Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Supporting Information

Nickel(II)-Catalyzed Direct Arylation of Aryl C–H Bonds with Arylboron Reagents Directed by a Removable Bidentate Auxiliary

Bin Liu, Zhuo-Zhuo Zhang, Xin Li, Bing-Feng Shi*

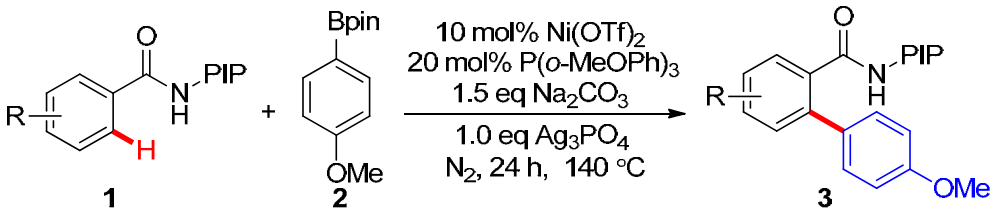
Department of Chemistry, Zhejiang University, Hangzhou 310027, China

Table of Contents:

General Information:

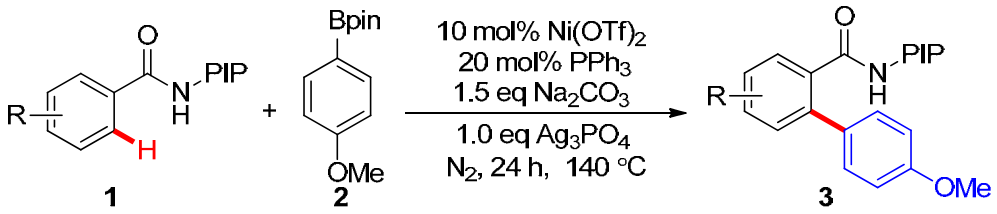
Toluene was dried by sodium and freshly distilled. The other materials and solvents were purchased from Aladdin and other commercial suppliers and used without additional purification. NMR spectra were recorded on a Bruke Avance operating for ^{1}H NMR at 400 MHz, ^{13}C NMR at 100 MHz using TMS as internal standard. Chemical shifts were given relative to $CDCl_3$ (7.26 ppm for ^{1}H NMR, 77.16 ppm for ^{13}C NMR) and DMSO-d_6 (2.50 ppm for ^{1}H NMR, 39.52 ppm for ^{13}C NMR). The following abbreviations (or combinations thereof) were used to explain multiplicities: s = singlet, d = doublet, t = triplet, m = multiplet, b = broad. Mass spectroscopy data of the products were collected on an HRMS-TOF instrument or a low-resolution MS instrument using EI. The substrates benzamides were synthesized from the corresponding carboxylic acids and $PIPNH_2$ according to the literature.[1]

General Procedure A for the Arylation:



To a 50 mL Schlenk tube was added substrate **1** (0.1 mmol), **2** (0.15 mmol), $Ni(OTf)_2$ (3.5 mg, 0.01 mmol), P(*o*-MeOPh)$_3$ (5.2 mg, 0.02 mmol), Na_2CO_3 (15 mg, 0.15 mmol) Ag_3PO_4 (42.0 mg, 0.1 mmol) and Toluene (1.5 mL). This tube was charged with N_2 and the mixture was then heated at 140 ℃ for 24 hour. The reaction mixture was cooled to room temperature, diluted with ethyl acetate and quenched with saturated NaCl solution. The aqueous phase was extracted with ethyl acetate (3×10 mL). The combined organic phase was dried with anhydrous magnesium sulfate. After concentration, the resulting residue was purified by flash chromatography to give target products.

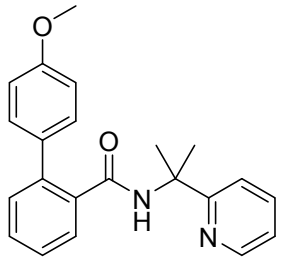
General Procedure B for the Arylation:



To a 50 mL Schlenk tube was added substrate **1** (0.1 mmol), **2** (0.15 mmol), $Ni(OTf)_2$ (3.5 mg, 0.01 mmol), PPh_3 (5.2 mg, 0.02 mmol), Na_2CO_3 (15 mg, 0.15 mmol) Ag_3PO_4 (42.0 mg, 0.1 mmol) and Toluene (1.5 mL). This tube was charged with N_2 and the mixture was then heated at 140 ℃ for 24 hour. The reaction mixture was cooled to room temperature, diluted with ethyl acetate and quenched with saturated NaCl solution. The aqueous phase was extracted with ethyl acetate (3×10 mL). The combined organic phase was dried with anhydrous magnesium sulfate. After concentration, the resulting residue was purified by flash chromatography to give target products.

Characterization Data of Products:

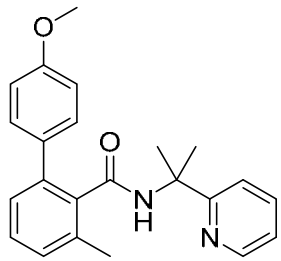
4'-Methoxy-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide



The title compound **3a** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **3a** as a white solid (29.4 mg, 85%). ^1H NMR (400 MHz, $CDCl_3$) δ 8.33 (d, J = 4.4 Hz, 1H), 7.70 (d, J = 7.6 Hz, 1H), 7.62 (t, J = 7.8 Hz, 1H), 7.48 (s, 1H), 7.43 (d, J = 7.6 Hz, 1H), 7.41 – 7.34 (m, 4H), 7.27 – 7.25 (m, 2H), 7.12 – 7.09 (m, 1H), 6.88 (d, J = 8.4 Hz, 2H), 3.76 (s, 3H), 1.64 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.63, 164.34, 159.30, 147.56, 139.52, 137.19, 136.94, 133.11, 130.35, 129.77, 128.83, 127.20, 121.70, 119.34, 113.86, 57.08, 55.41, 27.15; HRMS (EI-TOF) calcd for $C_{22}H_{22}N_2O_2$ (M^+): 346.1681, found: 346.1686.

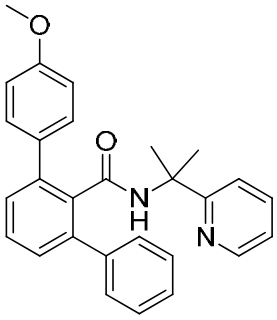
4'-Methoxy-3-methyl-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxa

mide



The title compound **3b** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **3b** as a white solid (20.0 mg, 56%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.35 (d, *J* = 4.4 Hz, 1H), 7.60 (td, *J* = 8.0, 1.6 Hz, 1H), 7.51 (s, 1H), 7.42 (d, *J* = 8.7 Hz, 2H), 7.30 (t, *J* = 7.6 Hz, 1H), 7.20–7.17 (m, 3H), 7.12 – 7.09 (m, 1H), 6.85 (d, *J* = 8.7 Hz, 2H), 3.77 (s, 3H), 2.44 (s, 3H), 1.60 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 168.87, 164.35, 159.02, 147.54, 139.07, 137.97, 136.95, 135.47, 133.44, 130.30, 128.98, 128.46, 127.40, 121.78, 119.43, 113.58, 56.99, 55.40, 27.22, 19.55; HRMS (EI-TOF) calcd for $C_{23}H_{24}N_2O_2$ (M^+): 360.1838, found: 360.1841.

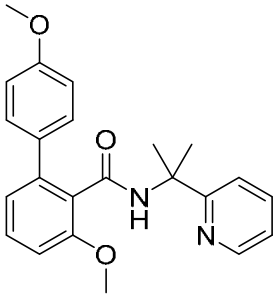
4-Methoxy-*N*-(2-(pyridin-2-yl)propan-2-yl)-[1,1':3',1''-terphenyl]-2'-carboxamid e



The title compound **3c** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **3c** as a white solid (31 mg, 74%) ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.32 (d, *J* = 5.2 Hz, 1H), 7.54 – 7.43 (m, 6H), 7.37 (s, 1H), 7.36 – 7.25 (m, 5H), 7.05 (ddd, *J* = 7.6, 5.2, 1.2 Hz), 6.92 (d, *J* = 8.0 Hz, 1H), 6.88 – 6.83 (m, 2H), 3.79 (s, 3H), 1.33 (s, 6H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.74, 164.24, 159.07, 147.43, 140.77, 140.23, 139.84, 137.37, 136.82, 133.19, 130.47, 129.35, 129.21, 128.79, 128.48, 128.01, 127.30, 121.57, 119.32, 113.49, 57.03, 55.36, 26.83. HRMS (EI-TOF) calcd for $C_{28}H_{26}N_2O_2$ (M^+):

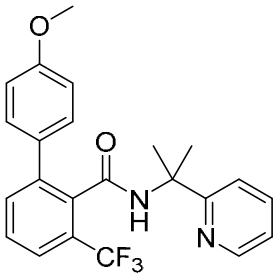
422.1994, found: 422.1994.

3,4'-Dimethoxy-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide



The title compound **3d** was prepared according to general procedure **B**. A purification by flash chromatography in petroleum ether : ethyl acetate = 1 : 1 gave **3d** as a white solid (15mg, 40%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.39 (d, *J* = 4.4 Hz, 1H), 7.60 (t, *J* = 7.2 Hz, 1H), 7.45 (d, *J* = 8.4 Hz, 2H), 7.39 (s, 1H), 7.35 (t, *J* = 8.0 Hz, 2H), 7.28 (d, *J* = 8.0 Hz, 1H), 7.10 (dd, *J* = 6.4, 5.4 Hz, 1H), 6.96 (d, *J* = 7.6 Hz, 1H), 6.91 (d, *J* = 8.4 Hz, 1H), 6.86 (d, *J* = 8.4 Hz, 2H), 3.87 (s, 3H), 3.78 (s, 3H), 1.62 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 166.70, 164.56, 159.14, 156.71, 147.65, 140.82, 136.88, 132.79, 130.24, 129.56, 127.74, 122.34, 121.65, 119.57, 113.59, 109.80, 57.35, 56.22, 55.39, 27.54; HRMS (EI-TOF) calcd for $C_{23}H_{24}N_2O_3$ (M^+): 376.1787, found: 376.1785.

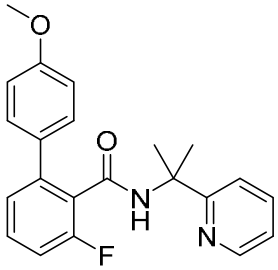
4'-Methoxy-N-(2-(pyridin-2-yl)propan-2-yl)-3-(trifluoromethyl)-[1,1'-biphenyl]-2-carboxamide



The title compound **3e** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **3e** as a white solid (25 mg, 61%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.34 (d, *J* = 4.8 Hz, 1H), 7.98 (s, 1H), 7.68 (dd, *J* = 6.4, 2.8Hz, 1H), 7.64 – 7.60 (m, 1H), 7.54 – 7.49 (m, 2H), 7.40 (d, *J* = 8.8 Hz, 2H), 7.21 (d, *J* = 8.0 Hz, 1H), 7.12 (dd, *J* = 7.2, 4.8 Hz, 1H), 6.85 (d, *J* = 8.4 Hz, 2H), 3.77 (s, 3H), 1.58 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 165.62, 164.08, 159.42, 147.31, 141.16, 137.12, 133.98, 131.92, 130.50, 128.65, 127.78 (q,

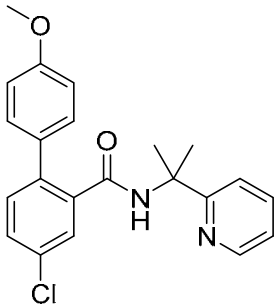
J_{C-F}= 31.0 Hz), 124.94 (q, J_{C-F}= 5.0 Hz), 121.86, 121.30 (q, J_{C-F} = 270 Hz), 119.46, 113.63, 57.21, 55.42, 26.75; HRMS (EI-TOF) calcd for $C_{23}H_{21}F_3N_2O_2$ (M^+): 414.1555, found: 414.1548.

3-Fluoro-4'-methoxy-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide



The title compound **3f** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **3f** as a white solid (28 mg, 78%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.38 (d, J = 4.4 Hz, 1H), 7.83 (s, 1H), 7.64 (td, J = 8.0, 1.6 Hz, 1H), 7.44 (d, J = 8.8 Hz, 2H), 7.40–7.34 (m, 1H), 7.28 (d, J = 8.4 Hz, 1H), 7.16–7.05 (m, 3H), 6.86 (d, J = 8.4 Hz, 2H), 3.78 (s, 3H), 1.67 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.12, 164.07, 159.68 (J_{C-F} = 246.2 Hz), 159.43, 147.51, 141.70 (q, J_{C-F} = 3.7 Hz), 137.13, 131.84, 131.82, 130.10 (q, J_{C-F} = 8.7 Hz), 130.10, 126.12 (q, J_{C-F} = 18.1 Hz), 125.61 (q, J_{C-F} = 2.9 Hz), 121.87, 119.46, 114.28 (J_{C-F} = 21.9 Hz), 113.77, 77.48, 77.16, 76.84, 57.39, 55.38, 27.29. HRMS (EI-TOF) calcd for $C_{22}H_{21}FN_2O_2$ (M+): 364.1587, found: 364.1590.

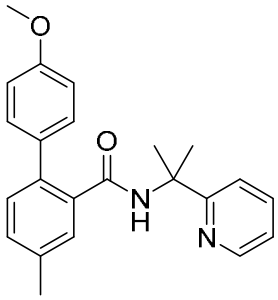
4-Chloro-4'-methoxy-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide



The title compound **3g** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **3g** as a white solid (31 mg, 82%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.32 (d, J = 4.4 Hz, 1H), 7.68 (d, J = 2.0 Hz, 1H), 7.68–7.62 (m, 2H), 7.41 (dd, J = 8.0, 2.2 Hz, 1H), 7.36 (d, J = 8.8 Hz,

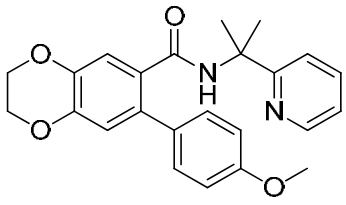
2H), 7.29–7.25 (m, 3H), 7.13 – 7.10 (m, 1H), 6.87 (d, *J* = 8.8 Hz, 2H), 3.76 (s, 3H), 1.64 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.21, 164.04, 159.52, 147.51, 138.56, 137.95, 137.07, 133.26, 131.87, 131.69, 130.29, 129.78, 128.83, 121.83, 119.33, 113.96, 57.14, 55.43, 27.06; HRMS (EI-TOF) calcd for $C_{22}H_{21}ClN_2O_2$ (M^+): 380.1292, found: 380.1295.

4'-Methoxy-4-methyl-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxa mide



The title compound **3h** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **3h** as a white solid (18 mg, 50%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.33 (d, *J* = 4.0 Hz, 1H), 7.62 (t, *J* = 7.8 Hz, 1H), 7.52 (s, 1H), 7.39 (s, 1H), 7.38 (d, *J* = 8.4 Hz, 2H), 7.26 – 7.25 (m, 3H), 7.10 (t, *J* = 6.0 Hz, 1H), 6.87 (d, *J* = 8.4 Hz, 2H), 3.76 (s, 3H), 2.41 (s, 3H), 1.63 (s, 7H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.80, 164.38, 159.18, 147.60, 137.06, 136.95, 136.90, 136.65, 133.09, 130.52, 130.38, 130.28, 129.41, 121.68, 119.34, 113.84, 57.09, 55.43, 27.17, 21.10; HRMS (EI-TOF) calcd for $C_{23}H_{24}N_2O_2$ (M+): 360.1838, found: 360.1834.

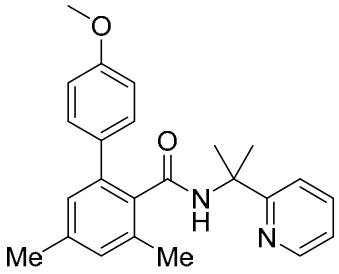
7-(4-methoxyphenyl)-N-(2-(pyridin-2-yl)propan-2-yl)-2,3-dihydrobenzo[b][1,4]di oxine-6-carboxamide



The title compound **3i** was prepared according to general procedure **B**. A purification by flash chromatography in petroleum ether : ethyl acetate = 1 : 1 gave **3i** as a white solid (17 mg, 43%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.32 (d, *J* = 4.8 Hz, 1H), 7.60 (td, *J* = 7.8, 2.0 Hz, 1H), 7.34 – 7.31 (m, 2H), 7.29 (s, 1H), 7.28 (s, 1H), 7.24 (d, *J* = 8.0

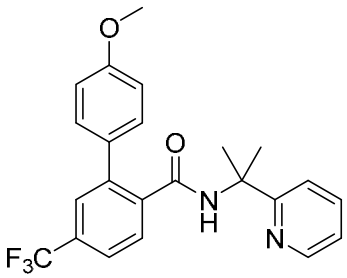
Hz, 1H), 7.10 – 7.07 (m, 1H), 6.87 – 6.83 (m, 2H), 6.83 (s, 1H), 4.29 (s, 4H), 3.75 (s, 3H), 1.59 (s, 6H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.60, 164.43, 159.16, 147.63, 144.61, 142.68, 136.82, 133.49, 132.66, 130.38, 130.32, 121.60, 119.28, 118.89, 118.33, 113.82, 64.74, 64.50, 57.04, 55.40, 27.16; HRMS (EI-TOF) calcd for $C_{24}H_{24}N_2O_4$ (M^+): 404.1736, found: 404.1735.

4'-Methoxy-3,5-dimethyl-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide



The title compound **3j** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **3j** as a white solid (25 mg, 67%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.35 (d, *J* = 4.8 Hz, 1H), 7.59 (td, *J* = 7.6, 1.4, 1H), 7.44 (s, 1H), 7.41 (d, *J* = 8.4 Hz, 2H), 7.18 (d, J = 8.0 Hz, 1H), 7.09 (dd, *J* = 7.2, 4.8 Hz, 1H), 7.01 (s, 1H), 6.99 (s, 1H), 6.85 (d, *J* = 8.4 Hz, 2H), 3.77 (s, 3H), 2.40 (s, 3H), 2.36 (s, 3H), 1.58 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.08, 164.42, 158.97, 147.54, 139.07, 138.16, 136.91, 135.46, 135.33, 133.58, 130.25, 129.73, 128.04, 121.73, 119.43, 113.56, 56.97, 55.40, 27.23, 21.30, 19.49; HRMS (EI-TOF) calcd for $C_{24}H_{26}N_2O_2$ (M+): 374.1994, found: 374.1995.

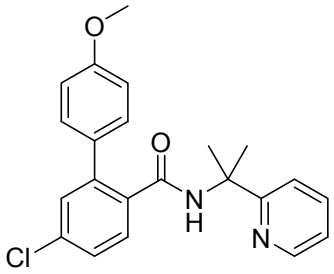
4'-Methoxy-N-(2-(pyridin-2-yl)propan-2-yl)-5-(trifluoromethyl)-[1,1'-biphenyl]-2-carboxamide



The title compound **3k** was prepared according to general procedure **B**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **3k** as a white solid (30 mg, 73%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.30 (d, *J* = 4.0 Hz 1H), 7.80 (d, *J* = 3.2 Hz, 1H), 7.79 (s, 1H), 7.67 – 7.62 (m, 3H), 7.41 (d, *J* = 8.4 Hz, 2H), 7.27 (d, *J* =

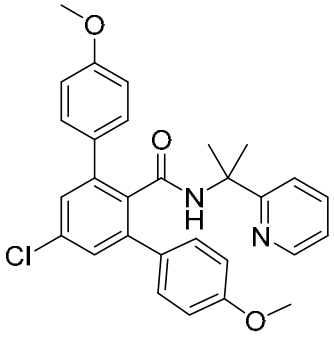
7.6 Hz, 1H), 7.12 (dd, *J* = 6.8, 5.2 Hz, 1H), 6.89 (d, *J* = 8.8 Hz, 2H), 3.76 (s, 3H), 1.66 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.46, 163.96, 159.78, 147.45, 140.46, 140.21, 137.15, 131.68 (q, *J* = 32.2 Hz), 131.62, 129.34, 127.20 (q, *J* = 3.6 Hz), 123.98 (q, *J* = 270.2 Hz), 123.93 (q, *J* = 3.0 Hz), 121.90, 119.34, 114.07, 57.15, 55.45, 27.07; HRMS (EI-TOF) calcd for $C_{23}H_{21}F_3N_2O_2$ (M^+): 414.1555, found: 414.1548.

5-Chloro-4'-methoxy-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxa mide



The title compound **3l** was prepared according to general procedure **B**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **3l** as a white solid (26 mg, 68%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.31 (d, *J* = 4.8 Hz, 1H), 7.66 – 7.64 (m, 2H), 7.60 (s, 1H), 7.37 (d, *J* = 8.4 Hz, 2H), 7.35 – 7.34 (m, 2H), 7.25 (d, *J* = 7.6 Hz, 1H), 7.10 (dd, *J* = 7.4, 4.8 Hz, 1H), 6.87 (d, *J* = 8.4 Hz, 2H), 3.75 (s, 3H), 1.63 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.58, 164.13, 159.67, 147.50, 141.29, 137.02, 135.58, 135.50, 131.74, 130.38, 130.29, 130.20, 127.24, 121.78, 119.31, 113.99, 57.09, 55.43, 27.08; HRMS (EI-TOF) calcd for $C_{22}H_{21}ClN_2O_2$ (M^+): 380.1292, found: 380.1296.

