

# Enantioselective Copper-Catalyzed Methylboration of Alkenes

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## 1. General

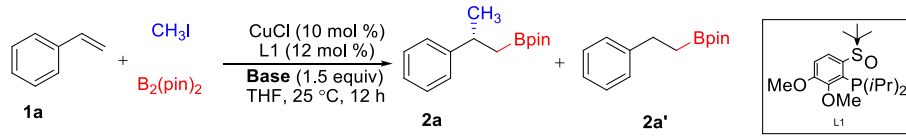
All commercial available reagents were used directly without further purification. Solvents used in catalytic reactions were dried and distilled in appropriate method. Solvent employed for column chromatography were purchased in technical grade quality without distillation before use. All catalytic reactions were operated in glovebox. NMR spectra were obtained on a Bruker 400 spectrometer in CDCl<sub>3</sub>, operating at 400 MHz for <sup>1</sup>H NMR, 101 MHz for <sup>13</sup>C NMR, 376 MHz for <sup>19</sup>F NMR and 128 MHz for <sup>11</sup>B NMR. The following abbreviations are used for spin multiplicity: s = singlet, d = doublet, dd = doublet of doublet, dt = doublet of triplet, ddd = doublet of doublet of doublet, t = triplet and m = multiplet. Optical rotation was recorded on PE polarimeter 341. Enantiomeric excess were measured by chiral HPLC analysis on Chiralcel OD-H, AD-H, OJ-H, AS-H chiral column (Daicel Chemical Industries, LTD). Electrospray ionization high-resolution mass spectra (ESI-HRMS) were recorded on a Bruke P-SIMS-Gly FT-ICR mass spectrometer.

## 2. Preparation of Substrates

All commercially available reagents were used as received without further purification. **1w**<sup>1</sup>, **3g**<sup>2</sup>, **3h**<sup>2</sup>, was synthesized according to literature.

## 3. Optimization of Enantioselective Methylboration of Alkenes

Table S1. Screening of Base<sup>a</sup>

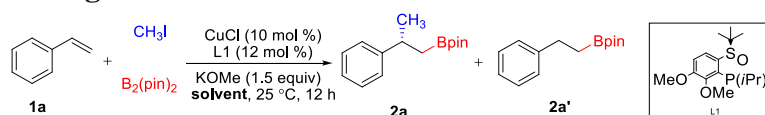
			
entry	base	yield(%) <sup>b</sup> ( <b>2a/2a'</b> )	er <sup>c</sup>
1	KOH	90:10	94:6
2	KO <sup>t</sup> Bu	88:12	93.5:6.5
3	NaO <sup>t</sup> Bu	92:8	92:8

4	LiO <sup>t</sup> Bu	98:trace	92.5:7.5
5	KOMe	96:trace	94.5:5.5
6	NaOMe	65:3	83:17

<sup>a</sup>Conditions: **1a** (0.2 mmol), CH<sub>3</sub>I (0.3 mmol), B<sub>2</sub>(pin)<sub>2</sub> (0.3 mmol), CuCl (10 mol %), **L1** (12 mol %), **Base** (0.3 mmol), THF (1.5 mL) at 25 °C for 12 h. <sup>b</sup>Determined by <sup>1</sup>H NMR spectroscopy.

<sup>c</sup>Determined by chiral HPLC analysis.

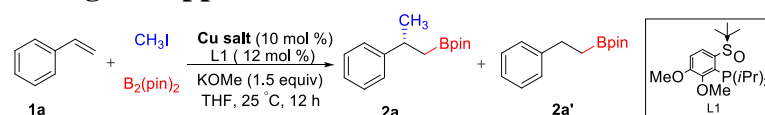
**Table S2. Screening of Solvent<sup>a</sup>**



entry	solvent	yield(%) <sup>b</sup> ( <b>2a/2a'</b> )	er <sup>c</sup>
1	THF	96:trace	94.5:5.5
2	2-MeTHF	83:15	85:15
3	Dioxane	88:10	87:13
4	MTBE	50:50	83:17
5	Toluene	60:40	75:25
6	DMF	Trace:15	n.d.

<sup>a</sup>Conditions: **1a** (0.2 mmol), CH<sub>3</sub>I (0.3 mmol), B<sub>2</sub>(pin)<sub>2</sub> (0.3 mmol), CuCl (10 mol %), **L1** (12 mol %), KOMe (0.3 mmol), **Solvent** (1.5 mL) at 25 °C for 12 h. <sup>b</sup>Determined by <sup>1</sup>H NMR spectroscopy. <sup>c</sup>Determined by chiral HPLC analysis.

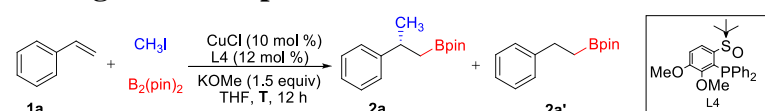
**Table S3. Screening of Copper Salts<sup>a</sup>**



entry	copper salt	yield(%) <sup>b</sup> ( <b>2a/2a'</b> )	er <sup>c</sup>
1	CuCl	97:trace	94.5:5.5
2	CuBr	96:trace	94:6
3	CuI	97:trace	92.5:7.5
4	CuOAc	68:30	93.5:6.5
5	Cu(OAc) <sub>2</sub>	86:8	93:7

<sup>a</sup>Conditions: **1a** (0.2 mmol), CH<sub>3</sub>I (0.3 mmol), B<sub>2</sub>(pin)<sub>2</sub> (0.3 mmol), **Copper Salt** (10 mol %), **L1** (12 mol %), KOMe (0.3 mmol), THF (1.5 mL) at 25 °C for 12 h. <sup>b</sup>Determined by <sup>1</sup>H NMR spectroscopy. <sup>c</sup>Determined by chiral HPLC analysis.

**Table S4. Screening of the Temperature<sup>a</sup>**

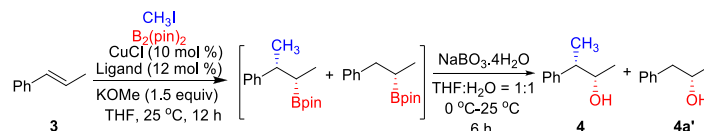


entry	temp	yield(%) <sup>b</sup> ( <b>2a/2a'</b> )	er <sup>c</sup>
1	45 °C	96:trace	94.5:5.5
2	25 °C	97:trace	97:3
3	10 °C	96:trace	95:5

4	0 °C	80:2	95:5
5	-10 °C	64:3	95.5:4.5

<sup>a</sup>Conditions: **1a** (0.2 mmol), CH<sub>3</sub>I (0.3 mmol), B<sub>2</sub>(pin)<sub>2</sub> (0.3 mmol), CuCl (10 mol %), **L4** (12 mol %), KOMe (0.3 mmol), THF (1.5 mL) at the appropriate temperature for 12 h. <sup>b</sup>Determined by <sup>1</sup>H NMR spectroscopy. <sup>c</sup>Determined by chiral HPLC analysis.

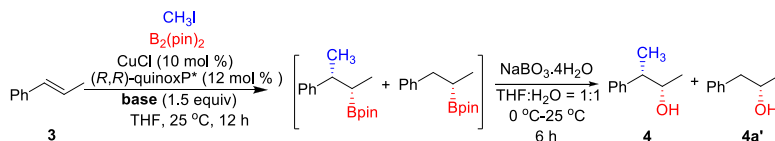
**Table S5. Screening of ligands in the internal olefinsystem<sup>a</sup>**



entry	ligand	yield(%) <sup>b</sup> (4/4a')	er <sup>c</sup>
1	<b>L4</b>	n.r.	n.d.
2	( <i>S,S</i> )-Me-DUPHOS	85:15	86:14
3	( <i>S,S</i> )- <i>i</i> Pr-DUPHOS	30:40	70:30
4	<b>(<i>R,R</i>)-quinoxP*</b>	<b>82:18</b>	<b>95:5</b>

<sup>a</sup>Conditions: **3** (0.2 mmol), CH<sub>3</sub>I (0.3 mmol), B<sub>2</sub>(pin)<sub>2</sub> (0.3 mmol), CuCl (10 mol %), **Ligand** (12 mol %), KOMe (0.3 mmol), THF (1.5 mL) at 25 °C for 12 h. <sup>b</sup>Determined by <sup>1</sup>H NMR spectroscopy. <sup>c</sup>Determined by chiral HPLC analysis.

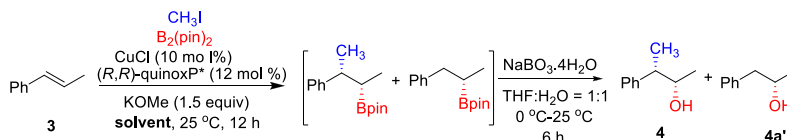
**Table S6. Screening of Bases in the internal olefinsystem<sup>a</sup>**



entry	base	yield(%) <sup>b</sup> (4/4a')	er <sup>c</sup>
1	LiOMe	30:20	91:9
2	NaOMe	57:19	92:8
3	<b>KOMe</b>	<b>83:17</b>	<b>95:5</b>
4	KO <sup>t</sup> Bu	80:19	89:11

<sup>a</sup>Conditions: **3** (0.2 mmol), CH<sub>3</sub>I (0.3 mmol), B<sub>2</sub>(pin)<sub>2</sub> (0.3 mmol), CuCl (10 mol %), (*R,R*)-quinoxP\* (12 mol %), **Base** (0.3 mmol), THF (1.5 mL) at 25 °C for 12 h. <sup>b</sup>Determined by <sup>1</sup>H NMR spectroscopy. <sup>c</sup>Determined by chiral HPLC analysis.

**Table S7. Screening of Solvent in the internal olefinsystem<sup>a</sup>**



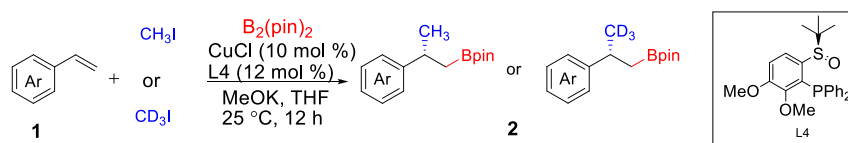
entry	solvent	yield(%) <sup>b</sup> (4/4a')	er <sup>c</sup>
1	<b>THF</b>	<b>82:18</b>	<b>95:5</b>
2	2-MeTHF	74:23	92.5:7.5
3	Toluene	76:24	92.5:7.5
4	Dioxane	81:18	93.5:6.5



<sup>a</sup>Conditions: **3** (0.2 mmol), CH<sub>3</sub>I (0.3 mmol), B<sub>2</sub>(pin)<sub>2</sub> (0.3 mmol), CuCl (10 mol %), (*R,R*)-quinoxP\* (12 mol %), MeOK (0.3 mmol), solvent (1.5 mL) at 25 °C for 12 h. <sup>b</sup>Determined by <sup>1</sup>H NMR spectroscopy. <sup>c</sup>Determined by chiral HPLC analysis.

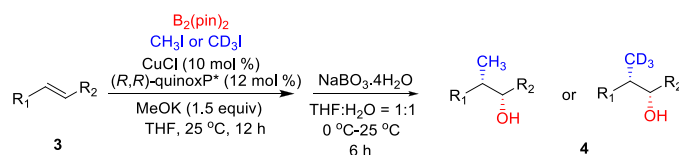
## 4. Copper-Catalyzed Enantioselective Methylboration of Alkenes

### 4.1 Procedure A for the transformation of vinylarenes:



In the glovebox, to a dry vial with a magnetic stir bar was added CuCl (10 mol %, 0.02 mmol, 1.9 mg), **L4** (12 mol %, 0.024 mmol, 10.2 mg) and 1 mL THF, then the mixture was stirred 30 minutes at room temperature. To the mixture was added B<sub>2</sub>(pin)<sub>2</sub> (76.3 mg, 0.3 mmol), styrene (0.2 mmol), CH<sub>3</sub>I or CD<sub>3</sub>I (0.3 mmol) and MeOK (0.3 mmol, 21 mg) successively (Note: MeOK must be added at last). After that, 0.5 mL of THF was added along the vial's wall to keep all reagents into the reaction solution. The vial was sealed with a rubber stopper, removed from the glovebox and stirred at room temperature for 12 hours. The reaction mixture was filtrated a celite pad, the solvent was removed under vacuo, and the residue was purified by column chromatography on silica gel to give the product **3**, the er was determined by chiral HPLC.

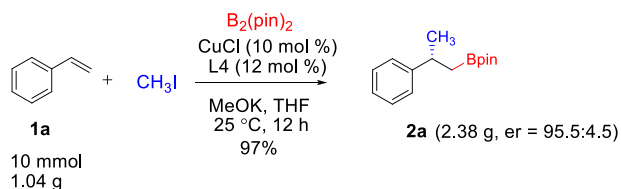
### 4.2 Procedure B for the transformation of $\beta$ -substituted styrenes or aliphatic olefins:



In the glovebox, to a dry vial with magnetic stir bar was added CuCl (10 mol %, 0.02 mmol, 1.9 mg), (*R,R*)-quinoxP\* (12 mol %, 0.024 mmol, 8.1 mg) and 1 mL THF,

then the mixture was stirred 30 minutes at room temperature. To the mixture was added  $B_2(\text{pin})_2$  (76.3 mg, 0.3 mmol), alkenes **3** (0.2 mmol),  $\text{CH}_3\text{I}$  or  $\text{CD}_3\text{I}$  (0.3 mmol) and MeOK (0.3 mmol, 21 mg) successively (Note: MeOK must be added at last). After that, 0.5 mL THF was added along the vial's wall to keep all reacts into the reaction solution. The vial was sealed with a rubber stopper, removed from the glovebox and stirred at room temperature for 12 hours. The reaction mixture was filtrated a celite pad, the solvent was removed under vacuo, and the residue was roughly purified by a flash column chromatography on silica gel to give methylboration product mixed with side hydroboration adduct. Considering that the corresponding alcohol derivatives can be separated, the methylboration product was characterized after oxidized to the alcohol. The mixture was dissolved in THF (2.0 mL) at 0 °C, then the aqueous solution of  $\text{NaBO}_3 \cdot 4\text{H}_2\text{O}$  (123.2 mg, 0.8 mmol) in 2 mL water was added dropwise. After addition, the reaction mixture was stirred for 6 hours at room temperature. After both methyl- and hydroboration adducts were consumed, sat.  $\text{Na}_2\text{S}_2\text{O}_3$  solution was added to quench the reaction. The mixture was extracted with EtOAc (3×10 mL) and the combined organic phase was dried over  $\text{Na}_2\text{SO}_4$ . After evaporating the solvent under vacuo, the residue was purified by flash column chromatography on silica gel with EtOAc: Petroleum ether (1:3) to give the product **4**.

### 4.3 The procedure for Scaled-up Reaction

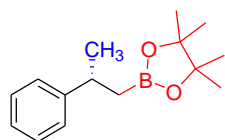


In the glovebox, to a 100 mL Schlenk flask with magnetic stir bar was added CuCl (10 mol %, 1 mmol, 95 mg), **L4** (12 mol %, 2.4 mmol, 510 mg) and 30 mL THF, then the mixture was stirred 60 minutes at room temperature. To the mixture was added  $B_2(\text{pin})_2$  (3.82 g, 15 mmol), **1a** (10 mmol),  $\text{CH}_3\text{I}$  (15 mmol, 2.13 g) and MeOK (15

mmol, 1.05 g) successively (Note: MeOK was added slowly to prevent the vigorously exothermic reaction). 25 mL THF was then added. The flask was sealed with rubber stopper, removed from the glovebox and stirred at room temperature for 24 hours. The reaction mixture was filtrated through a celite pad, the solvent was removed under vacuo, and the residue was purified by column chromatography on silica gel with EtOAc: Petroleum ether (40: 1) to give the product **2a** (2.38 g, 97% yield, er = 95.5:4.5) as a colorless oil.

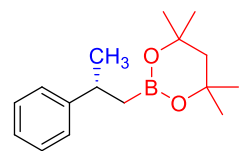
## 5. The Characterization Data for products

### (*R*)-4,4,5,5-tetramethyl-2-(2-phenylpropyl)-1,3,2-dioxaborolane (**2a**)



colorless oil (46.2 mg, 94% yield). er = 97:3, [Daicel Chiralpak OD-H, *n*-hexane/*i*-propanol = 500:1, 0.4 mL/min,  $\lambda$  = 220 nm, retention time: 14.74 min (major) and 18.00 min (minor) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.32–7.21 (m, 4H), 7.21–7.16 (m, 1H), 3.12–3.02 (m, 1H), 1.31 (d,  $J$  = 3.5 Hz, 3H), 1.21–1.18 (m, 14H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  149.23, 128.19, 126.64, 125.69, 82.99, 35.83, 24.94, 24.79, 24.71.  $^{11}\text{B}$  NMR (128 MHz,  $\text{CDCl}_3$ )  $\delta$  33.54. Optical Rotation:  $[\alpha]_{\text{D}}^{22}$  -19.2 ( $c$  = 0.255,  $\text{CH}_2\text{Cl}_2$ ). [Lit., +19.7945 ( $c$  0.56 in  $\text{CH}_2\text{Cl}_2$ ), (*S*)-isomer]<sup>3</sup>, confirmed as a (*R*)-isomer. HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{15}\text{H}_{23}\text{BO}_2$ ,  $[\text{M}+\text{H}]$ : 247.1863; found: 247.1844.

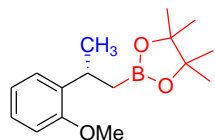
### (*R*)-4,4,6,6-tetramethyl-2-(2-phenylpropyl)-1,3,2-dioxaborinane (**2A**)



Colorless oil (46.8 mg, 90% yield). er = 95:5 [Daicel Chiralpak OJ-H, *n*-hexane/*i*-propanol = 98:2, 0.5 mL/min,  $\lambda$  = 220 nm, retention time: 7.79 min (major) and 8.22 min (minor) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.31–7.28 (m, 4H), 7.19–7.14 (m, 1H), 3.08–2.99 (m, 1H), 1.73 (s, 2H), 1.29–1.26 (m, 15H), 1.08 (d,  $J$  = 7.8 Hz, 2H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  149.90, 128.01, 126.87, 125.38, 70.23, 48.73, 36.09, 31.71, 31.69, 25.03.  $^{11}\text{B}$  NMR (128 MHz,  $\text{CDCl}_3$ )  $\delta$  29.44. Optical Rotation:  $[\alpha]_{\text{D}}^{25}$  -5.56 ( $c$  = 0.4,  $\text{CHCl}_3$ ).

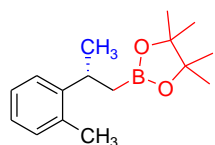
HRMS-ESI ( $m/z$ ): Calcd for  $C_{16}H_{25}BO_2$ ,  $[M+Na]$ : 283.1845; found: 283.1836.

**(*R*)-2-(2-(2-methoxyphenyl)propyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (2b)**



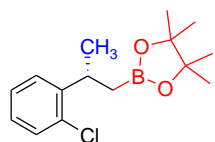
colorless oil (49.6 mg, 90% yield). er = 93.5:6.5, [Daicel Chiralpak OD-H, *n*-hexane/*i*-propanol = 500:1, 1.0 mL/min,  $\lambda$  = 220 nm, retention time: 4.51 min (major) and 5.14 min (minor) ];  $^1H$  NMR (400 MHz,  $CDCl_3$ )  $\delta$  7.25–7.13 (m, 2H), 6.94–6.83 (m, 2H), 3.84 (s, 3H), 3.53–3.44(m, 1H), 1.27 (d,  $J$  = 3.4 Hz, 3H), 1.21–1.15 (m, 14H).  $^{13}C$  NMR (100 MHz,  $CDCl_3$ )  $\delta$  156.76, 137.45, 126.58, 126.43, 120.46, 110.37, 82.85, 55.33, 28.49, 24.79, 24.67, 23.42. Optical Rotation:  $[\alpha]_D^{22}$ -5.33 ( $c$  = 0.60,  $CHCl_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $C_{16}H_{25}BO_3$ ,  $[M+Na]$ : 299.1789; found: 299.1787.

**(*R*)-4,4,5,5-tetramethyl-2-(2-*o*-tolylpropyl)-1,3,2-dioxaborolane (2c)**



colorless oil (49.4 mg, 95% yield). er = 97:3, [Daicel Chiralpak OD-H, *n*-hexane/*i*-propanol = 500:1, 0.4 mL/min,  $\lambda$  = 220 nm, retention time: 17.63 min (major) and 26.97 min (minor) ];  $^1H$  NMR (400 MHz,  $CDCl_3$ )  $\delta$  7.25–7.15 (m, 1H), 7.10 (t,  $J$  = 8.1 Hz, 1H), 7.06–7.04 (m, 2H), 3.33–3.27(m, 1H), 2.39 (s, 3H), 1.27 (d,  $J$  = 6.8 Hz, 3H), 1.17–1.15 (m, 14H).  $^{13}C$  NMR (100 MHz,  $CDCl_3$ )  $\delta$  147.20, 134.96, 129.97, 126.09, 125.35, 82.91, 30.68, 24.70, 24.61, 19.52. Optical Rotation:  $[\alpha]_D^{22}$ -4.00 ( $c$  = 0.45,  $CHCl_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $C_{16}H_{25}BO_2$ ,  $[M+Na]$ : 283.1840; found: 283.1850.

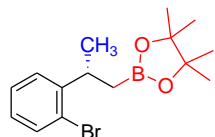
**(*R*)-2-(2-(2-chlorophenyl)propyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (2d)**



colorless oil (49.3 mg, 88% yield). er = 95:5, [Daicel Chiralpak OD-H, *n*-hexane/*i*-propanol = 98:2, 0.7 mL/min,  $\lambda$  = 220 nm, retention time: 5.33 min (major) and 5.74 min (minor) ];  $^1H$  NMR (400 MHz,  $CDCl_3$ )  $\delta$  7.33–7.31 (m, 2H), 7.22 (t,  $J$  = 7.6 Hz, 1H), 7.10 (t,  $J$  = 7.6 Hz, 1H), 3.62–3.53(m, 1H), 1.28 (d,  $J$  = 6.8 Hz, 3H), 1.22–1.12 (m, 14H).  $^{13}C$  NMR (100 MHz,  $CDCl_3$ )  $\delta$  146.14, 133.33, 129.31, 127.07, 126.83, 126.73, 82.03, 31.63, 24.71, 24.65, 23.45. Optical Rotation:  $[\alpha]_D^{22}$ -4.00 ( $c$  = 0.50,  $CHCl_3$ ). HRMS-ESI ( $m/z$ ): Calcd

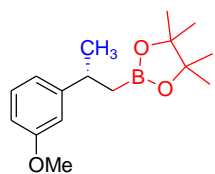
for C<sub>15</sub>H<sub>22</sub>BClO<sub>2</sub>, [M+Na]: 303.1294; found: 303.1303.

**(R)-2-(2-(2-bromophenyl)propyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (2e)**



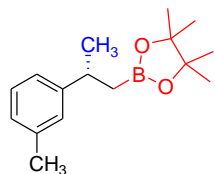
colorless oil (55.9 mg, 86% yield). er = 92.5:7.5, [Daicel Chiralpak OD-H, *n*-hexane/*i*-propanol = 500:1, 0.7 mL/min,  $\lambda$  = 220 nm, retention time: 5.52 min (major) and 6.16 min (minor) ]; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.52 (d, *J* = 7.9 Hz, 1H), 7.32–7.25 (m, 2H), 7.04–7.00 (m, 1H), 3.58–3.49(m, 1H), 1.27 (d, *J* = 6.8 Hz, 3H), 1.23–1.11 (m, 14H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  147.76, 132.65, 127.51, 127.16, 127.11, 124.23, 82.04, 34.39, 24.70, 24.66, 23.62. Optical Rotation: [ $\alpha$ ]<sub>D</sub><sup>22</sup>+1.39 (c = 0.645, CHCl<sub>3</sub>).HRMS-ESI (*m/z*): Calcd for C<sub>15</sub>H<sub>22</sub>BBrO<sub>2</sub>, [M+Na]: 347.0788; found: 347.0789.

**(R)-2-(2-(3-methoxyphenyl)propyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (2f)**



colorless oil (49.6 mg, 90% yield). er = 97:3, [Daicel Chiralpak OD-H, *n*-hexane/*i*-propanol = 500:1, 0.4 mL/min,  $\lambda$  = 220 nm, retention time: 20.13 min (major) and 22.64 min (minor) ]; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.20 (t, *J* = 7.8 Hz, 1H), 6.87–6.82 (m, 2H), 6.73–6.71 (m, 1H), 3.81 (s, 3H), 3.07–2.98 (m, 1H), 1.29 (d, *J* = 6.8 Hz, 3H), 1.20 (s, 12H), 1.18–1.13 (m, 2H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  159.52, 151.04, 129.12, 112.44, 110.98, 83.00, 55.09, 35.86, 24.79, 24.73, 24.70. Optical Rotation: [ $\alpha$ ]<sub>D</sub><sup>22</sup>-15.00 (c = 0.32, CHCl<sub>3</sub>). HRMS-ESI (*m/z*): Calcd for C<sub>16</sub>H<sub>25</sub>BO<sub>3</sub>,[M+Na]: 299.1789; found: 299.1796.

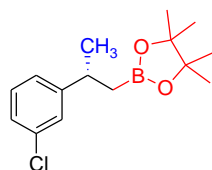
**(R)-4,4,5,5-tetramethyl-2-(2-m-tolylpropyl)-1,3,2-dioxaborolane (2g)**



colorless oil (47.8 mg, 92% yield). er = 97.5:2.5, [Daicel Chiralpak OD-H, *n*-hexane/*i*-propanol = 500:1, 0.4 mL/min,  $\lambda$  = 220 nm, retention time: 13.29 min (major) and 15.44 min (minor) ]; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.17 (t, *J* = 7.4 Hz, 1H), 7.07–6.97 (m, 3H), 3.06–2.97(m, 1H), 2.34 (s, 3H), 1.29 (d, *J* = 6.8 Hz, 3H), 1.19–1.15 (m, 14H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  149.20, 137.54, 128.08, 127.48, 126.38, 123.59, 82.96, 35.69, 24.77, 24.69, 21.47. Optical Rotation: [ $\alpha$ ]<sub>D</sub><sup>22</sup>-4.22 (c = 0.45, CHCl<sub>3</sub>). HRMS-ESI (*m/z*): Calcd for

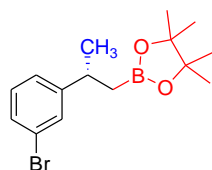
C<sub>16</sub>H<sub>25</sub>BO<sub>2</sub>, [M+Na]: 283.1840; found: 283.1844.

**(R)-2-(2-(3-chlorophenyl)propyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (2h)**



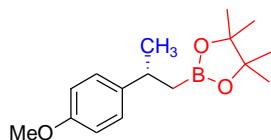
colorless oil (48.7 mg, 87% yield). er = 82:18, (Measured by chiral HPLC analysis with the corresponding alcohol obtained after oxidation)[Daicel Chiralpak OJ-H, *n*-hexane/*i*-propanol = 95:5, 0.5 mL/min,  $\lambda$  = 220 nm, retention time: 18.60 min (major) and 19.55 min (minor) ]; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.24–7.12 (m, 4H), 3.07–2.98(m, 1H), 1.28 (d, *J* = 7.2 Hz, 3H), 1.17 (s, 12H), 1.14 (d, *J* = 8.0 Hz, 2H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  151.25, 133.85, 129.47, 127.02, 125.81, 124.84, 83.07, 35.63, 24.75, 24.71, 21.60. Optical Rotation: [ $\alpha$ ]<sub>D</sub><sup>22</sup>-14.91 (*c* = 0.61, CHCl<sub>3</sub>). HRMS-ESI (*m/z*): Calcd for C<sub>15</sub>H<sub>22</sub>BClO<sub>2</sub>, [M+Na]: 303.1294; found: 303.1297.

**(R)-2-(2-(3-bromophenyl)propyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (2i)**



colorless oil (55.2 mg, 85% yield). er = 77:23, (Measured by chiral HPLC analysis with the corresponding alcohol obtained after oxidation)[Daicel Chiralpak OJ-H, *n*-hexane/*i*-propanol = 95:5, 0.5 mL/min,  $\lambda$  = 220 nm, retention time: 20.12 min (major) and 21.08 min (minor) ]; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.40 (t, *J* = 2.0 Hz, 1H), 7.29–7.27 (m, 1H), 7.19–7.11 (m, 2H), 3.06–2.97(m, 1H), 1.28 (d, *J* = 6.8 Hz, 3H), 1.17 (s, 12H), 1.14 (d, *J* = 8.0 Hz, 2H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  151.55, 129.98, 129.82, 128.76, 125.29, 122.23, 83.07, 35.63, 24.78, 24.73, 21.61. Optical Rotation: [ $\alpha$ ]<sub>D</sub><sup>22</sup>-12.02 (*c* = 0.715, CHCl<sub>3</sub>). HRMS-ESI (*m/z*): Calcd for C<sub>15</sub>H<sub>22</sub>BBrO<sub>2</sub>, [M+Na]: 347.0788; found: 347.0790.

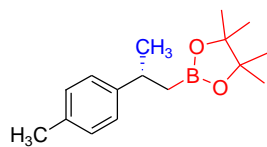
**(R)-2-(2-(4-methoxyphenyl)propyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (2j)**



colorless oil (49.1 mg, 89% yield). er = 94:6, [Daicel Chiralpak OD-H, *n*-hexane/*i*-propanol = 500:1, 0.4 mL/min,  $\lambda$  = 220 nm, retention time: 36.67 min (major) and 39.54 min (minor) ]; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.18 (d, *J* = 8.6 Hz, 2H), 6.83 (d, *J* = 8.6 Hz, 2H), 3.79 (s, 3H), 3.06–2.97(m, 1H), 1.27 (d, *J* = 6.8 Hz, 3H), 1.18 (s, 12H), 1.16–1.13 (m, 2H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  157.60, 141.48, 127.47, 113.55, 82.96, 55.25, 34.98,

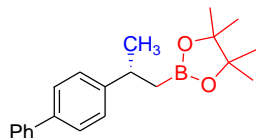
25.13, 24.77, 21.71. Optical Rotation:  $[\alpha]_D^{22}$ -14.50 ( $c = 0.60$ ,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{16}\text{H}_{25}\text{BO}_3$ ,  $[\text{M}+\text{Na}]$ : 299.1789; found: 299.1785.

**(R)-4,4,5,5-tetramethyl-2-(2-p-tolylpropyl)-1,3,2-dioxaborolane (2k)**



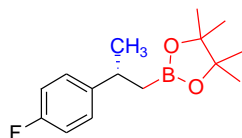
colorless oil (46.8 mg, 90% yield). er = 95:5, (Measured by chiral HPLC analysis with the corresponding alcohol obtained after oxidation)[Daicel Chiralpak AS-H, *n*-hexane/*i*-propanol = 98:2, 0.5 mL/min,  $\lambda = 220$  nm, retention time: 22.27 min (major) and 23.20 min (minor) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.16-7.09(m, 4H), 3.07-2.98(m, 1H), 2.32 (s, 3H), 1.28 (d,  $J = 6.8$  Hz, 3H), 1.20 (s, 12H), 1.17-1.14 (m, 2H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  146.31, 135.01, 128.84, 126.45, 82.98, 35.33, 24.88, 24.79, 24.70, 20.96. Optical Rotation:  $[\alpha]_D^{22}$ -17.93 ( $c = 0.485$ ,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{16}\text{H}_{25}\text{BO}_2$ ,  $[\text{M}+\text{Na}]$ : 283.1840; found: 283.1845.

**(R)-2-(2-(biphenyl-4-yl)propyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (2l)**



white solid (56.1 mg, 87% yield), m.p.=70°C. er = 96:4, [Daicel Chiralpak OD-H, *n*-hexane/*i*-propanol = 500:1, 0.4 mL/min,  $\lambda = 220$  nm, retention time: 22.00 min (major) and 24.30 min (minor) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.63-7.54(m, 4H), 7.46 (t,  $J = 7.8$  Hz, 2H), 7.37-7.33(m, 3H), 3.18-3.09(m, 1H), 1.36 (d,  $J = 6.8$  Hz, 3H), 1.25-1.23 (m, 2H), 1.21 (s, 12H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  148.42, 141.30, 138.64, 128.69, 127.08, 127.01, 126.95, 126.91, 83.05, 35.50, 24.87, 24.81, 24.73. Optical Rotation:  $[\alpha]_D^{22}$ -37.20 ( $c = 0.25$ ,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{21}\text{H}_{27}\text{BO}_2$ ,  $[\text{M}+\text{Na}]$ : 345.1996; found: 345.2001.

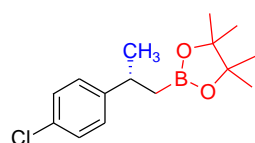
**(R)-2-(2-(4-fluorophenyl)propyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (2m)**



colorless oil (48.1 mg, 91% yield). er = 97:3, [Daicel Chiralpak OD-H, *n*-hexane/*i*-propanol = 500:1, 0.4 mL/min,  $\lambda = 220$  nm, retention time: 23.03 min (major) and 24.14 min (minor) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.22-7.19(m, 2H), 6.98-6.94(m, 2H), 3.09-3.01(m, 1H),

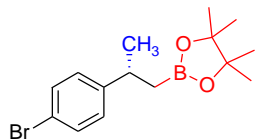
1.27 (d,  $J = 6.8$  Hz, 3H), 1.17 (s, 12H), 1.15 (d,  $J = 8.0$  Hz, 2H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  161.09 (d,  $J = 241.3$  Hz), 144.80 (d,  $J = 3.0$  Hz), 127.95 (d,  $J = 7.6$  Hz), 114.76 (d,  $J = 20.8$  Hz), 83.02, 35.15, 25.12, 24.73, 24.69.  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ )  $\delta$  -118.20. Optical Rotation:  $[\alpha]_{\text{D}}^{22}$ -12.08 ( $c = 0.695$ ,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{15}\text{H}_{22}\text{BFO}_2$ ,  $[\text{M}+\text{Na}]$ : 287.1589; found: 287.1588.

**(*R*)-2-(2-(4-chlorophenyl)propyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (2n)**



white solid (48.2 mg, 86% yield), m.p. = 32 °C. er = 96:4, (Measured by chiral HPLC analysis with the corresponding alcohol obtained after oxidation)[Daicel Chiralpak AD-H, *n*-hexane/*i*-propanol = 98:2, 1.0 mL/min,  $\lambda = 220$  nm, retention time: 18.29 min (minor) and 20.01 min (major) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.25-7.17(m, 4H), 3.07-2.98(m, 1H), 1.27 (d,  $J = 6.8$  Hz, 3H), 1.18 (s, 12H), 1.14 (d,  $J = 8.0$  Hz, 2H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  147.67, 131.19, 128.22, 128.03, 83.08, 35.26, 24.85, 24.75, 24.70. Optical Rotation:  $[\alpha]_{\text{D}}^{22}$ -26.41 ( $c = 0.265$ ,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{15}\text{H}_{22}\text{BClO}_2$ ,  $[\text{M}+\text{Na}]$ : 303.1294; found: 303.1298.

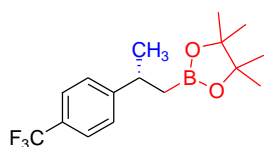
**(*R*)-2-(2-(4-bromophenyl)propyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (2o)**



white solid (55.2 mg, 85% yield), m.p.= 52 °C. er = 96:4, (Measured by chiral HPLC analysis with the corresponding alcohol obtained after oxidation)[Daicel Chiralpak AD-H, *n*-hexane/*i*-propanol = 98: 2, 1.0 mL/min,  $\lambda = 220$  nm, retention time: 19.95 min (minor) and 21.86 min (major) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.39 (d,  $J = 8.4$  Hz, 2H), 7.13 (d,  $J = 8.4$  Hz, 2H), 3.06-2.97(m, 1H), 1.26 (d,  $J = 6.8$  Hz, 3H), 1.18 (s, 12H), 1.14 (d,  $J = 8.0$  Hz, 2H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  148.21, 131.18, 128.47, 119.22, 83.08, 35.32, 24.76, 24.71. Optical Rotation:  $[\alpha]_{\text{D}}^{22}$ -29.45 ( $c = 0.55$ ,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{15}\text{H}_{22}\text{BBrO}_2$ ,  $[\text{M}+\text{Na}]$ : 347.0788; found: 347.0789.

**(*R*)-4,4,5,5-tetramethyl-2-(2-(4-(trifluoromethyl)phenyl)propyl)-1,3,2-dioxaborolane (2p)**

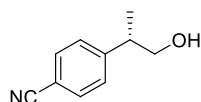




colorless oil (54.6 mg, 87% yield). er = 63:37, (Measured by chiral HPLC analysis with the corresponding alcohol obtained after oxidation)[Daicel Chiralpak AD-H, *n*-hexane/*i*-propanol =

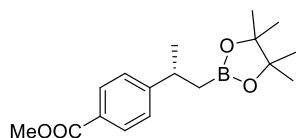
95: 5, 0.5 mL/min,  $\lambda$  = 220 nm, retention time: 16.70 min (minor) and 18.51 min (major) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.54 (d,  $J$  = 8.4 Hz, 2H), 7.36 (d,  $J$  = 8.4 Hz, 2H), 3.16-3.07(m, 1H), 1.30 (d,  $J$  = 7.2 Hz, 3H), 1.19-1.18 (m, 14H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  153.28, 128.01 (q,  $J$  = 31.3 Hz), 126.99, 125.13 (q,  $J$  = 3.7 Hz), 83.15, 35.74, 24.73, 24.66, 24.62.  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ )  $\delta$  -62.24. Optical Rotation:  $[\alpha]_{\text{D}}^{22}$ -4.00 ( $c$  = 0.50,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{16}\text{H}_{22}\text{BF}_3\text{O}_2$ ,  $[\text{M}+\text{Na}]$ : 337.1563;found: 337.1562.

#### 4-(1-hydroxypropan-2-yl)benzonitrile (2q)



colorless oil (17.9 mg, 56% yield).(The products were characterized by an oxidation procedure to convert Bpin to hydroxyl group, because the targeted methylboration product and the hydroboration by-product can not be separated by chromatography). er = 50:50, [Daicel ChiralpakAS-H, *n*-hexane/*i*-propanol = 95:5, 1.0 mL/min,  $\lambda$  = 220 nm,retention time: 32.08 min and 33.95 min ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.64 (d, $J$  = 8.2 Hz,2H), 7.38 (d, $J$  = 8.2 Hz,2H), 3.79–3.73 (m, 2H), 3.09–3.00 (m, 1H), 1.49–1.46 (m, 1H), 1.31(d, $J$  = 7.0 Hz,3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  149.68, 132.38, 128.37, 118.96, 110.44, 68.05, 42.56, 17.31.

#### (*R*)-methyl-4-(1-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)propan-2-yl)benzoate (2r)

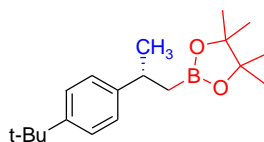


Colorless oil (41.3 mg, 68% yield).er = 95.5:4.5, [Daicel Chiralpak OD-H, *n*-hexane/*i*-propanol = 98:2, 1.0 mL/min,  $\lambda$  = 220 nm,retention time: 4.81 min (major) and 5.49 min (minor) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.95 (d, $J$  = 8.2 Hz,2H), 7.31 (d, $J$  = 8.2 Hz,2H),3.90 (s, 3H), 3.15–3.05 (m, 1H), 1.29 (d, $J$  = 6.8 Hz, 3H), 1.18–1.16 (m, 14H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  167.25, 154.73, 129.63, 127.64, 126.71, 83.10, 51.93, 35.90, 24.74, 24.70, 24.64. Optical Rotation:  $[\alpha]_{\text{D}}^{25}$ -1.00 ( $c$  = 1.4,  $\text{CHCl}_3$ ).HRMS-ESI

(*m/z*): Calcd for C<sub>17</sub>H<sub>25</sub>BO<sub>4</sub>, [M+Na]:327.1744; found: 327.1745.

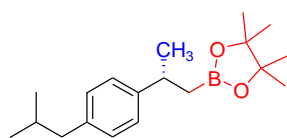
**(*R*)-2-(2-(4-*tert*-butylphenyl)propyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane**

**(2s)**



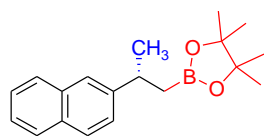
white solid (56.1 mg, 93% yield), m.p. = 36 °C. er = 98:2, (Measured by chiral HPLC analysis with the corresponding alcohol obtained after oxidation)[Daicel Chiralpak OJ-H, *n*-hexane/*i*-propanol = 98:2, 0.7 mL/min,  $\lambda$  = 220 nm, retention time: 16.59 min (minor) and 17.70 min (major) ]; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.32 (d, *J* = 8.4 Hz, 2H), 7.20 (d, *J* = 8.4 Hz, 2H), 3.09-3.01(m, 1H), 1.33 (s, 9H), 1.31 (d, *J* = 6.8 Hz, 3H), 1.19-1.15 (m, 14H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  148.36, 146.13, 126.25, 125.00, 82.94, 35.26, 34.30, 31.44, 24.81, 24.78, 24.65. Optical Rotation: [ $\alpha$ ]<sub>D</sub><sup>22</sup>-23.68 (c = 0.38, CHCl<sub>3</sub>). HRMS-ESI (*m/z*): Calcd for C<sub>19</sub>H<sub>31</sub>BO<sub>2</sub>, [M+Na]: 325.2309;found: 325.2318.

**(*R*)-2-(2-(4-isobutylphenyl)propyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (2t)**



colorless oil (54.4 mg, 90% yield). er = 96:4, [Daicel Chiralpak OZ-H, *n*-hexane/*i*-propanol = 90:10, 1.0 mL/min,  $\lambda$  = 220 nm, retention time: 4.20 min (minor) and 5.86 min (major) ]; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.16(d, *J* = 8.1 Hz, 2H), 7.06(d, *J* = 8.1 Hz, 2H), 3.03 (sext, *J* = 7.2 Hz, 1H), 2.45 (d, *J* = 7.4 Hz, 2H), 1.90-1.79 (m, 1H), 1.29 (d, *J* = 6.8 Hz, 3H), 1.18-1.15 (m, 14H), 0.91 (d, *J* = 6.6 Hz, 6H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  146.38, 138.88, 128.88, 126.32, 82.93, 45.05, 35.44, 30.25, 25.05, 24.75, 24.68, 22.37, 22.34. Optical Rotation: [ $\alpha$ ]<sub>D</sub><sup>22</sup>-23.03 (c = 0.165, CHCl<sub>3</sub>). HRMS-ESI (*m/z*): Calcd for C<sub>19</sub>H<sub>31</sub>BO<sub>2</sub>, [M+H]: 303.2489;found: 303.2496.

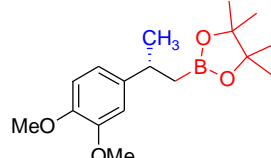
**(*R*)-4,4,5,5-tetramethyl-2-(2-(naphthalen-2-yl)propyl)-1,3,2-dioxaborolane (2u)**



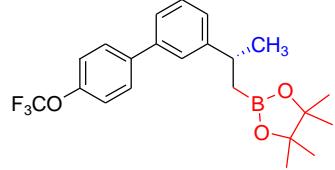
white solid (53.8 mg, 91% yield), m.p. = 56 °C. er = 97.5:2.5, [Daicel Chiralpak AD-H, *n*-hexane/*i*-propanol = 500:1, 0.4 mL/min,  $\lambda$  = 220 nm, retention time: 18.71 min (major) and

20.68 min (minor) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.83-7.79(m, 3H), 7.71(s, 1H), 7.49-7.41(m, 3H), 3.27(sext,  $J = 7.2$  Hz, 1H), 1.42 (d,  $J = 7.2$  Hz, 3H), 1.32-1.28 (m, 2H), 1.19(s, 12H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  146.74, 133.64, 132.13, 127.77, 127.61, 127.55, 125.88, 125.70, 124.95, 124.43, 83.04, 35.91, 24.79, 24.74. Optical Rotation:  $[\alpha]_{\text{D}}^{22}$ -30.53 ( $c = 0.465$ ,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{19}\text{H}_{25}\text{BO}_2$ ,  $[\text{M}+\text{Na}]$ : 319.1840; found: 319.1833.

**(*R*)-2-(2-(3,4-dimethoxyphenyl)propyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (2v)**

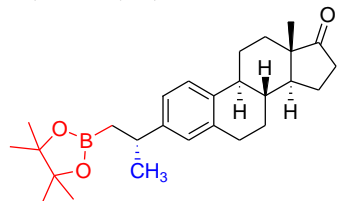
 colorless oil (53.8 mg, 88% yield). er = 94:6, [Daicel Chiralpak AD-H, *n*-hexane/*i*-propanol = 98:2, 1.0 mL/min,  $\lambda = 220$  nm, retention time: 6.21 min (major) and 7.38 min (minor) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  6.79(s, 3H), 3.88(s, 3H), 3.85(s, 3H), 3.00 (sext,  $J = 7.2$  Hz, 1H), 1.27 (d,  $J = 6.8$  Hz, 3H), 1.17 (s, 12H), 1.45 (d,  $J = 8.0$  Hz, 2H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  148.60, 146.96, 142.11, 118.21, 111.13, 110.21, 82.98, 55.92, 55.75, 45.05, 35.44, 25.12, 25.02, 24.79, 24.72. Optical Rotation:  $[\alpha]_{\text{D}}^{22}$ -25.78 ( $c = 0.19$ ,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{17}\text{H}_{27}\text{BO}_4$ ,  $[\text{M}+\text{Na}]$ : 329.1895; found: 329.1894.

**(*R*)-4,4,5,5-tetramethyl-2-(2-(4'-(trifluoromethoxy)biphenyl-3-yl)propyl)-1,3,2-dioxaborolane (2w)**

 colorless oil (73.1 mg, 90% yield). er = 92:8, (Measured by chiral HPLC analysis with the corresponding alcohol obtained after oxidation) [Daicel Chiralpak OJ-H, *n*-hexane/*i*-propanol = 95:5, 0.5 mL/min,  $\lambda = 220$  nm, retention time: 8.79 min (minor) and 9.20 min (major) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.64-7.61(m, 2H), 7.47(s, 1H), 7.38-7.37(m, 2H), 7.31-7.27(m, 2H), 3.15 (sext,  $J = 7.2$  Hz, 1H), 1.36 (d,  $J = 7.0$  Hz, 3H), 1.26-1.23(m, 2H), 1.19 (s, 6H), 1.18 (s, 6H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  149.92, 148.52, 140.42, 139.65, 128.78, 128.45, 126.07, 125.66, 124.53, 121.16, 83.05, 35.93, 24.93, 24.74, 24.68.  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ )  $\delta$  -57.79. Optical Rotation:  $[\alpha]_{\text{D}}^{22}$ -18.23 ( $c = 0.17$ ,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{22}\text{H}_{26}\text{BF}_3\text{O}_3$ ,

[M+Na]: 429.1819;found: 429.1817.

**(8R,9S,13S,14S)-13-methyl-3-((R)-1-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)propan-2-yl)-7,8,9,11,12,13,15,16-octahydro-6H-cyclopenta[a]phenanthren-17(14H)-one (2x)**

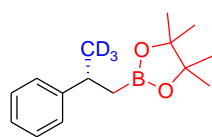


white solid (80.2 mg, 95% yield), m.p. = 116 °C. dr = 97.5:2.5, (Measured by chiral HPLC analysis with the corresponding alcohol obtained after oxidation) [Daicel

Chiralpak OJ-H, *n*-hexane/*i*-propanol = 90:10, 0.5 mL/min,

$\lambda$  = 220 nm, retention time: 31.20 min (minor) and 33.25 min (major) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.22(d,  $J$  = 8.0 Hz, 1H), 7.06(d,  $J$  = 8.0 Hz, 1H), 7.00 (s, 1H), 3.01 (sext,  $J$  = 7.2 Hz, 1H), 2.91-2.89 (m, 2H), 2.56-2.41 (m, 2H), 2.32-2.27 (m, 1H), 2.16-1.96 (m, 4H), 1.70-1.42 (m, 6H), 1.29 (d,  $J$  = 7.2 Hz, 3H), 1.22 (s, 6H), 1.21 (s, 6H), 1.16-1.13 (m, 2H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  146.87, 136.96, 136.05, 127.13, 125.21, 124.12, 123.95, 83.01, 50.53, 48.05, 44.35, 38.28, 35.90, 35.16, 31.63, 29.52, 26.65, 25.75, 24.68, 24.71, 24.45, 24.43, 21.61, 13.88. Optical Rotation:  $[\alpha]_{\text{D}}^{22} + 71.00$  ( $c$  = 0.20,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{27}\text{H}_{39}\text{BO}_3$ ,  $[\text{M}+\text{H}]$ : 423.3065;found: 423.3073.

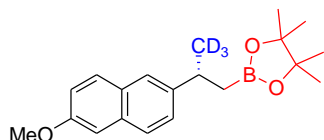
**(R)-4,4,5,5-tetramethyl-2-(1,1,1-d<sub>3</sub>-2-phenylpropyl)-1,3,2-dioxaborolane (2a-D)**



colorless oil (47.3 mg, 95% yield). er = 95:5, [Daicel Chiralpak OD-H, *n*-hexane/*i*-propanol = 500:1, 0.4 mL/min,  $\lambda$  = 220 nm, retention time: 12.76 min (major) and 14.41 min (minor) ];  $^1\text{H}$  NMR

(400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.32–7.27 (m, 4H), 7.21–7.16 (m, 1H), 3.07 (t,  $J$  = 8.0 Hz, 1H), 1.22-1.18 (m, 14H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  149.22, 128.20, 126.66, 125.70, 82.97, 35.62, 24.81, 24.73. Optical Rotation:  $[\alpha]_{\text{D}}^{22} - 17.55$  ( $c$  = 0.49,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{15}\text{H}_{20}\text{D}_3\text{BO}_2$ ,  $[\text{M}+\text{Na}]$ : 272.1877; found: 272.1873.

