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Cu(II)-catalyzed annulation of *α,β*-unsaturated ketoxime acetates with 3-formylchromones for the synthesis of functionalized 2,4-diarylpyridines

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Supporting Information

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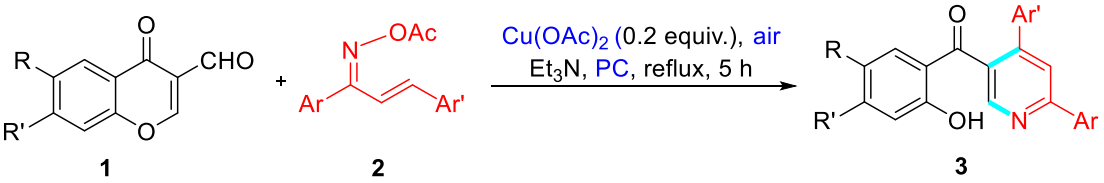
General Information

All compounds were fully characterised by spectroscopic data. The NMR spectra were recorded on a Bruker DRX600 or DRX500. Chemical shifts (δ) are expressed in ppm, J values are given in Hz, and deuterated DMSO-d_6 was used as solvent, the solvent residue in DMSO-d_6 (^{13}C NMR: 40.16 ppm, ^{1}H NMR, 2.50 ppm). IR spectra were recorded on a FT-IR Thermo Nicolet Avatar 360 using KBr pellet. The reactions were monitored by thin layer chromatography (TLC) using silica gel GF_{254}. The melting points were determined on a XT-4A melting point apparatus and are uncorrected. HRMs were performed on an Agilent LC/Msd TOF instrument.

The 3-formylchromones (**1a-1g**) were commercially available reagents. The α, β-unsaturated ketoxime (**2a-2g**)was synthesized by known literature procedures.[1] All the other chemicals and solvents were used as received without further purification unless otherwise stated. Two kinds of reagents which were used in the experiment were commercially available reagents.

General Procedure for the Preparation of 3

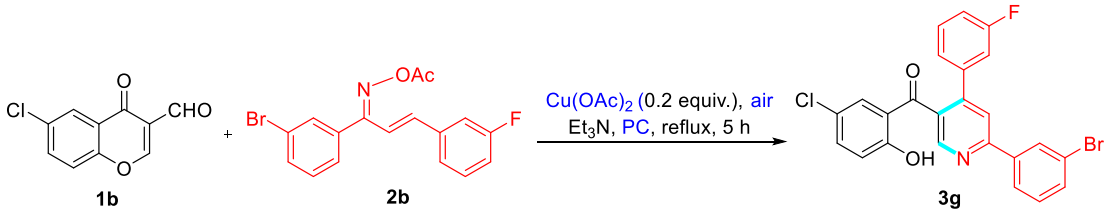


1 **2** **3**

A round-bottom flask was charged with the 3-formylchromones **1** (1.0 mmol, 1.0 equiv.), $Cu(OAc)_2$ (0.2 mmol, 0.2 equiv.), and Et_3N (2.0 mmol, 2.0 equiv.). Then, the flask was supplemented with propylene carbonate (PC) (3 mL) and the α,β-unsaturated Ketoxime **2** (1.1 mmol, 1.1 equiv.). Next, the mixture was stirred under reflux (on an oil bath) for five hours. At this stage, the substrates were completely consumed in the reaction system. After cooling the reaction mixture to room temperature, we extracted it with ethyl acetate (3 × 15 mL). The organic layer was washed with water and brine. Then, the combined organic phases were dried over $MgSO_4$. Finally, the organic phases were filtered and concentrated under reduced pressure. Thus, we obtained the crude product. Finally, we isolated the product **3** from

the crude mixture by performing flash column chromatography over silica gel. A mixture of petroleum ether/ethyl acetate (20:1-15:1, v/v) was used as the eluent.

Gram-Scale Experiments

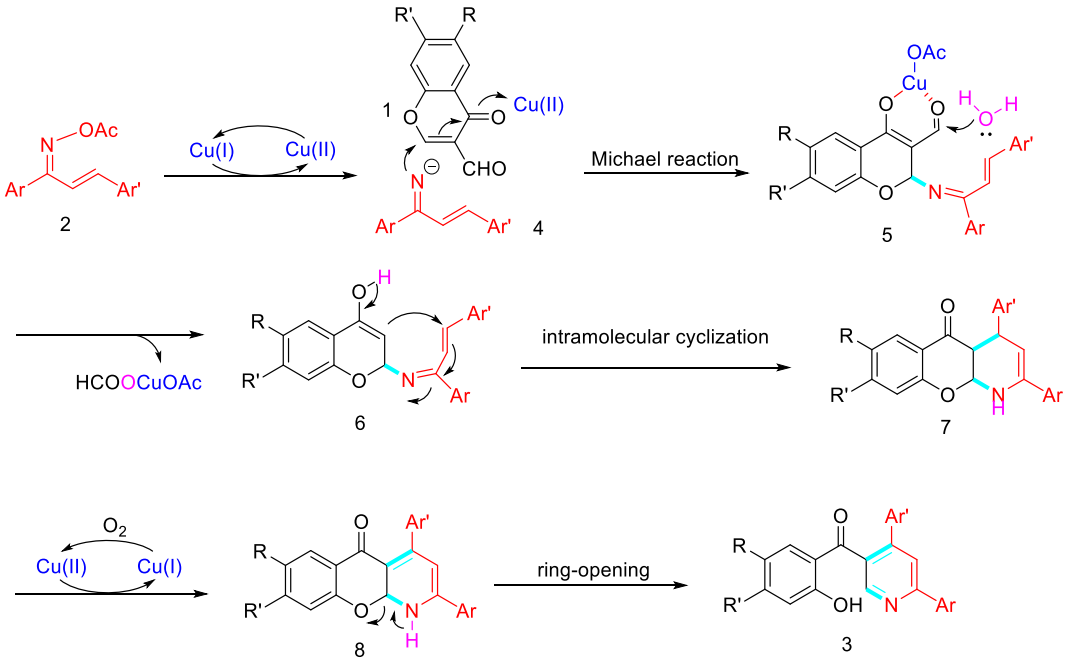


A round-bottom flask was charged with the 3-formylchromone **1b** (1.04 g, 5.0 mmol), $Cu(OAc)_2$ (0.18g, 1.0 mmol) and Et_3N (1.01g, 10.0 mmol). Then, the flask was supplemented with propylene carbonate (PC) (15 mL) and the *α,β*-unsaturated Ketoxime **2b** (1.99 g, 5.5 mmol), and the mixture was stirred under reflux (on oil bath) for 5 hours until the substrates were completely consumed. After cooling the reaction to room temperature, the mixture was extracted with ethyl acetate (3 × 150 mL). The organic layer was washed with water and brine, and the combined organic phases were dried over $MgSO_4$, filtered, and concentrated under reduced pressure to afford the crude product. Finally, product **3g** was purified from the crude mixture by flash column chromatography over silica gel using a mixture of petroleum ether/ethyl acetate (20:1, v/v) as the eluent with yield of 79% (1.89 g).

The proposed mechanism of the cascade reaction

Scheme S1 presents the proposed mechanism of the cascade reaction. Initially, the *α,β*-unsaturated ketoxime acetates **2** are converted to intermediates **4**, reduced by Cu(I). These key intermediates **4** then undergo a Michael reaction, attacking the double bond of the 3-formylchromones **1** to form intermediates **5**. This reaction involves the formation of copper complexes. Subsequently, intermediates **5** is transformed to intermediates **6** through a decarboxylation reaction promoted by water. The reaction then proceeds to form intermediates **7** via an intramolecular cyclization. Intermediates **7** undergoes ring-opening reaction to yield intermediates **8**. Finally,

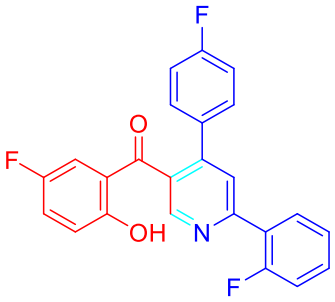
intermediates **8** is further oxidized by air in the presence of Cu(II) to produce the final products **3**.



Scheme S1. The Proposed Mechanism for the Formation of Compound **3**

Spectroscopic Data of 3a-3e'

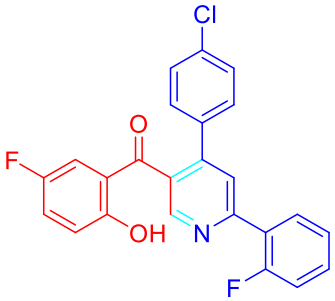
(5-Fluoro-2-hydroxyphenyl)(6-(2-fluorophenyl)-4-(4-fluorophenyl)pyridin-3-yl)-methanone (3a)



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 83%); Mp: 167.8−168.7 °C; IR (KBr) 3153, 3092, 2934, 1706, 1516, 1479, 1340, 1167, 1092, 977, 874, 769 cm^{-1}; ^1H NMR (500 MHz, DMSO-d_6): δ = 10.57 (s, 1H, OH), 8.79 (s, 1H, ArH), 8.05−8.08 (m, 1H, ArH), 7.87 (d, J = 0.95 Hz, 1H, ArH), 7.53−7.78 (m, 1H, ArH), 7.36−7.45 (m, 4H, ArH), 7.17−7.28 (m, 4H, ArH), 6.82−6.85 (m, 1H, ArH) ppm; $^{13}C\{^1H\}$ NMR (125 MHz, DMSO-d_6): δ = 196.3, 162.8 (J_1 = 245.0 Hz), 160.5 (J_1 = 247.5 Hz), 156.2, 155.4, 154.6, 154.3, 149.2, 147.7, 134.2 (J_3 = 6.3 Hz), 132.1 (J_3 = 8.8 Hz), 131.6, 131.6, 131.3 (J_3 = 7.5 Hz), 126.6 (J_3 = 11.3 Hz), 125.4, 125.4, 124.8 (J_3 = 8.8 Hz), 124.2 (J_3 = 6.3 Hz), 122.9 (J_2 = 23.8 Hz), 119.2 (J_3 = 7.5 Hz), 117.0, 116.7 (J_2 = 25.0

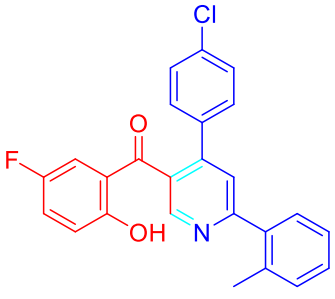
Hz), 116.0 (J_2 = 21.3 Hz) ppm. ^{19}F NMR (470 MHz, DMSO-d_6): δ = −108.3, −111.7, −120.1 ppm. HRMS (TOF ES$^+$): *m/z* calcd for $C_{24}H_{14}F_3NO_2$ $[M+H]^+$, 406.1049; found, 406.1049.

(4-(4-Chlorophenyl)-6-(2-fluorophenyl)pyridin-3-yl)(5-fluoro-2-hydroxyphenyl)-methanone (3b)



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 81%; Mp: 157.2−158.8 °C; IR (KBr) 3250, 3207, 1766, 1639, 1591, 1486, 1326, 1012, 955, 858, 694 cm^{-1}; ^{1}H NMR (500 MHz, DMSO-d_6): δ = 10.56 (s, 1H, OH), 8.79 (s, 1H, ArH), 8.04−8.07 (m, 1H, ArH), 7.88 (d, J = 0.65 Hz, 1H, ArH), 7.54−7.59 (m, 1H, ArH), 7.37−7.46 (m, 6H, ArH), 7.27−7.31 (m, 1H, ArH), 7.20−7.22 (m, 1H, ArH), 6.82−6.85 (m, 1H, ArH) ppm; ^{13}C{^{1}H} NMR (125 MHz, DMSO-d_6): δ = 196.1, 160.5 (J_1 = 247.5 Hz), 155.3 (J_1 = 235.0 Hz), 155.3, 154.7, 149.2, 147.5, 136.7, 134.2, 132.2 (J_3 = 8.8 Hz), 131.6, 130.9, 129.1, 126.6 (J_3 = 11.3 Hz), 125.4, 125.4, 124.8 (J_3 = 8.8 Hz), 124.3 (J_3 = 6.3 Hz), 122.9 (J_2 = 23.8 Hz), 119.3, 119.3, 116.9 (J_2 = 22.5 Hz), 116.8, 116.6 ppm. ^{19}F NMR (470 MHz, DMSO-d_6): δ = −116.5, −124.9 ppm. HRMS (TOF ES$^+$): *m/z* calcd for $C_{24}H_{14}ClF_2NO_2$ $[M+H]^+$, 422.0754; found, 422.0758.

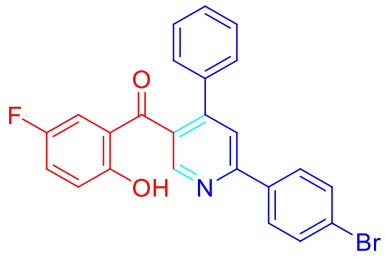
(4-(4-Chlorophenyl)-6-(o-tolyl)pyridin-3-yl)(5-fluoro-2-hydroxyphenyl)methan-one (3c)



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 80%); Mp: 155.7−156.6 °C; IR (KBr) 3248, 3151, 2998, 1820, 1728, 1626, 1485, 1334, 1244, 1062, 886, 619 cm^{-1}; ^{1}H NMR (500 MHz, DMSO-d_6): δ = 10.61 (s, 1H, OH), 8.73 (s, 1H, ArH), 7.64 (s, 1H, ArH), 7.57 (d, J = 7.3 Hz, 1H, ArH), 7.19−7.47 (m, 9H, ArH), 6.52−6.88 (m, 1H,

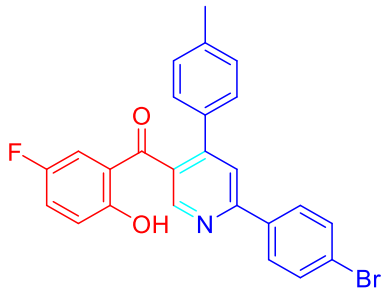
ArH), 2.43 (s, 3H, CH_3) ppm; $^{13}C\{^1H\}$ NMR (125 MHz, DMSO-d_6): δ = 196.6, 161.4, 155.5, 155.2 (J_1 = 235.0 Hz), 148.6, 147.3, 139.6, 136.7, 136.2, 134.1, 133.2, 131.3, 131.0, 130.3, 129.2, 129.0, 126.4, 124.6, 124.2, 124.2, 122.9 (J_2 = 23.8 Hz), 119.3 (J_3 = 7.5 Hz), 116.9, 116.7, 20.7 ppm. ^{19}F NMR (470MHz, DMSO-d_6): δ = −124.8 ppm. HRMS (TOF ES^+): *m/z* calcd for $C_{25}H_{17}ClFNO_2$ $[M+H]^+$, 418.1005; found, 418.1007.

(6-(4-Bromophenyl)-4-phenylpyridin-3-yl)(5-fluoro-2-hydroxyphenyl)methanone (3d)



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 80%); Mp: 193.5−194.2 °C; IR (KBr) 3251, 3035, 2916, 1765, 1580, 1433, 1248, 1178, 1005, 964, 907 cm^{-1}; ^1H NMR (600 MHz, DMSO-d_6): δ = 10.60 (s, 1H, OH), 8.74 (d, J = 0.24 Hz, 1H, ArH), 8.21−8.24 (m, 2H, ArH), 8.10 (s, 1H, ArH), 7.72−7.74 (m, 1H, ArH), 7.43−7.45 (m, 2H, ArH), 7.33−7.38 (m, 4H, ArH), 7.23−7.27 (m, 1H, ArH), 7.14−7.16 (m, 1H, ArH), 6.82−6.84 (m, 1H, ArH) ppm; $^{13}C\{^1H\}$ NMR (150 MHz, DMSO-d_6): δ = 196.9, 156.9, 155.6, 155.1 (J_1 = 234.0 Hz), 149.4, 149.2, 137.8, 137.4, 134.1, 132.3, 132.3, 129.6, 129.2 (J_3 = 7.5 Hz), 129.2, 128.9, 128.9, 124.0, 123.9, 123.9, 122.9 (J_2 = 22.5 Hz), 121.2, 119.3 (J_3 = 7.5 Hz), 116.9, 116.8 ppm. ^{19}F NMR (564 MHz, DMSO-d_6): δ = −124.9 ppm. HRMS (TOF ES^+): *m/z* calcd for $C_{24}H_{15}BrFNO_2$ $[M+H]^+$, 448.0343; found, 448.0349.

