

Supporting Information

Cross-Coupling of Phenol Derivatives with Umpolung Aldehydes Catalyzed by Nickel

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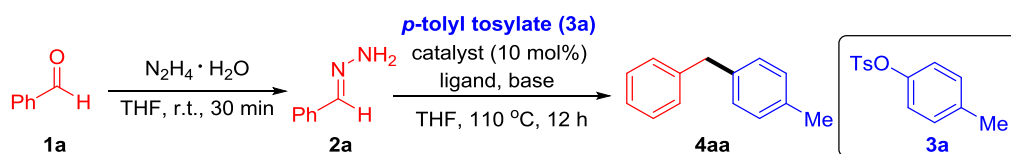
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1. General information

^1H NMR spectra were recorded on Bruker 400 or 500 MHz spectrometer and the chemical shifts were reported in parts per million (δ) relative to internal standard TMS (0 ppm) for CDCl_3 . The peak patterns are indicated as follows: s, singlet; d, doublet; dd, doublet of doublet; t, triplet; q, quartet; m, multiplet. The coupling constants, J , are reported in Hertz (Hz). ^{13}C NMR spectra were obtained at Bruker 100 or 125 MHz and referenced to the internal solvent signals (central peak is 77.0 ppm in CDCl_3). CDCl_3 was used as the NMR solvent. APEX II (Bruker Inc.) was used for HR-MS and APCI-MS. Flash column chromatography was performed over silica gel 200-300. The reagents (PMe_3 , $\text{Ni}(\text{COD})_2$) were weighed and handled in a glove box. All reagents were purchased from Alfa, Acros, Aldrich, and TCI and used without further purification.

2. Optimization of the reaction conditions

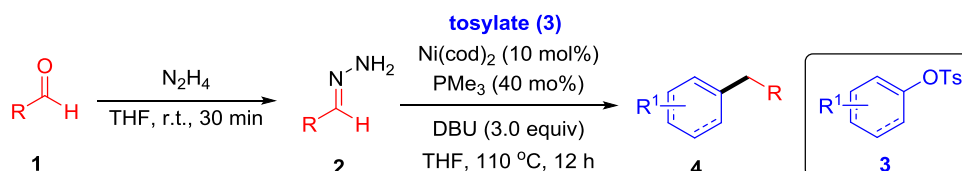
Table S1 Optimization of the reaction conditions^a



Entry	Catalyst	Ligand	Base	4aa (Yield,%) ^b
1	[Ru(<i>p</i> -cymene)Cl ₂] ₂	dmpe	<i>t</i> BuOK	N. D.
2	[Ru(<i>p</i> -cymene)Cl ₂] ₂	dmpe	DBU	N. D.
3	[Ru(<i>p</i> -cymene)Cl ₂] ₂	PMe ₃	DBU	N.D.
4	Pd(OAc) ₂	PMe ₃	DBU	trace
5	Pd(OAc) ₂	PMe ₃	<i>t</i> BuOK	N. D.
6	Pd(OAc) ₂	PMe ₃	K ₃ PO ₄	N.D.
7	Pd(OAc) ₂	PMe ₃	CsF	N.D.
8	Pd(OAc) ₂	PPh ₃	DBU	N.D.
9	Pd(OAc) ₂	dmpe	DBU	N.D.
10	Pd(OAc) ₂	dppe	DBU	N.D.
11	Pd(OAc) ₂	dppp	DBU	N.D.
12	Pd(OAc) ₂	Xantphos	DBU	N.D.
13	Pd(OAc) ₂	bipy	DBU	N.D.
14	Pd(PPh ₃) ₂ Cl ₂	PMe ₃	DBU	N.D.
15	Pd ₂ (bda) ₃	PMe ₃	DBU	trace
16	Pd(acac) ₂	PMe ₃	DBU	trace
17	PdCl ₂	PMe ₃	DBU	trace
18	FeCl ₂	PMe ₃	DBU	N.D.
19	Fe ₂ (CO) ₉	PMe ₃	DBU	N.D.
20	CuCl	PMe ₃	DBU	N.D.
21	Cu(OAc) ₂	PMe ₃	DBU	N.D.
22	CoCl ₂	PMe ₃	DBU	N.D.
23	Ni(COD) ₂	PMe ₃	DBU	80
24	Ni(COD) ₂	dcype	DBU	Trace
25	Ni(COD) ₂	dcypb	DBU	Trace
26 ^c	Ni(COD) ₂	PMe ₃	DBU	64
27 ^d	Ni(COD) ₂	PMe ₃	DBU	40
28 ^e	Ni(COD) ₂	PMe ₃	DBU	58

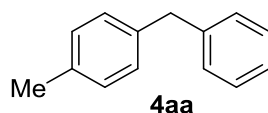
[a] Reaction conditions: **3a** (0.1 mmol), **1a** (0.3 mmol), N₂H₄•H₂O (0.36 mmol), [Ni] (10 mol%), ligand (40 mol% for monodentate, 20 mol% for bidentate), base (0.3 mmol), THF (0.5 mL), 110 °C, 12 h under N₂ unless otherwise noted. [b] NMR yields were determined by ¹H NMR using mesitylene as an internal standard. [c] The reaction was performed at 130 °C. [d] Dioxane was used instead of THF. [e] Toluene was used instead of THF.

3. General procedure and characterization data for product 4

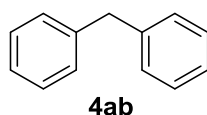


In situ preparation of hydrazone solution **2**: a mixture of aldehydes **1** (0.6 mmol, 3.0 equiv) and hydrazine monohydrate (36 μ L, 0.72 mmol, 64–65 wt%, 3.6 equiv) in THF (0.6 mL) solution was stirred for 30 min at room temperature in air. Before use, a small amount of anhydrous Na₂SO₄ and 4Å MS was added. Note that no drying with Na₂SO₄ and 4Å MS does not decrease the product yields.

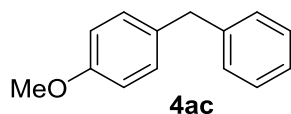
In a glove box, a flame-dried reaction tube (10 cm³) equipped with a magnetic stir bar was charged with Ni(COD)₂ (5.6 mg, 10 mol%), PMe₃ (8.5 μ L, 10 mol%) and THF (0.4 mL) before being sealed with a rubber septum. The reaction mixture was stirred at room temperature for 30 min. Then phenol tosylate **3**^[1] (0.2 mmol, 1.0 equiv), hydrazone solution **2** (0.6 mmol in 0.6 mL THF) and DBU (0.6 mmol, 90 μ L) was added sequentially. After that, the reaction mixture was sealed with aluminum cap and stirred at 110 °C for 12 hour. After the mixture was cooled to room temperature, the resulting solution was directly filtered through a pad of silica by EtOAc (3.0 mL). The crude mixture was analyzed by GC-MS. The solvent was evaporated *in vacuo* to give the crude products. NMR yields were determined by ¹H NMR using mesitylene as an internal standard. The residue was purified by flash column chromatography on silica gel (ethyl acetate/petroleum ether) to give the pure product **4**.



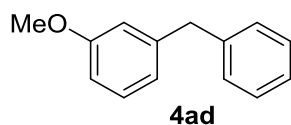
1-Benzyl-4-methylbenzene (4aa).^[2] (28 mg, 75% **Table 1**; 21 mg, 60% **Table 2**). Isolated by preparative TLC (hexane, R_f = 0.8); ¹H NMR (500 MHz, CDCl₃) δ 7.33–7.28 (m, 2H), 7.24–7.19 (m, 3H), 7.15–7.10 (m, 4H), 3.98 (s, 2H), 2.35 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 141.4, 138.1, 135.6, 129.2, 128.9, 128.8, 128.4, 126.0, 41.5, 21.0; EI-MS (m/z): 182.2.



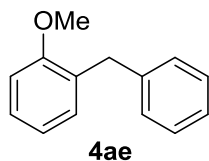
Diphenylmethane (4ab).^[2] (25 mg, 75% both **Table 2** and **3**). Isolated by preparative TLC (hexane, $R_f = 0.8$); ^1H NMR (500 MHz, CDCl_3) δ 7.37-7.33 (m, 4H), 7.29-7.24 (m, 6H), 4.05 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 141.2, 129.1, 128.6, 126.2, 42.1; EI-MS (m/z): 168.1.



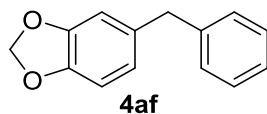
1-Benzyl-4-methoxybenzene (4ac).^[2] (29 mg, 73% **Table 2**; 32 mg, 82% **Table 3**). Isolated by preparative TLC (ethyl acetate: hexane = 1:40, $R_f = 0.6$); ^1H NMR (500 MHz, CDCl_3) δ 7.33-7.28 (m, 2H), 7.24-7.19 (m, 3H), 7.13 (d, $J = 8.5$ Hz, 2H), 6.86 (d, $J = 8.0$ Hz, 2H), 3.96 (s, 2H), 3.81 (s, 3H); ^{13}C NMR (125 MHz, CDCl_3) δ 158.0, 141.6, 133.3, 130.0, 128.8, 128.4, 126.0, 113.9, 55.3, 41.0; EI-MS (m/z): 198.1.



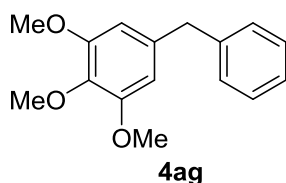
1-Benzyl-3-methoxybenzene (4ad).^[2] (29 mg, 74%). Isolated by preparative TLC (ethyl acetate: hexane = 1:40, $R_f = 0.6$); ^1H NMR (500 MHz, CDCl_3) δ 7.34-7.21 (m, 6H), 6.84-6.76 (m, 3H), 3.99 (s, 2H), 3.80 (s, 3H); ^{13}C NMR (125 MHz, CDCl_3) δ 159.7, 142.7, 140.9, 129.4, 128.9, 128.5, 126.1, 121.4, 114.8, 111.3, 55.2, 42.0; EI-MS (m/z): 198.1.



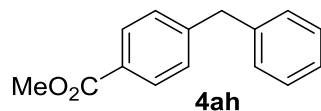
1-Benzyl-2-methoxybenzene (4ae).^[2] (28 mg, 70%). Isolated by preparative TLC (ethyl acetate: hexane = 1:40, $R_f = 0.6$); ^1H NMR (500 MHz, CDCl_3) δ 7.33-7.28 (m, 2H), 7.27-7.19 (m, 4H), 7.12-7.09 (m, 1H), 6.94-6.89 (m, 2H), 4.02 (s, 2H), 3.86 (s, 3H); ^{13}C NMR (125 MHz, CDCl_3) δ 157.4, 141.0, 130.3, 129.7, 129.0, 128.3, 127.4, 125.8, 120.5, 110.4, 55.4, 35.9; EI-MS (m/z): 198.1.



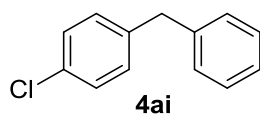
5-Benzylbenzo[d][1,3]dioxole (4af).^[4] (36 mg, 86%). Isolated by preparative TLC (ethyl acetate: hexane = 1:20, $R_f = 0.5$); ^1H NMR (500 MHz, CDCl_3) δ 7.34-7.28 (m, 2H), 7.25-7.19 (m, 3H), 6.79-6.74 (m, 1H), 6.71-6.67 (m, 2H), 5.94 (s, 2H), 3.92 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 147.7, 145.9, 141.3, 135.0, 128.8, 128.5, 126.1, 121.7, 109.4, 108.2, 100.8, 41.6; EI-MS (m/z): 212.1.



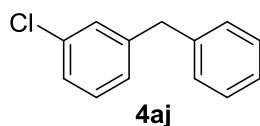
5-Benzyl-1,2,3-trimethoxybenzene (4ag).^[4] (47 mg, 92%). Isolated by preparative TLC (ethyl acetate: hexane = 1:5, R_f = 0.4); ^1H NMR (500 MHz, CDCl_3) δ 7.35-7.30 (m, 2H), 7.26-7.20 (m, 3H), 6.43 (s, 2H), 3.95 (s, 2H), 3.85 (s, 3H), 3.83 (s, 6H); ^{13}C NMR (125 MHz, CDCl_3) δ 153.2, 140.9, 136.7, 136.3, 128.8, 128.5, 126.2, 106.0, 60.9, 56.1, 42.2; EI-MS (m/z): 258.1.



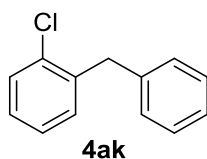
Methyl 4-benzylbenzoate (4ah).^[2] (26 mg, 57%). Isolated by preparative TLC (ethyl acetate: hexane = 1:60, R_f = 0.5); ^1H NMR (500 MHz, CDCl_3) δ 7.98 (d, J = 8.3 Hz, 2H), 7.34-7.31 (m, 2H), 7.28 (d, J = 8.3 Hz, 2H), 7.26-7.23 (m, 1H), 7.21-7.19 (m, 2H), 4.06 (s, 2H), 3.92 (s, 3H); ^{13}C NMR (125 MHz, CDCl_3) δ 167.1, 146.5, 140.1, 129.8, 129.0, 128.6, 128.1, 126.4, 52.0, 41.9; EI-MS (m/z): 226.3.



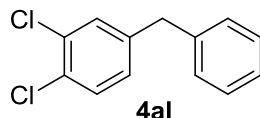
1-Benzyl-4-chlorobenzene (4ai).^[2] (35 mg, 87% **Table 2**; 29 mg, 72% **Table 3**). Isolated by preparative TLC (hexane, R_f = 0.5); ^1H NMR (500 MHz, CDCl_3) δ 7.35-7.23 (m, 5H), 7.21-7.17 (m, 2H), 7.16-7.11 (m, 2H), 3.98 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3): δ 140.6, 139.6, 131.9, 130.3, 128.9, 128.6, 126.3, 41.3; EI-MS (m/z): 202.1.



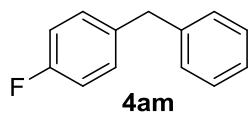
1-Benzyl-3-chlorobenzene (4aj).^[3] (37 mg, 92%). Isolated by preparative TLC (hexane, R_f = 0.5); ^1H NMR (500 MHz, CDCl_3) δ 7.36-7.31 (m, 2H), 7.28-7.19 (m, 6H), 7.12-7.08 (m, 1H), 3.98 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3): δ 143.2, 140.2, 134.3, 129.7, 129.0, 128.9, 128.6, 127.1, 126.4, 126.3, 41.6; EI-MS (m/z): 202.1.



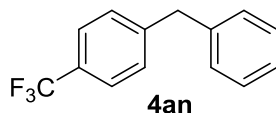
1-Benzyl-2-chlorobenzene (4ak).^[3] (32 mg, 78%). Isolated by preparative TLC (hexane, R_f = 0.5); ^1H NMR (500 MHz, CDCl_3) δ 7.42-7.39 (m, 1H), 7.35-7.30 (m, 2H), 7.27-7.16 (m, 6H), 4.14 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 139.5, 138.7, 134.3, 131.0, 129.5, 129.0, 128.5, 127.7, 126.8, 126.2, 39.2; EI-MS (m/z): 202.1.



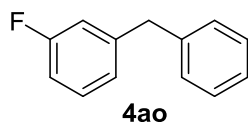
4-benzyl-1,2-dichlorobenzene (4al).^[3] (40 mg, 85%). Isolated by preparative TLC (hexane, R_f = 0.5); ^1H NMR (500 MHz, CDCl_3) δ 7.40-7.24 (m, 5H), 7.21-7.17 (m, 2H), 7.07-7.03 (m, 1H), 3.96 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 141.4, 139.7, 132.4, 130.8, 130.4, 130.1, 128.9, 128.7, 128.3, 126.6, 41.0; EI-MS (m/z): 236.1.



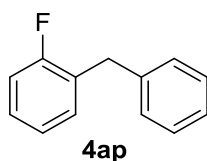
1-Benzyl-4-fluorobenzene (4am).^[2] (31 mg, 83%, **Table 2**; 22 mg, 58%, **Table 3**). Isolated by preparative TLC (hexane, $R_f = 0.7$); ^1H NMR (500 MHz, CDCl_3): δ 7.35-7.31 (m, 2H), 7.27-7.15 (m, 5H), 7.03-6.98 (m, 2H), 3.99 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 161.4 (d, $J_{\text{C-F}} = 244.0$ Hz), 141.0, 136.7 (d, $J_{\text{C-F}} = 2.8$ Hz), 130.3 (d, $J_{\text{C-F}} = 7.6$ Hz), 128.8, 128.5, 126.2, 115.2 (d, $J_{\text{C-F}} = 20.2$ Hz), 41.1; ^{19}F NMR (470 MHz, CDCl_3) δ -117.4; EI-MS (m/z): 186.2.



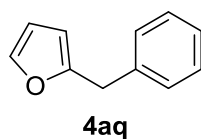
1-Benzyl-4-(trifluoromethyl)benzene (4an).^[2] (35 mg, 74%). Isolated by preparative TLC (hexane, $R_f = 0.8$); ^1H NMR (500 MHz, CDCl_3) δ 7.57 (d, $J = 8.0$ Hz, 2H), 7.37-7.30 (m, 4H), 7.28-7.23 (m, 1H), 7.23-7.18 (m, 2H), 4.07 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 145.2, 140.0, 129.2, 128.9, 128.7, 128.4 (q, $J_{\text{C-F}} = 32.4$ Hz), 126.5, 125.4 (t, $J_{\text{C-F}} = 3.6$ Hz), 124.2 (q, $J_{\text{C-F}} = 277$ Hz), 41.7; ^{19}F NMR (470 MHz, CDCl_3) δ -62.4; EI-MS (m/z): 236.2.



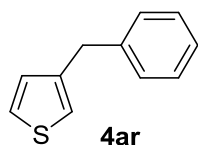
1-Benzyl-3-fluorobenzene (4ao).^[3] (36 mg, 96%). Isolated by preparative TLC (hexane, $R_f = 0.7$); ^1H NMR (500 MHz, CDCl_3) δ 7.36-7.31 (m, 2H), 7.29-7.20 (m, 4H), 7.03-6.99 (m, 1H), 6.95-6.88 (m, 2H), 4.01 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 163.0 (d, $J_{\text{C-F}} = 245.4$ Hz), 143.7 (d, $J_{\text{C-F}} = 7.2$ Hz), 140.3, 129.8 (d, $J_{\text{C-F}} = 8.2$ Hz), 128.9, 128.6, 126.4, 124.5 (d, $J_{\text{C-F}} = 2.8$ Hz), 115.8 (d, $J_{\text{C-F}} = 21.6$ Hz), 113.0 (d, $J_{\text{C-F}} = 21.0$ Hz), 41.6 (d, $J_{\text{C-F}} = 1.4$ Hz); ^{19}F NMR (470 MHz, CDCl_3): δ -113.5; EI-MS (m/z): 186.2.



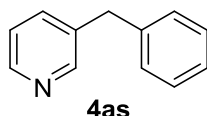
1-Benzyl-2-fluorobenzene (4ap).^[3] (34 mg, 93%). Isolated by preparative TLC (hexane, $R_f = 0.7$); ^1H NMR (500 MHz, CDCl_3) δ 7.35-7.31 (m, 2H), 7.29-7.16 (m, 5H), 7.11-7.05 (m, 2H), 4.05 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 161.0 (d, $J_{\text{C-F}} = 245.8$ Hz), 139.9, 131.1 (d, $J_{\text{C-F}} = 4.8$ Hz), 128.8, 128.5, 128.1 (d, $J_{\text{C-F}} = 16.2$ Hz), 128.0 (d, $J_{\text{C-F}} = 8.0$ Hz), 126.2, 124.1 (d, $J_{\text{C-F}} = 3.6$ Hz), 115.3 (d, $J_{\text{C-F}} = 22.0$ Hz), 34.8 (d, $J_{\text{C-F}} = 2.8$ Hz); ^{19}F NMR (470 MHz, CDCl_3) δ -117.8; EI-MS (m/z): 186.1.



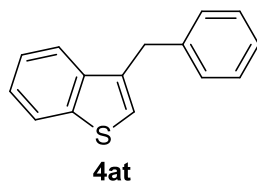
2-Benzylfuran (4aq).^[5] (30 mg, 96%). Isolated by preparative TLC (hexane, $R_f = 0.7$); ^1H NMR (500 MHz, CDCl_3) δ 7.36-7.31 (m, 3H), 7.29-7.24 (m, 3H), 6.34-6.31 (m, 1H), 6.03 (d, $J = 3.2$ Hz, 1H), 4.00 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 154.6, 141.5, 138.2, 128.7, 128.5, 126.5, 110.2, 106.2, 34.5; EI-MS (m/z): 158.2.



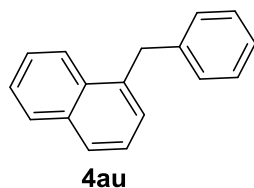
3-Benzylthiophene (4ar).^[5] (23 mg, 67%). Isolated by preparative TLC (hexane, $R_f = 0.7$); ^1H NMR (500 MHz, CDCl_3) δ 7.36-7.31 (m, 2H), 7.30-7.27 (m, 1H), 7.27-7.22 (m, 3H), 6.97-6.93 (m, 2H), 4.02 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 141.5, 140.6, 128.7, 128.5, 126.2, 125.6, 121.3, 36.6; EI-MS (m/z): 174.1.



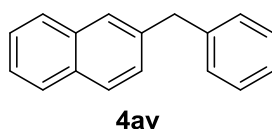
3-Benzylpyridine (4as).^[5] (32 mg, 94%, **Table 2**; 26 mg, 76%, **Table 3**). Isolated by preparative TLC (ethyl acetate: hexane = 1:3, $R_f = 0.4$); ^1H NMR (500 MHz, CDCl_3) δ 8.54 (s, 1H), 8.49 (d, $J = 2.8$ Hz, 1H), 7.49 (dt, $J = 7.8, 2.0$ Hz, 1H), 7.34-7.31 (m, 2H), 7.27-7.24 (m, 1H), 7.24-7.21 (m, 1H), 7.21-7.19 (m, 2H), 4.01 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 150.2, 147.7, 139.8, 136.3, 128.8, 128.7, 126.5, 123.5, 39.1; EI-MS (m/z): 169.1.



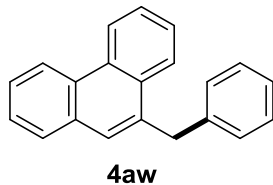
3-Benzylbenzo[b]thiophene (4at).^[2] (32 mg, 72%). Isolated by preparative TLC (ethyl acetate: hexane = 1:20, $R_f = 0.4$); ^1H NMR (500 MHz, CDCl_3) δ 7.91-7.88 (m, 1H), 7.75-7.72 (m, 1H), 7.39-7.36 (m, 2H), 7.35-7.33 (m, 2H), 7.31-7.28 (m, 2H), 7.27-7.24 (m, 1H), 7.04 (s, 1H), 4.23 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 140.6, 139.4, 138.8, 135.6, 128.9, 128.5, 126.4, 124.3, 124.0, 123.1, 122.9, 122.0, 35.0; EI-MS (m/z): 224.1.



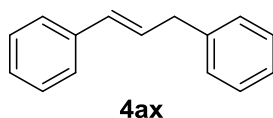
1-Benzylanthracene (4au).^[3] (41 mg, 95%, **Table 2**; 37 mg, 86%, **Table 3**). Isolated by preparative TLC (hexane, $R_f = 0.5$); ^1H NMR (500 MHz, CDCl_3) δ 8.07-8.03 (m, 1H), 7.93-7.89 (m, 1H), 7.81 (d, $J = 8.5$ Hz, 1H), 7.54-7.45 (m, 3H), 7.37-7.29 (m, 3H), 7.27-7.21 (m, 3H), 4.51 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 140.7, 136.7, 134.0, 132.2, 128.8, 128.7, 128.5, 127.4, 127.2, 126.1, 126.0, 125.6, 124.3, 39.1; EI-MS (m/z): 218.2.



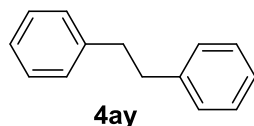
2-Benzylnaphthalene (4av).^[3] (40 mg, 92%, **Table 2**; 34 mg, 79%, **Table 3**). Isolated by preparative TLC (hexane, $R_f = 0.5$); ^1H NMR (500 MHz, CDCl_3) δ 7.86-7.81 (m, 3H), 7.69 (s, 1H), 7.52-7.46 (m, 2H), 7.38-7.34 (m, 3H), 7.30-7.25 (m, 3H), 4.20 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 141.0, 138.6, 133.7, 132.1, 129.1, 128.5, 128.1, 127.7, 127.6, 127.5, 127.2, 126.2, 126.0, 125.4, 42.2; EI-MS (m/z): 218.2.



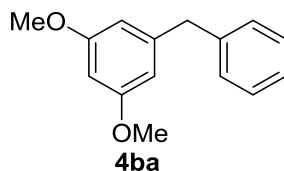
2-Benzylnaphthalene (4aw).^[6] (50 mg, 94%, **Table 2**; 41 mg, 77%, **Table 3**). Isolated by preparative TLC (hexane, $R_f = 0.5$); ^1H NMR (500 MHz, CDCl_3) δ 8.77 (d, $J = 8.5$ Hz, 1H), 8.71 (d, $J = 8.5$ Hz, 1H), 8.07 (d, $J = 8.0$ Hz, 1H), 7.85 (d, $J = 7.5$ Hz, 1H), 7.68-7.57 (m, 5H), 7.32-7.23 (m, 5H), 4.53 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 140.3, 134.8, 131.8, 131.4, 130.8, 130.0, 128.8, 128.5, 128.3, 127.9, 126.7, 126.6, 126.3, 126.2, 125.1, 123.1, 122.5, 39.6; EI-MS (m/z): 268.1.



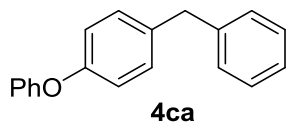
(E)-Prop-1-ene-1,3-diyl dibenzene (4ax).^[3] (14 mg, 37%). Isolated by preparative TLC (hexane, $R_f = 0.6$); ^1H NMR (500 MHz, CDCl_3) δ 7.43-7.23 (m, 10H), 6.52 (d, $J = 16.0$ Hz, 1H), 6.45-6.38 (m, 1H), 3.61 (d, $J = 7.0$ Hz, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 140.2, 137.5, 131.1, 129.3, 128.7, 128.5, 127.1, 126.2, 126.1, 39.4; EI-MS (m/z): 194.2.



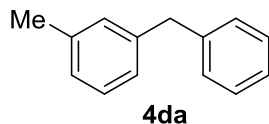
(E)-Prop-1-ene-1,3-diyl dibenzene (4ay). (16 mg, 45%). Isolated by preparative TLC (hexane, $R_f = 0.7$); ^1H NMR (500 MHz, CDCl_3) δ 7.40-7.37 (m, 4H), 7.31-7.28 (m, 6H), 3.03 (s, 4H); ^{13}C NMR (125 MHz, CDCl_3) δ 141.9, 128.5, 128.4, 126.0, 38.0; EI-MS (m/z): 182.1.



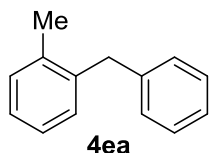
1-Benzyl-3,5-dimethoxybenzene (4ba).^[2] (38 mg, 83%). Isolated by preparative TLC (ethyl acetate:hexane = 1:5, $R_f = 0.5$); ^1H NMR (500 MHz, CDCl_3) δ 7.33-7.30 (m, 2H), 7.24-7.21 (m, 3H), 6.38 (d, $J = 2.2$ Hz, 2H), 6.35 (t, $J = 2.2$ Hz, 1H), 3.95 (s, 2H), 3.78 (s, 6H); ^{13}C NMR (125 MHz, CDCl_3) δ 160.8, 143.4, 140.7, 128.9, 128.5, 126.1, 107.1, 98.0, 55.3, 42.2; EI-MS (m/z): 228.1



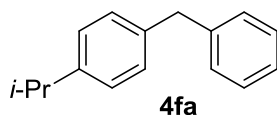
1-Benzyl-4-phenoxybenzene (4ca).^[3] (40 mg, 78%). Isolated by preparative TLC (ethyl acetate:hexane = 1:40, R_f = 0.5); ^1H NMR (500 MHz, CDCl_3) δ 7.38-7.33 (m, 4H), 7.27-7.24 (m, 3H), 7.21-7.19 (m, 2H), 7.14-7.11 (m, 1H), 7.05-7.03 (m, 2H), 7.00-6.98 (m, 2H), 4.01 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 157.5, 155.4, 141.2, 130.2, 129.7, 128.9, 128.5, 126.2, 123.0, 119.1, 118.7, 41.2; EI-MS (m/z): 260.1.



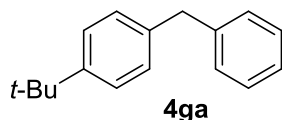
1-Benzyl-3-methylbenzene (4da).^[2] (28 mg, 77%). Isolated by preparative TLC (hexane, R_f = 0.8); ^1H NMR (500 MHz, CDCl_3) δ 7.28-7.26 (m, 2H), 7.20-7.15 (m, 4H), 7.01-6.98 (m, 3H), 3.94 (s, 2H), 2.31 (s, 3H); ^{13}C NMR (125 MHz, CDCl_3) δ 141.4, 141.2, 138.2, 129.9, 129.1, 128.6, 128.5, 127.0, 126.2, 126.1, 42.1, 21.6; EI-MS (m/z): 182.1.



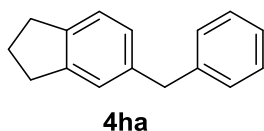
1-Benzyl-2-methylbenzene (4ea).^[2] (15 mg, 41%). Isolated by preparative TLC (hexane, R_f = 0.8); ^1H NMR (500 MHz, CDCl_3) δ 7.33-7.28 (m, 2H), 7.25-7.13 (m, 7H), 4.03 (s, 2H), 2.28 (s, 3H); ^{13}C NMR (125 MHz, CDCl_3) δ 140.4, 138.9, 136.7, 130.3, 130.0, 128.8, 128.4, 126.5, 126.0, 125.9, 39.5, 19.7; EI-MS (m/z): 182.1.



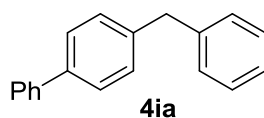
1-Benzyl-4-isopropylbenzene (4fa).^[3] (33 mg, 78%). Isolated by preparative TLC (hexane, R_f = 0.6); ^1H NMR (500 MHz, CDCl_3) δ 7.33-7.30 (m, 2H), 7.23-7.20 (m, 3H), 7.17 (d, J = 8.2 Hz, 2H), 7.14 (d, J = 8.2 Hz, 2H), 3.98 (s, 2H), 2.93-2.87 (m, 1H), 1.27 (s, 3H), 1.25 (s, 3H); ^{13}C NMR (125 MHz, CDCl_3) δ 146.6, 141.3, 138.5, 129.0, 128.8, 128.4, 126.5, 126.0, 41.5, 33.7, 24.1; EI-MS (m/z): 210.2.



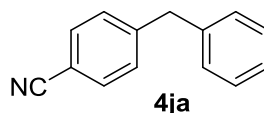
1-Benzyl-4-(tert-butyl)benzene (4ga).^[3] (36 mg, 80%). Isolated by preparative TLC (hexane, R_f = 0.6); ^1H NMR (500 MHz, CDCl_3) δ 7.35-7.31 (m, 4H), 7.25-7.21 (m, 3H), 7.16 (d, J = 8.4 Hz, 2H), 3.99 (s, 2H), 1.34 (s, 9H); ^{13}C NMR (125 MHz, CDCl_3) δ 148.9, 141.3, 138.1, 129.0, 128.5, 128.4, 126.0, 125.4, 41.5, 34.4, 31.4; EI-MS (m/z): 224.2.



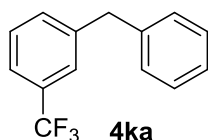
5-Benzyl-2,3-dihydro-1H-indene (4ha). (33 mg, 79%). Isolated by preparative TLC (hexane, $R_f = 0.6$); ^1H NMR (500 MHz, CDCl_3) δ 7.33-7.31 (m, 2H), 7.25-7.23 (m, 3H), 7.18 (d, $J = 7.6$ Hz, 1H), 7.10 (s, 1H), 7.01 (d, $J = 7.6$ Hz, 1H), 3.99 (s, 2H), 2.92-2.87 (m, 4H), 2.12-2.06 (m, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 144.6, 142.0, 141.7, 139.0, 128.9, 128.5, 126.8, 126.0, 124.9, 124.3, 41.8, 32.8, 32.5, 25.5; EI-MS (m/z): 208.2; HRMS (APCI) calcd for $\text{C}_{16}\text{H}_{15}$ [$\text{M} - \text{H}^+$], 207.1172; found: 207.1172.



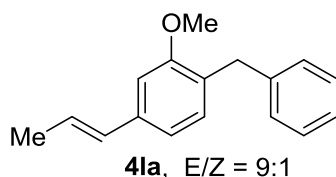
4-Benzyl-1,1'-biphenyl (4ia).^[6] (41 mg, 83%). Isolated by preparative TLC (hexane, $R_f = 0.5$); ^1H NMR (500 MHz, CDCl_3) δ 7.63-7.61 (m, 2H), 7.57 (d, $J = 8.2$ Hz, 2H), 7.49-7.46 (m, 2H), 7.39-7.34 (m, 3H), 7.31 (d, $J = 8.2$ Hz, 2H), 7.29-7.27 (m, 3H), 4.08 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 141.0, 140.3, 139.1, 129.4, 129.0, 128.8, 128.6, 127.3, 127.1, 127.0, 126.2, 41.6; EI-MS (m/z): 244.2.



4-Benzylbenzonitrile (4ja).^[3] (19 mg, 49%). Isolated by preparative TLC (ethyl acetate:hexane = 1:100, $R_f = 0.4$); ^1H NMR (500 MHz, CDCl_3) δ 7.60 (d, $J = 8.2$ Hz, 2H), 7.35-7.32 (m, 2H), 7.31 (d, $J = 8.2$ Hz, 2H), 7.28-7.25 (m, 1H), 7.19-7.17 (m, 2H), 4.06 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 146.7, 139.3, 132.3, 129.7, 129.0, 128.8, 126.7, 119.0, 110.1, 42.0; EI-MS (m/z): 193.1.

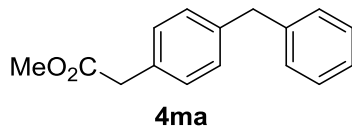


1-Benzyl-3-(trifluoromethyl)benzene (4ka).^[3] (27 mg, 58%). Isolated by preparative TLC (hexane, $R_f = 0.5$); ^1H NMR (500 MHz, CDCl_3) δ 7.51-7.47 (m, 2H), 7.45-7.37 (m, 2H), 7.36-7.31 (m, 2H), 7.28-7.24 (m, 1H), 7.22-7.19 (m, 2H), 4.07 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 142.0, 140.0, 132.3, 130.7 (q, $J_{\text{C-F}} = 31.7$ Hz), 128.9, 128.8, 128.7, 126.4, 125.6 (q, $J_{\text{C-F}} = 3.8$ Hz), 124.1 (d, $J_{\text{C-F}} = 277.5$ Hz), 123.0 (q, $J_{\text{C-F}} = 3.9$ Hz), 41.7; ^{19}F NMR (470 MHz, CDCl_3) δ -62.6; EI-MS (m/z): 236.2.

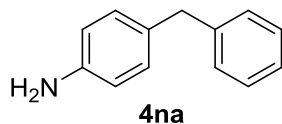


Benzyl-2-methoxy-4-(prop-1-en-1-yl)benzene (4la). (39 mg, 81%). Isolated by preparative TLC (ethyl acetate:hexane = 1:60, $R_f = 0.5$); **Major:** ^1H NMR (500 MHz, CDCl_3) δ 7.32-7.29 (m, 2H), 7.26-7.20 (m, 3H), 7.02

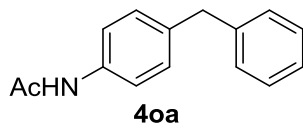
(d, $J = 8.0$ Hz, 1H), 6.90-6.88 (m, 2H), 6.44-6.40 (m, 1H), 6.31-6.21 (m, 1H), 3.99 (s, 2H), 3.86 (s, 3H), 1.92 (dd, $J = 6.6, 1.6$ Hz, 3H); ^{13}C NMR (125 MHz, CDCl_3) δ 157.5, 141.1, 137.5, 131.1, 130.4, 128.9, 128.3, 125.8, 125.2, 118.3, 107.8, 55.3, 35.7, 18.5; EI-MS (m/z): 238.2; HRMS (APCI) calcd for $\text{C}_{17}\text{H}_{19}\text{O}$ [$\text{M} + \text{H}^+$], 239.1430; found: 239.1430.



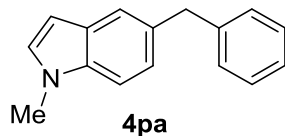
Methyl 2-(4-benzylphenyl)acetate (4ma).^[3] (39 mg, 82%). Isolated by preparative TLC (ethyl acetate:hexane = 1:40, $R_f = 0.5$); ^1H NMR (500 MHz, CDCl_3) δ 7.33-7.30 (m, 2H), 7.24-7.21 (m, 5H), 7.19-7.17 (m, 2H), 3.40 (s, 2H), 3.72 (s, 3H), 3.63 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 172.1, 141.0, 140.0, 131.7, 129.4, 129.1, 129.0, 128.5, 126.1, 52.0, 41.6, 40.8; EI-MS (m/z): 240.1.



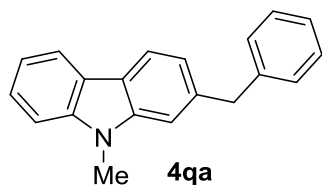
4-Benzylaniline (4na). (15 mg, 42%).^[6] Isolated by preparative TLC (ethyl acetate:hexane = 1:10, $R_f = 0.4$); ^1H NMR (500 MHz, CDCl_3) δ 7.33-7.28 (m, 2H), 7.23-7.19 (m, 3H), 7.03-6.99 (m, 2H), 6.68-6.64 (m, 2H), 3.91 (s, 2H), 3.55 (br, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 144.5, 141.9, 131.2, 129.8, 128.8, 128.4, 125.9, 115.3, 41.1; EI-MS (m/z): 183.2.



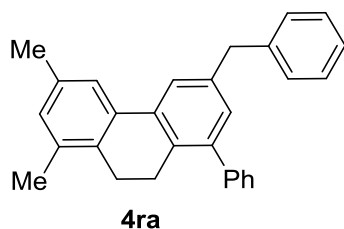
N-(4-Benzylphenyl)acetamide (4oa).^[3] (31 mg, 69%). Isolated by preparative TLC (ethyl acetate:hexane = 1:1, $R_f = 0.4$); ^1H NMR (500 MHz, CDCl_3) δ 7.43 (d, $J = 8.4$ Hz, 2H), 7.32-7.29 (m, 2H), 7.23-7.15 (m, 5H), 7.13 (br, 1H), 3.97 (s, 2H), 2.18 (s, 3H); ^{13}C NMR (125 MHz, CDCl_3) δ 168.2, 141.1, 137.2, 135.9, 129.4, 128.9, 128.5, 126.1, 120.1, 41.3, 24.6; EI-MS (m/z): 225.1.



