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Regioselective synthesis of unsymmetrical biheteroaryls *via* copper(II)-catalyzed cascade annulation

Sadhanendu Samanta and Alakananda Hajra*

Department of Chemistry, Visva-Bharati (A Central University), Santiniketan 731235, India;

Tel./Fax: +913463 261526; E-mail: alakananda.hajra@visva-bharati.ac.in

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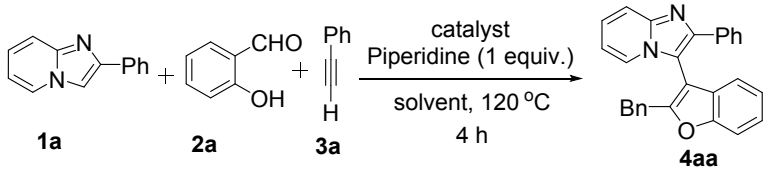
1. General information:

All reagents were purchased from commercial sources and used without further purification. ^{1}H NMR spectra were determined on 400 MHz spectrometer as solutions in $CDCl_3$. Chemical shifts are expressed in parts per million (δ) and the signals were reported as s (singlet), d (doublet), t (triplet), m (multiplet) and coupling constants (J) were given in Hz. $^{13}C\{^1H\}$ NMR spectra were recorded at 100 MHz in $CDCl_3$ solution. Chemical shifts as internal standard are referenced to $CDCl_3$ (δ = 7.26 for ^{1}H and δ = 77.16 for $^{13}C\{^1H\}$ NMR) as internal standard. TLC was done on silica gel coated glass slide. All solvents were dried and distilled before use. Commercially available solvents were freshly distilled before the reaction. All reactions involving moisture sensitive reactants were executed using oven dried glassware. All the imidazoheterocycles were prepared by our reported method.[1a,b]

2. Optimization table[a]

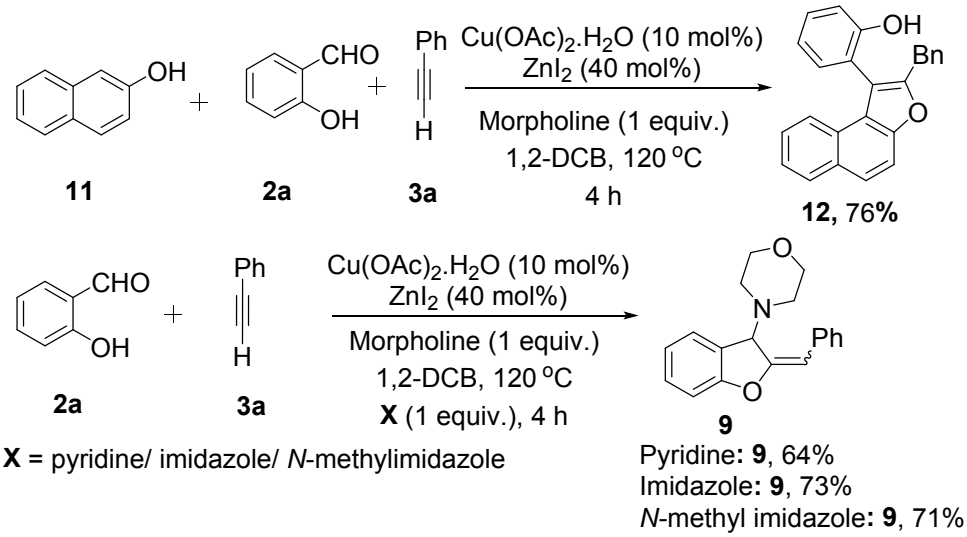


1a **2a** **3a** **4aa**

Entry	Catalyst (mol%)	Additives (mol%)	Solvent	Yields (%)
1	CuI (10)	ZnI_2 (20)	CH_3CN	57
2	CuI (10)	ZnI_2 (20)	Toluene	26
3	CuI (10)	ZnI_2 (20)	1,4-dioxane	11
4	CuI (10)	ZnI_2 (20)	1,2-DCE	28
5	CuI (10)	ZnI_2 (20)	Chlorobenzene	15
6	CuI (10)	ZnI_2 (20)	1,2-DCB	72
7	CuI (10)	ZnI_2 (20)	DMF	56
8	Cu_2O (10)	ZnI_2 (20)	1,2-DCB	42
9	CuBr (10)	ZnI_2 (20)	1,2-DCB	61
10	$Cu(OAc)_2.H_2O$ (10)	ZnI_2 (20	1,2-DCB	80
11	$Cu(OTf)_2$ (10)	ZnI_2 (20)	1,2-DCB	79
12	$CuBr_2$ (10)	ZnI_2 (20)	1,2-DCB	82
13	$CuCl_2$ (10)	ZnI_2 (20)	1,2-DCB	78
14	$Cu(OAc)_2.H_2O$ (10)	AgOTf (20)	1,2-DCB	43
15	$Cu(OAc)_2.H_2O$ (10)	1,10-phenanthroline (20)	1,2-DCB	26
16	$Cu(OAc)_2.H_2O$ (10)	$Zn(OTf)_2$ (20)	1,2-DCB	35
17	$Cu(OAc)_2.H_2O$ (10)	-	1,2-DCB	49
18	-	ZnI_2 (20)	1,2-DCB	16
19	$Cu(OAc)_2.H_2O$ (20)	ZnI_2 (40)	1,2-DCB	86
20	**$Cu(OAc)_2.H_2O$ (10)**	**ZnI_2 (40)**	**1,2-DCB**	**88**
21	$Cu(OAc)_2.H_2O$ (10)	ZnI_2 (40)	1,2-DCB	85[b], 77[c]
22	$Cu(OAc)_2.H_2O$ (10)	ZnI_2 (40)	1,2-DCB	53[d],76[e], 0[f]

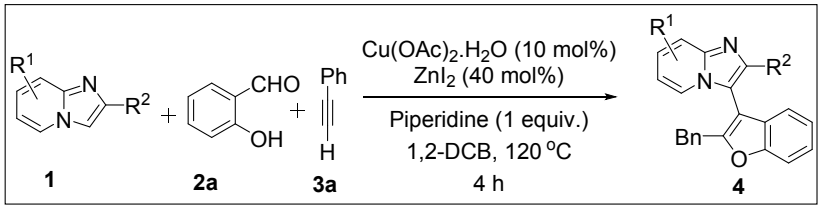
[a] *Reaction conditions*: Carried out with 0.2 mmol of **1a**, 0.2 mmol of **2a**, piperidine (1 equiv.) and 0.21 mmol of **3a** in presence of catalyst in 2 mL of solvent for 4 h at 120 °C. [b] Temperature at 140 °C. [c] Temperature at 80 °C for 12 h with 20 mol% catalyst. [d] 1 equiv. pyrrolidine. [e] 1 equiv. morpholine. [f] 1 equiv. 1,4-tetrahydroisoquinoline.

3. Substrates scope of other heterocycles:



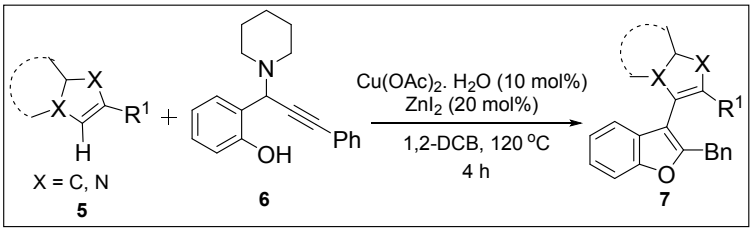
4. Experimental procedures:

4.1. Typical experimental procedure for the synthesized compounds (4aa-4ak):



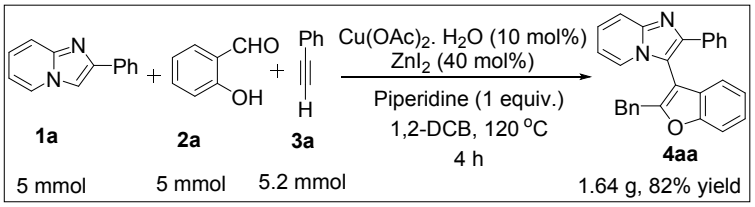
A mixture of salicyaldehyde (0.2 mmol, 24 mg) (**2a**), piperidine (1 equiv., 17 mg), phenylacetylene (0.21 mmol, 21 mg) (**3a**), and 2-phenylimidazo[1,2-*a*]pyridine (0.2 mmol, 38 mg) (**1a**) was taken in an oven dried reaction tube. Then Zinc iodide (40 mol%, 25.5 mg), and copper(II) acetate monohydrate (10 mol%, 4 mg) was added to it in 1,2-DCB (2 ml) and stirred at 120 °C for 4 h under open atmosphere. After completion of the reaction (TLC) the reaction was cooled to room temperature and extracted with dichloromethane. The organic phase was dried over anhydrous Na_2SO_4. The crude residue was obtained after evaporating the solvent in vacuum and was purified by column chromatography on silica gel using a mixture petroleum ether and ethyl acetate (75:25) as an eluting solvent to afford the pure product (**4aa**) (70 mg, 88%) as a white solid.

4. 2. **Typical experimental procedure for the synthesized compounds (4al-7da):**



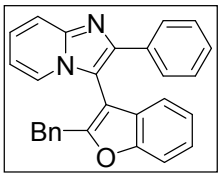
A mixture of 6-phenylimidazo[2,1-*b*]thiazole (0.2 mmol, 40 mg) (**5a**) and 2-(3-phenyl-1-(piperidin-1-yl)prop-2-yn-1-yl)phenol (0.2 mmol, 58.2 mg) (**6**) was taken in an oven dried reaction tube in presence of zinc iodide (20 mol%, 12.7 mg), and copper(II) acetate monohydrate (10 mol%, 4 mg) in 1,2-DCB (2 mL) and stirred at 120 °C for 4 h under open atmosphere. After completion of the reaction (TLC) the reaction was cooled to room temperature and extracted with dichloromethane. The organic phase was dried over anhydrous Na_2SO_4. The crude residue was obtained after evaporating the solvent in vacuum and was purified by column chromatography on silica gel using a mixture petroleum ether and ethyl acetate (76:24) as an eluting solvent to afford the pure product (**7aa**) (71%, 57 mg) as a yellow gummy mass.

4.3. Synthesis of 4aa on 5 mmol scale.

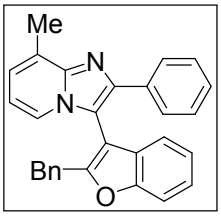


A mixture of salicyaldehyde (5 mmol, 610 mg) (**2a**), piperidine (5 equiv., 425 mg), phenylacetylene (5.2 mmol, 531 mg) (**3a**), and 2-phenylimidazo[1,2-*a*]pyridine (5 mmol, 970.4 mg) (**1a**) was taken in an oven dried 25 mL round bottom flask. Then Zinc iodide (40 mol%, 638.4 mg), and copper(II) acetate monohydrate (10 mol%, 99.8 mg) was added to it in 1,2-DCB (10 ml) and stirred at 120 °C for 4 h under open atmosphere. After completion of the reaction (TLC) the reaction was cooled to room temperature and extracted with dichloromethane. The organic phase was dried over anhydrous Na_2SO_4. The crude residue was obtained after evaporating the solvent in vacuum and was purified by column chromatography on silica gel using a mixture petroleum ether and ethyl acetate (75:25) as an eluting solvent to afford the pure product (**4aa**) (1.64 mg, 82%) as a white solid.

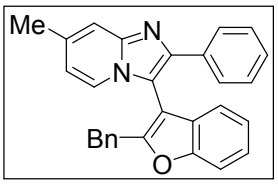
5. Characterization data for the synthesized products:



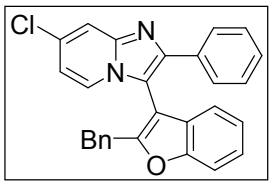
3-(2-Benzylbenzofuran-3-yl)-2-phenylimidazo[1,2-*a*]pyridine (4aa): White solid (88%, 70 mg); R_f = 0.50 (PE : EA = 75 : 25); M.p. 130-131 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.93-7.89 (m, 3H), 7.79 (d, J = 6.4 Hz, 1H), 7.73 (d, J = 8.4 Hz, 1H), 7.53-7.48 (m, 1H), 7.44-7.39 (m, 4H), 7.37-7.35 (m, 2H), 7.26-7.23 (m, 3H), 7.07-7.05 (m, 2H), 6.85 (t, J = 6.8 Hz, 1H), 4.02-3.92 (m, 2H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 157.3, 154.9, 145.7, 144.4, 136.1, 133.8, 128.7, 128.5, 128.4, 128.1, 127.8, 127.7, 126.7, 125.3, 124.7, 124.1, 123.4, 119.9, 117.8, 112.6, 111.8, 111.2, 105.5, 33.6. Anal. Calcd for $C_{28}H_{20}N_2O$: C, 83.98; H, 5.03; N, 7.00%; Found: C, 84.19; H, 5.07; N, 6.89%.



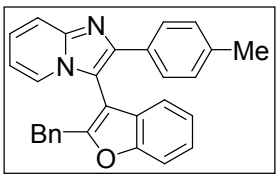
3-(2-Benzylbenzofuran-3-yl)-8-methyl-2-phenylimidazo[1,2-*a*]pyridine (4ba): Brown gummy mass (89%, 73 mg); R_f = 0.55 (PE : EA = 93 : 7); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.77-7.75 (m, 2H), 7.53 (t, J = 8.4 Hz, 2H), 7.34-7.23 (m, 4H), 7.19 (d, J = 4.0 Hz, 2H), 7.08-7.07 (m, 3H), 7.03 (d, J = 7.2 Hz, 1H), 6.90-6.88 (m, 2H), 6.60 (t, J = 6.8 Hz, 1H), 3.84-3.72 (m, 2H), 2.75 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 157.1, 155.0, 146.3, 144.1, 136.3, 134.3, 128.7, 128.6, 128.4, 128.2, 127.77, 127.71, 126.6, 124.6, 123.9, 123.4, 122.0, 120.0, 112.4, 111.7, 111.6, 106.1, 33.6, 17.2; Anal. Calcd for $C_{29}H_{22}N_2O$: C, 84.03; H, 5.35; N, 6.76%; Found: C, 83.88; H, 5.41; N, 6.68%.



3-(2-Benzylbenzofuran-3-yl)-7-methyl-2-phenylimidazo[1,2-*a*]pyridine (**4ca**): Brown gummy mass (87%, 72 mg); R_f = 0.45 (PE : EA = 76 : 24); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.71 (s, 3H), 7.53 (d, J = 8.0 Hz, 2H), 7.32 (t, J = 7.6 Hz, 1H), 7.21-7.13 (m, 5H), 7.08-7.06 (m, 3H), 6.86-6.83 (m, 2H), 6.56 (d, J = 6.8 Hz, 1H), 3.77-3.67 (m, 2H), 2.44 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 157.2, 154.9, 146.0, 143.8, 136.8, 136.1, 133.6, 128.7, 128.47, 128.40, 128.1, 127.8, 127.7, 126.6, 124.6, 123.4, 123.3, 119.8, 116.2, 115.5, 111.8, 110.7, 105.3, 33.5, 21.5; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{29}H_{23}N_2O$: 415.1805; found: 415.1795.

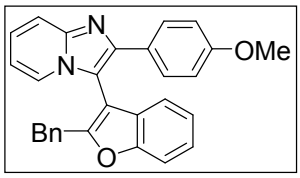


3-(2-Benzylbenzofuran-3-yl)-7-chloro-2-phenylimidazo[1,2-*a*]pyridine (**4da**): White solid (89%, 77mg); R_f = 0.45 (PE : EA = 78 : 22); M.p. 154-155 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.74-7.72 (m, 2H), 7.63 (d, J = 9.6 Hz, 1H), 7.57 (d, J = 8.4 Hz, 1H), 7.52 (s, 1H), 7.36-7.32 (m, 1H), 7.27-7.22 (m, 3H), 7.20-7.15 (m, 3H), 7.06-7.04 (m, 3H), 6.88-6.86 (m, 2H), 3.85-3.77 (m, 2H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 157.6, 155.0, 145.5, 144.1, 135.8, 133.6, 128.6, 128.4, 128.1, 128.0, 127.5, 126.8, 126.4, 124.9, 123.7, 121.9, 120.7, 119.8, 117.9, 111.88, 111.80, 105.2, 33.9. Anal. Calcd for $C_{28}H_{19}ClN_2O$: C, 77.33; H, 4.40; N, 6.44%; Found: C, 77.08; H, 4.35; N, 6.51%.

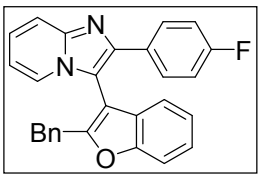


3-(2-Benzylbenzofuran-3-yl)-2-(*p*-tolyl)imidazo[1,2-*a*]pyridine (4ea): Brown gummy mass (73%, 60 mg); R_f = 0.40 (PE : EA = 77 : 23); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.76 (d, J = 9.2 Hz, 1H), 7.63-7.61 (m, 3H), 7.55 (d, J = 8.0 Hz, 1H), 7.36-7.31 (m, 1H), 7.26-7.17 (m, 3H), 7.08-7.04 (m, 5H), 6.89-6.87 (m, 2H), 6.69 (t, J = 6.8 Hz, 1H), 3.83-3.74 (m, 2H), 2.30 (s, 3H);

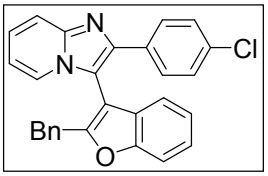
$^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 157.3, 155.0, 145.7, 144.6, 137.6, 136.2, 131.0, 129.3, 128.7, 128.4, 128.2, 127.5, 126.6, 125.1, 124.6, 124.1, 123.4, 120.0, 117.6, 112.4, 111.8, 110.9, 105.8, 33.6, 21.3; Anal. Calcd for $C_{29}H_{22}N_2O$: C, 84.03; H, 5.35; N, 6.76%; Found: C, 84.23; H, 5.39; N, 6.65%.



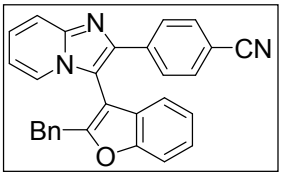
3-(2-Benzylbenzofuran-3-yl)-2-(4-methoxyphenyl)imidazo[1,2-*a*]pyridine (**4fa**): Brown gummy mass (71%, 61 mg); R_f = 0.50 (PE : EA = 76 : 24); ^1H NMR (400 MHz, $CDCl_3$): δ 7.81 (d, J = 9.2 Hz, 1H), 7.65-7.60 (m, 3H), 7.55 (d, J = 8.4 Hz, 1H), 7.35-7.31 (m, 1H), 7.27-7.23 (m, 1H), 7.21-7.16 (m, 2H), 7.09-7.06 (m, 3H), 6.89-6.87 (m, 2H), 6.75 (d, J = 8.4 Hz, 2H), 6.69 (t, J = 6.8 Hz, 1H), 3.79-3.73 (m, 5H); $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 159.4, 157.3, 155.0, 145.7, 144.3, 136.1, 128.9, 128.7, 128.6, 128.4, 128.1, 126.6, 126.3, 125.1, 124.6, 124.1, 123.4, 119.9, 117.5, 113.9, 112.4, 111.8, 105.7, 55.2, 33.6; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{29}H_{23}N_2O_2$: 431.1760; found: 431.1755.



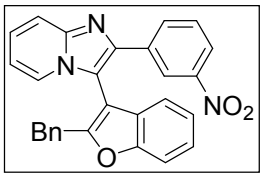
3-(2-Benzylbenzofuran-3-yl)-2-(4-fluorophenyl)imidazo[1,2-*a*]pyridine (**4ga**): Brown gummy mass (84%, 70 mg); R_f = 0.55 (PE : EA = 74 : 26); ^1H NMR (400 MHz, $CDCl_3$): δ 7.73-7.69 (m, 3H), 7.61 (d, J = 7.2 Hz, 1H), 7.56 (d, J = 8.4 Hz, 1H), 7.36-7.31 (m, 1H), 7.25-7.15 (m, 3H), 7.09-7.06 (m, 3H), 6.96-6.89 (m, 4H), 6.68 (t, J = 6.8 Hz, 1H), 3.86-3.76 (m, 2H); $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 162.6 ($J_{C\text{-}F}$ = 245 Hz), 157.3, 155.0, 145.8, 143.7, 136.0, 130.2 ($J_{C\text{-}F}$ = 3 Hz), 129.2 ($J_{C\text{-}F}$ = 8 Hz), 128.6, 128.4, 128.0, 126.7, 125.2, 124.8, 124.1, 123.5, 119.9, 117.6, 115.5 ($J_{C\text{-}F}$ = 21 Hz), 112.4, 111.8, 110.9, 105.6, 33.6; Anal. Calcd for $C_{28}H_{19}FN_2O$: C, 80.37; H, 4.58; N, 6.69%; Found: C, 80.21; H, 4.51; N, 6.60%.



3-(2-Benzylbenzofuran-3-yl)-2-(4-chlorophenyl)imidazo[1,2-*a*]pyridine (**4ha**): Light yellow gummy mass (78%, 67 mg); R_f = 0.45 (PE : EA = 80 : 20); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.66 (d, J = 8.8 Hz, 1H), 7.59-7.56 (m, 2H), 7.53-7.48 (m, 2H), 7.28-7.23 (m, 1H), 7.19-7.06 (m, 5H), 7.00-6.96 (m, 3H), 6.82-6.79 (m, 2H), 6.62-6.59 (m, 1H), 3.78-3.67 (m, 2H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 157.2, 154.9, 145.8, 143.3, 135.9, 133.7, 132.5, 128.79, 128.76, 128.6, 128.4, 127.9, 126.7, 125.4, 124.8, 124.1, 123.5, 119.8, 117.6, 112.6, 111.8, 111.3, 105.4, 33.6; Anal. Calcd for $C_{28}H_{19}ClN_2O$: C, 77.33; H, 4.40; N, 6.44%; Found: C, 77.55; H, 4.46; N, 6.32%.

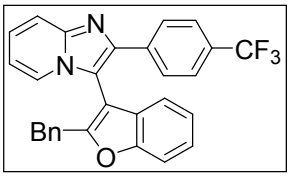


4-(3-(2-Benzylbenzofuran-3-yl)imidazo[1,2-*a*]pyridin-2-yl)benzonitrile (**4ia**): White solid (81%, 68 mg); R_f = 0.45 (PE : EA = 74 : 26); M.p. 145-146 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.82-7.80 (m, 2H), 7.72-7.69 (m, 1H), 7.62-7.58 (m, 2H), 7.48-7.46 (m, 2H), 7.38-7.34 (m, 1H), 7.29-7.18 (m, 2H), 7.13 (d, J = 6.8 Hz, 1H), 7.10-7.02 (m, 3H), 6.88-6.86 (m, 2H), 6.74-6.70 (m, 1H), 3.88-3.76 (m, 2H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 157.3, 155.0, 146.0, 142.3, 138.6, 135.6, 132.3, 128.5, 127.7, 126.8, 125.9, 125.0, 124.3, 123.7, 119.7, 119.1, 117.9, 112.9, 112.6, 111.9, 111.0, 105.2, 33.7; Anal. Calcd for $C_{29}H_{19}N_3O$: C, 81.86; H, 4.50; N, 9.88%; Found: C, 82.04; H, 4.47; N, 9.98%.

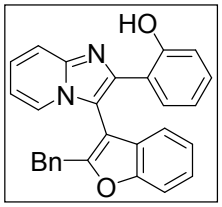


3-(2-Benzylbenzofuran-3-yl)-2-(3-nitrophenyl)imidazo[1,2-*a*]pyridine (**4ja**): Light yellow gummy mass (79%, 70 mg); R_f = 0.50 (PE : EA = 74 : 26); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.66 (t, J = 2.0 Hz, 1H), 8.04-8.01 (m, 1H), 7.97-7.95 (m, 1H), 7.75-7.72 (m, 1H), 7.66-7.60 (m, 2H), 7.39-7.27 (m, 3H), 7.23-7.19 (m, 1H), 7.14 (d, J = 6.8 Hz, 1H), 7.06-7.02 (m, 3H), 6.92-6.89 (m,

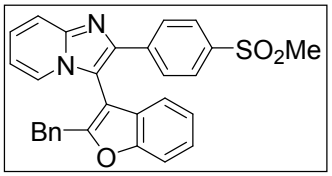
2H), 6.76-6.72 (m, 1H), 3.94-3.82 (m, 2H); $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 157.4, 155.0, 148.6, 145.9, 142.0, 135.9, 135.6, 132.9, 129.3, 128.4, 127.7, 126.8, 125.8, 125.0, 124.3, 123.7, 122.3, 119.7, 117.9, 112.9, 112.2, 111.9, 105.2, 33.8; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{28}H_{20}N_3O_3$: 446.1505; found: 446.1500.



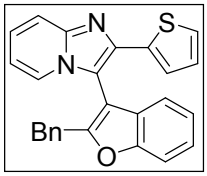
3-(2-Benzylbenzofuran-3-yl)-2-(4-(trifluoromethyl)phenyl)imidazo[1,2-*a*]pyridine (**4ka**): Brown gummy mass (78%, 73 mg); R_f = 0.50 (PE : EA = 76 : 24); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.84 (d, J = 8.0 Hz, 2H), 7.73 (d, J = 9.2 Hz, 1H), 7.64-7.58 (m, 2H), 7.49 (d, J = 8.4 Hz, 2H), 7.38-7.34 (m, 1H), 7.30-7.24 (m, 1H), 7.22-7.16 (m, 2H), 7.07-7.03 (m, 3H), 6.88-6.86 (m, 2H), 6.74-6.70 (m, 1H), 3.88-3.77 (m, 2H); $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 157.4, 155.0, 146.0, 143.0, 137.6, 135.8, 129.7, 129.4, 128.6, 128.5, 128.0, 127.6, 126.8, 125.5 ($J_{C\text{-}F}$ = 12 Hz, 9 Hz), 124.9, 124.3, 123.7, 119.8, 117.9, 112.8, 112.2, 111.9, 105.4, 33.7; Anal. Calcd for $C_{29}H_{19}F_3N_2O$: C, 74.35; H, 4.09; N, 5.98%; Found: C, 74.58; H, 4.03; N, 6.09%.



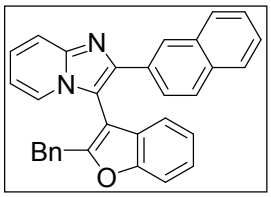
2-(3-(2-Benzylbenzofuran-3-yl)imidazo[1,2-*a*]pyridin-2-yl)phenol (4la): White solid (85%, 70 mg); R_f = 0.45 (PE : EA = 81 : 19); M.p. 210-211 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 13.15 (br s, 1H), 7.67-7.64 (m, 1H), 7.61-7.56 (m, 2H), 7.38-7.34 (m, 1H), 7.31-7.27 (m, 2H), 7.22-7.14 (m, 3H), 7.07-7.05 (m, 4H), 6.95-6.93 (m, 2H), 6.74-6.70 (m, 1H), 6.57-6.53 (m, 1H), 3.97-3.87 (m, 2H); $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 158.0, 157.8, 155.1, 143.38, 143.32, 135.8, 129.6, 128.7, 128.4, 127.9, 126.79, 126.70, 125.7, 124.9, 123.8, 123.6, 119.9, 118.9, 117.7, 116.7, 113.0, 111.8, 109.9, 105.7, 34.0; Anal. Calcd for $C_{28}H_{20}N_2O_2$: C, 80.75; H, 4.84; N, 6.73%; Found: C, 80.60; H, 4.89; N, 6.65%.



3-(2-Benzylbenzofuran-3-yl)-2-(4-(methylsulfonyl)phenyl)imidazo[1,2-*a*]pyridine (**4ma**): Yellow gummy mass (70%, 66 mg); R_f = 0.50 (PE : EA = 55 : 45); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.92 (d, J = 8.8 Hz, 2H), 7.79-7.75 (m, 3H), 7.61 (t, J = 8.4 Hz, 21H), 7.39-7.35 (m, 1H), 7.33-7.28 (m, 1H), 7.22 (t, J = 7.6 Hz, 1H), 7.14 (d, J = 8.0 Hz, 1H), 7.08-7.02 (m, 3H), 6.89-6.87 (m, 2H), 6.76-6.72 (m, 1H), 3.88-3.78 (m, 2H), 3.01 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 157.5, 155.0, 146.0, 142.2, 139.5, 139.2, 135.6, 130.0, 128.5, 128.1, 127.8, 127.6, 127.2, 126.9, 126.1, 125.1, 124.3, 123.8, 119.7, 117.9, 113.1, 112.0, 105.1, 44.6, 33.8; Anal. Calcd for $C_{29}H_{22}N_2O_3S$: C, 72.78; H, 4.63; N, 5.85%; Found: C, 72.99; H, 4.59; N, 5.78%.

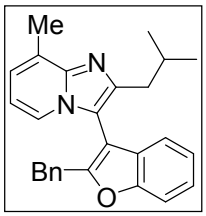


3-(2-Benzylbenzofuran-3-yl)-2-(thiophen-2-yl)imidazo[1,2-*a*]pyridine (**4na**): White solid (86%, 69 mg); R_f = 0.50 (PE : EA = 80 : 20); M.p. 179-180 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.70 (d, J = 8.8 Hz, 1H), 7.58-7.54 (m, 2H), 7.35-7.30 (m, 1H), 7.24-7.18 (m, 4H), 7.16-7.13 (m, 1H), 7.10-7.08 (m, 3H), 7.00-6.98 (m, 2H), 6.93-6.91 (m, 1H), 6.65 (t, J = 6.8 Hz, 1H), 3.95 (s, 2H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 157.9, 155.0, 145.6, 140.0, 137.1, 136.0, 128.6, 128.4, 127.9, 127.6, 126.7, 125.6, 125.2, 124.8, 124.6, 123.9, 123.4, 119.9, 117.3, 112.4, 111.6, 110.0, 105.0, 33.9; Anal. Calcd for $C_{26}H_{18}N_2OS$: C, 76.82; H, 4.46; N, 6.89%; Found: C, 76.63; H, 4.39; N, 6.99%.

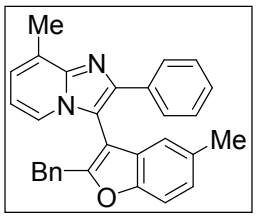


3-(2-Benzylbenzofuran-3-yl)-2-(naphthalen-2-yl)imidazo[1,2-*a*]pyridine (**4oa**): Brown gummy mass (78%, 70 mg); R_f = 0.45 (PE : EA = 78 : 22); ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.38 (s, 1H), 7.79-7.74 (m, 4H), 7.69-7.65 (m, 2H), 7.59 (d, J = 8.4 Hz, 1H), 7.46-7.40 (m, 2H), 7.38-

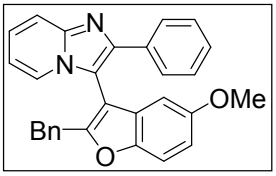
7.34 (m, 1H), 7.29-7.20 (m, 3H), 7.03-6.95 (m, 3H), 6.87-6.85 (m, 2H), 6.70-6.69 (m, 1H), 3.86-3.75 (m, 2H); $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 157.4, 155.0, 145.9, 144.4, 136.0, 133.6, 133.0, 131.5, 128.6, 128.5, 128.4, 128.3, 128.1, 127.6, 126.8, 126.6, 126.1, 125.35, 125.32, 124.8, 124.7, 124.2, 123.5, 120.0, 117.6, 112.4, 111.8, 111.6, 105.9, 33.7; Anal. Calcd for $C_{32}H_{22}N_2O$: C, 85.31; H, 4.92; N, 6.22%; Found: C, 85.11; H, 4.89; N, 6.30%.



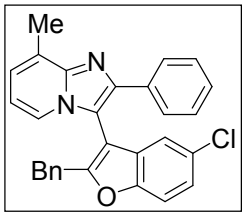
3-(2-Benzylbenzofuran-3-yl)-2-isobutyl-8-methylimidazo[1,2-*a*]pyridine (4pa): Brown gummy mass (90%, 70 mg); R_f = 0.60 (PE : EA = 81 : 19); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.53 (d, J = 8.4 Hz, 1H), 7.47 (d, J = 6.8 Hz, 1H), 7.31-7.29 (m, 1H), 7.23-7.17 (m, 4H), 7.12 (d, J = 8.4 Hz, 3H), 7.00 (d, J = 7.2 Hz, 1H), 6.59 (t, J = 7.2 Hz, 1H), 4.06-3.97 (m, 2H), 2.74 (s, 3H), 2.72-2.67 (m, 1H), 2.53-2.48 (m, 1H), 2.25-2.14 (m, 1H), 0.86 (d, J = 6.8 Hz, 3H), 0.73 (d, J = 6.8 Hz, 3H); $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 156.9, 154.8, 145.9, 145.8, 136.6, 128.7, 128.6, 128.5, 126.84, 126.82, 124.4, 123.8, 123.2, 122.0, 119.8. 112.7, 112.0, 111.6, 105.7, 37.4, 33.5, 28.9, 22.8, 22.2, 17.7; Anal. Calcd for $C_{27}H_{26}N_2O$: C, 82.20; H, 6.64; N, 7.10%; Found: C, 82.44; H, 6.69; N, 7.19%.



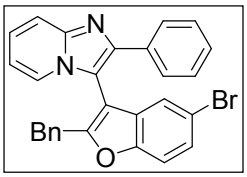
3-(2-Benzyl-5-methylbenzofuran-3-yl)-8-methyl-2-phenylimidazo[1,2-*a*]pyridine (4bb): Brown gummy mass (77%, 65 mg); R_f = 0.45 (PE : EA = 94 : 6); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.78-7.76 (m, 2H), 7.52 (d, J = 6.8 Hz, 1H), 7.42 (d, J = 8.4 Hz, 1H), 7.30-7.24 (m, 3H), 7.15-7.12 (m, 1H), 7.09-7.06 (m, 3H), 7.04-7.02 (m, 1H), 6.99 (s, 1H), 6.89-6.87 (m, 2H), 6.62 (t, J = 6.8 Hz, 1H), 3.81-3.70 (m, 2H), 2.75 (s, 3H), 2.35 (s, 3H); $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 157.2, 153.4, 146.3, 144.1, 136.4, 134.4, 133.0, 131.0, 130.6, 128.7, 128.6, 128.4, 127.7, 127.6, 126.6, 125.8, 123.7, 122.1, 119.8, 112.3, 111.8, 111.2, 105.9, 33.5, 21.4, 17.2; Anal. Calcd for $C_{30}H_{24}N_2O$: C, 84.08; H, 5.65; N, 6.54%; Found: C, 84.26; H, 5.59; N, 6.42%.



3-(2-Benzyl-5-methoxybenzofuran-3-yl)-2-phenylimidazo[1,2-*a*]pyridine (**4ac**): Brown solid (89%, 76 mg); R_f = 0.45 (PE : EA = 80 : 20); M.p. 135-136 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.77-7.75 (m, 2H), 7.72 (d, J = 9.2 Hz, 1H), 7.61 (d, J = 6.8 Hz, 1H), 7.43 (d, J = 8.8 Hz, 1H), 7.30-7.24 (m, 3H), 7.23-7.21 (m, 1H), 7.05 (t, J = 3.6 Hz, 3H), 6.93-6.90 (m, 1H), 6.88-6.86 (m, 2H), 6.69-6.66 (m, 1H), 6.59 (d, J = 2.4 Hz, 1H), 3.82-3.73 (m, 2H), 3.66 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 158.0, 156.5, 149.8, 145.8, 144.5, 136.2, 134.1, 128.8, 128.7, 128.6, 128.4, 127.8, 127.5, 126.6, 125.1, 124.1, 117.6, 113.4, 112.4, 112.3, 111.2, 105.9, 102.0, 55.9, 33.8; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{29}H_{23}N_2O_2$: 431.1760; found: 431.1756.

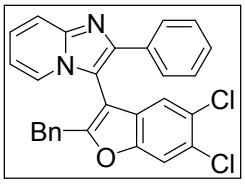


3-(2-Benzyl-5-chlorobenzofuran-3-yl)-8-methyl-2-phenylimidazo[1,2-*a*]pyridine (**4bd**): Light yellow gummy mass (83%, 74 mg); R_f = 0.50 (PE : EA = 92 : 8); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.74-7.72 (m, 2H), 7.48-7.43 (m, 2H), 7.30-7.24 (m, 4H), 7.16 (d, J = 2.0 Hz, 1H), 7.09-7.03 (m, 4H), 6.88-6.85 (m, 2H), 6.63 (t, J = 6.8 Hz, 1H), 3.82-3.71 (m, 2H), 2.74 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 158.8, 153.4, 146.4, 144.5, 135.9, 134.3, 129.8, 129.2, 128.8, 128.6, 128.5, 127.9, 127.8, 127.7, 126.8, 124.9, 123.9, 121.8, 119.5, 112.8, 112.6, 110.6, 106.0, 33.6, 17.2; Anal. Calcd for $C_{29}H_{21}ClN_2O$: C, 77.59; H, 4.72; N, 6.24%; Found: C, 77.38; H, 4.76; N, 6.11%.

