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Supporting Information

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Convenient Preparation of Polyfunctional Arylmagnesium Reagents Using a Direct Magnesium Insertion in the presence of LiCl**

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General All reactions were carried out under an argon atmosphere in flame-dried glassware. Syringes which were used to transfer anhydrous solvents or reagents were purged with argon prior to use. THF was continuously refluxed and freshly distilled from sodium benzophenone ketyl under nitrogen. Yields refer to isolated yields of compounds estimated to be >95% pure as determined by ^{1}H-NMR (25 °C) and capillary GC. Column chromatography was performed using SiO_2 (0.040 – 0.063 mm, 230 – 400 mesh ASTM) from Merck. All reagents were obtained from commercial sources. *O*-Boc-protected phenols[1], sulfonates[2] and pivalates[3] were prepared according to literature procedures. Liquid aldehydes and acid chlorides were distilled prior to use. Magnesium turnings (> 99.5%) and magnesium powder (> 99%) were obtained from Riedel-de Haën. CuCN, $ZnCl_2$ and LiCl were obtained from Fluka.

Preparation of CuCN·2LiCl solution:

CuCN·2LiCl solution (1.0 M in THF) was prepared by drying CuCN (7.17 g, 80 mmol) and LiCl (6.77 g, 160 mmol) in a Schlenk tube under vacuum at 140 °C for 5 h. After cooling, 80 mL dry THF was added and stirring was continued until all salts were dissolved.

Preparation of $ZnCl_2$ solution:

$ZnCl_2$ solution (1.0 M in THF) was prepared by drying $ZnCl_2$ (136.3 g, 100 mmol) in a Schlenk flask under vacuum at 140 °C for 5 h. After cooling, 100 mL dry THF was added and stirring was continued until all salts were dissolved.

Preparation of LiCl solution:

LiCl solution (0.5 M in THF) was prepared by drying LiCl (5.25 g, 125 mmol) in a Schlenk flask under vacuum at 140 °C for 5 h. After cooling, 250 mL dry THF was added and stirring was continued until all salts were dissolved.

Typical Procedure for the magnesium insertion (TP1):

A dry and argon-flushed *Schlenk*-flask, equipped with a magnetic stirrer and a septum, was charged with magnesium turnings (122 mg, 5 mmol). LiCl[4] (5.0 mL, 0.5 M in THF, 2.5 mmol) was added and the magnesium was activated with DIBAL-H (0.2 mL, 0.1 M in THF, 0.02 mmol). After 5 min of stirring the aryl chloride or bromide (2.0 mmol) was added in one portion at the given temperature. The reaction mixture was stirred for the indicated time and then canulated to a new *Schlenk*-flask for the reaction with an electrophile.

Typical procedure for cross-coupling reactions (TP2):

$ZnCl_2$ (2.0 mL, 1.0 M in THF, 2.0 mmol) was added to the freshly prepared magnesium reagent and the reaction mixture was stirred for 15 minutes (Zinc reagents were used directly). $Pd(dba)_2$ (23 mg, 2 mol%) and tfp (19 mg, 4 mol %) were added, followed by the addition of the corresponding aryl iodide (1.4 mmol), and the reaction mixture was stirred for the given time at 25 °C. The reaction was quenched with sat. NH_4Cl solution (10 mL) and extracted with Et_2O (3x 10 mL). The combined organic layers were dried over Na_2SO_4 and concentrated in vacuo. The crude residue was purified by flash column chromatography.

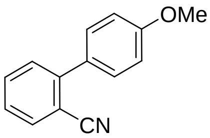
Typical procedure for acylations and allylations (TP3):

CuCN·2LiCl (0.4 mL, 1.0 M in THF, 20 mol %) was added to the freshly prepared magnesium or zinc reagent and the reaction mixture was stirred for 15 minutes. After the addition of the corresponding acid chloride or allyl bromide (1.4 mmol) the reaction mixture was stirred for the given time at 25 °C. The reaction was quenched with sat. NH_4Cl solution (10 mL) and extracted with Et_2O (3x 10 mL). The combined organic layers were dried over Na_2SO_4 and concentrated in vacuo. The crude residue was purified by flash column chromatography.

Typical Procedure for the magnesium insertion in the presence of $ZnCl_2$ (TP4):

A dry and argon-flushed *Schlenk*-flask, equipped with a magnetic stirrer and a septum, was charged with LiCl[4] (127 mg, 3.0 mmol) and was heated under vacuum until dry. $ZnCl_2$ (300 mg, 2.2 mmol) was added and also heated under vacuum until dry. Magnesium powder (78 mg, 3.2 mmol) and 3 mL THF were added and the magnesium was activated with DIBAL-H (0.2 mL, 0.1 M in THF, 0.02 mmol). After 5 min of stirring the aryl bromide (2.0 mmol) was added in one portion at the given temperature. The reaction mixture was stirred for the given time and then canulated to a new *Schlenk*-flask for the reaction with an electrophile.

3a:



The magnesium reagent **2a** was prepared according to **TP1** from 2-bromo benzonitrile (**1a**, 364 mg, 2.0 mmol) in 30 min at 25 °C. A cross-coupling reaction was performed according to **TP2** with 4-iodoanisole (328 mg, 1.4 mmol) in 3 h. Flash column chromatography (pentane/Et_2O = 20:1 → 6:1) furnished **3a** as a light yellow solid (249 mg, 85 %).

The magnesium reagent **2a** was prepared according to **TP1** from 2-chloro benzonitrile (275 mg, 2.0 mmol) in 45 min at 25 °C. A cross-coupling reaction was performed according to **TP2** with 4-iodoanisole (328 mg, 1.4 mmol) in 3 h. Flash column chromatography (pentane/Et_2O = 20:1 → 6:1) furnished **3a** as a light yellow solid (214 mg, 73 %).

m.p.: 66 – 69 °C

^{1}H-NMR (300 MHz, $CDCl_3$) δ: 7.73 (d, J = 8 Hz, 1H), 7.61 (dt, J = 8 Hz, J = 1 Hz, 1H), 7.53-7.47 (m, 3H), 7.39 (dt, J = 8 Hz, J = 1 Hz, 1H), 7.01 (d, J = 8 Hz, 2H), 3.85 (s, 3H).

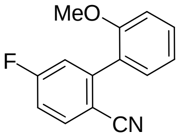
^{13}C-NMR (75 MHz, $CDCl_3$) δ: 160.1, 145.2, 133.7, 132.8, 130.5, 130.0, 129.9, 127.0, 119.0, 114.2, 111.1, 55.4.

MS (70 eV, EI) m/z (%): 209 (100) [M^+], 166 (45), 131 (49).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 2981, 2835, 2213, 1609, 1511, 1477, 1433, 1245, 1181, 1033, 834.

HRMS (EI) for $C_{14}H_{11}NO$ (209.0841): 209.0840.

3b:



The magnesium reagent **2b** was prepared according to **TP1** from 2-bromo-4-fluoro-benzonitrile (**1b**, 398 mg, 2.0 mmol) in 45 min at 25 °C. A cross-coupling reaction was performed according to **TP2** with 2-iodoanisole (328 mg, 1.4 mmol) in 3 h. Flash column chromatography (pentane/Et_2O 20:1 → 6:1) furnished **3b** as a light yellow solid (257 mg, 81 %).

m.p.: 124 – 126 °C

^{1}H-NMR (300 MHz, $CDCl_3$) δ: 7.74 (dd, J = 9 Hz, J = 6 Hz, 1H), 7.46 (dq, J = 8 Hz, J = 2 Hz, 1H), 7.30 (dd, J = 8 Hz, J = 2 Hz, 1H), 7.22 (dd, J = 9 Hz, J = 2 Hz, 1H), 7.16-7.05 (m, 3H), 3.87 (S, 3H).

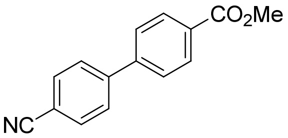
^{13}C-NMR (75 MHz, $CDCl_3$) δ: 164.3 (d, J = 256 Hz), 156.1, 145.4 (d, J = 9 Hz), 134.8 (d, J = 3 Hz), 130.5 (d, J = 14 Hz), 125.9, 120.6, 118.2 (d, J = 23 Hz), 117.7, 114.9, 114.6, 111.2, 109.4 (d, J = 3 Hz), 55.2.

MS (70 eV, EI) m/z (%): 227 (100) [M^+], 226 (28), 199 (26), 198 (34).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 3036, 2895, 2224, 1605, 1474, 1258, 1214, 1181, 1030, 938, 832.

HRMS (EI) for $C_{14}H_{10}FNO$ (227.0746): 227.0728.

3c:



The magnesium reagent **2c** was prepared according to **TP1** from 4-bromo benzonitrile (**1c**, 362 mg, 2.0 mmol) in 2 h at 25 °C. A cross-coupling reaction was performed according to **TP2** with methyl 4-iodobenzoate (367 mg, 1.4 mmol) in 4 h. Flash column chromatography (pentane/Et_2O = 20:1 → 6:1) furnished **3c** as a colorless solid (275 mg, 83 %).

The magnesium reagent **2c** was prepared according to **TP1** from 4-chloro benzonitrile (275 mg, 2.0 mmol) in 3 h at 25 °C. A cross-coupling reaction was performed according to **TP2** with methyl 4-iodobenzoate (367 mg, 1.4 mmol) in 4 h. Flash column chromatography (pentane/Et_2O = 20:1 → 6:1) furnished **3c** as a colorless solid (229 mg, 69 %).

m.p.: 144 – 145 °C

^{1}H-NMR (300 MHz, $CDCl_3$) δ: 8.11 (d, J = 9 Hz, 2H), 7.71 (d, J = 8 Hz, 2H), 7.68 (d, J = 9 Hz, 2H), 7.62 (d, J = 9 Hz, 2H), 3.91 (s, 3H).

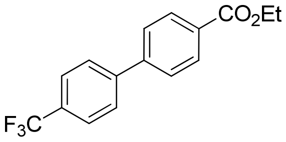
^{13}C-NMR (75 MHz, $CDCl_3$) δ: 166.4, 144.2, 143.3, 132.6, 130.2, 130.1, 127.8, 127.1, 118.5, 111.7, 52.2.

MS (70 eV, EI) m/z (%): 237 (41) [M^+], 206 (100).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 3408, 2224, 1715, 1604, 1431, 1277, 1181, 1102, 1006, 829.

HRMS (EI) for $C_{15}H_{11}NO_2$ (237.0790): 237.0778.

3d:



The magnesium reagent **2d** was prepared according to **TP1** from 4-bromo benzotrifluoride (**1d**, 450 mg, 2.0 mmol) in 30 min at 0 °C. A cross-coupling reaction was performed according to **TP2** with ethyl 4-iodobenzoate (386 mg, 1.4 mmol) in 1 h. Flash column chromatography (pentane/CH_2Cl_2 = 4:1) furnished **3d** as a colorless solid (398 mg, 97 %).

m.p.: 91 – 93 °C

^{1}H-NMR (400 MHz, $CDCl_3$) *δ*: 8.14 (d, *J* = 9 Hz, 2H), 7.71 (s, 4H), 7.65 (d, *J* = 9 Hz, 2H), 4.41 (q, *J* = 7 Hz, 2H), 1.41 (t, *J* = 7 Hz, 3H).

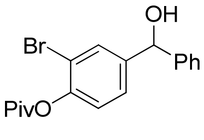
^{13}C-NMR (100 MHz, $CDCl_3$) *δ*: 166.2, 143.9, 143.6, 130.2, 130.2, 130.1 (q, *J* = 33 Hz), 127.6, 127.2, 125.8 (q, *J* = 4 Hz), 124.1 (q, *J* = 272 Hz), 61.1, 14.3.

MS (70 eV, EI) *m/z* (%): 294 (38) [M^+], 249 (100), 201 (29), 152 (27), 71 (33), 57 (54).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 2984, 1708, 1608, 1481, 1395, 1280, 1110, 838.

HRMS (EI) for $C_{16}H_{13}F_3O_2$ (294.0868): 294.0864.

3e:



The magnesium reagent **2e** was prepared according to **TP1** from 2,4-dibromophenyl pivalate (**1e**, 672 mg, 2.0 mmol) in 1 h at -20 °C. Benzaldehyde (149 mg, 1.4 mmol) was added at -20 °C and the mixture stirred for 30 min at this temperature. The reaction was quenched with sat. NH_4Cl solution (10 mL) and extracted with Et_2O (3x 10 mL). The combined organic layers were dried over Na_2SO_4 and concentrated *in vacuo*. Flash column chromatography (pentane/CH_2Cl_2 = 2:1 → CH_2Cl_2) furnished **3e** as a pale yellow oil (435 mg, 86 %).

^{1}H-NMR (400 MHz, $CDCl_3$) δ: 7.66 (d, J = 2 Hz, 1H), 7.37-7.30 (m, 6H), 7.06 (d, J = 8 Hz, 1H), 5.81 (s, 1H), 2.25 (brs, 1H) 1.40 (s, 9H).

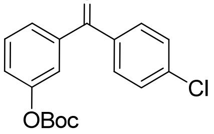
^{13}C-NMR (100 MHz, $CDCl_3$) δ: 176.0, 147.6, 143.0, 142.9, 131.2, 128.7, 128.0, 126.6, 126.5, 123.5, 116.1, 75.2, 39.3, 27.2.

MS (70 eV, EI) m/z (%): 362 (6) [M^+], 280 (25), 201 (20), 105 (100), 57 (95).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 3433, 2971, 1755, 1477, 1215, 1099, 1041, 892, 697.

HRMS (EI) for $C_{18}H_{19}BrO_3$ (362.0518): 362.0508.

3f:



The magnesium reagent **2f** was prepared according to **TP1** from 3-bromophenyl *tert*-butyl carbonate (**1f**, 546 mg, 2.0 mmol) in 1 h at -10 °C. An acylation reaction was performed according to

TP3 with 4-chlorobenzoyl chloride (245 mg, 1.4 mmol) in 1 h. Flash column chromatography (pentane/CH_2Cl_2 = 3:2) furnished **3f** as a colorless solid (440 mg, 95 %).

m.p.: 83 - 84 °C

^{1}H-NMR (400 MHz, $CDCl_3$) *δ*: 7.75 (d, *J* = 9 Hz, 2H), 7.62 (td, *J* = 2 Hz, *J* = 8 Hz, 1H), 7.59-7.58 (m, 1H), 7.51-7,45 (m, 3H), 7.42-7.39 (m, 1H), 1.55 (s, 9H).

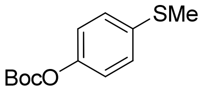
^{13}C-NMR (100 MHz, $CDCl_3$) *δ*: 194.1, 151.5, 151.0, 139.1, 138.5, 135.4, 131.4, 129.4, 128.7, 127.2, 125.6, 122.8, 84.1, 27.7.

MS (70 eV, EI) *m/z* (%): 232 (45) [M^+-Boc], 139 (52), 57 (100).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 2985, 1749, 1653, 1580, 1439, 1369, 1248, 1138, 1085, 1004, 906, 824, 778.

HRMS (EI) for $C_{13}H_9O_2Cl$ (232.0291 [M^+-Boc]): 232.0275.

3g:



The magnesium reagent **2g** was prepared according to **TP1** from 4-bromophenyl *tert*-butyl carbonate (**1g**, 546 mg, 2.0 mmol) in 20 min at -10 °C. $MeSO_2SMe$ (177 mg, 1.4 mmol) was added at -10 °C, the mixture was warmed to 25 °C and stirred for 1 h. The reaction was quenched with sat. NH_4Cl solution (10 mL) and extracted with Et_2O (3x 10 mL). The combined organic layers were dried over Na_2SO_4 and concentrated *in vacuo*. Flash column chromatography (pentane/CH_2Cl_2 = 4:1) furnished **3g** as a colorless solid (309 mg, 92 %).

m.p.: 58 - 60 °C

^{1}H-NMR (300 MHz, CDCl$_3$) δ: 7.26 (d, J = 9 Hz, 2H), 7.08 (d, J = 9 Hz, 2H), 2.46 (s, 3H), 1.54 (s, 9H).

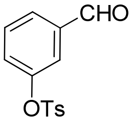
^{13}C-NMR (75 MHz, CDCl$_3$) δ: 151.8, 148.9, 135.5, 128.0, 121.7, 83.6, 27.7, 16.6.

MS (70 eV, EI) m/z (%): 240 (2) [M$^+$], 207 (5), 140 (100), 125 (27), 69 (10), 57 (84).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 2985, 1749, 1493, 1430, 1368, 1277, 1218, 1135, 1013, 890, 816, 779, 745.

HRMS (EI) for $C_{12}H_{16}O_3S$ (240.0820): 240.0817.

3h:



The magnesium reagent **2h** was prepared according to **TP1** from 3-bromophenyl 4-methylbenzenesulfonate (**1h,** 654 mg, 2.0 mmol) in 2 h at 0 °C. DMF (102 mg, 1.4 mmol) was added at 0 °C, the mixture warmed to 25 °C and stirred for 30 min. The reaction was quenched with sat. NH_4Cl solution (10 mL) and extracted with Et_2O (3x 10 mL). The combined organic layers were dried over Na_2SO_4 and concentrated *in vacuo*. Flash column chromatography (CH_2Cl_2) furnished **3h** as a colorless solid (299 mg, 77 %).

m.p.: 64 - 66 °C

^{1}H-NMR (300 MHz, $CDCl_3$) δ: 9.91 (s, 1H), 7.77 (td, J = 1 Hz, J = 8 Hz, 1H), 7.71 (d, J = 8 Hz, 2H), 7.50-7.45 (m, 2H), 7.33-7.27 (m, 3H), 2.44 (s, 3H).

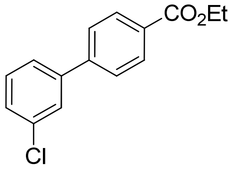
^{13}C-NMR (75 MHz, $CDCl_3$) δ: 190.5, 150.2, 145.8, 137.8, 132.0, 130.4, 129.9, 128.4, 128.3, 128.2, 123.0, 21.7.

MS (70 eV, EI) m/z (%): 276 (21) [M^+], 155 (74), 91 (100), 65 (21).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 3092, 3056, 2846, 2740, 1691, 1579, 1482, 1439, 1364, 1282, 1220, 1188, 1178, 1126, 1090, 933, 802, 736.

HRMS (EI) for $C_{14}H_{12}O_4S$ (276.0456): 276.0447.

3i:



The magnesium reagent **2i** was prepared according to **TP1** from 3-chlorobromobenzene (**1i**, 383 mg, 2.0 mmol) in 10 min at 25 °C. A cross-coupling reaction was performed according to **TP2** with ethyl 4-iodobenzoate (386 mg, 1.4 mmol) in 2 h. Flash column chromatography (pentane/CH_2Cl_2 = 4:1) furnished **3i** as a colorless solid (341 mg, 94 %).

m.p.: 67 – 69 °C

^{1}H-NMR (300 MHz, $CDCl_3$) δ: 8.11 (d, J = 9 Hz, 2H), 7.63-7.59 (m, 3H), 7.50-7.47 (m, 1H), 7.41-7.34 (m, 2H), 4.40 (q, J = 7 Hz, 2H), 1.41 (t, J = 7 Hz, 3H).

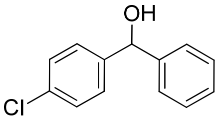
^{13}C-NMR (75 MHz, CDCl$_3$) *δ*: 166.3, 144.0, 141.9, 134.8, 130.1, 130.1, 129.8, 128.1, 127.4, 127.0, 125.4, 61.0, 14.3.

MS (70 eV, EI) *m/z* (%): 260 (49) [M$^+$], 232 (29), 215 (100), 152 (63), 76 (16).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 3061, 2977, 1703, 1608, 1595, 1559, 1471, 1393, 1364, 1274, 1183, 1099, 1018, 851, 761, 704, 690.

HRMS (EI) for $C_{15}H_{13}ClO_2$ (260.0604): 260.0601.

3j:



The magnesium reagent **2j** was prepared according to **TP1** from 1-bromo-4-chlorobenzene (**1j**, 383 mg, 2.0 mmol) in 10 min at 25 °C. Benzaldehyde (149 mg, 1.4 mmol) was added and the mixture stirred for 15 min at 25 °C. The reaction was quenched with sat. NH_4Cl solution (10 mL) and extracted with Et_2O (3x 10 mL). The combined organic layers were dried over Na_2SO_4 and concentrated *in vacuo*. Flash column chromatography (CH_2Cl_2) furnished **3j** as a colorless solid (271 mg, 89 %).

m.p.: 69 - 71 °C

^{1}H-NMR (400 MHz, CDCl$_3$) *δ*: 7.32-7.21 (m, 9H), 5,71 (s, 1H), 2.45 (brs, 1H).

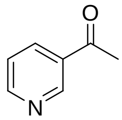
^{13}C-NMR (100 MHz, CDCl$_3$) *δ*: 143.4, 142.1, 133.2, 128.6, 128.5, 127.8, 127.7, 126.5, 75.5.

MS (70 eV, EI) *m/z* (%): 218 (41) [M^+], 165 (30), 139 (100), 105 (66), 78 (36).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 3351, 1588, 1485, 1453, 1402, 1191, 1086, 1011, 847, 791, 759.

HRMS (EI) for $C_{13}H_{11}OCl$(218.0498): 218.0491.

3k:



The magnesium reagent **2k** was prepared according to **TP1** from 3-bromo pyridine (**1k**, 314 mg, 2.0 mmol) in 30 min at 25 °C. An acylation reaction was performed according to **TP3** with acetyl chloride (109 mg, 1.4 mmol) in 1 h. Flash column chromatography (CH_2Cl_2) furnished **3k** as a colorless oil (152 mg, 90 %).

^{1}H NMR (300 MHz, $CDCl_3$) δ: 9.01 (d, *J* = 1 Hz, 1H), 8.63 (dt, *J* = 5, *J* = 2 Hz, 1H), 8.12-8.05 (m, 1H), 7.28 (dq, *J* = 8 Hz, *J* = 5, 1H), 2.49 (s, 3H).

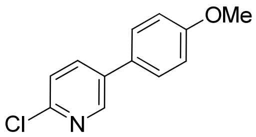
^{13}C NMR (75 MHz, $CDCl_3$) δ: 196.4, 153.2, 149.6, 135.1, 131.9, 123.3, 26.4 ppm.

MS (70 eV, EI) *m/z* (%): 121 (55) [M^+], 106 (91), 78 (100), 51 35), 43 (24).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 1679, 1584, 1416, 1357, 1265, 1022, 955, 801.

HRMS (EI) for C_7H_7NO (121.0528): 121.0521.

3l:



The magnesium reagent **2l** was prepared according to **TP1** from 5-bromo-2-chloropyridine (**1l**, 385 mg, 2.0 mmol) in 30 min at 0 °C. A cross-coupling reaction was performed according to **TP2** with 4-iodoanisol (328 mg, 1.4 mmol) in 6 h. Flash column chromatography (CH_2Cl_2) furnished **3l** as a colorless solid (258 mg, 84 %).

m.p.: 127 - 128 °C

^{1}H-NMR (300 MHz, $CDCl_3$) δ: 8.55 (d, J = 2 Hz, 1H), 7,78 (dd, J = 2 Hz, J = 8 Hz, 1H), 7.49-7.46 (m, 2H), 7.35 (d, J = 8 Hz, 1H), 7.00 (d, J = 9 Hz, 2H), 3.85 (s, 3H).

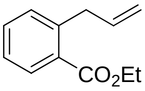
^{13}C-NMR (75 MHz, $CDCl_3$) δ: 160.0, 149.6, 147.5, 136.7, 135.3, 128.8, 128.1, 124.1, 114.7, 55.4.

MS (70 eV, EI) m/z (%): 219 (100) [M^+], 204 (50), 176 (39), 140 (21).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 3015, 2963, 2935, 2838, 1607, 1584, 1516, 1451, 1366, 1288, 1253, 1186, 1039, 814.

HRMS (EI) for $C_{12}H_{10}ONCl$ (219.0451): 219.0428.

6a:



The zinc reagent **5a** was prepared according to **TP4** from ethyl 2-bromobenzoate (**4a**, 458 mg, 2.0 mmol) in 3 h at 25 °C. An allylation reaction was performed according to **TP3** with allyl bromide (169 mg, 1.4 mmol) in 30 min. Flash column chromatography (pentane/Et_2O = 3:1) furnished **6a** as a colourless oil (232 mg, 88 %).

