Electronic Supplementary Material (ESI) for RSC Advances

Pot, Atom and Step Economy Synthesis: A Diversity-Oriented Approach to Construct 2-substituted Pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-ones

Haoyue Xiang, Yanhong Chen, Qian He, Yuyuan Xie and Chunhao Yang*

[a]State Key Laboratory of Drug Research, Shanghai Insitute of Materia Medica, Chinese Academy of Sciences, 555 Zuchongzhi Road, Shanghai, 201203,China. Fax: 86-21-50806770; Tel: 86-21-50806770; E-mail: chyang@mail.shcnc.ac.cn.

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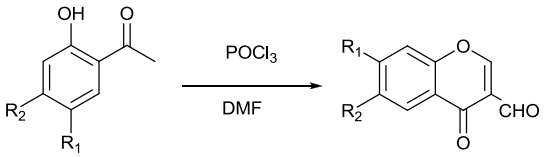
1. Experimental procedures

General information

Unless otherwise noted, all solvents and other reagents are commercially available and used without further purification. ^{1}H and ^{13}C NMR spectra were recorded on Varian Mercury-300/400 and Varian Mercury-400/500 spectrometers. MS and HRMS spectra were performed on a Finnigan MAT 95 spectrometer. Melting points were measured by Büchi 510 melting point apparatus without further corrected.

Preparation of the starting material substituted 3-formyl-4-chromenones[1]



Dimethylformamide (6.0 mL) was cooled in ice-cold water and 2-hydroxy acetophenone (0.01 mmol) was added to this with vigorous stirring; phosphorus oxychloride (2.0 mL) was slowly added into the solution. The pink colour thick mass was kept overnight at room temperature. The mixture was then decomposed by cold water and extracted by EtOAc (3×100 mL). Concentrated under reduced pressure, the crude product was further purified by column chromatography (PE: EtOAc 10:1).

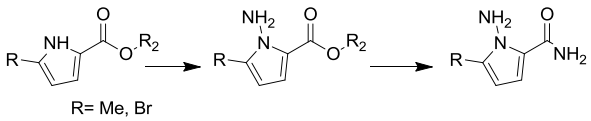
6-Methyl-4-oxo-4*H*-chromene-3-carbaldehyde (B2)

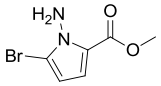
Yellow solid (64%). Mp 164-166 ℃. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 10.38 (s, 1H), 8.52 (s, 1H), 8.07 (s, 1H), 7.55 (d, 1H, *J* = 8.6 Hz), 7.42 (d, 1H, *J* = 8.6 Hz), 2.48 (s, 3H). IR (KBr) 3082, 2856, 1695, 1655, 1616, 1485, 949, 891, 825, 773, 545 486 cm^{-1}.

6-Chloro-4-oxo-4*H*-chromene-3-carbaldehyde (B3)

Yellow solid (89%). Mp 94-96 ℃. ^{1}H NMR (300 MHz, $CDCl_3$) δ = 10.36 (s, 1H), 8.54 (s, 1H), 8.25 (d, 1H, *J* = 2.6 Hz), 7.70 (dd, 1H, *J* = 8.9, 2.6 Hz), 7.51 (d, 1H, *J* = 8.9 Hz). IR (KBr) 3074, 2977, 2881, 1651, 1623, 1604, 1568, 1463, 1443, 1388, 1338, 1307, 1089, 1049, 997, 923, 842, 636, 543 cm^{-1}.

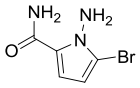
Preparation of the starting material compound A





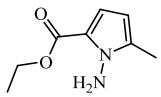
Methyl 1-amino-5-bromo-1*H*-pyrrole-2-carboxylate

Preparation according to the literature (WO2007/150001 A1, 2007), K_2CO_3 was used here to instead of NaOH. Yellow oil.^{1}H NMR (400 MHz, $CDCl_3$) δ 6.82 (d, *J* = 4.5 Hz, 1H), 6.11 (d, J = 4.5 Hz, 1H), 5.65 (s, 2H), 3.82 (s, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ 161.40, 120.73, 115.54, 111.26, 108.62, 51.36.

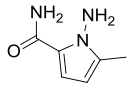


1-Amino-5-bromo-1*H*-pyrrole-2-carboxamide (A2)

Ammonolysis from methyl 1-amino-5-bromo-1*H*-pyrrole-2-carboxylate using NH_3 in MeOH at 100 ℃. Yellow solid. Mp 152-153 ℃.^{1}H NMR (400 MHz, DMSO-*d6*) δ 8.06 (br s, 1H), 7.26 (br s, 1H), 6.75 (d, *J* = 4.5 Hz, 1H), 6.57 (br s, 2H), 6.13 (d, *J* = 4.5 Hz, 1H). ^{13}C NMR (101 MHz, DMSO-*d6*) δ 162.51, 124.90, 111.69, 108.34, 107.59. m/z (EI): 205[M^+, Br^{81}, 46%], 447[M^+, Br^{79}, 49%], 188 (Br^{81}, 100%), 186 (Br^{79}, 98%), 79 (38%). calcd for $C_5H_6BrN_3O$, 202.9694;found; 202.9678 [M^+, Br^{79}].



Ethyl 1-amino-5-methyl-1*H*-pyrrole-2-carboxylate
Preparation according to the literature.[2] Yellow oil. ^{1}H NMR (300 MHz, $CDCl_3$) δ 6.77 (d, *J* = 4.2 Hz, 1H), 5.80 (dd, *J* = 4.2 Hz, 1H), 5.36 (s, 2H), 4.27 (q, *J* = 7.1 Hz, 2H), 1.34 (t, *J* = 7.1 Hz, 3H).

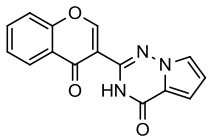


1-Amino-5-methyl-1*H*-pyrrole-2-carboxamide (A3)
Ammonolysis according to the literature from ethyl 1-amino-5-methyl-1H-pyrrole-2-carboxylate.[3] Yellow solid. Mp 170-171 ℃.^{1}H NMR (400 MHz, DMSO-*d6*) δ 7.93 (br s, 1H), 6.97 (br s, 1H), 6.58 (d, *J* = 4.4 Hz, 1H), 6.38 (br s, 2H), 5.72 (d, *J* = 4.4 Hz, 1H), 2.15 (s, 3H). ^{13}C NMR (101 MHz, DMSO-*d6*) δ 163.61, 133.14, 122.45, 110.43, 103.77, 11.66. *m/z* (EI):139 [M^+, 92%], 122 (100%), 94 (28%).calcd for $C_6H_9N_3O$, 139.0746;found, 139.0746 [M^+].

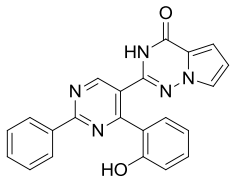
Typical procedure for synthesis of compound D1-40

A mixture of **A** (0.4mmol), **B** (0.4mmol), and $CuCl_2 \cdot H_2O$ (0.4mmol) in DMSO (5mL) was kept in the pre-heated 120 ℃ oil bath for 2h under air atmosphere. After the starting materials converted to the intermediate **C** completely, NaOAc (4 equiv.) and amidines or hydrazines (0.4mmol) were added, and then kept the reaction for another 1h. After the reaction was complete, the reaction was cooled to room temperature, and then diluted by water (40 mL). The mixtures was extracted with EtOAc (3 x 30mL), washed with water and brine, dried over anhydrous Na_2SO_4 and filtered. The solvent was removed under vacuum. The residue was applied on a silica-gel column (using CH_2Cl_2/MeOH=80/1) to afford yellow solid.

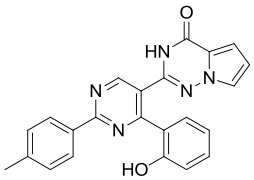
Characterization of the compounds



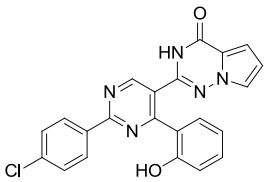
2-(4-Oxo-4*H*-chromen-3-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (C1)
White solid. Mp 282-284 ℃. ^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.79 (s, 1H), 8.93 (s, 1H), 8.16 (d, *J* = 7.9 Hz, 1H), 7.90 (t, *J* = 7.6 Hz, 1H), 7.77 (d, *J* = 8.4 Hz, 1H), 7.65 (s, 0H), 7.59 (t, *J* = 7.7 Hz, 1H), 6.95 (d, *J* = 5.5 Hz, 1H), 6.59 (dd, *J* = 4.3, 2.6 Hz, 1H).^{13}C NMR (126 MHz, DMSO-*d6*) δ 175.07, 158.58, 156.06, 154.39, 142.78, 135.64, 126.99, 125.81, 123.84, 122.00, 119.22, 119.06, 116.79, 111.04, 108.08. *m/z* (EI):279 [M^+, 100%], 108 (60%), 80 (10%).calcd for $C_{15}H_9N_3O_3$, 279.0644;found, 279.0641 [M^+].



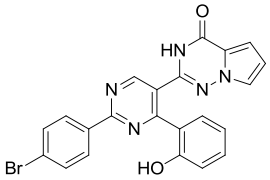
2-(4-(2-Hydroxyphenyl)-2-phenylpyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one(D1)
Yellow solid (71%). Mp 212-214 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.90 (br 1H), 10.06 (br, 1H), 9.09 (s, 1H), 8.50-8.47 (m, 2H), 7.73 (dd, *J* = 7.7, 1.7 Hz, 1H), 7.63 – 7.51 (m, 3H), 7.45 – 7.37 (m, 1H), 7.28 (ddd, *J* = 8.2, 7.3, 1.8 Hz, 1H), 6.99 (td, *J* = 7.5, 1.1 Hz, 1H), 6.93 – 6.84 (m, 1H), 6.75 (dd, *J* = 8.2, 0.9 Hz, 1H), 6.56 – 6.43 (m, 1H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 164.05, 163.09, 158.62, 155.40, 155.30, 146.14, 136.99, 132.29, 132.00, 131.95, 129.37, 128.57, 124.53, 123.76, 121.74, 119.77, 118.99, 115.83, 110.80, 107.68. *m/z* (EI):381 [M^+, 100%], 364 (62%), 109 (26%).calcd for $C_{22}H_{15}N_5O_2$, 381.1226;found, 381.1225 [M^+].



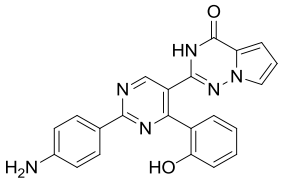
2-(4-(2-Hydroxyphenyl)-2-(p-tolyl)pyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D2)
Yellow solid (71%). Mp 258-260 ℃. ^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.91 (s, 1H), 10.03 (s, 1H), 9.06 (s, 1H), 8.39 (d, *J* = 8.1 Hz, 2H), 7.73 (dd, *J* = 7.6, 1.5 Hz, 1H), 7.46 – 7.34 (m, 3H), 7.29 (t, *J* = 7.6 Hz, 1H), 7.00 (t, *J* = 7.6 Hz, 1H), 6.90 (dd, *J* = 4.3, 1.6 Hz, 1H), 6.75 (d, *J* = 8.1 Hz, 1H), 6.51 (dd, *J* = 4.2, 2.8 Hz, 1H), 2.41 (s, 3H).^{13}C NMR (101 MHz, DMSO-*d6*) δ 163.60, 162.52, 158.05, 154.91, 154.80, 145.69, 141.45, 133.86, 131.77, 131.45, 129.50, 128.09, 124.07, 122.97, 121.25, 119.26, 118.51, 115.34, 110.29, 107.17, 21.09. *m/z* (EI):395 [M $^{+}$, 100%], 378 (71%), 109 (26%).calcd for $C_{23}H_{17}N_5O_2$, 395.1382;found, 395.1381 [M $^{+}$].



2-(2-(4-Chlorophenyl)-4-(2-hydroxyphenyl)pyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D3)
Yellow solid (69%). Mp 268-270 ℃. ^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.93 (s, 1H), 10.00 (s, 1H), 9.09 (s, 1H), 8.49 (d, *J* = 7.9 Hz, 2H), 7.73 (d, *J* = 7.7 Hz, 1H), 7.63 (d, *J* = 7.9 Hz, 2H), 7.43 – 7.37 (m, 1H), 7.28 (t, *J* = 7.8 Hz, 1H), 6.98 (t, *J* = 7.5 Hz, 1H), 6.89 (dd, *J* = 4.3, 1.6 Hz, 1H), 6.74 (d, *J* = 8.2 Hz, 1H), 6.49 (dd, *J* = 4.3, 2.7 Hz, 1H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 163.19, 163.07, 158.70, 155.37, 155.28, 146.04, 136.87, 135.85, 132.31, 132.06, 130.33, 129.49, 124.45, 123.96, 121.75, 119.77, 119.00, 115.81, 110.81, 107.68. *m/z* (EI):417 [M $^{+}$,Cl^{37} 32%], 415 [M $^{+}$,Cl^{35} 100%], 398 (62%), 400 (18%), 109 (46%). calcd for $C_{22}H_{14}ClN_5O_2$, 415.0836;found, 415.0839 [M $^{+}$].

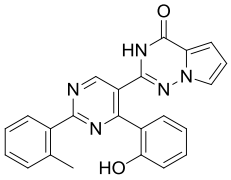


2-(2-(4-Bromophenyl)-4-(2-hydroxyphenyl)pyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D4)
Yellow solid (69%). Mp 279-281 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.95 (s, 1H), 10.02 (s, 1H), 9.11 (s, 1H), 8.43 (d, *J* = 8.5 Hz, 2H), 7.79 (d, *J* = 8.5 Hz, 2H), 7.74 (d, *J* = 6.8 Hz, 1H), 7.43-7.40 (m, 1H), 7.30 (t, *J* = 7.3 Hz, 1H), 7.00 (t, *J* = 7.6 Hz, 1H), 6.91 (d, *J* = 3.0 Hz, 1H), 6.75 (d, *J* = 8.2 Hz, 1H), 6.57 – 6.42 (m, 1H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 163.20, 158.70, 155.36, 155.28, 146.04, 136.20, 132.43, 132.31, 132.06, 130.54, 125.89, 124.44, 124.00, 121.75, 119.77, 119.00, 115.81, 110.81, 107.69. *m/z* (EI):461 [M $^{+}$,Br^{81} 96%], 459 [M $^{+}$,Br^{79} 100%], 444 (51%), 442 (53%), 109 (61%). calcd for $C_{22}H_{14}BrN_5O_2$, 459.0331;found, 459.0331 [M $^{+}$].



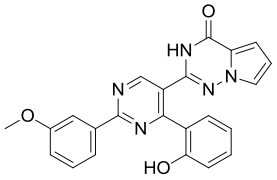
2-(2-(4-Aminophenyl)-4-(2-hydroxyphenyl)pyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D5)
Yellow solid (76%). Mp 265-266℃. ^{1}H NMR (400 MHz, DMSO-*d6*) δ 11.83 (br s, 1H), 10.11 (br s, 1H), 8.90 (s, 1H), 8.19 (d, *J* = 8.3 Hz, 2H), 7.66 (d, *J* = 7.7 Hz, 1H), 7.42 (s, 1H), 7.26 (d, *J* = 7.6 Hz, 1H), 6.98 (d, *J* = 7.5 Hz, 1H), 6.92 – 6.72 (m, 2H), 6.67 (d, *J* = 7.6 Hz, 2H), 6.51 (s, 1H), 5.86 (br s, 2H).^{13}C NMR (126 MHz, DMSO-*d6*) δ

164.55, 162.58, 158.20, 155.53, 155.28, 152.76, 146.45, 132.02, 131.69, 130.27, 124.60, 123.82, 121.63, 121.47, 119.60, 118.93, 115.87, 113.82, 110.67, 107.53. *m/z* (EI):396 [M $^+$, 100%], 379 (82%), 109 (36%). calcd for $C_{22}H_{16}N_6O_2$, 396.1335;found, 396.1334 [M $^+$].



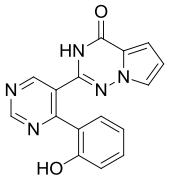
2-(4-(2-Hydroxyphenyl)-2-(o-tolyl)pyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D6)

Yellow solid (76%). Mp 270-272 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.96 (br s, 1H), 10.07 (br s, 1H), 9.12 (s, 1H), 7.96 (dd, *J* = 8.0, 1.7 Hz, 1H), 7.69 (dd, *J* = 7.8, 1.8 Hz, 1H), 7.48 – 7.32 (m, 4H), 7.27 (ddd, *J* = 8.3, 7.3, 1.8 Hz, 1H), 6.97 (td, *J* = 7.5, 1.0 Hz, 1H), 6.91 (dd, *J* = 4.3, 1.6 Hz, 1H), 6.76 (dd, *J* = 8.2, 1.0 Hz, 1H), 6.52 (dd, *J* = 4.3, 2.7 Hz, 1H), 2.61 (s, 3H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 167.05 (s), 162.58 (s), 158.13 (s), 155.38 (s), 155.28 (s), 146.16 (s), 137.65 (s), 137.57 (s), 132.16 (s), 131.94 (s), 131.85 (s), 131.06 (s), 130.38 (s), 126.47 (s), 124.42 (s), 122.99 (s), 121.71 (s), 119.73 (s), 118.99 (s), 115.86 (s), 110.81 (s), 107.68 (s), 21.74 (s). m/z (EI): 395 [100%], 302 (12%), 286 (14%). calcd for $C_{23}H_{17}N_5O_2$, 395.1382;found, 395.1387 [M $^+$].



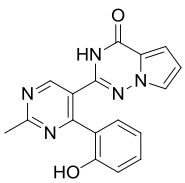
2-(4-(2-Hydroxyphenyl)-2-(3-methoxyphenyl)pyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D7)

Yellow solid (81%). Mp 210-212 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.94 (s, 1H), 10.03 (s, 1H), 9.08 (s, 1H), 8.08 (d, *J* = 7.6 Hz, 1H), 8.00 (s, 1H), 7.73 (d, *J* = 7.4 Hz, 1H), 7.49 (t, *J* = 7.9 Hz, 1H), 7.40 (s, 1H), 7.28 (t, *J* = 7.7 Hz, 1H), 7.16 (d, *J* = 7.6 Hz, 1H), 6.99 (t, *J* = 7.5 Hz, 1H), 6.89 (d, *J* = 4.1 Hz, 1H), 6.74 (d, *J* = 8.3 Hz, 1H), 6.50 (t, *J* = 3.4 Hz, 1H), 3.85 (s, 3H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 163.78, 163.03, 160.13, 158.57, 155.40, 155.27, 146.10, 138.44, 132.26, 131.99, 130.51, 124.49, 123.84, 121.74, 120.99, 119.79, 118.99, 117.75, 115.82, 113.41, 110.79, 107.66, 55.72. *m/z* (EI): 411 [M $^+$, 100%], 394 (62%), 109 (28%).calcd for $C_{23}H_{17}N_5O_3$, 411.1331;found, 411.1337.

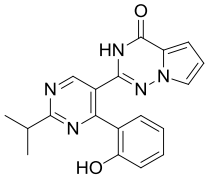


2-(4-(2-Hydroxyphenyl)pyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D8)

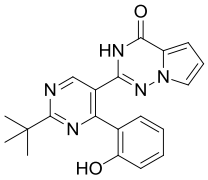
Yellow solid (71%). Mp 276-278 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.93 (br s, 1H), 10.05 (br s, 1H), 9.34 (s, 1H), 9.00 (s, 1H), 7.58 (d, *J* = 7.5 Hz, 1H), 7.39 (s, 1H), 7.25 (t, *J* = 7.4 Hz, 1H), 6.92 (t, *J* = 7.5 Hz, 1H), 6.89 (d, *J* = 3.3 Hz, 1H), 6.72 (d, *J* = 8.2 Hz, 1H), 6.49 (t, *J* = 3.0 Hz, 1H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 162.61, 159.37, 157.96, 155.35, 155.23, 145.94, 132.07, 132.01, 125.73, 124.03, 121.75, 119.66, 118.98, 115.86, 110.81, 107.68. *m/z* (EI):305 [M $^+$, 100%], 287 (84%), 109 (62%), 108 (40%).calcd for $C_{16}H_{11}N_5O_2$, 305.0913;found, 305.0914 [M $^+$].



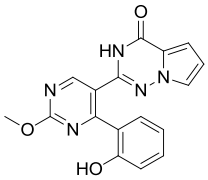
2-(4-(2-Hydroxyphenyl)-2-methylpyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D9)
Yellow solid (67%). Mp 236-238 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.84 (s, 1H), 10.04 (s, 1H), 8.87 (s, 1H), 7.54 (dd, *J* = 7.7, 1.7 Hz, 1H), 7.43 – 7.33 (m, 1H), 7.23 (td, *J* = 7.3, 1.8 Hz, 1H), 6.98 – 6.80 (m, 2H), 6.71 (d, *J* = 8.2 Hz, 1H), 6.49-6.47 (m, 1H), 2.72 (s, 3H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 168.53, 162.64, 158.06, 155.41, 155.26, 146.18, 132.02, 131.83, 124.07, 122.87, 121.70, 119.55, 118.93, 115.87, 110.74, 107.61, 26.23. *m/z* (EI):417 [M $^{+}$,Cl^{37} 32%], 319 (100%) , 302 (62%) , 109 (42%).calcd for $C_{17}H_{13}N_5O_2$, 319.1069;found, 319.1071 [M $^{+}$].



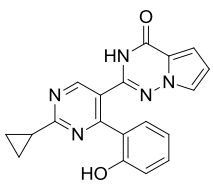
2-(4-(2-Hydroxyphenyl)-2-isopropylpyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D10)
Yellow solid (78%). Mp 190-192 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.85 (s, 1H), 10.12 (s, 1H), 8.92 (s, 1H), 7.57 (d, *J* = 7.6 Hz, 1H), 7.50 – 7.31 (m, 1H), 7.24 (t, *J* = 7.8 Hz, 1H), 6.92 (t, *J* = 7.5 Hz, 1H), 6.89 – 6.84 (m, 1H), 6.72 (d, *J* = 8.2 Hz, 1H), 6.52 – 6.44 (m, 1H), 3.26 - 3.19 (m, *J* = 14.2, 7.2 Hz, 1H), 1.34 (d, *J* = 6.9 Hz, 6H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 175.37, 162.53, 158.20, 155.52, 155.23, 146.22, 132.05, 131.87, 124.17, 123.01, 121.69, 119.64, 118.97, 115.91, 110.74, 107.62, 37.44, 22.03. *m/z* (EI):347 [M $^{+}$, 100%], 330 (65%), 109 (34%). calcd for $C_{19}H_{17}N_5O_2$, 347.1382;found, 347.1380 [M $^{+}$].



2-(2-(tert-Butyl)-4-(2-hydroxyphenyl)pyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D11)
Yellow solid (75%). Mp 136-138 ℃. ^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.84 (br s, 1H), 10.22 (br s, 1H), 8.95 (s, 1H), 7.59 (dd, *J* = 7.7, 1.7 Hz, 1H), 7.39 (dd, *J* = 2.4, 1.9 Hz, 1H), 7.31 – 7.20 (m, 1H), 6.94 (t, *J* = 7.5 Hz, 1H), 6.89 (dd, *J* = 4.3, 1.6 Hz, 1H), 6.74 (d, *J* = 8.2 Hz, 1H), 6.50 (dd, *J* = 4.3, 2.7 Hz, 1H), 1.43 (s, 9H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 177.16, 162.06, 158.00, 155.64, 155.25, 146.30, 132.03, 131.90, 124.22, 122.56, 121.68, 119.70, 118.98, 115.98, 110.73, 107.62, 29.85. *m/z* (EI):361 [M $^{+}$, 100%], 344 (54%), 109 (18%).calcd for $C_{20}H_{19}N_5O_2$, 361.1539;found, 361.1532 [M $^{+}$].

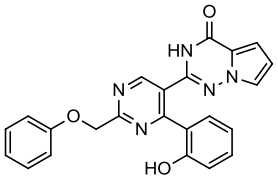


2-(4-(2-Hydroxyphenyl)-2-methoxypyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D12)
Yellow solid (75%). Mp 216-218 ℃. ^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.80 (s, 1H), 9.97 (s, 1H), 8.79 (s, 1H), 7.61 – 7.50 (m, 1H), 7.35 dd, *J* = 7.5, 1.5 Hz 1H), 7.23 (td, *J* = 7.7, 1.8 Hz, 1H), 6.92 (t, *J* = 7.5 Hz, 1H), 6.86 (dd, *J* = 4.2, 1.5 Hz, 1H), 6.71 (d, *J* = 8.1 Hz, 1H), 6.47 (dd, *J* = 4.2, 2.7 Hz, 1H), 4.01 (s, 3H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 165.55, 165.52, 160.81, 155.33, 146.04, 132.02, 131.98, 124.14, 121.60, 120.10, 119.58, 118.89, 115.84, 110.66, 107.52, 55.49. *m/z* (EI):335 [M $^{+}$, 100%], 318 (57%), 109 (60%). calcd for $C_{17}H_{13}N_5O_3$, 335.1018;found, 335.1018 [M $^{+}$].



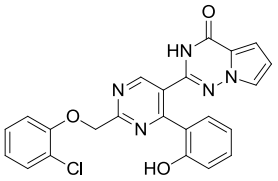
2-(2-Cyclopropyl-4-(2-hydroxyphenyl)pyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D13)

Yellow solid (78%). Mp 212-214 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.78 (s, 1H), 10.01 (s, 1H), 8.80 (s, 1H), 7.53 (dd, *J* = 7.5, 1.2, 1H), 7.38-7.36 (m, 1H), 7.22 (td, *J* = 7.5, 1.5 Hz, 1H), 6.91 (t, *J* = 7.5 Hz, 1H), 6.86 (dd, *J* = 3.9, 1.3 Hz, 1H), 6.70 (d, *J* = 8.2 Hz, 1H), 6.47 (dd, *J* = 4.2, 2.7 Hz, 1H), 2.36-2.6 (m, 1H), 1.17-1.12 (m, 4H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 172.30, 162.50, 157.93, 155.39, 155.26, 146.23, 131.99, 131.77, 124.26, 122.60, 121.67, 119.58, 118.91, 115.82, 110.72, 107.58, 18.59, 11.51. *m/z* (EI):417 [M $^{+}$,Cl^{37} 32%], 345 [M $^{+}$, 100%], 328 (64%), 109 (42%). calcd for $C_{19}H_{15}N_5O_2$, 345.1226;found, 345.1223 [M $^{+}$].



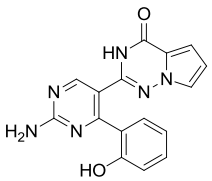
2-(4-(2-Hydroxyphenyl)-2-(phenoxymethyl)pyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D14)

Yellow solid (78%). Mp 206-208 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.92 (br s, 1H), 10.15 (br s, 1H), 9.02 (s, 1H), 7.52 (dd, *J* = 7.7, 1.7 Hz, 1H), 7.38 (dd, *J* = 2.7, 1.6 Hz, 1H), 7.34 – 7.19 (m, 3H), 7.08 – 6.82 (m, 5H), 6.72 (d, *J* = 8.1 Hz, 1H), 6.49 (dd, *J* = 4.3, 2.7 Hz, 1H), 5.39 (s, 2H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 166.53, 162.99, 158.62, 158.59, 155.54, 155.23, 145.90, 132.17, 132.08, 130.00,124.18, 123.73, 121.75, 121.39, 119.65, 118.97, 115.96, 115.18, 110.82, 107.71, 70.40.*m/z* (EI):411 [M $^{+}$, 100%], 394 [46%], 318 (60%), 183 (20%).calcd for $C_{23}H_{17}N_5O_3$, 411.1331;found, 411.1343 [M $^{+}$].



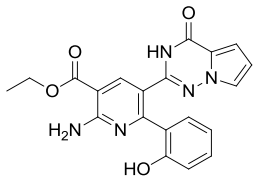
2-(2-((2-Chlorophenoxy)methyl)-4-(2-hydroxyphenyl)pyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D15)

Yellow solid (77%). Mp 95-96 ℃. ^{1}H NMR (400 MHz, DMSO-*d6*) δ 11.97 (s, 1H), 10.14 (s, 1H), 9.03 (s, 1H), 7.52 (dd, J = 7.8, 1.7 Hz, 1H), 7.47 (dd, J = 7.8, 1.6 Hz, 1H), 7.40 (dd, J = 2.7, 1.6 Hz, 1H), 7.32 – 7.22 (m, 2H), 7.18 (dd, J = 8.3, 1.5 Hz, 1H), 6.98 (td, J = 7.6, 1.4 Hz, 1H), 6.95 – 6.87 (m, 2H), 6.73 (dd, J = 8.2, 1.1 Hz, 1H), 6.51 (dd, J = 4.3, 2.7 Hz, 1H), 5.54(s, 2H). ^{13}C NMR (101 MHz, DMSO-*d6*) δ 165.64, 162.62, 158.33, 155.19, 154.90, 153.71, 145.58, 131.86, 131.78, 130.23, 128.32, 123.91, 123.39, 121.96, 121.50, 121.39, 119.30, 118.65, 115.61, 114.28, 110.46, 107.35, 70.61. *m/z* (EI):412 [M +,Cl37 32%], 410 [M $^{+}$,Cl^{35} 100%], 392 (12%), 183 (16%). calcd for $C_{23}H_{16}ClN_5O_3$, 445.0942;found, 445.0948 [M +].

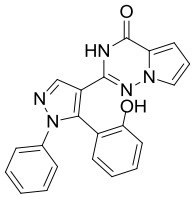


2-(2-Amino-4-(2-hydroxyphenyl)pyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D16)

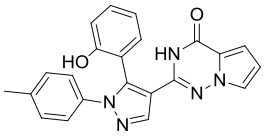
Yellow solid (76%). Mp > 300 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.56 (s, 1H), 10.68 (s, 1H), 8.44 (s, 1H), 7.42 (t, *J* = 2.1 Hz, 1H), 7.34 (dd, *J* = 7.8, 1.7 Hz, 1H), 7.27 (s, 2H), 7.21 (td, *J* = 8.5, 8.0, 1.9 Hz, 1H), 6.84 (dd, *J* = 4.1, 1.8 Hz, 1H), 6.77 (t, *J* = 8.8 Hz, 1H), 6.51 – 6.42 (m, 1H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 163.89, 163.34, 160.12, 156.53, 155.26, 146.91, 131.69, 130.97, 122.98, 121.56, 119.14, 118.79, 116.61, 113.87, 110.54, 107.40. *m/z* (EI): 320 [M^{+}, 100%], 302 (90%), 109 (84%), 108 (19%). calcd for $C_{16}H_{12}N_6O_2$, 320.1022;found, 320.1022 [M $^{+}$].



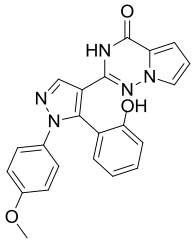
Ethyl 2-amino-6-(2-hydroxyphenyl)-5-(4-oxo-3,4-dihydropyrrolo[2,1-*f*][1,2,4]triazin-2-yl)nicotinate (D17)
Yellow solid (84%). Mp 280-282 ℃.^{1}H NMR (400 MHz, DMSO-*d6*) δ 11.60 (s, 1H), 10.66 (s, 1H), 8.32 (s, 1H), 7.72 (s, 2H), 7.44 (dd, *J* = 2.6, 1.7 Hz, 1H), 7.35 (dd, *J* = 7.7, 1.7 Hz, 1H), 7.20 (ddd, *J* = 8.0, 7.3, 1.7 Hz, 1H), 6.85 (dd, *J* = 4.3, 1.7 Hz, 1H), 6.83 – 6.75 (m, 2H), 6.50 (dd, *J* = 4.3, 2.6 Hz, 1H), 4.34 (q, *J* = 7.1 Hz, 2H), 1.33 (t, *J* = 7.1 Hz, 3H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 166.28, 159.84, 158.97, 156.34, 155.24, 147.75, 142.75, 131.30, 131.12, 123.97, 121.59, 119.07, 118.80, 116.61, 115.69, 110.57, 107.42, 103.11, 61.31, 14.68. *m/z* (EI): 391[100%], 373 (67%), 109 (67%). calcd for $C_{20}H_{17}N_5O_4$, 391.1281;found, 391.1280 [M $^{+}$].



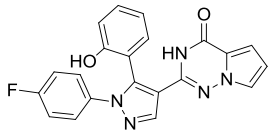
2-(5-(2-Hydroxyphenyl)-1-phenyl-1*H*-pyrazol-4-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D18)
Yellow solid (77%). Mp > 300 ℃.^{1}H NMR (400 MHz, DMSO-*d6*) δ 11.55 (s, 1H), 9.83 (s, 1H), 8.29 (s, 1H), 7.48 – 7.04 (m, 8H), 6.96 – 6.67 (m, 3H), 6.47 (dd, *J* = 4.2, 2.6 Hz, 1H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 155.71, 155.12, 142.32, 140.20, 140.03, 139.92, 132.56, 131.26, 129.27, 128.17, 124.83, 121.46, 119.22, 118.65, 116.40, 115.99, 113.97, 110.64, 107.64.m/z (EI): 369 [M^{+}, 100%], 351 (22%), 109 (62%). calcd for $C_{21}H_{15}N_5O_2$, 369.1226; found, 369.1221 [M $^{+}$].



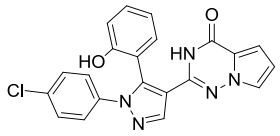
2-(5-(2-Hydroxyphenyl)-1-(p-tolyl)-1*H*-pyrazol-4-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one （D19）
Yellow solid (72%). Mp > 300 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.49 (br s, 1H), 9.79 (br s, 1H), 8.25 (s, 1H), 7.28 – 7.01 (m, 7H), 6.92 – 6.66 (m, 3H), 6.45 (dd, *J* = 4.3, 2.6 Hz, 1H), 2.26 (s, 3H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 155.70, 155.12, 142.36, 139.98, 139.82, 137.65, 132.56, 131.19, 129.70, 124.70, 121.44, 119.21, 118.64, 116.50, 115.98, 113.80, 110.62, 107.62, 20.98. *m/z* (EI): 383 [M^{+}, 100%], 365 (20%), 109 (60%). calcd for $C_{22}H_{17}N_5O_2$, 383.1382; found; 383.1385 [M $^{+}$]



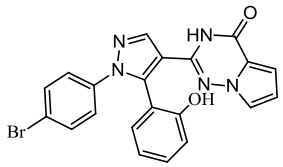
2-(5-(2-Hydroxyphenyl)-1-(4-methoxyphenyl)-1*H*-pyrazol-4-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D20)
Yellow solid (65%). Mp 268-270 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.46 (br s, 1H), 9.79 (br s, 1H), 8.23 (br s, 1H), 7.33 – 6.98 (m, 5H), 6.97 – 6.66 (m, 5H), 6.44 (t, *J* = 3.5 Hz, 1H), 3.72 (s, 3H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 158.92, 155.72, 155.14, 142.41, 138,88, 139.76, 133.09, 132.57, 131.15, 126.38, 121.43, 119.19, 118.63, 116.50, 115.98, 114.33, 113.56, 110.61, 107.61, 55.79. *m/z* (EI): 399 [M^{+}, 100%], 381 (18%), 109 (49%). calcd for $C_{22}H_{17}N_5O_3$, 399.1331;found, 399.1347 [M $^{+}$].



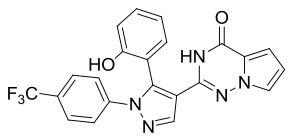
2-(1-(4-Fluorophenyl)-5-(2-hydroxyphenyl)-1*H*-pyrazol-4-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D21)
Yellow solid (75%). Mp 292-293 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.52 (s, 1H), 9.84 (s, 1H), 8.26 (s, 1H), 7.34 – 7.24 (m, 2H), 7.25 – 7.09 (m, 5H), 6.84 (dd, *J* = 4.3, 1.7 Hz, 1H), 6.82 – 6.72 (m, 2H), 6.45 (dd, *J* = 4.3, 2.6 Hz, 1H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 161.47 ((d, *J* = 245.57 Hz), 155.66, 155.14, 142.26, 140.24, 140.10, 136.46 (d, *J* = 2.9 Hz), 132.59, 131.36, 127.03 (d, *J* = 8.8 Hz), 121.46, 119.26, 118.64, 116.16 ((d, *J* = 23.44 Hz), 116.15, 116.06, 113.91 (s), 110.65, 107.64. *m/z* (EI): 387 [M^{+}, 100%], 369 (22%), 109 (66%). calcd for $C_{21}H_{14}FN_5O_2$, 387.1132;found; 387.1135 [M $^{+}$].



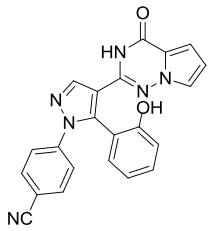
2-(1-(4-Chlorophenyl)-5-(2-hydroxyphenyl)-1*H*-pyrazol-4-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D22)
Yellow solid (64%). Mp > 300 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.59 (br s, 1H), 9.81 (br s, 1H), 8.29 (s, 1H), 7.42 (d, *J* = 8.3 Hz, 2H), 7.27 -7.17 (m, 5H), 6.85 - 6.79 (m, 3H), 6.45 (s, 1H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 155.60, 155.12, 142.16, 140.57, 140.04, 138.93, 132.59, 132.58, 131.47, 129.33, 126.35, 121.49, 119.34, 118.65, 116.10, 116.04, 114.17, 110.67, 107.66. m/z (EI): 405 [M^{+}, Cl^{37}, 37%], 403 [M^{+}, Cl^{35}, 100%], 385 (29%), 109 (96%). calcd for $C_{21}H_{14}ClN_5O_2$, 403.0836;found; 403.0836 [M $^{+}$].



2-(1-(4-Bromophenyl)-5-(2-hydroxyphenyl)-1*H*-pyrazol-4-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D23)
Yellow solid (68%). Mp > 300 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.59 (br s, 1H), 9.81 (br s, 1H), 8.30 (s, 1H), 7.55 (d, *J* = 8.6 Hz, 2H), 7.40 – 7.04 (m, 5H), 6.82 (dt, *J* = 8.2, 4.5 Hz, 3H), 6.45 (dd, *J* = 4.1, 2.7 Hz, 1H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 155.58, 155.11, 142.14, 140.61, 140.00, 139.35, 132.59, 132.26, 131.48, 126.61, 121.49, 121.03, 119.35, 118.65, 116.11, 116.03, 114.20, 110.67, 107.67. m/z (EI): 449 [M^{+}, Br^{81}, 86%], 447 [M^{+}, Br^{79}, 80%], 431 (Br^{81}, 18%), 433 (Br^{79}, 18%), 109 (74%). calcd for $C_{21}H_{14}BrN_5O_2$, 447.0331;found; 447.0338 [M $^{+}$, Br^{79}].

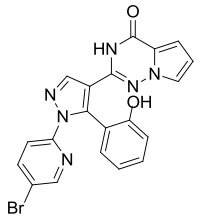


2-(5-(2-Hydroxyphenyl)-1-(4-(trifluoromethyl)phenyl)-1*H*-pyrazol-4-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D24)
Yellow solid (73%). Mp > 300 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.65 (br s, 1H), 9.83 (br s, 1H), 8.35 (s, 1H), 7.75 (d, *J* = 8.1 Hz, 2H), 7.47 (d, *J* = 8.2 Hz, 2H), 7.33 – 7.14 (m, 3H), 6.91 – 6.73 (m, 3H), 6.51 – 6.41 (m, 1H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 155.55, 155.11, 143.29, 142.02, 141.12, 140.21, 132.58, 131.66, 128.13 (q, *J* = 32.4 Hz, CF_3C), 126.60 (q, *J* = 3.5 Hz, CF_3C*CH*), 124.33 (q, *J* = 272.7 Hz, *CF_3*), 124.90, 121.52, 119.43, 118.66, 116.15, 115.86, 114.62, 110.70, 107.69. *m/z* (EI): 437 [M^{+}, 100%], 419 (30%), 109 (86%).calcd for $C_{22}H_{14}F_3N_5O_2$, 437.1100;found; 437.1103 [M $^{+}$].



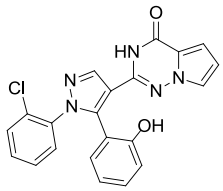
4-(5-(2-Hydroxyphenyl)-4-(4-oxo-3,4-dihydropyrrolo[2,1-*f*][1,2,4]triazin-2-yl)-1*H*-pyrazol-1-yl)benzonitrile (D25)

Yellow solid (51%). Mp > 300 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.64 (br s, 1H), 9.82 (br s, 1H), 8.35 (s, 1H), 7.85 (d, *J* = 8.4 Hz, 2H), 7.43 (d, *J* = 8.3 Hz, 2H), 7.35 – 7.11 (m, 3H), 6.97 – 6.70 (m, 3H), 6.46 (t, *J* = 3.5 Hz, 1H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 155.51, 155.10, 143.59, 141.91, 141.39, 140.26, 133.66, 132.57, 131.76, 124.81, 121.54, 119.48, 118.66, 118.63, 116.21, 115.77, 114.84, 110.73, 110.46, 107.72. *m/z* (EI): 394 [M^{+}, 100%], 376 (27%), 109 (70%). calcd for $C_{22}H_{14}N_6O_2$, 394.1178;found, 394.1177 [M^{+}].



