# Mild Regiospecific Synthesis of 1-alkoxy-isochromenes Catalysed by Well-Defined [Silver(I)(Pc-L)] Complexes

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## SUPPORTING INFORMATION

### PART I



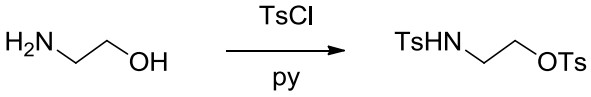
### PART II

## PART I

### General experimental details

All the reactions, that involve the use of reagents sensitive to oxygen or hydrolysis, were carried out under inert atmosphere. The glassware was previously dried in an oven at 110 °C and set with cycles of vacuum and nitrogen. Also syringes, used to transfer reagents and solvents, were previously set under nitrogen atmosphere. All chemicals and solvents are commercially available and were used after distillation and/or treatment with drying agents. The chromatographic column separations were conducted by flash technique, using silica gel from Sigma-Aldrich (pore size 60Å, particle size 230-400 mesh, Merck Grade 9385) and/or neutral aluminium oxide from Fluka (Brockman grade I, 0.05–0.15 mm, pH 7± 0.5). For thin-layer chromatography (TLC), Silica on TLC Alu foils with fluorescent indicator (254 nm) from Fluka was employed and the detection was performed by irradiation with UV light (λ = 254 nm and/or 366 nm). $^{1}$H NMR analysis were performed with a Varian-Gemini 200 or with Bruker Avance 300-DRX or Avance 400-DRX spectrometers at room temperature, respectively at 200, 300 or 400 MHz. The coupling constants (*J*) are expressed in Hertz (Hz), the chemical shifts (δ) in ppm. The multiplicity of the proton spectra were described by the following abbreviations: s (singlet), d (doublet), t (triplet), q (quartet), hex (sestet), hept (septet) dt (double triplet), dd (double doublet), td (triple doublet), m (multiplet), br (broad). $^{13}$C NMR analysis were performed with the same instruments at 50.3, 75.5 and 100 MHz; APT sequence was used to distinguish the methine and methyl carbon signals from those arising from methylene and quaternary carbon atoms. All $^{13}$C NMR spectra were recorded with complete proton decoupling. Low resolution MS spectra were recorded with a Fisons MD 800 spectrometer with electron impact source and a Thermo-Finnigan LCQ-advantage AP electrospray/ion trap equipped instrument, using a syringe pump device to directly inject sample solutions or with a VG Autospec M246 equipped with a FAB source (PcL ligand and metal complexes). The values are expressed as mass-charge ratio and the relative intensities of the most significant peaks are shown in brackets. High resolution MS spectra were recorded with a Bruker Daltonics ICR-FTMS APEX II electrospray equipped instrument. UV-vis spectra of the ligand and its silver complexes were obtained in $CHCl_3$ solutions using an Agilent 8453 UV-visible recording spectrophotometer. The melting points of the solid products were measured with a Stuart Scientific SMP3 apparatus and are uncorrected. The syntheses of the silver complexes were carried out in a nitrogen atmosphere employing standard Schlenk techniques. Dichloroethane and *n*-hexane were distilled prior use by standard procedures and stored under dinitrogen. Microwave promoted reactions were performed with a single-mode Personal Chemistry Microwave Synthesizer **"**Emrys Creator", using sealed glass vessels. The temperature was detected with a infrared sensor.

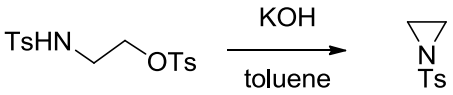
**Synthesis of 2-(tosylamino)ethyl tosylate:**[1]




Tosyl chloride (41.88 g, 220 mmol) was suspended in pyridine (25 ml) and the mixture was cooled to -40°C. A solution of 2-aminoethanol (6.22 g, 102 mmol) in pyridine (10 ml) was added dropwise over 15 mins under vigorous stirring, resulting in a dark orange mixture. The reaction temperature was adjusted to -10°C for 2h and then to rt. The yellow crude was filtered, washed with ethanol and recrystallized three times from ethanol, until complete removal of pyridine. The product was obtained as a white powder (18.05 g, 49% yield).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ = 7.76 (d, *J* = 8.2 Hz, 2H, $H_{ar}$), 7.72 (d, *J* = 8.2 Hz, 2H, $H_{ar}$), 7.37 (d, *J* = 8.0 Hz, 2H, $H_{ar}$), 7.32 (d, *J* = 8.0 Hz, 2H, $H_{ar}$), 4.83 (t, *J* = 6.1 Hz, 1H, NH), 4.07 (t, *J* = 5.1 Hz, 2H, $CH_2O$), 3.25 (pq, *J* = 5.5 Hz, 2H, $CH_2NH$), 2.48 (s, 3H, $CH_3$), 2.45 (s, 3H, $CH_3$) ppm.

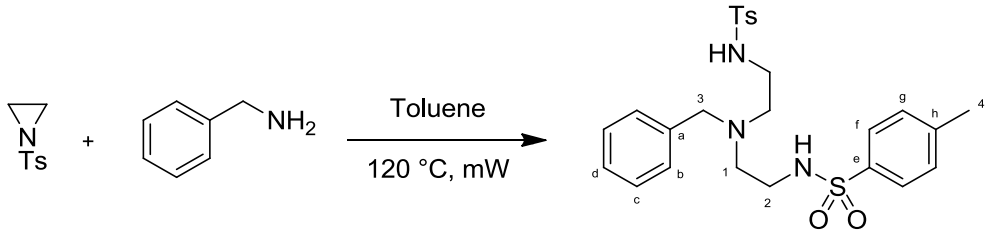
**Synthesis of 1-tosylaziridine:**[1]




A solution KOH (3.86 g, 68.8 mmol) in water (20 ml) was added dropwise to a suspension of 2-(tosylamino)ethyl tosylate (7.48 g, 20.2 mmol) in toluene (80 ml). After two hours of stirring, water (80 ml) and toluene (20 ml) were added, the organic layer separated, washed with water and dried over $Mg_2SO_4$. The solvent was evaporated under reduced pressure. The product was obtained as a white powder (3.69 g, 93% yield).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ = 7.85 (d, J = 8.2 Hz, 2H, $H_{ar}$), 7.37 (d, J = 8.2 Hz, 2H, $H_{ar}$), 2.47 (s, 4H, $CH_2$), 2.39 (s, 3H, $CH_3$) ppm.

**Synthesis of 1,7-ditosyl-4-benzyl-1,4,7-triazaheptane:**



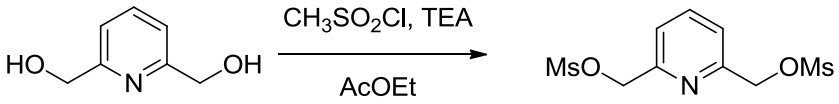

A solution of tosyl aziridine (1.60 g, 8.13 mmol) and benzylamine (0.396 g, 0.40 ml, 3.69 mmol) in toluene (15 mL) was stirred and heated by microwave irradiation for 1 h at 120 °C. The mixture was dried and used without any further purification. Yield quantitative (1.85 g, 3.69 mmol).

**$^{1}$H NMR** (400 MHz; $CDCl_3$): δ = 7.73 (4 H, d, *J*= 8.0 Hz, $H^f$), 7.29 (4 H, d, *J*=8.0 Hz, $H^g$), 7.27–7.25 (3 H, m, $H_{ar}$), 7.13 (2 H, m, $H_{ar}$), 5.17 (2H, br, NH), 3.44 (2 H, s, $H^3$), 2.93 (4 H, m, $CH_2{}^1$), 2.52 (4 H, m, $CH_2{}^2$), 2.43 (6 H, m, $CH_3{}^4$) ppm.

**$^{13}$C NMR** (100 MHz; $CDCl_3$): δ = 143.5 ($C^h$), 137.9 ($C^e$), 136.8 ($C^a$), 129.9 ($C^fH$), 129.0 ($C^bH$), 128.7 ($C^cH$), 127.6 ($C^dH$), 127.3 ($C^gH$), 58.6 ($C^3H_2$), 53.3 ($C^1H_2$), 40.8 ($C^2H_2$), 21.7 ($C^4H_3$) ppm.

**MS** (EI): *m/z* (%) = 501 (100) $[M]^+$.

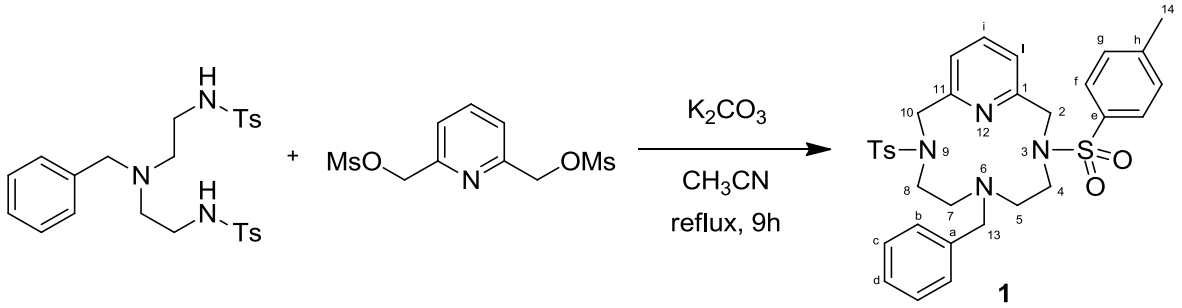
**Synthesis of 2,6-*bis*(methanesulfonyloxymethyl)pyridine:**[2]




2,6-Pyridinedimethanol (0.50 g, 3.57 mmol) was suspended in ethyl acetate (10 mL), triethylamine (1.82 g, 2.50 mL, 17.90 mmol) was added and the mixture was cooled to 0° C. Methanesulfonylchloride (1.27 g, 0.86 mL, 11.10 mmol) was slowly added and the mixture was stirred for 15 mins, after which the reaction was quenched by the addition of sat. aq. $NaHCO_3$ (10 mL). The mixture was extracted with ethyl acetate (3 × 15 mL), the organic layers washed with brine and dried over $Na_2SO_4$. The solvent was evaporated under reduced pressure. A white solid was obtained (0.96 g, 91% yield).

**$^{1}$H NMR** (400 MHz, $CDCl_3$): δ = 7.88 (t, J = 7.8 Hz, 1H, $H_{ar}$), 7.52 (d, J = 7.8 Hz, 2H, $H_{ar}$), 5.36 (s, 4H, $CH_2$), 3.13 (s, 6H, $CH_3$).

**Synthesis of 6-benzyl-3,9-ditosyl-3,6,9,15-tetraazabicyclo[9,3,1]pentadeca-1(15),11,13-triene 1:**




A solution of 1,7-ditosyl-4-benzyl-1,4,7-triazaheptane (1.85 g, 3.69 mmol), 2,6-*bis*(methanesulfonyloxymethyl)pyridine (1.09 g, 3.70 mmol) and micronized anhydrous potassium carbonate (1.53 g, 11.08 mmol) in freshly distilled acetonitrile (85 mL) was stirred and heated under reflux for 9 h. The mixture was washed with water (150 mL) and extracted with ethyl acetate. The solvent was evaporated under reduced pressure. The crude product was then crystallized in ethyl acetate, yielding a white solid (1.97 g, 88% yield).

**$^{1}$H NMR** (400 MHz; $CDCl_3$): δ = 7.73 (1H, t, *J* = 7.7 Hz, $H^{i}$), 7.59 (4H, d, *J* = 8.0 Hz, $H^{f}$), 7.33 (2H, d, *J* = 7.7 Hz, $H^{l}$), 7.32–7.30 (3H, m, $H_{ar}$), 7.24 (4H, d, *J*= 8.0 Hz, $H^{g}$), 7.18 (2H, m, $H_{ar}$), 4.34 (4H, m, $CH_2^{10}$ and $CH_2^{2}$), 3.48 (2H, s, $H^{13}$), 3.10 (4H, m, $CH_2^{4}$ and $CH_2^{8}$), 2.40 (6H, s, $CH_3^{14}$), 2.31 (4H, m, $CH_2^{5}$and $CH_2^{7}$) ppm.

**$^{13}$C NMR** (100 MHz; $CDCl_3$): δ = 155.0 ($C^{1}$), 143.3 ($C^{h}$), 139.2 ($C^{e}$), 138.8 ($C^{i}H$), 136.0 ($C^{a}$), 129.8 ($C^{g}H$), 128.6 ($C^{Ph}H$), 128.3 ($C^{Ph}H$), 128.2 ($C^{Ph}H$), 127.1 ($C^{f}H$), 124.0 ($C^{l}H$), 59.4 ($C^{13}H_2$), 54.3 ($C^{5}H_2$), 50.0 ($C^{2}H_2$), 44.2 ($C^{4}H_2$), 21.5 ($C^{14}H_3$) ppm.

**$^{15}$N NMR** (40 MHz; $CDCl_3$): δ = 312 ($N^{12}$), 94 (N-Ts), 32 ($N^{6}$).

**MS** (FAB): *m/z* (%) = 605 (80) $[MH]^+$, 449 (100) $[M – Ts]^+$.

**UV/vis** (5.2 $10^{-5}$ mol $L^{-1}$, $CHCl_3$ in 1-cm cuvettes): $\lambda_{max}$ [nm], (log ε) = 241 (4.19); 263 (3.93) nm.

**General procedure for the synthesis of silver complexes 2a-c:**

The silver salt and all silver-containing solutions were kept in the dark until the final isolation of the product. The ligand **1** was dissolved in 1,2-dichloroethane, the silver salt (weighed under a nitrogen atmosphere) was added and the mixture stirred for one hour, then filtered to remove any unreacted solid. The solvent was evaporated to dryness, then *n*-hexane was added and the product recovered by filtration.

**2a ($AgBF_4$): 1** (MW = 604.78; 0.5135 g; 0.849 mmol), $AgBF_4$ (MW = 194.67; 0.1653 g; 0.849 mmol), $C_2H_4Cl_2$ (42 mL); *n*-hexane (40 mL). Yield 0.66 g (MW = 799.46) 91 %.

**$^1$H NMR** (300 MHz, $CDCl_3$): δ = 7.77 (t, *J* = 7.7 Hz, 1H) overlapping with 7.74 (d, *J* = 8.0 Hz, 4H), 7.60 (d, *J* = 6.9 Hz, 2H), 7.45 (d, *J* = 8.0 Hz, 4H) overlapping with 7.42 (m, 3H), 7.28 (d, *J* = 7.7 Hz, 2H), 5.04 (d, *J* = 15.2 Hz, 2H), 3.97 (s, 2H), 3.70 (d, *J* = 15.2 Hz, 2H), 3.51 (m, 2H), 2.94 (m, 2H), 2.65 (m, 2H), 2.49 (s, 6H), 2.06 (m, 2H) ppm.

**$^{13}$C NMR** (100 MHz, $CDCl_3$) δ 153.4, 145.9, 140.5, 135.6, 130.9, 130.7, 130.6, 128.8, 128.6, 128.4, 125.0, 58.4, 56.3, 52.9, 47.5, 21.9 ppm.

**$^{19}$F NMR** (282 MHz, $CDCl_3$): δ = -152.8 .

**MS** (FAB): *m/z* (%) = 711 m/z (100) $[M^+ – BF_4]$, 605 (94) $[MH – AgBF_4]^+$

**UV/vis** ($5.2\ 10^{-5}$ mol $L^{-1}$, $CHCl_3$ in 1-cm cuvettes): $\lambda_{max}$ [nm], (log ε) = 243 (4.26); 263 (3.89) nm.

**2b** (**AgOTf): 1** (MW = 604.78; 0.2088 g; 0.345 mmol), AgOTf (MW = 256.94; 0.0887 g; 0.345 mmol), $C_2H_4Cl_2$ (17 mL); *n*-hexane (15 mL).Yield 0.22 g (MW = 861.72) 73 %.

**$^1$H NMR** (300 MHz, $CDCl_3$): δ = 7.83 (t, *J* = 7.7 Hz, 1H), 7.72 (d, *J* = 8.0 Hz, 4H), 7.65 (d, *J* = 7.1 Hz, 2H), 7.50 (m, 3H) overlapping with 7.45 (d, *J* = 8.0 Hz, 4H), 7.33 (d, *J* = 7.7 Hz, 2H), 5.01 (d, *J* = 14.9 Hz, 2H), 3.89 (s, 2H) overlapping with 3.85 (m, 2H), 3.53 (m, 2H), 3.04 (m, 2H), 2.87 (m, 2H), 2.51 (s, 6H), 2.22 (m, 2H) ppm.

**$^{13}$C NMR** (75 MHz, $CDCl_3$) δ 153.7, 145.9, 140.5, 136.0, 130.9, 130.7, 130.6, 129.1, 128.7, 128.2, 125.0, 58.9, 56.4, 53.5, 47.7, 21.8 ppm.

**$^{19}$F NMR** (282 MHz, $CDCl_3$): δ = -78.7 .

**MS** (FAB): *m/z* (%) = 711 m/z (100) $[M^+ – CF_3SO_3]$, 605 (90) $[MH – AgCF_3SO_3]^+$

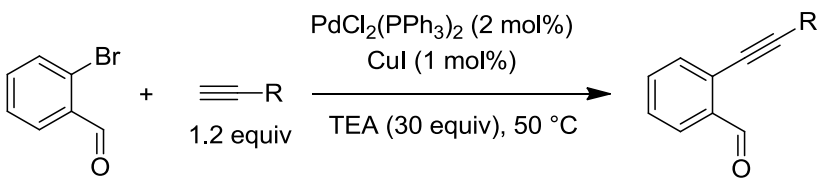
**UV/vis** ($5.1\ 10^{-5}$ mol $L^{-1}$, $CHCl_3$ in 1-cm cuvettes): $\lambda_{max}$ [nm], (log ε) = 242 (4.32); 263 (3.94) nm.

**2c ($AgNTf_2$): 1** (MW = 604.78; 0.1812 g; 0.300 mmol), $AgNTf_2$ (MW = 388.09; 0.1163 g; 0.300 mmol), $C_2H_4Cl_2$ (13 mL); *n*-hexane (15 mL). Yield 0.16 g (MW = 992.80) 54 %.

**$^1$H NMR** (300 MHz, $CDCl_3$): δ = 7.84 (t, *J* = 7.7 Hz, 1H), 7.71 (d, *J* = 8.0 Hz, 4H), 7.65 (d, *J* = 7.1 Hz, 2H), 7.50 (m, 3H) overlapping with 7.47 (d, *J* = 8.0 Hz, 4H), 7.28 (m, 2H), 5.05 (d, *J* = 14.9 Hz, 2H), 3.90 (s, 2H), 3.70 (m, 2H), 3.53 (m, 2H), 3.01 (m, 2H), 2.72 (m, 2H), 2.51 (s, 6H), 2.17 (m, 2H) ppm.

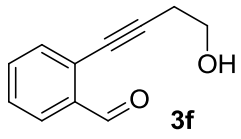
**General Procedure for the synthesis of 2-alkynylbenzaldehydes 3a-e:**

To a solution of *o*-bromobenzaldehyde (600 mg, 3.24 mmol) in dry TEA (30 equiv), the appropriate alkyne (3.89 mmol) and *trans*-dichlorobis(triphenylphosphine)palladium(II) (2 mol%) were added, under a nitrogen atmosphere. The reaction was stirred at rt for 10 min, and then CuI (1 mol%) was added. The reaction mixture was stirred at 50 °C until no more starting product was detectable by TLC analysis (eluent: hexane/ethyl acetate). The solvent was then evaporated under reduced pressure and the crude material was purified by flash chromatography over a silica gel column.




| 3 | R | t (h) | Yield (%) |
|---|---|---|---|
| **a** | *p*-MeO-Ph- | 3 | 96 |
| **b** | *p*-Me-Ph- | 2 | 77 |
| **c** | *m*-F-Ph- | 6 | 85 |
| **d** | *n*-Pr- | 5 | 79 |
| **e** | TMS- | 2 | 60 |

Alkynylbenzaldehydes **3a**,[3] **3b**,[4] **3c**[4], **3d**[5] and **3e**[4] are known compounds. They were characterized by $^1$H-NMR and spectral data are in good agreement with literature values.



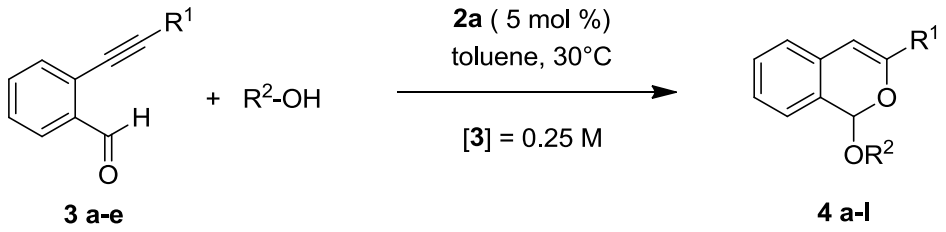

**Synthesis of 2-(4-hydroxybut-1-ynyl)benzaldehyde 3f:**[6] To a solution of *o*-bromobenzaldehyde (1.20 g, 6.48 mmol), and TEA (1.18 g, 1.62 mL, 11.67 mmol) in dry DMF (10 mL), but-3-yn-1-ol (0.5 g, 0.539 mL, 7.13 mmol) and *trans*-dichlorobis(triphenylphosphine)palladium(II) (90.9 mg, 0.13 mmol) were added under a nitrogen atmosphere. The reaction was stirred at rt for 10 min, and then CuI (24.7 mg, 0.13 mmol) was added. The reaction mixture was stirred at rt overnight, until no more starting product was detectable by TLC analysis (eluent: hexane/ethyl acetate = 6 : 4). The reaction mixture was poured in water (200 mL) and extracted with ethyl acetate (3 × 50 mL). The organic layer was dried with $Na_2SO_4$ and then evaporated to dryness under reduced pressure. The crude was purified by flash column chromatography on silica gel (Eluent: hexane/ethyl acetate = 8 : 2) to give corresponding 2-(4-hydroxybut-1-ynyl)benzaldehyde (1.12 g, 99 %) as viscous yellow oil.

**$^1$H NMR** (200 MHz, $CDCl_3$): δ = 10.44 (s, 1H, CHO), 7.86 (d, *J* = 7.7 Hz, 1H, $H_{ar}$), 7.54-7.39 (m, 3H, $H_{ar}$), 3.87 (t, *J* = 6.2 Hz, 2H, $CH_2$-O), 2.76 (t, *J* = 6.2 Hz, 2H, $C_{sp}$-$CH_2$) ppm.

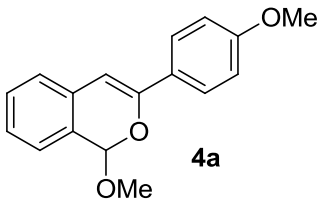
Spectral data are in good agreement with literature values.

**General Procedure for the synthesis of 1-alkoxyisochromenes 4 a-l:**

To a stirred solution of the appropriate *o*-alkynylbenzaldehyde **3a-e** (60 mg) in dry toluene ([3] = 0.25 M), the catalyst **2a** (5 mol%) and the alcohol (1.05 equiv) were added. The reaction mixture was stirred at 30 °C until no more starting product was detectable by TLC analysis (eluent: toluene/ ethyl acetate = 100:1). The reaction mixture was diluted with sat. aq. $NaHCO_3$ (20 ml) and extracted with ethyl acetate (3 × 10 ml). The organic layer was dried with $Na_2SO_4$ and then evaporated to dryness under reduced pressure. Unless otherwise stated, after this work-up the products **4** were sufficiently pure and did not need further purification.




**3 a-e** **4 a-l**




**4a**

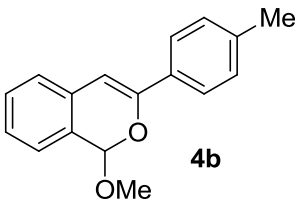
**1-Methoxy-3-(4-methoxyphenyl)-1*H*-isochromene 4a:** Reaction time: 2 h. White solid. Yield: 99 % (67 mg). Mp 124-126 °C.

**$^1$H NMR** (200 MHz, $CDCl_3$): δ = 7.76 (d, *J* = 8.8 Hz, 2H, $H_{ar}$), 7.40 – 7.16 (m, 4H, $H_{ar}$), 6.94 (d, *J* = 8.8 Hz, 2H, $H_{ar}$), 6.49 (s, 1H, $C_{sp2}$-H), 6.13 (s, 1H, $C_{sp3}$-H), 3.85 (s, 3H, $OCH_3$), 3.60 (s, 3H, $OCH_3$) ppm.

**$^{13}$C NMR** (50.3 MHz, $CDCl_3$): δ = 160.43 ($C_q$), 149.69 ($C_q$), 130.77 ($C_q$), 129.64 ($CH_{ar}$), 127.38 ($C_q$), 126.98 ($C_q$), 126.55 ($CH_{ar}$), 126.48 ($CH_{ar}$), 125.99 ($CH_{ar}$), 124.46 ($CH_{ar}$), 114.12 ($CH_{ar}$), 100.04 (C-H), 99.00 (C-H), 55.55 ($CH_3$), 55.31 ($CH_3$) ppm.

**MS** ESI(+): *m/z* (%) = 291.0 (45) $[M + Na]^+$, 269.3 (4) $[M + H]^+$, 237.2 (100) $[M – OCH_3)]^+$.

**HRMS** ESI $(M + H)^+$ calculated for $C_{17}H_{17}O_3$ 269.1172, found 269.1170.




**4b**

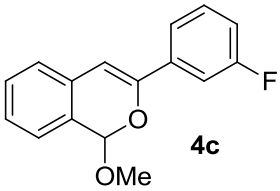
**1-Methoxy-3-(p-tolyl)-1*H*-isochromene 4b:**[7] Reaction time: 24 h. White solid. Yield: 97 % (67 mg). Mp 100-102 °C.

**$^1$H NMR** (200 MHz, $CDCl_3$): δ = 7.74 (d, *J* = 8.3 Hz, 2H, $H_{ar}$), 7.29 – 7.22 (m, 6H, $H_{ar}$), 6.59 (s, 1H, $C_{sp2}$-H), 6.16 (s, 1H, $C_{sp3}$-H), 3.62 (s, 3H, $OCH_3$), 2.41 (s, 1H, $CH_3$) ppm.

**$^{13}$C NMR** (50.3 MHz, $CDCl_3$): δ = 149.89 ($C_q$), 139.03 ($C_q$), 131.96 ($C_q$), 130.67 ($C_q$), 129.65 ($CH_{ar}$), 129.42 ($CH_{ar}$), 127.20 ($C_q$), 126.70 ($CH_{ar}$), 126.03 ($CH_{ar}$), 125.05 ($CH_{ar}$), 124.63 ($CH_{ar}$), 100.01 (C-H), 99.86 (C-H), 55.33 ($CH_3$), 21.54 ($CH_3$) ppm.

**MS** ESI(+): *m/z* (%) = 253.1 (20) $[M + H]^+$, 221.2 (100) $[M^+ - OCH_3)]^+$.

Spectral data are in good agreement with literature values.



**4c**

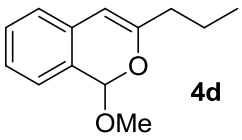
**3-(3-Fluorophenyl)-1-methoxy-1*H*-isochromene 4c:** Reaction time: 24 h. White solid. Yield: 98% (68 mg). Mp 93–95 °C.

**$^{1}$H NMR** (200 MHz, $CDCl_3$): δ = 7.59 (m, 1H, $H_{ar}$), 7.51 (m, 1H, $H_{ar}$), 7.42-7.15 (m, 5H, $H_{ar}$), 7.04 (ddt, *J* = 8.3, 2.6, 0.9 Hz, 1H, $H_{ar}$), 6.62 (s, 1H, $C_{sp2}$-H), 6.15 (s, 1H, $C_{sp3}$-H), 3.61 (s, 3H, $OCH_3$) ppm.

**$^{13}$C NMR** (50.3 MHz, $CDCl_3$): δ = 163.32 (d, $^{1}J_{C\text{-}F}$ = 245 Hz, $C_q$-F), 148.44 (d, $^{4}J_{C\text{-}F}$ = 3.0 Hz, $C_q$), 137.07 (d, $^{3}J_{C\text{-}F}$ = 8.0 Hz, $C_q$), 130.17 (d, $^{3}J_{C\text{-}F}$ = 8.4 Hz, $CH_{ar}$), 130.05 ($C_q$), 129.78 ($CH_{ar}$), 127.39 ($C_q$), 127.33 ($CH_{ar}$), 126.09 ($CH_{ar}$), 124.97 ($CH_{ar}$), 120.63 (d, $^{4}J_{C\text{-}F}$ = 2.7 Hz, $CH_{ar}$), 115.72 (d, $^{2}J_{C\text{-}F}$ = 21.4 Hz), 111.97 (d, $^{2}J_{C\text{-}F}$ = 23.4 Hz), 101.59 (CH), 100.08 (CH), 55.53 ($CH_3$) ppm.

**MS** ESI(+): *m/z* (%) = 225.3 (30) $[M^+ - OCH_3]^+$.

**HRMS** ESI $(M + H)^+$ calculated for $C_{16}H_{14}FO_2$ 257.0972, found 257.0967.



**4d**

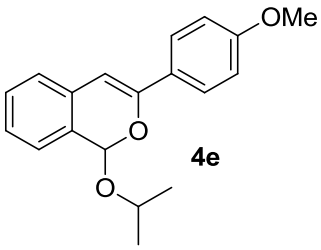
**1-Methoxy-3-propyl-1*H*-isochromene 4d:**[7,8] Reaction time: 2 h. Yellow oil. Yield (simple work-up): 98% (69 mg). Flash column chromatography: celite plug/neutral alumina 50%/silica 50%. Eluent: hexane/$CH_2Cl_2$ = 8:2 + 5% TEA. Yield (after column): 76% (53 mg).