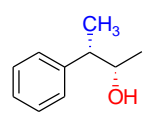
**(R)-1,1,1-d<sub>3</sub>-2-(2-(6-methoxynaphthalen-2-yl)propyl)-4,4,5,5-tetramethyl-1,3,2-dioxaborolane (2y-D)**



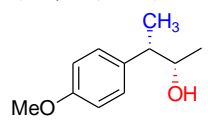
white solid (59.1 mg, 90% yield), m.p. = 58 °C. er = 93.5:6.5,

[Daicel Chiralpak AD-H, *n*-hexane/*i*-propanol = 98: 2, 1.0 mL/min,  $\lambda$  = 254 nm, retention time: 41.26 min (minor) and 45.72 min (major) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.73–7.70 (m, 2H), 7.65 (s, 1H), 7.45–7.42 (m, 1H), 7.18–7.14 (m, 2H), 3.93 (s, 1H), 3.23 (t,  $J$  = 8.0 Hz, 1H), 1.33–1.26 (m, 2H), 1.19 (s, 12H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  157.11, 144.46, 133.13, 129.13, 129.11, 126.73, 126.38, 124.37, 118.51, 83.02, 55.22, 35.53, 24.82, 24.78. Optical Rotation:  $[\alpha]_{\text{D}}^{22}$ -34.75 ( $c$  = 0.40,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{20}\text{H}_{24}\text{D}_3\text{BO}_3$ ,  $[\text{M}+\text{H}]$ : 330.2320; found: 330.2319.

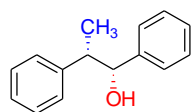
**(2*S*,3*S*)-3-phenylbutan-2-ol (4a)**

 colorless oil (21.1 mg, 70% yield). dr >99:1, er = 95:5, [Daicel ChiralpakAD-H, *n*-hexane/*i*-propanol = 98:2, 1.0 mL/min,  $\lambda$  = 220 nm, retention time: 12.04 min (minor) and 14.08 min (major) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.36–7.33(m, 2H), 7.27–7.23(m, 2H), 3.94–3.87(m, 1H), 2.80–2.73(m, 1H), 1.65(br, 1H), 1.37 (d,  $J$  = 7.2 Hz, 3H), 1.12 (d,  $J$  = 6.4 Hz, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  144.31, 128.45, 127.88, 126.46, 72.38, 47.21, 21.08, 16.08. The spectral data of the product were identical with the reported in the literature<sup>4</sup>. Optical Rotation:  $[\alpha]_{\text{D}}^{22}$ -0.85 ( $c$  = 1.05, EtOH), [Lit., -0.1 ( $c$  = 0.9 in EtOH), (2*S*,3*S*)-isomer]<sup>4</sup>, confirmed as a (2*S*,3*S*)-isomer. HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{10}\text{H}_{14}\text{O}$ ,  $[\text{M}+\text{H}]$ : 151.1117; found: 151.1121.

**(2*S*,3*S*)-3-(4-methoxyphenyl)butan-2-ol (4b)**

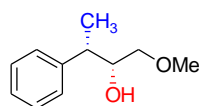
 white solid (24.5 mg, 68% yield), m.p. = 78 °C. dr >99:1, er = 93.5:6.5, [Daicel Chiralpak OC-H, *n*-hexane/*i*-propanol = 90:10, 0.5 mL/min,  $\lambda$  = 220 nm, retention time: 14.08 min (minor) and 14.90 min (major) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.17–7.13 (m, 2H), 6.90–6.86 (m, 2H), 3.89–3.84 (m, 1H), 3.82 (s, 3.82), 2.76–2.69 (m, 1H), 1.55 (br, 1H), 1.32 (d,  $J$  = 7.0 Hz, 3H), 1.10 (d,  $J$  = 6.2 Hz, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.16, 136.23, 128.75, 113.80, 72.46, 55.25, 46.22, 20.91, 16.14. Optical Rotation:  $[\alpha]_{\text{D}}^{22}$ +2.71 ( $c$  = 0.185,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{11}\text{H}_{16}\text{O}_2$ ,  $[\text{M}+\text{H}]$ : 181.1223; found: 181.1228.

**(1*R*,2*S*)-1,2-diphenylpropan-1-ol (4c)**



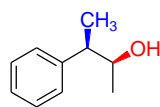
white solid (23.7 mg, 56% yield), m.p. = 57 °C. dr >99:1, er = 99:1, [Daicel Chiralpak OD-H, *n*-hexane/*i*-propanol = 90:10, 0.5 mL/min,  $\lambda$  = 220 nm, retention time: 14.79 min (minor) and 15.96 min (major) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.31-7.17 (m, 10H), 4.85 (dd,  $J$  = 2.8 Hz, 2.8 Hz, 1H), 3.17-3.11 (m, 1H), 1.89 (br, 1H), 1.34 (d,  $J$  = 7.2 Hz, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  143.58, 142.91, 128.28, 128.14, 128.02, 127.26, 126.50, 126.35, 78.75, 47.24, 14.98. Optical Rotation:  $[\alpha]_{\text{D}}^{22} +45.16$  ( $c$  = 0.155,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{15}\text{H}_{16}\text{O}$ ,  $[\text{M}+\text{H}]$ : 213.1273; found: 213.1275.

**(2*R*,3*S*)-1-methoxy-3-phenylbutan-2-ol (4d)**



colorless oil (28.8 mg, 80% yield). dr >99:1, er = 92:8, [Daicel Chiralpak OD-H, *n*-hexane/*i*-propanol = 90:10, 0.5 mL/min,  $\lambda$  = 220 nm, retention time: 9.69 min (minor) and 10.37 min (major) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.35-7.31(m, 2H), 7.26-7.22(m, 3H), 3.88-3.82(m, 1H), 3.31 (s, 3H), 3.25-3.22(m, 1H), 3.16-3.12(m, 1H), 2.87-2.80(m, 1H), 2.72(br, 1H), 1.41 (d,  $J$  = 7.0 Hz, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  144.04, 128.53, 127.62, 126.54, 75.26, 74.76, 58.92, 43.06, 17.73. Optical Rotation:  $[\alpha]_{\text{D}}^{22} +14.8$  ( $c$  = 0.25,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{11}\text{H}_{16}\text{O}_2$ ,  $[\text{M}+\text{H}]$ : 181.1223; found: 181.1225.

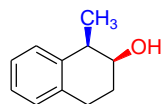
**(2*S*,3*R*)-3-phenylbutan-2-ol (4e)**



colorless oil (8.4 mg, 28% yield). dr >99:1, er = 99:1, [Daicel Chiralpak OJ-H, *n*-hexane/*i*-propanol = 95:5, 0.5 mL/min,  $\lambda$  = 220 nm, retention time: 23.46 min (major) and 26.86 min (minor) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.38-7.34(m, 2H), 7.28-7.22(m, 3H), 3.91-3.84(m, 1H), 2.74-2.66(m, 1H), 1.29 (d,  $J$  = 7.0 Hz, 3H), 1.25 (d,  $J$  = 6.2 Hz, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  143.58, 128.66, 128.06, 126.46, 72.38, 47.21, 21.08, 16.08. The spectral data of the product were identical with the reported in the literature<sup>4</sup>. Optical Rotation:  $[\alpha]_{\text{D}}^{22} +11.86$  ( $c$  = 1.5, EtOH), [Lit., +19.55 ( $c$  = 1.4 in EtOH), (2*S*,3*R*)-isomer]<sup>4</sup>, confirmed as a

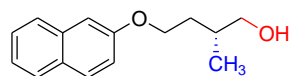
(2*S*,3*R*)-isomer.HRMS-ESI ( $m/z$ ): Calcd for C<sub>10</sub>H<sub>14</sub>O, [M+H]: 151.1117; found: 151.1118.

**(1*R*,2*S*)-1-methyl-1,2,3,4-tetrahydronaphthalen-2-ol (4f)**



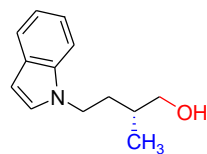
white solid (22.7 mg, 70% yield), m.p. = 89° C. dr >99:1, er = 98:2, [Daicel Chiralpak OD-H, *n*-hexane/*i*-propanol = 95:5, 1.0 mL/min,  $\lambda$  = 220 nm, retention time: 8.51 min (minor) and 9.18 min (major) ]; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.24-7.13 (m, 4H), 4.19-4.14 (m, 1H), 3.11-2.98 (m, 2H), 2.93-2.85 (m, 1H), 2.06-1.91 (m, 3H), 1.35 (d,  $J$  = 7.2 Hz, 3H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  140.36, 135.21, 128.85, 128.65, 126.04, 126.01, 70.21, 38.54, 27.31, 27.20, 16.62. Optical Rotation:  $[\alpha]_D^{22}$ -53.78 ( $c$  = 0.225, CHCl<sub>3</sub>). HRMS-ESI ( $m/z$ ): Calcd for C<sub>11</sub>H<sub>14</sub>O, [M+H]: 163.1117; found: 163.1118.

**(*R*)-2-methyl-4-(naphthalen-2-yloxy)butan-1-ol (4g)**



white solid (35.9 mg, 78% yield), m.p. = 45 °C. er = 92:8, [Daicel Chiralpak OJ-H, *n*-hexane/*i*-propanol = 90:10, 1.0 mL/min,  $\lambda$  = 254 nm, retention time: 30.05 min (major) and 36.93 min (minor) ]; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.81-7.74 (m, 3H), 7.49-7.35 (m, 2H), 7.18-7.16 (m, 2H), 4.25-4.14 (m, 2H), 3.61 (d,  $J$  = 5.4 Hz, 2H), 2.06-1.96 (m, 2H), 1.85 (br, 1H), 1.79-1.75 (m, 1H), 1.06 (d,  $J$  = 6.6 Hz, 3H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  156.78, 134.58, 129.43, 129.00, 127.67, 126.74, 126.39, 123.63, 118.88, 106.71, 68.02, 66.17, 33.36, 32.81, 16.86. Optical Rotation:  $[\alpha]_D^{22}$ -3.57 ( $c$  = 0.28, CHCl<sub>3</sub>). HRMS-ESI ( $m/z$ ): Calcd for C<sub>15</sub>H<sub>18</sub>O<sub>2</sub>, [M+H]: 231.1385; found: 231.1387.

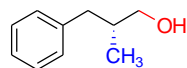
**(*R*)-4-(1*H*-indol-1-yl)-2-methylbutan-1-ol (4h)**



yellow oil (30.5 mg, 75% yield). er = 90:10, [Daicel Chiralpak OJ-H, *n*-hexane/*i*-propanol = 95:5, 1.0 mL/min,  $\lambda$  = 254 nm, retention time: 43.08 min (minor) and 44.02 min (major) ]; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.72 (d,  $J$  = 7.8 Hz, 1H), 7.42 (d,  $J$  = 8.2 Hz, 1H), 7.31-7.27 (m, 1H), 7.21-7.16 (m, 2H), 6.57 (d,  $J$  = 3.0 Hz, 1H), 4.21-4.20 (m, 2H), 3.47-3.45 (m, 2H),

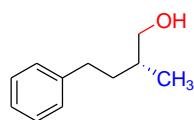
2.08-2.02 (m, 1H), 1.81 (br, 1H), 1.68-1.65 (m, 2H), 1.04 (d,  $J = 6.4$  Hz, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  135.95, 128.64, 127.72, 121.48, 121.07, 119.32, 109.44, 101.12, 67.85, 44.31, 33.69, 33.37, 16.52. Optical Rotation:  $[\alpha]_{\text{D}}^{22} +11.33$  ( $c = 0.30$ ,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{13}\text{H}_{17}\text{NO}$ ,  $[\text{M}+\text{H}]$ : 204.1382; found: 204.1385.

**(*R*)-2-methyl-3-phenylpropan-1-ol (4i)**



colorless oil (21.1 mg, 70% yield). er = 88:12, [Daicel Chiralpak OJ-H, *n*-hexane/*i*-propanol = 98:2, 1.0 mL/min,  $\lambda = 220$  nm, retention time: 14.51 min (major) and 15.69 min (minor) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.33-7.29 (m, 2H), 7.24-7.19 (m, 2H), 3.57 (dd,  $J = 10.5, 5.8$  Hz, 1H), 3.51 (dd,  $J = 10.5, 5.8$  Hz, 1H), 2.79 (dd,  $J = 13.4, 6.3$  Hz, 1H), 2.46 (dd,  $J = 13.4, 6.3$  Hz, 1H), 2.02-1.94 (m, 1H), 1.44 (br, 1H), 0.95 (d,  $J = 6.7$  Hz, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  140.64, 129.17, 128.29, 125.91, 67.68, 39.72, 37.82, 16.49. Optical Rotation:  $[\alpha]_{\text{D}}^{22} +2.22$  ( $c = 0.36$ ,  $\text{CHCl}_3$ ), [Lit., -3.0 ( $c = 0.67$  in  $\text{CHCl}_3$ ), (*S*)-isomer]<sup>5</sup>, confirmed as a (*R*)-isomer. HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{10}\text{H}_{14}\text{O}$ ,  $[\text{M}+\text{H}]$ : 151.1117; found: 151.1123.

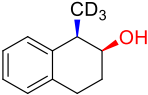
**(*R*)-2-methyl-4-phenylbutan-1-ol (4j)**



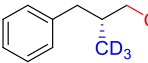
colorless oil (22.3 mg, 68% yield). er = 89:11, [Daicel Chiralpak AS-H, *n*-hexane/*i*-propanol = 95:5, 0.5 mL/min,  $\lambda = 220$  nm, retention time: 12.80 min (minor) and 13.47 min (major) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.36-7.32 (m, 2H), 7.26-7.22 (m, 3H), 3.56 (dd,  $J = 11.2, 6.0$  Hz, 1H), 3.49 (dd,  $J = 11.2, 6.0$  Hz, 1H), 2.80-2.73 (m, 1H), 2.69-2.61 (m, 1H), 2.18 (br, 1H), 1.86-1.77 (m, 1H), 1.71 (sext,  $J = 6.0$  Hz, 1H), 1.53-1.44 (m, 1H), 1.04 (d,  $J = 6.8$  Hz, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  142.70, 128.42, 128.39, 125.77, 67.07, 35.37, 35.06, 33.35, 16.58. Optical Rotation:  $[\alpha]_{\text{D}}^{22} +9.09$  ( $c = 0.55$ ,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{11}\text{H}_{16}\text{O}$ ,  $[\text{M}+\text{H}]$ : 165.1273; found: 165.1280.

**(1*R*,2*S*)-1-d<sub>3</sub>-methyl-1,2,3,4-tetrahydronaphthalen-2-ol (4f-D)**

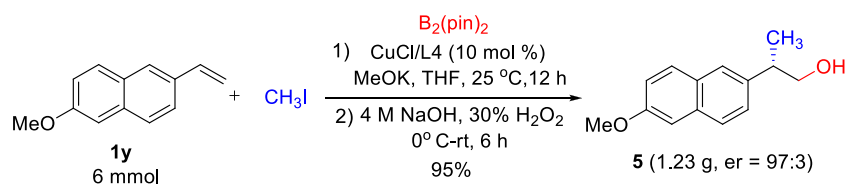



 white solid (25.2 mg, 76% yield), m.p. = 90 °C. dr >99:1, er = 98:2, [Daicel Chiralpak OD-H, *n*-hexane/*i*-propanol = 95:5, 1.0 mL/min,  $\lambda$  = 220 nm, retention time: 9.08 min (minor) and 9.75 min (major) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.23-7.12 (m, 4H), 4.19-4.14 (m, 1H), 3.06-2.97 (m, 2H), 2.92-2.86 (m, 1H), 2.04-1.94 (m, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  140.27, 135.19, 128.78, 128.62, 126.01, 125.99, 70.22, 38.30, 27.38, 27.12. Optical Rotation:  $[\alpha]_{\text{D}}^{22}$  -53.48 ( $c$  = 0.215,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{11}\text{H}_{11}\text{D}_3\text{O}$ ,  $[\text{M}+\text{H}]$ : 166.1308; found: 166.1306.

#### (*R*)-2-d<sub>3</sub>-methyl-3-phenylpropan-1-ol (4i-D)


 colorless oil (21.5 mg, 70% yield). er = 87:13, [Daicel Chiralpak OJ-H, *n*-hexane/*i*-propanol = 98:2, 1.0 mL/min,  $\lambda$  = 220 nm, retention time: 17.20 min (major) and 18.77 min (minor) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.34-7.29 (m, 2H), 7.24-7.20 (m, 3H), 3.56 (dd,  $J$  = 10.5, 5.8 Hz, 1H), 3.50 (dd,  $J$  = 10.5, 5.8 Hz, 1H), 2.79 (dd,  $J$  = 13.4, 6.3 Hz, 1H), 2.46 (dd,  $J$  = 13.4, 6.3 Hz, 1H), 2.00-1.93 (m, 1H), 1.59 (br, 1H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  140.67, 129.16, 128.28, 125.89, 67.64, 39.66, 37.58. Optical Rotation:  $[\alpha]_{\text{D}}^{22}$  +1.95 ( $c$  = 0.41,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{10}\text{H}_{11}\text{D}_3\text{O}$ ,  $[\text{M}+\text{H}]$ : 154.1308; found: 154.1309.

## 6. Synthesis of (*S*)-Naproxen



**Preparation of (*S*)-2-(6-methoxynaphthalen-2-yl)propan-1-ol (5).** In the glovebox, to a 100 mL Schlenk flask with magnetic stir bar was added CuCl (10 mol %, 57 mg, 0.6 mmol), **L4** (12 mol %, 306 mg, 0.72 mmol) and 25 mL THF. The mixture was stirred 60 minutes at room temperature. To the mixture was added  $\text{B}_2(\text{pin})_2$  (2.29 g, 9 mmol), 2-Methoxy-6-vinyl-naphthalene **1y** (1.1 g, 6 mmol),  $\text{CH}_3\text{I}$  (1.27 g, 9 mmol), and MeOK (9 mmol, 0.63 g) successively (Note: MeOK was added

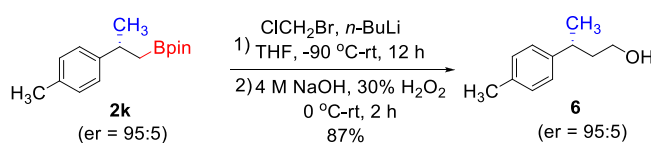
slowly to prevent the vigorously exothermic reaction), finally diluted by 15 mL THF. The flask was sealed with rubber stopper, removed from the glovebox and stirred at room temperature for 24 hours. The reaction mixture was filtrated through a celite pad and the solvent was removed under vacuo. The residue was dissolved in THF (30 mL) at 0 °C, then 4 M of aqueous NaOH (18 mL) and 30% H<sub>2</sub>O<sub>2</sub> (6 mL) was added slowly. After addition, the reaction mixture was stirred for 6 hours at room temperature. After the reaction was completed, sat. Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> solution (15 mL) was added to quench the reaction. The mixture was extracted with EtOAc (3×60 mL) and the combined organic phase was dried over Na<sub>2</sub>SO<sub>4</sub>. After evaporating solvent under vacuo, the residue was purified by column chromatography on silica gel with EtOAc:Petroleum ether (1:3) to obtain the product **5** as a white solid (1.23 g, 95% yield), m.p. = 87 °C. er = 97:3, [Daicel Chiralpak AD-H, *n*-hexane/*i*-propanol = 98:2, 1.0 mL/min, λ = 254 nm, retention time: 39.91 min (minor) and 44.21 min (major)]; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 7.75 (d, *J* = 5.8 Hz, 1H), 7.73 (d, *J* = 6.2 Hz, 1H), 7.63 (s, 1H), 7.74 (dd, *J* = 8.2, 1.6 Hz, 1H), 7.19-7.13 (m, 2H), 3.95 (s, 3H), 3.79 (d, *J* = 4.6 Hz, 2H), 3.15-3.06 (m, 1H), 1.52 (br, 1H), 1.38 (d, *J* = 7.0 Hz, 3H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 157.45, 138.71, 133.56, 129.13, 129.06, 127.23, 126.31, 125.92, 118.93, 105.62, 68.64, 54.33, 42.38, 17.67. Optical Rotation: [α]<sub>D</sub><sup>22</sup> -8.23 (c = 0.255, CHCl<sub>3</sub>). HRMS-ESI (*m/z*): Calcd for C<sub>14</sub>H<sub>16</sub>O<sub>2</sub>, [M+H]: 217.1223; found: 217.1231.



**Preparation of (S)-2-(6-Methoxy-naphthalen-2-yl)-propionic acid ((S)-Naprofen).** To a 50 mL Schlenk flask were added Fe(NO<sub>3</sub>)<sub>3</sub>·9H<sub>2</sub>O (0.23 g, 0.57 mmol), DCE (17 mL), TEMPO (89 mg, 0.57 mmol), KCl (42.5 mg, 0.57 mmol), and **5** (1.23 g, 5.7 mmol) sequentially. After evacuated and filled in the pure O<sub>2</sub> for three times with a balloon, the reaction was stirred at 25 °C for 24 h. The crude reaction mixture was filtrated through a celite, the combined organic phase was evaporated

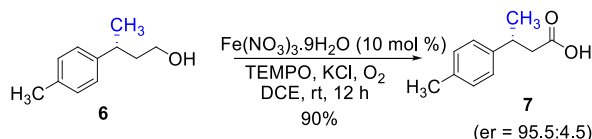
under vacuo and the residue was purified by column chromatography on silica gel with EtOAc:Petroleum ether (1:1.5) to obtain the product (**S**)-**Naproxen** as a white solid (1.18 g, 90% yield), m.p. = 142 °C. er = 97/3, [Daicel Chiralpak AD-H, *n*-hexane/*i*-propanol = 95:5, 0.5 mL/min,  $\lambda$  = 220 nm, retention time: 54.08 min (minor) and 57.43 min (major)]; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.74 – 7.71 (m, 3H), 7.42 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.16 – 7.13 (m, 2H), 3.94 (s, 3H), 3.90 (q, *J* = 7.2 Hz, 1H), 1.62 (d, *J* = 7.2 Hz, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>)  $\delta$  180.87, 157.72, 134.88, 133.84, 129.33, 128.91, 127.26, 126.22, 126.18, 119.07, 105.59, 55.33, 45.30, 18.15. Optical Rotation:  $[\alpha]_D^{22}$  +59.02 (*c* = 0.205, CHCl<sub>3</sub>). HRMS-ESI (*m/z*): Calcd for C<sub>14</sub>H<sub>14</sub>O<sub>3</sub>, [M+H]: 231.1015; found: 231.1013.

## 7. Formal Synthesis of (*R*)-*ar*-Turmerone and 8-Deoxyanisatin

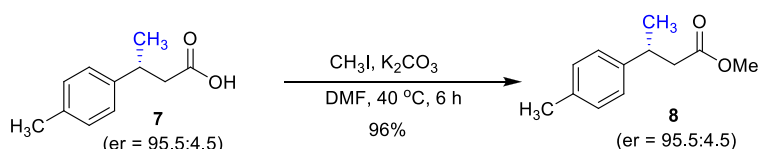


**Preparation of (*R*)-3-*p*-tolylbutan-1-ol (6).** To the dried Schlenk tube with magnetic stir bar was added **2k** (130 mg, 0.5 mmol, er = 95:5). After evacuated and filled in Ar for three times, ClCH<sub>2</sub>Br (193.5 mg, 1.5 mmol) and dried THF (1.5 mL) were added. The solution was cooled to -90 °C and added BuLi (0.6 mL, 2.5 M) very slowly. The reaction was warmed to room temperature and stirred for overnight. Quenched by saturated aq. NH<sub>4</sub>Cl, the mixture was extracted with EtOAc (3x15 mL). The organic phase was combined and washed with saturated aq. NaCl and dried over Na<sub>2</sub>SO<sub>4</sub>. After the removal of solvent, the residue was dissolved in 5 mL THF and cooled to 0 °C. The aq. NaOH (5 mL, 4 M) was added and the aq H<sub>2</sub>O<sub>2</sub> (2 mL, 30%w) was added dropwise. The mixture was stirred at room temperature for 2 hours and quenched by saturated aq. Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> at 0 °C. Then the mixture was extracted with EtOAc(3x15 mL), the organic phase was combined and dried over Na<sub>2</sub>SO<sub>4</sub>. After the removal of solvent, the residue was purified by flash column chromatography with

Petroether:Acetate(4:1) as the eluent to get **6** as a colorless oil (71.3 mg, 87% yield).  $er = 95:5$ , [Daicel Chiralpak OJ-H, *n*-hexane/*i*-propanol = 98:2, 1.0 mL/min,  $\lambda = 254$  nm, the environment temperature of chiral column is 40 °C, retention time: 19.22 min (minor) and 20.28 min (major) ];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.19-7.13 (m, 4H), 3.63-3.53 (m, 2H), 2.89 (sext,  $J = 7.2$  Hz, 1H), 2.38 (s, 3H), 1.90-1.85 (m, 2H), 1.78 (br, 1H), 1.31 (d,  $J = 7.0$  Hz, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  143.87, 135.58, 129.21, 126.86, 67.21, 41.03, 36.07, 22.58, 21.04. Optical Rotation:  $[\alpha]_{\text{D}}^{22}$ -24.09 ( $c = 0.22$ ,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{11}\text{H}_{16}\text{O}$ ,  $[\text{M}+\text{H}]$ : 165.1273; found: 165.1278.



**Preparation of (R)-3-p-tolylbutanoic acid (7).** To a tube with magnetic stir bar was added **6** (71.3 mg, 0.435 mmol),  $\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$  (17.6 mg, 0.0435 mmol), DCE (1.5 mL), TEMPO (6.8 mg, 0.0435 mmol), KCl (3.2 mg, 0.0435 mmol) sequentially. After evacuated and filled in the pure  $\text{O}_2$  with a balloon for three times, the reaction was stirred at 25 °C for 12 h. The crude reaction mixture was filtrated through a celite, the combined organic phase was evaporated under vacuo and purified by column chromatography on silica gel with EtOAc:Petroleum ether (1:2) to obtain the product **(R)-3-p-tolylbutanoic acid (7)** as a white solid (69.6 mg, 90% yield), m.p. = 128 °C.  $er = 95.5:4.5$ , [Daicel Chiralpak AD-H, *n*-hexane/*i*-propanol = 95:5, 0.2 mL/min,  $\lambda = 220$  nm, retention time: 36.03 min (minor) and 40.28 min (major)];  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.16 (s, 4H), 3.29 (sext,  $J = 7.2$  Hz, 1H), 2.70 (dd,  $J = 15.4$  Hz, 6.8 Hz, 1H), 2.61 (dd,  $J = 15.4$  Hz, 6.8 Hz, 1H), 2.37 (s, 3H), 1.35 (d,  $J = 7.0$  Hz, 3H).  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  179.00, 142.48, 136.04, 129.28, 126.61, 42.74, 35.77, 21.99, 21.04. Optical Rotation:  $[\alpha]_{\text{D}}^{22}$ -44.0 ( $c = 0.15$ ,  $\text{CHCl}_3$ ). HRMS-ESI ( $m/z$ ): Calcd for  $\text{C}_{11}\text{H}_{14}\text{O}_2$ ,  $[\text{M}+\text{H}]$ : 179.1066; found: 179.1069.



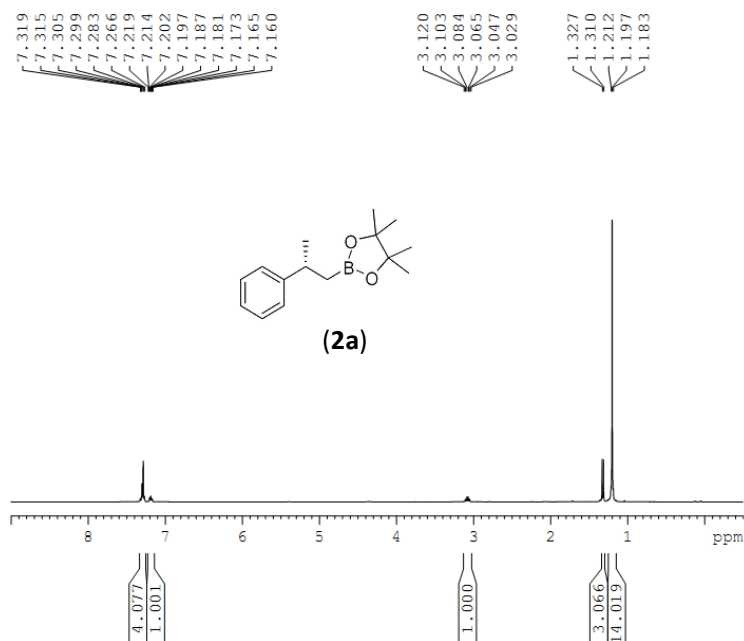
**Preparation of (R)-methyl 3-p-tolylbutanoate (8).** To a tube with magnetic stir bar was added **7** (0.2 mmol, 35.6 mg) and K<sub>2</sub>CO<sub>3</sub> (0.4 mmol, 55.2 mg). After evacuated and filled in Ar for three times, DMF (1 mL) and CH<sub>3</sub>I (0.4 mmol, 56.4 mg) were added and the mixture was stirred at 40 °C for 6 h. The reaction was quenched by addition of 3 mL H<sub>2</sub>O and extracted with EtOAc (3x5 mL). The organic phase was combined and dried over Na<sub>2</sub>SO<sub>4</sub>. After the removal of solvent, the residue was purified by flash column chromatography with petioether:Acetate (10:1) as the eluent to get colorless oil **8** (36.8 mg, 90% yield), er = 95.5:4.5, [Daicel Chiralpak AD-H, *n*-hexane/*i*-propanol = 500:1, 0.5 mL/min,  $\lambda$  = 254 nm, retention time: 19.21 min (minor) and 20.28 min (major)]; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.15 (s, 4H), 3.66 (s, 3H), 3.28 (m, 1H), 2.64 (dd, *J* = 15.1 Hz, 6.9 Hz, 1H), 2.56 (dd, *J* = 15.1 Hz, 6.9 Hz, 1H), 2.35 (s, 3H), 1.32 (d, *J* = 7.0 Hz, 3H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  172.94, 142.73, 135.89, 129.21, 126.58, 51.48, 42.84, 36.04, 21.88, 21.00. Optical Rotation: [ $\alpha$ ]<sub>D</sub><sup>22</sup> -31.05 (*c* = 0.95, CHCl<sub>3</sub>). HRMS-ESI (*m/z*): Calcd for C<sub>12</sub>H<sub>16</sub>O<sub>2</sub>, [M+Na]: 215.1048; found: 215.1052.

## 8. References

- (1) Chen, B.; Cao, P.; Yin, X.; Liao, Y.; Jiang, L.; Ye, J.; Wang, M.; Liao, J. *ACS Catal.* **2017**, *7*, 2425.
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- (4) Vitale, P.; Perna, F. M.; Perrone, M. G.; Scilimati, A. *Tetrahedron: Asymmetry* **2011**, *22*, 1985.
- (5) Kita, Y.; Hida, S.; Higashihara, K.; Sekhar Jena, H.; Higashida, K.; Mashima, K. *Angew. Chem. Int. Ed.* **2016**, *55*, 8299.

## 9. $^1\text{H}$ , $^{13}\text{C}$ , $^{11}\text{B}$ , $^{19}\text{F}$ NMR and HPLC Spectra

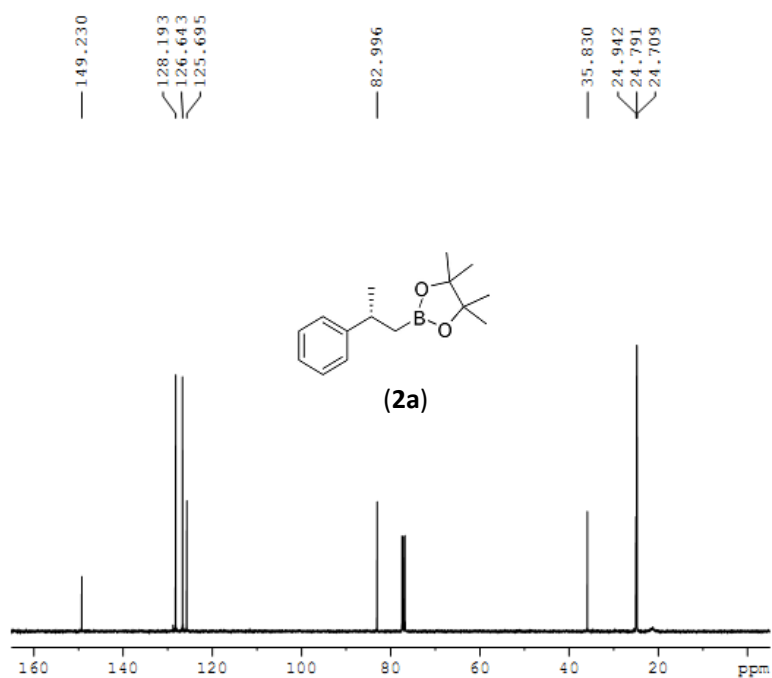
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FIDRES     0.122266 Hz
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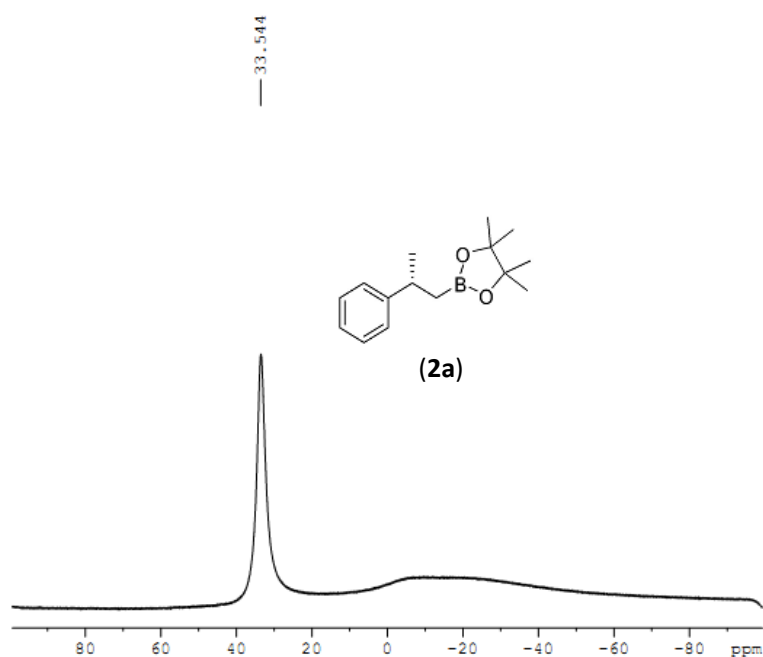
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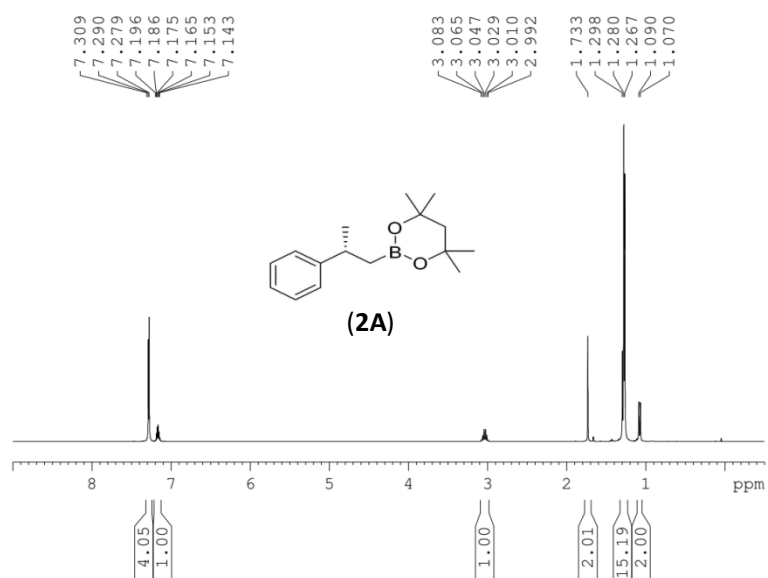


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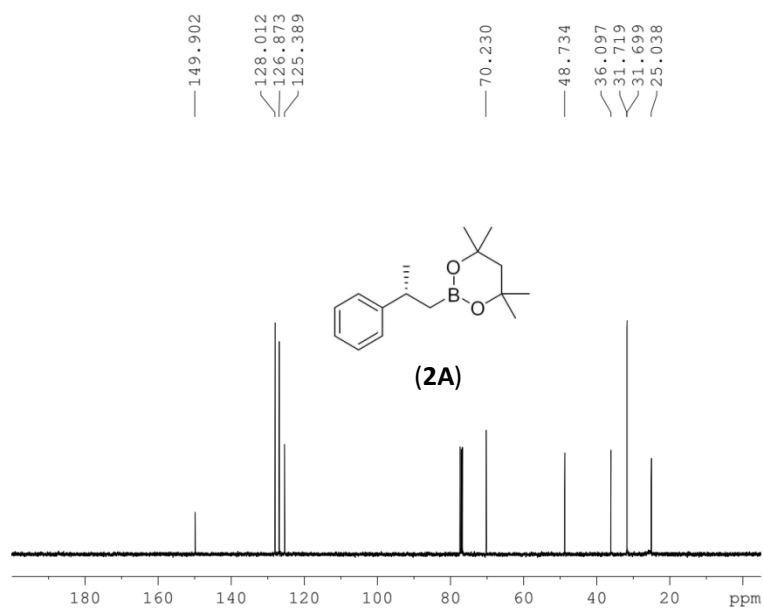


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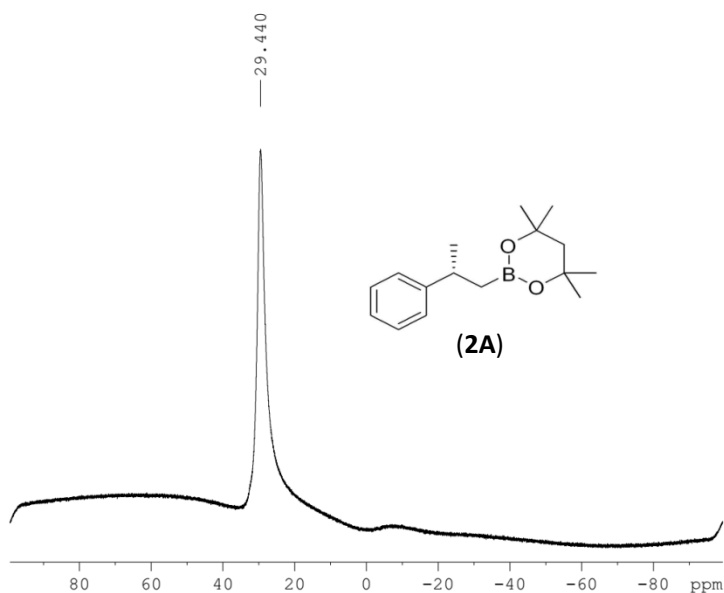
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DS            4
SWH           24038.461 Hz
FIDRES        0.366798 Hz
AQ            1.3631988 sec
RG            197.54
DW            20.800 usec
DE            6.50 usec
TE            0.0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0           1

```

```

===== CHANNEL f1 =====
SFO1          100.6228293 MHz
NUC1          13C
P1            9.31 usec
SI            32768
SF            100.6127685 MHz
WDW           EM
SSB           0
LB            1.00 Hz
GB            0
PC            1.40

```



```

NAME          CB-diB
EXPNO         11
PROCNO        1
Date_         20180205
Time          20.16
INSTRUM       spect
PROBHD        5 mm PABBO BB/
PULPROG       zg
TD            65536
SOLVENT       CDCl3
NS            128
DS            4
SWH           25510.203 Hz
FIDRES        0.389255 Hz
AQ            1.2845556 sec
RG            197.54
DW            19.600 usec
DE            6.50 usec
TE            0.0 K
D1            1.00000000 sec
TD0           1

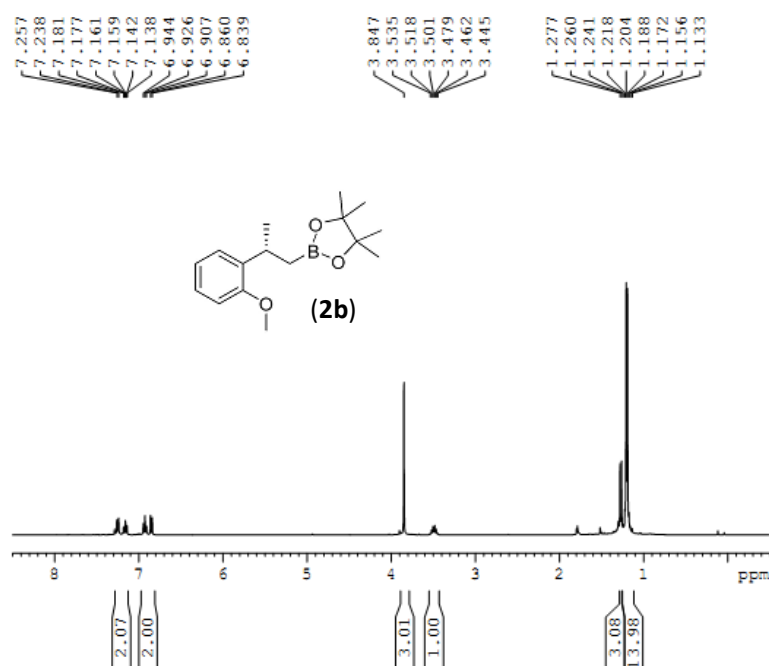
```

```

===== CHANNEL f1 =====
SFO1          128.3776052 MHz
NUC1          11B
P1            9.31 usec
SI            32768
SF            128.3776052 MHz
WDW           EM
SSB           0
LB            1.00 Hz
GB            0
PC            1.40

```



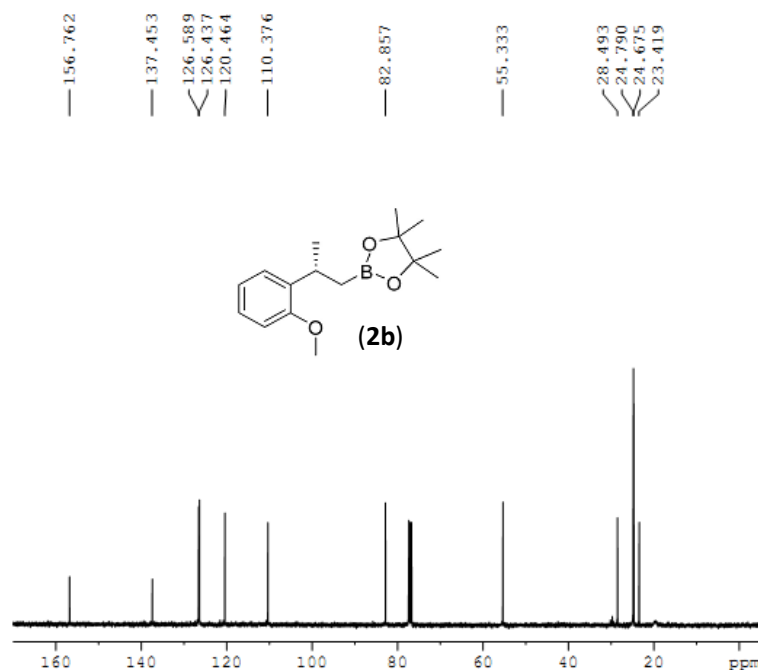


```

NAME      CB-17-110
EXPNO     22
PROCNO    1
Date_     20160805
Time      21.26
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         4
DS         0
SWH        8012.820 Hz
FIDRES     0.122266 Hz
AQ         4.0894966 sec
RG         19.81
DW         62.400 usec
DE         6.50 usec
TE         298.9 K
D1         1.00000000 sec
TD0        1
  
```

```

===== CHANNEL f1 =====
SFO1      400.1324710 MHz
NUC1       1H
P1         9.99 usec
SI         65536
SF         400.1300000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```

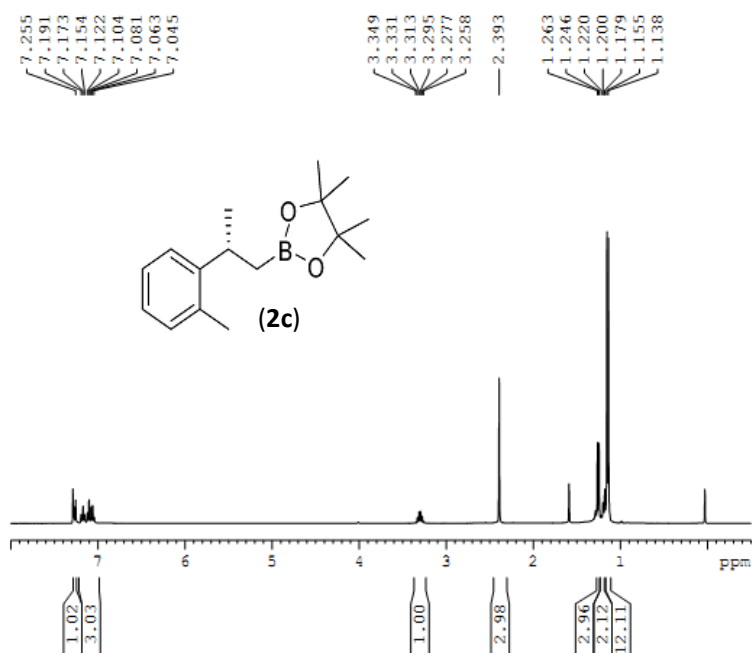


```

NAME      CB-17-110
EXPNO     21
PROCNO    1
Date_     20160805
Time      21.25
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         100
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         299.3 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
  
```

```

===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1       13C
P1         9.31 usec
SI         32768
SF         100.6127685 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```



```

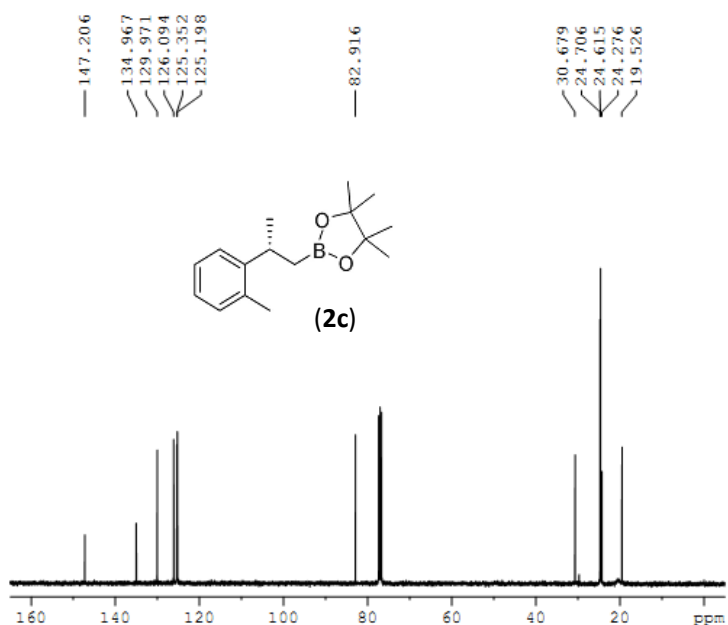
NAME      CB-17-21
EXPNO     10
PROCNO    1
Date_     20160719
Time      10.26
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         4
DS         0
SWH       8012.820 Hz
FIDRES    0.122266 Hz
AQ         4.0894966 sec
RG         78.29
DW         62.400 usec
DE         6.50 usec
TE         298.4 K
D1         1.00000000 sec
TD0        1

```

```

===== CHANNEL f1 =====
SFO1     400.1324710 MHz
NUC1      1H
P1        9.99 usec
SI        65536
SF        400.1300000 MHz
WDW       EM
SSB       0
LB        0.30 Hz
GB        0
PC        1.00

```



```

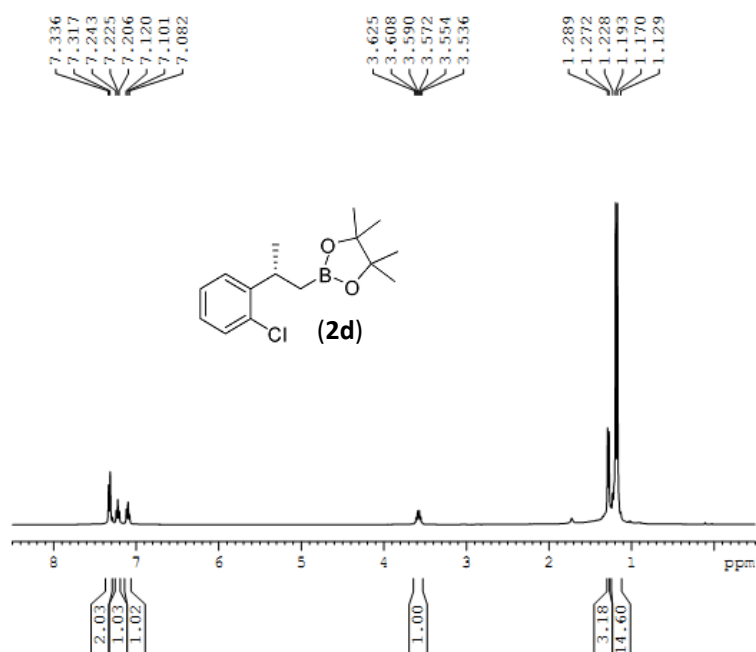
NAME      CB-17-21
EXPNO     20
PROCNO    1
Date_     20160719
Time      18.47
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         256
DS         4
SWH       24038.461 Hz
FIDRES    0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         299.7 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1

```

```

===== CHANNEL f1 =====
SFO1     100.6228293 MHz
NUC1      13C
P1        9.31 usec
SI        32768
SF        100.6127685 MHz
WDW       EM
SSB       0
LB        1.00 Hz
GB        0
PC        1.40

```

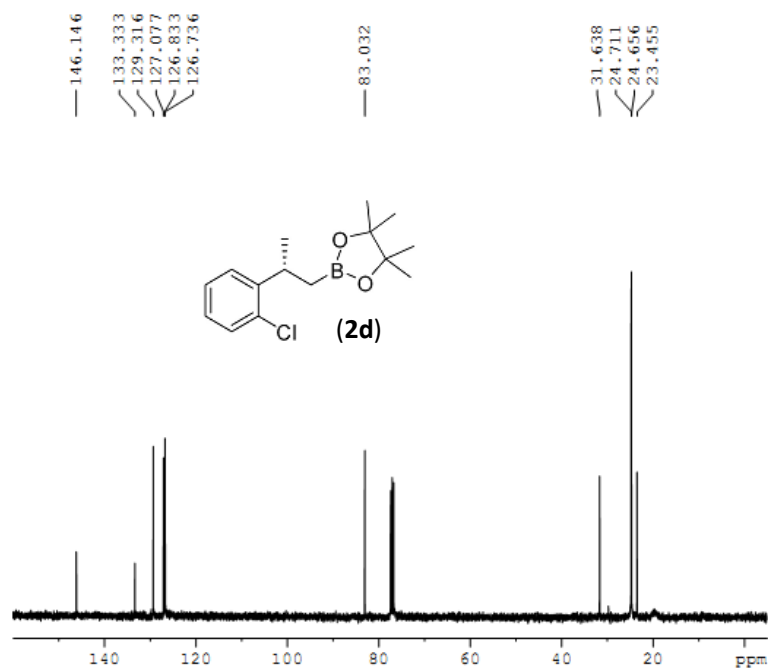