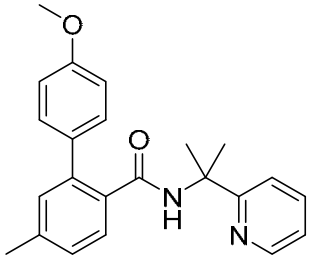
5'-Chloro-4,4''-dimethoxy-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1':3',1''-terphenyl]-2'-carboxamide



The title compound **3l`** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 1 : 2 gave **3l`** as a yellow

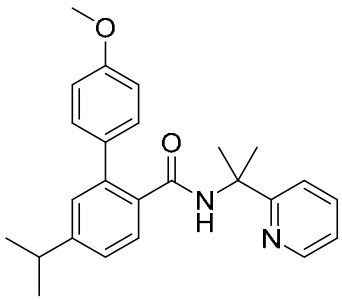
solid (8 mg, 17%). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.33 (d, *J* = 4.4 Hz, 1H), 7.52 (td, *J* = 7.8, 1.6 Hz, 1H), 7.48 (s, 1H), 7.44 (d, *J* = 8.4 Hz, 4H), 7.31 (s, 2H), 7.08 (dd, *J* = 6.8, 5.2 Hz, 1H), 6.97 (d, *J* = 8.0 Hz, 1H), 6.86 (d, *J* = 8.8 Hz, 4H), 3.79 (s, 6H), 1.35 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.18, 164.10, 159.41, 147.45, 141.63, 136.92, 135.95, 133.95, 132.02, 130.38, 128.64, 121.70, 119.35, 113.63, 57.03, 55.42, 26.87; HRMS (EI-TOF) calcd for $C_{29}H_{27}ClN_2O_3$ (M^+): 486.1710, found: 486.1705.

4'-Methoxy-5-methyl-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide



The title compound **3m** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **3m** as a white solid (26 mg, 72%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.32 (d, *J* = 4.4 Hz, 1H), 7.61 (t, *J* = 8.8 Hz, 2H), 7.38 (d, *J* = 8.0 Hz, 2H), 7.37 (s, 1H), 7.25 (d, *J* = 8.4 Hz, 2H), 7.18 (d, *J* = 7.6 Hz, 1H), 7.15 (s, 1H), 7.09 (dd, *J* = 6.4, 4.2 Hz, 1H), 6.88 (d, *J* = 8.4 Hz, 2H), 3.76 (s, 3H), 2.40 (s, 3H), 1.62 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.63, 164.40, 159.26, 147.58, 139.84, 139.52, 136.89, 134.28, 133.25, 131.05, 130.35, 129.02, 127.91, 121.65, 119.33, 113.83, 57.05, 55.41, 27.18, 21.42; HRMS (EI-TOF) calcd for $C_{23}H_{24}N_2O_2$ (M^+): 360.1838, found: 360.1834.

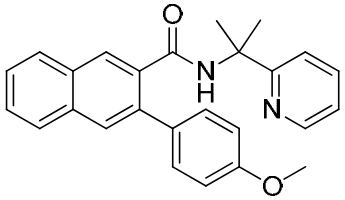
5-Isopropyl-4'-methoxy-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide



The title compound **3n** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **3n** as a white

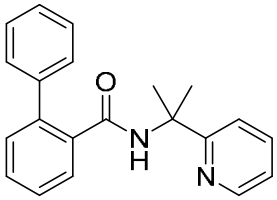
solid (17 mg, 44%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.33 (d, *J* = 4.0 Hz, 1H), 7.67–7.60 (m, 2H), 7.39 (d, *J* = 8.4 Hz, 2H), 7.37 (s, 1H), 7.26 – 7.24 (m, 2H), 7.19 (s, 1H), 7.11 – 7.08 (m, 1H), 6.89 (d, *J* = 8.8 Hz, 2H), 3.77 (s, 3H), 2.99 – 2.93 (m, 1H), 1.62 (s, 6H), 1.29 (s, 3H), 1.27 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.66, 164.43, 159.28, 150.81, 147.57, 139.58, 136.94, 134.65, 133.50, 130.41, 129.08, 128.54, 125.37, 121.68, 119.38, 113.86, 57.07, 55.44, 34.18, 27.20, 24.01; HRMS (EI-TOF) calcd for $C_{25}H_{28}N_2O_2$ (M+): 388.2151, found: 388.2159.

3-(4-Methoxyphenyl)-N-(2-(pyridin-2-yl)propan-2-yl)-2-naphthamide



The title compound **3o** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **3o** as a white solid (32 mg, 80%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.37 (d, *J* = 3.2 Hz, 1H), 8.24 (s, 1H), 7.92 (d, *J* = 7.6 Hz, 1H), 7.85 (d, *J* = 7.6 Hz, 1H), 7.80 (s, 1H), 7.67 (d, *J* = 7.8 Hz, 2H), 7.56 – 7.48 (m, 4H), 7.33 (d, *J* = 7.6 Hz, 1H), 7.15 (s, 1H), 6.92 (d, *J* = 8.4 Hz, 2H), 3.79 (s, 3H), 1.70 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.61, 159.32, 137.10, 133.88, 133.23, 132.01, 130.51, 129.27, 128.85, 128.45, 127.78, 127.45, 126.52, 121.90, 119.62, 113.91, 57.12, 55.47, 27.23; HRMS (EI-TOF) calcd for $C_{26}H_{24}N_2O_2$ (M^+): 396.1838, found: 396.1842.

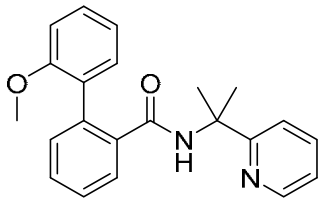
***N*-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide**



The title compound **4a** was prepared according to general procedure **B**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **4a** as a white solid (27 mg, 87%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.33 (d, *J* = 4.4 Hz, 1H), 7.72 (d, *J* = 7.6 Hz, 1H), 7.62 (td, *J* = 8.0, 1.2 Hz, 1H), 7.48 – 7.40 (m, 5H), 7.39-7.33 (m, 4H), 7.28 – 7.23 (m, 1H), 7.10 (dd, *J* = 6.4, 5.4 Hz, 1H), 1.60 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.52, 164.24, 147.54, 140.69, 139.93, 137.26, 137.02, 130.34, 129.83,

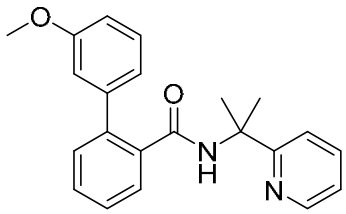
129.24, 128.85, 128.39, 127.59, 121.75, 119.35, 57.08, 27.07; HRMS (EI-TOF) calcd for $C_{21}H_{20}N_2O$ (M+): 316.1576, found: 316.1573.

2'-Methoxy-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide



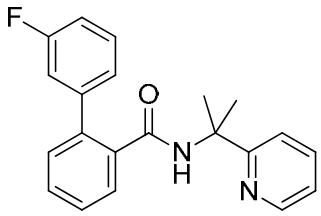
The title compound **4b** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **4b** as a white solid (28 mg, 82%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.36 (d, *J* = 4.9 Hz, 1H), 7.77 (dd, *J* = 7.5, 1.4 Hz, 1H), 7.61 – 7.55 (m, 1H), 7.47 – 7.38 (m, 2H), 7.37 (s, 1H), 7.31–7.25 (m, 3H), 7.15 (d, *J* = 8.0 Hz, 1H), 7.08 (ddd, *J* = 7.2, 4.8, 0.8 Hz, 1H), 7.03–6.99 (m, 1H), 6.86 (d, *J* = 8.2 Hz, 1H), 3.73 (s, 3H), 1.53 (s, 6H).; ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.11, 164.53, 156.52, 147.73, 137.84, 136.76, 136.13, 131.13, 130.95, 129.90, 129.68, 129.34, 128.49, 127.66, 121.55, 120.79, 119.27, 110.46, 57.03, 55.38, 27.24; HRMS (EI-TOF) calcd for $C_{22}H_{22}N_2O_2$ (M^+): 346.1681, found: 346.1686.

3'-Methoxy-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide



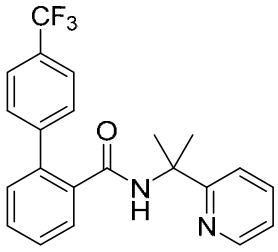
The title compound **4c** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **4c** as a white solid (23 mg, 66%). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.33 (d, *J* = 4.4 Hz, 1H), 7.73 (dd, *J* = 7.4, 1.4 Hz, 1H), 7.62 (td, *J* = 8.0, 2.0 Hz, 1H), 7.46 (m, 2H), 7.42 – 7.35 (m, 2H), 7.24 (d, *J* = 7.2 Hz, 2H), 7.10 (dd, *J* = 7.0, 5.4 Hz, 1H), 7.04 (d, *J* = 7.6 Hz, 1H), 7.02 (d, *J* = 2.3 Hz, 1H), 6.80 (dd, *J* = 8.4, 2.0 Hz, 1H), 3.78 (s, 3H), 1.61 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.36, 164.28, 159.61, 147.55, 142.13, 139.82, 137.32, 136.92, 130.15, 129.76, 129.42, 128.87, 127.68, 121.70, 121.65, 119.29, 114.50, 113.56, 57.09, 55.33, 27.08; HRMS (EI-TOF) calcd for $C_{22}H_{22}N_2O_2$ (M^+): 346.1681, found: 346.1686.

3'-Fluoro-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide



The title compound **4d** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **4d** as a white solid (30 mg, 90%). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.35 (d, *J* = 4.0 Hz, 1H), 7.80 (d, *J* = 7.2, 1H), 7.77 (s, 1H), 7.46 (m, 2H), 7.66 (t, *J* = 7.2 Hz, 1H), 7.51–7.45 (m, 2H), 7.43–7.36 (m, 2H), 7.29 (d, *J* = 8.0 Hz, 1H), 7.24–7.21 (m, 1H), 7.17–7.11 (m, 1H), 7.02 (d, *J* = 8.8 Hz, 1H), 1.64 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.95, 162.6 (d, J_{C-F} = 315 Hz), 147.15, 137.89, 133.70, 131.71 (d, J_{C-F} = 3 Hz), 131.09, 129.88, 129.6 (d, J_{C-F} = 8 Hz), 128.61, 128.28, 124.17, 121.85, 119.53, 115.54 (d, J_{C-F} = 21.9 Hz), 56.88, 27.05; HRMS (EI-TOF) calcd for $C_{21}H_{19}FN_2O$ (M^+): 334.1481, found: 334.1487.

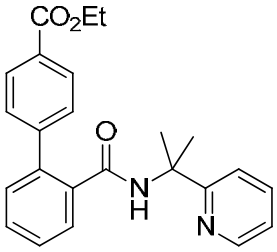
***N*-(2-(pyridin-2-yl)propan-2-yl)-4'-(trifluoromethyl)-[1,1'-biphenyl]-2-carboxamide**



The title compound **4e** was prepared according to general procedure **B**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **4e** as a white solid (31 mg, 81%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.29 (d, *J* = 4.4 Hz, 1H), 7.81 (s, 1H), 7.74 (d, *J* = 7.2 Hz, 1H), 7.64 (t, *J* = 7.6 Hz, 1H), 7.58 (brs, 4H), 7.52 – 7.44 (m, 2H), 7.37 (d, *J* = 7.6 Hz, 1H), 7.27 (d, *J* = 6.0 Hz, 2H), 7.12 (dd, *J* = 6.8, 4.8 Hz, 1H), 1.66 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.09, 164.02, 147.39, 144.42, 138.61, 137.61, 137.17, 130.23, 129.98, 129.63 (q, J_{C-F} = 32.2 Hz), 129.55, 128.80, 128.29, 125.19 (q, J_{C-F} = 3.7 Hz), 124.29 (q, J_{C-F} = 270.4 Hz), 121.91, 119.33, 77.48, 77.16, 76.84, 57.07, 27.01; HRMS (EI-TOF) calcd for $C_{22}H_{19}F_3N_2O$ (M+): 384.1449, found:

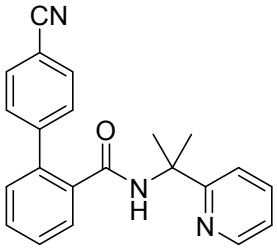
384.1450.

Ethyl 2'-((2-(pyridin-2-yl)propan-2-yl)carbamoyl)-[1,1'-biphenyl]-4-carboxylate



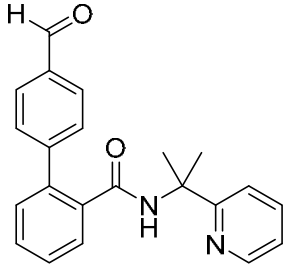
The title compound **4f** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 1 : 1 gave **4f** as a white solid (27mg, 70%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.31 (d, *J* = 4.8 Hz, 1H), 8.01 (d, *J* = 8.4 Hz, 2H), 7.77 (s, 1H), 7.72 (d, *J* = 7.4 Hz, 1H), 7.63 (t, *J* = 7.4 Hz, 1H), 7.54 (d, *J* = 8.1 Hz, 2H), 7.51 – 7.43 (m, 2H), 7.38 (d, *J* = 7.4 Hz, 1H), 7.26 (d, *J* = 8.0 Hz, 1H), 7.12-7.18 (m, 1H), 4.35 (q, *J* = 7.2 Hz, 2H), 1.65 (s, 6H), 1.38 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.25, 166.57, 164.11, 147.48, 145.35, 139.01, 137.53, 137.08, 130.24, 129.90, 129.59, 129.52, 129.17, 128.75, 128.15, 121.86, 119.36, 61.05, 57.11, 27.07, 14.47; HRMS (EI-TOF) calcd for $C_{24}H_{24}N_2O_3$ (M+): 388.1787, found: 388.1790.

4'-Cyano-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide



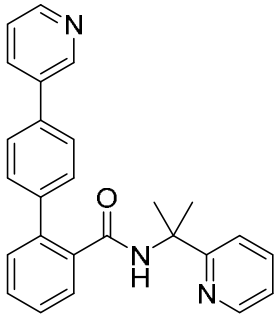
The title compound **4g** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 1 : 1 gave **4g** as a yellow solid (31 mg, 91%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.31 (d, *J* = 4.8 Hz, 1H), 7.98 (s, 1H), 7.73 – 7.68 (m, 2H), 7.59 (q, *J* = 8.4 Hz, 4H), 7.53 – 7.47 (m, 2H), 7.36 (d, *J* = 7.2 Hz, 1H), 7.31 (d, *J* = 8.0 Hz, 1H), 7.16 (dd, *J* = 7.4, 4.8 Hz, 1H), 1.68 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.00, 163.98, 147.34, 145.63, 138.22, 137.67, 137.36, 132.04, 130.11, 130.07, 129.91, 128.74, 128.64, 122.11, 119.47, 111.25, 57.07, 27.05; HRMS (EI-TOF) calcd for $C_{22}H_{19}N_3O$ (M^+): 341.1528, found: 341.1532.

4'-Formyl-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide



The title compound **4h** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 2 : 1 gave **2i** as a white solid (31 mg, 91%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.96 (s, 1H), 8.29 (d, *J* = 3.6 Hz, 1H), 7.91 (s, 1H), 7.85 (d, *J* = 7.2 Hz, 2H), 7.73 (d, *J* = 7.2 Hz, 1H), 7.65 (d, *J* = 8.0 Hz, 3H), 7.53-7.45 (m, 2H), 7.40 (d, *J* = 7.2 Hz, 1H), 7.27 (d, *J* = 10.0 Hz, 1H), 7.12 (t, *J* = 6.0 Hz, 1H), 1.66 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.07, 168.15, 164.02, 147.36, 147.16, 138.76, 137.65, 137.23, 135.38, 130.20, 130.19, 129.99, 129.88, 129.74, 128.76, 128.43, 121.97, 119.41, 57.07 (s, 2H), 27.04 (s, 4H); HRMS (EI-TOF) calcd for $C_{22}H_{20}N_2O_2$ (M+): 344.1525, found: 344.1529.

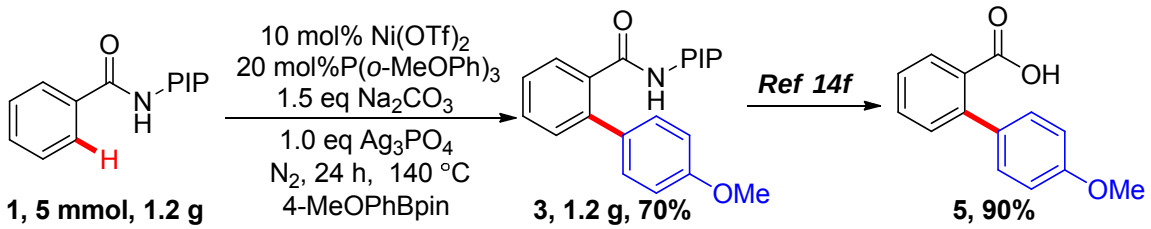
***N*-(2-(pyridin-2-yl)propan-2-yl)-4'-(pyridin-3-yl)-[1,1'-biphenyl]-2-carboxamide**



The title compound **4i** was prepared according to general procedure **A**. A purification by flash chromatography in petroleum ether : ethyl acetate = 1 : 1 gave **4i** as a yellow solid (23 mg, 59%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.75 (s, 1H), 8.57 (d, *J* = 4.0 Hz, 1H), 8.32 (d, *J* = 4.4 Hz, 1H), 7.81 (d, *J* = 8.0 Hz, 1H), 7.77 (s, 1H), 7.74 (d, *J* = 7.6 Hz, 1H), 7.63 – 7.54 (m, 6H), 7.49 (dd, *J* = 7.6, 1.6 Hz, 1H), 7.46 – 7.42 (m, 2H), 7.35 (dd, *J* = 7.6, 4.8 Hz, 1H), 7.27 (d, *J* = 4.8 Hz, 1H), 7.10 – 7.07 (m, 1H), 1.67 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.45, 164.18, 148.45, 148.19, 147.41, 140.67, 139.27, 137.42, 137.09, 136.90, 136.44, 134.49, 130.28, 129.97, 129.93, 128.83, 127.82, 127.06, 123.73, 121.82, 119.35, 57.08, 27.07; HRMS (EI-TOF) calcd for

$C_{26}H_{23}N_3O$ (M+): 393.1841, found: 393.1843.

Gram-Scale Synthesis of 3a and Removal of the Directing Group



1, 5 mmol, 1.2 g **3, 1.2 g, 70%** **5, 90%**

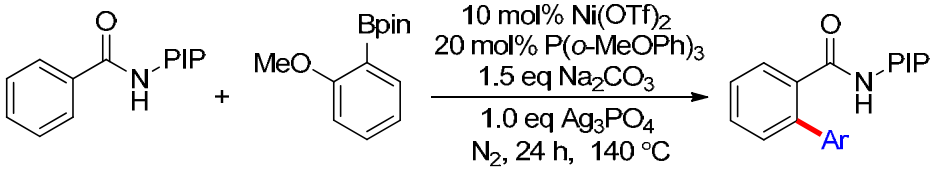
A mixture of **1a** (1.2 g, 5.0 mmol), **2a** (1.76 g, 7.5 mmol), $Ni(OTf)_2$ (0.131 g, 0.5 mmol), Na_2CO_3 (0.79 g, 7.5 mmol), P(*o*-MeOPh)$_3$ (0.262g, 1.0 mmol), Ag_3PO_3 (2.01 g, 5.0 mmol) and Toluene (10.0 mL) in a 100 mL Schlenk tube was vigorously stirred at 140 °C under N_2 for 24 hours. The reaction mixture was cooled to room temperature, diluted with dichloromethane and quenched with saturated NaCl solution. The aqueous phase was extracted with dichloromethane (3×100 mL). The combined organic phase was dried with anhydrous magnesium sulfate. After concentration, the resulting residue was purified by flash chromatography (petroleum ether : ethyl acetate = 1 : 1) to give the desired product **3a** (1.2g, 70%).

A solution of substrate **3a** (67.5 mg, 0.25 mmol) in a mixture of acetic acid (0.7 mL) and acetic anhydride (3.5 mL) was cooled to -15 °C and 380 mg of granular sodium nitrite (22 equiv) was added slowly in portions. After being stirred for 48 hours at -15 °C, the mixture was poured into a mixture of ice and water. (Caution! The nitrosoamide is unstable and the subsequent work-up should be carried out at 0 °C) The nitrosoamide was extracted with cold ether, and the organic phase was washed with ice water, with an aqueous solution of sodium carbonate (5%), with ice water, and then dried with anhydrous sodium sulfate under ice bath. The solvent was removed under reduce pressure under ice bath. The residue was dissolved in THF (10 mL)/ H_2O (3 mL) and cooled to -15 °C. Then 30% H_2O_2 (1.2 mL) was added followed by lithium hydroxide monohydrate (209.8 mg, 5.0 mmol). The mixture was stirred at -15 °C for 2 hours and at 0 °C overnight, and then quenched with an aqueous solution of Na_2SO_3. The mixture was basified with 1N NaOH and washed with ethyl acetate.

The aqueous phase was acidied with 1M HCl and extracted with ethyl acetate. The organic layer was washed with brine, dried over anhydrous sodium sulfate and concentrated in vacuo. The resulting residue was purified by flash chromatography (petroleum ether : ethyl acetate = 1 : 1). Product **5** was obtained as a light yellow solid (51.3 mg, 90%). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (d, *J* = 8.4, 1.2 Hz, 1H), 7.53 (td, *J* = 7.6, 1.4 Hz, 1H), 7.40-7.36 (m, 2H), 7.28 – 7.27 (m, 1H), 7.25 (d, *J* = 2.0 Hz, 1H), 6.94 – 6.90 (m, 2H), 3.84 (s, 3H);^{13}C NMR (101 MHz, $CDCl_3$) δ 172.94, 159.25, 143.01, 133.46, 132.14, 131.33, 130.80, 129.79, 129.43, 126.99, 113.77, 55.40.