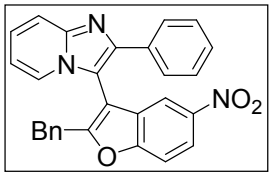


3-(2-Benzyl-5-bromobenzofuran-3-yl)-2-phenylimidazo[1,2-*a*]pyridine (4ae): Brown solid (73%, 69 mg); R_f = 0.50 (PE : EA = 82 : 18); M.p. 223-224 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.72-7.58 (m, 4H), 7.43-7.41 (m, 2H), 7.31-7.27 (m, 5H), 7.07-7.04 (m, 3H), 6.86-6.84 (m, 2H),

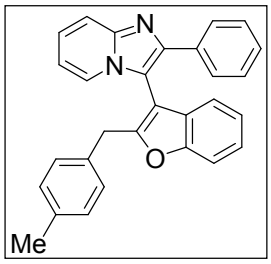
6.72 (t, J = 6.8 Hz, 1H), 3.82-3.73 (m, 2H); $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 158.9, 153.7, 145.9, 144.8, 135.7, 133.8, 130.2, 128.7, 128.6, 128.5, 128.0, 127.7, 127.5, 126.8, 125.3, 123.9, 122.4, 117.8, 116.7, 113.3, 112.7, 110.2, 105.4, 33.6; Anal. Calcd for $C_{28}H_{19}BrN_2O$: C, 70.16; H, 4.00; N, 5.84%; Found: C, 70.33; H, 3.97; N, 5.77%.



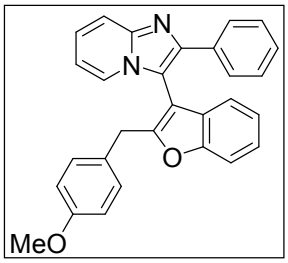
3-(2-Benzyl-5,6-dichlorobenzofuran-3-yl)-2-phenylimidazo[1,2-*a*]pyridine (**4af**): White solid (75%, 70 mg); R_f = 0.45 (PE : EA = 77 : 23); M.p. 165-166 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.71-7.68 (m, 3H), 7.48 (d, J = 6.8 Hz, 1H), 7.33 (d, J = 2.0 Hz, 1H), 7.30-7.22 (m, 4H), 7.04-7.00 (m, 4H), 6.86-6.84 (m, 2H), 6.68 (t, J = 6.8 Hz, 1H), 3.83 (s, 2H); $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 160.0, 149.4, 145.9, 145.0, 135.2, 133.7, 130.8, 129.6, 128.7, 128.6, 128.5, 128.1, 127.4, 126.9, 125.4, 125.0, 123.7, 118.1, 117.8, 117.7, 112.7, 109.5, 106.4, 33.7; Anal. Calcd for $C_{28}H_{18}Cl_2N_2O$: C, 71.65; H, 3.87; N, 5.97%; Found: C, 71.84; H, 3.82; N, 6.05%.



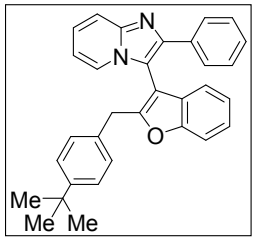
3-(2-Benzyl-5-nitrobenzofuran-3-yl)-2-phenylimidazo[1,2-*a*]pyridine (**4ag**): Light yellow solid (92%, 81 mg); R_f = 0.55 (PE : EA = 76 : 24); M.p. 184-185 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.28-8.25 (m, 1H), 8.10 (d, J = 2.4 Hz, 1H), 7.76 (d, J = 8.8 Hz, 1H), 7.70-7.68 (m, 2H), 7.64 (d, J = 9.2 Hz, 1H), 7.57 (d, J = 6.8 Hz, 1H), 7.31-7.27 (m, 4H), 7.10-7.06 (m, 3H), 6.90-6.88 (m, 2H), 6.74 (t, J = 6.8 Hz, 1H), 3.90-3.81 (m, 2H); $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 161.0, 157.7, 146.1, 145.3, 144.7, 135.1, 133.7, 128.9, 128.7, 128.6, 128.2, 127.5, 127.0, 125.5, 123.6, 120.7, 117.9, 116.2, 113.0, 112.3, 109.0, 106.9, 33.8; Anal. Calcd for $C_{28}H_{19}N_3O_3$: C, 75.49; H, 4.30; N, 9.43%; Found: C, 75.29; H, 4.36; N, 9.54%.



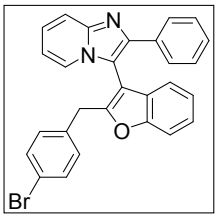
3-(2-(4-Methylbenzyl)benzofuran-3-yl)-2-phenylimidazo[1,2-*a*]pyridine (**4ah**): Brown gummy mass (79%, 65 mg); R_f = 0.50 (PE : EA = 78 : 22); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.75 (d, J = 8.0 Hz, 3H), 7.62 (d, J = 6.8 Hz, 1H), 7.55 (d, J = 8.0 Hz, 1H), 7.35-7.31 (m, 1H), 7.26-7.22 (m, 4H), 7.20-7.16 (m, 2H), 6.87 (d, J = 7.6 Hz, 2H), 6.77 (d, J = 7.6 Hz, 2H), 6.68 (t, J = 6.8 Hz, 1H), 3.80-3.71 (m, 2H), 2.21 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 157.6, 155.0, 145.8, 144.6, 136.3, 134.1, 133.1, 129.3, 129.1, 128.6, 128.2, 127.8, 127.6, 125.1, 124.6, 124.2, 123.4, 119.9, 117.7, 112.4, 111.8, 111.3, 105.6, 33.3, 21.0; Anal. Calcd for $C_{29}H_{22}N_2O$: C, 84.03; H, 5.35; N, 6.76%; Found: C, 84.26; H, 5.40; N, 6.67%.



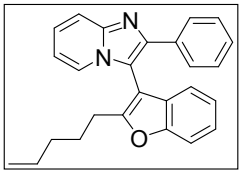
3-(2-(4-Methoxybenzyl)benzofuran-3-yl)-2-phenylimidazo[1,2-*a*]pyridine (**4ai**): Light yellow gummy mass (66%, 56 mg); R_f = 0.45 (PE : EA = 89 : 19); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.78-7.72 (m, 3H), 7.61 (d, J = 9.2 Hz, 1H), 7.55 (d, J = 8.4 Hz, 1H), 7.35-7.31 (m, 1H), 7.27-7.22 (m, 4H), 7.20-7.16 (m, 2H), 6.80-6.77 (m, 2H), 6.71-6.68 (m, 1H), 6.61-6.58 (m, 2H), 3.73 (d, J = 5.6 Hz, 2H), 3.69 (s, 3H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 158.3, 157.7, 155.0, 145.8, 144.5, 134.0, 129.7, 128.6, 128.27, 128.21, 128.1, 127.8, 127.6, 125.1, 124.6, 124.2, 123.4, 119.9, 117.7, 113.8, 112.4, 111.8, 105.4, 55.3, 32.8; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{29}H_{23}N_2O_2$: 431.1760; found: 431.1758.



3-(2-(4-(*tert*-Butyl)benzyl)benzofuran-3-yl)-2-phenylimidazo[1,2-*a*]pyridine (**4aj**): Brown gummy mass (65%, 59 mg); R_f = 0.45 (PE : EA = 77 : 23); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.75 (br s, 3H), 7.62-7.56 (m, 2H), 7.35-7.31 (m, 1H), 7.27-7.22 (m, 4H), 7.19 (d, J = 6.4 Hz, 2H), 7.07 (d, J = 8.4 Hz, 2H), 6.81 (d, J = 8.4 Hz, 2H), 6.67 (t, J = 6.8 Hz, 1H), 3.78 (s, 2H), 1.21 (s, 9H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 157.6, 155.0, 149.5, 134.2, 133.1, 128.6, 128.3, 127.8, 127.5, 125.3, 125.0, 124.6, 124.2, 123.4, 119.9, 117.7, 113.7, 112.3, 111.7, 105.7, 34.4, 33.2, 31.4; Anal. Calcd for $C_{32}H_{28}N_2O$: C, 84.18; H, 6.18; N, 6.14%; Found: C, 84.00; H, 6.12; N, 6.24%.

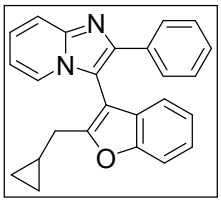


3-(2-(4-Bromobenzyl)benzofuran-3-yl)-2-phenylimidazo[1,2-*a*]pyridine (**4ak**): Brown gummy mass (67%, 64mg); R_f = 0.40 (PE : EA = 80 : 20); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.85-7.83 (m, 3H), 7.72-7.66 (m, 2H), 7.48-7.44 (m, 1H), 7.37-7.32 (m, 6H), 7.28-7.25 (m, 2H), 6.84-6.79 (m, 3H), 3.89-3.79 (m, 2H); ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$): δ 156.5, 155.0, 147.9, 144.8, 135.1, 134.1, 131.5, 130.4, 128.7, 128.1, 127.9, 127.6, 125.2, 124.9, 124.1, 123.6, 120.6, 120.0, 117.7, 112.5, 111.8, 106.1, 33.1; Anal. Calcd for $C_{28}H_{19}BrN_2O$: C, 70.16; H, 4.00; N, 5.84%; Found: C, 70.37; H, 4.03; N, 5.77%.

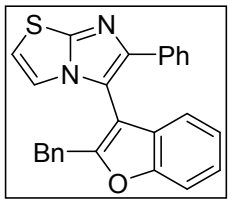


3-(2-Pentylbenzofuran-3-yl)-2-phenylimidazo[1,2-*a*]pyridine (**4al**): Yellow gummy mass (86%, 65mg); R_f = 0.45 (PE : EA = 88 : 12); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.80 (d, J = 8.8 Hz, 1H), 7.72-7.70 (m, 3H), 7.57 (d, J = 8.0 Hz, 1H), 7.35-7.31 (m, 1H), 7.28-7.20 (m, 4H), 7.18-

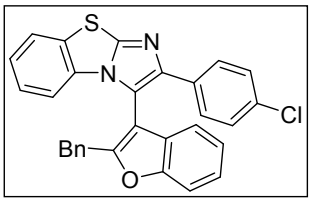
7.14 (m, 2H), 6.76-6.72 (m, 1H), 2.48-2.34 (m, 2H), 1.54-1.45 (m, 1H), 1.40-1.32 (m, 1H), 1.07-1.03 (m, 4H), 0.69 (t, J = 7.2 Hz, 3H); $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 159.5, 154.8, 145.7, 144.2, 134.0, 128.4, 128.1, 127.8, 127.6, 125.1, 124.3, 124.2, 123.3, 119.8, 117.7, 112.5, 111.8, 111.5, 104.8, 31.3, 27.1, 26.9, 22.2, 13.9; Anal. Calcd for $C_{26}H_{24}N_2O$: C, 82.07; H, 6.36; N, 7.36%; Found: C, 82.33; H, 6.41; N, 7.45%.



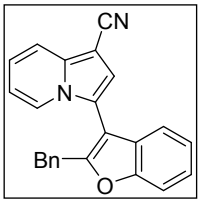
3-(2-(Cyclopropylmethyl)benzofuran-3-yl)-2-phenylimidazo[1,2-*a*]pyridine (**4am**): Brown gummy mass (83%, 60 mg); R_f = 0.50 (PE : EA = 87 : 13); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.77-7.71 (m, 4H), 7.60 (d, J = 8.4 Hz, 1H), 7.37-7.33 (m, 1H), 7.29-7.22 (m, 4H), 7.20-7.16 (m, 2H), 6.75-6.71 (m, 1H), 2.39 (d, J = 6.8 Hz, 2H), 0.87-0.79 (m, 1H), 0.29-0.25 (m, 2H), (-)0.08- (-)0.11 (m, 2H); $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 159.1, 154.9, 145.8, 144.3, 134.2, 128.5, 128.2, 127.8, 127.5, 125.0, 124.4, 124.2, 123.3, 119.9, 117.7, 112.4, 111.63, 111.60, 105.0, 32.1, 9.1, 4.6, 4.5; Anal. Calcd for $C_{25}H_{22}N_2O$: C, 82.39; H, 5.53; N, 7.69%; Found: C, 82.55; H, 5.60; N, 7.61%.



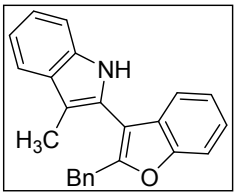
5-(2-Benzylbenzofuran-3-yl)-6-phenylimidazo[2,1-*b*]thiazole (**7aa**): yellow gummy mass (71%, 57 mg); R_f = 0.45 (PE : EA = 76 : 24); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.67-7.65 (m, 2H), 7.52 (d, J = 8.0 Hz, 1H), 7.34-7.29 (m, 1H), 7.27-7.18 (m, 5H), 7.14-7.10 (m, 3H), 6.98-6.95 (m, 3H), 6.73 (d, J = 4.8 Hz, 1H), 3.89-3.80 (m, 2H); $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$): δ 156.4, 154.8, 149.9, 145.7, 136.4, 134.4, 129.2, 128.8, 128.6, 128.5, 128.1, 127.3, 126.8, 124.9, 124.6, 123.4, 119.9, 117.9, 112.5, 111.7, 106.6, 33.7; Anal. Calcd for $C_{26}H_{18}N_2OS$: C, 76.82; H, 4.46; N, 6.89%; Found: C, 76.60; H, 4.42; N, 7.00%.



3-(2-Benzylbenzofuran-3-yl)-2-(4-chlorophenyl)benzo[*d*]imidazo[2,1-*b*]thiazole (**7ba**): Light yellow solid (62%, 60 mg); R_f = 0.45 (PE : EA = 92 : 7); M.p. 215-216 °C; H NMR (400 MHz, $CDCl_3$): δ 7.93 (d, J = 8.0 Hz, 1H), 7.75-7.72 (m, 4H), 7.68 (t, J = 1.2 Hz, 1H), 7.52-7.48 (m, 2H), 7.45-7.43 (m, 2H), 7.35-7.30 (m, 1H), 7.25-7.18 (m, 2H), 7.06 (d, J = 7.2 Hz, 2H), 6.96 (d, J = 8.0 Hz, 1H), 4.11 (s, 2H); $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 158.8, 153.4, 149.0, 145.5, 135.2, 133.4, 132.7, 132.4, 130.9, 130.4, 128.8, 128.7, 128.3, 128.1, 127.9, 126.8, 126.3, 124.9, 124.3, 122.6, 117.1, 113.4, 113.1, 112.8, 105.9, 33.9; Anal. Calcd for $C_{30}H_{19}ClN_2OS$: C, 73.39; H, 3.90; N, 5.71%; Found: C, 73.59; H, 3.96; N, 5.59%.

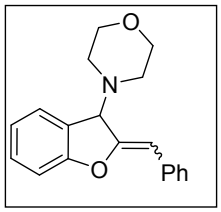


3-(2-benzylbenzofuran-3-yl)indolizine-1-carbonitrile (**7ca**): Yellow gummy mass (53%, 36 mg); R_f = 0.60 (PE : EA = 93 : 7); ^1H NMR (400 MHz, $CDCl_3$): δ 7.79-7.73 (m, 2H), 7.53 (d, J = 8.4 Hz, 1H),7.35-7.30 (m, 1H), 7.28-7.18 (m, 4H), 7.18-7.11 (m, 4H), 7.06 (s, 1H), 6.72-6.68 (m, 1H), 4.12-4.06 (m, 2H); $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 157.0, 154.5, 138.7, 136.7, 128.8, 128.6, 127.7, 127.0, 126.1, 124.9, 124.7, 123.4, 122.7, 119.9, 118.2, 118.0, 116.9, 113.0, 111.8, 106.7, 82.1, 33.4; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{24}H_{17}N_2O$: 349.1341; found: 349.1337.

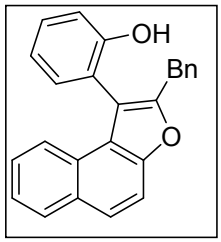


2-(2-Benzylbenzofuran-3-yl)-3-methyl-1*H*-indole (**7da**): Brown gummy mass (45%, 30 mg); R_f = 0.45 (PE : EA = 94 : 6); ^1H NMR (400 MHz, $CDCl_3$): δ 7.85 (s, 1H), 7.63 (d, J = 7.6 Hz, 1H), 7.48-7.44 (m, 2H), 7.34 (d, J = 8.0 Hz, 1H), 7.30-7.14 (m, 9H), 4.14 (s, 2H), 2.28 (s, 3H);

$^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 155.1, 154.5, 137.6, 136.4, 129.5, 129.4, 128.9, 128.8, 128.6, 126.8, 124.3, 123.1, 122.3, 120.2, 119.5, 118.9, 111.4, 111.0, 110.8, 33.6, 9.8; HRMS (ESI-TOF) *m/z*: $[M + H]^+$ Calcd for $C_{24}H_{20}NO$: 338.1539; found: 338.1538.



4-(2-Benzylidene-2,3-dihydrobenzofuran-3-yl)morpholine (**9**):[2] Yellow solid (73%, 42 mg); R_f = 0.45 (PE : EA = 86 : 14); M.p. 102-103 °C;^1H NMR (400 MHz, $CDCl_3$): δ 7.55-7.53 (m, 2H), 7.50-7.44 (m, 2H), 7.35-7.32 (m, 2H), 7.29-7.16 (m, 3H), 6.66 (s, 1H), 4.51 (s, 1H), 3.73 (t, J = 4.8 Hz, 4H), 2.51-2.44 (m, 4H); $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 156.9, 155.1, 138.7, 128.7, 128.6, 128.2, 127.9, 124.0, 122.8, 120.8, 111.5, 105.3, 69.8, 67.1, 52.3; Anal. Calcd for $C_{19}H_{19}NO_2$: C, 77.79; H, 6.53; N, 4.77%; Found: C, 78.01; H, 6.59; N, 4.68%.



2-(2-Benzylnaphtho[2,1-*b*]furan-1-yl)phenol (**12**): Yellow solid (76%, 53 mg); R_f = 0.55 (PE : EA = 94 : 6); ^1H NMR (400 MHz, $CDCl_3$): δ 7.87 (d, J = 8.4 Hz, 1H), 7.70 (d, J = 8.8 Hz, 1H), 7.63-7.61 (m, 2H), 7.45-7.40 (m, 2H), 7.38-7.25 (m, 4H), 7.22-7.19 (m, 3H), 7.12-7.05 (m, 2H), 5.00 (s, 1H), 4.07-3.98 (m, 2H); $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$): δ 154.8, 154.4, 152.4, 137.6, 131.7, 130.8, 130.4, 128.8, 128.7, 128.0, 126.8, 126.5, 125.7, 124.6, 122.7, 121.9, 121.1, 119.4, 115.8, 112.7, 112.4, 23.0; Anal. Calcd for $C_{25}H_{18}O_2$: C, 85.69; H, 5.18%; Found: C, 85.49; H, 5.22%.

6. References:

(1) (*a*) A. K. Bagdi, M. Rahman, S. Santra, A. Majee and A. Hajra, *Adv. Synth. Catal*., 2013, **355**, 1741; (*b*) S. Mishra, K. Monir, S. Mitra and A. Hajra, *Org. Lett*., 2014, **16**, 6084.
(2) N. Wongsa, U. Sommart, T. Ritthiwigrom, A. Yazici, S. Kanokmedhakul, K. Kanokmedhakul, A. C. Willis and S. G. Pyne, *J. Org. Chem*., 2013, **78**, 1138.

7. NMR spectra for the synthesized products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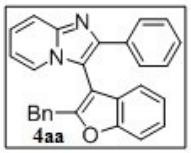
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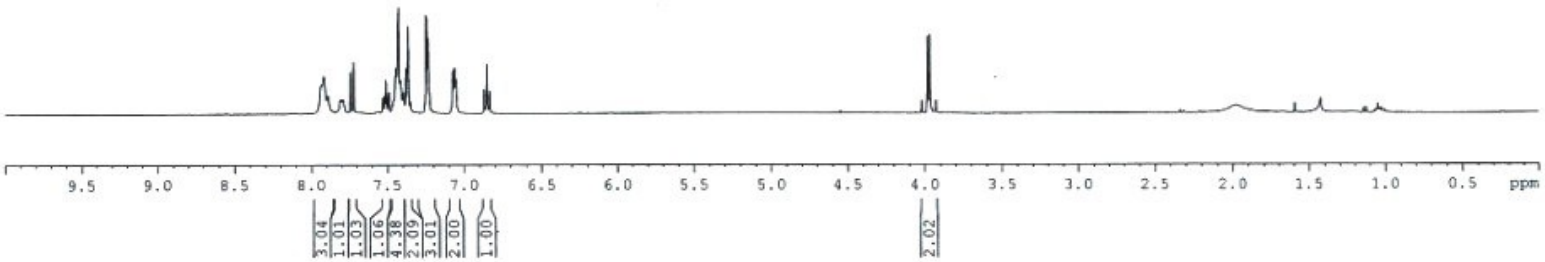
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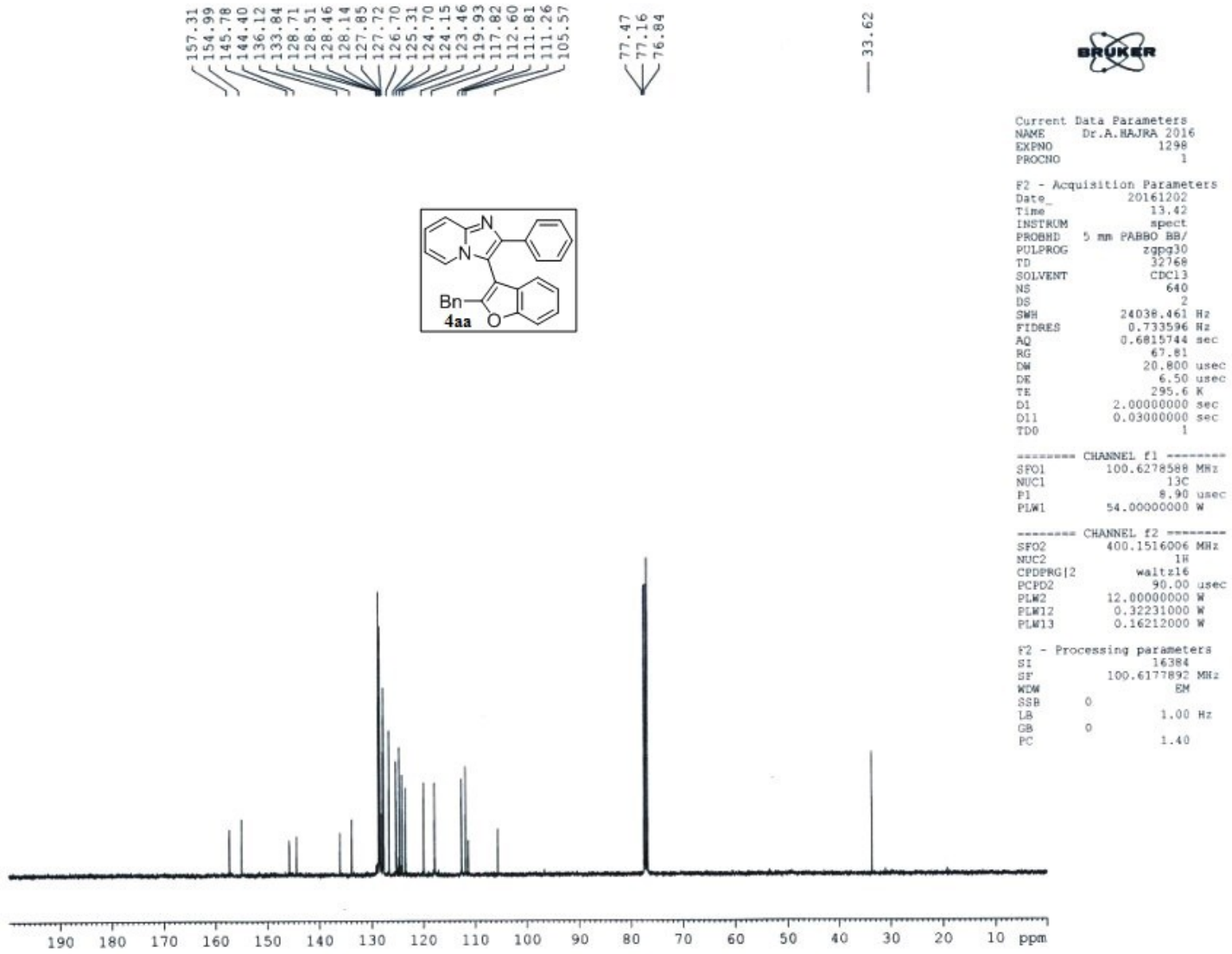

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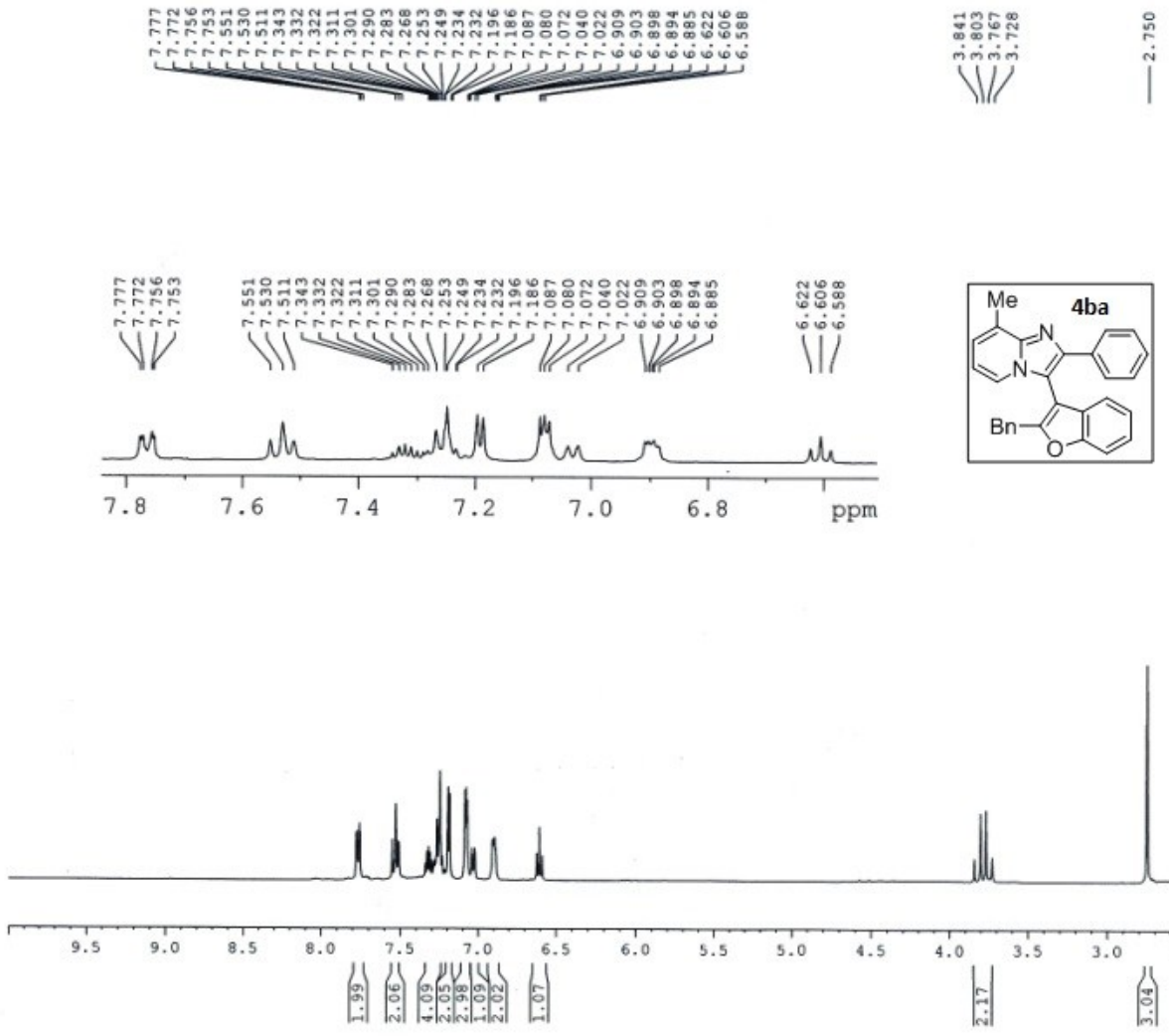
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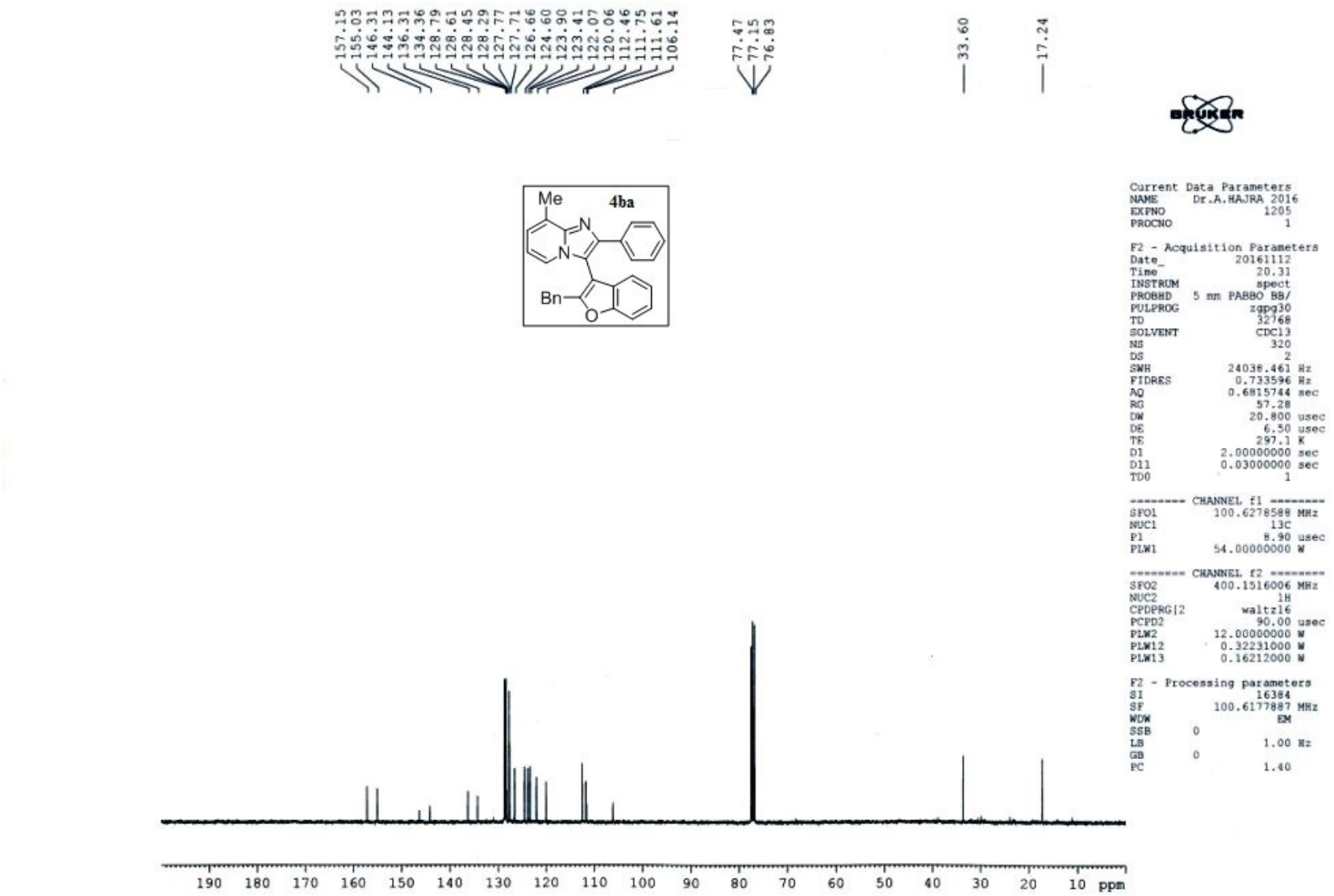
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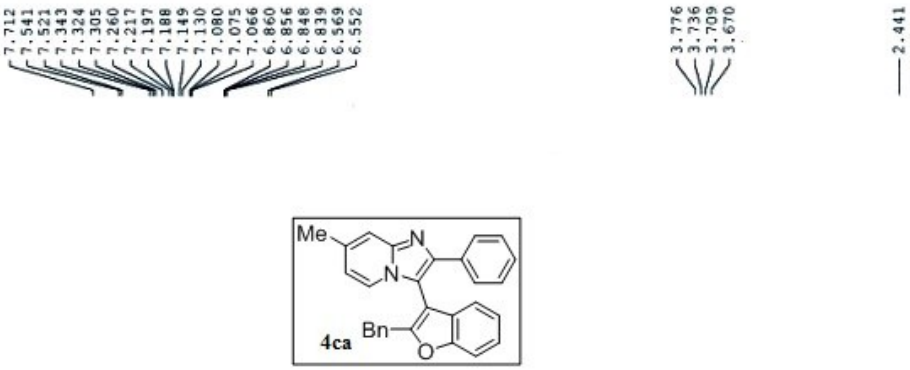
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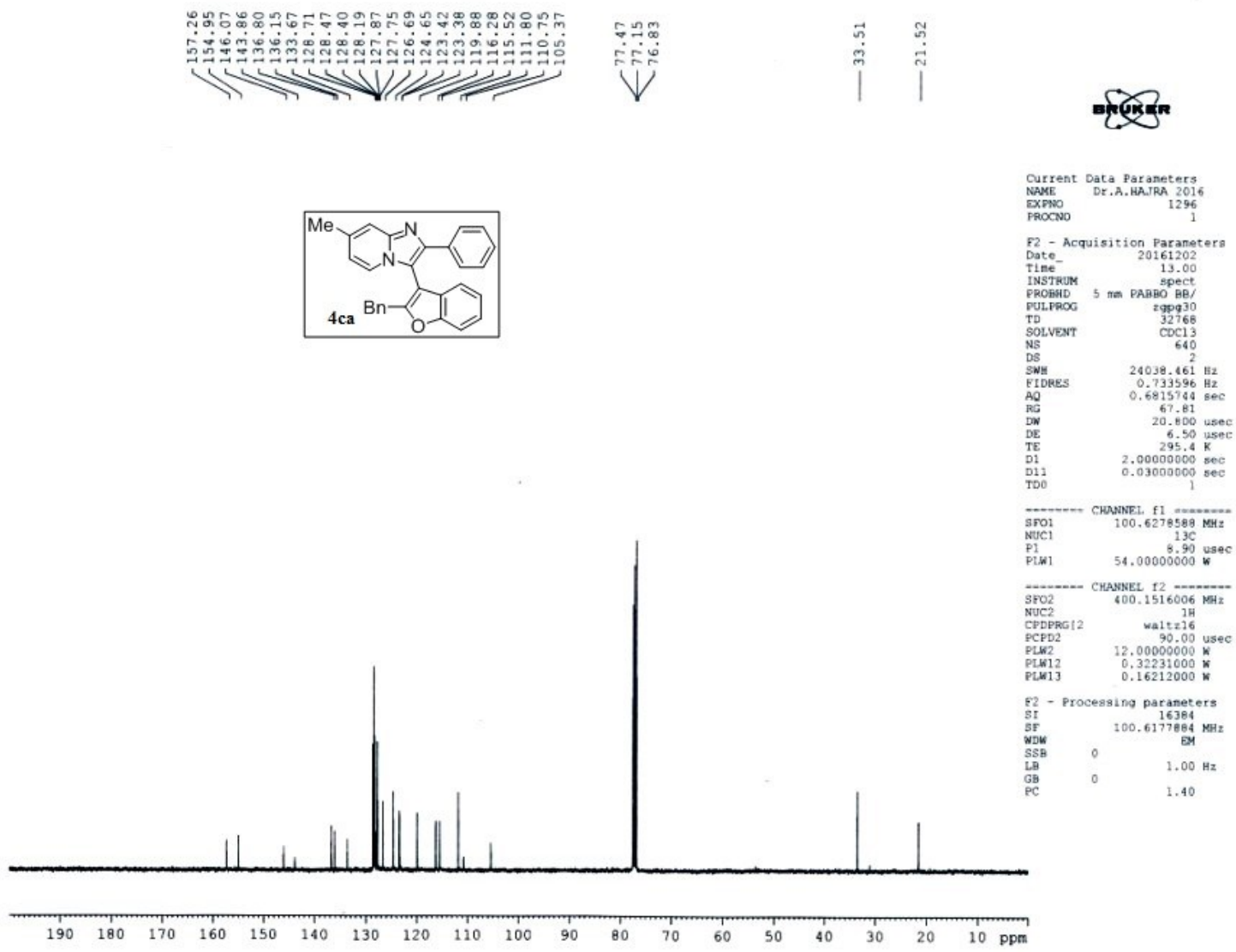
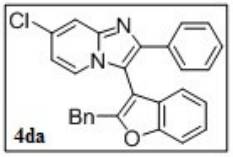
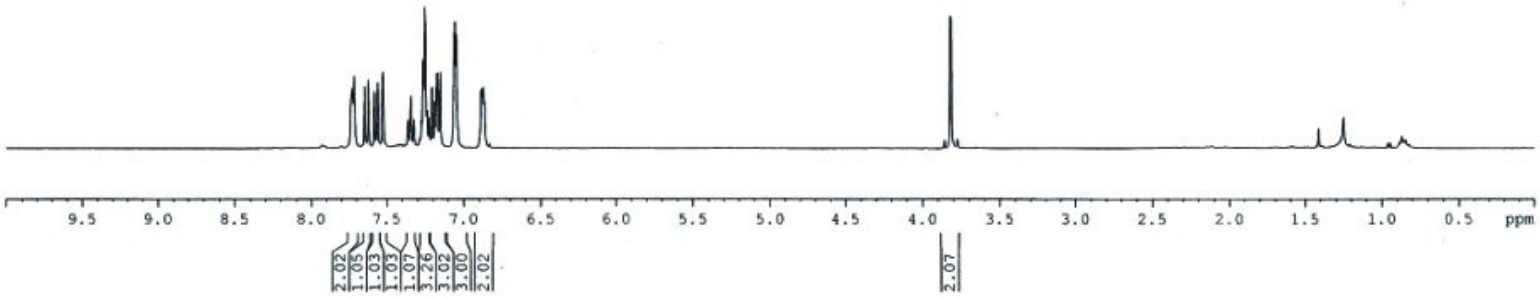
7.130
7.080
7.075
7.066
6.860
6.856
6.848
6.839
6.569
6.552
3.776
3.736
3.709
3.670
2.441
Me
N
N
Bn
O
4ca
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
3.05
2.02
1.00
5.07
3.02
2.03
1.00
2.03
3.04

