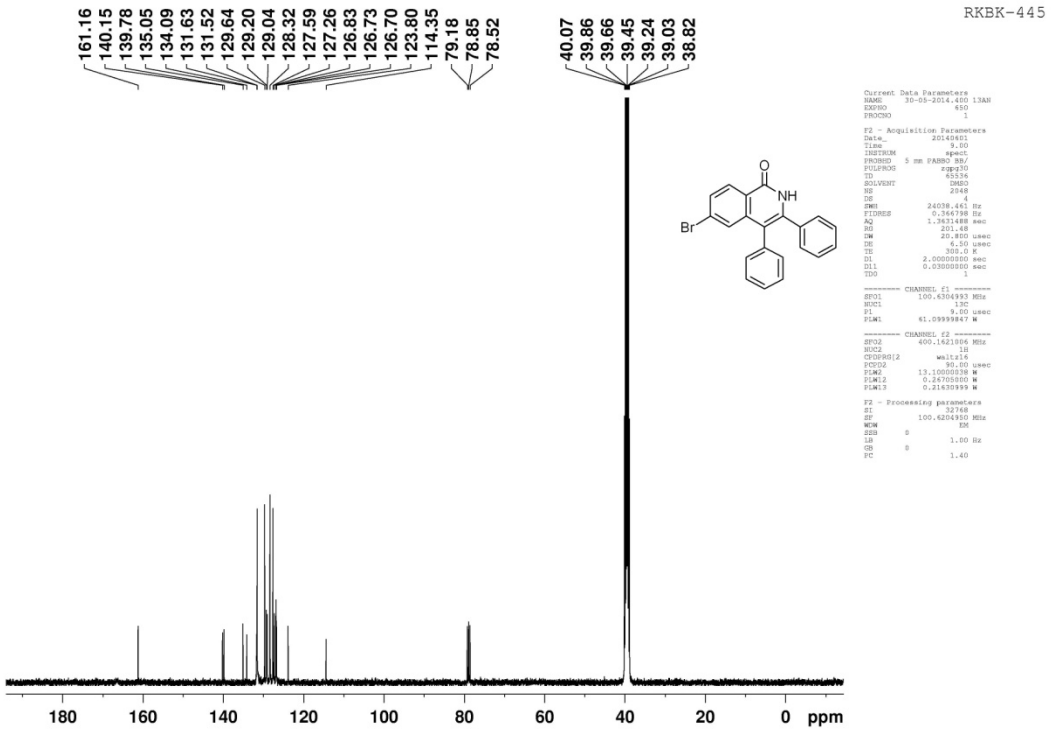


Fig. 54: ^{13}C NMR of 4ga

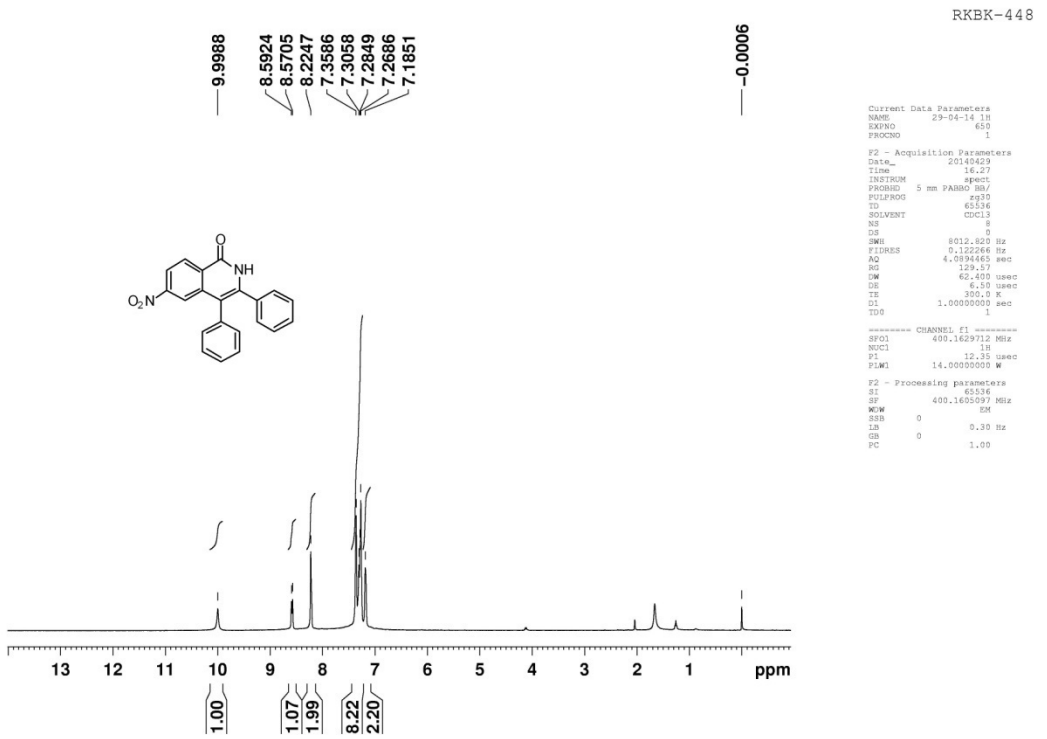


Fig. 55: ^{1}H NMR of 4ha

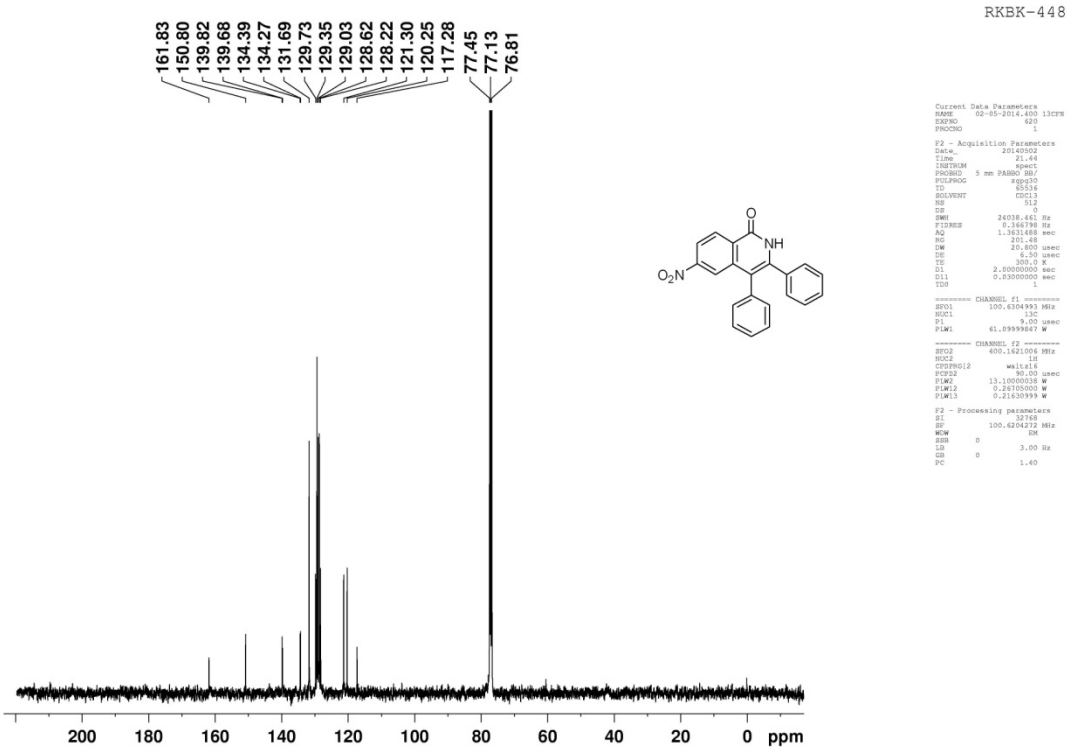


Fig. 56: ^{13}C NMR of 4ha

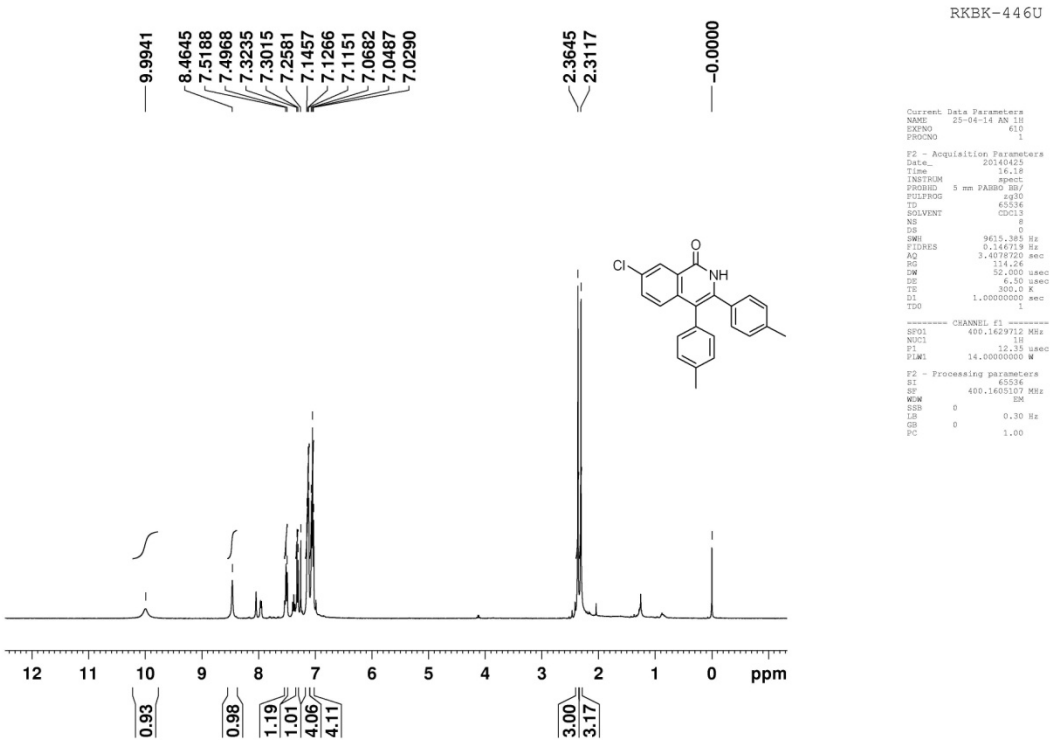


Fig. 57: ^{1}H NMR of 4ha

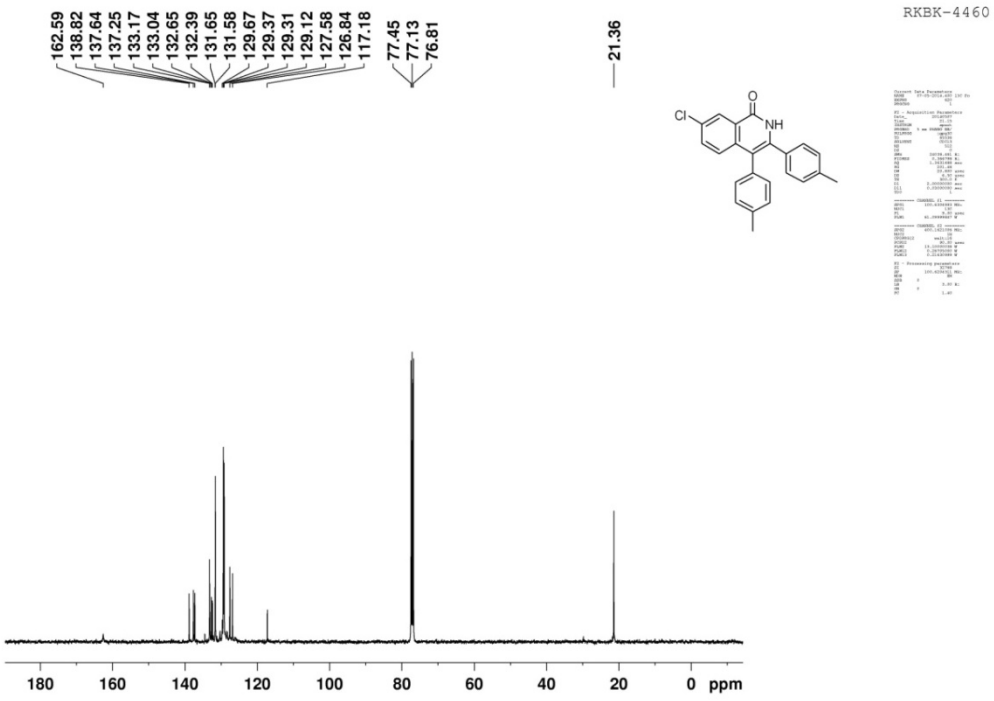


Fig. 58: ^{13}C NMR of 4ib

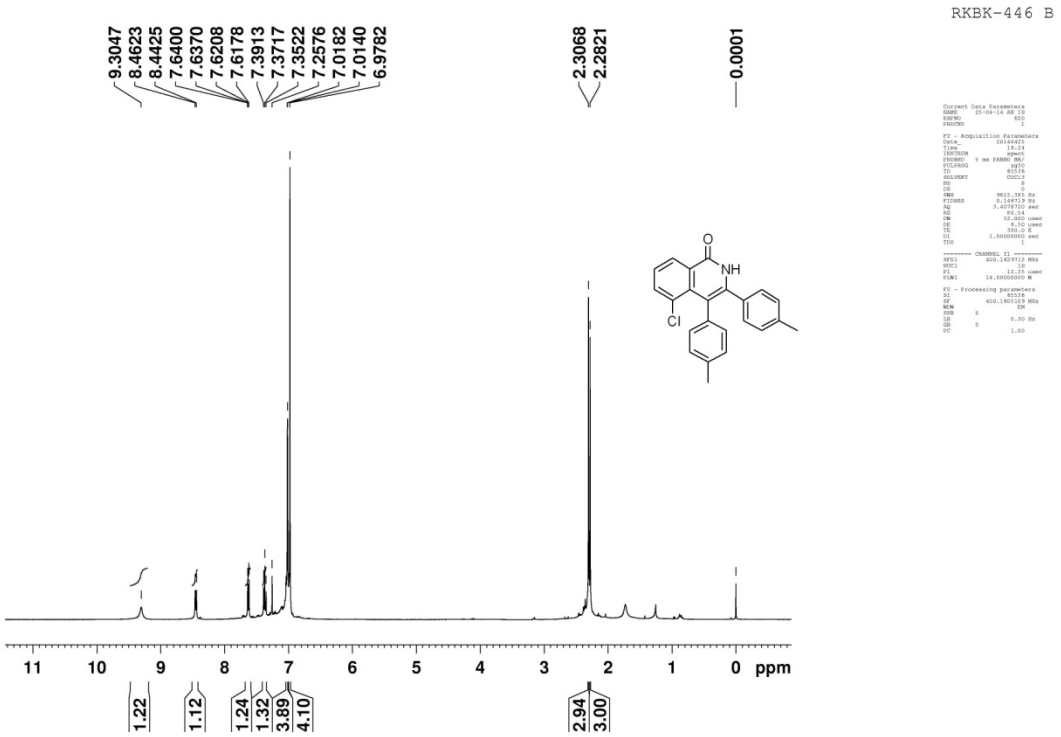


Fig. 59: ^{1}H NMR of 4ib

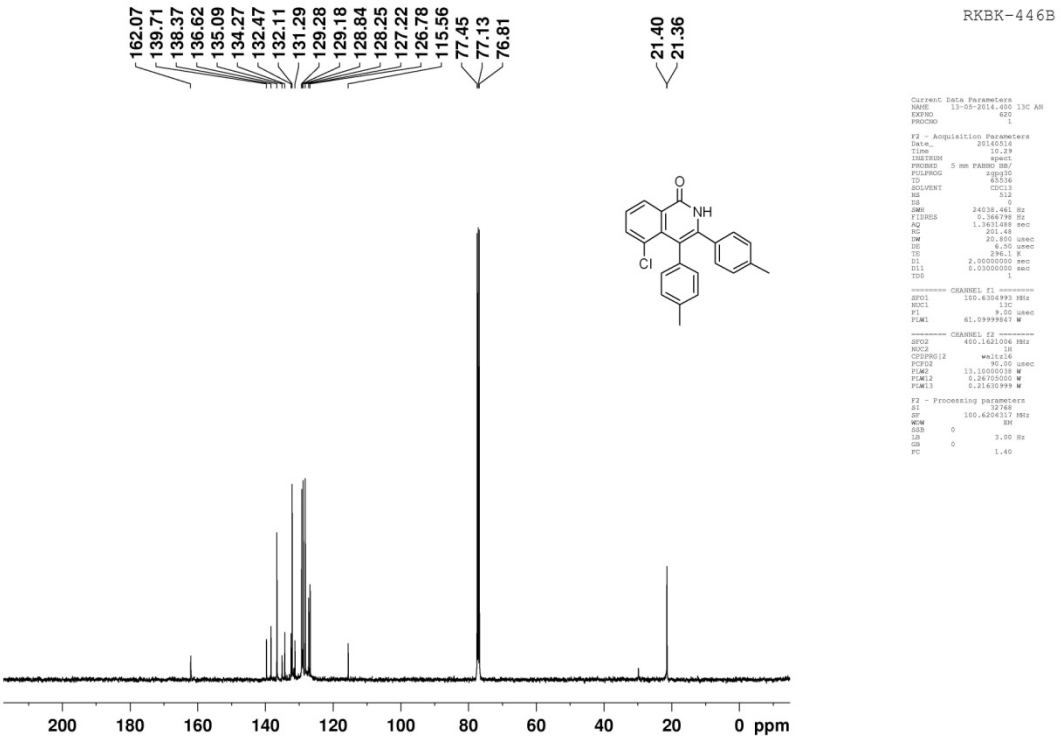


Fig. 60: ^{13}C NMR of 4ib