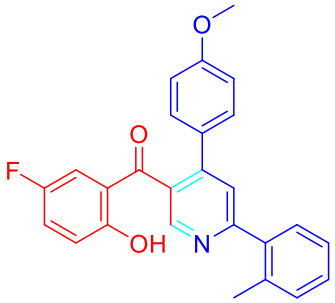
(6-(4-Bromophenyl)-4-(*p*-tolyl)pyridin-3-yl)(5-fluoro-2-hydroxyphenyl)methanone (3e)



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 78%); Mp: 160.9−161.9 °C; IR (KBr) 3306, 3196, 3014, 1631, 1590, 1481, 1330, 1176, 936, 881, 738, 630 cm^{-1}; ^1H NMR (600 MHz, DMSO-d_6): δ = 10.71 (s, 1H, OH), 8.72 (s, 1H, ArH), 8.20−8.22

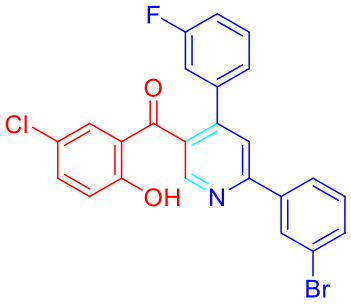
(m, 2H, ArH), 8.07 (s, 1H, ArH), 7.71−7.73 (m, 2H, ArH), 7.35 (d, J = 8.0 Hz, 2H, ArH), 7.26−7.30 (m, 1H, ArH), 7.15−7.19 (m, 3H, ArH), 6.86−6.89 (m, 1H, ArH), 2.28 (s, 3H, CH_3) ppm; $^{13}C\{^1H\}$ NMR (150 MHz, DMSO-d_6): δ = 197.3, 156.9, 155.9, 155.1 (J_1 = 235.5 Hz), 149.3, 149.1, 138.8, 137.5, 135.0, 133.9, 132.2, 132.2, 129.6, 129.6, 129.6, 129.1, 129.1, 124.0, 123.6, 123.6, 123.1 (J_2 = 24.0 Hz), 121.0, 119.4 (J_3 = 7.5 Hz), 117.0 (J_2 = 24.0 Hz), 21.2 ppm. ^{19}F NMR (564 MHz, DMSO-d_6): δ = −124.7 ppm. HRMS (TOF ES$^+$): m/z calcd for $C_{25}H_{17}BrFNO_2$ $[M+H]^+$, 462.0499; found, 462.0507.

(5-Fluoro-2-hydroxyphenyl)(4-(4-methoxyphenyl)-6-(*o*-tolyl)pyridin-3-yl)methanone (3f)



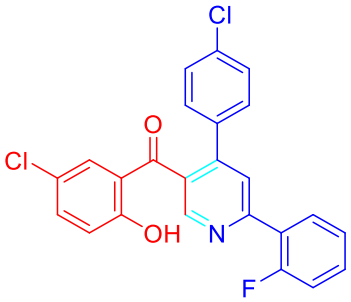
Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 71%); Mp: 159.8−161.4 °C; IR (KBr) 3392, 3179, 1719, 1622, 1584, 1328, 1191, 1092, 932, 861, 781, 624 cm^{-1}; ^1H NMR (600 MHz, DMSO-d_6): δ = 10.76 (s, 1H, OH), 8.69 (s, 1H, ArH), 7.61 (s, 1H, ArH), 7.57 (d, J = 7.4 Hz, 1H, ArH), 7.33−7.38 (m, 4H, ArH), 7.27−7.30 (m, 2H, ArH), 7.16−7.18 (m, 1H, ArH), 6.91−6.92 (m, 2H, ArH), 6.88−6.90 (m, 1H, ArH), 3.73 (s, 3H, CH_3), 2.43 (s, 3H, CH_3) ppm; $^{13}C\{^1H\}$ NMR (150 MHz, DMSO-d_6): δ = 197.8, 161.2, 160.2, 156.0, 155.1 (J_1 = 235.5 Hz), 148.4, 148.1, 139.8, 136.2, 132.9, 131.3, 130.6, 130.3, 130.0, 129.1, 126.4, 124.4, 123.6, 123.6, 123.2, 123.0, 119.4 (J_3 = 7.5 Hz), 117.0 (J_2 = 22.5 Hz), 114.6, 55.7, 20.7 ppm. ^{19}F NMR (564MHz, DMSO-d_6): δ = −124.7 ppm. HRMS (TOF ES$^+$): m/z calcd for $C_{26}H_{20}FNO_3$ $[M+H]^+$, 414.1500; found, 414.1497.

(6-(3-Bromophenyl)-4-(3-fluorophenyl)pyridin-3-yl)(5-chloro-2-hydroxyphenyl)-methanone (3g)



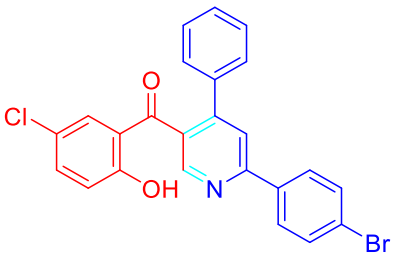
Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 80%); Mp: 172.2−173.4 °C; IR (KBr) 3278, 3223, 3183, 1735, 1633, 1582, 1465, 1338, 1222, 1180, 1041, 988 cm^{-1}; ^1H NMR (600 MHz, DMSO-d_6): δ = 10.77 (s, 1H, OH), 8.77 (s, 1H, ArH), 8.48 (t, J = 1.7 Hz, 1H, ArH), 8.28 (t, J = 7.9 Hz, 1H, ArH), 8.18 (s, 1H, ArH), 7.69−7.70 (m, 1H, ArH), 7.50 (t, J = 7.9 Hz, 1H, ArH), 7.35−7.41 (m, 4H, ArH), 7.18−7.22 (m, 2H, ArH), 6.85 (d, J = 8.8 Hz, 1H, ArH) ppm; $^{13}C\{^1H\}$ NMR (150 MHz, DMSO-d_6): δ = 195.8, 162.4 (J_1 = 243.0 Hz), 157.5, 156.5, 149.4, 148.1, 140.4, 140.1 (J_3 = 7.5 Hz), 135.1, 134.4, 133.0, 131.4, 130.8 (J_3 = 9.0 Hz), 130.5, 130.2, 126.6, 125.7, 125.4, 123.3, 122.9, 121.5, 119.6, 116.2 (J_2 = 22.5 Hz), 115.9 ppm. ^{19}F NMR (470 MHz, DMSO-d_6): δ = −112.9 ppm. HRMS (TOF ES^+): m/z calcd for $C_{24}H_{14}BrClFNO_2$ $[M+H]^+$, 481.9953; found, 481.9963.

(5-Chloro-2-hydroxyphenyl)(4-(4-chlorophenyl)-6-(2-fluorophenyl)pyridin-3-yl) methanone (3h)



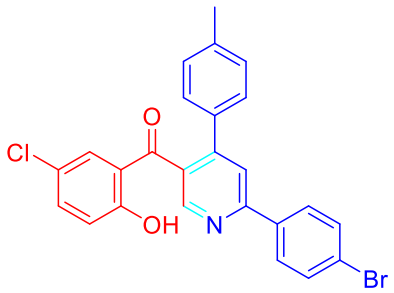
Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 79%); Mp: 164.2−164.8 °C; IR (KBr) 3388, 3239, 3082, 1645, 1564, 1047, 929, 896, 821, 729 cm^{-1}; ^1H NMR (600 MHz, DMSO-d_6): δ = 10.80 (s, 1H, OH), 8.80 (s, 1H, ArH), 8.05−8.07 (m, 1H, ArH), 7.88 (s, 1H, ArH), 7.54−7.57 (m, 1H, ArH), 7.36−7.45 (m, 8H, ArH), 6.85−6.86 (m, 1H, ArH) ppm; $^{13}C\{^1H\}$ NMR (150 MHz, DMSO-d_6): δ = 195.7, 160.5 (J_1 = 247.5 Hz), 157.6, 154.7, 149.3, 147.6, 136.7, 135.1, 134.2, 134.1, 132.1 (J_3 = 9.0 Hz), 131.6, 130.9, 130.6, 129.0, 126.6, 126.6, 125.4, 125.4, 125.4, 124.8 (J_3 = 9.0 Hz), 123.3, 119.7, 116.9 (J_2 = 22.5 Hz) ppm. ^{19}F NMR (564 MHz, DMSO-d_6): δ = −116.4 ppm. HRMS (TOF ES^+): m/z calcd for $C_{24}H_{14}Cl_2FNO_2$ $[M+H]^+$, 438.0458; found, 438.0463.

(6-(4-Bromophenyl)-4-phenylpyridin-3-yl)(5-chloro-2-hydroxyphenyl)methanone (3i)



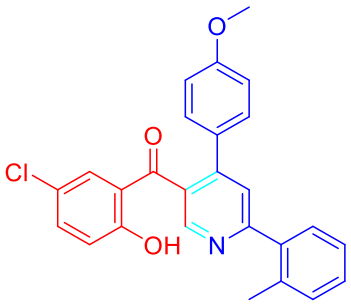
Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 78%); Mp: 180.3−181.0 °C; IR (KBr) 3453, 3338, 1731, 1590, 1464, 1332, 1274, 715, 615 cm^{-1}; ^1H NMR (600 MHz, DMSO-d_6): δ = 10.80 (s, 1H, OH), 8.74 (s, 1H, ArH), 8.23 (d, J = 8.5 Hz, 2H, ArH), 8.10 (s, 1H, ArH), 7.73 (d, J = 8.5 Hz, 2H, ArH), 7.43 (t, J = 4.0 Hz, 2H, ArH), 7.34−7.39 (m, 5H, ArH), 6.83 (d, J = 8.8 Hz, 1H, ArH) ppm; $^{13}C\{^1H\}$ NMR (150 MHz, DMSO-d_6): δ = 196.5, 157.8, 157.0, 149.4, 149.3, 137.8, 137.4, 135.1, 134.1, 132.3, 130.7, 129.7, 129.7, 129.2, 129.2, 129.1, 129.1, 129.0, 128.9, 125.1, 124.0, 123.2, 121.1, 119.7 ppm. HRMS (TOF ES^+): *m/z* calcd for $C_{24}H_{15}BrClNO_2[M+H]^+$, 464.0047; found, 464.0051.

(6-(4-Bromophenyl)-4-(*p*-tolyl)pyridin-3-yl)(5-chloro-2-hydroxyphenyl)methanone (3j)



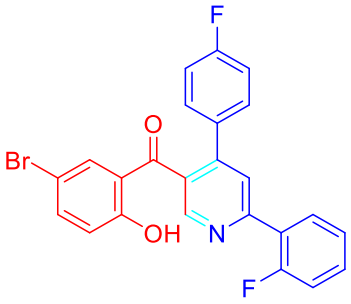
Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 77%); Mp: 155.4−155.9 °C; IR (KBr) 3252, 3131, 3086, 2856, 1973, 1747, 1633, 1571, 1467, 1217, 1061, 909, 874, 785 cm^{-1}; ^1H NMR (500 MHz, DMSO-d_6): δ = 10.84 (s, 1H, OH), 8.71 (s, 1H, ArH), 8.21 (d, J = 8.6 Hz, 2H, ArH), 8.06 (s, 1H, ArH), 7.73 (d, J = 8.6 Hz, 2H, ArH), 7.39−7.42 (m, 1H, ArH), 7.31−7.34 (m, 3H, ArH), 7.18 (d, J = 7.9 Hz, 2H, ArH), 6.86 (d, J = 8.8 Hz, 1H, ArH), 2.28 (s, 3H, CH_3) ppm; $^{13}C\{^1H\}$ NMR (125 MHz, DMSO-d_6): δ = 196.8, 157.9, 156.9, 149.3, 149.2, 138.8, 137.5, 135.2, 135.0, 134.0, 132.3, 132.3, 130.8, 129.6, 129.6, 129.5, 129.5, 129.1, 129.1, 125.0, 124.0, 123.2, 121.0, 119.8, 21.2 ppm. HRMS (TOF ES^+): *m/z* calcd for $C_{25}H_{17}BrClNO_2$ $[M+H]^+$, 478.0204; found, 478.0212.

(5-Chloro-2-hydroxyphenyl)(4-(4-methoxyphenyl)-6-(*o*-tolyl)pyridin-3-yl)methanone (3k)



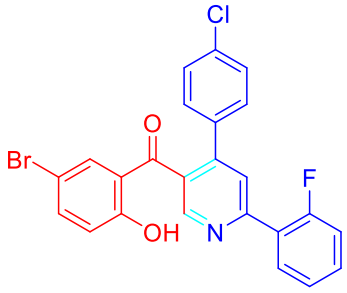
Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 70%); Mp: 110.2−111.6 °C; IR (KBr) 3196, 3069, 1520, 1465, 1332, 1041, 927, 874, 800, 635 cm^{-1}; ^1H NMR (500 MHz, DMSO-d_6): δ = 10.91 (s, 1H, OH), 8.70 (s, 1H, ArH), 7.57 (t, J = 11.6 Hz, 2H, ArH), 7.32−7.42 (m, 7H, ArH), 6.87−6.91 (m, 3H, ArH), 3.73 (s, 3H, CH_3), 2.43 (s, 3H, CH_3) ppm; $^{13}C\{^1H\}$ NMR (125 MHz, DMSO-d_6): δ = 197.2, 161.2, 160.2, 158.0, 148.6, 148.2, 139.8, 136.2, 135.2, 133.1, 131.3, 130.8, 130.6, 130.3, 130.3, 129.9, 129.1, 126.4, 125.0, 124.4, 123.2, 119.8, 114.5, 114.5, 55.7, 20.7 ppm. HRMS (TOF ES^+): *m/z* calcd for $C_{26}H_{20}ClNO_3$ $[M+H]^+$, 430.1204; found, 430.1203.

(5-Bromo-2-hydroxyphenyl)(6-(2-fluorophenyl)-4-(4-fluorophenyl)pyridin-3-yl)-methanone (3l)



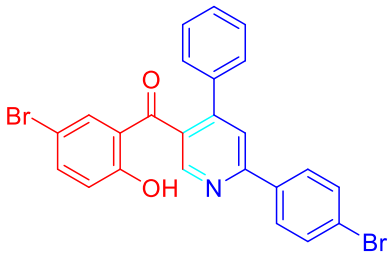
Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 81%); Mp: 117.5−118.8 °C; IR (KBr) 3354, 3130, 3001, 2876, 1914, 1736, 1675, 1471, 1329, 841, 692 cm^{-1}; ^1H NMR (500 MHz, DMSO-d_6): δ = 10.80 (s, 1H, OH), 8.79 (s, 1H, ArH), 8.04−8.08 (m, 1H, ArH), 7.87 (s, 1H, ArH), 7.50−7.58 (m, 3H, ArH), 7.29−7.44 (m, 4H, ArH), 7.20 (t, J = 8.8 Hz, 2H, ArH), 6,78 (d, J = 9.3 Hz, 1H, ArH) ppm; $^{13}C\{^1H\}$ NMR (125 MHz, DMSO-d_6): δ = 195.8, 162.8 (J_1 = 245.0 Hz), 160.5 (J_1 = 247.5 Hz), 157.9, 154.7, 149.3, 147.8, 137.8, 134.2, 134.2 (J_3 = 6.3 Hz), 133.5, 132.1 (J_3 = 7.5 Hz), 131.6, 131.6, 131.3 (J_3 = 8.8 Hz), 126.6 (J_3 = 11.3 Hz), 126.0, 125.4, 125.4, 124.8 (J_3 = 8.8 Hz), 120.0, 119.0 (J_2 = 22.5 Hz), 116.0 (J_2 = 21.3 Hz), 110.6 ppm. ^{19}F NMR (470 MHz, DMSO-d_6): δ = −113.0, −116.5 ppm. HRMS (TOF ES^+): *m/z* calcd for $C_{24}H_{14}BrF_2NO_2$ $[M+H]^+$, 466.0248; found, 466.0253.

(5-Bromo-2-hydroxyphenyl)(4-(4-chlorophenyl)-6-(2-fluorophenyl)pyridin-3-yl) methanone (3m)



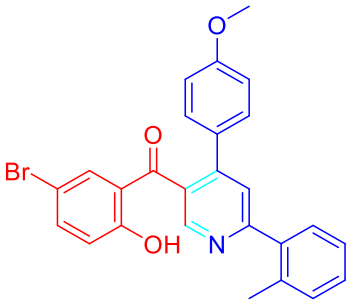
Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 78%); Mp: 172.2−173.4 °C; IR (KBr) 3245, 3070, 2836, 2629, 1606, 1432, 1379, 1257, 1201, 1084, 861, 732, 622 cm^{-1}; ^1H NMR (500 MHz, DMSO-d_6): δ = 10.82 (s, 1H, OH), 8.78 (s, 1H, ArH), 8.03−8.07 (m, 1H, ArH), 7.86 (s, 1H, ArH), 7.51−7.78 (m, 3H, ArH), 7.36−7.47 (m, 6H, ArH), 6.79 (d, J = 9.4 Hz 1H, ArH) ppm; $^{13}C\{^1H\}$ NMR (125 MHz, DMSO-d_6): δ = 195.6, 116.0 (J_1 = 240.3 Hz), 157.9, 154.7, 149.3, 147.6, 137.8, 136.6, 134.2, 134.2, 133.5, 132.2 (J_3 = 8.8 Hz), 131.6, 130.9, 129.0, 126.6, 126.0, 125.4, 125.4, 124.8, 124.7, 120.1, 117.1 (J_2 = 22.5 Hz), 110.6 ppm. ^{19}F NMR (470 MHz, DMSO-d_6): δ = −116.5 ppm. HRMS (TOF ES^+): *m/z* calcd for $C_{24}H_{14}BrClFNO_2$ $[M+H]^+$, 481.9953; found, 481.9960.