**$^{1}$H NMR** (200 MHz, $CDCl_3$): δ = 7.32 – 7.18 (m, 4H, $H_{ar}$), 7.05 (d, *J* = 7.4 Hz, 2H, $H_{ar}$), 5.95 (s, 1H, C-H), 5.79 (s, 1H, C-H), 3.53 (s, 3H, $OCH_3$), 2.29 (dt, *J* = 7.2, 4.4 Hz, 2H, $CH_2$), 1.67 (hex, *J* = 7.3 Hz, 2H, $CH_2$), 0.98 (t, *J* = 7.3 Hz, 3H, $CH_3$) ppm.

**$^{13}$C NMR** (50.3 MHz, $CDCl_3$): δ = 154.26 ($C_q$), 130.59 ($C_q$), 129.47 ($CH_{ar}$), 126.46 ($C_q$), 126.07 ($CH_{ar}$), 126.04 ($CH_{ar}$), 123.63 ($CH_{ar}$), 100.49 (C-H), 99.85 (C-H), 55.18 ($CH_3$), 36.15 ($CH_2$), 20.55 ($CH_2$), 13.79 ($CH_3$) ppm.

**MS** ESI(+): *m/z* (%) = 205.1 (32) $[M + H]^+$, 173.2 (78) $[M^+ - OCH_3]^+$.

Spectral data are in good agreement with literature values.



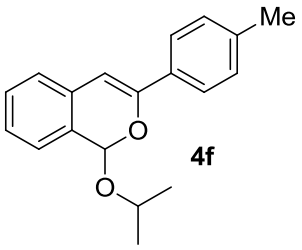

**1-Isopropoxy-3-(4-methoxyphenyl)-1*H*-isochromene 4e:** Reaction time: 6 h. Yellow solid. Yield (simple work-up): 99% (74 mg). Mp 120–122 °C.

**$^1$H NMR** (200 MHz, $CDCl_3$): δ = 7.75 (d, *J* = 9.0 Hz, 2H, $H_{ar}$), 7.38-7.17 (m, 4H, $H_{ar}$), 6.94 (d, *J* = 9.0 Hz, 2H, $H_{ar}$), 6.50 (s, 1H, $C_{sp2}$-H), 6.30 (s, 1H, $C_{sp3}$-H), 4.38 (hept, *J* = 6.2 Hz, 1H, CH *i*-Pr), 3.85 (s, 3H, $OCH_3$), 1.32 (d, *J* = 6.2 Hz, 3H, $CH_3$ *i*-Pr), 1.19 (d, *J* = 6.2 Hz, 3H, $CH_3$ *i*-Pr) ppm.

**$^{13}$C NMR** (50.3 MHz, $CDCl_3$): δ = 160.31 ($C_q$), 149.72 ($C_q$), 130.91 ($C_q$), 129.33 ($CH_{ar}$), 127.71 ($C_q$), 127.59 ($C_q$), 126.54 ($CH_{ar}$), 126.42 ($CH_{ar}$), 125.71 ($CH_{ar}$), 124.51 ($CH_{ar}$), 114.06 ($CH_{ar}$), 99.01 ($C_{sp2}$-H), 97.24 ($C_{sp3}$-H), 70.00 (CH *i*-Pr), 55.54 ($CH_3$), 23.83 ($CH_3$), 22.22 ($CH_3$) ppm.

**MS** ESI(+): *m/z* (%) = 319.1 (10) $[M + Na]^+$, 297.2 (5) $[M + H]^+$, 237.3 (100) $[M – OCH(CH_3)_2]^+$.

**HRMS** ESI $(M + H)^+$ calculated for $C_{19}H_{21}O_3$ 297.1485, found 297.1479.



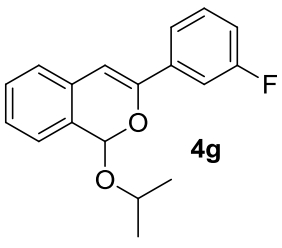

**1-Isopropoxy-3-(*p*-tolyl)-1*H*-isochromene 4f:** Reaction time: 24 h. Yellow solid. Yield: 97% (77mg). Mp 76– 78 °C.

**$^1$H NMR** (200 MHz, $CDCl_3$): δ = 7.69 (d, *J* = 8.3 Hz, 2H, $H_{ar}$), 7.42 – 7.14 (m, 6H, $H_{ar}$), 6.55 (s, 1H, $C_{sp2}$-H), 6.29 (s, 1H, $C_{sp3}$-H), 4.37 (hept, *J* = 6.1 Hz, 1H, CH *i*-Pr), 2.38 (s, 3H, $CH_3$), 1.31 (d, *J* = 6.1, 3H, $CH_3$ *i*-Pr), 1.17 (d, *J* = 6.1 Hz, 3H, $CH_3$ *i*-Pr) ppm.

**$^{13}$C NMR** (50.3 MHz, $CDCl_3$): δ = 149.88 ($C_q$), 138.83 ($C_q$), 132.26 ($C_q$), 130.79 ($C_q$), 129.34 ($CH_{ar}$), 127.76 ($C_q$), 126.61 ($CH_{ar}$), 125.72 ($CH_{ar}$), 125.02 ($CH_{ar}$), 124.63 ($CH_{ar}$), 99.83 ($C_{sp2}$-H), 97.18 ($C_{sp3}$-H), 69.98 (CH *i*-Pr), 23.80 ($CH_3$), 22.19 ($CH_3$), 21.52 ($CH_3$) ppm (one $CH_{ar}$ signal is obscured).

**MS** ESI(+): *m/z* (%) = 303.1 (100) $[M + Na]^+$, 221.2 (10) $[M – OCH(CH_3)_2]^+$.

**HRMS** ESI $(M + H)^+$ calculated for $C_{19}H_{21}O_2$ 281.1536, found 281.1531.




**3-(3-Fluorophenyl)-1-isopropoxy-1*H*-isochromene 4g:** Reaction time: 24 h. Yellow solid. Yield: 97% (77mg). Mp 73 –75 °C.

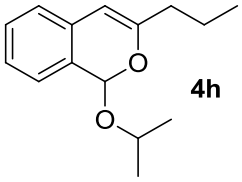
**$^1$H NMR** (200 MHz, $CDCl_3$): δ = 7.69–7.20 (m, 7H, $H_{ar}$), 7.03 (td, *J* = 8.3, 2.3 Hz, 1H, $H_{ar}$), 6.61 (s, 1H, $C_{sp2}$-H), 6.30 (s, 1H, $C_{sp3}$-H), 4.35 (hept, *J* =

6.1 Hz, 1H, CH *i*-Pr), 1.31 (d, *J* = 6.1 Hz, 3H, $CH_3$ *i*-Pr), 1.17 (d, *J* = 6.1 Hz, $CH_3$ *i*-Pr) ppm.

**$^{13}$C NMR** (50.3 MHz, $CDCl_3$): δ = 163.27 (d, $^1J_{C\text{-}F}$ = 245 Hz, $C_q$), 148.48 (d, $^4J_{C\text{-}F}$ = 2.9 Hz, $C_q$), 137.41 (d, $^3J_{C\text{-}F}$ = 7.9 Hz, $C_q$), 130.21 ($C_q$), 130.06 (d, $^3J_{C\text{-}F}$ = 8.4 Hz, $CH_{ar}$), 129.42 ($CH_{ar}$), 127.99 ($C_q$), 127.22 ($CH_{ar}$), 125.76 ($CH_{ar}$), 124.95 ($CH_{ar}$), 120.61 (d, $^4J_{C\text{-}F}$ = 2.9 Hz, $CH_{ar}$), 115.55 (d, $^2J_{C\text{-}F}$ = 21.4 Hz, $CH_{ar}$), 111.94 (d, $^2J_{C\text{-}F}$ = 23.4 Hz, $CH_{ar}$), 101.57 ($C_{sp2}$-H), 97.28 ($C_{sp3}$-H), 70.27 ($CH_3$), 23.75 ($CH_3$ *i*-Pr), 22.18 ($CH_3$ *i*-Pr) ppm.

**MS** ESI(+): *m/z* (%) = 307.2 (65) $[M + Na]^+$, 225.4 (42) $[M – OCH(CH_3)_2]^+$.

**HRMS** ESI $(M + H)^+$ calculated for $C_{18}H_{18}FO_2$ 285.1285, found 285.1291.



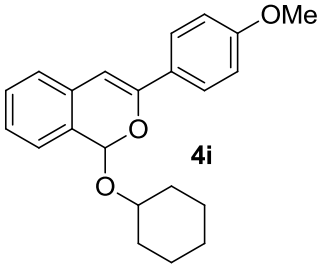

**1-Isopropoxy-3-propyl-1*H*-isochromene 4h:**[8] Reaction time: 1 h. Yellow oil. Yield (simple work-up): 89% (72 mg). Flash column chromatography: celite plug/neutral alumina 50%/silica 50%. Eluent: hexane/$CH_2Cl_2$ = 8:2 + 5% TEA. Yield (after column): 62% (50 mg).

**$^1$H NMR** (200 MHz, $CDCl_3$): δ = 7.30-7.14 (m, 3H, $H_{ar}$), 7.03 (m, 1H, $H_{ar}$), 6.11 (s, 1H, C-H), 5.77 (s, 1H, C-H), 4.24 (hept, *J* = 6.2 Hz, 1H, CH *i*-Pr), 2.25 (dt, *J* = 7.0, 3.0 Hz, 2H, $CH_2$), 1.64 (hex, *J* = 7.4 Hz, 2H, $CH_2$), 1.27 (d, *J* = 6.1 Hz, 3H, $CH_3$ *i*-Pr), 1.21 (d, *J* = 6.1 Hz, $CH_3$ *i*-Pr), 0.98 (t, *J* = 7.3 Hz, 3H, $CH_3$) ppm.

**$^{13}$C NMR** (50.3 MHz, $CDCl_3$): δ = 154.23 ($C_q$), 130.82 ($C_q$), 129.13 ($CH_{ar}$), 126.80 ($C_q$), 125.97 ($CH_{ar}$), 125.79 ($CH_{ar}$), 123.65 ($CH_{ar}$), 100.34 ($C_{sp2}$-H), 96.90 ($C_{sp3}$-H), 69.69 (CH *i*-Pr), 36.32 ($CH_2$), 23.75 ($CH_3$), 22.07 ($CH_3$), 20.37 ($CH_2$), 13.91 ($CH_3$) ppm.

**MS** ESI(+): *m/z* (%) = 255 (70) $[M + Na]^+$, 173.3 (50) $[M – OCH(CH_3)_2]^+$.

Spectral data are in good agreement with literature values.



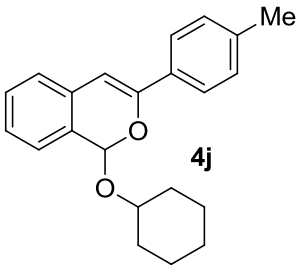

**1-(Cyclohexyloxy)-3-(4-methoxyphenyl)-1*H*-isochromene 4i:** Reaction time: 24 h. White solid. Mp 57–59 °C. Yield (simple work-up): 92% (79 mg). Flash column chromatography: celite plug/neutral alumina 50%/silica 50%. Eluent: hexane/$CH_2Cl_2$ = 7:3 + 5% TEA. Yield (after column): 67% (57 mg).

**$^1$H NMR** (200 MHz, $CDCl_3$): δ = 7.73 (d, *J* = 9.0 Hz, 1H, $H_{ar}$), 7.37 – 7.16 (m, 4H, $H_{ar}$), 6.94 (d, *J* = 9.0 Hz, 1H, $H_{ar}$), 6.48 (s, 1H, $C_{sp2}$-H), 6.33 (s, 1H, $C_{sp3}$-H), 4.02 (m, 1H, H Cy), 3.85 (s, 3H, $CH_3$), 2.10 (m, 1H, $CH_2$ Cy), 1.82-1.13 (m, 9H, $CH_2$) ppm.

**$^{13}$C NMR** (50.3 MHz, $CDCl_3$): δ = 160.29 ($C_q$), 149.81 ($C_q$), 130.97 ($C_q$), 129.24 ($CH_{ar}$), 127.78 ($C_q$), 127.71 ($C_q$), 126.54 ($CH_{ar}$), 126.36 ($CH_{ar}$), 125.74 ($CH_{ar}$), 124.44 ($CH_{ar}$), 114.05 ($CH_{ar}$), 98.96 ($C_{sp2}$-H), 97.11 ($C_{sp3}$-H), 76.03 (CH Cy), 55.54 ($CH_3$), 33.92 ($CH_2$), 32.30 ($CH_2$), 25.82 ($CH_2$), 24.60 ($CH_2$), 24.49 ($CH_2$) ppm.

**MS** ESI(+): *m/z* (%) = 359.2 (70) $[M + Na]^+$, 336.2 (15) $[M + H]^+$, 237.2 (100) $[M – OC_6H_{11}]^+$.

**HRMS** ESI $(M + H)^+$ calculated for $C_{22}H_{25}O_3$ 337.1798, found 337.1795.



**4j**

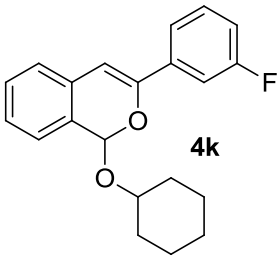
**1-(Cyclohexyloxy)-3-(*p*-tolyl)-1*H*-isochromene 4j:**[7] Reaction time: 24 h. Yellow solid. Mp 68-70 °C. Yield: 94 % (83 mg).

**$^1$H NMR** (200 MHz, $CDCl_3$): δ = 7.68 (d, *J* = 8.2 Hz, 2H, $H_{ar}$), 7.32 – 7.17 (m, 6H, $H_{ar}$), 6.55 (s, 1H, $C_{sp2}$-H), 6.34 (s, 1H, $C_{sp3}$-H), 4.02 (m, 1H, H Cy), 2.39 (m, 3H, $CH_3$), 2.08 (m, 1H, $CH_2$ Cy), 1.81-1.13 (m, 9H, $CH_2$) ppm.

**$^{13}$C NMR** (50.3 MHz, $CDCl_3$): δ = 150.02 ($C_q$), 138.78 ($C_q$), 132.35 ($C_q$), 130.89 ($C_q$), 129.33 ($CH_{ar}$), 129.24 ($CH_{ar}$), 127.94 ($C_q$), 126.55 ($CH_{ar}$), 125.76 ($CH_{ar}$), 125.05 ($CH_{ar}$), 124.58 ($CH_{ar}$), 99.79 ($C_{sp2}$-H), 97.10 ($C_{sp3}$-H), 76.00 (CH Cy), 33.91 ($CH_2$), 32.30 ($CH_2$), 25.85 ($CH_2$), 24.56 ($CH_2$), 24.47 ($CH_2$), 21.50 ($CH_3$) ppm.

**MS** ESI(+): *m/z* (%) = 343.5 (15) $[M + Na]^+$, 221.4 (10) $[M – OC_6H_{11}]^+$.

Spectral data are in good agreement with literature values.



**4k**

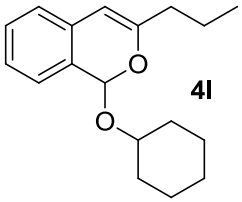
**1-(Cyclohexyloxy)-3-(3-fluorophenyl)-1*H*-isochromene 41k:** Reaction time: 48 h. Yellow oil. Yield: 96% (84 mg).

**$^1$H NMR** (200 MHz, $CDCl_3$): δ = 7.65 – 7.20 (m, 7H, $H_{ar}$), 7.05 (tdd, *J* = 8.3, 2.5, 0.9 Hz, 1H, $H_{ar}$), 6.62 (s, 1H, $C_{sp2}$-H), 6.36 (s, 1H, $C_{sp3}$-H), 4.03 (m, 1H, H Cy), 2.11 (m, 1H, $CH_2$ Cy), 1.82 – 1.15 (m, 9H, $CH_2$ Cy) ppm.

**$^{13}$C NMR** (50.3 MHz, $CDCl_3$): δ = 163.31 (d, $^1J_{C-F}$ = 245 Hz, $C_q$), 148.61 (d, $^4J_{C-F}$ = 2.9 Hz, $C_q$), 137.51 (d, $^3J_{C-F}$ = 7.9 Hz, $C_q$), 130.31 ($C_q$), 130.07 (d, $^3J_{C-F}$ = 8.3 Hz, $CH_{ar}$), 129.36 ($CH_{ar}$), 128.16 ($C_q$), 127.19 ($CH_{ar}$), 125.83 ($CH_{ar}$), 124.92 ($CH_{ar}$), 120.64 (d,$^4J_{C-F}$ = 2.4 Hz, $CH_{ar}$), 115.53 (d, $^2J_{C-F}$ = 21.4 Hz, $CH_{ar}$), 111.97 (d, $^2J_{C-F}$ = 23.4 Hz, $CH_{ar}$), 101.55 ($C_{sp2}$-H), 97.18 ($C_{sp3}$-H), 76.25 (CH Cy), 33.89 ($CH_2$), 32.29 $CH_2$), 25.81 ($CH_2$), 24.49 ($CH_2$), 24.41 ($CH_2$) ppm.

**MS** ESI(+): *m/z* (%) = 347.3 (15) $[M + Na]^+$, 363.3 (25) $[M + K]^+$, 225.3 (85) $[M – OC_6H_{11}]^+$.

**HRMS** ESI $(M + H)^+$ calculated for $C_{21}H_{22}FO_2$ 325.1598, found 325.1602.




**4l**

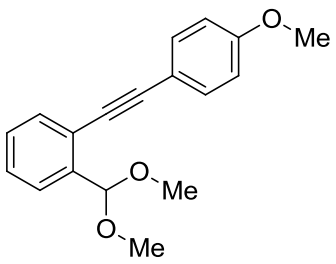
**1-(Cyclohexyloxy)-3-propyl-1*H*-isochromene 4l:** Reaction time: 2 h. Yellow oil. Yield: 94% (89 mg).

**$^1$H NMR** (200 MHz, $CDCl_3$): δ = 7.30-7.13 (m, 3H, $H_{ar}$), 7.02 (m, 1H, $H_{ar}$), 6.16 (s, 1H, C-H), 5.76 (s, 1H, C-H), 3.89 (m, 1H, H Cy), 2.25 (dt, *J* = 7.0, 3.1 Hz, 2H), 2.07 (m, 1H, $CH_2$), 1.95 – 1.48 (m, 6H, $CH_2$), 1.40-1.15 (m, 5H, $CH_2$), 0.98 (t, *J* = 7.3 Hz, 3H, $CH_3$) ppm.

**$^{13}$C NMR** (50.3 MHz, $CDCl_3$): δ = 154.32 ($C_q$), 130.83 ($C_q$), 129.06 ($CH_{ar}$), 127.23 ($C_q$), 125.92 ($CH_{ar}$), 125.85 ($CH_{ar}$), 123.60 ($CH_{ar}$), 100.28 ($C_{sp2}$-H), 96.81 ($C_{sp3}$-H), 75.79 (CH Cy), 36.36 ($CH_2$), 33.96 ($CH_2$), 32.22 ($CH_2$), 25.90 ($CH_2$), 24.64 ($CH_2$), 24.45 ($CH_2$), 20.38 ($CH_2$), 13.91 ($CH_3$) ppm.

**MS** ESI(+): *m/z* (%) = 295.2 (100) $[M + Na]^+$.

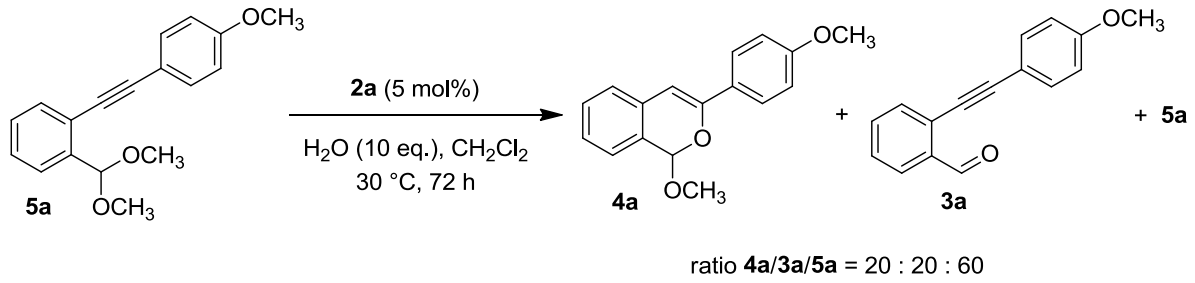
**HRMS** ESI $(M + H)^+$ calculated for $C_{18}H_{25}O_2$ 273.1849, found 273.1854.




**Synthesis of 1-(dimethoxymethyl)-2-((4-methoxyphenyl)ethynyl)-benzene 5a:** To a solution of **2a** (30 mg, 0.127 mmol) in dry MeOH (1.5 mL) *p*-toluenesulfonic acid (2.2 mg, 0.013 mmol) acid and 30 mg of molecular sieve (3 Å) were added. The mixture was stirred at 30 °C and the progress of the reaction was followed by TLC (Eluent: toluene/ethyl acetate = 99:1). After 20 h, the yellow solution was poured into a saturated solution of $NaHCO_3$ (10 mL) and extracted with ethyl acetate (3 × 5 mL). The organic layer was dried with $Na_2SO_4$ and then evaporated to dryness under reduced pressure to give **5a** as a yellow oil (36 mg, quantitative). The crude was sufficiently pure and was used without further purification.

**$^1$H NMR** (200 MHz, $CDCl_3$): δ = 7.63-7.58 (m, 1H, $H_{ar}$), 7.55-7.46 (m, 3H, $H_{ar}$), 7.38-7.29 (m, 2H, $H_{ar}$), 6.89 (d, *J* = 8.9 Hz, 1H, $H_{ar}$), 5.75 (s, 1H, C-H), 3.83 (s, 3H, $CH_3$), 3.44 (s, 6H, $CH_3$) ppm.

**Reaction of acetal 5a with the catalyst 2a**:




To a solution of dimethyl-acetal **5a** (27 mg, 0.095 mmol) in $CH_2Cl_2$ (2 mL), **2a** (4 mg, 0.0048 mmol) and distilled water (17 mg, 17 μL, 0.95 mmol) were added. The pale yellow mixture was vigorously stirred at 30 °C for 72 h. The organic phase was separated by the water drop, dried with $Na_2SO_4$ and then evaporated to dryness under reduced pressure. The $^1$H NMR analysis of the reaction crude displayed the presence of a mixture of isochromene **4a**, aldehyde **3a** and unreacted starting material **5a** in 20:20:60 ratio.

**Stability experiments of isochromene 4a:**

**Under acidic conditions: 4a** (80 mg, 0.298 mmol) was dissolved in ethyl acetate (1.20 mL) and *p*-toluenesulfonic acid (11.3 mg, 0.06 mmol) was added. The yellow solution was stirred at rt and the progress of the reaction was followed by TLC (Eluent: toluene/ethyl acetate = 99:1). After 2 h the starting material was almost completely disappeared on TLC (one main new spot with lower rf became visible) and the solution was turned to orange. After 24 h, the mixture was poured in water (30 mL) and extracted with ethyl acetate (3 × 10 mL). The organic layer was dried with $Na_2SO_4$ and then evaporated to dryness under reduced pressure to give an orange oil. The crude was roughly purified by filtration on a silica gel-plug (Eluent: hexane/ethyl acetate = 1:1) to give a yellow oil (60 mg) analyzed by $^1$H NMR spectroscopy.

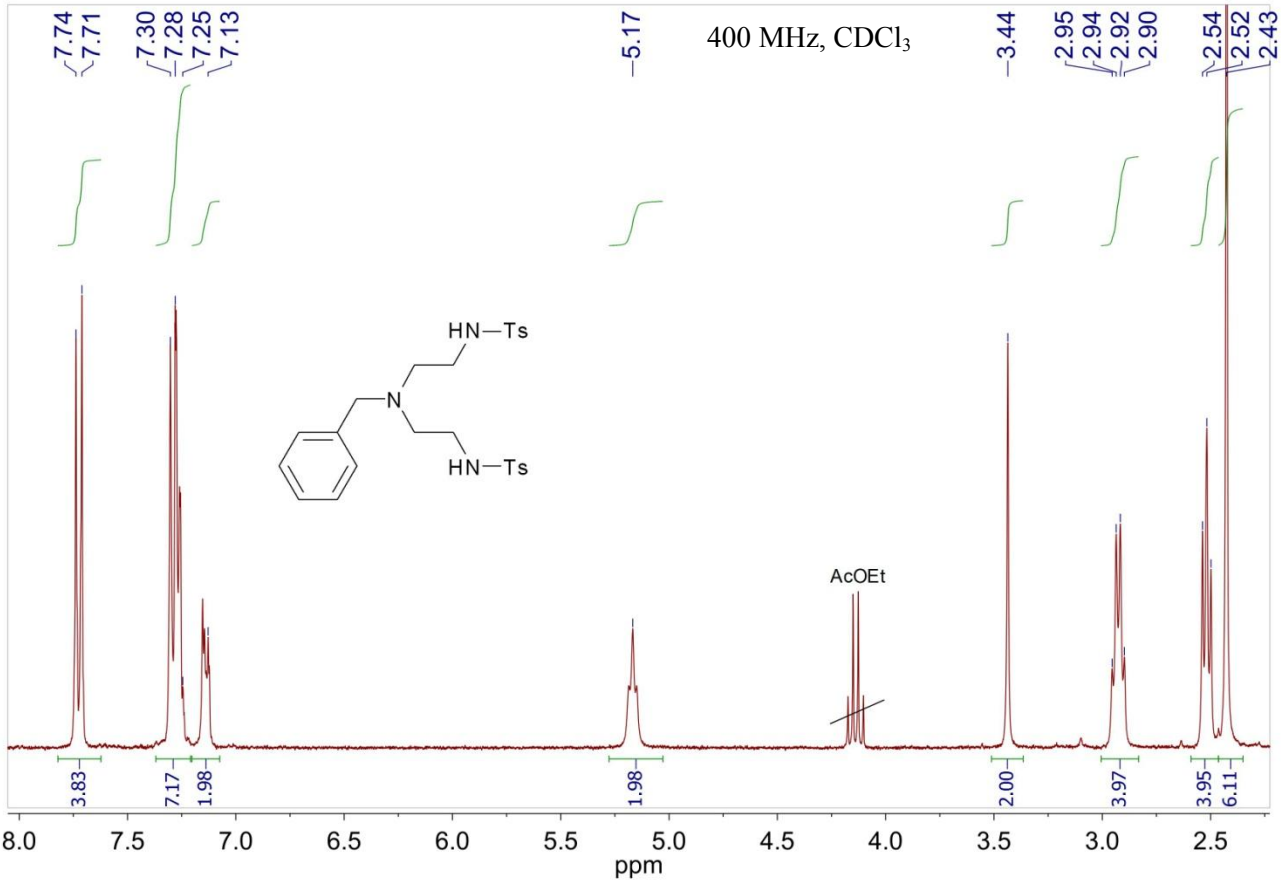
**Under alkaline conditions: 4a** (80 mg, 0.298 mmol) was dissolved in ethyl acetate (1.20 mL) and triethylamine (6.03 mg, 8.3 μL, 0.06 mmol) was added. The pale yellow cloudy solution was stirred at rt and the progress of the reaction was followed by TLC (Eluent: toluene/ethyl acetate = 99:1). After 84 h, the TLC analysis showed the starting material practically unmodified. The mixture was poured in water (30 mL) and extracted with ethyl acetate (3 × 10 mL). The organic layer was dried with $Na_2SO_4$ and then evaporated to dryness under reduced pressure to give white solid (77 mg). The $^1$H NMR analysis confirmed that the product was **4a** unmodified.