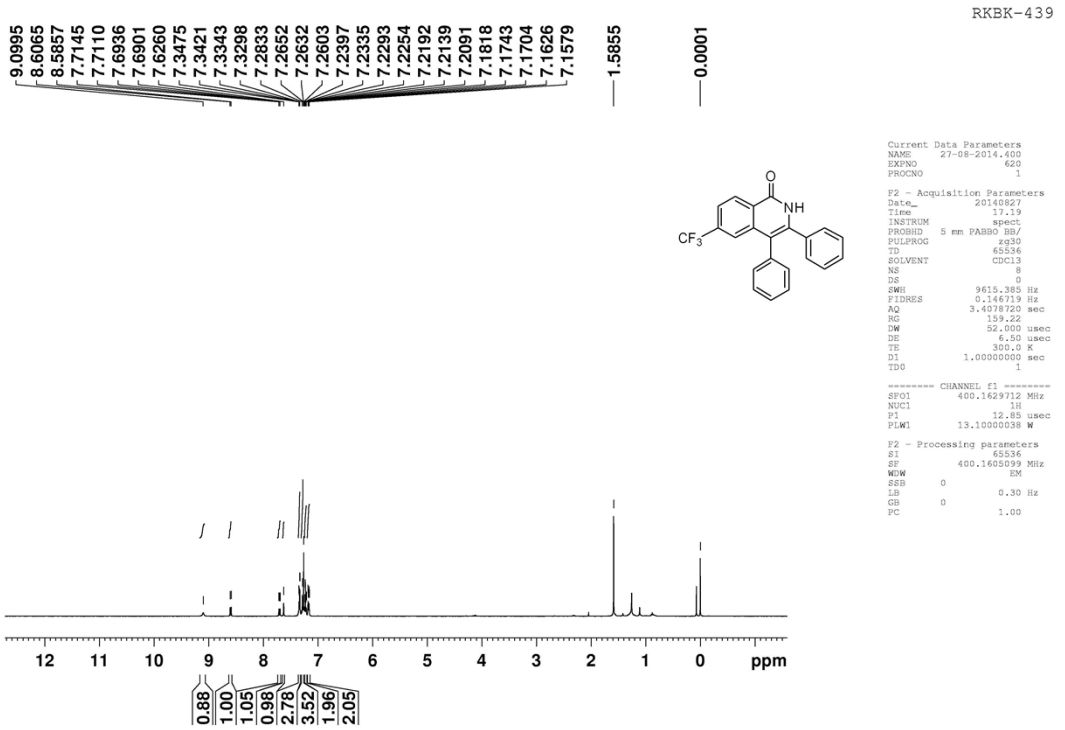


Fig. 61: ^{1}H NMR of 4ja

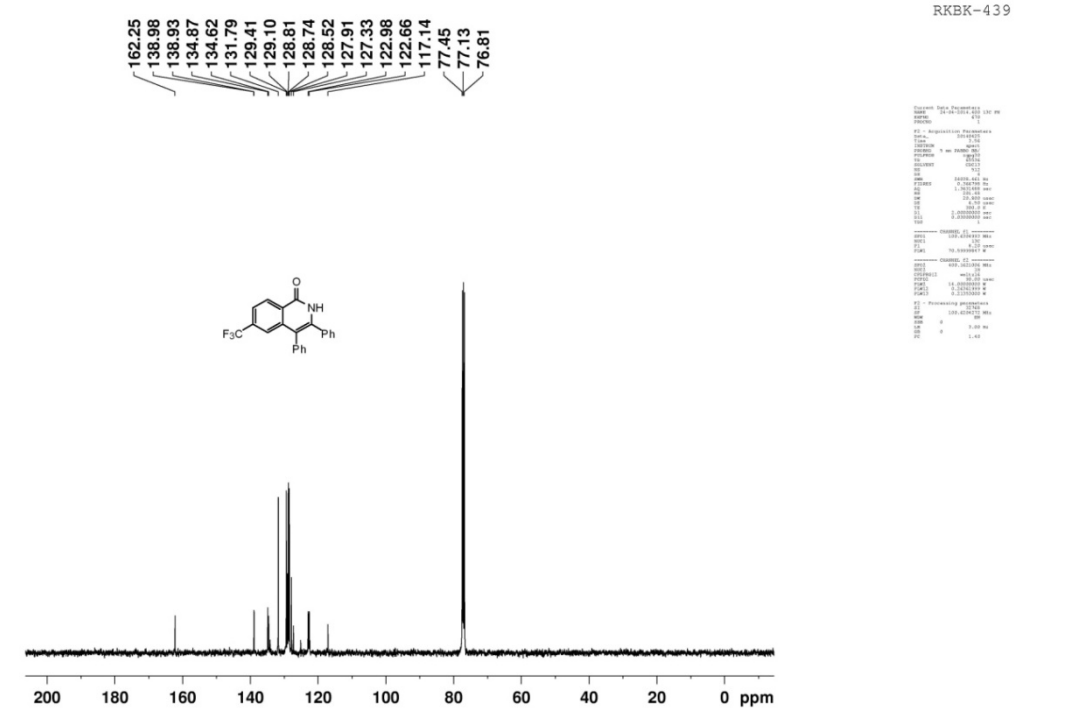


Fig. 62: ^{13}C NMR of 4ja

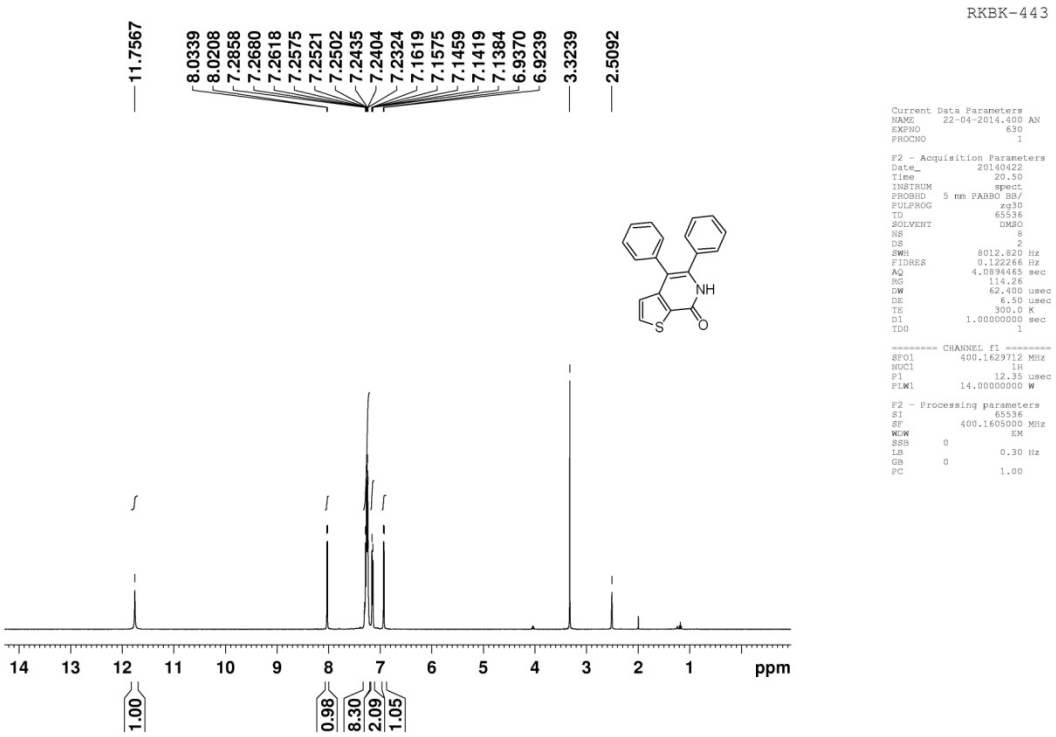


Fig. 63: ^{1}H NMR of 4ka

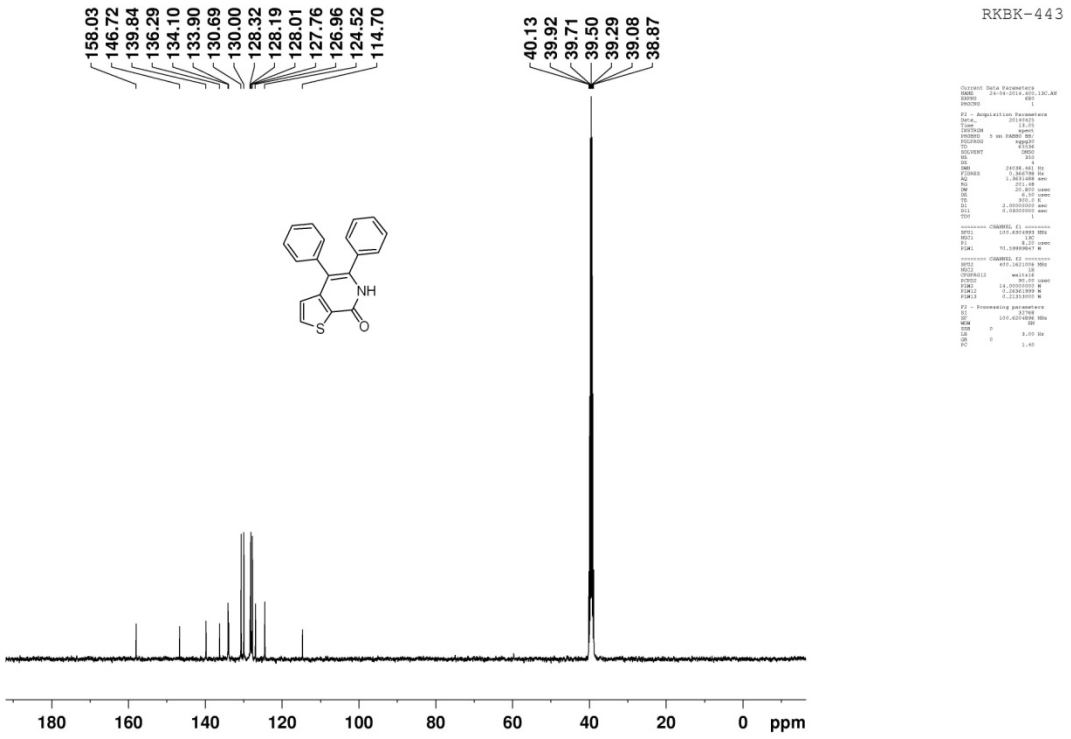


Fig. 64: ^{13}C NMR of 4ka

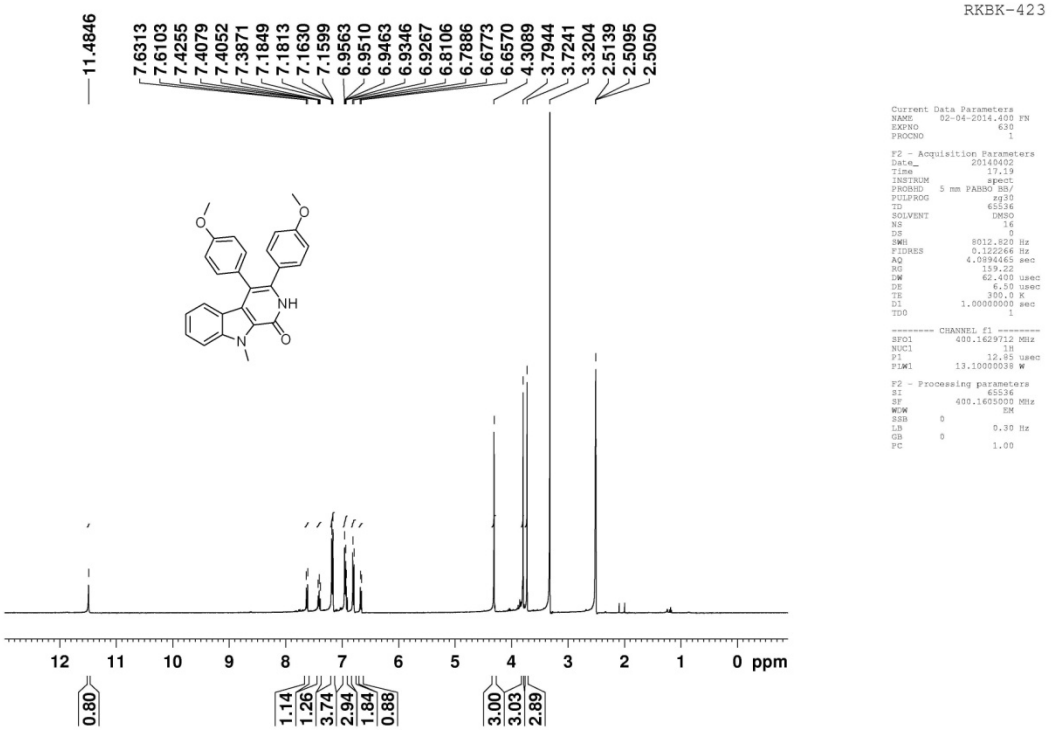


Fig. 65: ^{1}H NMR of 4lc

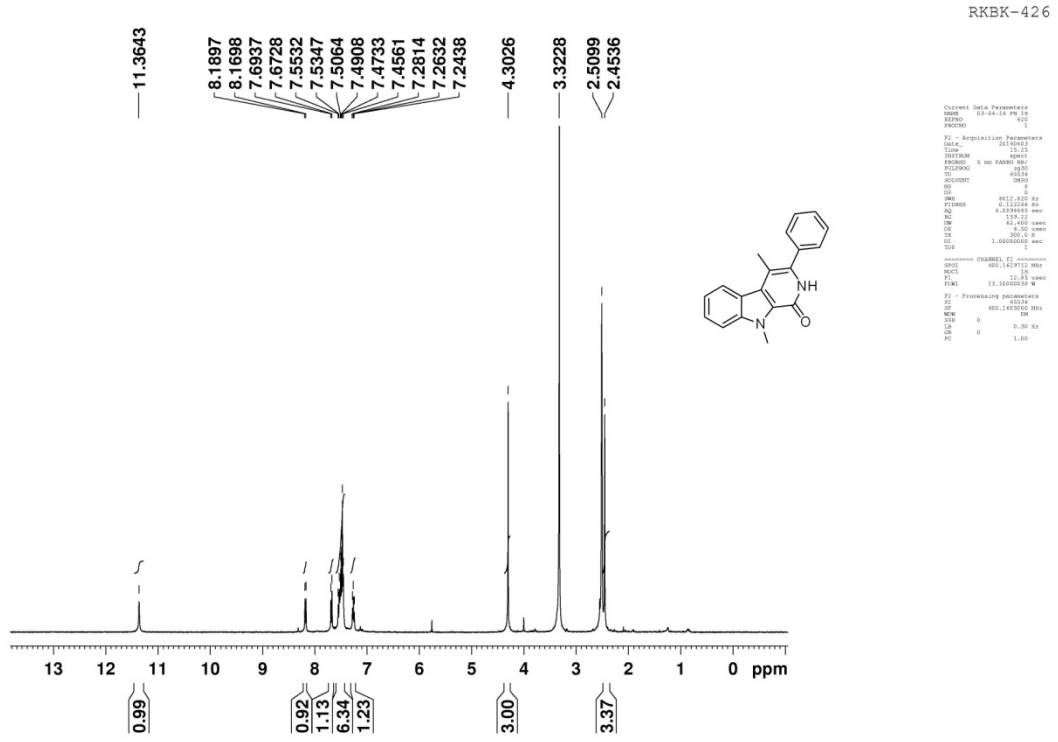


Fig. 66: ^{1}H NMR of 4lg

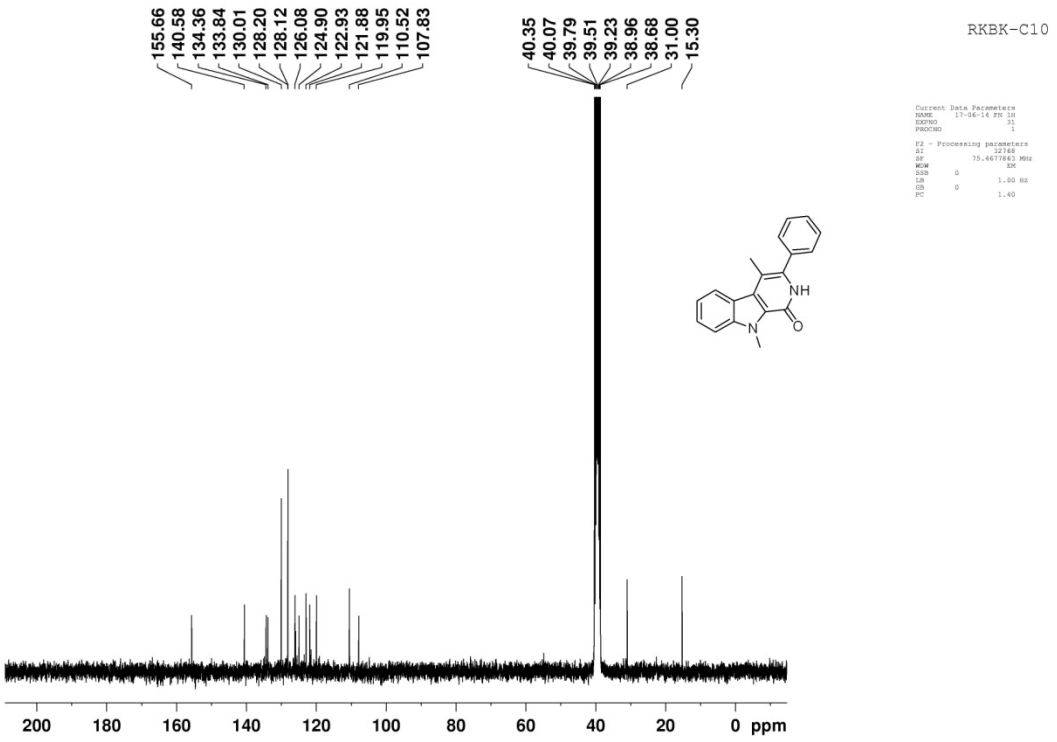


Fig. 67: ^{13}C NMR of 4lg

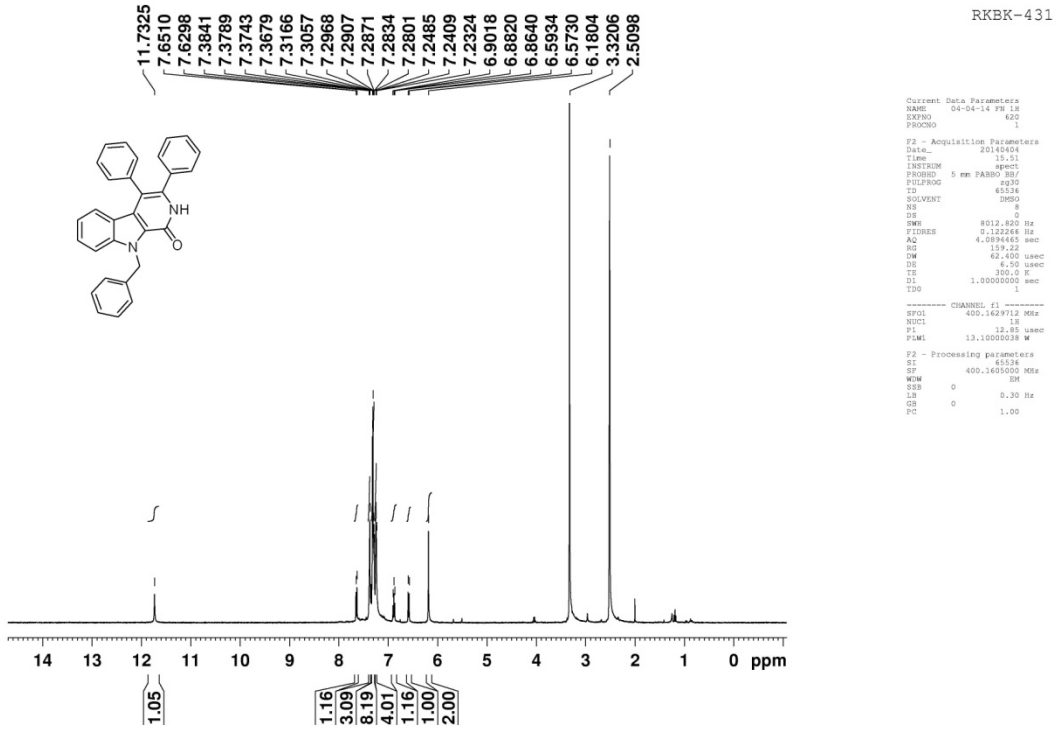