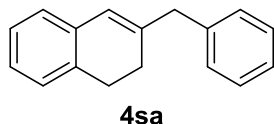
5-Benzyl-1-methyl-1H-indole (4pa). (30 mg, 68%). Isolated by preparative TLC (ethyl acetate:hexane = 1:2, $R_f = 0.4$); ^1H NMR (500 MHz, CDCl_3) δ 7.47 (s, 1H), 7.32-7.25 (m, 5H), 7.22-7.19 (m, 1H), 7.10 (dd, $J = 8.4, 1.4$ Hz, 1H), 7.05 (d, $J = 3.0$ Hz, 1H), 6.45 (d, $J = 3.0$ Hz, 1H), 4.12 (s, 2H), 3.80 (s, 3H); ^{13}C NMR (125 MHz, CDCl_3) δ 142.4, 135.5, 132.0, 129.0, 128.9, 128.7, 128.3, 125.8, 123.0, 120.8, 109.2, 100.6, 42.0, 32.9; EI-MS (m/z): 221.2.



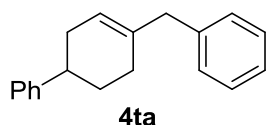
2-Benzyl-9-methyl-9H-carbazole (4qa). (40 mg, 73%). Isolated by preparative TLC (ethyl acetate:hexane = 1:2, R_f = 0.3); ^1H NMR (500 MHz, CDCl_3) δ 8.10 (d, J = 7.8 Hz, 1H), 8.05 (d, J = 7.8 Hz, 1H), 7.50 (td, J = 7.6, 1.0 Hz, 1H), 7.41 (d, J = 8.2 Hz, 1H), 7.34 (t, J = 7.2 Hz, 2H), 7.32-7.30 (m, 2H), 7.28-7.25 (m, 3H), 7.15 (dd, J = 8.0, 1.2 Hz, 1H), 4.25 (s, 2H), 3.83 (s, 3H); ^{13}C NMR (125 MHz, CDCl_3) δ 141.7, 141.5, 141.2, 139.1, 129.0, 128.5, 126.1, 125.3, 122.8, 121.1, 120.4, 120.3, 120.1, 118.9, 108.8, 108.4, 42.7, 29.1; EI-MS (m/z): 271.1.



3-Benzyl-6,8-dimethyl-1-phenyl-9,10-dihydrophenanthrene (4ra). (54 mg, 72%). Isolated by preparative TLC (hexane, R_f = 0.5); ^1H NMR (500 MHz, CDCl_3) δ 7.64 (s, 1H), 7.48 (s, 1H), 7.46-7.43 (m, 2H), 7.39-7.36 (m, 3H), 7.35-7.30 (m, 4H), 7.25-7.22 (m, 1H), 7.11 (s, 1H), 7.00 (s, 1H), 4.10 (s, 2H), 2.80-2.77 (m, 2H), 2.68-2.65 (m, 2H), 2.41 (s, 3H), 2.32 (s, 3H); ^{13}C NMR (125 MHz, CDCl_3) δ 141.6, 141.3, 140.9, 138.8, 135.7, 135.5, 134.9, 134.8, 133.1, 132.7, 130.2, 129.5, 129.4, 128.9, 128.5, 128.0, 126.9, 126.1, 124.3, 122.8, 42.0, 26.0, 24.5, 21.3, 19.7; HRMS (APCI) calcd for $\text{C}_{29}\text{H}_{27}$ [$\text{M} + \text{H}^+$], 375.2107; found: 375.2110.



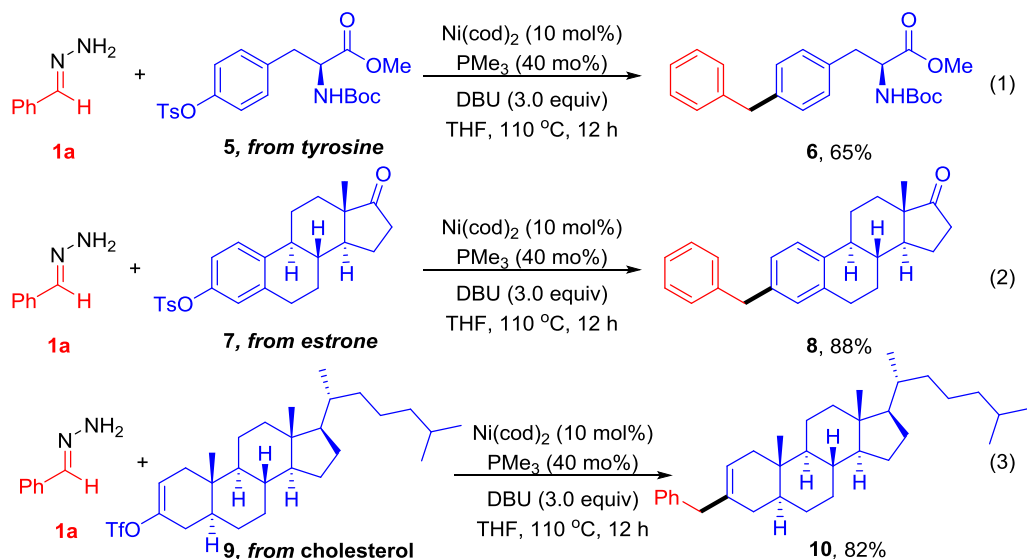
3-Benzyl-1,2-dihydronaphthalene (4sa). (22 mg, 51%). Isolated by preparative TLC (hexane, R_f = 0.5); ^1H NMR (500 MHz, CDCl_3) δ 7.34-7.31 (m, 2H), 7.28-7.21 (m, 3H), 7.17-7.14 (m, 1H), 7.12-7.09 (m, 2H), 7.03-7.01 (m, 1H), 6.29 (s, 1H), 3.54 (s, 2H), 2.82-2.79 (m, 2H), 2.24-2.21 (m, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 140.9, 139.4, 134.7, 134.4, 129.0, 128.4, 127.2, 126.4, 126.3, 126.2, 125.6, 124.0, 44.0, 28.2, 27.0; EI-MS (m/z): 220.2.



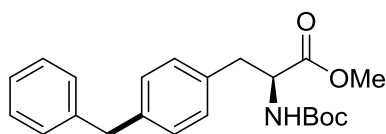
4-Benzyl-1,2,3,6-tetrahydro-1,1'-biphenyl (4ta). (34 mg, 68%). Isolated by preparative TLC (hexane, R_f = 0.6); ^1H NMR (500 MHz, CDCl_3) δ 7.34-7.30 (m, 4H), 7.25-7.21 (m, 6H), 5.59-5.57 (m, 1H), 3.34 (s, 2H), 2.80-2.74 (m, 1H), 2.36-2.32 (m, 1H), 2.24-2.17 (m, 1H), 2.13-2.09 (m, 1H), 2.04-2.00 (m, 1H), 1.96-1.91 (m, 1H), 1.81-1.73 (m, 1H); ^{13}C NMR (125 MHz, CDCl_3) δ 147.2, 140.2, 137.2, 129.0, 128.3, 128.2, 126.9, 126.0, 122.6,

44.3, 40.1, 33.6, 30.0, 28.8; EI-MS (*m/z*): 248.3; HRMS (APCI) calcd for C₁₉H₁₉ [M - H⁺], 247.1481; found: 247.1483.

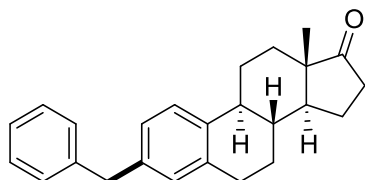
4. Synthesis of products 6, 8 and 10



The substrate **9** was prepared according to the reported literature^[7]. The synthetic procedure was similar to the general procedure for **4**.

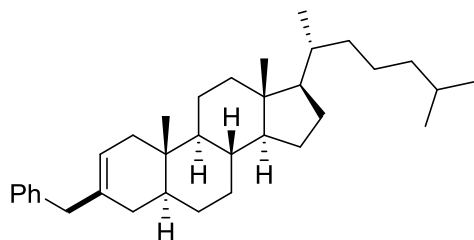


Methyl (S)-3-(4-benzylphenyl)-2-((tert-butoxycarbonyl)amino)propanoate (6). (48 mg, 65%). Isolated by preparative TLC (methanol:dichloromethane = 1:20, *R_f* = 0.5); ¹H NMR (500 MHz, CDCl₃) δ 7.32-7.29 (m, 2H), 7.24-7.19 (m, 3H), 7.13 (d, *J* = 8.0 Hz, 2H), 7.06 (d, *J* = 8.0 Hz, 2H), 4.97 (d, *J* = 8.2 Hz, 1H), 4.61-4.57 (m, 1H), 3.97 (s, 2H), 3.73 (s, 3H), 3.12-3.01 (m, 2H), 1.43 (s, 9H); ¹³C NMR (125 MHz, CDCl₃) δ 172.4, 155.1, 141.0, 139.9, 133.7, 129.4, 129.1, 128.9, 128.5, 126.1, 79.9, 54.4, 52.2, 41.5, 38.0, 28.3; HRMS (APCI) calcd for C₂₂H₂₇O₄NNa [M + Na⁺], 392.1832; found: 392.1829.



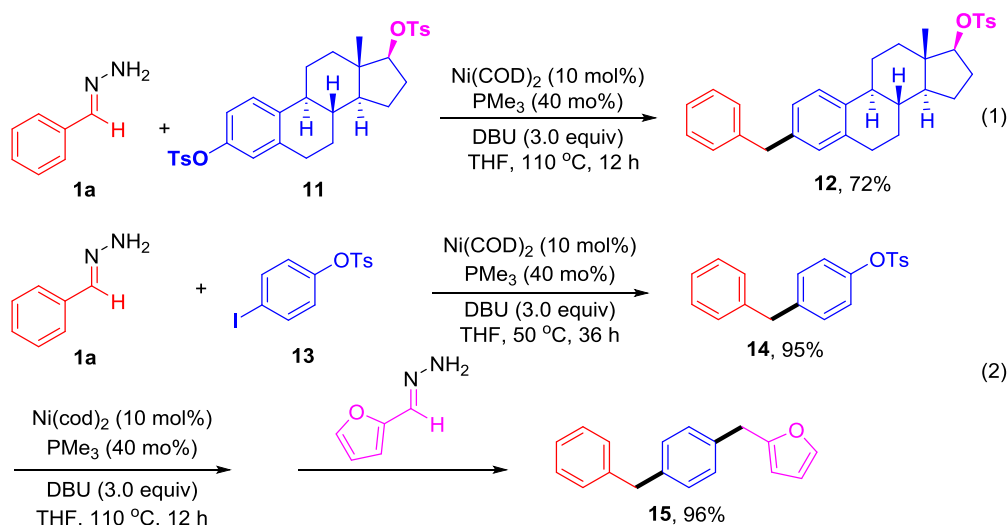
(8R,9S,13S,14S)-3-Benzyl-13-methyl-6,7,8,9,11,12,13,14,15,16-decahydro-17H-cyclopenta[a]phenanthren-17-one (8). (61 mg, 88%). Isolated by preparative TLC (ethyl acetate:hexane = 1:40, *R_f* = 0.5); ¹H NMR (500 MHz, CDCl₃) δ 7.34-7.31 (m, 2H), 7.25-7.21 (m, 4H), 7.02 (d, *J* = 8.0 Hz, 1H), 6.97 (s, 1H), 3.96 (s, 2H), 2.92-2.90 (m, 2H), 2.56-2.51 (m, 1H), 2.47-2.43 (m, 1H), 2.34-2.29 (m, 1H), 2.21-2.14 (m, 1H), 2.11-1.98 (m, 3H), 1.70-1.60 (m, 2H), 1.58-1.43 (m, 4H), 0.94 (s, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 220.9, 141.2, 138.6, 137.5,

136.5, 129.5, 128.9, 128.5, 126.4, 126.0, 125.5, 50.5, 48.0, 44.3, 41.5, 38.2, 35.9, 31.6, 29.4, 26.6, 25.7, 21.6, 13.9;
EI-MS (m/z): 344.4; HRMS (APCI) calcd for C₂₅H₂₉O [M + H⁺], 345.2213; found: 345.2210.

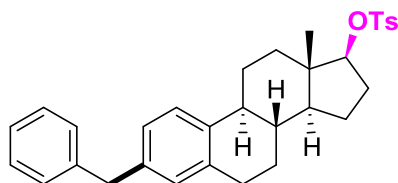


(5S,8R,9S,10S,13R,14S,17R)-3-Benzyl-10,13-dimethyl-17-((R)-6-methylheptan-2-yl)-4,5,6,7,8,9,10,11,12,13,14,15,16,17-tetradecahydro-1H-cyclopenta[a]phenanthrene (10). (75 mg, 82%). Isolated by preparative TLC (hexane, R_f = 0.7); ¹H NMR (500 MHz, CDCl₃) δ 7.31-7.28 (m, 2H), 7.22-7.18 (m, 3H), 5.43-5.41 (m, 1H), 3.27 (s, 2H), 2.02-1.98 (m, 2H), 1.85-1.52 (m, 9H), 1.36-0.97 (m, 18H), 0.93 (d, J = 6.6 Hz, 3H), 0.90 (d, J = 2.2 Hz, 3H), 0.88 (d, J = 2.2 Hz, 3H), 0.72 (s, 3H), 0.67 (s, 3H); ¹³C NMR (125 MHz, CDCl₃) δ 140.5, 135.7, 128.8, 128.2, 125.8, 122.0, 56.5, 56.3, 54.0, 44.2, 42.5, 41.8, 40.1, 40.0, 39.5, 36.2, 35.8, 35.6, 34.4, 33.0, 31.8, 28.7, 28.2, 28.0, 24.2, 23.8, 22.8, 22.6, 21.1, 18.7, 12.0, 11.8; EI-MS (m/z): 460.6; HRMS (APCI) calcd for C₃₄H₅₃ [M + H⁺], 461.4142; found: 461.4140.

5. Chemo-selectivity tests

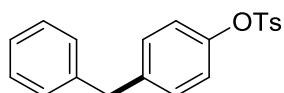


The substrate **11** was prepared according to the reported literature^[8]. The synthetic procedure was similar to the general procedure for **4**.

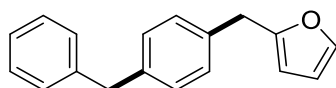


(8R,9S,13S,14S,17S)-3-Benzyl-13-methyl-7,8,9,11,12,13,14,15,16,17-decahydro-6H-cyclopenta[a]phenanthren-17-yl 4-methylbenzenesulfonate (12). (72 mg, 72%). Isolated by preparative TLC (ethyl acetate:hexane = 1:10, R_f = 0.6); ¹H NMR (500 MHz, CDCl₃) δ 7.84 (d, J = 8.2 Hz, 2H), 7.37 (d, J = 8.2 Hz, 2H), 7.32-7.29 (m, 2H),

7.23-7.18 (m, 4H), 6.98 (dd, $J = 8.0, 1.2$ Hz, 1H), 6.93 (s, 1H), 4.38 (t, $J = 8.4$ Hz, 1H), 3.93 (s, 2H), 2.84-2.81 (m, 2H), 2.49 (s, 3H), 2.29-2.24 (m, 1H), 2.21-2.16 (m, 1H), 2.05-1.98 (m, 1H), 1.88-1.79 (m, 2H), 1.77-1.67 (m, 2H), 1.50-1.40 (m, 3H), 1.38-1.31 (m, 1H), 1.20-1.12 (m, 2H), 0.85 (s, 3H); ^{13}C NMR (125 MHz, CDCl_3) δ 144.4, 141.3, 138.5, 137.6, 136.5, 134.3, 129.7, 129.4, 128.9, 128.4, 127.9, 126.3, 126.0, 125.4, 89.9, 49.2, 44.0, 43.3, 41.5, 38.3, 36.2, 29.4, 27.8, 27.1, 25.8, 23.0, 21.7, 11.8; EI-MS (m/z): 328.3 (-TsOH); HRMS (APCI) calcd for $\text{C}_{32}\text{H}_{36}\text{O}_3\text{NaS}$ $[\text{M} + \text{Na}^+]$, 523.2277; found: 523.2284.



4-Benzylphenyl 4-methylbenzenesulfonate (14). (62 mg, 92%). Isolated by preparative TLC (ethyl acetate:hexane = 1:10, $R_f = 0.5$); ^1H NMR (500 MHz, CDCl_3) δ 7.73 (d, $J = 8.2$ Hz, 2H), 7.33-7.31 (m, 4H), 7.25-7.22 (m, 1H), 7.16 (d, $J = 8.2$ Hz, 2H), 7.11 (d, $J = 8.6$ Hz, 2H), 6.92 (d, $J = 8.6$ Hz, 2H), 3.96 (s, 2H), 2.47 (s, 3H); ^{13}C NMR (125 MHz, CDCl_3) δ 148.0, 145.3, 140.4, 140.2, 132.6, 130.0, 129.7, 128.9, 128.6, 128.5, 126.3, 122.3, 41.2, 21.7; EI-MS (m/z): 338.1.



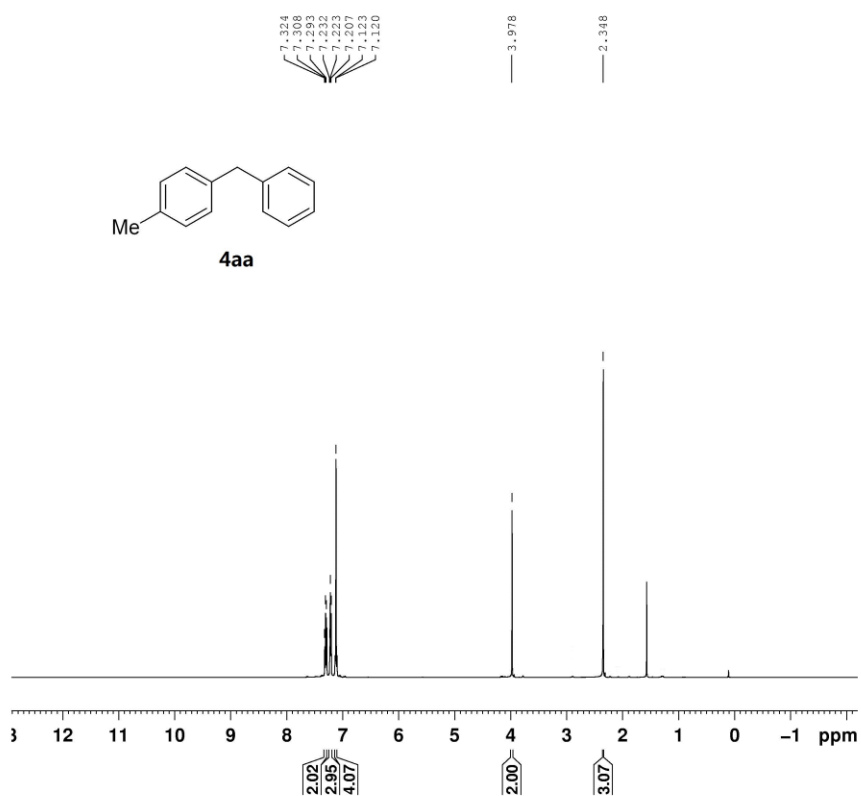
2-(4-Benzylbenzyl)furan (15). (48 mg, 96%). Isolated by preparative TLC (hexane, $R_f = 0.6$); ^1H NMR (500 MHz, CDCl_3) δ 7.35-7.34 (m, 1H), 7.33-7.30 (m, 2H), 7.24-7.20 (m, 3H), 7.18 (d, $J = 8.2$ Hz, 2H), 7.16 (d, $J = 8.2$ Hz, 2H), 6.32-6.31 (m, 1H), 6.03-6.02 (m, 1H), 3.99 (s, 2H), 3.97 (s, 2H); ^{13}C NMR (125 MHz, CDCl_3) δ 154.7, 141.5, 141.2, 139.3, 135.9, 129.1, 128.9, 128.8, 128.5, 126.1, 110.2, 106.2, 41.6, 34.1; EI-MS (m/z): 248.1; HRMS (APCI) calcd for $\text{C}_{18}\text{H}_{17}\text{O}$ $[\text{M} + \text{H}^+]$, 249.1274; found: 249.1276.

6. References

- [1] Phenol tosylates were easily synthesized according to the literatures, see: (a) Tang, Z.-Y.; Hu, Q.-S. Room-Temperature Ni(0)-Catalyzed Cross-Coupling Reactions of Aryl Arenesulfonates with Arylboronic Acids. *J. Am. Chem. Soc.* **2004**, *126*, 3058-3059; (b) Liao, L.-L.; Gui, Y.-Y.; Zhang, X.-B.; Shen, G.; Liu, H.-D.; Zhou, W.-J.; Li, J.; Yu, D.-G. Phosphorylation of Alkenyl and Aryl C-O Bonds via Photoredox/Nickel Dual Catalysis. *Org. Lett.* **2017**, *19*, 3735-3738; (c) Esguerra, K. V. N.; Lumb, J.-P. Selectivity in the Aerobic Dearomatization of Phenols: Total Synthesis of Dehydronornuciferine by Chemo- and Regioselective Oxidation. *Angew. Chem. Int. Ed.* **2018**, *57*, 1514-1518.
- [2] Vasilopoulos, A.; Zultanski, S. L.; Stahl, S. S. Feedstocks to Pharmacophores: Cu-Catalyzed Oxidative Arylation of Inexpensive Alkylarenes Enabling Direct Access to Diarylalkanes. *J. Am. Chem. Soc.* **2017**, *139*, 7705-7708.
- [3] Srimani, D.; Bej, A.; Sarkar, A. Palladium Nanoparticle Catalyzed Hiyama Coupling Reaction of Benzyl Halides. *J. Org. Chem.* **2010**, *75*, 4296-4299.

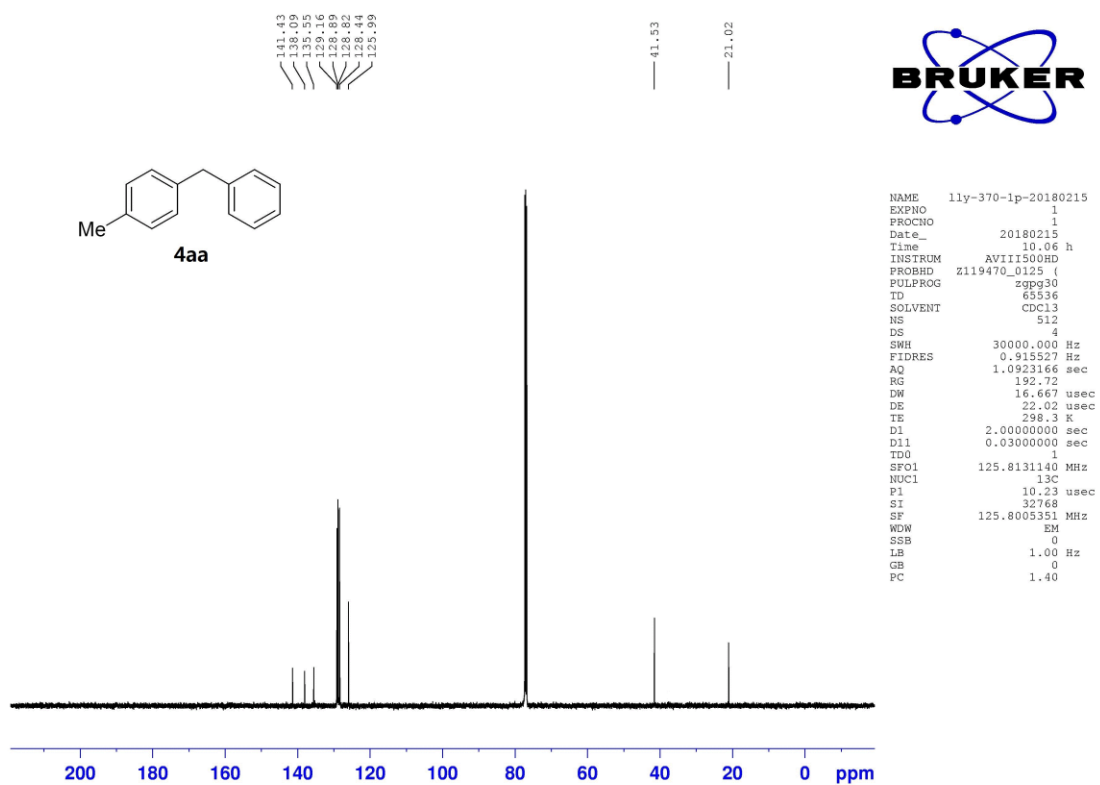
- [4] Ackerman, L. K. G.; Anka-Lufford, L. L.; Naodovic, M.; Weix, D. J. Cobalt Co-Catalysis for Cross-Electrophile Coupling: Diarylmethanes from Benzyl Mesylates and Aryl Halides. *Chem. Sci.* **2015**, *6*, 1115-1119.
- [5] Burns, M. J.; Fairlamb, I. J. S.; Kapdi, A. R.; Sehnal, P.; Taylor, R. J. K. Simple Palladium(II) Precatalyst for Suzuki–Miyaura Couplings: Efficient Reactions of Benzylic, Aryl, Heteroaryl, and Vinyl Coupling Partners. *Org. Lett.* **2007**, *9*, 5397-5400.
- [6] Nakajima, K.; Nojima, S.; Nishibayashi, Y. Nickel- and Photoredox-Catalyzed Cross-Coupling Reactions of Aryl Halides with 4-Alkyl-1,4-dihydropyridines as Formal Nucleophilic Alkylation Reagents. *Angew. Chem. Int. Ed.* **2016**, *55*, 14106-14110.
- [7] Yoshimura, F.; Abe, T.; Tanino, K. Synthesis of Aryl Amine Derivatives from Benzyl Nitriles via Electrocyclization of in Situ Generated N-Silyl Ketene Imines. *Org. Lett.* **2016**, *18*, 1630-1633.
- [8] Wang, F.; Chiba, K.; Tada, M. Facile Deoxygenation of Phenols and Enols Using Sodium Borohydride–Nickel Chloride. *J. Chem. Soc. Perkin .Trans. 1.* **1992**, *0*, 1897-1900.

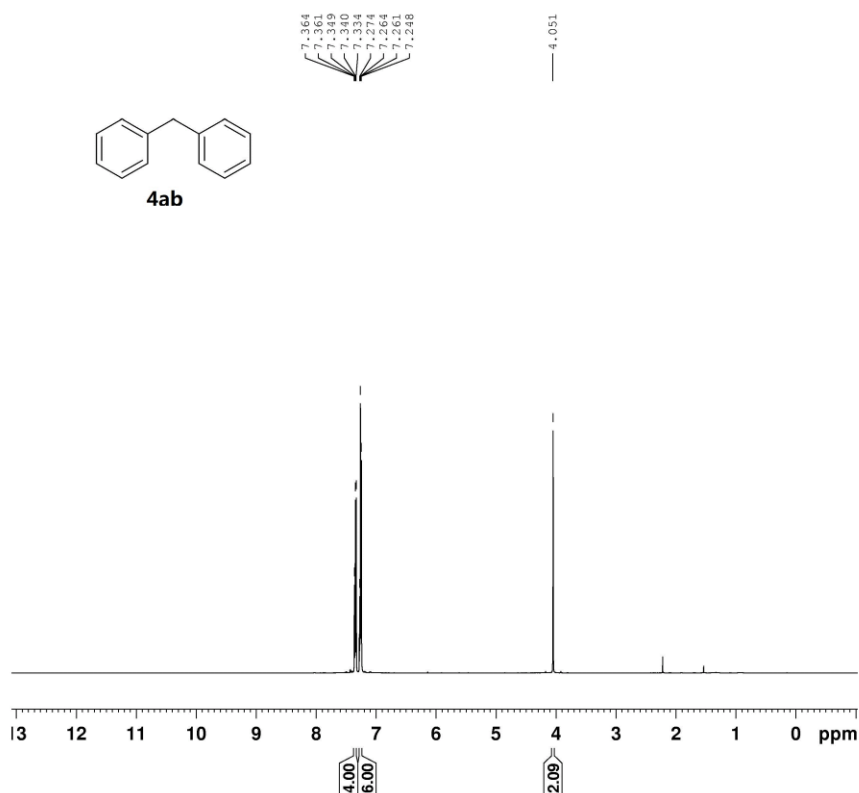
7. Copies of ^1H NMR and ^{13}C NMR spectra for all products.



