Electronic Supplementary Material (ESI) for Chemical Communications

Ruthenium-Catalyzed *ortho*-C−H Halogenations of Benzamides

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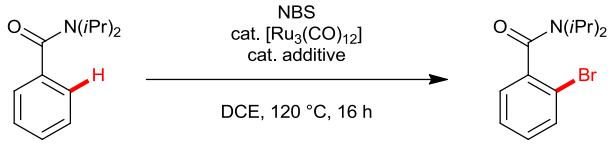
Supporting information

General Remarks

Catalytic reactions were carried out under a N_2 atmosphere using pre-dried seal tubes. Compound $[D]_1$-**4** was synthesized according to previously described method.[1] Commercially available chemicals were obtained from Acros Organics, Aldrich Chemical Co., Alfa Aesar, ABCR and TCI Europe, and were used without further purification. 1,2-Dichloroethane (DCE) was dried and distilled over CaH_2. Yields refer to isolated compounds, estimated to be >95 % pure as determined by ^{1}H-NMR and GC. TLC: Macherey-Nagel, TLC plates Alugram® Sil G/UV254. Detection under UV light at 254 nm. Chromatography: Separations were carried out on Merck Silica 60 (0.040–0.063 mm, 70–230 mesh ASTM). All IR spectra were recorded on a Bruker FT-IR Alpha device. MS: EI-MS: Finnigan MAT 95, 70 eV; ESI-MS: Finnigan LCQ. High resolution mass spectrometry (HRMS): APEX IV 7T FTICR, Bruker Daltonic. M. p.: Stuart® Melting Point Apparatus SMP3, values are uncorrected. NMR (^{1}H, ^{13}C, ^{19}F) spectra were recorded at 300 (^{1}H), 75 {^{13}C, APT (Attached Proton Test)} and 283 MHz (^{19}F), respectively, on Varian Unity-300 and AMX 300 instruments for $CDCl_3$ solutions if not otherwise specified, chemical shifts (δ) are given in ppm. Gas chromatography (GC) analysis applied instrument *7890A GC-System* with mass detector *5975C (Triplex-Axis-Detector)* from AGILENT TECHNOLOGIES equipped with *HP-5MS* column (30 m × 0.25 mm, film 0.25 µm). High-performance liquid chromatography (HPLC) was performed using a Knauer ClarityChrom (Smartline Pump 100, UV detection monitored at 254nm) with commercial normal phase 10 x 250 mm column.

Table S-1 Optimization of the reaction conditions[a]



1a **2a**

Entry	Additive (equiv)	2a[b]
1	---	27%
2[c]	---	---
3[c]	PivOH (2.0)	---
4	PivOH (2.0)	57%
5	PivOH (0.2)	19%
6	AcOH (2.0)	37%
7	Ac_2O (2.0)	60%
8	1-AdCO_2H (2.0)	57%
9	PTSA·H_2O (2.0)	5%
10	TFA (2.0)	39%
11	MesCO_2H (2.0)	9%
12	Cl_3CCO_2H (2.0)	18%
13	PhCO_2H (2.0)	24%
14	(3,4,5-*tri*-F)-$C_6H_2CO_2H$ (2.0)	2%
15	AgOAc (0.2)	58%
16	$AgOCOCF_3$ (0.2)	41%
17	AgOPiv (0.2)	60%
18	AgO_2CAd (0.2)	64%, 60%[d]
19	AgO_2CAd (0.5)	67%, 62%[d]
20	AgCl (0.2)	20%
21	PPh_3 (0.2)	---
22	$AgSbF_6$ (0.2)	18%
23	Ag_2CO_3 (0.2)	34%
24	KPF_6 (0.2)	22%
25	$PhI(OAc)_2$ (2.0)	21%
26	CsOAc (0.2)	24%
27[e]	AgO_2CAd (0.2)	21%
28[f]	AgO_2CAd (0.2)	51%
29[c]	AgO_2CAd (0.2)	---
30	AgO_2CAd (0.2) + $CuBr_2$ (2.0)	13%
31	AgO_2CAd (0.2) + AgCl (2.0)	52%
32	AgO_2CAd (0.2) + $Cu(OAc)_2$ (2.0)	58%

[a] General reaction conditions: **1a** (0.5 mmol), NBS (1.0 mmol), $[Ru_3(CO)_{12}]$ (3.3 mol%), additive, DCE (2.0 mL), 120 °C, 16 h. [b] NMR conversion with 1,3,5-trimethoxybenzene as internal standard. [c] Without $[Ru_3(CO)_{12}]$. [d] Isolated yield. [e] 1.0 mol% $[Ru_3(CO)_{12}]$. [f] 2.0 mol % $[Ru_3(CO)_{12}]$.

General Procedure A for the preparation of benzamide substrates[2]

To a round bottom-flask equipped with a magnetic stir bar were added the amine (1.10 equiv), Et_3N (1.25 equiv) and CH_2Cl_2 (0.5 M) under N_2. The acyl chloride (1.00 equiv) was added slowly and the reaction mixture was stirred at ambient temperature for 2 h. The mixture was diluted with CH_2Cl_2 (50 mL) and washed successively with 1M HCl (50 mL) and brine (50 mL). The organic layer was dried over anhydrous Na_2SO_4, filtered and concentrated under reduced pressure. The residue was purified by column chromatography on silica gel (*n*-hexane/EtOAc).

General Procedure B for the preparation of benzamide substrates[2]

To a round bottom-flask equipped with a magnetic stir bar were added under N_2 the carboxylic acid (1.00 equiv), DMF (1.50 equiv) and CH_2Cl_2 (0.5M). The reaction mixture was cooled to 0 °C and the oxalyl chloride (0.98 equiv) was added in few portions. The reaction was allowed to stir at ambient temperature for 5 h. Separately, the solution of the amine (2.25 equiv) in CH_2Cl_2 (0.5M) was prepared under N_2. The solution of the acyl chloride was added slowly to the solution of the amine and the reaction was stirred at ambient temperature for 4 h. The mixture was washed successively with 2N NaOH (25 mL), brine, 1M HCl (50 mL) and brine (50 mL). The organic phase was dried over anhydrous Na_2SO_4, filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel (*n*-hexane/EtOAc).

General Procedure C for the preparation of benzamide substrates:

Step 1:

Preparation of *N*,*N*-diisopropyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)benzamide: [3]

A 100 mL flask assembled with a magnetic stir bar, a septum inlet, and a condenser was charged with $Pd_2(dba)_3$·dba (0.58 g, 0.5 mmol, 2.5 mol %) and PCy_3 (0.56 g, 2.0 mmol, 10 mol %), and flushed with N_2. 1,4-Dioxane (50 mL) was added and the resulting mixture was then stirred for 10 min at ambient temperature. Bis(pinacolato)diboron (6.10 g, 24 mmol), KOAc (2.94 g, 30 mmol), and 3-chloro-*N*,*N*-diisopropylbenzamide (20 mmol) were added thereafter. After being stirred at 100 °C for 24 h, the reaction mixture was treated with H_2O (50 mL) at ambient temperature. The mixture was extracted with EtOAc (3 × 50 mL), washed with brine (100 mL), dried over anhydrous Na_2SO_4, filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel (*n*-hexane/EtOAc 20/1→10/1) yielding the target product (4.77 g, 72%) as a yellow solid.

Step 2:

Preparation of benzamide substrates: [4]

A 25 mL flask assembled with a magnetic stir bar, a septum inlet, and a condenser was charged with $Pd(OAc)_2$ (56.1 mg, 0.25 mmol, 5.0 mol %) and PPh_3 (131 mg, 0.50 mmol, 10 mol %), and flushed with N_2. 1,4-Dioxane (10 mL) was added and the resulting mixture was then stirred for 10 min at ambient temperature. *N*,*N*-diisopropyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)benzamide (1.66 g, 5.0 mmol), K_2CO_3 (20M, 0.5 mL), bromoarene (6.0 mmol) were added successively. After being stirred at 100 °C for 24 h, the reaction mixture was treated with HCl (2M, 25 mL) at ambient temperature. The mixture was extracted with EtOAc, washed with brine, dried over anhydrous Na_2SO_4, filtered and evaporated under reduced pressure. The residue was purified by column chromatography on silica gel (*n*-hexane/EtOAc).

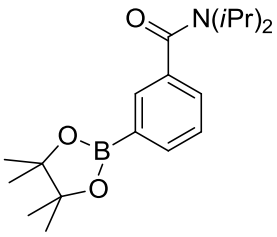
General Procedure D for the ruthenium-catalyzed *ortho*-C−H halogenation of benzamides:

To a seal tube equipped with a magnetic stir bar were added $Ru_3(CO)_{12}$ (10.5 mg, 3.3 mol %), AgO_2CAd (28.7 mg, 20 mol %) and DCE (2.0 mL) under N_2. Benzamide substrate **1** (0.5 mmol) and *N*-halosuccinimide (1.0 mmol) were added. After being stirred at ambient temperature for 10 min, the tube was placed in a pre-heated oil-bath and stirred at 120 °C for 16 h. The reaction mixture was then allowed to cool to ambient temperature, diluted with EtOAc (5 mL) and filtered through a short pad of silica gel and eluted with EtOAc (50 mL). After removing the solvent under reduced pressure, the product was purified by column chromatography on silica gel (*n*-hexane/EtOAc).

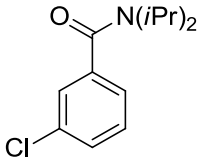
General Procedure E for the ruthenium-catalyzed *ortho*-C−H halogenation of benzamides:

To a seal tube equipped with a magnetic stir bar were added $Ru_3(CO)_{12}$ (10.5 mg, 3.3 mol %), AgO_2CAd (28.7 mg, 20 mol %) and DCE (2.0 mL) under N_2. Benzamide substrate **1** (0.5 mmol) and the first portion of *N*-halosuccinimide (0.5 mmol) were added. After being stirred at ambient temperature for 10 min, the tube was placed in a pre-heated oil-bath and stirred at 120 °C for 8 h. The mixture was then allowed to cool to ambient temperature, the second portion of *N*-halosuccinimide (0.5 mmol) was added under N_2 and the stirring was continued for further 14 h at 120 °C. The mixture was then allowed to cool to ambient temperature, diluted with EtOAc (5 mL) and filtered through a short pad of silica gel and

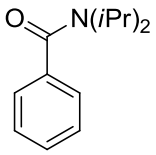
eluted with EtOAc (50 mL). After removing the solvent under reduced pressure, the product was purified by column chromatography on silica gel (*n*-hexane/EtOAc).



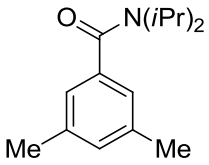
***N*,*N*-diisopropyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)benzamide**: M.p. = 130 −131 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.81−7.72 (m, 2H), 7.38−7.31 (m, 2H), 3.79 (s_{br}, 1H), 3.50 (s_{br}, 1H), 1.51 (s_{br}, 6H), 1.32 (s, 12H), 1.15 (s_{br}, 6H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 170.9 (C_q), 138.3 (C_q), 134.8 (CH), 131.9 (CH), 128.1 (CH), 127.6 (CH), 83.9 (C_q), 24.8 (CH_3), 20.7 (CH_3) {$\underline{C}H(CH_3)_2$ and one C_q are invisible}. IR (neat): 2978, 2932, 1627, 1445, 1323, 1138, 848, 704, 680 cm^{-1}. MS (EI) *m/z* (relative intensity) 331 (12) [M^+], 288 (38), 231 (100), 131 (18), 43 (20). HR-MS (EI) *m/z* calcd for $C_{19}H_{30}BNO_3$ 331.2319, found 331.2325.



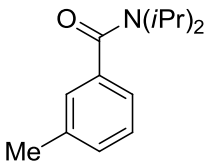
3-Chloro-*N*,*N*-diisopropylbenzamide: The representative procedure **A** was followed using 3-chlorobenzoyl chloride (1.28 mL, 10 mmol), Et_3N (1.73 mL, 12.5 mmol) and diisopropylamine (1.51 mL, 11 mmol). After 2 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1) yielded the desired product (2.34 g, 98%) as a white solid. M.p. = 67−68 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.34−7.25 (m, 3H), 7.15 (dd, J = 6.7, 2.2 Hz, 1H), 3.71 (s_{br}, 1H), 3.53 (s_{br}, 1H), 1.46 (s_{br}, 6H), 1.18 (s_{br}, 6H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 169.1 (C_q), 140.3 (C_q), 134.3 (C_q), 129.7 (CH), 128.6 (CH), 126.7 (CH), 123.5 (CH), 50.3 (CH), 46.0 (CH), 20.5 (CH_3). IR (neat): 2968, 2931, 1624, 1563, 1439, 1339, 1036, 805, 734 cm^{-1}. MS (EI) *m/z* (relative intensity) 239 (7) [M^+], 196 (20), 139 (100), 111 (28). HR-MS (EI) *m/z* calcd for $C_{13}H_{18}ClNO$ 239.1077, found 239.1084. The spectral data were in accordance with those reported in the literature.



***N,N*-diisopropylbenzamide** (**1a**): The representative procedure **A** was followed using benzoyl chloride (2.31 mL, 20 mmol), Et_3N (3.46 mL, 25 mmol) and diisopropylamine (3.09 mL, 22 mmol). After 2 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 4/1) yielded **1a** (2.58 g, 62%) as a white solid. M.p. = 73−74 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.48−7.21 (m, 5H), 3.76 (s_{br}, 1H), 3.61 (s_{br}, 1H), 1.47 (s_{br}, 6H), 1.17 (s_{br}, 6H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 170.9 (C_q), 138.9 (C_q), 128.5 (CH), 128.3 (CH), 125.5 (CH), 20.6 (CH_3) {$\underline{C}H(CH_3)_2$ is invisible}. IR (neat): 2967, 2930, 1624, 1440, 1370, 1338, 1026, 779, 705 cm^{-1}. MS (EI) *m/z* (relative intensity) 205 (8) [M^+], 162 (24), 105 (100), 77 (33). HR-MS (EI) *m/z* calcd for $C_{13}H_{19}NO$ 205.1467, found 205.1465. The spectral data were in accordance with those reported in the literature.[2]

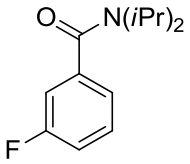


***N,N*-diisopropyl-3,5-dimethylbenzamide** (**1b**): The representative procedure **A** was followed using 3,5-dimethylbenzoyl chloride (1.48 mL, 10 mmol), Et_3N (1.73 mL, 12.5 mmol) and diisopropylamine (1.51 mL, 22 mmol). After 2 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1) yielded **1b** (2.26 g, 97%) as a white solid. M.p. = 115−116 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 6.95 (s, 1H), 6.87 (s, 2H), 3.80 (s_{br}, 1H), 3.50 (s_{br}, 1H), 2.28 (s, 6H), 1.48 (s_{br}, 6H), 1.14 (s_{br}, 6H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 171.3 (C_q), 138.9 (C_q), 137.9 (C_q), 130.3 (CH), 123.0 (CH), 50.6 (CH), 45.6 (CH), 21.2 (CH_3), 20.6 (CH_3), 20.6 (CH_3). IR (neat): 2969, 2926, 1620, 1440, 1347, 1211, 1043, 850, 774, 631 cm^{-1}. MS (EI) *m/z* (relative intensity) 233 (10) [M^+], 190 (20), 133 (100), 105 (23). HR-MS (EI) *m/z* calcd for $C_{15}H_{23}NO$ 233.1780, found 233.1782.

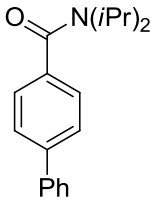


***N,N*-diisopropyl-3-methylbenzamide** (**1c**): The representative procedure **B** was followed using 3-methylbenzoic acid (2.72 g, 20 mmol), DMF (2.20 mL, 30 mmol), oxalyl chloride (2.04 mL, 24 mmol), Et_3N (7.20 mL, 52 mmol) and diisopropylamine (4.15 mL, 48 mmol).

After 9 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 15/1) yielded **1c** (2.35 g, 55%) as a white solid. M.p. = 63−64 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.25 (dd, J = 7.4, 7.4 Hz, 1H), 7.16 (d, J = 7.4 Hz, 1H), 7.12 (s, 1H), 7.08 (d, J = 7.4 Hz, 1H), 3.79 (s_{br}, 1H), 3.53 (s_{br}, 1H), 2.35 (s, 3H), 1.49 (s_{br}, 6H), 1.15 (s_{br}, 6H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 171.1 (C_q), 138.9 (C_q), 138.2 (C_q), 129.2 (CH), 128.2 (CH), 126.2 (CH), 122.4 (CH), 50.5 (CH), 46.7 (CH), 21.3 (CH_3), 21.2 (CH_3), 20.7 (CH_3). IR (neat): 2965, 2928, 1626, 1443, 1370, 1338, 1210, 1038, 813, 751 cm^{-1}. MS (EI) *m/z* (relative intensity) 219 (8) [M^+], 176 (24), 119 (100), 91 (34), 57 (32). HR-MS (EI) *m/z* calcd for $C_{14}H_{21}NO$ 219.1623, found 219.1618. The spectral data were in accordance with those reported in the literature.[2]

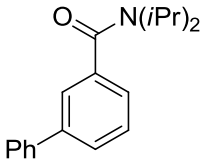


3-Fluoro-*N*,*N*-diisopropylbenzamide (**1d**): The representative procedure **A** was followed using 3-fluorobenzoyl chloride (2.40 mL, 20 mmol), Et_3N (3.46 mL, 25 mmol) and diisopropylamine (3.09 mL, 22 mmol). After 2 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1) yielded **1d** (3.15 g, 99%) as a white solid. M.p. = 52−53 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.31 (ddd, J = 7.6, 5.6, 0.5 Hz, 1H), 7.11−6.92 (m, 3H), 3.71 (s_{br}, 1H), 3.52 (s_{br}, 1H), 1.46 (s_{br}, 6H), 1.14 (s_{br}, 6H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 169.3 (d, $^{4}J_{C–F}$ = 2 Hz, C_q), 162.5 (d, $^{1}J_{C–F}$ = 247 Hz, C_q), 140.8 (d, $^{3}J_{C–F}$ = 7 Hz, C_q), 130.2 (d, $^{3}J_{C–F}$ = 8 Hz, CH), 121.1 (d, $^{4}J_{C–F}$ = 3 Hz, CH), 115.5 (d, $^{2}J_{C–F}$ = 21 Hz, CH), 112.8 (d, $^{2}J_{C–F}$ = 22 Hz, CH), 50.8 (CH), 45.9 (CH), 20.5 (CH_3). ^{19}F-NMR (283 MHz, $CDCl_3$): δ = − (112.0−112.1) (m). IR (neat): 2969, 2932, 1629, 1583, 1446, 1339, 1145, 1038, 787, 751, 522 cm^{-1}. MS (EI) *m/z* (relative intensity) 223 (8) [M^+], 180 (12), 123 (100). HR-MS (EI) *m/z* calcd for $C_{13}H_{18}FNO$ 223.1372, found 223.1368. The spectral data were in accordance with those reported in the literature.[5]

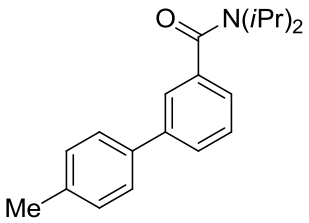


***N*,*N*-diisopropyl-[1,1'-biphenyl]-4-carboxamide** (**1e**): The representative procedure **A** was followed using [1,1'-biphenyl]-4-carbonyl chloride (4.33 g, 20 mmol), Et_3N (3.46 mL,

25 mmol) and diisopropylamine (3.09 mL, 22 mmol). After 2 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1) yielded **1e** (4.76 g, 85%) as a white solid. M.p. = 132−133 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.67−7.54 (m, 4H), 7.52−7.30 (m, 5H), 3.84 (s_{br}, 1H), 3.62 (s_{br}, 1H), 1.43 (s_{br}, 6H), 1.25 (s_{br}, 6H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 170.8 (C_q), 141.4 (C_q), 140.4 (C_q), 137.7 (C_q), 128.8 (CH), 127.5 (CH), 127.1 (CH), 127.0 (CH), 126.1 (CH), 20.7 (CH_3) {$\underline{C}H(CH_3)_2$ is invisible}. IR (neat): 2970, 2927, 1624, 1437, 1339, 1209, 835, 747, 689 cm^{-1}. MS (EI) *m/z* (relative intensity) 281 (10) [M^+], 238 (28), 181 (100), 152 (37). HR-MS (EI) *m/z* calcd for $C_{19}H_{23}NO$ 281.1780, found 281.1779.

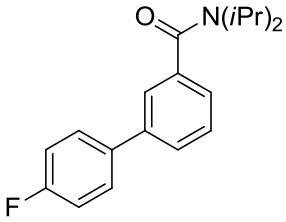


***N*,*N*-diisopropyl-[1,1'-biphenyl]-3-carboxamide** (**1f**): The representative procedure **B** was followed using [1,1'-biphenyl]-3-carboxylic acid (0.59 g, 3.0 mmol), DMF (0.33 mL, 4.5 mmol), oxalyl chloride (0.31 mL, 3.6 mmol), Et_3N (1.08 mL, 7.8 mmol) and diisopropylamine (1.01 mL, 7.2 mmol). After 9 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1) yielded **1f** (0.70 g, 83%) as a white solid. M.p. = 77−78 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.64−7.51 (m, 4H), 7.51−7.41 (m, 3H), 7.36 (dd, *J* = 7.2, 7.2 Hz, 1H), 7.28 (d, *J* = 7.6 Hz, 1H), 3.87 (s_{br}, 1H), 3.58 (s_{br}, 1H), 1.43 (s_{br}, 6H), 1.19 (s_{br}, 6H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 170.8 (C_q), 141.4 (C_q), 140.4 (C_q), 139.3 (C_q), 128.8 (CH), 128.7 (CH), 127.5 (CH), 127.3 (CH), 127.1 (CH), 124.3 (CH), 124.2 (CH), 50.8 (CH), 45.9 (CH), 20.7 (CH_3). IR (neat): 2960, 2928, 1623, 1438, 1339, 1037, 762, 703 cm^{-1}. MS (EI) *m/z* (relative intensity) 281 (18) [M^+], 238 (30), 181 (100), 152 (36). HR-MS (EI) *m/z* calcd for $C_{19}H_{23}NO$ 281.1780, found 281.1784. The spectral data were in accordance with those reported in the literature.[2]

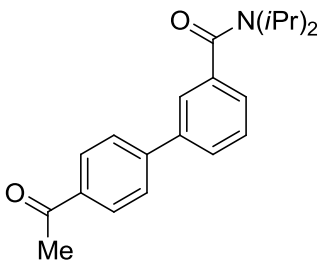


***N*,*N*-diisopropyl-4'-methyl-[1,1'-biphenyl]-3-carboxamide** (**1g**): The representative procedure **C** was followed using *N*,*N*-diisopropyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)benzamide (1.66 g, 5.0 mmol) and 1-bromo-4-methylbenzene (0.74 mL, 6.0 mmol). After 24 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1→5/1)

yielded **1g** (1.17 g, 80%) as a yellow solid. M.p. = 95−96 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.61−7.51 (m, 2H), 7.50 (s, 1H), 7.48 (d, J = 8.2 Hz, 2H), 7.41 (dd, J = 7.6, 7.2 Hz, 1H), 7.23 (d, J = 8.2 Hz, 2H), 3.87 (s_{br}, 1H), 3.56 (s_{br}, 1H), 2.38 (s, 3H), 1.52 (s_{br}, 6H), 1.16 (s_{br}, 6H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 170.9 (C_q), 141.3 (C_q), 139.4 (C_q), 137.6 (C_q), 137.3 (C_q), 129.5 (CH), 128.8 (CH), 127.1 (CH), 126.9 (CH), 124.1 (CH), 124.1 (CH), 21.1 (CH_3), 20.7 (CH_3) {$\underline{C}H(CH_3)_2$ is invisible}. IR (neat): 2966, 2927, 1629, 1439, 1340, 1035, 825, 700 cm^{-1}. MS (EI) *m/z* (relative intensity) 295 (15) [M^{+}], 252 (30), 195 (100), 181 (30), 152 (42). HR-MS (EI) *m/z* calcd for $C_{20}H_{25}NO$ 295.1936, found 295.1940.

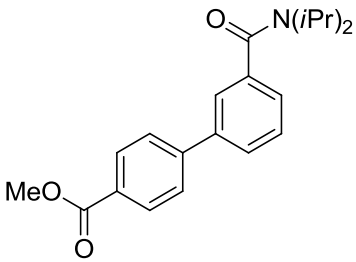


4'-Fluoro-*N*,*N*-diisopropyl-[1,1'-biphenyl]-3-carboxamide (**1h**): The representative procedure **C** was followed using *N*,*N*-diisopropyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)benzamide (1.66 g, 5.0 mmol) and 1-bromo-4-fluorobenzene (0.66 mL, 6.0 mmol). After 24 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1→5/1) yielded **1h** (1.33 g, 89%) as a yellow solid. M.p. = 114−115 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.57−7.48 (m, 3H), 7.49−7.41 (m, 2H), 7.32−7.24 (m, 1H), 7.18−7.07 (m, 2H), 3.88 (s_{br}, 1H), 3.58 (s_{br}, 1H), 1.50 (s_{br}, 6H), 1.17 (s_{br}, 6H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 170.6 (C_q), 162.5 (d, $^{1}J_{C–F}$ = 248 Hz, C_q), 140.4 (C_q), 139.4 (C_q), 136.5 (d, $^{4}J_{C–F}$ = 3 Hz, C_q), 128.6 (d, $^{3}J_{C–F}$ = 8 Hz, CH), 127.1 (CH), 127.1 (CH), 124.2 (CH), 124.2 (CH), 115.6 (d, $^{2}J_{C–F}$ = 22 Hz, CH), 50.9 (CH), 45.8 (CH), 20.8 (CH_3). ^{19}F-NMR (283 MHz, $CDCl_3$): δ = − (115.2−115.3) (m). IR (neat): 2968, 2930, 1628, 1509, 1439, 1342, 1220, 1154, 892, 701 cm^{-1}. MS (EI) *m/z* (relative intensity) 299 (12) [M^{+}], 256 (24), 199 (100), 181 (32), 170 (36). HR-MS (EI) *m/z* calcd for $C_{19}H_{22}FNO$ 299.1685, found 299.1677.

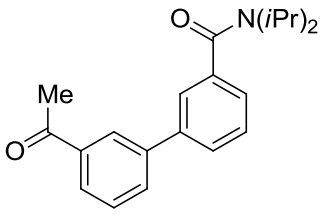


4'-Acetyl-*N*,*N*-diisopropyl-[1,1'-biphenyl]-3-carboxamide (**1i**): The representative procedure **C** was followed using *N*,*N*-diisopropyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-

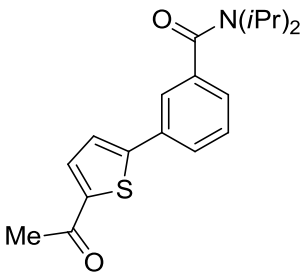
2-yl)benzamide (1.66 g, 5.0 mmol) and 1-(4-bromophenyl)ethan-1-one (1.20 g, 6.0 mmol). After 24 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 5/1→3/1) yielded **1i** (0.91 g, 56%) as a yellow solid. M.p. = 134−135 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 8.01 (d, *J* = 8.3 Hz, 2H), 7.66 (d, *J* = 8.3 Hz, 2H), 7.60 (d, *J* = 7.8 Hz, 1H), 7.54 (s, 1H), 7.45 (dd, *J* = 7.8, 7.6 Hz, 1H), 7.30 (d, *J* = 7.6 Hz, 1H), 3.83 (s_{br}, 1H), 3.55 (s_{br}, 1H), 2.61 (s, 3H), 1.50 (s_{br}, 6H), 1.19 (s_{br}, 6H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 197.6 (C_q), 170.5 (C_q), 145.0 (C_q), 140.2 (C_q), 139.6 (C_q), 136.0 (C_q), 129.0 (CH), 128.9 (CH), 127.5 (CH), 127.2 (CH), 125.2 (CH), 124.5 (CH), 50.8 (CH), 46.0 (CH), 26.6 (CH_3), 20.7 (CH_3). IR (neat): 2966, 2929, 1684, 1622, 1444, 1369, 1344, 1256, 845, 787 cm^{-1}. MS (EI) *m/z* (relative intensity) 323 (16) [M^+], 280 (33), 223 (100), 152 (16). HR-MS (EI) *m/z* calcd for $C_{21}H_{25}NO_2$ 323.1885, found 323.1885.



Methyl 3'-(diisopropylcarbamoyl)-[1,1'-biphenyl]-4-carboxylate (**1j**): The representative procedure **C** was followed using *N*,*N*-diisopropyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)benzamide (1.00 g, 3.0 mmol) and methyl 4-bromobenzoate (0.77 g, 3.6 mmol). After 24 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 5/1→4/1) yielded **1j** (0.75 g, 74%) as a yellow solid. M.p. = 152−153 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 8.09 (d, *J* = 8.6 Hz, 2H), 7.64 (d, *J* = 8.6 Hz, 2H), 7.60 (dq, *J* = 7.6, 0.8 Hz, 1H), 7.54 (t, *J* = 1.5 Hz, 1H), 7.46 (dd, *J* = 7.6, 7.6 Hz, 1H), 7.30 (dt, *J* = 7.6, 1.5 Hz, 1H), 3.92 (s, 3H), 3.84 (s_{br}, 1H), 3.58 (s_{br}, 1H), 1.50 (s_{br}, 6H), 1.17 (s_{br}, 6H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 170.5 (C_q), 166.8 (C_q), 144.9 (C_q), 140.3 (C_q), 139.6 (C_q), 130.1 (CH), 129.2 (C_q), 129.0 (CH), 127.5 (CH), 127.0 (CH), 125.1 (CH), 124.5 (CH), 52.1 (CH_3), 51.1 (CH), 45.9 (CH), 20.7 (CH_3). IR (neat): 2929, 1723, 1626, 1426, 1344, 1271, 1103, 768, 711 cm^{-1}. MS (EI) *m/z* (relative intensity) 339 (15) [M^+], 296 (43), 239 (100), 152 (33). HR-MS (EI) *m/z* calcd for $C_{21}H_{25}NO_3$ 339.1834, found 339.1830.

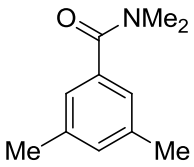


3'-Acetyl-*N*,*N*-diisopropyl-[1,1'-biphenyl]-3-carboxamide (**1k**): The representative procedure **C** was followed using *N*,*N*-diisopropyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)benzamide (1.00 g, 3.0 mmol) and 1-(3-bromophenyl)ethan-1-one (0.72 g, 3.6 mmol). After 24 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 5/1→3/1) yielded **1k** (0.74 g, 76%) as a yellow solid. M.p. = 89−90 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 8.16 (t, *J* = 1.8 Hz, 1H), 7.93 (dq, *J* = 7.7, 1.3 Hz, 1H), 7.77 (dq, *J* = 7.7, 1.3, 1H), 7.57 (dq, *J* = 7.7, 1.3 Hz, 1H), 7.57−7.51 (m, 2H), 7.46 (dd, *J* = 7.7, 7.6 Hz, 1H), 7.29 (dt, *J* = 7.6, 1.3 Hz, 1H), 3.83 (s_{br}, 1H), 3.58 (s_{br}, 1H), 2.64 (s, 3H), 1.51 (s_{br}, 6H), 1.21 (s_{br}, 6H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 198.0 (C_q), 170.6 (C_q), 141.1 (C_q), 140.6 (C_q), 139.6 (C_q), 137.7 (C_q), 131.7 (CH), 129.1 (CH), 129.0 (CH), 127.5 (CH), 127.5 (CH), 127.0 (CH), 124.8 (CH), 124.5 (CH), 26.8 (CH_3), 20.8 (CH_3) {$\underline{C}H(CH_3)_2$ is invisible}. IR (neat): 2930, 2869, 1687, 1626, 1435, 1340, 1238, 1036, 784, 587 cm^{-1}. MS (EI) *m/z* (relative intensity) 323 (30) [M^+], 280 (60), 223 (100), 152 (30). HR-MS (EI) *m/z* calcd for $C_{21}H_{25}NO_2$ 323.1885, found 323.1891.

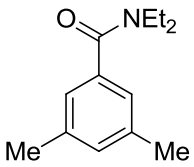


3-(5-Acetylthiophen-2-yl)-*N*,*N*-diisopropylbenzamide (**1l**): The representative procedure **C** was followed using *N*,*N*-diisopropyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)benzamide (1.66 g, 5.0 mmol) and 1-(5-bromothiophen-2-yl)ethan-1-one (1.23 g, 6.0 mmol). After 24 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 5/1→3/1) yielded **1l** (0.99 g, 60%) as a yellow solid. M.p. = 124−125 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.69−7.49 (m, 3H), 7.42 (dd, *J* = 7.8, 7.6 Hz, 1H), 7.33 (dd, *J* = 4.0, 1.2 Hz, 1H), 7.29 (d, *J* = 7.6 Hz, 1H), 3.81 (s_{br}, 1H), 3.57 (s_{br}, 1H), 2.55 (s, 3H), 1.51 (s_{br}, 6H), 1.21 (s_{br}, 6H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 190.5 (C_q), 170.0 (C_q), 151.7 (C_q), 143.4 (C_q), 139.7 (C_q), 133.6 (C_q), 133.4 (CH), 129.3 (CH), 126.4 (CH), 126.0 (CH), 124.3 (CH), 123.4 (CH), 50.9 (CH), 45.9 (CH), 26.5 (CH_3), 24.8 (CH_3), 20.7 (CH_3). IR (neat): 2974, 2933, 1651, 1618, 1440, 1344, 1273, 1040, 794, 694, 610 cm^{-1}. MS (EI) *m/z* (relative intensity) 329 (15) [M^+],

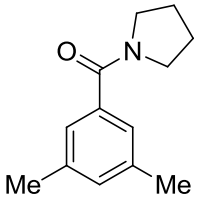
286 (30), 229 (100), 43 (17). HR-MS (EI) *m/z* calcd for $C_{19}H_{23}NO_2S$ 329.1449, found 329.1442.



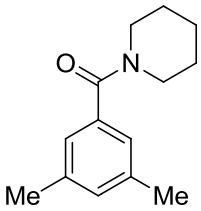
***N*,*N*,3,5-tetramethylbenzamide** (**1m**): The representative procedure **A** was followed using 3,5-dimethylbenzoyl chloride (2.96 mL, 20 mmol), Et_3N (3.46 mL, 25 mmol) and dimethylamine (40% wt in water, 10 mL, 22 mmol). After 2 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 3/1→2/1) yielded **1m** (3.26 g, 92%) as a colorless liquid. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.01 (s, 1H), 7.00 (s, 2H), 3.08 (s, 3H), 2.96 (s, 3H), 2.31 (s, 6H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 171.9 (C_q), 137.9 (C_q), 136.3 (C_q), 130.9 (CH), 124.5 (CH), 39.5 (CH_3), 35.2 (CH_3), 21.2 (CH_3). IR (neat): 2920, 1626, 1599, 1495, 1390, 1256, 1179, 1104, 858, 759, 665 cm^{-1}. MS (EI) *m/z* (relative intensity) 177 (28) [M^+], 133 (100), 105 (47), 77 (20). HR-MS (EI) *m/z* calcd for $C_{11}H_{15}NO$ 177.1154, found 177.1147.



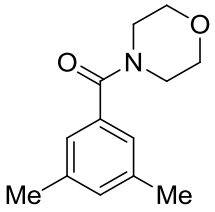
***N*,*N*-diethyl-3,5-dimethylbenzamide** (**1n**): The representative procedure **A** was followed using 3,5-dimethylbenzoic acid (3.00 g, 20 mmol), DMF (2.20 mL, 30 mmol), oxalyl chloride (2.04 mL, 24 mmol), Et_3N (7.20 mL, 52 mmol) and diethylamine (5.0 mL, 48 mmol). After 9 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 5/1) yielded **1n** (3.66 g, 89%) as a colorless liquid. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 6.98 (s, 1H), 6.93 (s, 2H), 3.50 (s_{br}, 2H), 3.23 (s_{br}, 2H), 2.29 (s, 6H), 1.22 (s_{br}, 3H), 1.08 (s_{br}, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 171.6 (C_q), 137.9 (C_q), 137.2 (C_q), 130.5 (CH), 123.8 (CH), 43.1 (CH_2), 39.0 (CH_2), 21.2 (CH_3), 14.2 (CH_3), 12.9 (CH_3). IR (neat): 2970, 2933, 1627, 1423, 1379, 1218, 1110, 856, 806, 756, 651 cm^{-1}. MS (EI) *m/z* (relative intensity) 205 (32) [M^+], 133 (100), 105 (35), 77 (16). HR-MS (EI) *m/z* calcd for $C_{13}H_{19}NO$ 205.1467, found 205.1468.



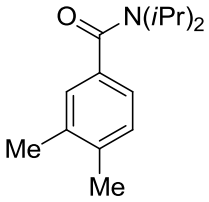
(3,5-Dimethylphenyl)(pyrrolidin-1-yl)methanone (**1o**): The representative procedure **B** was followed using 3,5-dimethylbenzoic acid (3.00 g, 20 mmol), DMF (2.20 mL, 30 mmol), oxalyl chloride (2.04 mL, 24 mmol), Et_3N (7.20 mL, 52 mmol) and pyrrolidine (2.36 mL, 48 mmol). After 9 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 3/1) yielded **1o** (3.68 g, 90%) as a white solid. M.p. = 114−115 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.09 (s, 2H), 7.01 (s, 1H), 3.62 (t, *J* = 6.6 Hz, 2H), 3.40 (t, *J* = 6.6 Hz, 2H), 2.31 (s, 6H), 1.94 (pent, *J* = 6.6 Hz, 2H), 1.85 (pent, *J* = 6.6 Hz, 2H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 170.0 (C_q), 137.7 (C_q), 137.2 (C_q), 131.1 (CH), 124.6 (CH), 49.5 (CH_2), 46.0 (CH_2), 26.3 (CH_2), 24.4 (CH_2), 21.2 (CH_3). IR (neat): 3042, 2870, 1616, 1594, 1412, 1225, 859, 760, 618 cm^{-1}. MS (EI) *m/z* (relative intensity) 203 (50) [M^+], 133 (100), 105 (46), 77 (25). HR-MS (ESI) *m/z* calcd for $[(C_{13}H_{17}NO)H]^+$ 204.1388, found 204.1385.



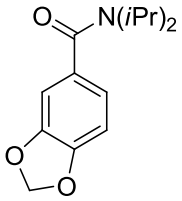
(3,5-Dimethylphenyl)(piperidin-1-yl)methanone (**1p**): The representative procedure **B** was followed using 3,5-dimethylbenzoic acid (3.00 g, 20 mmol), DMF (2.20 mL, 30 mmol), oxalyl chloride (2.04 mL, 24 mmol), Et_3N (7.20 mL, 52 mmol) and piperidine (4.74 mL, 48 mmol). After 9 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 4/1) yielded **1p** (4.08 g, 94%) as a white solid. M.p. = 66−67 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 6.99 (s, 1H), 6.95 (s, 2H), 3.67 (s_{br}, 2H), 3.31 (s_{br}, 2H), 2.30 (s, 6H), 1.64 (s_{br}, 4H), 1.49 (s_{br}, 2H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 170.5 (C_q), 137.9 (C_q), 136.4 (C_q), 130.7 (CH), 124.2 (CH), 48.6 (CH_2), 42.9 (CH_2), 26.4 (CH_2), 25.5 (CH_2), 24.5 (CH_2), 21.1 (CH_3). IR (neat): 2992, 2852, 1619, 1596, 1426, 1299, 1227, 1117, 861, 756 cm^{-1}. MS (EI) *m/z* (relative intensity) 217 (43) [M^+], 216 (100), 133 (94), 105 (40). HR-MS (EI) *m/z* calcd for $C_{14}H_{19}NO$ 217.1467, found 217.1468.



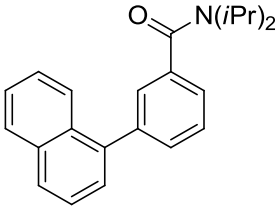
(3,5-Dimethylphenyl)(morpholino)methanone (**1q**): The representative procedure **B** was followed using 3,5-dimethylbenzoic acid (3.00 g, 20 mmol), DMF (2.20 mL, 30 mmol), oxalyl chloride (2.04 mL, 24 mmol), Et_3N (7.20 mL, 52 mmol) and morpholine (4.15 mL, 48 mmol). After 9 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 3/1) yielded **1q** (4.18 g, 95%) as a white solid. M.p. = 83−84 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.01 (s, 1H), 6.96 (s, 2H), 3.84−3.51 (m, 6H), 3.43 (s_{br}, 2H), 2.30 (s, 6H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 170.6 (C_q), 138.1 (C_q), 135.2 (C_q), 131.2 (CH), 124.5 (CH), 66.8 (CH_2), 48.0 (CH_2), 42.4 (CH_2), 21.1 (CH_3). IR (neat): 2916, 2853, 1620, 1429, 1302, 1228, 1111, 859, 755, 621 cm^{-1}. MS (EI) *m/z* (relative intensity) 219 (13) [M^+], 133 (100), 43 (40). HR-MS (EI) *m/z* calcd for $C_{13}H_{17}NO_2$ 219.1259, found 219.1259. The spectral data were in accordance with those reported in the literature.[6]



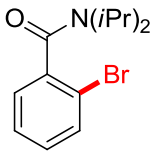
***N*,*N*-diisopropyl-3,4-dimethylbenzamide** (**1r**): The representative procedure **B** was followed using 3,4-dimethylbenzoic acid (1.50 g, 10 mmol), DMF (1.10 mL, 15 mmol), oxalyl chloride (1.02 mL, 12 mmol), Et_3N (3.60 mL, 26 mmol) and diisopropylamine (3.38 mL, 24 mmol). After 9 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1) yielded **1r** (1.90 g, 81%) as a white solid. M.p. = 81−82 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.09 (d, *J* = 7.5 Hz, 1H), 7.06 (d, *J* = 1.8 Hz, 1H), 7.00 (dd, *J* = 7.5, 1.8 Hz, 1H), 3.68 (s_{br}, 2H), 2.22 (s, 3H), 2.22 (s, 3H), 1.31 (s_{br}, 12H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 171.2 (C_q), 137.0 (C_q), 136.6 (C_q), 136.5 (C_q), 129.3 (CH), 126.9 (CH), 122.8 (CH), 20.7 (CH_3), 19.6 (CH_3), 19.5 (CH_3) {$\underline{C}H(CH_3)_2$ is invisible}. IR (neat): 2963, 1928, 1616, 1433, 1331, 1151, 1039, 803, 601 cm^{-1}. MS (EI) *m/z* (relative intensity) 233 (10) [M^+], 190 (17), 133 (100), 105 (17). HR-MS (EI) *m/z* calcd for $C_{15}H_{23}NO$ 233.1780, found 233.1783.



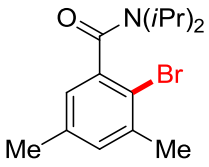
***N*,*N*-diisopropylbenzo[*d*][1,3]dioxole-5-carboxamide** (**1s**): The representative procedure **B** was followed using benzo[*d*][1,3]dioxole-5-carboxylic acid (3.32 g, 20 mmol), DMF (2.20 mL, 30 mmol), oxalyl chloride (2.04 mL, 24 mmol), Et_3N (3.60 mL, 26 mmol) and diisopropylamine (3.38 mL, 24 mmol). After 9 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 5/1) yielded **1s** (3.30 g, 66%) as a white solid. M.p. = 97−98 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 6.83−6.74 (m, 3H), 5.96 (s, 2H), 3.68 (s_{br}, 2H), 1.31 (s_{br}, 12H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 170.3 (C_q), 147.8 (C_q), 147.8 (C_q), 132.7 (C_q), 119.5 (CH), 108.2 (CH), 106.7 (CH), 101.1 (CH_2), 20.7 (CH_3) {$\underline{C}H(CH_3)_2$ is invisible}. IR (neat): 2996, 2965, 1619, 1497, 1439, 1370, 1328, 1250, 1038, 931, 875 cm^{-1}. MS (EI) *m/z* (relative intensity) 249 (16) [M^+], 206 (21), 149 (100). HR-MS (EI) *m/z* calcd for $C_{14}H_{19}NO_3$ 249.1365, found 249.1378.



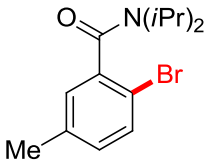
***N*,*N*-diisopropyl-3-(naphthalen-1-yl)benzamide** (**1t**): The representative procedure **C** was followed using *N*,*N*-diisopropyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)benzamide (1.66 g, 5.0 mmol) and 1-bromonaphthalene (0.84 mL, 6.0 mmol). After 24 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1) yielded **1t** (1.07 g, 64%) as a pale yellow solid. M.p. = 152−153 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.96−7.84 (m, 3H), 7.57−7.49 (m, 4H), 7.48−7.36 (m 4H), 4.00 (s_{br}, 1H), 3.56 (s_{br}, 1H), 1.52 (s_{br}, 6H), 1.25 (s_{br}, 6H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 170.8 (C_q), 140.9 (C_q), 139.5 (C_q), 139.0 (C_q), 133.8 (C_q), 131.4 (C_q), 130.3 (CH), 128.5 (CH), 128.3 (CH), 127.9 (CH), 127.1 (CH), 127.0 (CH), 126.1 (CH), 125.8 (CH), 125.8 (CH), 125.3 (CH), 124.5 (CH), 50.8 (CH), 45.8 (CH), 20.7 (CH_3). IR (neat): 2969, 1624, 1438, 1339, 1038, 798, 781, 706 cm^{-1}. MS (EI) *m/z* (relative intensity) 331 (18) [M^+], 288 (35), 231 (100), 202 (60), 43 (22). HR-MS (EI) *m/z* calcd for $C_{23}H_{25}NO$ 331.1936, found 331.1941.



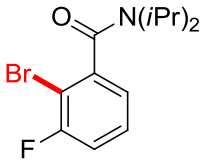
2-Bromo-*N*,*N*-diisopropylbenzamide (**2a**): The representative procedure **D** was followed using *N*,*N*-diisopropylbenzamide (**1a**) (103 mg, 0.5 mmol) and NBS (178 mg, 1.0 mmol). After 16 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1→5/1) yielded **2a** (86 mg, 60%) as a white solid. M.p. = 73−74 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.57 (d, J = 7.6 Hz, 1H), 7.53 (dd, J = 7.6, 7.6 Hz, 1H), 7.22−7.12 (m, 2H), 3.65−3.43 (m, 2H), 1.56 (d, J = 6.7 Hz, 3H), 1.55 (d, J = 6.7 Hz, 3H), 1.22 (d, J = 6.7 Hz, 3H), 1.04 (d, J = 6.7 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 168.0 (C_q), 140.1 (C_q), 132.7 (CH), 129.3 (CH), 127.4 (CH), 126.5 (CH), 118.8 (C_q), 51.1 (CH), 45.9 (CH), 20.7 (CH_3), 20.6 (CH_3), 20.5 (CH_3), 20.0 (CH_3). IR (neat): 2975, 2930, 1626, 1438, 1339, 1019, 770 cm^{-1}. MS (EI) *m/z* (relative intensity) 285 (7) [M^+] (^{81}Br), 283 (7) [M^+] (^{79}Br), 242 (25), 240 (26), 185 (98), 185 (100). HR-MS (EI) *m/z* calcd for $C_{13}H_{18}BrNO$ 283.0572, found 283.0567. The spectral data were in accordance with those reported in the literature.[2]



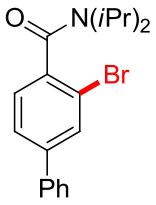
2-Bromo-*N*,*N*-diisopropyl-3,5-dimethylbenzamide (**2b**): The representative procedure **D** was followed using *N*,*N*-diisopropyl-3,5-dimethylbenzamide (**1b**) (233 mg, 1.0 mmol) and NBS (356 mg, 2.0 mmol) at 80 °C. After 16 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1) yielded **2b** (277 mg, 89%) as a white solid. M.p. = 200−201 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.00 (s, 1H), 6.80 (s, 1H), 3.63 (sept, J = 6.7 Hz, 1H), 3.50 (sept, J = 6.7 Hz, 1H), 2.36 (s, 3H), 2.25 (s, 3H), 1.57 (d, J = 6.7 Hz, 3H), 1.55 (d, J = 6.7 Hz, 3H), 1.22 (d, J = 6.7 Hz, 3H), 1.05 (d, J = 6.7 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 168.7 (C_q), 140.4 (C_q), 138.4 (C_q), 137.2 (C_q), 130.9 (CH), 124.4 (CH), 117.7 (C_q), 51.0 (CH), 45.7 (CH), 23.0 (CH_3), 20.7 (CH_3), 20.6 (CH_3), 20.6 (CH_3), 20.5 (CH_3), 19.9 (CH_3). IR (neat): 2960, 2928, 1626, 1442, 1368, 1346, 1209, 1026, 865, 778 cm^{-1}. MS (EI) *m/z* (relative intensity) 313 (15) [M^+] (^{81}Br), 311 (15) [M^+] (^{79}Br), 270 (28), 268 (28), 213 (98), 211 (100), 104 (17). HR-MS (EI) *m/z* calcd for $C_{15}H_{22}BrNO$ 311.0885, found 311.0877.



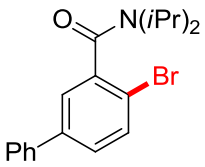
2-Bromo-*N*,*N*-diisopropyl-5-methylbenzamide (**2c**): The representative procedure **D** was followed using *N*,*N*-diisopropyl-3-methylbenzamide (**1c**) (110 mg, 0.5 mmol) and NBS (178 mg, 1.0 mmol). After 16 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1→5/1) yielded **2c** (95 mg, 64%) as a white solid. M.p. = 162−163 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.40 (d, J = 8.2 Hz, 1H), 7.03−6.94 (m, 2H), 3.61 (sept, J = 6.7 Hz, 1H), 3.51 (sept, J = 6.7 Hz, 1H), 2.29 (s, 3H), 1.57 (d, J = 6.7 Hz, 3H), 1.55 (d, J = 6.7 Hz, 3H), 1.23 (d, J = 6.7 Hz, 3H), 1.06 (d, J = 6.7 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 168.3 (C_q), 139.9 (C_q), 137.6 (C_q), 132.5 (CH), 130.2 (CH), 127.1 (CH), 115.4 (C_q), 51.1 (CH), 45.9 (CH), 20.8 (CH_3), 20.8 (CH_3), 20.6 (CH_3), 20.6 (CH_3), 20.1 (CH_3). IR (neat): 2960, 2928, 1626, 1441, 1337, 1044, 831, 804, 622, 459 cm^{-1}. MS (EI) *m/z* (relative intensity) 299 (5) [M$^+$] (^{81}Br), 297 (5) [M$^+$] (^{79}Br), 256 (25), 254 (25), 199 (97), 197 (100). HR-MS (EI) *m/z* calcd for $C_{14}H_{20}BrNO$ 297.0728, found 297.0721. The spectral data were in accordance with those reported in the literature.[2]



2-Bromo-3-fluoro-*N*,*N*-diisopropylbenzamide (**2d**): The representative procedure **E** was followed using 3-fluoro-*N*,*N*-diisopropylbenzamide (**1d**) (223 mg, 1.0 mmol) and NBS (356 mg, 2.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 5/1) yielded **2d** (165 mg, 55%) as a white solid. M.p. = 134−135 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.28 (dddd, J = 8.2, 7.8, 4.9, 0.8 Hz, 1H), 7.06 (ddd, J = 8.2, 8.2, 1.5 Hz, 1H), 6.95 (dq, J = 7.8, 0.8 Hz, 1H), 3.63−3.43 (m, 2H), 1.56 (d, J = 6.7 Hz, 3H), 1.54 (d, J = 6.7 Hz, 3H), 1.21 (d, J = 6.7 Hz, 3H), 1.05 (d, J = 6.7 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 166.9 (d, $^{4}J_{C-F}$ = 2 Hz, C_q), 159.2 (d, $^{1}J_{C-F}$ = 249 Hz, C_q), 142.2 (C_q), 129.2 (d, $^{3}J_{C-F}$ = 8 Hz, CH), 121.8 (d, $^{4}J_{C-F}$ = 4 Hz, CH), 115.8 (d, $^{2}J_{C-F}$ = 22 Hz, CH), 106.4 (d, $^{2}J_{C-F}$ = 22 Hz, C_q), 51.2 (CH), 46.1 (CH), 20.7 (CH_3), 20.6 (CH_3), 20.6 (CH_3), 20.1 (CH_3). ^{19}F-NMR (283 MHz, $CDCl_3$): δ = − (105.1−105.2) (m). IR (neat): 2970, 2932, 2874, 1625, 1437, 1339, 1205, 1041, 790, 603 cm^{-1}. MS (EI) *m/z* (relative intensity) 303 (4) [M$^+$] (^{81}Br), 301 (4) [M$^+$] (^{79}Br), 202 (90), 200 (100), 174 (16), 172 (18), 57 (48). HR-MS (ESI) *m/z* calcd for $[(C_{13}H_{17}FBrNO)H]^+$ 302.0556, found 302.0551.

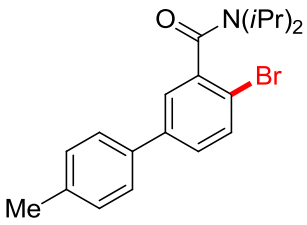


3-Bromo-*N*,*N*-diisopropyl-[1,1'-biphenyl]-4-carboxamide (**2e**): The representative procedure **E** was followed using 3-bromo-*N*,*N*-diisopropyl-[1,1'-biphenyl]-4-carboxamide (**1e**) (281 mg, 1.0 mmol) and NBS (712 mg, 4.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 5/1) and normal phase HPLC (*n*-hexane/EtOAc: 15/1→1/9) yielded **2e** (173 mg, 48%) as a colorless oil. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.76 (d, J = 1.6 Hz, 1H), 7.57−7.49 (m, 3H), 7.47−7.39 (m 2H), 7.39−7.32 (m, 1H), 7.22 (d, J = 7.8 Hz, 1H), 3.68 (sept, J = 6.7 Hz, 1H), 3.53 (sept, J = 6.7 Hz, 1H), 1.59 (d, J = 6.7 Hz, 3H), 1.57 (d, J = 6.7 Hz, 3H), 1.25 (d, J = 6.7 Hz, 3H), 1.08 (d, J = 6.7 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 168.1 (C_q), 142.6 (C_q), 139.0 (C_q), 138.7 (C_q), 131.3 (CH), 128.9 (CH), 128.0 (CH), 127.0 (CH), 126.8 (CH), 126.3 (CH), 119.3 (C_q), 51.2 (CH), 46.0 (CH), 20.8 (CH_3), 20.7 (CH_3), 20.6 (CH_3), 20.1 (CH_3). IR (neat): 2968, 2931, 1631, 1437, 1336, 1044, 754, 696 cm^{-1}. MS (EI) *m/z* (relative intensity) 361 (10) [M^+] (^{81}Br), 359 (10) [M^+] (^{79}Br), 318 (32), 316 (33), 261 (99), 259 (100), 152 (70). HR-MS (EI) *m/z* calcd for $C_{19}H_{22}BrNO$ 359.0885, found 359.0885.

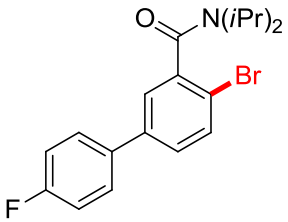


4-Bromo-*N*,*N*-diisopropyl-[1,1'-biphenyl]-3-carboxamide (**2f**): The representative procedure **E** was followed using *N*,*N*-diisopropyl-[1,1'-biphenyl]-3-carboxamide (**1f**) (141 mg, 0.5 mmol) and NBS (267 mg, 1.5 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 20/1→10/1) yielded **2f** (117 mg, 65%) as a white solid. M.p. = 151−152 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.61 (d, J = 8.2 Hz, 1H), 7.55 (d, J = 7.8 Hz, 2H), 7.51−7.37 (m, 4H), 7.36 (d, J = 2.2 Hz, 1H), 3.69 (sept, J = 6.6 Hz, 1H), 3.55 (sept, J = 6.6 Hz, 1H), 1.61 (d, J = 6.6 Hz, 3H), 1.59 (d, J = 6.6 Hz, 3H), 1.26 (d, J = 6.6 Hz, 3H), 1.08 (d, J = 6.6 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 168.0 (C_q), 140.8 (C_q), 140.5 (C_q), 139.4 (C_q), 133.2 (CH), 128.9 (CH), 128.1 (CH), 127.9 (CH), 127.0 (CH), 125.1 (CH), 117.9 (C_q), 51.2 (CH), 46.0 (CH), 20.9 (CH_3), 20.7 (CH_3), 20.6 (CH_3), 20.1 (CH_3). IR (neat): 2931, 2873, 1631, 1444, 1369, 1337, 1039, 786 cm^{-1}. MS (EI) *m/z* (relative intensity) 361 (8)

[M^+] (^{81}Br), 359 (8) [M^+] (^{79}Br), 318 (38), 316 (37), 261 (98), 259 (100), 152 (85). HR-MS (EI) *m/z* calcd for $C_{19}H_{22}BrNO$ 359.0885, found 359.0882. The spectral data were in accordance with those reported in the literature.[2]

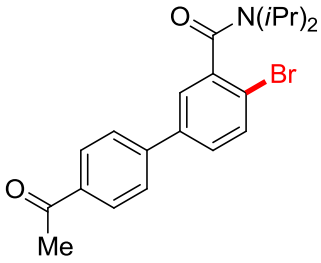


4-Bromo-*N*,*N*-diisopropyl-4'-methyl-[1,1'-biphenyl]-3-carboxamide (**2g**): The representative procedure **E** was followed using *N*,*N*-diisopropyl-4'-methyl-[1,1'-biphenyl]-3-carboxamide (**1g**) (148 mg, 0.5 mmol) and NBS (178 mg, 1.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 20/1→10/1) yielded **2g** (88 mg, 47%) as a white solid. M.p. = 193−194 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.57 (dd, *J* = 8.1, 0.5 Hz, 1H), 7.44 (dt, *J* = 8.1, 0.5 Hz, 2H), 7.37 (dd, *J* = 8.2, 2.2 Hz, 1H), 7.34 (d, *J* = 2.0 Hz, 1H), 7.23 (d, *J* = 8.2 Hz, 2H), 3.67 (sept, *J* = 6.7 Hz, 1H), 3.52 (sept, *J* = 6.7 Hz, 1H), 2.37 (s, 3H), 1.59 (d, *J* = 6.7 Hz, 3H), 1.57 (d, *J* = 6.7 Hz, 3H), 1.24 (d, *J* = 6.7 Hz, 3H), 1.05 (d, *J* = 6.7 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 168.1 (C_q), 140.7 (C_q), 140.4 (C_q), 137.8 (C_q), 136.5 (C_q), 133.1 (CH), 129.6 (CH), 127.9 (CH), 126.8 (CH), 124.8 (CH), 117.5 (C_q), 51.2 (CH), 46.0 (CH), 21.1 (CH_3), 20.9 (CH_3), 20.7 (CH_3), 20.6 (CH_3), 20.1 (CH_3). IR (neat): 2969, 2929, 1631, 1441, 1336, 1021, 803, 514 cm^{-1}. MS (ESI) *m/z* (relative intensity) 396 (28) [$(M+Na)^+$], 749 (100) [$(2M+H)^+$]. HR-MS (ESI) *m/z* calcd for $[(C_{20}H_{24}BrNO)H]^+$ 374.1114, found 374.1107.