^{1}H-NMR (300 MHz, $CDCl_3$) δ: 7.90 (dd, J = 8 Hz, J = 1 Hz, 1H), 7.47-7.25 (m, 1H), 7.23 (t, J = 7 Hz, 2H), 6.11-5.98 (m, 1H), 5.07-5.01 (m, 2H), 4.37 (q, J = 7 Hz, 2H), 3.79 (d, J = 6 Hz, 2H), 1.41 (t, J = 6 Hz, 3H).

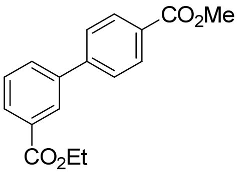
^{13}C-NMR (75 MHz, $CDCl_3$) δ: 167.6, 141.3, 137.4, 131.8, 130.8, 130.4, 130.1. 126.1, 115.4, 60.7, 38.3, 14.2.

MS (70 eV, EI) m/z (%): 190 (53) [M^+], 175 (63), 147 (74), 145 (73), 144 (37), 117 (81), 116 (45), 115 (100).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 3056, 2982, 1423, 1266.

HRMS (EI) for $C_{12}H_{14}O_2$ (190.0994): 190.0996.

6b:



The zinc reagent **5b** was prepared according to **TP4** from ethyl 3-bromo benzoate (**4b**, 458 mg, 2.0 mmol) in 3 h at 25 °C. A cross-coupling reaction was performed according to **TP2** with methyl 4-iodobenzoate (367 mg, 1.4 mmol) in 4 h. Flash column chromatography (pentane/Et_2O = 20:1 → 6:1) furnished **6b** as a colorless oil (310 mg, 78 %).

^{1}H NMR (300 MHz, $CDCl_3$) δ: 8.05 (d, *J* = 9 Hz, 2H), 7.87 (d, *J* = 8 Hz, 1H), 7.53 (t, *J* = 8 Hz, 1H), 7.45-7.32 (m, 4H), 4.08 (q, *J* = 7 Hz, 2H), 3.92 (s, 3H), 0.99 (t, *J* = 7 Hz, 3H).

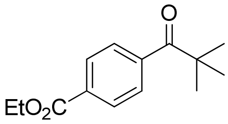
^{13}C NMR (75 MHz, $CDCl_3$) δ: 168.1, 166.9, 146.4, 141.5, 131.3, 130.9, 130.4, 130.0, 129.2, 128.8, 128.4, 127.7, 61.0, 52.1, 13.7.

MS (70 eV, EI) *m/z* (%): 284 (M^+, 100), 253 (46), 239 (92), 225 32), 152 (39), 76 (20).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 2987, 2947, 1712, 1609, 1433, 1399, 1268, 1243, 1175, 1110, 854.

HRMS (EI) for $C_{17}H_{16}O_4$ (284.1049): 284.1040.

6c:



The zinc reagent **5c** was prepared according to **TP4** from ethyl 4-bromobenzoate (**4c**, 458 mg, 2.0 mmol) in 3 h at 25 °C. An acylation reaction was performed according to **TP3** with 2,2-dimethylpropanoyl chloride (168 mg, 1.4 mmol) in 30 min. Flash column chromatography (pentane/Et_2O = 3:1) furnished **6c** as a colourless oil (249 mg, 76 %).

^{1}H-NMR (300 MHz, $CDCl_3$) *δ*: 8.05 (d, *J* = 9 Hz, 2H), 7.64 (d, *J* = 9 Hz, 2H), 4.38 (q, *J* = 7 Hz, 2H), 1.39 (t, *J* = 7 Hz, 3H), 1.39 (s, 9H).

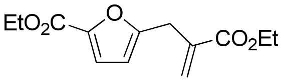
^{13}C-NMR (75 MHz, CDCl$_3$) *δ*: 208.8, 165.3, 142.3, 131.6, 128.7, 126.8, 60.7, 43.8, 27.2, 13.8.

MS (70 eV, EI) *m/z* (%): 189 (30), 178 (100), 177 (28), 149 (80), 57 (36).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 2976, 1716, 1678, 1270, 1186, 1103, 1019, 955, 732, 716.

HRMS (EI) for $C_{14}H_{18}O_3$ (234.1256): 234.1245.

6d:



The zinc reagent **5d** was prepared according to **TP4** from ethyl 5-bromo-2-furoate (**4d**, 438 mg, 2.0 mmol) in 3 h at 25 °C. An allylation reaction was performed according to **TP3** with ethyl 2-(bromomethyl)acrylate (270 mg, 1.4 mmol) in 1 h. Flash column chromatography (Et_2O) furnished **6d** as a yellowish oil (279 mg, 79 %).

^{1}H-NMR (300 MHz, CDCl$_3$) *δ*: 7.05 (d, *J* = 3 Hz, 1H), 6.27 (s, 1H), 6.15 (d, *J* = 3 Hz, 1H), 5.59 (s, 1H), 4.30 (q, *J* = 7 Hz, 2H), 4.17 (q, *J* = 7 Hz, 2H), 3.69 (s, 2H), 1.32 (t, *J* = 7 Hz, 3H), 1.24 (t, *J* = 7 Hz, 3H).

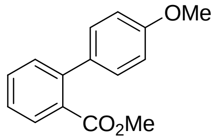
^{13}C-NMR (75 MHz, CDCl$_3$) *δ*: 166.7, 158.7, 157.3, 143.7, 136.2, 127.3, 118.9, 109.1, 60.9, 60.8, 30.9, 14.3, 14.1.

MS (70 eV, EI) *m/z* (%): 252 (13) [M$^+$], 217 (40), 206 (62), 178 (100), 150 (30), 149 (14), 133 (13), 105 (16).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 2981, 1709, 1517, 1296, 1125, 1014, 808, 759.

HRMS (EI) for $C_{13}H_{16}O_5$ (252.0998): 252.0988.

6e:



The zinc reagent **5e** was prepared according to **TP4** from methyl 2-bromo benzoate (**4e**, 428 mg, 2.0 mmol) in 2.5 h at 25 °C. A cross-coupling reaction was performed according to **TP2** with 4-iodoanisole (328 mg, 1.4 mmol) in 3 h. Flash column chromatography (pentane/EtOAc = 25:1 → 10:1) furnished **6e** as a pale yellow oil (303 mg, 89 %).

^{1}H-NMR (300 MHz, CDCl$_3$) δ: 7.82 (d, J = 8 Hz, 1H), 7.53 (t, J = 8 Hz, 1H), 7.40 (t, J = 7 Hz, 2H), 7.29 (d, J = 7 Hz, 2H), 6.97 (d, J = 7.1 Hz, 2H), 3.87 (s, 3H), 3.70 (s, 3H).

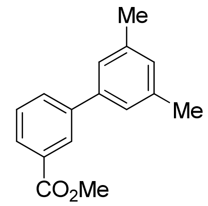
^{13}C-NMR (75 MHz, CDCl$_3$) δ: 169.3, 158.9, 141.9, 133.6, 131.1, 130.8, 130.6, 129.6, 129.4, 126.7, 113.5, 55.2, 51.9.

MS (70 eV, EI) *m/z* (%): 242 (100) [M$^+$], 211 (82), 168 (24), 139 (25).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 2942, 283, 1715, 1609, 1514, 1447, 1279, 1240, 1175, 1086, 1027.

HRMS (EI) for $C_{15}H_{14}O_3$ (242.0943): 242.0957.

6f:



The zinc reagent **5f** was prepared according to **TP4** from methyl 3-bromo benzoate (**4f**, 428 mg, 2.0 mmol) in 3 h at 25 °C. A cross-coupling reaction was performed according to **TP2** with 1-iodo-3,5-diemtyl benzene (325 mg, 1.4 mmol) in 3 h. Flash column chromatography (pentane/Et_2O = 20:1 → 6:1) furnished **6f** as a pale yellow oil (265 mg, 79 %).

^{1}H-NMR (300 MHz, $CDCl_3$) δ: 8.29 (s, 1H), 8.02 (d, *J* = 8 Hz, 1H), 7.81 (t, *J* = 9 Hz, 1H), 7.52-7.41 (m, 1H), 7.26 (s, 2H), 7.05 (s, 1H), 3.97 (s, 3H), 2.42 (s, 6H).

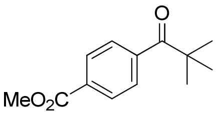
^{13}C-NMR (75 MHz, $CDCl_3$) δ: 167.1, 141.7, 140.1, 138.4, 132.6, 131.6, 130.6, 129.4, 128.7, 128.3, 125.1, 52.2, 21.4.

MS (70 eV, EI) *m/z* (%): 240 (100) [M^+], 181 (22), 166 (23), 165 (29).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 2949, 1719, 1602, 1582, 1434, 1528, 1203, 1112, 1082, 1000, 849, 754.

HRMS (EI) for **$C_{16}H_{16}O_2$** (240.1150): 240.1153.

6g:



The zinc reagent **5g** was prepared according to **TP4** from methyl 4-bromo benzoate (**4g**, 428 mg, 2.0 mmol) in 3 h at 25 °C. An acylation reaction was performed according to **TP3** with pivaloyl chloride (168 mg, 1.4 mmol) in 2 h. Flash column chromatography (pentane/EtOAc = 10:1) furnished **6h** as a colorless oil (262 mg, 85 %).

^{1}H-NMR (300 MHz, $CDCl_3$) δ: 8.05 (d, *J* = 8 Hz, 2H), 7.63 (d, *J* = 8 Hz, 2H), 3.92 (s, 3H), 1.31 (s, 9H).

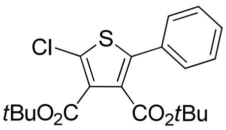
^{13}C-NMR (75 MHz, $CDCl_3$) δ: 209.0, 165.9, 142.5, 131.6, 128.9, 126.9, 51.9, 43.9, 27.2.

MS (70 eV, EI) *m/z* (%): 220 (100) [M^+], 189 (42), 161 (23).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 2953, 2970, 2869, 1723, 1676, 1435, 1276, 1187, 1106, 955.

HRMS (EI) for **$C_{13}H_{16}O_3$** (220.1099): 220.1092.

8:



A dry and argon-flushed *Schlenk*-flask, equipped with a magnetic stirrer and a septum, was charged with magnesium turnings (292 mg, 12 mmol). LiCl (12.5 mL, 0.5 M in THF, 6.3 mmol) was added and the magnesium was activated with DIBAL-H (0.5 mL, 0.1 M in THF, 0.05 mmol). Di-*tert*-butyl 2,5-dichlorothiophene-3,4-dicarboxylate (**7**, 1.77 g, 5.0 mmol) was added in one portion at -50 °C. The reaction mixture was stirred for 3 h and then canulated to a new *Schlenk*-flask. $ZnCl_2$ (5.0 mL, 1 M in THF, 5.0 mmol) was added to the freshly prepared magnesium reagent and the reaction mixture was stirred for 15 minutes. $Pd(dba)_2$ (86 mg, 3 mol%) and tfp (69 mg, 6 mol %) were added, followed by the addition of ioobenzene (714 mg, 3.5 mmol), and the reaction mixture was stirred for 3 h at 25 °C. The reaction was quenched with sat. NH_4Cl solution (15 mL) and extracted with Et_2O (3x 15 mL). The combined organic layers were dried over Na_2SO_4 and concentrated *in vacuo*. Flash column chromatography (pentane/CH_2Cl_2 = 4:1 → 1:1) furnished **8** as a colorless solid (1.13 g, 82 %).

m.p.: 84 – 86 °C

^{1}H-NMR (300 MHz, CDCl$_3$) δ: 7.42 – 7.35 (m, 5H), 1.59 (s, 9H), 1.34 (s, 9H).

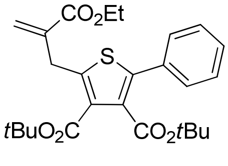
^{13}C-NMR (75 MHz, CDCl$_3$) δ: 162.3, 161.1, 142.4, 132.5, 131.9, 131.3, 131.2, 129.2, 128.9, 128.3, 82.7, 82.2, 28.1, 27.7.

MS (70 eV, EI) *m/z* (%): 394 (9) [M$^+$], 282 (100), 265 (30), 238 (21), 57 (18).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 2976, 1727, 1708, 1365, 1233, 1149, 765.

HRMS (EI) for $C_{20}H_{23}ClO_4S$ (394.1006): 394.0992.

9:



The magnesium insertion was performed according to **TP1** from **8** (790 mg, 2.0 mmol) in 3 h at -50 °C. A allylation reaction was performed according to **TP2** with ethyl (2-bromomethyl)acrylate (270 mg, 1.4 mmol) in 30 min. Flash column chromatography (CH_2Cl_2) furnished **9** as a colorless oil (580 mg, 88 %).

^{1}H-NMR (600 MHz, $CDCl_3$) δ: 7.42 – 7.40 (m, 2H), 7.37 – 7.33 (m, 3H), 6.30 (d, J = 1 Hz, 1H), 5.60 (d, J = 1 Hz, 1H), 4.23 (q, J = 7 Hz, 2H), 4.00 (m, 2H), 1.53 (s, 9H), 1.36 (s, 9H), 1.30 (t, J = 7 Hz, 3H).

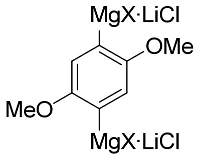
^{13}C-NMR (150 MHz, $CDCl_3$) δ: 166.3, 163.7, 162.6, 144.4, 142.2, 138.5, 132.8, 132.5, 132.1, 129.1, 128.4, 128.2, 126.9, 81.9, 81.8, 61.0, 30.8, 28.1, 27.8, 14.2.

MS (70 eV, EI) m/z (%): 472 (1) [M^+], 360 (31), 342 (100), 270 (27), 57 (16).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 2977, 1707, 1631, 1475, 1392, 1365, 1244, 1150, 1122, 950, 847, 696.

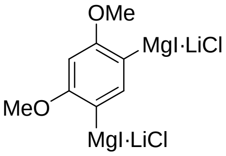
HRMS (EI) for $C_{26}H_{32}O_6S$ (472.1920): 472.1929.

10:



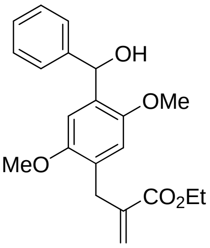
A dry 25 mL *Schlenk*-flask was charged with lithium chloride (1.06 g, 25 mmol) and the lithium chloride was heated under vacuum until thoroughly dry. The flask was then charged with magnesium turnings (1.22 g, 50 mmol) and thoroughly dried by heating under vacuum. Upon cooling to room temperature the flask was flushed with argon and charged with 1,4-diiodo-2,5-dimethyoxy-benzene (1.95 g, 5 mmol) or 1,4-dibromo-2,5-dimethoxy-benzene (1.48 g, 5 mmol). Following attachment of a refluxing condenser, THF (12.5 mL) was added and the reaction stirred and allowed to reflux. The reaction was then allowed to cool to 25 °C and stirred until the reaction was complete by GC analysis of hydrolysed reaction aliquots. After 1.5 h (2.5 h in case of the dibromide) the solution was removed from the excess magnesium using a syringe. The concentration of **11** was determined by titration.[5]

11:



A dry 25 mL *Schlenk*-flask was charged with lithium chloride (1.06 g, 25 mmol) and the lithium chloride was heated under vacuum until thoroughly dry. The flask was then charged with magnesium turnings (1.22 g, 50 mmol) and thoroughly dried by heating under vacuum. Upon cooling to room temperature the flask was flushed with argon, charged with 1,5-diiodo-2,4-dimethoxybenzene (1.95 g, 5 mmol) and cooled to 0 °C. THF (12.5 mL) was added and the reaction stirred for 1 hour before allowed to warm to 25 °C. The mixture was stirred until the reaction was complete by GC analysis of hydrolysed reaction aliquots. After 16 h the solution was removed from the excess magnesium using a syringe. The concentration of **14** was determined by titration.[5]

12:



To a solution of **10** (3.23 mL, 0.31 M in THF, 1.0 mmol) was added CuCN·2LiCl (1.0 mL, 1 M in THF, 1.0 mmol) and after stirring for 10 min at 25 °C the resulting suspension was cooled to -78 °C and benzaldehyde (0.071 mL, 0.7 mmol) was added dropwise. After stirring for 20 min at -78 °C the reaction was warmed directly to -30 °C and stirred for a further 30 min before 2-bromomethyl-acrylic acid ethyl ester (270 mg, 1.4 mmol) was added and the reaction was allowed to warm to 25 °C before being quenched with sat. NH_4Cl. Following extraction with diethyl ether (3 x 5 mL) the organic phases were combined, washed with brine and dried ($MgSO_4$). The volatiles were removed in vacuo and the crude product purified by flash column chromatography (pentane/Et_2O = 3:2) to give **12** (221 mg, 89 %) as a light yellow oil.

^{1}H-NMR (300 MHz, $CDCl_3$) δ: 7.21-7.44 (m, 5H), 6.82 (s, 1H), 6.72 (s, 1H), 6.19 (dd, J = 1 Hz, J = 2 Hz, 1H), 6.02 (brs, 1H), 5.37 (q, J = 2 Hz, 1H), 4.21 (q, J = 7 Hz, 2H), 3.73 (s, 3H), 3.71 (s, 3H), 3.61 (s, 2H), 3.01 (brs, 1H), 1.29 (t, *J* = 7 Hz, 3H).

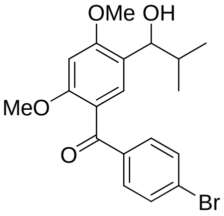
^{13}C-NMR (75 MHz, CDCl$_3$) δ: 167.1, 151.7, 150.5, 143.4, 139.3, 130.8, 128.2, 127.2, 127.1, 126.5, 125.6, 114.1, 110.9, 77.2, 72.2, 60.7, 56.1, 32.0, 14.2.

MS (70 eV, EI) *m/z* (%): 357 (18) [M$^+$+H], 356 (100), 282 (6), 279 (7), 205 (26), 105 (32).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 3479, 2933, 1710, 1630, 1502, 1463, 1403, 1253, 1208, 1131, 1041, 862, 698.

HRMS (EI) for $C_{21}H_{24}O_5$ (356.1624): 356.1586.

13:



To a solution of **11** (2.94 mL, 0.34 M in THF, 1.0 mmol) was added CuCN·2LiCl (1.0 mL, 1 M in THF, 1.0 mmol) and after stirring for 10 min at 25 °C the resulting suspension was cooled to -78 °C and isobutyraldehyde (0.064 mL, 0.7 mmol) was added dropwise. After stirring for 20 min at -78 °C the reaction was warmed directly to -30 °C and stirred for a further 30 minutes before 4-bromo-benzoyl chloride (307 mg, 1.4 mmol) was added and the reaction was allowed to warm to 25 °C before being quenched with sat. NH_4Cl. Following extraction with diethyl ether (3 x 5 mL) the organic phases were combined, washed with brine and dried ($MgSO_4$). The volatiles were removed in vacuo and the crude product purified by flash column chromatography (pentane/Et_2O = 1:1) to give **15** (212 mg, 77 %) as a light pink solid.

m.p.: 169 – 170 °C

^{1}H-NMR (300 MHz, $CDCl_3$) δ: 7.59-7.65 (m, 2H), 7.52-7.58 (m, 2H), 7.38 (s, 1H), 6.47 (s, 1H), 4.53 (d, *J* = 7 Hz, 1H), 3.92 (s, 3H), 3.74 (s, 3H), 2.22 (brs, 1H), 2.02 (dtt, *J* = 7 Hz, *J* = 7 Hz, *J* = 7 Hz, 1H), 1.00 (d, *J* = 7 Hz, 3H), 0.81 (d, *J* = 7 Hz, 3H).

^{13}C-NMR (75 MHz, $CDCl_3$) δ: 194.3, 160.4, 158.8, 137.7, 131.3, 131.2, 130.6, 127.3 124.1, 119.9, 95.1, 75.5, 55.8, 55.6, 34.1, 19.5, 18.3.

MS (70 eV, EI) *m/z* (%): 393 (4) [M^++H], 349 (100), 193 (19), 185 (14).

IR (ATR) $\tilde{\nu}$ (cm^{-1}): 3474, 2948, 1634, 1581, 1454, 1279, 1206, 1167, 1004, 917, 819, 762, 657.

HRMS (EI) for $C_{19}H_{21}BrO_4$ (392.0623): 392.0603.

[1] W. Lin, O. Baron, P. Knochel, *Org. Lett.* **2006**, *24*, 5673.

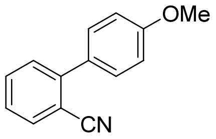
[2] I. Sapountzis, W. Lin, M. Fischer, P. Knochel, *Angew. Chem. Int. Ed.* **2004**, *43*, 4364.

[3] J. Lee, R. Velarde-Ortiz, A. Guijarro, J. R. Wurst, R. D. Rieke, *J. Org. Chem.* **2000**, *65*, 5428.

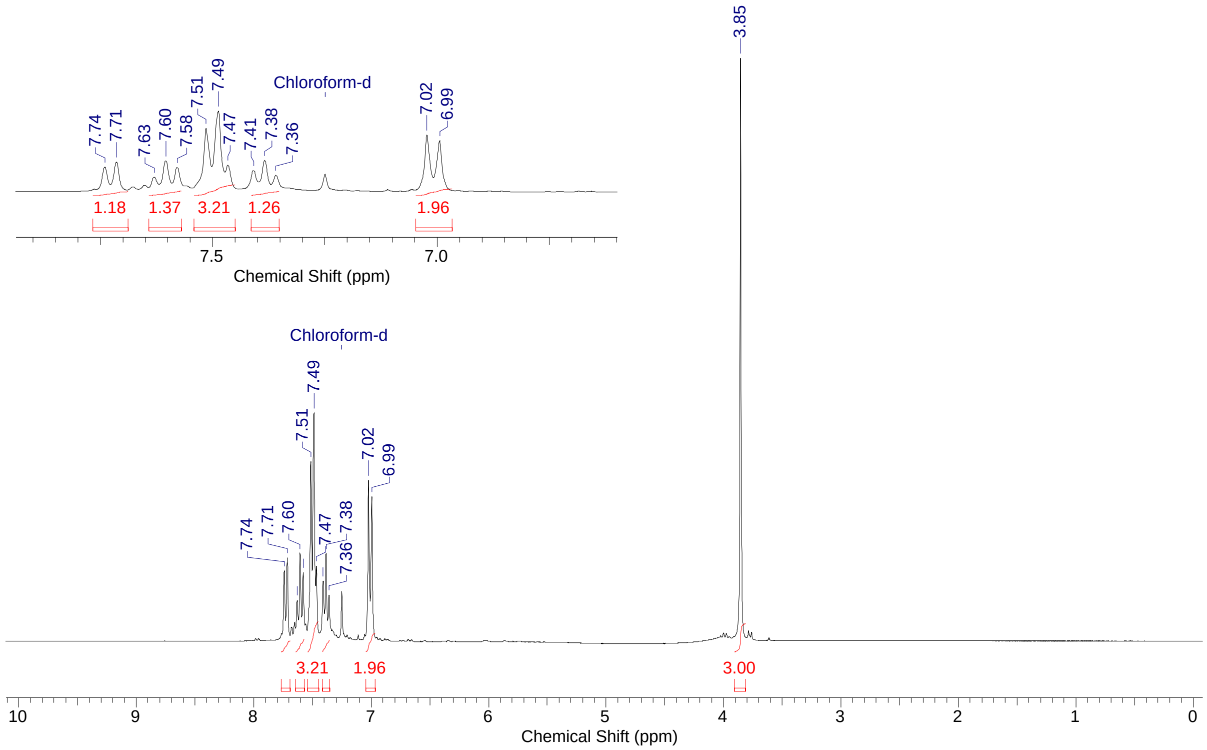
[4] The use of a LiCl solution in THF or neat LiCl gave the same results.