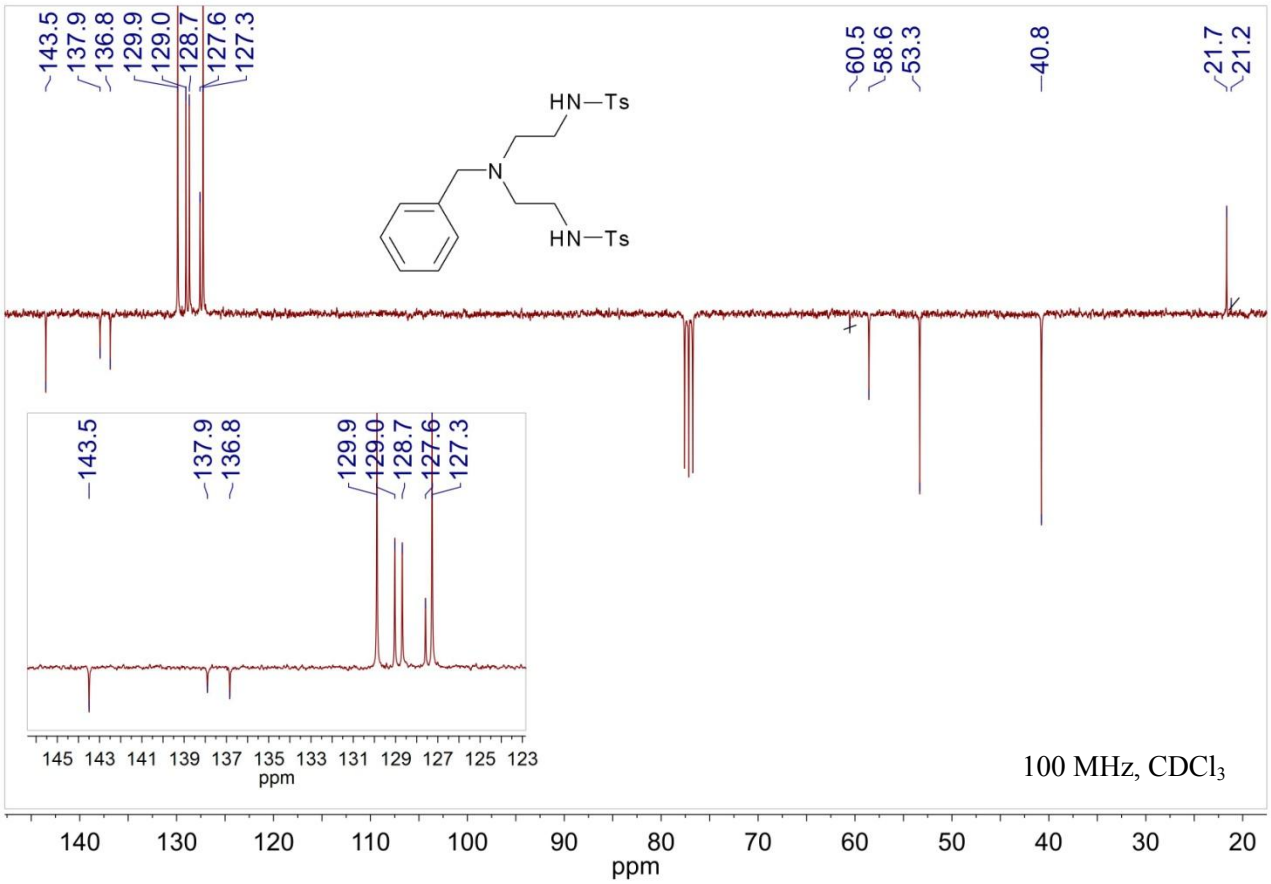
**Trapping experiment: Synthesis of isochromene 4m:**[9] To a stirred solution of 2-(4-hydroxybut-1-ynyl)benzaldehyde **3f** (60 mg, 0.344 mmol) in dry toluene (1.4 mL), the catalyst **2b** (16.6 mg, 0.172 mmol) was added. The reaction mixture was stirred at 30 °C for 4.5 h, until no more starting product was detectable by TLC analysis (Eluent: hexane/ethyl acetate = 7:3). The reaction mixture was diluted with sat. aq. $NaHCO_3$ (20 ml) and extracted with ethyl acetate (3 × 10 ml). The organic layer was dried with $Na_2SO_4$ and then evaporated to dryness under reduced pressure. The crude was purified by flash column chromatography on a short silica gel column (Eluent: hexane/ethyl acetate = 100 : 1, + 3% triethylamine) to give corresponding isochromene **4m** (30 mg, 50 %) as a white solid.

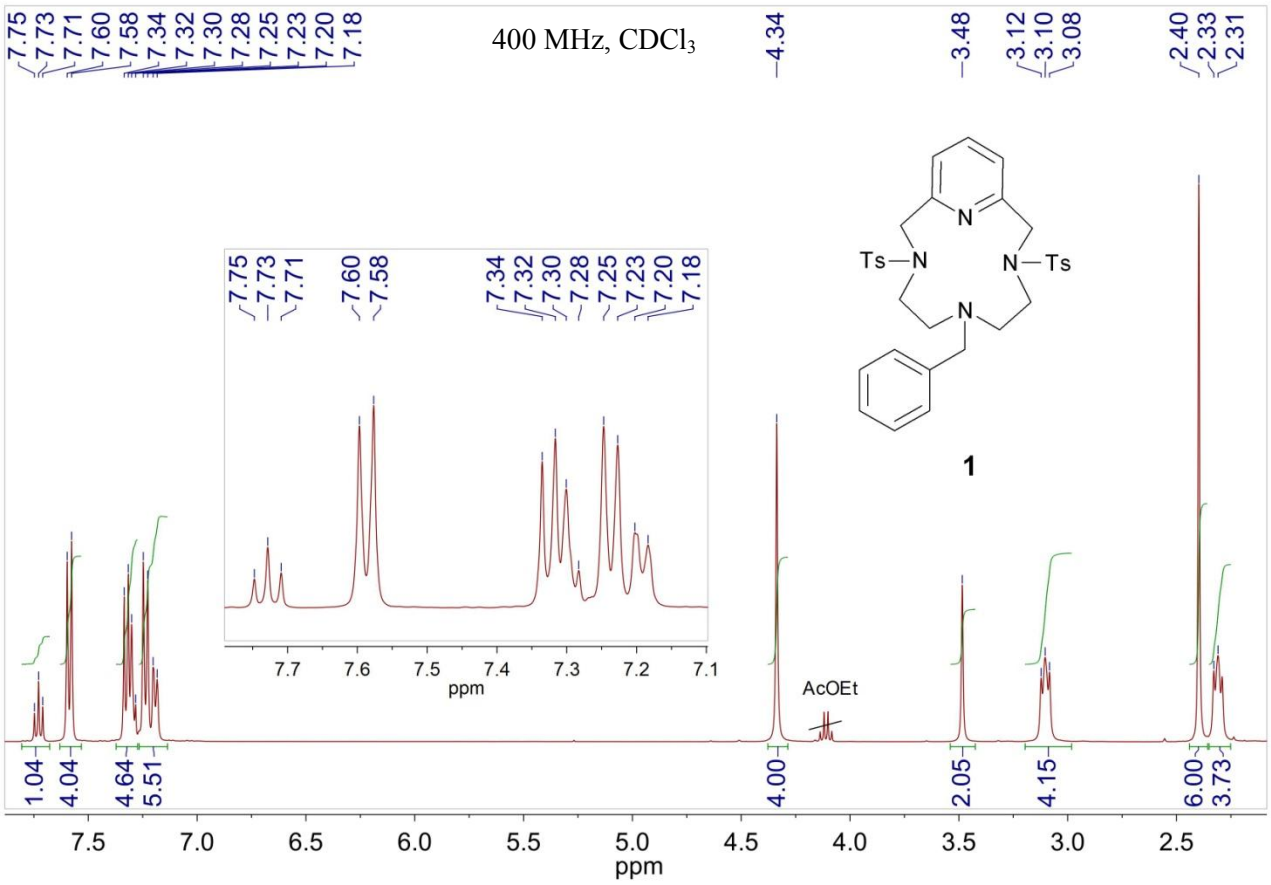
**$^1$H NMR** (200 MHz, $CDCl_3$): δ = 7.31-7.17 (m, 3H, $H_{ar}$), 6.97 (d, *J* = 7.2 Hz, 1H, $H_{ar}$), 6.00 (s, 1H, C-H), 5.77 (s, 1H, C-H), 4.62 (ddd, *J* = 10.4, 8.7, 4.3 Hz, 1H, $CH_2$), 3.75 (dt, *J* = 8.7, 3.3 Hz, 1H, $CH_2$), 2.53 (m, 2H, $CH_2$) ppm.

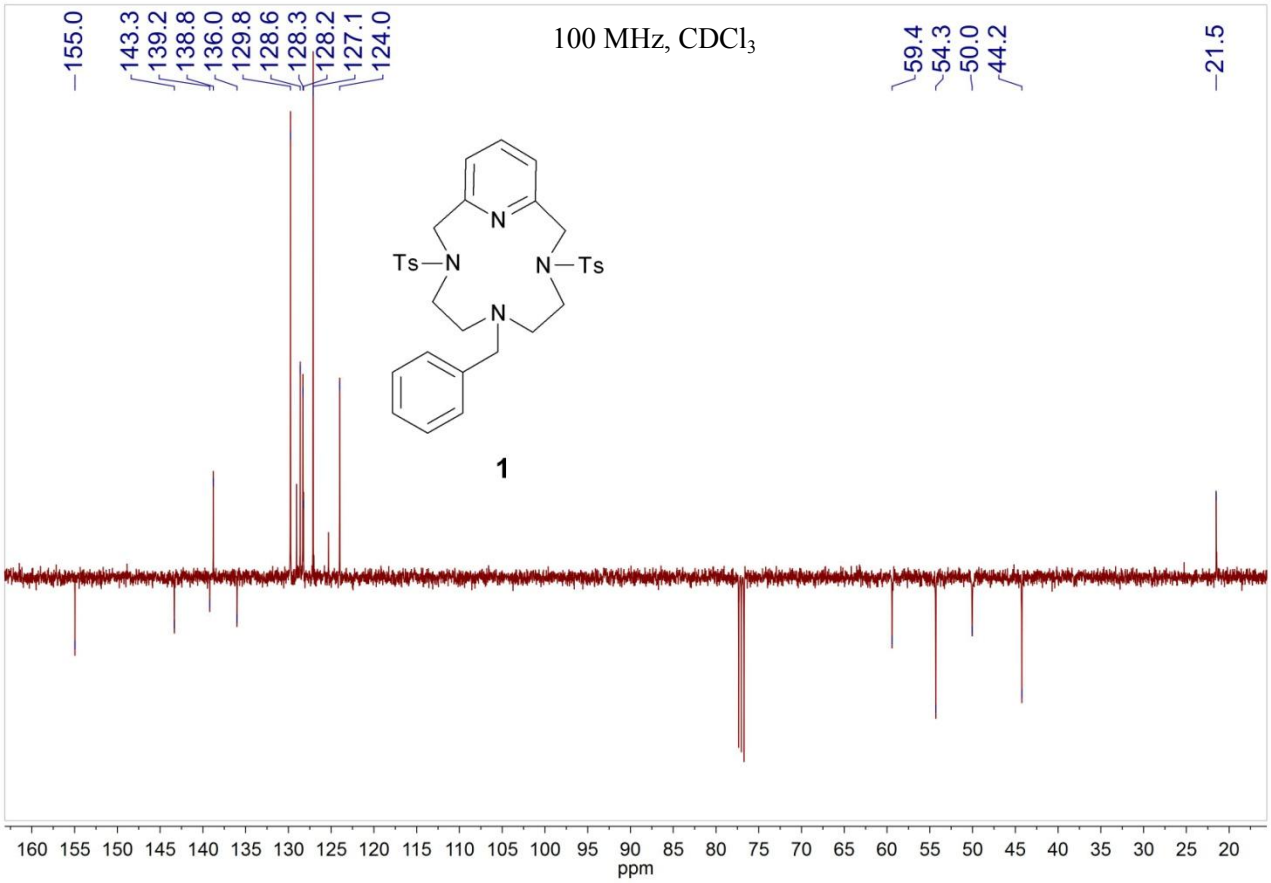
Spectral data are in good agreement with literature values.

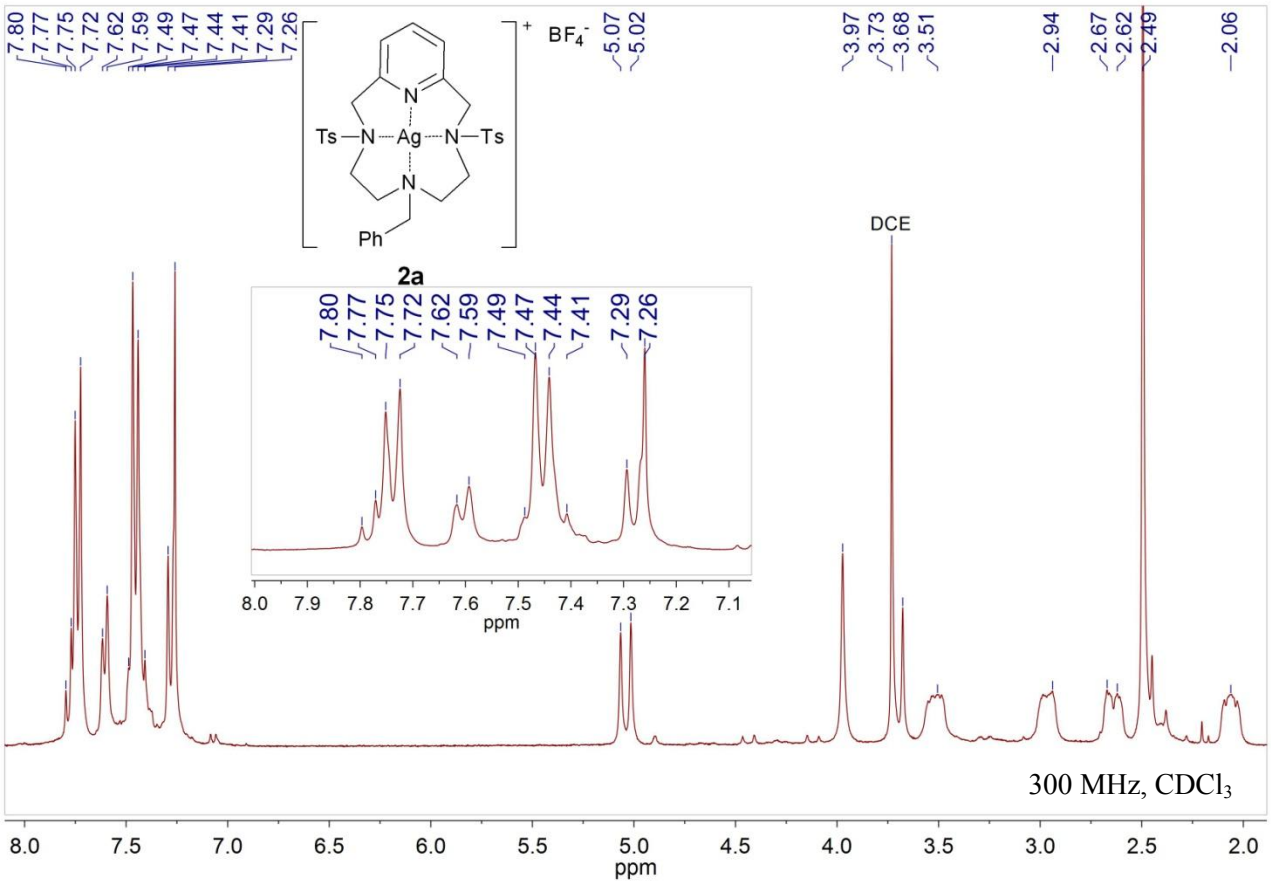
**PART II**

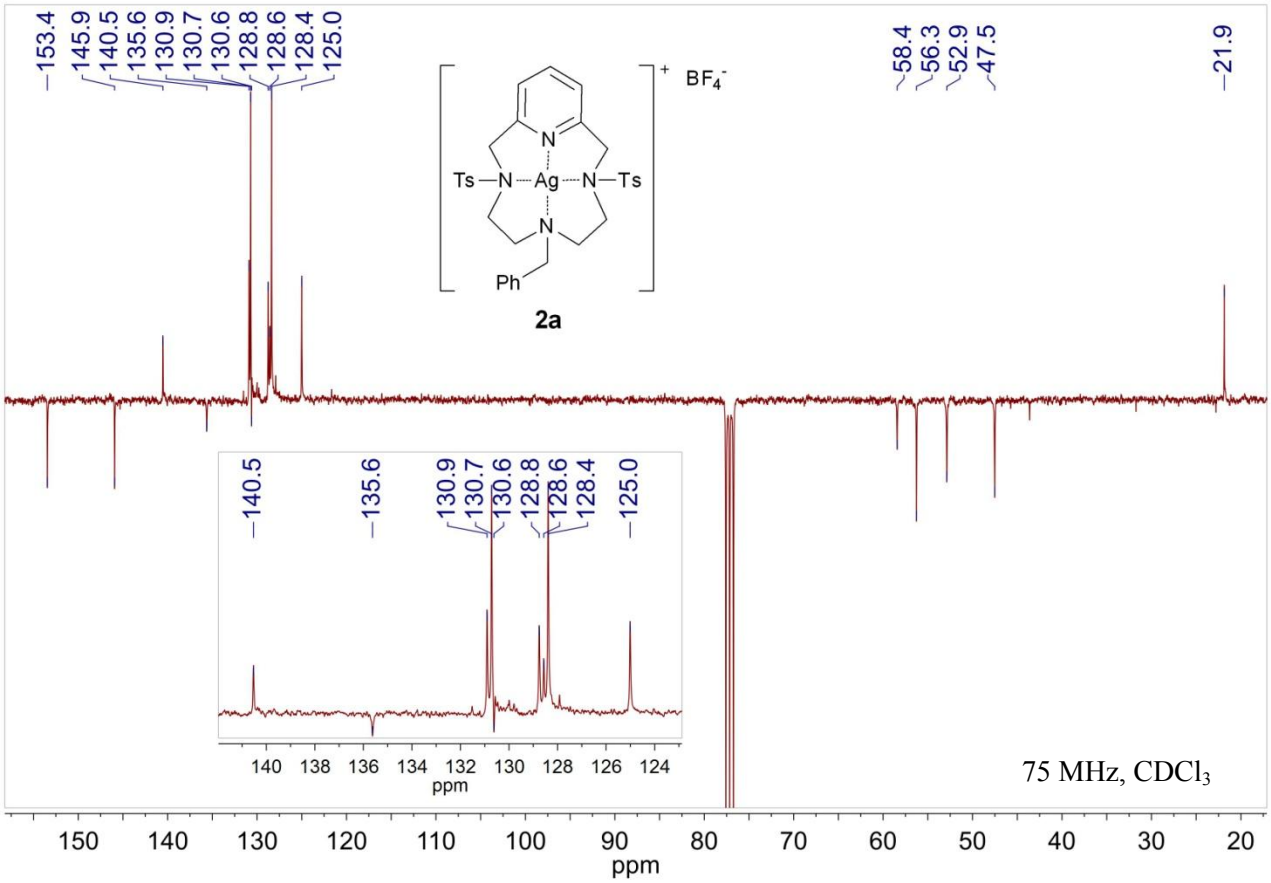

7.74
7.71
7.30
7.28
7.25
7.13
5.17
3.44
2.95
2.94
2.92
2.90
2.54
2.52
2.43
400 MHz, CDCl3
HN—Ts
N
HN—Ts
AcOEt
3.83
7.17
1.98
1.98
2.00
3.97
3.95
6.11
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
ppm

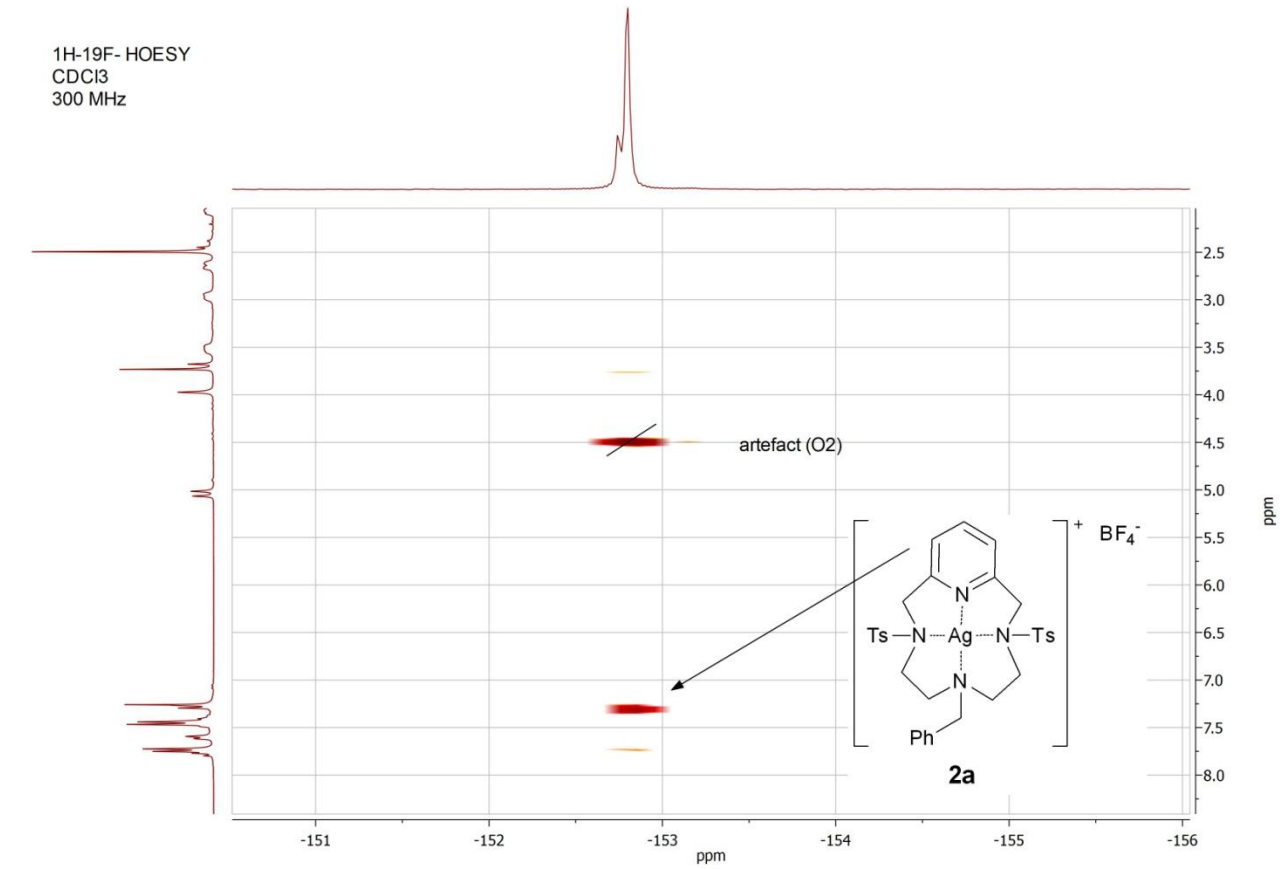

143.5
137.9
136.8
129.9
129.0
128.7
127.6
127.3
60.5
58.6
53.3
40.8
21.7
21.2
HN—Ts
N
HN—Ts
143.5
137.9
136.8
129.9
129.0
128.7
127.6
127.3
145 143 141 139 137 135 133 131 129 127 125 123
ppm
100 MHz, CDCl3
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm

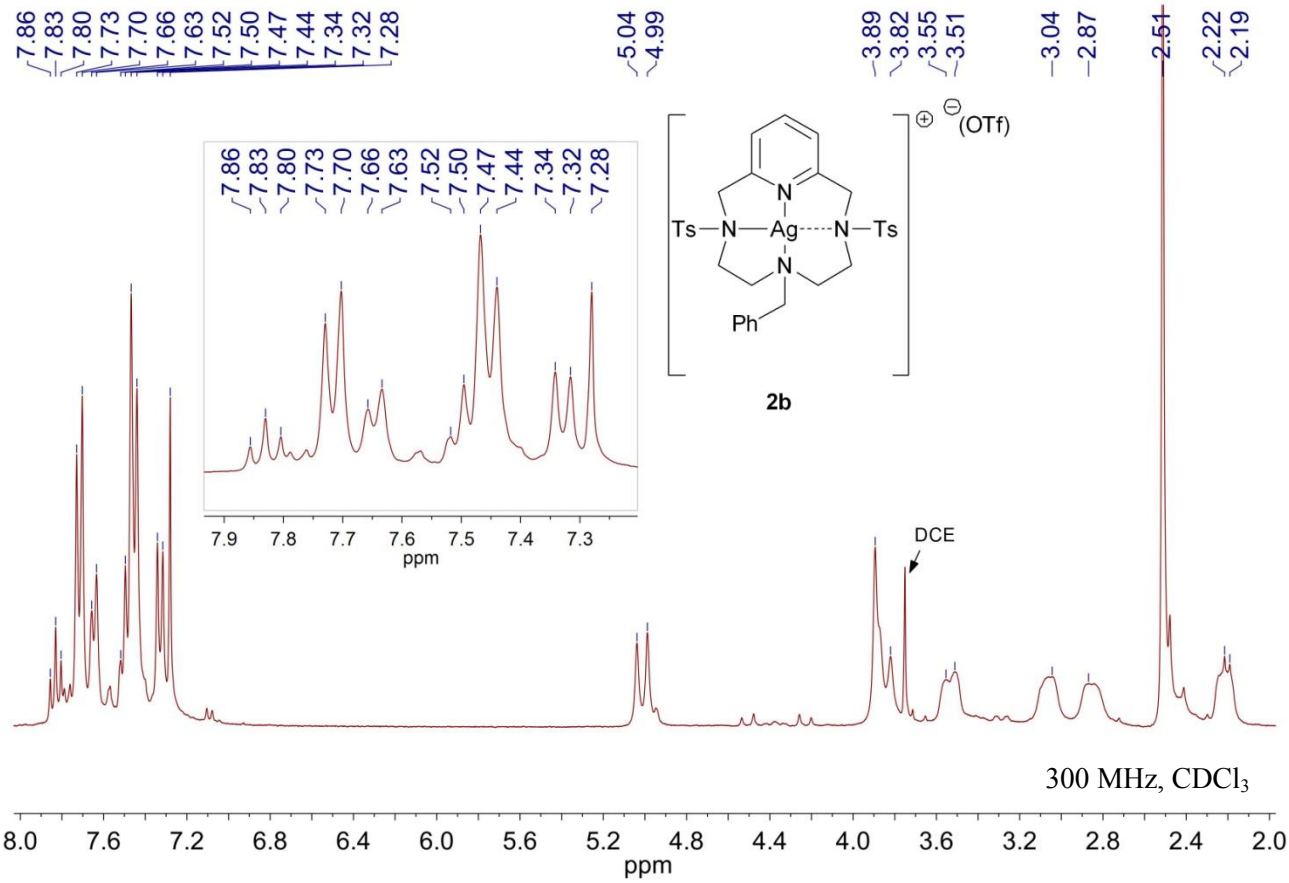

400 MHz, CDCl3
7.75
7.73
7.71
7.60
7.58
7.34
7.32
7.30
7.28
7.25
7.23
7.20
7.18
4.34
3.48
3.12
3.10
3.08
2.40
2.33
2.31
Ts—N
N—Ts
N
1
AcOEt
1.04
4.04
4.64
5.51
4.00
2.05
4.15
6.00
3.73
ppm


100 MHz, CDCl3
155.0
143.3
139.2
138.8
136.0
129.8
128.6
128.3
128.2
127.1
124.0
59.4
54.3
50.0
44.2
21.5
Ts—N
N—Ts
N
1
ppm

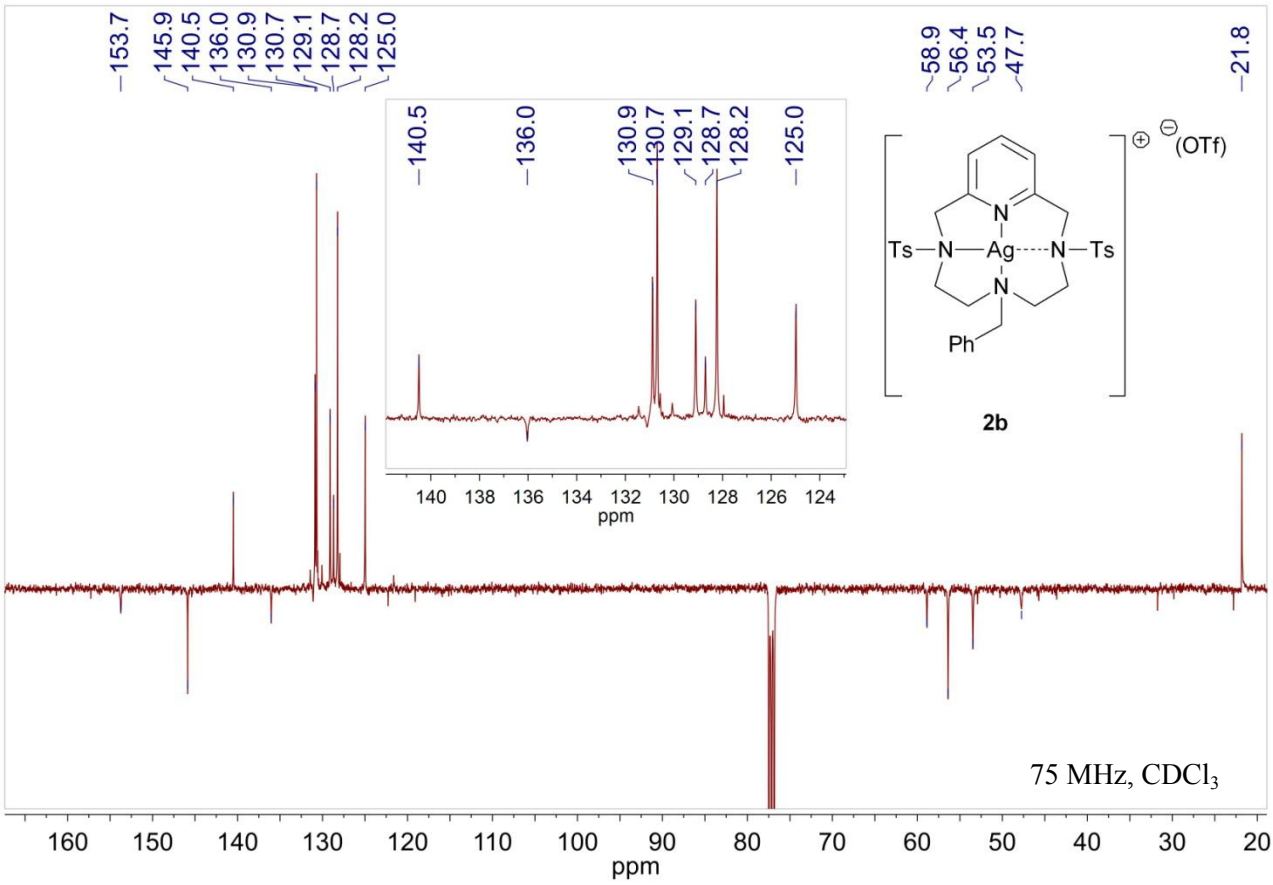

7.80
7.77
7.75
7.72
7.62
7.59
7.49
7.47
7.44
7.41
7.29
7.26
5.07
5.02
3.97
3.73
3.68
3.51
2.94
2.67
2.62
2.49
2.06
BF4-
Ts—N—Ag—N—Ts
Ph
2a
DCE
ppm
300 MHz, CDCl3

