Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Supporting Information

Pd(II)-Catalyzed Asymmetric Intramolecular Arylation of Unbiased Methylene C(sp^3)-H Bonds Using Readily Accessible 3,3'-F_2-BINOL as Chiral Ligand

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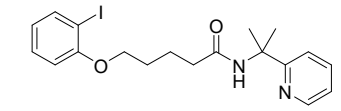
1. General Information

All the materials and solvent were purchased from commercial suppliers and used without additional purification. $Pd(OAc)_2$, $PdBr_2$ was purchased from Laajoo (China), PdI_2 was purchased form Strem. (*S*)-BIONL and derivatives were purchased from Laajoo (China) and Daicel (China). NMR spectra were recorded on a Bruke Avance operating for ^1H NMR at 400 MHz, ^{13}C NMR at 100 MHz, ^{19}F NMR at 376 MHz using TMS as internal standard. The peaks were internally referenced to residual undeuterated chloroform in $CDCl_3$ (δ H = 7.26 ppm, δ C = 77.16 ppm). The following abbreviations (or combinations thereof) were used to explain multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet. Mass spectroscopy data of the products were collected on an HRMS-TOF instrument. The ee value was determined on Shimadzu HPLC using CHIRALPAK column with hexane and 2-propanol as eluent, Wavelength = 254 nm.

2. Experiment Detail and Characterization Date

2.1 Preparation of Substrates.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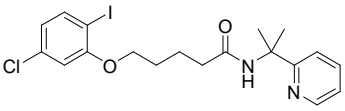
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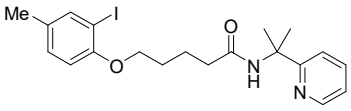
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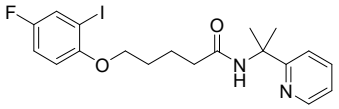
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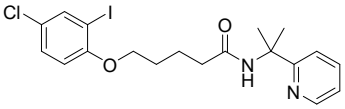
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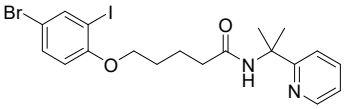
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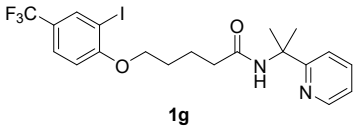
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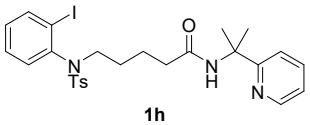
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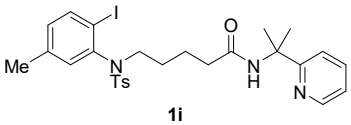
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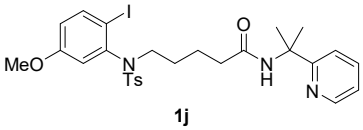
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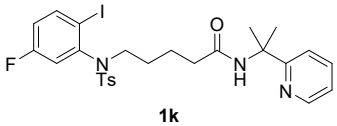
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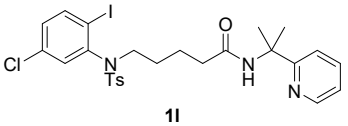
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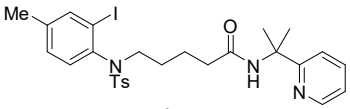
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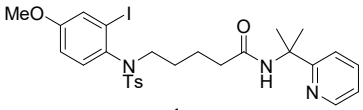
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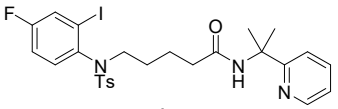
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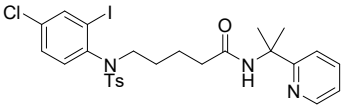
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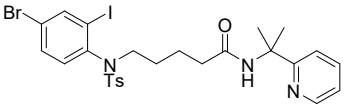
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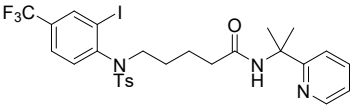
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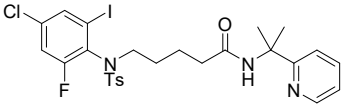
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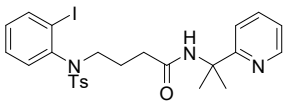
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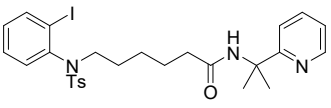
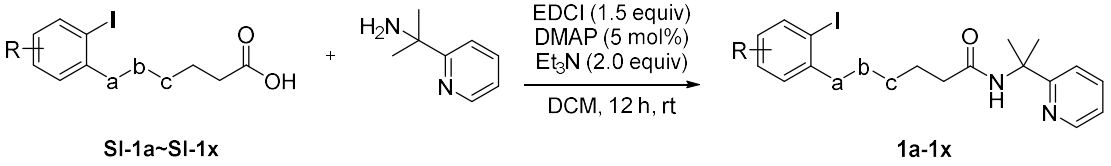
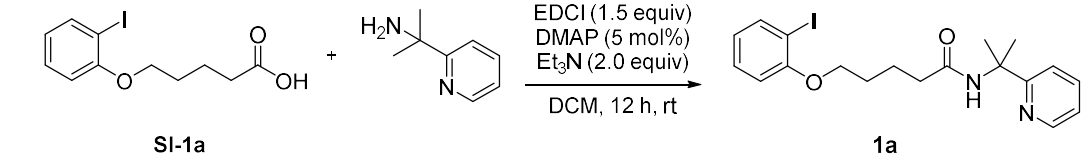

1u

Aliphatic amides (**1a-1x**) were prepared according to the following procedure according to the literature[1] and the synthesis of **1a** was presented as a typical example (**GP**).



SI-1a~SI-1x **1a-1x**

for example

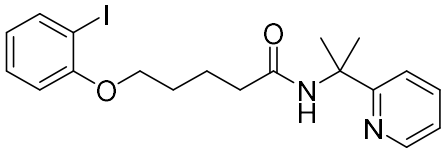


SI-1a **1a**

General Procedure (GP):

A mixture of compound **SI-1a**, PIP-NH_2 (1.2 equiv), EDCI (1.5 equiv), DMAP (5 mol%), Et_3N (2.0 equiv) in DCM (30 mL) was stirred at rt for 12 h. The reaction mixture was then diluted with H_2O, and extracted with DCM (20 mL x 3). The organic layers were combined, washed with brine, dried over anhydrous Na_2SO4. Compound **1a** was purified by flash chromatography and obtained as a white solid.

5-(2-iodophenoxy)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1a



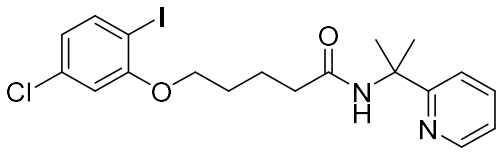
1a was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as white solid (2.4 g, 78% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.50 (d, *J* = 4.8 Hz, 1H), 7.80 – 7.66 (m, 3H), 7.40 (d, *J* = 8.1 Hz, 1H), 7.28 (d, *J* = 8.2 Hz, 1H), 7.22 – 7.16 (m, 1H), 6.80 (dd, *J* = 8.3, 1.5 Hz, 1H), 6.69 (td, *J* = 7.5, 1.4 Hz, 1H), 4.07 – 4.00 (m, 2H), 2.43 – 2.35 (m, 2H), 1.96 – 1.88 (m, 4H), 1.75 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.1, 164.7, 157.6, 147.7, 139.5, 137.2, 129.5, 122.5, 121.9, 119.6, 112.2, 86.8, 69.0, 56.5, 37.3, 28.6, 27.7, 22.6.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{19}H_{23}IN_2O_2H$ 439.0877; found: 439.0878.

5-(5-chloro-2-iodophenoxy)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1b



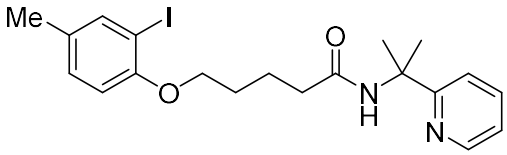
1b was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as white solid (0.72 g, 46% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52-8.47 (m, 1H), 7.76 (s, 1H), 7.71 (td, *J* = 7.7, 1.8 Hz, 1H), 7.64 (d, *J* = 8.3 Hz, 1H), 7.39 (dt, *J* = 8.1, 1.1 Hz, 1H), 7.21-7.15 (m, 1H), 6.76 (d, *J* = 2.2 Hz, 1H), 6.70 (dd, *J* = 8.3, 2.2 Hz, 1H), 4.05 – 3.99 (m, 2H), 2.41 – 2.35 (m, 2H), 1.94 – 1.88 (m, 4H), 1.75 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.9, 164.7, 158.2, 147.7, 139.8, 137.2, 135.2, 122.5, 122.0, 119.6, 112.7, 84.0, 69.3, 56.5, 37.3, 28.5, 27.6, 22.5.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{19}H_{22}ClIN_2O_2H$ 473.0487; found: 473.0491.

5-(2-iodo-4-methylphenoxy)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1c



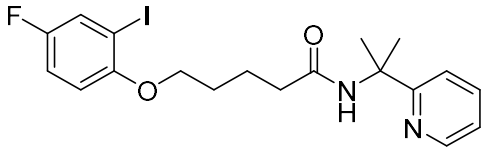
1c was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as white solid (1.90 g, 55% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.54 – 8.46 (m, 1H), 7.79 – 7.66 (m, 2H), 7.58 (d, *J* = 2.1 Hz, 1H), 7.39 (dt, *J* = 8.1, 1.1 Hz, 1H), 7.21 – 7.14 (m, 1H), 7.05 (dd, *J* = 8.5, 2.2 Hz, 1H), 6.69 (d, *J* = 8.3 Hz, 1H), 4.05 – 3.96 (m, 2H), 2.42 – 2.32 (m, 2H), 2.24 (s, 3H), 1.94 – 1.84 (m, 4H), 1.75 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.1, 164.7, 155.6, 147.8, 139.8, 137.2, 132.1, 130.0, 122.0, 119.6, 112.2, 86.7, 69.2, 56.5, 37.4, 28.7, 27.7, 22.7, 20.1.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{25}IN_2O_2H$ 453.1033; found: 453.1036.

5-(4-fluoro-2-iodophenoxy)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1d



1d was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as white solid (0.82 g, 31% yield).

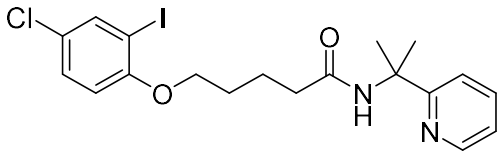
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52 – 8.46 (m, 1H), 7.76 (s, 1H), 7.71 (td, J = 7.8, 1.8 Hz, 1H), 7.47 (dd, *J* = 7.6, 3.0 Hz, 1H), 7.40 (dt, *J* = 8.2, 1.1 Hz, 1H), 7.22 – 7.15 (m, 1H), 7.03 – 6.94 (m, 1H), 6.72 (dd, *J* = 9.0, 4.6 Hz, 1H), 4.02 – 3.96 (m, 2H), 2.38 (t, *J* = 6.8 Hz, 2H), 1.95-1.84 (m, 4H), 1.75 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.0, 164.7, 156.8 (d, $^1J_{C\text{-}F}$ = 244.4 Hz), 154.3, 147.7, 137.2, 126.1 (d, $^2J_{C\text{-}F}$ = 25.2 Hz), 122.0, 119.6, 115.7 (d, $^2J_{C\text{-}F}$ = 22.2 Hz), 112.4 (d, $^3J_{C\text{-}F}$ = 9.0 Hz), 86.2 (d, $^3J_{C\text{-}F}$ = 8.0 Hz), 69.8, 56.5, 37.3, 29.4, 28.7, 27.7, 22.6.

^{19}F NMR (376 MHz, $CDCl_3$) δ -122.42.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{19}H_{22}FIN_2O_2H$ 457.0783; found: 457.0784.

5-(4-chloro-2-iodophenoxy)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1e



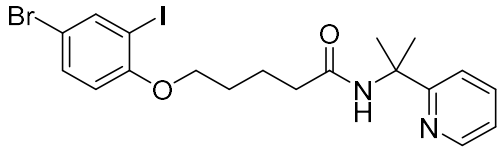
1e was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as white solid (0.42 g, 16% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52 – 8.48 (m, 1H), 7.76 (s, 1H), 7.73 – 7.68 (m, 3H), 7.39 (d, *J* = 8.1 Hz, 1H), 7.25 – 7.15 (m, 2H), 6.69 (d, *J* = 8.8 Hz, 1H), 4.00 – 3.97 (m, 2H), 2.43 – 2.32 (m, 2H), 1.94 – 1.86 (m, 4H), 1.75 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.0, 164.7, 156.6, 147.7, 138.6, 137.2, 129.3, 126.3, 122.0, 119.6, 112.6, 86.9, 69.5, 56.5, 37.3, 28.6, 27.7, 22.6.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{19}H_{22}ClIN_2O_2H$ 473.0487; found: 473.0489.

5-(4-bromo-2-iodophenoxy)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1f



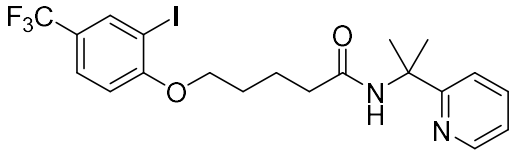
1f was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as white solid (2.76 g, 92% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.53-8.45 (m, 1H), 7.84 (d, *J* = 2.4 Hz, 1H), 7.75 (s, 1H), 7.70 (td, *J* = 7.8, 1.8 Hz, 1H), 7.42 – 7.33 (m, 2H), 7.21 – 7.15 (m, 1H), 6.65 (d, *J* = 8.7 Hz, 1H), 4.02 – 3.97 (m, 2H), 2.42 – 2.33 (m, 2H), 1.93 – 1.86 (m, 4H), 1.75 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 172.0, 164.7, 157.0, 147.7, 141.2, 137.2, 132.2, 122.0, 119.6, 113.4, 113.2, 87.5, 69.4, 56.5, 37.3, 28.5, 27.6, 22.5.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{19}H_{22}BrIN_2O_2H$ 516.9982; found: 516.9985.

5-(2-iodo-4-(trifluoromethyl)phenoxy)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1g



1g was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as white solid (0.65 g, 49% yield).

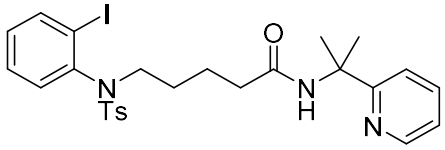
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52-8.48 (m, 1H), 7.99 (dd, *J* = 2.2, 0.8 Hz, 1H), 7.78 (s, 1H), 7.73 – 7.69 (m, 2H), 7.56 – 7.50 (m, 1H), 7.40 (dt, *J* = 8.1, 1.1 Hz, 1H), 7.22 – 7.17 (m, 1H), 6.82 (d, *J* = 8.6 Hz, 1H), 4.12 – 4.06 (m, 2H), 2.42-2.35 (m, 2H), 1.96 – 1.89 (m, 4H), 1.75 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.9, 164.7, 160.1, 147.7, 137.3, 136.6 (q, $^3J_{C\text{-}F}$ = 4.0 Hz), 127.0 (q, $^3J_{C\text{-}F}$ = 4.0 Hz), 126.1 (q, $^1J_{C\text{-}F}$ = 271.69 Hz), 124.4 (q, $^2J_{C\text{-}F}$ = 32.3 Hz), 122.0, 119.6, 111.2, 86.3, 69.4, 56.5, 37.2, 28.4, 27.6, 22.5.

^{19}F NMR (376 MHz, $CDCl_3$) δ -61.62.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{22}F_3IN_2O_2H$ 507.0751; found: 507.0749.

5-((*N*-(2-iodophenyl)-4-methylphenyl)sulfonamido)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1h



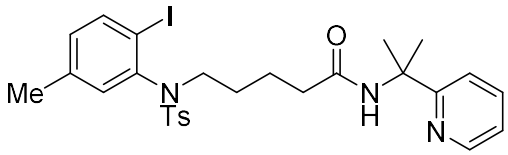
1h was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as white solid (2.88 g, 61% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.47 (d, *J* = 4.8 Hz, 1H), 7.87 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.72 – 7.64 (m, 2H), 7.60 (d, *J* = 8.0 Hz, 2H), 7.35 (d, *J* = 8.1 Hz, 1H), 7.25 – 7.13 (m, 4H), 6.98 (t, *J* = 7.7 Hz, 1H), 6.87 (dd, *J* = 8.0, 1.6 Hz, 1H), 3.71 – 3.60 (m, 1H), 3.37 – 3.29 (m, 1H), 2.41 (s, 3H), 2.26 – 2.13 (m, 2H), 1.74 – 1.64 (m, 7H), 1.63 – 1.40 (m, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.7, 164.6, 147.7, 143.8, 141.7, 140.6, 137.2, 136.0, 130.2, 129.9, 129.6, 128.9, 128.3, 121.9, 119.5, 103.5, 56.5, 51.7, 37.2, 27.8, 27.6, 23.1, 21.7.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{26}H_{30}IN_3O_3SH$ 592.1125; found: 592.1128.

5-((*N*-(2-iodo-5-methylphenyl)-4-methylphenyl)sulfonamido)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1i



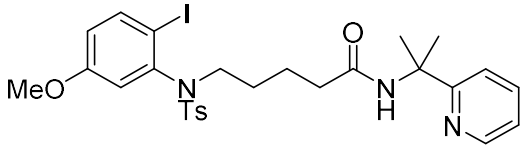
1i was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as light yellow oil (1.89 g, 82% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52 – 8.47 (m, 1H), 7.76 – 7.67 (m, 3H), 7.66 – 7.62 (m, 2H), 7.37 (dt, *J* = 8.1, 1.1 Hz, 1H), 7.27 (d, *J* = 6.8 Hz, 2H), 7.22-7.16 (m, 1H), 6.82 (dd, *J* = 8.2, 2.1 Hz, 1H), 6.74 (d, *J* = 2.1 Hz, 1H), 3.67 – 3.58 (m, 1H), 3.40 – 3.31 (m, 1H), 2.43 (s, 3H), 2.24 – 2.17 (m, 5H), 1.74 – 1.65 (m, 7H), 1.62 – 1.42 (m, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.8, 164.6, 147.7, 143.8, 141.4, 140.1, 139.2, 137.2, 136.2, 131.3, 131.0, 129.5, 128.4, 122.0, 119.6, 98.9, 56.5, 51.7, 37.3, 27.9, 27.6, 23.2, 21.7, 20.9.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{27}H_{32}IN_3O_3SH$ 606.1282; found: 606.1286.

5-((*N*-(2-iodo-5-methoxyphenyl)-4-methylphenyl)sulfonamido)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1j



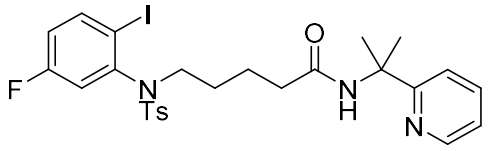
1j was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as light yellow oil (1.02 g, 62% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52-8.48 (m, 1H), 7.73 – 7.63 (m, 5H), 7.37 (dt, *J* = 8.1, 1.1 Hz, 1H), 7.30 – 7.26 (m, 2H), 7.21 – 7.15 (m, 1H), 6.62 (dd, *J* = 8.8, 2.9 Hz, 1H), 6.47 (d, *J* = 2.9 Hz, 1H), 3.70 – 3.60 (m, 4H), 3.39 – 3.30 (m, 1H), 2.42 (s, 3H), 2.24 – 2.18 (m, 2H), 1.76 – 1.68 (m, 7H), 1.62 – 1.41 (m, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.8, 164.6, 160.3, 147.7, 143.8, 142.5, 140.5, 137.2, 136.1, 129.6, 128.4, 122.0, 119.6, 116.3, 91.6, 56.5, 55.6, 51.8, 37.3, 27.9, 27.6, 23.2, 21.7.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{27}H_{32}IN_3O_4SH$ 622.1231; found: 622.1232.

5-((*N*-(5-fluoro-2-iodophenyl)-4-methylphenyl)sulfonamido)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1k



1k was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as white solid (1.39 g, 85% yield).

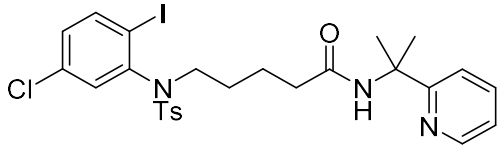
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52 – 8.47 (m, 1H), 7.83 (dd, *J* = 8.8, 6.1 Hz, 1H), 7.70 (td, *J* = 7.8, 1.8 Hz, 2H), 7.65 – 7.61 (m, 2H), 7.37 (dt, *J* = 8.1, 1.1 Hz, 1H), 7.29 (d, *J* = 8.0 Hz, 2H), 7.22 – 7.15 (m, 1H), 6.85 – 6.76 (m, 1H), 6.67 (dd, *J* = 9.2, 2.9 Hz, 1H), 3.71 – 3.60 (m, 1H), 3.39-3.28 (m, 1H), 2.44 (s, 3H), 2.22 (td, *J* = 7.2, 2.2 Hz, 2H), 1.76 – 1.67 (m, 7H), 1.62 – 1.39 (m, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 171.6, 164.6, 162.7 (d, $^{1}J_{C\text{-}F}$ = 251.49 Hz),147.7, 144.2, 143.2 (d, $^{3}J_{C\text{-}F}$ = 9.1 Hz), 141.0 (d, $^{3}J_{C\text{-}F}$ = 8.1 Hz), 135.6, 129.8, 128.3, 122.0, 119.6, 117.8 (d, $^{2}J_{C\text{-}F}$ = 23.2 Hz), 117.7 (d, $^{2}J_{C\text{-}F}$ = 22.2 Hz), 96.8 (d, $^{4}J_{C\text{-}F}$ = 4.0 Hz), 56.5, 51.8, 37.2, 27.8, 27.6, 23.1, 21.7.

^{19}F NMR (376 MHz, $CDCl_3$) δ -112.00.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{26}H_{29}FIN_3O_3SH$ 610.1031; found: 610.1033.

5-((*N*-(5-chloro-2-iodophenyl)-4-methylphenyl)sulfonamido)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1l



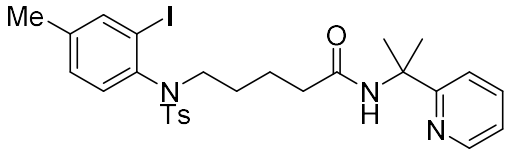
1l was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as light yellow oil (1.05 g, 53% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.51 – 8.46 (m, 1H), 7.80 (d, *J* = 8.5 Hz, 1H), 7.74 – 7.67 (m, 2H), 7.65 – 7.60 (m, 2H), 7.37 (dt, *J* = 8.0, 1.1 Hz, 1H), 7.30 (d, *J* = 8.1 Hz, 2H), 7.21 – 7.16 (m, 1H), 7.01 (dd, *J* = 8.5, 2.4 Hz, 1H), 6.86 (d, *J* = 2.4 Hz, 1H), 3.68-3.60 (m, 1H), 3.37 – 3.26 (m, 1H), 2.44 (s, 3H), 2.22 (td, *J* = 7.2, 1.7 Hz, 2H), 1.74 – 1.66 (m, 7H), 1.62 – 1.39 (m, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.7, 164.6, 147.7, 144.2, 143.1, 141.1, 137.2, 135.6, 134.7, 130.4, 130.2, 129.8, 128.3, 122.0, 119.6, 100.9, 56.5, 51.8, 37.2, 27.8, 27.6, 23.1, 21.7.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{26}H_{29}ClIN_3O_3SH$ 626.0736; found: 626.0739.

5-((*N*-(2-iodo-4-methylphenyl)-4-methylphenyl)sulfonamido)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1m



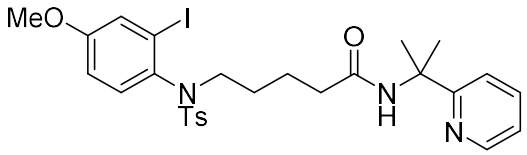
1m was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as light yellow oil (1.58 g, 64% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.49 (dt, *J* = 4.9, 1.4 Hz, 1H), 7.73 – 7.67 (m, 3H), 7.65 – 7.60 (m, 2H), 7.37 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.29 – 7.24 (m, 3H), 7.21 – 7.15 (m, 1H), 7.02 (dd, *J* = 8.1, 2.0 Hz, 1H), 6.74 (d, *J* = 8.1 Hz, 1H), 3.70-3.60 (m, 1H), 3.37 – 3.27 (m, 1H), 2.42 (s, 3H), 2.27 (s, 3H), 2.24 – 2.17 (m, 2H), 1.69 (s, 3H), 1.68 (s, 1H), 1.67 – 1.35 (m, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.8, 147.7, 143.7, 141.0, 140.3, 139.0, 137.2, 136.2, 129.7, 129.6, 128.3, 122.0, 119.6, 103.2, 56.5, 51.7, 37.3, 27.8, 27.6, 23.2, 21.7, 20.6.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{27}H_{32}IN_3O_3SH$ 606.1282; found: 606.1280.

5-((*N*-(2-iodo-4-methoxyphenyl)-4-methylphenyl)sulfonamido)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1n



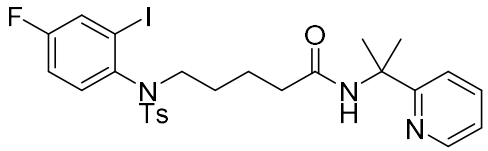
1n was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as yellow oil (1.20 g, 54% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.50 (d, *J* = 4.8 Hz, 1H), 7.76 – 7.67 (m, 2H), 7.62 (d, *J* = 7.8 Hz, 2H), 7.41 – 7.34 (m, 2H), 7.28 (s, 2H), 7.19 (dd, *J* = 7.4, 5.0 Hz, 1H), 6.79 – 6.71 (m, 2H), 3.77 (s, 3H), 3.70 – 3.60 (m, 1H), 3.36-3.25 (m, 1H), 2.43 (s, 3H), 2.27 – 2.15 (m, 2H), 1.76 – 1.68 (dm, 7H), 1.66 – 1.39 (m, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.8, 164.6, 159.4, 147.7, 143.7, 137.2, 136.1, 134.2, 130.1, 129.6, 128.2, 125.2, 121.9, 119.5, 114.8, 56.4, 55.7, 51.7, 37.2, 27.8, 27.6, 23.1, 21.7.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{27}H_{32}IN_3O_4SH$ 622.1231; found: 622.1233.

5-((*N*-(4-fluoro-2-iodophenyl)-4-methylphenyl)sulfonamido)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1o



1o was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as white solid (0.25 g, 13% yield).

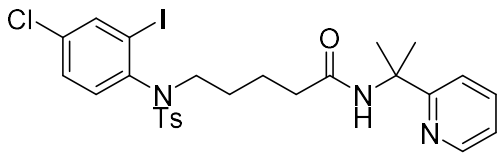
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52-8.47 (m, 1H), 7.76 – 7.67 (m, 2H), 7.59 (td, *J* = 8.0, 2.3 Hz, 3H), 7.38 (dt, *J* = 8.1, 1.1 Hz, 1H), 7.28 (d, *J* = 8.1 Hz, 2H), 7.22-7.17 (m, 1H), 6.99 – 6.92 (m, 1H), 6.84 (dd, *J* = 8.8, 5.4 Hz, 1H), 3.70 – 3.3.60 (m, 1H), 3.38 – 3.28 (m, 1H), 2.43 (s, 3H), 2.25 – 2.18 (m, 2H), 1.76 – 1.67 (m, 7H), 1.61 – 1.38 (m, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.7, 164.6, 161.4 (d, $^1J_{C\text{-}F}$ = 255.5 Hz), 147.7, 144.0, 138.1 (d, $^4J_{C\text{-}F}$ = 3.0 Hz), 137.3, 135.8, 130.8 (d, $^3J_{C\text{-}F}$ = 9.0 Hz), 129.7, 128.3, 127.4 (d, $^2J_{C\text{-}F}$ = 24.2 Hz), 122.0, 119.6, 115.9 (d, $^2J_{C\text{-}F}$ = 22.2 Hz), 103.5 (d, $^3J_{C\text{-}F}$ = 9.1 Hz), 56.5, 51.8, 37.2, 27.8, 27.6, 23.1, 21.7.

^{19}F NMR (376 MHz, $CDCl_3$) δ -111.17.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{26}H_{29}FIN_3O_3SH$ 610.1031; found: 610.1033.

5-((*N*-(4-chloro-2-iodophenyl)-4-methylphenyl)sulfonamido)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1p



1p was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as yellow oil (1.40 g, 64% yield).

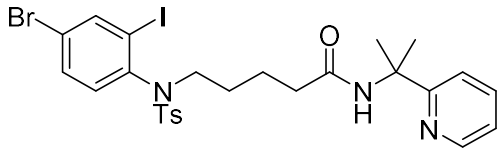
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.49 (d, *J* = 4.9 Hz, 1H), 7.86 (d, *J* = 2.4 Hz, 1H), 7.76 – 7.67 (m, 2H), 7.60 (d, *J* = 7.9 Hz, 2H), 7.37 (d, *J* = 8.1 Hz, 1H), 7.28 (d, *J* = 7.9 Hz, 2H), 7.20 (td, *J* = 8.3, 3.7 Hz, 2H),

6.79 (d, *J* = 8.5 Hz, 1H), 3.70 – 3.59 (m, 1H), 3.37 – 3.27 (m, 1H), 2.43 (s, 3H), 2.25 – 2.17 (m, 2H), 1.69 (s, 3H), 1.68 (s, 1H), 1.66 – 1.35 (m, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.6, 164.5, 147.7, 144.0, 140.5, 139.9, 137.2, 135.7, 134.9, 130.6, 129.7, 129.1, 128.2, 122.0, 119.6, 103.8, 56.5, 51.7, 37.1, 27.8, 27.6, 27.5, 23.1, 21.7.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{26}H_{29}ClIN_3O_3SH$ 626.0736; found: 626.0736.

5-((*N*-(4-bromo-2-iodophenyl)-4-methylphenyl)sulfonamido)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1q



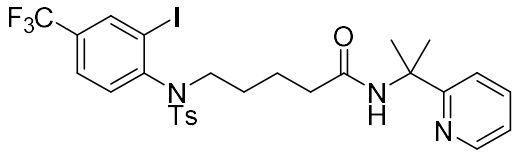
1q was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as yellow oil (2.48 g, 70% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.51 – 8.46 (m, 1H), 8.01 (d, *J* = 2.2 Hz, 1H), 7.76 – 7.67 (m, 2H), 7.63 – 7.58 (m, 2H), 7.36 (td, *J* = 8.3, 1.7 Hz, 2H), 7.28 (d, *J* = 8.1 Hz, 2H), 7.22-7.16 (m, 1H), 6.73 (d, *J* = 8.4 Hz, 1H), 3.69 – 3.59 (m, 1H), 3.36-3.26 (m, 1H), 2.43 (s, 3H), 2.24 – 2.17 (m, 2H), 1.69 (s, 3H), 1.68 (s, 1H), 1.66 – 1.38 (m, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.6, 164.5, 147.7, 144.0, 142.6, 141.0, 137.2, 135.7, 132.1, 131.0, 129.7, 128.2, 122.9, 122.0, 119.6, 104.3, 56.4, 51.6, 37.1, 27.8, 27.6, 27.5, 23.0, 21.7.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{26}H_{29}BrIN_3O_3SH$ 670.0230; found: 670.0228.

5-((*N*-(2-iodo-4-(trifluoromethyl)phenyl)-4-methylphenyl)sulfonamido)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1r



1r was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as light yellow oil (1.78 g, 72% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.48 (dt, *J* = 4.8, 1.4 Hz, 1H), 8.12 (d, *J* = 2.1 Hz, 1H), 7.75 (s, 1H), 7.71 (td, *J* = 4.0 Hz, 2H), 7.64 – 7.59 (m, 2H), 7.49 (dd, *J* = 8.3, 2.1 Hz, 1H), 7.37 (dt, *J* = 8.1, 1.1 Hz, 1H),

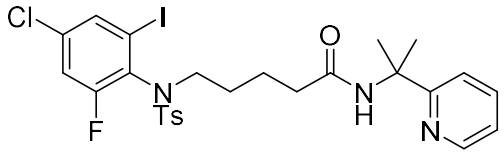
7.30 (d, *J* = 8.1 Hz, 2H), 7.23 – 7.15 (m, 1H), 7.00 (d, *J* = 8.2 Hz, 1H), 3.73 – 3.63 (m, 1H), 3.42 – 3.30 (m, 1H), 2.44 (s, 3H), 2.25 – 2.18 (m, 2H), 1.67 (d, *J* = 8.3 Hz, 7H), 1.64 – 1.39 (m, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.5, 164.5, 147.6, 145.3, 144.2, 137.5 (q, $^{3}J_{C\text{-}F}$ = 4.0 Hz), 137.2, 135.6, 131.6 (q, $^{2}J_{C\text{-}F}$ = 32.3 Hz), 130.4, 129.8, 128.2, 125.9 (q, $^{3}J_{C\text{-}F}$ = 4.0 Hz), 122.6 (q, $^{1}J_{C\text{-}F}$ = 274.7 Hz), 122.0, 119.5, 103.4, 56.4, 51.7, 37.0, 27.8, 27.5, 23.0, 21.7.

^{19}F NMR (376 MHz, $CDCl_3$) δ -62.73.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{27}H_{29}F_3IN_3O_3SH$ 660.0999; found: 660.0998.

5-((*N*-(4-chloro-2-fluoro-6-iodophenyl)-4-methylphenyl)sulfonamido)-*N*-(2-(pyridin-2-yl)propan-2-yl)pentanamide 1s



1s was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as light yellow oil (0.65 g, 55% yield).

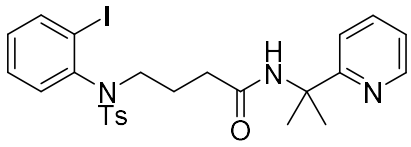
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.49 (dt, *J* = 4.8, 1.4 Hz, 1H), 7.77 – 7.65 (m, 5H), 7.37 (d, *J* = 8.1 Hz, 1H), 7.28 (d, *J* = 8.1 Hz, 2H), 7.21 – 7.15 (m, 1H), 7.05 (dd, *J* = 9.5, 2.3 Hz, 1H), 3.68 – 3.58 (m, 1H), 3.43 – 3.32 (m, 1H), 2.42 (s, 3H), 2.22 (t, *J* = 7.1 Hz, 2H), 1.69 (s, 6H), 1.66 – 1.44 (m, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.6, 164.5, 159.4 (d, $^{1}J_{C\text{-}F}$ = 259.6 Hz), 147.6, 144.0, 137.2, 136.9, 135.9 (d, $^{3}J_{C\text{-}F}$ = 11.1 Hz), 135.6 (d, $^{4}J_{C\text{-}F}$ = 3.0 Hz), 129.7, 129.3 (d, $^{3}J_{C\text{-}F}$ = 14.1 Hz),128.0, 122.0, 119.6, 117.7 (d, $^{2}J_{C\text{-}F}$ = 25.2 Hz), 104.9, 56.5, 50.4, 37.2, 28.2, 27.5, 23.1, 21.7.

^{19}F NMR (376 MHz, $CDCl_3$) δ -108.10.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{26}H_{28}ClFIN_3O_3SH$ 666.0461; found: 666.0465.

4-((*N*-(2-iodophenyl)-4-methylphenyl)sulfonamido)-*N*-(2-(pyridin-2-yl)propan-2-yl)butanamide 1t



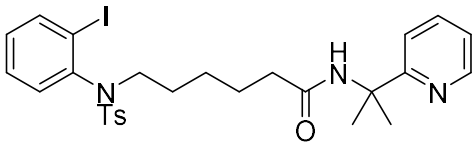
1t was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as white solid (1.67 g, 81% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.54 – 8.48 (m, 1H), 7.91 (dd, *J* = 7.9, 1.5 Hz, 1H), 7.69 (td, *J* = 7.7, 1.8 Hz, 1H), 7.66 – 7.58 (m, 3H), 7.40 (dt, *J* = 8.1, 1.1 Hz, 1H), 7.28 (t, *J* = 2.5 Hz, 2H), 7.24 (d, *J* = 1.5 Hz, 1H), 7.22 – 7.14(m, 1H), 7.01 (td, *J* = 7.7, 1.6 Hz, 1H), 6.87 (dd, *J* = 7.9, 1.6 Hz, 1H), 3.83 – 3.72 (m, 1H), 3.46 – 3.35 (m, 1H), 2.48 – 2.32 (m, 5H), 1.84 – 1.76 (m, 2H), 1.73 (s, 3H), 1.71 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 171.4, 164.7, 147.9, 143.9, 142.0, 140.7, 137.1, 130.1, 130.0, 129.7, 129.1, 128.4, 121.9, 119.6, 103.6, 56.7, 51.6 34.8, 27.8, 27.6, 24.4, 21.7.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{25}H_{28}IN_3O_3SH$ 578.0969; found: 578.0969.

6-((*N*-(2-iodophenyl)-4-methylphenyl)sulfonamido)-*N*-(2-(pyridin-2-yl)propan-2-yl)hexanamide 1u



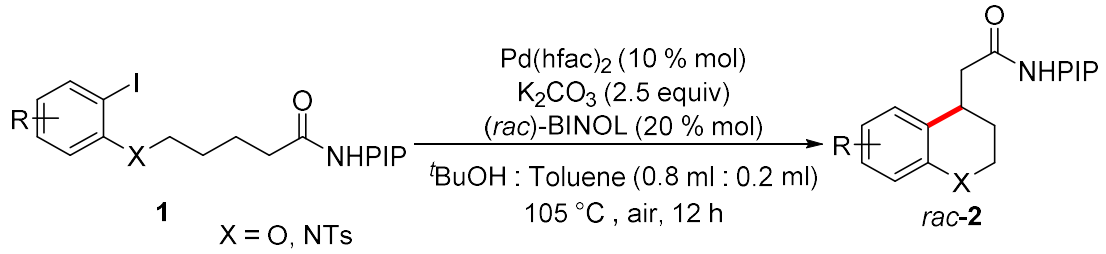
1u was prepared following **GP** and purified by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give as white solid (1.72 g, 84% yield).

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52-8.46 (m, 1H), 7.90 (dd, *J* = 7.9, 1.5 Hz, 1H), 7.70 (td, *J* = 7.8, 1.8 Hz, 1H), 7.65 (s, 1H), 7.61 (dt, *J* = 8.6, 2.1 Hz, 1H), 7.38 (dt, *J* = 8.1, 1.1 Hz, 1H), 7.28 (d, *J* = 1.6 Hz, 2H), 7.24 (d, *J* = 1.5 Hz, 1H), 7.20 – 7.15 (m, 1H), 7.01 (td, *J* = 7.6, 1.6 Hz, 1H), 6.90 (dd, *J* = 7.9, 1.6 Hz, 1H), 3.68-3.57 (m, 1H), 3.41 – 3.30 (m, 1H), 2.43 (s, 3H), 2.19 (t, *J* = 7.5 Hz, 2H), 1.72 (d, *J* = 1.2 Hz, 6H), 1.63 – 1.53 (m, 2H), 1.48 – 1.22 (m, 4H).

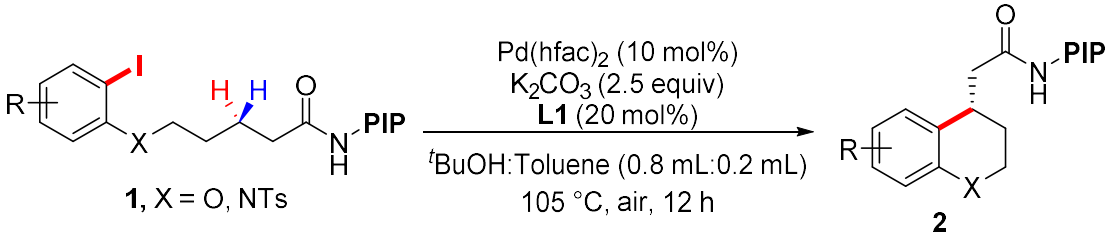
^{13}C NMR (101 MHz, $CDCl_3$) δ 172.1, 164.7, 147.7, 143.7, 141.8, 140.6, 137.2, 136.2, 130.3, 129.9, 129.6, 128.9, 128.3, 122.0, 119.6, 103.5, 56.5, 51.9, 37.6, 28.1, 27.6, 26.6, 25.3, 21.7.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{27}H_{32}IN_3O_3SH$ 606.1282; found: 606.1280.

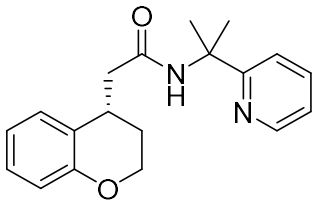
2.2 General Procedure for the Enantioselective Intramolecular C-H Arylation



General Procedure for the Synthesis of Racemic Product *rac*-2: To a 50 mL Schlenk tube was added aliphatic amide **1** (0.10 mmol, 1.0 equiv), *rac*-BINOL (5.7 mg, 20 mol%), K_2CO_3 (34.5 mg, 2.5 equiv), $Pd(hfac)_2$ (5.2 mg, 10 mol%) and toluene: *t*-BuOH (0.2 mL: 0.8 mL). The mixture was stirred at 105 °C (aluminum heat transfer block) for 12 h under air. After cooling to room temperature, the mixture was diluted with ethyl acetate, filtrated through celite. After concentration, the resulting residue was purified by preparative TLC using Hexane/EtOAc as the eluent to afford the desired racemic product *rac*-**2**.



General Procedure for the Synthesis of Chiral Product 2: To a 50 mL Schlenk tube was added aliphatic amide **1** (0.10 mmol, 1.0 equiv), **L1** (6.4 mg, 20 mol%), K_2CO_3 (34.5 mg, 2.5 equiv), $Pd(hfac)_2$ (5.2 mg, 10 mol%) and toluene: *t*-BuOH (0.2 mL: 0.8 mL). The mixture was stirred at 105 °C (aluminum heat transfer block) for 12 h under air. After cooling to room temperature, the mixture was diluted with ethyl acetate, filtrated through celite. After concentration, the resulting residue was purified by preparative TLC using Hexane/EtOAc as the eluent to afford the desired product **2**.



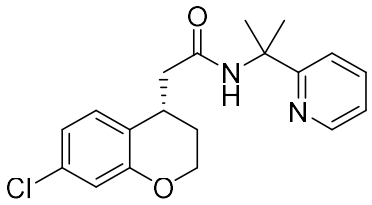
(*S*)-2-(chroman-4-yl)-*N*-(2-(pyridin-2-yl)propan-2-yl)acetamide 2a:

A purification by flash chromatography in petroleum ether: ethyl acetate = 1:1 to give **2a** as a white solid (26.7 mg, 86%). The ee value was determined by HPLC analysis on a Chiralcel OD-H column (hexane/isopropanol = 85/15, flow = 0.8 mL/min) with tr = 9.7 min (minor), 10.9 min (major): 97% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.51 – 8.45 (m, 1H), 7.81 (s, 1H), 7.72 (td, *J* = 7.8, 1.8 Hz, 1H), 7.40 (d, *J* = 8.1 Hz, 1H), 7.23 – 7.16 (m, 2H), 7.13-7.04 (m, 1H), 6.84 (td, J = 7.5, 1.3 Hz, 1H), 6.80 (dd, J = 8.2, 1.3 Hz, 1H), 4.26 – 4.14 (m, 2H), 3.51-3.40 (m, 1H), 2.77 (dd, *J* = 14.4, 5.4 Hz, 1H), 2.42 (dd, *J* = 14.5, 9.5 Hz, 1H), 2.22 – 2.11 (m, 1H), 1.89 – 1.83 (m, 1H), 1.77 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 170.5, 164.4, 154.7, 147.7, 137.3, 129.0, 127.7, 125.4, 122.1, 120.4, 119.6, 117.0, 63.7, 56.8, 44.7, 30.8, 27.6, 27.5, 27.5.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{19}H_{22}N_2O_2H$ 311.1754; found: 311.1755.



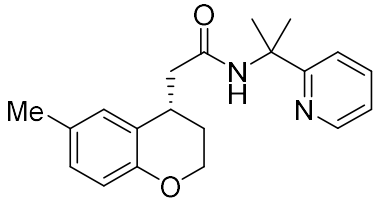
(*S*)-2-(7-chlorochroman-4-yl)-*N*-(2-(pyridin-2-yl)propan-2-yl)acetamide 2b:

A purification by flash chromatography in petroleum ether: ethyl acetate = 1:1 to give **2b** as a white solid (26.5 mg, 77%). The ee value was determined by HPLC analysis on a Chiralcel OD-H column (hexane/isopropanol = 80/20, flow = 1.0 mL/min) with tr = 5.7 min (minor), 6.8 min (major): 90% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.51 – 8.45 (m, 1H), 7.85 (s, 1H), 7.74 (td, *J* = 7.8, 1.8 Hz, 1H), 7.43 – 7.38 (m, 1H), 7.24 – 7.18 (m, 1H), 7.13 – 7.06 (m, 1H), 6.84 – 6.75 (m, 2H), 4.23 – 4.14 (m, 2H), 3.47 – 3.37 (m, 1H), 2.70 (dd, *J* = 14.5, 5.7 Hz, 1H), 2.41 (dd, *J* = 14.5, 9.0 Hz, 1H), 2.18 – 2.08 (m, 1H), 1.89 – 1.80 (m, 1H), 1.77 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 170.2, 164.3, 155.4, 147.6, 137.5, 132.7, 130.0, 124.0, 122.2, 120.6, 119.7, 117.1, 63.9, 56.7, 44.5, 30.4, 27.6, 27.5, 27.3.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{19}H_{21}ClN_2O_2H$ 345.1364; found: 345.1364.



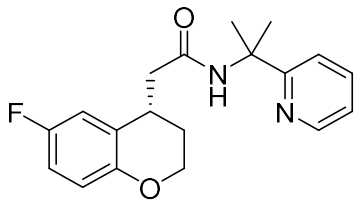
(*S*)-2-(6-methylchroman-4-yl)-*N*-(2-(pyridin-2-yl)propan-2-yl)acetamide 2c:

A purification by flash chromatography in petroleum ether: ethyl acetate = 1:1 to give **2c** as a white solid (26.6 mg, 82%). The ee value was determined by HPLC analysis on a Chiralcel AS-H column (hexane/isopropanol = 80/20, flow = 1.0 mL/min) with tr = 5.7 min (minor), 9.3 min (major): 95% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.51 – 8.43 (m, 1H), 7.84 (s, 1H), 7.72 (td, *J* = 7.8, 1.8 Hz, 1H), 7.40 (dt, *J* = 8.1, 1.0 Hz, 1H), 7.22 – 7.16 (m, 1H), 6.99 (d, *J* = 2.2 Hz, 1H), 6.89 (dd, *J* = 8.2, 2.2 Hz, 1H), 6.70 (d, *J* = 8.3 Hz, 1H), 4.22 – 4.10 (m, 2H), 3.47 – 3.36 (m, 1H), 2.74 (dd, *J* = 14.4, 5.6 Hz, 1H), 2.42 (dd, *J* = 14.4, 9.1 Hz, 1H), 2.22 (s, 3H), 2.19 – 2.08 (m, 1H), 1.87 – 1.81 (m, 1H), 1.77 (s, 3H), 1.76 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 170.6, 164.4, 152.4, 147.7, 137.3, 129.5, 129.3, 128.4, 125.0, 122.1, 119.6, 116.8, 63.6, 56.7, 44.9, 30.8, 27.7, 27.6, 27.5, 20.7.

HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{24}N_2O_2H$ 325.1911; found: 325.1909.



(*S*)-2-(6-fluorochroman-4-yl)-*N*-(2-(pyridin-2-yl)propan-2-yl)acetamide 2d:

A purification by flash chromatography in petroleum ether: ethyl acetate = 1:1 to give **2d** as a white solid (26.2 mg, 80%). The ee value was determined by HPLC analysis on a Chiralcel OD-H column (hexane/isopropanol = 85/15, flow = 1.0 mL/min) with tr = 6.6 min (minor), 8.2 min (major): 96% ee.

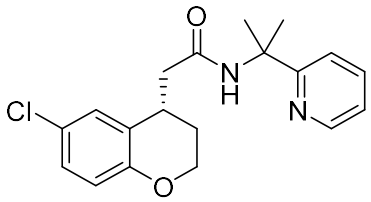
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.50 – 8.42 (m, 1H), 7.88 (s, 1H), 7.72 (td, *J* = 7.8, 1.8 Hz, 1H), 7.39 (dt, *J* = 8.1, 1.1 Hz, 1H), 7.22 – 7.15 (m, 1H), 6.89 (dd, *J* = 9.4, 3.0 Hz, 1H), 6.78 (td, J = 8.4, 8.0, 3.0 Hz, 1H), 6.72 (dd, J = 9.0, 5.0 Hz, 1H),4.23 – 4.09 (m, 2H), 3.48 – 3.34 (m, 1H), 2.71 (dd,

J = 14.5, 5.8 Hz, 1H), 2.42 (dd, *J* = 14.5, 8.9 Hz, 1H), 2.20 – 2.06 (m, 1H), 1.88 – 1.79 (m, 1H), 1.77 (s, 3H), 1.76 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 170.1, 164.3, 156.8 (d, $^{1}J_{C\text{-}F}$ = 238.36), 150.7, 147.7, 137.3, 126.4 (d, $^{3}J_{C\text{-}F}$ = 7.1 Hz), 122.1, 119.6, 117.9 (d, $^{3}J_{C\text{-}F}$ = 8.1 Hz), 114.8 (d, $^{2}J_{C\text{-}F}$ = 23.2 Hz), 114.5 (d, $^{2}J_{C\text{-}F}$ = 23.2 Hz), 63.8, 56.7, 44.6, 31.0, 27.6, 27.5, 27.4.

^{19}F NMR (376 MHz, $CDCl_3$) δ -123.94.

HRMS (ESI) m/z: $[M + H]^+$ Calcd. for $C_{19}H_{21}FN_2O_2H$ 329.1660; found: 329.1661.



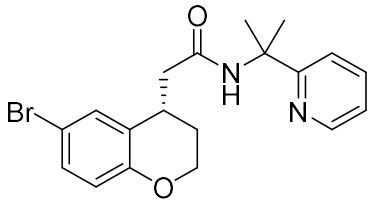
(*S*)- 2-(6-chlorochroman-4-yl)-*N*-(2-(pyridin-2-yl)propan-2-yl)acetamide 2e:

A purification by flash chromatography in petroleum ether: ethyl acetate = 1:1 to give **2e** as a pale yellow solid (21.3 mg, 62%). The ee value was determined by HPLC analysis on a Chiralcel AS-H column (hexane/isopropanol = 70/30, flow = 1.0 mL/min) with tr = 4.2 min (minor), 5.0 min (major): 92% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.54 – 8.40 (m, 1H), 7.87 (s, 1H), 7.72 (td, *J* = 7.8, 1.8 Hz, 1H), 7.40 (d, *J* = 8.1 Hz, 1H), 7.23 – 7.14 (m, 2H), 7.02 (dd, *J* = 8.7, 2.6 Hz, 1H), 6.72 (d, *J* = 8.7 Hz, 1H), 4.26 – 4.08 (m, 2H), 3.48 – 3.35 (m, 1H), 2.70 (dd, *J* = 14.5, 6.0 Hz, 1H), 2.43 (dd, *J* = 14.4, 8.7 Hz, 1H), 2.20 – 2.06 (m, 1H), 1.88 – 1.81 (m, 2H), 1.78 (s, 3H), 1.77 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 170.1, 164.3, 153.3, 147.6, 137.4, 128.6, 127.7, 126.9, 125.1, 122.1, 119.6, 118.3, 63.8, 56.7, 44.5, 30.8, 27.6, 27.3.

HRMS (ESI) m/z: $[M + H]^+$ Calcd. for $C_{19}H_{21}ClN_2O_2H$ 345.1364; found: 345.1365.



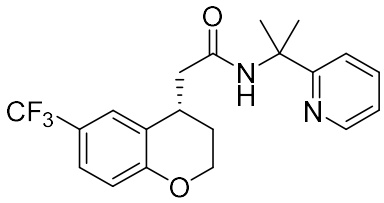
(*S*)-2-(6-bromochroman-4-yl)-*N*-(2-(pyridin-2-yl)propan-2-yl)acetamide 2f:

A purification by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give **2f** as a pale yellow solid (32.2 mg, 83%). The ee value was determined by HPLC analysis on a Chiralcel IA column (hexane/isopropanol = 80/20, flow = 1.0 mL/min) with tr = 13.6 min (minor), 15.9 min (major): 97% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.51 – 8.43 (m, 1H), 7.90 (s, 1H), 7.72 (td, *J* = 7.8, 1.8 Hz, 1H), 7.39 (d, *J* = 8.1 Hz, 1H), 7.30 (d, *J* = 2.4 Hz, 1H), 7.22 – 7.12 (m, 2H), 6.67 (d, *J* = 8.7 Hz, 1H), 4.2 – 4.12 (m, 2H), 3.48 – 3.36 (m, *J* = 8.4, 5.8 Hz, 1H), 2.69 (dd, *J* = 14.4, 6.0 Hz, 1H), 2.42 (dd, *J* = 14.4, 8.7 Hz, 1H), 2.18 – 2.06 (m, 1H), 1.89 – 1.80 (m, 1H), 1.77 (s, 3H), 1.76 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 167.0, 164.3, 153.8, 147.6, 137.3, 131.6, 130.6, 127.5, 122.1, 119.6, 118.9, 112.4, 63.8, 56.7, 44.5, 30.7, 27.6, 27.5, 27.2.

HRMS (ESI) m/z: $[M + H]^+$ Calcd. for $C_{19}H_{21}BrN_2O_2H$ 389.0859; found: 389.0858.



(*S*)-*N*-(2-(pyridin-2-yl)propan-2-yl)-2-(6-(trifluoromethyl)chroman-4-yl)acetamide 2g:

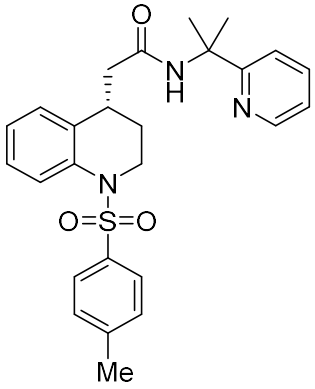
A purification by flash chromatography in petroleum ether: ethyl acetate = 1:1 to give **2g** as a white solid (32.6 mg, 86%). The ee value was determined by HPLC analysis on a Chiralcel AS-H column (hexane/isopropanol = 80/20, flow = 1.0 mL/min) with tr = 4.3 min (minor), 5.3 min (major): 96% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.50 – 8.42 (m, 1H), 7.92 (s, 1H), 7.72 (td, *J* = 7.8, 1.8 Hz, 1H), 7.46 (d, *J* = 2.3 Hz, 1H), 7.40 (dt, *J* = 8.0, 1.1 Hz, 1H), 7.32 (dd, *J* = 8.6, 2.3 Hz, 1H), 7.22 – 7.15 (m, 1H), 6.85 (d, *J* = 8.5 Hz, 1H), 4.31 – 4.16 (m, 2H), 3.56 – 3.43 (m, 1H), 2.74 (dd, *J* = 14.5, 6.1 Hz, 1H), 2.46 (dd, *J* = 14.5, 8.6 Hz, 1H), 2.23 – 2.10 (m, 1H), 1.93 – 1.85 (m, 2H), 1.77 (s, 3H), 1.76 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 169.9, 164.3, 157.3, 147.6, 137.4, 126.4 (q, $^3J_{C\text{-}F}$ = 3.8 Hz), 125.7, 124.6 (q, $^1J_{C\text{-}F}$ =271.7 Hz), 124.9 (q, $^3J_{C\text{-}F}$ = 4.0 Hz), 122.5 (q, $^2J_{C\text{-}F}$ = 32.3 Hz), 122.1, 119.6, 117.4, 64.1, 56.7, 44.4, 30.7, 27.5, 27.5, 27.2.

^{19}F NMR (376 MHz, $CDCl_3$) δ -61.39.

HRMS (ESI) m/z: $[M + H]^+$ Calcd. for $C_{20}H_{21}F_3N_2O_2H$ 379.1628; found: 379.1629.