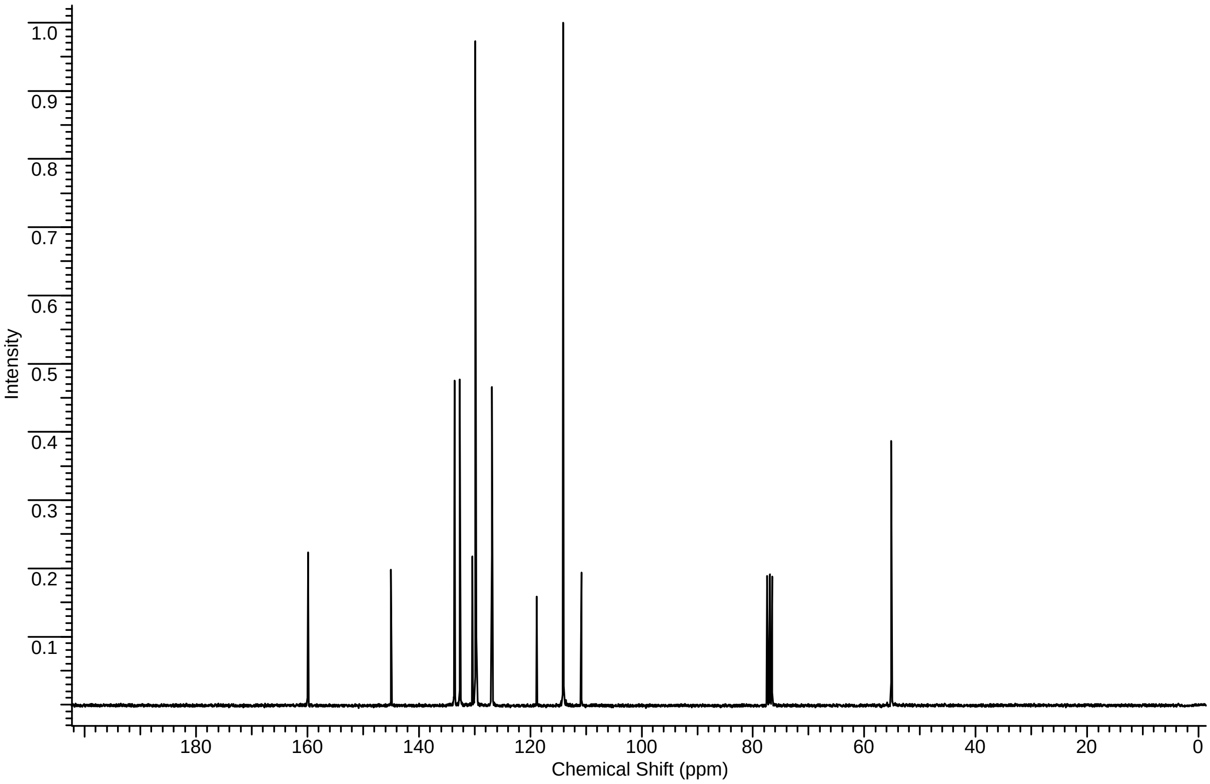
[5] A. Krasovskiy, P. Knochel, *Synthesis*, **2006**, 762.

3a:



16 May 2008





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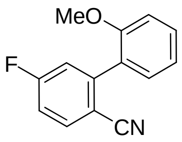
MeO
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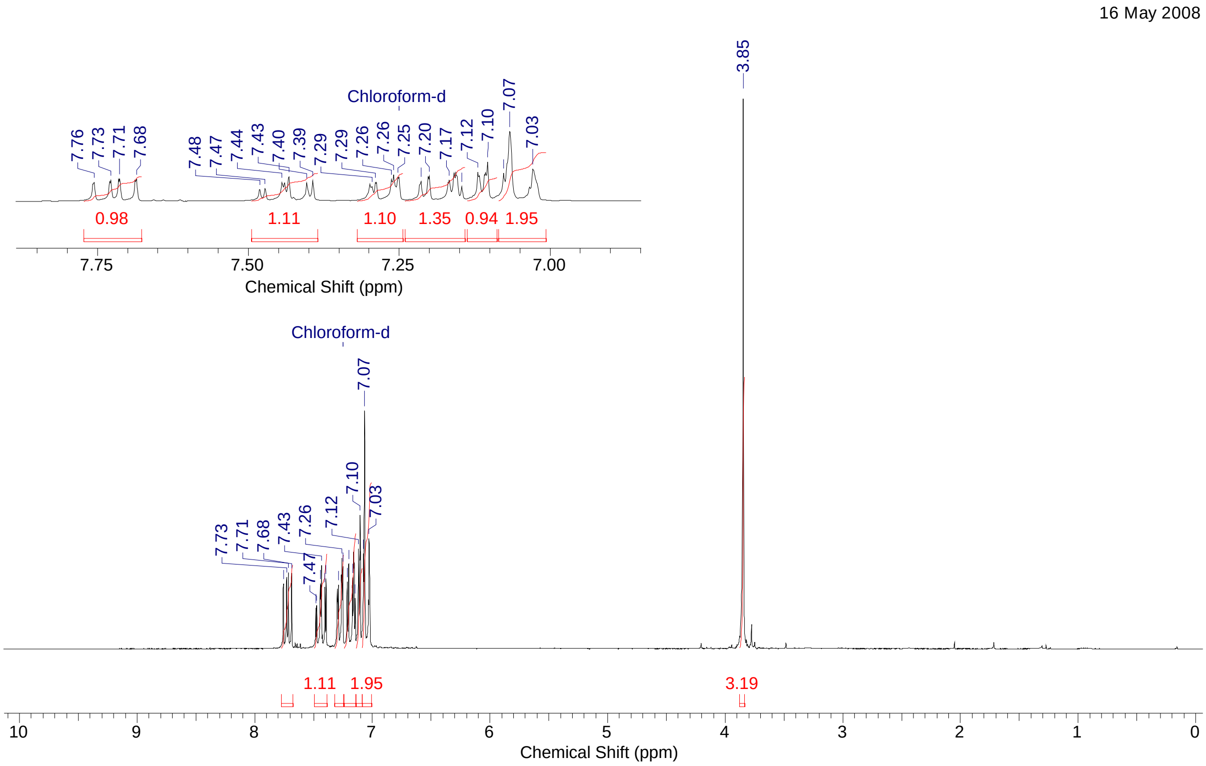
16 May 2008
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3
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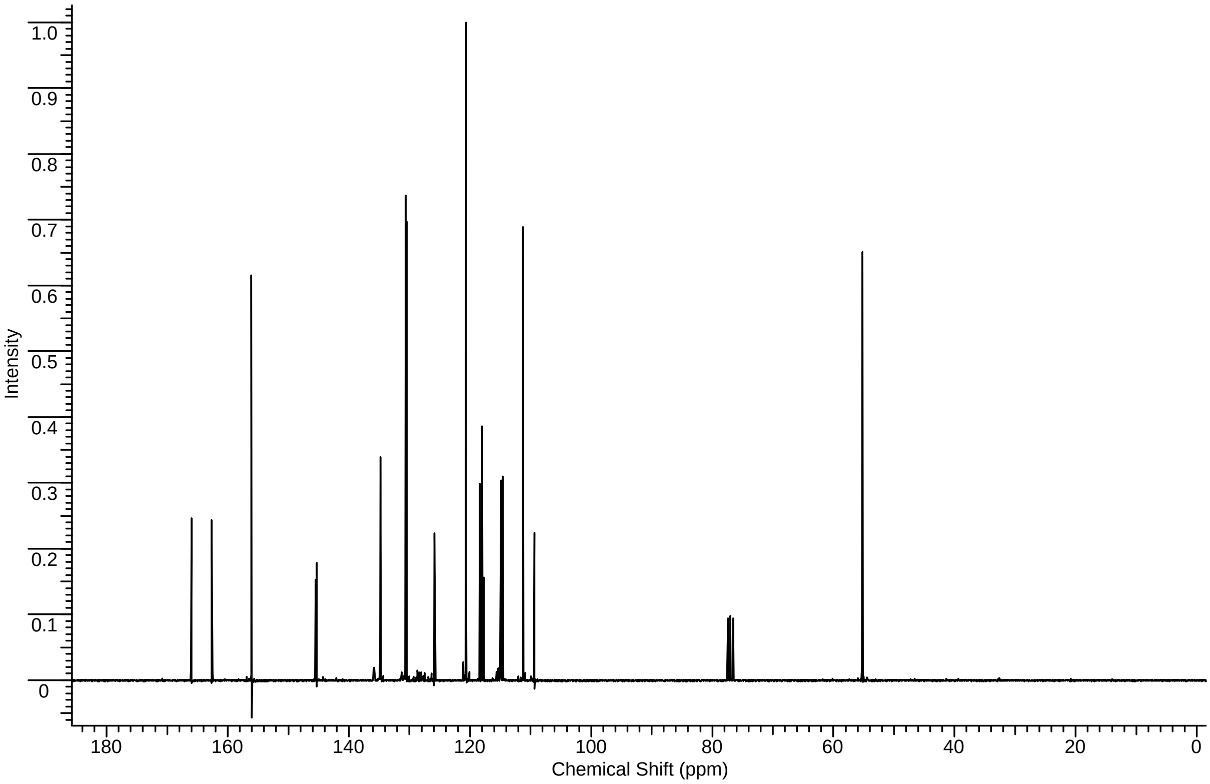
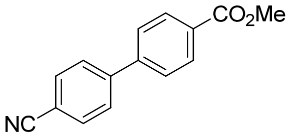
1
0
Chemical Shift (ppm)


Intensity
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
180
160
140
120
100
80
60
40
20
0
Chemical Shift (ppm)

3c:



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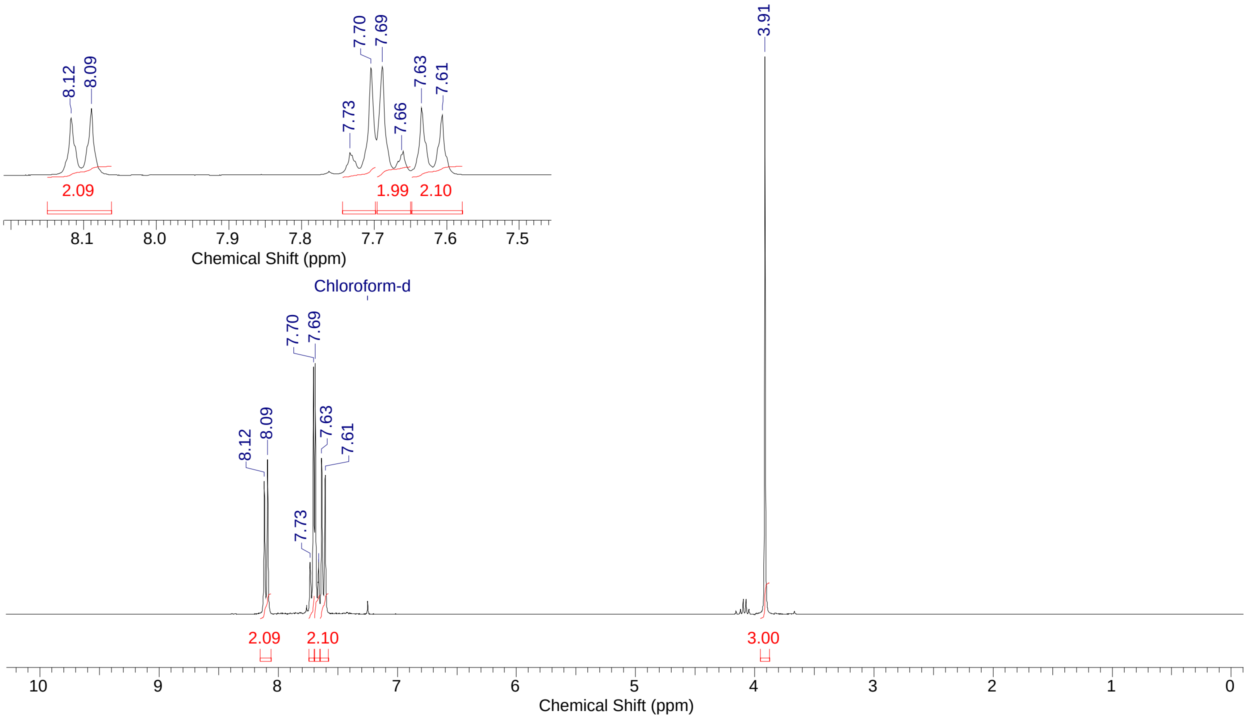
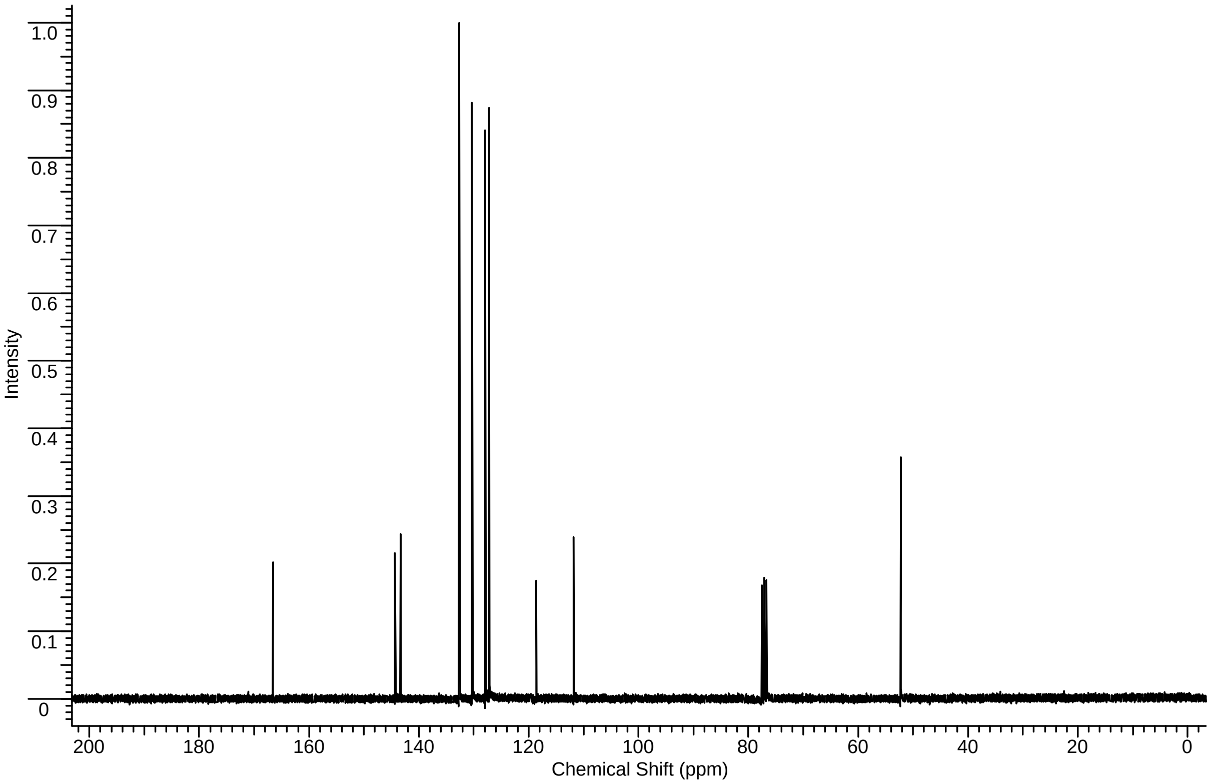
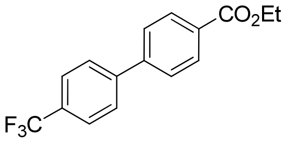
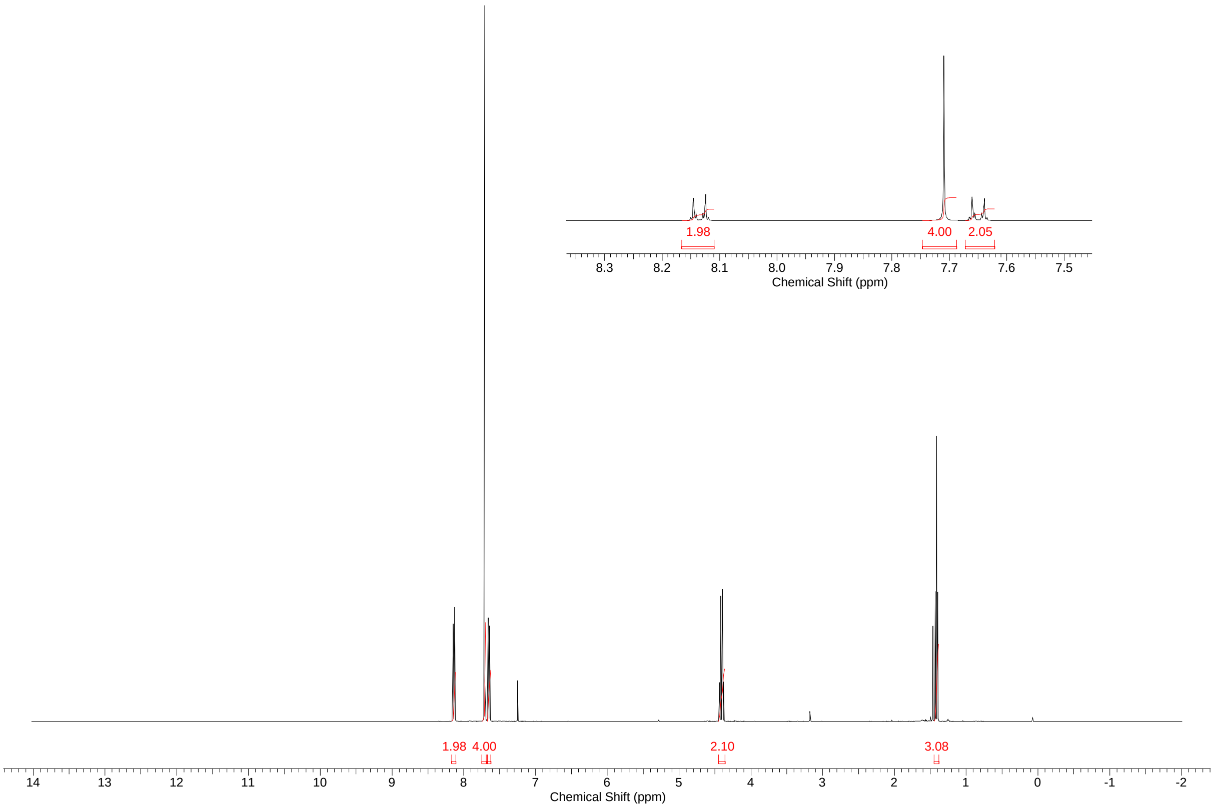
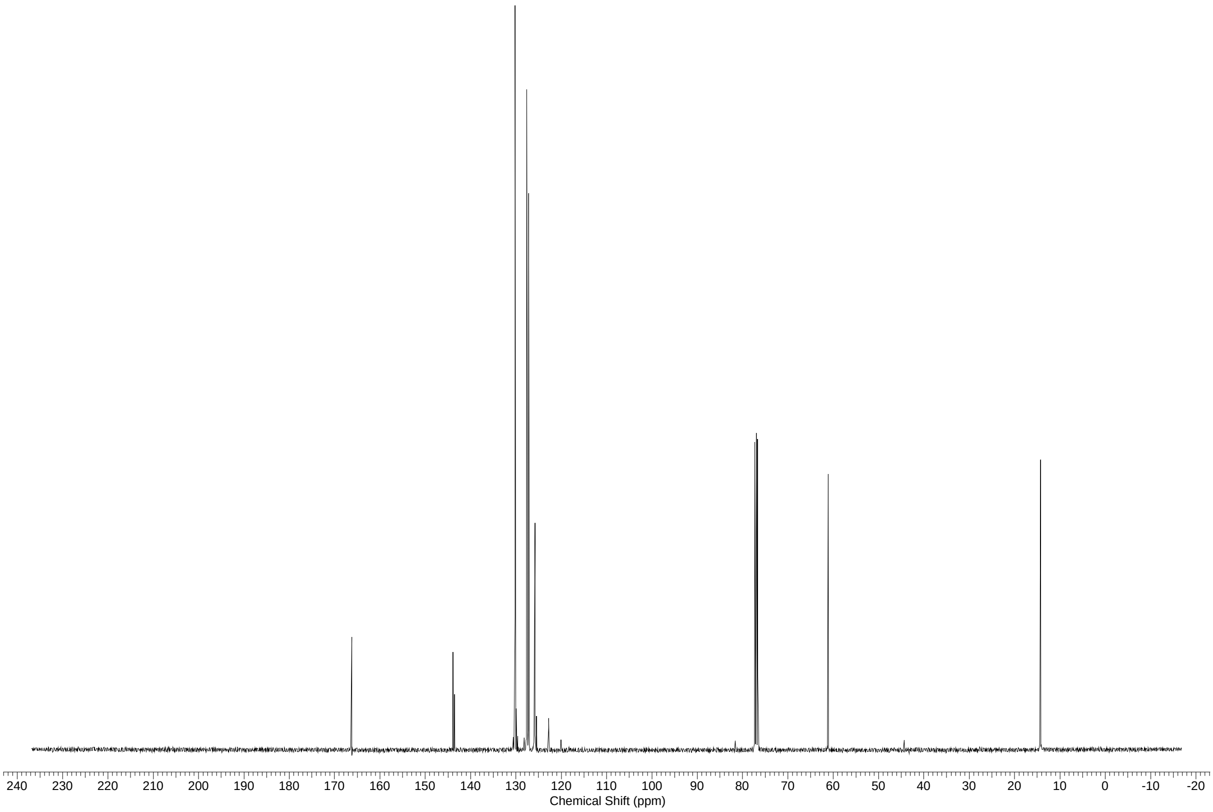




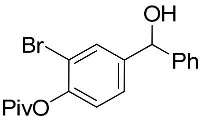
3d:


CO$_2$Et
F$_3$C

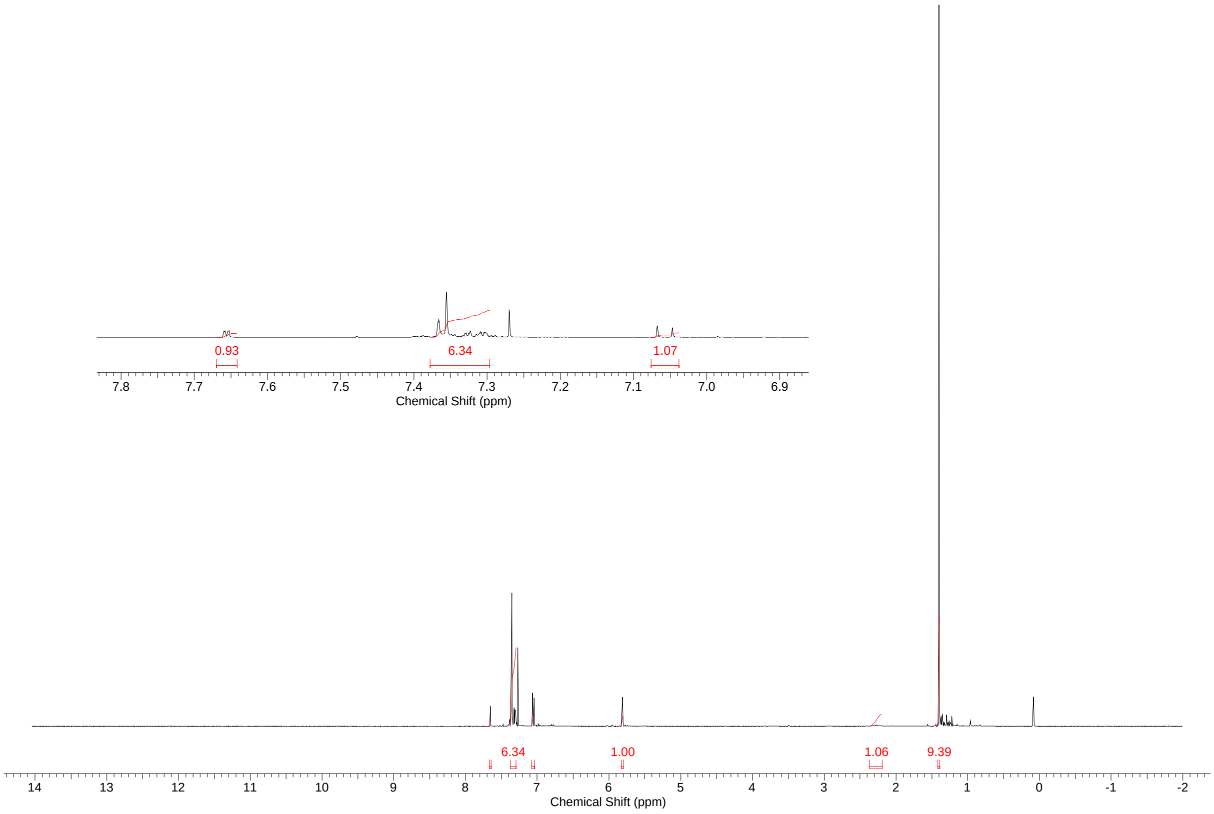

1.98
4.00
2.05
8.3
8.2
8.1
8.0
7.9
7.8
7.7
7.6
7.5
Chemical Shift (ppm)
1.98
4.00
2.10
3.08
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
Chemical Shift (ppm)