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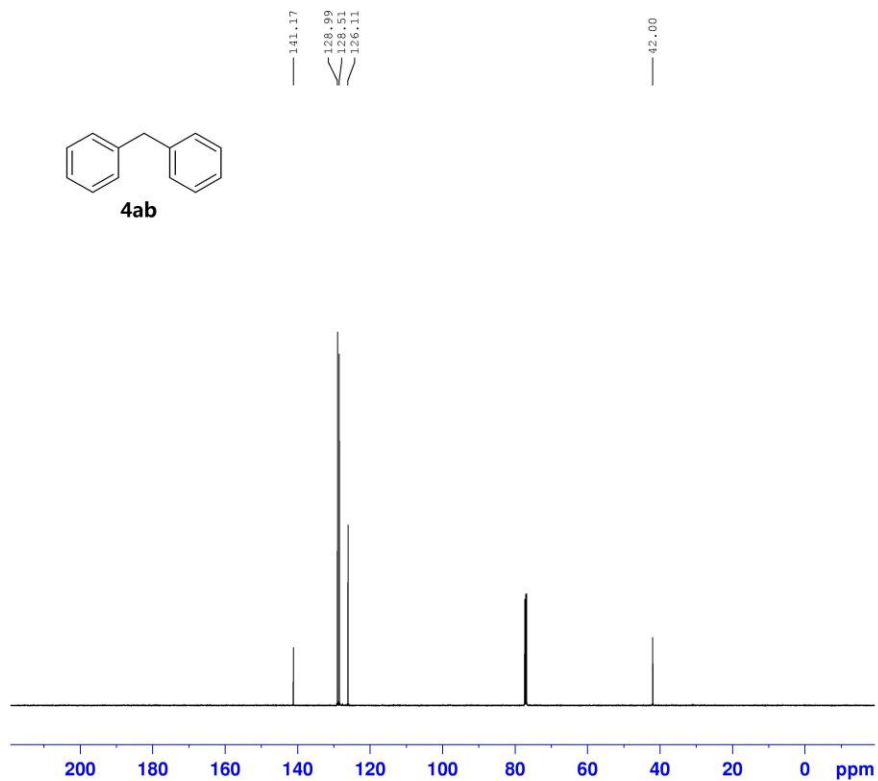
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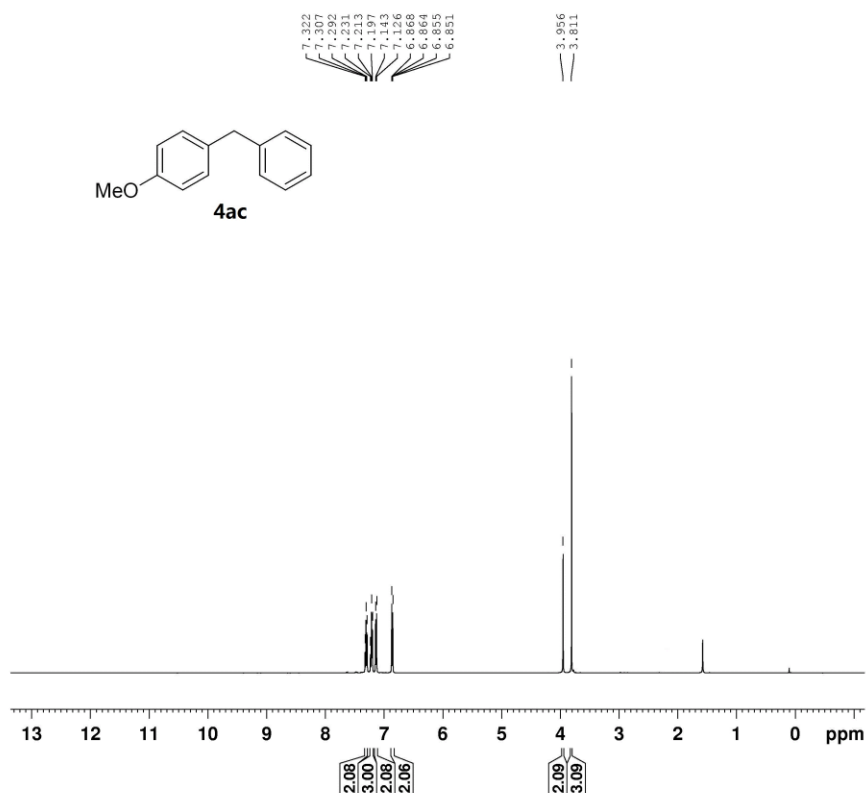
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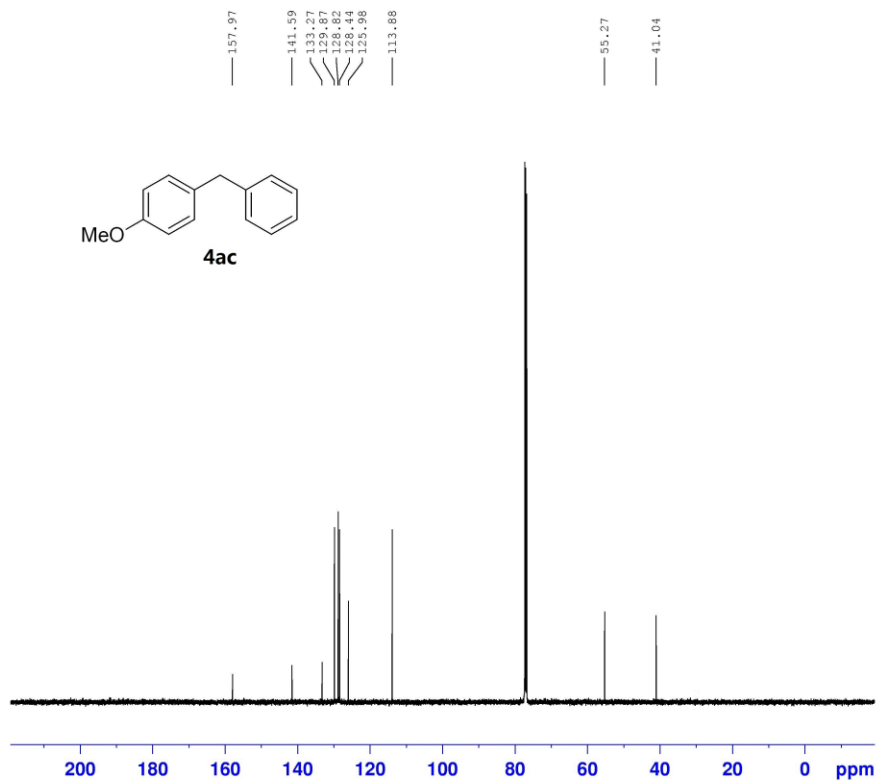
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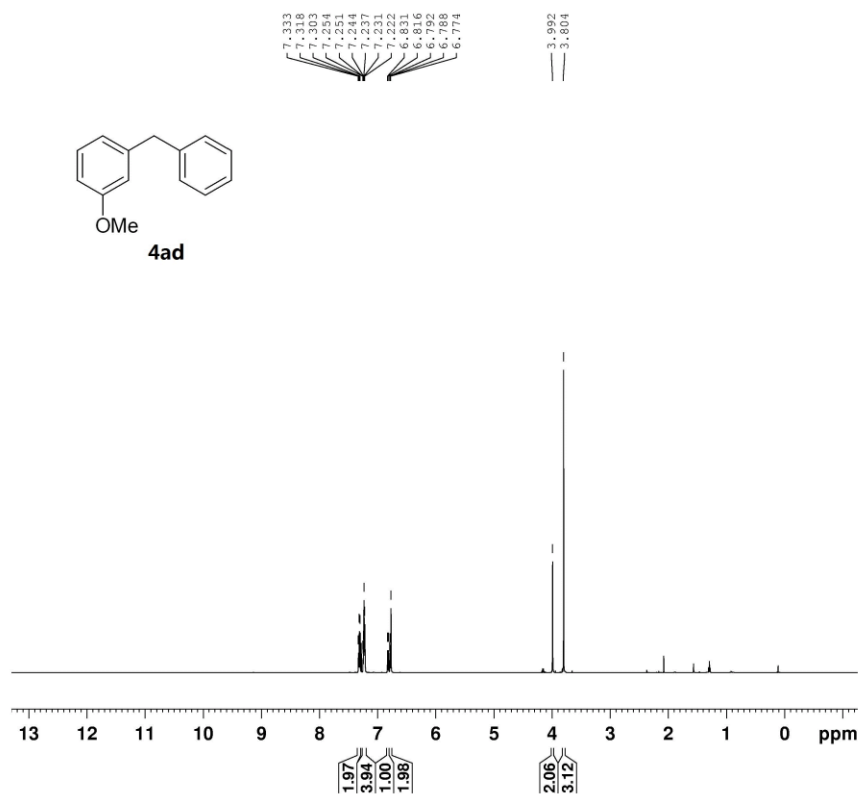
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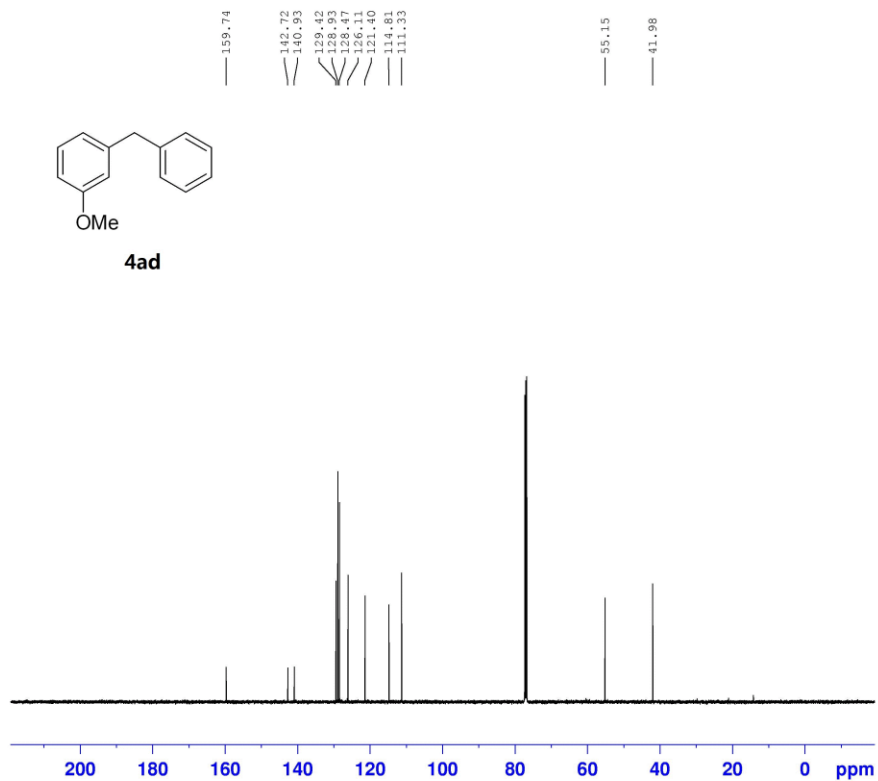
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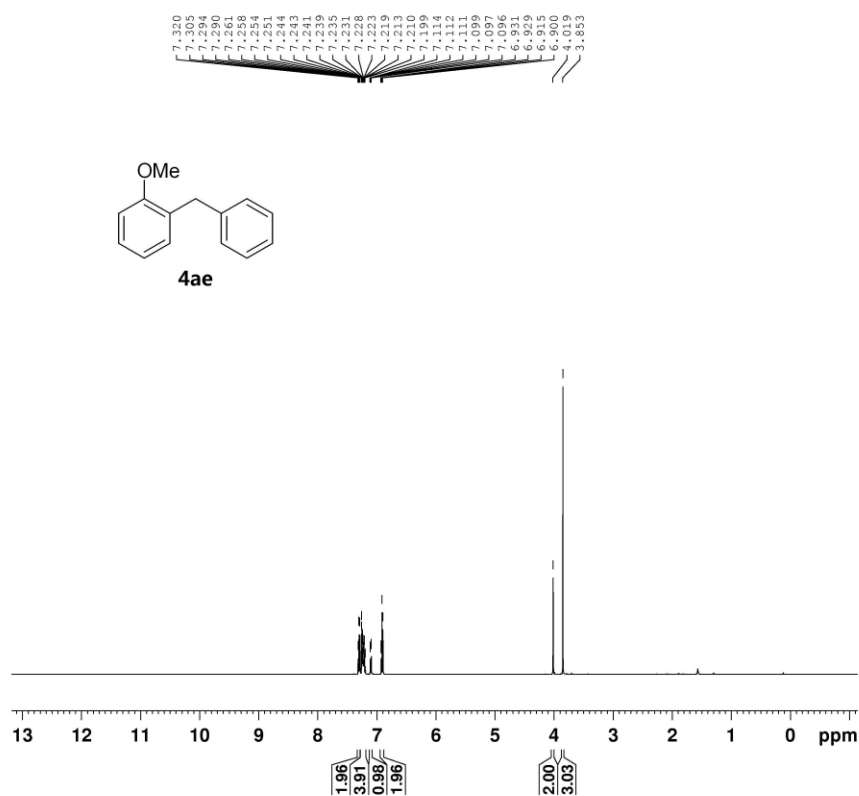
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TD0        1
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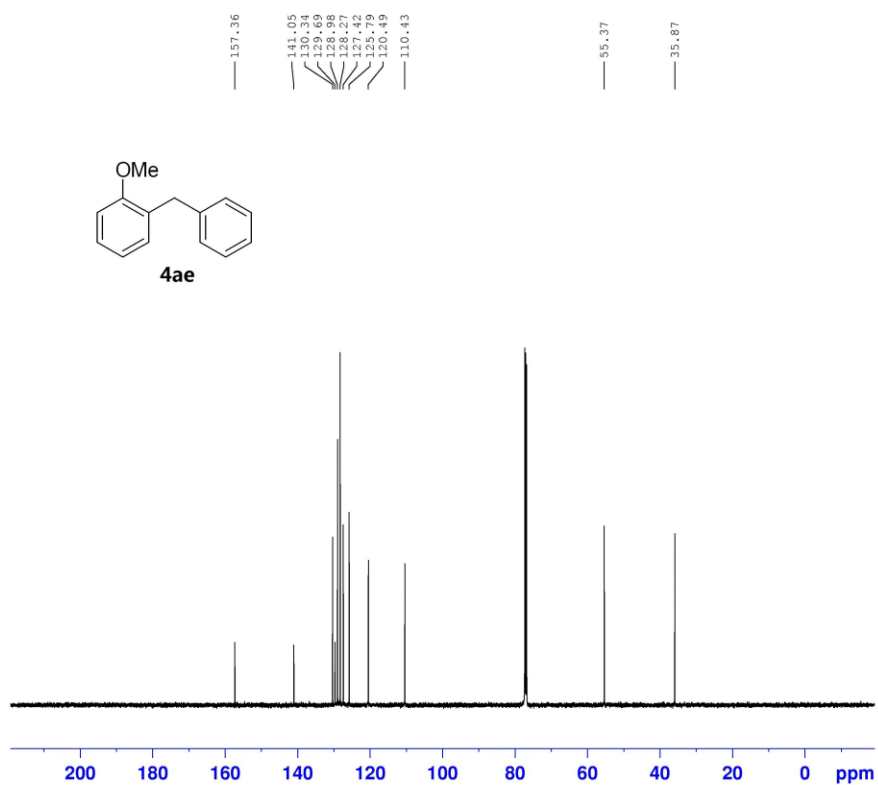
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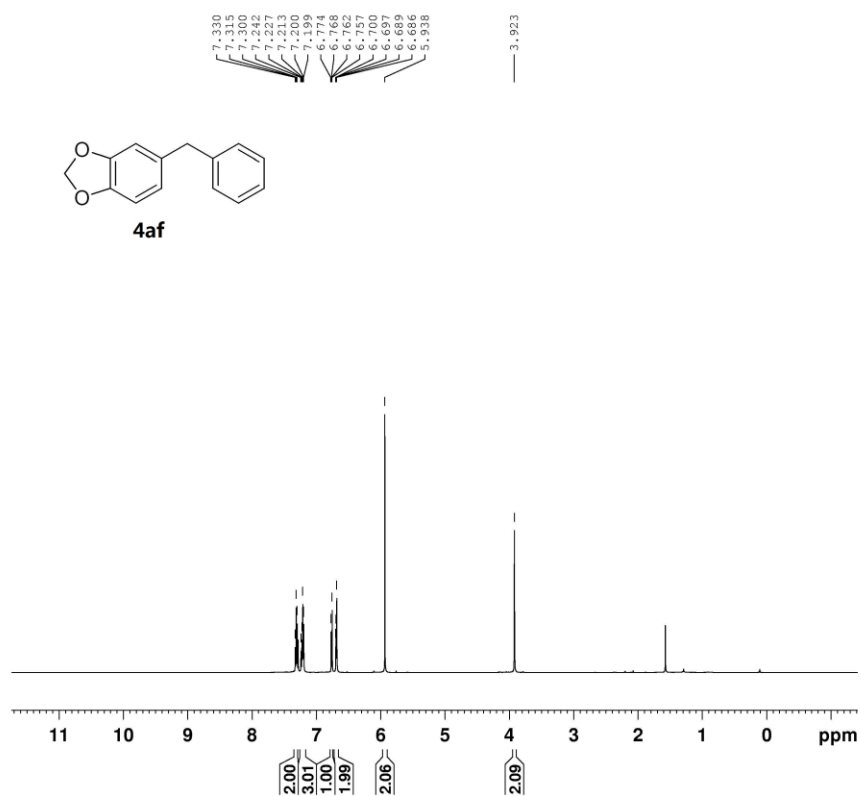
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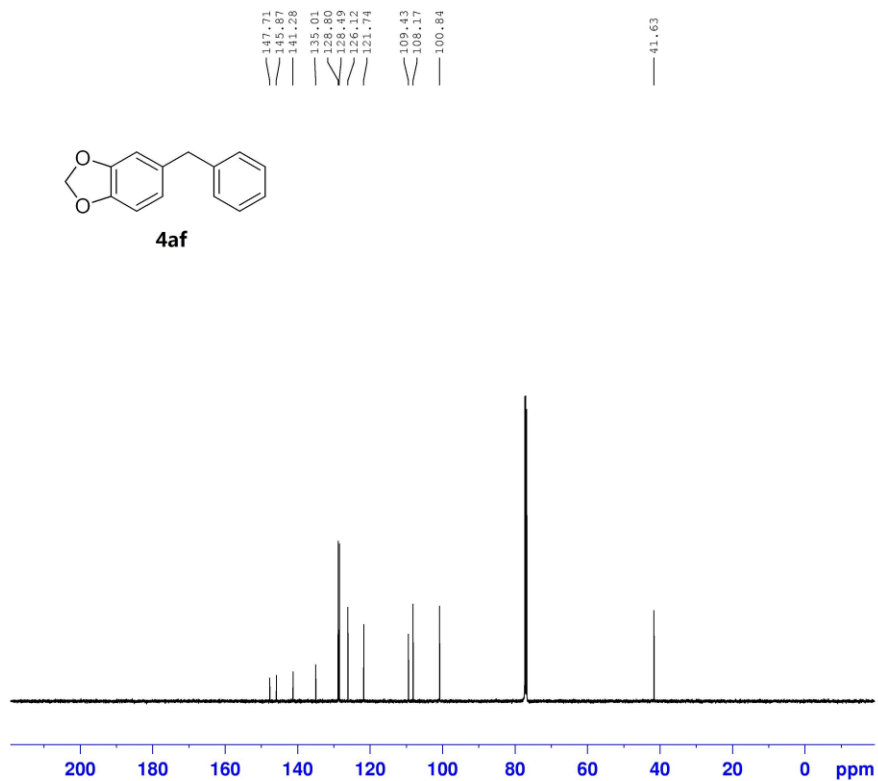
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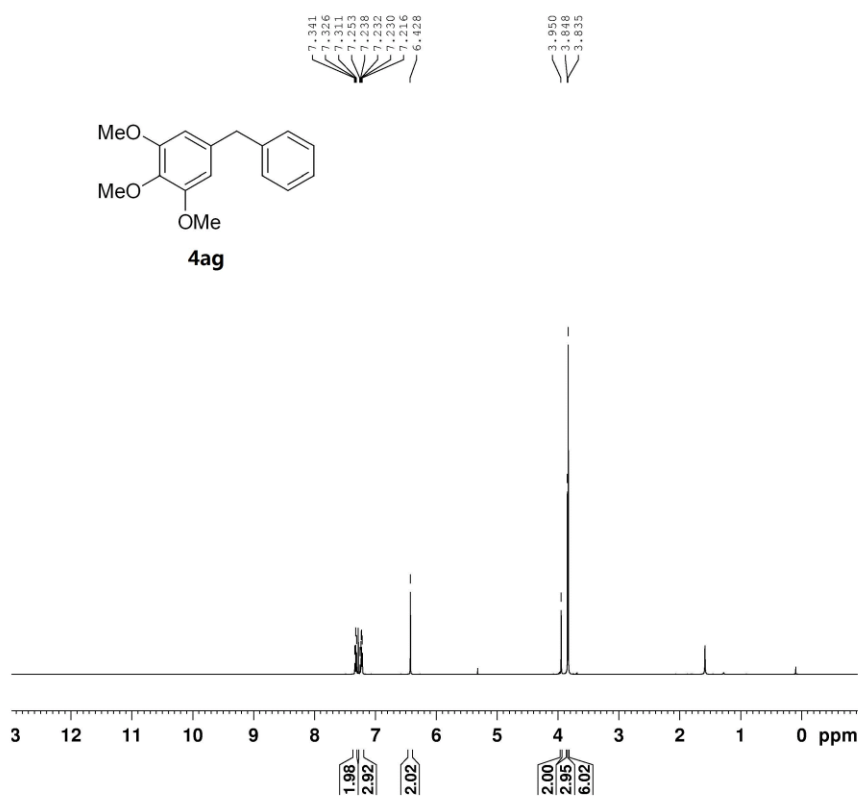
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DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         106.56
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



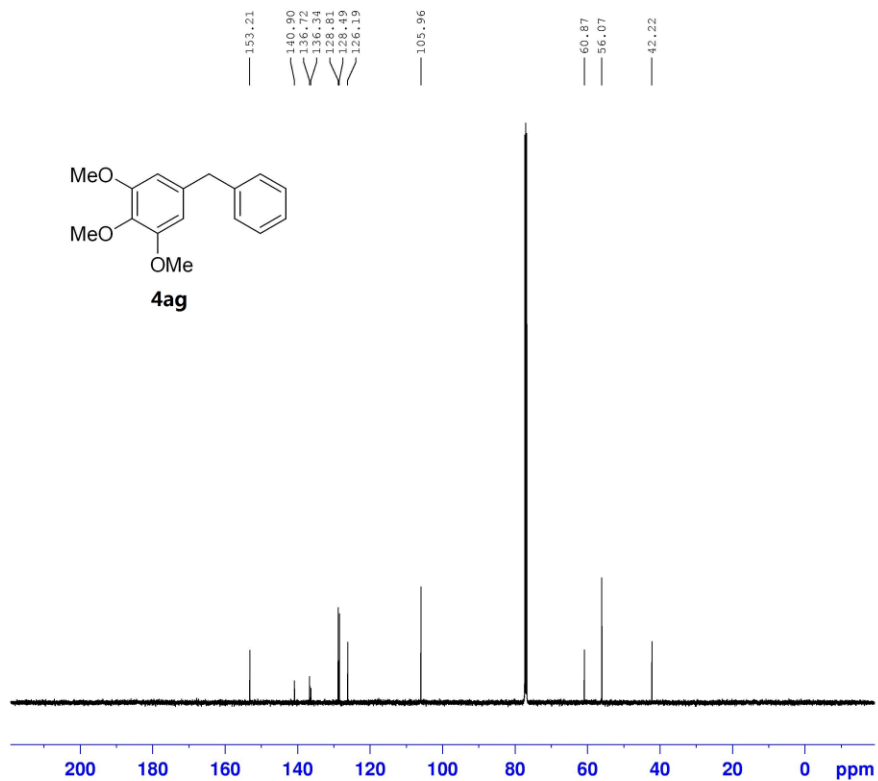
```

NAME      lly-326-1p-20171204
EXPNO     1
PROCNO    1
Date_     20171204
Time      8.14 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SFO1       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



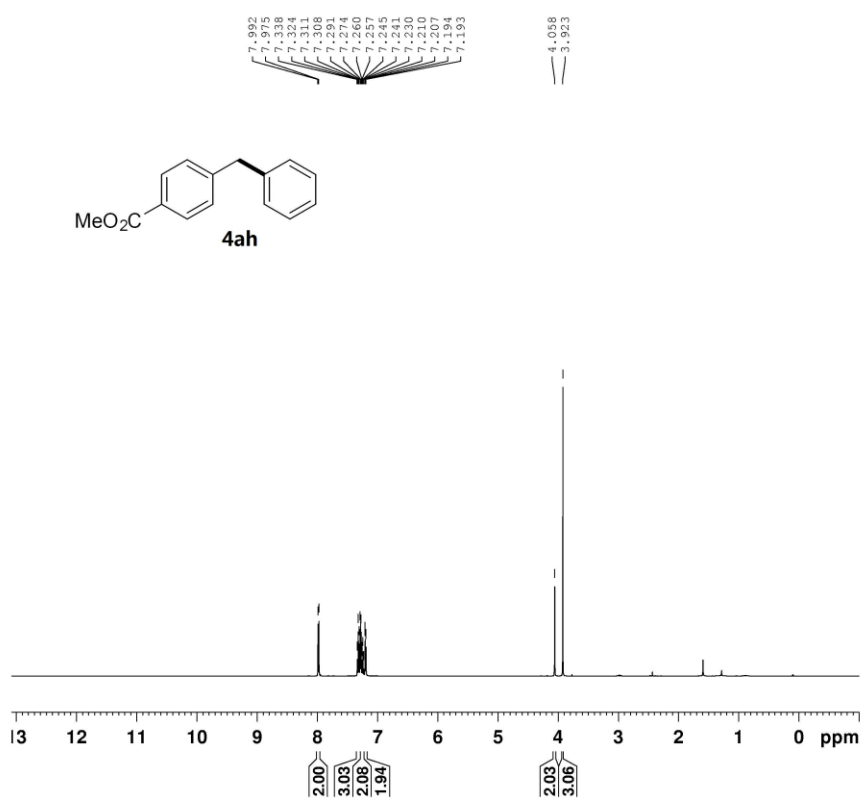
```

NAME      lly-372-3p-20180217
EXPNO     1
PROCNO    1
Date_     20180217
Time      7.17 h
INSTRUM   AVIII500HD
PROBHD    z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         169.11
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



```

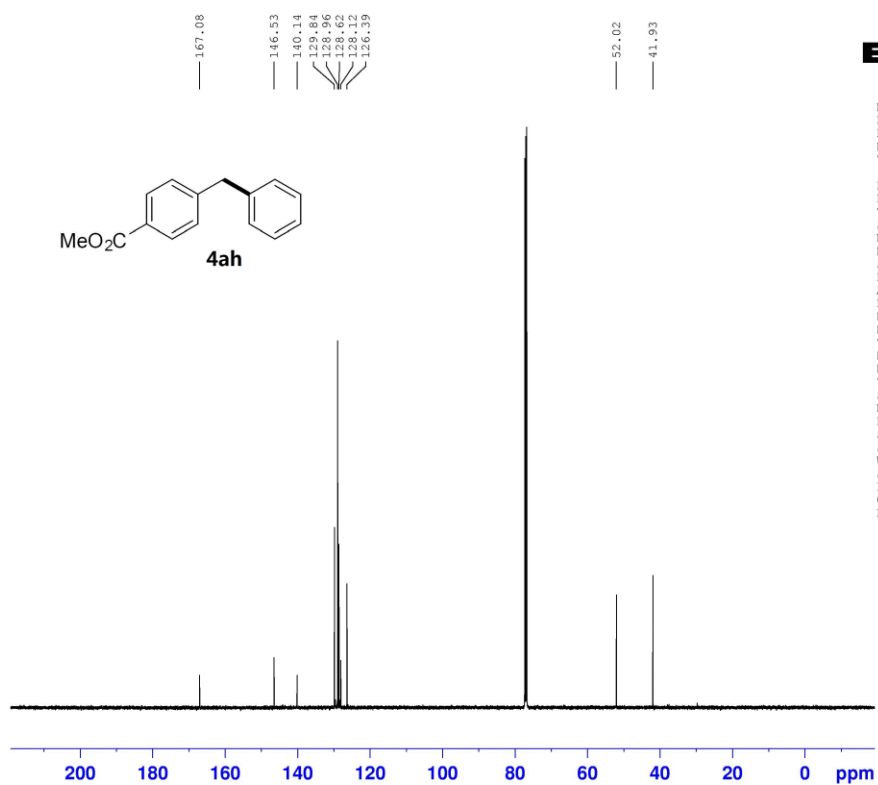
NAME      11y-372-3p-20180217
EXPNO     1
PROCNO     1
Date_      20180217
Time       6.59 h
INSTRUM    AVIII500HD
PROBHD     Z119470_0125 (
PULPROG    zgpg30
TD         65536
SOLVENT     CDCl3
NS         512
DS         4
SWH         30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SFO1       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW         EM
SSB         0
LB         1.00 Hz
GB         0
PC         1.40
  
```



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```

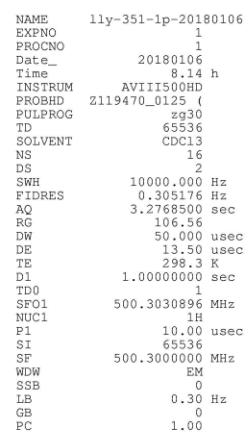
NAME 11y-357-4bp-20180303
EXPNO 1
PROCNO 1
Date_ 20180303
Time 13.31 h
INSTRUM AVIII500HD
PROBHD Z119470_0125 (
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
SWH 10000.000 Hz
FIDRES 0.305176 Hz
AQ 3.2768500 sec
RG 106.56
DW 50.000 usec
DE 13.50 usec
TE 298.3 K
D1 1.00000000 sec
TD0 1
SF01 500.3030896 MHz
NUC1 1H
P1 10.00 usec
SI 65536
SF 500.3000000 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
  
```

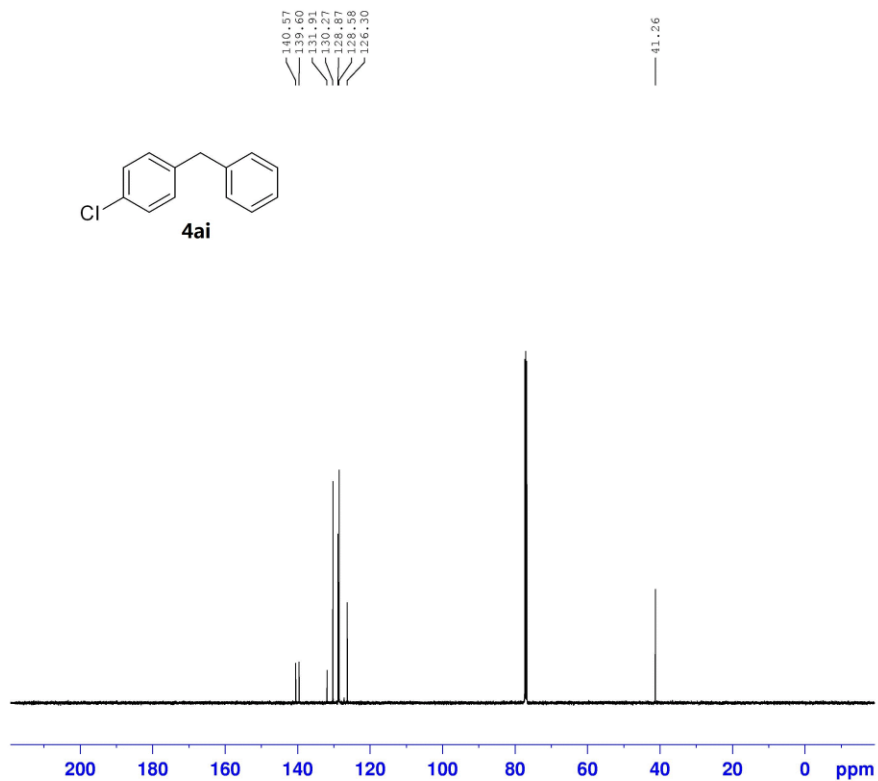


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```

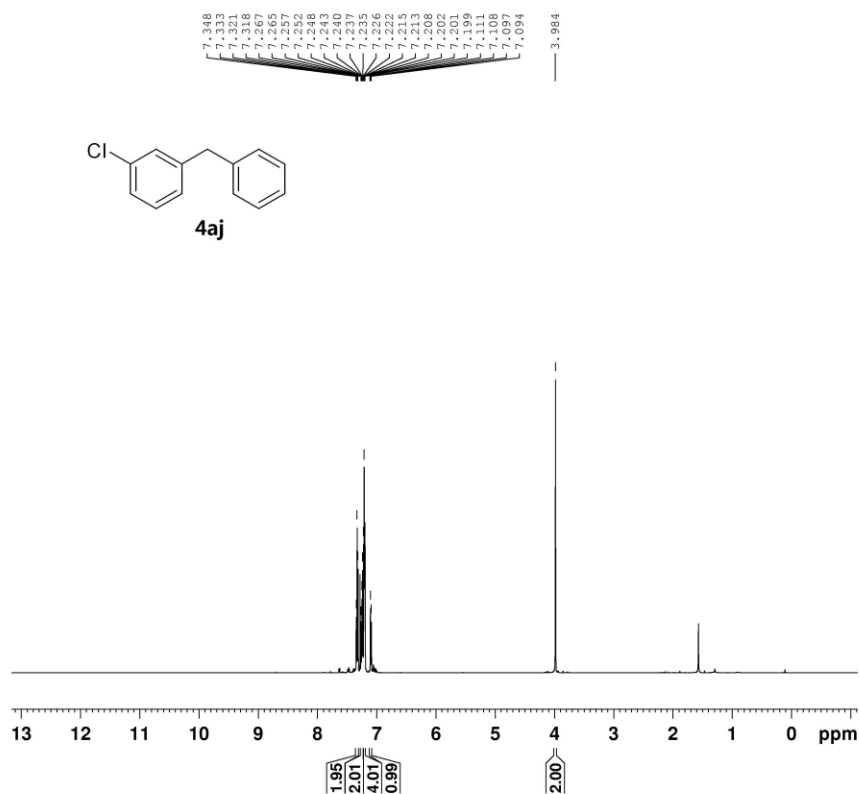
NAME      lly-357-4bp-20180303
EXPNO     2
PROCNO    1
Date_     20180303
Time      14.26 h
INSTRUM    AVIII500HD
PROBHD     Z119470_0125 (
PULPROG    zgpg30
TD         65536
SOLVENT    CDCl3
NS         1024
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SF01       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```





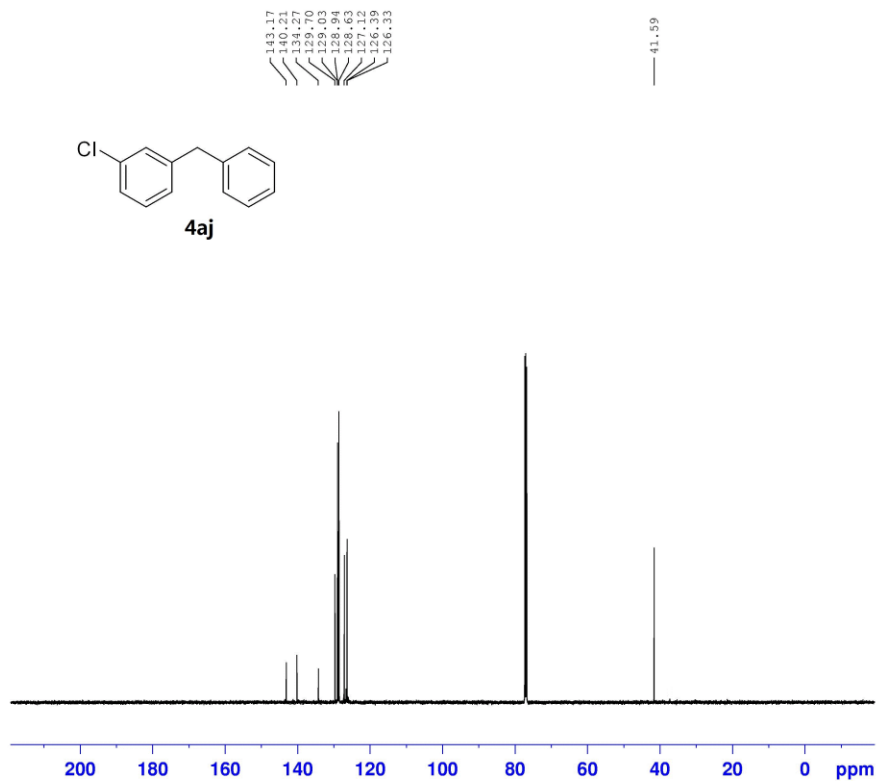
```

NAME      lly-351-1p-20180106
EXPNO     1
PROCNO    1
Date_     20190106
Time      1.13 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT    CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SFO1       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



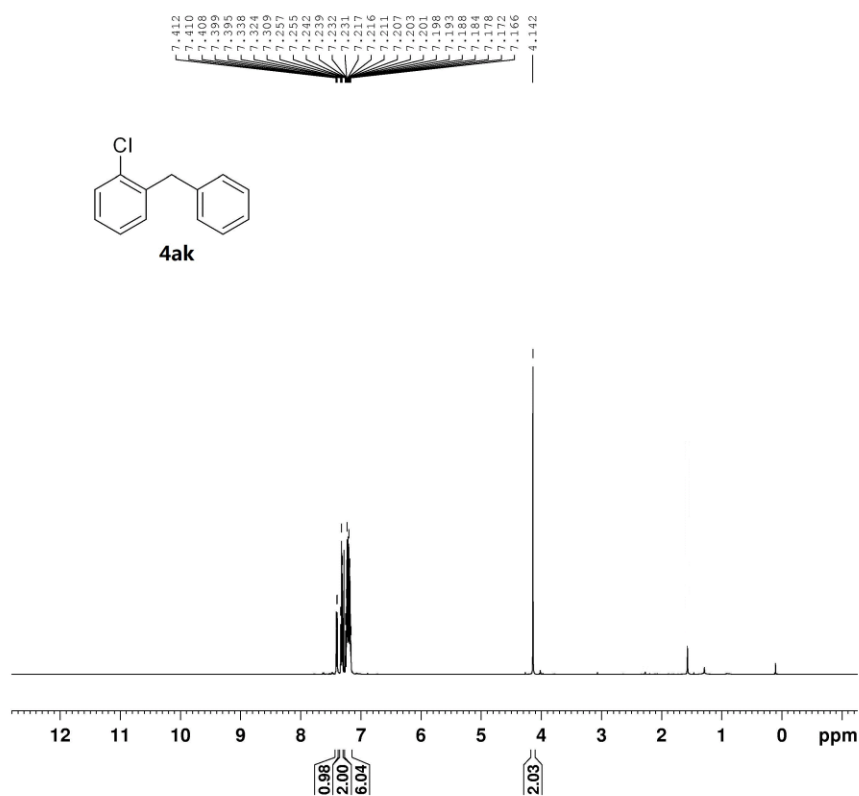
```

NAME      lly-351-3p-20180107
EXPNO     1
PROCNO    1
Date_     20170107
Time      6.20 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         106.56
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



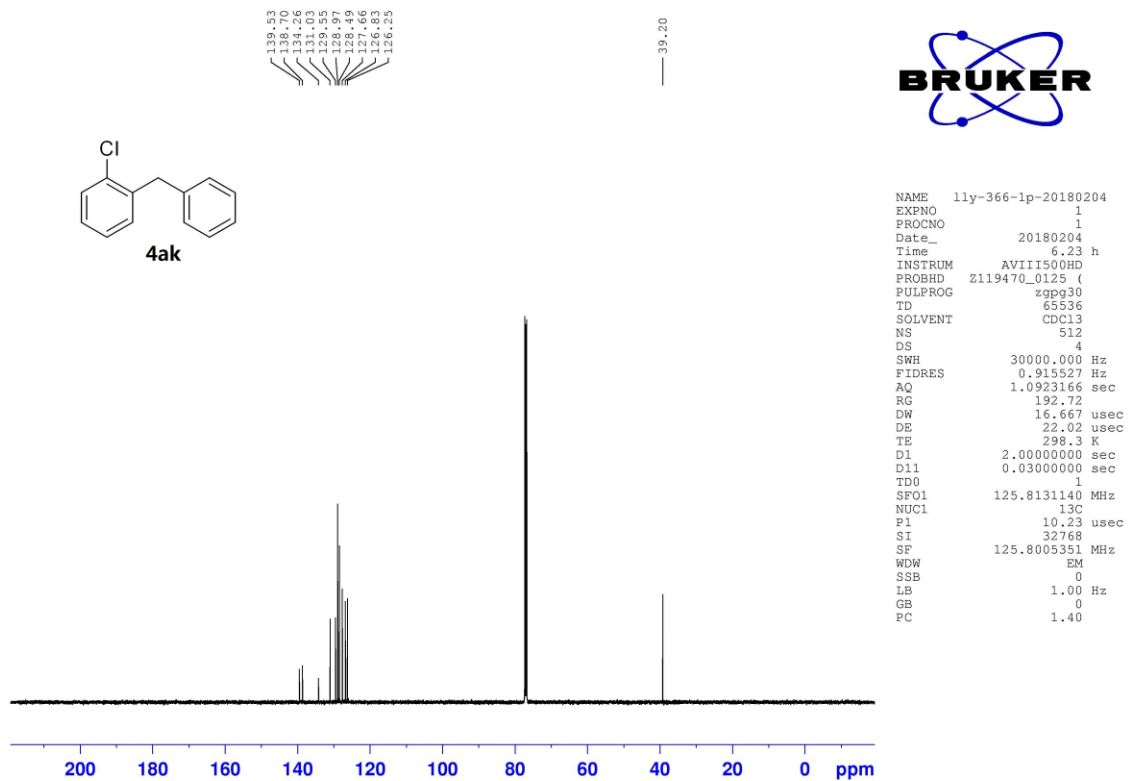
```

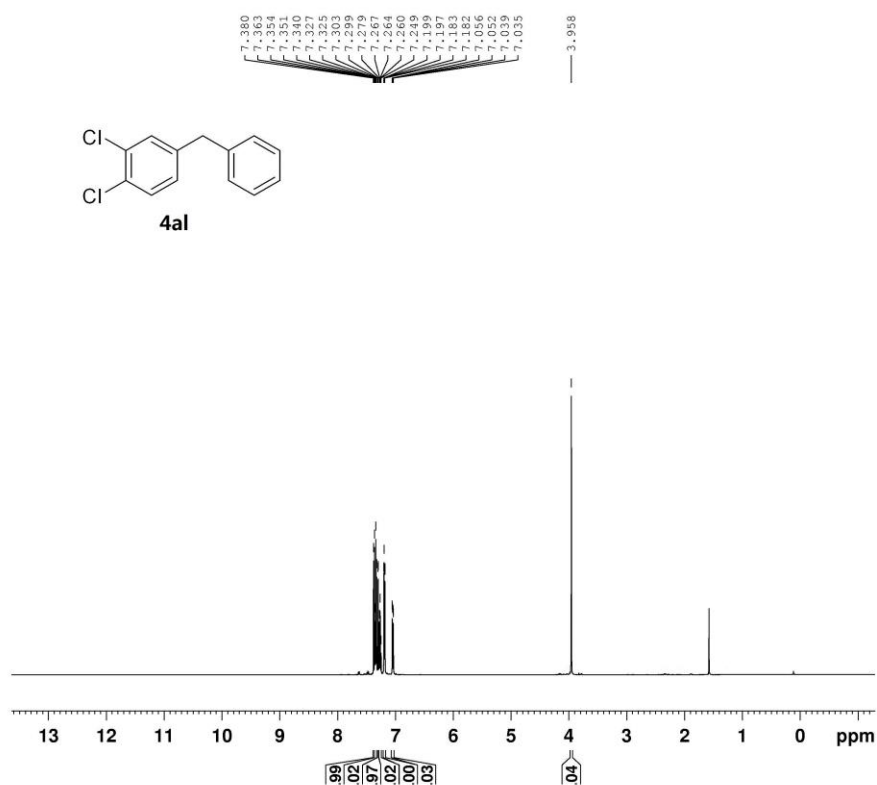
NAME      11y-351-3p-20180107
EXPNO     1
PROCNO    1
Date_     20180107
Time      10.42 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT    CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SF01       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



```

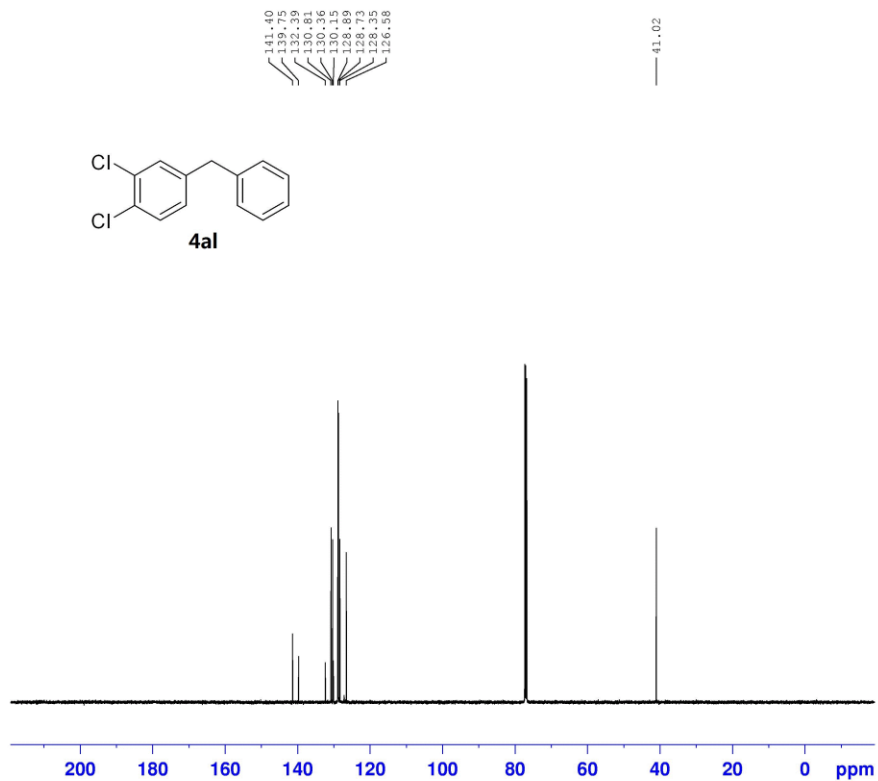
NAME      lly-366-1p-20180204
EXPNO     1
PROCNO    1
Date_     20180204
Time      11.48h
INSTRUM   AVIIS500HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT    CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         106.56
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SF01       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```





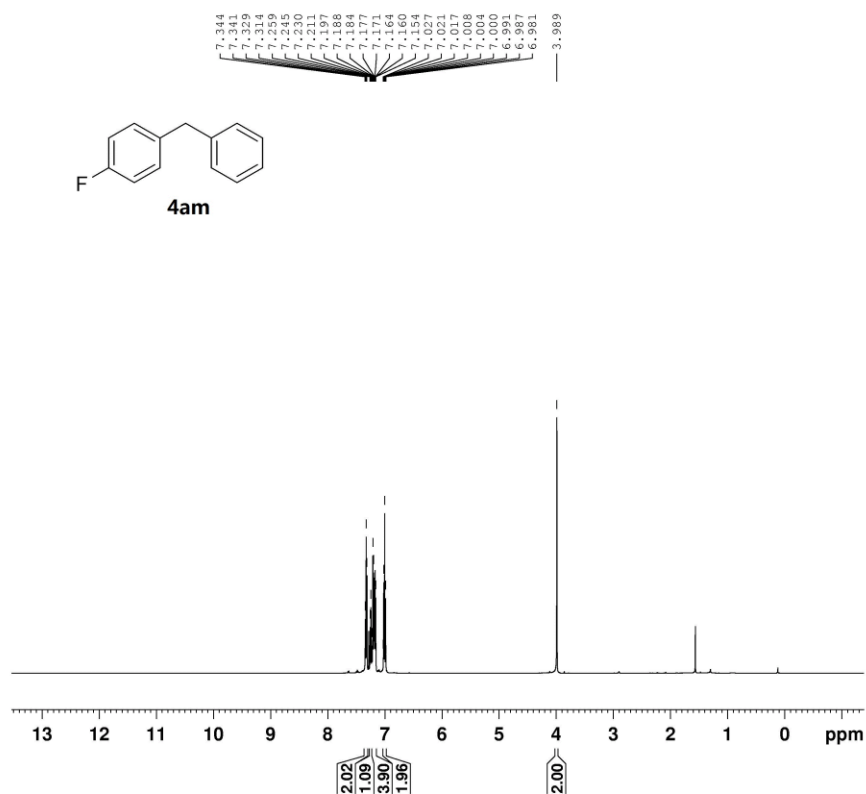
```

NAME      11y-330-2p-20171230
EXPNO     1
PROCNO    1
Date_     20171230
Time      8.43 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         106.56
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