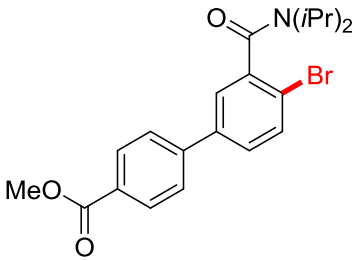


4-Bromo-4'-fluoro-*N*,*N*-diisopropyl-[1,1'-biphenyl]-3-carboxamide (**2h**): The representative procedure **E** was followed using 4'-fluoro-*N*,*N*-diisopropyl-[1,1'-biphenyl]-3-carboxamide (**1h**) (150 mg, 0.5 mmol) and NBS (178 mg, 1.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 20/1→10/1) yielded **2h** (102 mg, 54%) as a white solid. M.p. = 156−157 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.59 (d, *J* = 8.2 Hz, 1H), 7.49 (dd, *J* = 8.6, 8.6 Hz, 2H), 7.33 (dd, *J* = 8.2, 2.3 Hz, 1H), 7.30 (d, *J* = 2.3 Hz, 1H), 7.11 (dd, *J* = 8.6, 8.6 Hz, 2H), 3.66 (sept, *J* = 6.6 Hz, 1H), 3.63 (sept, *J* = 6.6 Hz, 1H),

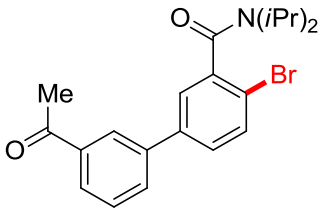
1.58 (d, *J* = 6.6 Hz, 3H), 1.56 (d, *J* = 6.6 Hz, 3H), 1.25 (d, *J* = 6.6 Hz, 3H), 1.07 (d, *J* = 6.6 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 167.9 (C_q), 162.7 (d, $^1J_{C-F}$ = 247 Hz, C_q), 140.5 (C_q), 139.9 (C_q), 135.6 (d, $^4J_{C-F}$ = 3 Hz, C_q), 133.2 (CH), 128.7 (d, $^3J_{C-F}$ = 9 Hz, CH), 128.0 (CH), 124.9 (CH), 117.9 (C_q), 115.9 (d, $^2J_{C-F}$ = 22 Hz, CH), 51.2 (CH), 46.1 (CH), 20.9 (CH_3), 20.7 (CH_3), 20.6 (CH_3), 20.1 (CH_3). ^{19}F-NMR (283 MHz, $CDCl_3$): δ = − (114.3−114.6) (m). IR (neat): 2966, 2928, 1631, 1599, 1442, 1337, 1226, 849, 813 cm^{-1}. MS (EI) *m/z* (relative intensity) 379 (9) [M$^+$] (^{81}Br), 377 (9) [M$^+$] (^{79}Br), 336 (35), 334 (36), 279 (99), 277 (100), 170 (75), 135 (60). HR-MS (EI) *m/z* calcd for $C_{19}H_{21}FBrNO$ 377.0791, found 377.0790.



4'-Acetyl-4-bromo-*N*,*N*-diisopropyl-[1,1'-biphenyl]-3-carboxamide (**2i**): The representative procedure **E** was followed using 4'-acetyl-*N*,*N*-diisopropyl-[1,1'-biphenyl]-3-carboxamide (**1i**) (162 mg, 0.5 mmol) and NBS (178 mg, 1.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 5/1→3/1) yielded **2i** (70 mg, 34%) as a white solid. M.p. = 203−204 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 8.01 (d, *J* = 8.2 Hz, 2H), 7.66−7.58 (m, 3H), 7.42 (dd, *J* = 8.2, 2.2 Hz, 1H), 7.38 (d, *J* = 2.2 Hz, 1H), 3.65 (sept, *J* = 6.7 Hz, 1H), 3.53 (sept, *J* = 6.7 Hz, 1H), 2.62 (s, 3H), 1.58 (d, *J* = 6.7 Hz, 3H), 1.57 (d, *J* = 6.7 Hz, 3H), 1.25 (d, *J* = 6.7 Hz, 3H), 1.07 (d, *J* = 6.7 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 197.5 (C_q), 167.8 (C_q), 143.8 (C_q), 140.7 (C_q), 139.5 (C_q), 136.3 (C_q), 133.4 (CH), 129.0 (CH), 128.2 (CH), 127.1 (CH), 125.1 (CH), 119.0 (C_q), 51.3 (CH), 46.1 (CH), 26.7 (CH_3), 20.9 (CH_3), 20.7 (CH_3), 20.6 (CH_3), 20.0 (CH_3). IR (neat): 2989, 1681, 1637, 1603, 1441, 1337, 1257, 1016, 813, 604 cm^{-1}. MS (EI) *m/z* (relative intensity) 403 (11) [M$^+$] (^{81}Br), 401 (11) [M$^+$] (^{79}Br), 360 (43), 358 (43), 303 (99), 301 (100), 151 (18), 43 (41). HR-MS (EI) *m/z* calcd for $C_{21}H_{24}BrNO_2$ 401.0990, found 401.0990.

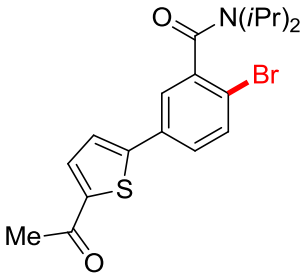


Methyl 4'-bromo-3'-(diisopropylcarbamoyl)-[1,1'-biphenyl]-4-carboxylate (**2j**): The representative procedure **E** was followed using methyl 4'-bromo-3'-(diisopropylcarbamoyl)-[1,1'-biphenyl]-4-carboxylate (**1j**) (170 mg, 0.5 mmol) and NBS (178 mg, 1.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1→4/1) yielded **2j** (120 mg, 57%) as a white solid. M.p. = 182−183 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 8.08 (dt, *J* = 8.4, 1.8 Hz, 2H), 7.62 (d, *J* = 8.2 Hz, 1H), 7.59 (dt, *J* = 8.4, 1.8 Hz, 2H), 7.41 (dd, *J* = 8.2, 2.2 Hz, 1H), 7.38 (d, *J* = 2.2 Hz, 1H), 3.94 (s, 3H), 3.65 (sept, *J* = 6.7 Hz, 1H), 3.53 (sept, *J* = 6.7 Hz, 1H), 1.58 (d, *J* = 6.7 Hz, 3H), 1.57 (d, *J* = 6.7 Hz, 3H), 1.25 (d, *J* = 6.7 Hz, 3H), 1.07 (d, *J* = 6.7 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 167.8 (C_q), 166.7 (C_q), 143.7 (C_q), 140.7 (C_q), 139.6 (C_q), 133.4 (CH), 130.2 (CH), 129.5 (C_q), 128.2 (CH), 126.9 (CH), 125.1 (CH), 118.9 (C_q), 52.2 (CH_3), 51.2 (CH), 46.1 (CH), 20.9 (CH_3), 20.7 (CH_3), 20.6 (CH_3), 20.0 (CH_3). IR (neat): 2960, 1719, 1629, 1435, 1368, 1340, 1271, 1102, 769, 710 cm^{-1}. MS (EI) *m/z* (relative intensity) 419 (10) [M^+] (^{81}Br), 417 (10) [M^+] (^{79}Br), 376 (42), 374 (42), 319 (98), 317 (100), 151 (19). HR-MS (EI) *m/z* calcd for $C_{21}H_{24}BrNO_3$ 417.0940, found 417.0934.

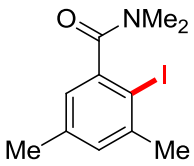


3'-Acetyl-4-bromo-*N*,*N*-diisopropyl-[1,1'-biphenyl]-3-carboxamide (**2k**): The representative procedure **E** was followed using 3'-acetyl-*N*,*N*-diisopropyl-[1,1'-biphenyl]-3-carboxamide (**1k**) (162 mg, 0.5 mmol) and NBS (178 mg, 1.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1→4/1) yielded **2k** (93 mg, 46%) as a white solid. M.p. = 159−160 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 8.11 (t, *J* = 1.6 Hz, 1H), 7.93 (dt, *J* = 7.8, 1.6 Hz, 1H), 7.72 (dq, *J* = 7.6, 1.1 Hz, 1H), 7.62 (d, *J* = 8.2 Hz, 1H), 7.52 (dd, *J* = 7.8, 7.6 Hz, 1H), 7.41 (dd, *J* = 8.2, 2.3 Hz, 1H), 7.37 (d, *J* = 2.3 Hz, 1H), 3.65 (sept, *J* = 6.7 Hz, 1H), 3.53 (sept, *J* = 6.7 Hz, 1H), 2.63 (s, 3H), 1.58 (d, *J* = 6.7 Hz, 3H), 1.57 (d, *J* = 6.7 Hz, 3H), 1.24 (d, *J* = 6.7 Hz, 3H), 1.06 (d, *J* = 6.7 Hz, 3H). ^{13}C-NMR

(75 MHz, $CDCl_3$): δ = 197.8 (C_q), 167.8 (C_q), 140.6 (C_q), 140.0 (C_q), 139.8 (C_q), 137.7 (C_q), 133.4 (CH), 131.5 (CH), 129.2 (CH), 128.2 (CH), 127.8 (CH), 126.7 (CH), 125.1 (CH), 118.7 (C_q), 51.2 (CH), 46.1 (CH), 26.8 (CH_3), 20.9 (CH_3), 20.7 (CH_3), 20.6 (CH_3), 20.0 (CH_3). IR (neat): 2982, 2934, 1677, 1629, 1451, 1367, 1397, 1036, 807, 602 cm^{-1}. MS (EI) *m/z* (relative intensity) 403 (11) [M^+] (^{81}Br), 401 (11) [M^+] (^{79}Br), 360 (46), 358 (46), 303 (98), 301 (100), 151 (15). HR-MS (EI) *m/z* calcd for $C_{21}H_{24}BrNO_2$ 401.0990, found 401.0991.

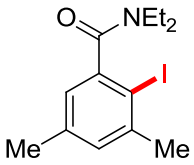


5-(5'-Acetylthiophen-2-yl)-2-bromo-*N*,*N*-diisopropylbenzamide (**2l**): The representative procedure **E** was followed using 3-(5'-acetylthiophen-2-yl)-*N*,*N*-diisopropylbenzamide (**1l**) (165 mg, 0.5 mmol) and NBS (178 mg, 1.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 4/1→3/1) yielded **2l** (76 mg, 37%) as a white solid. M.p. = 181−183 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.62 (d, *J* = 4.0 Hz, 1H), 7.58 (d, *J* = 8.2 Hz, 1H), 7.43 (dd, *J* = 8.2, 2.2 Hz, 1H), 7.40 (d, *J* = 2.2 Hz, 1H), 7.29 (d, *J* = 4.0 Hz, 1H), 3.62 (sept, *J* = 6.7 Hz, 1H), 3.53 (sept, *J* = 6.7 Hz, 1H), 2.54 (s, 3H), 1.59 (d, *J* = 6.7 Hz, 3H), 1.55 (d, *J* = 6.7 Hz, 3H), 1.24 (d, *J* = 6.7 Hz, 3H), 1.07 (d, *J* = 6.7 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 190.5 (C_q), 167.3 (C_q), 150.3 (C_q), 143.8 (C_q), 140.9 (C_q), 133.6 (CH), 133.3 (CH), 133.0 (C_q), 127.0 (CH), 124.6 (CH), 124.0 (CH), 119.5 (C_q), 51.3 (CH), 46.1 (CH), 26.5 (CH_3), 20.9 (CH_3), 20.6 (CH_3), 20.6 (CH_3), 20.0 (CH_3). IR (neat): 2977, 2936, 1653, 1621, 1435, 1340, 1281, 1021, 827, 796, 599 cm^{-1}. MS (EI) *m/z* (relative intensity) 409 (10) [M^+] (^{81}Br), 407 (10) [M^+] (^{79}Br), 366 (40), 364 (40), 309 (100), 307 (100), 185 (14). HR-MS (ESI) *m/z* calcd for $[(C_{19}H_{22}BrNO_2S)H]^+$ 408.0627, found 408.0620.

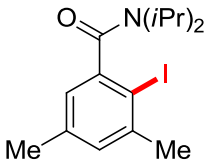


2-Iodo-*N*,*N*,3,5-tetramethylbenzamide (**3m**): The representative procedure **E** was followed using *N*,*N*,3,5-tetramethylbenzamide (**1m**) (177 mg, 1.0 mmol) and NIS (450 mg, 2.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 3/1) yielded **3m** (237 mg, 78%) as a yellow solid. M.p. = 82−83 °C. ^{1}H-NMR (300 MHz, $CDCl_3$):

δ = 6.98 (s, 1H), 6.76 (s, 1H), 3.07 (s, 3H), 2.79 (s, 3H), 2.36 (s, 3H), 2.21 (s, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 171.3 (C_q), 143.5 (C_q), 142.0 (C_q), 138.4 (C_q), 130.3 (CH), 124.8 (CH), 94.9 (C_q), 38.3 (CH_3), 34.5 (CH_3), 28.4 (CH_3), 20.6 (CH_3). IR (neat): 2913, 2853, 1626, 1505, 1441, 1399. 1125, 1003, 863, 663 cm^{-1}. MS (EI) *m/z* (relative intensity) 303 (38) [M^+], 259 (100), 231 (24), 104 (20). HR-MS (EI) *m/z* calcd for $C_{11}H_{14}INO$ 303.0120, found 303.0118.

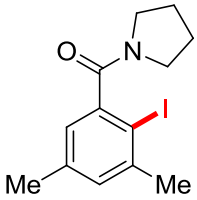


***N*,*N*-Diethyl-2-iodo-3,5-dimethylbenzamide** (**3n**): The representative procedure **E** was followed using *N*,*N*-diethyl-3,5-dimethylbenzamide (**1n**) (205 mg, 1.0 mmol) and NIS (450 mg, 2.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1→5/1) and normal phase HPLC (*n*-hexane/EtOAc: 15/1→7/1) yielded **3n** (235 mg, 71%) as a colorless oil. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.02 (s, 1H), 6.79 (s, 1H), 3.84 (hex, *J* = 6.9 Hz, 1H), 3.28 (hex, *J* = 6.9 Hz, 1H), 3.20−3.03 (m, 2H), 2.39 (s, 3H), 2.24 (s, 3H), 1.28 (t, *J* = 6.9 Hz, 3H), 1.05 (t, *J* = 6.9 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 170.7 (C_q), 143.6 (C_q), 142.1 (C_q), 138.2 (C_q), 130.2 (CH), 124.8 (CH), 95.4 (C_q), 42.6 (CH_2), 38.7 (CH_2), 28.5 (CH_3), 20.7 (CH_3), 13.8 (CH_3), 12.3 (CH_3). IR (neat): 2972, 2932, 1628, 1432, 1317, 1129, 1008, 857, 806, 648 cm^{-1}. MS (EI) *m/z* (relative intensity) 331 (57) [M^+], 259 (100), 231 (32), 204 (50), 135 (33), 104 (37). HR-MS (EI) *m/z* calcd for $C_{13}H_{18}INO$ 331.0433, found 331.0432.

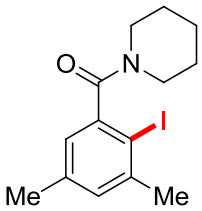


2-Iodo-*N*,*N*-diisopropyl-3,5-dimethylbenzamide (3d): The representative procedure **E** was followed using *N*,*N*-diisopropyl-3,5-dimethylbenzamide (**1d**) (233 mg, 1.0 mmol) and NIS (450 mg, 2.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1) yielded **3d** (305 mg, 85%) as a white solid. M.p. = 195−196 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 6.98 (s, 1H), 6.71 (s, 1H), 3.59 (hept, *J* = 6.8 Hz, 1H), 3.48 (hept, *J* = 6.8 Hz, 1H), 2.39 (s, 3H), 2.23 (s, 3H), 1.60 (d, *J* = 6.8 Hz, 3H), 1.54 (d, *J* = 6.8 Hz, 3H), 1.24 (d, *J* = 6.8 Hz, 3H), 1.03 (d, *J* = 6.8 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 170.5 (C_q), 145.0 (C_q), 142.2 (C_q), 138.2 (C_q), 129.9 (CH), 123.8 (CH), 95.0 (C_q), 51.1 (CH), 45.8 (CH), 28.5 (CH_3), 20.7 (CH_3), 20.7 (CH_3), 20.7 (CH_3), 20.6 (CH_3), 19.9 (CH_3). IR (neat):

2958, 2926, 1625, 1442, 1368, 1344, 1208, 864, 777, 630 cm^{-1}. MS (EI) *m/z* (relative intensity) 359 (40) [M^+], 316 (48), 259 (100), 232 (40), 133 (32), 104 (32). HR-MS (ESI) *m/z* calcd for [($C_{15}H_{22}INO$)H]$^+$ 360.0824, found 360.0817.

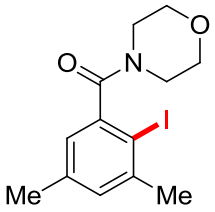


(2-Iodo-3,5-dimethylphenyl)(pyrrolidin-1-yl)methanone (**3o**): The representative procedure **E** was followed using (3,5-dimethylphenyl)(pyrrolidin-1-yl)methanone (**1o**) (203 mg, 1.0 mmol) and NIS (450 mg, 2.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1) yielded **3e** (238 mg, 72%) as a white solid. M.p. = 107−108 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.00 (s, 1H), 6.80 (s, 1H), 3.61 (t, *J* = 6.7 Hz, 2H), 3.25−3.01 (m, 2H), 2.38 (s, 3H), 2.23 (s, 3H), 1.99−1.80 (m, 4H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 169.5 (C_q), 144.7 (C_q), 142.1 (C_q), 138.5 (C_q), 130.4 (CH), 124.6 (CH), 94.7 (C_q), 48.3 (CH_2), 45.4 (CH_2), 28.4 (CH_3), 25.9 (CH_2), 24.5 (CH_2), 20.7 (CH_3). IR (neat): 2963, 2930, 1626, 1434, 1364, 1322, 1148, 1036, 816, 608 cm^{-1}. MS (EI) *m/z* (relative intensity) 329 (67) [M^+], 259 (100), 231 (34), 202 (49), 133 (37), 104 (42). HR-MS (EI) *m/z* calcd for $C_{13}H_{16}INO$ 329.0277, found 329.0275.

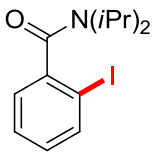


(2-Iodo-3,5-dimethylphenyl)(piperidin-1-yl)methanone (**3p**): The representative procedure **E** was followed using (3,5-dimethylphenyl)(piperidin-1-yl)methanone (**1p**) (217 mg, 1.0 mmol) and NIS (450 mg, 2.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 5/1→4/1) yielded **3p** (275 mg, 80%) as a white solid. M.p. = 77−78 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.01 (s, 1H), 6.77 (s, 1H), 3.84−3.74 (m, 1H), 3.70−3.60 (m, 1H), 3.25−3.07 (m, 2H), 2.41 (s, 3H), 2.25 (s, 3H), 1.80−1.54 (m, 5H), 1.53−1.35 (m, 1H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 169.8 (C_q), 143.6 (C_q), 142.2 (C_q), 138.4 (C_q), 130.3 (CH), 124.7 (CH), 95.1 (C_q), 47.8 (CH_2), 42.3 (CH_2), 28.5 (CH_3), 26.1 (CH_2), 25.3 (CH_2), 24.5 (CH_2), 20.7 (CH_3). IR (neat): 2936, 2852, 1625, 1435, 1217, 1006, 855, 658 cm^{-1}. MS (EI) *m/z* (relative intensity) 343 (52) [M^+], 342 (100), 259 (93), 231 (23), 216 (43),

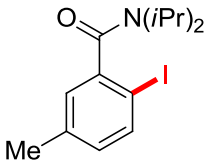
104 (28). HR-MS (EI) *m/z* calcd for $C_{14}H_{18}INO$ 343.0433, found 343.0438.



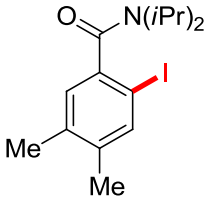
(2-Iodo-3,5-dimethylphenyl)(morpholino)methanone (**3q**): The representative procedure **E** was followed using (3,5-dimethylphenyl)(morpholino)methanone (**1q**) (219 mg, 1.0 mmol) and NIS (450 mg, 2.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 3/1→2/1) and normal phase HPLC (*n*-hexane/EtOAc: 7/1→3/1) yielded **3q** (248 mg, 72%) as a white solid. M.p. = 135−136 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.03 (s, 1H), 6.77 (s, 1H), 3.86−3.68 (m, 5H), 3.60−3.50 (m, 1H), 3.32−3.11 (m, 2H), 2.40 (s, 3H), 2.25 (s, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 170.0 (C_q), 142.5 (C_q), 142.2 (C_q), 138.6 (C_q), 130.8 (CH), 124.9 (CH), 95.0 (C_q), 66.6 (CH_2), 66.5 (CH_2), 47.1 (CH_2), 41.8 (CH_2), 28.5 (CH_3), 20.7 (CH_3). IR (neat): 2901, 2856, 1627, 1460, 1434, 1106, 1007, 860, 662 cm^{-1}. MS (EI) *m/z* (relative intensity) 345 (30) [M^+], 359 (100), 2313 (17), 104 (20). HR-MS (EI) *m/z* calcd for $C_{13}H_{16}INO_2$ 345.0226, found 345.0211.



2-Iodo-*N*,*N*-diisopropylbenzamide (**3a**): The representative procedure **E** was followed using *N*,*N*-diisopropylbenzamide (**1a**) (103 mg, 0.5 mmol) and NIS (225 mg, 1.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1→5/1) and normal phase HPLC (*n*-hexane/EtOAc: 19/1→9/1) yielded **3a** (88 mg, 53%) as a white solid. M.p. = 188−189 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.80 (dd, *J* = 8.0, 1.0 Hz, 1H), 7.34 (ddd, *J* = 7.6, 7.5, 1.0 Hz, 1H), 7.11 (dd, *J* = 7.6, 1.6 Hz, 1H), 7.00 (ddd, *J* = 8.0, 7.5, 1.6 Hz, 1H), 3.63−3.42 (m, 2H), 1.58 (d, *J* = 6.8 Hz, 3H), 1.54 (d, *J* = 6.8 Hz, 3H), 1.25 (d, *J* = 6.8 Hz, 3H), 1.04 (d, *J* = 6.8 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 169.8 (C_q), 144.2 (C_q), 139.3 (CH), 129.4 (CH), 128.2 (CH), 125.8 (CH), 92.2 (C_q), 51.2 (CH), 46.0 (CH), 20.7 (CH_3), 20.7 (CH_3), 20.6 (CH_3), 20.0 (CH_3). IR (neat): 2967, 2929, 1618, 1581, 1435, 1339, 1012, 771 cm^{-1}. MS (EI) *m/z* (relative intensity) 331 (7) [M^+], 288 (27), 230 (100), 202 (21), 43 (23). HR-MS (EI) *m/z* calcd for $C_{13}H_{18}INO$ 331.0433, found 331.0414. The spectral data were in accordance with those reported in the literature.[2]

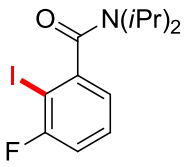


2-Iodo-*N*,*N*-diisopropyl-5-methylbenzamide (**3c**): The representative procedure **E** was followed using *N*,*N*-diisopropyl-3-methylbenzamide (**1c**) (219 mg, 1.0 mmol) and NIS (450 mg, 2.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1) and normal phase HPLC (*n*-hexane/EtOAc: 19/1→9/1) yielded **3c** (221 mg, 64%) as a white solid. M.p. = 161−162 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.63 (d, J = 8.0 Hz, 1H), 6.93 (d, J = 2.0 Hz, 1H), 6.82 (dt, J = 8.0, 0.7 Hz, 1H), 3.58 (sept, J = 6.7 Hz, 1H), 3.49 (sept, J = 6.7 Hz, 1H), 2.27 (s, 3H), 1.57 (d, J = 6.7 Hz, 3H), 1.54 (d, J = 6.7 Hz, 3H), 1.25 (d, J = 6.7 Hz, 3H), 1.05 (d, J = 6.7 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 169.9 (C_q), 144.0 (C_q), 139.0 (CH), 138.4 (C_q), 130.4 (CH), 126.5 (CH), 88.0 (C_q), 51.2 (CH), 45.9 (CH), 20.9 (CH_3), 20.8 (CH_3), 20.7 (CH_3), 20.6 (CH_3), 20.0 (CH_3). IR (neat): 2966, 2928, 1621, 1441, 1337, 1012, 834, 803, 621, 455 cm^{-1}. MS (EI) *m/z* (relative intensity) 345 (11) [M^+], 302 (23), 245 (100), 218 (16), 90 (22). HR-MS (ESI) *m/z* calcd for [($C_{14}H_{20}INO$)H]$^+$ 346.0668, found 346.0662. The spectral data were in accordance with those reported in the literature.[7]

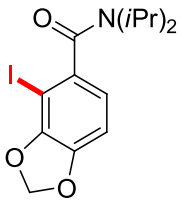


2-Iodo-*N*,*N*-diisopropyl-4,5-dimethylbenzamide (**3r**): The representative procedure **E** was followed using *N*,*N*-diisopropyl-3,4-dimethylbenzamide (**1r**) (233 mg, 1.0 mmol) and NIS (450 mg, 2.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 20/1→10/1) yielded **3r** (187 mg, 52%) as a white solid. M.p. = 106−107 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.55 (s, 1H), 6.94 (s, 1H), 3.62 (sept, J = 6.7 Hz, 1H), 3.49 (sept, J = 6.7 Hz, 1H), 2.21 (s, 3H), 2.17 (s, 3H), 1.58 (d, J = 6.7 Hz, 3H), 1.56 (d, J = 6.7 Hz, 3H), 1.26 (d, J = 6.7 Hz, 3H), 1.06 (d, J = 6.7 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 170.0 (C_q), 141.8 (C_q), 139.7 (CH), 138.4 (C_q), 137.0 (C_q), 126.8 (CH), 88.3 (C_q), 51.1 (CH), 45.8 (CH), 20.8 (CH_3), 20.7 (CH_3), 20.6 (CH_3), 20.0 (CH_3), 19.3 (CH_3), 19.1 (CH_3). IR (neat): 2970, 2929, 1623, 1435, 1359, 1322, 1043, 817, 609 cm^{-1}. MS (EI) *m/z* (relative intensity) 359 (10) [M^+], 316 (28), 259 (100), 232 (17), 104 (13). HR-MS (EI) *m/z*

calcd for $C_{15}H_{22}INO$ 359.0746, found 359.0745.

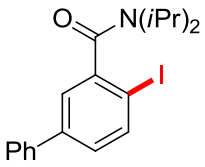


3-Fluoro-2-iodo-*N*,*N*-diisopropylbenzamide (**3d**): The representative procedure **E** was followed using 3-fluoro-*N*,*N*-diisopropylbenzamide (**1d**) (223 mg, 1.0 mmol) and NIS (450 mg, 2.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 5/1) yielded **3d** (128 mg, 36%) as a white solid. M.p. = 124−125 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.32 (ddd, J = 8.0, 5.2, 0.7 Hz, 1H), 7.00 (ddd, J = 8.0, 7.6, 1.5 Hz, 1H), 6.93 (dd, J = 7.6, 1.0 Hz, 1H), 3.62−3.43 (m, 2H), 1.60 (d, J = 6.6 Hz, 3H), 1.56 (d, J = 6.6 Hz, 3H), 1.26 (d, J = 6.6 Hz, 3H), 1.07 (d, J = 6.6 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 168.6 (d, $^{4}J_{C–F}$ = 2 Hz, C_q), 161.8 (d, $^{1}J_{C–F}$ = 246 Hz, C_q), 146.4 (d, $^{3}J_{C–F}$ = 8 Hz, C_q), 130.3 (d, $^{3}J_{C–F}$ = 8 Hz, CH), 121.4 (d, $^{4}J_{C–F}$ = 3 Hz, CH), 114.8 (d, $^{2}J_{C–F}$ = 24 Hz, CH), 80.5 (d, $^{2}J_{C–F}$ = 26 Hz, C_q), 51.3 (CH), 46.1 (CH), 20.8 (CH_3), 20.7 (CH_3), 20.6 (CH_3), 20.0 (CH_3). ^{19}F-NMR (283 MHz, $CDCl_3$): δ = − (90.8−90.9) (m). IR (neat): 2967, 2930, 1620, 1435, 1340, 1203, 1041, 788, 604 cm^{-1}. MS (EI) *m/z* (relative intensity) 349 (10) [M^+], 306 (28), 249 (100), 220 (18), 43 (16). HR-MS (EI) *m/z* calcd for $C_{13}H_{17}FINO$ 349.0339, found 349.0339.

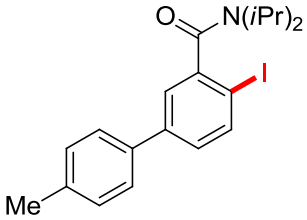


4-Iodo-*N*,*N*-diisopropylbenzo[*d*][1,3]dioxole-5-carboxamide (**3s**): The representative procedure **E** was followed using 4-iodo-*N*,*N*-diisopropylbenzo[*d*][1,3]dioxole-5-carboxamide (**1s**) (249 mg, 1.0 mmol) and NIS (450 mg, 2.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 5/1) yielded **3s** (277 mg, 73%) as a white solid. M.p. = 149−150 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 6.73 (d, J = 7.8 Hz, 1H), 6.61 (d, J = 7.8 Hz, 1H), 6.02 (dd, J = 7.0, 1.2 Hz, 2H), 3.62 (sept, J = 6.7 Hz, 1H), 3.47 (sept, J = 6.7 Hz, 1H), 1.55 (d, J = 6.7 Hz, 3H), 1.52 (d, J = 6.7 Hz, 3H), 1.22 (d, J = 6.7 Hz, 3H), 1.04 (d, J = 6.7 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 169.1 (C_q), 149.7 (C_q), 145.5 (C_q), 137.5 (C_q), 119.1 (CH), 108.3 (CH), 100.7 (C_q), 70.0 (CH_2), 51.2 (CH), 46.0 (CH), 20.8 (CH_3), 20.7 (CH_3), 20.6 (CH_3), 20.2 (CH_3). IR (neat): 2961, 2927, 1621, 1445, 1339, 1242, 1033, 898, 803,

593 cm^{-1}. MS (EI) *m/z* (relative intensity) 375 (13) [M^+], 332 (20), 275 (100), 149 (12). HR-MS (EI) *m/z* calcd for $C_{14}H_{18}INO_3$ 375.0331, found 375.0329.

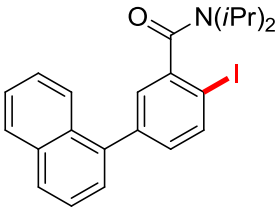


4-Iodo-*N*,*N*-diisopropyl-[1,1'-biphenyl]-3-carboxamide (**3f**): The representative procedure **E** was followed using *N*,*N*-diisopropyl-[1,1'-biphenyl]-3-carboxamide (**1f**) (141 mg, 0.5 mmol) and NIS (338 mg, 1.5 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 20/1→10/1) yielded **3f** (130 mg, 64%) as a white solid. M.p. = 171−172 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.84 (d, *J* = 8.2 Hz, 1H), 7.53 (dt, *J* = 7.0, 2.0 Hz, 2H), 7.43 (dt, *J* = 7.0, 2.0 Hz, 2H), 7.36 (dt, *J* = 7.0, 1.3 Hz, 1H), 7.32 (d, *J* = 2.2 Hz, 1H), 7.23 (dd, *J* = 8.2, 2.2 Hz, 1H), 3.65 (sept, *J* = 6.7 Hz, 1H), 3.52 (sept, *J* = 6.7 Hz, 1H), 1.60 (d, *J* = 6.7 Hz, 3H), 1.58 (d, *J* = 6.7 Hz, 3H), 1.28 (d, *J* = 6.7 Hz, 3H), 1.06 (d, *J* = 6.7 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 169.6 (C_q), 144.5 (C_q), 141.4 (C_q), 139.6 (CH), 139.4 (C_q), 128.9 (CH), 128.1 (CH), 127.9 (CH), 126.9 (CH), 124.3 (CH), 90.8 (C_q), 51.2 (CH), 46.0 (CH), 20.8 (CH_3), 20.7 (CH_3), 20.6 (CH_3), 20.0 (CH_3). IR (neat): 2967, 2930, 1622, 1444, 1337, 1209, 785, 608 cm^{-1}. MS (EI) *m/z* (relative intensity) 407 (15) [M^+], 364 (35), 307 (100), 280 (25), 152 (45). HR-MS (EI) *m/z* calcd for $C_{19}H_{22}INO$ 407.0746, found 407.0727.



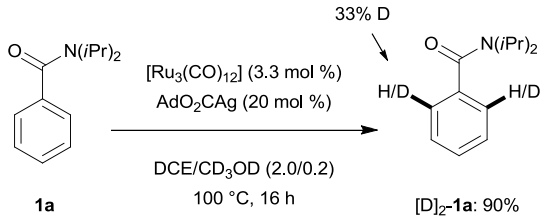
4-Iodo-*N*,*N*-diisopropyl-4'-methyl-[1,1'-biphenyl]-3-carboxamide (**3g**): The representative procedure **E** was followed using *N*,*N*-diisopropyl-4'-methyl-[1,1'-biphenyl]-3-carboxamide (**1g**) (148 mg, 0.5 mmol) and NIS (225 mg, 1.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 20/1→10/1) yielded **3g** (145 mg, 68%) as a white solid. M.p. = 210−212 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.82 (d, *J* = 8.2 Hz, 1H), 7.43 (dt, *J* = 8.1, 1.8 Hz, 2H), 7.30 (d, *J* = 2.2 Hz, 1H), 7.26−7.19 (m, 3H), 3.65 (sept, *J* = 6.6 Hz, 1H), 3.52 (sept, *J* = 6.6 Hz, 1H), 2.37 (s, 3H), 1.60 (d, *J* = 6.6 Hz, 3H), 1.57 (d, *J* = 6.6 Hz, 3H), 1.27 (d, *J* = 6.6 Hz, 3H), 1.06 (d, *J* = 6.6 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 169.8 (C_q), 144.5 (C_q), 141.4 (C_q), 139.6 (CH), 137.8 (C_q), 136.6 (C_q), 129.6 (CH), 128.0

(CH), 126.7 (CH), 124.1 (CH), 90.4 (C_q), 51.2 (CH), 46.0 (CH), 21.1 (CH_3), 20.8 (CH_3), 20.7 (CH_3), 20.7 (CH_3), 20.0 (CH_3). IR (neat): 2968, 2929, 1627, 1440, 1335, 1034, 802, 515 cm^{-1}. MS (ESI) *m/z* (relative intensity) 422 (82) $[(M+H)^+]$, 444 (37) $[(M+Na)^+]$, 843 (100) $[(2M+H)^+]$. HR-MS (ESI) *m/z* calcd for $[(C_{20}H_{24}INO)H]^+$ 422.0975, found 422.0970.



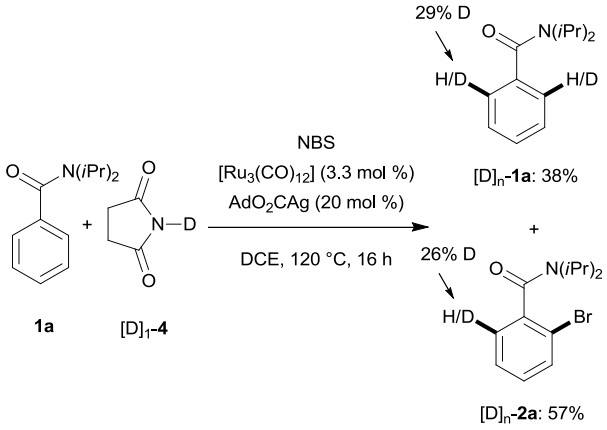
2-Iodo-*N*,*N*-diisopropyl-5-(naphthalen-1-yl)benzamide (**3t**): The representative procedure **E** was followed using *N*,*N*-diisopropyl-3-(naphthalen-1-yl)benzamide (**1t**) (166 mg, 0.5 mmol) and NIS (225 mg, 1.0 mmol). After 22 h, purification by column chromatography on silica gel (*n*-hexane/EtOAc: 20/1→10/1) yielded **3t** (134 mg, 59%) as a white solid. M.p. = 161−162 °C. ^{1}H-NMR (300 MHz, $CDCl_3$): δ = 7.91 (d, *J* = 8.2 Hz, 1H), 7.89 (d, *J* = 8.2 Hz, 1H), 7.86 (d, *J* = 8.6 Hz, 1H), 7.82 (d, *J* = 8.6 Hz, 1H), 7.50 (dd, *J* = 8.2, 7.0 Hz, 1H), 7.46 (ddd, *J* = 8.0, 7.0, 1.5 Hz, 1H), 7.42 (ddd, *J* = 7.6, 7.5, 1.5 Hz, 1H), 7.37 (dd, *J* = 7.5, 1.1 Hz, 1H), 7.25 (dd, *J* = 2.2, 2.1 Hz, 1H), 7.15 (dd, *J* = 8.2, 2.1 Hz, 1H), 3.77 (sept, *J* = 6.6 Hz, 1H), 3.51 (sept, *J* = 6.6 Hz, 1H), 1.61 (d, *J* = 6.7 Hz, 3H), 1.51 (d, *J* = 6.7 Hz, 3H), 1.33 (d, *J* = 6.7 Hz, 3H), 1.09 (d, *J* = 6.7 Hz, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$): δ = 169.6 (C_q), 144.2 (C_q), 141.0 (C_q), 139.3 (CH), 138.3 (C_q), 133.7 (C_q), 131.1 (CH), 128.4 (CH), 128.2 (CH), 127.4 (CH), 126.9 (CH), 126.3 (CH), 126.0 (CH), 125.5 (CH), 125.3 (CH), 91.0 (C_q), 51.4 (CH), 46.0 (CH), 20.9 (CH_3), 20.7 (CH_3), 20.6 (CH_3), 20.1 (CH_3) (One C_q is invisible). IR (neat): 2968, 2933, 1624, 1439, 1368, 1331, 1159, 1038, 1011, 778 cm^{-1}. MS (ESI) *m/z* (relative intensity) 458 $[(M+H)^+]$ (46), 915 $[(2M+H)^+]$ (100). HR-MS (ESI) *m/z* calcd for $[(C_{25}H_{18}F_3NO)H]^+$ 458.0975, found 458.0968.

Studies with isotopically labelled CD_3OD (Scheme S-1)



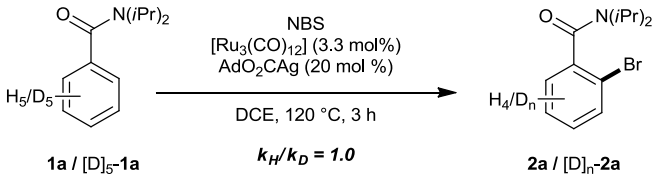
A mixture of *N*,*N*-diisopropylbenzamide (**1a**) (103 mg, 0.5 mmol), $Ru_3(CO)_{12}$ (10.5 mg, 3.3 mol %) and AgO_2CAd (28.7 mg, 20 mol %) in DCE (2.0 mL) and CD_3OD (0.2 mL) was stirred under N_2 for 16 h at 100 °C. The mixture was then allowed to cool to ambient temperature, diluted with EtOAc (5 mL), filtered through a short pad of silica gel and eluted with EtOAc (50 mL). After removing the solvent under reduced pressure, the product was purified by column chromatography on silica gel (*n*-hexane/EtOAc: 4/1) to yield a mixture **1a** and $[D]_2$-**1a** (93 mg, 90%) as a white solid. The deuterium incorporation was estimated to be 33% by ^{1}H NMR spectroscopy.

Studies with isotopically labelled compounds (Scheme 5)



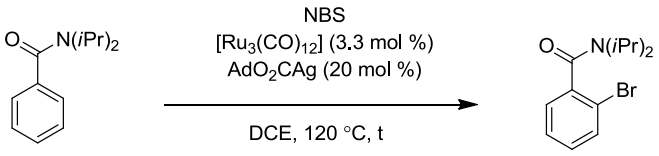
A mixture of *N*,*N*-diisopropylbenzamide (**1a**) (205 mg, 1.0 mmol), NBS (356 mg, 2.0 mmol), $Ru_3(CO)_{12}$ (21.1 mg, 3.3 mol %), AgO_2CAd (57.4 mg, 20 mol %) and $[D]_1$-**4** (200 mg, 2.0 mmol) in DCE (3.0 mL) was stirred at 120 °C under N_2 for 16 h. The mixture was then allowed to cool down to ambient temperature, diluted with EtOAc (5 mL), filtered through a short pad of silica gel and eluted with EtOAc (50 mL). After removing the solvent under reduced pressure, the product was purified by column chromatography on silica gel (*n*-hexane/EtOAc: 10/1→5/1) to give $[D]_n$-**2a** (164 mg, 57%) as a white solid and $[D]_n$-**1a** (79 mg, 38%) as a white solid. The deuterium incorporation was estimated by ^{1}H NMR spectroscopy

Kinetic isotope effect studies by parallel experiments (Scheme 6)



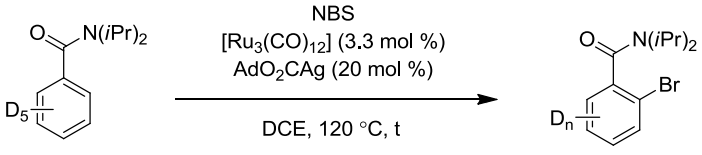
1a / $[D]_5$-**1a** k_H/k_D = 1.0 **2a** / $[D]_n$-**2a**

A mixture of benzamide **1a** or $[D]_5$-**1a** (1.0 mmol), NBS (356 mg, 2.0 mmol), $Ru_3(CO)_{12}$ (21.1 mg, 3.3 mol %), AgO_2CAd (57.4 mg, 20 mol %) and the internal standard 1,3,5-tri-*tert*-butylbenzene (246 mg, 1.0 mmol) in DCE (8.0 mL) was stirred at 120 °C under N_2. For three hours, an aliquot (0.2 mL) was collected every fifteen minutes and submitted to GC analysis to determine the conversion.



1a **2a**

Entry	1	2	3	4	5	6	7	8	9	10	11	12
Prod.	2	9	20	25	31	35	39	42	44	46	48	49
S.M.	98	91	80	75	69	65	61	58	56	54	52	51



$[D]_5$-**1a** $[D]_n$-**2a**

Entry	1	2	3	4	5	6	7	8	9	10	11	12
Prod.	2	9	19	25	31	35	39	41	43	44	46	46
S.M.	98	91	81	75	69	65	61	59	57	56	54	54

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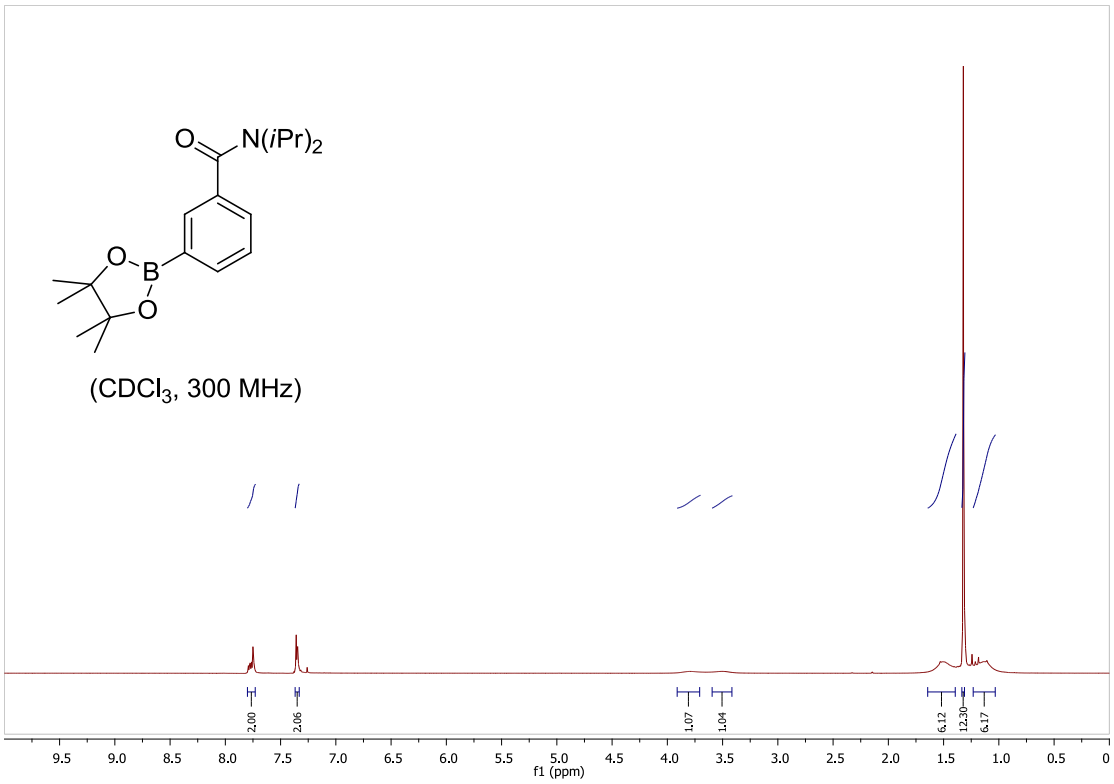
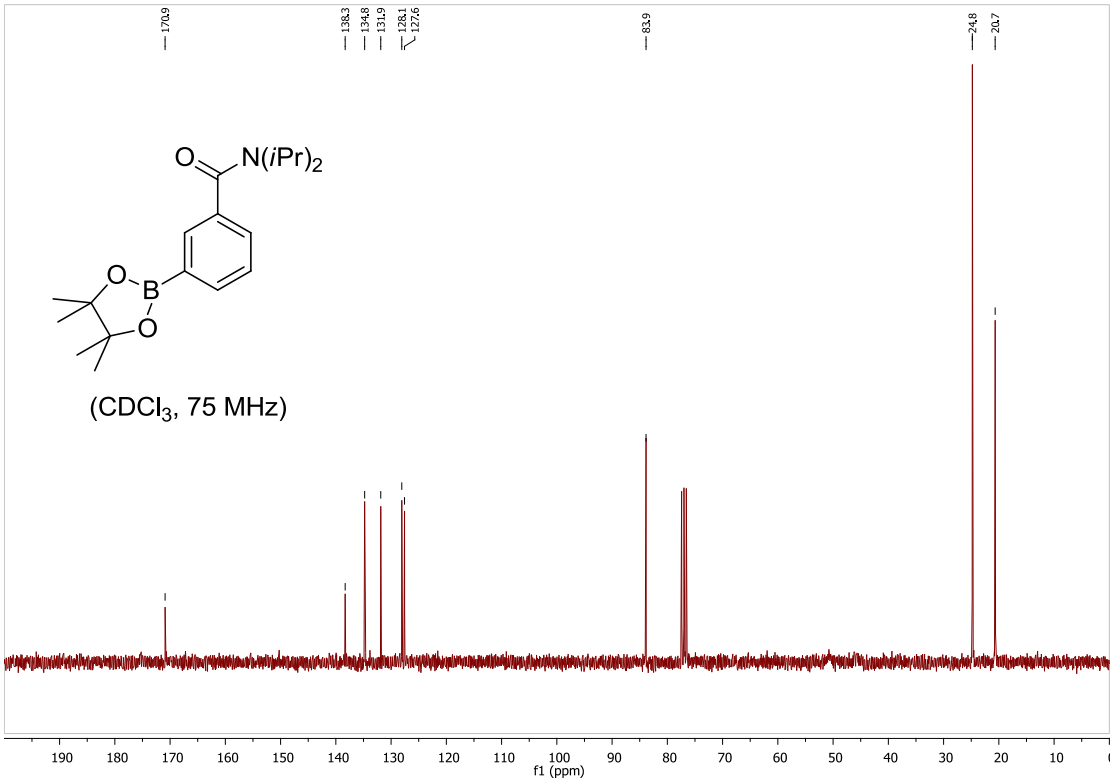
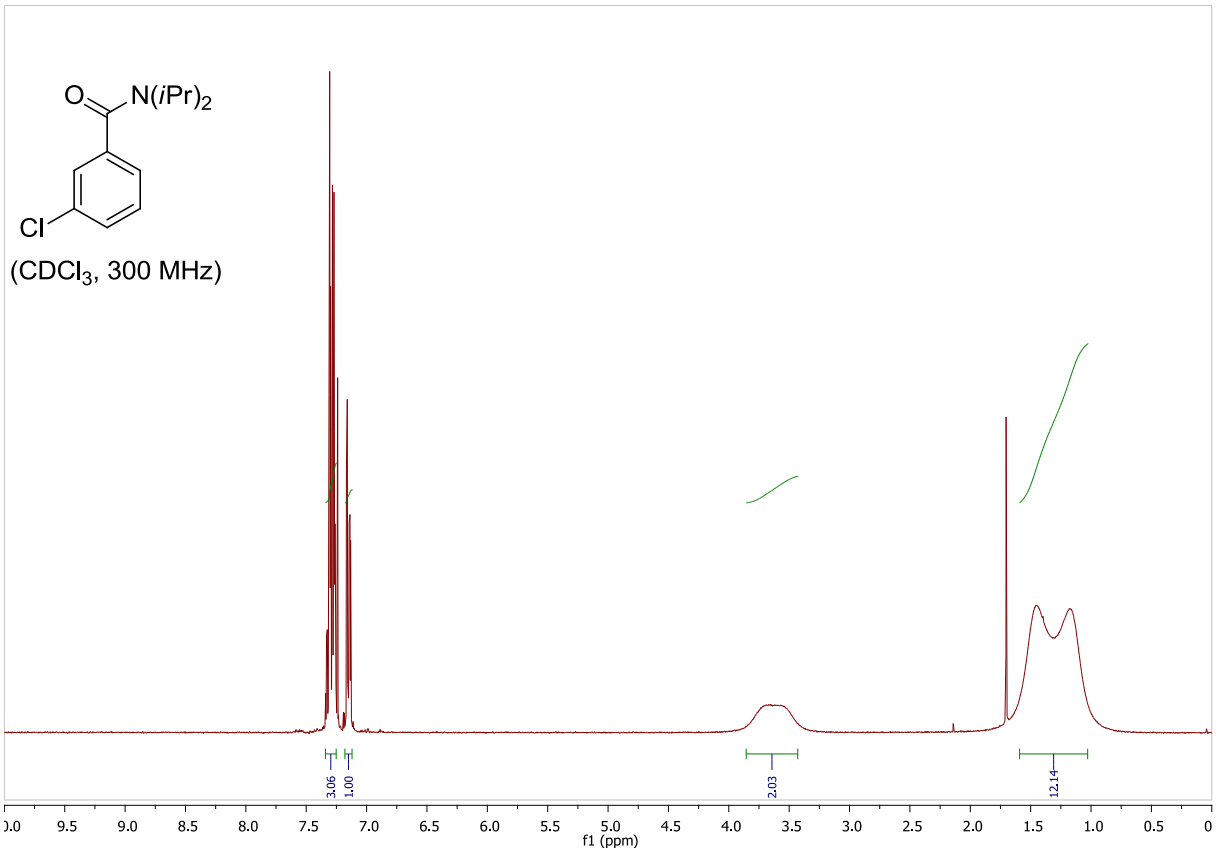
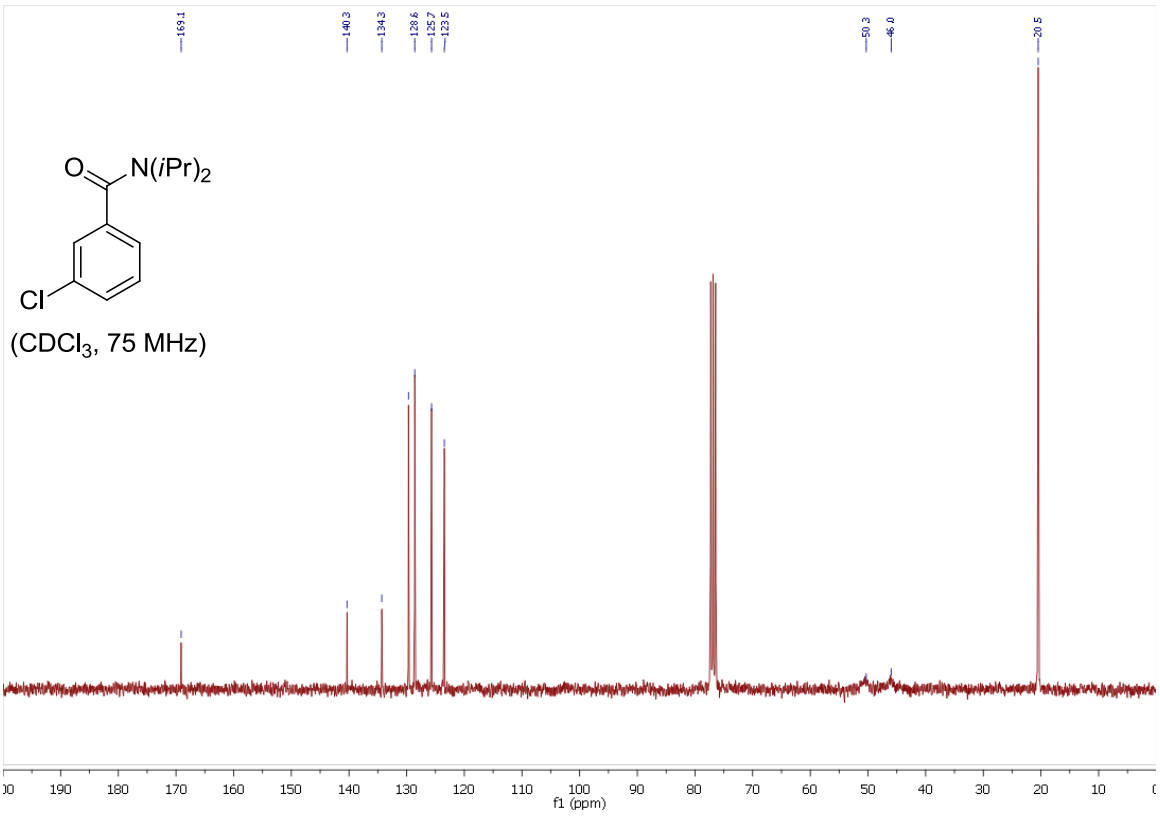
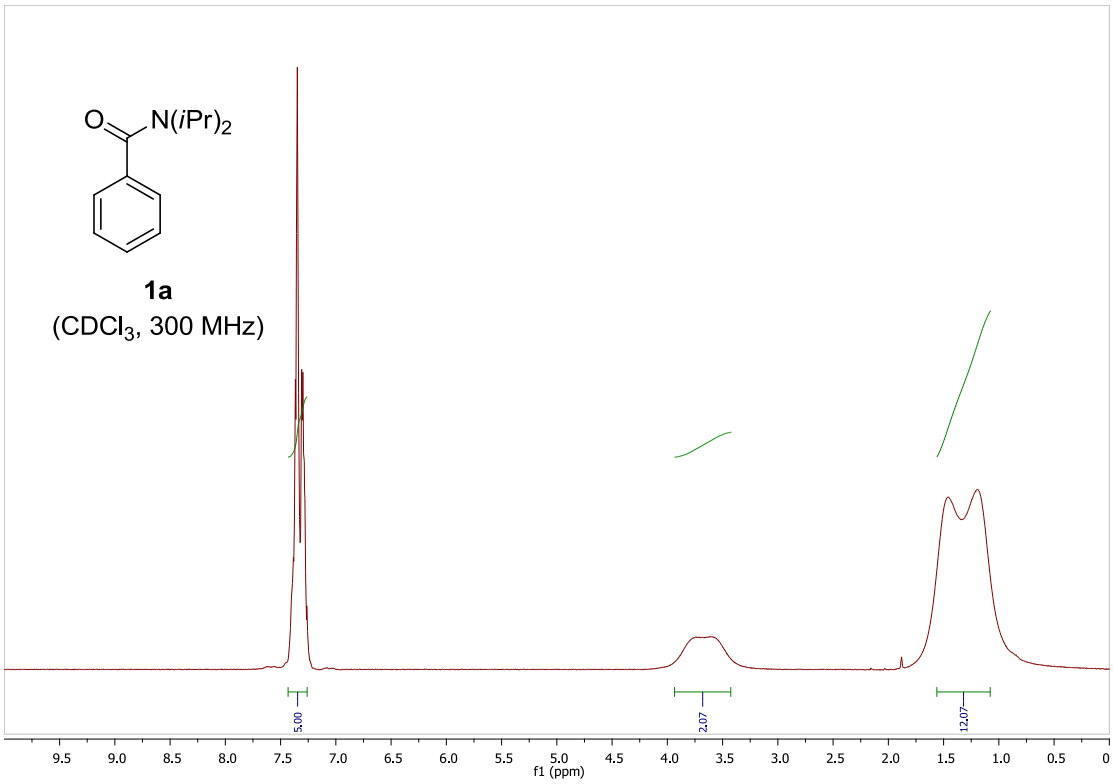
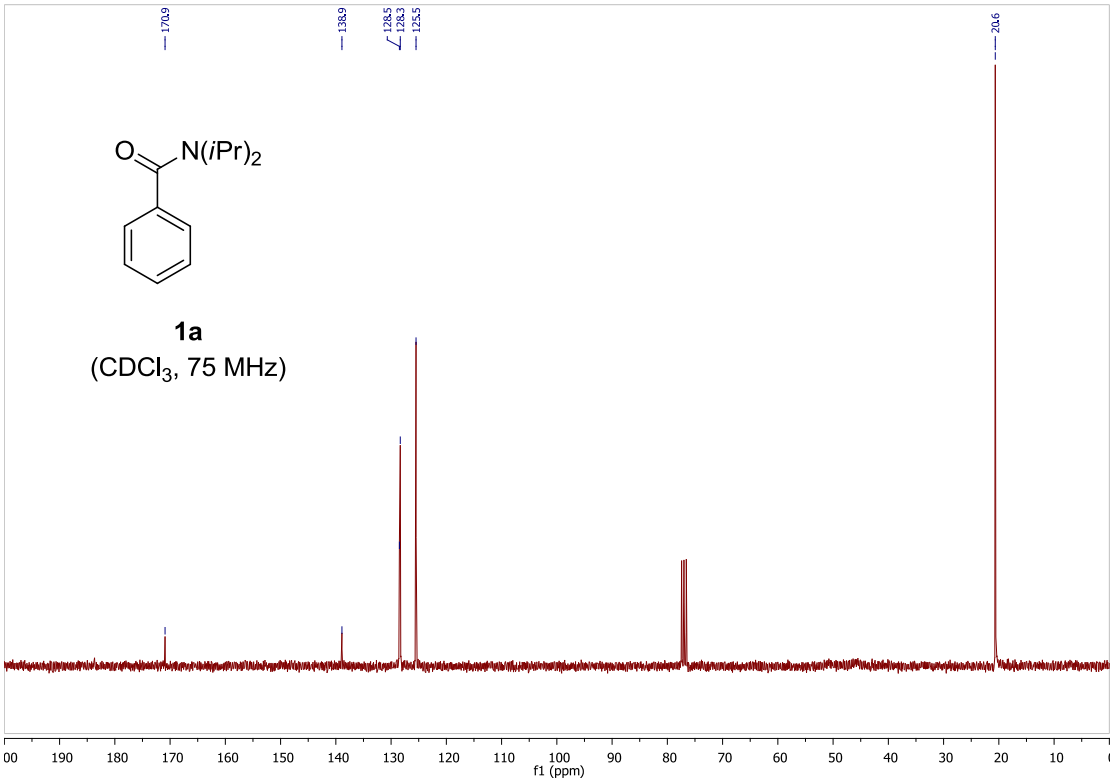