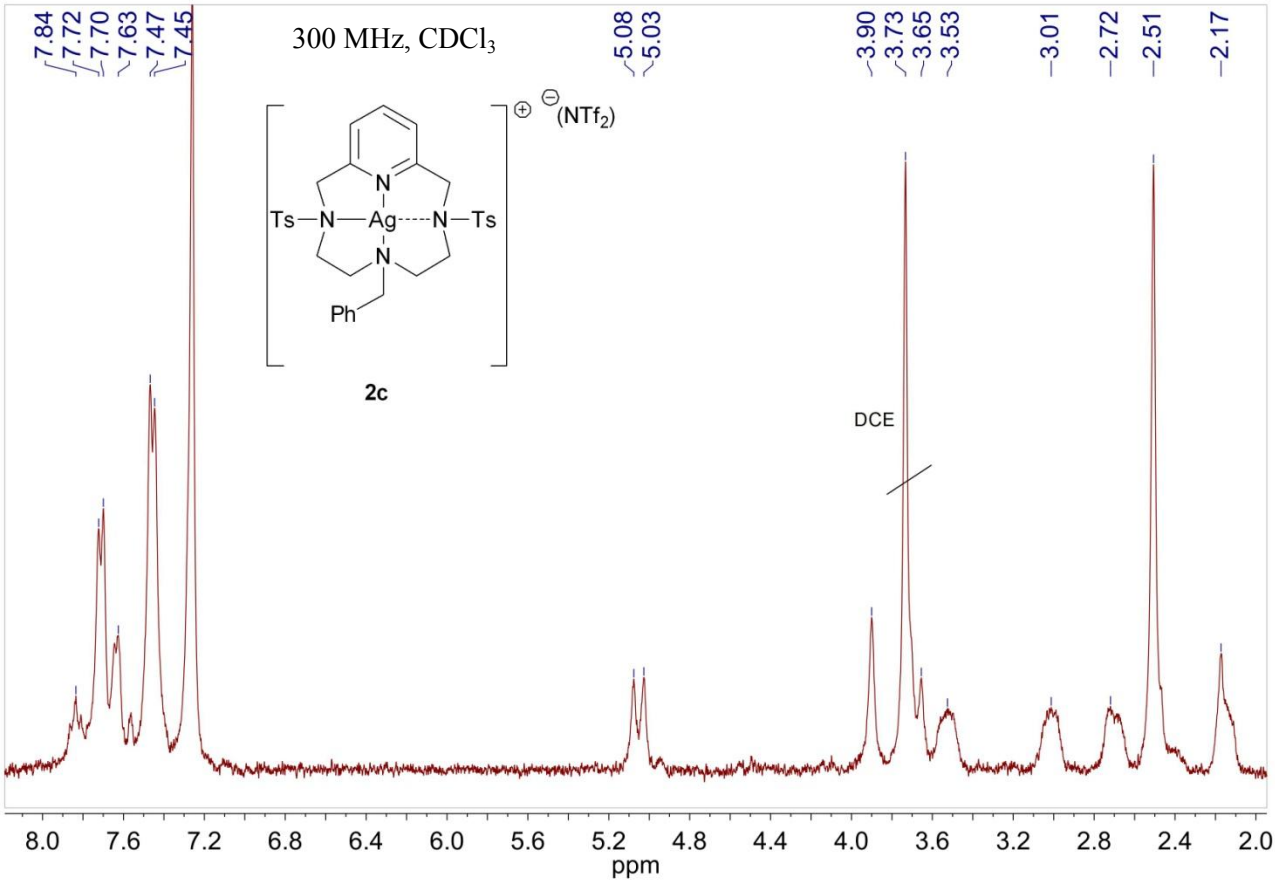

153.4
145.9
140.5
135.6
130.9
130.7
130.6
128.8
128.6
128.4
125.0
58.4
56.3
52.9
47.5
21.9
BF4-
Ts—N—Ag—N—Ts
Ph
2a
ppm
75 MHz, CDCl3

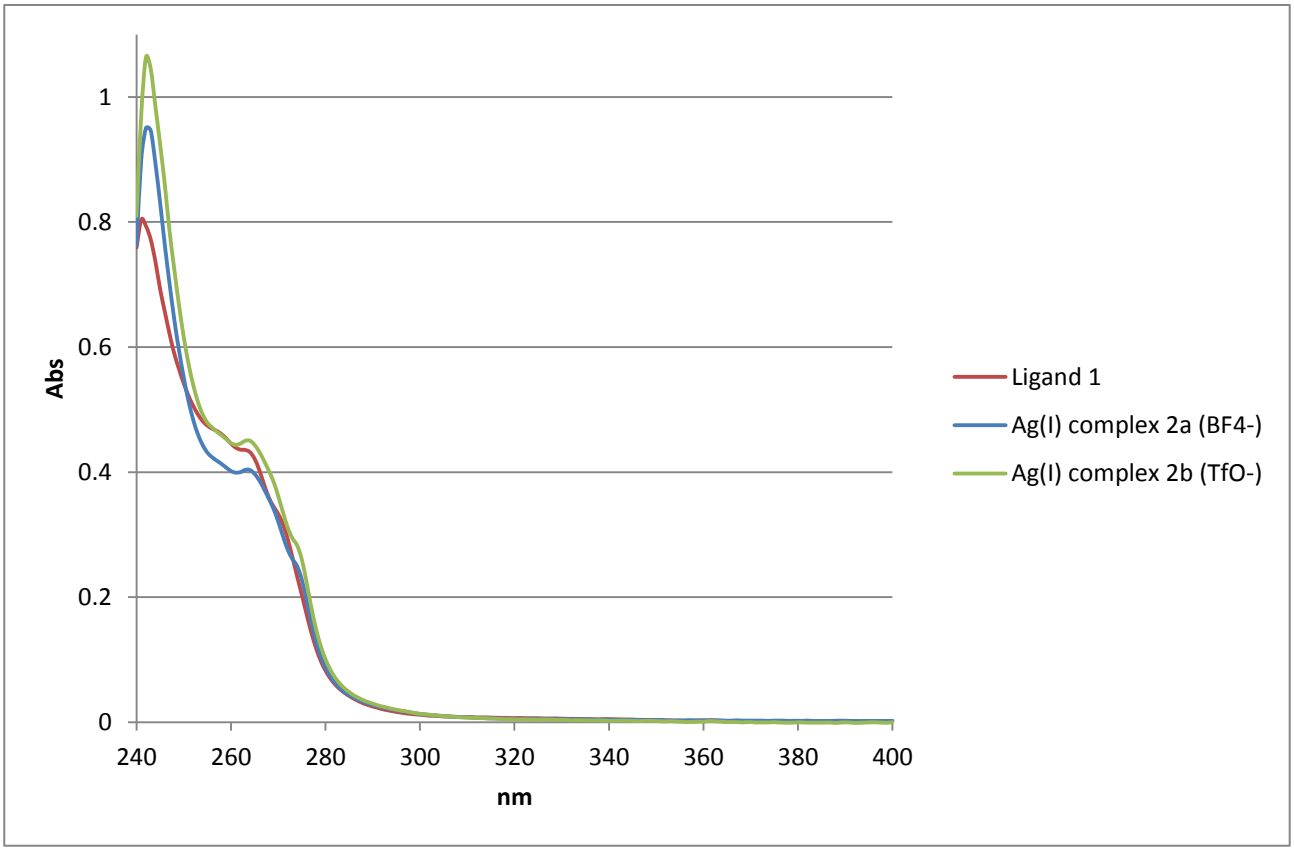


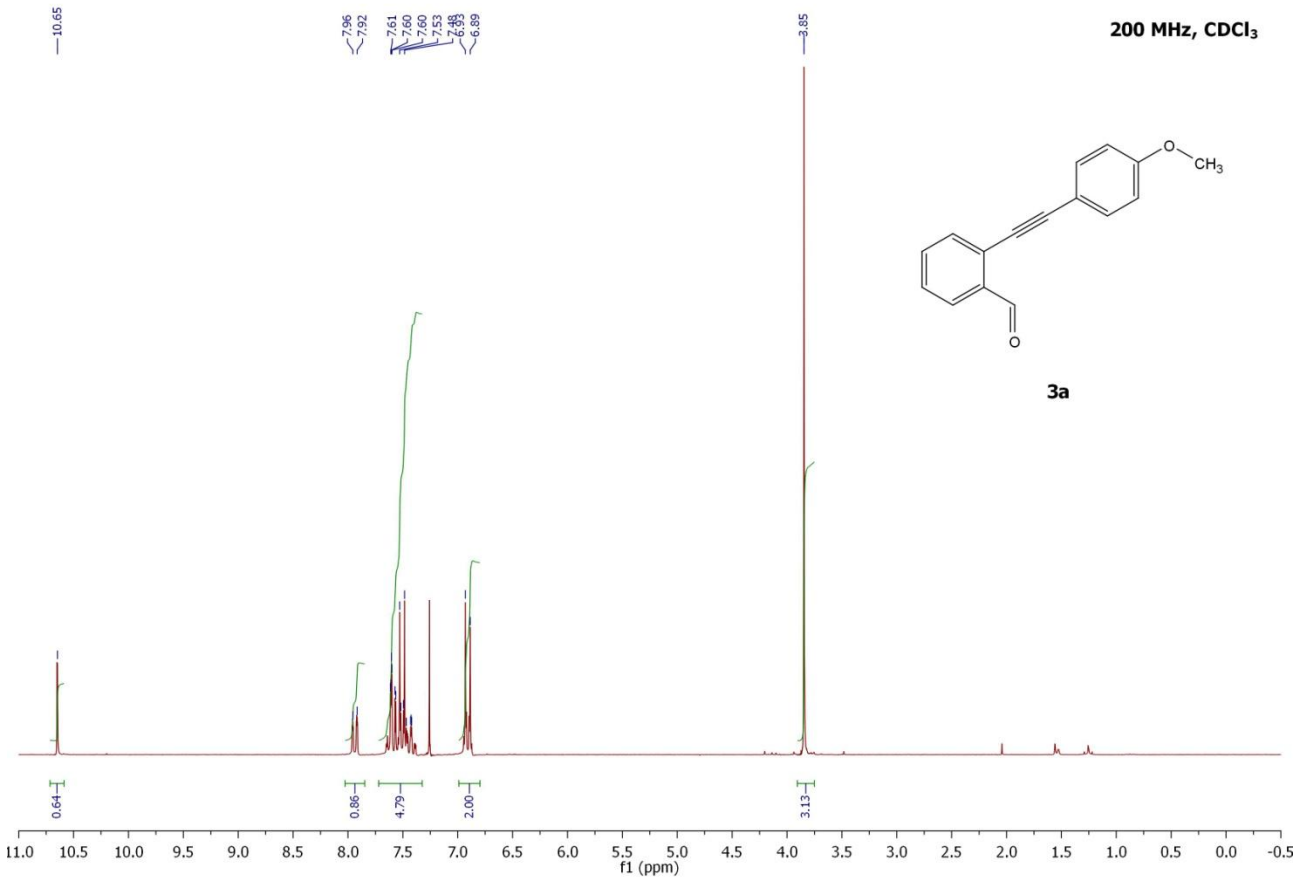

300 MHz, $CDCl_3$

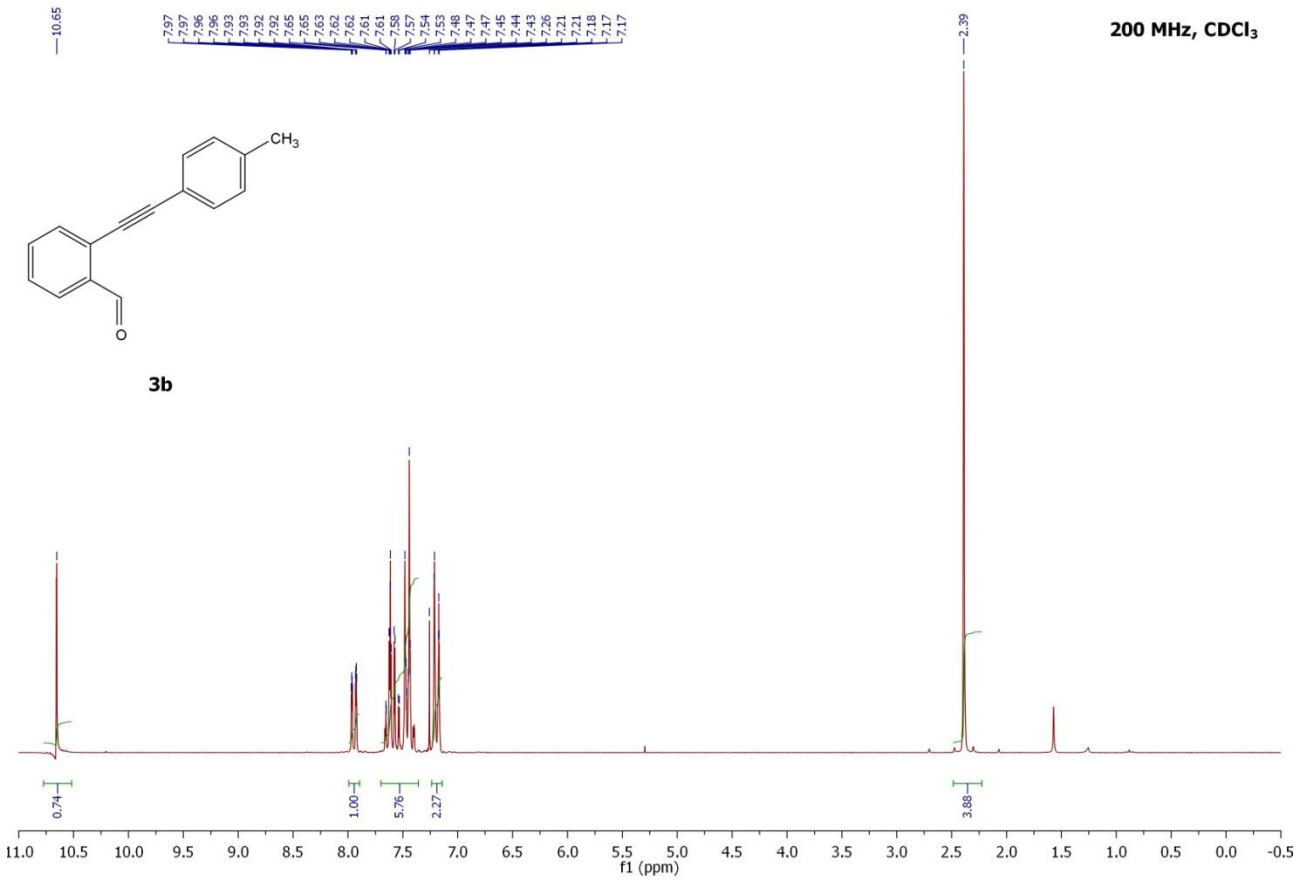

153.7
145.9
140.5
136.0
130.9
130.7
129.1
128.7
128.2
125.0
58.9
56.4
53.5
47.7
21.8
140.5
136.0
130.9
130.7
129.1
128.7
128.2
125.0
140 138 136 134 132 130 128 126 124
ppm
(OTf)
Ts
N
Ag
N
Ts
N
Ph
2b
75 MHz, CDCl3
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20
ppm

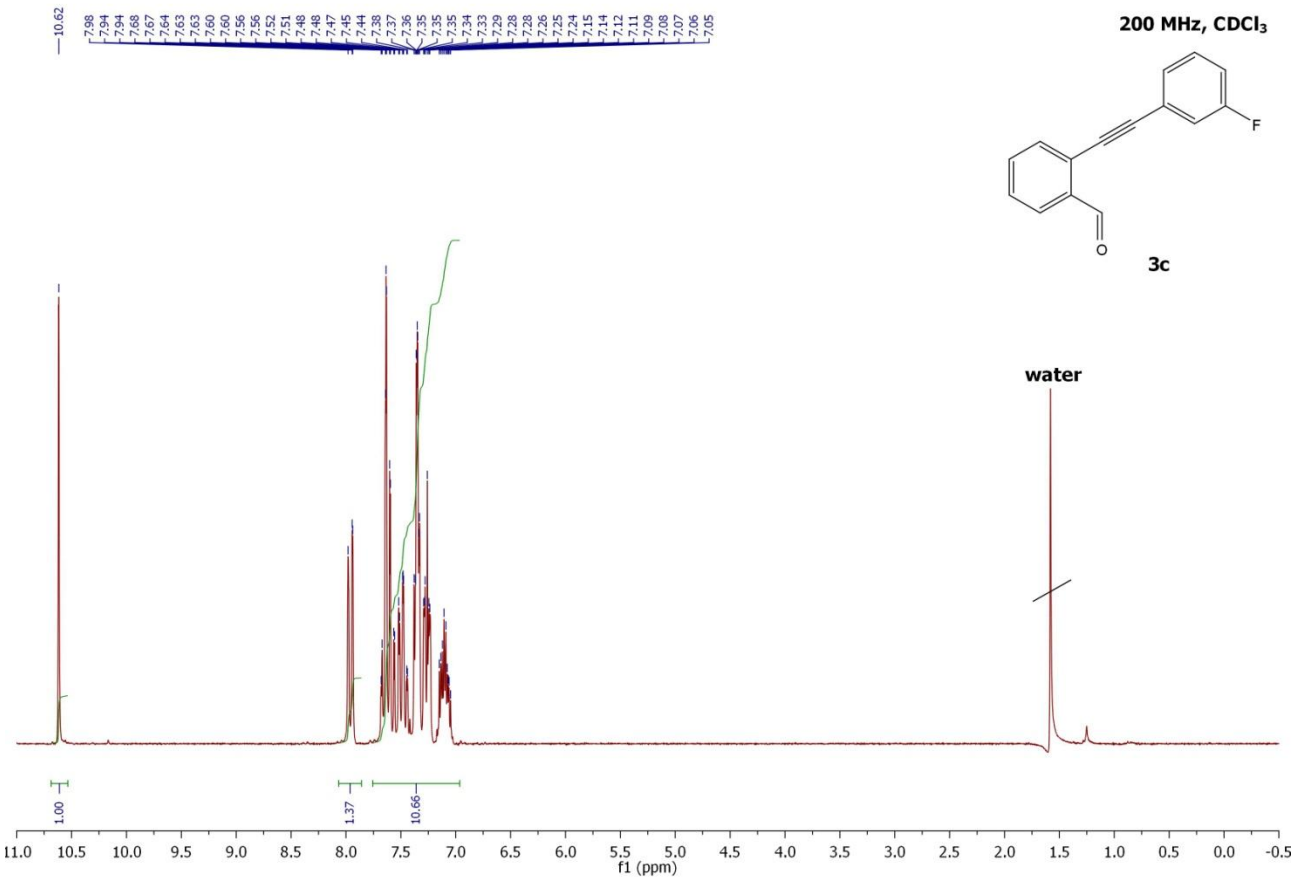

7.84
7.72
7.70
7.63
7.47
7.45
300 MHz, CDCl3
5.08
5.03
3.90
3.73
3.65
3.53
3.01
2.72
2.51
2.17
(NTf2)
Ts
N
Ag
N
Ts
N
Ph
2c
DCE
8.0 7.6 7.2 6.8 6.4 6.0 5.6 5.2 4.8 4.4 4.0 3.6 3.2 2.8 2.4 2.0
ppm

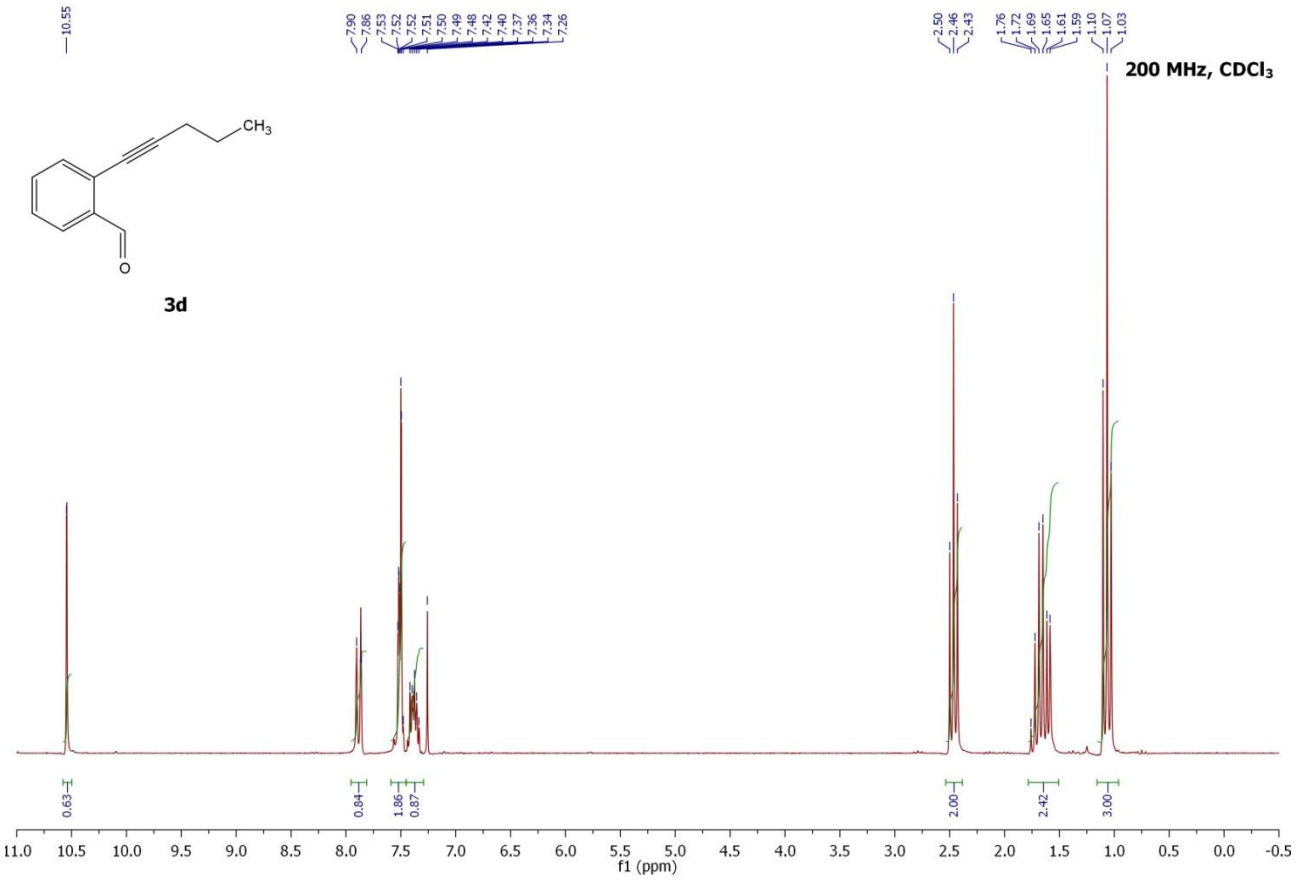


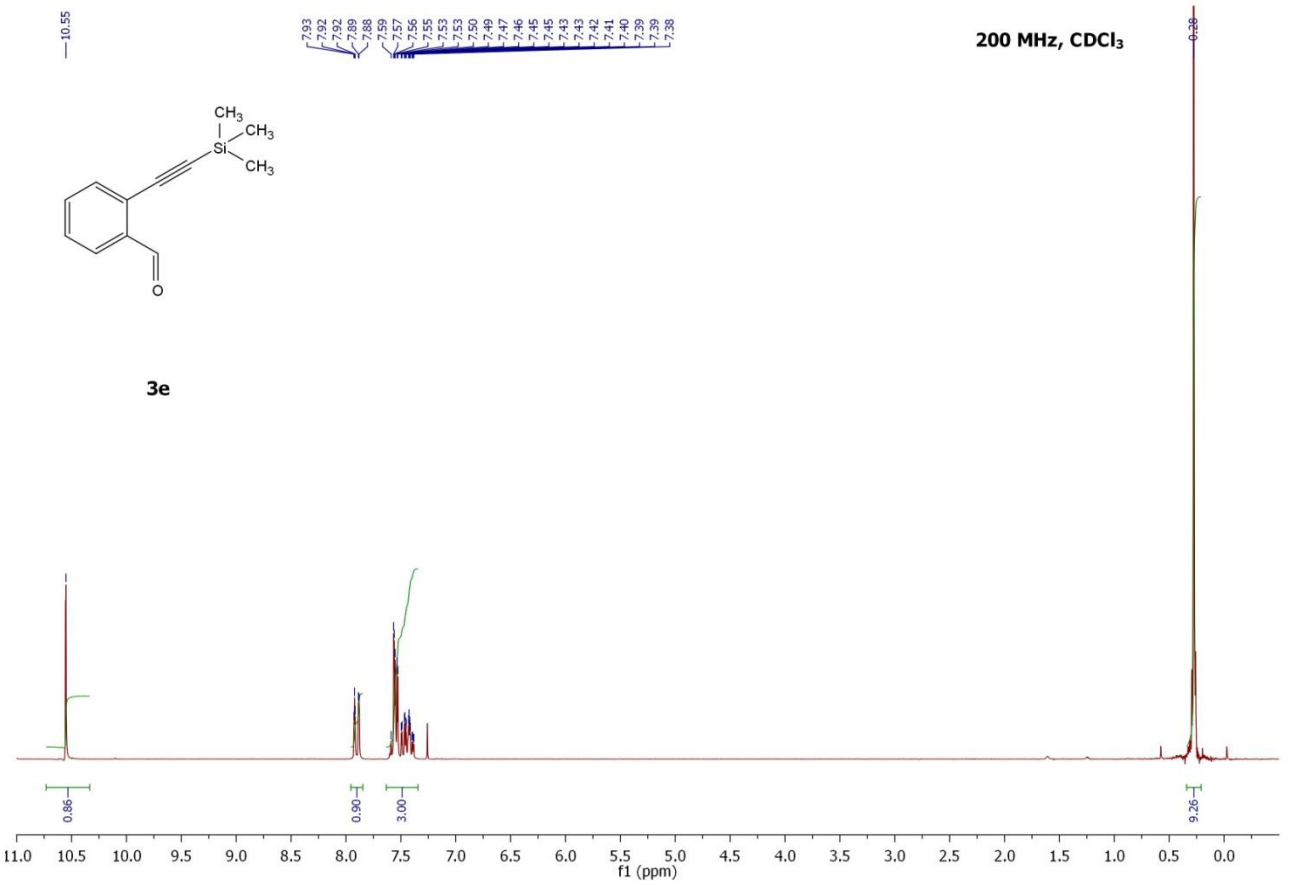

Superimposed UV spectra of ligand **1** and Ag complexes **2a** and **2b** ($10^{-5}$ M solutions in $CHCl_3$).