```

NAME      cb-17-114
EXPNO     20
PROCNO    1
Date_     20160808
Time      10.04
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         4
DS         0
SWH        8012.820 Hz
FIDRES     0.122266 Hz
AQ         4.0894966 sec
RG         30.81
DW         62.400 usec
DE         6.50 usec
TE         298.5 K
D1         1.00000000 sec
TD0        1

===== CHANNEL f1 =====
SFO1      400.1324710 MHz
NUC1       1H
P1         9.99 usec
SI         65536
SF         400.1300000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00

```

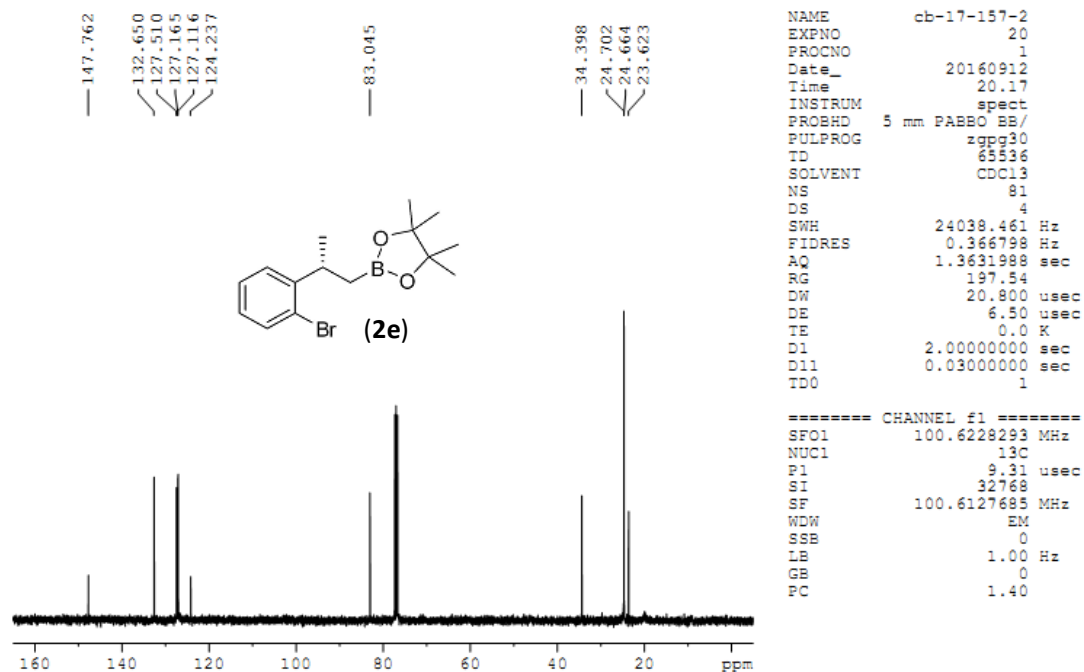
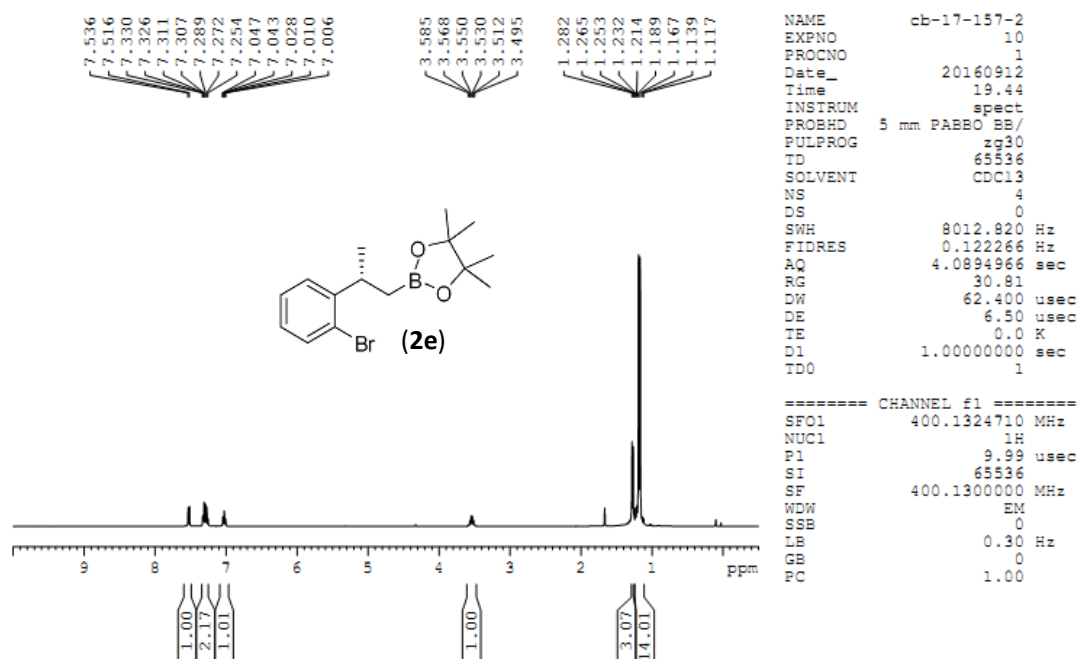


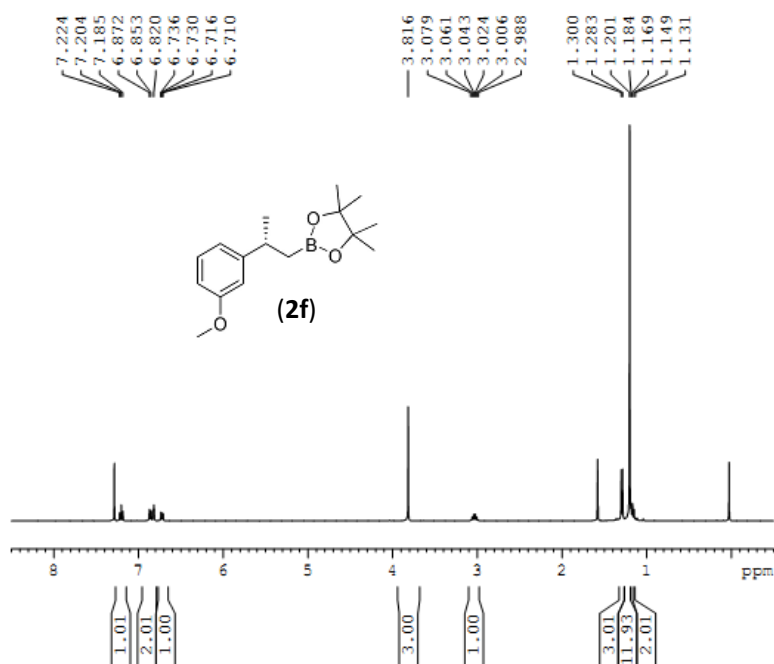
```

NAME      cb-17-114
EXPNO     21
PROCNO    1
Date_     20160808
Time      10.05
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         100
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         298.7 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1

===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1      13C
P1         9.31 usec
SI         32768
SF         100.6127695 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40

```



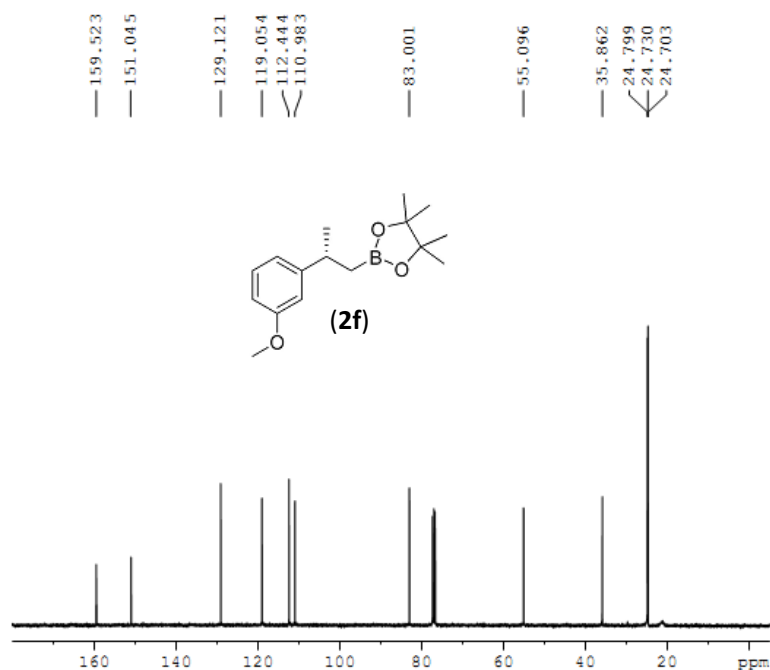


```

NAME          CB-17-25
EXPNO         10
PROCNO        1
Date_         20160719
Time          10.47
INSTRUM       spect
PROBHD        5 mm PABBO BB/
PULPROG       zg30
TD            65536
SOLVENT       CDCl3
NS            4
DS            0
SWH           8012.820 Hz
FIDRES        0.122266 Hz
AQ            4.0894966 sec
RG            63.21
DW            62.400 usec
DE            6.50 usec
TE            299.5 K
D1            1.00000000 sec
TD0           1

===== CHANNEL f1 =====
SFO1          400.1324710 MHz
NUC1          1H
P1            9.99 usec
SI            65536
SF            400.1300000 MHz
WDW           EM
SSB           0
LB            0.30 Hz
GB            0
PC            1.00

```

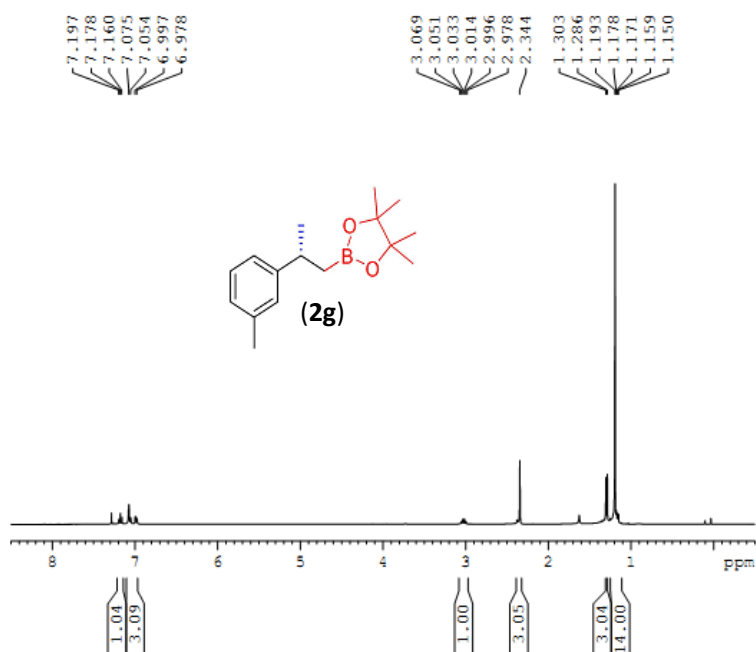


```

NAME          CB-17-25
EXPNO         20
PROCNO        1
Date_         20160719
Time          19.07
INSTRUM       spect
PROBHD        5 mm PABBO BB/
PULPROG       zgpg30
TD            65536
SOLVENT       CDCl3
NS            256
DS            4
SWH           24038.461 Hz
FIDRES        0.366798 Hz
AQ            1.3631988 sec
RG            197.54
DW            20.800 usec
DE            6.50 usec
TE            299.6 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0           1

===== CHANNEL f1 =====
SFO1          100.6228293 MHz
NUC1          13C
P1            9.31 usec
SI            32768
SF            100.6127685 MHz
WDW           EM
SSB           0
LB            1.00 Hz
GB            0
PC            1.40

```

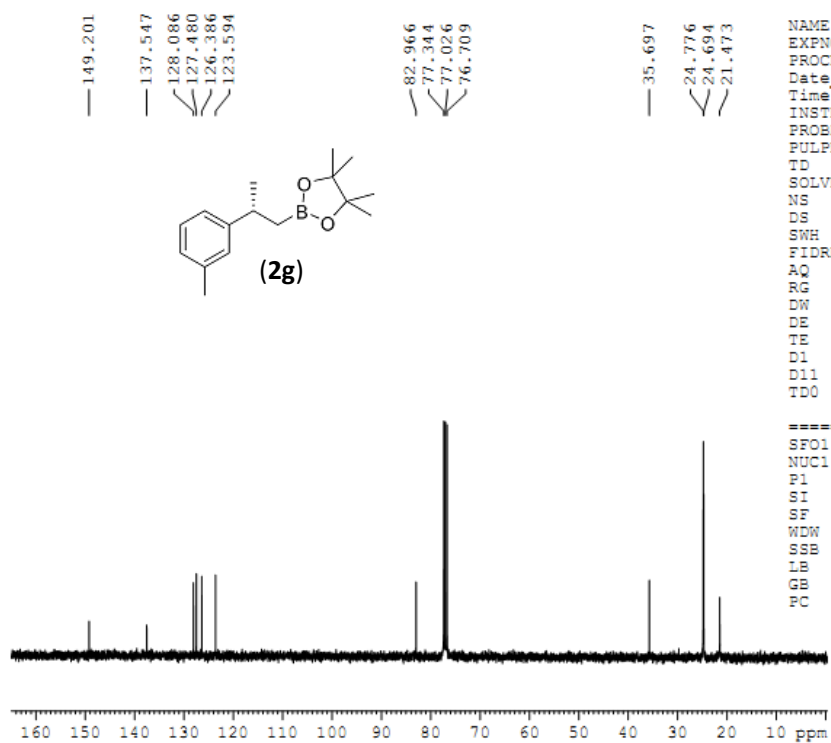


```

NAME      cb-17-107
EXPNO     20
PROCNO    1
Date_     20160802
Time      21.32
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         4
DS         0
SWH        8012.820 Hz
FIDRES     0.122266 Hz
AQ         4.0894966 sec
RG         48.33
DW         62.400 usec
DE         6.50 usec
TE         298.7 K
D1         1.00000000 sec
TD0        1
  
```

```

===== CHANNEL f1 =====
SFO1      400.1324710 MHz
NUC1       1H
P1         9.99 usec
SI         65536
SF         400.1300000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```

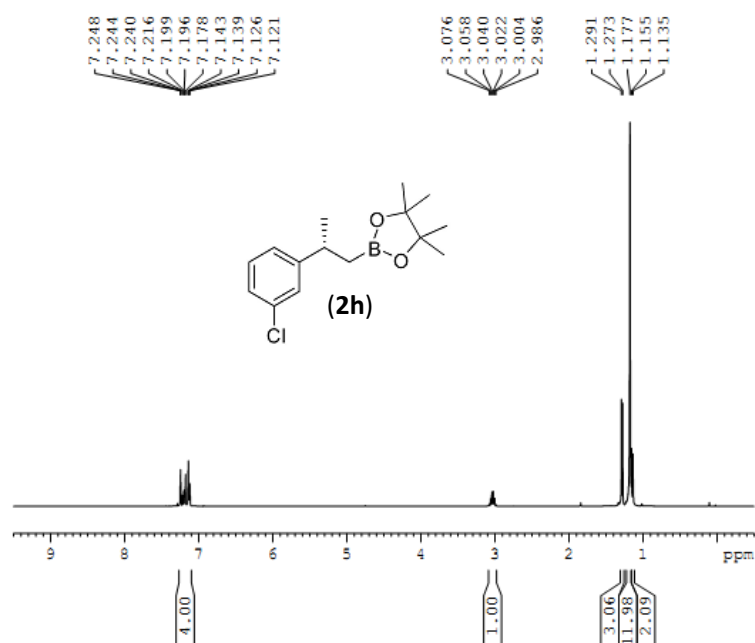


```

NAME      cb-17-107
EXPNO     21
PROCNO    1
Date_     20160802
Time      21.33
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         100
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         299.0 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
  
```

```

===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1       13C
P1         9.31 usec
SI         32768
SF         100.6127685 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```

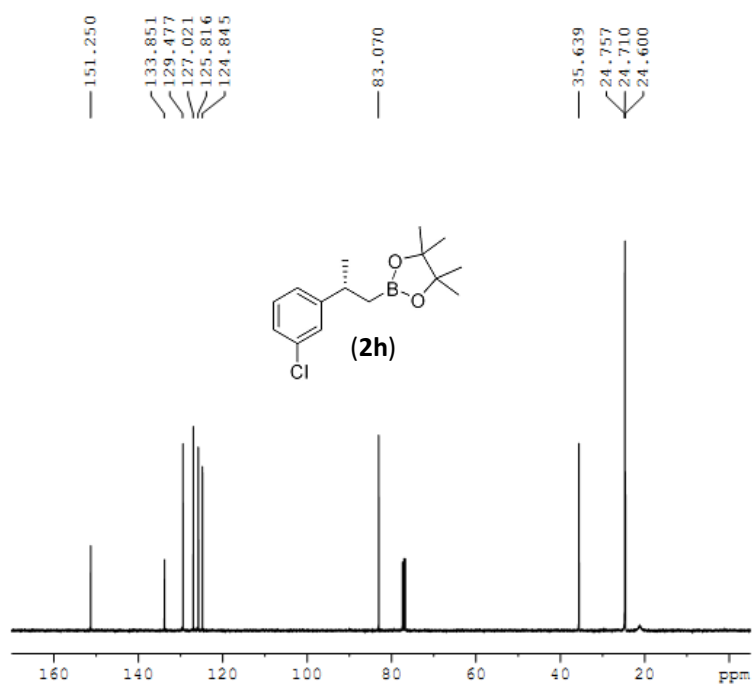


```

NAME      cb-19-201p
EXPNO     10
PROCNO    1
Date_     20170316
Time      10.55
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         4
DS         0
SWH        8012.820 Hz
FIDRES     0.122266 Hz
AQ         4.0894966 sec
RG         6.87
DW         62.400 usec
DE         6.50 usec
TE         297.2 K
D1         1.00000000 sec
TD0        1

===== CHANNEL f1 =====
SFO1      400.1324710 MHz
NUC1       1H
P1         9.99 usec
SI         65536
SF         400.1300000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00

```

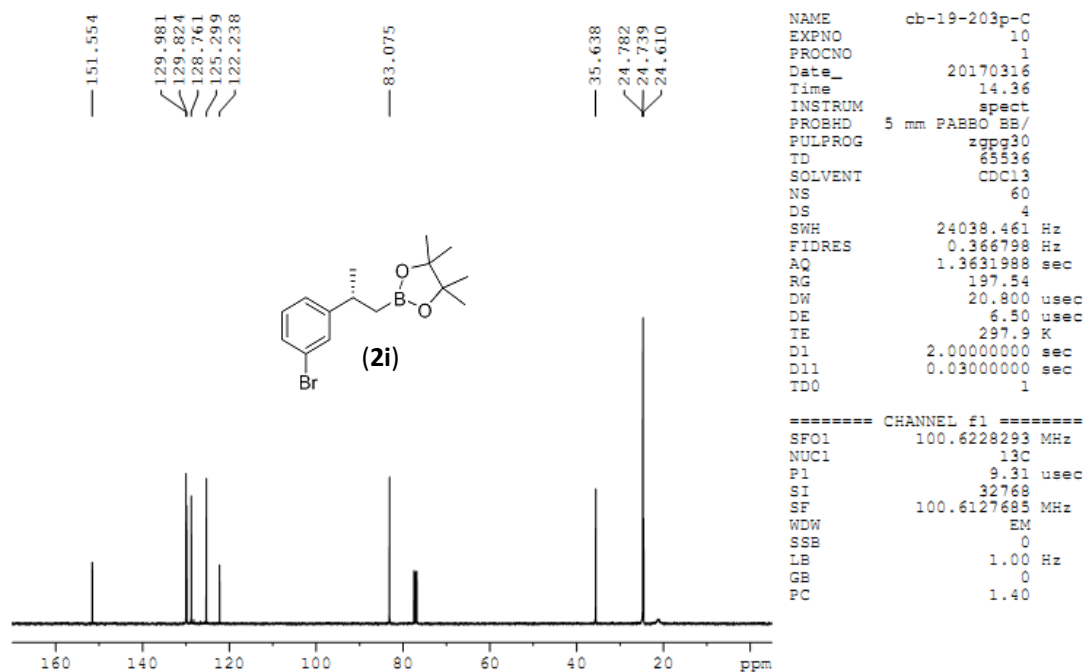
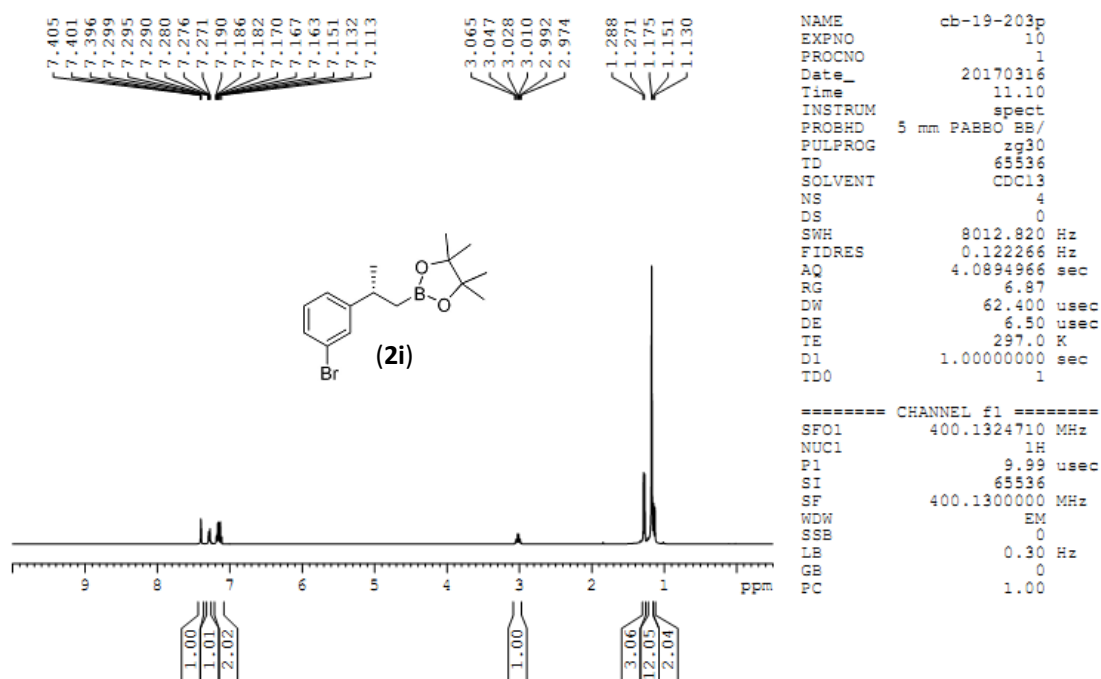


```

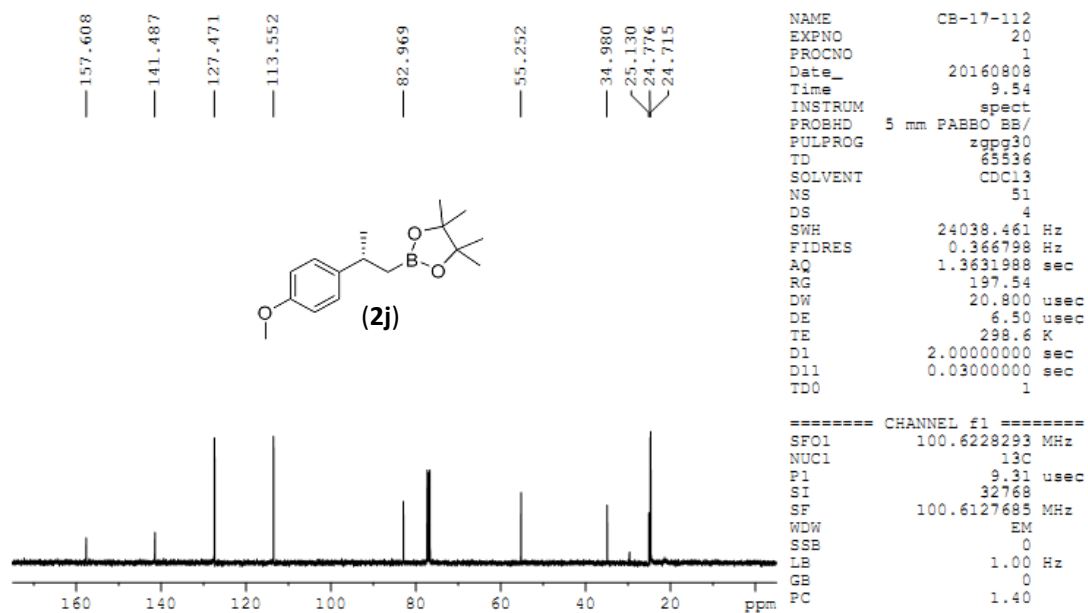
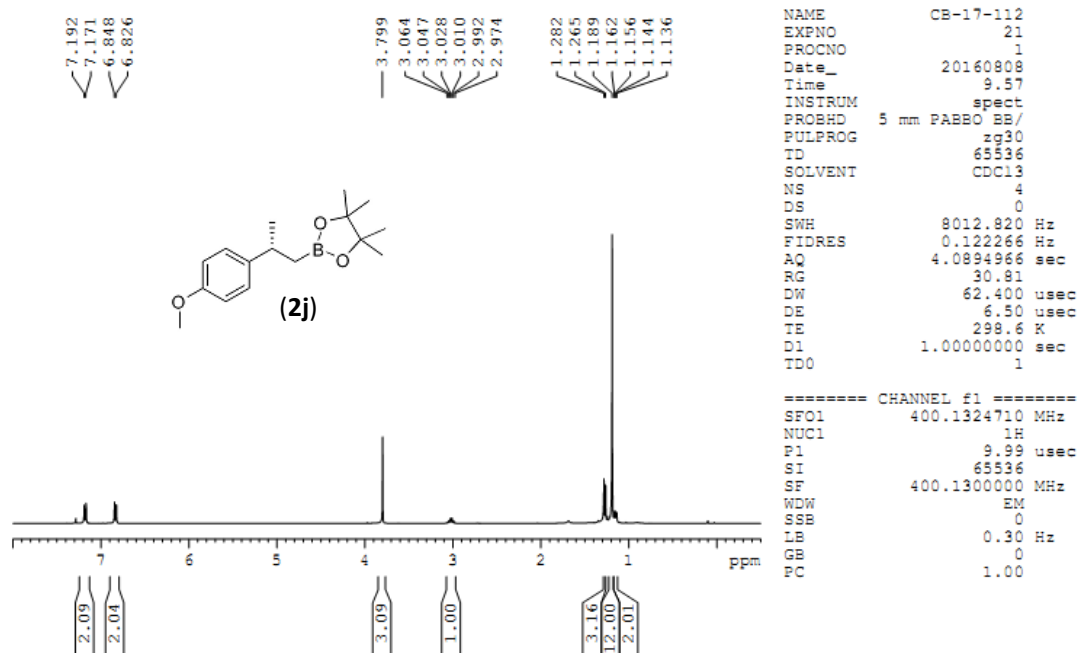
NAME      cb-19-201p-C
EXPNO     10
PROCNO    1
Date_     20170316
Time      14.29
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         60
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         297.9 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1

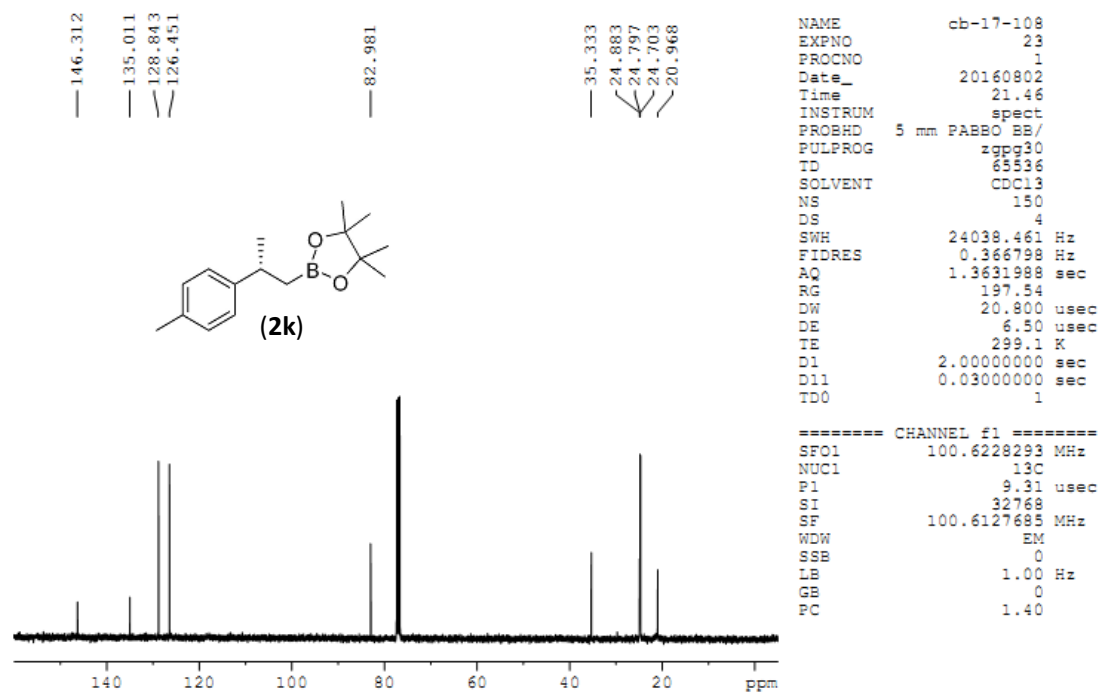
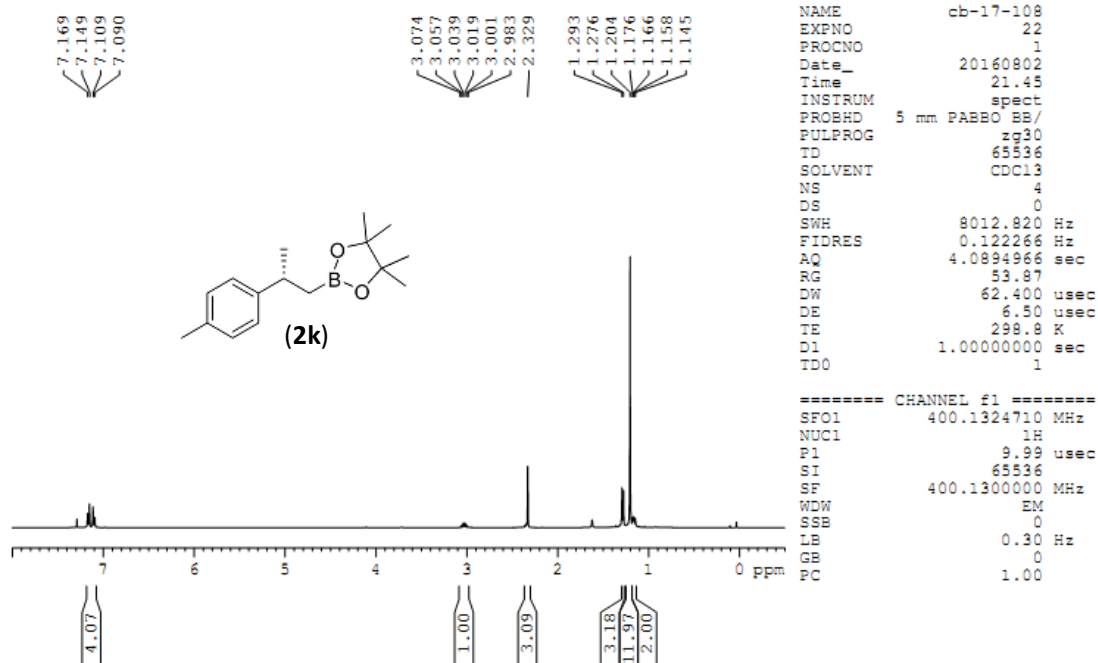
===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1      13C
P1         9.31 usec
SI         32768
SF         100.6127685 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40

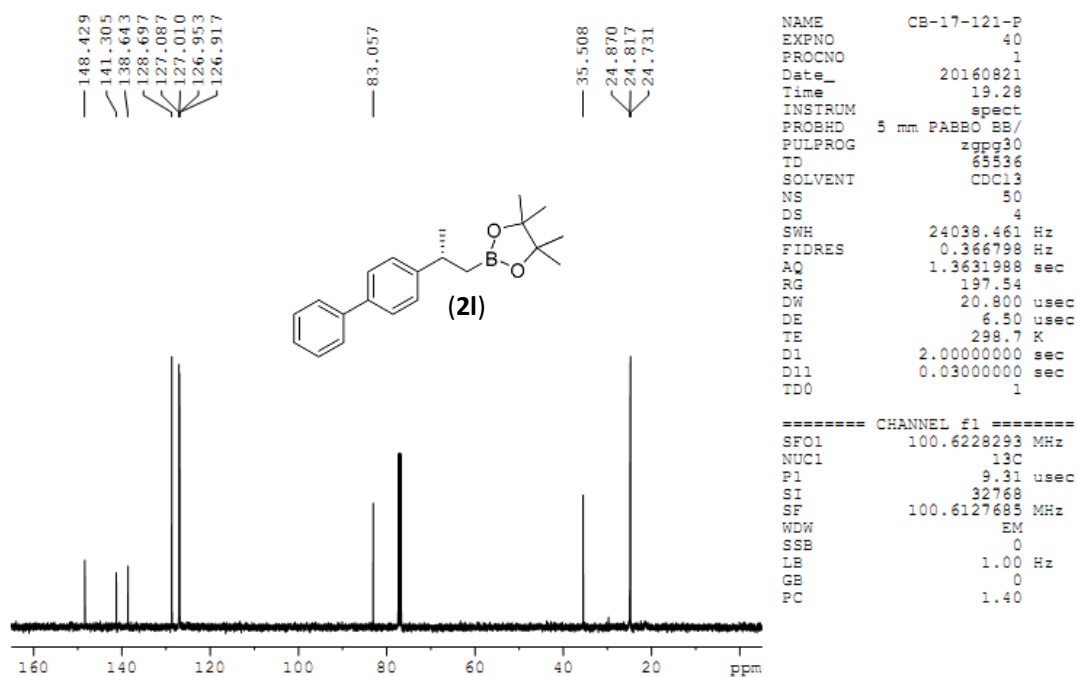
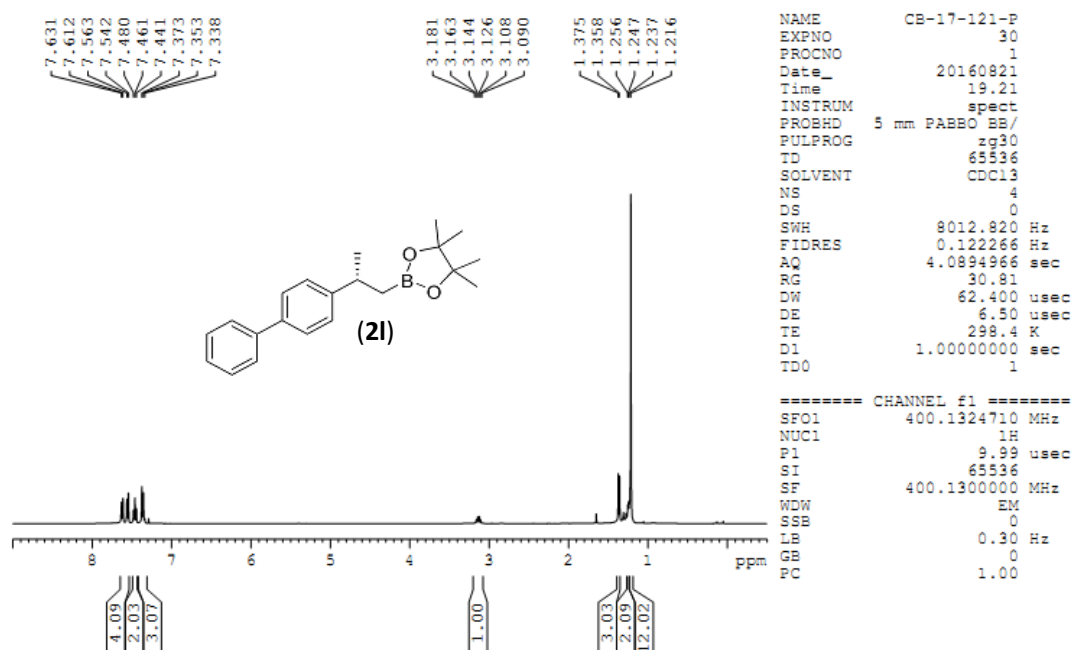
```

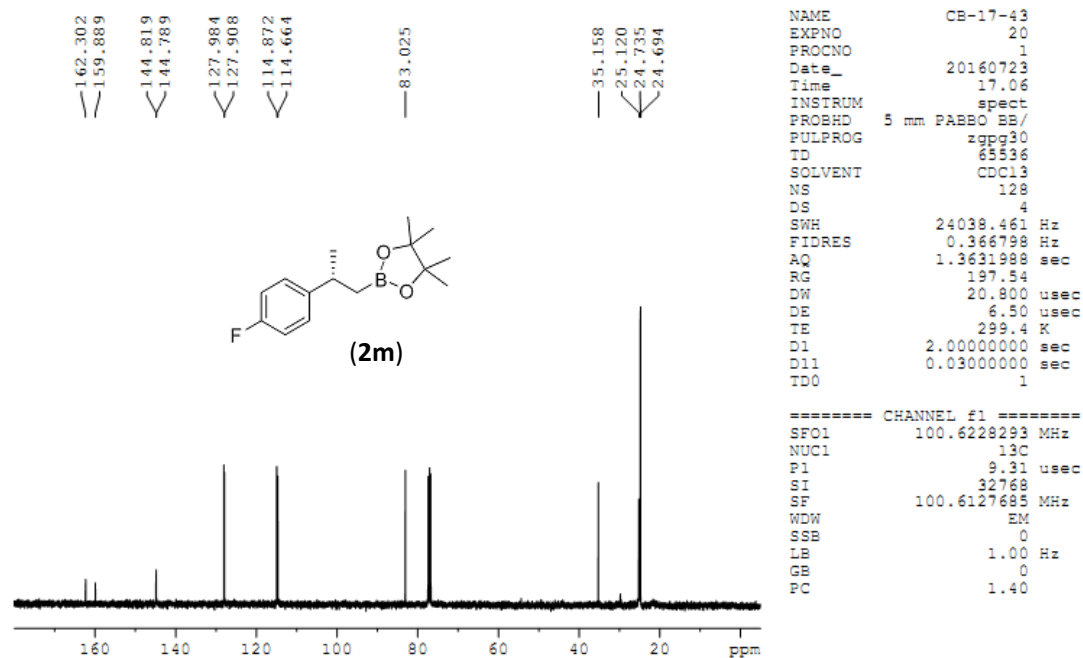
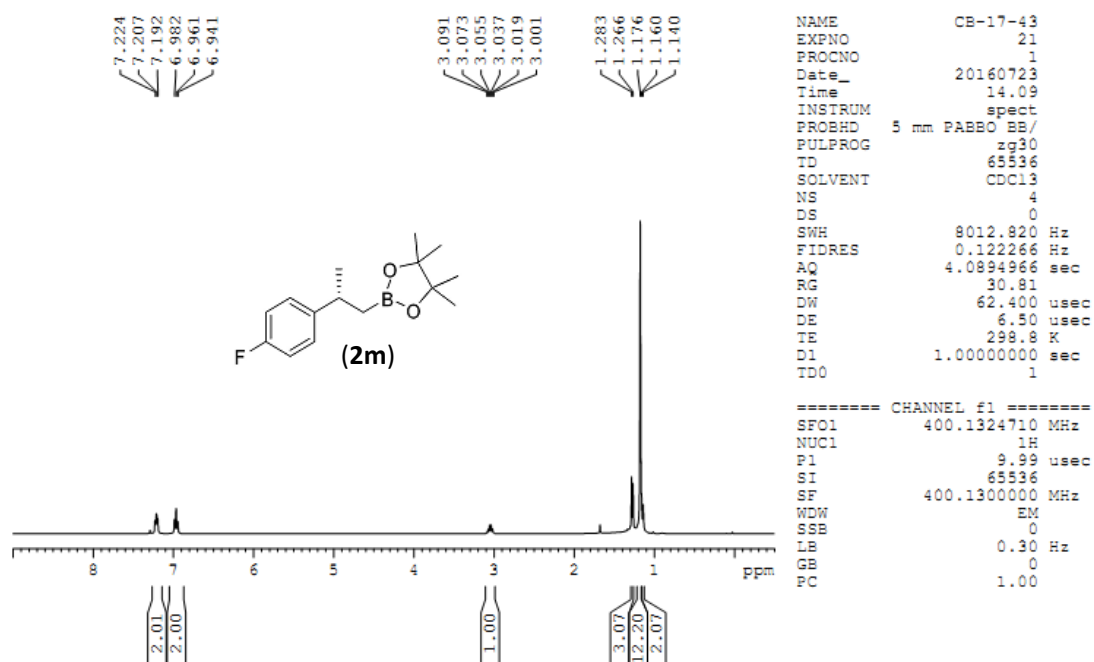


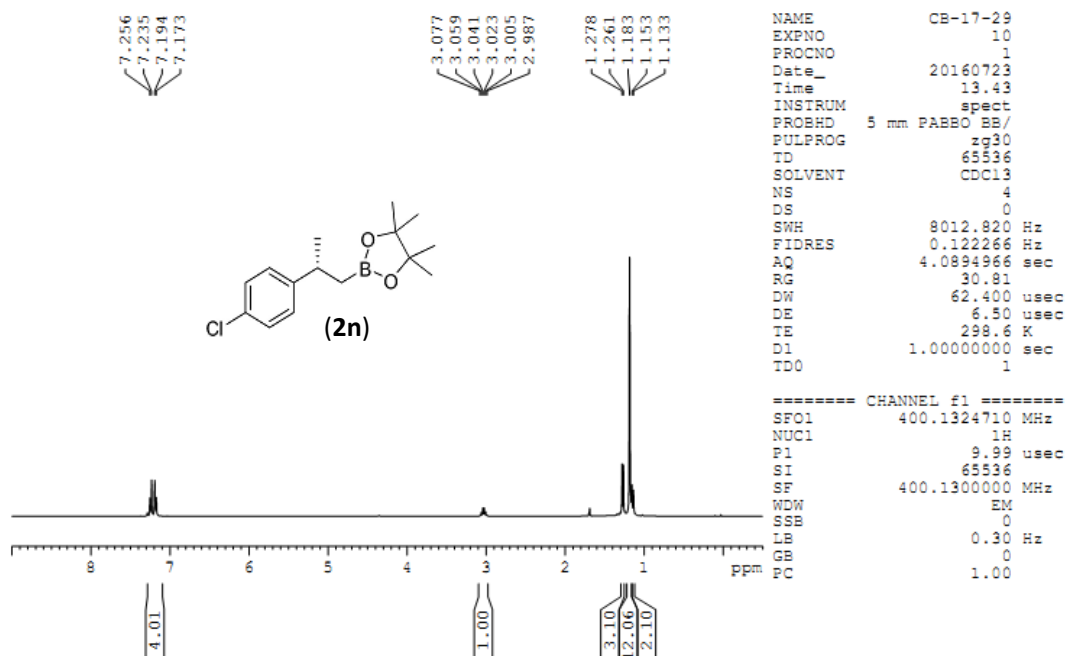
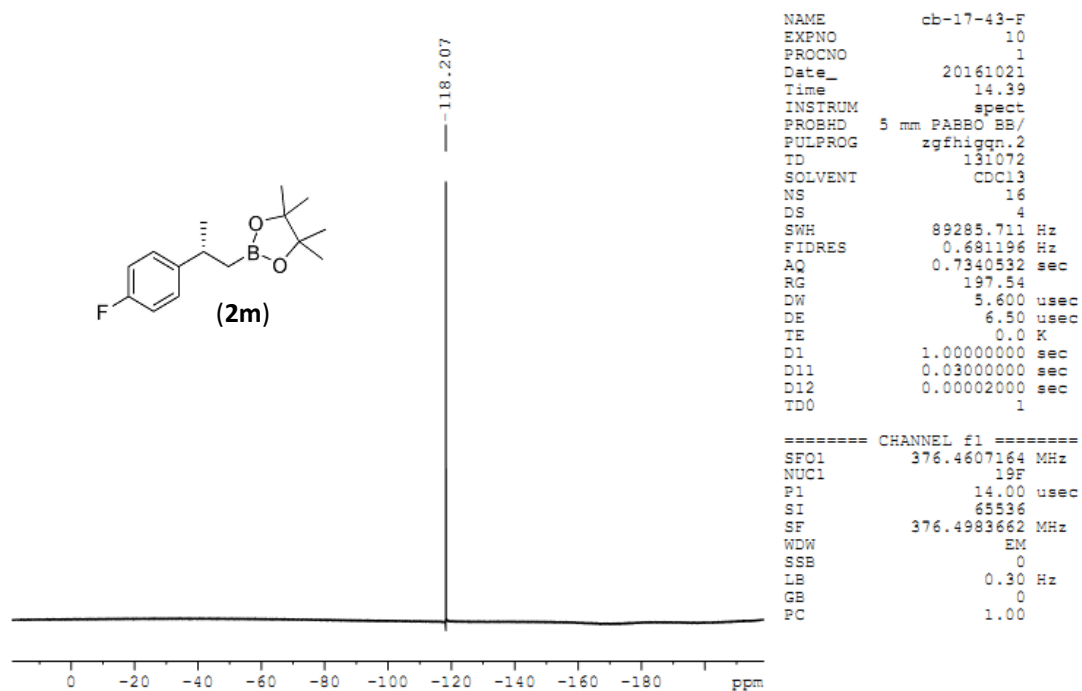


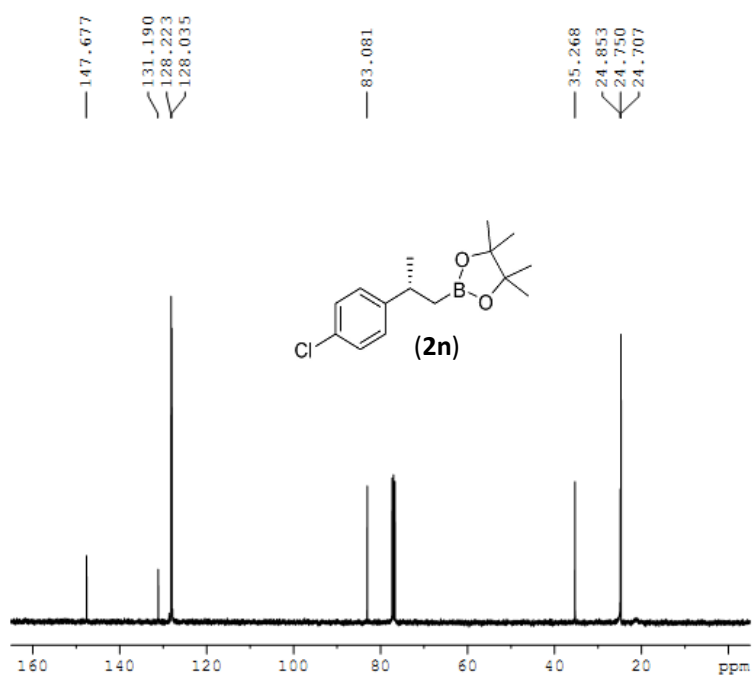












```

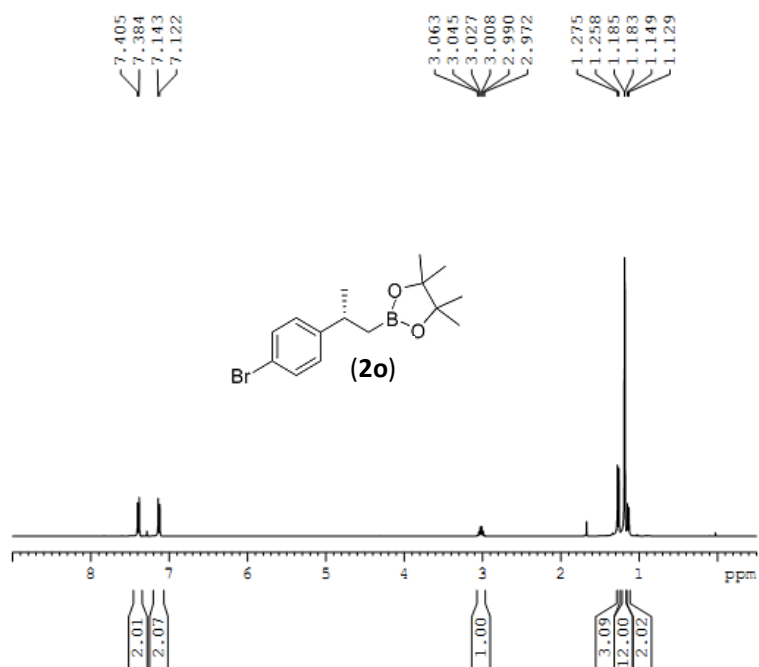
NAME      CB-17-29
EXPNO     20
PROCNO    1
Date_     20160723
Time      16.07
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD        65536
SOLVENT   CDCl3
NS         130
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         299.4 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1

```

```

===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1      13C
P1        9.31 usec
SI        32768
SF        100.6127695 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40

```