Fig. 68: ^{1}H NMR of 4ma

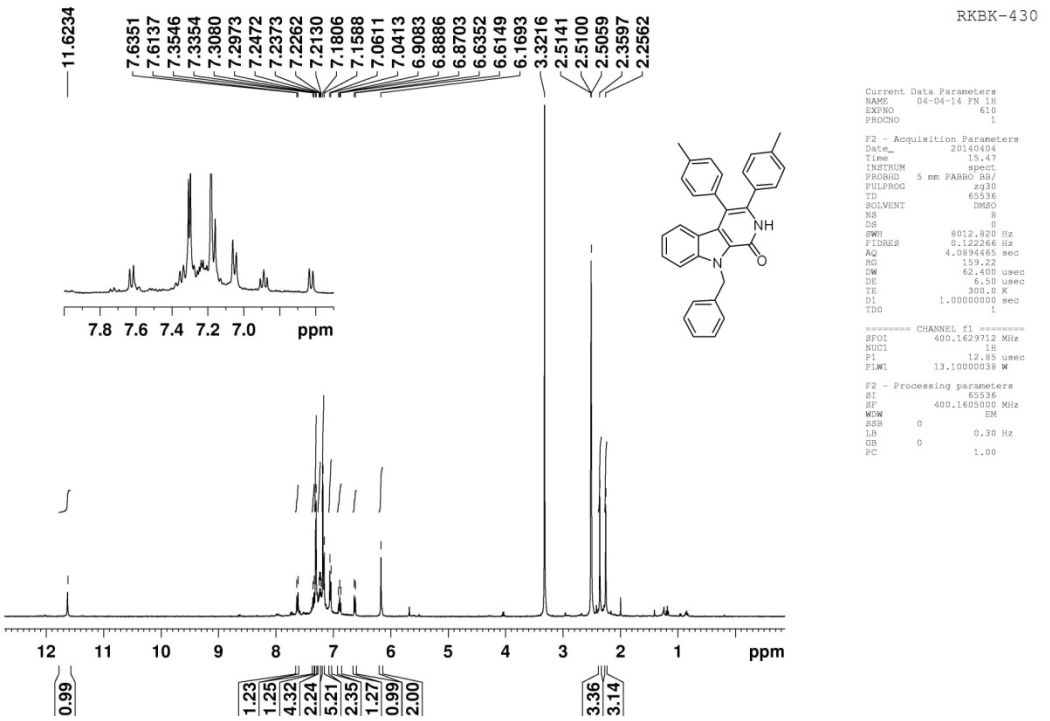


Fig. 69: ^{1}H NMR of 4mb

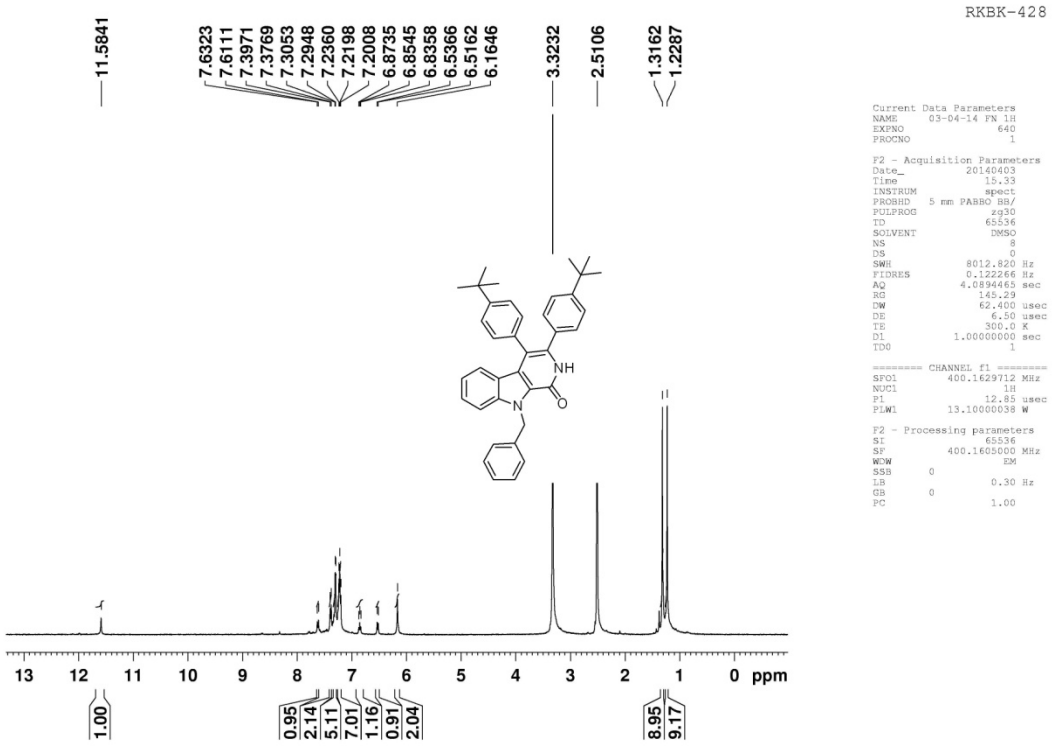


Fig. 70: ^{1}H NMR of 4md

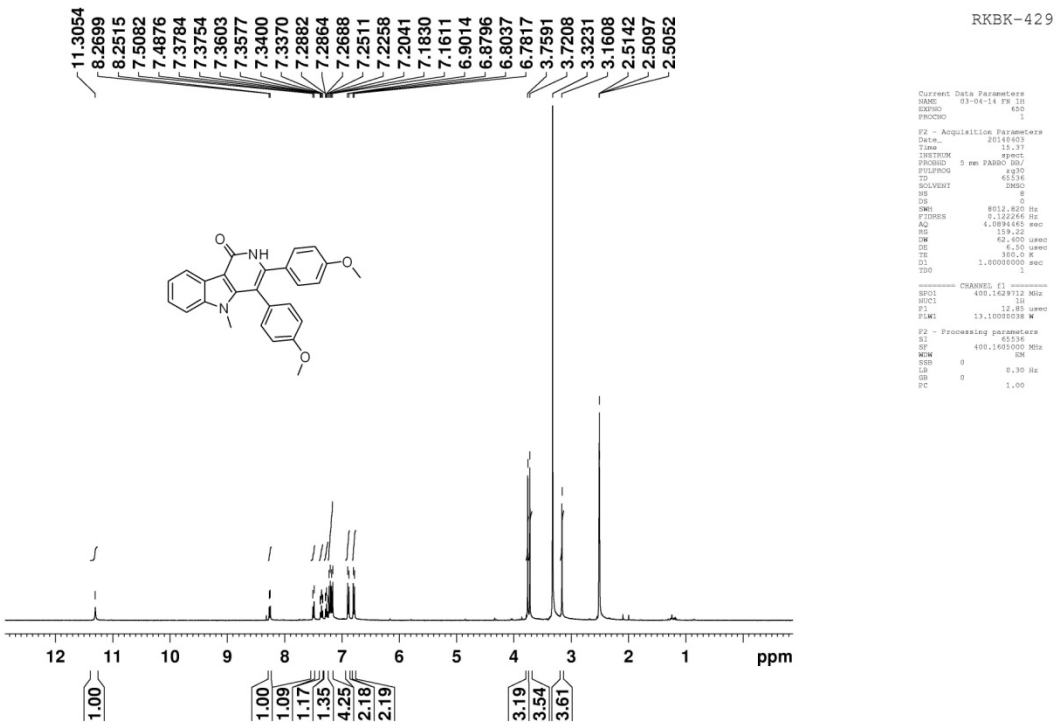


Fig. 71: ^{1}H NMR of 4nc

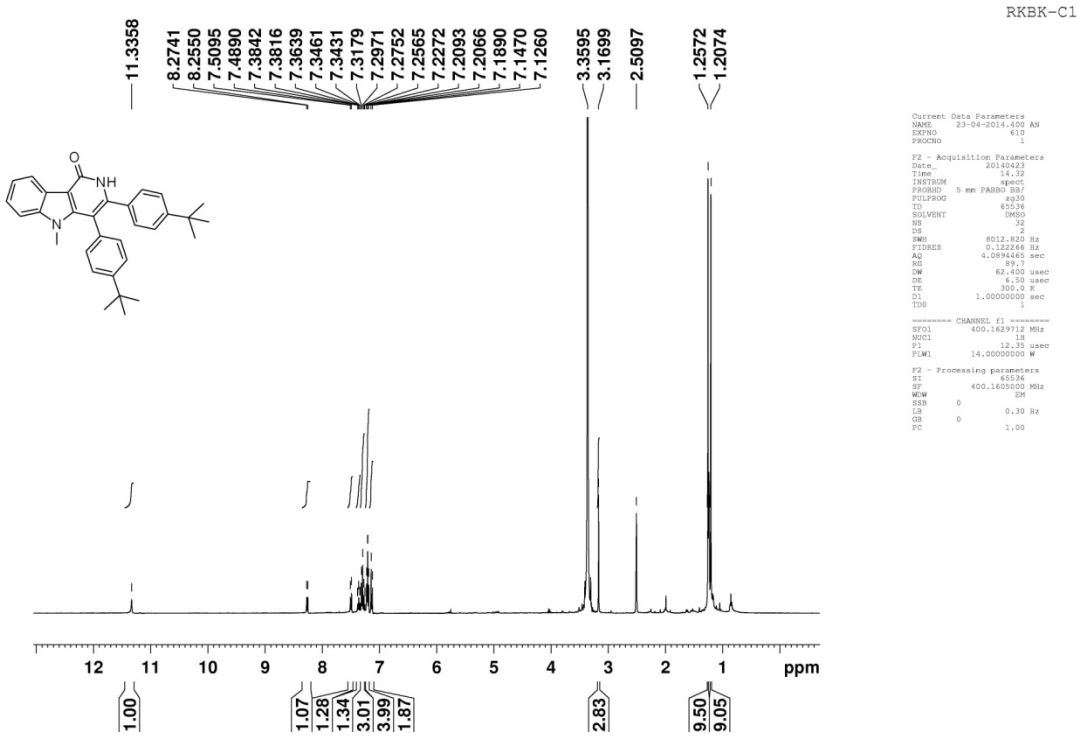


Fig. 72: ^{1}H NMR of 4nd

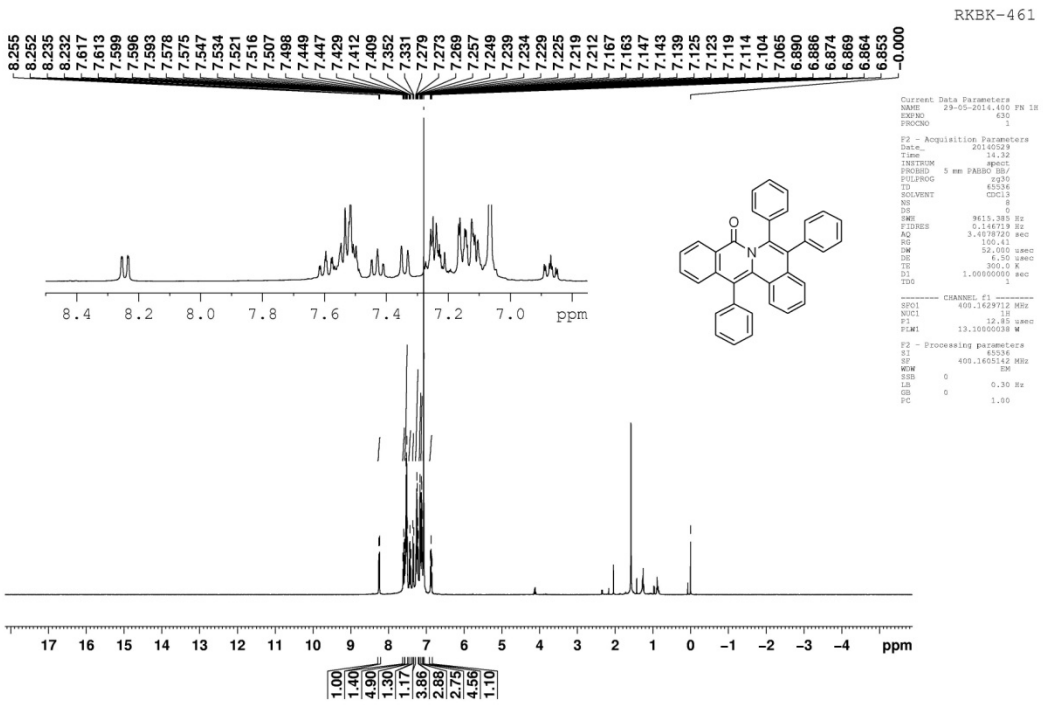


Fig. 73: ^{1}H NMR of 6

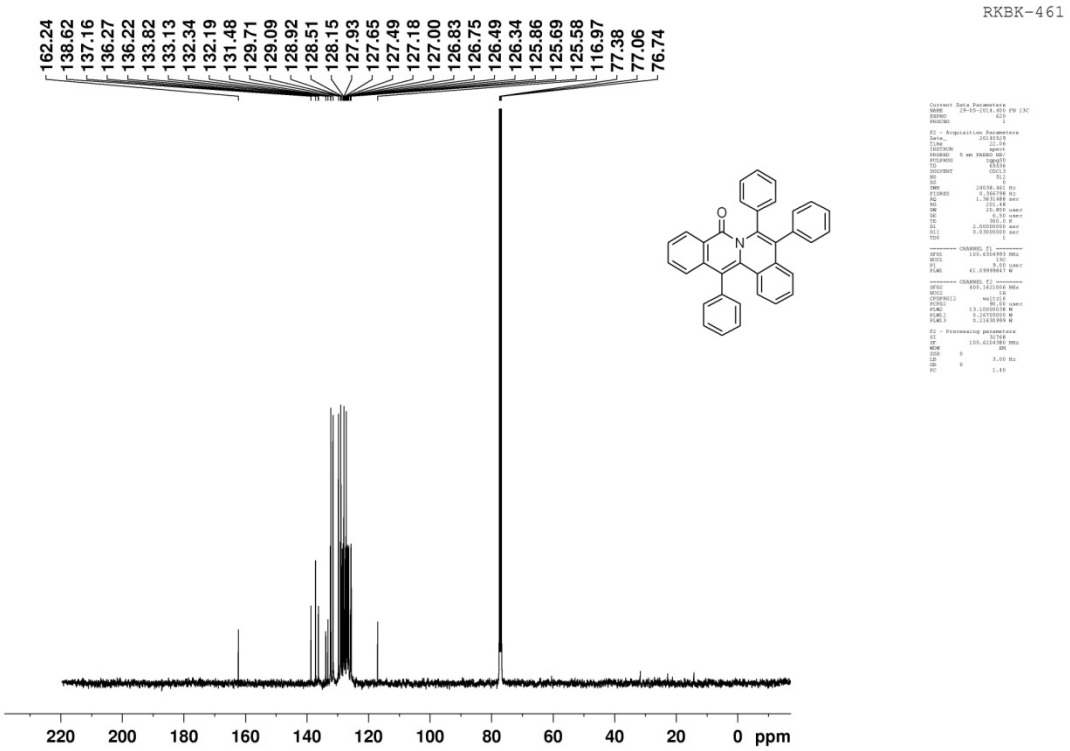


Fig. 74: ^{13}C NMR of 6

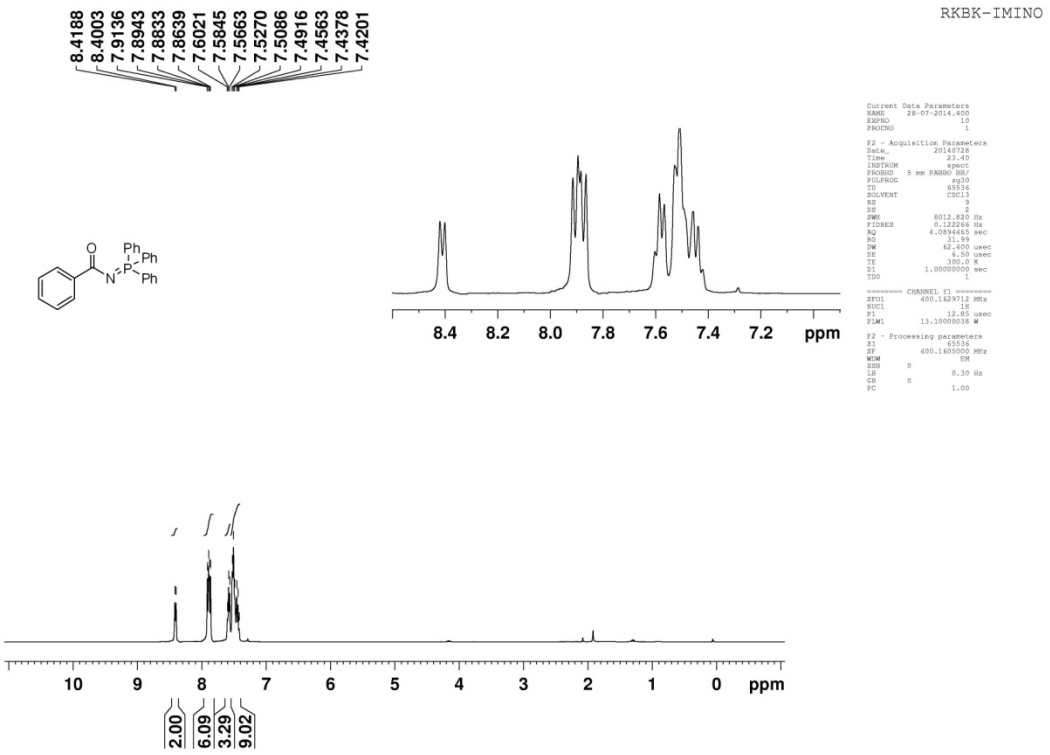