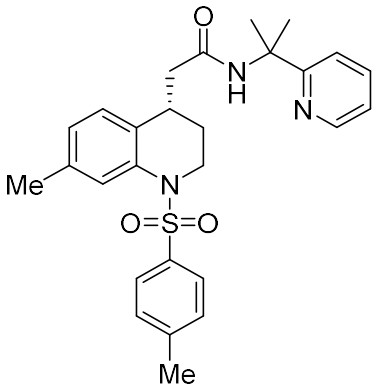
(*S*)-*N*-(2-(pyridin-2-yl)propan-2-yl)-2-(1-tosyl-1,2,3,4-tetrahydroquinolin-4-yl)acetamide 2h:

A purification by flash chromatography in petroleum ether: ethyl acetate = 1:1 to give **2h** as a pale-yellow oil (45.9 mg, 99%). The ee value was determined by HPLC analysis on a Chiralcel AS-H column (hexane/isopropanol = 70/30, flow = 0.8 mL/min) with tr = 13.5 min (minor), 16.5 min (major): 95% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.55 – 8.46 (m, 1H), 7.81 (dd, *J* = 8.3, 1.2 Hz, 1H), 7.73 (td, *J* = 7.8, 1.8 Hz, 1H), 7.57 (s, 1H), 7.53 – 7.47 (m, 2H), 7.38 (dt, *J* = 8.1, 1.0 Hz, 1H), 7.24 – 7.11 (m, 5H), 7.08 (td, *J* = 7.4, 1.3 Hz, 1H), 3.81 (t, *J* = 6.0 Hz, 2H), 3.25 – 3.14 (m, 1H), 2.36 (s, 3H), 2.36 – 2.31 (m, 1H), 1.86 – 1.77 (m, 2H), 1.71 (s, 6H), 1.58 – 1.48 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 170.1, 164.3, 147.6, 143.8, 137.4, 136.7, 136.7, 133.3, 129.7, 128.8, 127.4, 127.0, 125.2, 124.9, 122.2, 119.7, 56.7, 44.4, 44.3, 32.7, 27.5, 26.5, 21.6.

HRMS (ESI) m/z: $[M + H]^+$ Calcd. for $C_{26}H_{29}N_3O_3SH$ 464.2002; found: 464.2003.



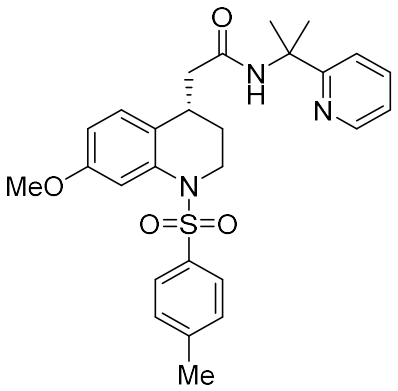
(*S*)-2-(7-methyl-1-tosyl-1,2,3,4-tetrahydroquinolin-4-yl)-*N*-(2-(pyridin-2-yl)propan-2-yl)acetamide 2i:

A purification by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give **2i** as a white solid (45.3 mg, 95%). The ee value was determined by HPLC analysis on a Chiralcel AD-H column (hexane/isopropanol = 80/20, flow = 1.0 mL/min) with tr = 12.7 min (minor), 14.1 min (major): 94% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.50 (dd, *J* = 5.1, 1.6 Hz, 1H), 7.72 (td, *J* = 7.8, 1.8 Hz, 1H), 7.64 (s, 1H), 7.54 (s, 1H), 7.50 (d, J = 8.0 Hz, 1H), 7.37 (d, *J* = 8.1 Hz, 1H), 7.21 (dd, *J* = 7.8, 3.4 Hz, 3H), 7.02 (d, *J* = 7.9 Hz, 1H), 6.90 (dd, *J* = 7.9, 1.7 Hz, 1H), 3.85 – 3.70 (m, 2H), 3.21 – 3.09 (m, 1H), 2.39 – 2.27 (m, 7H), 1.82 – 1.73 (m, 2H), 1.71 (s, 6H), 1.53 – 1.43 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 170.2, 164.3, 147.6, 143.7, 137.3, 136.8, 136.6, 136.5, 130.2, 129.7, 128.5, 127.4, 126.2, 125.4, 122.1, 119.6, 56.6, 44.5, 32.3, 27.5, 26.4, 21.6, 21.4.

HRMS (ESI) m/z: $[M + H]^+$ Calcd. for $C_{27}H_{31}N_3O_3SH$ 478.2159; found: 478.2160.



(*S*)-2-(7-methoxy-1-tosyl-1,2,3,4-tetrahydroquinolin-4-yl)-*N*-(2-(pyridin-2-yl)propan-2-yl)acetamide 2j:

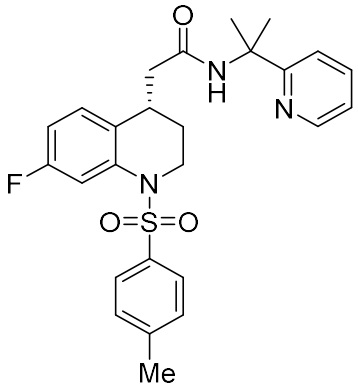
A purification by flash chromatography in petroleum ether: ethyl acetate = 2:1 to give **2j** as a pale yellow oil (43.4 mg, 88%). The ee value was determined by HPLC analysis on a Chiralcel OD-H column (hexane/isopropanol = 85/15, flow = 0.8 mL/min) with tr = 19.9 min (minor), 23.9 min (major): 92% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.54 – 8.44 (m, 1H), 7.71 (td, *J* = 7.8, 1.7 Hz, 1H), 7.55 (s, 1H), 7.53 – 7.48 (m, 2H), 7.40 (d, *J* = 2.6 Hz, 1H), 7.36 (dt, J = 7.9, 1.0 Hz, 1H), 7.24 – 7.16 (m, 3H), 7.03 (d, *J* = 8.5 Hz, 1H), 6.65 (dd, *J* = 8.6, 2.6 Hz, 1H), 3.84 – 3.74 (m, 5H), 3.20 – 3.07 (m, 1H),

2.36 (s, 3H), 2.29 (dd, *J* = 14.4, 5.3 Hz, 1H), 1.78 (dd, *J* = 14.4, 9.7 Hz, 1H), 1.70 (s, 6H), 1.53 – 1.42 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 170.2, 164.3, 158.2, 147.6, 143.8, 137.4, 137.3, 136.7, 129.7, 129.4, 127.3, 125.1, 122.1, 119.6, 112.1, 109.3, 56.6, 55.5, 44.6, 44.5, 32.1, 27.5, 26.4, 21.6.

HRMS (ESI) m/z: $[M + H]^+$ Calcd. for $C_{27}H_{31}N_3O_4SH$ 494.2108; found: 494.2110.



(*S*)-2-(7-fluoro-1-tosyl-1,2,3,4-tetrahydroquinolin-4-yl)-*N*-(2-(pyridin-2-yl)propan-2-yl)acetamide 2k:

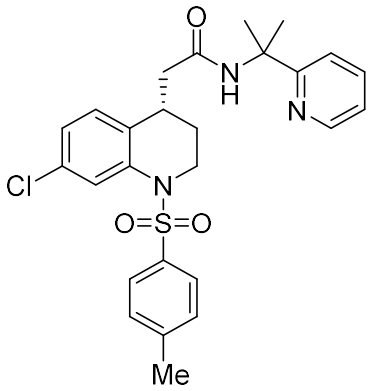
A purification by flash chromatography in dichloromethane: ethyl acetate = 9:1 to give **2k** as a pale yellow oil (37.5 mg, 78%). The ee value was determined by HPLC analysis on a Chiralcel AD-H column (hexane/isopropanol = 80/20, flow = 1.0 mL/min) with tr = 13.8 min (minor), 16.4 min (major): 94% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.51 – 8.45 (m, 1H), 7.72 (td, *J* = 7.7, 1.6 Hz, 1H), 7.65 – 7.57 (m, 2H), 7.54 (d, *J* = 8.0 Hz, 2H), 7.36 (dt, *J* = 8.2, 1.0 Hz, 1H), 7.25 – 7.18 (m, 3H), 7.08 (dd, *J* = 8.7, 6.4 Hz, 1H), 6.76 (td, *J* = 8.2, 2.6 Hz, 1H), 3.89 – 3.80 (m, 1H), 3.78 – 3.69 (m, 1H), 3.25 – 3.14 (m, 1H), 2.36 (s, 3H), 2.27 (dd, *J* = 14.5, 5.5 Hz, 1H), 1.86 (dd, *J* = 14.5, 9.4 Hz, 1H), 1.75 – 1.66 (m, 7H), 1.58 – 1.51 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 169.8, 164.2, 161.1 (d, $^{1}J_{C\text{-}F}$ = 244.4 Hz), 147.6, 144.1, 137.7 (d, $^{3}J_{C\text{-}F}$ = 11.1 Hz), 137.4, 136.2, 129.9 (d, $^{3}J_{C\text{-}F}$ = 7.1 Hz), 128.4 (d, $^{4}J_{C\text{-}F}$ = 3.0 Hz), 127.3, 122.2, 119.6, 112.0 (d, $^{2}J_{C\text{-}F}$ = 22.2 Hz), 111.2 (d, $^{2}J_{C\text{-}F}$ = 26.2 Hz), 56.7, 44.3, 44.1, 32.3, 27.5, 27.5, 26.3, 21.6.

^{19}F NMR (376 MHz, $CDCl_3$) δ -114.12.

HRMS (ESI) m/z: $[M + H]^+$ Calcd. for $C_{26}H_{28}FN_3O_3SH$ 482.1908; found: 482.1911.



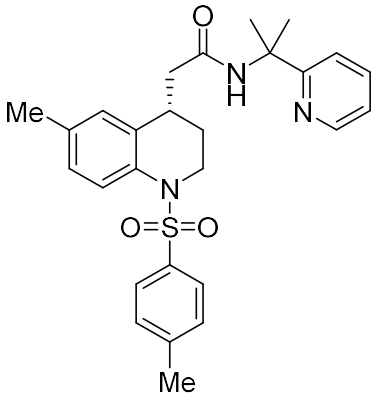
(*S*)-2-(7-chloro-1-tosyl-1,2,3,4-tetrahydroquinolin-4-yl)-*N*-(2-(pyridin-2-yl)propan-2-yl)acetamide 2l:

A purification by flash chromatography in dichloromethane: ethyl acetate = 9:1 to give **2l** as a pale yellow oil (44.7 mg, 90%). The ee value was determined by HPLC analysis on a Chiralcel AD-H column (hexane/isopropanol = 80/20, flow = 1.0 mL/min) with tr = 9.1 min (minor), 10.0 min (major): 95% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.50 (dd, *J* = 4.9, 1.5 Hz, 1H), 7.88 (d, *J* = 1.9 Hz, 1H), 7.73 (td, *J* = 7.8, 1.8 Hz, 1H), 7.61 (s, 1H), 7.55 (d, *J* = 8.0 Hz, 2H), 7.37 (d, *J* = 8.1 Hz, 1H), 7.25-7.19 (m, 3H), 7.10 – 7.00 (m, 2H), 3.88 – 3.68 (m, 2H), 3.25 – 3.12 (m, 1H), 2.38 (s, 3H), 2.27 (dd, *J* = 14.5, 5.5 Hz, 1H), 1.86 (dd, *J* = 14.5, 9.3 Hz, 1H), 1.79 – 1.72 (m, 1H), 1.71 (s, 6H), 1.59 – 1.50 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 169.7, 164.2, 147.6, 144.2, 137.6, 137.4, 136.3, 132.3, 131.4, 129.9, 129.8, 127.3, 125.1, 124.3, 122.2, 119.6, 56.7, 44.2, 44.1, 32.4, 27.5, 27.5, 26.3, 21.7.

HRMS (ESI) m/z: $[M + H]^+$ Calcd. for $C_{26}H_{28}ClN_3O_3SH$ 498.1613; found: 498.1614.



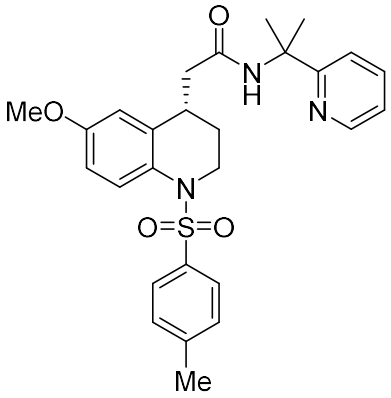
(*S*)-2-(6-methyl-1-tosyl-1,2,3,4-tetrahydroquinolin-4-yl)-*N*-(2-(pyridin-2-yl)propan-2-yl)acetamide 2m:

A purification by flash chromatography in petroleum ether: ethyl acetate = 1:1 to give **2m** as a pale yellow solid (45.8 mg, 96%). The ee value was determined by HPLC analysis on a Chiralcel AS-H column (hexane/isopropanol = 80/20, flow = 1.0 mL/min) with tr = 21.0 min (minor), 28.1 min (major): 96% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.53 – 8.45 (m, 1H), 7.76 – 7.65 (m, 2H), 7.54 (s, 1H), 7.51 – 7.45 (m, 2H), 7.37 (dt, *J* = 8.1, 1.1 Hz, 1H), 7.23 – 7.16 (m, 3H), 7.02 – 6.89 (m, 2H), 3.82 – 3.70 (m, 2H), 3.20 – 3.08 (m, 1H), 2.36 (s, 3H), 2.29 (dd, *J* = 14.4, 5.4 Hz, 1H), 2.24 (s, 3H), 1.82 – 1.66 (m, 8H), 1.52 – 1.43 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 170.2, 164.3, 147.5, 143.7, 137.4, 136.7, 134.8, 134.0, 133.0, 129.7, 129.2, 127.7, 127.4, 124.8, 122.1, 119.6, 56.6, 44.5, 44.4, 32.6, 27.6, 27.5, 26.5, 21.6, 20.9.

HRMS (ESI) m/z: $[M + H]^+$ Calcd. for $C_{27}H_{31}N_3O_3SH$ 478.2159; found: 478.2161.



(*S*)-2-(6-methoxy-1-tosyl-1,2,3,4-tetrahydroquinolin-4-yl)-*N*-(2-(pyridin-2-yl)propan-2-yl)acetamide 2n:

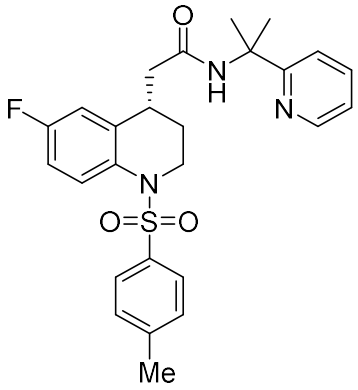
A purification by flash chromatography in petroleum ether: ethyl acetate = 1:1 to give **2n** as a pale yellow oil (44.3 mg, 90%). The ee value was determined by HPLC analysis on a Chiralcel AD-H column (hexane/isopropanol = 80/20, flow = 1.0 mL/min) with tr = 9.8 min (minor), 11.6 min (major): 94% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.53 – 8.46 (m, 1H), 7.76 – 7.67 (m, 2H), 7.55 (s, 1H), 7.48 – 7.41 (m, 2H), 7.37 (dt, *J* = 8.0, 1.1 Hz, 1H), 7.24 – 7.17 (m, 3H), 6.76 (dd, *J* = 9.0, 3.0 Hz, 1H), 6.66 (d,

J = 2.9 Hz, 1H), 3.84 – 3.65 (m, 5H), 3.17 – 3.07 (m, 1H), 2.36 (s, 3H), 2.31 (dd, *J* = 14.5, 5.0 Hz, 1H), 1.75 – 1.63 (m, 8H), 1.47 – 1.36 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 170.1, 164.3, 157.2, 147.5, 143.7, 137.4, 136.6, 135.1, 129.7, 129.6, 127.4, 126.9, 122.2, 119.7, 113.2, 112.8, 56.7, 55.5, 44.6, 44.5, 32.7, 27.5, 26.1, 21.6.

HRMS (ESI) m/z: $[M + H]^+$ Calcd. for $C_{27}H_{31}N_3O_4SH$ 494.2108; found: 494.2110.



(*S*)-2-(6-fluoro-1-tosyl-1,2,3,4-tetrahydroquinolin-4-yl)-*N*-(2-(pyridin-2-yl)propan-2-yl)acetamide 2o:

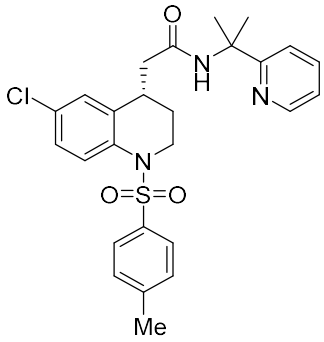
A purification by flash chromatography in petroleum ether: ethyl acetate = 1:1 to give **2o** as a pale yellow oil (35.1 mg, 73%). The ee value was determined by HPLC analysis on a Chiralcel OD-H column (hexane/isopropanol = 80/20, flow = 0.8 mL/min) with tr = 15.3 min (minor), 17.8 min (major): 96% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.55 – 8.46 (m, 1H), 7.82 – 7.68 (m, 2H), 7.62 (s, 1H), 7.49 – 7.43 (m, 2H), 7.37 (dt, *J* = 8.0, 1.1 Hz, 1H), 7.25 – 7.18 (m, 3H), 6.94 – 6.81 (m, 2H), 3.84 – 3.68 (m, 2H), 3.19 – 3.09 (m, 1H), 2.38 (s, 3H), 2.26 (dd, *J* = 14.5, 5.5 Hz, 1H), 1.80 (dd, *J* = 14.5, 9.3 Hz, 1H), 1.75 – 1.66 (m, 7H), 1.51 – 1.40 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 169.8, 164.2, 160.2 (d, $^{1}J_{C\text{-}F}$ = 246.4 Hz), 147.5, 144.0, 137.5, 136.5, 135.7 (d, $^{3}J_{C\text{-}F}$ = 7.1 Hz), 132.6 (d, $^{4}J_{C\text{-}F}$ = 3.0 Hz), 129.8, 127.4, 127.1 (d, $^{3}J_{C\text{-}F}$ = 8.1 Hz), 122.2, 119.7, 114.9 (d, $^{2}J_{C\text{-}F}$ = 22.2 Hz), 114.0 (d, $^{2}J_{C\text{-}F}$ = 22.2 Hz), 56.7, 44.5, 44.2, 32.7, 27.6, 27.5, 26.22, 21.6.

^{19}F NMR (376 MHz, $CDCl_3$) δ -116.85.

HRMS (ESI) m/z: $[M + H]^+$ Calcd. for $C_{26}H_{28}FN_3O_3SH$ 482.1908; found: 482.1907.



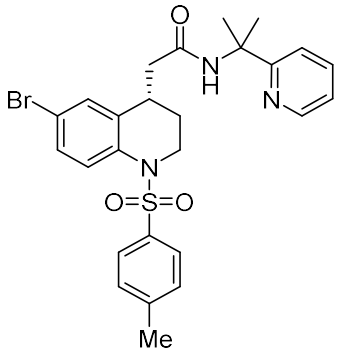
(*S*)-2-(6-chloro-1-tosyl-1,2,3,4-tetrahydroquinolin-4-yl)-*N*-(2-(pyridin-2-yl)propan-2-yl)acetamide 2p:

A purification by flash chromatography in petroleum ether: ethyl acetate = 1:1 to give **2p** as a pale yellow oil (49.2 mg, 99%). The ee value was determined by HPLC analysis on a Chiralcel AD-H column (hexane/isopropanol = 80/20, flow = 1.0 mL/min) with tr = 12.0 min (minor), 13.2 min (major): 95% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.49 (dt, *J* = 5.0, 1.4 Hz, 1H), 7.81 – 7.68 (m, 2H), 7.61 (s, 1H), 7.48 (dd, J = 8.6, 1.9 Hz, 1H), 7.37 (dd, *J* = 8.1, 1.3 Hz, 1H), 7.25 – 7.18 (m, 3H), 7.16 – 7.10 (m, 2H), 3.85 – 3.68 (m, 2H), 3.22 – 3.09 (m, 1H), 2.37 (s, 3H), 2.25 (dd, *J* = 14.5, 5.6 Hz, 1H), 1.85 (dd, *J* = 14.5, 9.1 Hz, 1H), 1.75 – 1.65 (m, 7H), 1.54 – 1.44 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 169.6, 164.2, 147.5, 144.1, 137.4, 136.3, 135.2, 135.0, 130.5, 129.9, 128.5, 127.3, 127.1, 126.2, 122.2, 119.6, 56.7, 44.3, 44.0, 32.6, 27.5, 26.2, 21.6.

HRMS (ESI) m/z: $[M + H]^+$ Calcd. for $C_{26}H_{28}ClN_3O_3SH$ 498.1613; found: 498.1615.



(*S*)-2-(6-bromo-1-tosyl-1,2,3,4-tetrahydroquinolin-4-yl)-*N*-(2-(pyridin-2-yl)propan-2-yl)acetamide 2q:

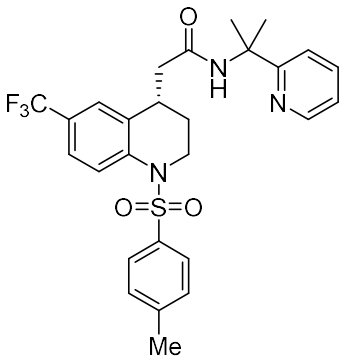
A purification by flash chromatography in petroleum ether: ethyl acetate = 1:1 to give **2q** as a pale yellow oil (51.9 mg, 96%). The ee value was determined by HPLC analysis on a Chiralcel IB N-5

column (hexane/isopropanol = 85/15, flow = 1.0 mL/min) with tr = 15.7 min (minor), 17.3 min (major): 96% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.53 – 8.45 (m, 1H), 7.77 – 7.68 (m, 2H), 7.62 (s, 1H), 7.53 – 7.47 (m, 2H), 7.37 (dt, *J* = 8.2, 1.1 Hz, 1H), 7.31 – 7.27 (m, 2H), 7.25 – 7.19 (m, 3H), 3.85 – 3.68 (m, 2H), 3.21 – 3.10 (m, 1H), 2.37 (s, 3H), 2.25 (dd, *J* = 14.5, 5.7 Hz, 1H), 1.87 (dd, *J* = 14.5, 9.2 Hz, 1H), 1.77 – 1.66 (m, 7H), 1.57 – 1.45 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 169.6, 164.2, 147.5, 144.1, 137.4, 136.3, 135.8, 135.3, 131.5, 130.0, 129.9, 127.3, 126.4, 122.2, 119.6, 118.4, 56.7, 44.2, 44.0, 32.6, 27.6, 27.5, 26.3, 21.6.

HRMS (ESI) m/z: $[M + H]^+$ Calcd. for $C_{26}H_{28}BrN_3O_3SH$ 542.1108; found: 542.1111.



(*S*)-*N*-(2-(pyridin-2-yl)propan-2-yl)-2-(1-tosyl-6-(trifluoromethyl)-1,2,3,4-tetrahydroquinolin-4-yl)acetamide 2r:

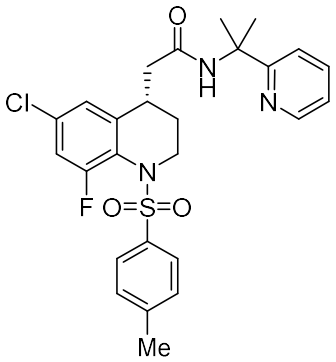
A purification by flash chromatography in petroleum ether: ethyl acetate = 1:1 to give **2r** as a white solid (52.0 mg, 98%). The ee value was determined by HPLC analysis on a Chiralcel IA column (hexane/isopropanol = 80/20, flow = 1.0 mL/min) with tr = 9.1 min (minor), 11.0 min (major): 96% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.54 – 8.41 (m, 1H), 7.97 – 7.90 (m, 1H), 7.77 – 7.65 (m, 2H), 7.59 – 7.50 (m, 2H), 7.46 – 7.33 (m, 3H), 7.26 – 7.18 (m, 3H), 3.96 – 3.70 (m, 2H), 3.37 – 3.17 (m, 1H), 2.37 (s, 3H), 2.32 (dd, *J* = 14.5, 5.8 Hz, 1H), 2.04 – 1.94 (m, 1H), 1.84 – 1.74 (m, 1H), 1.71 (s, 3H), 1.70 (s, 3H), 1.67 – 1.59 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 169.5, 164.2, 147.5, 144.4, 139.8, 137.4, 136.2, 133.2, 130.0, 127.3, 126.5 (q, $^2J_{C\text{-}F}$ = 32.3 Hz),125.8 (q, $^3J_{C\text{-}F}$ = 3.0 Hz), 124.1 (q, $^1J_{C\text{-}F}$ = 272.7 Hz), 124.1, 123.9 (q, $^3J_{C\text{-}F}$ = 4.0 Hz), 122.2, 119.6, 56.7, 44.2, 43.9, 32.9, 27.5, 26.5, 21.6.

^{19}F NMR (376 MHz, $CDCl_3$) δ -62.19.

HRMS (ESI) m/z: $[M + H]^+$ Calcd. for $C_{27}H_{28}F_3N_3O_3SH$ 532.1876; found: 532.1877.



(*S*)-2-(6-chloro-8-fluoro-1-tosyl-1,2,3,4-tetrahydroquinolin-4-yl)-*N*-(2-(pyridin-2-yl)propan-2-yl)acetamide 2s:

A purification by flash chromatography in petroleum ether: ethyl acetate = 1:1 to give **2s** as pale yellow oil (27 mg, 52%). The ee value was determined by HPLC analysis on a Chiralcel AD-H column (hexane/isopropanol = 80/20, flow = 1.0 mL/min) with tr = 12.4 min (minor), 15.9 min (major): 93% ee.

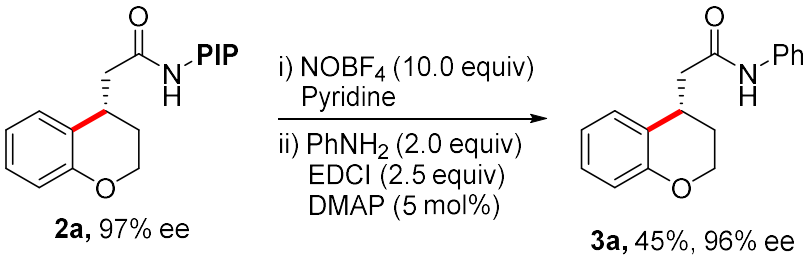
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.50 (d, J = 4.3 Hz, 1H), 7.86 – 7.76 (m, 3H), 7.72 (td, *J* = 7.8, 1.7 Hz, 1H), 7.38 (d, J = 8.1 Hz, 1H), 7.32 (d, J = 8.1 Hz, 1H), 7.24 – 7.16 (m, 1H), 7.10 – 7.03 (m, 1H), 6.99 (dd, *J* = 10.0, 2.3 Hz, 1H), 3.83 – 3.71 (m, 1H), 3.48 – 3.31 (m, 2H), 2.65 (dd, *J* = 14.5, 6.0 Hz, 1H), 2.43 (s, 3H), 2.37 (dd, *J* = 14.5, 8.8 Hz, 1H), 2.19 – 2.09 (m, 1H), 1.96 – 1.85 (m, 1H), 1.74 (s, 3H), 1.73 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 169.7, 164.2, 157.0 (d, $^1J_{C\text{-}F}$ = 255.5 Hz), 147.7, 144.1, 139.7, 137.3 (d, $^3J_{C\text{-}F}$ = 6.1 Hz), 131.7 (d, $^3J_{C\text{-}F}$ = 11.1 Hz), 129.8, 127.7, 127.6, 124.4 (d, $^2J_{C\text{-}F}$ = 12.1 Hz),123.9 (d, $^4J_{C\text{-}F}$ = 3.0 Hz), 122.1, 119.6, 115.3 (d, $^2J_{C\text{-}F}$ = 25.2 Hz), 56.8, 44.8, 44.0, 32.6, 32.6, 28.7, 27.6, 27.5, 21.7.

^{19}F NMR (376 MHz, $CDCl_3$) δ -112.55.

HRMS (ESI) m/z: $[M + Na]^+$ Calcd. for $C_{26}H_{28}ClFN_3O_3SNa$ 538.1338; found: 538.1339.

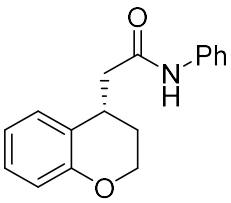
3. Derivatizations



2a, 97% ee

3a, 45%, 96% ee

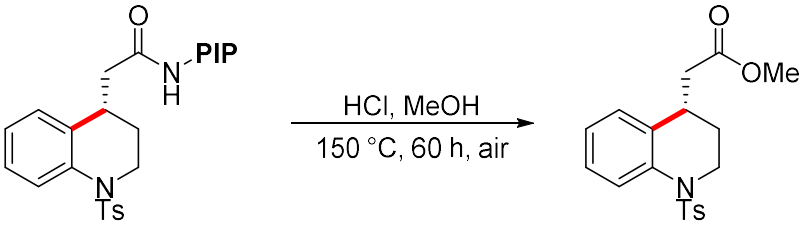
To a 25 mL flask was added aliphatic amide **2a** (0.10 mmol) and pyridine (2.0 mL). The reaction mixture was cooled to -30 °C and then $NOBF_4$ (10.0 equiv) was added for three times. The reaction was stirred in -30 °C for 2 h then warmed to room temperature and stirred for another 5 h. The reaction mixture was acidified to pH 3 with aq. HCl (3 M), and extracted with EtOAc (10 mL x 3). The organic layers were combined, washed with brine, dried over anhydrous Na_2SO_4, and concentrated to give compound without further purification. Then $PhNH_2$ (2.0 equiv), EDCI (2.5 equiv), DMAP (5 mol%), DCM (2 mL) was added and stirred at rt for 12 h. The reaction mixture was diluted with H_2O, and extracted with DCM (10 mL x 3). The organic layers were combined, washed with brine, dried over anhydrous Na_2SO_4, Purification by flash chromatography.



(*S*)-2-(chroman-4-yl)-*N*-phenylacetamide 3a:

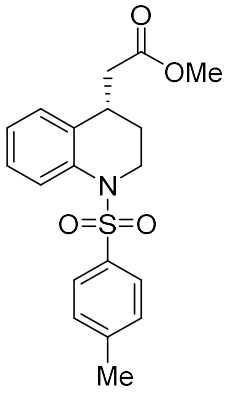
3a was a known compound[2] and purification by flash chromatography in petroleum ether: ethyl acetate = 3:1 to give **3a** as yellow oil (12.0 mg, 45%). The ee value was determined by HPLC analysis on a Chiralcel OD-H column (hexane/isopropanol = 90/10, flow = 1.0 mL/min) with tr = 33.2 min (minor), 38.6 min (major): 96% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 – 7.43 (m, 2H), 7.33 (t, *J* = 7.9 Hz, 2H), 7.21 – 7.07 (m, 4H), 6.90 – 6.79 (m, 2H), 4.27 – 4.14 (m, 2H), 3.58 – 3.48 (m, 1H), 2.84 (dd, *J* = 14.7, 5.7 Hz, 1H), 2.55 (dd, *J* = 14.7, 8.6 Hz, 1H), 2.28 – 2.19 (m, 1H), 1.96 – 1.84 (m, 1H).



2h, 95% ee **3b,** 43% 94% ee

To a 50 mL Schlenk tube was added aliphatic amide **2h** (0.10 mmol) and MeOH: HCl (4 mL: 1 mL). The reaction was stirred at 150 °C (oil bath) for 60 h. The reaction mixture was alkalized to pH 10 with aq. Na_2CO_3, and extracted with EtOAc (10 mL x 3). The organic layers were combined, washed with brine, dried over anhydrous Na_2SO_4, Purified by preparative TLC.



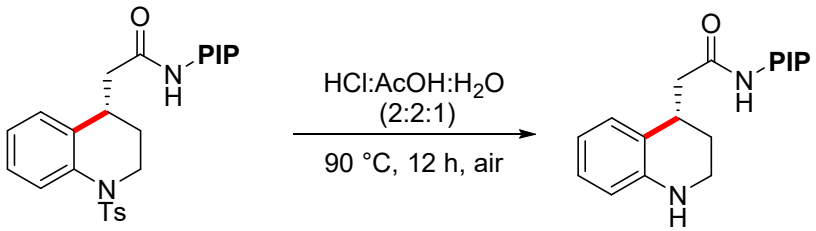
methyl (*S*)-2-(1-tosyl-1,2,3,4-tetrahydroquinolin-4-yl)acetate 3b:

A purification by preparative TLC in petroleum ether: ethyl acetate = 3:1 to give **3b** as a yellow oil (15.4 mg, 43%). The ee value was determined by HPLC analysis on a Chiralcel AD-H column (hexane/isopropanol = 80/20, flow = 1.0 mL/min) with tr = 6.8 min (minor), 7.6 min (major): 94% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 (d, *J* = 8.0 Hz, 1H), 7.47 (d, *J* = 8.4 Hz, 2H), 7.24 – 7.18 (m, 3H), 7.13 – 7.05 (m, 2H), 3.84 (ddd, *J* = 13.9, 7.3, 4.5 Hz, 1H), 3.88 – 3.80 (m, 1H), 3.79 – 3.70 (m, 1H), 3.64 (s, 3H), 3.11 – 3.01 (m, 1H), 2.41 (dd, *J* = 15.6, 4.8 Hz, 1H), 2.38 (s, 3H), 1.99 (dd, *J* = 15.8, 9.9 Hz, 1H), 1.82 – 1.72 (m, 1H), 1.51 – 1.42 (m, 1H).

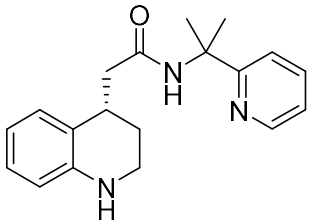
^{13}C NMR (101 MHz, $CDCl_3$) δ 172.4, 144.0, 136.7, 136.5, 132.5, 129.8, 128.3, 127.3, 125.3, 125.1, 51.9, 44.149, 40.8, 32.4, 26.7, 21.7.

HRMS (ESI) m/z: $[M + Na]^+$ Calcd. for $C_{19}H_{21}NO_4SNa$ 382.1083; found: 382.1085.



2h, 95% ee **3c,** 80%, 95%

To a 50 mL Schlenk tube was added aliphatic amide **2h** (0.10 mmol) and HCl: CH_3COOH: H_2O (2 mL: 2 mL: 1 mL). The reaction was stirred at 90 °C (oil bath) for 12 h. The reaction mixture was alkalized to pH 10 with aq. NaOH, and extracted with EtOAc (10 mL x 3). The organic layers were combined, dried over anhydrous Na_2SO_4, Purified by preparative TLC.



(*S*)-*N*-(2-(pyridin-2-yl)propan-2-yl)-2-(1,2,3,4-tetrahydroquinolin-4-yl)acetamide 3c:

A purification by preparative TLC in petroleum ether: ethyl acetate = 1:1 to give **3c** as a yellow oil (24.7 mg, 80%). The ee value was determined by HPLC analysis on a Chiralcel AS-H column (hexane/isopropanol = 80/20, flow = 1.0 mL/min) with tr = 5.4 min (minor), 6.8 min (major): 95% ee.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.48 (d, *J* = 5.0 Hz, 1H), 7.76 – 7.64 (m, 2H), 7.40 (d, *J* = 8.1 Hz, 1H), 7.18 (dd, *J* = 7.5, 5.0 Hz, 1H), 7.08 (d, *J* = 7.6 Hz, 1H), 6.97 (t, *J* = 7.6 Hz, 1H), 6.60 (t, *J* = 7.4 Hz, 1H), 6.48 (d, *J* = 8.0 Hz, 1H), 3.46 – 3.37 (m, 1H), 3.36 – 3.24 (m, 2H), 2.68 (dd, *J* = 14.2, 5.7 Hz, 1H), 2.40 (dd, *J* = 14.2, 9.2 Hz, 1H), 2.07 – 1.97 (m, 1H), 1.88 – 1.80 (m, 1H), 1.76 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 170.9, 164.6, 147.7, 144.5, 137.2, 129.0, 127.3, 124.2, 122.0, 119.6, 117.1, 114.4, 56.7, 45.2, 38.7, 32.8, 27.7, 27.6, 26.8.

HRMS (ESI) m/z: $[M + H]^+$ Calcd. for $C_{19}H_{23}N_3OH$ 310.1914; found: 310.1915.

4. X-Ray Crystallographic Data

A single crystal of **2k** suitable for X-ray crystallography was obtained by crystallization via evaporation from its hexane/ethyl acetate solution.

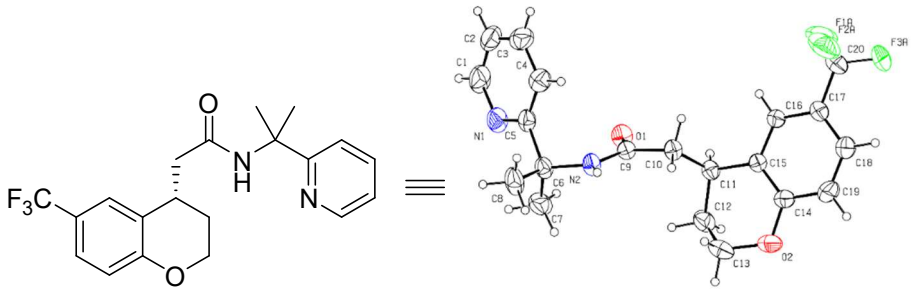


Table S1. Crystal data and structure refinement for **2k**

Identification code	compound_**2k**
Empirical formula	$C_{20}H_{21}F_3N_2O_2$
Formula weight	378.39
Temperature/K	310
Crystal system	orthorhombic
Space group	P43
a/Å	10.1440(7)
b/Å	10.1440(7)
c/Å	19.1105(14)
α/°	90
β/°	90
γ/°	90
Volume/Å^3	1966.5(3)
Z	4
ρ_{calc}g/cm^3	1.278
μ/mm^{-1}	0.966
F(000)	792.0
Crystal size/mm^3	0.03 × 0.04 × 0.36
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/°	4.36 to 68.25
Index ranges	-12 ≤ h ≤ 12, -12 ≤ k ≤ 12, -23 ≤ l ≤ 22
Reflections collected	27682
Independent reflections	3546 [R_{int} = 0.0453, R_{sigma} = 0.0264]
Data/restraints/parameters	3546/7/274
Goodness-of-fit on F^2	1.055
Final R indexes [I>=2σ (I)]	R_1 = 0.0340, wR_2 = 0.0889
Final R indexes [all data]	R_1 = 0.0415, wR_2 = 0.0923
Largest diff. peak/hole / e Å^{-3}	0.127/-0.175
Flack parameter	-0.05(5)

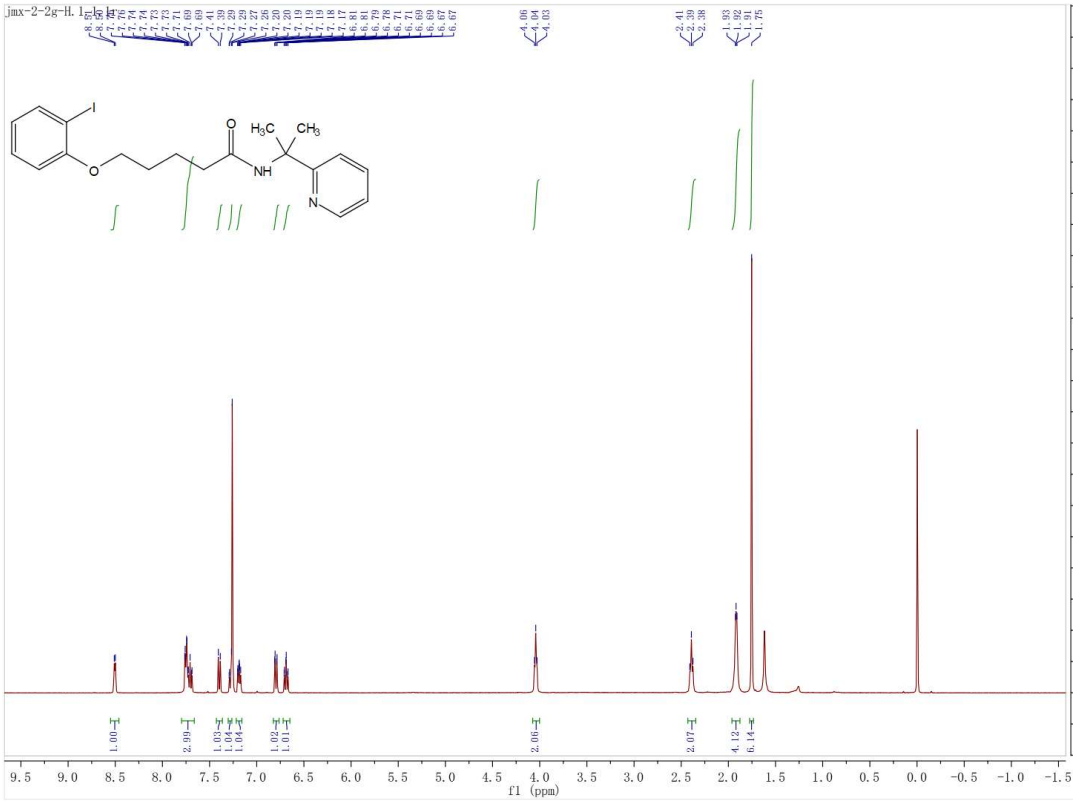
5. References

1) Y. Feng, Y. Wang, B. Landgraf, S. Liu and G. Chen, Facile Benzo-Ring Construction via Palladium-Catalyzed Functionalization of Unactivated sp^3 C−H Bonds under Mild Reaction Conditions, *Org. Lett*. **2010**, *12*, 3414-3417.

2) Y.-Q. Han, Q. Zhang, X. Yang, M.-X. Jiang, Y. Ding and B.-F. Shi, Pd(II)-Catalyzed enantioselective intramolecular arylation of unbiased C(sp^3)−H bonds to construct chiral benzo-ring compounds, *Org. Lett.* 2021, **23**, 97-101.