240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
Chemical Shift (ppm)

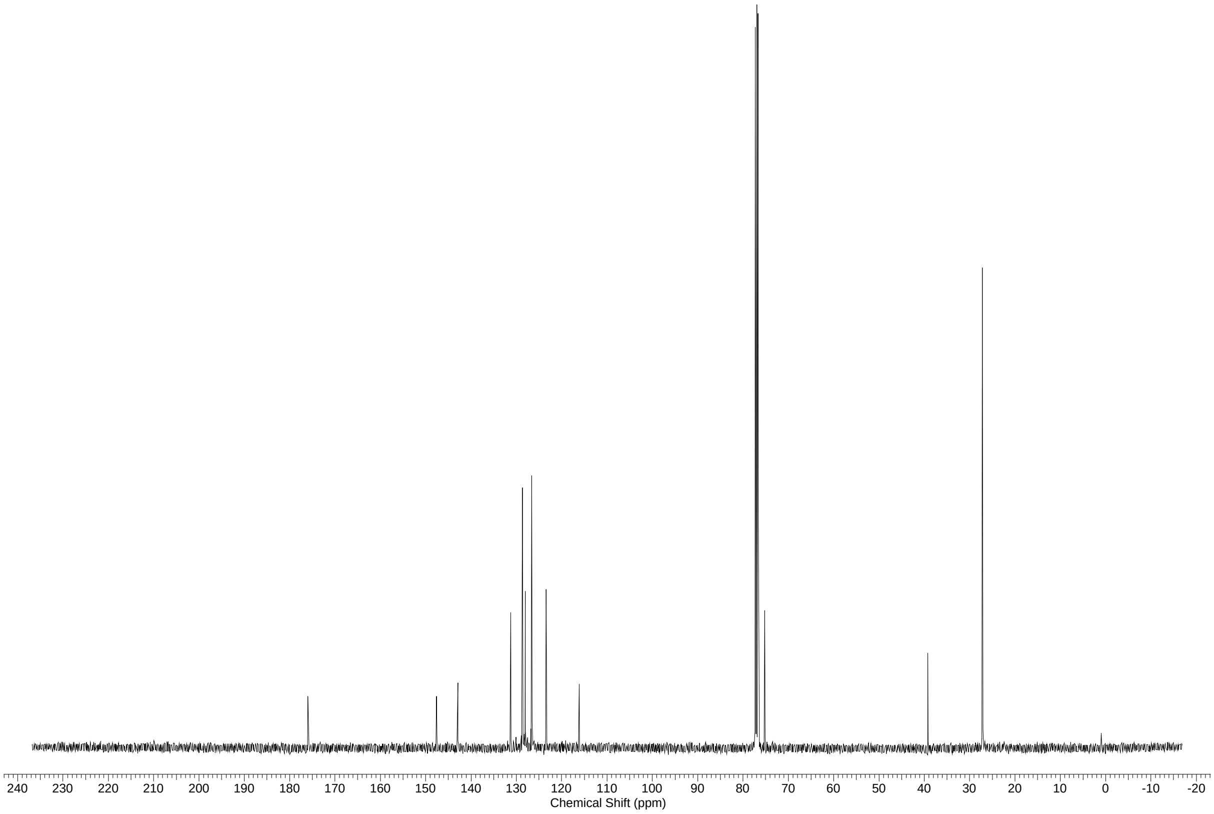
3e:



OH
Br
Ph
PivO

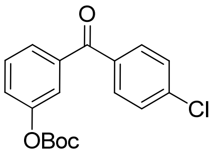


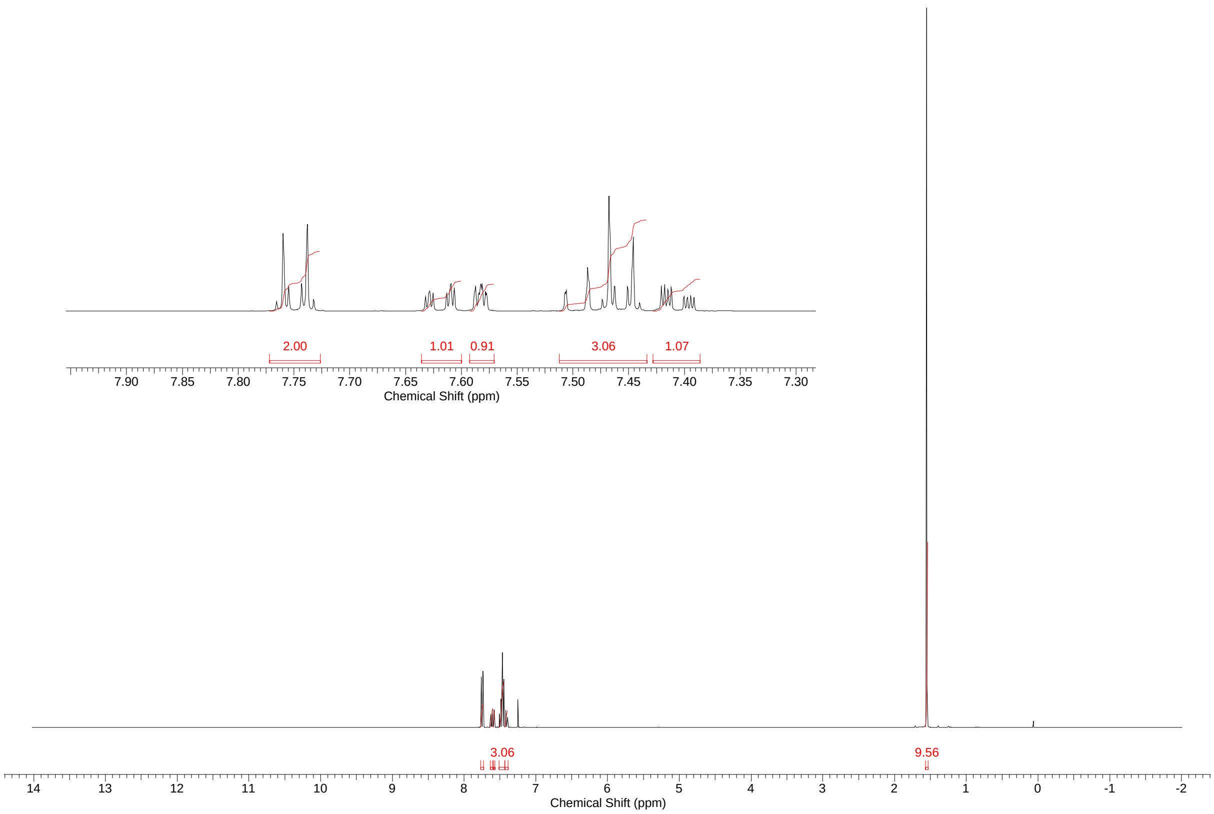
0.93
6.34
1.07
7.8
7.7
7.6
7.5
7.4
7.3
7.2
7.1
7.0
6.9
Chemical Shift (ppm)
6.34
1.00
1.06
9.39
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
Chemical Shift (ppm)

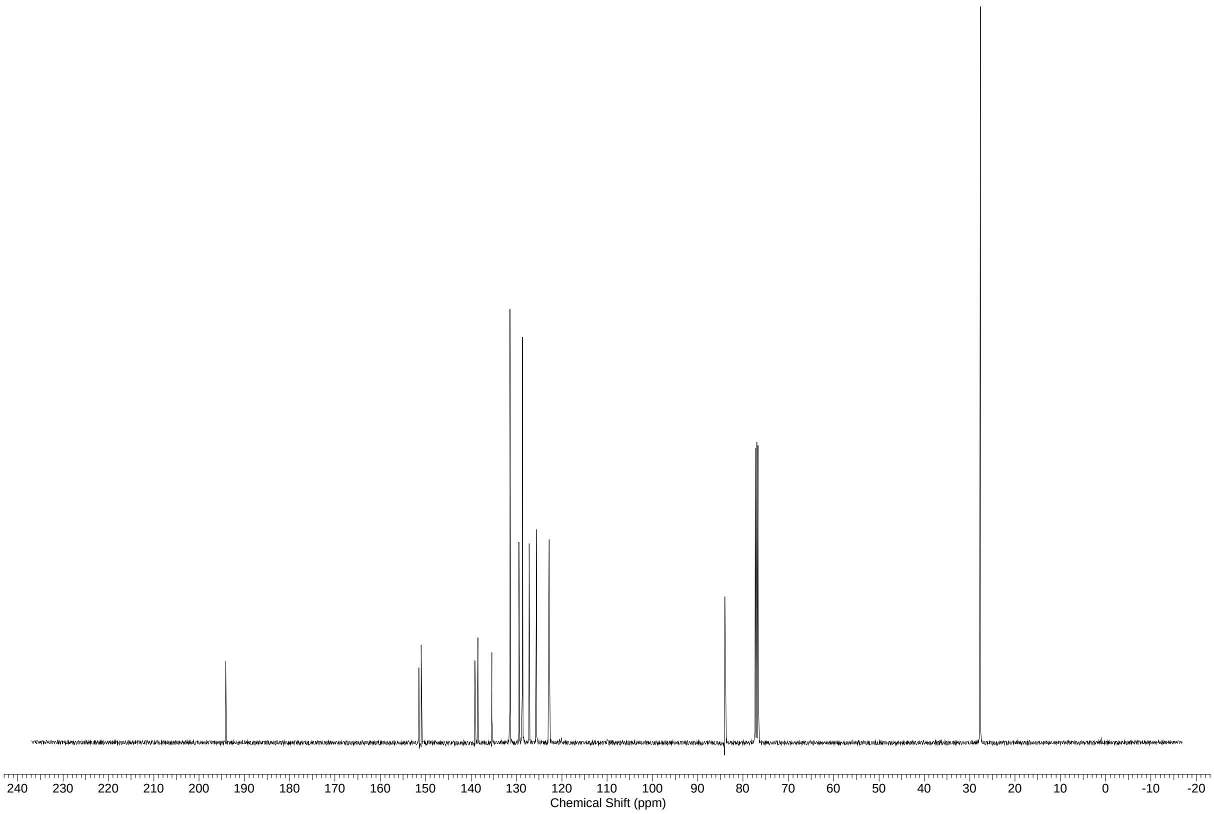


240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
Chemical Shift (ppm)

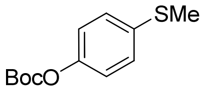
3f:

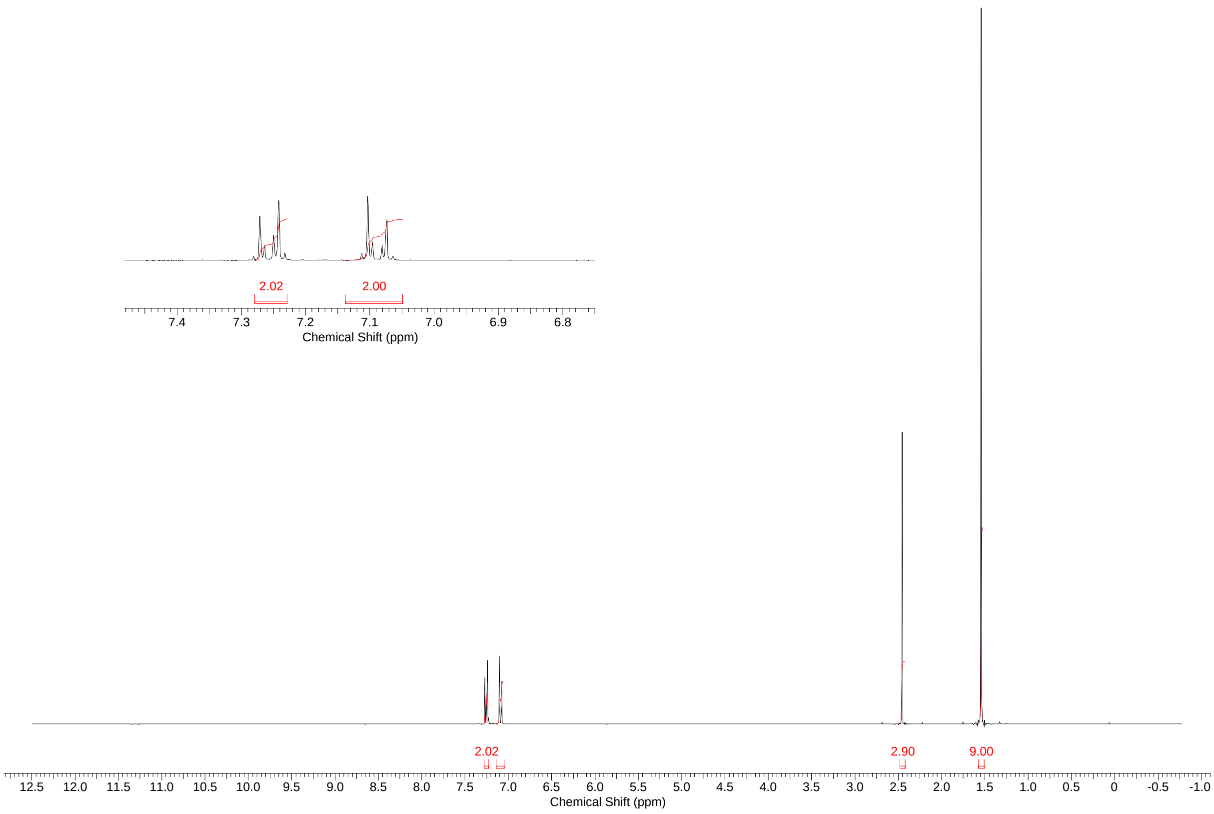

O
Cl
OBoc

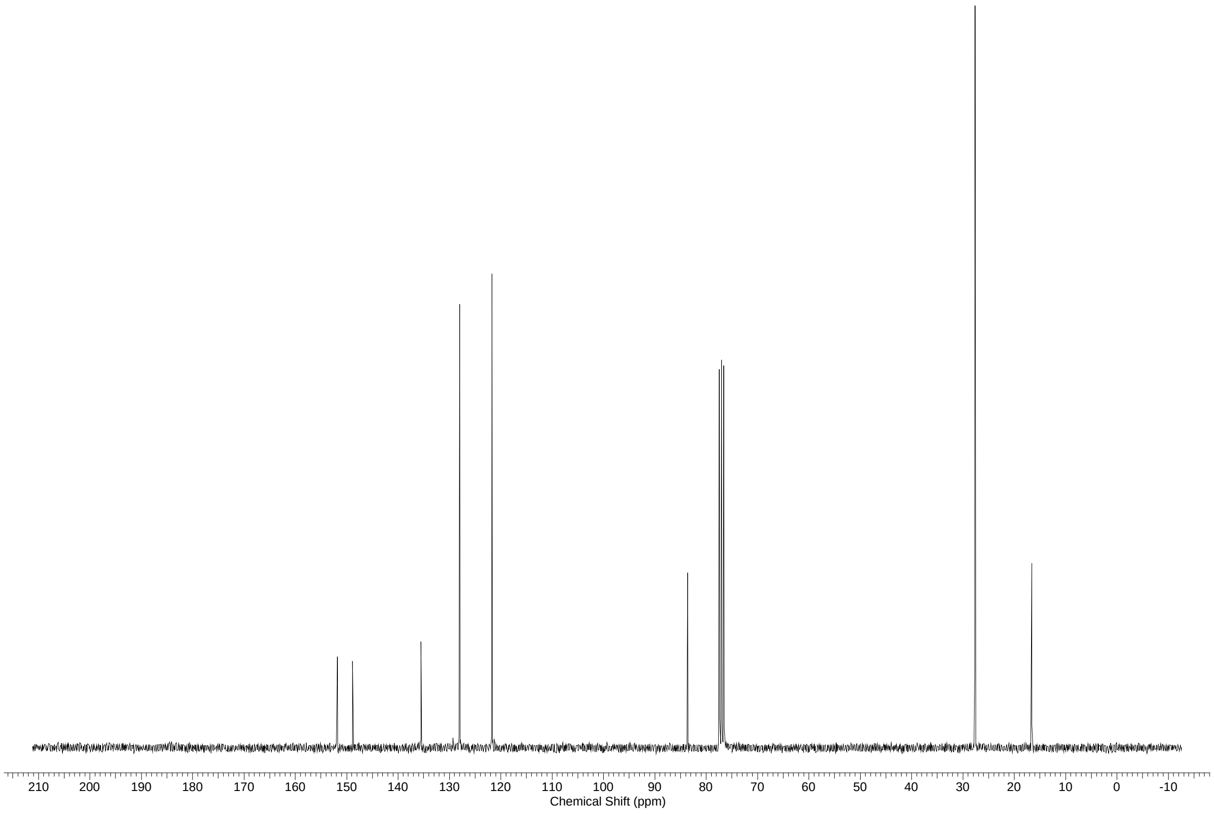

2.00
1.01
0.91
3.06
1.07
7.90
7.85
7.80
7.75
7.70
7.65
7.60
7.55
7.50
7.45
7.40
7.35
7.30
Chemical Shift (ppm)
3.06
9.56
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
Chemical Shift (ppm)


240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
Chemical Shift (ppm)

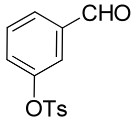
3g:

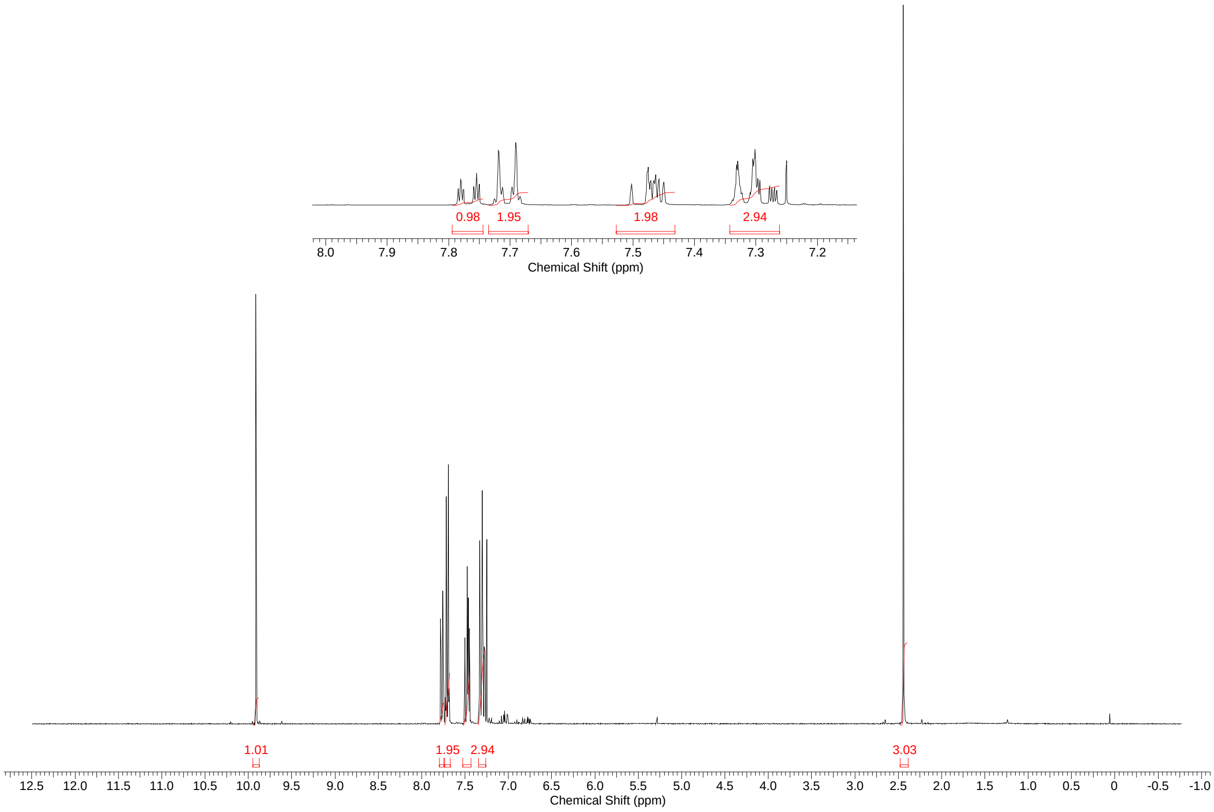

SMe
BocO

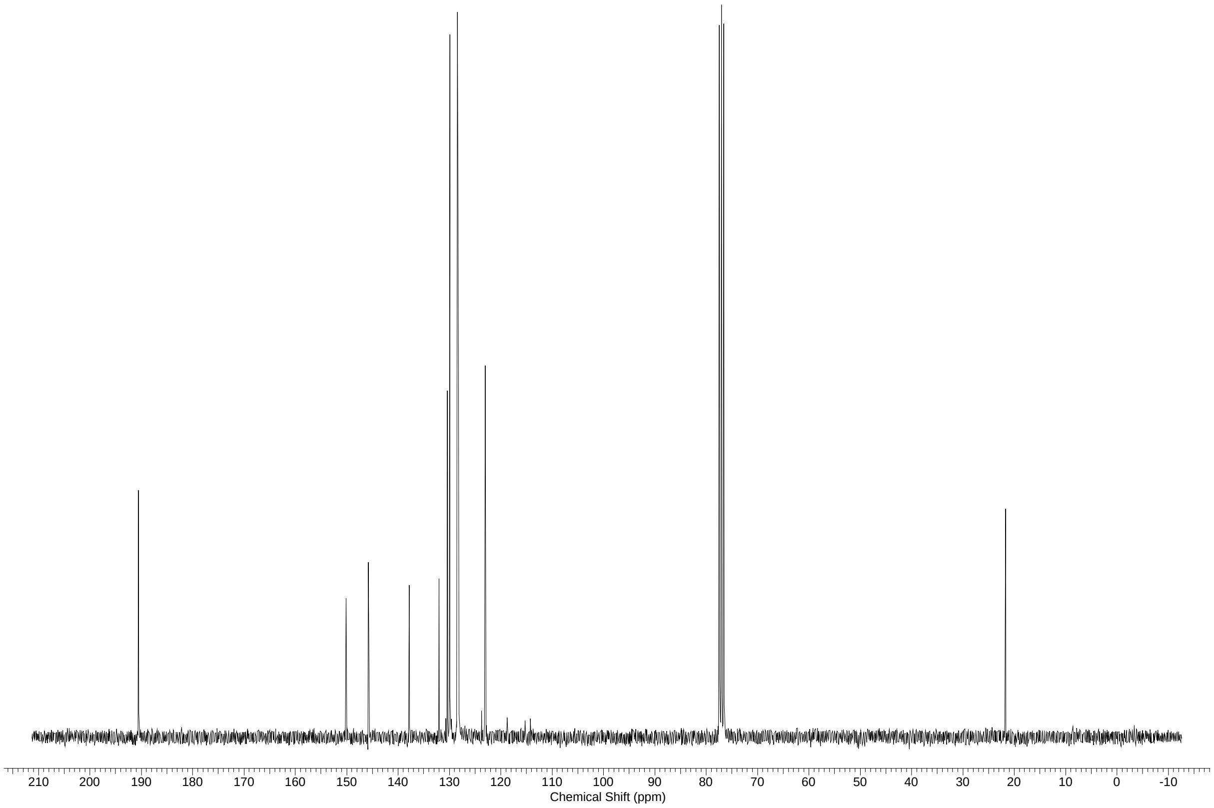

2.02
2.00
7.4
7.3
7.2
7.1
7.0
6.9
6.8
Chemical Shift (ppm)
2.02
2.90
9.00
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
-0.5
-1.0
Chemical Shift (ppm)


210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
Chemical Shift (ppm)

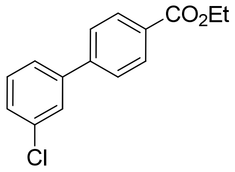
3h:

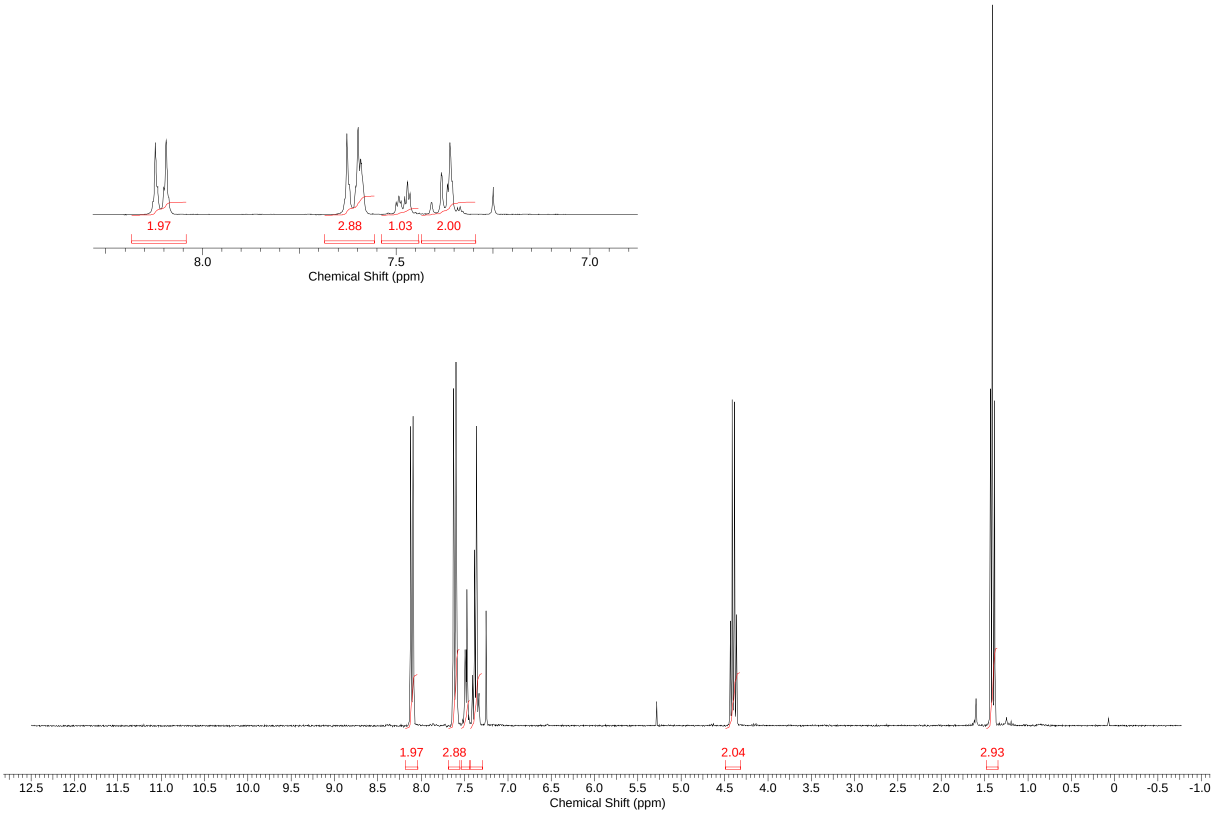

CHO
OTs

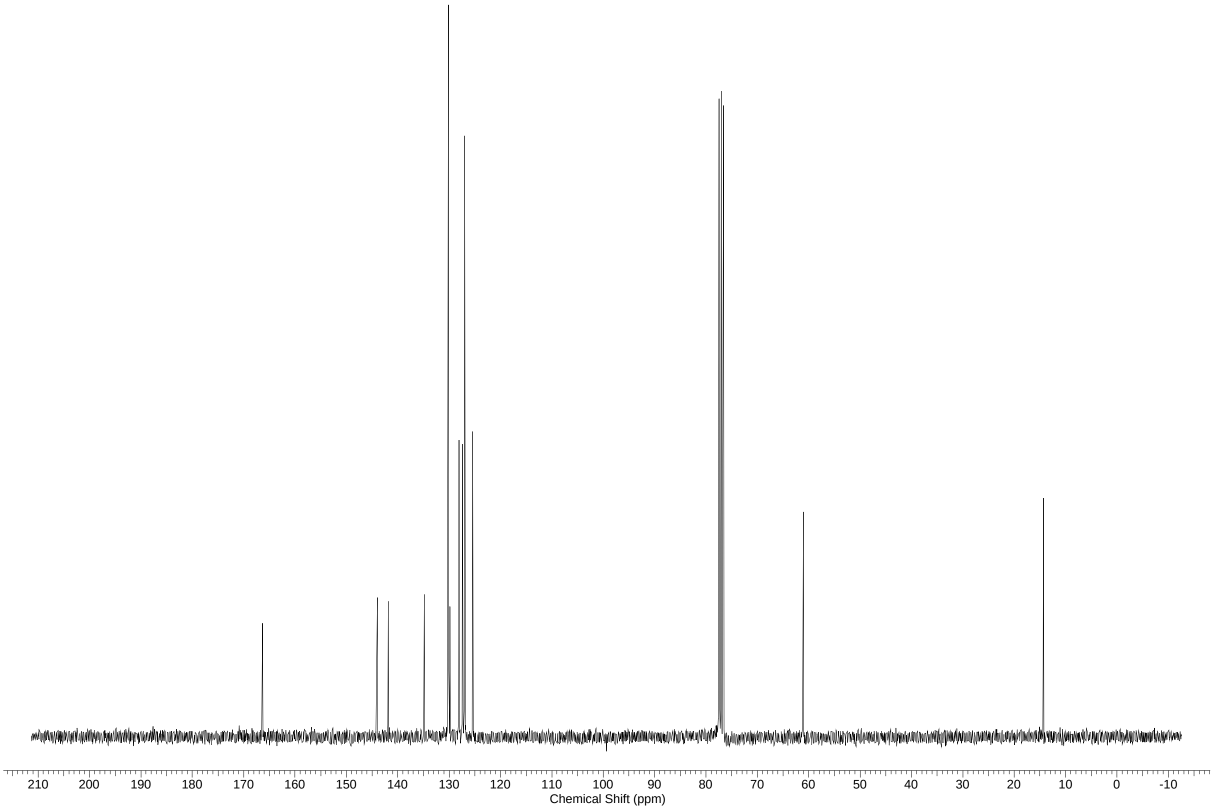

0.98
1.95
1.98
2.94
8.0
7.9
7.8
7.7
7.6
7.5
7.4
7.3
7.2
Chemical Shift (ppm)
1.01
1.95
2.94
3.03
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
-0.5
-1.0
Chemical Shift (ppm)


210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
Chemical Shift (ppm)

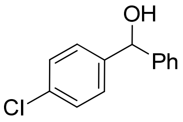
3i:

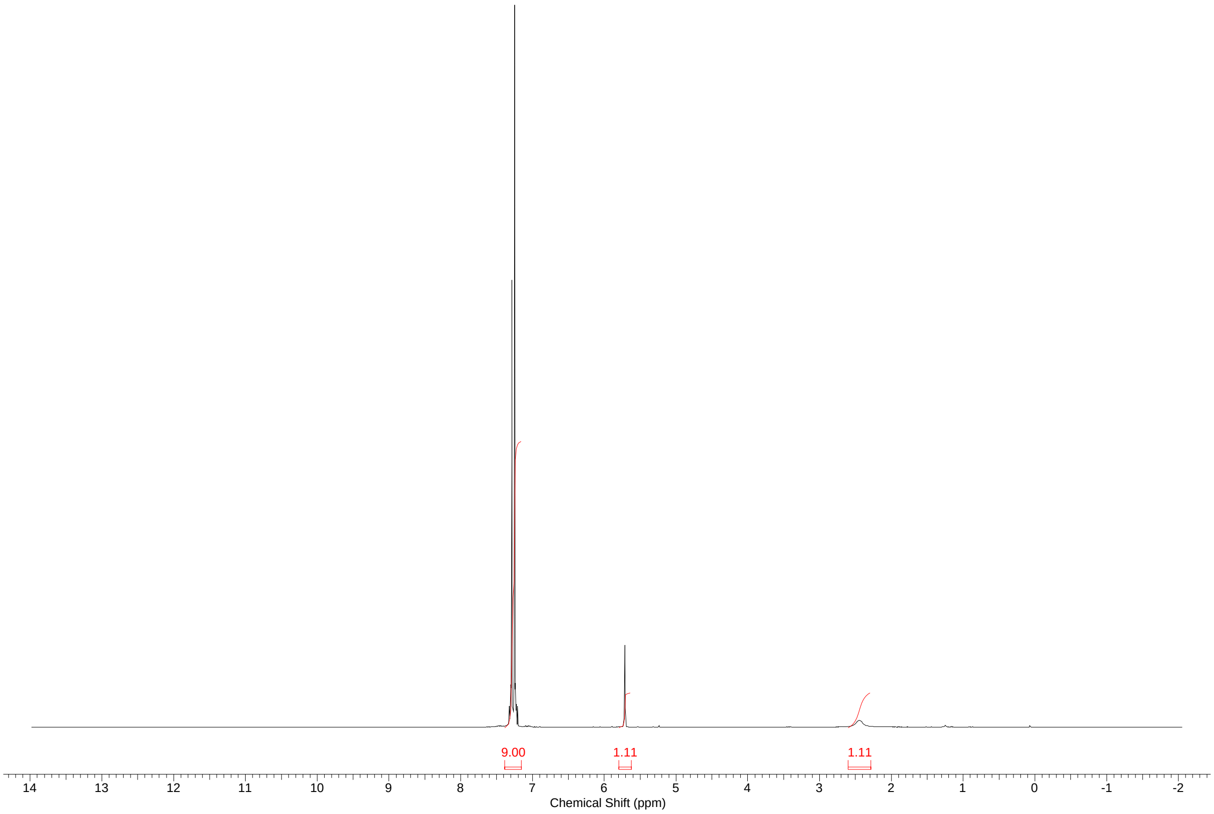

CO2Et
Cl

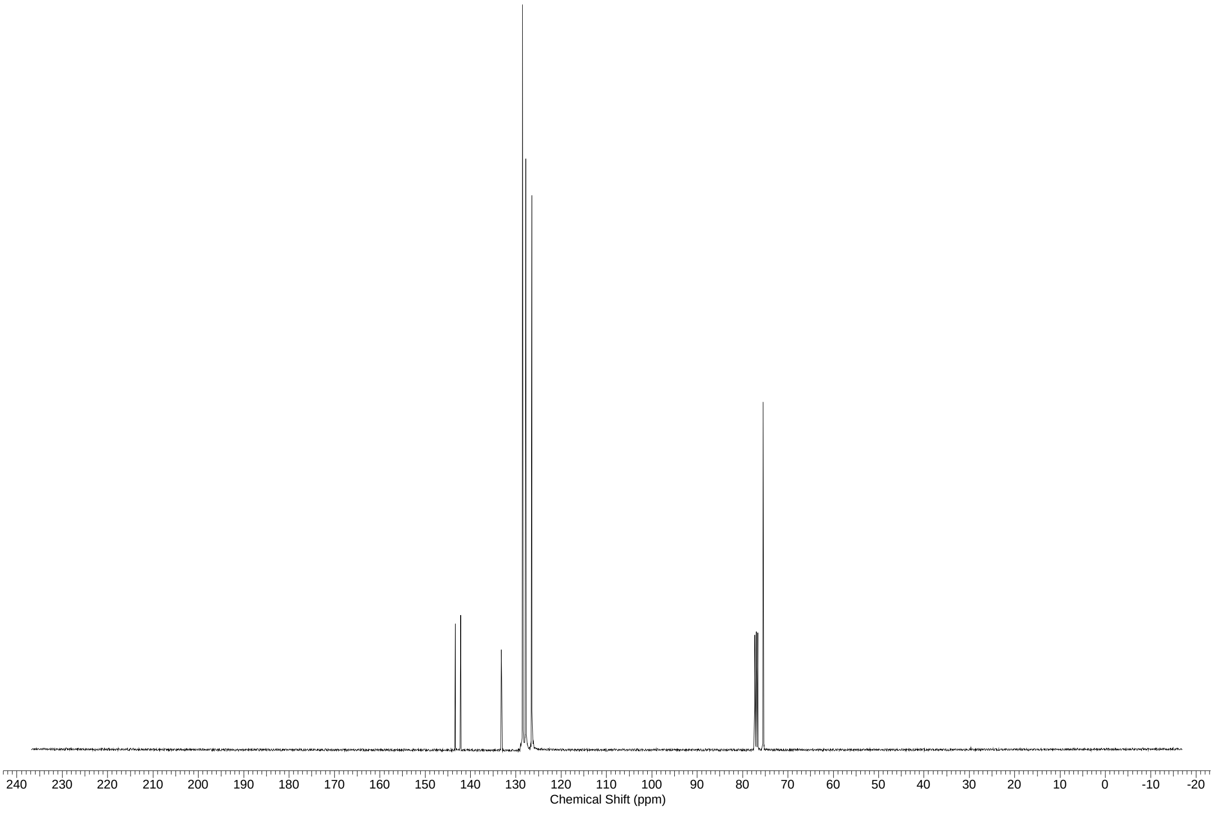

1.97
2.88
1.03
2.00
8.0
7.5
7.0
Chemical Shift (ppm)
1.97
2.88
2.04
2.93
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
-0.5
-1.0
Chemical Shift (ppm)


210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
Chemical Shift (ppm)

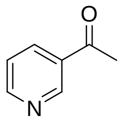
3j:


OH
Ph
Cl


9.00
1.11
1.11
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
Chemical Shift (ppm)


240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
Chemical Shift (ppm)

3k:



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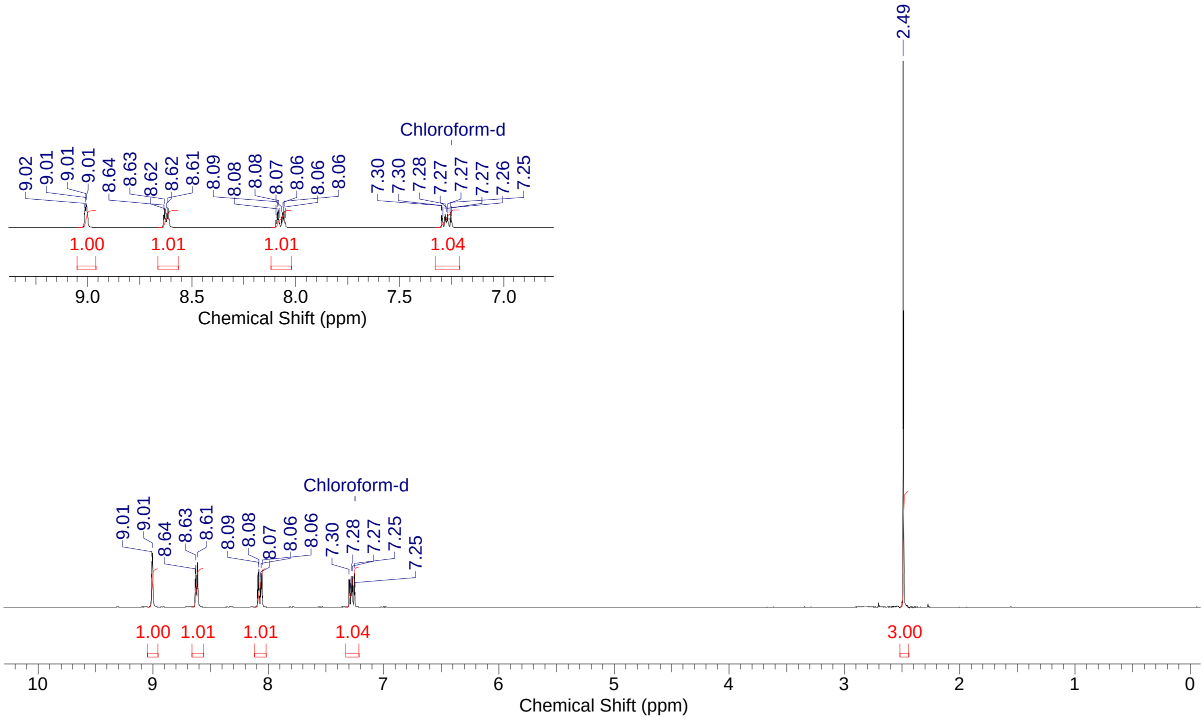
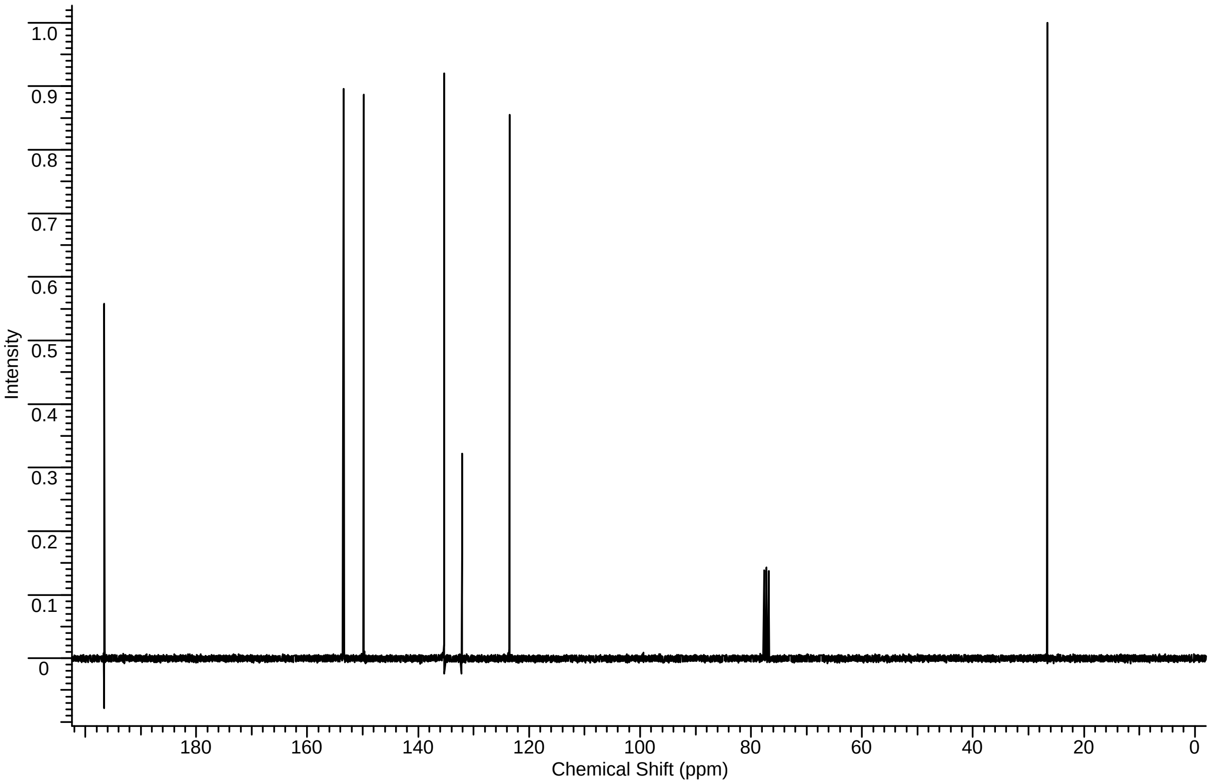
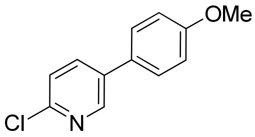
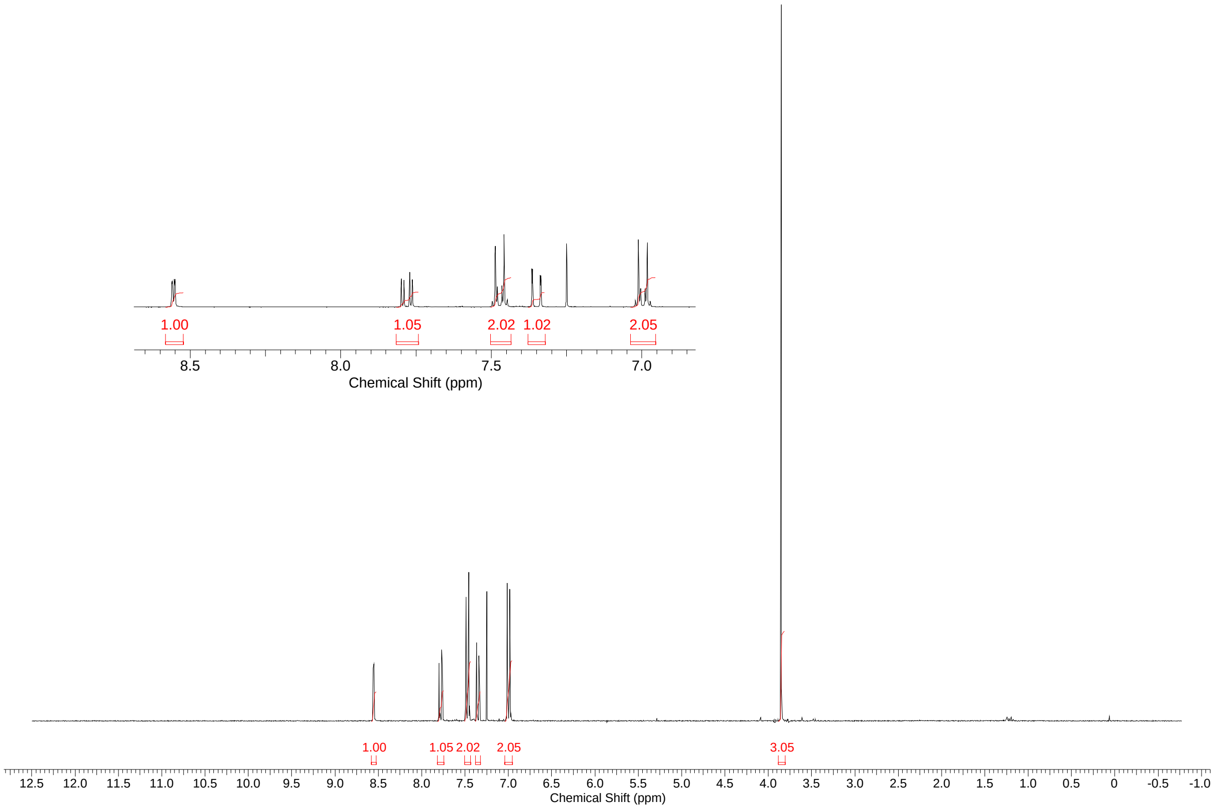
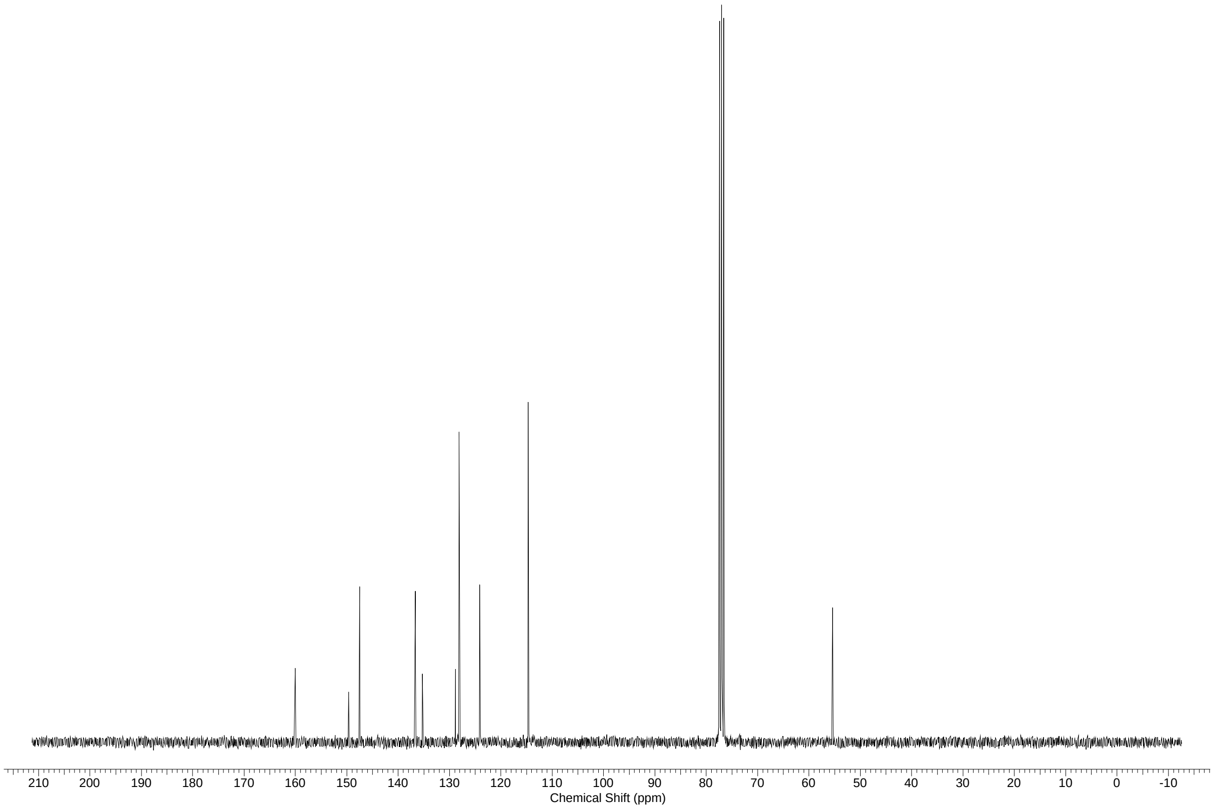