Mechanistic Investigation

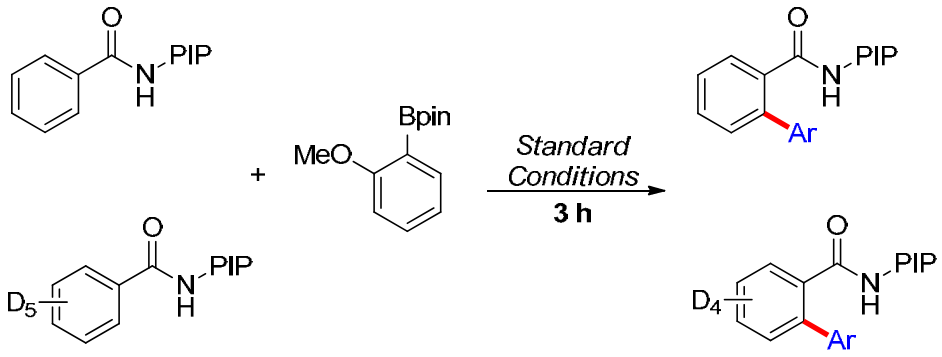
1) Radical Scavenger Reactions



Additive (1.0 equiv)	Yield
---	86%
TEMPO	Trace
Hydroquinone	N.R
2,6-Di-*tert*-butyl-4-methylphenol	N.R

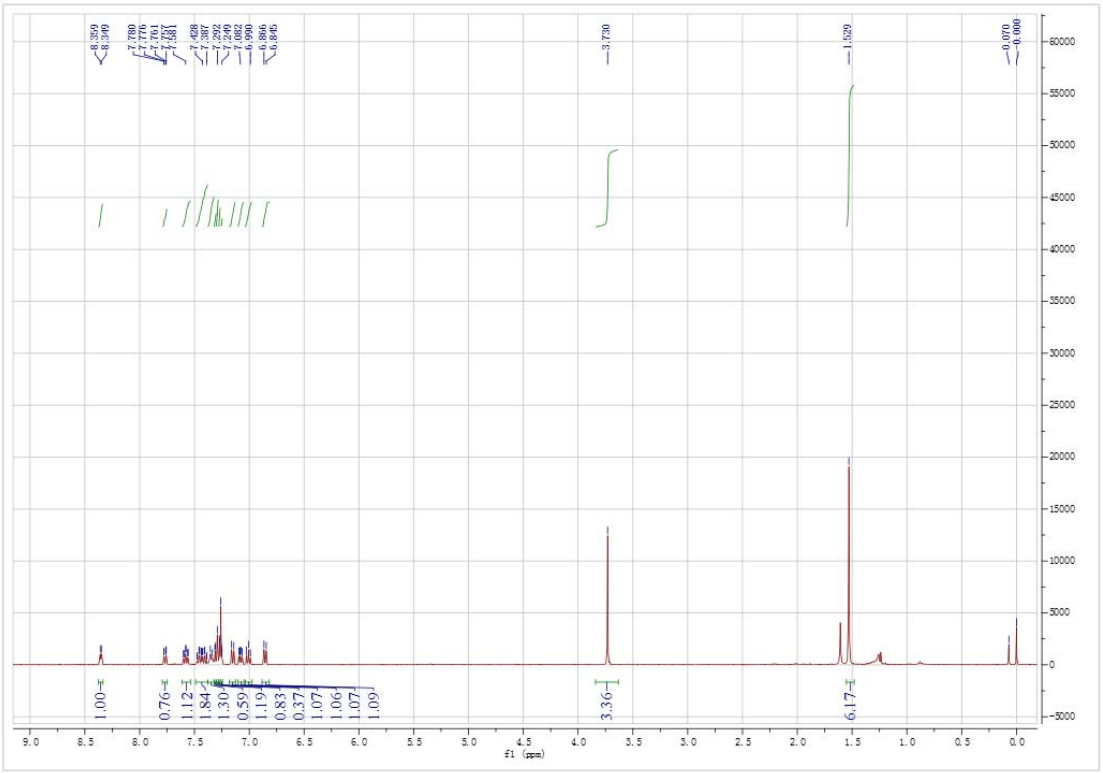
To a 50 mL Schlenk tube was added substrate **1** (0.1 mmol), **2** (0.15 mmol), $Ni(OTf)_2$ (3.5 mg, 0.01 mmol), P(*o*-MeOPh)$_3$ (5.2 mg, 0.02 mmol), Na_2CO_3 (15 mg, 0.15 mmol) Ag_3PO_4 (42.0 mg, 0.1 mmol), Additive (0.1 mmol) and Toluene (1.5 mL). This tube was charged with N_2 and the mixture was then heated at 140 ℃ for 24 hour. The reaction mixture was cooled to room temperature, diluted with ethyl acetate and quenched with saturated NaCl solution. The results were observed by TLC.

2) Investigation of intermolecular Kinetic Isotopic Effect



20% yield, K_H/K_D = 3.2

To a 50 mL Schlenk tube was added substrate **1** (0.1 mmol), *d*$_1$-**1** (0.1 mmol), **2** (0.3 mmol), Ni(OTf)$_2$ (7.0 mg, 0.02 mmol), P(*o*-MeOPh)$_3$ (10.4 mg, 0.04 mmol), Na_2CO_3 (30 mg, 0.3 mmol) Ag_3PO_4 (84.0 mg, 0.2 mmol) and Toluene (2.0 mL). This tube was charged with N_2 and the mixture was then heated at 140 ℃ for 3 hour. The reaction mixture was cooled to room temperature, diluted with ethyl acetate and quenched with saturated NaCl solution. The aqueous phase was extracted with ethyl acetate (3×10 mL). The combined organic phase was dried with anhydrous magnesium sulfate. After concentration, the resulting residue was purified by flash chromatography to give product, which was analyzed by ^{1}H NMR. Yield: 20%, ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.35 (d, *J* = 4.2 Hz, 1H), 7.77 (dd, *J* = 7.5, 1.4 Hz, 0.76H), 7.58 (td, *J* = 7.9, 1.8 Hz, 1H), 7.43 (m, 2H), 7.36 (s, 1H), 7.31-7.25 (m, 3H), 7.15 (d, *J* = 8.0 Hz, 1H), 7.10 – 7.05 (m, 1H), 7.01 (t, *J* = 7.1 Hz, 1H), 6.86 (d, *J* = 8.2 Hz, 1H), 3.73 (s, 3H), 1.53 (s, 6H).

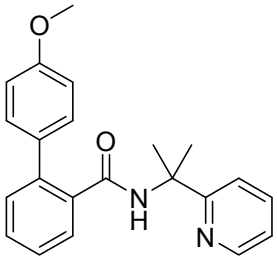


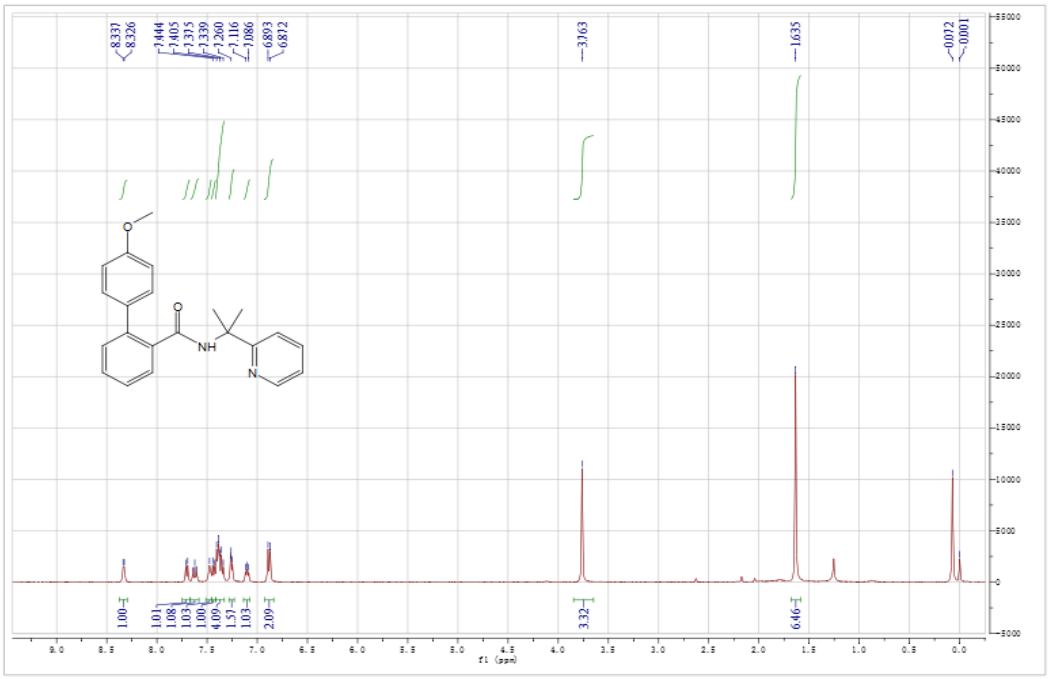
References:

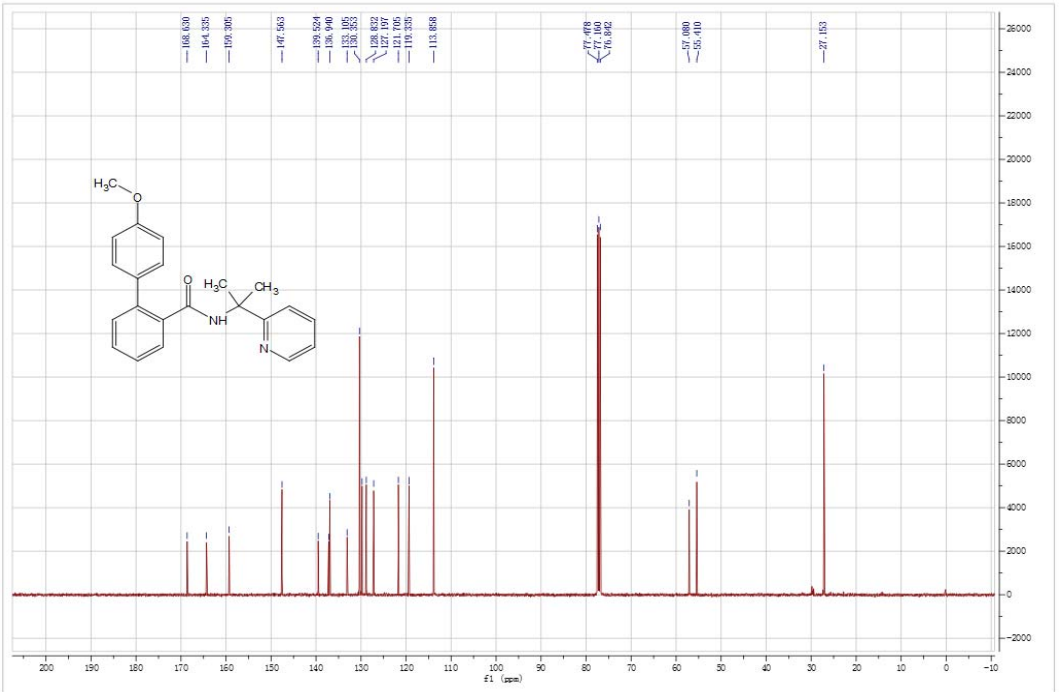
1. Li, X.; Liu, Y.-H.; Gu, W.-J.; Li, B.; Chen, F.-J.; Shi, B.-F. *Org. Lett*. **2014**, *16*, 3904−3907.

NMR Spectra:

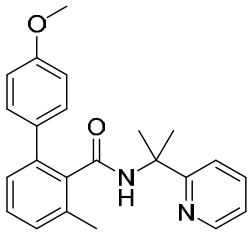
4'-Methoxy-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide

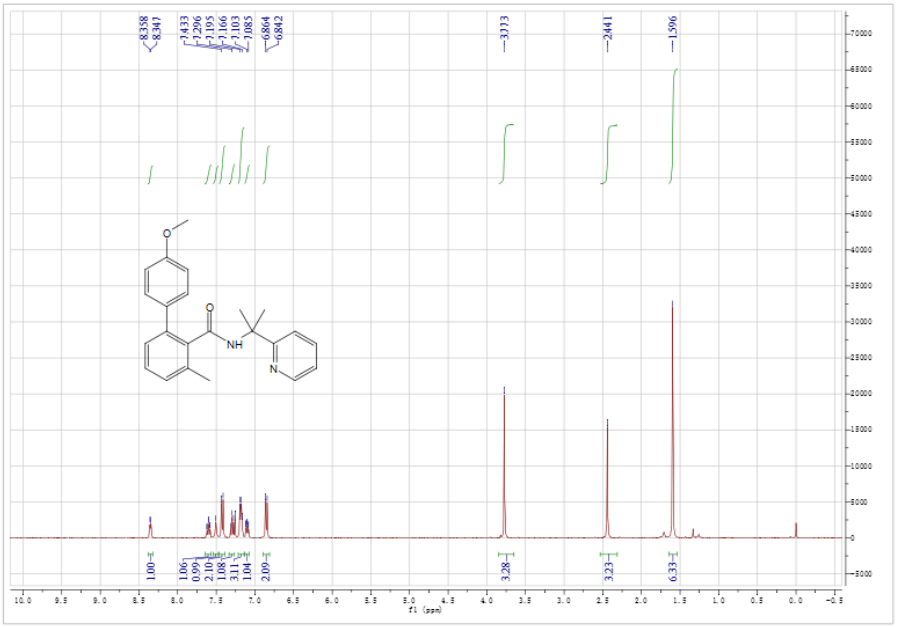


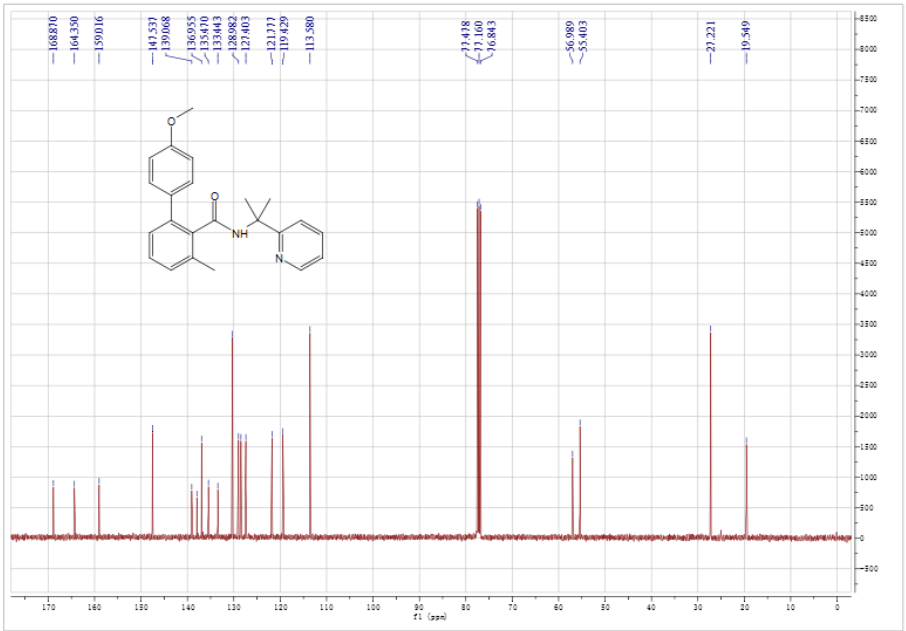




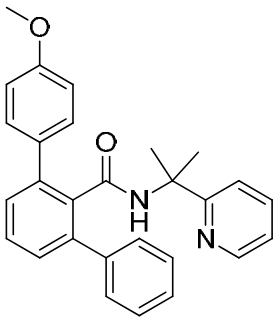
4'-Methoxy-3-methyl-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxa mide

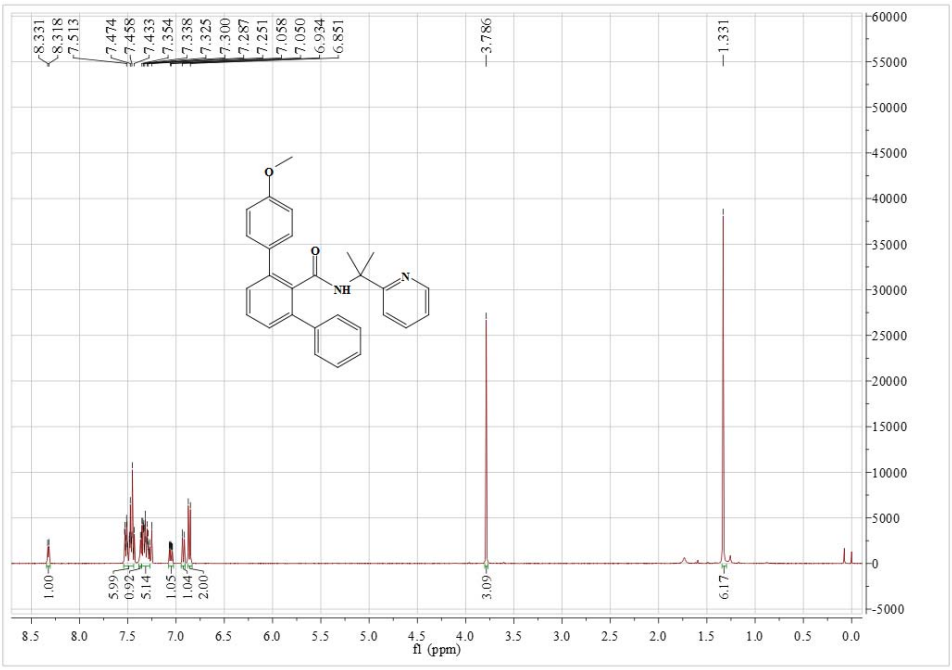


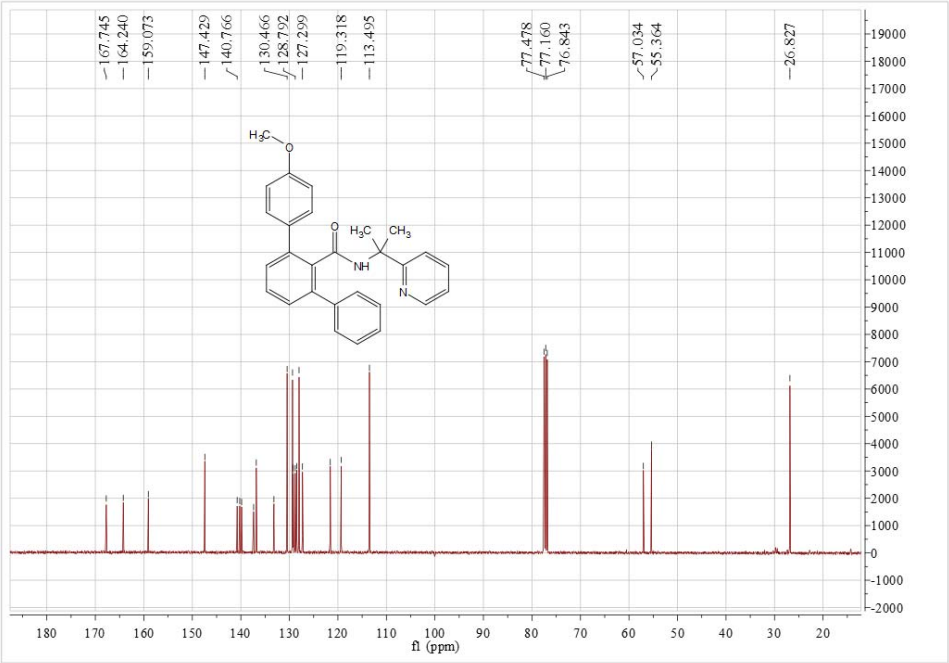




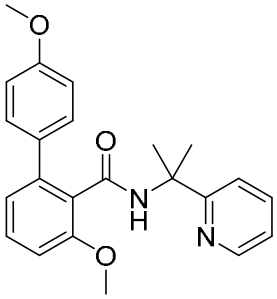
4-Methoxy-*N*-(2-(pyridin-2-yl)propan-2-yl)-[1,1':3',1''-terphenyl]-2'-carboxamide