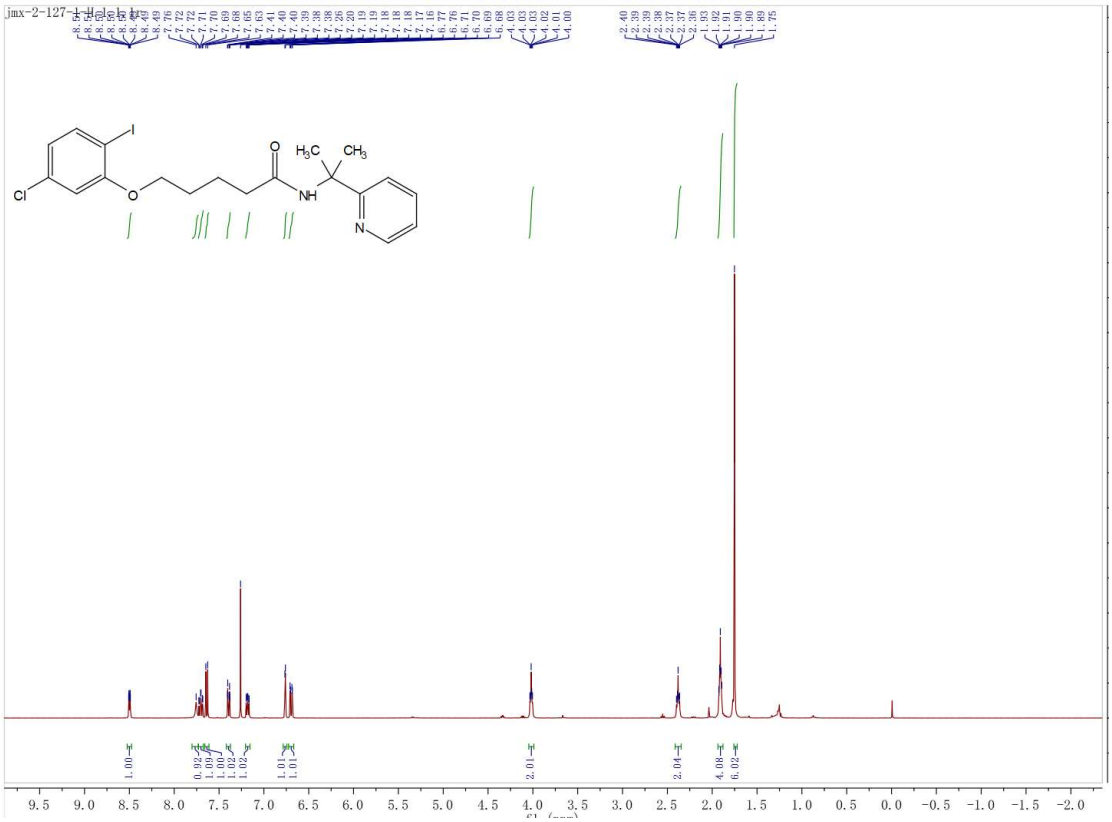
6. NMR Spectra

1a, ^{1}H NMR, 400 MHz, $CDCl_3$

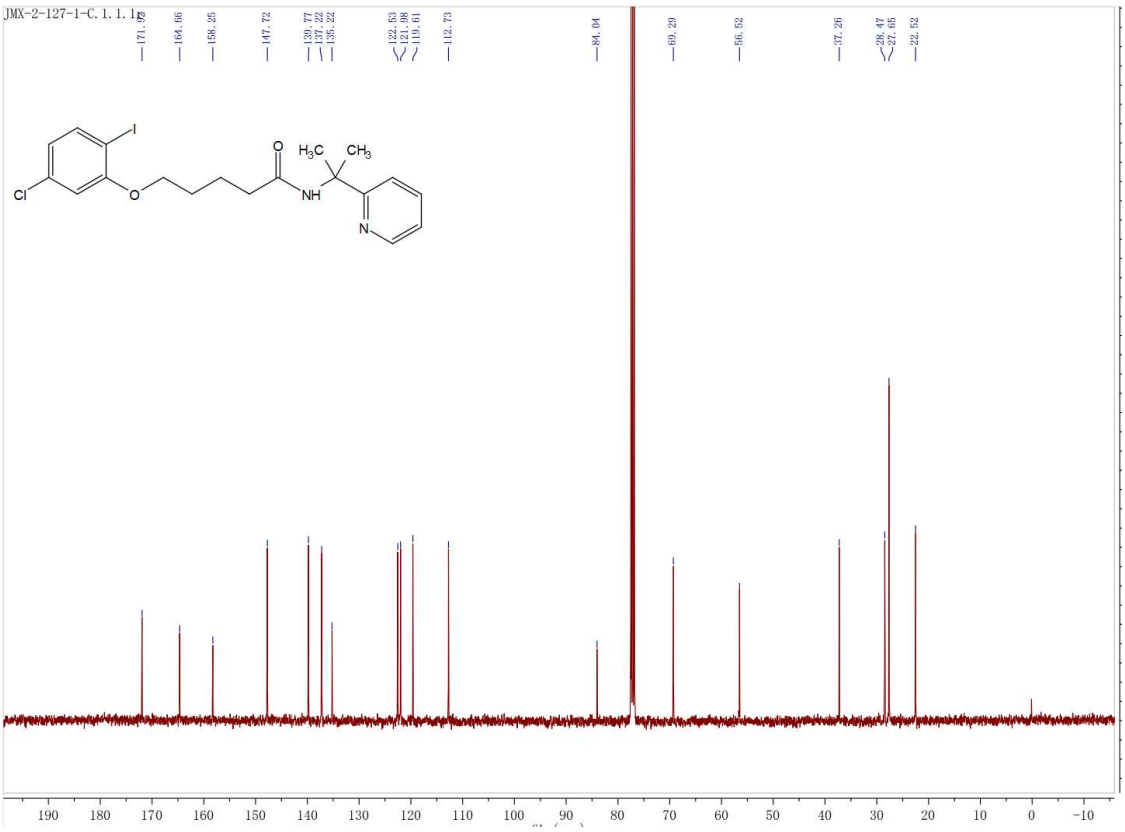


1a,^{13}C NMR, 101 MHz, $CDCl_3$

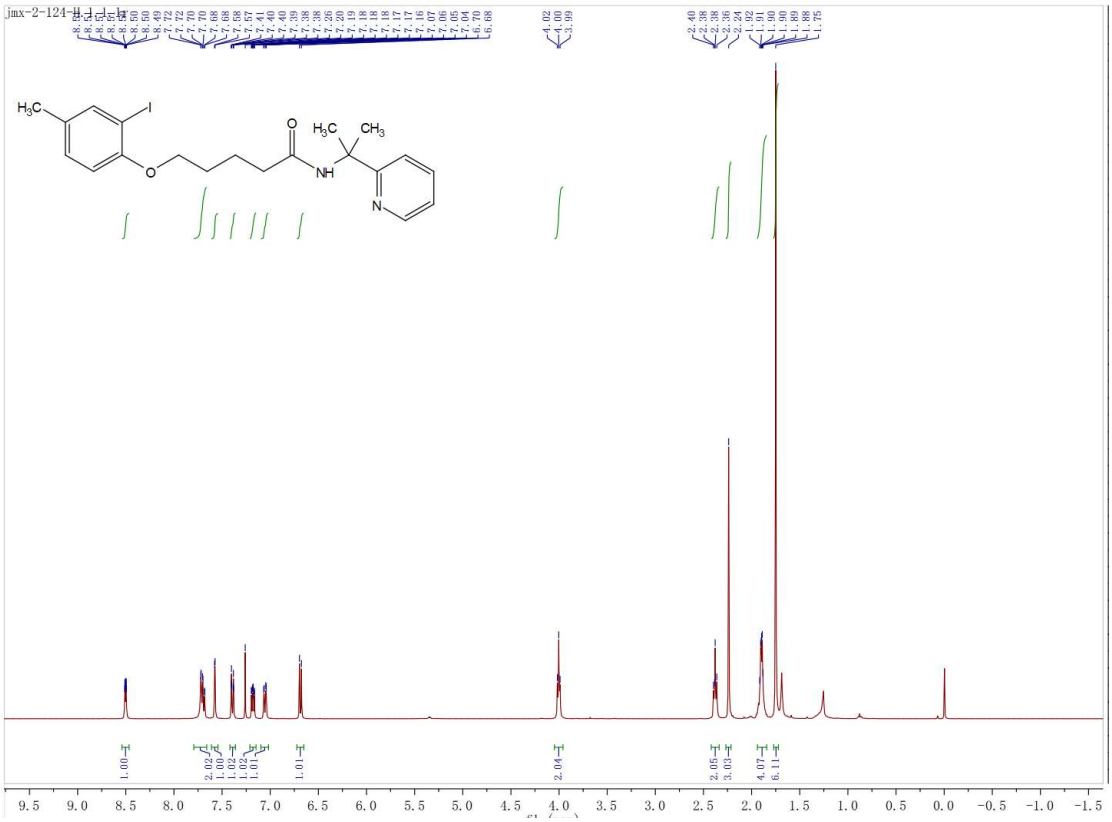
1b, ^{1}H NMR, 400 MHz, $CDCl_3$



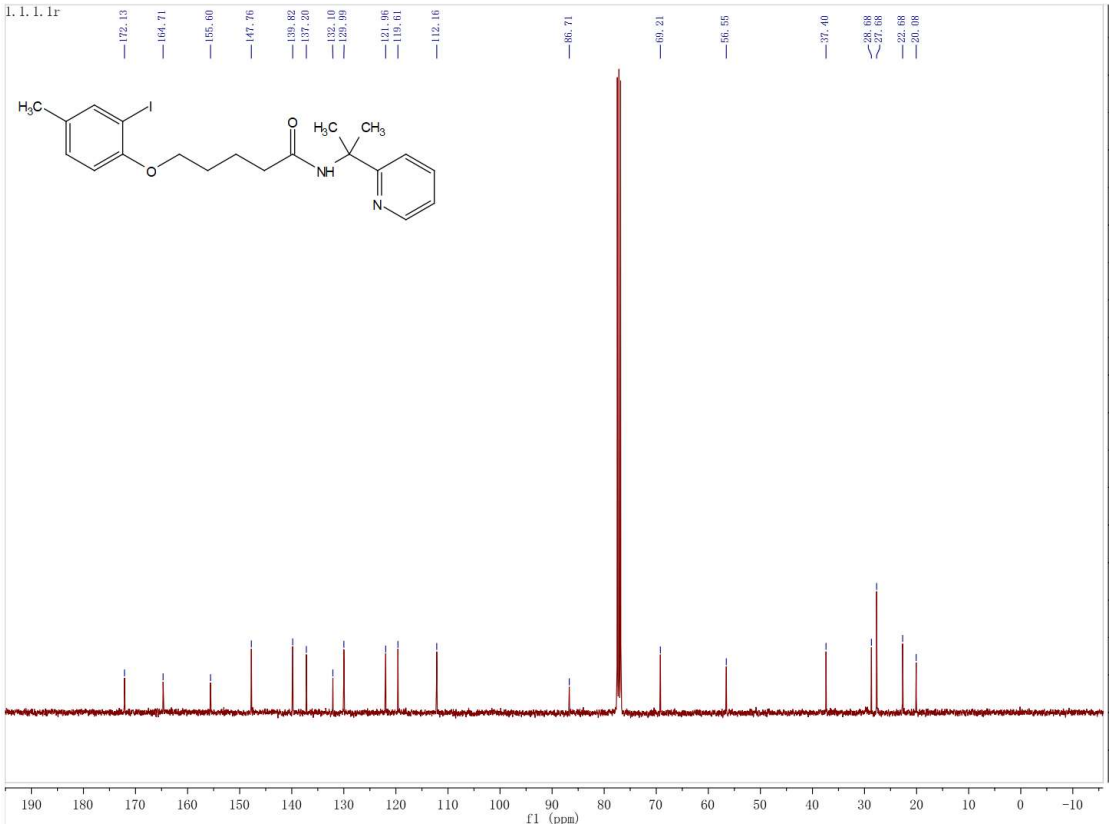
1b, ^{13}C NMR, 101 MHz, $CDCl_3$



1c, ^{1}H NMR, 400 MHz, $CDCl_3$

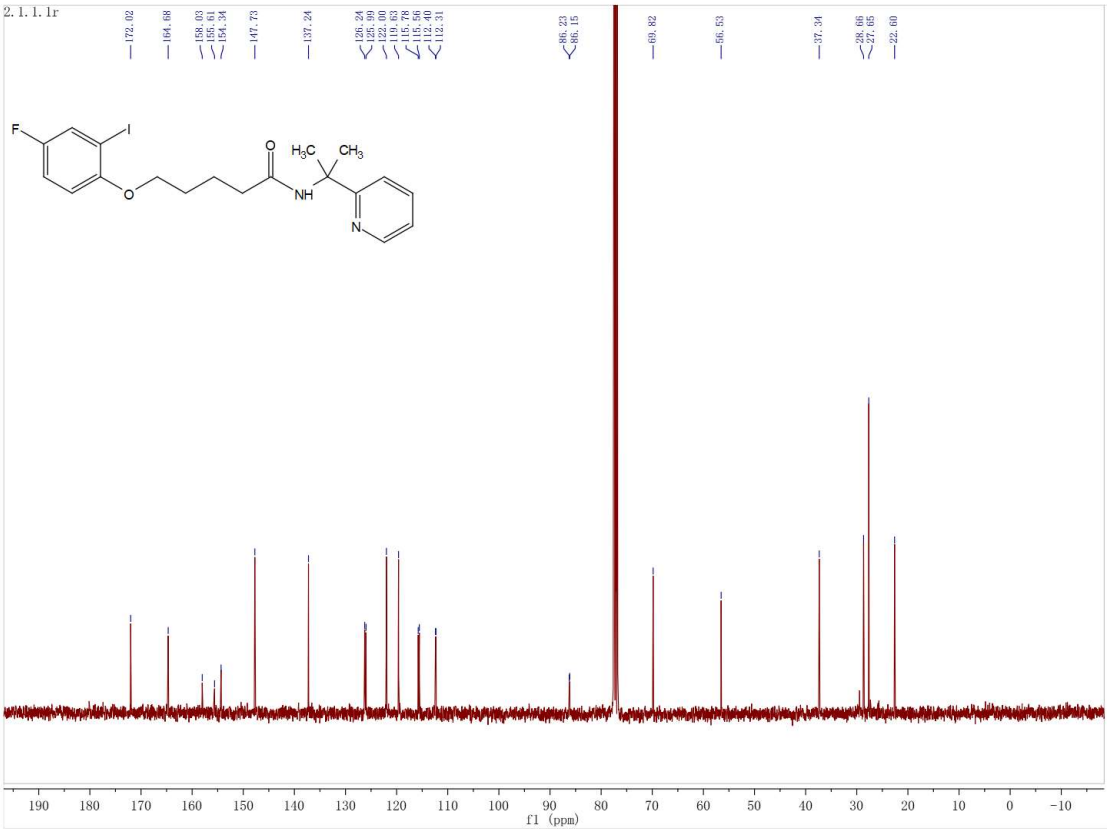


1c, ^{13}C NMR, 101 MHz, $CDCl_3$

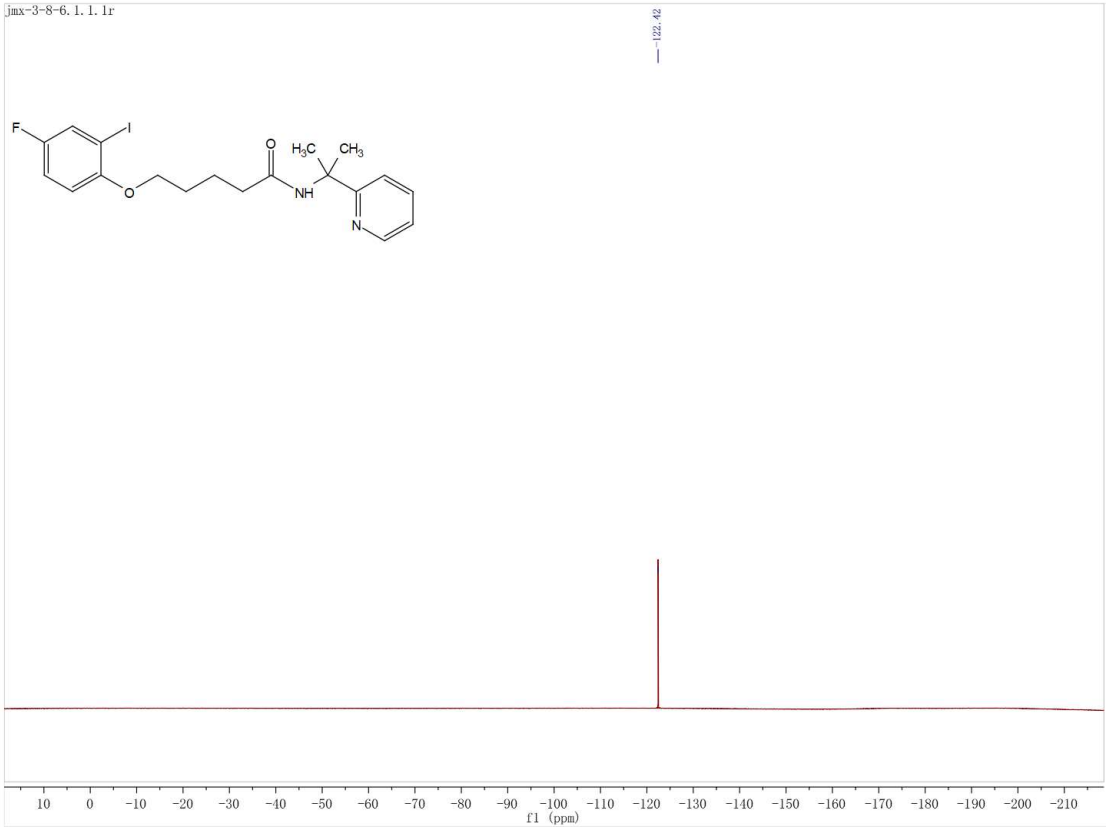


1d, ^{1}H NMR, 400 MHz, $CDCl_3$

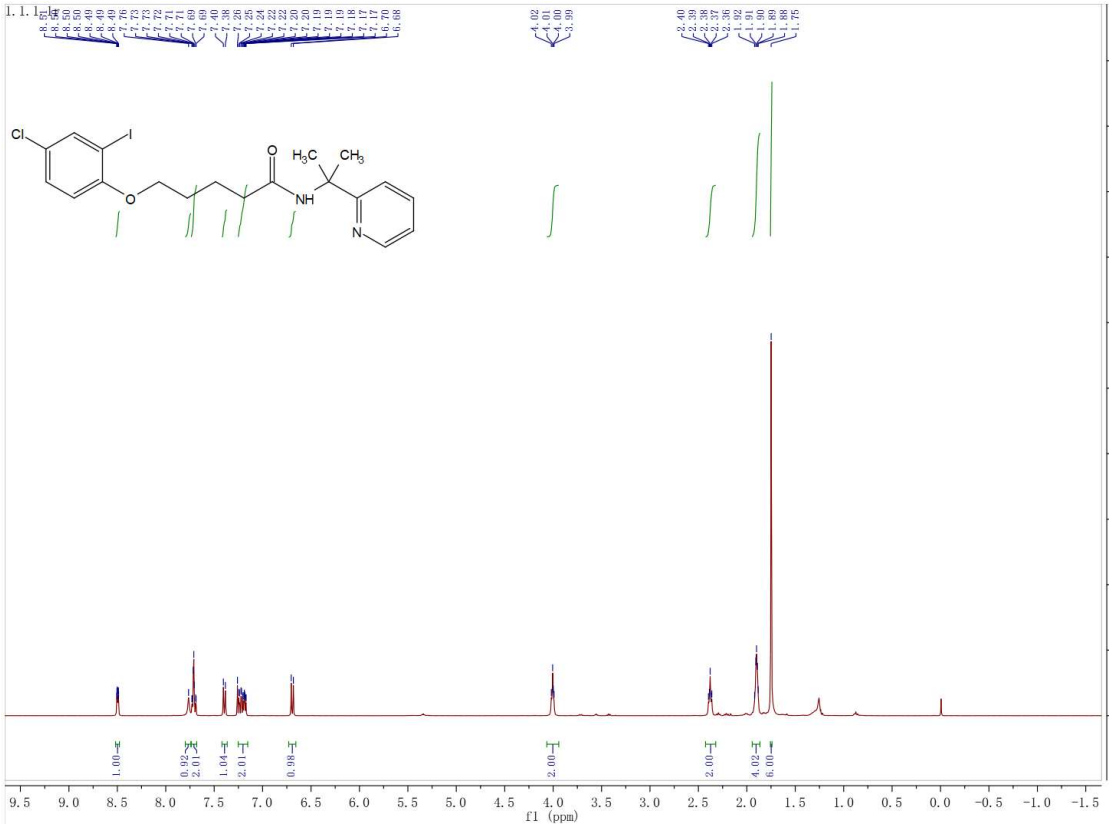
1d, ^{13}C NMR, 101 MHz, $CDCl_3$



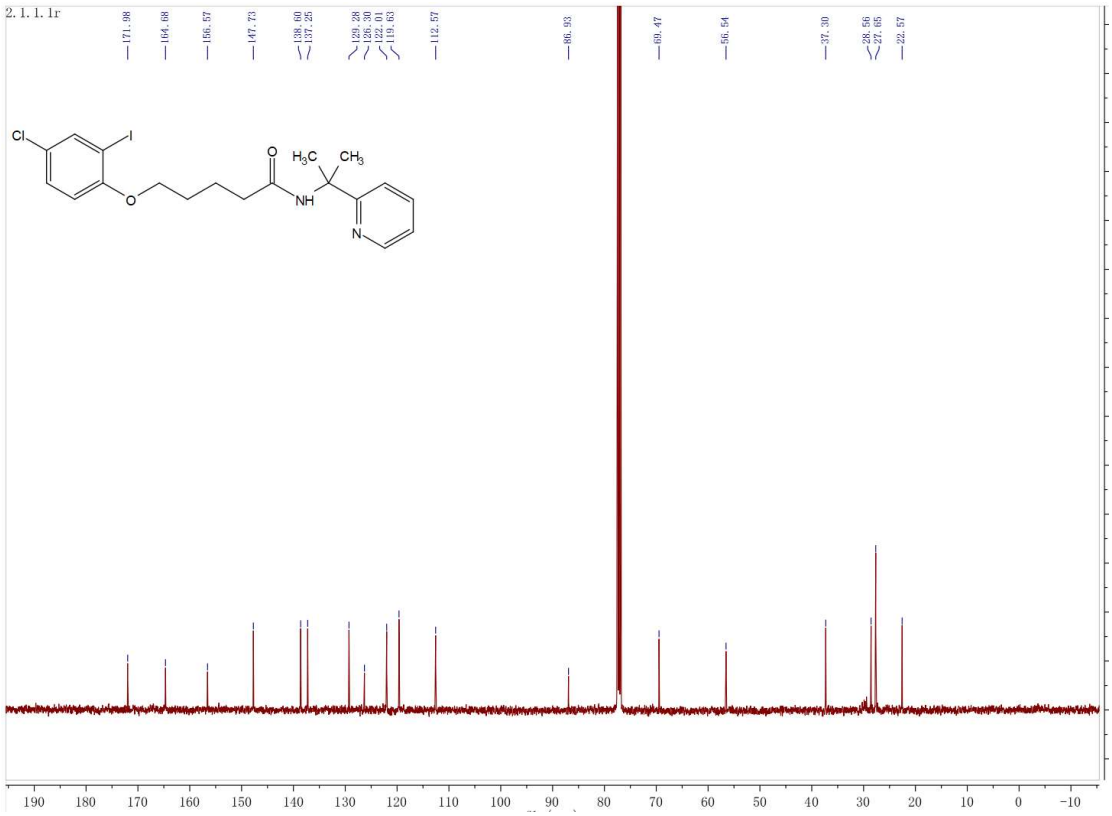
1d, ^{19}F NMR, 376 MHz, $CDCl_3$



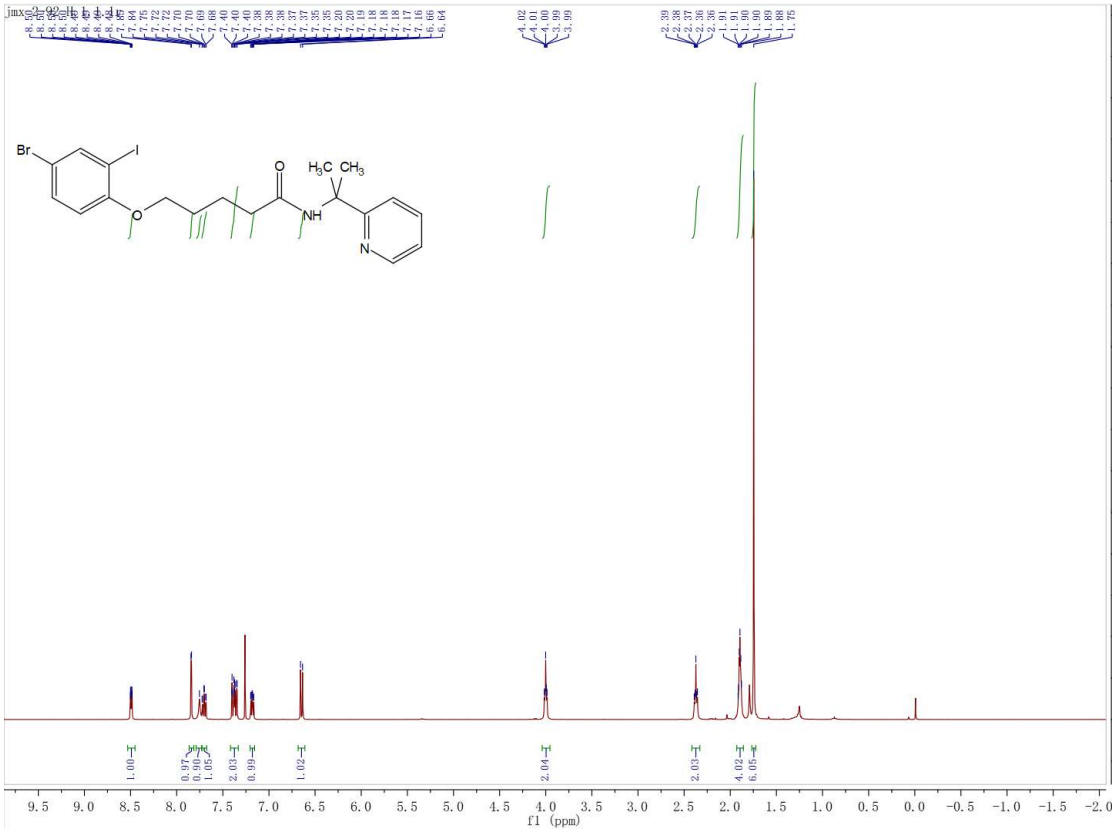
1e, ^{1}H NMR, 400 MHz, $CDCl_3$



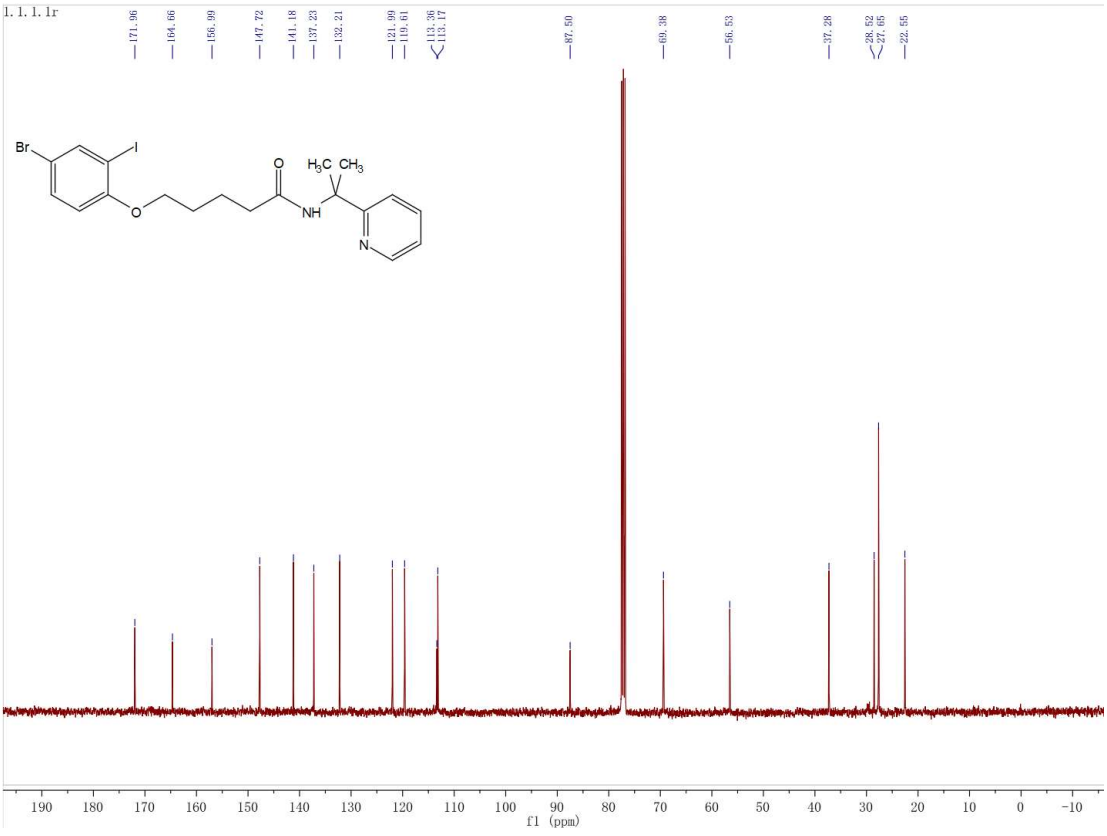
1e, ^{13}C NMR, 101 MHz, $CDCl_3$



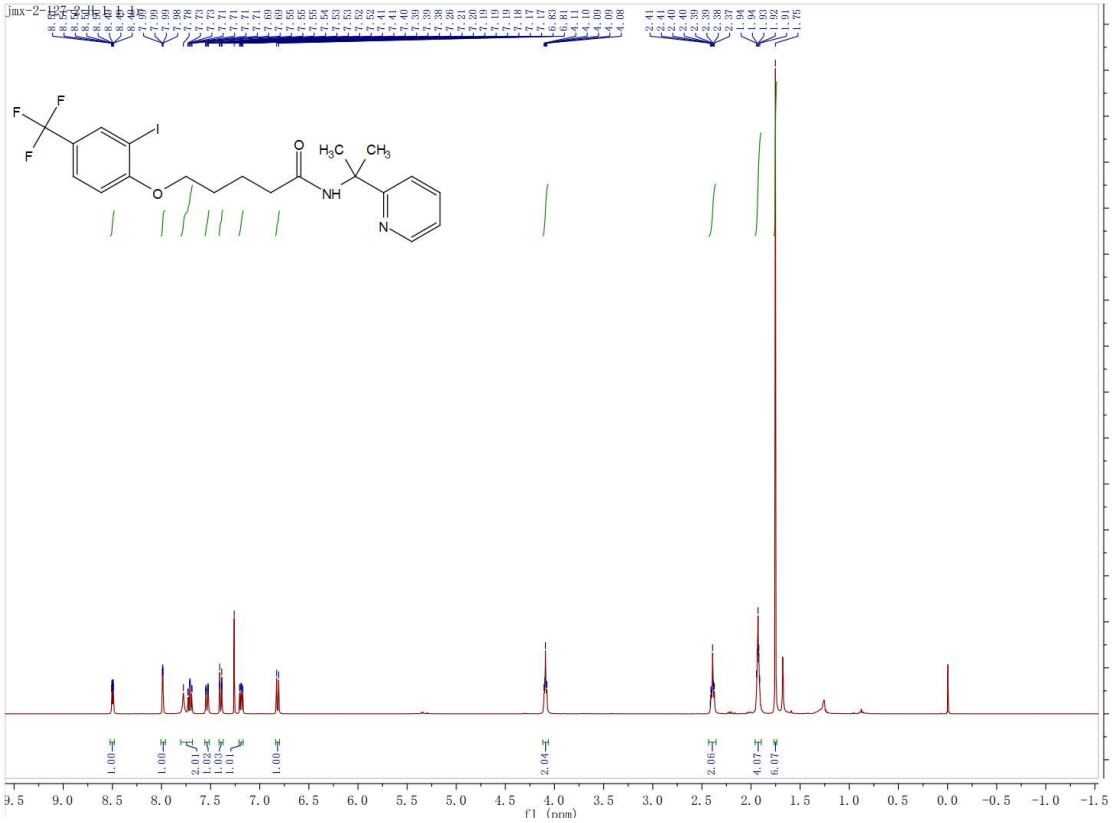
1f, ^{1}H NMR, 400 MHz, $CDCl_3$



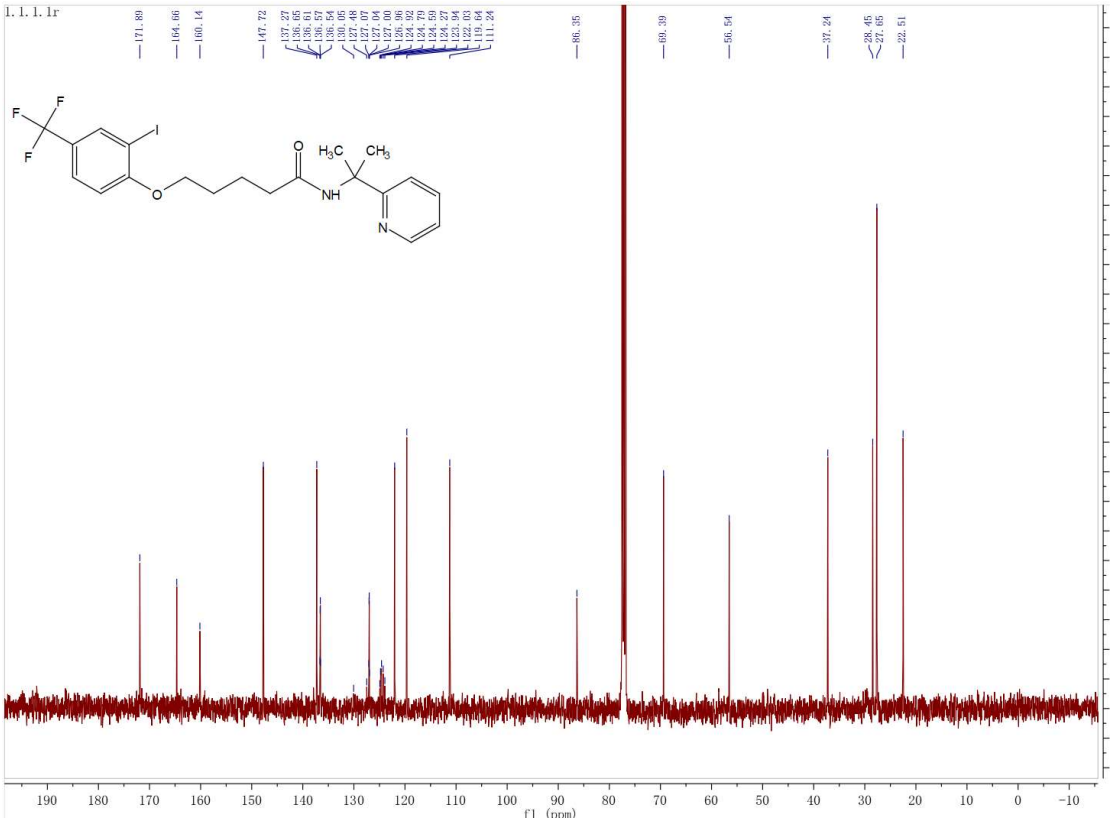
1f, ^{13}C NMR, 101 MHz, $CDCl_3$



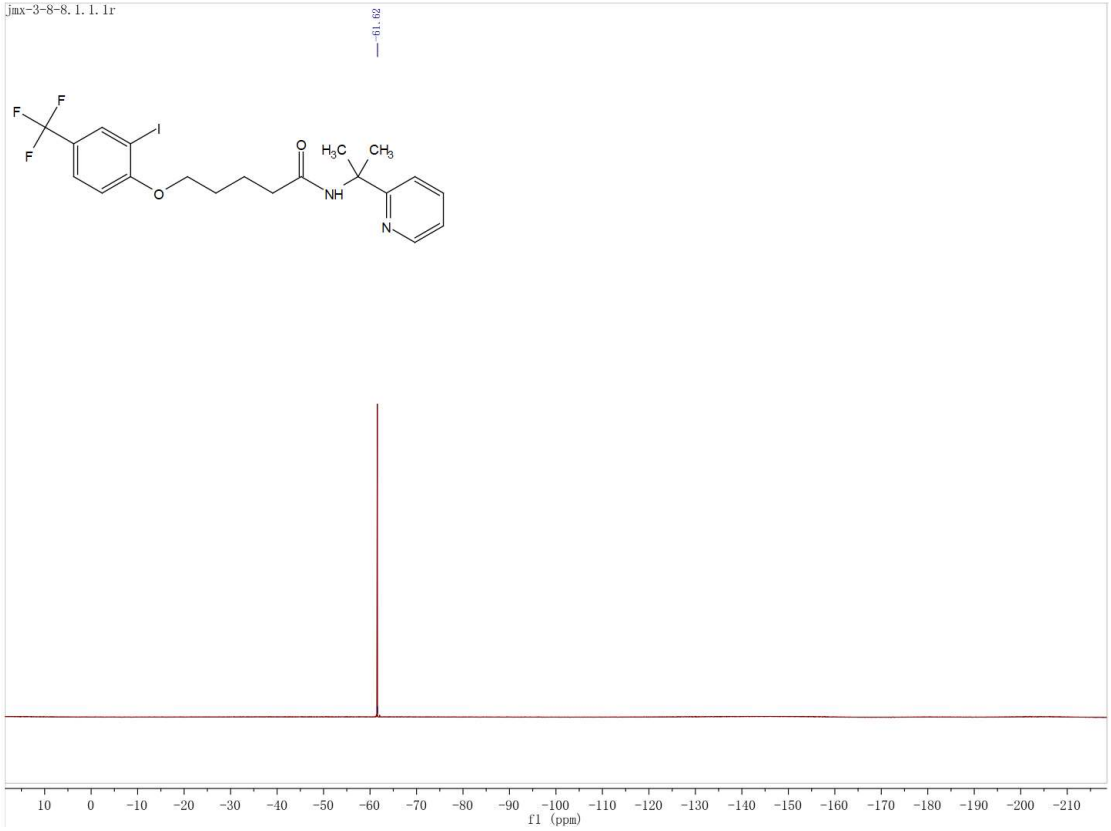
1g, ^{1}H NMR, 400 MHz, $CDCl_3$



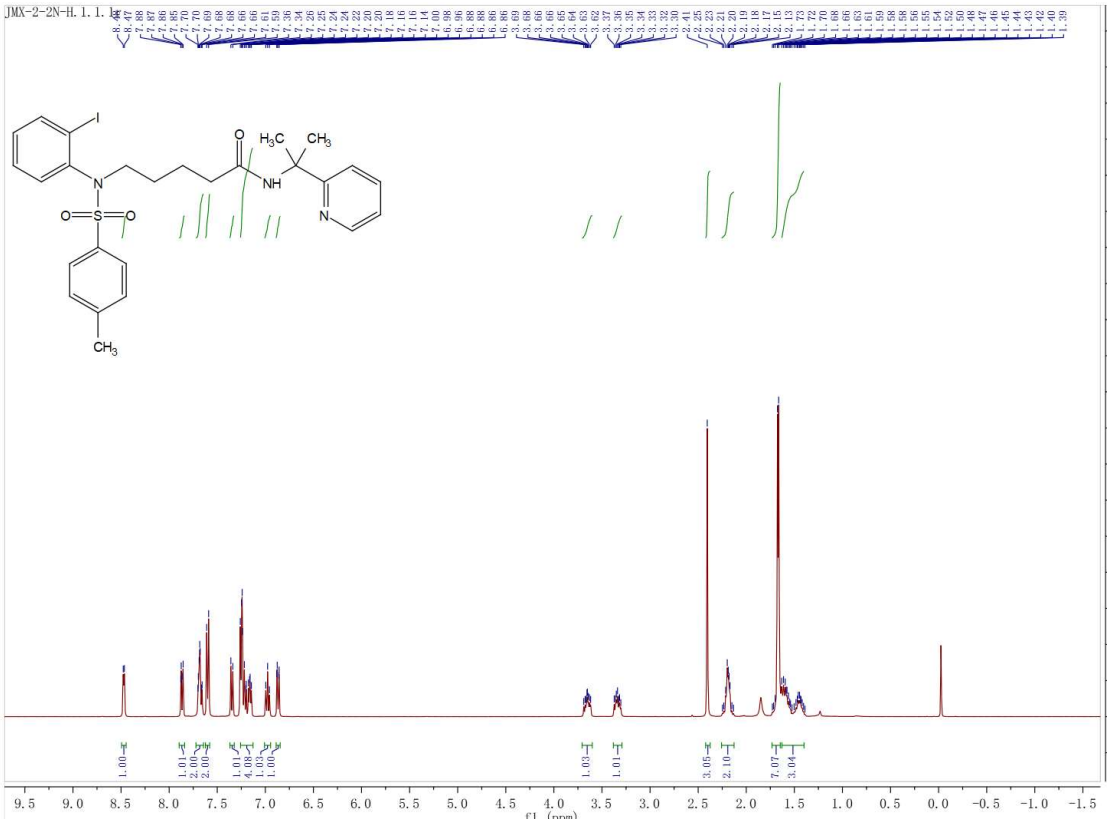
1g, ^{13}C NMR, 101 MHz, $CDCl_3$



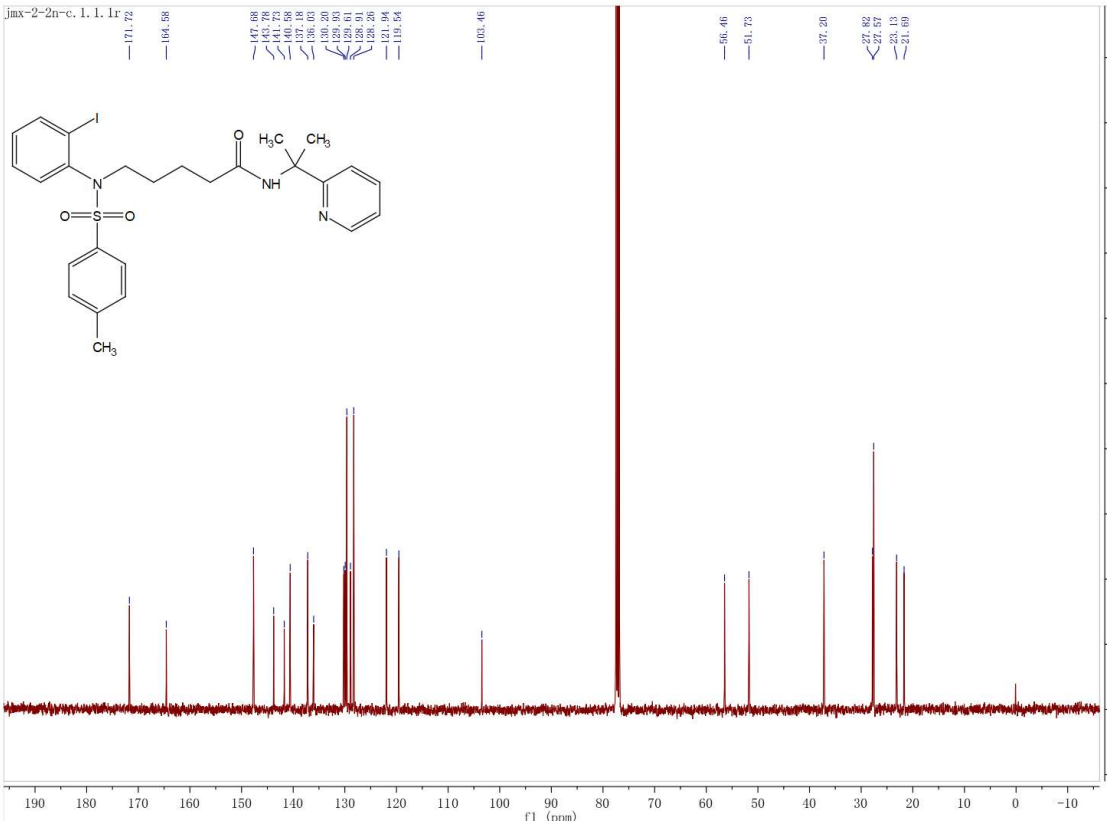
1g, ^{19}F NMR, 376 MHz, $CDCl_3$



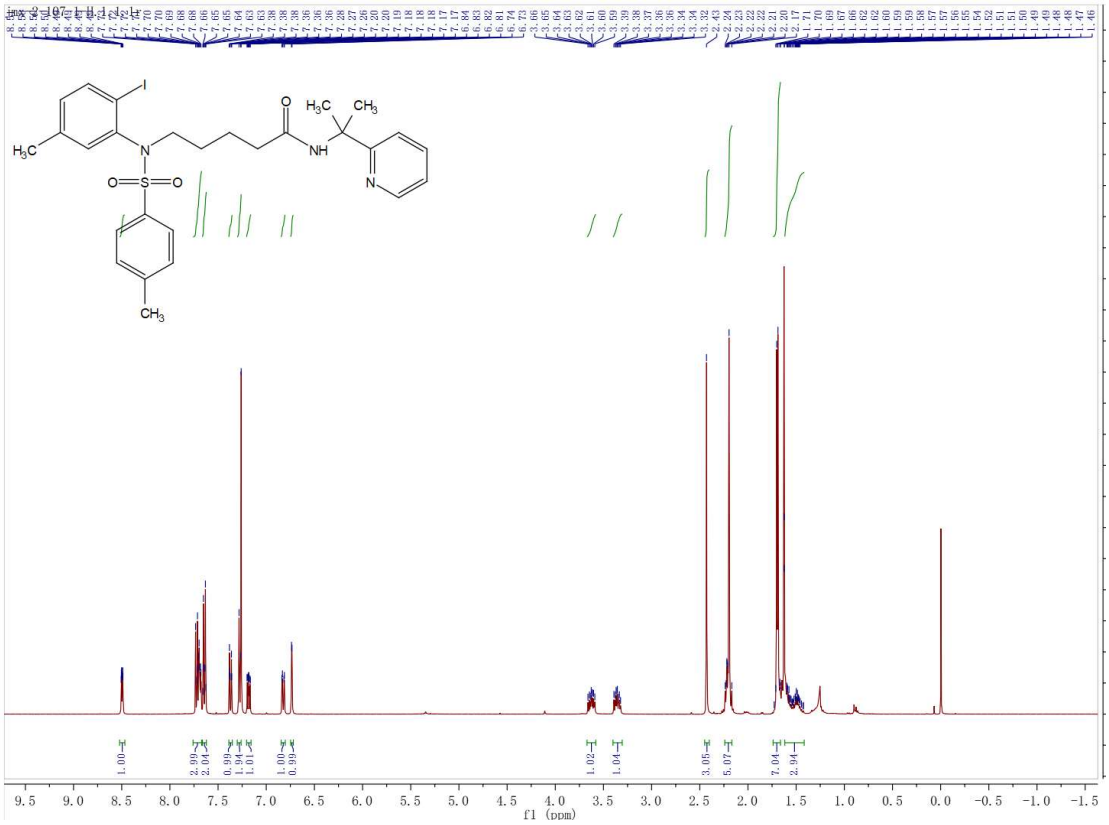
1h, ^{1}H NMR, 400 MHz, $CDCl_3$



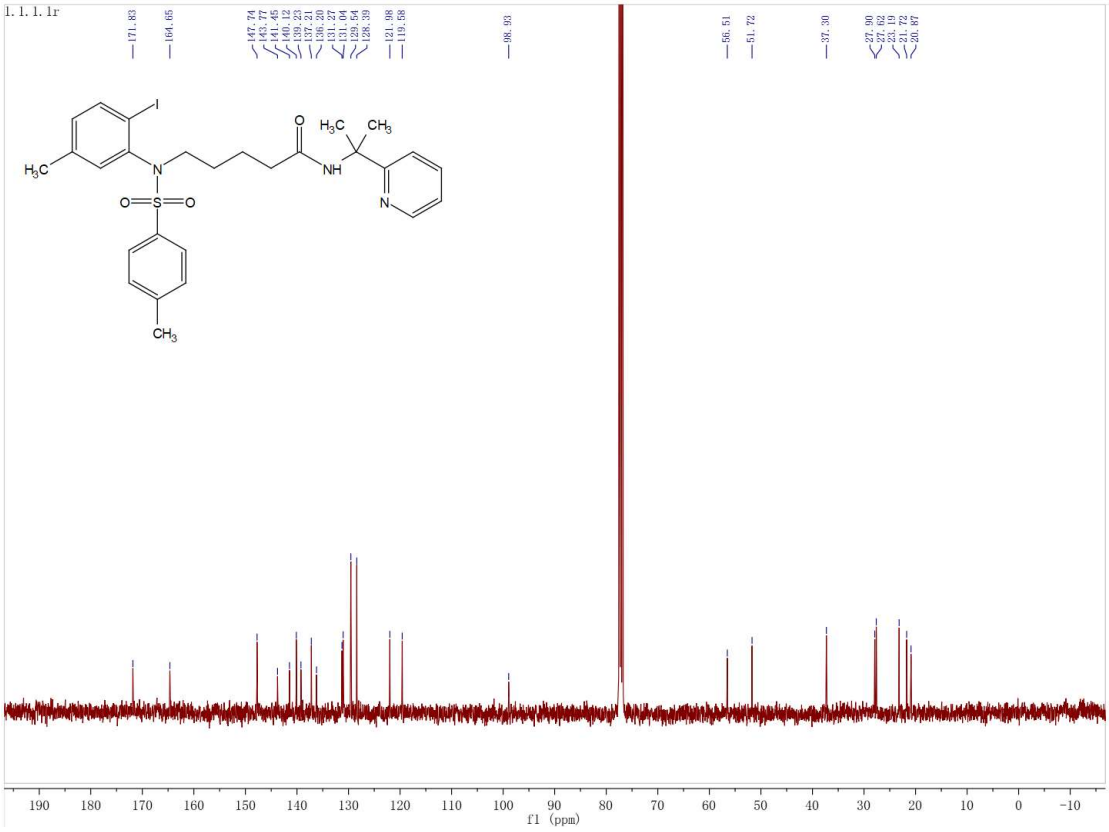
1h, ^{13}C NMR, 101 MHz, $CDCl_3$



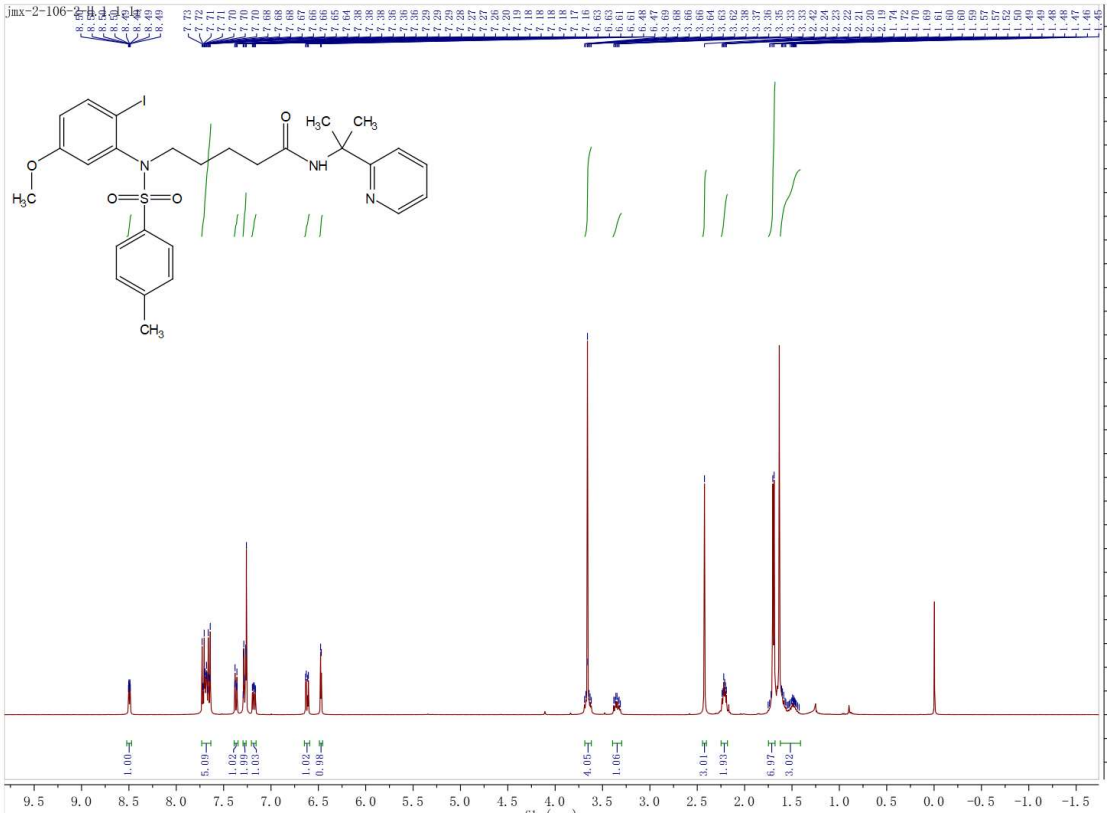
1i, ^{1}H NMR, 400 MHz, $CDCl_3$



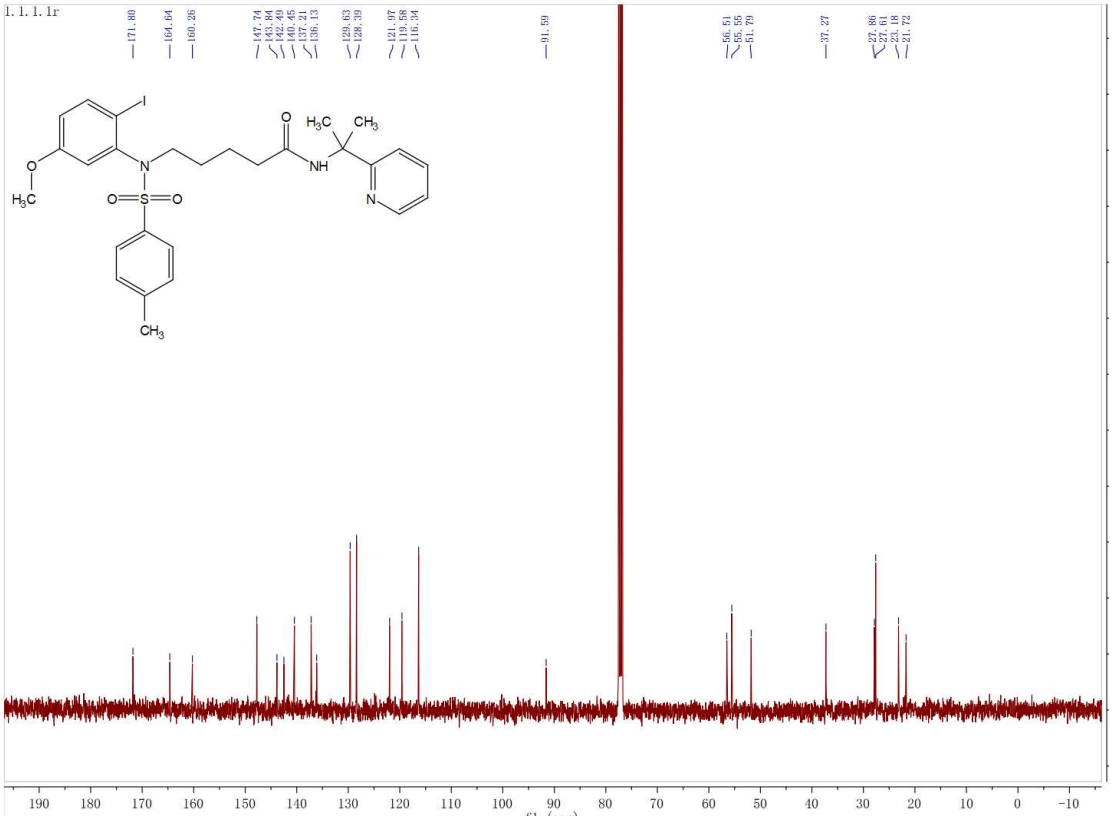
1i, ^{13}C NMR, 101 MHz, $CDCl_3$



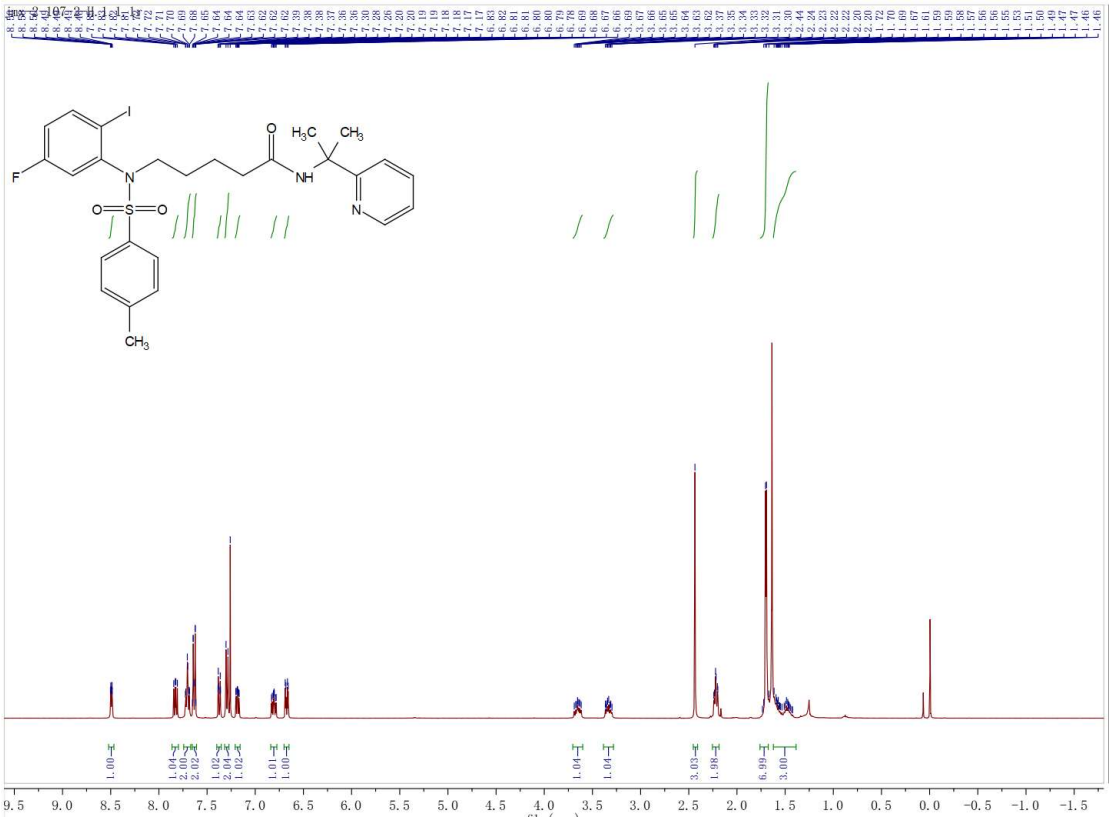
1j, ^{1}H NMR, 400 MHz, $CDCl_3$



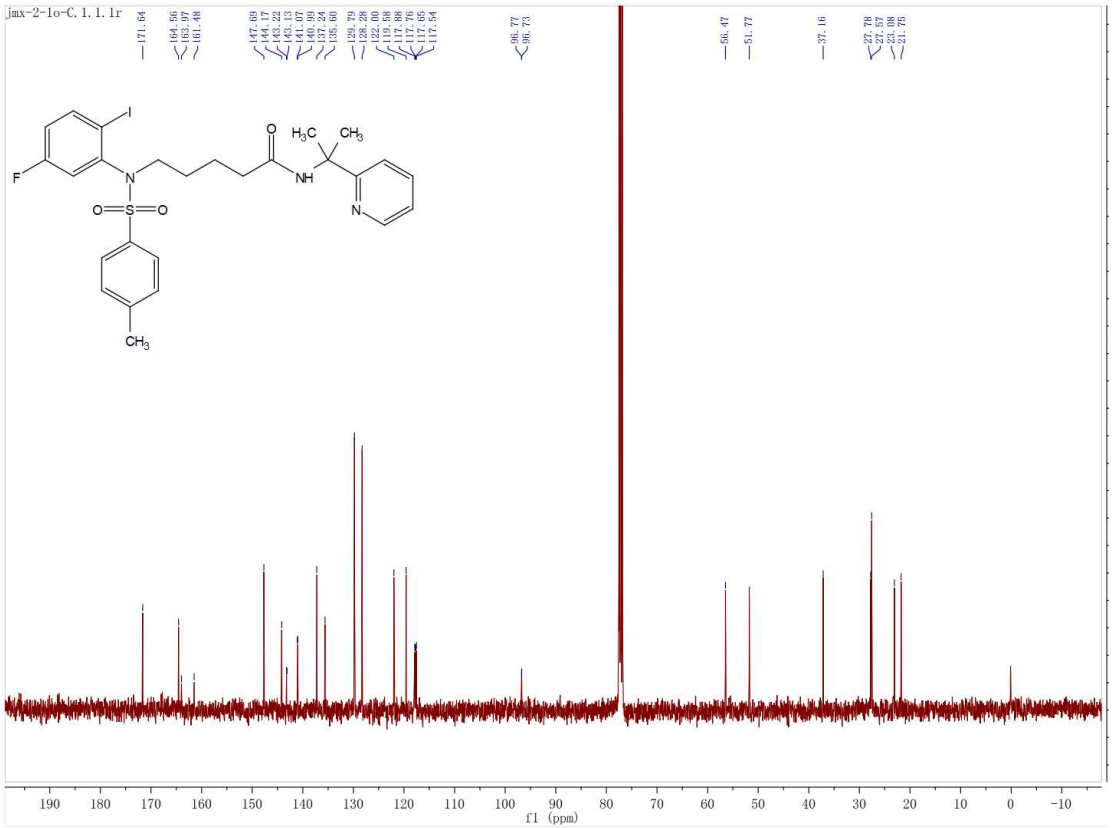
1j, ^{13}C NMR, 101 MHz, $CDCl_3$



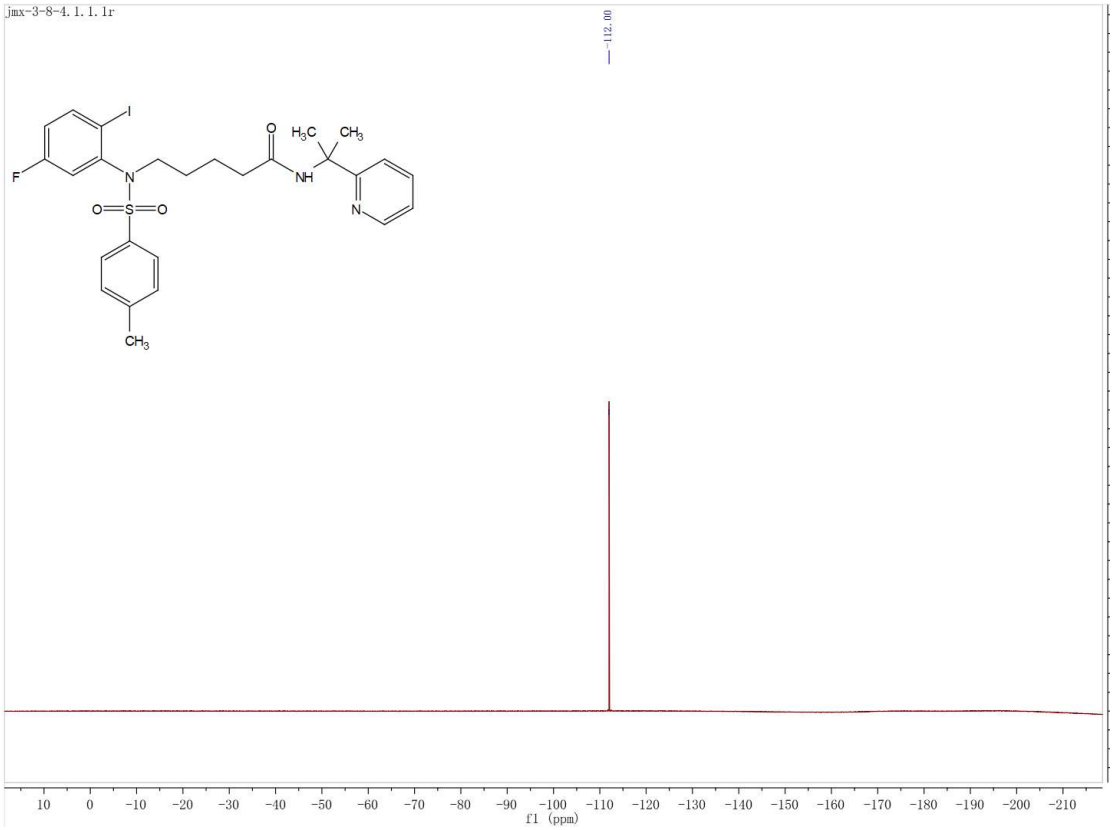
1k, ^{1}H NMR, 400 MHz, $CDCl_3$



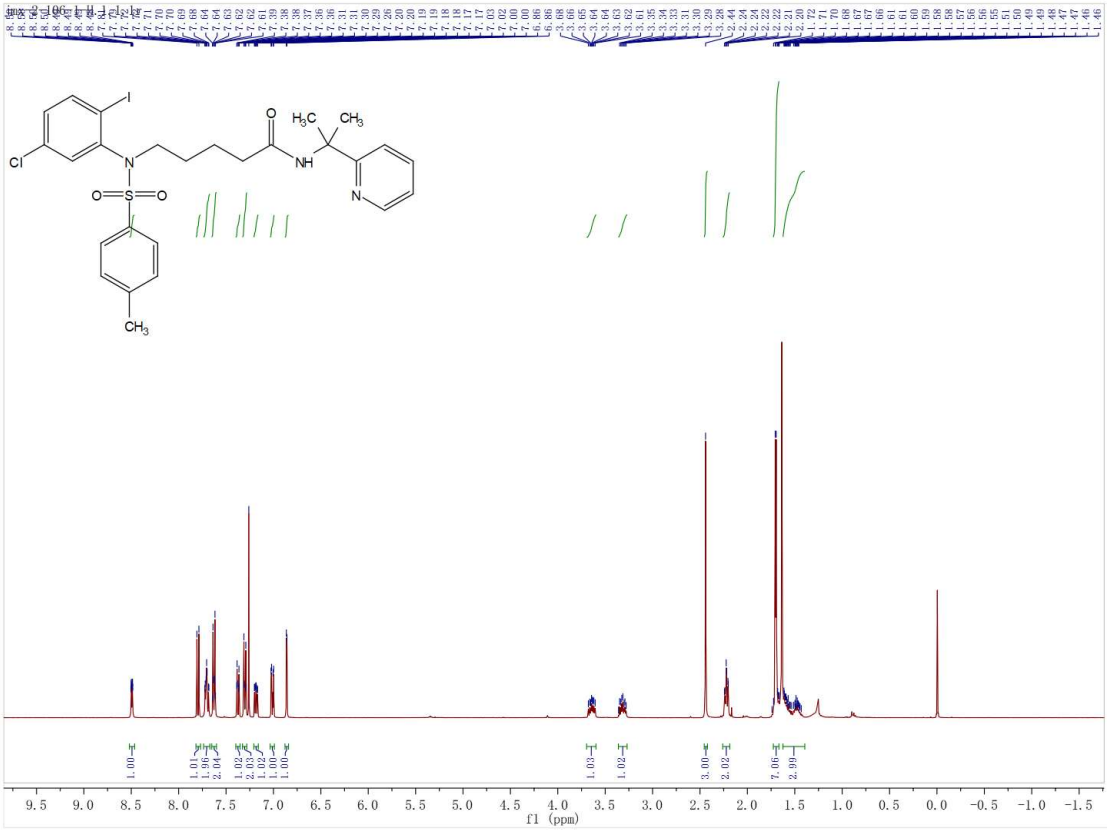
1k,^{13}C NMR, 101 MHz, $CDCl_3$



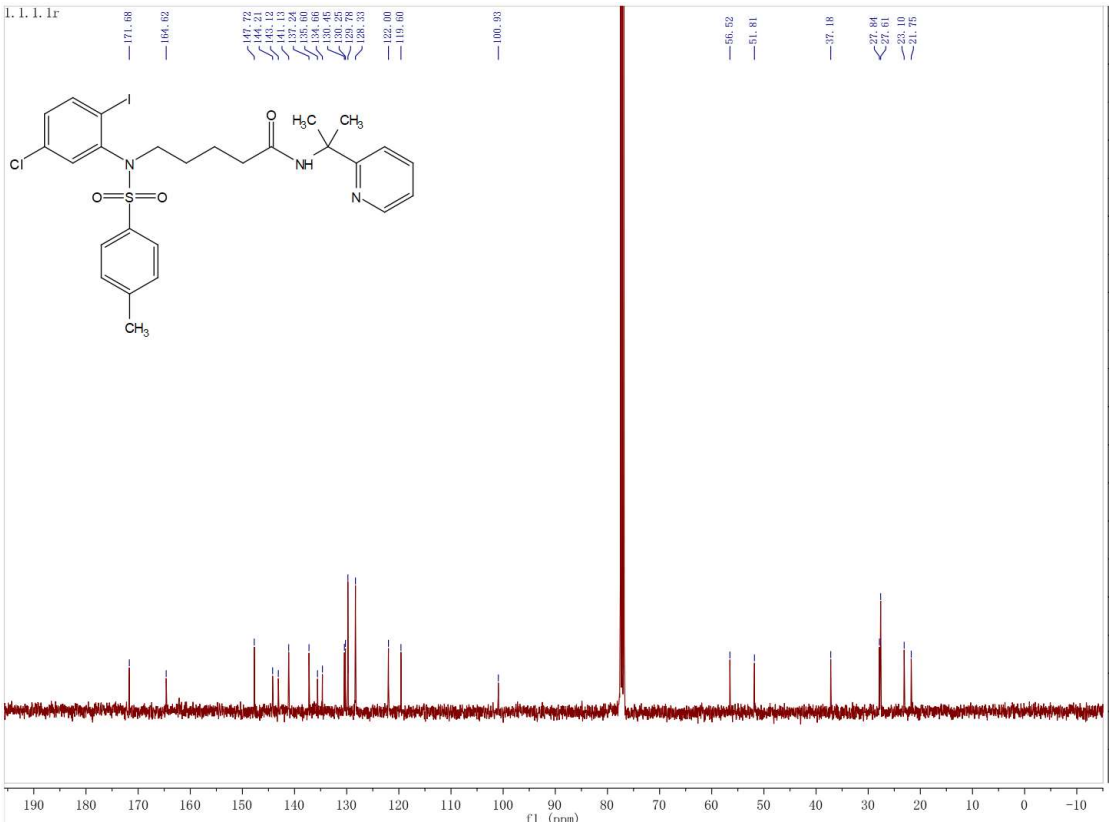
1k, ^{19}F NMR, 376 MHz, $CDCl_3$



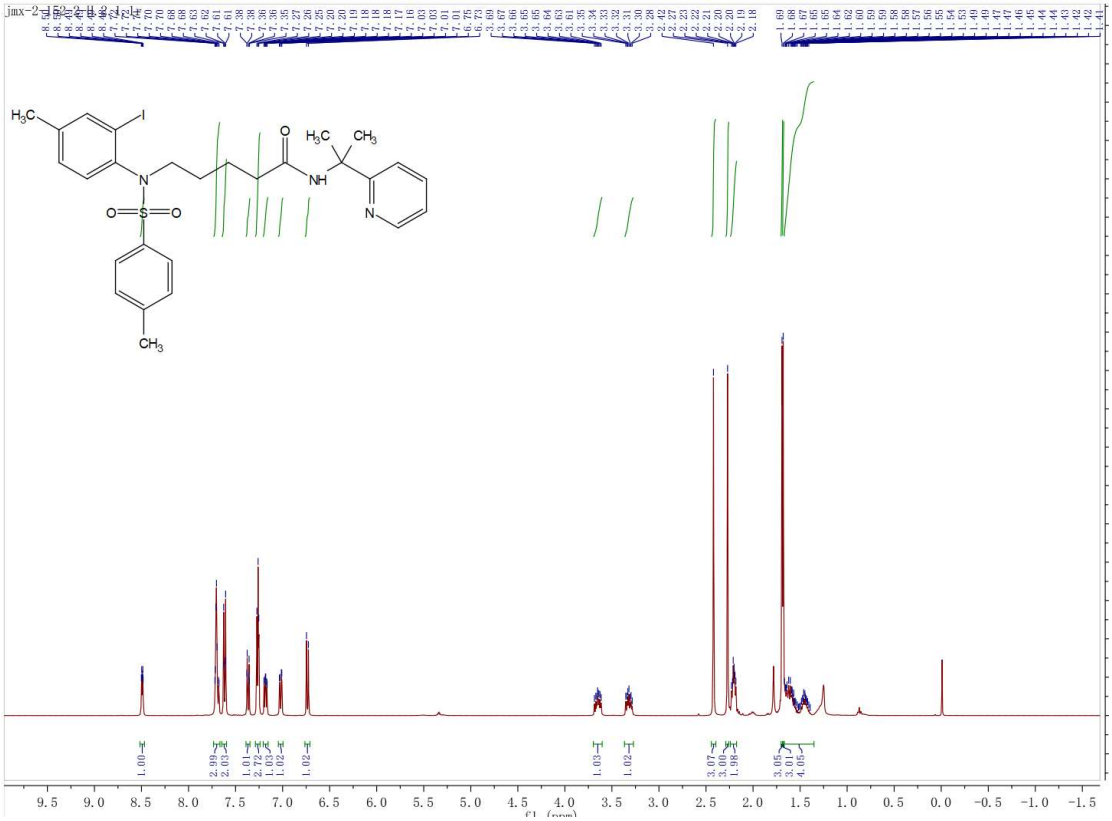
1l, ^{1}H NMR, 400 MHz, $CDCl_3$



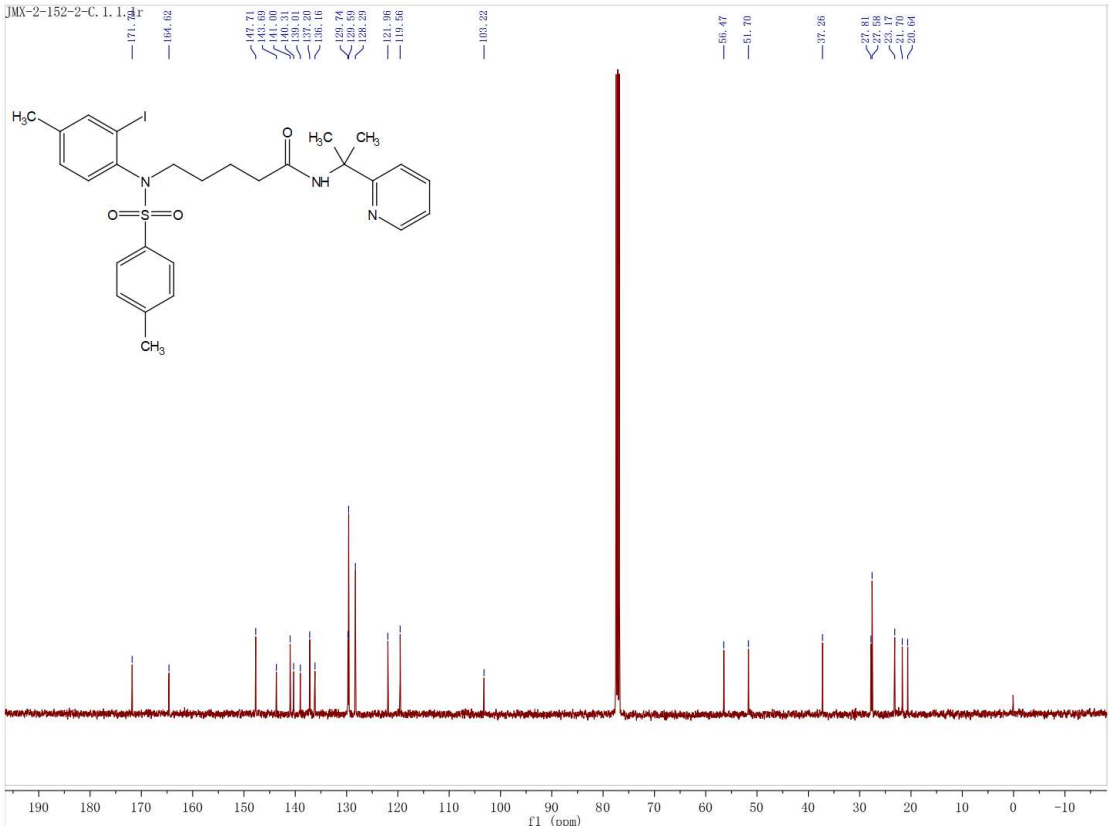
1l, ^{13}C NMR, 101 MHz, $CDCl_3$



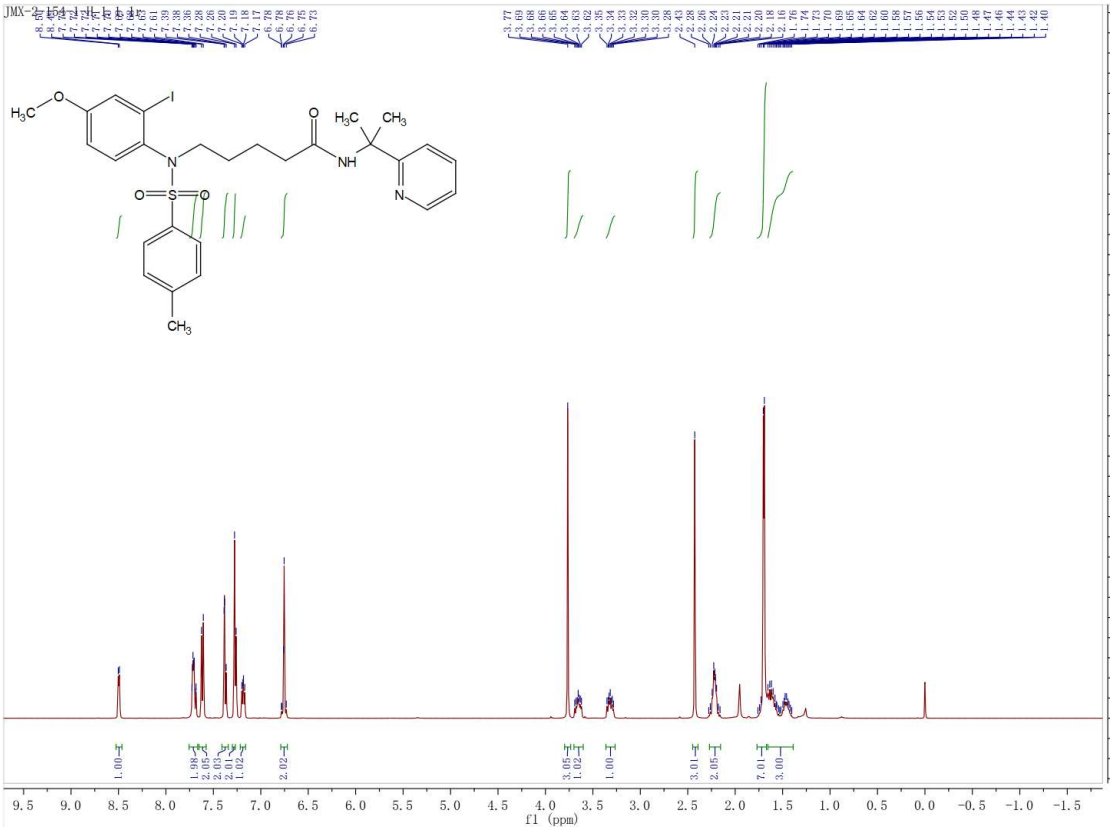
1m, ^{1}H NMR, 400 MHz, $CDCl_3$