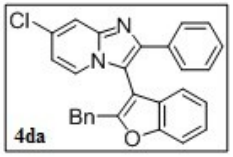

157.26
154.95
146.07
143.86
136.80
136.15
133.67
128.71
128.47
128.40
128.19
127.87
127.75
126.69
124.65
123.42
123.38
119.88
116.28
115.52
111.80
110.75
105.37
77.47
77.15
76.83
33.51
21.52
Me
N
N
Bn
O
4ca
BRUKER
Current Data Parameters
NAME Dr.A.HAJRA 2016
EXPNO 1296
PROCNO 1
F2 - Acquisition Parameters
Date_ 20161202
Time 13.00
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 640
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 67.81
DW 20.800 usec
DE 6.50 usec
TE 295.4 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
CHANNEL f1
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W
CHANNEL f2
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W
F2 - Processing parameters
SI 16384
SF 100.6177884 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm


7.735
7.728
7.725
7.720
7.716
7.712
7.646
7.622
7.582
7.561
7.528
7.363
7.360
7.346
7.342
7.325
7.322
7.273
7.263
7.260
7.251
7.246
7.236
7.225
7.206
7.187
7.179
7.170
7.155
7.151
7.063
7.056
7.047
6.887
6.883
6.874
6.866

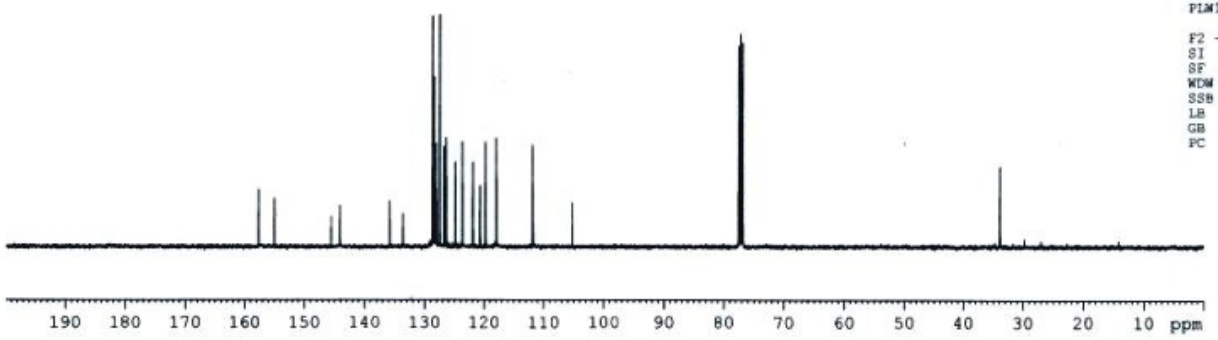

3.859
3.819
3.815
3.775

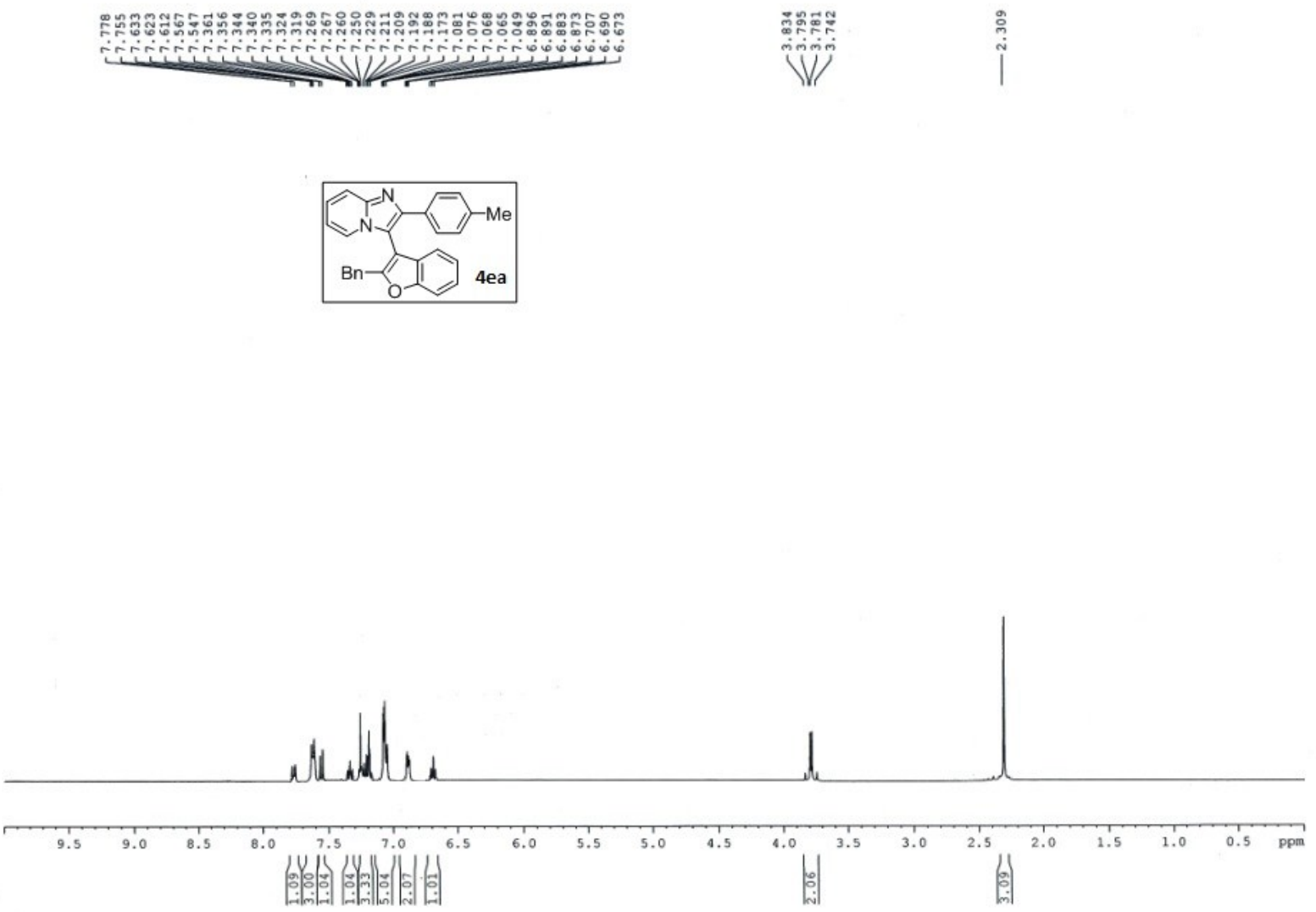

Cl
N
N
Bn
O
4da


9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.02
1.05
1.03
1.07
3.26
3.02
3.00
2.02
2.07




```
Current Data Parameters
NAME      Dr.A.HAJRA 2017
EXPNO             1115
PROCNO               1

F2 - Acquisition Parameters
Date_         20170627
Time             19.21
INSTRUM          spect
PROBHD   5 mm PABBO BB/
PULPROG        zgpg30
TD              32768
SOLVENT         CDCl3
NS                400
DS                  2
SWH         24038.461 Hz
FIDRES       0.733596 Hz
AQ           0.6815744 sec
RG               57.28
DW              20.800 usec
DE               6.50 usec
TE              299.0 K
D1          2.00000000 sec
D11         0.03000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1       100.6278588 MHz
NUC1              13C
P1               8.90 usec
PLW1      54.00000000 W

======== CHANNEL f2 ========
SFO2       400.1516006 MHz
NUC2              1H
CPDPRG[2       waltz16
PCPD2            90.00 usec
PLW2      12.00000000 W
PLW12      0.32231000 W
PLW13      0.16212000 W

F2 - Processing parameters
SI               16384
SF         100.6177882 MHz
WDW                EM
SSB      0
LB               1.00 Hz
GB       0
PC               1.40
```

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7.612
7.567
7.547
7.361
7.356
7.344
7.340
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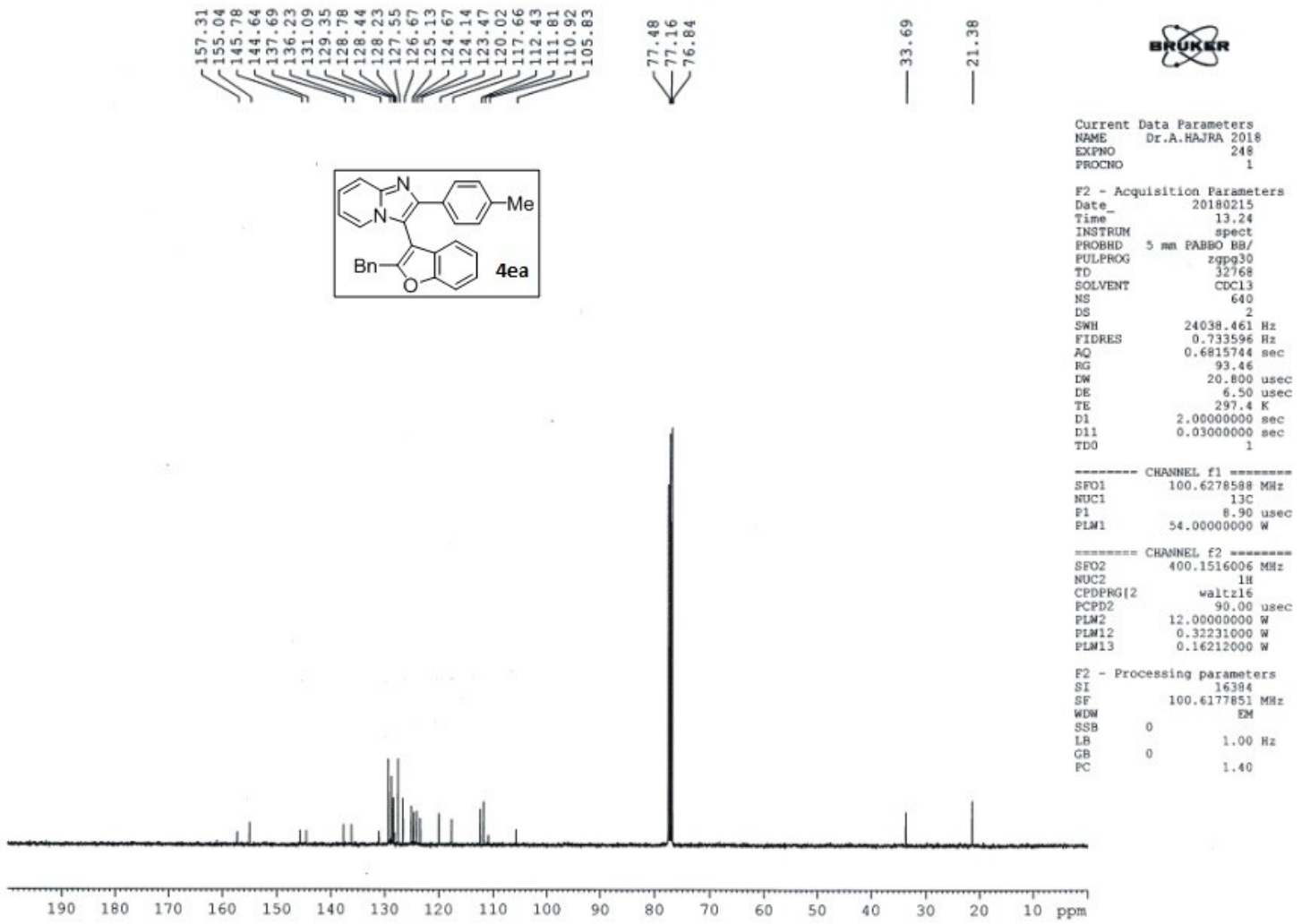
7.324
7.319
7.269
7.267
7.260
7.250
7.229
7.211
7.209
7.192
7.188
7.173
7.081
7.076
7.068
7.065
7.049
6.896
6.891
6.883
6.873
6.707
6.690
6.673
3.834
3.795
3.781
3.742
2.309
N
N
Me
Bn
O
4ea
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
1.09
3.00
1.04
1.04
3.33
5.04
2.07
1.01
2.06
3.09




```
Current Data Parameters
NAME      Dr.A.HAJRA 2018
EXPNO              248
PROCNO               1

F2 - Acquisition Parameters
Date_          20180215
Time             13.24
INSTRUM          spect
PROBHD   5 mm PABBO BB/
PULPROG        zgpg30
TD               32768
SOLVENT          CDCl3
NS                 640
DS                   2
SWH          24038.461 Hz
FIDRES        0.733596 Hz
AQ            0.6815744 sec
RG               93.46
DW               20.800 usec
DE                6.50 usec
TE               297.4 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1       100.6278588 MHz
NUC1              13C
P1                8.90 usec
PLW1      54.00000000 W

======== CHANNEL f2 ========
SFO2       400.1516006 MHz
NUC2              1H
CPDPRG[2       waltz16
PCPD2            90.00 usec
PLW2      12.00000000 W
PLW12      0.32231000 W
PLW13      0.16212000 W

F2 - Processing parameters
SI               16384
SF         100.6177851 MHz
WDW                EM
SSB      0
LB               1.00 Hz
GB       0
PC               1.40
```


7.826
7.803
7.655
7.633
7.618
7.601
7.564
7.543
7.359
7.355
7.342
7.338
7.321
7.318
7.278
7.277
7.260
7.239
7.232
7.212
7.195
7.194
7.185
7.182
7.166
7.090
7.081
7.075
7.065
6.897
6.892
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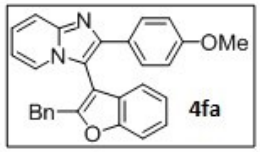
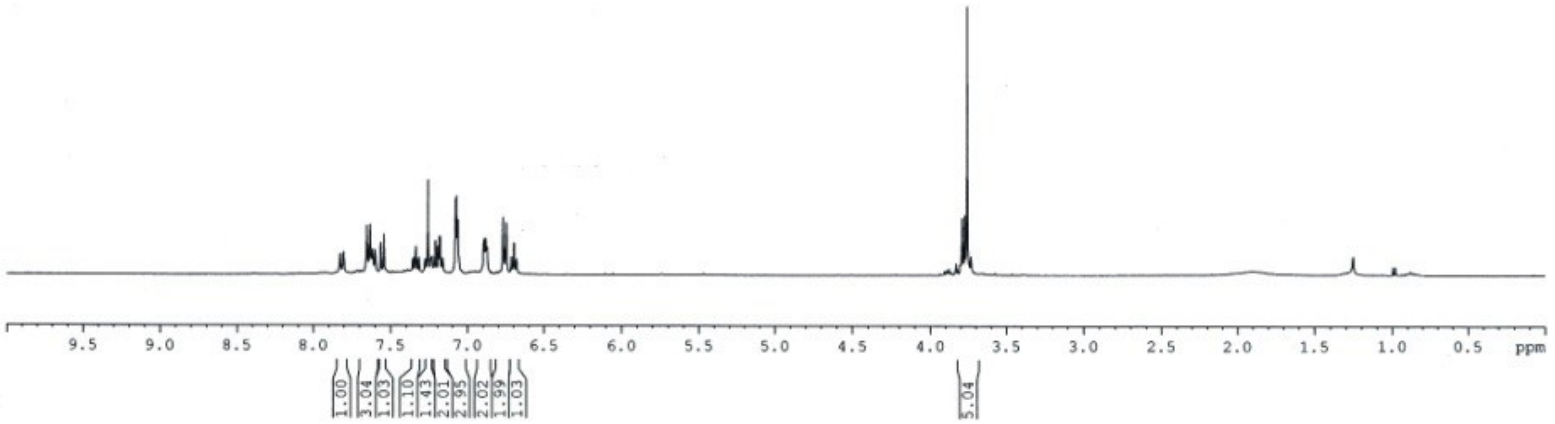
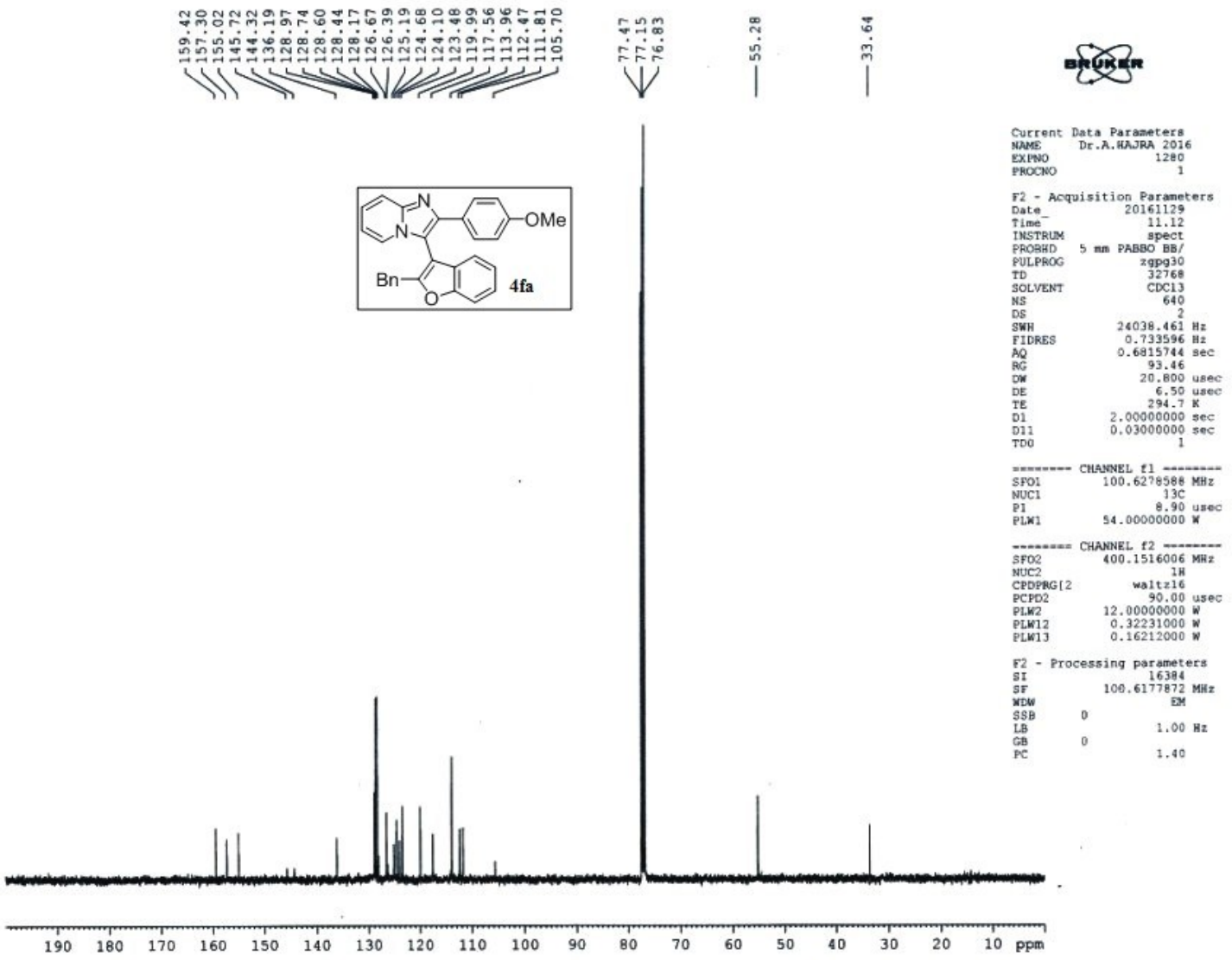
6.697
6.681


3.792
3.774
3.758
3.735


N
N
OMe
Bn
O
4fa

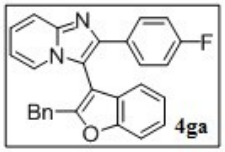

9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
1.00
3.04
1.03
1.10
1.43
2.01
2.95
2.02
1.99
1.03
5.04

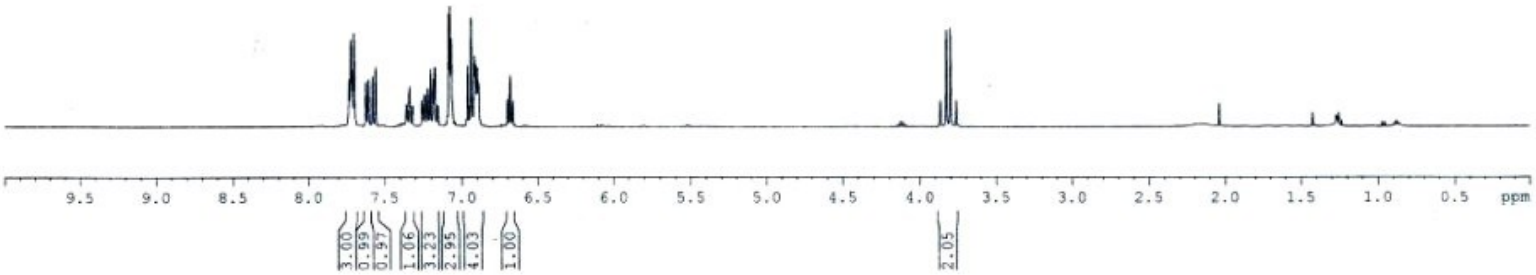


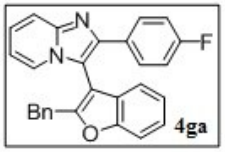

```
Current Data Parameters
NAME      Dr.A.HAJRA 2016
EXPNO             1280
PROCNO               1

F2 - Acquisition Parameters
Date_         20161129
Time             11.12
INSTRUM          spect
PROBHD   5 mm PABBO BB/
PULPROG        zgpg30
TD              32768
SOLVENT          CDCl3
NS                 640
DS                   2
SWH          24038.461 Hz
FIDRES        0.733596 Hz
AQ            0.6815744 sec
RG                93.46
DW               20.800 usec
DE                6.50 usec
TE               294.7 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1       100.6278588 MHz
NUC1               13C
P1                8.90 usec
PLW1       54.00000000 W

======== CHANNEL f2 ========
SFO2       400.1516006 MHz
NUC2               1H
CPDPRG[2        waltz16
PCPD2            90.00 usec
PLW2       12.00000000 W
PLW12       0.32231000 W
PLW13       0.16212000 W

F2 - Processing parameters
SI                16384
SF         100.6177872 MHz
WDW                  EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```


7.734
7.720
7.712
7.699
7.622
7.604
7.580
7.559
7.361
7.357
7.343
7.340
7.323
7.319
7.258
7.252
7.241
7.239
7.220
7.203
7.185
7.177
7.174
7.158
7.094
7.085
7.079
7.069
6.962
6.940
6.918
6.914
6.909
6.900
6.891
6.700
6.683
6.666

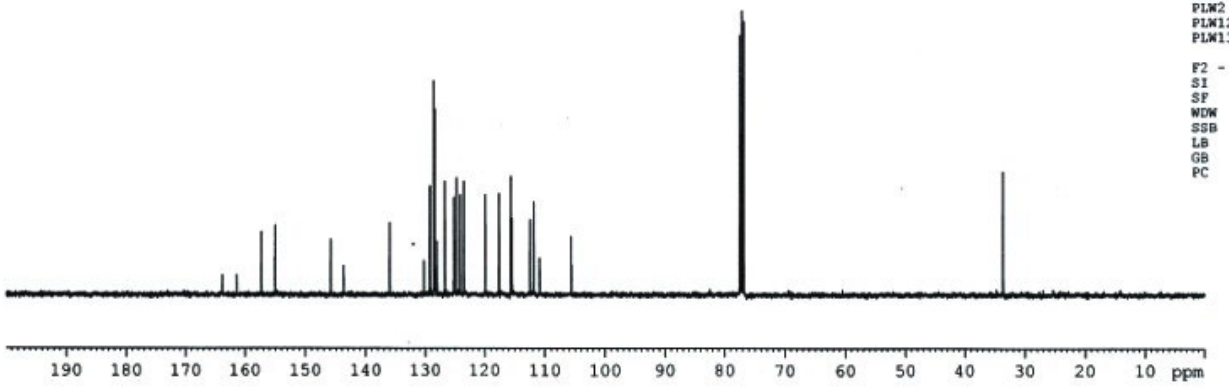

3.869
3.830
3.803
3.764


N
N
F
Bn
O
4ga


9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
3.00
0.99
0.97
1.06
3.23
2.95
4.03
1.00
2.05




```
Current Data Parameters
NAME      Dr.A.HAJRA 2017
EXPNO               1182
PROCNO                 1

F2 - Acquisition Parameters
Date_           20170709
Time              21.14
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG         zgpg30
TD               32768
SOLVENT           CDCl3
NS                  300
DS                    2
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ             0.6815744 sec
RG                57.28
DW               20.800 usec
DE                6.50 usec
TE                298.8 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        100.6278588 MHz
NUC1                13C
P1                 8.90 usec
PLW1        54.00000000 W

======== CHANNEL f2 ========
SFO2        400.1516006 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.00000000 W
PLW12        0.32231000 W
PLW13        0.16212000 W