```

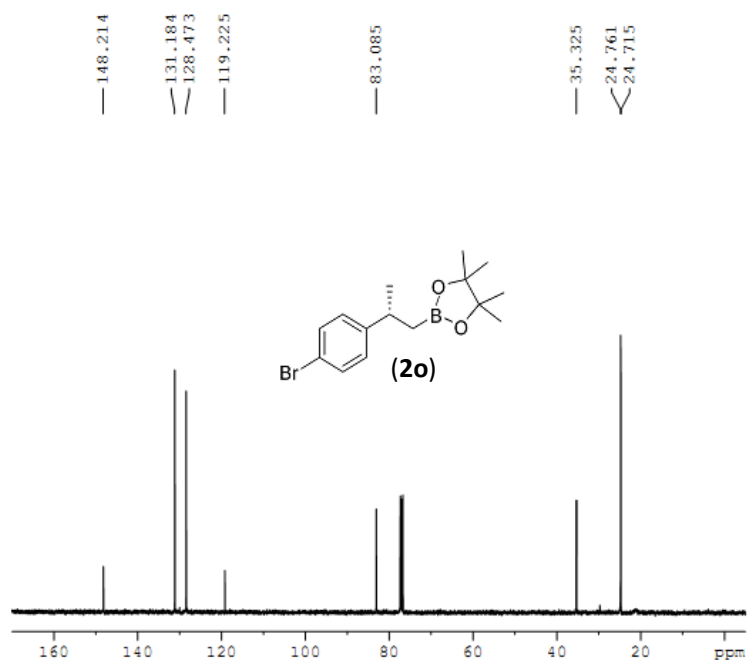
NAME      CB-17-41
EXPNO     10
PROCNO    1
Date_     20160723
Time      13.57
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zg30
TD        65536
SOLVENT   CDCl3
NS         4
DS         0
SWH        8012.820 Hz
FIDRES     0.122266 Hz
AQ         4.0894966 sec
RG         30.81
DW         62.400 usec
DE         6.50 usec
TE         298.8 K
D1         1.00000000 sec
TD0        1

```

```

===== CHANNEL f1 =====
SFO1      400.1324710 MHz
NUC1      1H
P1        9.99 usec
SI        65536
SF        400.1300000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00

```



```

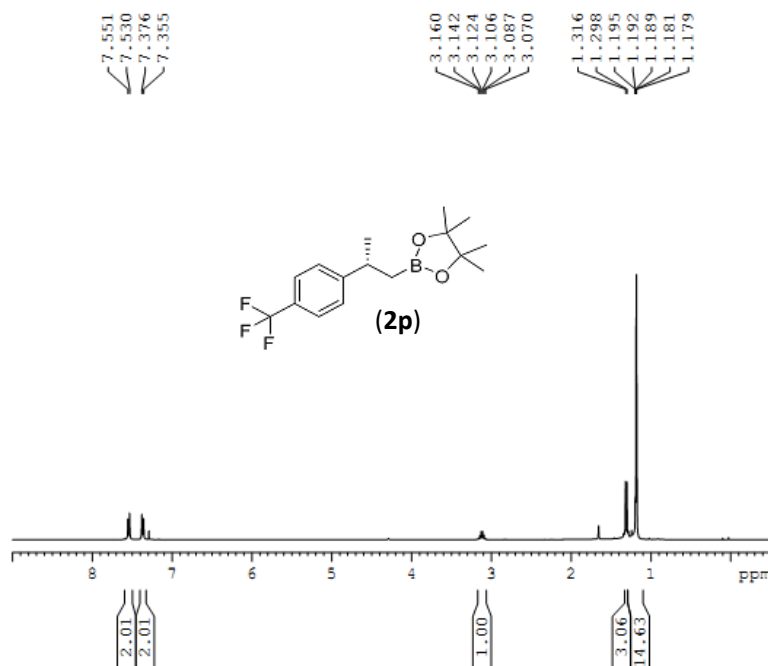
NAME      CB-17-41
EXPNO     20
PROCNO    1
Date_     20160723
Time      16.22
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         100
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         299.5 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1

```

```

===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1       13C
P1         9.31 usec
SI         32768
SF         100.6127685 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40

```



```

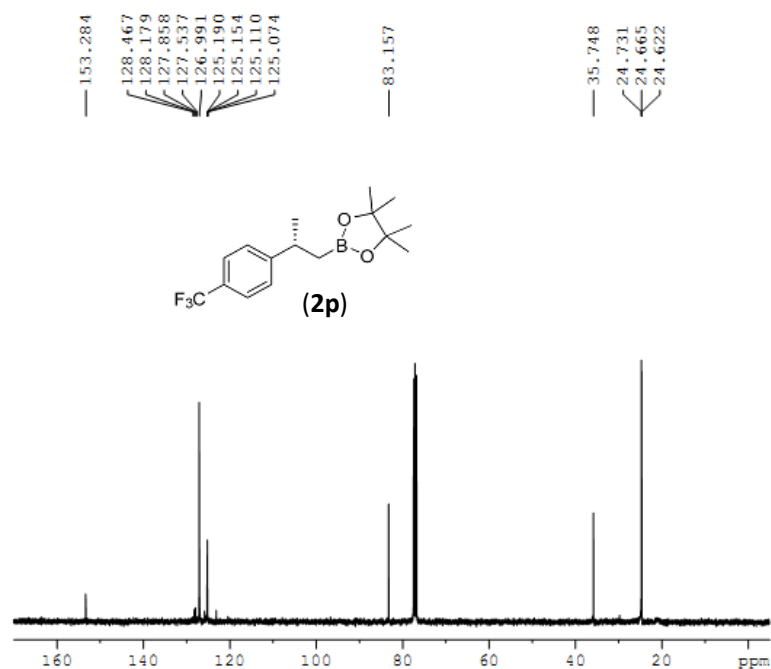
NAME      cb-19-210p-3
EXPNO     10
PROCNO    1
Date_     20170329
Time      11.25
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         4
DS         0
SWH        9012.920 Hz
FIDRES     0.122266 Hz
AQ         4.0894966 sec
RG         30.81
DW         62.400 usec
DE         6.50 usec
TE         297.8 K
D1         1.00000000 sec
TD0        1

```

```

===== CHANNEL f1 =====
SFO1      400.1324710 MHz
NUC1       1H
P1         9.99 usec
SI         65536
SF         400.1300000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00

```



```

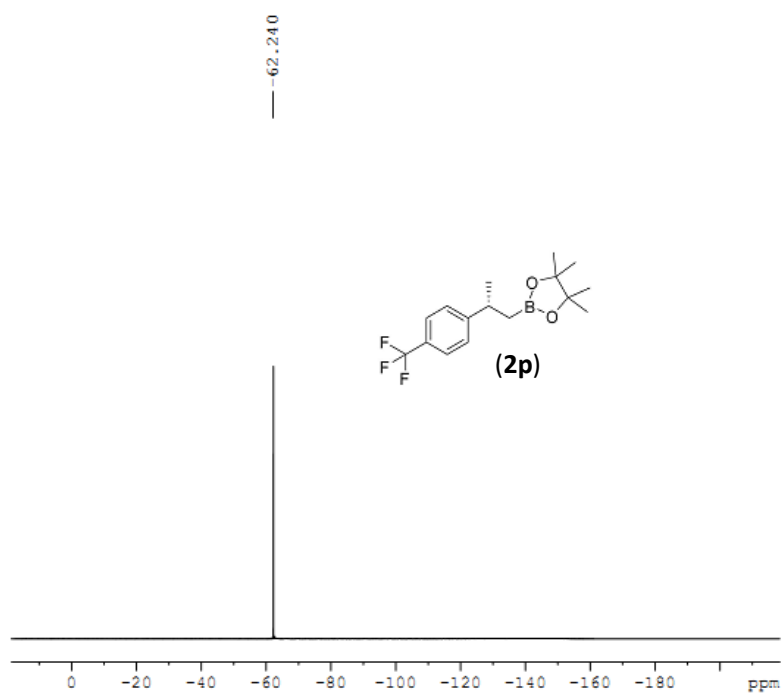
NAME      cb-19-210p-3-C
EXPNO     10
PROCNO    1
Date_     20170329
Time      14.16
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         300
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         298.8 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1

```

```

===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1       13C
P1         9.31 usec
SI         32768
SF         100.6127685 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40

```



```

NAME      cb-19-210p
EXPNO     11
PROCNO    1
Date_     20170327
Time      9.16
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgfhgqn.2
TD         131072
SOLVENT   CDCl3
NS         9
DS         4
SWH        89285.711 Hz
FIDRES     0.681196 Hz
AQ         0.7340532 sec
RG         197.54
DW         5.600 usec
DE         6.50 usec
TE         296.9 K
D1         1.00000000 sec
D11        0.03000000 sec
D12        0.00002000 sec
TD0        1

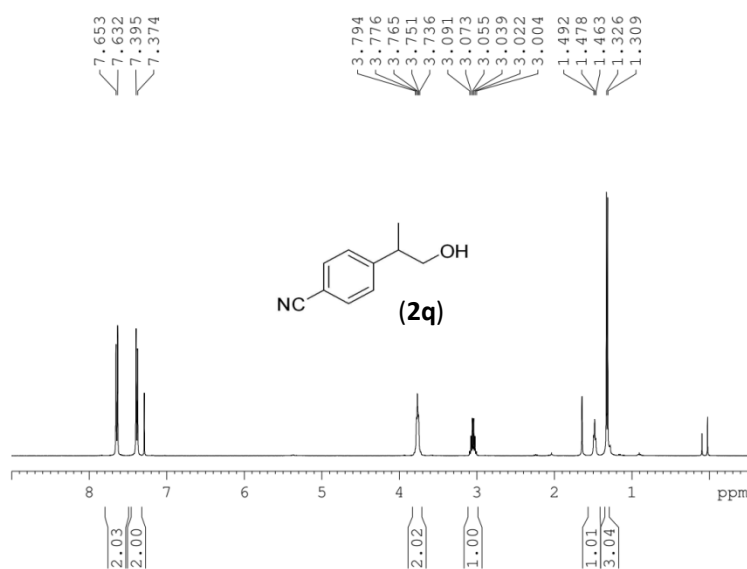
```

```

===== CHANNEL f1 =====
SFO1      376.4607164 MHz
NUC1       19F
P1         14.00 usec
SI         65536
SF         376.4983662 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00

```





```

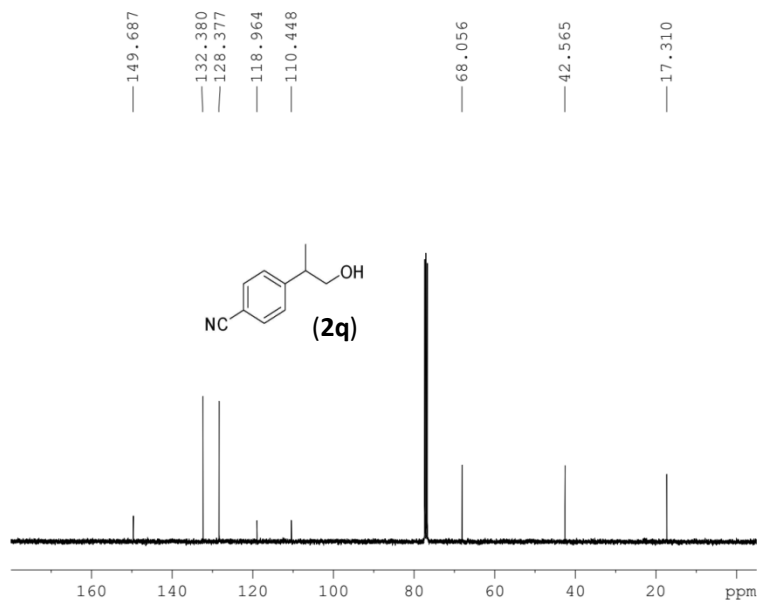
NAME      CB-CN-OH-P
EXPNO     10
PROCNO    1
Date_     20180207
Time      11.43
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zg30
TD         65536
SOLVENT   CDC13
NS         4
DS         0
SWH        8012.820 Hz
FIDRES     0.122266 Hz
AQ         4.0894966 sec
RG         78.29
DW         62.400 usec
DE         6.50 usec
TE         0.0 K
D1         1.00000000 sec
TD0        1

```

```

===== CHANNEL f1 =====
SFO1      400.1324710 MHz
NUC1       1H
P1         9.99 usec
SI         65536
SF         400.1300000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00

```



```

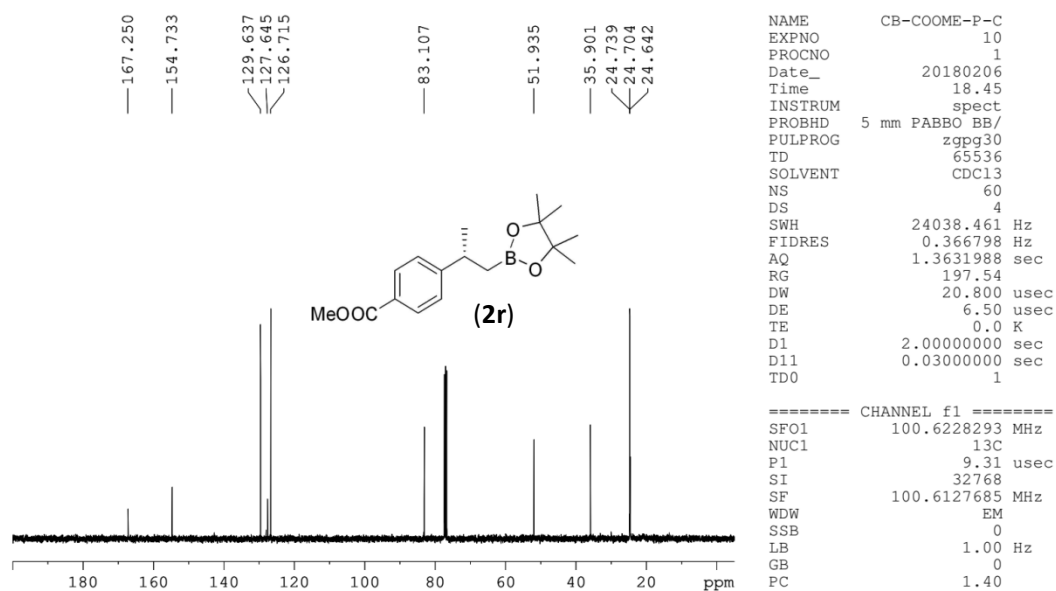
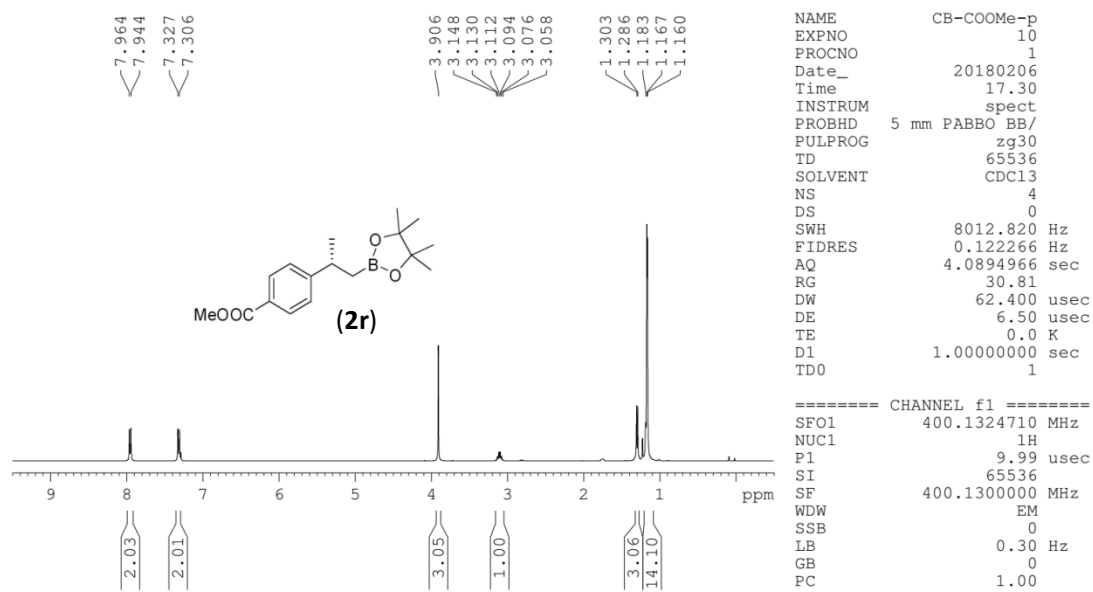
NAME      CB-CN-OH-P
EXPNO     11
PROCNO    1
Date_     20180207
Time      11.45
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD         65536
SOLVENT   CDC13
NS         256
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         0.0 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1

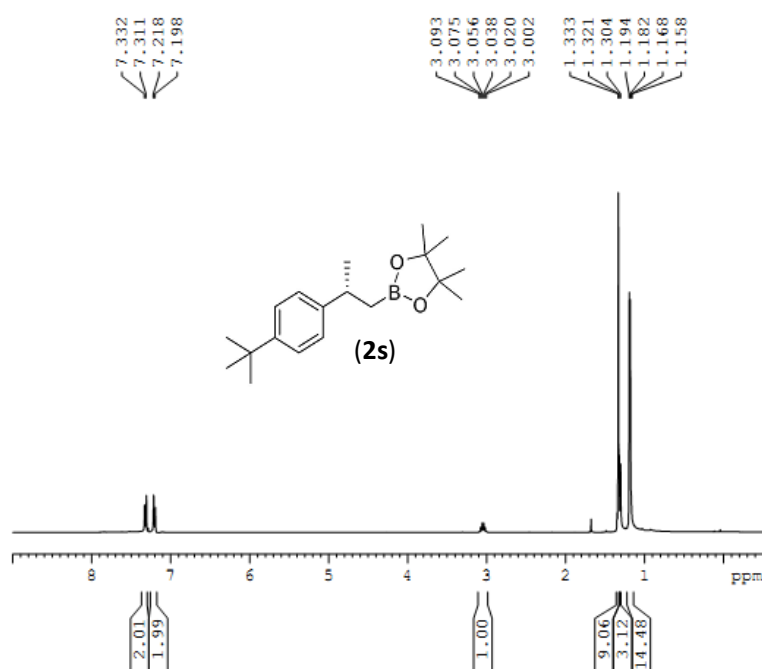
```

```

===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1       13C
P1         9.31 usec
SI         32768
SF         100.6127685 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40

```





```

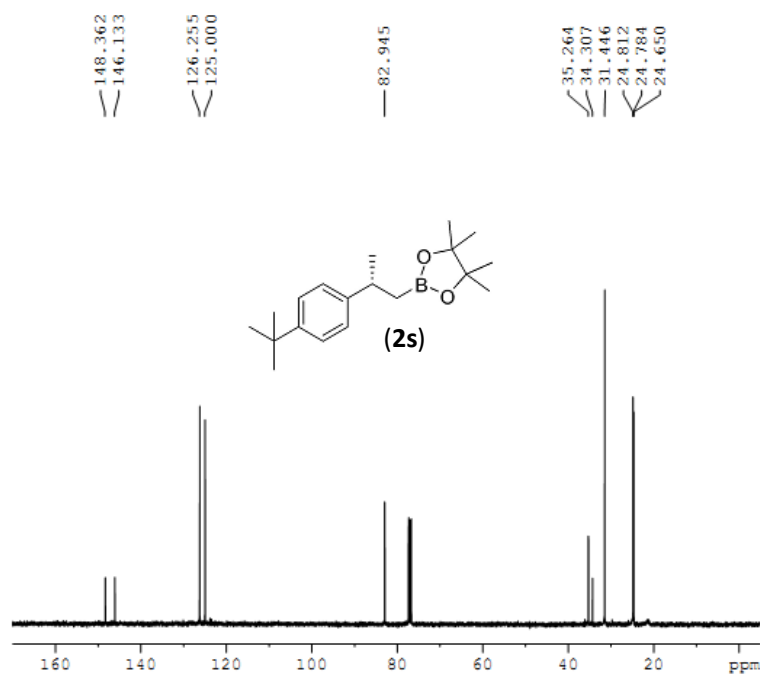
NAME      CB-17-42
EXPNO     10
PROCNO    1
Date_     20160723
Time      14.02
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         4
DS         0
SWH        8012.920 Hz
FIDRES     0.122266 Hz
AQ         4.0894966 sec
RG         17.39
DW         62.400 usec
DE         6.50 usec
TE         298.7 K
D1         1.00000000 sec
TD0        1

```

```

===== CHANNEL f1 =====
SFO1      400.1324710 MHz
NUC1       1H
P1         9.99 usec
SI         65536
SF         400.1300000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00

```



```

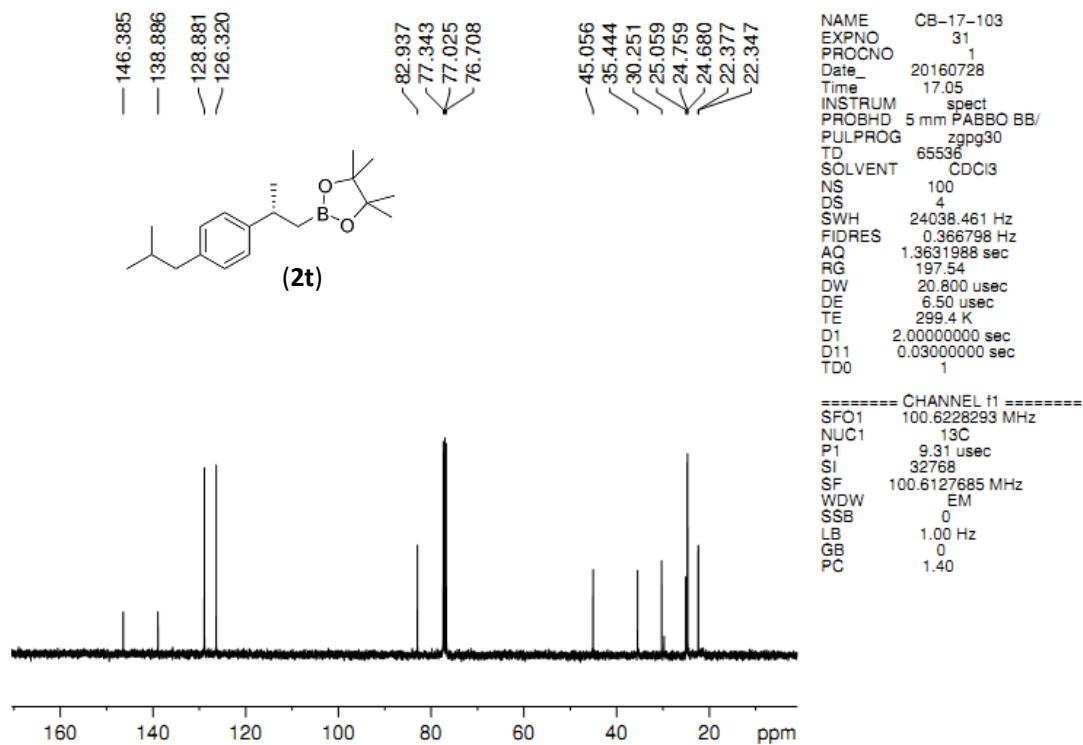
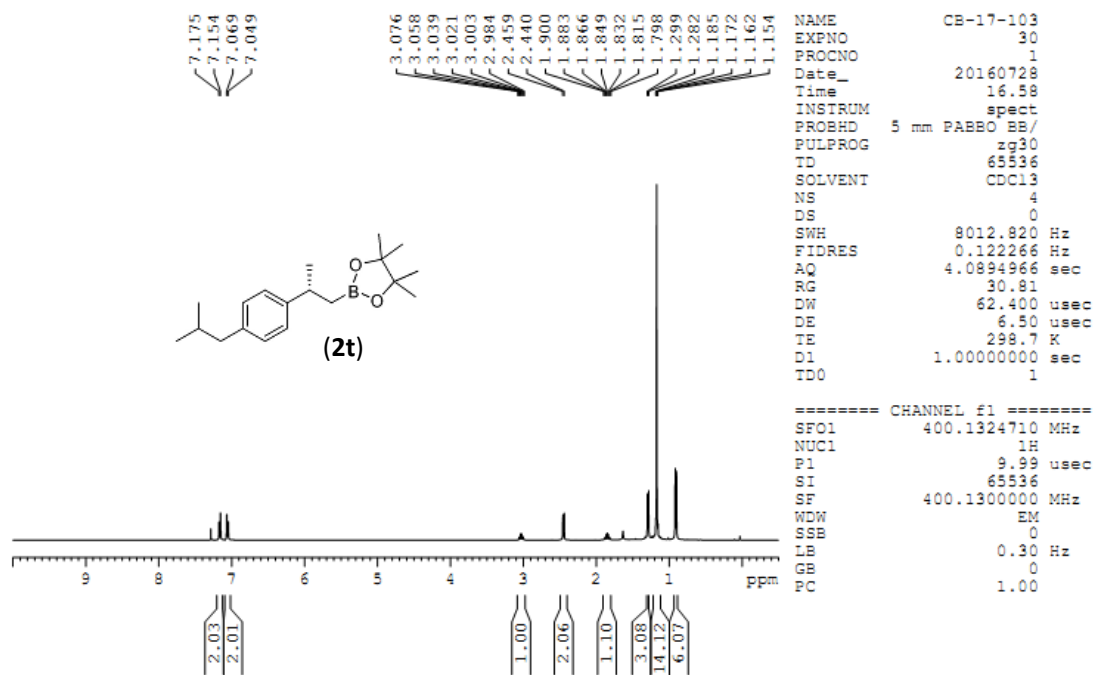
NAME      CB-17-42
EXPNO     20
PROCNO    1
Date_     20160723
Time      16.33
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         100
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         299.5 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1

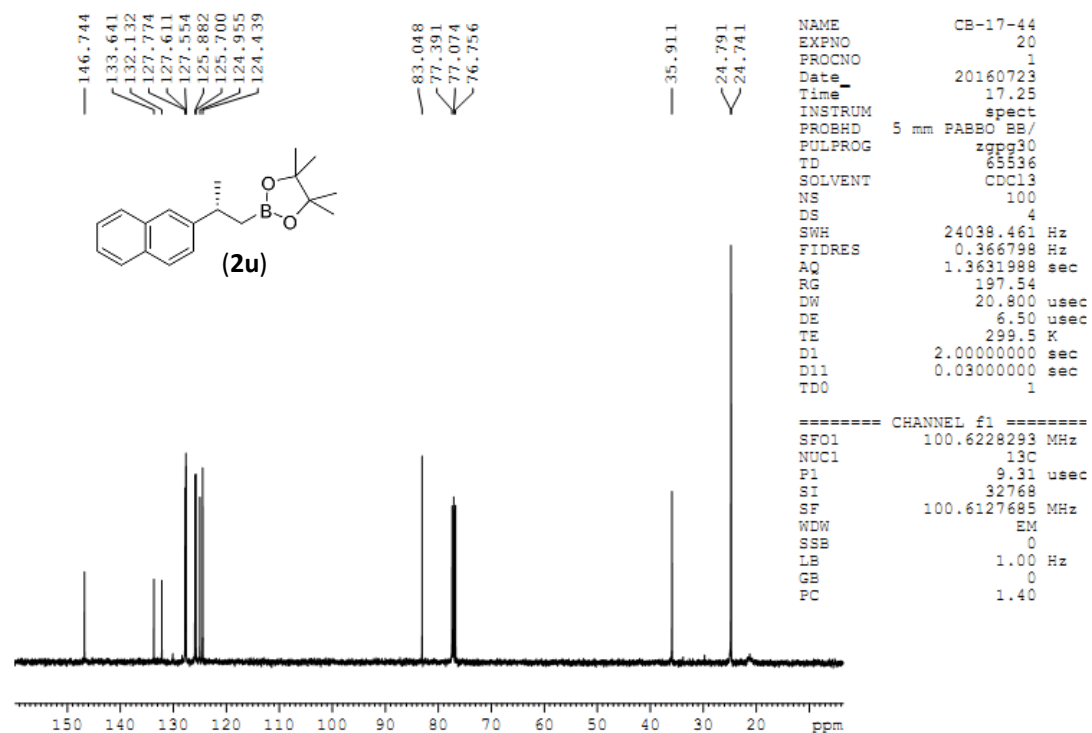
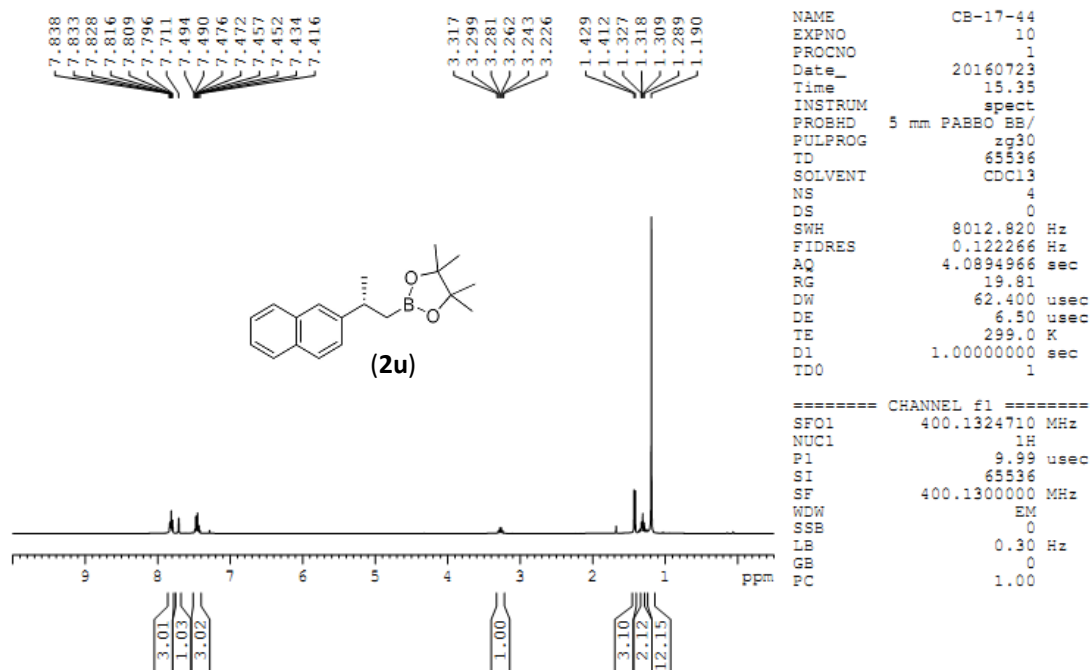
```

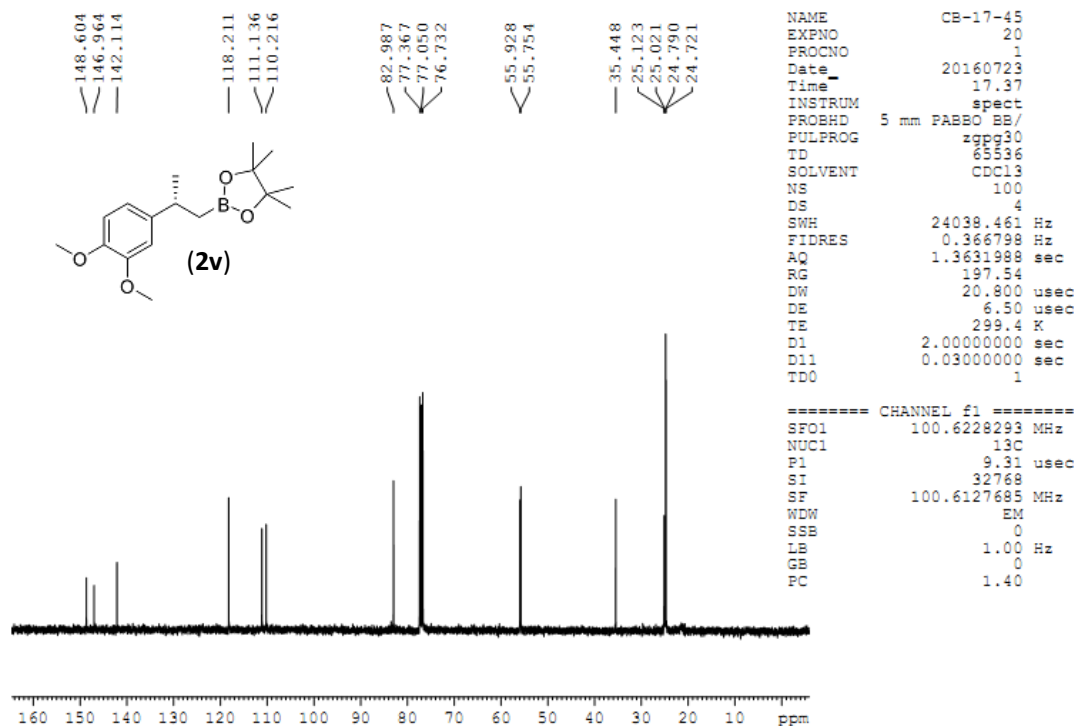
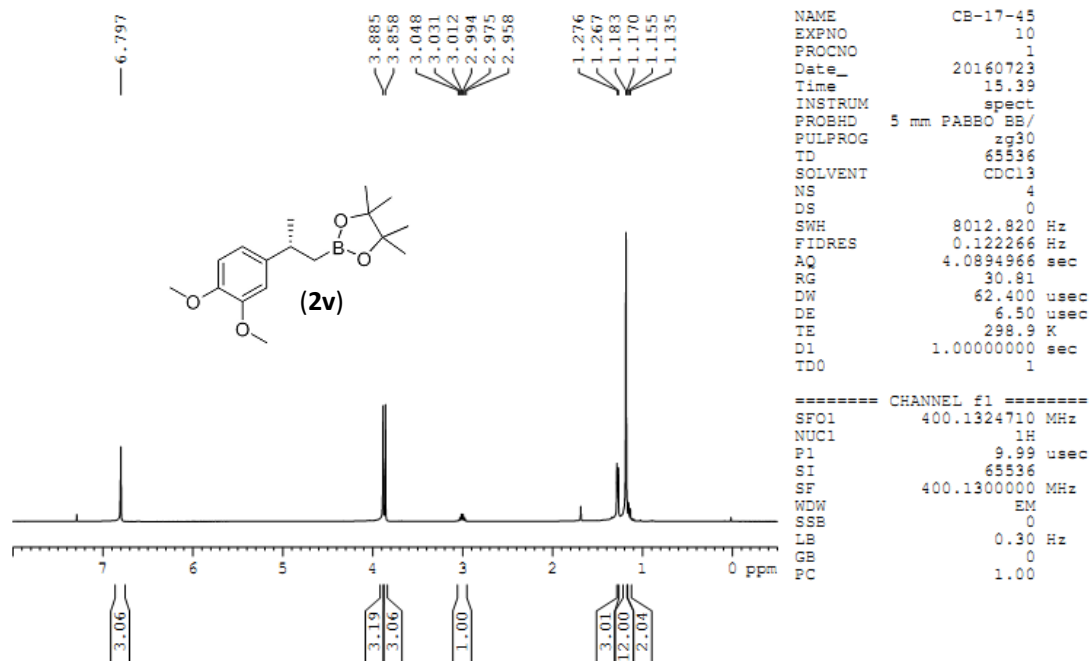
```

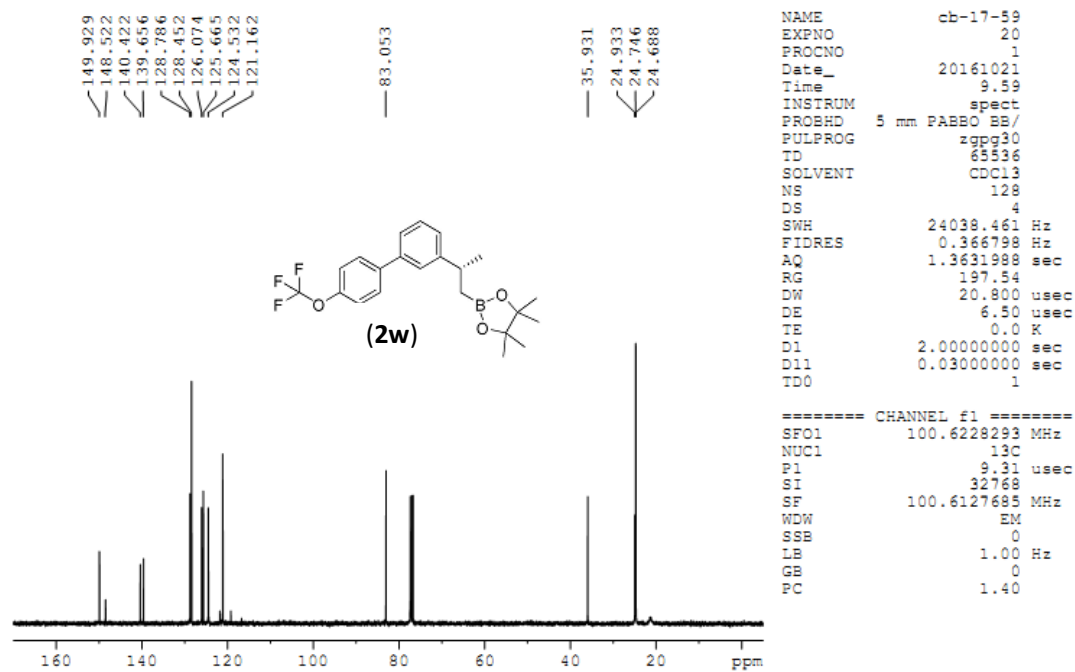
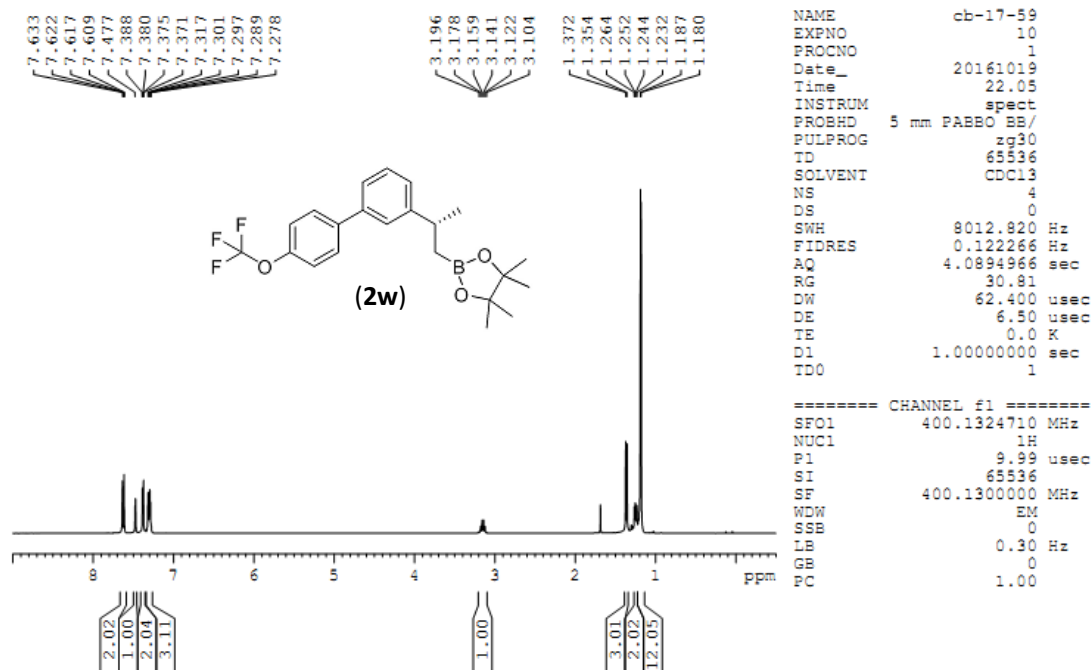
===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1      13C
P1         9.31 usec
SI         32768
SF         100.6127685 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40

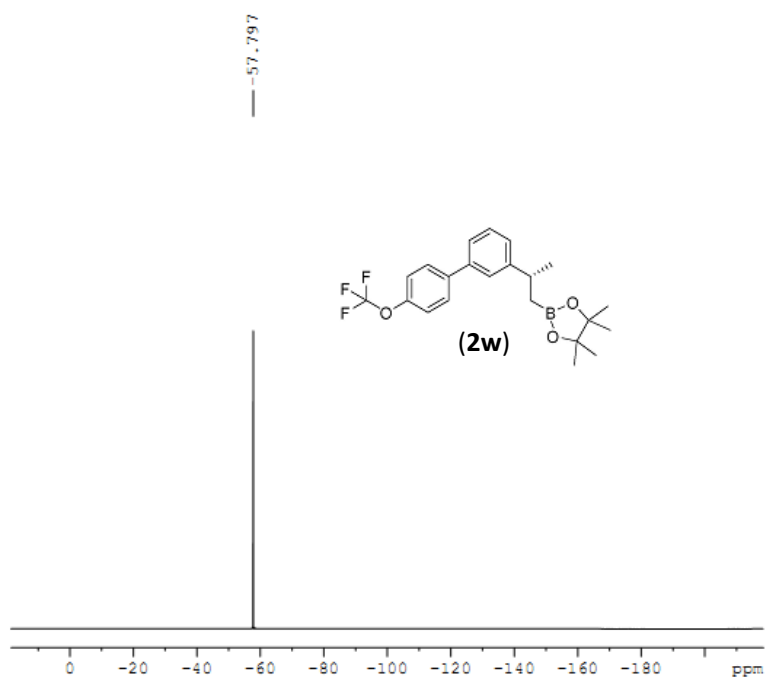
```









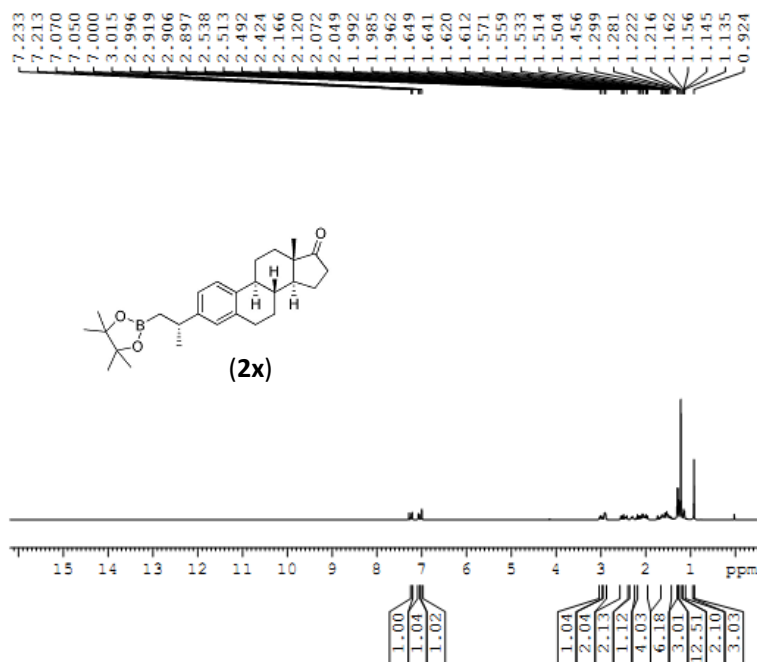


```

NAME          cb-17-59
EXPNO         21
PROCNO        1
Date_         20161021
Time          10.01
INSTRUM       spect
PROBHD        5 mm PABBO BB/
PULPROG       zgfhigqn.2
TD            131072
SOLVENT       CDCl3
NS            16
DS            4
SWH           89285.711 Hz
FIDRES        0.681196 Hz
AQ            0.7340532 sec
RG            197.54
DW            5.600 usec
DE            6.50 usec
TE            0.0 K
D1            1.00000000 sec
D11           0.03000000 sec
D12           0.00002000 sec
TD0           1

===== CHANNEL f1 =====
SFO1          376.4607164 MHz
NUC1          13F
P1            14.00 usec
SI            65536
SF            376.4983662 MHz
WDW           EM
SSB           0
LB            0.30 Hz
GB            0
PC            1.00

```



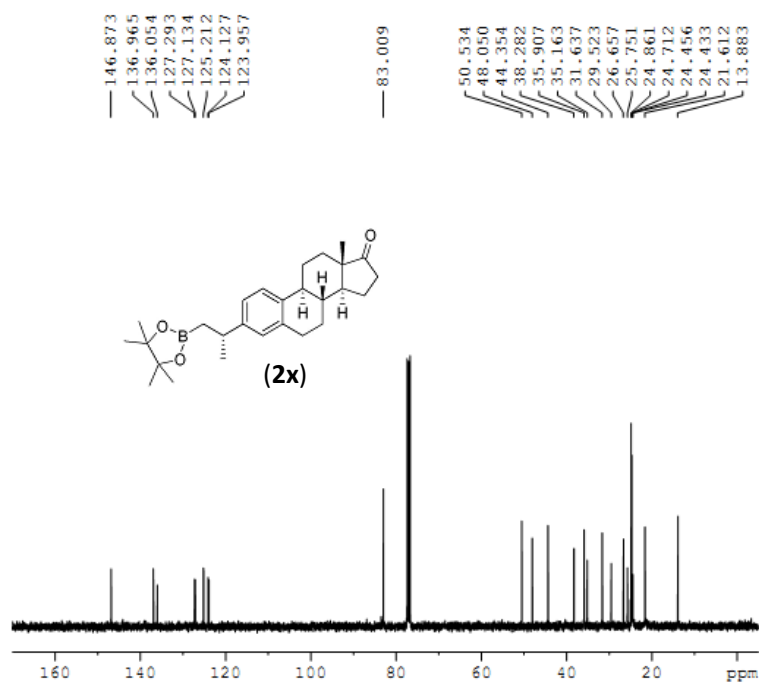
```

NAME          cb-19-205p
EXPNO         10
PROCNO        1
Date_         20170316
Time          11.12
INSTRUM       spect
PROBHD        5 mm PABBO BB/
PULPROG       zg30
TD            65536
SOLVENT       CDCl3
NS            4
DS            0
SWH           8012.820 Hz
FIDRES        0.122266 Hz
AQ            4.0894966 sec
RG            30.81
DW            62.400 usec
DE            6.50 usec
TE            297.0 K
D1            1.00000000 sec
TD0           1

===== CHANNEL f1 =====
SFO1          400.1324710 MHz
NUC1          1H
P1            9.99 usec
SI            65536
SF            400.1300000 MHz
WDW           EM
SSB           0
LB            0.30 Hz
GB            0
PC            1.00

```



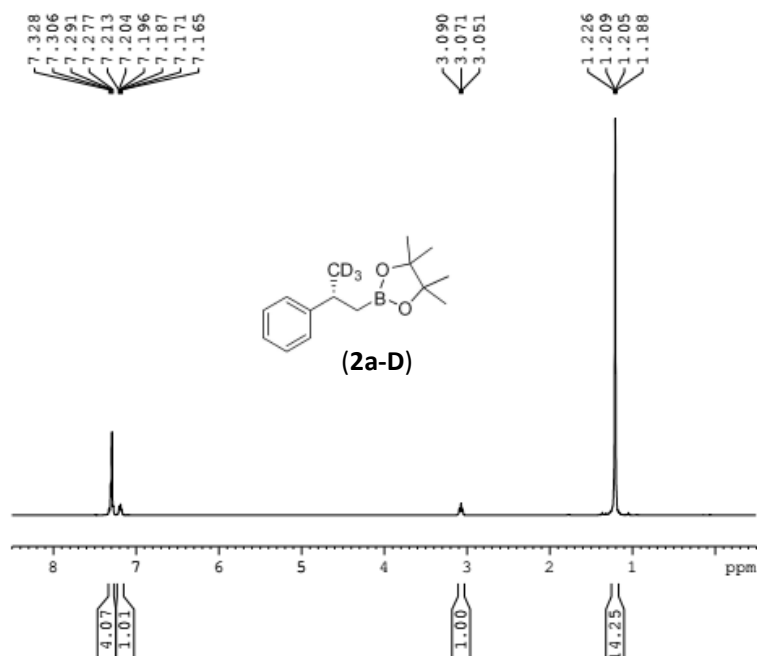


```

NAME      cb-19-205p-C
EXPNO     10
PROCNO    1
Date_     20170316
Time      14.45
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         100
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         298.0 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1

===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1      13C
P1         9.31 usec
SI         32768
SF         100.6127685 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40

```

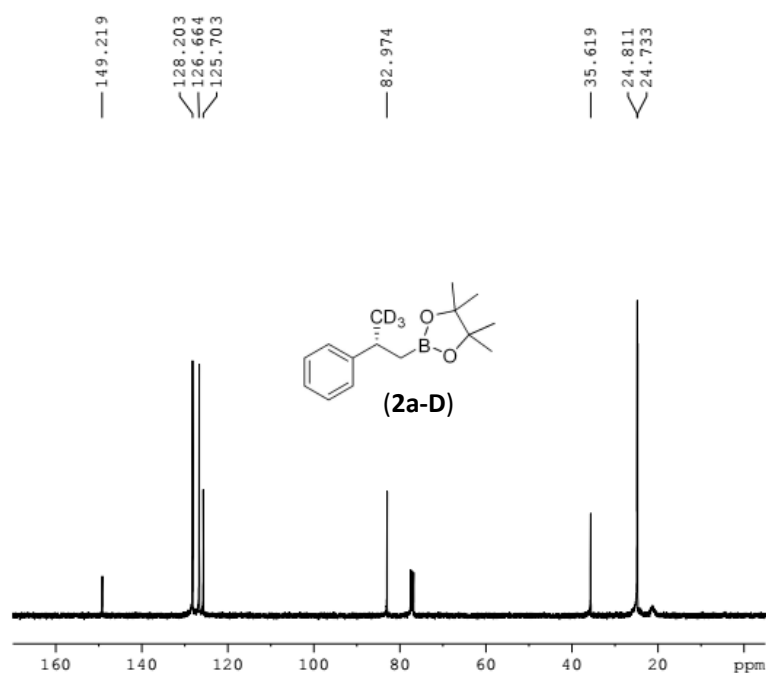


```

NAME      CB-19-216p
EXPNO     10
PROCNO    1
Date_     20170517
Time      9.15
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         4
DS         0
SWH        8012.820 Hz
FIDRES     0.122266 Hz
AQ         4.0894966 sec
RG         8.85
DW         62.400 usec
DE         6.50 usec
TE         300.7 K
D1         1.00000000 sec
TD0        1

----- CHANNEL f1 -----
SFO1      400.1324710 MHz
NUC1      1H
P1         9.99 usec
SI         65536
SF         400.1300000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00

```

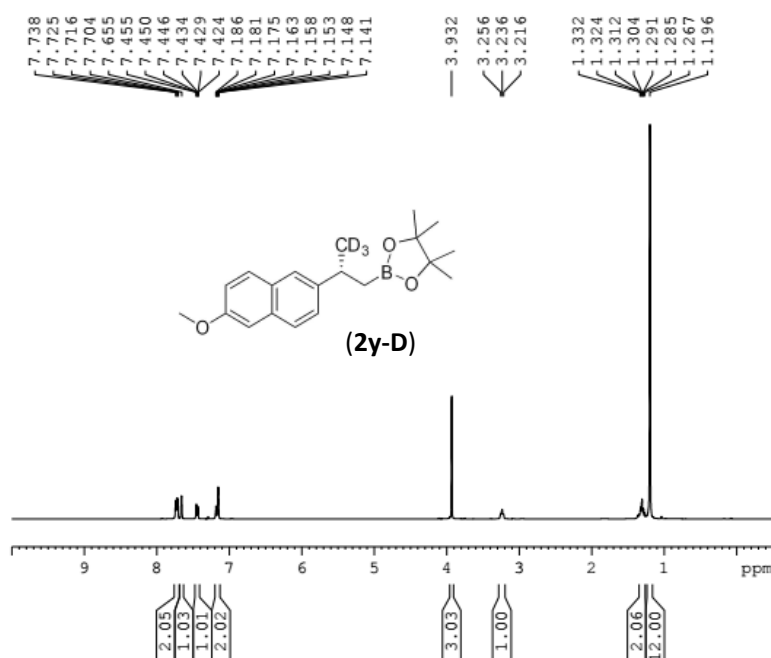


