

# **Asymmetric organocatalytic conjugated addition of pyrazolin-5-ones to *ortho*-quinomethanes: construction of vicinal tertiary and all-carbon quaternary stereocenters**

Ming-Ming Chu,<sup>a</sup> Suo-Suo Qi,<sup>a</sup> Wan-Zhen Ju,<sup>a</sup> Yi-Feng Wang,<sup>a\*</sup> Xue-Yang Chen,<sup>a</sup>  
Dan-Qian Xu,<sup>a\*</sup> Zhen-Yuan Xu<sup>a</sup>

<sup>a</sup> Catalytic Hydrogenation Research Center, State Key Laboratory Breeding Base of Green  
Chemistry-Synthesis Tech-nology, Key Laboratory of Green Pesticides and Cleaner Production  
Technology of Zhejiang Province, Department of Green Chemistry and Technology  
Zhejiang University of Technology  
Hangzhou 310014, China  
E-mail: [chrc@zjut.edu.cn](mailto:chrc@zjut.edu.cn)

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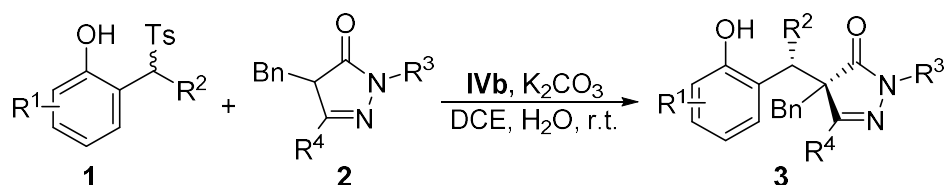
## 1. General information

Unless otherwise stated, all reagents were purchased from commercial suppliers and used without purifications. 2-(phenyl(tosyl)methyl)phenols<sup>[1]</sup> and pyrazolin-5-ones<sup>[2]</sup> were synthesized according to the known method. All reactions were carried out in glassware. Reactions were monitored by TLC on silica gel precoated on glass plates, and spots were visualized with UV light at 254nm. Flash column chromatography was performed on silica-gel. <sup>1</sup>H and <sup>13</sup>C NMR were recorded in CDCl<sub>3</sub> on Bruker AVANCE III (500 MHz). TMS served as internal standard (d= 0 ppm) for <sup>1</sup>H NMR and CDCl<sub>3</sub> was used as internal standard (d= 77.0 ppm) for <sup>13</sup>C NMR; High-resolution electrospray ionization mass spectra (HR-ESI-MS) were recorded on an Agilent 6545 Q-TOF LCMS spectrometer equipped with an ESI source and controlled by using MassHunter software. Specific rotations were performed on a Rudolph Autopol IV automatic polarimeter. Chiral HPLC analyses were performed using Agilent 1260 chromatography. Chiralpak IA, IC, ID, and OD-H columns were purchased from Daicel Chemical Industries (Shanghai, China).

[1] M.-W. Chen, L.-L. Cao, Z.-S. Ye, G.-F. Jiang, Y.-G. Zhou, *Chem. Commun.* **2013**, 49, 1660-1662.

[2] Z. Wang, Z. Yang, D. Chen, X. Liu, L. Lin, X. Feng, *Angew. Chem. Int. Ed.* **2011**, 50, 4928-4932.

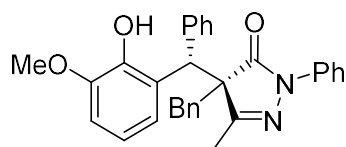
## 2. General procedure for the synthesis of 3



To a test tube were added catalyst **IVb** (0.05 mmol, 5 mol%), K<sub>2</sub>CO<sub>3</sub> (1.2 equiv., 0.12 mmol), the substituted 2-(phenyl(tosyl)methyl)phenol **1** or **4** (0.1 mmol) and pyrazolin-5-ones **2** (1.2 equiv., 0.12 mmol), 1.5 mL DCE and 0.5 mL H<sub>2</sub>O were then added through syringe. The resulting mixture was stirred at room temperature for 12 h. Then it was extracted with CH<sub>2</sub>Cl<sub>2</sub>, and the organic layer was concentrated under reduced pressure. The crude product was purified by flash chromatography to afford the product. The stereoselectivities were determined by Chiral HPLC using a Chiralpak IA, IC, ID, or AD-H column.

## 3. Characterization data of product 3

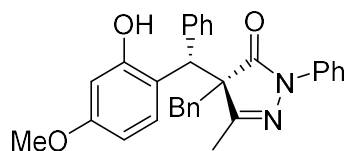
(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (**3aa**)



Compound was isolated as a white solid (93% yield) after flash column chromatography on silica-gel. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.70 (d, *J* = 8.1 Hz, 1H), 7.44 (dd, *J* = 26.6, 7.8 Hz, 4H), 7.31 (t, *J* = 7.9 Hz, 2H), 7.23 (t, *J* = 7.4 Hz, 2H), 7.15 (dq, *J* = 23.1, 7.6 Hz, 7H), 6.92 (t, *J* = 8.1 Hz, 1H), 6.81 (d, *J* = 8.0 Hz, 1H), 6.15 (s, 1H), 5.19 (s, 1H), 3.88 (s, 3H), 3.41 (d, *J* = 13.6 Hz, 1H), 3.14 (d, *J* = 13.6 Hz, 1H), 2.22 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 174.47, 161.62, 146.27, 143.71, 139.26, 137.50, 134.94, 129.24, 128.85, 128.56, 128.48, 128.15, 127.23, 127.09, 125.29, 124.49, 123.94, 120.14, 119.21, 109.33, 63.78, 56.00, 46.78, 40.82, 15.16. [α]<sub>D</sub><sup>25</sup> = 32 (c =

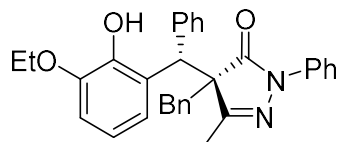
1.0 in CH<sub>2</sub>Cl<sub>2</sub>). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/*i*-PrOH = 70/30), 1.0 mL/min; Major enantiomer: *t*<sub>R</sub> = 7.56 min, minor enantiomer: *t*<sub>R</sub> = 11.13 min. 97:3 *dr*, 99% *ee*. HRMS (ESI) calcd for C<sub>31</sub>H<sub>28</sub>N<sub>2</sub>O<sub>3</sub>Na *m/z* [M + Na]<sup>+</sup>: 499.1992, found: 499.1988.

**(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-4-methoxyphenyl)(phenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3ba)**



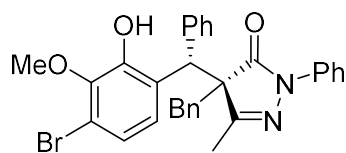
Compound was isolated as a white solid (84% yield) after flash column chromatography on silica-gel. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.69 – 7.65 (m, 1H), 7.46 – 7.43 (m, 1H), 7.38 (d, *J* = 8.5 Hz, 1H), 7.28 (dd, *J* = 3.1, 2.0 Hz, 6H), 7.14 (dd, *J* = 4.3, 2.3 Hz, 5H), 7.07 (dd, *J* = 6.7, 3.0 Hz, 3H), 6.46 (dd, *J* = 8.6, 2.6 Hz, 1H), 6.40 (s, 1H), 4.88 (s, 1H), 3.60 (s, 3H), 3.37 (d, *J* = 13.7 Hz, 1H), 3.02 (d, *J* = 13.6 Hz, 1H), 2.29 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 175.95, 163.25, 160.16, 155.71, 138.81, 136.63, 134.22, 130.53, 129.13, 129.06, 128.66, 128.62, 128.50, 128.39, 128.23, 128.14, 127.33, 127.26, 126.10, 125.49, 120.69, 106.31, 65.36, 55.04, 46.98, 41.24, 15.16. [α]<sub>D</sub><sup>25</sup> = 74 (*c* = 1.0 in CH<sub>2</sub>Cl<sub>2</sub>). The enantiomers were analyzed by HPLC using Daicel Chiralpak AD-H column at 254 nm (n-hexane/*i*-PrOH = 85/15), 1.0 mL/min; Major enantiomer: *t*<sub>R</sub> = 48.4 min, minor enantiomer: *t*<sub>R</sub> = 12.7 min. 56:44 *dr*, 90% *ee*. HRMS (ESI) calcd for C<sub>31</sub>H<sub>28</sub>N<sub>2</sub>O<sub>3</sub>Na *m/z* [M + Na]<sup>+</sup>: 499.1992, found: 499.1992.

**(*R*)-4-benzyl-4-((*S*)-(3-ethoxy-2-hydroxyphenyl)(phenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3ca)**



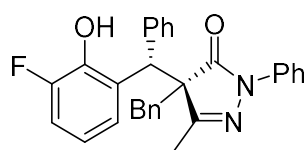
Compound was isolated as a colorless oil (80% yield) after flash column chromatography on silica-gel. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.68 (dd, *J* = 8.1, 1.3 Hz, 1H), 7.44 (ddd, *J* = 25.7, 8.4, 1.2 Hz, 4H), 7.33 – 7.29 (m, 2H), 7.22 (t, *J* = 7.3 Hz, 2H), 7.17 – 7.10 (m, 7H), 6.89 (t, *J* = 8.1 Hz, 1H), 6.79 (dd, *J* = 8.1, 1.4 Hz, 1H), 6.14 (s, 1H), 6.01 (s, 0H), 5.19 (s, 1H), 4.12 (dd, *J* = 12.7, 7.0 Hz, 2H), 3.41 (d, *J* = 13.6 Hz, 1H), 3.14 (d, *J* = 13.6 Hz, 1H), 2.22 (s, 3H), 1.46 (t, *J* = 7.0 Hz, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 174.46, 161.59, 145.50, 143.79, 139.29, 137.52, 134.97, 129.23, 128.87, 128.54, 128.46, 128.14, 127.20, 127.07, 125.26, 124.45, 123.77, 120.12, 119.17, 110.16, 64.56, 63.77, 46.78, 40.82, 15.16, 14.91. [α]<sub>D</sub><sup>25</sup> = 25 (*c* = 1.0 in CH<sub>2</sub>Cl<sub>2</sub>). The enantiomers were analyzed by HPLC using Daicel Chiralpak ID column at 254 nm (n-hexane/*i*-PrOH = 70/30), 0.7 mL/min; Major enantiomer: *t*<sub>R</sub> = 10.68 min, minor enantiomer: *t*<sub>R</sub> = 43.44 min. 88:12 *dr*, 99% *ee*. HRMS (ESI) calcd for C<sub>32</sub>H<sub>30</sub>N<sub>2</sub>O<sub>3</sub>Na *m/z* [M + Na]<sup>+</sup>: 513.2149, found: 513.2140.

**(*R*)-4-benzyl-4-((*S*)-(4-bromo-2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3da)**



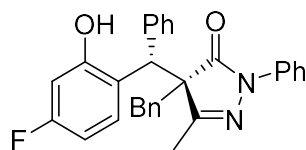
Compound was isolated as a white solid (96% yield) after flash column chromatography on silica-gel. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.94 (d, *J* = 2.0 Hz, 1H), 7.44 (d, *J* = 7.7 Hz, 2H), 7.38 (d, *J* = 7.3 Hz, 2H), 7.32 (t, *J* = 7.9 Hz, 2H), 7.24 (t, *J* = 7.3 Hz, 2H), 7.17 (dt, *J* = 23.2, 7.8 Hz, 7H), 6.92 (d, *J* = 2.2 Hz, 1H), 6.16 (s, 1H), 5.11 (s, 1H), 3.85 (s, 3H), 3.41 (d, *J* = 13.5 Hz, 1H), 3.07 (d, *J* = 13.5 Hz, 1H), 2.20 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 174.32, 161.22, 146.92, 142.94, 138.52, 137.33, 134.67, 129.22, 128.76, 128.63, 128.60, 128.21, 127.50, 127.21, 126.47, 126.19, 125.50, 120.36, 113.00, 111.33, 63.64, 56.27, 46.64, 40.73, 15.09. [α]<sub>D</sub><sup>25</sup> = 54 (c = 1.0 in CH<sub>2</sub>Cl<sub>2</sub>). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer: *t*<sub>R</sub> = 18.60 min, minor enantiomer: *t*<sub>R</sub> = 34.63 min. 98:2 *dr*, 97% *ee*. HRMS (ESI) calcd for C<sub>31</sub>H<sub>27</sub>N<sub>2</sub>O<sub>3</sub>Na *m/z* [M + Na]<sup>+</sup>: 577.1097, found: 577.1099.

**(*R*)-4-benzyl-4-((*S*)-(3-fluoro-2-hydroxyphenyl)(phenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3ea)**



Compound was isolated as white solid (92% yield) after flash column chromatography on silica-gel. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.73 (dd, *J* = 8.1, 1.3 Hz, 1H), 7.45 (dd, *J* = 8.7, 1.2 Hz, 2H), 7.41 – 7.36 (m, 2H), 7.35 – 7.28 (m, 2H), 7.20 – 7.08 (m, 6H), 6.91 (dd, *J* = 9.6, 8.2 Hz, 3H), 6.82 (dd, *J* = 8.1, 1.3 Hz, 1H), 5.17 (s, 1H), 3.89 (s, 3H), 3.41 (d, *J* = 13.6 Hz, 1H), 3.09 (d, *J* = 13.6 Hz, 1H), 2.23 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 174.77, 161.84, 151.59 (d, *J* = 237.5 Hz), 142.30 (d, *J* = 13.9 Hz), 138.44, 137.06, 134.37, 129.13, 128.61, 128.59 (d, *J* = 5.3 Hz), 128.57, 128.23, 127.50, 127.49 (d, *J* = 2.4), 127.28, 127.09, 125.69, 120.36, 119.67 (d, *J* = 7.4 Hz), 114.39 (d, *J* = 18.3 Hz), 64.13, 47.99, 40.80, 15.07. [α]<sub>D</sub><sup>25</sup> = 65 (c = 1.0 in CH<sub>2</sub>Cl<sub>2</sub>). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer: *t*<sub>R</sub> = 15.28 min, minor enantiomer: *t*<sub>R</sub> = 32.80 min. 95:5 *dr*, 88% *ee*. HRMS (ESI) calcd for C<sub>30</sub>H<sub>25</sub>FN<sub>2</sub>O<sub>2</sub>Na *m/z* [M + Na]<sup>+</sup>: 487.1792, found: 487.1791.

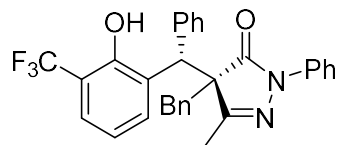
**(*R*)-4-benzyl-4-((*S*)-(4-fluoro-2-hydroxyphenyl)(phenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3fa)**



Compound was isolated as a white solid (93% yield) after flash column chromatography on silica-gel. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 9.08 (s, 1H), 7.51 – 7.46 (m, 1H), 7.29 – 7.22 (m, 9H), 7.16 (dd, *J* = 4.0, 2.5 Hz, 4H), 7.07 (dd, *J* = 6.5, 3.0 Hz, 2H), 6.63 (td, *J* = 8.3, 2.6 Hz, 1H), 6.56 (dd, *J* = 10.1, 2.2 Hz, 1H), 4.90 (s, 1H), 3.34 (d, *J* = 13.6 Hz, 1H), 3.01 (d, *J* = 13.6 Hz, 1H), 2.30 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 175.84, 163.07, δ 162.90 (d, *J* = 246.2 Hz), 155.97 (d, *J* = 11.3 Hz), 138.28, 136.45, 133.97, 133.35 (d, *J* = 9.5 Hz), 129.05, 128.57 (d, *J* = 19.8 Hz), 128.30, 127.49, 127.45, 126.35, 120.92, 120.48 (d, *J* = 2.9 Hz), 107.05 (d, *J* = 21.1 Hz), 65.16, 49.94, 41.09, 15.11. [α]<sub>D</sub><sup>25</sup> = 102 (c = 1.0 in CH<sub>2</sub>Cl<sub>2</sub>). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/*i*-PrOH = 85/15), 0.7 mL/min; Major

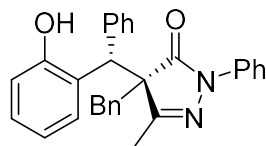
enantiomer:  $t_R = 17.6$  min, minor enantiomer:  $t_R = 8.2$  min. 72:28 *dr*, 94% *ee*. HRMS (ESI) calcd for  $C_{30}H_{25}FN_2O_2Na$   $m/z$   $[M + Na]^+$ : 487.1792, found: 487.1792.

**(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-3-(trifluoromethyl)phenyl)(phenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3ga)**



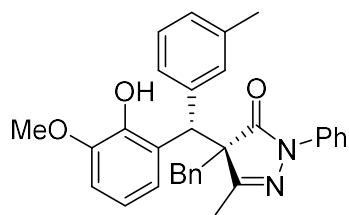
Compound was isolated as a white solid (80% yield) after flash column chromatography on silica-gel.  $^1H$  NMR (500 MHz,  $CDCl_3$ )  $\delta$  7.75 – 7.66 (m, 3H), 7.51 – 7.47 (m, 2H), 7.42 – 7.36 (m, 3H), 7.36 – 7.27 (m, 4H), 7.20 – 7.15 (m, 2H), 7.14 (q,  $J = 1.3$  Hz, 2H), 7.10 – 7.07 (m, 2H), 6.90 (t,  $J = 7.9$  Hz, 1H), 5.90 (s, 1H), 5.16 (s, 1H), 3.34 (d,  $J = 13.4$  Hz, 1H), 3.00 (d,  $J = 13.4$  Hz, 1H), 2.18 (s, 3H).  $^{13}C$  NMR (126 MHz,  $CDCl_3$ )  $\delta$  174.24, 161.56, 150.21, 137.28, 137.02, 134.26, 132.58, 129.15, 128.68, 128.24, 128.23, 127.30,  $\delta$  125.56 (q,  $J = 4.66$  Hz),  $\delta$  124.40 (q,  $J = 273.17$  Hz), 120.94, 119.96,  $\delta$  116.44 (q,  $J = 29.23$  Hz), 62.69, 46.91, 42.01, 14.71.  $[\alpha]_D^{25} = 19$  ( $c = 1.0$  in  $CH_2Cl_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak AD-H column at 254 nm (n-hexane/*i*-PrOH = 85/15), 1.0 mL/min; Major enantiomer:  $t_R = 8.0$  min, minor enantiomer:  $t_R = 5.0$  min. 72:28 *dr*, 94% *ee*. HRMS (ESI) calcd for  $C_{31}H_{25}F_3N_2O_2Na$   $m/z$   $[M + Na]^+$ : 537.1760, found: 487.1759.

**(*R*)-4-benzyl-4-((*S*)-(2-hydroxyphenyl)(phenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3ha)**



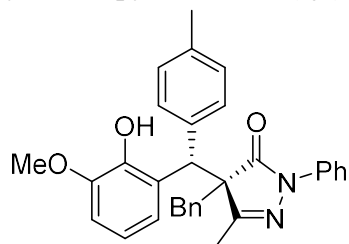
Compound was isolated as a white solid (73% yield) after flash column chromatography on silica-gel.  $\delta$   $^1H$  NMR (500 MHz,  $DMSO-d_6$ )  $\delta$  9.82 (s, 1H), 7.67 (d,  $J = 7.3$  Hz, 2H), 7.45 (d,  $J = 7.6$  Hz, 2H), 7.36 – 7.30 (m, 7H), 7.16 – 7.08 (m, 7H), 6.61 (t,  $J = 8.0$  Hz, 1H), 5.13 (s, 1H), 3.30 (d,  $J = 13.3$  Hz, 1H), 2.94 (d,  $J = 13.2$  Hz, 1H), 2.15 (s, 3H).  $^{13}C$  NMR (126 MHz,  $DMSO-d_6$ )  $\delta$  174.34, 162.39, 154.11, 138.40, 137.29, 134.98, 130.92, 129.02, 128.81, 128.76, 128.26, 127.98, 127.69, 126.98, 126.76, 126.20, 125.03, 119.18, 119.06, 115.47, 62.48, 46.15, 40.81, 14.41.  $[\alpha]_D^{25} = 24$  ( $c = 1.0$  in  $CH_2Cl_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_R = 31.2$  min, minor enantiomer:  $t_R = 12.4$  min. 64:36 *dr*, 84% *ee*. HRMS (ESI) calcd for  $C_{30}H_{26}N_2O_2Na$   $m/z$   $[M + Na]^+$ : 469.1886, found: 487.1885.

**(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(*m*-tolyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3ia)**



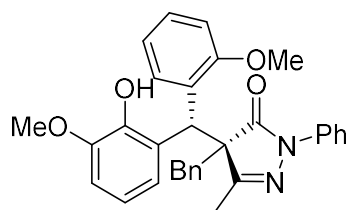
Compound was isolated as white solid (94% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.50 (dd,  $J = 8.2, 1.4$  Hz, 1H), 7.35 (d,  $J = 7.6$  Hz, 2H), 7.19 (t,  $J = 7.9$  Hz, 2H), 7.07 (d,  $J = 8.4$  Hz, 2H), 7.03 – 6.96 (m, 7H), 6.86 (d,  $J = 7.4$  Hz, 1H), 6.78 (t,  $J = 8.1$  Hz, 1H), 6.67 (dd,  $J = 8.1, 1.3$  Hz, 1H), 6.01 (s, 1H), 5.02 (s, 1H), 3.76 (s, 3H), 3.25 (d,  $J = 13.6$  Hz, 1H), 3.03 (d,  $J = 13.5$  Hz, 1H), 2.10 (s, 3H), 2.08 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.49, 161.70, 146.17, 143.60, 139.18, 137.98, 137.50, 134.97, 129.42, 129.21, 128.53, 128.34, 128.11, 127.98, 127.03, 125.80, 125.23, 124.41, 123.97, 120.09, 119.14, 109.23, 63.62, 55.96, 46.73, 40.69, 21.42, 15.11.  $[\alpha]_{\text{D}}^{25} = 4$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak AD-H column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_{\text{R}} = 20.67$  min, minor enantiomer:  $t_{\text{R}} = 49.90$  min. 96:4 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{30}\text{H}_{32}\text{N}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 513.2149, found: 513.2148.

**(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(*p*-tolyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3ja)**



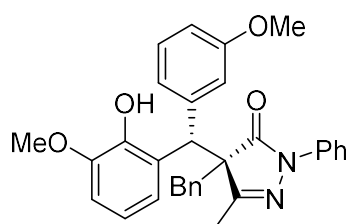
Compound was isolated as colorless oil (94% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.53 – 7.45 (m, 4H), 7.34 – 7.30 (m, 2H), 7.18 – 7.13 (m, 3H), 7.12 (d,  $J = 2.7$  Hz, 4H), 6.91 – 6.78 (m, 4H), 6.21 (s, 1H), 5.87 (s, 1H), 3.89 (s, 3H), 3.82 (s, 3H), 3.40 (d,  $J = 13.6$  Hz, 1H), 3.26 (d,  $J = 13.6$  Hz, 1H), 2.17 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.72, 162.30, 156.59, 146.14, 144.08, 137.59, 135.06, 129.26, 129.04, 128.50, 128.25, 128.16, 128.00, 126.93, 125.06, 124.61, 124.02, 120.69, 119.94, 118.74, 111.13, 109.14, 63.48, 55.94, 55.80, 40.85, 37.94, 14.77.  $[\alpha]_{\text{D}}^{25} = -13$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_{\text{R}} = 21.00$  min, minor enantiomer:  $t_{\text{R}} = 25.16$  min. 96:4 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{30}\text{H}_{32}\text{N}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 513.2149, found: 513.2141.

**(*R*)-4-benzyl-4-((*R*)-(2-hydroxy-3-methoxyphenyl)(2-methoxyphenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3ka)**



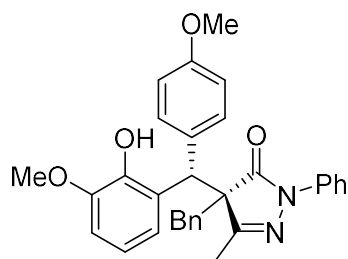
Compound was isolated as a colorless oil (91% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.64 (d,  $J$  = 8.0 Hz, 1H), 7.48 (dd,  $J$  = 8.5, 1.2 Hz, 2H), 7.34 – 7.28 (m, 4H), 7.17 – 7.09 (m, 6H), 7.04 (d,  $J$  = 7.9 Hz, 2H), 6.91 (t,  $J$  = 8.1 Hz, 1H), 6.80 (dd,  $J$  = 8.1, 1.4 Hz, 1H), 6.14 (s, 1H), 5.16 (s, 1H), 3.88 (s, 3H), 3.39 (d,  $J$  = 13.6 Hz, 1H), 3.16 (d,  $J$  = 13.6 Hz, 1H), 2.26 (s, 3H), 2.22 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.49, 161.73, 146.20, 143.57, 137.50, 136.77, 136.22, 134.94, 129.19, 129.16, 128.65, 128.52, 128.09, 127.02, 125.21, 124.66, 123.81, 120.08, 119.15, 109.19, 63.75, 55.95, 46.40, 40.83, 20.91, 15.16.  $[\alpha]_{\text{D}}^{25}$  = 4 ( $c$  = 1.0 in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_{\text{R}}$  = 29.36 min, minor enantiomer:  $t_{\text{R}}$  = 32.49 min. 93:7 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{32}\text{H}_{30}\text{N}_2\text{O}_4\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 529.2098, found: 529.2095.

**(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(3-methoxyphenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3la)**



Compound was isolated as colorless oil (93% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.65 (d,  $J$  = 7.8 Hz, 1H), 7.50 (d,  $J$  = 7.7 Hz, 2H), 7.31 (t,  $J$  = 7.9 Hz, 2H), 7.17 – 7.08 (m, 7H), 7.01 – 6.95 (m, 2H), 6.91 (t,  $J$  = 8.1 Hz, 1H), 6.80 (d,  $J$  = 7.3 Hz, 1H), 6.72 (dd,  $J$  = 8.1, 2.1 Hz, 1H), 6.14 (s, 1H), 5.16 (s, 1H), 3.88 (s, 3H), 3.64 (s, 3H), 3.37 (d,  $J$  = 13.5 Hz, 1H), 3.15 (d,  $J$  = 13.5 Hz, 1H), 2.22 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.44, 161.67, 159.51, 146.19, 143.64, 140.81, 137.52, 134.84, 129.41, 129.20, 128.52, 128.10, 127.06, 125.18, 124.27, 123.87, 121.15, 119.92, 119.17, 114.33, 112.85, 109.29, 63.61, 55.97, 55.00, 46.69, 40.83, 15.13.  $[\alpha]_{\text{D}}^{25}$  = -3 ( $c$  = 1.0 in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_{\text{R}}$  = 20.28 min, minor enantiomer:  $t_{\text{R}}$  = 36.74 min. 95:5 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{32}\text{H}_{30}\text{N}_2\text{O}_4\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 529.2098, found: 529.2093.

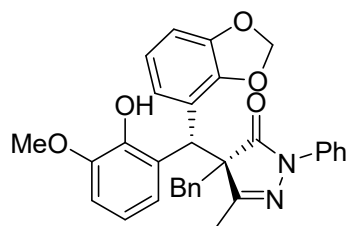
**(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(4-methoxyphenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3ma)**



Compound was isolated as a colorless oil (93% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.64 (d,  $J$  = 8.0 Hz, 1H), 7.48 (dd,  $J$  = 8.5, 1.2 Hz, 2H), 7.34 – 7.28 (m, 4H), 7.17 – 7.09 (m, 6H), 7.04 (d,  $J$  = 7.9 Hz, 2H), 6.91 (t,  $J$  = 8.1 Hz, 1H), 6.80 (dd,  $J$  = 8.1, 1.4 Hz, 1H), 6.14 (s, 1H), 5.16 (s, 1H), 3.88 (s, 3H), 3.39 (d,  $J$  = 13.6 Hz, 1H), 3.16 (d,  $J$  = 13.6 Hz, 1H), 2.26 (s, 3H), 2.22 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.51, 161.74,

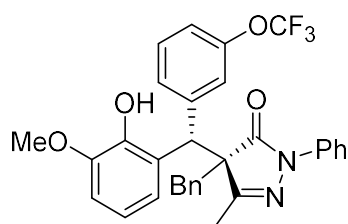
158.57, 146.22, 143.52, 137.47, 134.96, 131.30, 129.87, 129.16, 128.52, 128.10, 127.02, 125.22, 124.83, 123.69, 120.05, 119.16, 113.80, 109.18, 63.94, 55.94, 55.09, 45.93, 40.76, 15.16.  $[\alpha]_D^{25} = 4$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak AD-H column at 254 nm ( $n$ -hexane/ $i$ -PrOH = 80/20), 0.7 mL/min; Major enantiomer:  $t_R = 30.42$  min, minor enantiomer:  $t_R = 51.01$  min. 87:13 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{32}\text{H}_{30}\text{N}_2\text{O}_4\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 529.2098, found: 529.2093.

**(*R*)-4-((*R*)-benzo[d][1,3]dioxol-4-yl(2-hydroxy-3-methoxyphenyl)methyl)-4-benzyl-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3na)**



Compound was isolated as a colorless oil (83% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.70 (dd,  $J = 8.1, 1.3$  Hz, 1H), 7.50 – 7.43 (m, 2H), 7.34 – 7.30 (m, 2H), 7.14 (dt,  $J = 7.6, 4.8$  Hz, 4H), 7.09 (dd,  $J = 7.4, 2.1$  Hz, 2H), 6.95 – 6.86 (m, 3H), 6.80 (dd,  $J = 8.1, 1.2$  Hz, 1H), 6.66 (d,  $J = 8.1$  Hz, 1H), 6.14 (s, 1H), 5.85 (dd,  $J = 11.3, 1.5$  Hz, 2H), 5.10 (s, 1H), 3.88 (s, 3H), 3.37 (d,  $J = 13.5$  Hz, 1H), 3.09 (d,  $J = 13.6$  Hz, 1H), 2.24 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.43, 161.65, 147.58, 146.59, 146.22, 143.51, 137.43, 134.86, 132.97, 129.16, 128.56, 128.54, 128.11, 127.05, 125.29, 124.65, 123.56, 122.04, 120.11, 119.25, 109.33, 109.28, 108.08, 100.92, 63.88, 55.95, 46.27, 40.78, 15.18.  $[\alpha]_D^{25} = 6$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm ( $n$ -hexane/ $i$ -PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_R = 31.82$  min, minor enantiomer:  $t_R = 52.97$  min. 88:12 *dr*, 97% *ee*. HRMS (ESI) calcd for  $\text{C}_{32}\text{H}_{28}\text{N}_2\text{O}_5\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 543.1890, found: 543.1886.

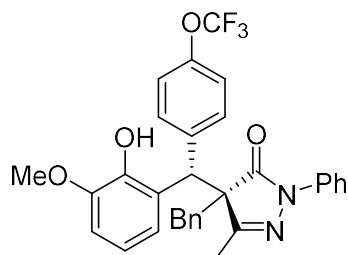
**(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(3-(trifluoromethoxy)phenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3oa)**



Compound was isolated as colorless oil (81% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.74 (dd,  $J = 8.2, 1.4$  Hz, 1H), 7.48 – 7.40 (m, 2H), 7.36 (d,  $J = 7.9$  Hz, 1H), 7.31 (t,  $J = 8.0$  Hz, 2H), 7.25 (dd,  $J = 17.4, 9.4$  Hz, 2H), 7.15 (q,  $J = 6.4, 4.7$  Hz, 4H), 7.10 (dd,  $J = 7.3, 2.0$  Hz, 2H), 7.05 (d,  $J = 8.2$  Hz, 1H), 6.94 (t,  $J = 8.1$  Hz, 1H), 6.83 (dd,  $J = 8.1, 1.3$  Hz, 1H), 6.13 (s, 1H), 5.19 (s, 1H), 3.89 (s, 3H), 3.41 (d,  $J = 13.6$  Hz, 1H), 3.08 (d,  $J = 13.6$  Hz, 1H), 2.22 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.12, 161.16, 149.10, 146.30, 143.72, 141.54, 137.29, 134.62, 129.74, 129.17, 128.53, 128.20, 127.19, 127.09, 125.39, 123.67, 123.54, 121.73, 120.37 (q,  $J = 257.3$  Hz), 120.02, 119.53, 119.43, 109.56, 63.68, 55.97, 46.18, 40.69, 15.06.  $[\alpha]_D^{25} = 35$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm ( $n$ -hexane/ $i$ -PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_R =$

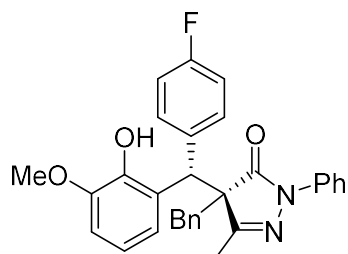
13.75 min, minor enantiomer:  $t_R$  = 19.64 min. 98:2 *dr*, 99% *ee*. HRMS (ESI) calcd for  $C_{32}H_{27}F_3N_2O_4Na$   $m/z$   $[M + Na]^+$ : 583.1815, found: 583.1809.

**(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(4-(trifluoromethoxy)phenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3pa)**



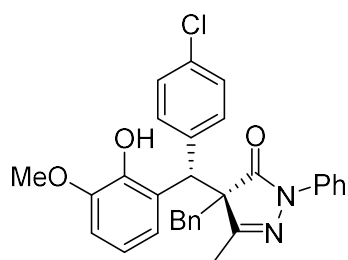
Compound was isolated as a colorless oil (89% yield) after flash column chromatography on silica-gel.  $^1H$  NMR (500 MHz,  $CDCl_3$ )  $\delta$  7.78 (dd,  $J$  = 8.2, 1.4 Hz, 1H), 7.42 (t,  $J$  = 9.1 Hz, 4H), 7.31 (t,  $J$  = 8.0 Hz, 2H), 7.18 – 7.13 (m, 4H), 7.13 – 7.10 (m, 2H), 7.07 (d,  $J$  = 8.2 Hz, 2H), 6.95 (t,  $J$  = 8.1 Hz, 1H), 6.83 (dd,  $J$  = 8.1, 1.4 Hz, 1H), 6.14 (s, 1H), 5.19 (s, 1H), 3.90 (s, 3H), 3.43 (d,  $J$  = 13.6 Hz, 1H), 3.06 (d,  $J$  = 13.6 Hz, 1H), 2.24 (s, 3H).  $^{13}C$  NMR (126 MHz,  $CDCl_3$ )  $\delta$  174.26, 161.29, 148.24, 146.32, 143.70, 137.85, 137.26, 134.75, 130.23, 129.15, 128.60, 128.22, 127.18, 125.50, 123.97, 123.69, 120.73, 120.36 (q,  $J$  = 257.3 Hz), 120.14, 119.40, 109.50, 63.80, 55.98, 45.79, 40.52, 15.08.  $[\alpha]_D^{25}$  = 32 ( $c$  = 1.0 in  $CH_2Cl_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (*n*-hexane/*i*-PrOH = 90/10), 0.7 mL/min; Major enantiomer:  $t_R$  = 22.70 min, minor enantiomer:  $t_R$  = 25.78 min. 96:4 *dr*, 99% *ee*. HRMS (ESI) calcd for  $C_{32}H_{27}N_2O_4Na$   $m/z$   $[M + Na]^+$ : 583.1815, found: 583.1808.

**(*R*)-4-benzyl-4-((*S*)-(4-fluorophenyl)(2-hydroxy-3-methoxyphenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3qa)**



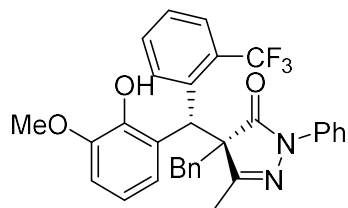
Compound was isolated as a white solid (95% yield) after flash column chromatography on silica-gel.  $^1H$  NMR (500 MHz,  $CDCl_3$ )  $\delta$  7.73 (dd,  $J$  = 8.1, 1.3 Hz, 1H), 7.45 (dd,  $J$  = 8.7, 1.2 Hz, 2H), 7.41 – 7.36 (m, 2H), 7.35 – 7.28 (m, 2H), 7.20 – 7.08 (m, 6H), 6.91 (dd,  $J$  = 9.6, 8.2 Hz, 3H), 6.82 (dd,  $J$  = 8.1, 1.3 Hz, 1H), 5.17 (s, 1H), 3.89 (s, 3H), 3.41 (d,  $J$  = 13.6 Hz, 1H), 3.09 (d,  $J$  = 13.6 Hz, 1H), 2.23 (s, 3H).  $^{13}C$  NMR (126 MHz,  $CDCl_3$ )  $\delta$  174.34, 161.84 (d,  $J$  = 246.2 Hz), 161.45, 146.27, 143.61, 137.34, 135.01 (d,  $J$  = 3.4 Hz), 134.80, 130.40 (d,  $J$  = 8.0 Hz), 129.14, 128.59, 128.17, 127.12, 125.38, 124.30, 123.64, 120.03, 119.31, 115.27 (d,  $J$  = 21.2 Hz), 109.37, 63.87, 55.96, 45.79, 40.63, 15.09.  $[\alpha]_D^{25}$  = 39 ( $c$  = 1.0 in  $CH_2Cl_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak ID column at 254 nm (*n*-hexane/*i*-PrOH = 70/30), 1.0 mL/min; Major enantiomer:  $t_R$  = 12.82 min, minor enantiomer:  $t_R$  = 50.63 min. 93:7 *dr*, 99% *ee*. HRMS (ESI) calcd for  $C_{31}H_{27}FN_2O_3Na$   $m/z$   $[M + Na]^+$ : 517.1898, found: 517.1984.

**(*R*)-4-benzyl-4-((*S*)-(4-chlorophenyl)(2-hydroxy-3-methoxyphenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3ra)**



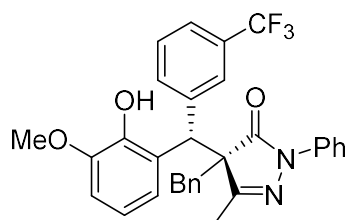
Compound was isolated as a white solid (93% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.68 (dd,  $J = 8.2, 1.4$  Hz, 1H), 7.46 (dd,  $J = 8.6, 1.2$  Hz, 2H), 7.36 – 7.30 (m, 4H), 7.22 – 7.16 (m, 3H), 7.16 – 7.12 (m, 3H), 7.10 (dd,  $J = 7.4, 2.1$  Hz, 2H), 6.92 (t,  $J = 8.1$  Hz, 1H), 6.81 (dd,  $J = 8.1, 1.4$  Hz, 1H), 6.13 (s, 1H), 5.16 (s, 1H), 3.89 (s, 3H), 3.40 (d,  $J = 13.6$  Hz, 1H), 3.10 (d,  $J = 13.6$  Hz, 1H), 2.22 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.24, 161.36, 146.26, 143.62, 137.81, 137.32, 134.68, 133.09, 130.15, 129.15, 128.60, 128.17, 127.15, 125.41, 123.98, 123.60, 120.03, 119.34, 109.44, 63.65, 55.97, 45.95, 40.69, 15.10.  $[\alpha]_{\text{D}}^{25} = 11$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak ID column at 254 nm (n-hexane/*i*-PrOH = 70/30), 1.0 mL/min; Major enantiomer:  $t_{\text{R}} = 20.00$  min, minor enantiomer:  $t_{\text{R}} = 24.35$  min. 95:5 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{31}\text{H}_{27}\text{ClN}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 533.1602, found: 533.1596.

**(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(2-(trifluoromethyl)phenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3sa)**



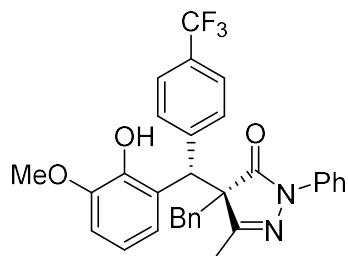
Compound was isolated as a white solid (89% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.67 (d,  $J = 7.7$  Hz, 1H), 7.56 (dd,  $J = 11.2, 7.6$  Hz, 3H), 7.41 (t,  $J = 7.7$  Hz, 1H), 7.37 – 7.31 (m, 3H), 7.17 (t,  $J = 7.3$  Hz, 1H), 7.09 (q,  $J = 5.8, 5.2$  Hz, 5H), 6.84 (h,  $J = 7.3$  Hz, 3H), 6.17 (s, 1H), 5.72 (s, 1H), 3.93 (s, 3H), 3.55 (d,  $J = 13.4$  Hz, 1H), 3.34 (d,  $J = 13.3$  Hz, 1H), 2.07 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  173.89, 161.48, 146.16, 143.80, 138.81, 137.54, 134.28, 132.16, 129.47, 128.69, 128.63, 128.27 (q,  $J = 29.5$  Hz), 127.95, 127.33, 127.14, 126.83 (q,  $J = 6.3$  Hz), 125.20, 124.88, 121.42, 124.21 (q,  $J = 274.8$  Hz), 119.65, 118.21, 109.43, 63.17, 56.05, 41.96, 41.84, 14.45.  $[\alpha]_{\text{D}}^{25} = -125$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_{\text{R}} = 8.55$  min, minor enantiomer:  $t_{\text{R}} = 10.94$  min. 99:1 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{32}\text{H}_{27}\text{F}_3\text{N}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 567.1866, found: 567.1859.

**(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(3-(trifluoromethyl)phenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3ta)**



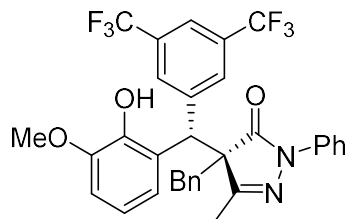
Compound was isolated as white solid (92% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.75 (dd,  $J$  = 8.2, 1.3 Hz, 1H), 7.68 (s, 1H), 7.62 (d,  $J$  = 8.3 Hz, 1H), 7.48 – 7.41 (m, 3H), 7.36 – 7.29 (m, 3H), 7.16 (q,  $J$  = 6.4, 5.1 Hz, 4H), 7.11 (dd,  $J$  = 7.4, 2.0 Hz, 2H), 6.95 (t,  $J$  = 8.1 Hz, 1H), 6.83 (dd,  $J$  = 8.1, 1.4 Hz, 1H), 6.15 (s, 1H), 5.25 (s, 1H), 3.89 (s, 3H), 3.43 (d,  $J$  = 13.6 Hz, 1H), 3.10 (d,  $J$  = 13.6 Hz, 1H), 2.22 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.11, 161.15, 146.29, 143.72, 140.30, 137.23, 134.63, 132.04, 130.73 (q,  $J$  = 32.0 Hz), 129.16, 128.97, 128.56, 128.22, 127.20, 125.70 (q,  $J$  = 3.8 Hz), 125.45, 124.12 (q,  $J$  = 3.7 Hz), 123.90 (q,  $J$  = 272.5 Hz), 123.58, 123.55, 120.04, 119.47, 109.58, 63.63, 55.97, 46.32, 40.54, 15.03.  $[\alpha]_{\text{D}}^{25}$  = 20 ( $c$  = 1.0 in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_{\text{R}}$  = 13.37 min, minor enantiomer:  $t_{\text{R}}$  = 18.64 min. 97:3 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{32}\text{H}_{27}\text{F}_3\text{N}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 567.1866, found: 567.1856.

**(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(4-(trifluoromethyl)phenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3ua)**



Compound was isolated as a colorless oil (90% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.72 (dd,  $J$  = 8.1, 1.4 Hz, 1H), 7.50 (q,  $J$  = 8.4 Hz, 4H), 7.46 – 7.40 (m, 2H), 7.36 – 7.29 (m, 2H), 7.19 – 7.13 (m, 4H), 7.11 (dd,  $J$  = 7.4, 2.0 Hz, 2H), 6.94 (t,  $J$  = 8.1 Hz, 1H), 6.83 (dd,  $J$  = 8.1, 1.4 Hz, 1H), 6.14 (s, 1H), 5.25 (s, 1H), 3.89 (s, 3H), 3.43 (d,  $J$  = 13.5 Hz, 1H), 3.10 (d,  $J$  = 13.6 Hz, 1H), 2.23 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.14, 161.19, 146.31, 143.73, 143.36, 137.25, 134.57, 129.17, 129.41 (q,  $J$  = 32.6 Hz), 128.63, 128.22, 127.23, 125.41 (q,  $J$  = 3.7 Hz), 123.98 (q,  $J$  = 272.7 Hz), 123.69, 123.54, 120.07, 119.44, 109.60, 63.52, 55.99, 46.32, 40.66, 15.09.  $[\alpha]_{\text{D}}^{25}$  = 21 ( $c$  = 1.0 in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/*i*-PrOH = 95/5), 1.0 mL/min; Major enantiomer:  $t_{\text{R}}$  = 28.40 min, minor enantiomer:  $t_{\text{R}}$  = 30.18 min. 97:3 *dr*, 98% *ee*. HRMS (ESI) calcd for  $\text{C}_{32}\text{H}_{27}\text{F}_3\text{N}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 567.1866, found: 567.1860.

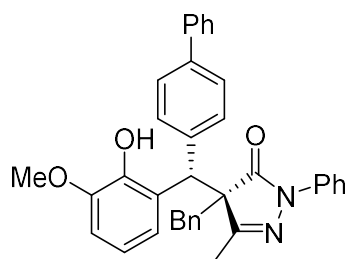
**(*R*)-4-benzyl-4-((*S*)-(3,5-bis(trifluoromethyl)phenyl)(2-hydroxy-3-methoxyphenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3va)**



Compound was isolated as a colorless oil (95% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.88 (s, 2H), 7.83 (d,  $J$  = 8.1 Hz, 1H), 7.71 (s, 1H), 7.43 (d,  $J$  = 7.7 Hz, 2H), 7.32 (t,  $J$  = 7.9 Hz, 2H), 7.19 – 7.14 (m, 4H), 7.10 (dd,  $J$  = 7.1, 2.3 Hz, 2H), 6.99 (t,  $J$  = 8.1 Hz, 1H), 6.86 (dd,  $J$  = 8.2, 1.3 Hz, 1H), 6.14 (s, 1H), 5.30 (s, 1H), 3.91 (s, 3H),

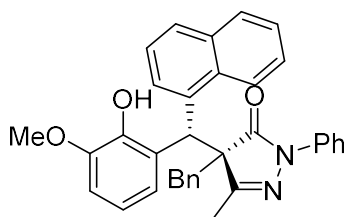
3.46 (d,  $J = 13.6$  Hz, 1H), 3.05 (d,  $J = 13.7$  Hz, 1H), 2.23 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  173.81, 160.71, 146.38, 143.78, 141.94, 137.00, 134.39, 131.71 (q,  $J = 33.4$  Hz) 129.14, 129.01 (q,  $J = 2.65$  Hz), 128.58, 128.34, 127.35, 125.64, 123.26, 123.08 (q,  $J = 273.42$  Hz), 122.72, 121.23-121.41 (m), 119.96, 119.86, 109.93, 63.54, 56.02, 46.06, 40.33, 14.97.  $[\alpha]_{\text{D}}^{25} = 15$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/*i*-PrOH = 95/5), 1.0 mL/min; Major enantiomer:  $t_{\text{R}} = 12.09$  min, minor enantiomer:  $t_{\text{R}} = 15.96$  min. 97:3 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{33}\text{H}_{26}\text{F}_6\text{N}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 635.1740, found: 635.1729.

**(*R*)-4-((*S*)-[1,1'-biphenyl]-4-yl(2-hydroxy-3-methoxyphenyl)methyl)-4-benzyl-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3wa)**



Compound was isolated as white solid (90% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.73 (d,  $J = 7.9$  Hz, 1H), 7.52 (d,  $J = 7.4$  Hz, 2H), 7.48 (dd,  $J = 7.5, 4.3$  Hz, 6H), 7.41 (t,  $J = 7.6$  Hz, 2H), 7.32 (t,  $J = 7.9$  Hz, 3H), 7.15 (p,  $J = 7.0, 6.3$  Hz, 6H), 6.95 (t,  $J = 8.1$  Hz, 1H), 6.82 (d,  $J = 7.7$  Hz, 1H), 6.17 (s, 1H), 5.24 (s, 1H), 3.90 (s, 3H), 3.43 (d,  $J = 13.5$  Hz, 1H), 3.17 (d,  $J = 13.6$  Hz, 1H), 2.27 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.44, 161.63, 146.26, 143.67, 140.52, 139.98, 138.26, 137.45, 134.88, 129.21, 128.65, 128.57, 128.15, 127.19, 127.13, 127.09, 126.94, 125.32, 124.38, 123.87, 120.15, 119.26, 109.34, 63.76, 55.98, 46.39, 40.78, 15.20.  $[\alpha]_{\text{D}}^{25} = -51$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_{\text{R}} = 25.44$  min, minor enantiomer:  $t_{\text{R}} = 24.17$  min. 95:5 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{37}\text{H}_{32}\text{N}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 575.2305, found: 575.2296.

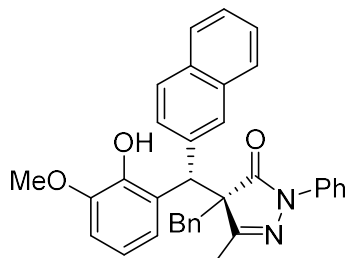
**(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(naphthalen-1-yl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3xa)**



Compound was isolated as white solid (91% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.42 (d,  $J = 8.6$  Hz, 1H), 7.82 (d,  $J = 7.8$  Hz, 1H), 7.73 (d,  $J = 8.2$  Hz, 1H), 7.66 – 7.60 (m, 2H), 7.57 – 7.52 (m, 2H), 7.47 (d,  $J = 7.2$  Hz, 1H), 7.37 (t,  $J = 7.2$  Hz, 2H), 7.35 – 7.31 (m, 1H), 7.22 – 7.11 (m, 7H), 6.86 – 6.75 (m, 2H), 6.37 (s, 1H), 6.08 (s, 1H), 3.91 (s, 3H), 3.54 (d,  $J = 13.2$  Hz, 1H), 3.38 (d,  $J = 13.2$  Hz, 1H), 1.96 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.34, 161.93, 145.88, 143.26, 137.67, 136.43, 134.42, 134.04, 131.77, 129.42, 128.93, 128.61, 127.96, 127.95, 127.11, 126.64, 125.54, 125.37, 125.23, 125.15, 123.88, 123.01, 122.70, 119.83, 118.82, 109.31, 62.75, 55.98, 41.80, 41.47, 14.60.  $[\alpha]_{\text{D}}^{25} = -182$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The

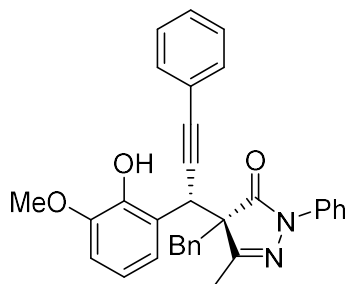
enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_R$  = 20.70 min, minor enantiomer:  $t_R$  = 27.63 min. 98:2 *dr*, 99% *ee*. HRMS (ESI) calcd for  $C_{35}H_{30}N_2O_3Na$   $m/z$   $[M + Na]^+$ : 549.2153, found: 549.2149.

**(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(naphthalen-2-yl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3ya)**



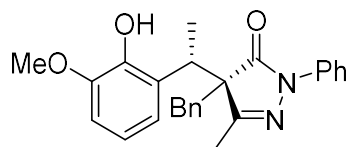
Compound was isolated as white solid (95% yield) after flash column chromatography on silica-gel.  $^1H$  NMR (500 MHz,  $CDCl_3$ )  $\delta$  7.83 (s, 1H), 7.78 – 7.74 (m, 1H), 7.73 – 7.67 (m, 2H), 7.63 (dd,  $J$  = 8.1, 1.2 Hz, 1H), 7.54 (dd,  $J$  = 8.6, 1.9 Hz, 1H), 7.50 (dd,  $J$  = 8.6, 1.1 Hz, 2H), 7.43 (dt,  $J$  = 6.2, 3.4 Hz, 2H), 7.36 – 7.31 (m, 2H), 7.19 – 7.13 (m, 6H), 6.91 (t,  $J$  = 8.1 Hz, 1H), 6.80 (dd,  $J$  = 8.1, 1.4 Hz, 1H), 6.18 (s, 1H), 5.38 (s, 1H), 3.88 (s, 3H), 3.45 (d,  $J$  = 13.4 Hz, 1H), 3.27 (d,  $J$  = 13.6 Hz, 1H), 2.22 (s, 3H).  $^{13}C$  NMR (126 MHz,  $CDCl_3$ )  $\delta$  174.43, 161.68, 146.20, 143.65, 137.47, 136.97, 134.77, 133.29, 132.45, 129.26, 128.58, 128.17, 128.12, 127.92, 127.40, 127.25, 127.10, 127.09, 126.02, 125.83, 125.31, 124.25, 124.06, 120.14, 119.18, 109.33, 63.50, 55.97, 46.91, 40.99, 15.18.  $[\alpha]_D^{25}$  = -75 ( $c$  = 1.0 in  $CH_2Cl_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_R$  = 29.37 min, minor enantiomer:  $t_R$  = 32.88 min. 94:6 *dr*, 99% *ee*. HRMS (ESI) calcd for  $C_{35}H_{30}N_2O_3Na$   $m/z$   $[M + Na]^+$ : 549.2153, found: 549.2148.