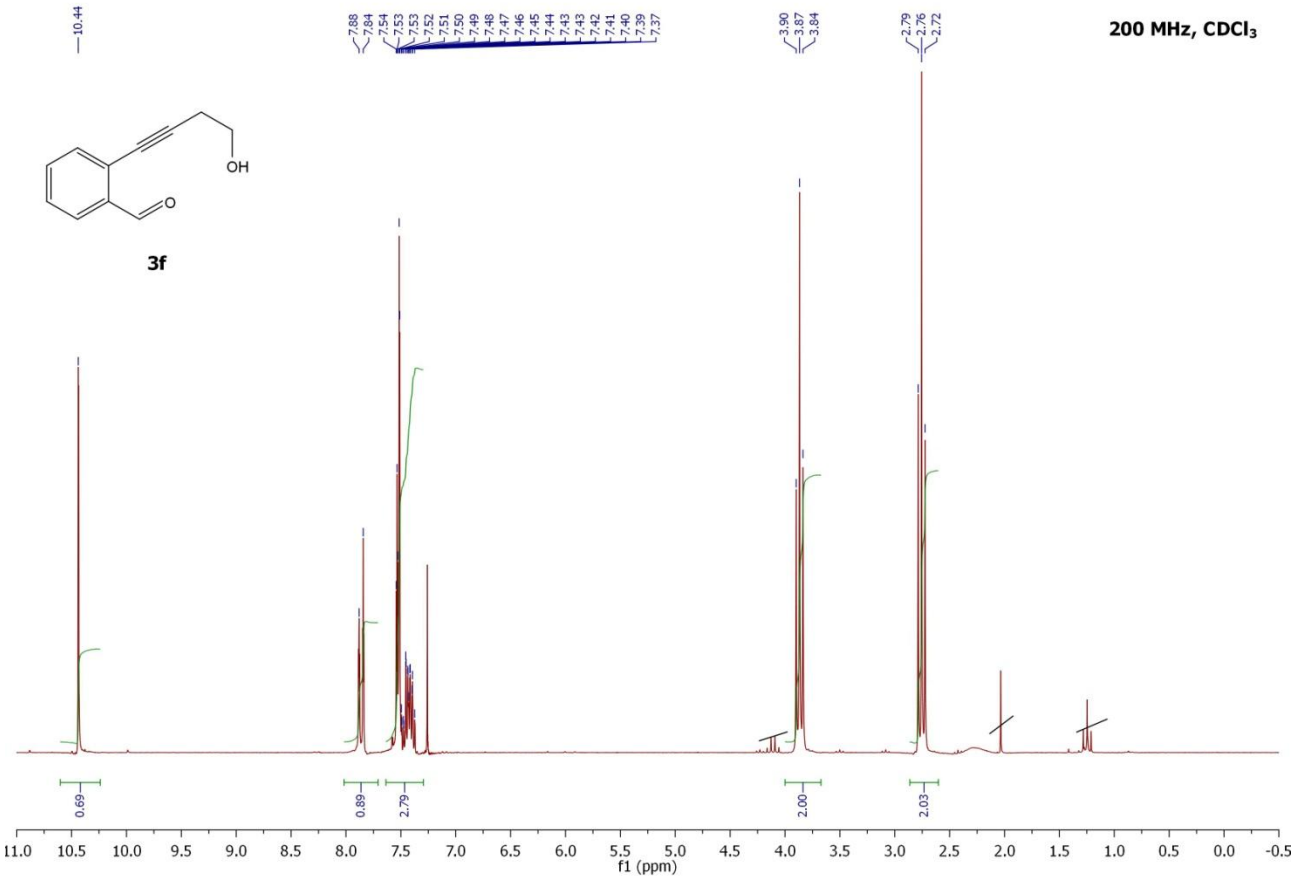

200 MHz, CDCl3
10.65
7.96
7.92
7.61
7.60
7.60
7.53
7.48
6.93
6.89
3.85
O
CH3
O
3a
0.64
0.86
4.79
2.00
3.13
f1 (ppm)

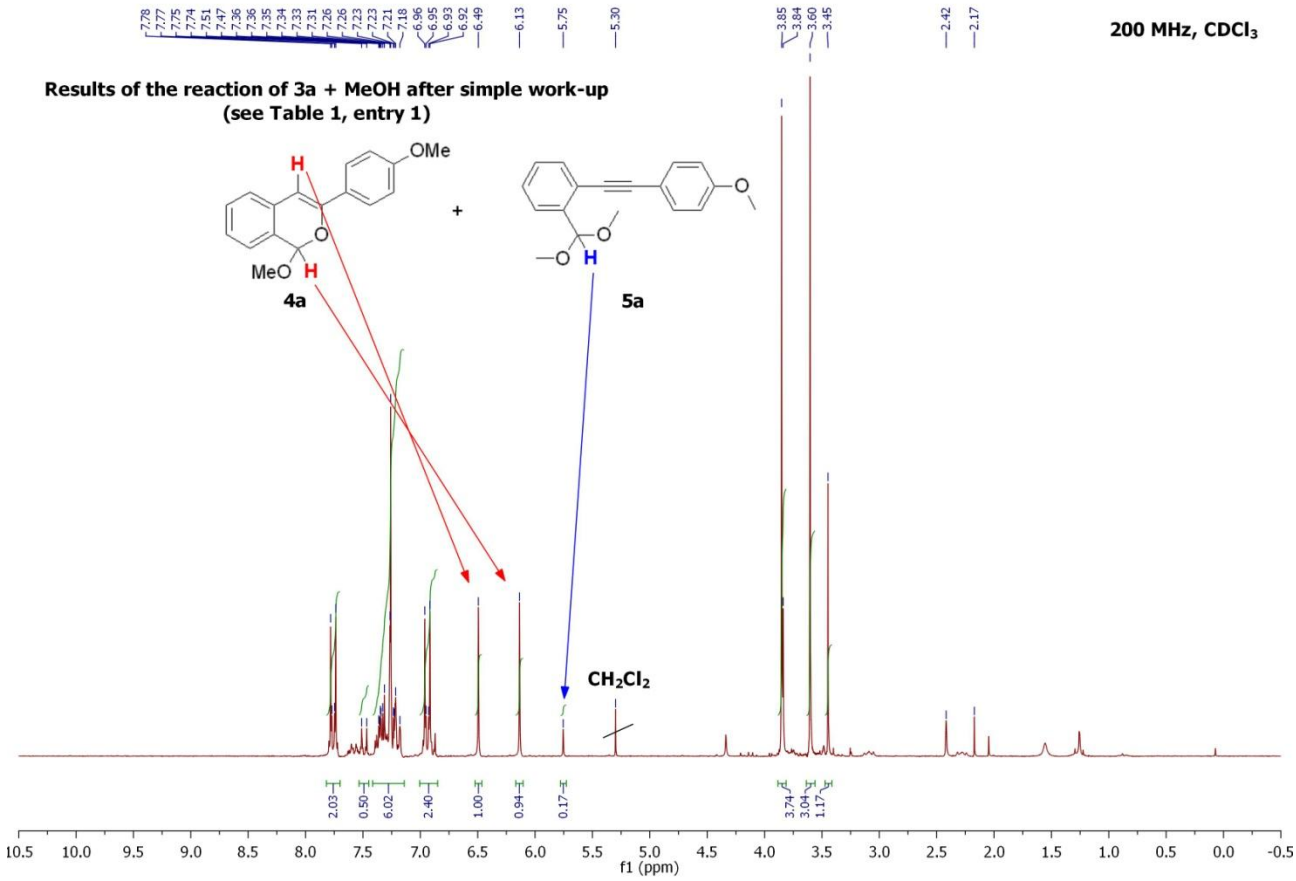

200 MHz, CDCl3
10.65
7.97
7.97
7.96
7.96
7.93
7.93
7.92
7.92
7.65
7.63
7.62
7.62
7.61
7.61
7.58
7.57
7.54
7.53
7.48
7.47
7.47
7.45
7.44
7.43
7.26
7.21
7.21
7.18
7.17
7.17
2.39
CH3
O
3b
0.74
1.00
5.76
2.27
3.88
f1 (ppm)

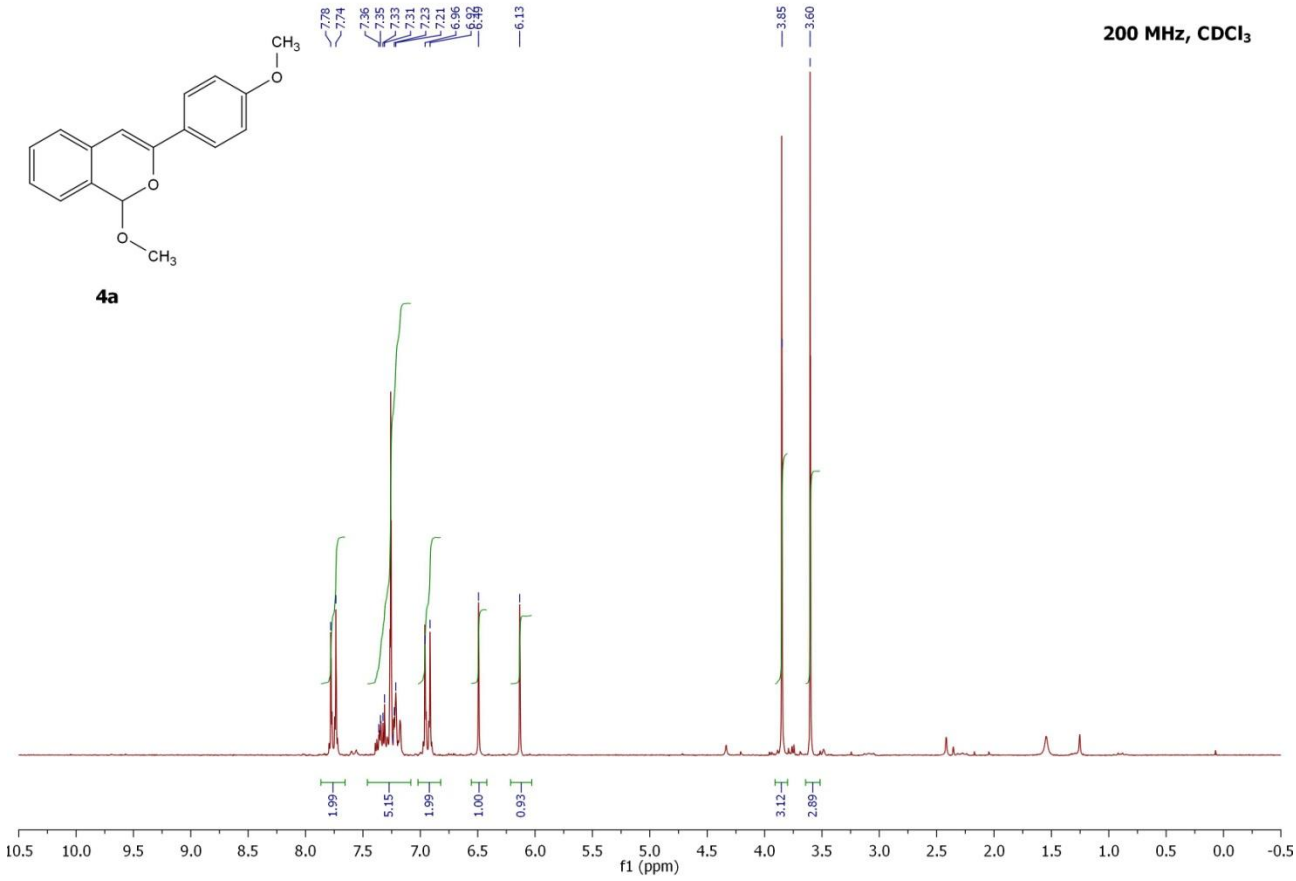

200 MHz, CDCl3
F
O
3c
water
1.00
1.37
10.66
f1 (ppm)

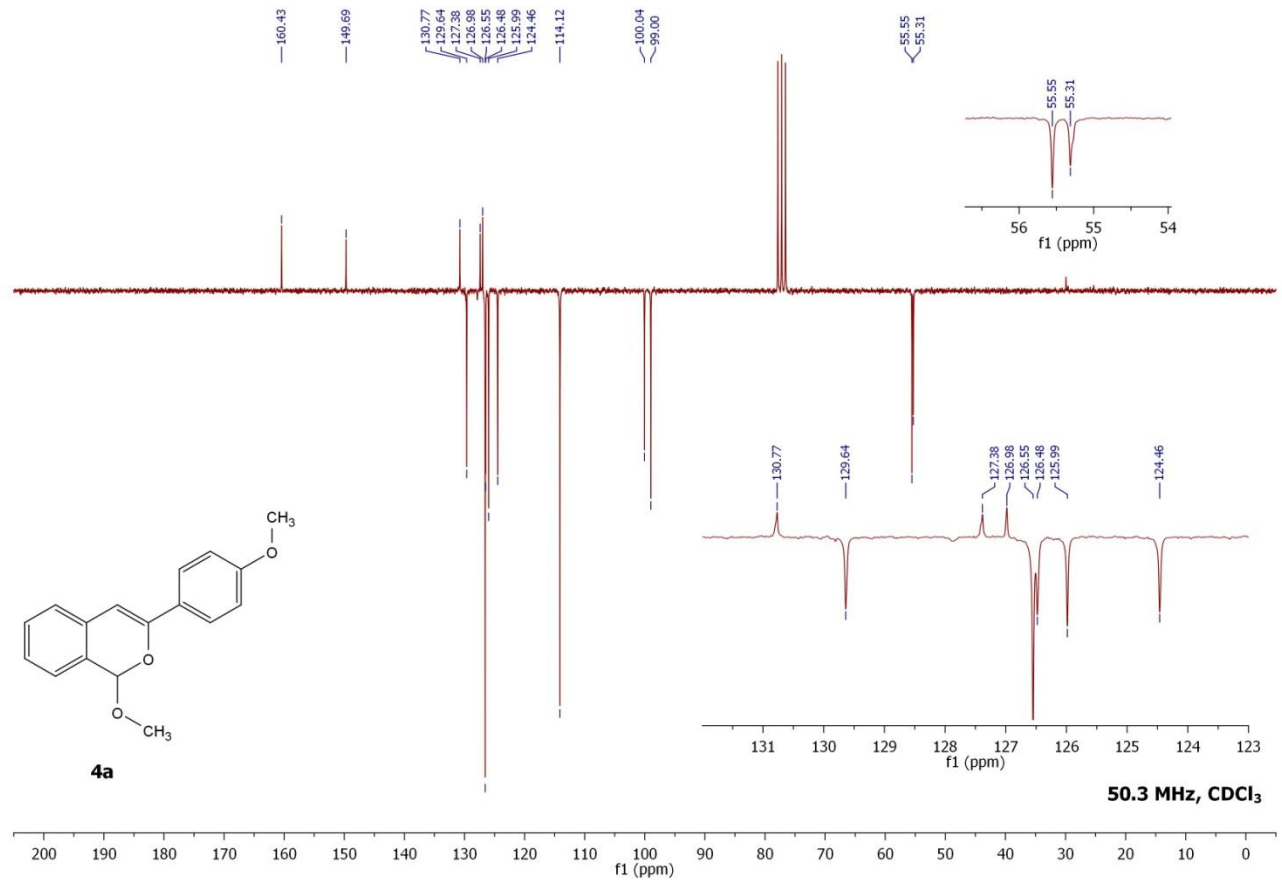

200 MHz, CDCl3
CH3
O
3d
0.63
0.84
1.86
0.87
2.00
2.42
3.00
f1 (ppm)

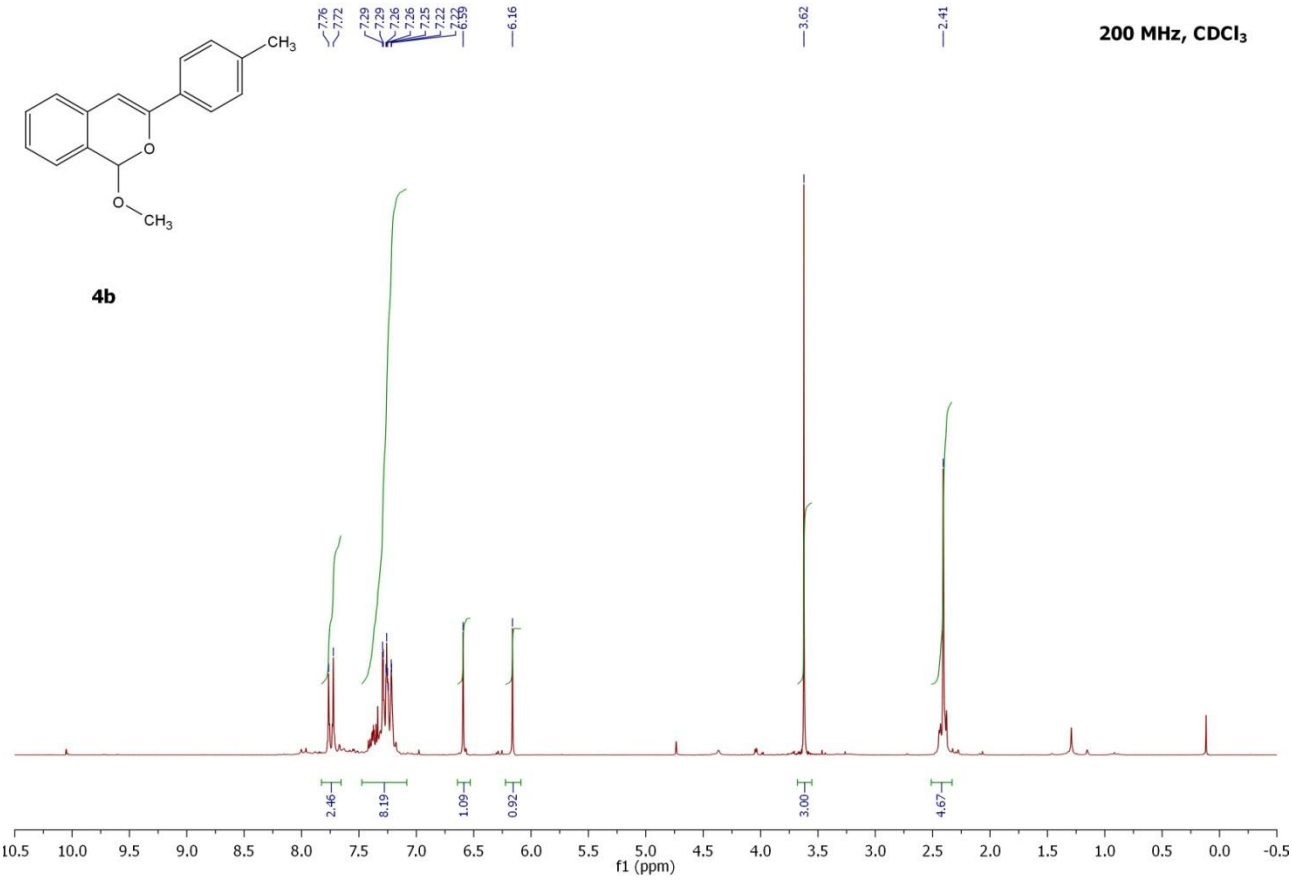

200 MHz, CDCl3
3e
f1 (ppm)

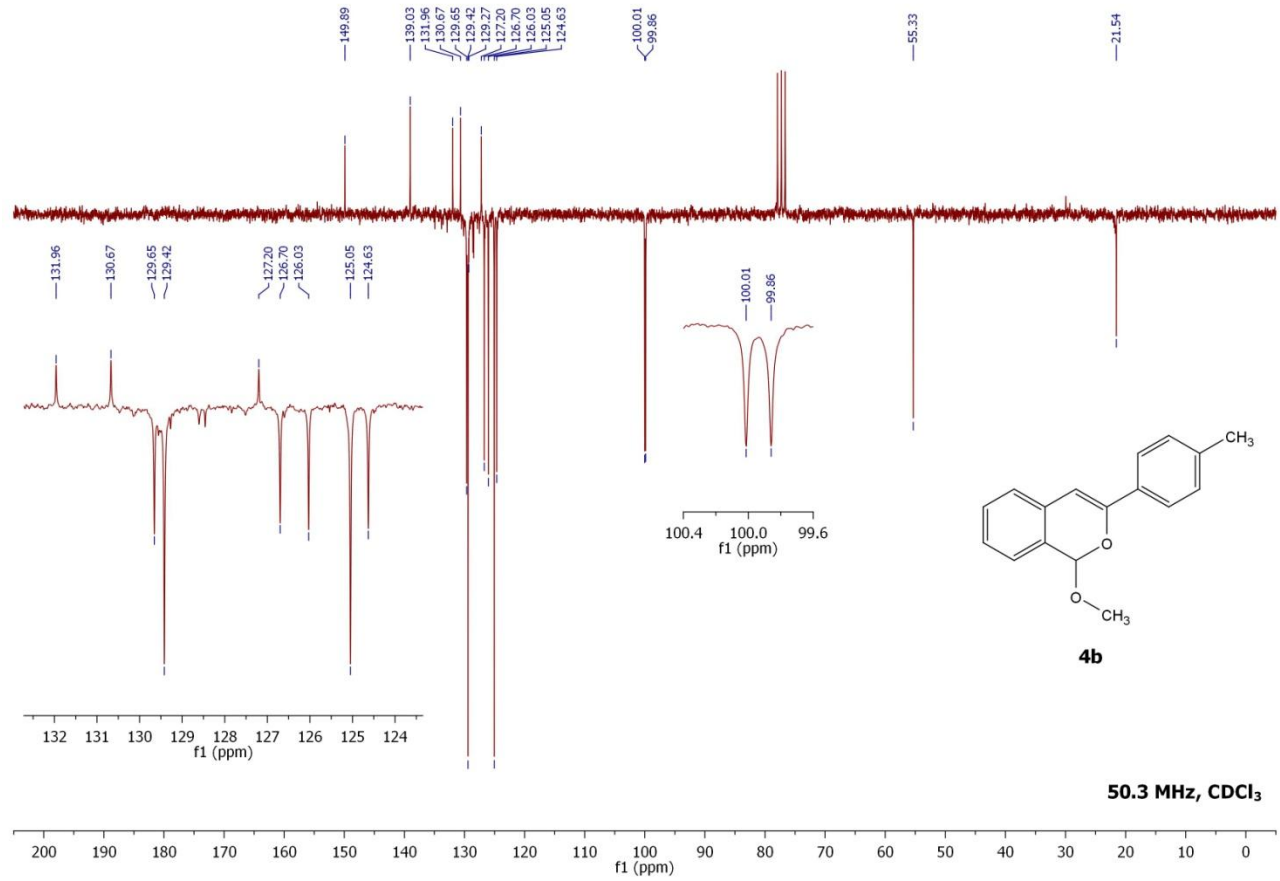

200 MHz, CDCl3
3f
f1 (ppm)

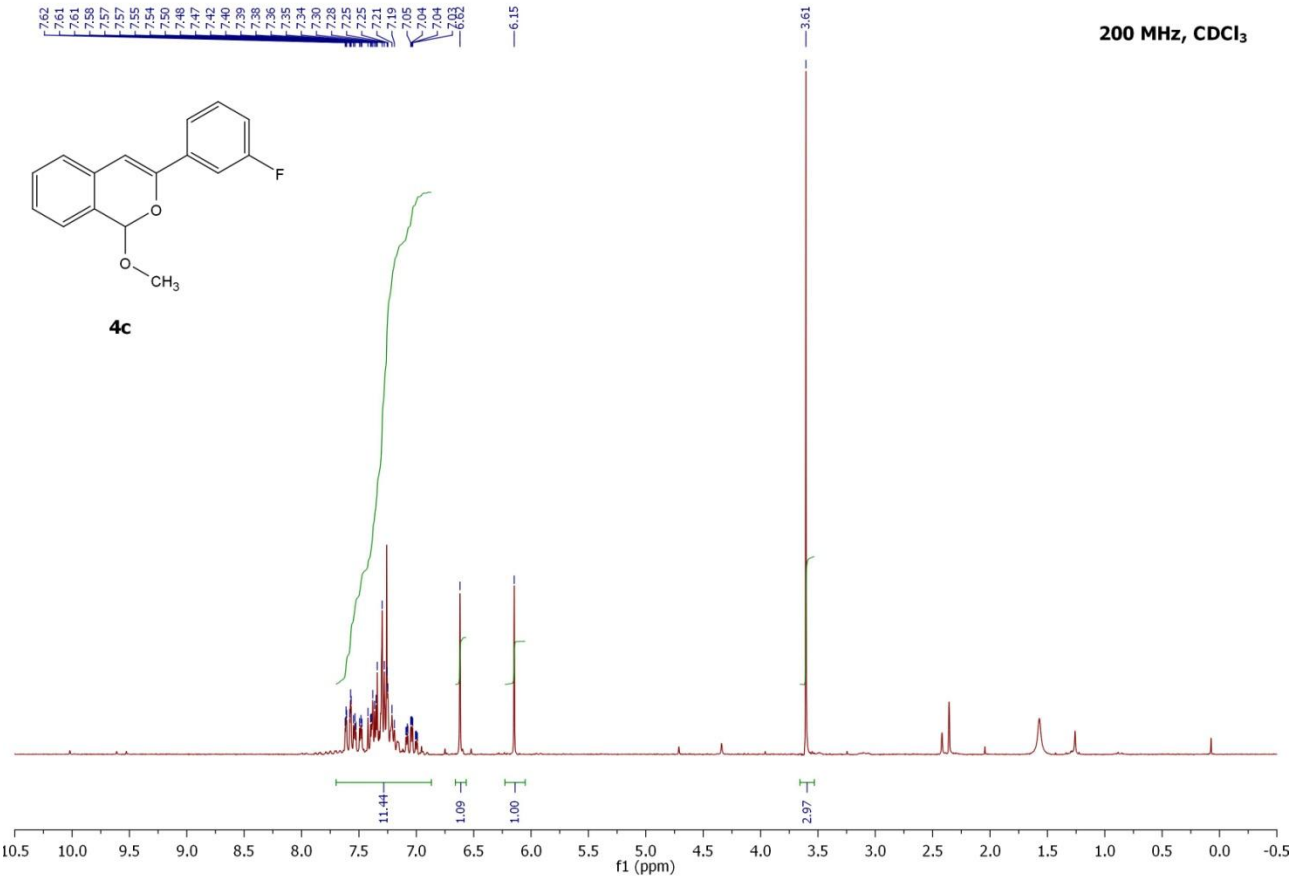

200 MHz, CDCl3
Results of the reaction of 3a + MeOH after simple work-up
(see Table 1, entry 1)
OMe
H
MeO
H
4a
+
O
O
O
H
5a
CH2Cl2
f1 (ppm)

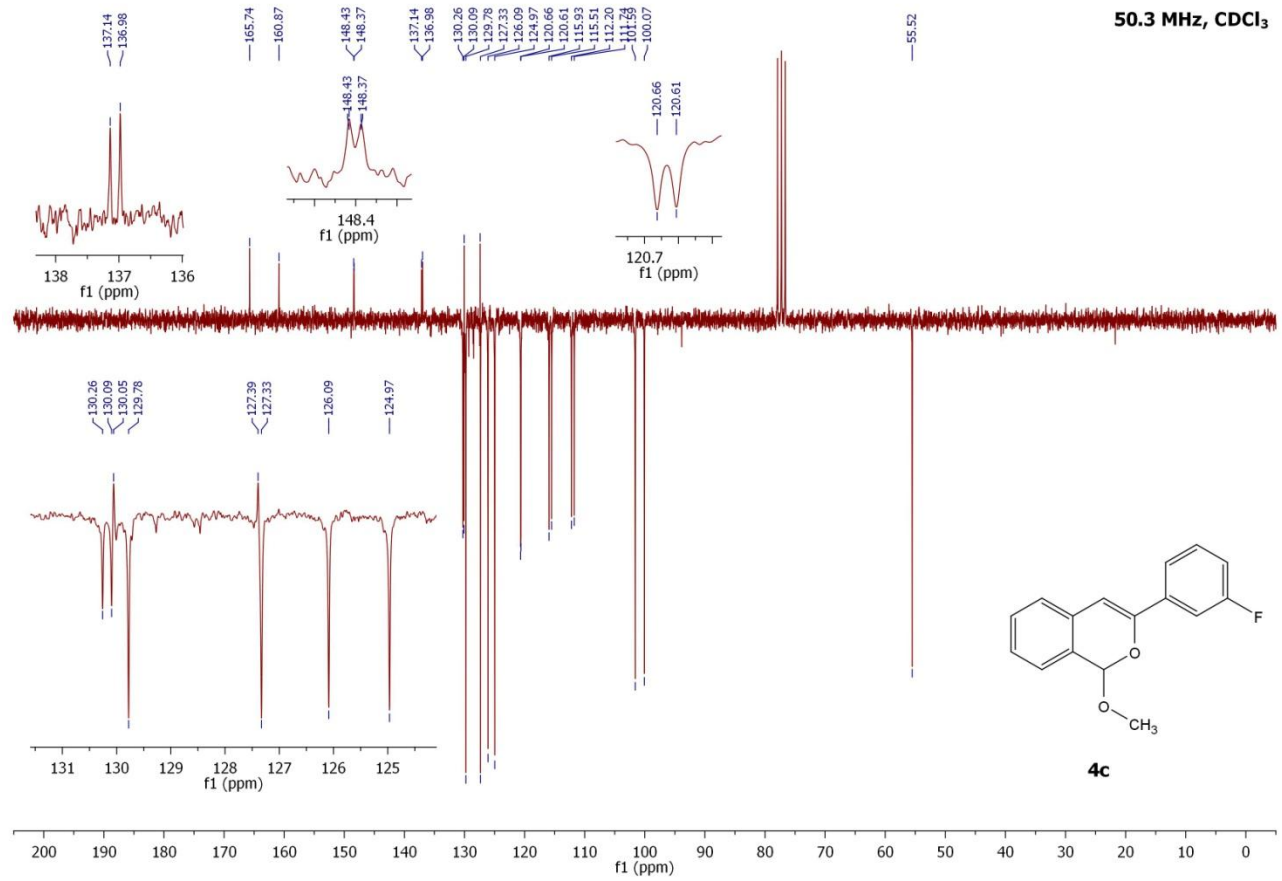

200 MHz, CDCl3
CH3
O
O
O
CH3
4a
f1 (ppm)

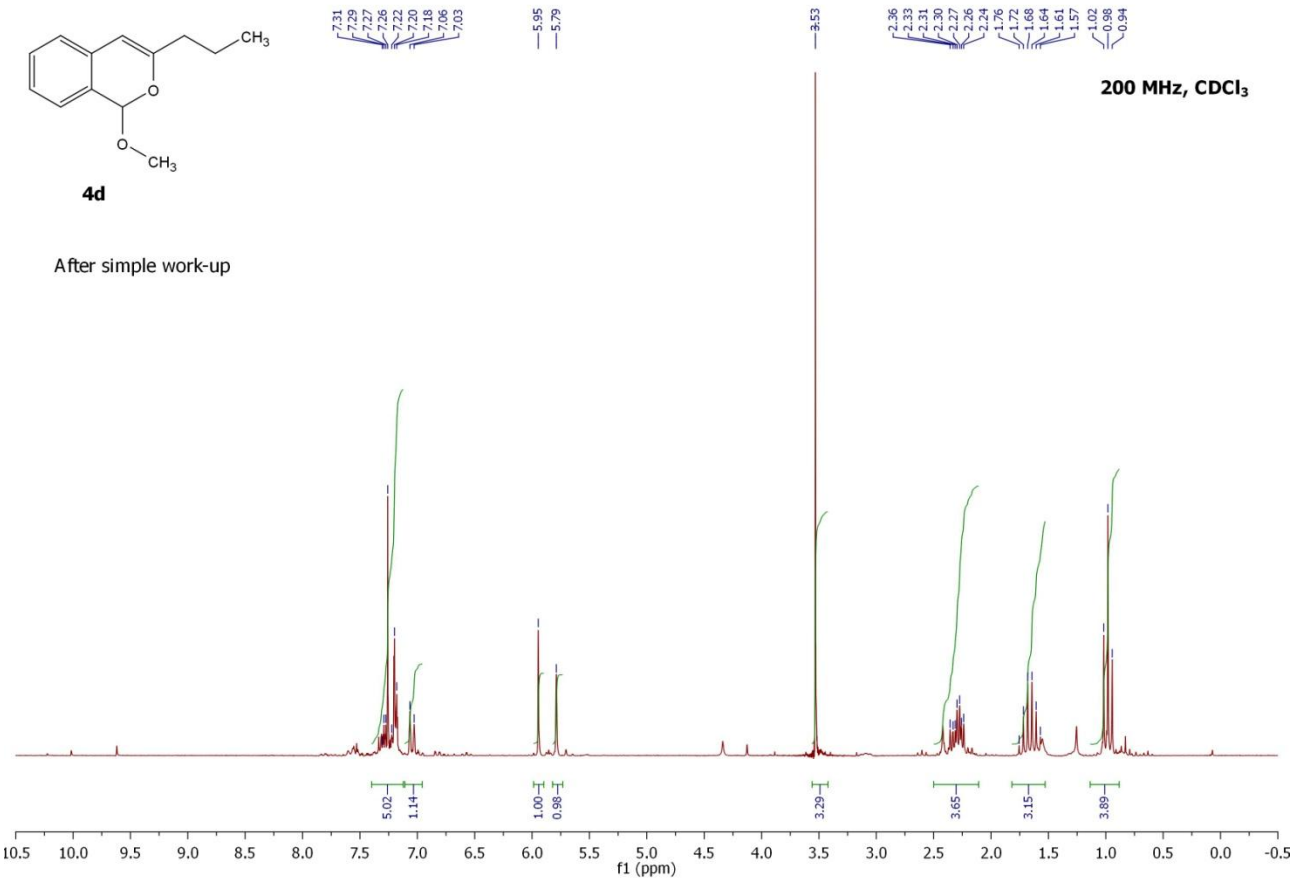

160.43
149.69
130.77
129.64
127.38
126.98
126.55
126.48
125.99
124.46
114.12
100.04
99.00
55.55
55.31
f1 (ppm)
CH3
O
O
O
CH3
4a
50.3 MHz, CDCl3
f1 (ppm)