```

NAME      CB-19-216P-C
EXPNO     10
PROCNO    1
Date_     20170522
Time      21.08
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         88
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         301.1 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1

===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1       13C
P1         9.31 usec
SI         32768
SF         100.6127685 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40

```

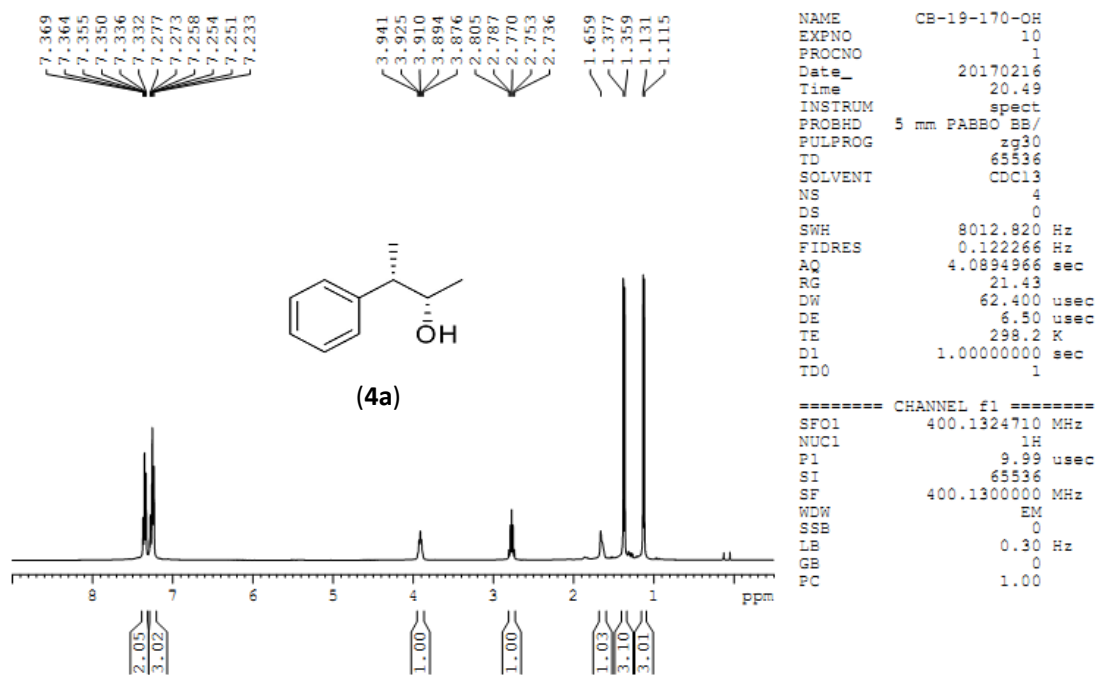
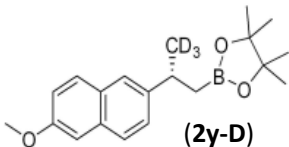


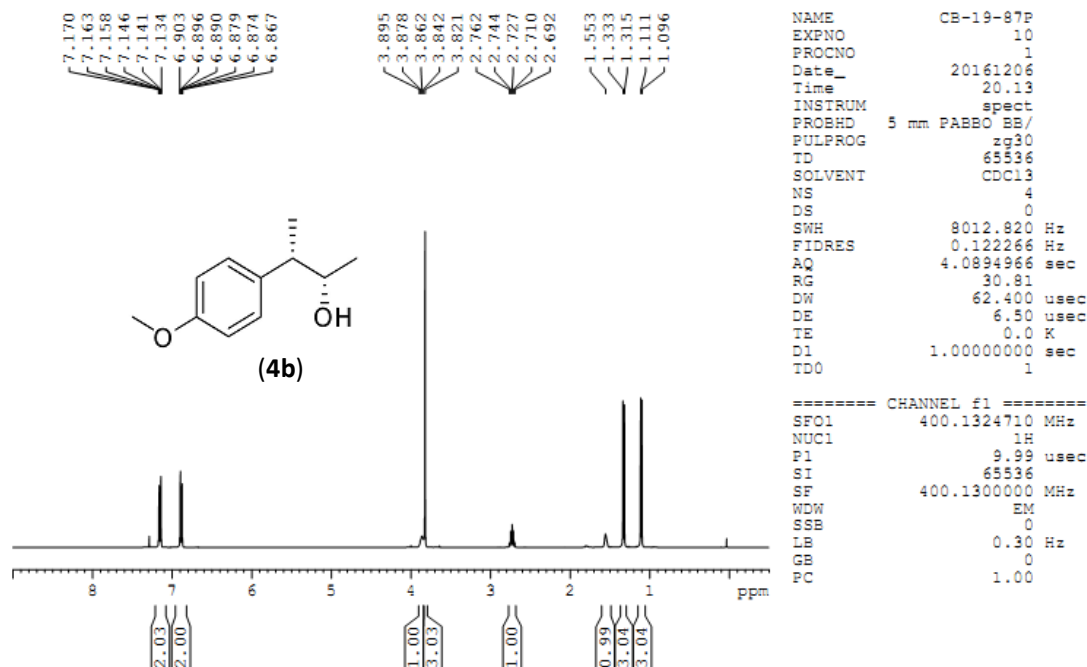
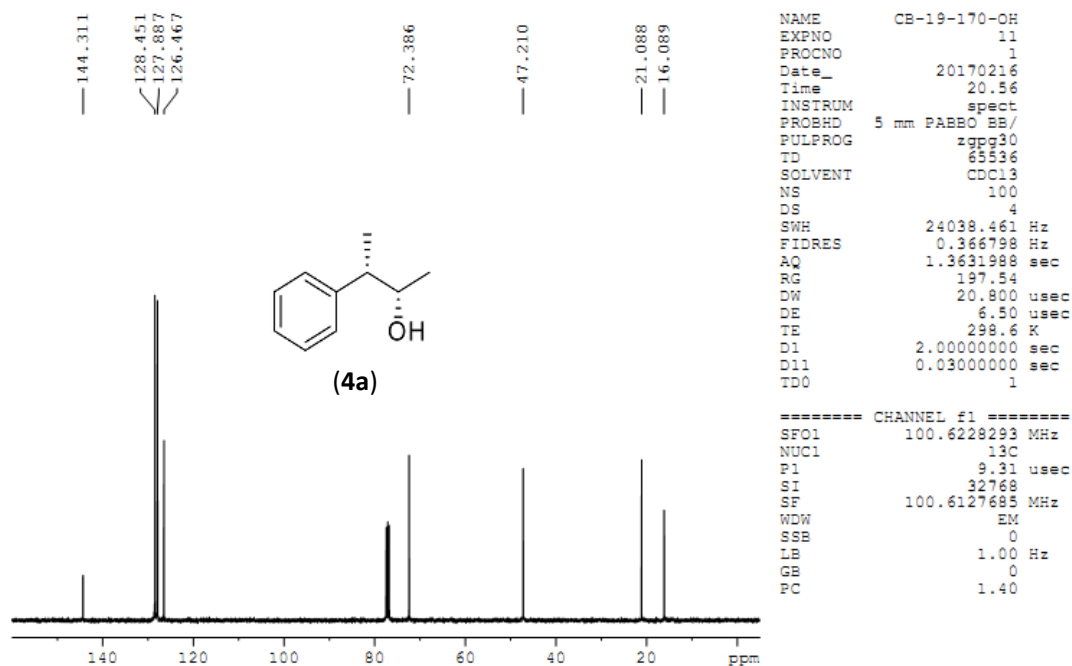
```

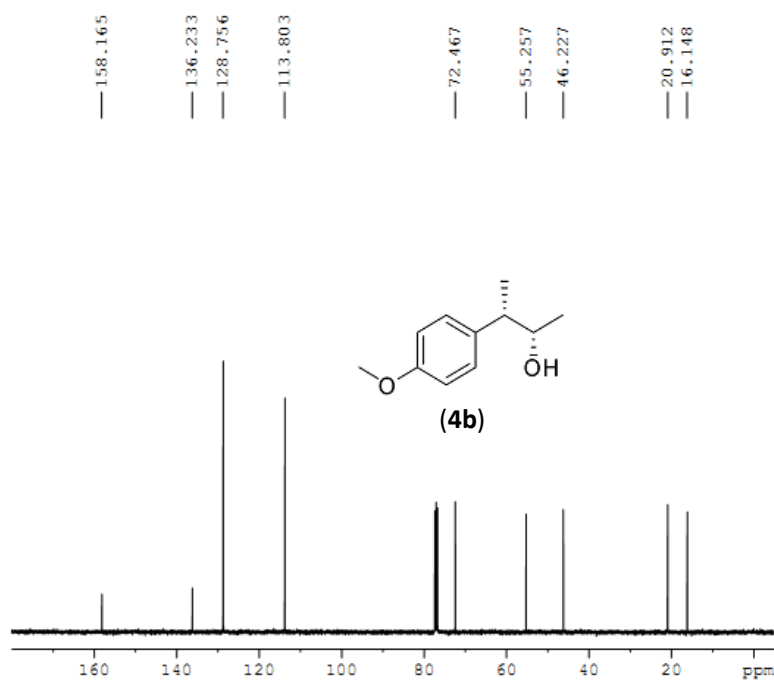
NAME      CB-19-218p
EXPNO     10
PROCNO    1
Date_     20170517
Time      9.18
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         4
DS         0
SWH        8012.820 Hz
FIDRES     0.122266 Hz
AQ         4.0894966 sec
RG         7.74
DW         62.400 usec
DE         6.50 usec
TE         300.7 K
D1         1.00000000 sec
TD0        1

===== CHANNEL f1 =====
SFO1      400.1324710 MHz
NUC1       1H
P1         9.99 usec
SI         65536
SF         400.1300000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00

```





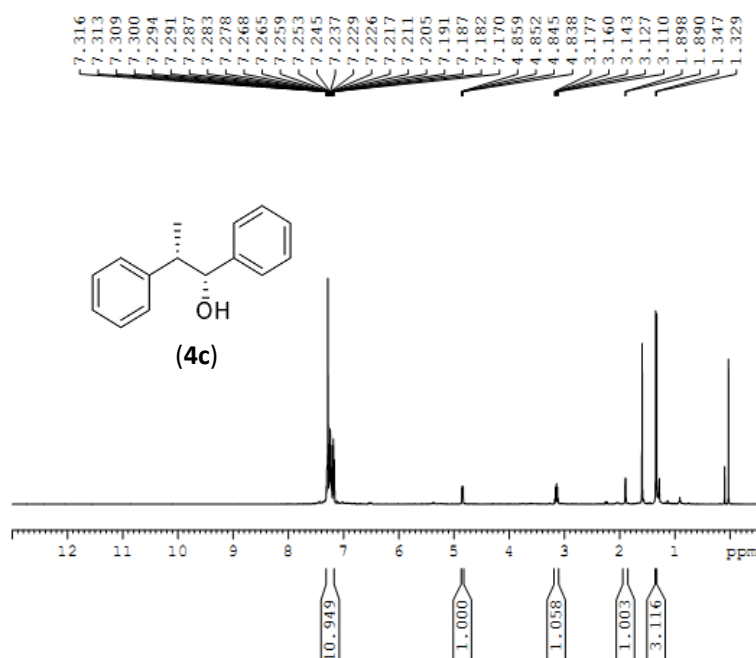


```

NAME      cb-19-87p-C
EXPNO     10
PROCNO    1
Date_     20161207
Time      17.18
INSTRUM    spect
PROBHD     5 mm PABBO BB/
PULPROG    zgpg30
TD         65536
SOLVENT    CDCl3
NS         78
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         0.0 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
  
```

```

===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1       13C
P1         9.31 usec
SI         32768
SF         100.6127685 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```

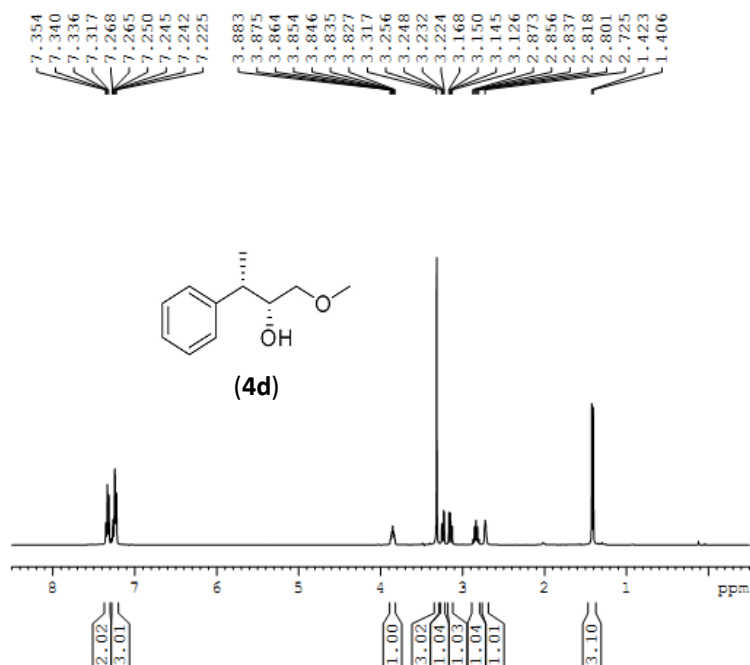
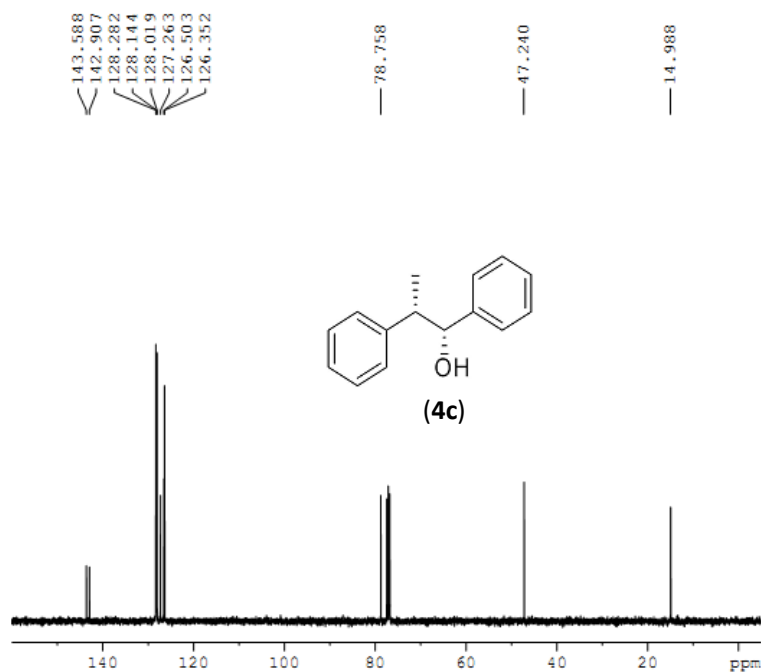


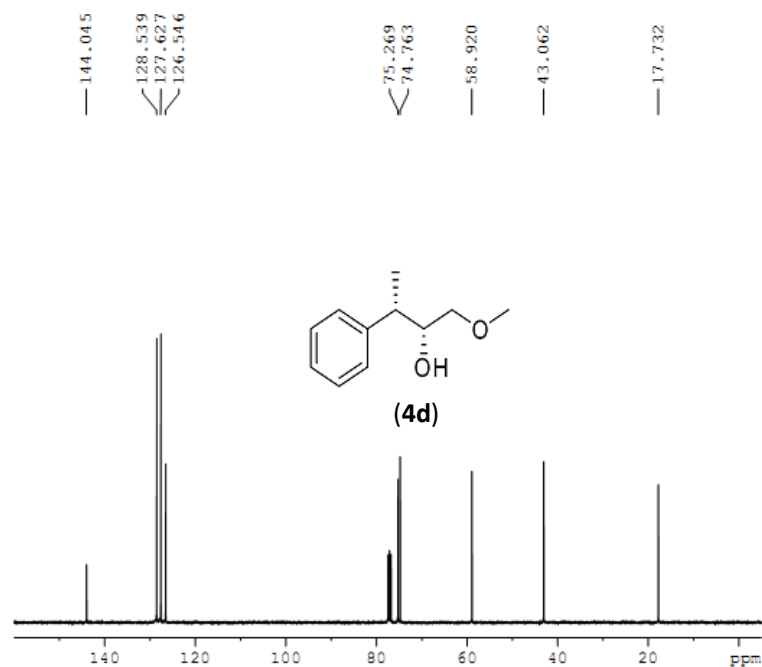
```

NAME      cb-19-88p
EXPNO     10
PROCNO    1
Date_     20161207
Time      17.10
INSTRUM    spect
PROBHD     5 mm PABBO BB/
PULPROG    zg30
TD         65536
SOLVENT    CDCl3
NS         4
DS         0
SWH        8012.820 Hz
FIDRES     0.122266 Hz
AQ         4.0894966 sec
RG         98.98
DW         62.400 usec
DE         6.50 usec
TE         0.0 K
D1         1.00000000 sec
TD0        1
  
```

```

===== CHANNEL f1 =====
SFO1      400.1324710 MHz
NUC1       1H
P1         9.99 usec
SI         65536
SF         400.1300000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



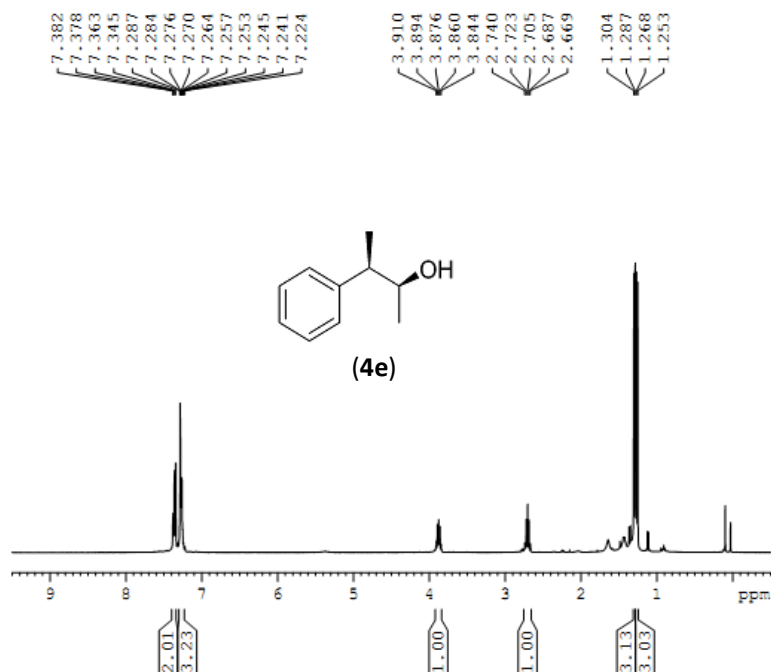


```

NAME      cb-19-146-OH
EXPNO     20
PROCNO    1
Date_     20170117
Time      17.35
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD        65536
SOLVENT   CDCl3
NS         80
DS         4
SWH       24038.461 Hz
FIDRES    0.366798 Hz
AQ        1.3631988 sec
RG        197.54
DW        20.800 usec
DE        6.50 usec
TE        0.0 K
D1        2.00000000 sec
D11       0.03000000 sec
TD0       1
  
```

```

===== CHANNEL f1 =====
SFO1    100.6228293 MHz
NUC1     13C
P1       9.31 usec
SI       32768
SF       100.6127685 MHz
WDW      EM
SSB      0
LB       1.00 Hz
GB       0
PC       1.40
  
```

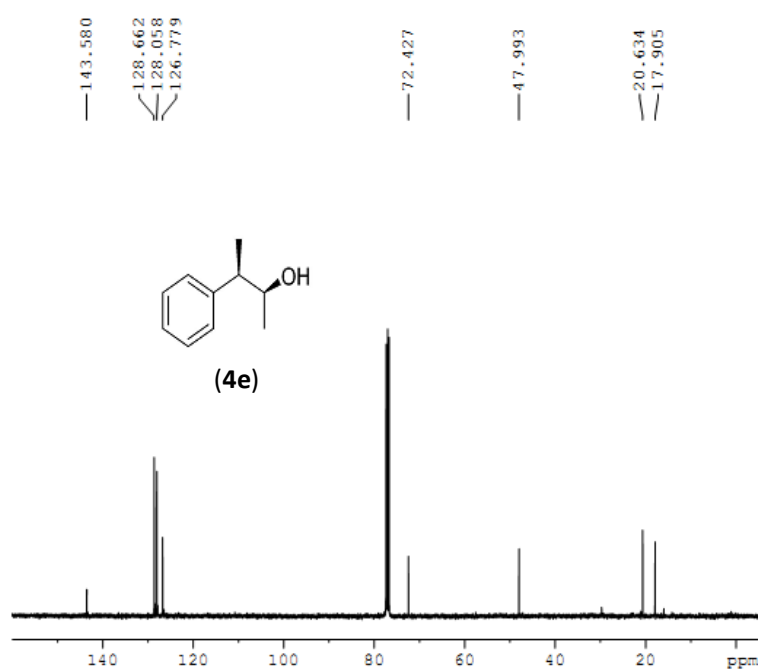


```

NAME      cb-19-115-OH
EXPNO     10
PROCNO    1
Date_     20161224
Time      13.50
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zg30
TD        65536
SOLVENT   CDCl3
NS         4
DS         0
SWH       8012.820 Hz
FIDRES    0.122266 Hz
AQ        4.0894966 sec
RG        71.18
DW        62.400 usec
DE        6.50 usec
TE        0.0 K
D1        1.00000000 sec
TD0       1
  
```

```

===== CHANNEL f1 =====
SFO1    400.1324710 MHz
NUC1     1H
P1       9.99 usec
SI       65536
SF       400.1300000 MHz
WDW      EM
SSB      0
LB       0.30 Hz
GB       0
PC       1.00
  
```

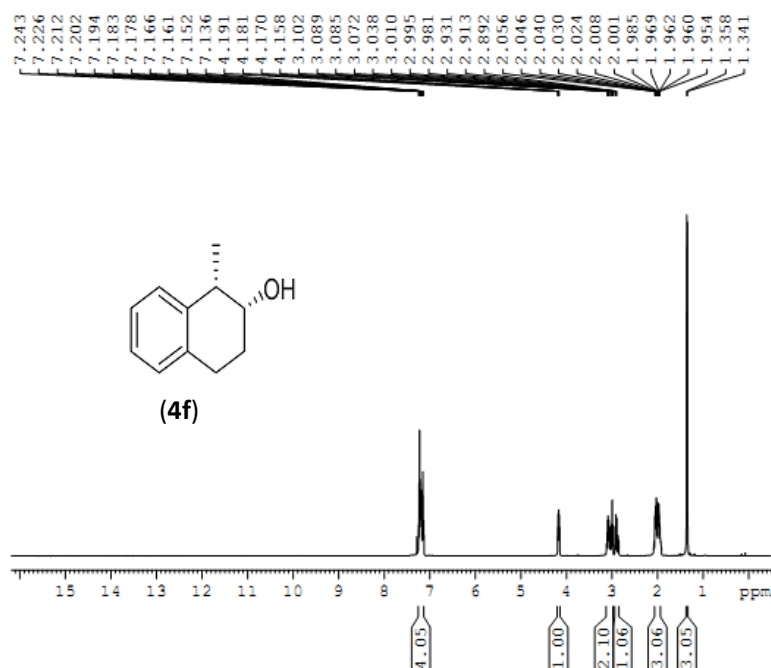


```

NAME      cb-19-115-OH
EXPNO     11
PROCNO    1
Date_     20161224
Time      14.20
INSTRUM    spect
PROBHD     5 mm PABBO BB/
PULPROG    zgpg30
TD         65536
SOLVENT    CDCl3
NS         512
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         0.0 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
  
```

```

===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1      13C
P1        9.31 usec
SI        32768
SF        100.6127685 MHz
WDW       EM
SSB       0
LB        1.00 Hz
GB        0
PC        1.40
  
```



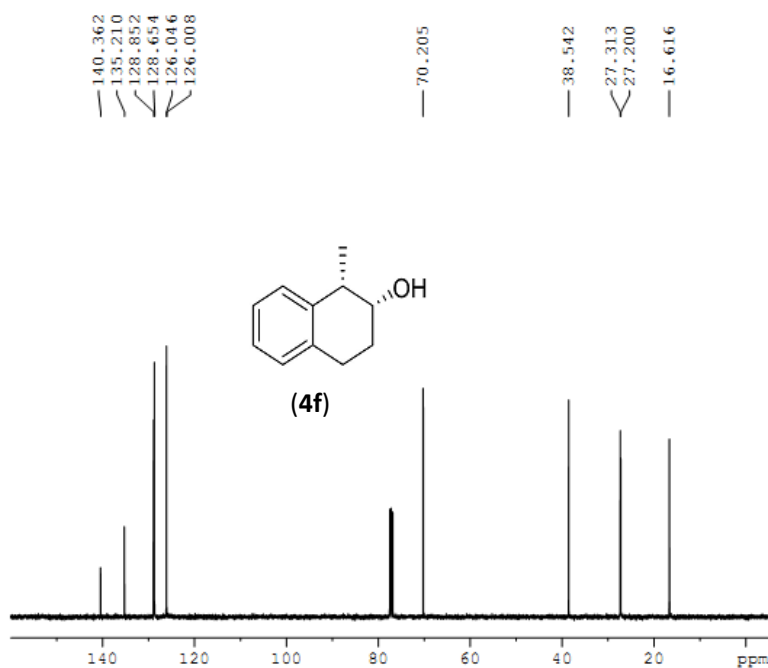
```

NAME      cb-19-106-OH
EXPNO     10
PROCNO    1
Date_     20161216
Time      10.59
INSTRUM    spect
PROBHD     5 mm PABBO BB/
PULPROG    zg30
TD         65536
SOLVENT    CDCl3
NS         4
DS         0
SWH        8012.820 Hz
FIDRES     0.122266 Hz
AQ         4.0894966 sec
RG         17.39
DW         62.400 usec
DE         6.50 usec
TE         0.0 K
D1         1.00000000 sec
TD0        1
  
```

```

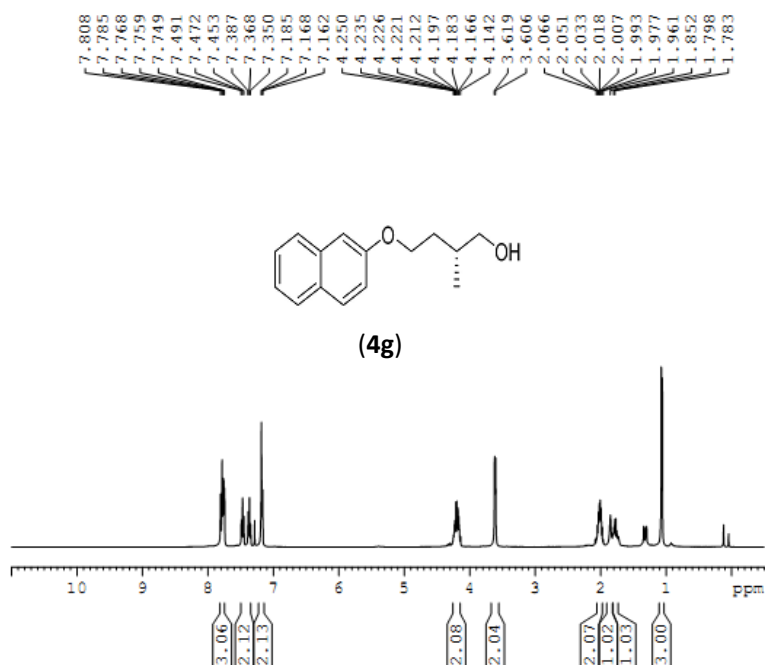
===== CHANNEL f1 =====
SFO1      400.1324710 MHz
NUC1      1H
P1        9.99 usec
SI        65536
SF        400.1300000 MHz
WDW       EM
SSB       0
LB        0.30 Hz
GB        0
PC        1.00
  
```





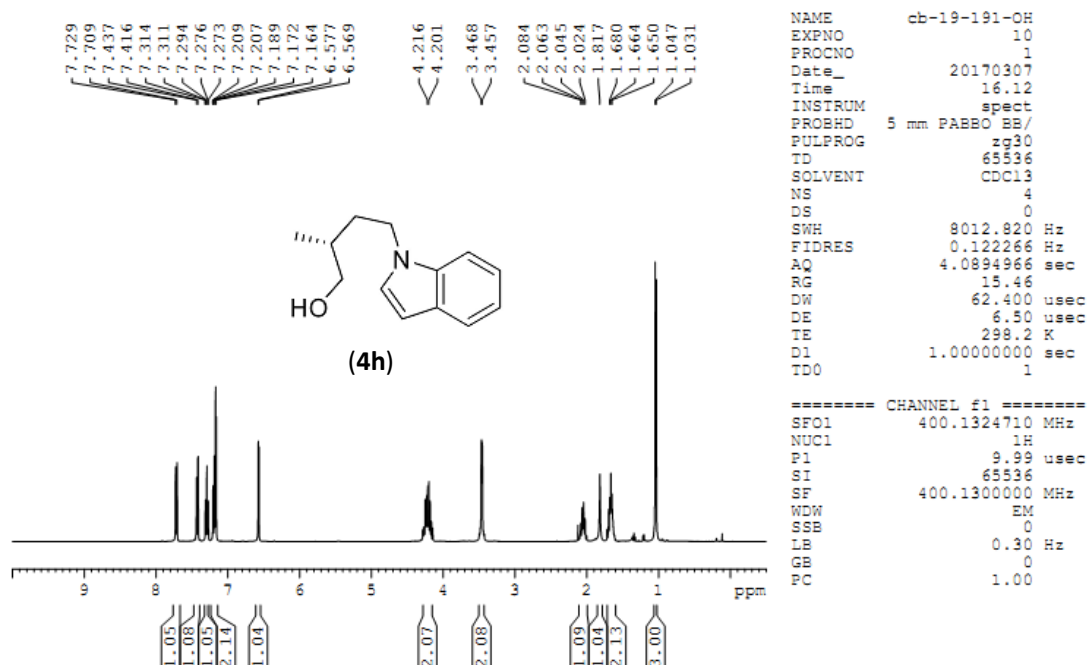
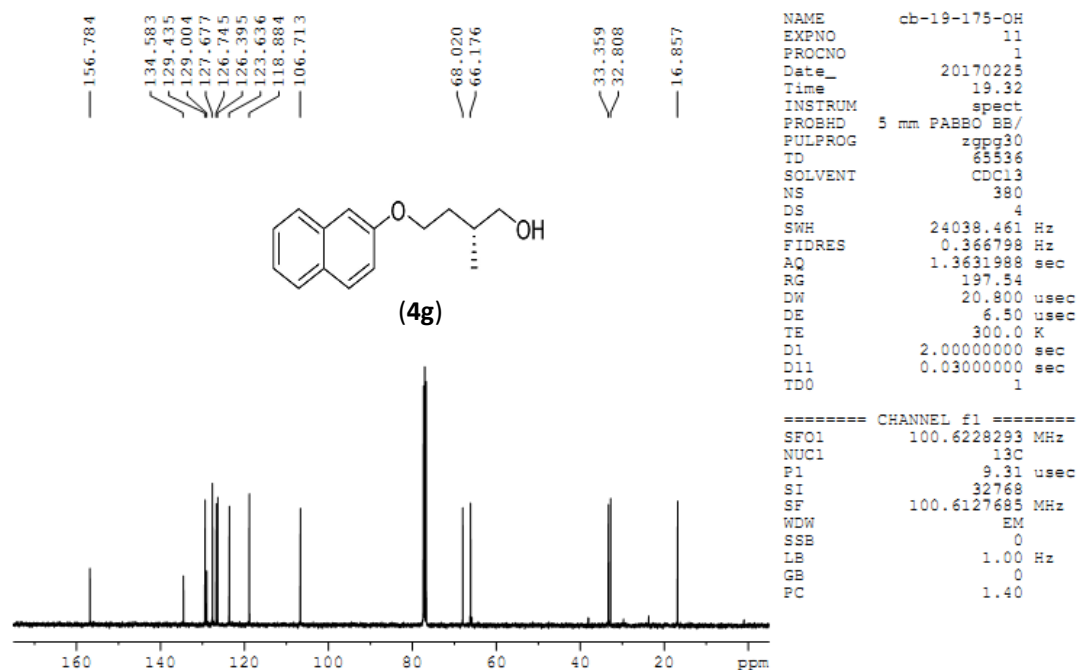
NAME cb-19-106-OH  
EXPNO 11  
PROCNO 1  
Date\_ 20161216  
Time 11.03  
INSTRUM spect  
PROBHD 5 mm PABBO BB/  
PULPROG zgpg30  
TD 65536  
SOLVENT CDCl3  
NS 56  
DS 4  
SWH 24038.461 Hz  
FIDRES 0.366798 Hz  
AQ 1.3631988 sec  
RG 197.54  
DW 20.800 usec  
DE 6.50 usec  
TE 0.0 K  
D1 2.00000000 sec  
D11 0.03000000 sec  
TD0 1

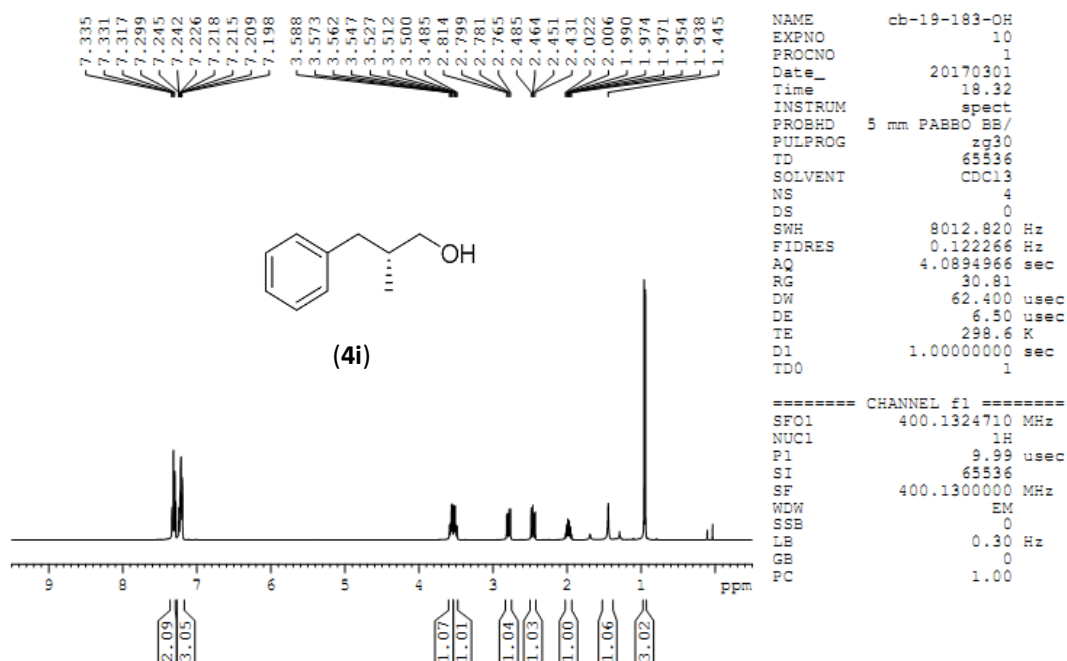
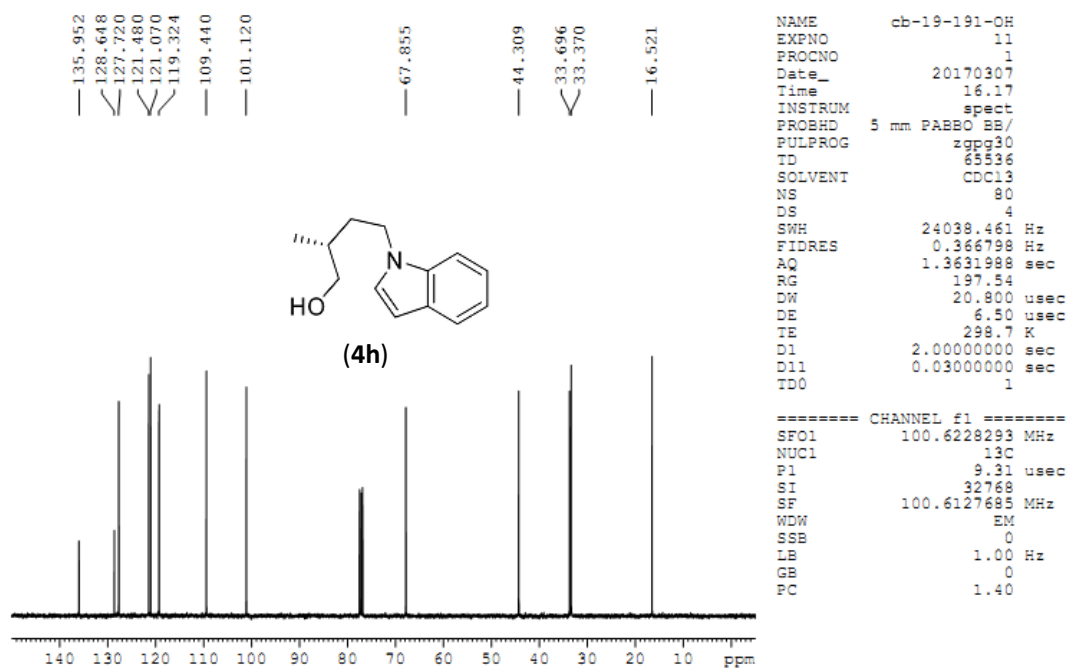
===== CHANNEL f1 =====  
SFO1 100.6228293 MHz  
NUC1 13C  
P1 9.31 usec  
SI 32769  
SF 100.6127695 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 1.40

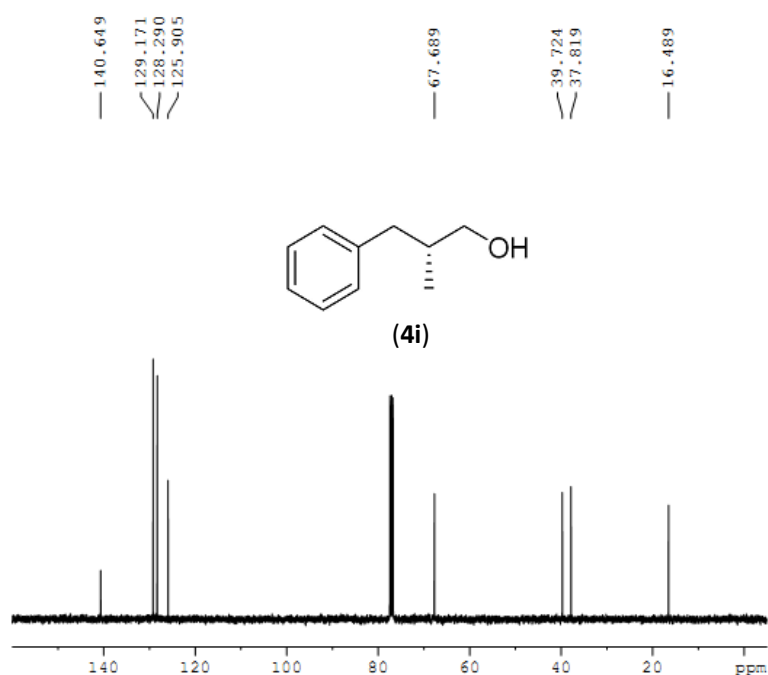


NAME cb-19-175-OH  
EXPNO 10  
PROCNO 1  
Date\_ 20170225  
Time 19.09  
INSTRUM spect  
PROBHD 5 mm PABBO BB/  
PULPROG zg30  
TD 65536  
SOLVENT CDCl3  
NS 4  
DS 0  
SWH 8012.820 Hz  
FIDRES 0.122266 Hz  
AQ 4.0894966 sec  
RG 30.81  
DW 62.400 usec  
DE 6.50 usec  
TE 299.4 K  
D1 1.00000000 sec  
TD0 1

===== CHANNEL f1 =====  
SFO1 400.1324710 MHz  
NUC1 1H  
P1 9.99 usec  
SI 65536  
SF 400.1300000 MHz  
WDW EM  
SSB 0  
LB 0.30 Hz  
GB 0  
PC 1.00







```

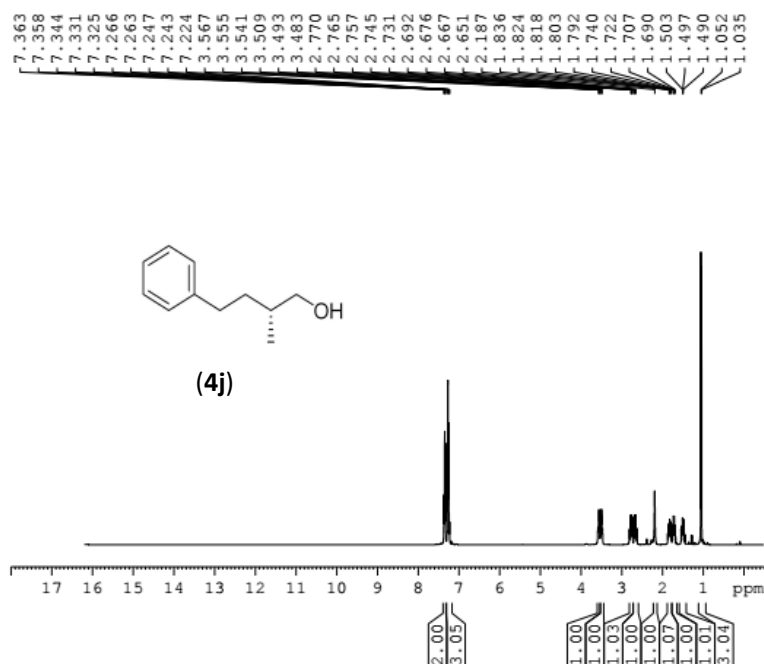
NAME      cb-19-183-OH-C
EXPNO     10
PROCNO    1
Date_     20170301
Time      21.03
INSTRUM    spect
PROBHD     5 mm PABBO BB/
PULPROG    zgpg30
TD         65536
SOLVENT    CDCl3
NS         80
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         298.9 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1

```

```

===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1      13C
P1        9.21 usec
SI        32768
SF        100.6127685 MHz
WDW       EM
SSB       0
LB        1.00 Hz
GB        0
PC        1.40

```



```

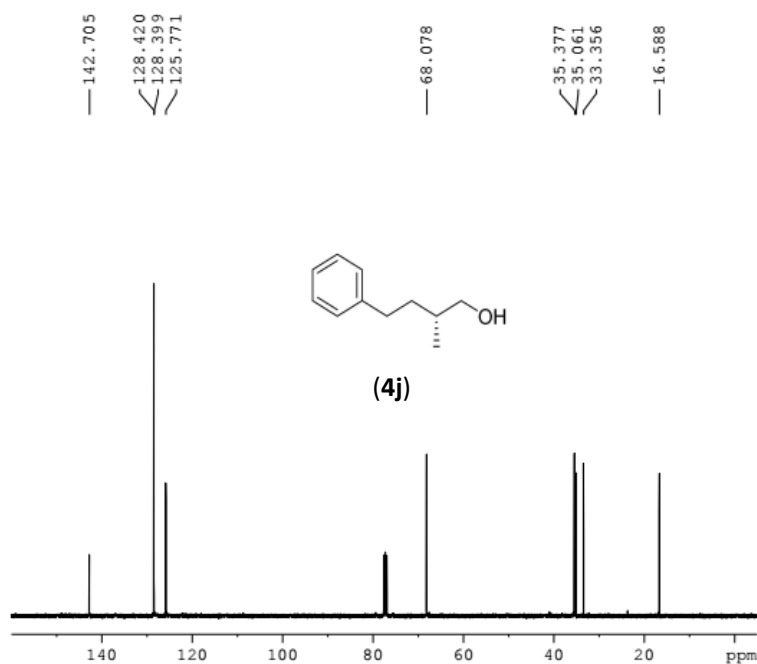
NAME      CB-19-196-OH-P
EXPNO     10
PROCNO    1
Date_     20170311
Time      21.03
INSTRUM    spect
PROBHD     5 mm PABBO BB/
PULPROG    zg30
TD         65536
SOLVENT    CDCl3
NS         4
DS         0
SWH        8012.820 Hz
FIDRES     0.122266 Hz
AQ         4.0894966 sec
RG         7.74
DW         62.400 usec
DE         6.50 usec
TE         297.6 K
D1         1.00000000 sec
TD0        1

```

```

===== CHANNEL f1 =====
SFO1      400.1324710 MHz
NUC1      1H
P1        9.99 usec
SI        65536
SF        400.1300000 MHz
WDW       EM
SSB       0
LB        0.30 Hz
GB        0
PC        1.00

```

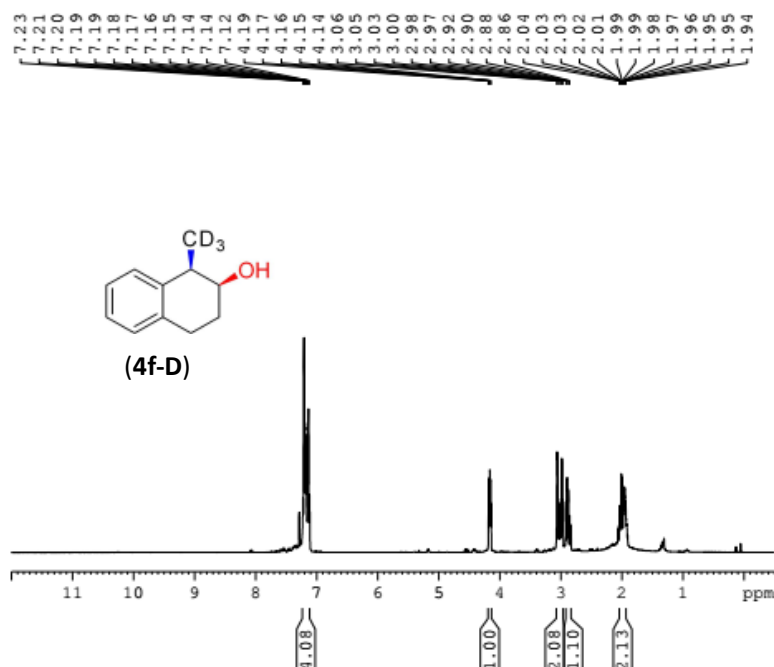


```

NAME      CB-19-196-OH-P
EXPNO     11
PROCNO    1
Date_     20170311
Time      21.06
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD         65536
SOLVENT   CDC13
NS         18
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         297.8 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1

===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1       13C
P1         9.31 usec
SI         32768
SF         100.6127685 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40

```

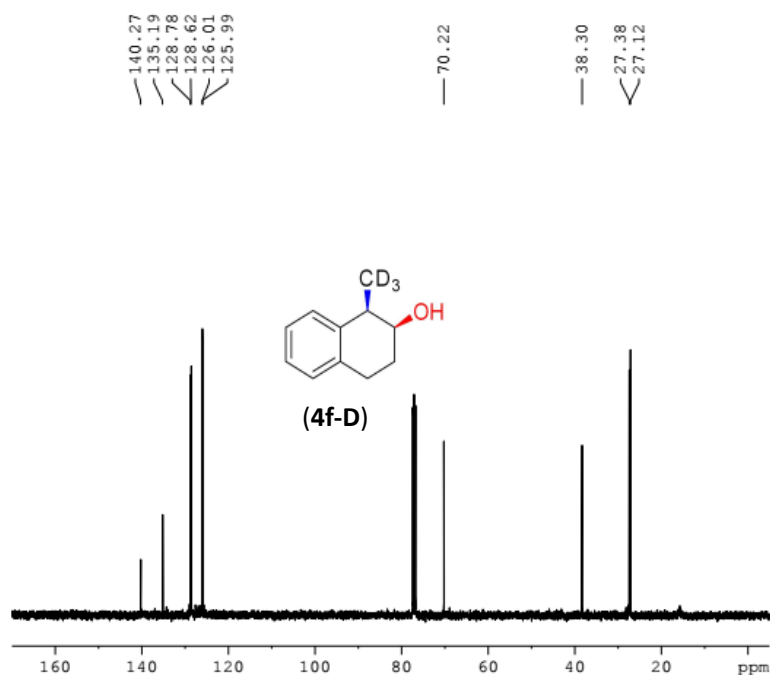


```

NAME      cb-19-220-oh-p
EXPNO     10
PROCNO    1
Date_     20170531
Time      12.52
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zg30
TD         65536
SOLVENT   CDC13
NS         4
DS         0
SWH        8012.820 Hz
FIDRES     0.122266 Hz
AQ         4.0894966 sec
RG         30.81
DW         62.400 usec
DE         6.50 usec
TE         301.5 K
D1         1.00000000 sec
TD0        1

===== CHANNEL f1 =====
SFO1      400.1324710 MHz
NUC1       1H
P1         9.99 usec
SI         65536
SF         400.1300000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00

```

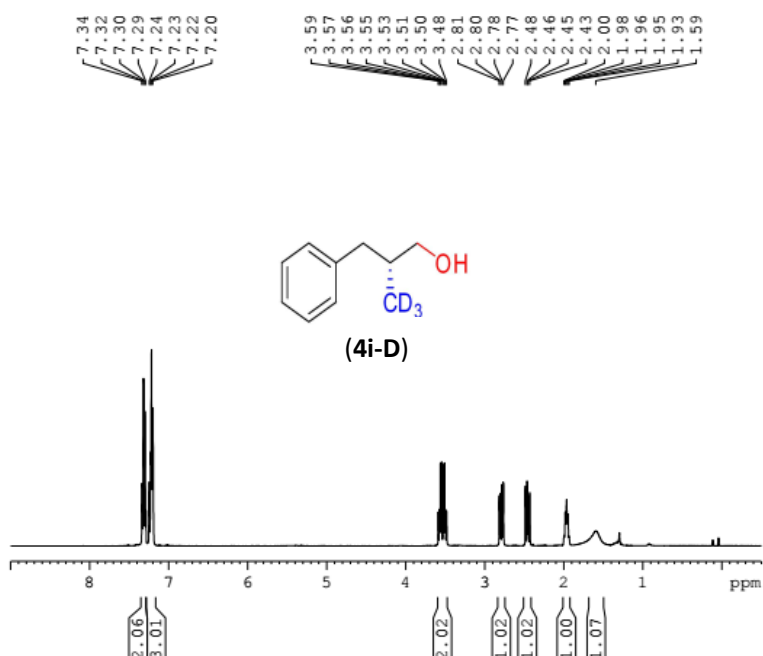