**(*R*)-4-benzyl-4-((*S*)-1-(2-hydroxy-3-methoxyphenyl)-3-phenylprop-2-yn-1-yl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3za)**



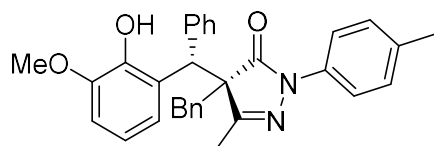
Compound was isolated as a colorless oil (78% yield) after flash column chromatography on silica-gel.  $^1H$  NMR (500 MHz,  $CDCl_3$ )  $\delta$  7.50 (d,  $J$  = 7.7 Hz, 2H), 7.40 – 7.37 (m, 2H), 7.30 – 7.27 (m, 5H), 7.23 – 7.16 (m, 7H), 6.89 (t,  $J$  = 8.0 Hz, 1H), 6.80 (dd,  $J$  = 8.0, 1.4 Hz, 1H), 6.17 (s, 1H), 5.03 (s, 1H), 3.86 (s, 3H), 3.52 (d,  $J$  = 13.7 Hz, 1H), 3.35 (d,  $J$  = 13.7 Hz, 1H), 2.51 (s, 3H).  $^{13}C$  NMR (126 MHz,  $CDCl_3$ )  $\delta$  173.21, 160.71, 146.69, 143.35, 137.42, 134.90, 131.63, 129.20, 128.51, 128.28, 128.24, 128.21, 127.15, 125.11, 122.82, 122.75, 121.53, 119.77, 119.53, 110.35, 86.75, 84.53, 63.96, 56.06, 39.20, 35.43, 15.88.  $[\alpha]_D^{25}$  = -47 ( $c$  = 1.0 in  $CH_2Cl_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak ID column at 254 nm (n-hexane/*i*-PrOH = 60/40), 0.7 mL/min; Major enantiomer:  $t_R$  = 14.92 min, minor enantiomer:  $t_R$  = 42.04 min. 80:20 *dr*, 86% *ee*. HRMS (ESI) calcd for  $C_{37}H_{30}N_2O_3Na$   $m/z$   $[M + Na]^+$ : 573.2149, found: 573.2140.

**(R)-4-benzyl-4-((S)-1-(2-hydroxy-3-methoxyphenyl)ethyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3Aa)**



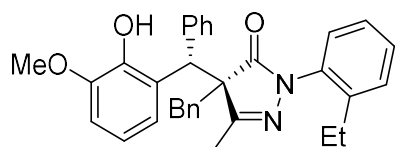
Compound was isolated as a colorless oil (40% yield) after flash column chromatography on silica-gel. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.64 (d, *J* = 8.6 Hz, 2H), 7.35 – 7.32 (m, 3H), 7.17 – 7.13 (m, 5H), 7.06 – 7.02 (m, 2H), 6.95 (t, *J* = 8.0 Hz, 1H), 6.13 (s, 1H), 3.92 (s, 3H), 3.91 (q, *J* = 8.0 Hz, 1H), 3.12 (d, *J* = 13.7 Hz, 1H), 2.98 (d, *J* = 13.7 Hz, 1H), 2.30 (s, 3H), 1.25 (d, *J* = 7.3 Hz, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 174.36, 162.29, 146.19, 143.73, 137.65, 135.52, 128.99, 128.60, 128.14, 127.04, 126.90, 125.02, 122.74, 119.56, 119.34, 109.27, 64.19, 56.02, 38.99, 16.07, 14.87, 14.65. [ $\alpha$ ]<sub>D</sub><sup>25</sup> = 94 (*c* = 1.0 in CH<sub>2</sub>Cl<sub>2</sub>). The enantiomers were analyzed by HPLC using Daicel Chiralpak ID column at 254 nm (n-hexane/*i*-PrOH = 80/20), 1.0 mL/min; Major enantiomer: *t*<sub>R</sub> = 20.56 min, minor enantiomer: *t*<sub>R</sub> = 13.33 min. 60:40 *dr*, 90% *ee*. HRMS (ESI) calcd for C<sub>26</sub>H<sub>26</sub>N<sub>2</sub>O<sub>3</sub>Na *m/z* [*M* + Na]<sup>+</sup>: 437.1836, found: 437.1828.

**(R)-4-benzyl-4-((S)-2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-5-methyl-2-(p-tolyl)-2,4-dihydro-3H-pyrazol-3-one (3ab)**



Compound was isolated as a white solid (85% yield) after flash column chromatography on silica-gel. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.68 (dd, *J* = 8.2, 1.3 Hz, 1H), 7.42 – 7.38 (m, 2H), 7.30 (d, *J* = 8.4 Hz, 2H), 7.22 (t, *J* = 7.4 Hz, 2H), 7.19 – 7.16 (m, 1H), 7.15 – 7.08 (m, 7H), 6.90 (t, *J* = 8.1 Hz, 1H), 6.80 (dd, *J* = 8.1, 1.3 Hz, 1H), 5.16 (s, 1H), 3.89 (s, 3H), 3.39 (d, *J* = 13.5 Hz, 1H), 3.11 (d, *J* = 13.6 Hz, 1H), 2.32 (s, 3H), 2.20 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 174.29, 161.45, 146.24, 143.66, 139.26, 135.04, 135.00, 134.97, 129.24, 129.12, 128.84, 128.47, 128.13, 127.20, 127.06, 124.48, 123.96, 120.25, 119.18, 109.27, 63.65, 55.99, 46.75, 40.76, 20.98, 15.15. [ $\alpha$ ]<sub>D</sub><sup>25</sup> = 34 (*c* = 1.0 in CH<sub>2</sub>Cl<sub>2</sub>). The enantiomers were analyzed by HPLC using Daicel Chiralpak ID column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer: *t*<sub>R</sub> = 26.31 min, minor enantiomer: *t*<sub>R</sub> = 52.49 min. 97:3 *dr*, 97% *ee*. HRMS (ESI) calcd for C<sub>32</sub>H<sub>30</sub>N<sub>2</sub>O<sub>3</sub>Na *m/z* [*M* + Na]<sup>+</sup>: 513.2149, found: 513.2139.

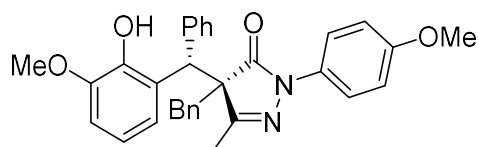
**(R)-4-benzyl-2-(2-ethylphenyl)-4-((S)-2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-5-methyl-2,4-dihydro-3H-pyrazol-3-one (3ac)**



Compound was isolated as a colorless oil (77% yield) after flash column chromatography on silica-gel. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.95 (d, *J* = 8.1 Hz, 1H), 7.54 – 7.48 (m, 2H), 7.29 (t, *J* = 7.4 Hz, 2H), 7.26 – 7.22 (m, 4H), 7.21 – 7.16 (m, 4H), 7.03 (td, *J* = 7.5, 1.9 Hz, 1H), 6.94 (t, *J* = 8.1 Hz, 1H), 6.82 (dd, *J* = 8.1, 1.3 Hz, 1H), 6.29 (dd, *J* = 7.9, 1.2 Hz, 1H), 6.26 (s, 1H), 5.18 (s, 1H), 3.89 (s, 3H), 3.44 (d, *J* = 13.5 Hz, 1H), 3.03 (d, *J* = 13.5 Hz, 1H), 2.38 (s, 3H), 1.87 (qd, *J* =

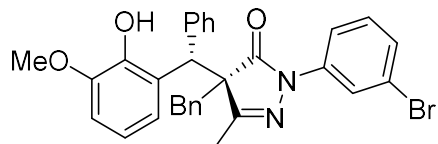
7.6, 4.4 Hz, 2H), 0.94 (t,  $J = 7.6$  Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.82, 160.90, 146.50, 143.85, 141.09, 138.87, 135.13, 135.08, 129.85, 129.49, 128.46, 128.37, 128.35, 128.34, 127.24, 127.14, 126.55, 125.92, 124.90, 123.89, 119.35, 109.36, 63.58, 56.00, 46.75, 40.40, 23.27, 15.51, 14.07.  $[\alpha]_{\text{D}}^{25} = 55$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IC column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_{\text{R}} = 16.39$  min, minor enantiomer:  $t_{\text{R}} = 21.40$ . 97:3 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{33}\text{H}_{32}\text{N}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 527.2305, found: 527.2297.

**(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-2-(4-methoxyphenyl)-5-methyl-2,4-dihydro-3H-pyrazol-3-one (3ad)**



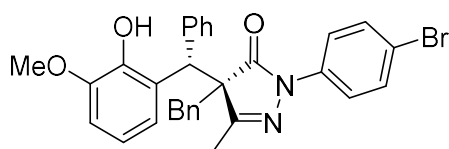
Compound was isolated as a white solid (93% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.71 (d,  $J = 8.1$  Hz, 1H), 7.44 – 7.39 (m, 2H), 7.28 – 7.21 (m, 4H), 7.21 – 7.10 (m, 6H), 6.91 (t,  $J = 8.1$  Hz, 1H), 6.85 – 6.82 (m, 2H), 6.80 (dd,  $J = 8.1, 1.2$  Hz, 1H), 5.17 (s, 1H), 3.88 (s, 3H), 3.78 (s, 3H), 3.11 (d,  $J = 13.5$  Hz, 1H), 2.21 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.22, 161.41, 157.36, 146.28, 143.69, 139.27, 135.01, 130.71, 129.29, 128.88, 128.46, 128.14, 127.22, 127.08, 124.51, 123.94, 122.28, 119.19, 113.84, 109.29, 63.59, 55.99, 55.43, 46.71, 40.69, 15.15.  $[\alpha]_{\text{D}}^{25} = 36$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IC column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_{\text{R}} = 25.55$  min, minor enantiomer:  $t_{\text{R}} = 41.21$ . 97:3 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{32}\text{H}_{30}\text{N}_2\text{O}_4\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 529.2098, found: 529.2091.

**(*R*)-4-benzyl-2-(3-bromophenyl)-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-5-methyl-2,4-dihydro-3H-pyrazol-3-one (3ae)**



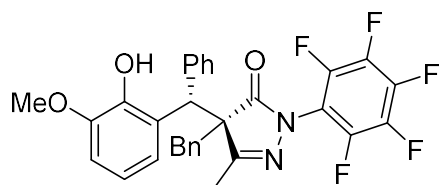
Compound was isolated as a colorless oil (78% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.70 (t,  $J = 1.9$  Hz, 1H), 7.60 (d,  $J = 8.1$  Hz, 1H), 7.52 (ddd,  $J = 8.2, 2.1, 1.0$  Hz, 1H), 7.38 – 7.34 (m, 2H), 7.27 – 7.15 (m, 5H), 7.14 – 7.11 (m, 3H), 7.06 (dd,  $J = 7.2, 2.3$  Hz, 2H), 6.91 (t,  $J = 8.1$  Hz, 1H), 6.81 (dd,  $J = 8.1, 1.3$  Hz, 1H), 6.08 (s, 1H), 5.17 (s, 1H), 3.89 (s, 3H), 3.37 (d,  $J = 13.6$  Hz, 1H), 3.14 (d,  $J = 13.6$  Hz, 1H), 2.21 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.53, 162.10, 146.21, 143.61, 139.06, 138.60, 134.65, 129.86, 129.12, 128.72, 128.53, 128.17, 127.95, 127.30, 127.18, 124.18, 123.72, 122.30, 122.20, 119.19, 117.85, 109.30, 63.94, 55.99, 46.64, 40.86, 15.17.  $[\alpha]_{\text{D}}^{25} = 27$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak ID column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_{\text{R}} = 21.93$  min, minor enantiomer:  $t_{\text{R}} = 75.67$  min. 96:4 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{31}\text{H}_{27}\text{BrN}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 577.1097, found: 577.1090.

**(*R*)-4-benzyl-2-(4-bromophenyl)-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-5-methyl-2,4-dihydro-3H-pyrazol-3-one (3af)**



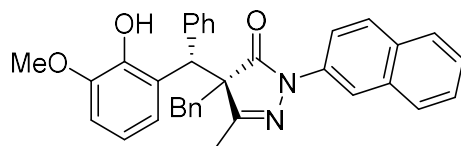
Compound was isolated as a white solid (85% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.61 (d,  $J$  = 8.1 Hz, 1H), 7.41 (s, 4H), 7.37 – 7.34 (m, 2H), 7.24 – 7.16 (m, 3H), 7.12 (dd,  $J$  = 5.2, 1.9 Hz, 3H), 7.07 – 7.04 (m, 2H), 6.90 (t,  $J$  = 8.1 Hz, 1H), 6.80 (dd,  $J$  = 8.1, 1.4 Hz, 1H), 6.08 (s, 1H), 5.16 (s, 1H), 3.89 (s, 3H), 3.37 (d,  $J$  = 13.5 Hz, 1H), 3.13 (d,  $J$  = 13.6 Hz, 1H), 2.20 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.44, 162.05, 146.23, 143.64, 139.09, 136.54, 134.73, 131.57, 129.14, 128.76, 128.52, 128.16, 127.30, 127.16, 124.23, 123.73, 121.08, 119.20, 118.03, 109.31, 63.92, 56.00, 46.66, 40.82, 15.19.  $[\alpha]_{\text{D}}^{25}$  = 40 ( $c$  = 1.0 in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/i-PrOH = 90/10), 0.7 mL/min; Major enantiomer:  $t_{\text{R}}$  = 10.36 min, minor enantiomer:  $t_{\text{R}}$  = 9.70 min. 89:11 *dr*, 98% *ee*. HRMS (ESI) calcd for  $\text{C}_{31}\text{H}_{27}\text{BrN}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 577.1097, found: 577.1094.

**(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-5-methyl-2-(perfluorophenyl)-2,4-dihydro-3H-pyrazol-3-one (3ag)**



Compound was isolated as white solid (95% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.68 (dd,  $J$  = 8.2, 1.3 Hz, 1H), 7.42 – 7.38 (m, 2H), 7.30 (d,  $J$  = 8.4 Hz, 2H), 7.22 (t,  $J$  = 7.4 Hz, 2H), 7.19 – 7.16 (m, 1H), 7.15 – 7.08 (m, 7H), 6.90 (t,  $J$  = 8.1 Hz, 1H), 6.80 (dd,  $J$  = 8.1, 1.3 Hz, 1H), 5.16 (s, 1H), 3.89 (s, 3H), 3.39 (d,  $J$  = 13.5 Hz, 1H), 3.11 (d,  $J$  = 13.6 Hz, 1H), 2.32 (s, 3H), 2.20 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.74, 163.37, 146.23, 144.64 – 144.43 (m), 143.63, 142.54 – 142.34 (m), 140.27 – 140.00 (m), 138.80 – 138.56 (m), 138.59, 136.88 – 136.45 (m), 134.13, 129.36, 128.84, 128.62, 128.38, 124.08, 123.54, 119.39, 111.91 – 111.53 (m), 109.37, 62.74, 55.97, 46.66, 40.78, 15.35.  $[\alpha]_{\text{D}}^{25}$  = 1 ( $c$  = 1.0 in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak ID column at 254 nm (n-hexane/i-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_{\text{R}}$  = 10.46 min, minor enantiomer:  $t_{\text{R}}$  = 37.30 min. 99:1 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{31}\text{H}_{23}\text{F}_5\text{N}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 589.1521, found: 589.1511.

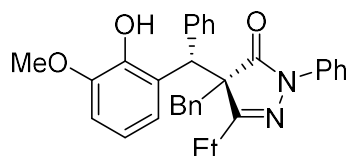
**(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-5-methyl-2-(naphthalen-2-yl)-2,4-dihydro-3H-pyrazol-3-one (3ah)**



Compound was isolated as a white solid (94% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.05 (d,  $J$  = 2.0 Hz, 1H), 7.84 – 7.78 (m, 3H), 7.73 – 7.67 (m, 2H), 7.45 (dd,  $J$  = 7.9, 1.5 Hz, 4H), 7.26 – 7.21 (m, 2H), 7.20 – 7.16 (m, 1H), 7.16 – 7.11 (m, 5H), 6.95 (t,  $J$  = 8.1 Hz, 1H), 6.82 (dd,  $J$  = 8.0, 1.3 Hz, 1H), 6.17 (s, 1H), 5.24 (s, 1H), 3.89 (s, 3H),

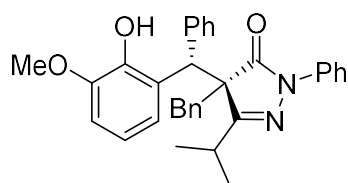
3.46 (d,  $J = 13.5$  Hz, 1H), 3.19 (d,  $J = 13.6$  Hz, 1H), 2.27 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.69, 161.92, 146.27, 143.70, 139.27, 135.14, 134.91, 133.41, 131.15, 129.24, 128.85, 128.56, 128.38, 128.21, 127.99, 127.55, 127.29, 127.15, 126.25, 125.31, 124.42, 123.92, 119.25, 117.02, 109.33, 63.93, 56.01, 46.81, 40.94, 15.25.  $[\alpha]_{\text{D}}^{25} = 53$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IC column at 254 nm (n-hexane/i-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_{\text{R}} = 9.75$  min, minor enantiomer:  $t_{\text{R}} = 17.67$  min. 95:5 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{35}\text{H}_{30}\text{N}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 549.2149, found: 549.2135.

**(*R*)-4-benzyl-5-ethyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3ai)**



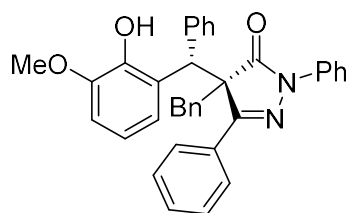
Compound was isolated as a colorless oil (89% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.64 (dd,  $J = 8.2, 1.3$  Hz, 1H), 7.56 – 7.49 (m, 2H), 7.41 – 7.36 (m, 2H), 7.35 – 7.30 (m, 2H), 7.24 – 7.19 (m, 2H), 7.19 – 7.11 (m, 5H), 7.08 (dd,  $J = 7.4, 2.1$  Hz, 2H), 6.91 (t,  $J = 8.1$  Hz, 1H), 6.80 (dd,  $J = 8.0, 1.4$  Hz, 1H), 6.15 (s, 1H), 5.20 (s, 1H), 3.89 (s, 3H), 3.38 (d,  $J = 13.6$  Hz, 1H), 3.16 (d,  $J = 13.6$  Hz, 1H), 2.60 (q,  $J = 7.3$  Hz, 2H), 1.10 (t,  $J = 7.3$  Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.77, 165.33, 146.19, 143.64, 139.48, 137.70, 135.00, 129.20, 128.74, 128.51, 128.43, 128.06, 127.11, 127.01, 125.15, 124.55, 124.05, 120.09, 119.13, 109.22, 63.70, 55.96, 46.78, 41.12, 22.04, 8.60.  $[\alpha]_{\text{D}}^{25} = 32$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IC column at 254 nm (n-hexane/i-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_{\text{R}} = 9.16$  min, minor enantiomer:  $t_{\text{R}} = 15.1$  min. 98:2 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{32}\text{H}_{30}\text{N}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 513.2149, found: 513.2135.

**(*R*)-4-benzyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-5-isopropyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3aj)**



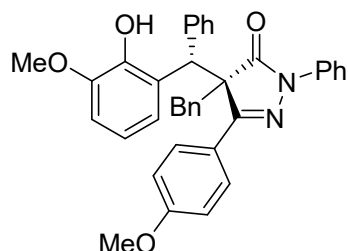
Compound was isolated as a colorless oil (85% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.65 (d,  $J = 7.8$  Hz, 2H), 7.40 – 7.34 (m, 3H), 7.28 (d,  $J = 7.2$  Hz, 2H), 7.22 – 7.14 (m, 4H), 7.13 – 7.07 (m, 5H), 6.88 (t,  $J = 8.0$  Hz, 1H), 6.80 (dd,  $J = 8.0, 1.4$  Hz, 1H), 6.29 (s, 1H), 5.38 (s, 1H), 3.34 (d,  $J = 14.0$  Hz, 1H), 3.30 (d,  $J = 14.0$  Hz, 1H), 2.93 (hept,  $J = 6.9$  Hz, 1H), 1.15 (d,  $J = 6.8$  Hz, 3H), 1.06 (d,  $J = 6.8$  Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.77, 169.16, 146.09, 143.59, 140.61, 137.83, 135.17, 129.37, 128.61, 128.46, 128.28, 127.95, 126.95, 126.82, 125.34, 125.13, 124.99, 119.92, 119.07, 109.11, 62.94, 56.00, 46.36, 41.33, 28.43, 21.90, 21.26.  $[\alpha]_{\text{D}}^{25} = -44$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/i-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_{\text{R}} = 25.58$  min, minor enantiomer:  $t_{\text{R}} = 54.29$  min. 97:3 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{33}\text{H}_{32}\text{N}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M} + \text{Na}]^+$ : 527.2305, found: 527.2293.

**(R)-4-benzyl-4-((S)-(2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-2,5-diphenyl-2,4-dihydro-3H-pyrazol-3-one (3ak)**



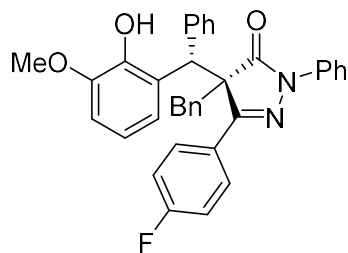
Compound was isolated as a colorless oil (82% yield) after flash column chromatography on silica-gel. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 8.13 (dd, *J* = 6.6, 3.2 Hz, 2H), 7.92 (d, *J* = 8.0 Hz, 1H), 7.52 (dd, *J* = 5.0, 1.9 Hz, 3H), 7.49 (dt, *J* = 8.6, 1.6 Hz, 2H), 7.36 – 7.32 (m, 2H), 7.22 – 7.18 (m, 3H), 7.07 (dd, *J* = 5.1, 1.9 Hz, 3H), 7.03 – 6.97 (m, 6H), 6.86 (dd, *J* = 8.1, 1.2 Hz, 1H), 6.33 (s, 1H), 5.79 (s, 1H), 3.92 (s, 3H), 3.69 (d, *J* = 13.7 Hz, 1H), 3.53 (d, *J* = 13.7 Hz, 1H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 175.11, 159.13, 146.32, 144.04, 138.72, 137.36, 134.94, 131.69, 129.98, 129.42, 129.06, 128.67, 128.54, 128.05, 127.88, 127.04, 127.03, 126.88, 125.59, 124.59, 124.30, 120.49, 119.20, 109.40, 64.06, 56.03, 46.58, 41.29. [α]<sub>D</sub><sup>25</sup> = -44 (c = 1.0 in CH<sub>2</sub>Cl<sub>2</sub>). The enantiomers were analyzed by HPLC using Daicel Chiralpak ID column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer: t<sub>R</sub> = 12.82 min, minor enantiomer: t<sub>R</sub> = 50.62 min. 93:7 *dr*, 99% *ee*. HRMS (ESI) calcd for C<sub>36</sub>H<sub>30</sub>N<sub>2</sub>O<sub>3</sub>Na *m/z* [M + Na]<sup>+</sup>: 561.2149, found: 561.2141.

**(R)-4-benzyl-4-((S)-(2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-5-(4-methoxyphenyl)-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3al)**



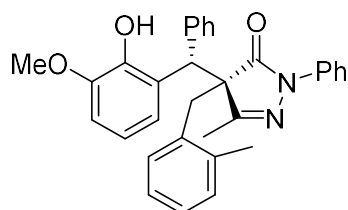
Compound was isolated as a colorless oil (82% yield) after flash column chromatography on silica-gel. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 8.10 – 8.07 (m, 2H), 7.97 – 7.91 (m, 1H), 7.51 – 7.46 (m, 2H), 7.35 – 7.31 (m, 2H), 7.23 – 7.20 (m, 2H), 7.19 – 7.15 (m, 1H), 7.08 (dt, *J* = 4.8, 1.7 Hz, 3H), 7.06 – 7.03 (m, 3H), 7.03 – 6.96 (m, 6H), 6.85 (dd, *J* = 8.1, 1.3 Hz, 1H), 6.37 (s, 1H), 5.76 (s, 1H), 3.93 (s, 3H), 3.91 (s, 3H), 3.63 (d, *J* = 13.7 Hz, 1H), 3.51 (d, *J* = 13.7 Hz, 1H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 174.96, 160.91, 158.93, 146.33, 144.04, 138.76, 137.43, 135.04, 129.43, 129.10, 128.69, 128.62, 128.50, 128.03, 127.85, 127.00, 126.83, 125.45, 124.63, 124.39, 124.36, 120.44, 114.08, 109.39, 64.01, 56.02, 55.32, 46.72, 41.21. [α]<sub>D</sub><sup>25</sup> = -52 (c = 1.0 in CH<sub>2</sub>Cl<sub>2</sub>). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer: t<sub>R</sub> = 19.96 min, minor enantiomer: t<sub>R</sub> = 35.47 min. 95:5 *dr*, 99% *ee*. HRMS (ESI) calcd for C<sub>37</sub>H<sub>32</sub>N<sub>2</sub>O<sub>4</sub>Na *m/z* [M+Na]<sup>+</sup>: 591.2254, found: 591.2250.

**(R)-4-benzyl-5-(4-fluorophenyl)-4-((S)-(2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3am)**



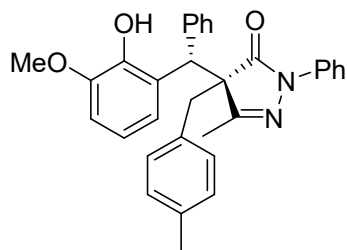
Compound was isolated as a colorless oil (79% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.13 – 8.09 (m, 2H), 7.88 (d,  $J$  = 8.1 Hz, 1H), 7.51 – 7.46 (m, 2H), 7.36 – 7.32 (m, 2H), 7.24 – 7.18 (m, 5H), 7.09 (dd,  $J$  = 5.1, 1.9 Hz, 3H), 7.06 – 6.98 (m, 6H), 6.86 (dd,  $J$  = 8.1, 1.3 Hz, 1H), 6.28 (s, 1H), 5.72 (s, 1H), 3.92 (s, 3H), 3.64 (d,  $J$  = 13.7 Hz, 1H), 3.52 (d,  $J$  = 13.7 Hz, 1H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.90,  $\delta$  163.65 (d,  $J$  = 251.4 Hz), 158.21, 146.27, 143.94, 138.59, 137.29, 134.81, 129.32, 129.03, 129.03 (d,  $J$  = 8.2 Hz), 128.57, 128.12, 127.98 (d,  $J$  = 3.5 Hz), 127.94, 127.15, 126.96, 125.65, 124.43, 124.12, 120.44, 119.26, 115.82 (d,  $J$  = 21.9 Hz), 109.42, 63.89, 56.02, 46.53, 41.24.  $[\alpha]_{\text{D}}^{25}$  = -45 ( $c$  = 1.0 in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/*i*-PrOH = 90/10), 1.0 mL/min; Major enantiomer:  $t_{\text{R}}$  = 22.50 min, minor enantiomer:  $t_{\text{R}}$  = 29.53 min. 97:3 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{36}\text{H}_{29}\text{FN}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M}+\text{Na}]^+$ : 579.2054, found: 579.2044.

**(*R*)-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-5-methyl-4-(2-methylbenzyl)-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3an)**



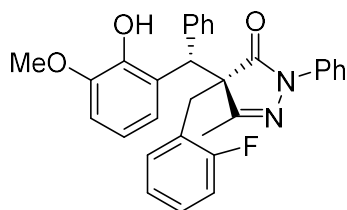
Compound was isolated as a colorless oil (84% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.83 (d,  $J$  = 8.0 Hz, 1H), 7.46 – 7.40 (m, 4H), 7.34 – 7.29 (m, 2H), 7.21 (dd,  $J$  = 8.2, 6.4 Hz, 2H), 7.18 – 7.13 (m, 2H), 7.07 (d,  $J$  = 7.5 Hz, 1H), 7.03 (td,  $J$  = 7.5, 6.8, 2.5 Hz, 1H), 6.98 – 6.90 (m, 3H), 6.81 (dd,  $J$  = 8.0, 1.4 Hz, 1H), 6.13 (s, 1H), 5.18 (s, 1H), 3.89 (s, 3H), 3.45 (d,  $J$  = 14.5 Hz, 1H), 3.21 (d,  $J$  = 14.5 Hz, 1H), 2.29 (s, 3H), 2.19 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.78, 161.84, 146.11, 143.66, 139.00, 137.45, 136.52, 133.75, 130.48, 128.79, 128.58, 128.56, 128.39, 127.20, 126.88, 125.68, 125.27, 124.58, 123.88, 120.13, 119.19, 109.22, 63.26, 55.96, 46.86, 35.66, 20.04, 15.08.  $[\alpha]_{\text{D}}^{25}$  = -4 ( $c$  = 1.0 in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak AD-H column at 254 nm (n-hexane/*i*-PrOH = 90/10), 0.7 mL/min; Major enantiomer:  $t_{\text{R}}$  = 19.70 min, minor enantiomer:  $t_{\text{R}}$  = 43.00 min. 90:10 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{32}\text{H}_{30}\text{N}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M}+\text{Na}]^+$ : 513.2149, found: 513.2151.

**(*R*)-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-5-methyl-4-(4-methylbenzyl)-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3ao)**



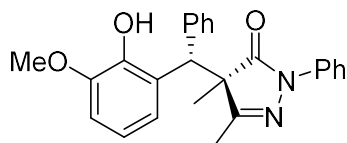
Compound was isolated as a colorless oil (95% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.67 (dd,  $J$  = 8.1, 1.4 Hz, 1H), 7.47 (dd,  $J$  = 8.6, 1.2 Hz, 2H), 7.43 – 7.38 (m, 2H), 7.35 – 7.30 (m, 2H), 7.25 – 7.20 (m, 2H), 7.19 – 7.14 (m, 2H), 6.99 (d,  $J$  = 8.1 Hz, 2H), 7.00 – 6.89 (m, 3H), 6.80 (dd,  $J$  = 8.0, 1.4 Hz, 1H), 6.15 (s, 1H), 5.17 (s, 1H), 3.88 (s, 3H), 3.37 (d,  $J$  = 13.6 Hz, 1H), 3.10 (d,  $J$  = 13.6 Hz, 1H), 2.21 (s, 3H), 2.21 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.54, 161.78, 146.17, 143.59, 139.20, 137.44, 136.53, 131.72, 128.99, 128.82, 128.77, 128.52, 128.43, 127.16, 125.23, 124.38, 123.82, 120.10, 119.12, 109.19, 63.75, 55.92, 46.71, 40.36, 20.93, 15.15.  $[\alpha]_{\text{D}}^{25}$  = 39 ( $c$  = 1.0 in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IC column at 254 nm (n-hexane/*i*-PrOH = 90/10), 0.7 mL/min; Major enantiomer:  $t_{\text{R}}$  = 19.16 min, minor enantiomer:  $t_{\text{R}}$  = 37.45 min. 98:2 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{32}\text{H}_{30}\text{N}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M}+\text{Na}]^+$ : 513.2149, found: 513.2148.

**(R)-4-(2-fluorobenzyl)-4-((S)-(2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3ap)**



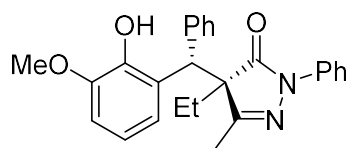
Compound was isolated as a colorless oil (94% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.64 (dd,  $J$  = 8.2, 1.4 Hz, 1H), 7.50 (dd,  $J$  = 8.6, 1.2 Hz, 2H), 7.42 – 7.37 (m, 2H), 7.35 – 7.30 (m, 2H), 7.22 (t,  $J$  = 7.3 Hz, 2H), 7.20 – 7.14 (m, 3H), 7.12 – 7.05 (m, 1H), 6.99 – 6.84 (m, 3H), 6.80 (dd,  $J$  = 8.1, 1.4 Hz, 1H), 6.17 (s, 1H), 5.22 (s, 1H), 3.89 (s, 3H), 3.54 (d,  $J$  = 13.8 Hz, 1H), 3.21 – 3.14 (m, 1H), 2.21 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.34,  $\delta$  160.78 (d,  $J$  = 244.7 Hz), 162.27, 146.17, 143.63, 139.18, 137.38, 131.64 (d,  $J$  = 3.9 Hz), 128.83 (d,  $J$  = 8.6 Hz), 128.66, 128.57, 128.51, 127.22, 124.02, 124.00 (d,  $J$  = 36.1 Hz), 123.83, 121.92 (d,  $J$  = 15.4 Hz), 119.95, 119.11, 115.09 (d,  $J$  = 23.1 Hz), 109.22, 63.17, 55.94, 46.56, 32.70, 14.47.  $[\alpha]_{\text{D}}^{25}$  = 9.0 ( $c$  = 1.0 in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IC column at 254 nm (n-hexane/*i*-PrOH = 95/5), 0.7 mL/min; Major enantiomer:  $t_{\text{R}}$  = 18.42 min, minor enantiomer:  $t_{\text{R}}$  = 45.23 min. 98:2 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{31}\text{H}_{27}\text{FN}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M}+\text{Na}]^+$ : 517.1890, found: 517.1895.

**(R)-4-((S)-(2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-4,5-dimethyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3aq)**



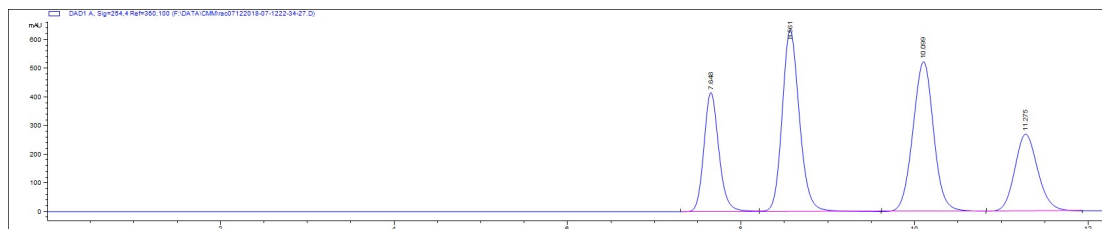
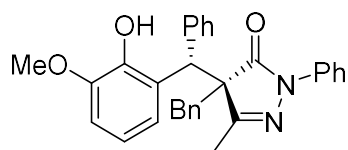
Compound was isolated as a colorless oil (81% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.76 (dd,  $J = 8.7, 1.2$  Hz, 2H), 7.54 (dd,  $J = 8.0, 1.4$  Hz, 1H), 7.40 – 7.36 (m, 2H), 7.34 – 7.31 (m, 2H), 7.23 – 7.15 (m, 4H), 6.86 (t,  $J = 8.0$  Hz, 1H), 6.77 (dd,  $J = 8.1, 1.4$  Hz, 1H), 6.03 (s, 1H), 4.99 (s, 1H), 3.87 (s, 3H), 2.17 (s, 3H), 1.44 (s, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  175.57, 164.04, 146.18, 143.58, 139.08, 137.91, 128.70, 128.35, 127.14, 125.01, 124.50, 123.27, 119.37, 119.05, 109.17, 57.40, 55.92, 46.73, 20.81, 14.23.  $[\alpha]_{\text{D}}^{25} = -100$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IA column at 254 nm (n-hexane/*i*-PrOH = 90/10), 0.7 mL/min; Major enantiomer:  $t_{\text{R}} = 21.43$  min, minor enantiomer:  $t_{\text{R}} = 23.25$  min. 92:8 *dr*, 97% *ee*. HRMS (ESI) calcd for  $\text{C}_{25}\text{H}_{24}\text{N}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M}+\text{Na}]^+$ : 423.1679, found: 423.1677.

**(*R*)-4-ethyl-4-((*S*)-(2-hydroxy-3-methoxyphenyl)(phenyl)methyl)-5-methyl-2-phenyl-2,4-dihydro-3H-pyrazol-3-one (3ar)**

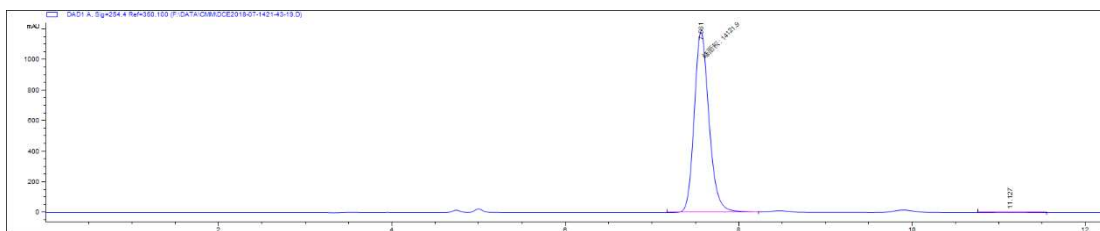


Compound was isolated as a colorless oil (85% yield) after flash column chromatography on silica-gel.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.79 – 7.72 (m, 2H), 7.58 (dd,  $J = 8.1, 1.3$  Hz, 1H), 7.41 – 7.36 (m, 2H), 7.36 – 7.32 (m, 2H), 7.21 – 7.17 (m, 3H), 7.15 (dd,  $J = 8.4, 6.0$  Hz, 1H), 6.86 (t,  $J = 8.1$  Hz, 1H), 6.76 (dd,  $J = 8.0, 1.4$  Hz, 1H), 6.03 (s, 1H), 5.00 (s, 1H), 3.87 (s, 3H), 2.15 (s, 3H), 2.09 – 2.04 (dd,  $J = 14.0, 7.3$  Hz, 1H), 1.87 (dd,  $J = 14.0, 7.3$  Hz, 1H), 0.70 (t,  $J = 7.5$  Hz, 3H).  $^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ )  $\delta$  174.85, 162.46, 146.13, 143.56, 139.24, 137.74, 128.71, 128.69, 128.37, 127.12, 125.09, 124.58, 123.50, 119.50, 119.02, 109.10, 63.08, 55.92, 46.70, 27.51, 14.41, 8.44.  $[\alpha]_{\text{D}}^{25} = -70$  ( $c = 1.0$  in  $\text{CH}_2\text{Cl}_2$ ). The enantiomers were analyzed by HPLC using Daicel Chiralpak IE column at 254 nm (n-hexane/*i*-PrOH = 90/10), 0.7 mL/min; Major enantiomer:  $t_{\text{R}} = 29.62$  min, minor enantiomer:  $t_{\text{R}} = 72.78$  min. 95:5 *dr*, 99% *ee*. HRMS (ESI) calcd for  $\text{C}_{26}\text{H}_{26}\text{N}_2\text{O}_3\text{Na}$   $m/z$   $[\text{M}+\text{Na}]^+$ : 437.1836, found: 437.1838.

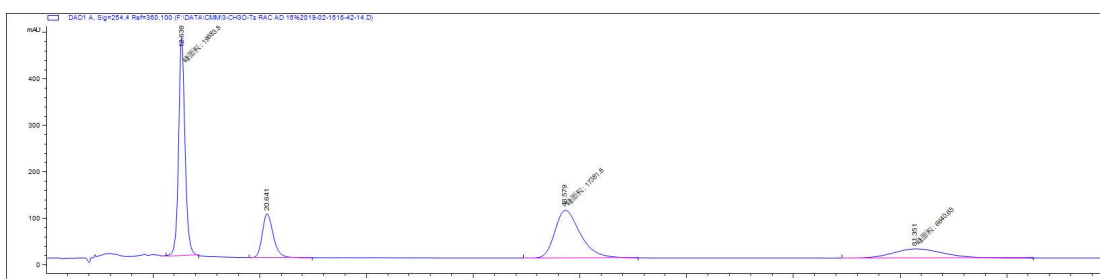
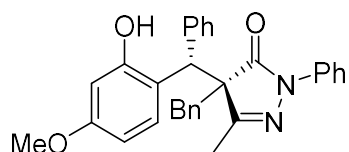
**4. HPLC spectra of products 3**



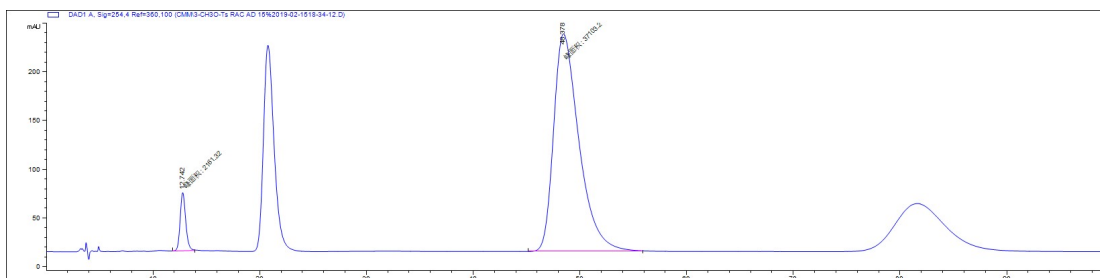
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	7.648	4986.5	415.1	0.1842	0.816	18.273	BV
2	8.561	8733.3	631.1	0.2134	0.809	32.004	VB
3	10.099	8648.2	521.2	0.2576	1.012	31.692	BB
4	11.275	4920.4	267.4	0.2827	0.848	18.031	BB



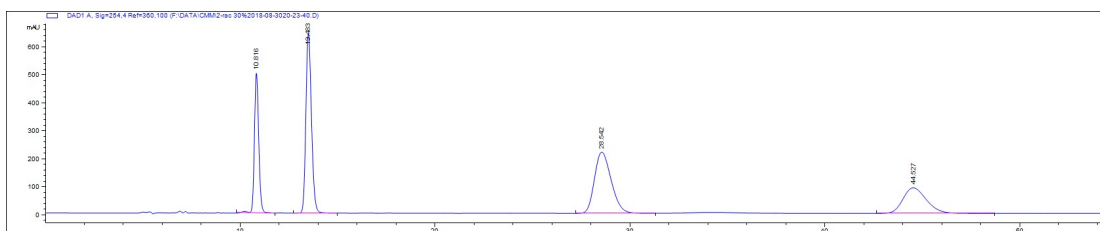
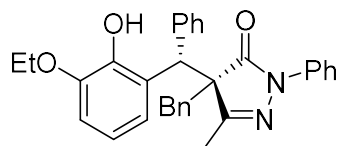
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	7.561	14337.3	1182.7	0.1811	0.787	99.853	BV R
2	11.127	21.1	1.2	0.2689	0.922	0.147	BB



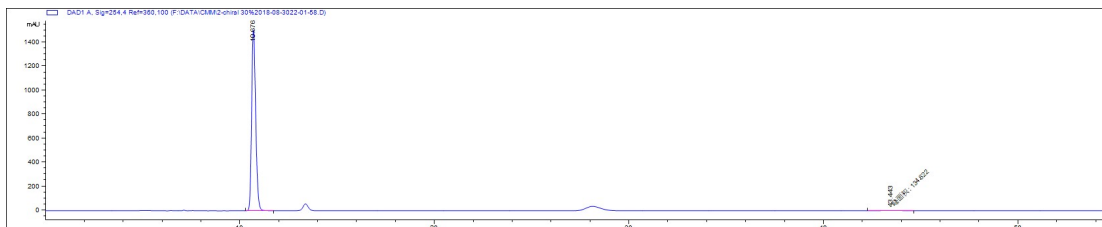
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	12.638	19683.8	470	0.698	0.866	39.022	MM
2	20.641	6736.1	94.2	1.0981	0.739	13.354	BB
3	48.579	17381.8	103.4	2.8022	0.7	34.459	MM
4	81.351	6640.7	19.8	5.581	0.812	13.165	MM



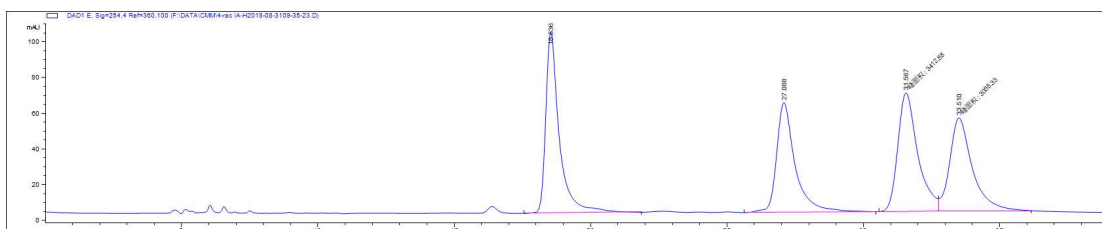
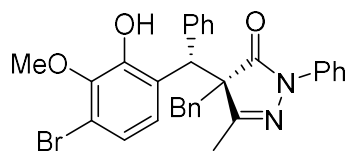
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	12.742	2161.3	59.6	0.6047	0.832	5.504	MM
2	48.378	37103.2	223.2	2.7709	0.608	94.496	MM



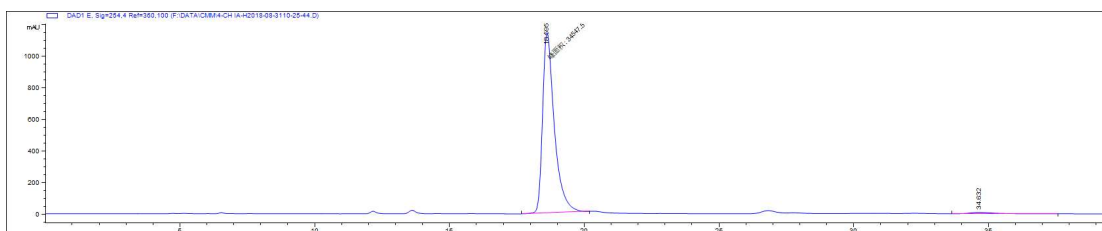
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	10.816	7786	500.7	0.2366	0.887	18.840	VB R
2	13.483	12830.3	643.5	0.3086	0.785	31.046	BB
3	28.542	13065.2	219.3	0.9331	0.739	31.615	BB
4	44.527	7644.9	91.5	1.2863	0.751	18.499	BB



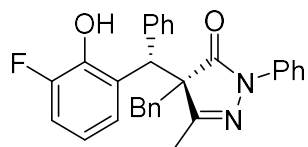
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	10.676	21867.1	1507.1	0.2253	0.766	99.388	BB
2	43.443	134.6	1.8	1.2569	0.902	0.612	MM

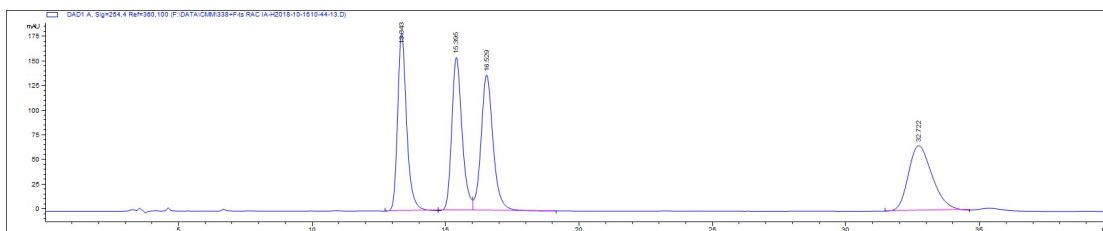


#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	18.536	3507.7	101	0.5052	0.529	27.223	BB
2	27.088	2908.9	61.2	0.6969	0.605	22.576	BB
3	31.567	3412.9	66.3	0.8581	0.675	26.488	MF
4	33.51	3055.3	52.2	0.9757	0.661	23.713	FM

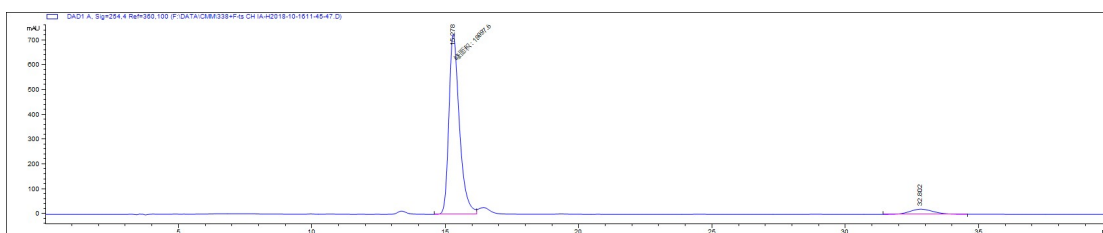


#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	18.595	34547.5	1138.2	0.5059	0.587	98.475	MM
2	34.632	535	8.8	0.9019	0.6	1.525	BB

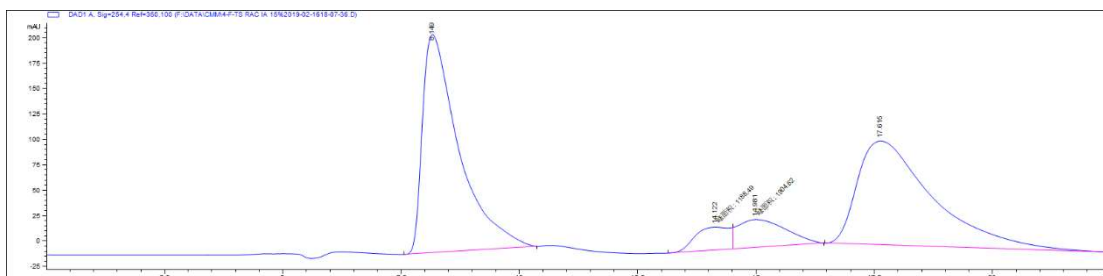
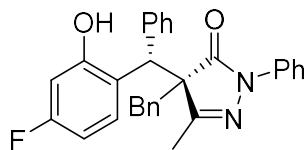




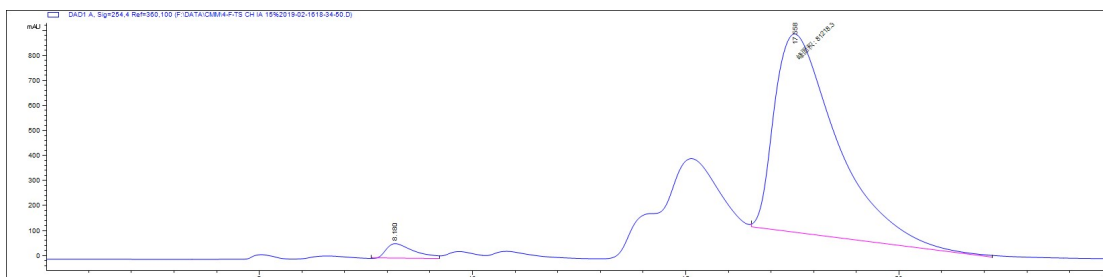
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	13.343	4274.7	181.6	0.3546	0.736	25.171	BB
2	15.395	4214.2	156.3	0.4106	0.76	24.815	BV
3	16.529	4368.8	138.5	0.4781	0.808	25.725	VB
4	32.722	4124.9	66.3	0.9475	0.725	24.289	BB



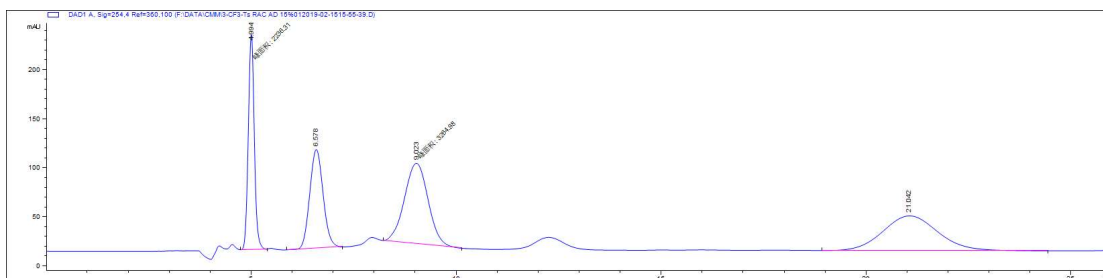
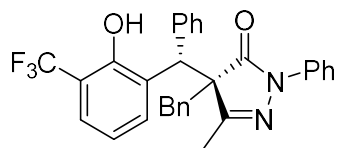
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	15.278	19997.6	727.6	0.458	0	93.931	MF
2	32.802	1292.2	20.8	0.9493	0.842	6.069	BB



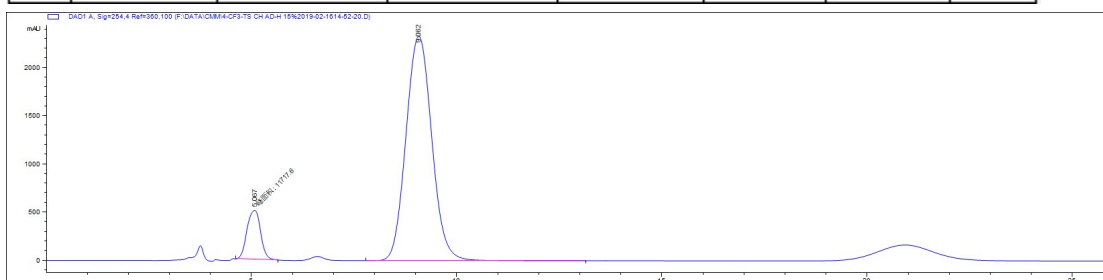
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	8.149	11498.6	214.8	0.7985	0.345	44.471	BB
2	14.122	1188.5	22.5	0.8791	0	4.597	MF
3	14.981	1904.6	27.5	1.1528	0.585	7.366	FM
4	17.615	11264.8	102.1	1.6087	0.416	43.567	BBA