F2 - Processing parameters
SI                 16384
SF          100.6177897 MHz
WDW                   EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
```




7.679
7.657
7.599
7.592
7.588
7.575
7.571
7.564
7.537
7.520
7.500
7.480
7.282
7.278
7.264
7.261
7.243
7.239
7.191
7.189
7.175
7.170
7.167
7.152
7.149
7.142
7.140
7.123
7.102
7.095
7.082
7.080
7.063
7.003
6.998
6.990
6.986
6.976
6.967
6.963
6.826
6.818
6.814
6.804
6.795
6.628
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6.592
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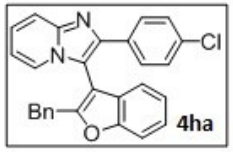
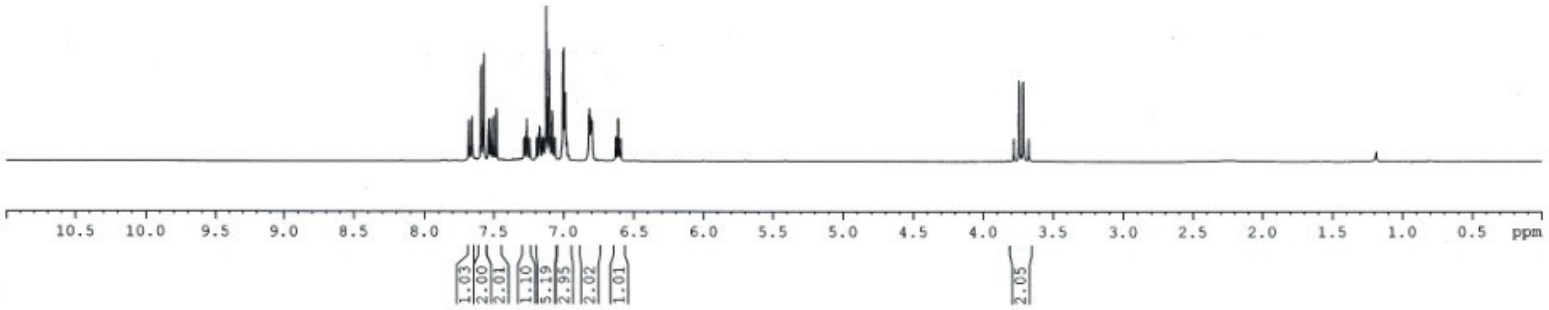
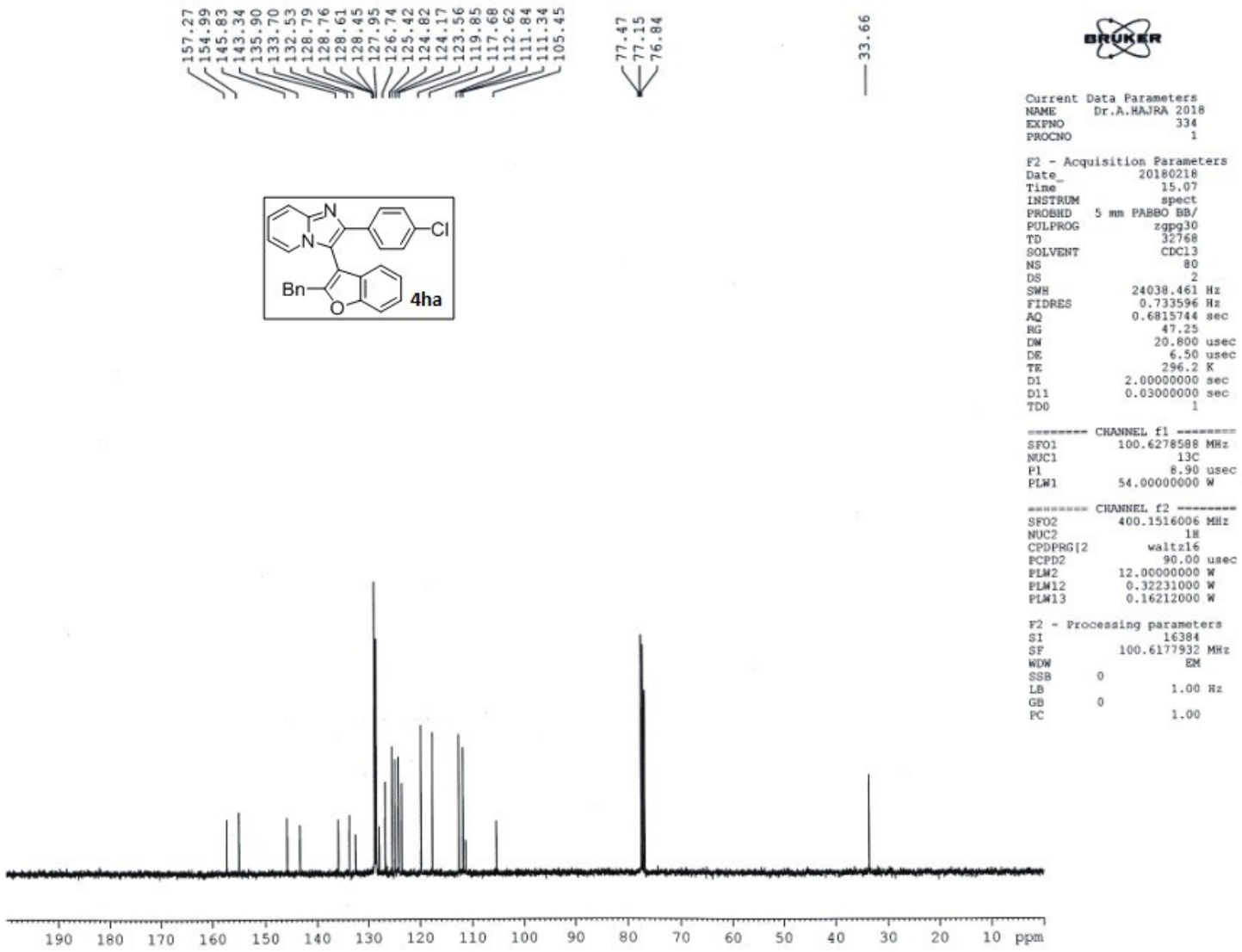
3.740
3.712
3.673


N
N
Cl
Bn
O
4ha


10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
1.03
2.00
2.01
1.10
5.19
2.95
2.02
1.01
2.05



BRUKER

Current Data Parameters
NAME Dr.A.HAJRA 2018
EXPNO 334
PROCNO 1

F2 - Acquisition Parameters
Date_ 20180218
Time 15.07
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 80
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 47.25
DW 20.800 usec
DE 6.50 usec
TE 296.2 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

======== CHANNEL f1 ========
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W

======== CHANNEL f2 ========
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W

F2 - Processing parameters
SI 16384
SF 100.6177932 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.00


7.825
7.820
7.808
7.803
7.721
7.719
7.698
7.696
7.629
7.625
7.621
7.607
7.585
7.487
7.483
7.469
7.466
7.383
7.380
7.365
7.362
7.345
7.342
7.299
7.296
7.282
7.279
7.273
7.259
7.257
7.247
7.227
7.208
7.189
7.144
7.126
7.102
7.099
7.095
7.083
7.076
7.071
7.067
7.063
7.048
7.044
7.033
7.028
7.022
6.886
6.884
6.868
6.864
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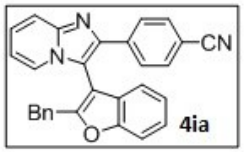
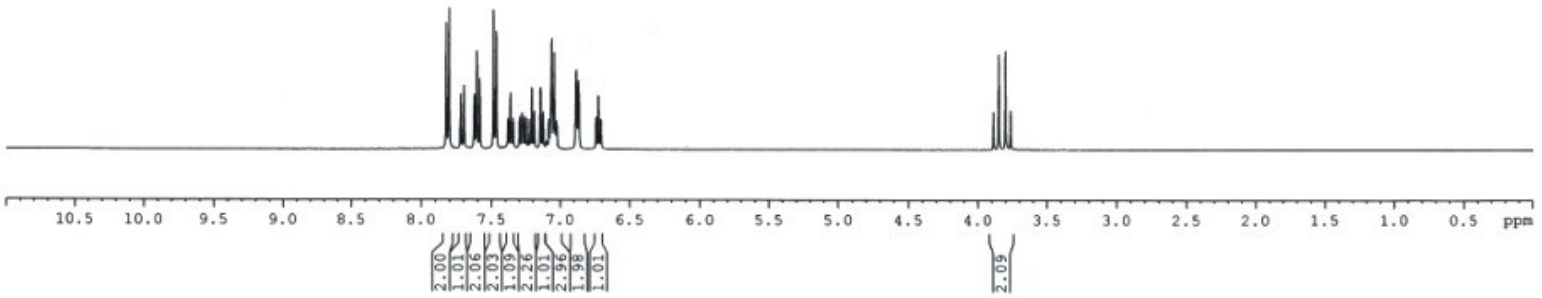
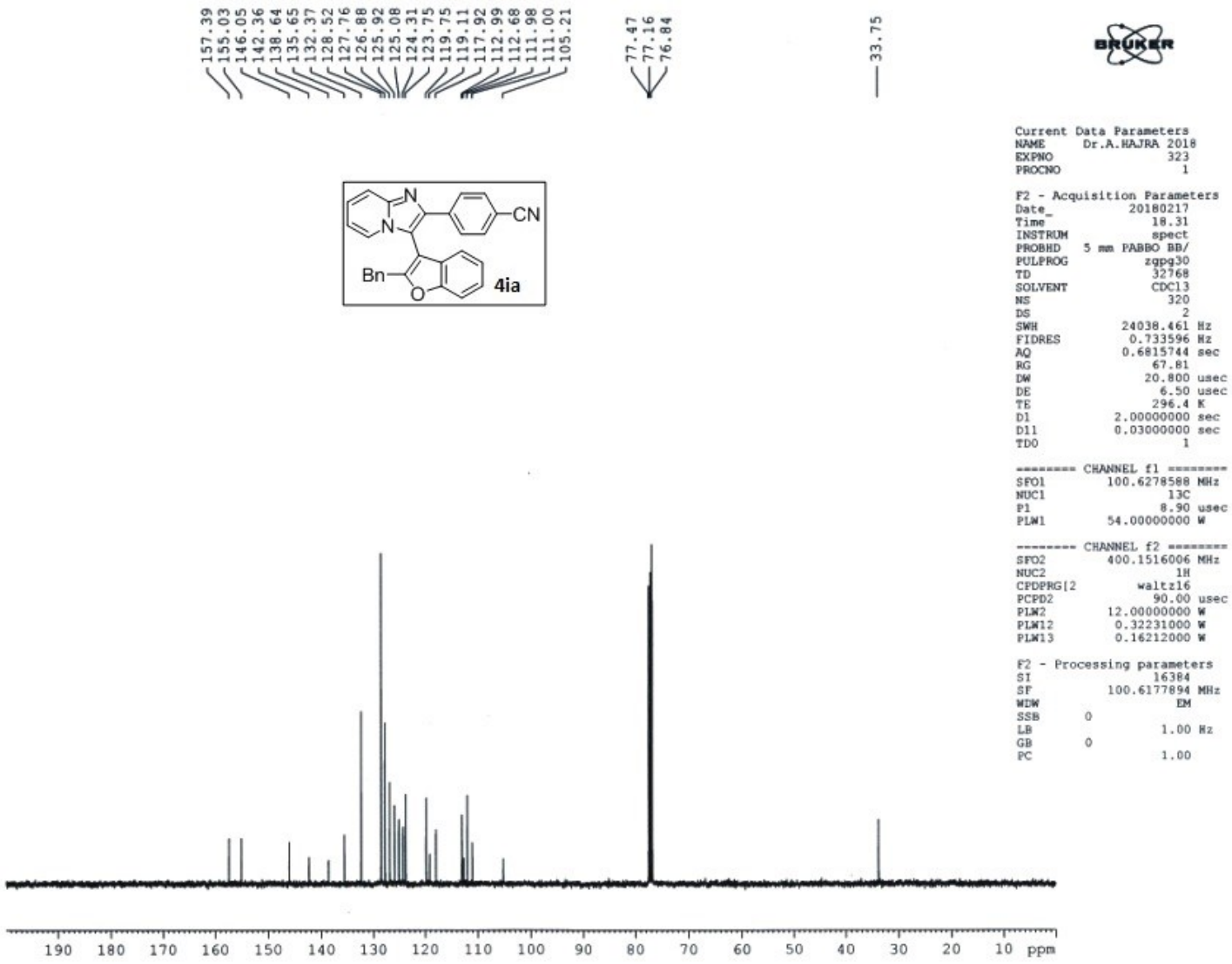
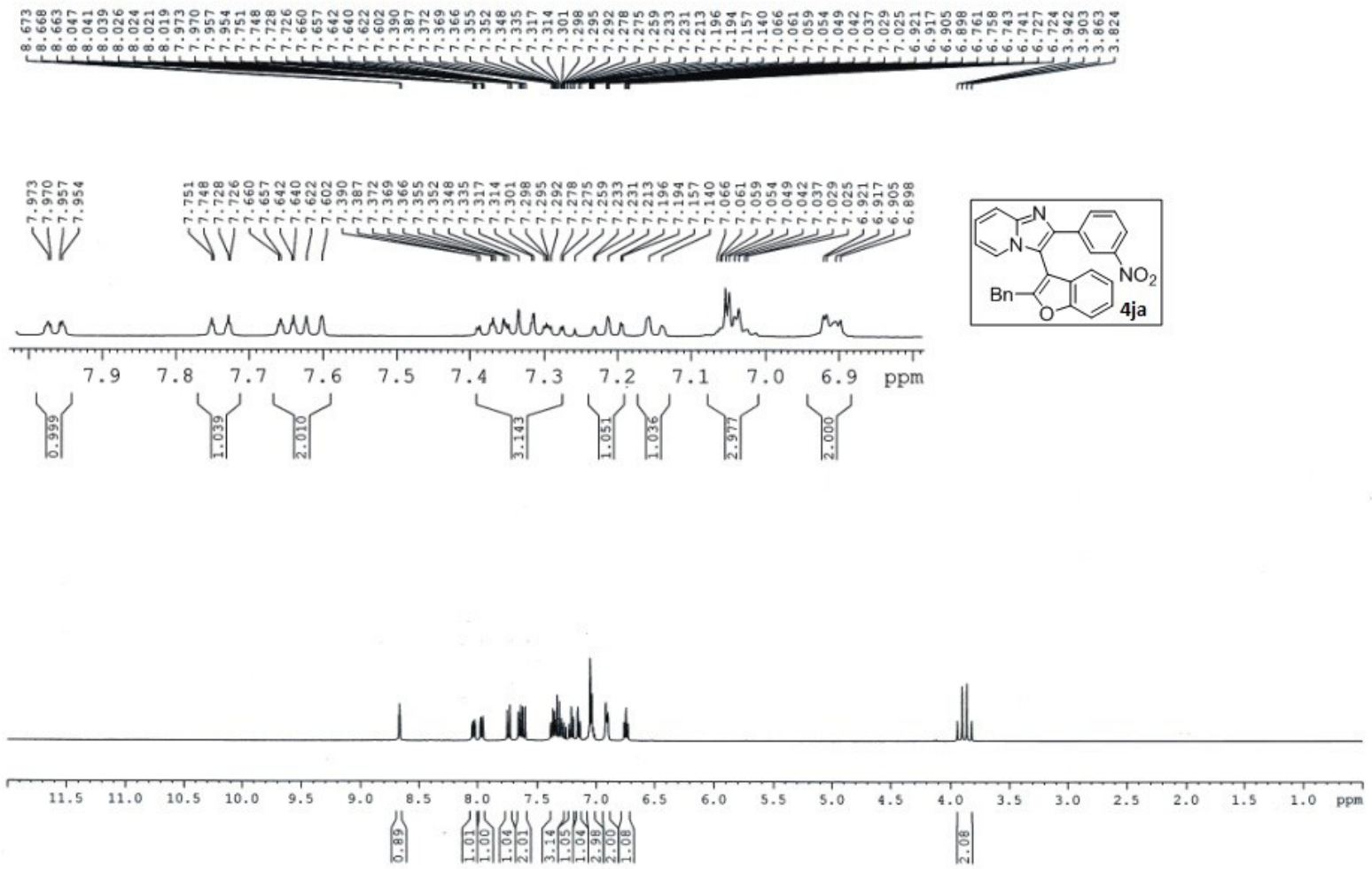
6.738
6.723
6.720
6.706
6.704
3.888
3.849
3.801
3.762


N
N
CN
Bn
O
4ia


10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.00
1.01
2.06
2.03
2.09
2.26
1.01
2.96
1.98
1.01
2.09


157.39
155.03
146.05
142.36
138.64
135.65
132.37
128.52
127.76
126.88
125.92
125.08
124.31
123.75
119.75
119.11
117.92
112.99
112.68
111.98
111.00
105.21
77.47
77.16
76.84
33.75
BRUKER
Current Data Parameters
NAME Dr.A.HAJRA 2018
EXPNO 323
PROCNO 1
F2 - Acquisition Parameters
Date_ 20180217
Time 18.31
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 320
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 67.81
DW 20.800 usec
DE 6.50 usec
TE 296.4 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
======== CHANNEL f1 ========
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W
======== CHANNEL f2 ========
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W
F2 - Processing parameters
SI 16384
SF 100.6177894 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.00
N
N
CN
Bn
O
4ia
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm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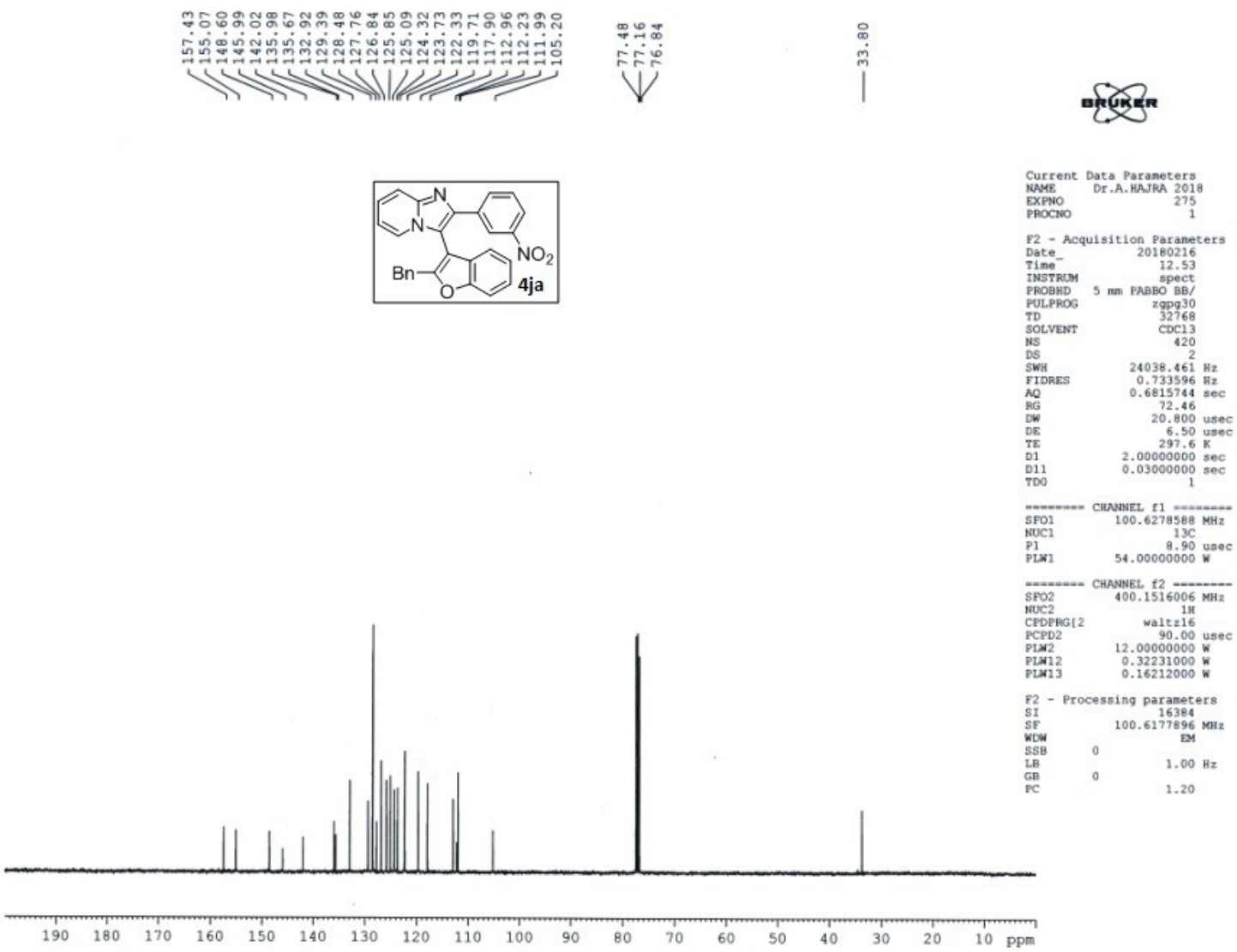
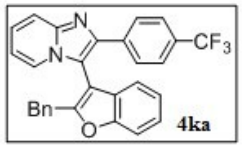
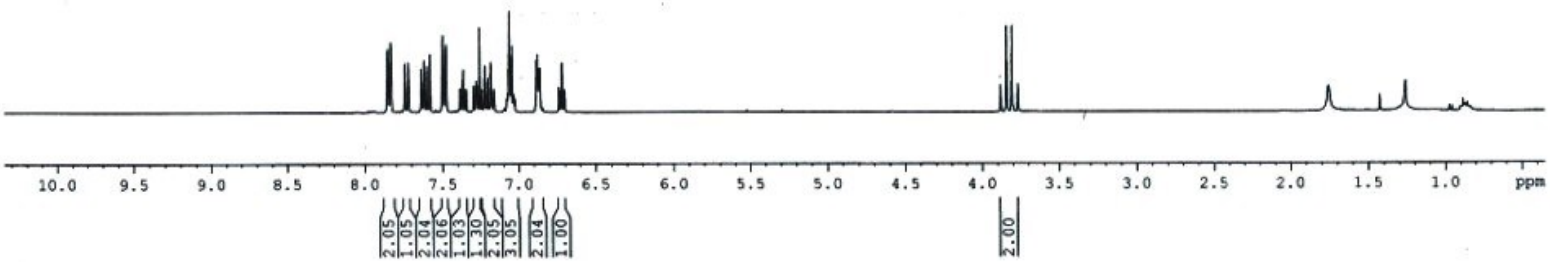
8.668
8.663
8.047
8.041
8.039
8.026
8.024
8.021
8.019
7.973
7.970
7.957
7.954
7.751
7.748
7.728
7.726
7.660
7.657
7.642
7.640
7.622
7.602
7.390
7.387
7.372
7.369
7.366
7.355
7.352
7.348
7.335
7.317
7.314
7.301
7.298
7.295
7.292
7.278
7.275
7.259
7.233
7.231
7.213
7.196
7.194
7.157
7.140
7.066
7.061
7.059
7.054
7.049
7.042
7.037
7.029
7.025
6.921
6.917
6.905
6.898
6.761
6.758
6.743
6.741
6.727
6.724
3.942
3.903
3.863
3.824
Bn
NO2
4ja
7.9
7.8
7.7
7.6
7.5
7.4
7.3
7.2
7.1
7.0
6.9
ppm
0.999
1.039
2.010
3.143
1.051
1.036
2.977
2.000
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
ppm
0.89
1.01
1.00
1.04
2.01
3.14
1.05
1.04
2.98
2.00
1.08
2.08


157.43
155.07
148.60
145.99
142.02
135.98
135.67
132.92
129.39
128.48
127.76
126.84
125.85
125.09
124.32
123.73
122.33
119.71
117.90
112.96
112.23
111.99
105.20
77.48
77.16
76.84
33.80
BRUKER
Bn
NO2
4ja
Current Data Parameters
NAME Dr.A.HAJRA 2018
EXPNO 275
PROCNO 1
F2 - Acquisition Parameters
Date_ 20180216
Time 12.53
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 420
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 72.46
DW 20.800 usec
DE 6.50 usec
TE 297.6 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
======== CHANNEL f1 ========
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W
======== CHANNEL f2 ========
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W
F2 - Processing parameters
SI 16384
SF 100.6177896 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.20
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm


7.856
7.836
7.746
7.723
7.643
7.640
7.638
7.625
7.623
7.606
7.584
7.501
7.480
7.389
7.385
7.371
7.368
7.365
7.351
7.347
7.301
7.297
7.283
7.281
7.278
7.275
7.259
7.244
7.242
7.224
7.206
7.187
7.185
7.168
7.165
7.077
7.066
7.064
7.059
7.052
7.048
7.040
7.035
6.886
6.882
6.868
6.863
6.740
6.737
6.723
6.720
6.706
6.703
3.882
3.843
3.809
3.770


N
N
CF3
Bn
O
4ka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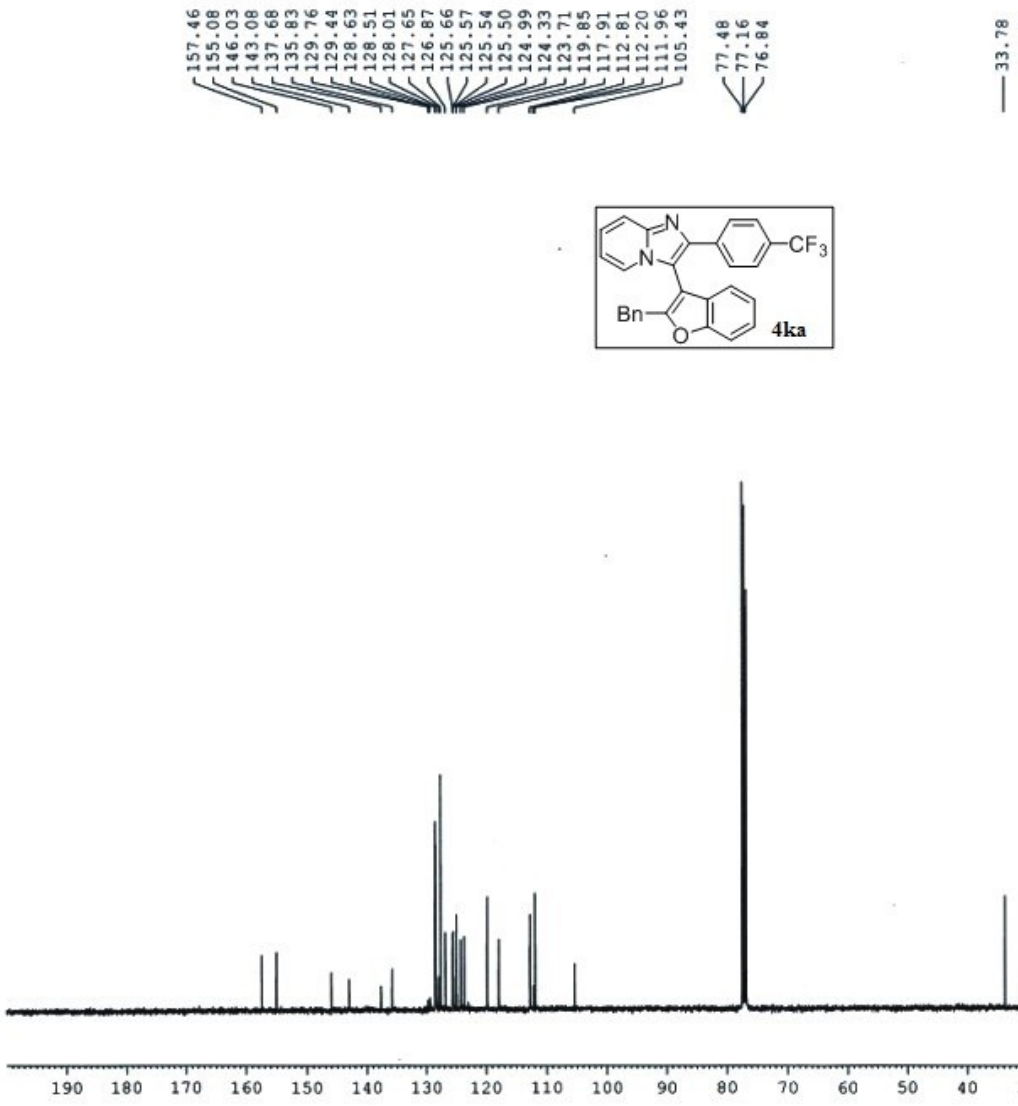
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
ppm
2.05
1.05
2.04
2.06
1.03
1.30
2.05
3.05
2.04
1.00
2.00



BRUKER

Current Data Parameters
NAME Dr.A.HAJRA 2017
EXPNO 1047
PROCNO 1

F2 - Acquisition Parameters
Date_ 20170618
Time 19.20
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 800
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 77.59
DW 20.800 usec
DE 6.50 usec
TE 298.8 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

======== CHANNEL f1 ========
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W

======== CHANNEL f2 ========
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W

F2 - Processing parameters
SI 16384
SF 100.6177838 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40


13.159
7.671
7.669
7.648
7.646
7.616
7.595
7.582
7.580
7.577
7.565
7.563
7.386
7.382
7.368
7.365
7.362
7.348
7.344
7.313
7.310
7.302
7.298
7.293
7.291
7.287
7.282
7.278
7.273
7.271
7.259
7.229
7.210
7.208
7.193
7.191
7.185
7.180
7.175
7.173
7.166
7.164
7.160
7.158
7.146
7.142
7.070
7.064
7.056
7.053
6.957
6.951
6.943
6.941
6.933
6.746
6.743
6.729
6.726
6.712
6.709
6.577
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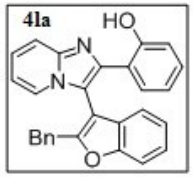
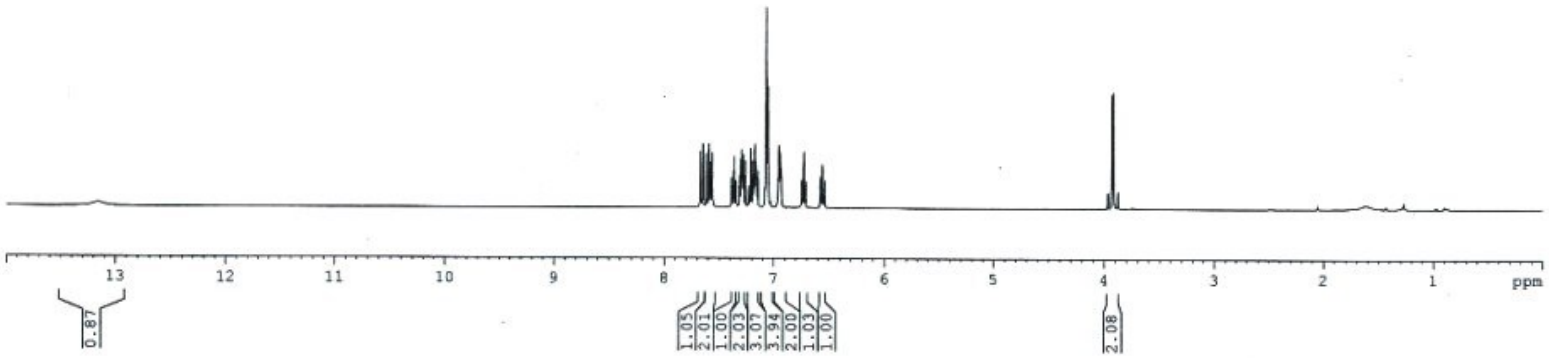
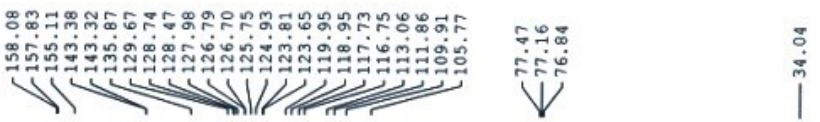
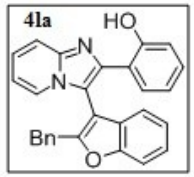
6.537
3.970
3.930
3.919
3.879

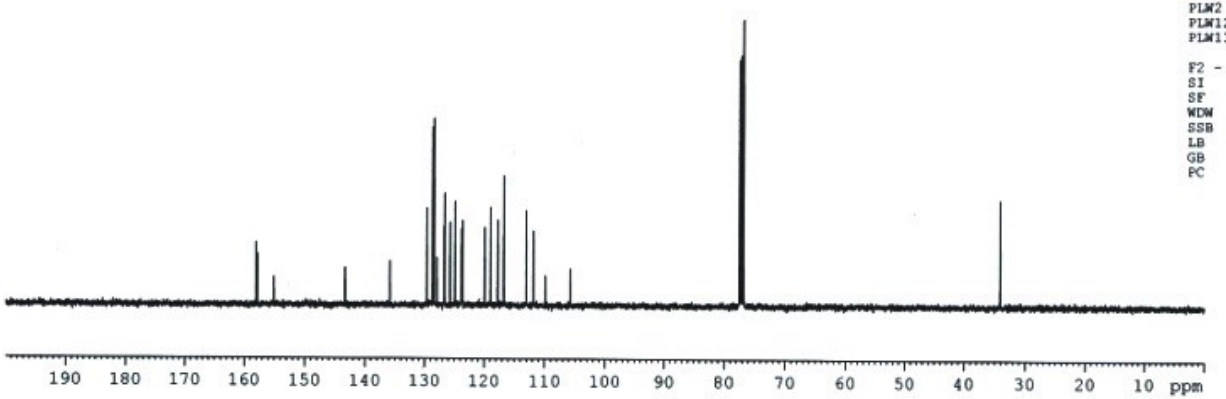

4la
HO
N
N
Bn
O


13
12
11
10
9
8
7
6
5
4
3
2
1
ppm
0.87
1.05
2.01
1.00
2.03
3.07
3.94
2.00
1.03
1.00
2.08

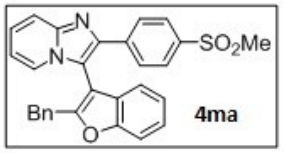


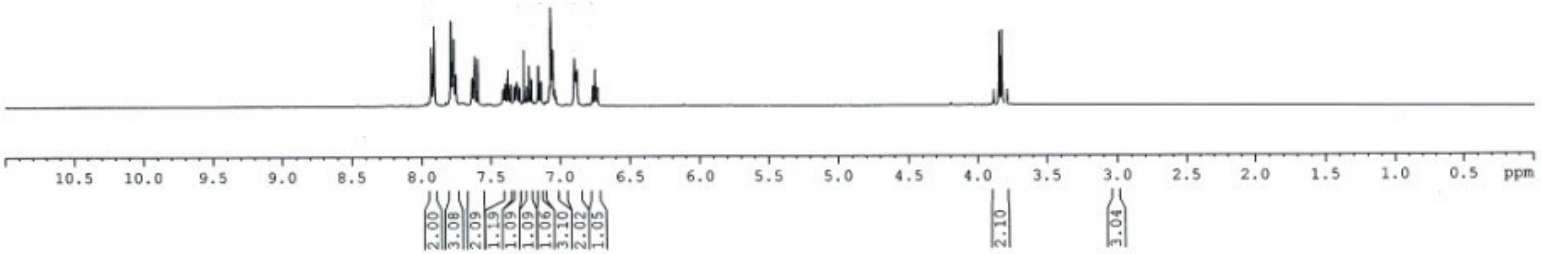


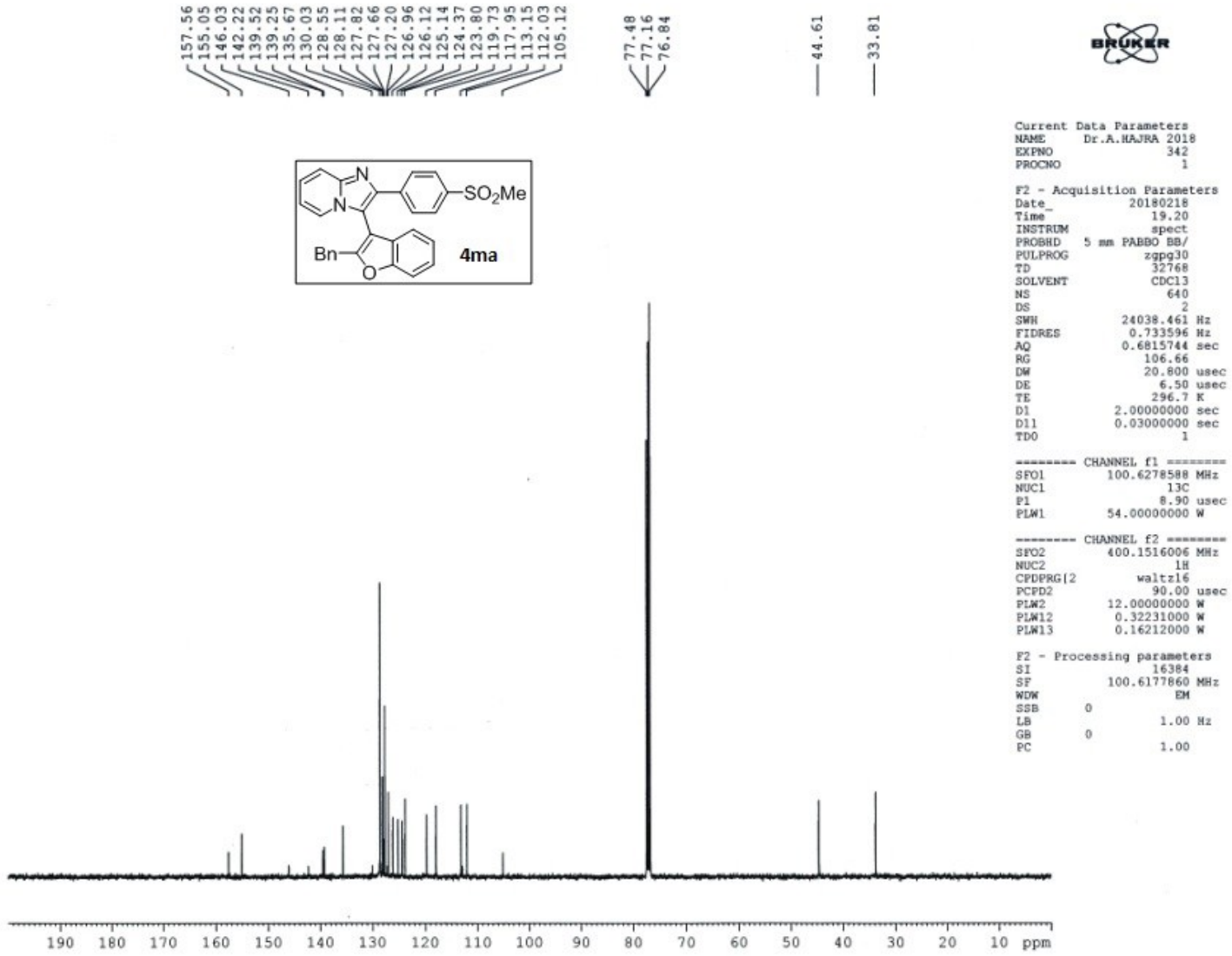

```
Current Data Parameters
NAME      Dr.A.HAJRA 2017
EXPNO             1189
PROCNO               1

F2 - Acquisition Parameters
Date_           20170710
Time              18.43
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG         zgpg30
TD              32768
SOLVENT           CDCl3
NS                  250
DS                    2
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ             0.6815744 sec
RG                77.59
DW               20.800 usec
DE                6.50 usec
TE                298.6 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1         100.6278588 MHz
NUC1               13C
P1                8.90 usec
PLW1         54.00000000 W

======== CHANNEL f2 ========
SFO2         400.1516006 MHz
NUC2               1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2         12.00000000 W
PLW12         0.32231000 W
PLW13         0.16212000 W

F2 - Processing parameters
SI                16384
SF           100.6177864 MHz
WDW                EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```




7.932
7.910
7.790
7.774
7.769
7.754
7.636
7.615
7.594
7.396
7.393
7.378
7.375
7.373
7.357
7.354
7.330
7.327
7.313
7.310
7.309
7.305
7.290
7.288
7.260
7.242
7.223
7.205
7.157
7.137
7.081
7.076
7.069
7.064
7.058
7.054
7.051
7.042
7.038
7.028
6.897
6.893
6.888
6.880
6.874
6.765
6.763
6.747
6.731
6.729
3.882
3.843
3.825
3.786
3.016

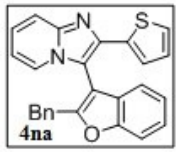

N
N
SO2Me
Bn
O
4ma


10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.00
3.08
2.09
1.19
1.09
1.09
1.06
3.10
2.02
1.05
2.10
3.04

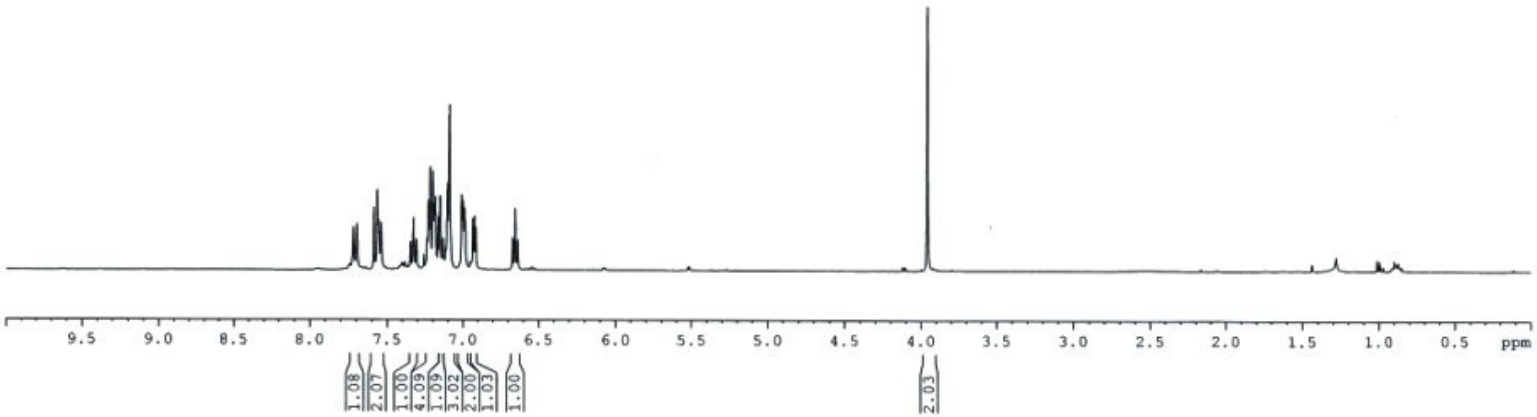


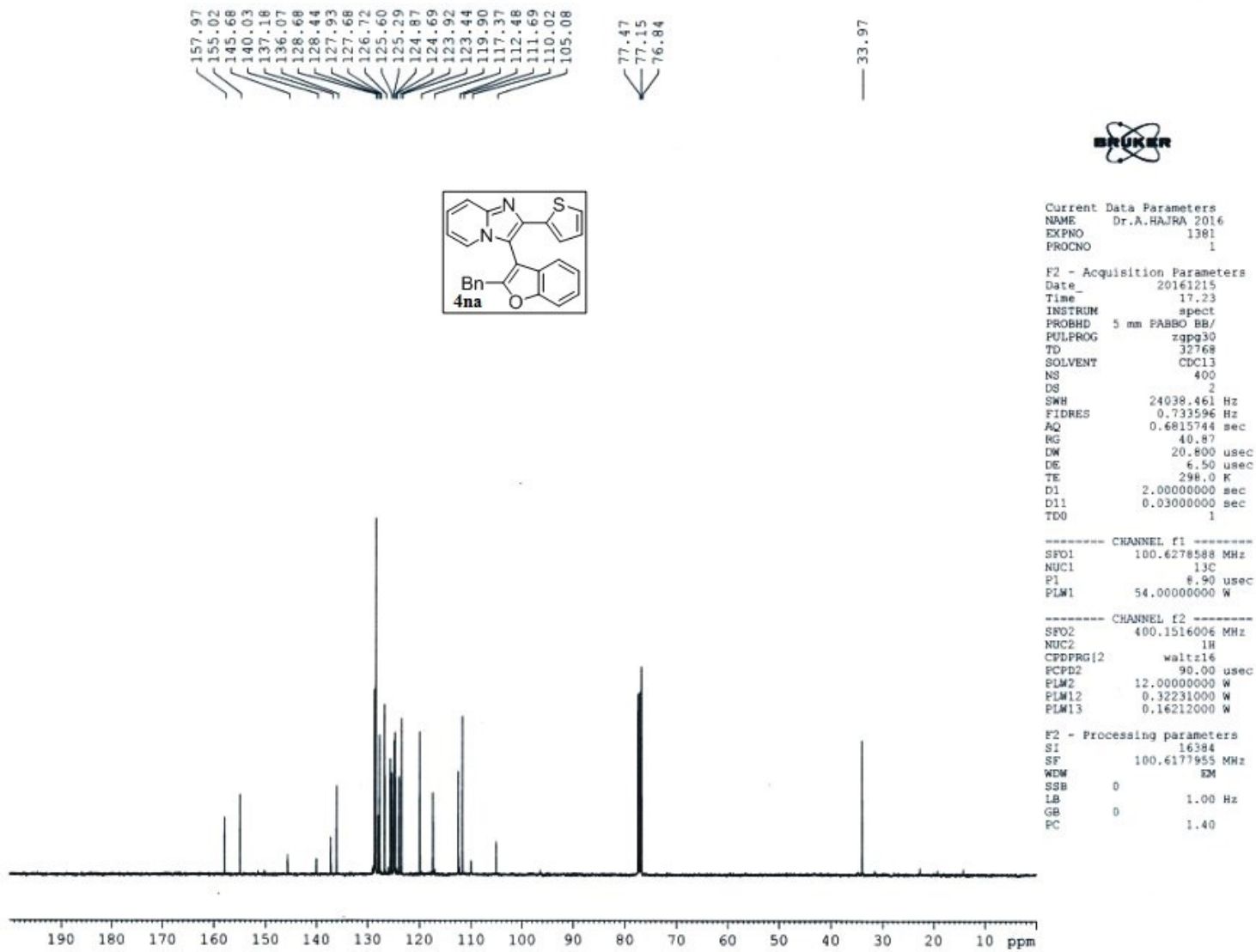

```
Current Data Parameters
NAME      Dr.A.HAJRA 2018
EXPNO              342
PROCNO               1

F2 - Acquisition Parameters
Date_          20180218
Time              19.20
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG         zgpg30
TD              32768
SOLVENT          CDCl3
NS                 640
DS                   2
SWH          24038.461 Hz
FIDRES        0.733596 Hz
AQ            0.6815744 sec
RG               106.66
DW               20.800 usec
DE                6.50 usec
TE               296.7 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1        100.6278588 MHz
NUC1               13C
P1                8.90 usec
PLW1         54.00000000 W

======== CHANNEL f2 ========
SFO2        400.1516006 MHz
NUC2               1H
CPDPRG[2        waltz16
PCPD2            90.00 usec
PLW2         12.00000000 W
PLW12         0.32231000 W
PLW13         0.16212000 W

F2 - Processing parameters
SI                16384
SF          100.6177860 MHz
WDW                EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.00
```


7.718
7.696
7.587
7.566
7.559
7.541
7.350
7.346
7.332
7.329
7.312
7.308
7.260
7.240
7.238
7.230
7.218
7.201
7.191
7.184
7.166
7.154
7.152
7.135
7.105
7.101
7.093
7.088
7.008
7.000
6.990
6.985
6.935
6.925
6.923
6.913
6.669
6.652
6.636
3.957


N
S
N
Bn
O

4na


9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
1.08
2.07
1.00
4.09
1.09
3.02
2.00
1.03
1.00
2.03




```
Current Data Parameters
NAME      Dr.A.HAJRA 2016
EXPNO               1381
PROCNO                 1

F2 - Acquisition Parameters
Date_           20161215
Time               17.23
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG         zgpg30
TD              32768
SOLVENT          CDCl3
NS                 400
DS                   2
SWH          24038.461 Hz
FIDRES        0.733596 Hz
AQ            0.6815744 sec
RG                40.87
DW               20.800 usec
DE                6.50 usec
TE               298.0 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1        100.6278588 MHz
NUC1                13C
P1                 8.90 usec
PLW1        54.00000000 W

======== CHANNEL f2 ========
SFO2        400.1516006 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2        12.00000000 W
PLW12        0.32231000 W
PLW13        0.16212000 W

F2 - Processing parameters
SI                 16384
SF          100.6177955 MHz
WDW                   EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
```