```

NAME      cb-19-220-oh-p
EXPNO     11
PROCNO    1
Date_     20170531
Time      12.58
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         80
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         302.1 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1

===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1      13C
P1         9.31 usec
SI         32768
SF         100.6127685 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40

```

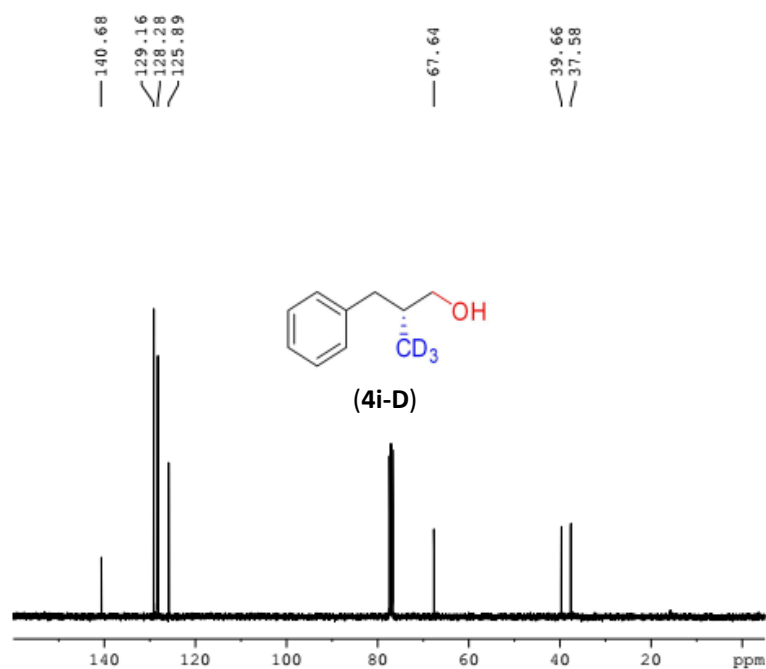


```

NAME      cb-19-222-oh-p
EXPNO     10
PROCNO    1
Date_     20170531
Time      13.02
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         4
DS         0
SWH        8012.820 Hz
FIDRES     0.122266 Hz
AQ         4.0894966 sec
RG         30.81
DW         62.400 usec
DE         6.50 usec
TE         301.6 K
D1         1.00000000 sec
TD0        1

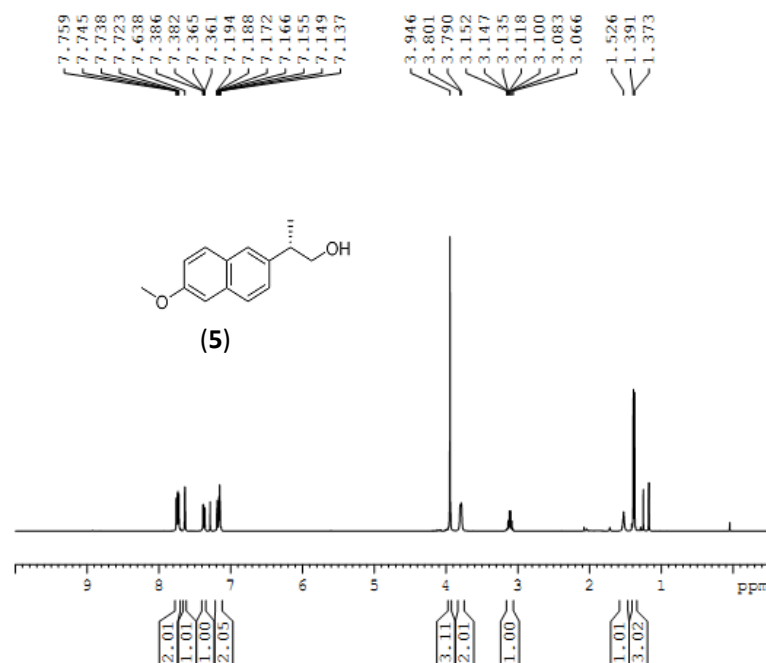
===== CHANNEL f1 =====
SFO1      400.1324710 MHz
NUC1      1H
P1         9.99 usec
SI         65536
SF         400.1300000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00

```



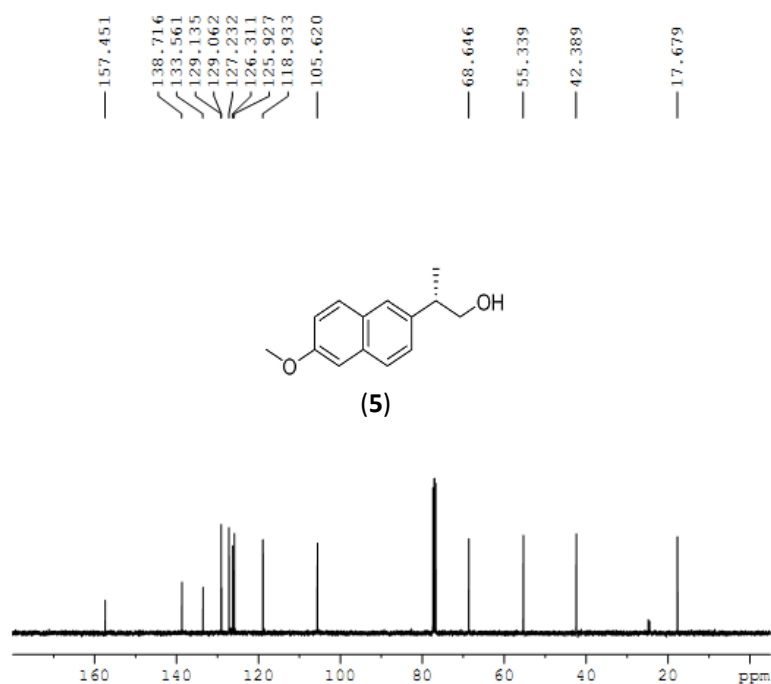
NAME cb-19-222-oh-p  
EXPNO 11  
PROCNO 1  
Date\_ 20170531  
Time 13.07  
INSTRUM spect  
PROBHD 5 mm PABBO BB/  
PULPROG zgpg30  
TD 65536  
SOLVENT CDCl3  
NS 80  
DS 4  
SWH 24038.461 Hz  
FIDRES 0.366798 Hz  
AQ 1.3631988 sec  
RG 197.54  
DW 20.800 usec  
DE 6.50 usec  
TE 302.1 K  
D1 2.00000000 sec  
D11 0.03000000 sec  
TD0 1

----- CHANNEL f1 -----  
SFO1 100.6228293 MHz  
NUC1 13C  
P1 9.31 usec  
SI 32768  
SF 100.6127685 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 1.40



NAME cb-19-158-OH  
EXPNO 10  
PROCNO 1  
Date\_ 20170117  
Time 20.47  
INSTRUM spect  
PROBHD 5 mm PABBO BB/  
PULPROG zg30  
TD 65536  
SOLVENT CDCl3  
NS 4  
DS 0  
SWH 8012.820 Hz  
FIDRES 0.122266 Hz  
AQ 4.0894966 sec  
RG 30.81  
DW 62.400 usec  
DE 6.50 usec  
TE 0.0 K  
D1 1.00000000 sec  
TD0 1

===== CHANNEL f1 =====  
SFO1 400.1324710 MHz  
NUC1 1H  
P1 9.99 usec  
SI 65536  
SF 400.1300000 MHz  
WDW EM  
SSB 0  
LB 0.30 Hz  
GB 0  
PC 1.00



```

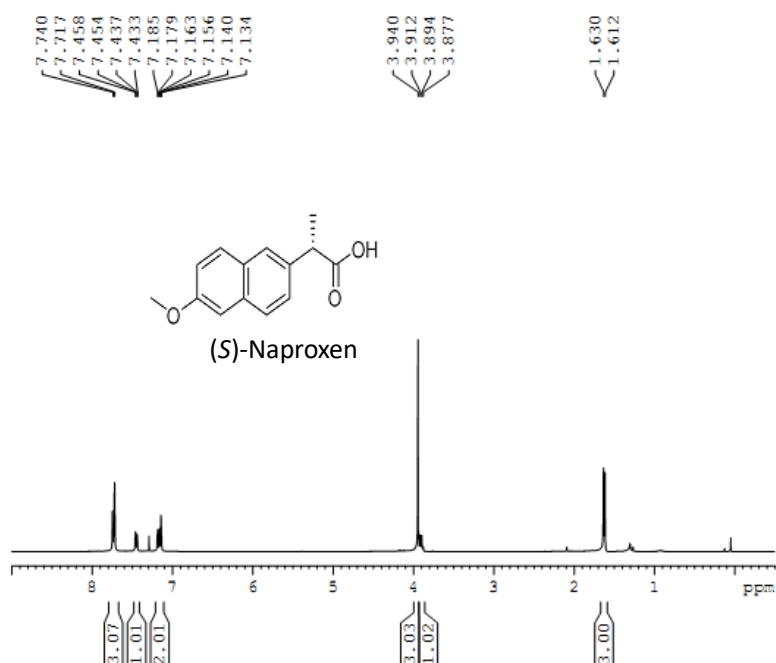
NAME      cb-19-158-OH
EXPNO     11
PROCNO    1
Date_     20170117
Time      20.53
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         80
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         0.0 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1

```

```

===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1       13C
P1         9.31 usec
SI         32768
SF         100.6127685 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40

```



```

NAME      cb-19-167-p
EXPNO     10
PROCNO    1
Date_     20170217
Time      18.18
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         4
DS         0
SWH        8012.820 Hz
FIDRES     0.122266 Hz
AQ         4.0894966 sec
RG         30.81
DW         62.400 usec
DE         6.50 usec
TE         298.5 K
D1         1.00000000 sec
TD0        1

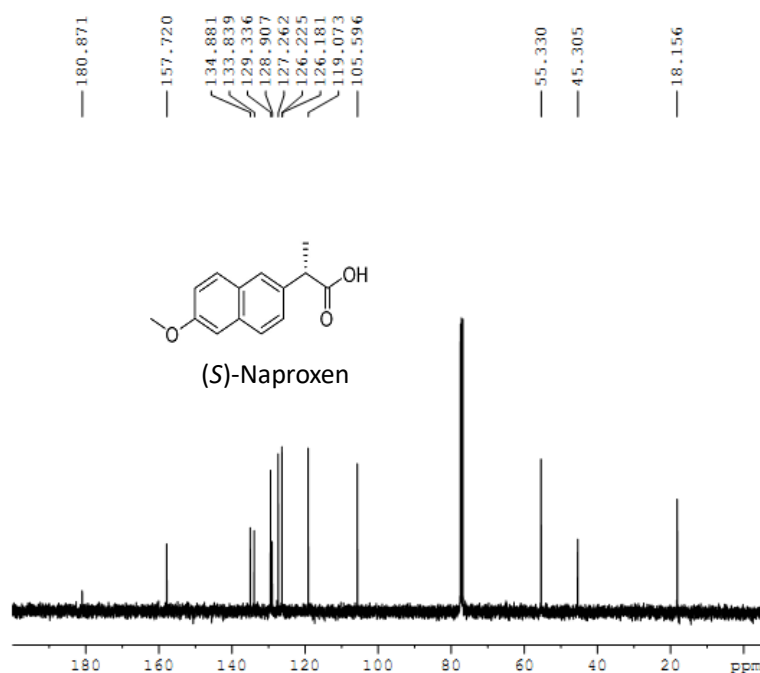
```

```

===== CHANNEL f1 =====
SFO1      400.1324710 MHz
NUC1       1H
P1         9.99 usec
SI         65536
SF         400.1300000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00

```





```

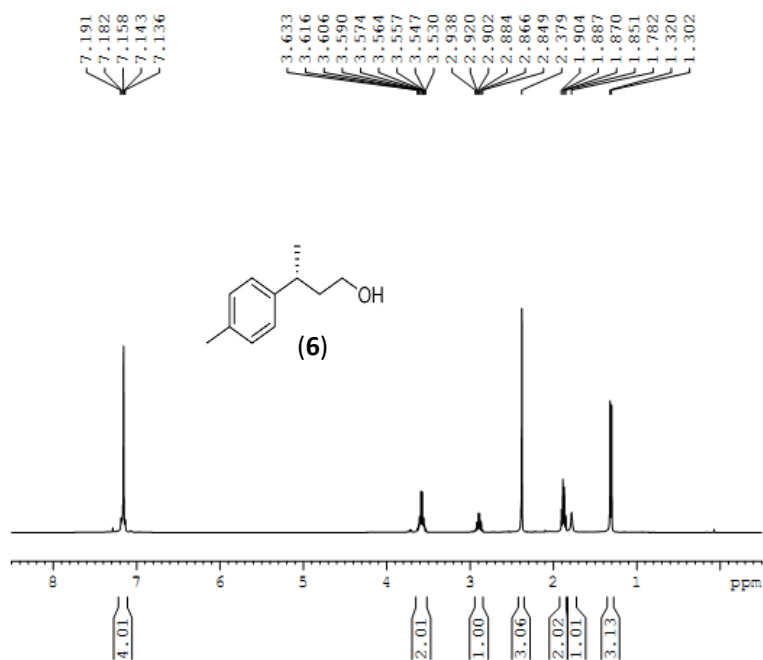
NAME      cb-19-167-p
EXPNO     11
PROCNO    1
Date_     20170217
Time      18.23
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         68
DS         4
SWH       24038.461 Hz
FIDRES    0.366798 Hz
AQ        1.3631988 sec
RG        197.54
DW        20.800 usec
DE        6.50 usec
TE        299.1 K
D1        2.00000000 sec
D11       0.03000000 sec
TD0       1

```

```

===== CHANNEL f1 =====
SFO1     100.6228293 MHz
NUC1      13C
P1        9.31 usec
SI        32768
SF       100.6127685 MHz
WDW       EM
SSB       0
LB        1.00 Hz
GB        0
PC        1.40

```



```

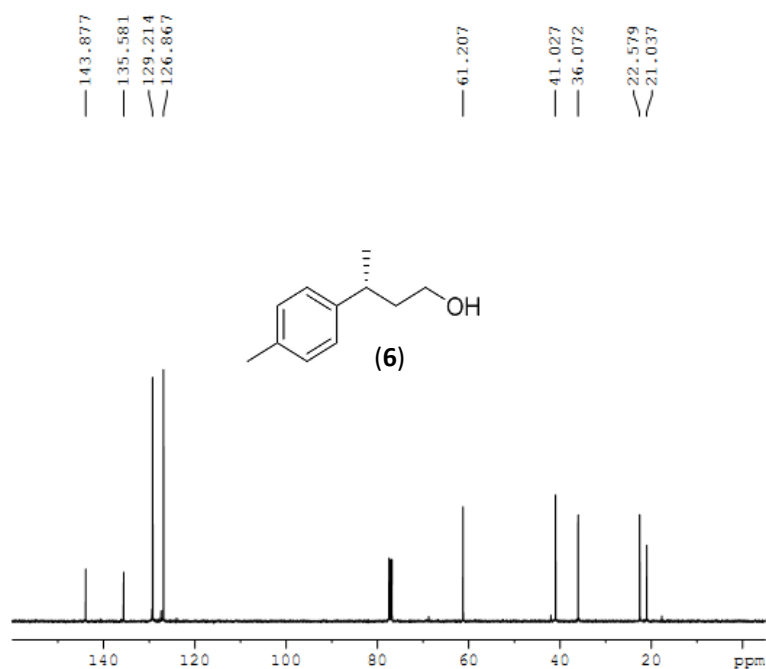
NAME      cb-19-159-OH
EXPNO     10
PROCNO    1
Date_     20170116
Time      21.05
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         4
DS         0
SWH       8012.820 Hz
FIDRES    0.122266 Hz
AQ        4.0894966 sec
RG        15.46
DW        62.400 usec
DE        6.50 usec
TE        0.0 K
D1        1.00000000 sec
TD0       1

```

```

===== CHANNEL f1 =====
SFO1     400.1324710 MHz
NUC1      1H
P1        9.99 usec
SI        65536
SF       400.1300000 MHz
WDW       EM
SSB       0
LB        0.30 Hz
GB        0
PC        1.00

```

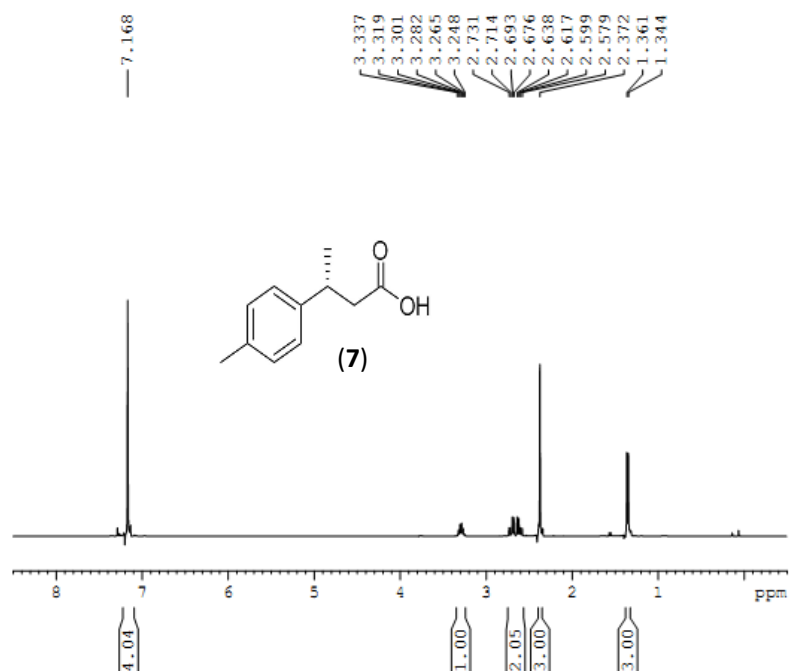


```

NAME      cb-19-159-OH
EXPNO     11
PROCNO    1
Date_     20170116
Time      21.11
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zgpg30
TD         65536
SOLVENT   CDCl3
NS         98
DS         4
SWH        24038.461 Hz
FIDRES     0.366798 Hz
AQ         1.3631988 sec
RG         197.54
DW         20.800 usec
DE         6.50 usec
TE         0.0 K
D1         2.00000000 sec
D11        0.03000000 sec
TD0        1
  
```

```

===== CHANNEL f1 =====
SFO1      100.6228293 MHz
NUC1      13C
P1         9.31 usec
SI        32768
SF         100.6127685 MHz
WDW        EM
SSB        0
LB         1.00 Hz
GB         0
PC         1.40
  
```

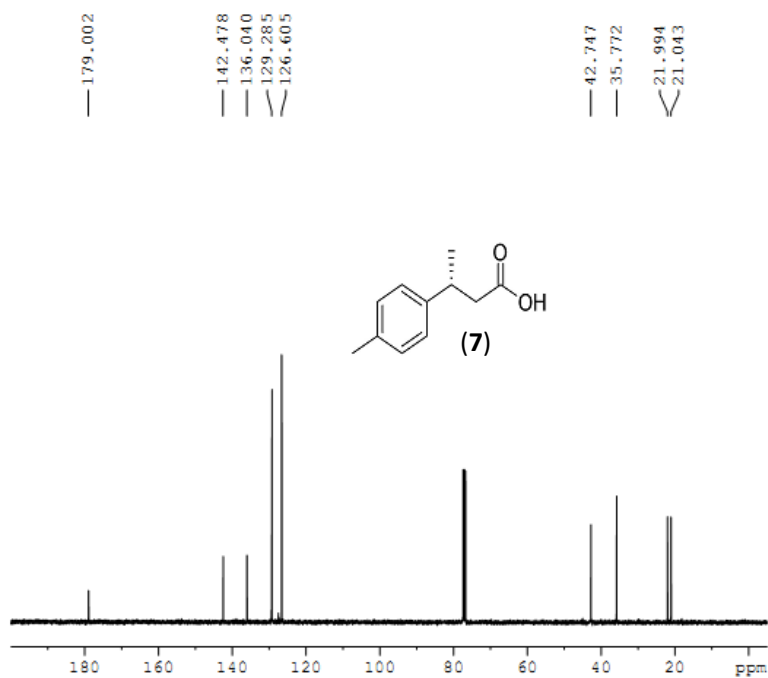


```

NAME      cb-19-177p
EXPNO     10
PROCNO    1
Date_     20170223
Time      18.53
INSTRUM   spect
PROBHD    5 mm PABBO BB/
PULPROG   zg30
TD         65536
SOLVENT   CDCl3
NS         4
DS         0
SWH        8012.820 Hz
FIDRES     0.122266 Hz
AQ         4.0894966 sec
RG         30.81
DW         62.400 usec
DE         6.50 usec
TE         298.8 K
D1         1.00000000 sec
TD0        1
  
```

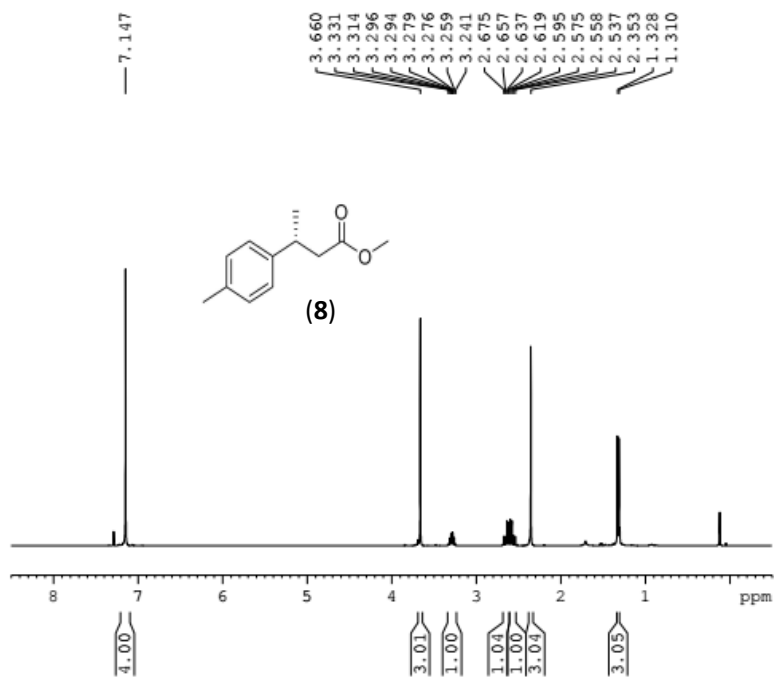
```