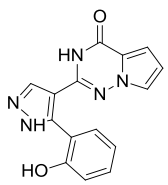
2-(1-(5-Bromopyridin-2-yl)-5-(2-hydroxyphenyl)-1*H*-pyrazol-4-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D26)

Yellow solid (52%). Mp 276-278 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.64 (br s, 1H), 9.62 (br s, 1H), 8.35 (d, *J* = 2.6 Hz, 1H), 8.26 (s, 1H), 8.19 (dd, *J* = 8.6, 2.3 Hz, 1H), 7.58 (d, *J* = 8.6 Hz, 1H), 7.30 (t, *J* = 2.1 Hz, 1H), 7.26 – 7.08 (m, 2H), 6.85 (dd, *J* = 4.2, 1.8 Hz, 1H), 6.83 – 6.67 (m, 2H), 6.47 (dd, *J* = 4.2, 2.5 Hz, 1H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 155.14, 155.08, 151.57, 148.91, 142.14, 141.88, 141.28, 140.30, 132.12, 130.96, 121.58, 120.58, 119.27, 119.05, 118.70, 116.53, 115.81, 114.69, 110.71, 107.67. *m/z* (EI): 450[M^{+}, Br^{81}, 98%], 448 [M^{+}, Br^{79}, 100%], 433 (Br^{81}, 50%), 431 (Br^{79}, 52%), 275(72%), 109 (74%). calcd for $C_{20}H_{13}BrN_6O_2$, 448.0283;found; 448.0282 [M^{+}, Br^{79}].



2-(1-(2-Chlorophenyl)-5-(2-hydroxyphenyl)-1*H*-pyrazol-4-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D27)

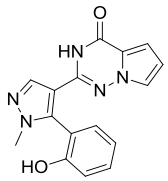
Yellow solid (66%). Mp > 300 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.58 (br s, 1H), 9.82 (br s, 1H), 8.27 (s, 1H), 7.53 (dd, *J* = 8.1, 1.7 Hz, 1H), 7.49 – 7.31 (m, 3H), 7.22 (dd, *J* = 2.6, 1.5 Hz, 1H), 7.12 (ddd, *J* = 8.6, 7.3, 1.7 Hz, 1H), 7.01 (dd, *J* = 7.6, 1.7 Hz, 1H), 6.84 (dd, *J* = 4.2, 1.6 Hz, 1H), 6.74 (dd, *J* = 8.3, 1.2 Hz, 1H), 6.67 (td, *J* = 7.4, 1.2 Hz, 1H), 6.45 (dd, *J* = 4.2, 2.7 Hz, 1H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 155.61 , 155.19, 142.56, 141.59, 140.38, 137.33, 131.88, 131.48, 131.38, 131.15, 130.53, 130.39, 128.14, 121.44, 118.85, 118.70 , 115.90, 115.61, 113.23, 110.59 , 107.59 . *m/z* (EI): 405 [M^{+}, Cl^{37}, 92%], 403 [M^{+}, Cl^{35}, 33%], 385 (33%), 109 (100%). calcd for $C_{21}H_{14}ClN_5O_2$, 403.0836;found; 403.0844 [M^{+}, Cl^{35}].



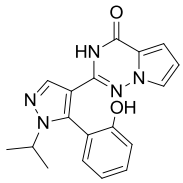
2-(5-(2-Hydroxyphenyl)-1*H*-pyrazol-4-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D28)

Yellow solid (48%). Mp 282-283 ℃. ^{1}H NMR (300 MHz, DMSO-*d6*) δ 13.31 (br s, 1H), 11.54 (s, 1H), 9.87 (s, 1H), 8.08 (br s, 1H), 7.63 – 7.28 (m, 2H), 7.22 (t, *J* = 7.6 Hz, 1H), 6.87 (t, *J* = 7.1 Hz, 3H), 6.48 (d, *J* = 4.4 Hz, 1H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 155.33, 155.10, 147.71, 143.80, 139.89, 139.44, 131.49, 131.12, 130.70,

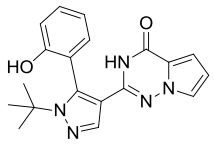
121.40, 119.33, 118.79, 116.40, 116.20, 111.62, 110.43, 107.35. *m/z* (EI): 293 [M^+, 100%], 275 (32%), 109 (60%), 108 (11%). calcd for $C_{15}H_{11}N_5O_2$, 293.0913;found, 293.0914 [M^+].



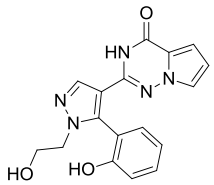
2-(5-(2-Hydroxyphenyl)-1-methyl-1*H*-pyrazol-4-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D29)
Yellow solid (49%). Mp 291-292 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.43 (br s, 1H), 9.92 (br s, 1H), 8.02 (s, 1H), 7.28 (d, *J* = 7.9 Hz, 2H), 7.16 (s, 1H), 7.04 – 6.85 (m, 2H), 6.81 (s, 1H), 6.42 (s, 1H), 3.65 (s, 3H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 155.60, 155.20, 142.63, 140.13, 138.42, 132.57, 131.26, 121.32, 119.30, 118.61, 116.22, 116.13, 112.06, 110.50, 107.49, 37.59. *m/z* (EI): 307 [M^+, 100%], 289 (12%), 109 (53%). calcd for $C_{16}H_{13}N_5O_2$, 307.1069;found; 307.1069 [M^+].



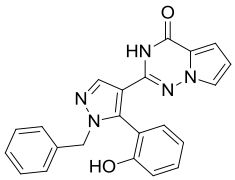
2-(5-(2-Hydroxyphenyl)-1-isopropyl-1*H*-pyrazol-4-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D30)
Yellow solid (48%). Mp 292 ℃ decomposed.^{1}H NMR (500 MHz, DMSO-*d6*) δ 11.36 (s, 1H), 9.88 (s, 1H), 8.11 (s, 1H), 7.30 (td, *J* = 7.8, 1.8 Hz, 1H), 7.23 (dd, *J* = 7.8, 1.7 Hz, 1H), 7.10 (t, *J* = 2.2 Hz, 1H), 6.94 (d, *J* = 8.2 Hz, 1H), 6.90 (t, *J* = 7.4 Hz, 1H), 6.80 (dd, *J* = 4.3, 1.8 Hz, 1H), 6.41 (dd, *J* = 4.2, 2.6 Hz, 1H), 4.22 (dt, *J* = 13.1, 6.6 Hz, 1H), 1.37 (d, *J* = 6.6 Hz, 3H), 1.29 (d, *J* = 6.6 Hz, 3H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 155.74, 155.14, 142.61, 139.03, 138.65, 132.47, 131.21, 121.27, 119.44, 118.60, 116.39, 116.16, 111.50, 110.48, 107.50, 50.65, 23.23, 22.52. *m/z* (EI): 335 [M^+, 100%], 320 (36%), 109 (66%). calcd for $C_{18}H_{17}N_5O_2$, 335.1382;found; 335.1385 [M^+].



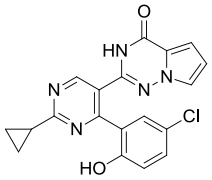
2-(1-(tert-Butyl)-5-(2-hydroxyphenyl)-1*H*-pyrazol-4-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D31)
Yellow solid (65%). Mp 248-250 ℃.^{1}H NMR (400 MHz, DMSO-*d6*) δ 11.51 (s, 1H), 9.76 (s, 1H), 8.38 (s, 1H), 7.45 – 7.37 (m, 2H), 7.18 (td, *J* = 8.1, 1.8 Hz, 1H), 6.89 – 6.80 (m, 3H), 6.49 (dd, *J* = 4.3, 2.6 Hz, 1H), 1.60 (s, 9H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 155.26, 155.24, 146.88, 143.64, 130.57, 129.84, 129.71, 121.40, 120.00, 119.27, 118.82, 116.09, 111.53, 110.45, 107.38, 59.42, 29.72. *m/z* (EI): 349 [M^+, 100%], 331 (5%), 293 (46%), 275 (63%), 109 (90%). calcd for $C_{19}H_{19}N_5O_2$, 349.1539;found, 349.1542 [M^+].



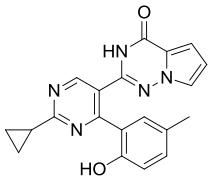
2-(1-(2-Hydroxyethyl)-5-(2-hydroxyphenyl)-1*H*-pyrazol-4-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D32)
Yellow solid (63%). Mp 210-212 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.39 (br s, 1H), 9.86 (br s, 1H), 8.07 (s, 1H), 7.29 (t, *J* = 6.9 Hz, 2H), 7.17 – 7.06 (m, 1H), 6.98 – 6.84 (m, 2H), 6.81 (dd, *J* = 3.7, 1.9 Hz, 1H), 6.42 (dd, *J* = 4.3, 2.3 Hz, 1H), 4.82 (br s, 1H), 3.96 (t, *J* = 6.4 Hz, 2H), 3.66 (br s, 2H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 155.58, 155.18, 142.62, 140.37, 138.75, 132.81, 131.18, 121.30, 119.32, 118.60, 116.21, 116.14, 111.97, 110.49, 107.49, 60.05, 51.87. *m/z* (EI): 337 [M^+, 100%], 319 (14%), 294 (22%), 109 (64%). calcd for $C_{17}H_{15}N_5O_3$, 337.1175;found; 337.1181 [M^+].



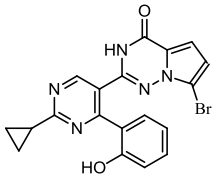
2-(1-Benzyl-5-(2-hydroxyphenyl)-1*H*-pyrazol-4-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D33)
Yellow solid (70%). Mp 258-259 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 9.96 (br s, 1H), 8.10 (s, 1H), 7.37 – 7.09 (m, 6H), 7.04 – 6.91 (m, 3H), 6.90 – 6.77 (m, 2H), 6.42 (dd, *J* = 4.2, 2.5 Hz, 1H), 5.18 (s, 2H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 155.56, 155.16, 142.55, 140.42, 139.19, 137.37, 132.48, 131.37, 128.79, 127.89, 127.70, 121.34, 119.37, 118.61, 116.25, 116.06, 112.42, 110.53, 107.53, 53.26. *m/z* (EI): 383 [M^{+}, 100%], 279 (17%), 109 (78%), 91 (78%). calcd for $C_{22}H_{17}N_5O_2$, 307.1069;found; 383.1382 [M $^{+}$].



2-(4-(5-Chloro-2-hydroxyphenyl)-2-cyclopropylpyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D34)
Yellow solid (58%). Mp 266-267 ℃. yellow solid ^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.85 (s, 1H), 10.25 (s, 1H), 8.85 (s, 1H), 7.55 (d, *J* = 2.7 Hz, 1H), 7.44 (dd, *J* = 2.6, 1.7 Hz, 1H), 7.29 (dd, *J* = 8.7, 2.8 Hz, 1H), 6.89 (dd, *J* = 4.3, 1.6 Hz, 1H), 6.72 (d, *J* = 8.7 Hz, 1H), 6.50 (dd, *J* = 4.3, 2.7 Hz, 1H), 2.43 – 2.27 (m, 1H), 1.24 – 1.03 (m, 4H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 172.61, 160.99, 158.07, 155.26, 154.22, 145.99, 131.38, 131.28, 126.22, 122.97, 122.72, 121.77, 118.89, 117.48, 110.78, 107.67, 18.64, 11.67. *m/z* (EI):381 [M $^{+}$,Cl^{37} 36%], 379 [M $^{+}$, Cl^{35} 100%], 362 (68%), 344 (38%) , 109 (70%). calcd for $C_{19}H_{14}ClN_5O_2$, 379.0836;found,379.0835 [M $^{+}$].

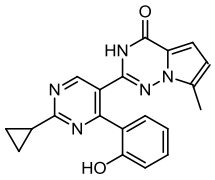


2-(2-Cyclopropyl-4-(2-hydroxy-5-methylphenyl)pyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D35)
Yellow solid (69%). Mp 235-236 ℃. yellow solid ^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.78 (s, 1H), 9.75 (s, 1H), 8.80 (s, 1H), 7.41 (br , 1H), 7.37 (br, 1H), 7.05 (d, *J* = 8.2 Hz, 1H), 6.88 (d, *J* = 3.9 Hz, 1H), 6.61 (d, *J* = 8.3 Hz, 1H), 6.49 (s, 1H), 2.34-2.30 (s, 1H), 2.26 (s, 3H), 1.14 (d, *J* = 7.8 Hz, 4H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 172.26, 162.46, 157.91, 155.27, 153.22, 146.35, 132.36, 132.19, 127.84, 123.93, 122.65, 121.69, 118.94, 115.70, 110.67, 107.53, 20.60, 18.62, 11.47. *m/z* (EI):359 [M $^{+}$, 100%], 342 (66%), 109 (46%). calcd for $C_{20}H_{17}N_5O_2$, 359.1382;found, 359.1382[M $^{+}$]

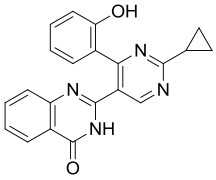


7-Bromo-2-(2-cyclopropyl-4-(2-hydroxyphenyl)pyrimidin-5-yl)pyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D36)
Yellow solid (82%). Mp 278-279 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 12.08 (br s, 1H), 9.93 (br s, 1H), 8.83 (s, 1H), 7.55 (dd, *J* = 7.7, 1.8 Hz, 1H), 7.24 (td, *J* = 7.9, 1.8 Hz, 1H), 6.98 (d, *J* = 4.5 Hz, 1H), 6.93 (td, *J* = 7.5, 1.0 Hz, 1H), 6.73 – 6.63 (m, 2H), 2.33 (tt, *J* = 7.1, 5.4 Hz, 1H), 1.22 – 1.04 (m, 4H). ^{13}C NMR (101 MHz, DMSO-*d6*) δ 174.00, 164.26, 159.21, 156.56, 156.13, 148.27, 125.87, 123.81, 121.65, 121.01, 117.10, 114.62, 109.84, 104.65, 20.07, 12.98. *m/z* (EI): 425[M^{+}, Br^{81}, 98%], 423 [M^{+}, Br^{79}, 100%], 408 (Br^{81}, 72%), 406 (Br^{79}, 68%), 252 (68%),

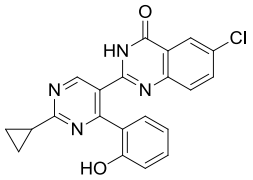
189 (56%). calcd for $C_{19}H_{14}BrN_5O_2$, 423.0330; found; 423.0331 [M^+, Br^{79}].



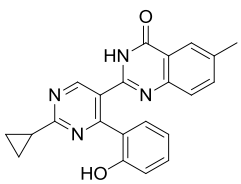
2-(2-Cyclopropyl-4-(2-hydroxyphenyl)pyrimidin-5-yl)-7-methylpyrrolo[2,1-*f*][1,2,4]triazin-4(3*H*)-one (D37)
Yellow solid (84%). Mp 244-245 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 11.85 (s, 1H), 9.87 (s, 1H), 8.84 (s, 1H), 7.49 (dd, *J* = 7.6, 1.8 Hz, 1H), 7.23 (t, *J* = 7.7 Hz, 1H), 6.93 (t, *J* = 7.5 Hz, 1H), 6.80 (d, *J* = 4.2 Hz, 1H), 6.67 (d, *J* = 8.3 Hz, 1H), 6.28 (d, *J* = 4.7 Hz, 1H), 2.40 – 2.24 (m, 1H), 1.93 (s, 3H), 1.21 – 1.06 (m, 4H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 172.32, 163.10, 157.46, 155.29, 154.96, 144.97, 131.52, 131.16, 129.61, 125.18, 122.66, 119.41, 118.02, 115.45, 109.72, 106.91, 18.58, 11.45, 10.56. *m/z* (EI): 359 [M^+, 100%], 342 (72%), 123 (38%). calcd for $C_{20}H_{17}N_5O_2$, 359.1382;found, 359.1380 [M^+].



2-(2-Cyclopropyl-4-(2-hydroxyphenyl)pyrimidin-5-yl)quinazolin-4(3*H*)-one (D38)
Yellow solid (82%). Mp 216-218 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 12.32 (br s, 1H), 9.87 (br s, 1H), 8.82 (s, 1H), 8.09 (d, *J* = 7.9 Hz, 1H), 7.87 – 7.64 (m, 1H), 7.54 (dd, *J* = 7.7, 1.8 Hz, 1H), 7.46 (dd, *J* = 8.3, 6.8 Hz, 1H), 7.40 (d, *J* = 8.2 Hz, 1H), 7.20 (t, *J* = 7.7 Hz, 1H), 6.90 (t, *J* = 7.4 Hz, 1H), 6.63 (d, *J* = 8.2 Hz, 1H), 2.38 – 2.24 (m, 1H), 1.18 – 1.06 (m, 4H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 171.98, 162.44, 162.26, 157.72, 155.51, 152.56, 149.35, 134.76, 132.00, 131.67, 127.73, 126.95, 126.19, 125.22, 124.42, 121.45, 119.46, 115.71, 18.59, 11.44. *m/z* (EI): 356 [M^+, 60%], 339 (100%), 120 (30%). calcd for $C_{21}H_{16}N_4O_2$, 356.1273;found, 356.1281 [M^+].



6-Chloro-2-(2-cyclopropyl-4-(2-hydroxyphenyl)pyrimidin-5-yl)quinazolin-4(3*H*)-one (D39)
Yellow solid (65%). Mp 228-230 ℃.yellow solid ^{1}H NMR (300 MHz, DMSO-*d6*) δ 12.56 (s, 1H), 9.83 (s, 1H), 8.82 (s, 1H), 8.03 (s, 1H), 7.74 (d, *J* = 7.4 Hz, 1H), 7.55 (d, *J* = 7.5 Hz, 1H), 7.41 (d, *J* = 8.6 Hz, 1H), 7.19 (t, *J* = 7.4 Hz, 1H), 6.91 (t, *J* = 7.2 Hz, 1H), 6.62 (d, *J* = 8.4 Hz, 1H), 2.31 (s, 1H), 1.11 (s, 4H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 172.19, 162.47, 161.38, 157.71, 155.45, 153.22, 148.10, 134.93, 132.07, 131.75, 131.22, 129.98, 125.22, 125.00, 124.43, 122.70, 119.56, 115.70, 18.63, 11.49. *m/z* (EI):392 [M^+,Cl^{37} 25%], 390 [M^+, Cl^{35} 67%], 373 (100%), 154 (30%). calcd for $C_{21}H_{15}ClN_4O_2$, 390.0884; found, 390.0883 [M^+].



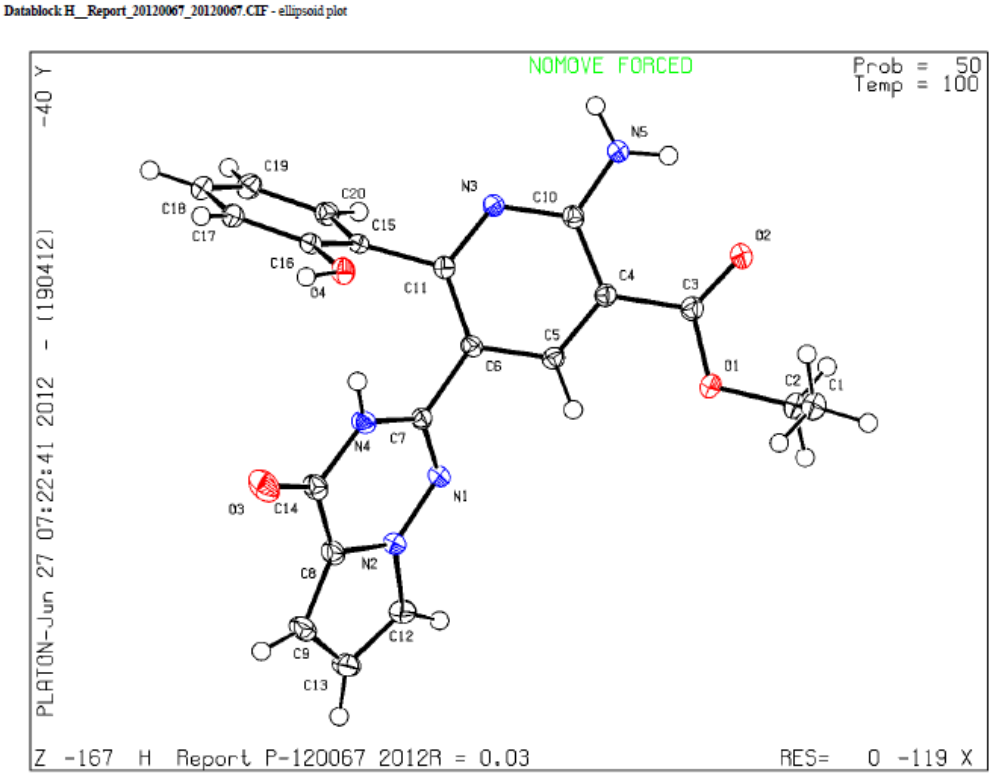
2-(2-Cyclopropyl-4-(2-hydroxyphenyl)pyrimidin-5-yl)-6-methylquinazolin-4(3*H*)-one (D40)

Yellow solid (72%). Mp 272-273 ℃.^{1}H NMR (300 MHz, DMSO-*d6*) δ 12.25 (s, 1H), 9.89 (s, 1H), 8.83 (s, 1H), 7.90 (s, 1H), 7.68 – 7.40 (m, 2H), 7.32 (d, *J* = 8.3 Hz, 1H), 7.24 - 7.18 (m, 1H), 6.91 (t, *J* = 7.1 Hz, 1H), 6.65 (d, *J* = 7.7 Hz, 1H), 2.43 (s, 3H), 2.37 - 2.29 (m, 1H), 1.30 – 0.94 (m, 4H). ^{13}C NMR (126 MHz, DMSO-*d6*) δ 171.88, 162.48, 162.20, 157.73, 155.59, 151.67, 147.40, 136.71, 136.0, 131.96 , 131.65, 127.64, 125.58, 125.28, 124.43, 121.23, 119.45, 115.75, 21.28, 18.58, 11.42. *m/z* (EI): 370 [M^+, 52%], 353 (100%), 134 (26%). calcd for $C_{22}H_{18}N_4O_2$, 370.1430;found, 370.1430 [M^+].

2. Notes and References

1. R.G. Nandgaonkar and V.N. Ingle, *Asian J. Chem.*, 2005, **17**, 2016-2018.
2. J. Hynes, W. W. Doubleday, A. J. Dyckman, J. D. Godfrey, J. A. Grosso, S. Kiau and K. Leftheris, *J Org Chem*, 2004, **69**, 1368-1371.
3. M. W. Bundesmann, S. B. Coffey and S. W. Wright, *Tetrahedron Lett*, 2010, **51**, 3879-3882.

3. X-ray crystallography of compound D17, D23 and D30



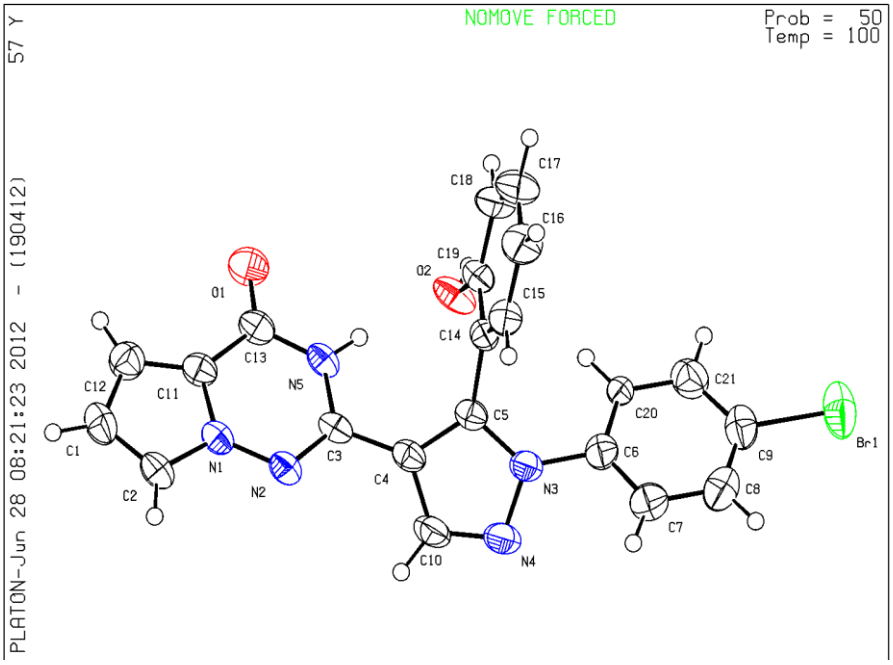
D17

A specimen of $C_{20}H_{17}N_5O_4$ was used for the X-ray crystallographic analysis. The X-ray intensity data were measured.

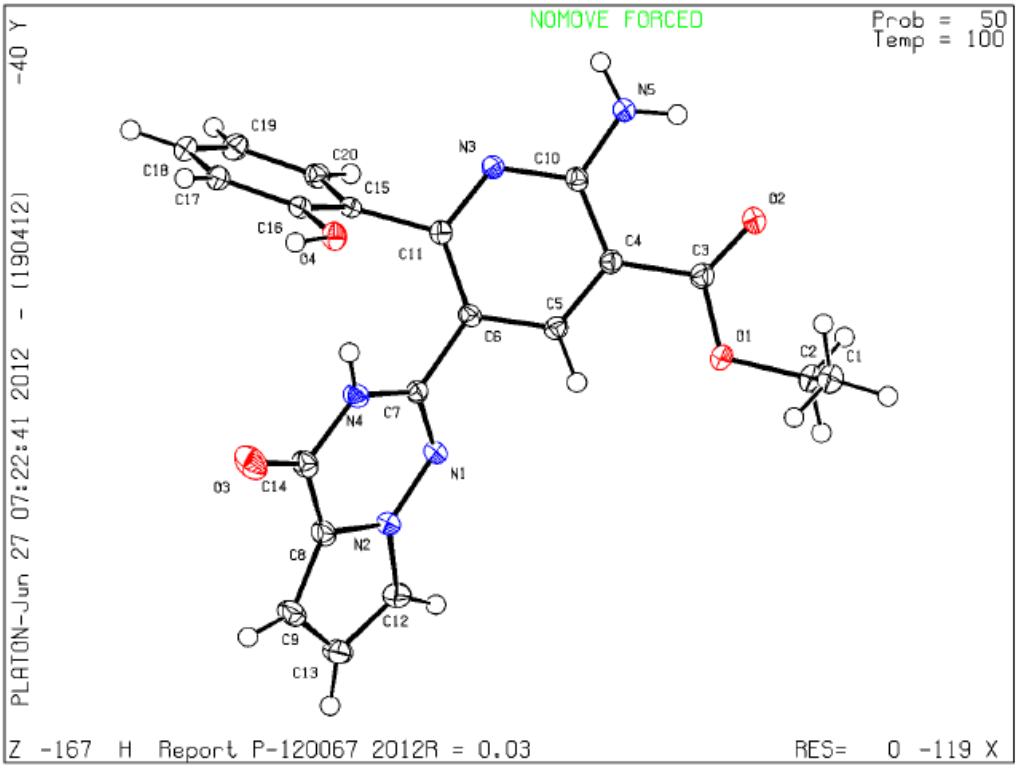
The total exposure time was 5.58 hours. The frames were integrated with the Bruker SAINT software package using a narrow-frame algorithm. The integration of the data using a triclinic unit cell yielded a total of 11939 reflections to a maximum θ angle of 27.57° (0.77 Å resolution), of which 4057 were independent (average redundancy 2.943, completeness = 96.8%, R_{int} = 1.43%, R_{sig} = 1.23%) and 3810 (93.91%) were greater than $2\sigma(F^2)$.The final cell constants of a = 7.1731(2) Å, b = 9.0580(3) Å, c = 15.2735(5) Å, α = 96.9650(10)°, β = 93.3370(10)°, γ = 112.6080(10)°, volume = 903.39(5) $Å^3$, are based upon the refinement of the XYZ-centroids of 9559 reflections above 20 σ(I) with 4.931° < 2θ < 55.07°.Data were corrected for absorption effects using the multi-scan method (SADABS). The ratio of minimum to maximum apparent transmission was 0.926.

The structure was solved and refined using the Bruker SHELXTL Software Package, using the space group P -1, with Z = 2 for the formula unit, $C_{20}H_{17}N_5O_4$.The final anisotropic full-matrix least-squares refinement on F^2 with 273 variables converged at R1 = 3.43%, for the observed data and wR2 = 9.31% for all data. The goodness-of-fit was 1.055. The largest peak in the final difference electron density synthesis was 0.362 $e^-/Å^3$ and the largest hole was -0.232 $e^-/Å^3$ with an RMS deviation of 0.045 $e^-/Å^3$. On the basis of the final model, the calculated density was 1.439 g/cm^3 and F(000), 408 e^-.

The crystal structure for **D17** has been deposited at the Cambridge Crystallographic Data Center and allocated the reference no. CCDC 909193.



Datablock: H__Report_20120067_20120067.CIF - ellipsoid plot

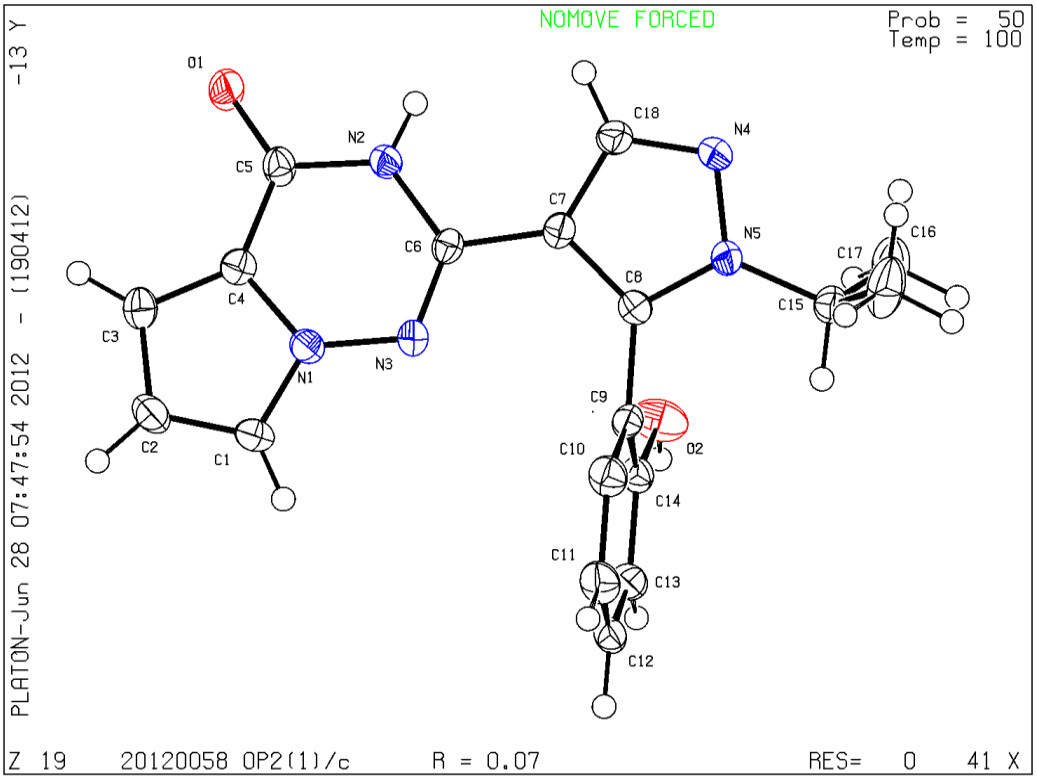


ıured.

ing a narrow-
imum θ angle
)9.3%, Rint =
) = 10.4533(7)
ased upon the
corrected for
ısmission was

with Z = 2 for
les converged
eak in the final
on of 0.056 e-

reference no.



D30

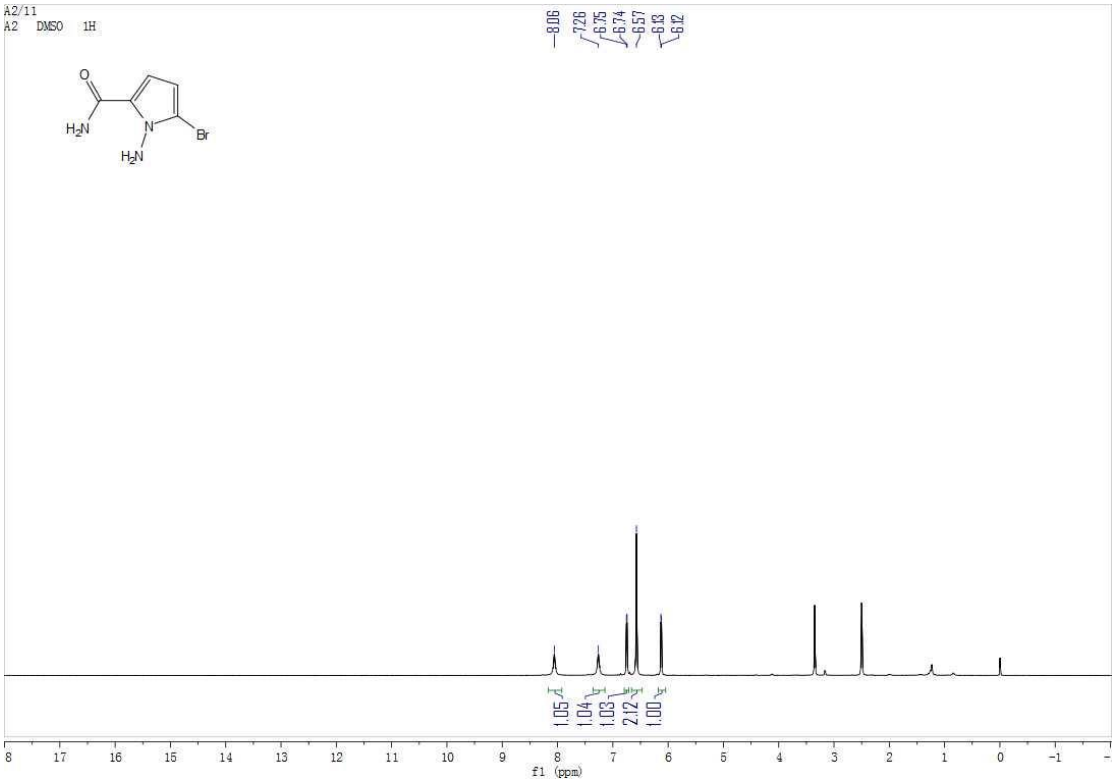
A specimen of $C_{18}H_{17}N_5O_2$ was used for the X-ray crystallographic analysis. The X-ray intensity data were measured.

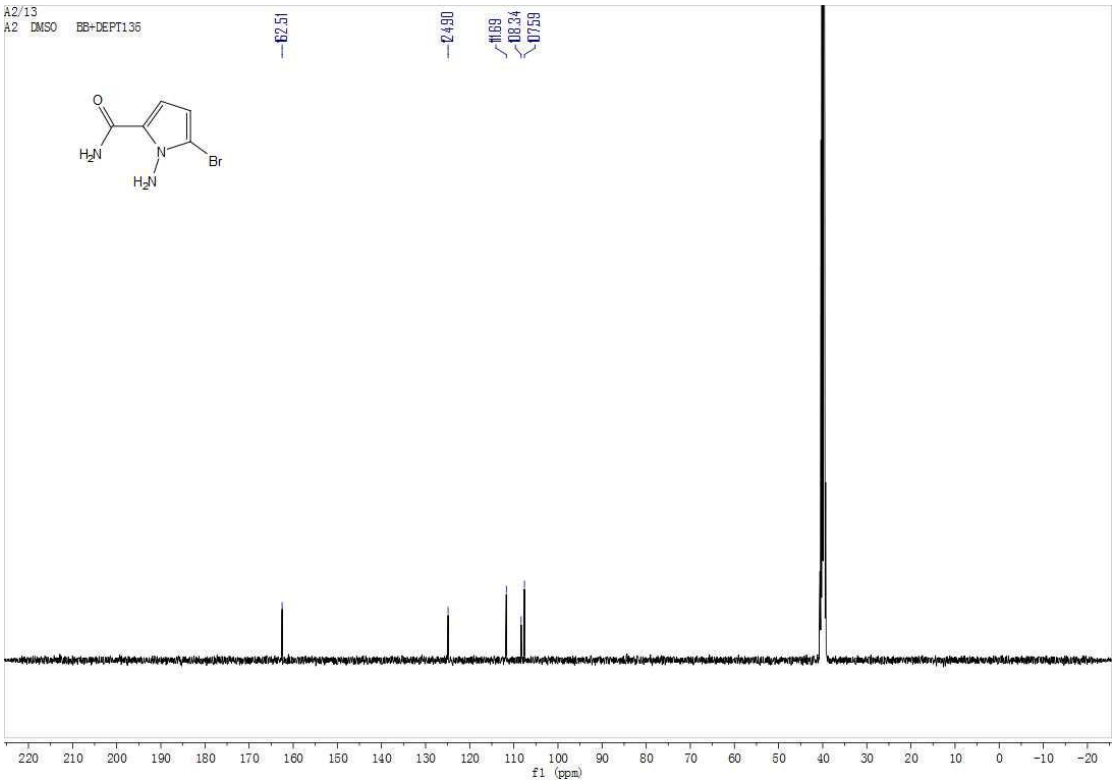
The total exposure time was 1.90 hours. The frames were integrated with the Bruker SAINT software package using a narrow-frame algorithm. The integration of the data using a monoclinic unit cell yielded a total of 9884 reflections to a maximum θ angle of 25.00° (0.84 Å resolution), of which 2794 were independent (average redundancy 3.538, completeness = 97.4%, R_{int} = 5.08%, R_{sig} = 4.98%) and 2495 (89.30%) were greater than $2\sigma(F^2)$. The final cell constants of a = 16.640(8) Å, b = 7.053(4) Å, c = 14.173(7) Å, β = 101.753(8)°, volume = 1628.5(14) $Å^3$, are based upon the refinement of the XYZ-centroids of 7950 reflections above 20 σ(I) with 5.001° < 2θ < 55.31°. Data were corrected for absorption effects using the multi-scan method (SADABS). The ratio of minimum to maximum apparent transmission was 0.807.

The structure was solved and refined using the Bruker SHELXTL Software Package, using the space group P 1 21/c 1, with Z = 4 for the formula unit, $C_{18}H_{16}N_5O_2$. The final anisotropic full-matrix least-squares refinement on F^2 with 239 variables converged at R1 = 7.36%, for the observed data and wR2 = 21.33% for all data. The goodness-of-fit was 1.106. The largest peak in the final difference electron density synthesis was 0.448 $e^-/Å^3$ and the largest hole was -0.485 $e^-/Å^3$ with an RMS deviation of 0.089 $e^-/Å^3$. On the basis of the final model, the calculated density was 1.364 g/cm^3 and F(000), 700 e^-.

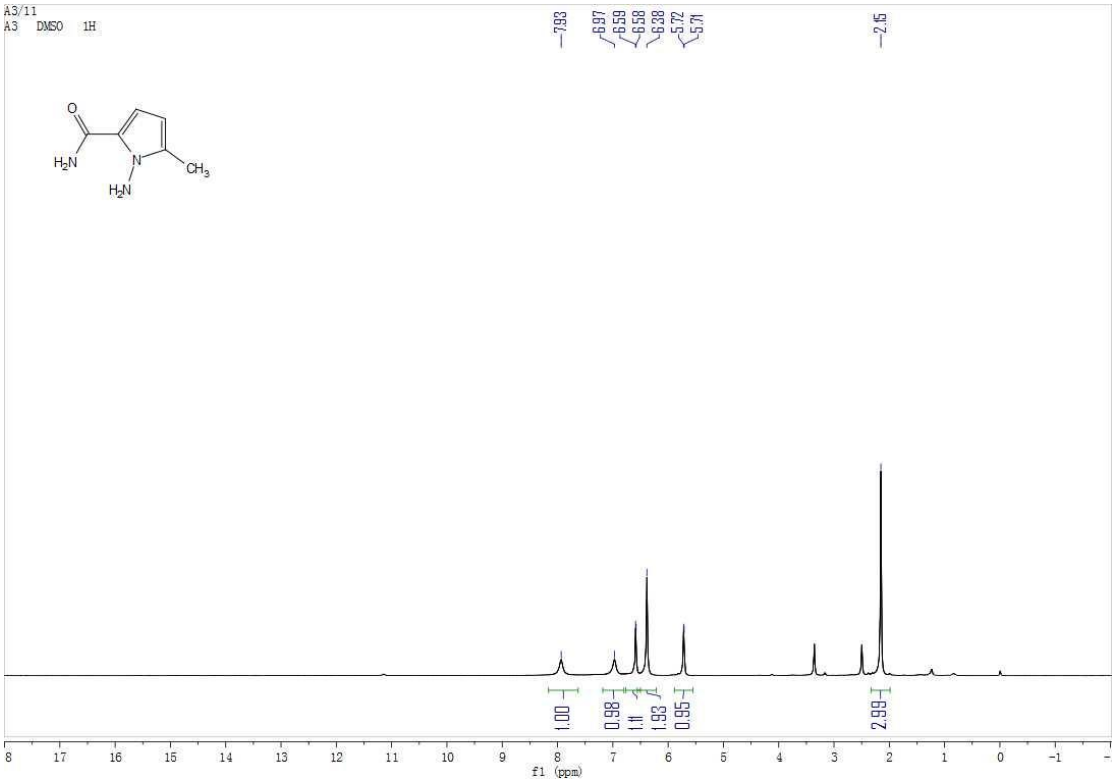
The crystal structure for **D30** has been deposited at the Cambridge Crystallographic Data Center and allocated the reference no. CCDC 909191.