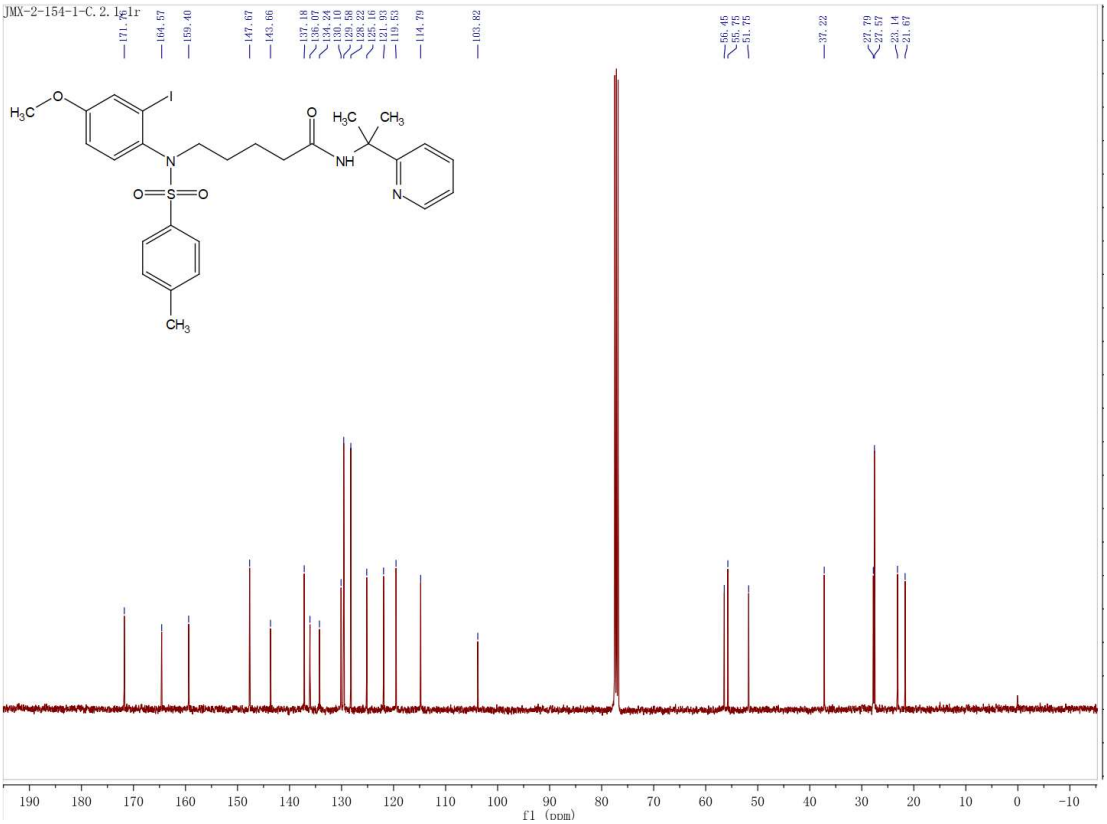
1m,^{13}C NMR, 101 MHz, $CDCl_3$



1n, ^{1}H NMR, 400 MHz, $CDCl_3$

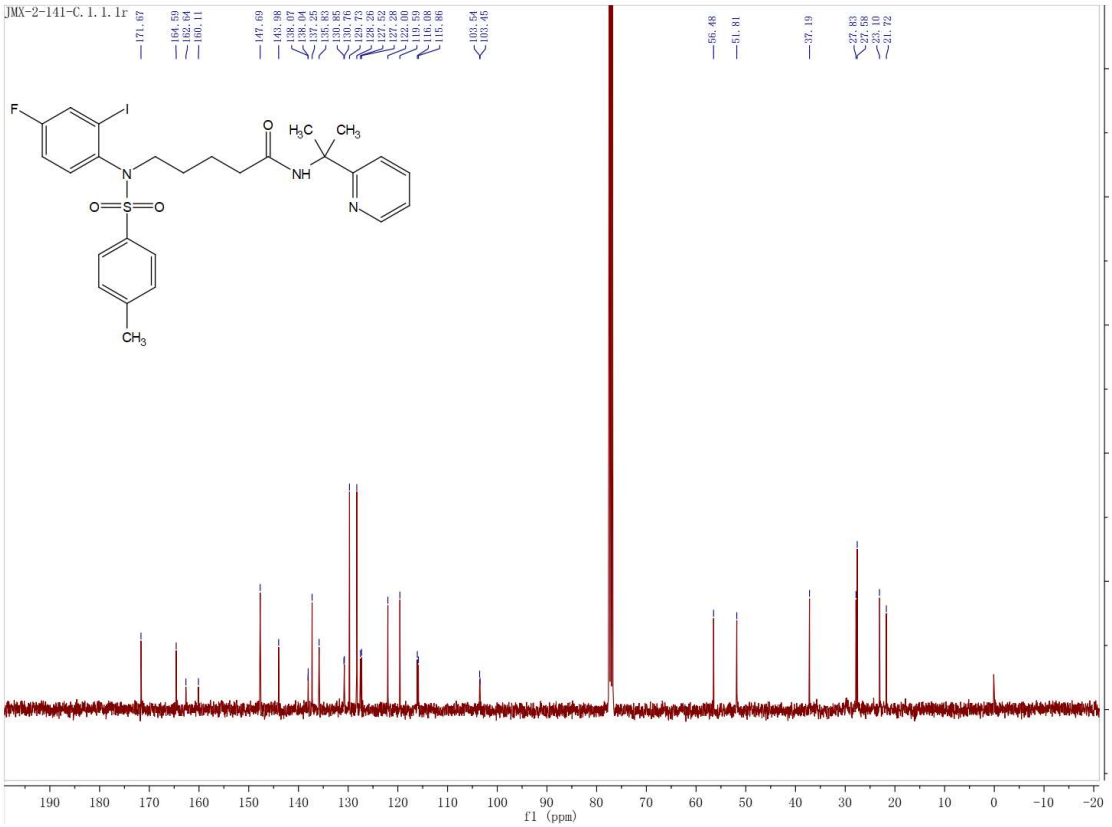


1n,^{13}C NMR, 101 MHz, $CDCl_3$

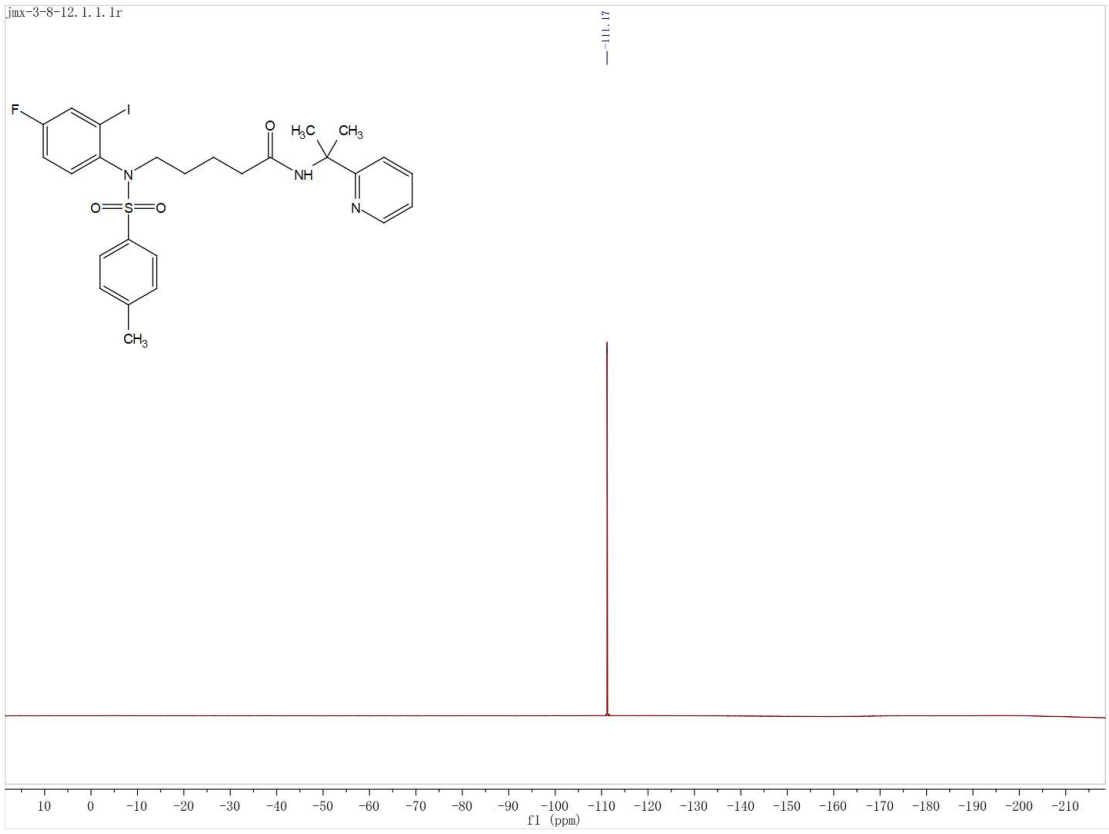


1o, ^{1}H NMR, 400 MHz, $CDCl_3$

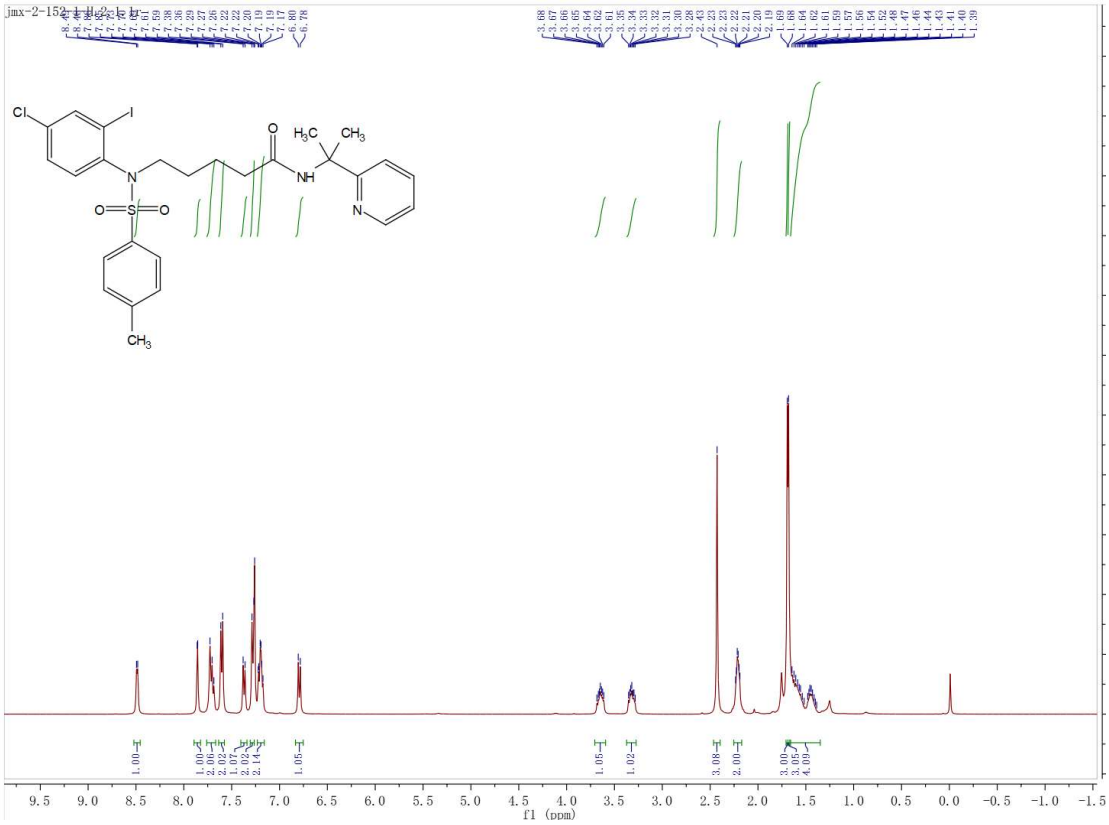
1o, ^{13}C NMR, 101 MHz, $CDCl_3$



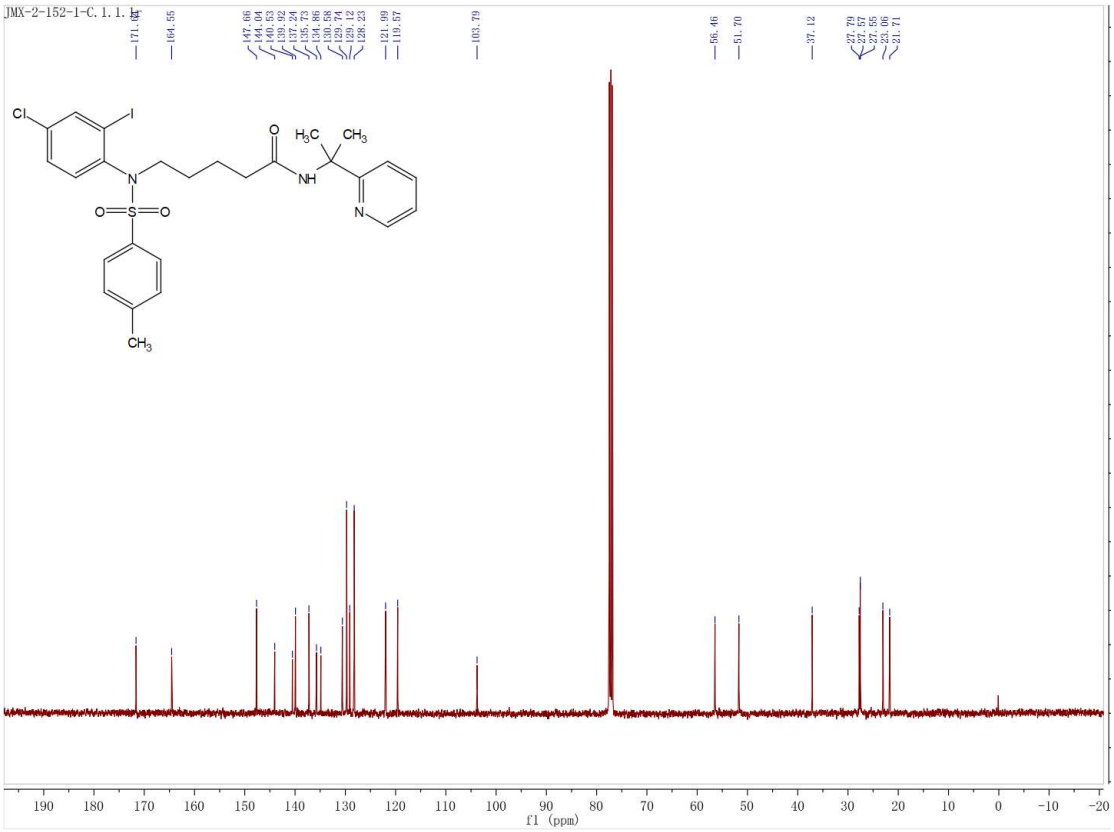
1o, ^{19}F NMR, 376 MHz, $CDCl_3$



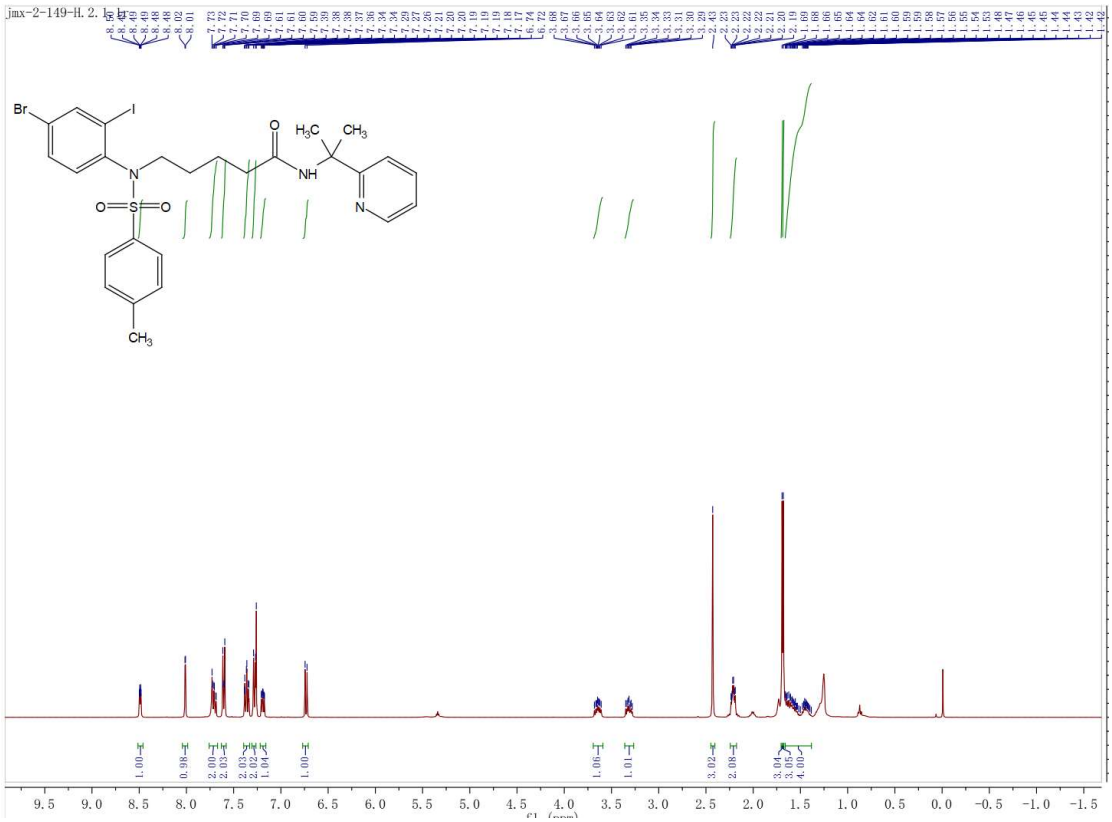
1p, ^{1}H NMR, 400 MHz, $CDCl_3$



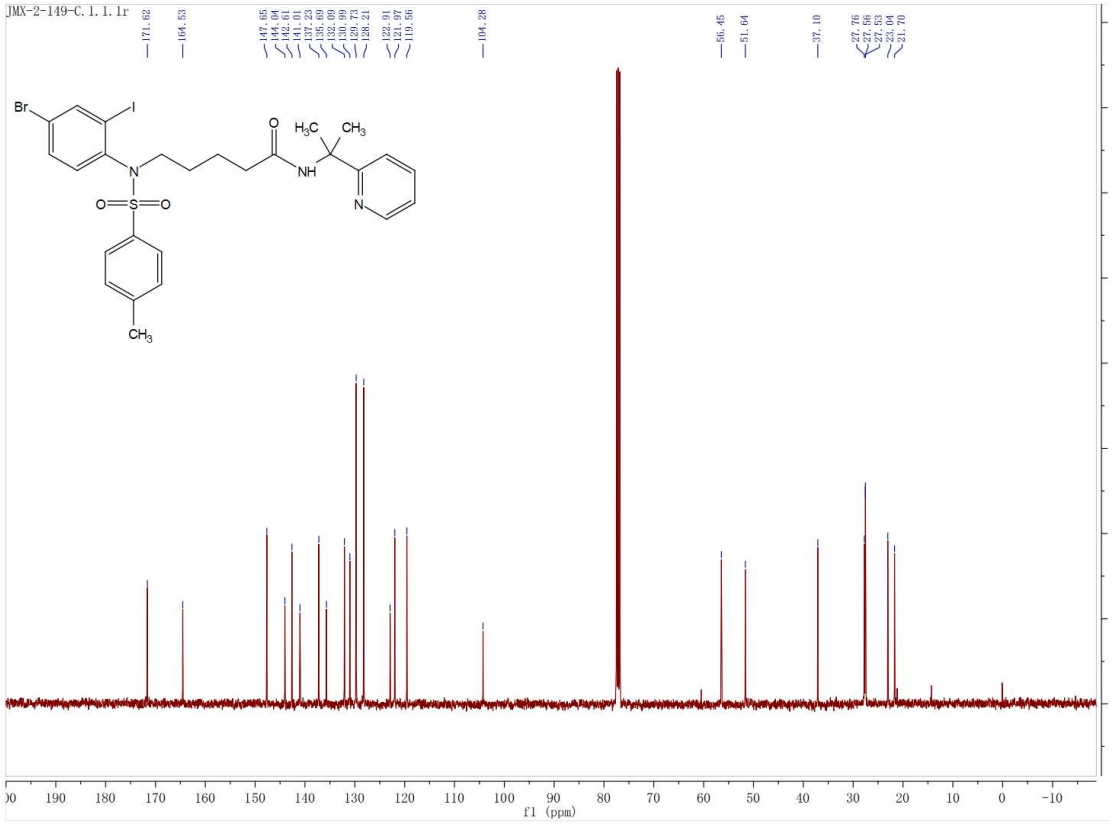
1p, ^{13}C NMR, 101 MHz, $CDCl_3$



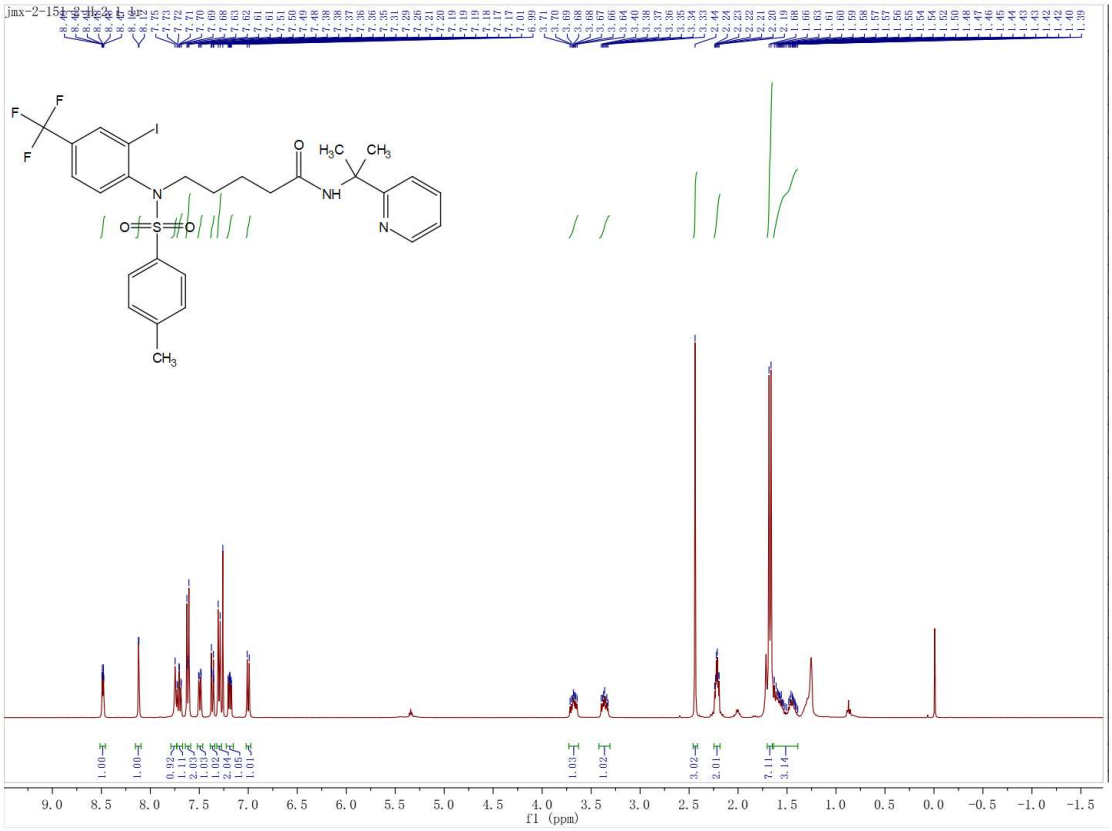
1q, ^{1}H NMR, 400 MHz, $CDCl_3$



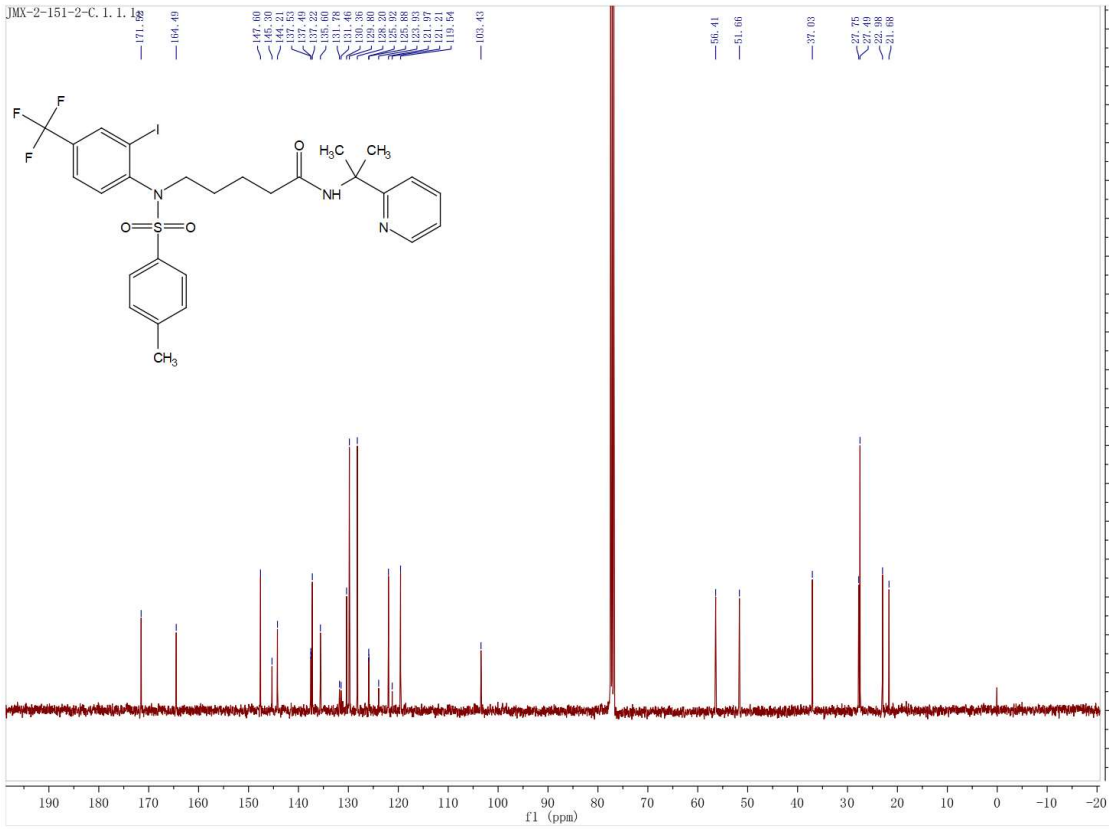
1q, ^{13}C NMR, 101 MHz, $CDCl_3$



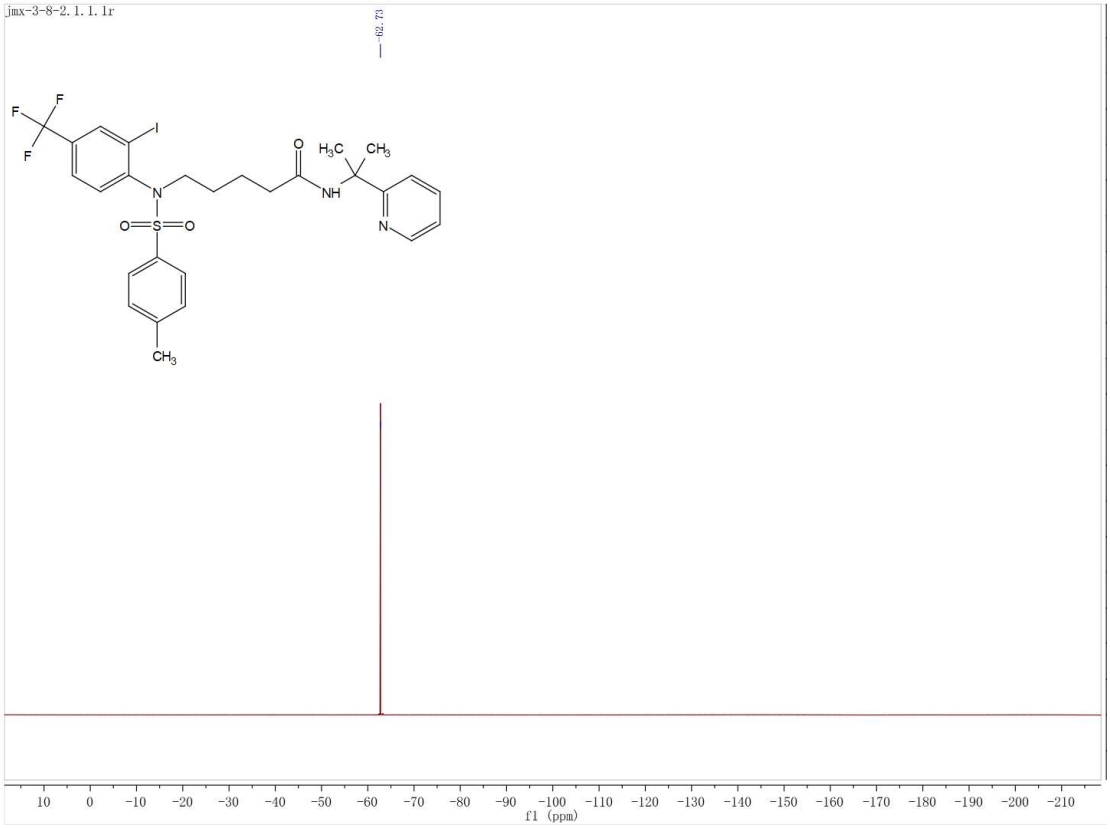
1r, ^{1}H NMR, 400 MHz, $CDCl_3$



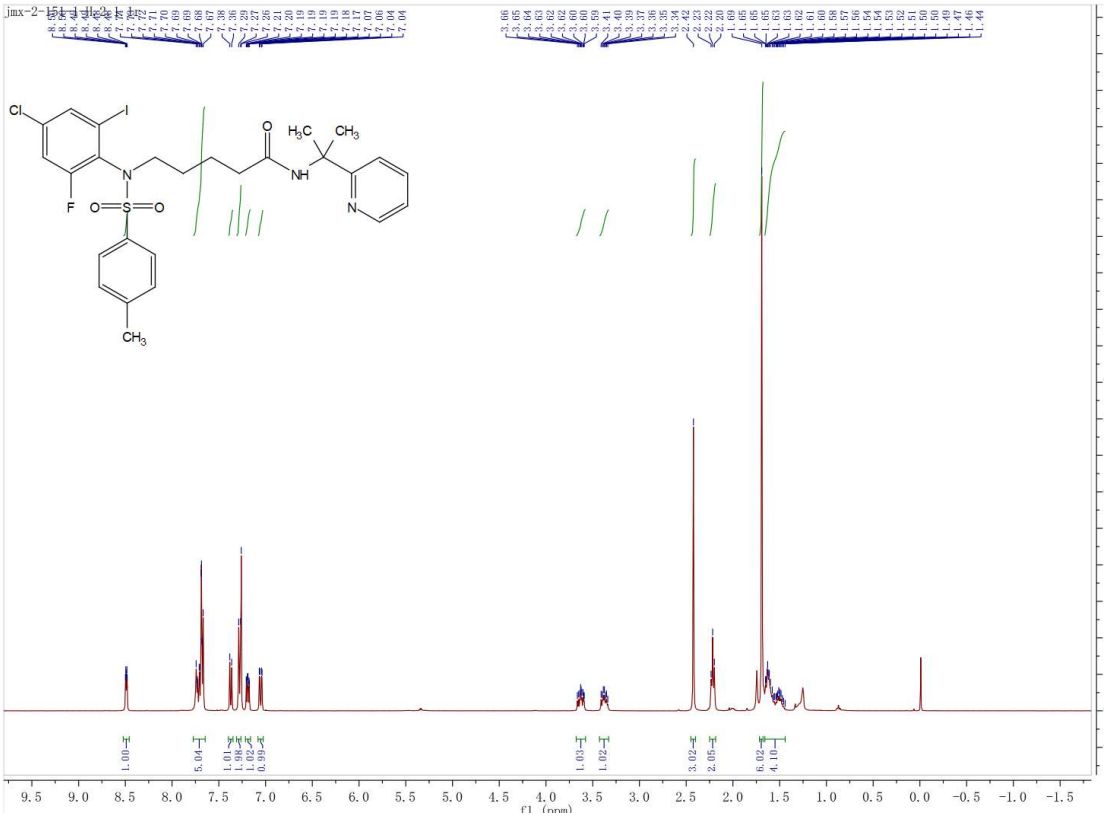
1r, ^{13}C NMR, 101 MHz, $CDCl_3$



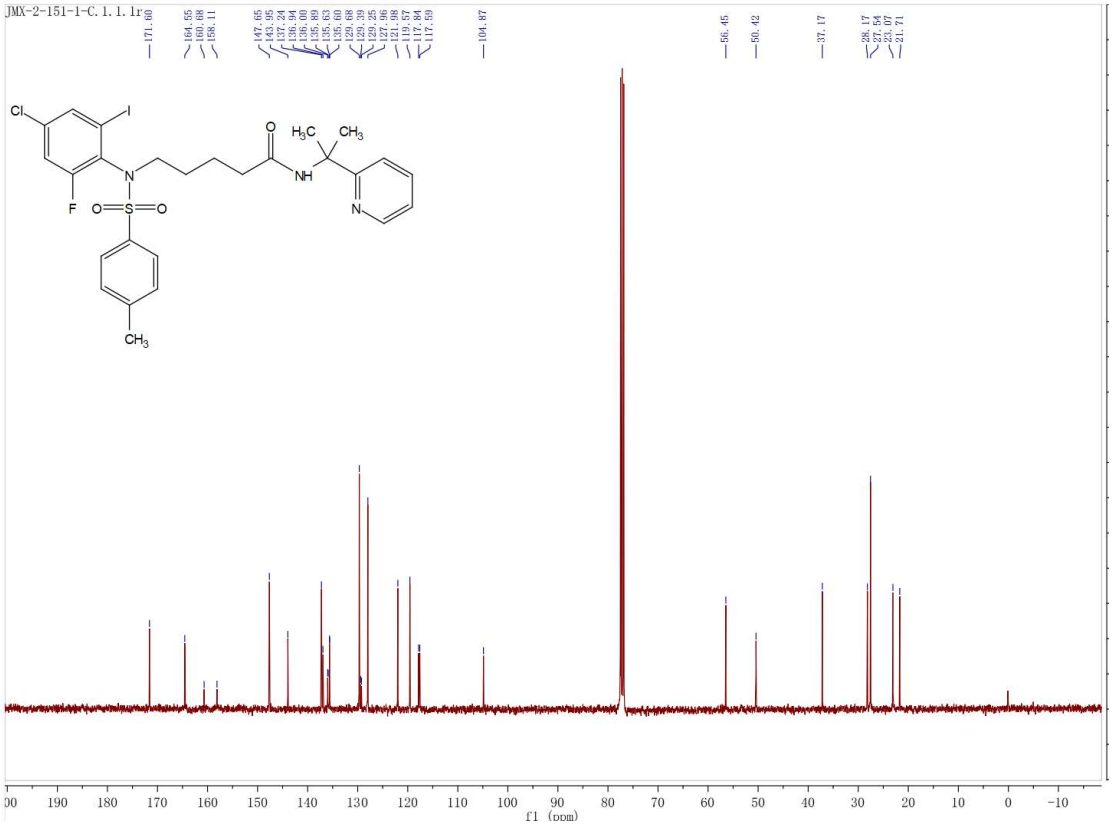
1r, ^{19}F NMR, 376 MHz, $CDCl_3$



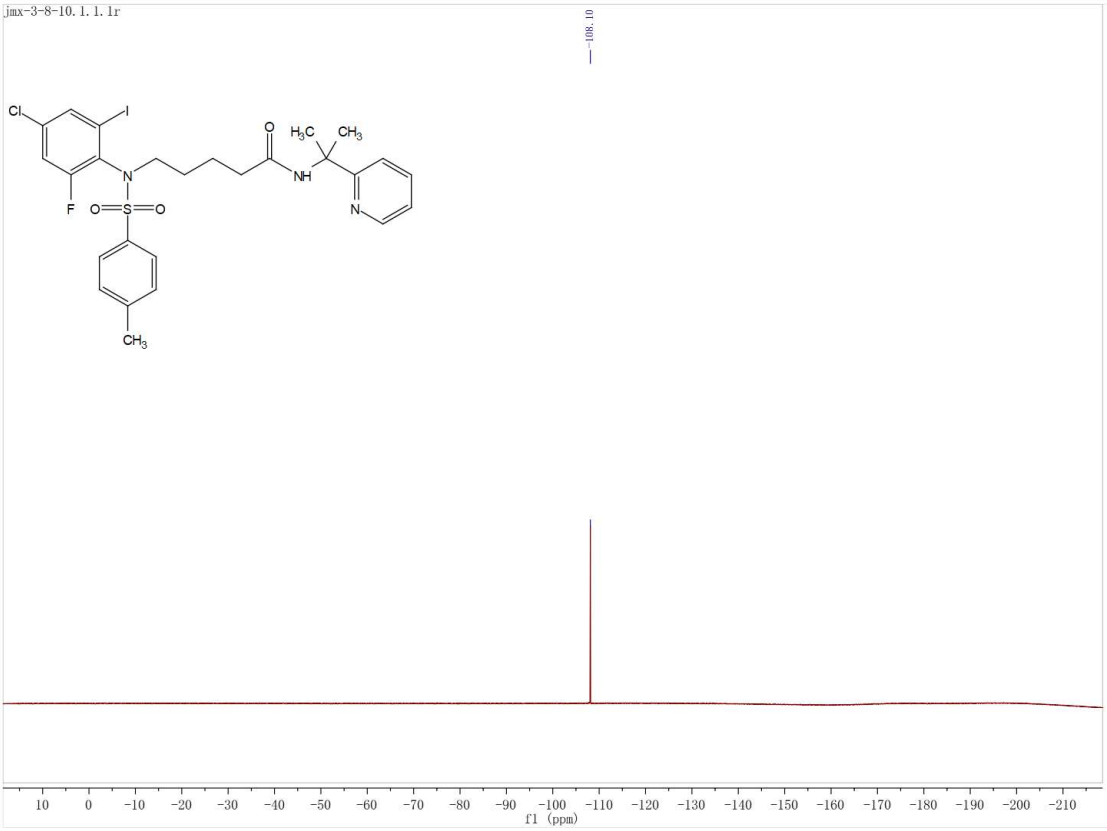
1s, ^{1}H NMR, 400 MHz, $CDCl_3$



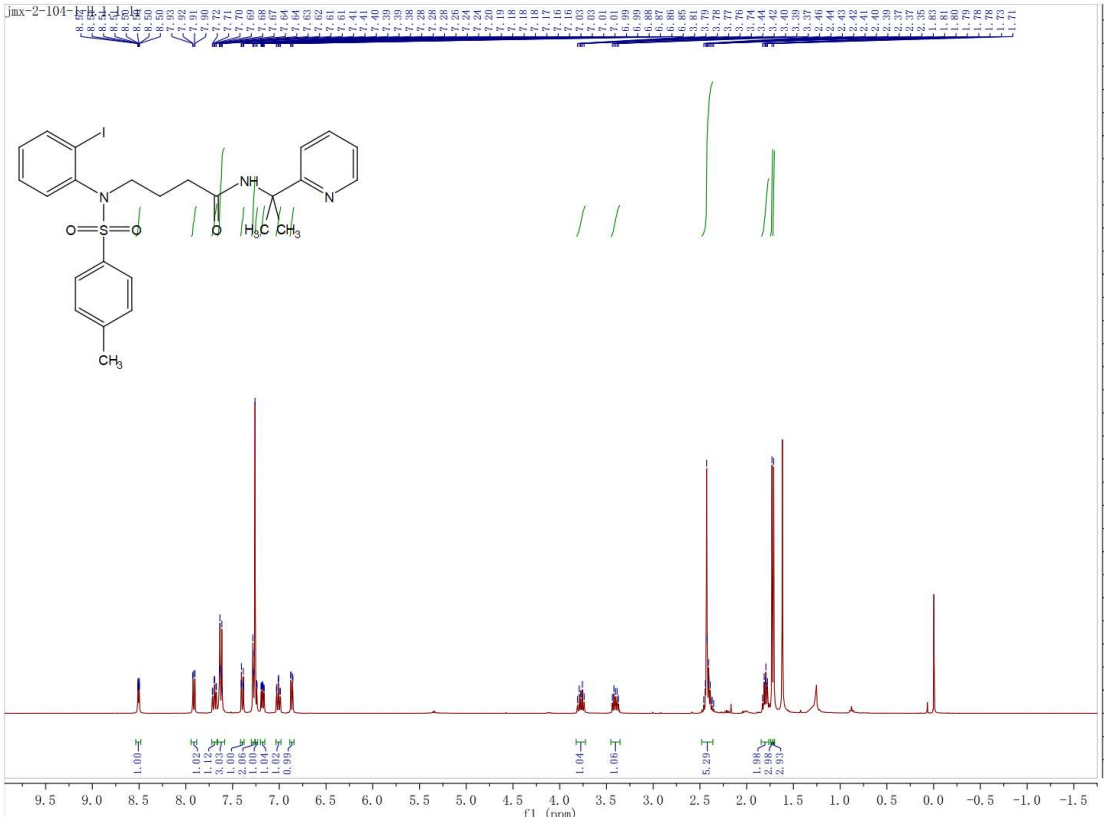
1s, ^{13}C NMR, 101 MHz, $CDCl_3$



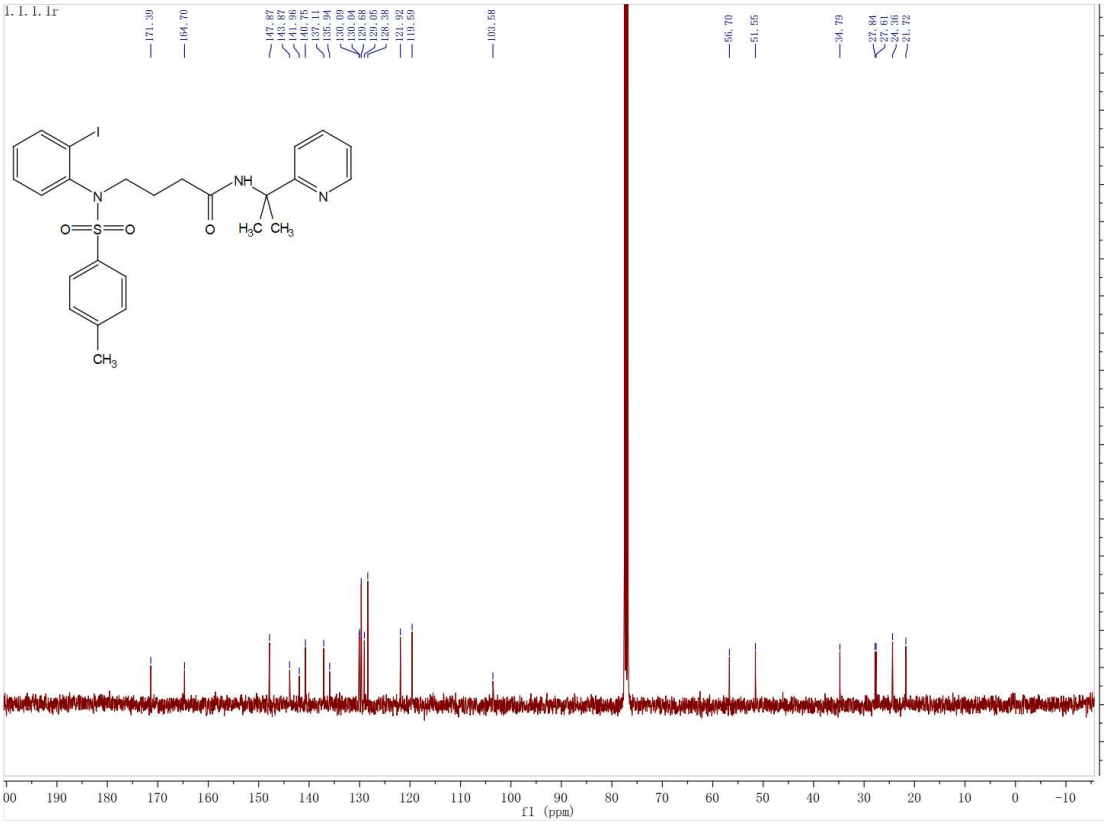
1s, ^{19}F NMR, 376 MHz, $CDCl_3$



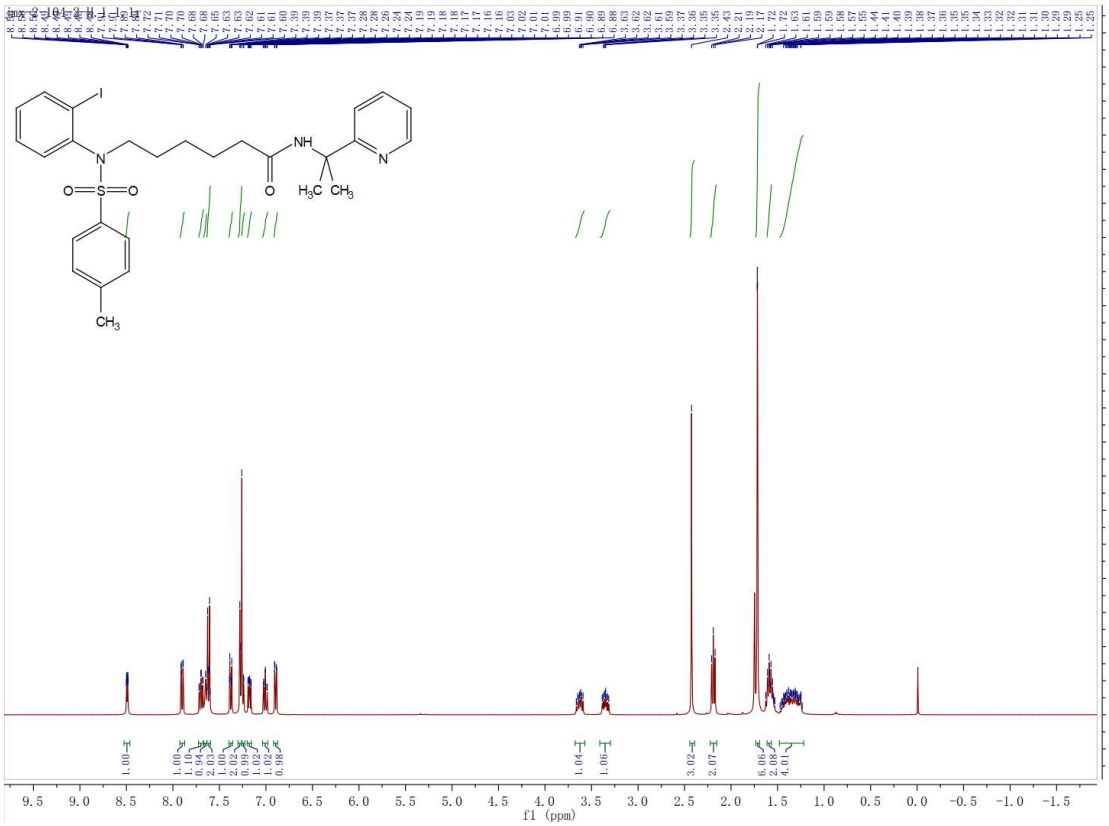
1t, ^{1}H NMR, 400 MHz, $CDCl_3$



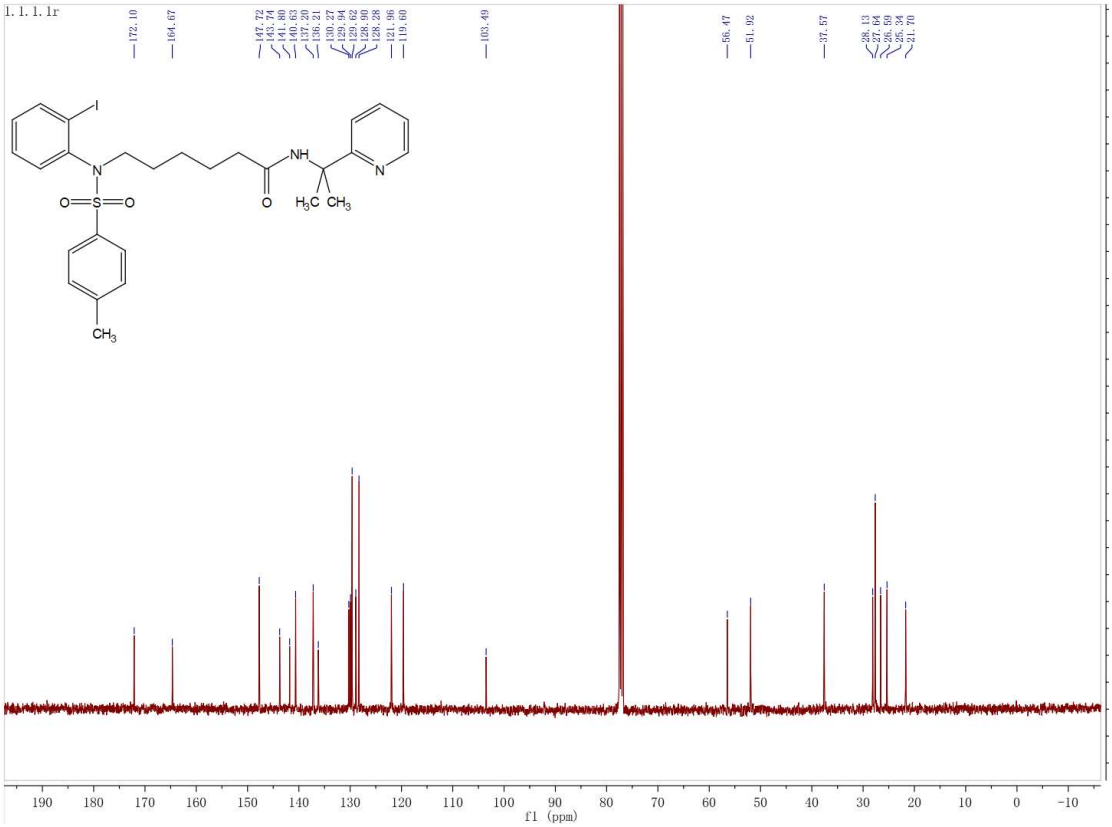
1t, ^{13}C NMR, 101 MHz, $CDCl_3$



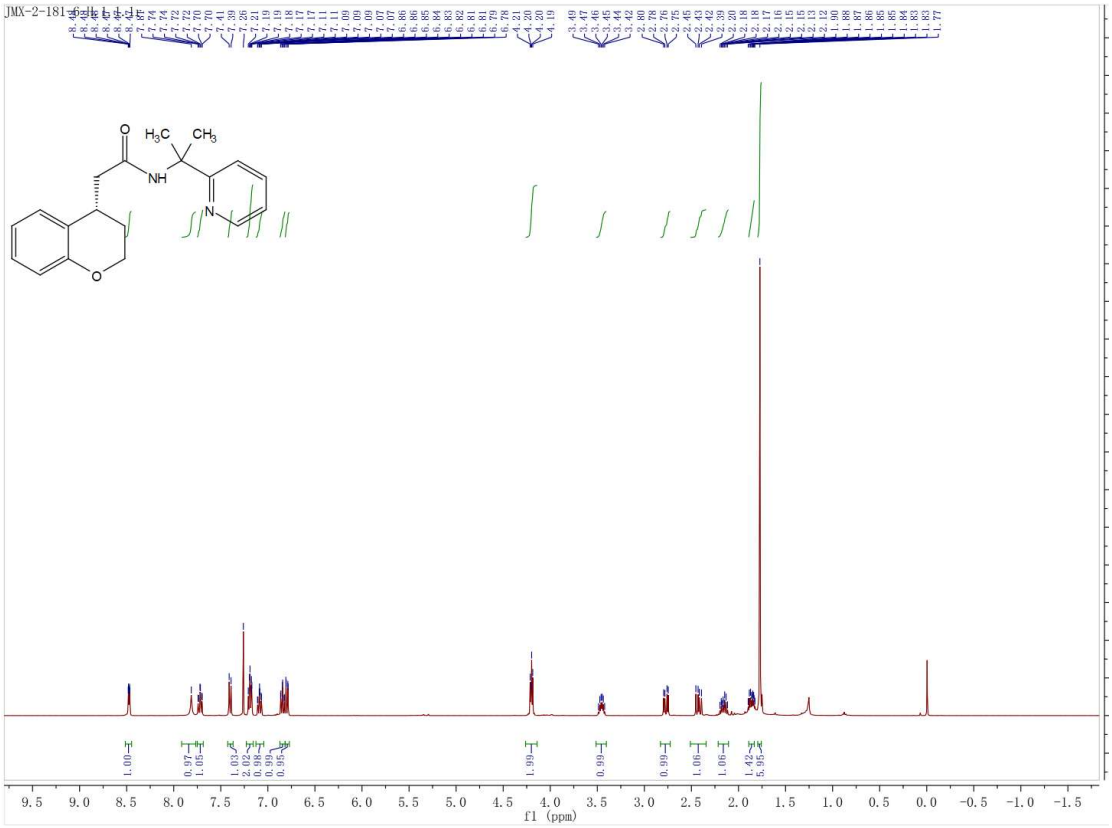
1u, ^{1}H NMR, 400 MHz, $CDCl_3$



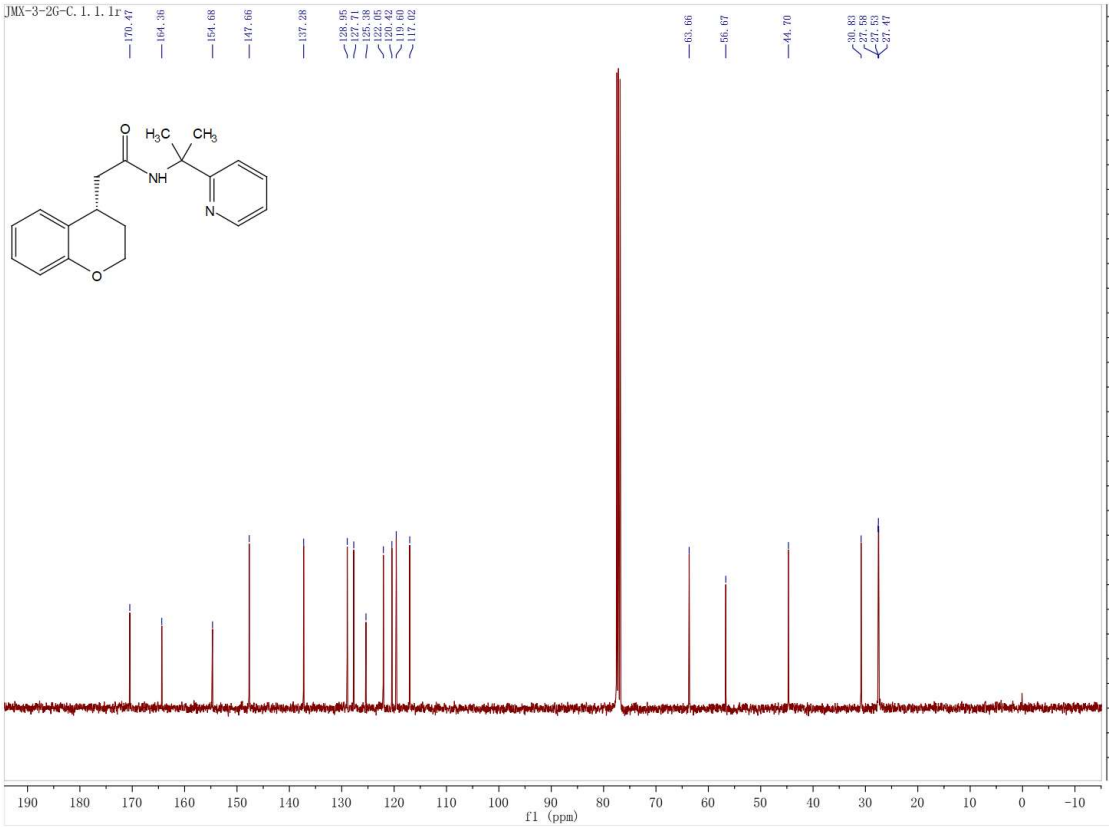
1u, ^{13}C NMR, 101 MHz, $CDCl_3$



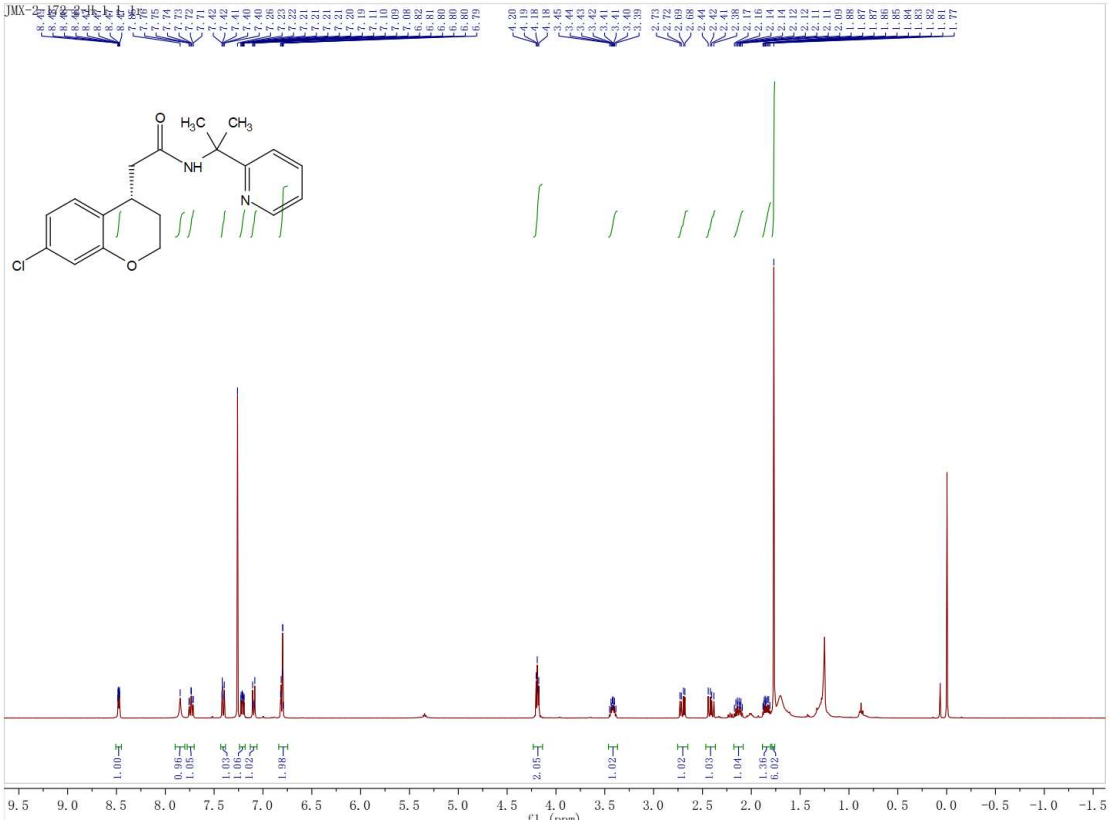
2a, ^{1}H NMR, 400 MHz, $CDCl_3$



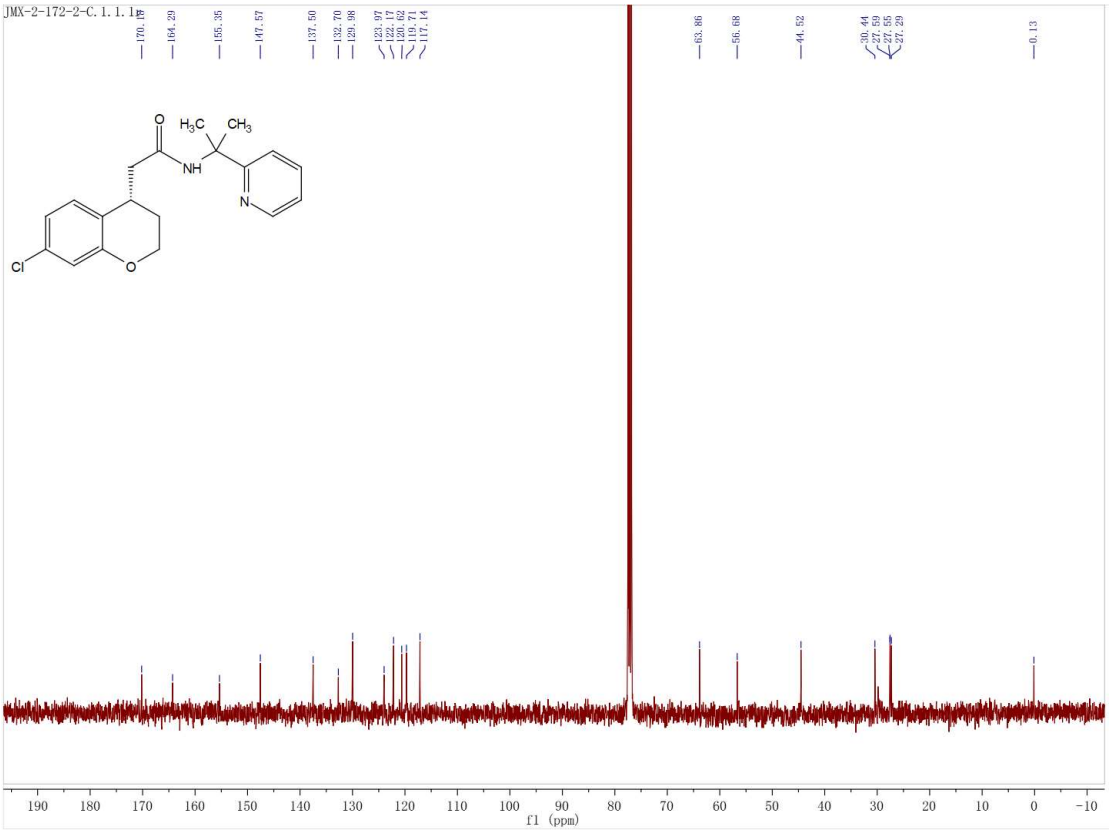
2a, ^{13}C NMR, 101 MHz, $CDCl_3$



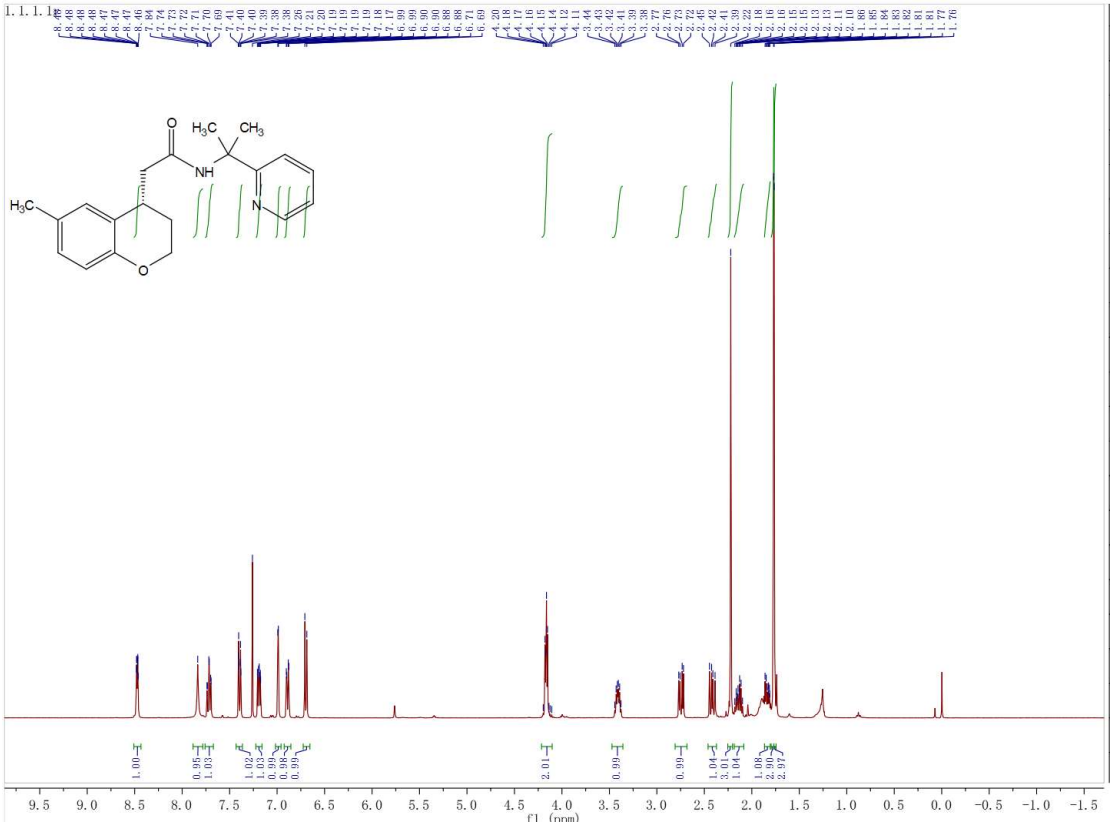
2b, ^{1}H NMR, 400 MHz, $CDCl_3$



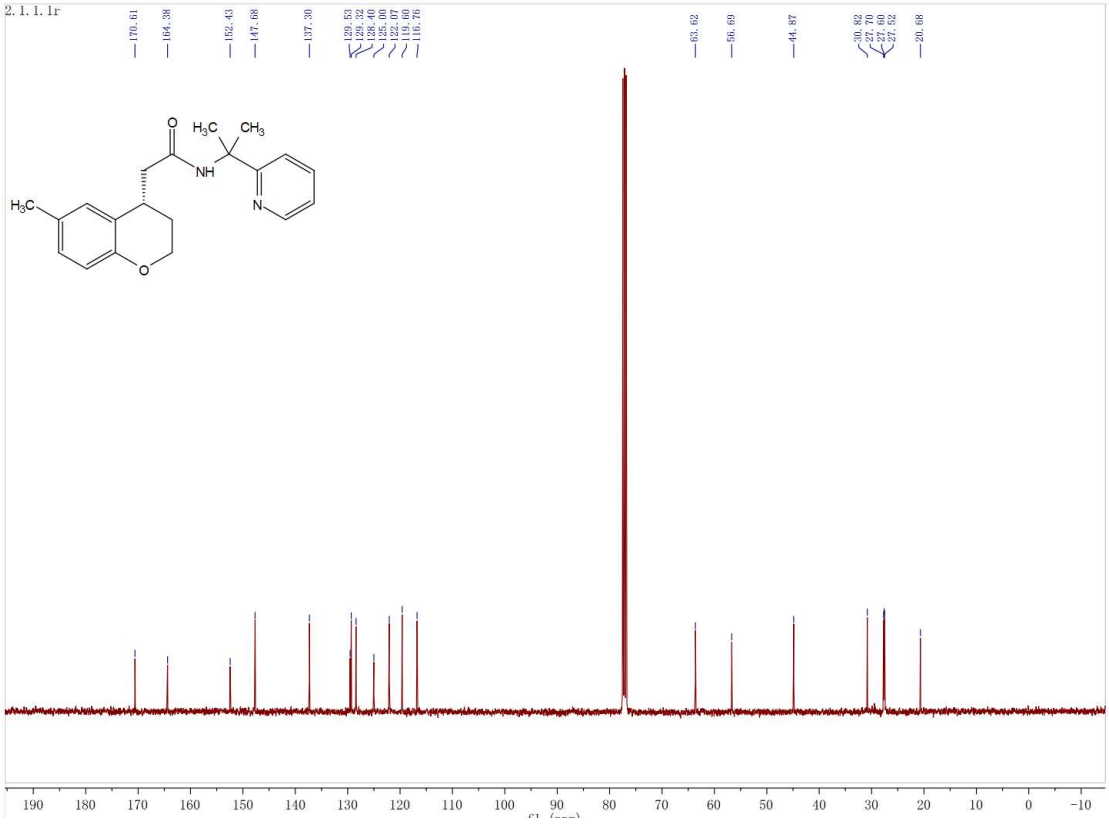
2b, ^{13}C NMR, 101 MHz, $CDCl_3$



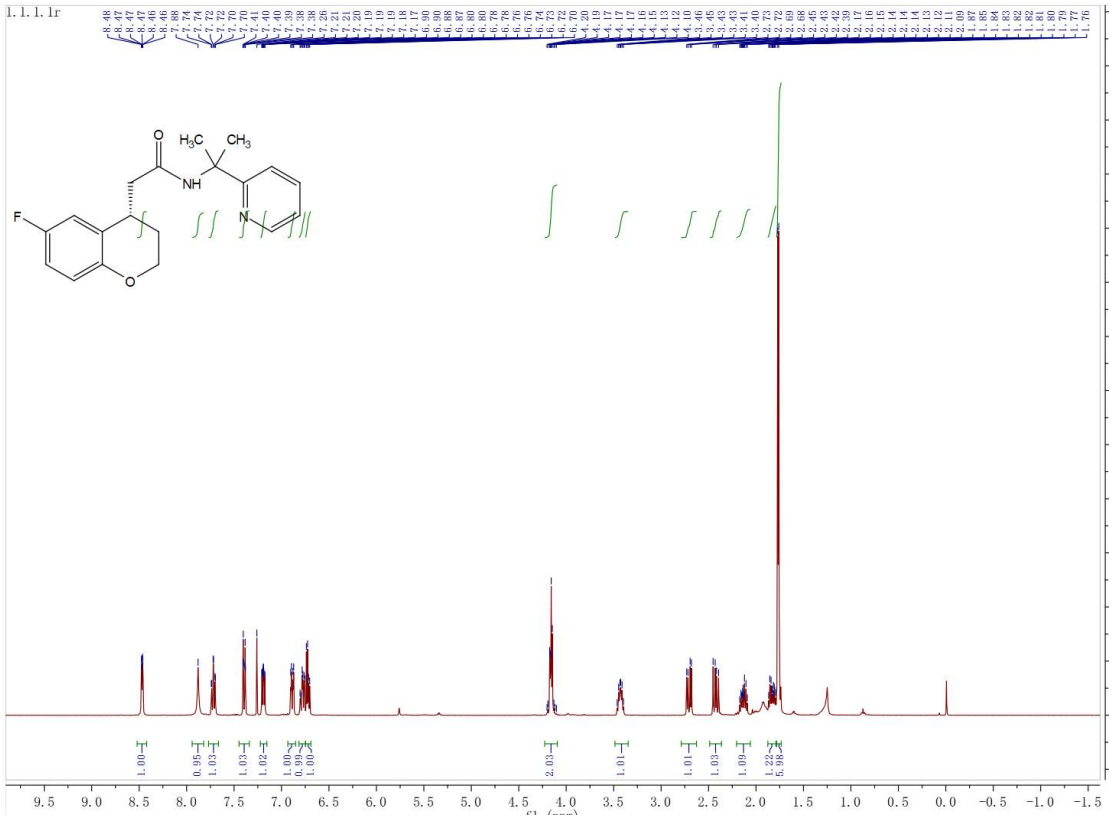
2c, ^{1}H NMR, 400 MHz, $CDCl_3$



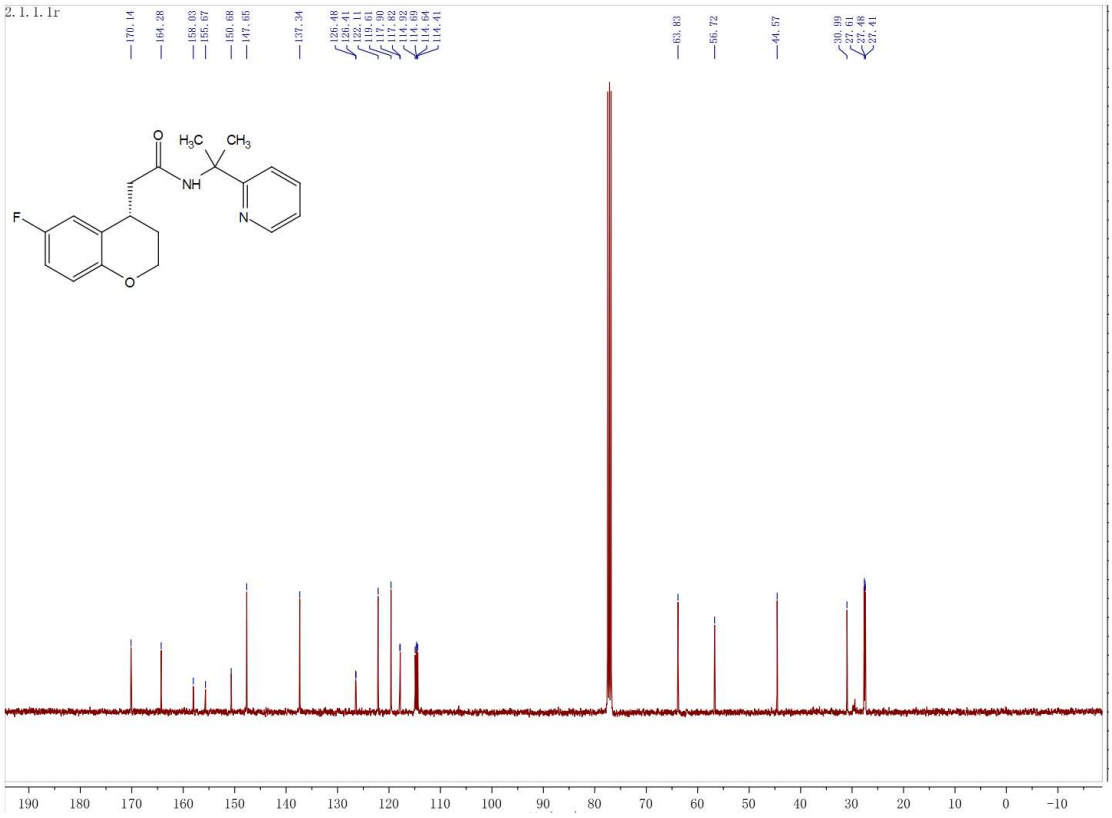
2c, ^{13}C NMR, 101 MHz, $CDCl_3$



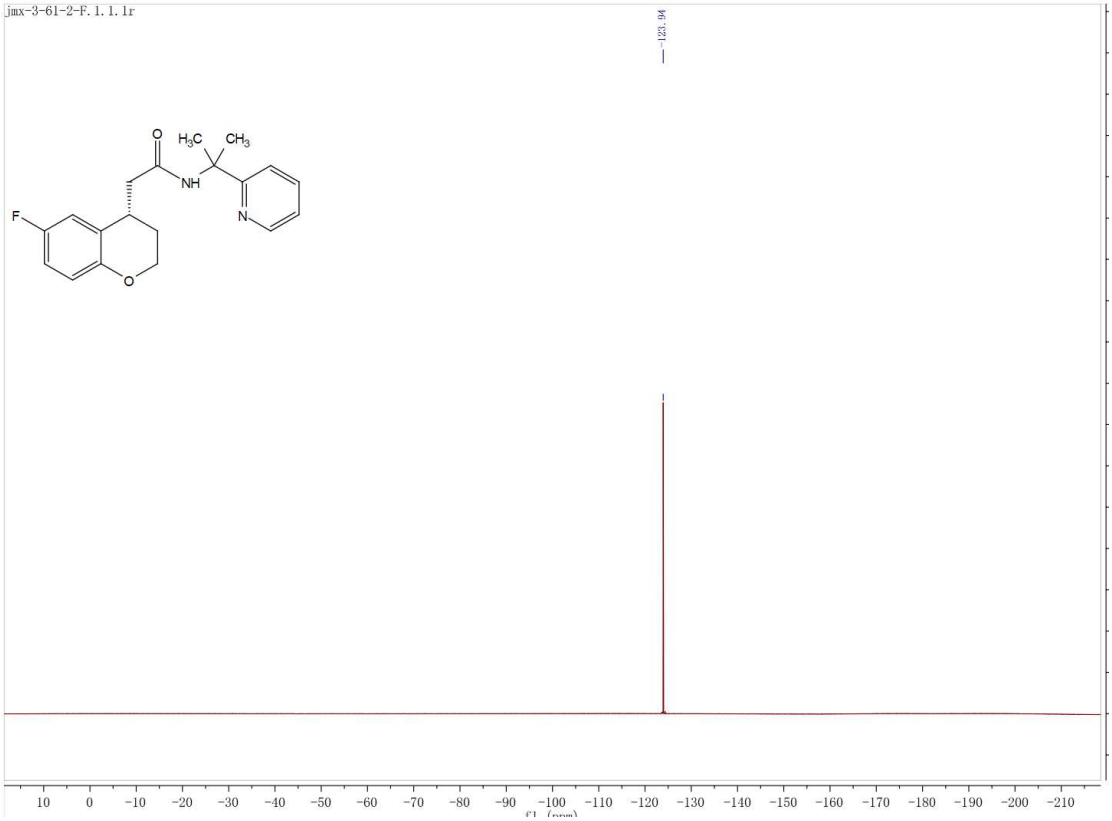
2d, ^{1}H NMR, 400 MHz, $CDCl_3$



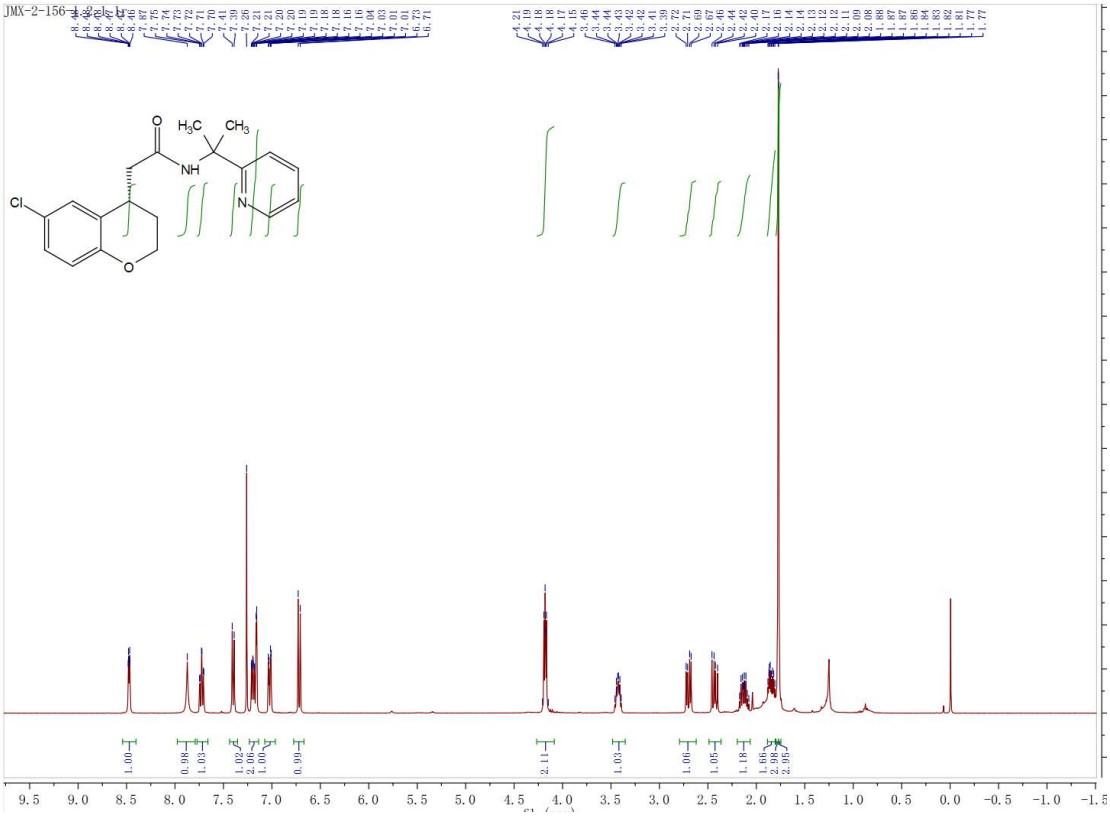
2d, ^{13}C NMR, 101 MHz, $CDCl_3$



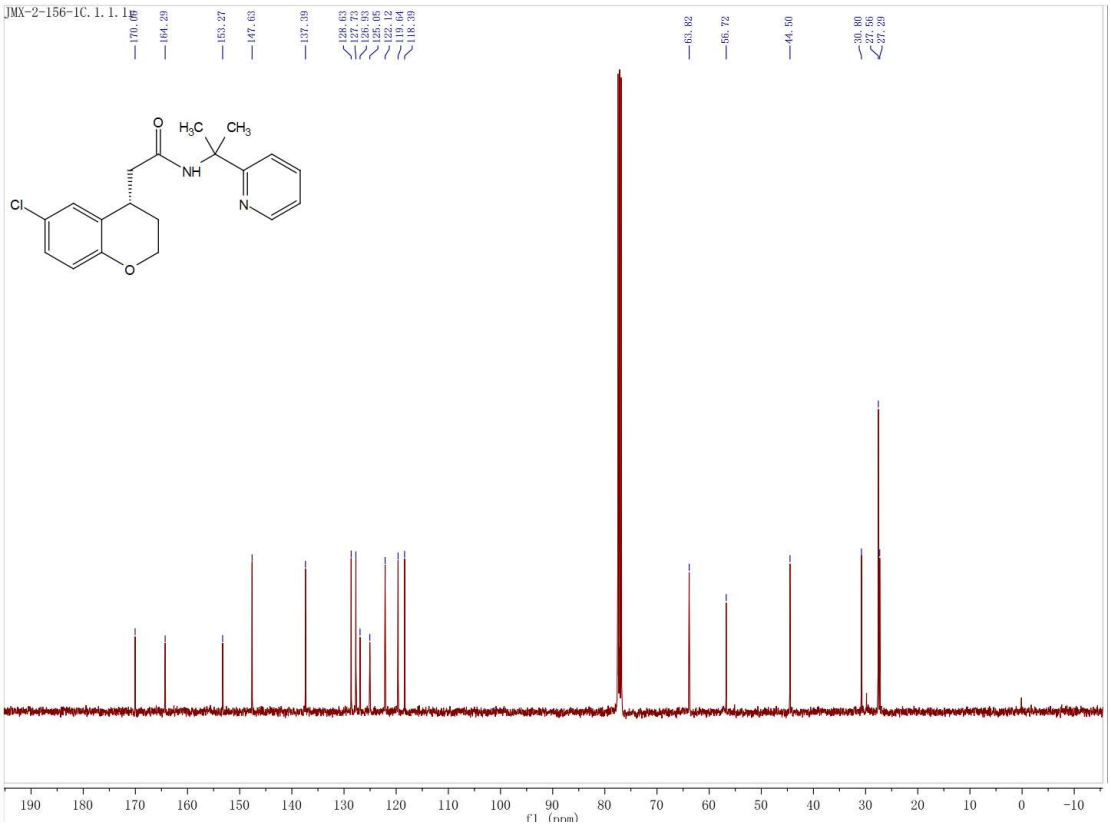