O
N(iPr)2
O
B
O
(CDCl3, 300 MHz)
2.00
2.06
1.07
1.04
6.12
12.30
6.17
f1 (ppm)

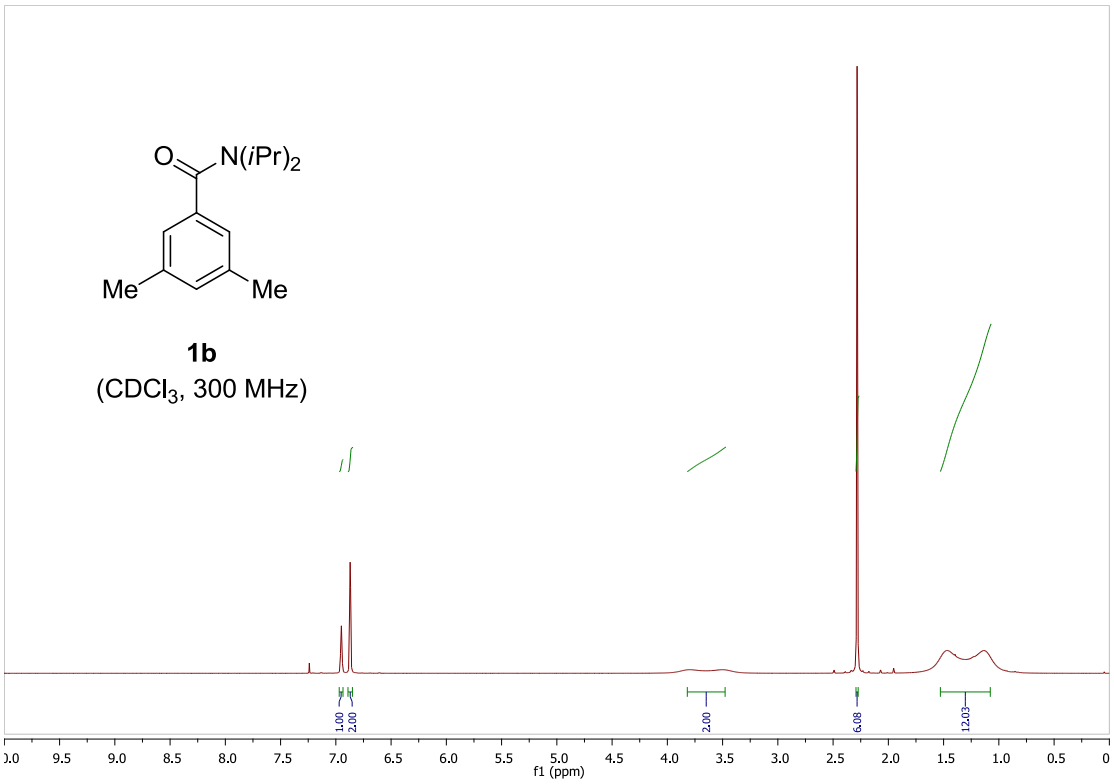

170.9
138.3
134.8
131.9
128.1
127.6
83.9
24.8
20.7
O
N(iPr)2
O
B
O
(CDCl3, 75 MHz)
f1 (ppm)

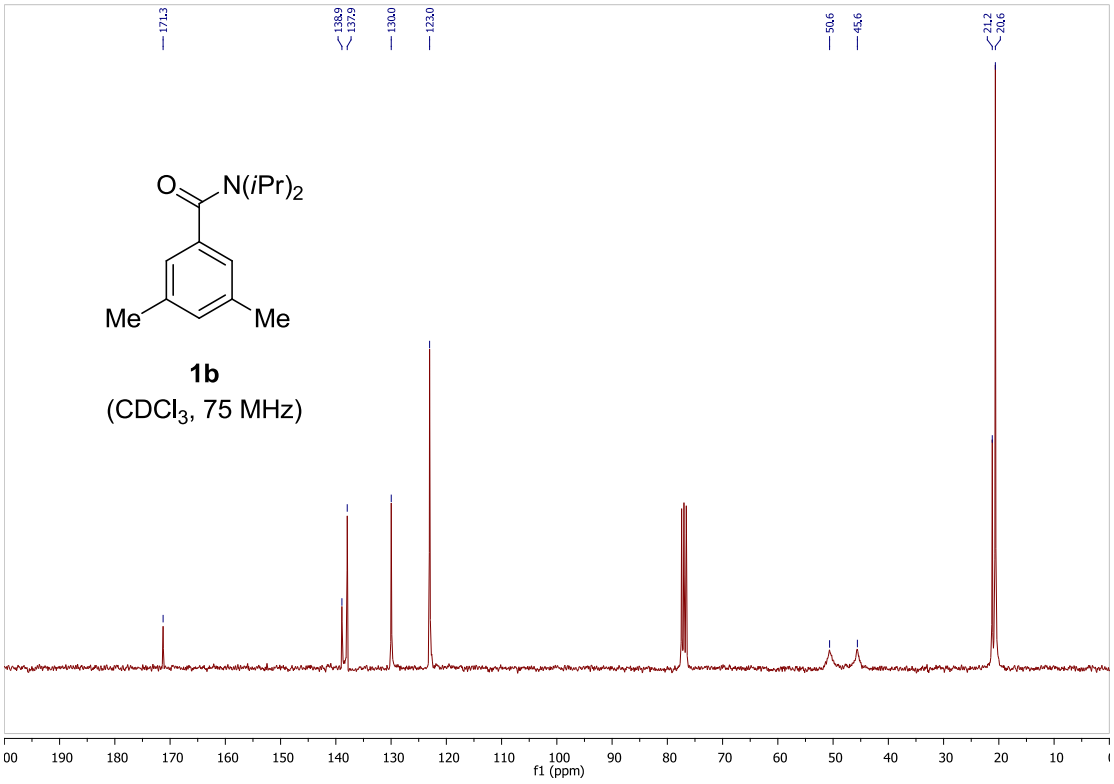

O
N(iPr)2
Cl
(CDCl3, 300 MHz)
3.06
1.00
2.03
12.14
f1 (ppm)

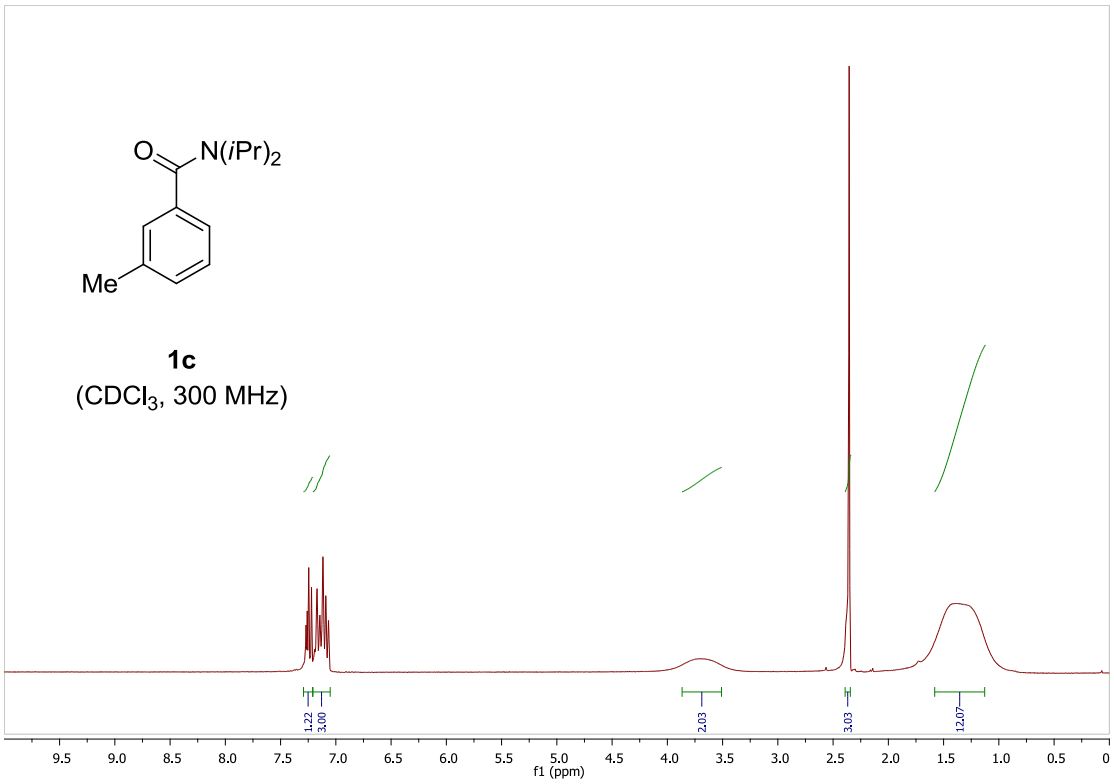

169.1
140.3
134.3
128.6
125.7
123.5
50.3
46.0
20.5
O
N(iPr)2
Cl
(CDCl3, 75 MHz)
f1 (ppm)

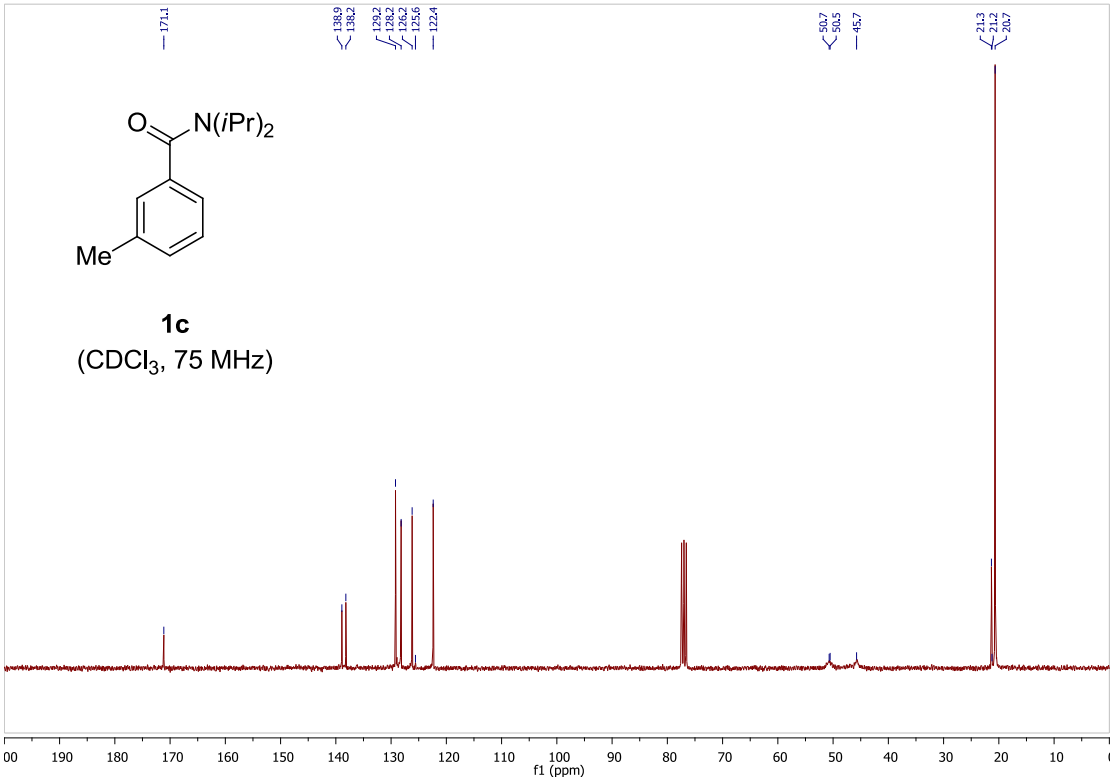

O
N(iPr)2
1a
(CDCl3, 300 MHz)
5.00
2.07
12.07
f1 (ppm)

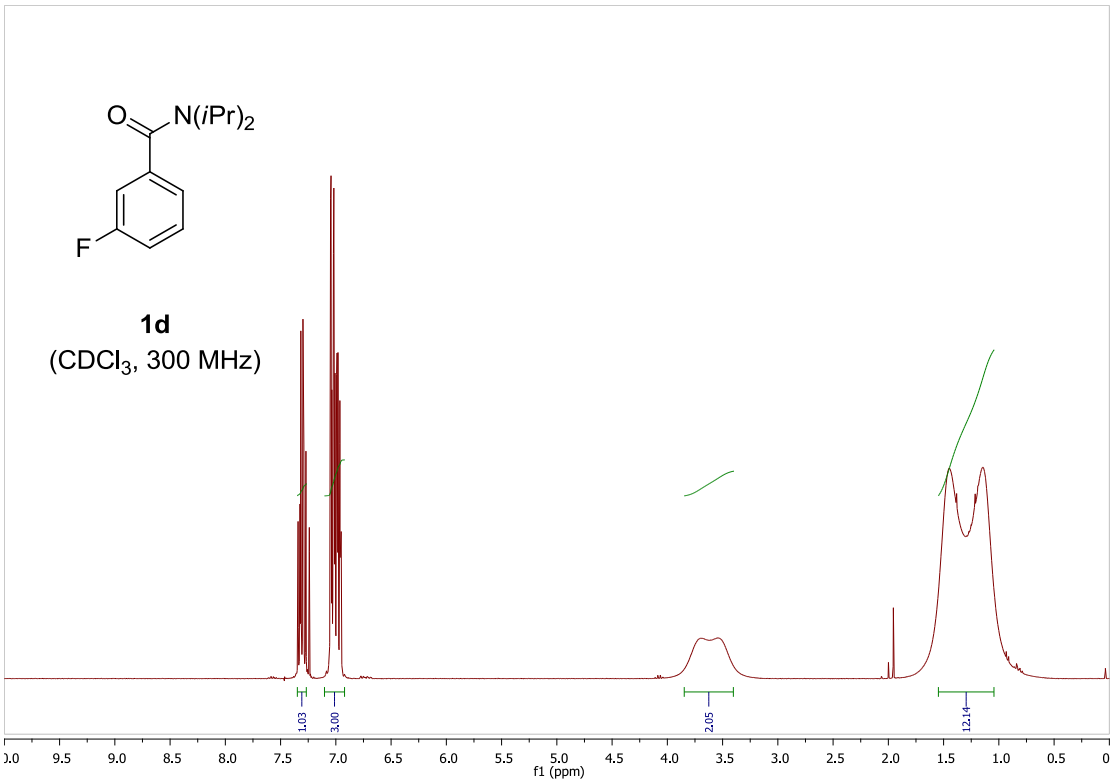

170.9
138.9
128.5
128.3
125.5
20.6
O
N(iPr)2
1a
(CDCl3, 75 MHz)
f1 (ppm)

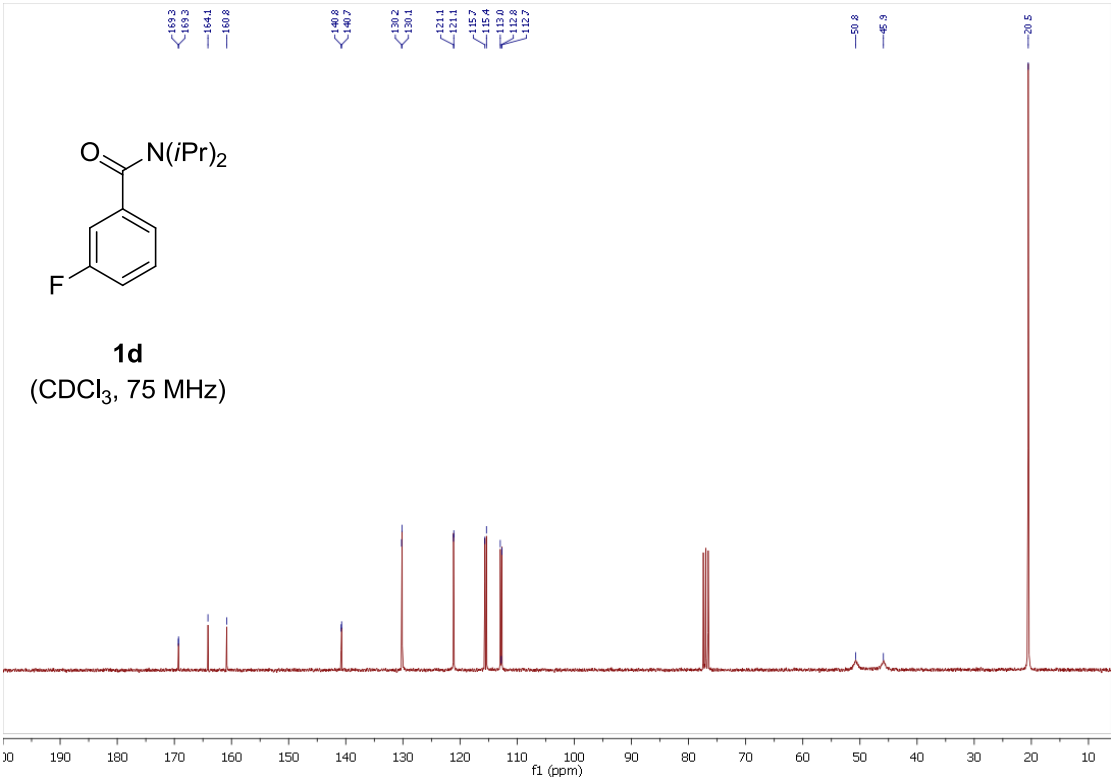

O
N(iPr)2
Me
Me
1b
(CDCl3, 300 MHz)
1.00
2.00
2.00
6.08
12.03
f1 (ppm)

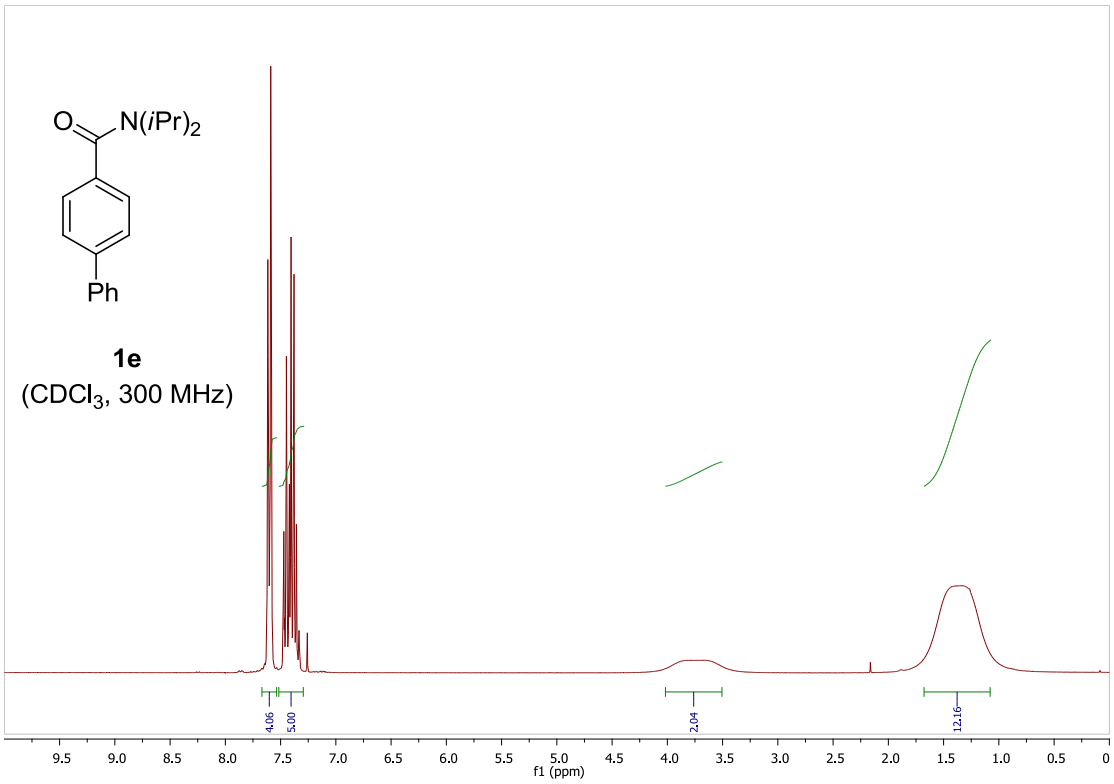

171.3
138.9
137.9
130.0
123.0
50.6
45.6
21.2
20.6
O
N(iPr)2
Me
Me
1b
(CDCl3, 75 MHz)
f1 (ppm)

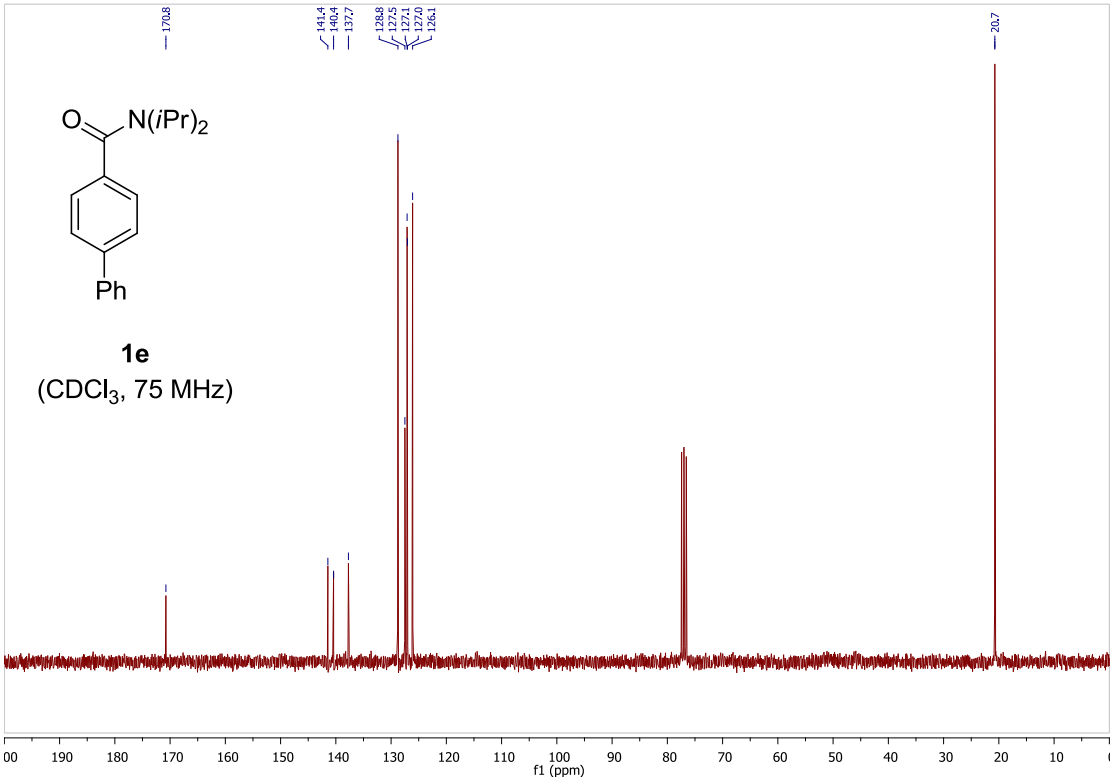

O
N(iPr)2
Me
1c
(CDCl3, 300 MHz)
1.22
3.00
2.03
3.03
12.07
f1 (ppm)

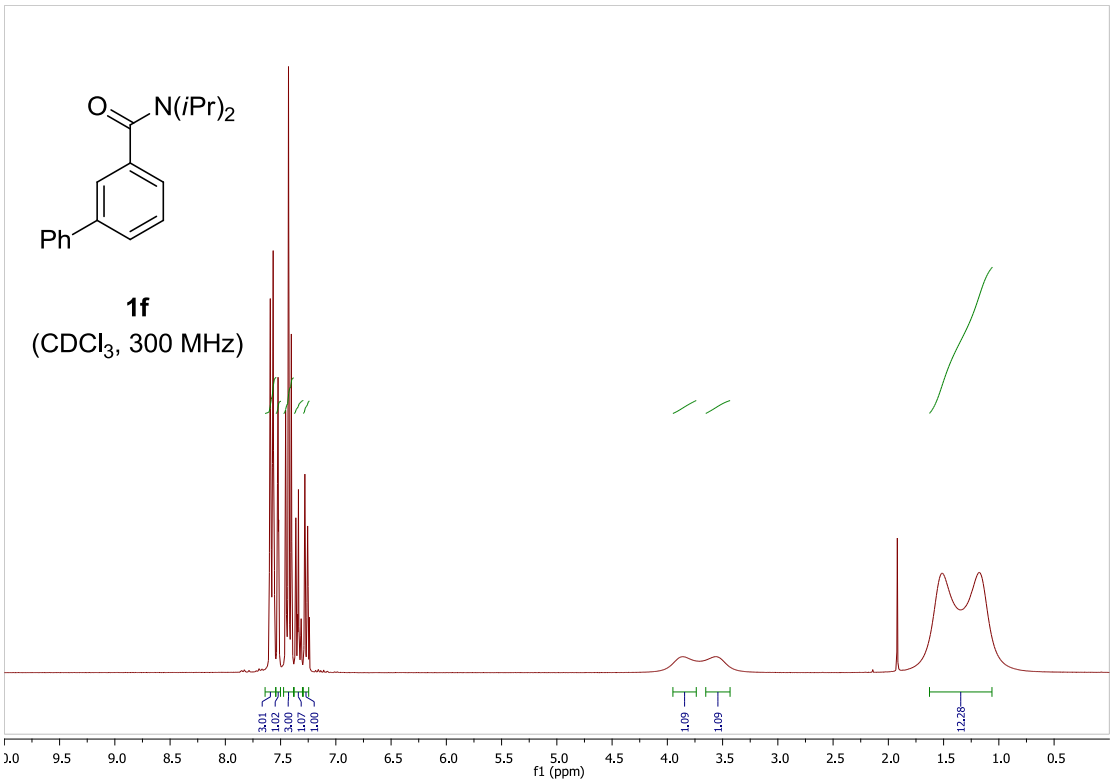

171.1
138.9
138.2
129.2
128.2
127.2
125.6
122.4
50.7
50.5
45.7
21.3
21.2
20.7
O
N(iPr)2
Me
1c
(CDCl3, 75 MHz)
f1 (ppm)

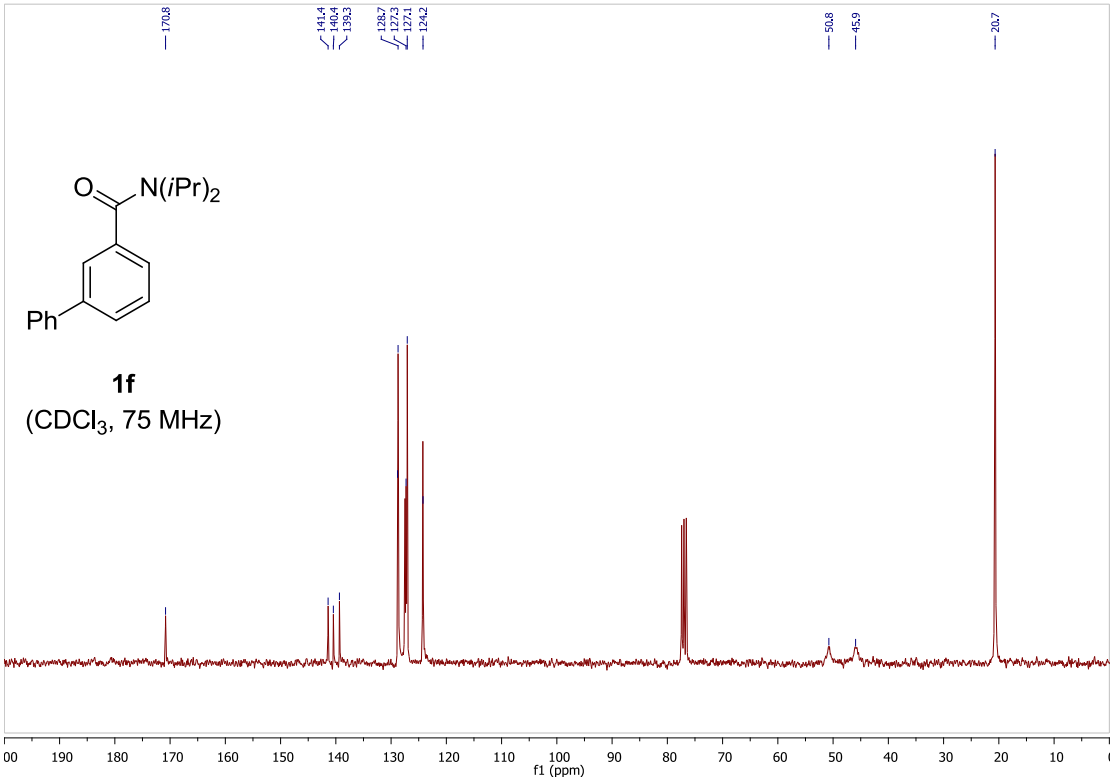

O
N(iPr)2
F
1d
(CDCl3, 300 MHz)
1.03
3.00
2.05
12.14
f1 (ppm)

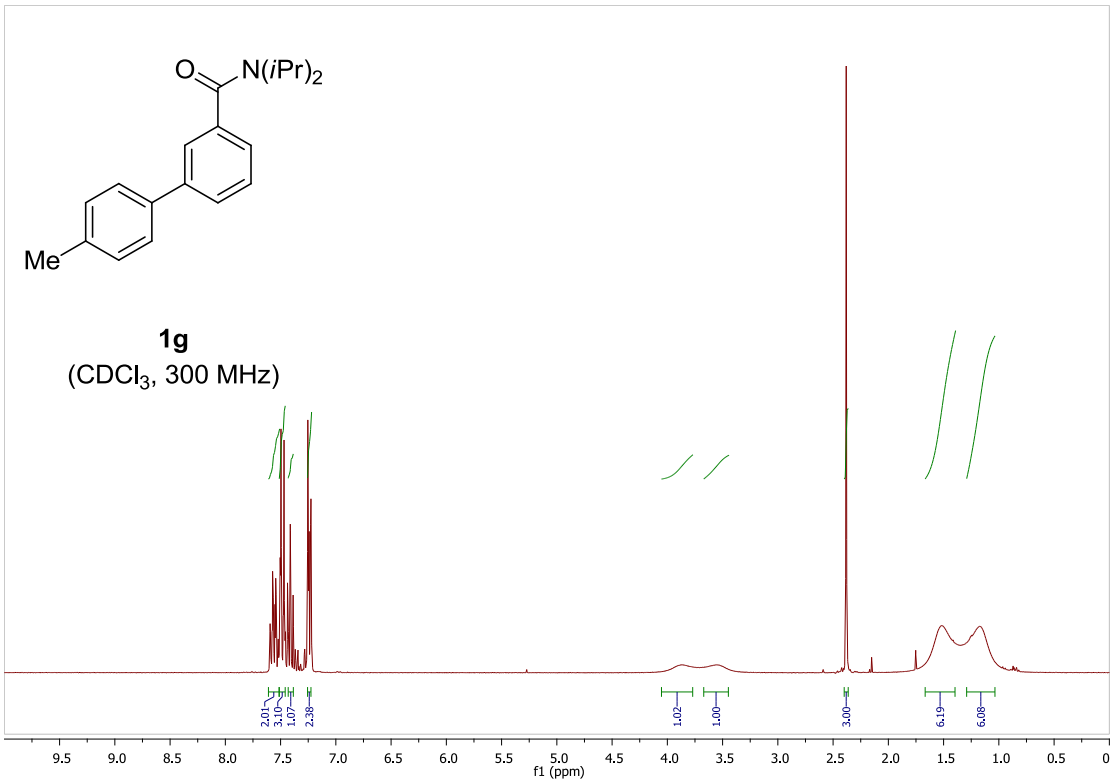

O
N(iPr)2
F
1d
(CDCl3, 75 MHz)
f1 (ppm)

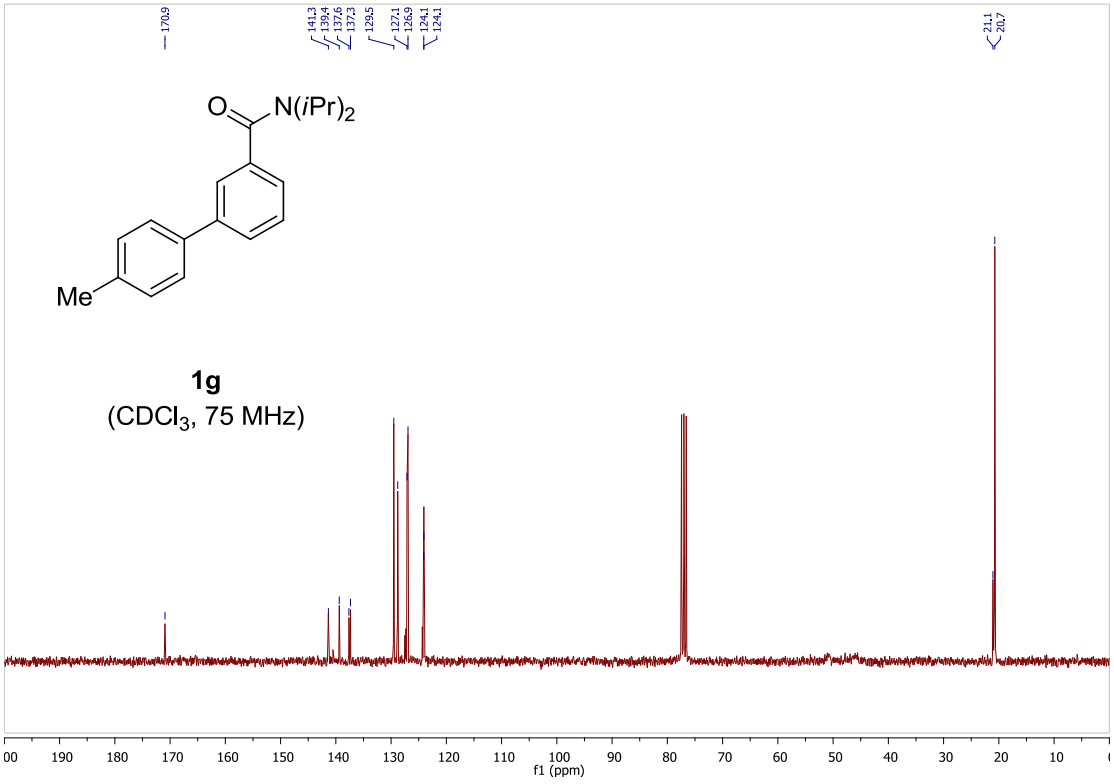

O
N(iPr)2
Ph
1e
(CDCl3, 300 MHz)
4.06
5.00
2.04
12.16
f1 (ppm)

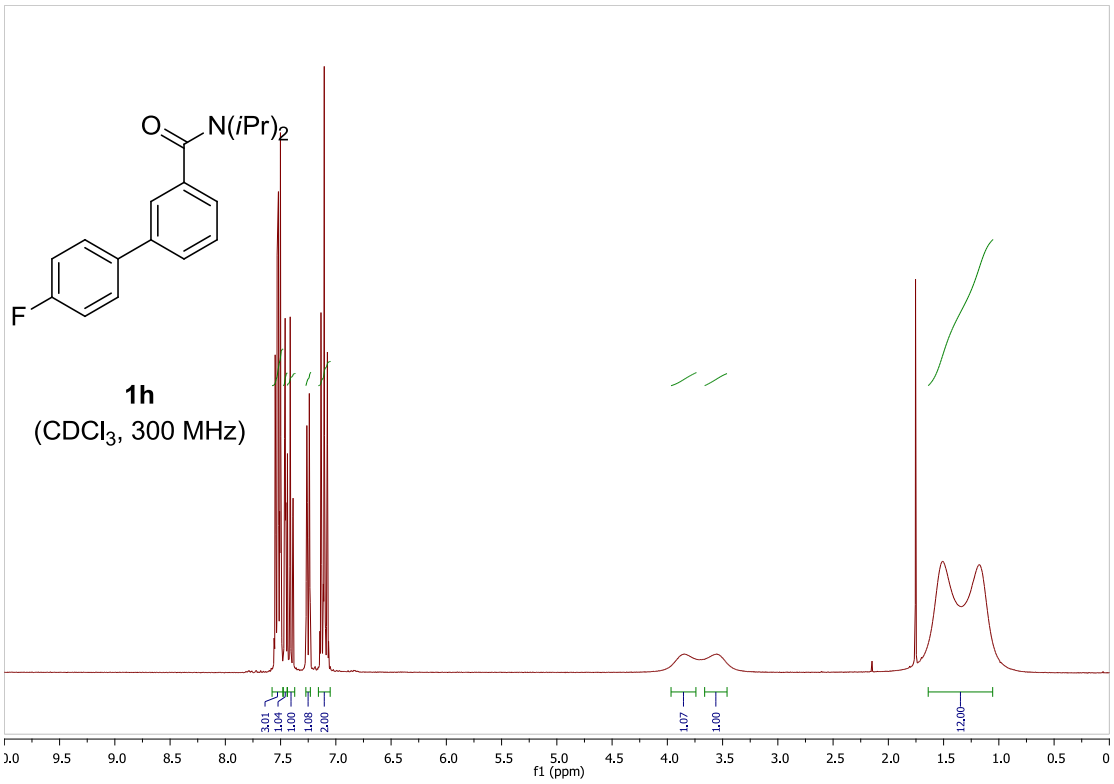

170.8
141.4
140.4
137.7
128.8
127.5
127.1
127.0
126.1
20.7
O
N(iPr)2
Ph
1e
(CDCl3, 75 MHz)
f1 (ppm)

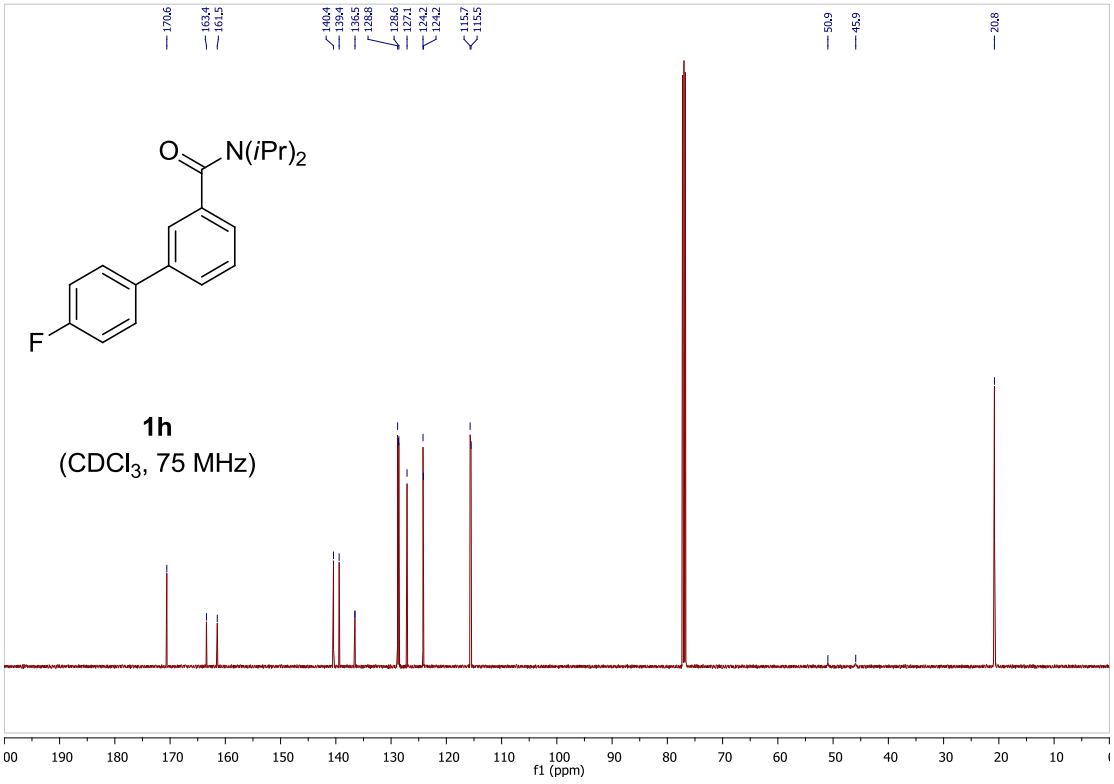

O
N(iPr)2
Ph
1f
(CDCl3, 300 MHz)
3.01
1.02
3.00
1.07
1.00
1.09
1.09
12.28
f1 (ppm)

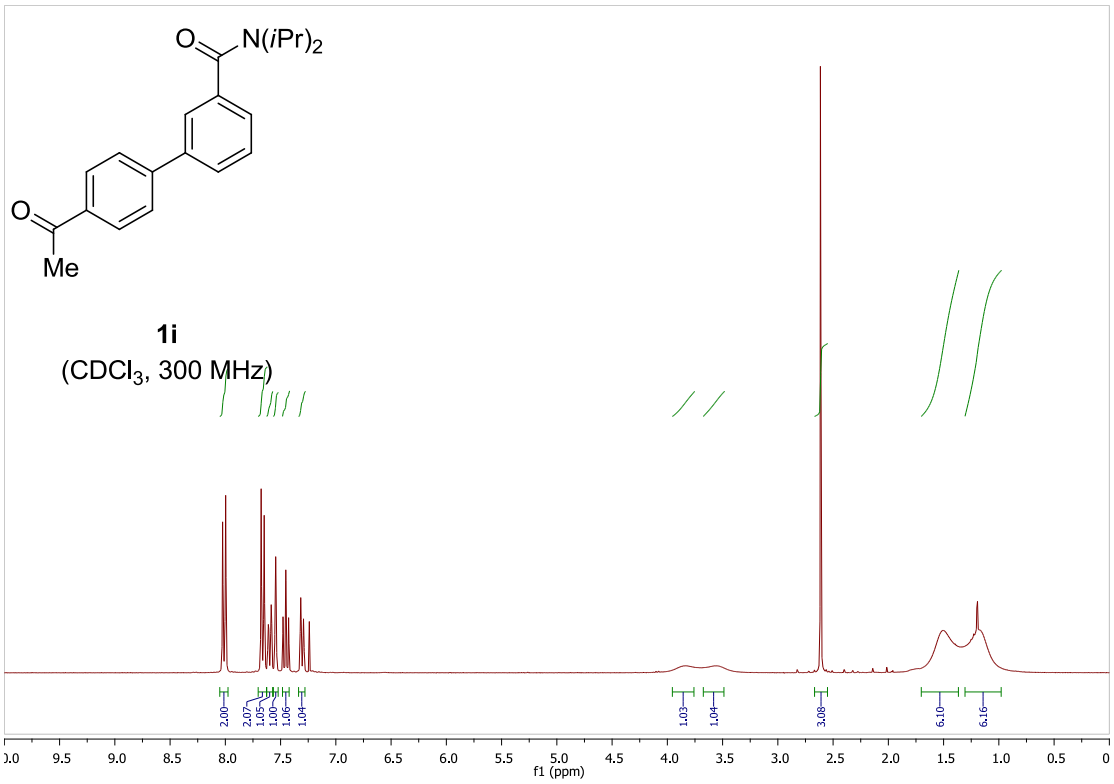

170.8
141.4
140.4
139.3
128.7
127.3
127.1
124.2
50.8
45.9
20.7
O
N(iPr)2
Ph
1f
(CDCl3, 75 MHz)
f1 (ppm)

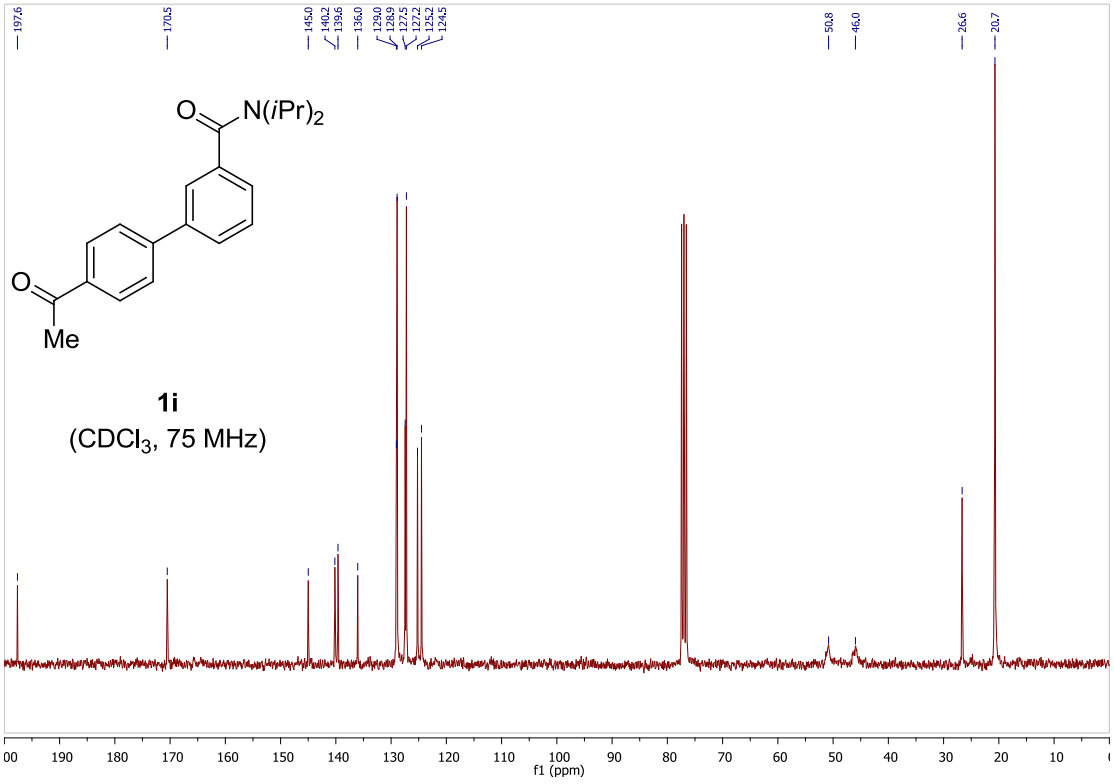

O
N(iPr)2
Me
1g
(CDCl3, 300 MHz)
2.01
3.10
1.07
2.38
1.02
1.00
3.00
6.19
6.08
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0
f1 (ppm)

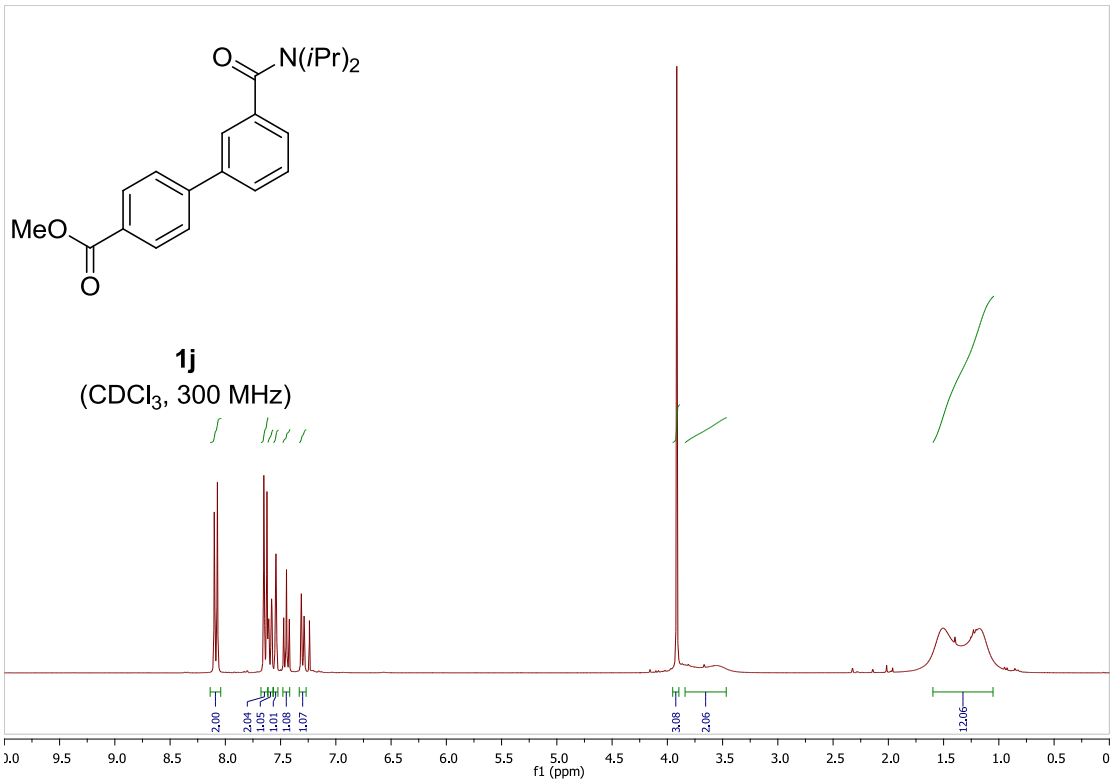

170.9
141.3
139.4
137.6
137.3
129.5
127.1
126.9
124.1
124.1
21.1
20.7
O
N(iPr)2
Me
1g
(CDCl3, 75 MHz)
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

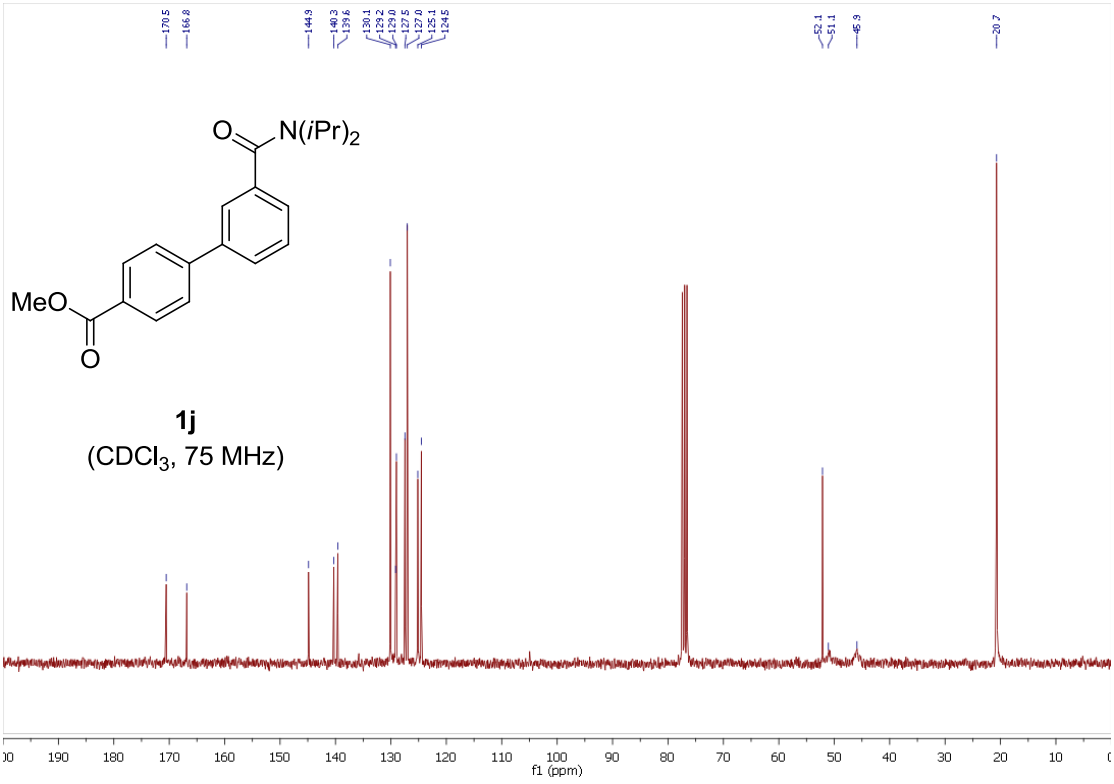

O
N(iPr)2
F
1h
(CDCl3, 300 MHz)
3.01
1.04
1.00
1.08
2.00
1.07
1.00
12.00
f1 (ppm)

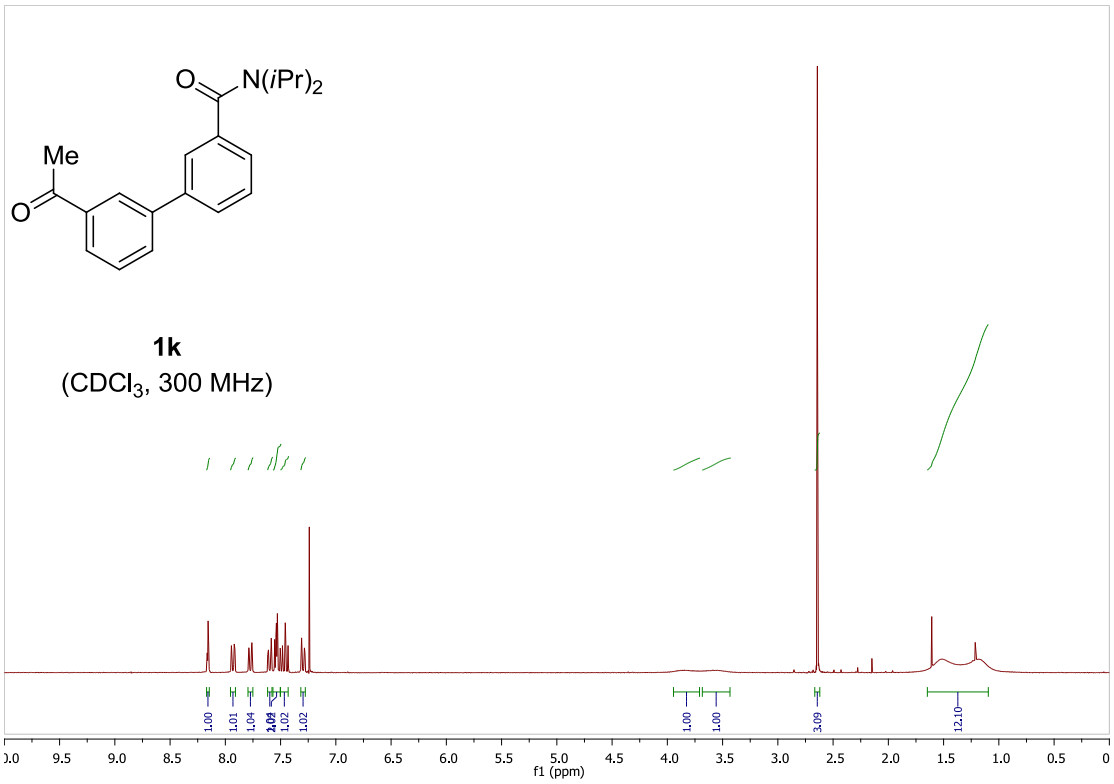

170.6
163.4
161.5
140.4
139.4
136.5
128.8
128.6
127.1
124.2
124.2
115.7
115.5
50.9
45.9
20.8
O
N(iPr)2
F
1h
(CDCl3, 75 MHz)
f1 (ppm)

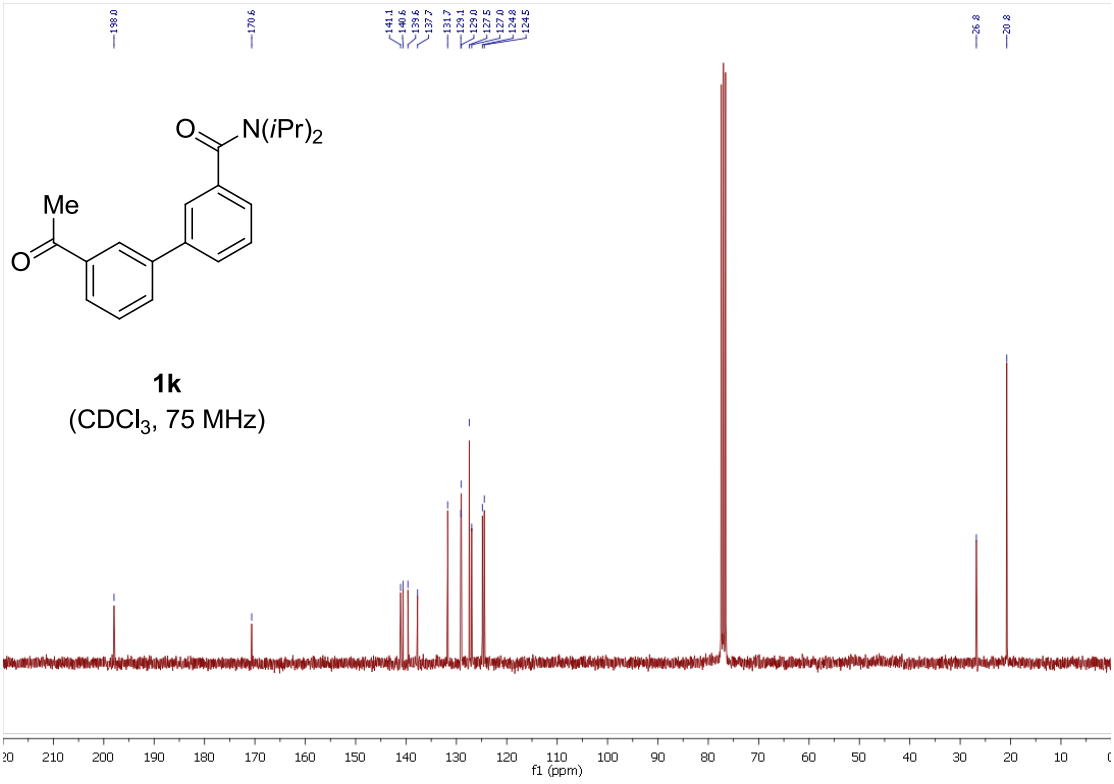

O
N(iPr)2
O
Me
1i
(CDCl3, 300 MHz)
2.00
2.07
1.05
1.00
1.06
1.04
1.03
1.04
3.08
6.10
6.16
f1 (ppm)