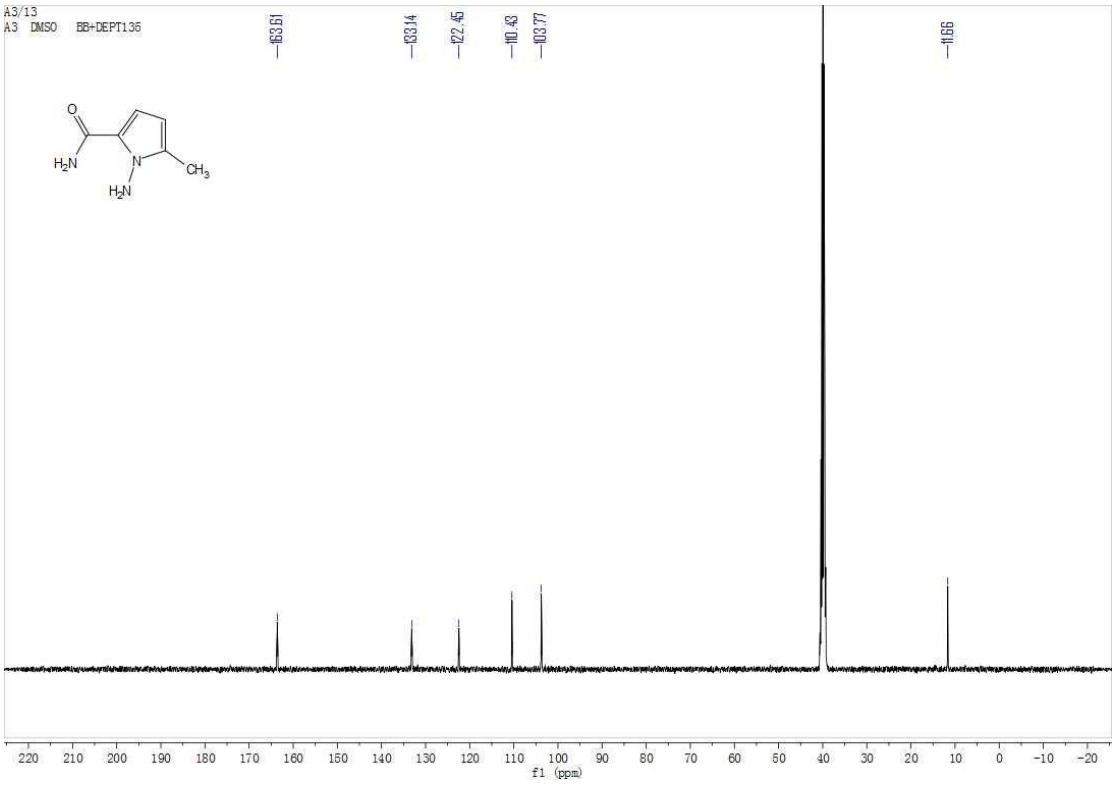
4. ^{1}H NMR and ^{13}C NMR



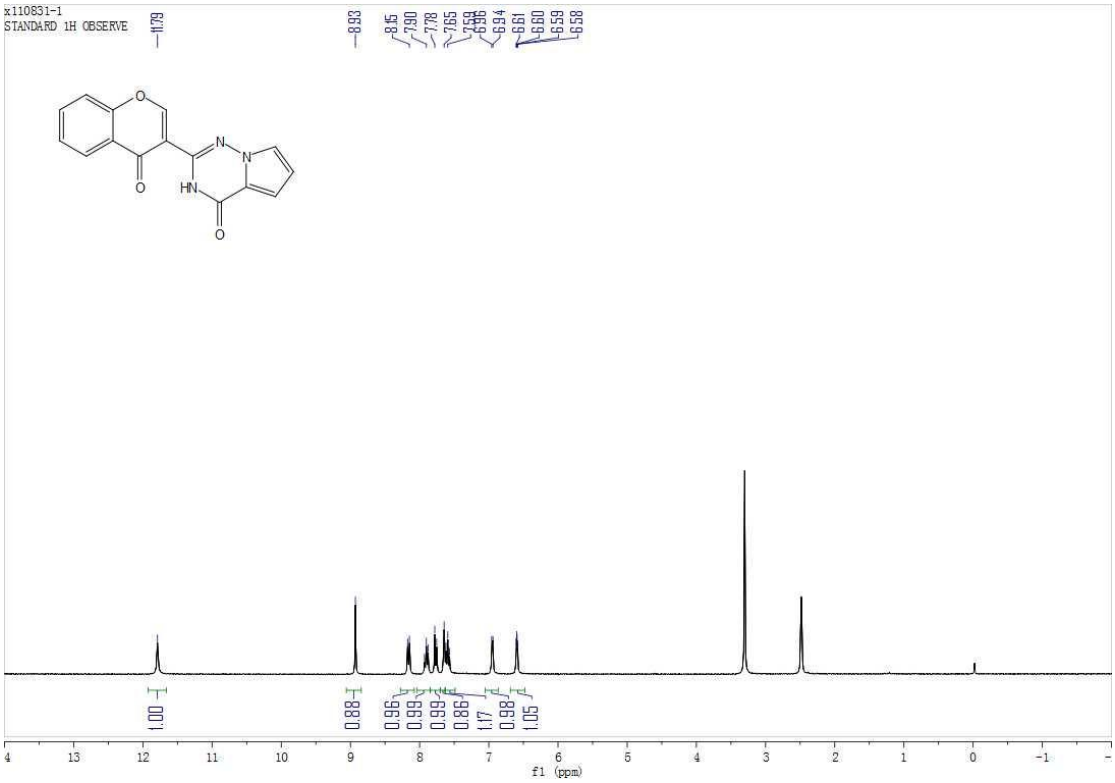


A2


A3/11
A3 DMSO 1H
7.93
6.97
6.59
6.58
6.38
5.72
5.71
2.45
1.00
0.98
1.11
1.93
0.95
2.99
f1 (ppm)


A3/13
A3 DMSO BB+DEPT136
163.61
133.14
122.45
110.43
103.77
11.66
f1 (ppm)

A3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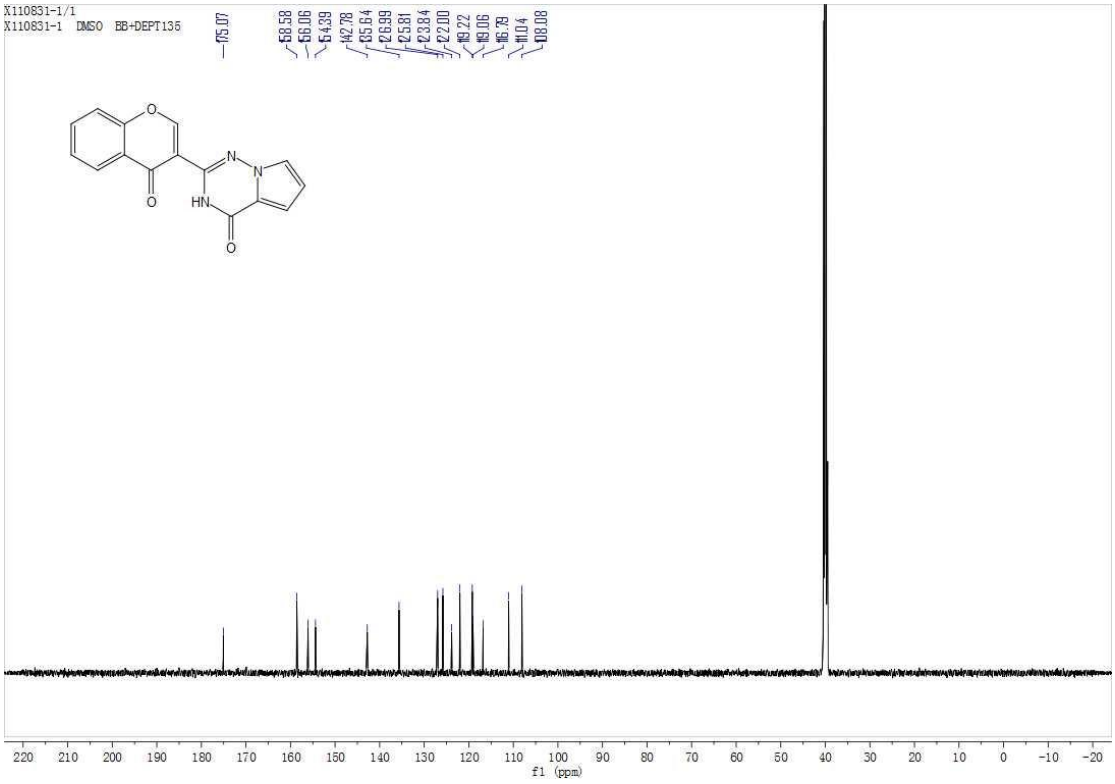
11.79
8.93
8.45
7.90
7.78
7.65
7.59
7.56
6.94
6.61
6.60
6.59
6.58
O
N
N
HN
O
O
1.00
0.88
0.95
0.99
0.99
0.86
1.17
0.98
1.05
f1 (ppm)


X110831-1/1
X110831-1 DMSO BB+DEPT135
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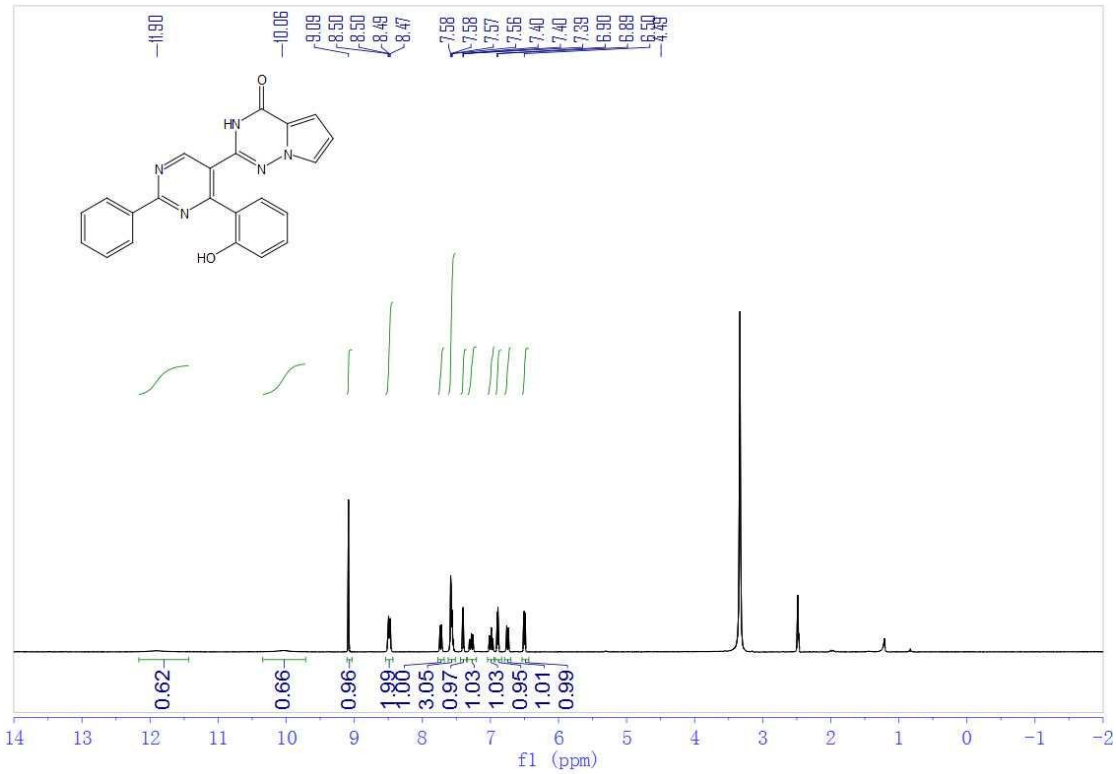
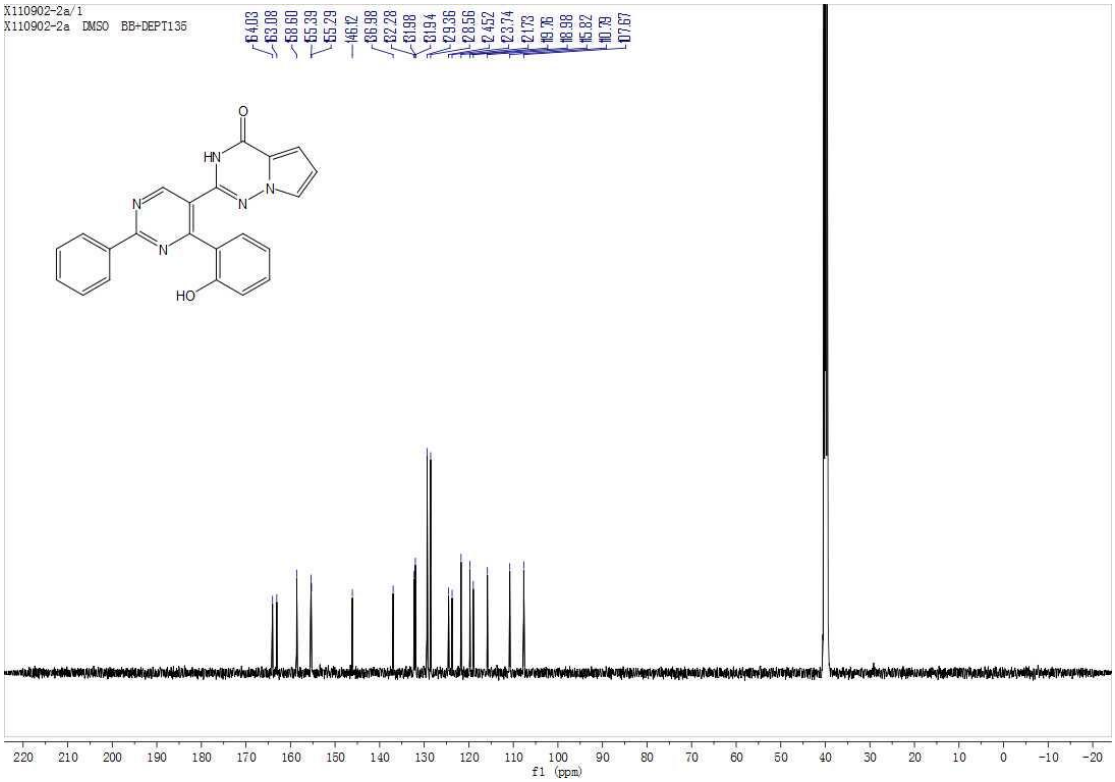
158.58
156.06
154.39
142.78
135.64
126.99
125.81
123.84
122.00
119.22
119.06
116.79
111.04
108.08
O
N
N
HN
O
O
f1 (ppm)

C1


11.90
10.06
9.09
8.50
8.50
8.49
8.47
7.58
7.58
7.57
7.56
7.40
7.40
7.39
6.90
6.89
5.50
5.49
HN
N
N
N
N
HO
0.62
0.66
0.96
1.99
1.00
3.05
0.97
1.03
1.03
0.95
1.01
0.99
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2
f1 (ppm)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X110902-2a DMSO BB+DEPT135
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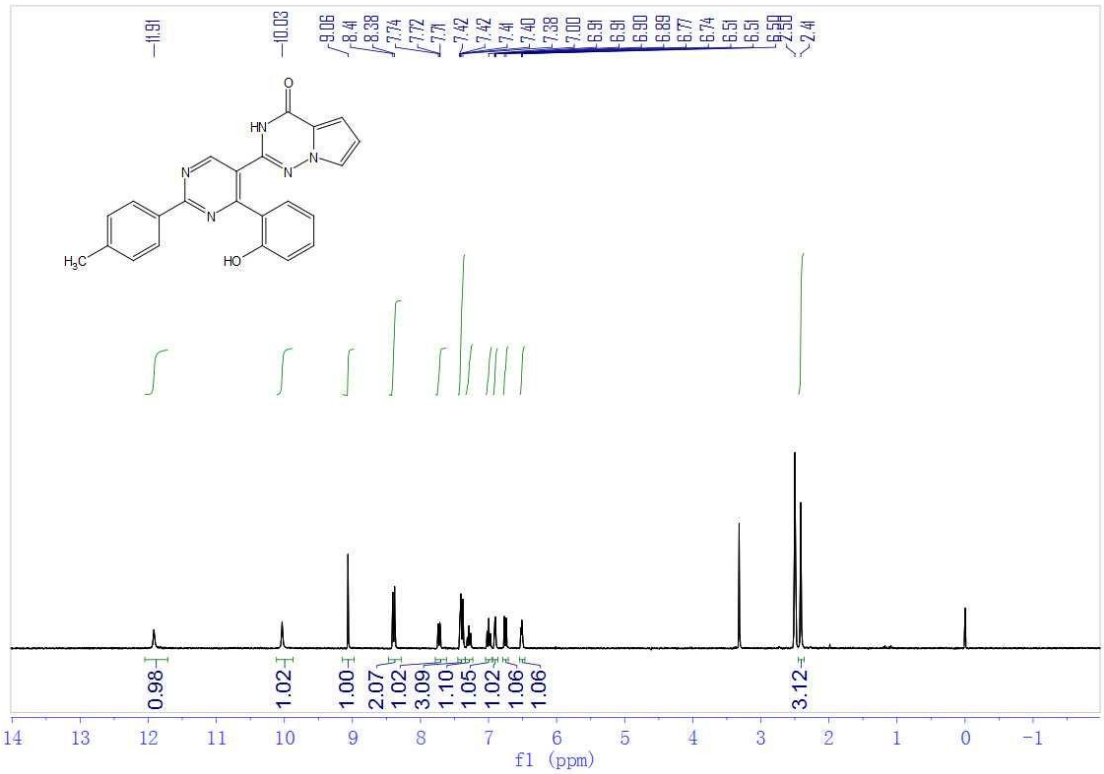
163.08
158.60
155.39
155.29
146.12
136.98
132.28
131.98
131.94
129.36
128.56
122.452
123.74
121.73
119.76
118.98
115.82
110.79
107.67
HN
N
N
N
N
HO
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)

D1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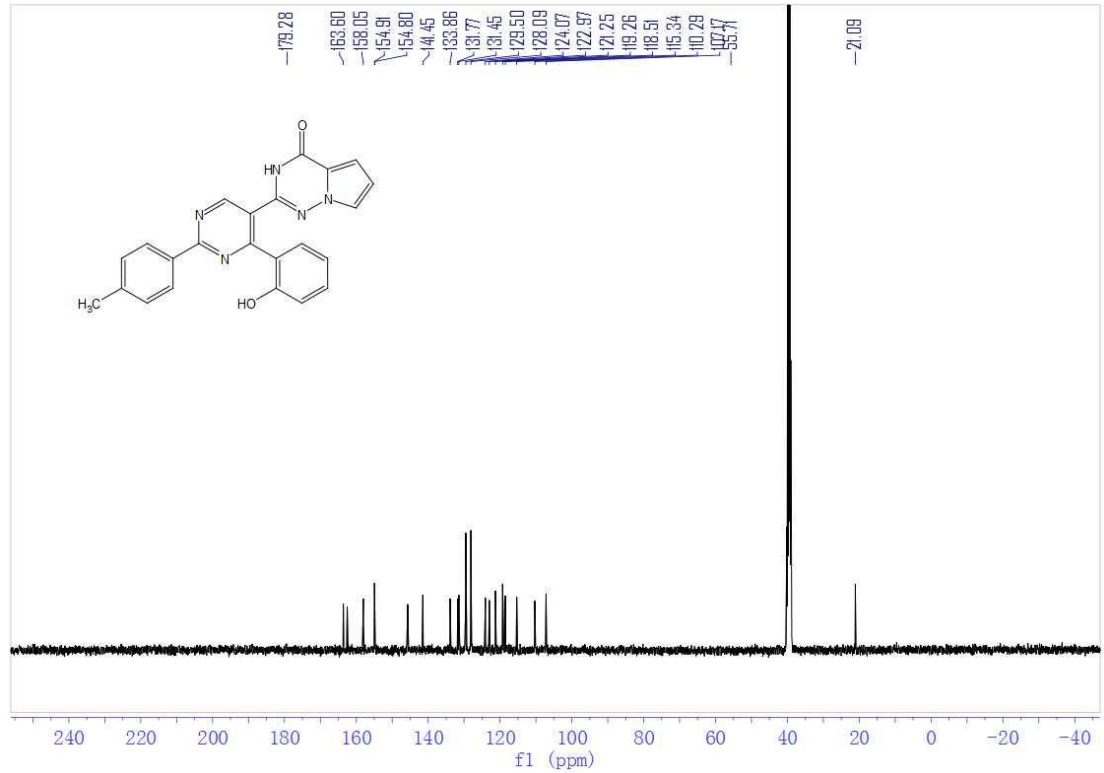
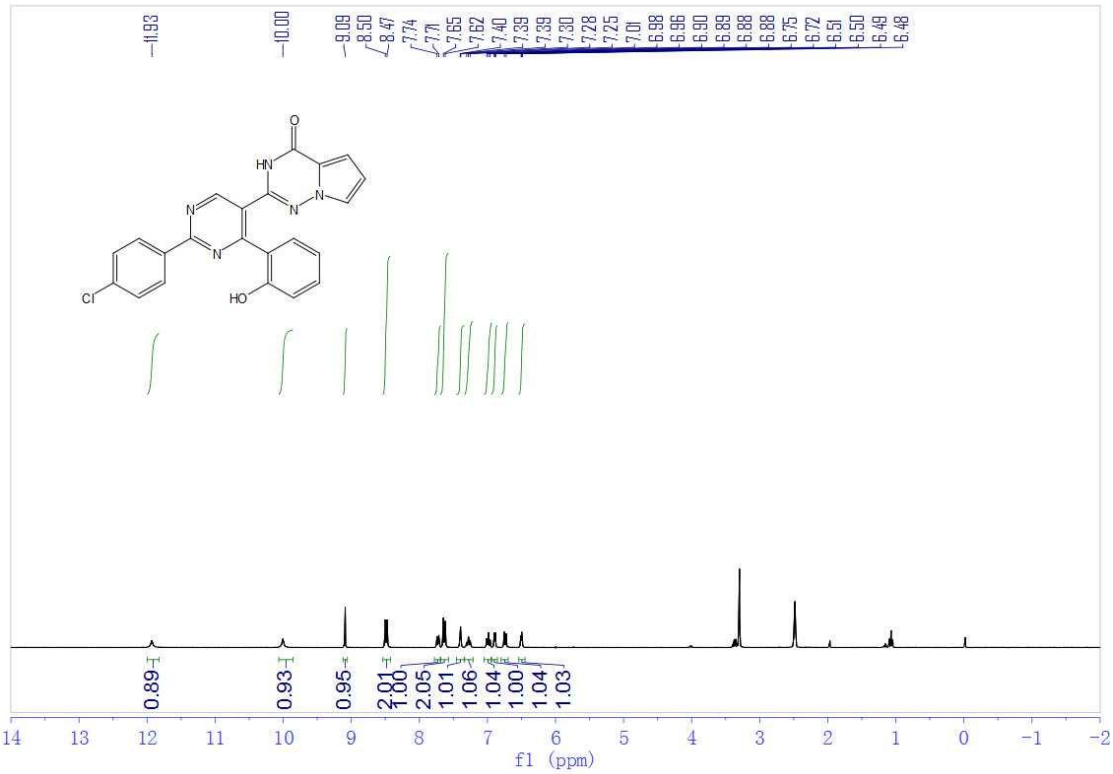
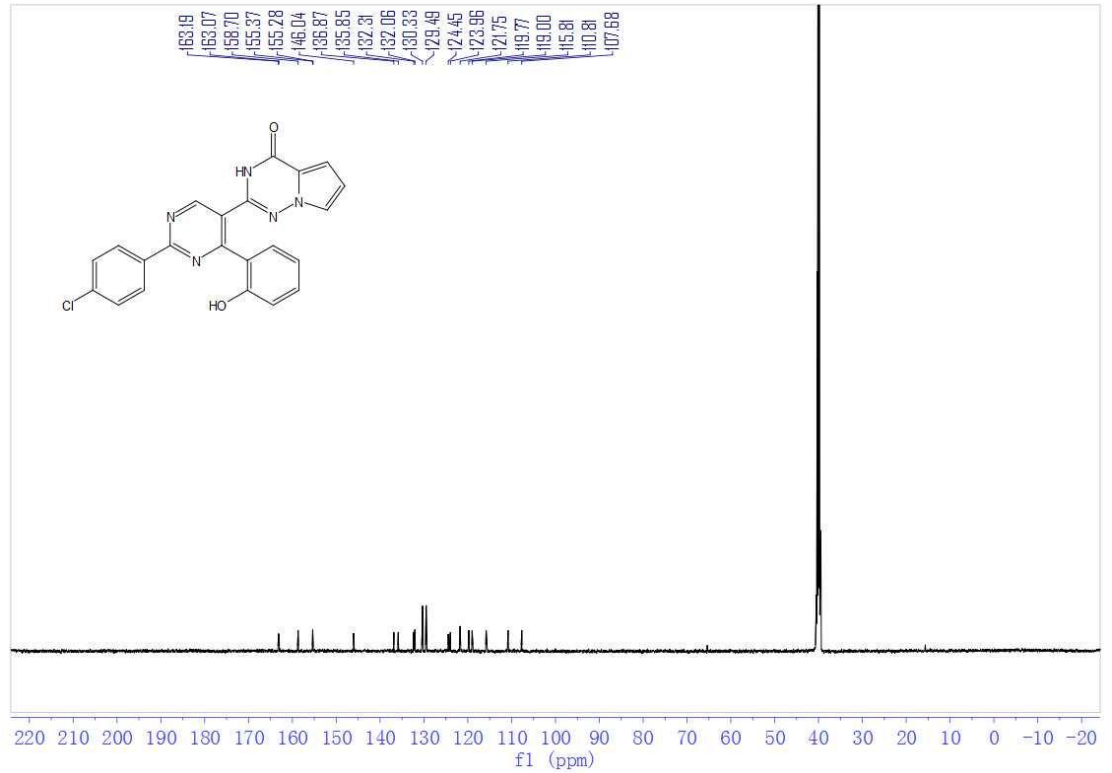
10.03
9.06
8.41
8.38
7.74
7.72
7.71
7.42
7.42
7.41
7.40
7.38
7.00
6.91
6.91
6.90
6.89
6.77
6.74
6.51
6.51
2.50
2.41
0.98
1.02
1.00
2.07
1.02
3.09
1.10
1.05
1.02
1.06
1.06
3.12
f1 (ppm)


179.28
163.60
158.05
154.91
154.80
144.45
133.86
131.77
131.45
129.50
128.09
124.07
122.97
121.25
119.26
118.51
115.34
110.29
107.47
55.71
21.09
f1 (ppm)

D2


11.93
10.00
9.09
8.50
8.47
7.74
7.71
7.65
7.62
7.40
7.39
7.39
7.30
7.28
7.25
7.01
6.98
6.96
6.90
6.89
6.88
6.88
6.75
6.72
6.51
6.50
6.49
6.48
O
HN
N
N
N
Cl
HO
0.89
0.93
0.95
2.01
1.00
2.05
1.01
1.06
1.04
1.00
1.04
1.03
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 −1 −2
f1 (ppm)


163.19
163.07
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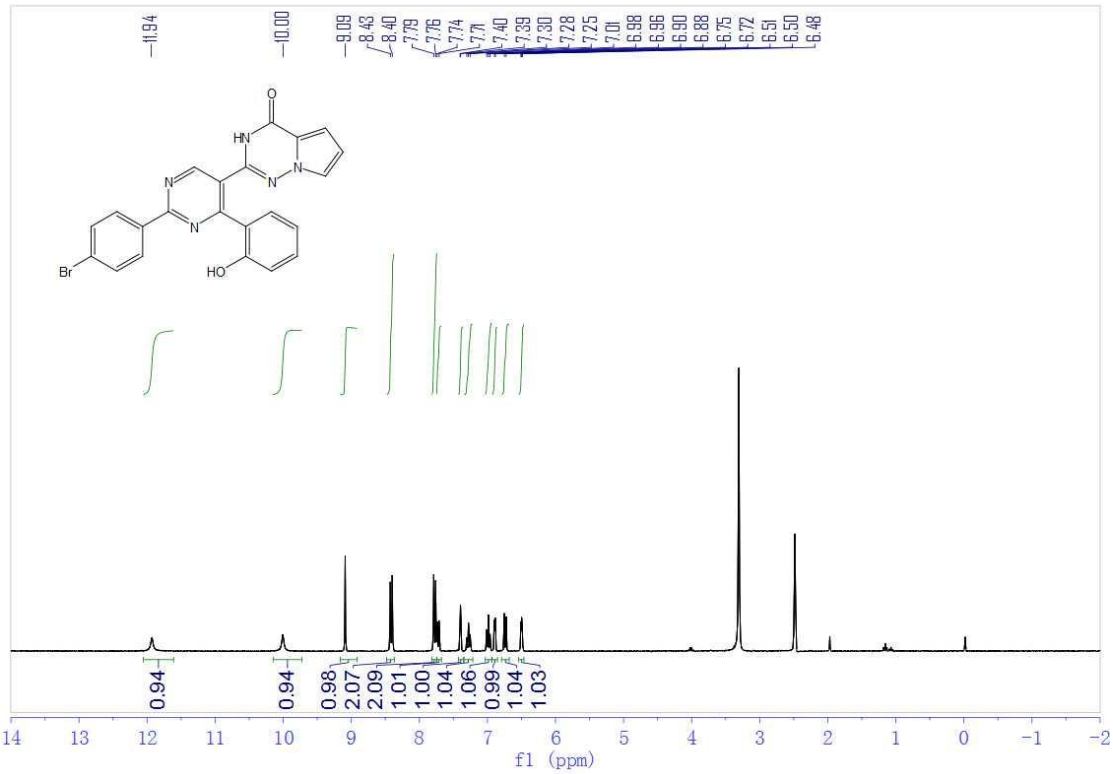
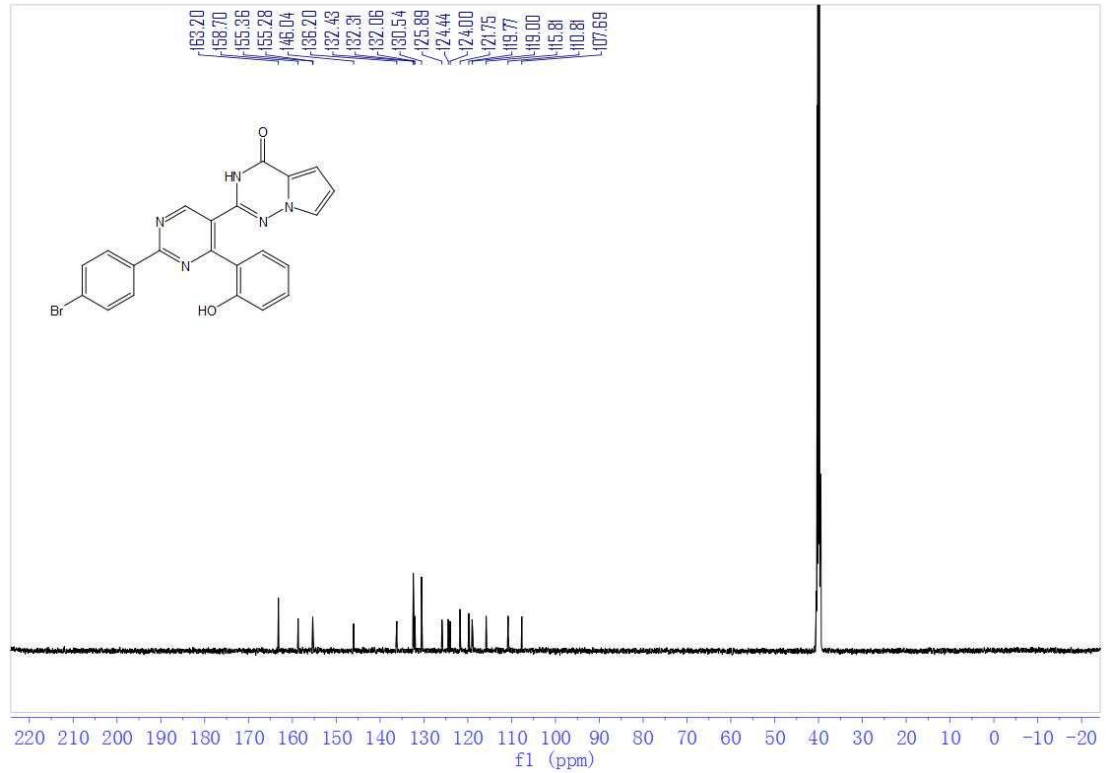
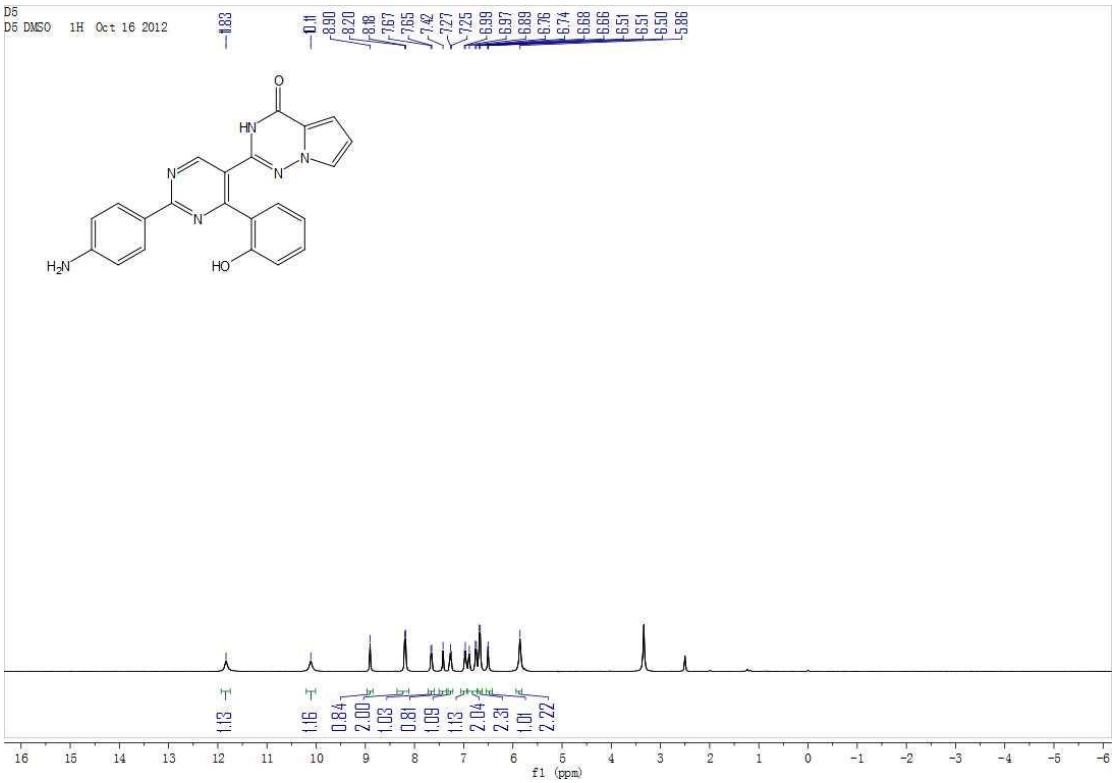
155.37
155.28
146.04
136.87
135.85
132.31
132.06
130.33
129.49
124.45
123.96
121.75
119.77
119.00
115.81
110.81
107.68
O
HN
N
N
N
Cl
HO
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10 −20
f1 (ppm)

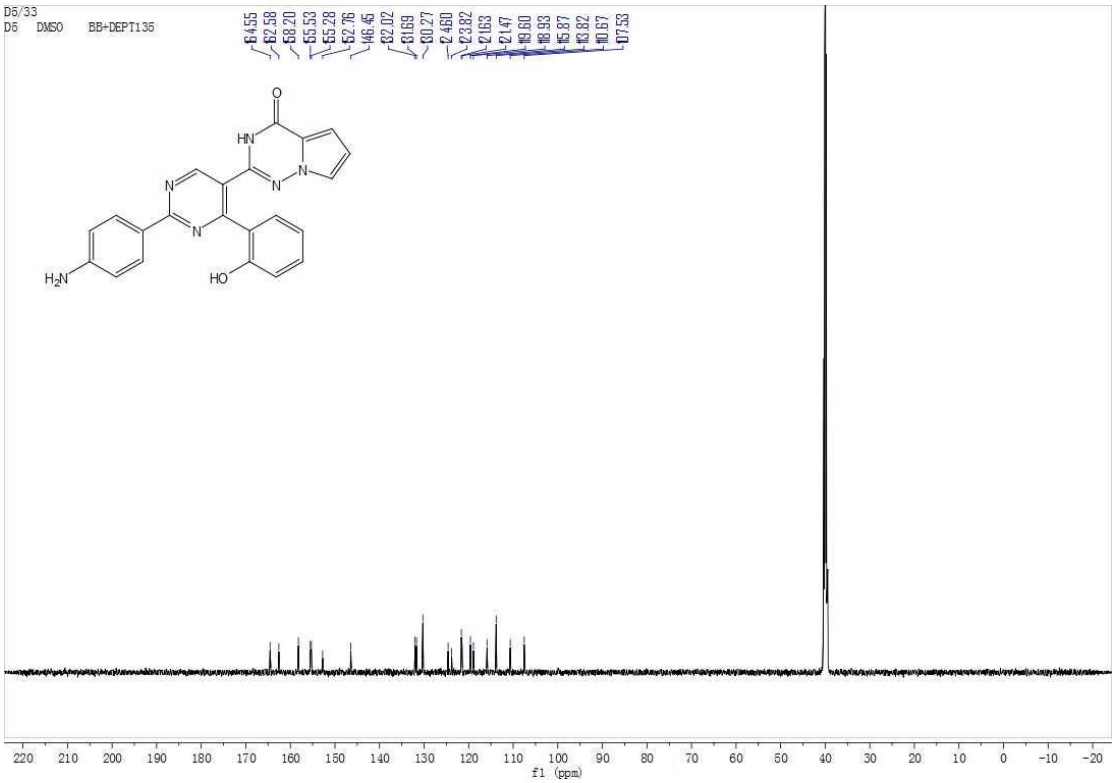
D3



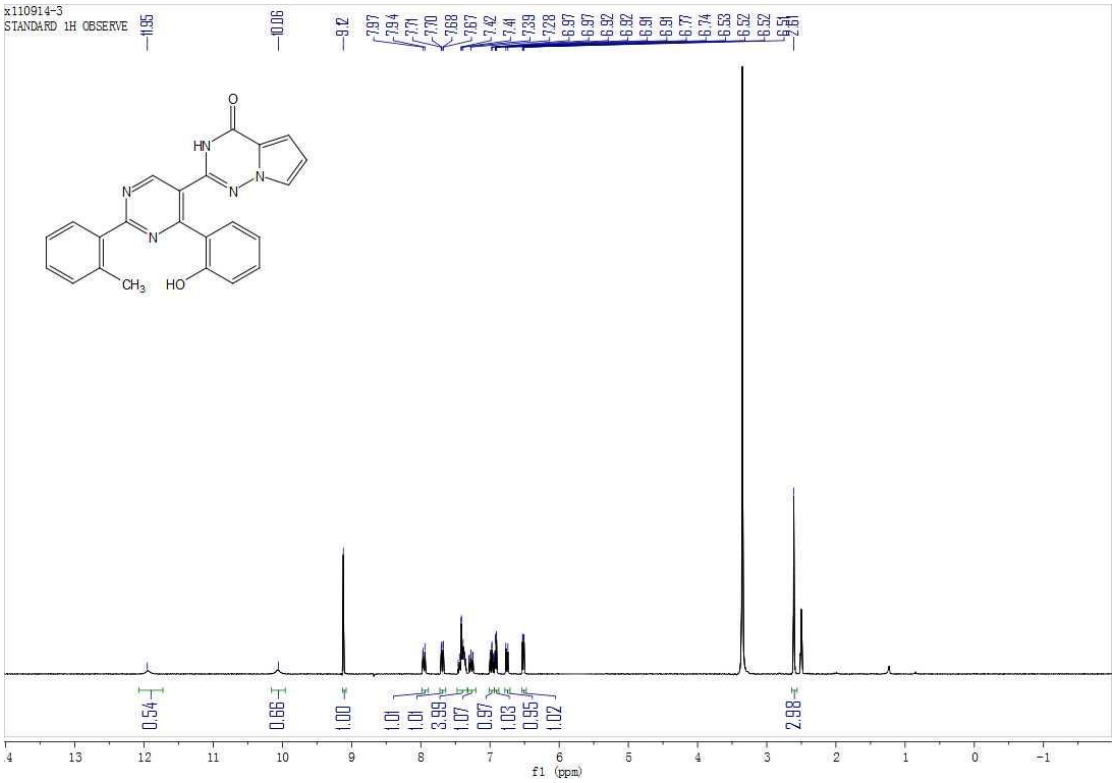


D4





D5


x110914-3
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10.06
9.12
7.97
7.94
7.71
7.70
7.68
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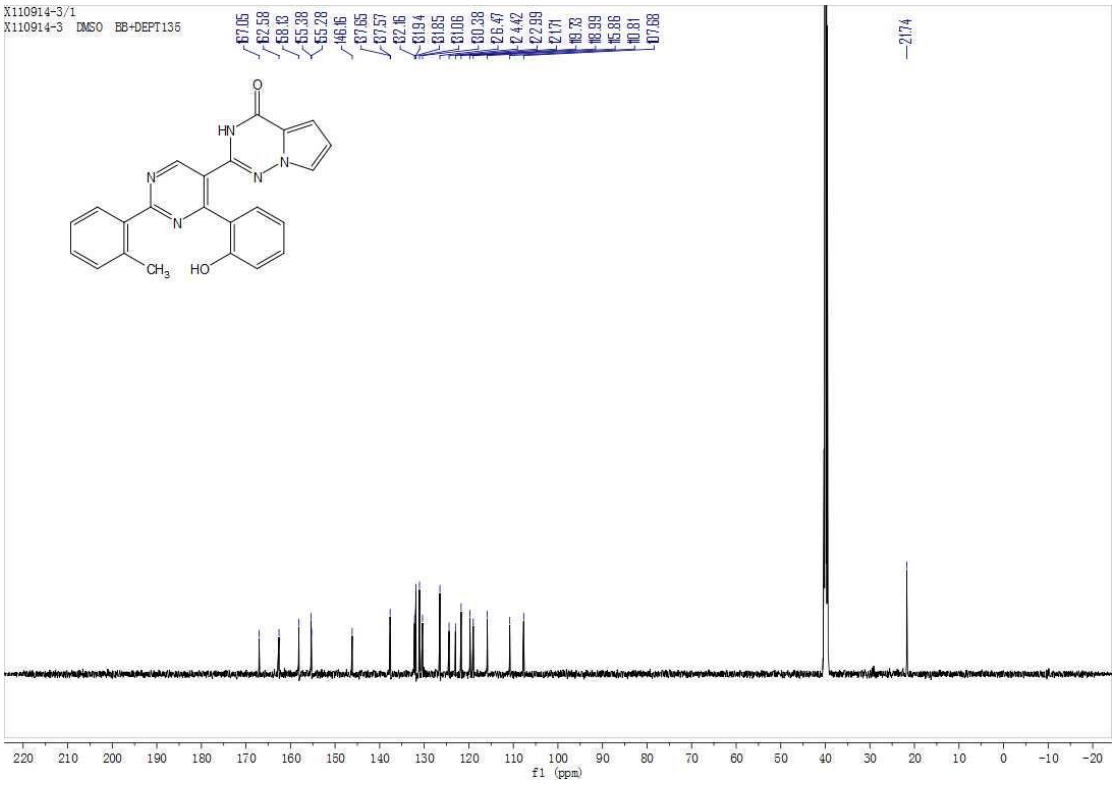
7.42
7.41
7.39
7.28
6.97
6.97
6.92
6.92
6.91
6.91
6.77
6.74
6.53
6.52
6.52
6.51
2.61
HN
N
N
N
N
O
CH3
HO
0.54
0.66
1.00
1.01
1.01
3.99
1.07
0.97
1.03
0.95
1.02
2.98
f1 (ppm)