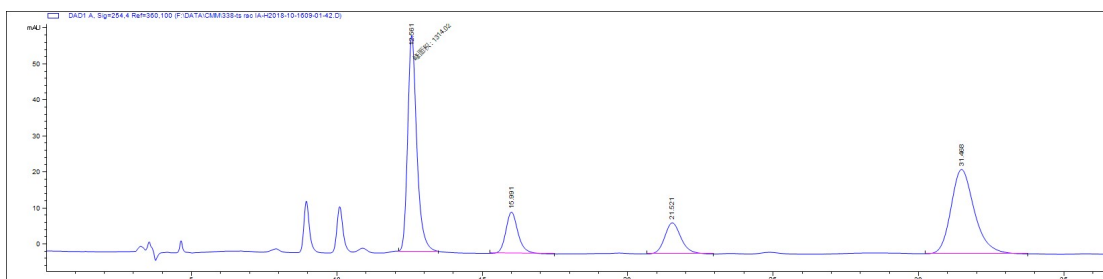
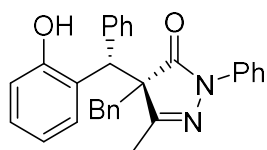
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	8.18	2726.7	59	0.6832	0.444	3.248	BV
2	17.558	81218.3	791.4	1.7104	0.452	96.752	MM



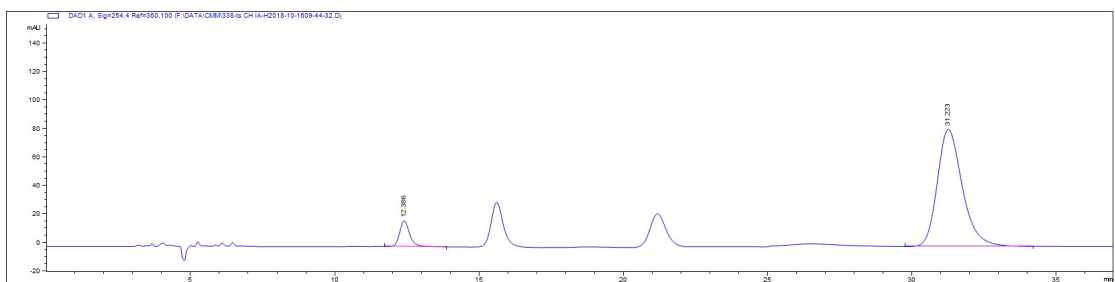
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	4.994	2236.3	219.5	0.1698	0.973	20.170	MM
2	6.578	2284.6	100.6	0.3549	0.923	20.605	BB
3	9.023	3265	81.8	0.665	0.986	29.447	MM
4	21.042	3301.7	35.4	1.4276	0.907	29.778	BB



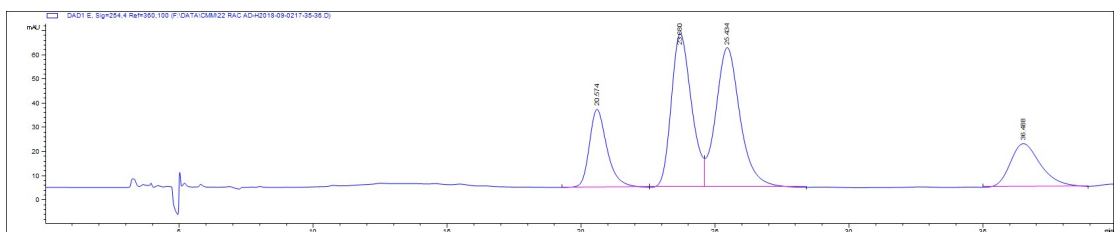
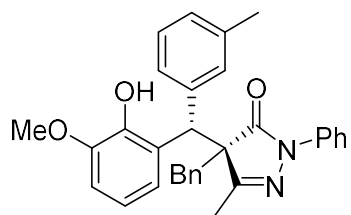
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	5.067	11717.6	507.7	0.3847	1.222	10.331	MM
2	9.062	101706.5	2327.4	0.6878	0.929	89.669	BB



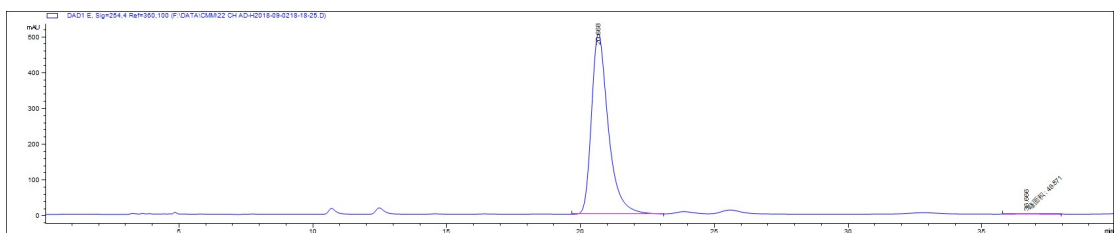
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	12.561	1314	60	0.3647	0.764	39.812	MM
2	15.991	338.7	11.5	0.4479	0.804	10.262	BB
3	21.521	338.7	8.6	0.6043	0.821	10.262	BB
4	31.468	1309.1	23.4	0.847	0.773	39.663	BB



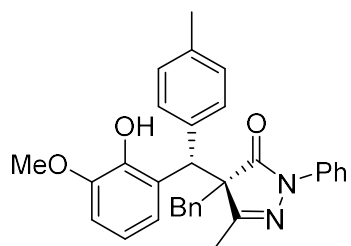
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	12.386	441.3	18.1	0.3683	0.787	8.168	BB
2	31.223	4961.5	82.3	0.921	0.744	91.832	BB

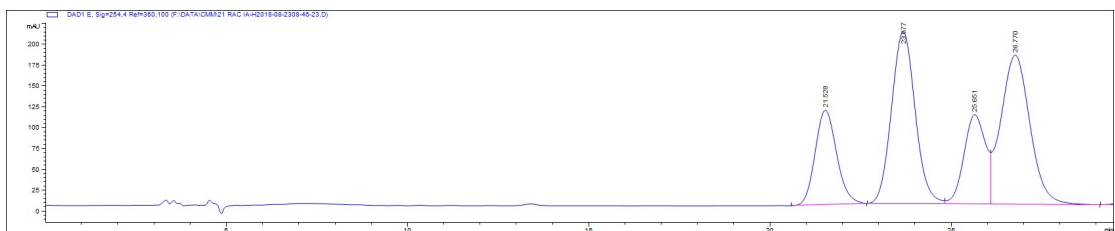


#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	20.574	1495.9	32.3	0.6996	0.715	15.059	BB
2	23.68	3356.5	63.7	0.8046	0.756	33.789	BV
3	25.434	3673.2	57.9	0.9557	0.832	36.977	VB
4	36.488	1408.1	17.9	1.1833	0.72	14.175	BB

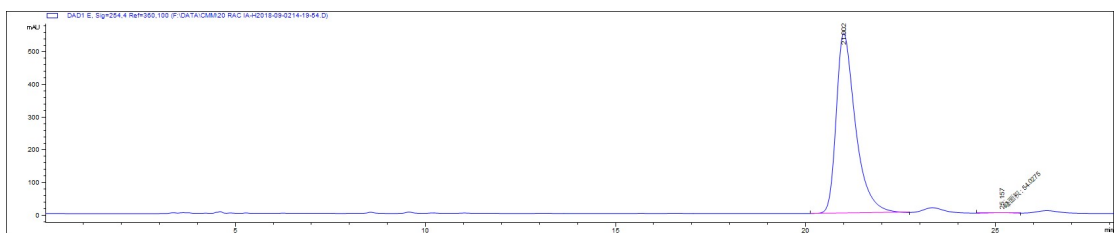


#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	20.668	22032.7	505.8	0.6562	0.647	99.774	BB
2	36.666	49.9	7.6E-1	1.0922	0.734	0.226	MM

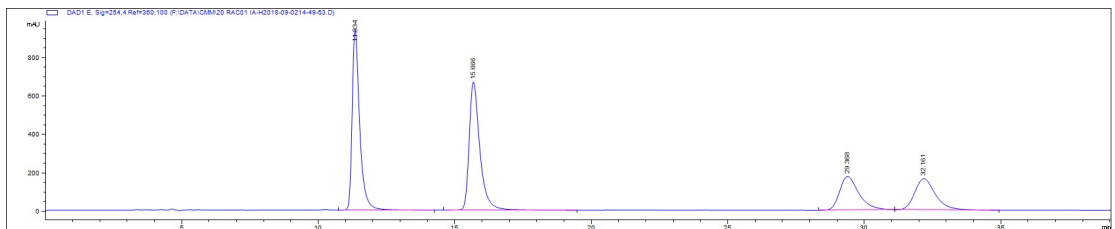
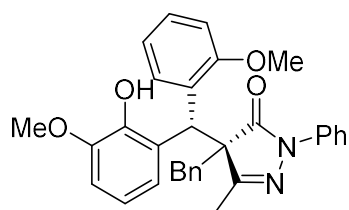




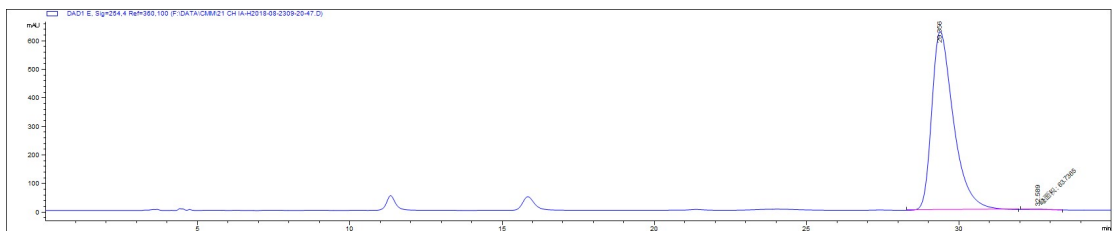
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	21.528	4667.7	113	0.6439	0.863	16.414	BB
2	23.677	9363.3	206	0.7084	0.929	32.927	BV
3	25.651	4458.4	106.9	0.6384	0.997	15.679	VV
4	26.77	9947.2	178.6	0.8519	0.912	34.980	VB



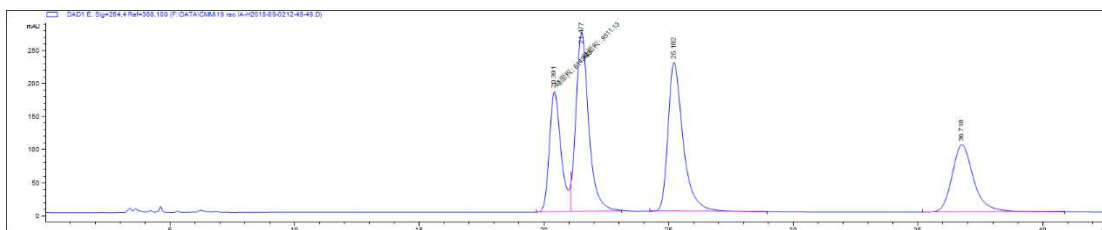
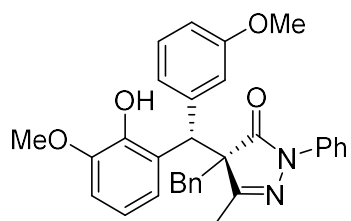
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	21.002	19400.2	551.4	0.5284	0.593	99.712	BB
2	25.157	56.1	1.6	0.6009	1.203	0.288	MM



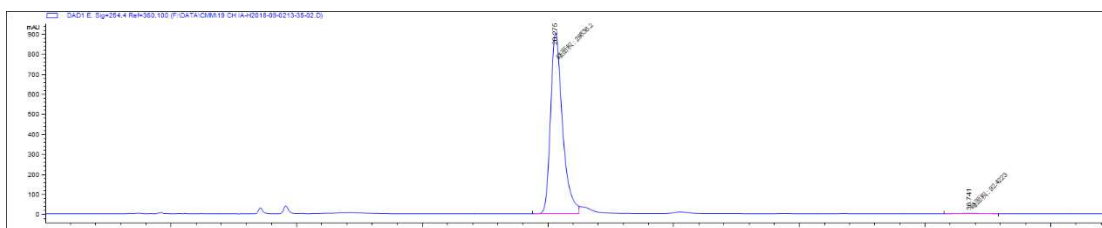
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	11.334	18092.5	939.6	0.2867	0.582	33.869	BB
2	15.666	18174.6	666.2	0.4083	0.6	34.022	BB
3	29.368	8588.3	175.3	0.7397	0.662	16.077	BB
4	32.161	8564.2	162.2	0.8039	0.734	16.032	BB



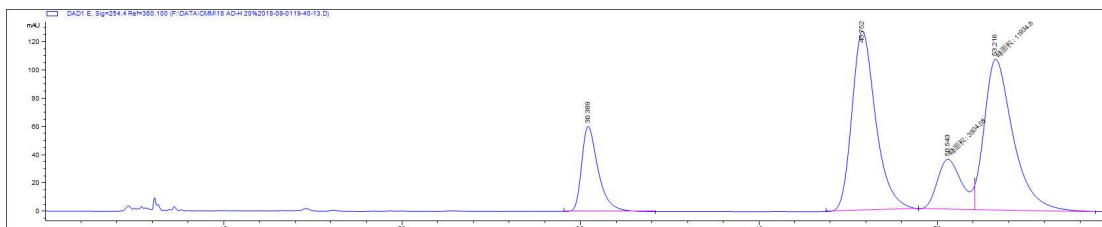
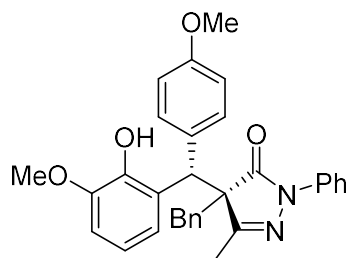
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	29.356	31298.9	626.9	0.7485	0.591	99.797	BB
2	32.589	63.7	1.5	0.6895	0.629	0.203	MM



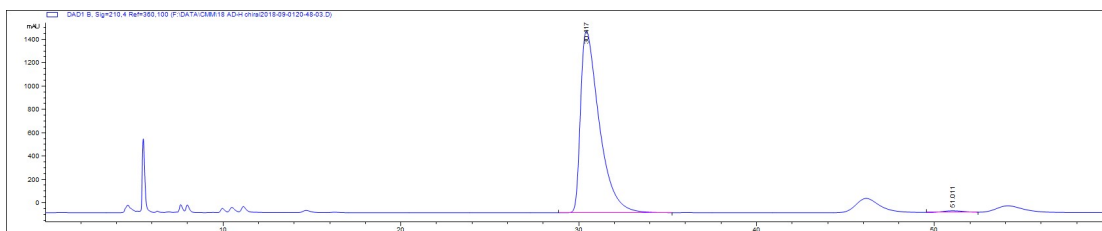
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	20.391	6149.4	182.7	0.5611	0	19.571	MF
2	21.477	9511.1	271.5	0.5838	0.72	30.269	FM
3	25.182	9536.9	225.7	0.633	0.613	30.351	BB
4	36.718	6224.1	102.2	0.9226	0.772	19.808	BB



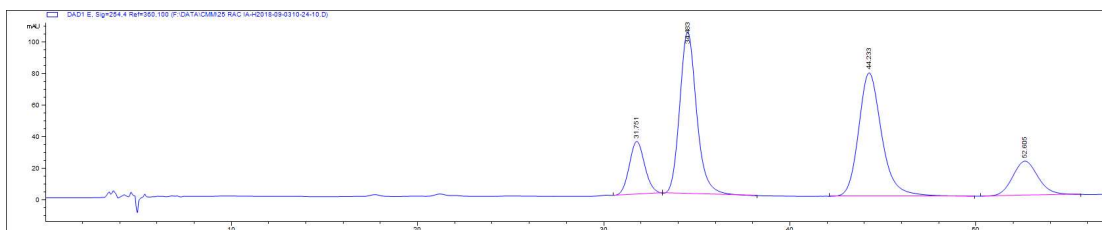
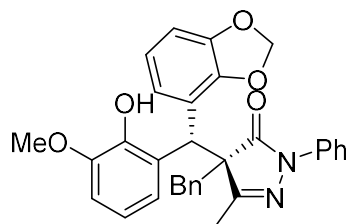
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	20.275	29836.2	902.1	0.5512	0.684	99.691	MF
2	36.741	92.4	1.5	1.002	0.893	0.309	MM



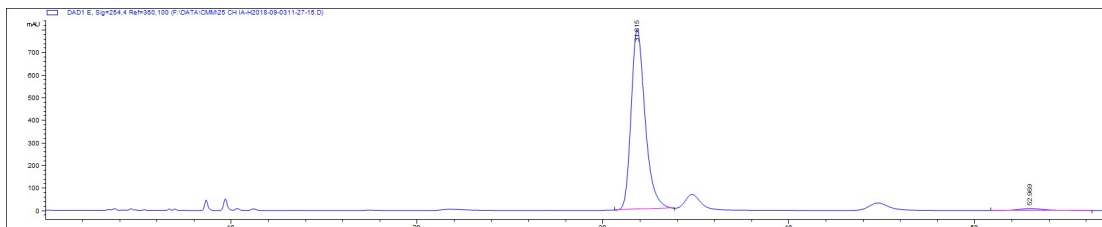
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	30.389	3871.1	60.2	0.9636	0.602	12.455	BB
2	45.752	11770	127.1	1.4086	0.736	37.870	BB
3	50.543	3504.1	35.5	1.6461	0	11.274	MF
4	53.216	11934.8	106.8	1.8632	0.607	38.400	FM



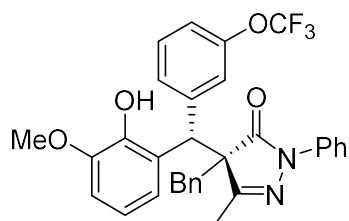
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	30.417	112963.9	1548.2	1.0912	0.416	99.107	BB
2	51.011	1018.4	12.9	1.17	0.925	0.893	BB

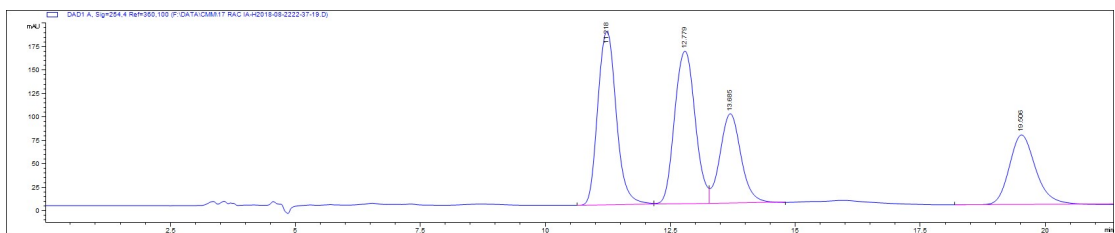


#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	31.751	1939.2	33.5	0.8889	0.9	11.223	BB
2	34.483	6496.3	102.4	0.962	0.817	37.598	BB
3	44.233	6766.4	78.1	1.3168	0.773	39.161	BB
4	52.605	2076.4	21.7	1.4711	0.893	12.018	BB

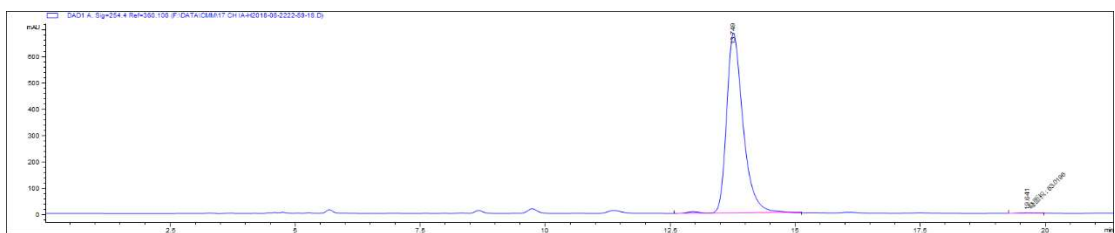


#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	31.815	41671.3	794.8	0.8017	0.717	98.260	BB
2	52.969	737.7	8.3	1.3022	0.845	1.740	BB

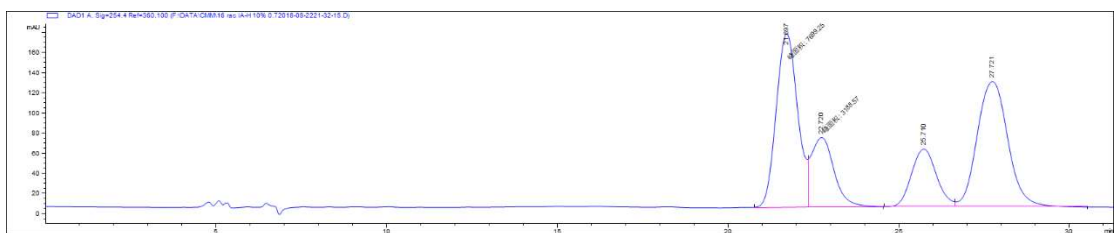
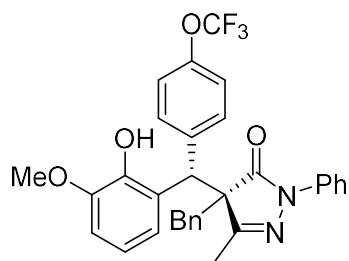




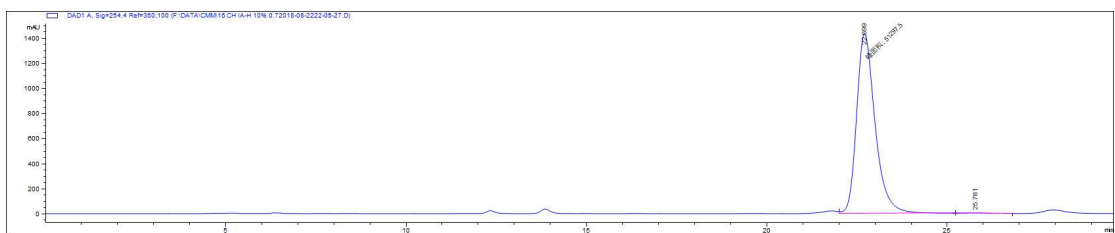
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	11.218	4746.6	184.5	0.4061	0.894	31.843	BV
2	12.779	4659	162.3	0.4569	0.961	31.256	VV
3	13.685	2774.7	95	0.4526	0.894	18.614	VB
4	19.506	2726	74.1	0.5634	0.8	18.287	BBA



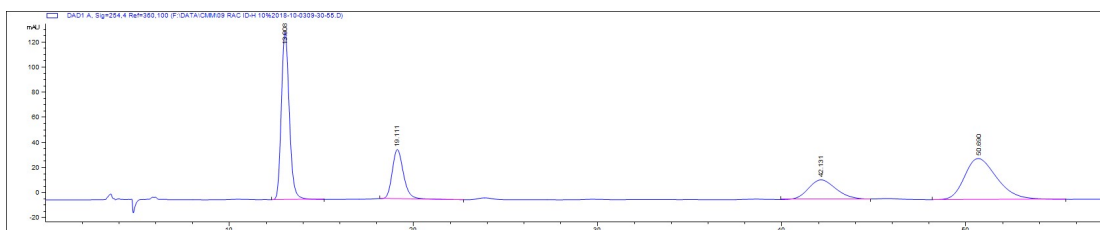
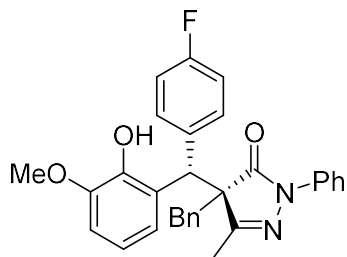
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	13.749	15756.4	682.7	0.3454	0.676	99.602	VB R
2	19.641	63	2.1	0.495	1.16	0.398	MM



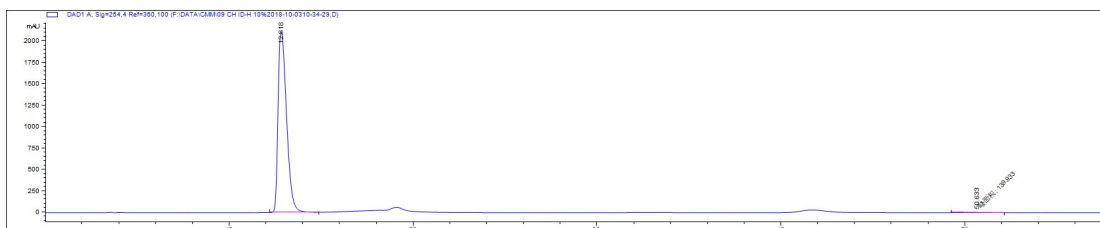
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	21.697	7699.2	173.5	0.7397	0	35.595	MF
2	22.72	3188.6	69.8	0.7615	0.719	14.741	FM
3	25.71	2932.5	57.5	0.8015	0.921	13.557	BV
4	27.721	7810	124.7	0.9924	0.934	36.107	VB



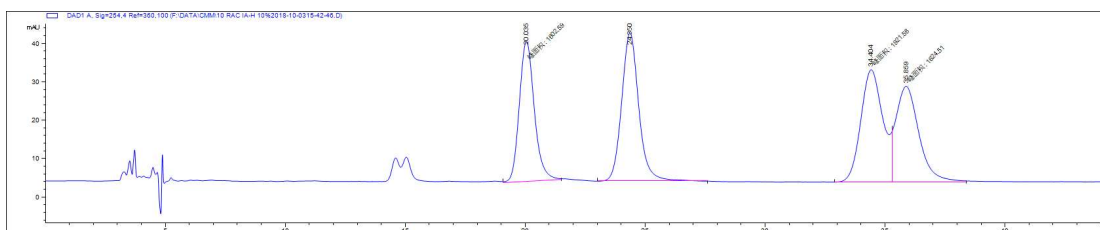
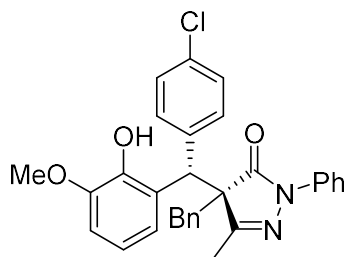
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	22.699	51297.5	1438.4	0.5944	0.721	99.773	FM
2	25.781	116.7	3.1	0.5627	0.703	0.227	BB



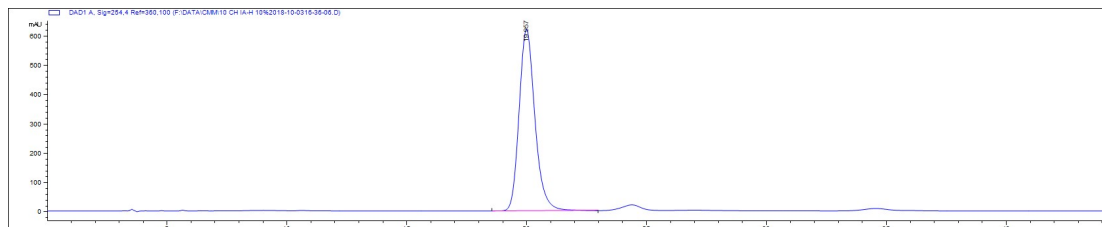
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	13.008	4003.8	133	0.4652	0.811	35.556	BB
2	19.111	1665.7	39.1	0.6513	0.777	14.792	BB
3	42.131	1597.4	15.4	1.5101	0.818	14.186	BB
4	50.69	3993.7	32.5	1.8358	0.713	35.466	BB



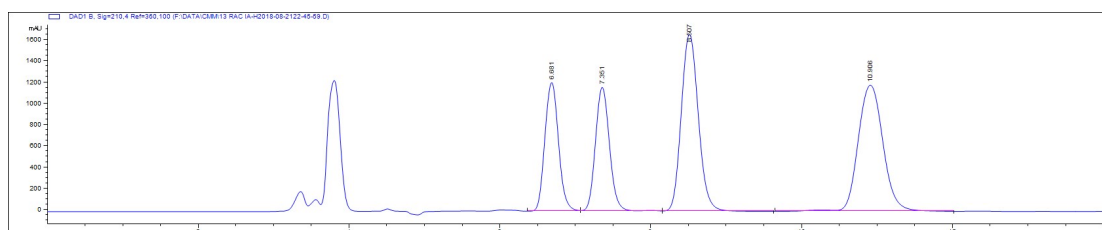
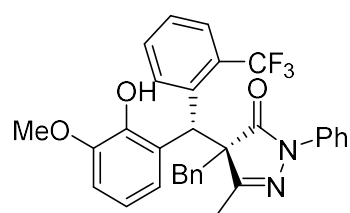
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	12.818	67924.8	2111.8	0.5032	0.539	99.794	BB
2	50.633	139.9	1.5	1.5929	0.881	0.206	MM



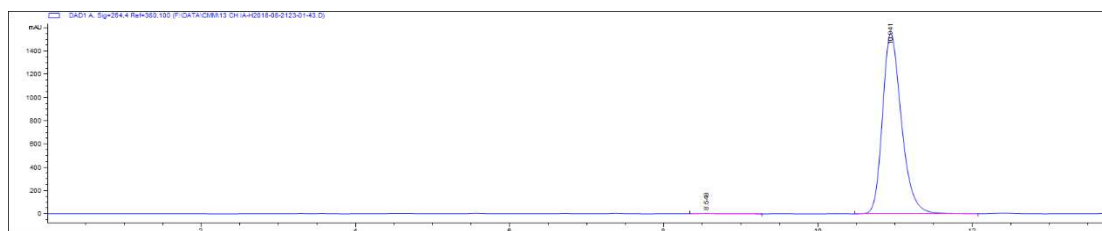
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	20.035	1602.6	36.5	0.7309	0.864	22.665	MM
2	24.35	1922.2	38.6	0.7585	0.875	27.185	BB
3	34.404	1921.6	29.3	1.0924	0	27.176	MF
4	35.859	1624.5	25	1.0832	0.697	22.975	FM



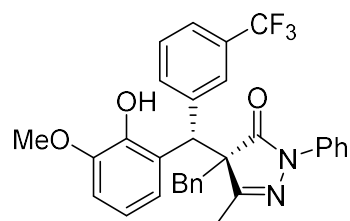
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	19.957	28352.6	617.5	0.7037	0.808	100.000	BB

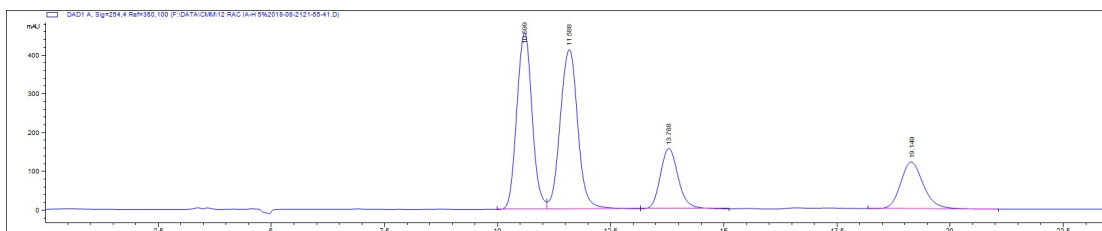


#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	6.681	15261.5	1212	0.1989	0.945	18.209	BV
2	7.351	15118.1	1166.1	0.2026	0.885	18.038	VV R
3	8.507	26140.8	1665.8	0.2471	0.87	31.190	BB
4	10.906	27292.1	1188.8	0.3609	0.955	32.563	VB R

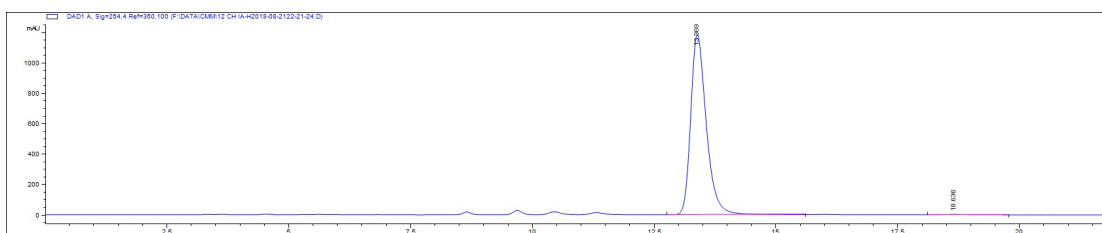


#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	8.548	36.8	2.8	0.2021	0.707	0.138	BB
2	10.941	26583.1	1555.9	0.2613	0.719	99.862	BB

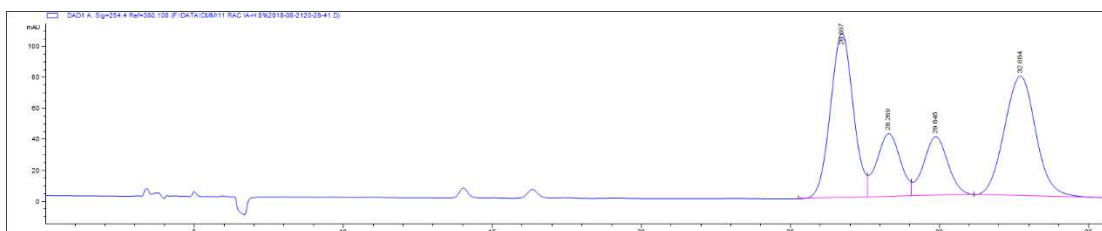
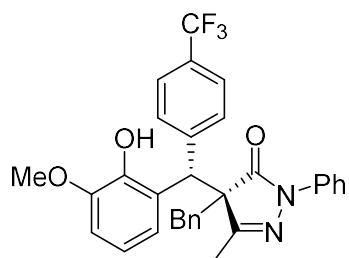




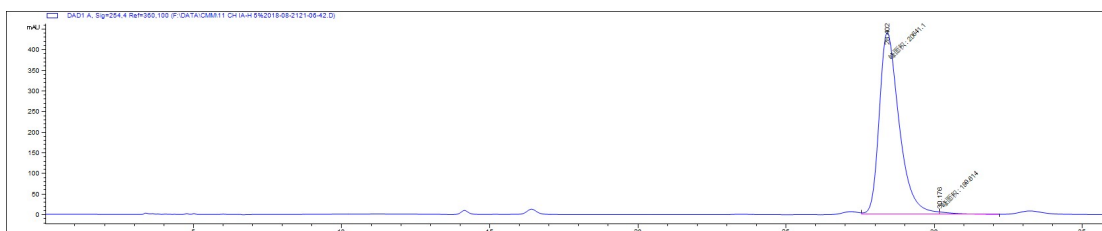
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	10.599	10719.1	457	0.3697	0.994	35.272	BV
2	11.588	11174	412.8	0.4278	1.012	36.769	VB
3	13.788	4285.3	156.2	0.428	0.838	14.101	BB
4	19.149	4211.5	120.9	0.5346	0.811	13.858	BB



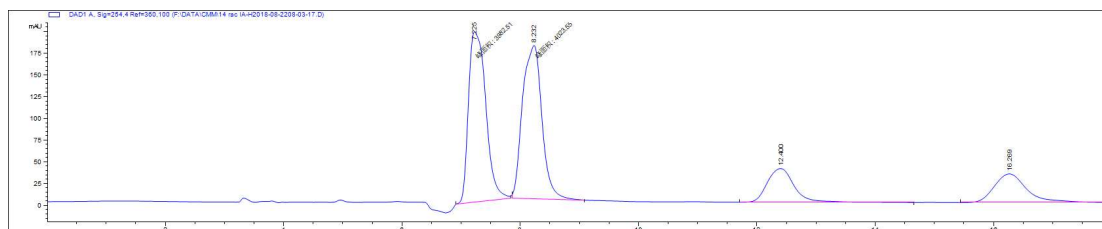
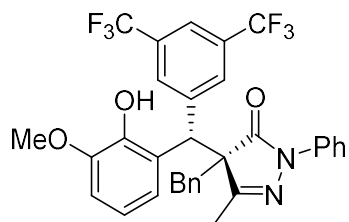
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	13.369	26540.4	1189.8	0.3382	0.67	99.727	BB
2	18.636	72.6	2.2	0.4939	0.646	0.273	BB



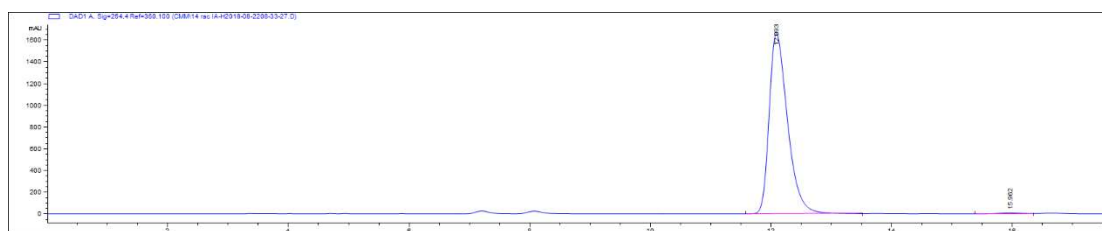
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	26.697	5668.9	106.5	0.823	0.974	36.025	BV
2	28.269	2257.9	40.7	0.8451	0.975	14.348	VV
3	29.845	2147.9	38	0.8591	0.969	13.649	VB
4	32.684	5661.4	77.3	1.1342	0.993	35.977	BBA



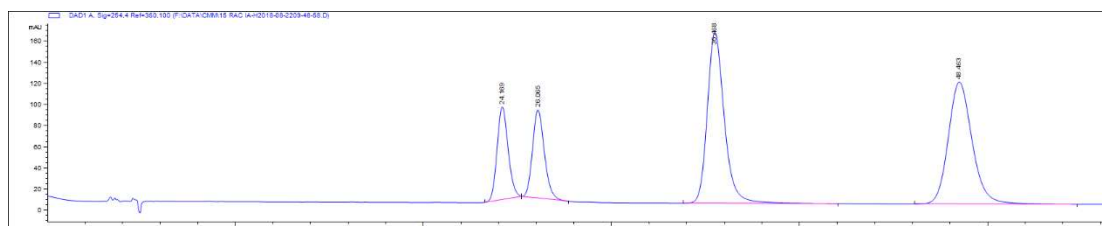
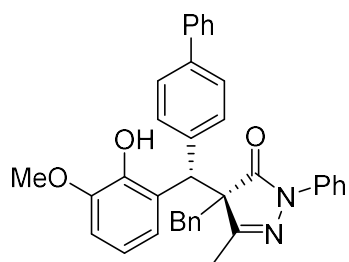
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	28.402	20641.1	440.2	0.7816	0.644	99.042	MF
2	30.176	199.6	6	0.5502	0	0.958	FM



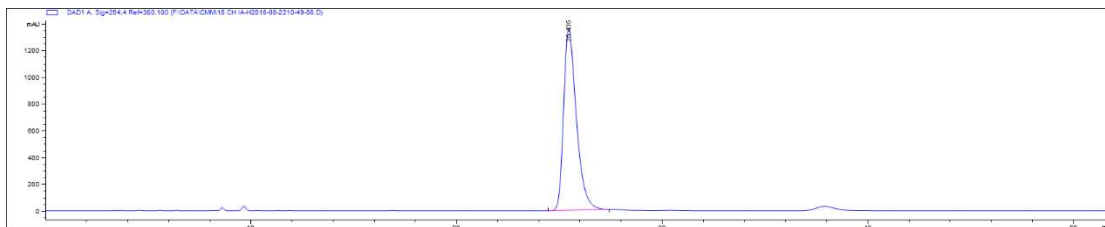
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	7.225	3982.5	195.9	0.3389	0.542	37.963	MM
2	8.232	4023.6	176.4	0.3802	1.335	38.354	MM
3	12.4	1228.3	38.8	0.4994	0.884	11.709	BB
4	16.269	1256.2	32.9	0.5895	0.796	11.974	BB



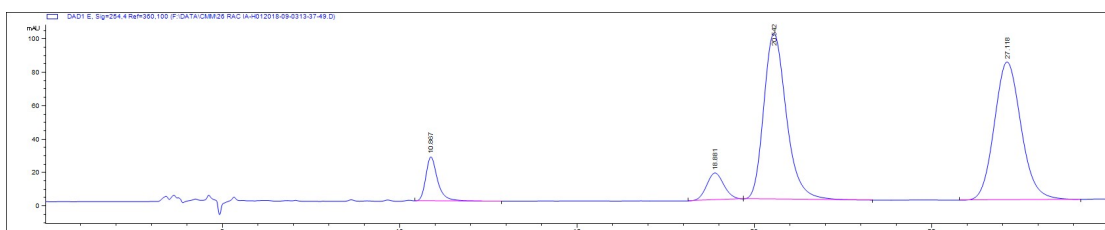
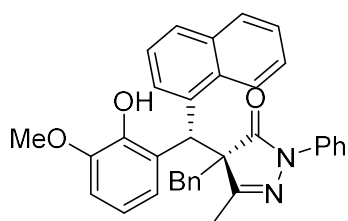
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	12.093	35111.6	1656.4	0.3253	0.604	99.365	BB
2	15.962	224.2	7.7	0.4444	0.798	0.635	BV



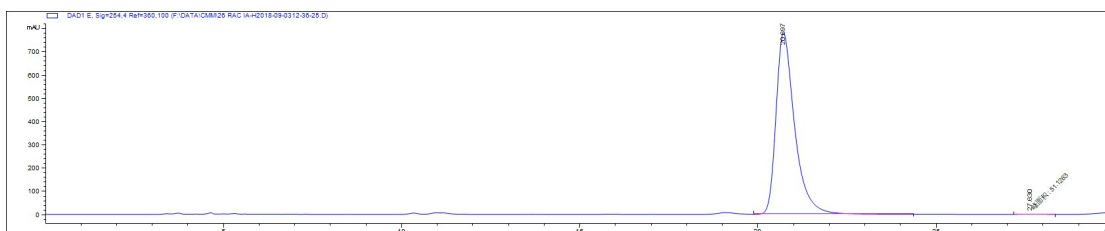
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	24.169	3563.7	87.3	0.6303	0.858	12.940	BB
2	26.065	3645.3	82.9	0.6747	0.805	13.236	BB
3	35.468	10159.5	161.1	0.9615	0.741	36.889	BB
4	48.463	10172	115.1	1.3691	0.811	36.935	BB



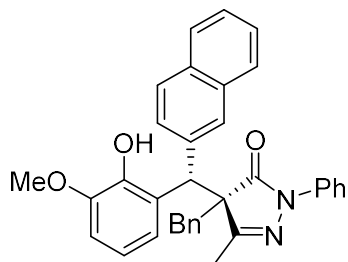
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	25.435	58362.4	1348.2	0.6571	0.624	100.000	BB

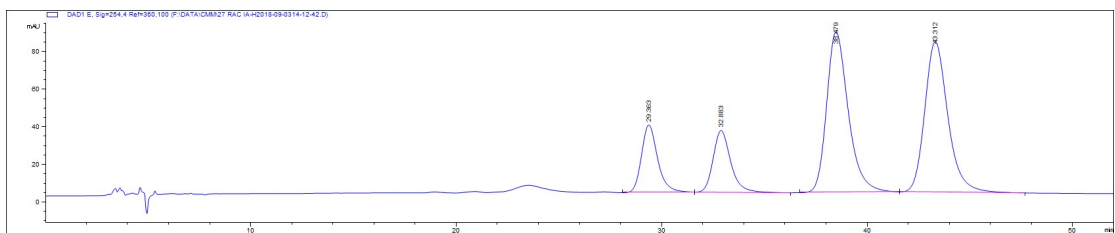


#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	10.867	610.6	26.3	0.3491	0.698	6.175	BB
2	18.881	545	16.1	0.5249	0.907	5.511	BB
3	20.542	4394.6	99	0.688	0.759	44.439	BB
4	27.118	4338.7	82.4	0.8179	0.866	43.875	BB

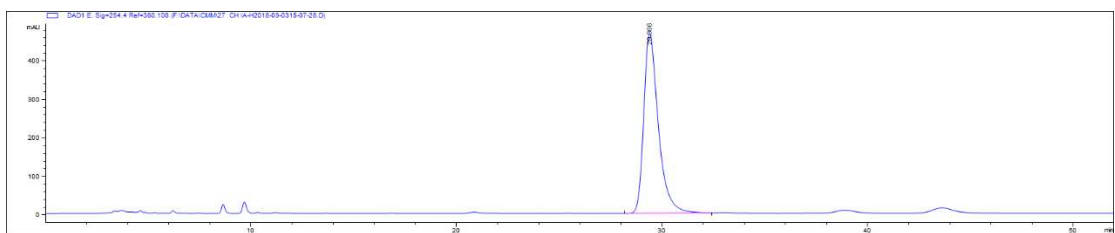


#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	20.697	28433.9	779.4	0.5496	0.615	99.821	BB
2	27.63	51.1	8.7E-1	0.9776	0.668	0.179	MM

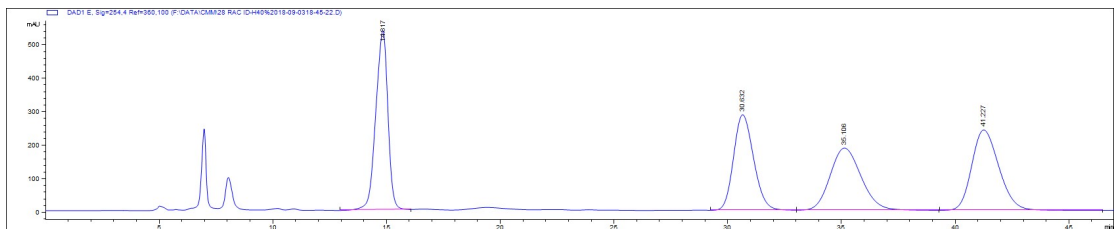
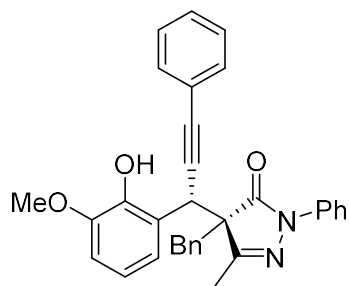




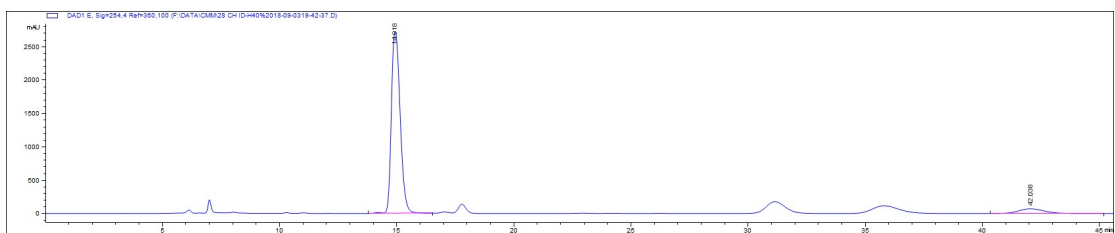
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	29.363	1968.3	35.9	0.8329	0.779	11.970	BB
2	32.883	1959.3	32.8	0.9081	0.769	11.916	BB
3	38.479	6250.4	85.3	1.1188	0.723	38.013	BB
4	43.312	6265	80	1.1992	0.782	38.101	BB



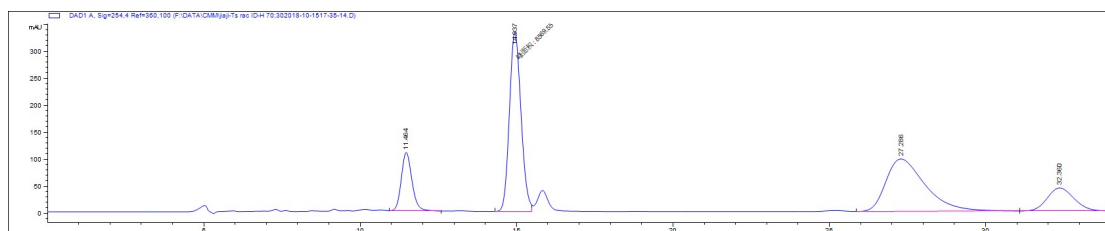
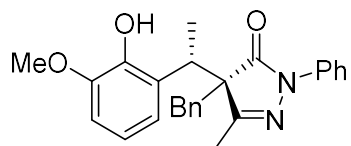
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	29.366	23153.2	468.3	0.7428	0.629	100.000	BB



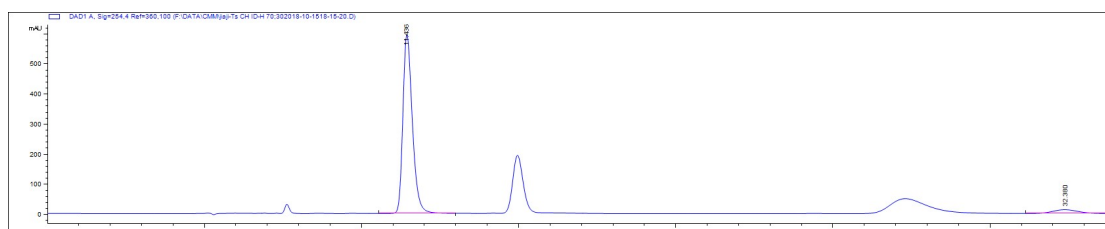
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	14.817	19862	536.8	0.5936	1.353	26.543	BB
2	30.632	17490.6	285.5	0.9547	0.799	23.374	BB
3	35.106	17568.1	185.7	1.4776	0.823	23.477	BB
4	41.227	19909.3	240.2	1.2911	0.757	26.606	BB



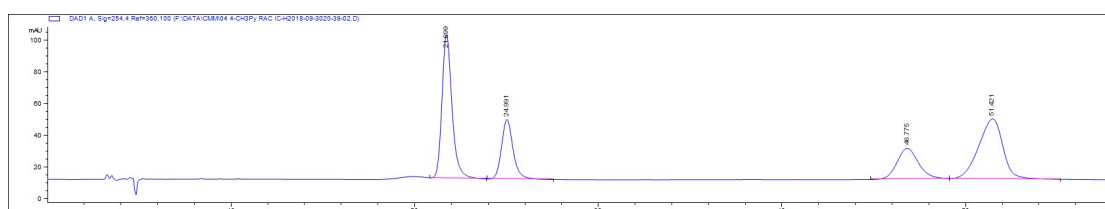
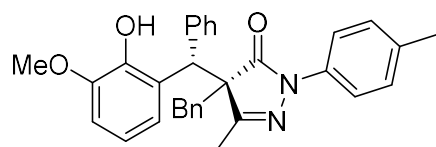
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	14.918	70436.9	2701.7	0.4071	0.712	93.053	VB R
2	42.038	5258.9	69	1.1835	0.833	6.947	BBA



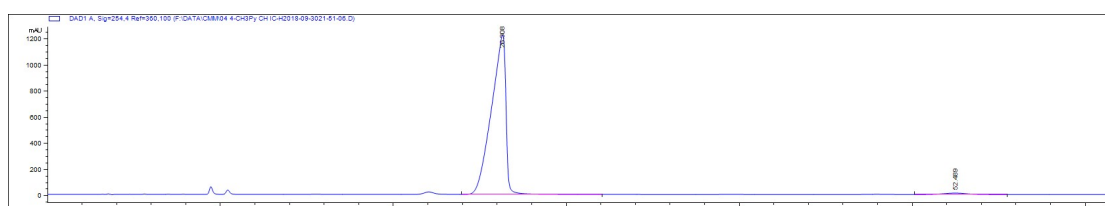
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	11.464	2557.8	107.6	0.3655	0.816	11.601	BB
2	14.937	8569.6	331.3	0.4312	0.851	38.867	MM
3	27.286	8404.9	96.6	1.3275	0.58	38.120	BB
4	32.36	2516.1	42.4	0.9261	0.834	11.412	BB



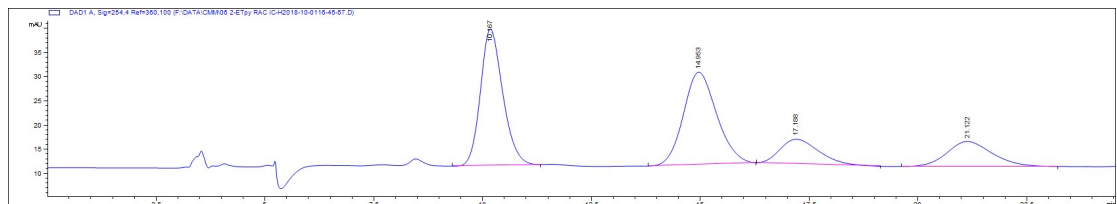
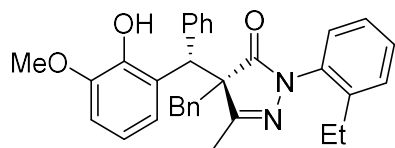
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	11.436	12543.9	596.6	0.3213	0.686	94.637	BB
2	32.38	710.9	12.6	0.8791	0.901	5.363	BB