2d, ^{19}F NMR, 376 MHz, $CDCl_3$



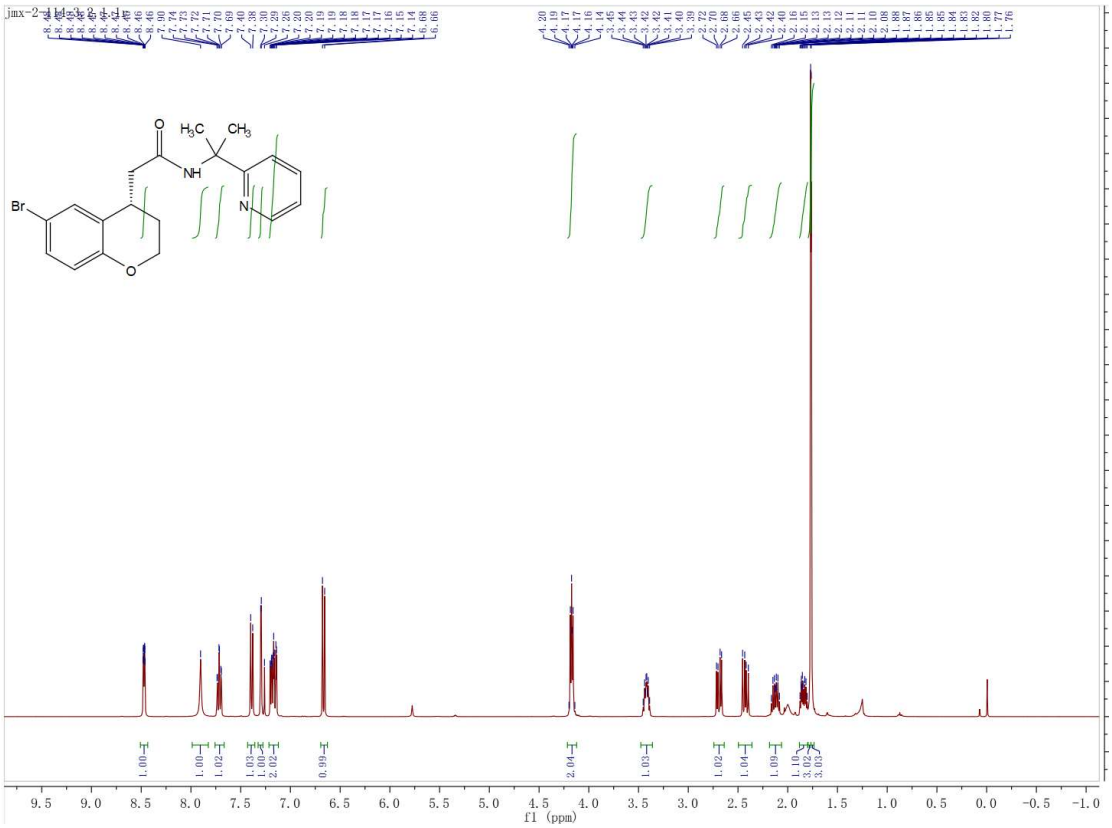
2e, ^{1}H NMR, 400 MHz, $CDCl_3$



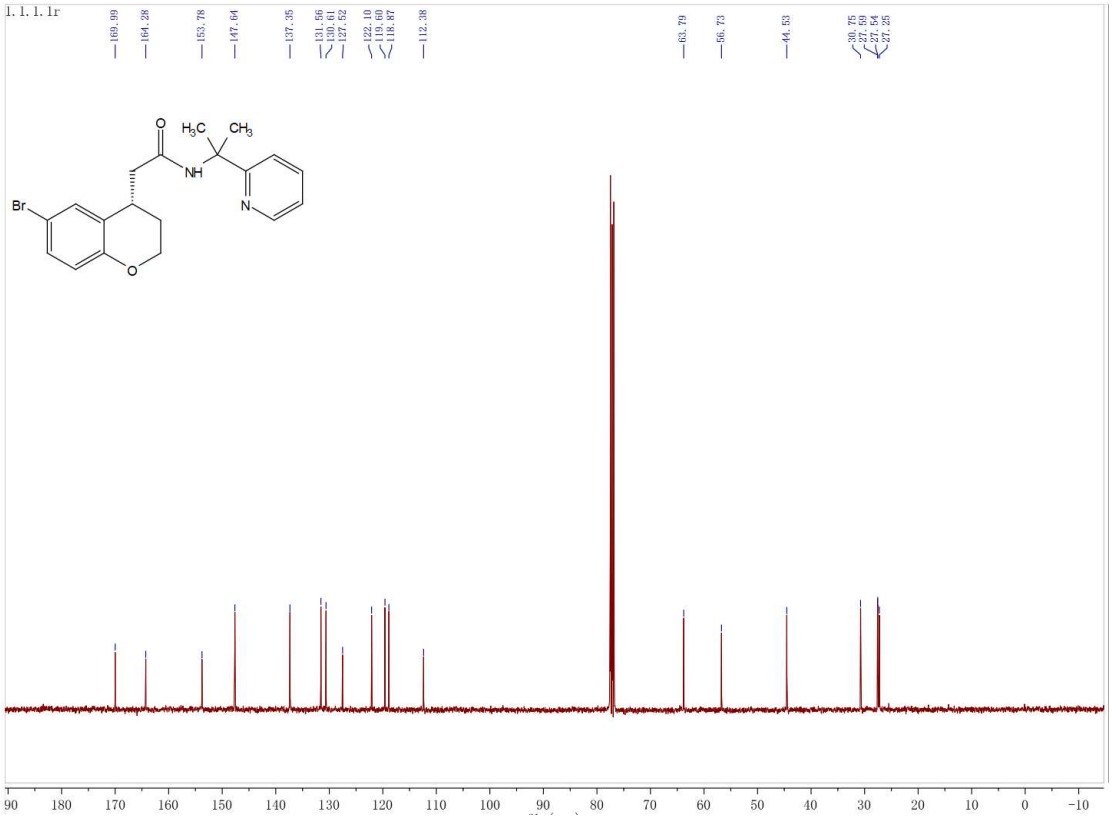
2e,^{13}C NMR, 101 MHz, $CDCl_3$



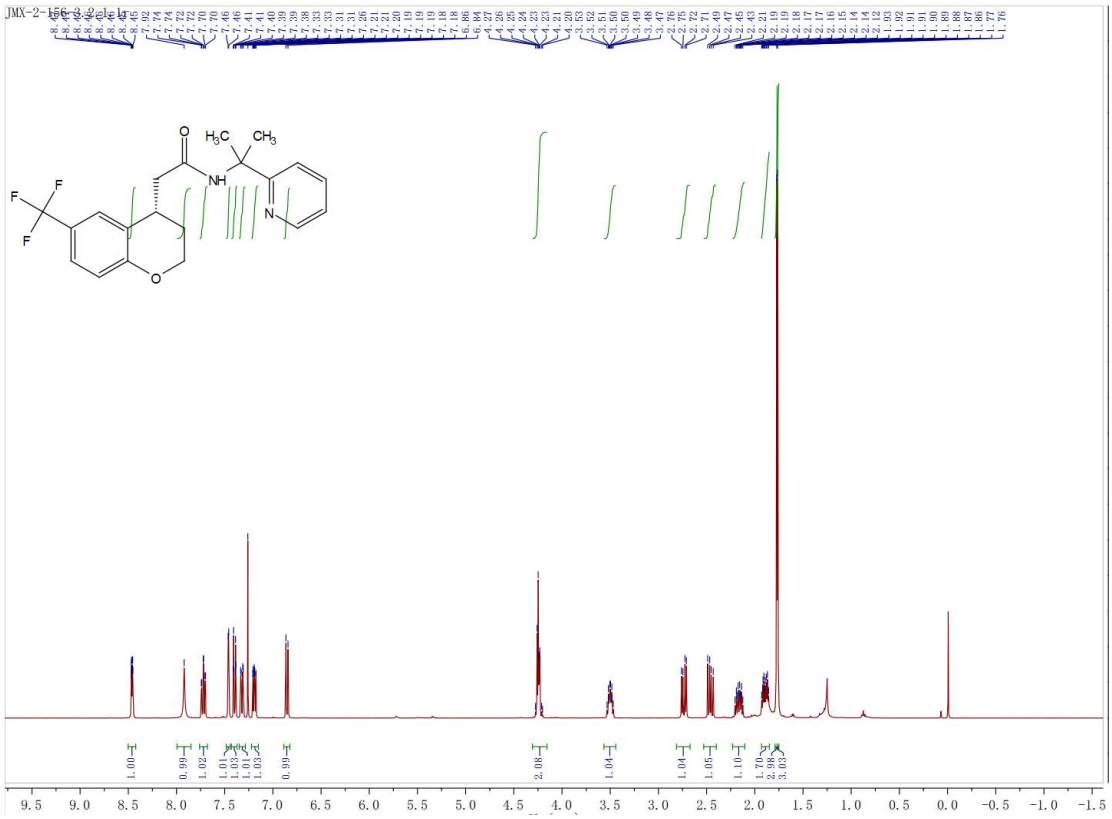
2f, ^{1}H NMR, 400 MHz, $CDCl_3$



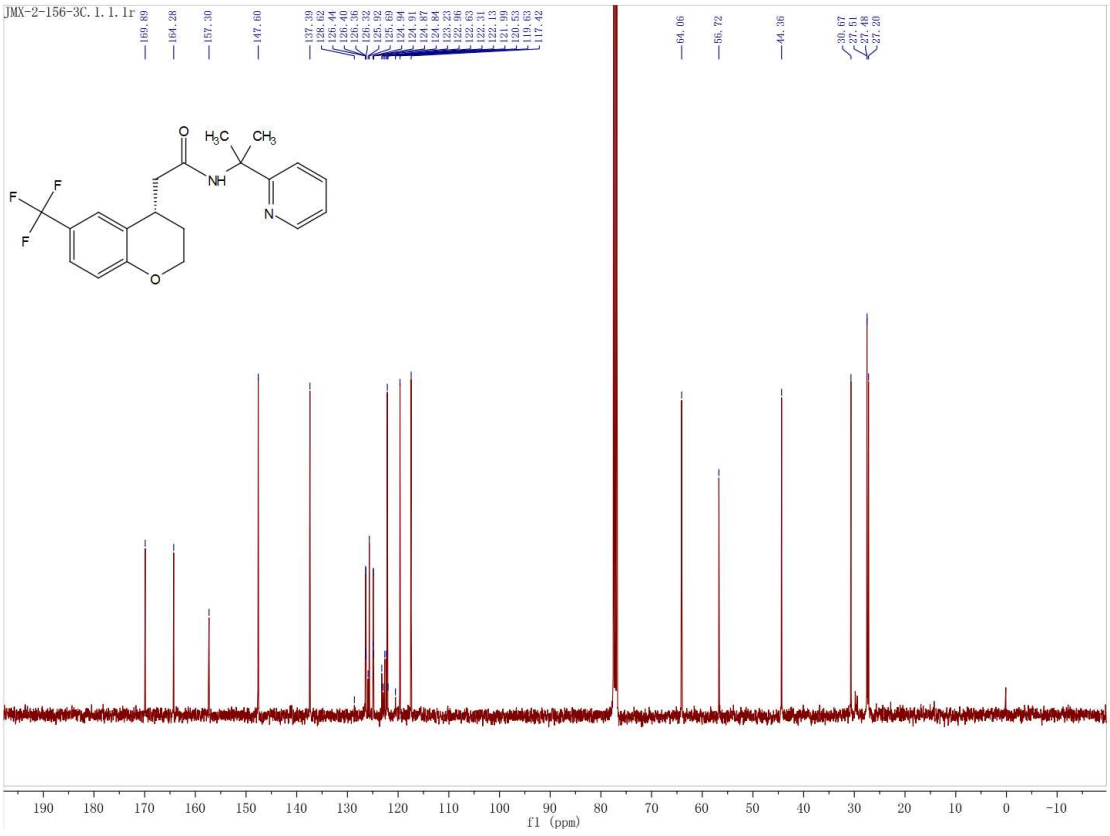
2f, ^{13}C NMR, 101 MHz, $CDCl_3$



2g, ^{1}H NMR, 400 MHz, $CDCl_3$

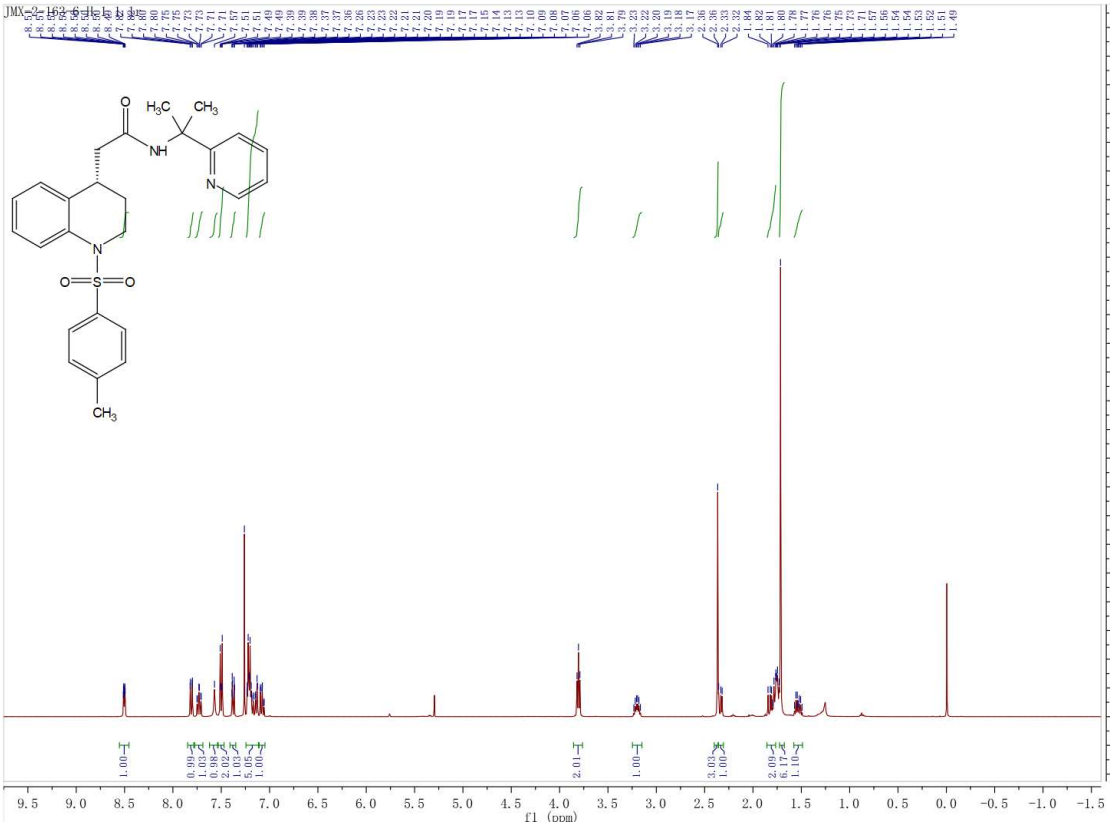


2g, ^{13}C NMR, 101 MHz, $CDCl_3$

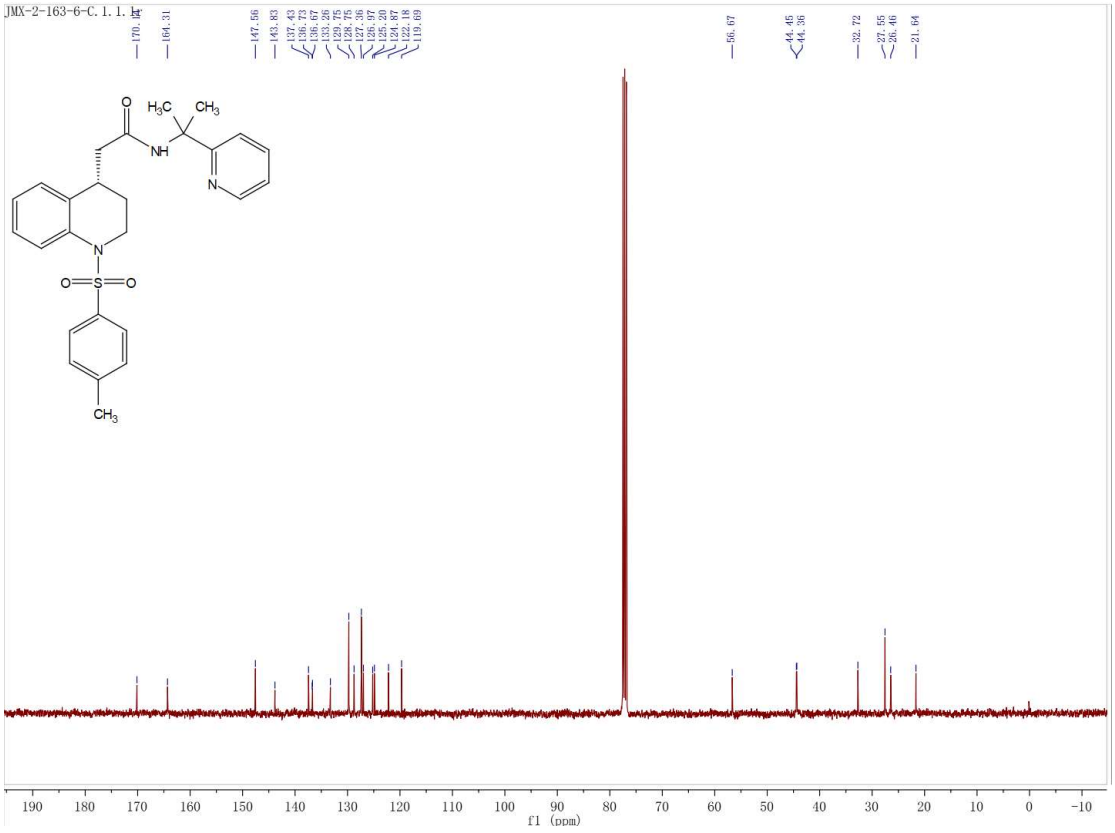


2g, ^{19}F NMR, 376 MHz, $CDCl_3$

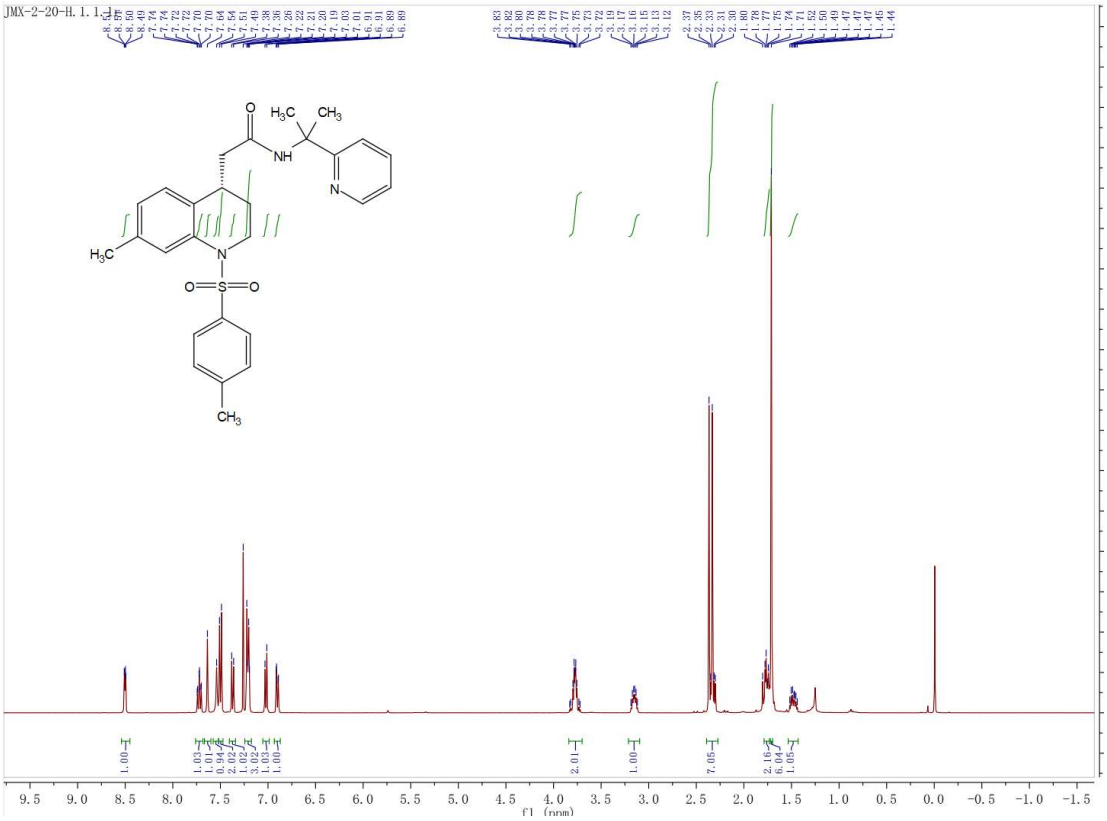
2h, ^{1}H NMR, 400 MHz, $CDCl_3$



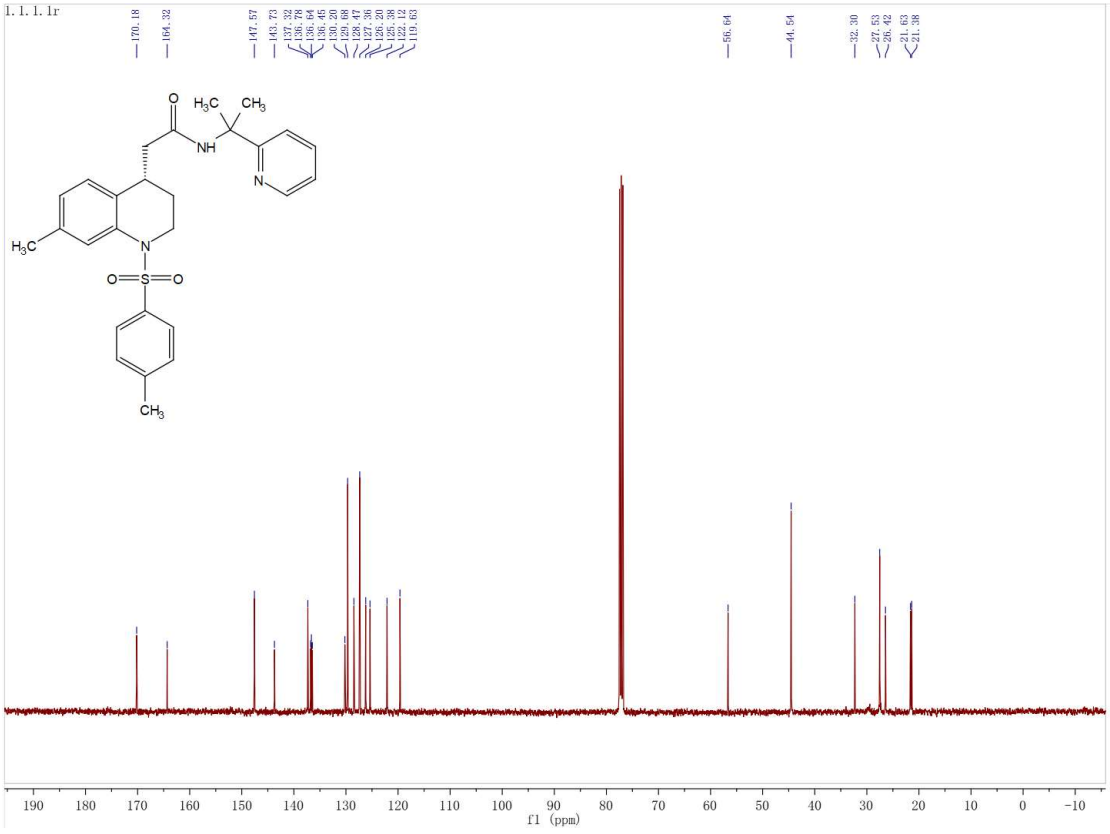
2h, ^{13}C NMR, 101 MHz, $CDCl_3$



2i, ^{1}H NMR, 400 MHz, $CDCl_3$

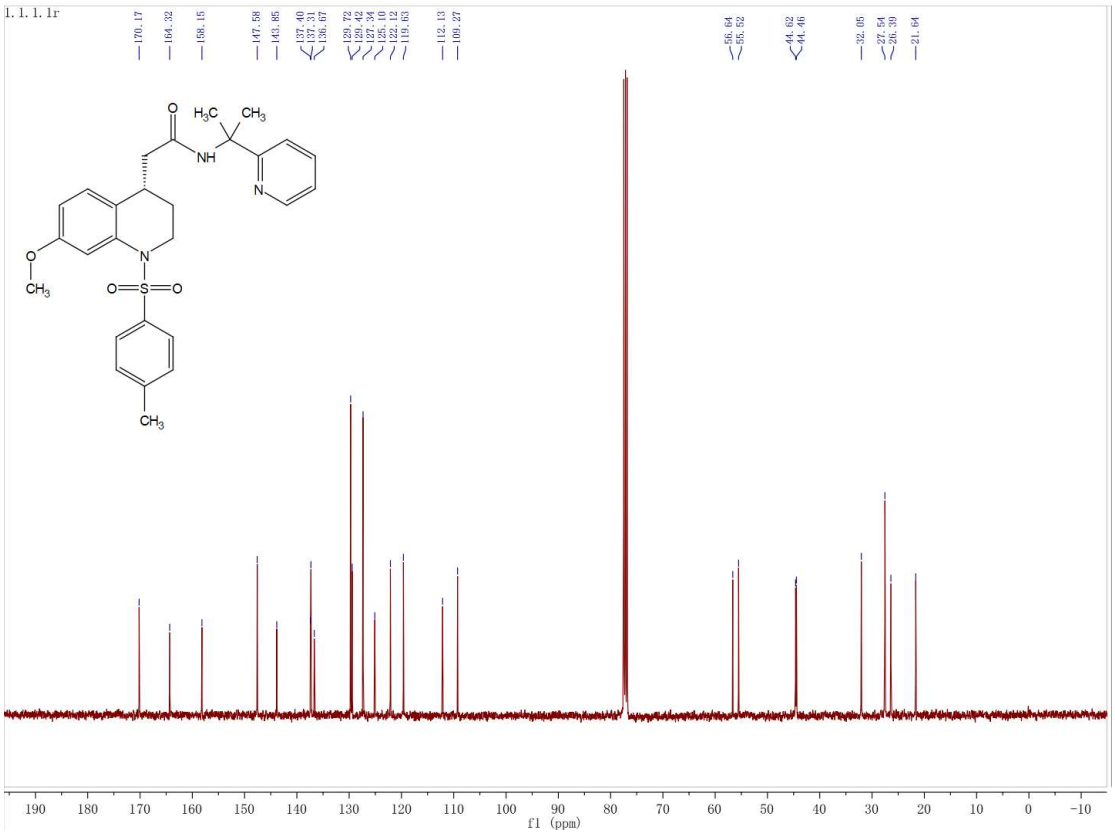


2i, ^{13}C NMR, 101 MHz, $CDCl_3$

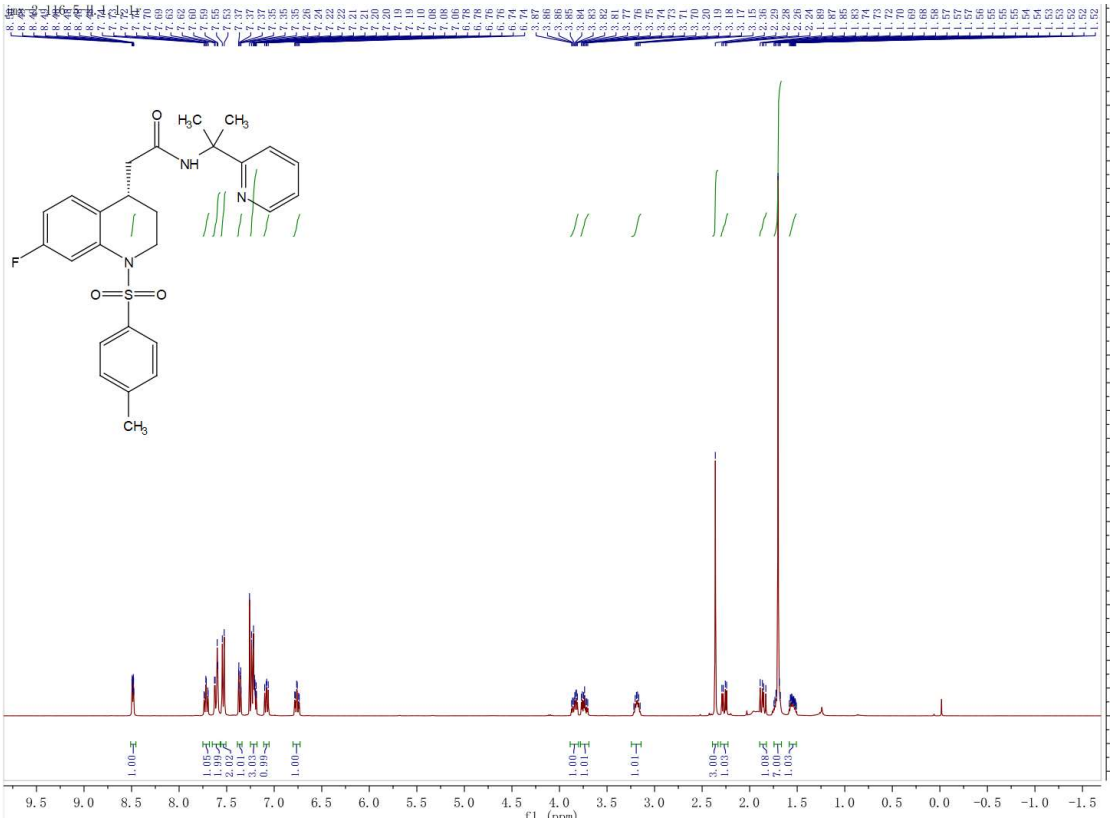


2j, ^{1}H NMR, 400 MHz, $CDCl_3$

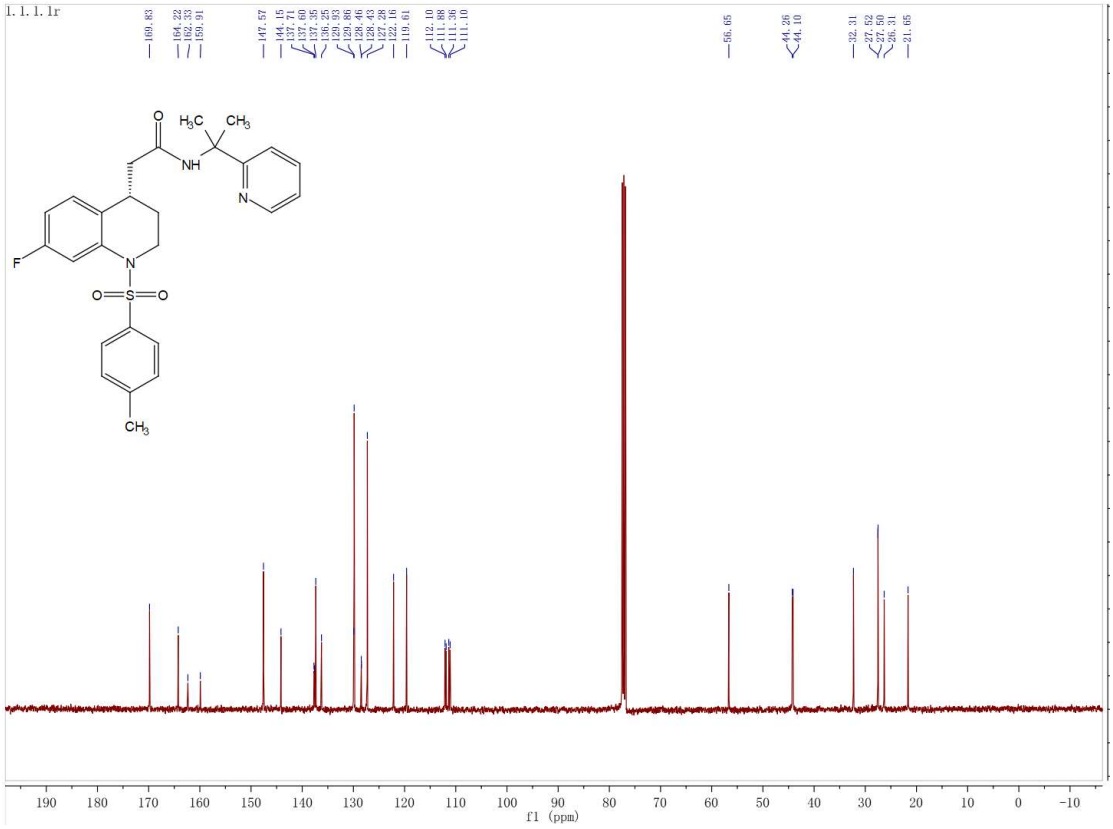
2j, ^{13}C NMR, 101 MHz, $CDCl_3$



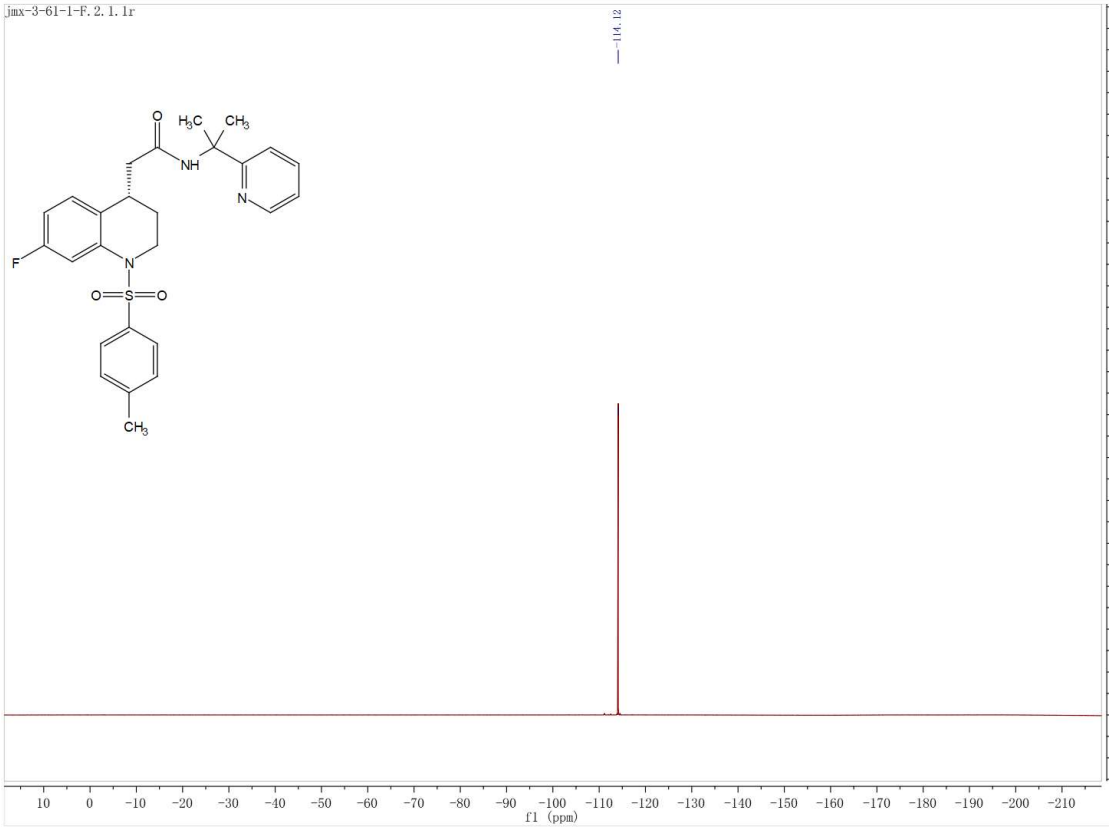
2k, ^{1}H NMR, 400 MHz, $CDCl_3$



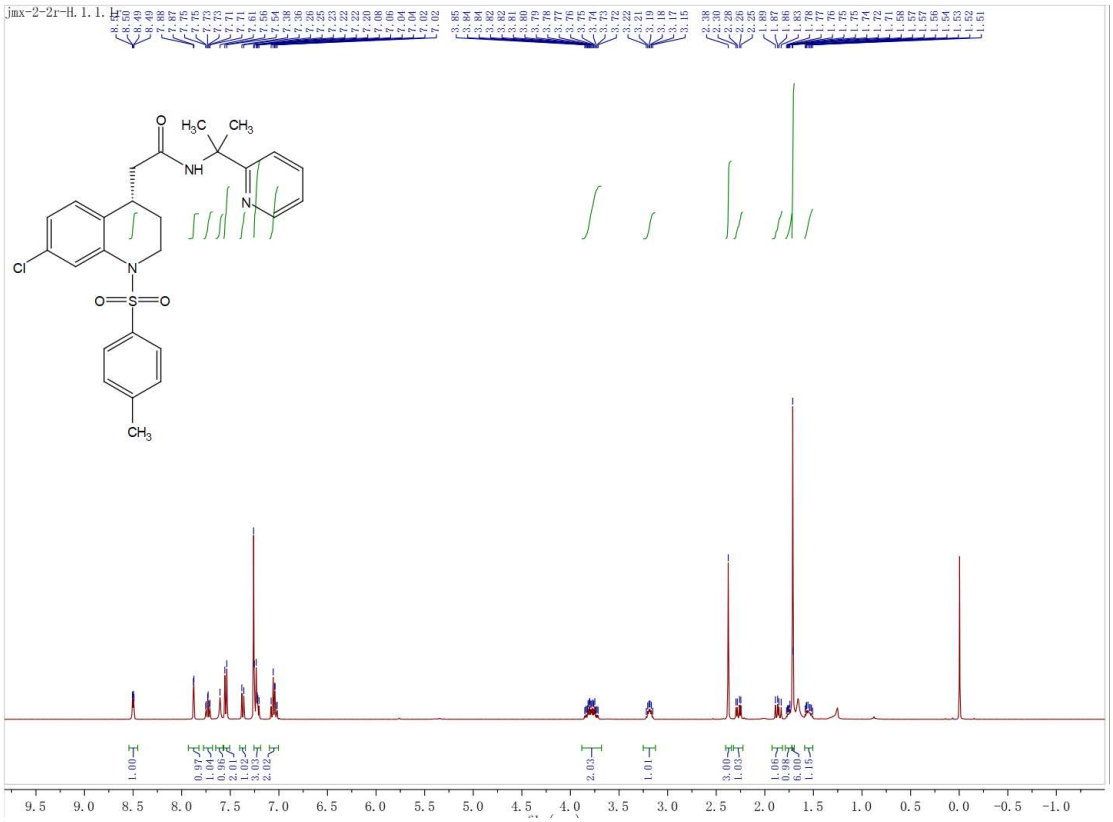
2k, ^{13}C NMR, 101 MHz, $CDCl_3$



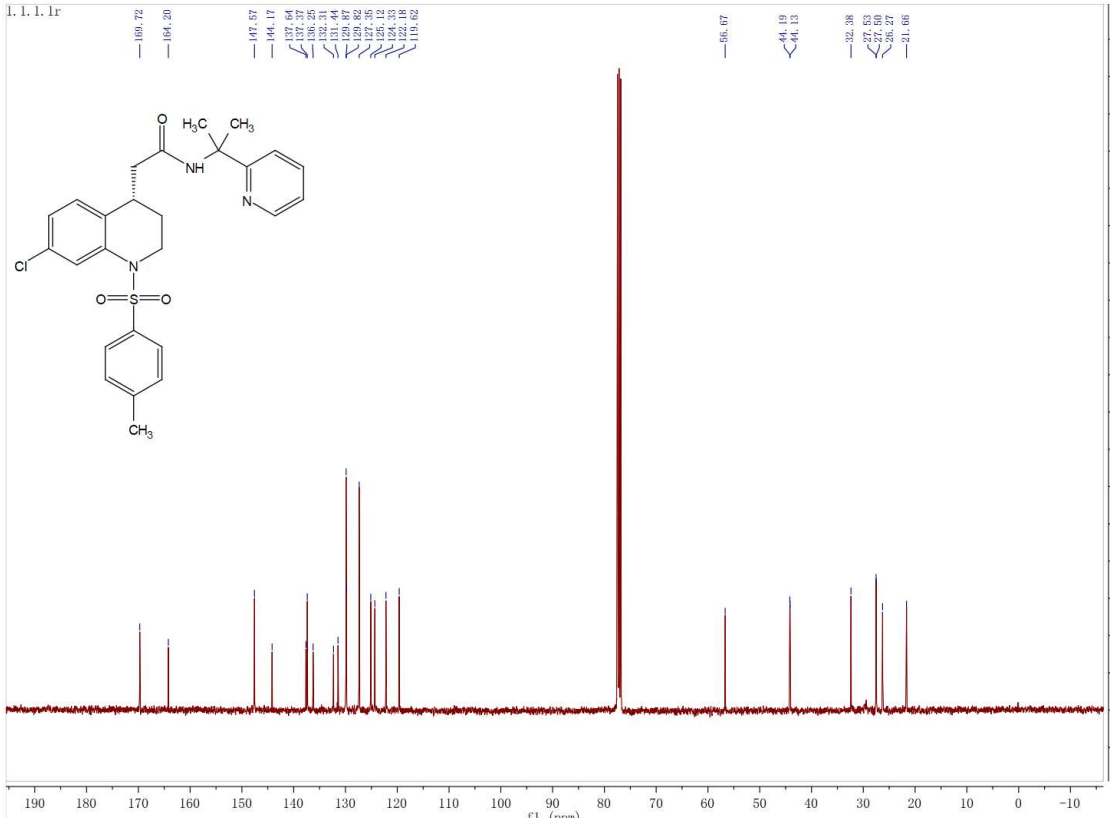
2k, ^{19}F NMR, 376 MHz, $CDCl_3$



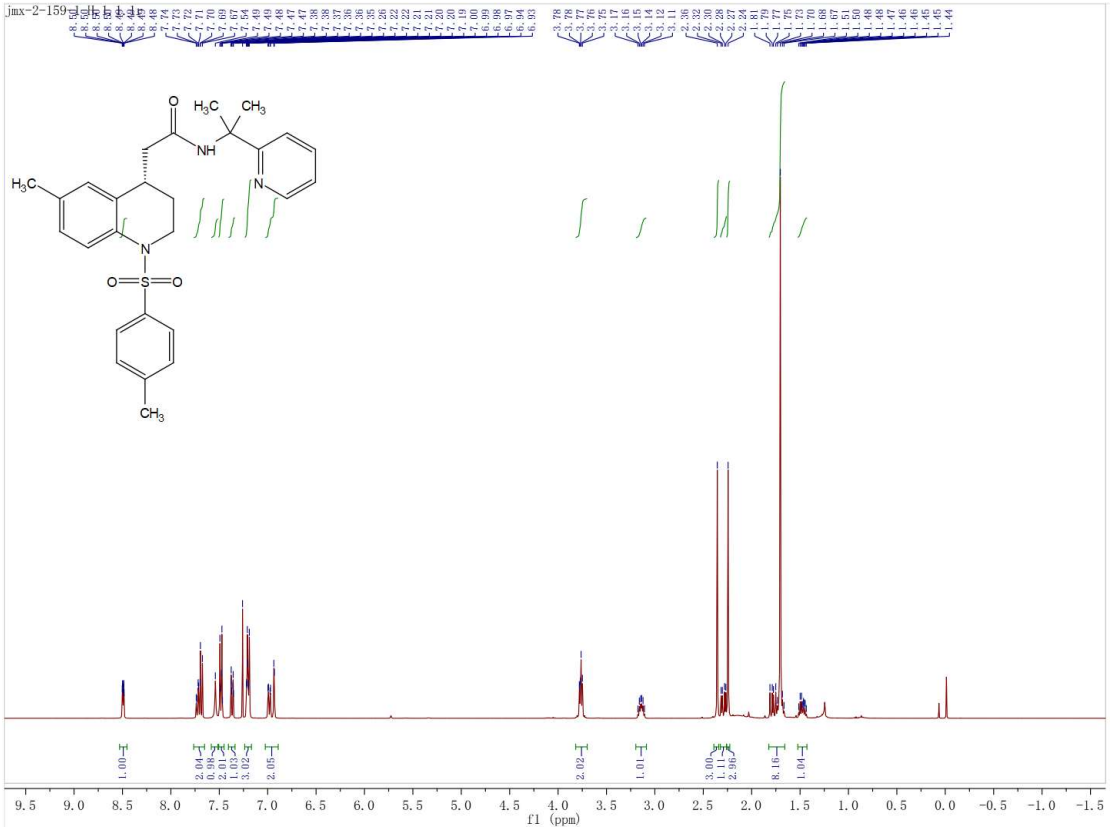
2l, ^{1}H NMR, 400 MHz, $CDCl_3$



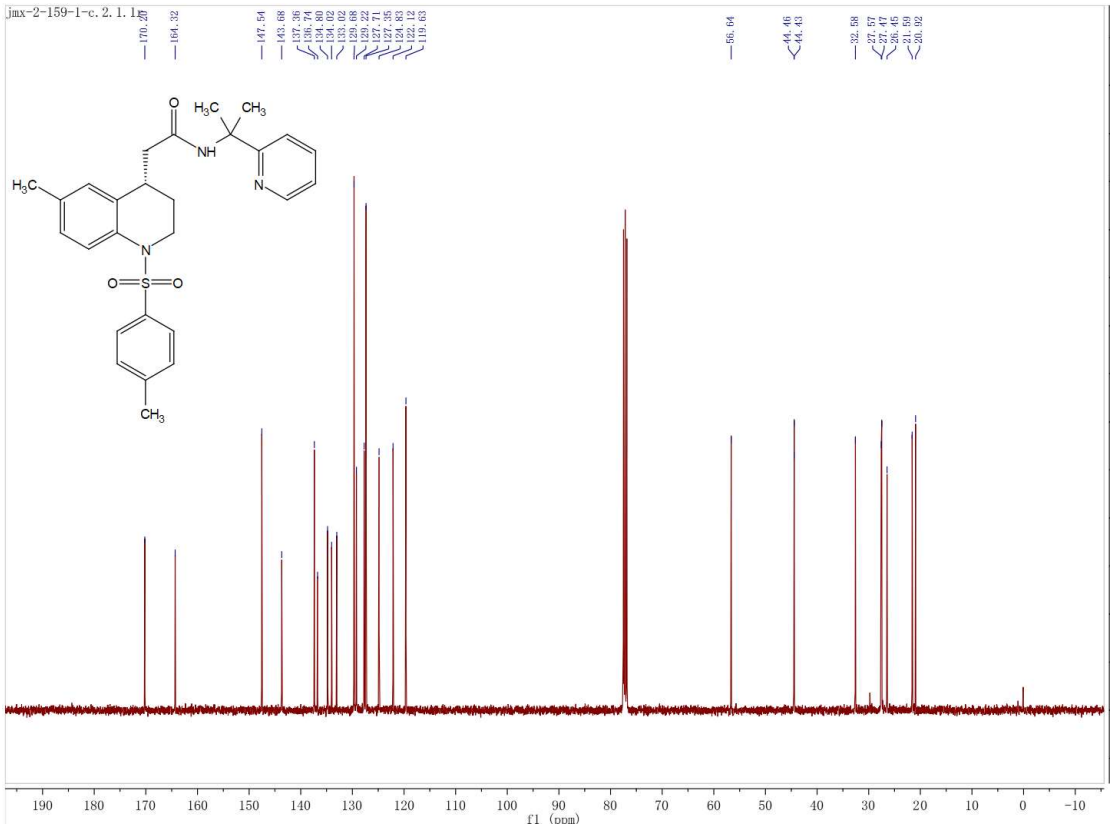
2l, ^{13}C NMR, 101 MHz, $CDCl_3$



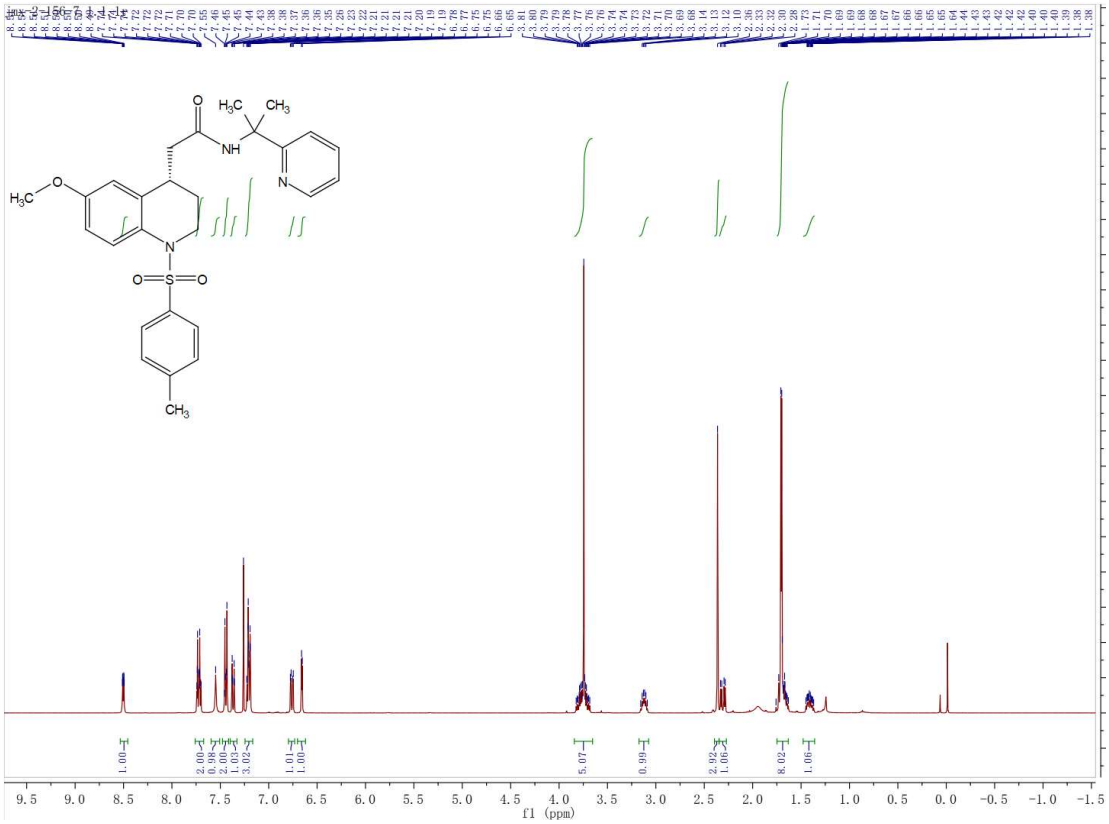
2m, ^{1}H NMR, 400 MHz, $CDCl_3$



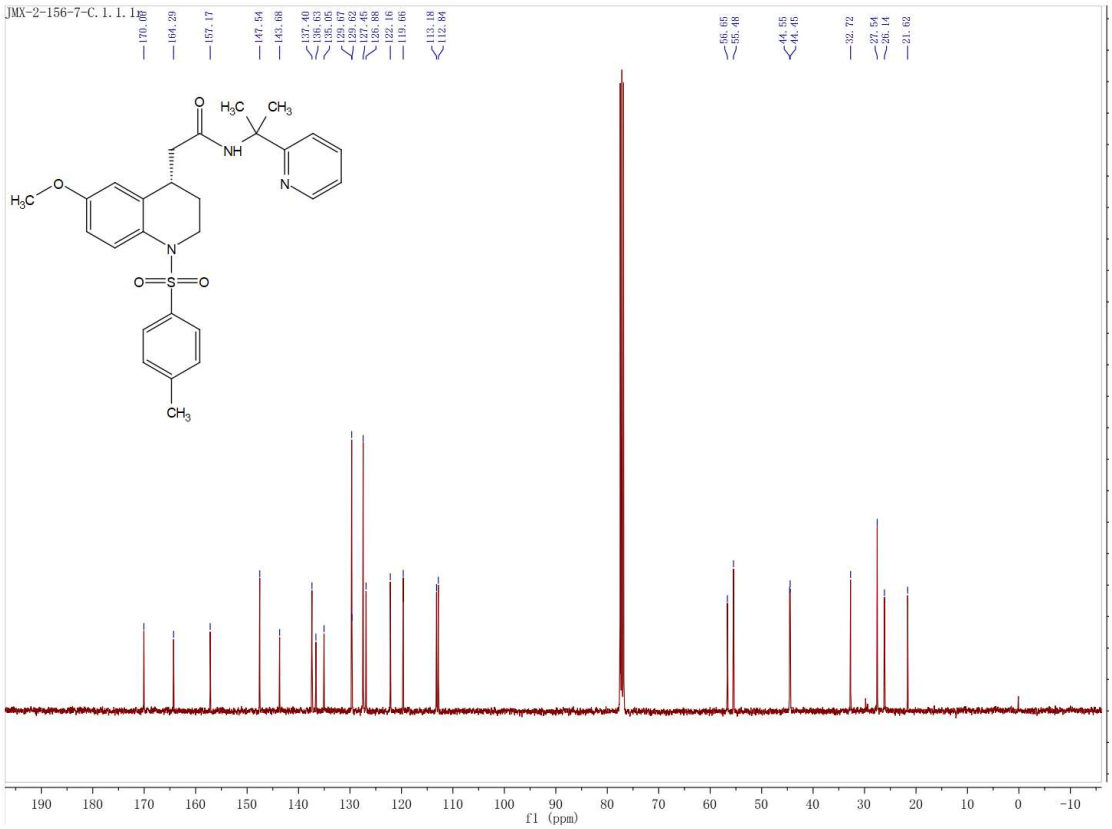
2m,^{13}C NMR, 101 MHz, $CDCl_3$



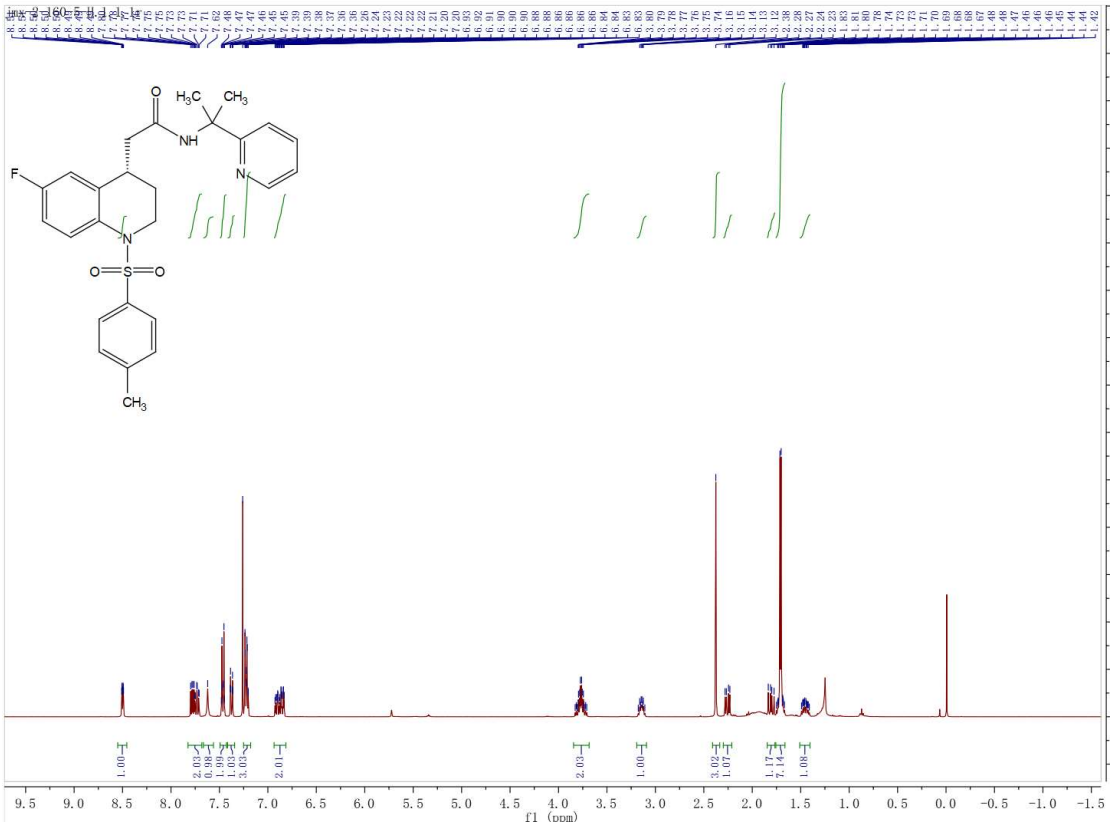
2n, ^{1}H NMR, 400 MHz, $CDCl_3$



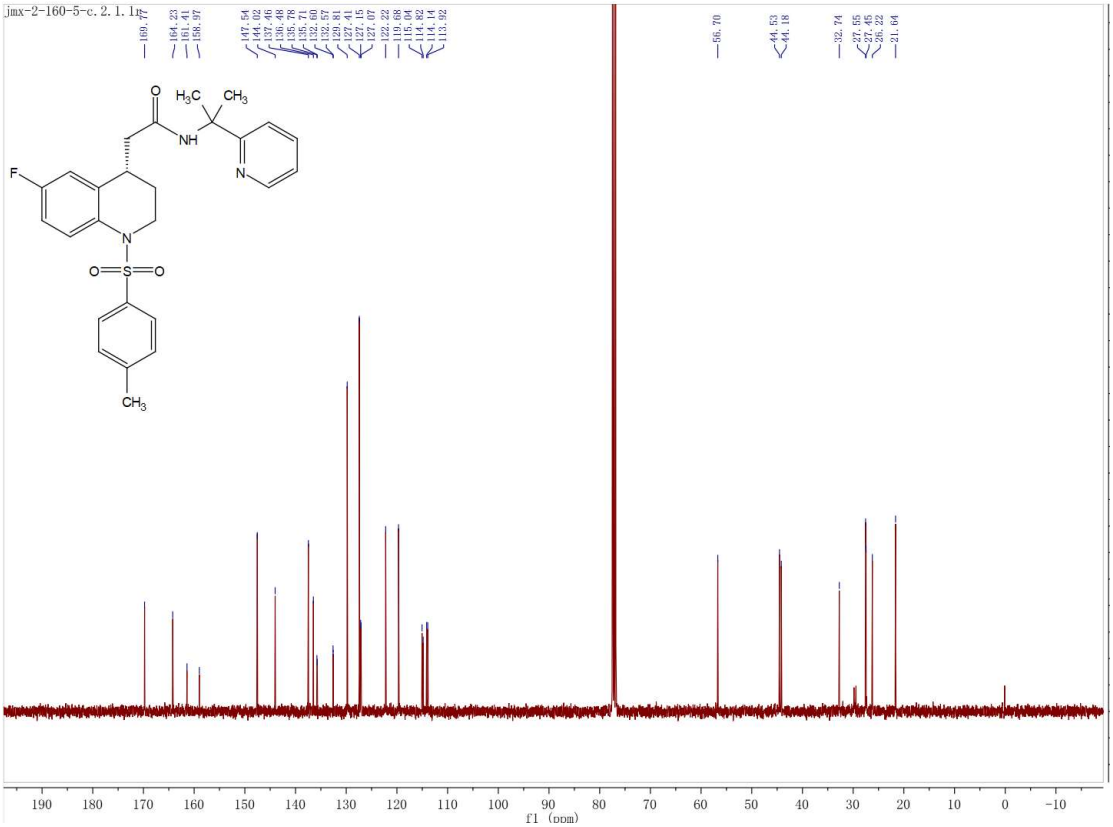
2n, ^{13}C NMR, 101 MHz, $CDCl_3$



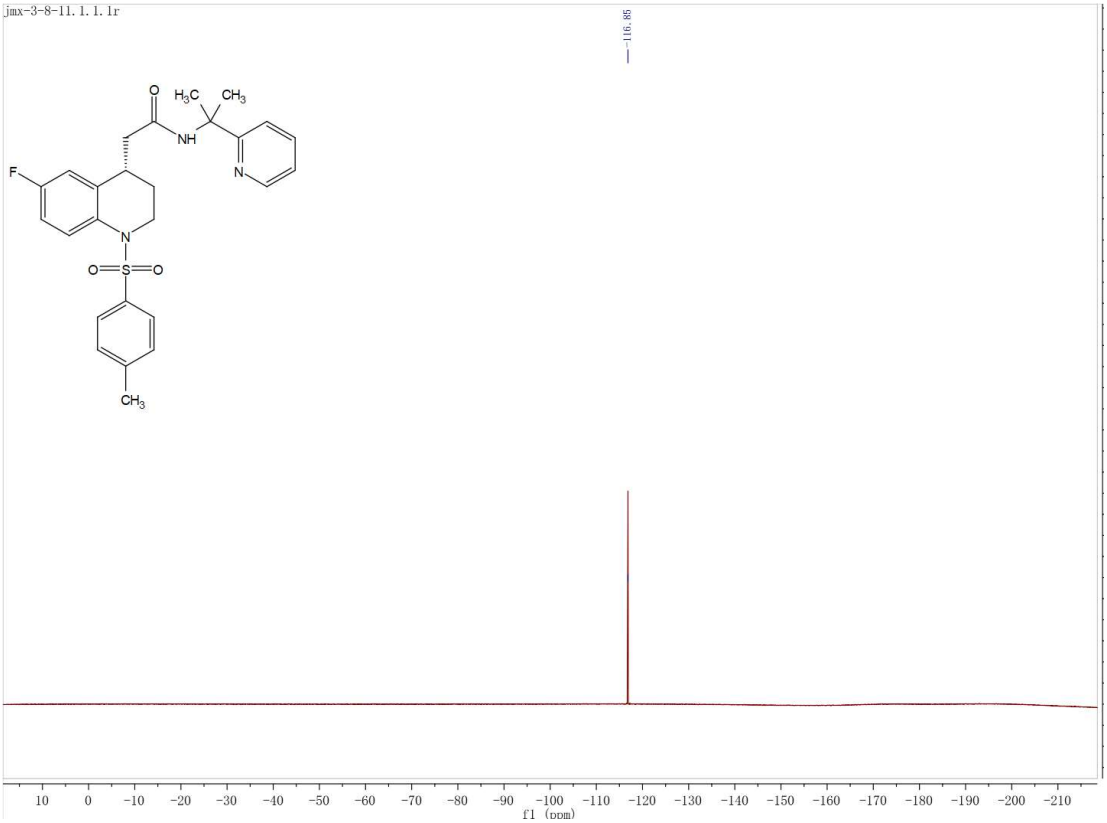
2o, ^{1}H NMR, 400 MHz, $CDCl_3$



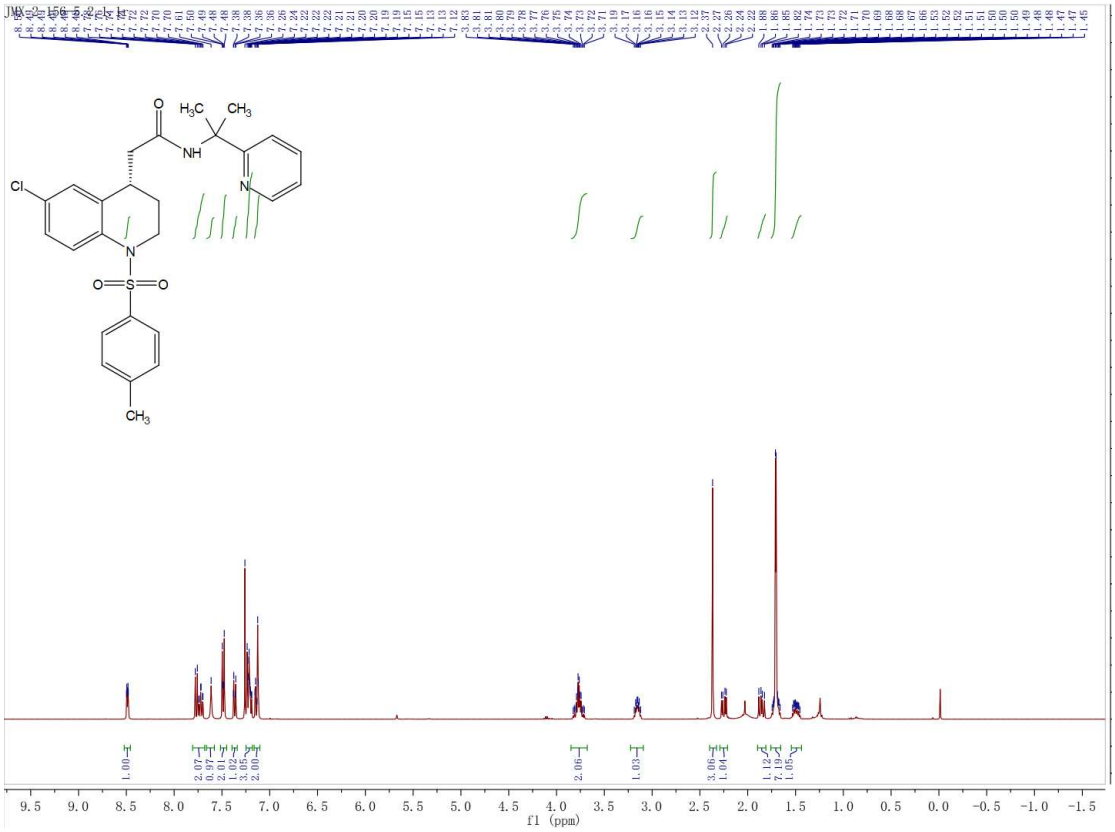
2o, ^{13}C NMR, 101 MHz, $CDCl_3$



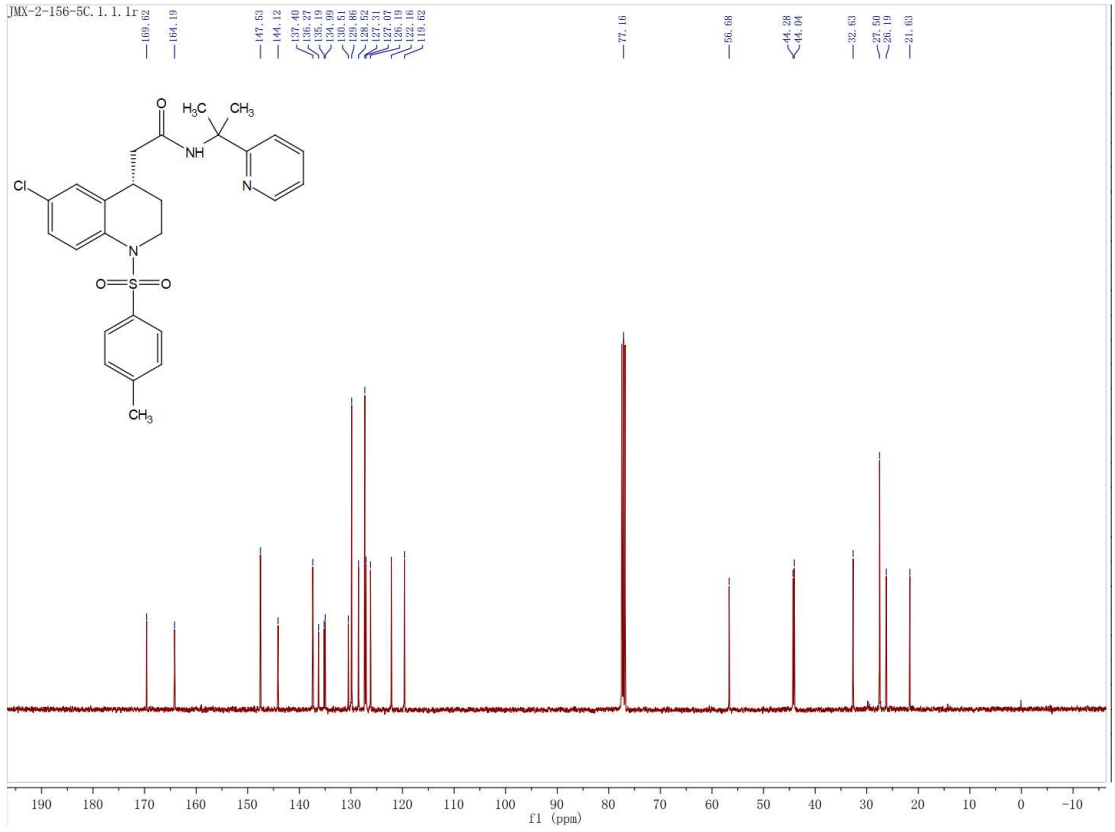
2o, ^{19}F NMR, 376 MHz, $CDCl_3$



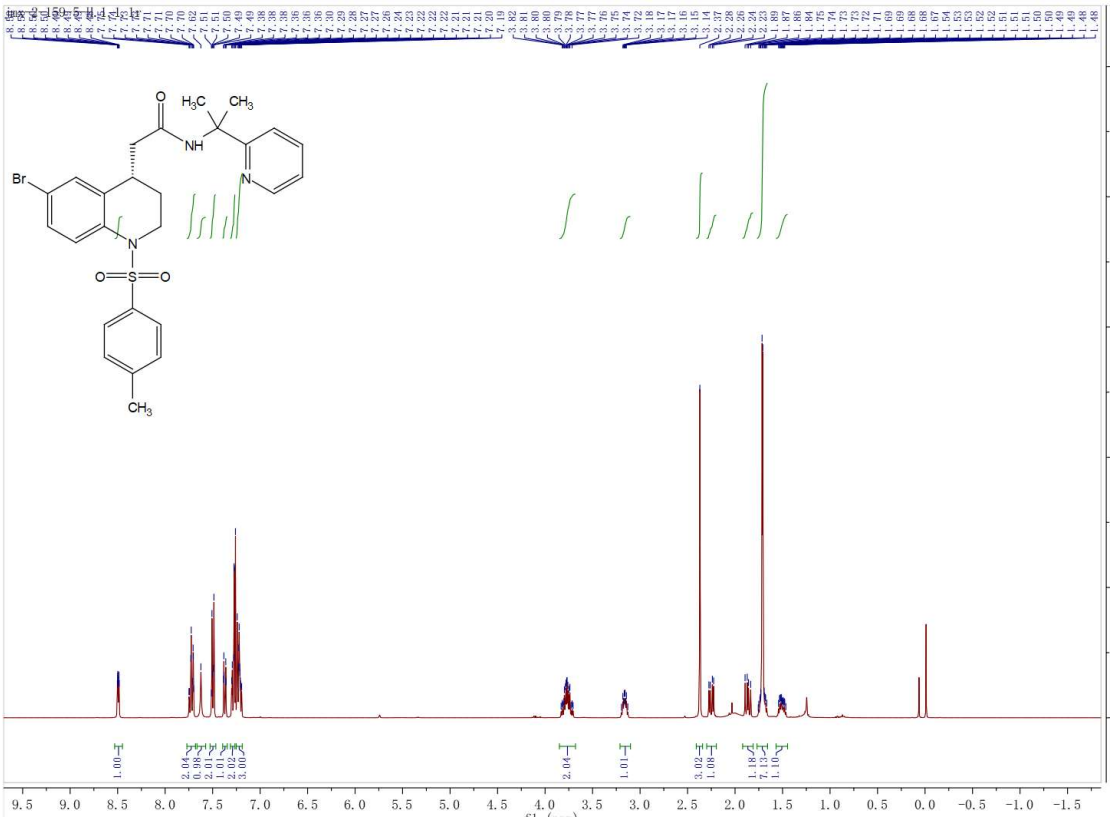
2p, ^{1}H NMR, 400 MHz, $CDCl_3$



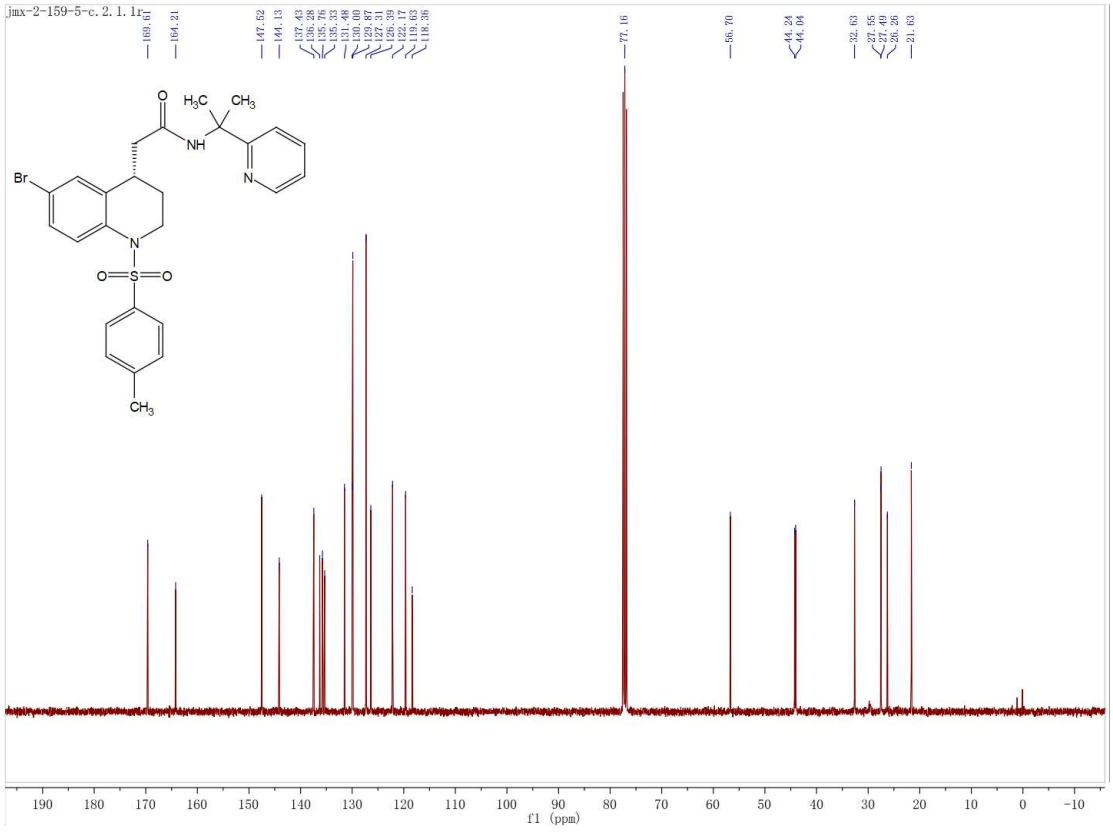
2p, ^{13}C NMR, 101 MHz, $CDCl_3$



2q, ^{1}H NMR, 400 MHz, $CDCl_3$

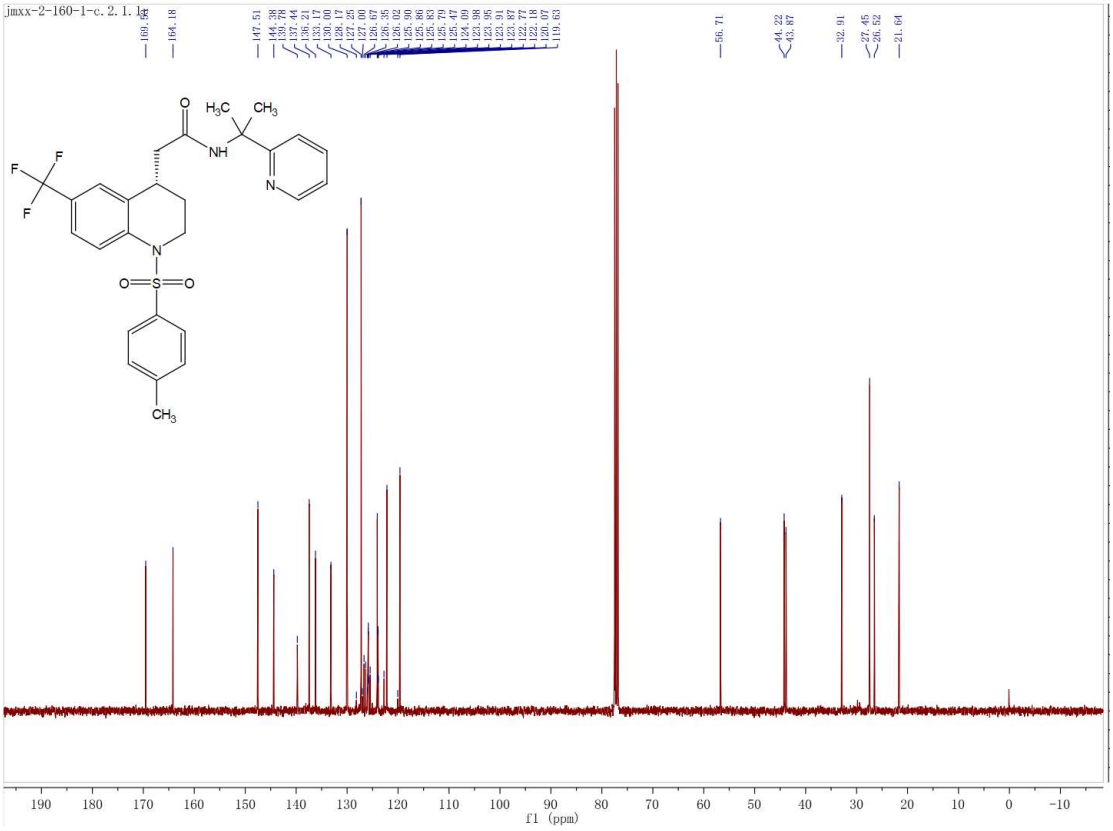