(5-Bromo-2-hydroxyphenyl)(6-(4-bromophenyl)-4-phenylpyridin-3-yl)methanone (3n)



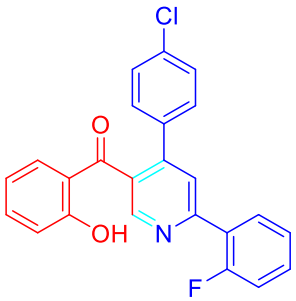
Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, 77%); Mp: 134.4−135.8 °C; IR (KBr) 3176, 3098, 1898, 1770, 1606, 1486, 1333, 868, 702, 647 cm^{-1}; ^1H NMR (600 MHz, DMSO-d_6): δ = 10.83 (s, 1H, OH), 8.74 (s, 1H, ArH), 8.22 (d, J = 8.5 Hz, 1H, ArH), 8.10 (d, J = 10.5 Hz, 1H, ArH), 7.73 (d, J = 8.5 Hz, 2H, ArH), 7.33−7.50 (m, 8H, ArH), 6.78 (d, J = 8.8 Hz, 1H, ArH) ppm; $^{13}C\{^1H\}$ NMR (150 MHz, DMSO-d_6): δ = 196.4, 158.2, 157.0, 149.4, 149.3, 137.9, 137.8, 137.4, 134.1, 133.7, 132.3, 132.3, 129.7, 129.7, 129.2, 129.2, 129.2, 128.9, 128.9, 125.6, 125.6, 124.1, 121.1, 120.1, 110.5 ppm. HRMS (TOF ES^+): *m/z* calcd for $C_{24}H_{15}Br_2NO_2$ $[M+H]^+$, 507.9542; found, 507.9547.

(5-Bromo-2-hydroxyphenyl)(4-(4-methoxyphenyl)-6-(*o*-tolyl)pyridin-3-yl)methan-one (3o)



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 68%); Mp: 147.6−149.1 °C; IR (KBr) 3349, 3281, 3056, 2749, 1807, 1628, 1510, 1464, 1333, 1210, 914, 691 cm^{-1}; ^1H NMR (500 MHz, DMSO-d_6): δ = 10.90 (s, 1H, OH), 8.69 (s, 1H, ArH), 7.48−7.60 (m, 1H, ArH), 7.31−7.39 (m, 5H, ArH), 6.92 (d, J = 8.8 Hz, 2H, ArH), 6.81 (d, J = 8.8 Hz, 1H, ArH), 3.73 (s, 3H, CH_3), 2.42 (s, 3H, CH_3), ppm; $^{13}C\{^1H\}$ NMR (125 MHz, DMSO-d_6): δ = 196.9, 161.2, 160.2, 158.3, 148.5, 148.2, 139.7, 137.9, 136.2, 133.7, 133.2, 131.3, 130.6, 130.3, 129.9, 129.9, 129.2, 126.4, 125.7, 124.4, 120.1, 114.5, 114.5, 110.5, 55.7, 20.8 ppm. HRMS (TOF ES^+): *m/z* calcd for $C_{26}H_{20}BrNO_3$ $[M+H]^+$, 474.0699; found, 474.0710.

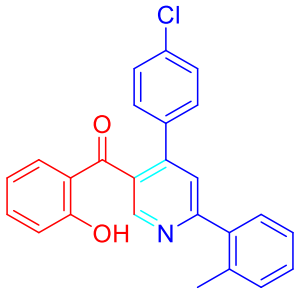
(4-(4-Chlorophenyl)-6-(2-fluorophenyl)pyridin-3-yl)(2-hydroxyphenyl)methan-one (3p)



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 76%); Mp: 167.5−168.1 °C; IR (KBr) 3218, 3141, 3049, 2990, 1620, 1587, 1311, 1209, 1150, 1093, 932, 828, 757, 696 cm^{-1}; ^1H NMR (600 MHz, DMSO-d_6): δ = 10.96 (s, 1H, OH), 8.79 (s, 1H, ArH), 8.05−8.08 (m, 1H, ArH), 7.90 (s, 1H, ArH), 7.54−7.57 (m, 1H, ArH), 7.37−7.47 (m, 8H, ArH), 6.83−6.91 (m, 2H, ArH) ppm; $^{13}C\{^1H\}$ NMR (150 MHz, DMSO-d_6): δ = 198.4, 160.5 (J_1 = 247.5Hz), 160.1, 154.6, 149.1, 147.3, 136.7, 136.6, 134.2, 133.9, 132.5, 132.1 (J_3 = 9.0 Hz), 131.6, 130.8, 129.2, 126.7, 126.6, 125.4, 125.4, 124.8 (J_3 = 7.5 Hz), 122.9, 119.8, 117.9, 116.9 (J_2 = 22.5 Hz) ppm. ^{19}F NMR (564 MHz, DMSO-d_6): δ = −116.5 ppm. HRMS (TOF ES^+): *m/z* calcd for $C_{24}H_{15}ClFNO_2$ $[M+H]^+$,

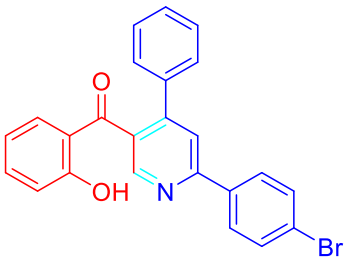
404.0848; found, 404.0848.

(4-(4-Chlorophenyl)-6-(*o*-tolyl)pyridin-3-yl)(2-hydroxyphenyl)methanone (3q)



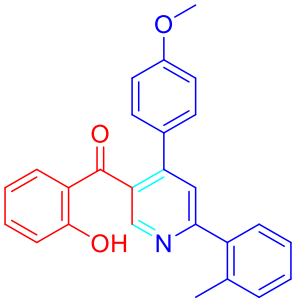
Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 77%); Mp: 163.1−164.9 °C; IR (KBr) 3275, 3044, 2874, 2367, 1565, 1504, 1060, 905, 868, 817, 685 cm^{-1}; ^1H NMR (500 MHz, DMSO-d_6): δ = 11.02 (s, 1H, OH), 8.73 (s, 1H, ArH), 7.67 (s, 1H, ArH), 7.58 (d, J = 7.3 Hz, 1H, ArH), 7.32−7.48 (m, 9H, ArH), 6.84−6.92 (m, 2H, ArH), 2.44 (s, 3H, CH_3) ppm; $^{13}C\{^1H\}$ NMR (125 MHz, DMSO-d_6): δ = 199.0, 161.3, 160.2, 148.5, 147.1, 139.6, 136.7, 136.6, 136.2, 134.1, 133.0, 132.6, 131.3, 130.9, 130.9, 130.3, 129.2, 129.1, 129.1, 126.4, 124.7, 122.8, 119.8, 117.9, 20.7 ppm. HRMS (TOF ES^+): *m/z* calcd for $C_{25}H_{18}ClNO_2$ $[M+H]^+$, 400.1099; found, 400.1100.

(6-(4-Bromophenyl)-4-phenylpyridin-3-yl)(2-hydroxyphenyl)methanone (3r)



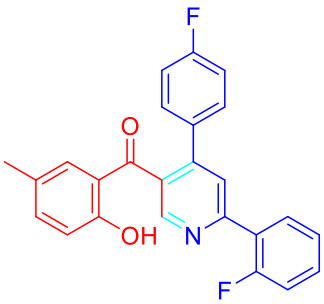
Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 74%); Mp: 205.8−206.6 °C; IR (KBr) 3372, 3296, 3008, 1774, 1620, 1529, 1394, 1110, 1062, 942, 813, 788 cm^{-1}; ^1H NMR (500 MHz, DMSO-d_6): δ = 11.08 (s, 1H, OH), 8.73 (s, 1H, ArH), 8.19 (d, J = 8.4 Hz, 1H, ArH), 8.13 (s, 1H, ArH), 7.73 (d, J = 8.4 Hz, 1H, ArH), 7.32−7.46 (m, 8H, ArH), 6.89 (d, J = 8.3 Hz, 1H, ArH), 6.79−6.82 (t, J = 7.5 Hz, 1H, ArH) ppm; $^{13}C\{^1H\}$ NMR (125 MHz, DMSO-d_6): δ = 199.3, 160.4, 156.8, 149.2, 149.0, 137.9, 137.4, 136.6, 133.9, 132.6, 132.3, 132.3, 129.6, 129.6, 129.2, 129.1, 129.1, 129.0, 129.0, 124.0, 122.5, 121.2, 119.7, 117.9 ppm. HRMS (TOF ES^+): *m/z* calcd for $C_{24}H_{16}BrNO_2$ $[M+H]^+$, 430.0437; found, 430.0438.

(2-Hydroxyphenyl)(4-(4-methoxyphenyl)-6-(*o*-tolyl)pyridin-3-yl)methanone (3s)



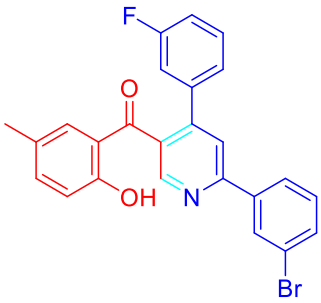
Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 67%); Mp: 145.6−146.3 °C; IR (KBr) 3231, 2941, 2671, 1830, 1675, 1596, 1263, 1011, 980, 796, 581 cm^{-1}; ^1H NMR (500 MHz, DMSO-d_6): δ = 11.24 (s, 1H, OH), 8.68 (s, 1H, ArH), 7.63 (s, 1H, ArH), 7.57 (d, J = 7.3 Hz, 1H, ArH), 7.45−7.48 (m, 1H, ArH), 7.33−7.40 (m, 6H, ArH), 6.91−6.94 (m, 3H, ArH), 6.82−6.85 (m, 1H, ArH), 3.72 (s, 3H, CH_3), 2.44 (s, 3H, CH_3) ppm; $^{13}C\{^1H\}$ NMR (125 MHz, DMSO-d_6): δ = 200.2, 161.1, 160.7, 160.2, 148.3, 147.8, 139.8, 136.8, 136.2, 132.8, 132.6, 131.3, 130.5, 130.5, 130.3, 129.9, 129.1, 126.4, 124.5, 122.2, 119.8, 118.0, 114.7, 114.7, 55.6, 20.8 ppm. HRMS (TOF ES^+): *m/z* calcd for $C_{26}H_{21}NO_3$ $[M+H]^+$, 396.1594; found, 396.1594.

(6-(2-Fluorophenyl)-4-(4-fluorophenyl)pyridin-3-yl)(2-hydroxy-5-methylphenyl)-methanone (3t)



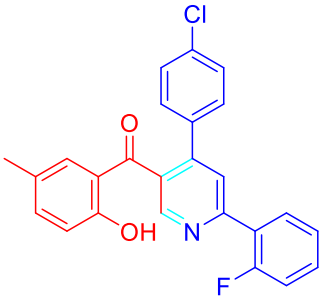
Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 78%); Mp: 136.7−137.8 °C; IR (KBr) 3231, 1820, 1607, 1522, 1473, 1421, 1159, 842, 724, 690 cm^{-1}; ^1H NMR (500 MHz, DMSO-d_6): δ = 10.86 (s, 1H, OH), 8.78 (s, 1H, ArH), 8.06−8.09 (m, 1H, ArH), 7.90 (s, 1H, ArH), 7.53−7.57 (m, 1H, ArH), 7.40−7.46 (m, 2H, ArH), 7.38 (d, J = 7.3 Hz, 2H, ArH), 7.19−7.27 (m, 4H, ArH), 6.81 (d, J = 8.4 Hz, 1H, ArH), 2.14 (s, 3H, CH_3) ppm; $^{13}C\{^1H\}$ NMR (125 MHz, DMSO-d_6): δ = 198.8, 162.8 (J_1 = 245.0 Hz), 160.5 (J_1 = 247.5 Hz), 158.4, 154.5, 149.1, 147.6, 137.5, 134.3, 134.3, 134.0, 132.1 (J_3 = 6.3 Hz), 132.0, 131.6, 131.6, 131.1 (J_3 = 8.8 Hz), 128.5, 126.6 (J_3 = 11.3 Hz), 125.4, 125.4, 124.9 (J_3 = 8.8 Hz), 122.1, 117.8, 116.9 (J_2 = 22.5 Hz), 116.1 (J_2 = 21.3 Hz) ppm. ^{19}F NMR (470 MHz, DMSO-d_6): δ = −113.0, −116.4 ppm. HRMS (TOF ES^+): *m/z* calcd for $C_{25}H_{17}F_2NO_2$ $[M+H]^+$, 402.1300; found, 402.1297.

(6-(3-Bromophenyl)-4-(3-fluorophenyl)pyridin-3-yl)(2-hydroxy-5-methylphenyl)-methanone (3u)



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 77%); Mp: 127.1−128.6 °C; IR (KBr) 3241, 2971, 1728, 1669, 1595, 1479, 1183, 818, 702, 669 cm^{-1}; ^1H NMR (600 MHz, DMSO-d_6): δ = 10.83 (s, 1H, OH), 8.75 (s, 1H, ArH), 8.49 (t, J = 1.8 Hz, 1H, ArH), 8.29−8.30 (m, 1H, ArH), 8.21 (s, 1H, ArH), 7.69−7.71 (m, 1H, ArH),7.50 (t, J = 7.9 Hz, 1H, ArH), 7.38−7.41 (m, 2H, ArH), 7.17−7.27 (m, 4H, ArH), 6.81 (d, J = 8.4 Hz,1H, ArH), 2.15 (s, 3H, CH_3) ppm; $^{13}C\{^1H\}$ NMR (150 MHz, DMSO-d_6): δ = 198.7, 162.5 (J_1 = 243.0 Hz), 158.3, 156.4, 149.1, 147.9, 140.5, 140.3 (J_3 = 7.5 Hz), 137.5, 134.2, 133.0, 132.1, 131.4, 130.9 (J_3 = 7.5 Hz), 130.2, 128.5, 126.6, 125.4, 122.9, 122.2, 121.6, 117.8, 116.1 (J_2 = 22.5 Hz), 115.9, 20.2 ppm. ^{19}F NMR (470 MHz, DMSO-d_6): δ = −112.8 ppm. HRMS (TOF ES^+): m/z calcd for $C_{25}H_{17}BrFNO_2$ $[M+H]^+$, 462.0499; found, 462.0508.

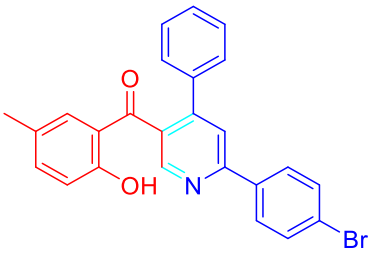
(4-(4-Chlorophenyl)-6-(2-fluorophenyl)pyridin-3-yl)(2-hydroxy-5-methylphenyl)-methanone (3v)



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 75%); Mp: 157.1−158.4 °C; IR (KBr) 3243, 3181, 3042, 1738, 1640, 1533, 1329, 1218, 1088, 987, 809, 692 cm^{-1}; ^1H NMR (600 MHz, DMSO-d_6): δ = 10.82 (s, 1H, OH), 8.78 (s, 1H, ArH), 8.07 (t, J = 7.3 Hz, 1H, ArH), 7.90 (s, 1H, ArH), 7.56 (t, J = 6.4 Hz, 1H, ArH), 7.38−7.46 (m, 6H, ArH), 7.27 (t, J = 16.5 Hz, 2H, ArH), 6.82 (d, J = 8.4 Hz, 1H, ArH), 2.16 (s, 3H, CH_3) ppm; $^{13}C\{^1H\}$ NMR (150 MHz, DMSO-d_6): δ = 198.5, 160.5 (J_1 = 247.5 Hz), 158.3, 154.6, 149.1, 147.4, 137.5, 136.8, 134.2, 134.0, 132.2, 132.1, 131.6, 131.6, 130.7, 129.2, 128.5, 126.6, 126.6, 125.4, 125.4, 124.8 (J_3 = 9.0 Hz), 122.3, 117.8, 116.9 (J_2 = 22.5 Hz), 20.2 ppm. ^{19}F NMR (470 MHz, DMSO-d_6): δ = −116.5 ppm.

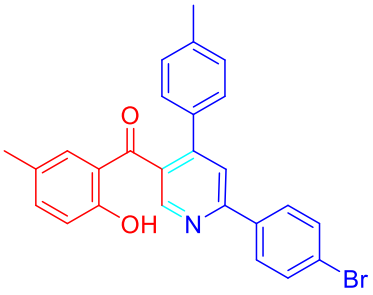
HRMS (TOF ES$^+$): *m/z* calcd for $C_{25}H_{17}ClFNO_2$ $[M+H]^+$, 418.1005; found, 418.1004.