Fig. 75: ^{1}H NMR of 2a

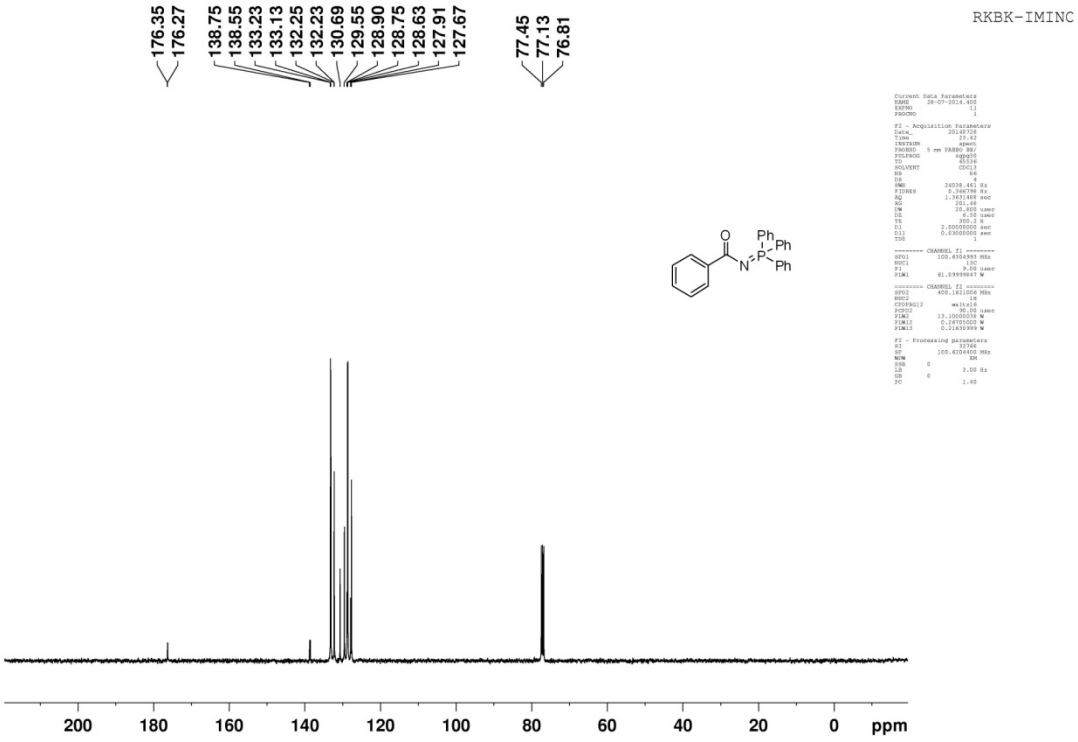


Fig. 76: ^{13}C NMR of 2a

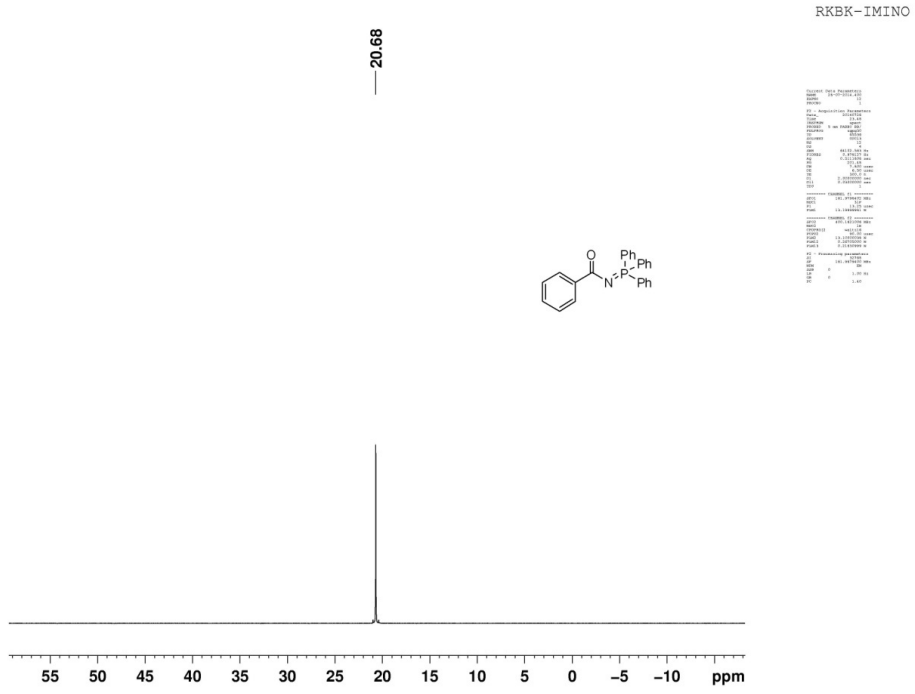


Fig. 77: ^{31}P NMR of 2a

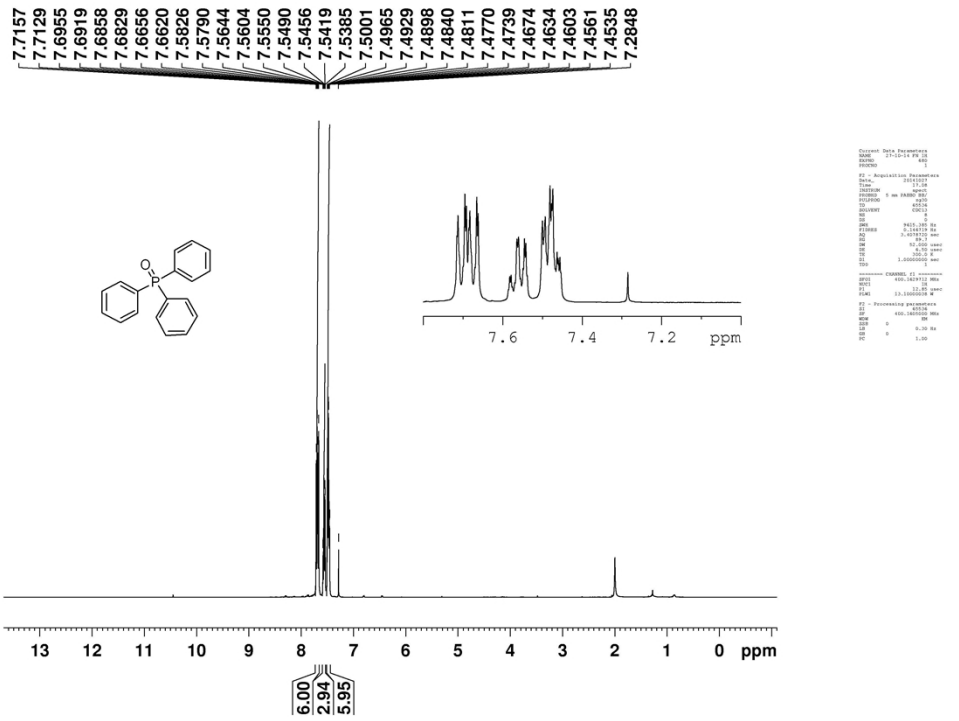


Fig. 78: ^{1}H NMR of Triphenyl phosphine oxide

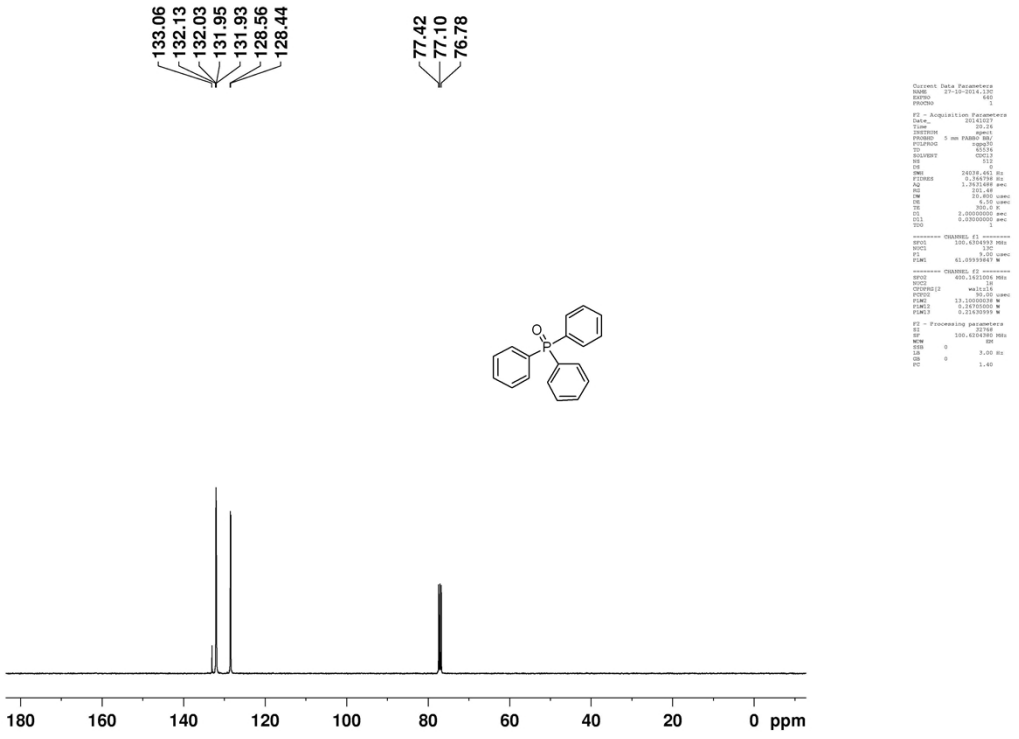


Fig. 79: ^{13}C NMR of Triphenyl phosphine oxide

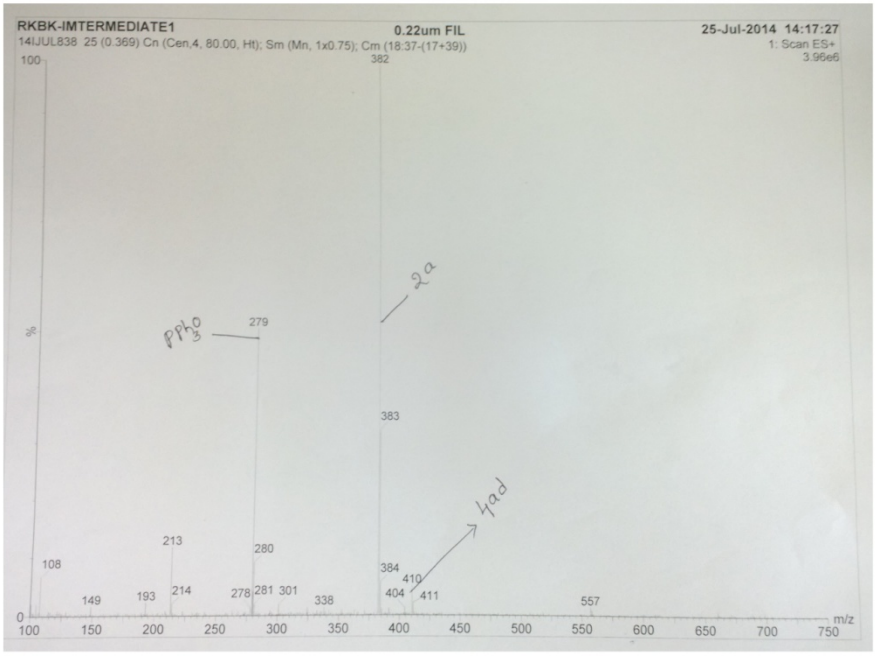
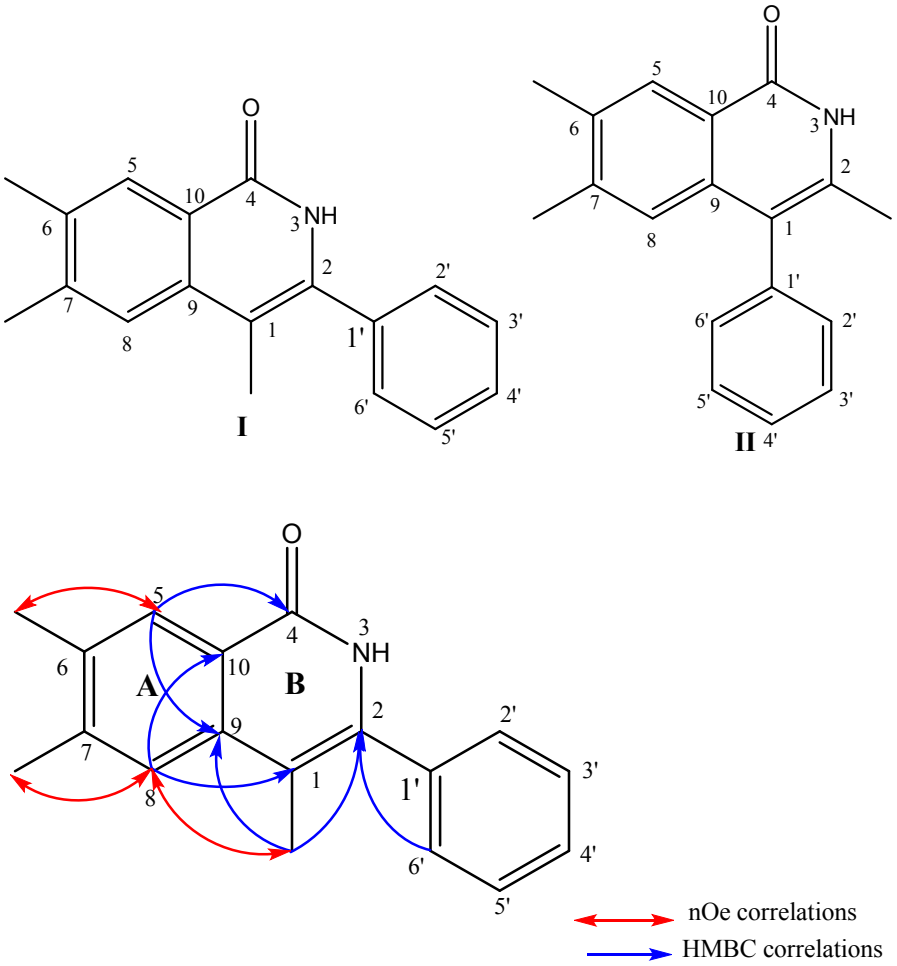


Figure 80: Mass spectrum of crude 2a and 4ad

VIII. 2-D spectra of compounds 4bg, 4lg