8.384
7.794
7.783
7.779
7.771
7.761
7.758
7.751
7.741
7.692
7.674
7.672
7.658
7.609
7.588
7.462
7.457
7.445
7.440
7.431
7.422
7.418
7.405
7.400
7.387
7.380
7.373
7.366
7.359
7.352
7.345
7.292
7.290
7.276
7.272
7.270
7.267
7.259
7.253
7.250
7.235
7.228
7.221
7.220
7.201
7.037
7.034
7.029
7.019
7.012
7.006
7.002
6.995
6.992
6.981
6.976
6.965
6.960
6.955
6.877
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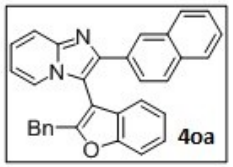
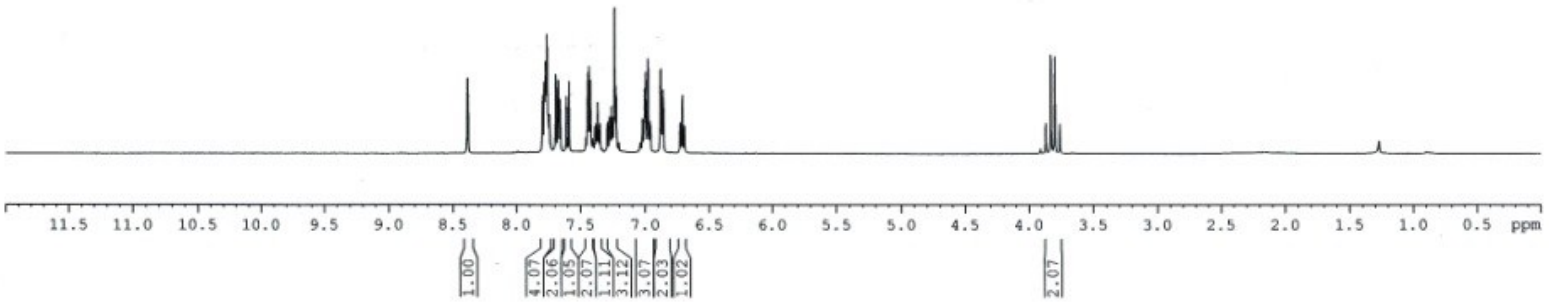
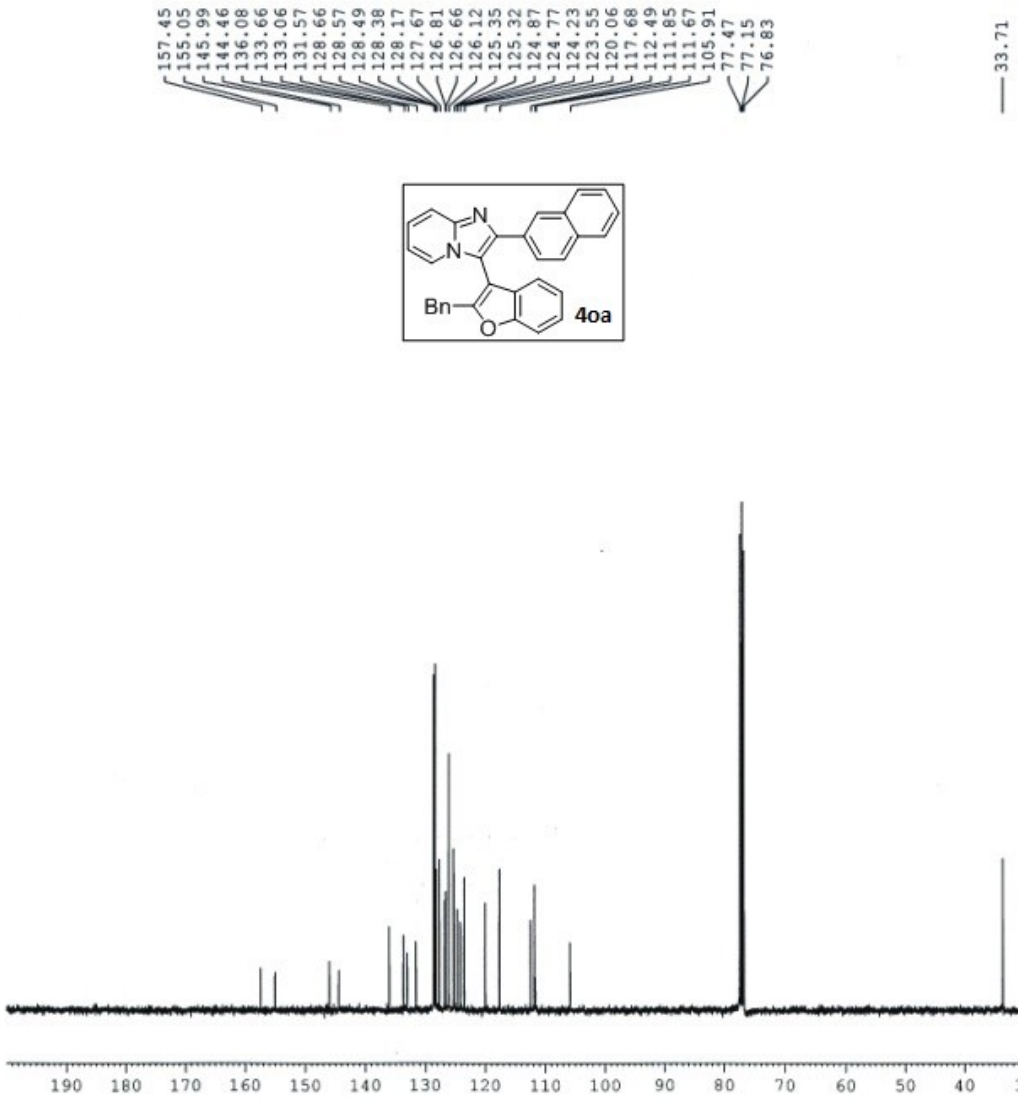
3.868
3.829
3.798
3.759


N
N
Bn
O
4oa


11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 ppm
1.00
4.07
2.06
1.05
2.07
1.11
3.12
3.07
2.03
1.02
2.07



BRUKER

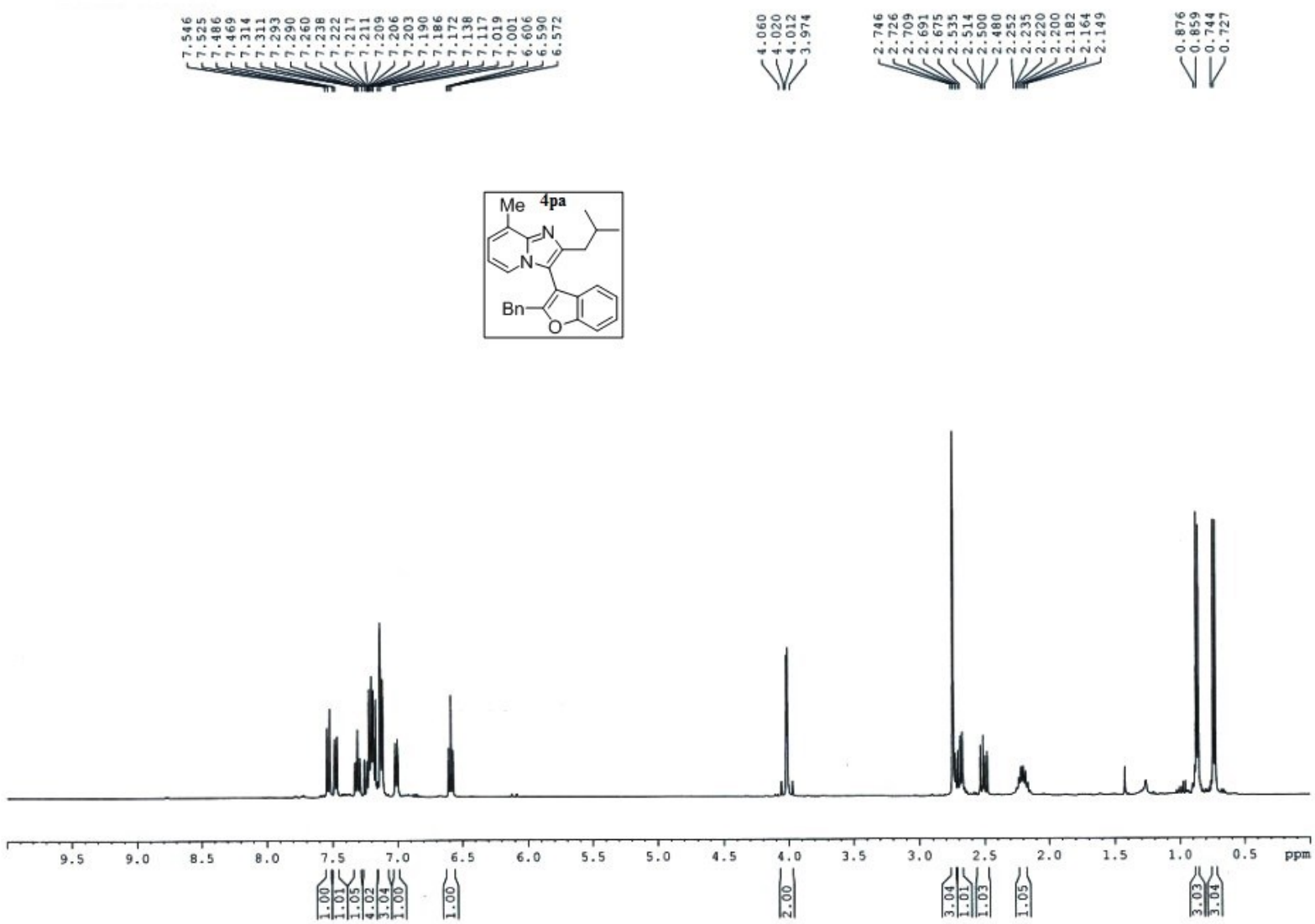
```
Current Data Parameters
NAME      Dr.A.HAJRA 2018
EXPNO              341
PROCNO               1

F2 - Acquisition Parameters
Date_          20180218
Time             18.29
INSTRUM          spect
PROBHD   5 mm PABBO BB/
PULPROG        zgpg30
TD             32768
SOLVENT        CDCl3
NS               330
DS                 2
SWH        24038.461 Hz
FIDRES         0.733596 Hz
AQ             0.6815744 sec
RG               106.66
DW              20.800 usec
DE               6.50 usec
TE              296.5 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0                1

======== CHANNEL f1 ========
SFO1       100.6278588 MHz
NUC1             13C
P1              8.90 usec
PLW1      54.00000000 W

======== CHANNEL f2 ========
SFO2       400.1516006 MHz
NUC2             1H
CPDPRG[2       waltz16
PCPD2           90.00 usec
PLW2      12.00000000 W
PLW12      0.32231000 W
PLW13      0.16212000 W

F2 - Processing parameters
SI               16384
SF         100.6177887 MHz
WDW                EM
SSB      0
LB              1.00 Hz
GB       0
PC              1.00
```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7.311
7.293
7.290
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7.238
7.222
7.217
7.211
7.209
7.206
7.203
7.190
7.186
7.172
7.138
7.117
7.019
7.001
6.606
6.590
6.572
4.060
4.020
4.012
3.974
2.746
2.726
2.709
2.691
2.675
2.535
2.514
2.500
2.480
2.252
2.235
2.220
2.200
2.182
2.164
2.149
0.876
0.859
0.744
0.727
Me
4pa
N
N
Bn
O
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
1.00
1.01
1.05
4.02
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1.00
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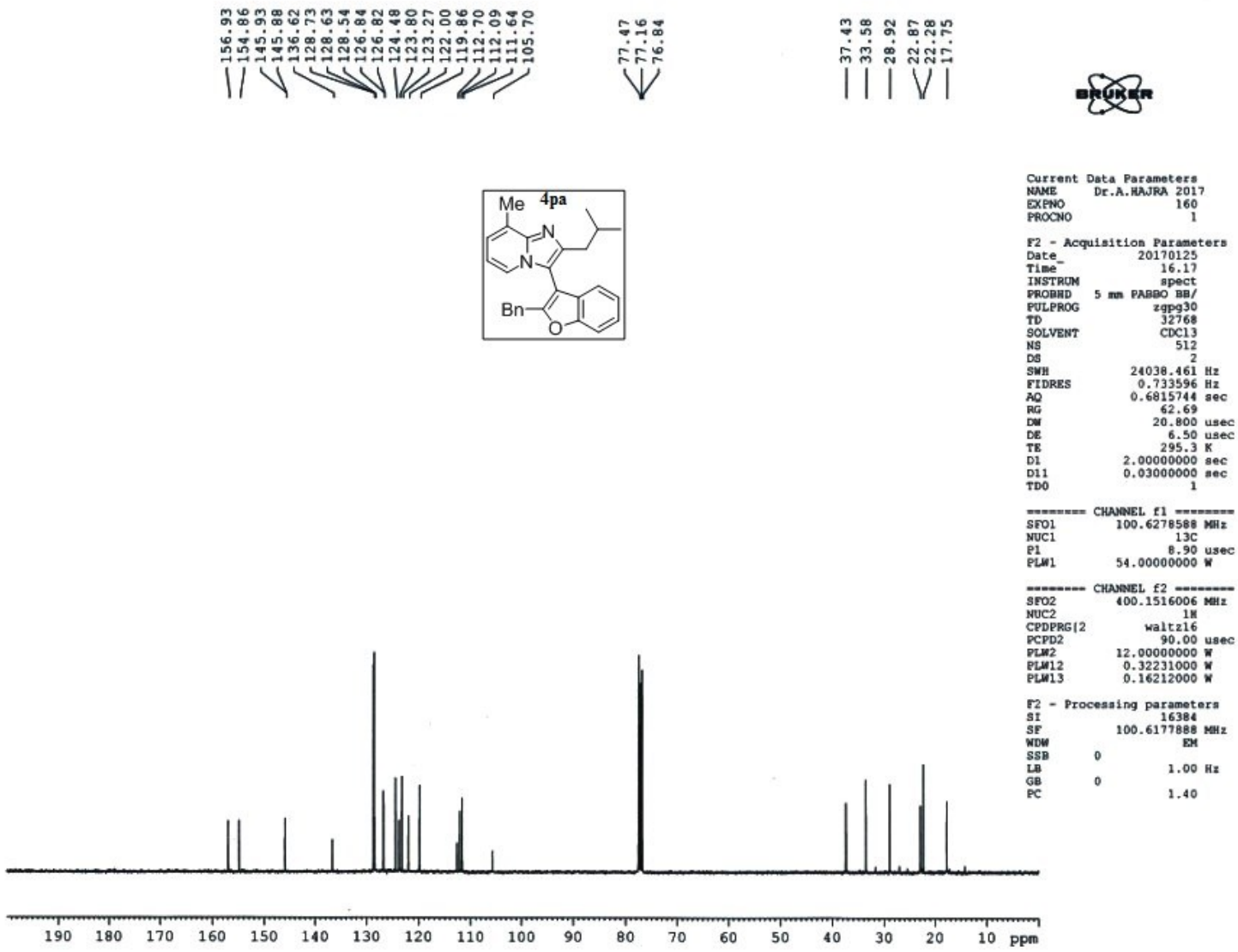
1.01
1.03
1.05
3.03
3.04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128.54
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126.82
124.48
123.80
123.27
122.00
119.86
112.70
112.09
111.64
105.70
77.47
77.16
76.84
37.43
33.58
28.92
22.87
22.28
17.75
Me
4pa
N
N
Bn
O
Current Data Parameters
NAME Dr.A.HAJRA 2017
EXPNO 160
PROCNO 1
F2 - Acquisition Parameters
Date_ 20170125
Time 16.17
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 512
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 62.69
DW 20.800 usec
DE 6.50 usec
TE 295.3 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
======== CHANNEL f1 ========
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W
======== CHANNEL f2 ========
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W
F2 - Processing parameters
SI 16384
SF 100.6177888 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm


7.787
7.782
7.777
7.767
7.763
7.535
7.518
7.434
7.413
7.301
7.294
7.290
7.280
7.271
7.260
7.255
7.244
7.150
7.147
7.129
7.126
7.097
7.087
7.080
7.071
7.065
7.049
7.047
7.035
7.033
7.029
6.993
6.897
6.891
6.886
6.883
6.874
6.637
6.620
6.603
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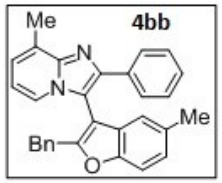
3.778
3.746
3.707
2.754
2.357


Me
4bb
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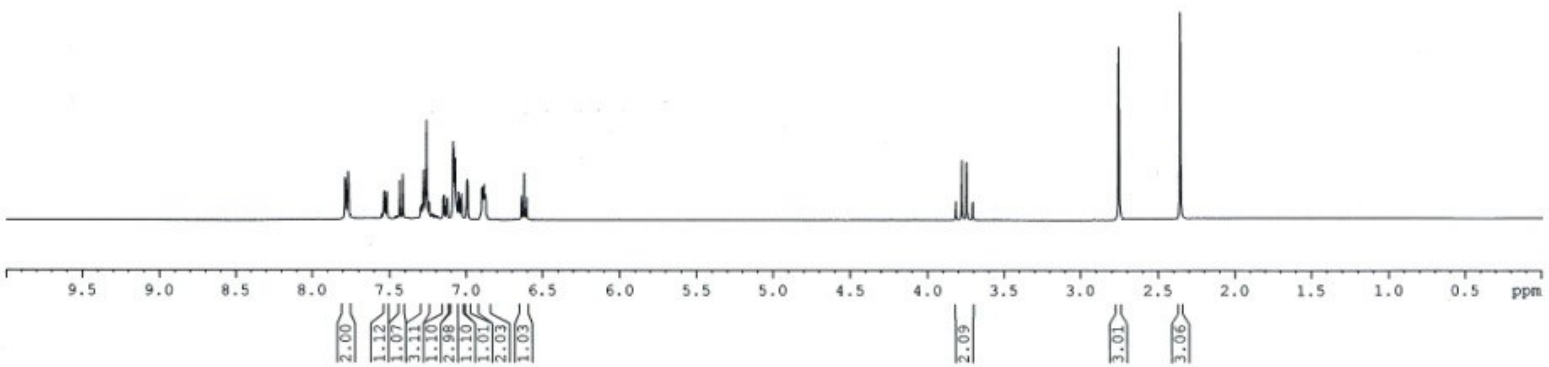
N
Me
Bn
O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6.0
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5.0
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4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.00
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1.10
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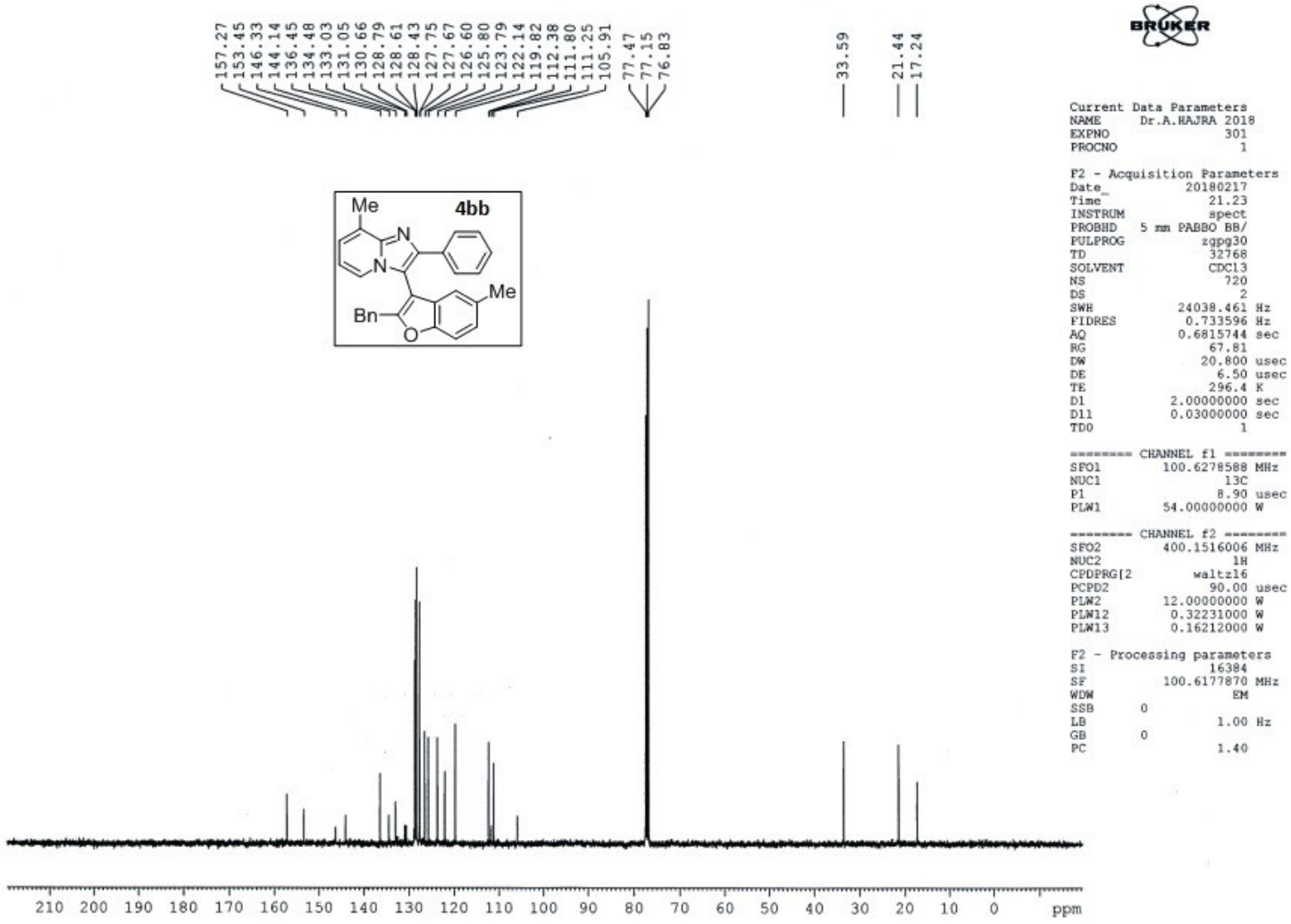
2.03
1.03
2.09
3.01
3.06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131.05
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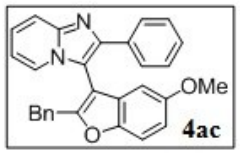
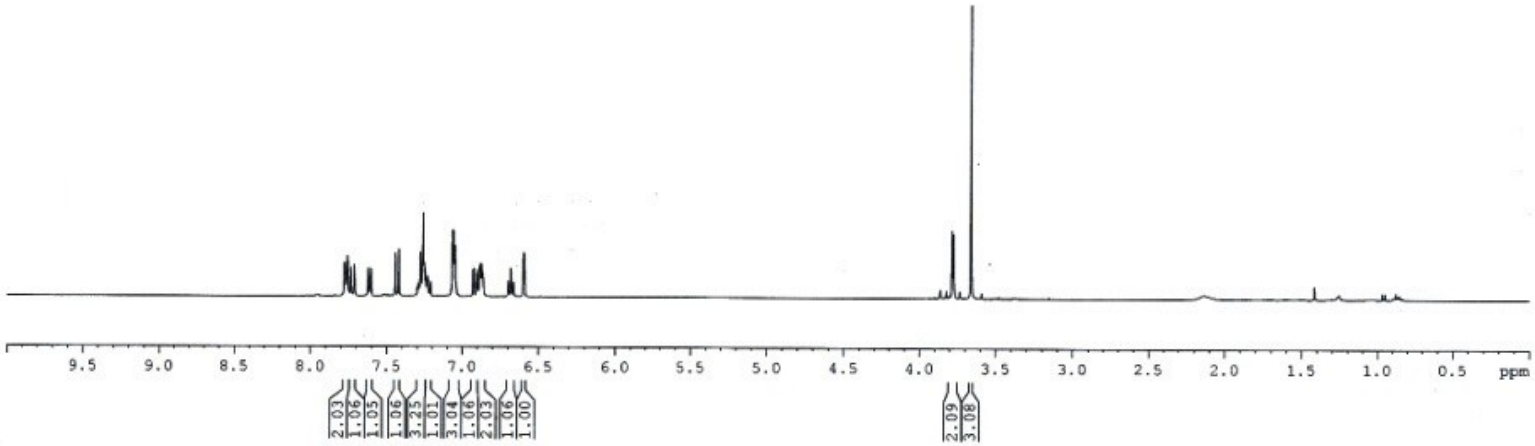
128.61
128.43
127.75
127.67
126.60
125.80
123.79
122.14
119.82
112.38
111.80
111.25
105.91
77.47
77.15
76.83
33.59
21.44
17.24
Me
4bb
N
N
Me
Bn
O
BRUKER
Current Data Parameters
NAME Dr.A.HAJRA 2018
EXPNO 301
PROCNO 1
F2 - Acquisition Parameters
Date_ 20180217
Time 21.23
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 720
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 67.81
DW 20.800 usec
DE 6.50 usec
TE 296.4 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
======== CHANNEL f1 ========
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W
======== CHANNEL f2 ========
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W
F2 - Processing parameters
SI 16384
SF 100.6177870 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


7.778
7.773
7.758
7.754
7.735
7.712
7.622
7.605
7.442
7.420
7.300
7.292
7.278
7.259
7.254
7.246
7.236
7.233
7.227
7.214
7.211
7.065
7.058
7.049
6.930
6.923
6.907
6.901
6.886
6.881
6.872
6.863
6.697
6.695
6.681
6.664
6.662
6.597
6.591


3.822
3.783
3.774
3.735
3.661


N
N
OMe
Bn
O
4ac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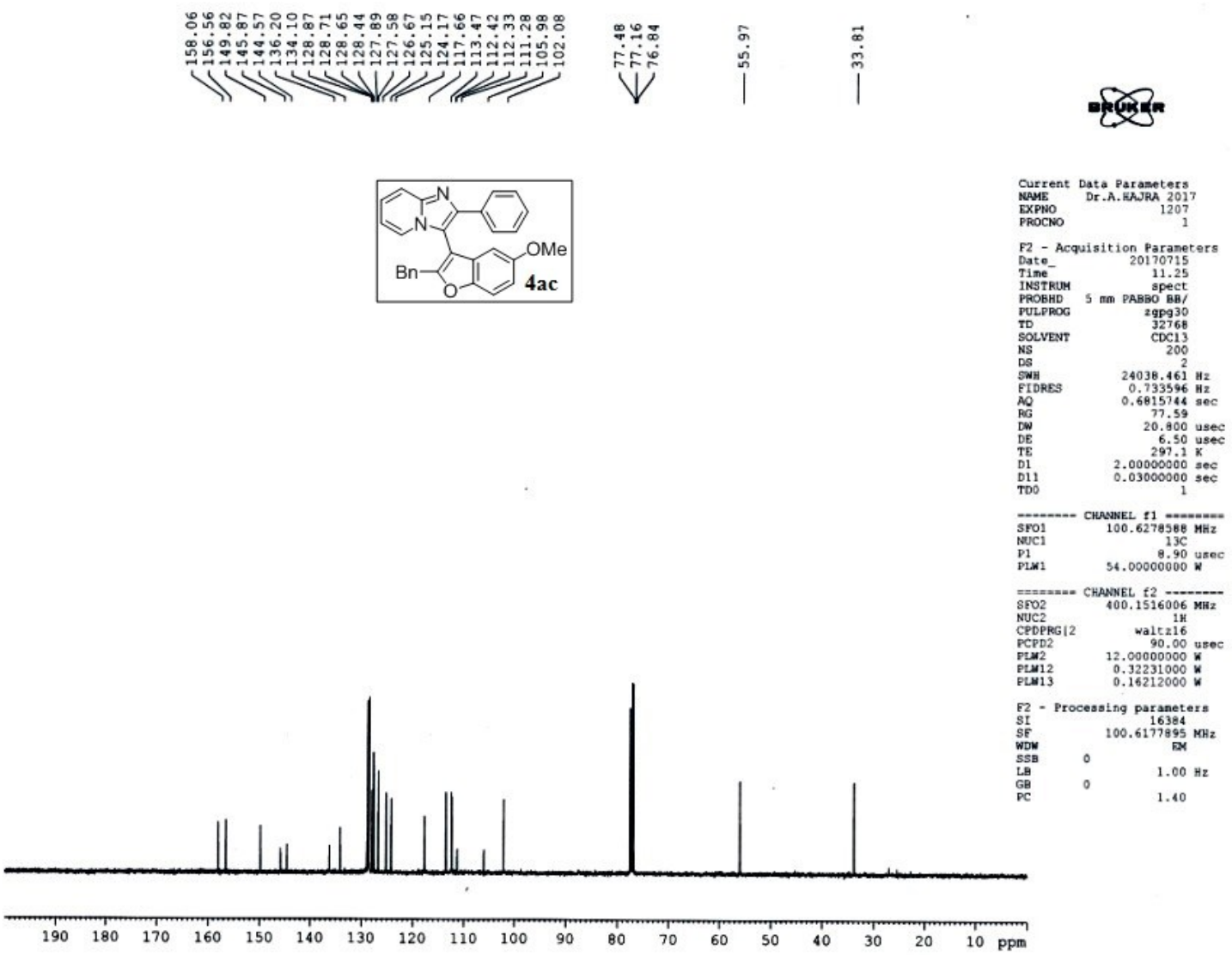
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.03
1.06
1.05
1.06
3.25
1.01
3.04
1.06
2.03
1.06
1.00
2.09
3.08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145.87
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136.20
134.10
128.87
128.71
128.65
128.44
127.89
127.58
126.67
125.15
124.17
117.66
113.47
112.42
112.33
111.28
105.98
102.08
77.48
77.16
76.84
55.97
33.81
N
N
OMe
Bn
O
4ac
Current Data Parameters
NAME Dr.A.HAJRA 2017
EXPNO 1207
PROCNO 1
F2 - Acquisition Parameters
Date_ 20170715
Time 11.25
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 200
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 77.59
DW 20.800 usec
DE 6.50 usec
TE 297.1 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
======== CHANNEL f1 ========
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W
======== CHANNEL f2 ========
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W
F2 - Processing parameters
SI 16384
SF 100.6177895 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm


7.744
7.739
7.735
7.724
7.721
7.485
7.468
7.460
7.439
7.304
7.300
7.296
7.288
7.282
7.264
7.261
7.251
7.247
7.170
7.165
7.098
7.088
7.083
7.075
7.072
7.063
7.052
7.050
7.038
7.035
6.881
6.876
6.868
6.858
6.650
6.633
6.616
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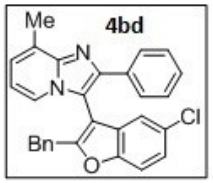
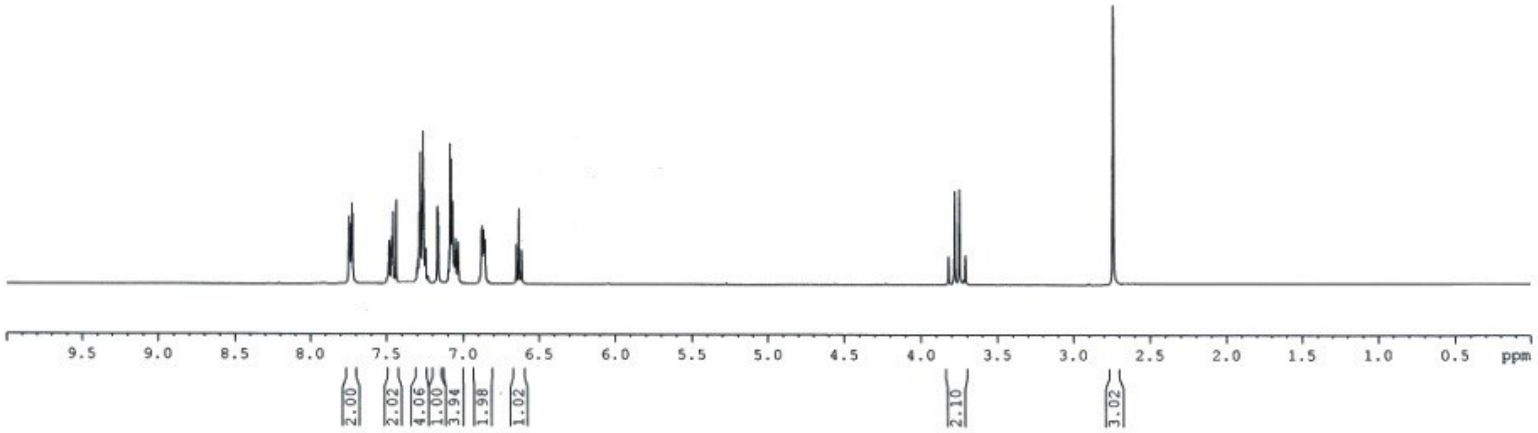
3.781
3.751
3.712
2.743