(6-(4-Bromophenyl)-4-phenylpyridin-3-yl)(2-hydroxy-5-methylphenyl)methanone (3w)



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 72%); Mp: 148.7−149.6 °C; IR (KBr) 3258, 2173, 1951, 1818, 1668, 1592, 1473, 1384, 464 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6): δ = 10.96 (s, 1H, OH), 8.73 (s, 1H, ArH), 8.23−8.24 (m, 2H, ArH), 8.14 (s, 1H, ArH), 7.73−7.74 (m, 2H, ArH), 7.46 (t, J = 4.2 Hz, 2H, ArH), 7.33−7.39 (m, 3H, ArH), 7.25−7.26 (m, 1H, ArH),7.18 (d, J = 1.6 Hz, 1H, ArH), 6.81 (d, J = 8.5 Hz, 1H, ArH), 2.12 (s, 3H, CH_3) ppm; ^{13}C{^{1}H} NMR (150 MHz, DMSO-d_6): δ = 199.5, 158.6, 156.8, 149.2, 149.1, 140.0, 137.6, 137.5, 133.8, 132.4, 132.3, 129.6, 129.6, 129.2, 129.2, 129.1, 129.1, 129.0, 129.0, 128.4, 124.0, 121.8, 121.2, 117.8, 20.1 ppm. HRMS (TOF ES$^+$): *m/z* calcd for $C_{25}H_{18}BrNO_2$ $[M+H]^+$, 444.0594; found, 444.0601.

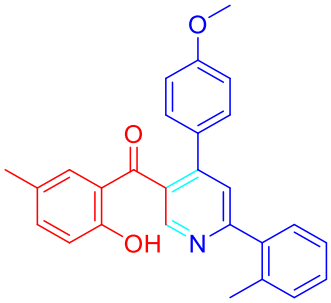
(6-(4-Bromophenyl)-4-(*p*-tolyl)pyridin-3-yl)(2-hydroxy-5-methylphenyl)methanone (3x)



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 71%); Mp: 149.3−150.2 °C; IR (KBr) 3280, 3173, 2991, 2756, 1724, 1592, 1483, 1336, 1218, 1062, 960, 739, 684 cm^{-1}; ^{1}H NMR (500 MHz, DMSO-d_6): δ = 11.04 (s, 1H, OH), 8.70 (s, 1H, ArH), 8.21 (d, J = 8.5 Hz, 2H, ArH), 8.09 (s, 1H, ArH), 7.72 (d, J = 8.4 Hz, 2H, ArH), 7.35 (d, J = 7.9 Hz, 2H, ArH), 7.27 (d, J = 7.2 Hz, 1H, ArH), 7.18 (d, J = 6.0 Hz, 3H, ArH), 6.83 (d, J = 8.4 Hz, 1H, ArH), 2.27 (s, 3H, CH_3), 2.12 (s, 3H, CH_3) ppm; ^{13}C{^{1}H} NMR (125 MHz, DMSO-d_6): δ = 199.8, 158.9, 156.8, 149.2, 149.0, 138.8, 137.7, 137.5, 135.1, 133.6, 132.4, 132.3, 132.3, 129.7, 129.7, 129.6, 129.6, 129.0, 129.0, 128.4,

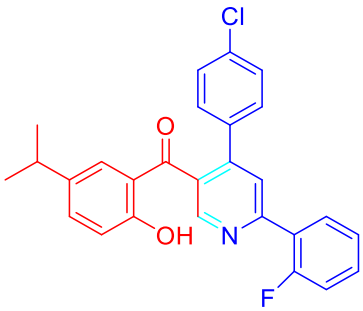
124.0, 121.6, 121.1, 117.9, 21.2, 20.2 ppm. HRMS (TOF ES$^+$): *m/z* calcd for $C_{26}H_{20}BrNO_2$ $[M+H]^+$, 458.0750; found, 458.0747.

(2-Hydroxy-5-methylphenyl)(4-(4-methoxyphenyl)-6-(*o*-tolyl)pyridin-3-yl)methanone (3y)



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 64%); Mp: 167.3−168.9 °C; IR (KBr) 3342, 3037, 1735, 1593, 1477, 1303, 1253, 1182, 954, 848, 770, 661 cm^{-1}; ^{1}H NMR (500 MHz, DMSO-*d*$_6$): δ = 11.07 (s, 1H, OH), 8.67 (s, 1H, ArH), 7.59 (t, *J* = 15.3 Hz, 2H, ArH), 7.32−7.39 (m, 5H, ArH), 7.28−7.30 (m, 1H, ArH), 7.19 (d, *J* = 1.6 Hz, 1H, ArH), 6.93 (d, *J* = 8.8 Hz, 2H, ArH), 6.85 (d, *J* = 8.4 Hz, 1H, ArH), 3.73 (s, 3H, CH_3), 2.44 (s, 3H, CH_3), 2.14 (s, 3H, CH_3) ppm; ^{13}C{^{1}H} NMR (125 MHz, DMSO-*d*$_6$): δ = 200.1, 161.0, 160.2, 158.8, 148.3, 147.9, 139.7, 137.7, 136.2, 132.7, 132.4, 131.3, 130.4, 130.4, 130.3, 130.1, 129.1, 128.4, 126.4, 124.5, 121.7, 117.9, 114.7, 114.7, 55.7, 20.8, 20.2 ppm. HRMS (TOF ES$^+$): *m/z* calcd for $C_{27}H_{23}NO_3$ $[M+H]^+$, 410.1751; found, 410.1755.

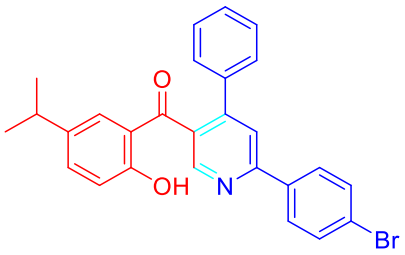
(4-(4-Chlorophenyl)-6-(2-fluorophenyl)pyridin-3-yl)(2-hydroxy-5-isopropylphenyl)-methanone (3z)



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 72%); Mp: 158.2−159.6 °C; IR (KBr) 3273, 3137, 3033, 2965, 1814, 1736, 1592, 1400, 1093, 855, 781, 684 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-*d*$_6$): δ = 10.68 (s, 1H, OH), 8.71 (t, *J* = 6.3 Hz, 1H, ArH), 7.99 (s, 1H, ArH), 7.81 (s, 1H, ArH), 7.08−7.46 (m, 9H, ArH), 6.71 (d, *J* = 6.0 Hz, 1H, ArH), 2.64 (s, 1H, CH), 0.98 (t, *J* = 3.1 Hz, 6H, CH_3) ppm; ^{13}C{^{1}H} NMR (150 MHz, DMSO-*d*$_6$): δ = 198.5, 160.5 (J_1 = 247.5 Hz), 158.2, 154.6, 149.3, 147.3, 139.4, 136.7,

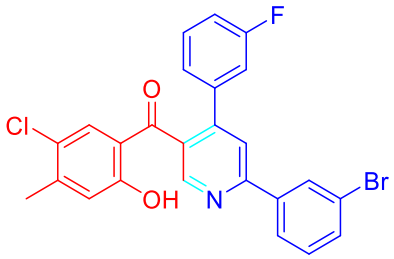
134.6, 134.2 (J_2 = 22.5 Hz), 132.1, 131.6, 130.8, 130.8, 129.4, 129.1, 129.1, 126.6 (J_3 = 10.5 Hz), 125.4, 124.6, 122.4, 117.9, 117.0, 116.9, 32.8, 24.2, 24.2 ppm. ^{19}F NMR (564 MHz, DMSO-d_6): δ = −116.4 ppm. HRMS (TOF ES$^+$): *m/z* calcd for $C_{27}H_{21}ClFNO_2$ $[M+H]^+$, 446.1318; found, 446.1318.

(6-(4-Bromophenyl)-4-phenylpyridin-3-yl)(2-hydroxy-5-isopropylphenyl)meth-anone (3a')



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 71%); Mp: 144.7−145.2 °C; IR (KBr) 3267, 3110, 3083, 1685, 1627, 1590, 1476, 621, 455 cm^{-1}; ^{1}H NMR (500 MHz, DMSO-d_6): δ = 10.97 (s, 1H, OH), 8.75 (s, 1H, ArH), 8.23 (t, J = 27.7 Hz, 3H, ArH), 7.74 (d, J = 8.6 Hz, 2H, ArH), 7.45 (t, J = 4.1 Hz, 2H, ArH), 7.10−7.37 (m, 4H, ArH), 6.80 (d, J = 8.6 Hz, 2H, ArH), 2.50−2.72 (m, 1H, ArH), 1.03 (d, J = 6.9 Hz, 6H, CH_3) ppm; ^{13}C{^{1}H} NMR (125 MHz, DMSO-d_6): δ = 199.5, 158.7, 156.8, 149.2, 149.1, 139.3, 137.9, 137.4, 134.9, 133.9, 132.3, 132.3, 129.6, 129.6, 129.6, 129.2, 129.2, 129.1, 129.1, 129.0, 124.0, 121.7, 121.0, 117.9, 32.7, 24.1, 24.1 ppm. HRMS (TOF ES$^+$): *m/z* calcd for $C_{27}H_{22}BrNO_2$ $[M+H]^+$, 472.0907; found, 472.0906.

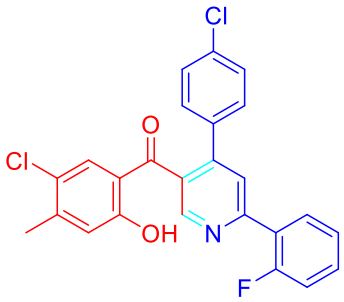
(6-(3-Bromophenyl)-4-(3-fluorophenyl)pyridin-3-yl)(5-chloro-2-hydroxy-4-methy l-phenyl)meth -anone (3b')



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 79%); Mp: 120.2−121.1 °C; IR (KBr) 3355, 3263, 3120, 1640, 1590, 1464, 1336, 1223, 1089, 999, 845, 687 cm^{-1}; ^{1}H NMR (500 MHz, DMSO-d_6): δ = 10.86 (s, 1H, OH), 8.75 (s, 1H, ArH), 8.48 (d, J = 1.6 Hz, 1H, ArH), 8.29 (d, J = 8.0 Hz, 1H, ArH), 8.20 (s, 1H, ArH), 7.69−7.71 (m, 1H, ArH), 7.50 (t, J = 7.9 Hz, 1H, ArH), 7.37−7.42 (m, 3H, ArH), 7.19−7.23 (m, 2H, ArH), 6.85 (s, 1H, ArH), 2.26 (s, 3H, CH_3) ppm. ^{13}C{^{1}H} NMR (125 MHz,

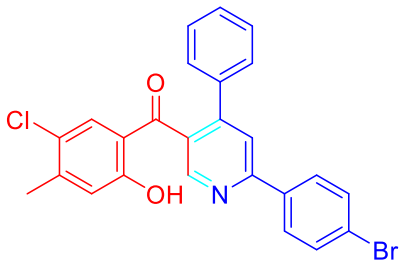
DMSO-d_6): δ = 162.5 (J_1 = 243.8 Hz), 158.1, 156.4, 149.1, 147.9, 147.9, 144.3, 140.4, 140.1 (J_3 = 8.8 Hz), 134.3, 133.0, 131.3 (J_2 = 23.8 Hz), 130.9 (J_3 = 8.8 Hz), 130.2, 126.6, 125.5, 124.0, 122.9, 122.7, 121.6, 120.2, 116.2, 116.0, 113.9, 20.5 ppm. ^{19}F NMR (470 MHz, DMSO-d_6): δ = −112.8 ppm. HRMS (TOF ES$^+$): *m/z* calcd for $C_{25}H_{16}BrClFNO_2$ $[M+H]^+$, 496.0110; found, 496.0112.

(5-Chloro-2-hydroxy-4-methylphenyl)(4-(4-chlorophenyl)-6-(2-fluorophenyl)pyri -din-3-yl)meth -anone (3c')



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 78%); Mp: 173.3−173.9 °C; IR (KBr) 3275, 3137, 3012, 2882, 1734, 1560, 1232, 1061, 930, 817, 739 cm^{-1}; ^{1}H NMR (500 MHz, DMSO-d_6): δ = 10.86 (s, 1H, OH), 8.78 (s, 1H, ArH), 8.06 (t, J = 7.3 Hz, 1H, ArH), 7.89 (s, 1H, ArH), 7.54−7.57 (m, 1H, ArH), 7.36−7.46 (m, 7H, ArH), 6.86 (s, 1H, ArH), 2.27 (s, 3H, CH_3) ppm. ^{13}C{^{1}H} NMR (125 MHz, DMSO-d_6): δ = 195.9, 160.5 (J_1 = 248.8 Hz), 158.1, 154.6, 149.1, 147.4, 144.3, 136.7, 134.2, 134.1, 132.1 (J_3 = 6.3 Hz), 131.6, 131.3, 130.8, 129.1, 126.7, 126.6, 125.4, 125.4, 124.8 (J_3 = 8.8 Hz), 124.1, 122.7, 120.2, 116.9 (J_2 = 23.8 Hz), 20.5 ppm. ^{19}F NMR (470 MHz, DMSO-d_6): δ = −116.5 ppm. HRMS (TOF ES$^+$): *m/z* calcd for $C_{25}H_{16}Cl_2FNO_2$ $[M+H]^+$, 452.0615; found, 452.0617.

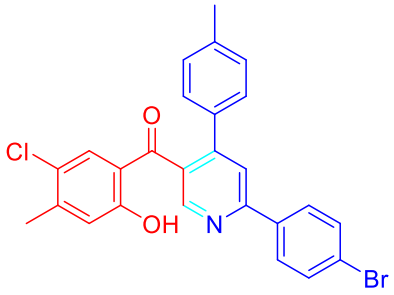
(6-(4-Bromophenyl)-4-phenylpyridin-3-yl)(5-chloro-2-hydroxy-4-methylphenyl)- methanone (3d')



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 77%); Mp: 157.2−157.9 °C; IR (KBr) 3404, 3380, 3144, 2968, 1847, 1794, 1668, 1595, 1259, 977, 784 cm^{-1}; ^{1}H NMR (600 MHz, DMSO-d_6): δ = 10.96 (s, 1H, OH), 8.74 (s, 1H, ArH),8.21−8.23 (m, 2H, ArH), 8.11 (s, 1H, ArH), 7.71−7.73 (m, 2H, ArH), 7.44−7.46 (m, 2H, ArH),

7.35−7.40 (m, 4H, ArH), 6.85 (s, 1H, ArH), 2.25 (s, 3H, CH_3) ppm; $^{13}C\{^1H\}$ NMR (150 MHz, DMSO-d_6): δ = 196.9, 158.5, 156.9, 149.2, 149.1, 144.4, 137.8, 137.4, 133.9, 132.2, 132.2, 131.5, 129.6, 129.4, 129.4, 129.2, 129.1, 129.1, 129.0, 124.0, 123.9, 122.2, 121.1, 120.2, 20.5 ppm. HRMS (TOF ES^+): *m/z* calcd for $C_{25}H_{17}BrClNO_2$ $[M+H]^+$, 478.0204; found, 478.0212.

(6-(4-Bromophenyl)-4-(*p*-tolyl)pyridin-3-yl)(5-chloro-2-hydroxy-4-methylphenyl) -methanone (3e')



Yellow solid ($V_{Petroleum\ ether}/V_{Ethyl\ acetate}$ = 20:1, R_f = 0.2, 74%); Mp: 159.2−161.3 °C; IR (KBr) 3260, 3149, 1882, 1732, 1667, 781, 668, 575 cm^{-1}; ^1H NMR (500 MHz, DMSO-d_6): δ = 10.98 (s, 1H, OH), 8.70 (s, 1H, ArH), 8.21 (d, *J* = 8.6 Hz, 2H, ArH), 8.07 (s, 1H, ArH), 7.72 (d, *J* = 8.5 Hz, 2H, ArH), 7.34 (d, *J* = 9.0 Hz, 3H, ArH), 7.19 (d, *J* = 7.9 Hz, 2H, ArH), 6.87 (s, 1H, ArH), 2.27 (d, *J* = 10.5 Hz, 6H, CH_3) ppm; $^{13}C\{^1H\}$ NMR (125 MHz, DMSO-d_6): δ = 197.2, 158.6, 156.8, 149.1, 149.0, 144.5, 138.8, 137.4, 134.9, 133.8, 132.2, 132.2, 131.5, 129.6, 129.6, 129.6, 129.6, 129.0, 129.0, 124.0, 123.9, 122.2, 121.0, 120.3, 21.2, 20.5 ppm. HRMS (TOF ES^+): *m/z* calcd for $C_{26}H_{19}BrClNO_2$ $[M+H]^+$, 492.0360; found, 492.0359.

X-ray Structure and Data of 3a'[2]

Single crystal culture and confirmation: First, compound **3a'** (20 mg) was added to a bottle and dissolved by the addition of DMSO (0.5 mL). Then, the bottle was placed in a dry, ventilated place at room temperature for 10 days. Some crystals appeared, and for single crystal parsing, crystals were selected with sizes of 0.22 mm x 0.14 mm x 0.12 mm. The Bruker D8 VENTURE was used to obtain single crystal diffraction at 150.0 K with the use of three-circle diffractometer MoK (lambda = 0.71073 A) for diffraction intensity data collection, using Φ and omega scanning. The crystal structure was solved by the atomic method using the SHELXL 2018/3 (Sheldrick, 2015) program (Supporting Information, Figure S1, CCDC 2260765).