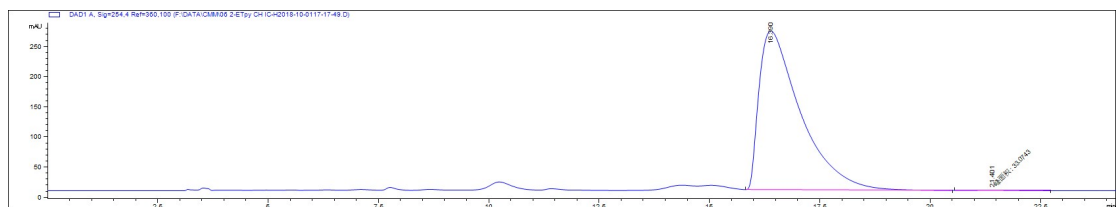
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	21.699	3454.6	90.5	0.5794	0.763	34.089	BB
2	24.991	1650.2	37.5	0.6708	0.829	16.284	BB
3	46.775	1568.3	19.3	1.2316	0.879	15.475	BB
4	51.421	3461	37.8	1.3625	1.284	34.152	BB



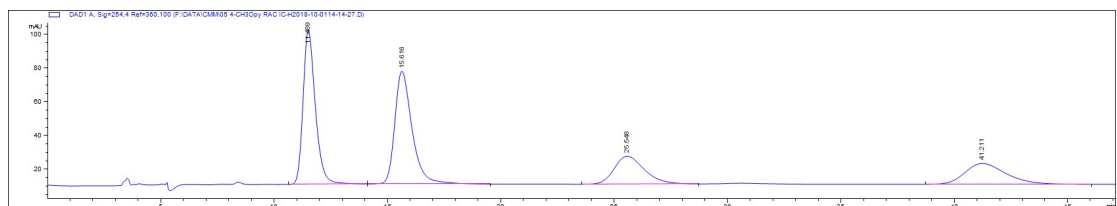
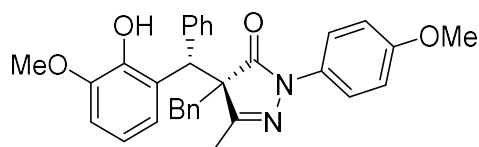
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	26.308	70960	1221.5	0.8197	3.201	98.523	BB
2	52.489	1063.6	10.9	1.4176	1.006	1.477	BB



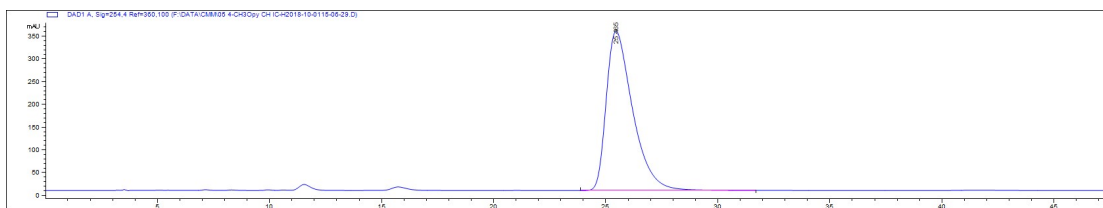
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	10.167	1009.6	28.3	0.5445	0.766	37.133	BB
2	14.953	1016.2	19.2	0.8169	0.825	37.378	BB
3	17.188	317.4	5.1	0.9093	0.666	11.673	BB
4	21.122	375.6	5.2	0.9927	0.794	13.816	BB



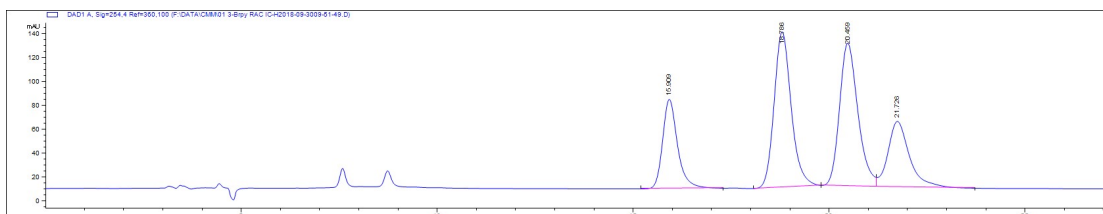
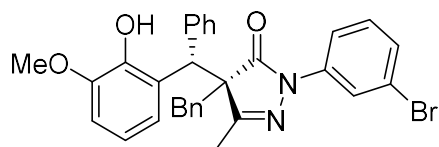
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	16.39	17232.9	263.5	0.9849	0.362	99.808	BB
2	21.401	33.1	5.2E-1	1.0704	0.636	0.192	MM



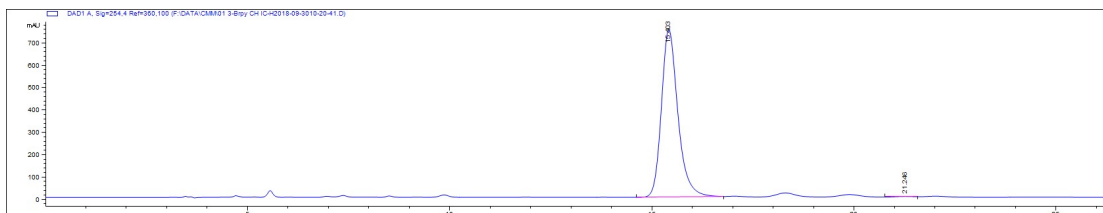
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	11.489	3435.3	91.1	0.5722	0.693	34.169	BB
2	15.616	3532.9	66.6	0.7968	0.649	35.139	BB
3	25.548	1529.5	16.5	1.3534	0.723	15.213	BB
4	41.211	1556.4	12.3	1.7719	0.711	15.480	BB



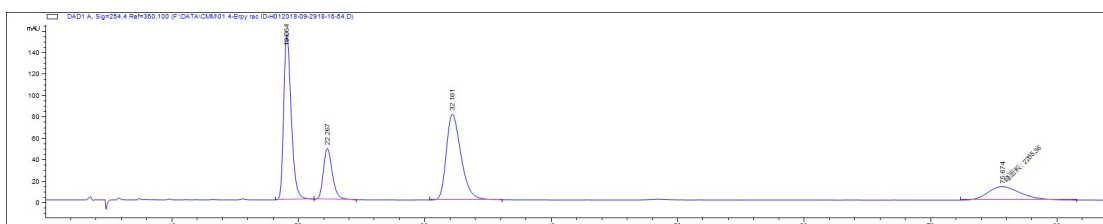
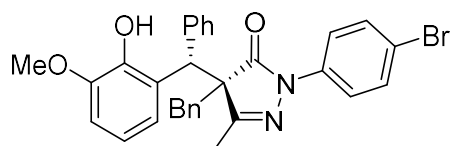
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	25.465	28768	350.9	1.2505	0.542	100.000	BB



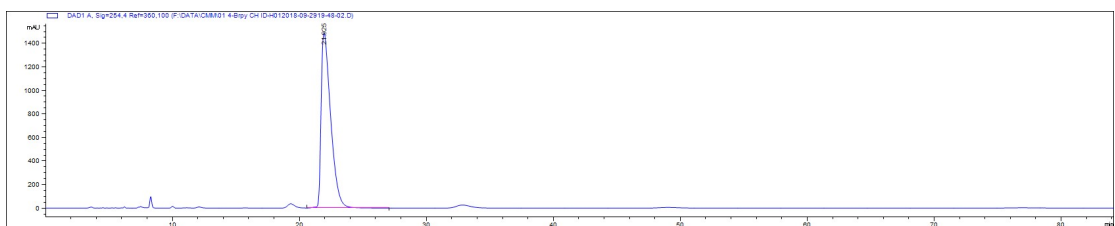
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	15.909	1992.4	75	0.3999	0.75	16.667	BB
2	18.786	3960.3	130.6	0.4618	0.832	33.130	BB
3	20.459	3915.9	119.9	0.499	0.758	32.758	BV
4	21.726	2085.4	55	0.5664	0.722	17.445	VB



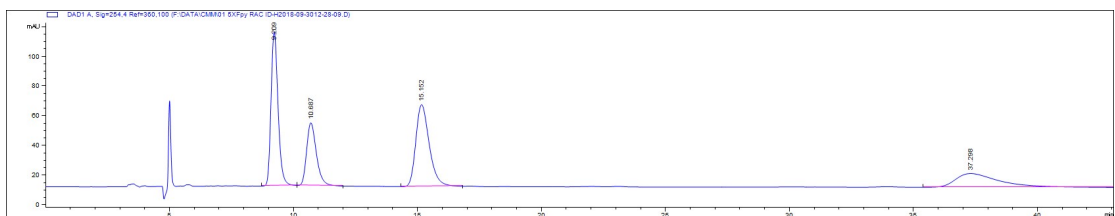
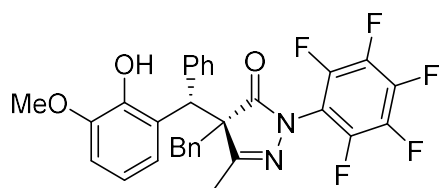
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	15.403	21087.3	746	0.4298	0.76	99.787	BB
2	21.246	45	1.8	0.4005	1.454	0.213	BB



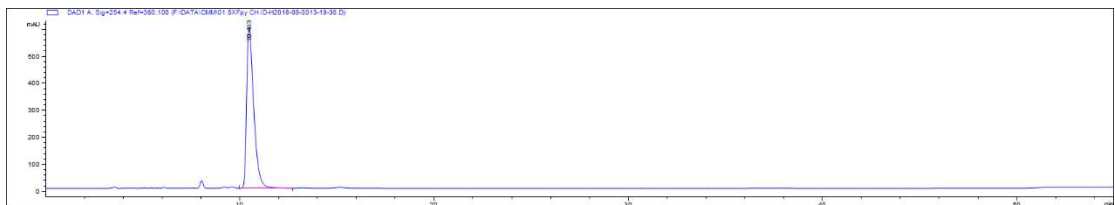
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	19.064	6425.6	154.8	0.6362	0.669	36.707	BB
2	22.267	2345.6	47.6	0.7532	0.752	13.399	BB
3	32.161	6468.6	80.2	1.2309	0.666	36.952	BB
4	75.674	2265.4	12.5	3.0117	0.784	12.941	MM



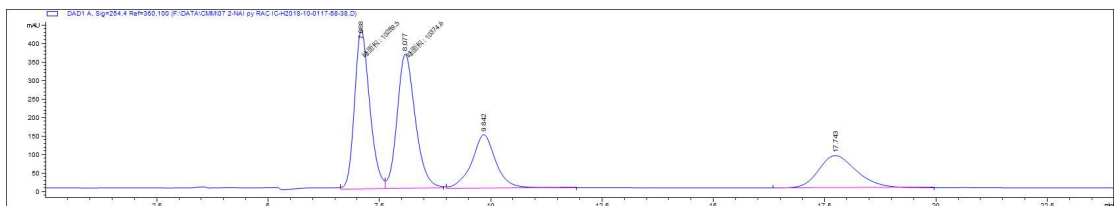
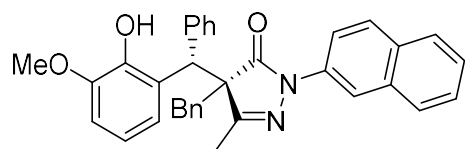
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	21.925	77867.3	1489.9	0.7977	0.411	100.000	BB



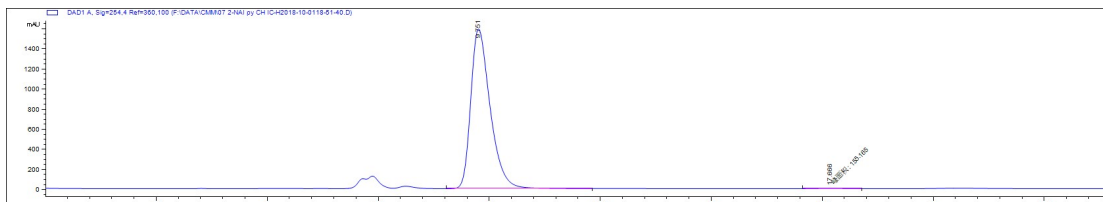
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	9.209	2046.7	104	0.3035	0.769	31.712	BB
2	10.687	1168.2	42.4	0.4232	0.71	18.101	BB
3	15.152	2088.7	55.3	0.581	0.707	32.363	BB
4	37.298	1150.3	9.3	1.6725	0.491	17.824	BBA



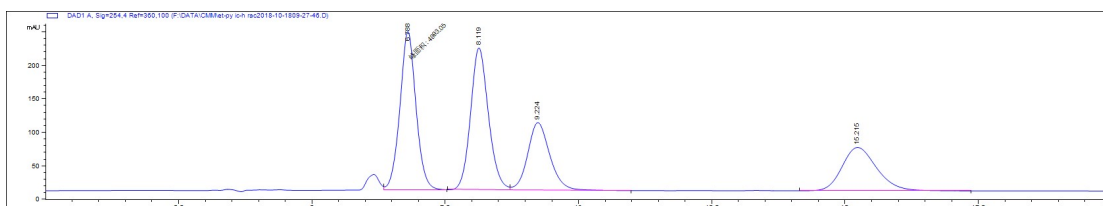
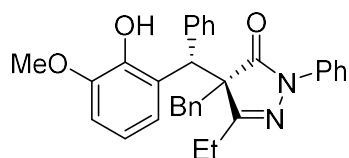
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	10.463	15192.5	590.8	0.39	0.501	100.000	BB



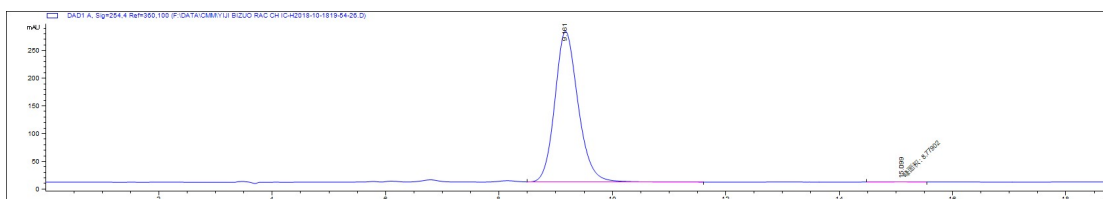
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	7.088	10289.5	430.4	0.3984	0.774	32.772	MF
2	8.077	10374.6	363.8	0.4753	0.782	33.043	FM
3	9.842	5547.1	145	0.5562	0.969	17.667	VB
4	17.743	5186.4	87.2	0.9081	0.749	16.518	BB



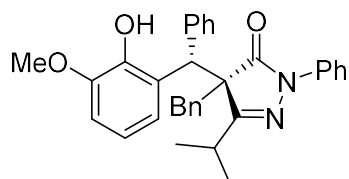
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	9.751	48192.6	1590.3	0.4595	0.629	99.679	BB
2	17.666	155.2	3.1	0.8247	0.733	0.321	MM

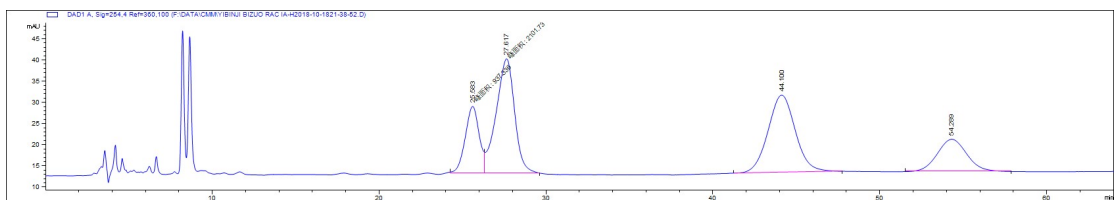


#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	6.788	4993.1	236.6	0.3517	0.957	31.660	MM
2	8.119	4950.3	211.6	0.357	0.843	31.388	BV
3	9.224	2910.7	100.7	0.4393	0.812	18.456	VB
4	15.215	2917	64.5	0.6957	0.771	18.496	BB

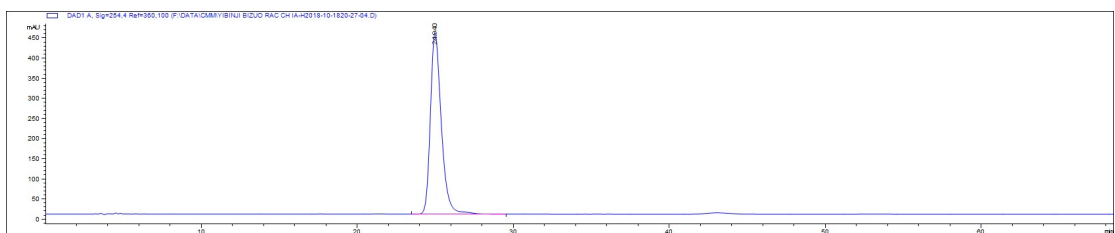


#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	9.161	7728.5	271.5	0.4341	0.8	99.887	BB
2	15.099	8.8	2.6E-1	0.4205	1.635	0.113	MM

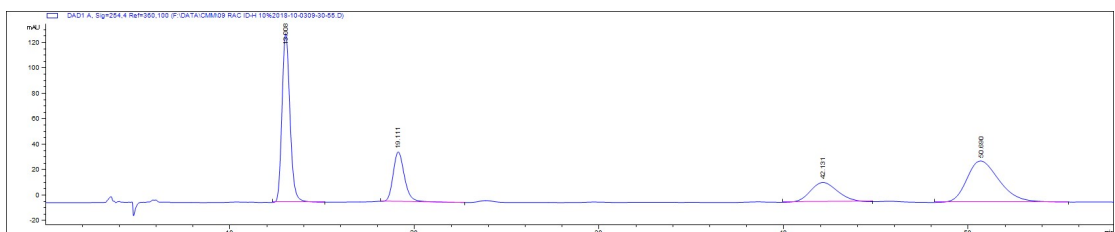
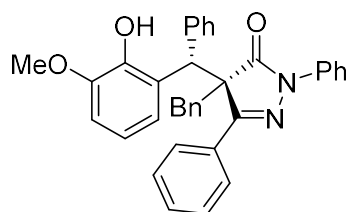




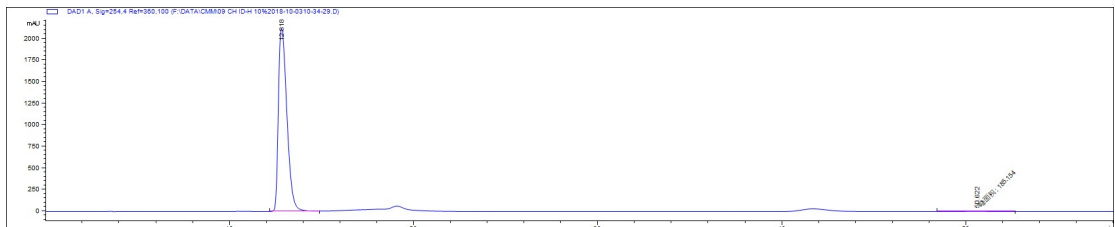
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	25.583	937.3	15.9	0.9827	1.11	15.481	MF
2	27.617	2101.7	27.2	1.2901	1.239	34.712	FM
3	44.1	2074.9	18.2	1.6414	0.966	34.269	BB
4	54.289	940.8	7.6	1.5486	0.946	15.539	BB



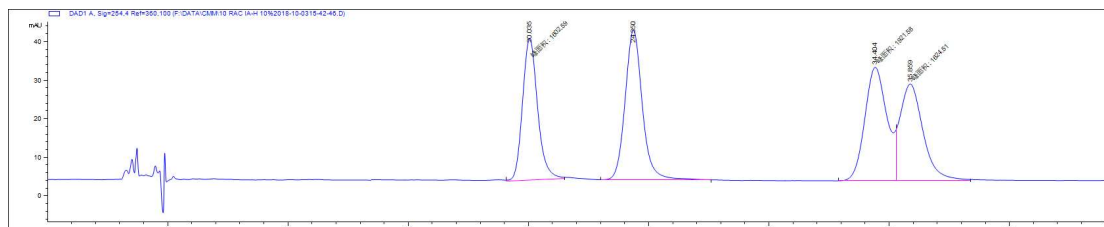
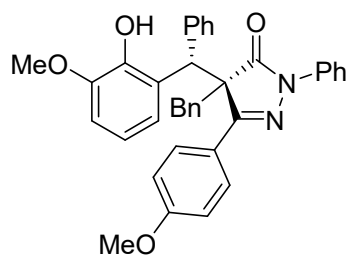
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	24.94	21671.8	450.3	0.8022	0.716	100.000	MF



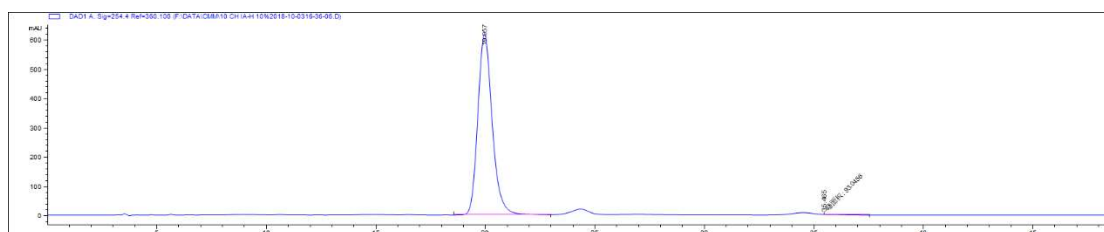
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	13.008	4003.8	133	0.4652	0.811	35.556	BB
2	19.111	1665.7	39.1	0.6513	0.777	14.792	BB
3	42.131	1597.4	15.4	1.5101	0.818	14.186	BB
4	50.69	3993.7	32.5	1.8358	0.713	35.466	BB



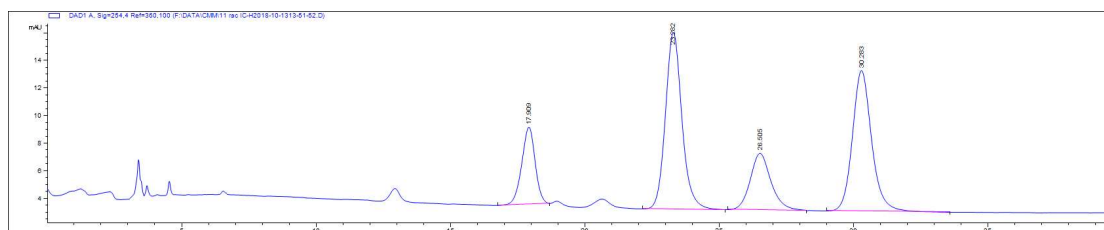
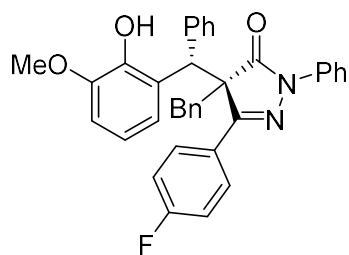
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	12.818	67924.8	2111.8	0.5032	0.539	99.728	BB
2	50.622	185.2	1.7	1.8107	1.072	0.272	MM



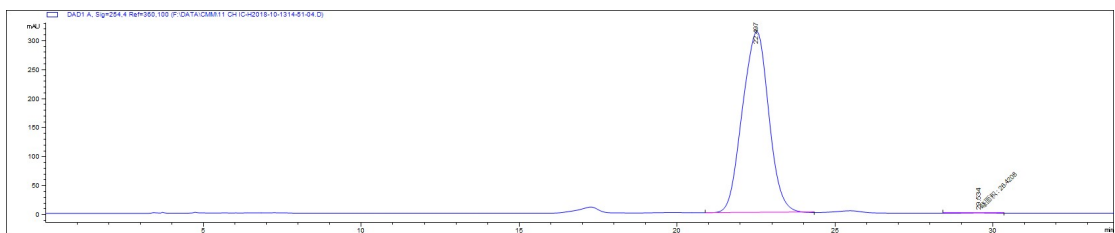
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	20.035	1602.6	36.5	0.7309	0.864	22.665	MM
2	24.35	1922.2	38.6	0.7585	0.875	27.185	BB
3	34.404	1921.6	29.3	1.0924	0	27.176	MF
4	35.859	1624.5	25	1.0832	0.697	22.975	FM



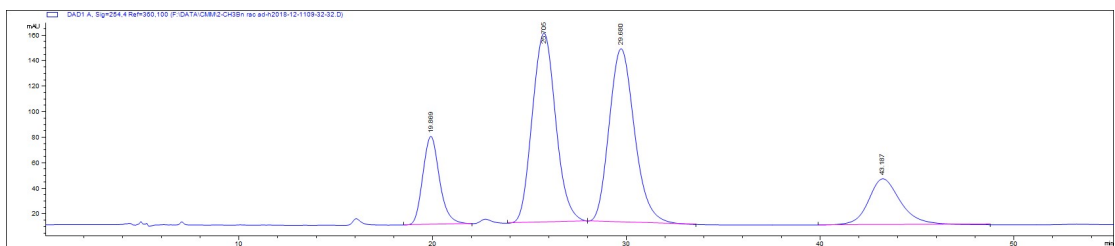
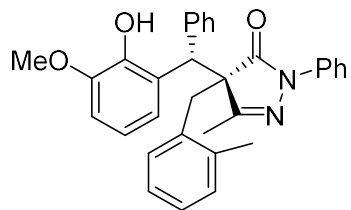
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	19.957	28352.6	617.5	0.7037	0.808	99.673	BB
2	35.465	93	1.9	0.8122	0	0.327	FM



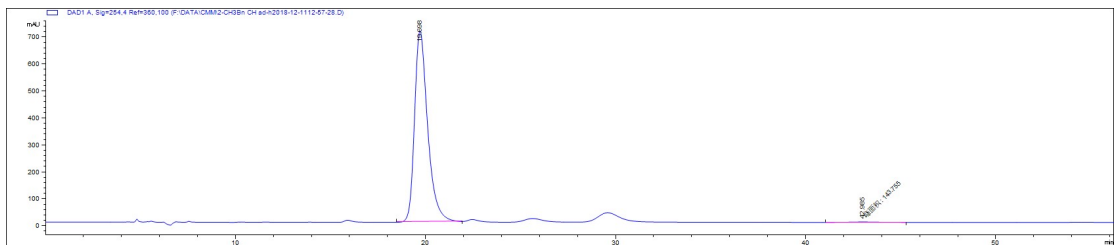
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	17.909	193.8	5.6	0.5273	1.129	13.171	BB
2	23.282	546.5	12.8	0.651	0.871	37.144	BB
3	26.505	222.6	4.1	0.8017	0.82	15.129	BB
4	30.283	508.4	10.2	0.7607	0.832	34.556	BB



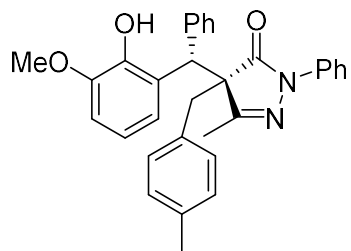
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	22.497	18066.2	311.4	0.9347	1.133	99.854	BB
2	29.534	26.4	4.8E-1	0.9205	1.246	0.146	MM

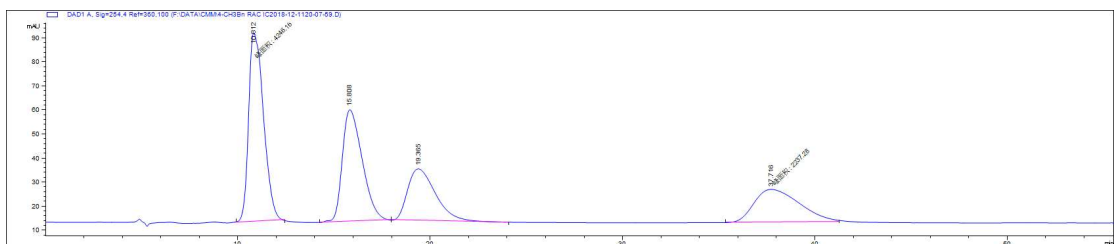


#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	19.869	4150.4	69.2	0.9296	0.87	12.492	BB
2	25.705	12465.6	148.5	1.3313	0.948	37.518	BB
3	29.68	12388.3	136.2	1.4151	0.825	37.286	BB
4	43.187	4220.9	36.2	1.7383	0.772	12.704	BB

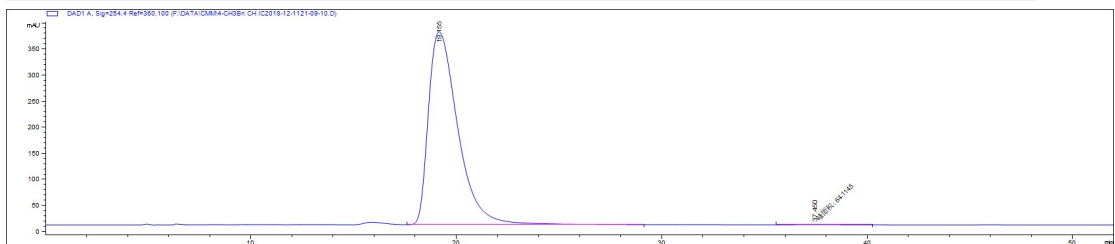


#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	19.698	34026.7	709.7	0.7274	0.668	99.579	BB
2	42.985	143.8	1.4	1.723	0.797	0.421	MM

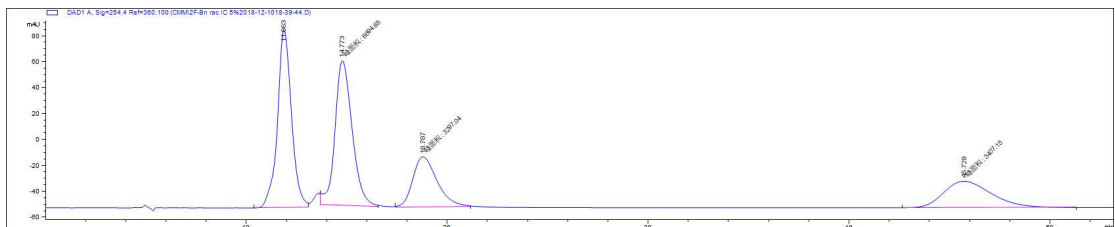
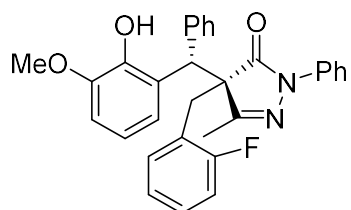




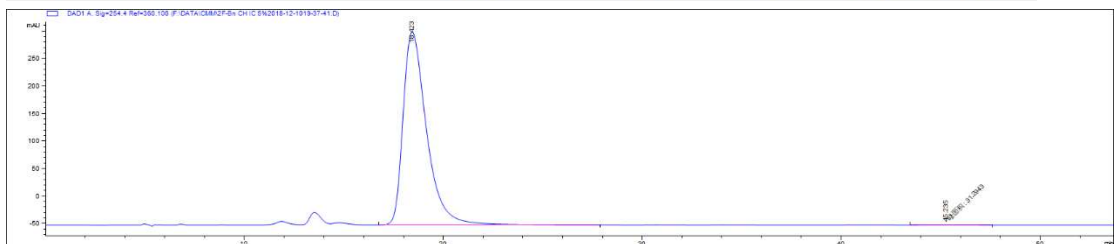
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	10.812	4246.2	78.6	0.8999	0.522	35.309	MM
2	15.808	3361.9	46.6	1.1255	0.588	27.956	BB
3	19.365	2180.2	21.6	1.5179	0.585	18.130	BB
4	37.716	2237.3	13.7	2.7267	0.603	18.604	MM



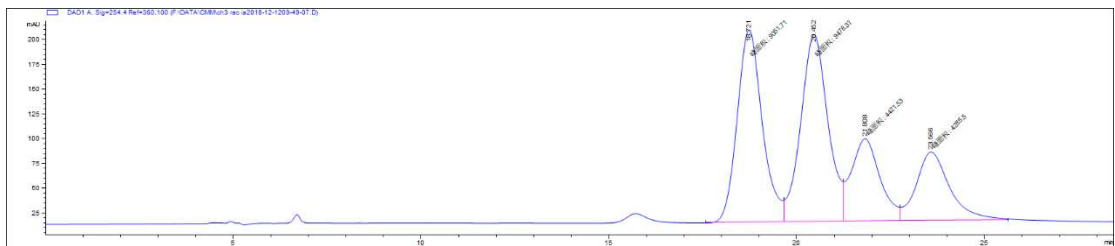
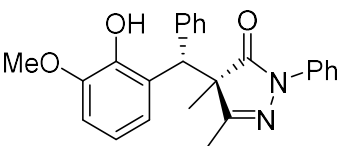
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	19.155	36806	370.3	1.5336	0.527	99.826	BB
2	37.45	64.1	4E-1	2.6429	0.552	0.174	MM



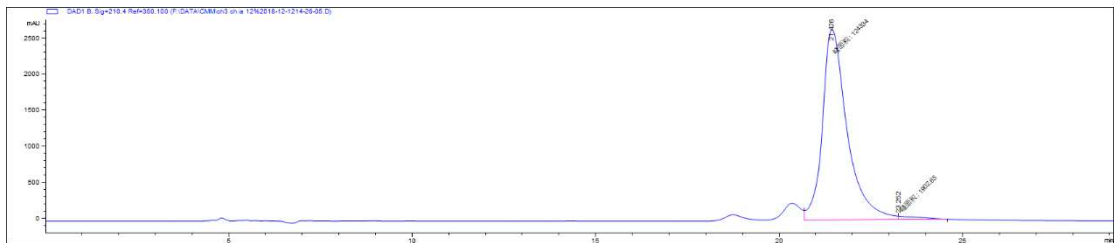
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	11.863	6702.1	137.2	0.744	0.858	32.738	BV
2	14.773	6694.7	111.9	0.9967	0.754	32.702	MM
3	18.787	3297	38.9	1.4119	0.707	16.105	MM
4	45.729	3778.1	21.5	2.9268	0.722	18.455	MM



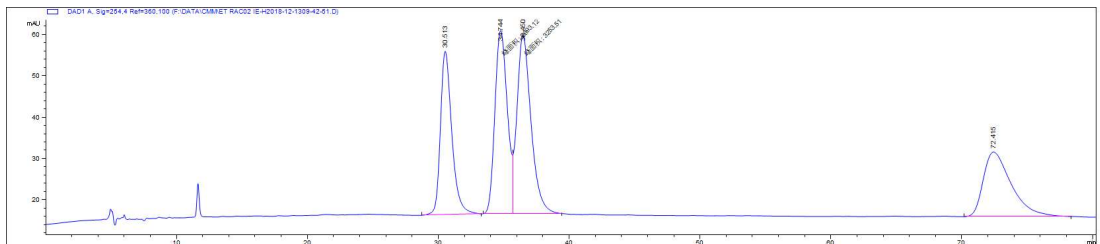
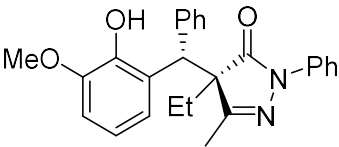
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	18.423	28857.6	351.6	1.2435	0.579	99.892	BB
2	45.235	31.3	2.1E-1	2.4489	0.681	0.108	MM



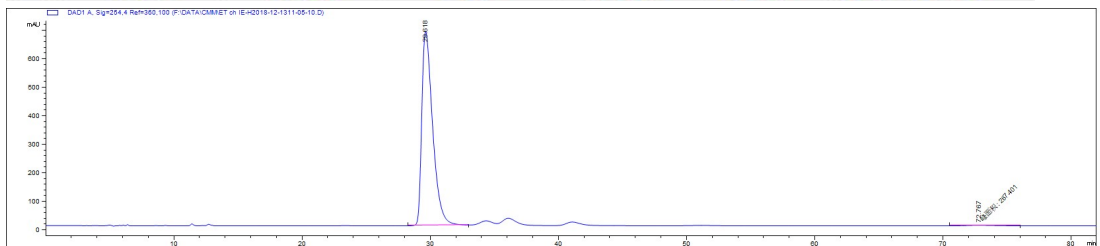
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	18.721	9051.7	193.9	0.778	0	33.233	MF
2	20.452	9478.4	188.5	0.8382	0.927	34.799	MF
3	21.808	4421.5	83	0.8881	0.862	16.233	MF
4	23.566	4285.5	68.9	1.0368	0.771	15.734	FM



#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	21.426	124334.2	2638	0.7855	0.609	98.493	MF
2	23.252	1902.7	45.9	0.691	0	1.507	FM

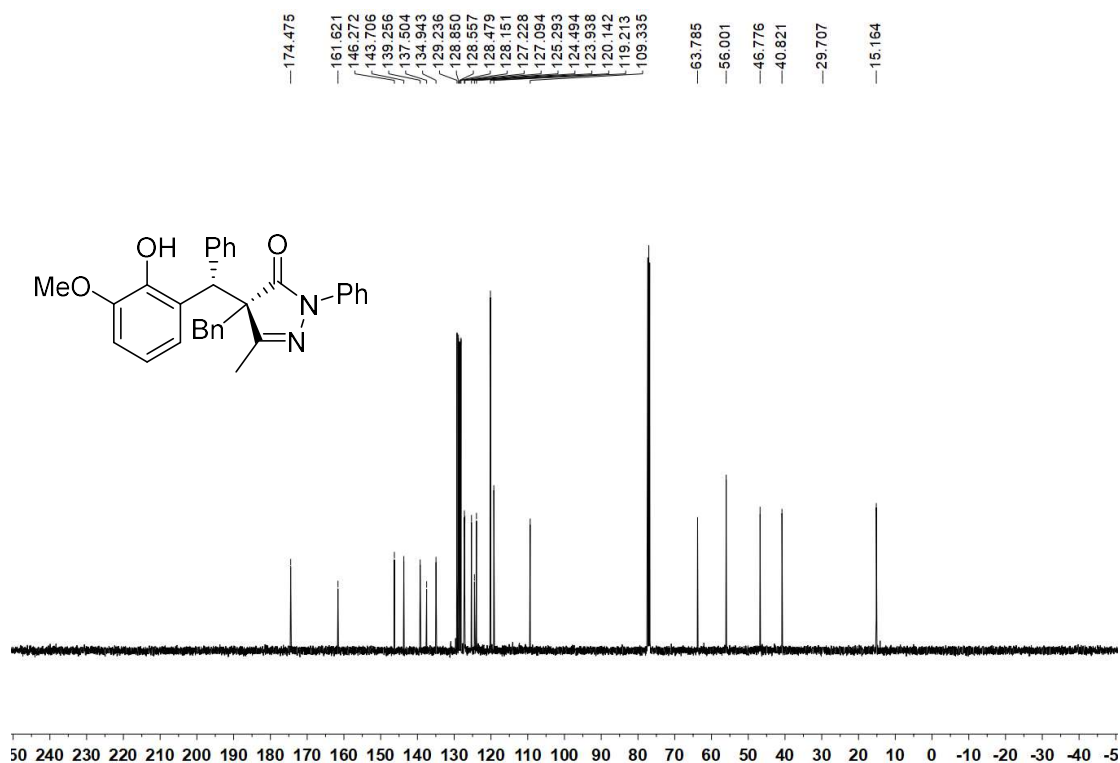
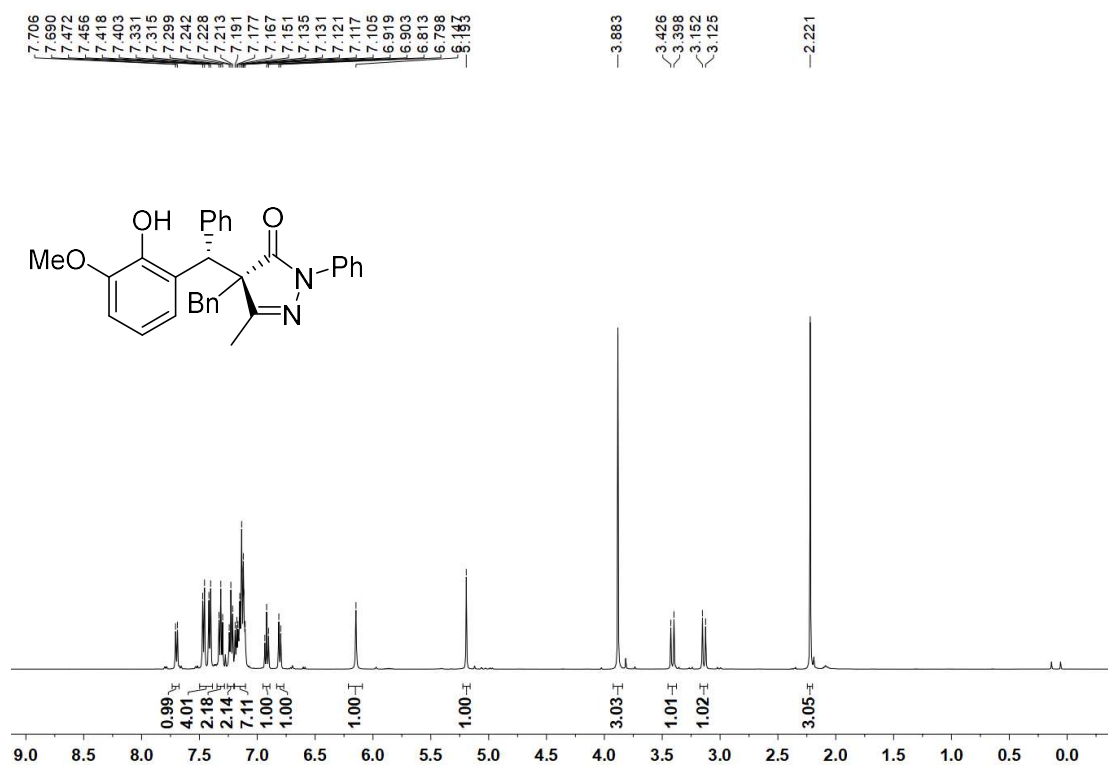


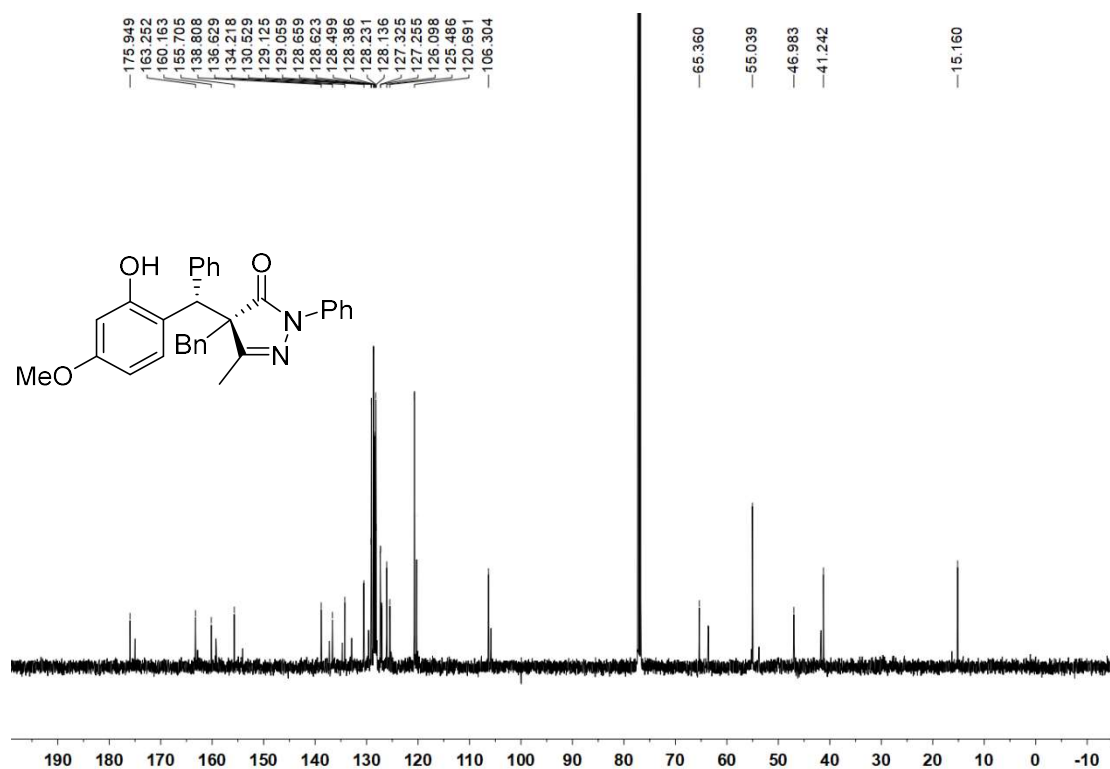
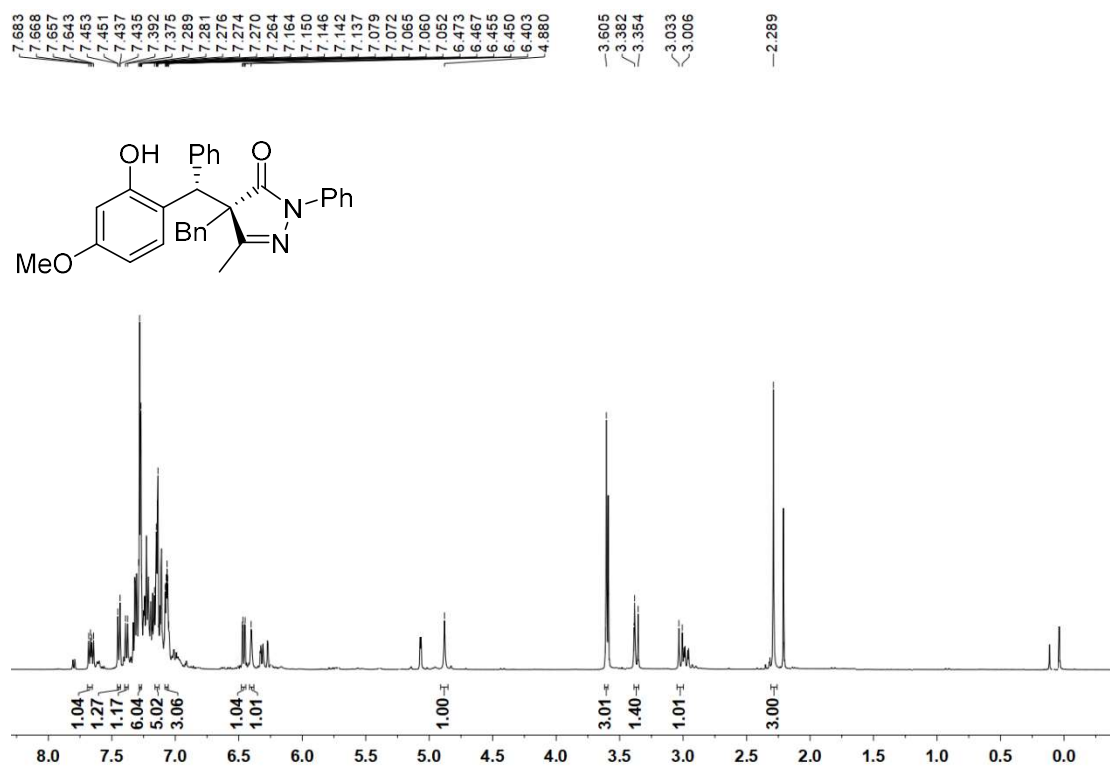
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1	30.513	2404	39.7	0.9268	0.689	21.885	BB
2	34.744	2993.1	44.6	1.118	0	27.247	MF
3	36.45	3253.5	43.6	1.2435	0.681	29.618	FM
4	72.415	2334.4	15.7	2.0249	0.544	21.250	BB

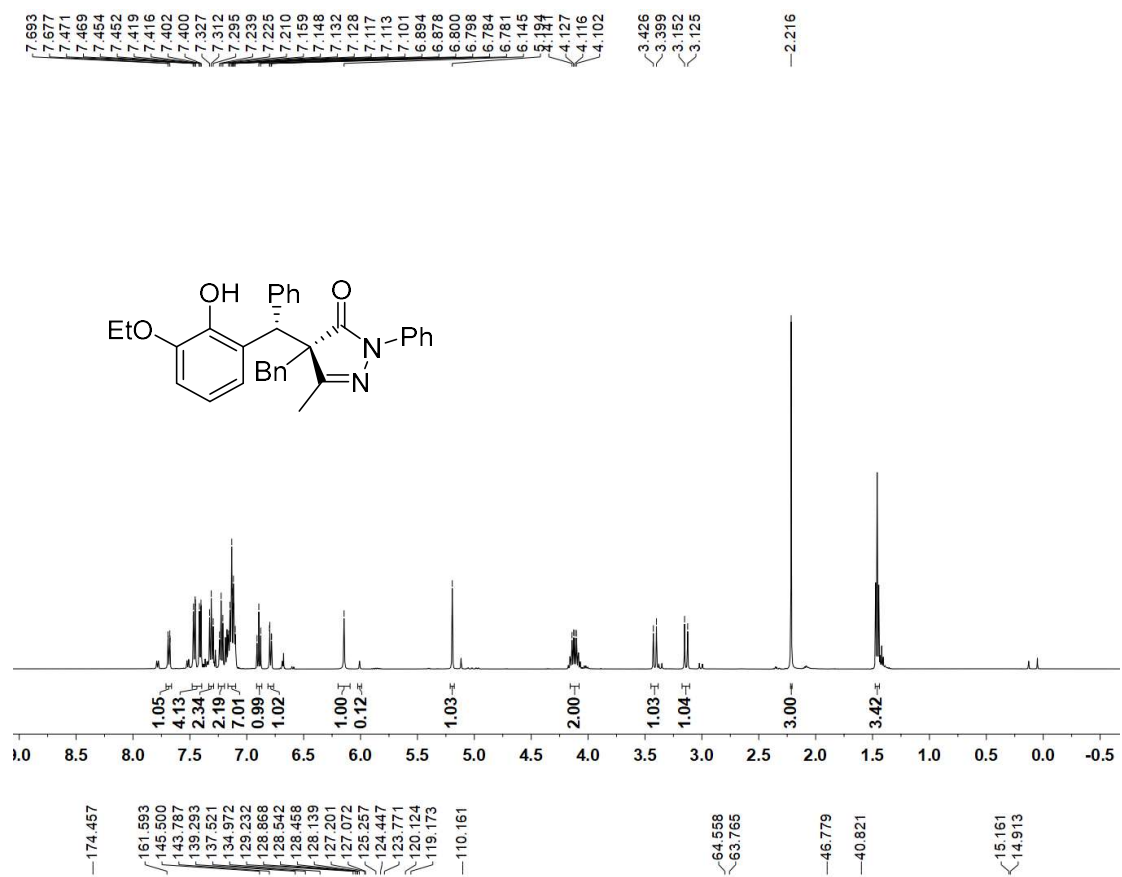


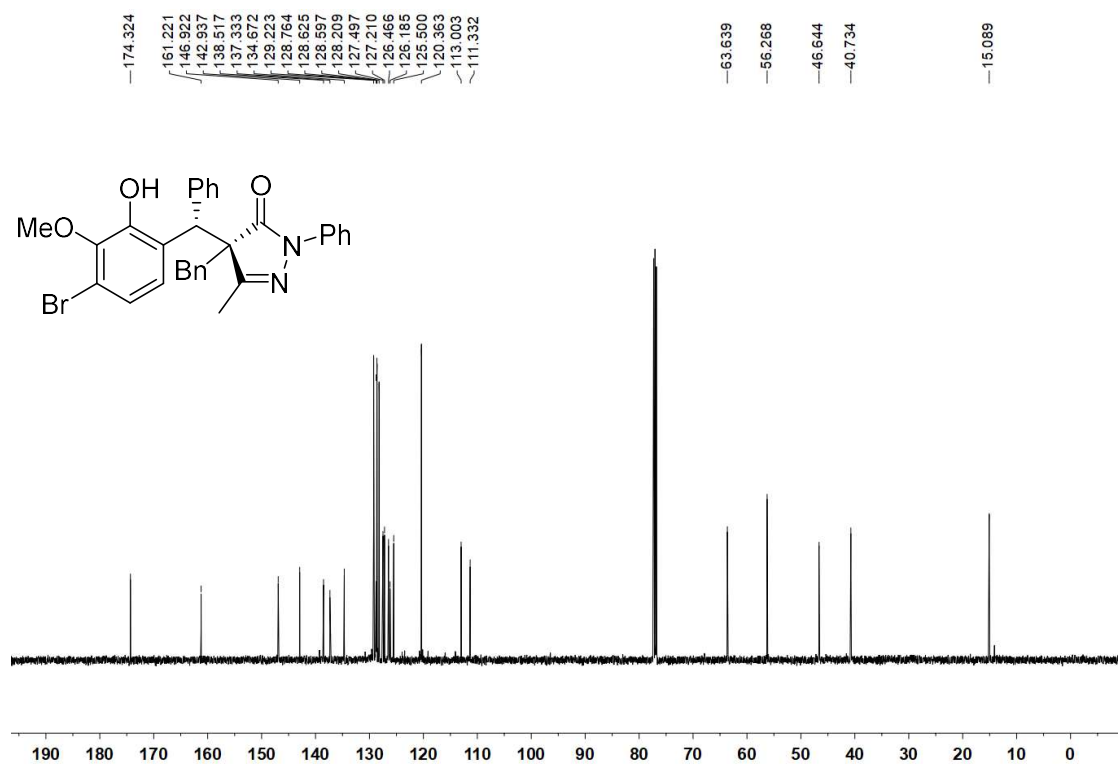
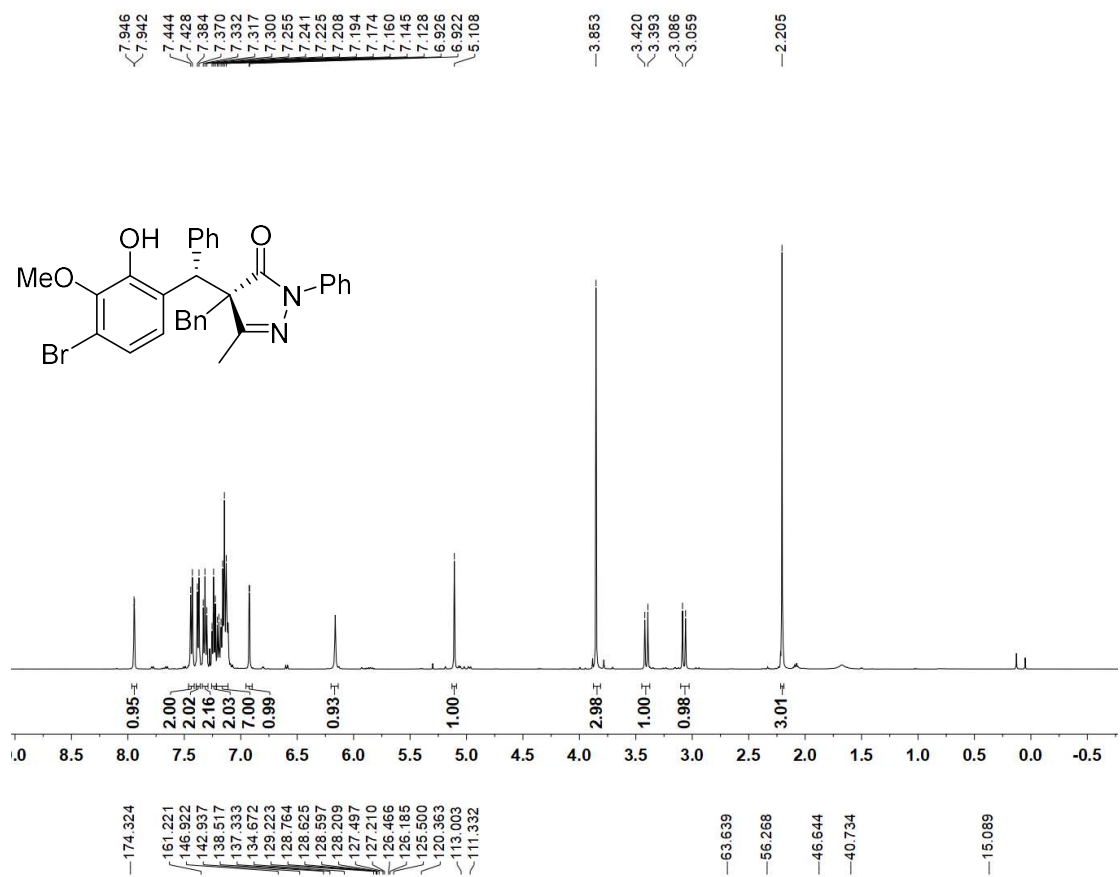
#	时间	峰面积	峰高	峰宽	对称因子	峰面积 %	类型
1	29.618	40259	683.4	0.8973	0.513	99.340	BB
2	72.767	267.4	1.8	2.4725	0.763	0.660	MM