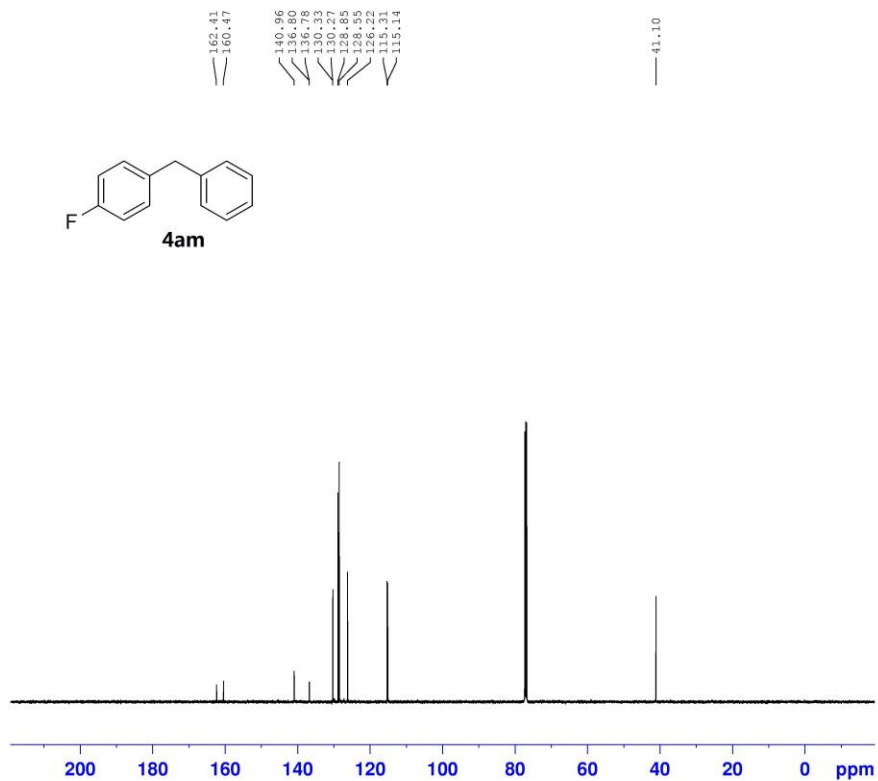
```

NAME      lly-330-2p-20171229
EXPNO     1
PROCNO    1
Date_     20171229
Time      11.12 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SF01       125.8131140 MHz
NUC1       13C
P1         10.23 usec
S1         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



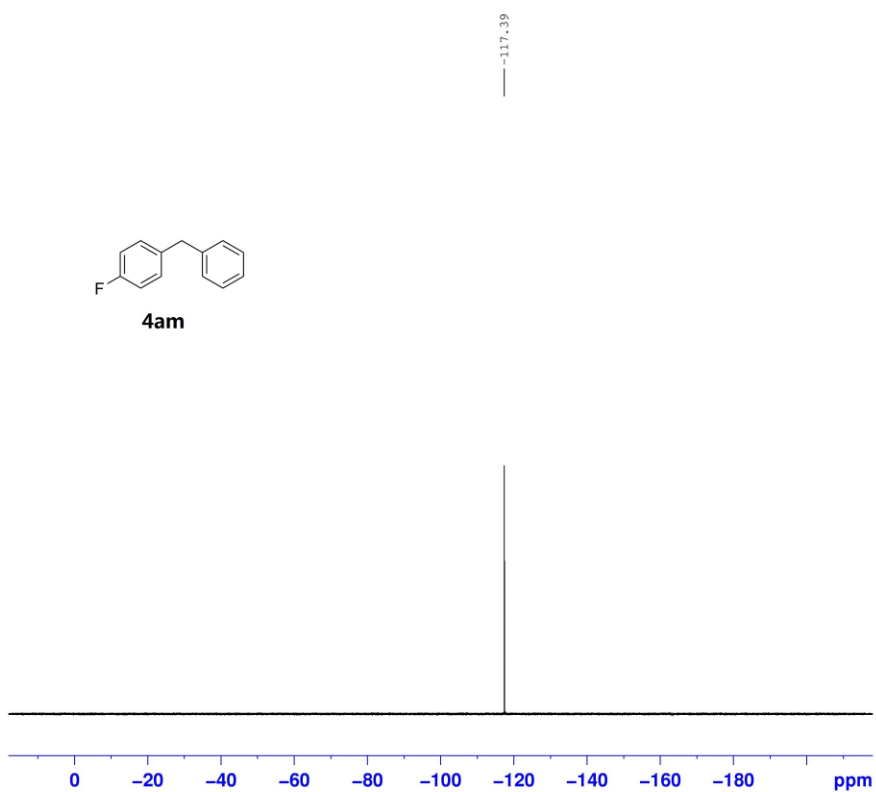
```

NAME      lly-359-1p-20180110
EXPNO     1
PROCNO    1
Date_     20180110
Time      4.24 h
INSTRUM    AVIII500HD
PROBHD     Z119470_0125 (
PULPROG    zg30
TD          65536
SOLVENT     CDCl3
NS          16
DS          2
SWH         10000.000 Hz
FIDRES      0.305176 Hz
AQ          3.2768500 sec
RG          106.56
DW          50.000 usec
DE          13.50 usec
TE          298.3 K
D1          1.00000000 sec
TD0         1
SFO1        500.3030896 MHz
NUC1        1H
P1          10.00 usec
SI          65536
SF          500.3000000 MHz
WDW         EM
SSB         0
LB          0.30 Hz
GB          0
PC          1.00
  
```



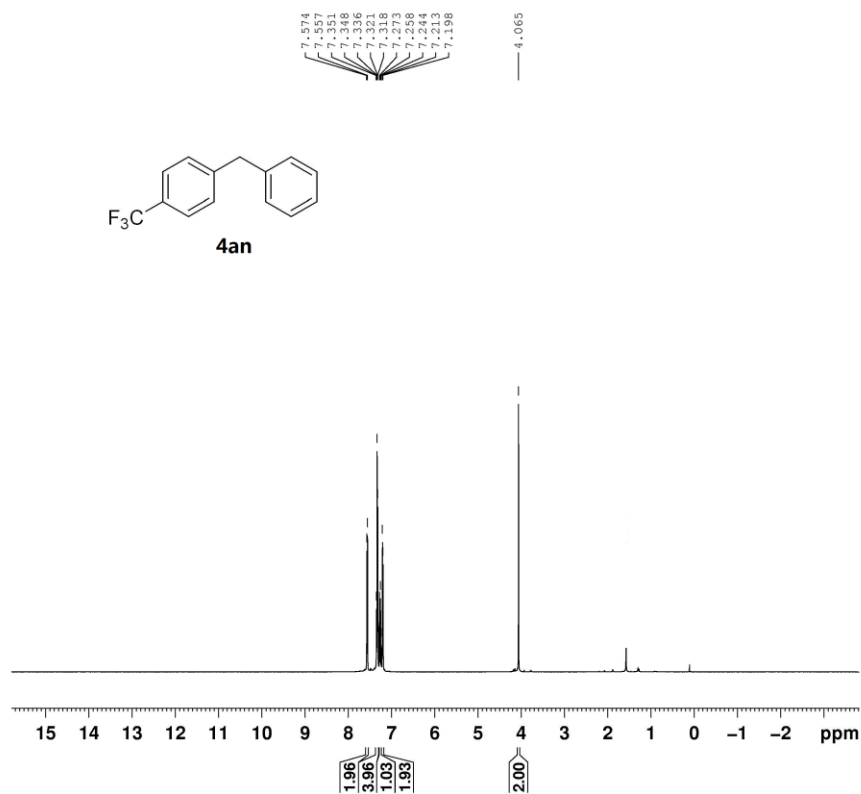
```

NAME      lly-359-1p-20180110
EXPNO     1
PROCNO    1
Date_     20180110
Time      6.43 h
INSTRUM   AVII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT    CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SF01       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



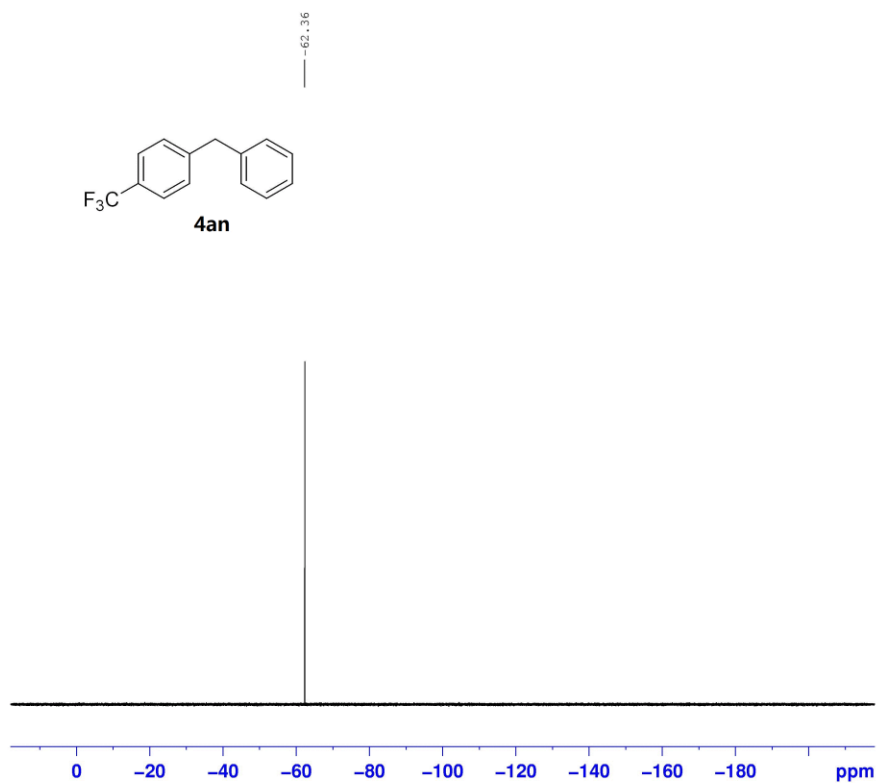
```

NAME      11y-359-lp-20180110
EXPNO     1
PROCNO    1
Date_     20180110
Time      16.28 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         131072
SOLVENT    CDCl3
NS         16
DS         4
SWH        111111.109 Hz
FIDRES     1.695421 Hz
AQ         0.5898740 sec
RG         192.72
DW         4.500 usec
DE         35.33 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1      470.7052618 MHz
NUC1       13C
P1         15.00 usec
P2         30.00 usec
SI         65536
SF         470.7523370 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



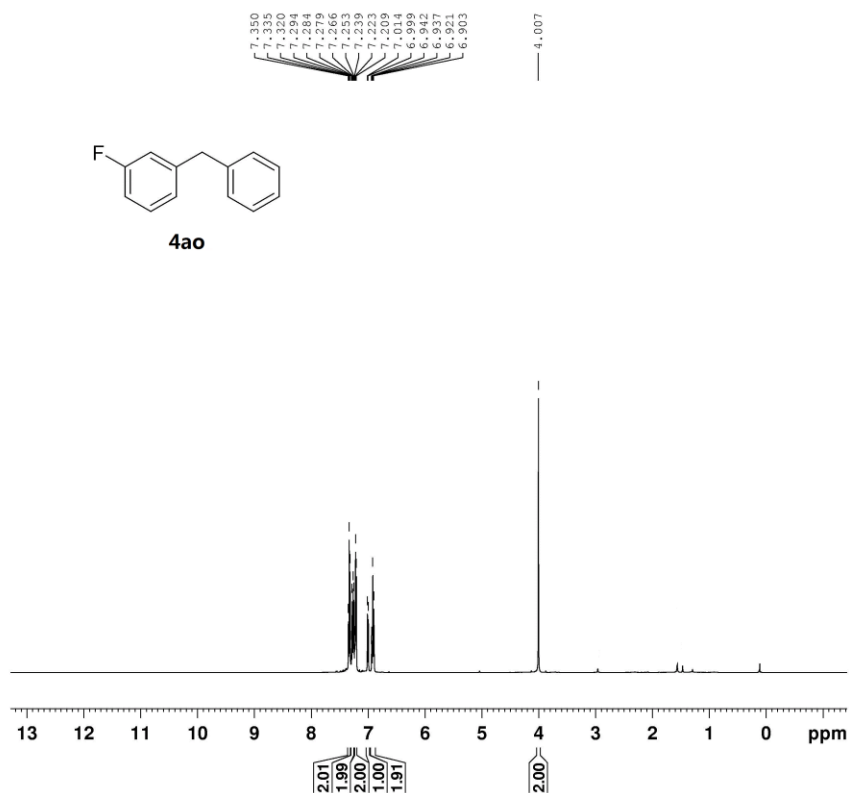
```

NAME      1ly-CF3-20180201
EXPNO     1
PROCNO    1
Date_     20180201
Time      22.59 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         106.56
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```

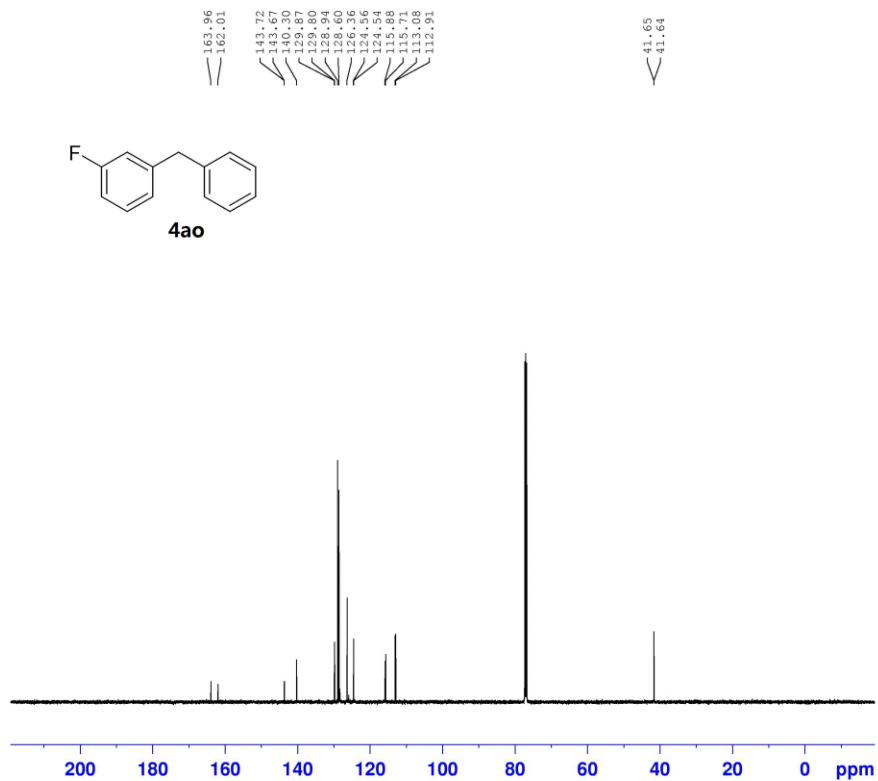
```

NAME      lly-CF3-20180201
EXPNO     1
PROCNO    1
Date_     20180201
Time      1.45 h
INSTRUM   AVIII500HD
PROBHD    Z119470.0125 (
PULPROG   zgpg30
TD         131072
SOLVENT    CDCl3
NS         16
DS         4
SWH        111111.109 Hz
FIDRES     1.695421 Hz
AQ         0.5898740 sec
RG         192.72
DW         4.500 usec
DE         35.33 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1       470.7052618 MHz
NUC1       13C
P1         15.00 usec
P2         30.00 usec
SI         65536
SF         470.7523370 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



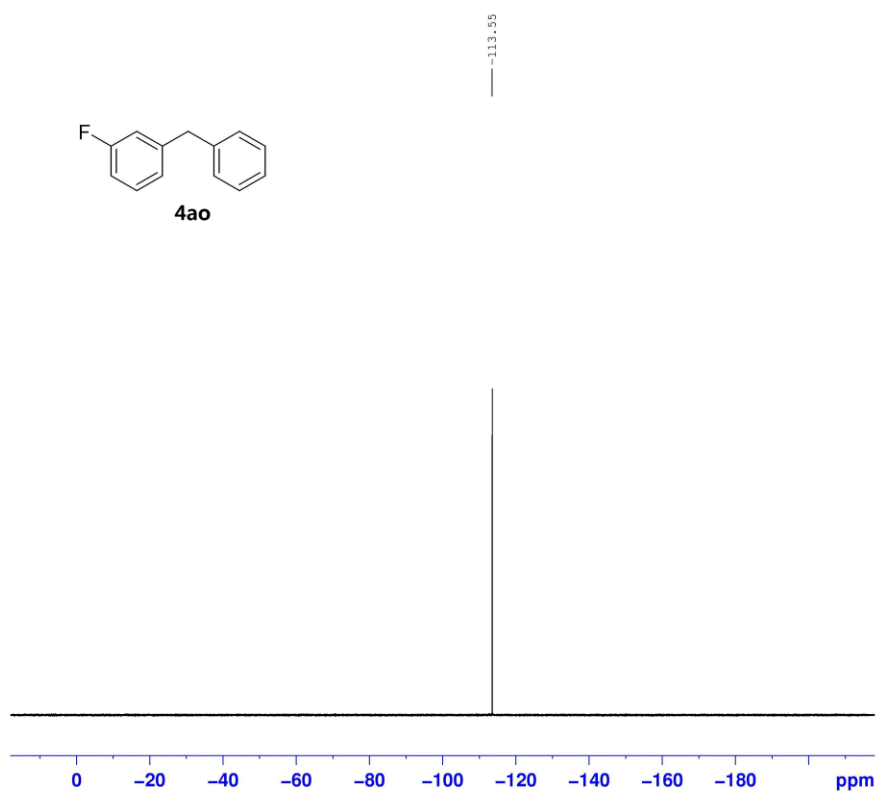
```

NAME      11y-359-3p-20180112
EXPNO     1
PROCNO    1
Date_     20181012
Time      19.10 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         106.56
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



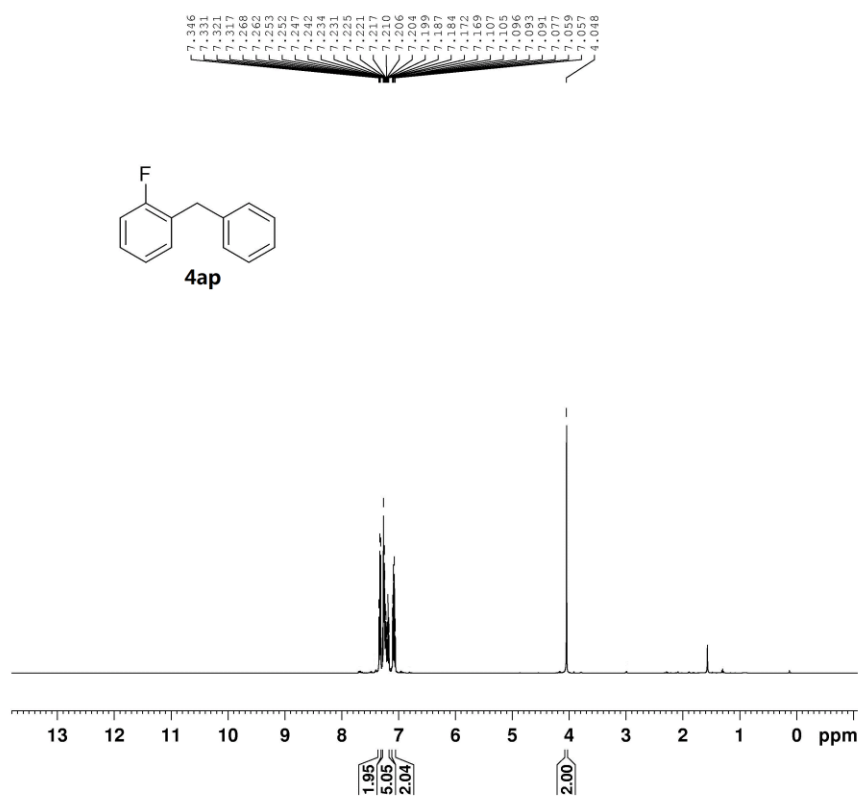
```

NAME      11y-359-3p-20180112
EXPNO     1
PROCNO    1
Date_     20180112
Time      20.03 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ          1.0923166 sec
RG          192.72
DW          16.667 usec
DE          22.02 usec
TE          298.3 K
D1          2.00000000 sec
D11         0.03000000 sec
TD0         1
SF01       125.8131140 MHz
NUC1        13C
P1          10.23 usec
SI          32768
SF          125.8005351 MHz
WDW         EM
SSB         0
LB          1.00 Hz
GB          0
PC          1.40
  
```



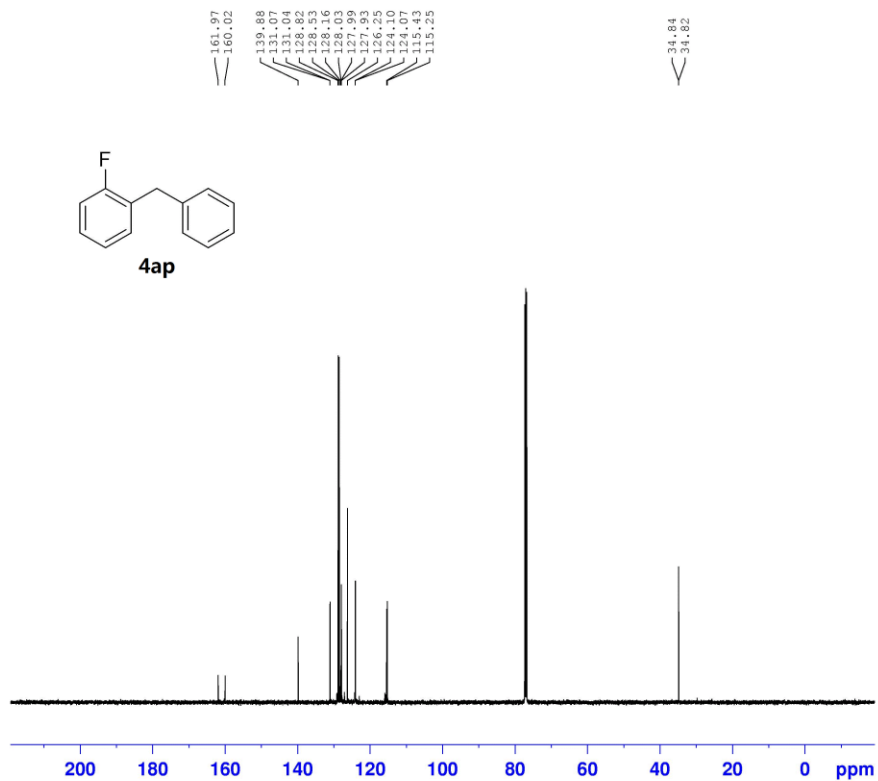
```

NAME      lly-359-3p-20180112
EXPNO     1
PROCNO    1
Date_     20180112
Time      20.05 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         131072
SOLVENT    CDCl3
NS         16
DS         4
SWH        111111.109 Hz
FIDRES     1.695421 Hz
AQ         0.5898740 sec
RG         192.72
DW         4.500 usec
DE         35.33 usec
TE         298.3 K
D1         1.0000000 sec
TD0        1
SF01       470.7052618 MHz
NUC1       13C
P1         15.00 usec
P2         30.00 usec
SI         65536
SF         470.7523370 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



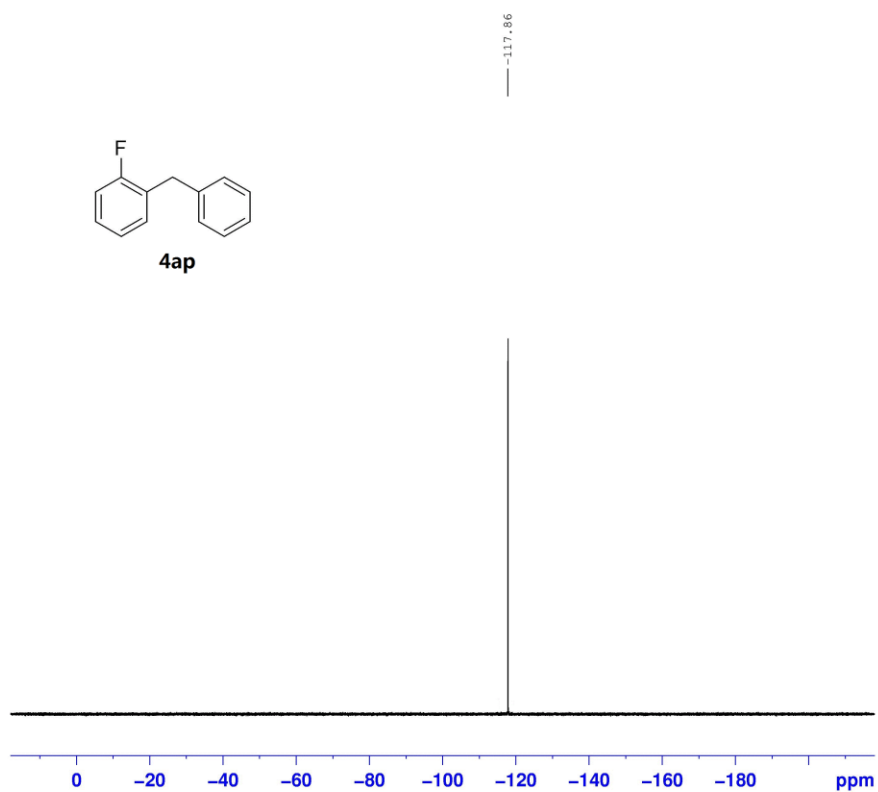
```

NAME      11y-365-2p-20180309
EXPNO     1
PROCNO    1
Date_     20180309
Time      4.09 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT    CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         106.56
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



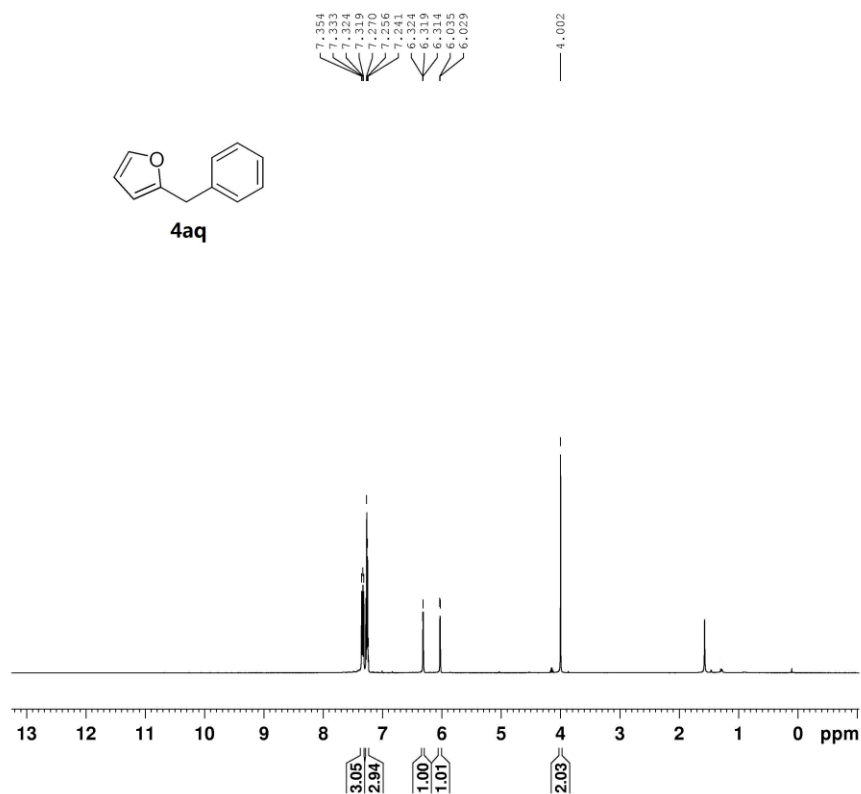
```

NAME      lly-365-2p-20180309
EXPNO     1
PROCNO    1
Date_     20180309
Time      6.49 h
INSTRUM    AVIII500HD
PROBHD     Z119470_0125 (
PULPROG    zgpg30
TD         65536
SOLVENT     CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SFO1       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



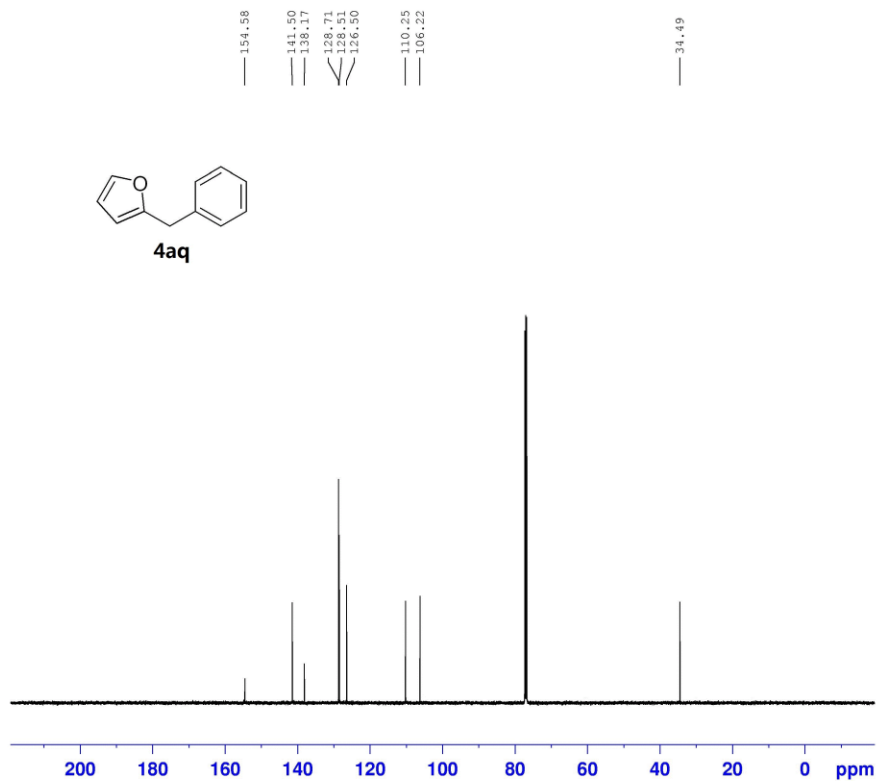
```

NAME      11y-365-2p-F-20180306
EXPNO     1
PROCNO    1
Date_     20180306
Time      1.39 h
INSTRUM   AVIIT500HD
PROBHD    Z119470_0125 (
PULPROG   zgpgaf1gn.b
TD         131072
SOLVENT   CDCl3
NS         16
DS         4
SWH        111111.109 Hz
FIDRES     1.695421 Hz
AQ         0.5898740 sec
RG         192.72
DW         4.500 usec
DE         35.33 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1       470.7052618 MHz
NUC1       13C
P1         15.00 usec
P2         30.00 usec
SI         65536
SF         470.7523370 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



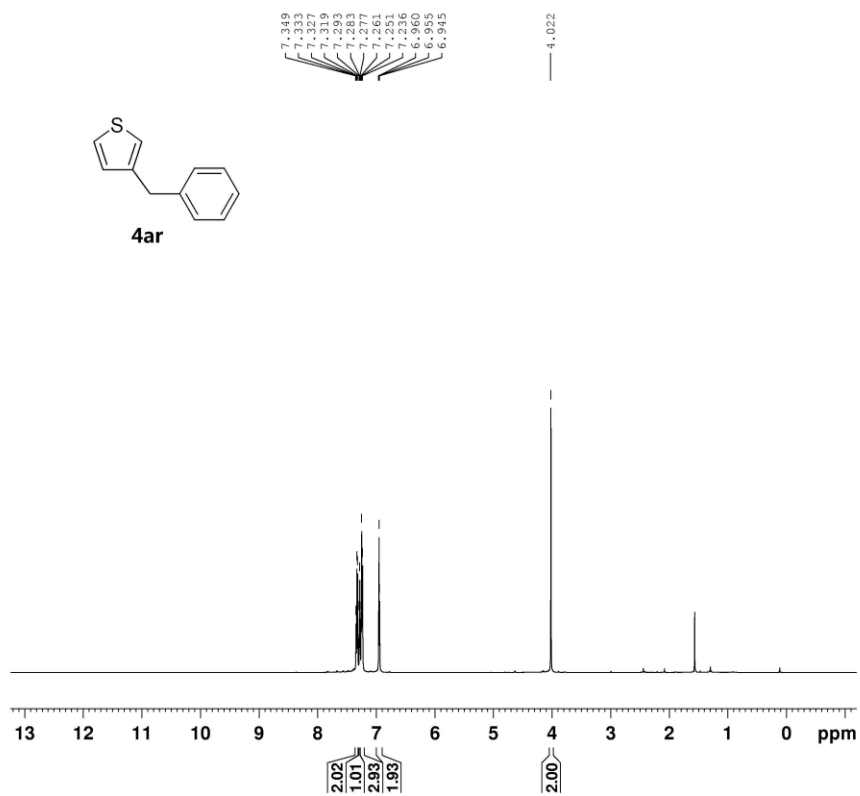
```

NAME      lly-368-2p-20180214
EXPNO     1
PROCNO    1
Date_     20180214
Time      9.44 h
INSTRUM   AVII500HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT    CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         106.56
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1      500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



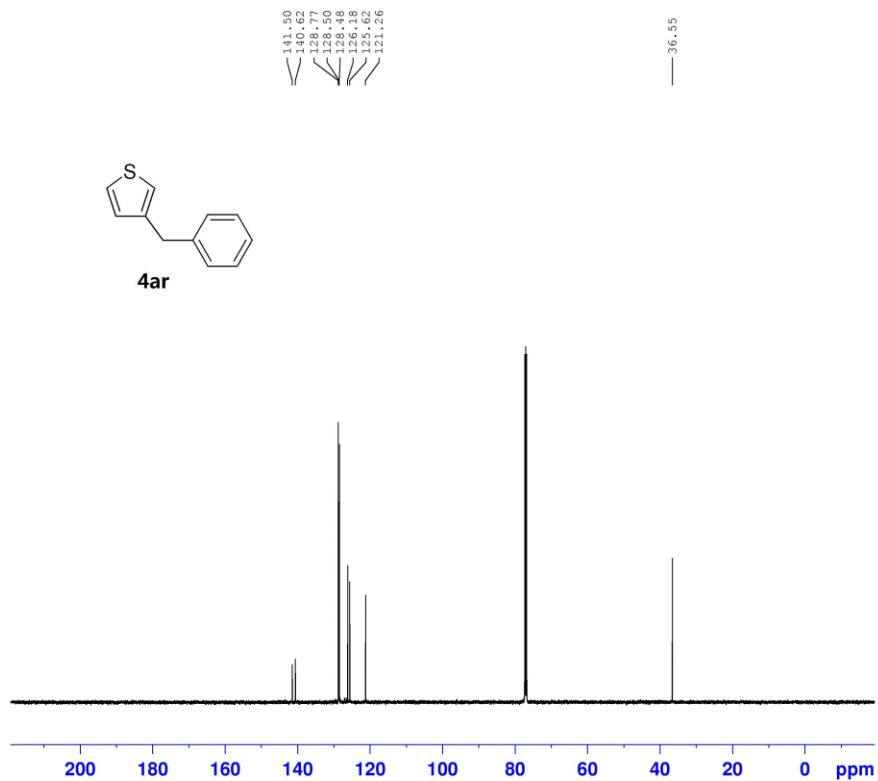
```

NAME      lly-368-2p-20180214
EXPNO     1
PROCNO    1
Date_     20180214
Time      21.34 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT    CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SFO1       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



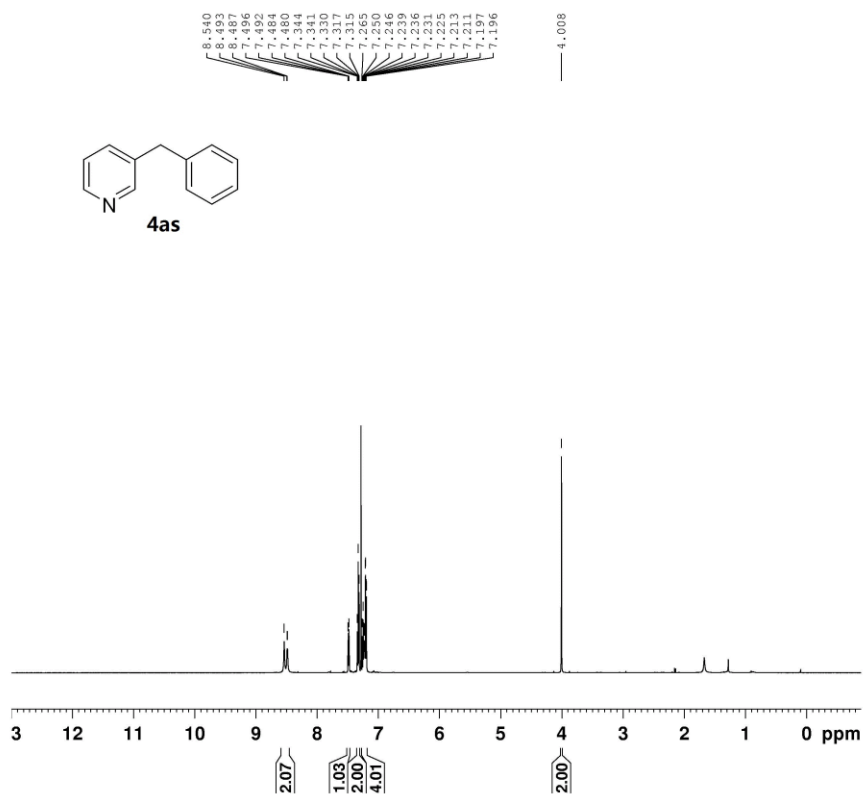
```

NAME      1ly-368-1p-20180214
EXPNO     1
PROCNO    1
Date_     20180214
Time      5.55 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT    CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         106.56
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SF01       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



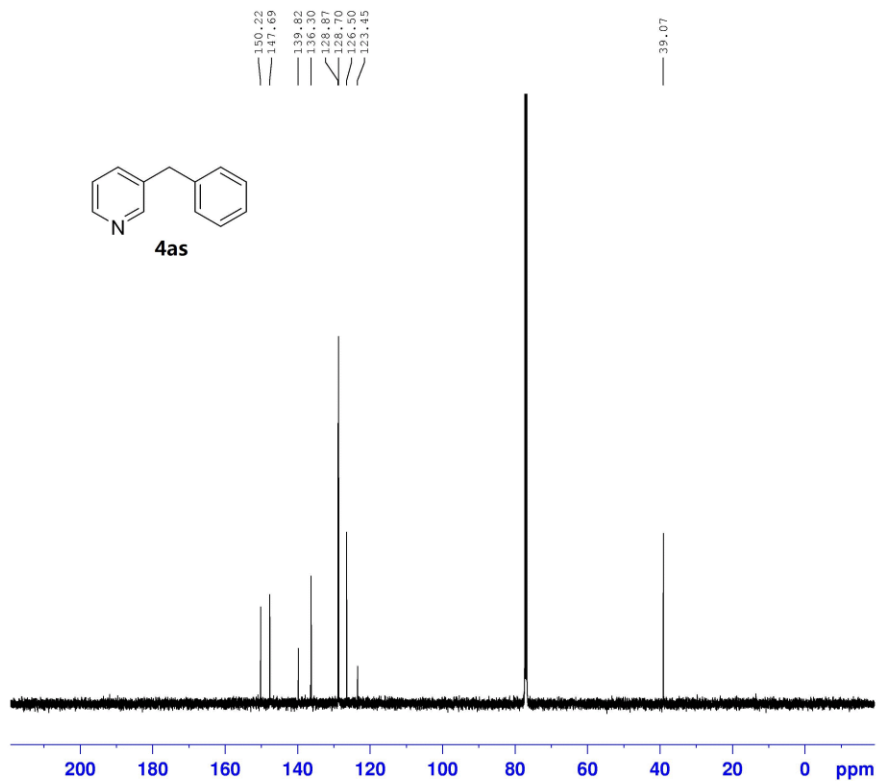
```