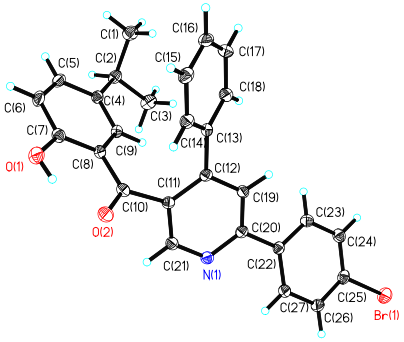


Figure S1. X-Ray crystal structure of **3a'**, ellipsoid is drawn at the 30% probability level.

Table S1. Crystal data and structure refinement for **3a'**

Identification code	mo_20220809D_0m
Empirical formula	$C_{27}H_{22}BrNO_2$
Formula weight	472.36 g/mol
Crystal system	Triclinic
Space group	P -1
Unit cell dimensions	a = 9.2238(5) Å = 110.335(2)°. b = 10.8056(10) Å = 99.439(2)°. c = 12.0232(7) Å = 92.472(2)°.
Volume	1101.93(10) $Å^3$
Z	2
Density (calculated)	1.424 mg/m^3
Absorption coefficient	1.889 mm^{-1}
F(000)	484
Theta range for data collection	2.02 to 28.34°.
Index ranges	-12<=h<=12, -14<=k<=13, -36<=l<=16
Reflections collected	19730
Independent reflections	5438 [R(int) = 0.0604]
Refinement method	Full-matrix least-squares on F^2
Data / restraints / parameters	5483 / 0 / 283
Goodness-of-fit on F^2	1.002
Final R indexes [I>=2sigma(I)]	R_1 = 0.0401, wR_2 = 0.0711
Final R indexes (all data)	R_1 = 0.0786, wR_2 = 0.0818
Extinction coefficient	n/a
Largest diff. peak and hole	0.252 /-0.316e.$Å^{-3}$

Table S2. Bond Lengths for **3a'**

Atom	Atom	Length/Å	Atom	Atom	Length/Å
Br(1)	C(25)	1.902(2)	C(11)	C(21)	1.389(3)
O(1)	H(1)	0.8400	C(12)	C(13)	1.483(3)
O(1)	C(7)	1.356(3)	C(12)	C(19)	1.390(3)
O(2)	C(10)	1.242(3)	C(13)	C(14)	1.398(3)
N(1)	C(20)	1.349(3)	C(13)	C(18)	1.391(3)
N(1)	C(21)	1.331(3)	C(14)	H(14)	0.9500
C(1)	H(1A)	0.9800	C(14)	C(15)	1.379(3)
C(1)	H(1B)	0.9800	C(15)	H(15)	0.9500
C(1)	H(1C)	0.9800	C(15)	C(16)	1.378(3)
C(1)	C(2)	1.523(3)	C(16)	H(16)	0.9500
C(2)	H(2)	1.000	C(16)	C(17)	1.386(3)
C(2)	C(3)	1.529(3)	C(17)	H(17)	0.9500
C(2)	C(4)	1.519(3)	C(17)	C(18)	1.385(3)
C(3)	H(3A)	0.9800	C(18)	H(18)	0.9500
C(3)	H(3B)	0.9800	C(19)	H(19)	0.9500
C(3)	H(3C)	0.9800	C(19)	C(20)	1.386(3)
C(4)	C(5)	1.409(3)	C(20)	C(22)	1.486(3)
C(4)	C(9)	1.372(3)	C(21)	H(21)	0.9500
C(5)	H(5)	0.9500	C(22)	C(23)	1.393(3)
C(5)	C(6)	1.373(3)	C(22)	C(27)	1.391(3)
C(6)	H(6)	0.9500	C(23)	H(23)	0.9500
C(6)	C(7)	1.386(3)	C(23)	C(24)	1.388(3)
C(7)	C(8)	1.409(3)	C(24)	H(24)	0.9500
C(8)	C(9)	1.408(3)	C(24)	C(25)	1.375(3)
C(8)	C(10)	1.455(3)	C(25)	C(26)	1.383(3)
C(9)	H(9)	0.9500	C(26)	H(26)	0.9500
C(10)	C(11)	1.497(3)	C(26)	C(27)	1.386(3)
C(11)	C(12)	1.404(3)	C(27)	H(27)	0.9500

Table S3. Bond Angles for **3a'**

Atom	Atom	Atom	Angle/°	Atom	Atom	Atom	Angle/°
C(7)	O(1)	H(1)	109.5	C(21)	N(1)	C(20)	116.75(19)
H(1A)	C(1)	H(1B)	109.5	H(1A)	C(1)	H(1C)	109.5
H(1B)	C(1)	H(1C)	109.5	C(2)	C(1)	H(1C)	109.5
C(1)	C(2)	H(2)	107.8	C(1)	C(2)	C(3)	110.3(2)
C(3)	C(2)	H(2)	107.8	C(4)	C(2)	C(1)	110.2(18)
C(4)	C(2)	H(2)	107.8	C(4)	C(2)	C(3)	112.9(18)
C(2)	C(3)	H(3A)	109.5	C(2)	C(3)	C(3B)	109.5
C(2)	C(3)	C(3C)	109.5	C(3A)	C(3)	C(3B)	109.5
H(3A)	C(3)	H(3C)	109.5	C(3B)	C(3)	H(3C)	109.5
C(5)	C(4)	C(2)	119.8(19)	C(9)	C(4)	C(2)	123.3(18)
C(9)	C(4)	C(5)	116.9(2)	C(4)	C(5)	H(5)	118.9
C(6)	C(5)	C(4)	122.2(2)	C(6)	C(5)	H(5)	118.9
C(5)	C(6)	H(6)	119.9	C(5)	C(5)	C(7)	120.2(19)
C(7)	C(6)	H(6)	119.9	O(1)	C(7)	C(6)	118.6(19)
O(1)	C(7)	C(8)	122.0(2)	C(6)	C(7)	C(8)	119.5(2)
C(7)	C(8)	C(10)	120.4(19)	C(9)	C(8)	C(7)	118.4(19)
C(9)	C(8)	C(10)	121.2(18)	C(4)	C(9)	C(8)	122.7(18)
C(4)	C(9)	H(9)	118.7	O(2)	C(10)	C(11)	118.2(19)
O(2)	C(10)	C(8)	121.8(19)	C(12)	C(11)	C(10)	124.4(19)
C(8)	C(10)	C(11)	120.0(18)	C(12)	C(11)	C(10)	124.4(19)
C(21)	C(11)	C(10)	117.4(19)	C(21)	C(11)	H(12)	118.2(19)
C(11)	C(12)	C(13)	122.4(18)	C(19)	C(12)	C(11)	116.9(19)
C(19)	C(12)	C(13)	120.7(19)	C(18)	C(13)	C(12)	120.5(2)
C(18)	C(13)	C(12)	120.6(19)	C(18)	C(13)	H(14)	118.9(2)
C(13)	C(14)	H(14)	119.8	C(15)	C(14)	C(13)	120.4(2)
C(15)	C(14)	H(14)	119.8	C(14)	C(15)	H(15)	119.9
C(16)	C(15)	C(14)	120.3(2)	C(16)	C(15)	H(15)	119.9
C(15)	C(16)	H(16)	120.0	C(15)	C(16)	C(17)	120.0(2)
C(17)	C(16)	H(16)	120.0	C(16)	C(17)	H(17)	120.0
C(18)	C(17)	C(16)	120.1(2)	C(18)	C(17)	H(17)	120.0
C(13)	C(18)	H(18)	119.8	C(17)	C(18)	C(13)	120.3(2)
C(17)	C(18)	H(18)	119.8	C(12)	C(19)	H(19)	119.6
C(20)	C(19)	C(12)	120.7(2)	C(20)	C(19)	H(19)	119.6
N(1)	C(20)	C(19)	122.4(19)	N(1)	C(20)	C(22)	116.1(19)
C(19)	C(20)	C(22)	121.5(2)	N(1)	C(21)	C(11)	125.0(2)

N(1)	C(21)	H(21)	117.5	C(11)	C(21)	H(21)	117.5
C(23)	C(22)	C(20)	121.0(19)	C(27)	C(22)	C(20)	120.2(2)
C(27)	C(22)	C(23)	118.8(19)	C(22)	C(23)	H(23)	119.6
C(24)	C(23)	C(22)	120.9(2)	C(24)	C(23)	H(23)	119.6
C(23)	C(24)	H(24)	120.6	C(25)	C(24)	C(23)	118.9(2)
C(25)	C(24)	H(24)	120.6	C(24)	C(25)	Br(1)	118.8(17)
C(24)	C(25)	C(26)	121.8(2)	C(26)	C(25)	Br(1)	119.5(17)
C(25)	C(26)	H(26)	120.6	C(25)	C(26)	C(27)	118.8(2)
C(27)	C(26)	H(26)	120.6	C(22)	C(27)	H(27)	119.6
C(26)	C(27)	C(22)	120.9(2)	C(26)	C(27)	H(27)	119.6