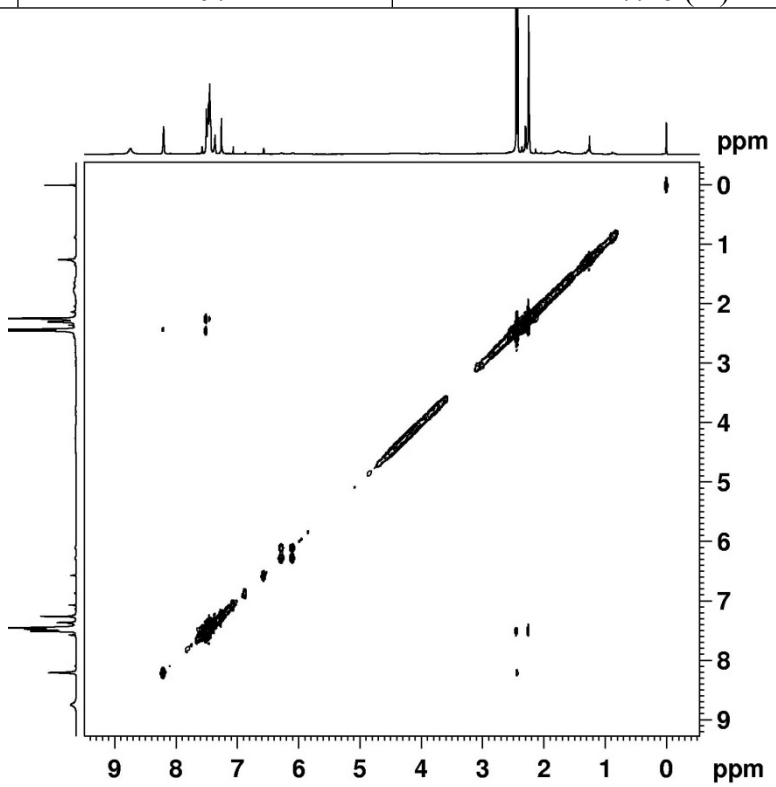


Important HMBC and nOe correlations of 4bg

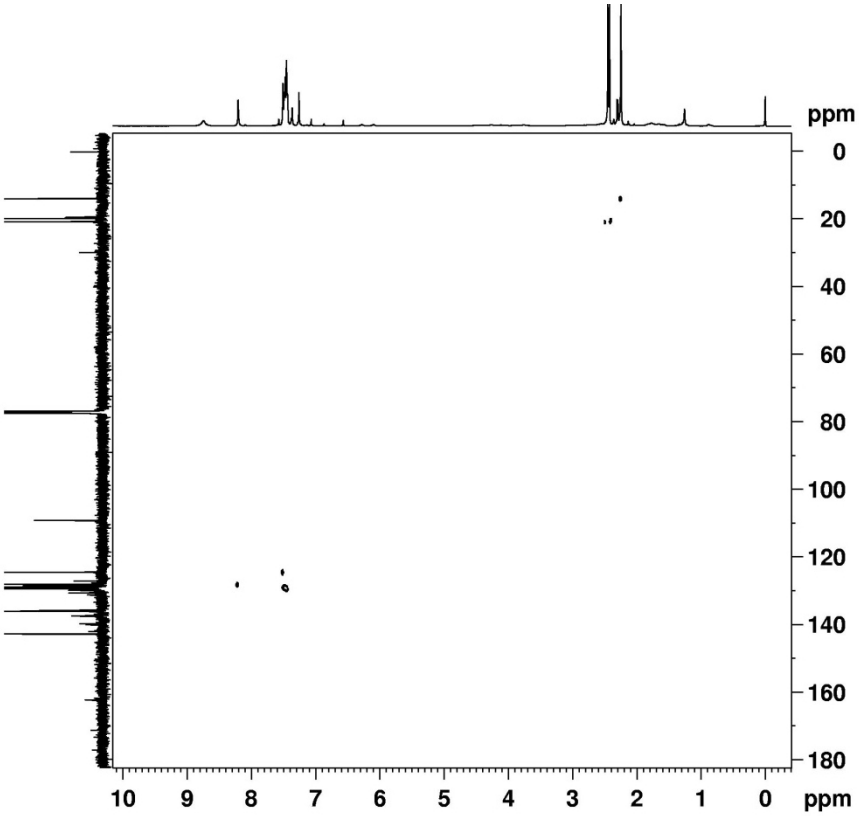
The entire ^{1}H and ^{13}C NMR signal assignments and skeletal connectivity were established from a combination of various 1D and 2D NMR experiments. HMBC gave the information about the connectivity of atoms in the molecule while NOESY established the spatial correlations between proximate protons in the molecule. HMBC correlations of H-8 to C-1 and 1-CH_3 to