X110914-3/1
X110914-3 DMSO BB+DEPT135
167.05
162.58
158.13
155.38
155.28
146.16
137.65
137.57
132.16
131.94
131.85
131.06
130.38
126.47
124.42
122.99
121.71
119.73
118.99
115.88
110.81
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21.74
HN
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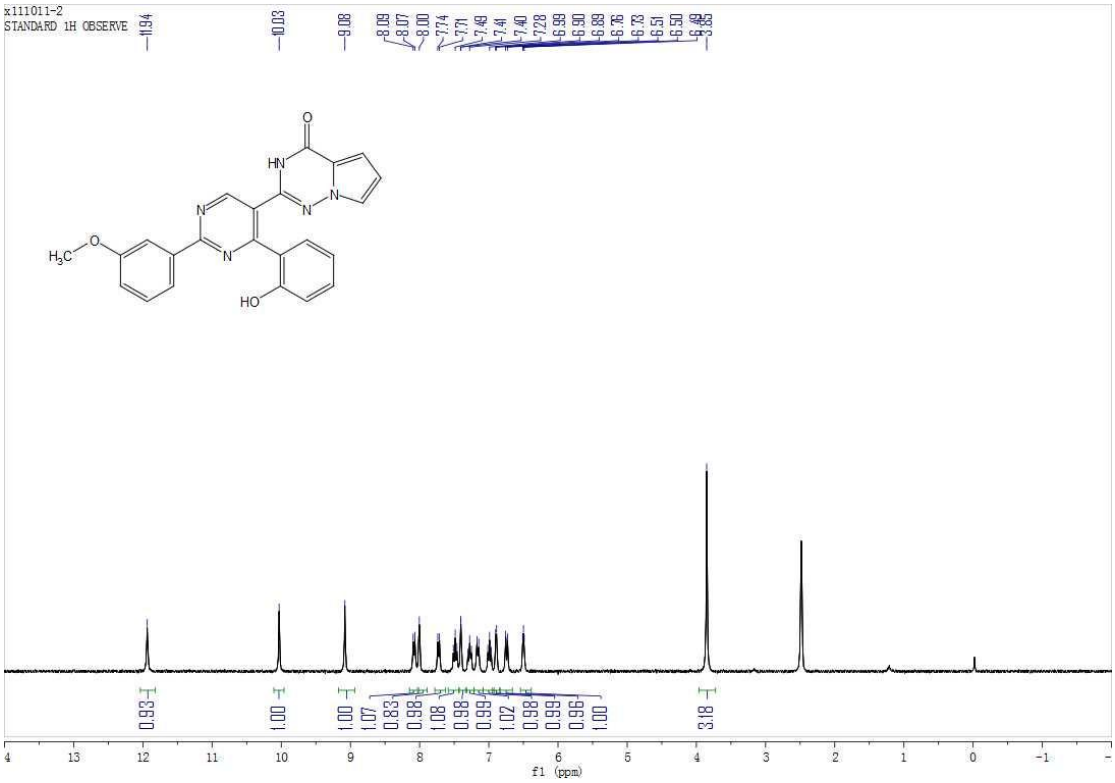
N
N
N
O
CH3
HO
f1 (ppm)

D6


x111011-2
STANDARD 1H OBSERVE
11.94
10.03
9.08
8.09
8.07
8.00
7.74
7.71
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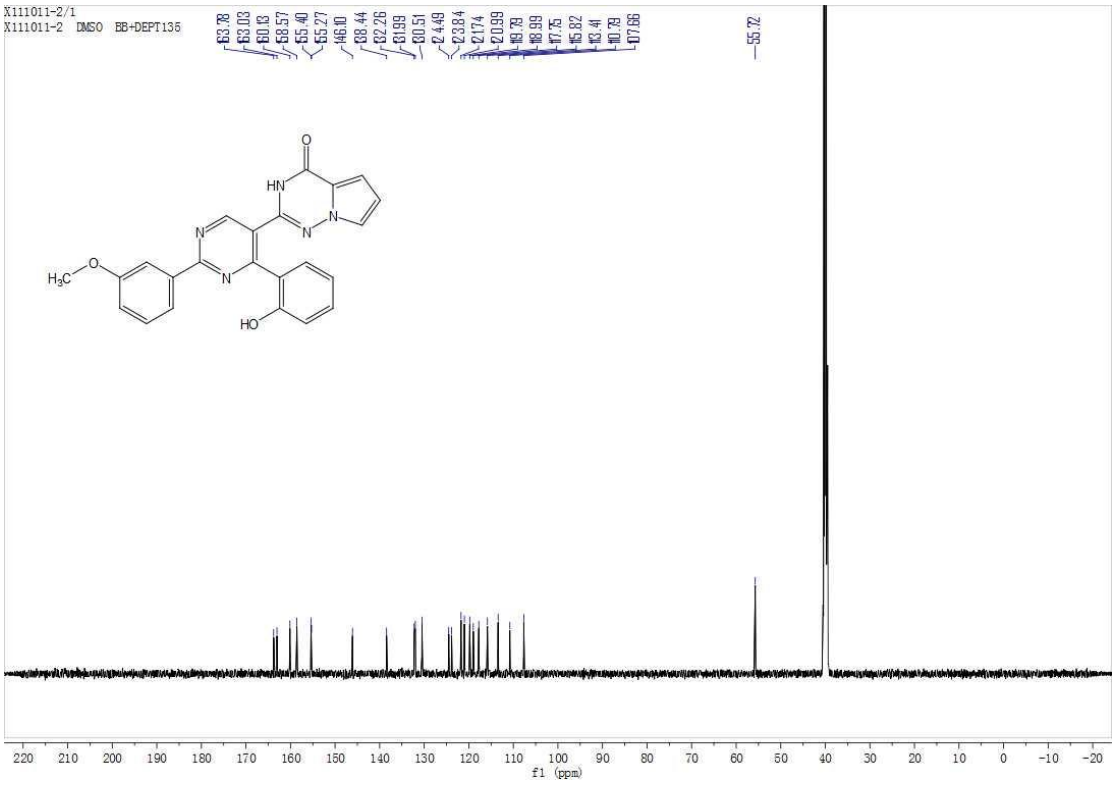
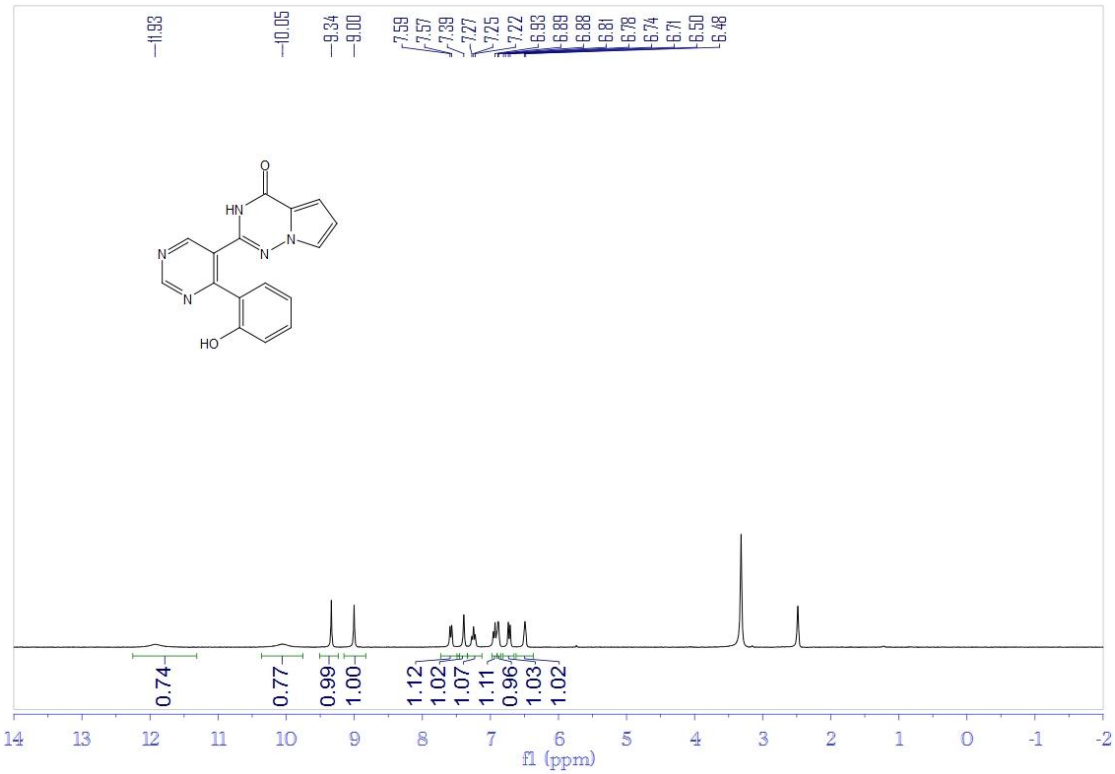
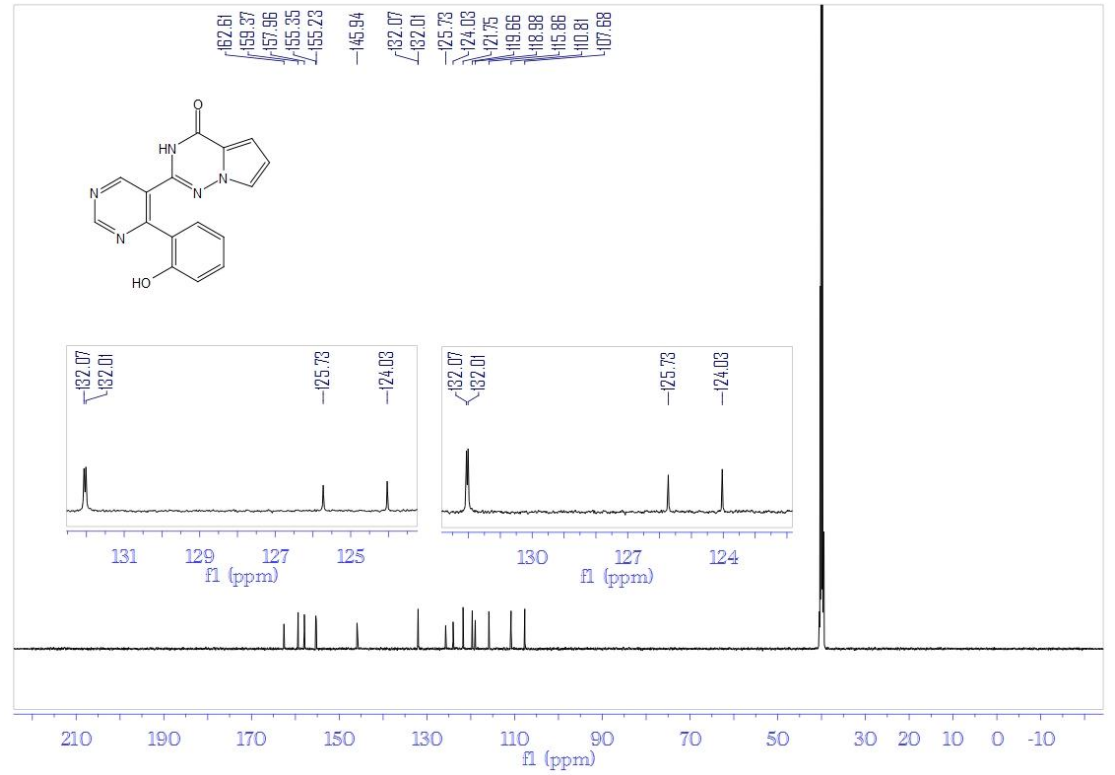
7.34
7.40
7.28
6.98
6.90
6.89
6.76
6.73
6.51
6.50
6.49
3.85
O
HN
N
N
N
H3C
O
HO
0.93
1.00
1.00
1.07
0.83
0.98
1.08
0.98
0.99
1.02
0.98
0.99
0.96
1.00
3.18
f1 (ppm)

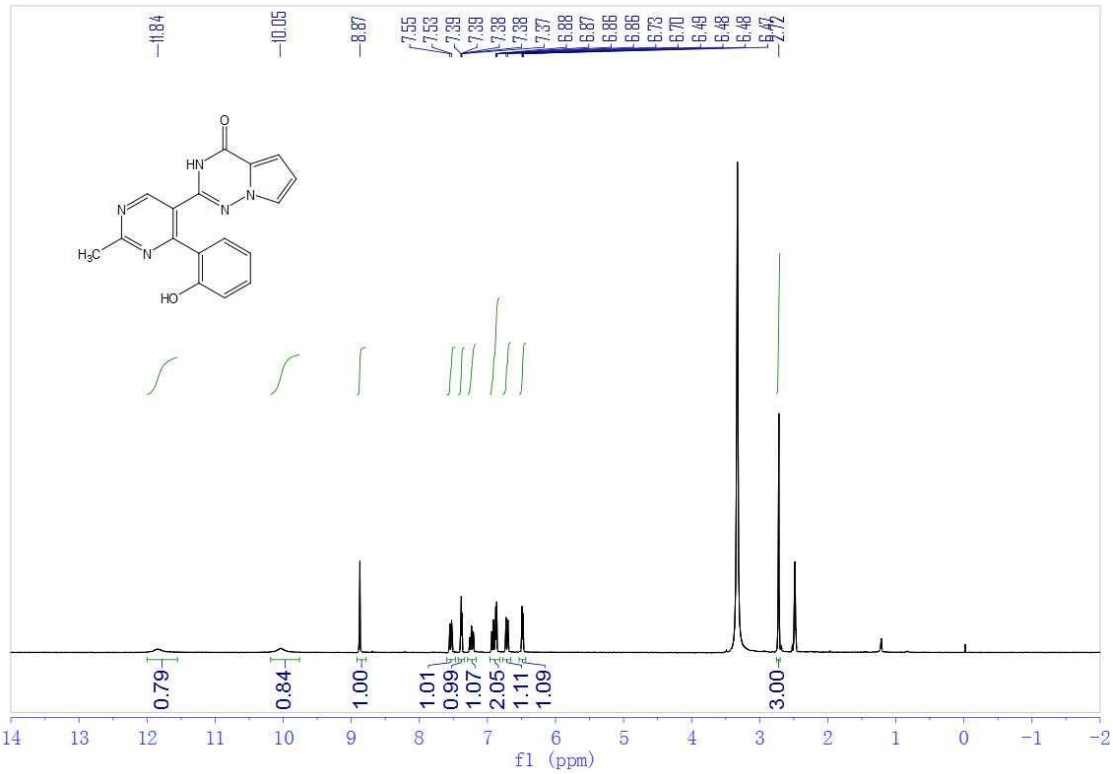

X111011-2/1
X111011-2 DMSO BB+DEPT135
163.78
163.03
160.13
158.57
155.40
155.27
146.10
138.44
132.26
131.99
130.51
124.49
123.84
121.74
120.99
119.79
118.99
117.75
115.82
113.41
110.79
107.66
55.72
O
HN
N
N
N
H3C
O
HO
f1 (ppm)

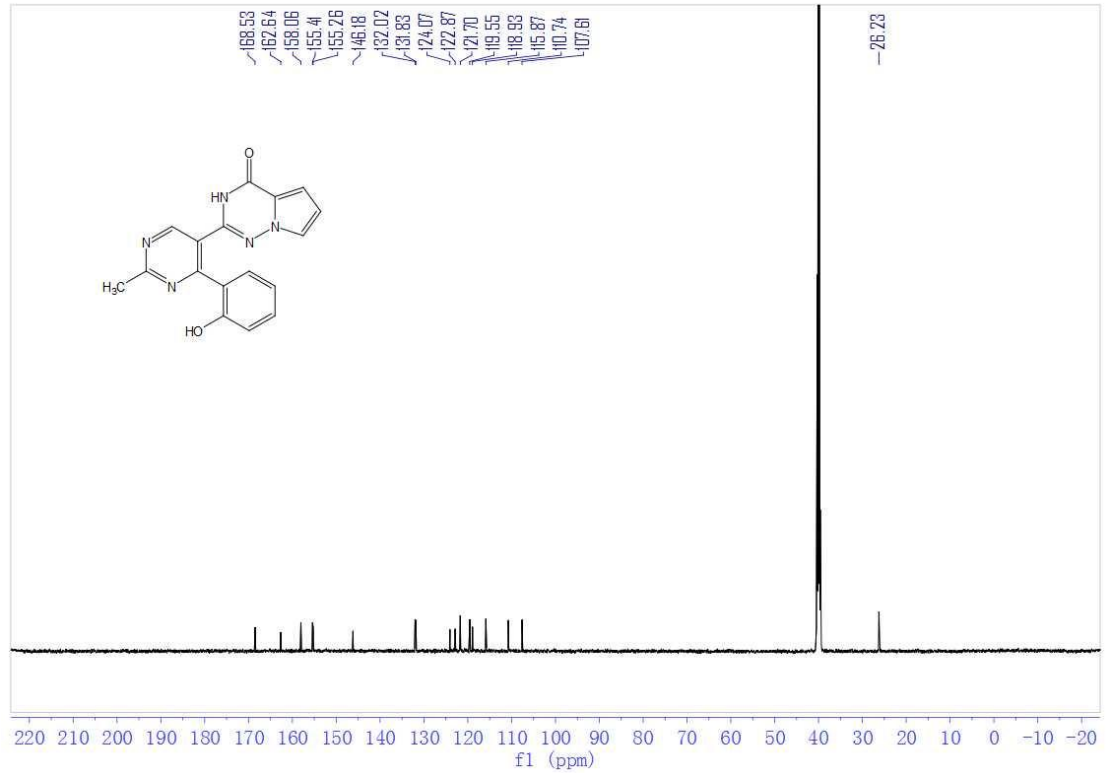
D7


11.93
10.05
9.34
9.00
7.59
7.57
7.39
7.27
7.25
7.22
6.83
6.89
6.88
6.81
6.78
6.74
6.71
6.50
6.48
HN
N
N
N
HO
0.74
0.77
0.99
1.00
1.12
1.02
1.07
1.11
0.96
1.03
1.02
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2
f1 (ppm)

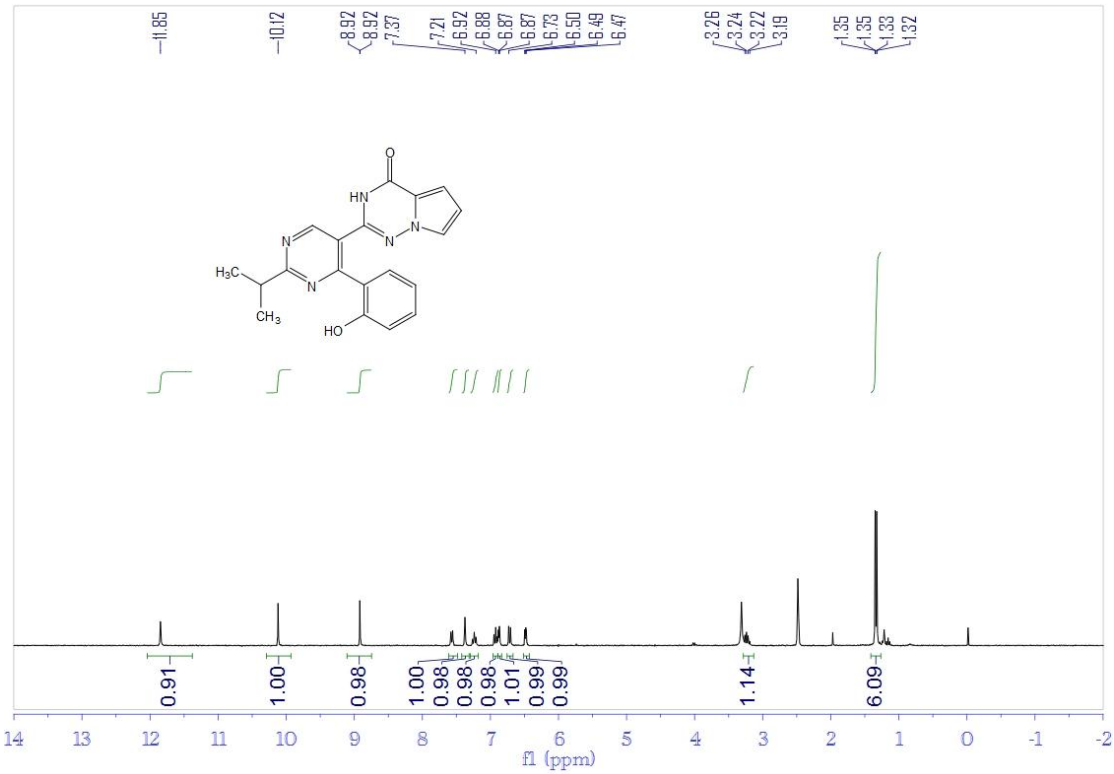

162.61
159.37
157.96
155.35
155.23
145.94
132.07
132.01
125.73
124.03
121.75
119.66
118.98
115.86
110.81
107.68
HN
N
N
N
HO
132.07
132.01
125.73
124.03
131 129 127 125
f1 (ppm)
130 127 124
f1 (ppm)
210 190 170 150 130 110 90 70 50 30 20 10 0 -10
f1 (ppm)

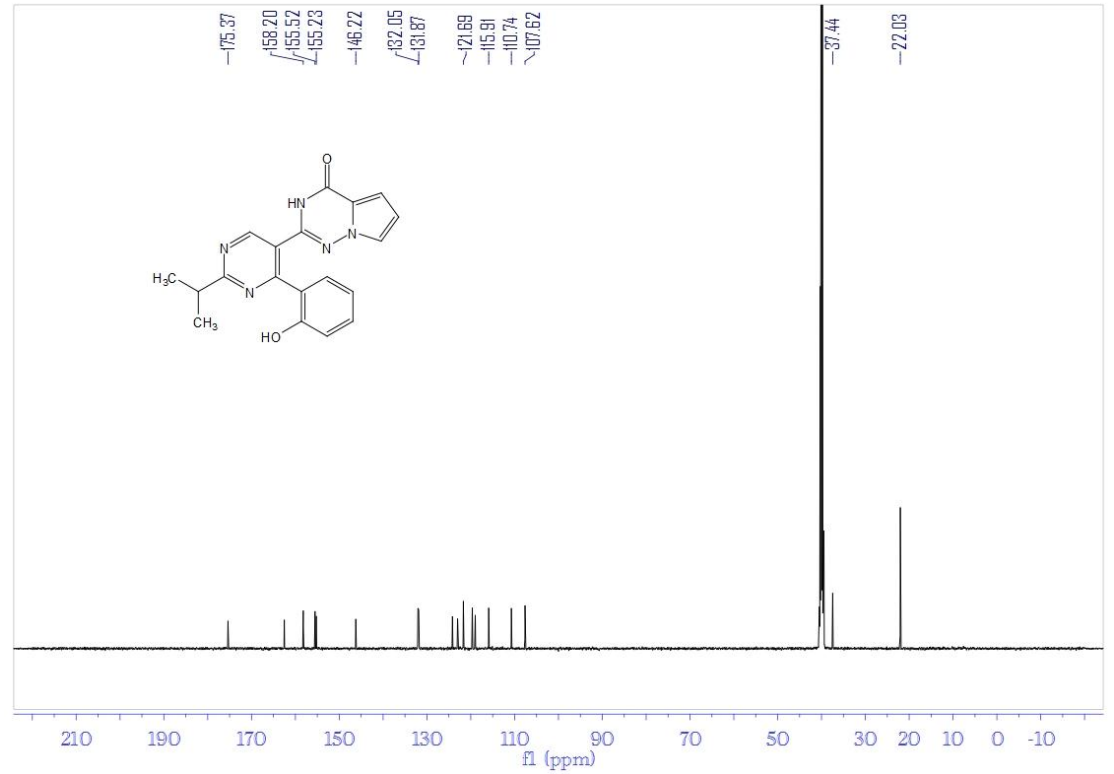
D8


11.84
10.05
8.87
7.55
7.53
7.39
7.39
7.38
7.38
7.37
6.88
6.87
6.86
6.86
6.73
6.70
6.49
6.48
6.48
6.47
2.72
HN
N
N
N
H3C
HO
0.79
0.84
1.00
1.01
0.99
1.07
2.05
1.11
1.09
3.00
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 −1 −2
f1 (ppm)

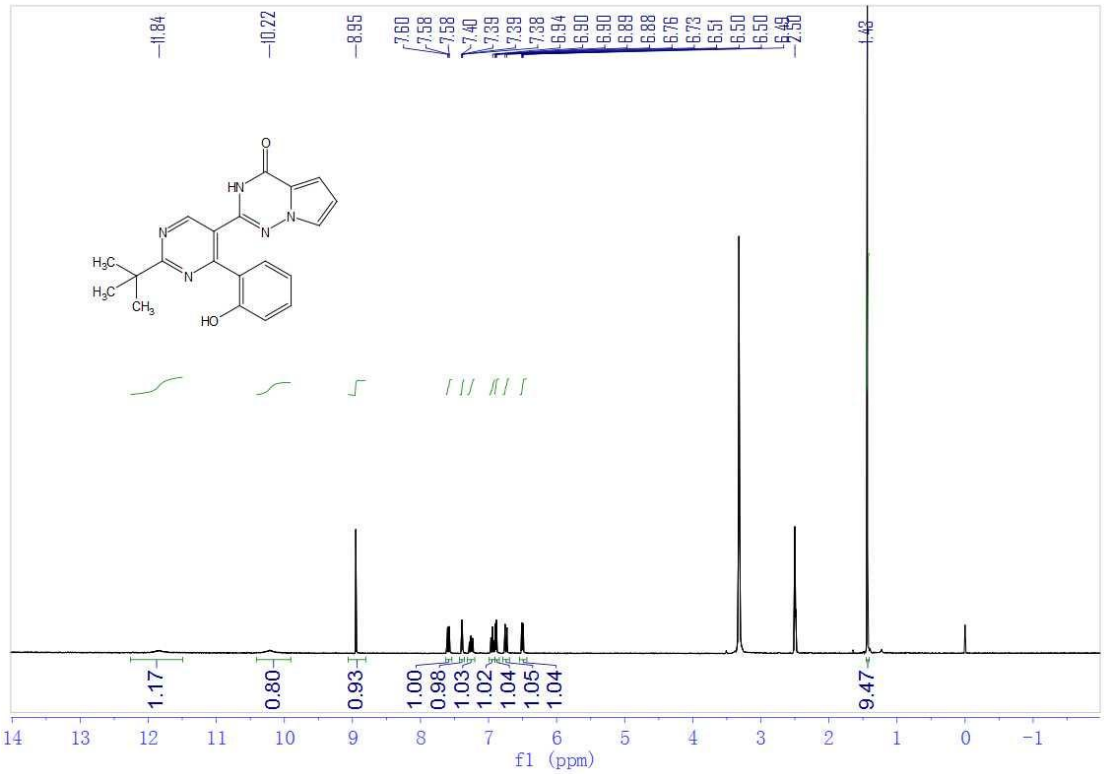

168.53
162.64
158.06
155.41
155.26
146.18
132.02
131.83
124.07
122.87
121.70
119.55
118.93
115.87
110.74
107.61
26.23
HN
N
N
N
H3C
HO
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10 −20
f1 (ppm)

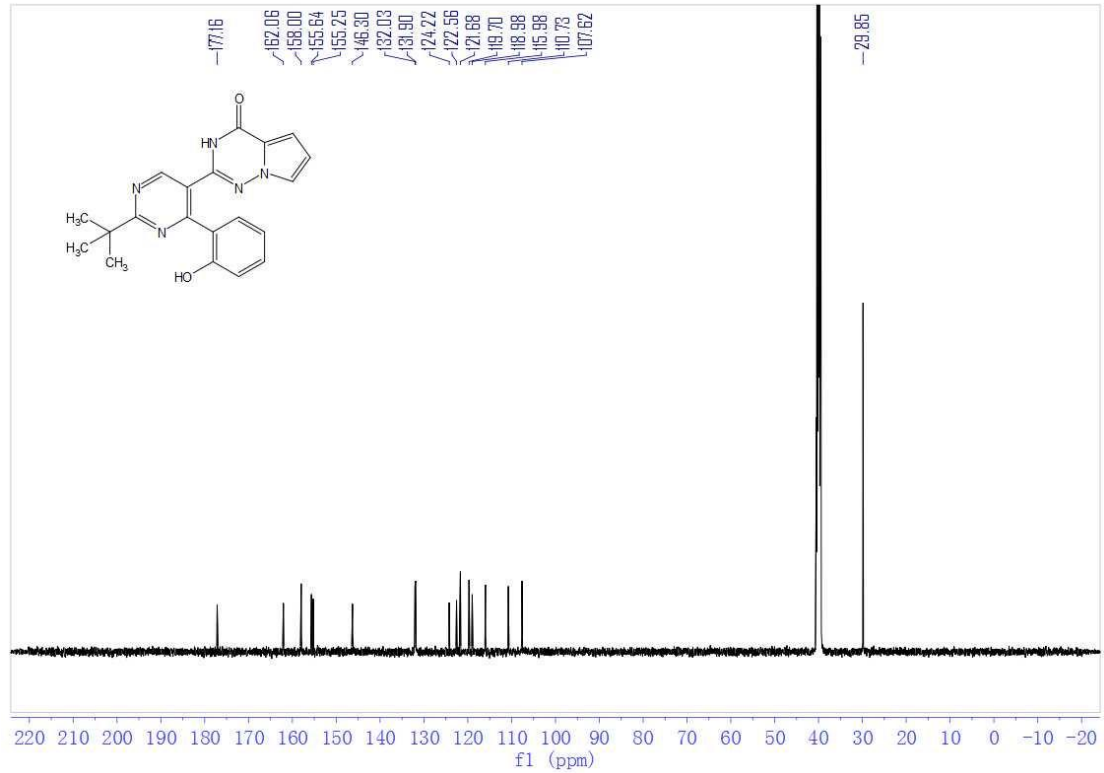
D9


11.85
10.12
8.92
8.92
7.37
7.21
6.92
6.88
6.87
6.87
6.73
6.50
6.49
6.47
3.26
3.24
3.22
3.19
1.35
1.35
1.33
1.32
0.91
1.00
0.98
1.00
0.98
0.98
1.01
0.99
0.99
1.14
6.09
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2
f1 (ppm)

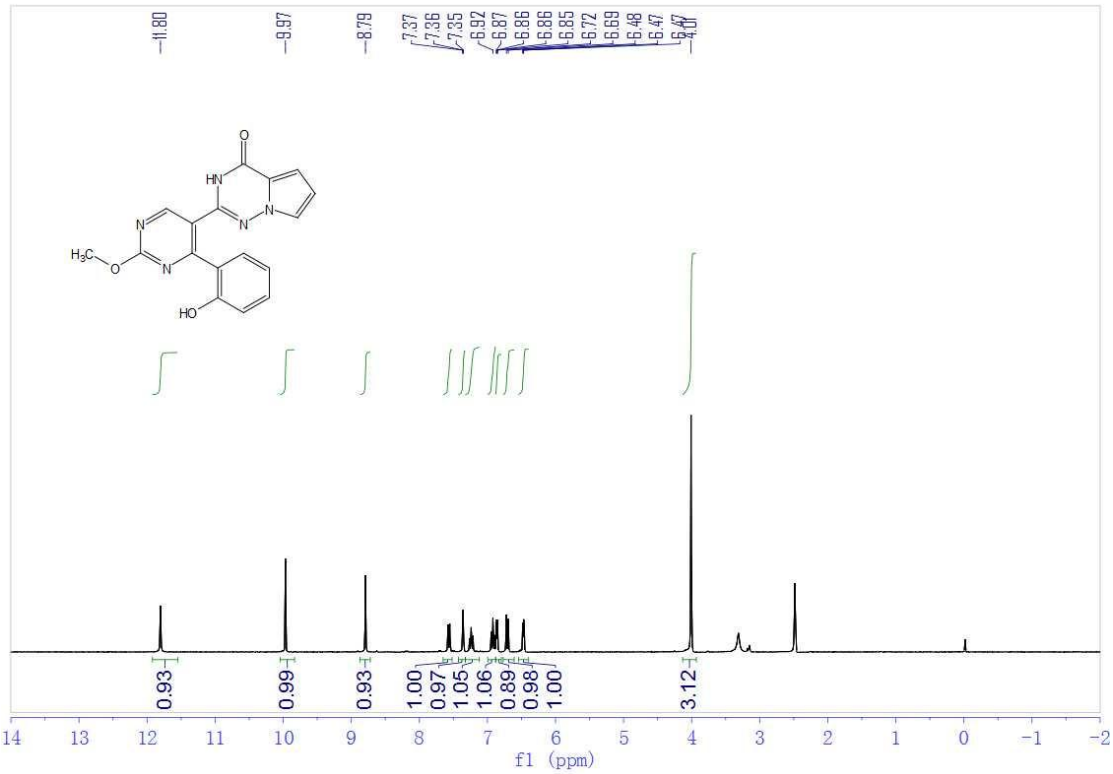

175.37
158.20
155.52
155.23
146.22
132.05
131.87
121.69
115.91
110.74
107.62
37.44
22.03
210 190 170 150 130 110 90 70 50 30 20 10 0 -10
f1 (ppm)

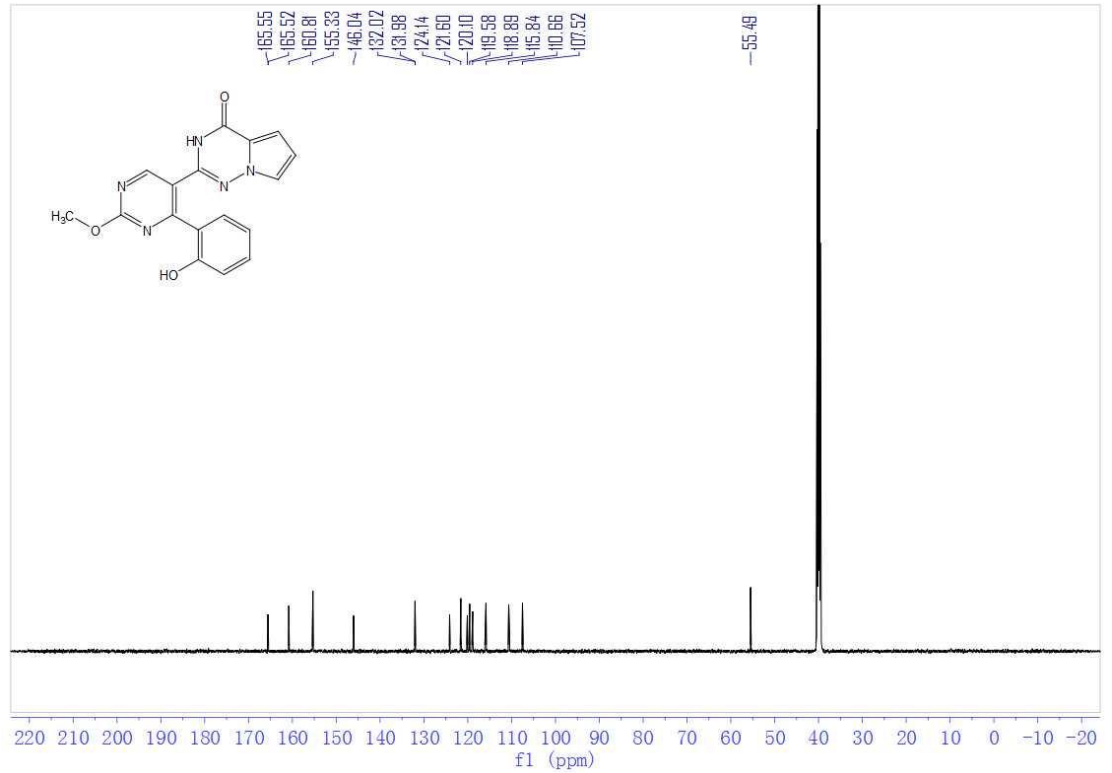
D10


11.84
10.22
8.95
7.60
7.58
7.58
7.40
7.39
7.39
7.38
6.94
6.90
6.90
6.89
6.88
6.76
6.73
6.51
6.50
6.50
6.49
2.50
1.48
1.17
0.80
0.93
1.00
0.98
1.03
1.02
1.04
1.05
1.04
9.47
f1 (ppm)

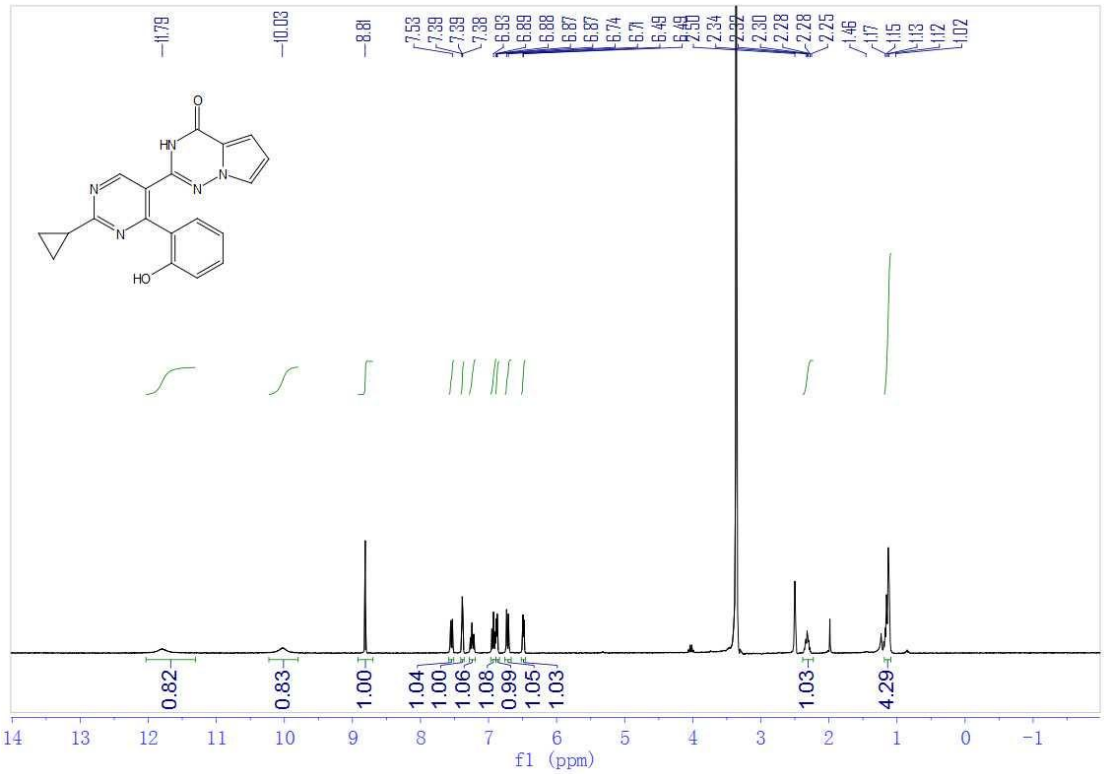

177.16
162.06
158.00
155.64
155.25
146.30
132.03
131.90
124.22
122.56
121.68
119.70
118.98
115.98
110.73
107.62
29.85
f1 (ppm)