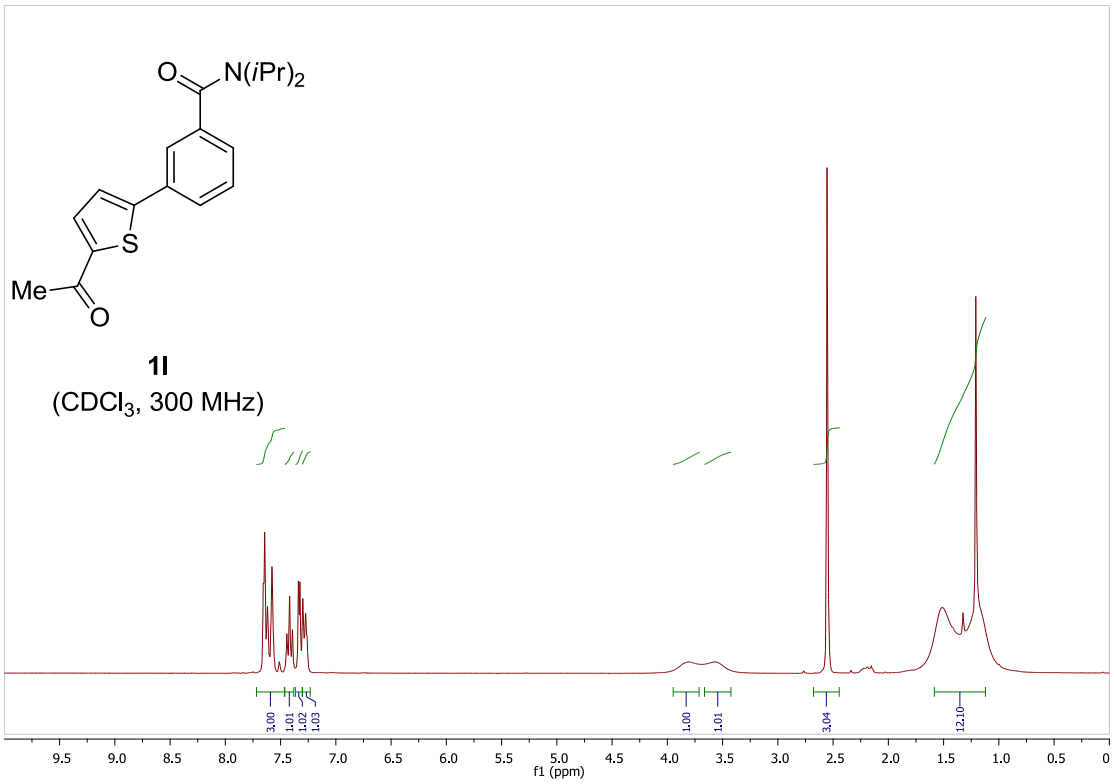

197.6
170.5
145.0
140.2
139.6
136.0
129.0
128.9
127.5
127.2
125.2
124.5
50.8
46.0
26.6
20.7
O
N(iPr)2
O
Me
1i
(CDCl3, 75 MHz)
f1 (ppm)

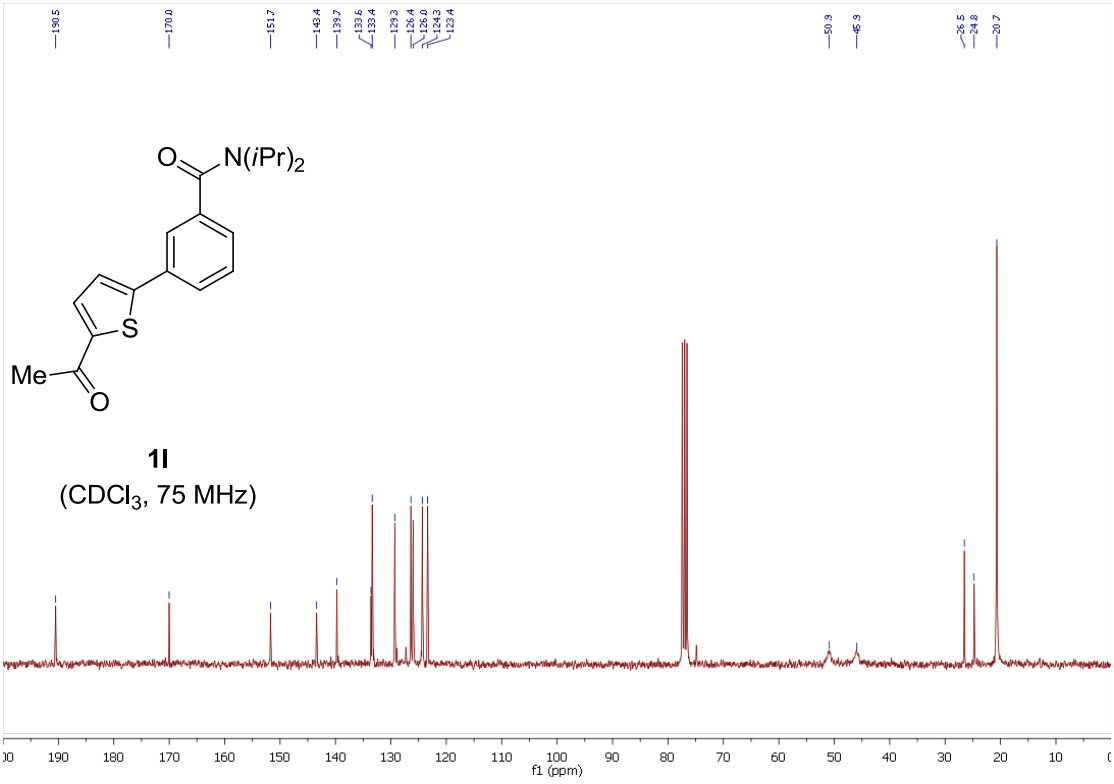

O
N(iPr)2
MeO
O
1j
(CDCl3, 300 MHz)
2.00
2.04
1.05
1.01
1.08
1.07
3.08
2.06
12.06
f1 (ppm)

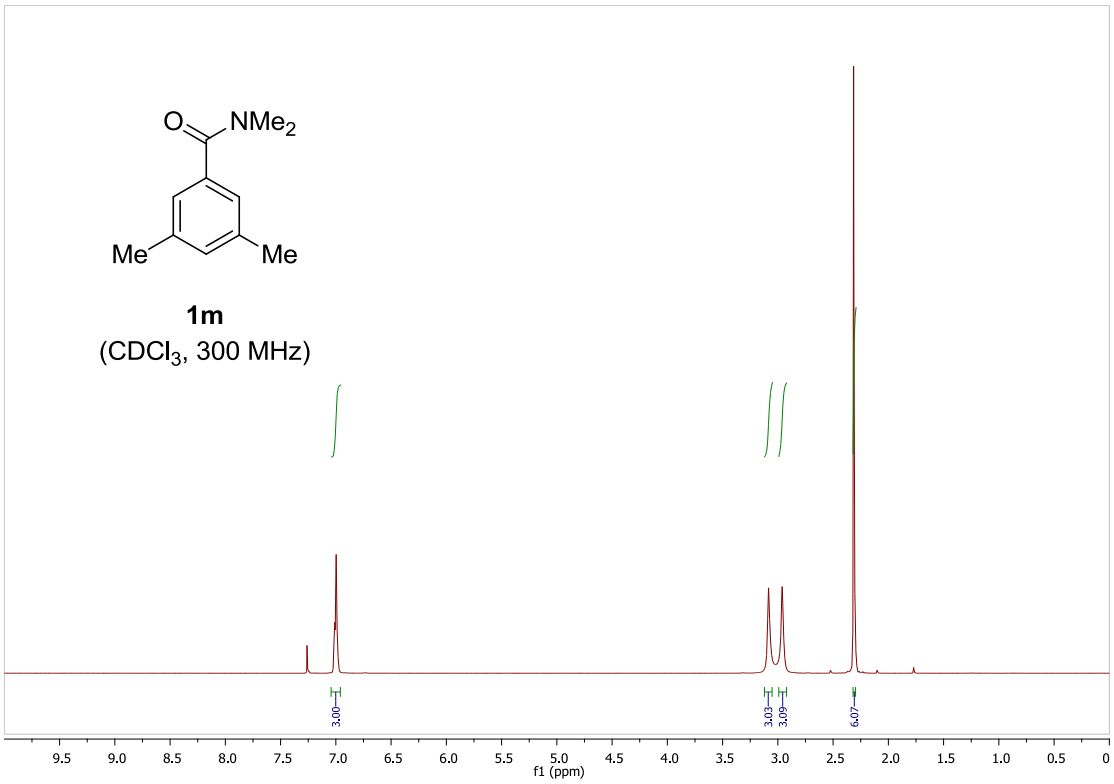

170.5
166.8
144.9
140.3
139.6
130.1
129.2
129.0
127.5
127.0
125.1
124.5
52.1
51.1
46.9
20.7
O
N(iPr)2
MeO
O
1j
(CDCl3, 75 MHz)
f1 (ppm)

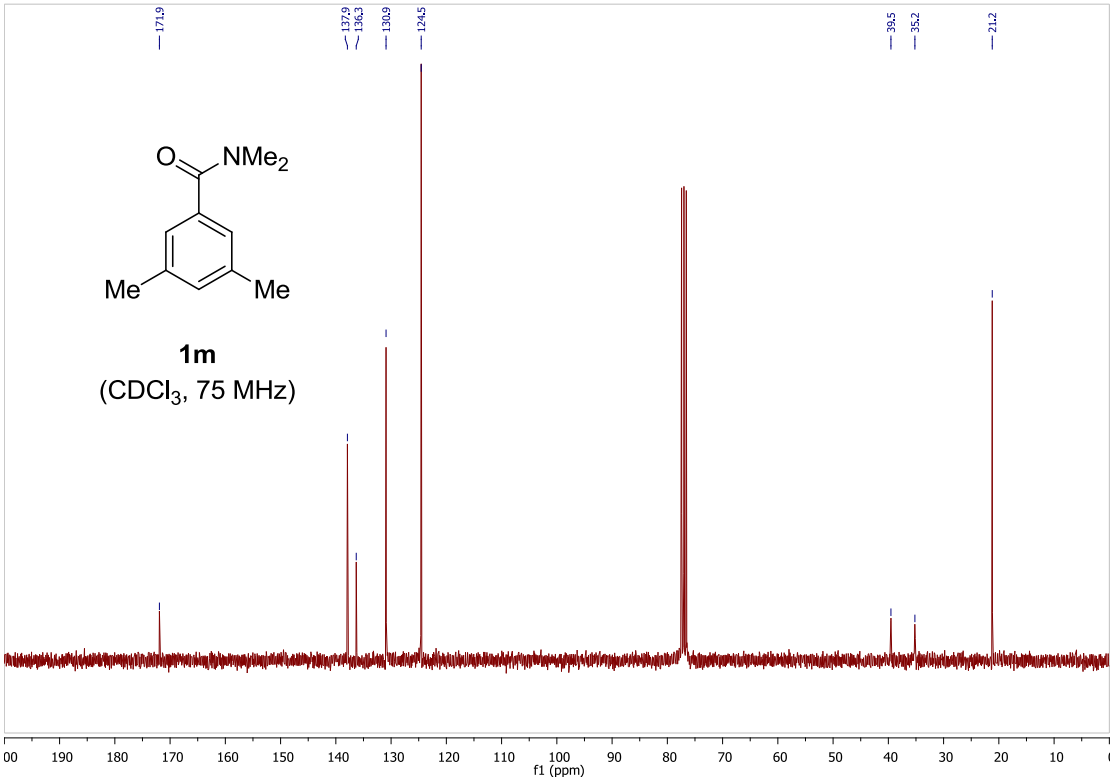

O
N(iPr)2
Me
O
1k
(CDCl3, 300 MHz)
1.00
1.01
1.04
2.04
1.02
1.02
1.00
1.00
3.09
12.10
f1 (ppm)

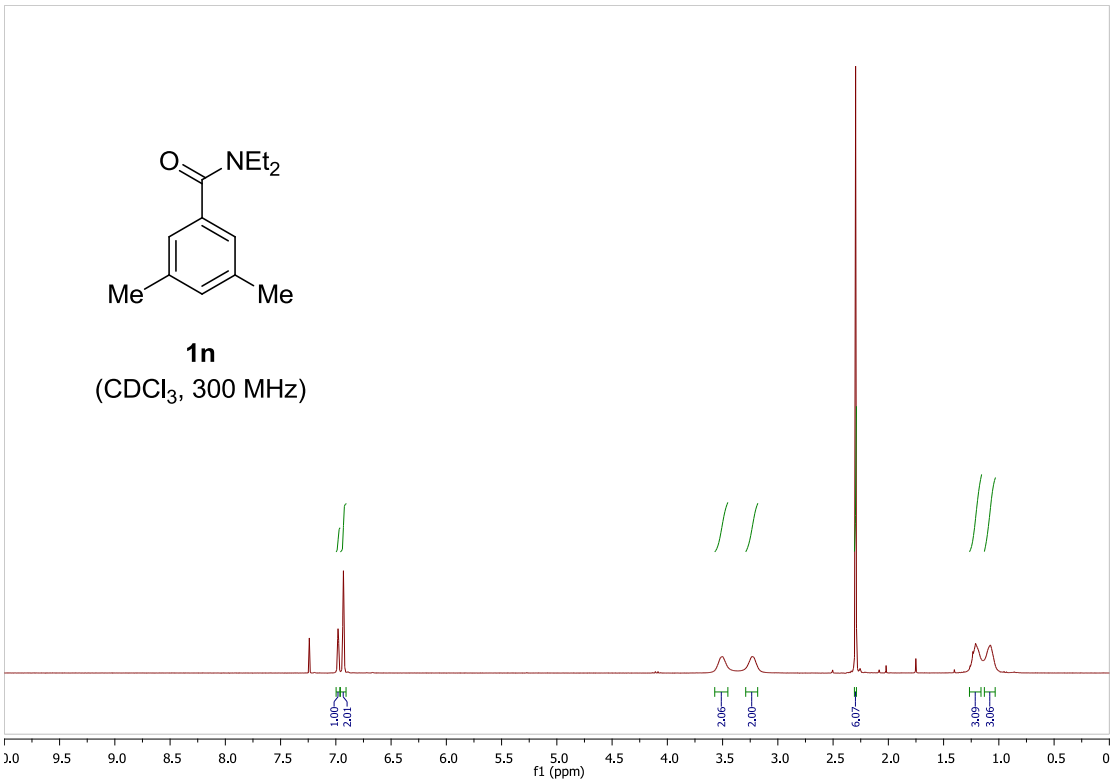

198.0
170.6
141.1
140.6
139.6
137.7
131.7
129.1
129.0
128.5
127.5
127.0
124.8
124.5
26.8
20.8
O
N(iPr)2
Me
O
1k
(CDCl3, 75 MHz)
f1 (ppm)

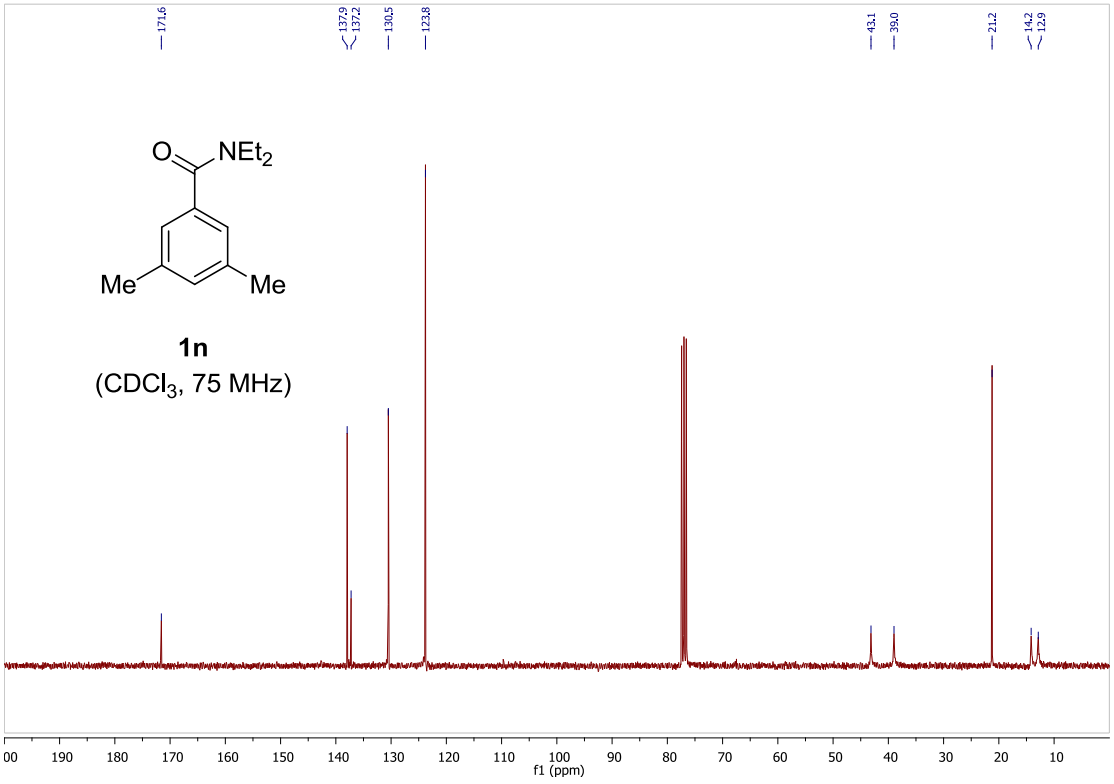

O
N(iPr)2
S
Me
O
1l
(CDCl3, 300 MHz)
3.00
1.01
1.02
1.03
1.00
1.01
3.04
12.10
f1 (ppm)

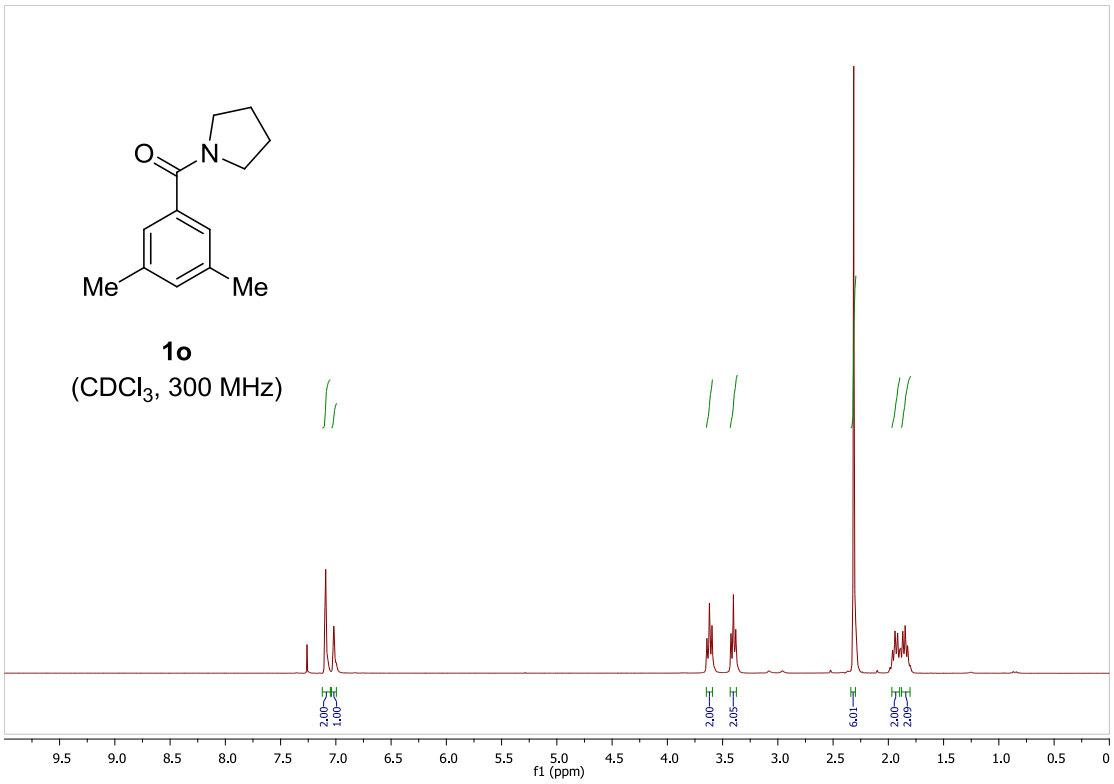

190.5
170.0
151.7
143.4
139.7
133.6
133.4
129.3
126.4
126.0
124.3
123.4
50.9
46.9
26.5
24.8
20.7
O
N(iPr)2
S
Me
O
1l
(CDCl3, 75 MHz)
f1 (ppm)

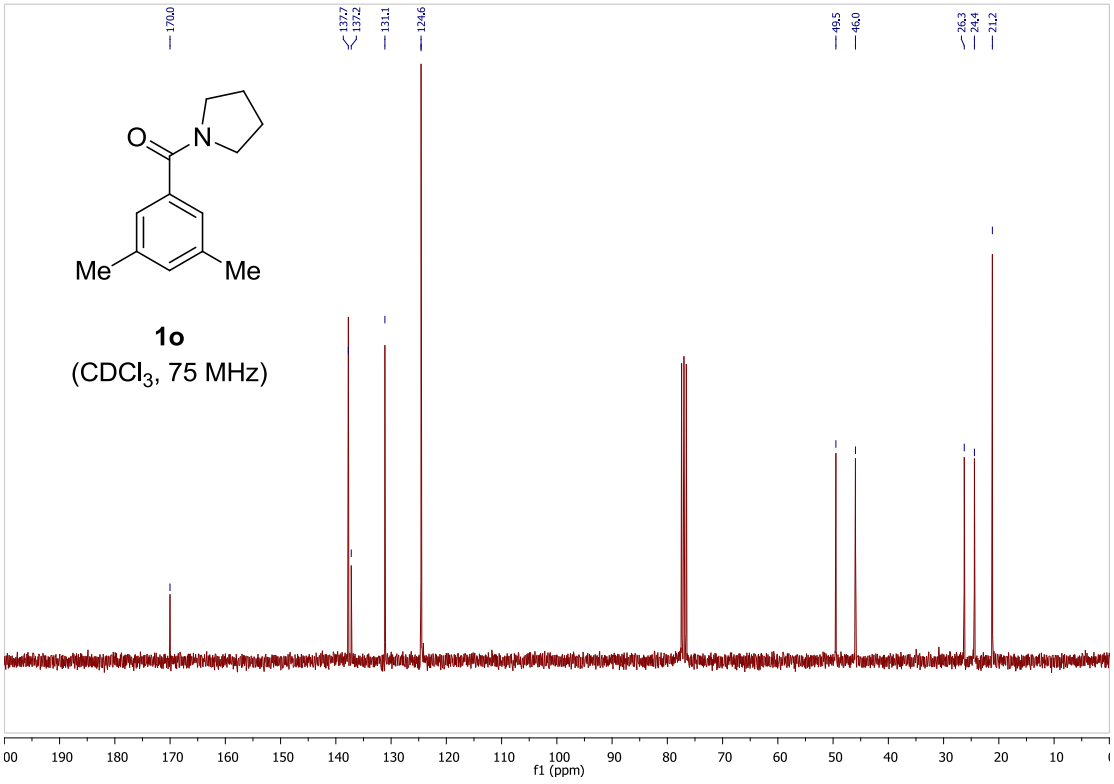

O
NMe2
Me
Me
1m
(CDCl3, 300 MHz)
3.00
3.03
3.09
6.07
f1 (ppm)

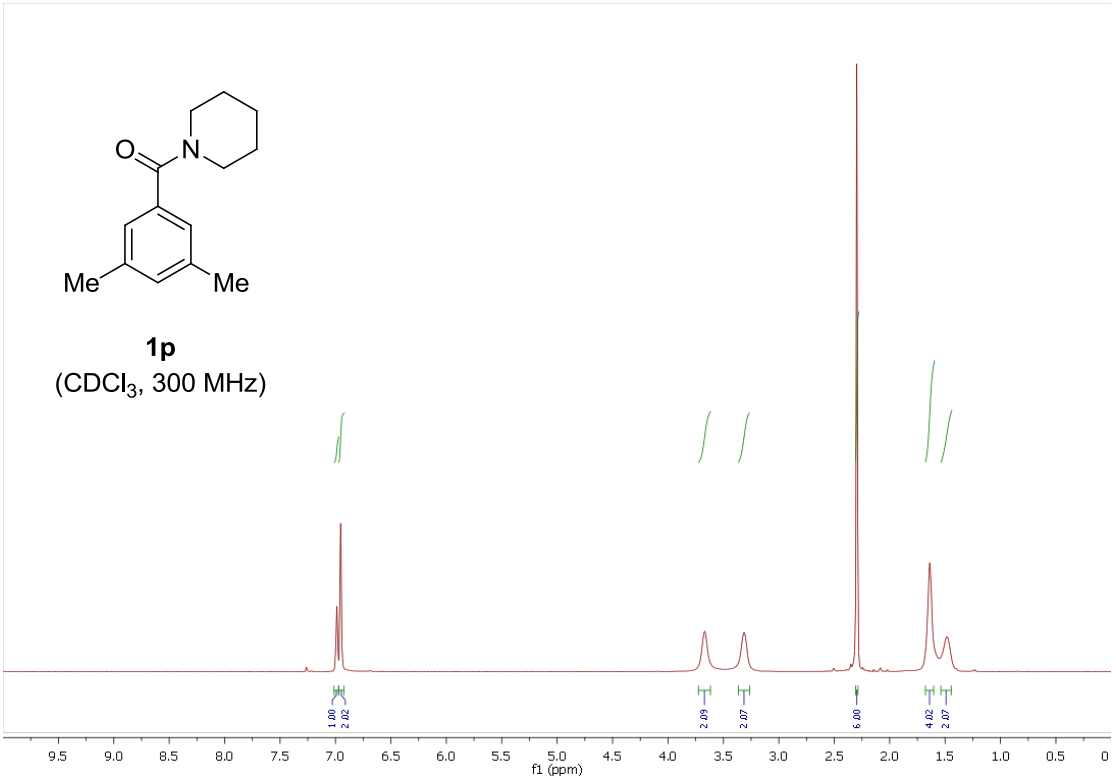

171.9
137.9
136.3
130.9
124.5
39.5
35.2
21.2
O
NMe2
Me
Me
1m
(CDCl3, 75 MHz)
f1 (ppm)

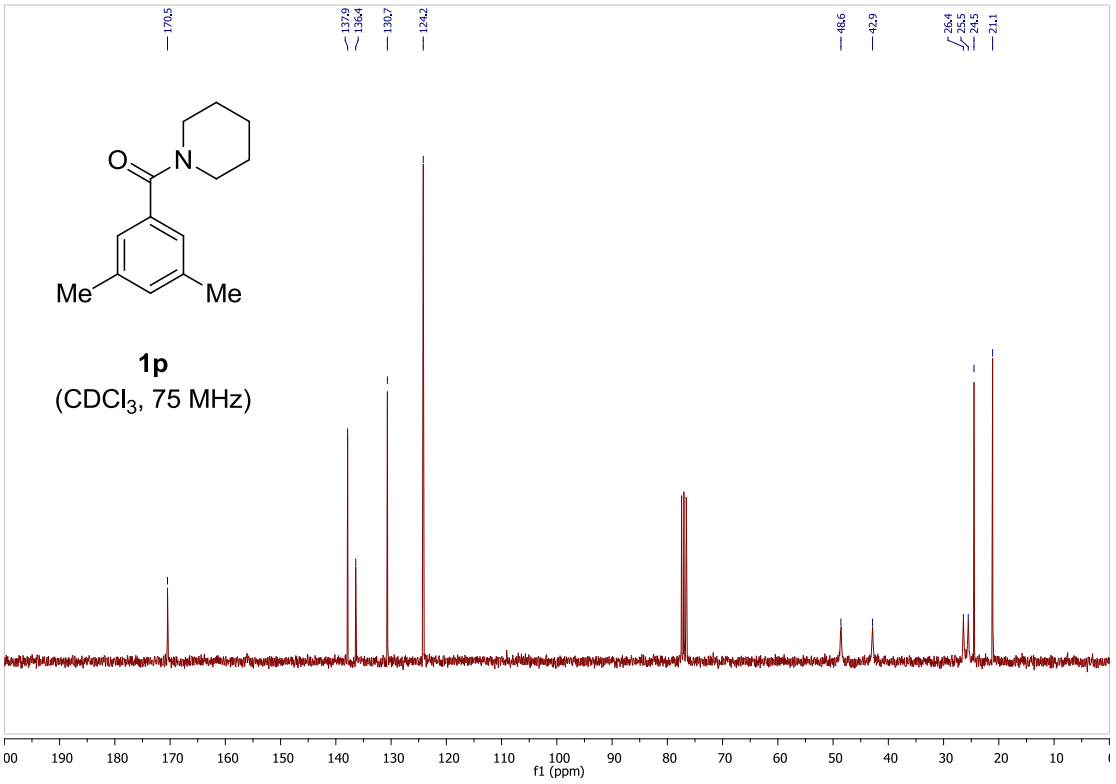

O
NEt2
Me
Me
1n
(CDCl3, 300 MHz)
1.00
2.01
2.06
2.00
6.07
3.09
3.06
f1 (ppm)

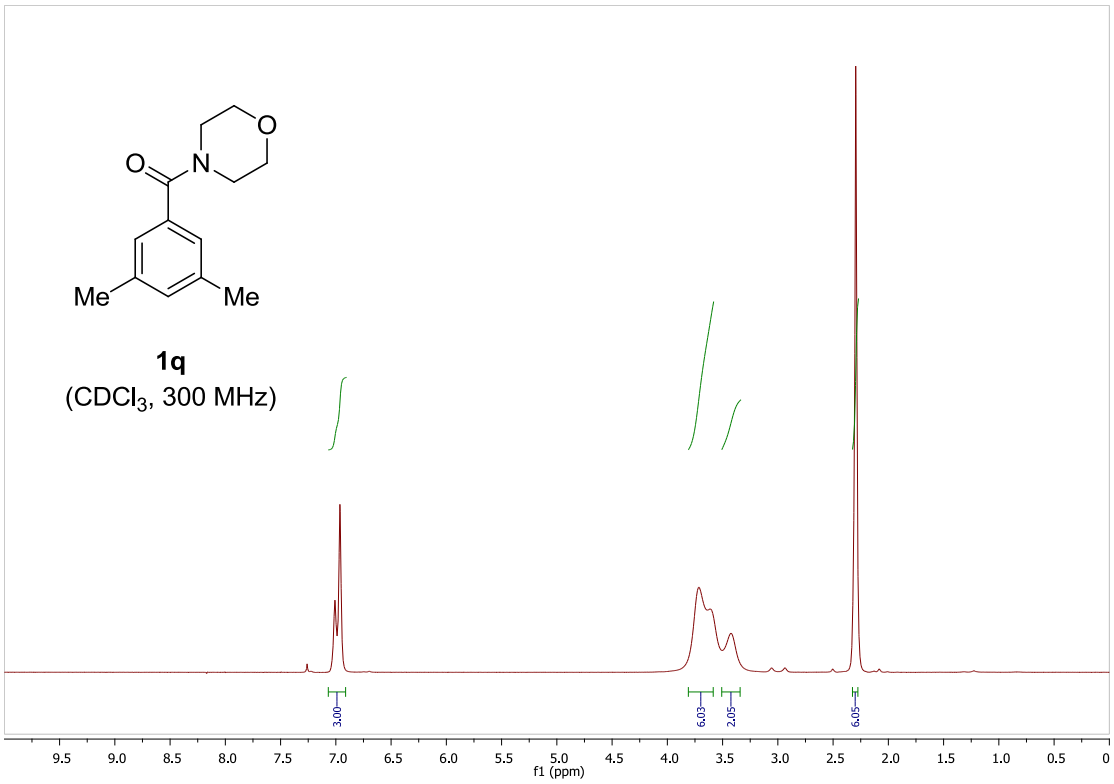

171.6
137.9
137.2
130.5
123.8
43.1
39.0
21.2
14.2
12.9
O
NEt2
Me
Me
1n
(CDCl3, 75 MHz)
f1 (ppm)

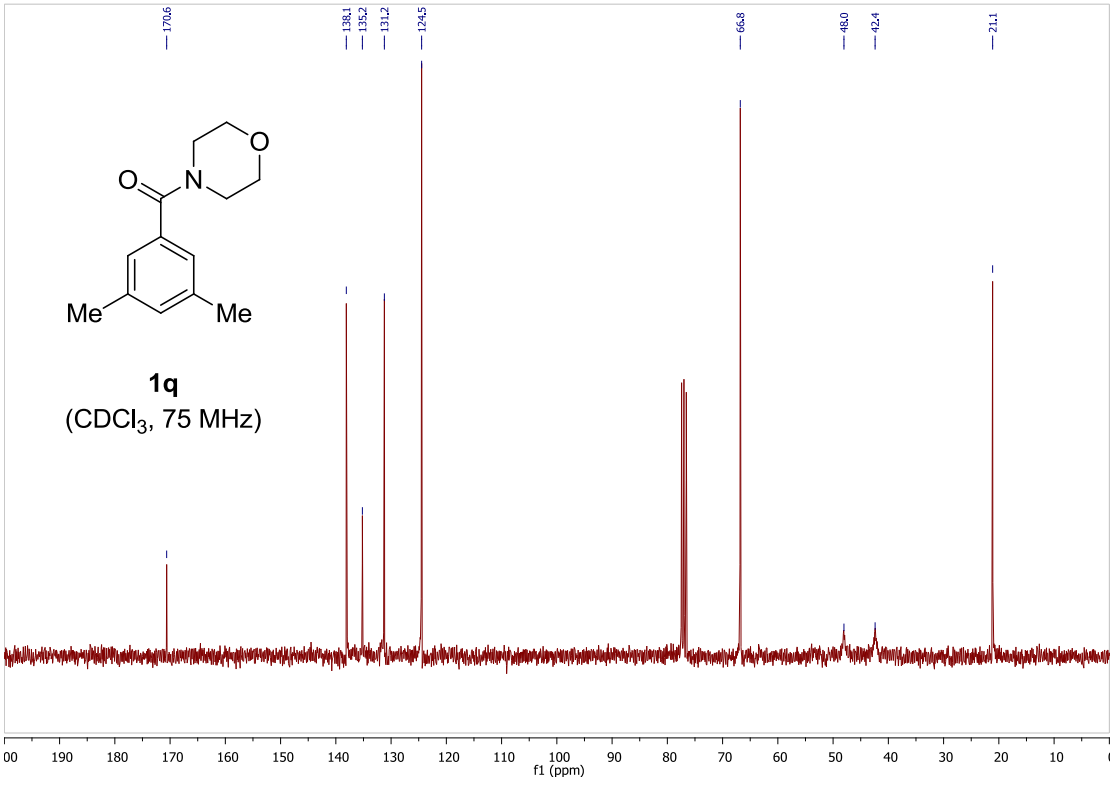

O
N
Me
Me
1o
(CDCl3, 300 MHz)
2.00
1.00
2.00
2.05
6.01
2.00
2.09
f1 (ppm)

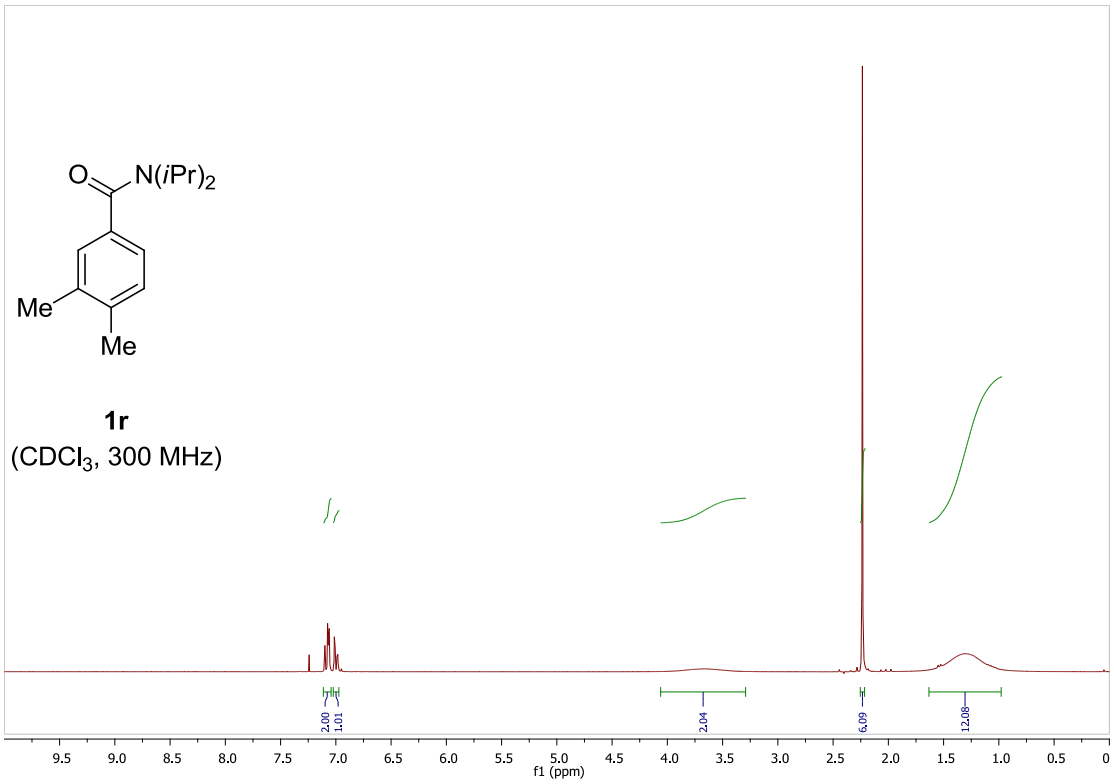

170.0
137.7
137.2
131.1
124.6
49.5
46.0
26.3
24.4
21.2
O
N
Me
Me
1o
(CDCl3, 75 MHz)
f1 (ppm)

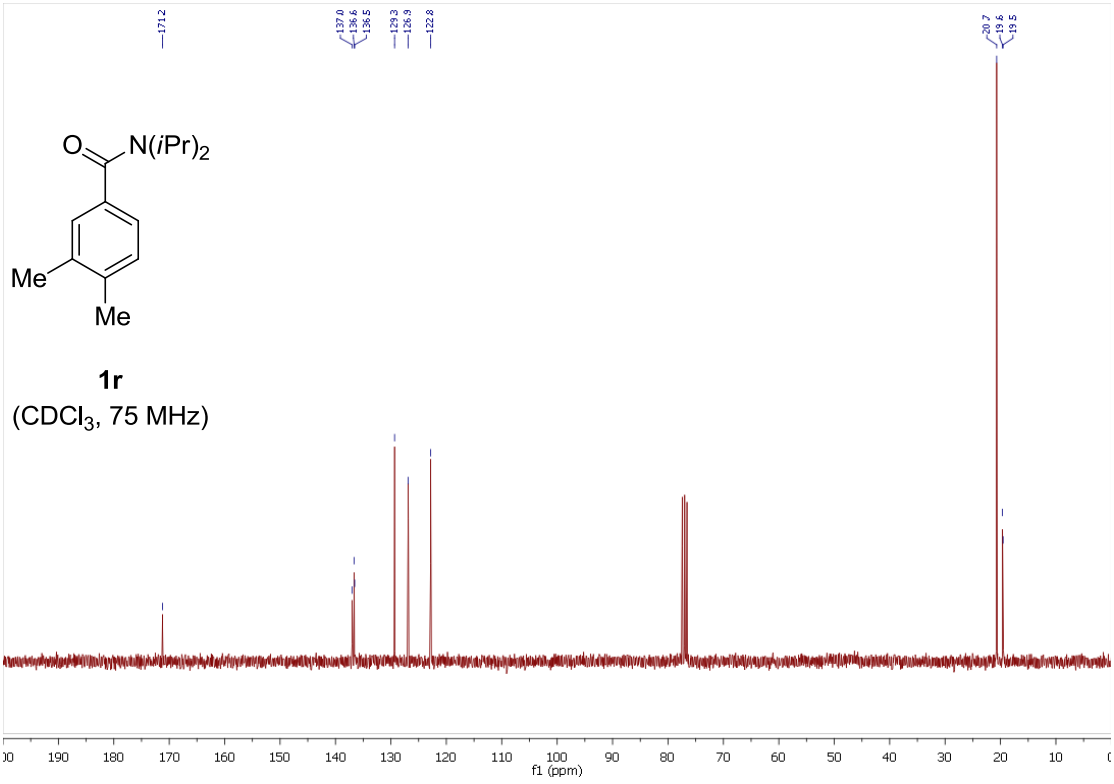

O
N
Me
Me
1p
(CDCl3, 300 MHz)
1.00
2.02
2.09
2.07
6.00
4.02
2.07
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0
f1 (ppm)

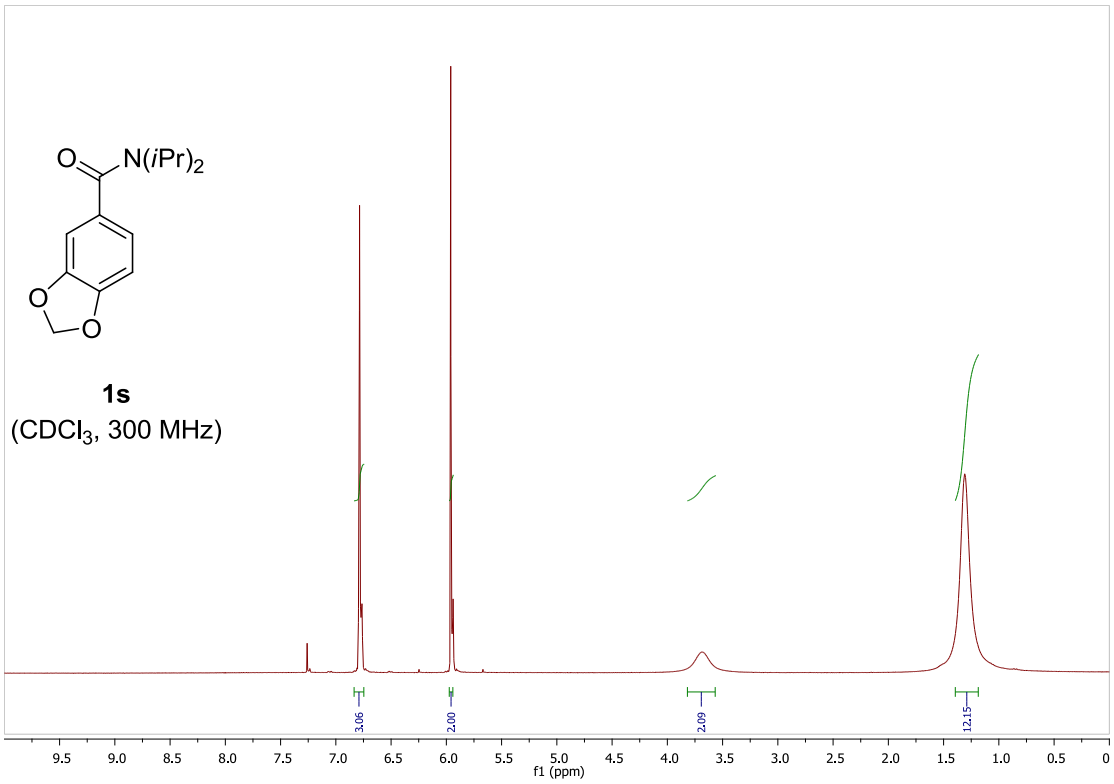

170.5
137.9
136.4
130.7
124.2
48.6
42.9
26.4
25.5
24.5
21.1
O
N
Me
Me
1p
(CDCl3, 75 MHz)
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

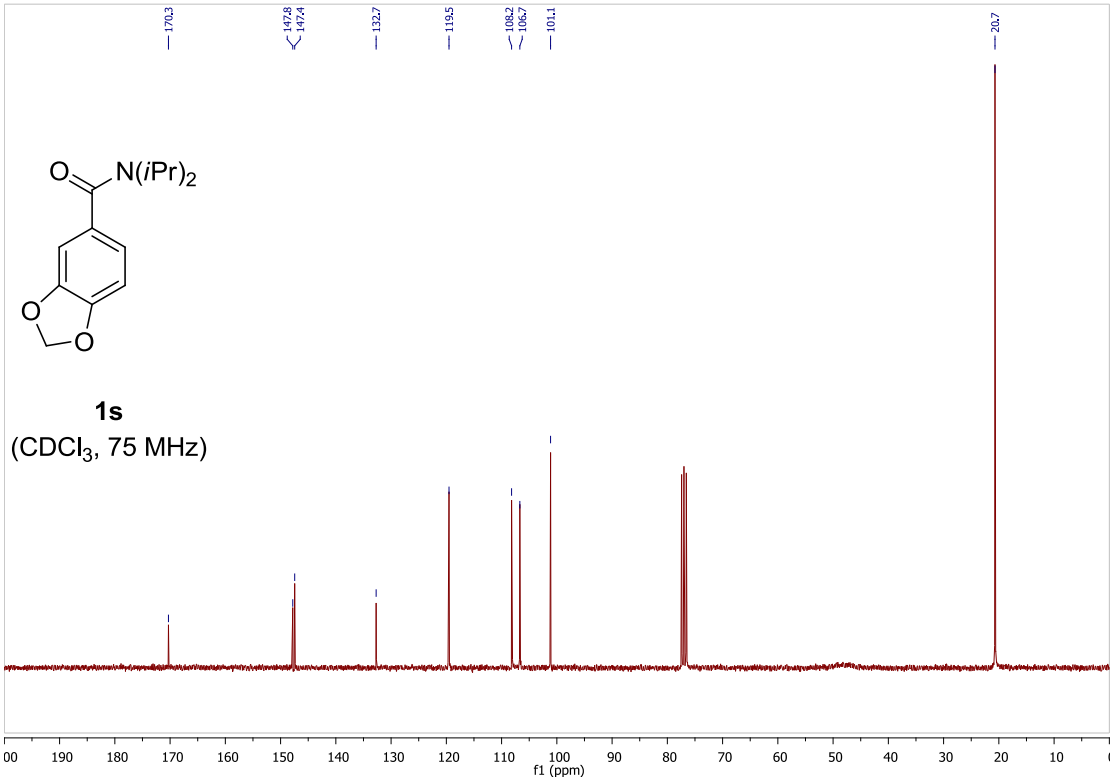

O
N
O
Me
Me
1q
(CDCl3, 300 MHz)
3.00
6.03
2.05
6.05
f1 (ppm)

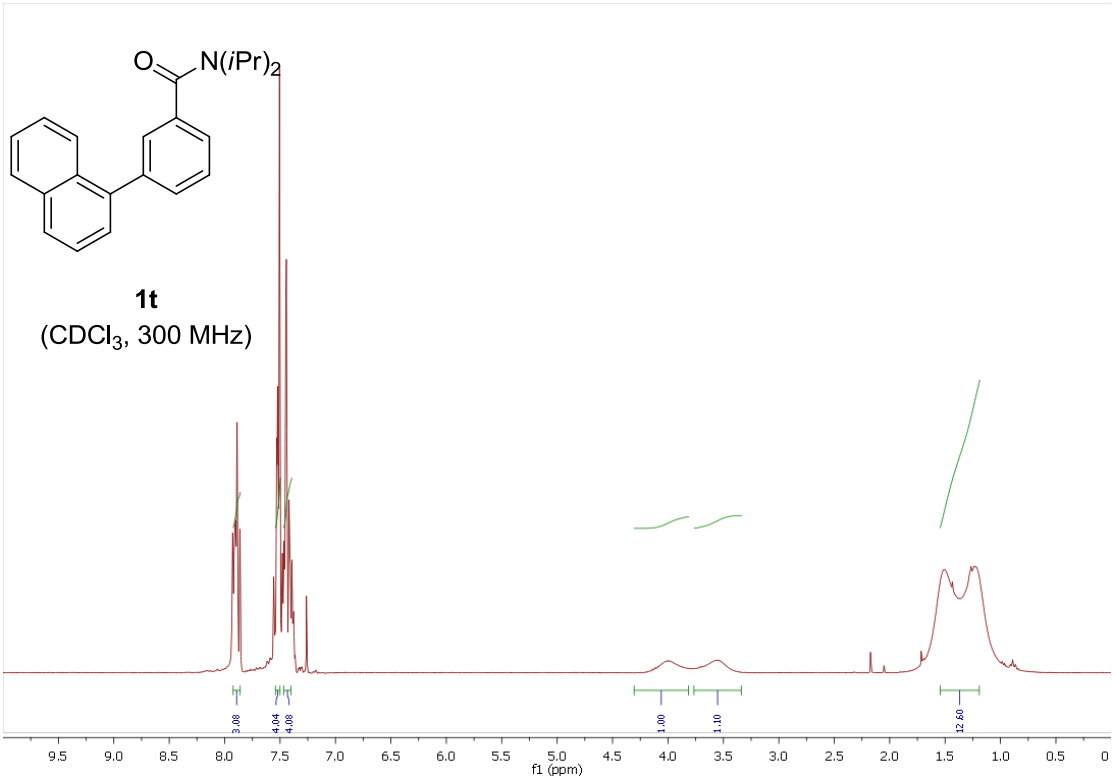

170.6
138.1
135.2
131.2
124.5
66.8
48.0
42.4
21.1
O
N
O
Me
Me
1q
(CDCl3, 75 MHz)
f1 (ppm)

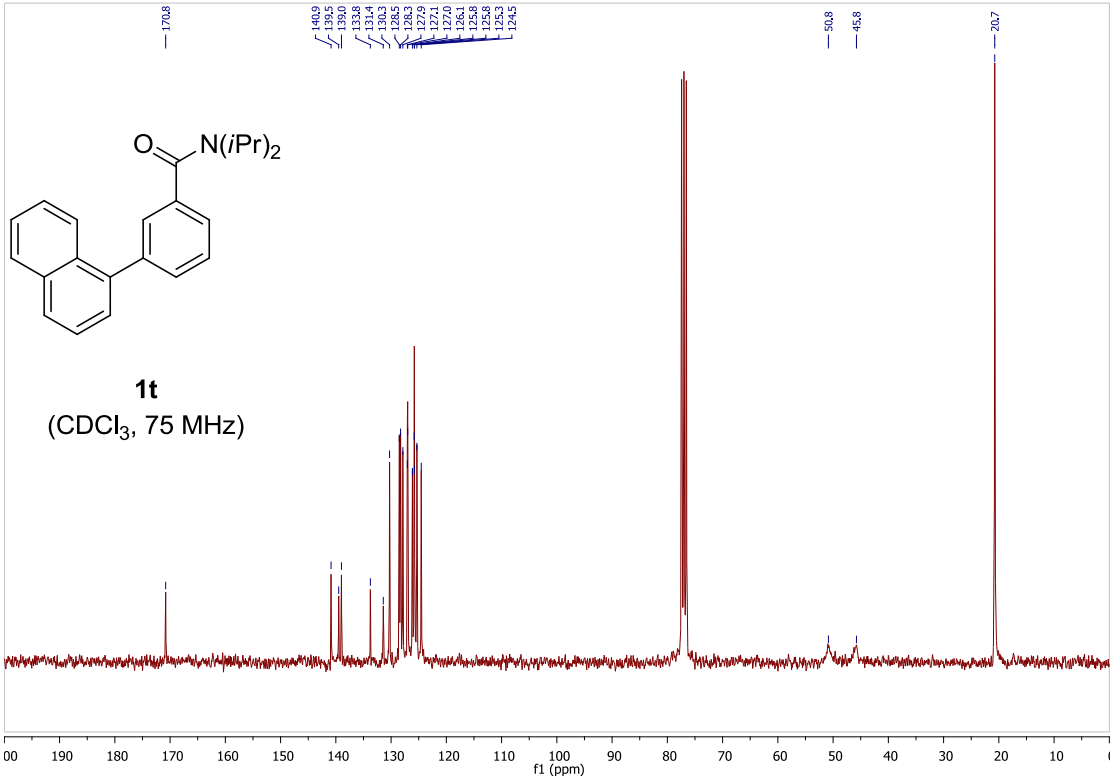

O
N(iPr)2
Me
Me
1r
(CDCl3, 300 MHz)
2.00
1.01
2.04
6.09
12.08
f1 (ppm)

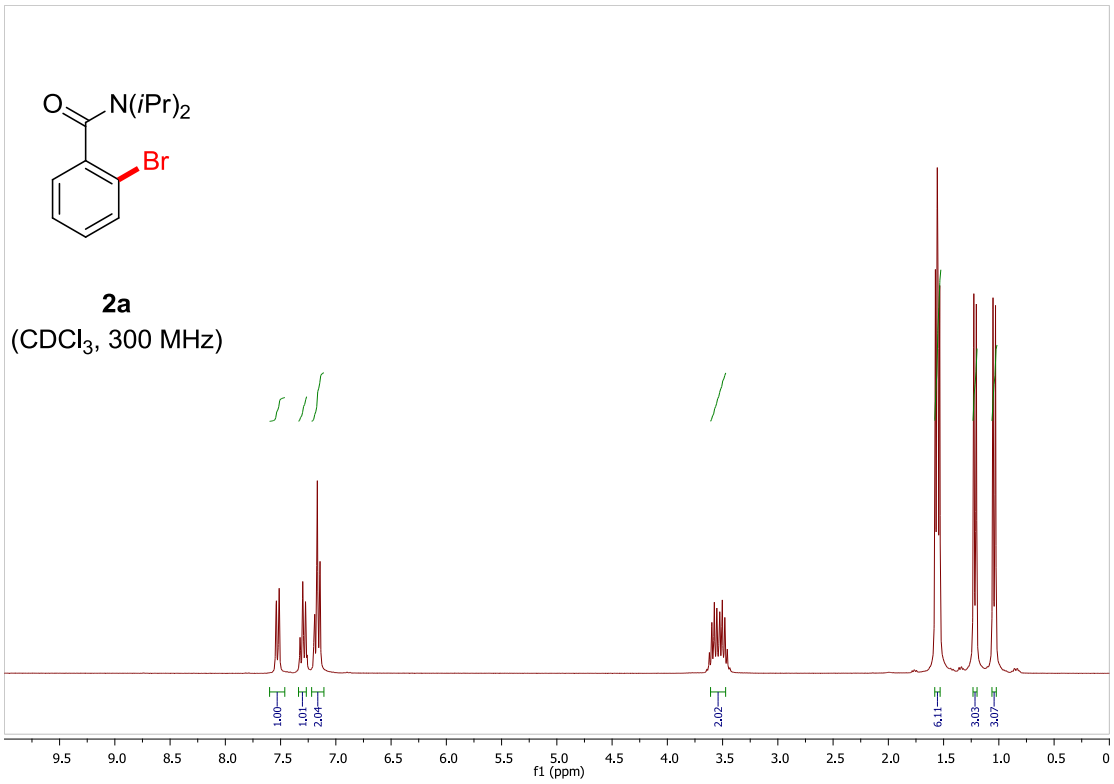

171.2
137.0
136.6
136.5
129.3
126.9
122.8
20.7
19.6
19.5
O
N(iPr)2
Me
Me
1r
(CDCl3, 75 MHz)
f1 (ppm)

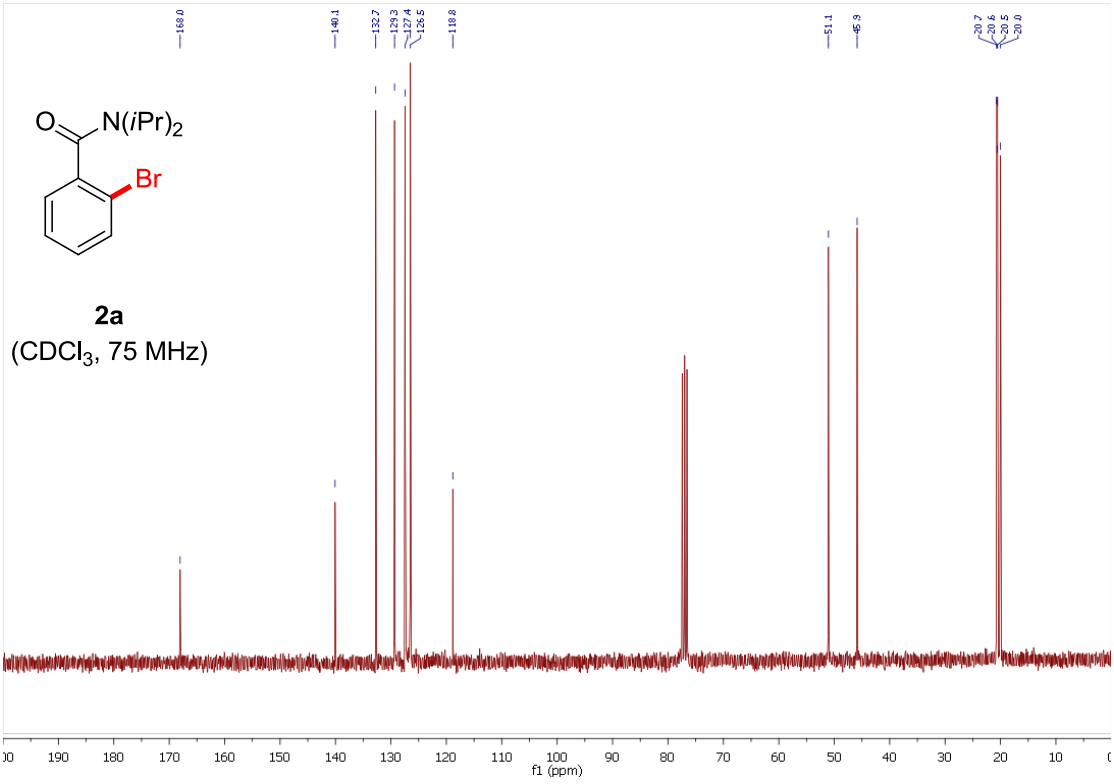

O
N(iPr)2
O
O
1s
(CDCl3, 300 MHz)
3.06
2.00
2.09
12.15
f1 (ppm)

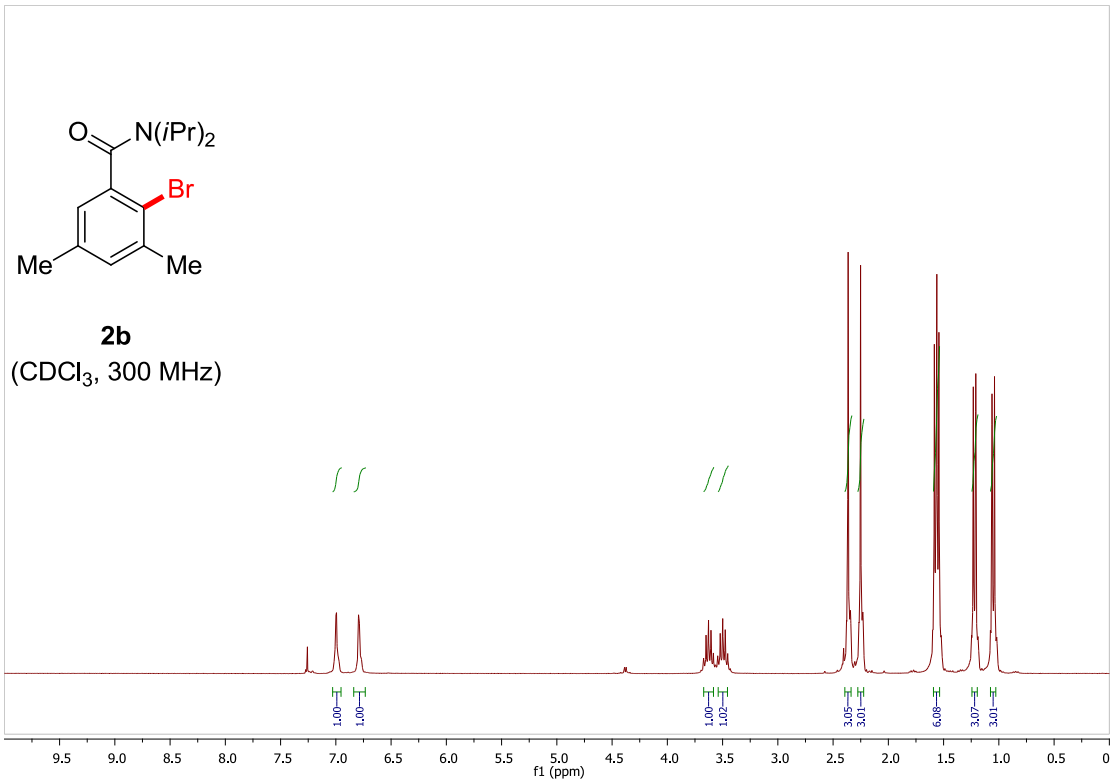

170.3
147.8
147.4
132.7
119.5
108.2
106.7
101.1
20.7
O
N(iPr)2
O
O
1s
(CDCl3, 75 MHz)
f1 (ppm)