NAME      lly-368-1p-20180214
EXPNO     1
PROCNO    1
Date_     20180214
Time      21.42 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SFO1       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



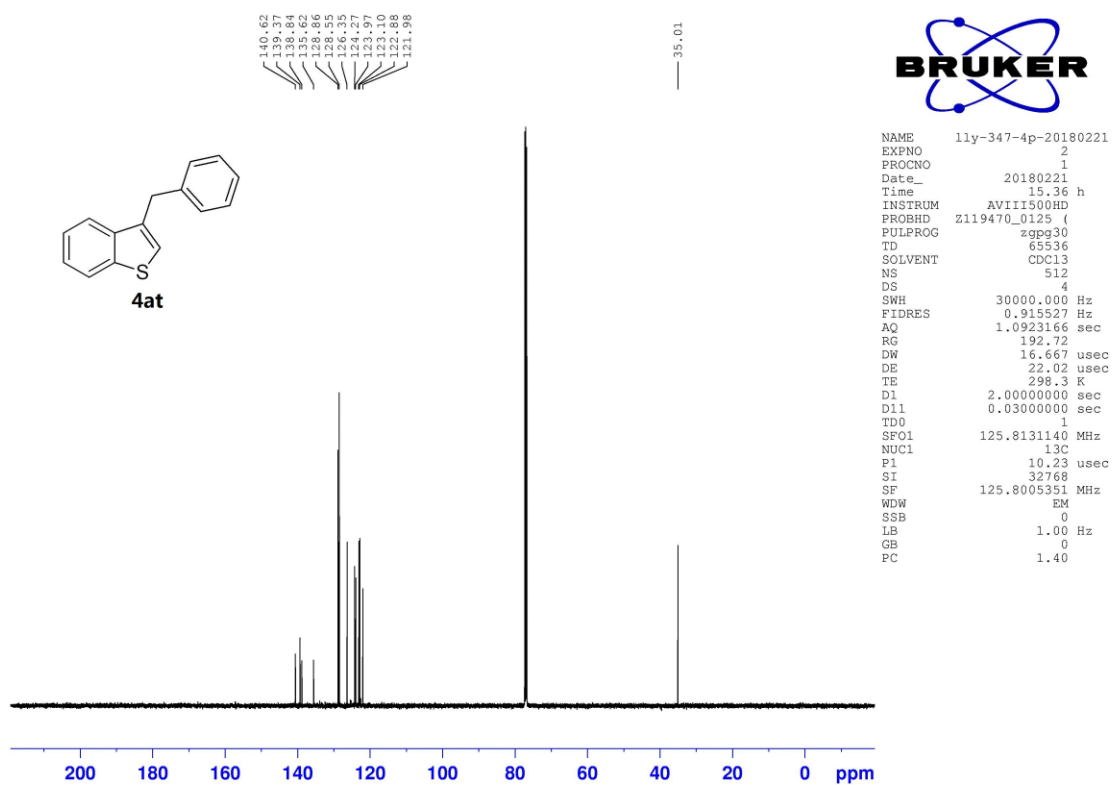
```

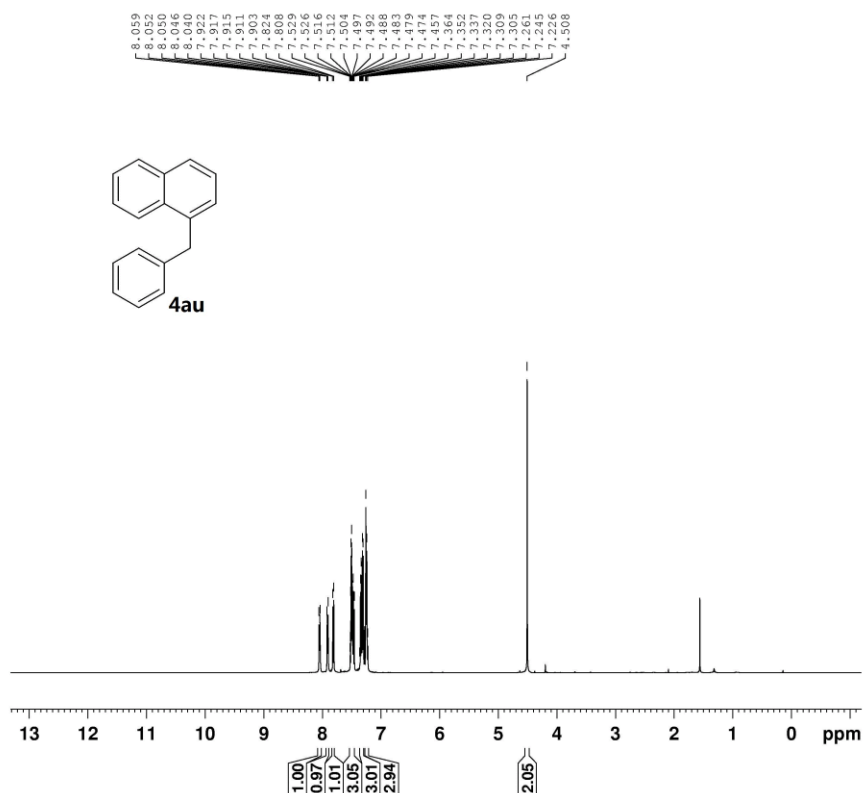
NAME      lly-342-1p-20180214
EXPNO     1
PROCNO    1
Date_     20180214
Time      20.28 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         192.72
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



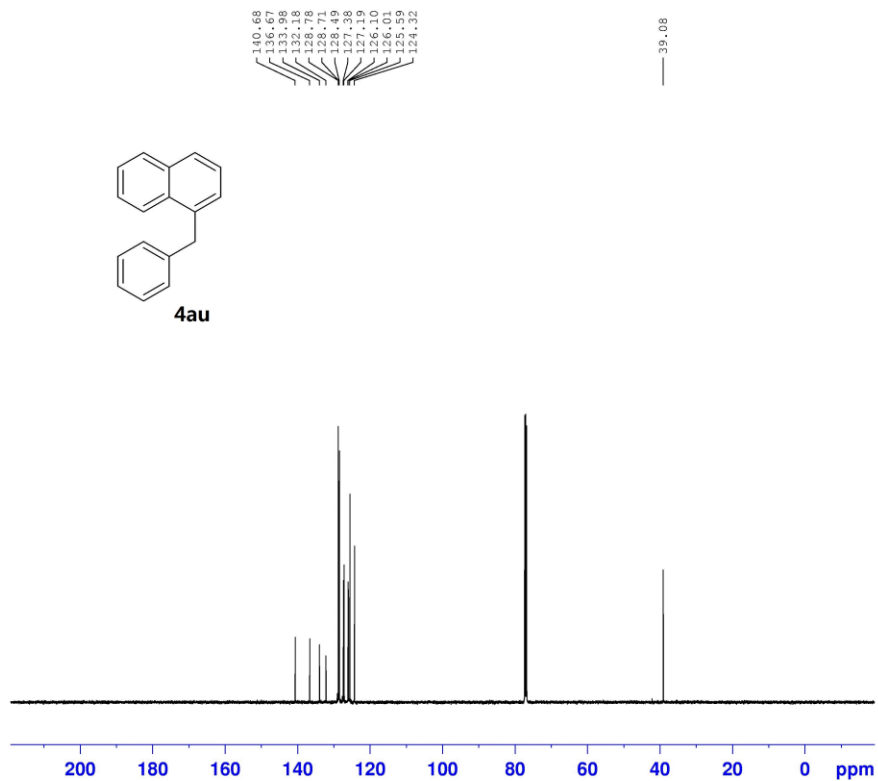
```

NAME      1ly-342-1p-20180214
EXPNO     2
PROCNO    1
Date_     20180214
Time      21.23 h
INSTRUM   AVII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT    CDCl3
NS         1024
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SFO1       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```

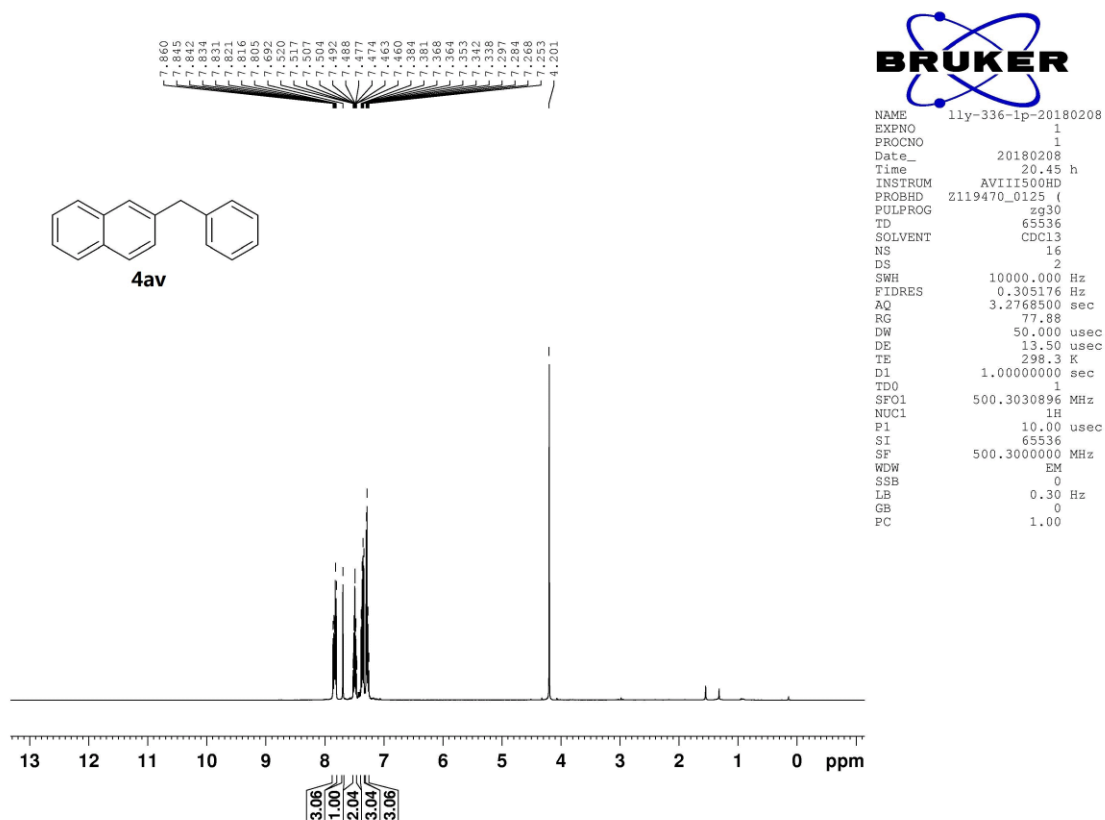


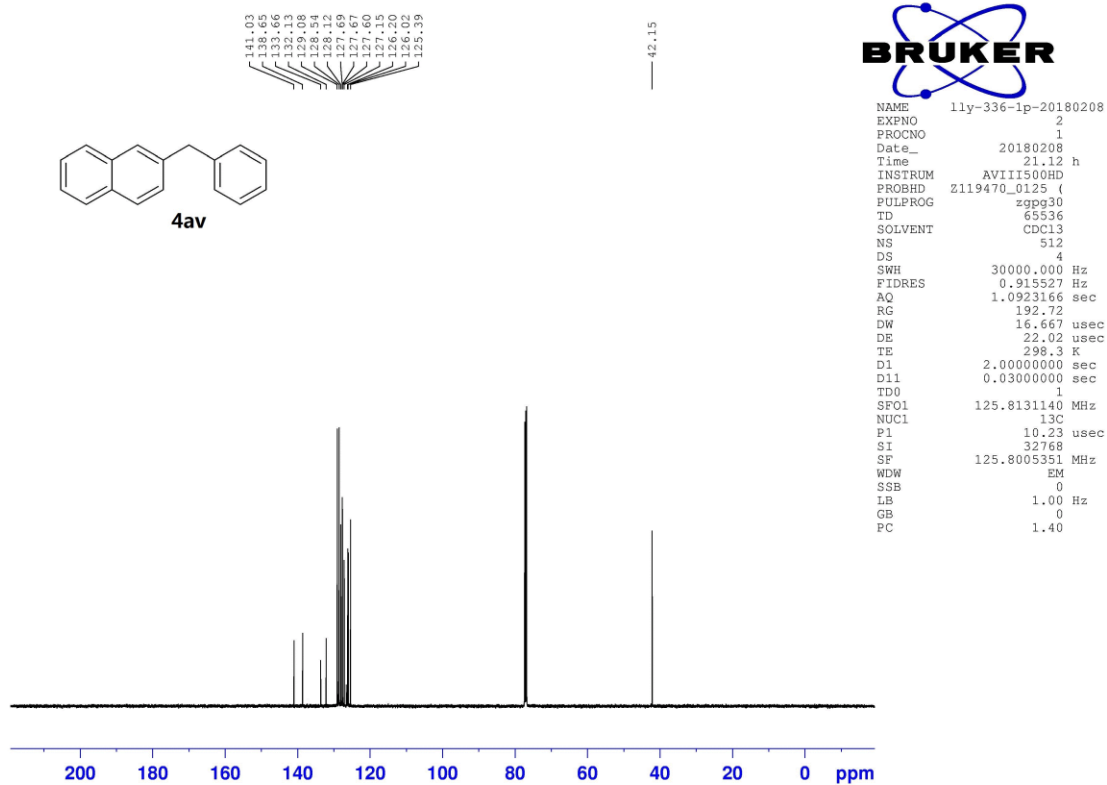
NAME 1ly-327-1p-20171220
 EXPNO 1
 PROCNO 1
 Date_ 20171220
 Time 10.08 h
 INSTRUM AVIII500HD
 PROBHD Z119470_0125 (
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 10000.000 Hz
 FIDRES 0.305176 Hz
 AQ 3.2768500 sec
 RG 87.38
 DW 50.000 usec
 DE 13.50 usec
 TE 298.3 K
 D1 1.00000000 sec
 TD0 1
 SFO1 500.3030896 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 500.3000000 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00

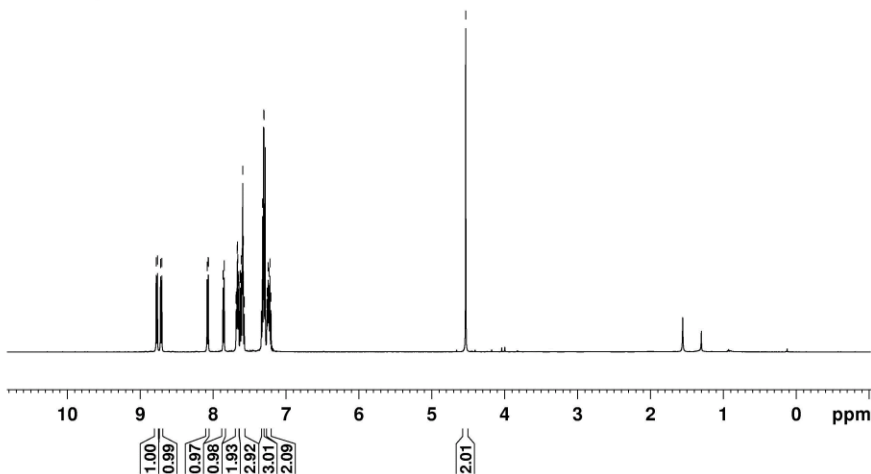
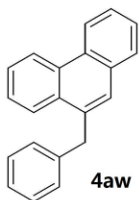
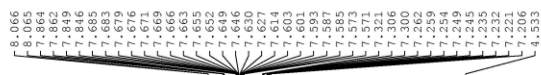


```

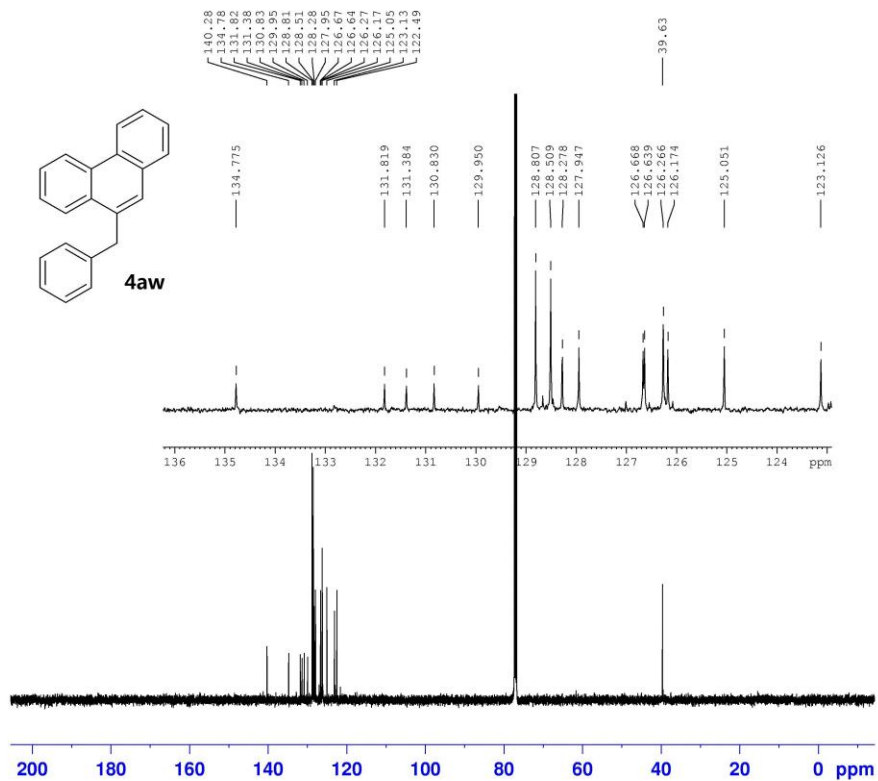
NAME      11y-327-1p-20171220
EXPNO     1
PROCNO    1
Date_     20171220
Time      9.46 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT    CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SFO1       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```





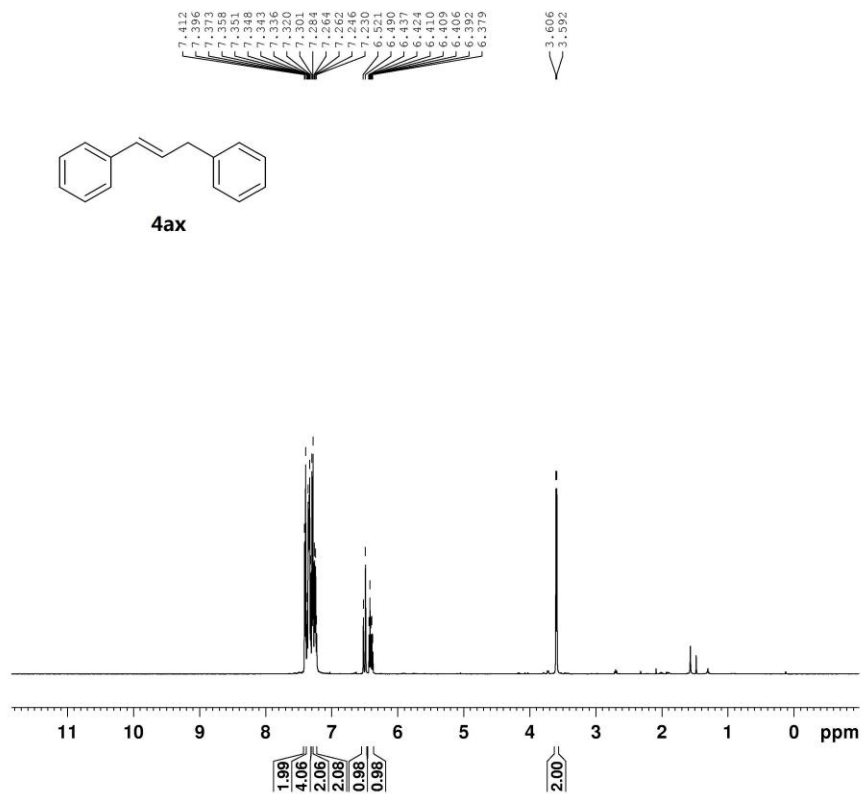


NAME 1ly-343-3p-20180217
EXPNO 1
PROCNO 1
Date_ 20180217
Time 16.58 h
INSTRUM AVII500HD
PROBHD Z119470_0125 (
PULPROG zg30
TD 65536
SOLVENT CDC13
NS 16
DS 2
SWH 10000.000 Hz
FIDRES 0.305176 Hz
AQ 3.2768500 sec
RG 106.56
DW 50.000 usec
DE 13.50 usec
TE 298.3 K
D1 1.00000000 sec
TD0 1
SF01 500.3030896 MHz
NUC1 1H
P1 10.00 usec
SI 65536
SF 500.3000000 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00



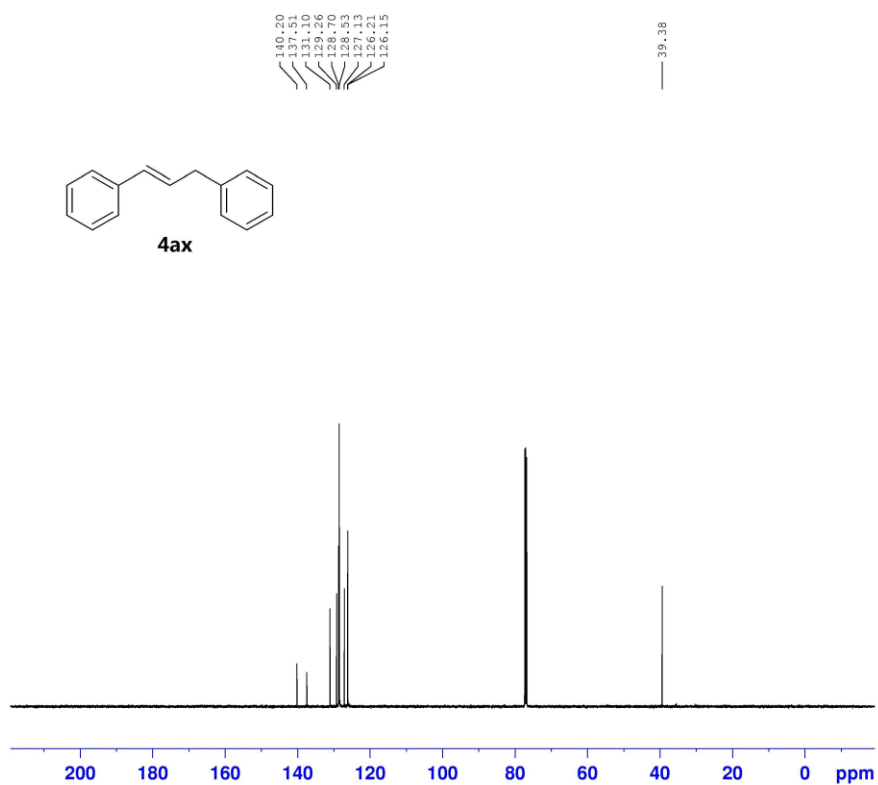
```

NAME      11y-343-3p-20180217
EXPNO     1
PROCNO    1
Date_     20180217
Time      23.41 h
INSTRUM   AVII1500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT    CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SF01       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



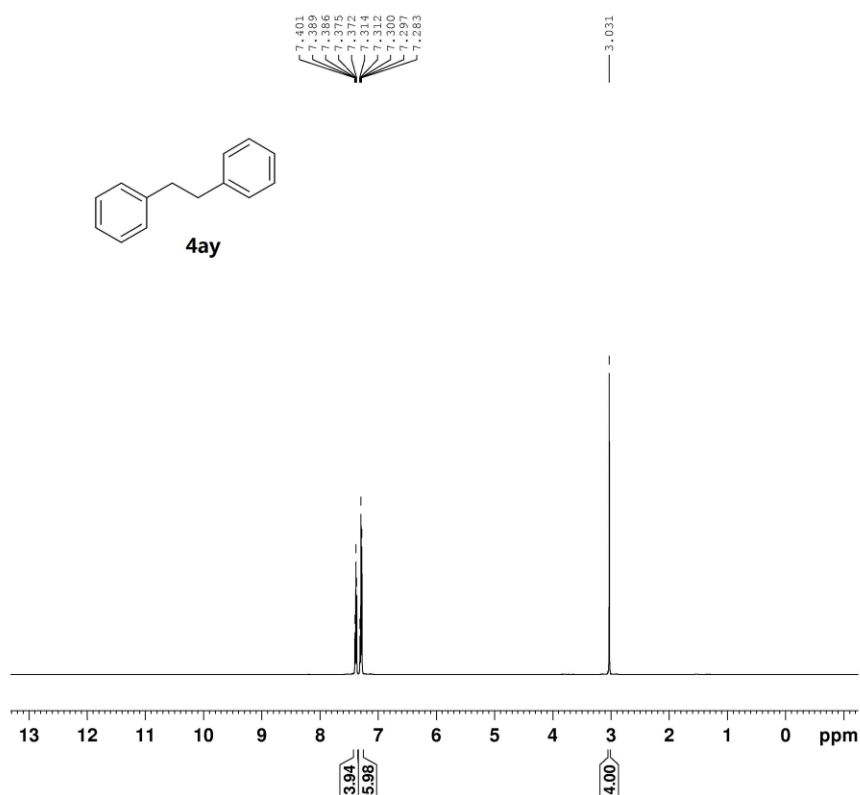
```

NAME      11y-352-2p-20180106
EXPNO     1
PROCNO    1
Date_     20180106
Time      23.03 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT    CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         106.56
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
DL         1.00000000 sec
TD0        1
SFO1       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



```

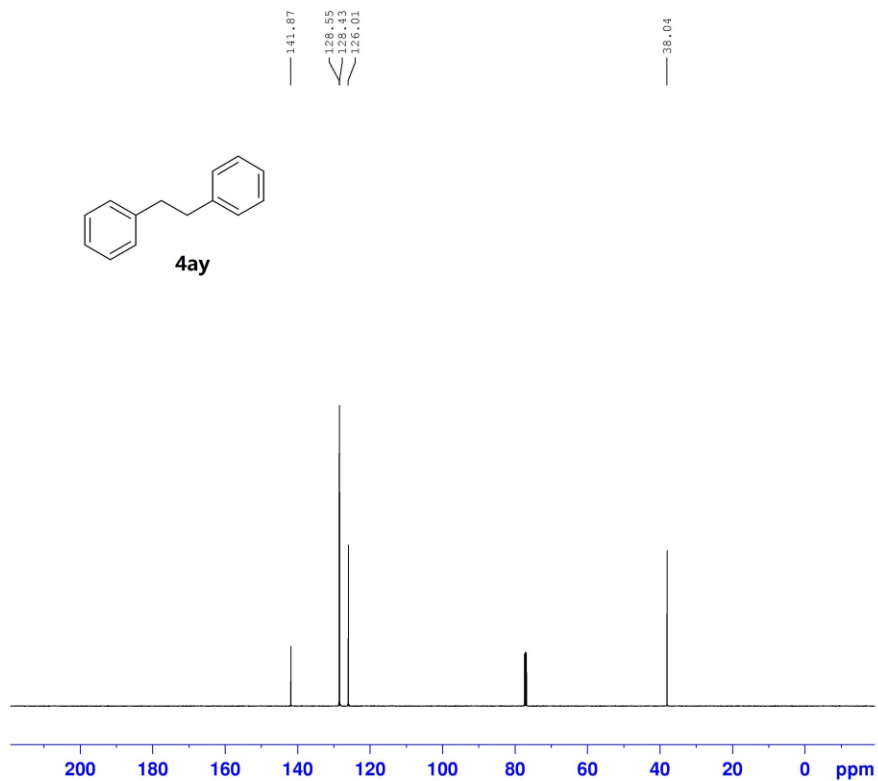
NAME      lly-351-2p-20180106
EXPNO     1
PROCNO    1
Date_     20180106
Time      13.15 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ          1.0923166 sec
RG          192.72
DW          16.667 usec
DE          22.02 usec
TE          298.3 K
D1          2.00000000 sec
D11         0.03000000 sec
TD0         1
SF01       125.8131140 MHz
NUC1        13C
F1          10.23 usec
SI          32768
SF          125.8005351 MHz
WDW         EM
SSB         0
LB          1.00 Hz
GB          0
PC          1.40
  
```



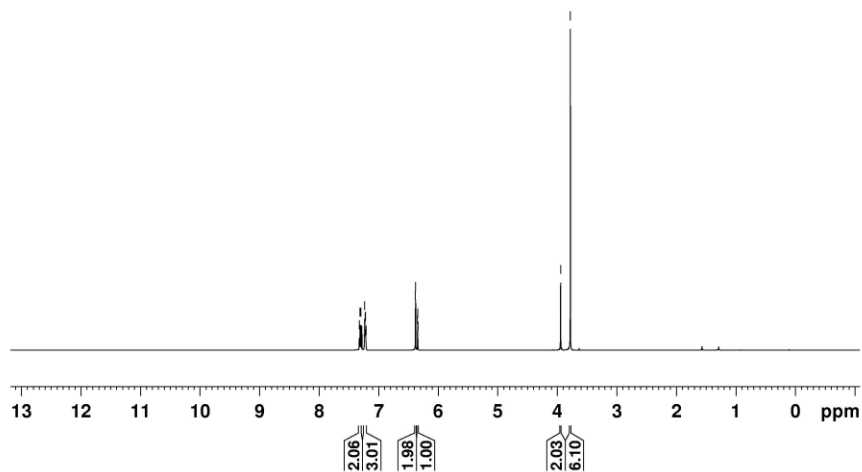
BRUKER

```

NAME      11y-355-1p-20180302
EXPNO     1
PROCNO    1
Date_     20180302
Time      10.48 h
INSTRUM    AVIII500HD
PROBHD     Z119470_0125 (
PULPROG    zg30
TD         65536
SOLVENT    CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         25.23
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



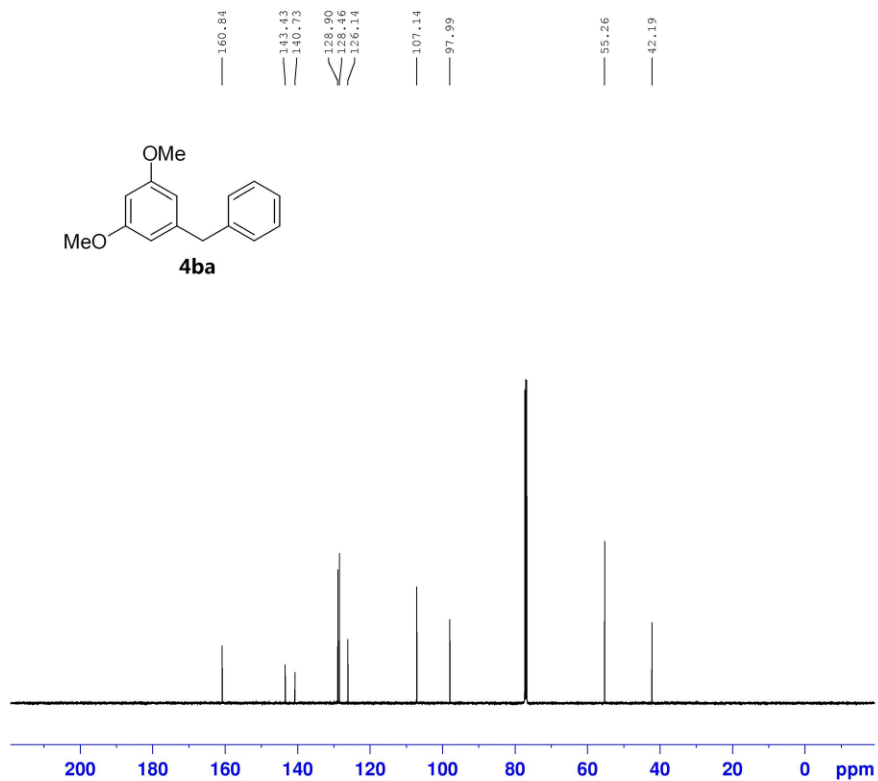
NAME 1ly-355-1p-20180302
 EXPNO 2
 PROCNO 1
 Date_ 20180302
 Time 11.17 h
 INSTRUM AVIII500HD
 PROBHD Z119470_0125 (
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 512
 DS 4
 SWH 30000.000 Hz
 FIDRES 0.915527 Hz
 AQ 1.0923166 sec
 RG 192.72
 DW 16.667 usec
 DE 22.02 usec
 TE 298.3 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1
 SFO1 125.8131140 MHz
 NUC1 13C
 P1 10.23 usec
 SI 32768
 SF 125.8005351 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40



BRUKER

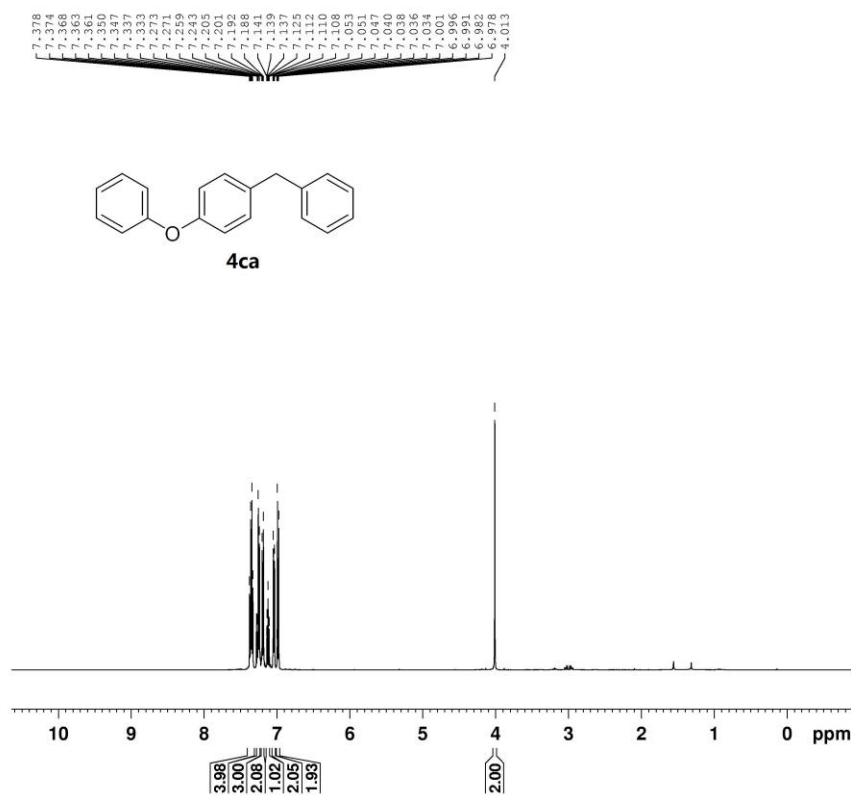
```

NAME          1ly-333-3ap-20180206
EXPNO              1
PROCNO           1
Date_            20180206
Time              17.49 h
INSTRUM          AVI11500HD
PROBHD           Z119470_0125 4
PULPROG          zg30
TD               65536
SOLVENT          CDCl3
NS               16
DS               2
SWH              10000.00 MHz
FIDRES           0.305176 Hz
AQ               3.2768500 sec
RG              106.56
DW               50.000 usec
DE               13.50 usec
TE               298.3 K
D1               1.00000000 sec
TDO              1
SF01             500.3030896 MHz
NUC1              1H
P2               10.00 usec
SI               65536
SF               500.3000000 MHz
WDW              EM
SSB              0
GB               0
CB               0
GB              1.00
  
```



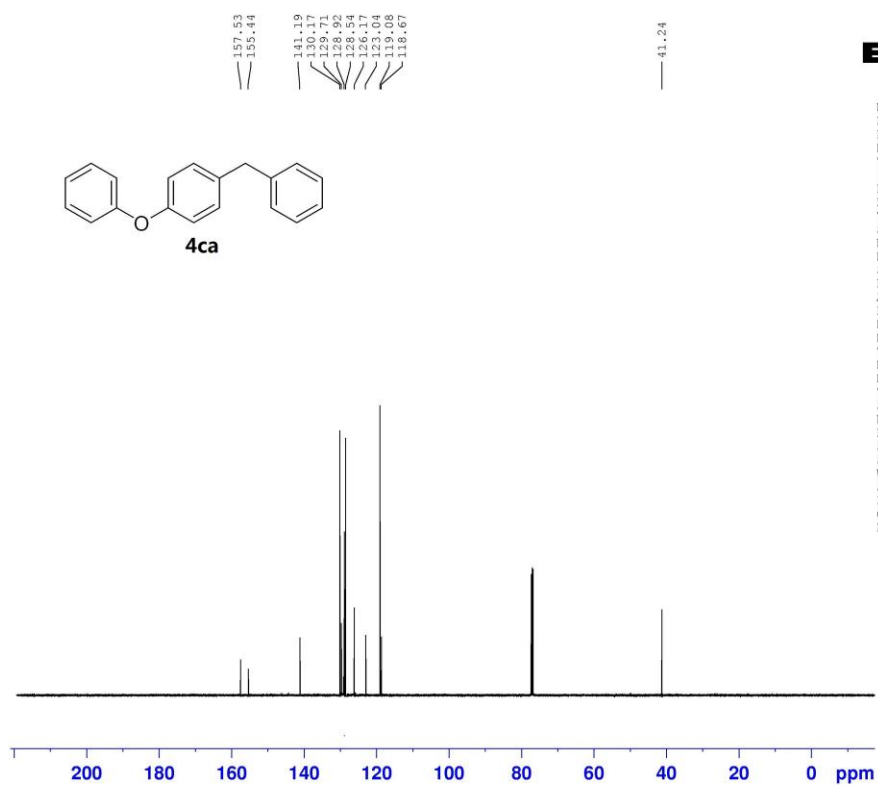
```

NAME      lly-333-3ap-20180206
EXPNO     2
PROCNO    1
Date_     20180206
Time      18.56 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ          1.0923166 sec
RG          192.72
DW          16.667 usec
DE          22.02 usec
TE          298.3 K
D1          2.00000000 sec
D11         0.03000000 sec
TD0         1
SFO1       125.8131140 MHz
NUC1        13C
F1          10.23 usec
SI          32768
SF          125.8005351 MHz
WDW         EM
SSB         0
LB          1.00 Hz
GB          0
PC          1.40
  