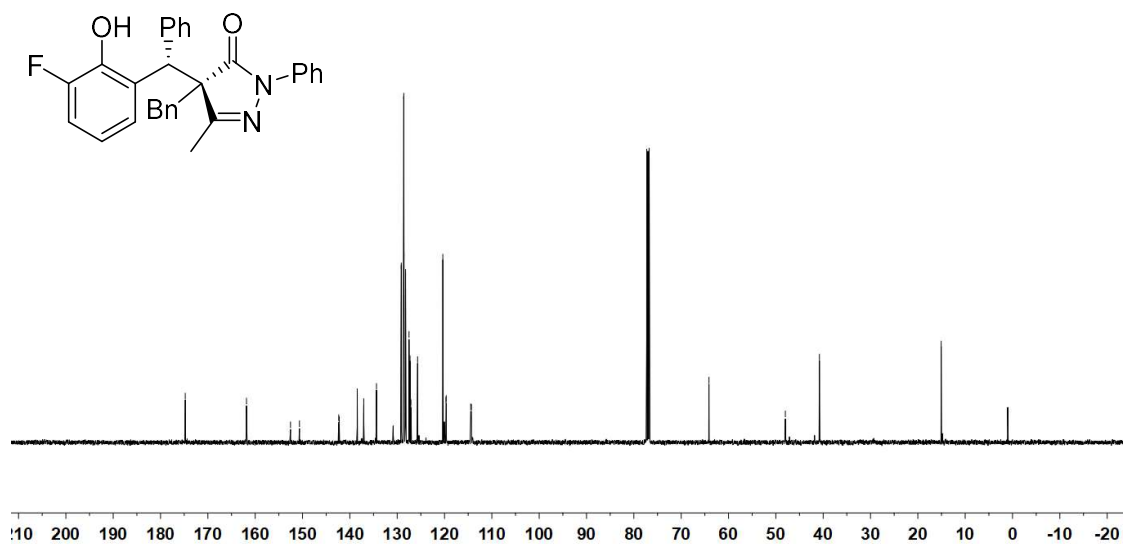
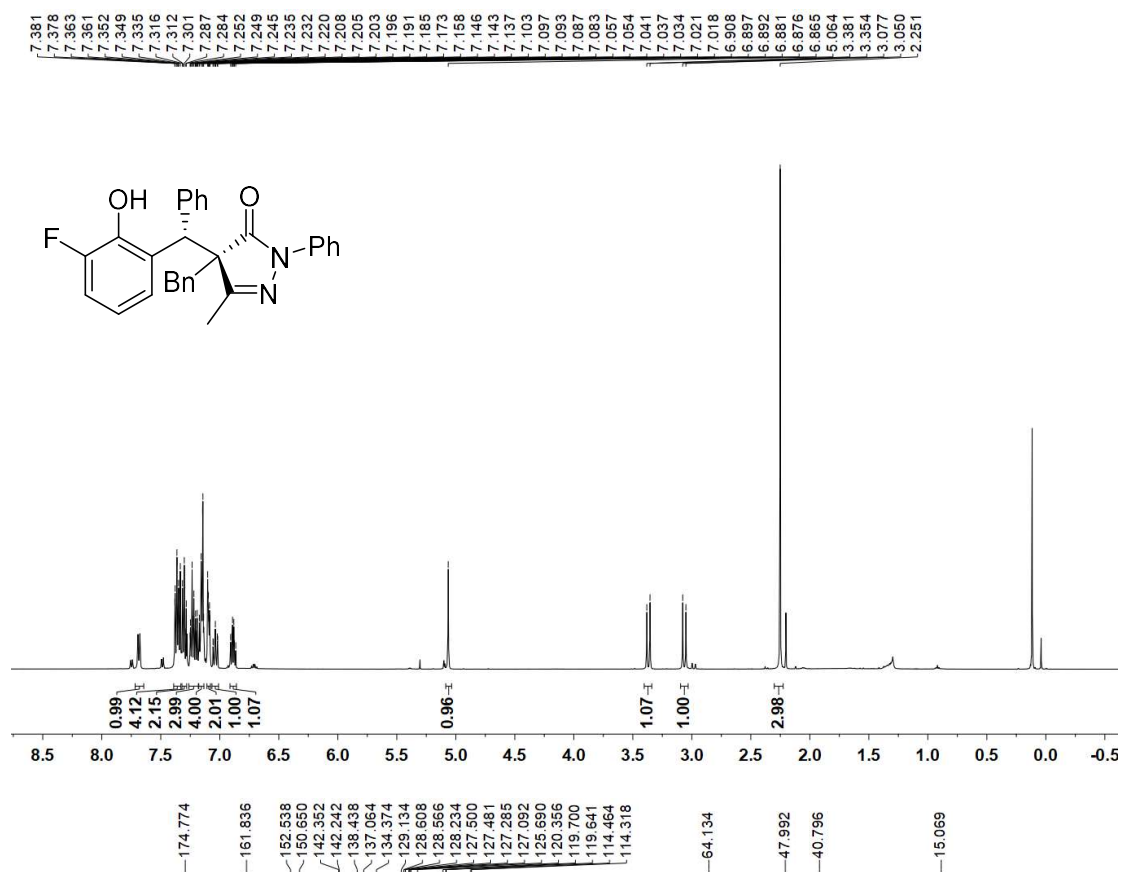
## 5. NMR spectra of products 3

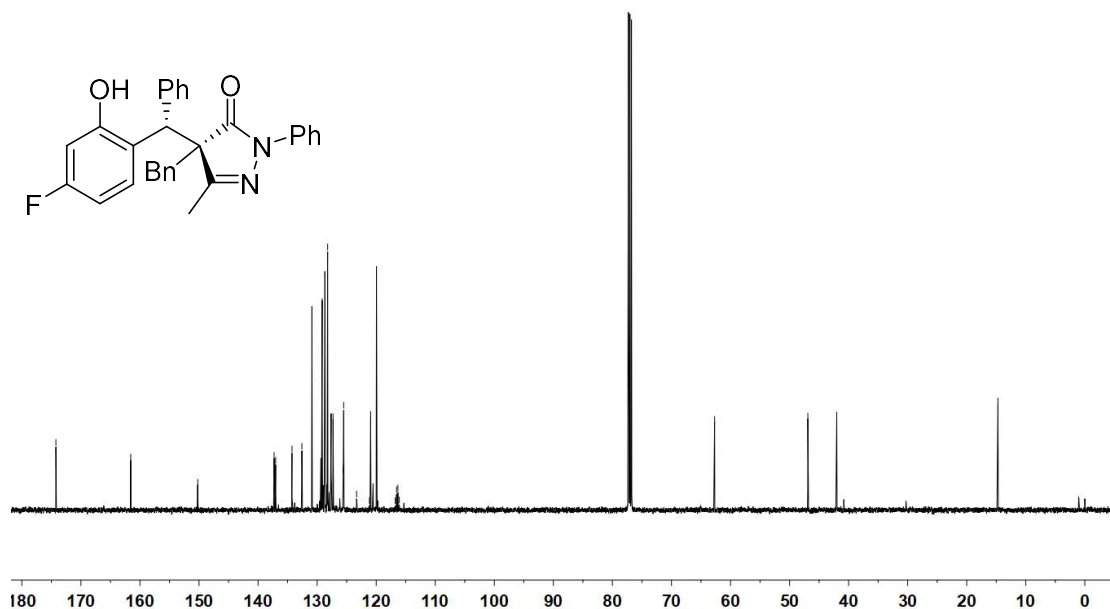
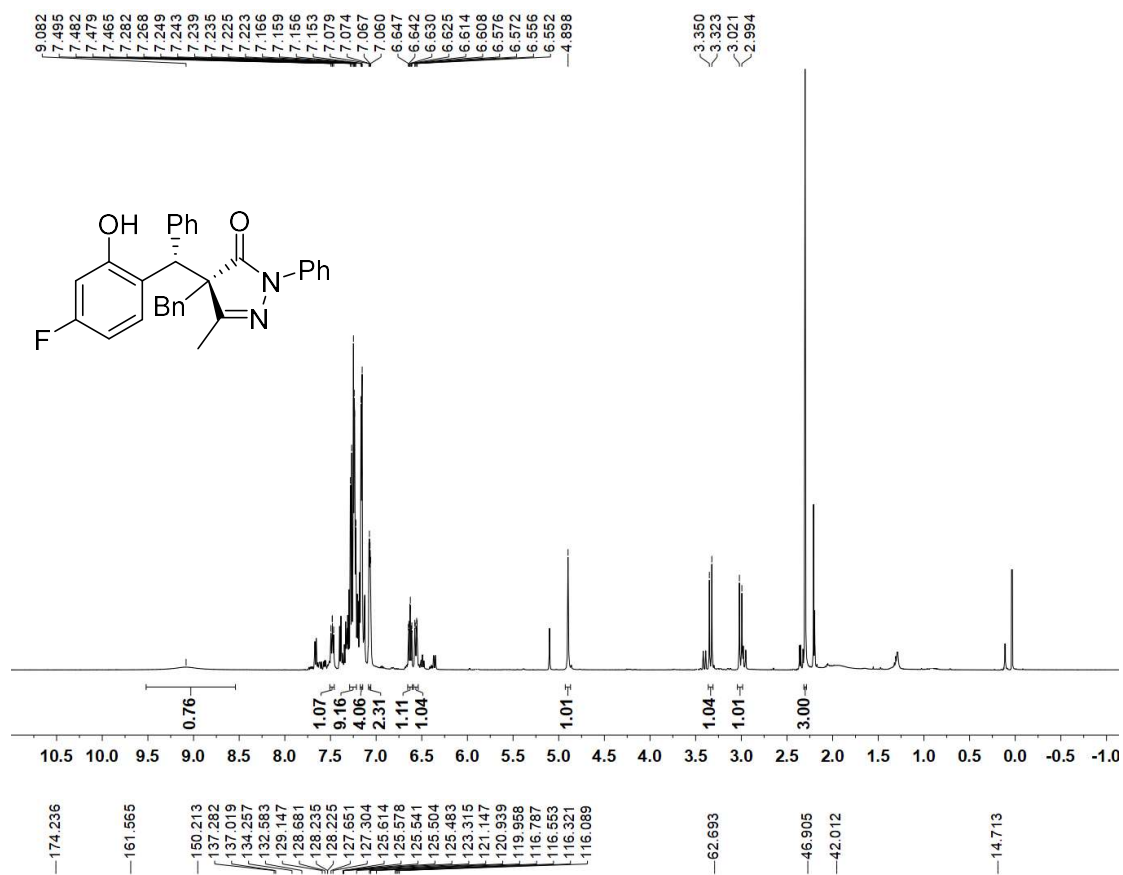


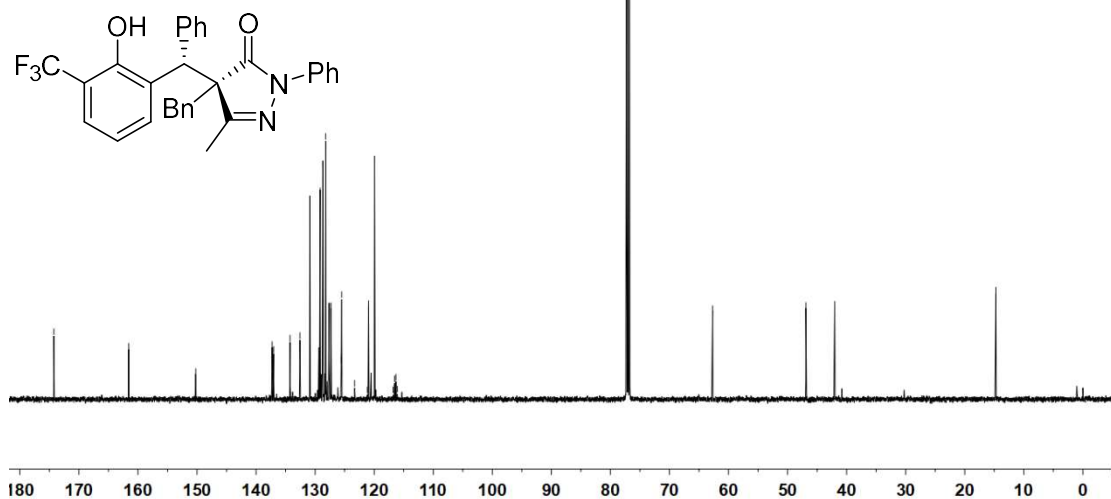
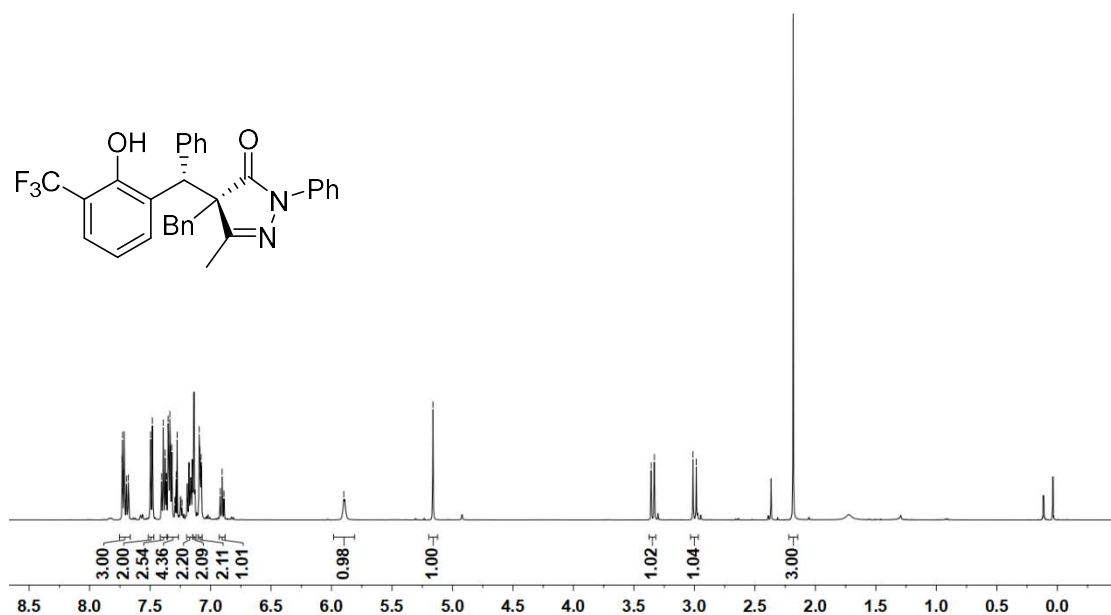


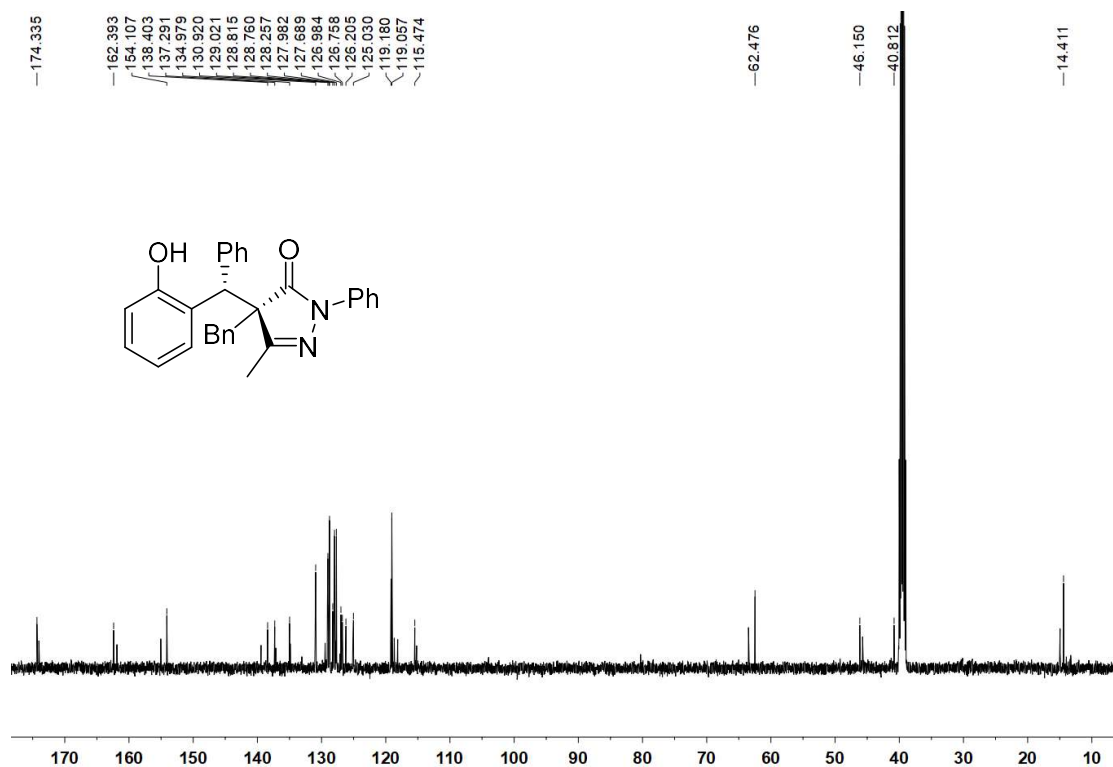
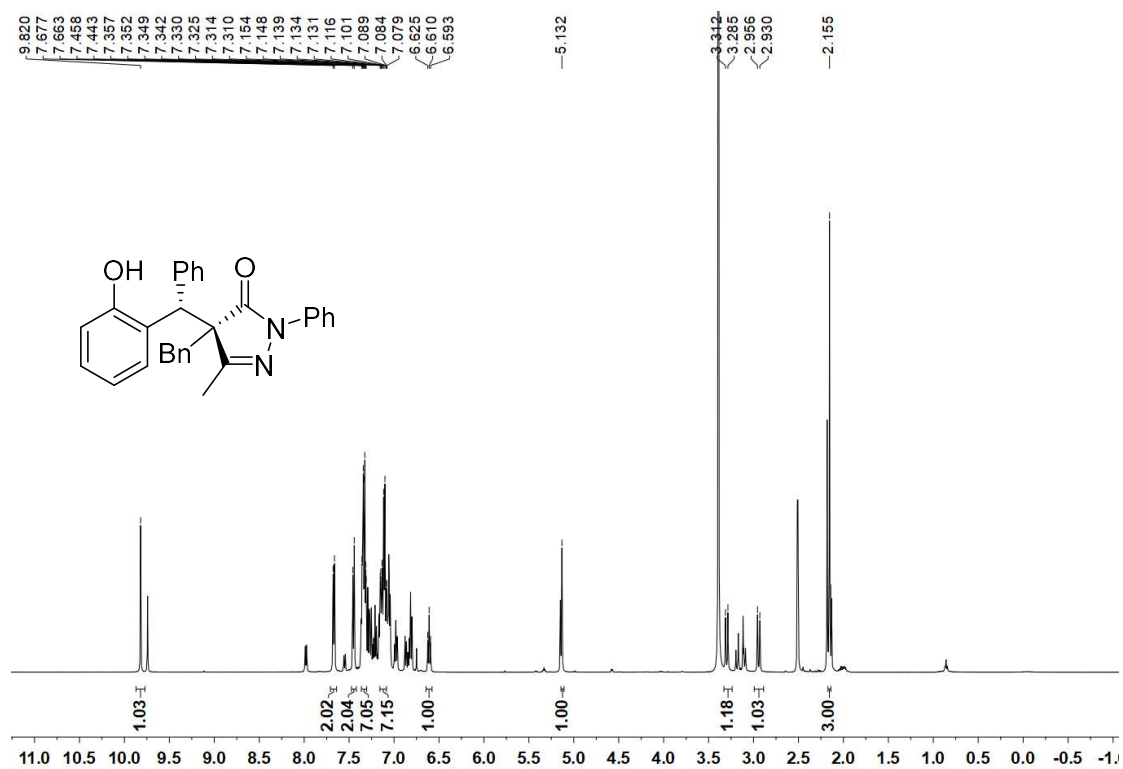


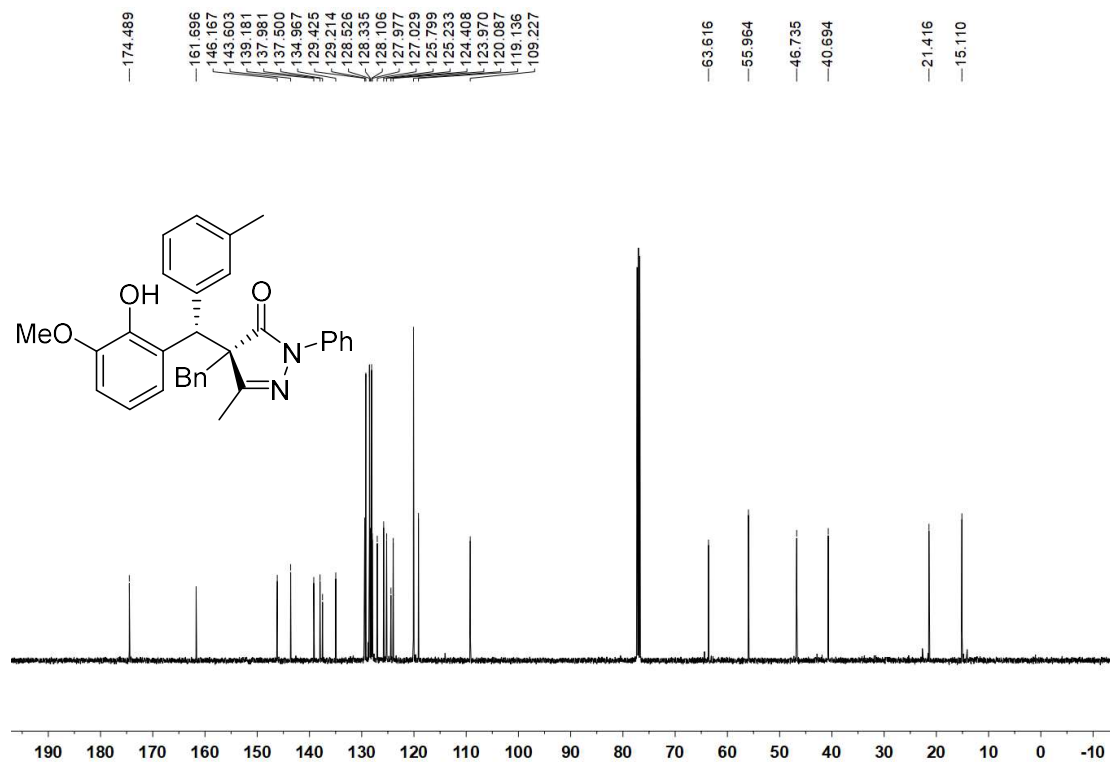
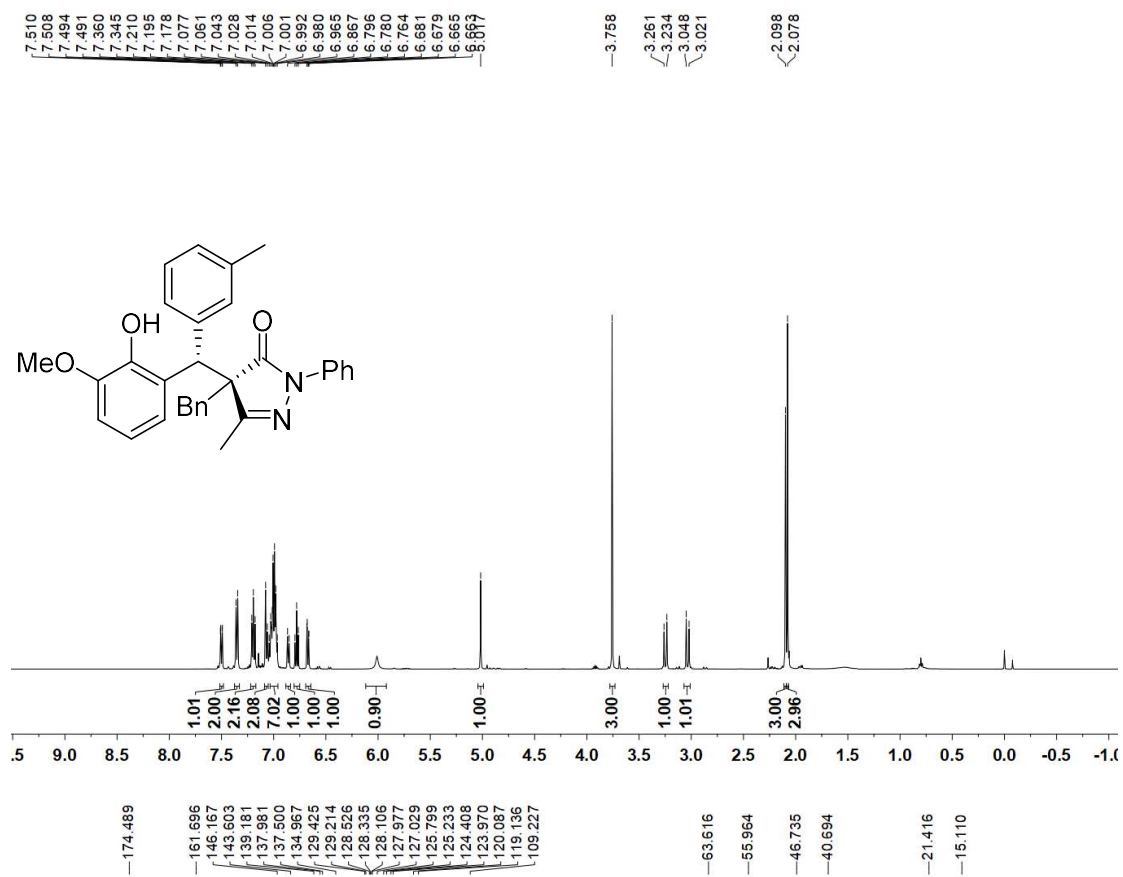


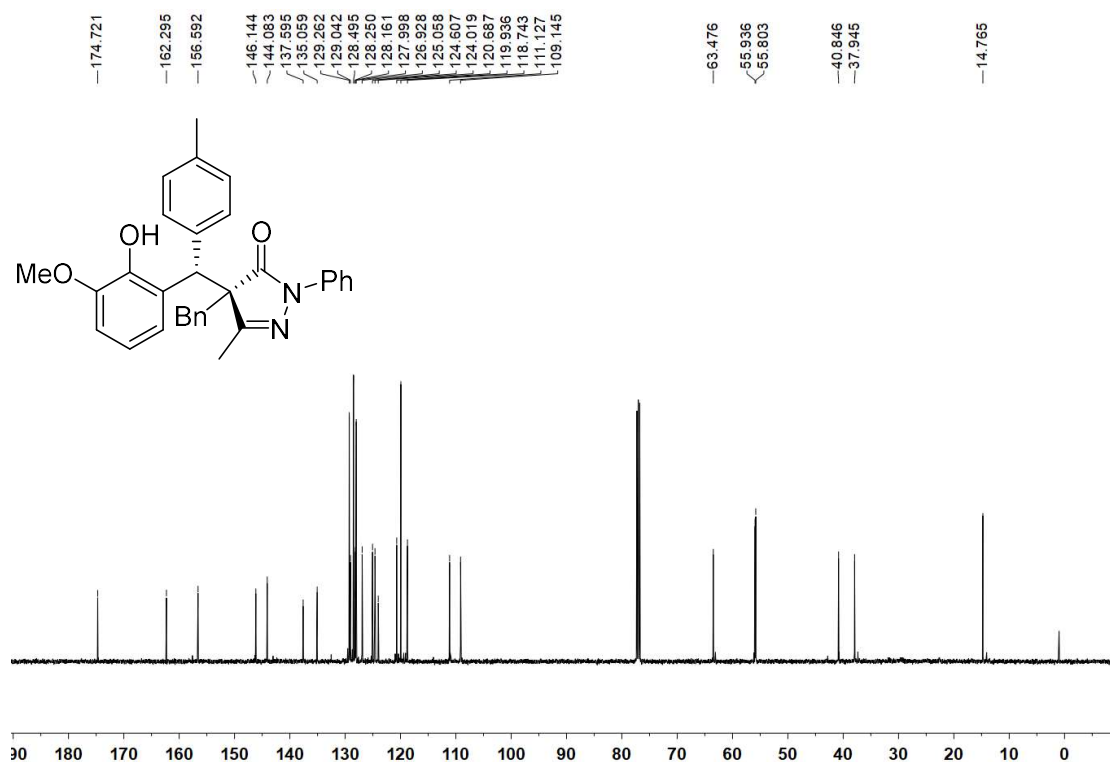
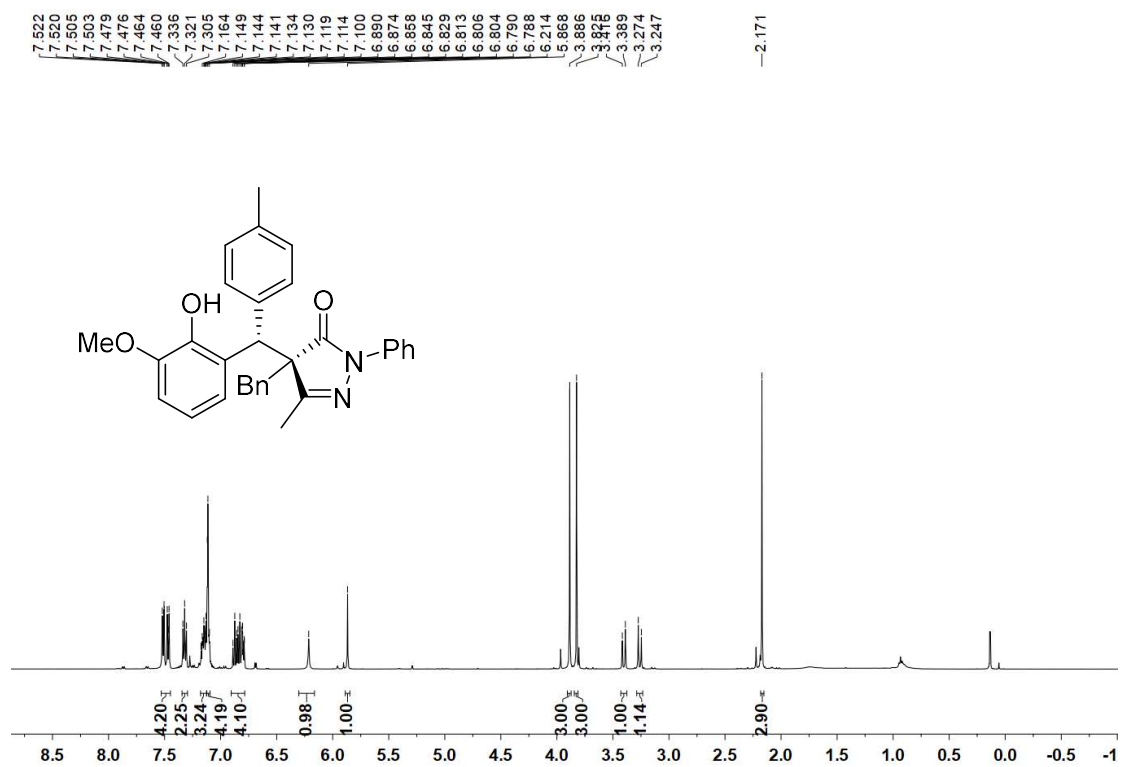


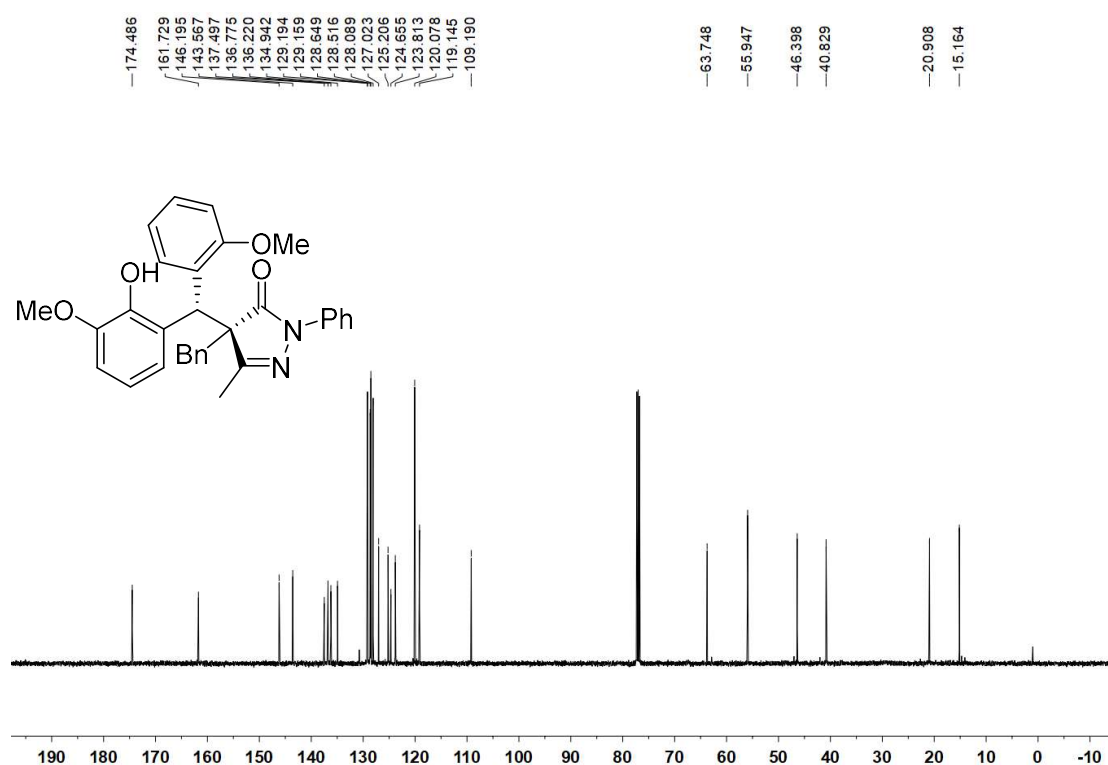
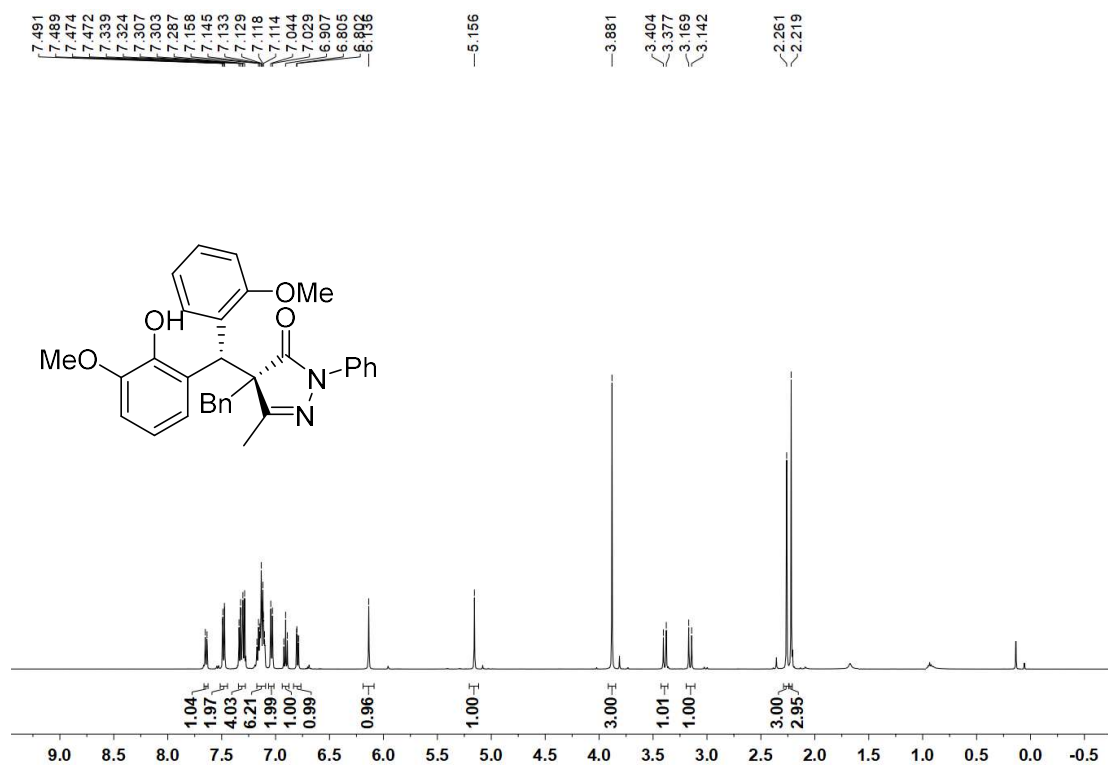


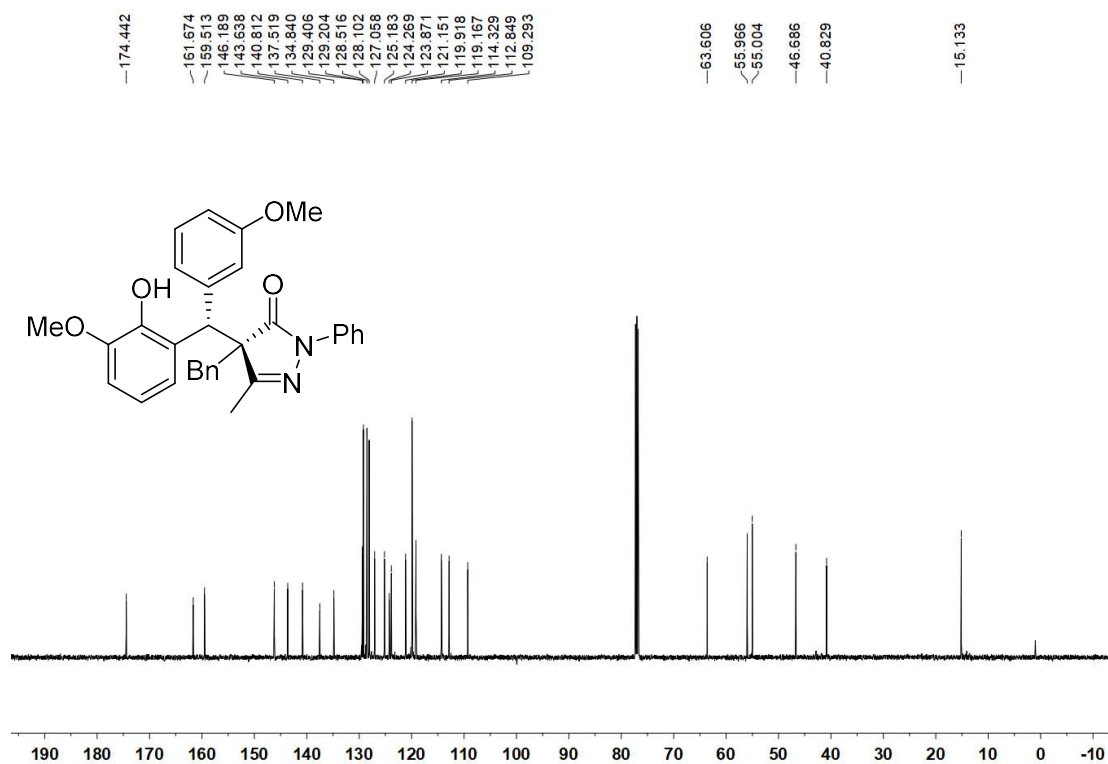
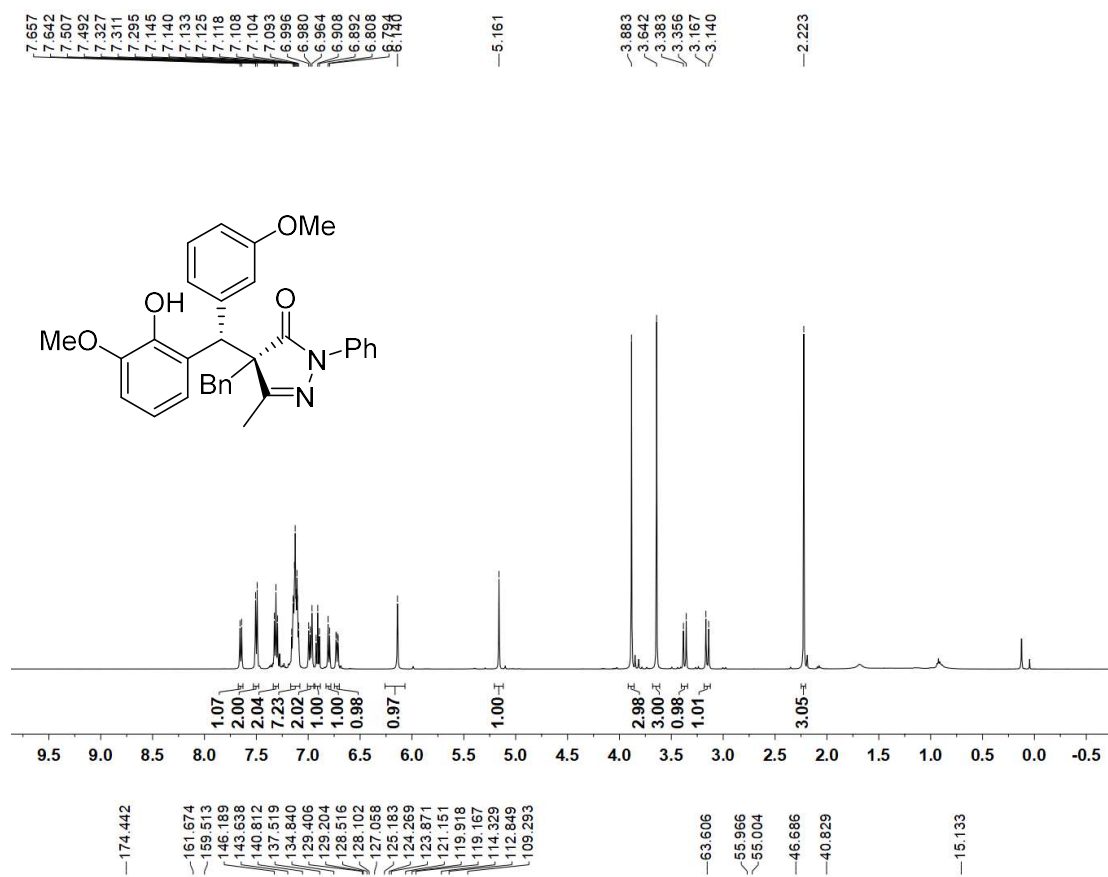


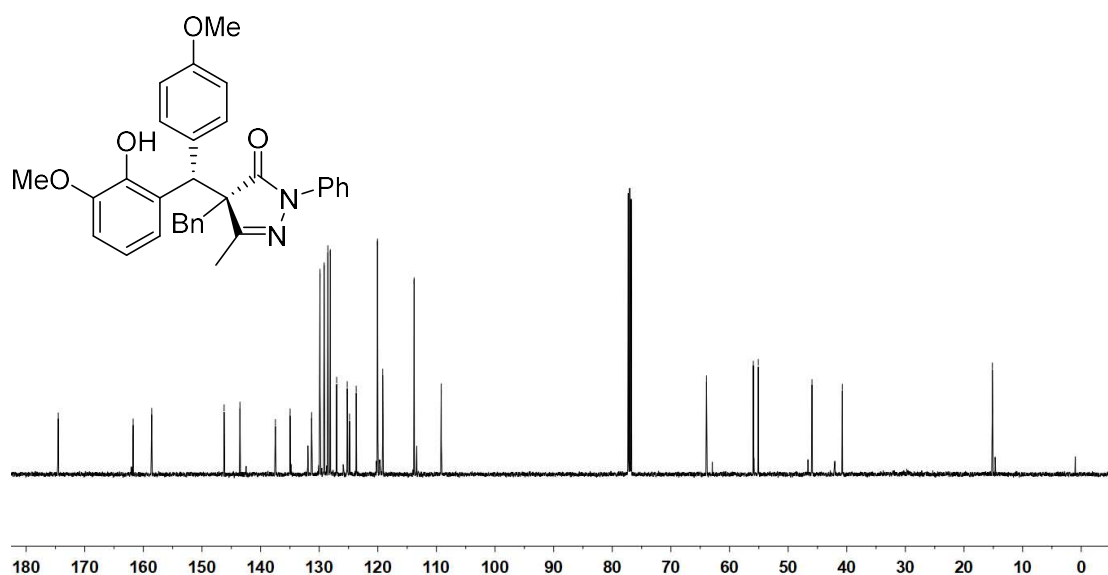
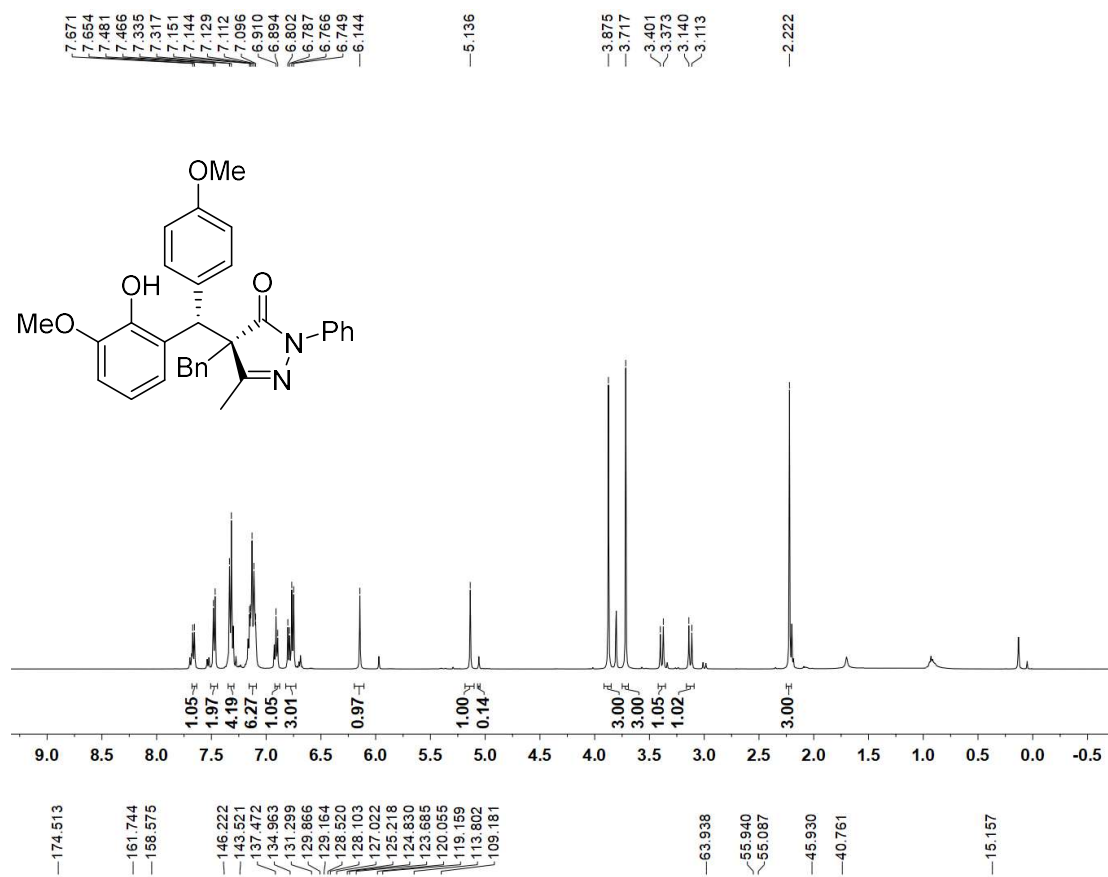