===== CHANNEL f1 =====
SFO1      400.1324710 MHz
NUC1      1H
P1         9.99 usec
SI        65536
SF         400.1300000 MHz
WDW        EM
SSB        0
LB         0.30 Hz
GB         0
PC         1.00
  
```



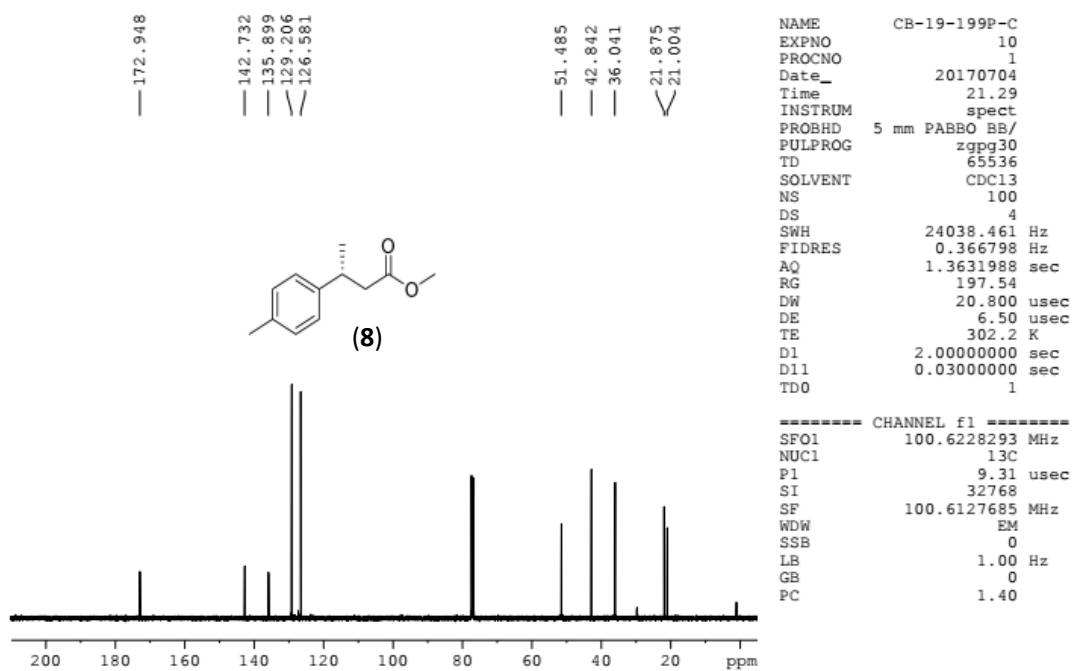
NAME cb-19-177p  
EXPNO 11  
PROCNO 1  
Date\_ 20170223  
Time 18.58  
INSTRUM spect  
PROBHD 5 mm PABBO BB/  
PULPROG zgpg30  
TD 65536  
SOLVENT CDCl3  
NS 80  
DS 4  
SWH 24038.461 Hz  
FIDRES 0.366798 Hz  
AQ 1.3631988 sec  
RG 197.54  
DW 20.800 usec  
DE 6.50 usec  
TE 299.5 K  
D1 2.00000000 sec  
D11 0.03000000 sec  
TD0 1

===== CHANNEL f1 =====  
SFO1 100.6228293 MHz  
NUC1 13C  
P1 9.31 usec  
SI 32768  
SF 100.6127685 MHz  
WDW EM  
SSB 0  
LB 1.00 Hz  
GB 0  
PC 1.40

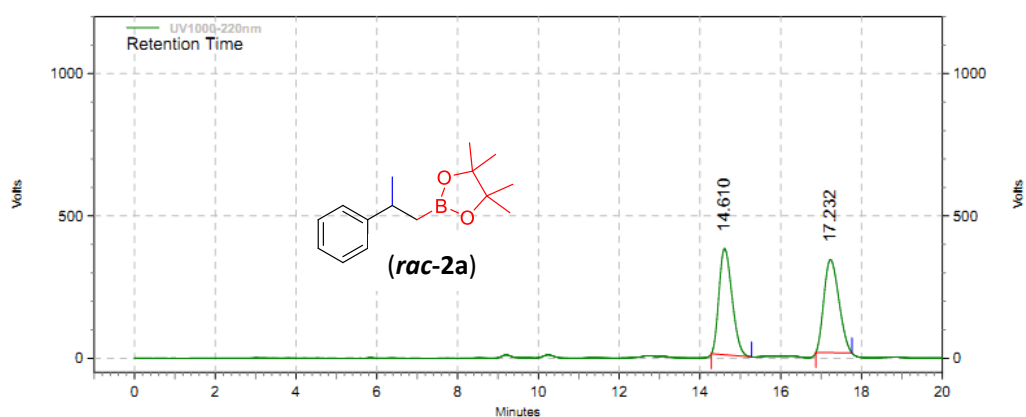


NAME CB-19-229-P  
EXPNO 10  
PROCNO 1  
Date\_ 20170704  
Time 20.14  
INSTRUM spect  
PROBHD 5 mm PABBO BB/  
PULPROG zg30  
TD 65536  
SOLVENT CDCl3  
NS 4  
DS 0  
SWH 8012.820 Hz  
FIDRES 0.122266 Hz  
AQ 4.0894966 sec  
RG 30.81  
DW 62.400 usec  
DE 6.50 usec  
TE 301.7 K  
D1 1.00000000 sec  
TD0 1

===== CHANNEL f1 =====  
SFO1 400.1324710 MHz  
NUC1 1H  
P1 9.99 usec  
SI 65536  
SF 400.1300000 MHz  
WDW EM  
SSB 0  
LB 0.30 Hz  
GB 0  
PC 1.00



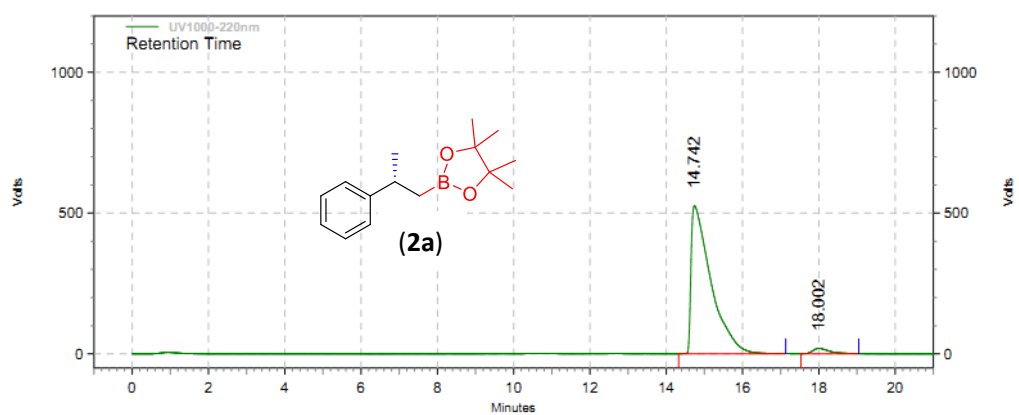
# HPLC



## UV1000-220nm

### Results

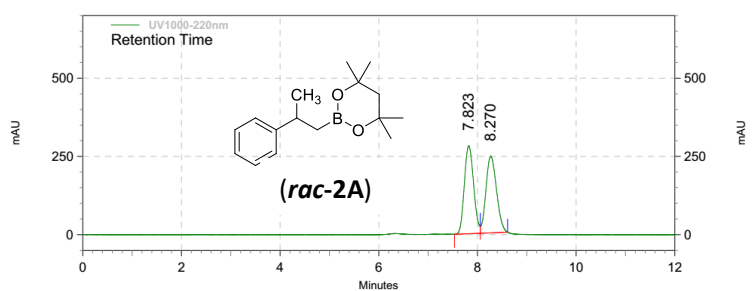
Retention Time	Area	Area %	Height	Height %
14.610	8385510	49.98	372936	53.31
17.232	8391552	50.02	326621	46.69
Totals	16777062	100.00	699557	100.00



## UV1000-220nm

### Results

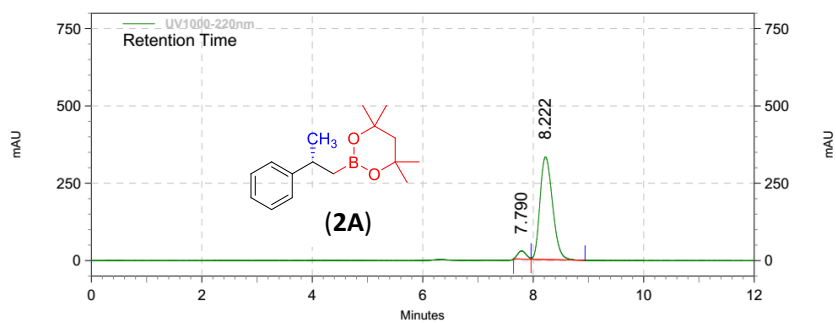
Retention Time	Area	Area %	Height	Height %
14.742	18992727	97.08	525174	96.50
18.002	570797	2.92	19036	3.50
Totals	19563524	100.00	544210	100.00



#### UV1000-220nm

##### Results

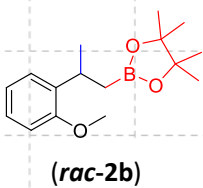
Retention Time	Area	Area %	Height	Height %
7.823	3655872	50.03	280995	53.44
8.270	3651052	49.97	244811	46.56
Totals	7306924	100.00	525806	100.00



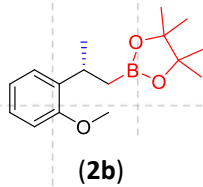
#### UV1000-220nm

##### Results

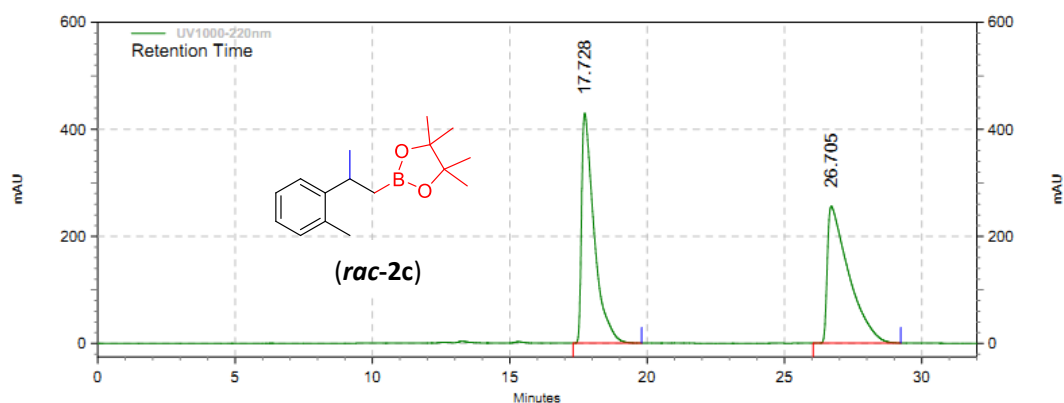
Retention Time	Area	Area %	Height	Height %
7.790	281249	5.10	26497	7.39
8.222	5233258	94.90	331869	92.61
Totals	5514507	100.00	358366	100.00



Totals	7956270	100.00	1101023	100.00
--------	---------	--------	---------	--------



Totals	6028851	100.00	874889	100.00
--------	---------	--------	--------	--------

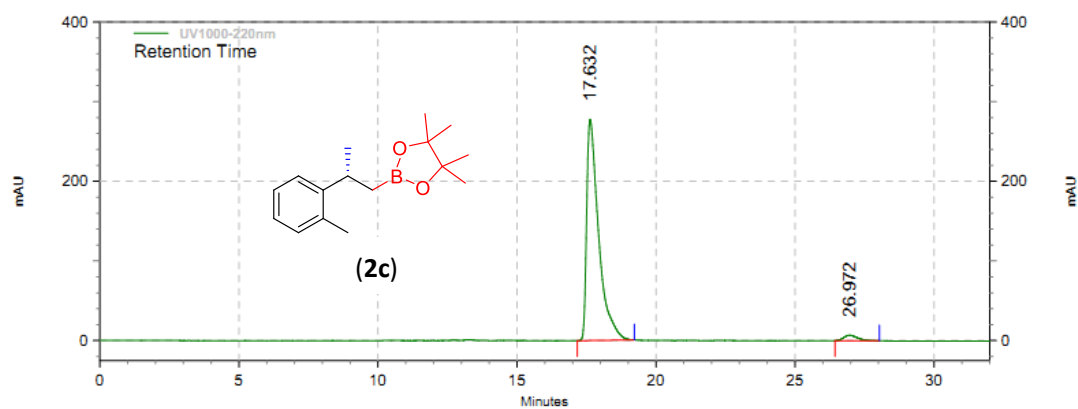


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
17.728	13663310	49.59	429798	62.68
26.705	13891851	50.41	255877	37.32

Totals	27555161	100.00	685675	100.00
--------	----------	--------	--------	--------



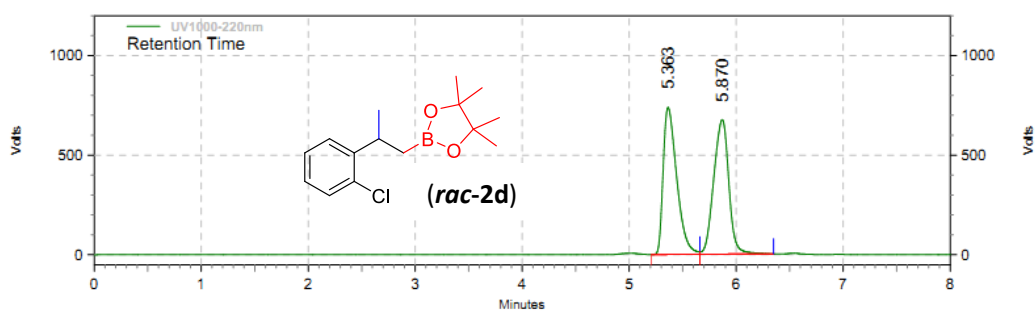
#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
17.632	8287359	97.16	277895	97.59
26.972	241914	2.84	6860	2.41

Totals	8529273	100.00	284755	100.00
--------	---------	--------	--------	--------

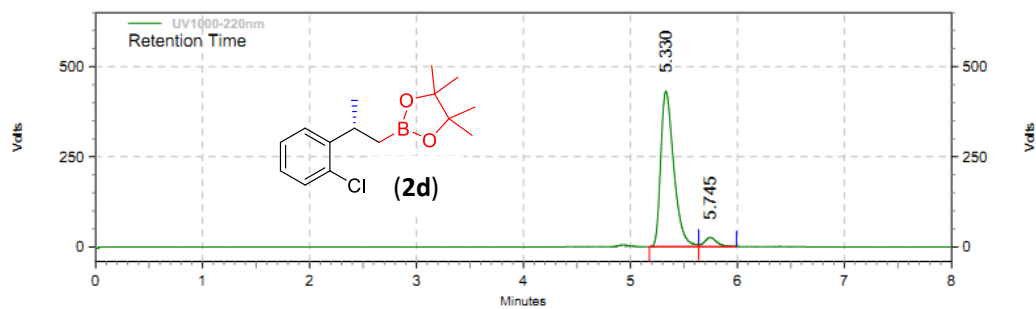




#### UV1000-220nm

##### Results

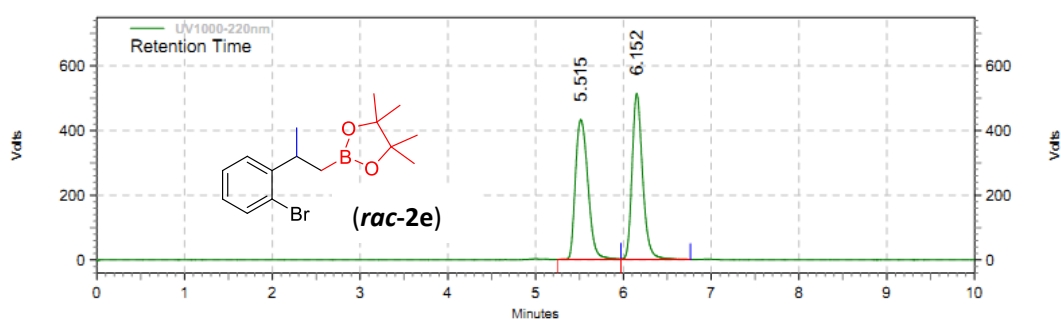
Retention Time	Area	Area %	Height	Height %
5.363	6513047	49.62	737694	52.24
5.870	6613475	50.38	674503	47.76
Totals	13126522	100.00	1412197	100.00



#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
5.330	3658603	94.75	431341	94.41
5.745	202800	5.25	25536	5.59
Totals	3861403	100.00	456877	100.00

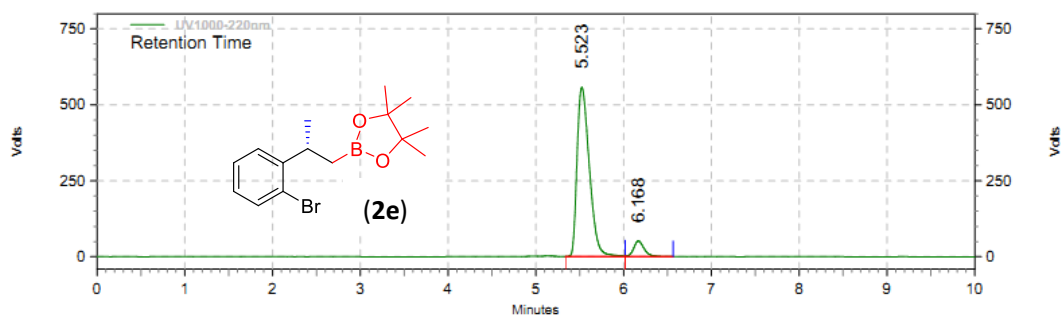


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
5.515	4299249	50.03	432027	45.75
6.152	4293775	49.97	512396	54.25

Totals	8593024	100.00	944423	100.00
--------	---------	--------	--------	--------

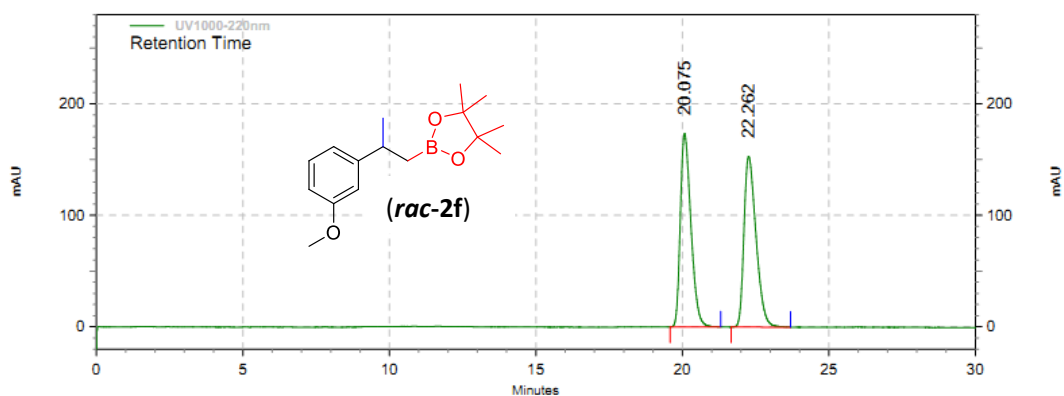


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
5.523	5420434	92.69	556963	91.57
6.168	427524	7.31	51278	8.43

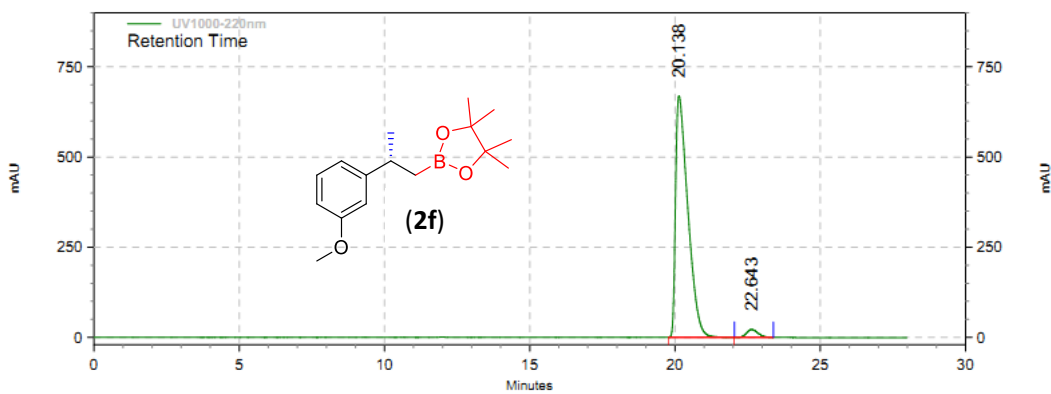
Totals	5847958	100.00	608241	100.00
--------	---------	--------	--------	--------



#### UV1000-220nm

##### Results

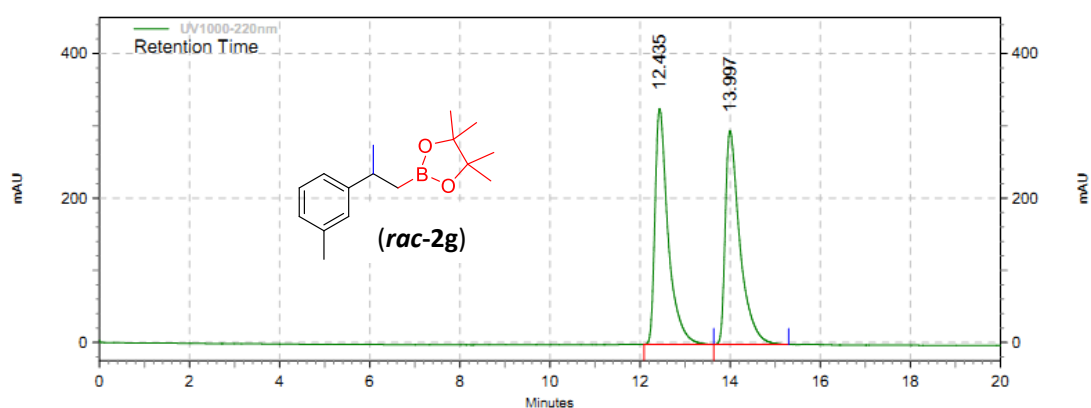
Retention Time	Area	Area %	Height	Height %
20.075	4353476	49.83	173409	53.10
22.262	4383500	50.17	153159	46.90
Totals	8736976	100.00	326568	100.00



#### UV1000-220nm

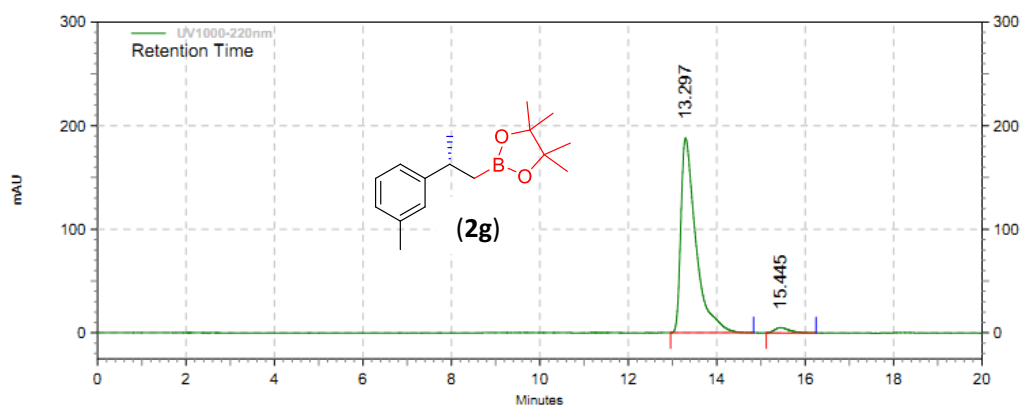
##### Results

Retention Time	Area	Area %	Height	Height %
20.138	19713748	96.99	669960	96.82
22.643	611737	3.01	22026	3.18
Totals	20325485	100.00	691986	100.00



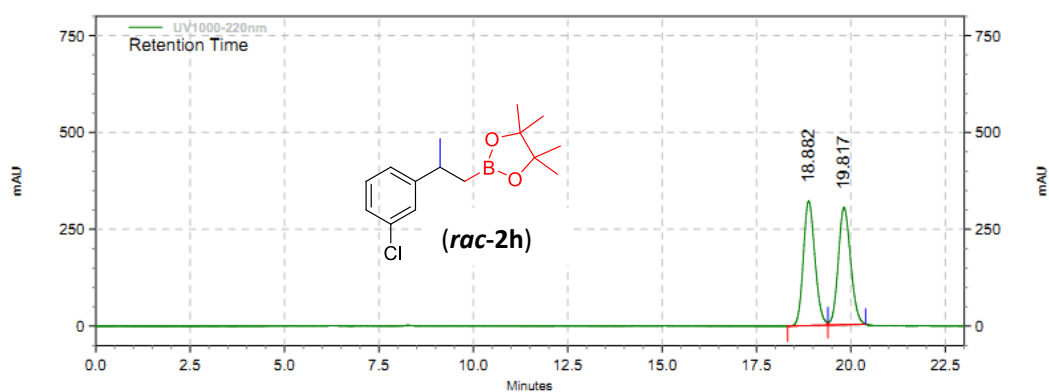
**UV1000-220nm  
Results**

Retention Time	Area	Area %	Height	Height %
12.435	6619991	49.84	326466	52.45
13.997	6663677	50.16	296011	47.55
Totals	13283668	100.00	622477	100.00



**UV1000-220nm  
Results**

Retention Time	Area	Area %	Height	Height %
13.297	4439258	97.41	187915	97.39
15.445	118145	2.59	5041	2.61
Totals	4557403	100.00	192956	100.00

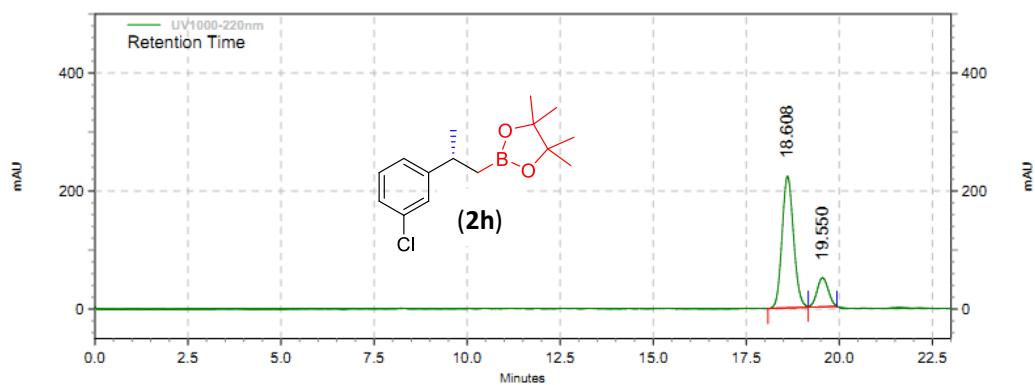


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
18.882	6862882	49.93	321453	51.52
19.817	6882652	50.07	302438	48.48

Totals	13745534	100.00	623891	100.00
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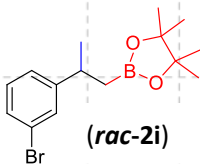


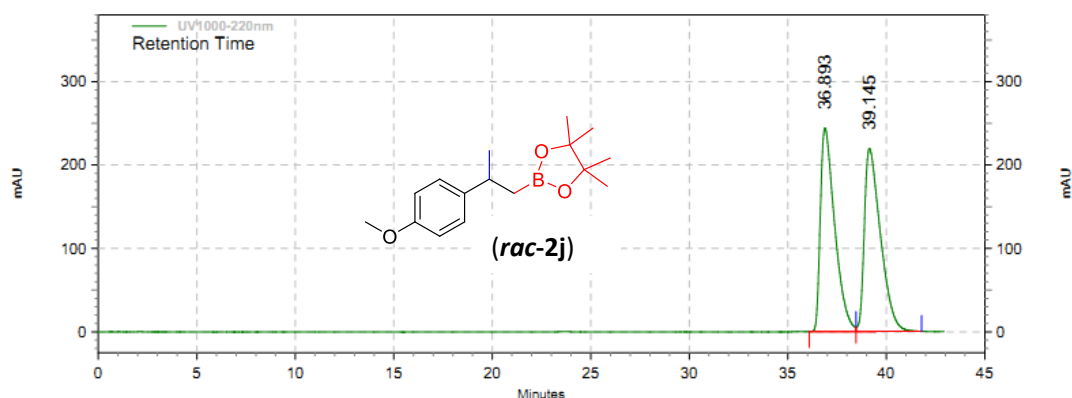
#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
18.608	4791635	82.30	223087	81.92
19.550	1030709	17.70	49230	18.08

Totals	5822344	100.00	272317	100.00
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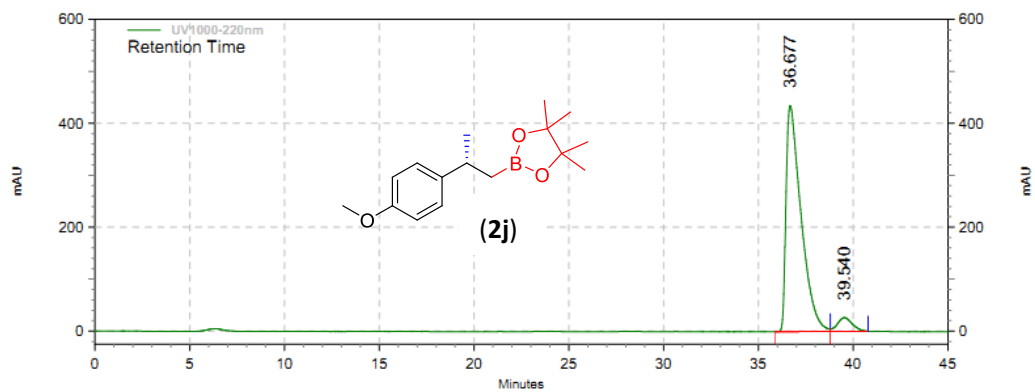


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
36.893	12405261	49.81	244160	52.66
39.145	12501299	50.19	219512	47.34

Totals	24906560	100.00	463672	100.00
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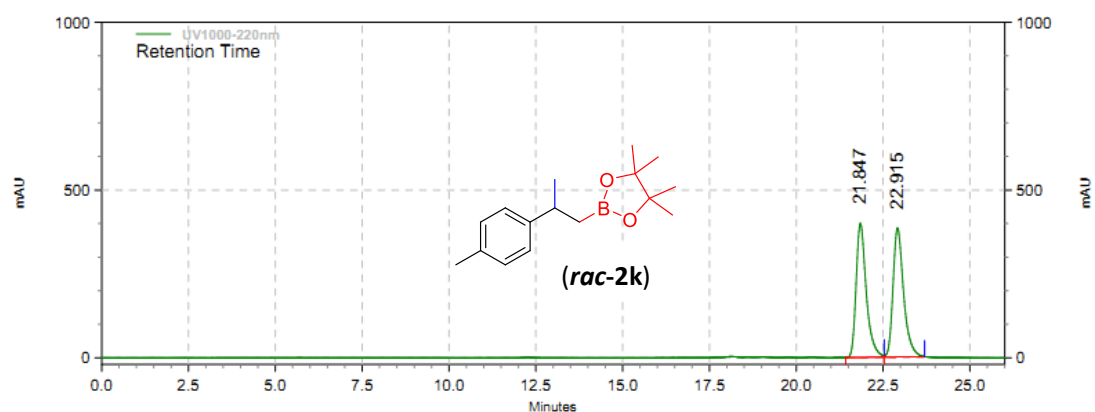


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
36.677	23966279	94.34	435002	94.28
39.540	1437904	5.66	26394	5.72

Totals	25404183	100.00	461396	100.00
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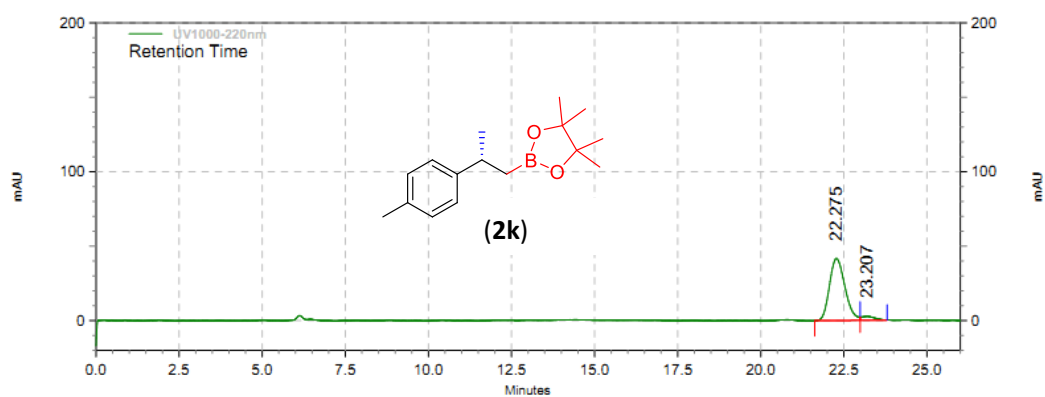


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
21.847	8091601	49.85	399680	50.94
22.915	8140409	50.15	384890	49.06

Totals	16232010	100.00	784570	100.00
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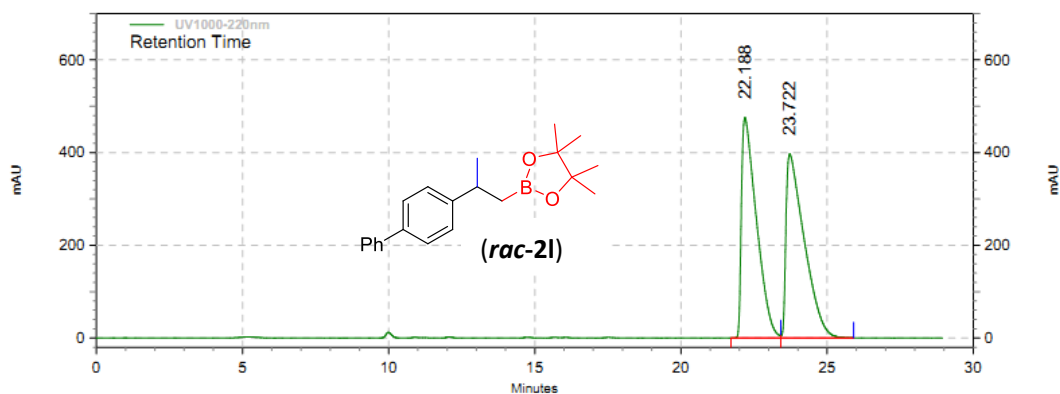
#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
22.275	1347045	94.90	41662	94.12
23.207	72464	5.10	2604	5.88

Totals	1419509	100.00	44266	100.00
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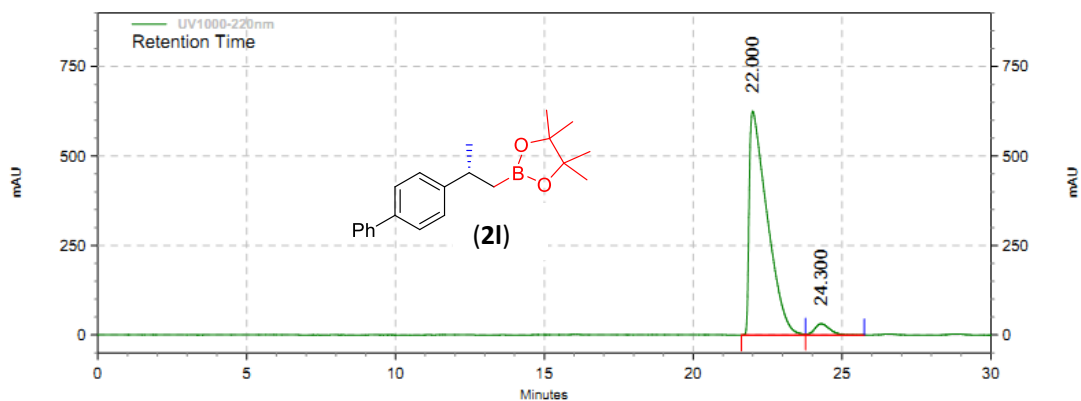


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
22.188	16977696	49.54	475504	54.51
23.722	17292475	50.46	396887	45.49

Totals	34270171	100.00	872391	100.00
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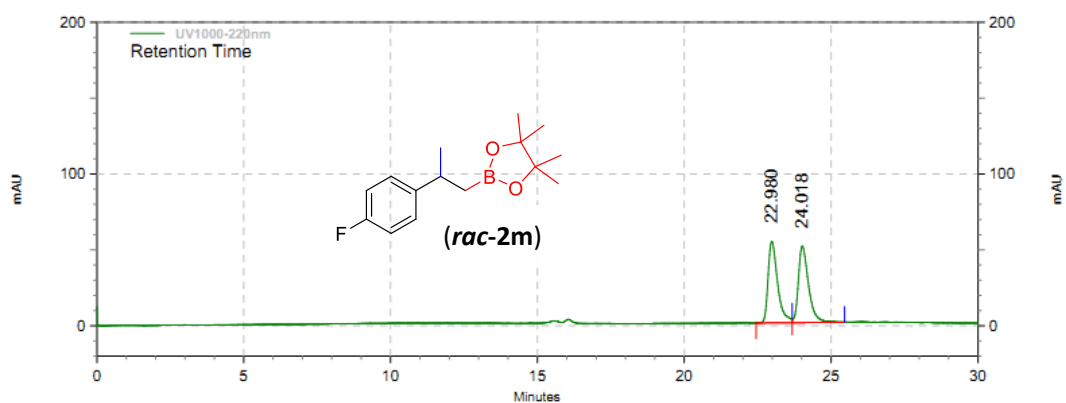


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
22.000	26219499	95.96	625606	95.23
24.300	1104451	4.04	31345	4.77

Totals	27323950	100.00	656951	100.00
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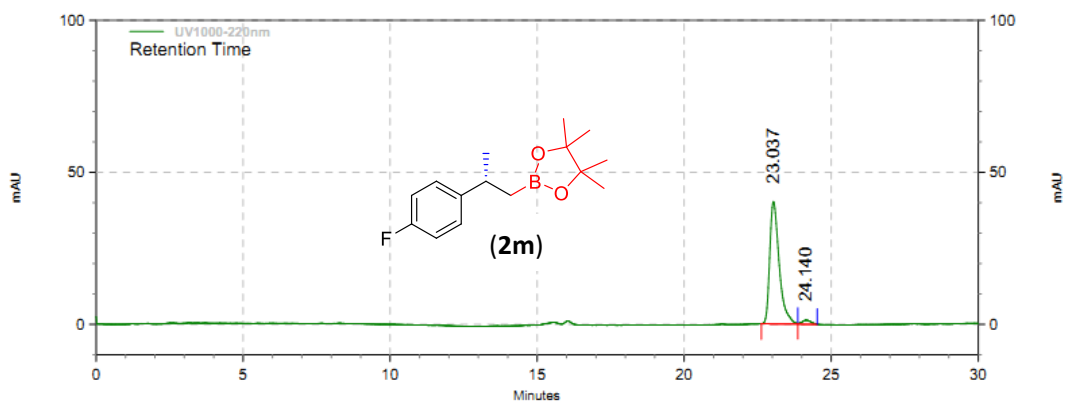


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
22.980	1209098	49.91	53665	51.59
24.018	1213337	50.09	50350	48.41

Totals	2422435	100.00	104015	100.00
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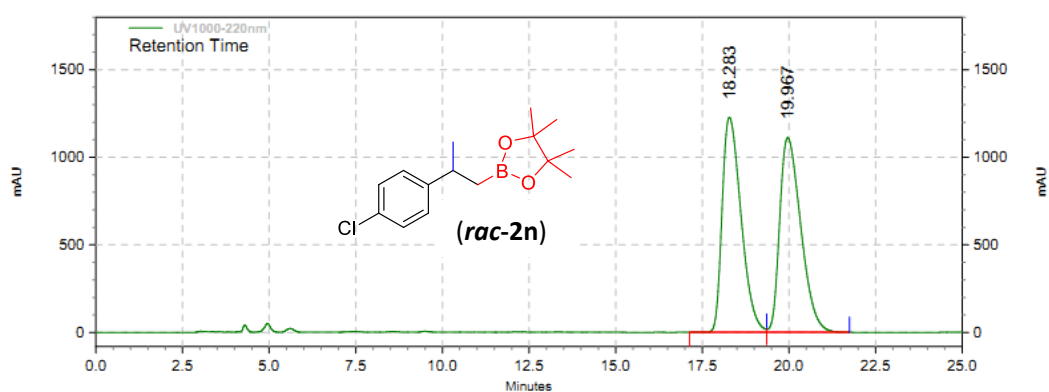


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
23.037	896676	97.05	40220	96.83
24.140	27243	2.95	1318	3.17

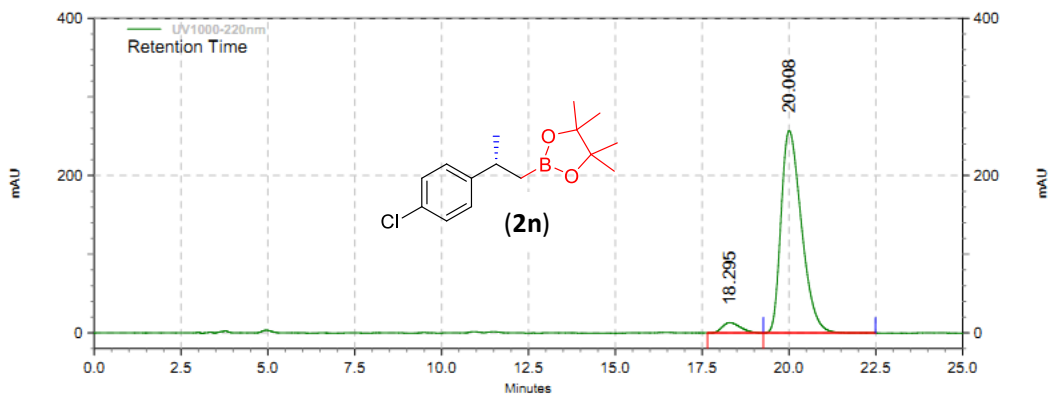
Totals	923919	100.00	41538	100.00
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#### UV1000-220nm

##### Results

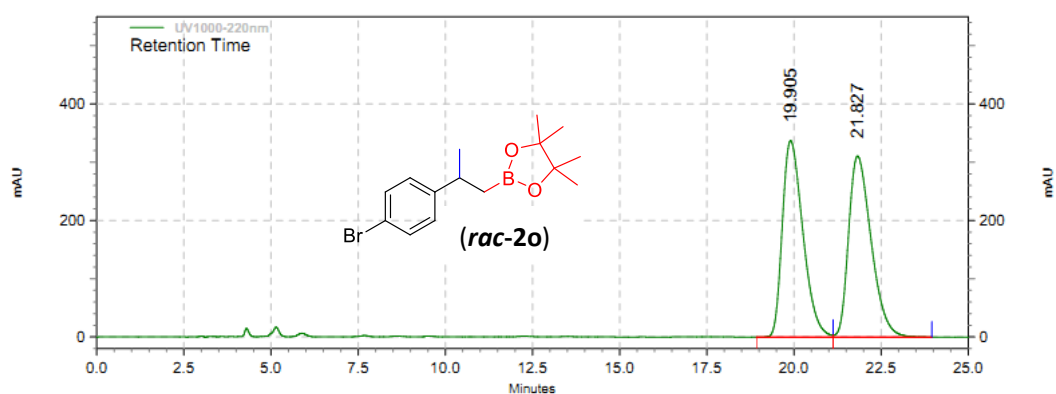
Retention Time	Area	Area %	Height	Height %
18.283	46669024	49.69	1227262	52.47
19.967	47250751	50.31	1111605	47.53
Totals	93919775	100.00	2338867	100.00



#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
18.295	481334	4.36	13136	4.86
20.008	10557360	95.64	257290	95.14
Totals	11038694	100.00	270426	100.00

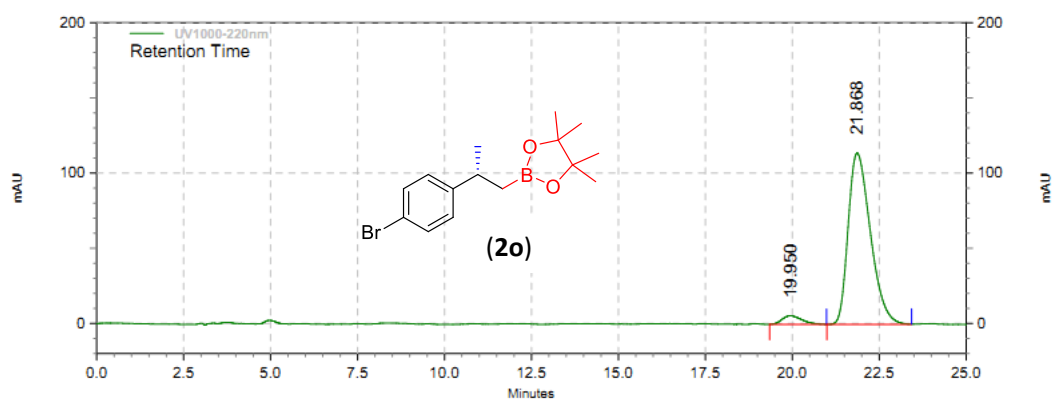


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
19.905	13820832	49.69	337284	52.03
21.827	13993144	50.31	310953	47.97

Totals	27813976	100.00	648237	100.00
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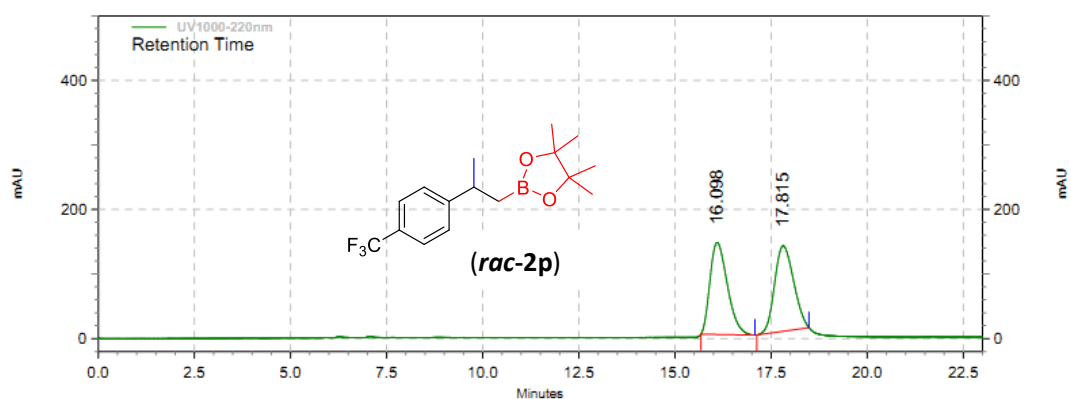


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
19.950	222791	4.22	5647	4.72
21.868	5060740	95.78	113899	95.28

Totals	5283531	100.00	119546	100.00
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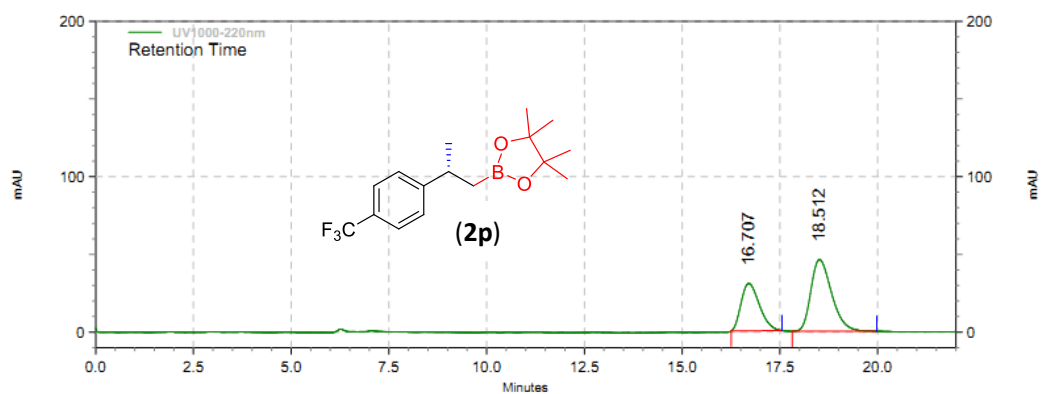


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
16.098	4494000	49.66	142485	51.84
17.815	4555343	50.34	132392	48.16

Totals	9049343	100.00	274877	100.00
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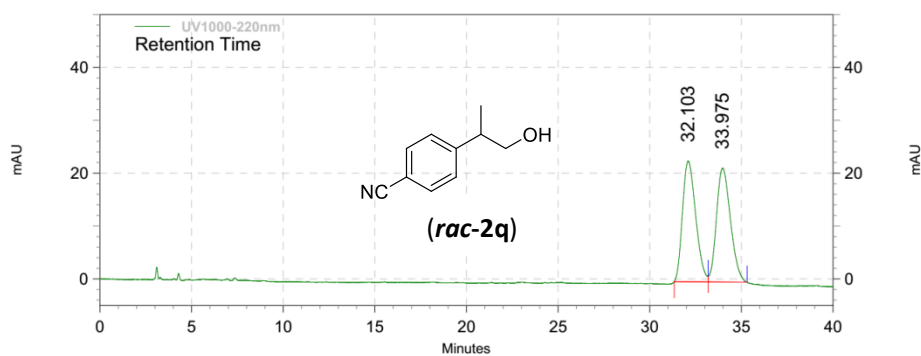


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
16.707	993747	36.77	30516	39.78
18.512	1708571	63.23	46198	60.22

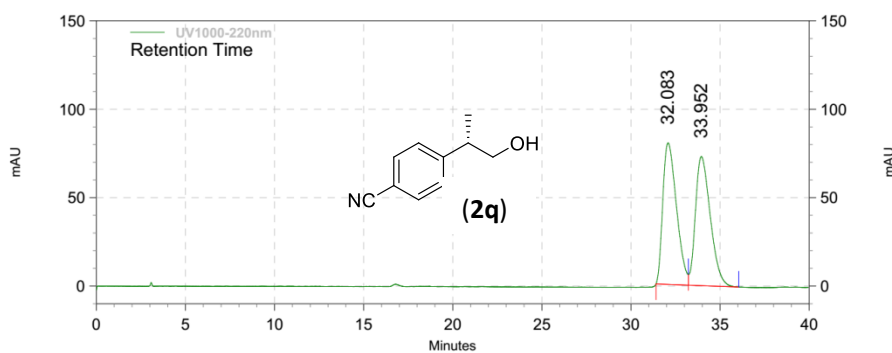
Totals	2702318	100.00	76714	100.00
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#### UV1000-220nm

##### Results

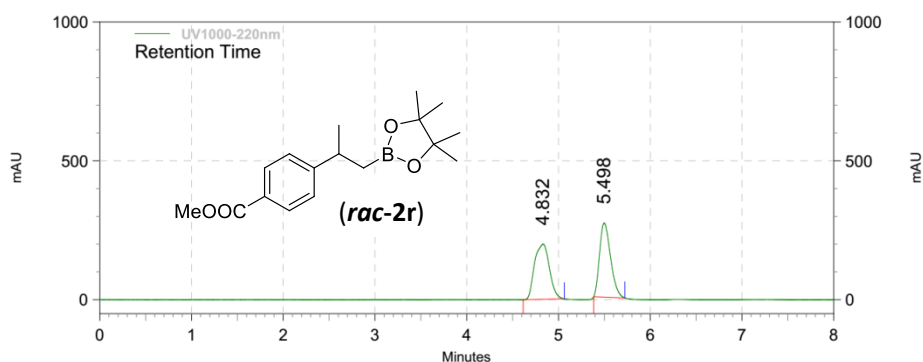
Retention Time	Area	Area %	Height	Height %
32.103	1143488	49.96	22837	51.48
33.975	1145441	50.04	21527	48.52
Totals	2288929	100.00	44364	100.00



#### UV1000-220nm

##### Results

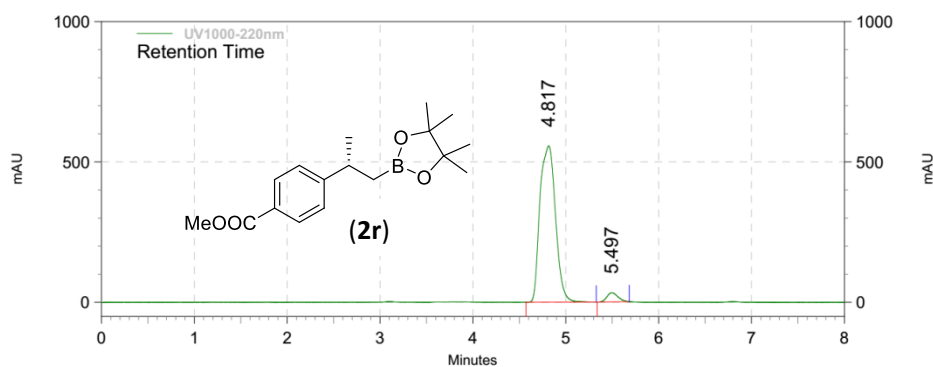
Retention Time	Area	Area %	Height	Height %
32.083	4265891	50.12	79992	52.29
33.952	4245668	49.88	72978	47.71
Totals	8511559	100.00	152970	100.00



**UV1000-220nm  
Results**

Retention Time	Area	Area %	Height	Height %
4.832	2232704	50.07	198658	42.65
5.498	2226034	49.93	267181	57.35

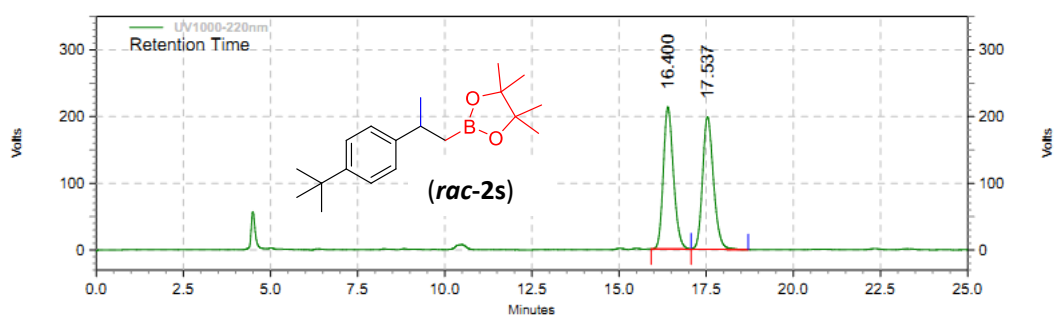
Totals	4458738	100.00	465839	100.00
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**UV1000-220nm  
Results**

Retention Time	Area	Area %	Height	Height %
4.817	6476998	96.01	556338	94.43
5.497	269265	3.99	32799	5.57

Totals	6746263	100.00	589137	100.00
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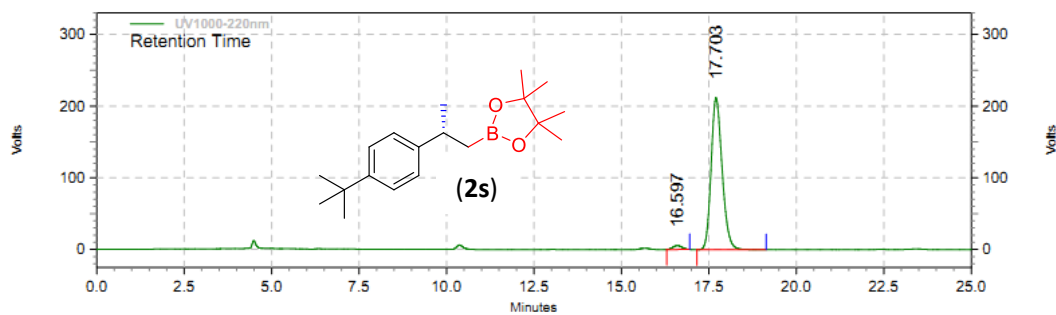


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
16.400	4307064	49.79	213181	51.72
17.537	4343597	50.21	199012	48.28

Totals	8650661	100.00	412193	100.00
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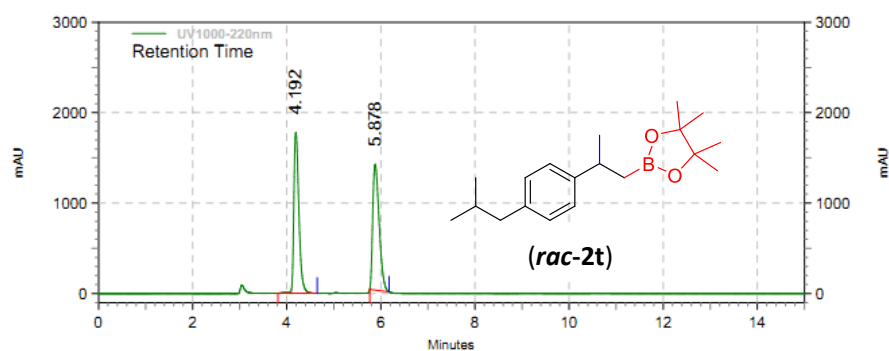
#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
16.597	99245	2.08	5432	2.50
17.703	4664860	97.92	211975	97.50

Totals	4764105	100.00	217407	100.00
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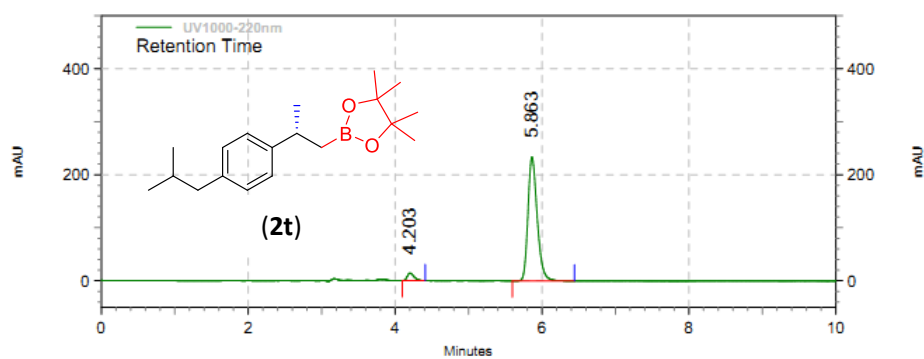


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
4.192	13175467	49.92	1777894	56.10
5.878	13215887	50.08	1391167	43.90

Totals	26391354	100.00	3169061	100.00
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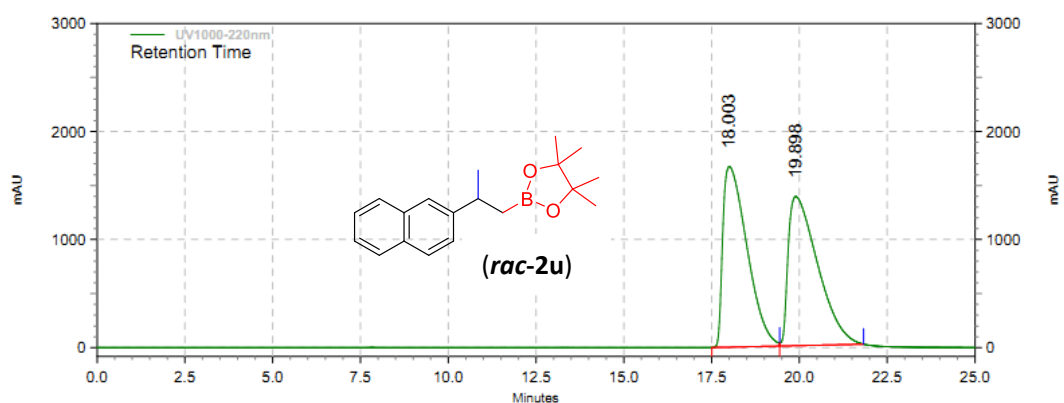


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
4.203	92205	4.32	14295	5.77
5.863	2041705	95.68	233459	94.23

Totals	2133910	100.00	247754	100.00
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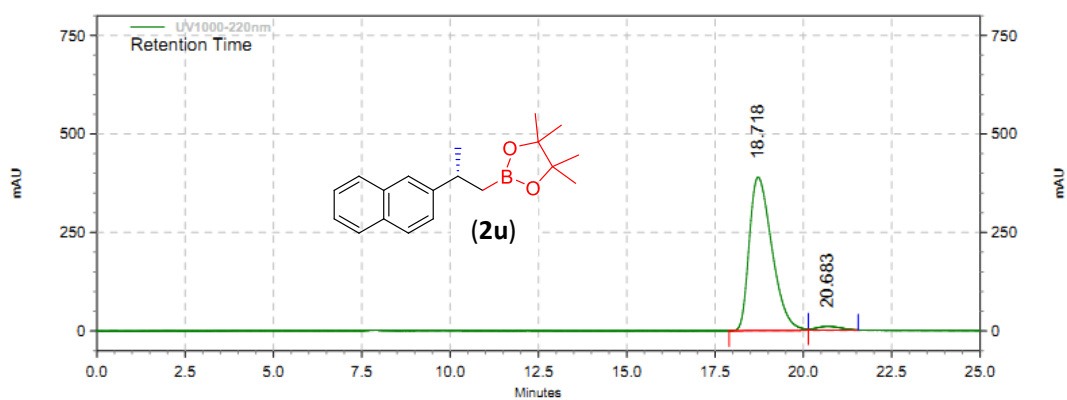


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
18.003	79965494	49.83	1670678	54.76
19.898	80520172	50.17	1380142	45.24

Totals	160485666	100.00	3050820	100.00