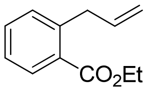
31:


OMe
Cl
N

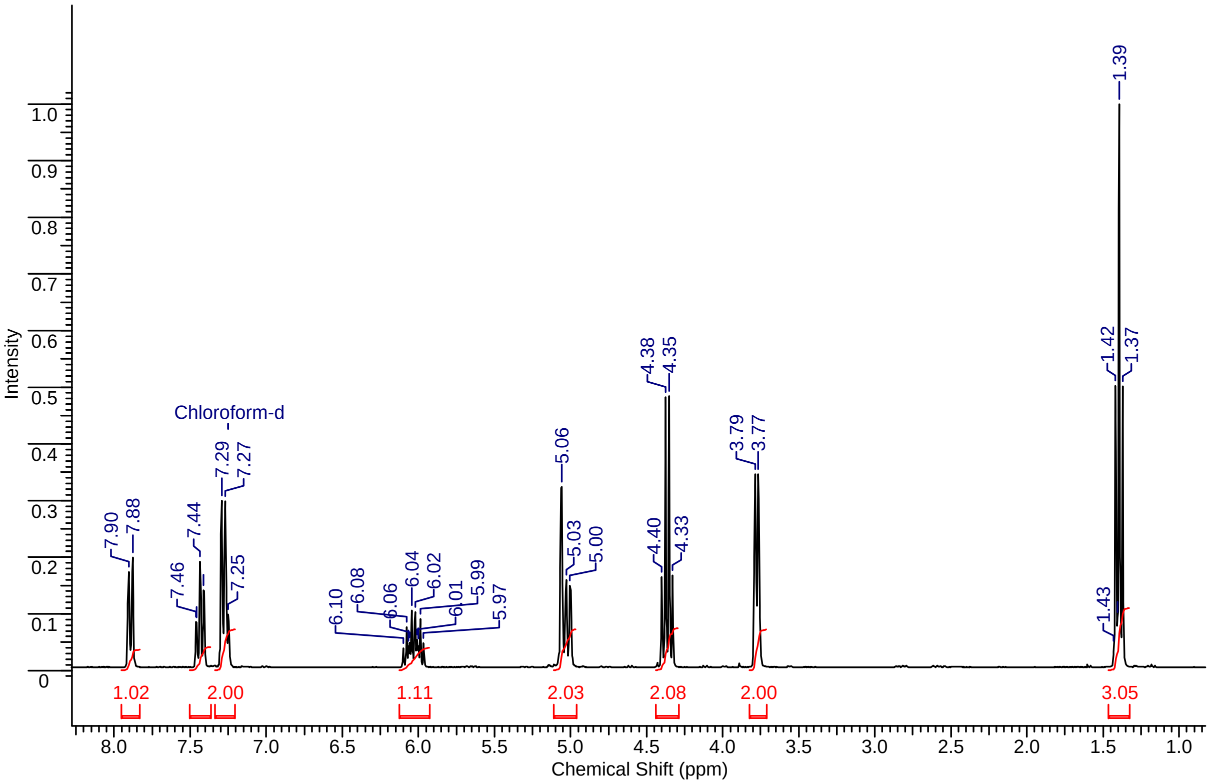

1.00
1.05
2.02
1.02
2.05
8.5
8.0
7.5
7.0
Chemical Shift (ppm)
1.00
1.05
2.02
2.05
3.05
12.5 12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0 -0.5 -1.0
Chemical Shift (ppm)


210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
Chemical Shift (ppm)

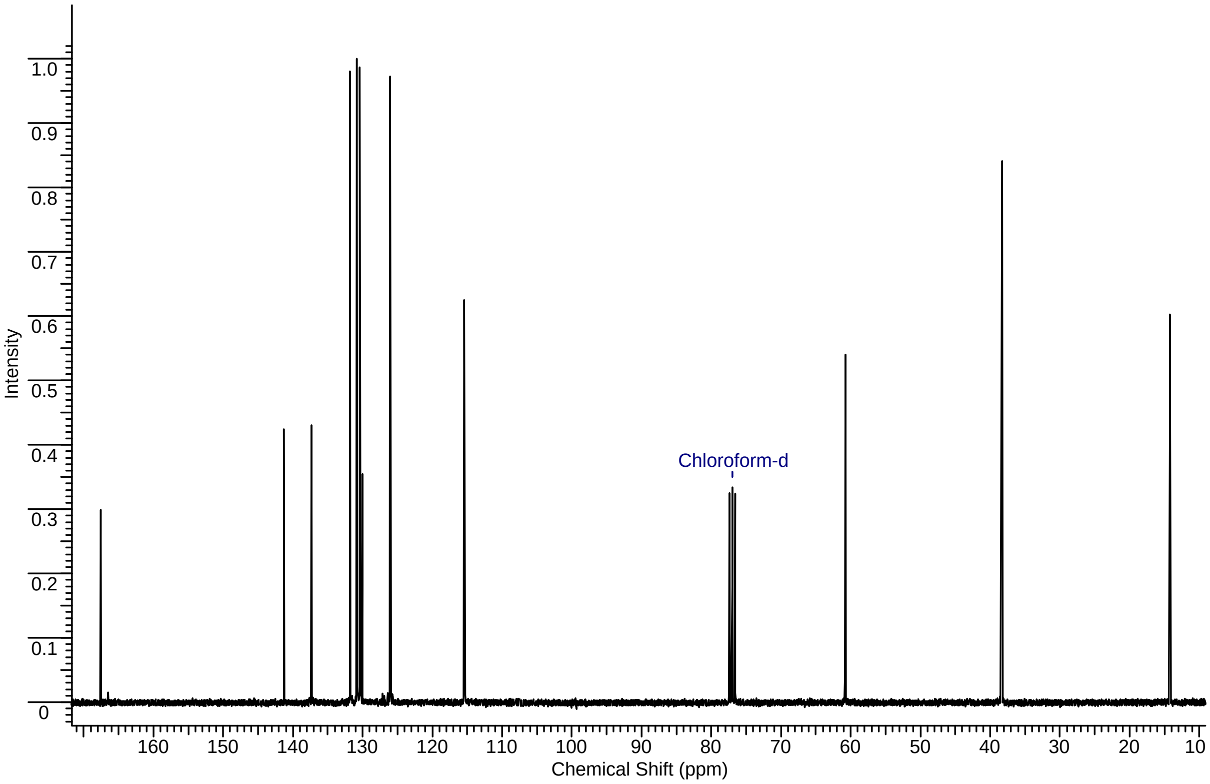
6a:



CO2Et

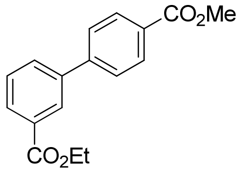


Intensity
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Chloroform-d
7.90
7.88
7.46
7.44
7.29
7.27
7.25
6.10
6.08
6.06
6.04
6.02
6.01
5.99
5.97
5.06
5.03
5.00
4.40
4.38
4.35
4.33
3.79
3.77
1.43
1.42
1.39
1.37
1.02
2.00
1.11
2.03
2.08
2.00
3.05
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
Chemical Shift (ppm)



Intensity
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Chloroform-d
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

6b:



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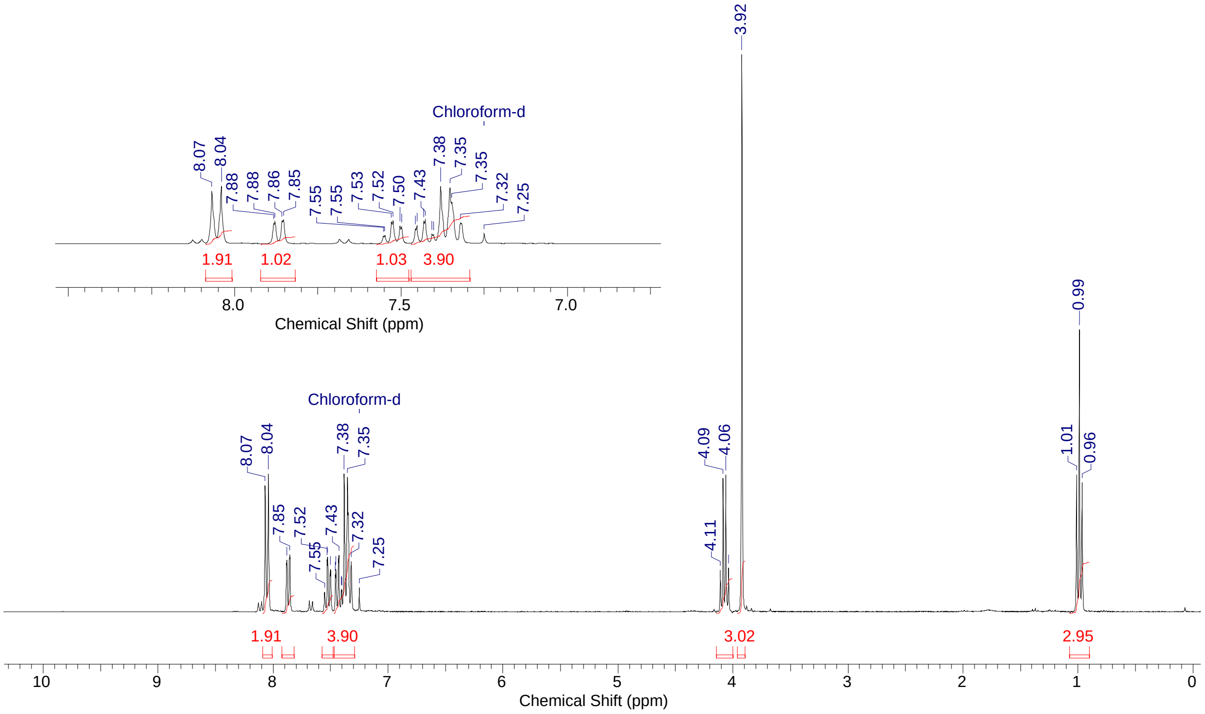
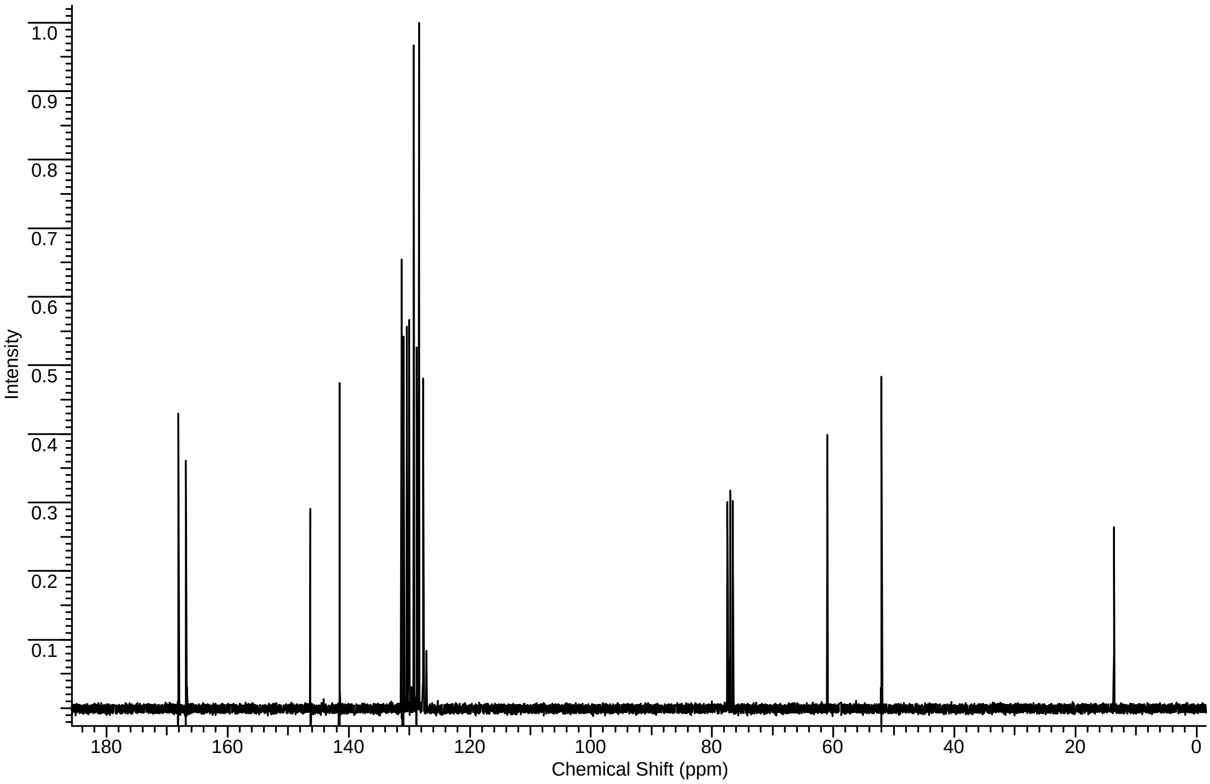
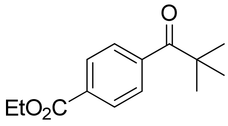
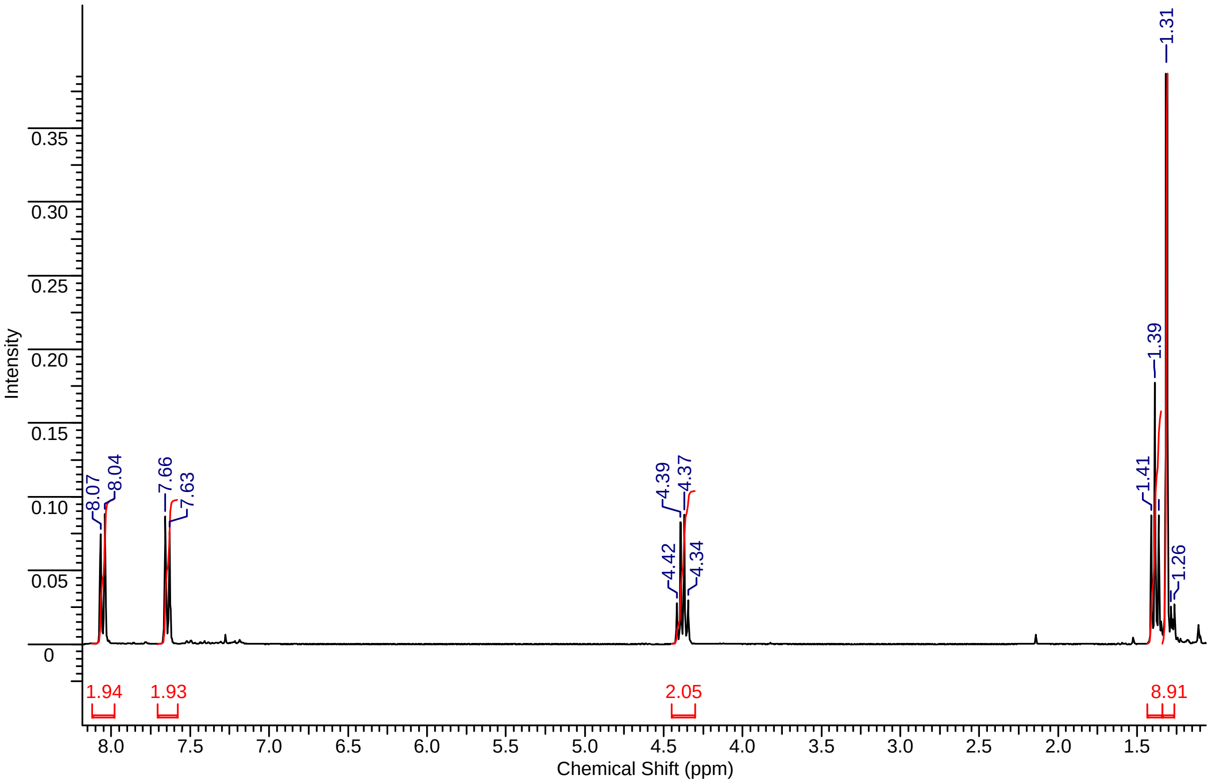
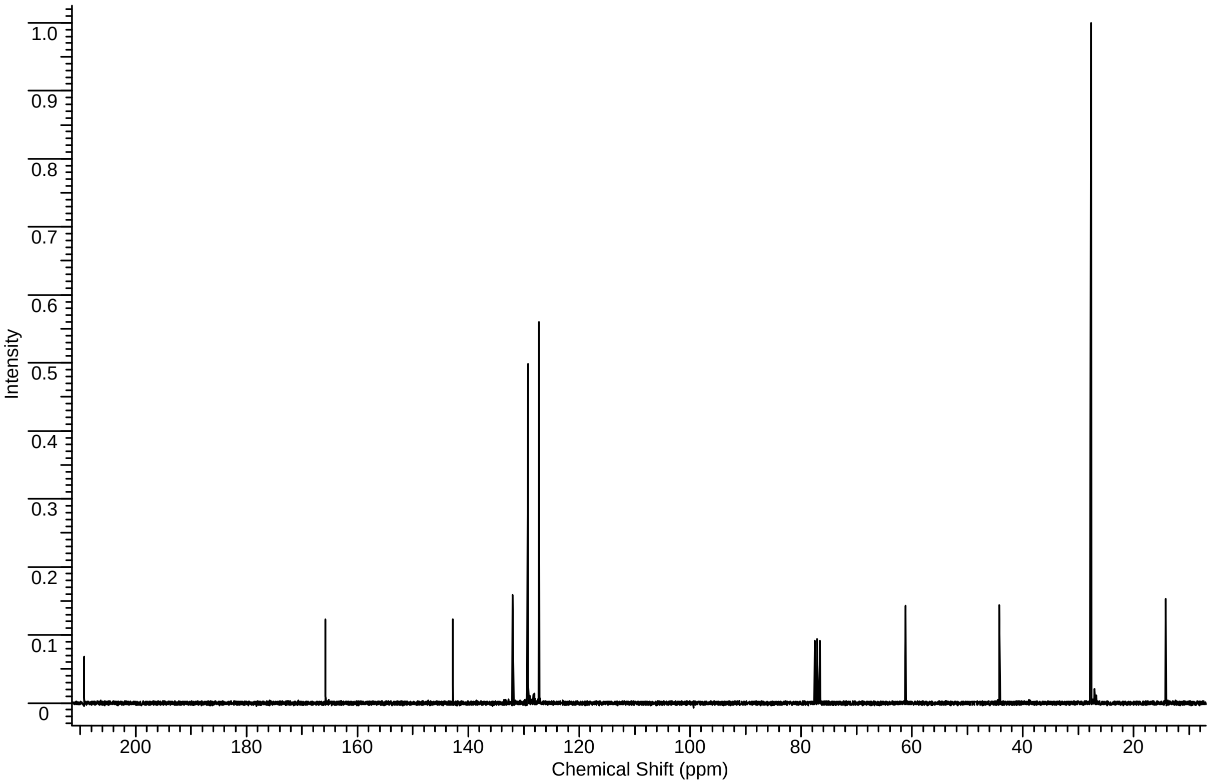




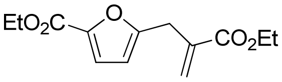
6c:

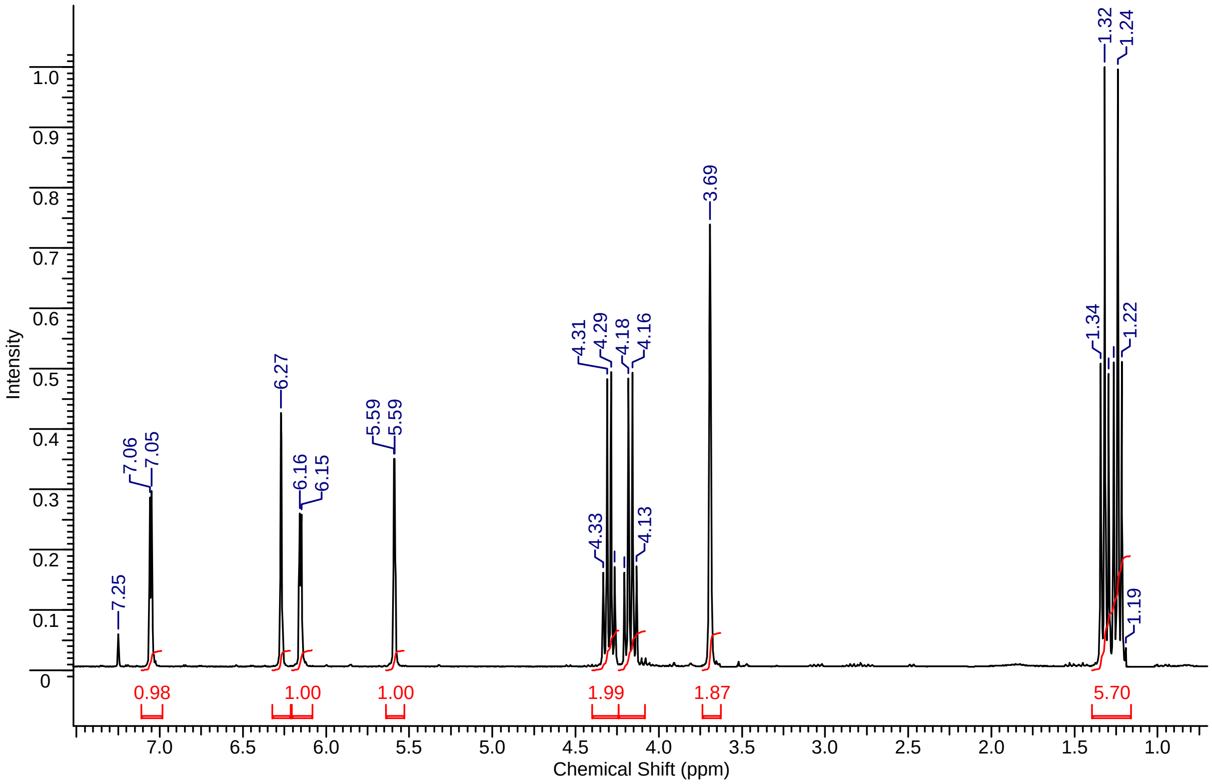

O
EtO2C

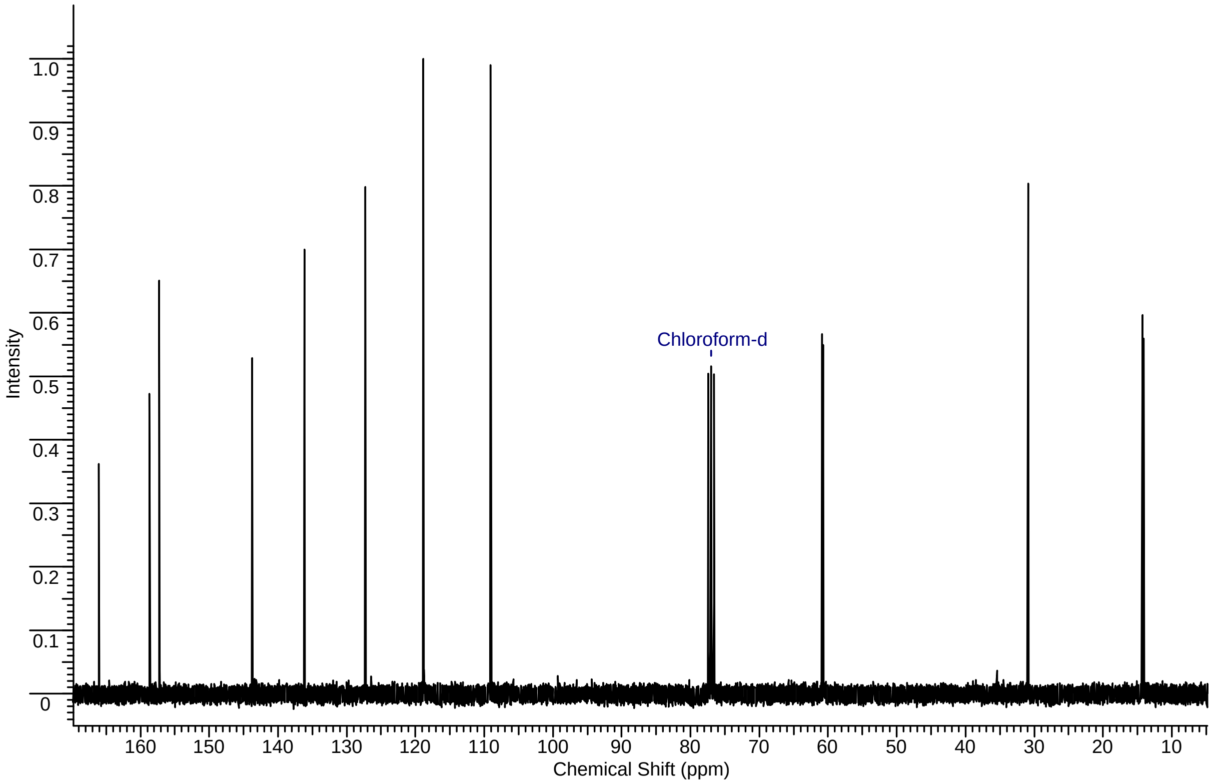

8.07
8.04
7.66
7.63
4.42
4.39
4.37
4.34
1.41
1.39
1.31
1.26
1.94
1.93
2.05
8.91
Intensity
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
Chemical Shift (ppm)