C-9 indicated that CH_3 group is attached to C-1 in molecular structure I, whereas such HMBC correlations are not possible in molecular structure II. At the same time H-5 is giving HMBC correlation with quaternary carbon (C=O) C-4 and H-2′,6′ is also giving HMBC correlation with C-2, these correlations determined the connectivity of ring A to ring B and phenyl ring to ring B respectively. Important nOe correlation between 1-CH_3 and H-8 showed the proximity of both protons in the space and provided strong evidence for the attachment of CH_3 at C-1 atom.

^{1}H and ^{13}C signal assignments of 4bg

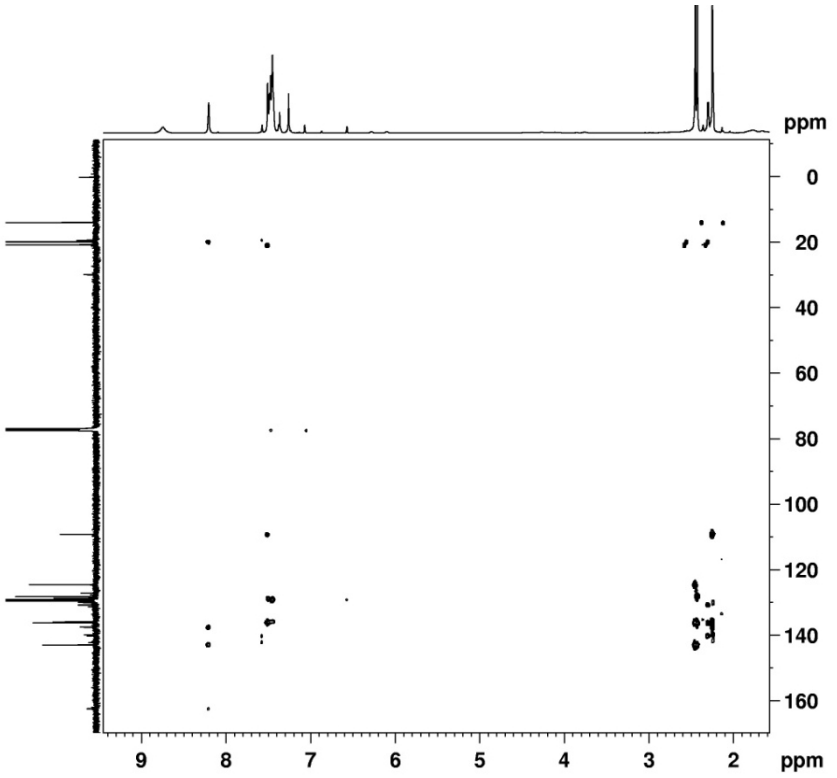
Carbon position	^{13}C Chemical shift (ppm)	^{1}H Chemical shift (ppm)
C-1	106.1	-
C-1-CH_3	14.0	2.24 (s)
C-2	134.9	-
N-H-3	-	8.74 (s)
C-4	161.6	-
C-5	128.1	8.20 (s)
C-6	136.1	-
C-6-CH_3	19.8	2.42 (s)
C-7	142.8	-
C-7-CH_3	20.8	2.45 (s)
C-8	124.5	7.51 (s)
C-9	136.8	-
C-10	135.5	-
C-1'	136.4	-
C-2',C-6'	128.9	7.47 (m)
C-3',C-5'	129.4	7.45 (m)
C-4'	129.1	7.46 (m)