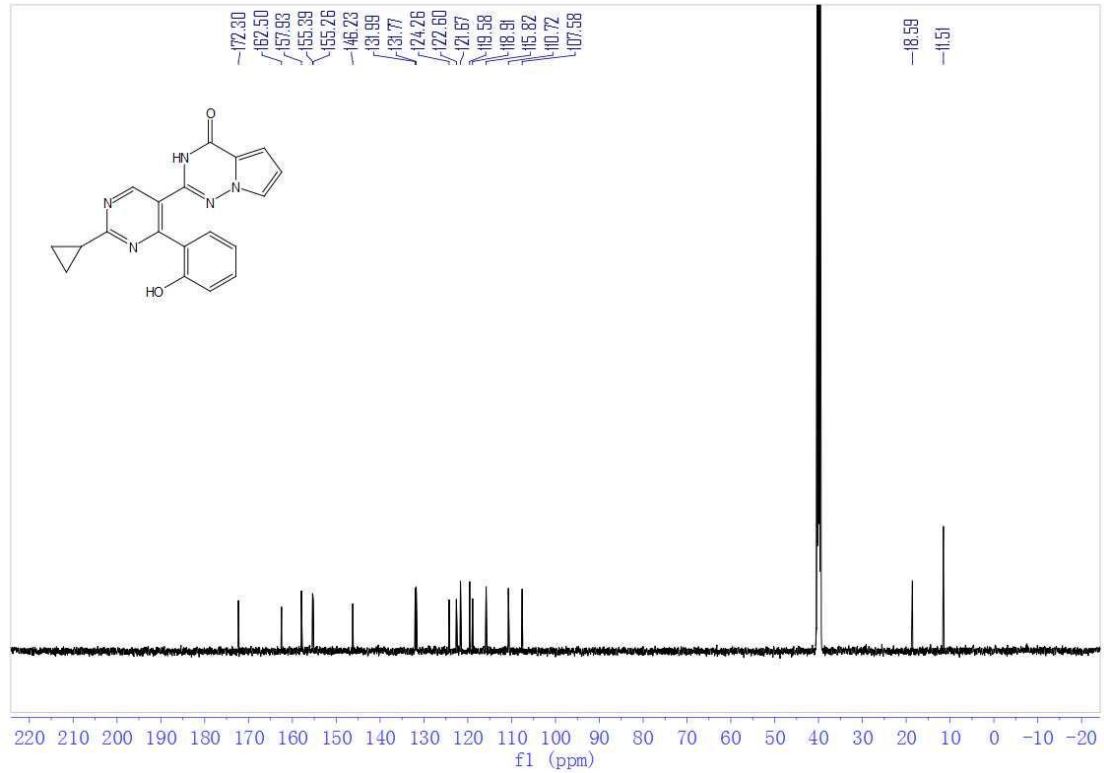
D11


11.80
9.97
8.79
7.37
7.36
7.35
6.92
6.87
6.86
6.68
6.85
6.72
6.69
6.48
6.47
6.47
4.07
0.93
0.99
0.93
1.00
0.97
1.05
1.06
0.89
0.98
1.00
3.12
f1 (ppm)

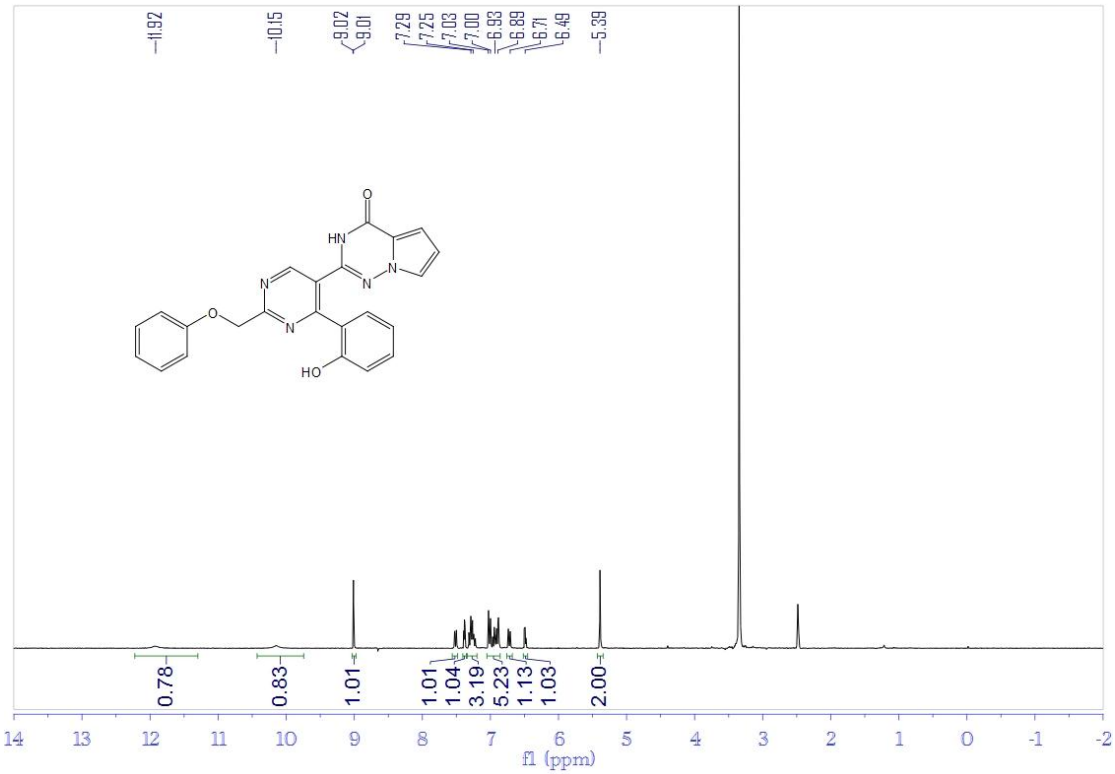

165.55
165.52
160.81
155.33
146.04
132.02
131.98
124.14
121.60
120.10
119.58
118.89
115.84
110.66
107.52
55.49
f1 (ppm)

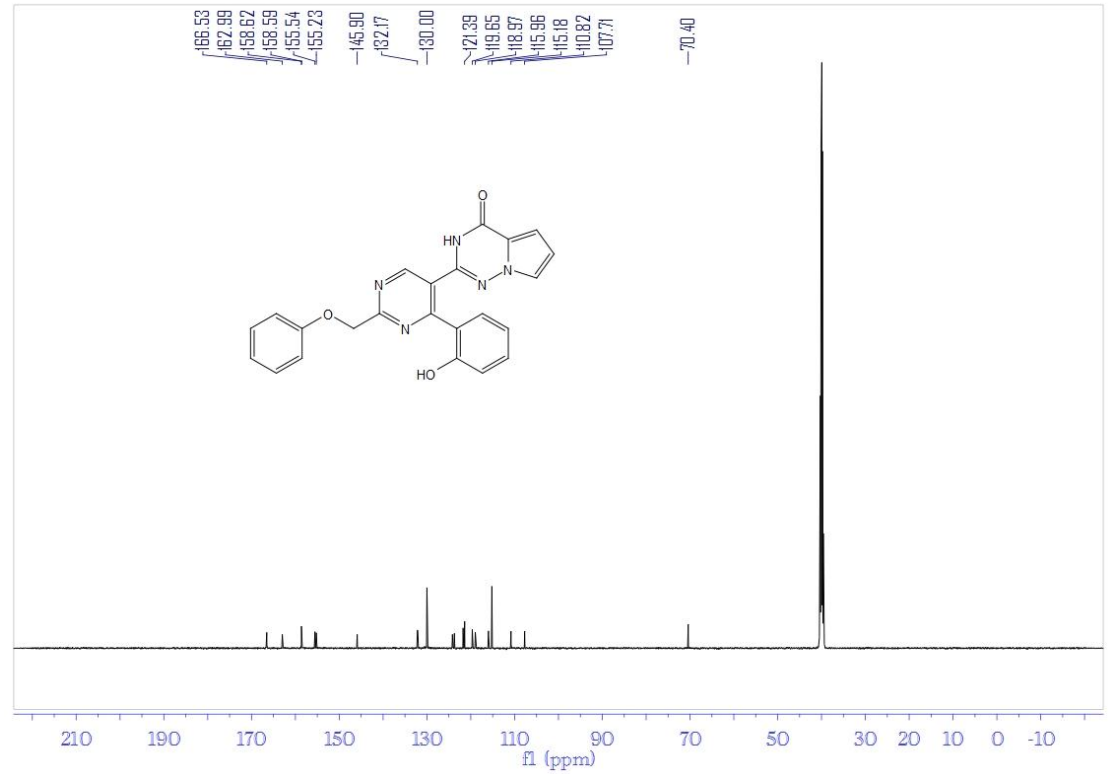
D12


11.79
10.03
8.81
7.53
7.39
7.39
7.39
7.38
6.93
6.89
6.88
6.87
6.87
6.74
6.71
6.49
6.49
2.34
2.32
2.30
2.28
2.28
2.25
1.46
1.17
1.15
1.13
1.12
1.02
0.82
0.83
1.00
1.04
1.00
1.06
1.08
0.99
1.05
1.03
1.03
4.29
f1 (ppm)

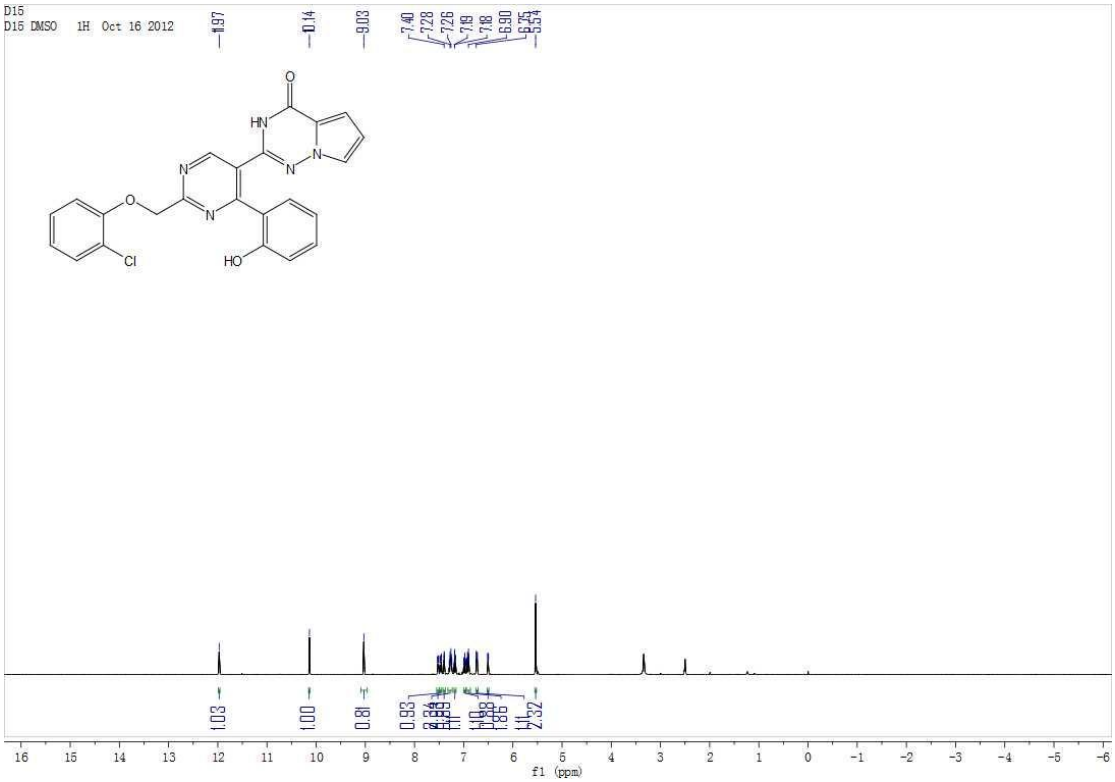

172.30
162.50
157.93
155.39
155.26
146.23
131.99
131.77
124.26
122.60
121.67
119.58
118.91
115.82
110.72
107.58
18.59
11.51
f1 (ppm)

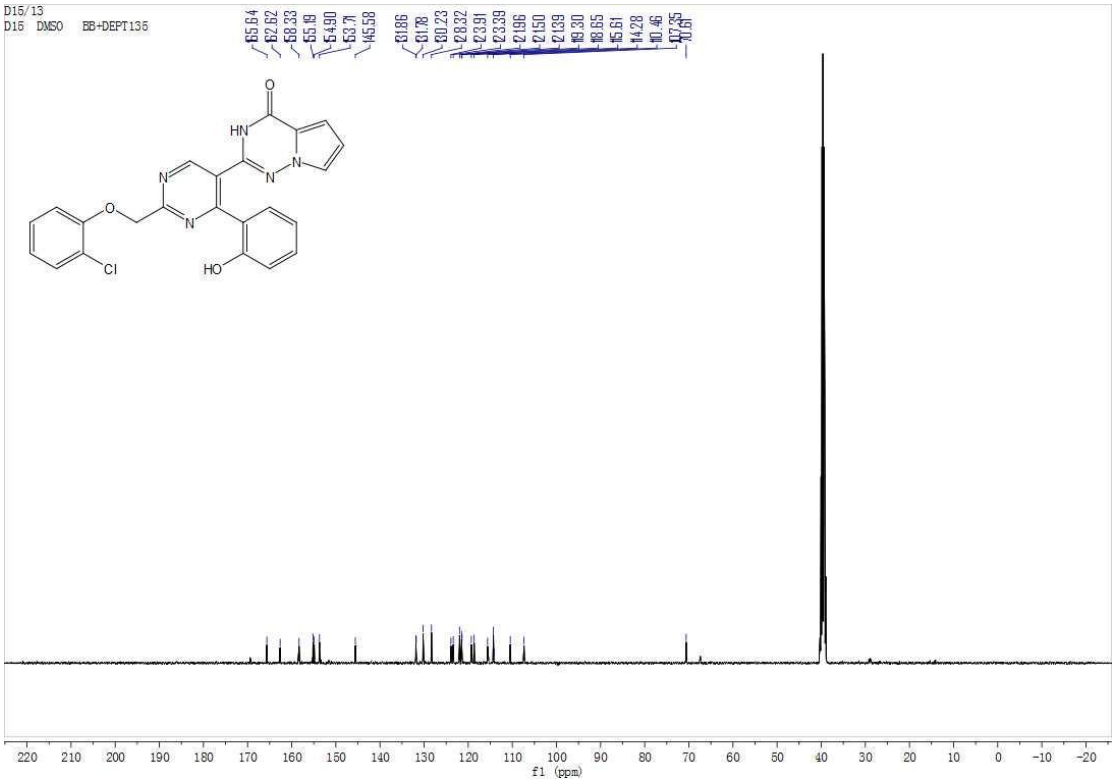
D13


11.92
10.15
9.02
9.01
7.29
7.25
7.03
7.00
6.93
6.89
6.71
6.49
5.39
0.78
0.83
1.01
1.01
1.04
3.19
5.23
1.13
1.03
2.00
f1 (ppm)

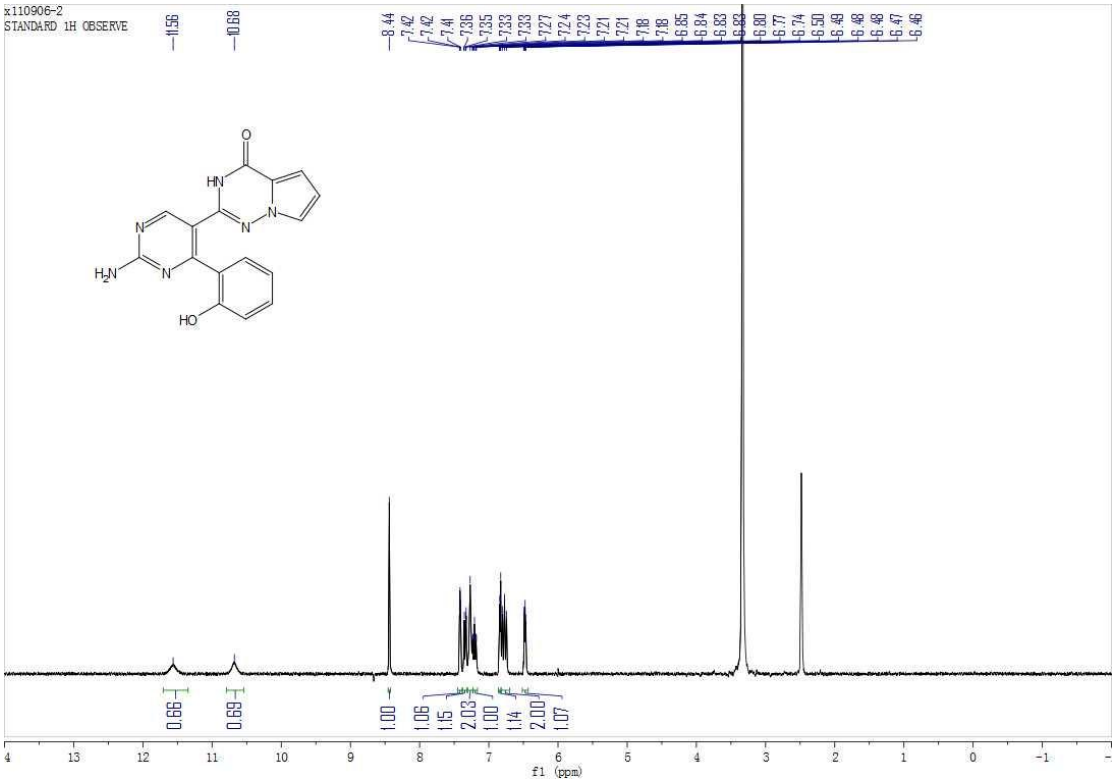

166.53
162.99
158.62
158.59
155.54
155.23
145.90
132.17
130.00
121.39
119.65
118.97
115.96
115.18
110.82
107.71
70.40
f1 (ppm)

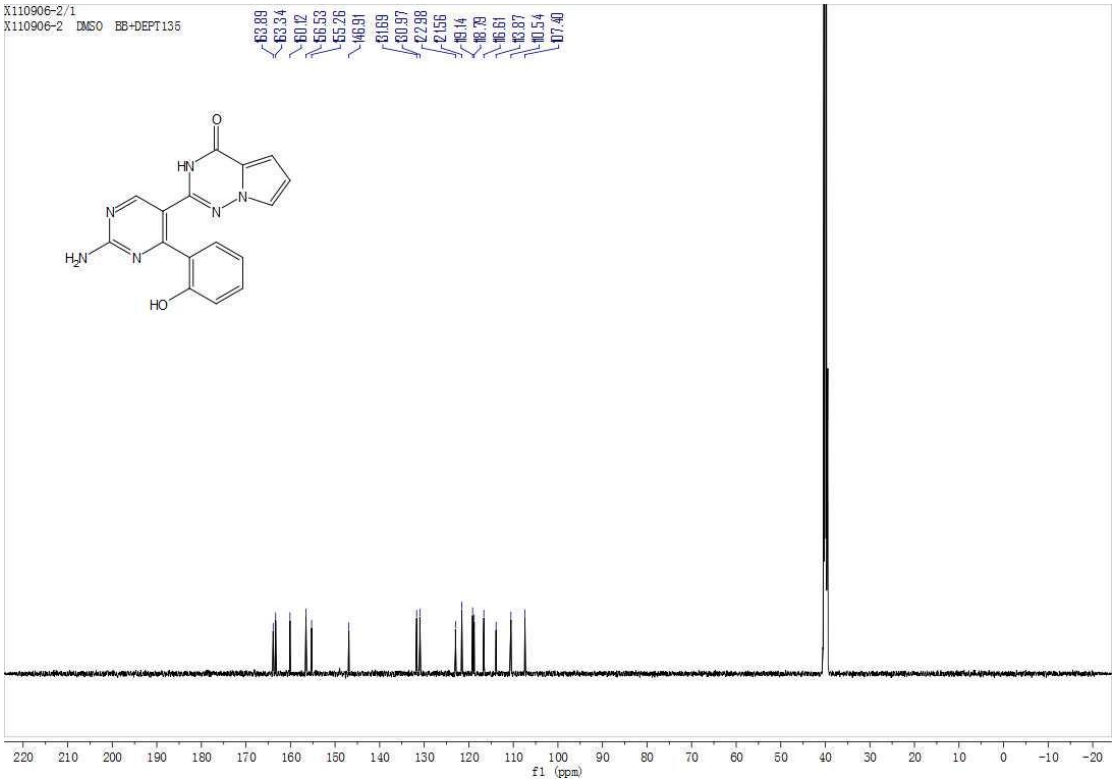
D14


D15
D15 DMSO 1H Oct 16 2012
f1 (ppm)

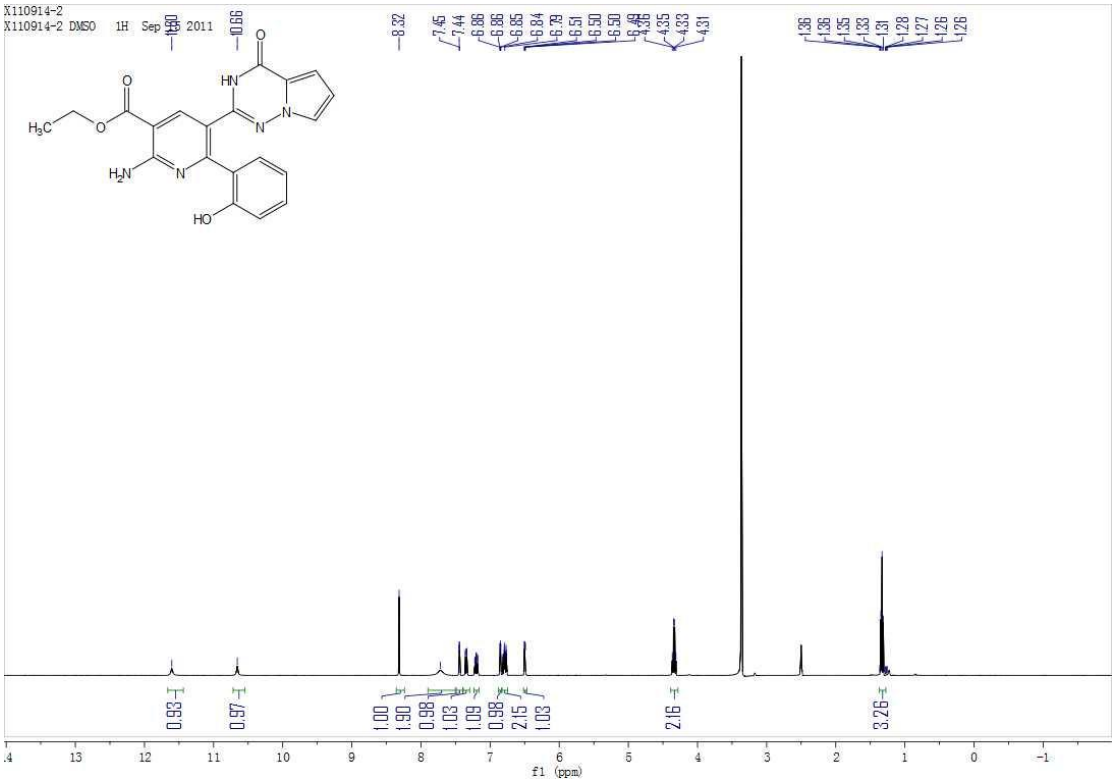

D15/13
D15 DMSO BB+DEPT135
f1 (ppm)

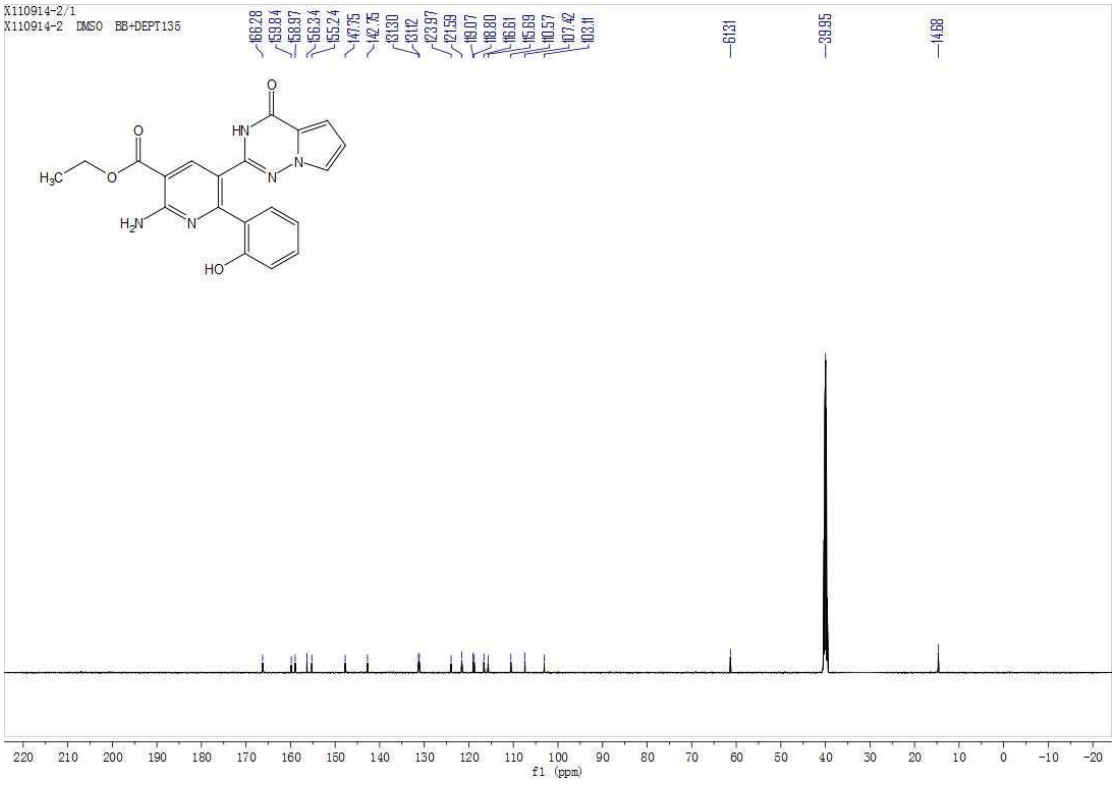
D15


x110906-2
STANDARD 1H OBSERVE
11.56
10.68
8.44
7.42
7.42
7.41
7.36
7.35
7.33
7.33
7.27
7.24
7.23
7.21
7.21
7.18
7.18
6.85
6.84
6.83
6.82
6.80
6.77
6.74
6.50
6.49
6.48
6.48
6.47
6.46
HN
O
N
N
N
H2N
HO
0.66
0.69
1.00
1.06
1.15
2.03
1.00
1.14
2.00
1.07
f1 (ppm)

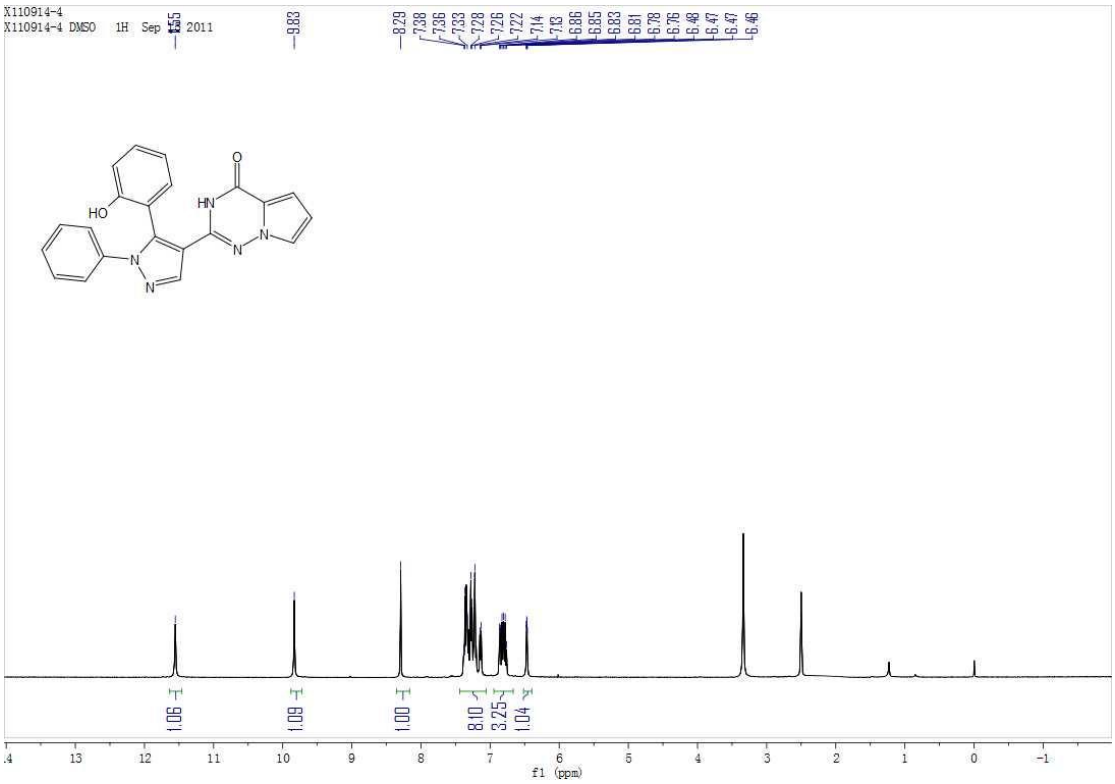

X110906-2/1
X110906-2 DMSO BB+DEPT135
163.89
163.34
160.12
156.53
155.26
146.91
131.69
130.97
122.98
121.56
119.14
118.78
116.61
113.87
110.54
107.40
HN
O
N
N
N
H2N
HO
f1 (ppm)

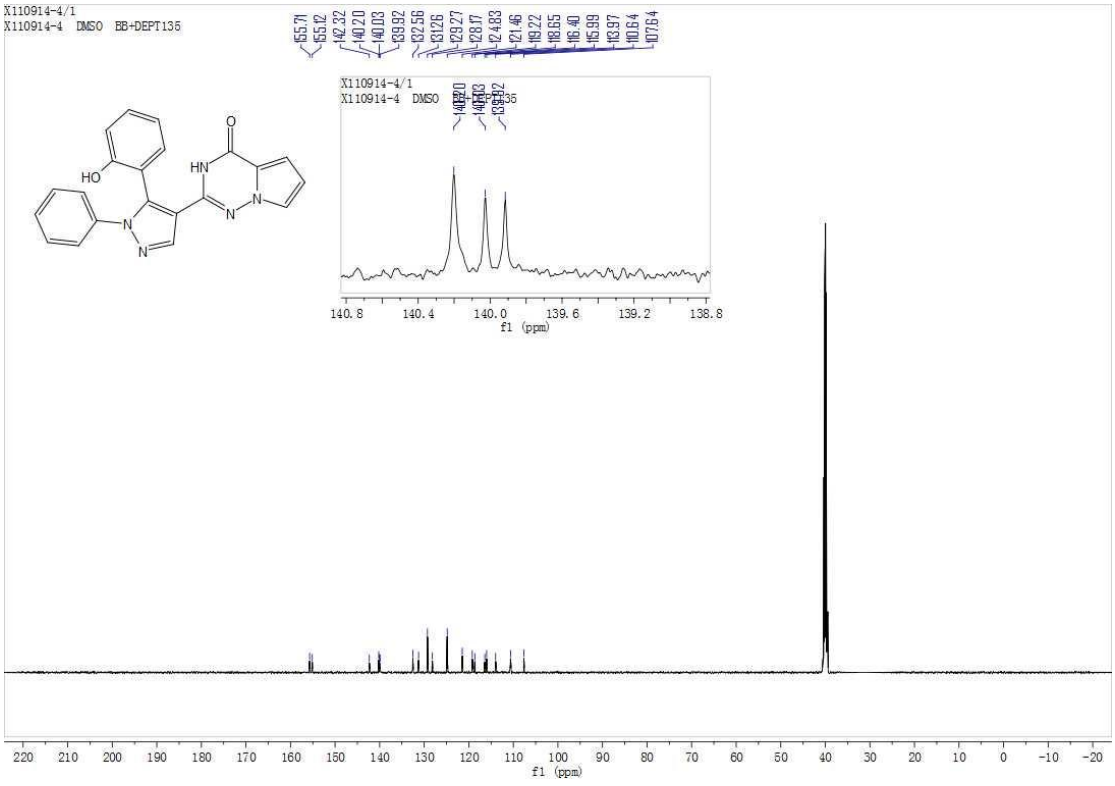
D16


X110914-2
X110914-2 DMSO 1H Sep 2011
f1 (ppm)

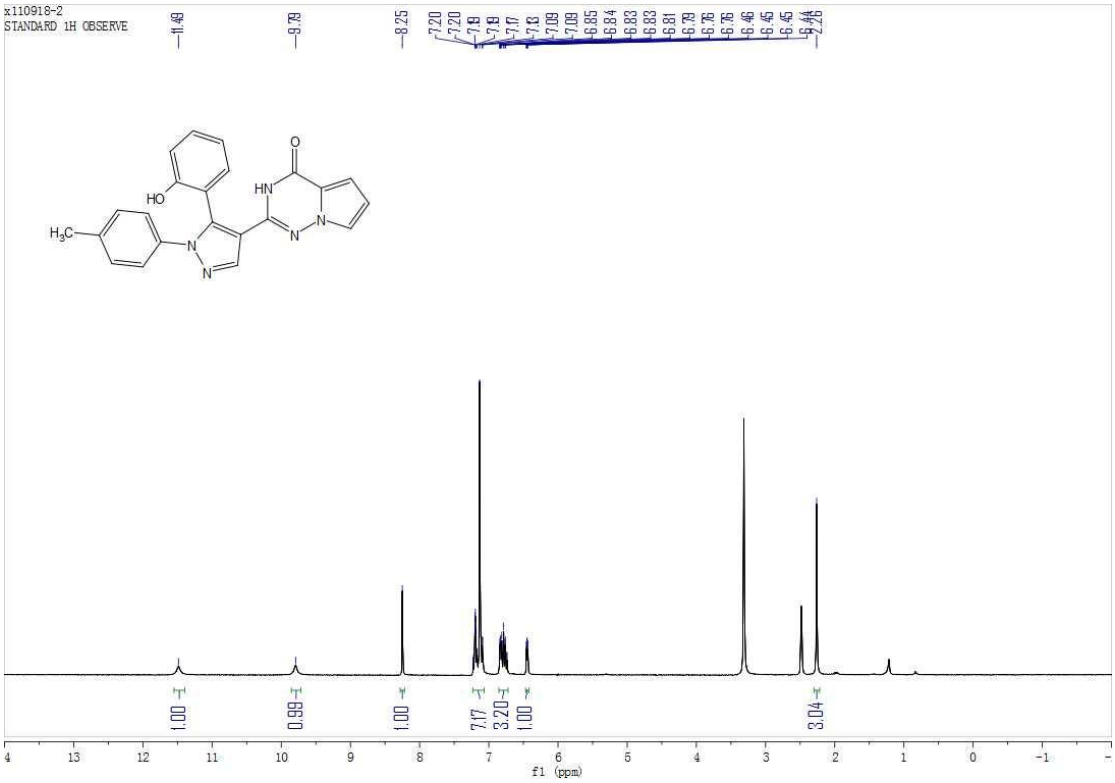

X110914-2/1
X110914-2 DMSO BB+DEPT135
f1 (ppm)

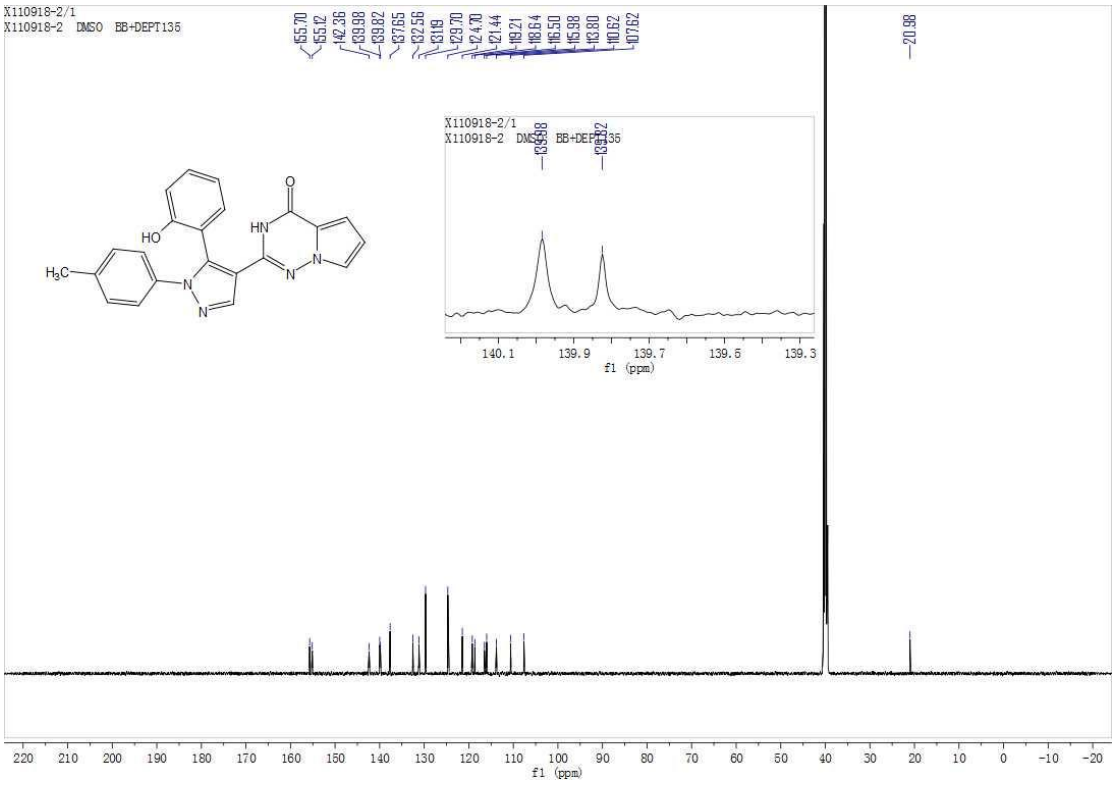
D17


X110914-4
X110914-4 DMSO 1H Sep 2011
9.83
8.29
7.38
7.36
7.33
7.28
7.26
7.22
7.14
7.13
6.86
6.85
6.83
6.81
6.78
6.76
6.48
6.47
6.47
6.46
HO
HN
O
N
N
N
1.06
1.09
1.00
8.10
3.25
1.04
f1 (ppm)

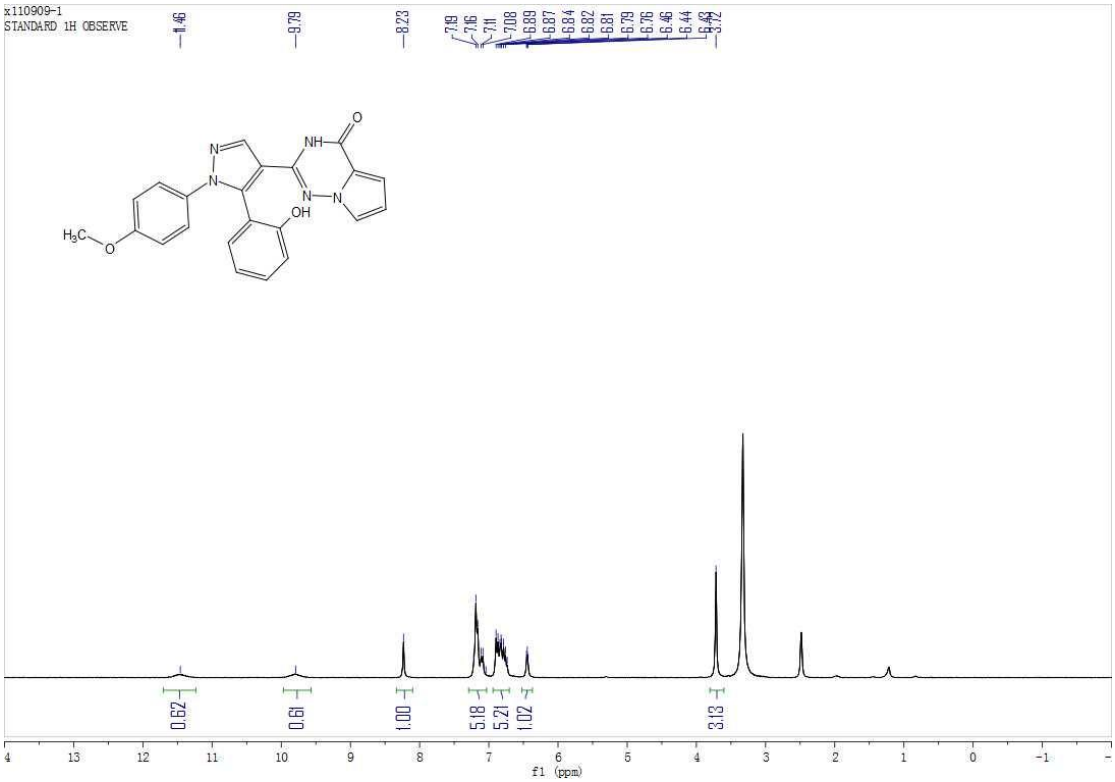

X110914-4/1
X110914-4 DMSO BB+DEPT135
155.71
155.12
142.32
140.20
140.03
139.92
132.56
131.26
129.27
128.47
124.83
121.46
119.22
118.65
116.40
115.99
103.97
100.64
97.64
X110914-4/1
X110914-4 DMSO
HO
HN
O
N
N
N
140.8
140.4
140.0
139.6
139.2
138.8
f1 (ppm)
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
f1 (ppm)