Intensity
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
200
180
160
140
120
100
80
60
40
20
Chemical Shift (ppm)

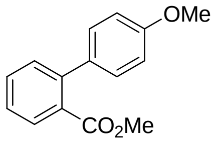
6d:


EtO$_2$C
O
CO$_2$Et


Intensity
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
7.25
7.06
7.05
6.27
6.16
6.15
5.59
5.59
4.33
4.31
4.29
4.18
4.16
4.13
3.69
1.34
1.32
1.24
1.22
1.19
0.98
1.00
1.00
1.99
1.87
5.70
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
Chemical Shift (ppm)


Intensity
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Chloroform-d
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

6e:



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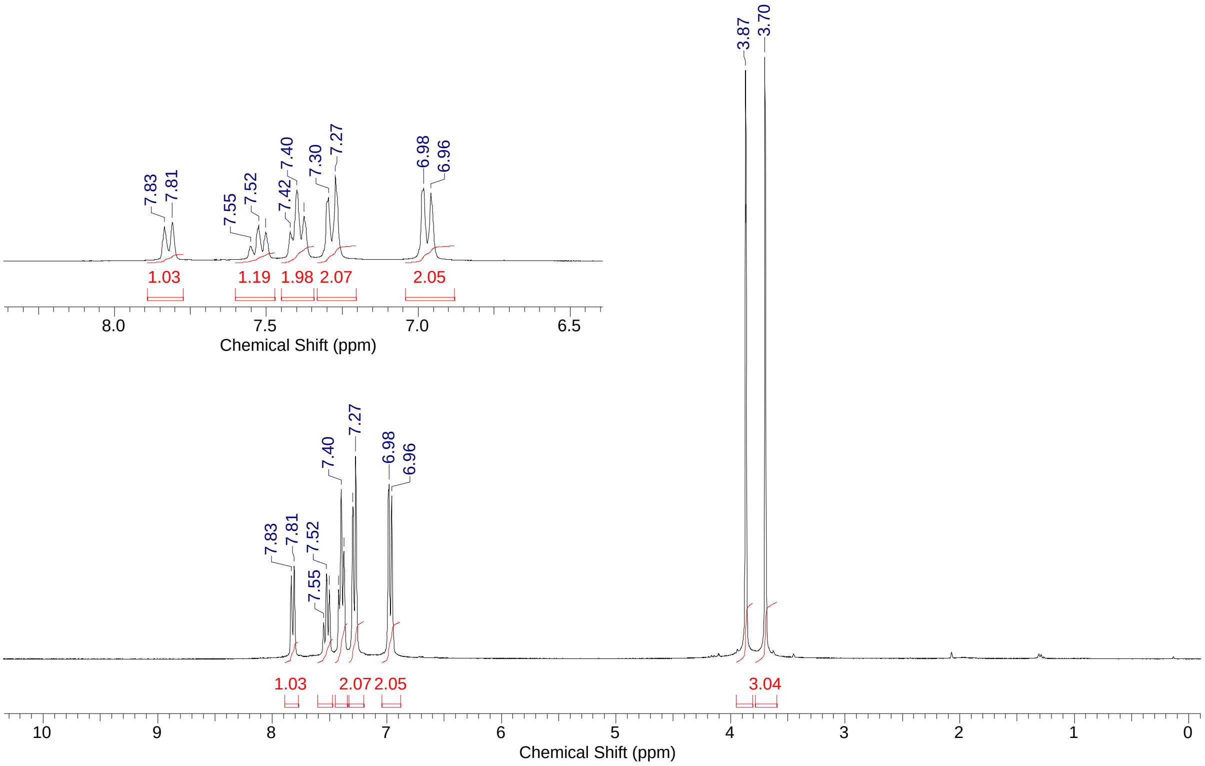
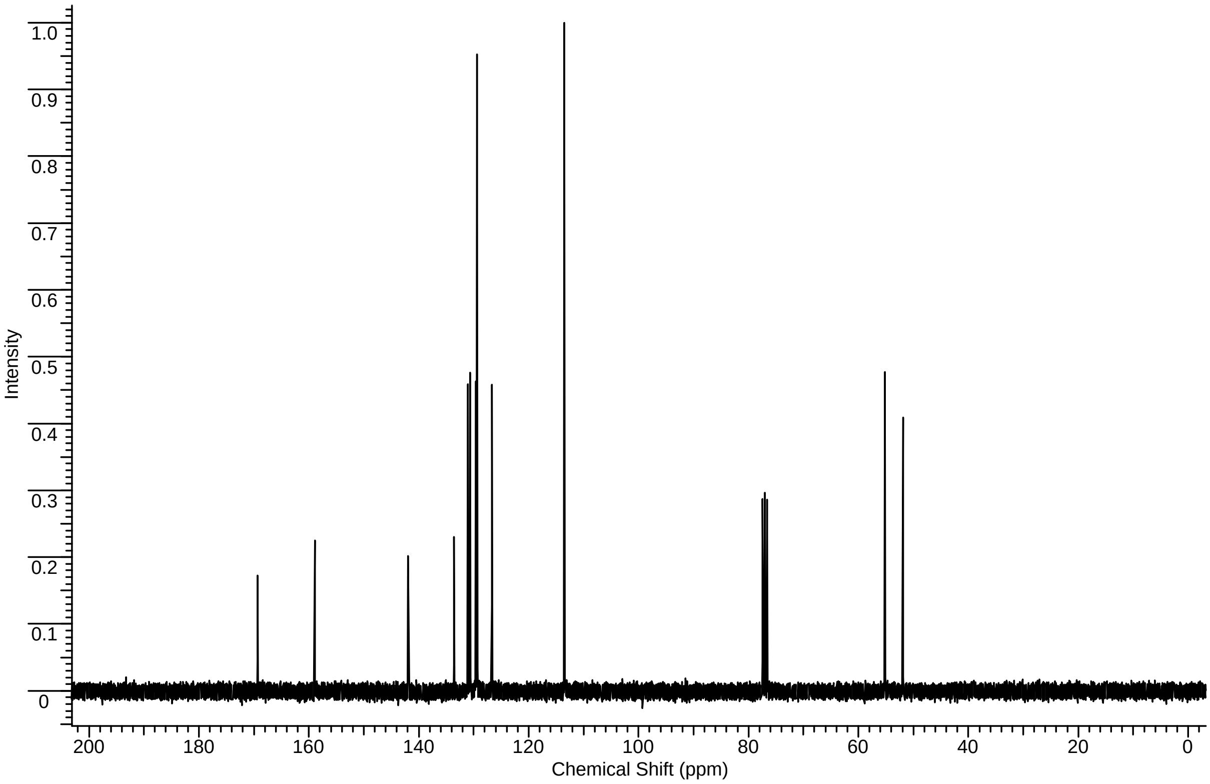
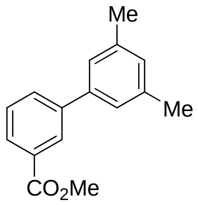
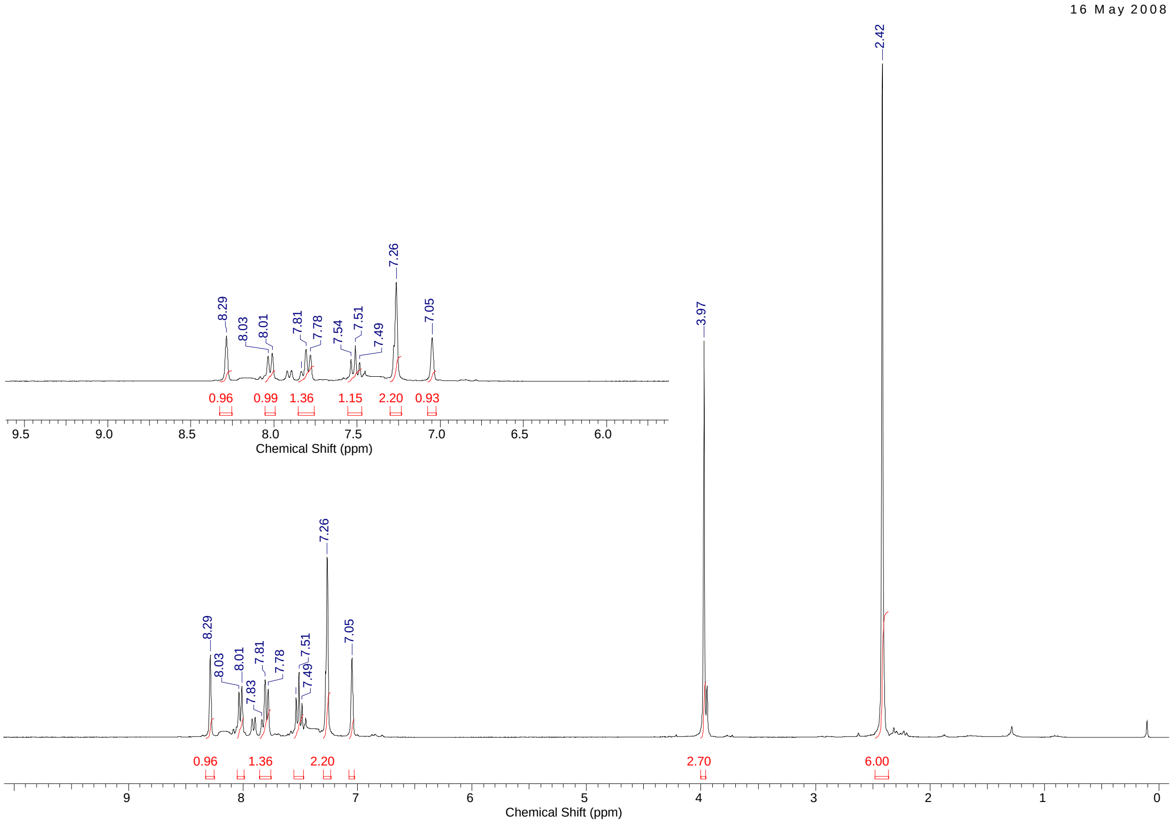
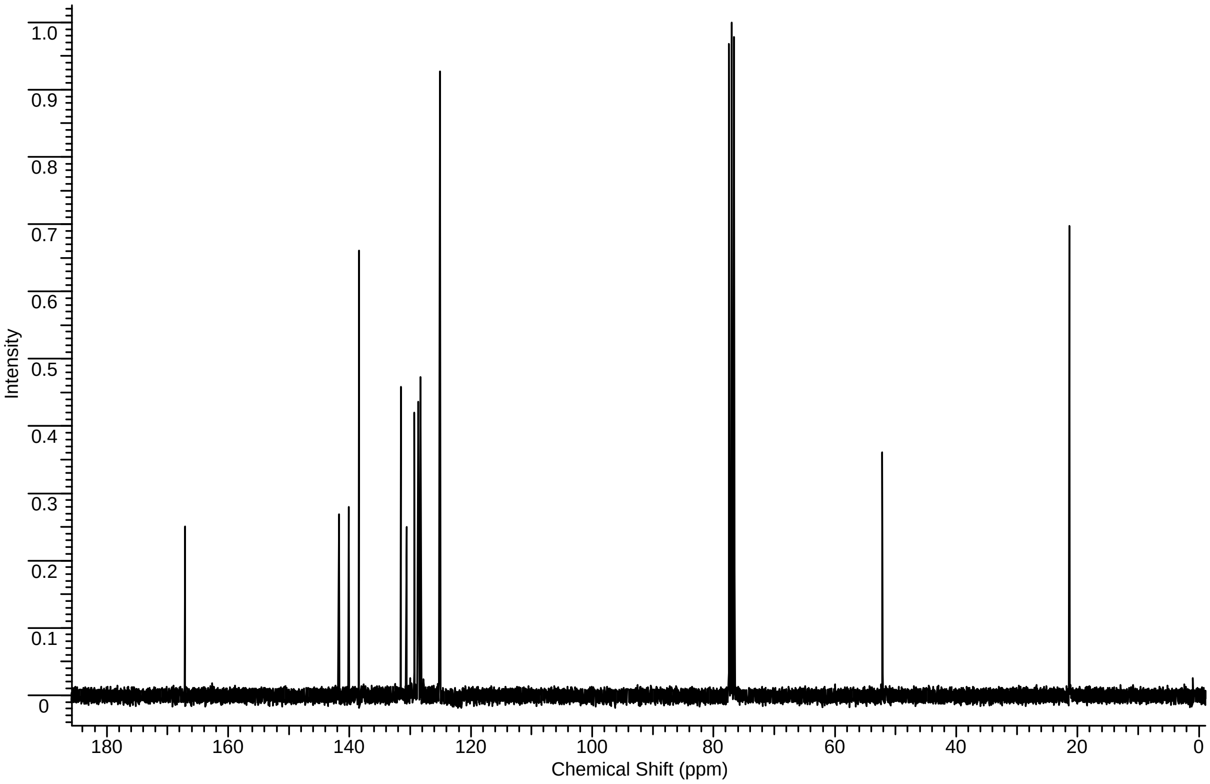




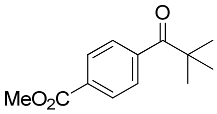
6f:

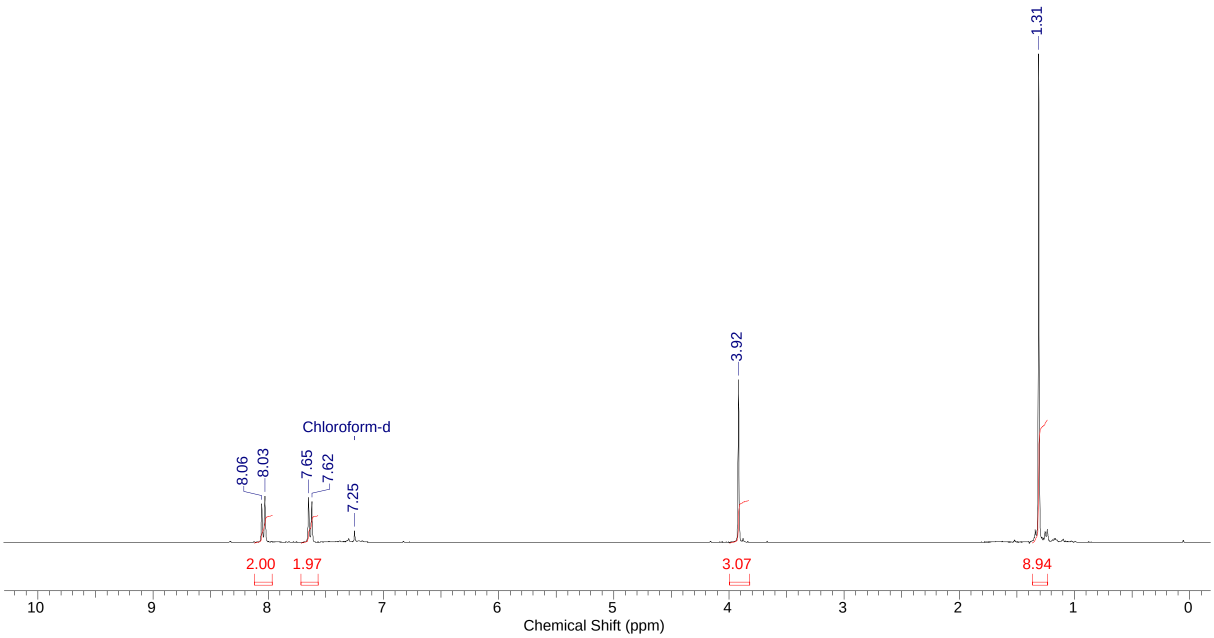

Me
Me
CO2Me

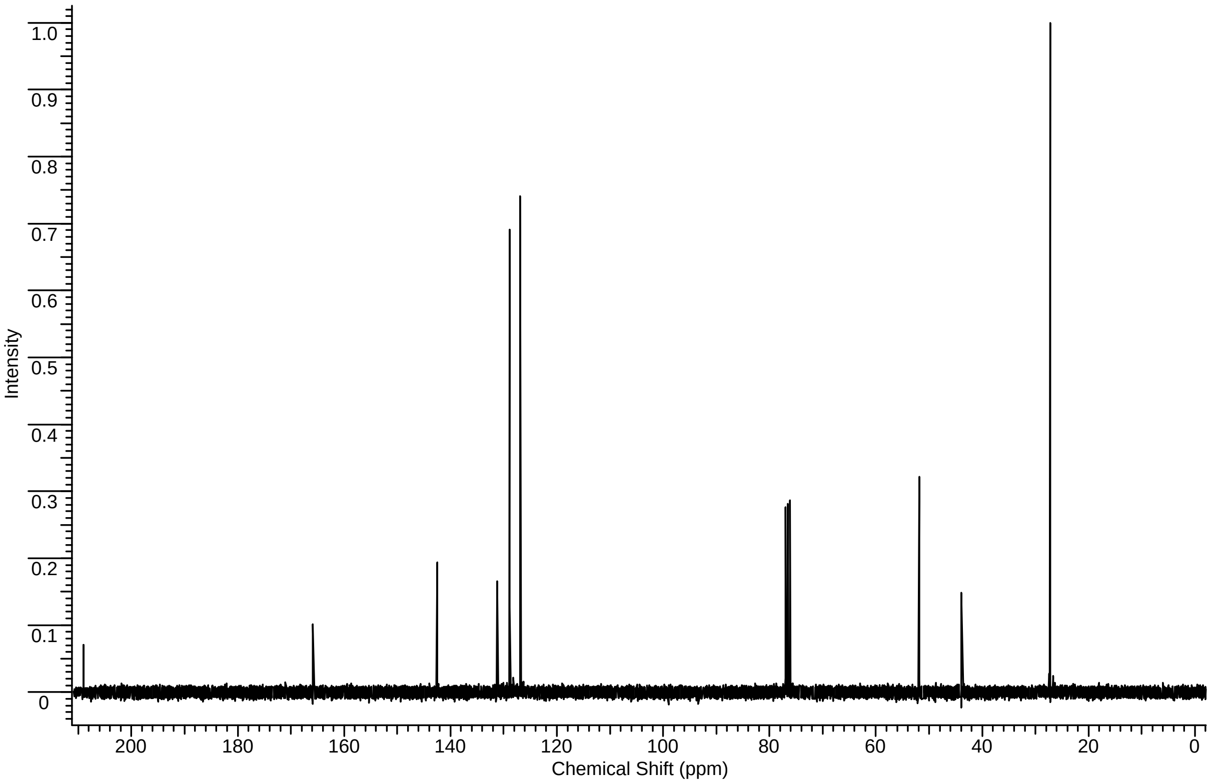

16 May 2008
8.29
8.03
8.01
7.81
7.78
7.54
7.51
7.49
7.26
7.05
0.96
0.99
1.36
1.15
2.20
0.93
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
Chemical Shift (ppm)
7.83
3.97
2.42
2.70
6.00
9
8
7
6
5
4
3
2
1
0
Chemical Shift (ppm)


Intensity
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
180
160
140
120
100
80
60
40
20
0
Chemical Shift (ppm)

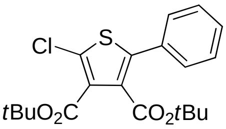
6g:


MeO2C
O

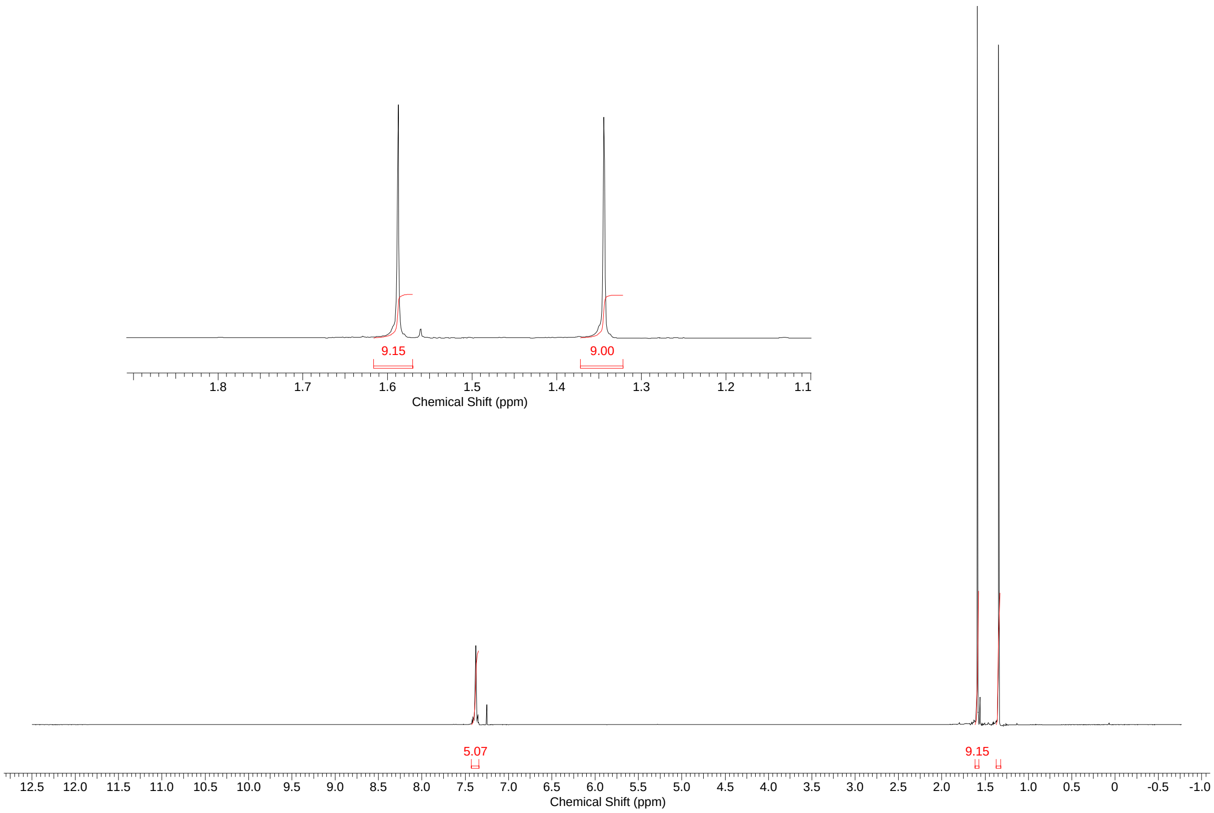

8.06
8.03
7.65
7.62
7.25
Chloroform-d
3.92
1.31
2.00
1.97
3.07
8.94
10
9
8
7
6
5
4
3
2
1
0
Chemical Shift (ppm)