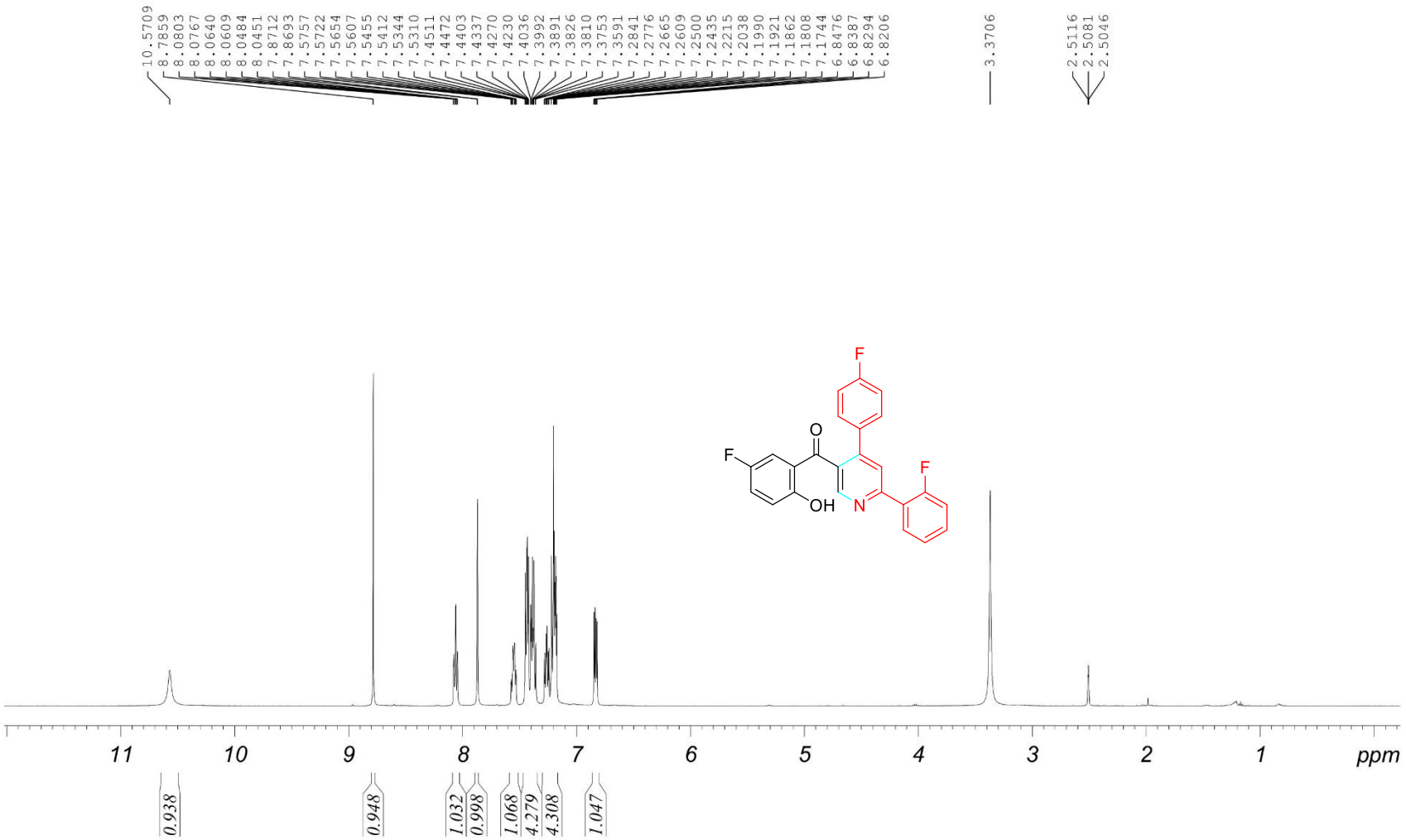


Figure S2. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3a**

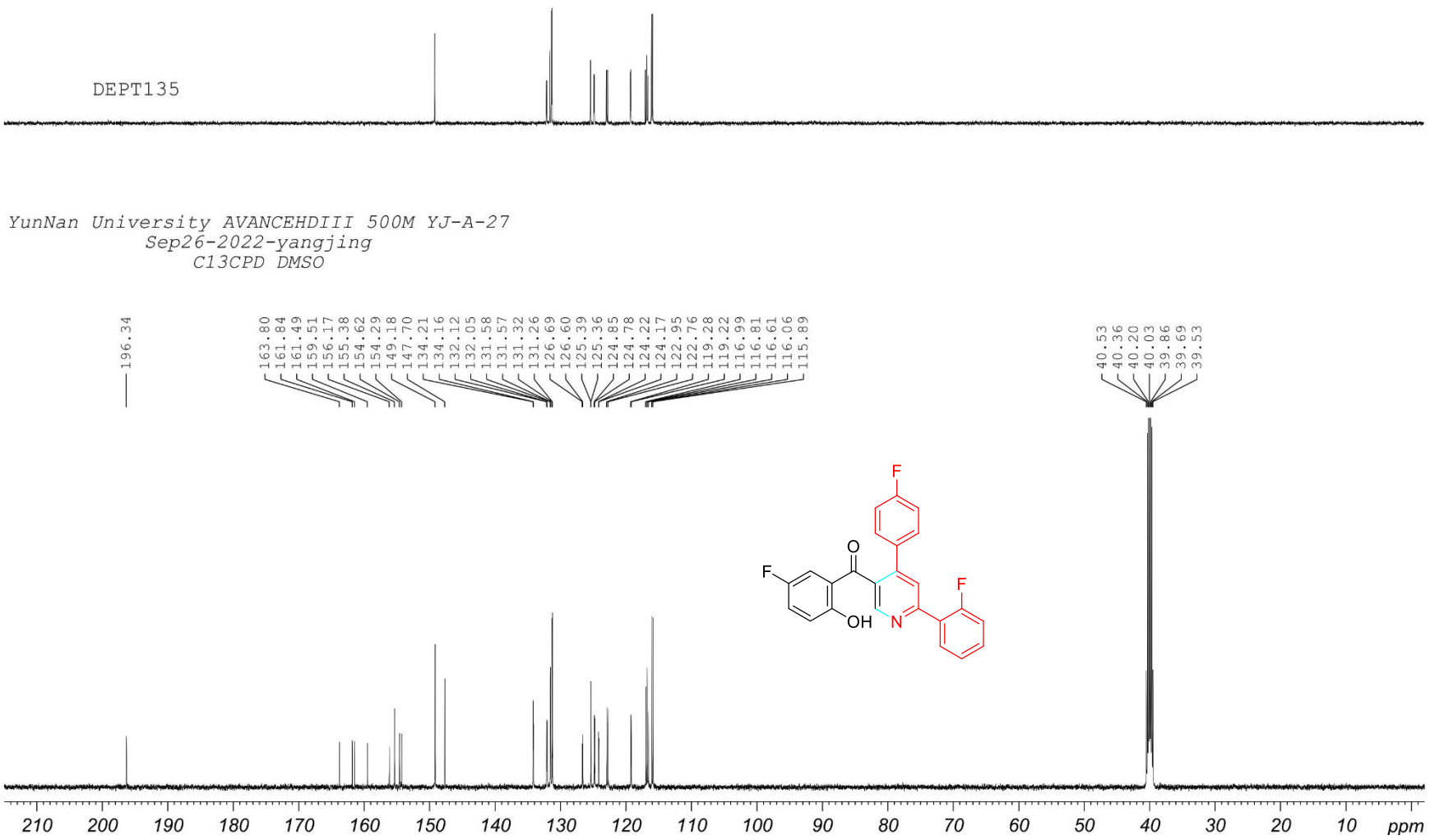


Figure S3. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3a**

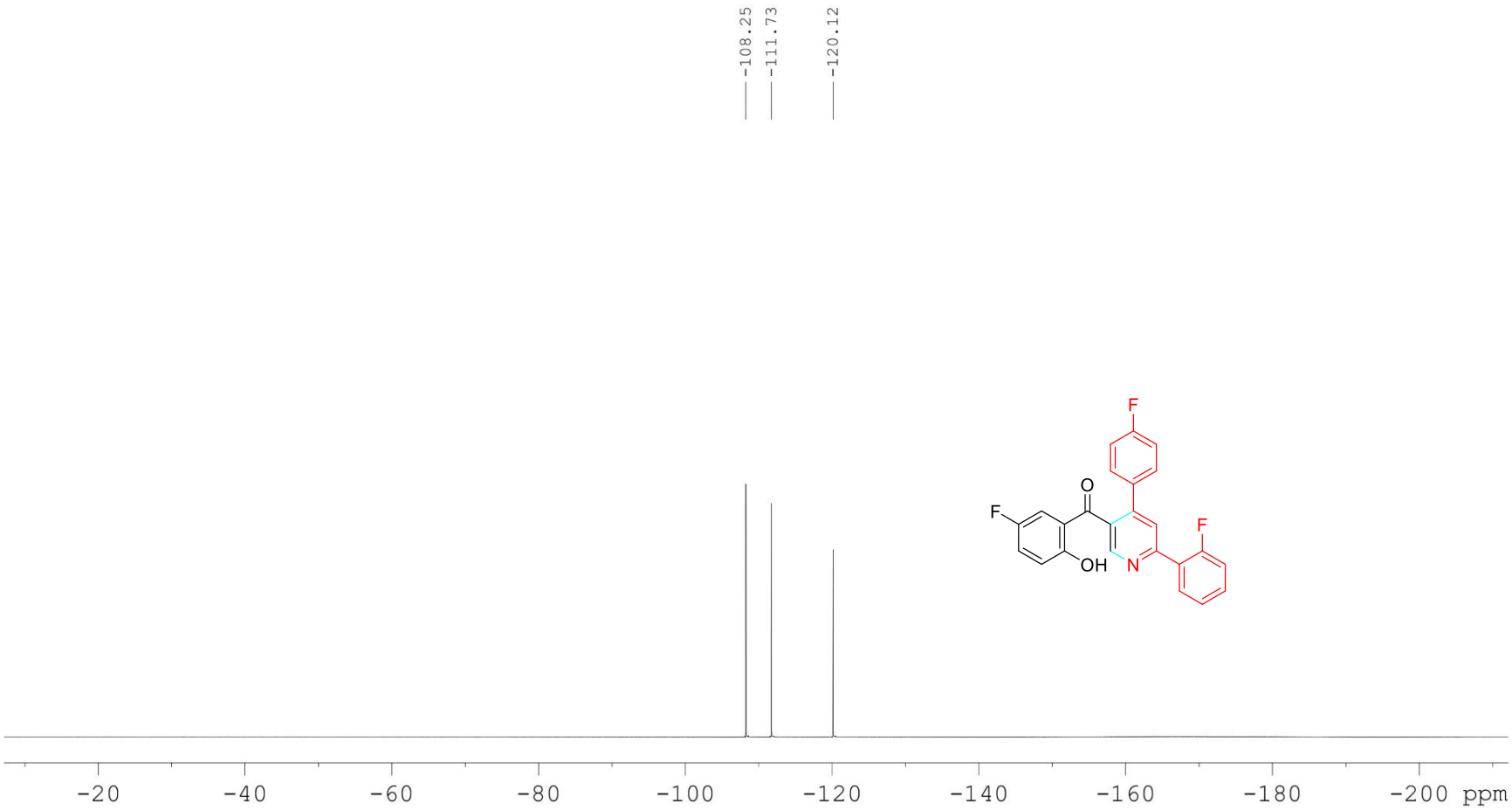


Figure S4. ^{19}F NMR (470 MHz, DMSO-d_6) spectra of compound **3a**

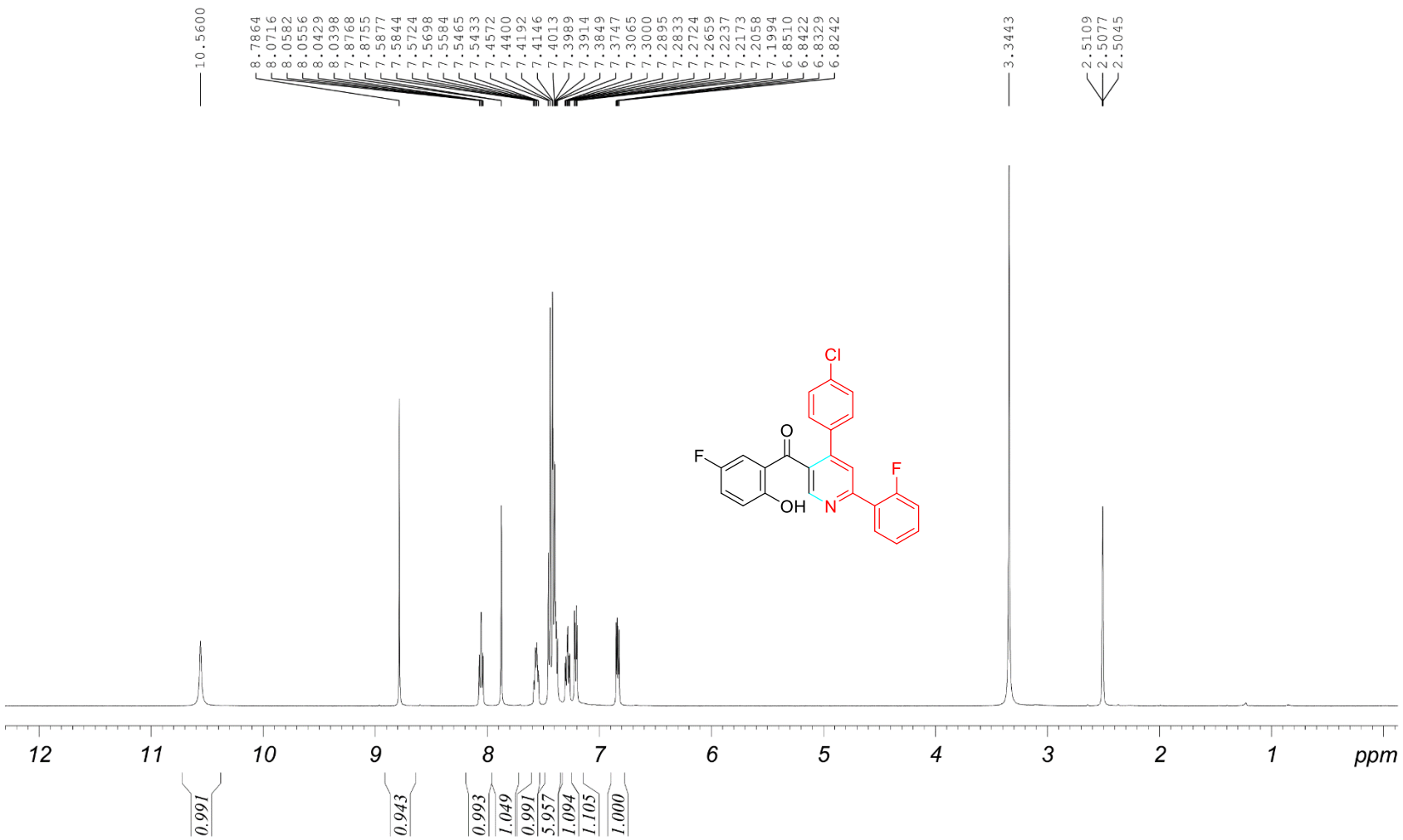


Figure S5. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3b**

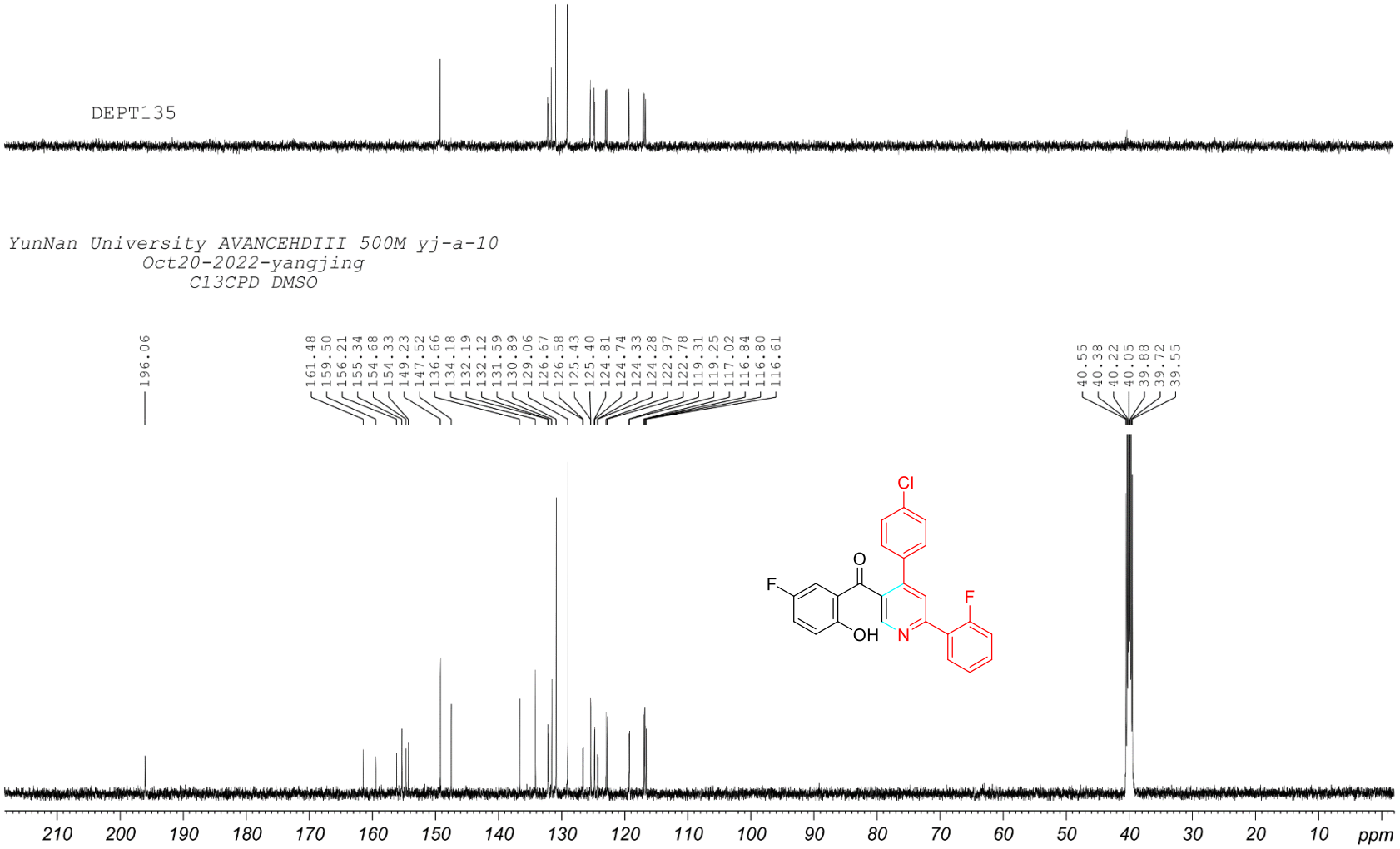


Figure S6. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3b**

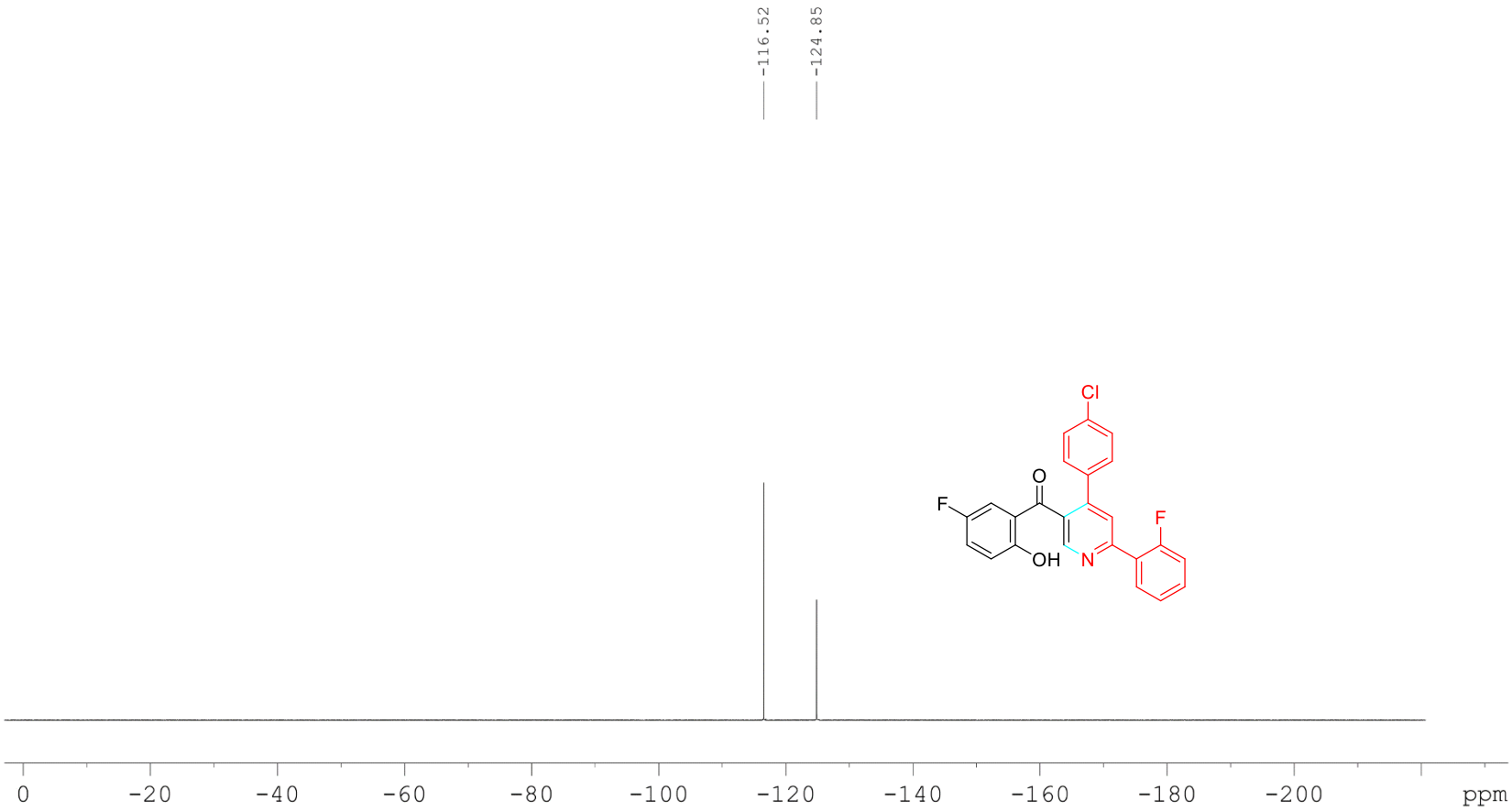