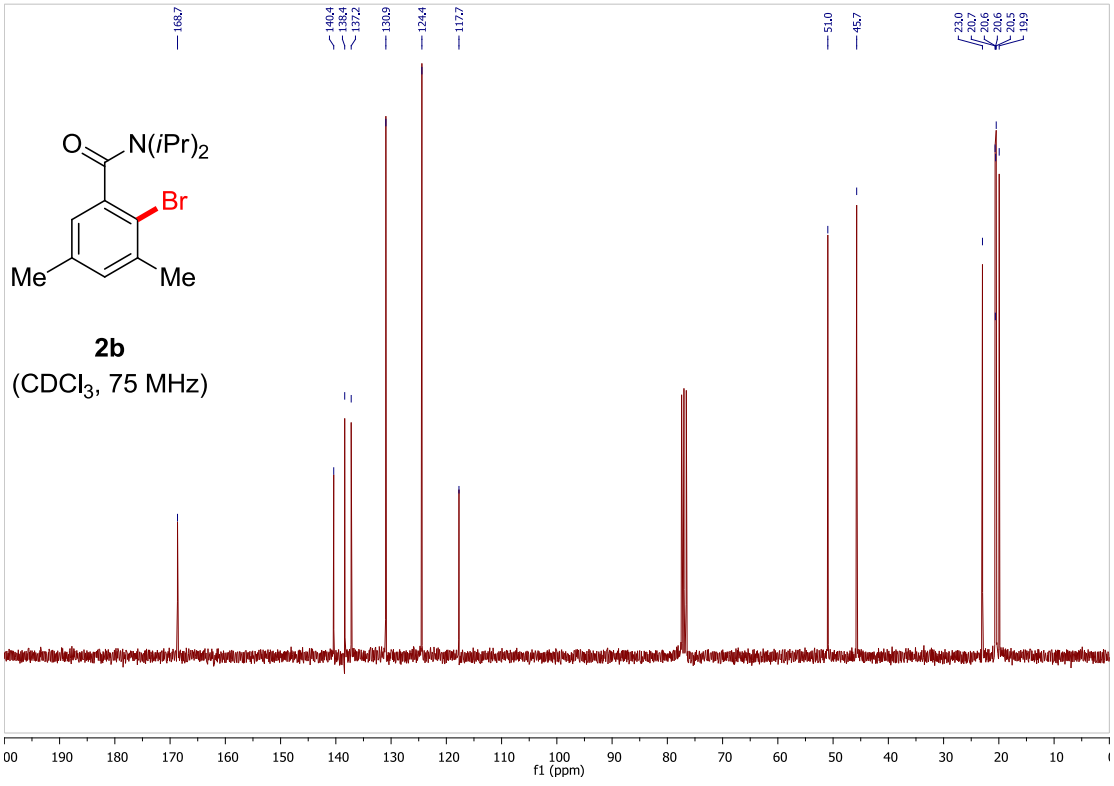

O
N(iPr)2
1t
(CDCl3, 300 MHz)
3.08
4.04
4.08
1.00
1.10
12.60
f1 (ppm)

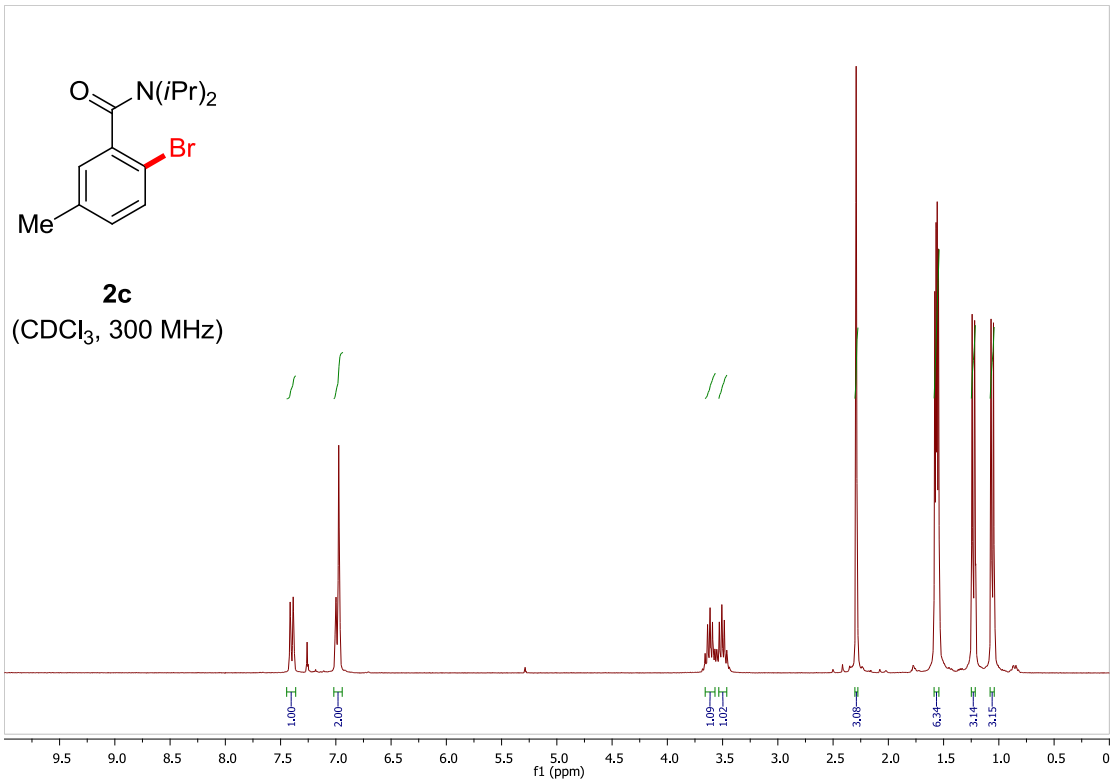

170.8
140.9
139.5
139.0
133.8
131.4
130.3
128.5
128.3
127.9
127.1
127.0
126.1
125.8
125.5
125.3
124.5
50.8
45.8
20.7
O
N(iPr)2
1t
(CDCl3, 75 MHz)
f1 (ppm)

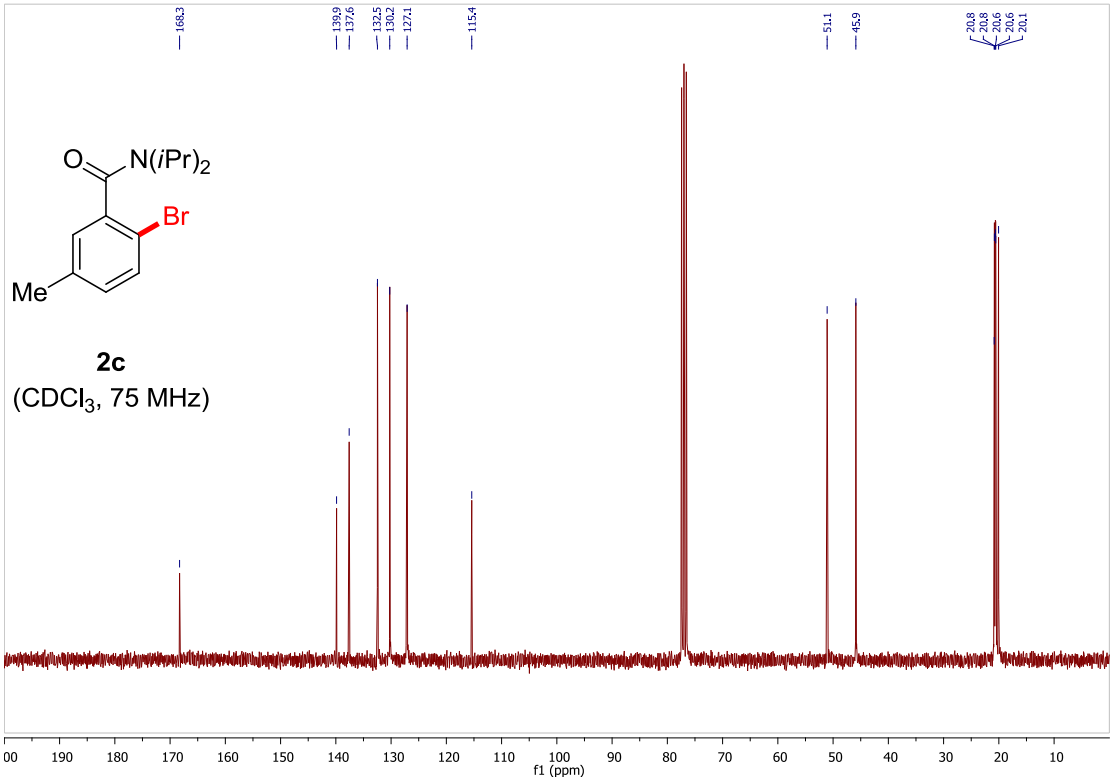

O
N(iPr)2
Br
2a
(CDCl3, 300 MHz)
1.00
1.01
2.04
2.02
6.11
3.03
3.07
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0
f1 (ppm)

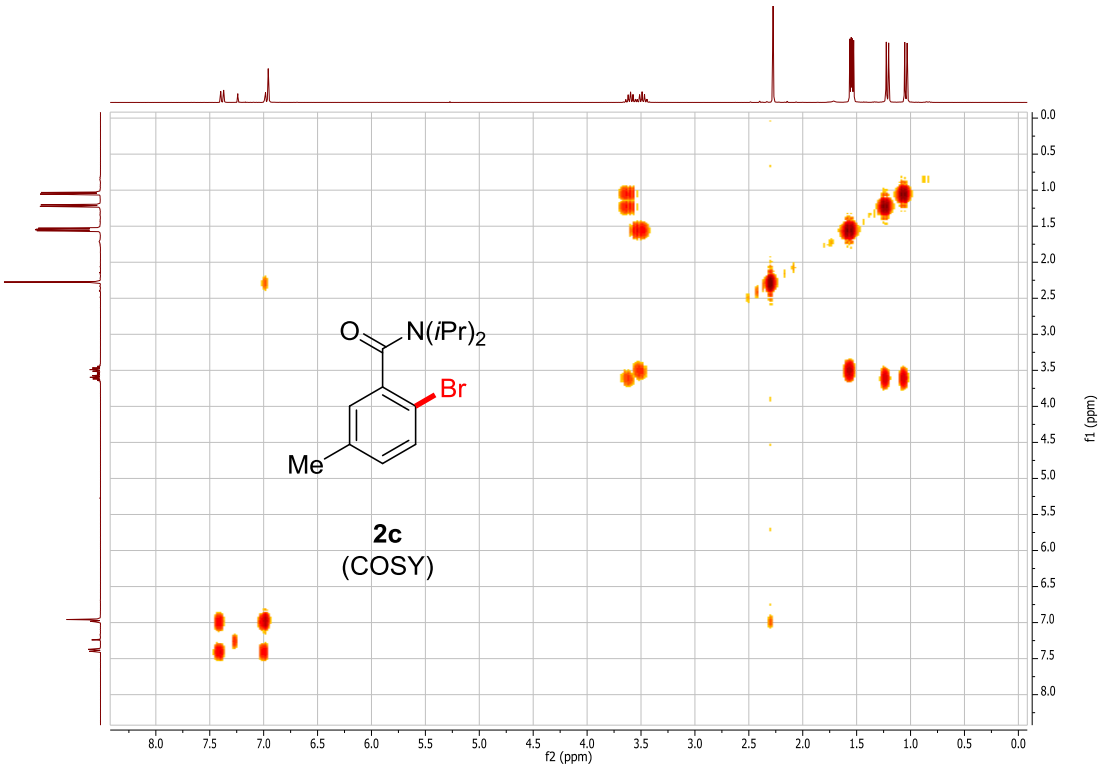

168.0
140.1
132.7
129.3
127.4
126.5
118.8
51.1
46.3
20.7
20.6
20.5
20.0
O
N(iPr)2
Br
2a
(CDCl3, 75 MHz)
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

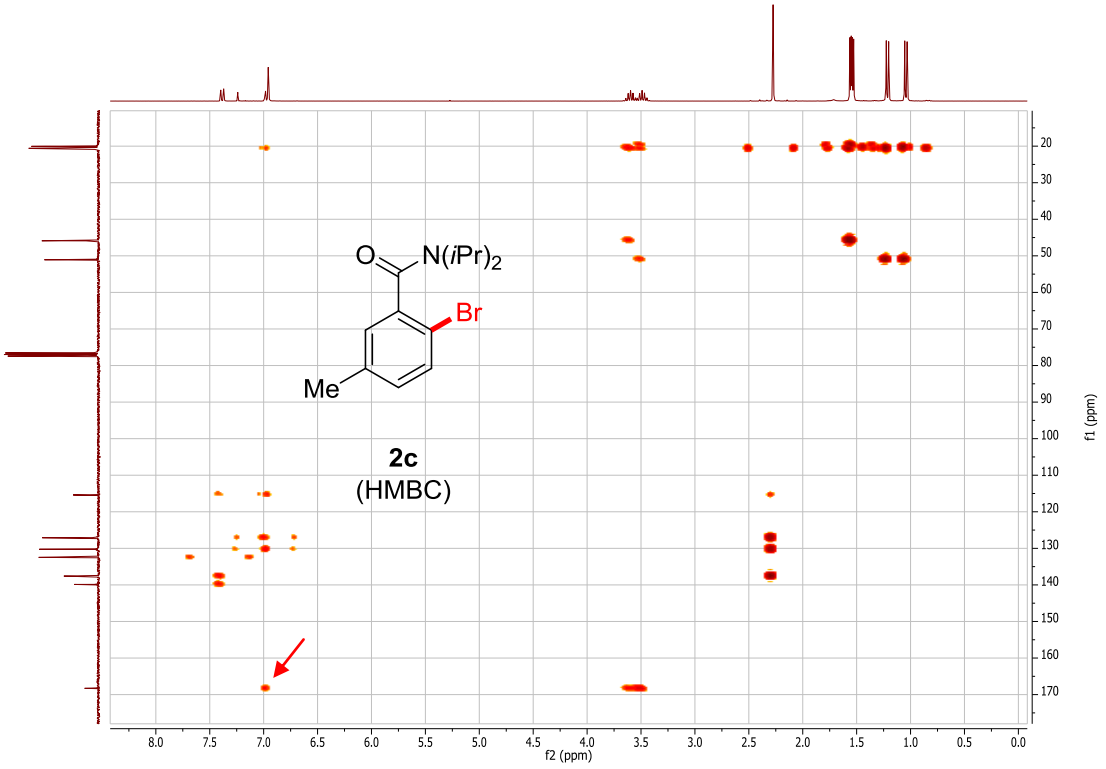

O
N(iPr)2
Br
Me
Me
2b
(CDCl3, 300 MHz)
1.00
1.00
1.00
1.02
3.05
3.01
6.08
3.07
3.01
f1 (ppm)

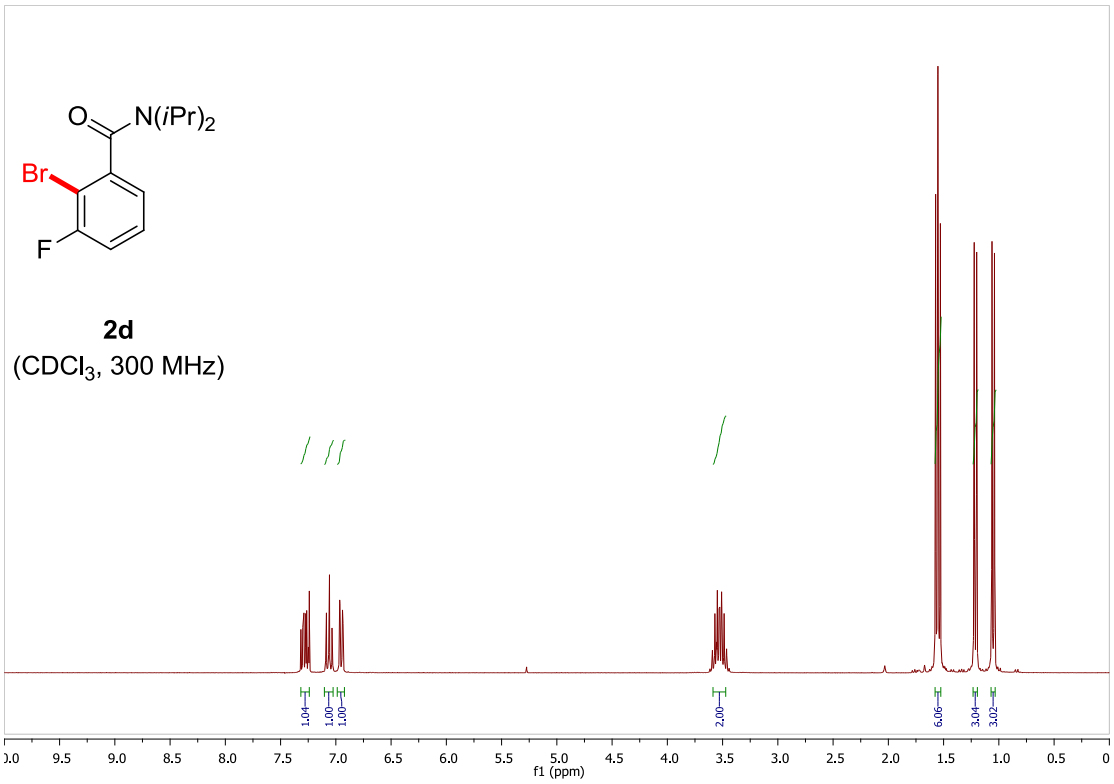

168.7
140.4
138.4
137.2
130.9
124.4
117.7
51.0
45.7
23.0
20.7
20.6
20.6
20.5
19.9
O
N(iPr)2
Br
Me
Me
2b
(CDCl3, 75 MHz)
f1 (ppm)

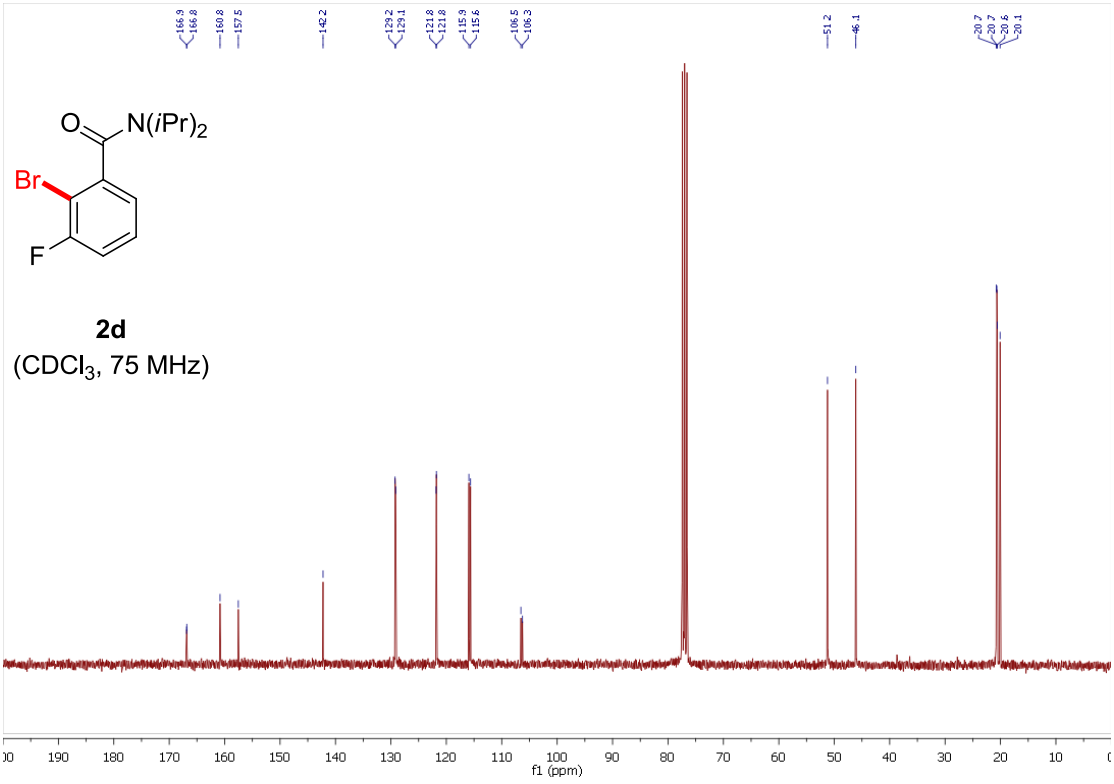

O
N(iPr)2
Br
Me
2c
(CDCl3, 300 MHz)
1.00
2.00
1.09
1.02
3.08
6.34
3.14
3.15
f1 (ppm)

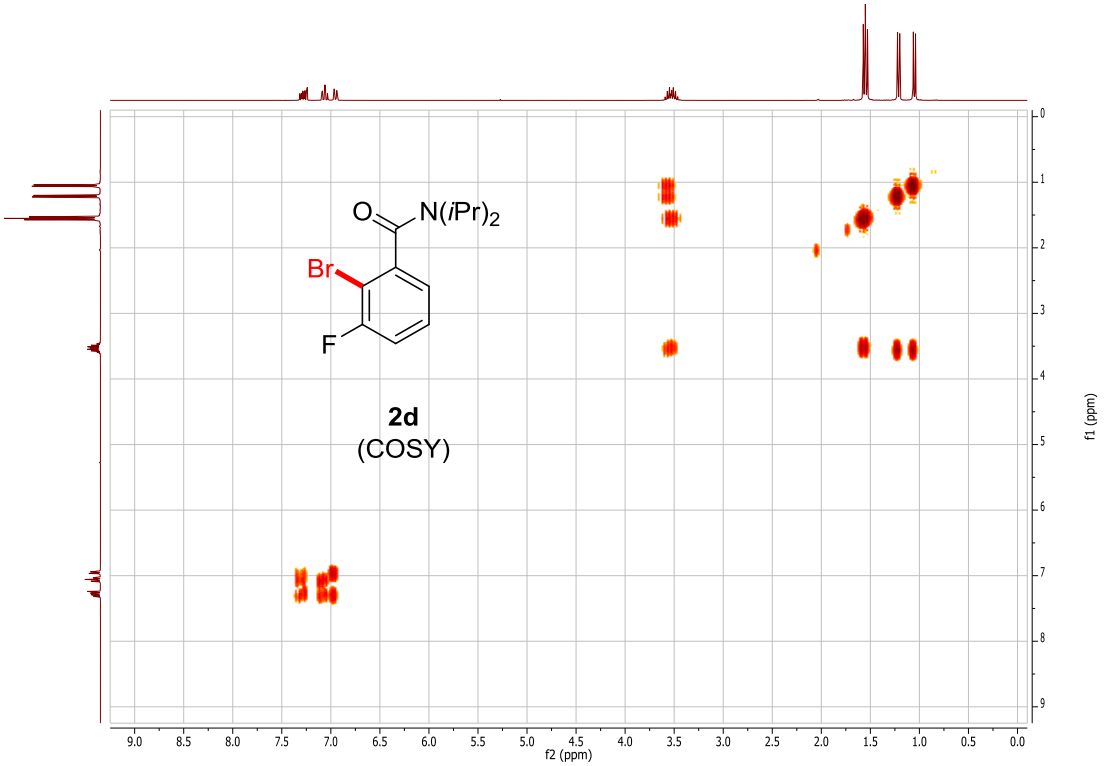

168.3
139.9
137.6
132.5
130.2
127.1
115.4
51.1
45.9
20.8
20.8
20.6
20.6
20.1
O
N(iPr)2
Br
Me
2c
(CDCl3, 75 MHz)
f1 (ppm)

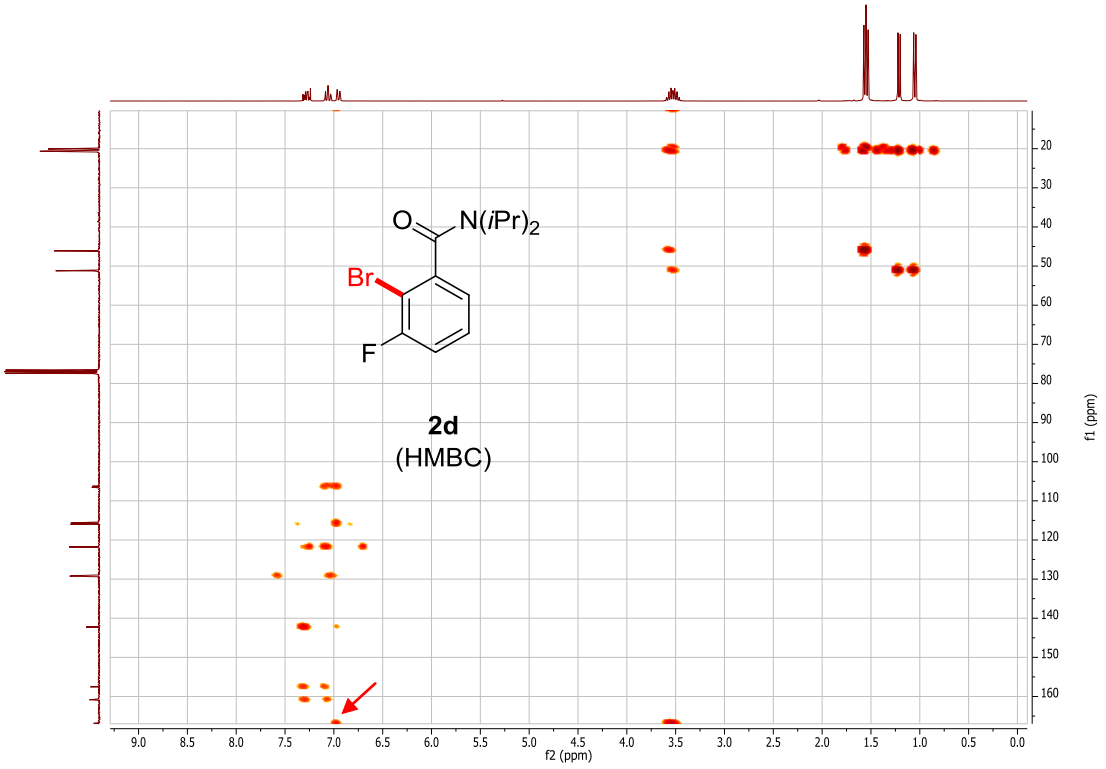


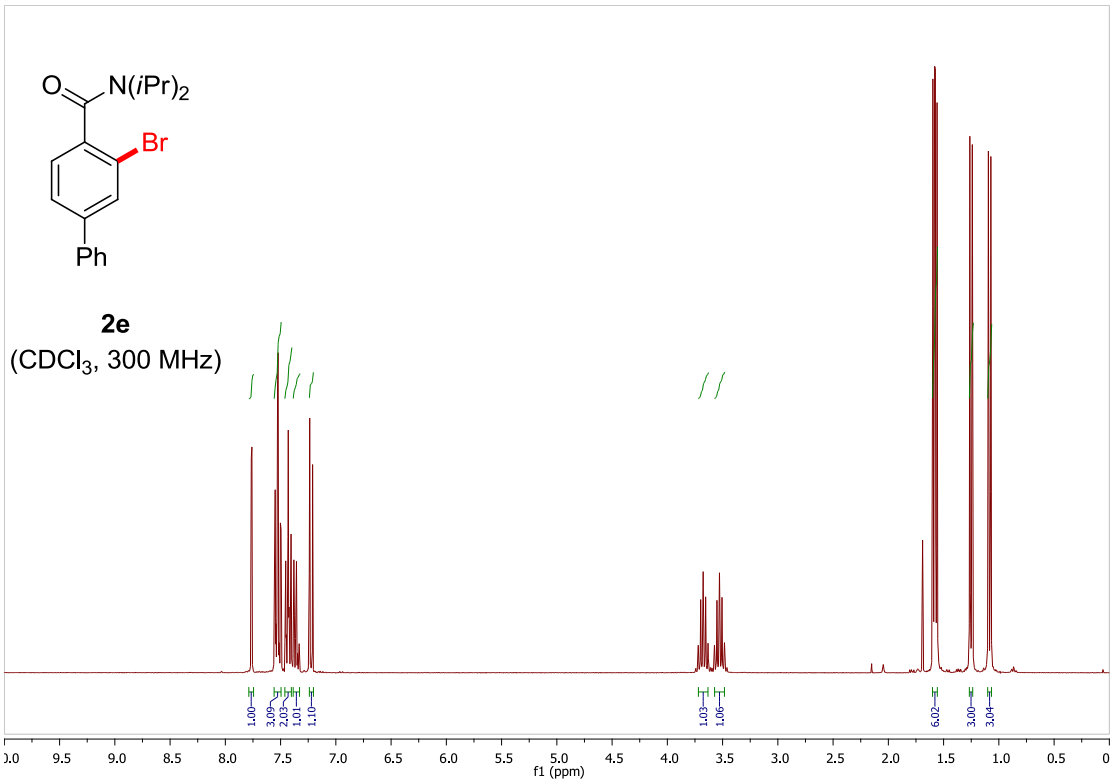


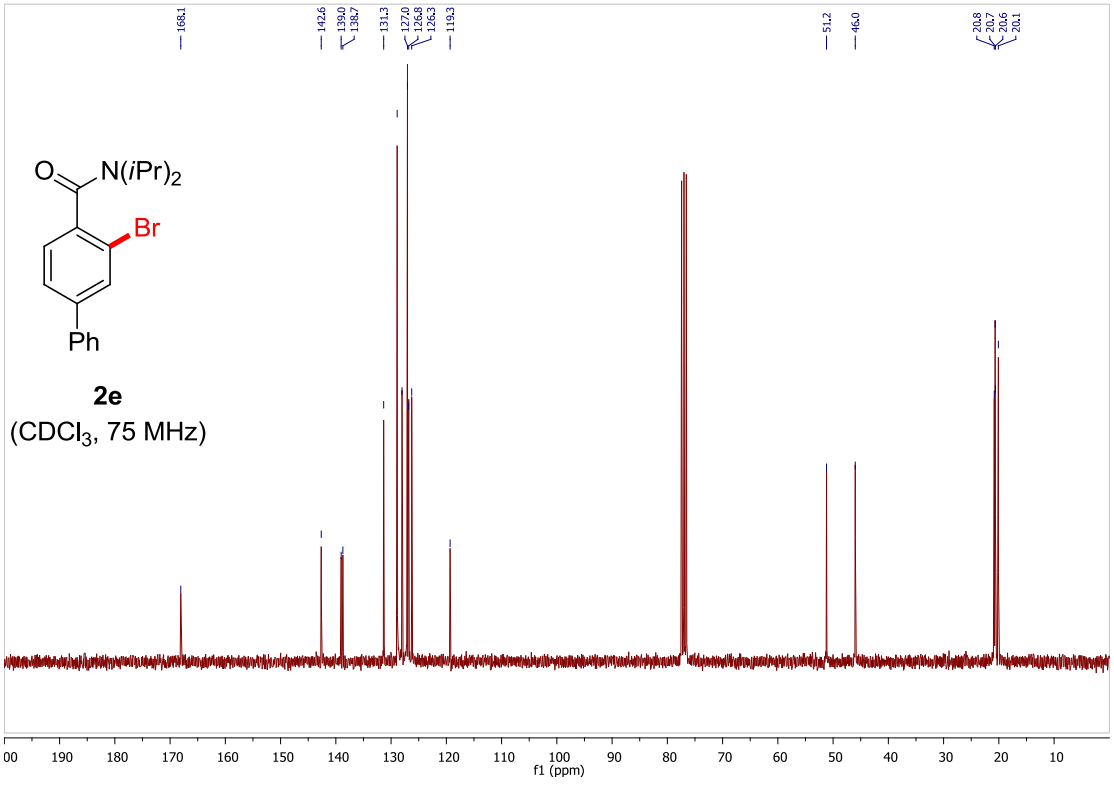

O
N(iPr)2
Br
F
2d
(CDCl3, 300 MHz)
1.04
1.00
1.00
2.00
6.06
3.04
3.02
f1 (ppm)

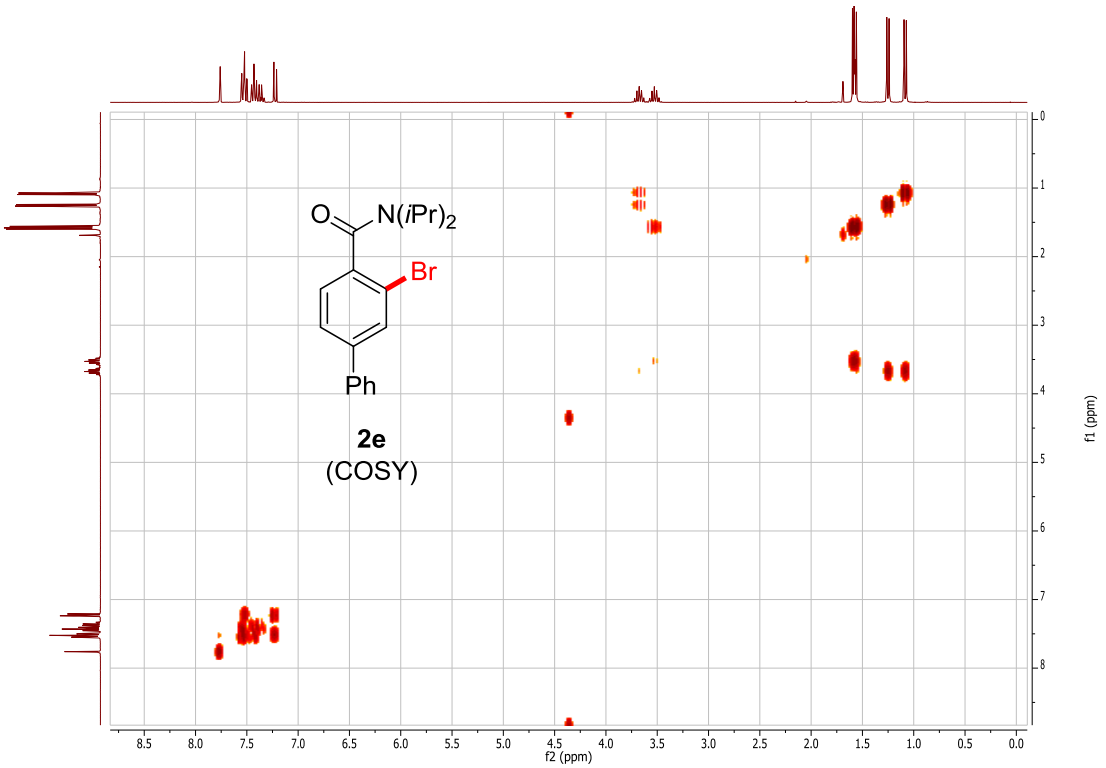

166.9
166.8
160.8
157.5
142.2
129.2
129.1
121.8
121.8
115.9
115.6
106.5
106.3
51.2
46.1
20.7
20.7
20.6
20.1
O
N(iPr)2
Br
F
2d
(CDCl3, 75 MHz)
f1 (ppm)

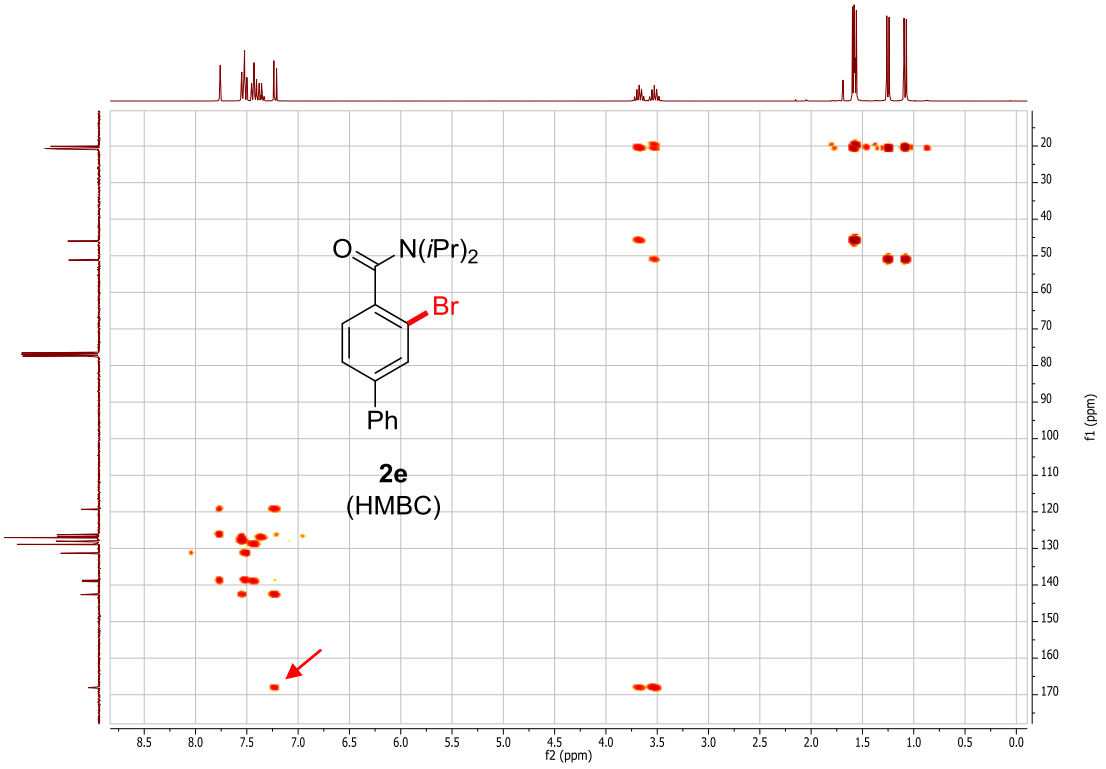

O
N(iPr)2
Br
F
2d
(COSY)
f2 (ppm)
f1 (ppm)

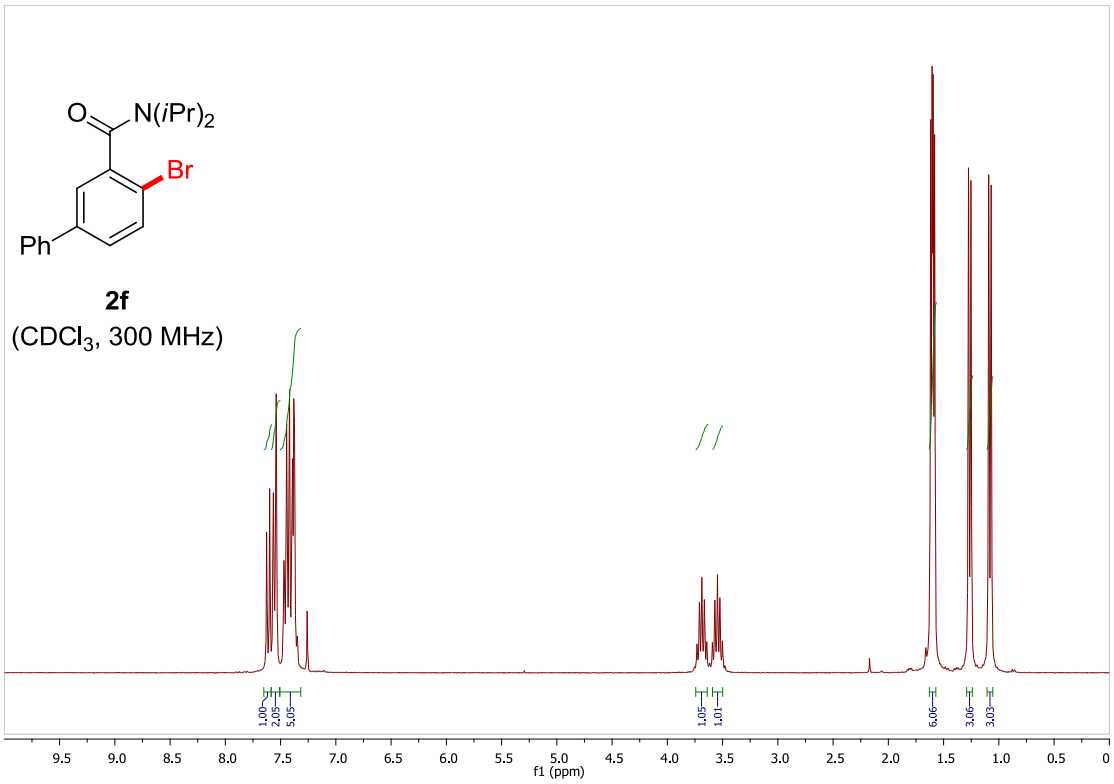

O
N(iPr)2
Br
F
2d
(HMBC)
f2 (ppm)
f1 (ppm)

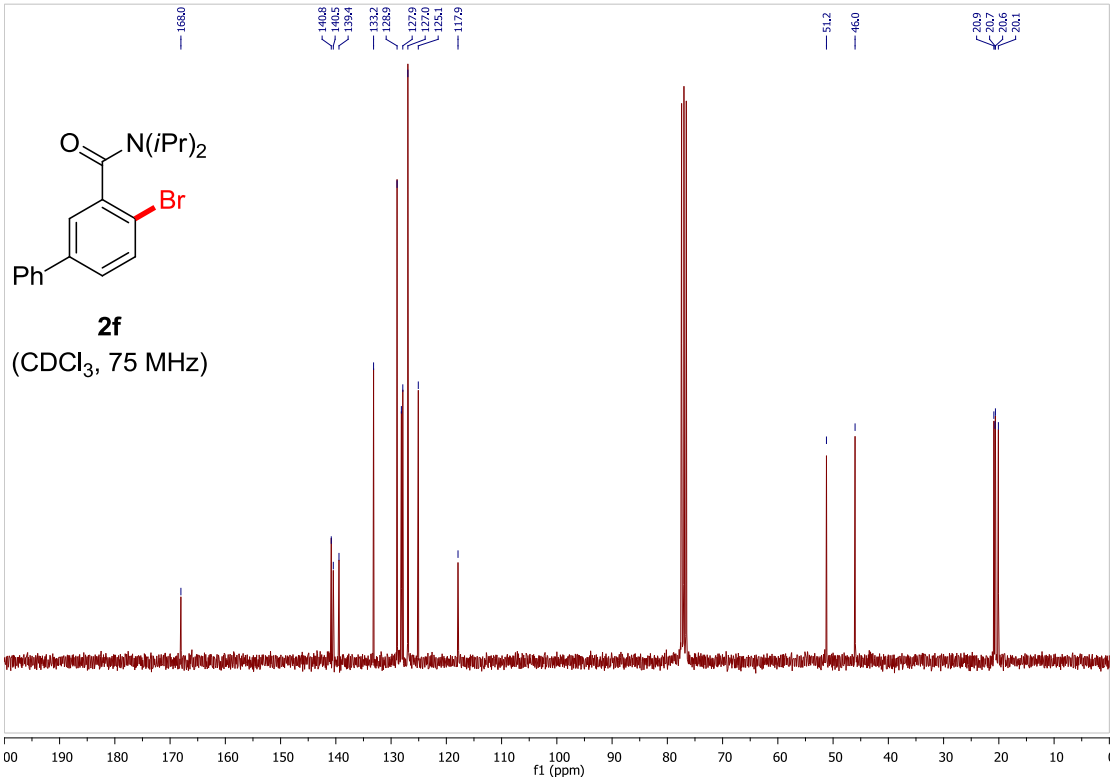

O
N(iPr)2
Br
Ph
2e
(CDCl3, 300 MHz)
1.00
3.09
2.03
1.01
1.10
1.03
1.06
6.02
3.00
3.04
f1 (ppm)

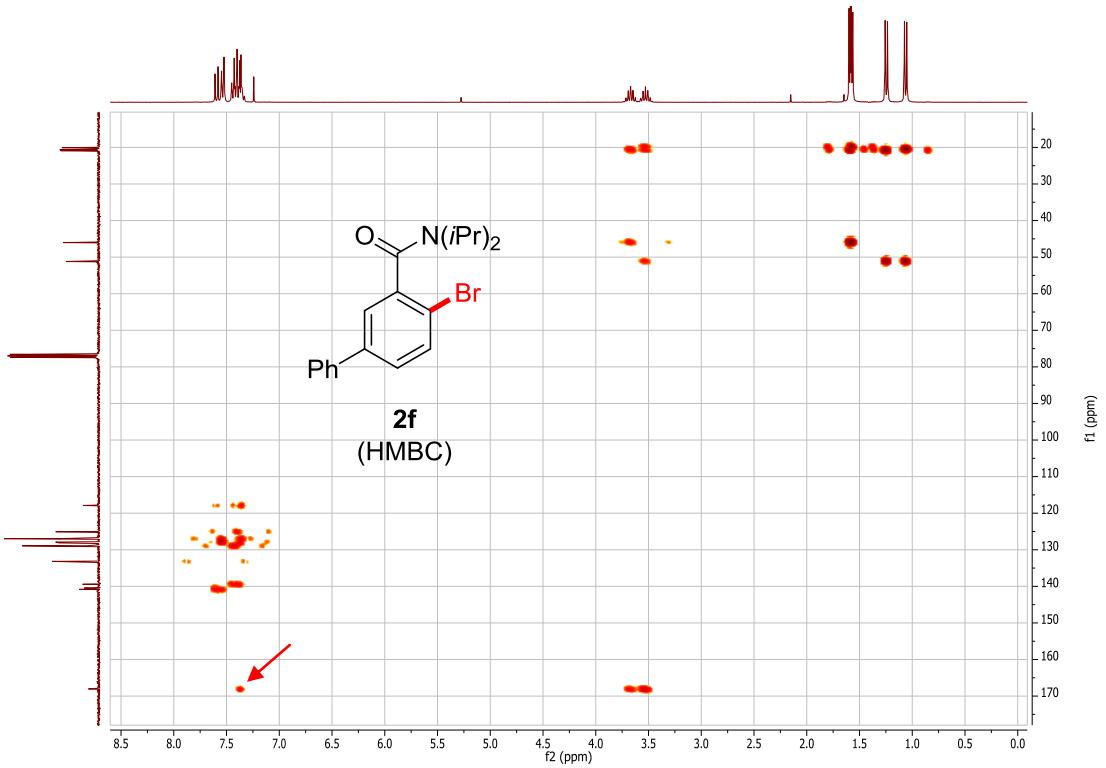

168.1
142.6
139.0
138.7
131.3
127.0
126.8
126.3
119.3
51.2
46.0
20.8
20.7
20.6
20.1
O
N(iPr)2
Br
Ph
2e
(CDCl3, 75 MHz)
f1 (ppm)

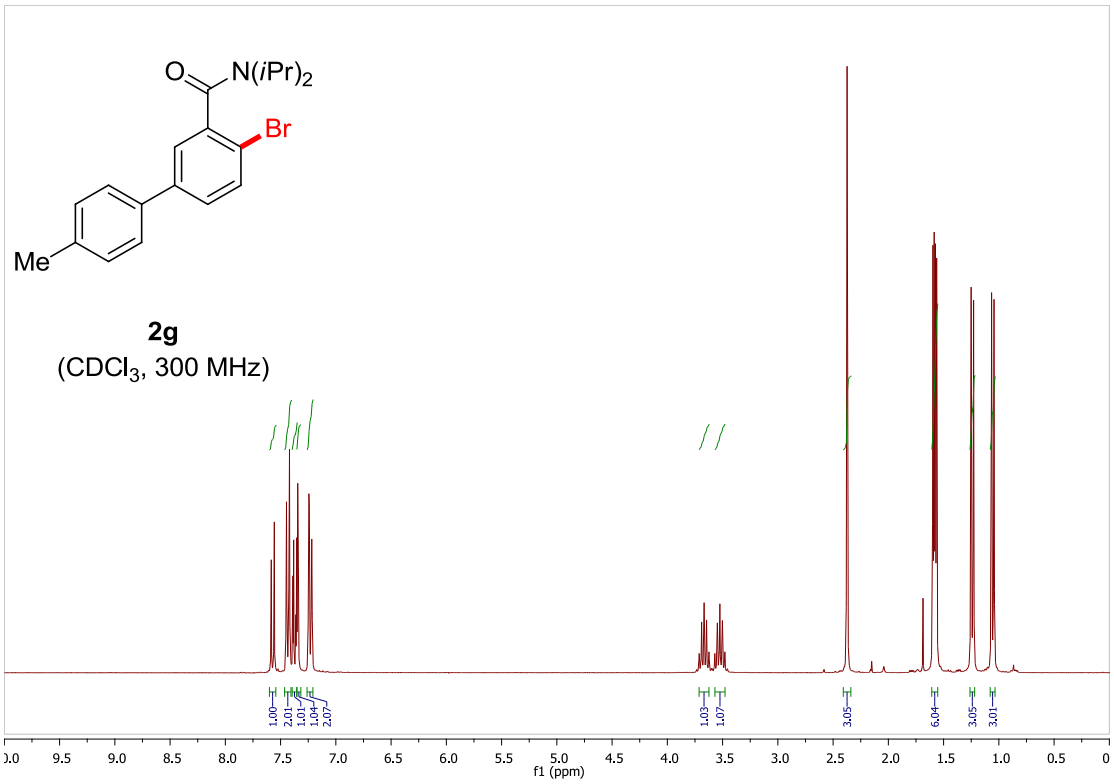


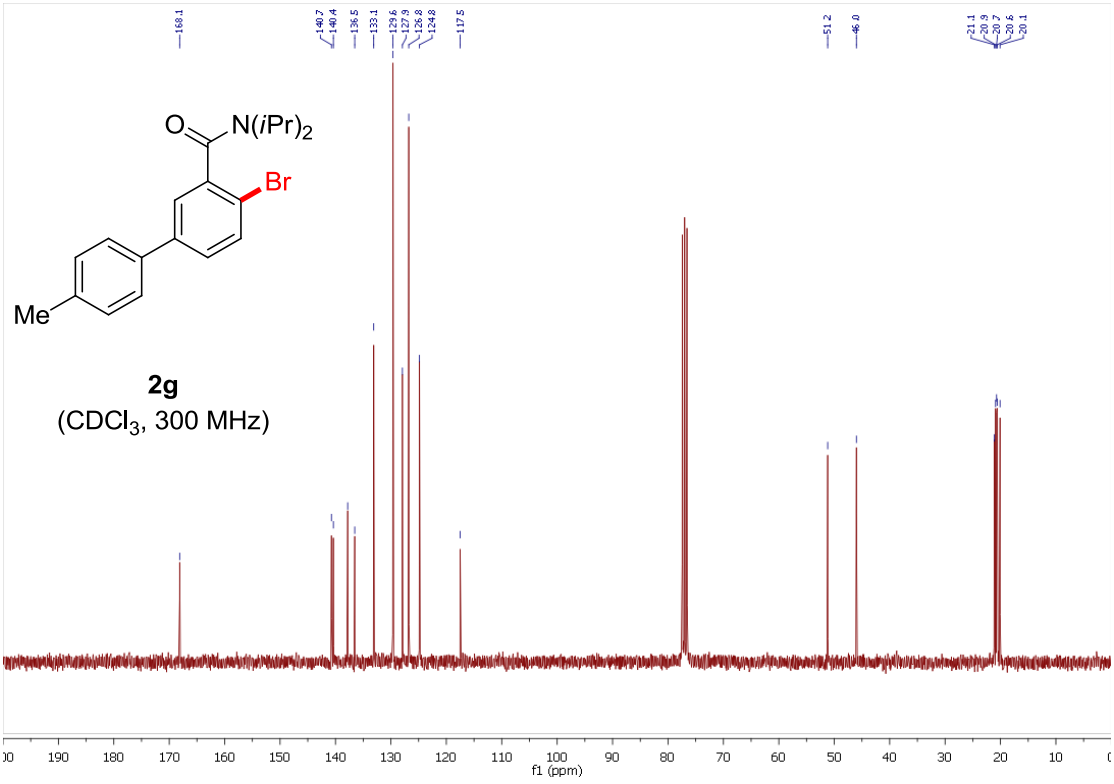


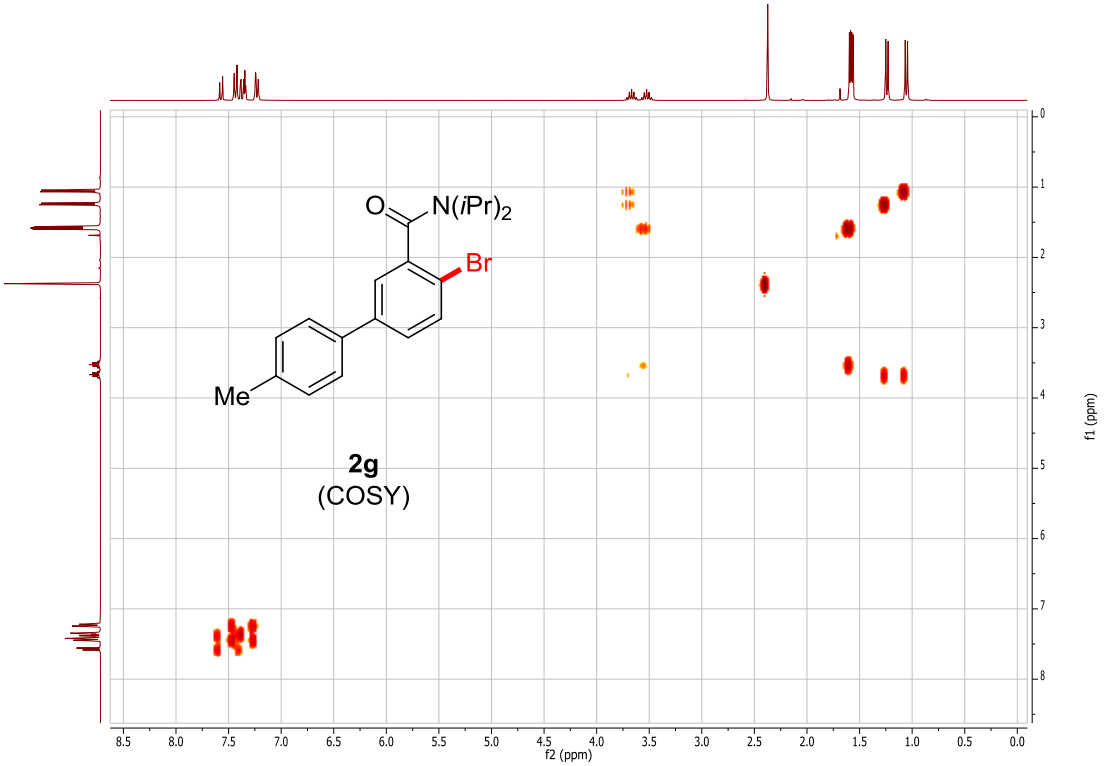

O
N(iPr)2
Br
Ph
2f
(CDCl3, 300 MHz)
1.00
2.05
5.05
1.05
1.01
6.06
3.06
3.03
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0
f1 (ppm)

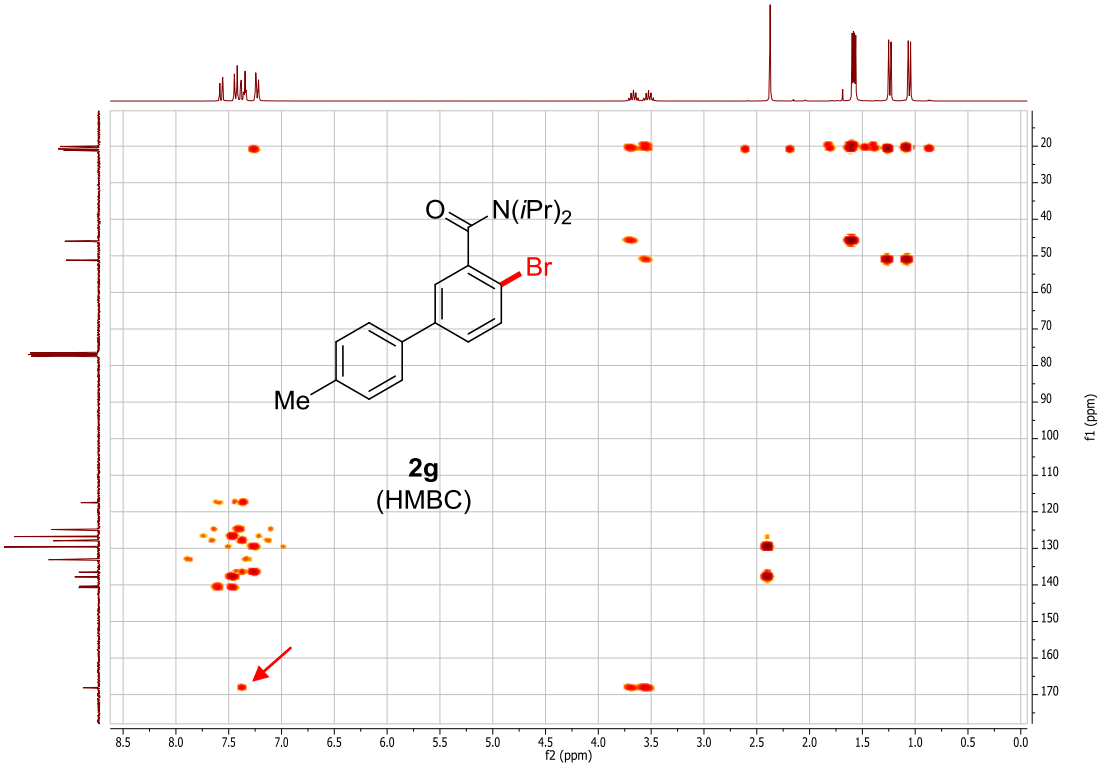

168.0
140.8
140.5
139.4
133.2
128.9
127.9
127.0
125.1
117.9
51.2
46.0
20.9
20.7
20.6
20.1
O
N(iPr)2
Br
Ph
2f
(CDCl3, 75 MHz)
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