Intensity
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
200
180
160
140
120
100
80
60
40
20
0
Chemical Shift (ppm)

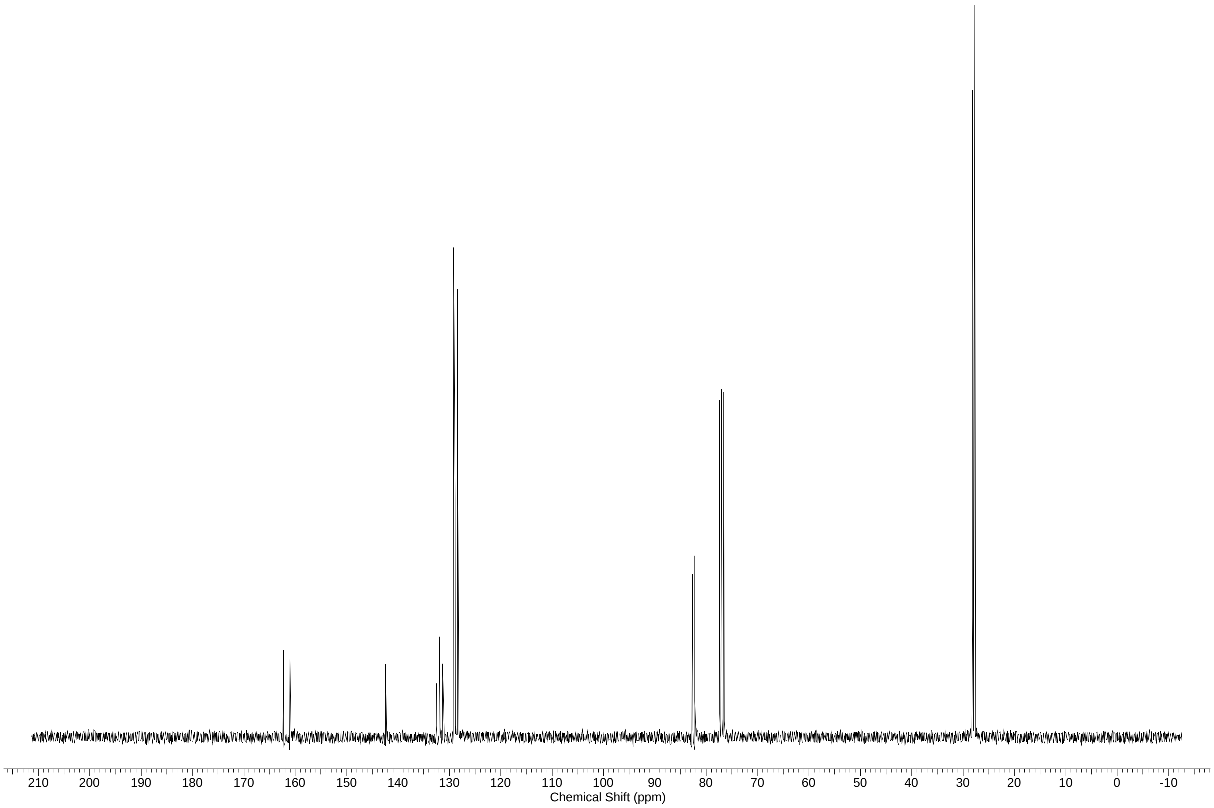
8 :



Cl
S
tBuO$_2$C
CO$_2t$Bu

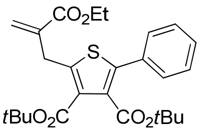


9.15
9.00
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
Chemical Shift (ppm)
5.07
9.15
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
-0.5
-1.0
Chemical Shift (ppm)

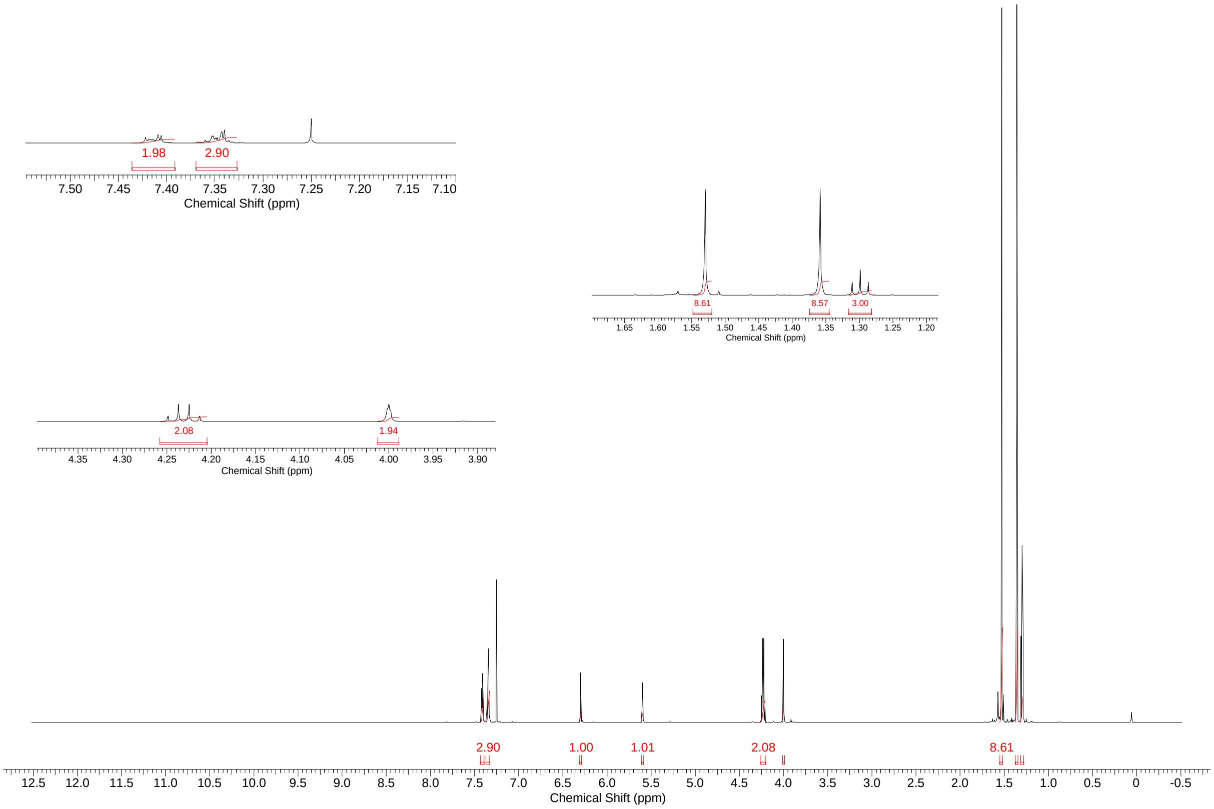


210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
Chemical Shift (ppm)

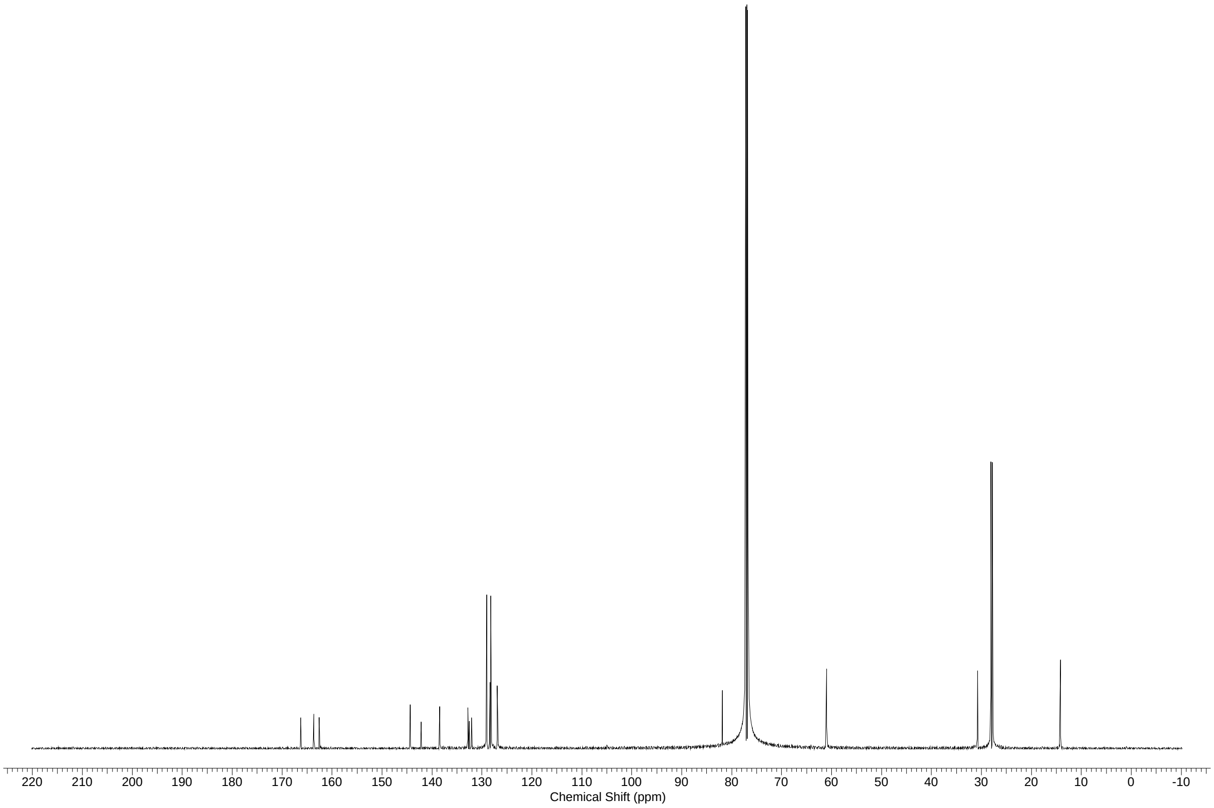
9 :



CO2Et
S
tBuO2C
CO2tBu

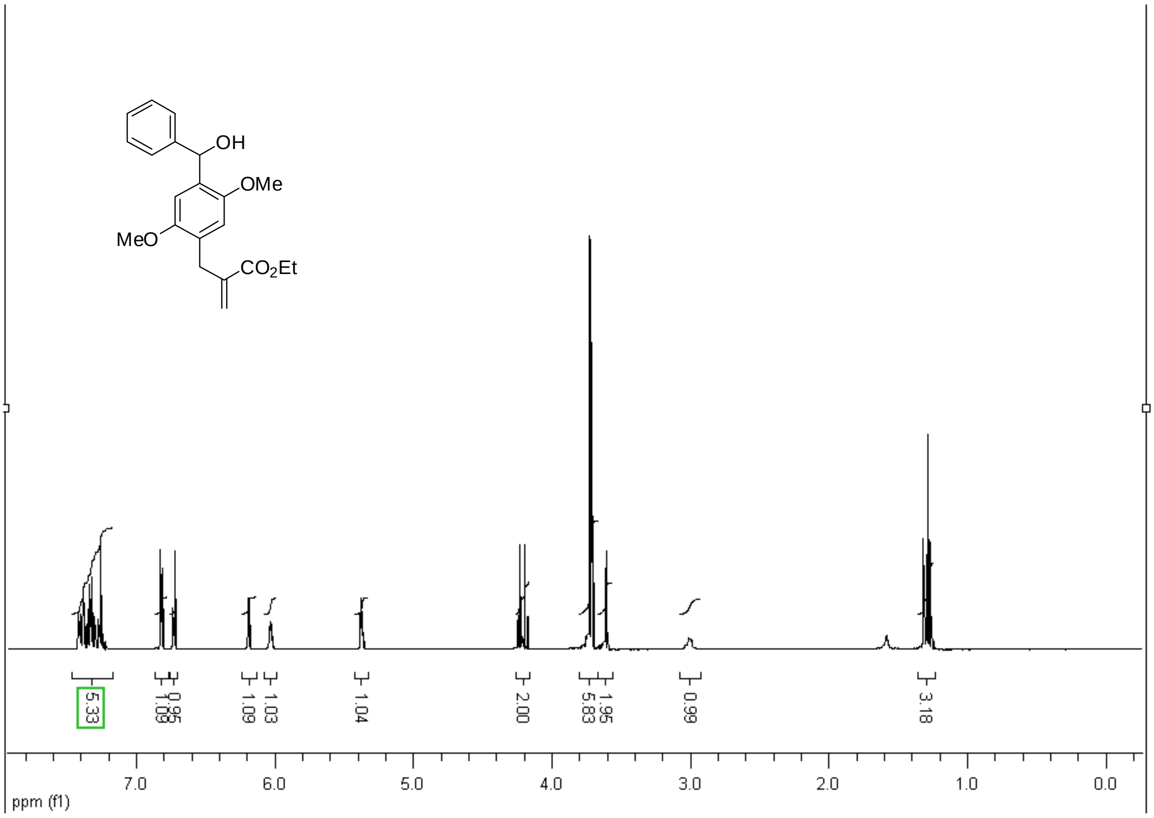


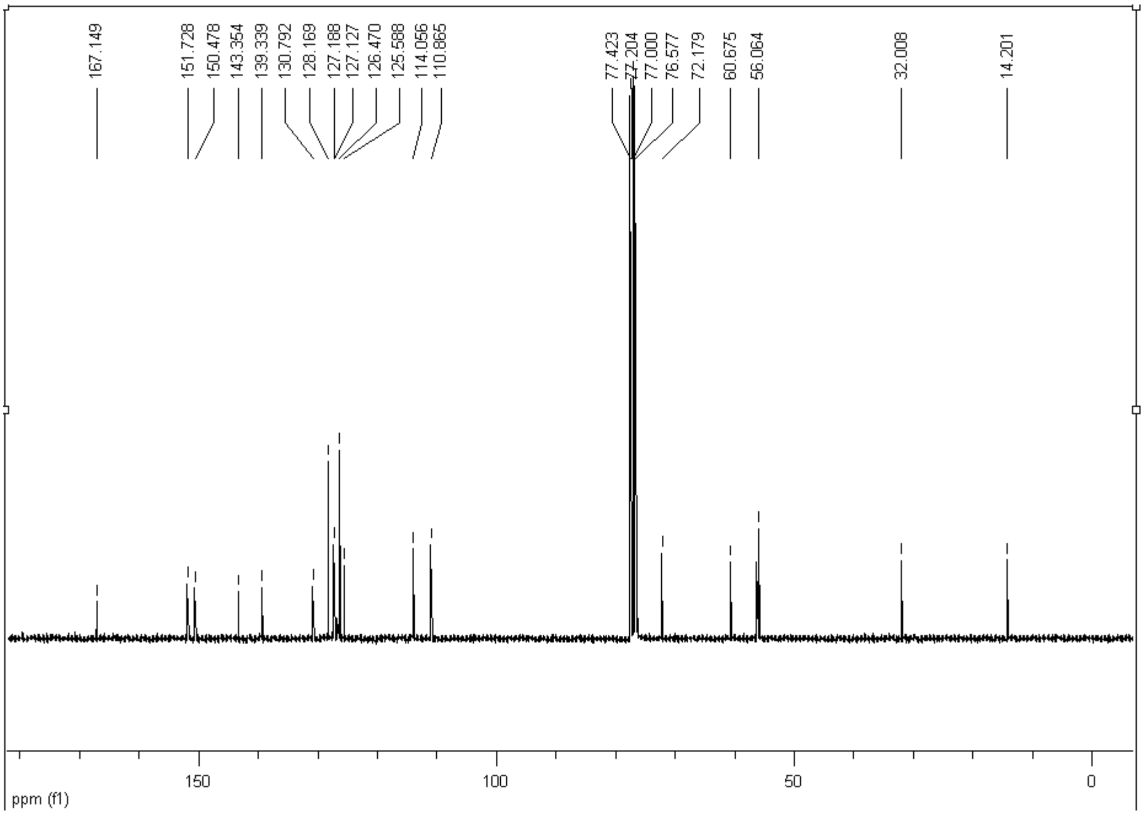
1.98
2.90
7.50
7.45
7.40
7.35
7.30
7.25
7.20
7.15
7.10
Chemical Shift (ppm)
8.61
8.57
3.00
1.65
1.60
1.55
1.50
1.45
1.40
1.35
1.30
1.25
1.20
Chemical Shift (ppm)
2.08
1.94
4.35
4.30
4.25
4.20
4.15
4.10
4.05
4.00
3.95
3.90
Chemical Shift (ppm)
2.90
1.00
1.01
2.08
8.61
12.5
12.0
11.5
11.0
10.5
10.0
9.5
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
0
-0.5
Chemical Shift (ppm)



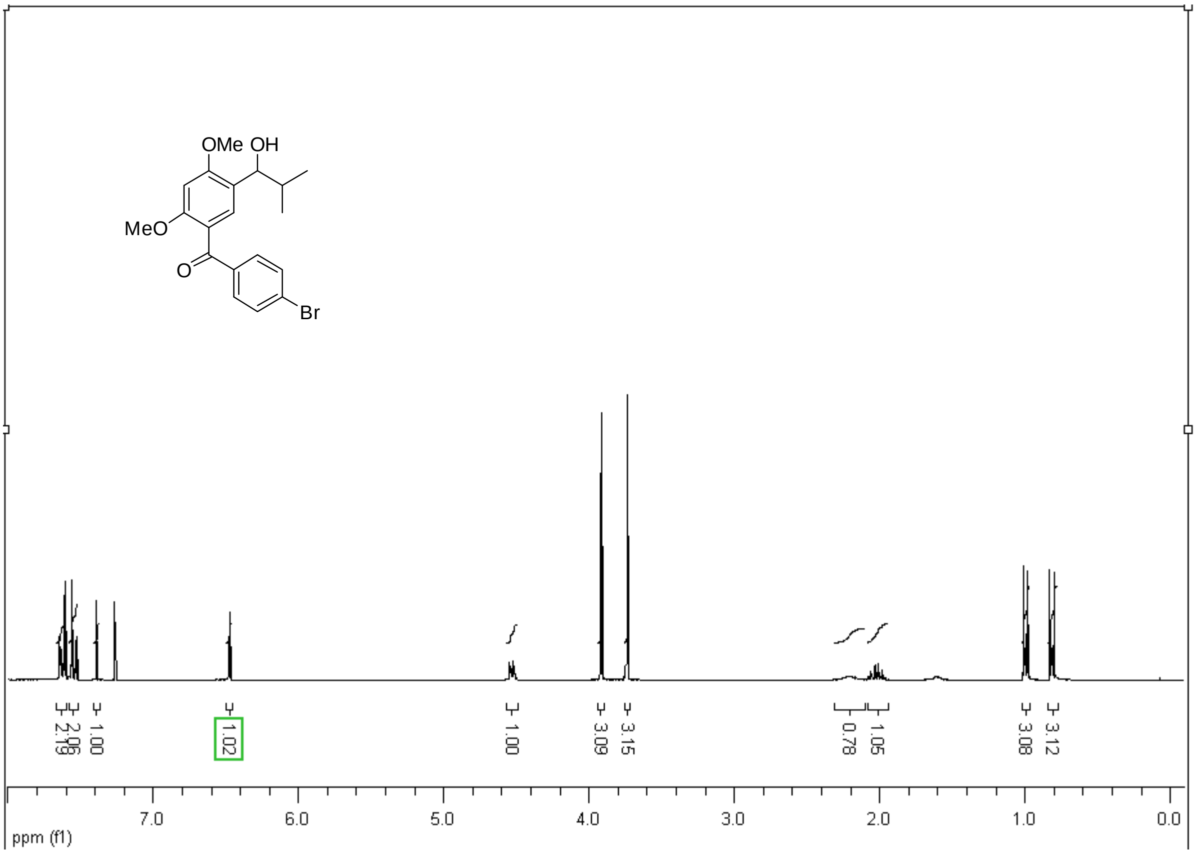
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
Chemical Shift (ppm)

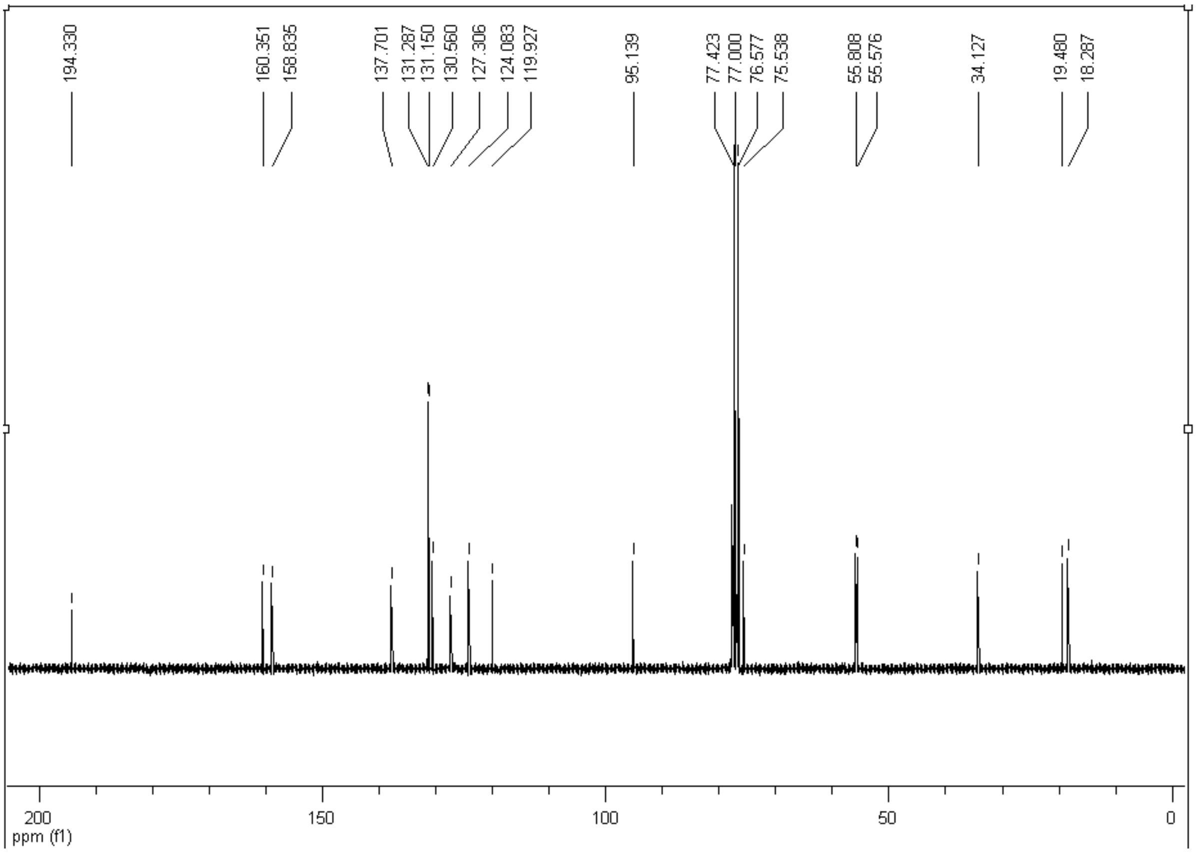
12:


OH
OMe
MeO
CO_2Et
5.33
1.09
0.85
1.09
1.03
1.04
2.00
5.83
1.95
0.99
3.18
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (f1)


167.149
151.728
150.478
143.354
139.339
130.792
128.169
127.188
127.127
126.470
125.588
114.056
110.865
77.423
77.204
77.000
76.577
72.179
60.675
56.064
32.008
14.201
150
100
50
0
ppm (f1)

13:


OMe
OH
MeO
O
Br
2.19
2.06
1.00
1.02
1.00
3.09
3.15
0.78
1.05
3.08
3.12
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
ppm (f1)


194.330
160.351
158.835
137.701
131.287
131.150
130.560
127.306
124.083
119.927
95.139
77.423
77.000
76.577
75.538
55.808
55.576
34.127
19.480
18.287
200
150
100
50
0
ppm (f1)