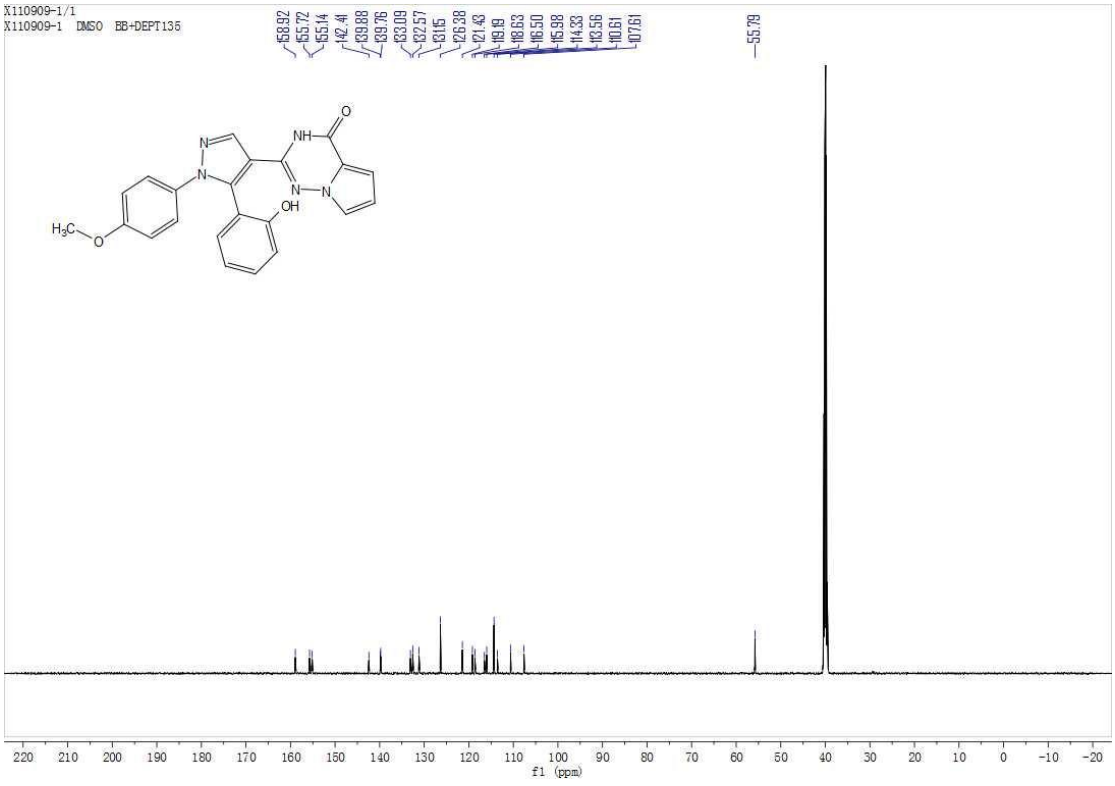
D18


x110918-2
STANDARD 1H OBSERVE
f1 (ppm)

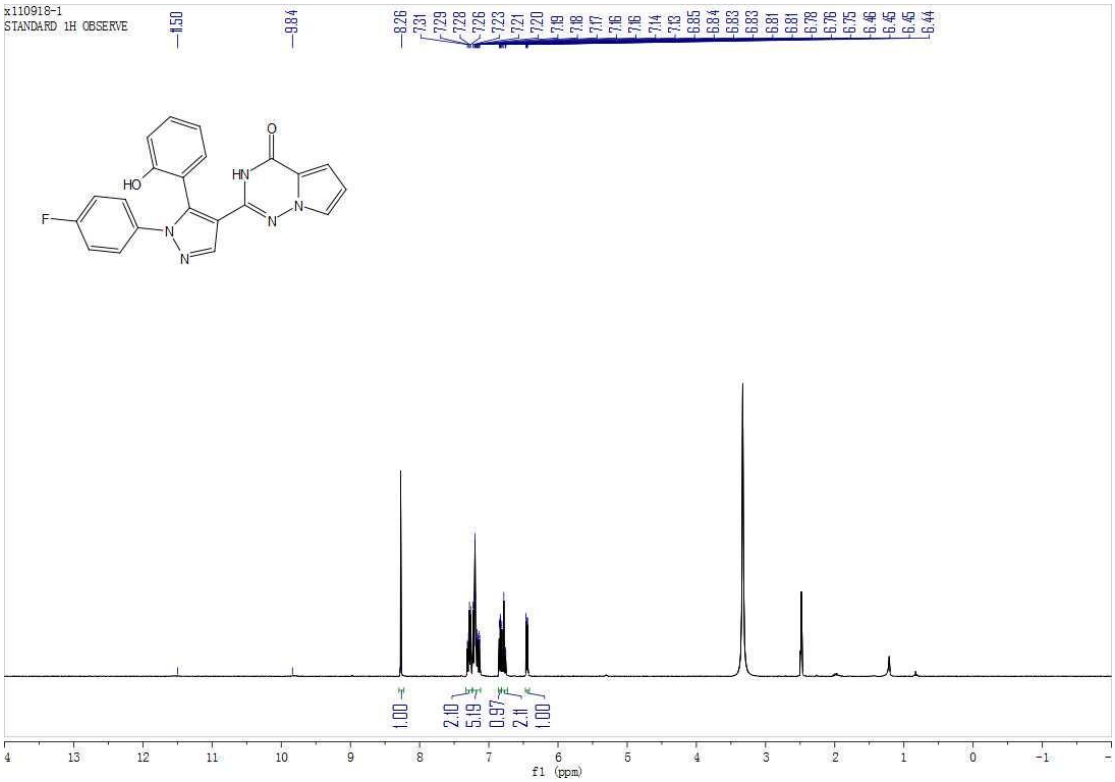

X110918-2/1
X110918-2 DMSO BB+DEPT135
f1 (ppm)

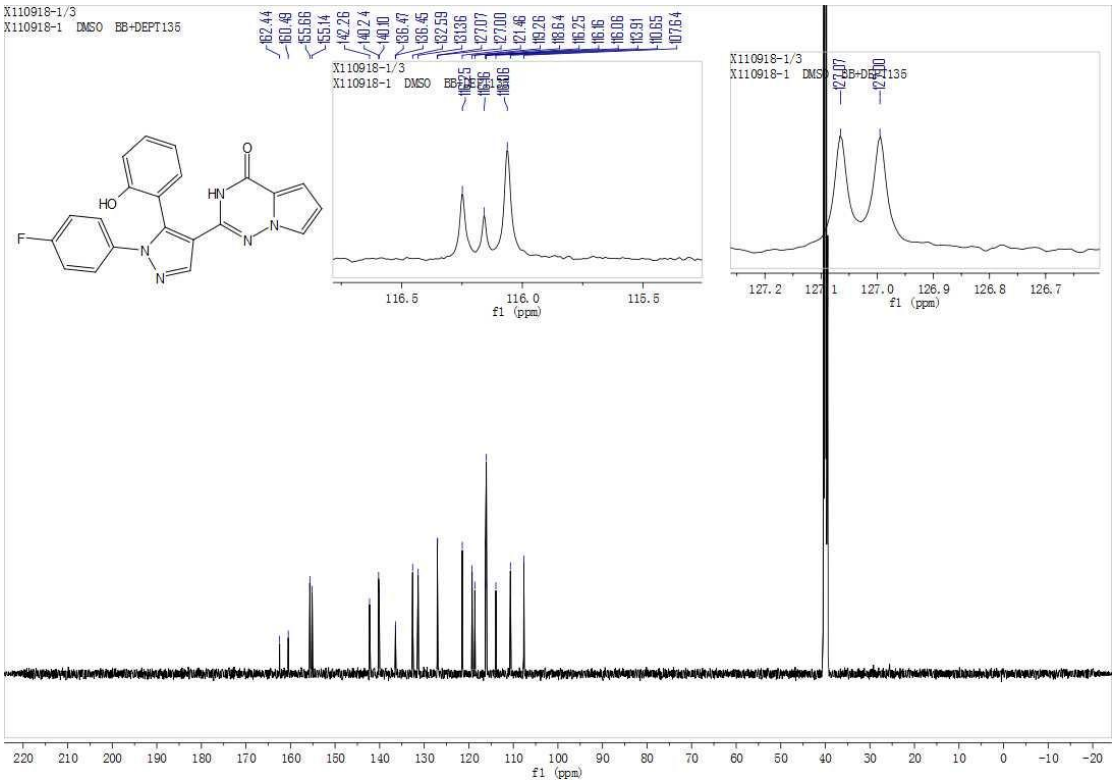
D19


x110909-1
STANDARD 1H OBSERVE
11.46
9.79
8.23
7.19
7.16
7.11
7.08
6.89
6.87
6.84
6.82
6.81
6.79
6.76
6.46
6.44
6.43
3.72
NH
O
N
N
N
N
OH
H3C
O
0.62
0.61
1.00
5.18
5.21
1.02
3.13
f1 (ppm)

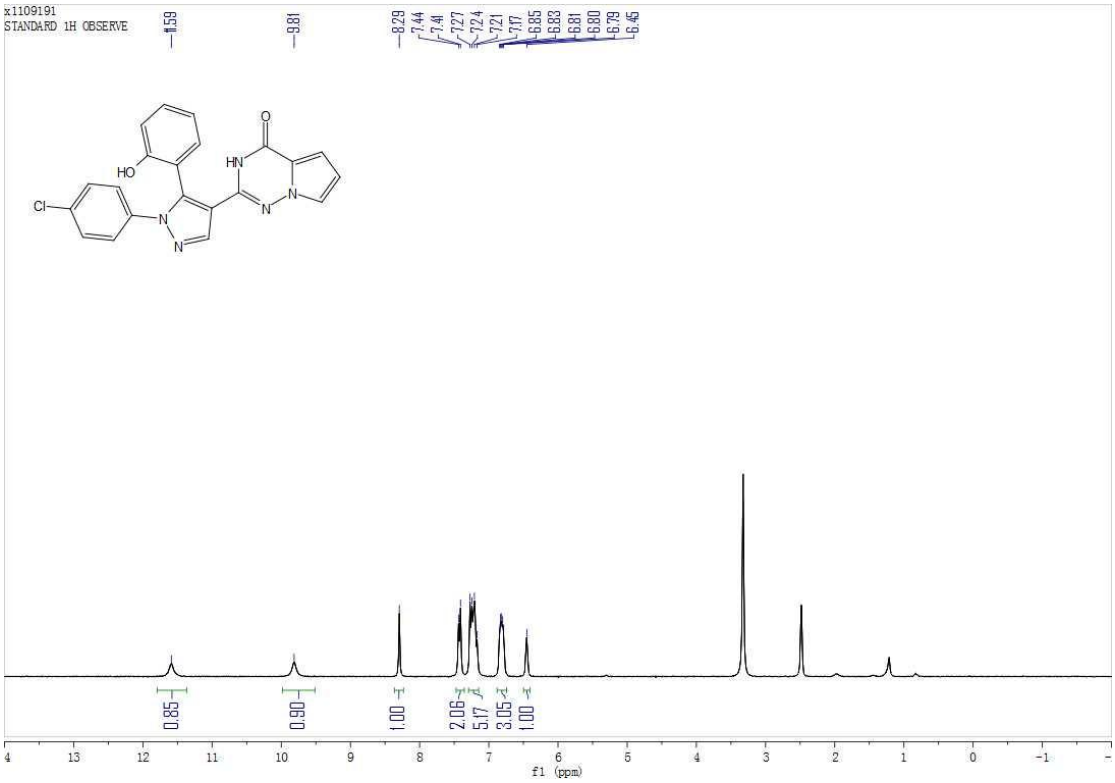

X110909-1/1
X110909-1 DMSO BB+DEPT135
158.92
155.72
155.14
142.41
139.88
139.76
133.09
132.57
131.15
126.38
121.43
119.19
118.63
116.50
115.98
114.33
113.56
110.61
107.61
55.79
NH
O
N
N
N
N
OH
H3C
O
f1 (ppm)

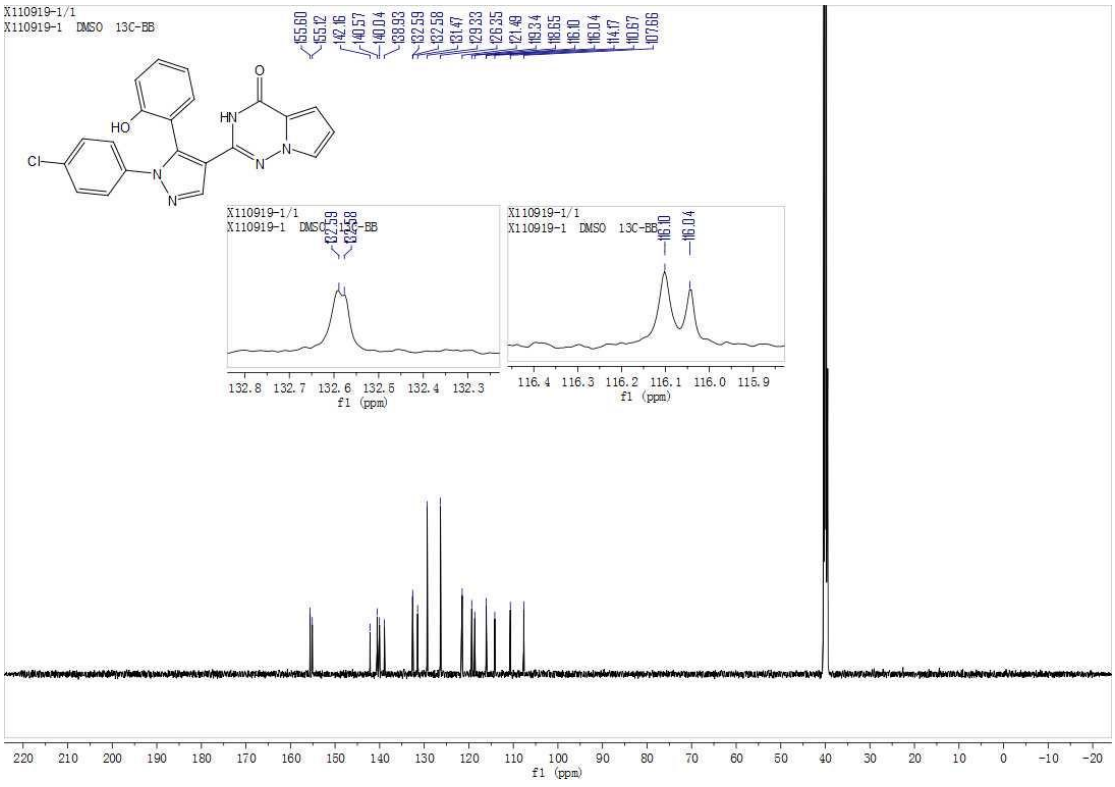
D20


x110918-1
STANDARD 1H OBSERVE
f1 (ppm)

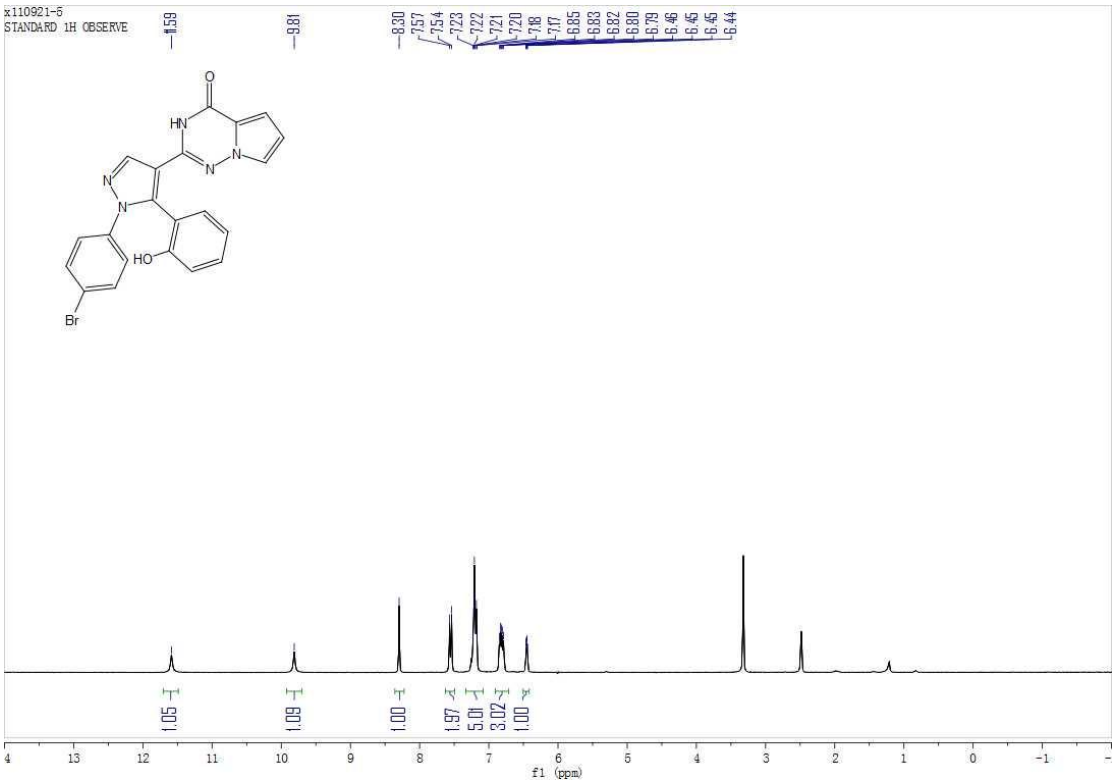

X110918-1/3
X110918-1 DMSO BB+DEPT135
f1 (ppm)

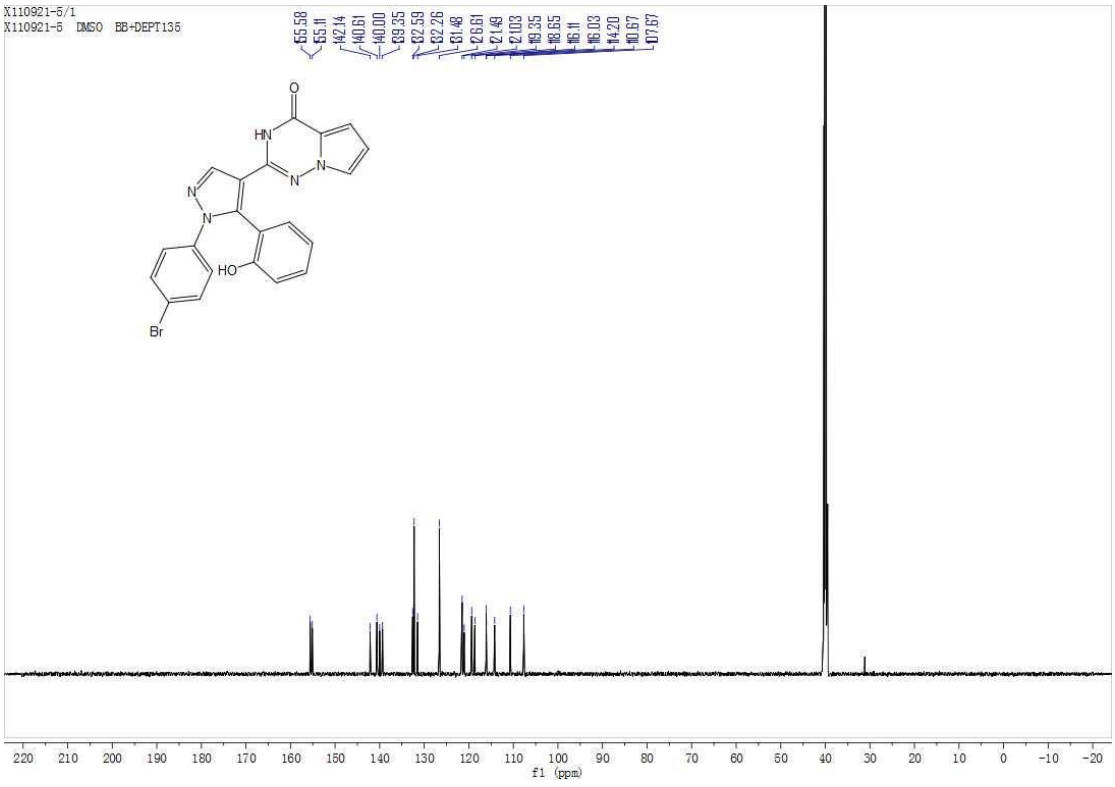
D21


x1109191
STANDARD 1H OBSERVE
11.59
9.81
8.29
7.44
7.41
7.27
7.24
7.21
7.17
6.85
6.83
6.81
6.80
6.79
6.45
HO
HN
O
N
N
N
Cl
0.85
0.90
1.00
2.06
5.17
3.05
1.00
f1 (ppm)

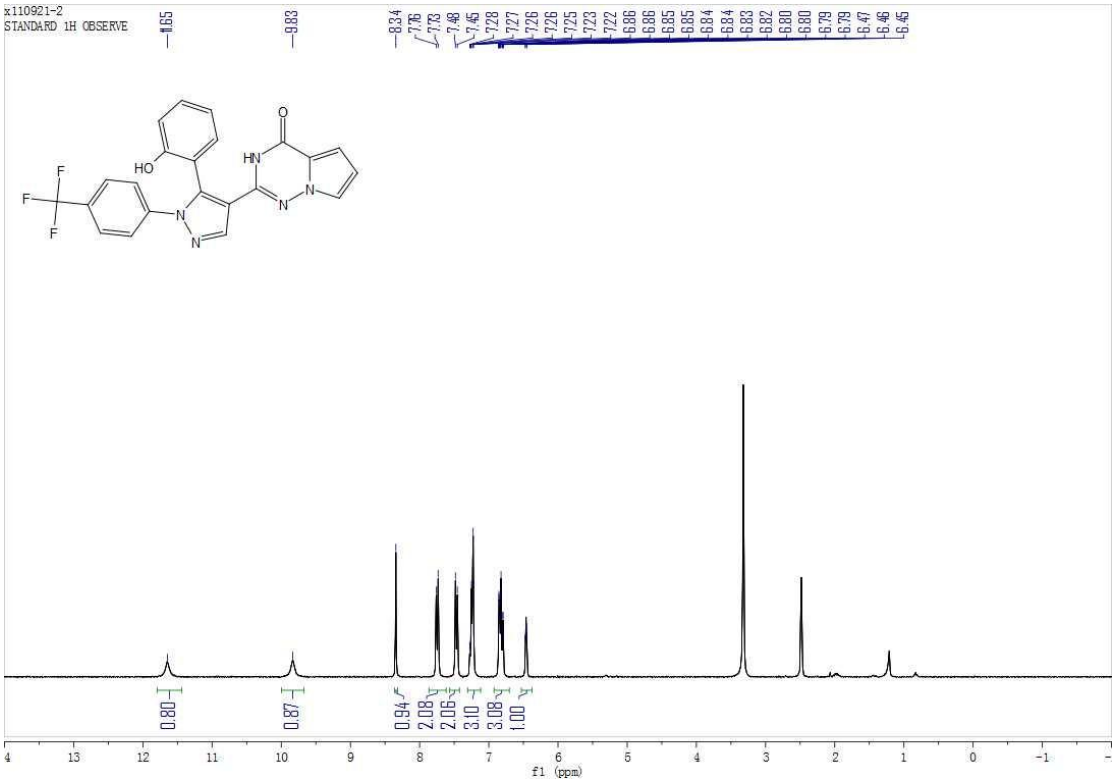

X110919-1/1
X110919-1 DMSO 13C-BB
155.80
155.12
142.16
140.57
140.04
138.93
132.59
132.58
131.47
129.33
126.35
121.49
118.34
118.65
116.10
116.04
114.47
110.67
107.66
HO
HN
O
N
N
N
Cl
X110919-1/1
X110919-1 DMSO 13C-BB
132.59
132.58
132.8 132.7 132.6 132.5 132.4 132.3
f1 (ppm)
X110919-1/1
X110919-1 DMSO 13C-BB
116.10
116.04
116.4 116.3 116.2 116.1 116.0 115.9
f1 (ppm)
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)

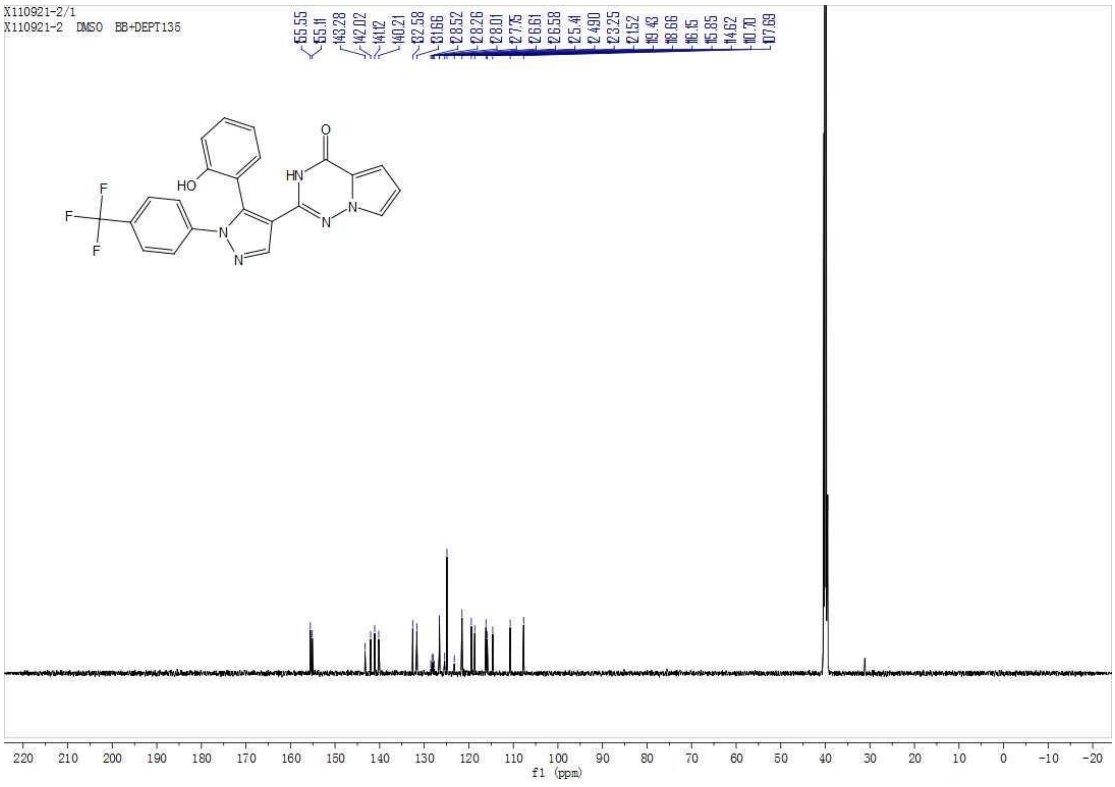
D22


x110921-5
STANDARD 1H OBSERVE
11.59
9.81
8.30
7.57
7.54
7.23
7.22
7.21
7.20
7.18
7.17
6.85
6.83
6.82
6.80
6.79
6.46
6.45
6.44
HN
N
N
N
HO
Br
1.05
1.09
1.00
1.97
5.01
3.02
1.00
f1 (ppm)

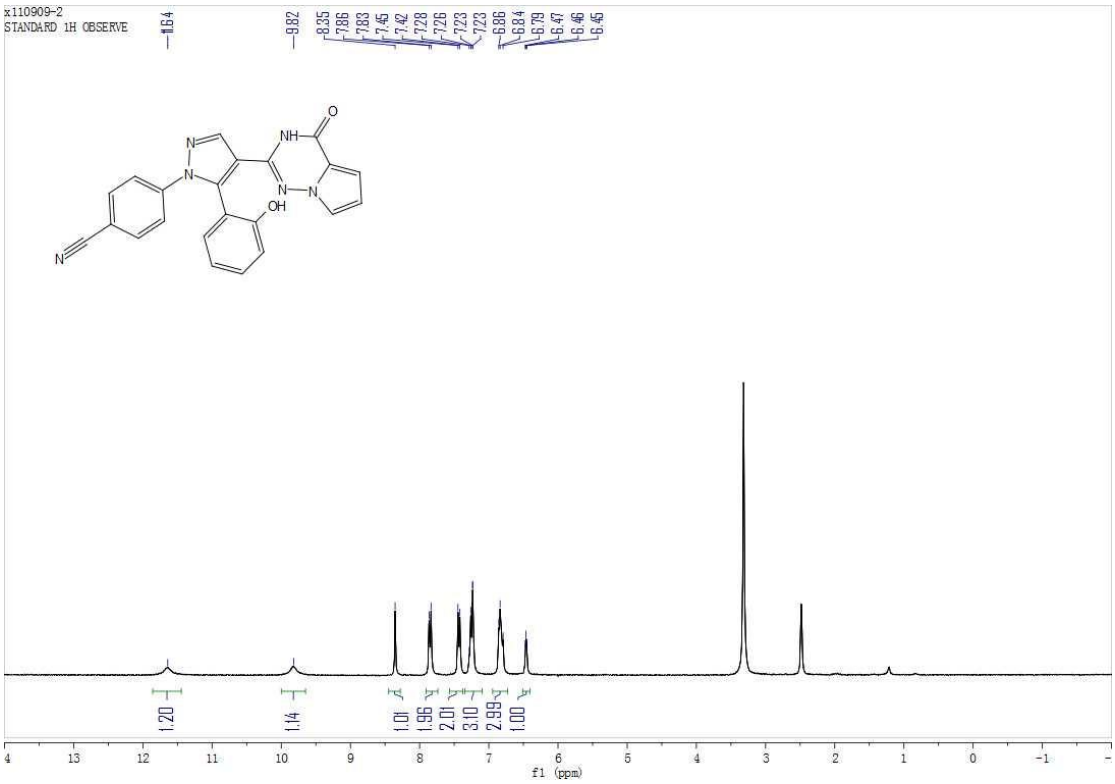

X110921-5/1
X110921-5 DMSO BB+DEPT135
155.58
155.11
142.14
140.61
140.00
129.35
122.59
122.26
121.48
120.61
121.49
121.03
119.35
118.65
116.11
116.03
114.20
110.67
107.67
HN
N
N
N
HO
Br
f1 (ppm)

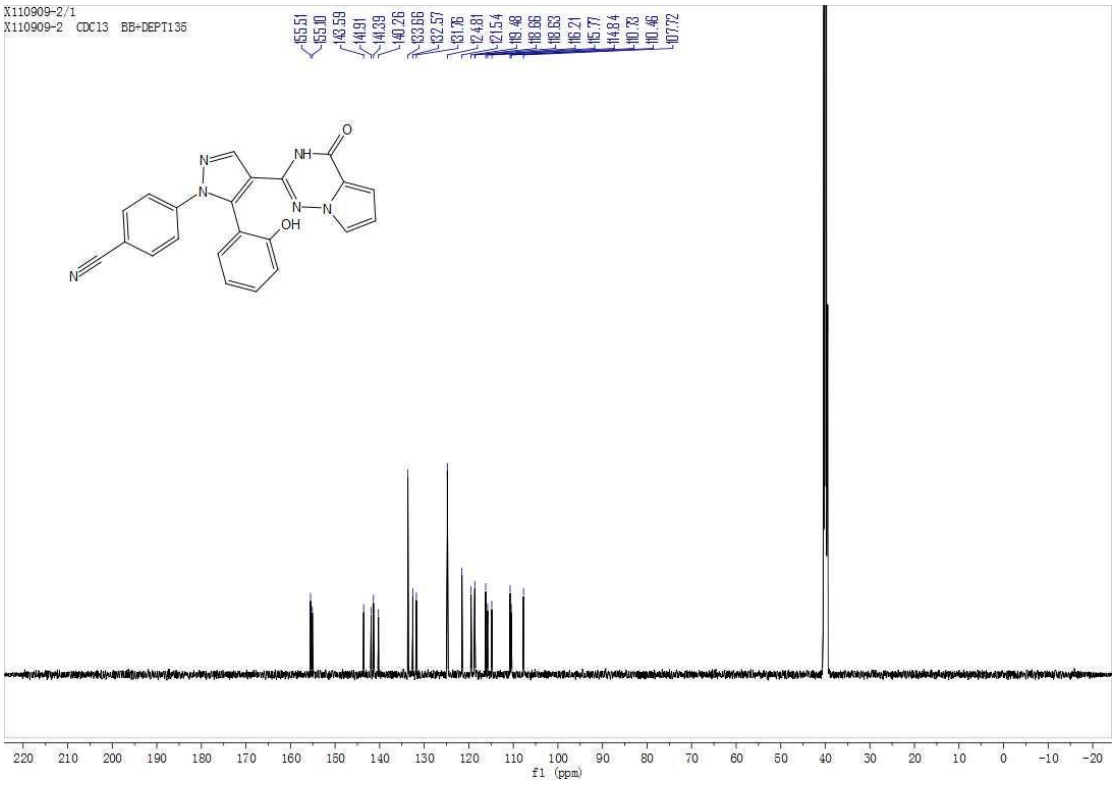
D23


x110921-2
STANDARD 1H OBSERVE
f1 (ppm)

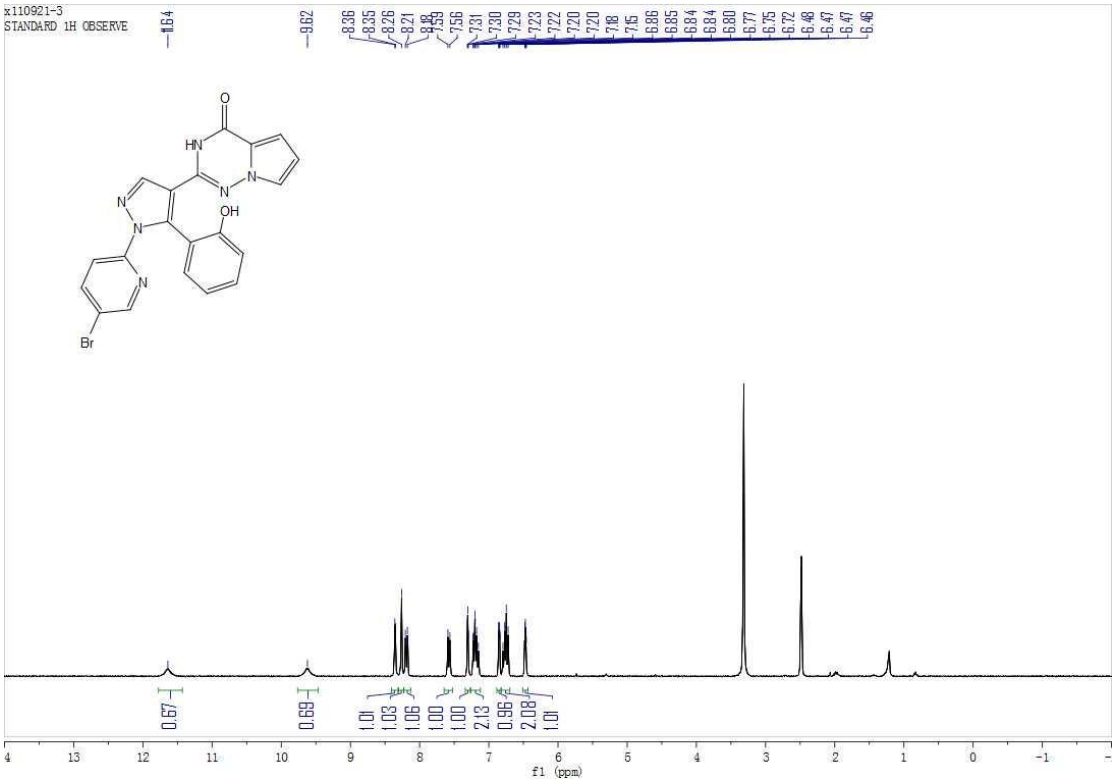

X110921-2/1
X110921-2 DMSO BB+DEPT135
f1 (ppm)

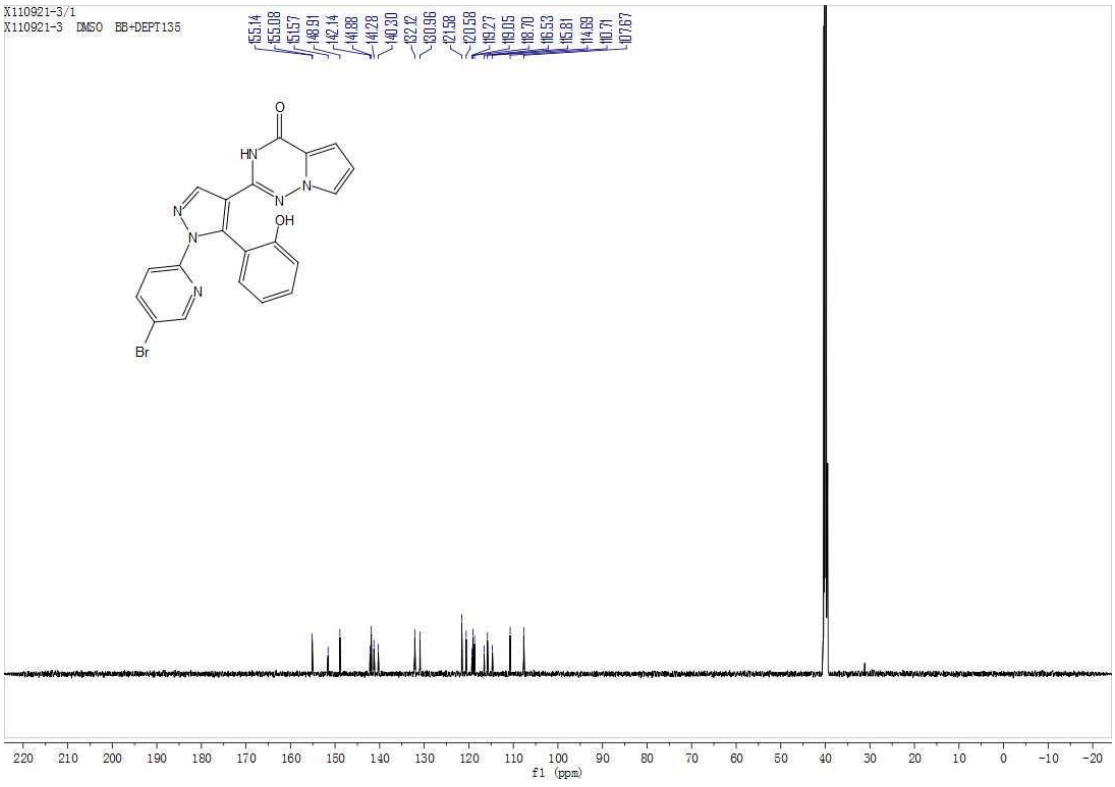
D24


x110909-2
STANDARD 1H OBSERVE
16.4
9.82
8.35
7.86
7.83
7.45
7.42
7.28
7.26
7.23
7.23
6.86
6.84
6.79
6.47
6.46
6.45
NH
O
N
N
N
N
OH
N
1.20
1.14
1.01
1.96
2.01
3.10
2.99
1.00
f1 (ppm)

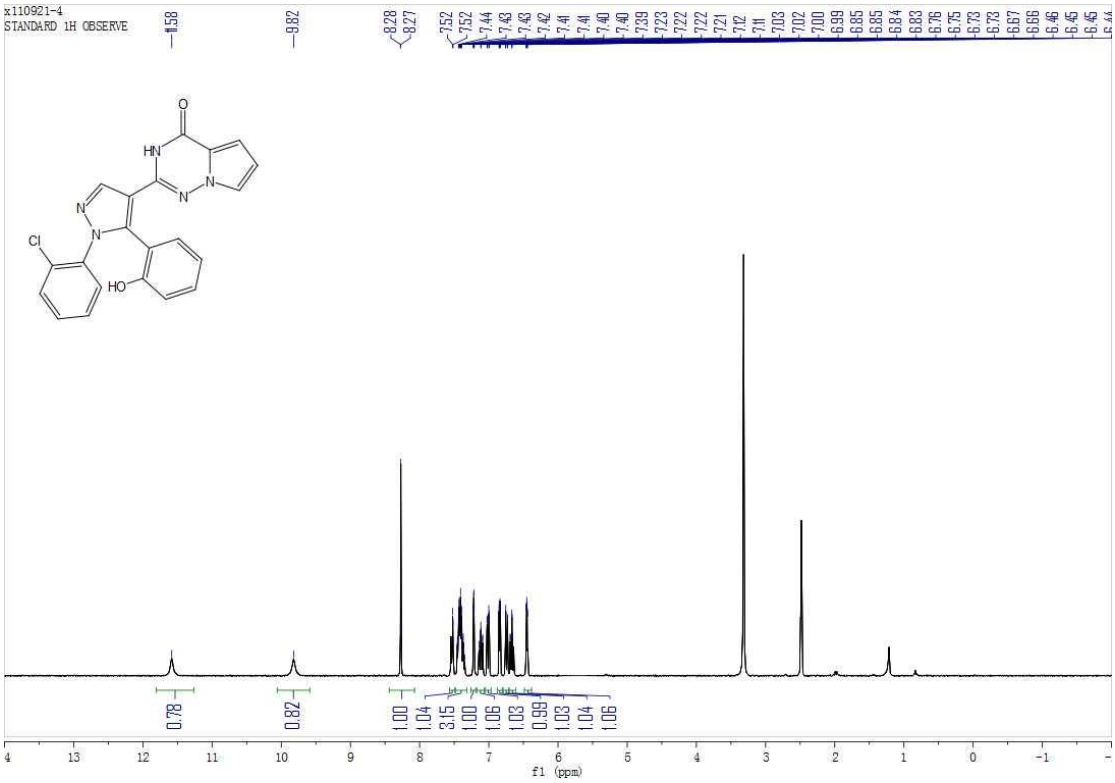

X110909-2/1
X110909-2 CDCl3 BB+DEPT135
155.51
155.10
143.59
141.91
141.39
140.26
133.66
132.57
131.76
127.48
121.54
119.48
118.86
118.53
116.21
115.77
114.84
110.73
110.46
107.72
NH
O
N
N
N
N
OH
N
f1 (ppm)