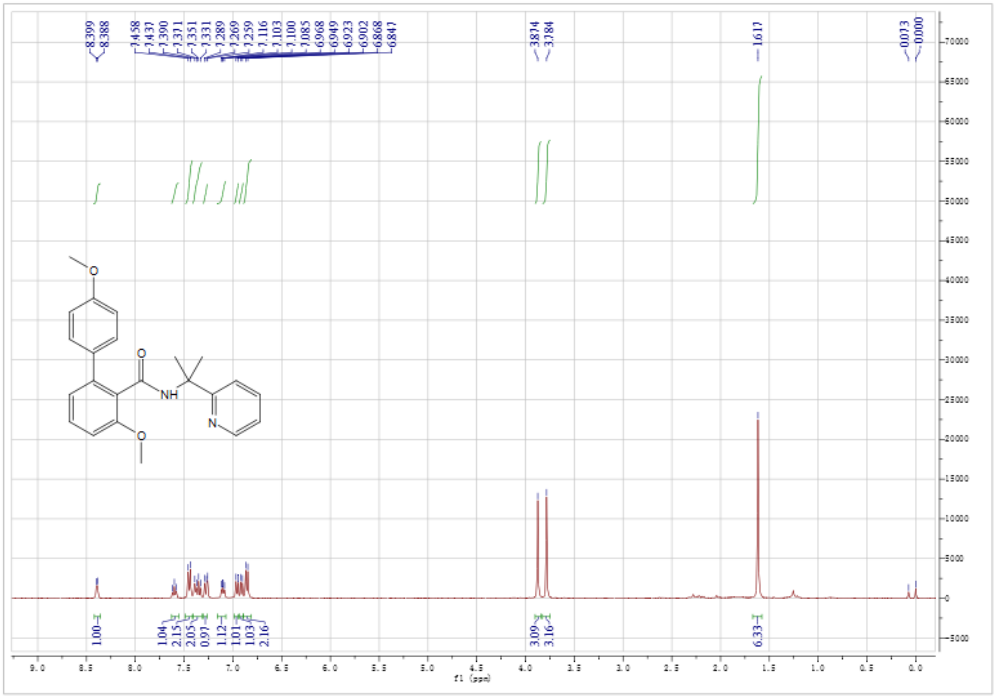


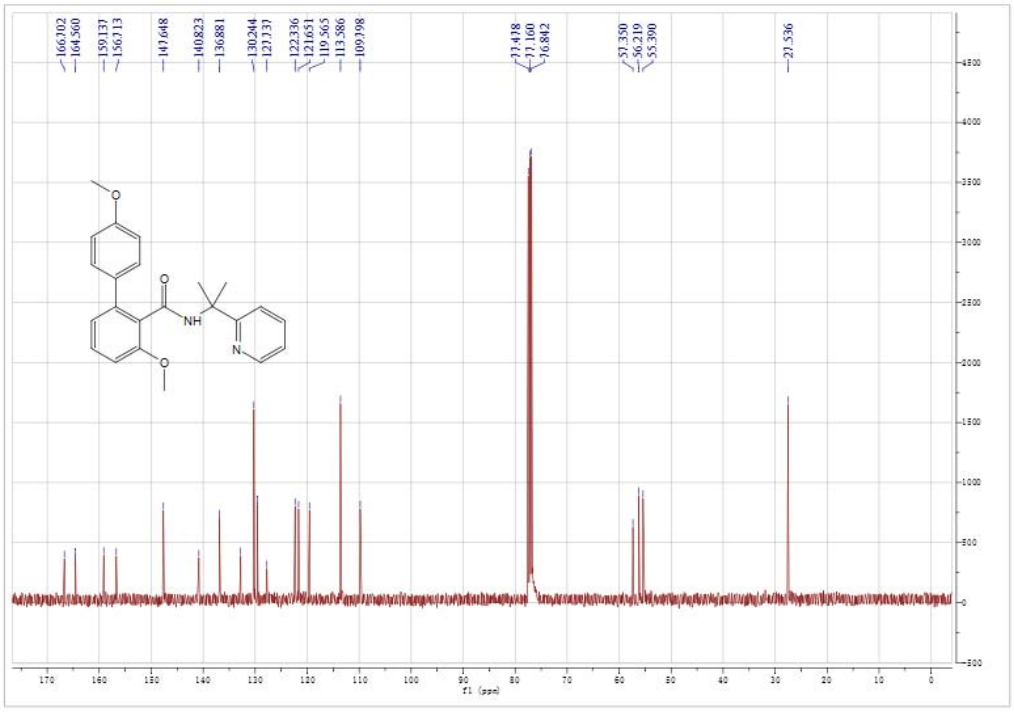




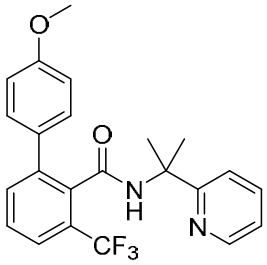
3,4'-Dimethoxy-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide

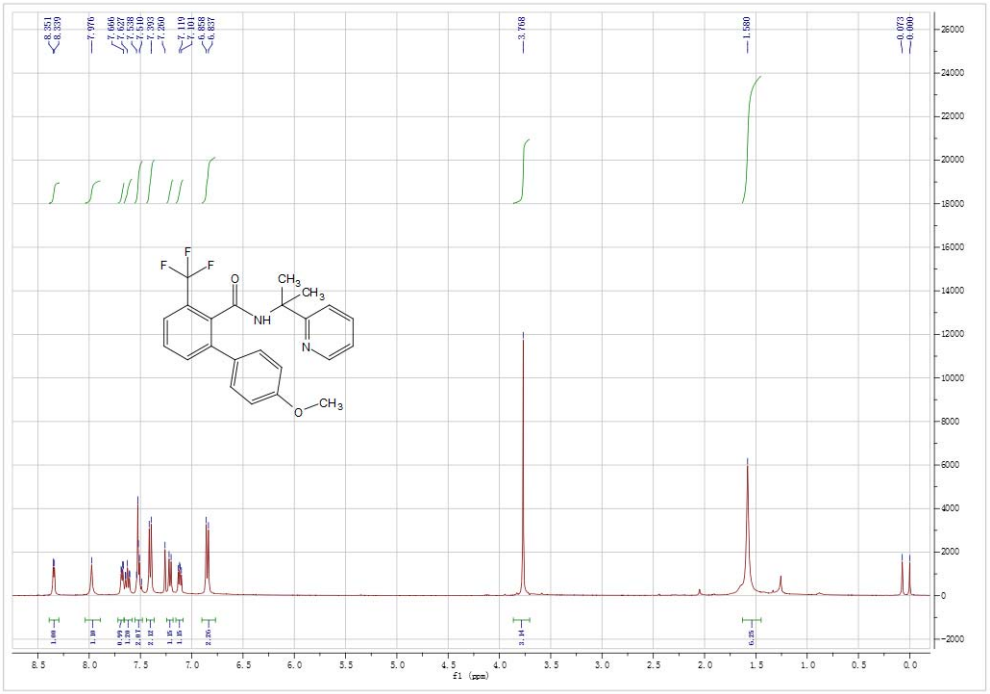


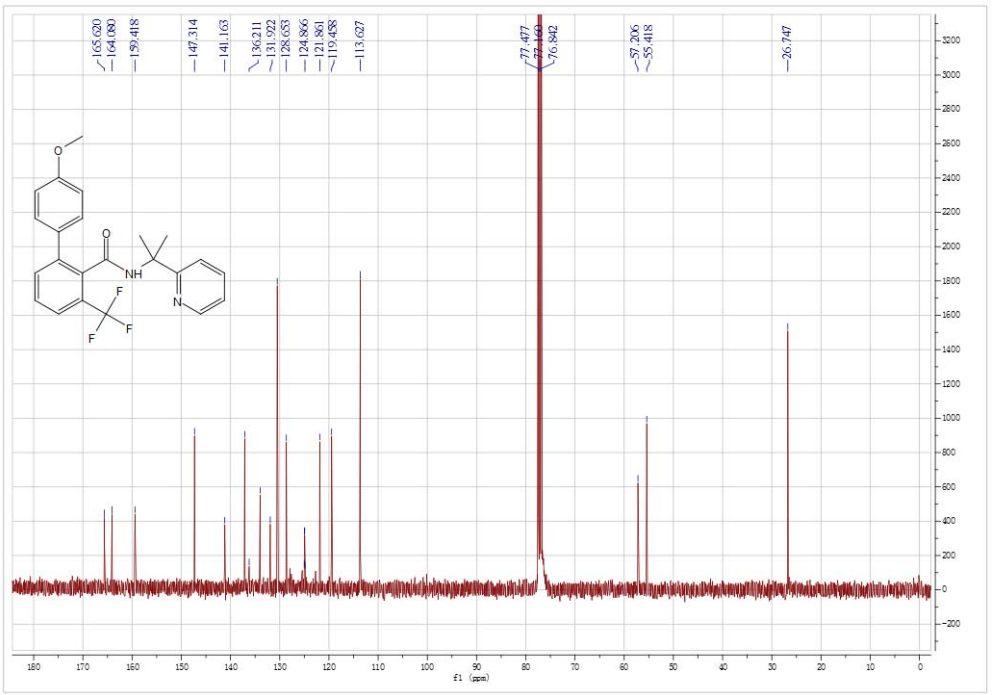




4'-Methoxy-N-(2-(pyridin-2-yl)propan-2-yl)-3-(trifluoromethyl)-[1,1'-biphenyl]-2-carboxamide







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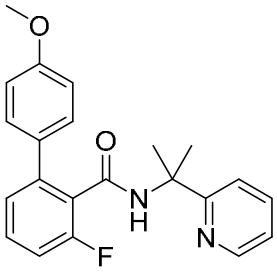
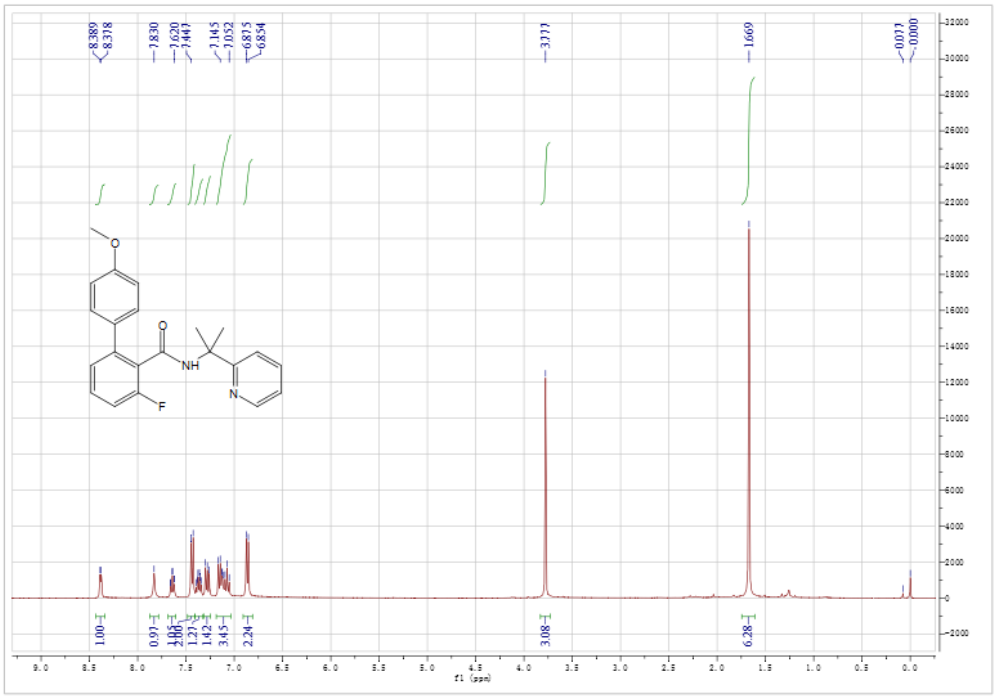
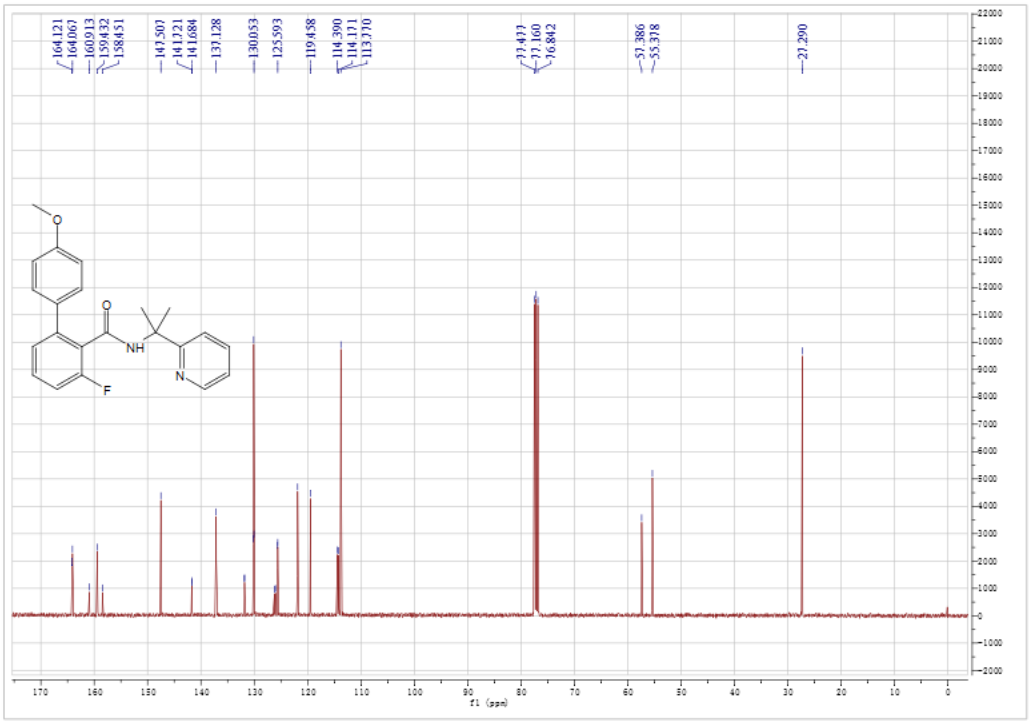
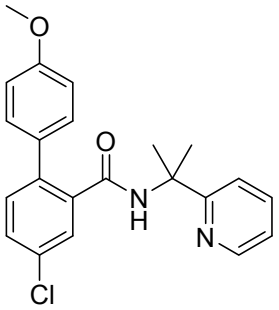
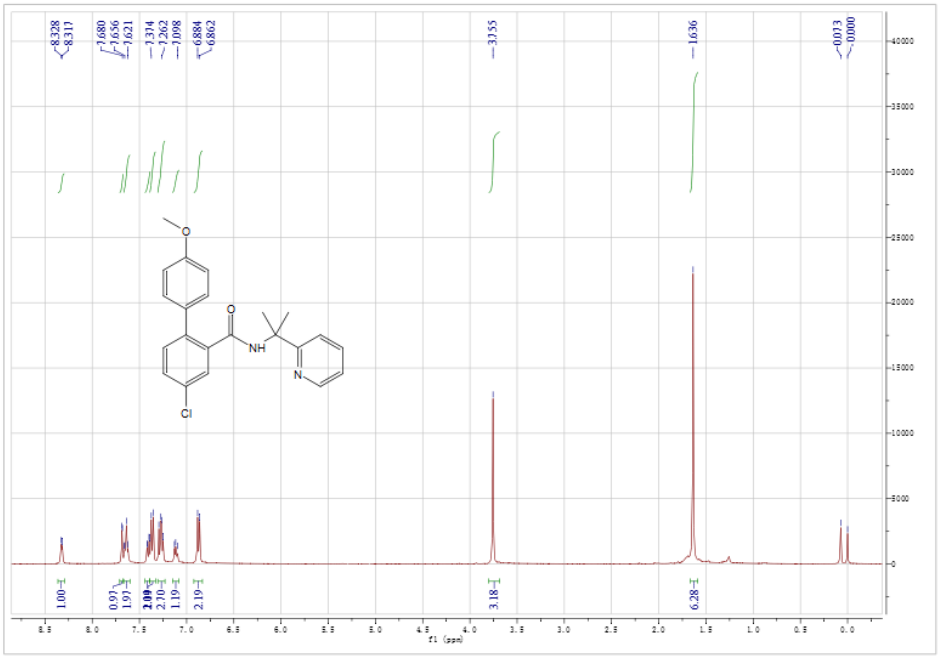


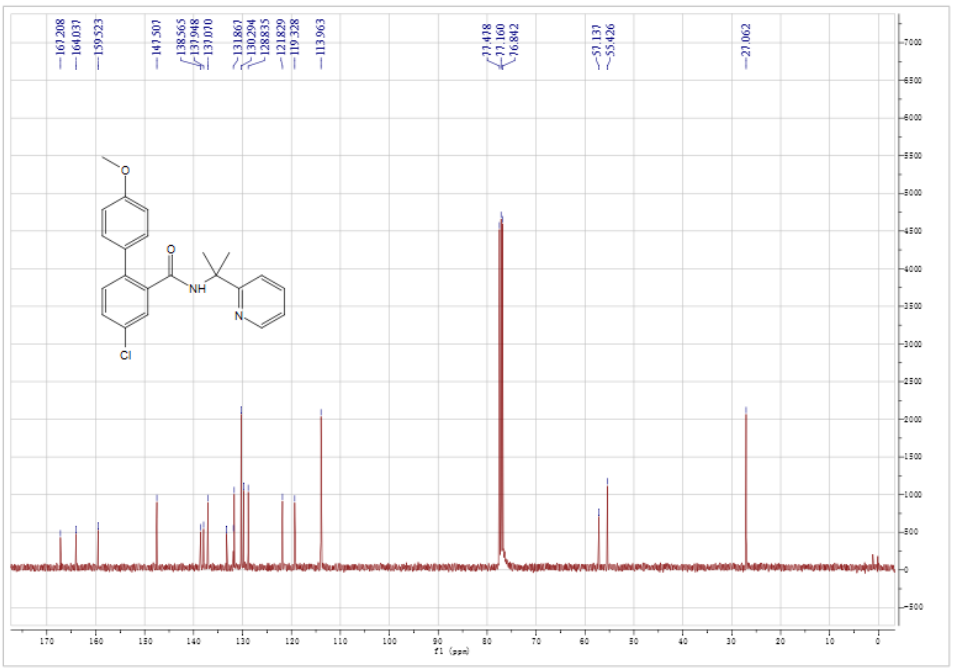




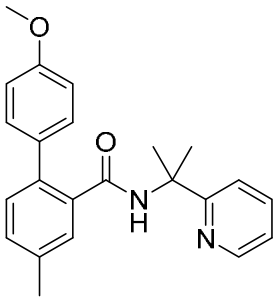
4-Chloro-4'-methoxy-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide