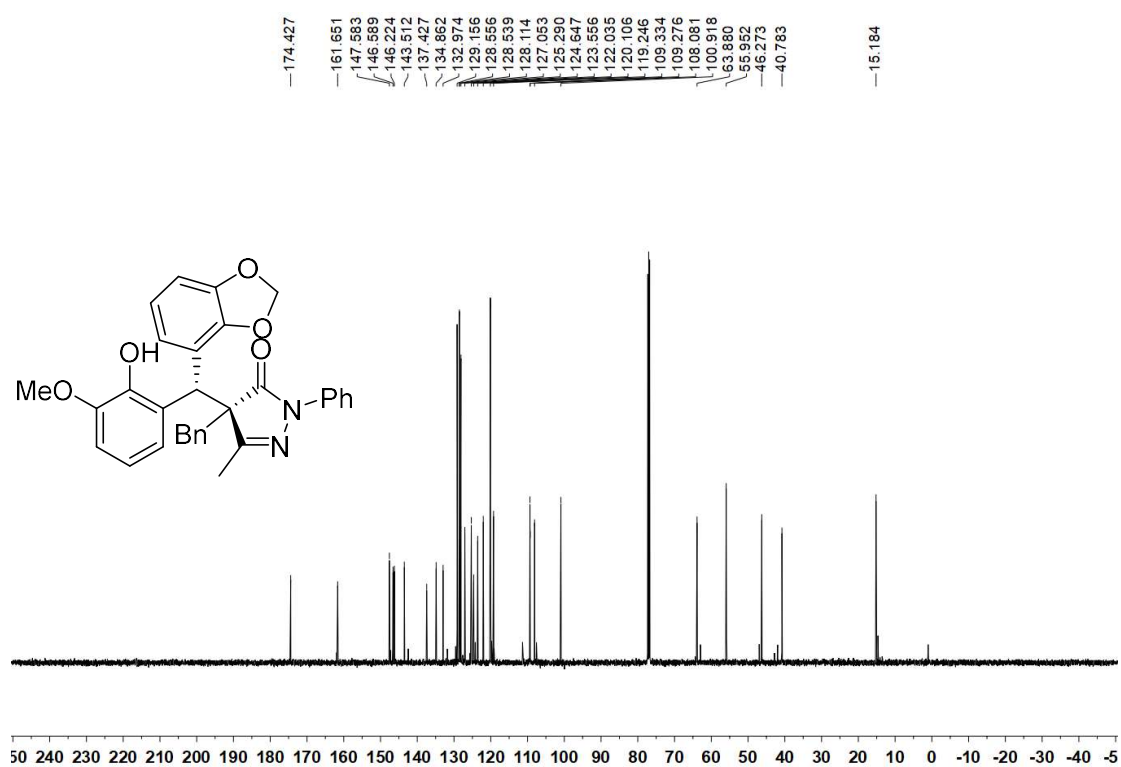
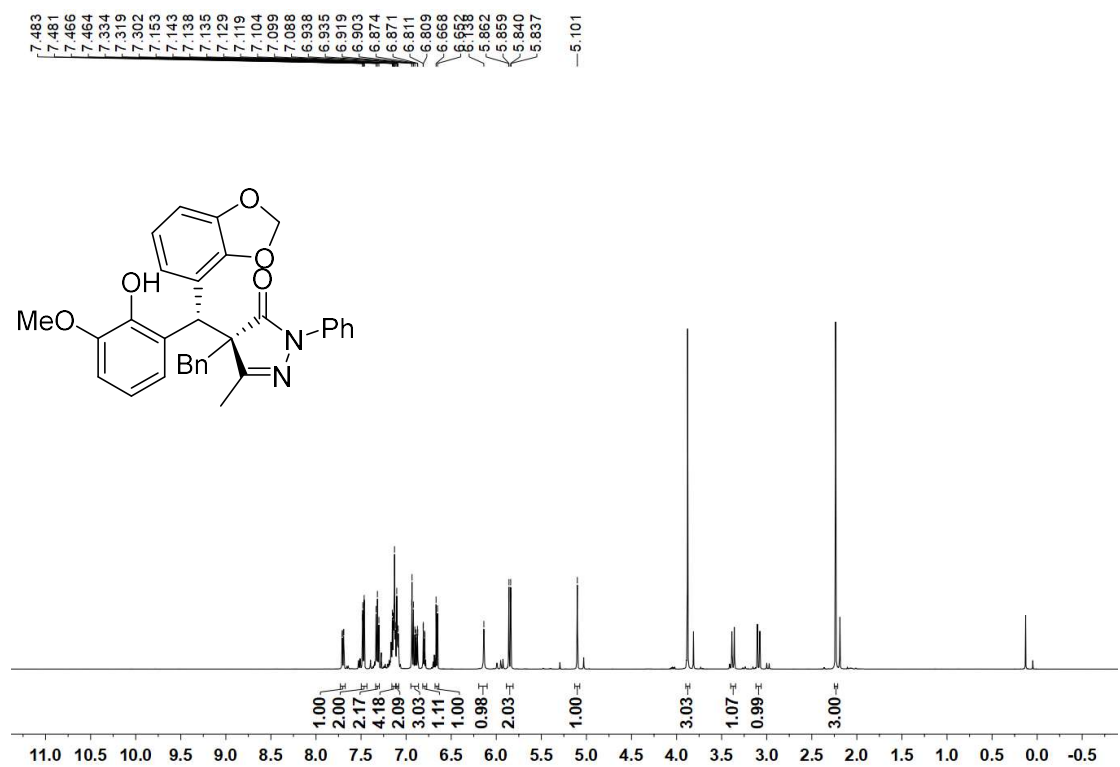




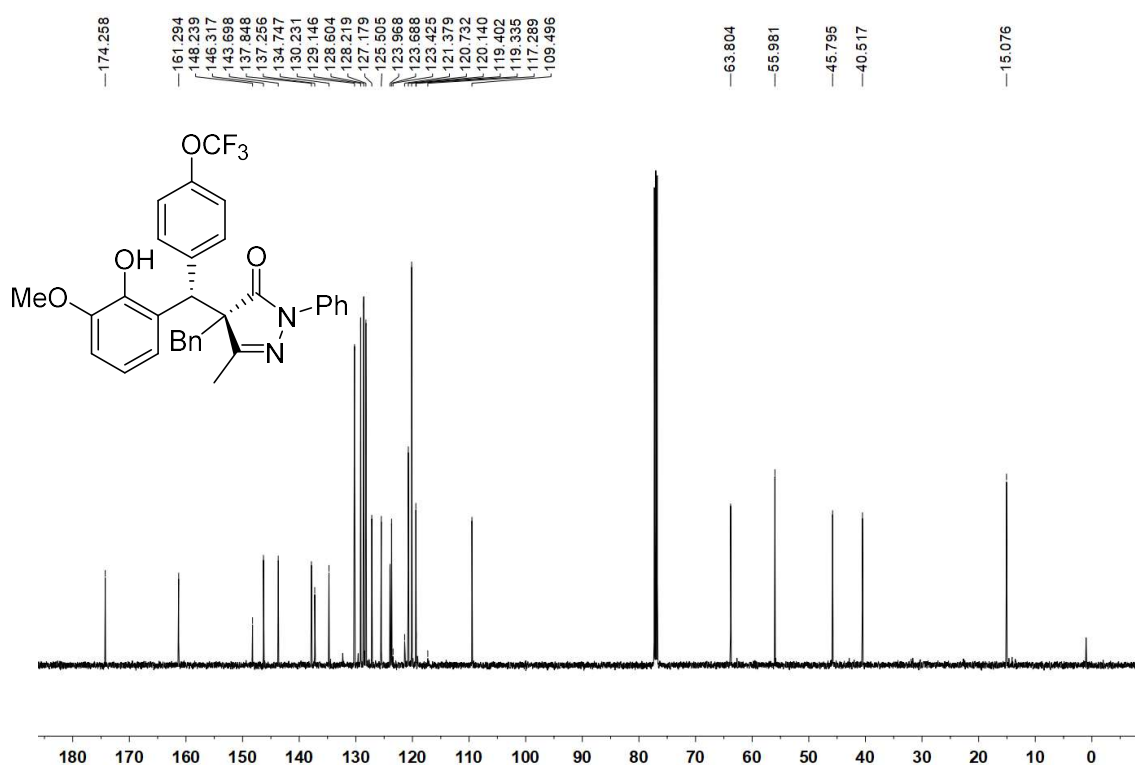
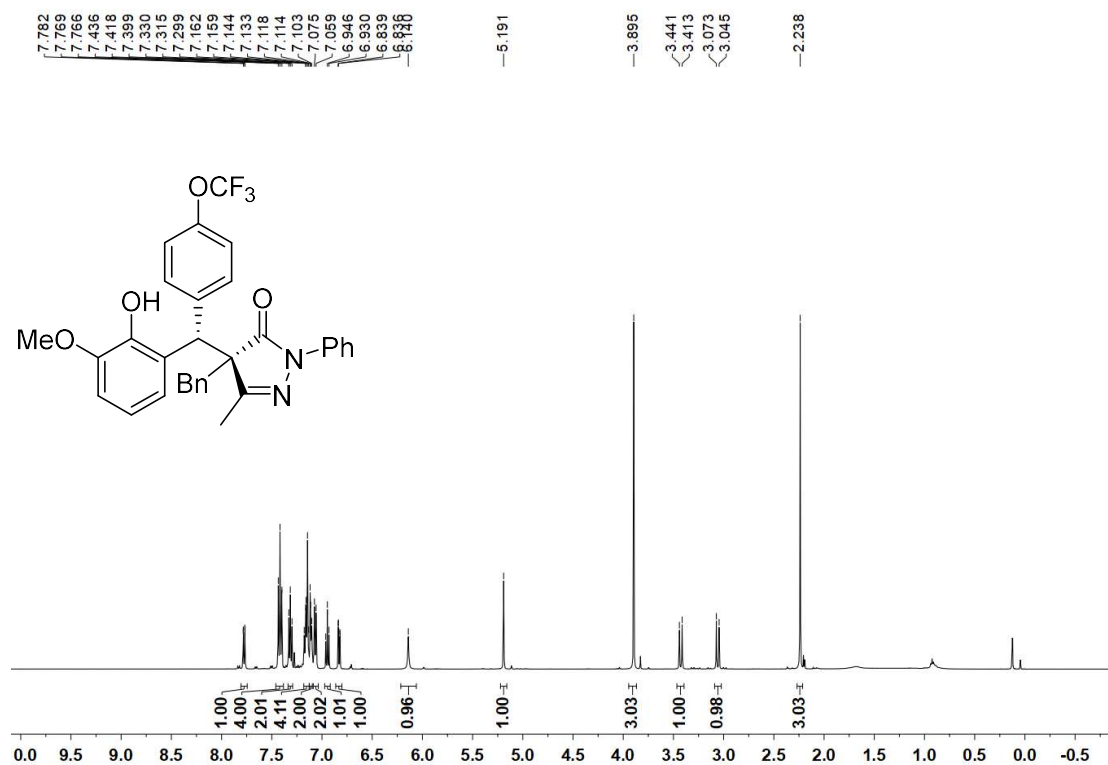


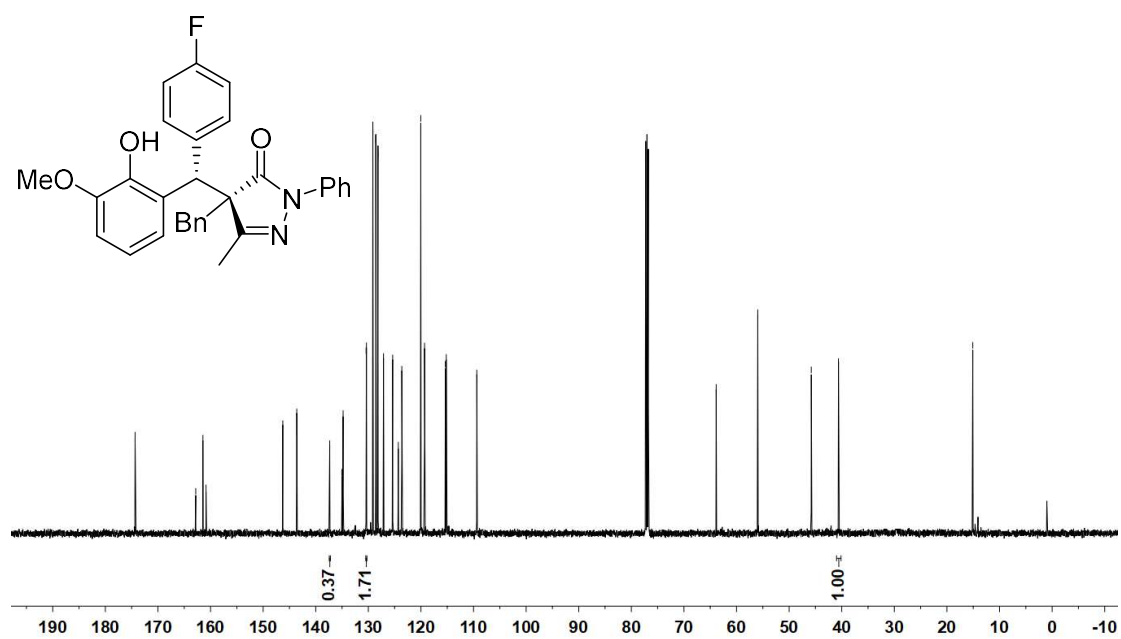
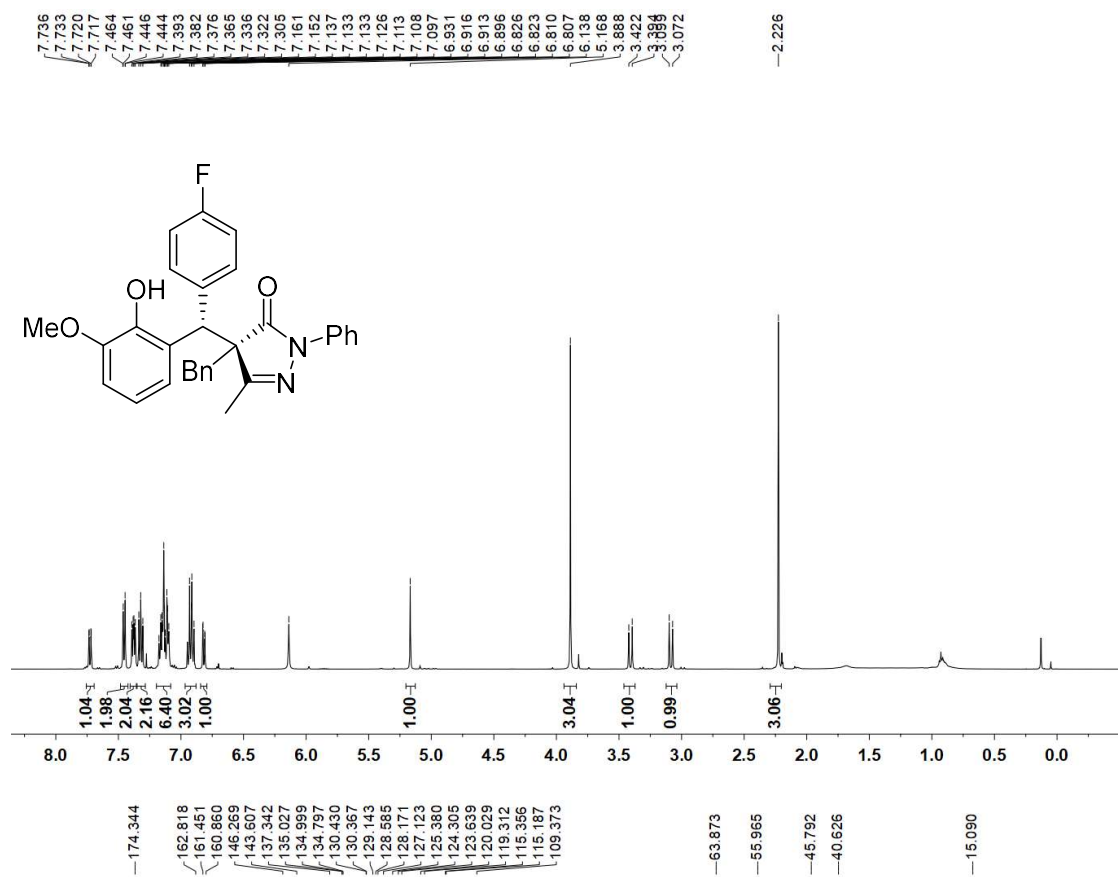


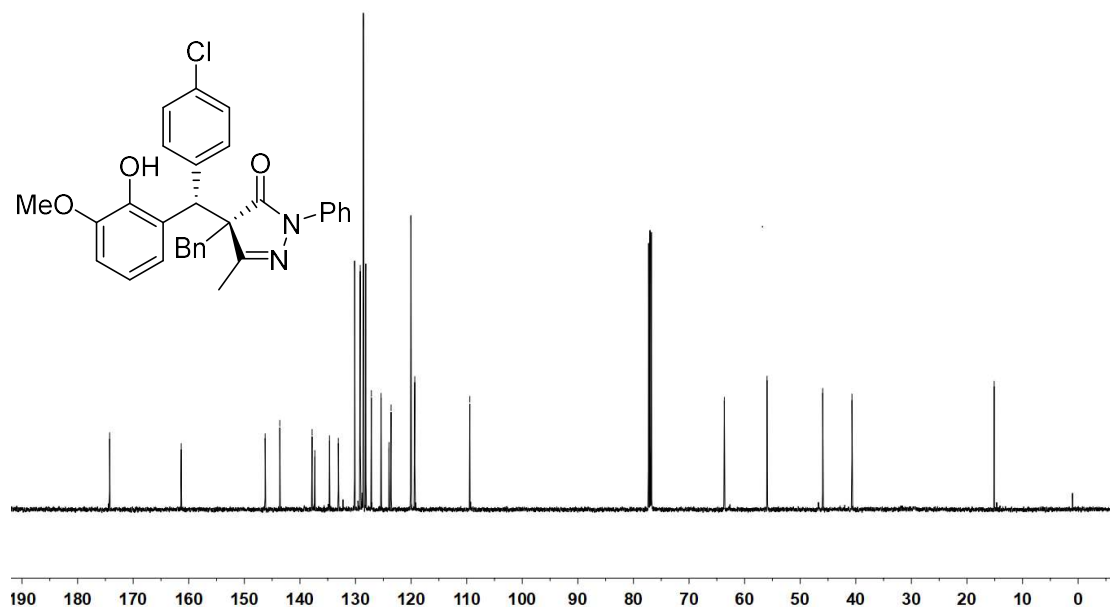
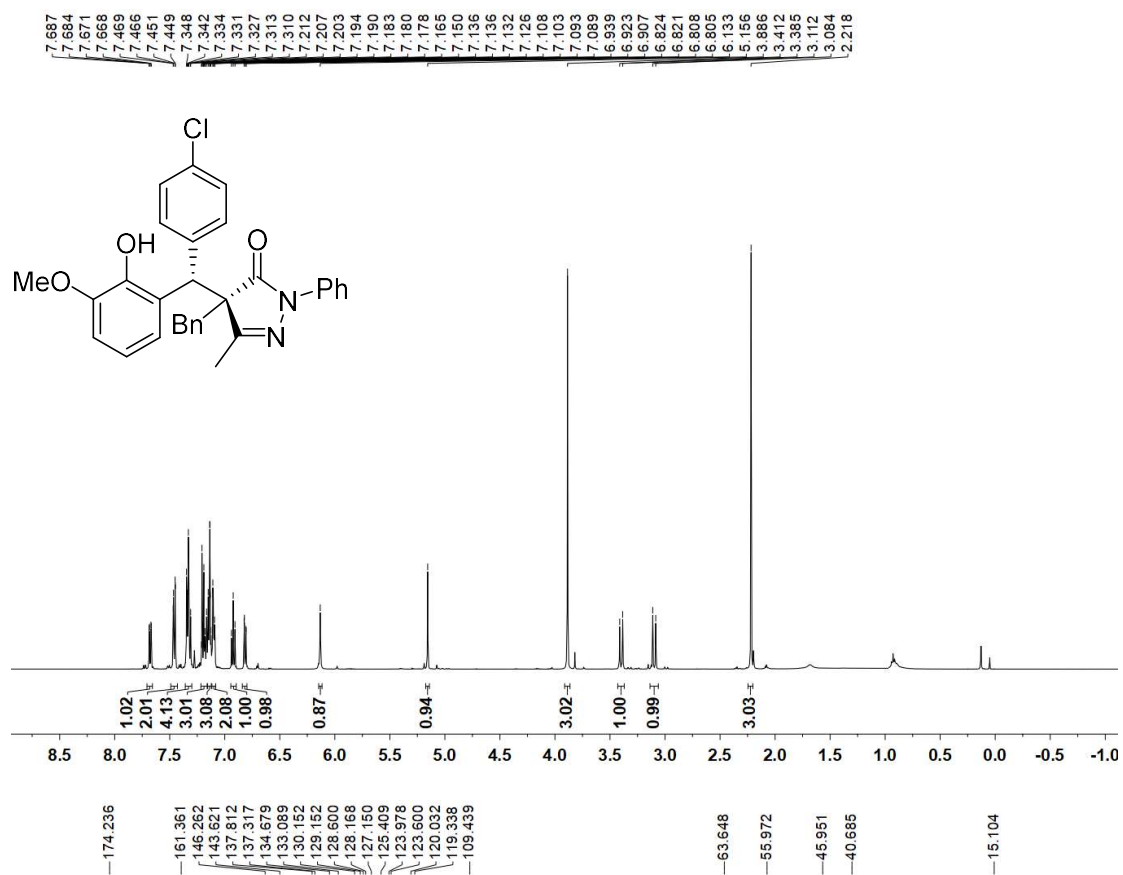


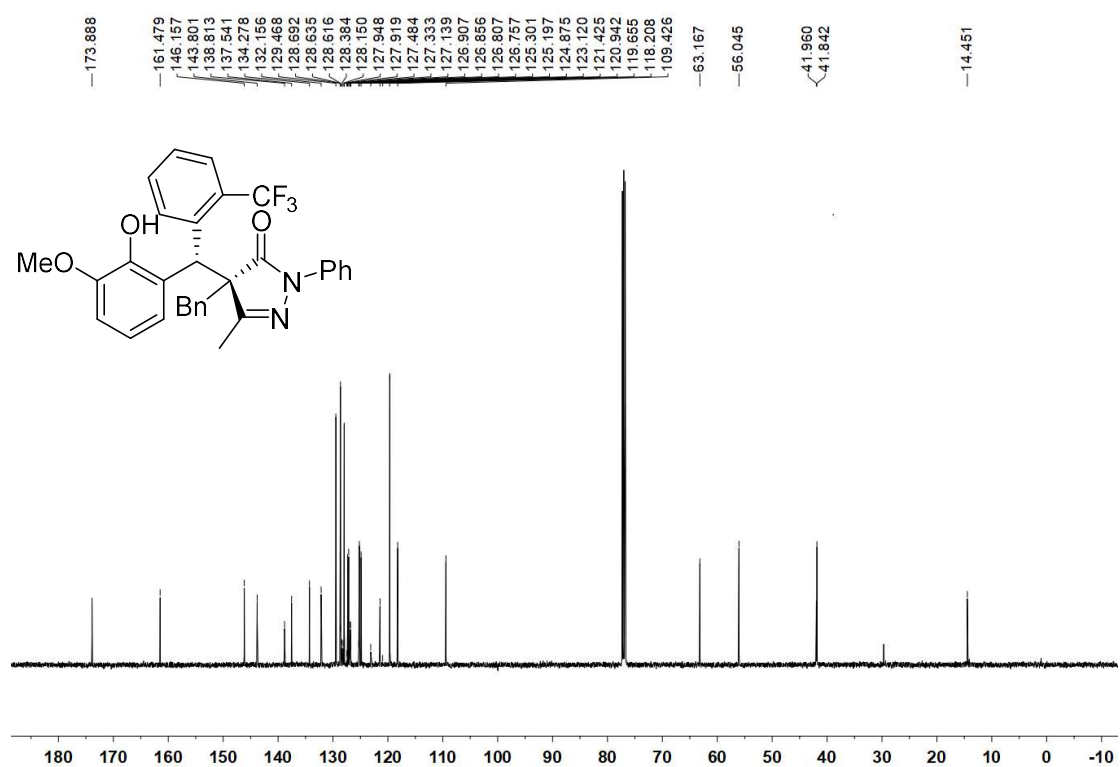
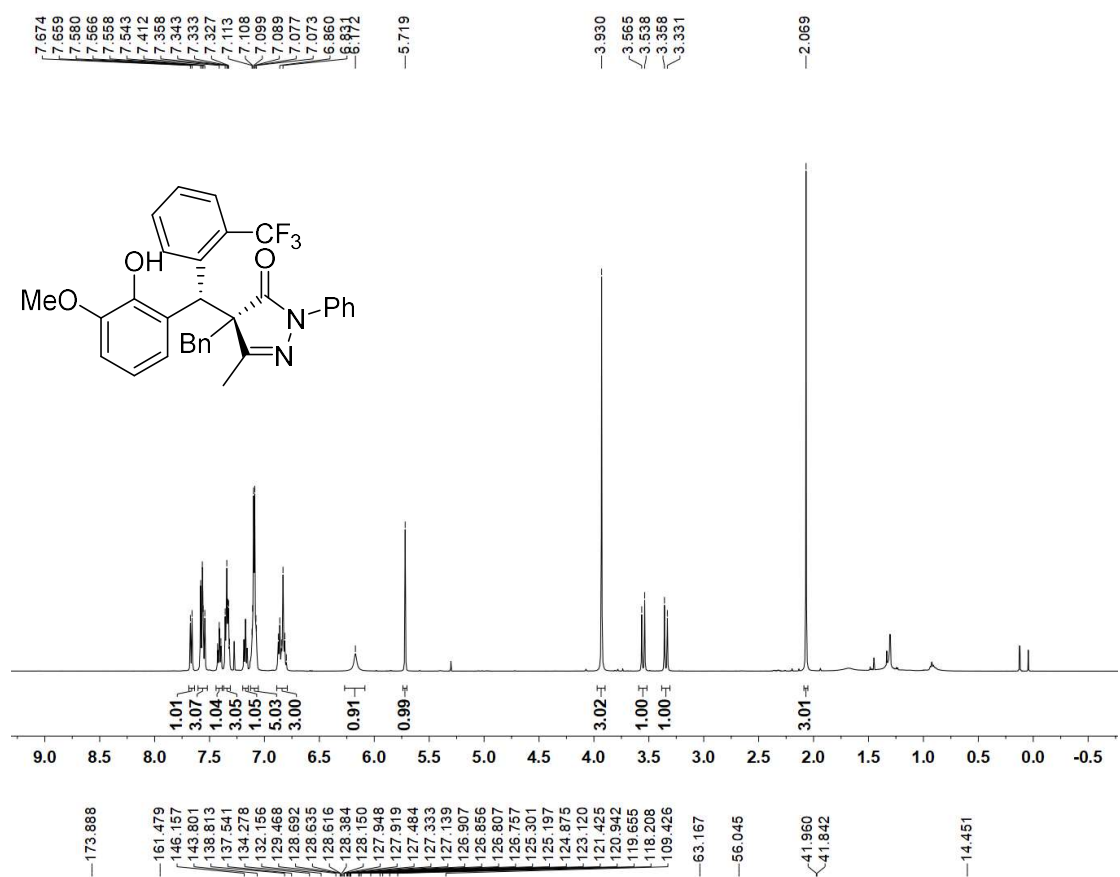


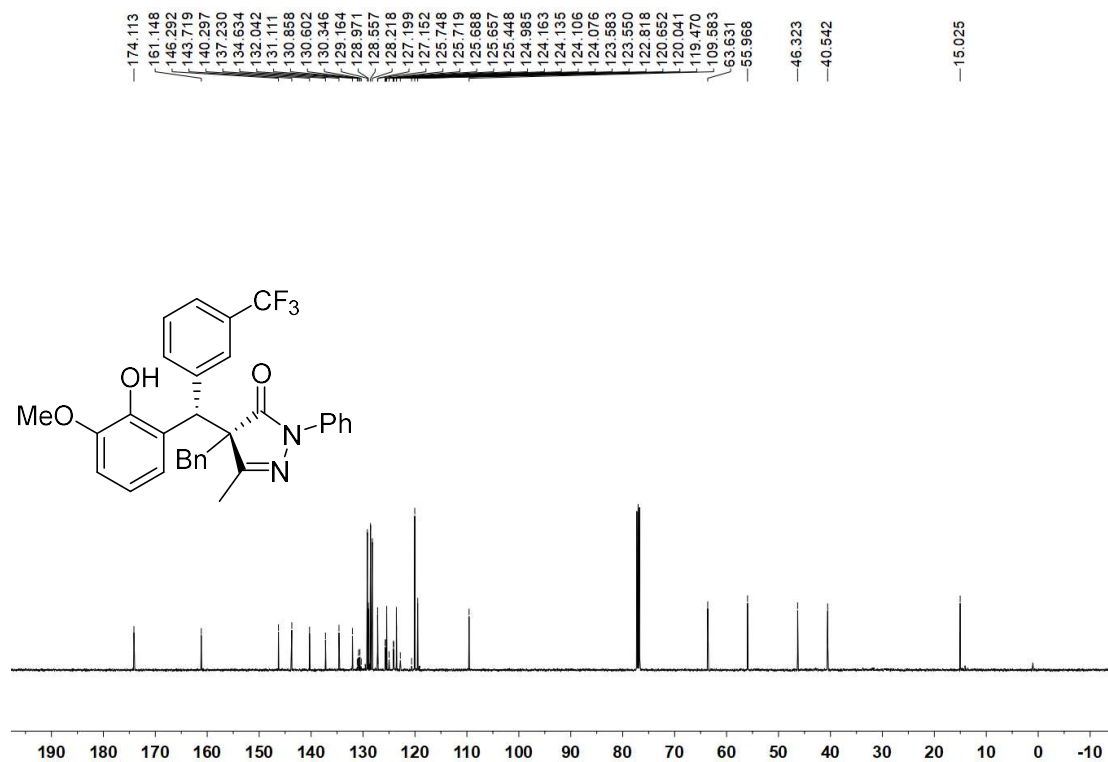
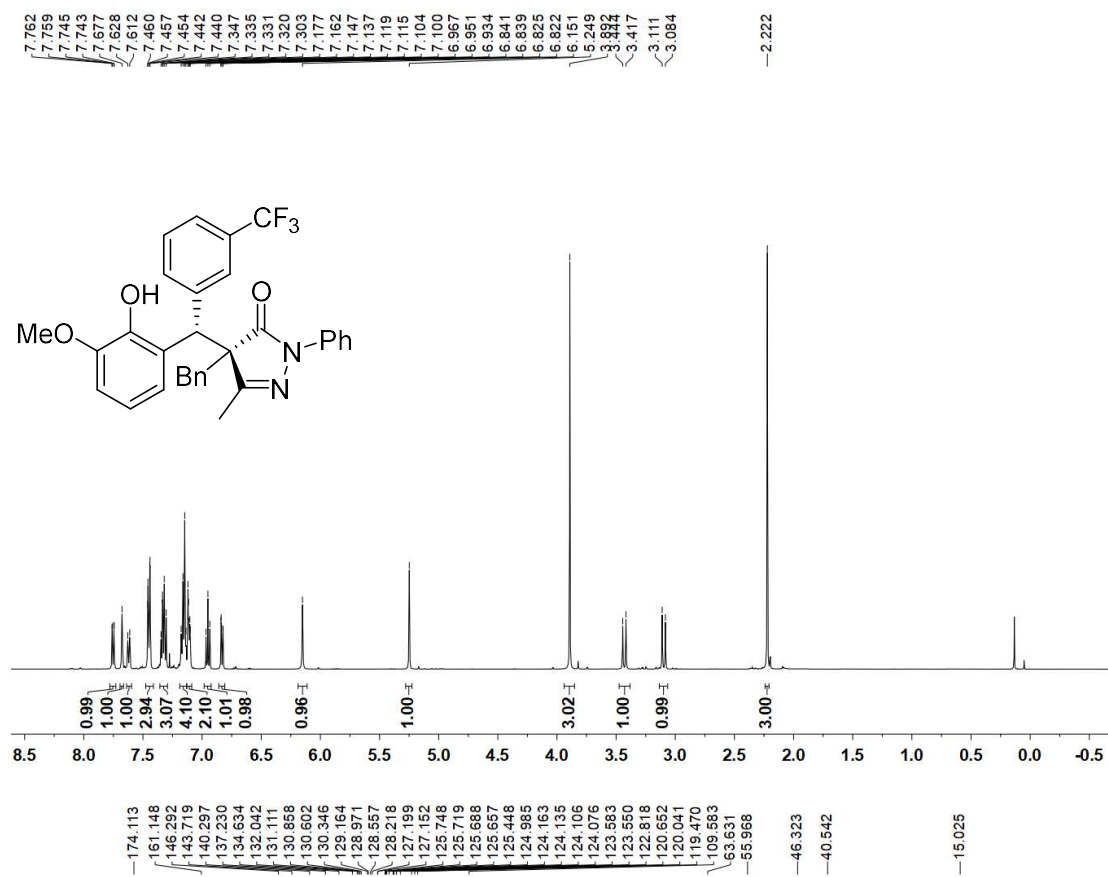


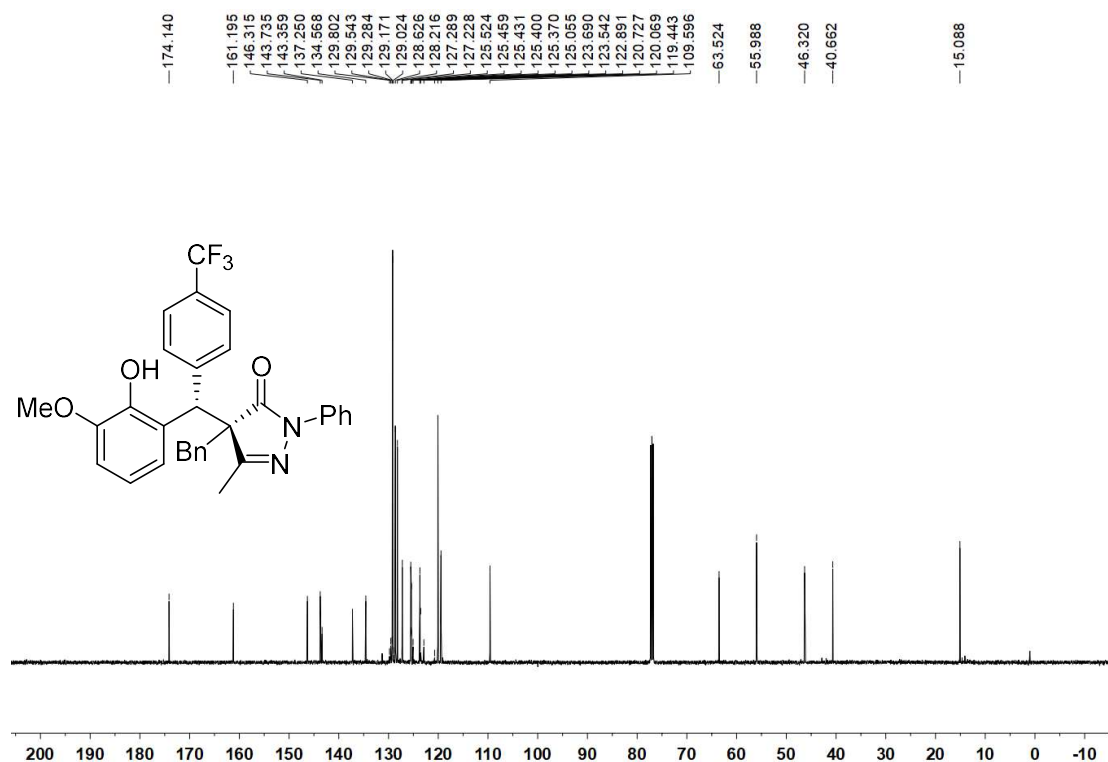
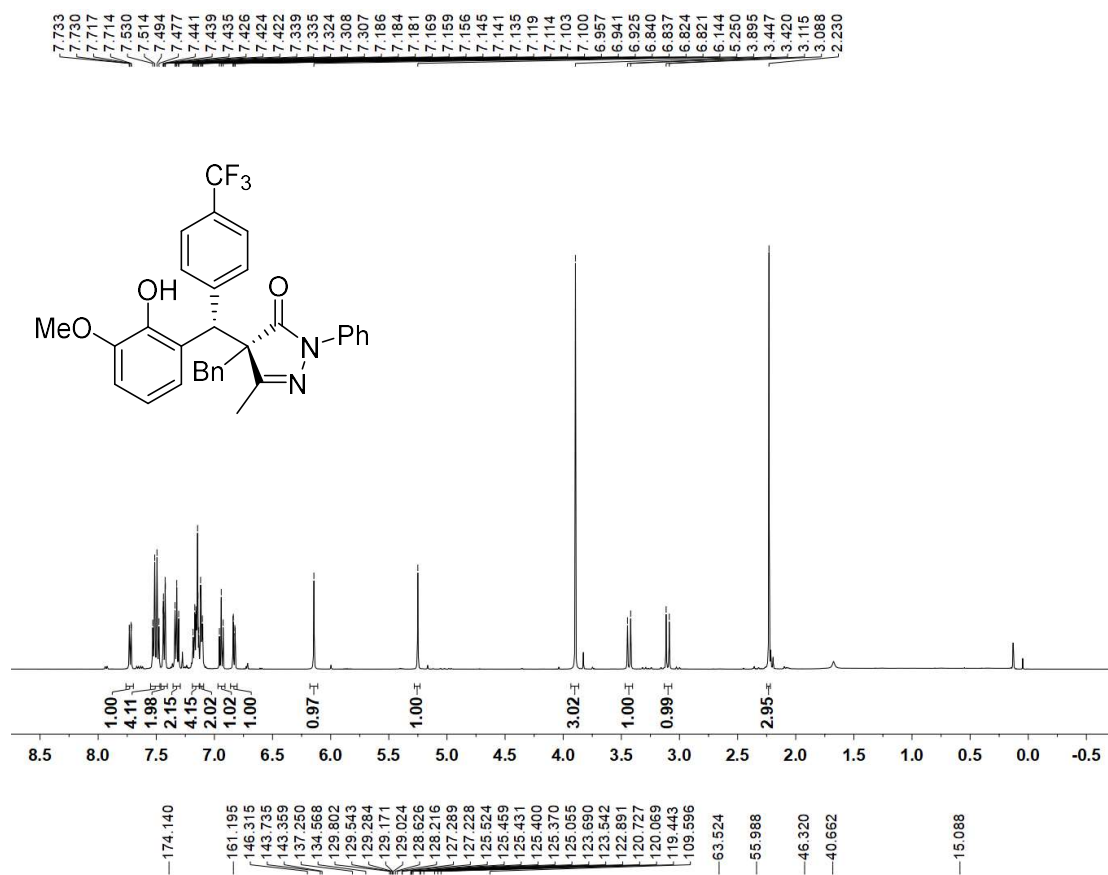


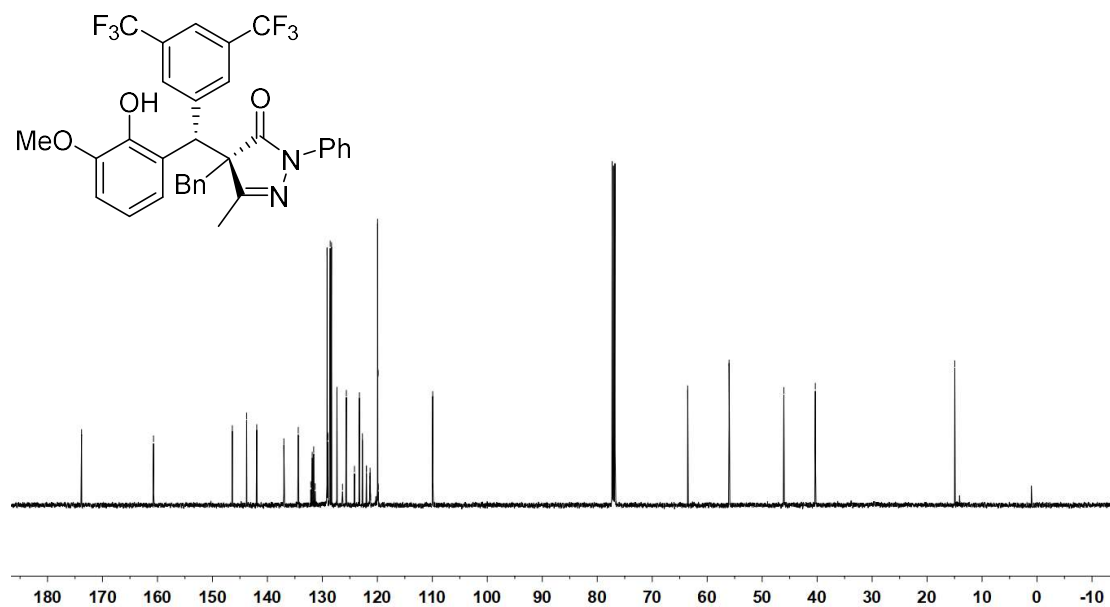
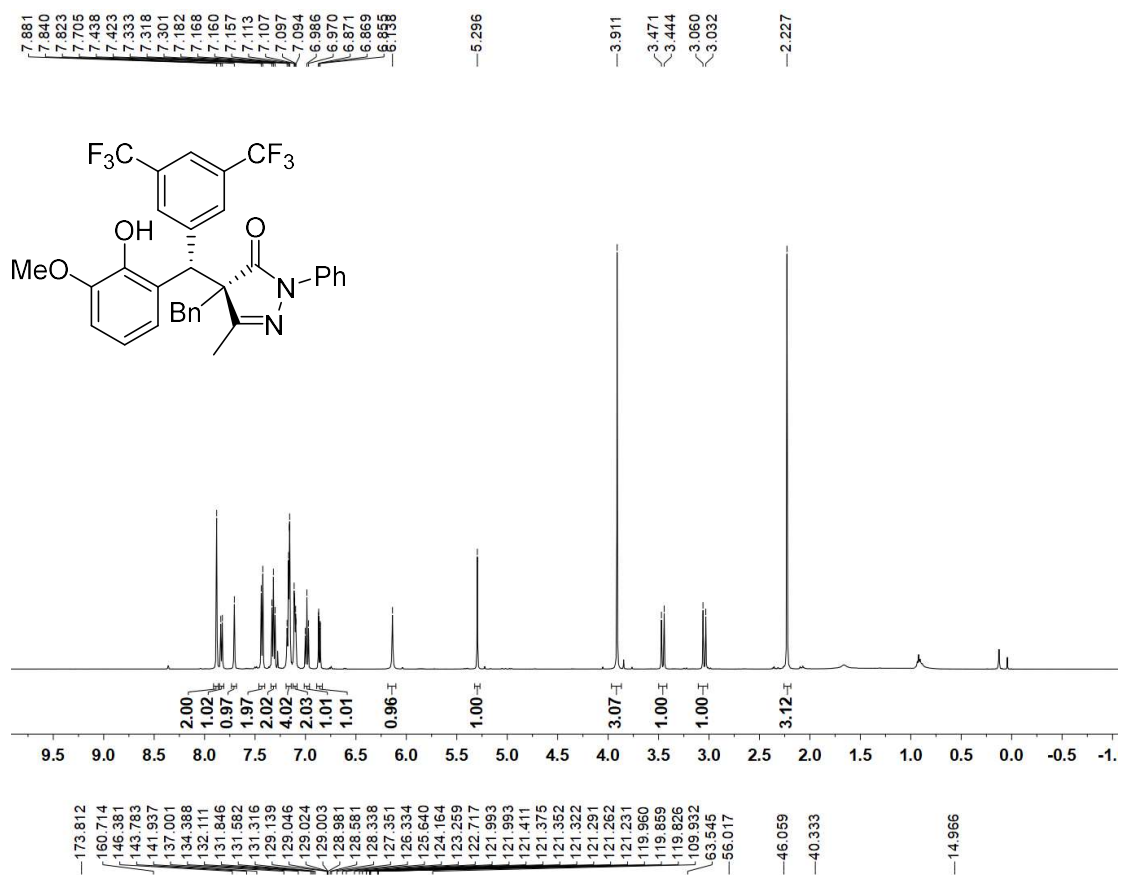


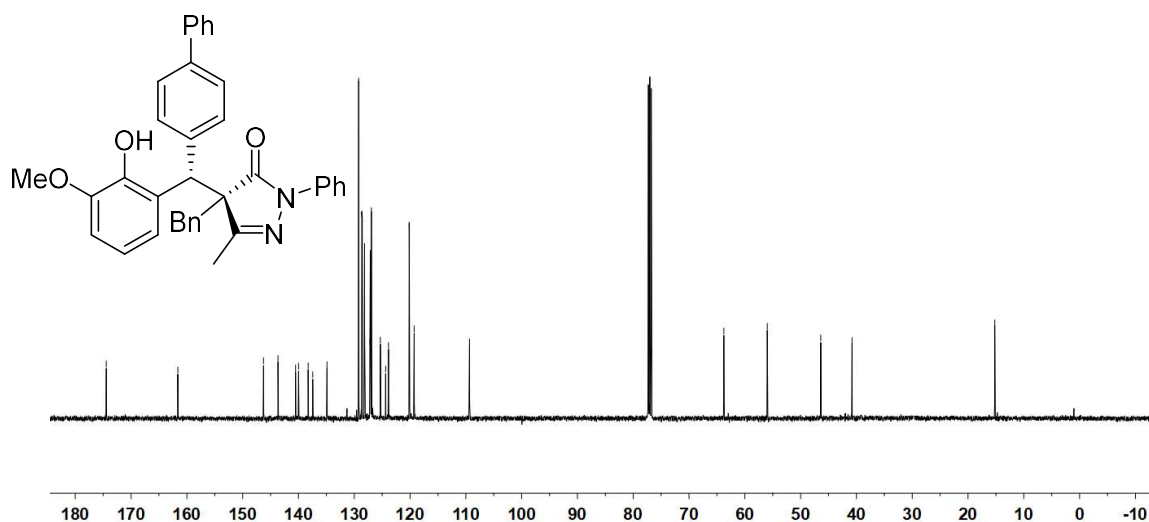
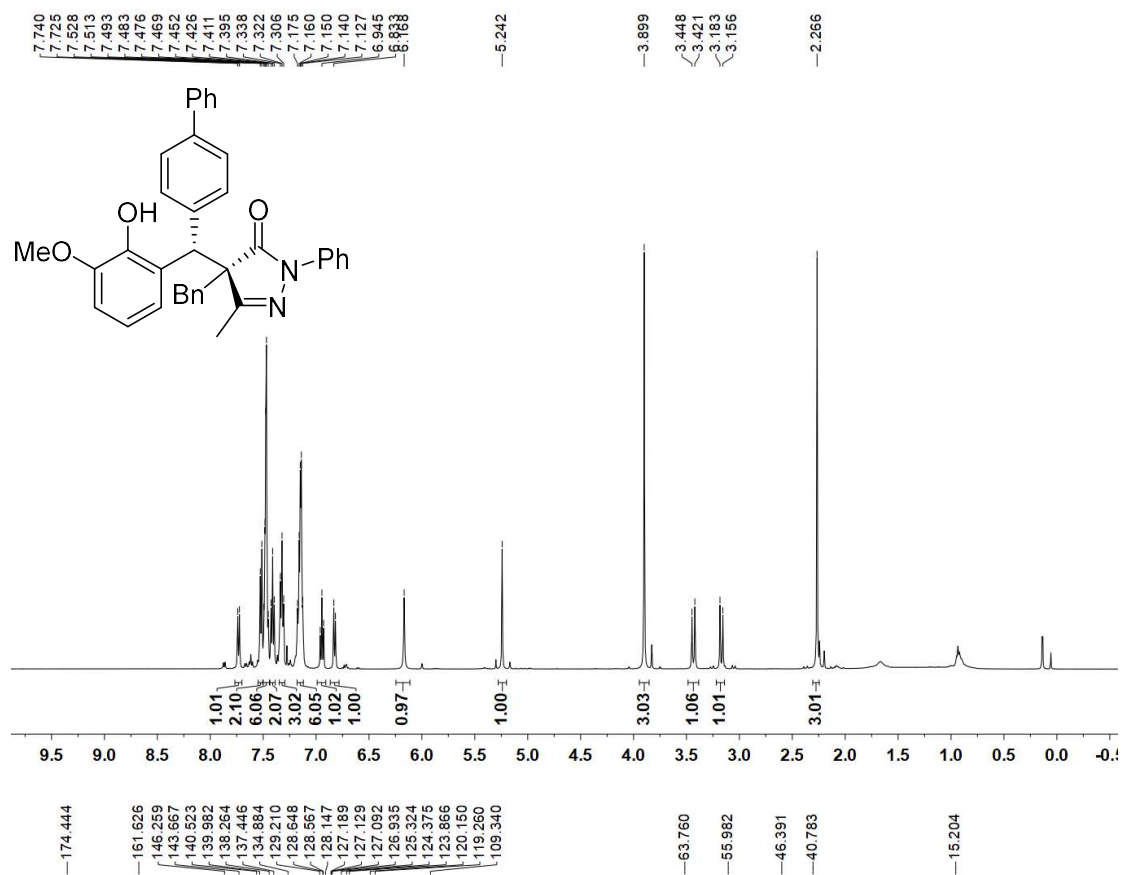


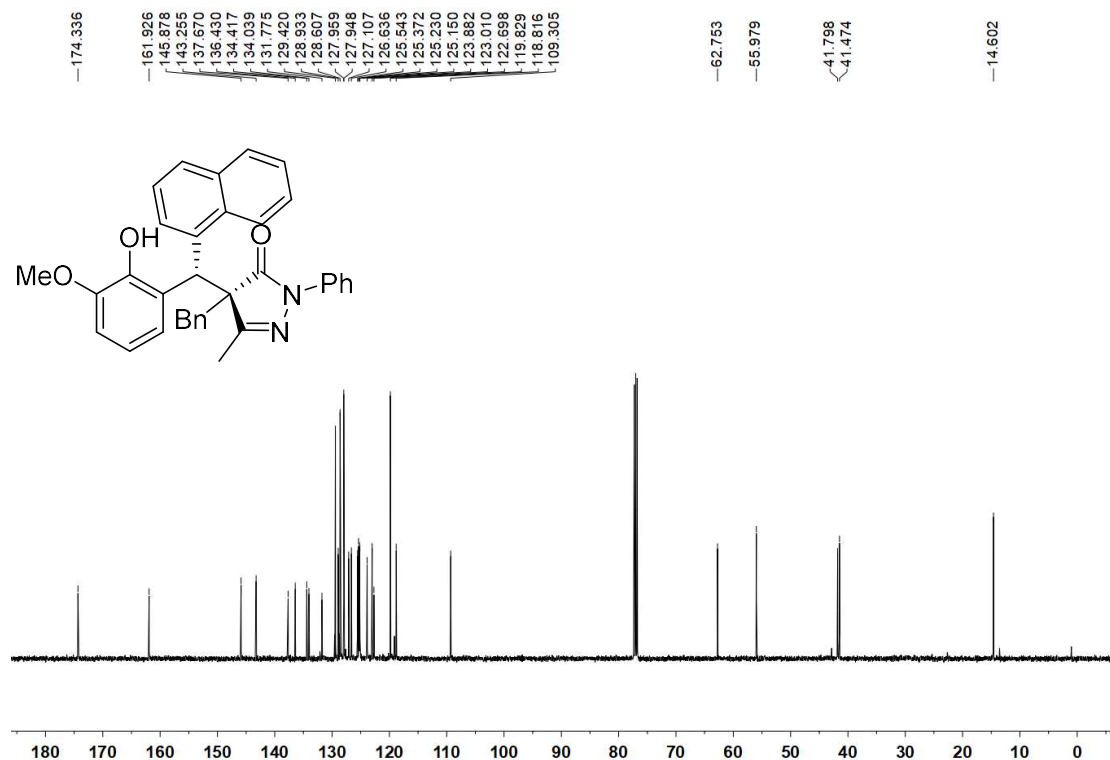
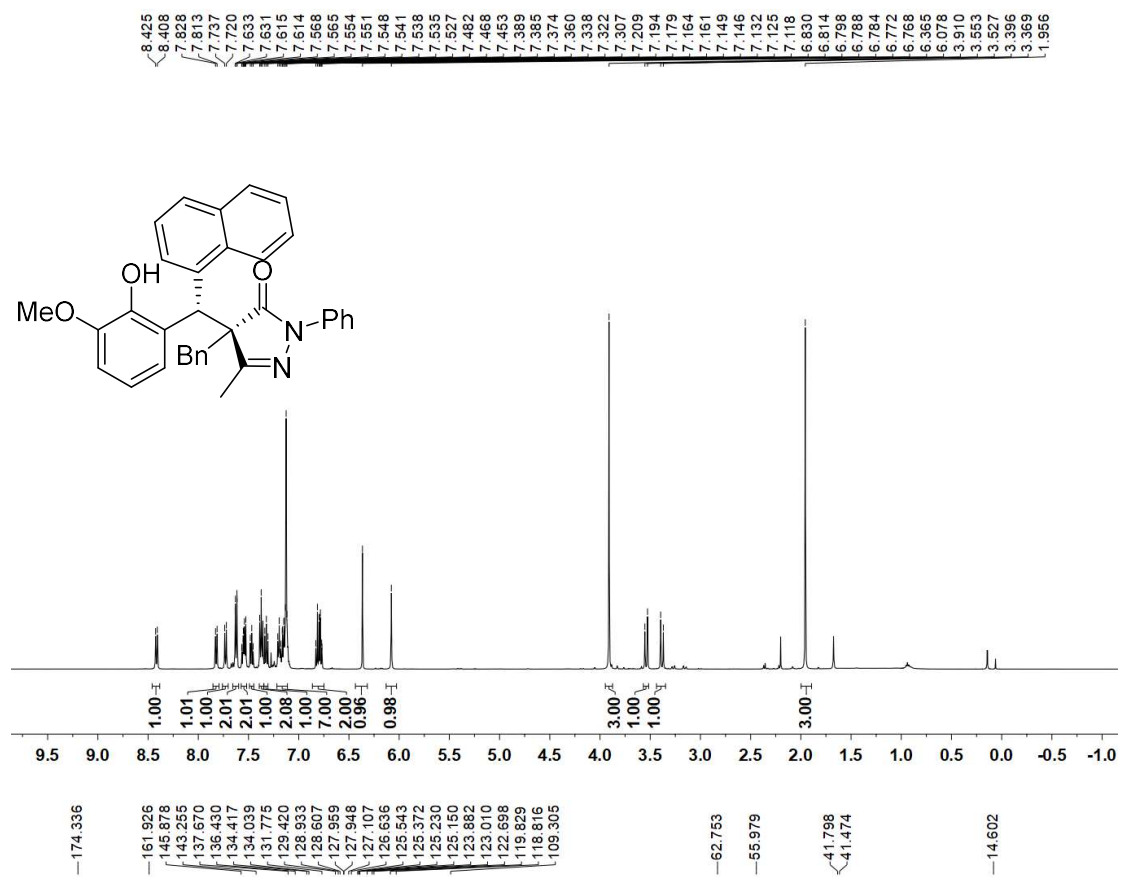