2q, ^{13}C NMR, 101 MHz, $CDCl_3$

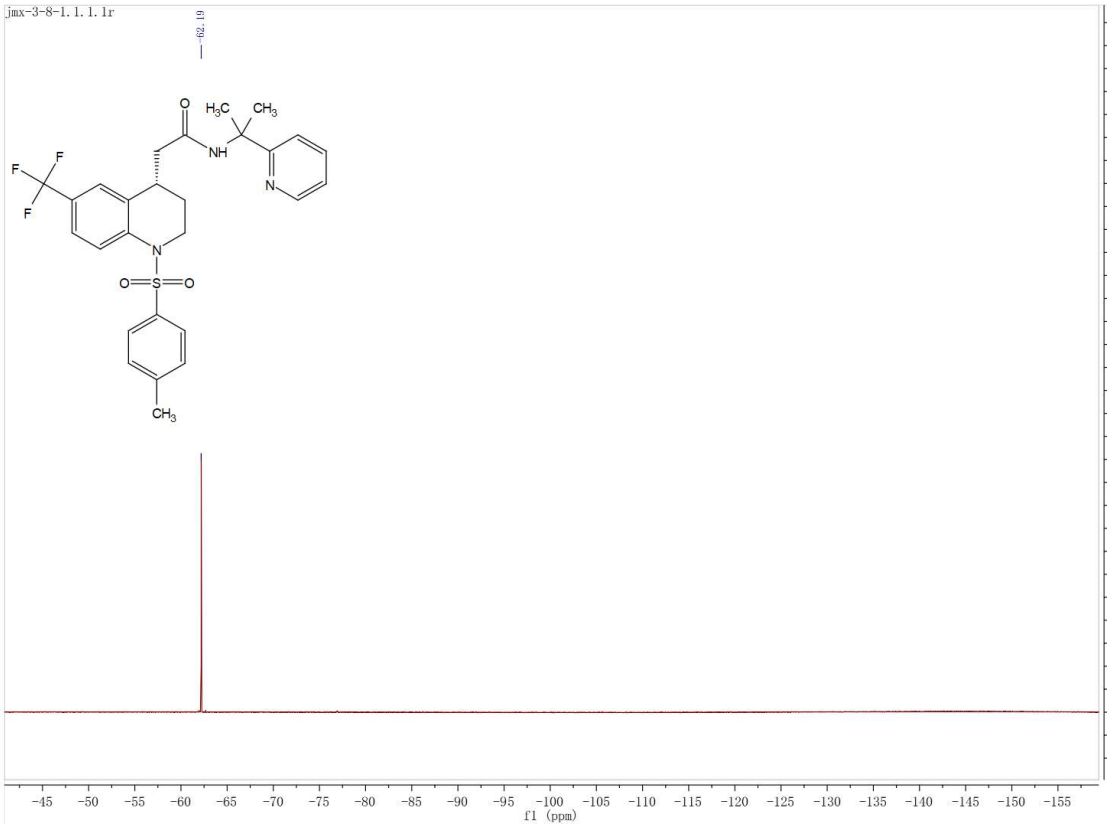


2r, ^{1}H NMR, 400 MHz, $CDCl_3$

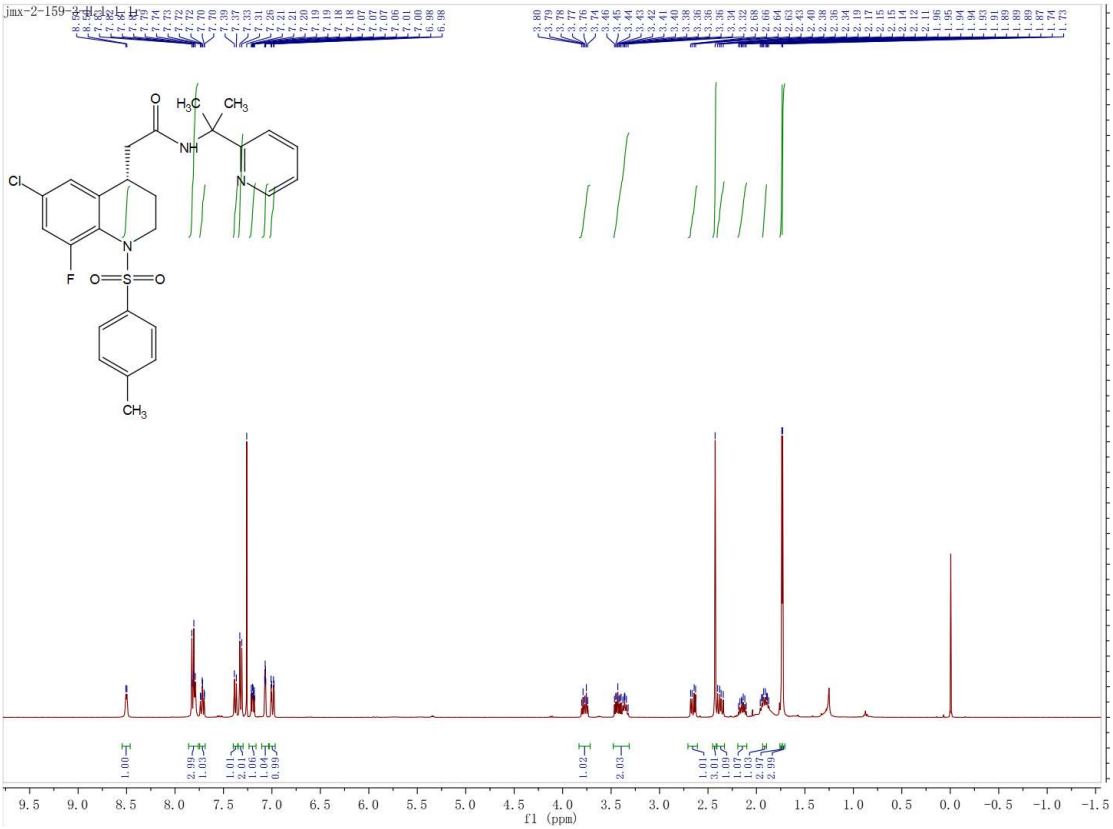
2r, ^{13}C NMR, 101 MHz, $CDCl_3$



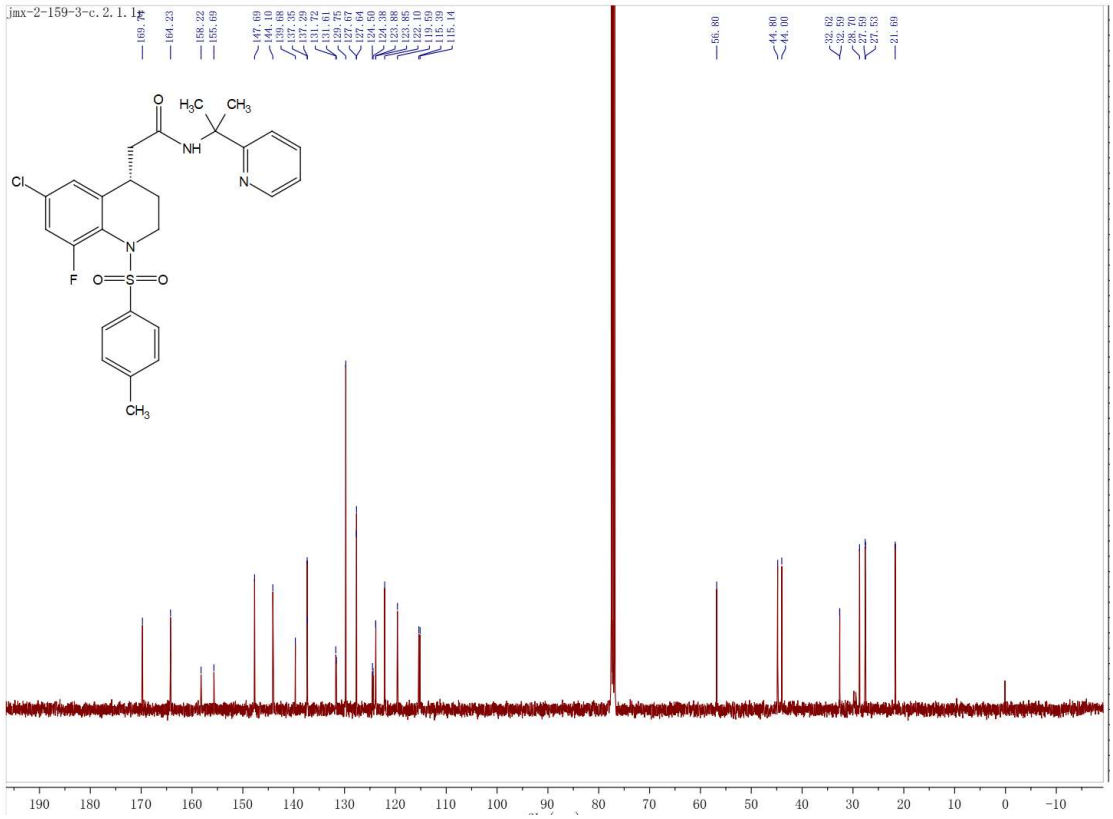
2r, ^{19}F NMR, 376 MHz, $CDCl_3$



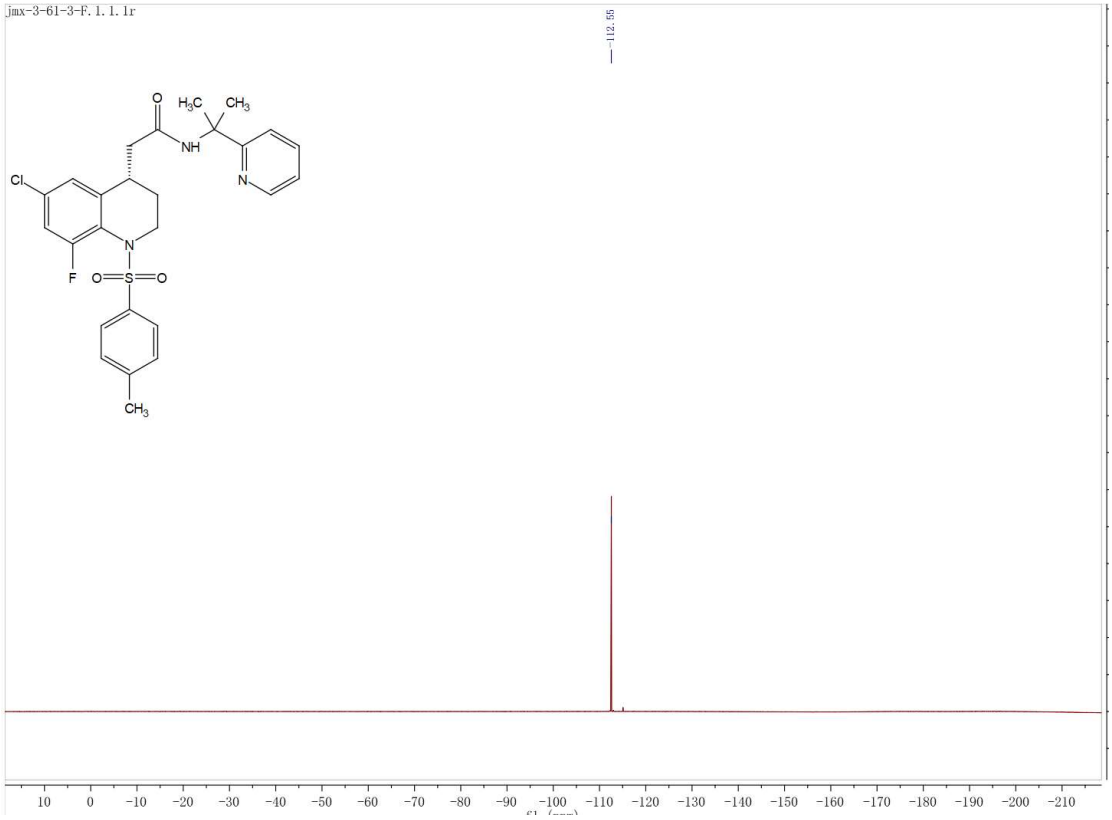
2s, ^{1}H NMR, 400 MHz, $CDCl_3$



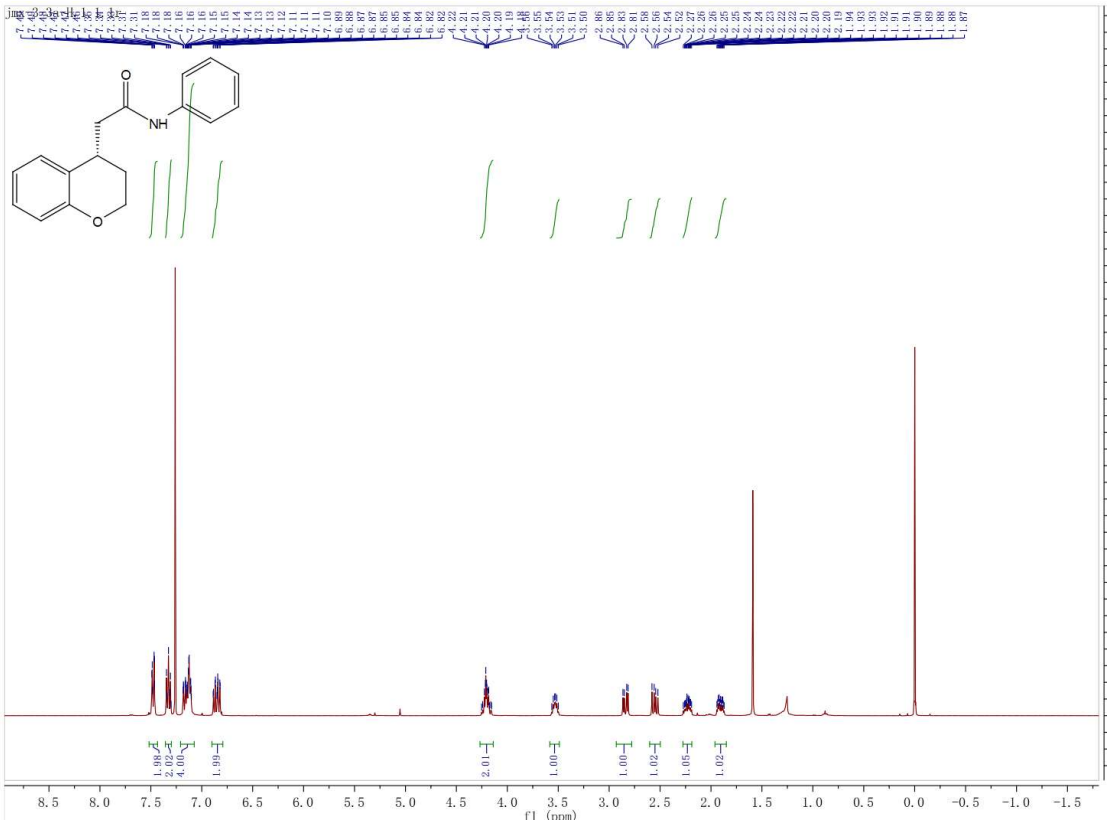
2s, ^{13}C NMR, 101 MHz, $CDCl_3$



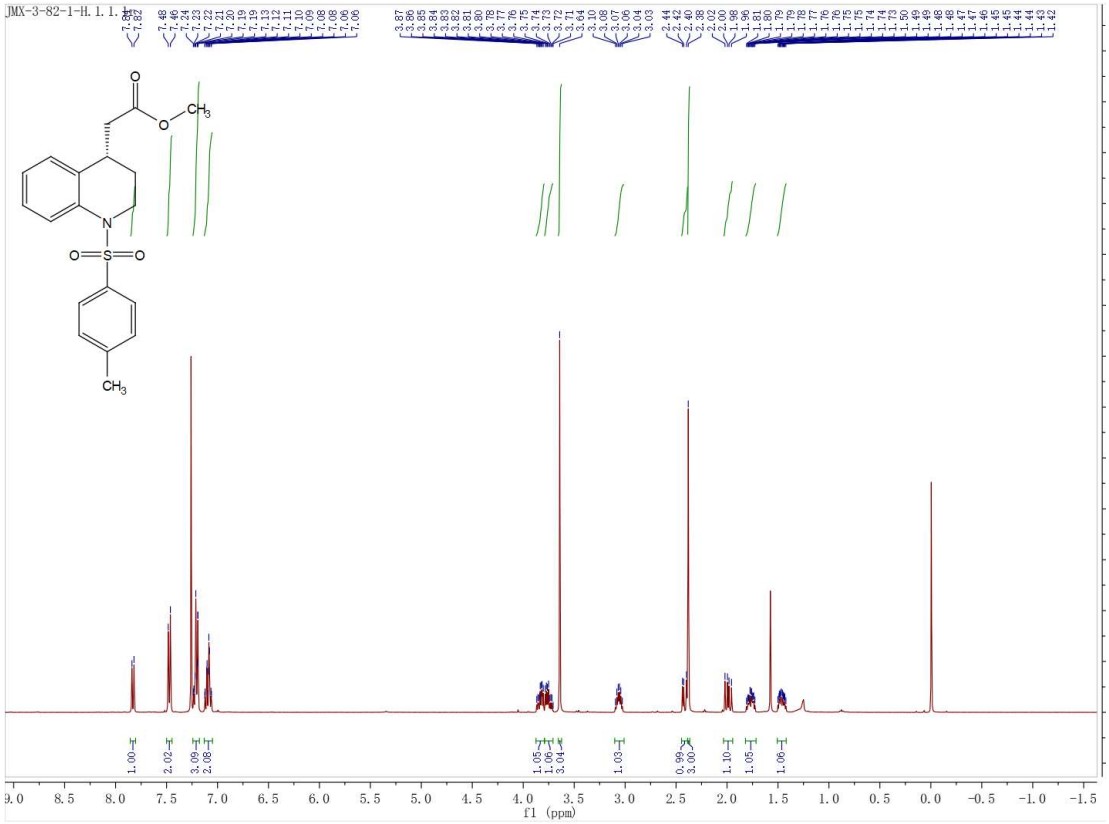
2s, ^{19}F NMR, 376 MHz, $CDCl_3$



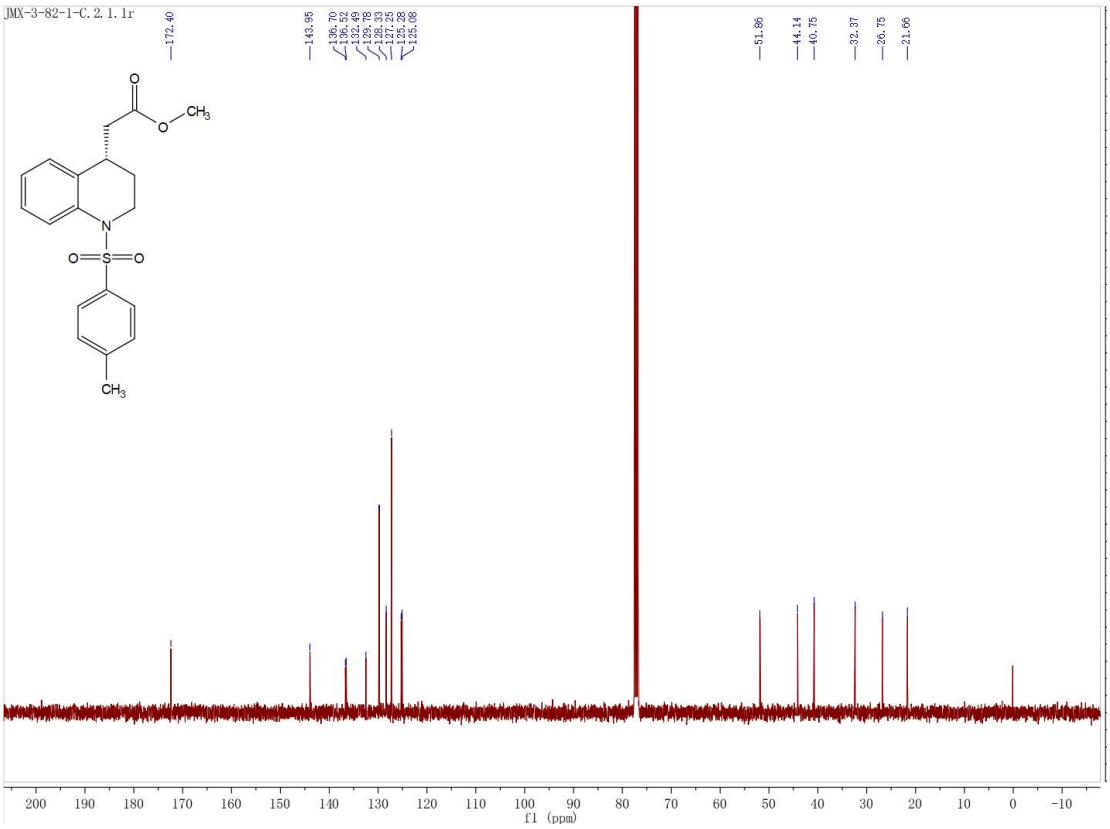
3a, ^{1}H NMR, 400 MHz, $CDCl_3$



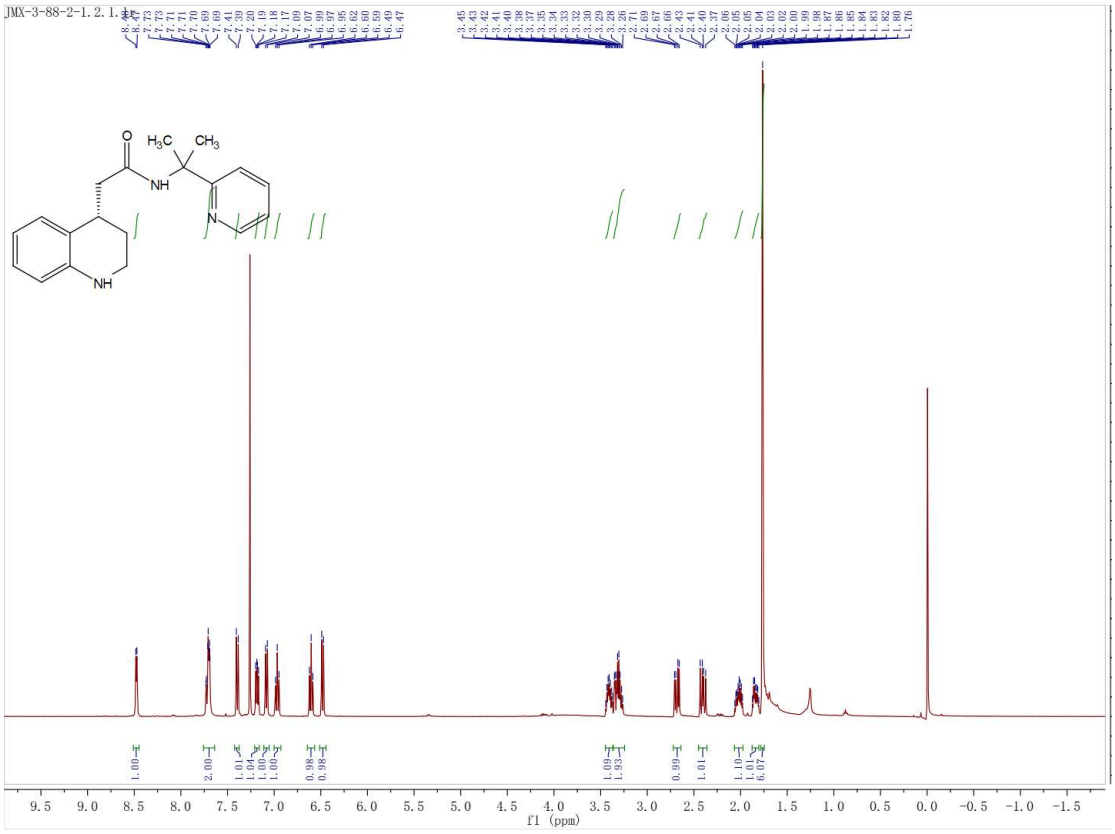
3b, ^{1}H NMR, 400 MHz, $CDCl_3$



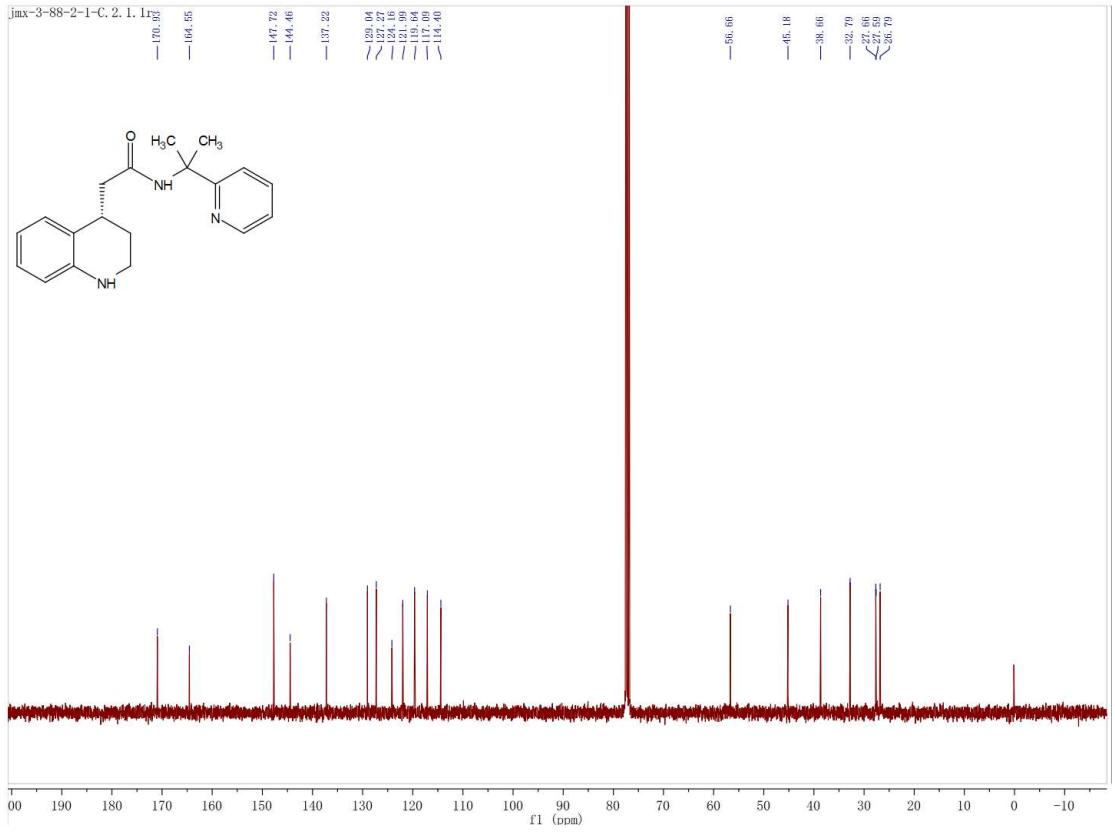
3b, ^{13}C NMR, 101 MHz, $CDCl_3$



3c, ^{1}H NMR, 400 MHz, $CDCl_3$



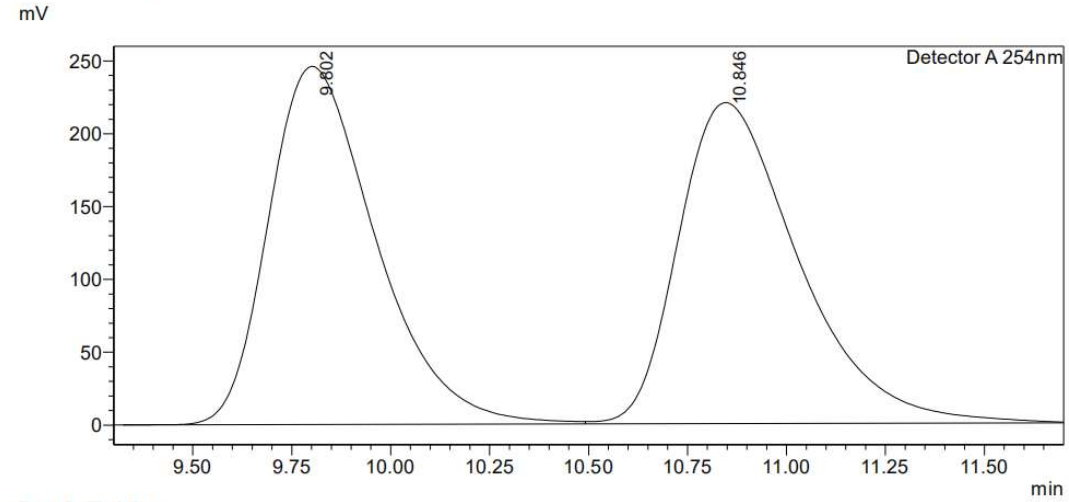
3c, ^{13}C NMR, 101 MHz, $CDCl_3$



7. HPLC Charts

2a: OD-H, Hexane/iPrOH=85/15, rate=0.8 mL/min, 254 nm

<Chromatogram>

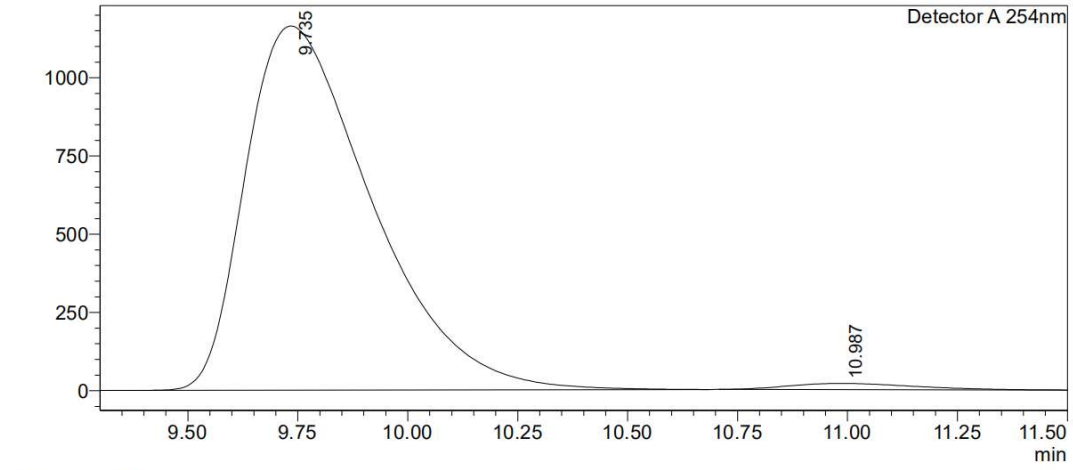


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.802	4635578	245886	49.808		M	
2	10.846	4671256	220393	50.192		V M	
Total		9306834	466279				

<Chromatogram>



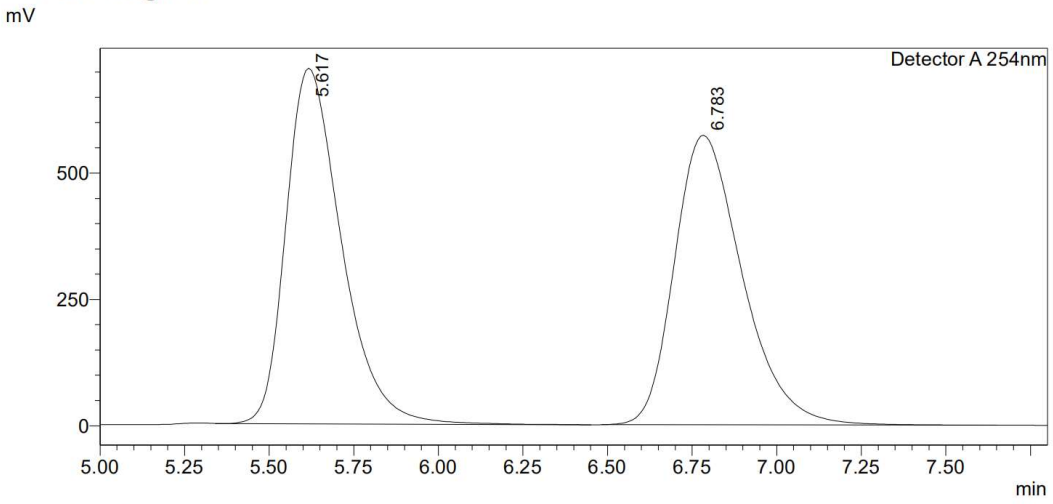
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.735	23244619	1163315	98.305		M	
2	10.987	400781	20092	1.695		M	
Total		23645401	1183408				

2b: OD-H, Hexane/iPrOH=80/20, rate=1.0 mL/min, 254 nm

<Chromatogram>

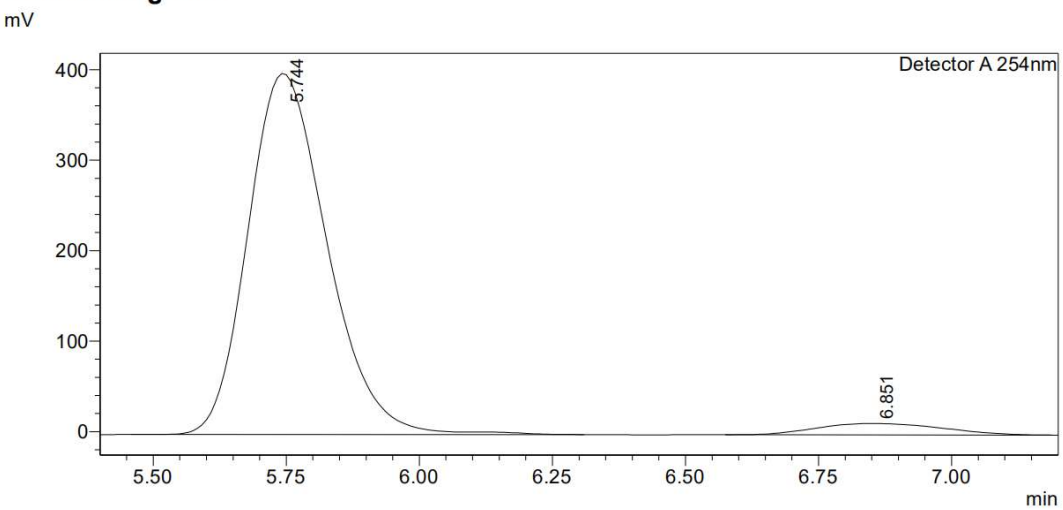


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.617	8045590	703505	50.144		M	
2	6.783	7999431	573059	49.856		M	
Total		16045020	1276564				

<Chromatogram>



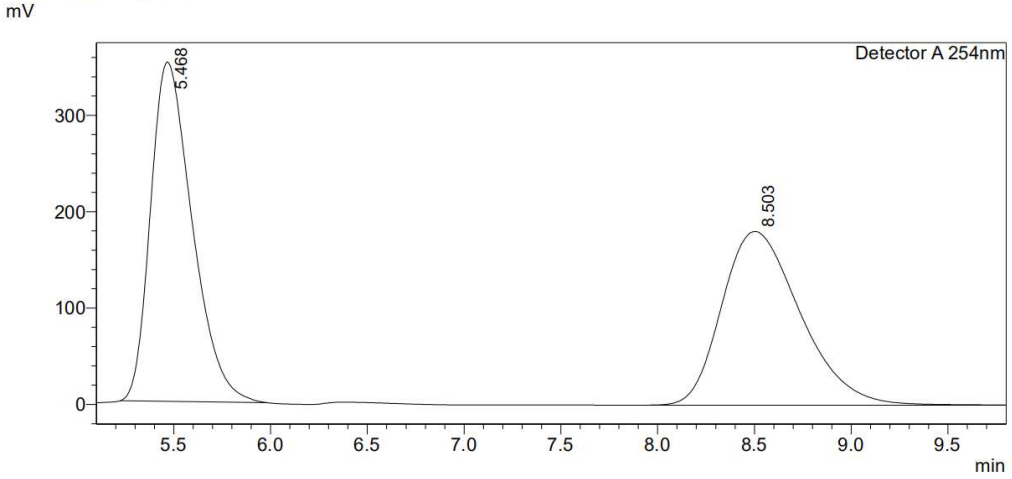
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.744	4132806	398903	95.206		M	
2	6.851	208091	12631	4.794		M	
Total		4340897	411534				

2c: AS-H, Hexane/iPrOH=80/20, rate=1.0 mL/min, 254 nm

<Chromatogram>

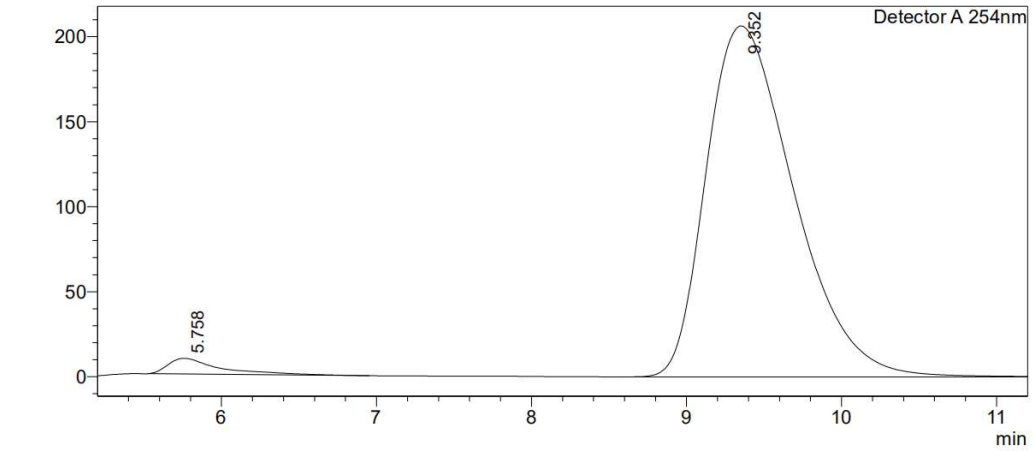


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.468	5275201	352175	50.893		M	
2	8.503	5090028	180164	49.107		M	
Total		10365230	532340				

<Chromatogram>



<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.758	215721	9213	2.589		M	