Me
4bd
N
N
Cl
Bn
O


9.5
9.0
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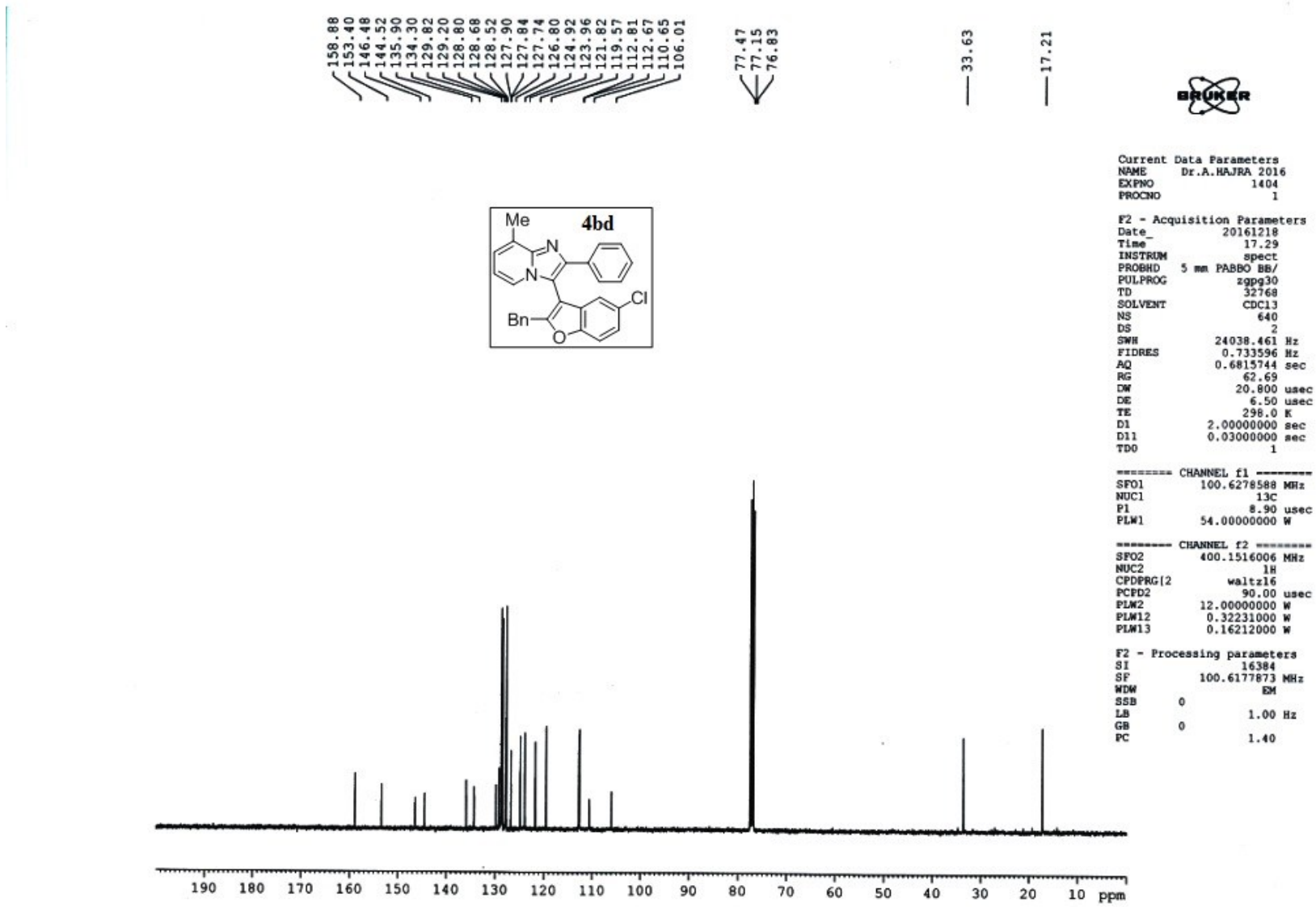
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.00
2.02
4.06
1.00
3.94
1.98
1.02
2.10
3.02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134.30
129.82
129.20
128.80
128.68
128.52
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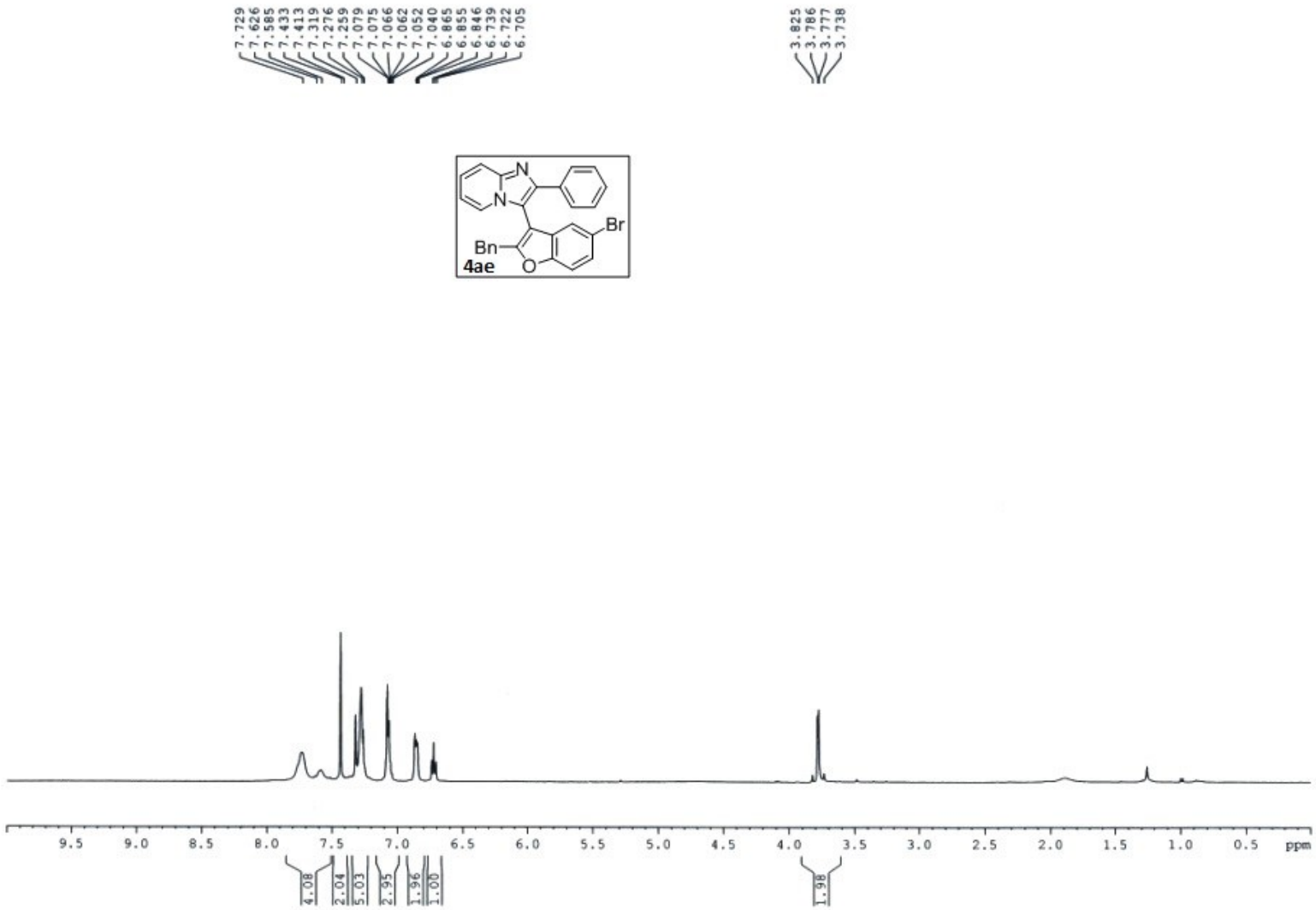
126.80
124.92
123.96
121.82
119.57
112.81
112.67
110.65
106.01
77.47
77.15
76.83
33.63
17.21
BRUKER
Me
4bd
N
N
Cl
Bn
O
Current Data Parameters
NAME Dr.A.HAJRA 2016
EXPNO 1404
PROCNO 1
F2 - Acquisition Parameters
Date_ 20161218
Time 17.29
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 640
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 62.69
DW 20.800 usec
DE 6.50 usec
TE 298.0 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
======== CHANNEL f1 ========
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W
======== CHANNEL f2 ========
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W
F2 - Processing parameters
SI 16384
SF 100.6177873 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm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7.259
7.079
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7.066
7.062
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7.040
6.865
6.855
6.846
6.739
6.722
6.705
3.825
3.786
3.777
3.738
N
N
Br
Bn
4ae
O
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
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1.0
0.5
ppm
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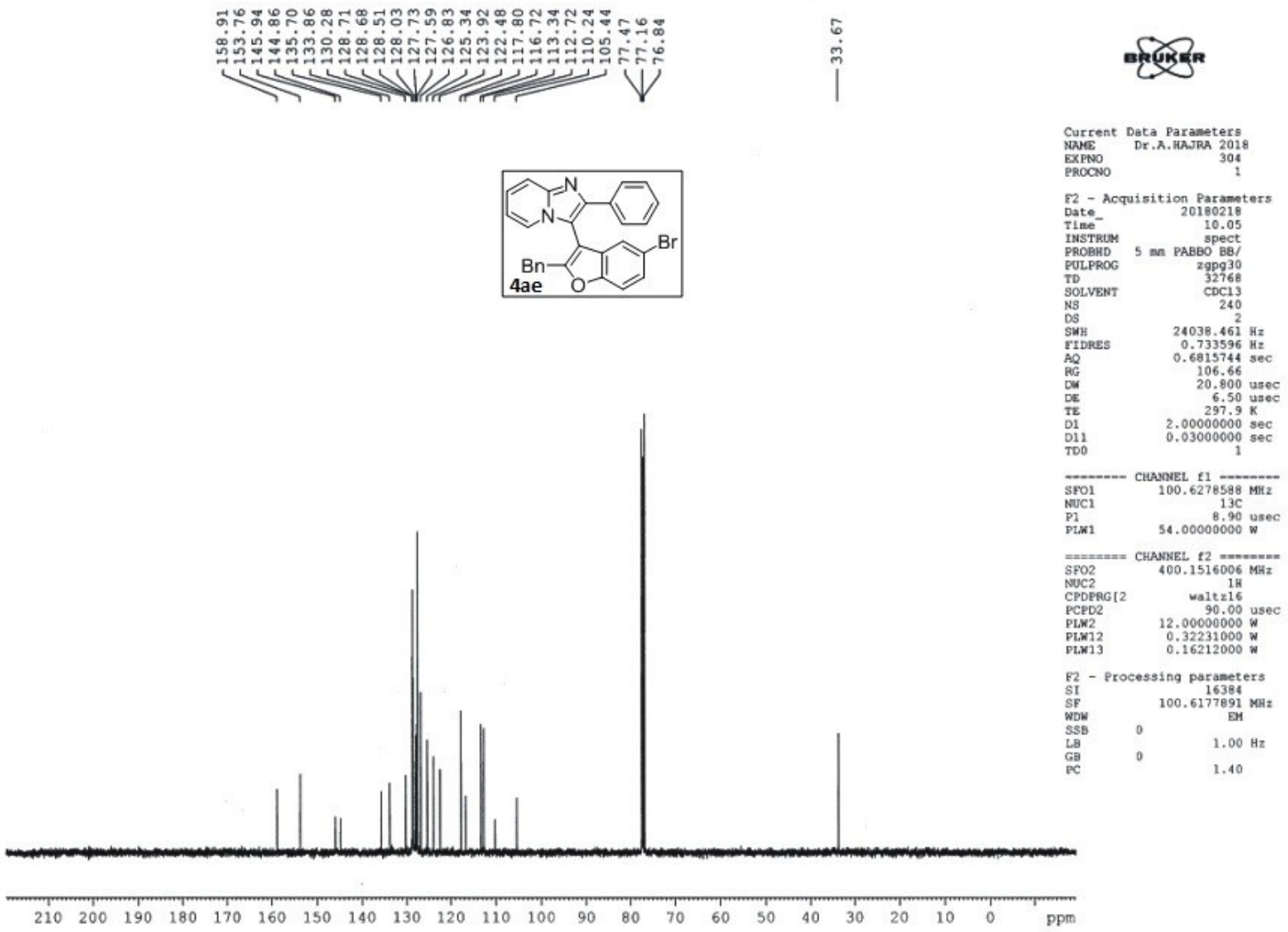
2.04
5.03
2.95
1.96
1.00
1.98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153.76
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130.28
128.71
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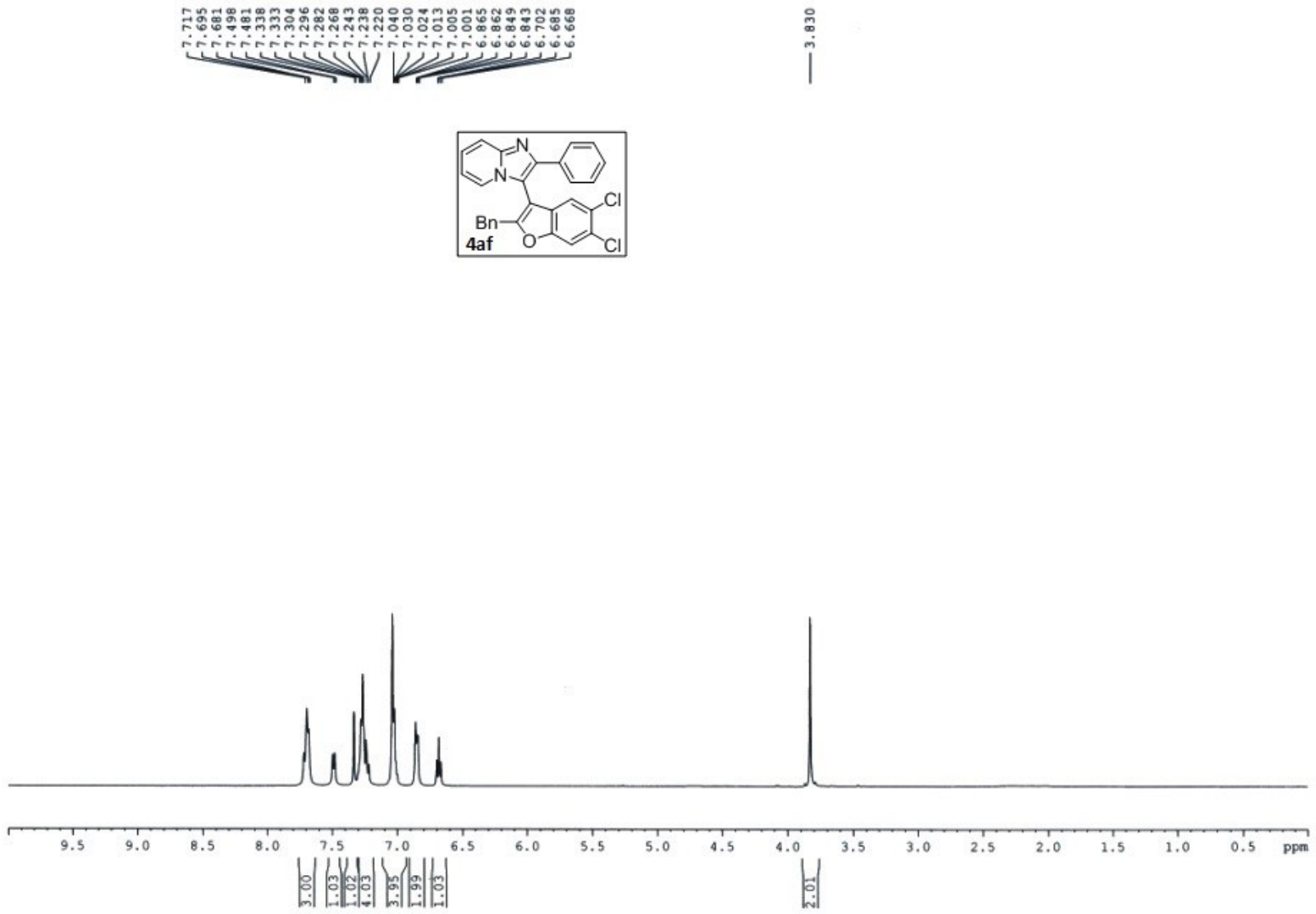
128.03
127.73
127.59
126.83
125.34
123.92
122.48
117.80
116.72
113.34
112.72
110.24
105.44
77.47
77.16
76.84
33.67
Br
Bn
4ae
O
N
N
BRUKER
Current Data Parameters
NAME Dr.A.HAJRA 2018
EXPNO 304
PROCNO 1
F2 - Acquisition Parameters
Date_ 20180218
Time 10.05
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 240
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 106.66
DW 20.800 usec
DE 6.50 usec
TE 297.9 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
======== CHANNEL f1 ========
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W
======== CHANNEL f2 ========
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W
F2 - Processing parameters
SI 16384
SF 100.6177891 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm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7.268
7.243
7.238
7.220
7.040
7.030
7.024
7.013
7.005
7.001
6.865
6.862
6.849
6.843
6.702
6.685
6.668
3.830
N
N
Cl
Cl
Bn
O
4af
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
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ppm
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4.03
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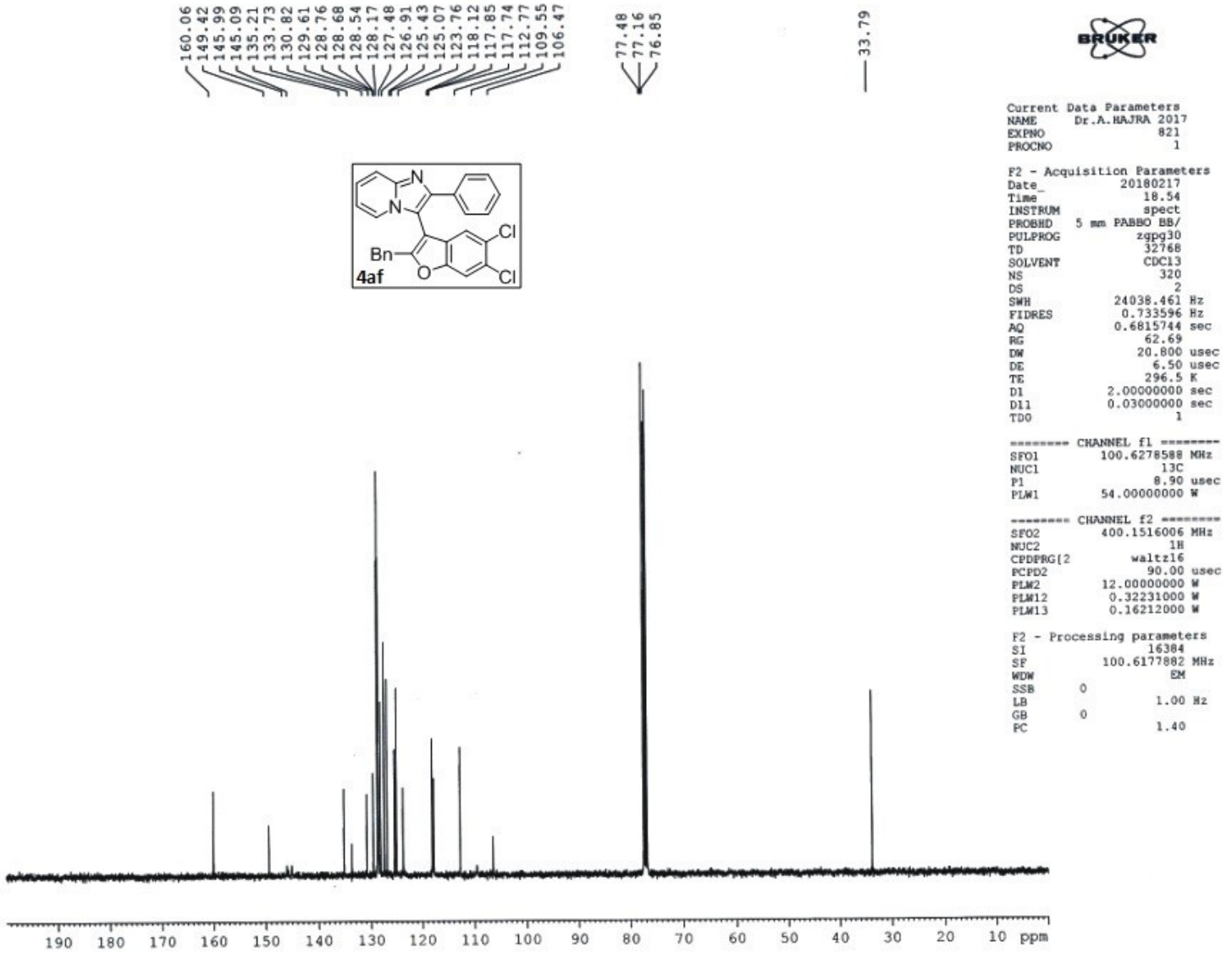
2.01



Current Data Parameters
NAME Dr.A.HAJRA 2017
EXPNO 821
PROCNO 1

F2 - Acquisition Parameters
Date_ 20180217
Time 18.54
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 320
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 62.69
DW 20.800 usec
DE 6.50 usec
TE 296.5 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

======== CHANNEL f1 ========
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W

======== CHANNEL f2 ========
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W

F2 - Processing parameters
SI 16384
SF 100.6177882 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40


8.283
8.277
8.260
8.254
8.104
8.098
7.774
7.752
7.706
7.696
7.687
7.682
7.656
7.633
7.580
7.563
7.310
7.309
7.287
7.275
7.270
7.260
7.104
7.100
7.091
7.087
7.076
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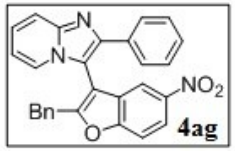
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NO2
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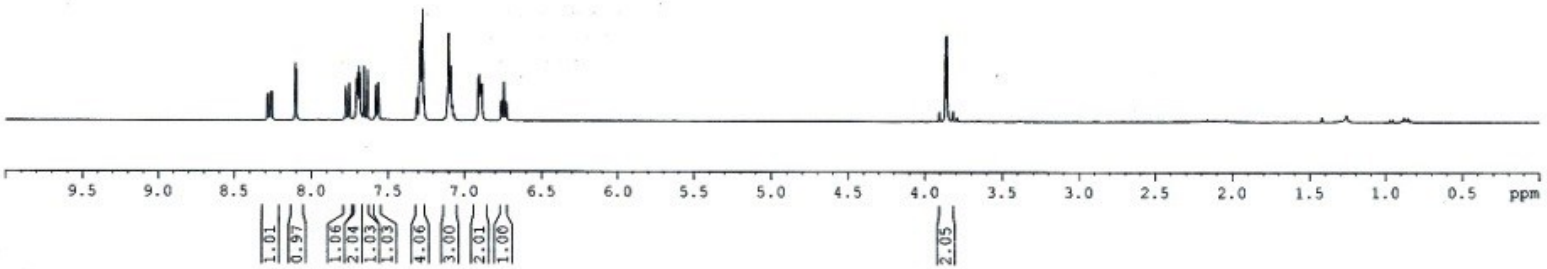
O
4ag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4.5
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3.5
3.0
2.5
2.0
1.5
1.0
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4.06
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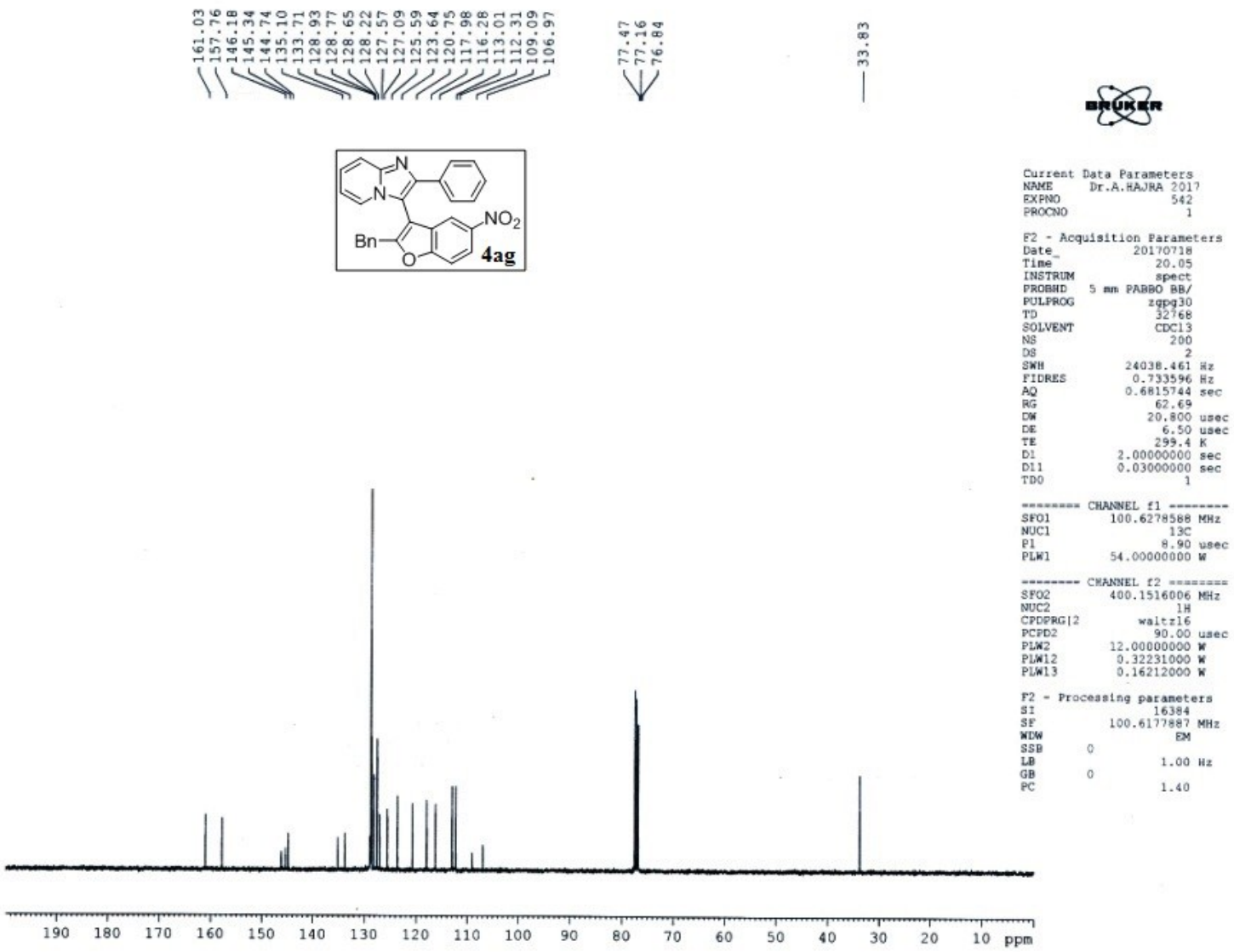
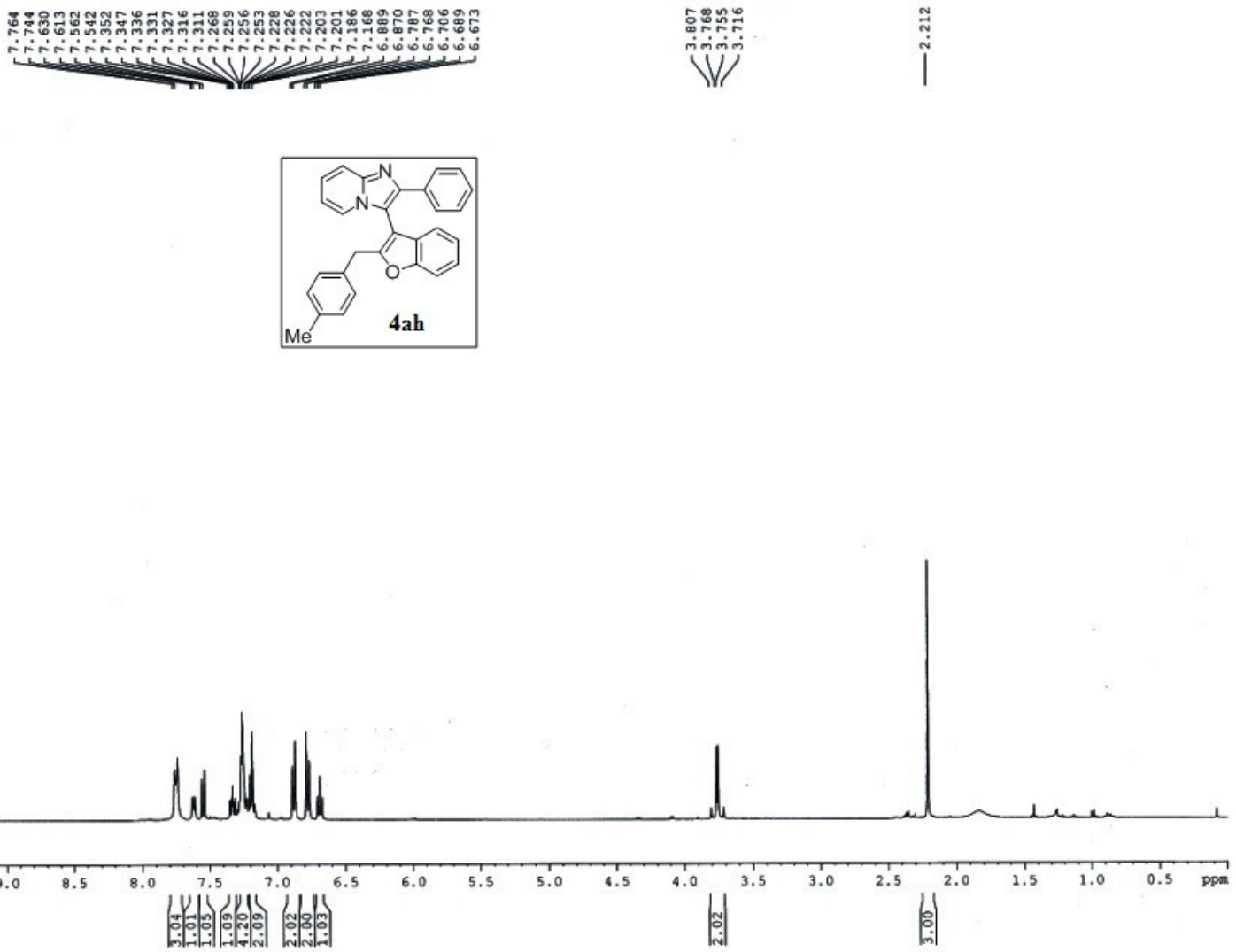
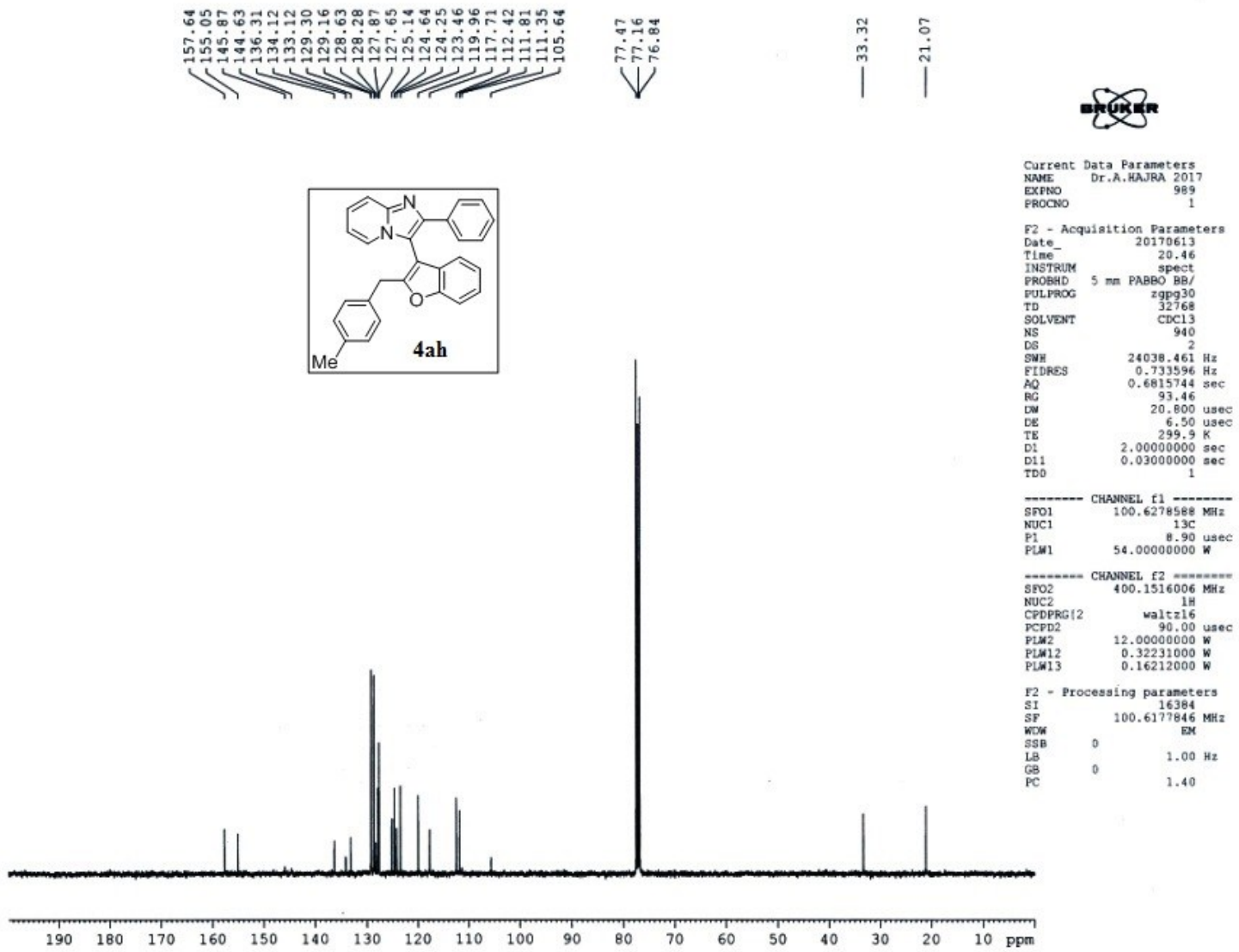
2.01
1.00
2.05

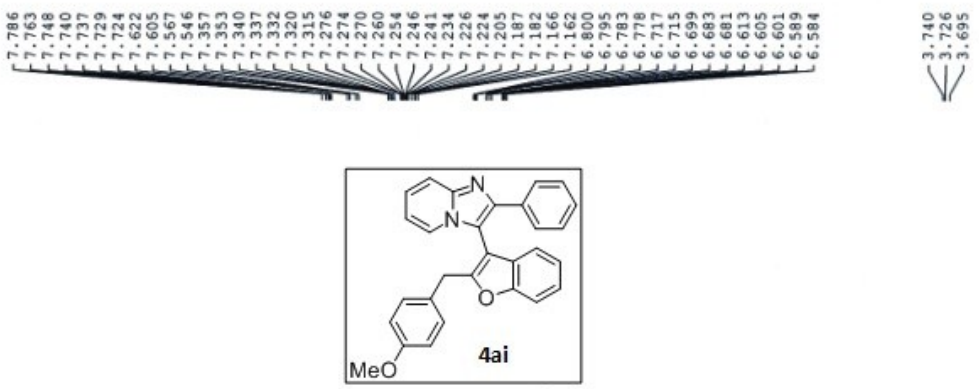



```
Current Data Parameters
NAME      Dr.A.HAJRA 2017
EXPNO                542
PROCNO                 1

F2 - Acquisition Parameters
Date_           20170718
Time_              20.05
INSTRUM            spect
PROBHD   5 mm PABBO BB/
PULPROG          zgpg30
TD                32768
SOLVENT           CDCl3
NS                  200
DS                    2
SWH           24038.461 Hz
FIDRES         0.733596 Hz
AQ             0.6815744 sec
RG                62.69
DW                20.800 usec
DE                 6.50 usec
TE                299.4 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1        100.6278588 MHz
NUC1                13C
P1                 8.90 usec
PLW1       54.00000000 W

======== CHANNEL f2 ========
SFO2        400.1516006 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             90.00 usec
PLW2       12.00000000 W
PLW12       0.32231000 W
PLW13       0.16212000 W

F2 - Processing parameters
SI                 16384
SF          100.6177887 MHz
WDW                   EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
```