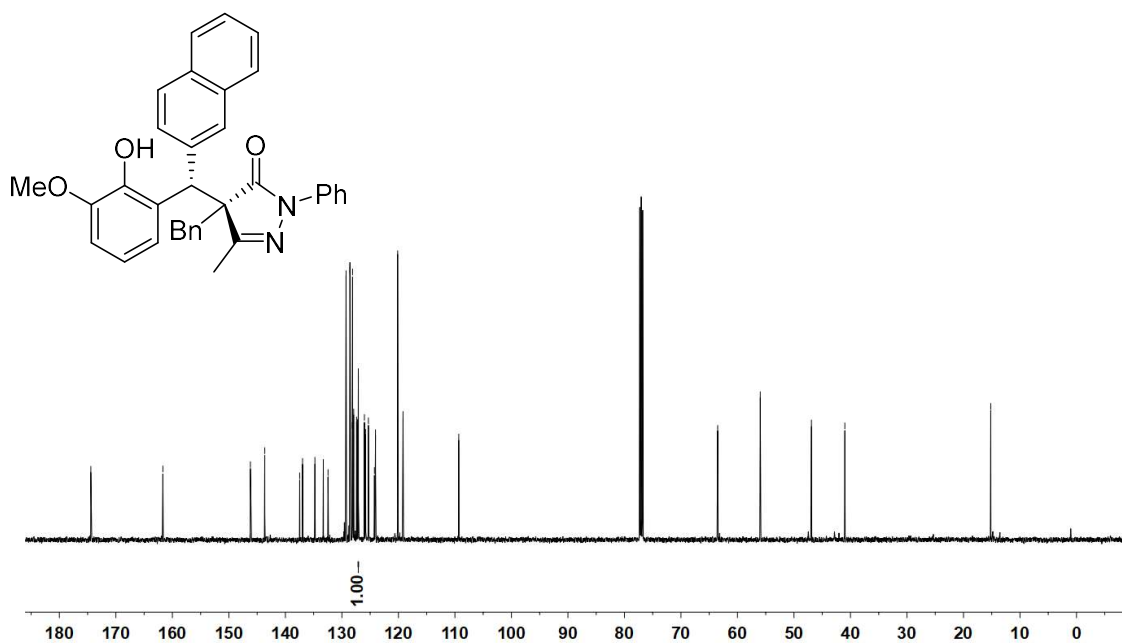
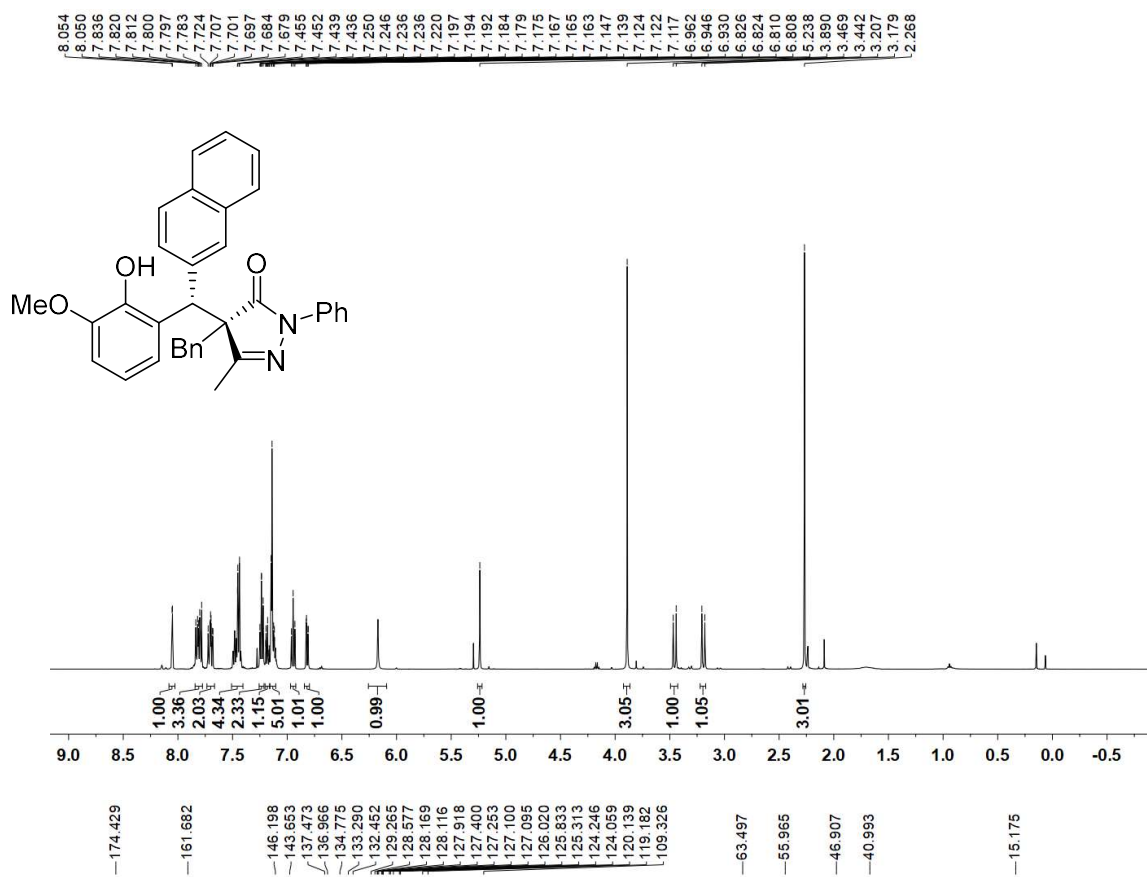


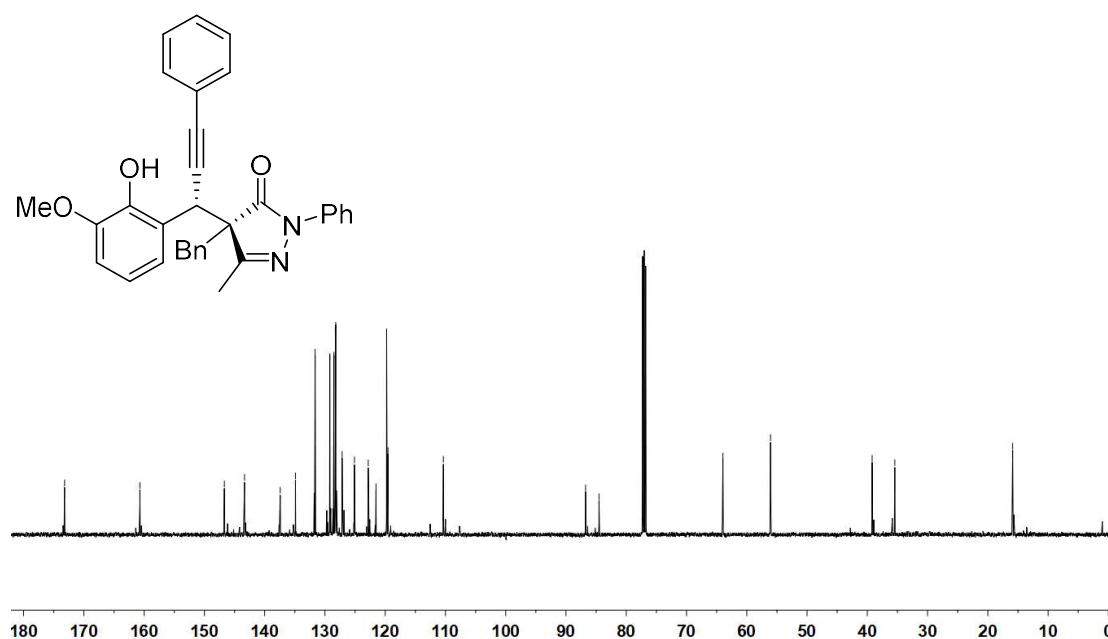
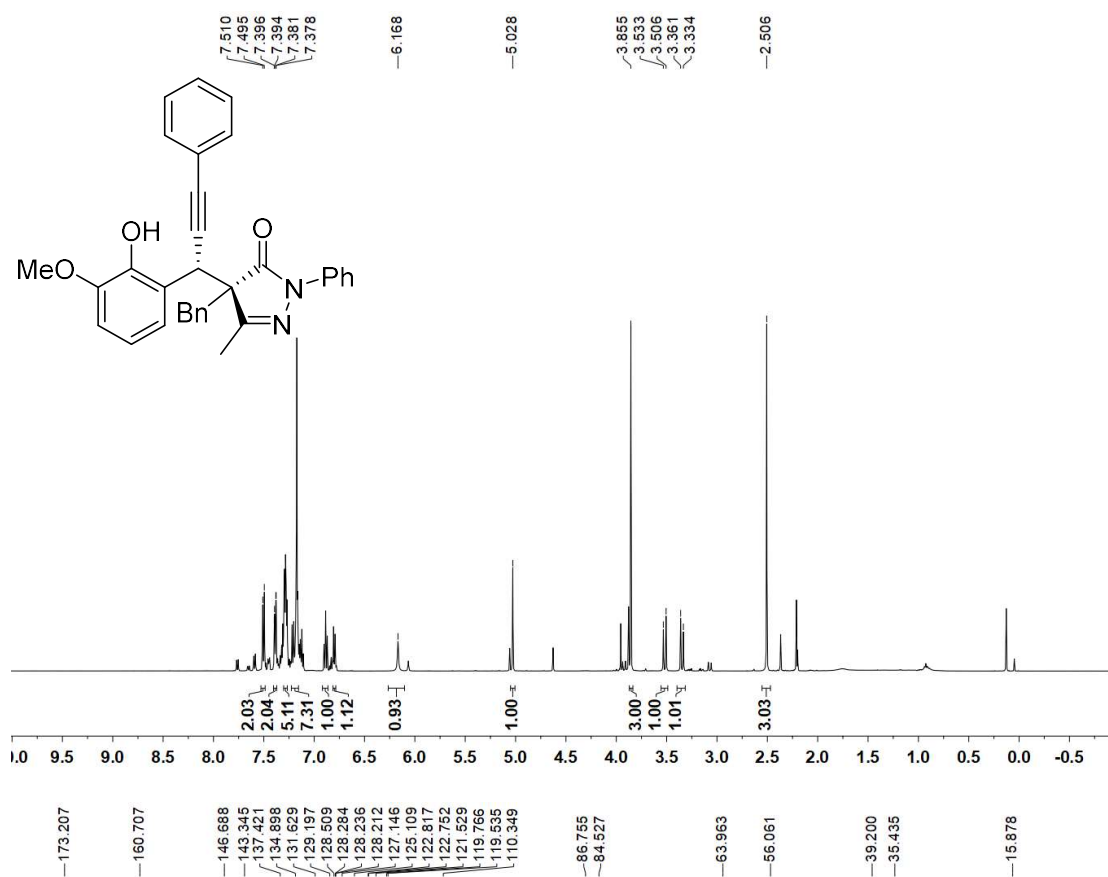


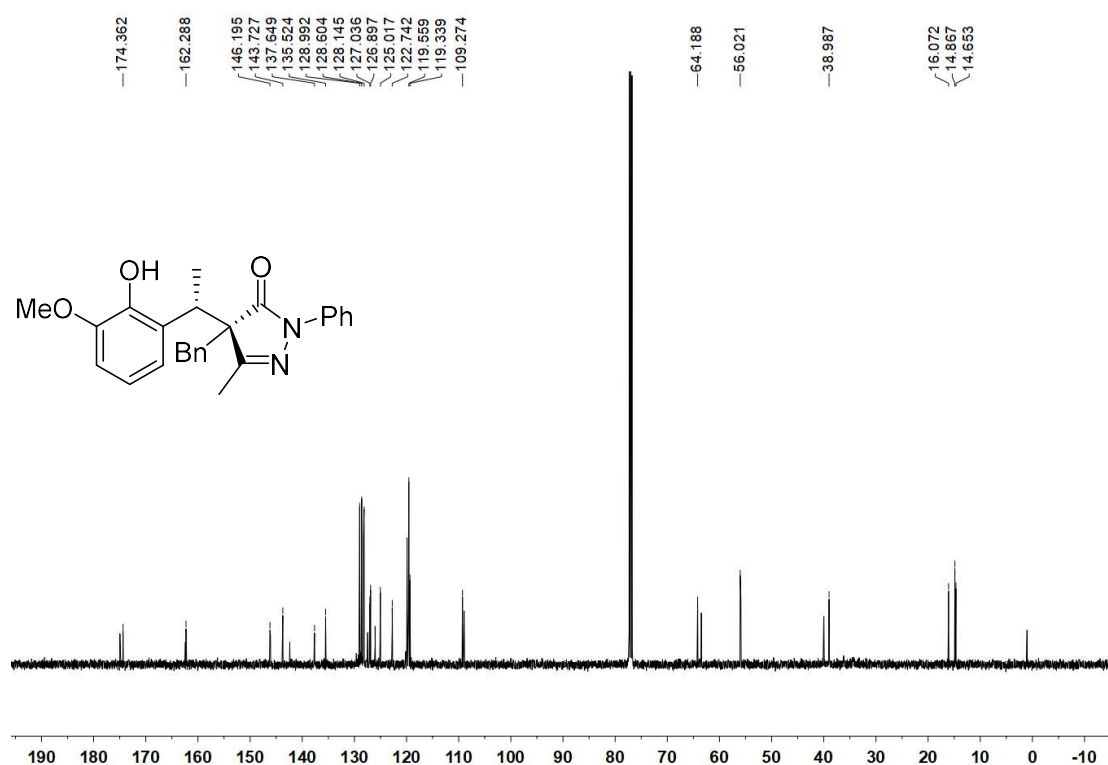
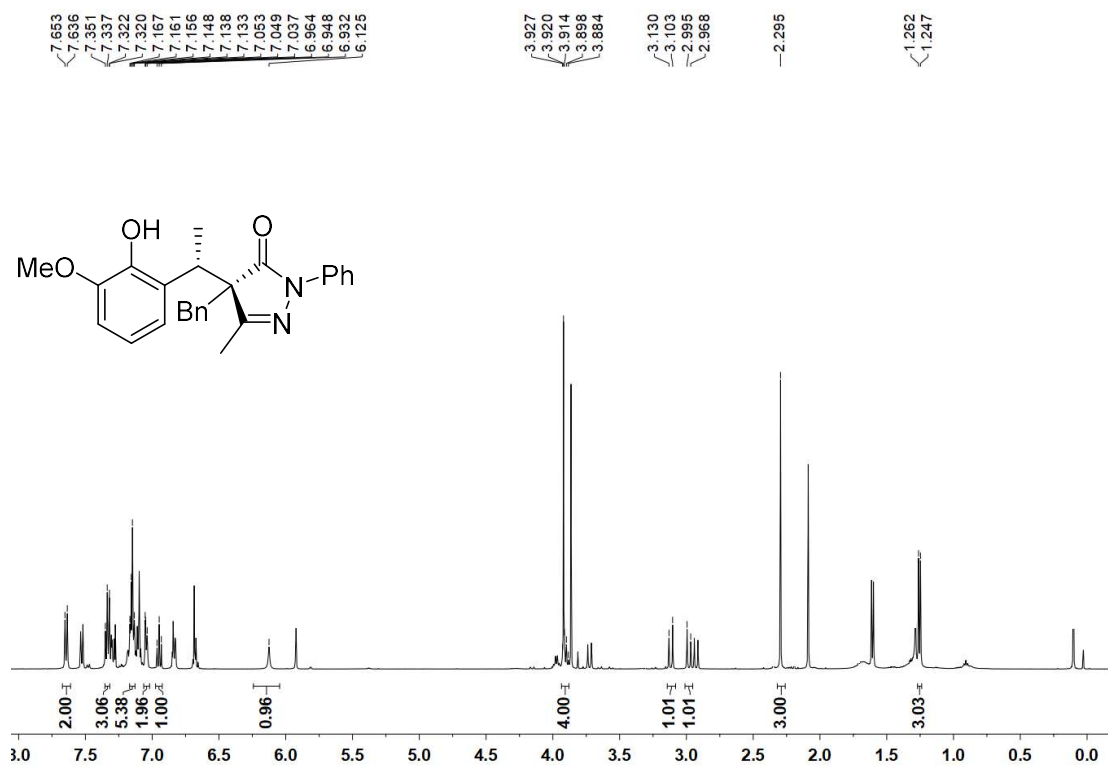


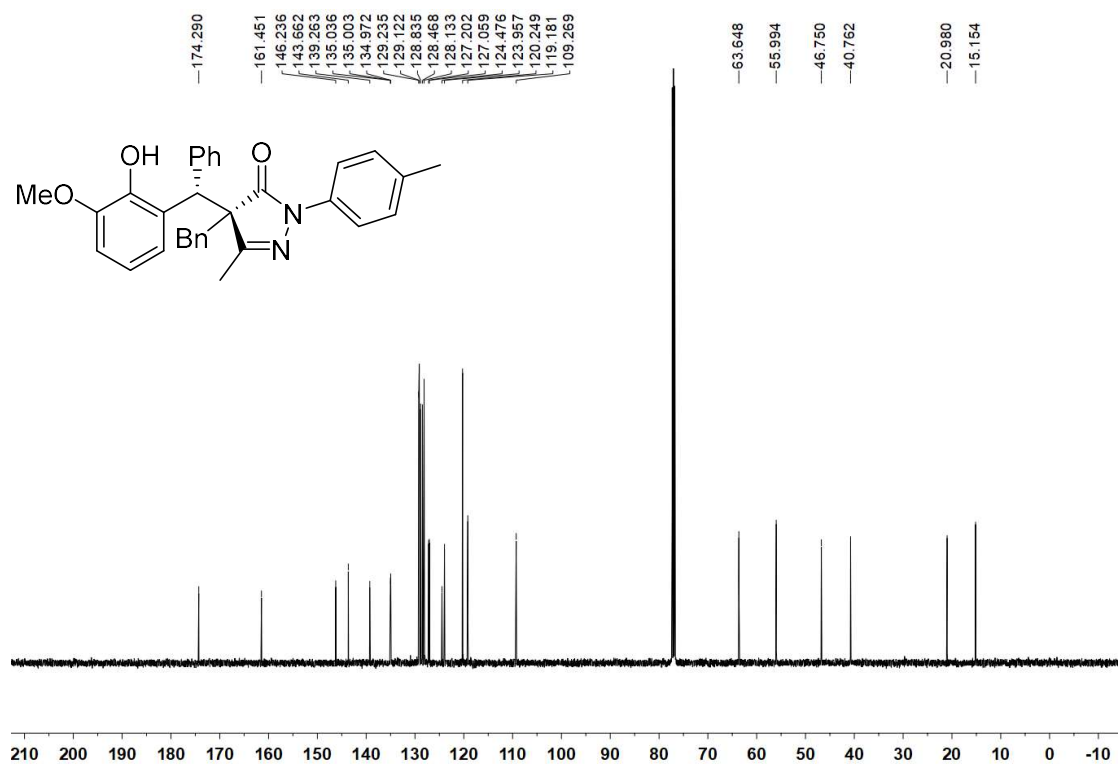
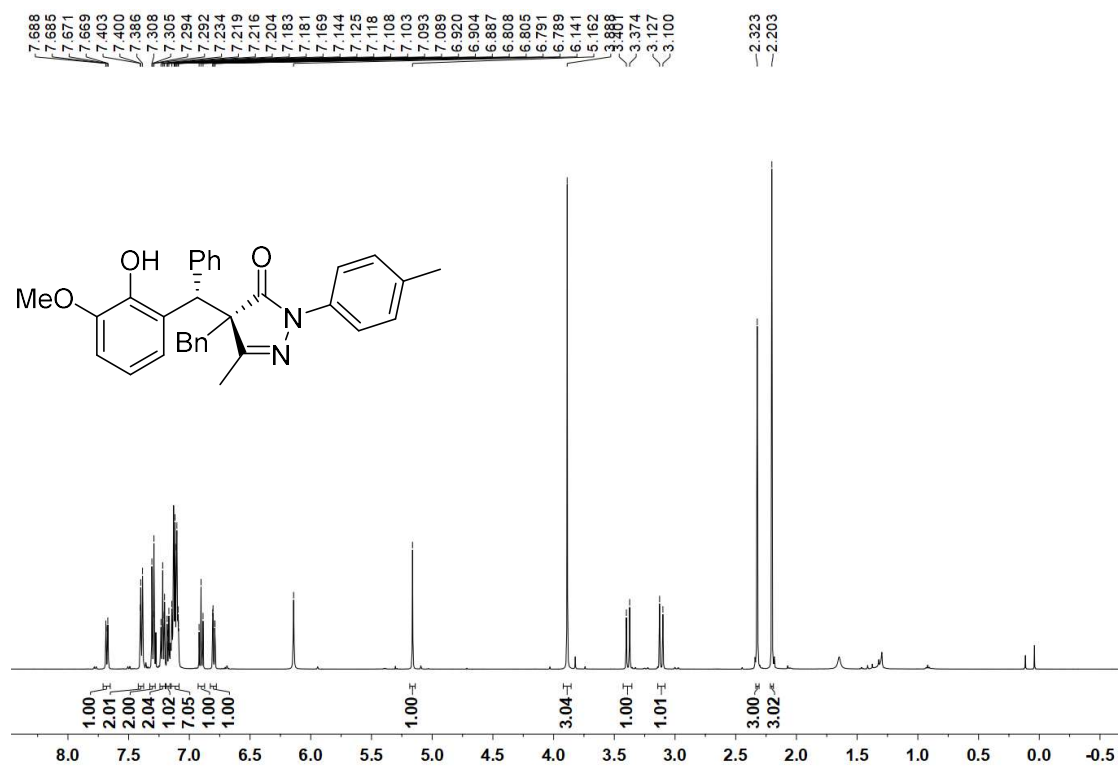


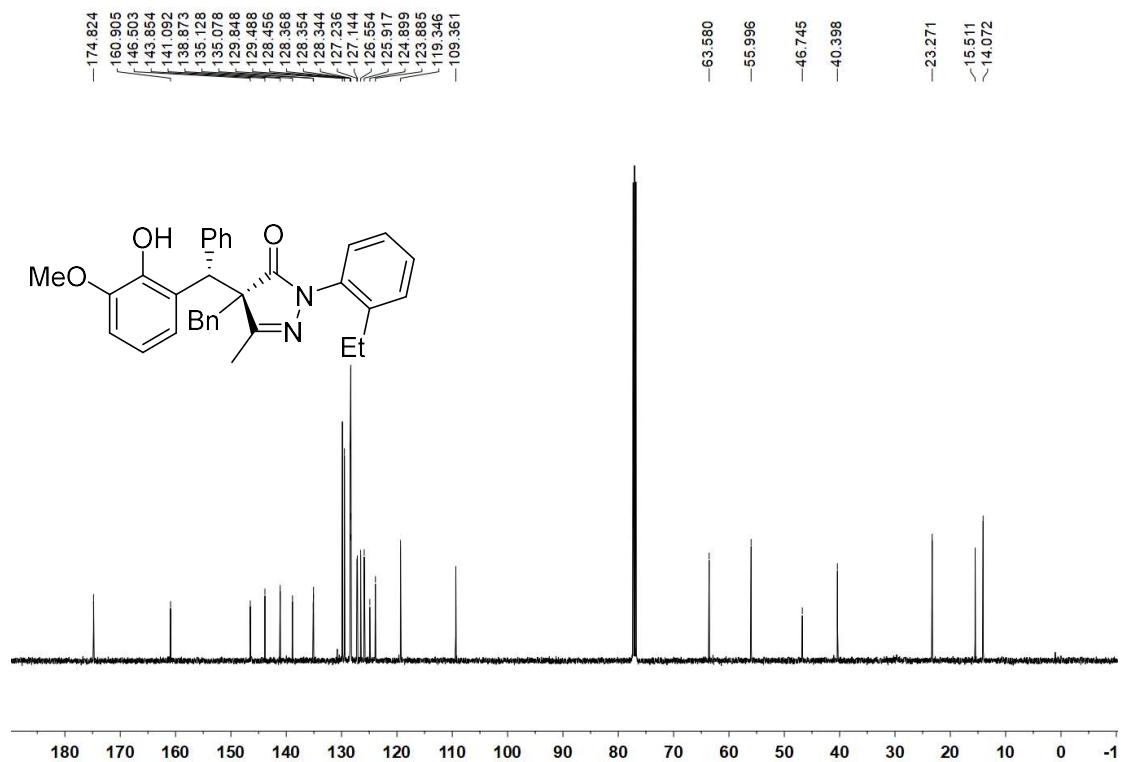
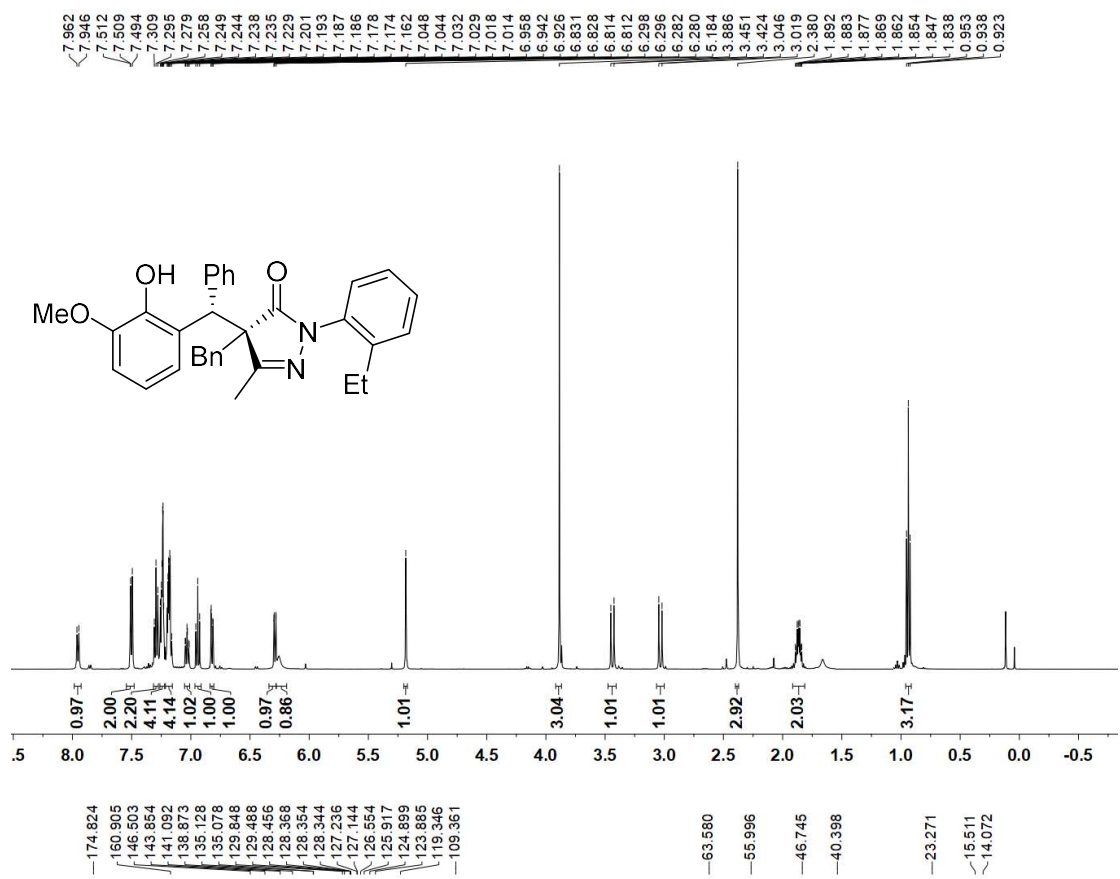


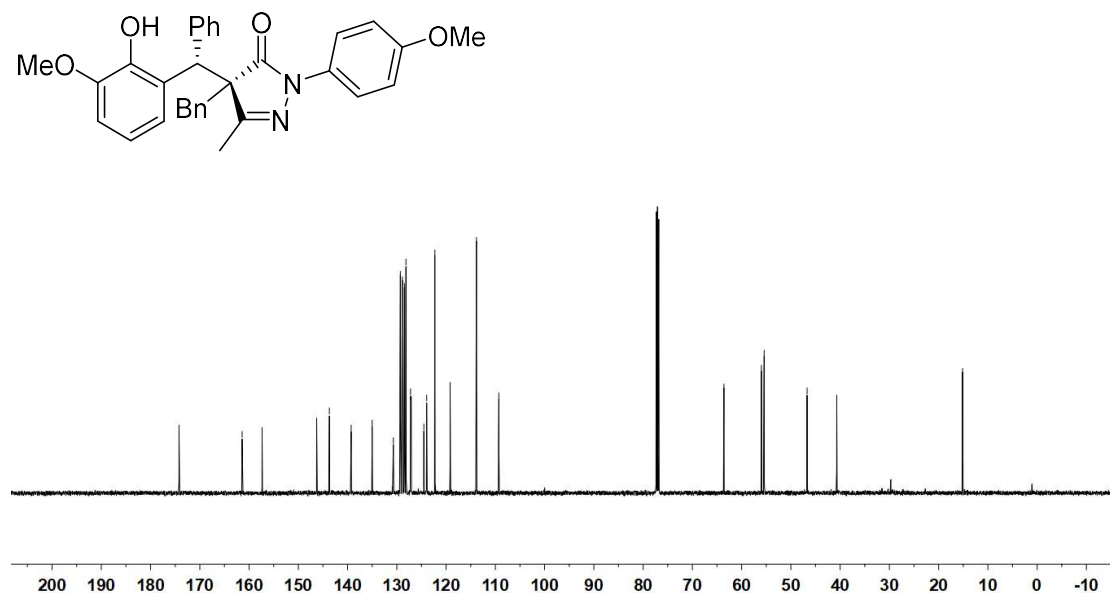
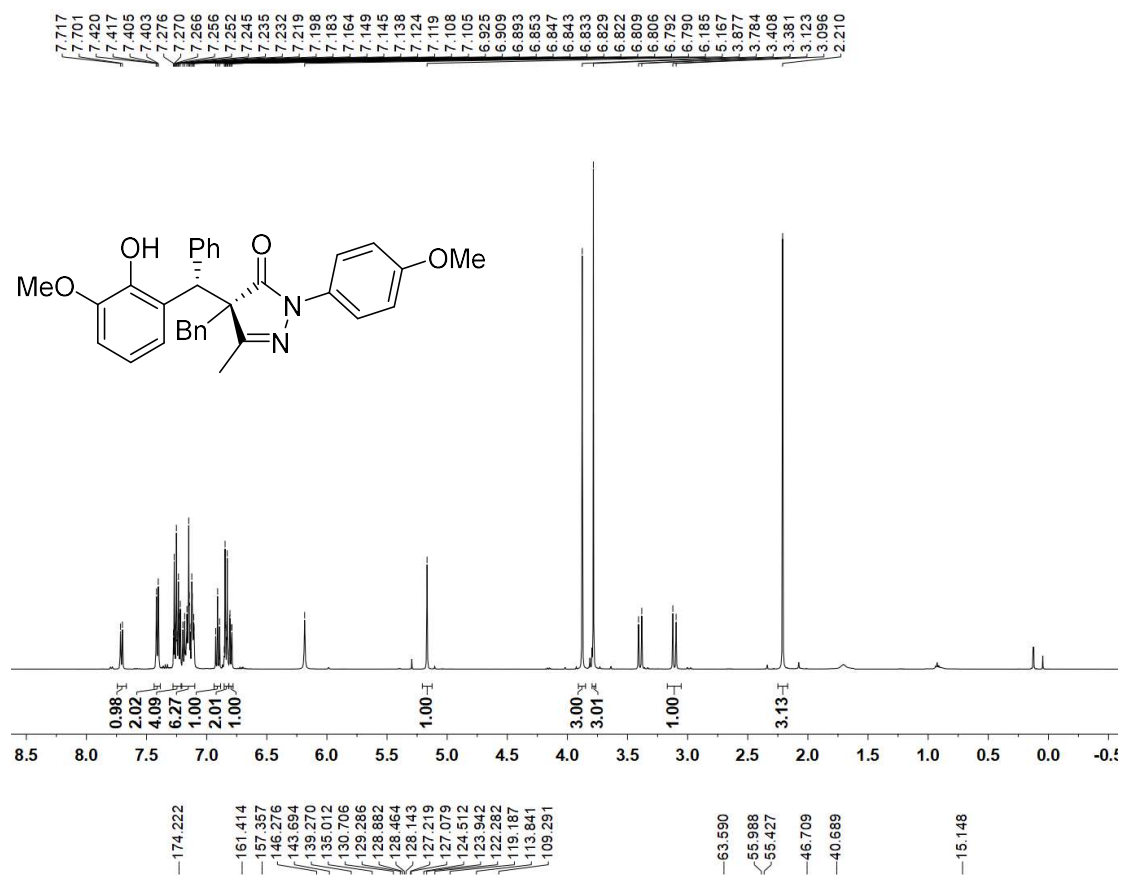


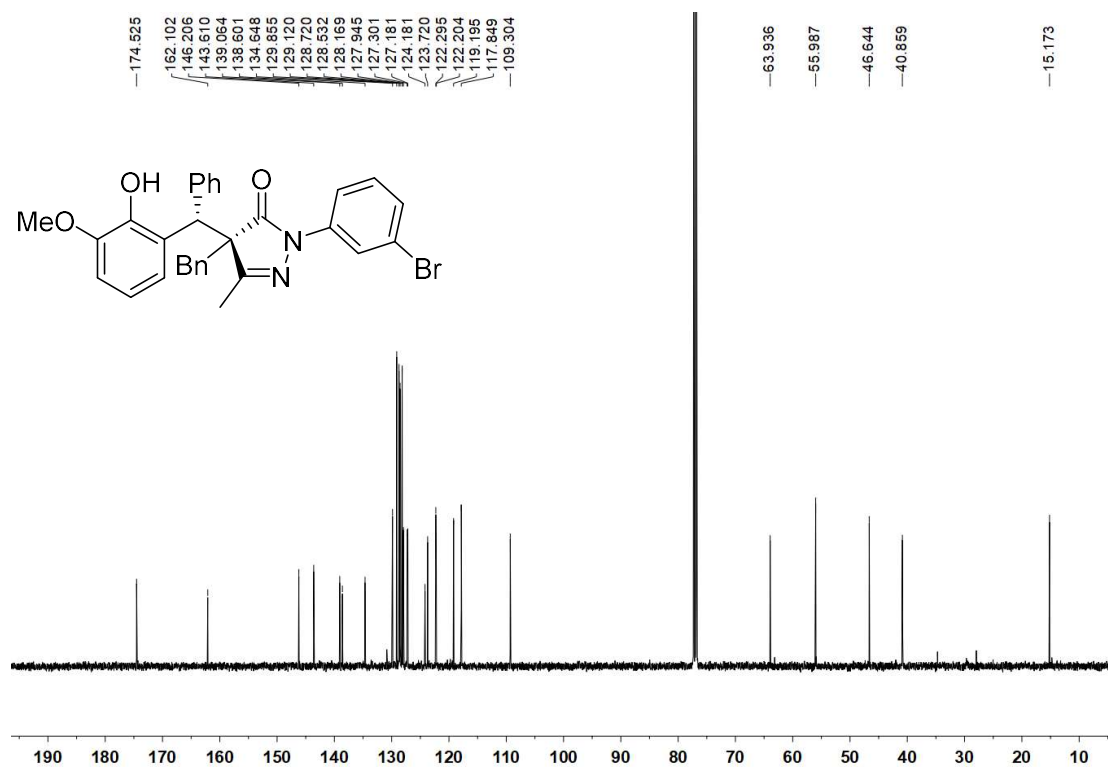
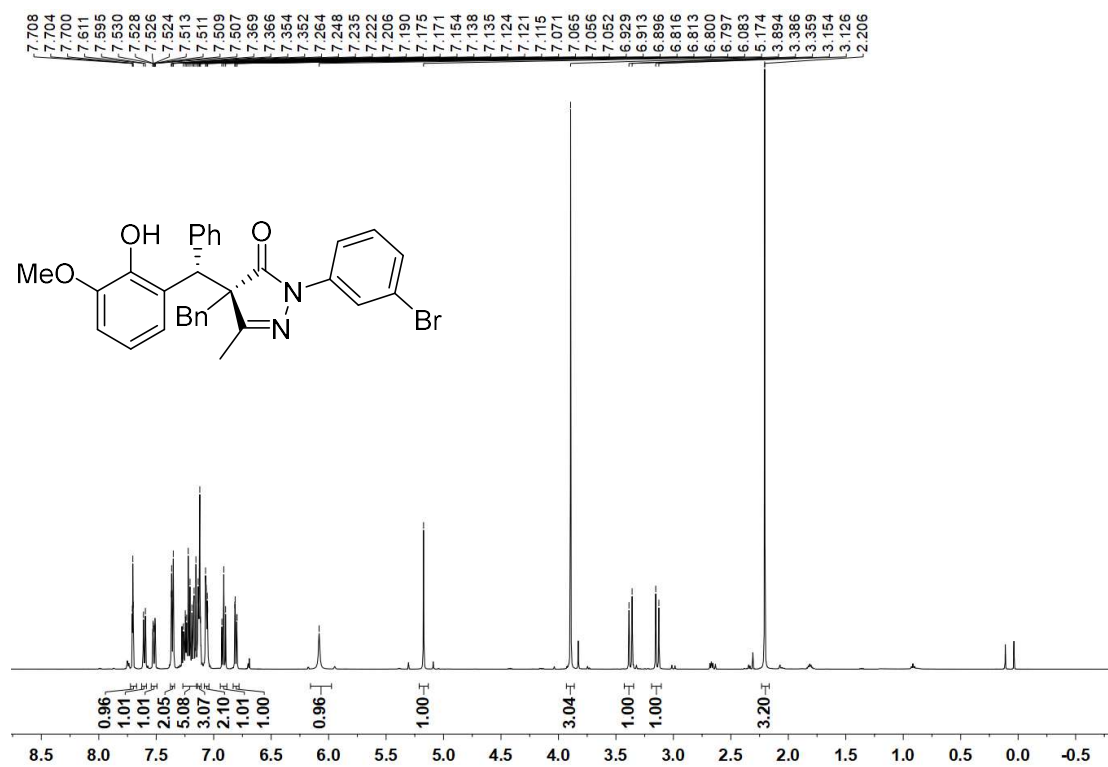




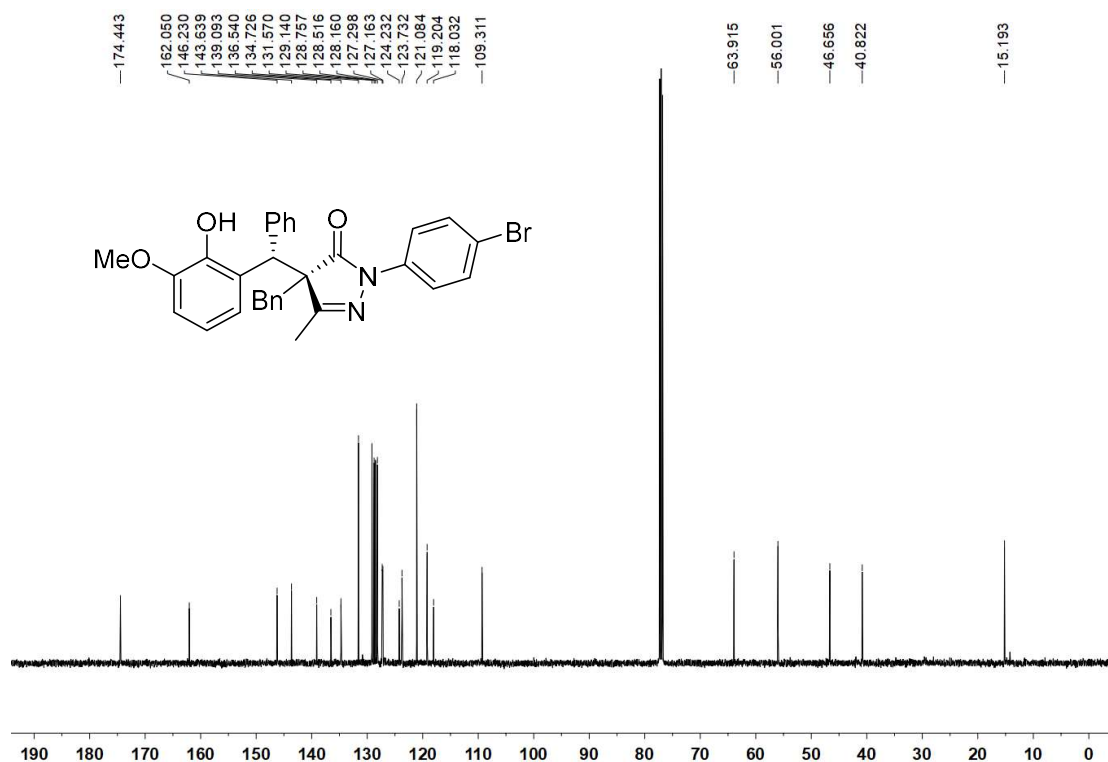
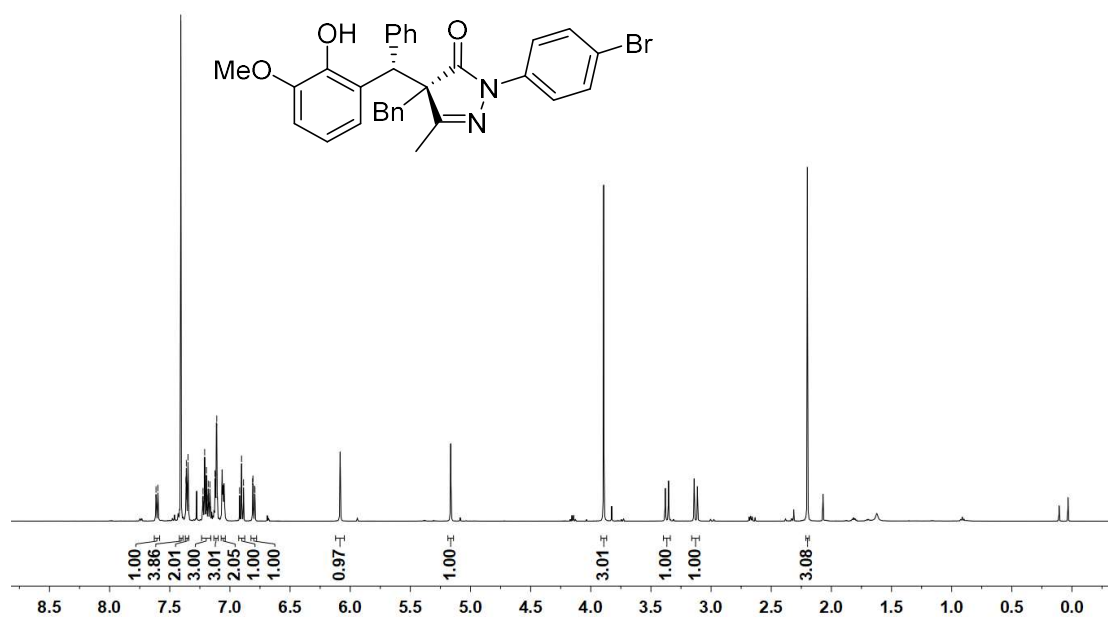


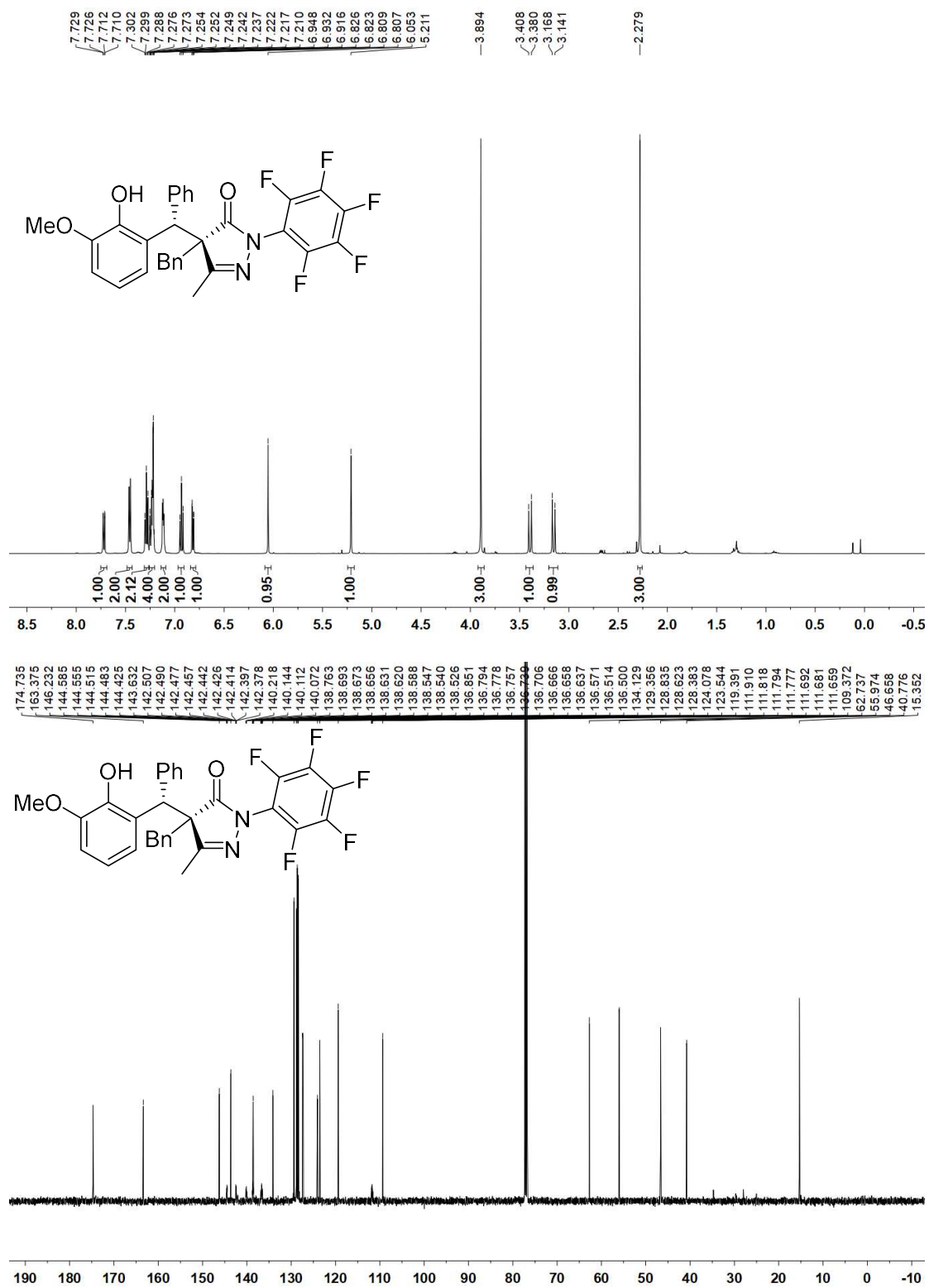


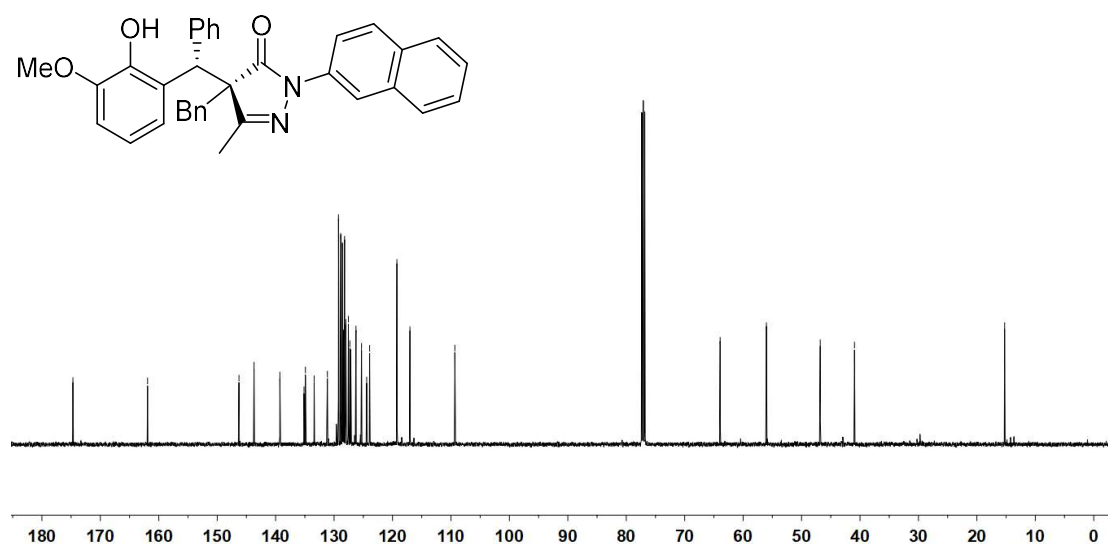
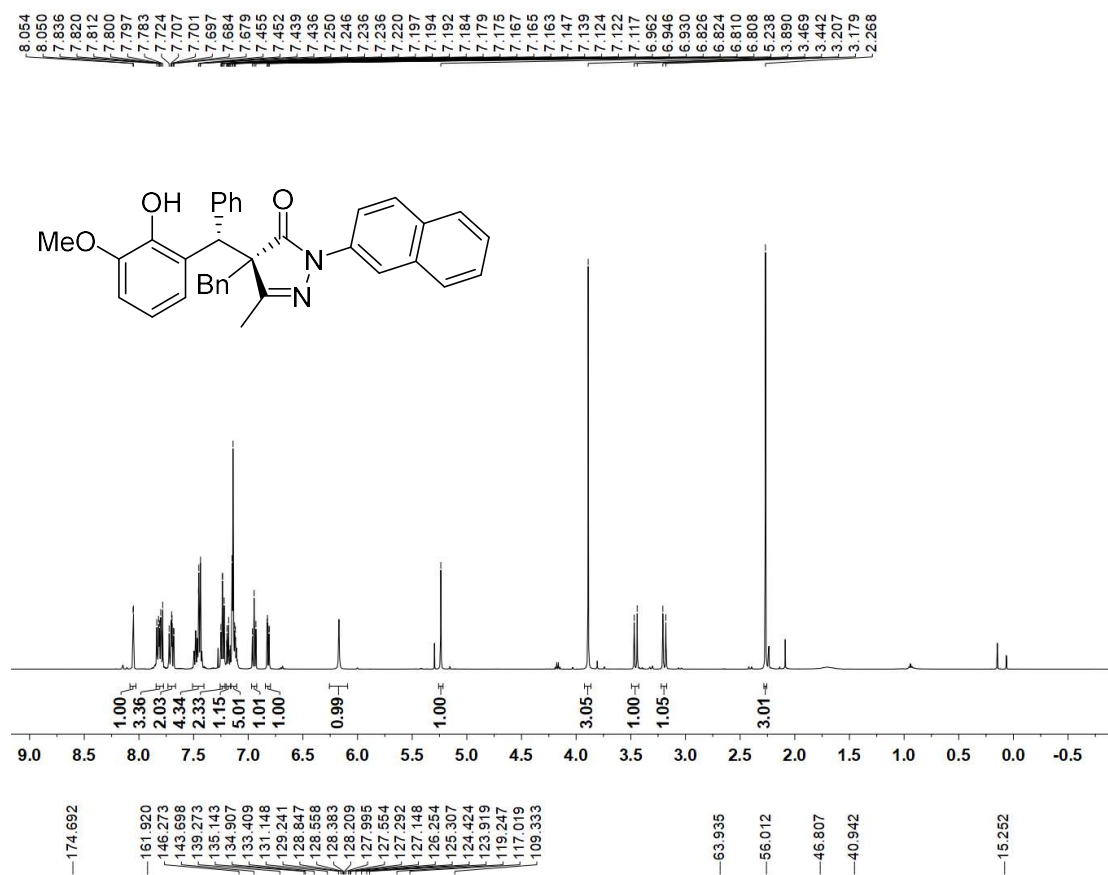