```



```

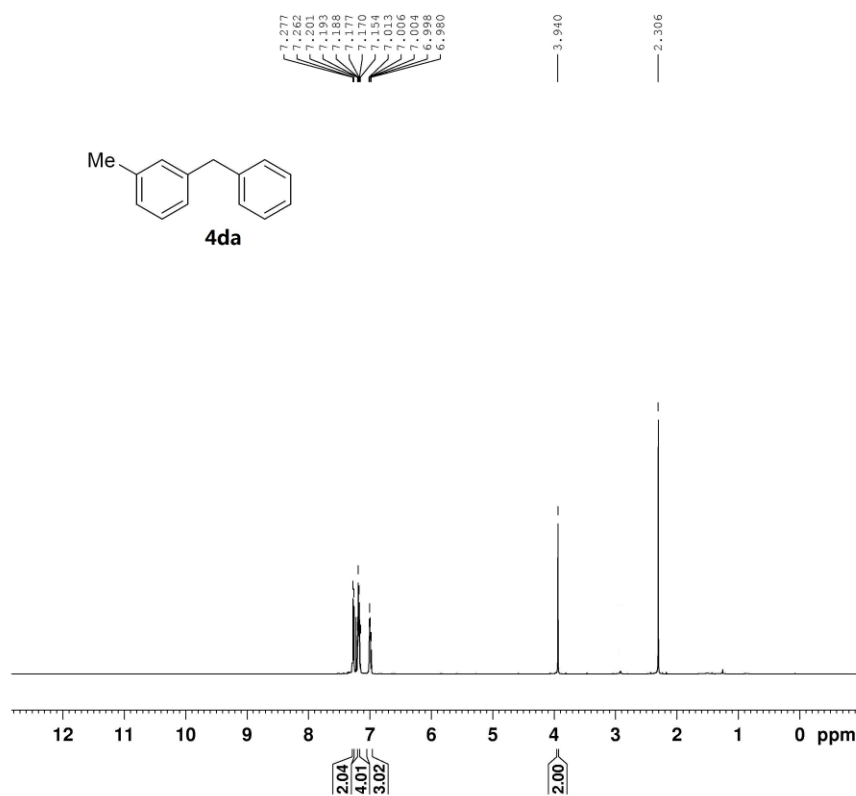
NAME      lly-343-2p-20180217
EXPNO     1
PROCNO    1
Date_     20180217
Time      16.26 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT    CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         71.03
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.0000000 sec
TD0        1
SFO1       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



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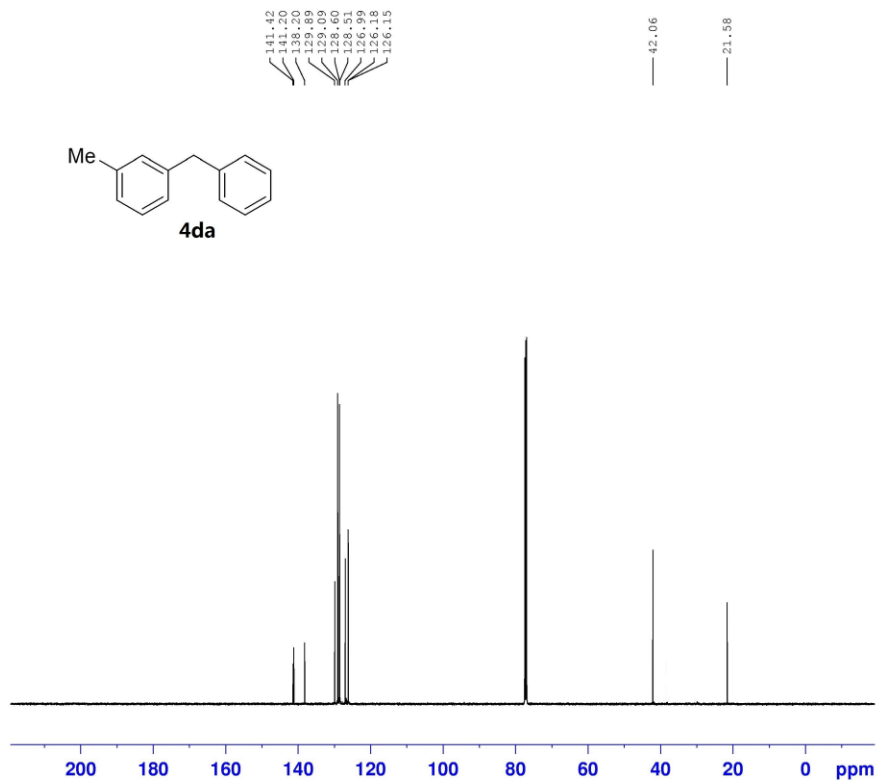
```

NAME      11y-343-2p-20180217
EXPNO     2
PROCNO    1
Date_     20180217
Time      16.53 h
INSTRUM    AVIII500HD
PROBHD     Z119470_0125 (
PULPROG    zgpg30
TD         65536
SOLVENT    CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SF01       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        no
SSB        0
LB         0.00 Hz
GB         0
PC         1.40
  
```



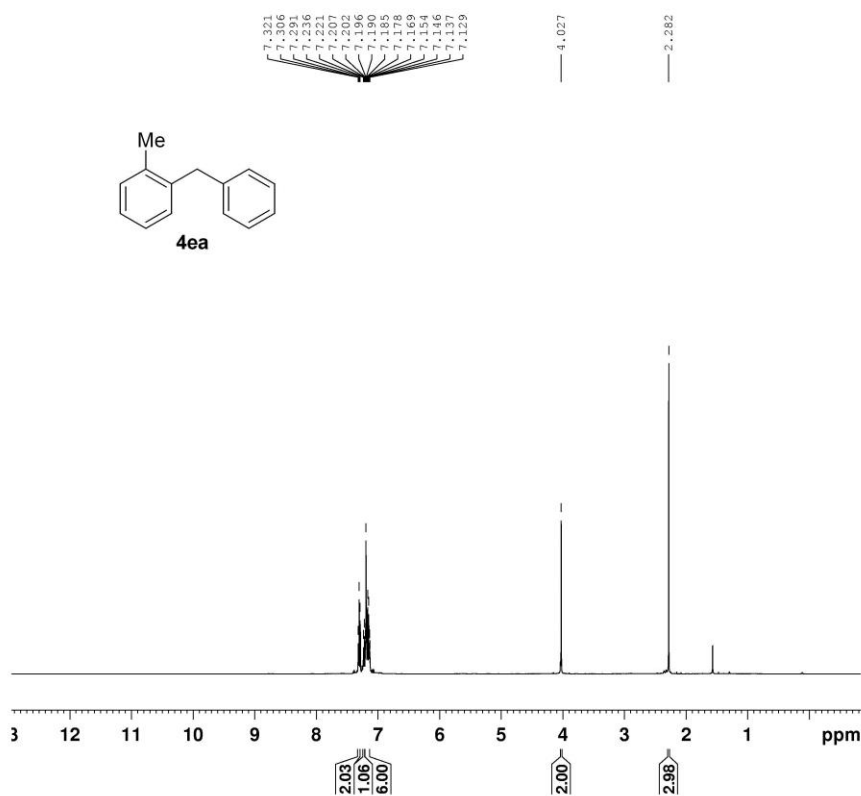
```

NAME      lly-388-4ap-20180210
EXPNO     1
PROCNO    1
Date_     20180210
Time      11.23 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT    CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         87.38
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1      500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000280 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



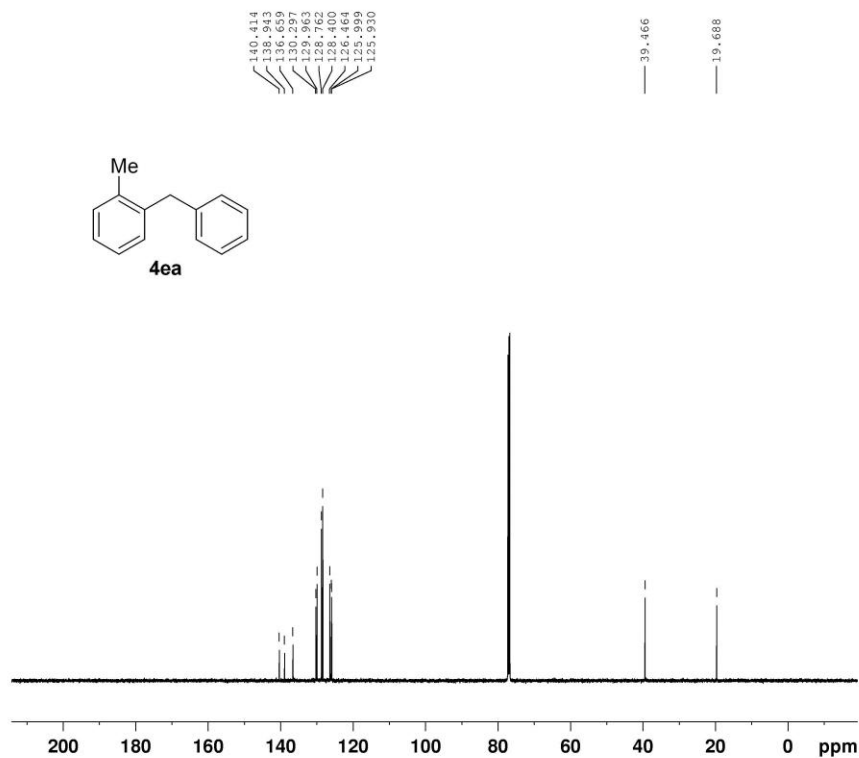
```

NAME      lly-388-4ap-20180210
EXPNO     2
PROCNO    1
Date_     20180210
Time      12.42 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         1500
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SFO1       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005180 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



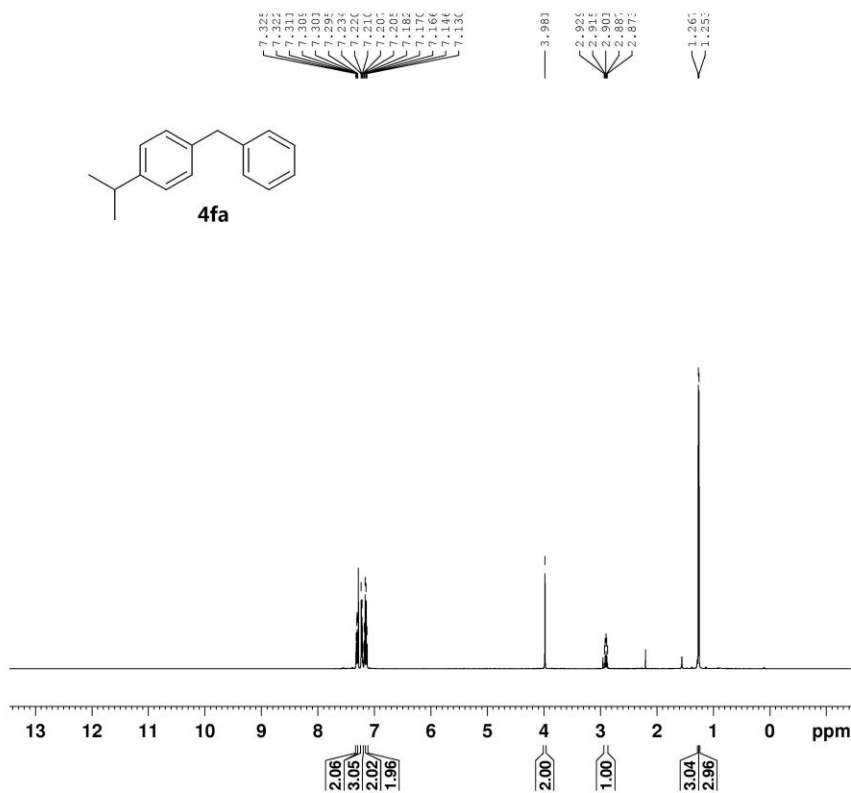
```

NAME      11y-361-lap-20180306
EXPNO     1
PROCNO    1
Date_     20180306
Time      4.14 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT    CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         106.56
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```

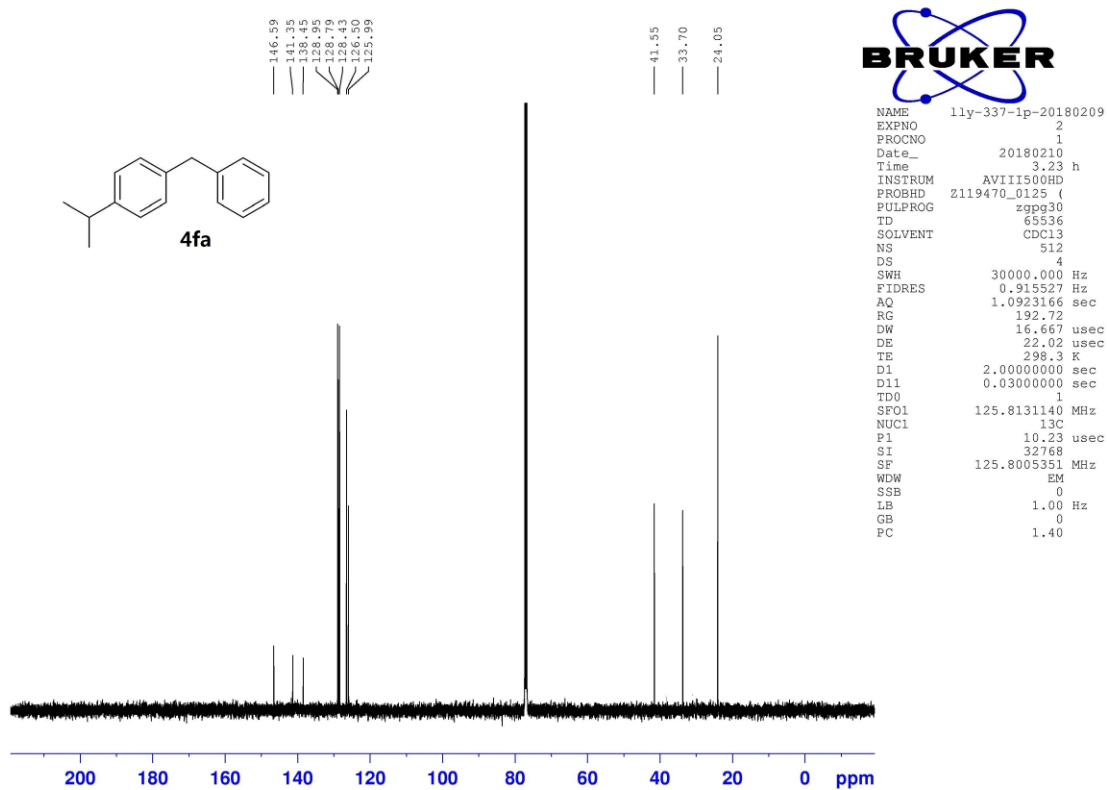


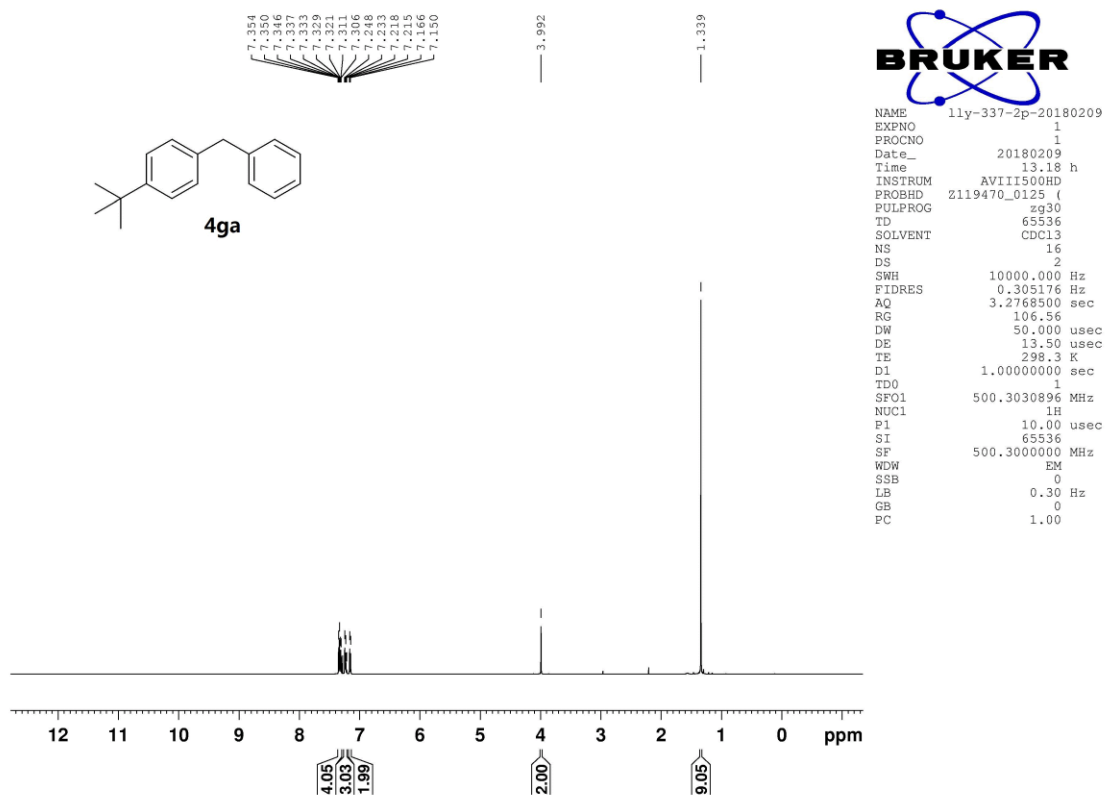
```

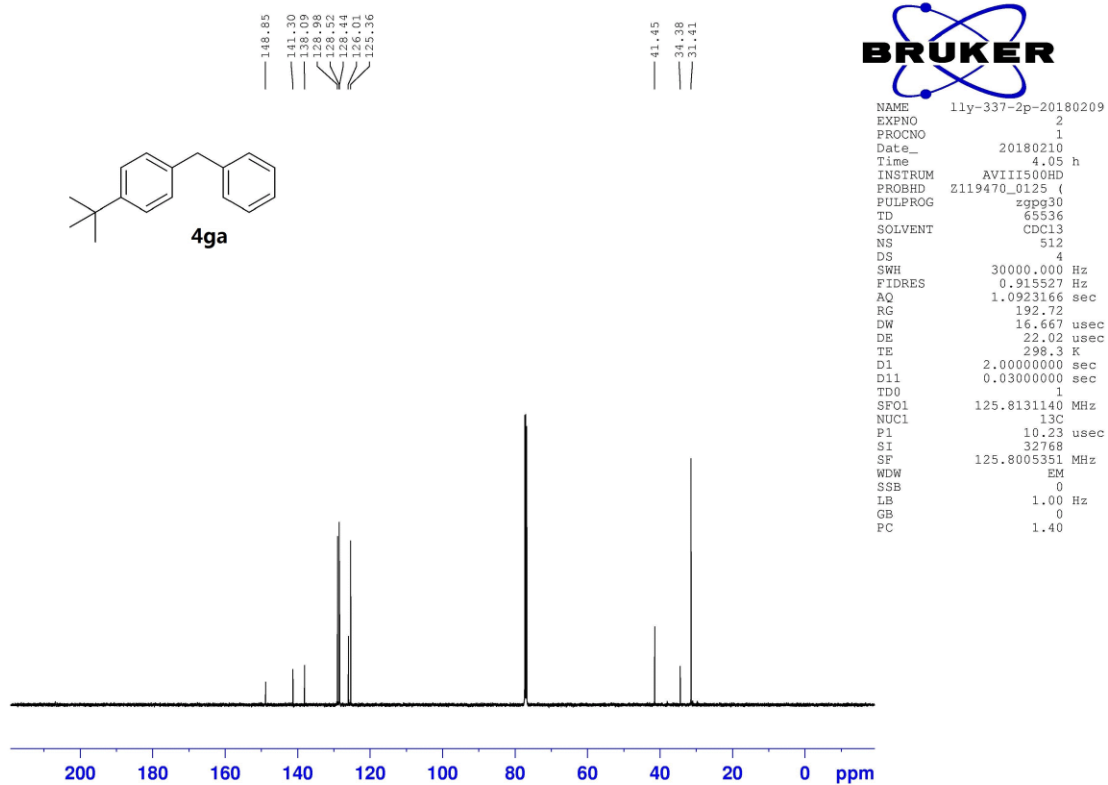
NAME      lly-361-lap-20180306
EXPNO     1
PROCNO    1
Date_     20180306
Time      7.20 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT    CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SF01       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```

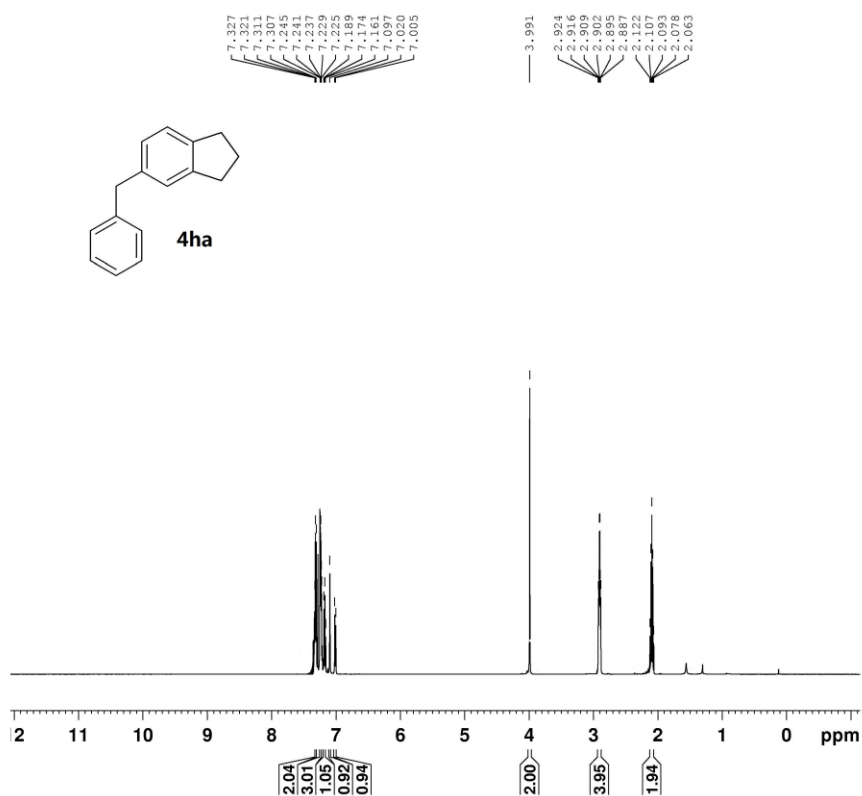


NAME	11y-337-1p-20180209
EXPNO	1
PROCNO	1
Date_	20180209
Time	13.12 h
INSTRUM	AVII1500HD
PROBHD	2119470_0125
PULPROG	zg30
TD	65536
SOLVENT	CDCl3
NS	16
DS	2
SWH	10000.0000 Hz
FIDRES	0.305176 Hz
AQ	3.2768500 sec
RG	169.11
DW	50.0000 usec
DE	13.50
TE	298.3 K
D1	1.00000000 sec
TD0	1
SFO1	500.303896 MHz
NUC1	1H
P1	10.00 usec
SI	65536
SP	500.3000000 MHz
WDW	EM
SSB	0
LB	0.30 Hz
GB	0
PC	1.00



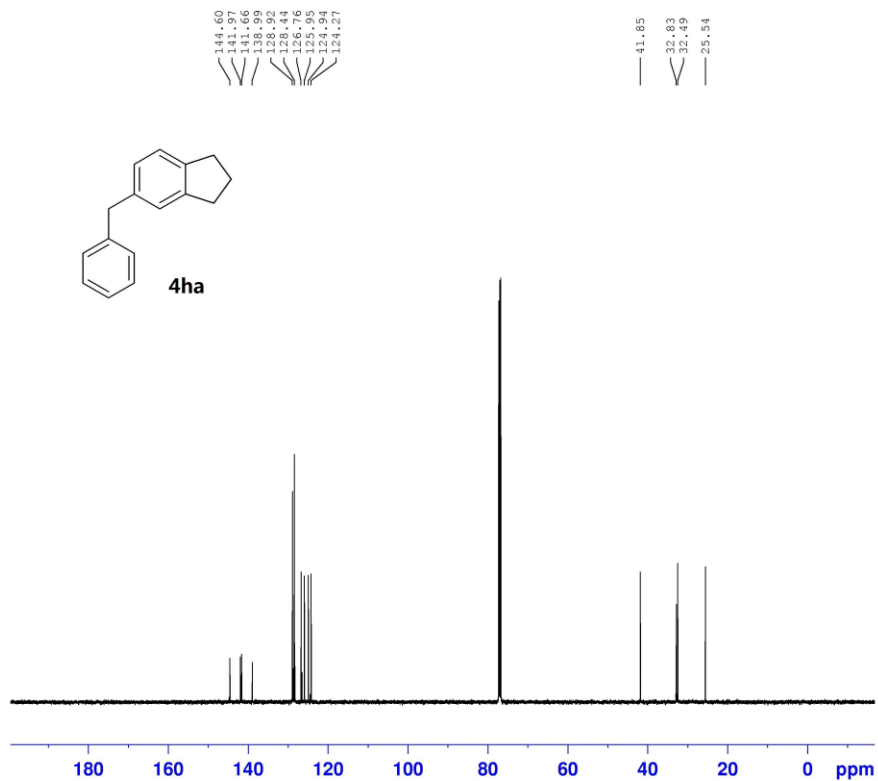






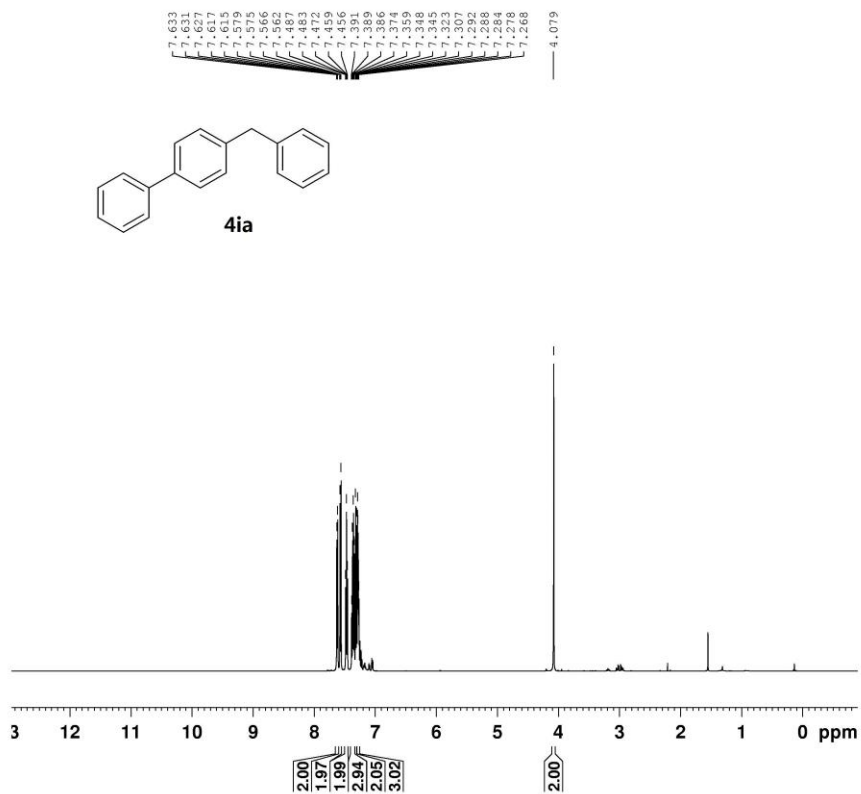
BRUKER

NAME 11y-343-1p-20180217
 EXPNO 1
 PROCNO 1
 Date_ 20180217
 Time 15.54 h
 INSTRUM AVIII500HD
 PROBHD Z119470_0125 (
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 10000.000 Hz
 FIDRES 0.305176 Hz
 AQ 3.2768500 sec
 RG 106.56
 DW 50.000 usec
 DE 13.50 usec
 TE 298.3 K
 D1 1.00000000 sec
 TD0 1
 SFO1 500.3030896 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 500.3000000 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00

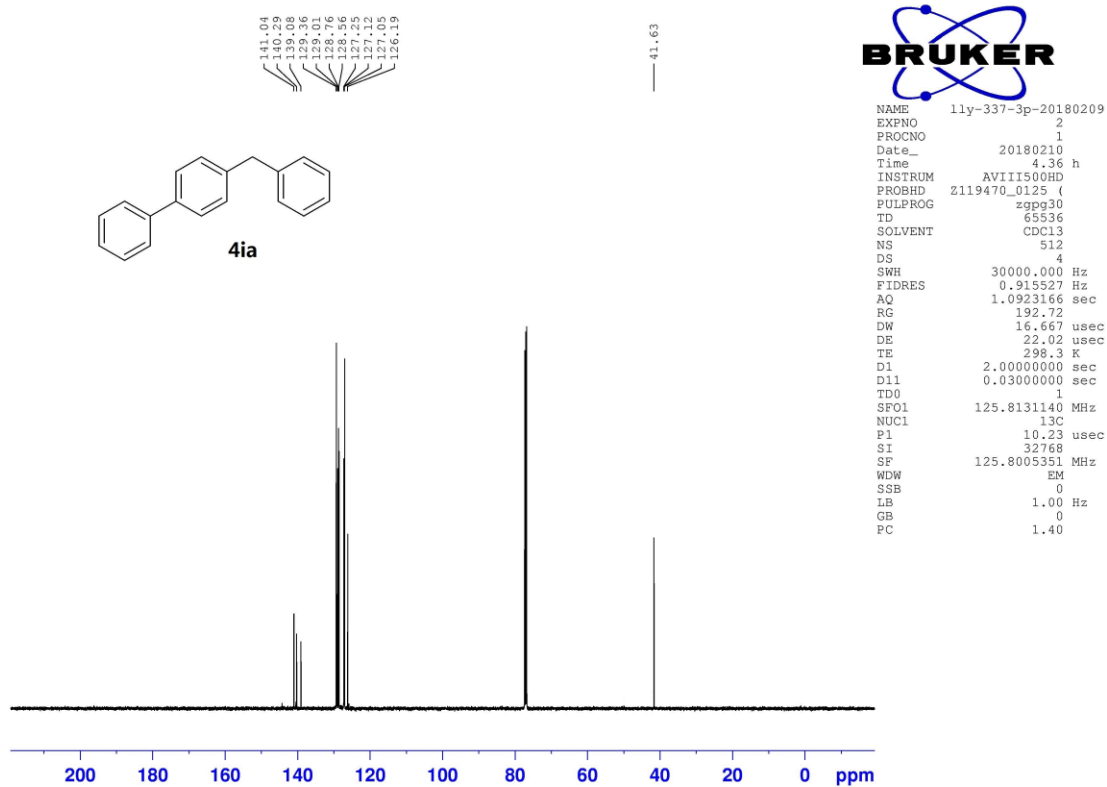


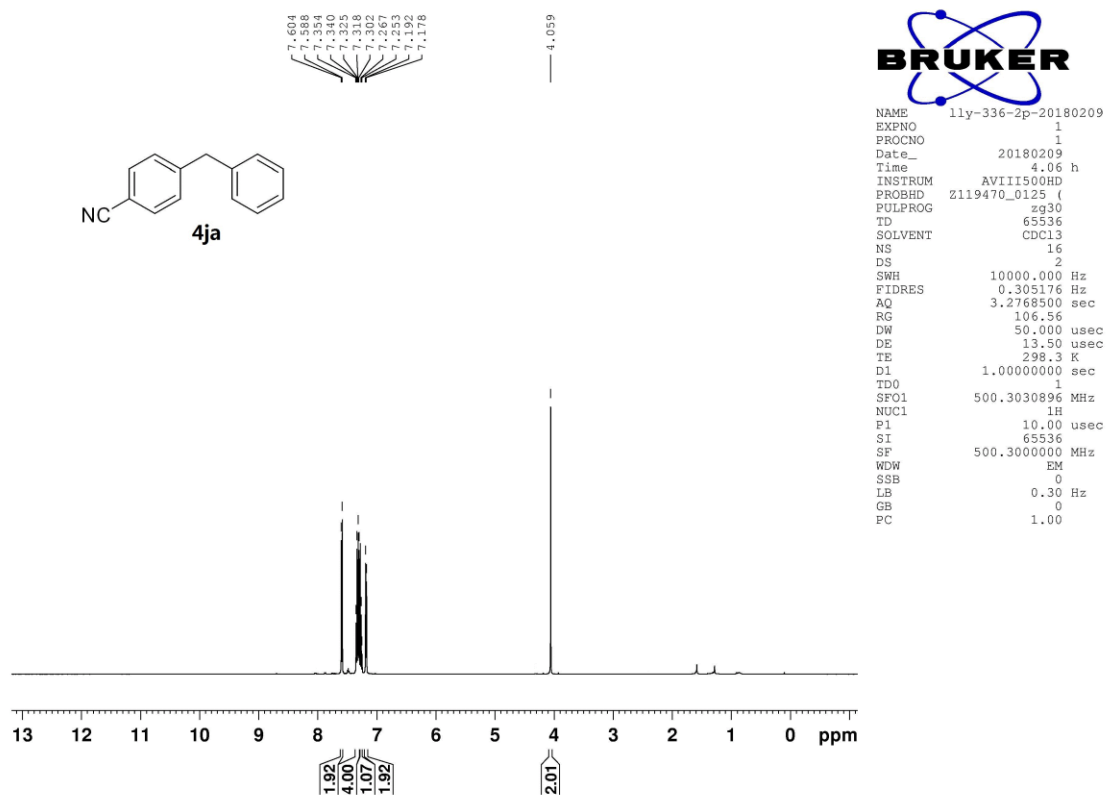
```

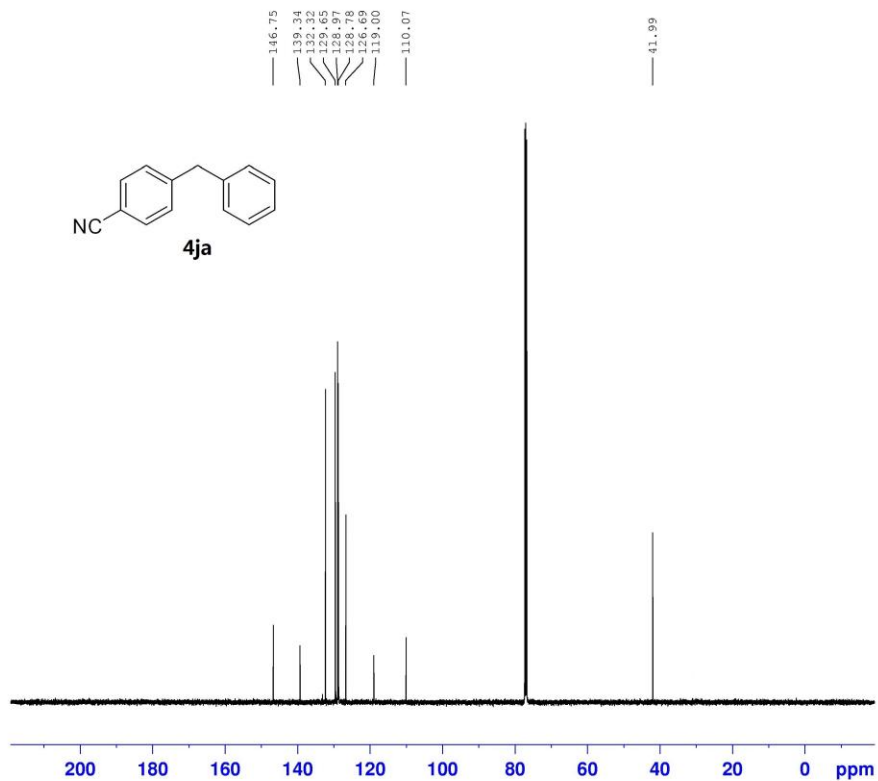
NAME      11y-343-1p-20180217
EXPNO     2
PROCNO    1
Date_     20180217
Time      16.21 h
INSTRUM    AVIII500HD
PROBHD    z119470_0125 (
PULPROG    zgpg30
TD         65536
SOLVENT    CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SFO1       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



NAME 1ly-337-3p-20180209
 EXPNO 1
 PROCNO 1
 Date_ 20180209
 Time 13.23 h
 INSTRUM AVIII500HD
 PROBHD Z119470_0125 (
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 10000.000 Hz
 FIDRES 0.305176 Hz
 AQ 3.2768500 sec
 RG 77.88
 DW 50.000 usec
 DE 13.50 usec
 TE 298.3 K
 D1 1.00000000 sec
 TD0 1
 SF01 500.3030896 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 500.3000000 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00

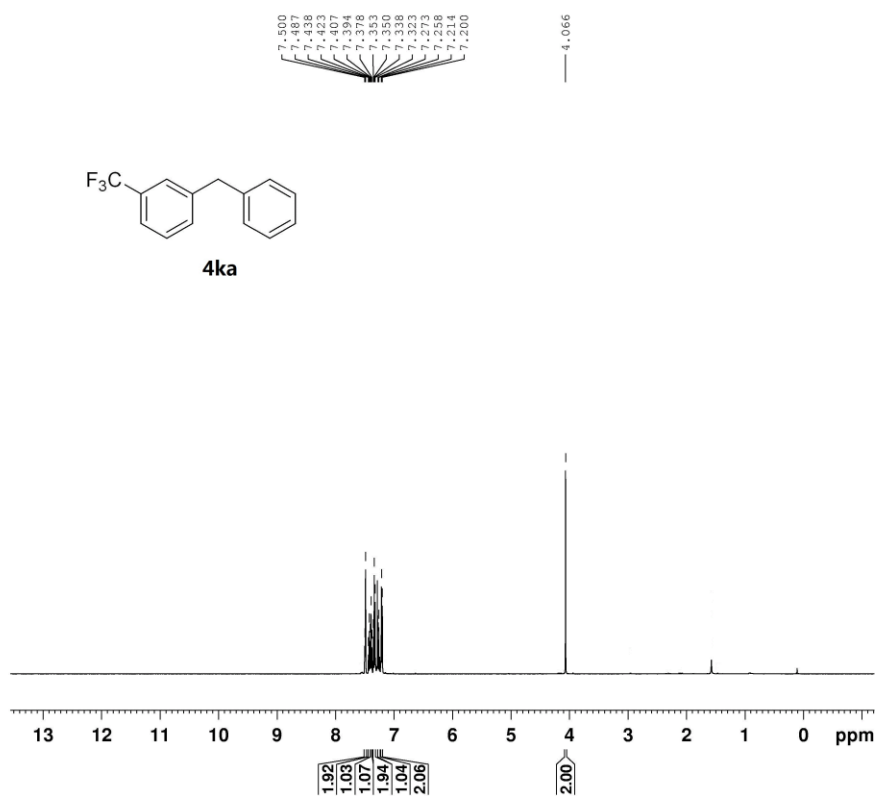






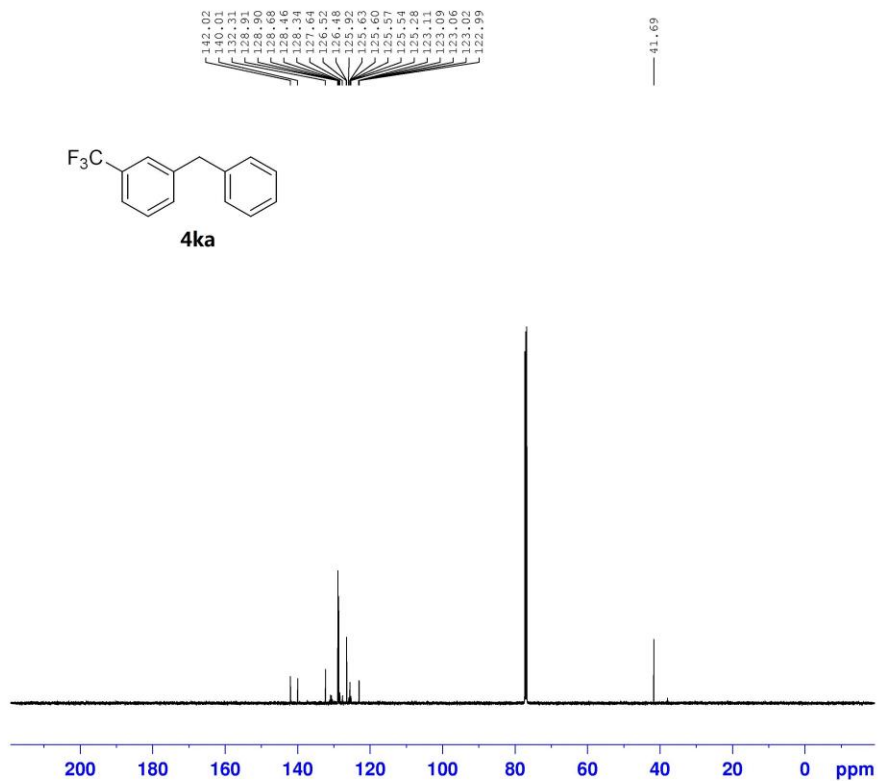
```

NAME      11y-336-2p-20180209
EXPNO     2
PROCNO    1
Date_     20180209
Time      4.34 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SF01       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



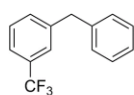
```