7.764
7.744
7.630
7.613
7.562
7.542
7.352
7.347
7.336
7.331
7.327
7.316
7.311
7.268
7.259
7.256
7.253
7.228
7.226
7.222
7.203
7.201
7.186
7.168
6.889
6.870
6.787
6.768
6.706
6.689
6.673
3.807
3.768
3.755
3.716
2.212
N
N
O
Me
4ah
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
3.04
1.01
1.05
1.09
4.20
2.09
2.02
2.00
1.03
2.02
3.00




```
Current Data Parameters
NAME      Dr.A.HAJRA 2017
EXPNO              989
PROCNO               1

F2 - Acquisition Parameters
Date_          20170613
Time             20.46
INSTRUM          spect
PROBHD   5 mm PABBO BB/
PULPROG        zgpg30
TD              32768
SOLVENT          CDCl3
NS                 940
DS                   2
SWH          24038.461 Hz
FIDRES        0.733596 Hz
AQ            0.6815744 sec
RG                93.46
DW               20.800 usec
DE                6.50 usec
TE               299.9 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1       100.6278588 MHz
NUC1               13C
P1                8.90 usec
PLW1      54.00000000 W

======== CHANNEL f2 ========
SFO2       400.1516006 MHz
NUC2               1H
CPDPRG[2        waltz16
PCPD2            90.00 usec
PLW2      12.00000000 W
PLW12      0.32231000 W
PLW13      0.16212000 W

F2 - Processing parameters
SI                16384
SF         100.6177846 MHz
WDW                EM
SSB   0
LB                1.00 Hz
GB    0
PC                1.40
```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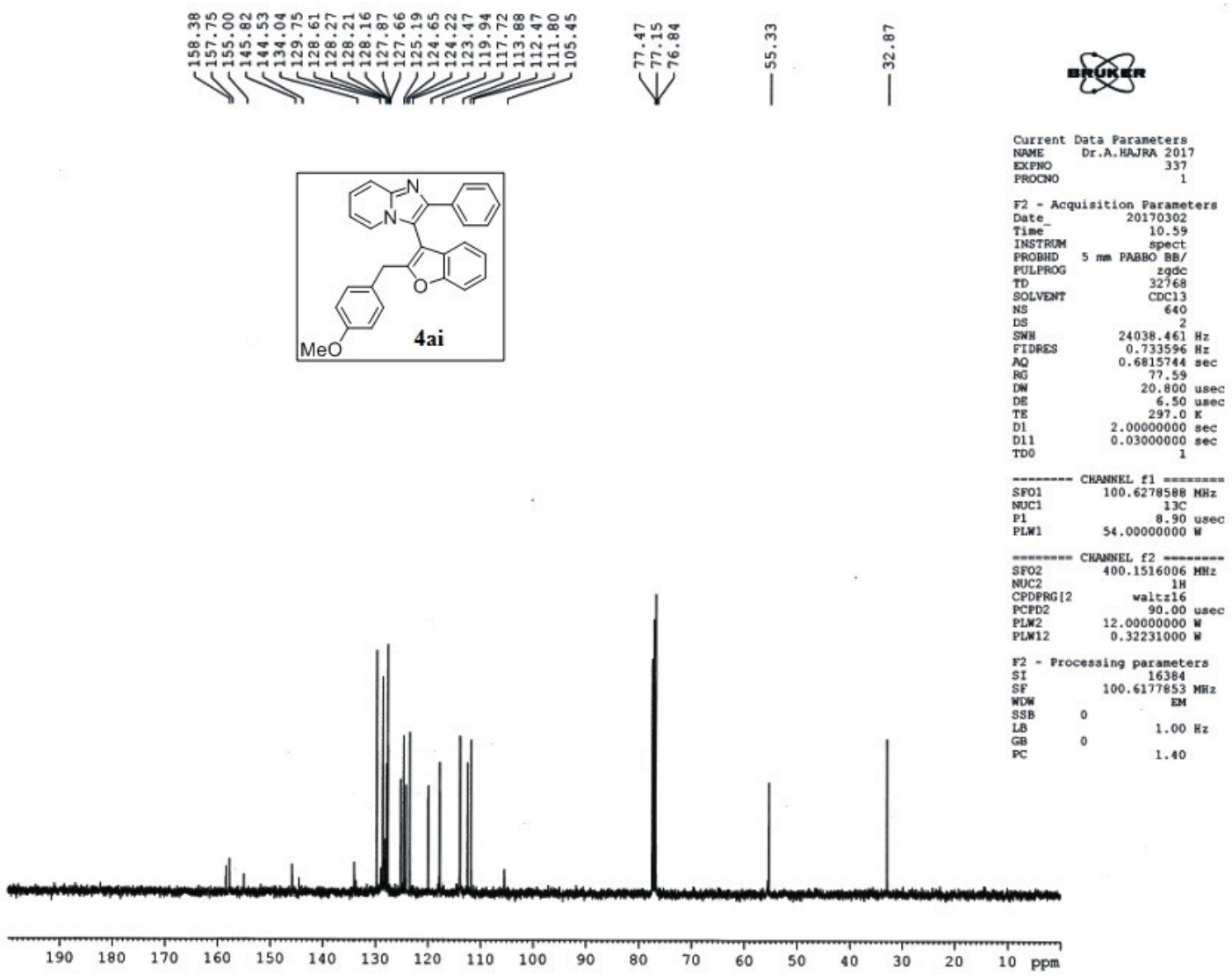
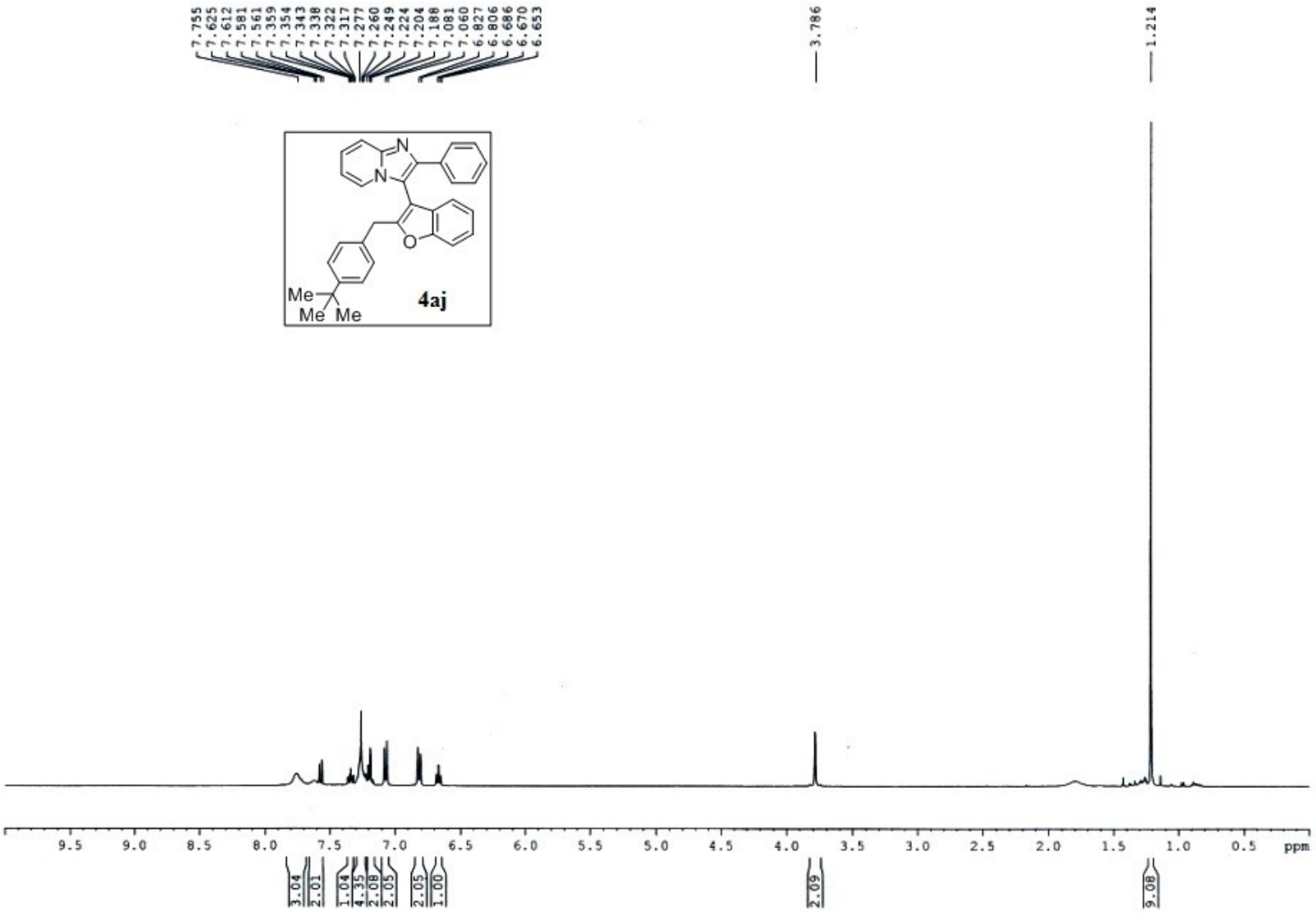
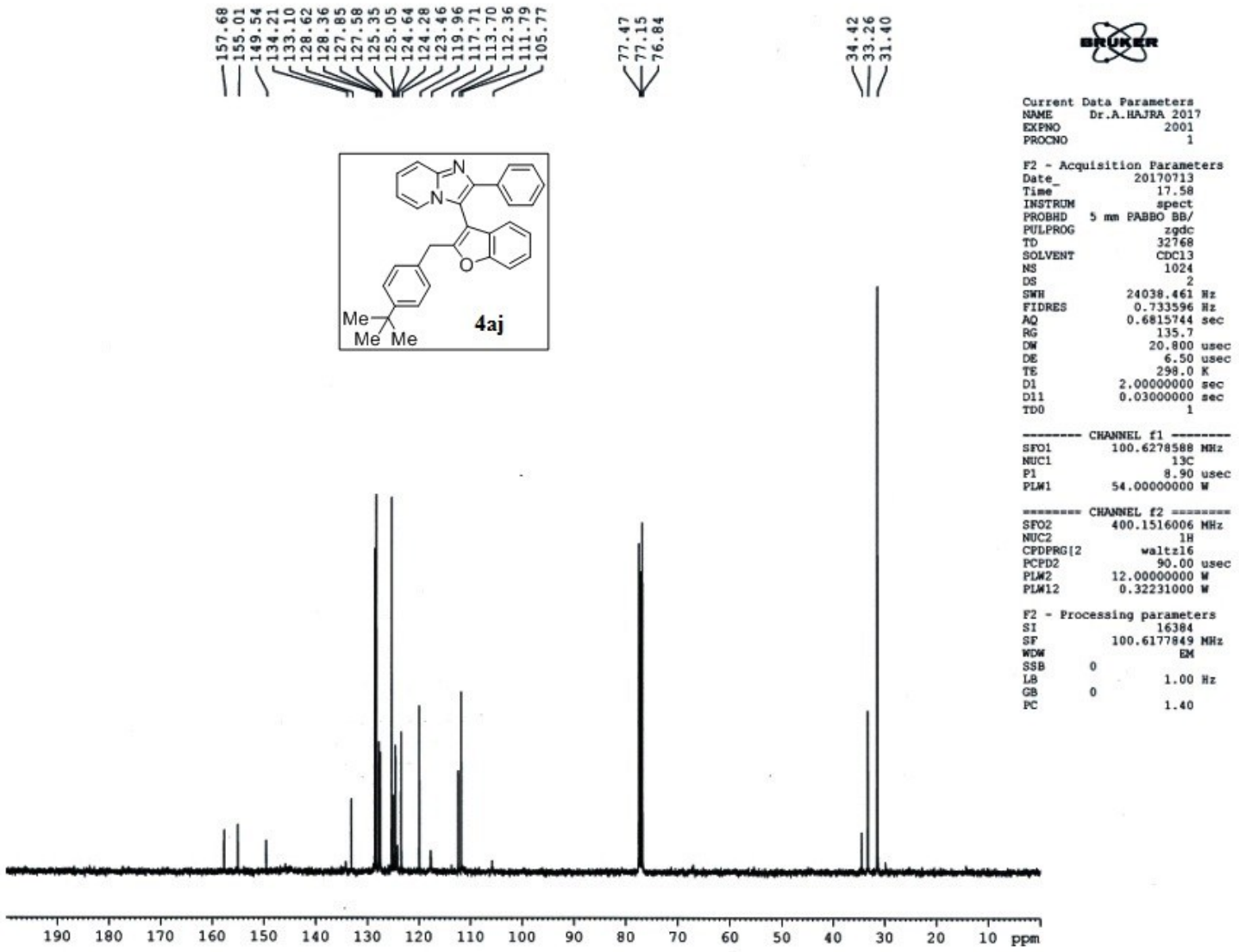
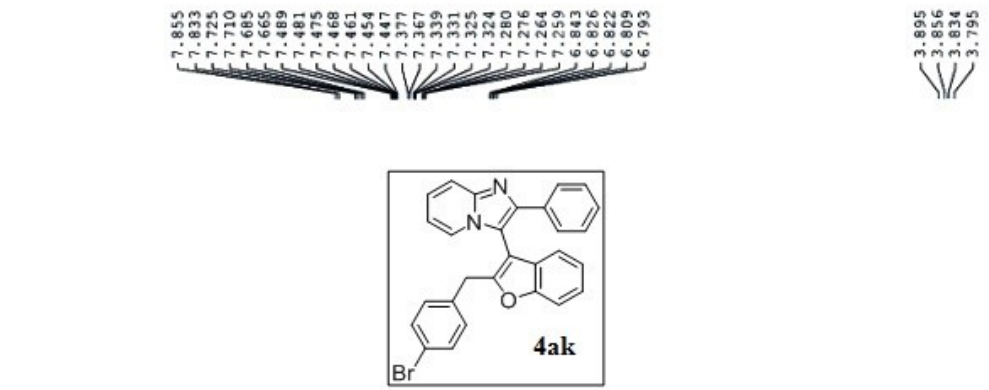
7.748
7.740
7.737
7.729
7.724
7.622
7.605
7.567
7.546
7.357
7.353
7.340
7.337
7.332
7.320
7.315
7.276
7.274
7.270
7.260
7.254
7.246
7.241
7.234
7.226
7.224
7.205
7.187
7.182
7.166
7.162
6.800
6.795
6.783
6.778
6.717
6.715
6.699
6.683
6.681
6.613
6.605
6.601
6.589
6.584
3.740
3.726
3.695
MeO
4ai
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
3.07
1.00
1.09
1.08
4.22
2.05
2.04
1.08
1.95
1.92
3.01

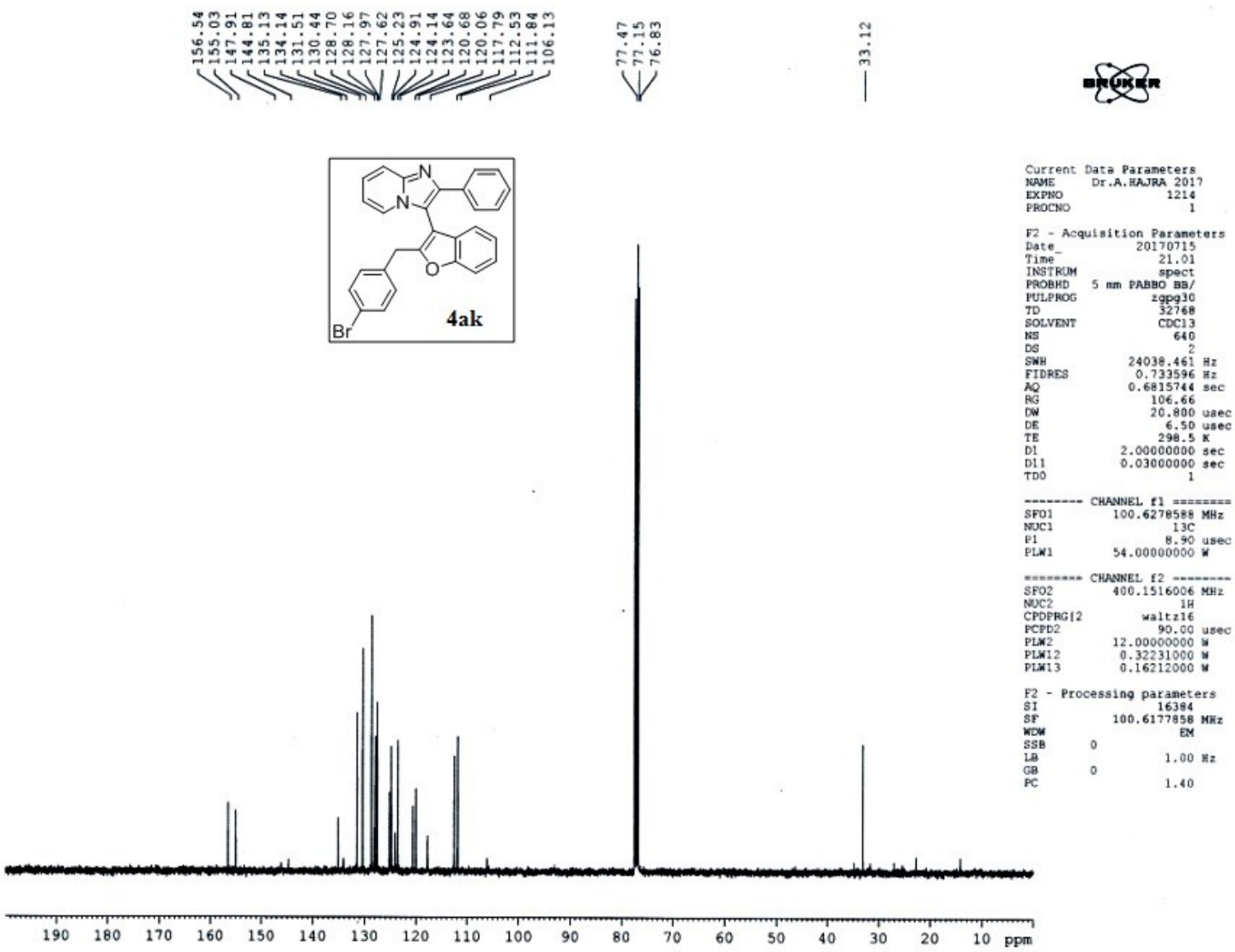

158.38
157.75
155.00
145.82
144.53
134.04
129.75
128.61
128.27
128.21
128.16
127.87
127.66
125.19
124.65
124.22
123.47
119.94
117.72
113.88
112.47
111.80
105.45
77.47
77.15
76.84
55.33
32.87
MeO
4ai
Current Data Parameters
NAME Dr.A.HAJRA 2017
EXPNO 337
PROCNO 1
F2 - Acquisition Parameters
Date_ 20170302
Time 10.59
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgdc
TD 32768
SOLVENT CDCl3
NS 640
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 77.59
DW 20.800 usec
DE 6.50 usec
TE 297.0 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
======== CHANNEL f1 ========
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W
======== CHANNEL f2 ========
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
F2 - Processing parameters
SI 16384
SF 100.6177853 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm


7.755
7.625
7.612
7.581
7.561
7.359
7.354
7.343
7.338
7.322
7.317
7.277
7.260
7.249
7.224
7.204
7.188
7.081
7.060
6.827
6.806
6.686
6.670
6.653
3.786
1.214
N
N
O
Me
Me Me
4aj
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
3.04
2.01
1.04
4.35
2.08
2.05
2.05
1.00
2.09
9.08