Figure S7. ^{19}F NMR (470 MHz, DMSO-d_6) spectra of compound **3b**

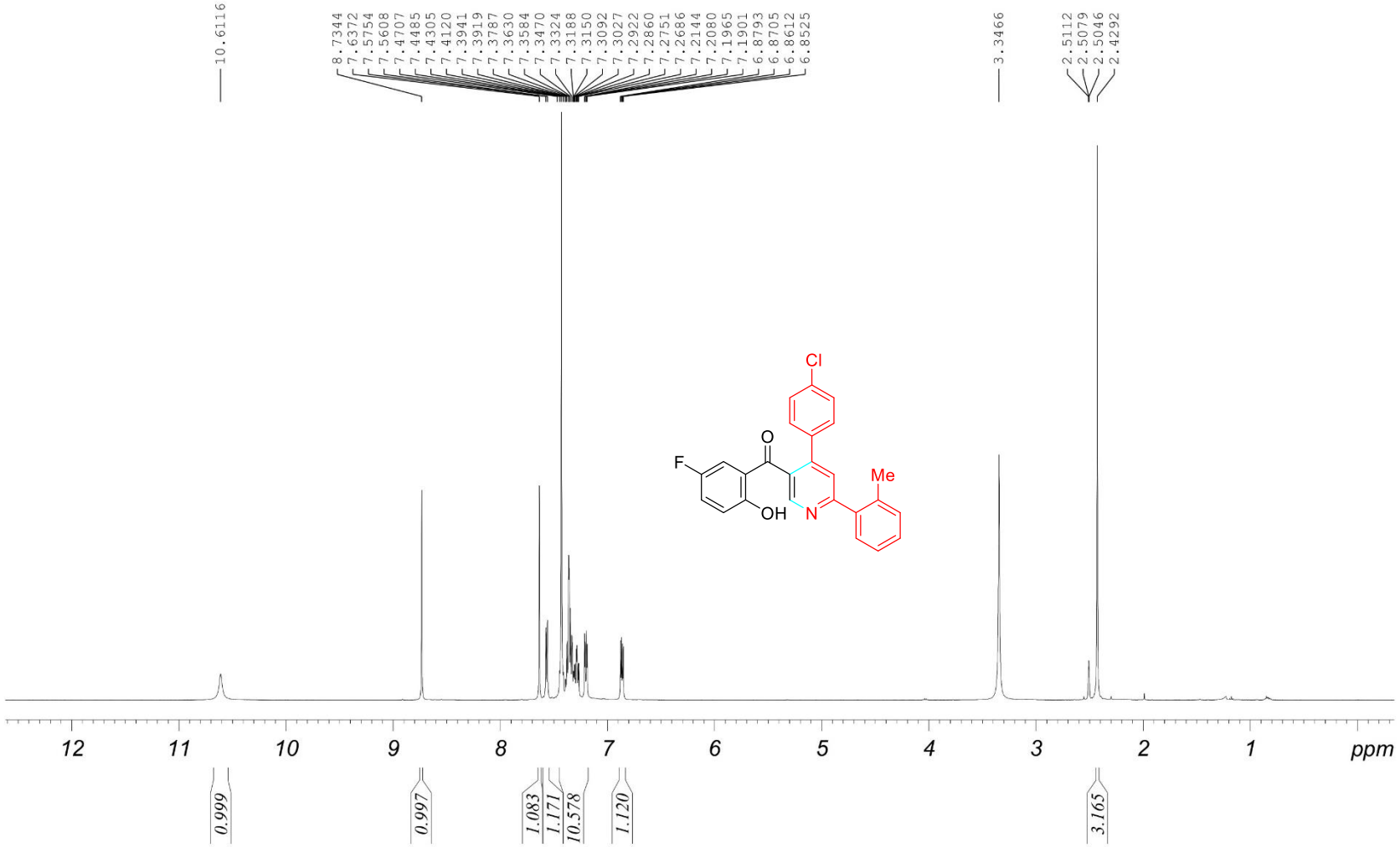


Figure S8. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3c**

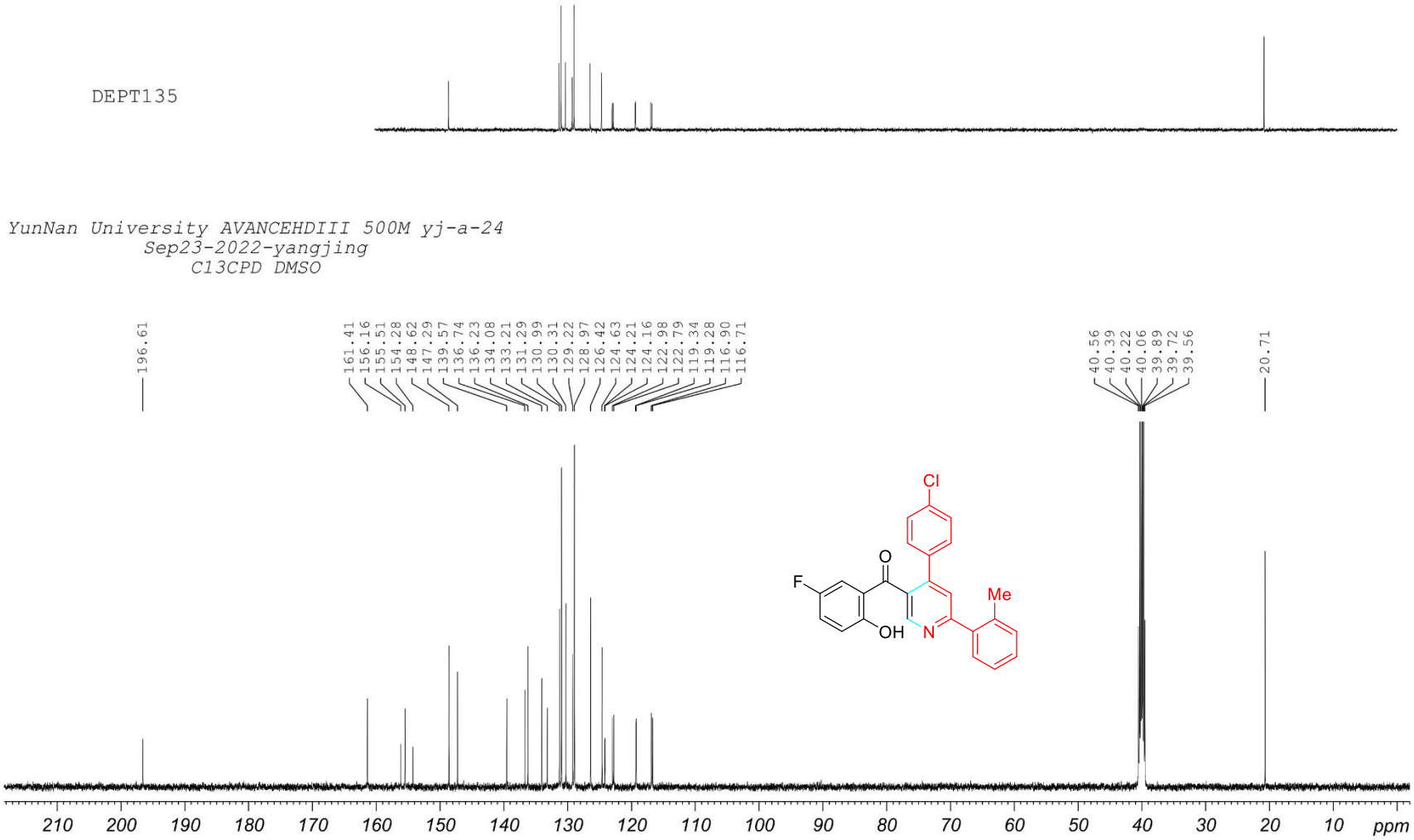


Figure S9. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3c**

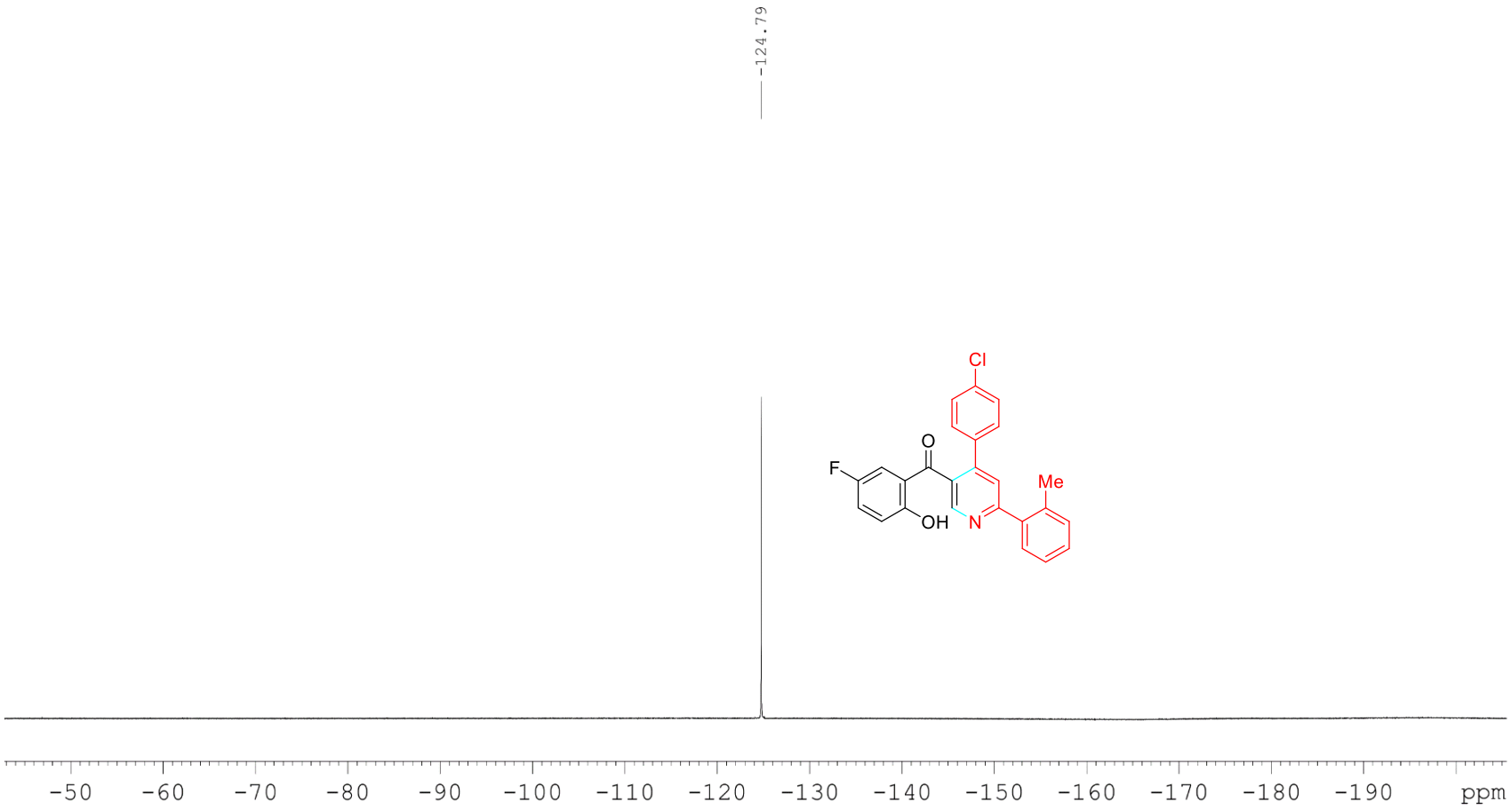


Figure S10. ^{19}F NMR (470 MHz, DMSO-d_6) spectra of compound **3c**

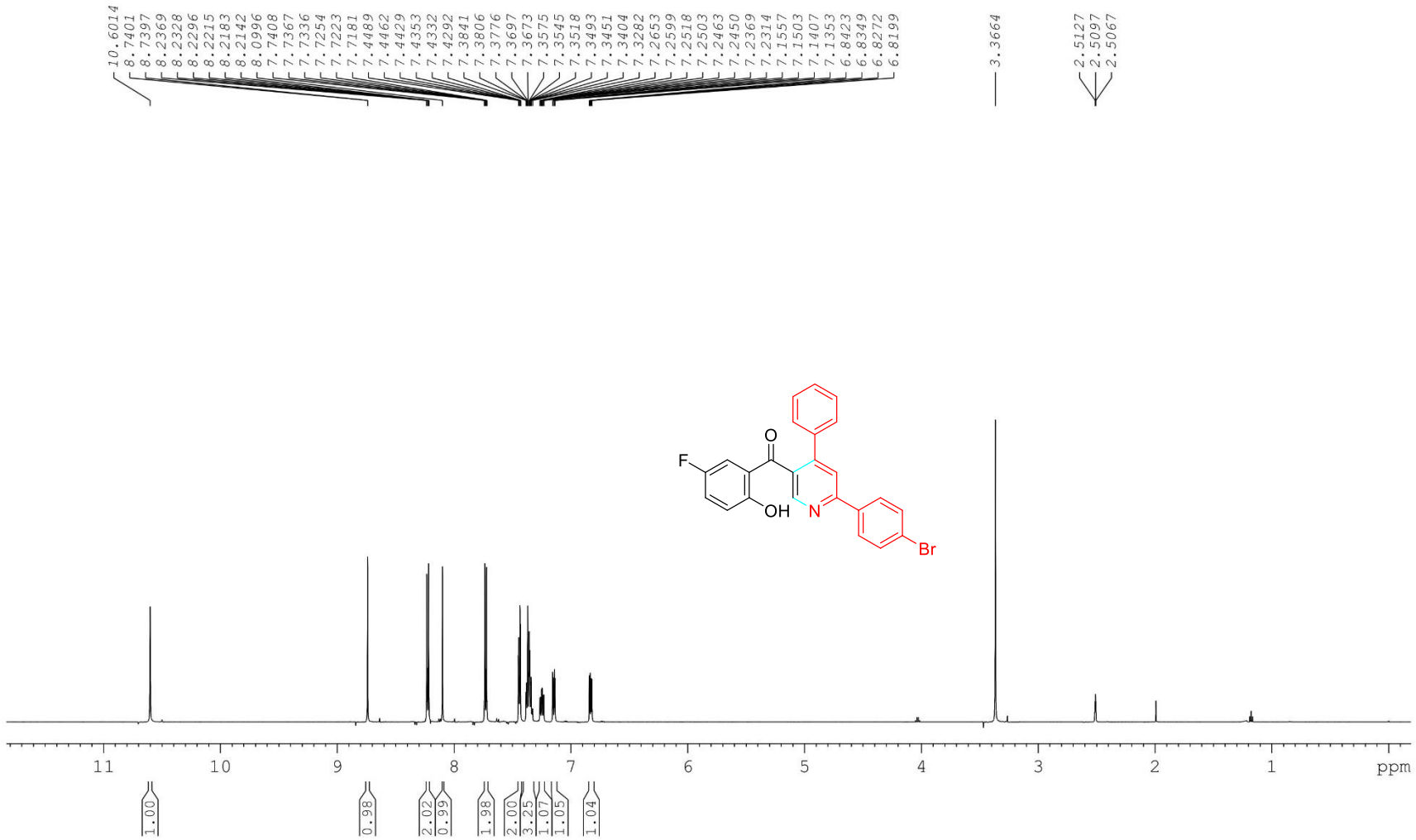


Figure S11. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3d**

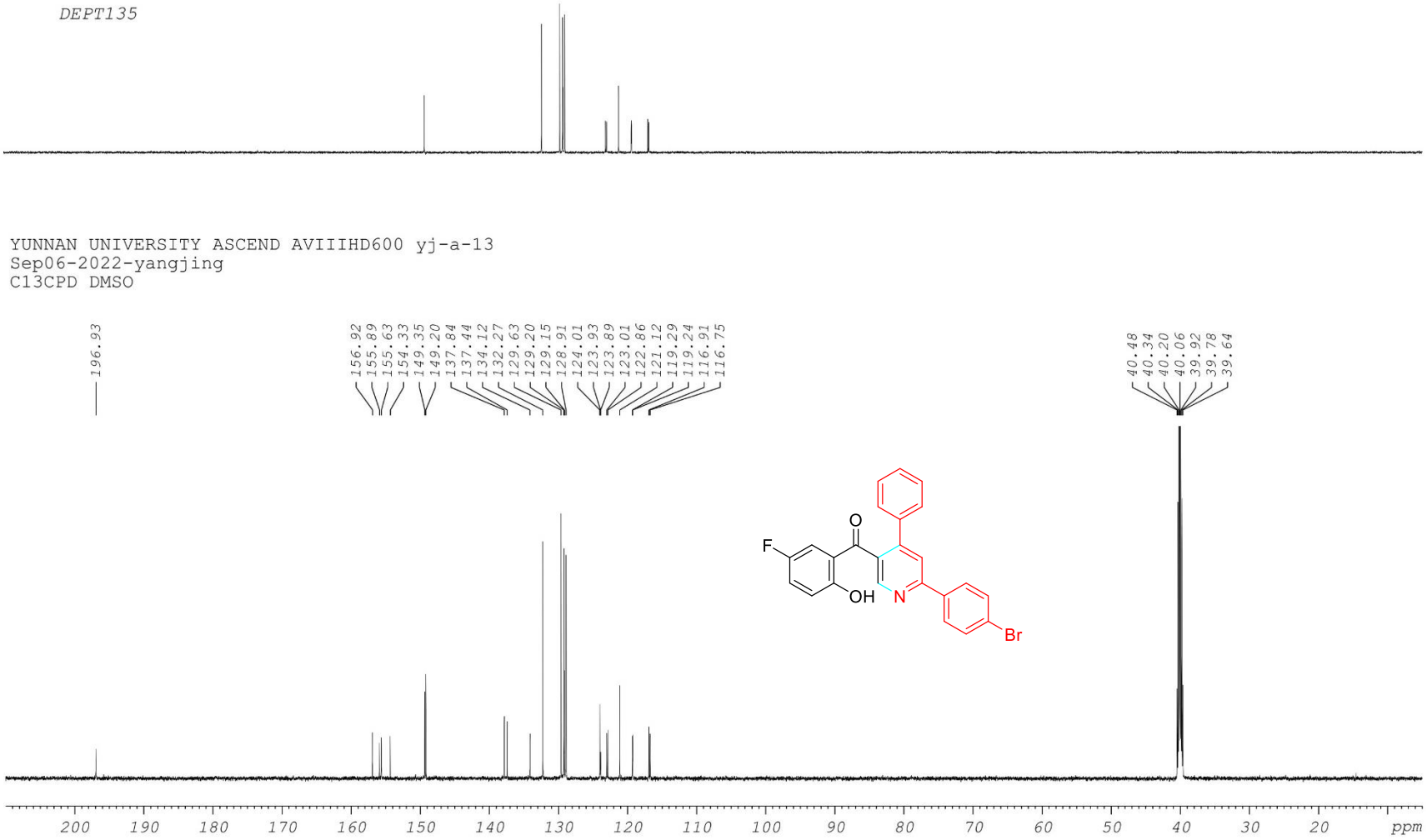


Figure S12. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3d**