2	9.352	8115734	206430	97.411		M	
Total		8331455	215642				

2d: OD-H, Hexane/iPrOH=85/15, rate=1.0 mL/min, 254 nm

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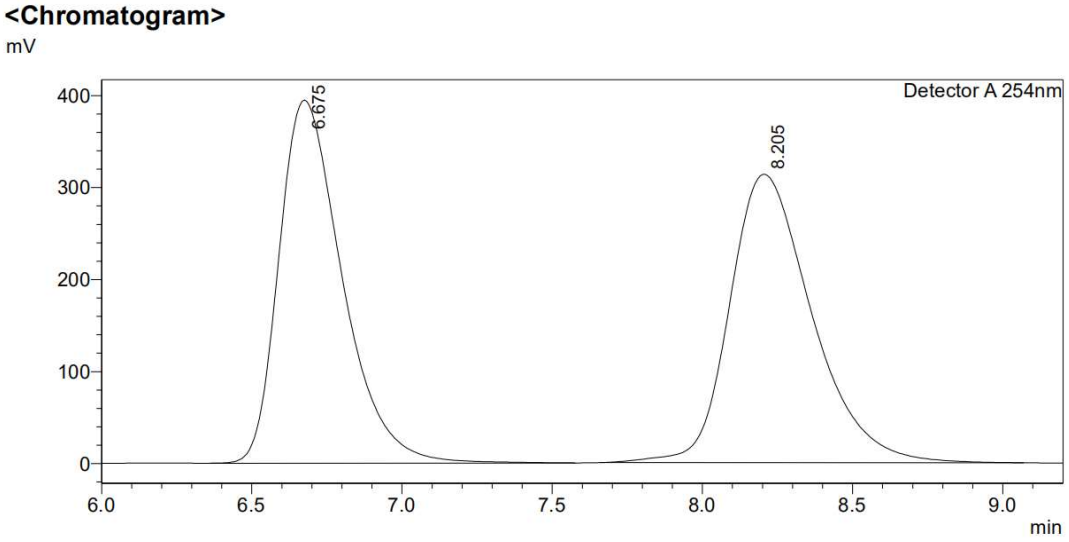

<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.675	5772260	394598	49.117		M	
2	8.205	5979837	313468	50.883		M	
Total		11752097	708066				

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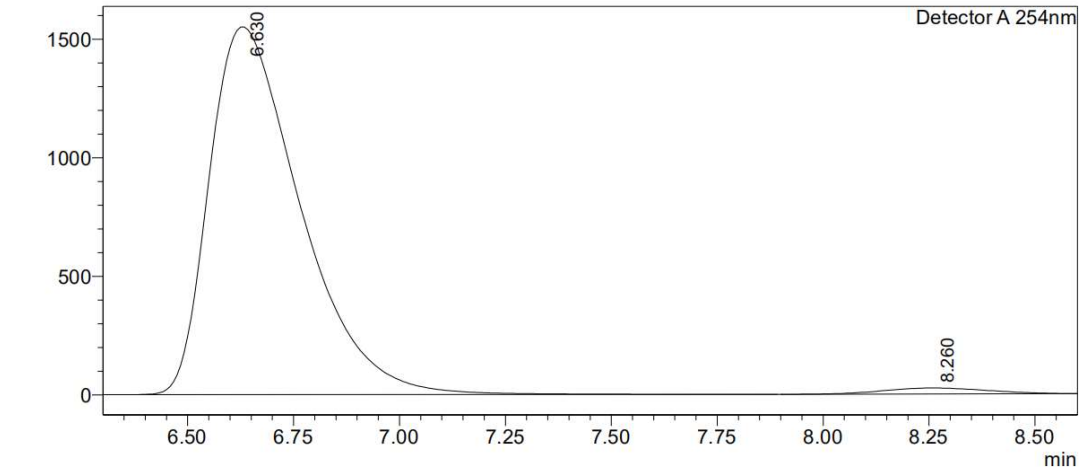

<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.630	23154648	1550086	98.110		M	
2	8.260	446049	25573	1.890		M	
Total		23600697	1575659				

2e: AS-H, Hexane/iPrOH=70/30, rate=1.0 mL/min, 254 nm

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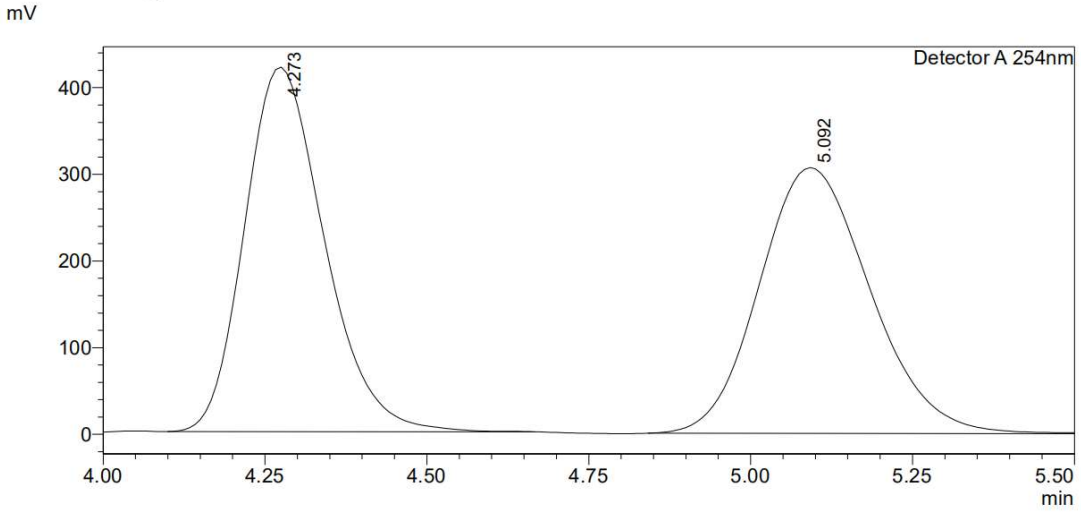
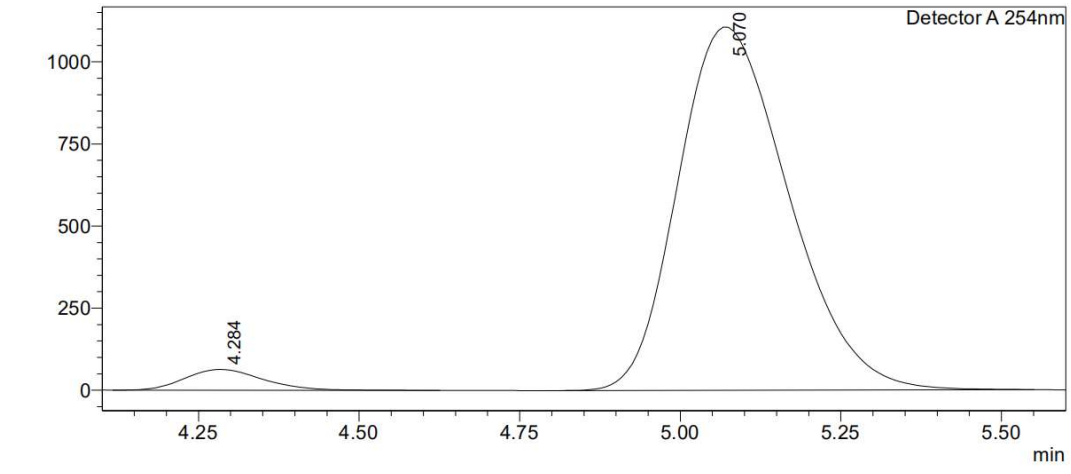


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.273	3607322	420396	49.626		M	
2	5.092	3661712	306637	50.374		M	
Total		7269034	727033				

<Chromatogram>



<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.284	530960	63288	3.857		M	
2	5.070	13234591	1105457	96.143		M	
Total		13765551	1168745				

2f: IA, Hexane/iPrOH=80/20, rate=1.0 mL/min, 254 nm

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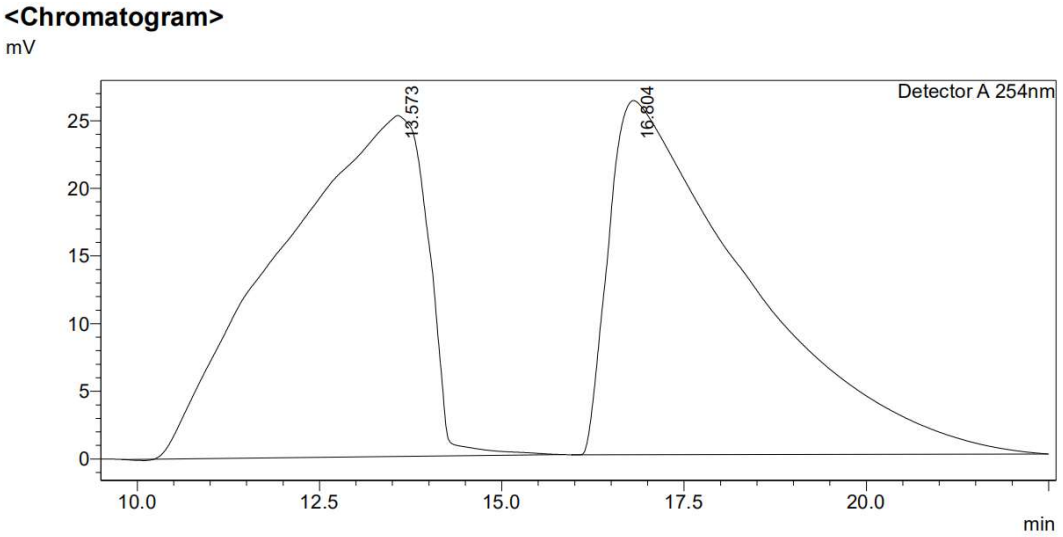
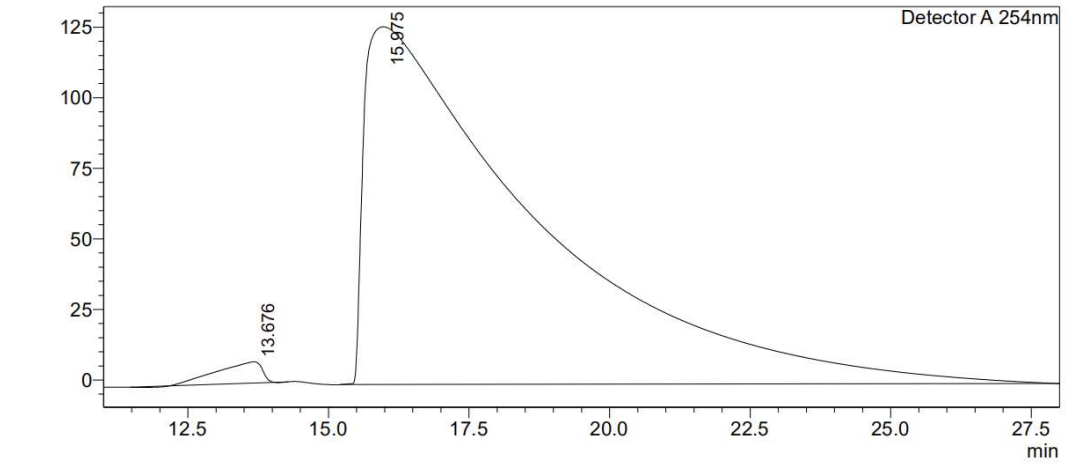


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	13.573	3553552	25201	50.595		M	
2	16.804	3469968	26175	49.405		M	
Total		7023520	51375				

<Chromatogram>



<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	13.676	424821	7525	1.558		M	
2	15.975	26849532	126747	98.442		M	
Total		27274353	134272				

2g: AS-H, Hexane/iPrOH=80/20, rate=1.0 mL/min, 254 nm

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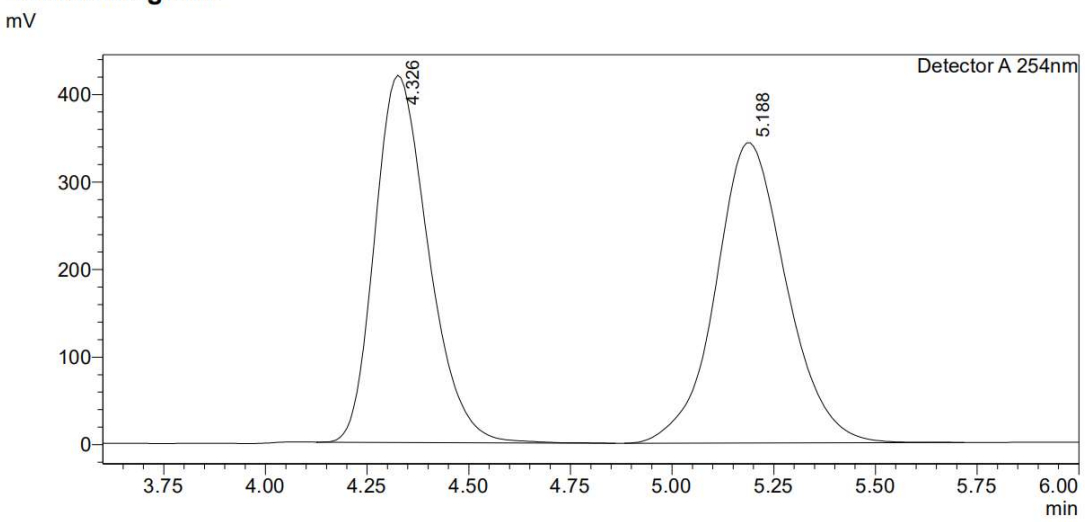
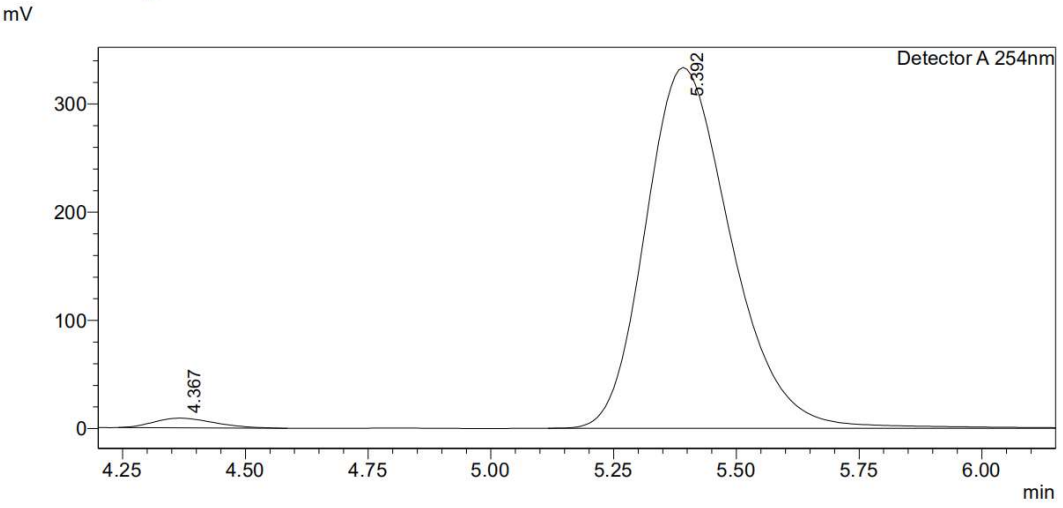


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.326	3849669	419447	48.087		M	
2	5.188	4155955	342921	51.913		M	
Total		8005623	762368				

<Chromatogram>



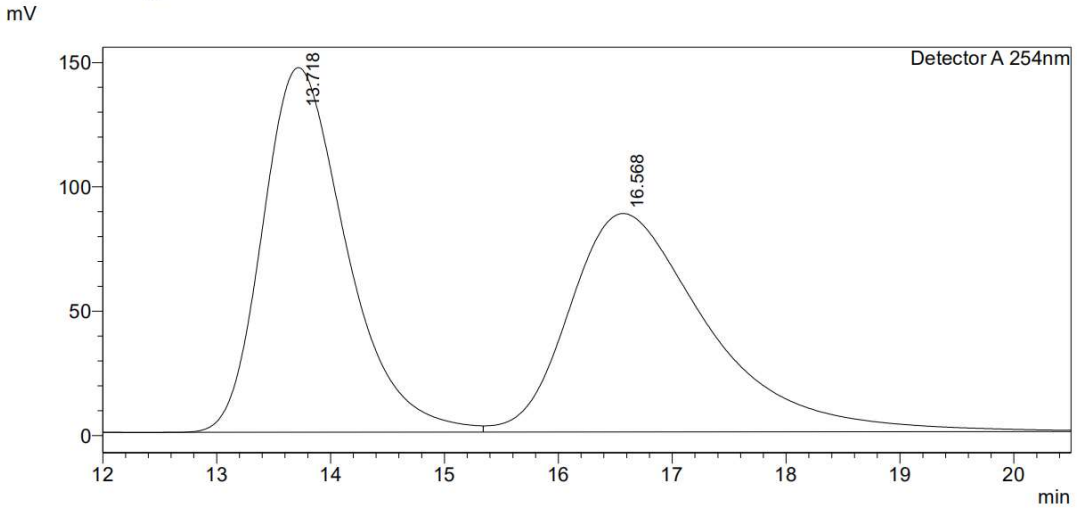
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	4.367	76503	8926	1.850		M	
2	5.392	4059505	333439	98.150		M	
Total		4136007	342365				