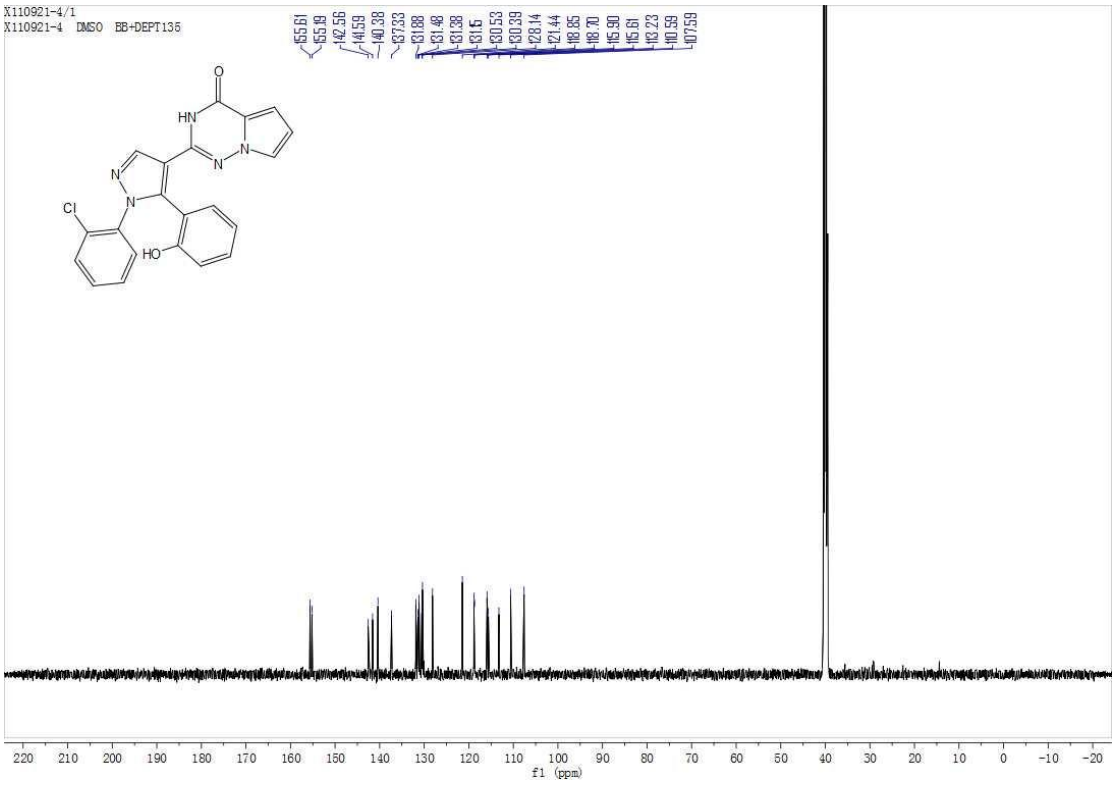
D25


x110921-3
STANDARD 1H OBSERVE
11.64
9.62
8.36
8.35
8.26
8.21
8.18
7.59
7.56
7.31
7.30
7.29
7.23
7.22
7.20
7.20
7.18
7.15
6.86
6.85
6.84
6.84
6.80
6.77
6.75
6.72
6.48
6.47
6.47
6.46
O
HN
N
N
N
OH
N
Br
0.67
0.69
1.01
1.03
1.06
1.00
1.00
2.13
0.96
2.08
1.01
f1 (ppm)

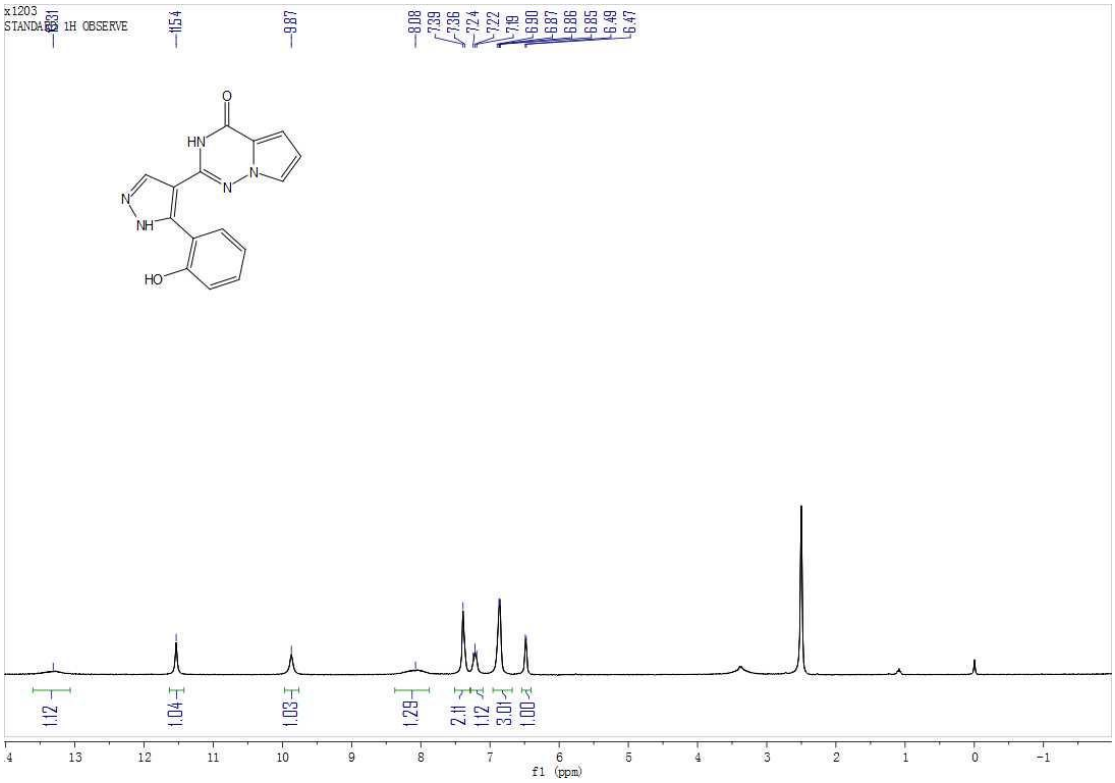

X110921-3/1
X110921-3 DMSO BB+DEPT135
155.14
155.08
151.57
148.91
142.14
141.88
141.28
140.30
132.12
130.96
121.58
120.58
119.27
119.05
118.70
116.53
115.81
114.69
110.71
107.67
O
HN
N
N
N
OH
N
Br
f1 (ppm)

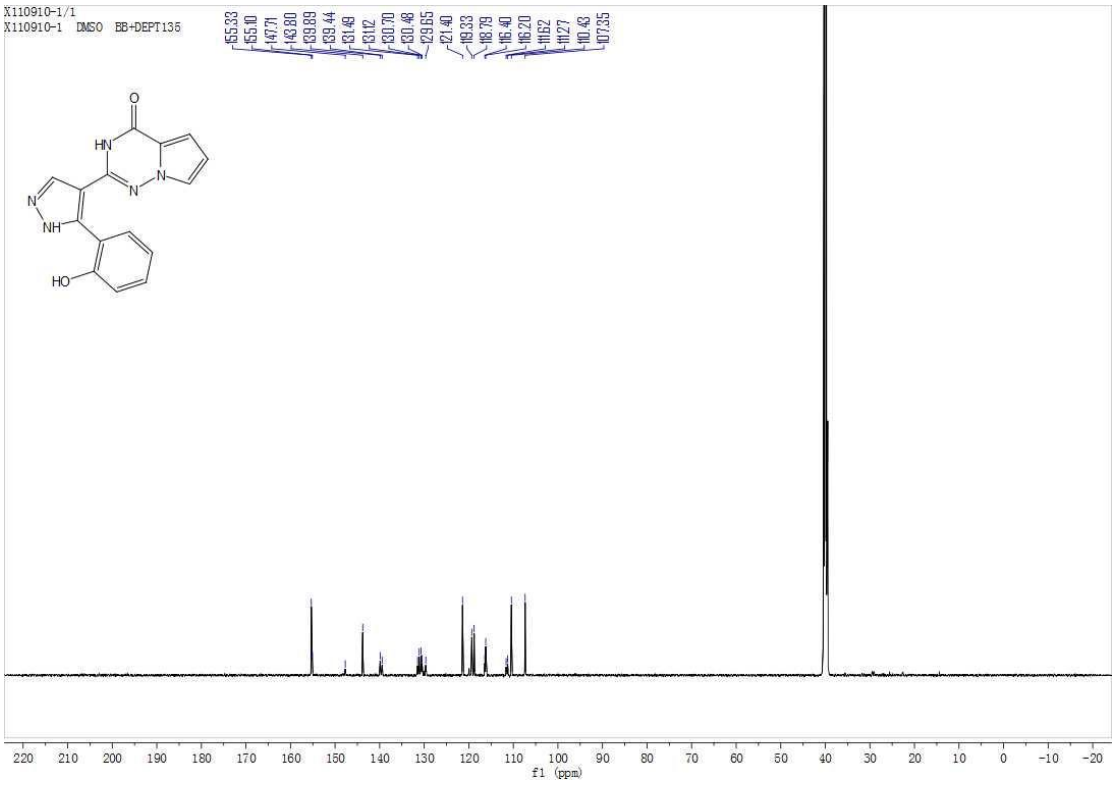
D26


x110921-4
STANDARD 1H OBSERVE
f1 (ppm)

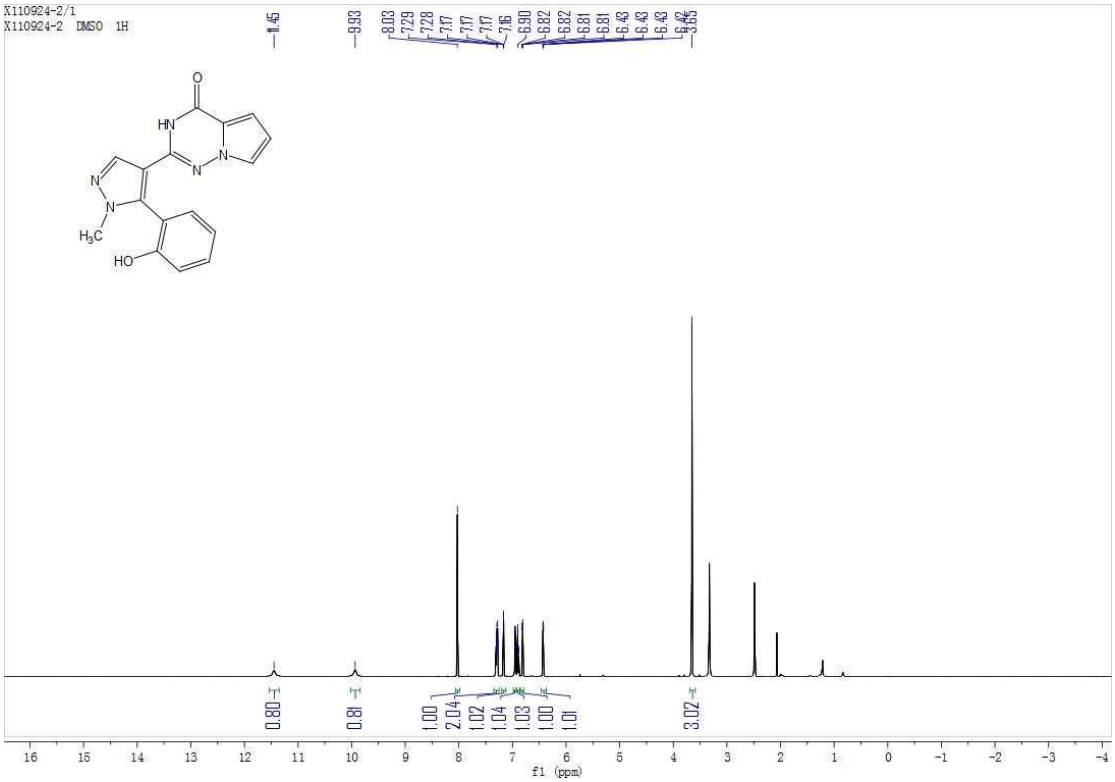

X110921-4/1
X110921-4 DMSO BB+DEPT135
f1 (ppm)

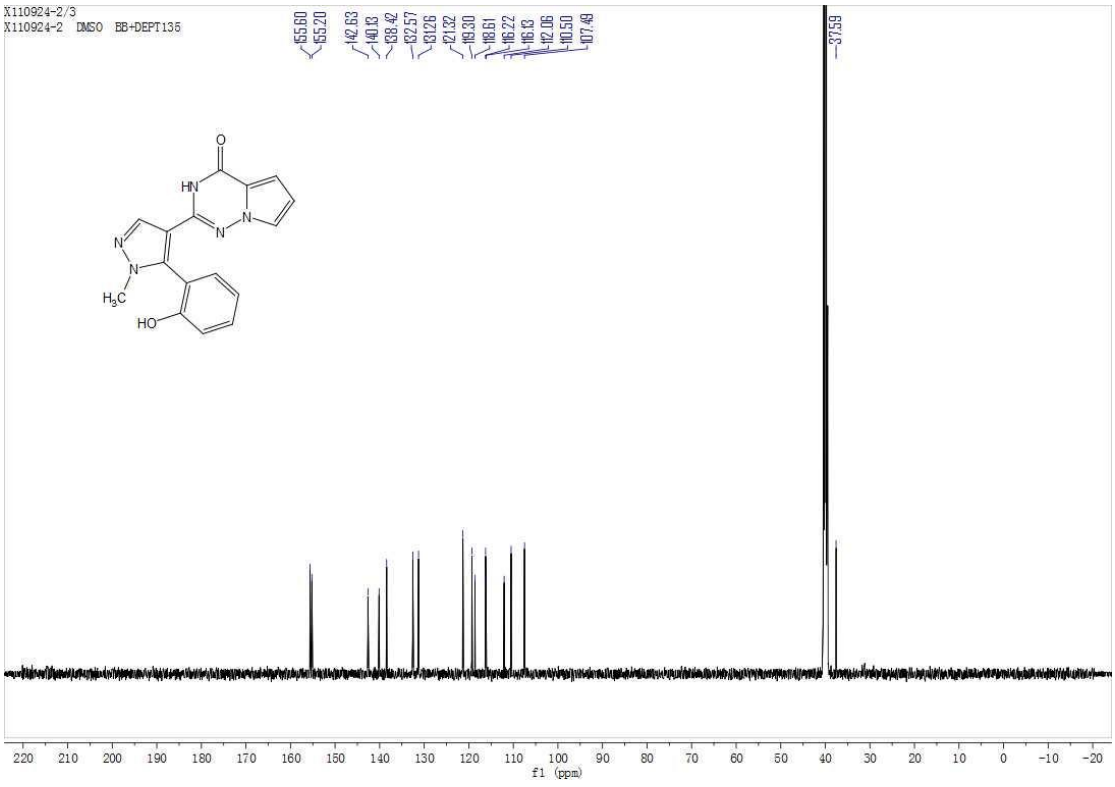
D27


x1203
STANDARD 1H OBSERVE
11.54
9.87
8.08
7.39
7.36
7.24
7.22
7.19
6.90
6.87
6.86
6.85
6.49
6.47
HN
O
N
N
NH
HO
1.12
1.04
1.03
1.29
2.11
1.12
3.01
1.00
f1 (ppm)

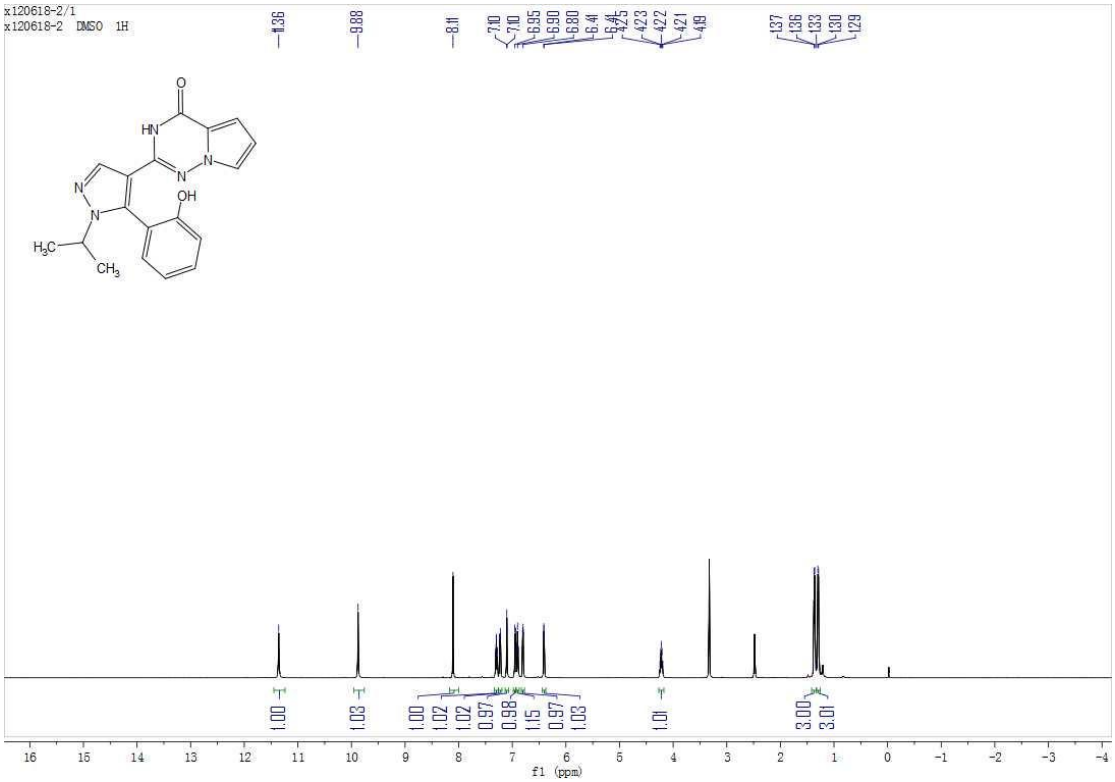

X110910-1/1
X110910-1 DMSO BB+DEPT135
155.33
155.10
147.71
143.80
139.89
139.44
131.49
131.12
130.70
130.48
129.65
121.40
119.33
118.79
116.40
116.20
111.62
111.27
110.43
107.35
HN
O
N
N
NH
HO
f1 (ppm)

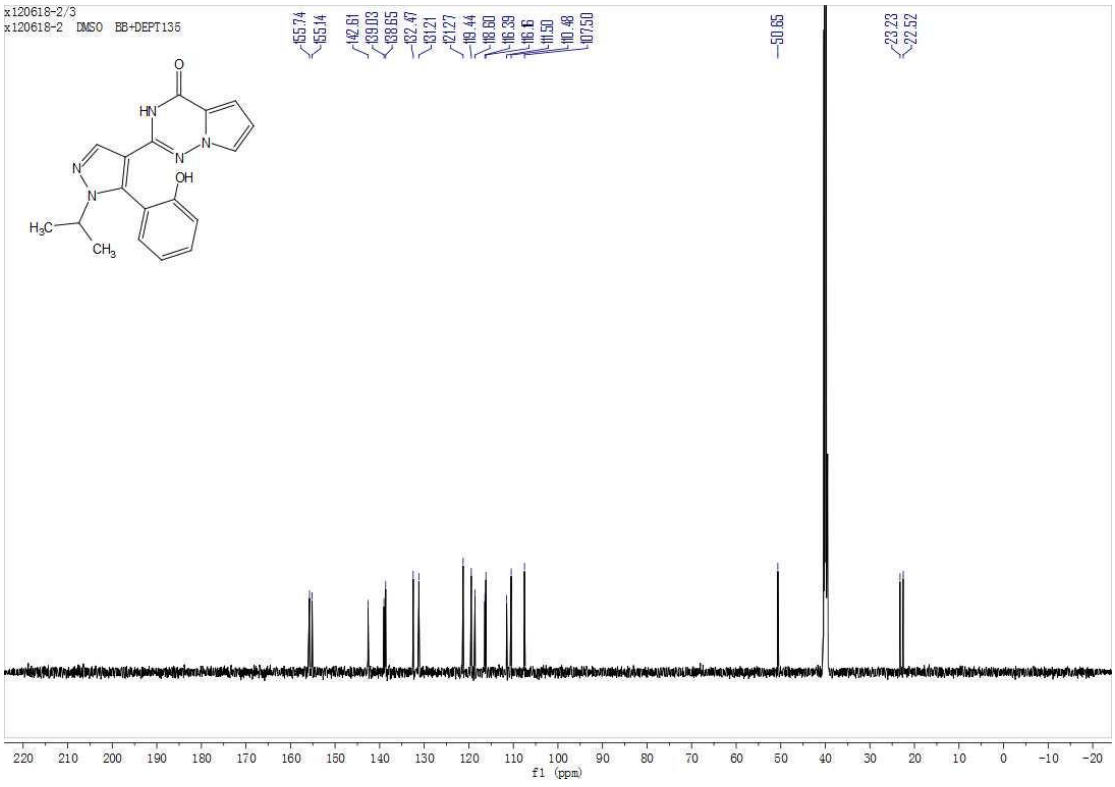
D28


X110924-2/1
X110924-2 DMSO 1H
f1 (ppm)

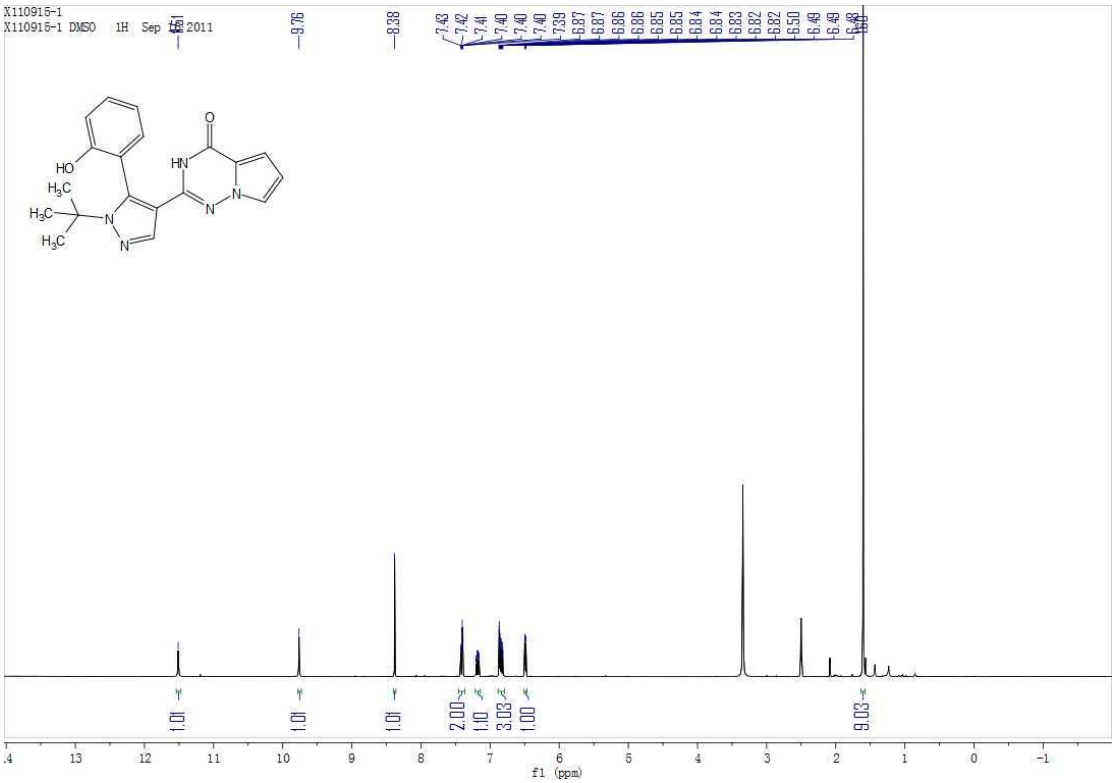

X110924-2/3
X110924-2 DMSO BB+DEPT135
f1 (ppm)

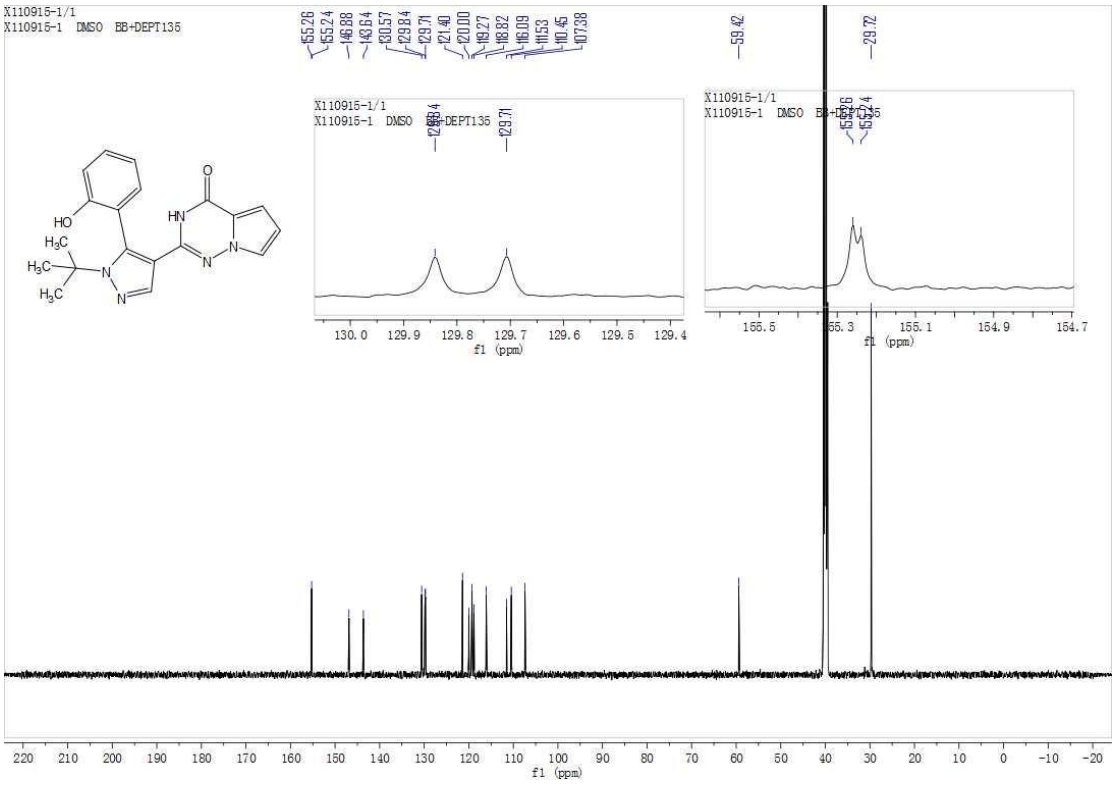
D29


x120618-2/1
x120618-2 DMSO 1H
f1 (ppm)

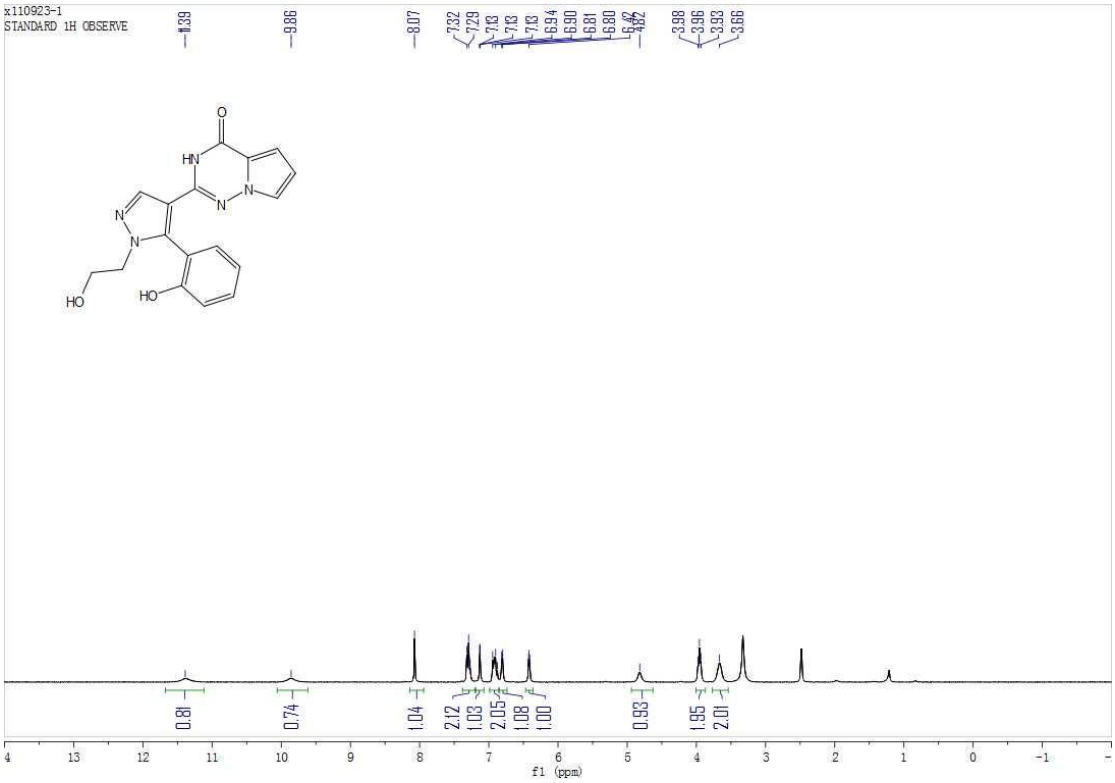

x120618-2/3
x120618-2 DMSO BB+DEPT135
f1 (ppm)

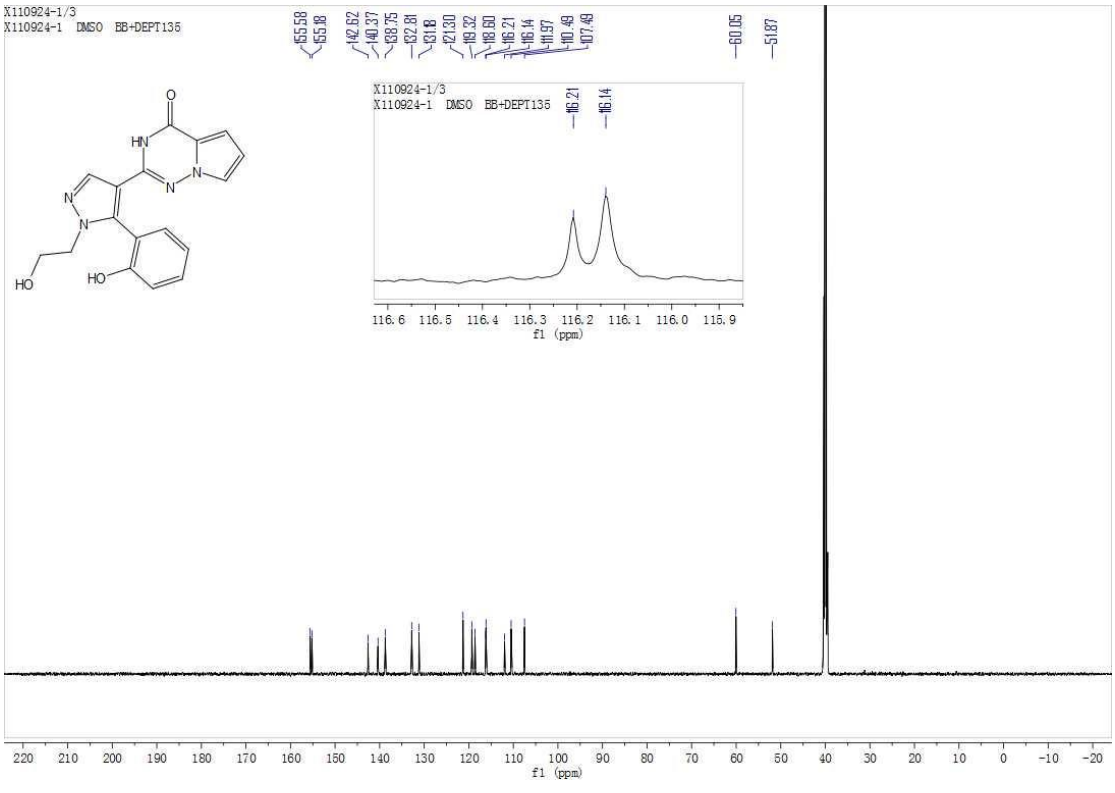
D30


X110915-1
X110915-1 DMSO 1H Sep 2011
9.76
8.38
7.43
7.42
7.41
7.40
7.40
7.40
7.39
6.87
6.87
6.86
6.86
6.85
6.85
6.84
6.84
6.83
6.82
6.82
6.50
6.49
6.49
6.48
HO
H3C
H3C
H3C
N
N
HN
O
N
N
1.01
1.01
1.01
2.00
1.10
3.03
1.00
9.03
f1 (ppm)

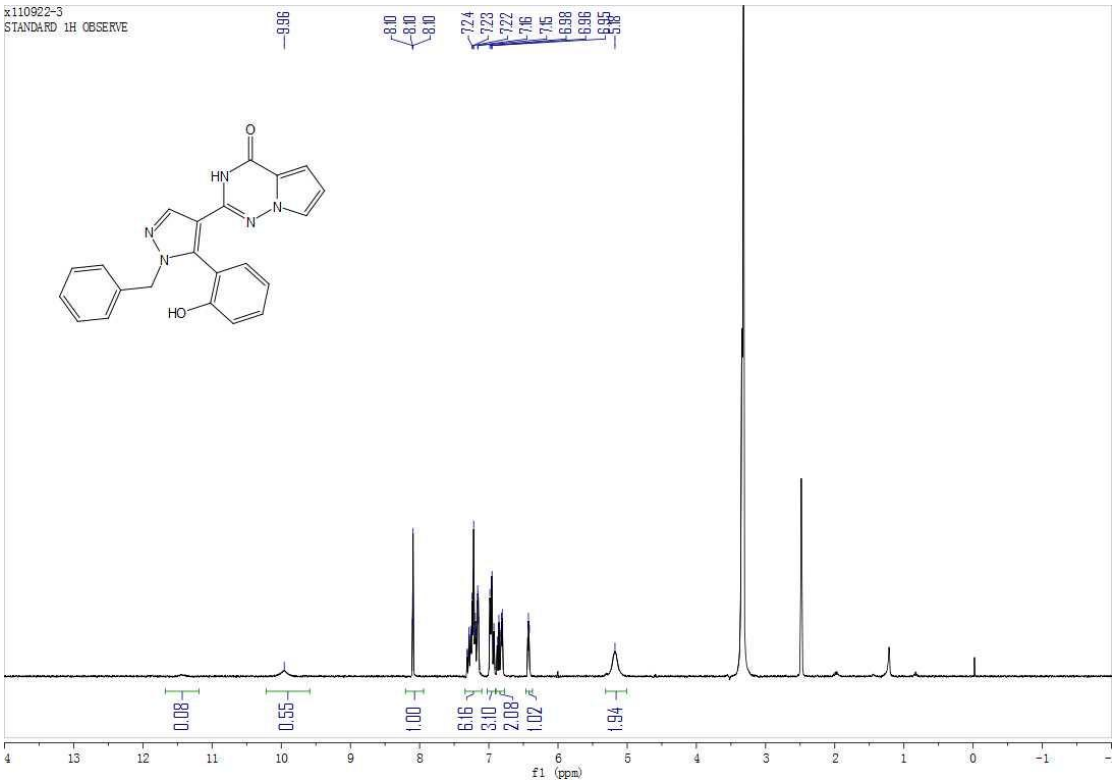

X110915-1/1
X110915-1 DMSO BB+DEPT135
155.26
155.24
146.88
143.64
130.57
129.84
129.71
121.40
120.00
109.27
108.82
106.09
101.53
100.45
97.38
59.42
29.72
X110915-1/1
X110915-1 DMSO BB+DEPT135
129.84
129.71
130.0
129.9
129.8
129.7
129.6
129.5
129.4
f1 (ppm)
X110915-1/1
X110915-1 DMSO BB+DEPT135
155.26
155.24
155.5
155.3
155.1
154.9
154.7
f1 (ppm)
HO
H3C
H3C
H3C
N
N
HN
O
N
N
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
f1 (ppm)

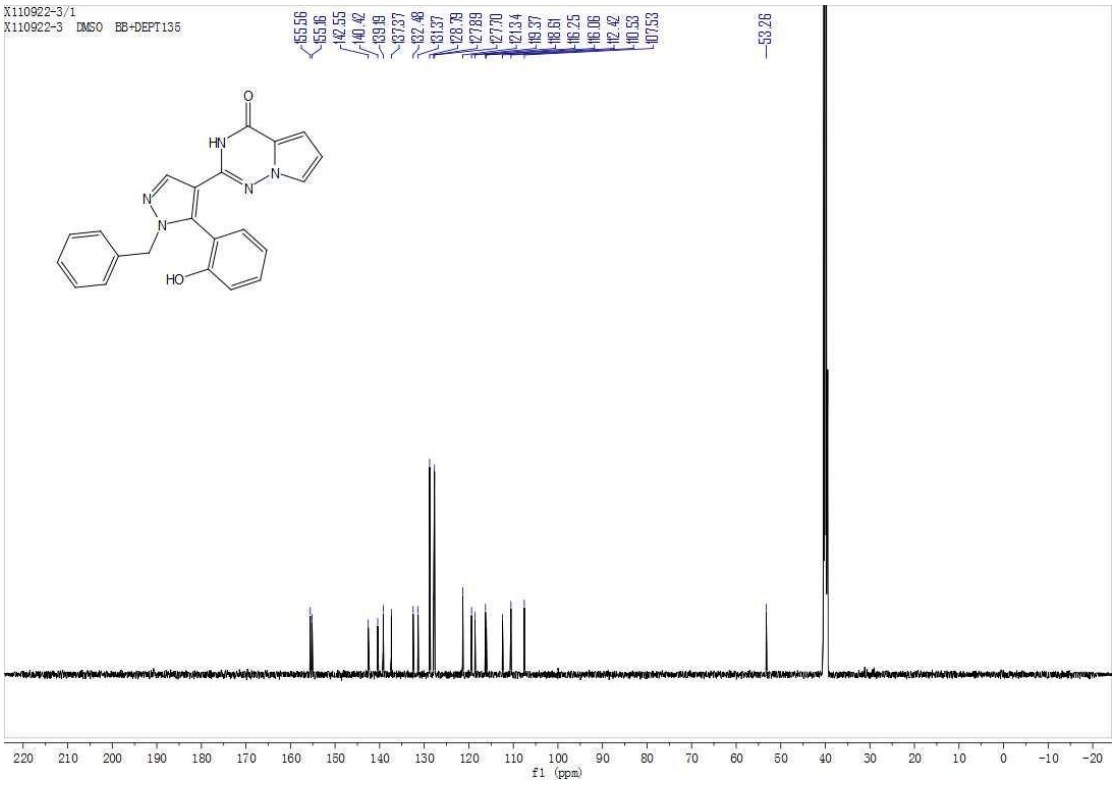
D31


x110923-1
STANDARD 1H OBSERVE
11.39
9.86
8.07
7.32
7.29
7.13
7.13
7.13
6.94
6.90
6.81
6.80
6.62
4.82
3.98
3.96
3.93
3.66
0.81
0.74
1.04
2.12
1.03
2.05
1.08
1.00
0.93
1.95
2.01
f1 (ppm)