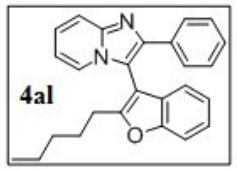


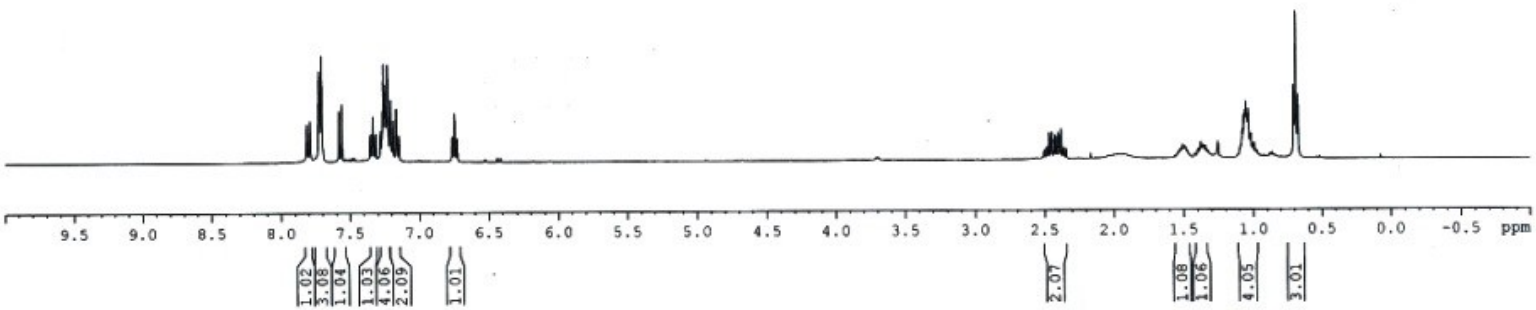

```
Current Data Parameters
NAME      Dr.A.HAJRA 2017
EXPNO             2001
PROCNO               1

F2 - Acquisition Parameters
Date_          20170713
Time              17.58
INSTRUM           spect
PROBHD   5 mm PABBO BB/
PULPROG           zgdc
TD               32768
SOLVENT          CDCl3
NS                1024
DS                   2
SWH          24038.461 Hz
FIDRES        0.733596 Hz
AQ            0.6815744 sec
RG                135.7
DW               20.800 usec
DE                6.50 usec
TE                298.0 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1        100.6278588 MHz
NUC1                13C
P1                 8.90 usec
PLW1        54.00000000 W

======== CHANNEL f2 ========
SFO2        400.1516006 MHz
NUC2                1H
CPDPRG[2        waltz16
PCPD2             90.00 usec
PLW2        12.00000000 W
PLW12        0.32231000 W

F2 - Processing parameters
SI                16384
SF          100.6177849 MHz
WDW                 EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```

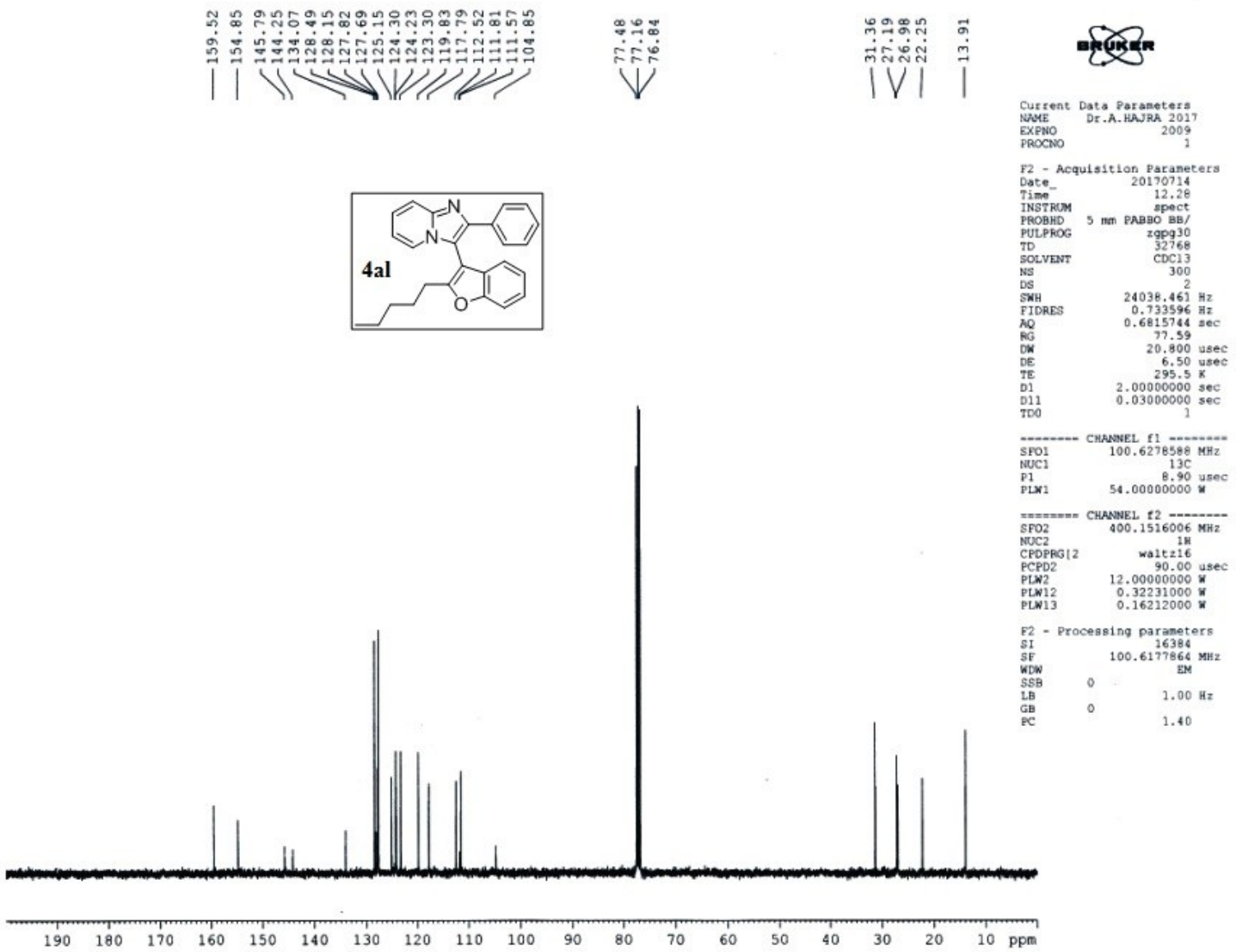

7.855
7.833
7.725
7.710
7.685
7.665
7.489
7.481
7.475
7.468
7.461
7.454
7.447
7.377
7.367
7.339
7.331
7.325
7.324
7.280
7.276
7.264
7.259
6.843
6.826
6.822
6.809
6.793
3.895
3.856
3.834
3.795
N
N
O
Br
4ak
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
3.03
2.01
1.08
6.22
2.02
3.00
2.06


156.54
155.03
147.91
144.81
135.13
134.14
131.51
130.44
128.70
128.16
127.97
127.62
125.23
124.91
124.14
123.64
120.68
120.06
117.79
112.53
111.84
106.13
77.47
77.15
76.83
33.12
BRUKER
N
N
O
Br
4ak
Current Data Parameters
NAME Dr.A.HAJRA 2017
EXPNO 1214
PROCNO 1
F2 - Acquisition Parameters
Date_ 20170715
Time 21.01
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 640
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 106.66
DW 20.800 usec
DE 6.50 usec
TE 298.5 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
CHANNEL f1
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W
CHANNEL f2
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W
F2 - Processing parameters
SI 16384
SF 100.6177858 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

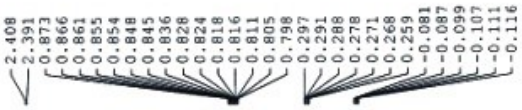

7.814
7.792
7.727
7.724
7.707
7.705
7.580
7.560
7.357
7.353
7.338
7.335
7.332
7.318
7.314
7.281
7.278
7.270
7.264
7.259
7.256
7.248
7.242
7.239
7.229
7.227
7.207
7.189
7.187
7.166
7.148
7.146
6.761
6.760
6.745
6.743
6.727
6.726
2.488
2.467
2.446
2.429
2.418
2.402
2.381
2.359
2.344
1.540
1.525
1.516
1.507
1.489
1.485
1.476
1.468
1.454
1.401
1.395
1.386
1.380
1.373
1.364
1.354
1.346
1.331
1.325
1.078
1.071
1.061
1.055
1.051
1.038
0.708
0.691
0.673

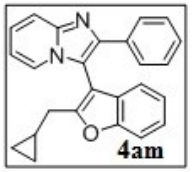

4al

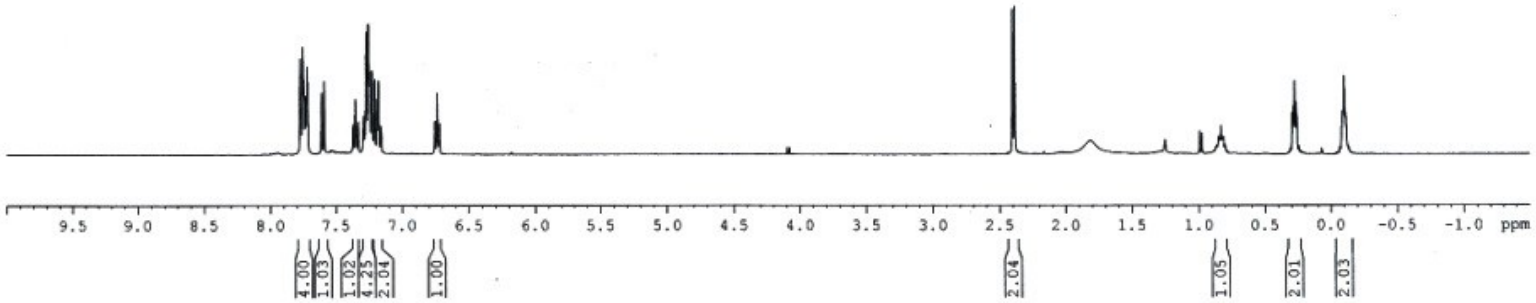

9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
ppm
1.02
3.08
1.04
1.03
4.06
2.09
1.01
2.07
1.08
1.06
4.05
3.01

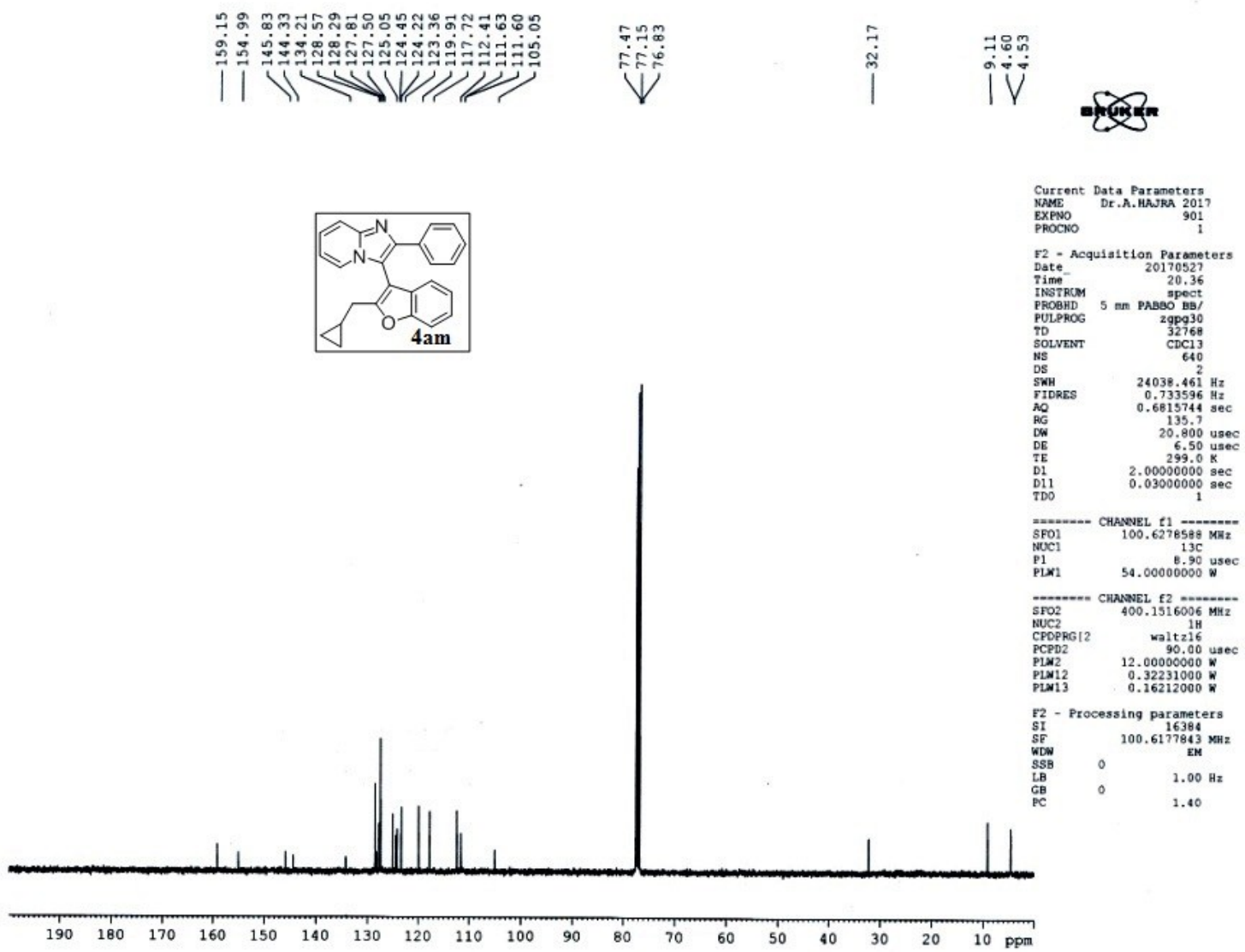

159.52
154.85
145.79
144.25
134.07
128.49
128.15
127.82
127.69
125.15
124.30
124.23
123.30
119.83
117.79
112.52
111.81
111.57
104.85
77.48
77.16
76.84
31.36
27.19
26.98
22.25
13.91
4al
Current Data Parameters
NAME Dr.A.HAJRA 2017
EXPNO 2009
PROCNO 1
F2 - Acquisition Parameters
Date_ 20170714
Time 12.28
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 300
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 77.59
DW 20.800 usec
DE 6.50 usec
TE 295.5 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
======== CHANNEL f1 ========
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W
======== CHANNEL f2 ========
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W
F2 - Processing parameters
SI 16384
SF 100.6177864 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm


7.777
7.773
7.756
7.754
7.748
7.736
7.734
7.722
7.719
7.612
7.591
7.373
7.369
7.356
7.352
7.335
7.331
7.294
7.289
7.272
7.259
7.254
7.247
7.243
7.240
7.231
7.227
7.208
7.191
7.190
7.181
7.178
7.162
6.755
6.753
6.738
6.722
6.719


2.408
2.391
0.873
0.866
0.861
0.855
0.854
0.848
0.845
0.836
0.828
0.824
0.818
0.816
0.811
0.805
0.798
0.297
0.291
0.288
0.278
0.271
0.268
0.259
-0.081
-0.087
-0.099
-0.107
-0.111
-0.116

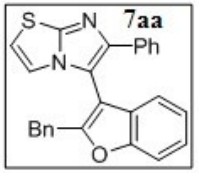

4am

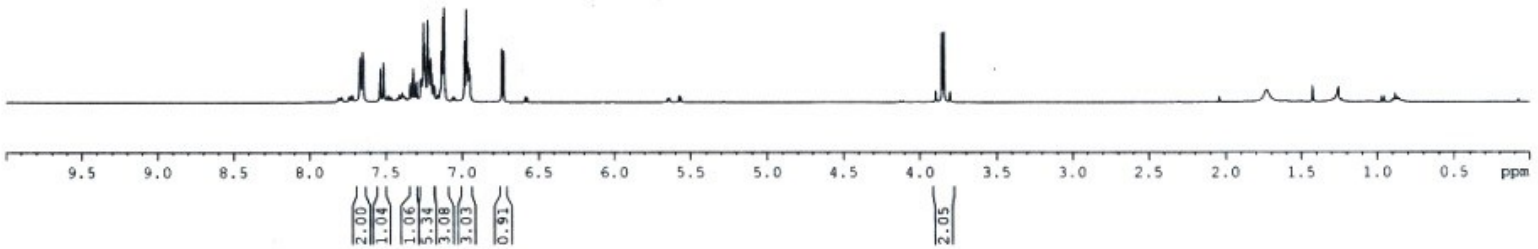

9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
ppm
4.00
1.03
1.02
4.25
2.04
1.00
2.04
1.05
2.01
2.03


159.15
154.99
145.83
144.33
134.21
128.57
128.29
127.81
127.50
125.05
124.45
124.22
123.36
119.91
117.72
112.41
111.63
111.60
105.05
77.47
77.15
76.83
32.17
9.11
4.60
4.53
4am
Current Data Parameters
NAME Dr.A.HAJRA 2017
EXPNO 901
PROCNO 1
F2 - Acquisition Parameters
Date_ 20170527
Time 20.36
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 640
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 135.7
DW 20.800 usec
DE 6.50 usec
TE 299.0 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
======== CHANNEL f1 ========
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W
======== CHANNEL f2 ========
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W
F2 - Processing parameters
SI 16384
SF 100.6177843 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm


7.670
7.666
7.650
7.647
7.535
7.515
7.340
7.336
7.322
7.319
7.301
7.298
7.272
7.269
7.265
7.259
7.251
7.243
7.224
7.216
7.212
7.205
7.199
7.185
7.181
7.144
7.140
7.135
7.133
7.124
7.118
7.109
7.100
6.986
6.975
6.965
6.956
6.950
6.744
6.732


3.895
3.856
3.844
3.804


S
N
7aa
Ph
N
Bn
O


9.5
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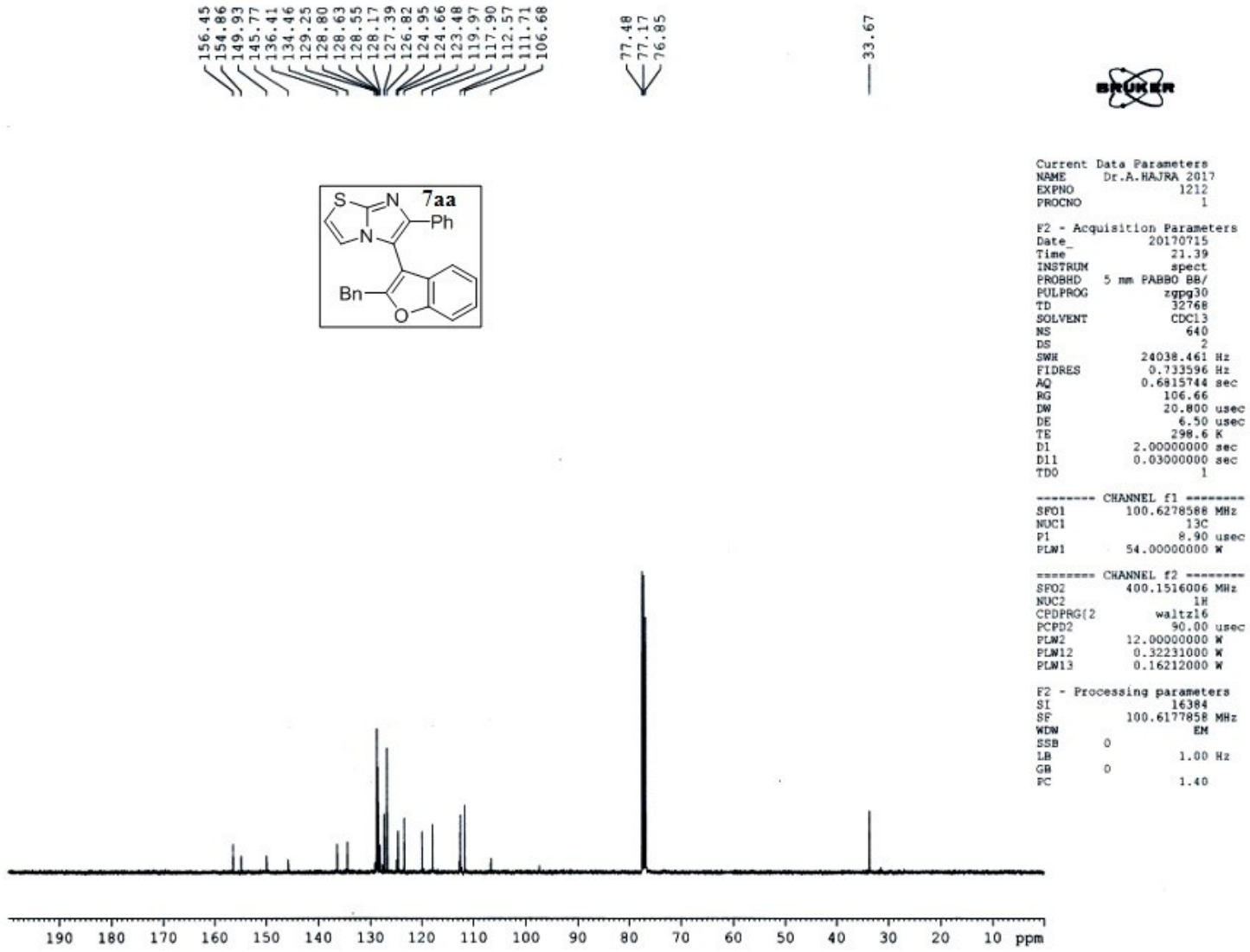
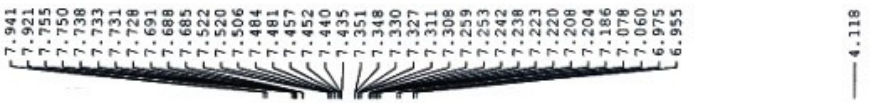
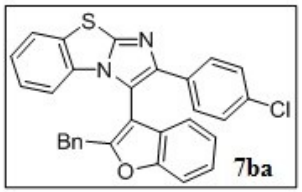
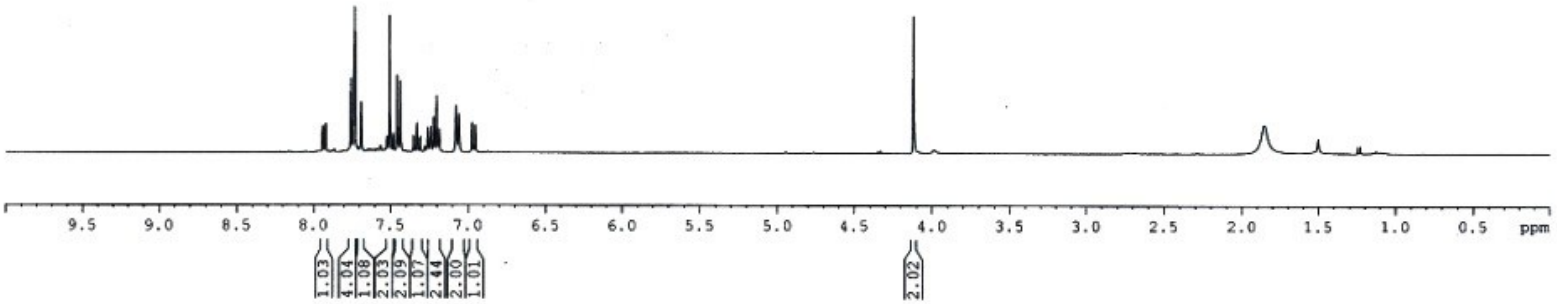
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.00
1.04
1.06
5.34
3.08
3.03
0.91
2.05

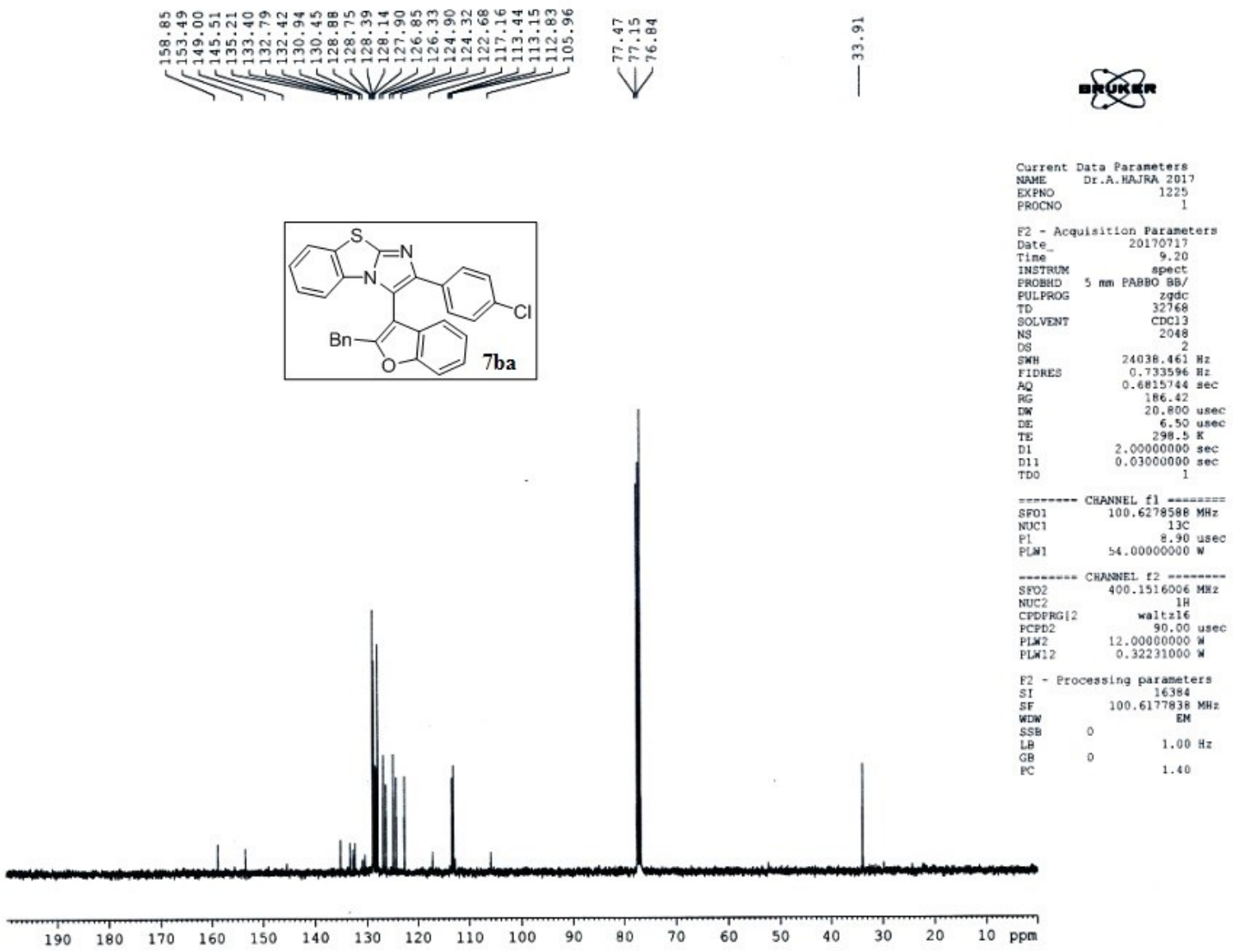

156.45
154.86
149.93
145.77
136.41
134.46
129.25
128.80
128.63
128.55
128.17
127.39
126.82
124.95
124.66
123.48
119.97
117.90
112.57
111.71
106.68
77.48
77.17
76.85
33.67
7aa
Ph
Bn
Current Data Parameters
NAME Dr.A.HAJRA 2017
EXPNO 1212
PROCNO 1
F2 - Acquisition Parameters
Date_ 20170715
Time 21.39
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 640
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 106.66
DW 20.800 usec
DE 6.50 usec
TE 298.6 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
CHANNEL f1
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W
CHANNEL f2
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG(2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W
F2 - Processing parameters
SI 16384
SF 100.6177858 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

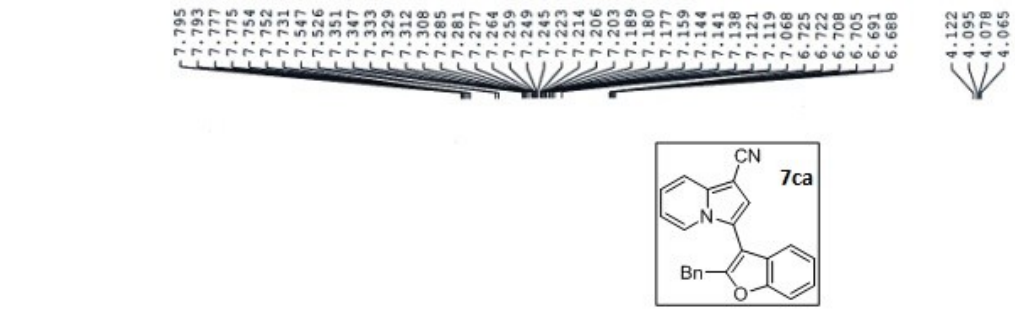

7.941
7.921
7.755
7.750
7.738
7.733
7.731
7.728
7.691
7.688
7.685
7.522
7.520
7.506
7.484
7.481
7.457
7.452
7.440
7.435
7.351
7.348
7.330
7.327
7.311
7.308
7.259
7.253
7.242
7.238
7.223
7.220
7.208
7.204
7.186
7.078
7.060
6.975
6.955
4.118

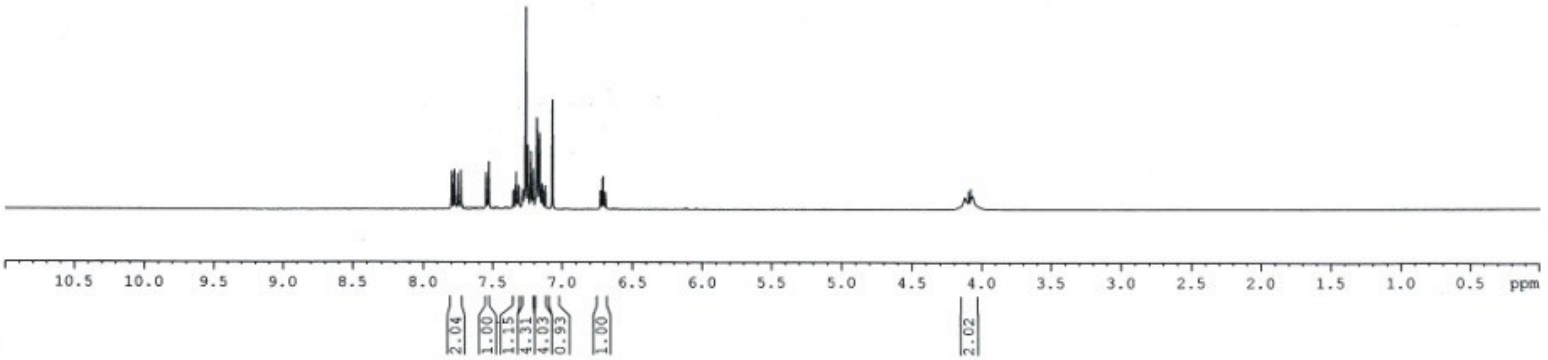

S
N
N
Cl
Bn
O

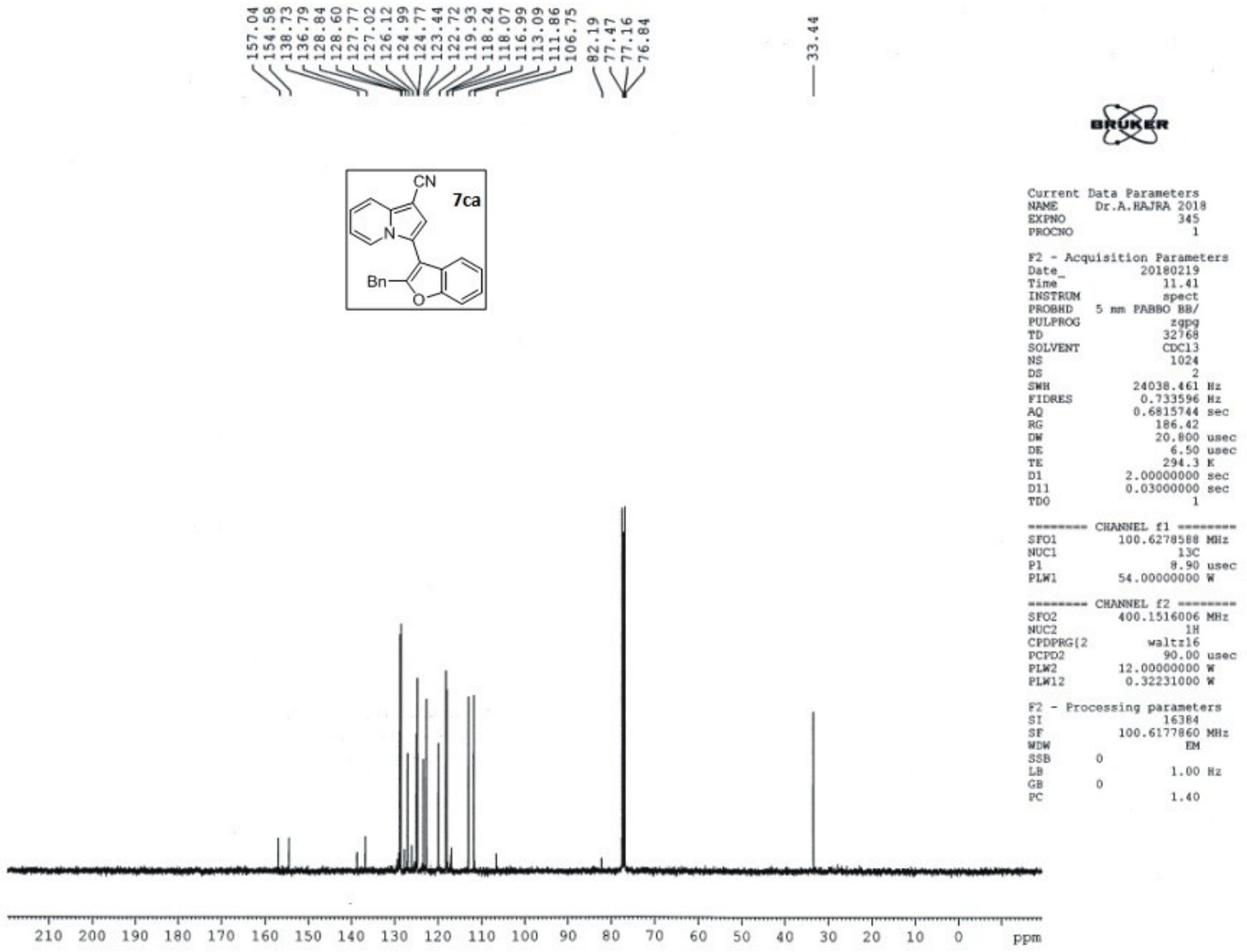
7ba

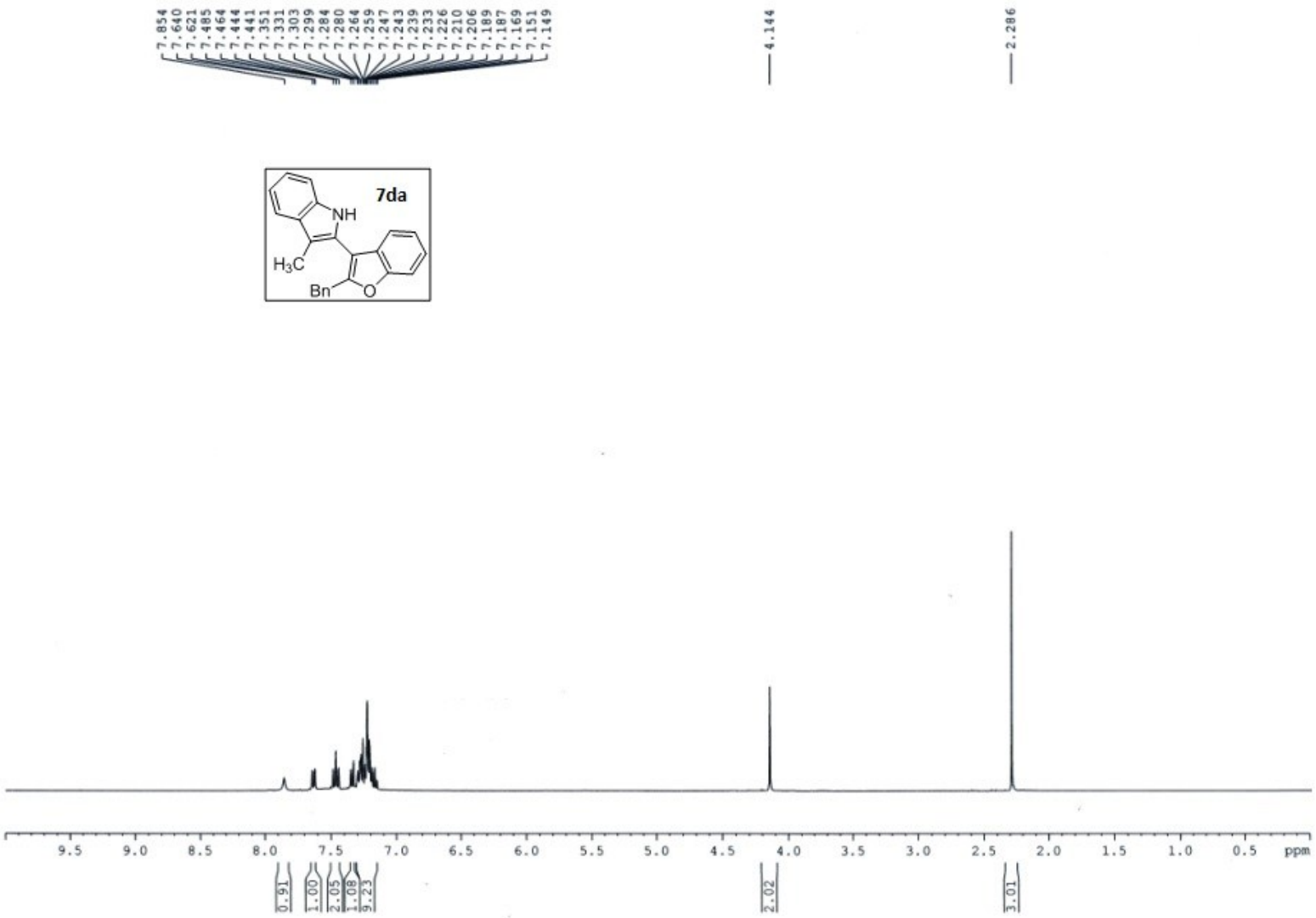

9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
1.03
4.04
1.08
2.03
2.09
1.07
2.44
2.00
1.01
2.02

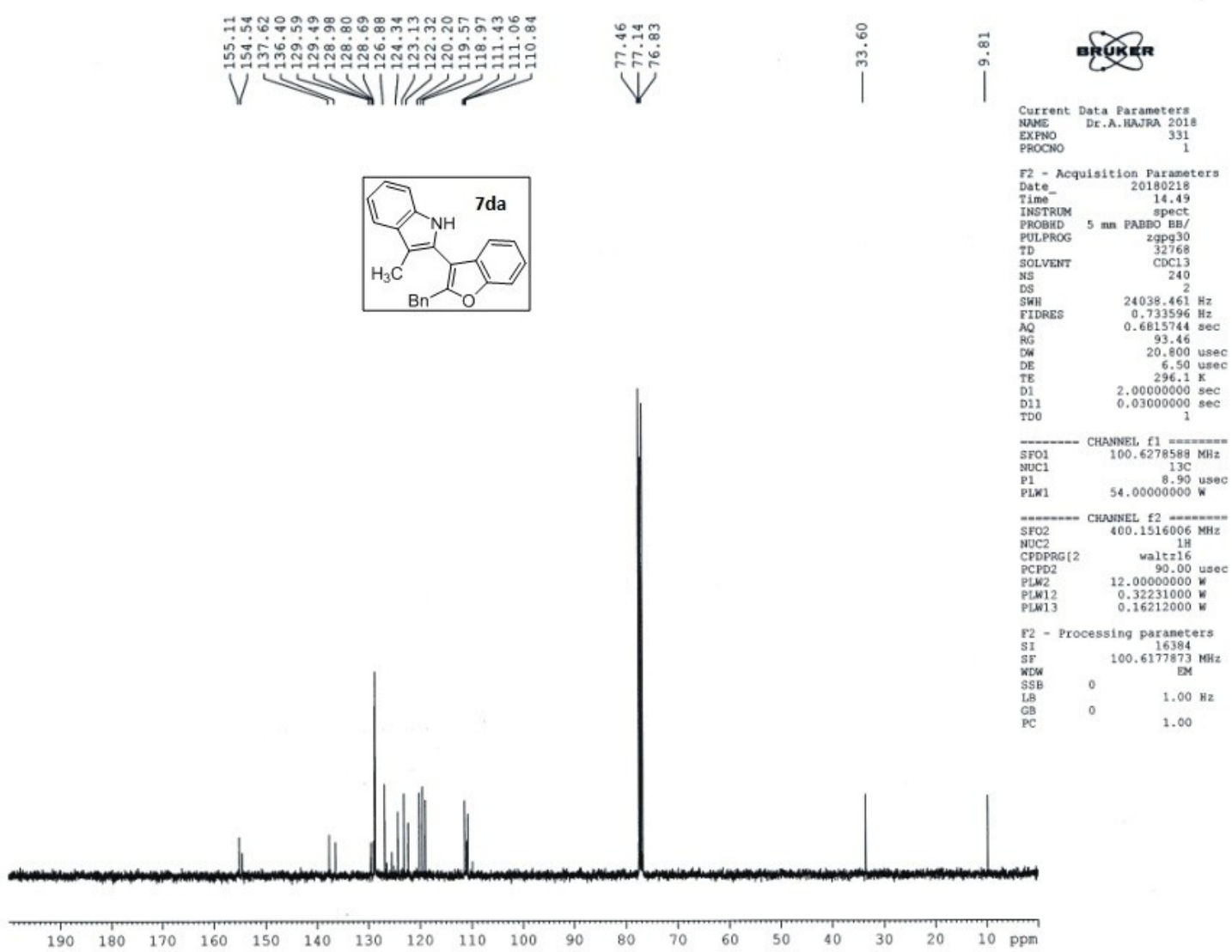

158.85
153.49
149.00
145.51
135.21
133.40
132.79
132.42
130.94
130.45
128.88
128.75
128.39
128.14
127.90
126.85
126.33
124.90
124.32
122.68
117.16
113.44
113.15
112.83
105.96
77.47
77.15
76.84
33.91
BRUKER
S
N
N
Cl
Bn
O
7ba
Current Data Parameters
NAME Dr.A.HAJRA 2017
EXPNO 1225
PROCNO 1
F2 - Acquisition Parameters
Date_ 20170717
Time 9.20
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgdc
TD 32768
SOLVENT CDCl3
NS 2048
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 186.42
DW 20.800 usec
DE 6.50 usec
TE 298.5 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
======== CHANNEL f1 ========
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W
======== CHANNEL f2 ========
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
F2 - Processing parameters
SI 16384
SF 100.6177838 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

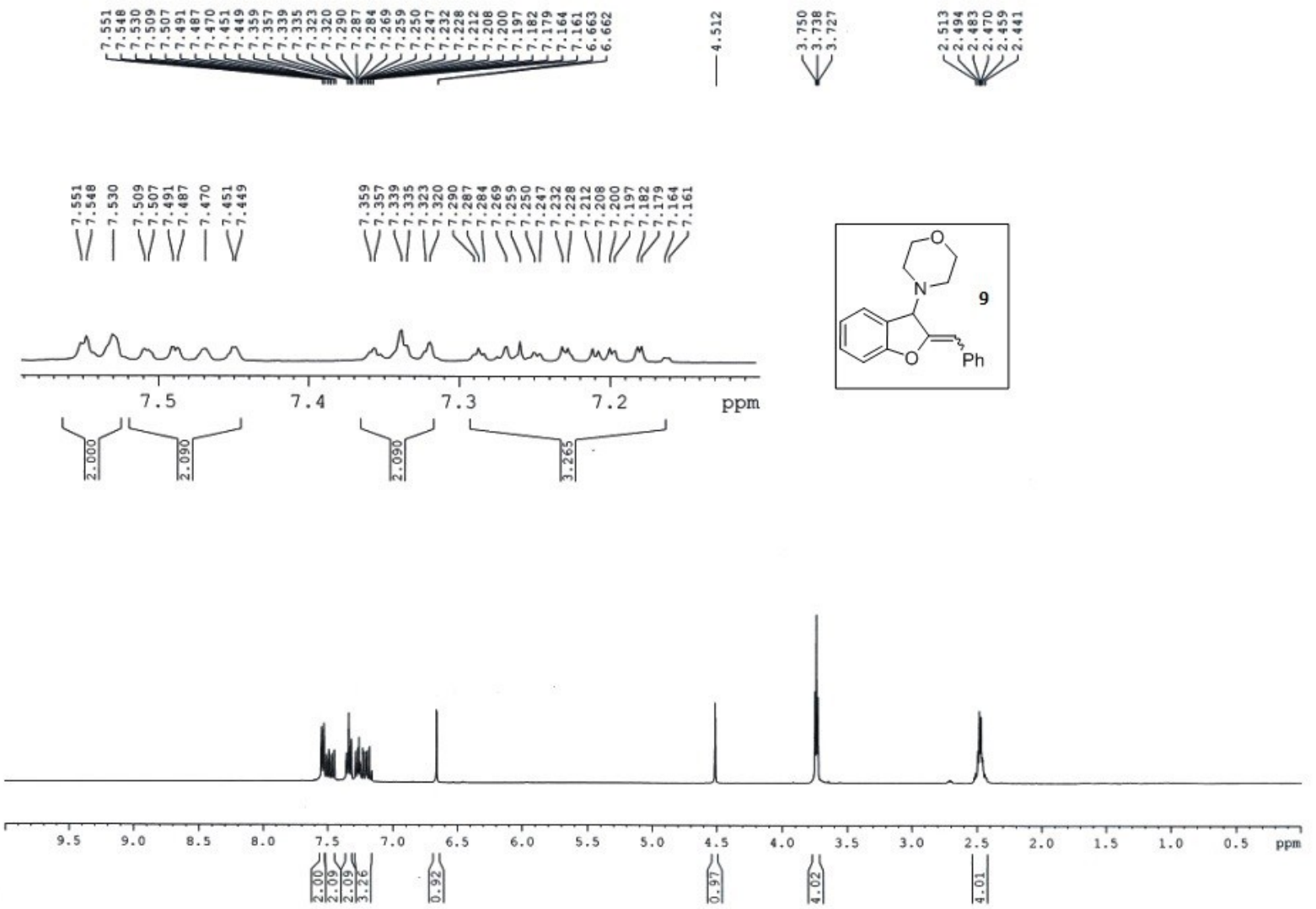

7.795
7.793
7.777
7.775
7.754
7.752
7.731
7.547
7.526
7.351
7.347
7.333
7.329
7.312
7.308
7.285
7.281
7.277
7.264
7.259
7.249
7.245
7.223
7.214
7.206
7.203
7.189
7.180
7.177
7.159
7.144
7.141
7.138
7.121
7.119
7.068
6.725
6.722
6.708
6.705
6.691
6.688
4.122
4.095
4.078
4.065
CN
7ca
N
Bn
O

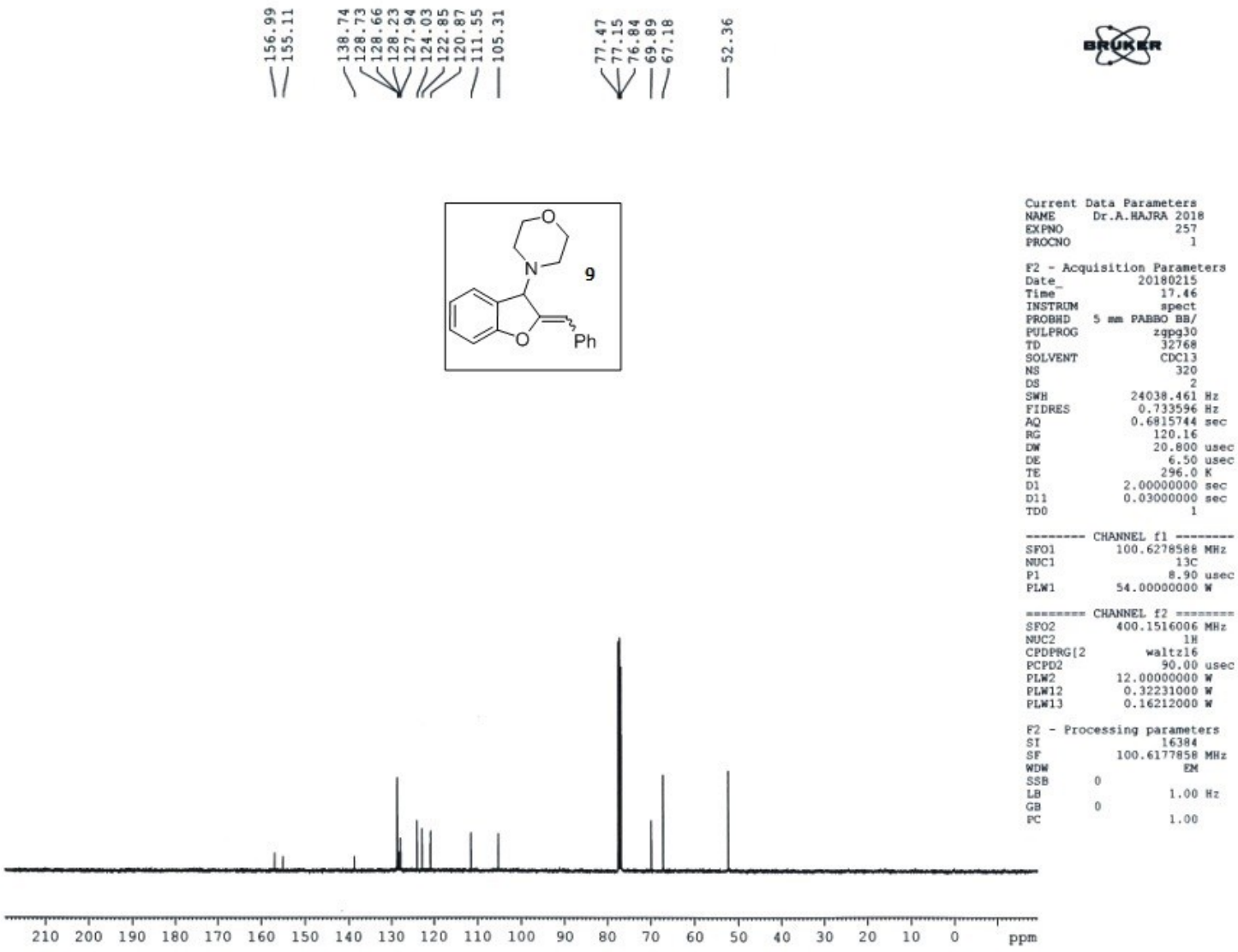

10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.04
1.00
1.15
4.31
4.03
0.93
1.00
2.02

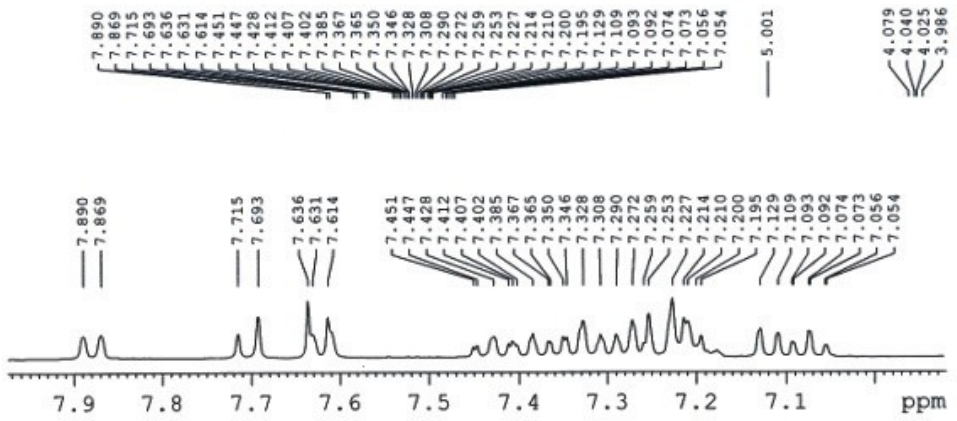

157.04
154.58
138.73
136.79
128.84
128.60
127.77
127.02
126.12
124.99
124.77
123.44
122.72
119.93
118.24
118.07
116.99
113.09
111.86
106.75
82.19
77.47
77.16
76.84
33.44
CN
7ca
N
Bn
O
BRUKER
Current Data Parameters
NAME Dr.A.HAJRA 2018
EXPNO 345
PROCNO 1
F2 - Acquisition Parameters
Date_ 20180219
Time 11.41
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg
TD 32768
SOLVENT CDCl3
NS 1024
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 186.42
DW 20.800 usec
DE 6.50 usec
TE 294.3 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
======== CHANNEL f1 ========
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W
======== CHANNEL f2 ========
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
F2 - Processing parameters
SI 16384
SF 100.6177860 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
ppm


7.854
7.640
7.621
7.485
7.464
7.444
7.441
7.351
7.331
7.303
7.299
7.284
7.280
7.264
7.259
7.247
7.243
7.239
7.233
7.226
7.210
7.206
7.189
7.187
7.169
7.151
7.149
4.144
2.286
7da
NH
H3C
Bn
O
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
0.91
1.00
2.05
1.08
9.23
2.02
3.01


155.11
154.54
137.62
136.40
129.59
129.49
128.98
128.80
128.69
126.88
124.34
123.13
122.32
120.20
119.57
118.97
111.43
111.06
110.84
77.46
77.14
76.83
33.60
9.81
7da
NH
H3C
Bn
O
BRUKER
Current Data Parameters
NAME Dr.A.HAJRA 2018
EXPNO 331
PROCNO 1
F2 - Acquisition Parameters
Date_ 20180218
Time 14.49
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 240
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 93.46
DW 20.800 usec
DE 6.50 usec
TE 296.1 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
======== CHANNEL f1 ========
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W
======== CHANNEL f2 ========
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W
F2 - Processing parameters
SI 16384
SF 100.6177873 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.00
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm


7.551
7.548
7.530
7.509
7.507
7.491
7.487
7.470
7.451
7.449
7.359
7.357
7.339
7.335
7.323
7.320
7.290
7.287
7.284
7.269
7.259
7.250
7.247
7.232
7.228
7.212
7.208
7.200
7.197
7.182
7.179
7.164
7.161
6.663
6.662
4.512
3.750
3.738
3.727
2.513
2.494
2.483
2.470
2.459
2.441
9
Ph
7.5
7.4
7.3
7.2
ppm
2.000
2.090
2.090
3.265
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
2.00
2.09
2.09
3.26
0.92
0.97
4.02
4.01


156.99
155.11
138.74
128.73
128.66
128.23
127.94
124.03
122.85
120.87
111.55
105.31
77.47
77.15
76.84
69.89
67.18
52.36
BRUKER
9
Ph
Current Data Parameters
NAME Dr.A.HAJRA 2018
EXPNO 257
PROCNO 1
F2 - Acquisition Parameters
Date_ 20180215
Time 17.46
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 32768
SOLVENT CDCl3
NS 320
DS 2
SWH 24038.461 Hz
FIDRES 0.733596 Hz
AQ 0.6815744 sec
RG 120.16
DW 20.800 usec
DE 6.50 usec
TE 296.0 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
CHANNEL f1
SFO1 100.6278588 MHz
NUC1 13C
P1 8.90 usec
PLW1 54.00000000 W
CHANNEL f2
SFO2 400.1516006 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 90.00 usec
PLW2 12.00000000 W
PLW12 0.32231000 W
PLW13 0.16212000 W
F2 - Processing parameters
SI 16384
SF 100.6177858 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.00
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm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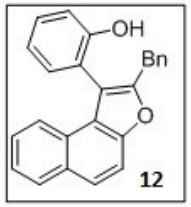
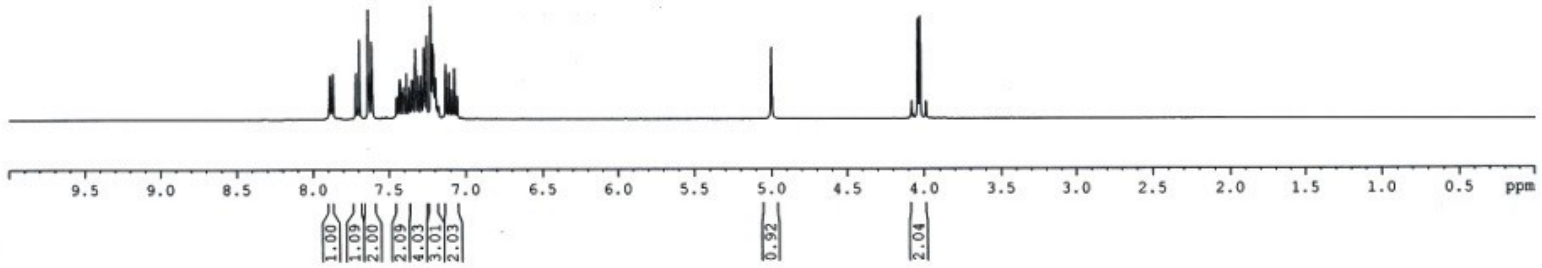
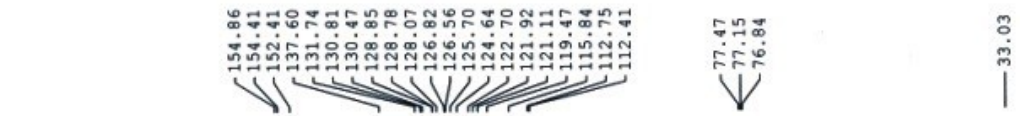
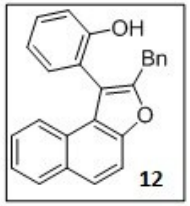
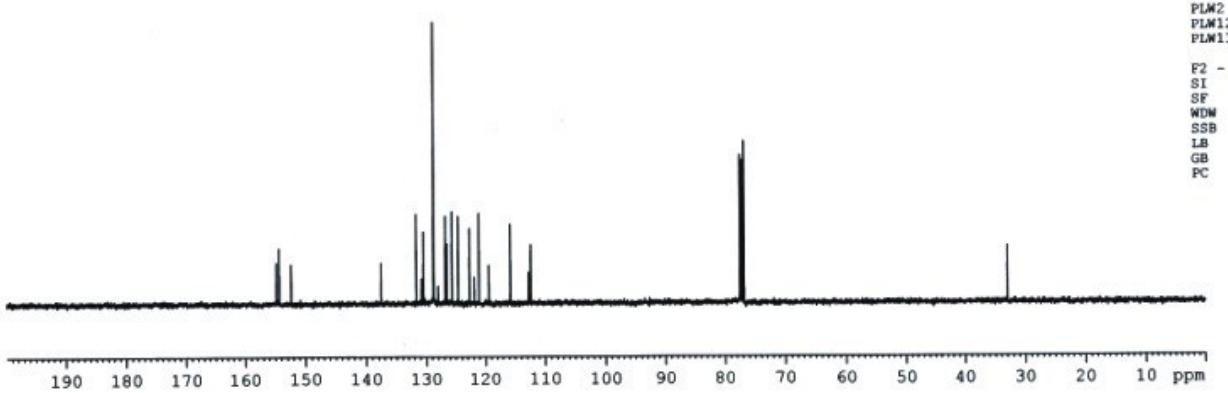
7.636
7.631
7.614
7.451
7.447
7.428
7.412
7.407
7.402
7.385
7.367
7.365
7.350
7.346
7.328
7.308
7.290
7.272
7.259
7.253
7.227
7.214
7.210
7.200
7.195
7.129
7.109
7.093
7.092
7.074
7.073
7.056
7.054
5.001
4.079
4.040
4.025
3.986
7.9
7.8
7.7
7.6
7.5
7.4
7.3
7.2
7.1
ppm


OH
Bn
O
12


9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
ppm
1.00
1.09
2.00
2.09
4.03
3.01
2.03
0.92
2.04








```
Current Data Parameters
NAME      Dr.A.HAJRA 2017
EXPNO             1820
PROCNO               1

F2 - Acquisition Parameters
Date_         20171104
Time             21.13
INSTRUM          spect
PROBHD   5 mm PABBO BB/
PULPROG        zgpg30
TD             32768
SOLVENT         CDC13
NS                 80
DS                  2
SWH         24038.461 Hz
FIDRES       0.733596 Hz
AQ           0.6815744 sec
RG              62.69
DW              20.800 usec
DE               6.50 usec
TE              297.2 K
D1          2.00000000 sec
D11         0.03000000 sec
TD0                 1

======== CHANNEL f1 ========
SFO1       100.6278588 MHz
NUC1              13C
P1               8.90 usec
PLW1       54.00000000 W

======== CHANNEL f2 ========
SFO2       400.1516006 MHz
NUC2              1H
CPDPRG[2       waltz16
PCPD2            90.00 usec
PLW2       12.00000000 W
PLW12       0.32231000 W
PLW13       0.16212000 W

F2 - Processing parameters
SI                16384
SF         100.6177897 MHz
WDW                EM
SSB       0
LB               1.00 Hz
GB        0
PC               1.20
```