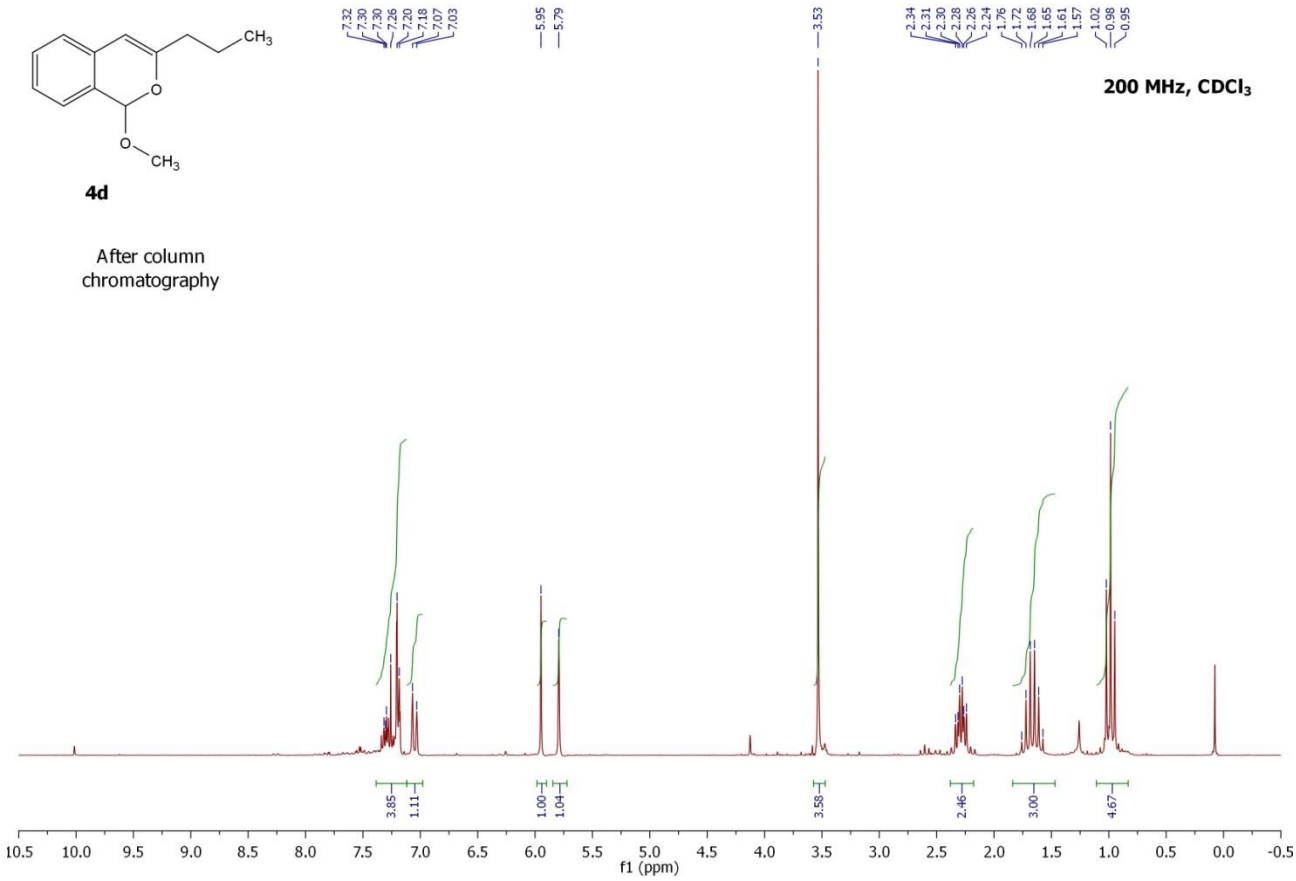

7.76
7.72
7.29
7.29
7.26
7.26
7.25
7.22
6.59
6.16
3.62
2.41
CH3
O
O
CH3
4b
200 MHz, CDCl3
2.46
8.19
1.09
0.92
3.00
4.67
f1 (ppm)

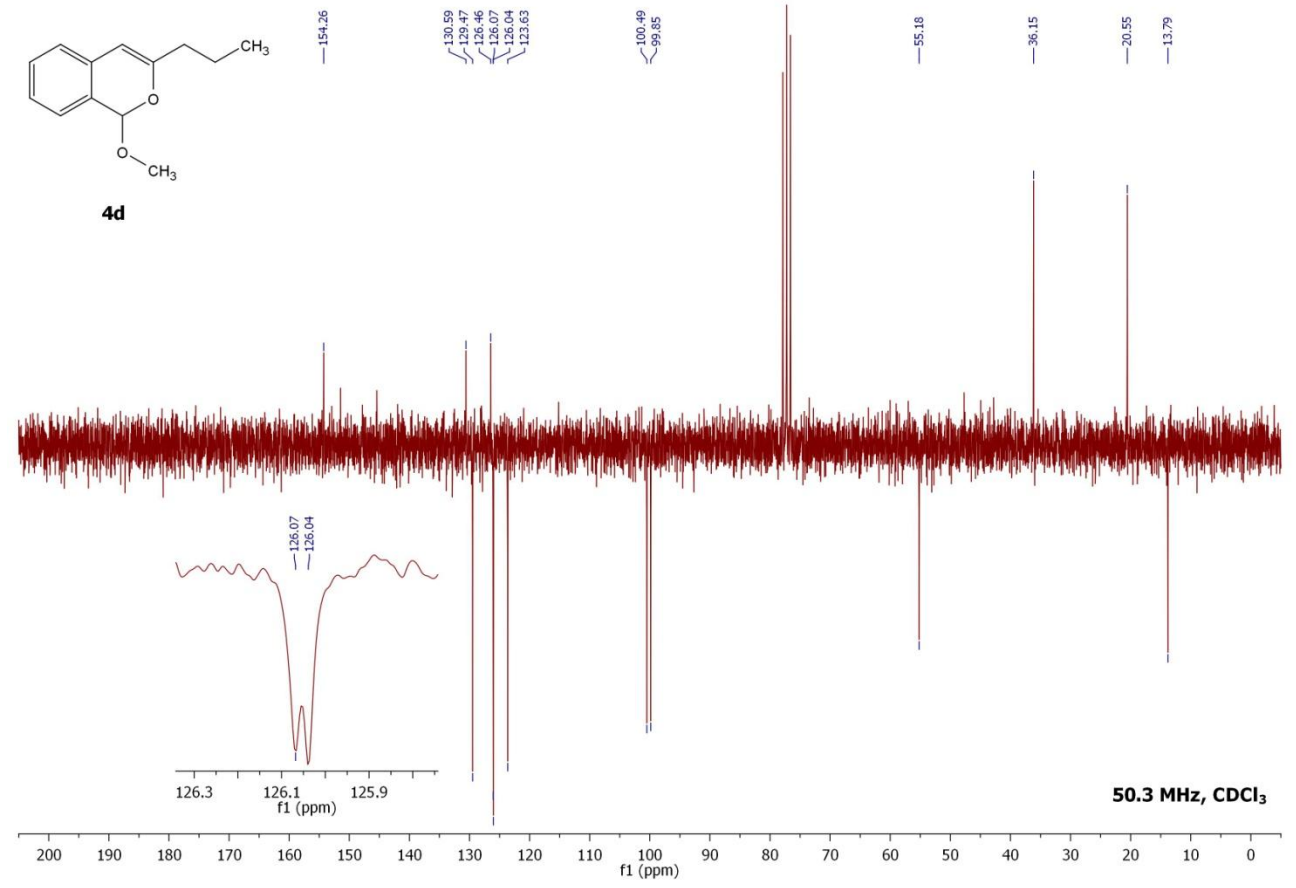

149.89
139.03
131.96
130.67
129.65
129.42
129.27
127.20
126.70
126.03
125.05
124.63
100.01
99.86
55.33
21.54
CH3
O
O
CH3
4b
50.3 MHz, CDCl3
f1 (ppm)

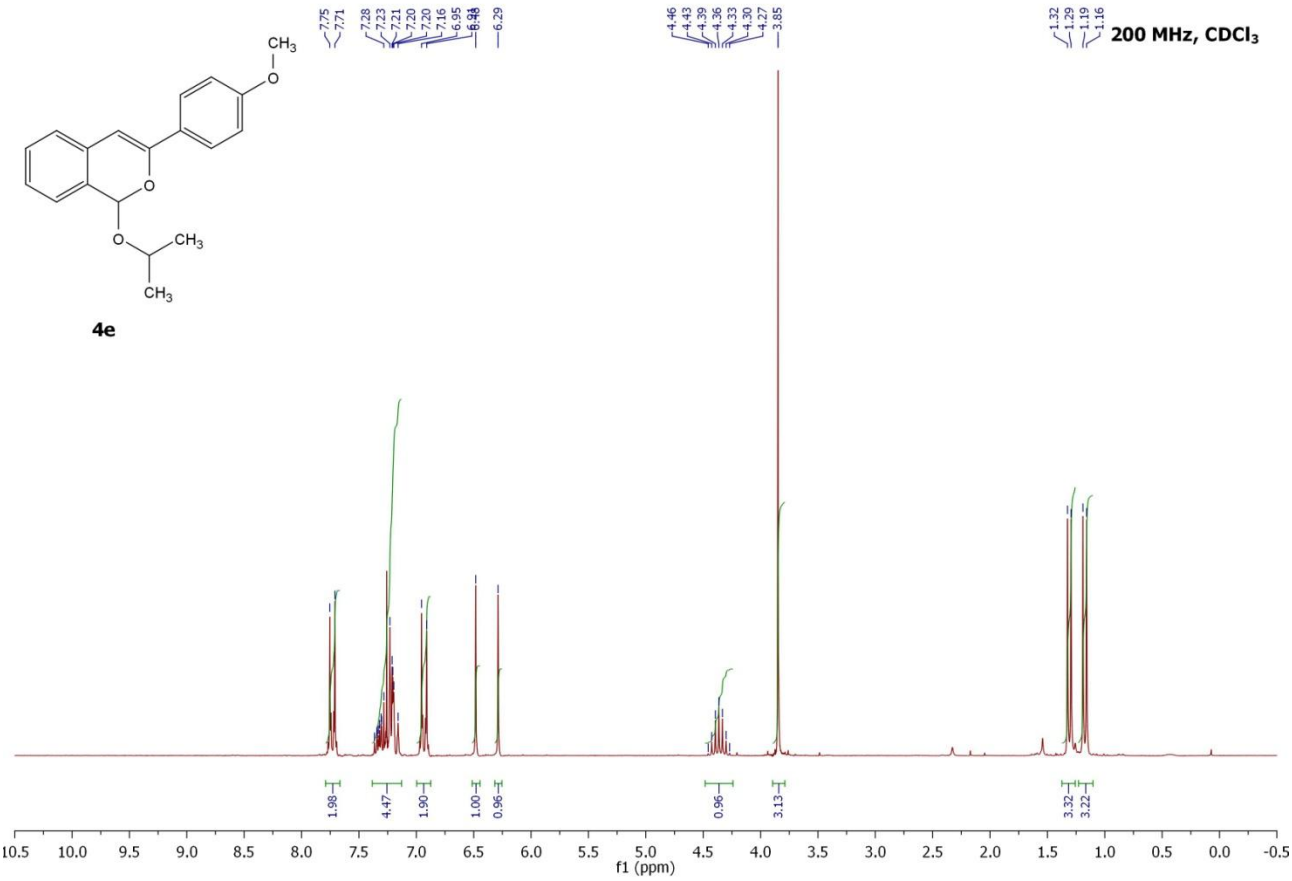

7.62
7.61
7.61
7.58
7.57
7.57
7.55
7.54
7.50
7.48
7.47
7.42
7.40
7.39
7.38
7.36
7.35
7.34
7.30
7.28
7.25
7.25
7.21
7.19
7.05
7.04
7.04
7.03
6.62
6.15
3.61
F
O
O
CH3
4c
200 MHz, CDCl3
11.44
1.09
1.00
2.97
f1 (ppm)

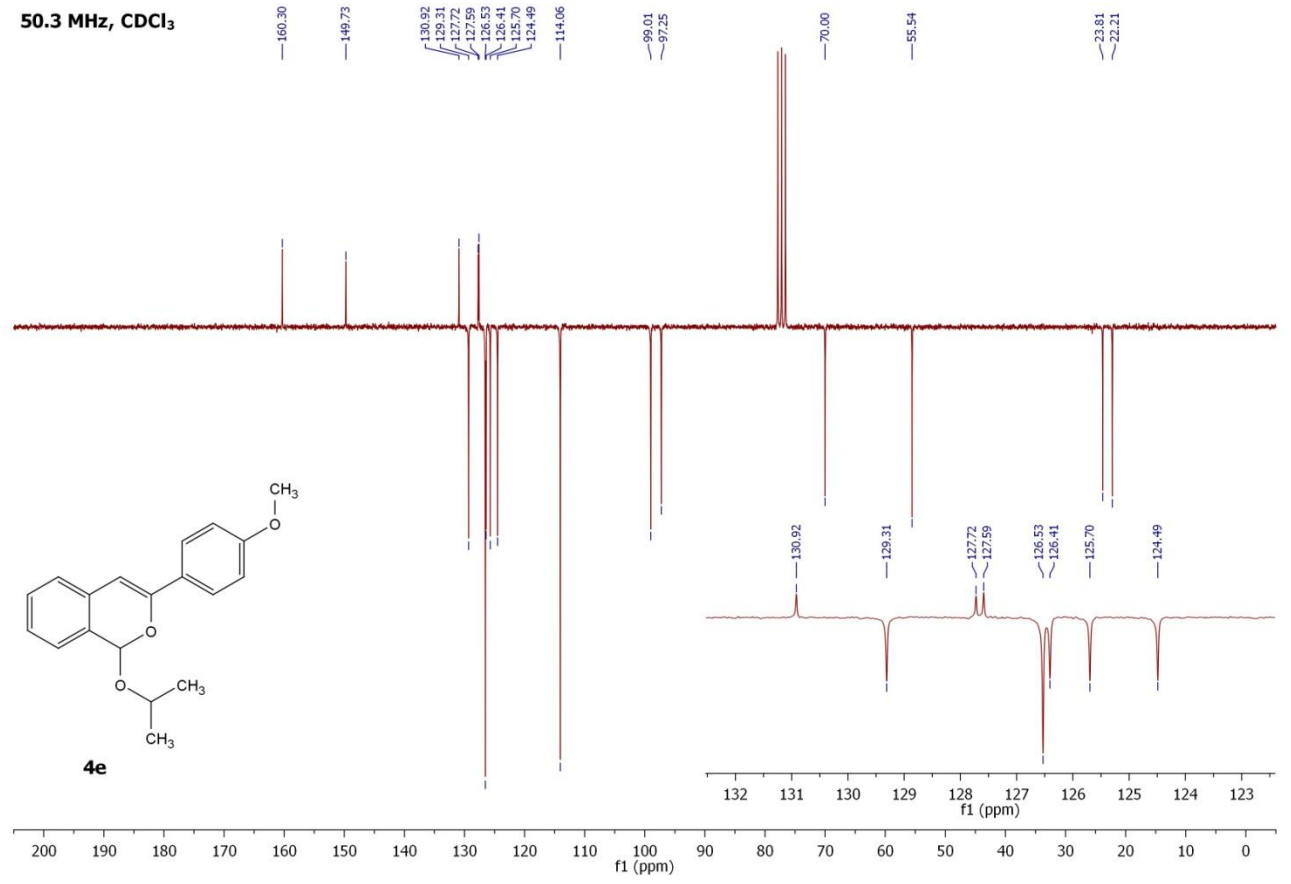

50.3 MHz, CDCl3
4c
f1 (ppm)

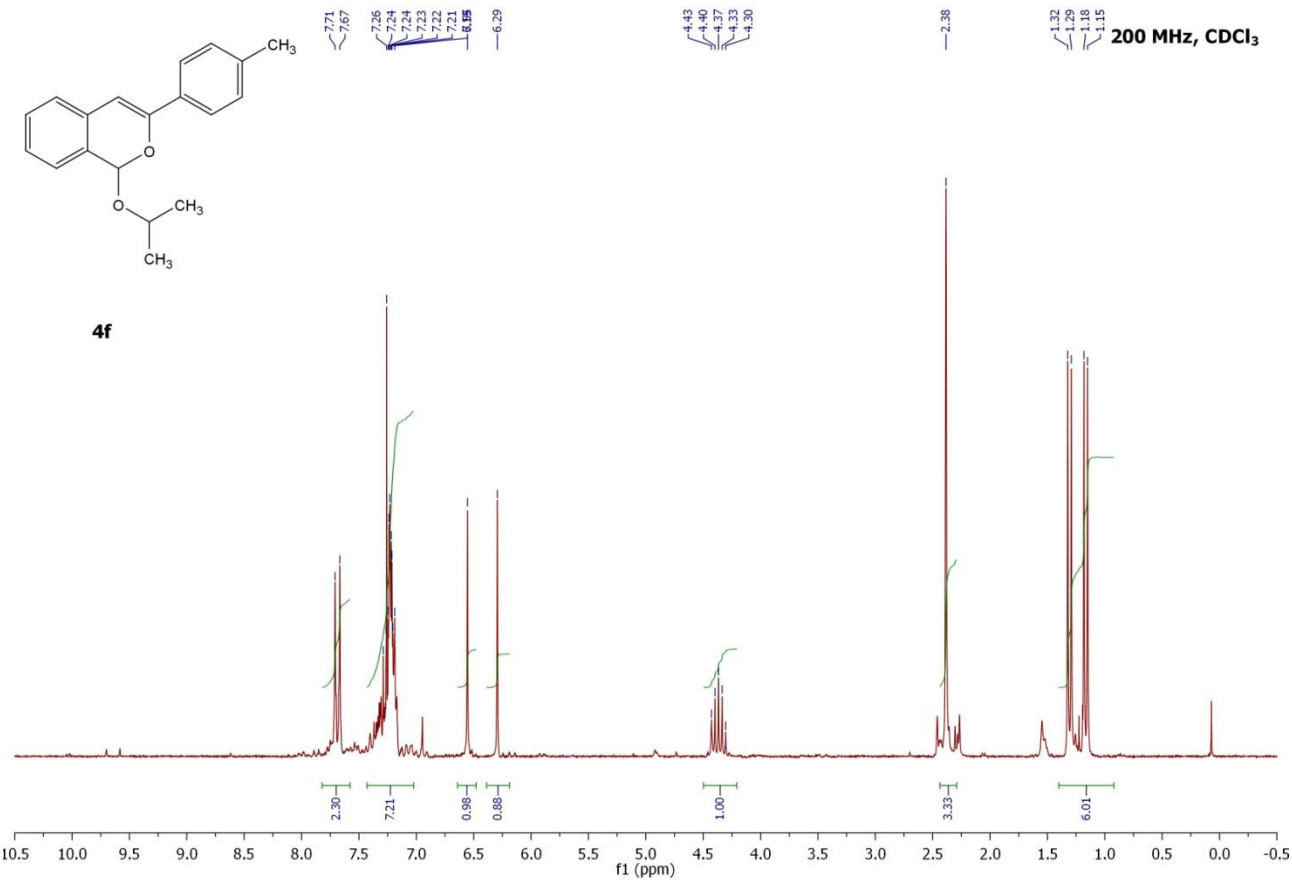

4d
After simple work-up
200 MHz, CDCl3
f1 (ppm)

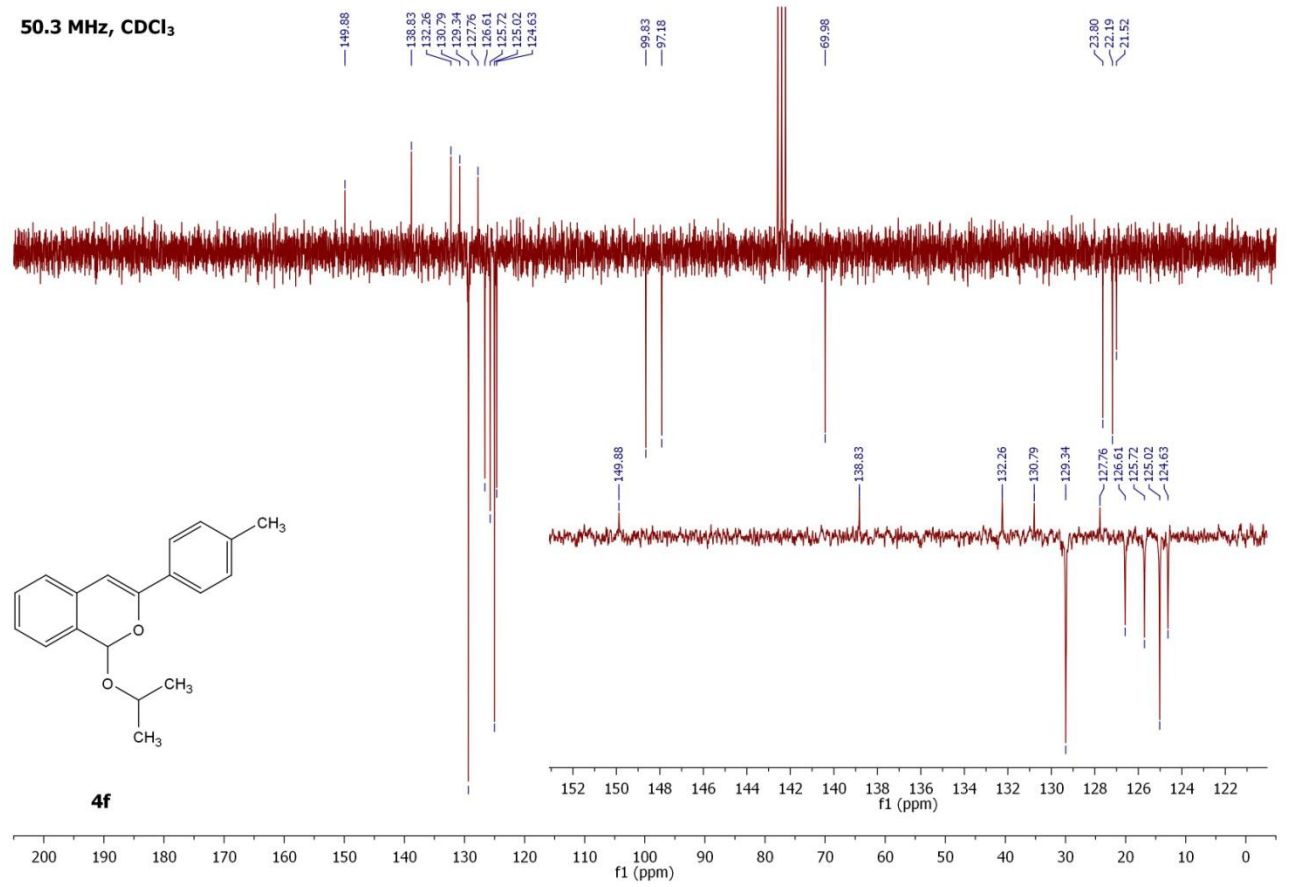

4d
After column chromatography
200 MHz, CDCl3
f1 (ppm)

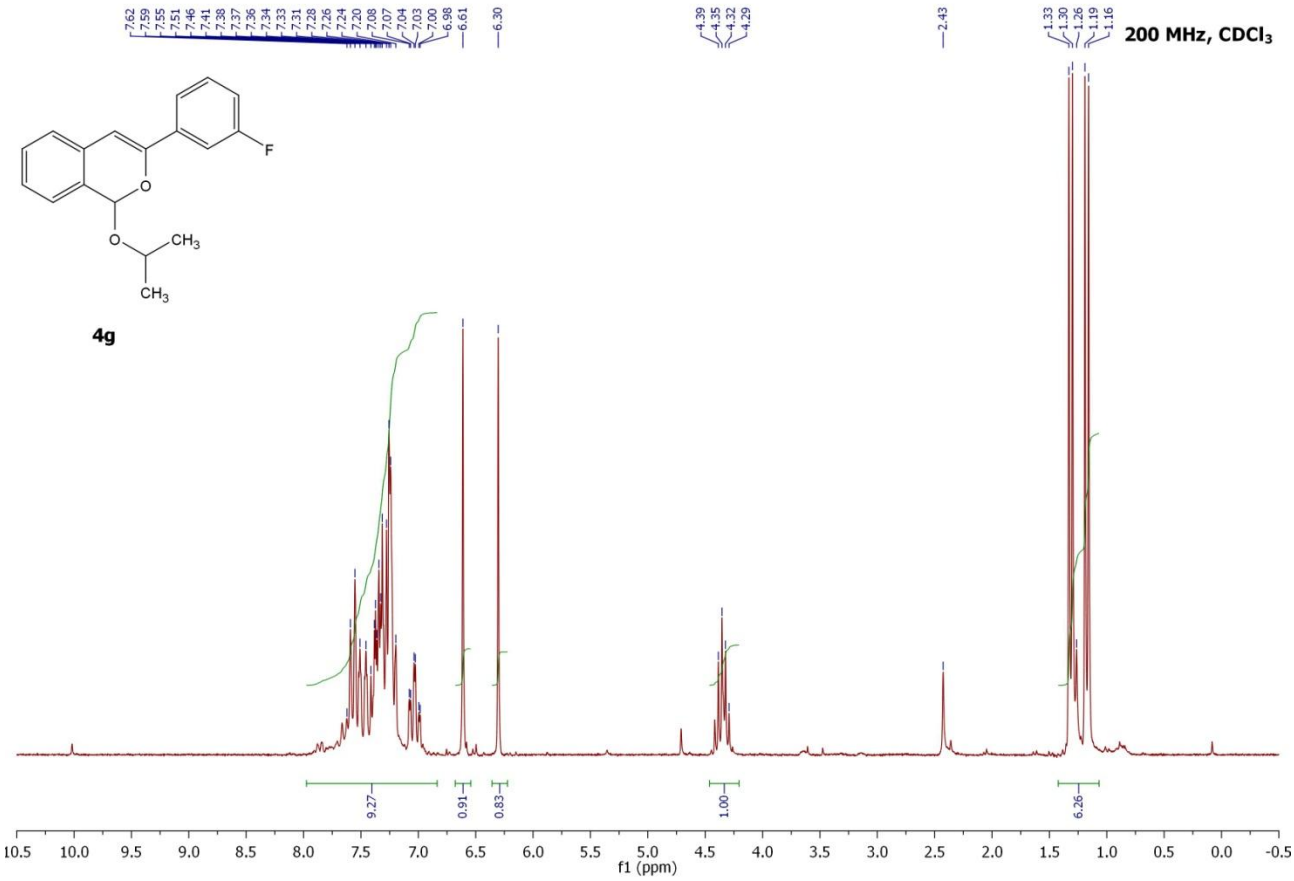

4d
50.3 MHz, CDCl3
f1 (ppm)