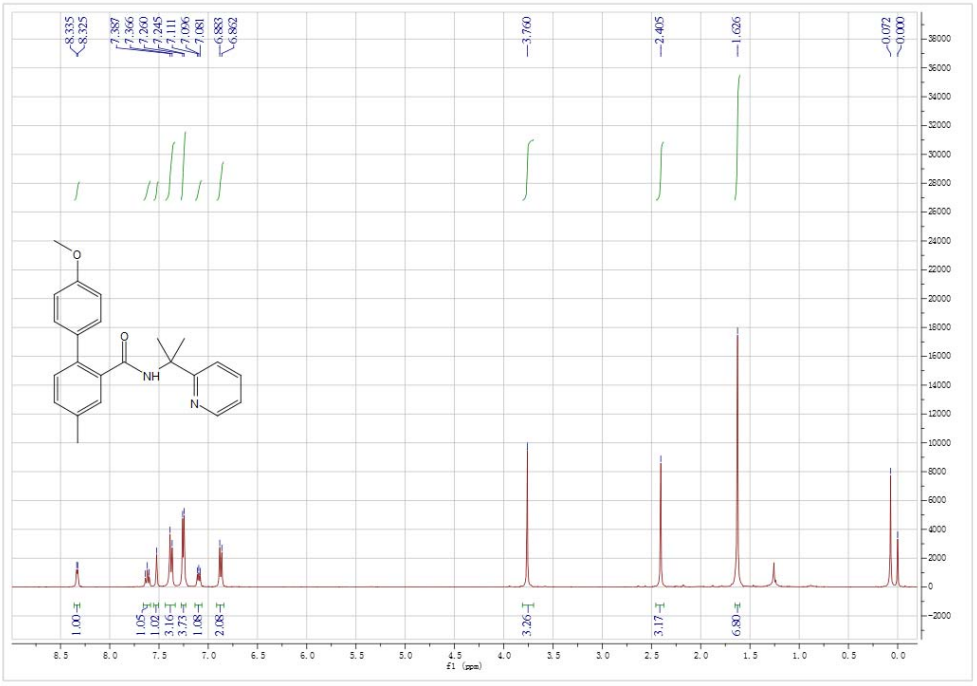


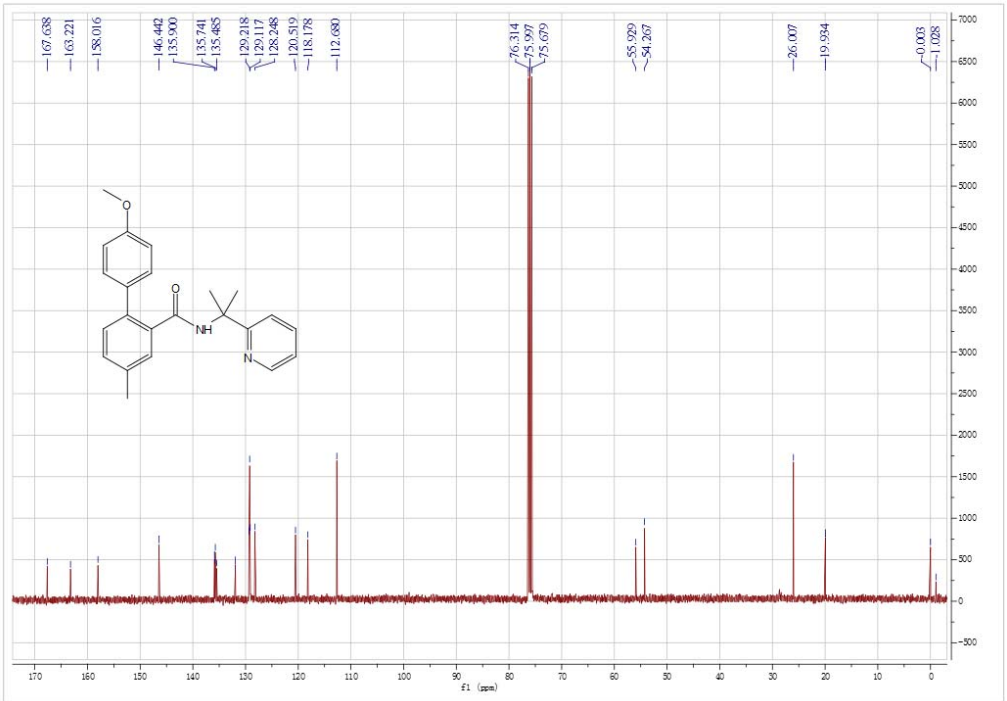




4'-Methoxy-4-methyl-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide







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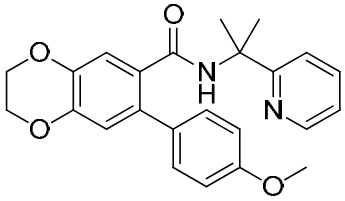
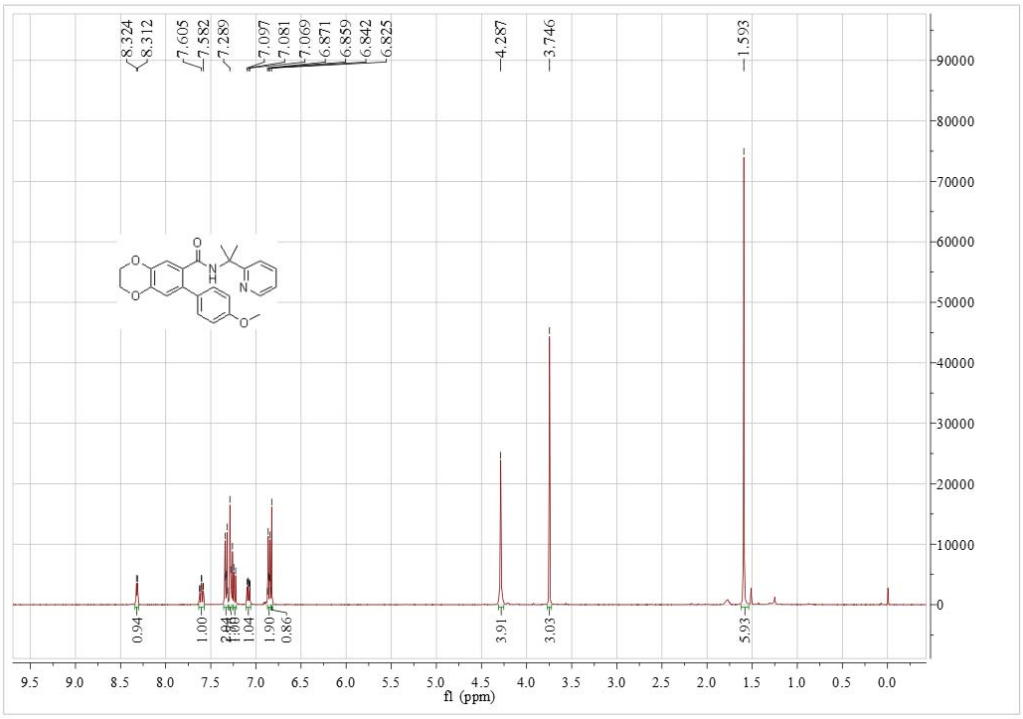
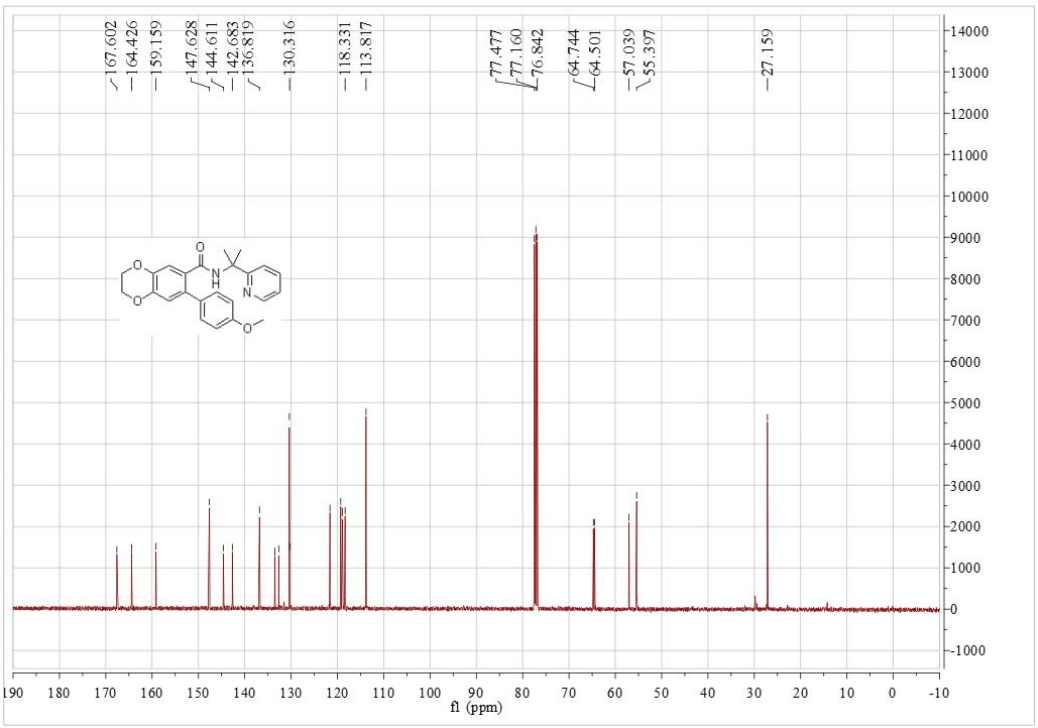
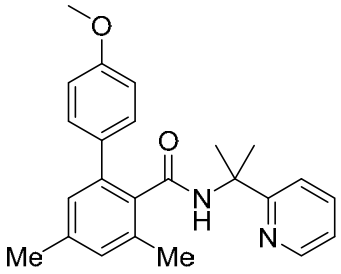
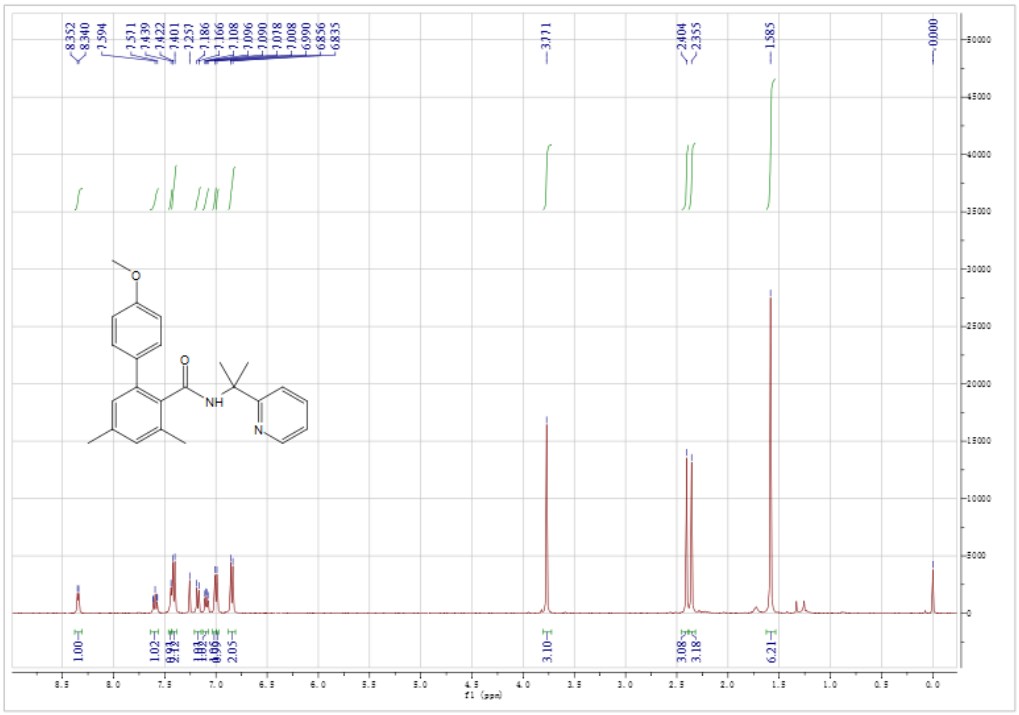


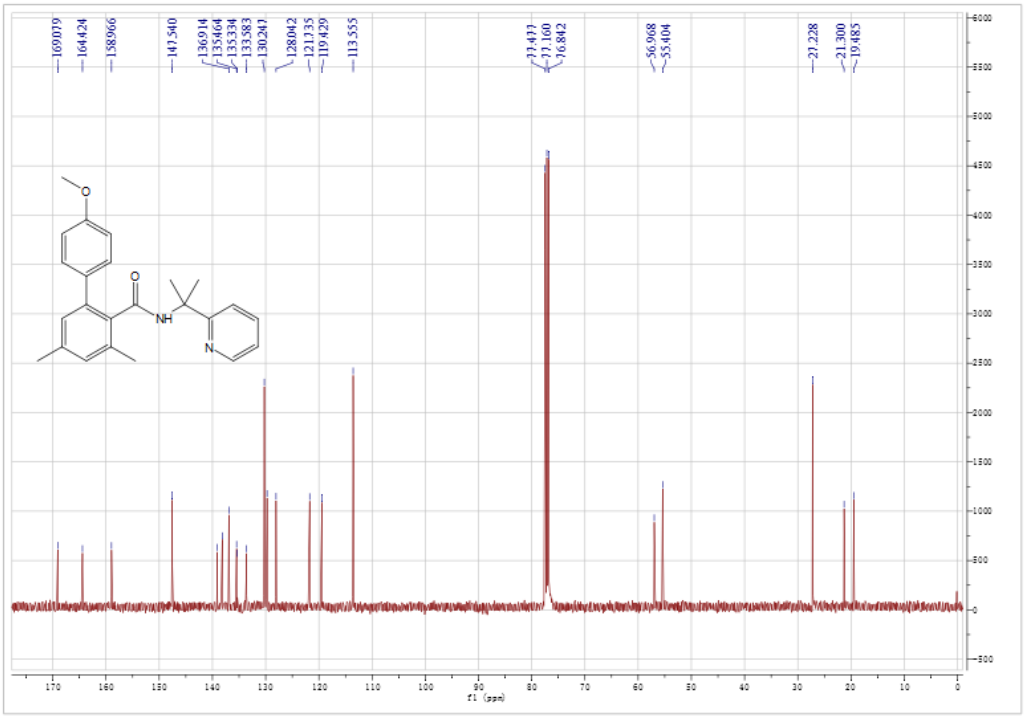




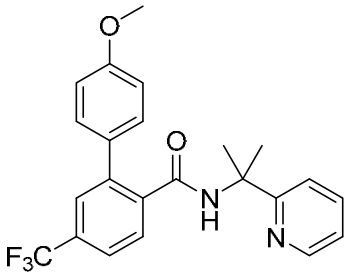
4'-Methoxy-3,5-dimethyl-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide

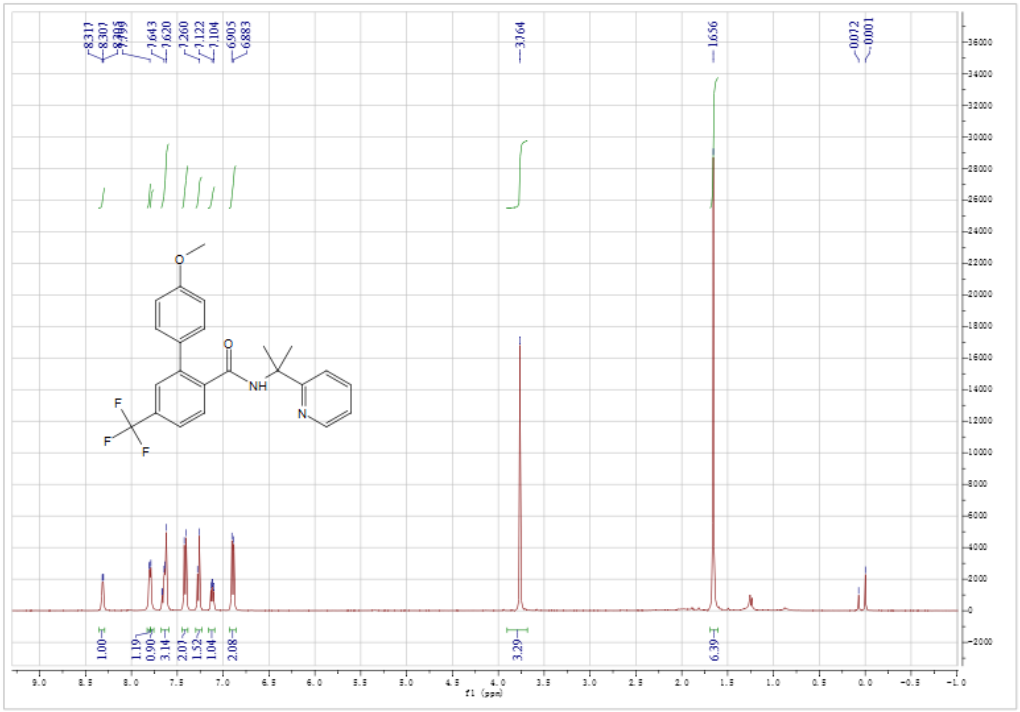


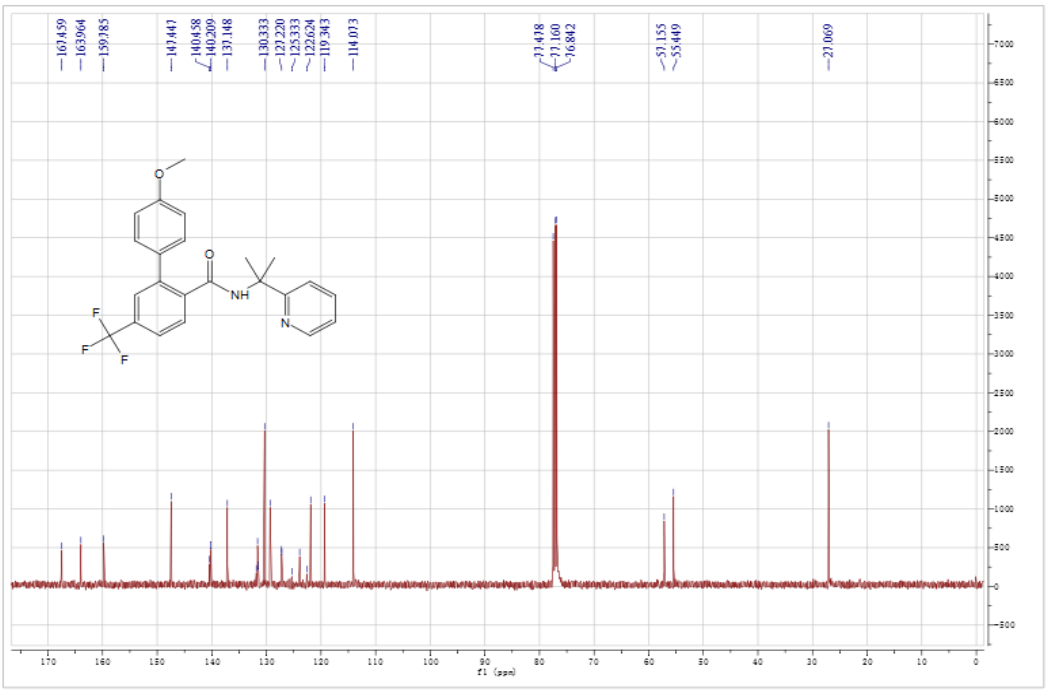




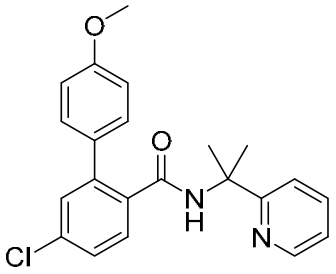
4'-Methoxy-N-(2-(pyridin-2-yl)propan-2-yl)-5-(trifluoromethyl)-[1,1'-biphenyl]-2-carboxamide

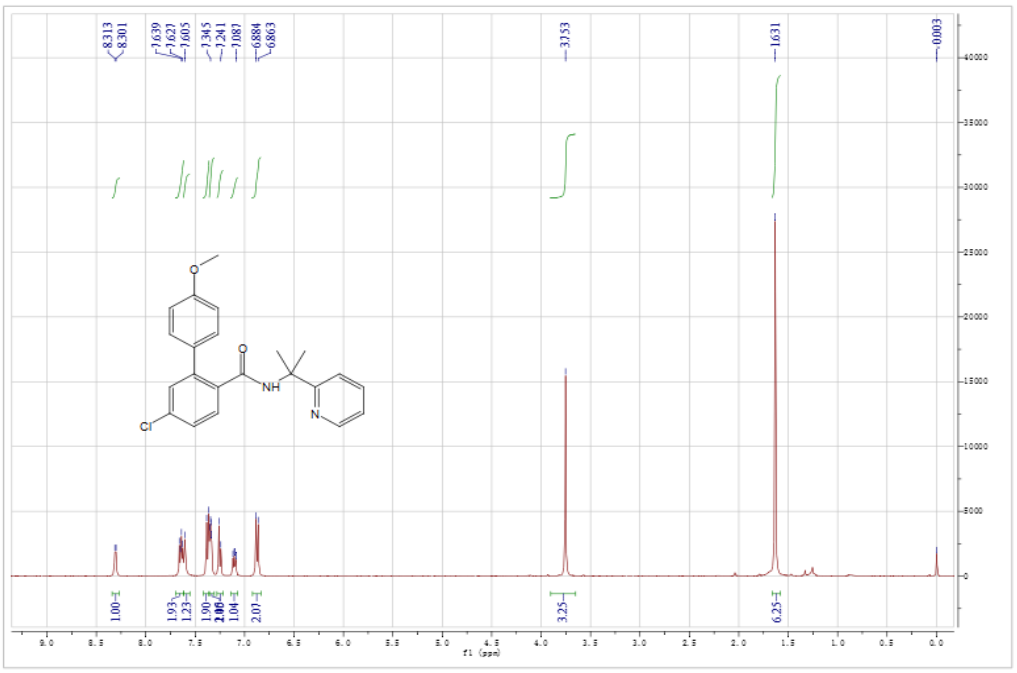


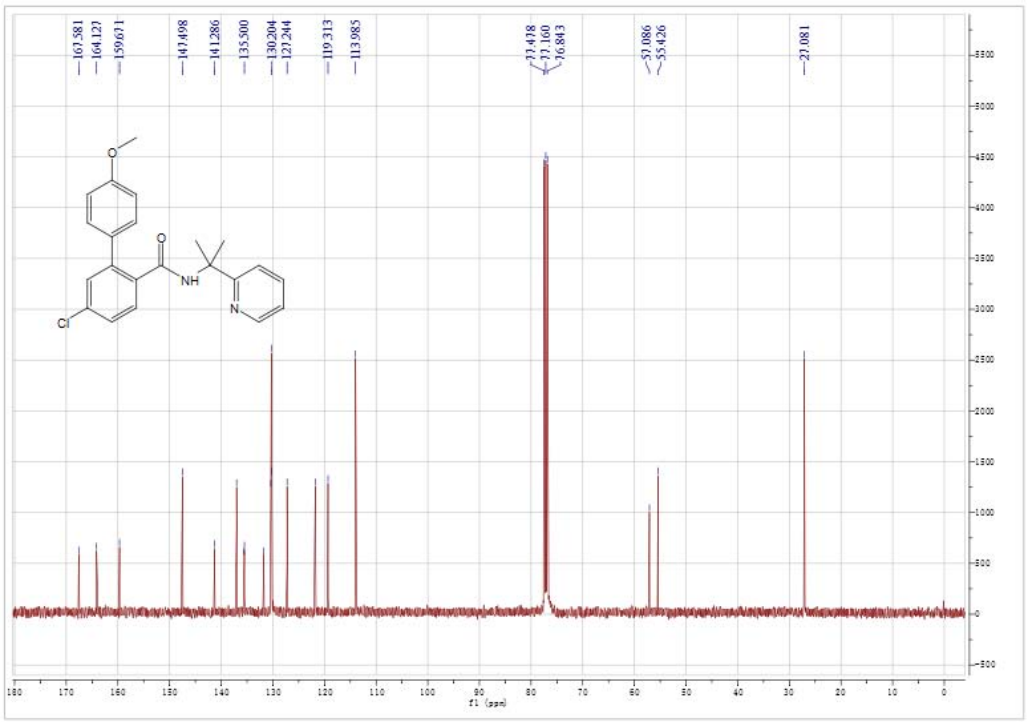




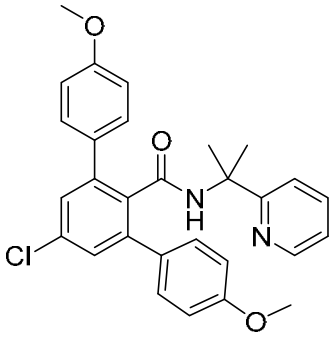
5-Chloro-4'-methoxy-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide

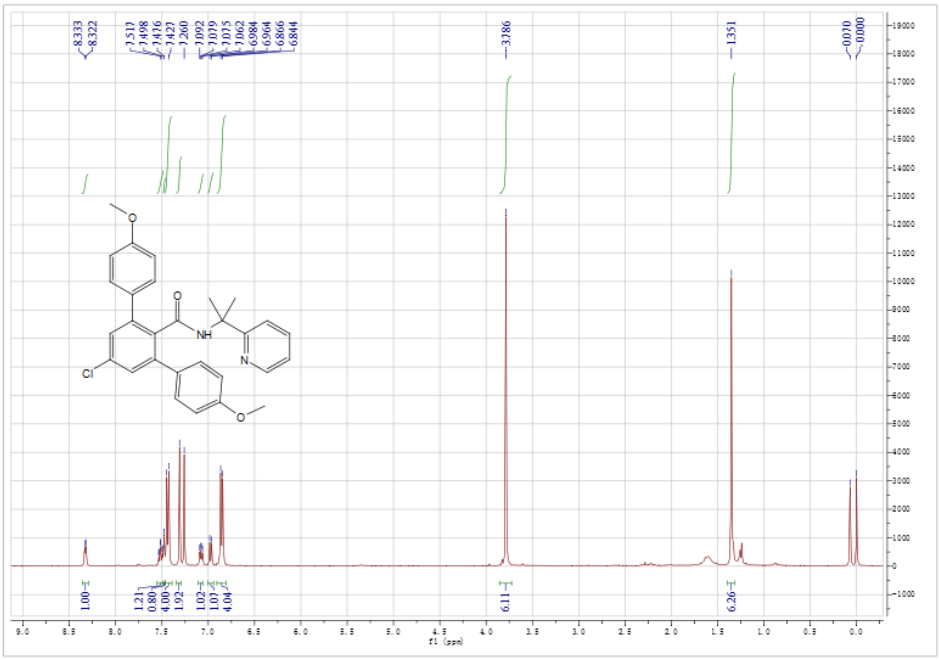


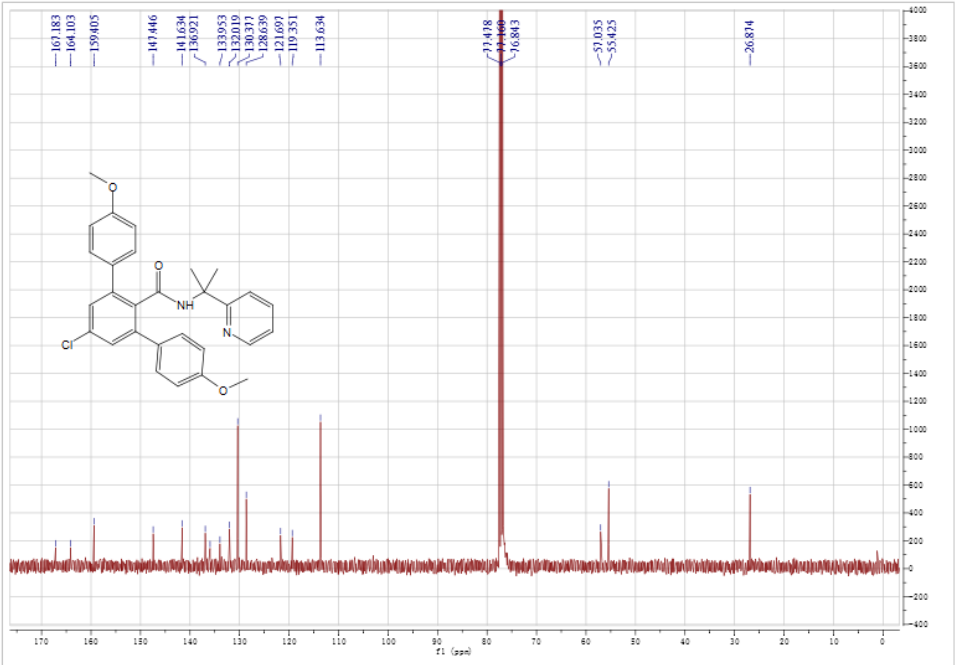




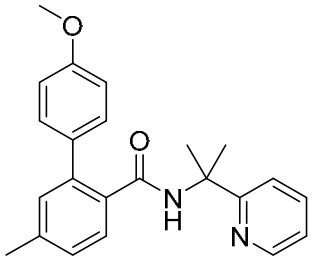
5'-Chloro-4,4''-dimethoxy-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1':3',1''-terphenyl]-2'-carboxamide

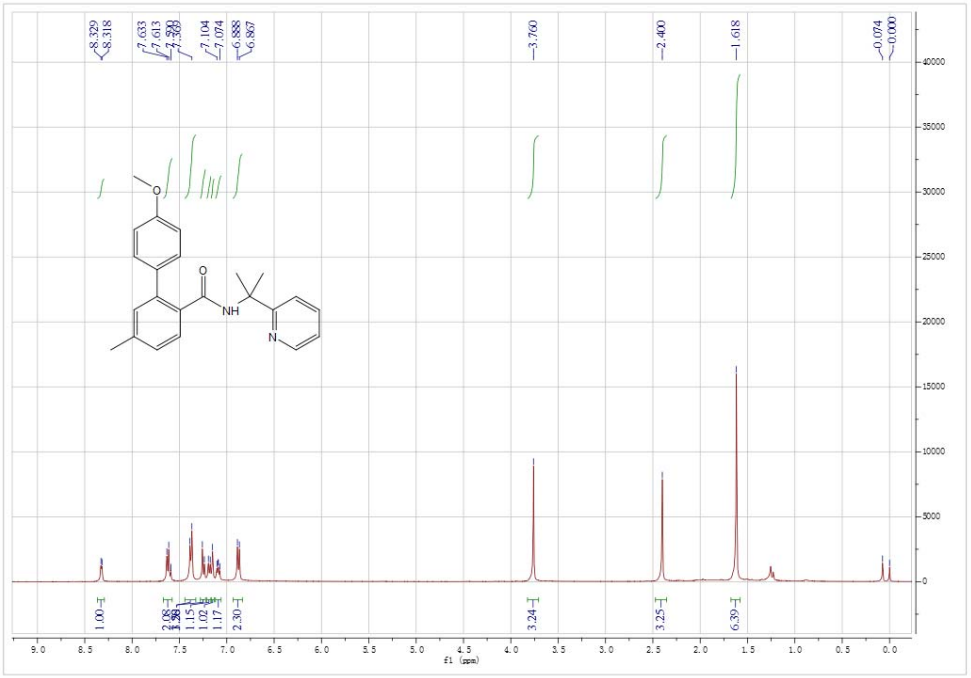


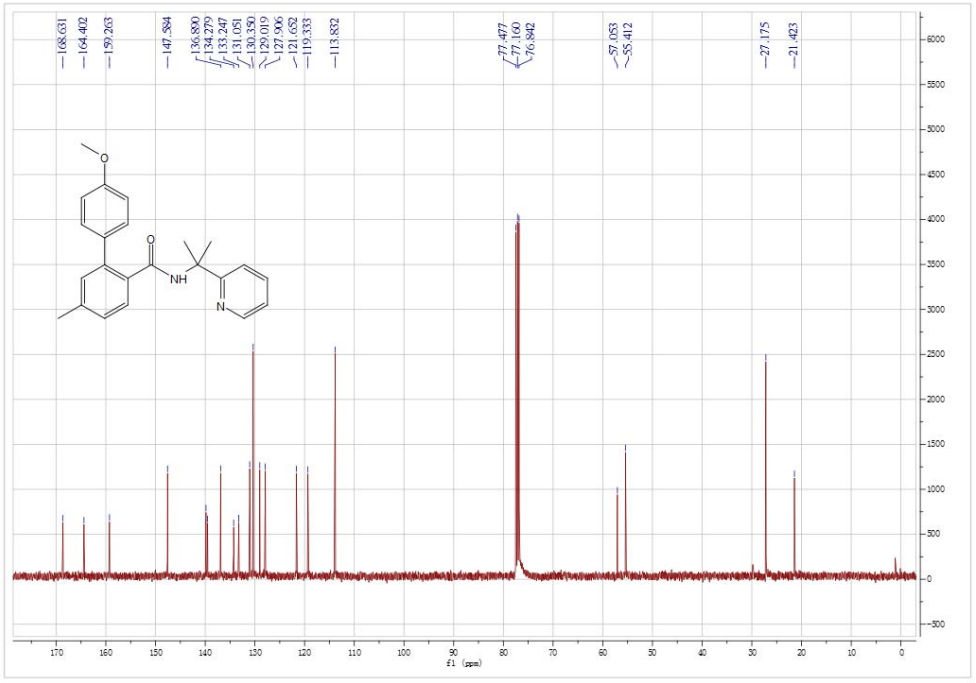




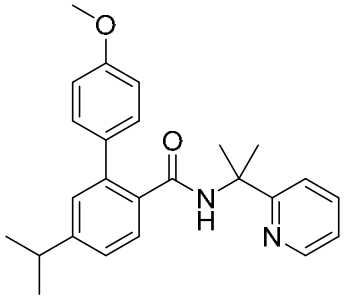
4'-Methoxy-5-methyl-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide

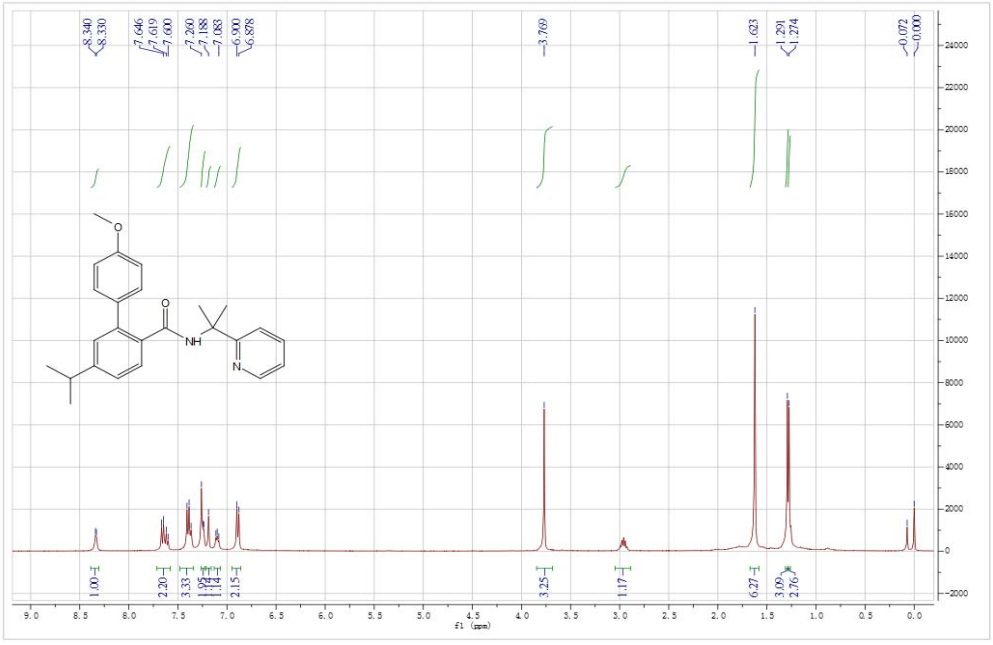


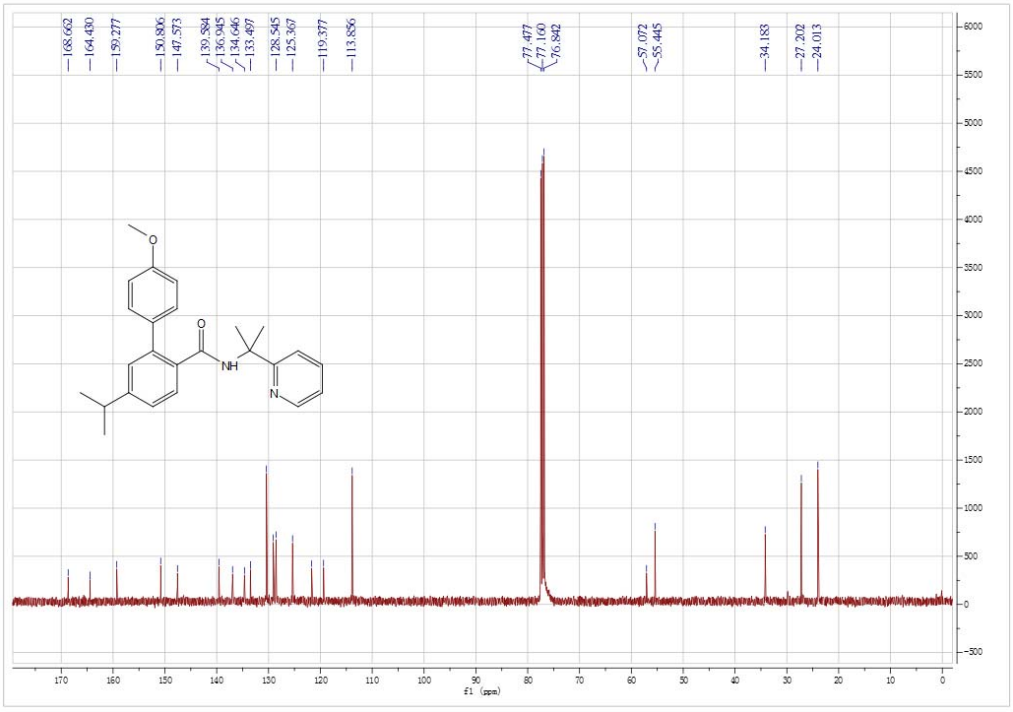




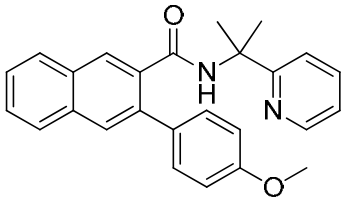
5-Isopropyl-4'-methoxy-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide

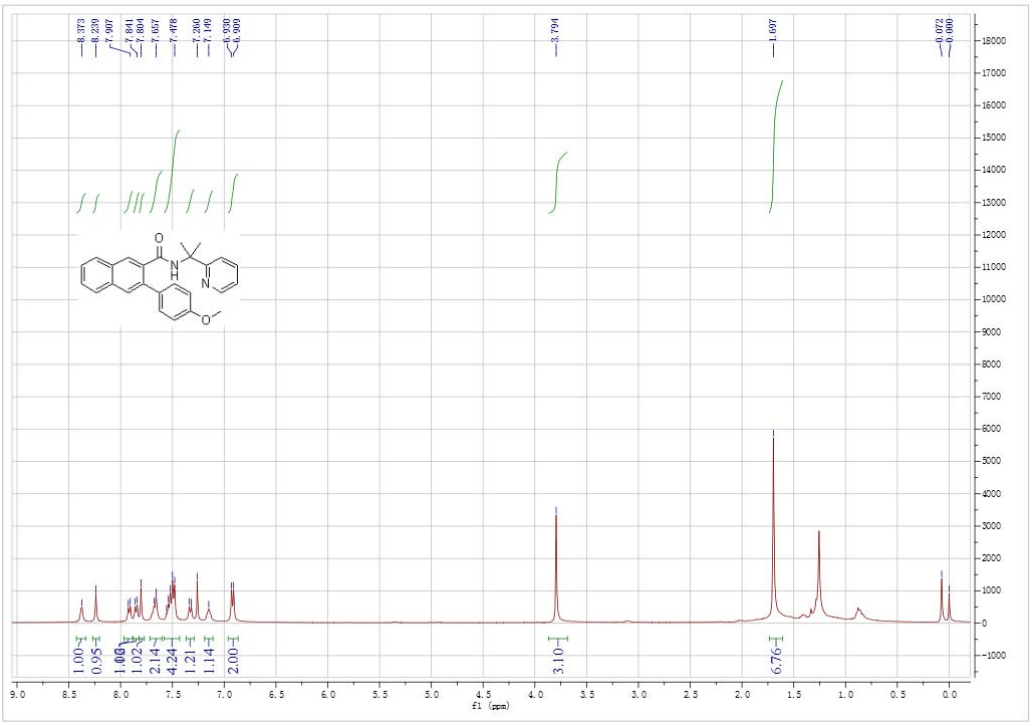


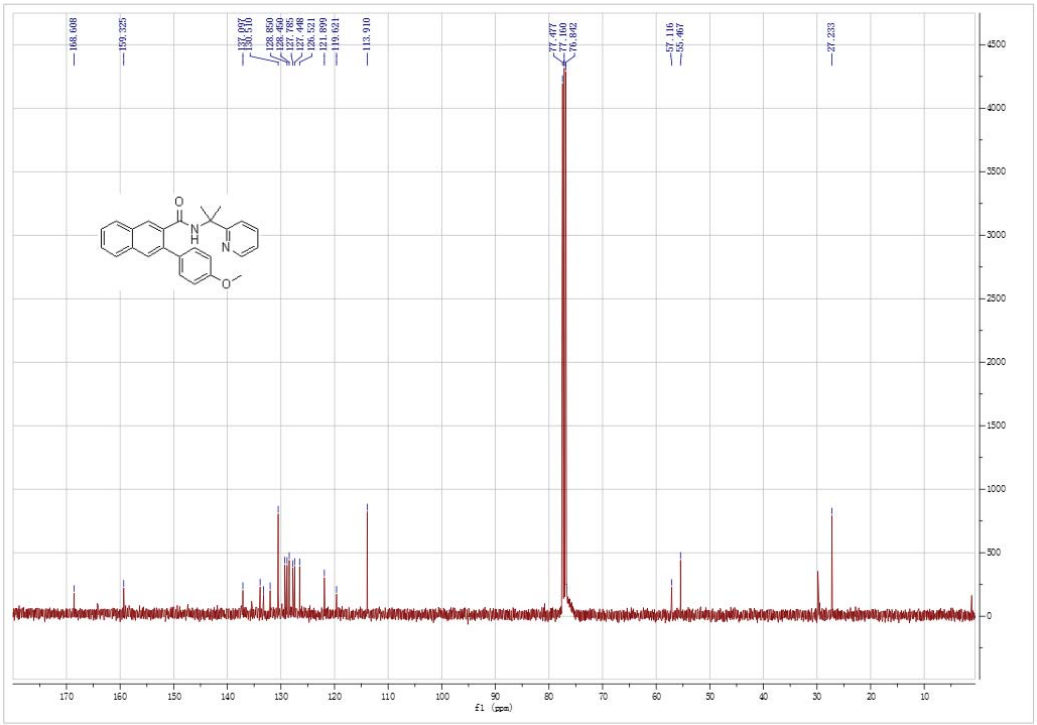




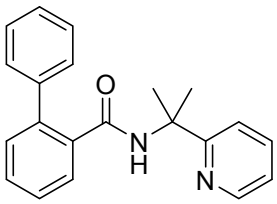
3-(4-Methoxyphenyl)-N-(2-(pyridin-2-yl)propan-2-yl)-2-naphthamide

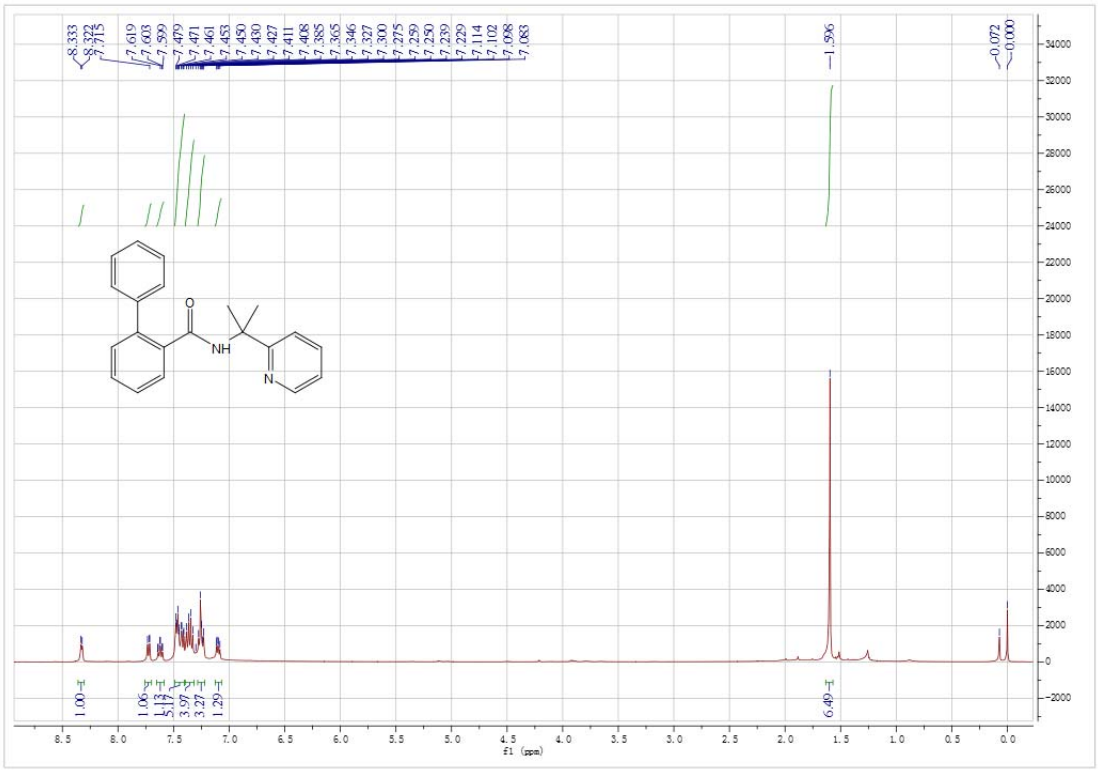


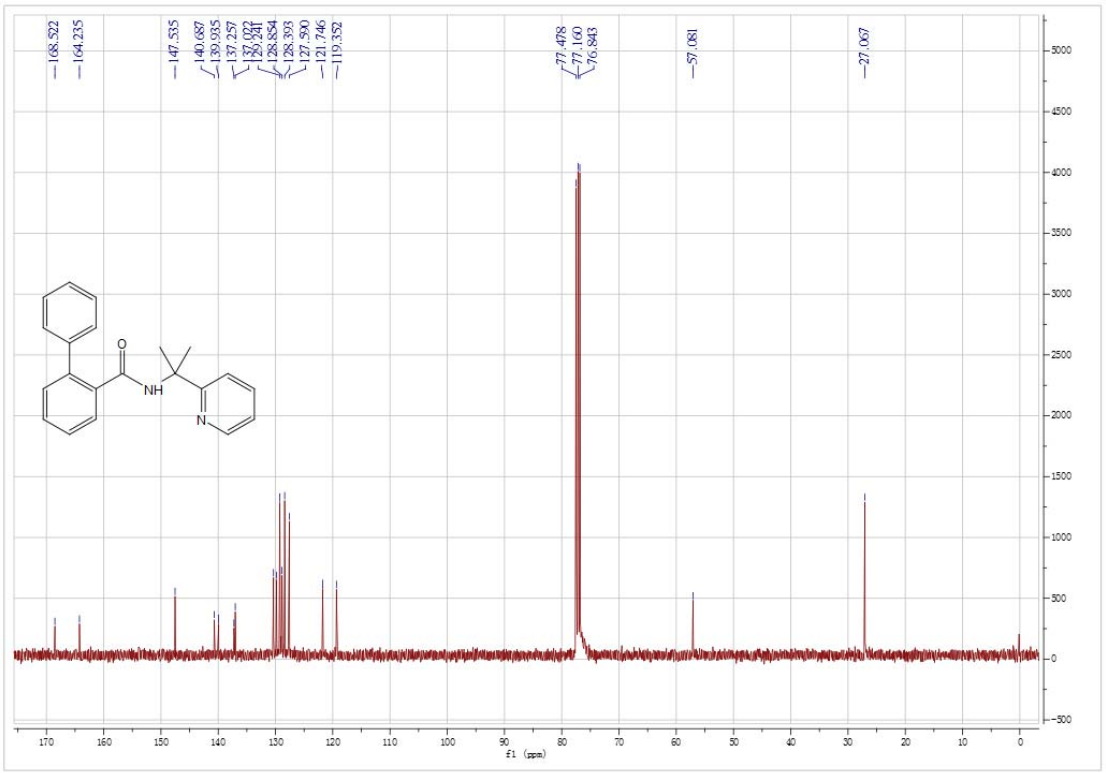




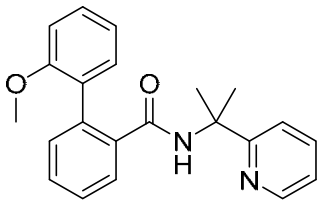
***N*-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide**