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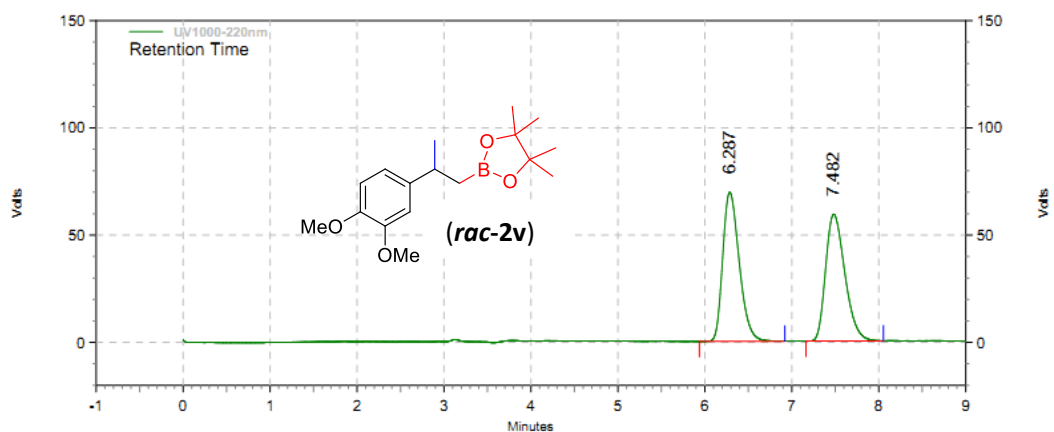


#### UV1000-220nm

##### Results

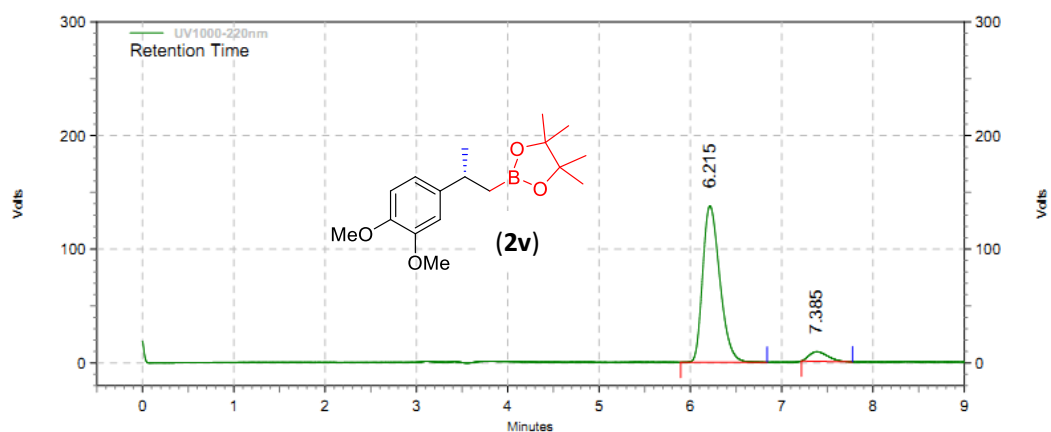
Retention Time	Area	Area %	Height	Height %
18.718	17335309	97.45	389107	97.59
20.683	452827	2.55	9629	2.41

Totals	17788136	100.00	398736	100.00
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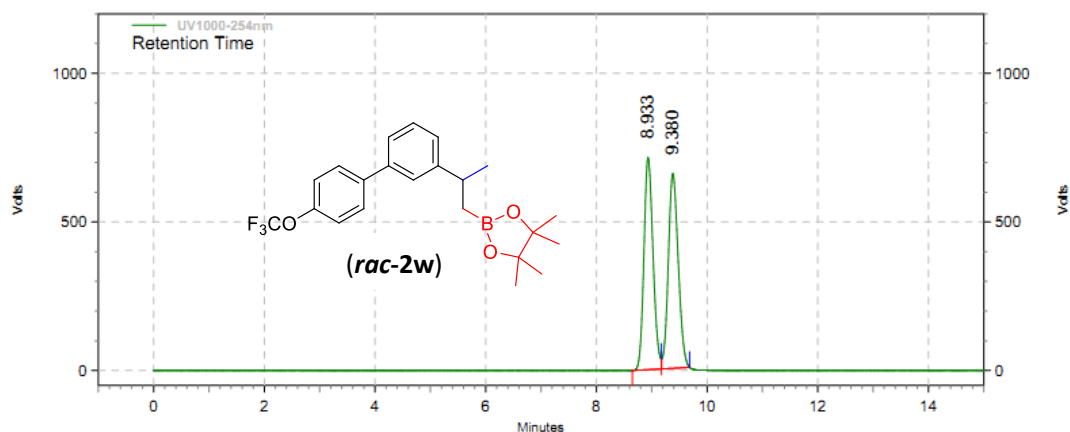
**UV1000-220nm  
Results**

Retention Time	Area	Area %	Height	Height %
6.287	918831	50.27	69491	54.04
7.482	908836	49.73	59112	45.96
Totals	1827667	100.00	128603	100.00



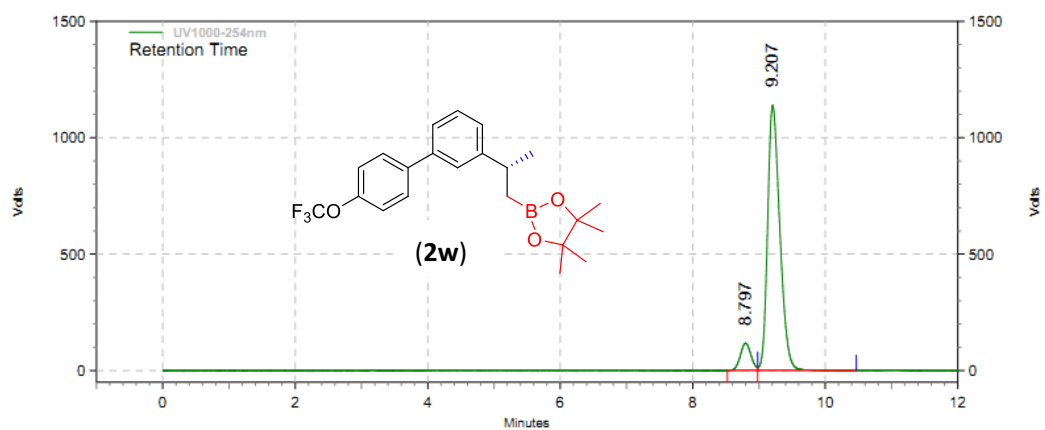
**UV1000-220nm  
Results**

Retention Time	Area	Area %	Height	Height %
6.215	1793684	93.76	137576	94.25
7.385	119373	6.24	8393	5.75
Totals	1913057	100.00	145969	100.00



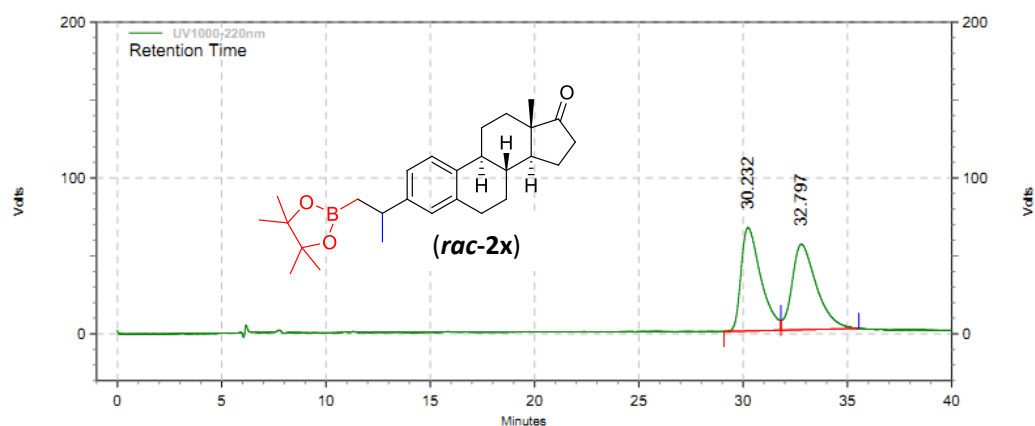
**UV1000-254nm  
Results**

Retention Time	Area	Area %	Height	Height %
8.933	8137736	49.98	713445	52.15
9.380	8143242	50.02	654553	47.85
Totals	16280978	100.00	1367998	100.00



**UV1000-254nm  
Results**

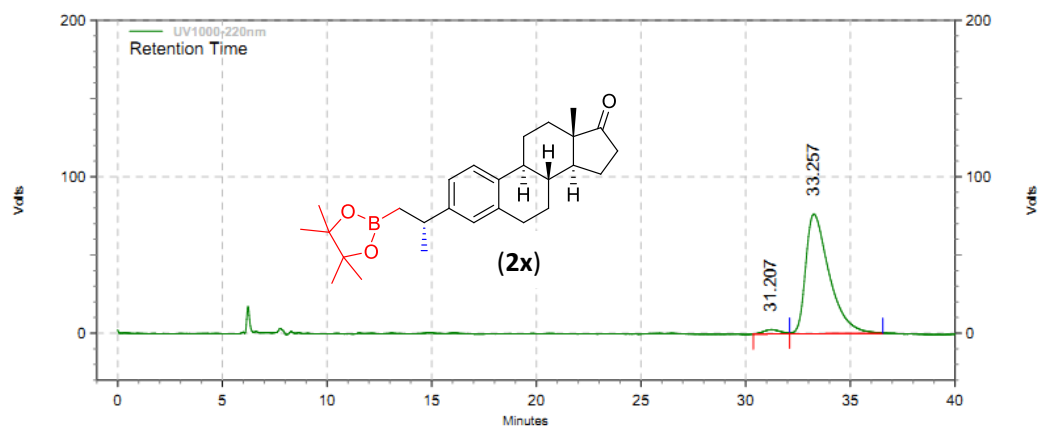
Retention Time	Area	Area %	Height	Height %
8.797	1313131	8.26	117261	9.34
9.207	14581061	91.74	1138655	90.66
Totals	15894192	100.00	1255916	100.00



**UV1000-220nm  
Results**

Retention Time	Area	Area %	Height	Height %
30.232	4369288	49.45	66250	54.70
32.797	4467271	50.55	54861	45.30

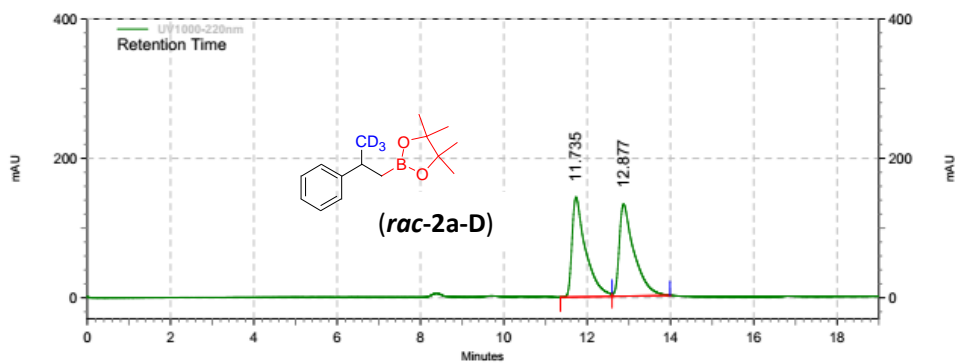
Totals	8836559	100.00	121111	100.00
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**UV1000-220nm  
Results**

Retention Time	Area	Area %	Height	Height %
31.207	152135	2.49	2769	3.49
33.257	5967384	97.51	76524	96.51

Totals	6119519	100.00	79293	100.00
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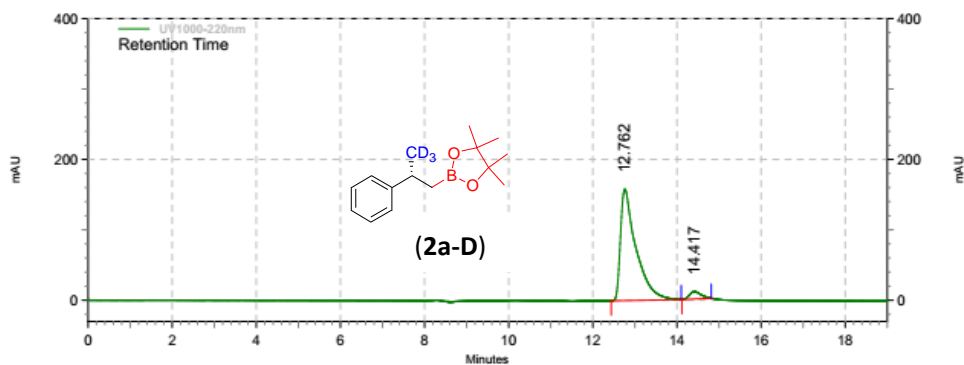


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
11.735	3256694	49.92	143190	52.05
12.877	3267661	50.08	131933	47.95

Totals	6524355	100.00	275123	100.00
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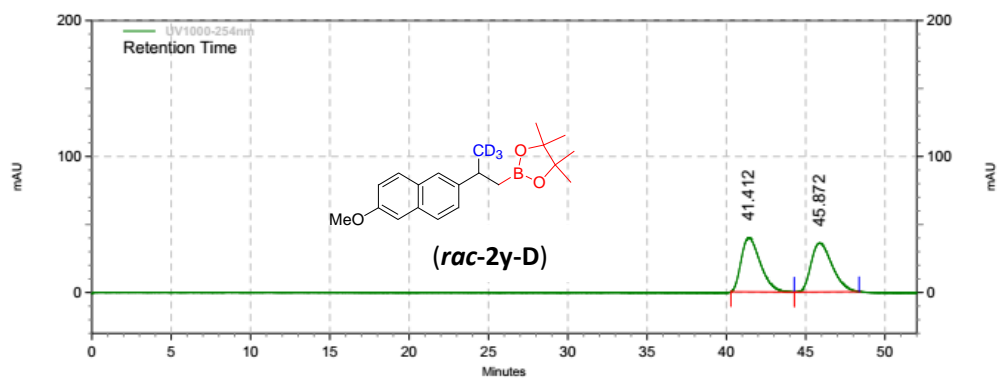


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
12.762	4057592	95.32	158126	93.74
14.417	199331	4.68	10563	6.26

Totals	4256923	100.00	168689	100.00
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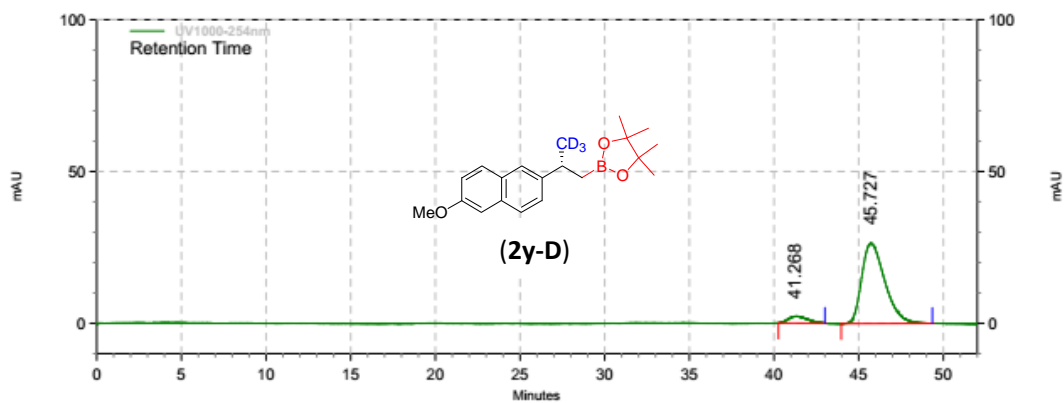


#### UV1000-254nm

##### Results

Retention Time	Area	Area %	Height	Height %
41.412	3332905	50.07	39761	52.53
45.872	3323409	49.93	35933	47.47

Totals	6656314	100.00	75694	100.00
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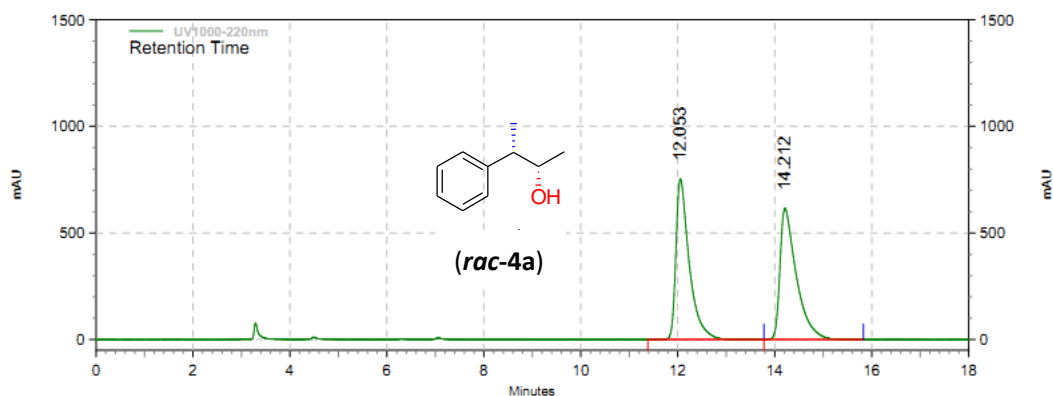


#### UV1000-254nm

##### Results

Retention Time	Area	Area %	Height	Height %
41.268	173995	6.50	2215	7.73
45.727	2504086	93.50	26435	92.27

Totals	2678081	100.00	28650	100.00
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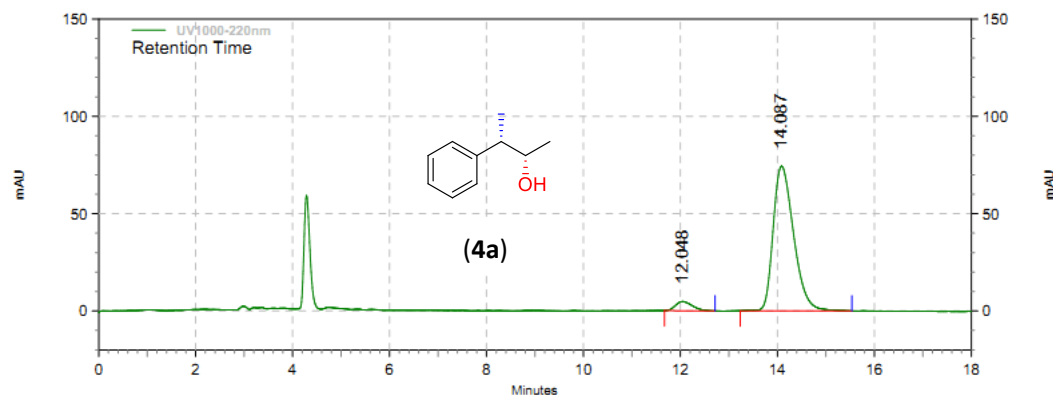


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
12.053	14452208	50.01	754183	55.06
14.212	14448952	49.99	615599	44.94

Totals	28901160	100.00	1369782	100.00
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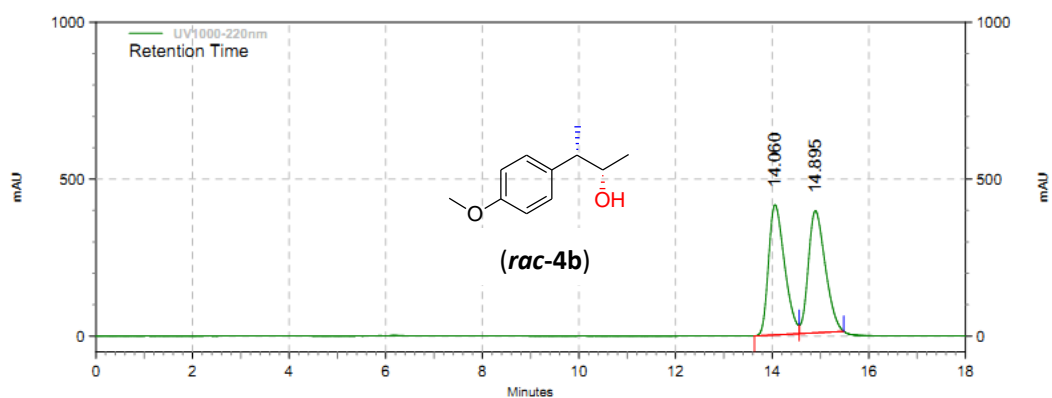
#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
12.048	115137	5.01	4742	5.99
14.087	2184005	94.99	74362	94.01

Totals	2299142	100.00	79104	100.00
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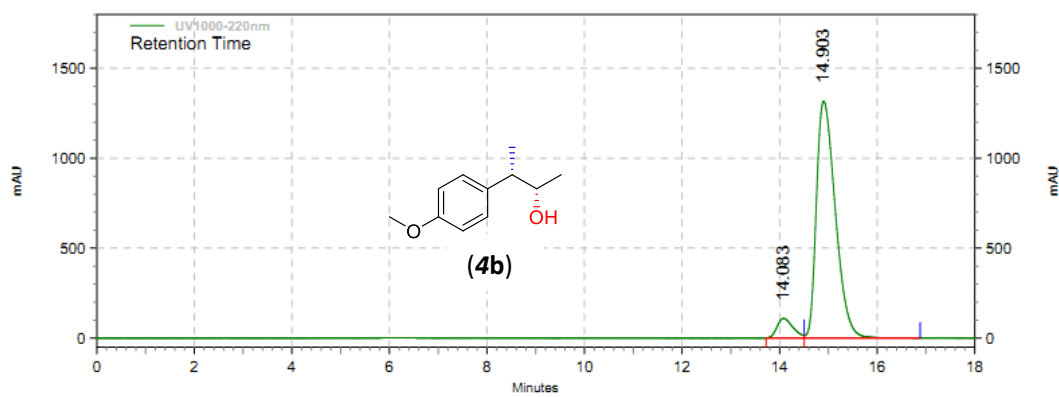


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
14.060	9519757	50.06	414393	51.57
14.895	9498811	49.94	389085	48.43

Totals	19018568	100.00	803478	100.00
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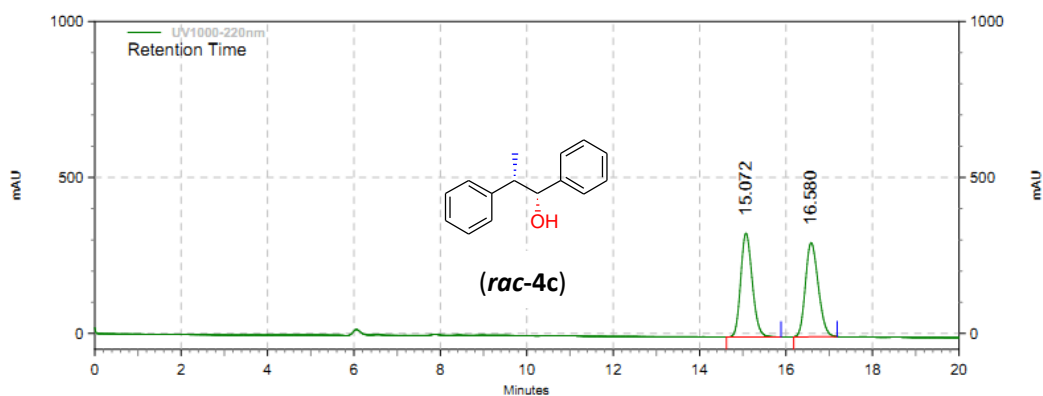


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
14.083	2462807	6.49	108677	7.62
14.903	35467423	93.51	1318163	92.38

Totals	37930230	100.00	1426840	100.00
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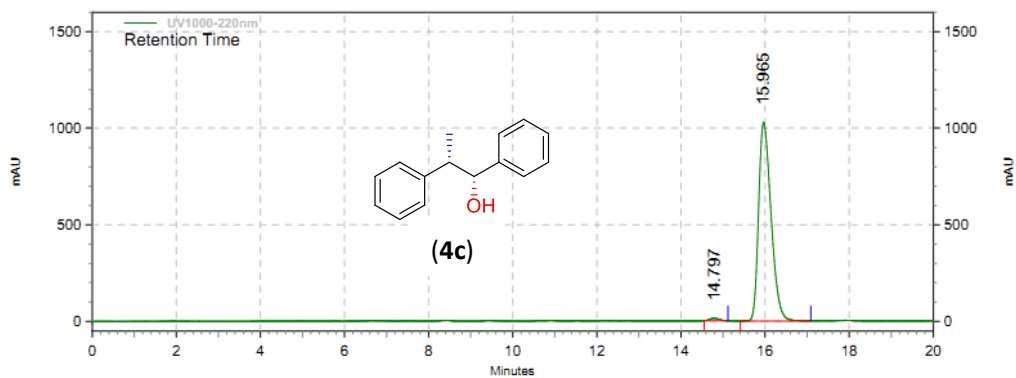


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
15.072	6191568	49.82	332512	52.43
16.580	6236920	50.18	301727	47.57

Totals	12428488	100.00	634239	100.00
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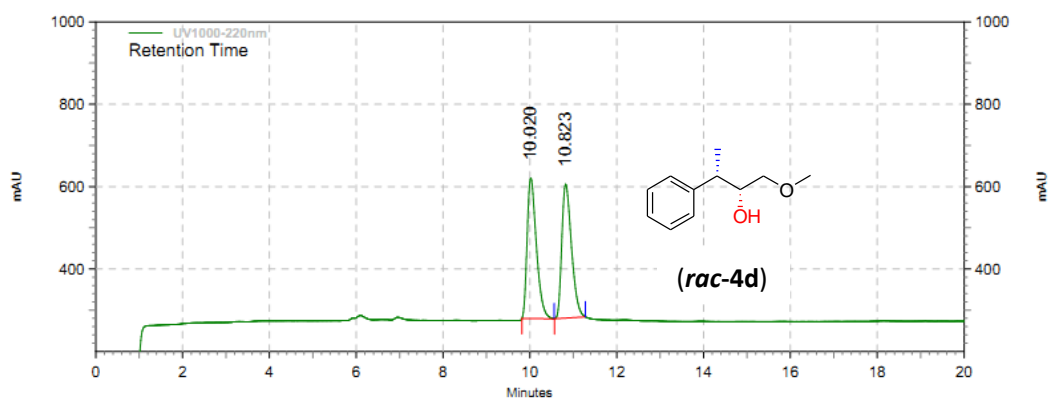


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
14.797	212870	1.00	13155	1.26
15.965	21080327	99.00	1027894	98.74

Totals	21293197	100.00	1041049	100.00
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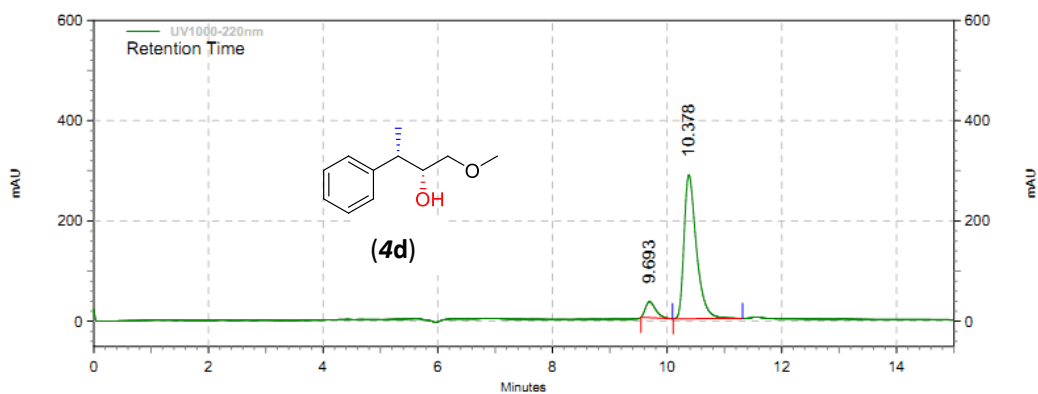


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
10.020	5046521	50.05	341314	51.21
10.823	5035656	49.95	325140	48.79

Totals	10082177	100.00	666454	100.00
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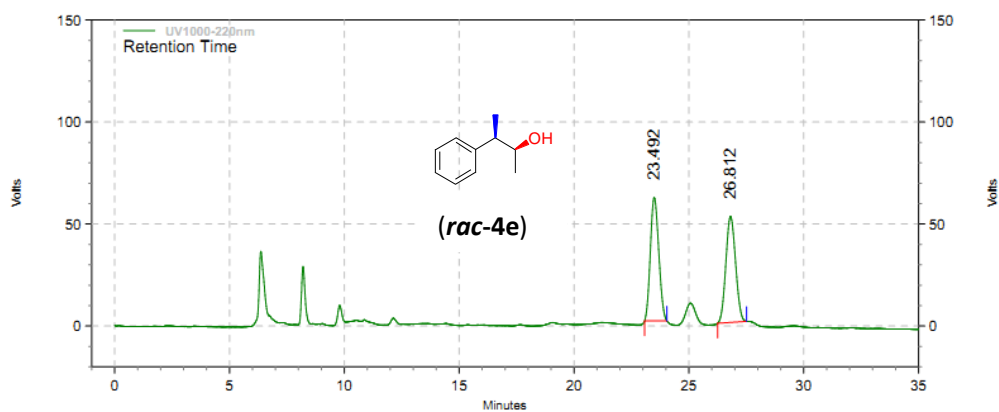


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
9.693	393449	8.40	31816	9.98
10.378	4291315	91.60	287045	90.02

Totals	4684764	100.00	318861	100.00
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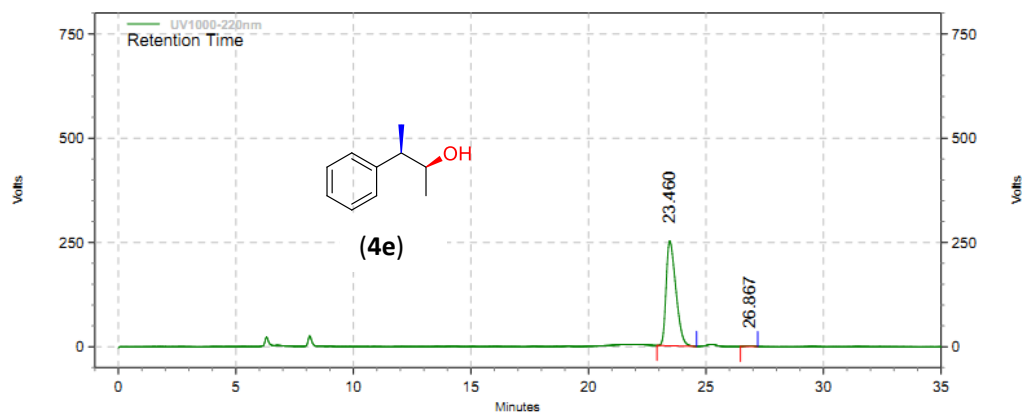


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
23.492	1535228	50.15	60468	53.78
26.812	1525743	49.85	51965	46.22

Totals	3060971	100.00	112433	100.00
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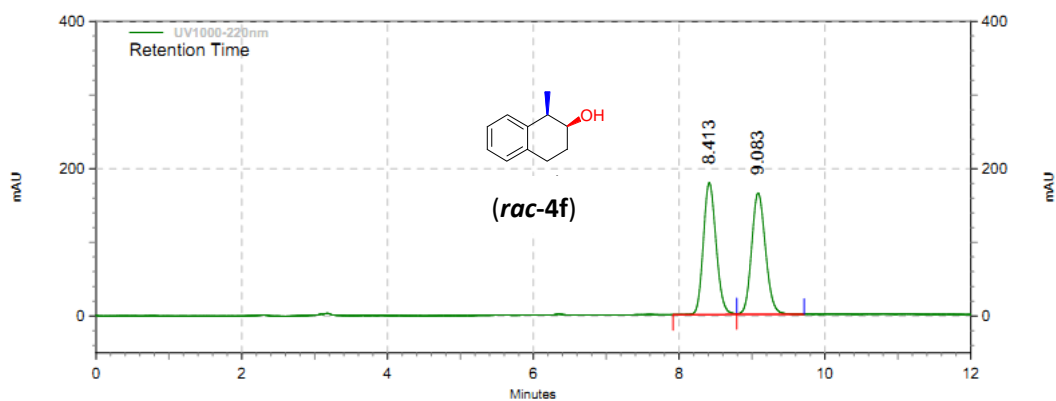


#### UV1000-220nm

##### Results

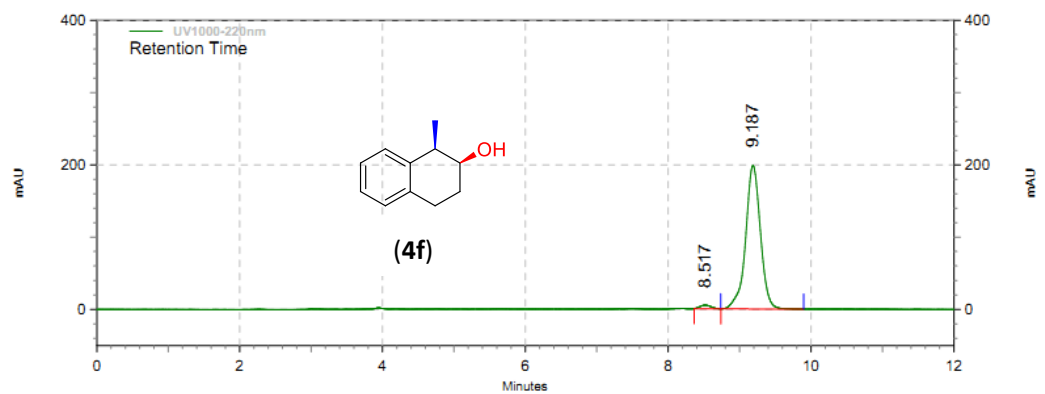
Retention Time	Area	Area %	Height	Height %
23.460	7226962	99.36	250910	99.25
26.867	46494	0.64	1902	0.75

Totals	7273456	100.00	252812	100.00
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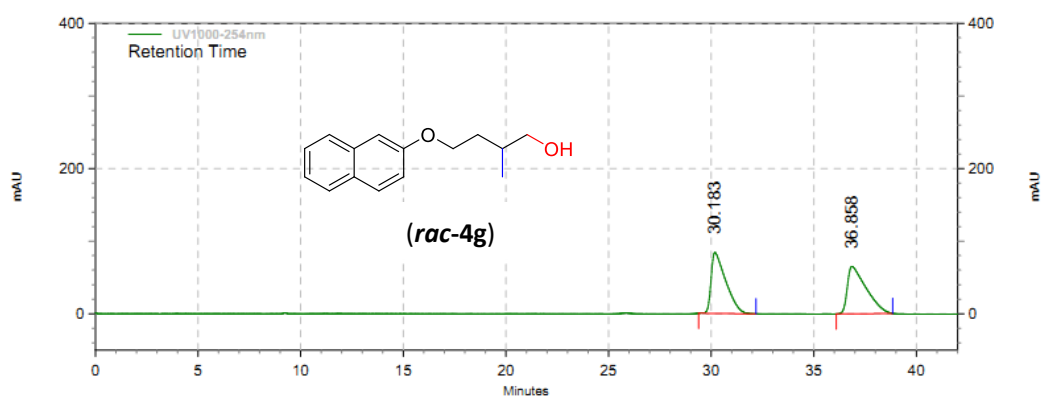
**UV1000-220nm  
Results**

Retention Time	Area	Area %	Height	Height %
8.413	2179208	49.91	178920	52.03
9.083	2186990	50.09	164933	47.97
Totals	4366198	100.00	343853	100.00



**UV1000-220nm  
Results**

Retention Time	Area	Area %	Height	Height %
8.517	52315	1.80	4904	2.41
9.187	2858486	98.20	198397	97.59
Totals	2910801	100.00	203301	100.00

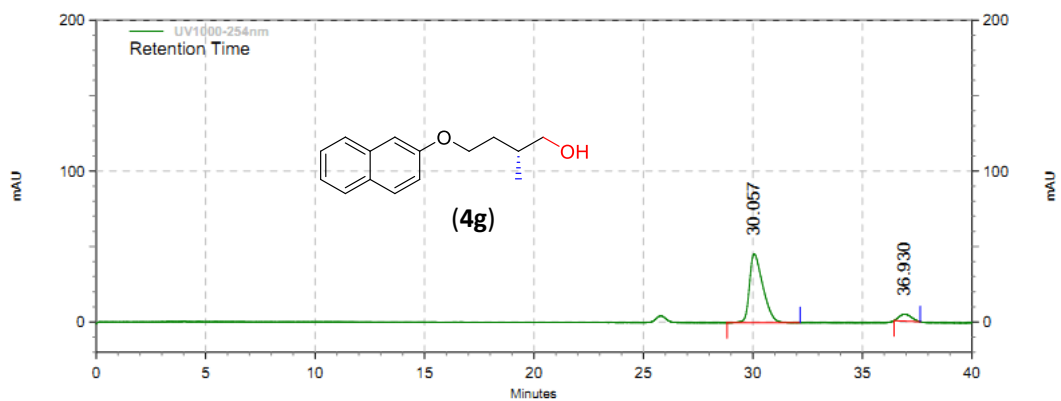


#### UV1000-254nm

##### Results

Retention Time	Area	Area %	Height	Height %
30.183	4176599	50.15	83959	56.26
36.858	4151475	49.85	65277	43.74

Totals	8328074	100.00	149236	100.00
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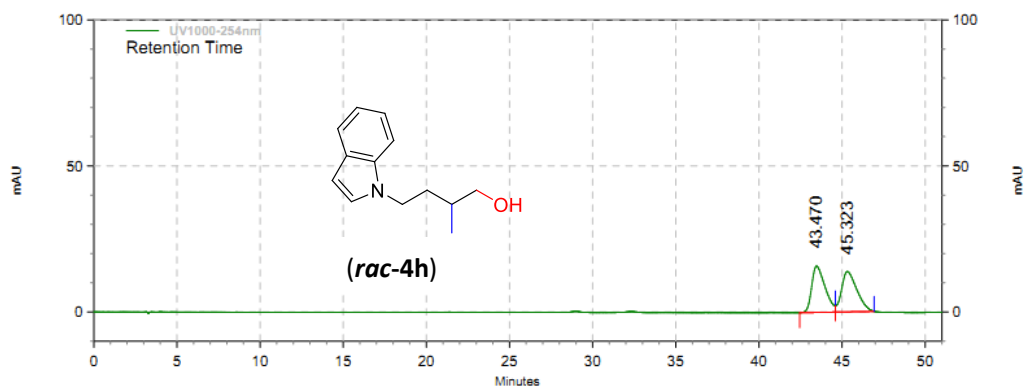


#### UV1000-254nm

##### Results

Retention Time	Area	Area %	Height	Height %
30.057	1940711	91.66	45685	90.90
36.930	176589	8.34	4571	9.10

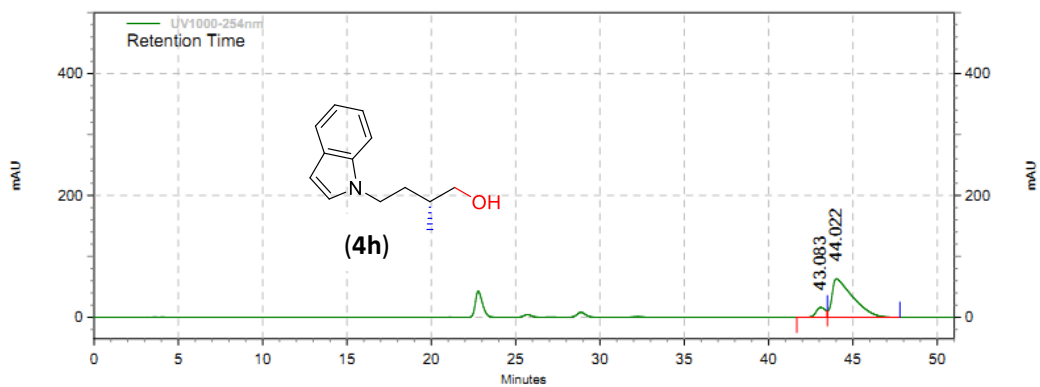
Totals	2117300	100.00	50256	100.00
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#### UV1000-254nm

##### Results

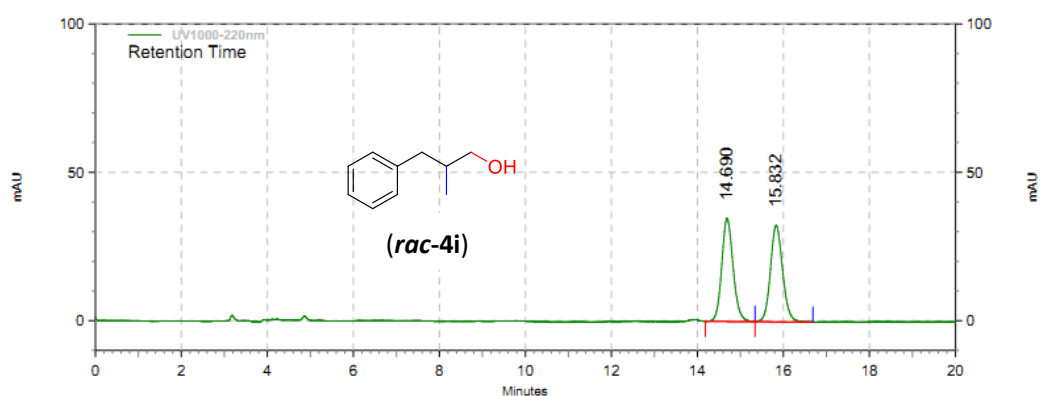
Retention Time	Area	Area %	Height	Height %
43.470	881562	50.05	15814	53.43
45.323	879931	49.95	13783	46.57
Totals	1761493	100.00	29597	100.00



#### UV1000-254nm

##### Results

Retention Time	Area	Area %	Height	Height %
43.083	625050	10.30	16170	20.37
44.022	5443593	89.70	63201	79.63
Totals	6068643	100.00	79371	100.00

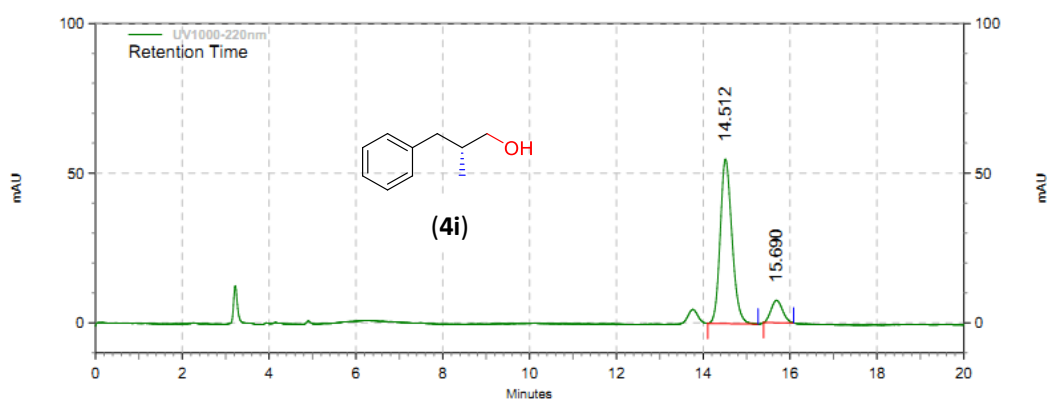


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
14.690	640077	49.95	34781	51.66
15.832	641377	50.05	32541	48.34

Totals	1281454	100.00	67322	100.00
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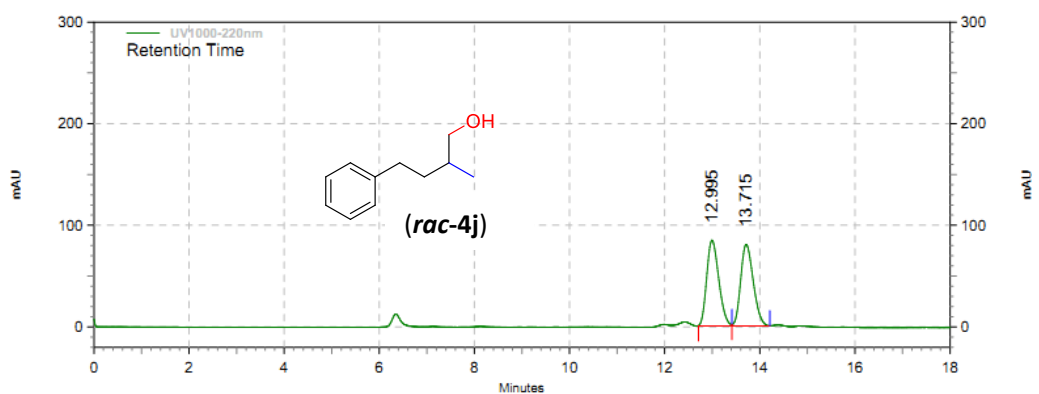
#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
14.512	1035401	88.19	54979	87.98
15.690	138709	11.81	7511	12.02

Totals	1174110	100.00	62490	100.00
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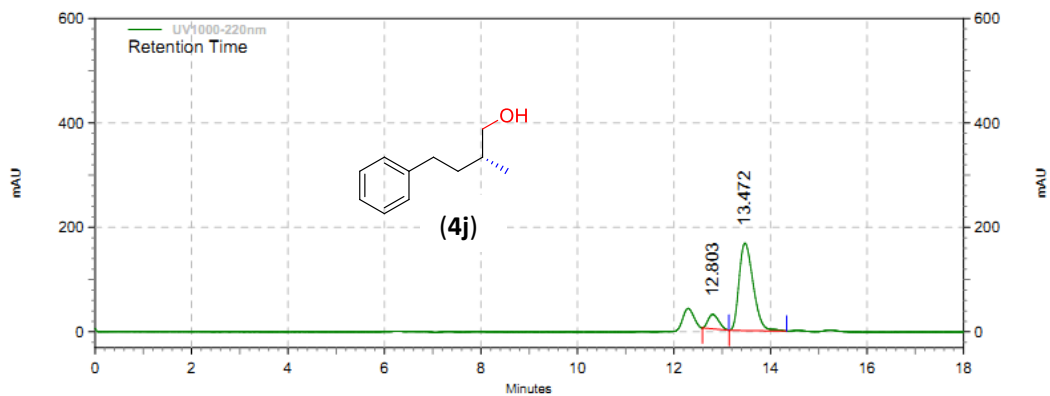


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
12.995	1476038	50.12	84210	51.24
13.715	1469121	49.88	80146	48.76

Totals	2945159	100.00	164356	100.00
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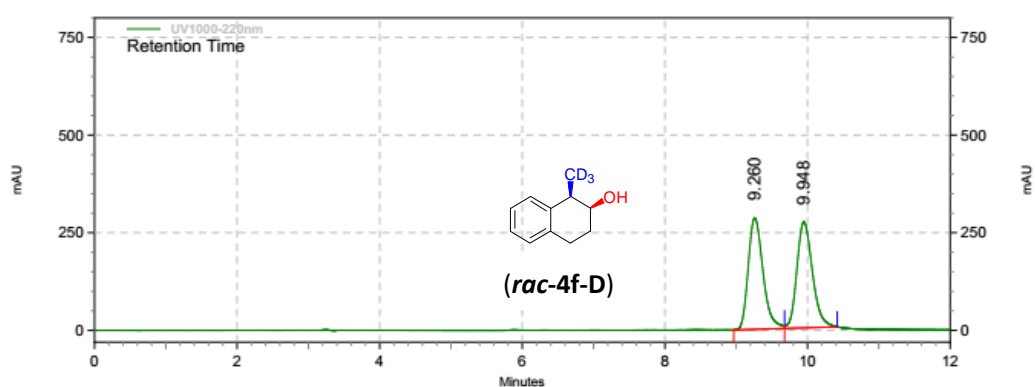


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
12.803	427186	11.16	27781	14.24
13.472	3399415	88.84	167289	85.76

Totals	3826601	100.00	195070	100.00
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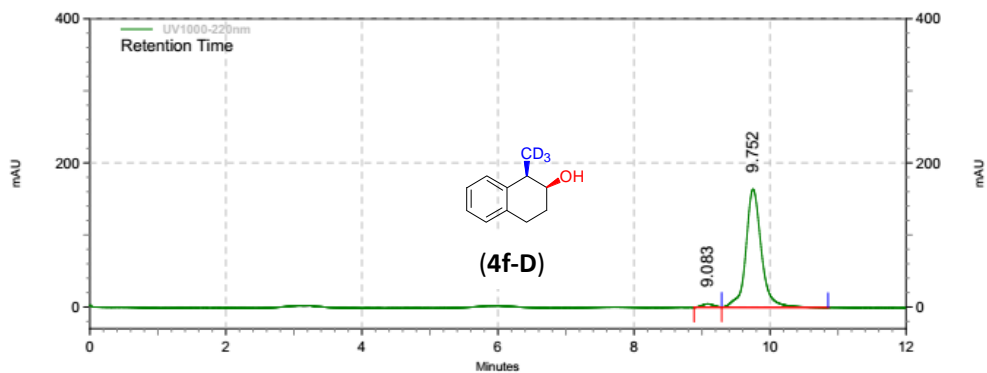


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
9.260	4094735	49.90	285369	51.29
9.948	4111902	50.10	271043	48.71

Totals	8206637	100.00	556412	100.00
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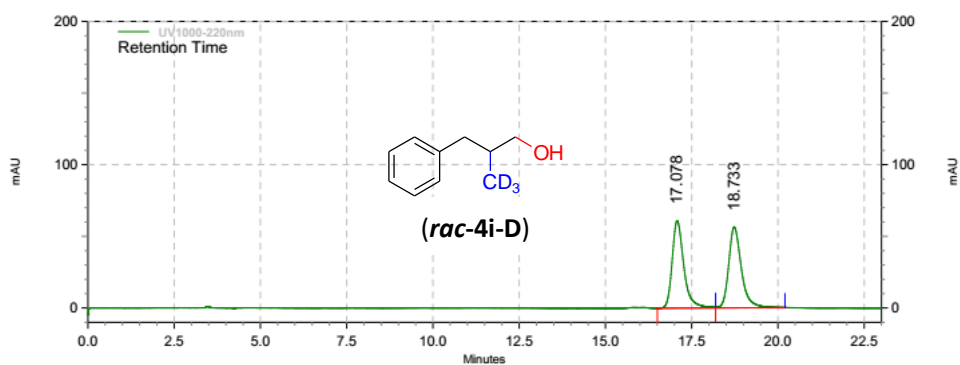


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
9.083	56549	2.14	4736	2.81
9.752	2584084	97.86	163986	97.19

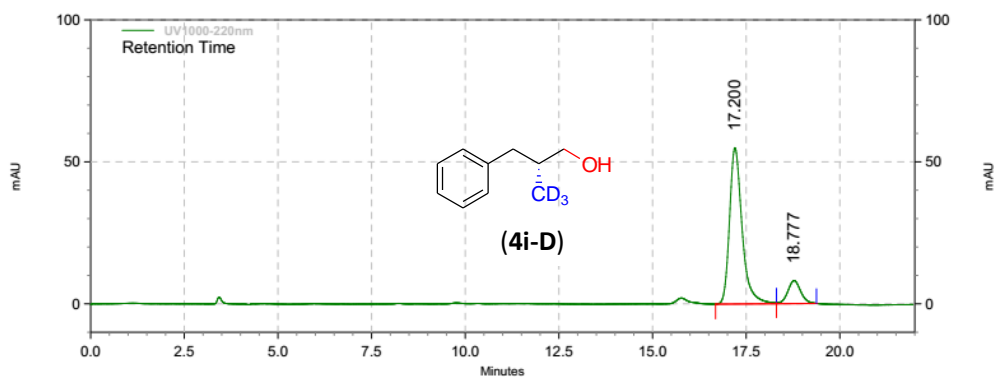
Totals	2640633	100.00	168722	100.00
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#### UV1000-220nm

##### Results

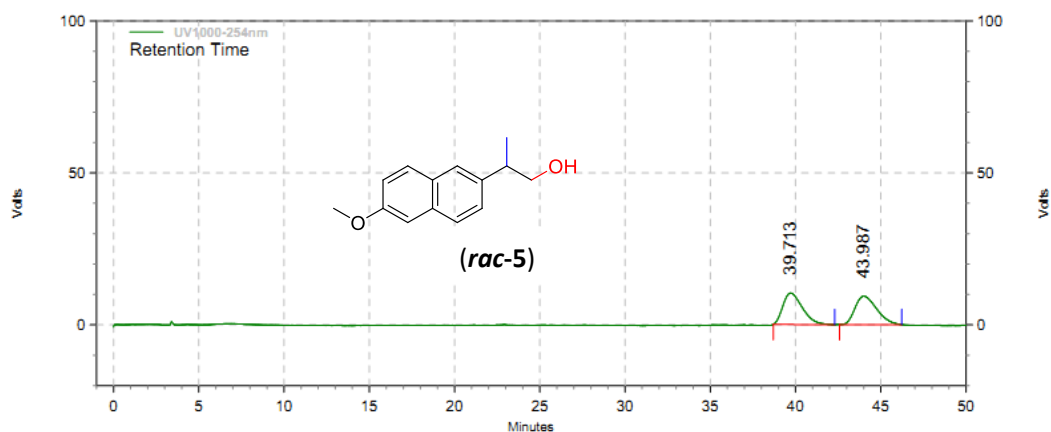
Retention Time	Area	Area %	Height	Height %
17.078	1436981	49.93	61135	52.01
18.733	1440886	50.07	56407	47.99
Totals	2877867	100.00	117542	100.00



#### UV1000-220nm

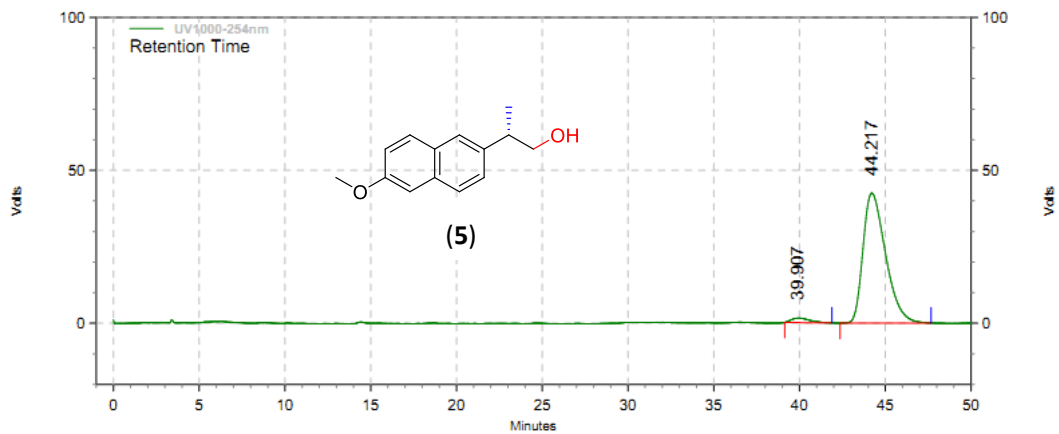
##### Results

Retention Time	Area	Area %	Height	Height %
17.200	1284779	86.91	55037	87.17
18.777	193548	13.09	8098	12.83
Totals	1478327	100.00	63135	100.00



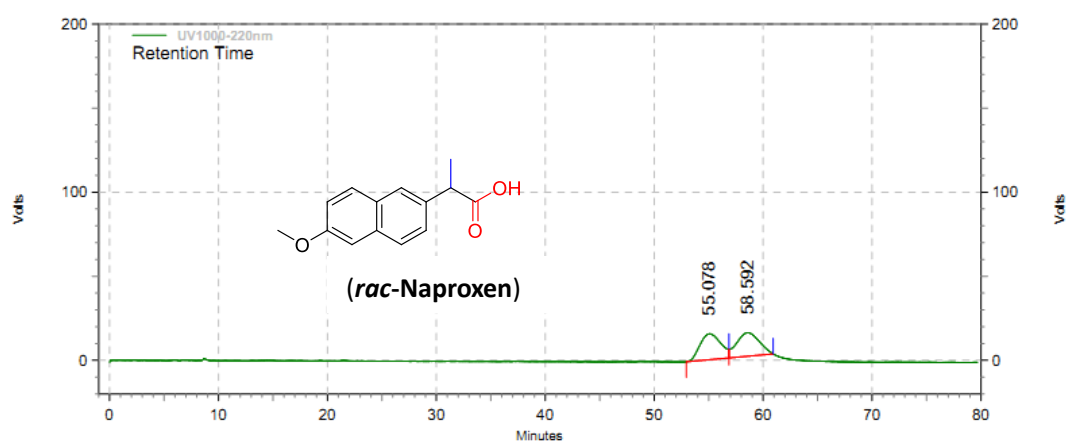
**UV1000-254nm  
Results**

Retention Time	Area	Area %	Height	Height %
39.713	822679	49.82	10342	52.51
43.987	828576	50.18	9354	47.49
Totals	1651255	100.00	19696	100.00



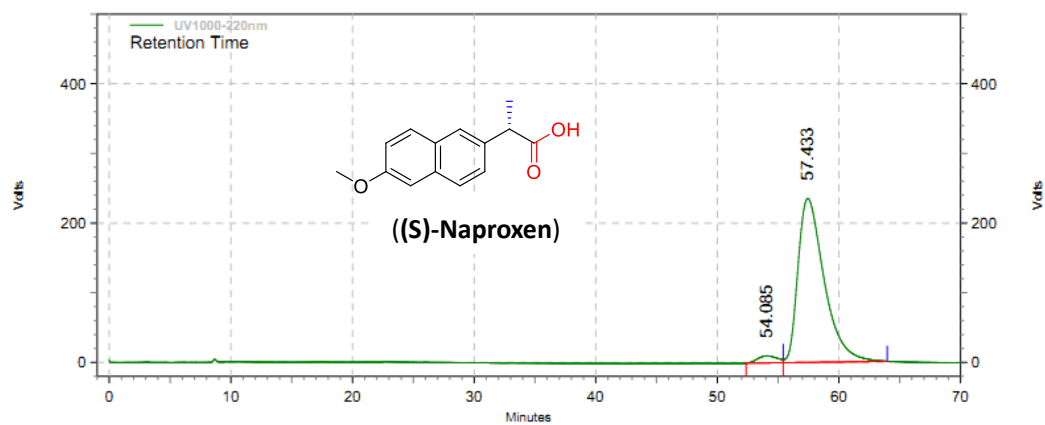
**UV1000-254nm  
Results**

Retention Time	Area	Area %	Height	Height %
39.907	109835	2.75	1449	3.30
44.217	3888296	97.25	42524	96.70
Totals	3998131	100.00	43973	100.00



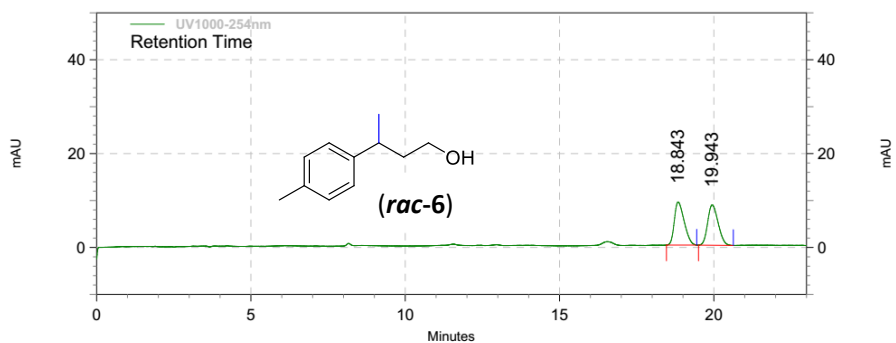
**UV1000-220nm  
Results**

Retention Time	Area	Area %	Height	Height %
55.078	2040234	50.17	15386	52.30
58.592	2026484	49.83	14032	47.70
Totals	4066718	100.00	29418	100.00



**UV1000-220nm  
Results**

Retention Time	Area	Area %	Height	Height %
54.085	1141922	3.14	10107	4.12
57.433	35232270	96.86	235460	95.88
Totals	36374192	100.00	245567	100.00

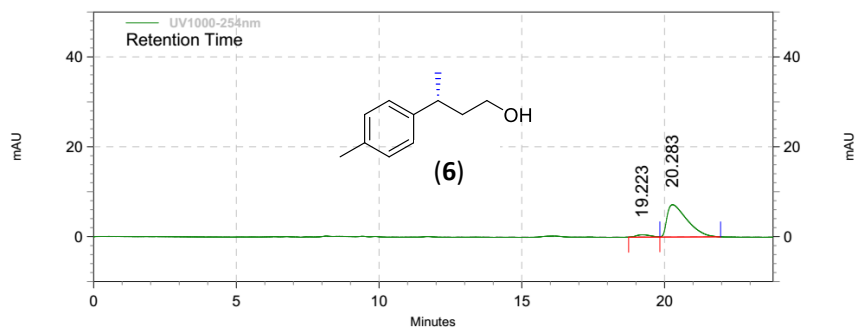


#### UV1000-254nm

##### Results

Retention Time	Area	Area %	Height	Height %
18.843	203212	50.01	9180	51.63
19.943	203092	49.99	8600	48.37

Totals	406304	100.00	17780	100.00
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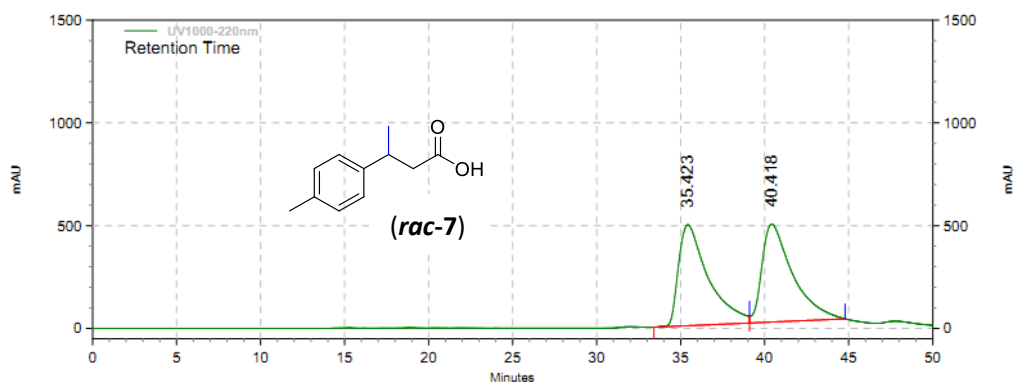


#### UV1000-254nm

##### Results

Retention Time	Area	Area %	Height	Height %
19.223	17946	4.88	529	6.85
20.283	349873	95.12	7196	93.15

Totals	367819	100.00	7725	100.00
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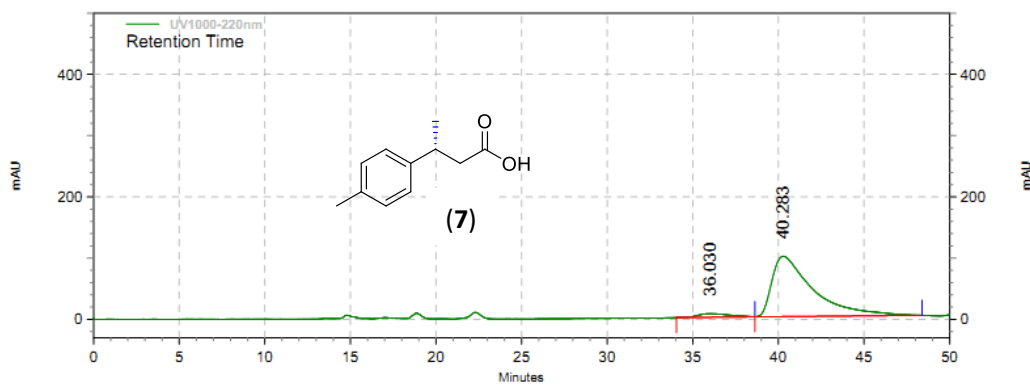


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
35.423	60291281	49.86	490744	50.73
40.418	60630393	50.14	476557	49.27

Totals	120921674	100.00	967301	100.00
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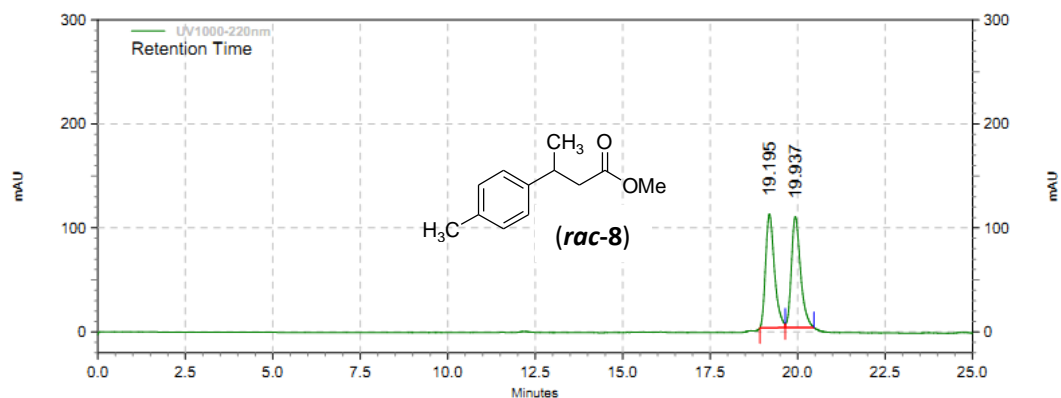


#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
36.030	757884	4.43	5773	5.54
40.283	16339049	95.57	98471	94.46

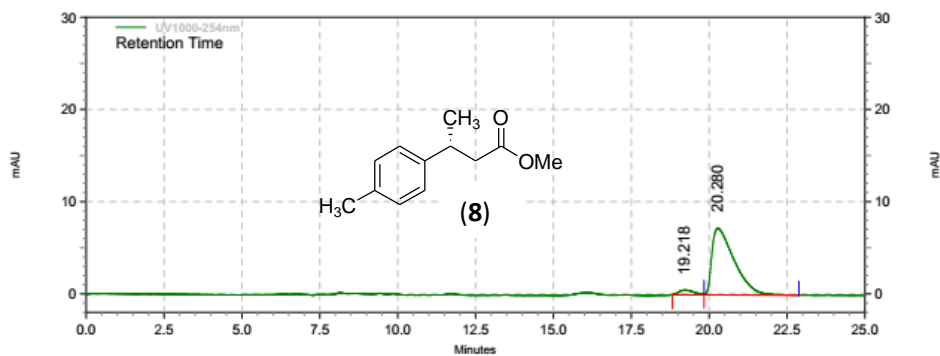
Totals	17096933	100.00	104244	100.00
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#### UV1000-220nm

##### Results

Retention Time	Area	Area %	Height	Height %
19.195	1924987	49.72	109216	50.58
19.937	1946508	50.28	106714	49.42
Totals	3871495	100.00	215930	100.00



#### UV1000-254nm

##### Results

Retention Time	Area	Area %	Height	Height %
19.218	17033	4.56	512	6.63
20.280	356734	95.44	7216	93.37
Totals	373767	100.00	7728	100.00