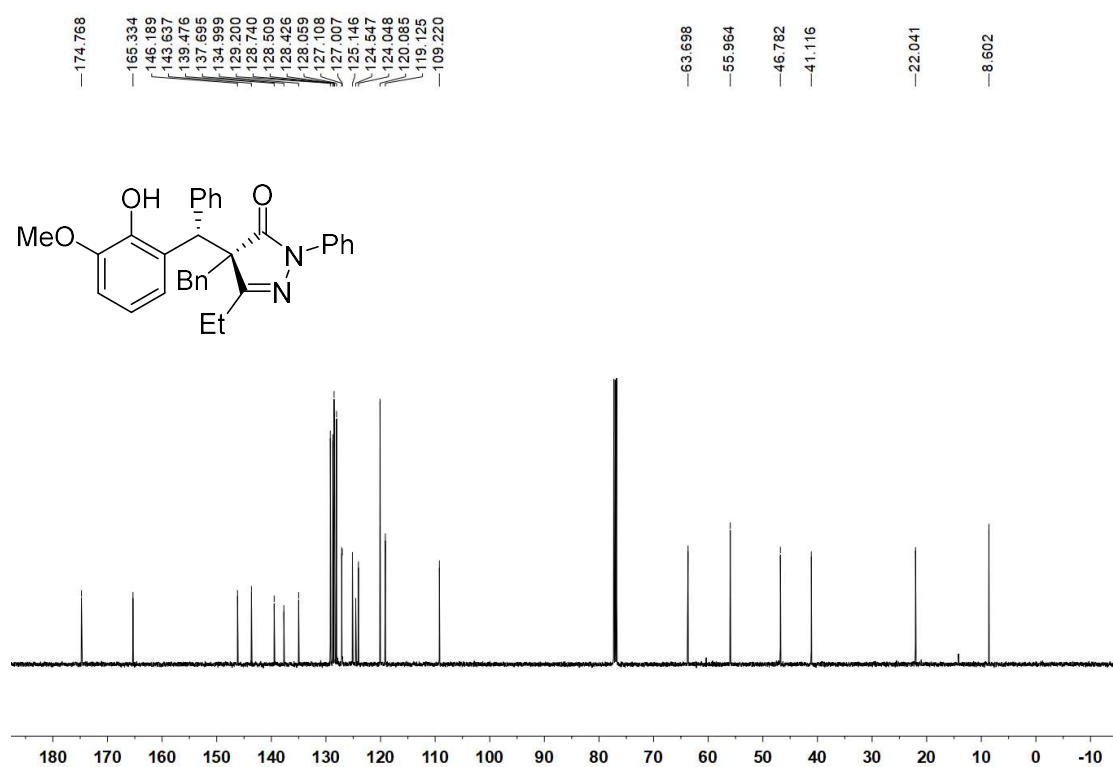
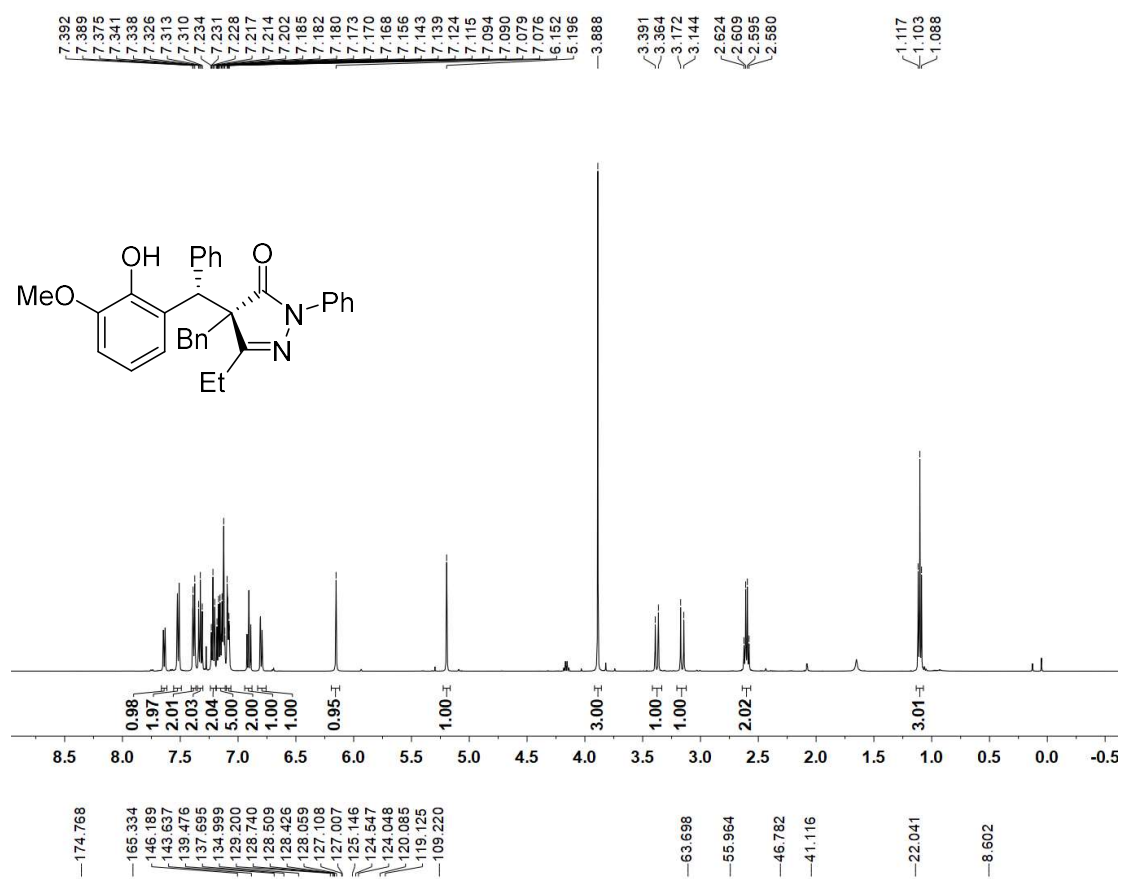


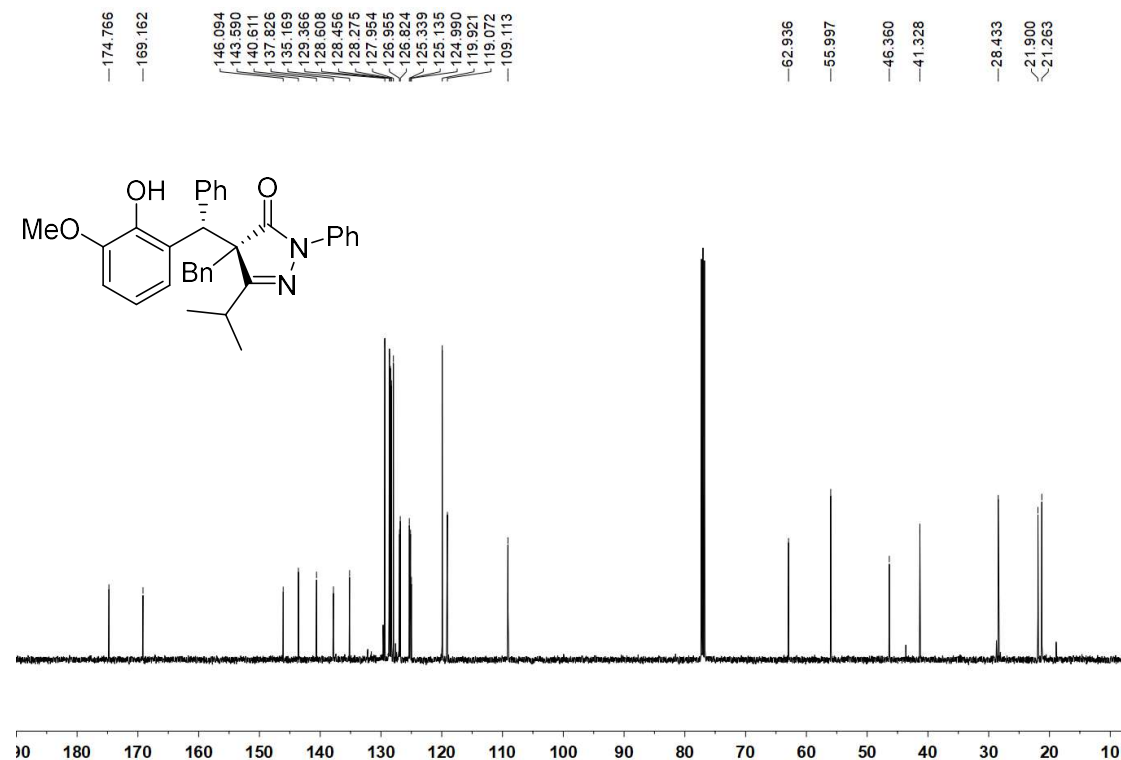
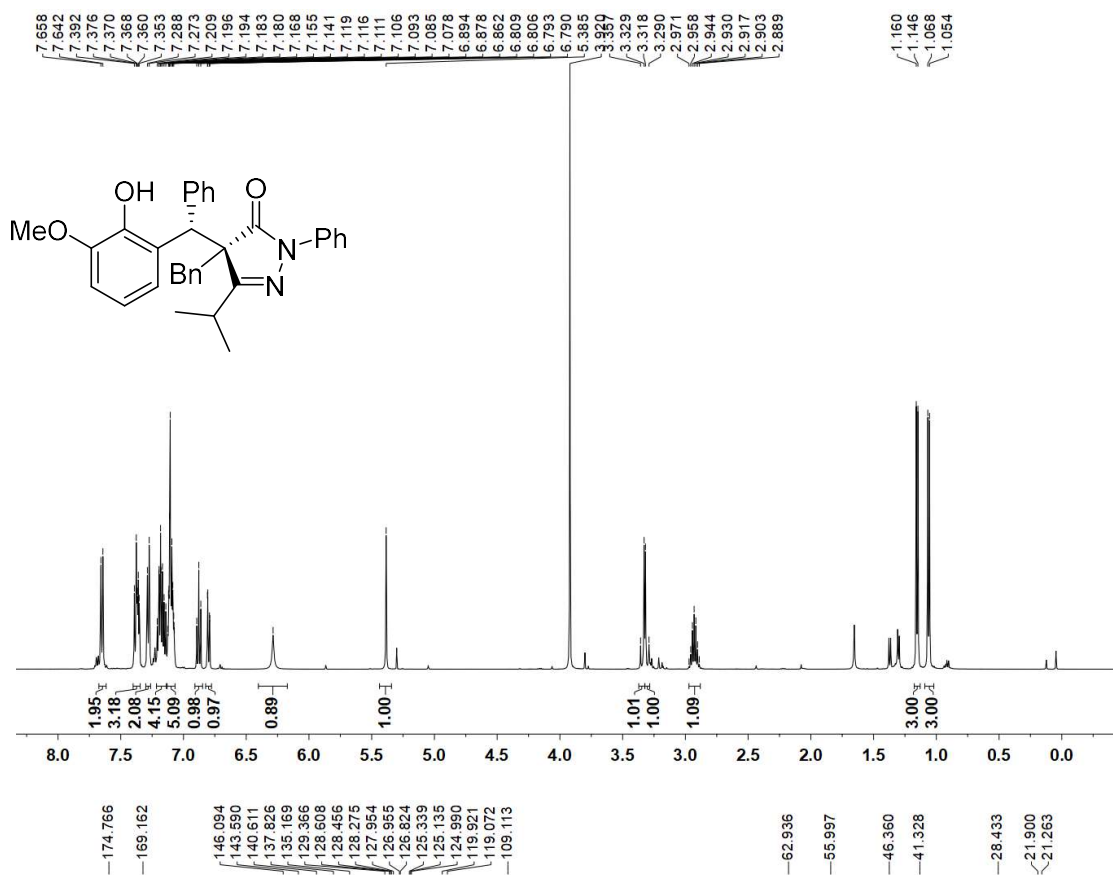
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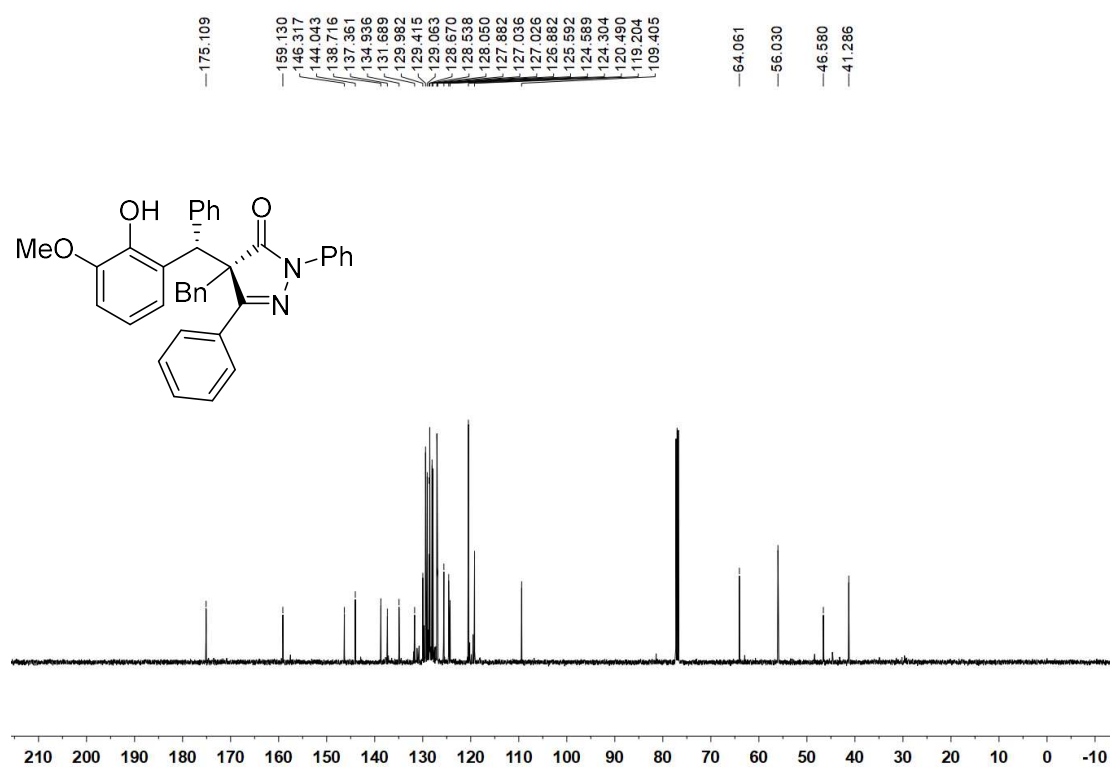
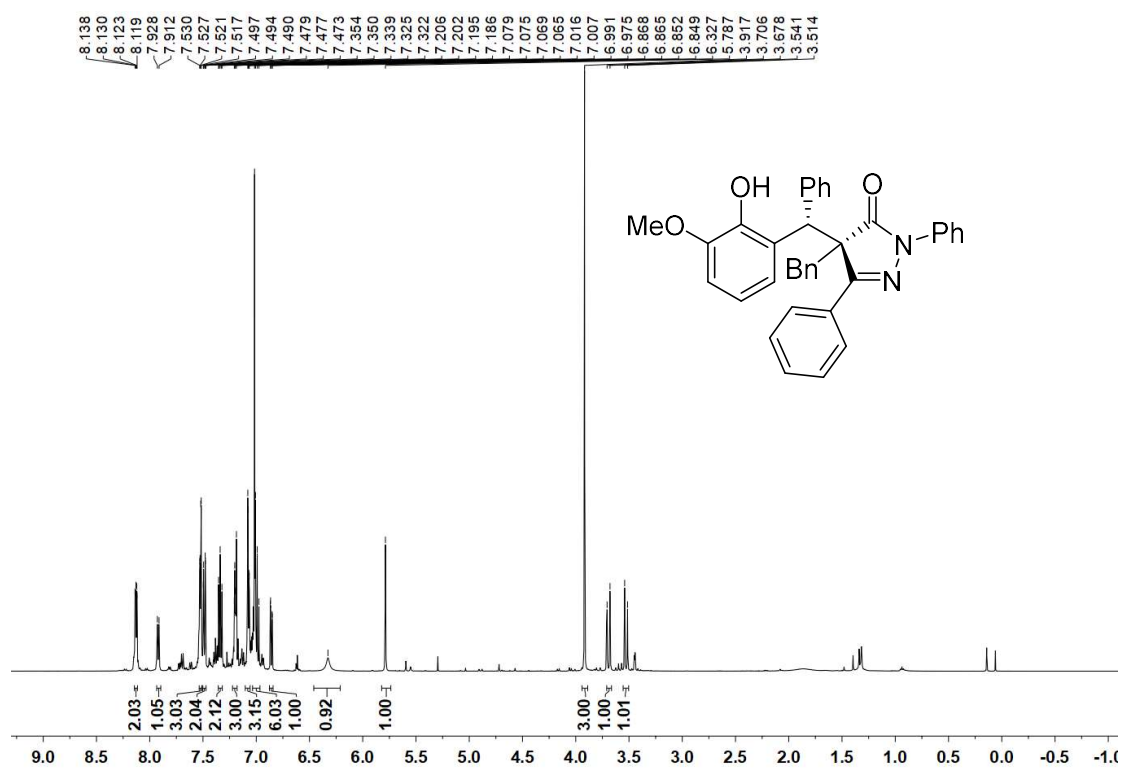


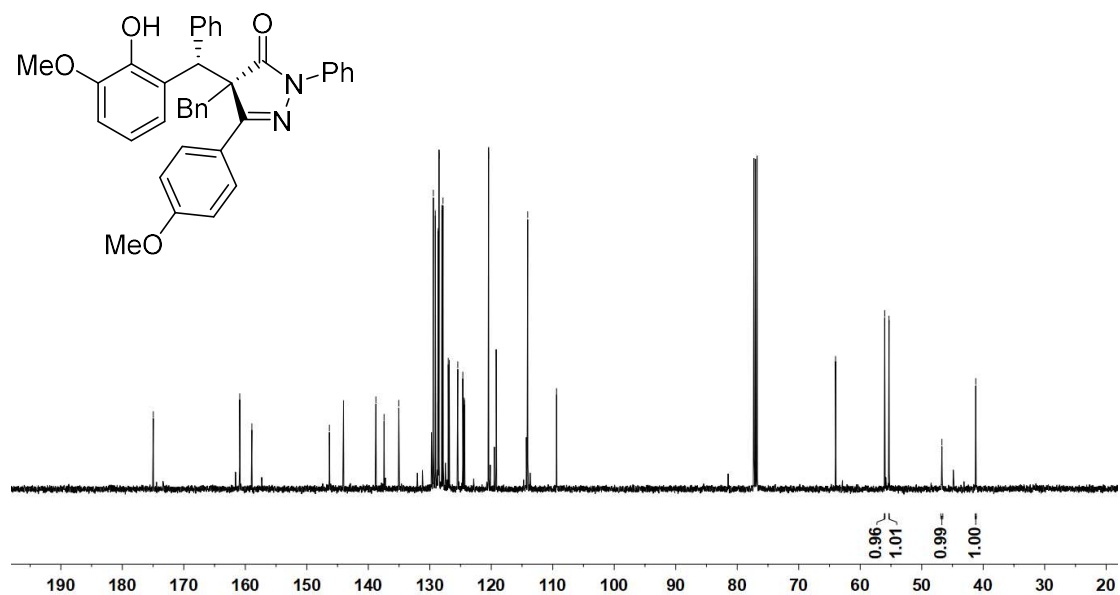
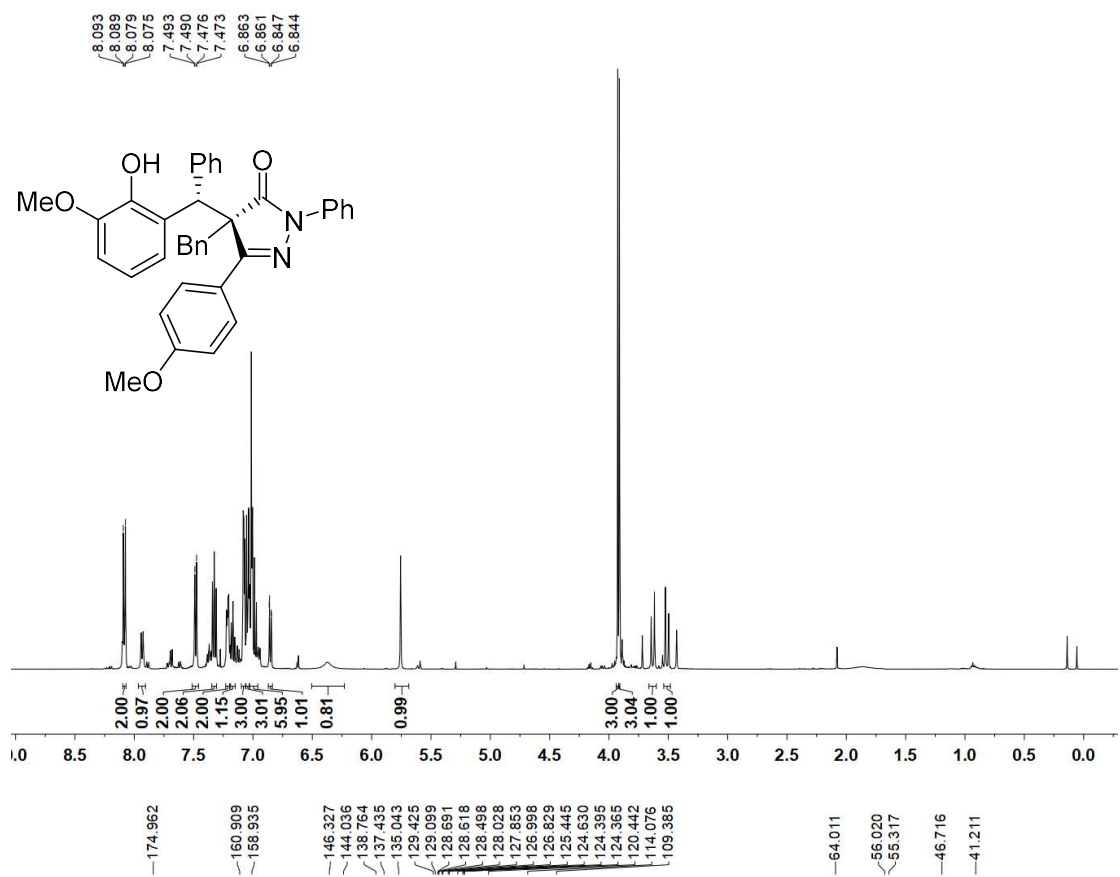


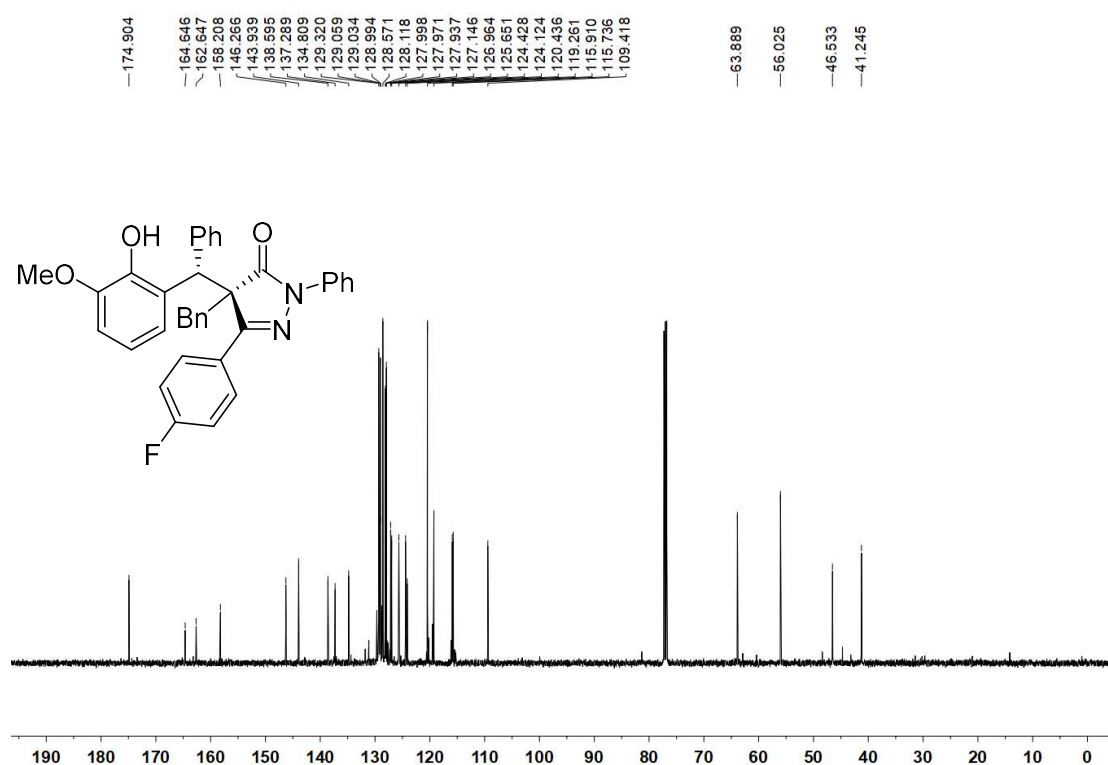
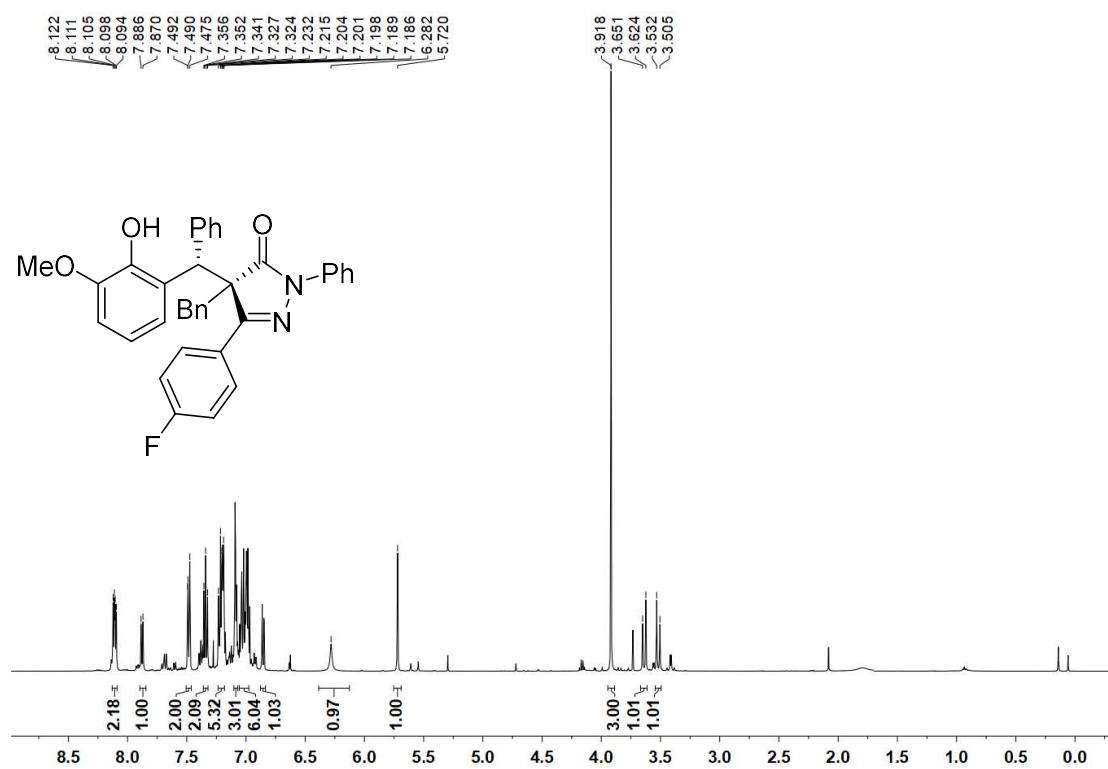


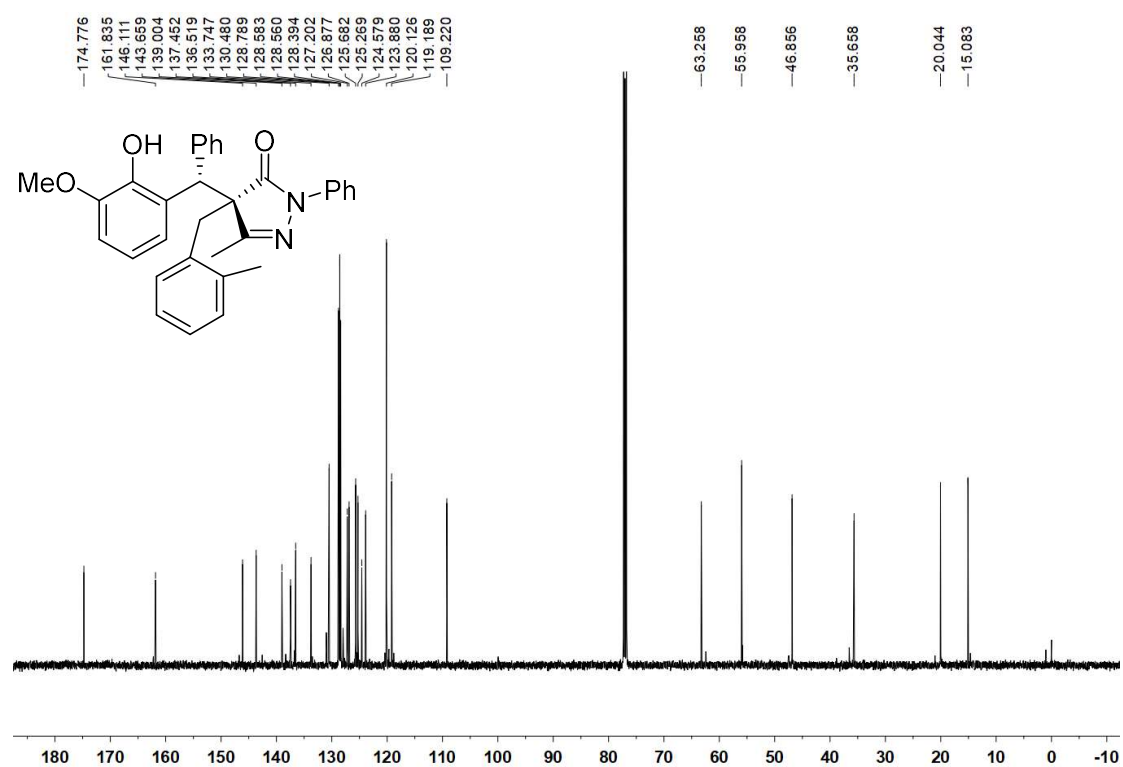
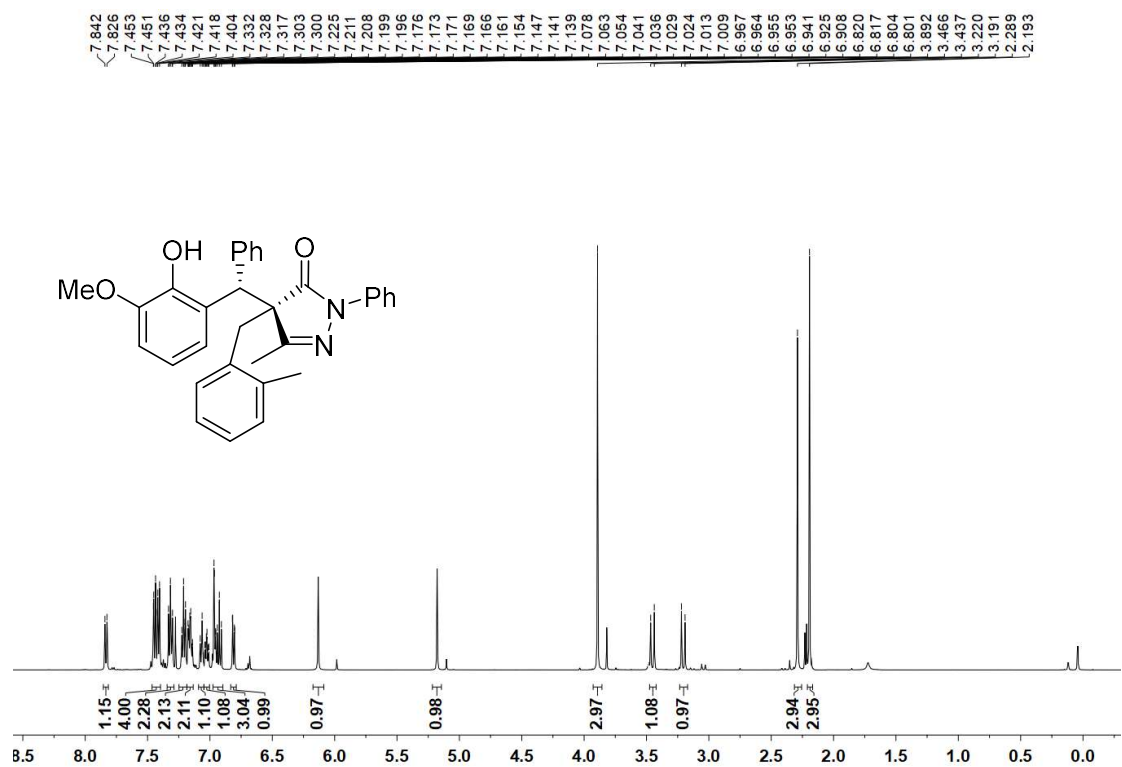


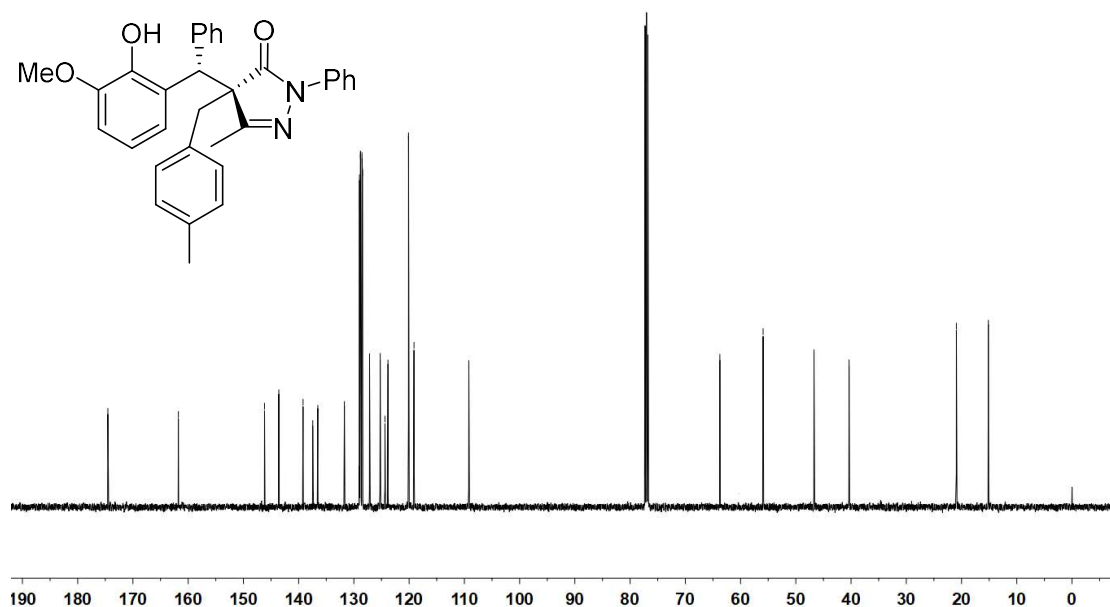
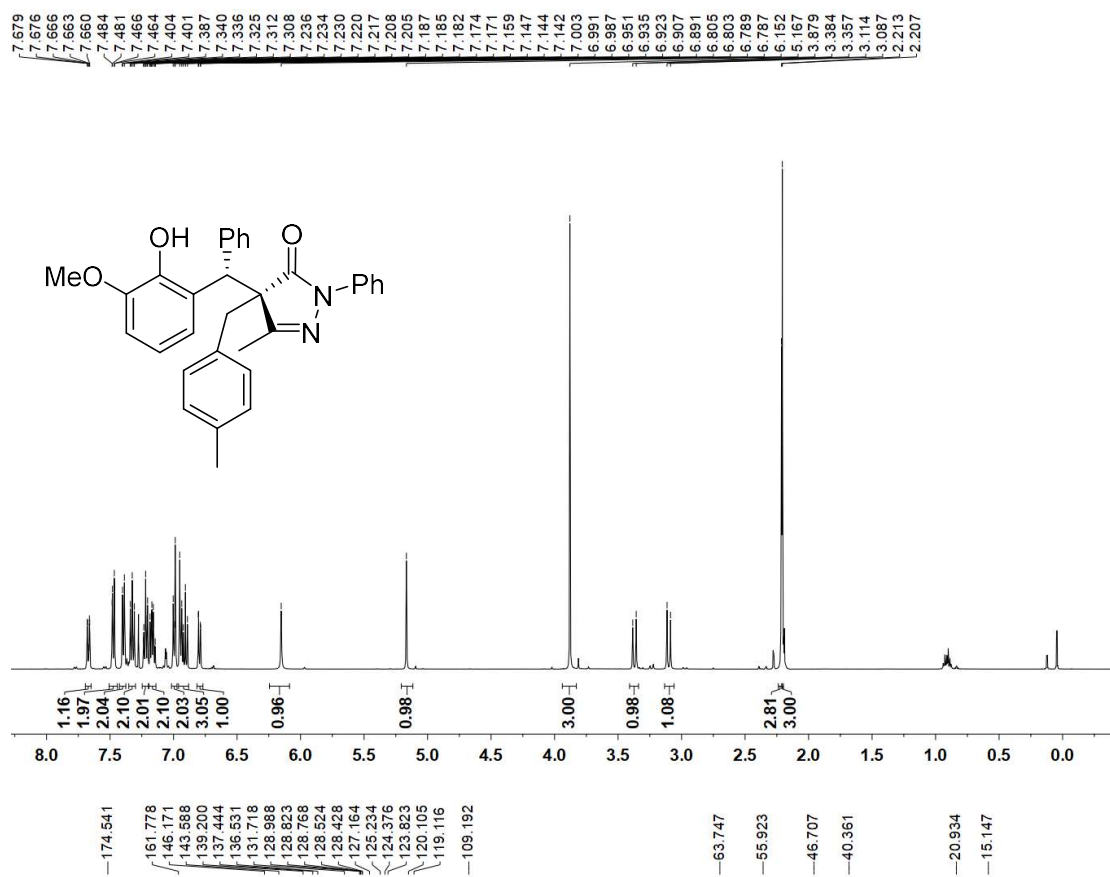


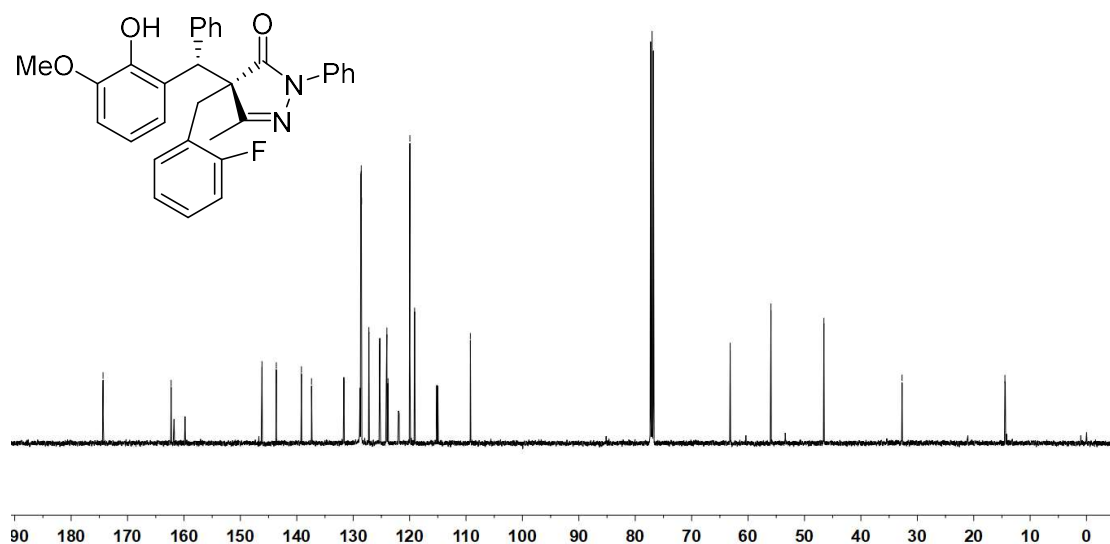
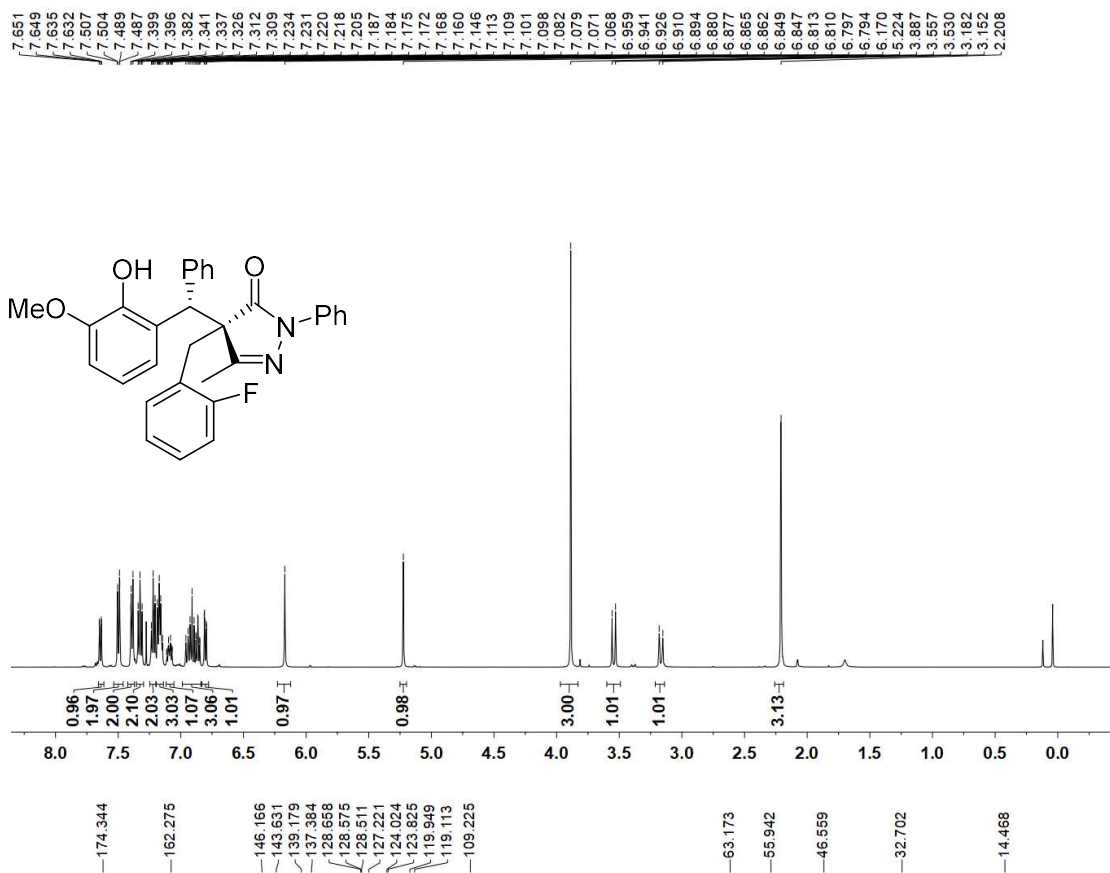


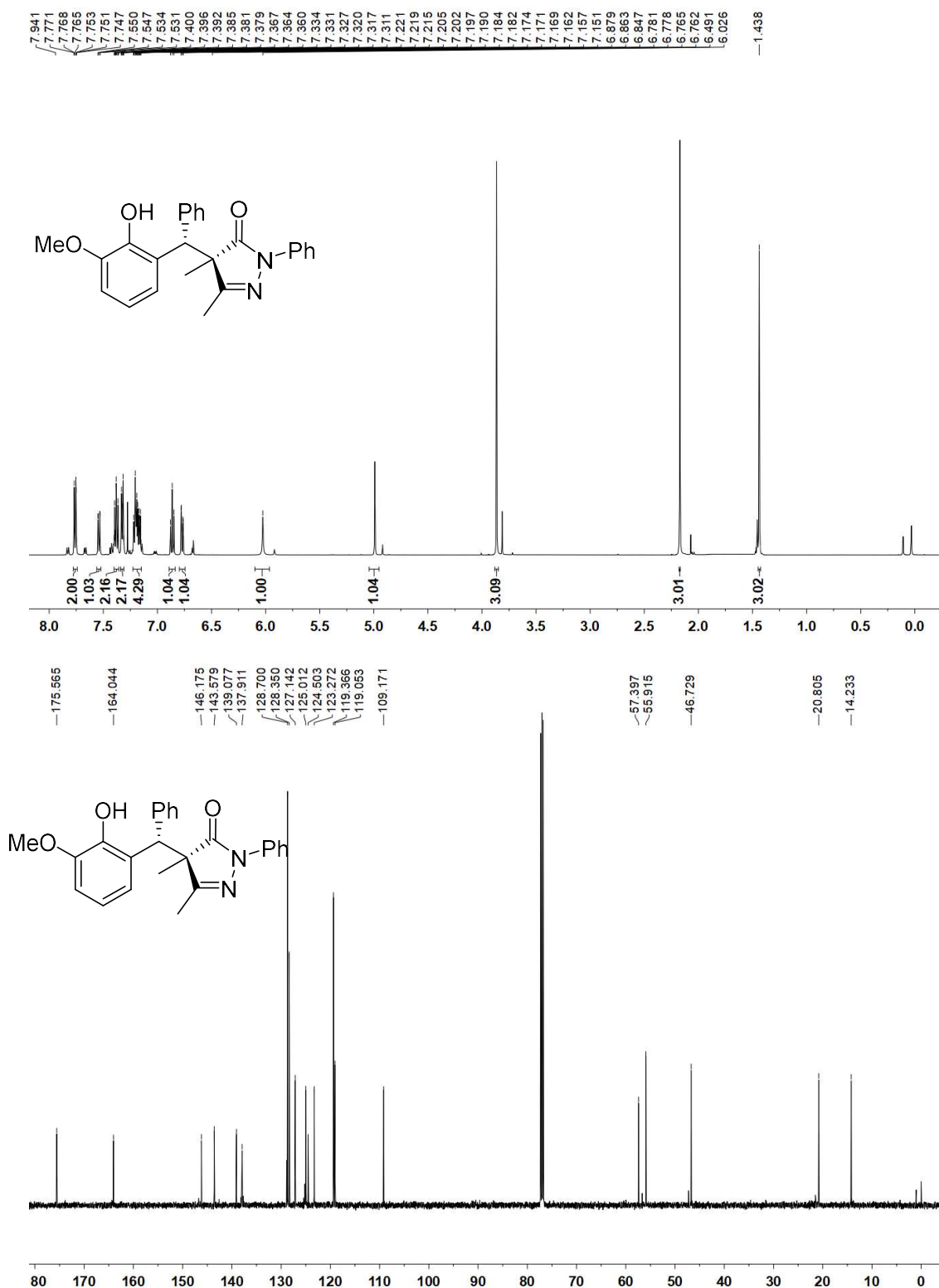


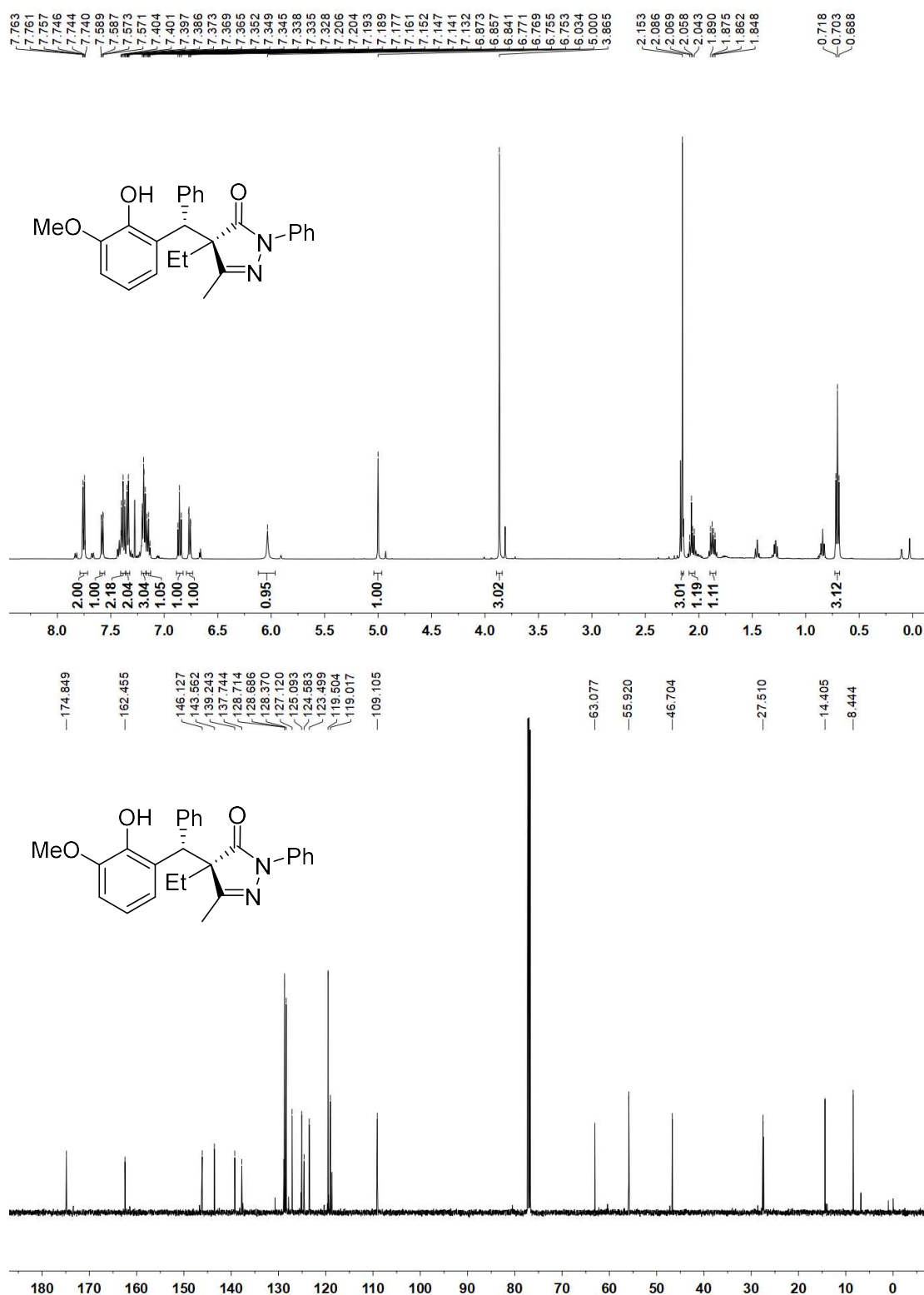






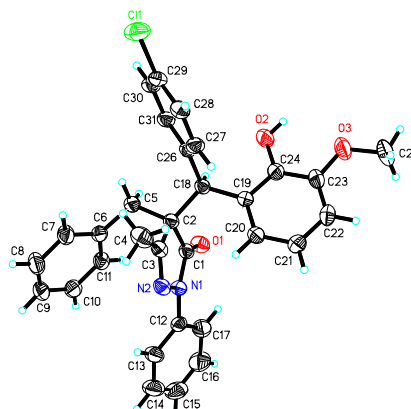
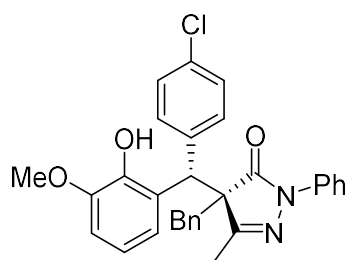






## 6. Crystal data and structure refinement for enantiopure **3ra**.

Crystals of enantiopure **3ra** suitable for X-ray analysis were obtained from crystallization in a solution of ethyl acetate and n-hexan



CCDC deposition number	1875350	
Empirical formula	C <sub>31</sub> H <sub>27</sub> Cl N <sub>2</sub> O <sub>3</sub>	
Formula weight	529.01	
Temperature	296(2) K	
Wavelength	0.71073 Å	
Crystal system	Orthorhombic	
Space group	P 21 21 21	
Unit cell dimensions	a = 9.0064(3) Å	α = 90°.
	b = 9.7885(3) Å	β = 90°.
	c = 30.9078(11) Å	γ = 90°.
Volume	2724.80(16) Å <sup>3</sup>	
Z	4	
Density (calculated)	1.290 Mg/m <sup>3</sup>	
Absorption coefficient	0.179 mm <sup>-1</sup>	
F(000)	1112	
Crystal size	0.200 x 0.170 x 0.140 mm <sup>3</sup>	
Theta range for data collection	2.182 to 25.996°.	
Index ranges	-11 ≤ h ≤ 10, -12 ≤ k ≤ 10, -34 ≤ l ≤ 38	
Reflections collected	13582	
Independent reflections	5302 [R(int) = 0.0320]	
Completeness to theta = 25.242°	99.0 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.7456 and 0.6367	
Refinement method	Full-matrix least-squares on F <sup>2</sup>	
Data / restraints / parameters	5302 / 0 / 347	
Goodness-of-fit on F <sup>2</sup>	1.083	
Final R indices [I > 2σ(I)]	R1 = 0.0448, wR2 = 0.1069	
R indices (all data)	R1 = 0.0615, wR2 = 0.1185	
Absolute structure parameter	0.02(3)	
Extinction coefficient	0.030(5)	
Largest diff. peak and hole	0.202 and -0.242 e.Å <sup>-3</sup>	