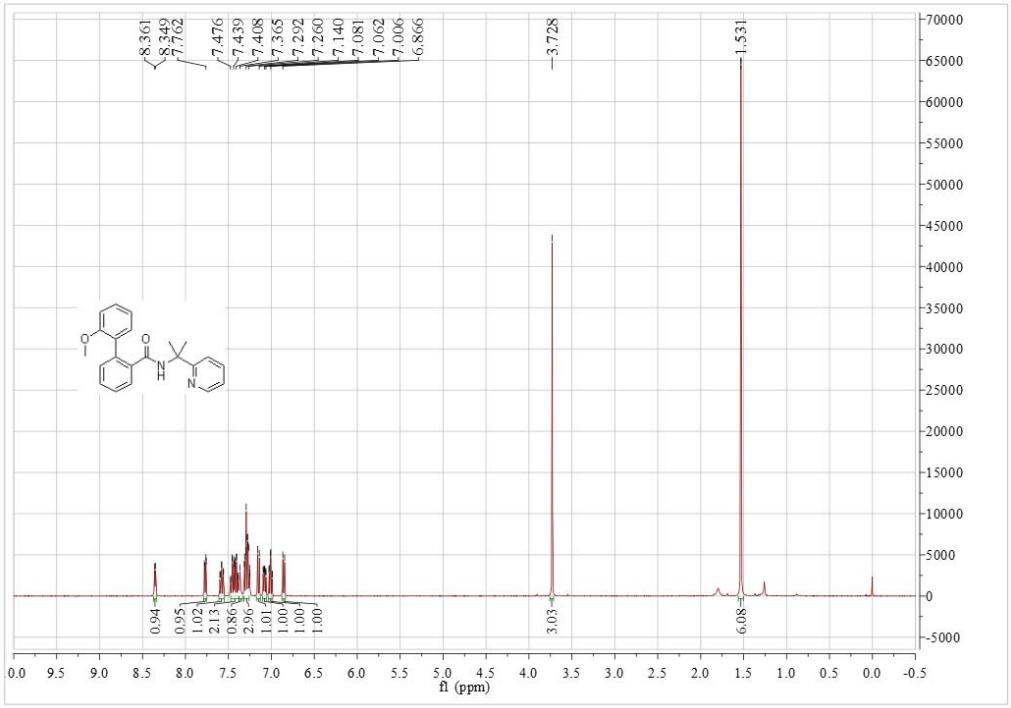


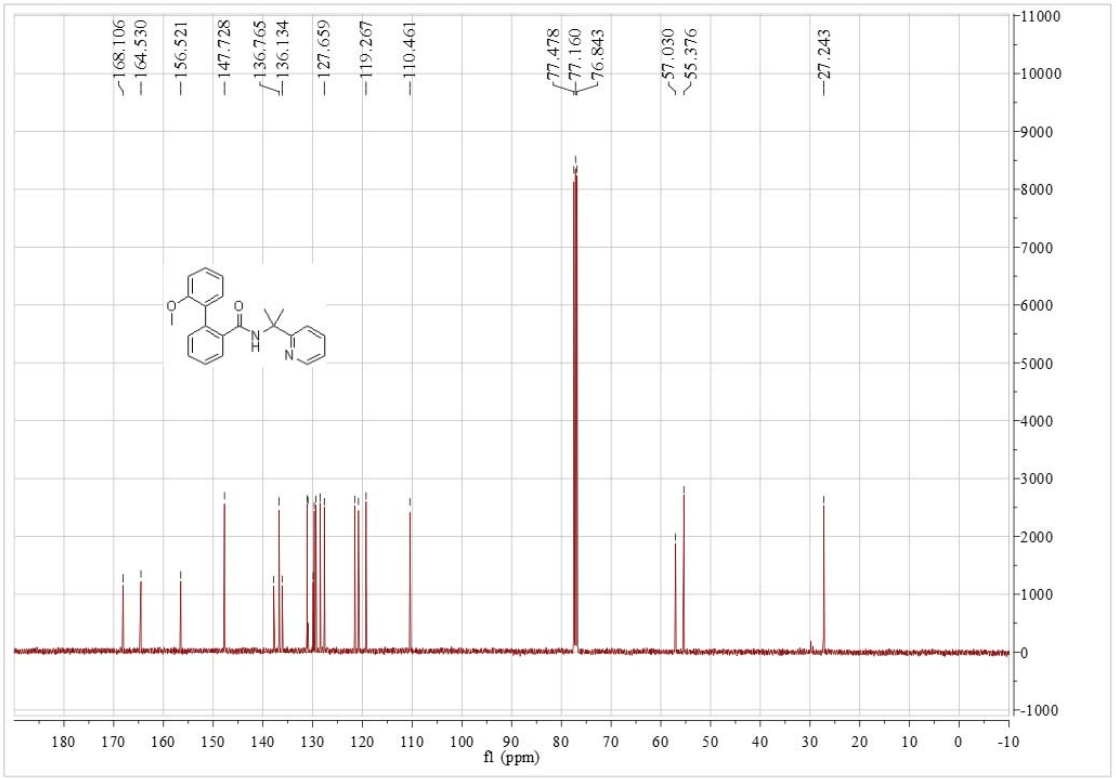




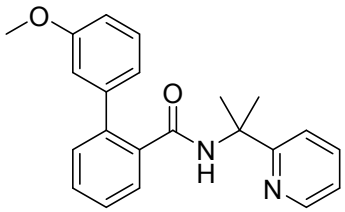
2'-Methoxy-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide

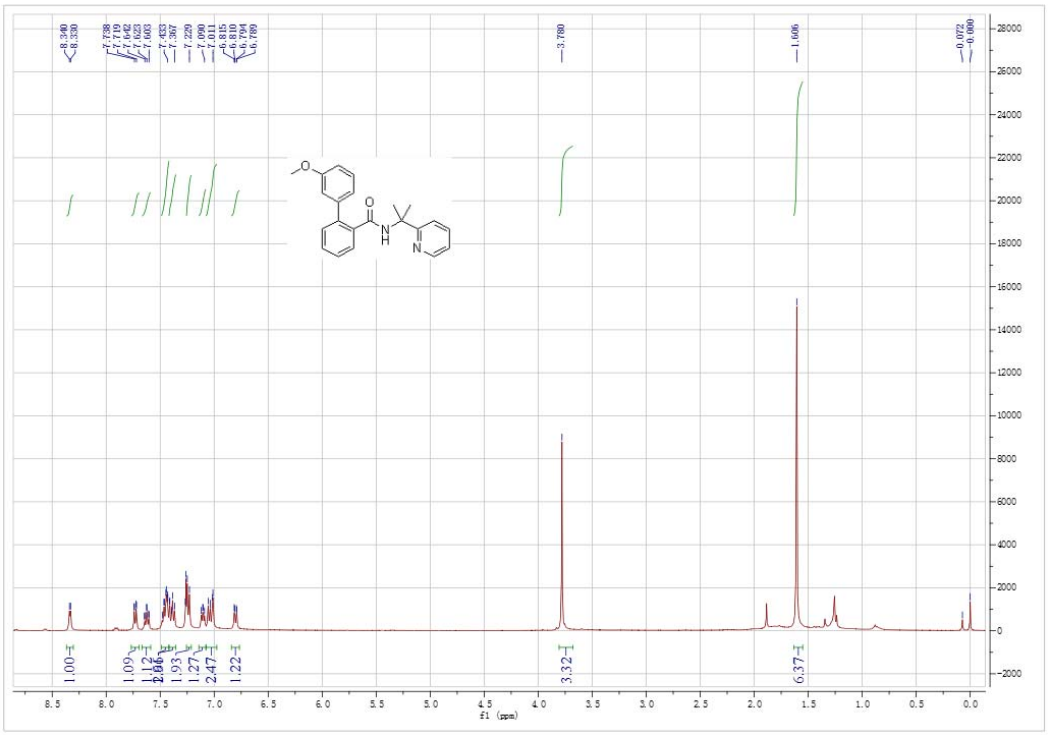


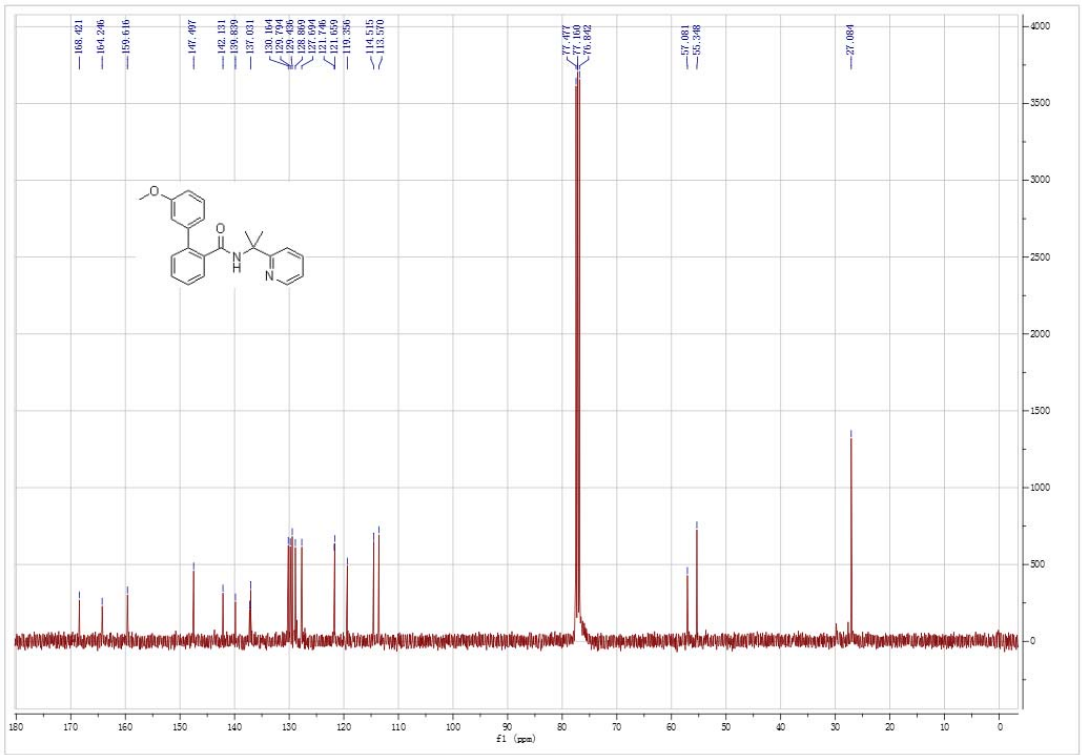




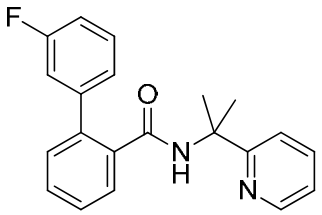
3'-Methoxy-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide

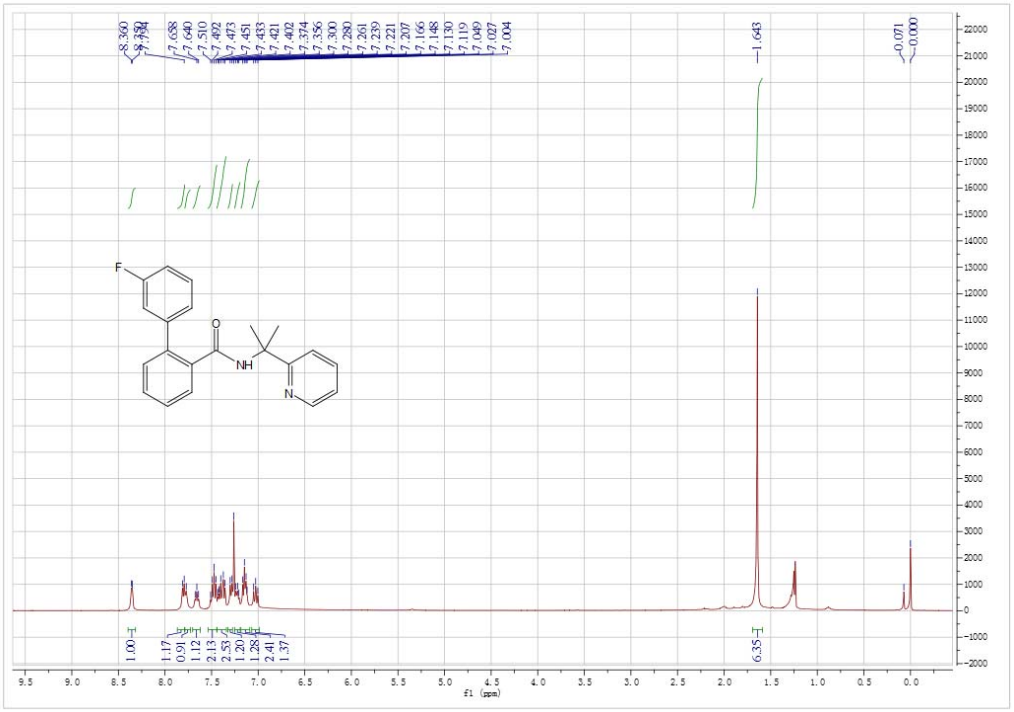


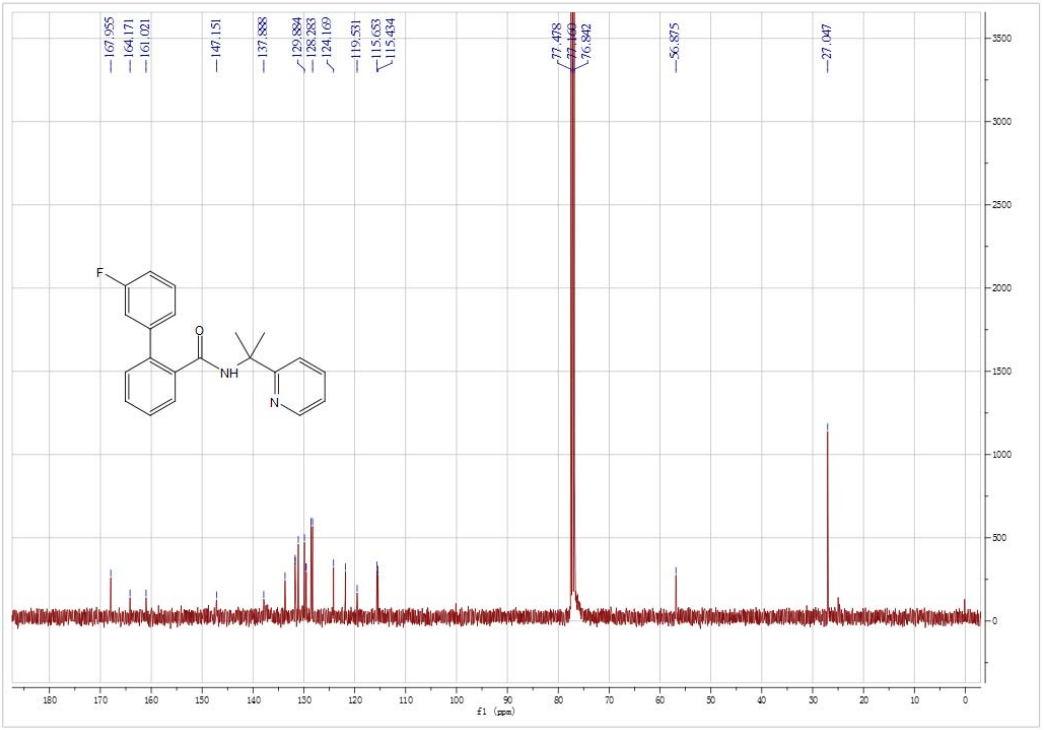




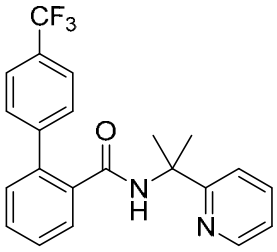
3'-Fluoro-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide

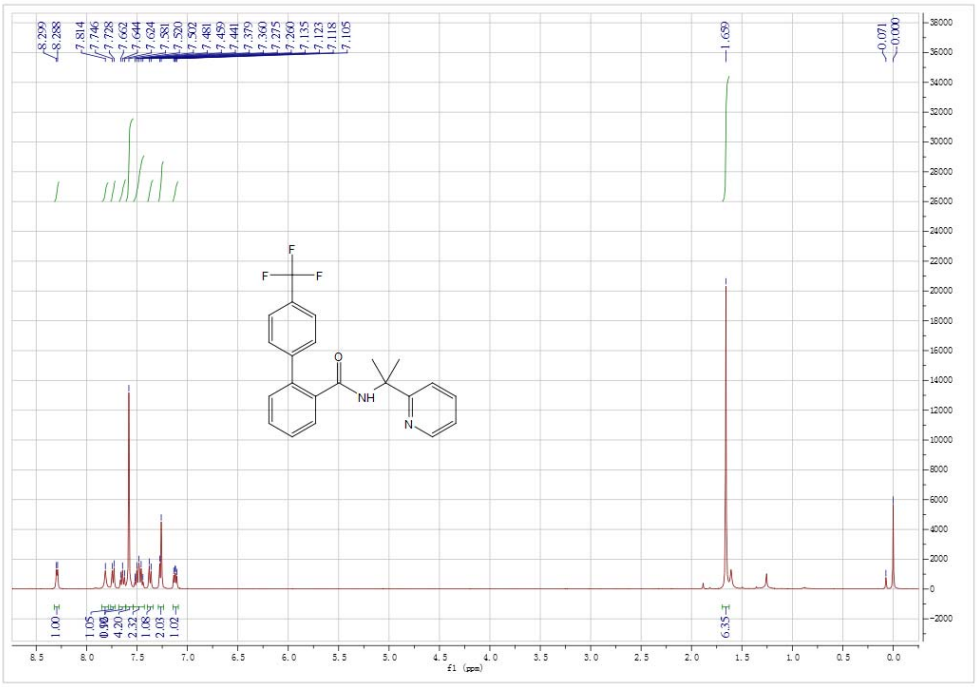


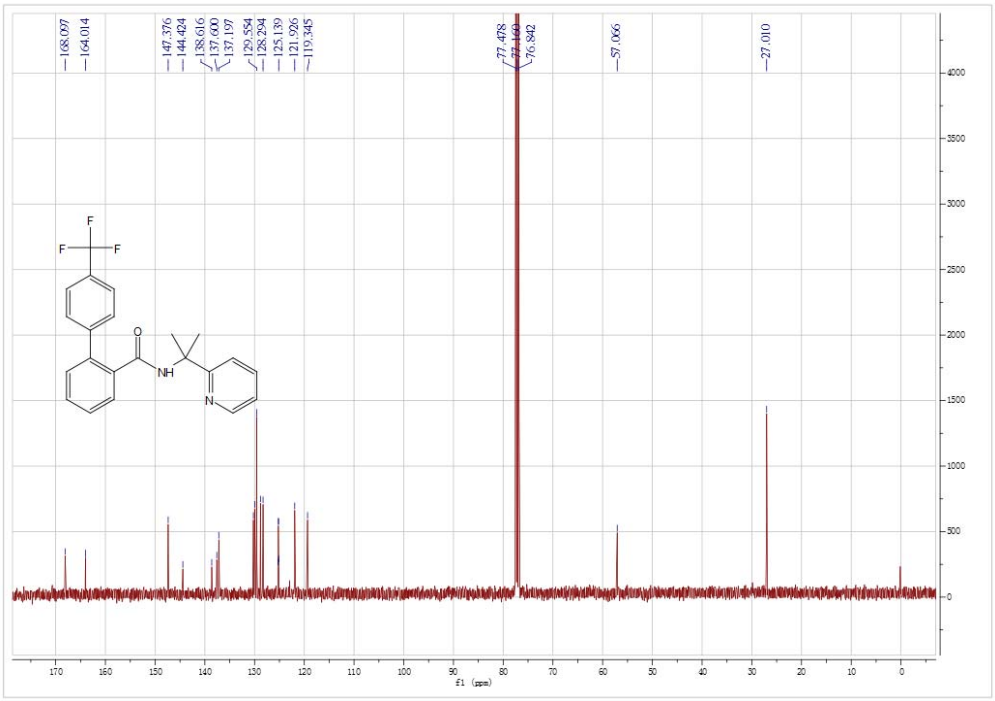




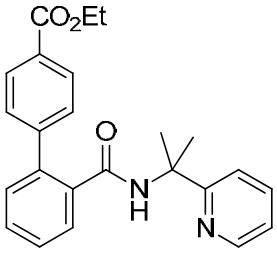
***N*-(2-(pyridin-2-yl)propan-2-yl)-4'-(trifluoromethyl)-[1,1'-biphenyl]-2-carboxamide**