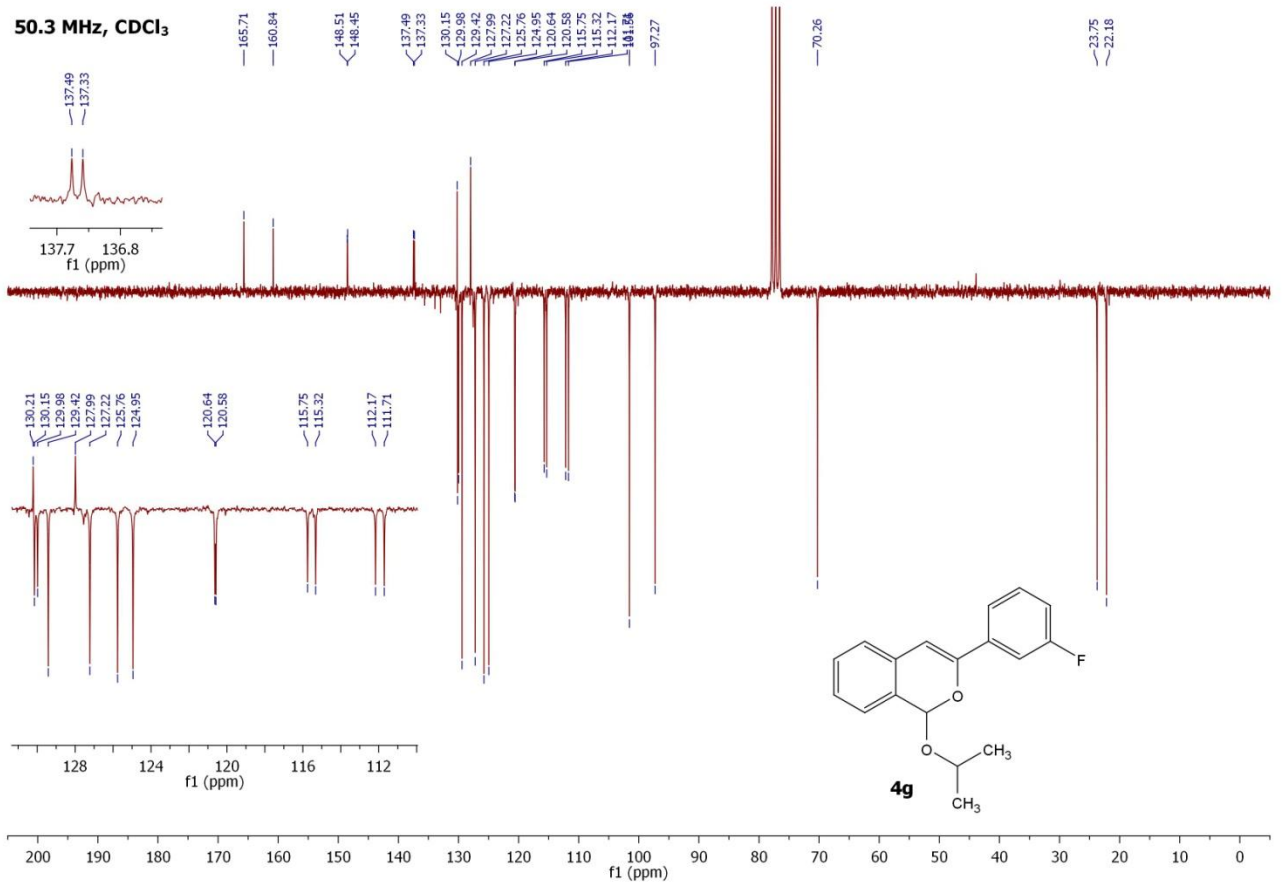

200 MHz, CDCl3
4e
f1 (ppm)

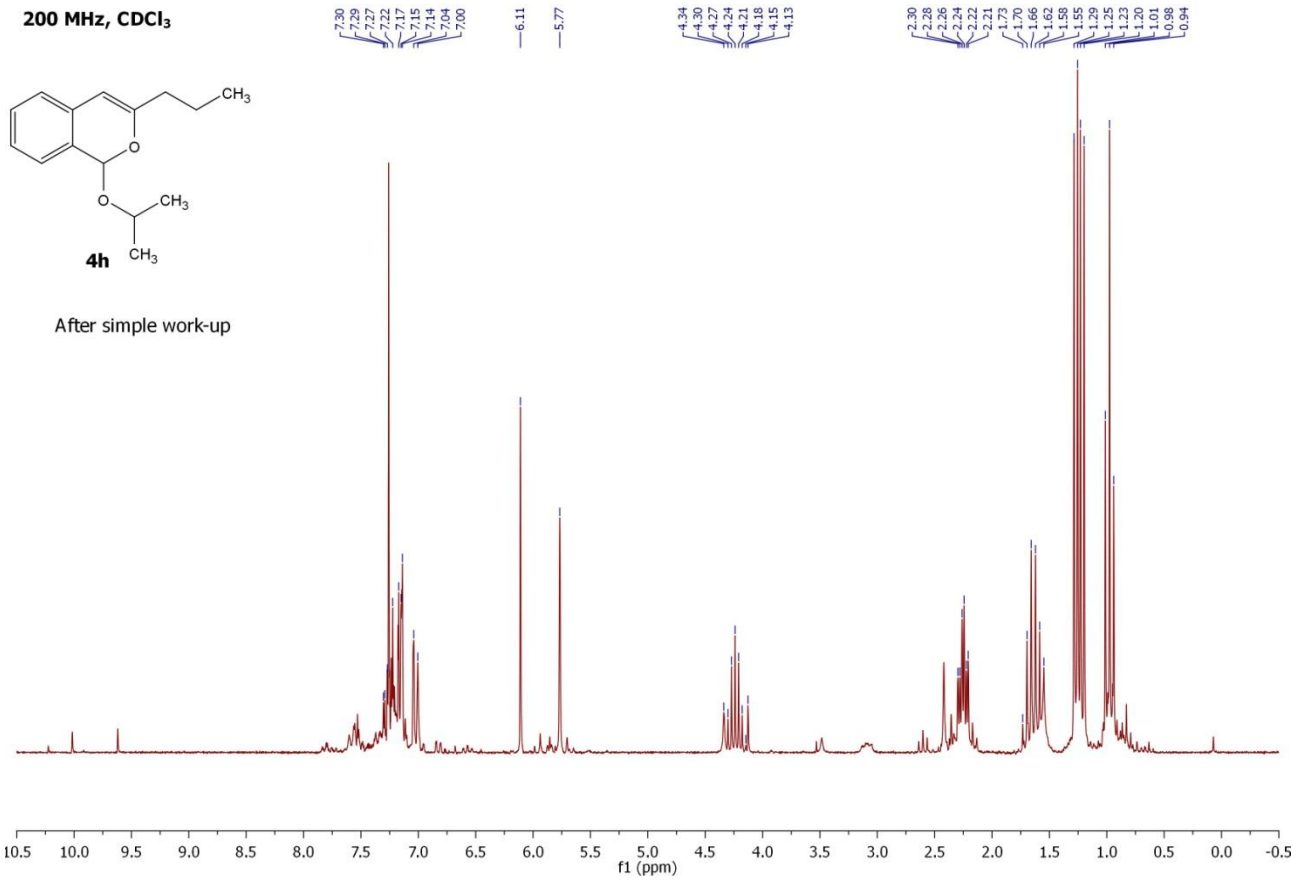

50.3 MHz, CDCl3
4e
f1 (ppm)

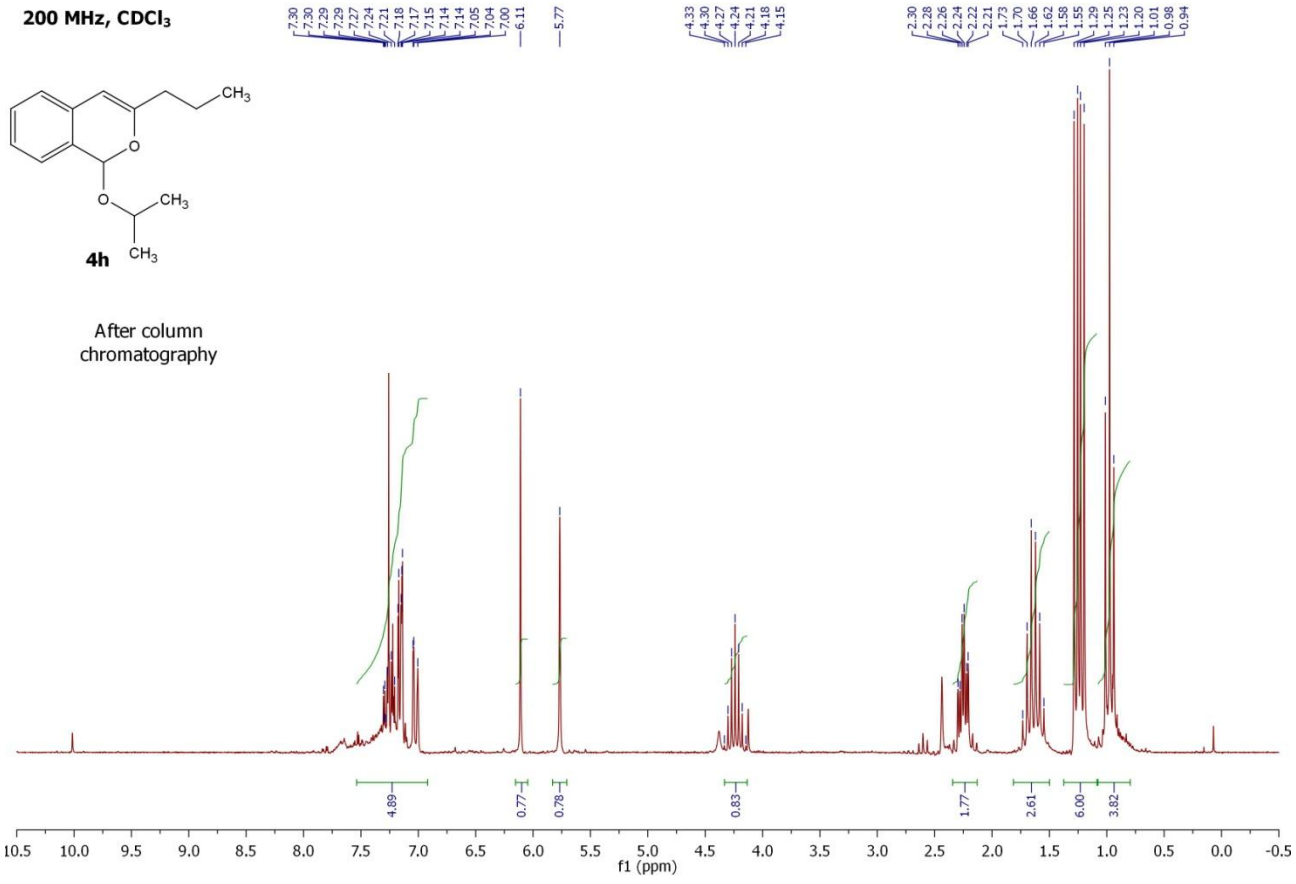

200 MHz, CDCl3
4f
f1 (ppm)

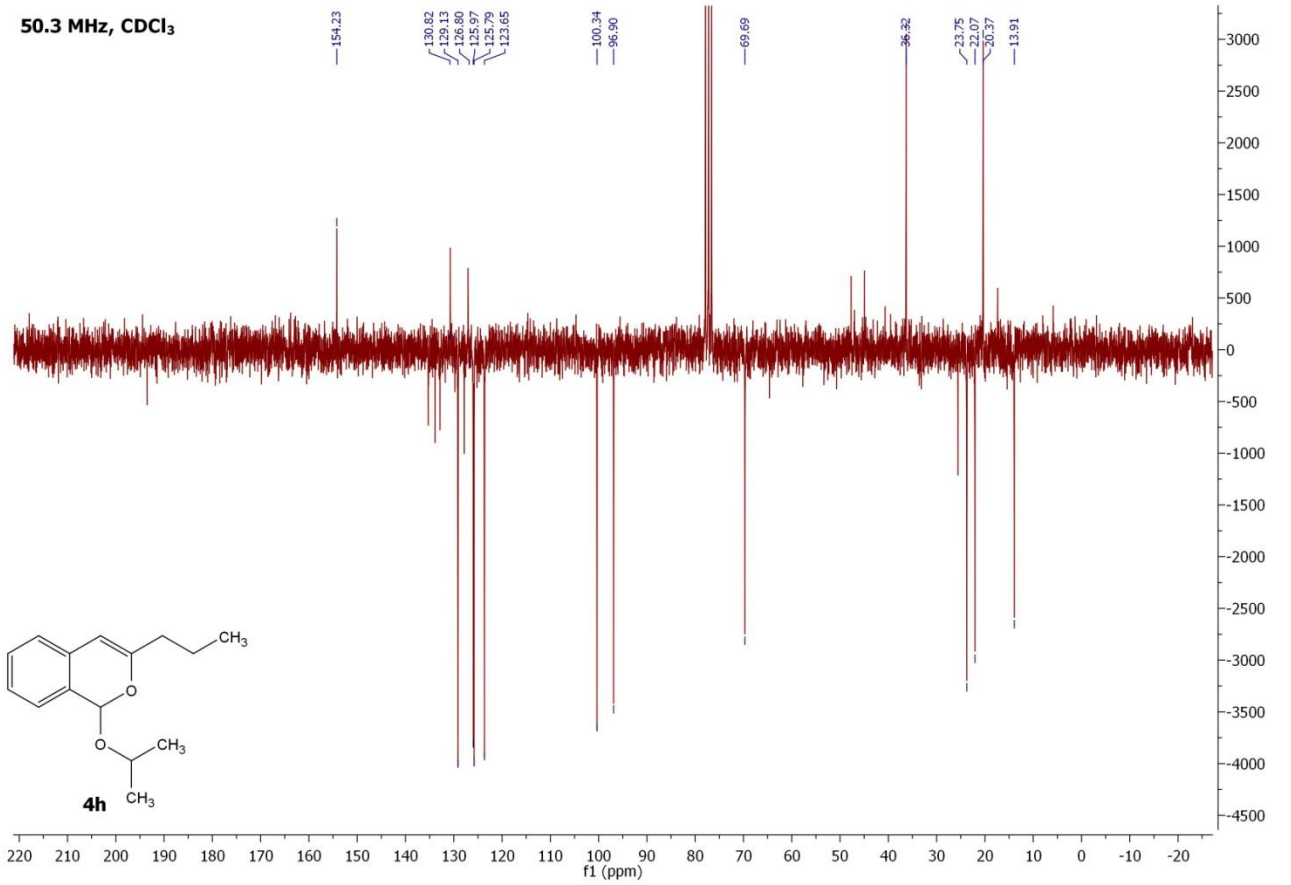

50.3 MHz, CDCl3
4f
f1 (ppm)

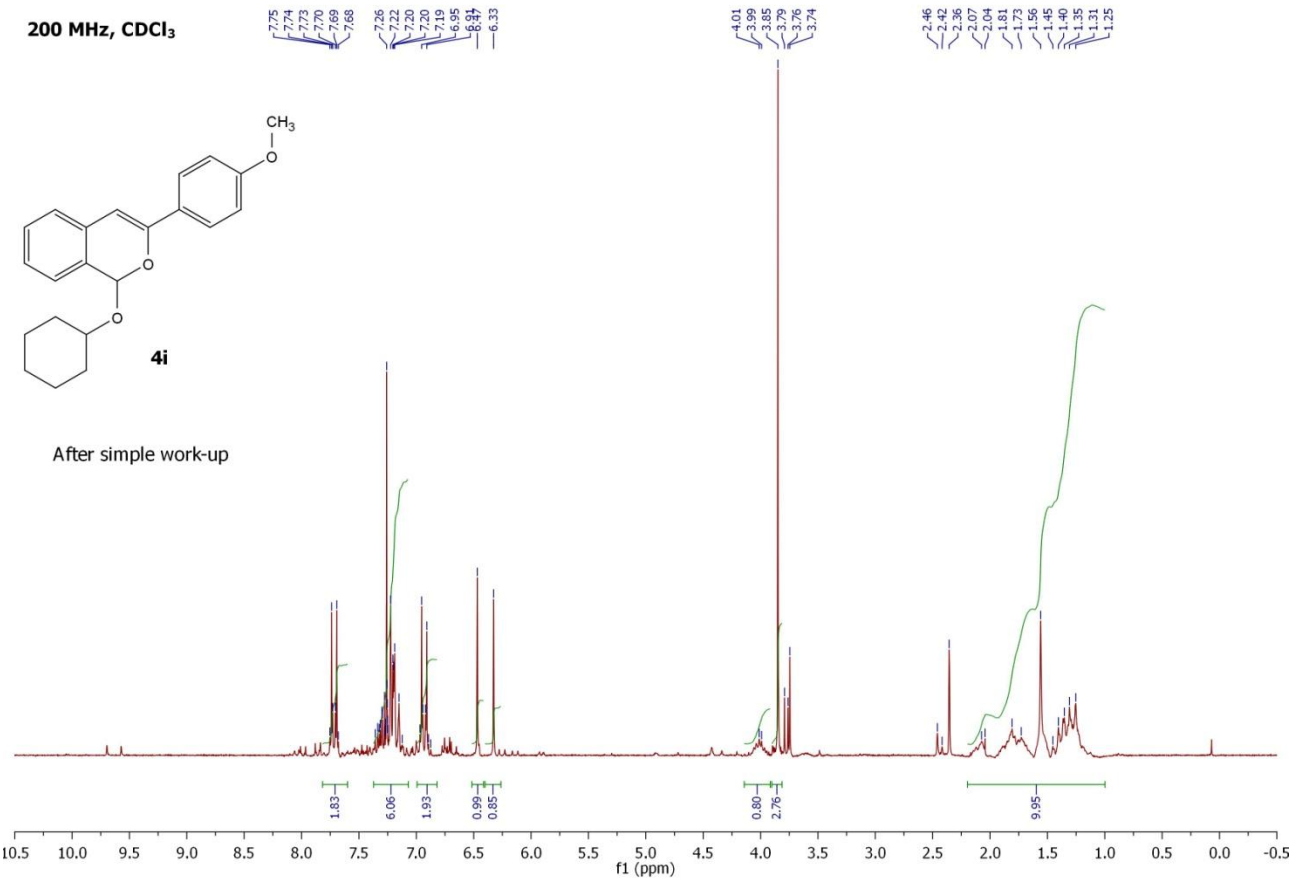

200 MHz, CDCl3
4g
9.27
0.91
0.83
1.00
6.26
f1 (ppm)

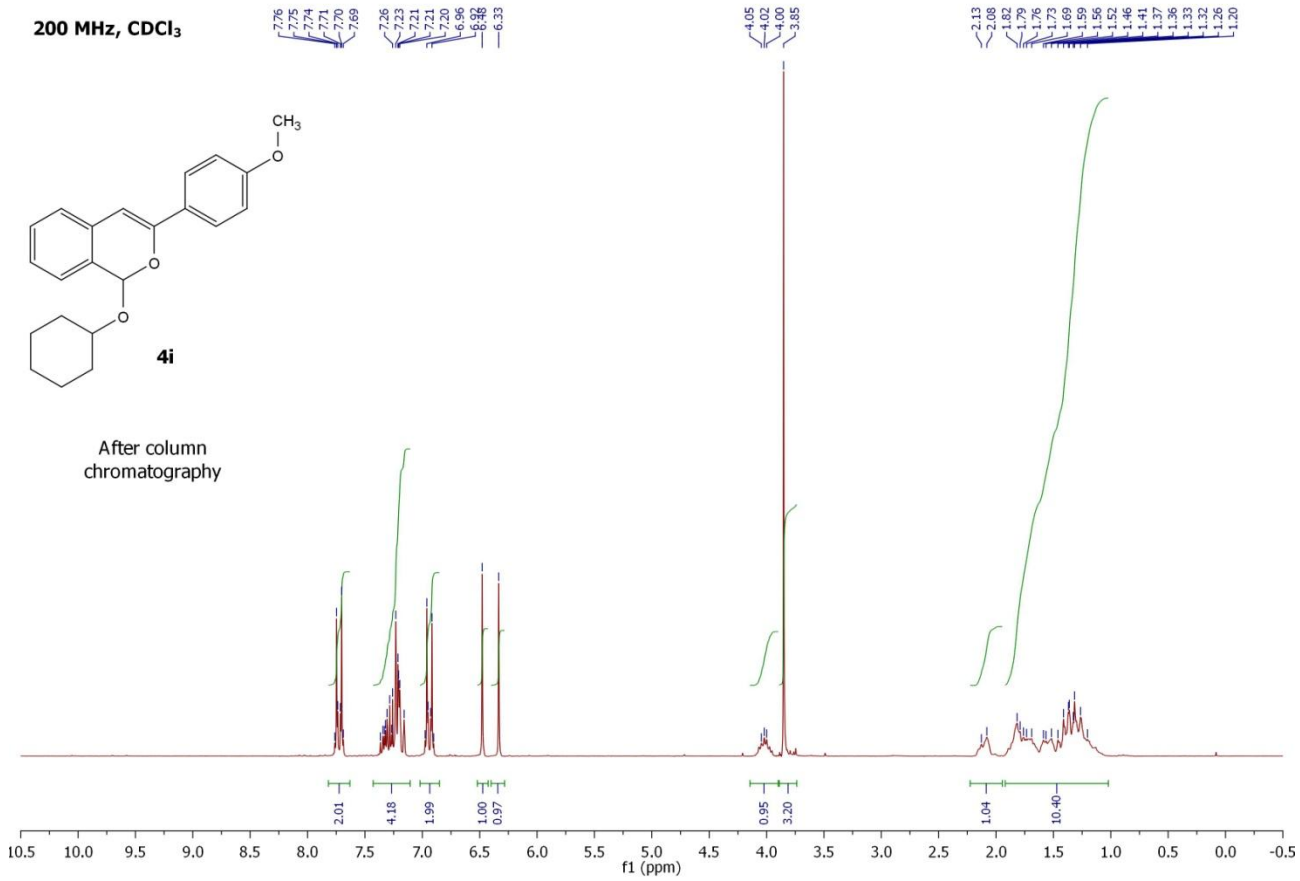

50.3 MHz, CDCl3
4g
f1 (ppm)

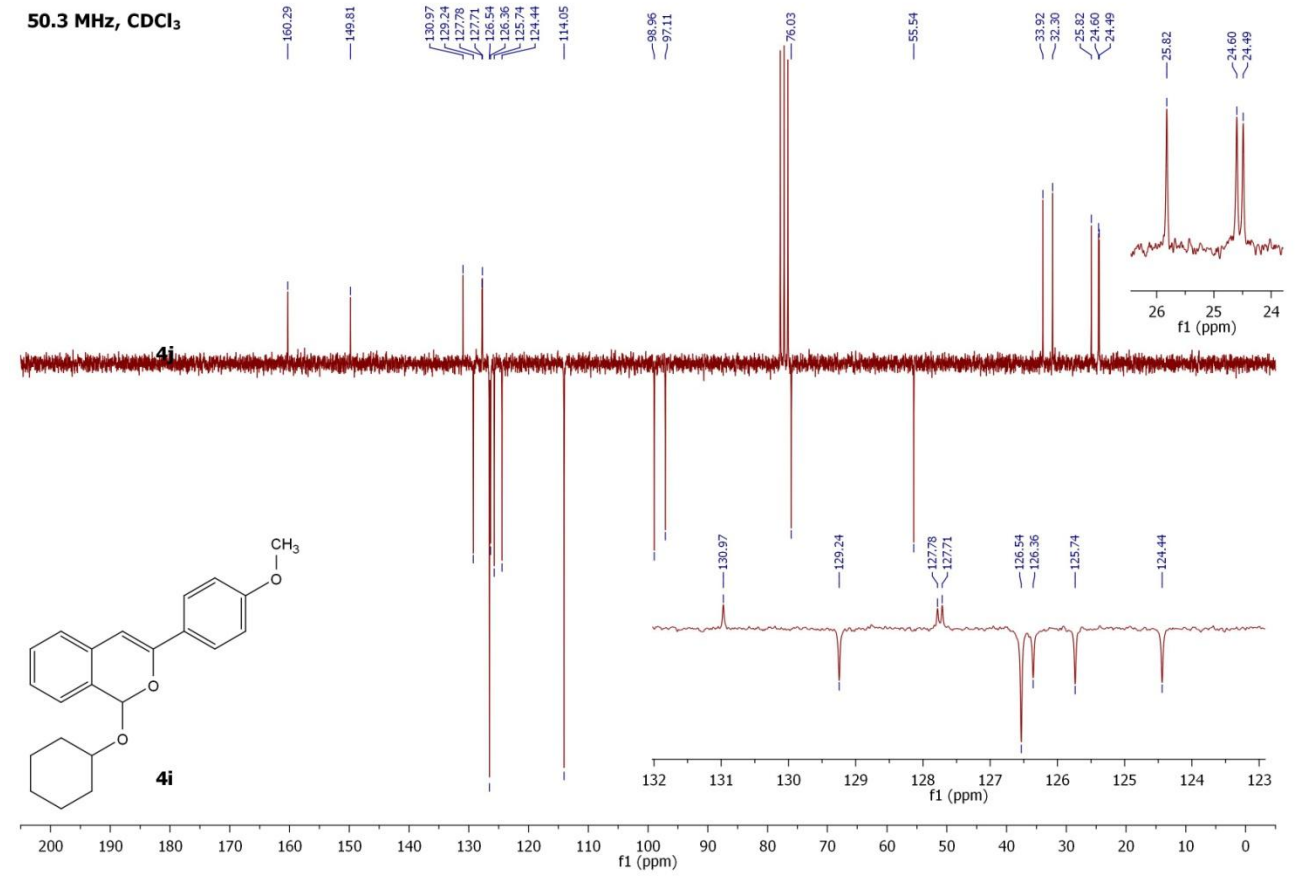

200 MHz, CDCl3
4h
After simple work-up
f1 (ppm)

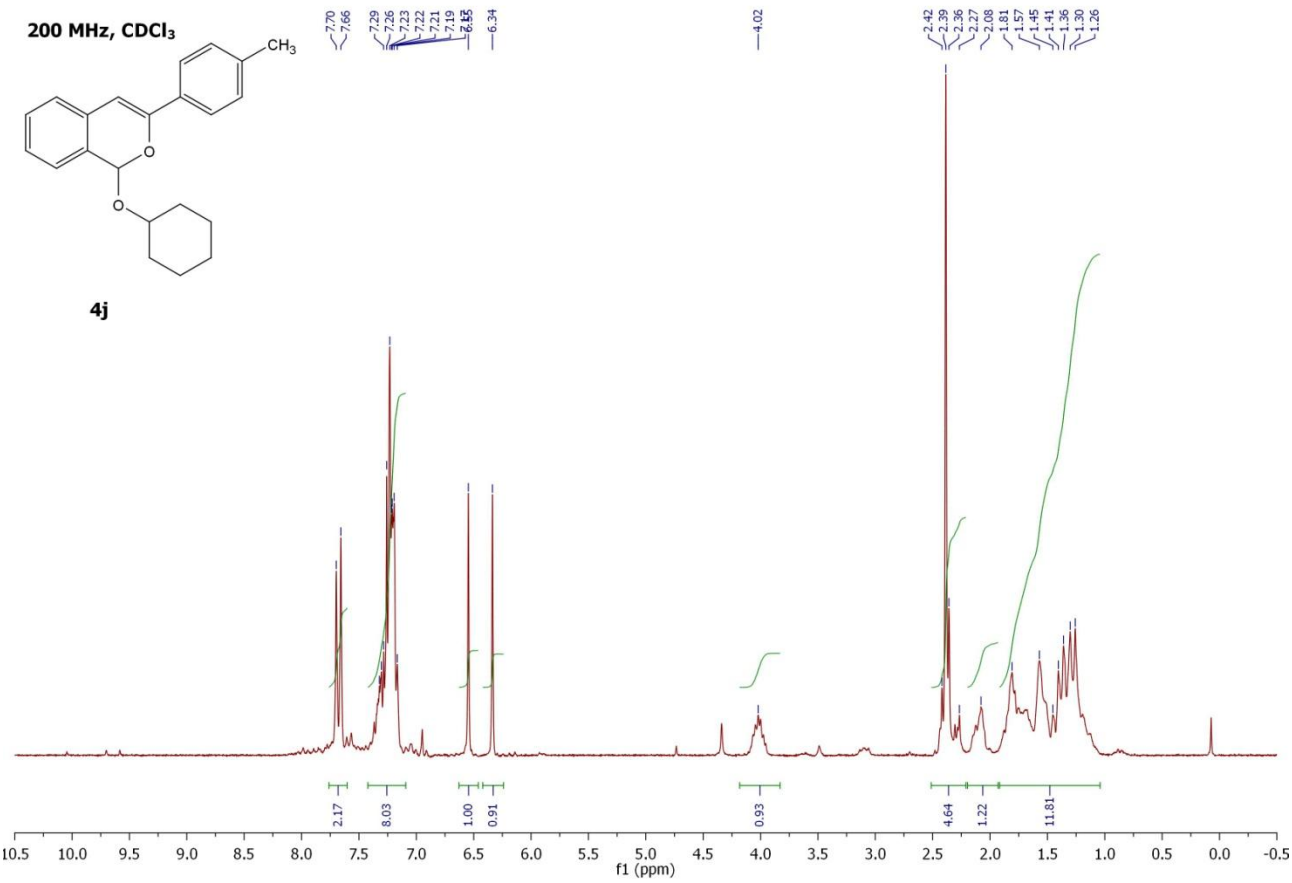

200 MHz, CDCl3
4h
After column chromatography
f1 (ppm)

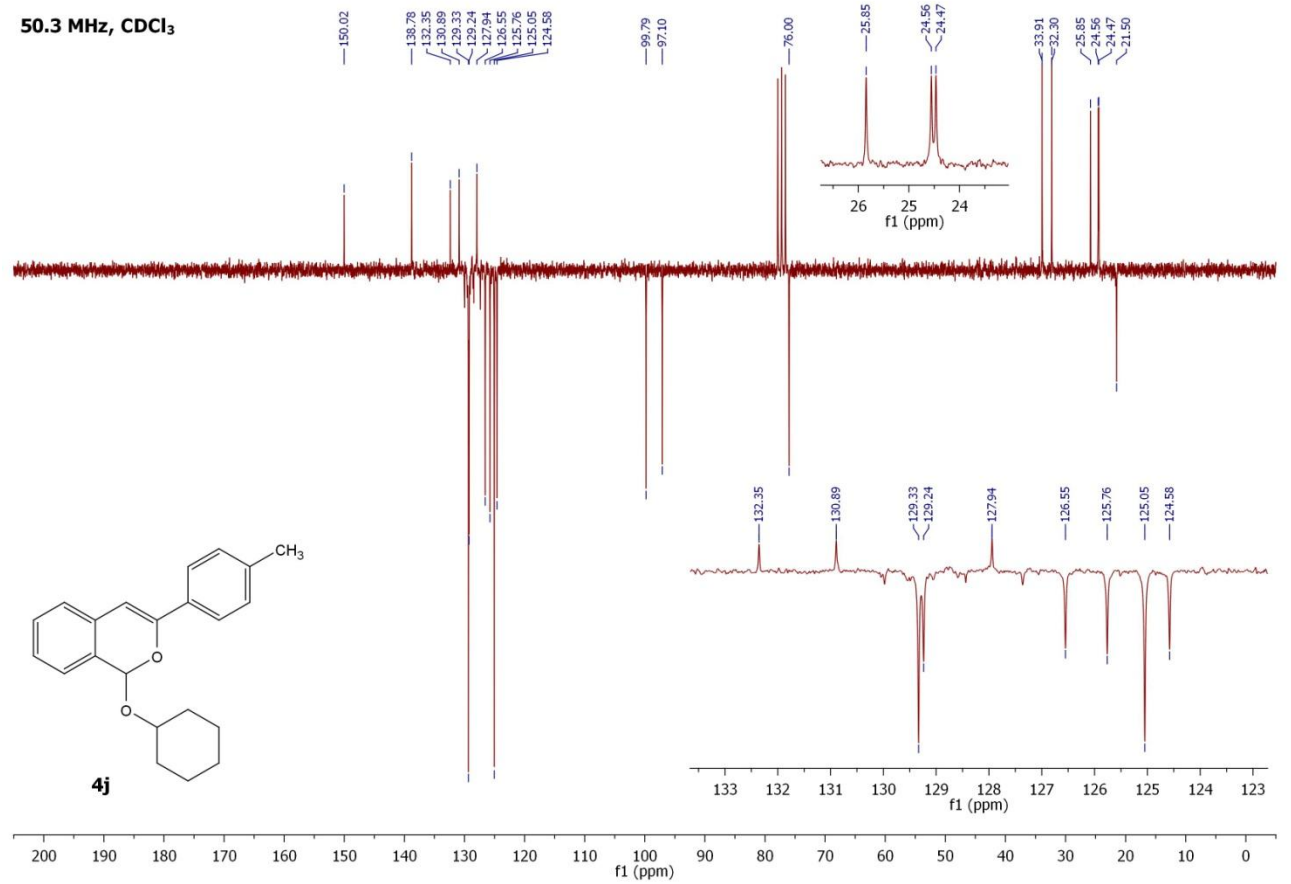

50.3 MHz, CDCl3
154.23
130.82
129.13
126.80
125.97
125.79
123.65
100.34
96.90
69.69
36.32
23.75
22.07
20.37
13.91
CH3
O
O
CH3
CH3
4h
f1 (ppm)