2h: AS-H, Hexane/iPrOH=70/30, rate=0.8 mL/min, 254 nm

<Chromatogram>

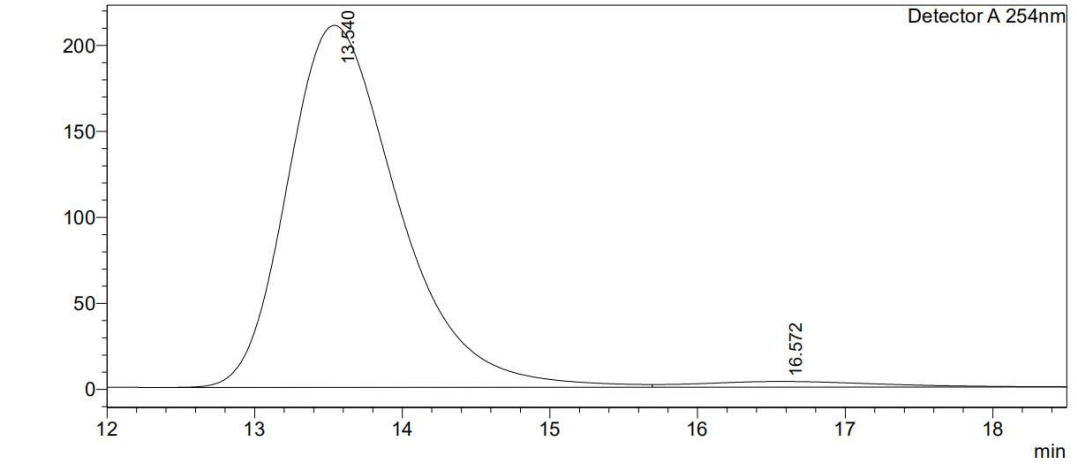


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	13.718	7497360	146640	50.106		M	
2	16.568	7465685	87816	49.894		V M	
Total		14963045	234456				

<Chromatogram>



<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	13.540	10988172	210450	97.549		M	
2	16.572	276035	3260	2.451		V M	
Total		11264206	213710				

2i: AD-H, Hexane/iPrOH=80/20, rate=1.0 mL/min, 254 nm

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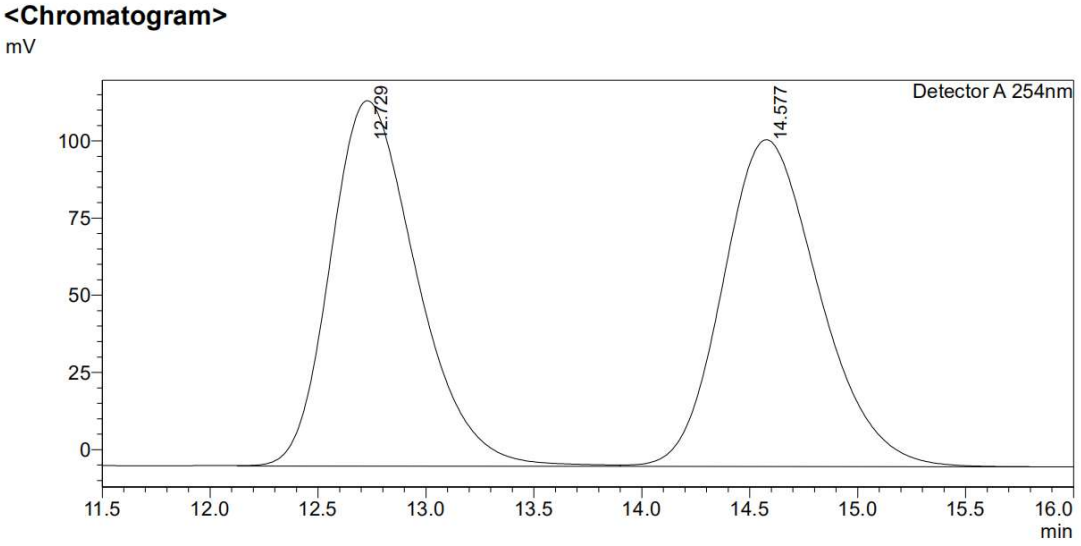
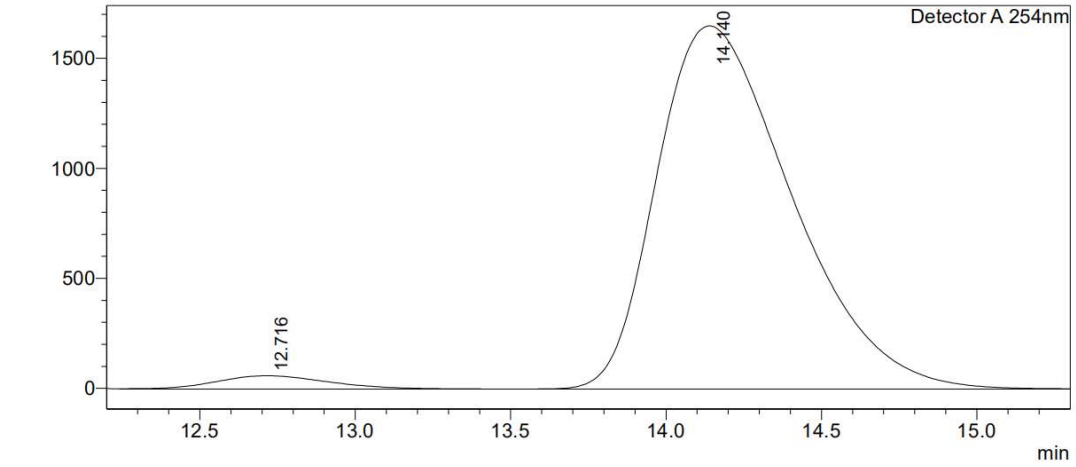


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	12.729	3292447	118369	49.959			
2	14.577	3297909	105856	50.041		V	
Total		6590357	224225				

<Chromatogram>



<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	12.716	1522478	60237	2.963			
2	14.140	49852042	1650780	97.037		V	
Total		51374521	1711017				

2j: OD-H, Hexane/iPrOH=85/15, rate=0.8 mL/min, 254 nm

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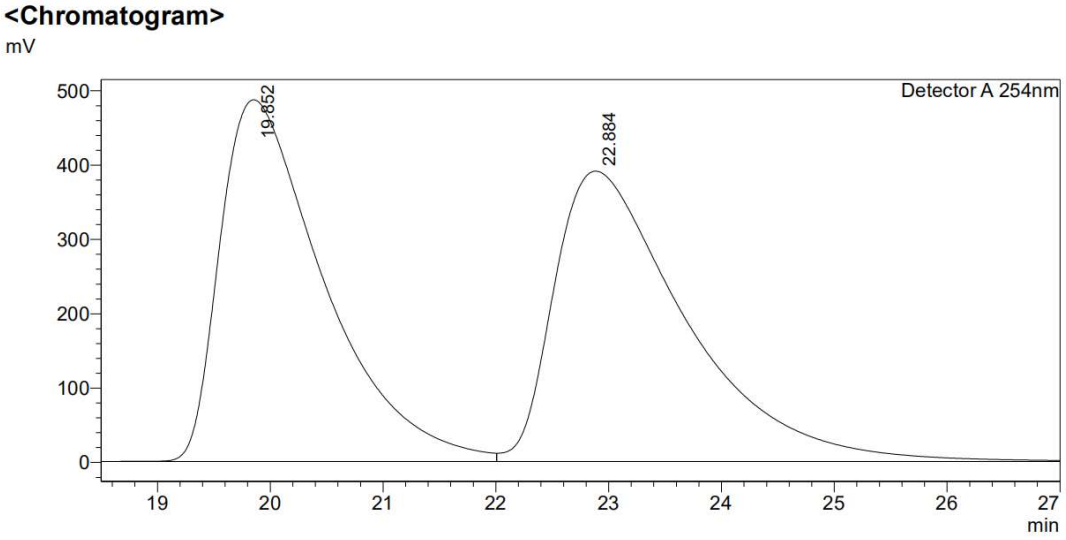
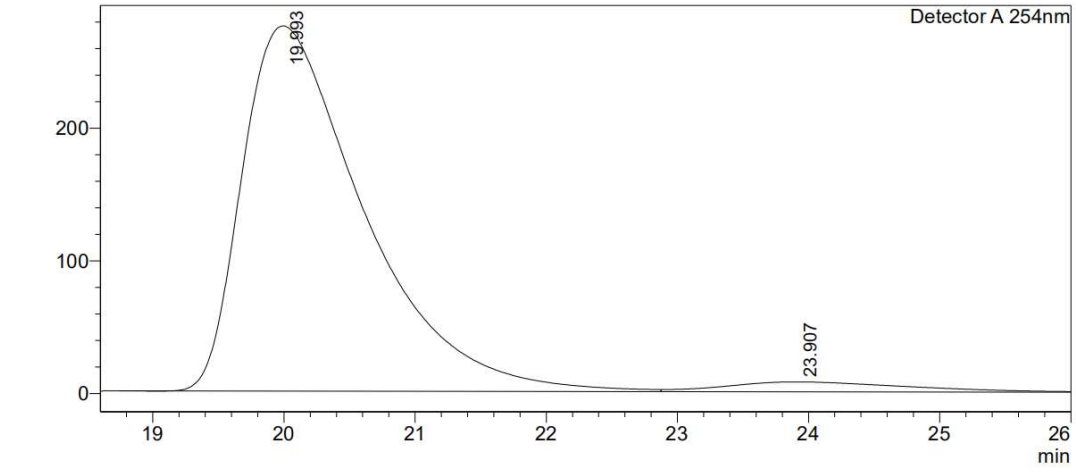


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	19.852	31214464	486566	49.512		M	
2	22.884	31830296	390583	50.488		V M	
Total		63044760	877149				

<Chromatogram>



<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	19.993	17793700	275316	96.111		M	
2	23.907	719922	7445	3.889		V M	
Total		18513622	282761				

2k: AD-H, Hexane/iPrOH=80/20, rate=1.0 mL/min, 254 nm

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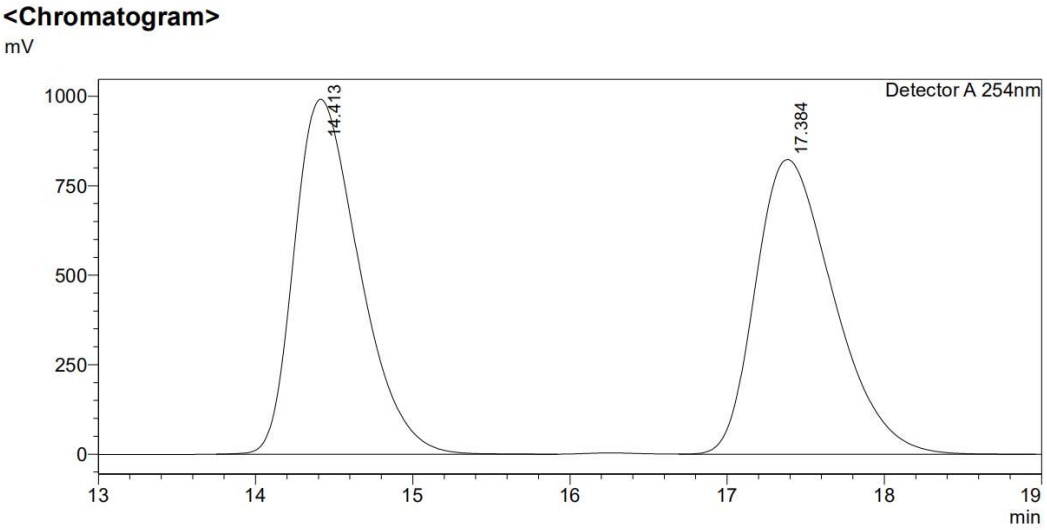
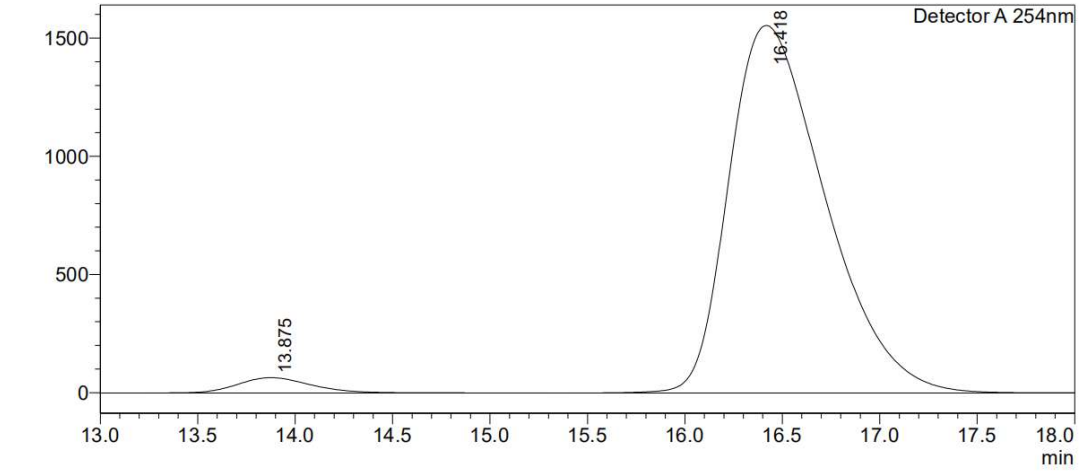


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	14.413	28521930	991908	50.025		M	
2	17.384	28493268	823796	49.975			
Total		57015198	1815703				

<Chromatogram>



<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	13.875	1704957	64525	3.092			
2	16.418	53432909	1554692	96.908			
Total		55137866	1619217				

2l: AD-H, Hexane/iPrOH=80/20, rate=1.0 mL/min, 254 nm

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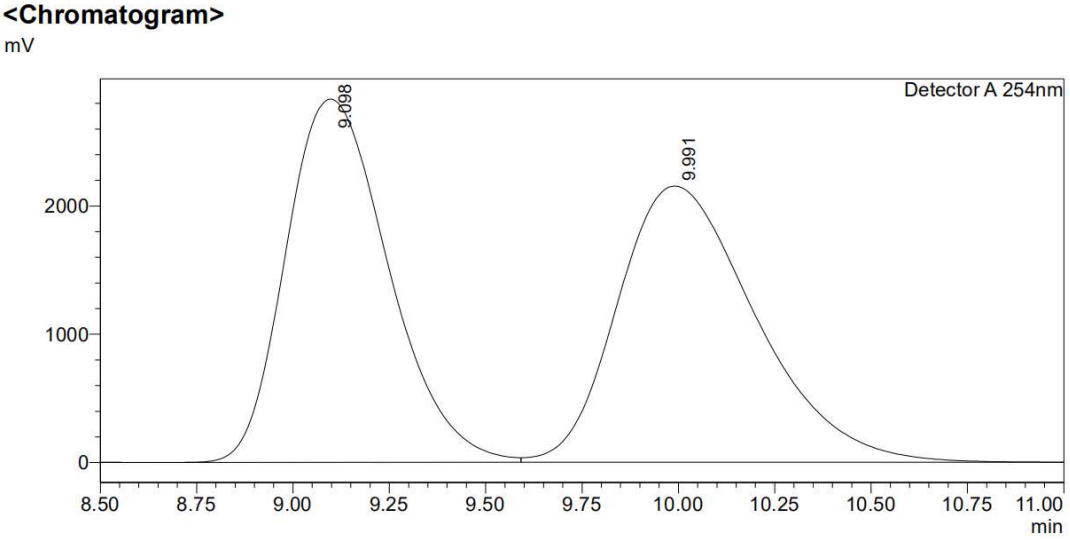
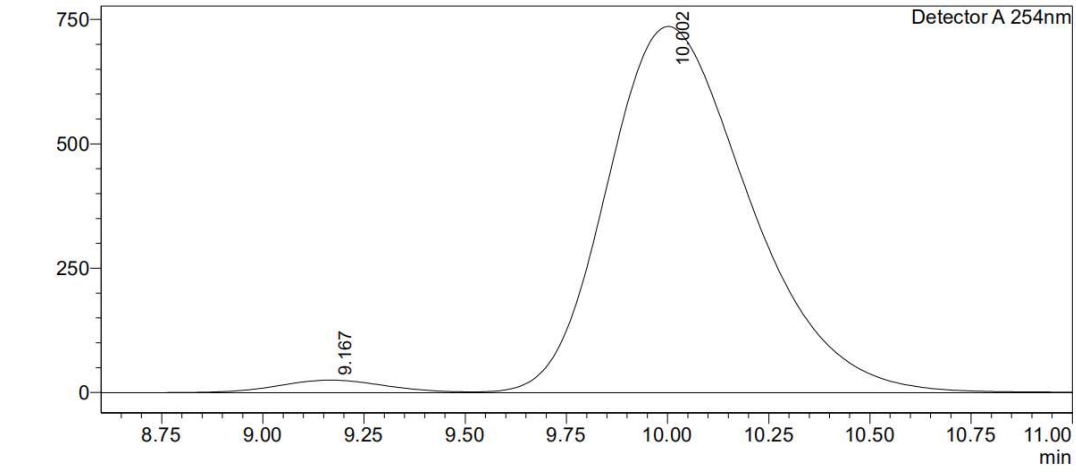


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.098	52499001	2831021	49.442		M	
2	9.991	53682954	2153483	50.558		V M	
Total		106181954	4984504				

<Chromatogram>



<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.167	467391	25238	2.533		M	
2	10.002	17984180	736060	97.467		V M	
Total		18451571	761298				

2m: AS-H, Hexane/iPrOH=80/20, rate=1.0 mL/min, 254 nm

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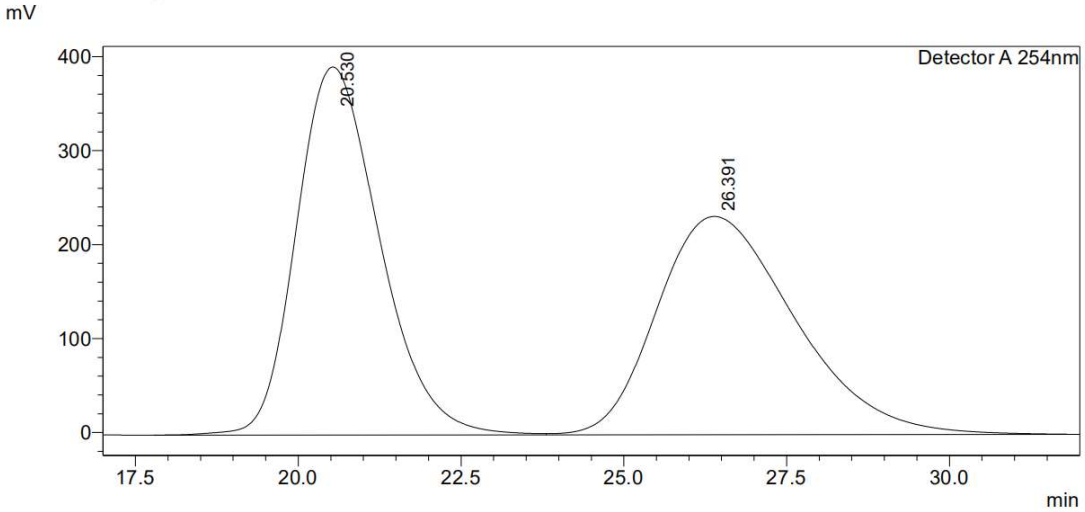
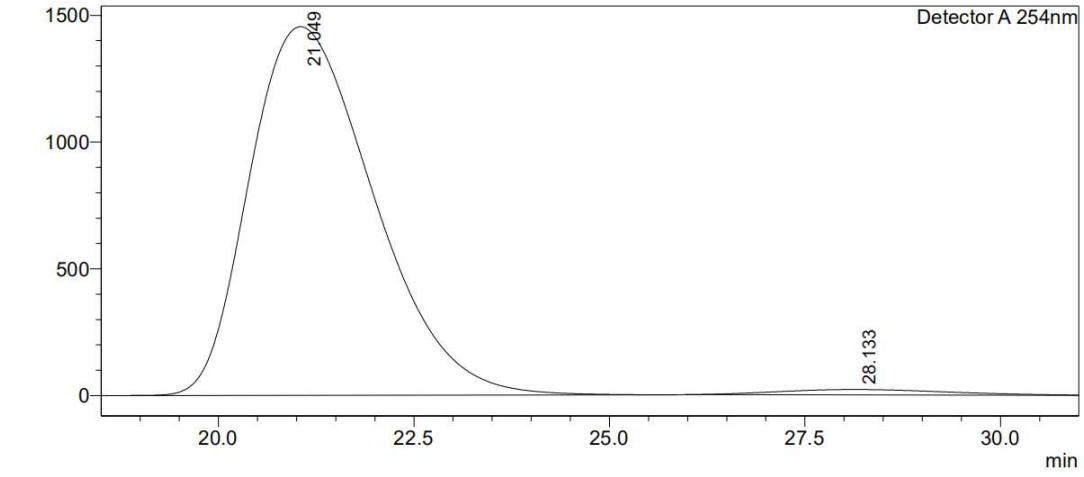


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	20.530	34912050	391576	50.547			
2	26.391	34155887	232212	49.453		V	
Total		69067937	623787				

<Chromatogram>



<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	21.049	160525786	1454202	97.997		M	
2	28.133	3281606	21597	2.003		M	
Total		163807392	1475799				

2n: AD-H, Hexane/iPrOH=80/20, rate=1.0 mL/min, 254 nm

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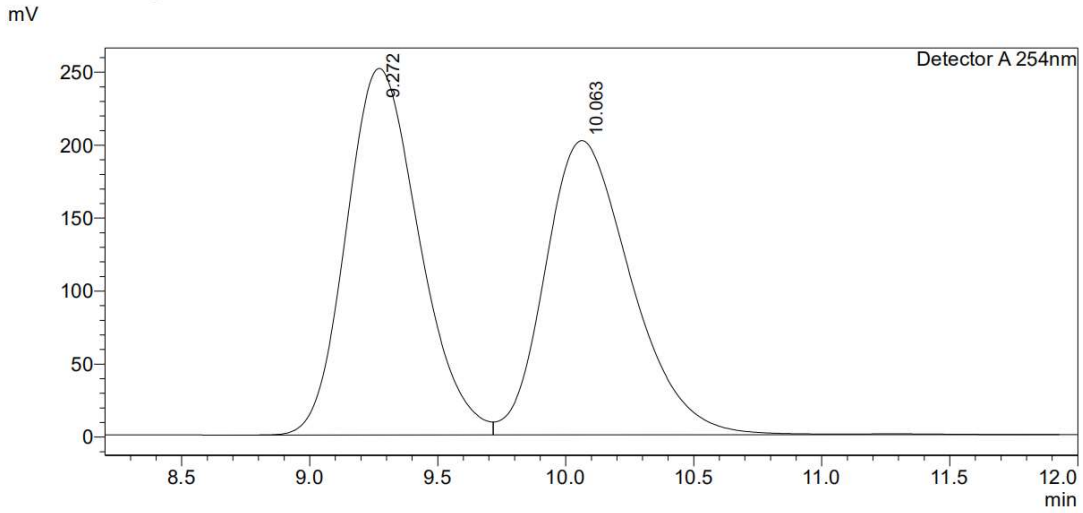
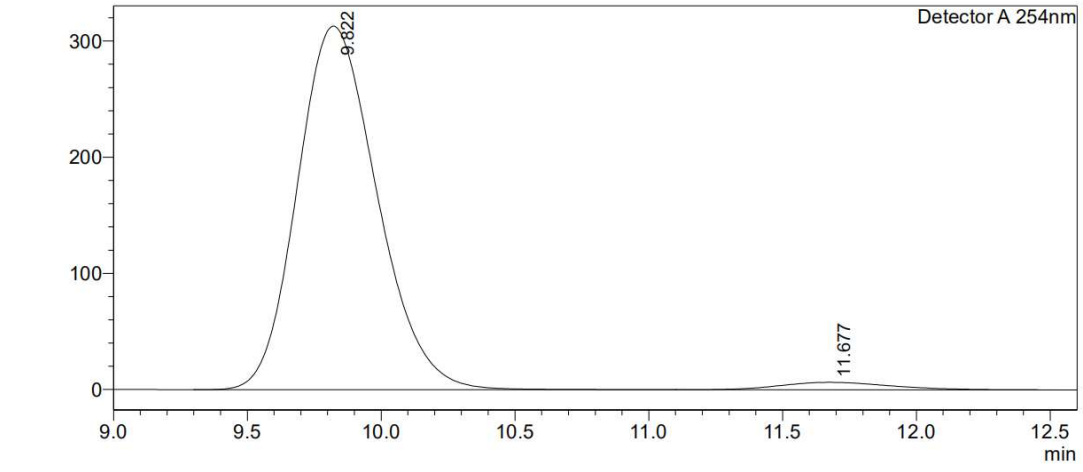


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.272	4964583	251079	51.282		M	
2	10.063	4716364	201515	48.718		V M	
Total		9680947	452595				

<Chromatogram>



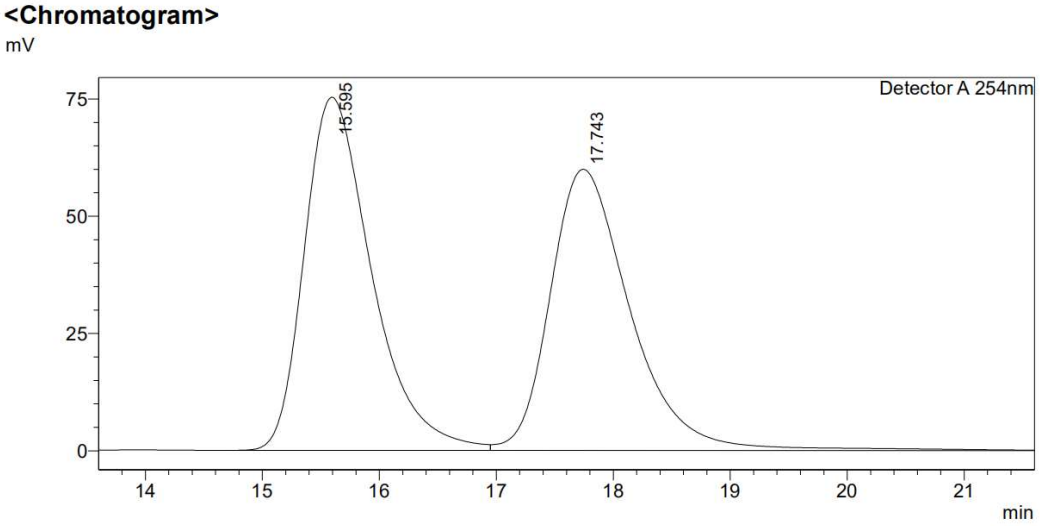
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.822	6489931	313014	97.266		M	
2	11.677	182451	6388	2.734		M	
Total		6672382	319403				

2o: OD-H, Hexane/iPrOH=80/20, rate=0.8 mL/min, 254 nm

<Chromatogram>

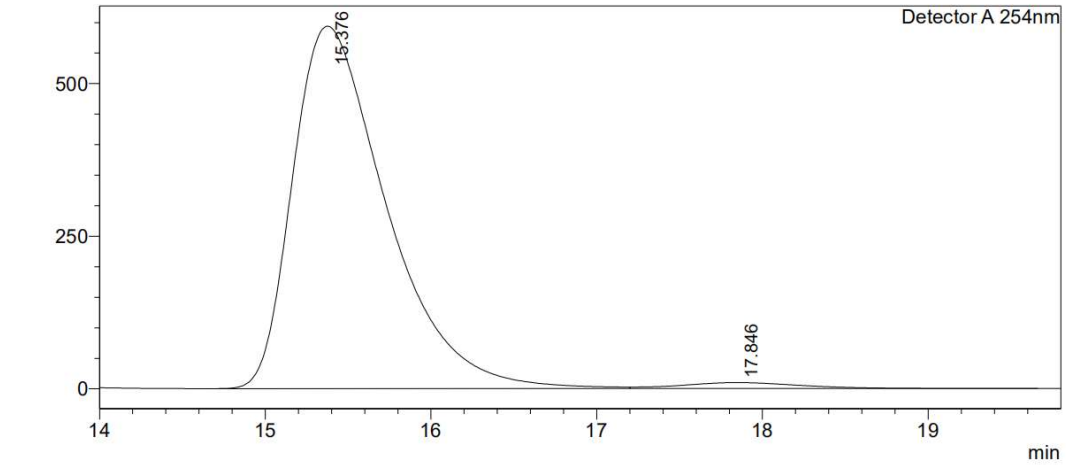


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	15.595	3016593	75266	51.265		M	
2	17.743	2867762	59942	48.735		V M	
Total		5884355	135208				

<Chromatogram>



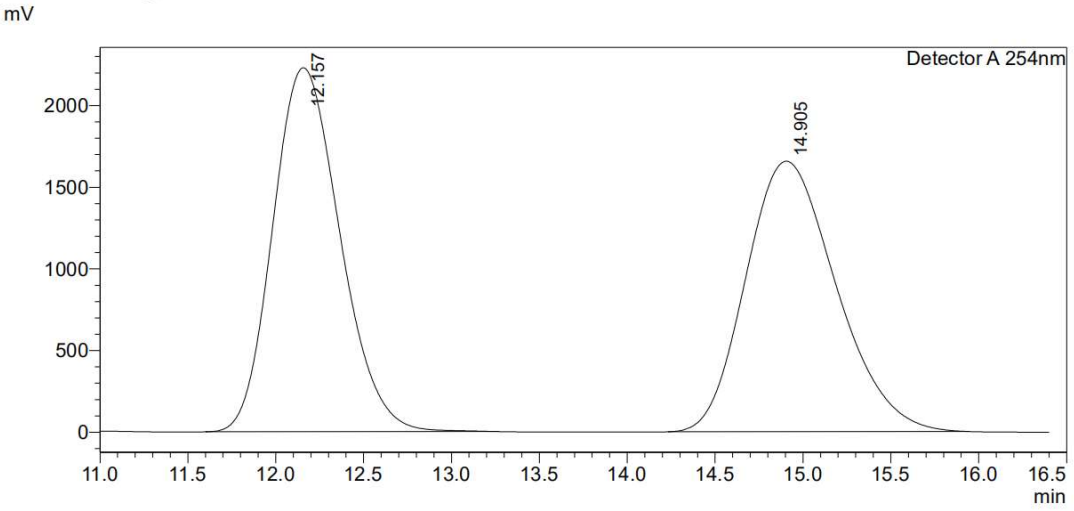
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	15.376	23368805	593582	97.924		M	
2	17.846	495383	9784	2.076		V M	
Total		23864188	603366				

2p: AD-H, Hexane/iPrOH=80/20, rate=1.0 mL/min, 254 nm

<Chromatogram>

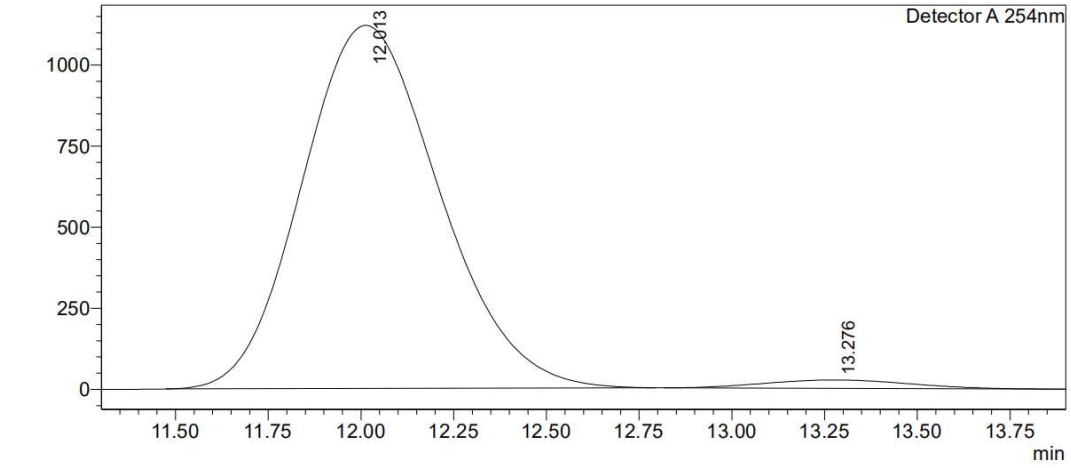


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	12.157	59255289	2228282	50.069		M	
2	14.905	59092452	1655795	49.931		M	
Total		118347741	3884077				

<Chromatogram>



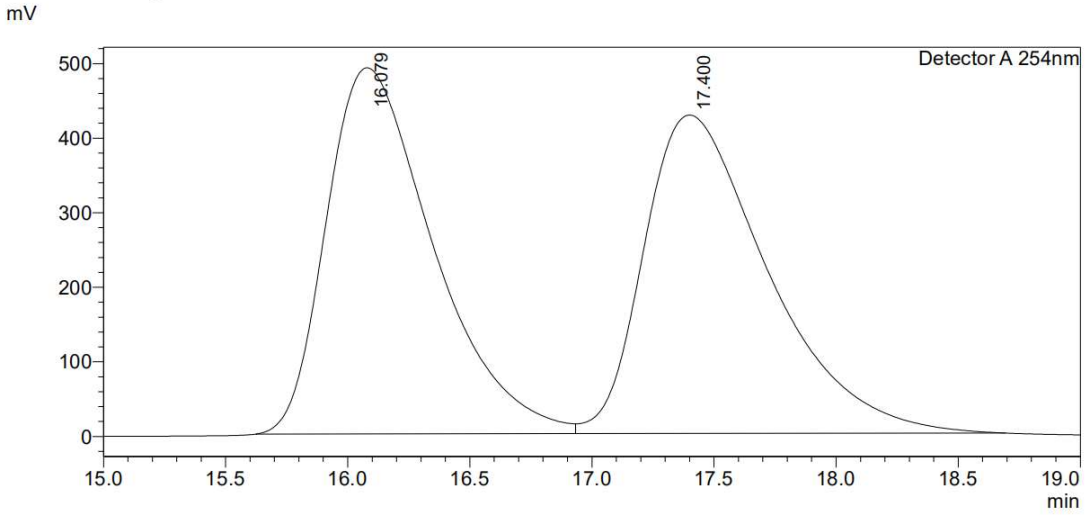
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	12.013	28882909	1119835	97.611		M	
2	13.276	706782	26075	2.389		M	
Total		29589691	1145911				

2q: IB N-5, Hexane/iPrOH=85/15, rate=1.0 mL/min, 254 nm

<Chromatogram>

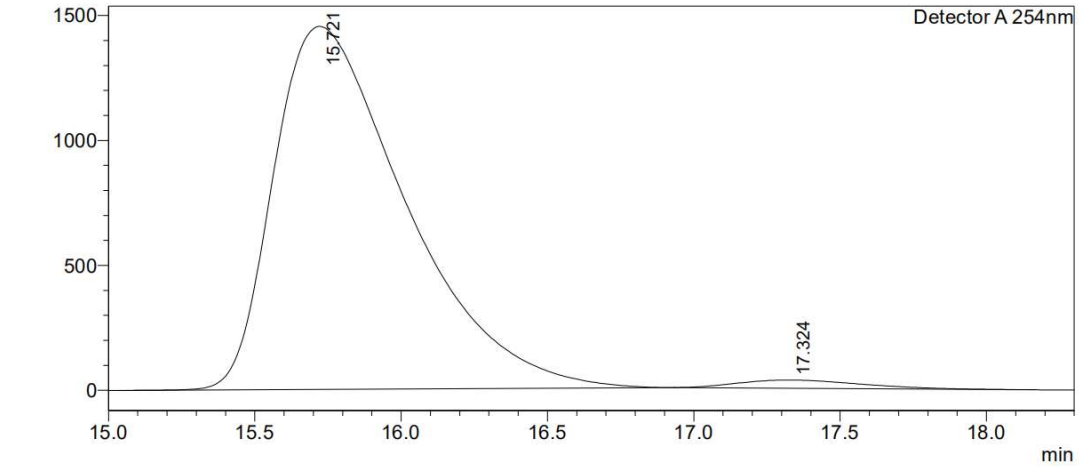


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	16.079	14920358	490807	49.740		M	
2	17.400	15076327	427094	50.260		V M	
Total		29996685	917901				

<Chromatogram>



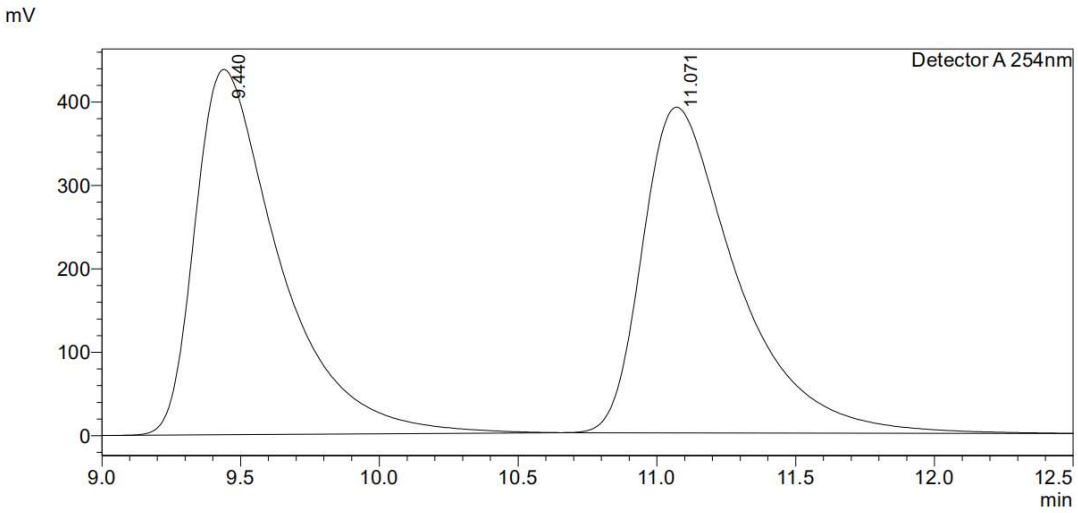
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	15.721	45581903	1452074	97.911		M	
2	17.324	972581	32992	2.089		M	
Total		46554484	1485067				

2r: IA, Hexane/iPrOH=80/20, rate=1.0 mL/min, 254 nm

<Chromatogram>

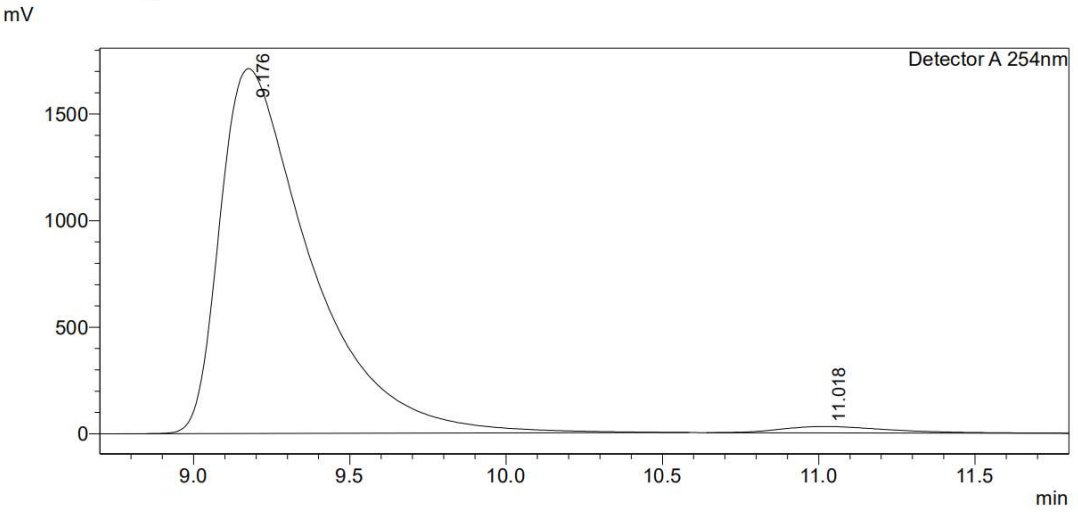


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.440	9298910	437872	50.014		M	
2	11.071	9293765	390341	49.986		M	
Total		18592675	828213				

<Chromatogram>



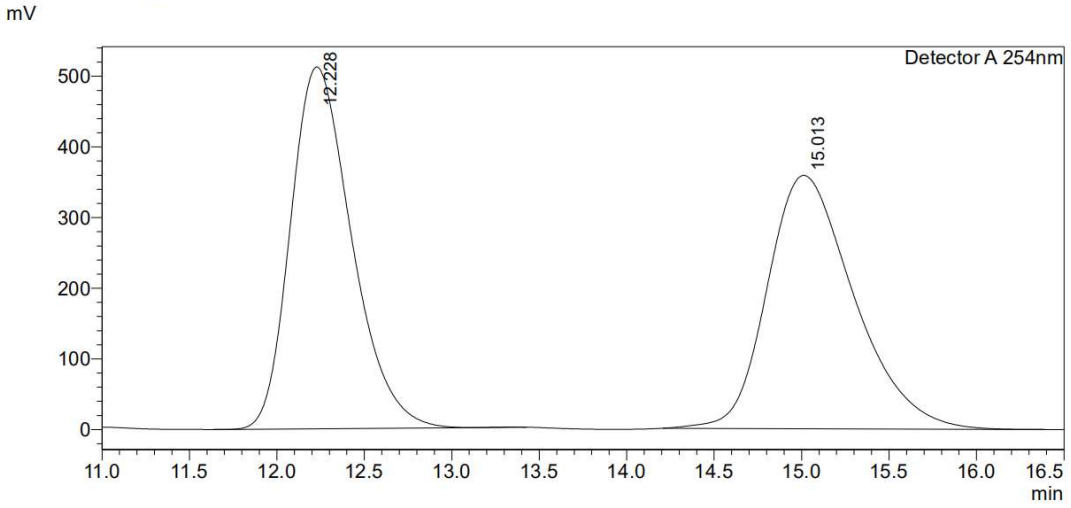
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	9.176	34625210	1712007	97.991		M	
2	11.018	710006	29822	2.009			
Total		35335217	1741829				

2s: AD-H, Hexane/iPrOH=80/20, rate=1.0 mL/min, 254 nm

<Chromatogram>

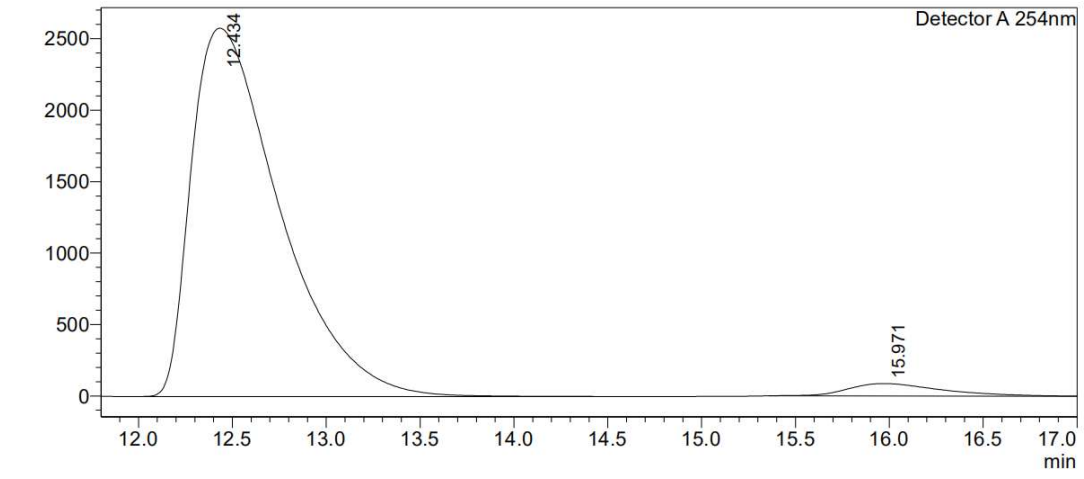


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	12.228	12444802	511988	50.155		M	
2	15.013	12367975	358409	49.845		M	
Total		24812777	870397				

<Chromatogram>



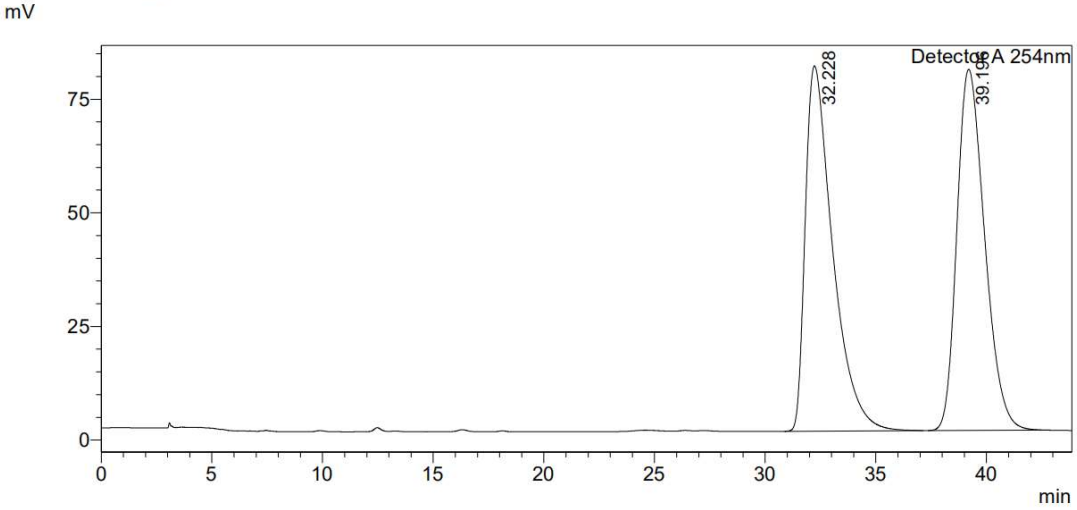
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	12.434	84690403	2577721	96.515		M	
2	15.971	3057631	87361	3.485		M	
Total		87748034	2665082				

3a: AD-H, Hexane/iPrOH= 90/10, rate=1.0 mL/min, 254 nm

<Chromatogram>

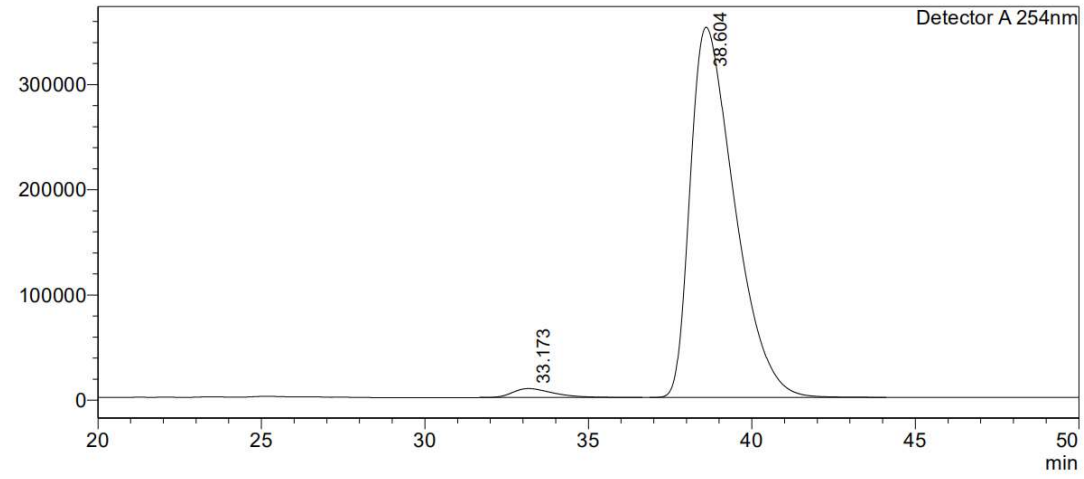


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	32.228	6910736	80371	49.969			
2	39.196	6919262	79474	50.031			
Total		13829998	159844				

<Chromatogram>



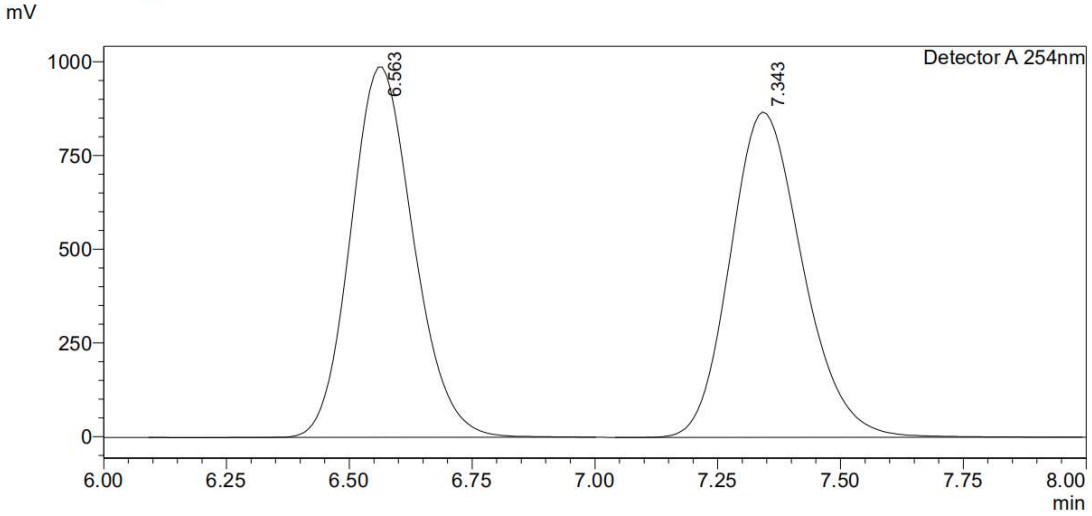
<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	33.173	740244	8516	2.180			
2	38.604	33215619	351926	97.820			
Total		33955863	360443				

3b: AD-H, Hexane/iPrOH= 80/20, rate=1.0 mL/min, 254 nm

<Chromatogram>

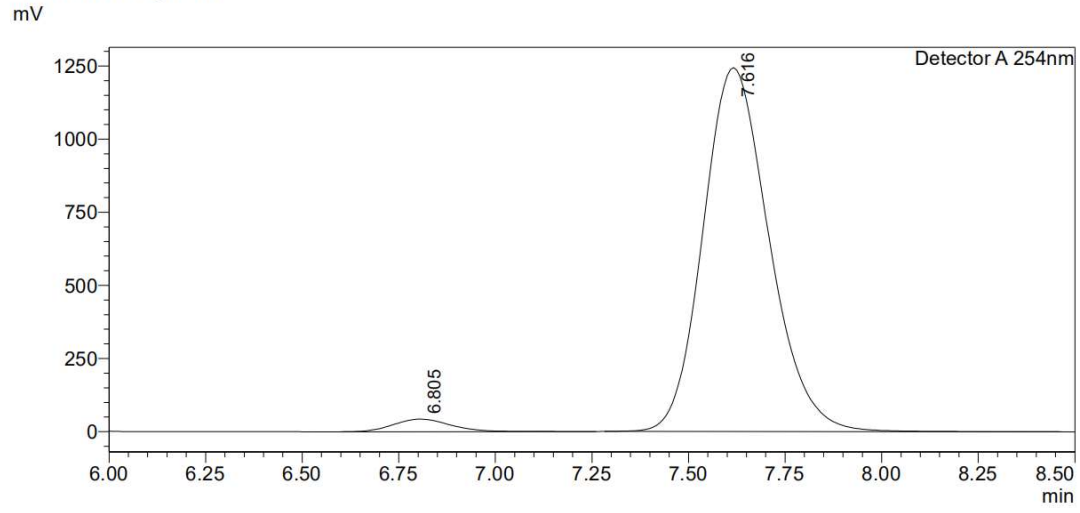


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.563	8815433	987522	49.701		M	
2	7.343	8921443	867800	50.299		M	
Total		17736876	1855321				

<Chromatogram>



<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	6.805	443479	42763	2.911		M	
2	7.616	14792376	1243875	97.089		M	
Total		15235855	1286638				

3c: AS-H, Hexane/iPrOH= 70/30, rate=1.0 mL/min, 254 nm

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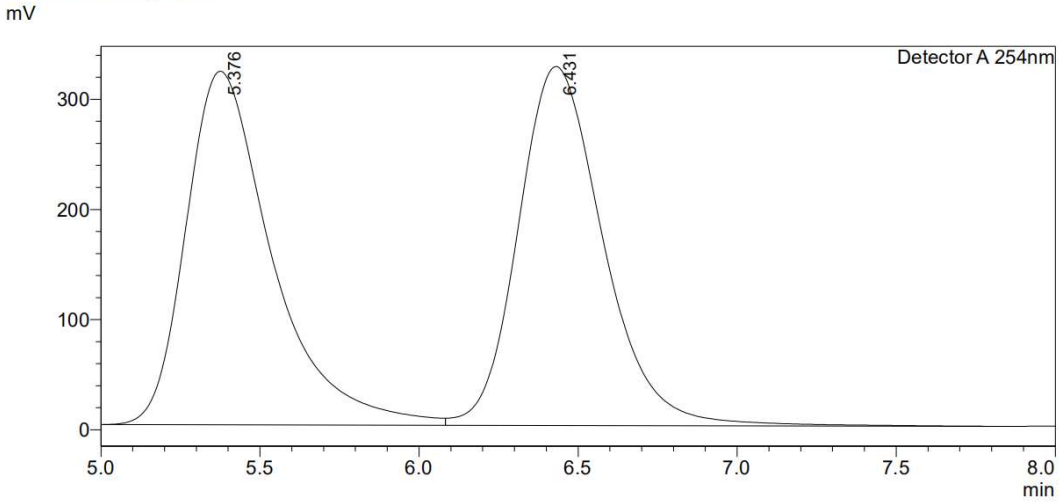
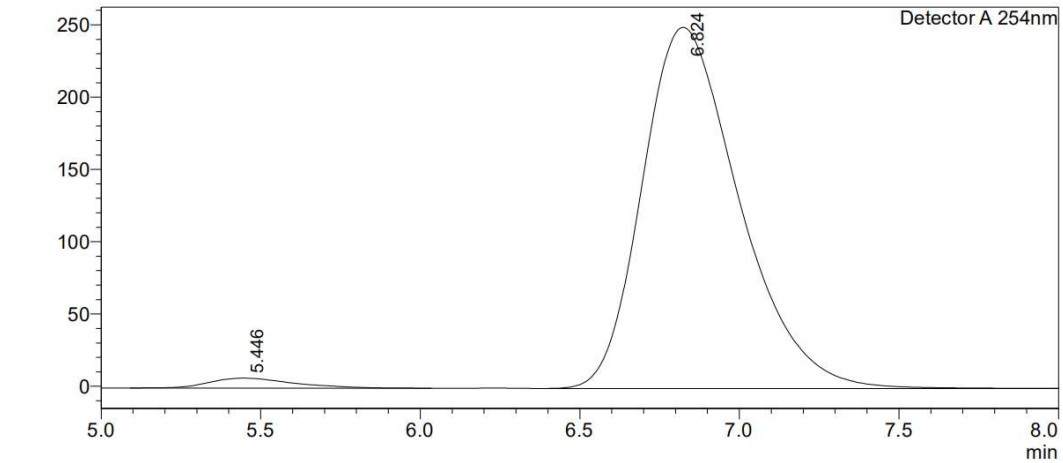


<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.376	6041098	321052	49.924		M	
2	6.431	6059587	325899	50.076		V M	
Total		12100685	646951				

<Chromatogram>



<Peak Table>

Detector A 254nm

Peak#	Ret. Time	Area	Height	Conc.	Unit	Mark	Name
1	5.446	126537	6900	2.337		M	
2	6.824	5287223	249834	97.663		M	
Total		5413760	256735				