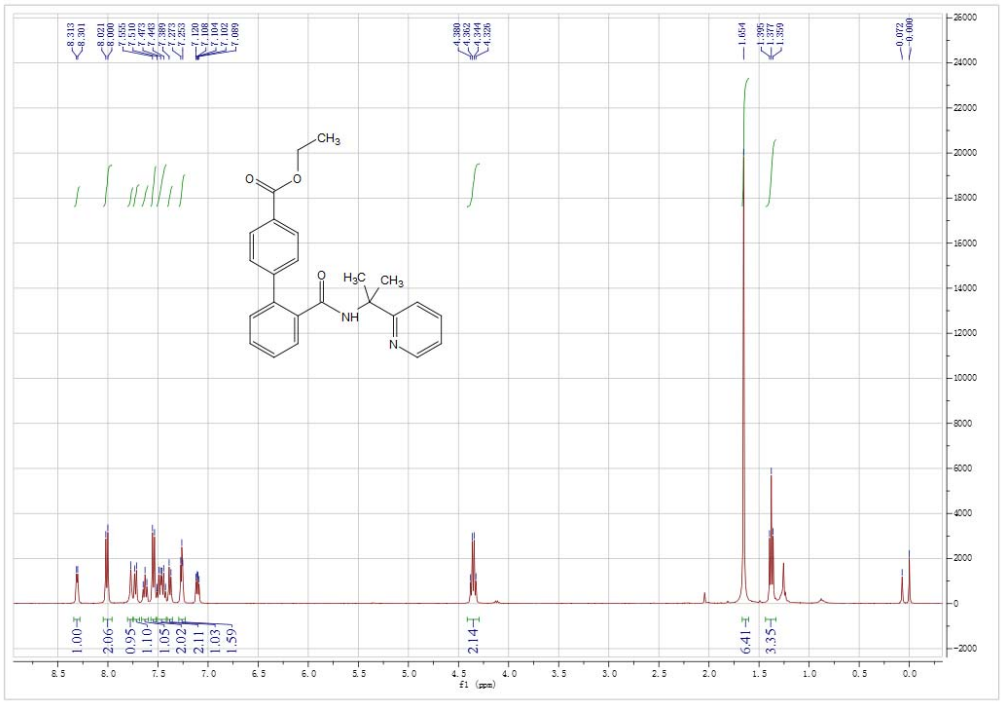


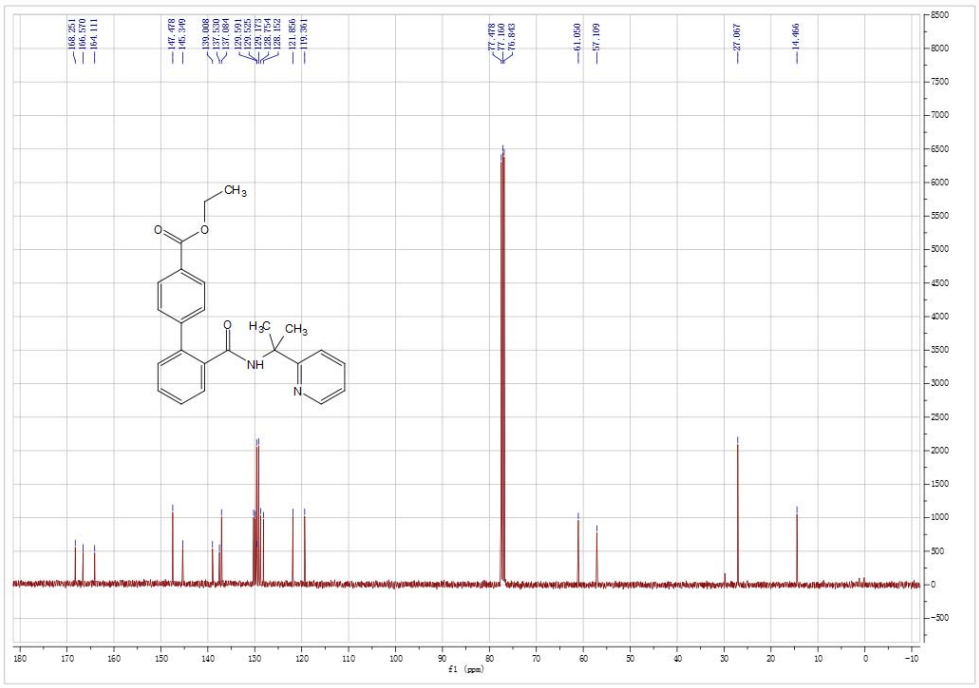




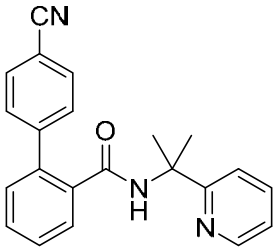
Ethyl 2'-((2-(pyridin-2-yl)propan-2-yl)carbamoyl)-[1,1'-biphenyl]-4-carboxylate

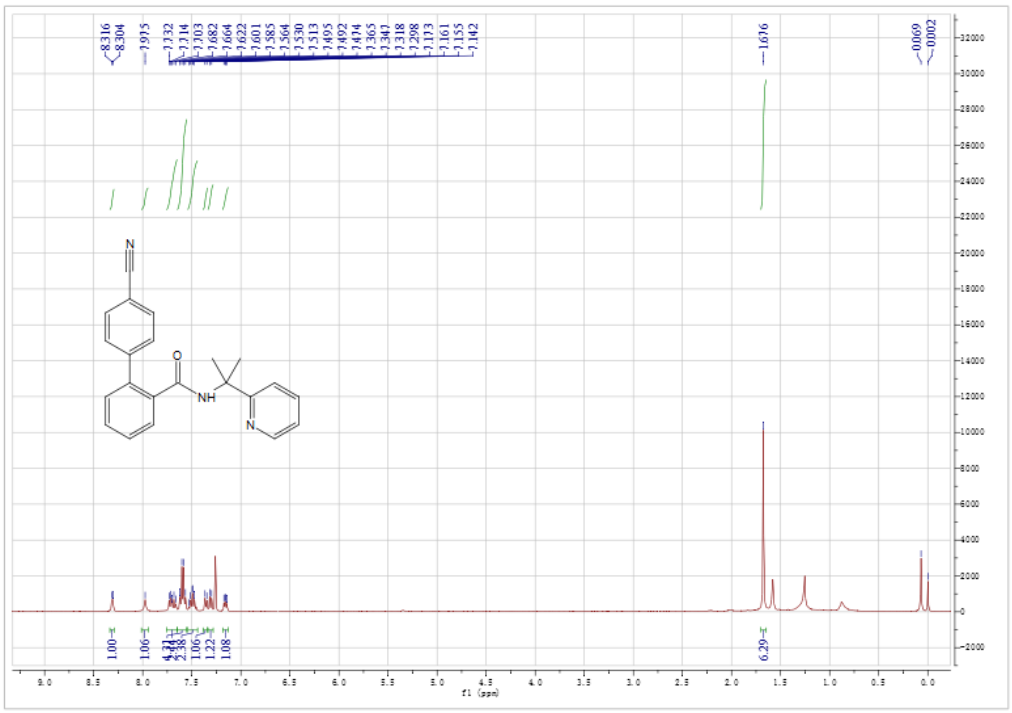


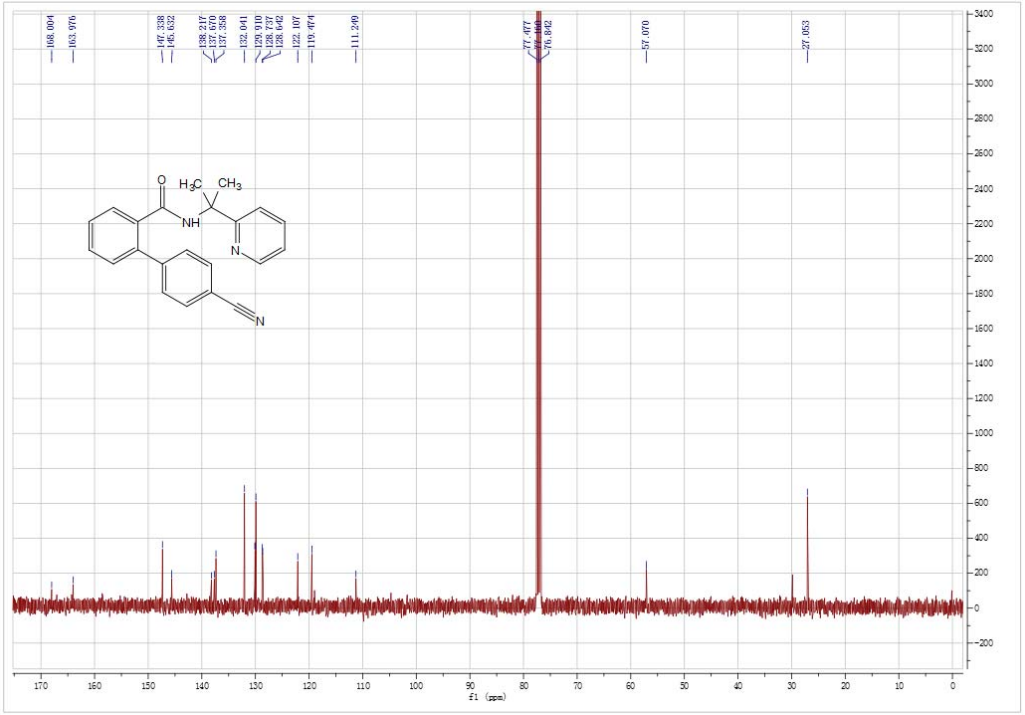




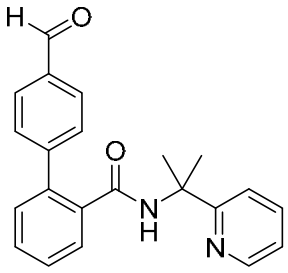
4'-Cyano-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide

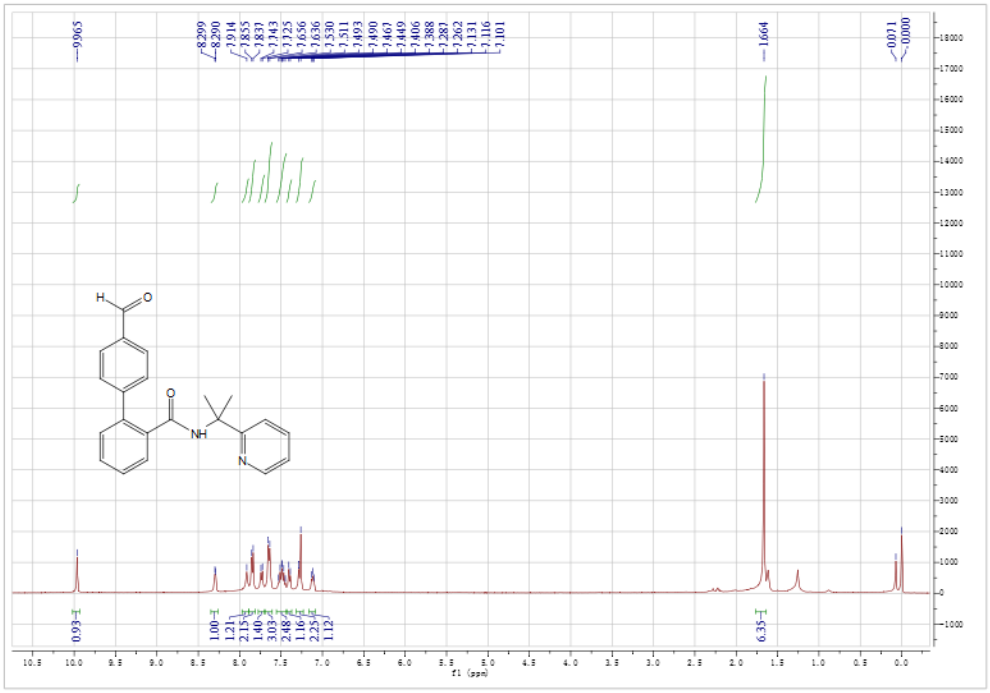


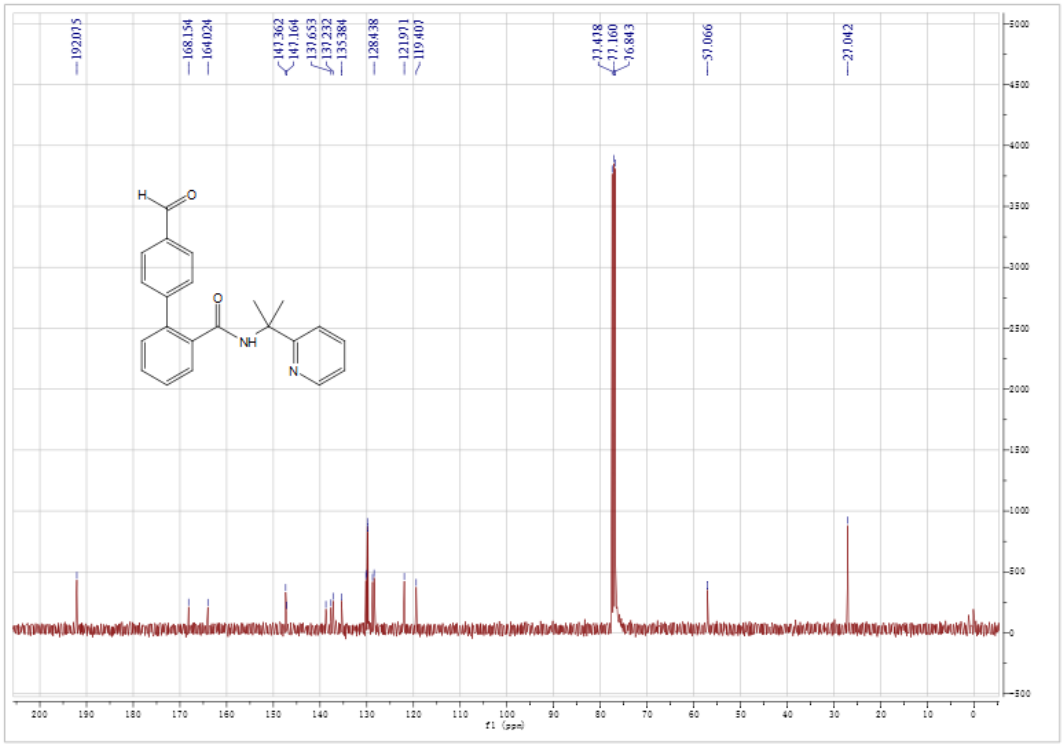




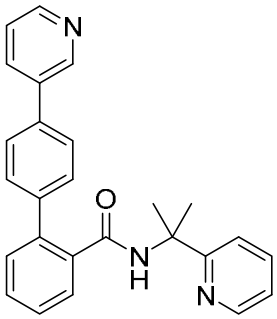
4'-Formyl-N-(2-(pyridin-2-yl)propan-2-yl)-[1,1'-biphenyl]-2-carboxamide

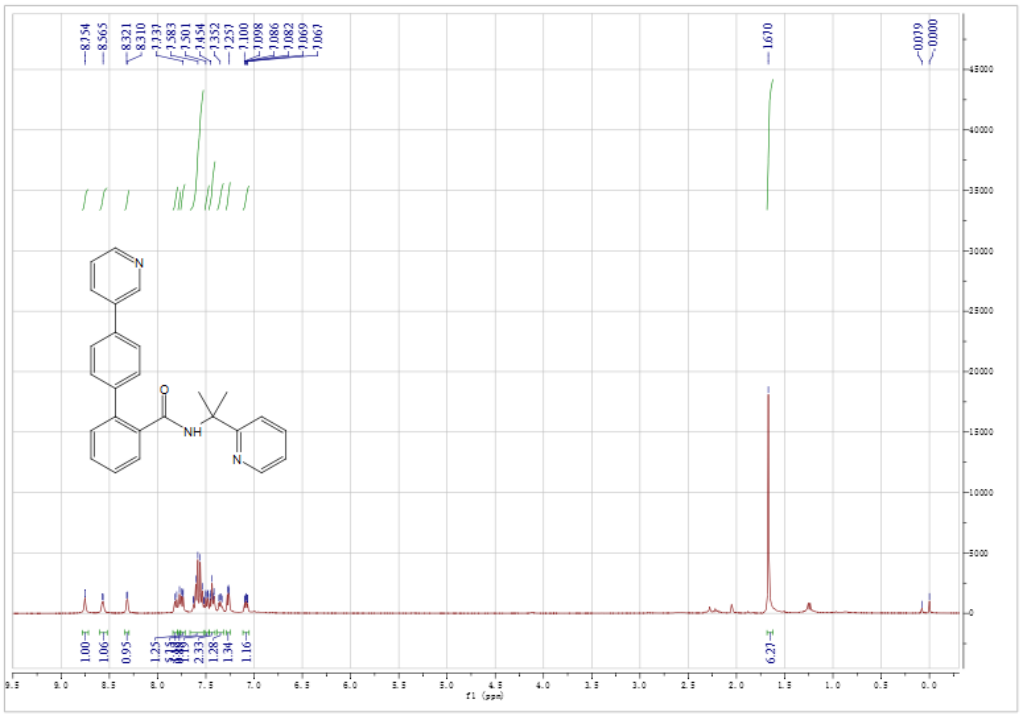


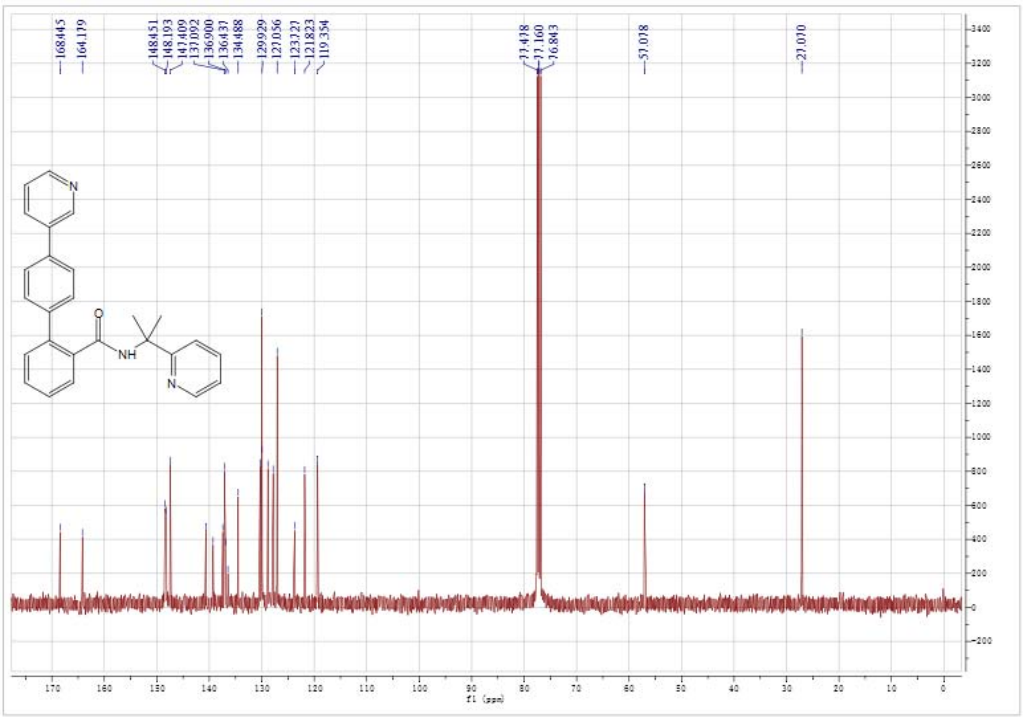




***N*-(2-(pyridin-2-yl)propan-2-yl)-4'-(pyridin-3-yl)-[1,1'-biphenyl]-2-carboxamide**







4'-Methoxy-[1,1'-biphenyl]-2-carboxylic acid