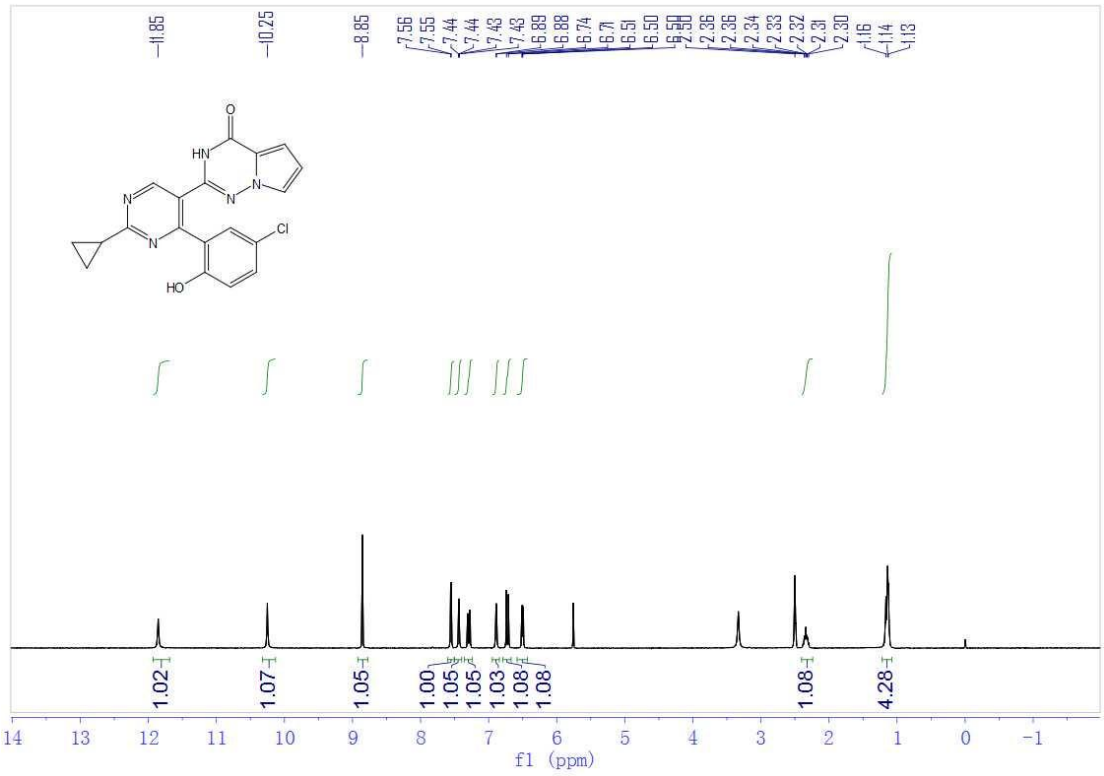

X110924-1/3
X110924-1 DMSO BB+DEPT135
155.58
155.18
142.62
140.37
138.75
132.81
131.18
121.30
119.32
118.60
116.21
116.14
111.97
110.49
107.49
60.05
51.87
X110924-1/3
X110924-1 DMSO BB+DEPT135
116.21
116.14
f1 (ppm)
f1 (ppm)

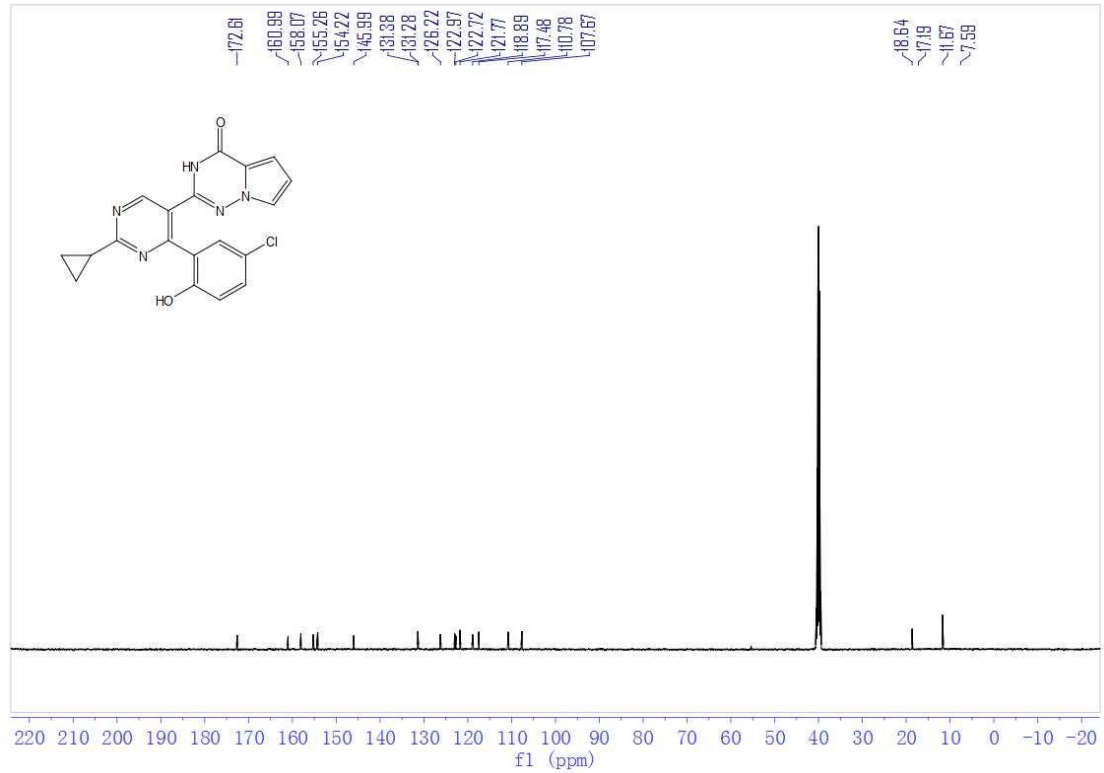
D32


x110922-3
STANDARD 1H OBSERVE
9.96
8.10
8.10
8.10
7.24
7.23
7.22
7.16
7.15
6.98
6.96
6.95
5.26
O
HN
N
N
N
HO
0.08
0.55
1.00
6.16
3.10
2.08
1.02
1.94
f1 (ppm)

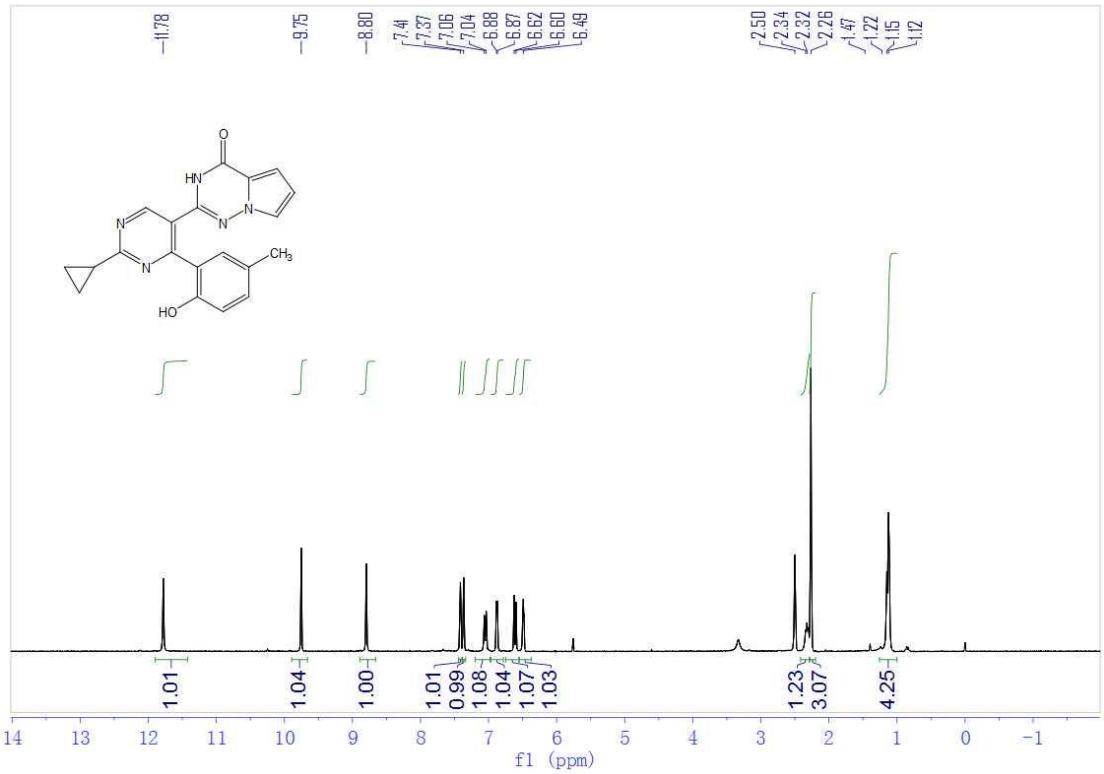

X110922-3/1
X110922-3 DMSO BB+DEPT135
155.56
155.16
142.55
140.42
139.19
137.37
132.48
131.37
128.79
127.89
127.70
121.34
119.37
118.61
116.25
116.06
112.42
110.53
107.53
53.26
O
HN
N
N
N
HO
f1 (ppm)

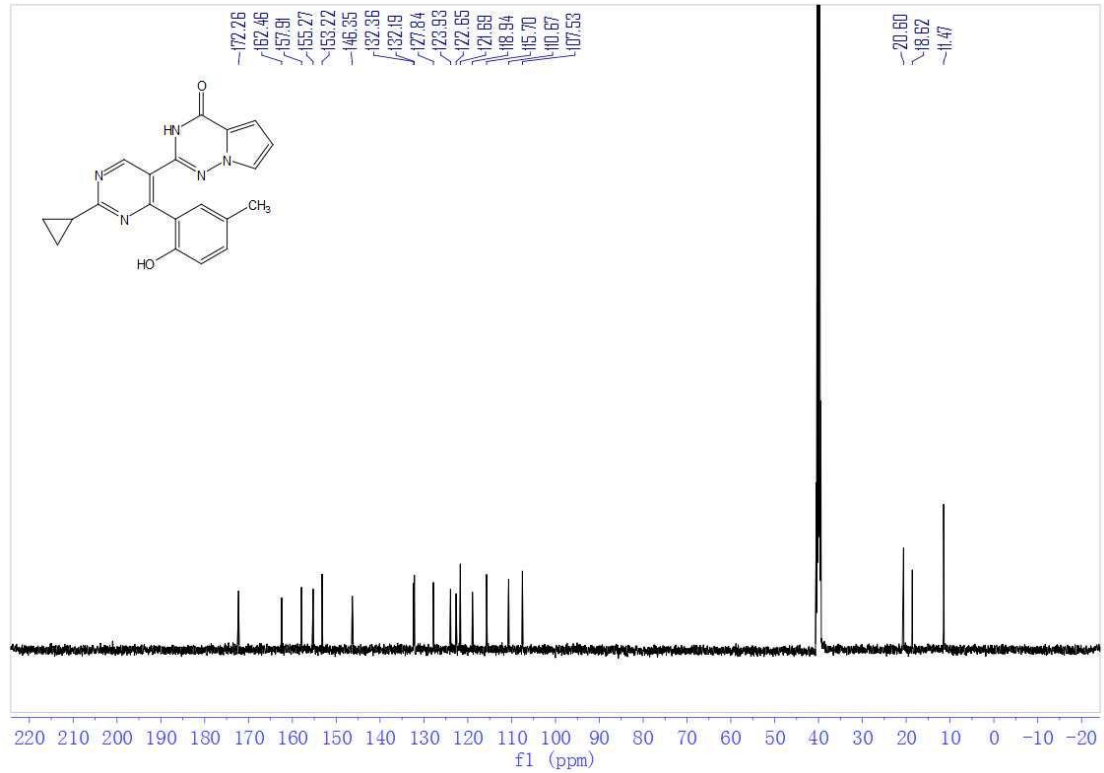
D33


11.85
10.25
8.85
7.56
7.55
7.44
7.44
7.43
7.43
6.89
6.88
6.74
6.71
6.51
6.50
2.36
2.36
2.34
2.33
2.32
2.31
2.30
1.16
1.14
1.13
HN
N
N
N
N
Cl
HO
1.02
1.07
1.05
1.00
1.05
1.05
1.03
1.08
1.08
1.08
4.28
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1
f1 (ppm)

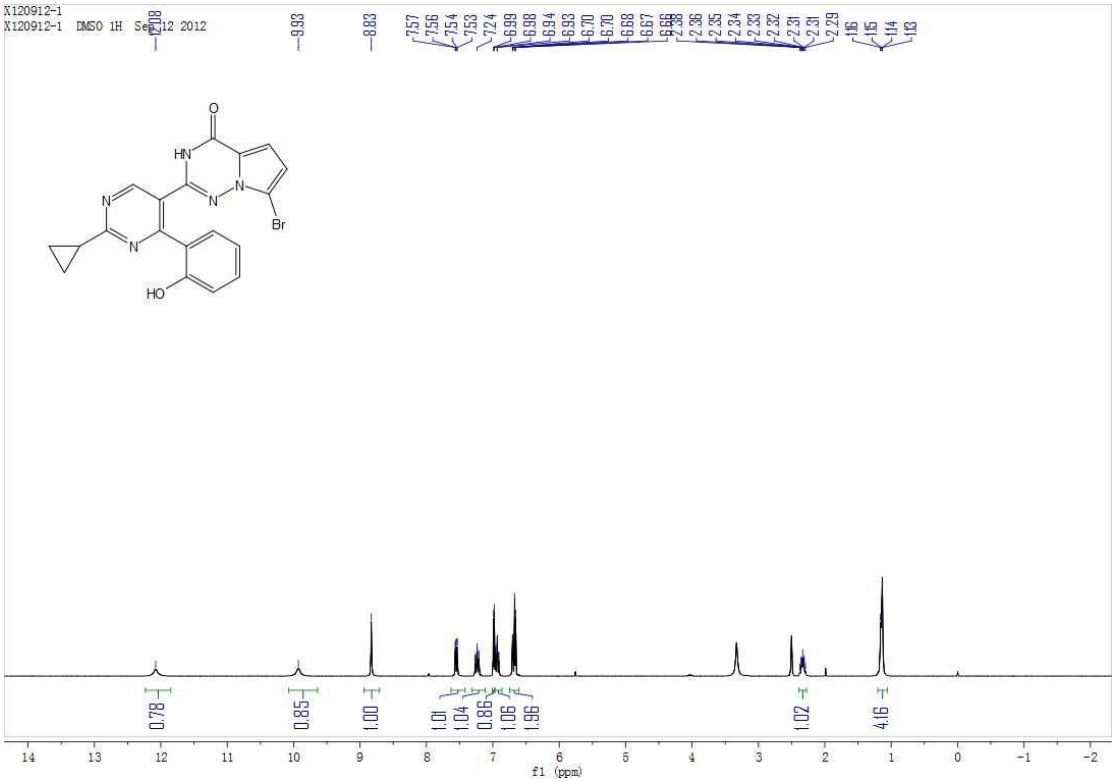

172.61
160.99
158.07
155.26
154.22
145.99
131.38
131.28
126.22
122.97
122.72
121.77
118.89
117.48
110.78
107.67
18.64
17.19
11.67
7.59
HN
N
N
N
N
Cl
HO
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)

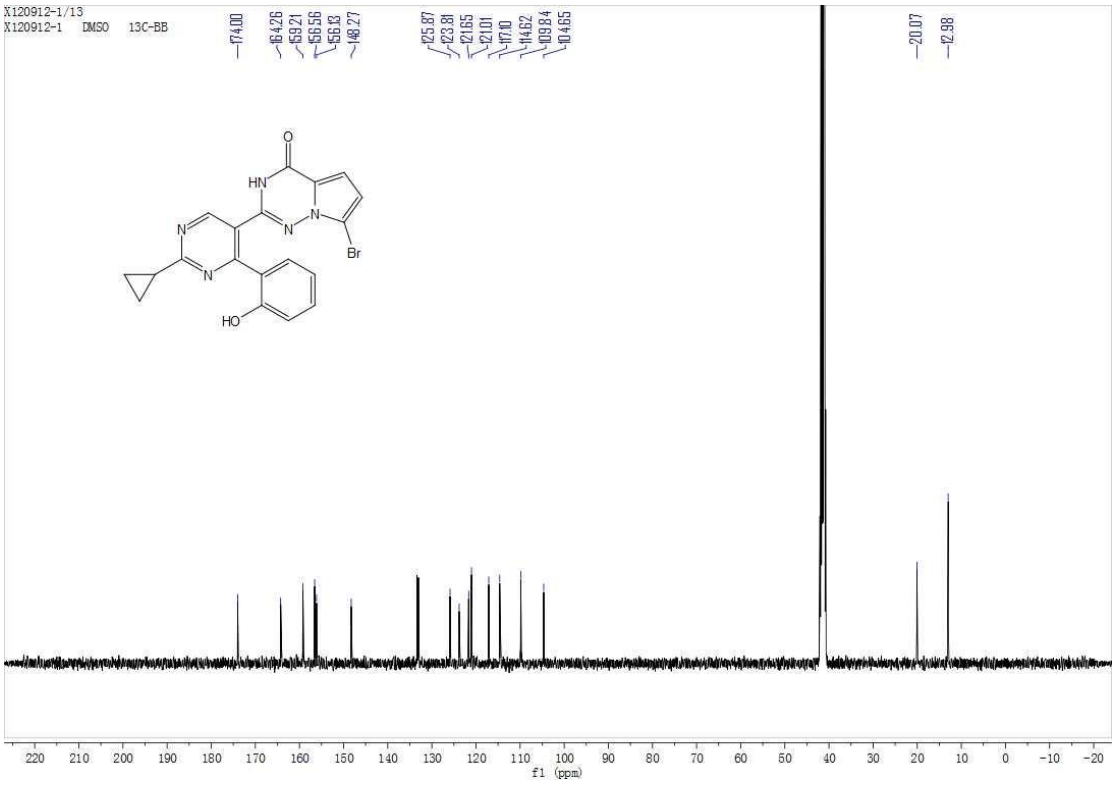
D34


11.78
9.75
8.80
7.44
7.37
7.06
7.04
6.88
6.87
6.62
6.60
6.49
2.50
2.34
2.32
2.26
1.47
1.22
1.15
1.12
HN
N
N
N
CH3
HO
1.01
1.04
1.00
1.01
0.99
1.08
1.04
1.07
1.03
1.23
3.07
4.25
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1
f1 (ppm)

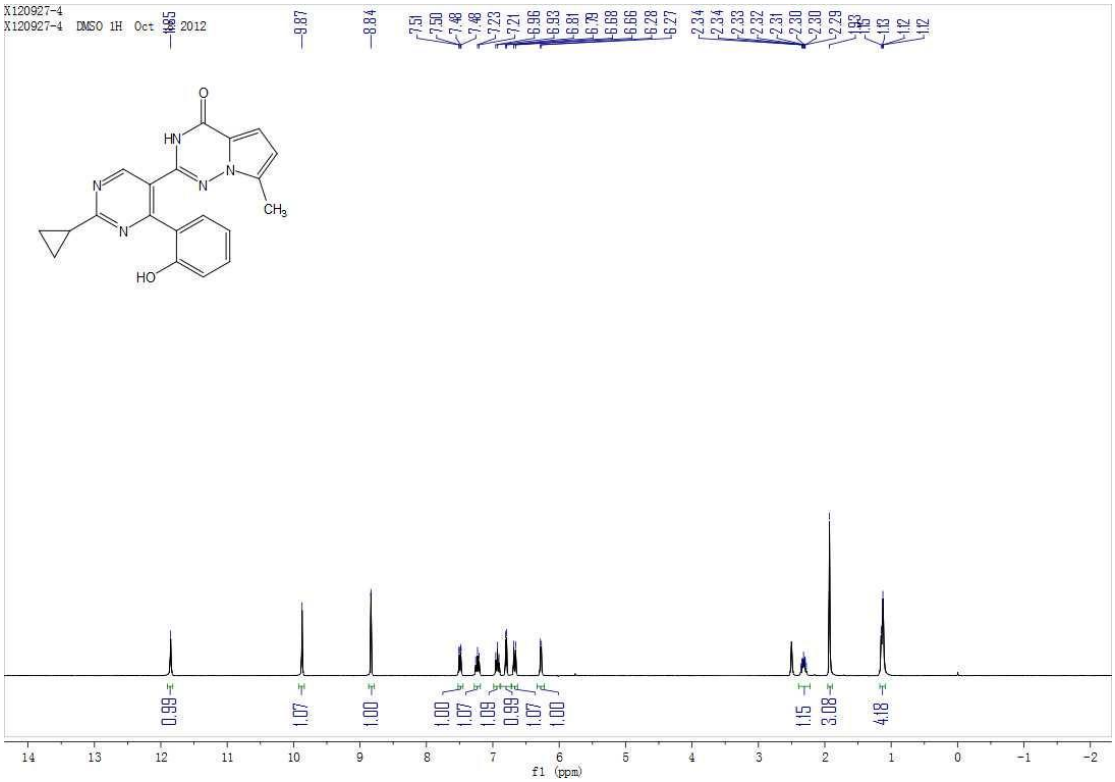

172.26
162.46
157.91
155.27
153.22
146.35
132.36
132.19
127.84
123.93
122.65
121.69
118.94
115.70
110.67
107.53
20.60
18.62
11.47
HN
N
N
N
CH3
HO
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)

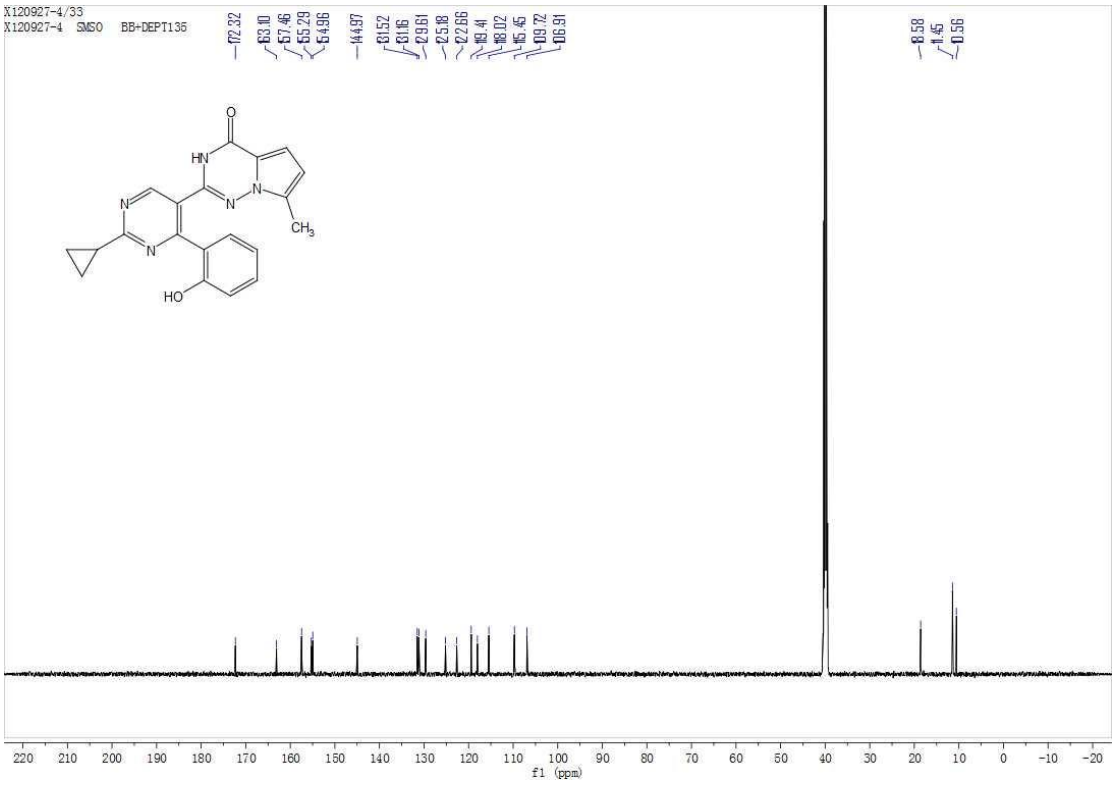
D35


X120912-1
X120912-1 DMSO 1H
HN
N
N
N
Br
HO
f1 (ppm)

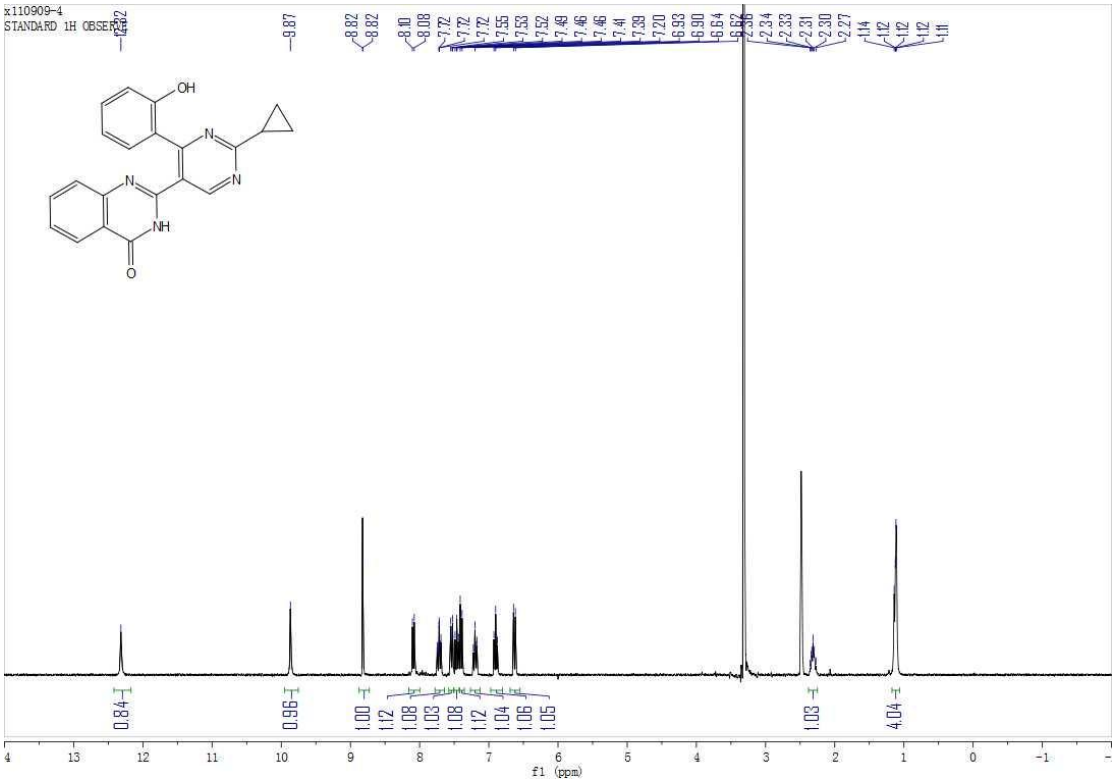

X120912-1/13
X120912-1 DMSO 13C-BB
HN
N
N
N
Br
HO
f1 (ppm)

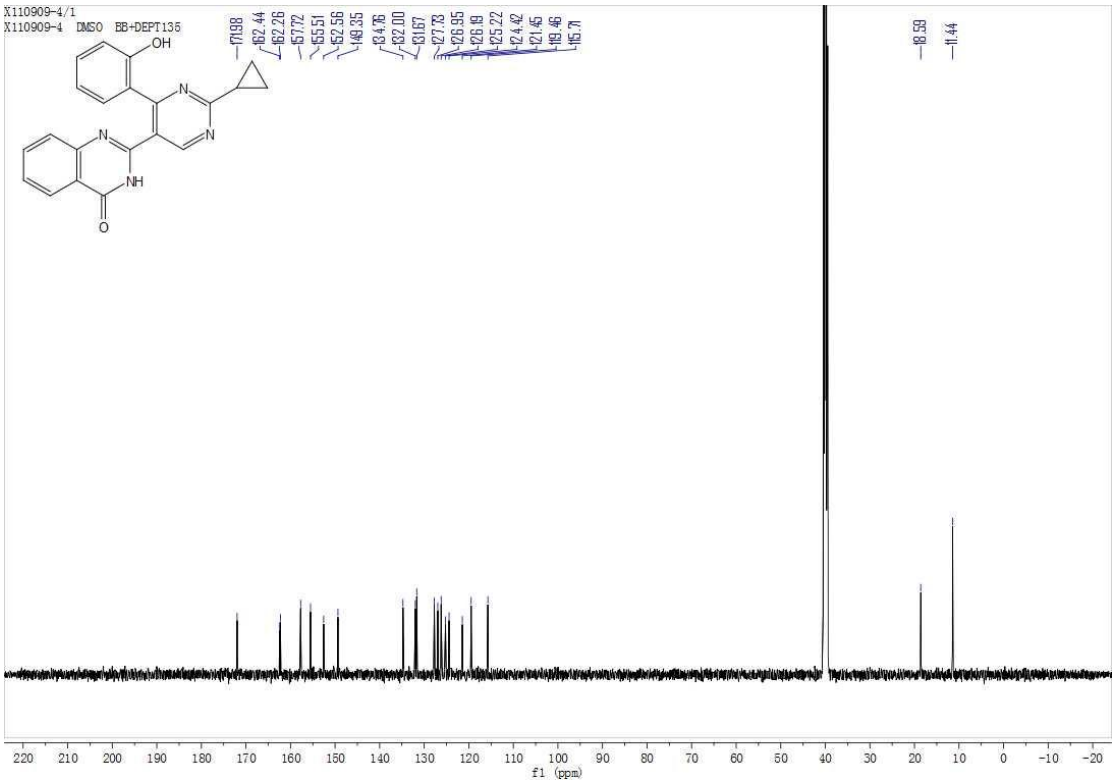
D36


X120927-4
X120927-4 DMSO 1H Oct 4 2012
9.87
8.84
7.51
7.50
7.48
7.23
7.21
6.96
6.93
6.81
6.79
6.68
6.66
6.28
6.27
2.34
2.34
2.33
2.32
2.31
2.30
2.30
2.29
1.13
1.12
1.12
HN
N
N
N
CH3
HO
0.99
1.07
1.00
1.00
1.07
1.09
0.99
1.07
1.00
1.15
3.08
4.18
f1 (ppm)

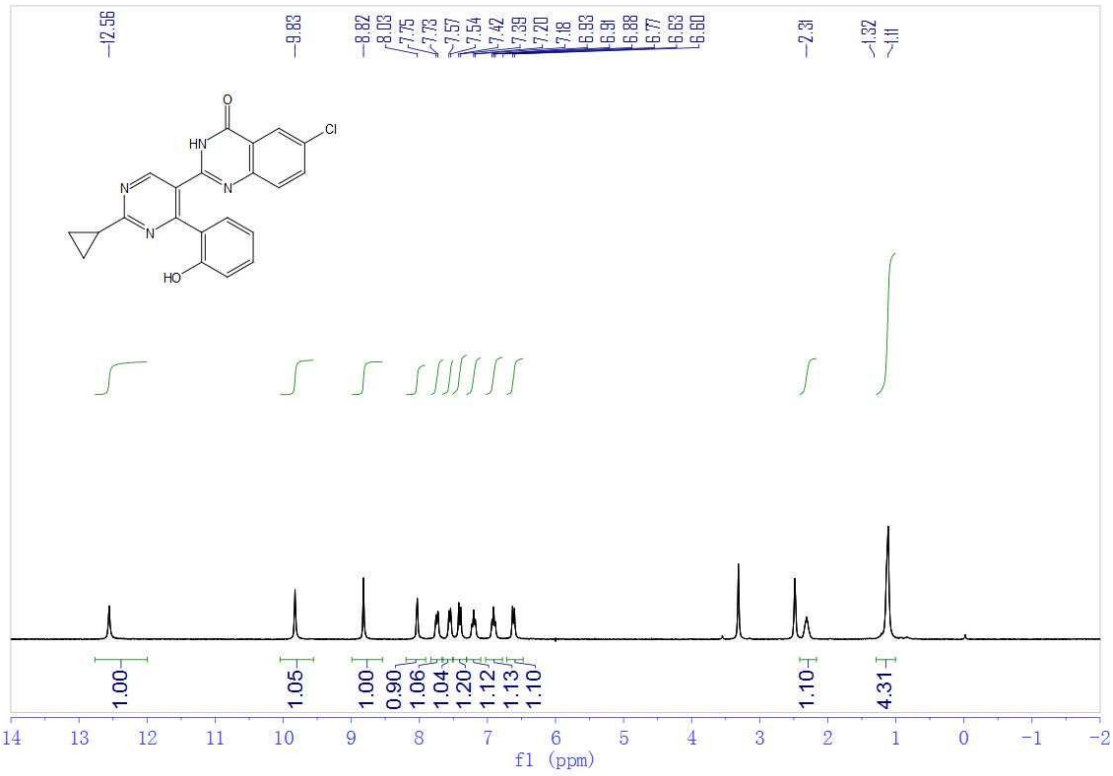

X120927-4/33
X120927-4 SMSO BB+DEPT135
172.32
163.10
157.46
155.29
154.98
144.97
131.52
131.16
129.61
125.18
122.66
118.41
118.02
115.45
109.72
106.91
18.58
11.45
10.56
HN
N
N
N
CH3
HO
f1 (ppm)

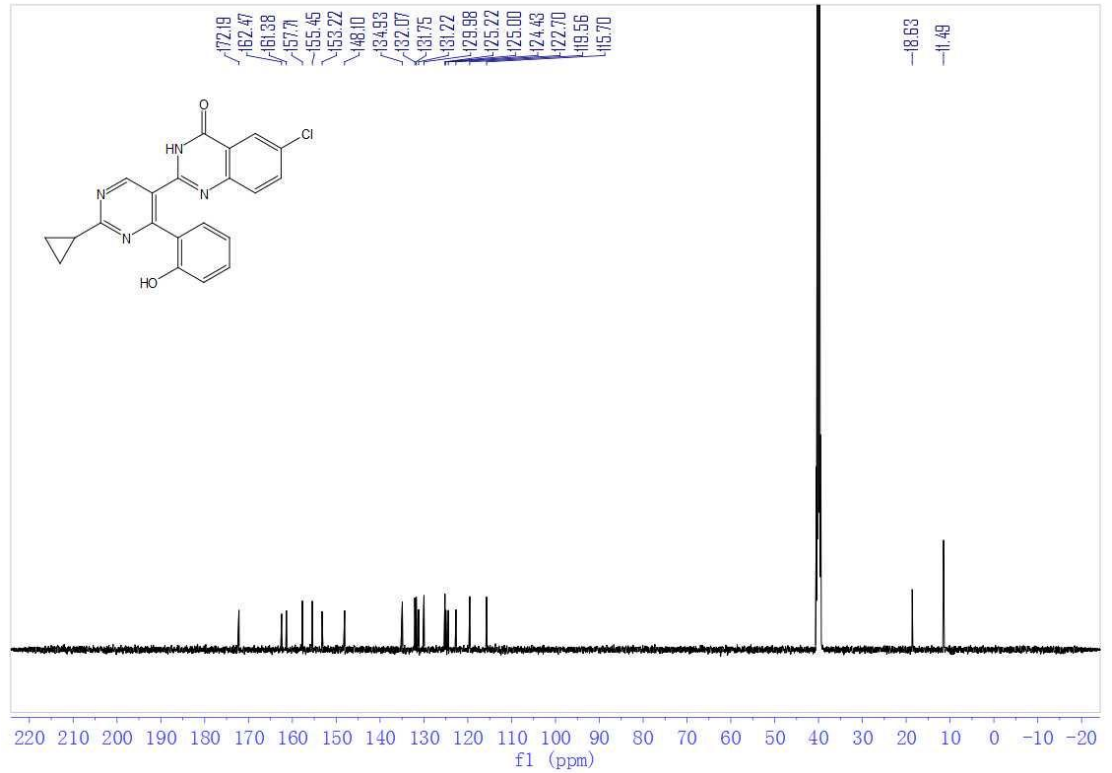
D37


x110909-4
STANDARD 1H OBSERVE
OH
N
N
N
NH
O
f1 (ppm)

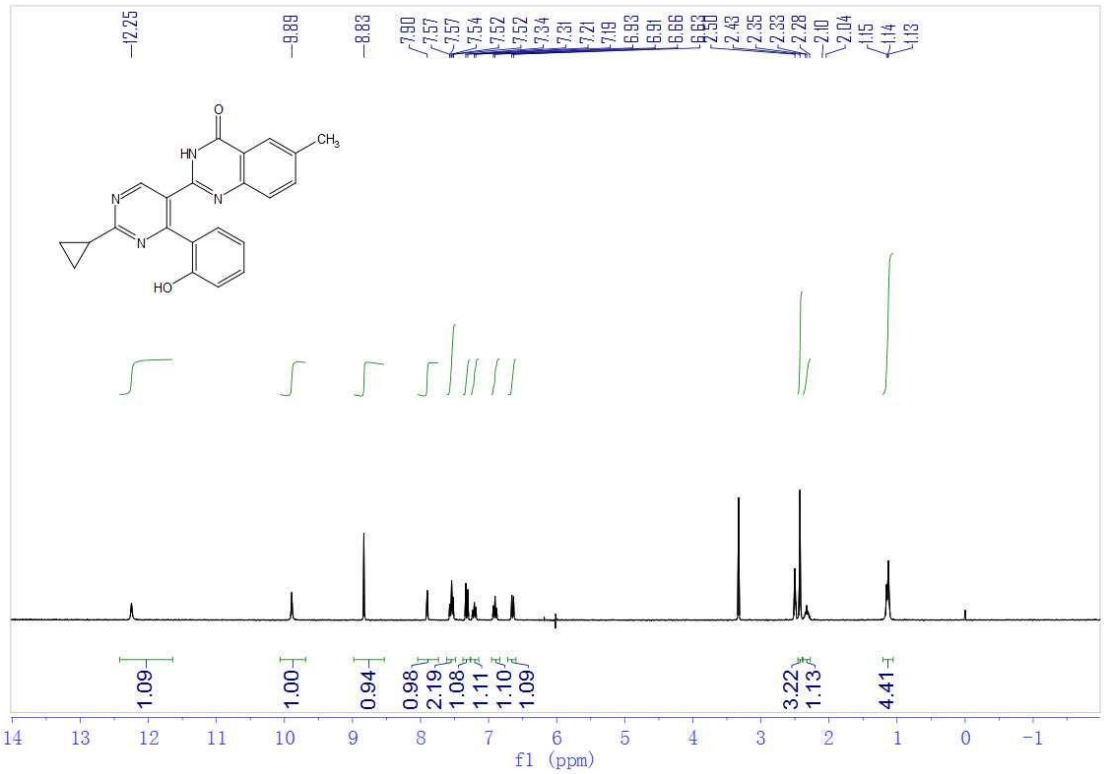

X110909-4/1
X110909-4 DMSO BB+DEPT135
OH
N
N
N
NH
O
f1 (ppm)

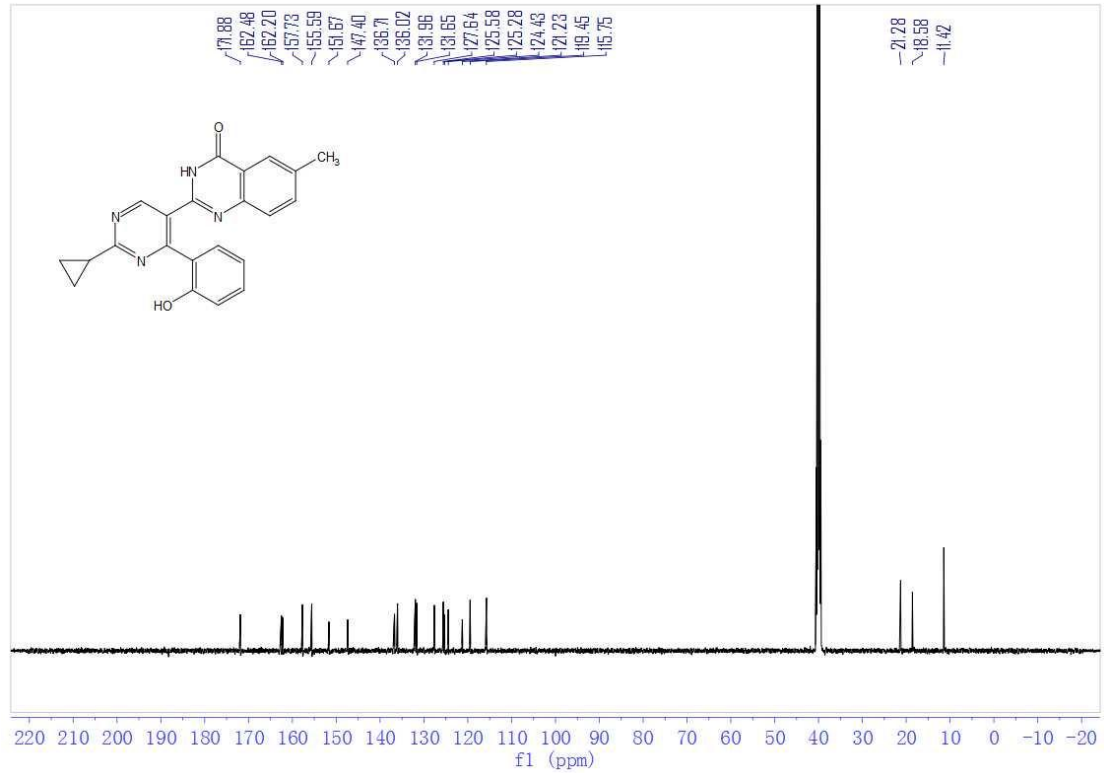
D38


12.56
9.83
8.82
8.03
7.75
7.73
7.57
7.54
7.42
7.39
7.20
7.18
6.93
6.91
6.88
6.77
6.63
6.60
2.31
1.32
1.11
HN
N
N
HO
Cl
1.00
1.05
1.00
0.90
1.06
1.04
1.20
1.12
1.13
1.10
1.10
4.31
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 −1 −2
f1 (ppm)


172.19
162.47
161.38
157.71
155.45
153.22
148.10
134.93
132.07
131.75
131.22
129.98
125.22
125.00
124.43
122.70
119.56
115.70
18.63
11.49
HN
N
N
HO
Cl
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10 −20
f1 (ppm)

D39


12.25
9.89
8.83
7.90
7.57
7.57
7.54
7.52
7.52
7.34
7.31
7.21
7.19
6.93
6.91
6.66
6.63
2.50
2.43
2.35
2.33
2.28
2.10
2.04
1.15
1.14
1.13
HN
O
CH3
N
N
N
HO
1.09
1.00
0.94
0.98
2.19
1.08
1.11
1.10
1.09
3.22
1.13
4.41
14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1
f1 (ppm)


171.88
162.48
162.20
157.73
155.59
151.67
147.40
136.71
136.02
131.96
131.65
127.64
125.58
125.28
124.43
121.23
119.45
115.75
21.28
18.58
11.42
HN
O
CH3
N
N
N
HO
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)

D40