200 MHz, CDCl3
7.75
7.74
7.73
7.70
7.69
7.68
7.26
7.22
7.20
7.20
7.19
6.95
6.34
6.33
4.01
3.99
3.85
3.79
3.76
3.74
2.46
2.42
2.36
2.07
2.04
1.81
1.73
1.56
1.45
1.40
1.35
1.31
1.25
CH3
O
O
O
4i
After simple work-up
1.83
6.06
1.93
0.99
0.85
0.80
2.76
9.95
f1 (ppm)

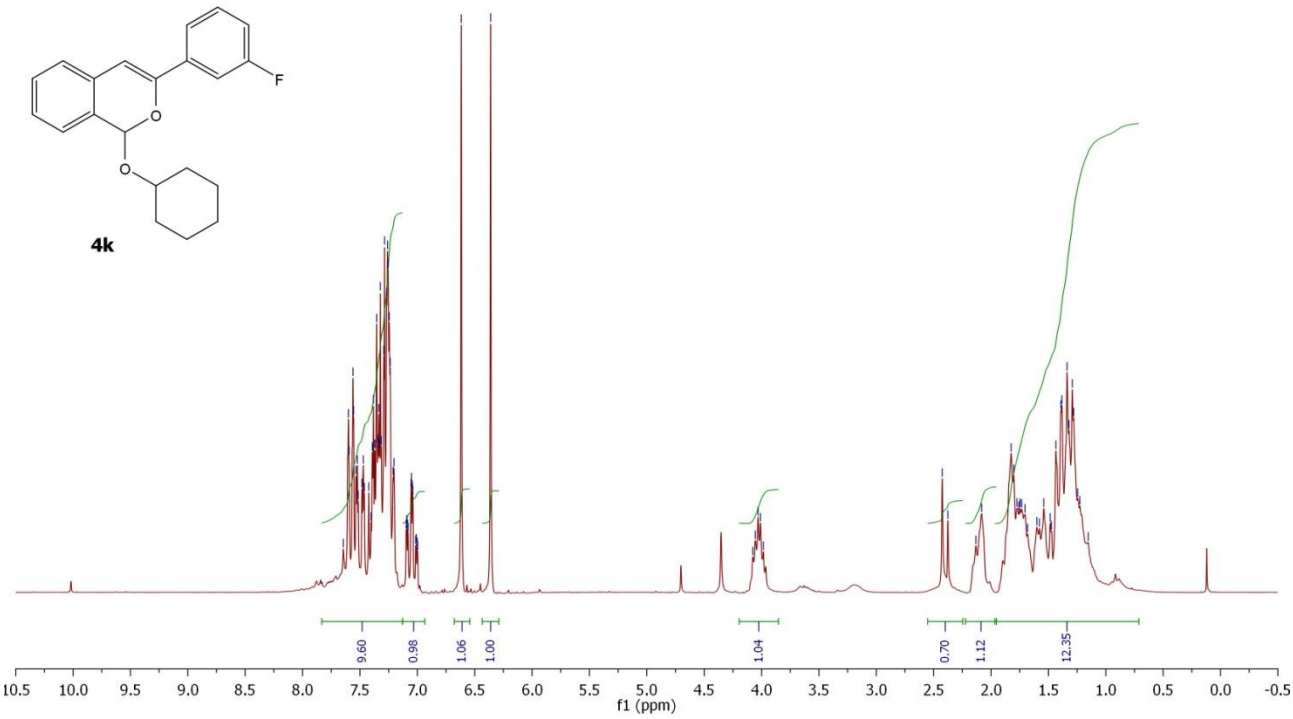

200 MHz, CDCl3
4i
After column chromatography
f1 (ppm)


50.3 MHz, CDCl3
4i
f1 (ppm)

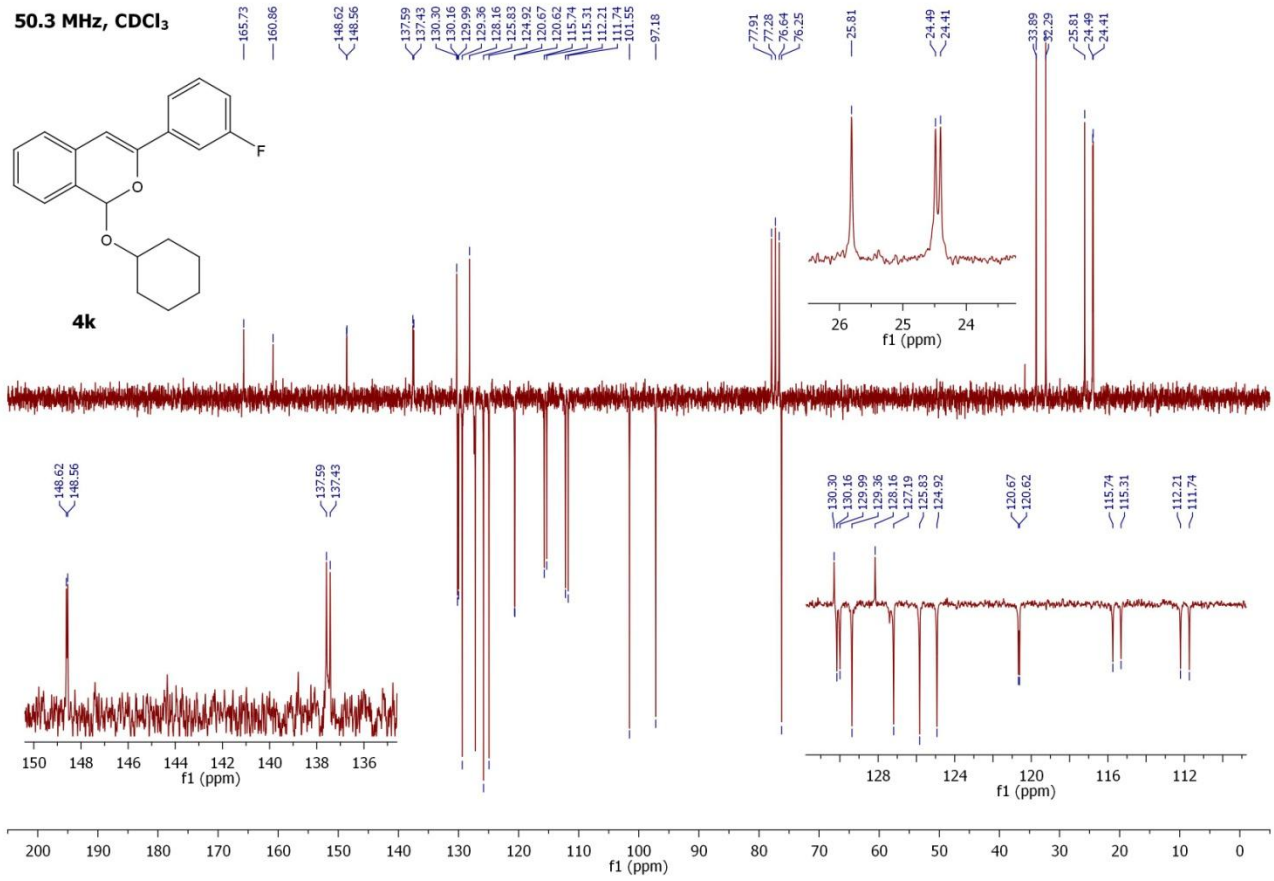

200 MHz, CDCl3
CH3
O
O
4j
7.70
7.66
7.29
7.26
7.23
7.22
7.21
7.19
6.34
4.02
2.42
2.39
2.36
2.27
2.08
1.81
1.57
1.45
1.41
1.36
1.30
1.26
2.17
8.03
1.00
0.91
0.93
4.64
1.22
11.81
f1 (ppm)

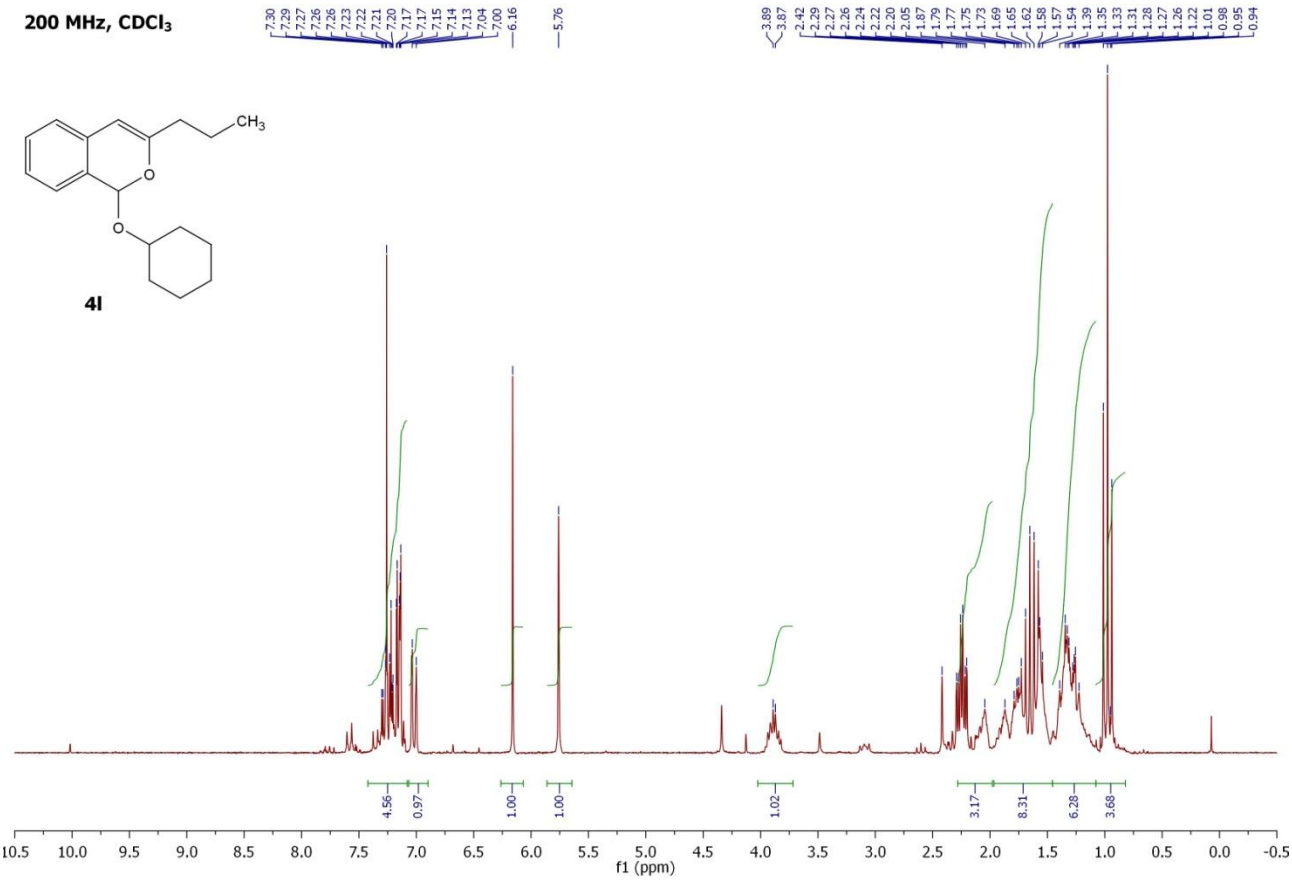

50.3 MHz, CDCl3
150.02
138.78
132.35
130.89
129.33
129.24
127.94
126.55
125.76
125.05
124.58
99.79
97.10
76.00
25.85
24.56
24.47
33.91
32.30
25.85
24.56
24.47
21.50
f1 (ppm)
CH3
O
O
4j
f1 (ppm)

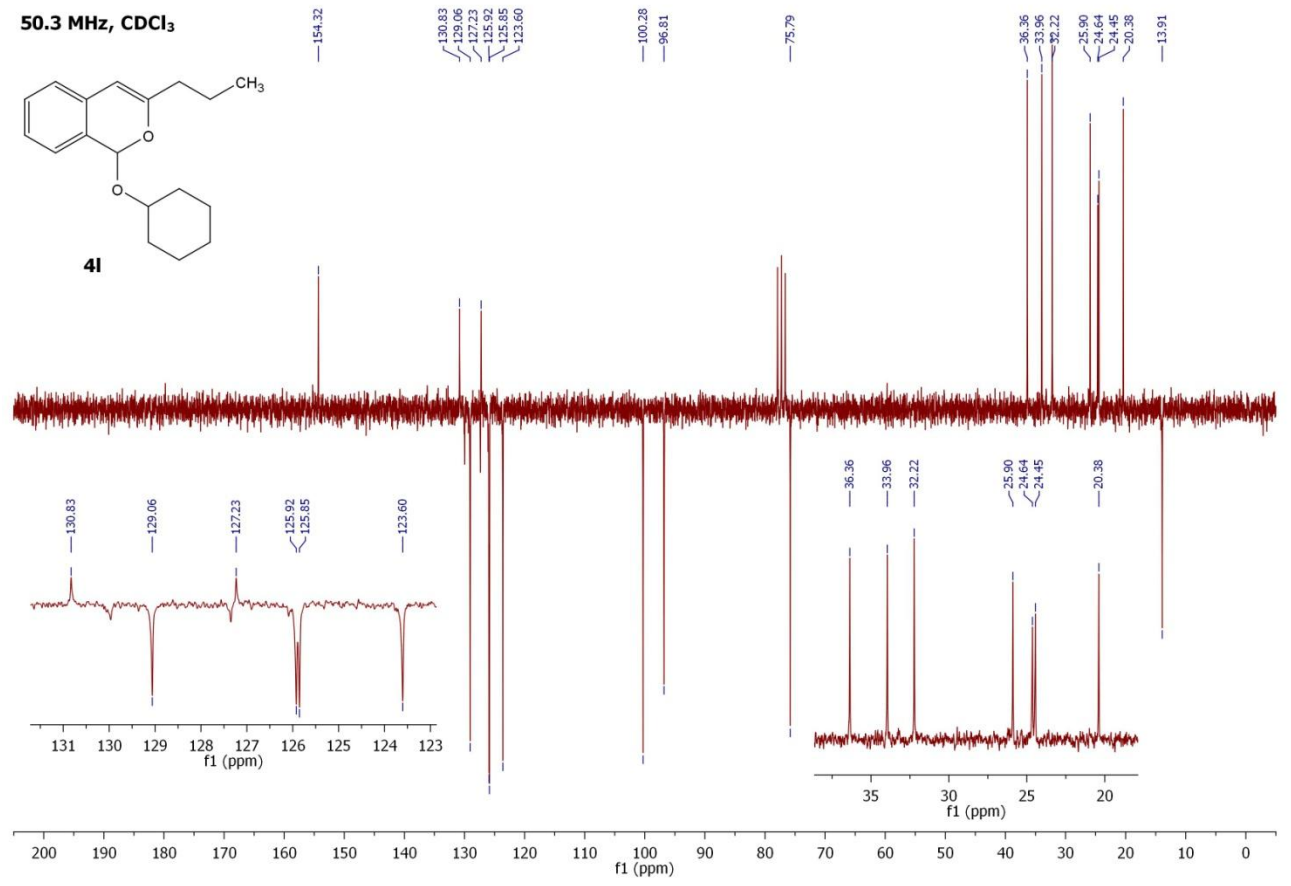
**200 MHz, $CDCl_3$**

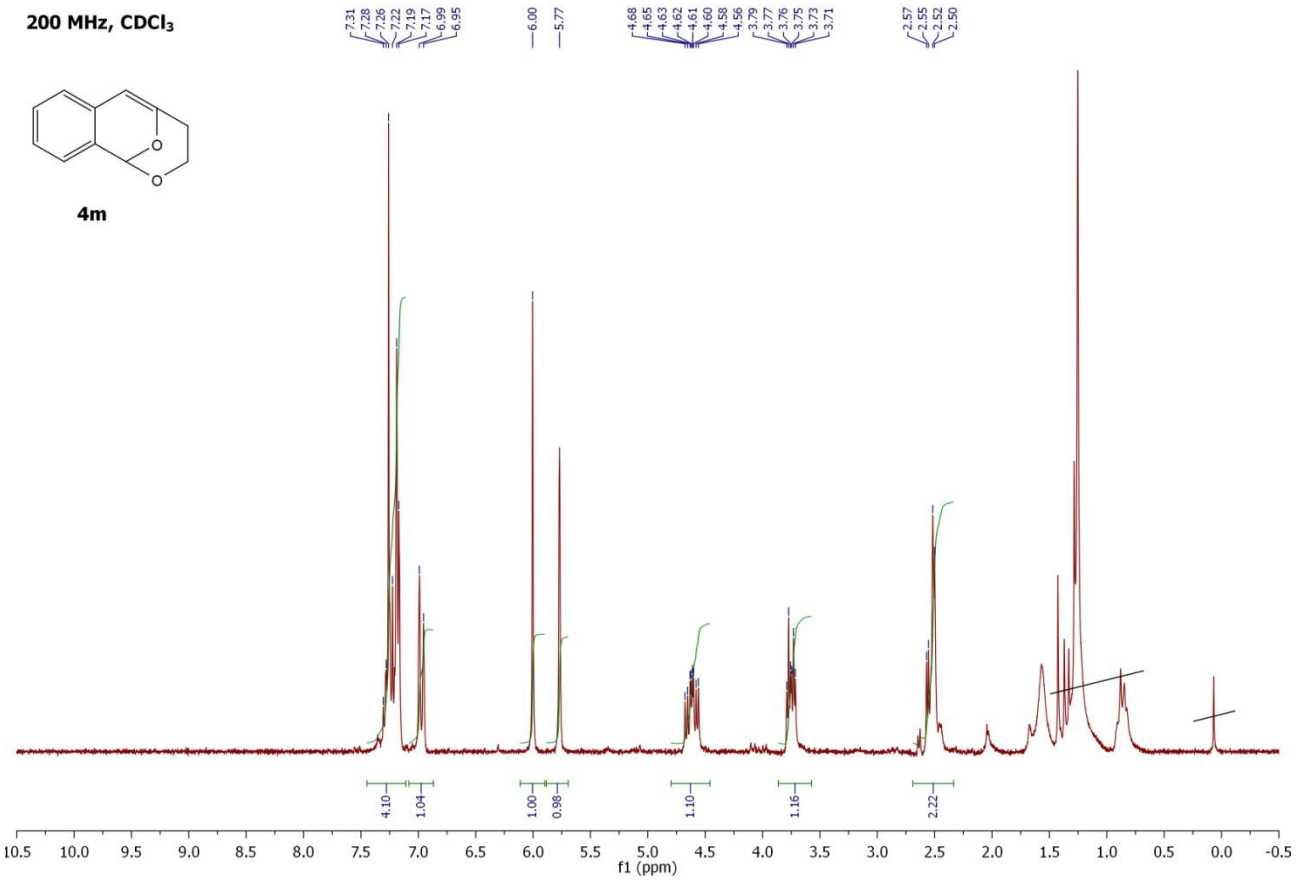


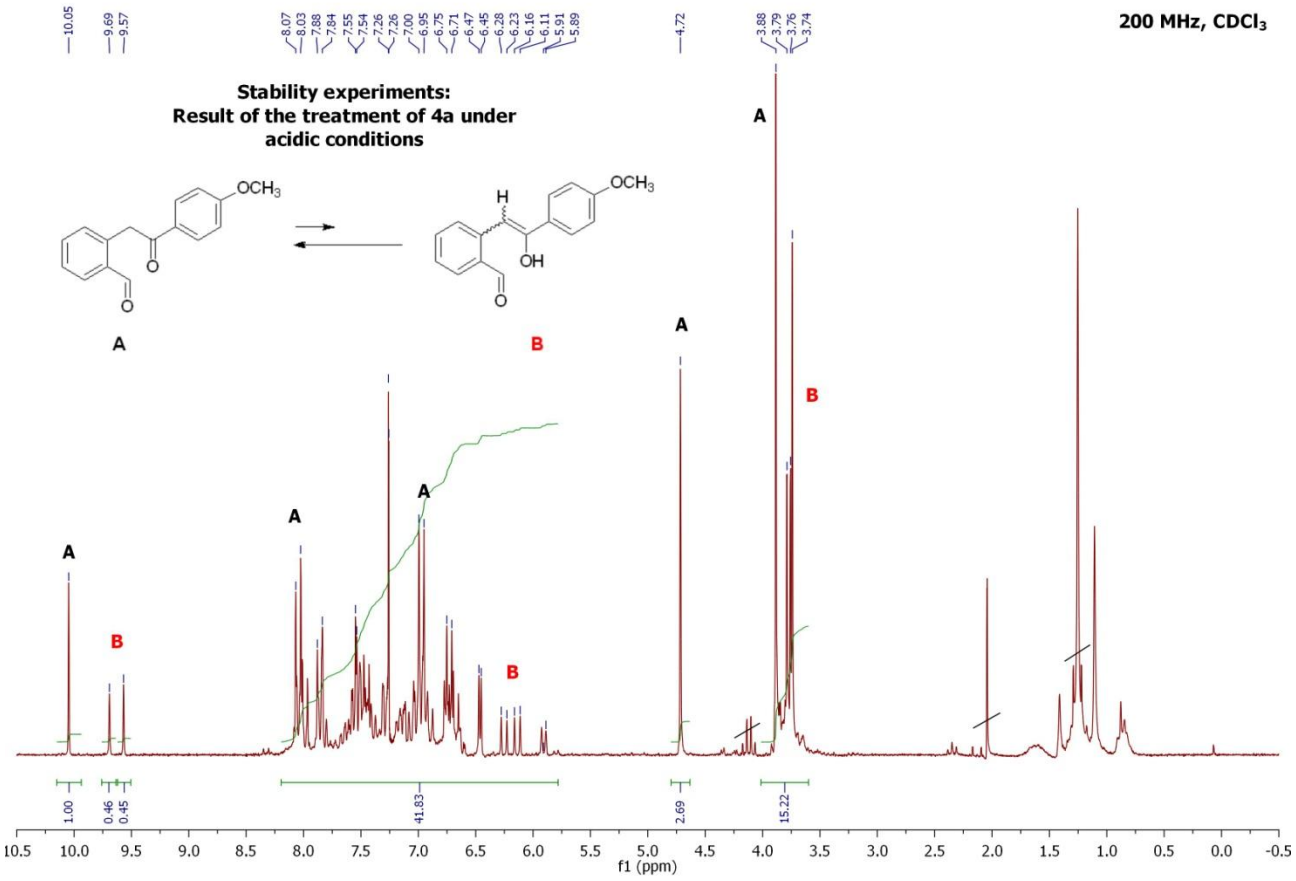

**50.3 MHz, $CDCl_3$**



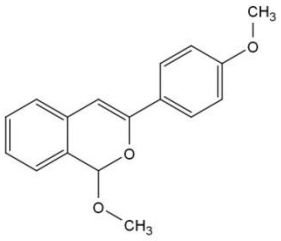

200 MHz, CDCl3
CH3
O
O
4l
7.30 7.29 7.27 7.26 7.26 7.23 7.22 7.21 7.20 7.17 7.17 7.15 7.14 7.13 7.04 7.00 6.16 5.76
3.89 3.87 2.42 2.29 2.27 2.26 2.24 2.22 2.20 2.05 1.87 1.79 1.77 1.75 1.73 1.69 1.65 1.62 1.58 1.57 1.54 1.39 1.35 1.33 1.31 1.28 1.27 1.26 1.22 1.01 0.98 0.95 0.94
4.56 0.97 1.00 1.00 1.02 3.17 8.31 6.28 3.68
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 0.0 -0.5
f1 (ppm)


50.3 MHz, CDCl3
CH3
O
O
4l
154.32 130.83 129.06 127.23 125.92 125.85 123.60 100.28 96.81 75.79 36.36 33.96 32.22 25.90 24.64 24.45 20.38 13.91
131 130 129 128 127 126 125 124 123
f1 (ppm)
35 30 25 20
f1 (ppm)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


200 MHz, CDCl3
4m
f1 (ppm)

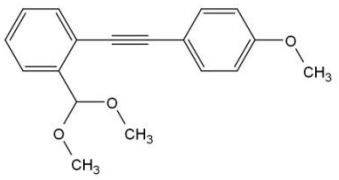

200 MHz, CDCl3
Stability experiments:
Result of the treatment of 4a under
acidic conditions
A
B
f1 (ppm)

**Stability experiments:**
**Result of the treatment of 4a under alkaline conditions**

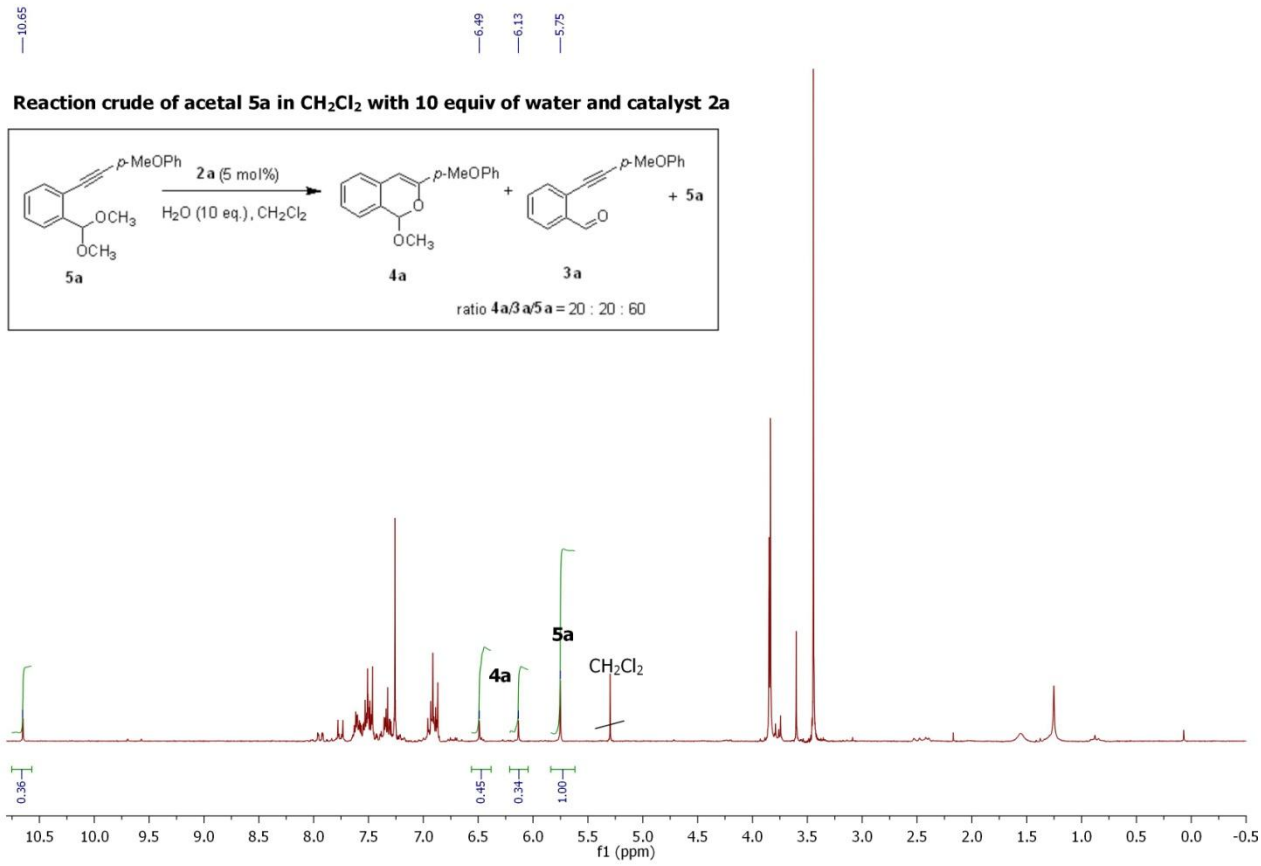


**4a**



**5a**

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