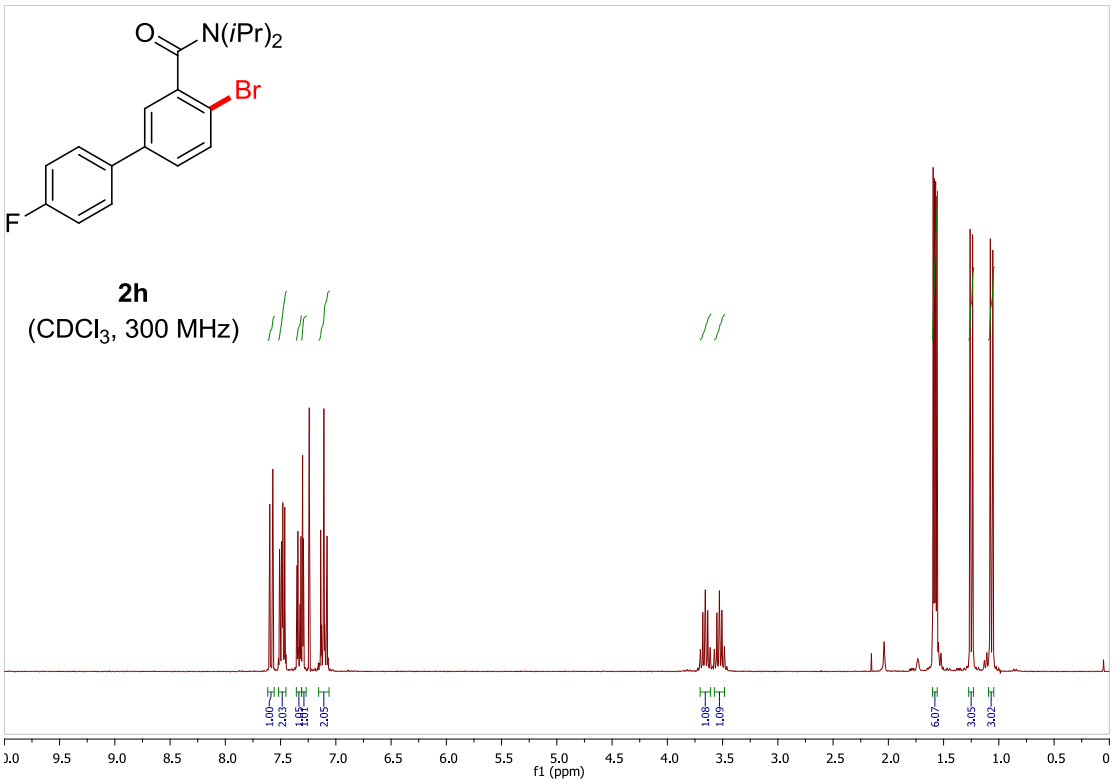


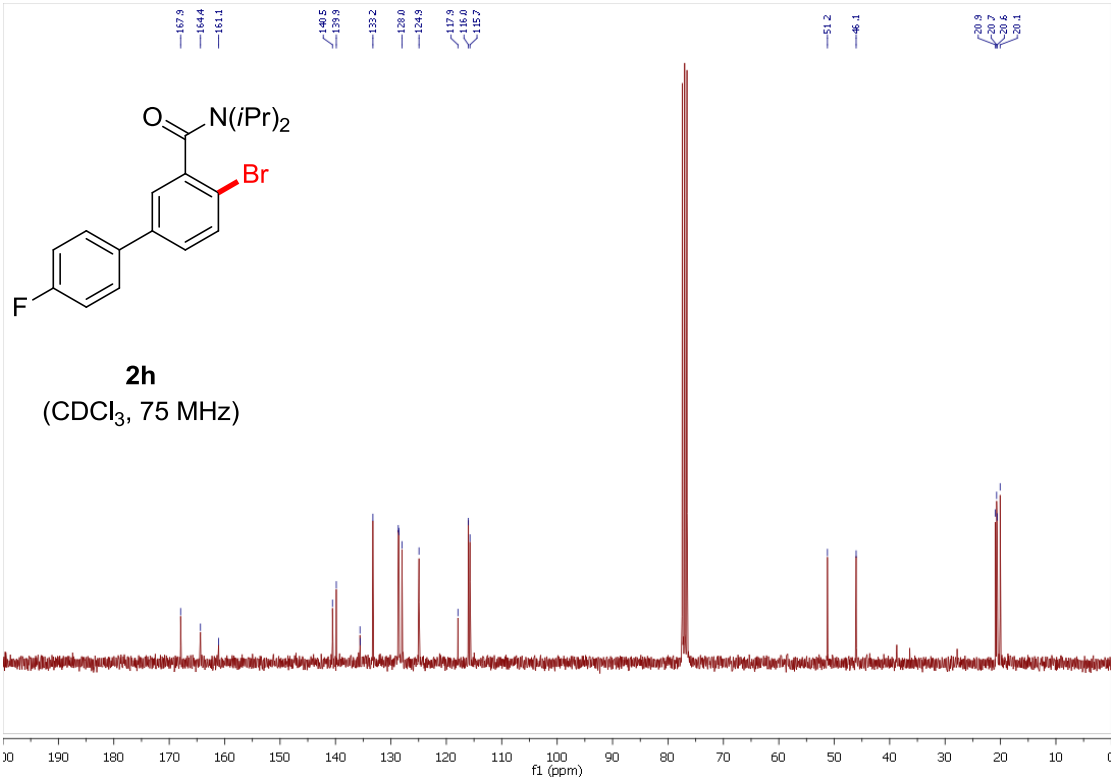

O
N(iPr)2
Br
Me
2g
(CDCl3, 300 MHz)
f1 (ppm)

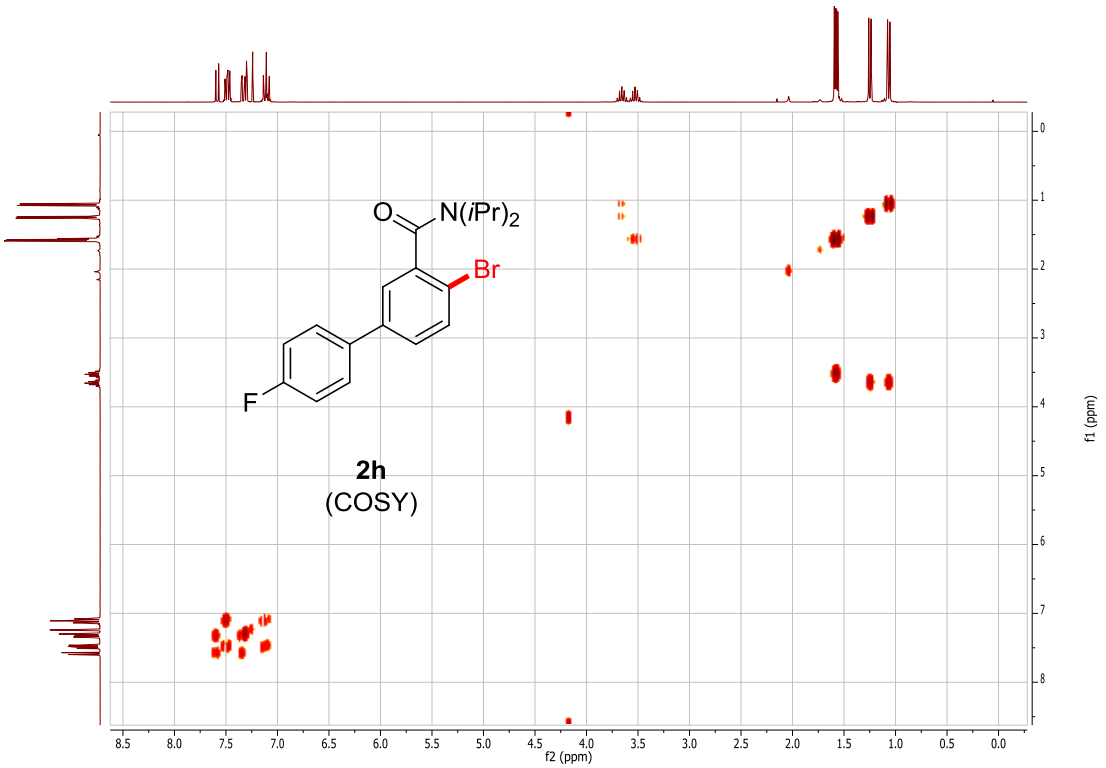

O
N(iPr)2
Br
Me
2g
(CDCl3, 300 MHz)
f1 (ppm)

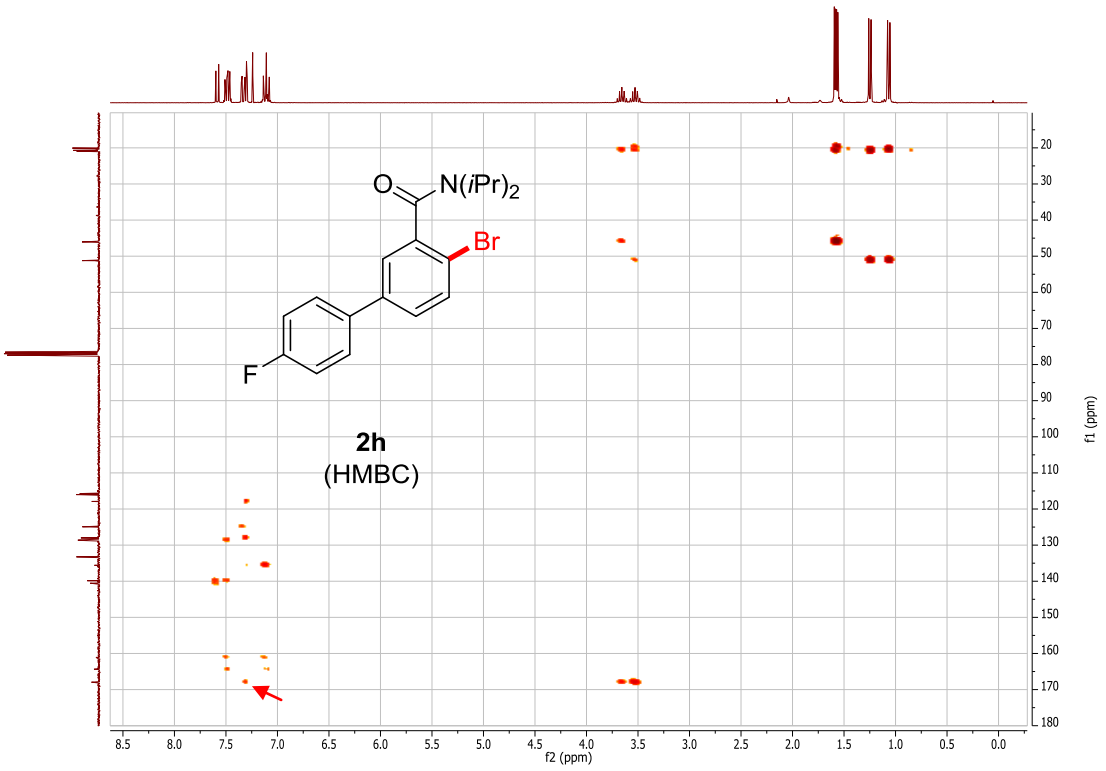


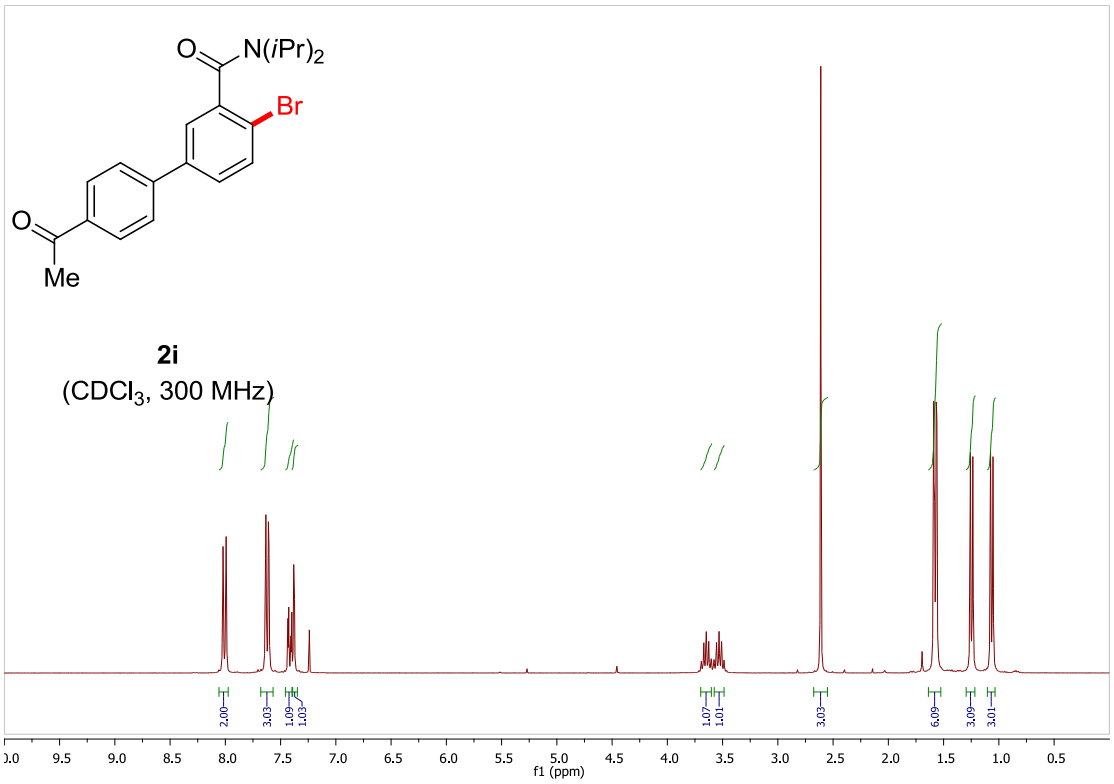


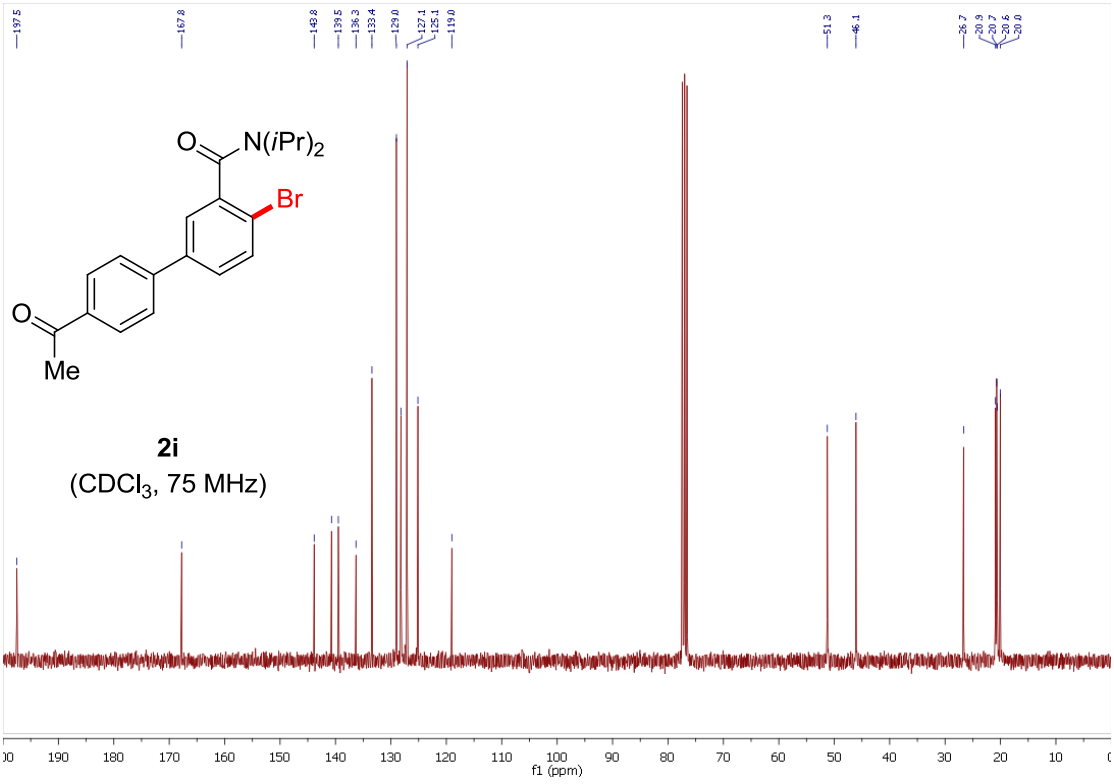

O
N(iPr)2
Br
F
2h
(CDCl3, 300 MHz)
1.00
2.03
1.05
1.01
2.05
1.08
1.09
6.07
3.05
3.02
f1 (ppm)

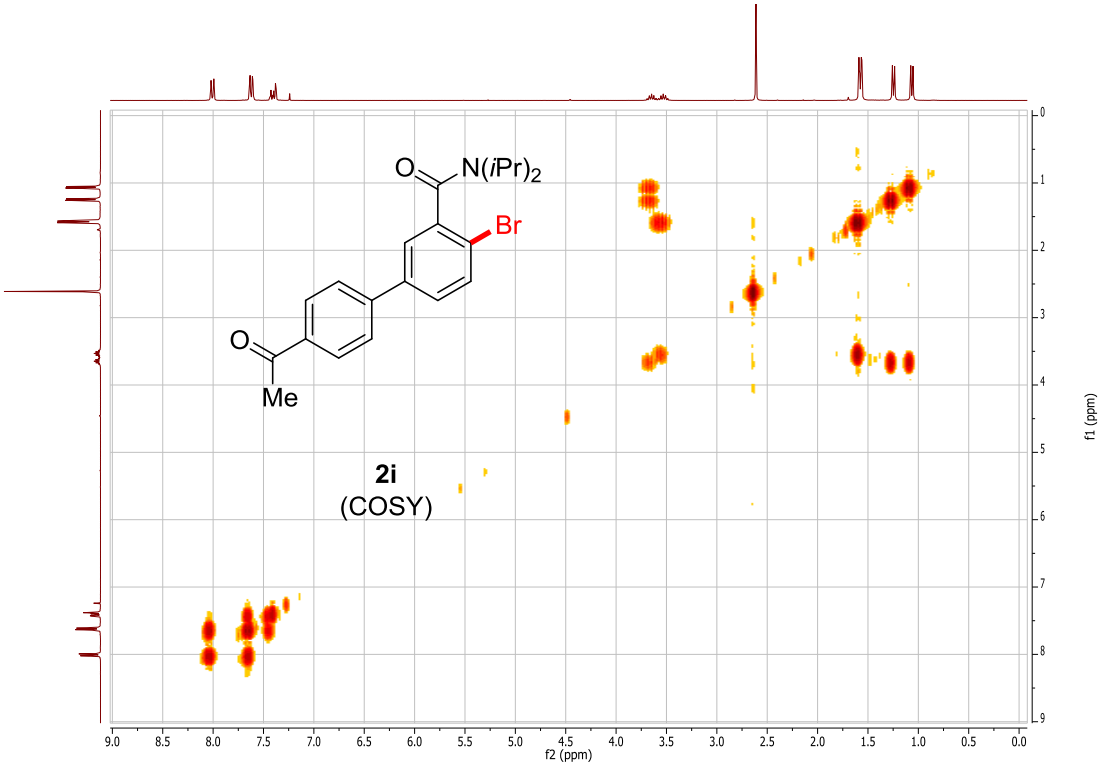

167.9
164.4
161.1
140.5
139.9
133.2
128.0
124.9
117.9
116.0
115.7
51.2
46.1
20.9
20.7
20.6
20.1
O
N(iPr)2
Br
F
2h
(CDCl3, 75 MHz)
f1 (ppm)

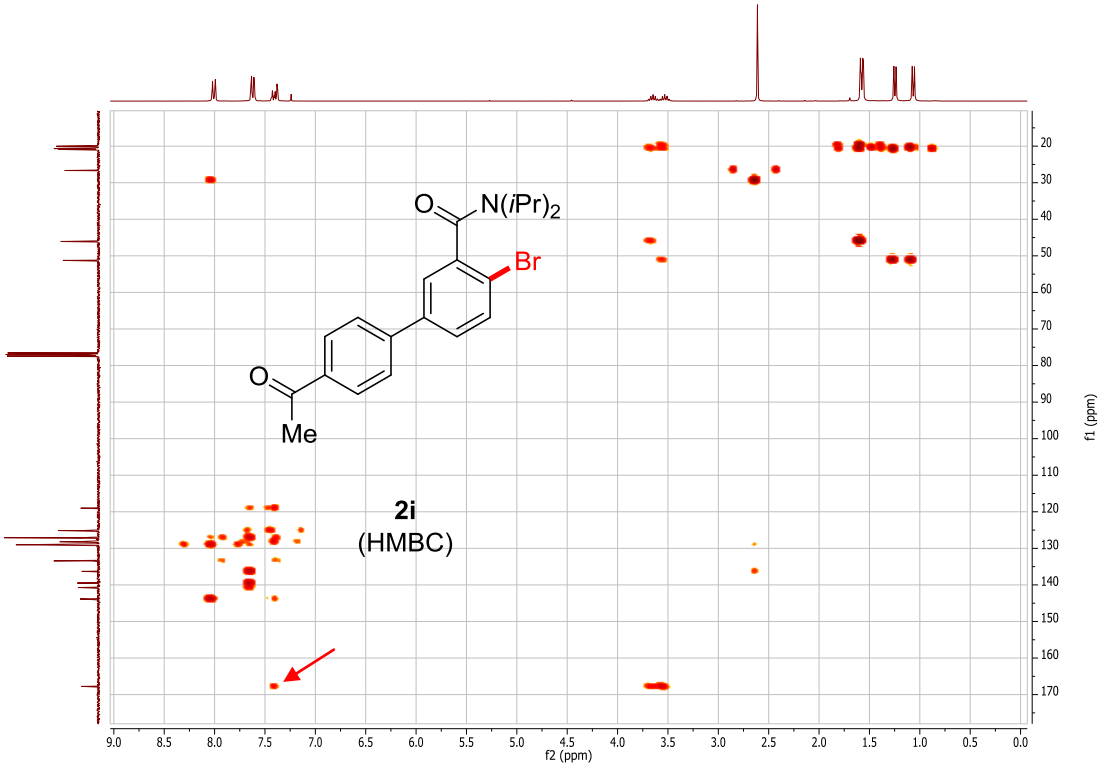


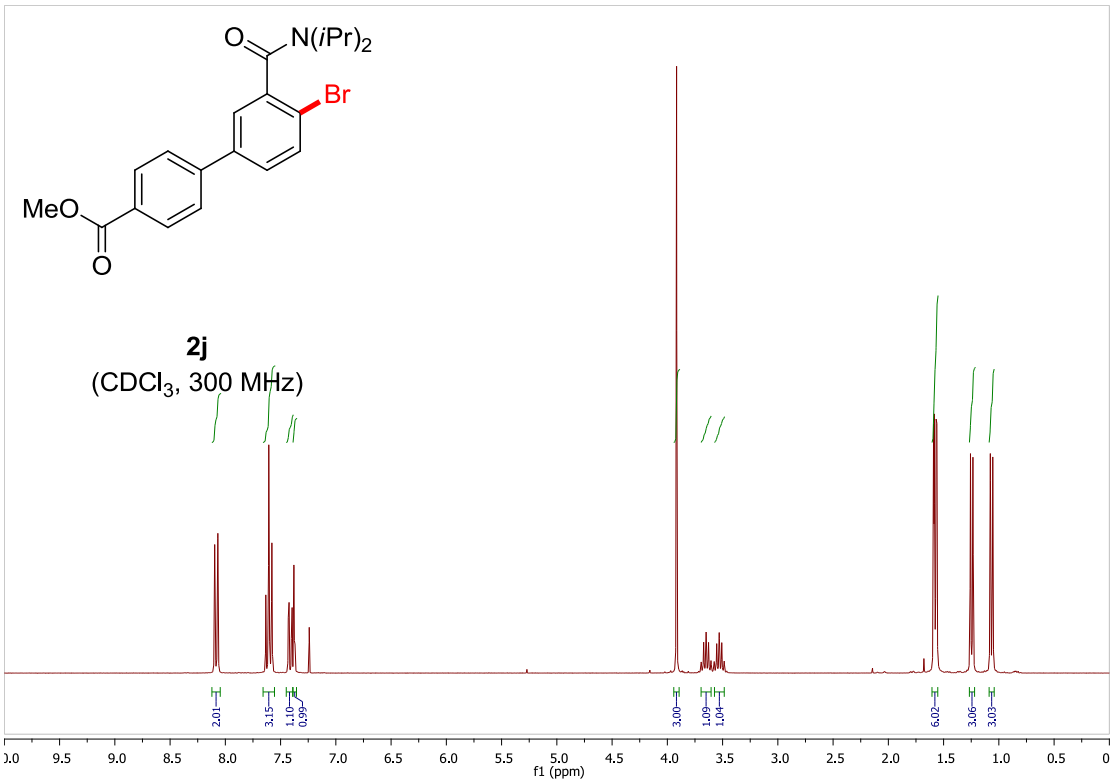


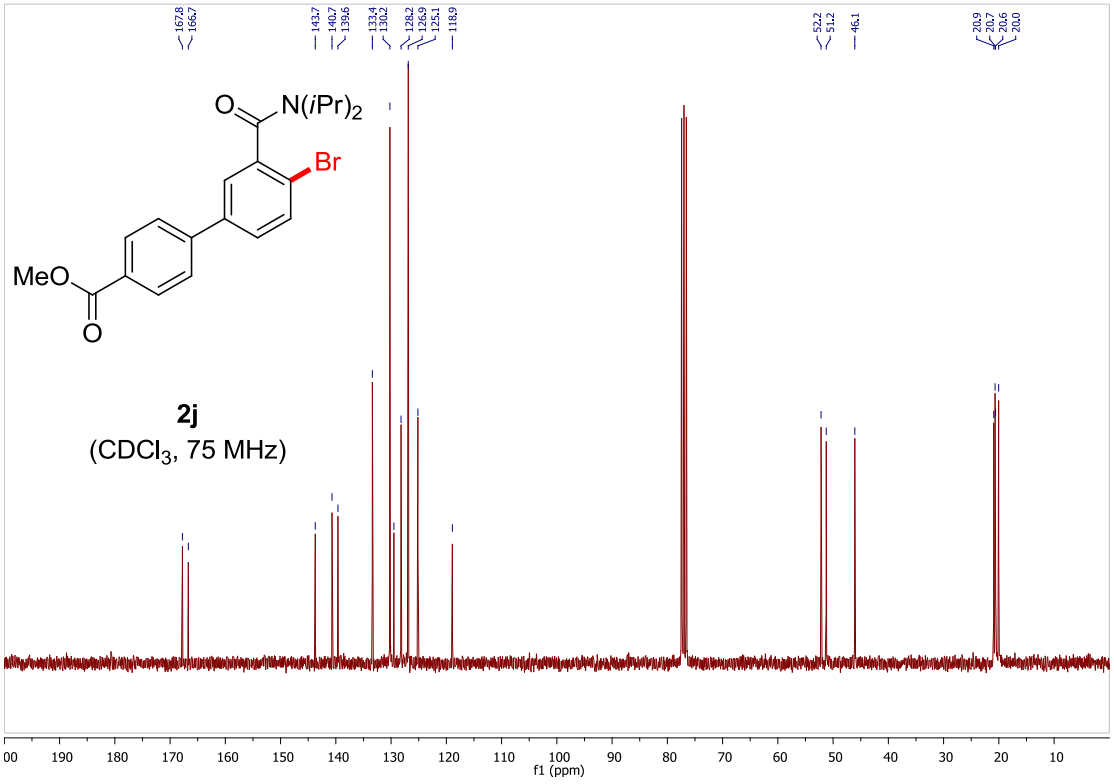

O
N(iPr)2
Br
O
Me
2i
(CDCl3, 300 MHz)
f1 (ppm)

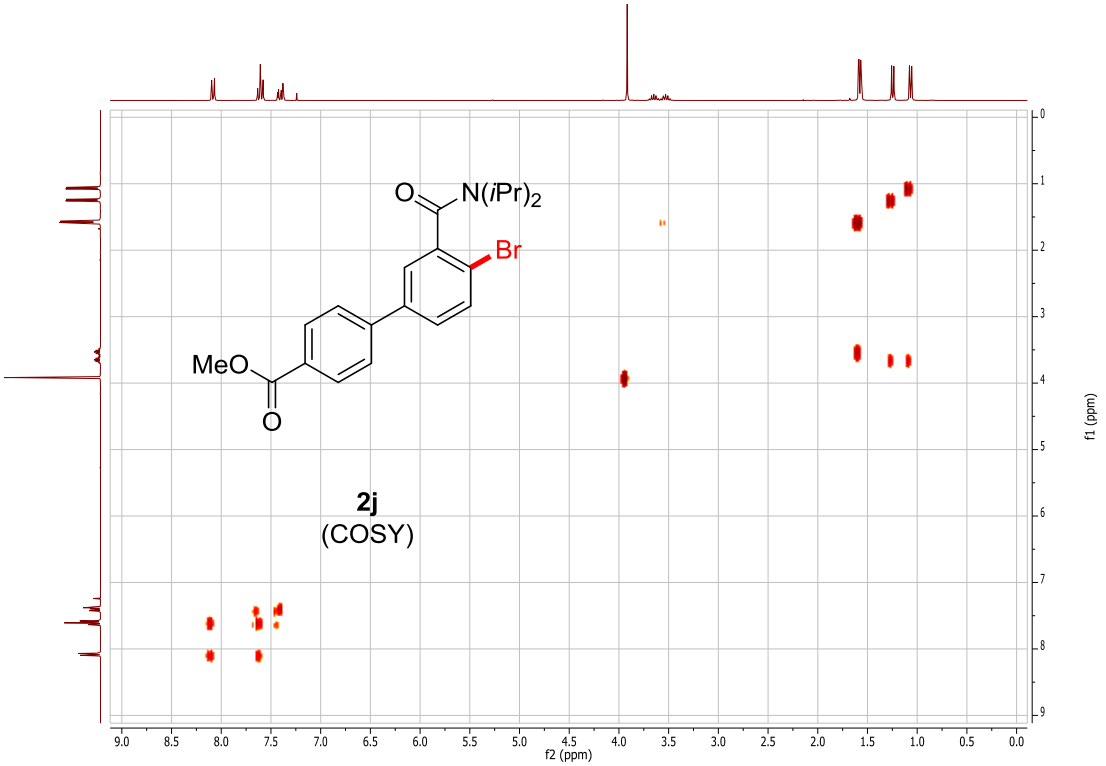

O
N(iPr)2
Br
O
Me
2i
(CDCl3, 75 MHz)
f1 (ppm)

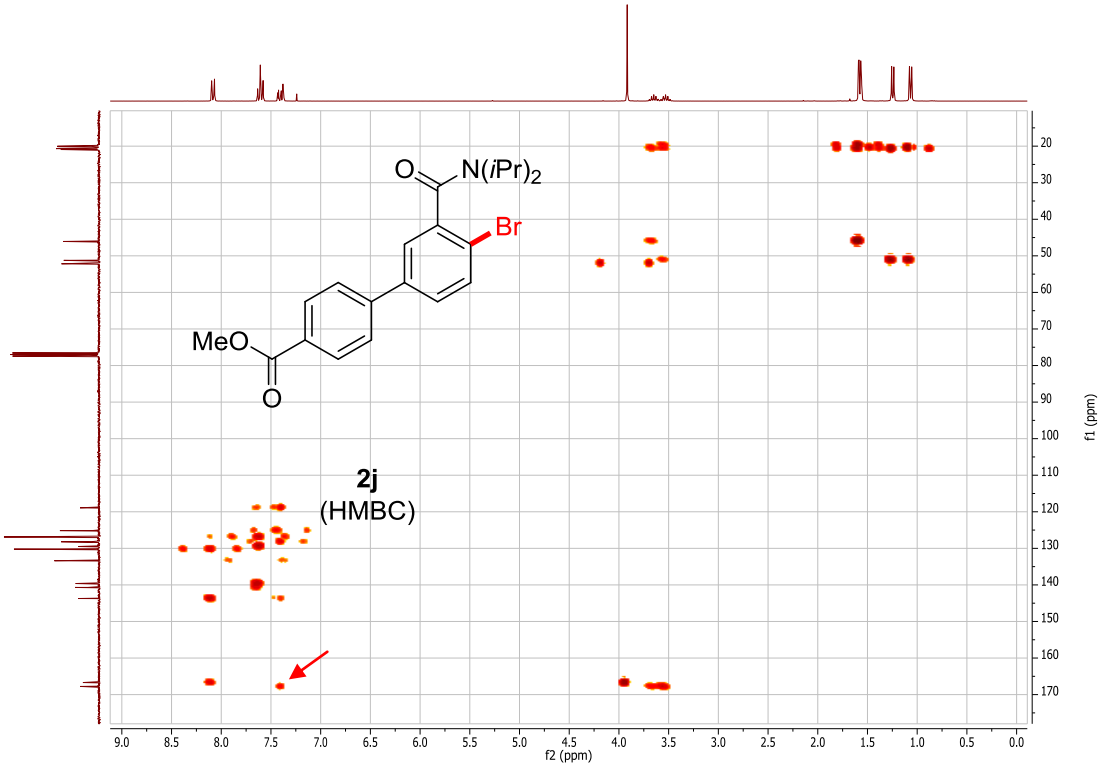


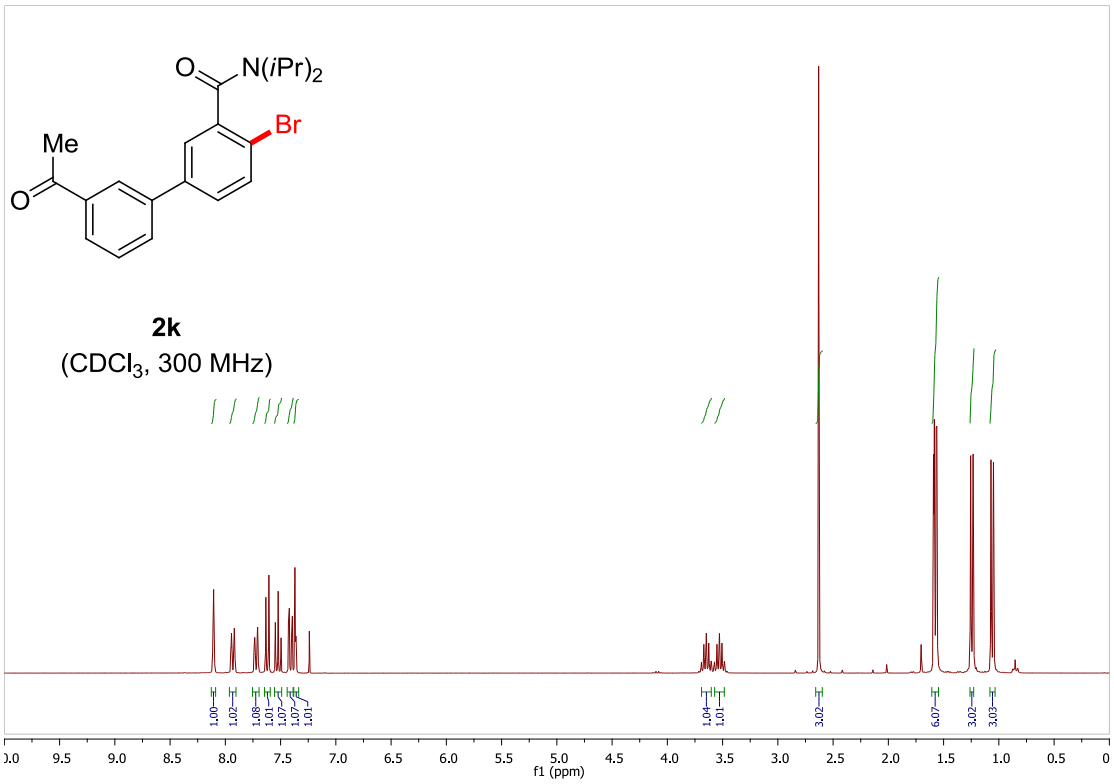


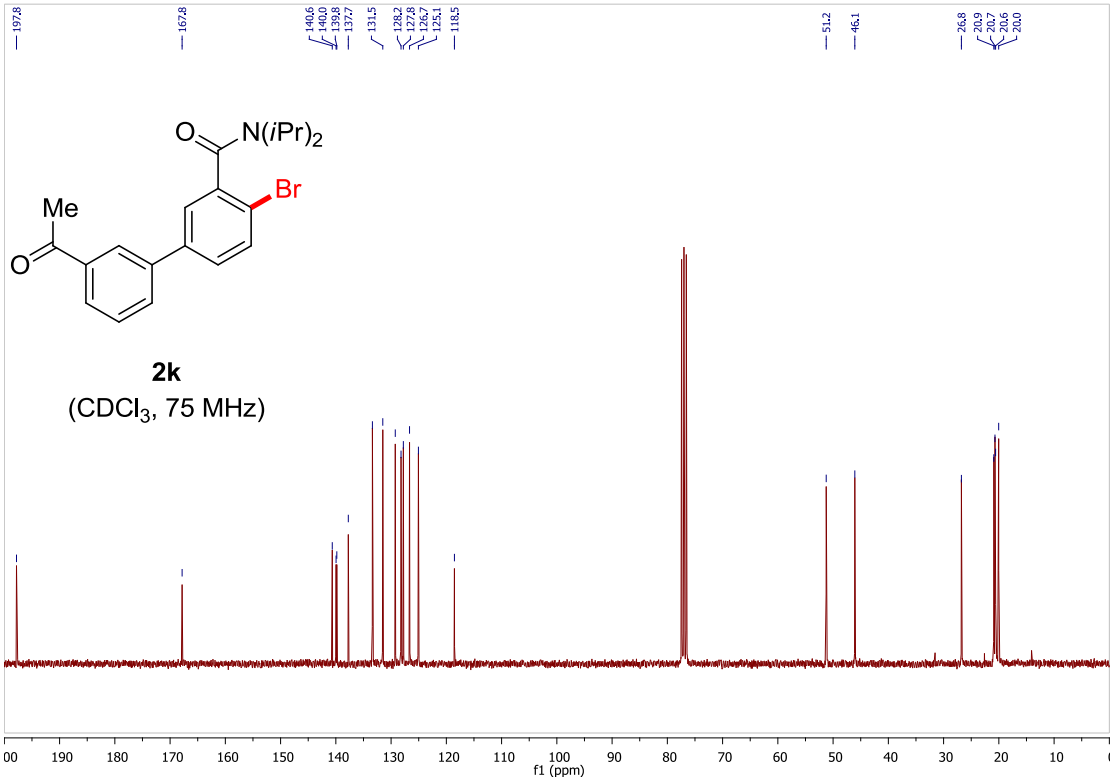

O
N(iPr)2
Br
MeO
O
2j
(CDCl3, 300 MHz)
2.01
3.15
1.10
0.99
3.00
1.09
1.04
6.02
3.06
3.03
f1 (ppm)

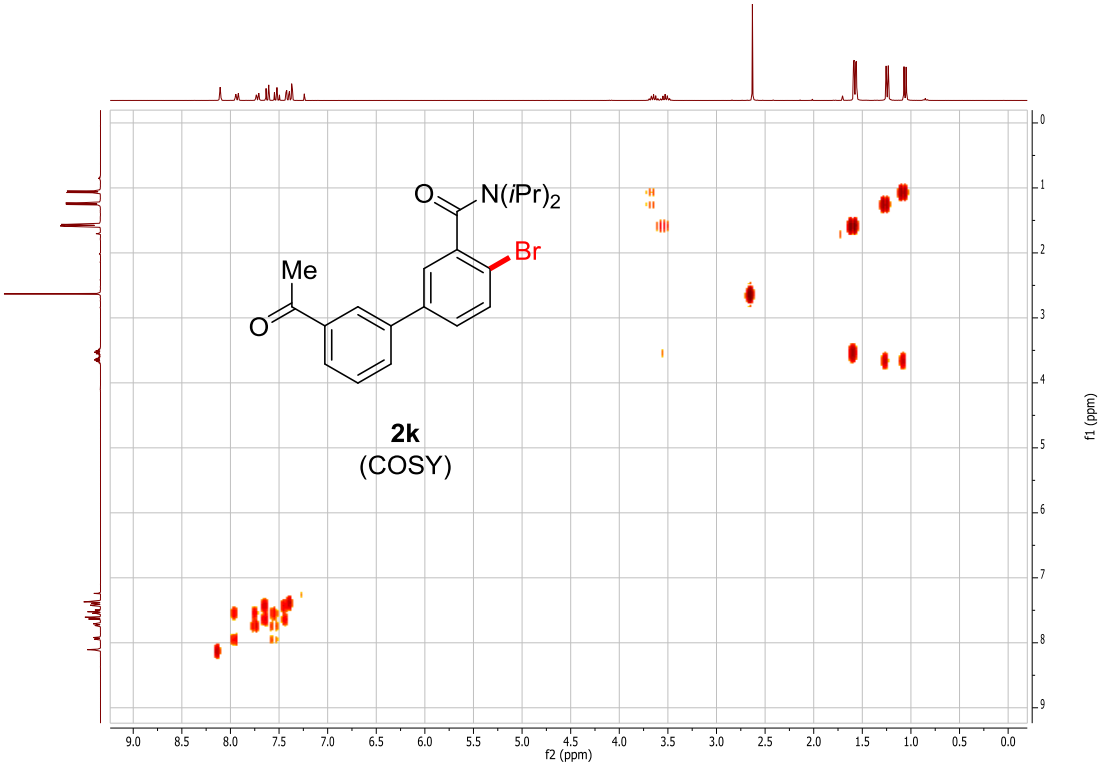

167.8
166.7
143.7
140.7
139.6
133.4
130.2
128.2
126.9
125.1
118.9
52.2
51.2
46.1
20.9
20.7
20.6
20.0
O
N(iPr)2
Br
MeO
O
2j
(CDCl3, 75 MHz)
f1 (ppm)

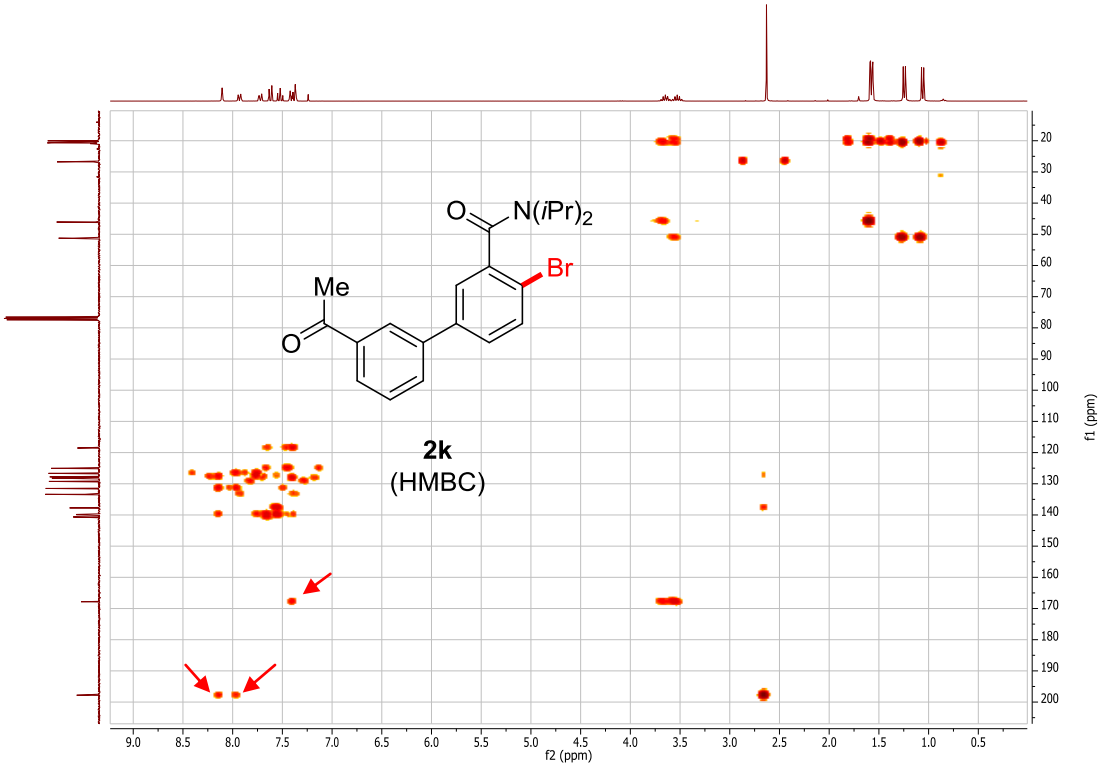


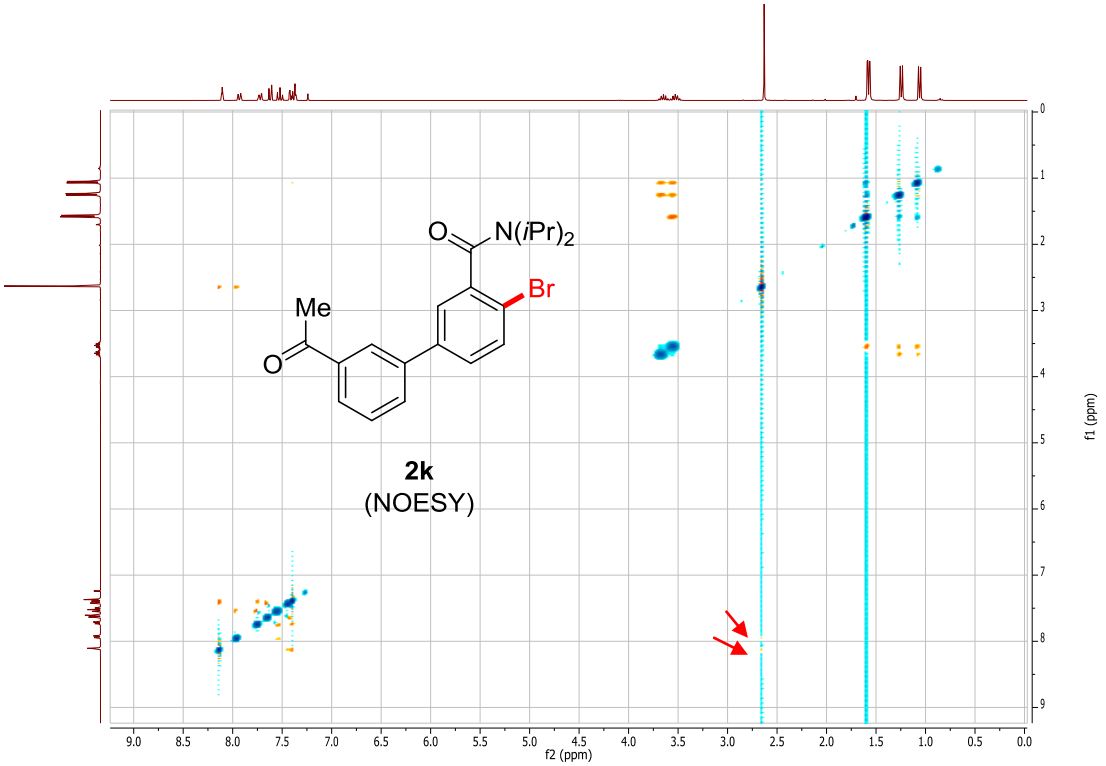


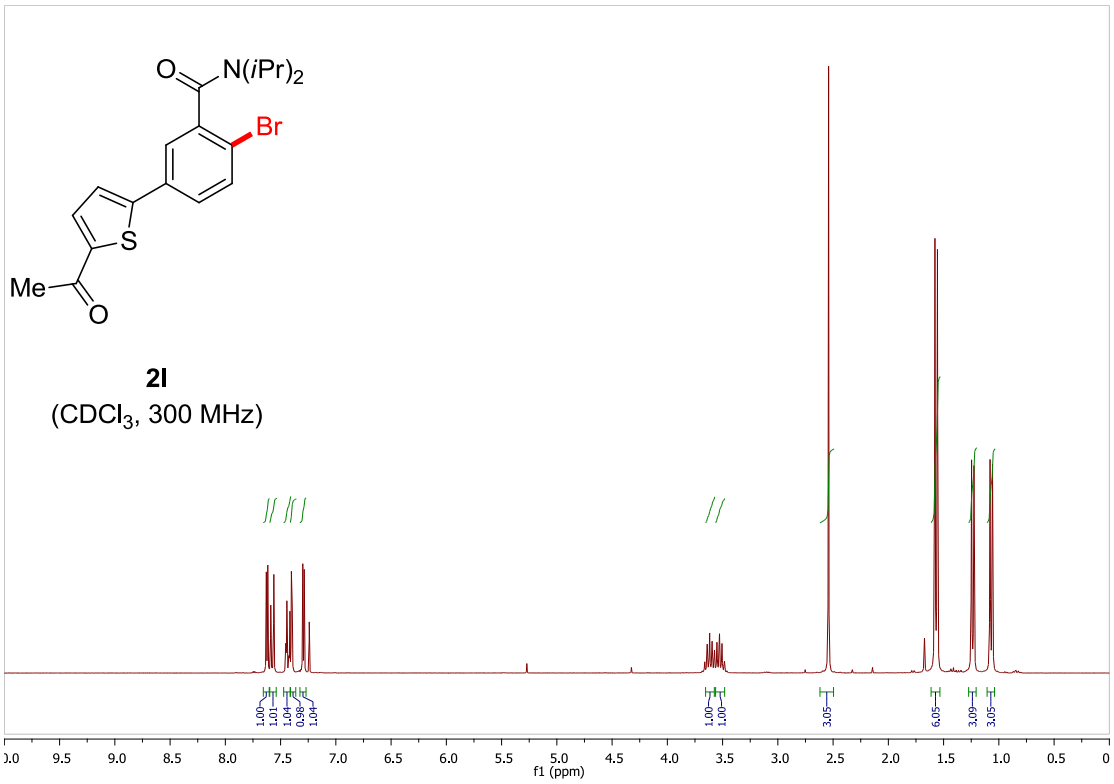

O
N(iPr)2
Br
Me
O
2k
(CDCl3, 300 MHz)
1.00
1.02
1.08
1.01
1.07
1.07
1.01
1.04
1.01
3.02
6.07
3.02
3.03
f1 (ppm)

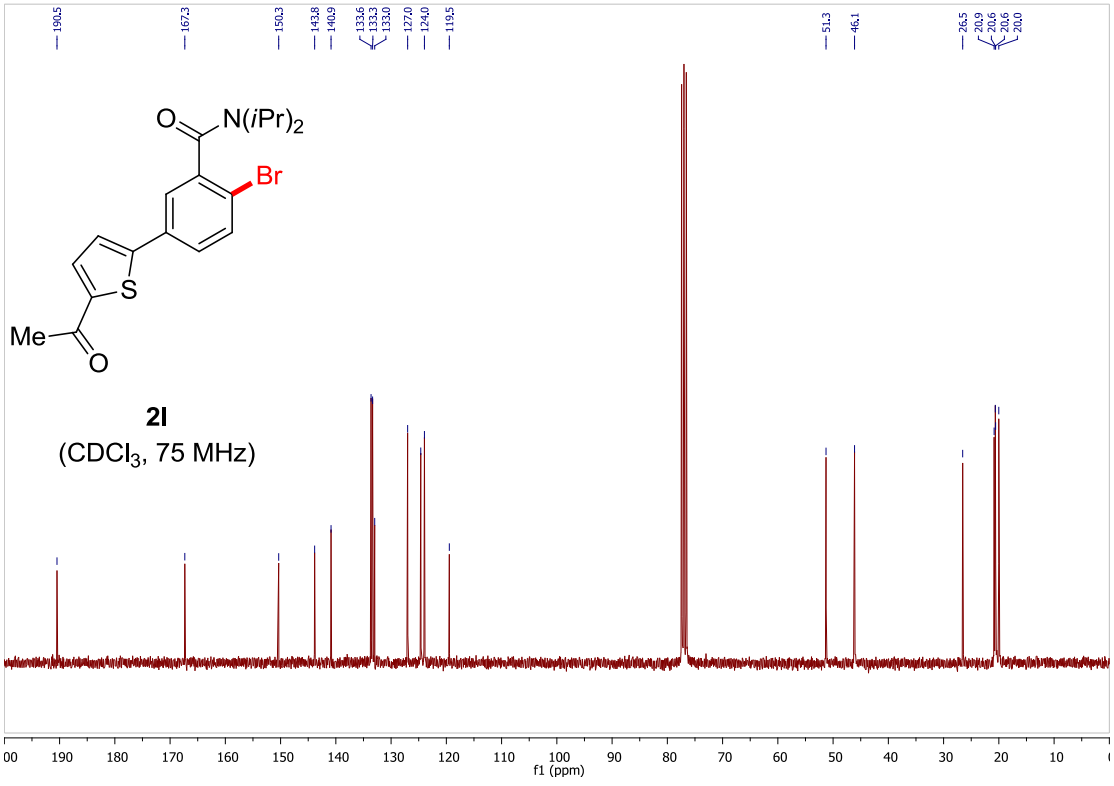

197.8
167.8
140.6
140.0
139.8
137.7
131.5
128.2
127.8
126.7
125.1
118.5
51.2
46.1
26.8
20.9
20.7
20.6
20.0
O
N(iPr)2
Br
Me
O
2k
(CDCl3, 75 MHz)
f1 (ppm)

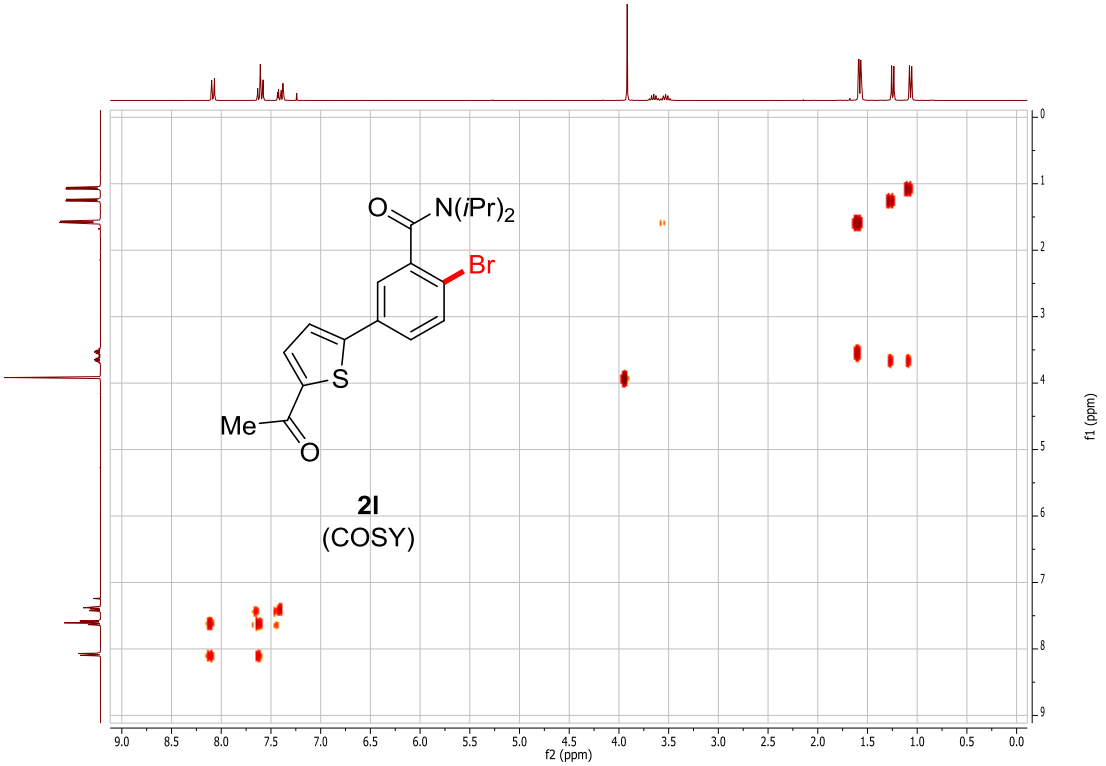


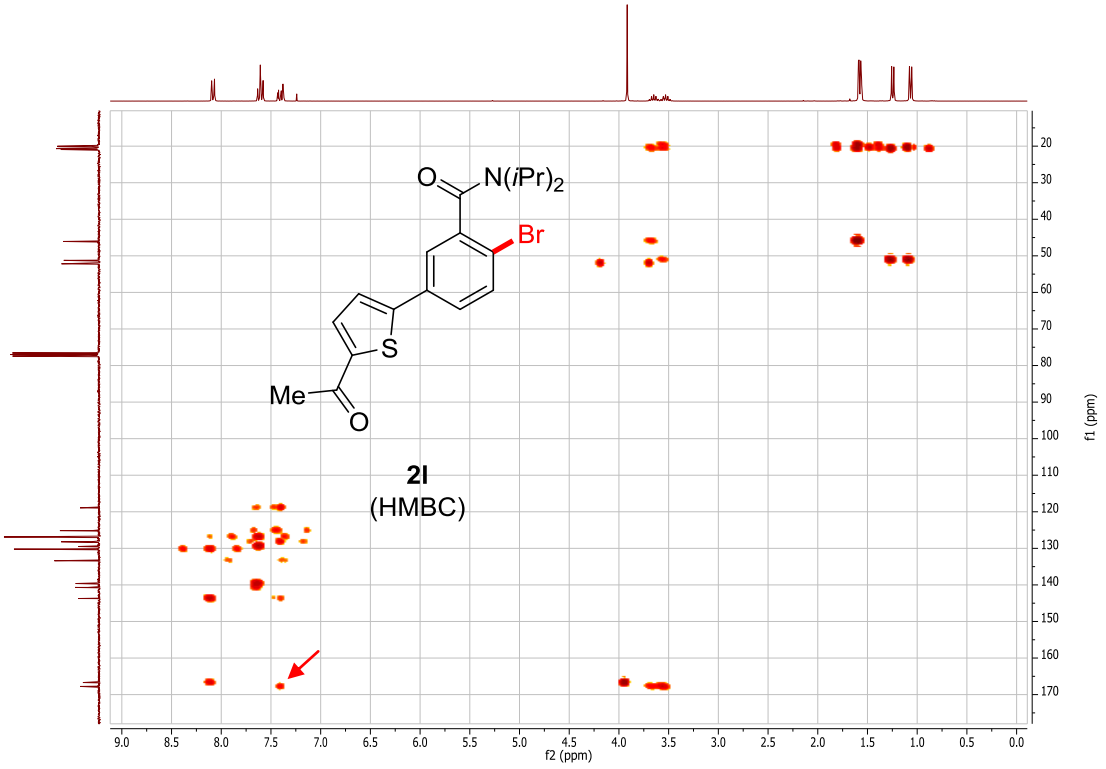


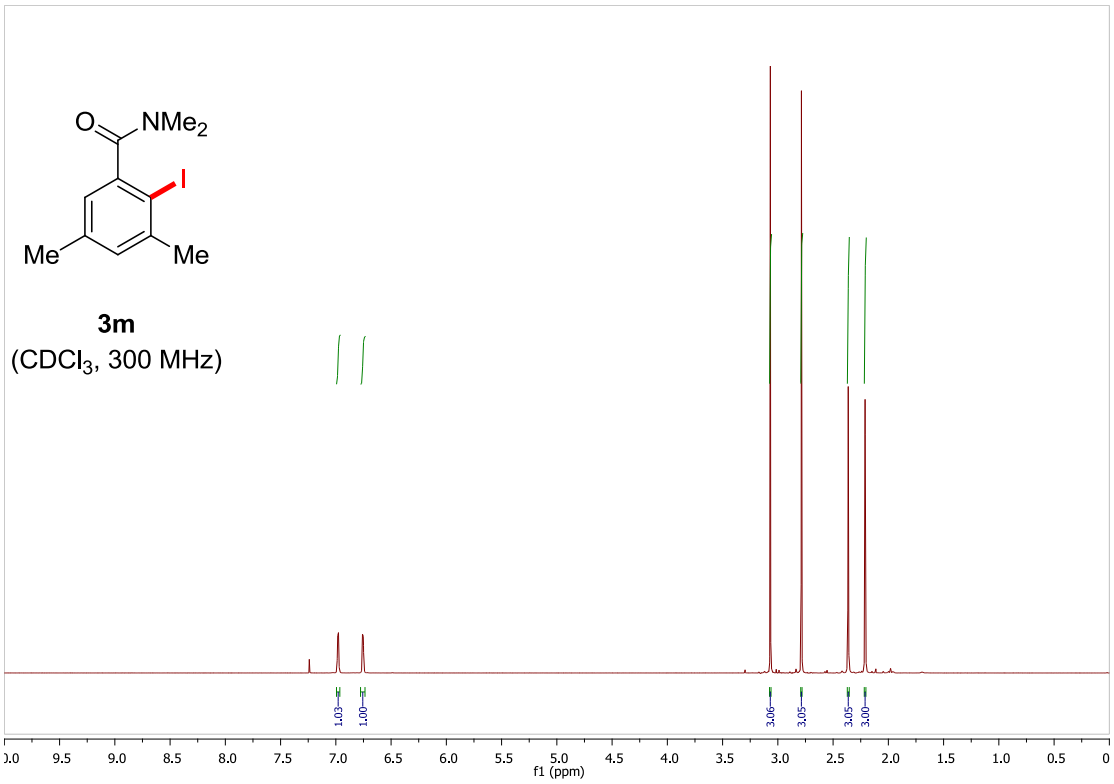


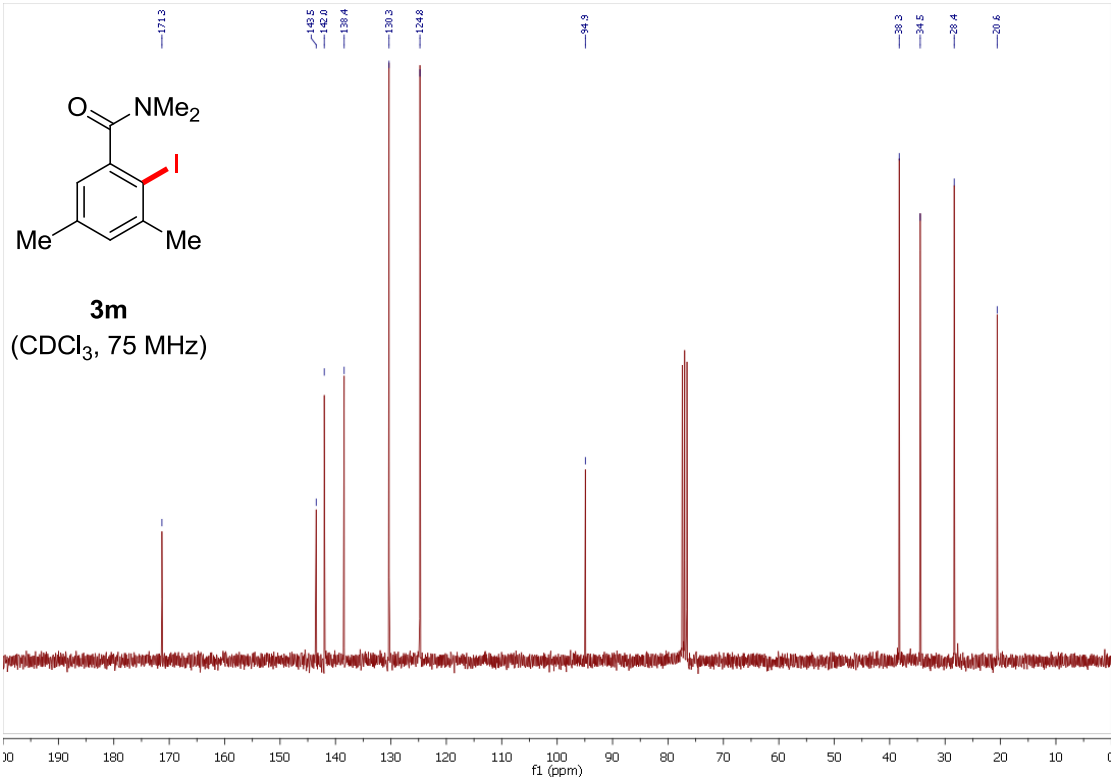

O
N(iPr)2
Br
S
Me
O
2l
(CDCl3, 300 MHz)
1.00
1.01
1.04
0.98
1.04
1.00
1.00
3.05
6.05
3.09
3.05
f1 (ppm)