NAME      1ly-359-2p-20180111
EXPNO     1
PROCNO    1
Date_     20180111
Time      10.01 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT    CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         106.56
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



```

NAME      11y-359-2p-20180111
EXPNO     1
PROCNO    1
Date_     20180111
Time      10.29 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SFO1       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



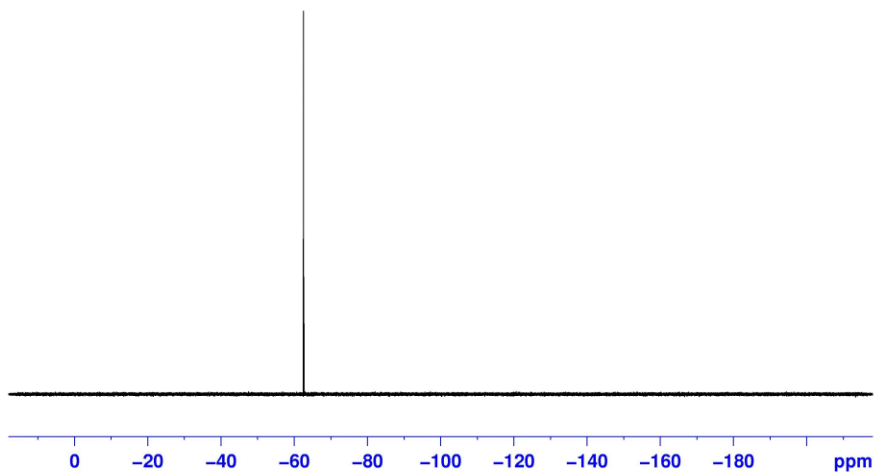
4ka

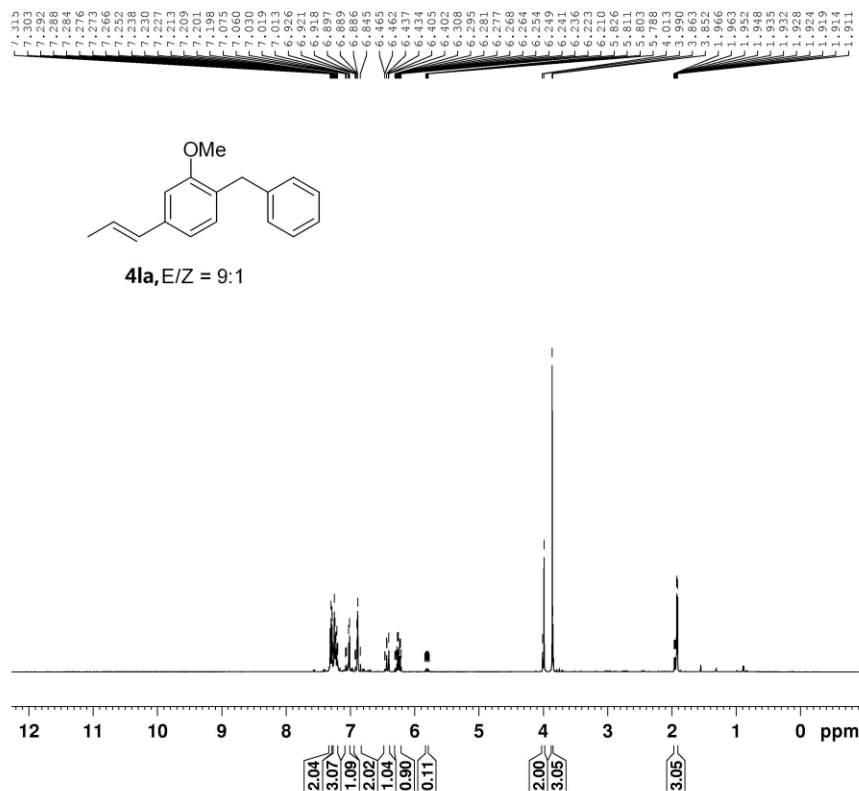
— -62.55



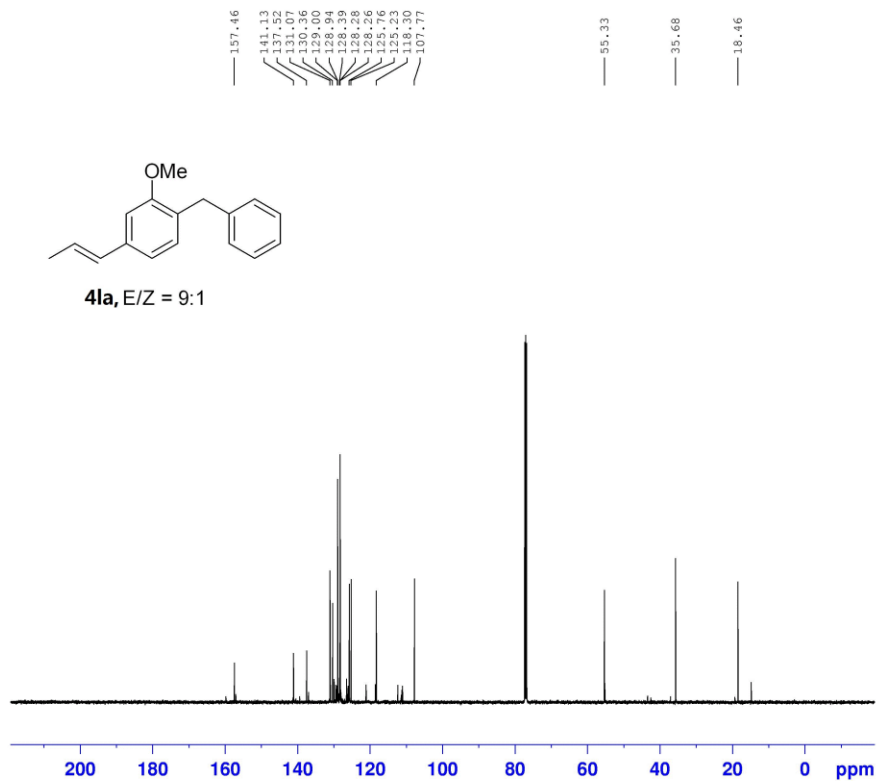
```

NAME      1ly-359-2p-20180111
EXPNO     1
PROCNO    1
Date_     20180111
Time      1.50 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         131072
SOLVENT    CDCl3
NS         16
DS         4
SWH        111111.109 Hz
FIDRES     1.695421 Hz
AQ         0.5898740 sec
RG         192.72
DW         4.500 usec
DE         35.33 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SF01       470.7052618 MHz
NUC1       13C
P1         15.00 usec
P2         30.00 usec
SI         65536
SF         470.7523370 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



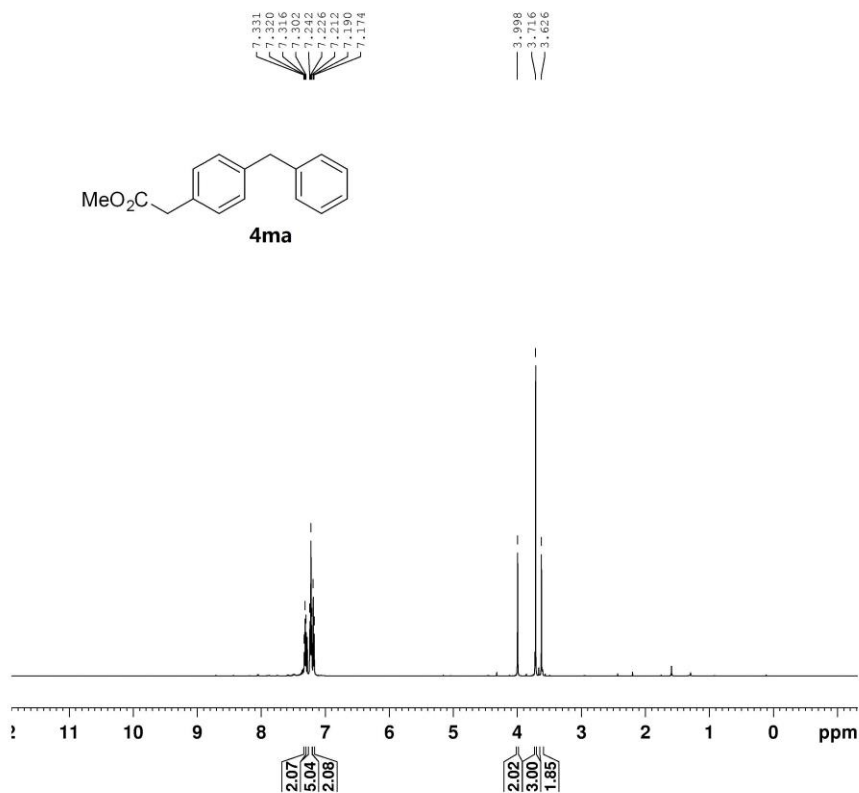


NAME 1ly-338-3p-20181210
EXPNO 1
PROCNO 1
Date_ 20180210
Time 13.31 h
INSTRUM AVIII500HD
PROBHD Z119470_0125 (
PULPROG zg30
TD 65536
SOLVENT CDC13
NS 16
DS 2
SWH 10000.000 Hz
FIDRES 0.305176 Hz
AQ 3.2768500 sec
RG 71.03
DW 50.000 usec
DE 13.50 usec
TE 298.3 K
D1 1.00000000 sec
TD0 1
SF01 500.3030896 MHz
NUC1 1H
P1 10.00 usec
SI 65536
SF 500.3000000 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

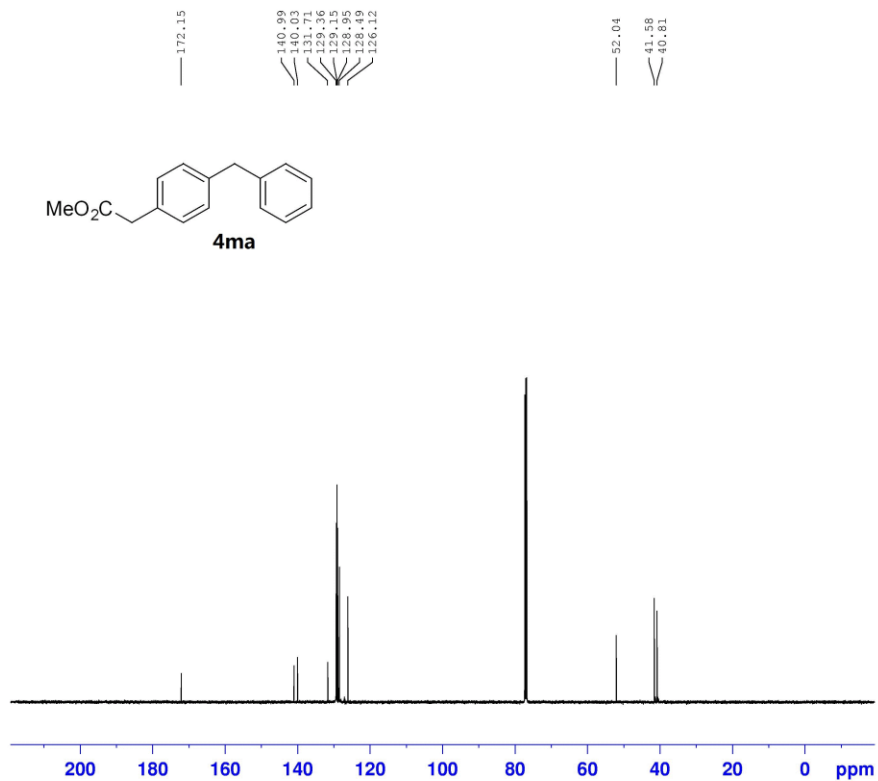


```

NAME      11y-338-3p-20181210
EXPNO     2
PROCNO    1
Date_     20180210
Time      13.59 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT    CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SFO1       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```

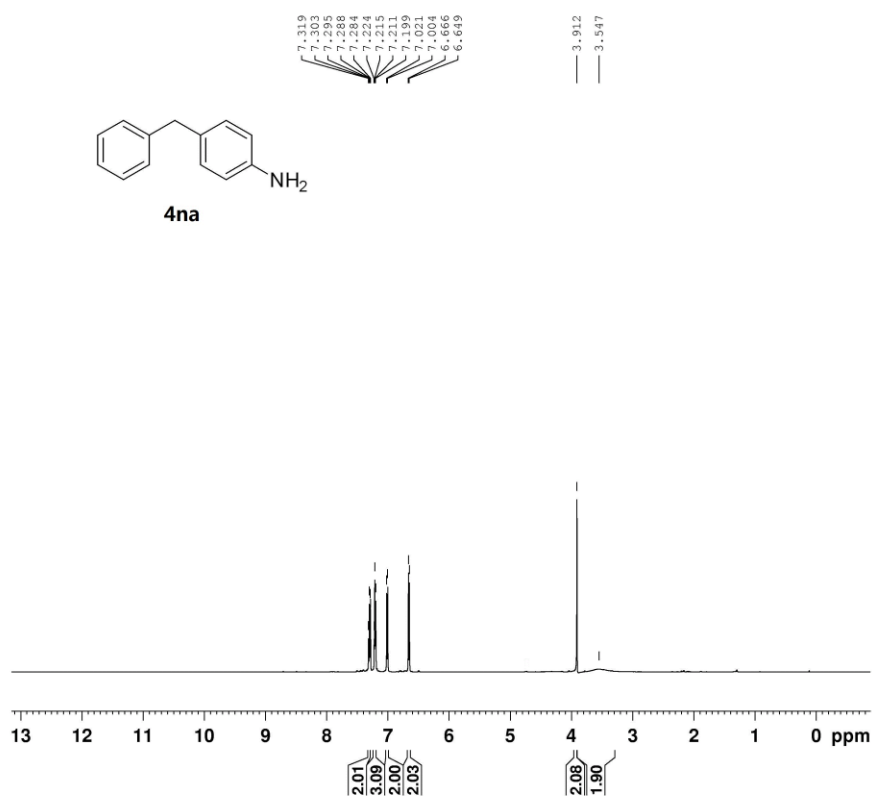


NAME 1ly-339-3p-20180211
 EXPNO 1
 PROCNO 1
 Date_ 20180211
 Time 13.01 h
 INSTRUM AVIII500HD
 PROBHD Z119470_0125 (
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 10000.000 Hz
 FIDRES 0.305176 Hz
 AQ 3.2768500 sec
 RG 106.56
 DW 50.000 usec
 DE 13.50 usec
 TE 298.3 K
 D1 1.00000000 sec
 TD0 1
 SFO1 500.3030896 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 500.3000000 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00



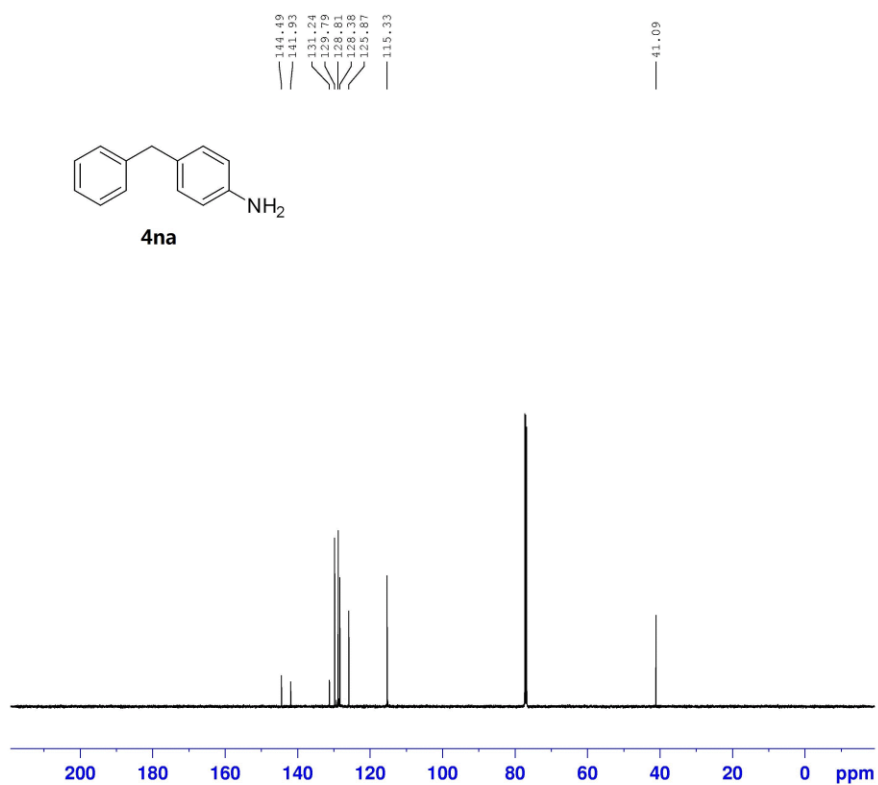
```

NAME      1ly-339-3p-20180211
EXPNO     2
PROCNO    1
Date_     20180211
Time      13.28 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT    CDC13
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SF01       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



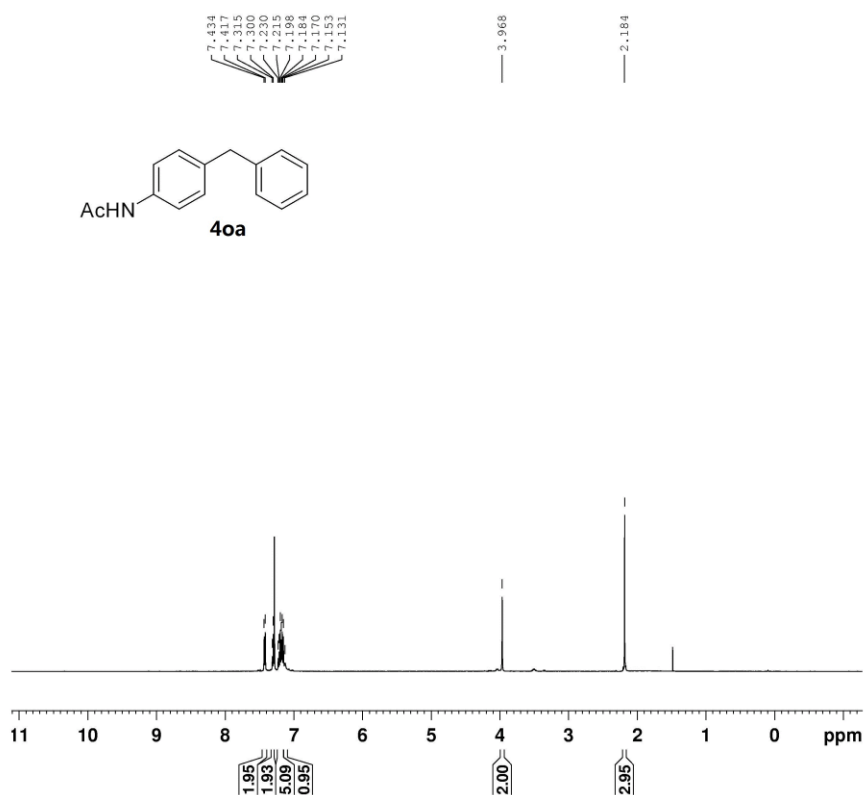
```

NAME      11y-360-1p-20180201
EXPNO     1
PROCNO    1
Date_     20180201
Time      8.29 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT    CDC13
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         106.56
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



```

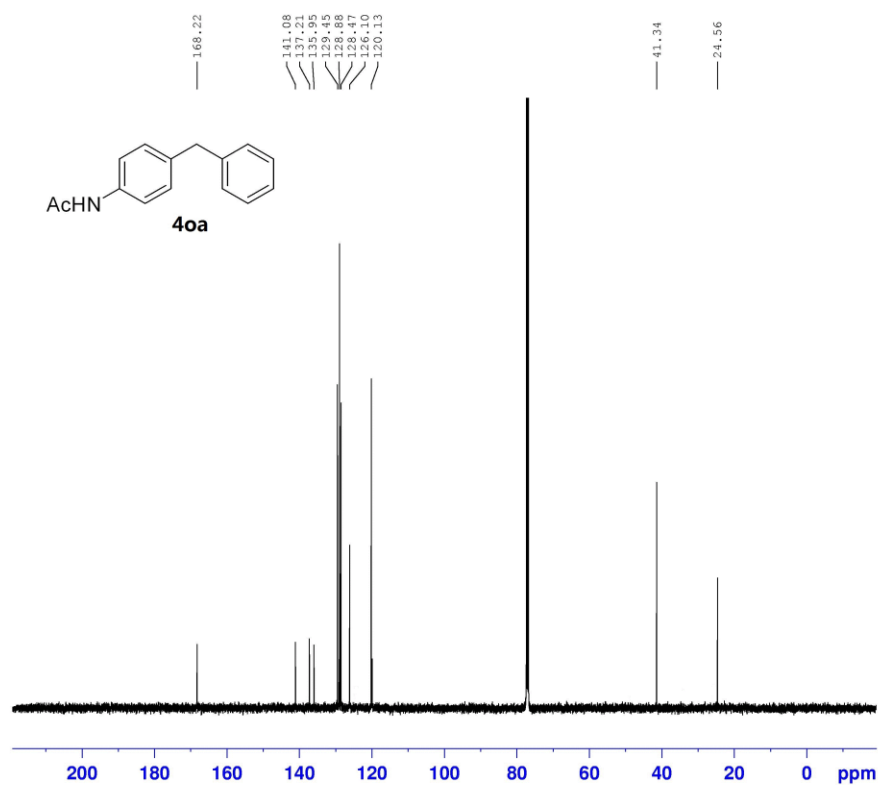
NAME      11y-360-1p-20180201
EXPNO     1
PROCNO    1
Date_     20180201
Time      10.26 h
INSTRUM    AVII500HD
PROBHD     Z119470_0125 (
PULPROG    zgpg30
TD         65536
SOLVENT     CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SF01       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



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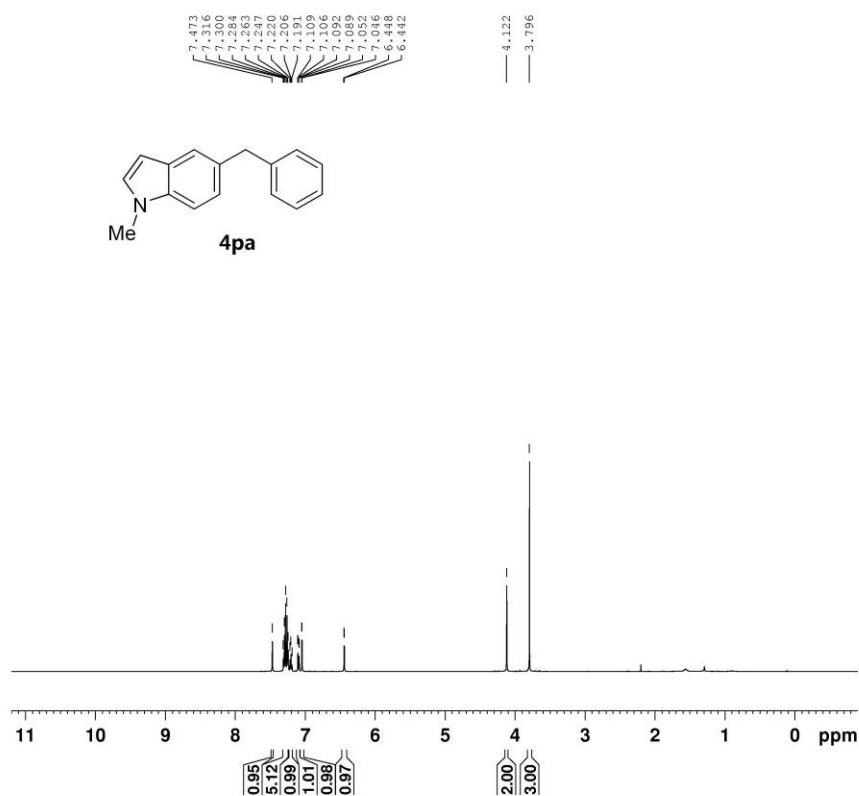
```

NAME 11y-343-abp-20180218
EXPNO 1
PROCNO 1
Date_ 20180218
Time 8.59 h
INSTRUM AVIII500HD
PROBHD Z119470_0125 (
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
SWH 10000.000 Hz
FIDRES 0.305176 Hz
AQ 3.2768500 sec
RG 192.72
DW 50.000 usec
DE 13.50 usec
TE 298.3 K
D1 1.0000000 sec
TD0 1
SF01 500.3030896 MHz
NUC1 1H
P1 10.00 usec
SI 65536
SF 500.3000000 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
  
```



```

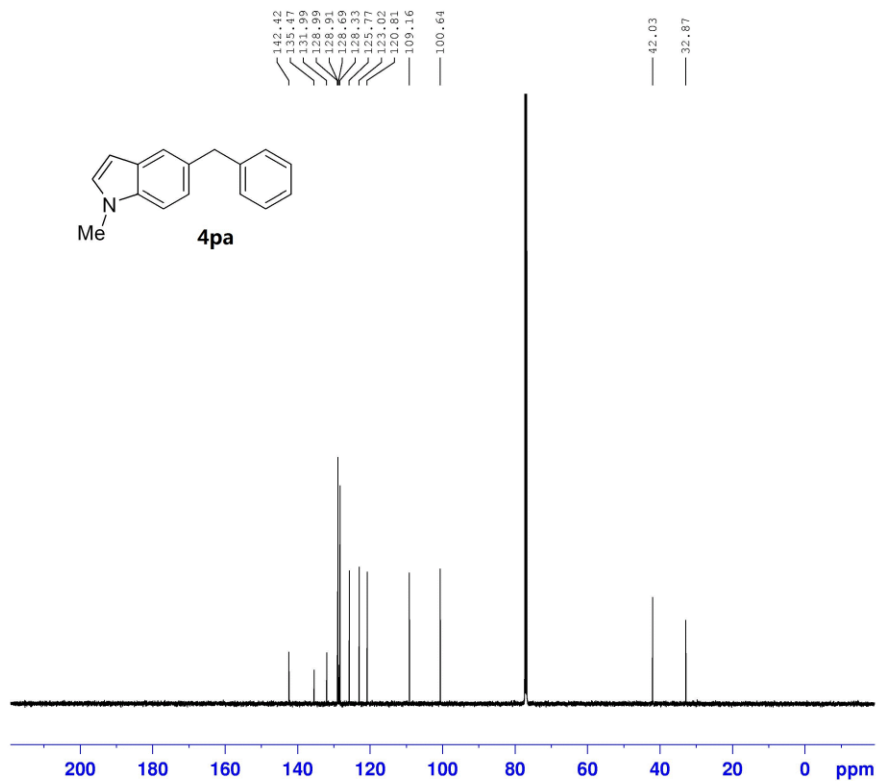
NAME      1ly-343-4ap-20180218
EXPNO     2
PROCNO    1
Date_     20180218
Time      9.59 h
INSTRUM    AVIII500HD
PROBHD     Z119470_0125 (
PULPROG    zgpg30
TD         65536
SOLVENT     CDCl3
NS         1024
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SFO1       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



BRUKER

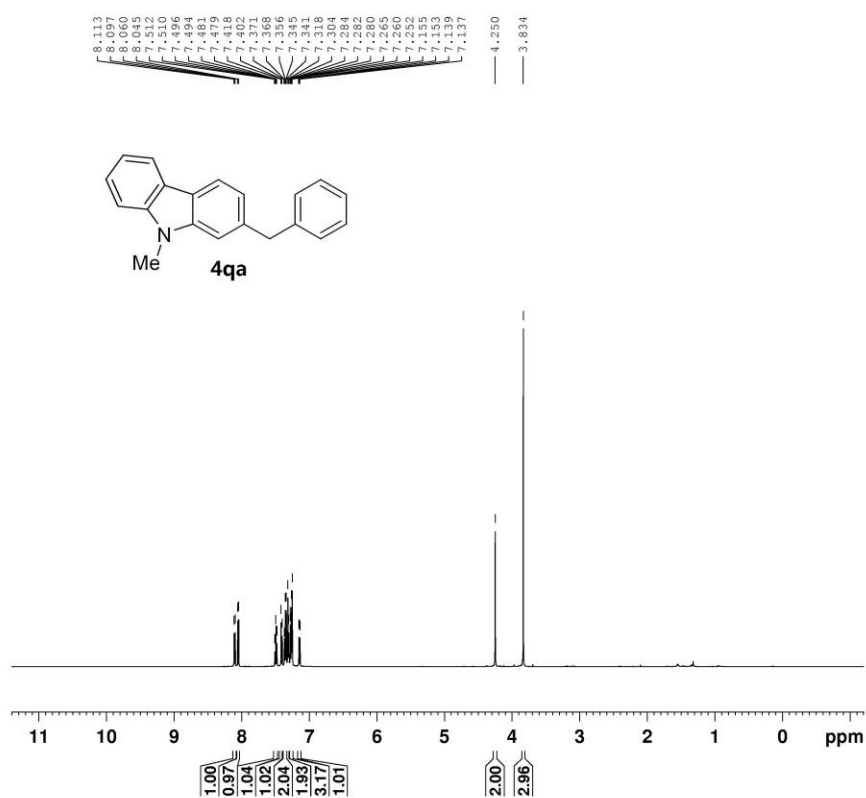
```

NAME      11y-340-1p-20180212
EXPNO     1
PROCNO    1
Date_     20180213
Time      1.28 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         106.56
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



```

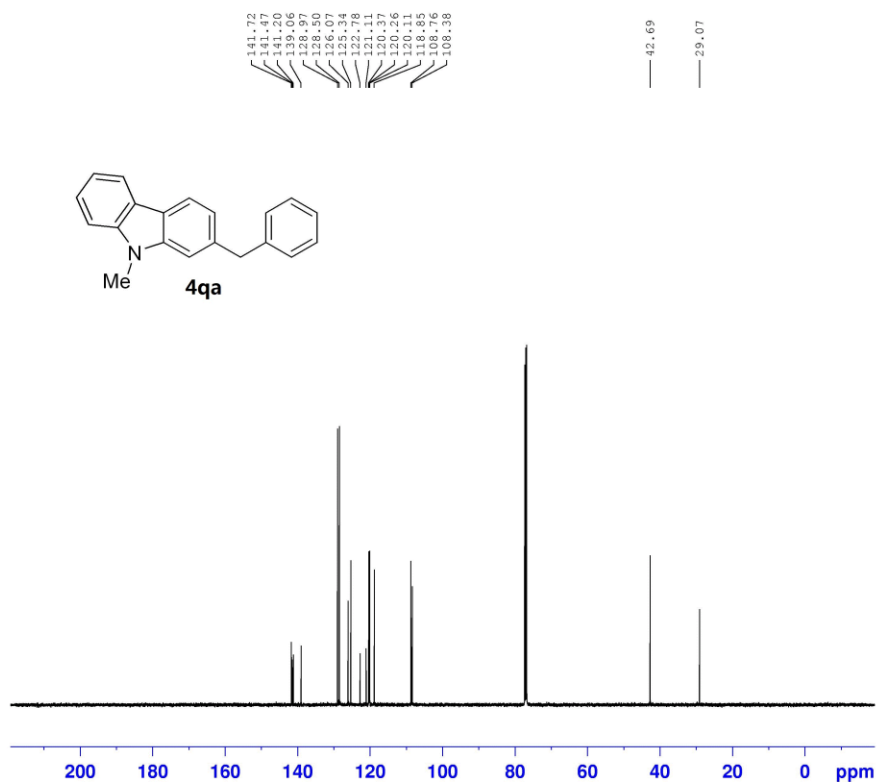
NAME      1ly-340-1p-20180212
EXPNO     2
PROCNO    1
Date_     20180213
Time      2.22 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT    CDCl3
NS         1024
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SFO1      125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



BRUKER

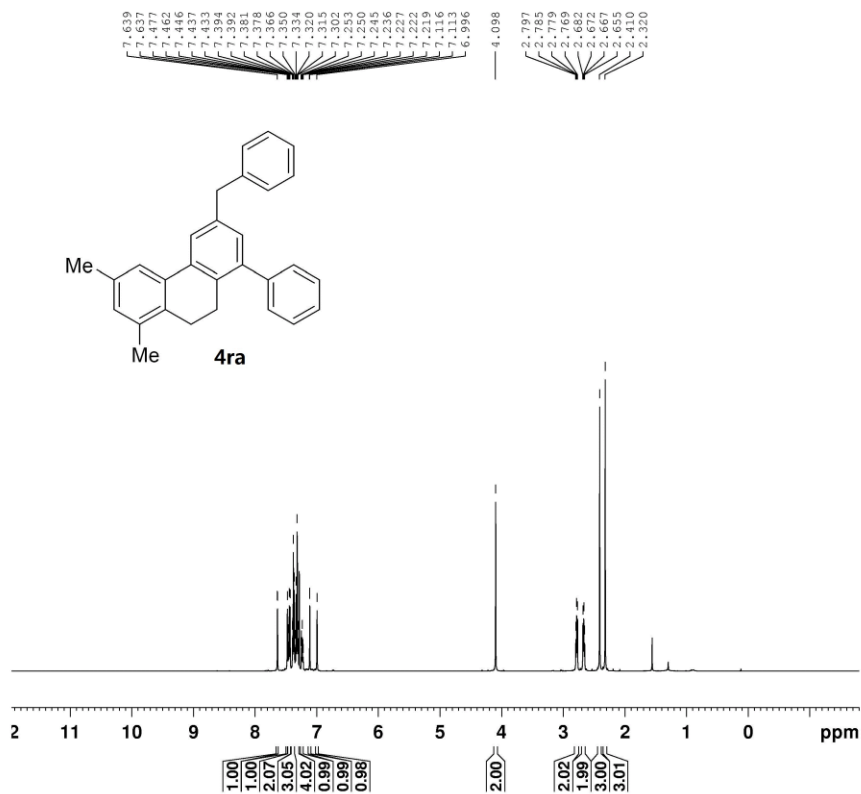
```

NAME      11y-342-2p-20180214
EXPNO     1
PROCNO    1
Date_     20180214
Time      13.15 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         106.56
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



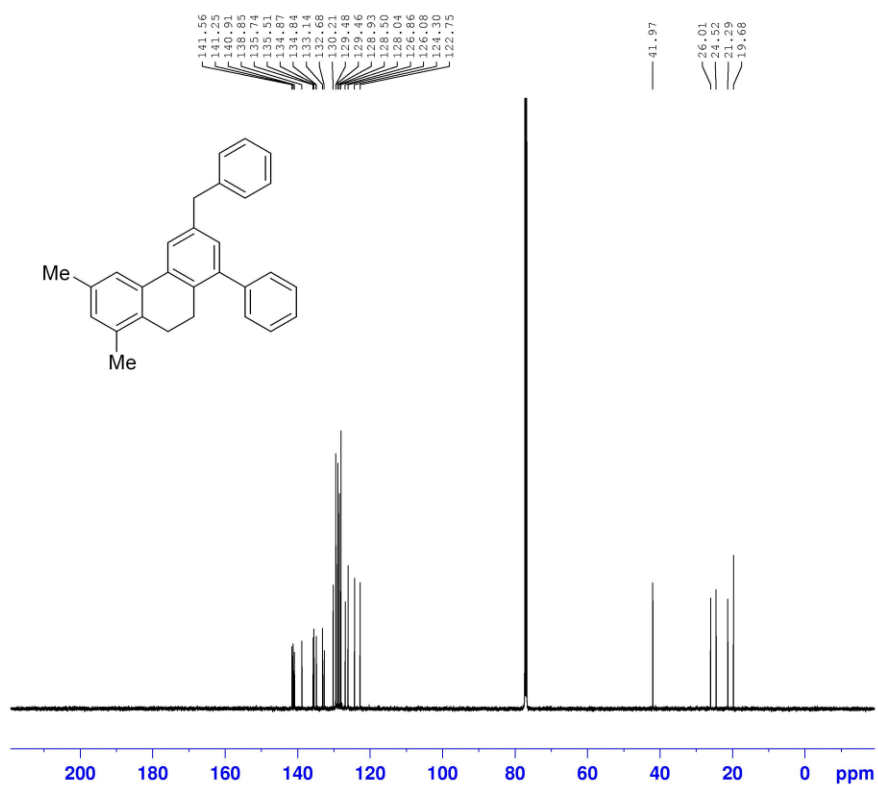
```

NAME      11y-342-2p-20180214
EXPNO     2
PROCNO    1
Date_     20180214
Time      13.43 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SFO1      125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```

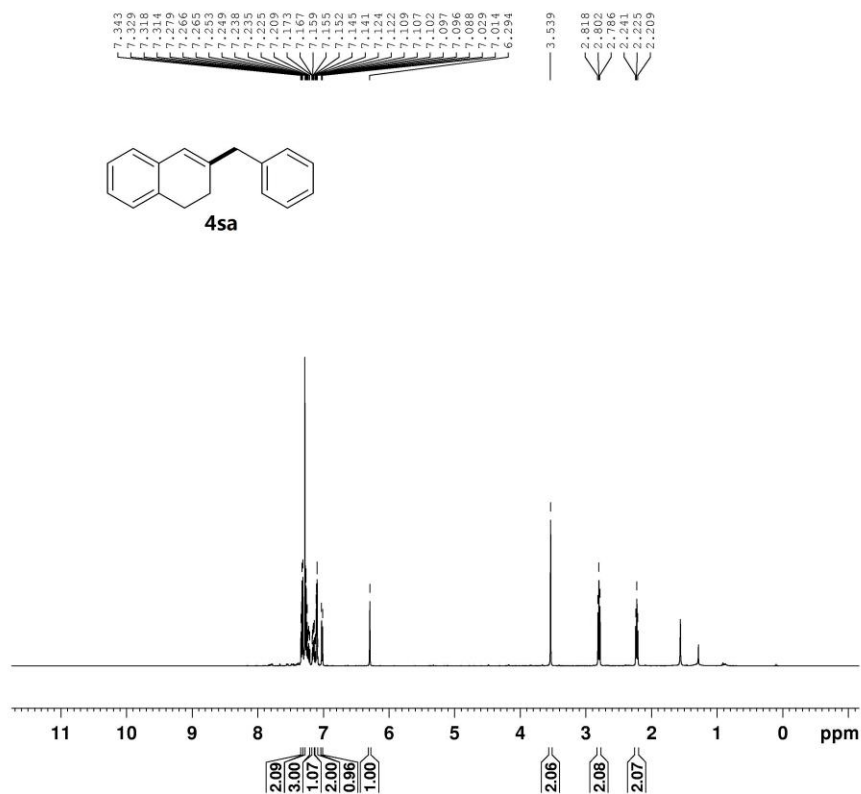