NOESY spectrum of 4bg

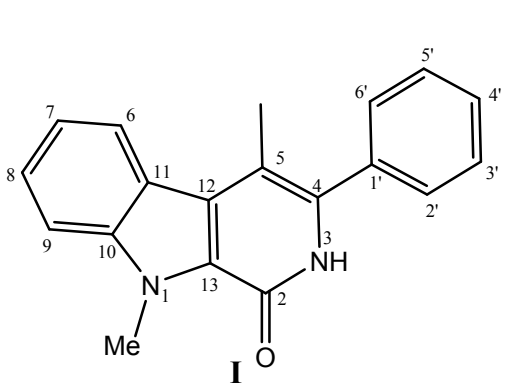


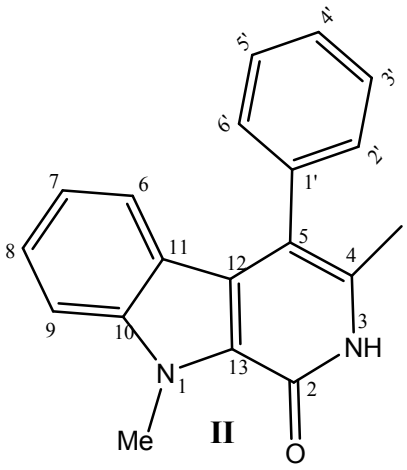
HSQC spectrum of 4bg

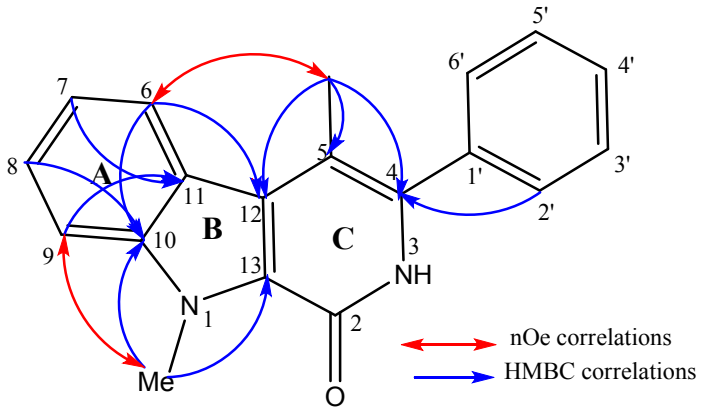


HMBC spectrum of 4bg

Compound-4lg







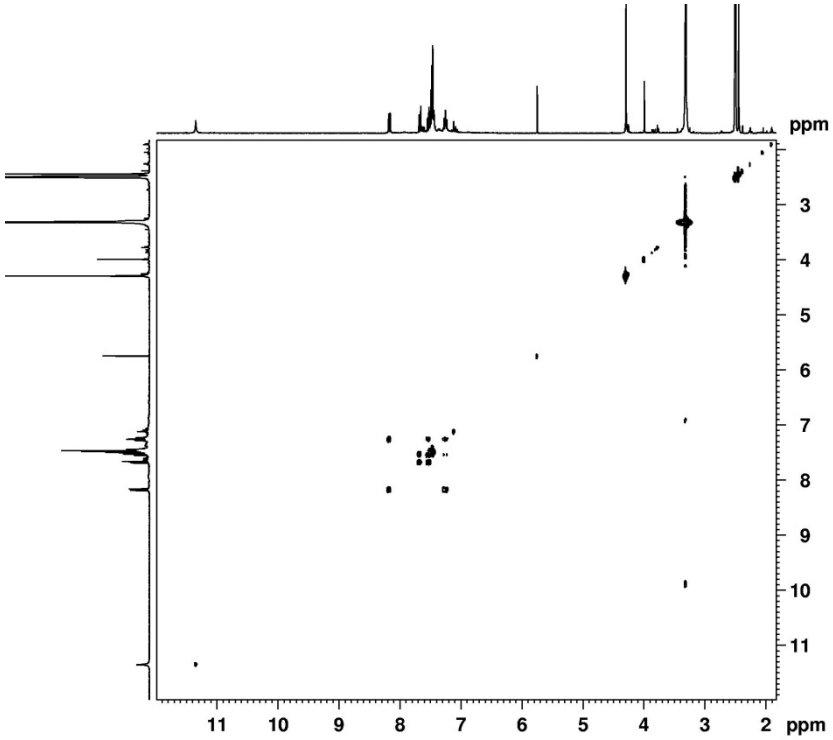
Important HMBC and nOe correlations of 4lg

COSY experiment established the two spin systems H-6 to H-9 in ring C and phenyl ring. HMBC correlations of H-6 and 5-CH_3 to C-12 and 5-CH_3, H-2', H-6' to C-4 clearly indicated that CH_3 group is attached to C-5 of ring C and phenyl ring to C-4 atoms respectively in molecular structure I, which is not possible in molecular structure II. At the same time H-6 and H-8 giving HMBC correlation to quaternary carbon C-10 and H-7 and H-9 is giving HMBC correlation with quaternary carbon C-11, and fixed the positions of quaternary carbons. Important nOe correlation between 5-CH_3 and H-6 showed the proximity of both protons in the space and played an important role to establish the attachment of methyl group at C-5 atom in structure I, such nOe correlation would be absent in structure II.

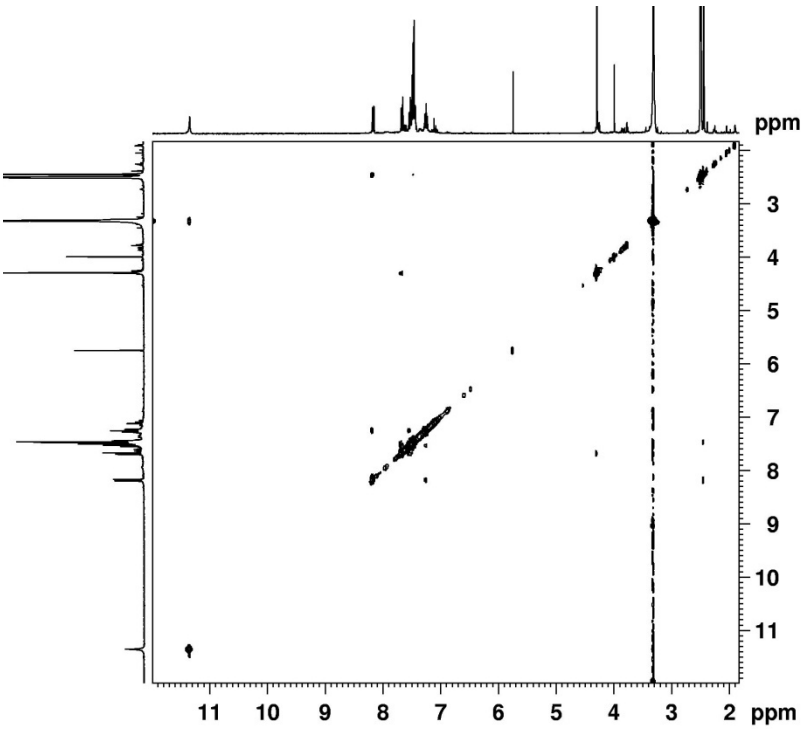
Carbon position	^{13}C Chemical shift (ppm)	^{1}H Chemical shift (ppm)
N-CH_3	31.5	4.30 (s)
C-2	155.6	-
N-H-3	-	11.34 (s)
C-4	133.9	-
C-5	107.9	-

C-5-CH_3	15.6	2.44 (s)
C-6	122.9	8.18 (d, *J* = 8.10 Hz)
C-7	120.4	7.26 (t, *J* = 7.60 Hz)
C-8	126.7	7.53 (t, *J* = 7.60 Hz)
C-9	110.0	7.68 (d, *J* = 8.10Hz)
C-10	140.6	-
C-11	122.0	-
C-12	126.0	-
C-13	125.8	-
C-1'	134.2	-
C-2',C-6'	129.9	7.49 (m)
C-3',C-5'	128.6	7.46 (m)
C-4’	128.3	7.45 (m)

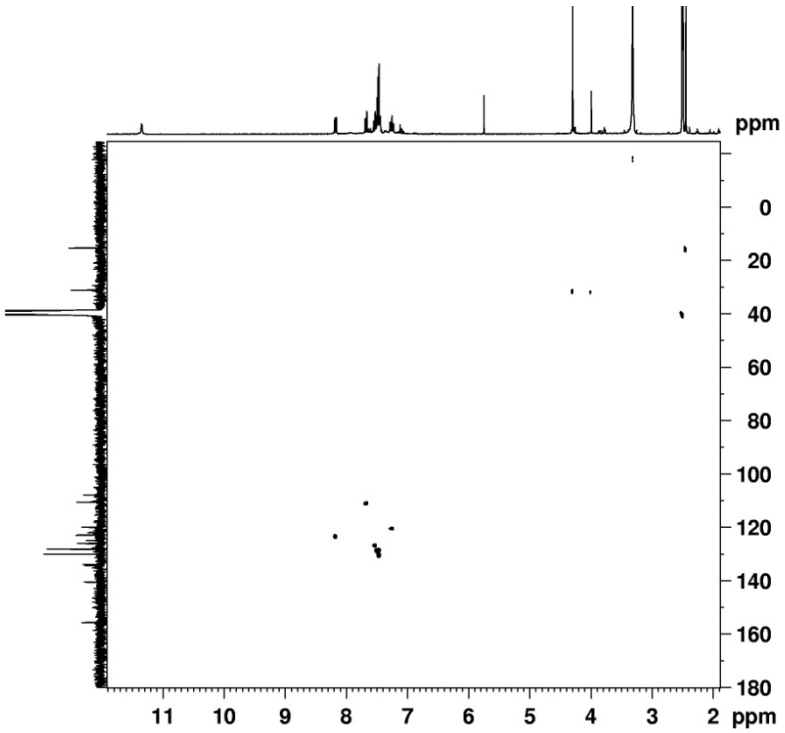
^{1}H and ^{13}C signal assignments of 4lg



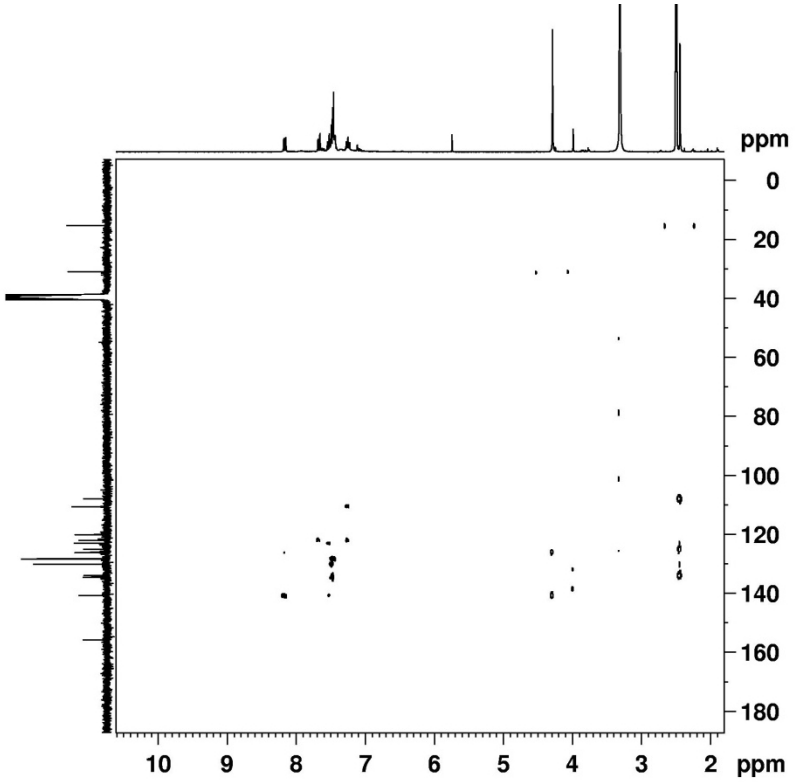
COSY spectrum of 4lg



NOESY spectrum of 4lg



HSQC spectrum of 4lg



HMBC spectrum of 4lg

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