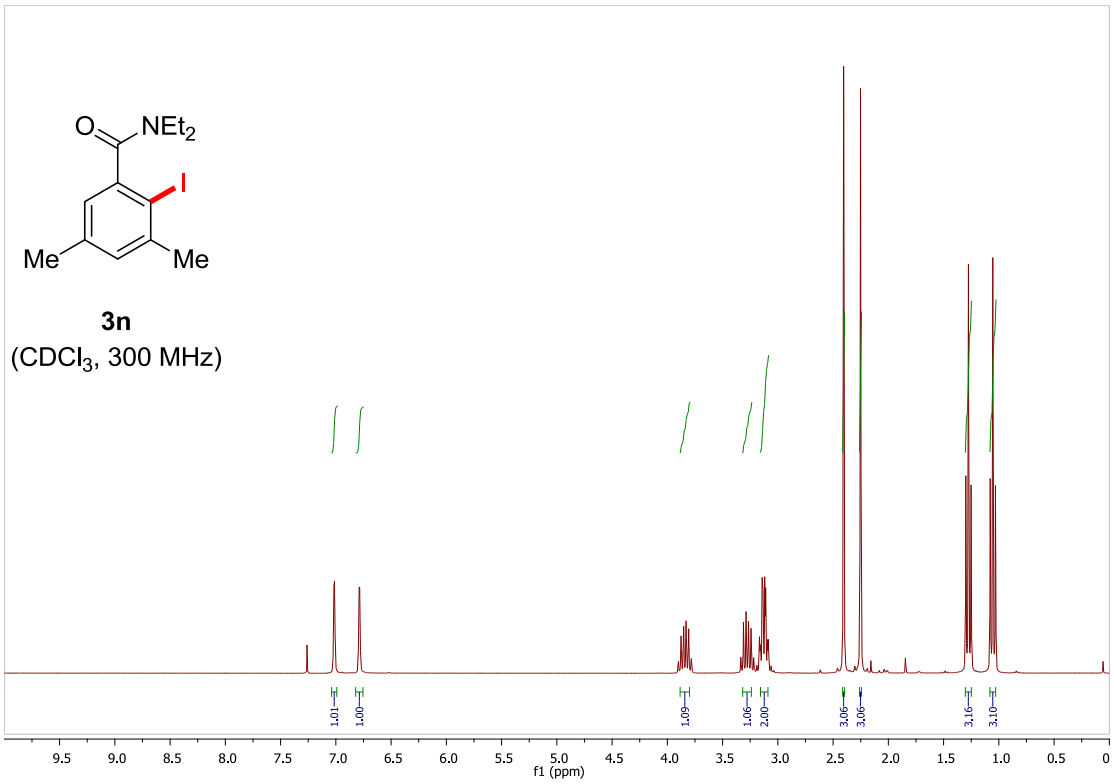

190.5
167.3
150.3
143.8
140.9
133.6
133.3
133.0
127.0
124.0
119.5
51.3
46.1
26.5
20.9
20.6
20.6
20.0
O
N(iPr)2
Br
S
Me
O
2l
(CDCl3, 75 MHz)
f1 (ppm)

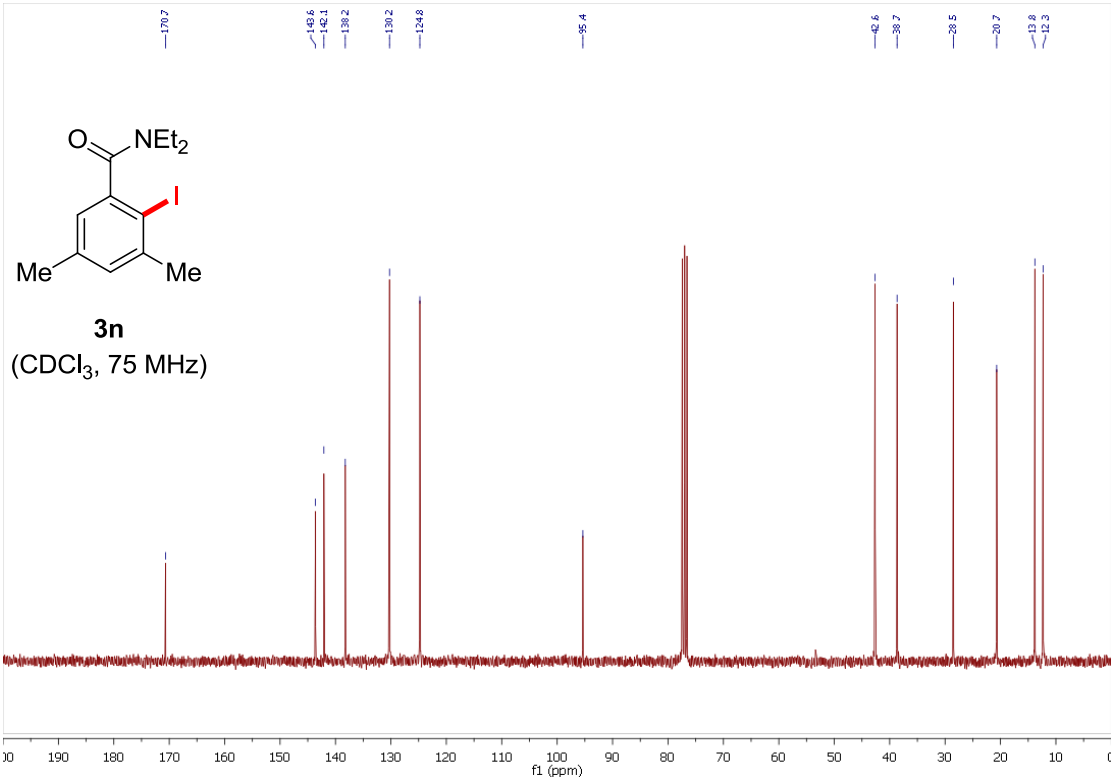


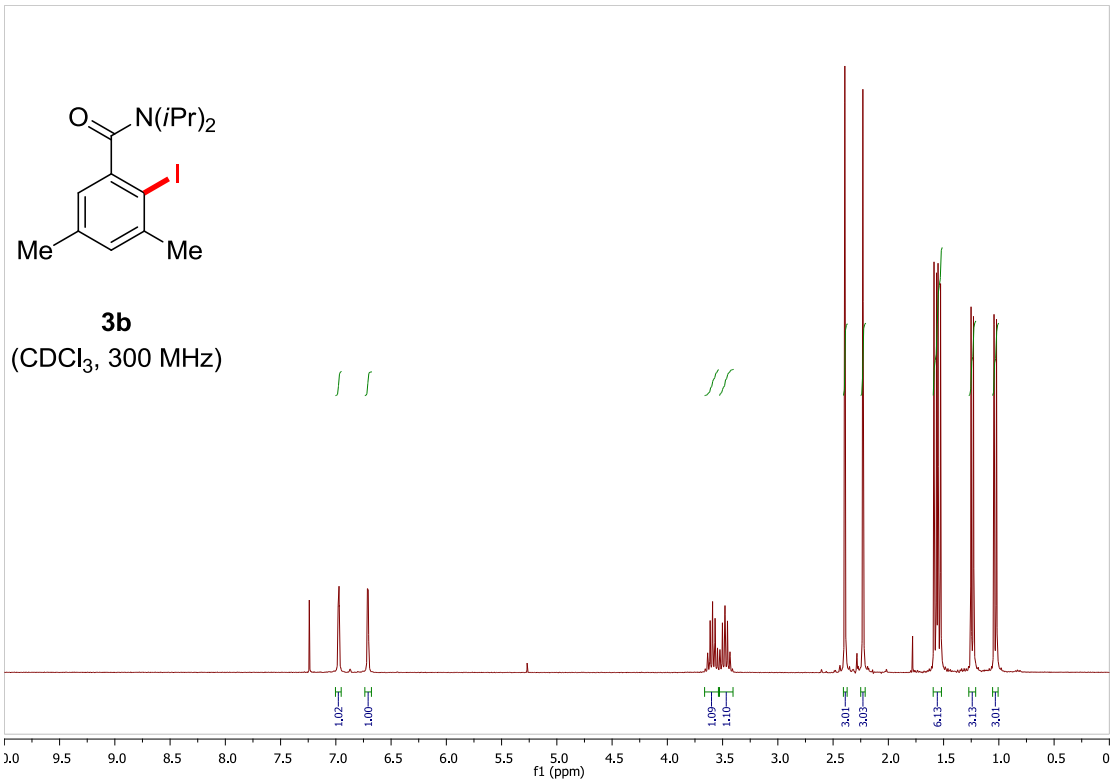


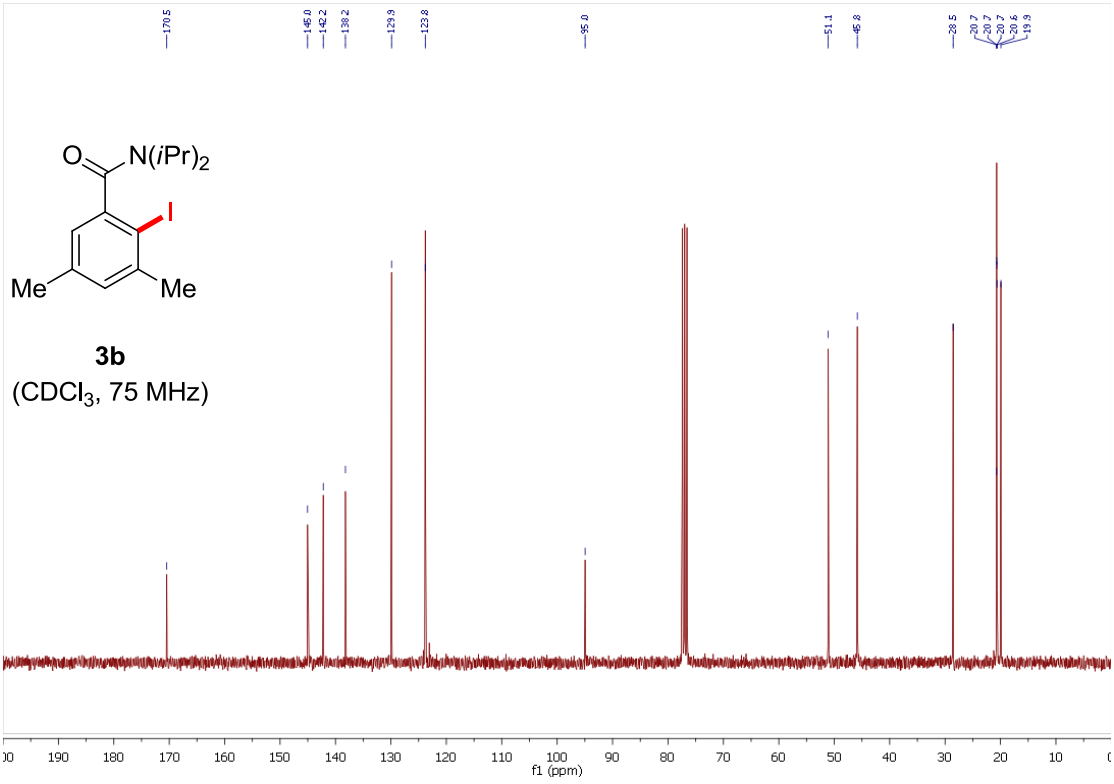

O
NMe2
I
Me
Me
3m
(CDCl3, 300 MHz)
1.03
1.00
3.06
3.05
3.05
3.00
f1 (ppm)

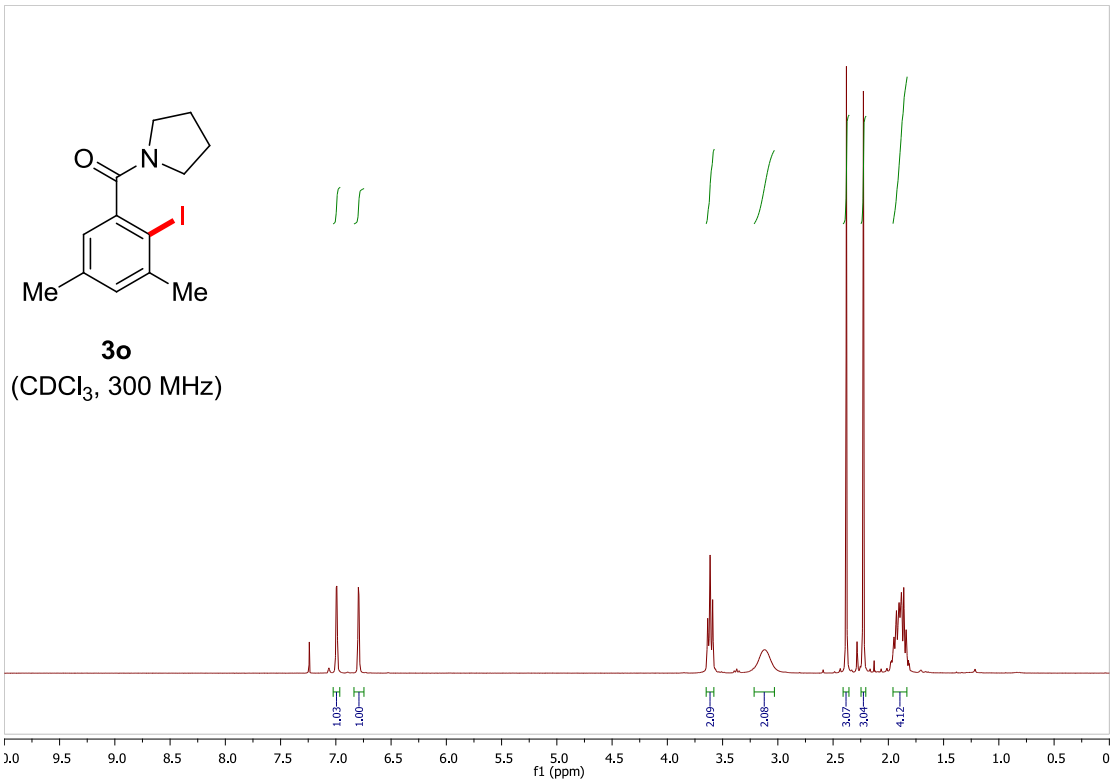

171.3
149.5
142.0
138.4
130.3
124.8
94.9
38.3
34.5
28.4
20.6
O
NMe2
I
Me
Me
3m
(CDCl3, 75 MHz)
f1 (ppm)


O
NEt2
I
Me
Me
3n
(CDCl3, 300 MHz)
1.01
1.00
1.09
1.06
2.00
3.06
3.06
3.16
3.10
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
f1 (ppm)


170.7
149.6
142.1
138.2
130.2
124.8
95.4
42.6
38.7
28.5
20.7
13.8
12.3
O
NEt2
I
Me
Me
3n
(CDCl3, 75 MHz)
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

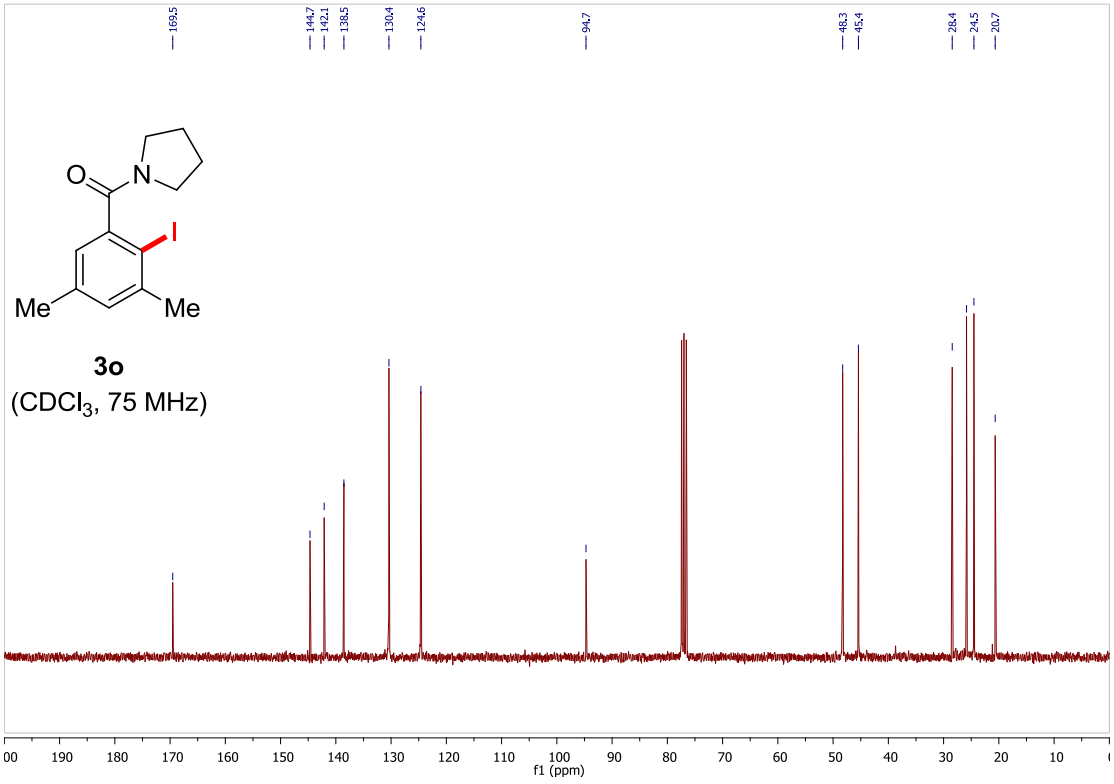

O
N(iPr)2
I
Me
Me
3b
(CDCl3, 300 MHz)
1.02
1.00
1.09
1.10
3.01
3.03
6.13
3.13
3.01
f1 (ppm)


170.5
146.0
142.2
138.2
129.9
123.8
95.0
51.1
45.8
28.5
20.7
20.7
20.7
20.6
19.9
O
N(iPr)2
I
Me
Me
3b
(CDCl3, 75 MHz)
f1 (ppm)



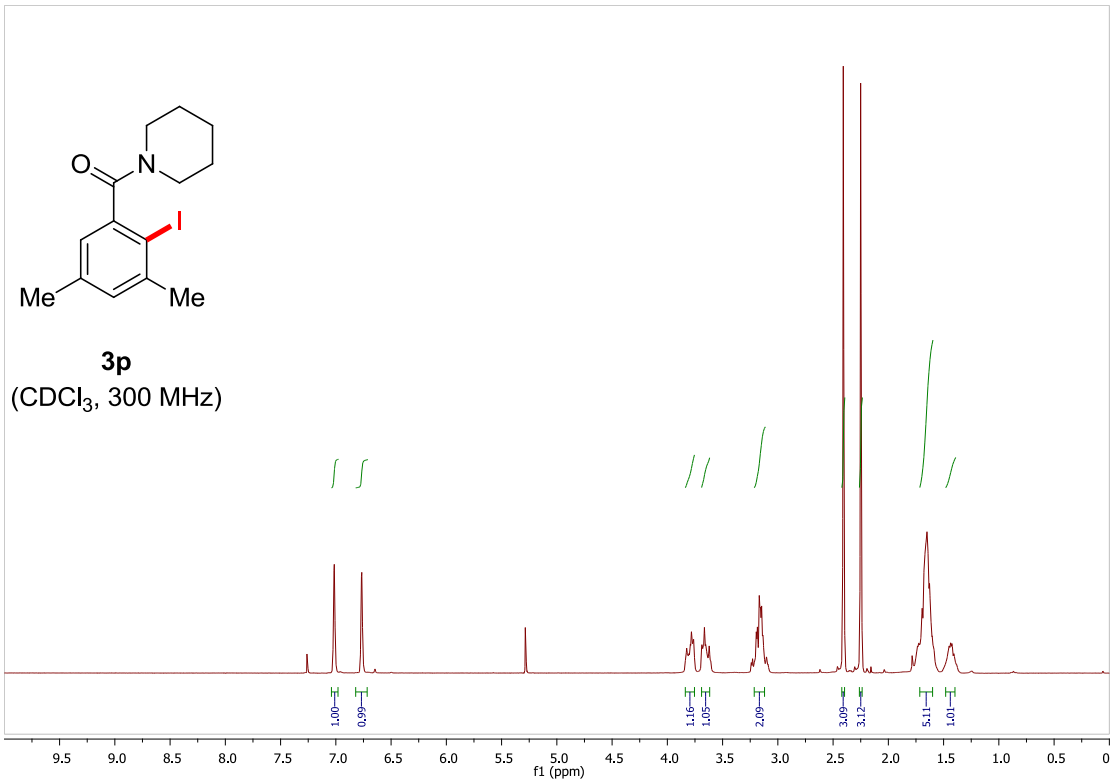
3o

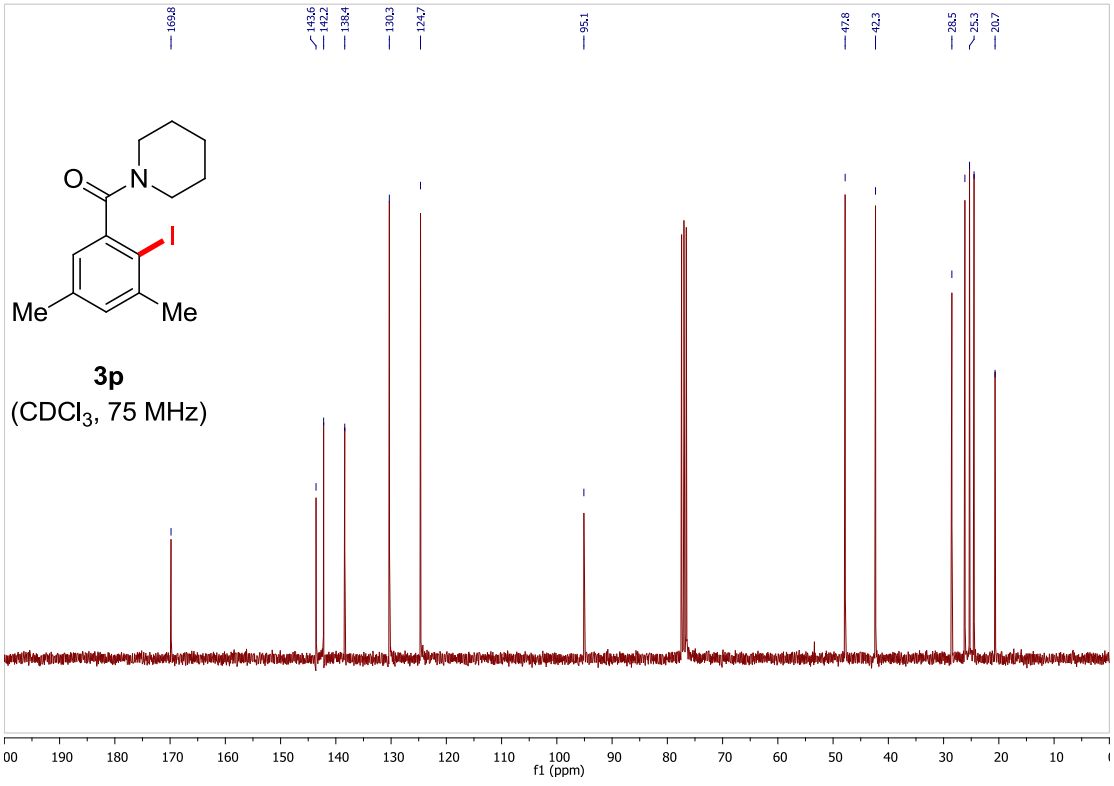
($CDCl_3$, 300 MHz)

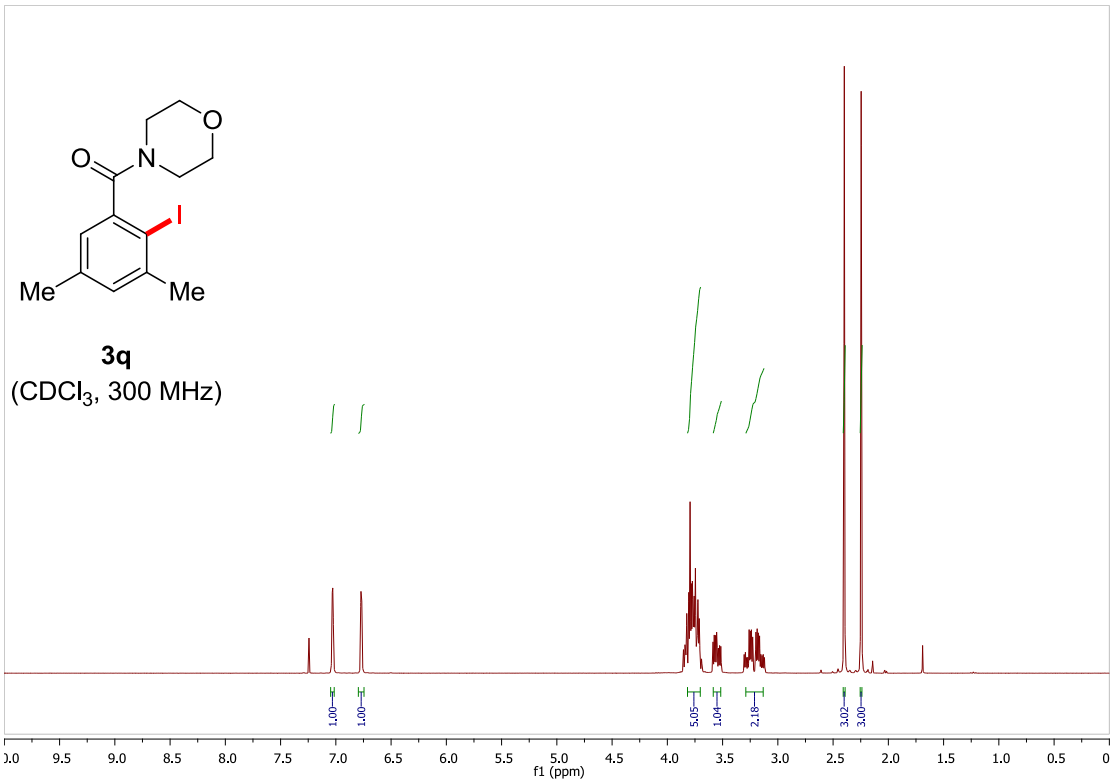


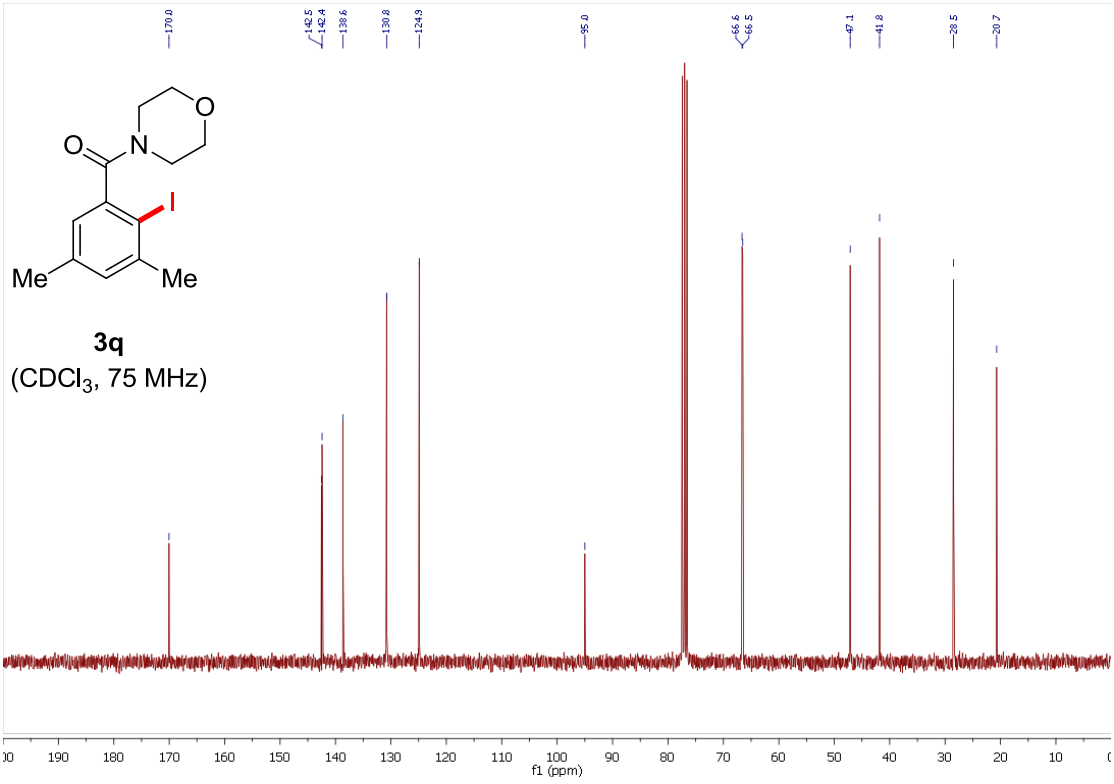
3o

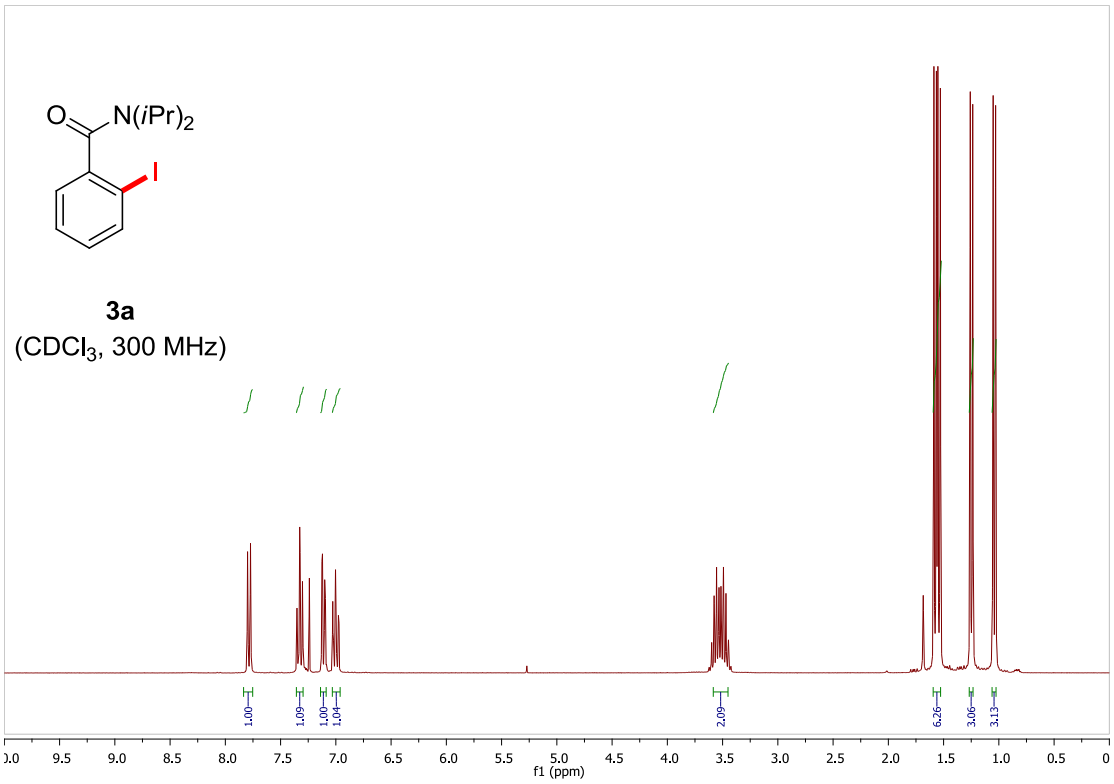
($CDCl_3$, 75 MHz)

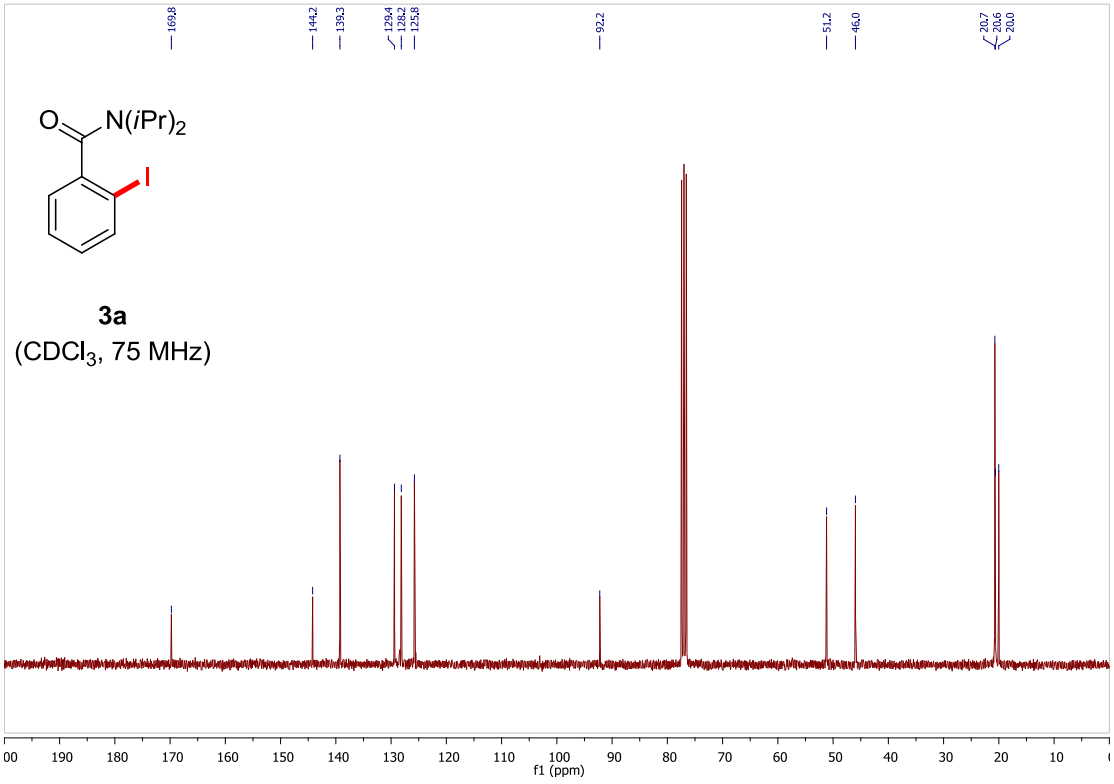

O
N
I
Me
Me
3p
(CDCl3, 300 MHz)
1.00
0.99
1.16
1.05
2.09
3.09
3.12
5.11
1.01
f1 (ppm)

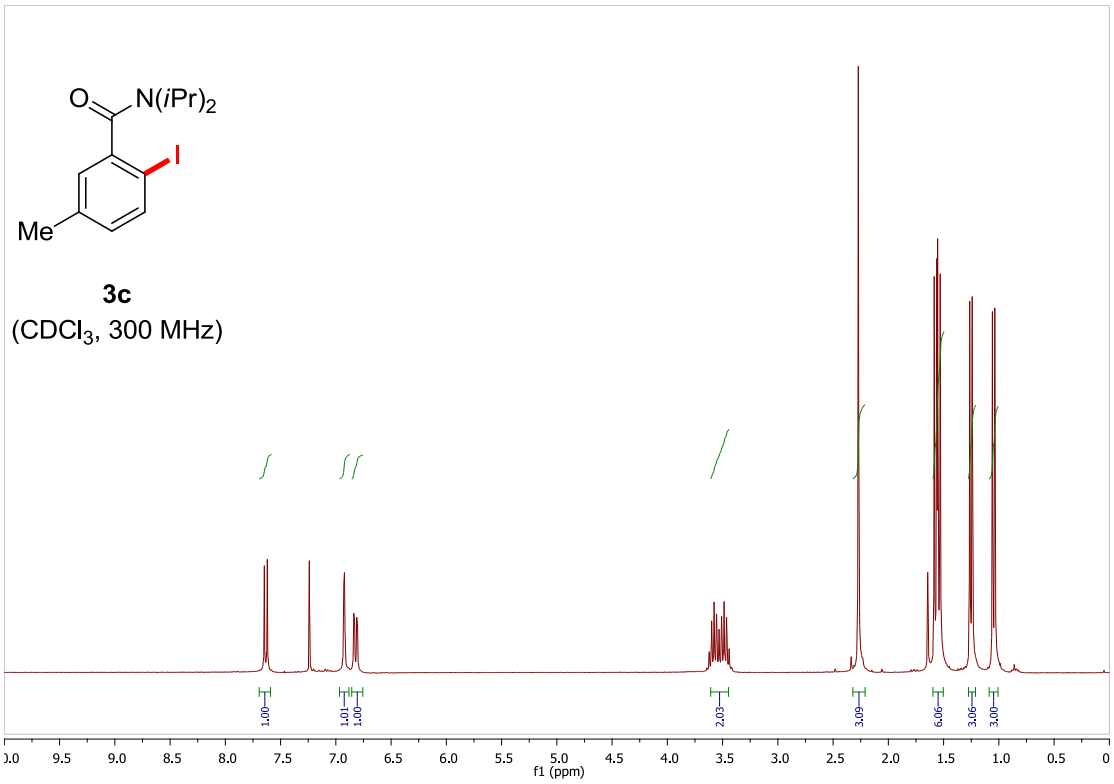

169.8
143.6
142.2
138.4
130.3
124.7
95.1
47.8
42.3
28.5
25.3
20.7
O
N
I
Me
Me
3p
(CDCl3, 75 MHz)
f1 (ppm)

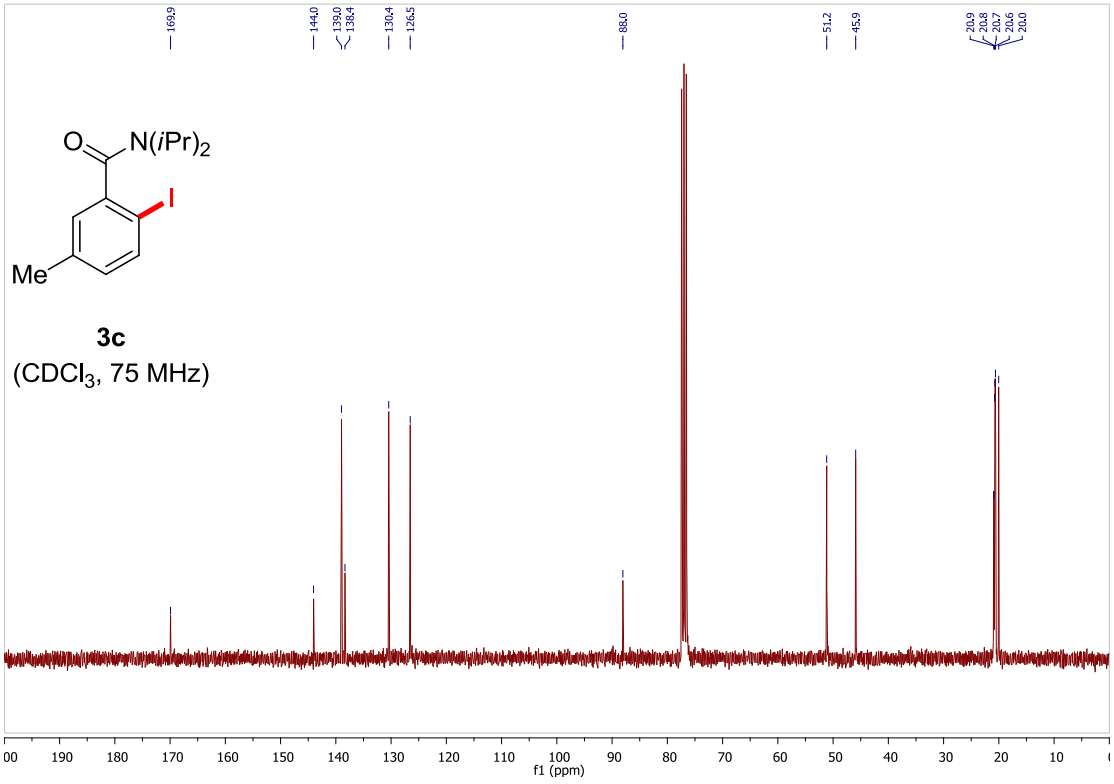

O
O
N
I
Me
Me
3q
(CDCl3, 300 MHz)
1.00
1.00
5.05
1.04
2.18
3.02
3.00
f1 (ppm)

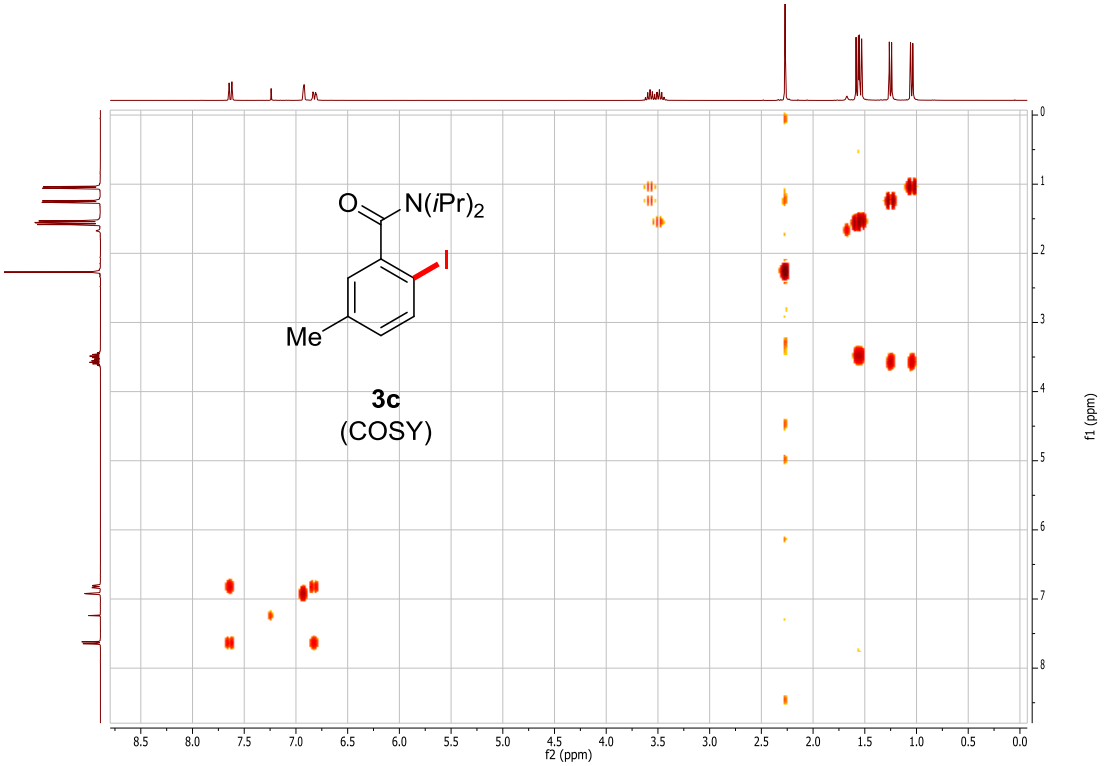

170.0
142.5
142.4
138.6
130.8
124.9
95.0
66.6
66.5
47.1
41.8
28.5
20.7
O
O
N
I
Me
Me
3q
(CDCl3, 75 MHz)
f1 (ppm)

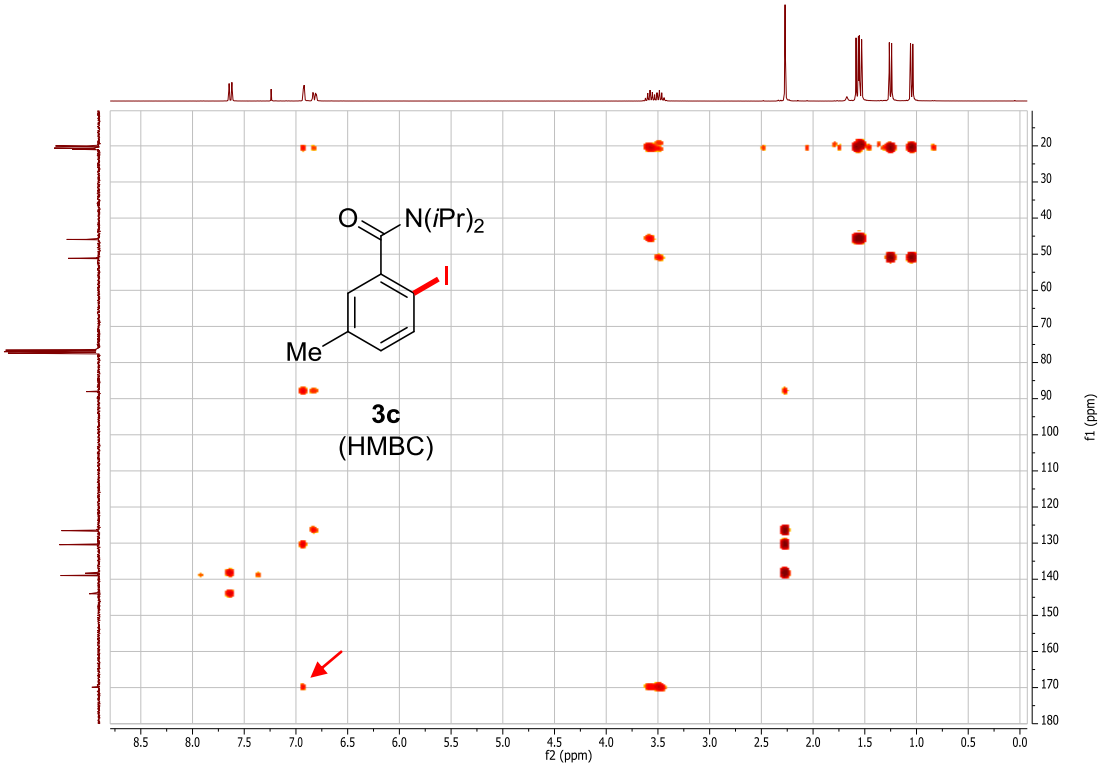

O
N(iPr)2
I
3a
(CDCl3, 300 MHz)
1.00
1.09
1.00
1.04
2.09
6.26
3.06
3.13
f1 (ppm)

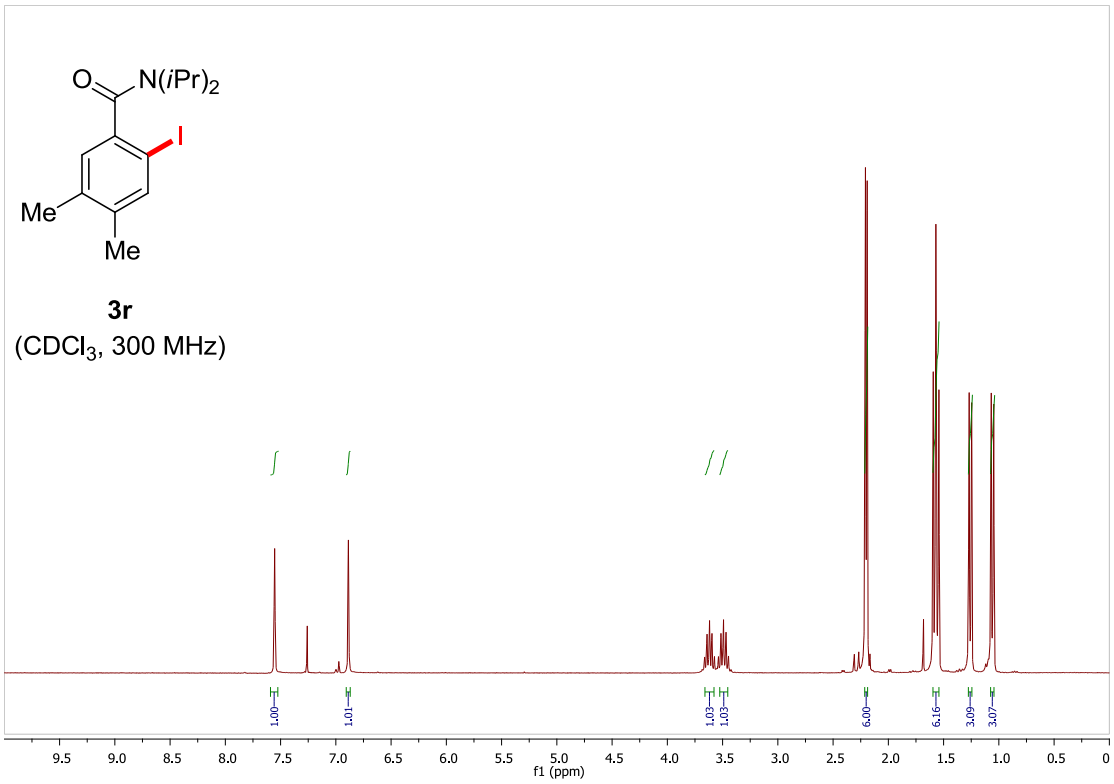

169.8
144.2
139.3
128.4
128.2
125.8
92.2
51.2
46.0
20.7
20.6
20.0
O
N(iPr)2
I
3a
(CDCl3, 75 MHz)
f1 (ppm)

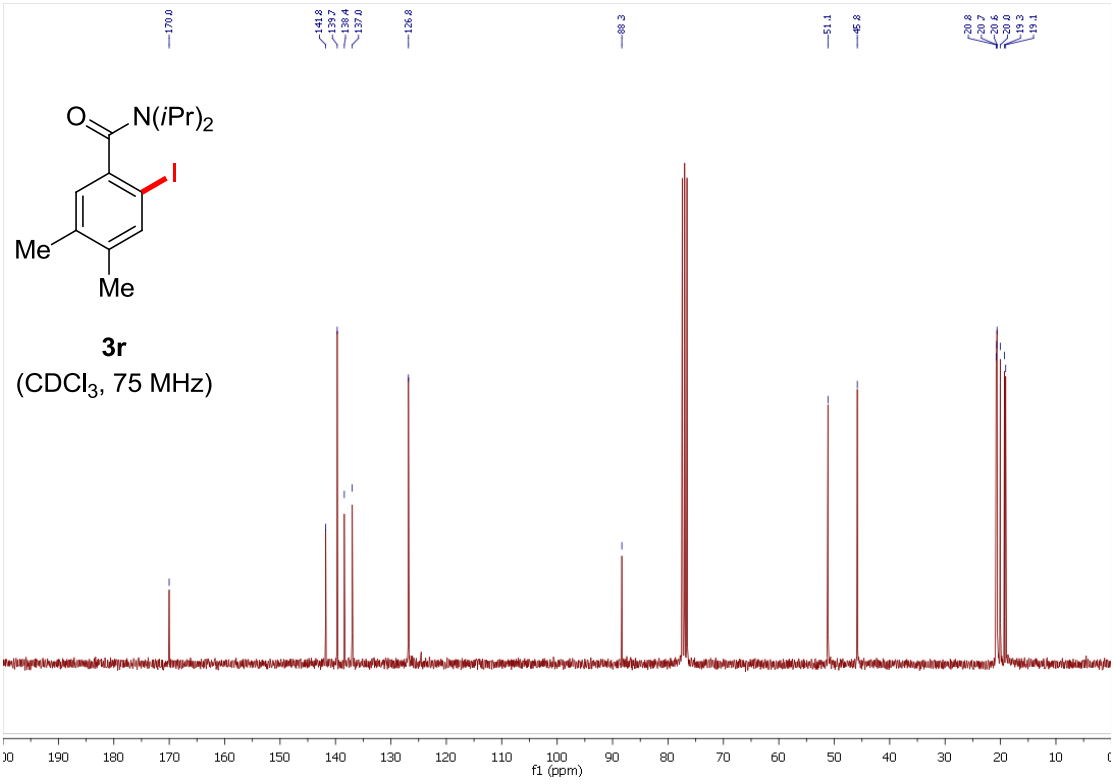

O
N(iPr)2
I
Me
3c
(CDCl3, 300 MHz)
1.00
1.01
1.00
2.03
3.09
6.06
3.06
3.00
f1 (ppm)

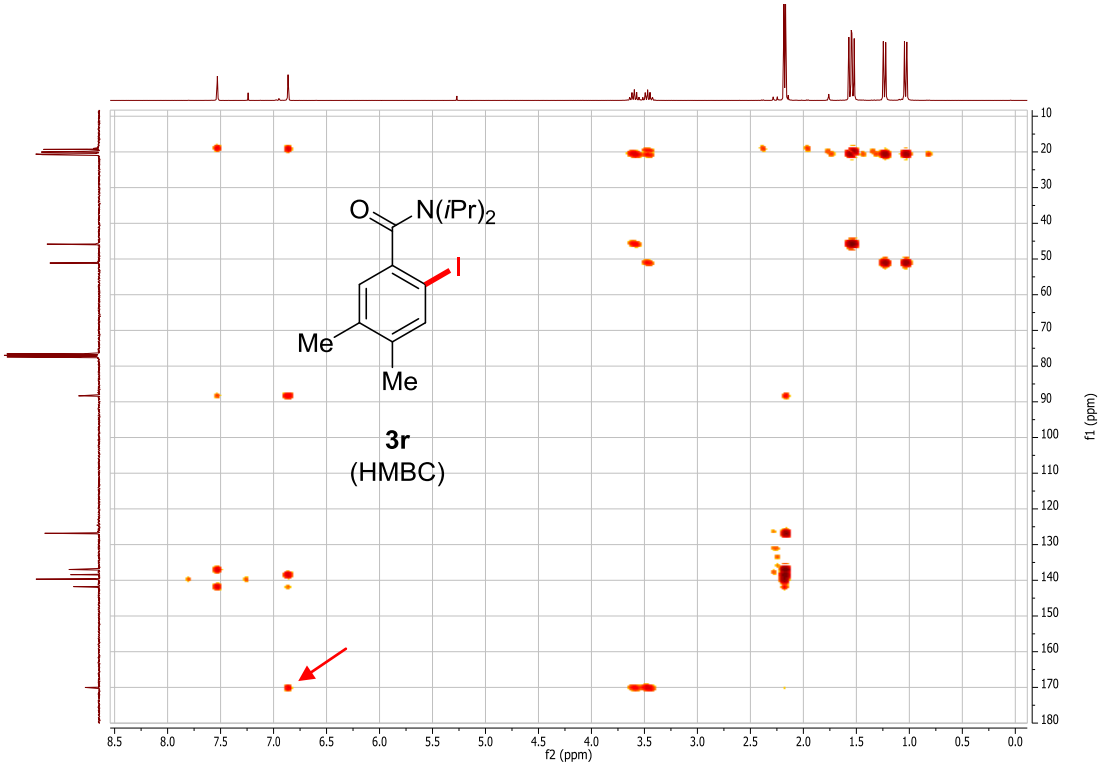

169.9
144.0
139.0
138.4
130.4
126.5
88.0
51.2
45.9
20.9
20.8
20.7
20.6
20.0
O
N(iPr)2
I
Me
3c
(CDCl3, 75 MHz)
f1 (ppm)