```

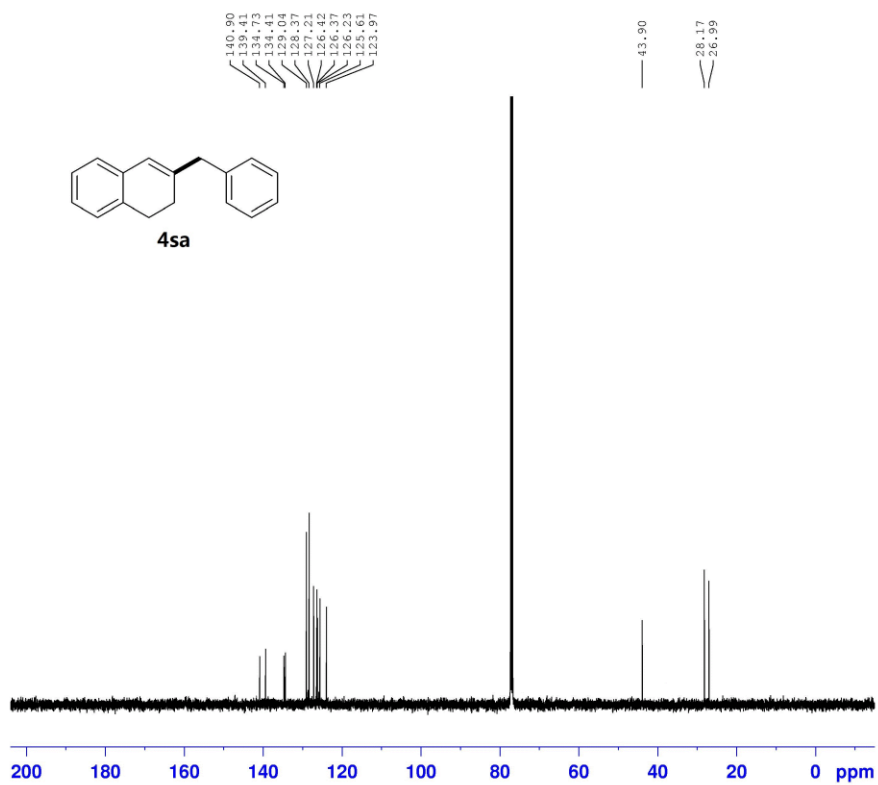
NAME      lly-343-5p-20180218
EXPNO     1
PROCNO    1
Date_     20180218
Time      17.28 h
INSTRUM   AVIIS00HD
PROBHD    Z119470_0125 (
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         106.56
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SF01       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



NAME 11y-343-5p-20180218
 EXPNO 2
 PROCNO 1
 Date_ 20180218
 Time 20.30 h
 INSTRUM AVIII500HD
 PROBHD z119470_0125 (
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 2000
 DS 4
 SWH 30000.000 Hz
 FIDRES 0.915527 Hz
 AQ 1.0923166 sec
 RG 192.72
 DW 16.667 usec
 DE 22.02 usec
 TE 298.3 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1
 SFO1 125.8131140 MHz
 NUC1 13C
 P1 10.23 usec
 SI 32768
 SF 125.8005351 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

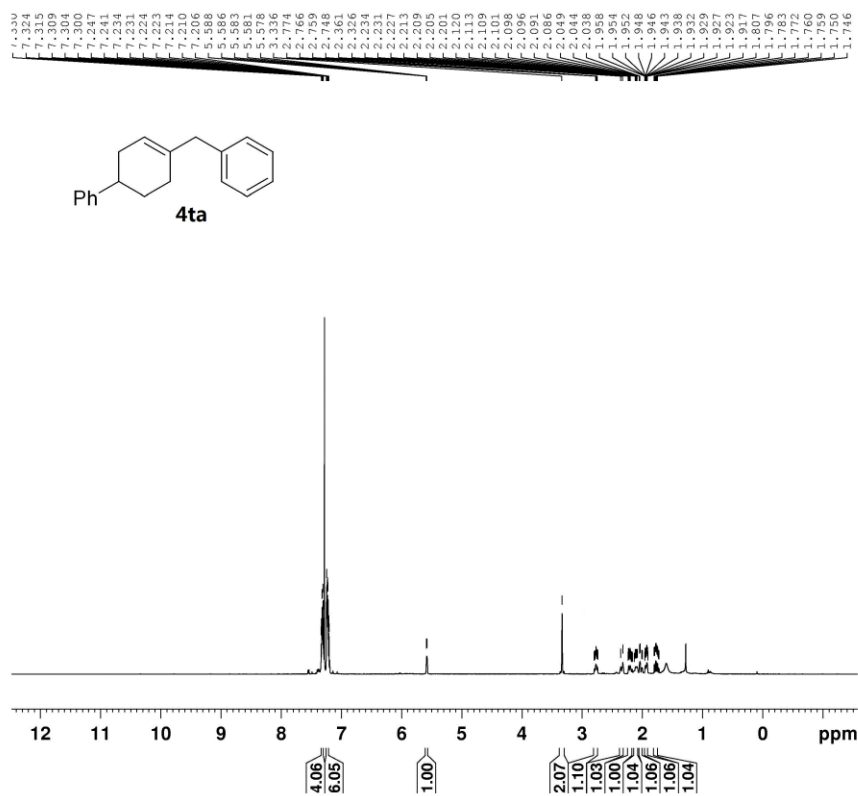


NAME 1ly-349-3p-20180223
 EXPNO 1
 PROCNO 1
 Date_ 20180224
 Time 6.24 h
 INSTRUM AVIII500HD
 PROBHD Z119470_0125 (
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 10000.000 Hz
 FIDRES 0.305176 Hz
 AQ 3.2768500 sec
 RG 192.72
 DW 50.000 usec
 DE 13.50 usec
 TE 298.3 K
 D1 1.00000000 sec
 TD0 1
 SF01 500.3030896 MHz
 NUC1 1H
 P1 10.00 usec
 S1 65536
 SF 500.3000000 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00



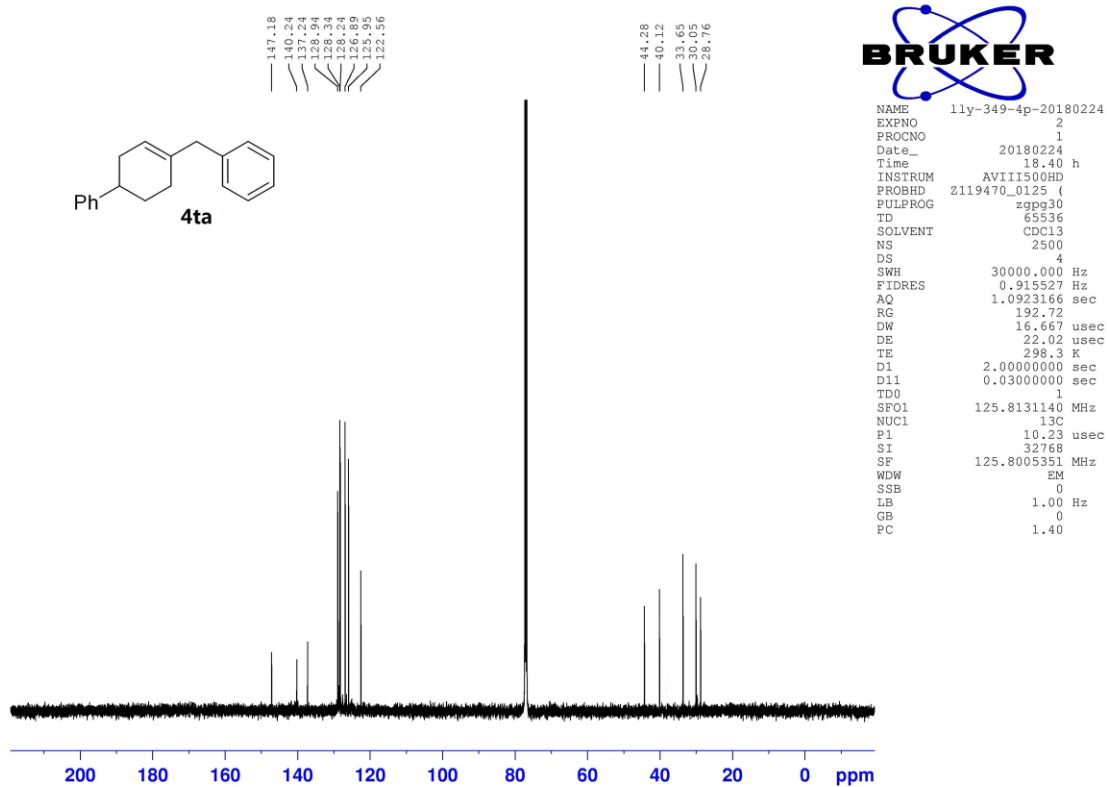
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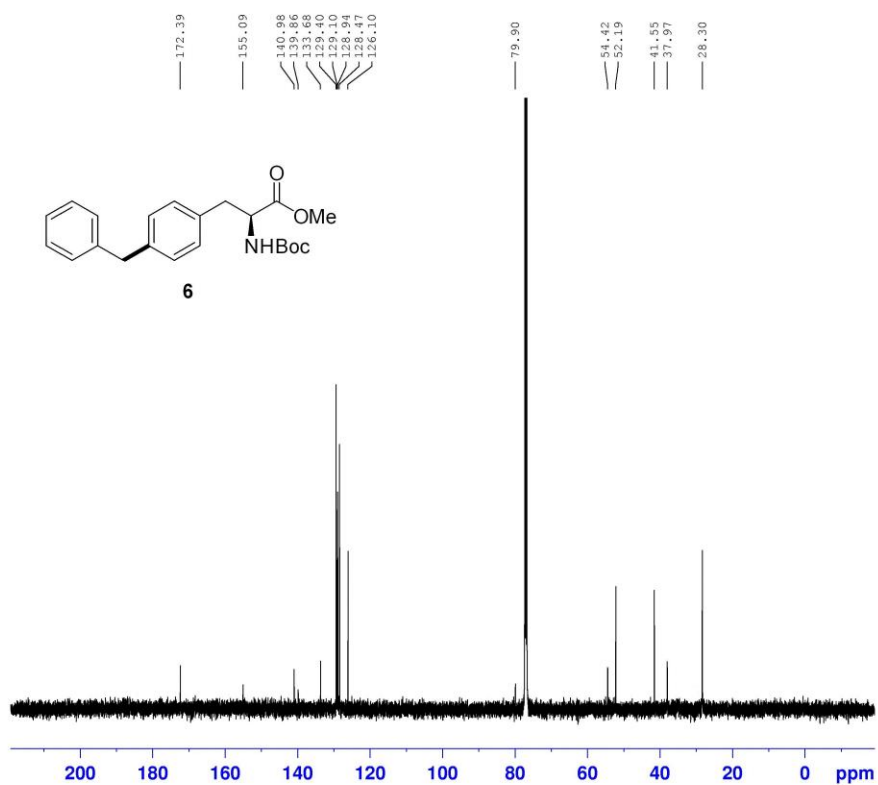
NAME      1ly-349-3p-20180223
EXPNO     2
PROCNO    1
Date_     20180224
Time      6.52 h
INSTRUM   AVII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ          1.0923166 sec
RG          192.72
DW          16.667 usec
DE          22.02 usec
TE         298.3 K
D1          2.00000000 sec
D11        0.03000000 sec
TD0         1
SF01       125.8131140 MHz
NUC1       13C
P1          10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB         0
LB          1.00 Hz
GB          0
PC          1.40
  
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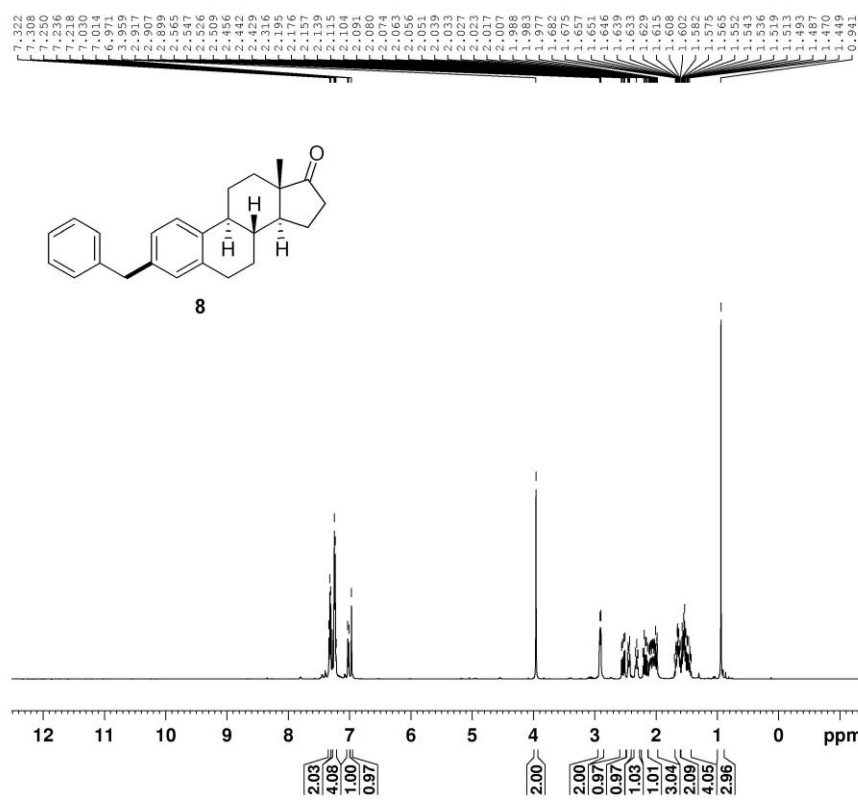
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NAME 11y-349-4p-20180224
 EXPNO 1
 PROCNO 1
 Date_ 20180224
 Time 16.27 h
 INSTRUM AVIII500HD
 PROBHD Z119470_0125 (
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 10000.000 Hz
 FIDRES 0.305176 Hz
 AQ 3.2768500 sec
 RG 192.72
 DW 50.000 usec
 DE 13.50 usec
 TE 298.3 K
 D1 1.00000000 sec
 TD0 1
 SFO1 500.3030896 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 500.3000000 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00





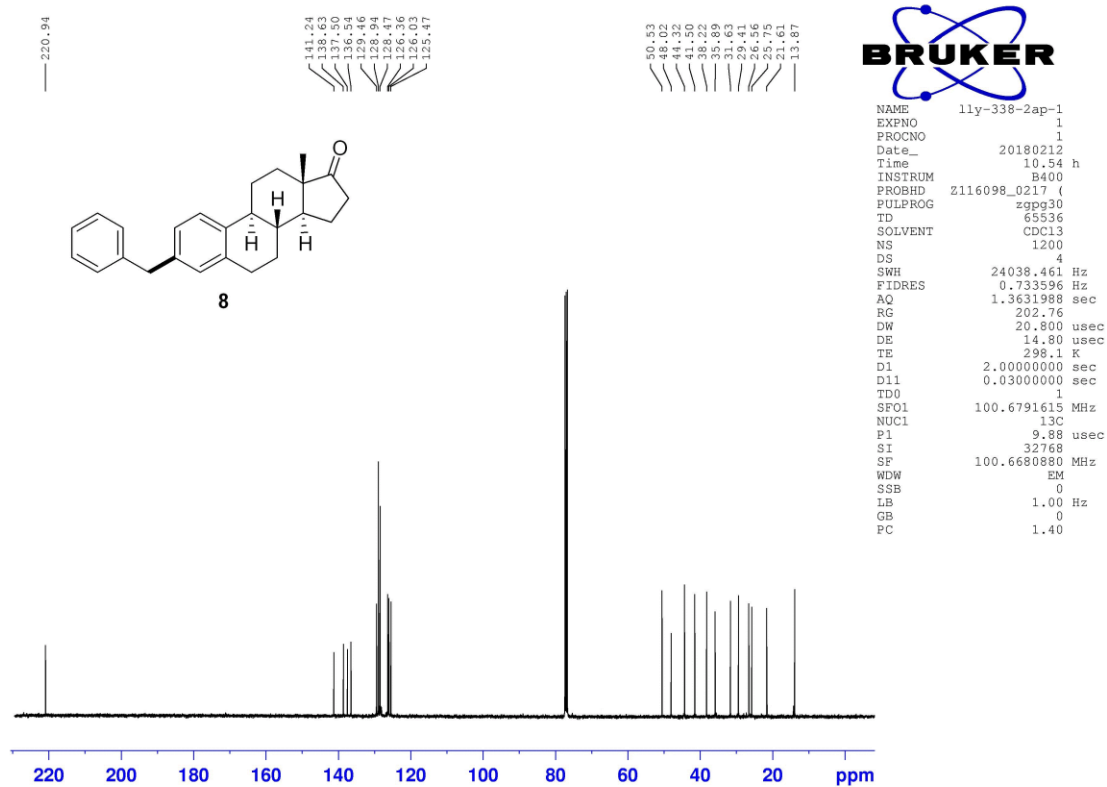
NAME 11y-340-2p-20180213
 EXPNO 2
 PROCNO 1
 Date_ 20180213
 Time 23.04 h
 INSTRUM AVIII500HD
 PROBHD Z119470_0125 (
 PULPROG zgpg30
 TD 65536
 SOLVENT CDCl3
 NS 3200
 DS 4
 SWH 30000.000 Hz
 FIDRES 0.915527 Hz
 AQ 1.0923166 sec
 RG 192.72
 DW 16.667 usec
 DE 22.02 usec
 TE 298.3 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1
 SFO1 125.8131140 MHz
 NUC1 13C
 P1 10.23 usec
 SI 32768
 SF 125.8005351 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40

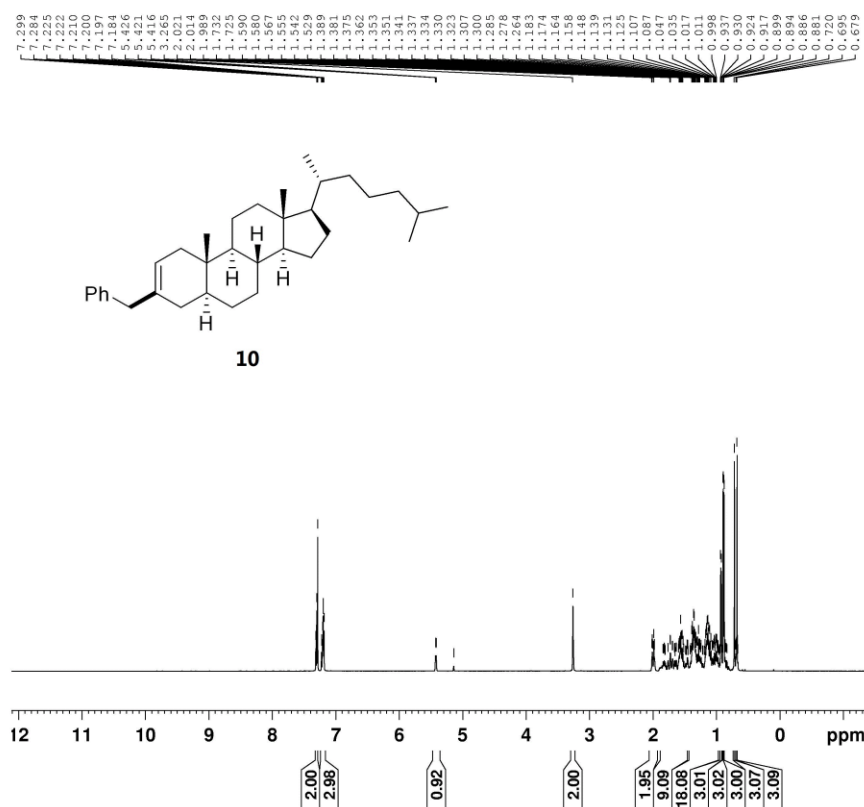


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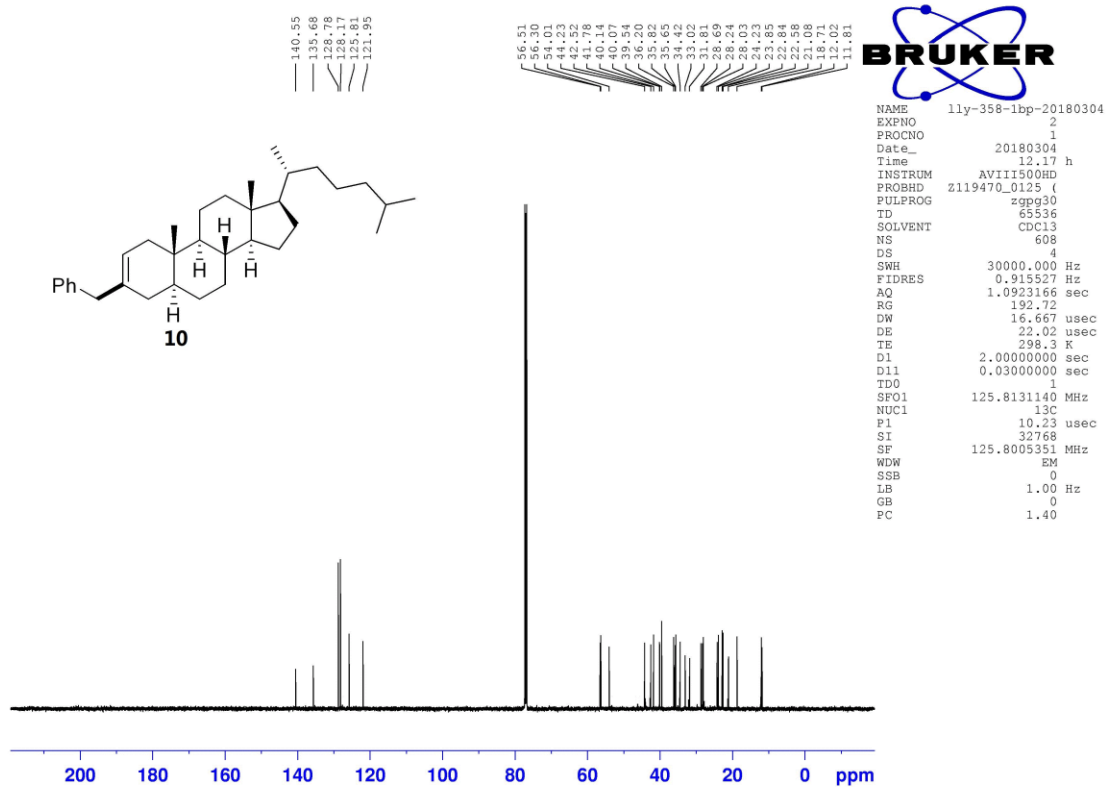
NAME      11y-338-2p-20181210
EXPNO     1
PROCNO    1
Date_     20180210
Time      14.39 h
INSTRUM    AVIII500HD
PROBHD     Z119470_0125 (
PULPROG    zg30
TD         65536
SOLVENT    CDCl3
NS         16
DS         2
SWH        10000.000 Hz
FIDRES     0.305176 Hz
AQ         3.2768500 sec
RG         63.07
DW         50.000 usec
DE         13.50 usec
TE         298.3 K
D1         1.00000000 sec
TD0        1
SFO1       500.3030896 MHz
NUC1       1H
P1         10.00 usec
SI         65536
SF         500.3000000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```

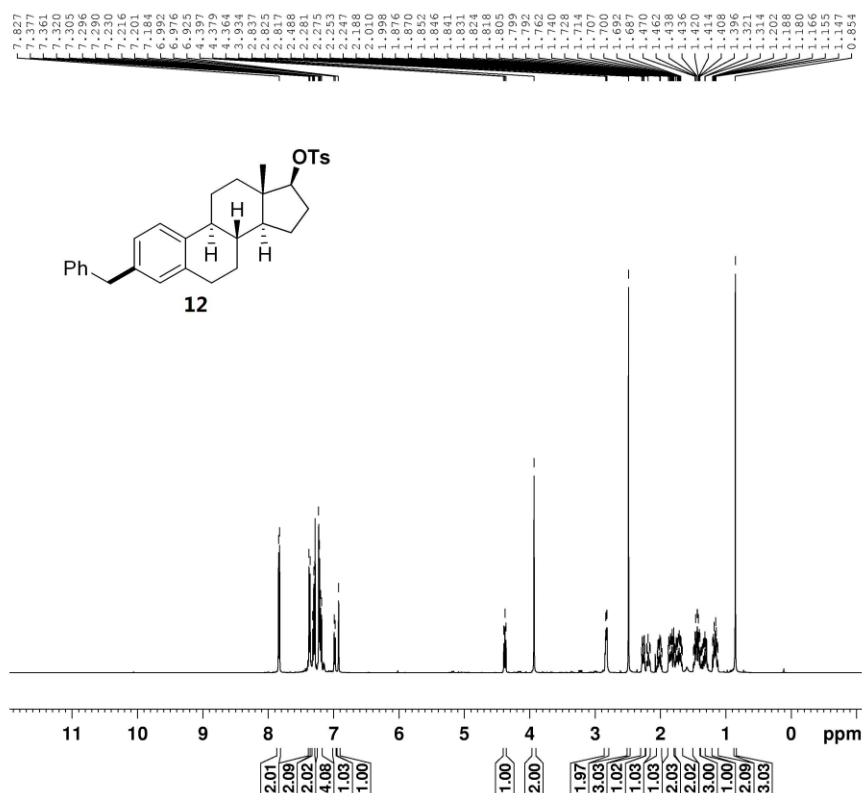




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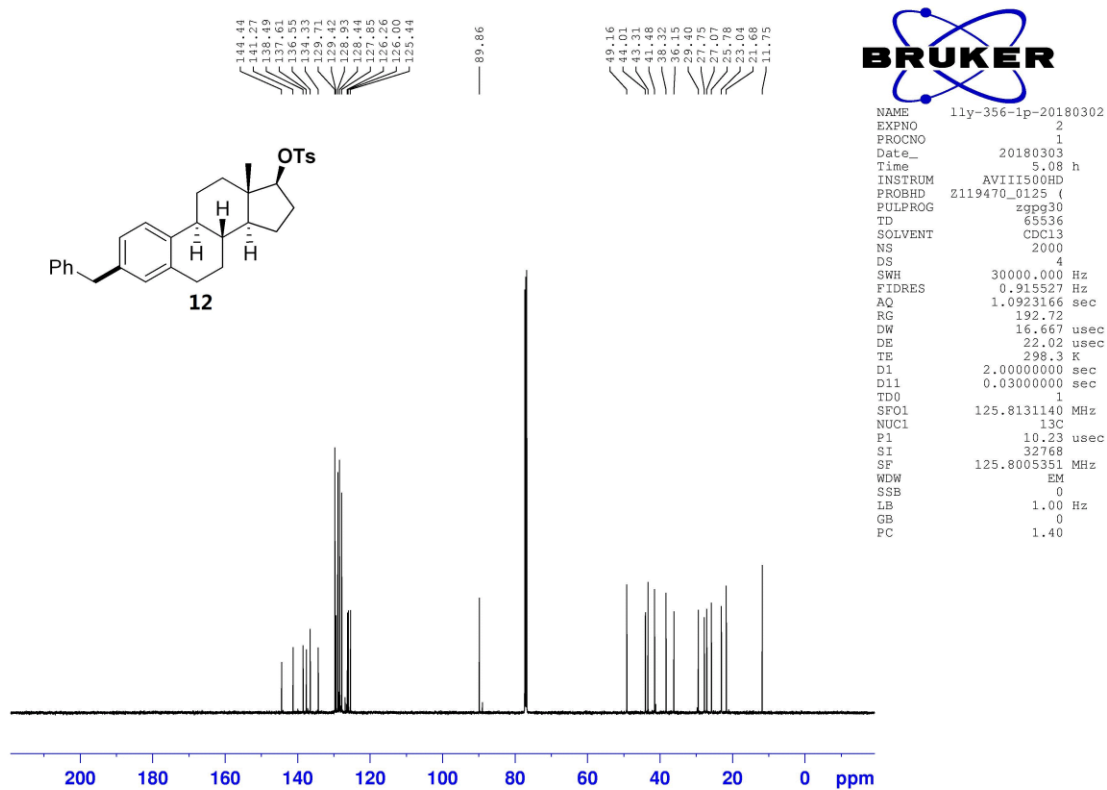
NAME 11y-358-1bp-20180304
 EXPNO 1
 PROCNO 1
 Date_ 20180304
 Time 11.44 h
 INSTRUM AVIII500HD
 PROBHD Z119470_0125 ()
 PULPROG zg30
 TD 65536
 SOLVENT CDCl₃
 NS 16
 DS 2
 SWH 10000.000 Hz
 FIDRES 0.305176 Hz
 AQ 3.2768500 sec
 RG 77.88
 DW 50.000 usec
 DE 13.50 usec
 TE 298.3 K
 D1 1.00000000 sec
 TD0 1
 SFO1 500.3030896 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 500.3000000 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00

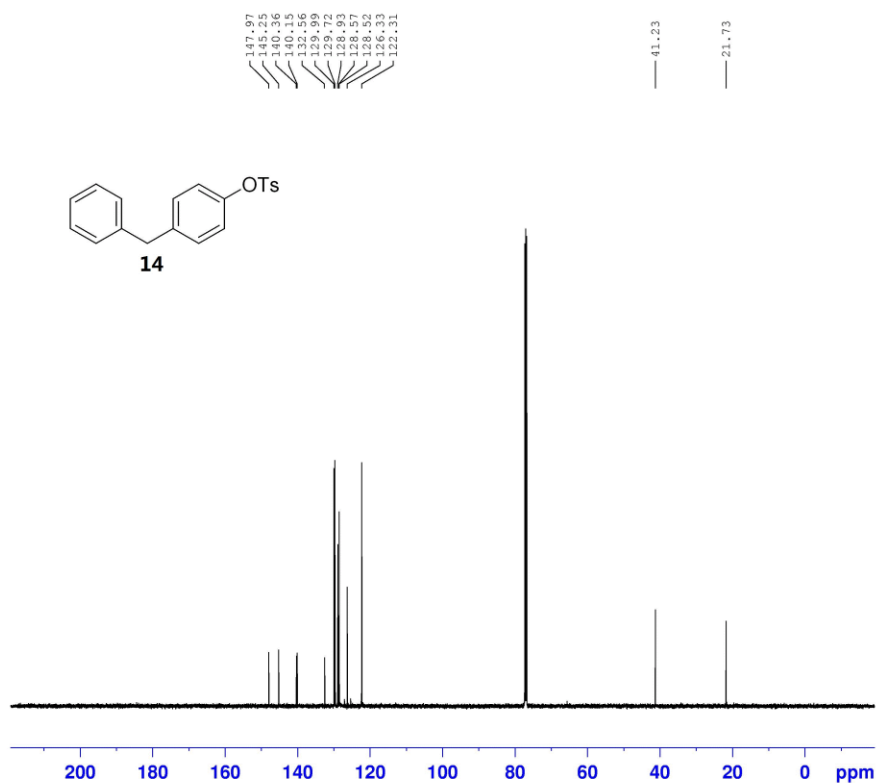




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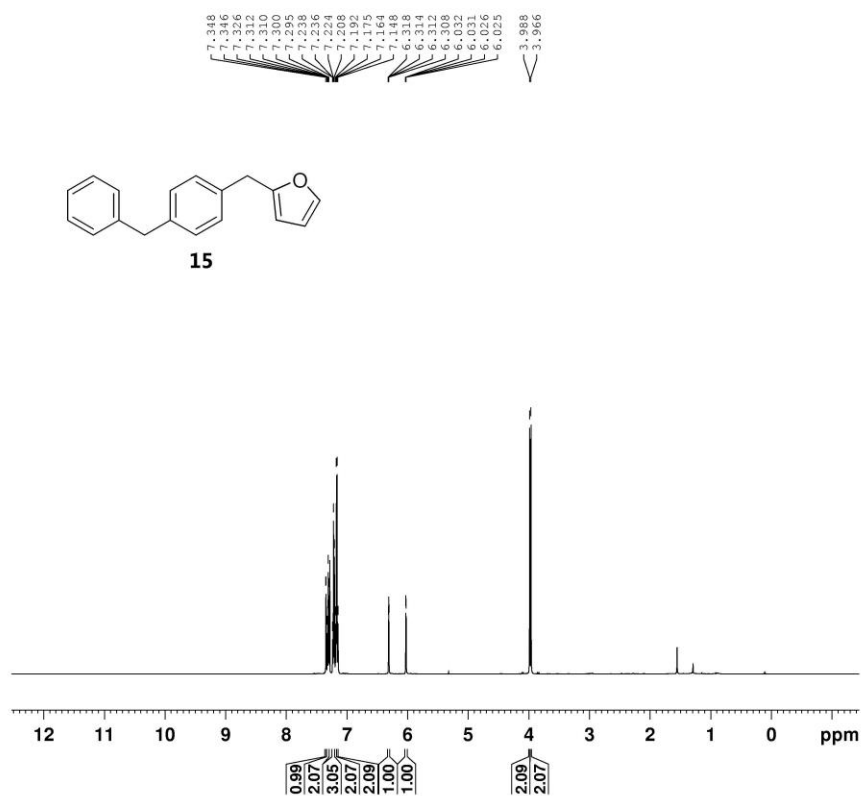
NAME 11y-356-1p-20180302
 EXPNO 1
 PROCNO 1
 Date_ 20180302
 Time 12.59 h
 INSTRUM AVIII500HD
 PROBHD Z119470_0125 (
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 10000.000 Hz
 FIDRES 0.305176 Hz
 AQ 3.2768500 sec
 RG 71.03
 DW 50.000 usec
 DE 13.50 usec
 TE 298.3 K
 D1 1.00000000 sec
 TD0 1
 SFO1 500.3030896 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 500.3000000 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00



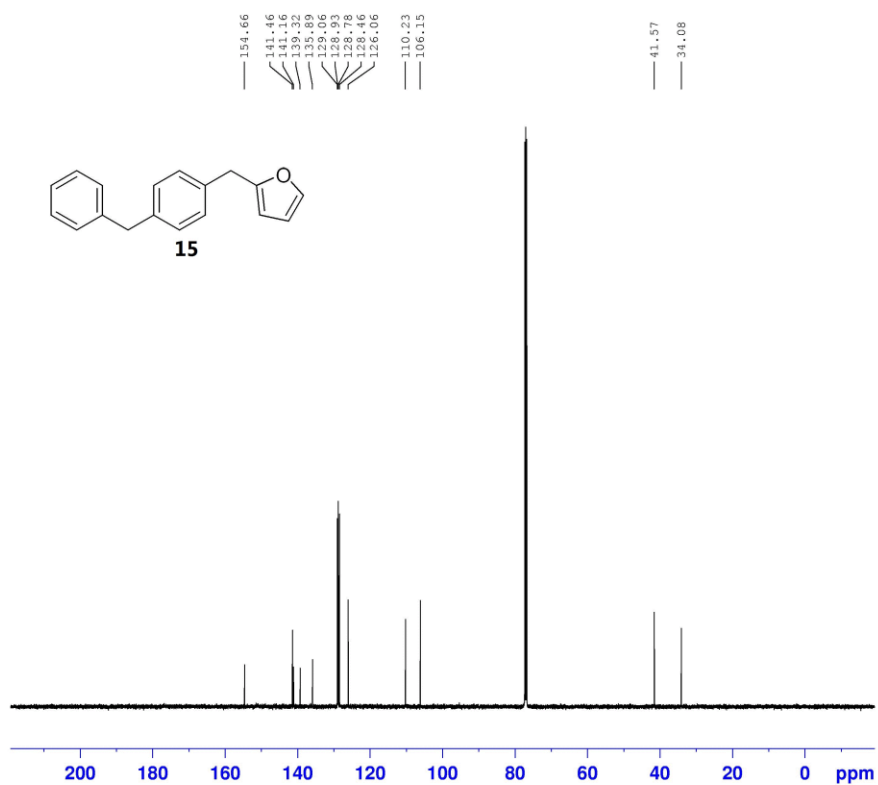


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NAME      11y-335-4p-20180208
EXPNO     2
PROCNO    1
Date_     20180209
Time      2.11 h
INSTRUM   AVIII500HD
PROBHD    Z119470_0125 (
PULPROG   zgpg30
TD         65536
SOLVENT    CDCl3
NS         512
DS         4
SWH        30000.000 Hz
FIDRES     0.915527 Hz
AQ         1.0923166 sec
RG         192.72
DW         16.667 usec
DE         22.02 usec
TE         298.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
SF01       125.8131140 MHz
NUC1       13C
P1         10.23 usec
SI         32768
SF         125.8005351 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



NAME 11y-345-13p-20180220
 EXPNO 1
 PROCNO 1
 Date_ 20180220
 Time 14.11 h
 INSTRUM AVIII500HD
 PROBHD Z119470_0125 (
 PULPROG zg30
 TD 65536
 SOLVENT CDCl3
 NS 16
 DS 2
 SWH 10000.000 Hz
 FIDRES 0.305176 Hz
 AQ 3.2768500 sec
 RG 106.56
 DW 50.000 usec
 DE 13.50 usec
 TE 298.3 K
 D1 1.00000000 sec
 TD0 1
 SF01 500.3030896 MHz
 NUC1 1H
 P1 10.00 usec
 SI 65536
 SF 500.3000000 MHz
 WDW EM
 SSB 0
 LB 0.30 Hz
 GB 0
 PC 1.00



NAME 1ly-345-13p-20180220
 EXPNO 2
 PROCNO 1
 Date_ 20180220
 Time 14.38 h
 INSTRUM AVII500HD
 PROBHD Z119470_0125 (
 PULPROG zgpg30
 TD 65536
 SOLVENT CDC13
 NS 512
 DS 4
 SWH 30000.000 Hz
 FIDRES 0.915527 Hz
 AQ 1.0923166 sec
 RG 192.72
 DW 16.667 usec
 DE 22.02 usec
 TE 298.3 K
 D1 2.00000000 sec
 D11 0.03000000 sec
 TD0 1
 SFO1 125.8131140 MHz
 NUC1 13C
 P1 10.23 usec
 SI 32768
 SF 125.8005351 MHz
 WDW EM
 SSB 0
 LB 1.00 Hz
 GB 0
 PC 1.40