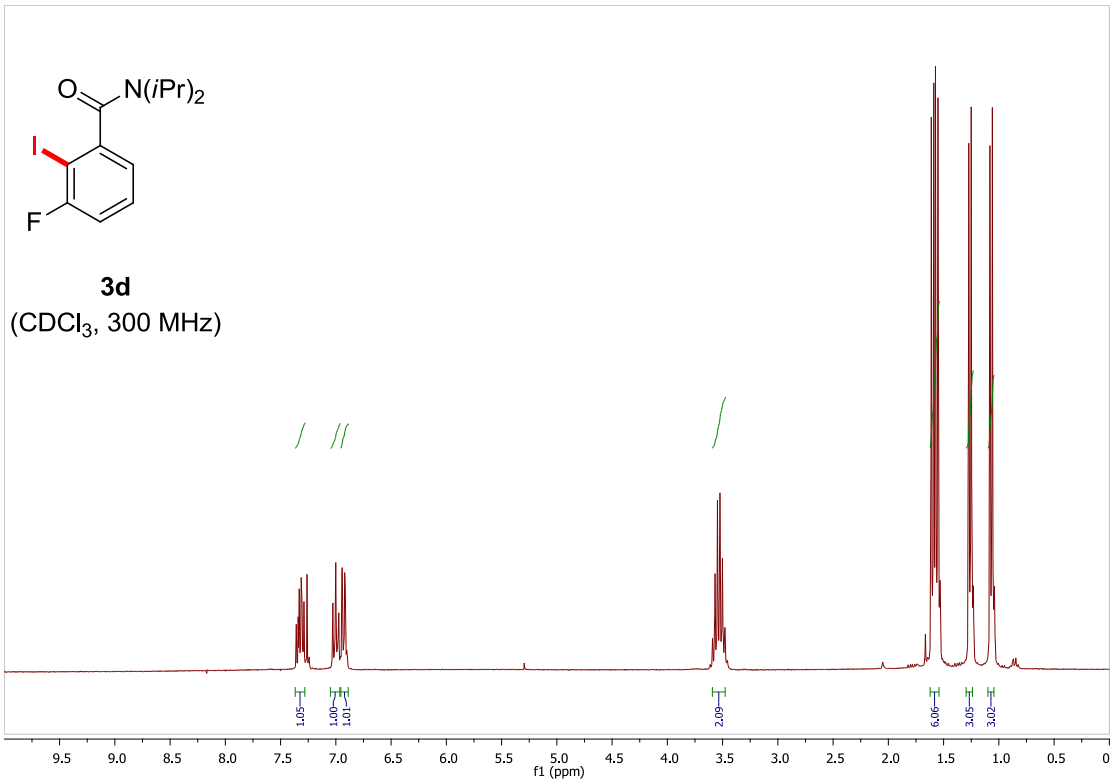


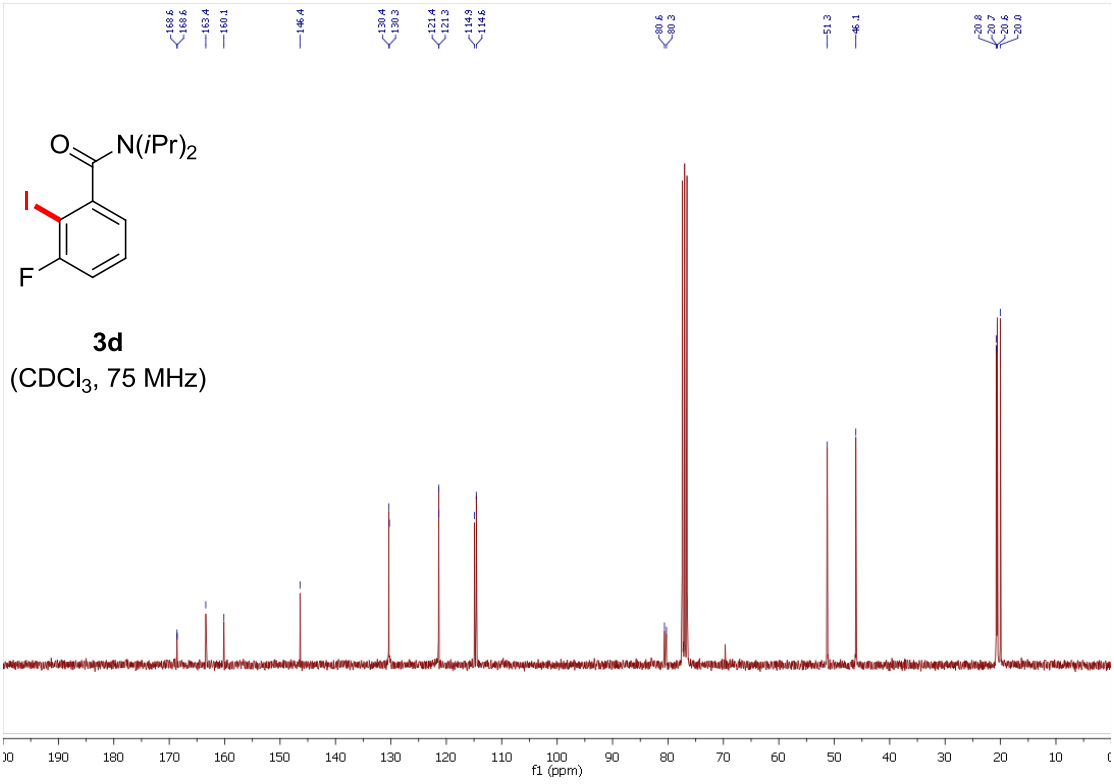


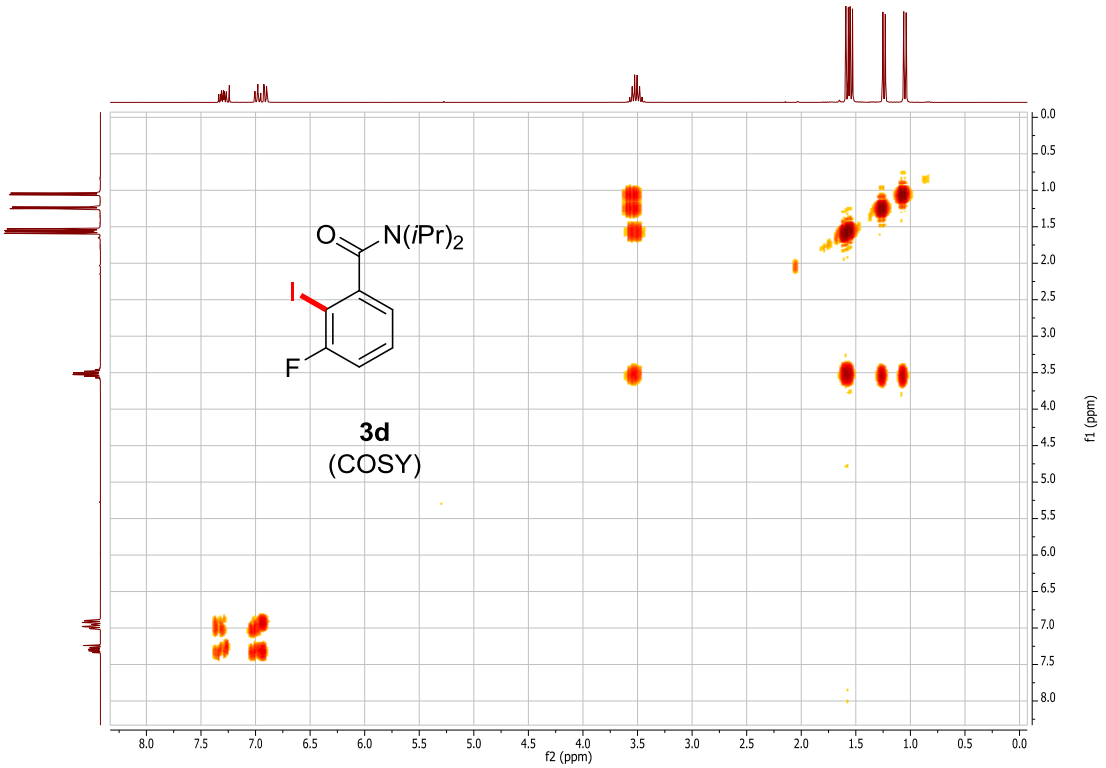

O
N(iPr)2
I
Me
Me
3r
(CDCl3, 300 MHz)
1.00
1.01
1.03
1.03
6.00
6.16
3.09
3.07
f1 (ppm)

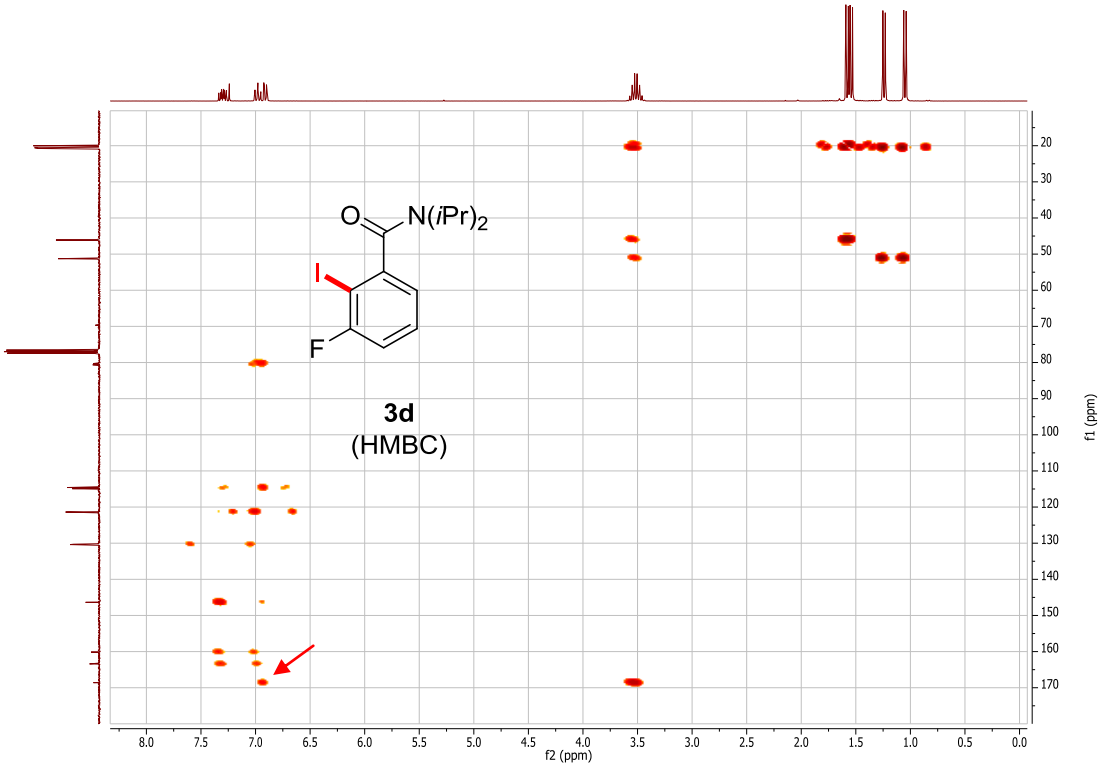

170.0
141.8
139.7
138.4
137.0
126.8
88.3
51.1
45.8
20.8
20.7
20.6
20.0
19.3
19.1
O
N(iPr)2
I
Me
Me
3r
(CDCl3, 75 MHz)
f1 (ppm)

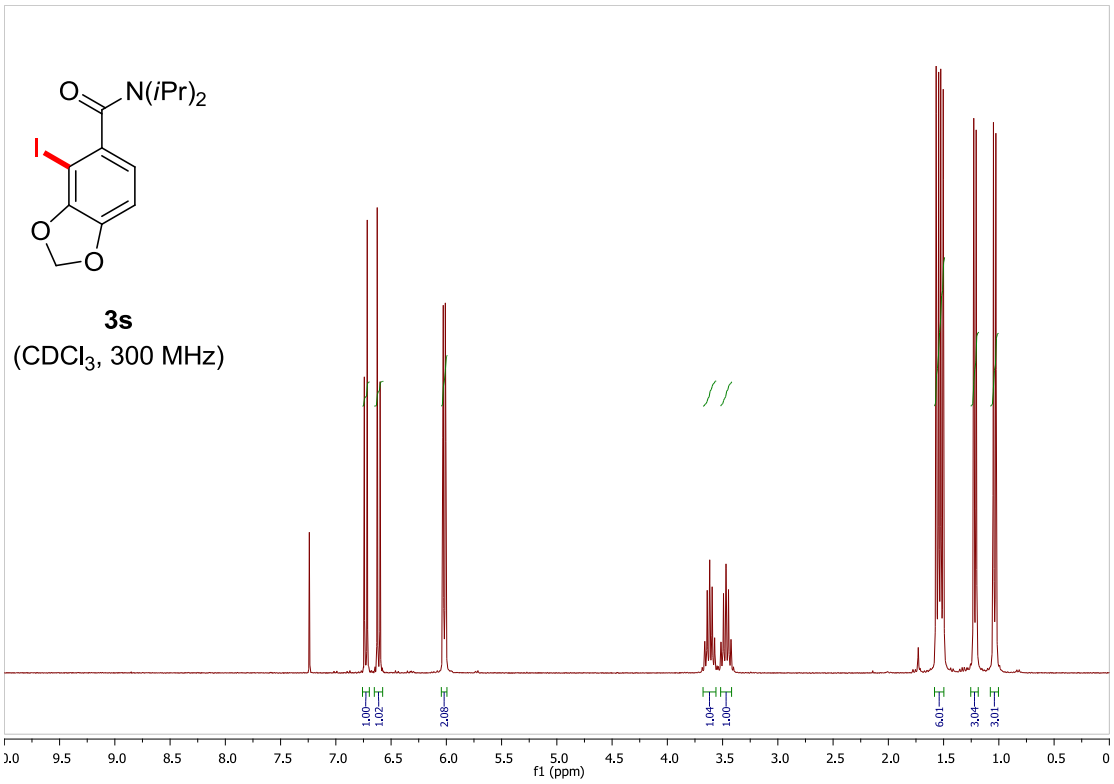


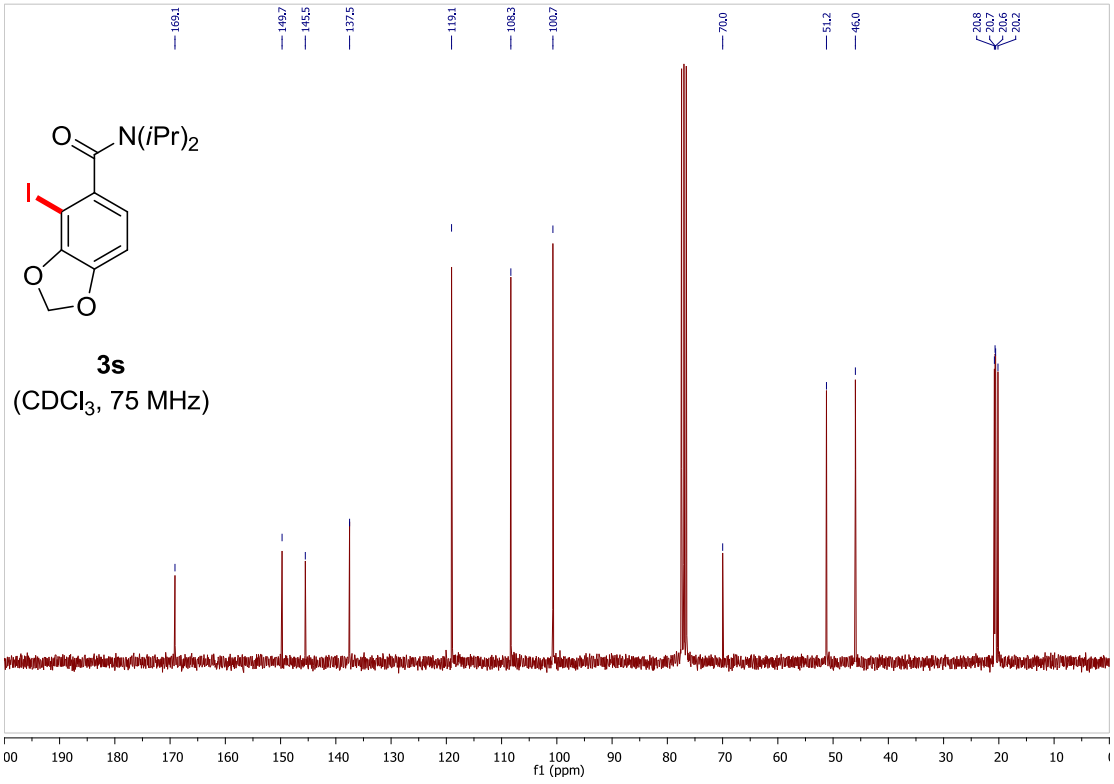

O
N(iPr)2
I
F
3d
(CDCl3, 300 MHz)
f1 (ppm)

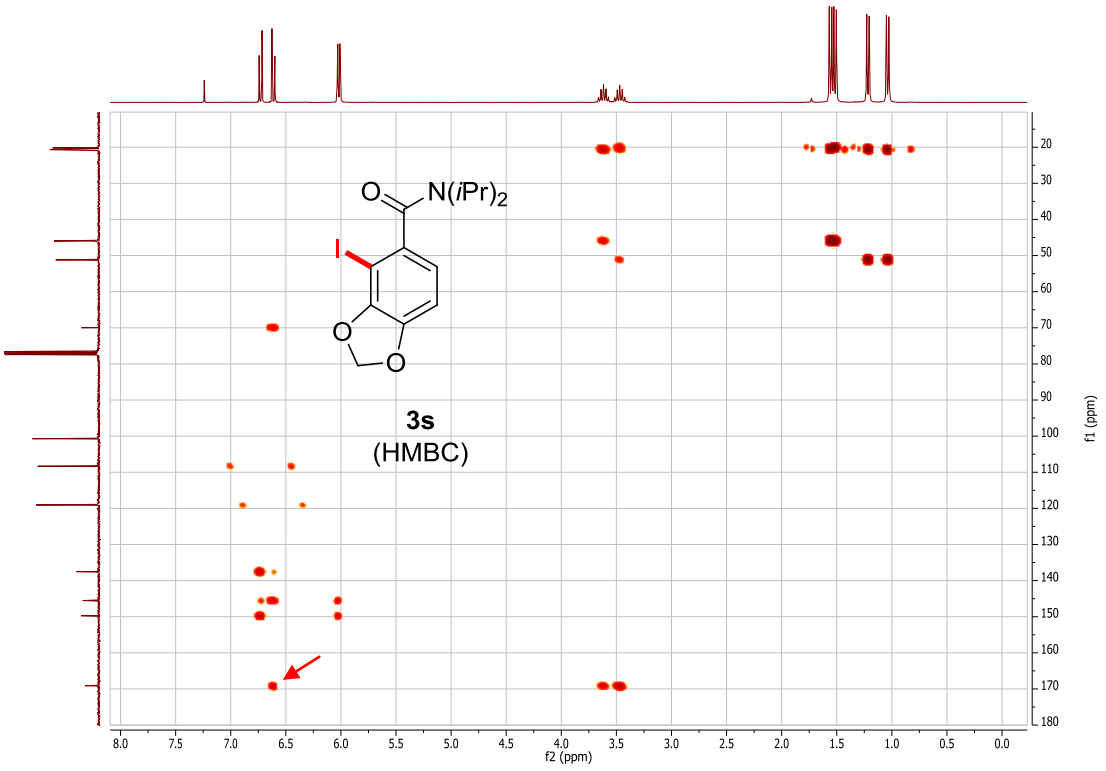

O
N(iPr)2
I
F
3d
(CDCl3, 75 MHz)
f1 (ppm)

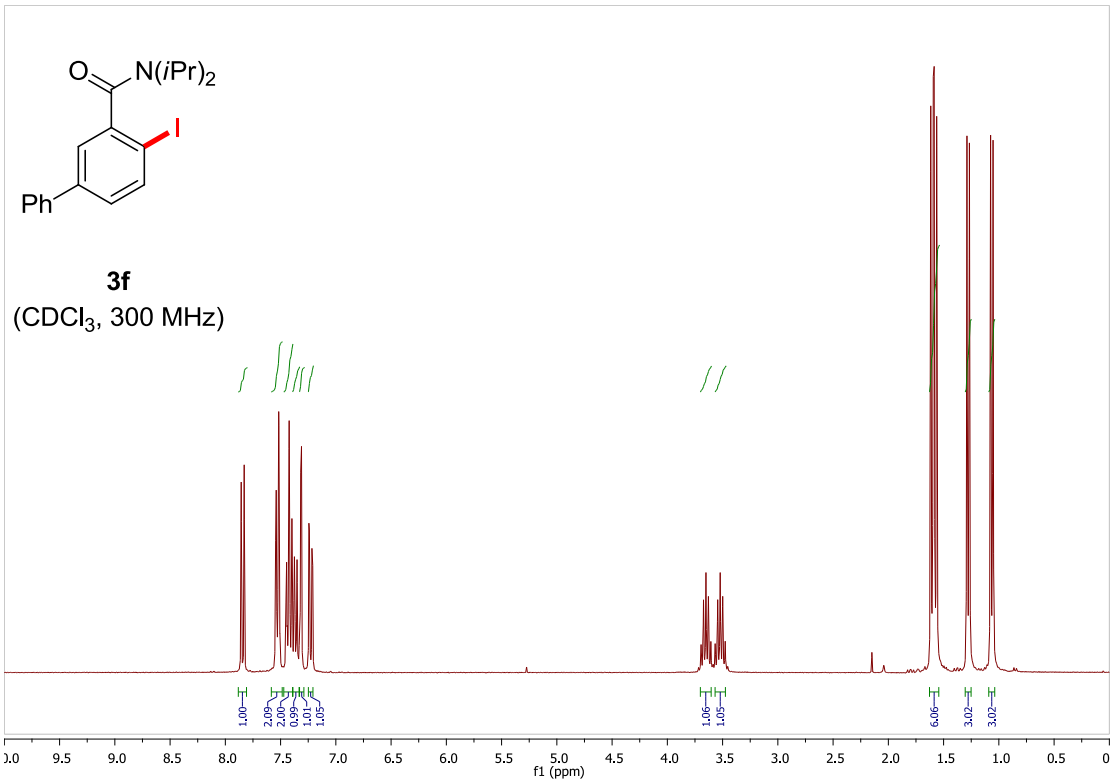

O
N(iPr)2
I
F
3d
(COSY)
f2 (ppm)
f1 (ppm)

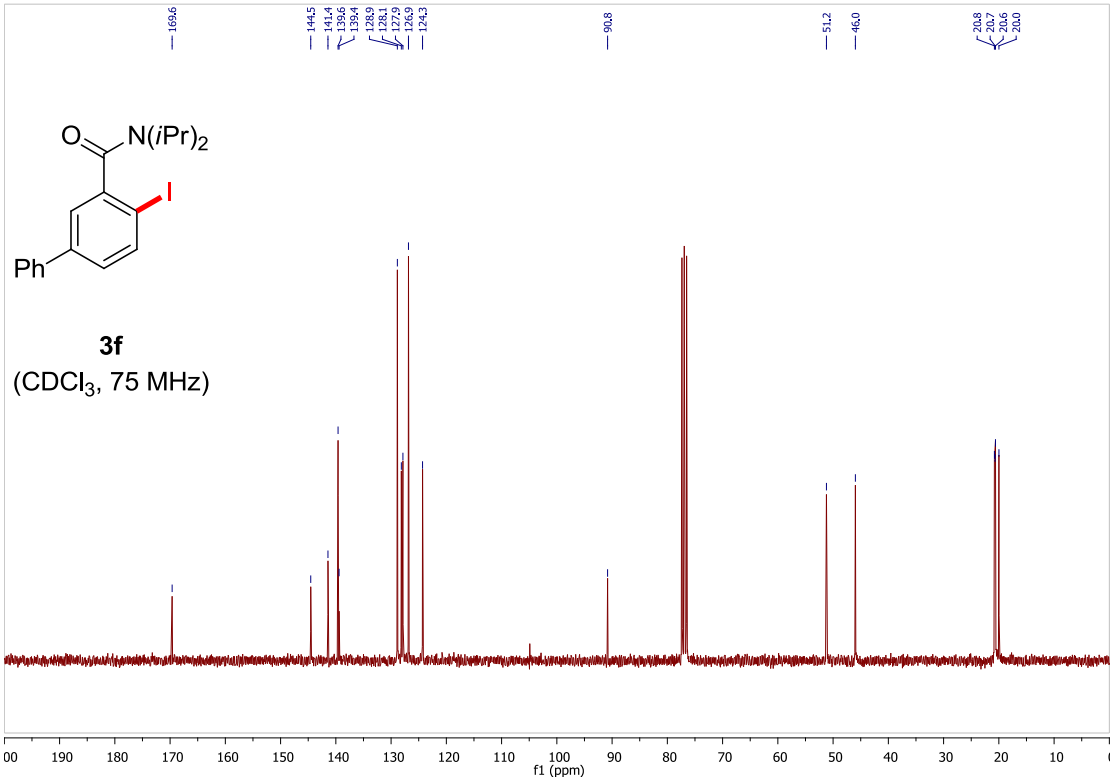

O
N(iPr)2
I
F
3d
(HMBC)
f2 (ppm)
f1 (ppm)

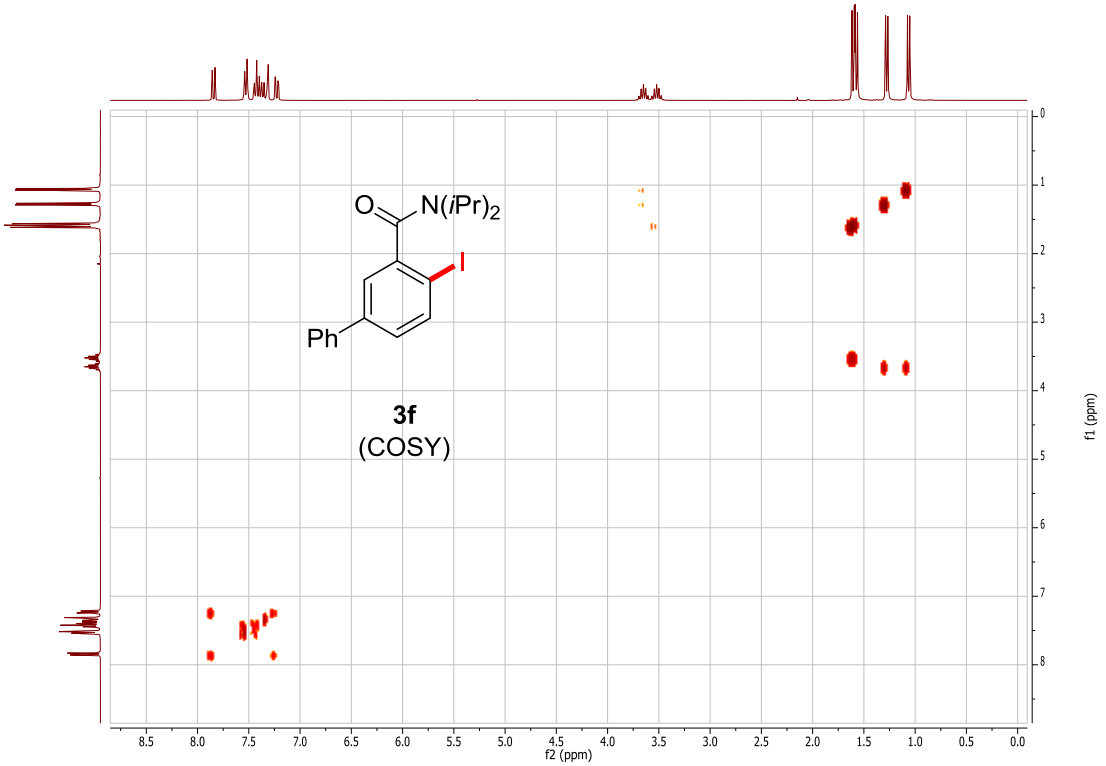

O
N(iPr)2
I
O
O
3s
(CDCl3, 300 MHz)
1.00
1.02
2.08
1.04
1.00
6.01
3.04
3.01
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


169.1
149.7
145.5
137.5
119.1
108.3
100.7
70.0
51.2
46.0
20.8
20.7
20.6
20.2
O
N(iPr)2
I
O
O
3s
(CDCl3, 75 MHz)
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

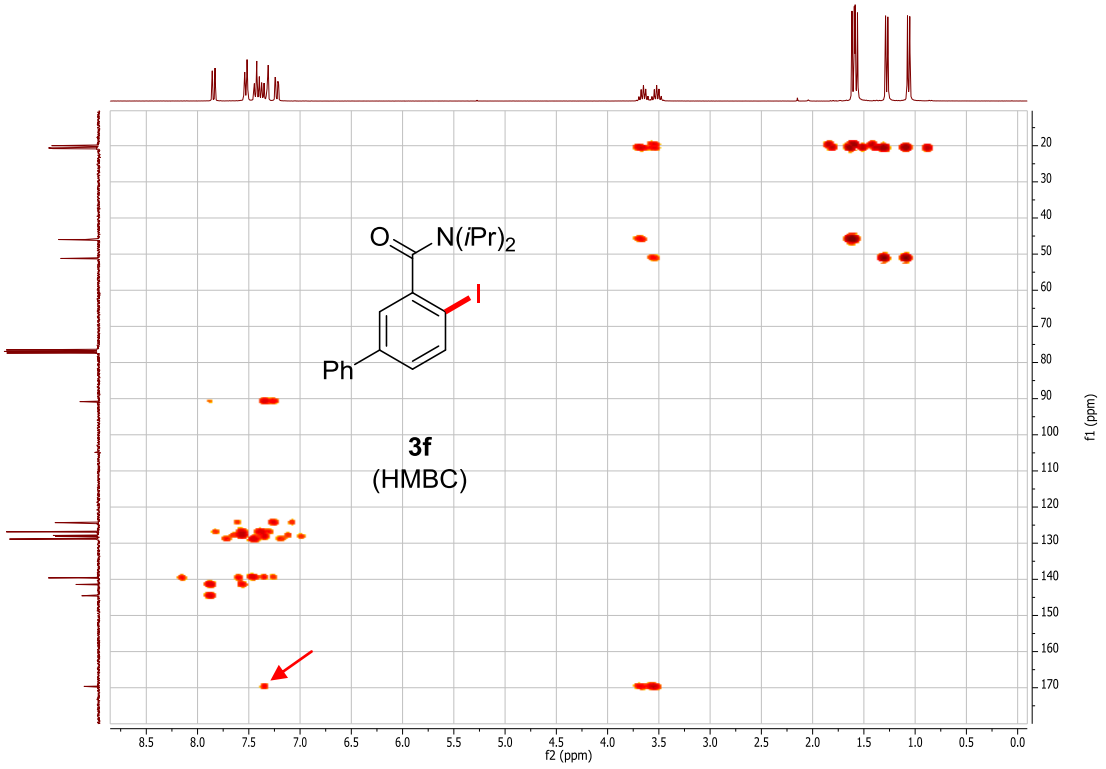



O
N(iPr)2
I
Ph
3f
(CDCl3, 300 MHz)
1.00
2.09
2.00
0.99
1.01
1.05
1.06
1.05
6.06
3.02
3.02
f1 (ppm)

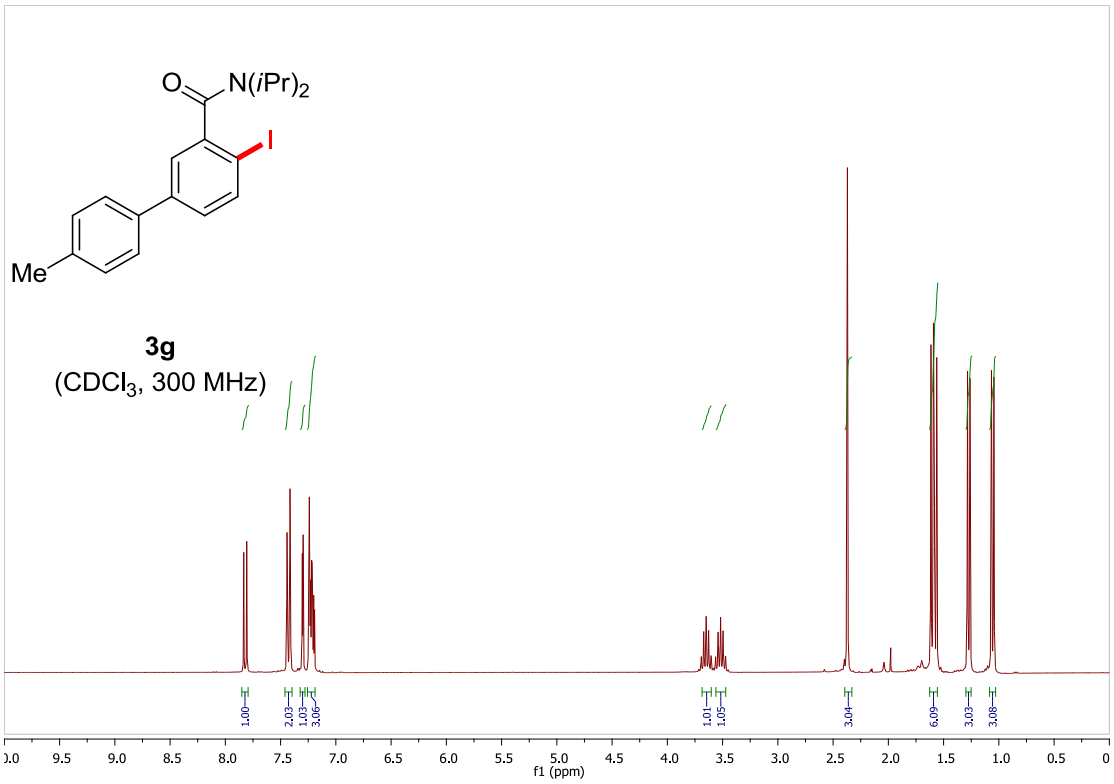

169.6
144.5
141.4
139.6
139.4
128.9
128.1
127.9
126.9
124.3
90.8
51.2
46.0
20.8
20.7
20.6
20.0
O
N(iPr)2
I
Ph
3f
(CDCl3, 75 MHz)
f1 (ppm)

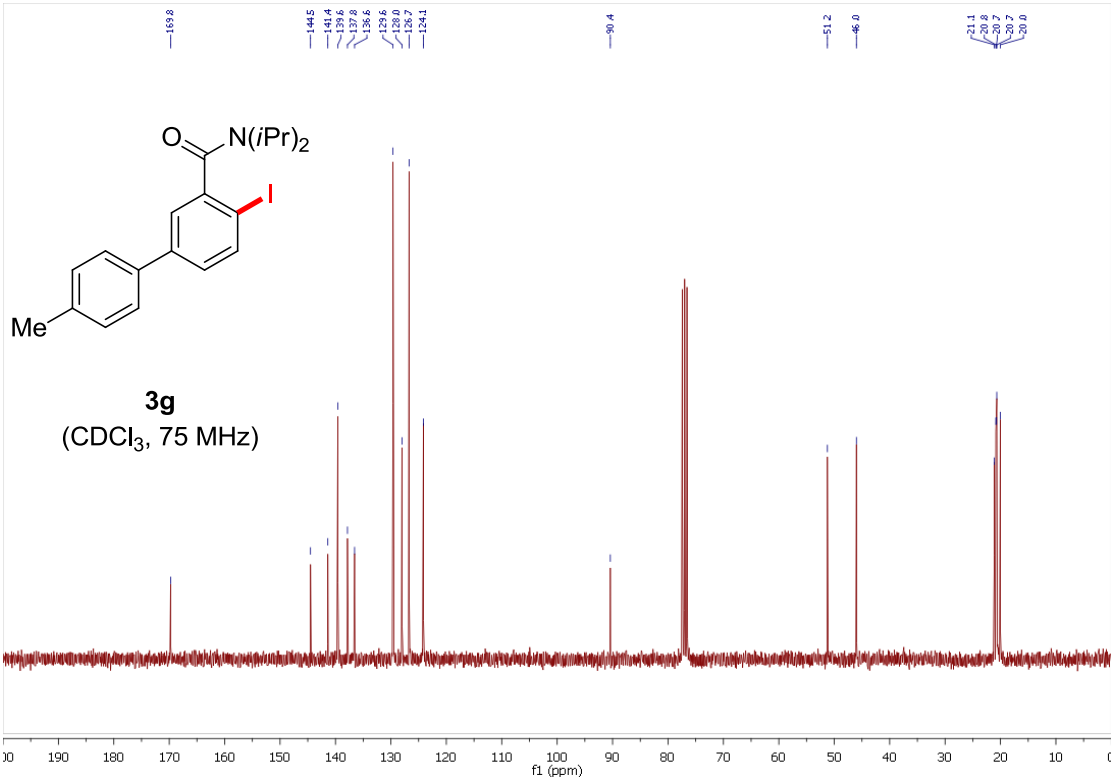


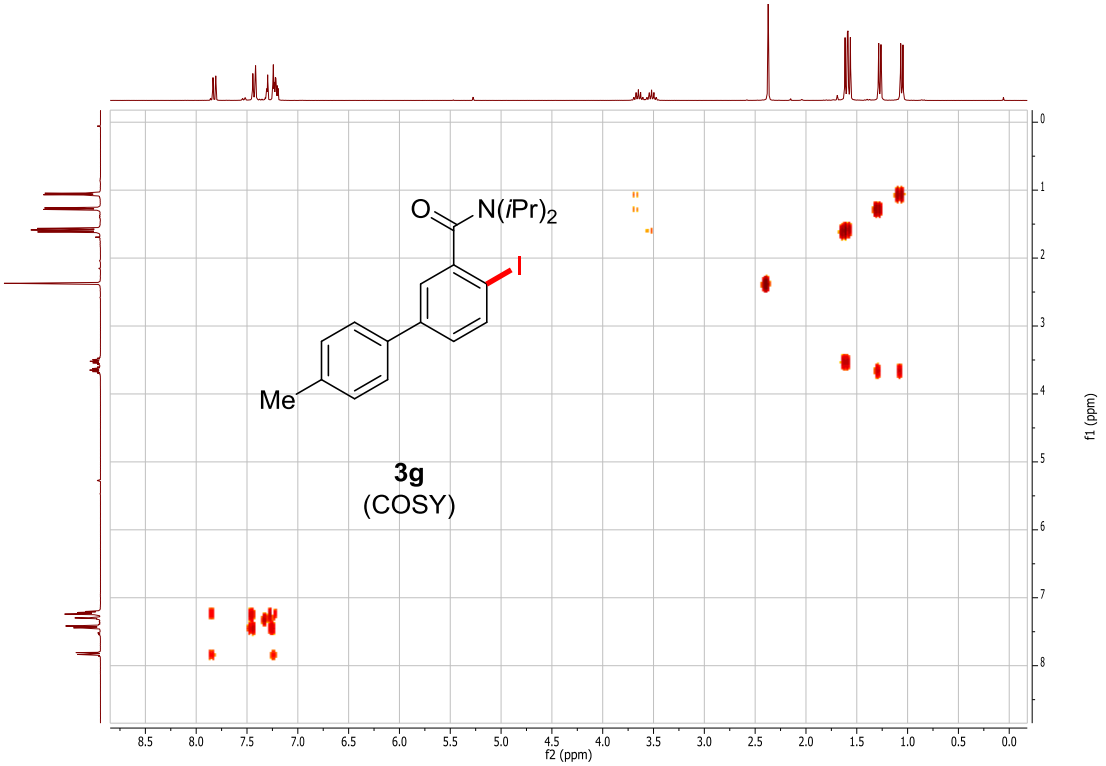
3f
(COSY)

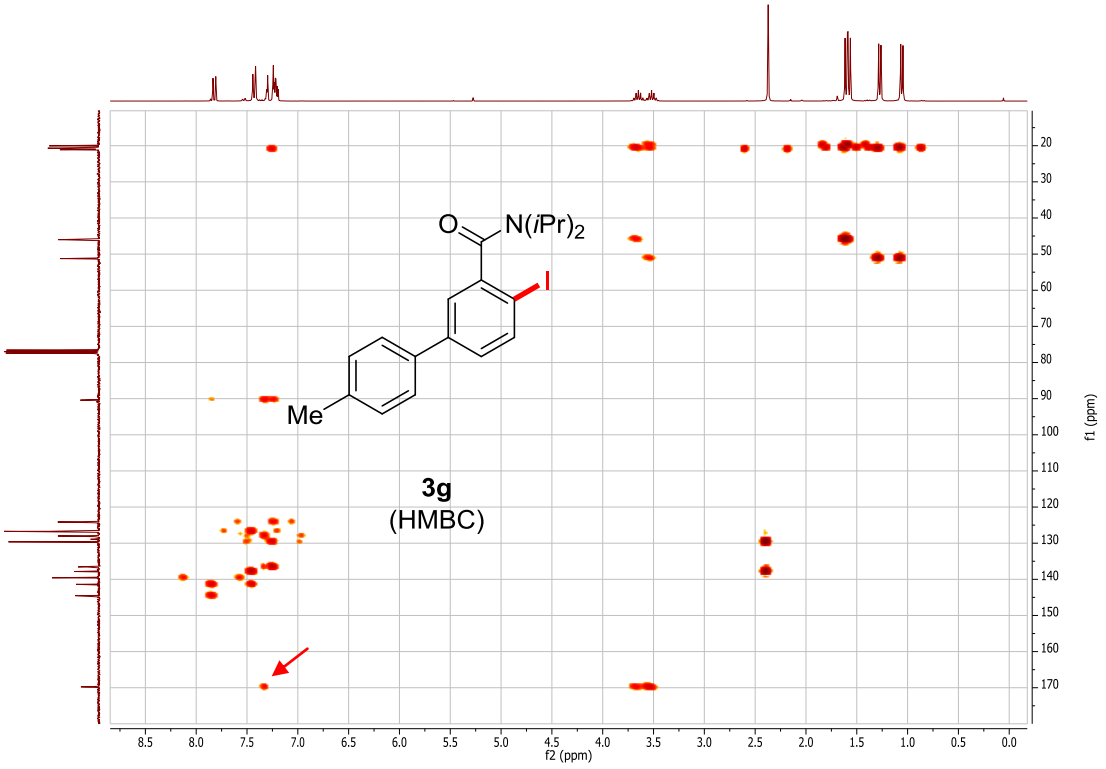


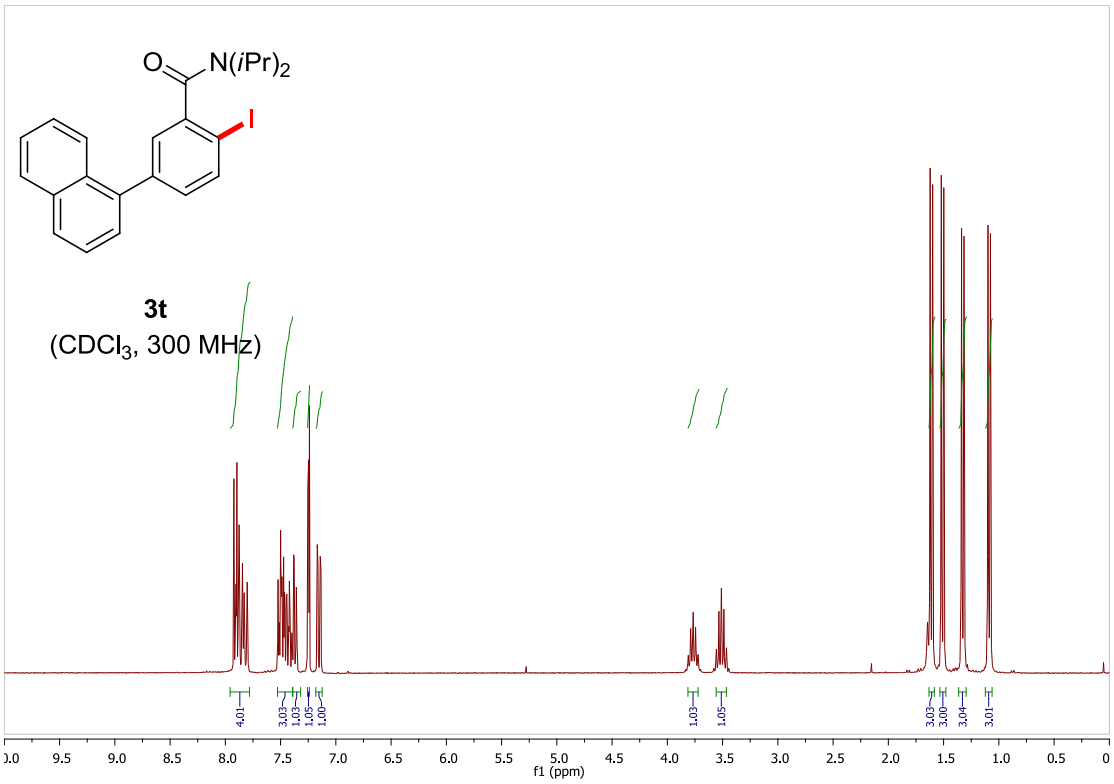
3f
(HMBC)

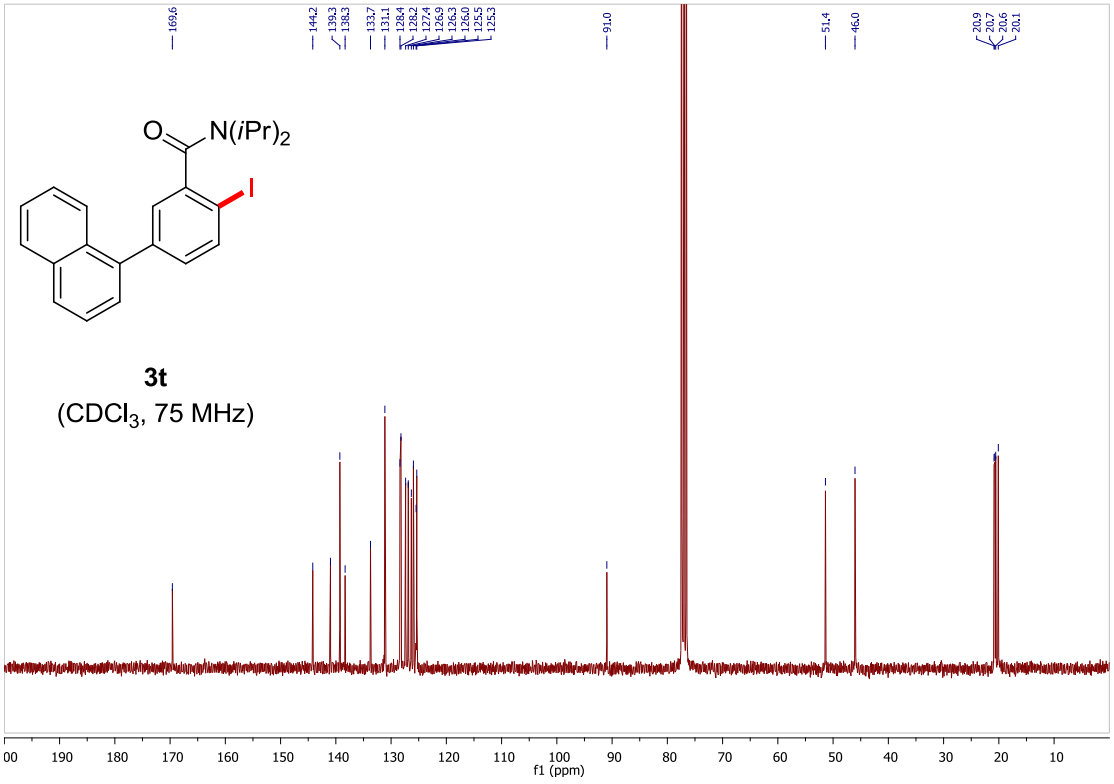

O
N(iPr)2
I
Me
3g
(CDCl3, 300 MHz)
1.00
2.03
1.03
3.06
1.01
1.05
3.04
6.09
3.03
3.08
f1 (ppm)

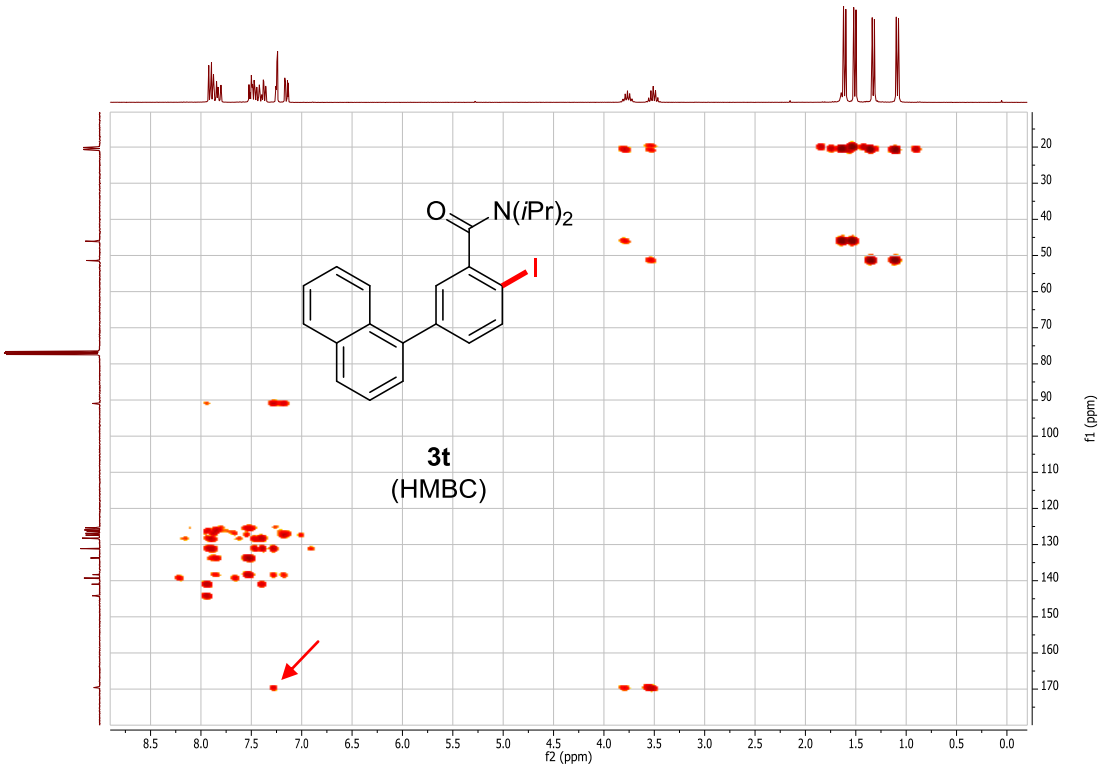

169.8
144.5
141.4
139.6
137.8
136.6
129.6
128.0
126.7
124.1
90.4
51.2
46.0
21.1
20.8
20.7
20.7
20.7
20.0
O
N(iPr)2
I
Me
3g
(CDCl3, 75 MHz)
f1 (ppm)

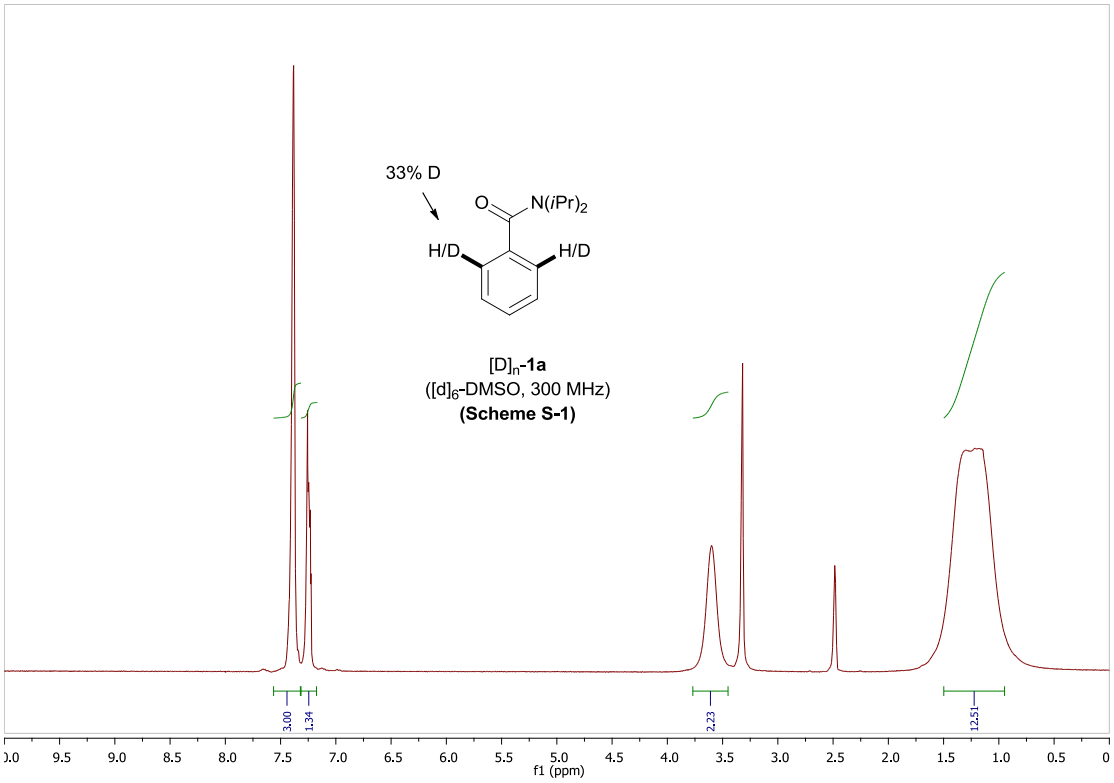


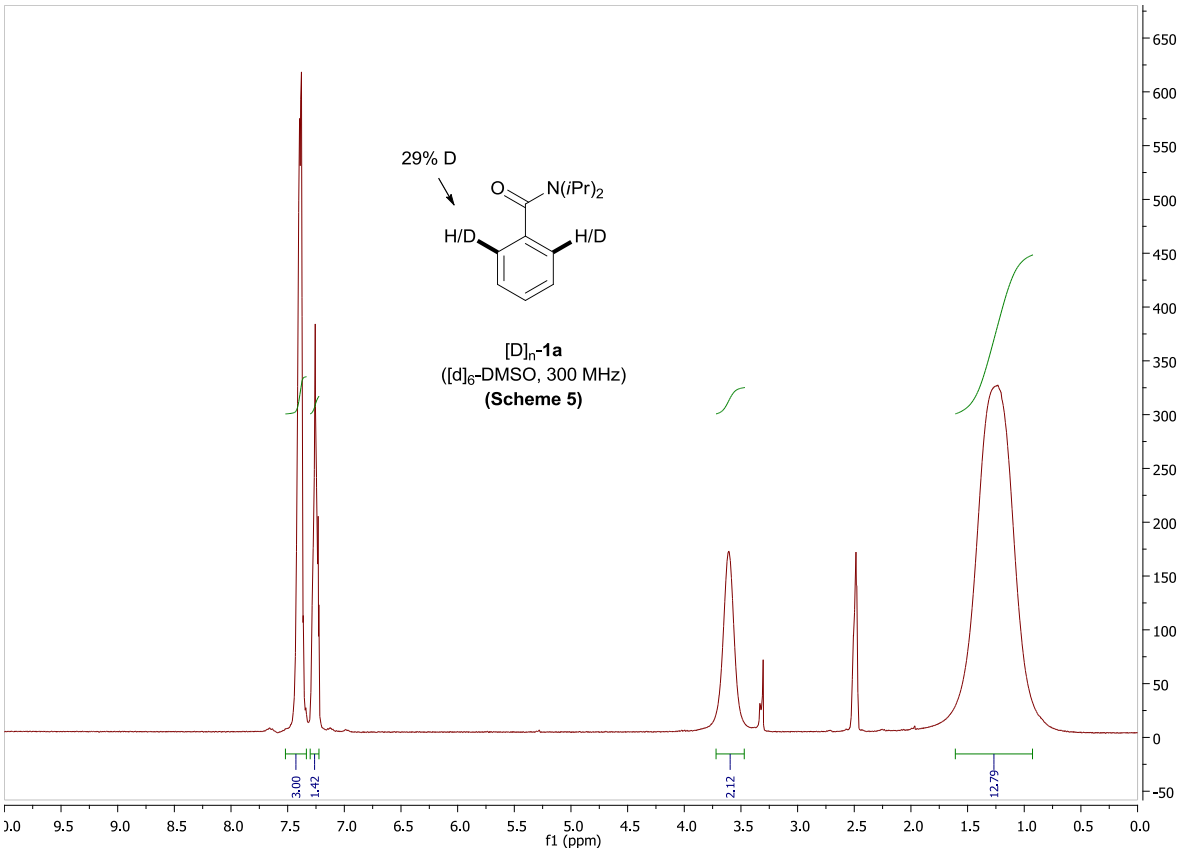


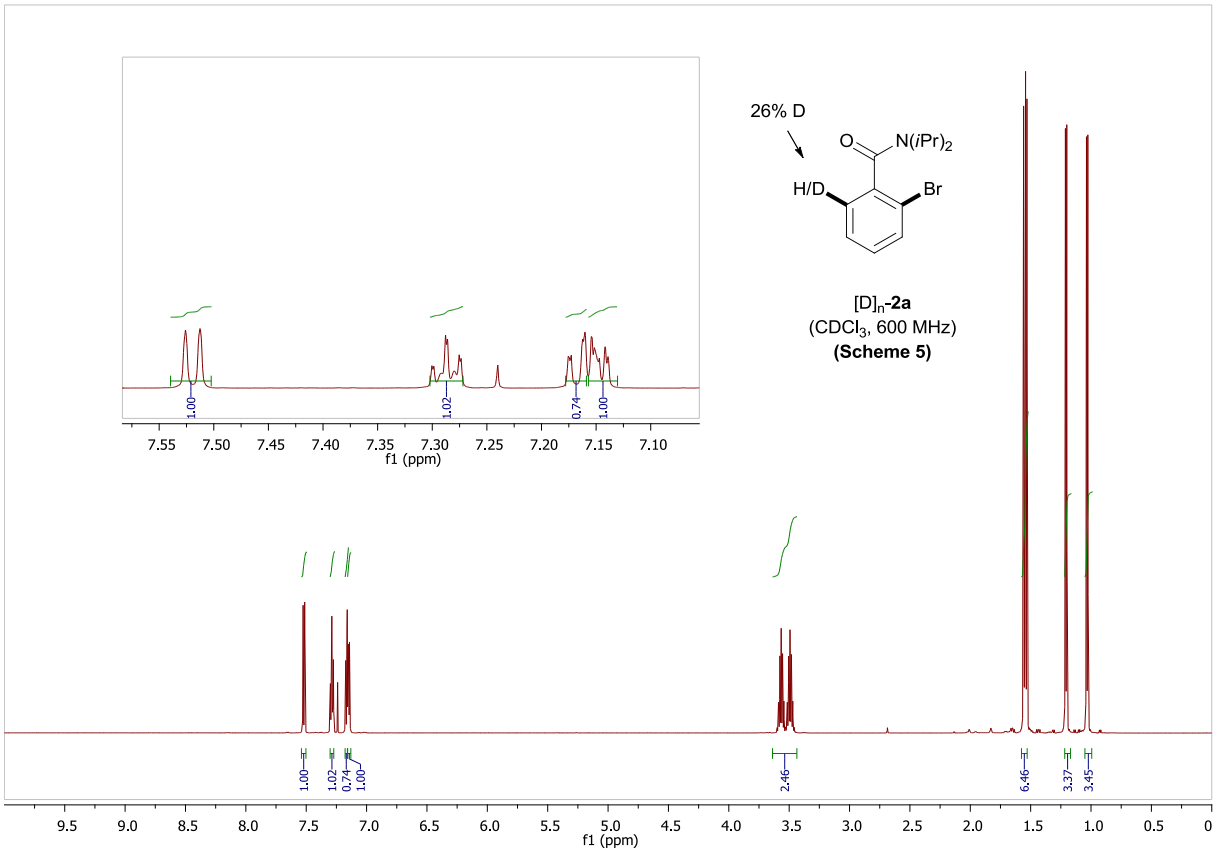

O
N(iPr)2
I
3t
(CDCl3, 300 MHz)
4.01
3.03
1.03
1.05
1.00
1.03
1.05
3.03
3.00
3.04
3.01
f1 (ppm)


169.6
144.2
139.3
138.3
133.7
131.1
128.4
128.2
127.4
126.9
126.3
126.0
125.5
125.3
91.0
51.4
46.0
20.9
20.7
20.6
20.1
O
N(iPr)2
I
3t
(CDCl3, 75 MHz)
f1 (ppm)


O
N(iPr)2
I
3t
(HMBC)
f2 (ppm)
f1 (ppm)


33% D
O
N(iPr)2
H/D
H/D
[D]n-1a
([d]6-DMSO, 300 MHz)
(Scheme S-1)
3.00
1.34
2.23
12.51
f1 (ppm)


29% D
O
N(iPr)2
H/D
H/D
[D]n-1a
([d]6-DMSO, 300 MHz)
(Scheme 5)
3.00
1.42
2.12
12.79
f1 (ppm)


26% D
O
N(iPr)2
H/D
Br
[D]n-2a
(CDCl3, 600 MHz)
(Scheme 5)
1.00
1.02
0.74
1.00
2.46
6.46
3.37
3.45
f1 (ppm)