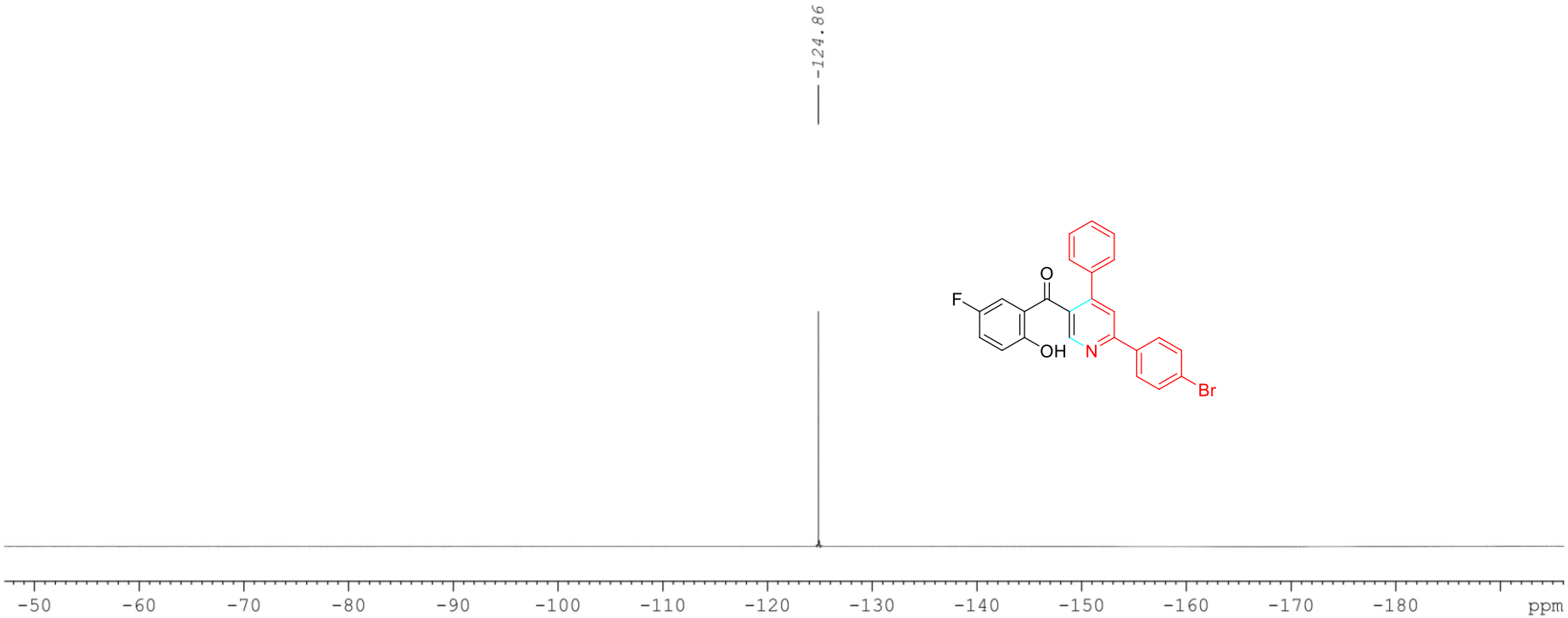


Figure S13. ^{19}F NMR (564 MHz, DMSO-d_6) spectra of compound **3d**

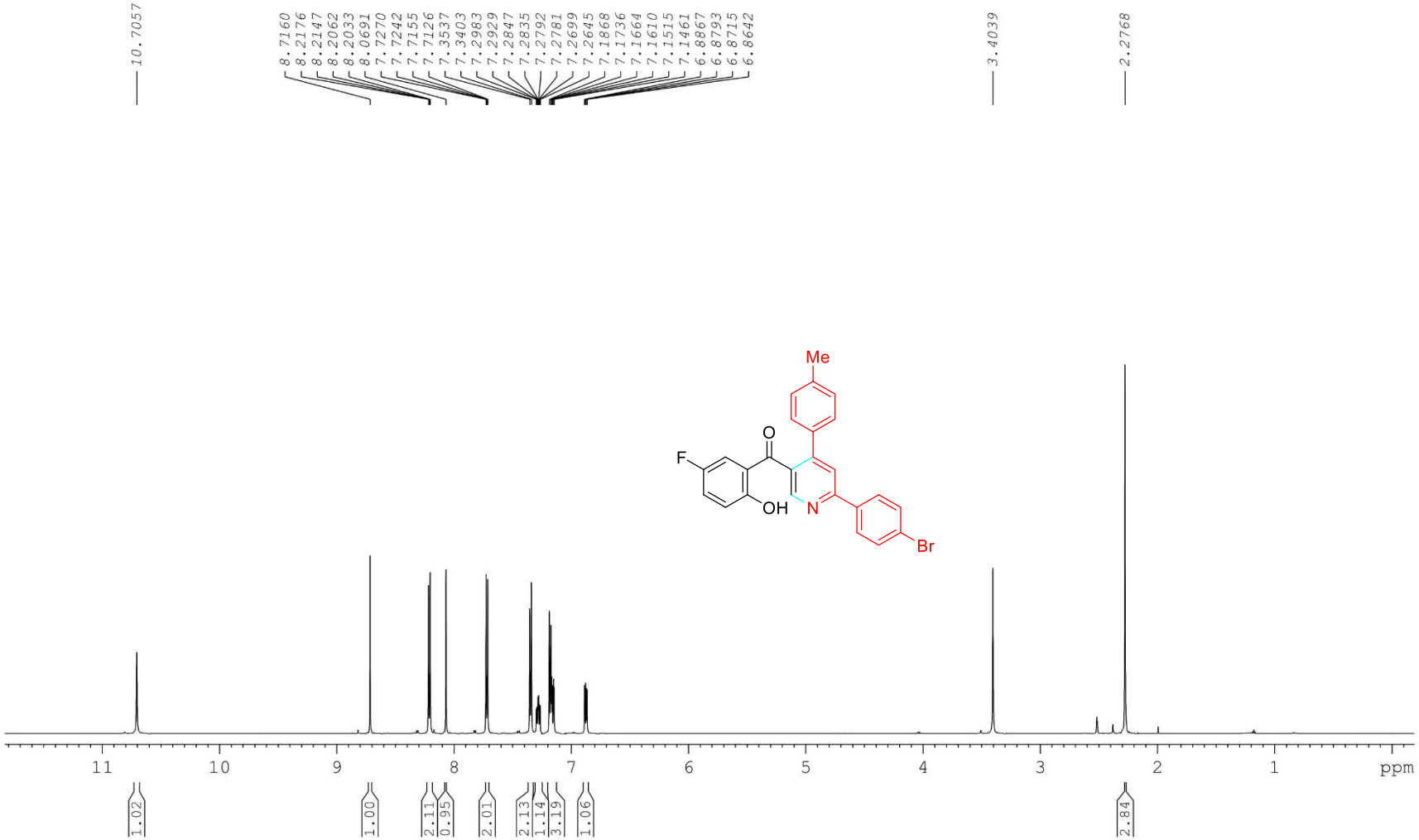


Figure S14. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3e**

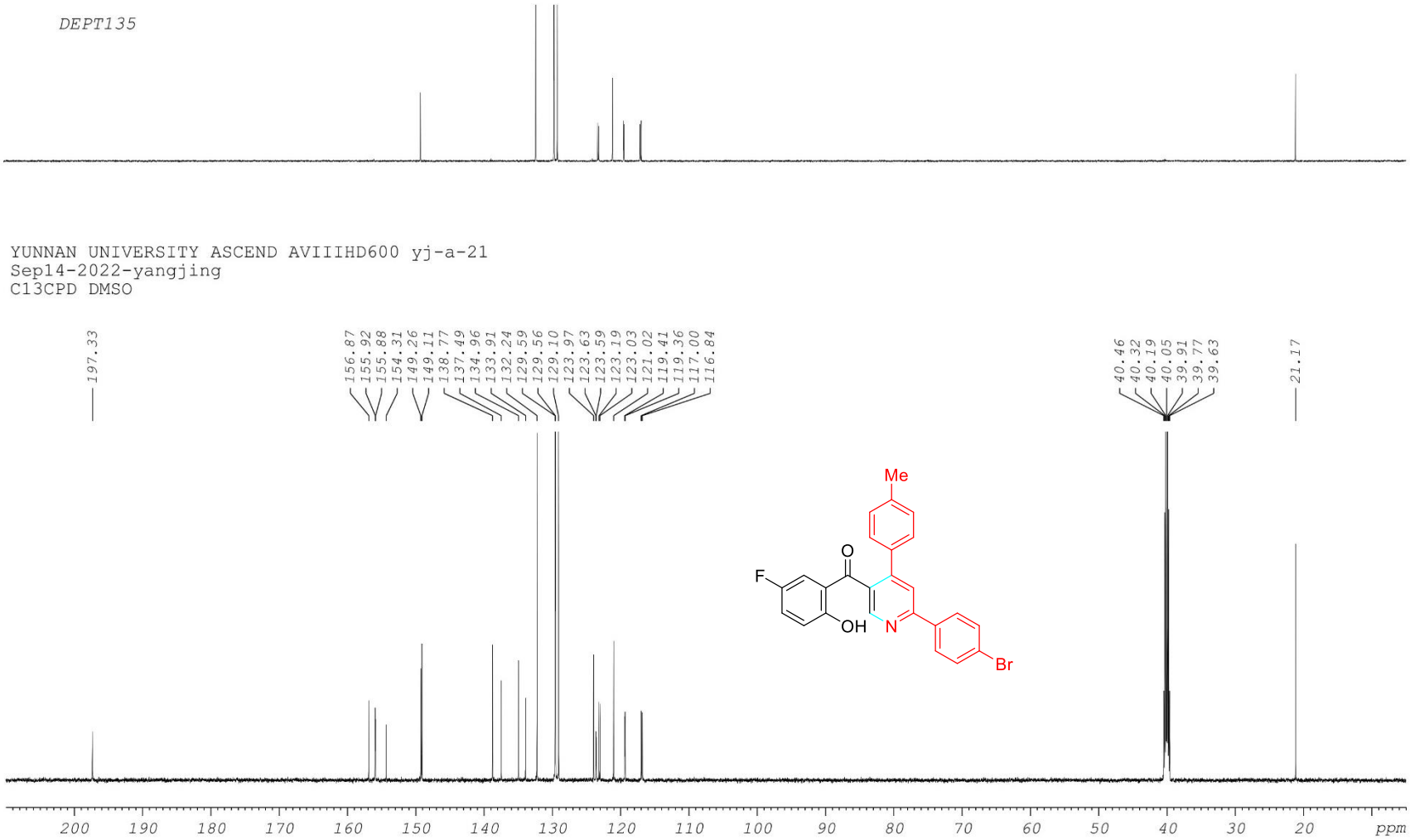


Figure S15. ^{13}C NMR (150MHz, DMSO-d_6) spectra of compound **3e**

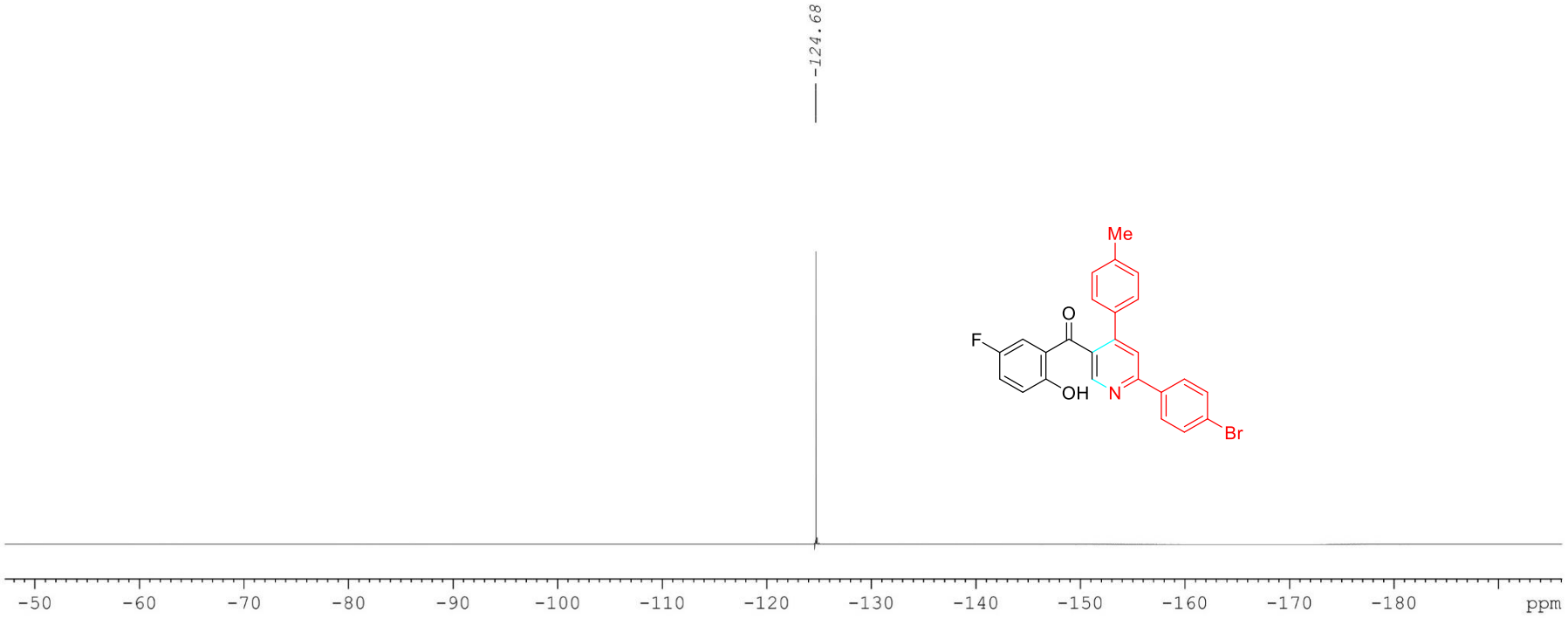


Figure S16. ^{19}F NMR (564 MHz, DMSO-d_6) spectra of compound **3e**

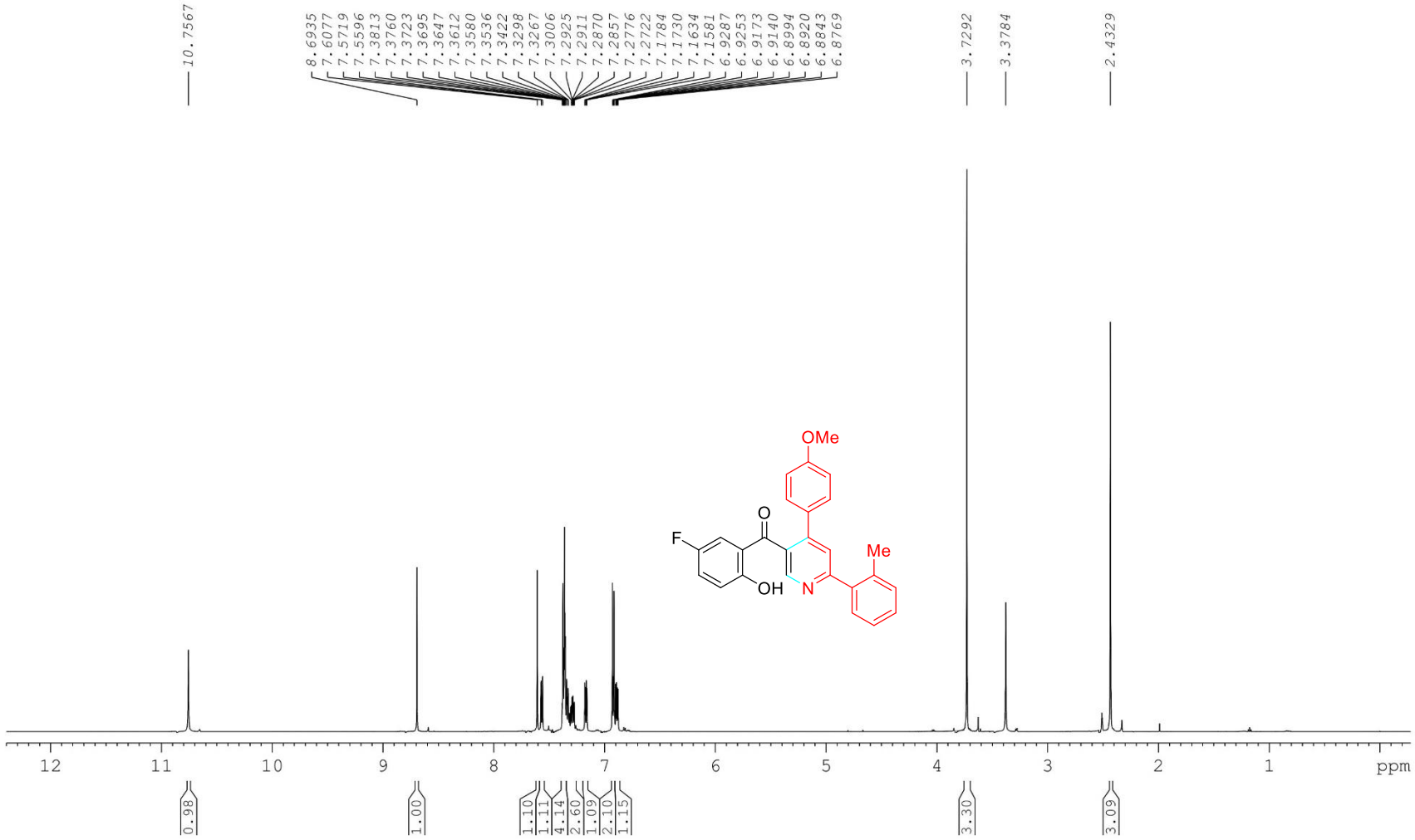


Figure S17. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3f**

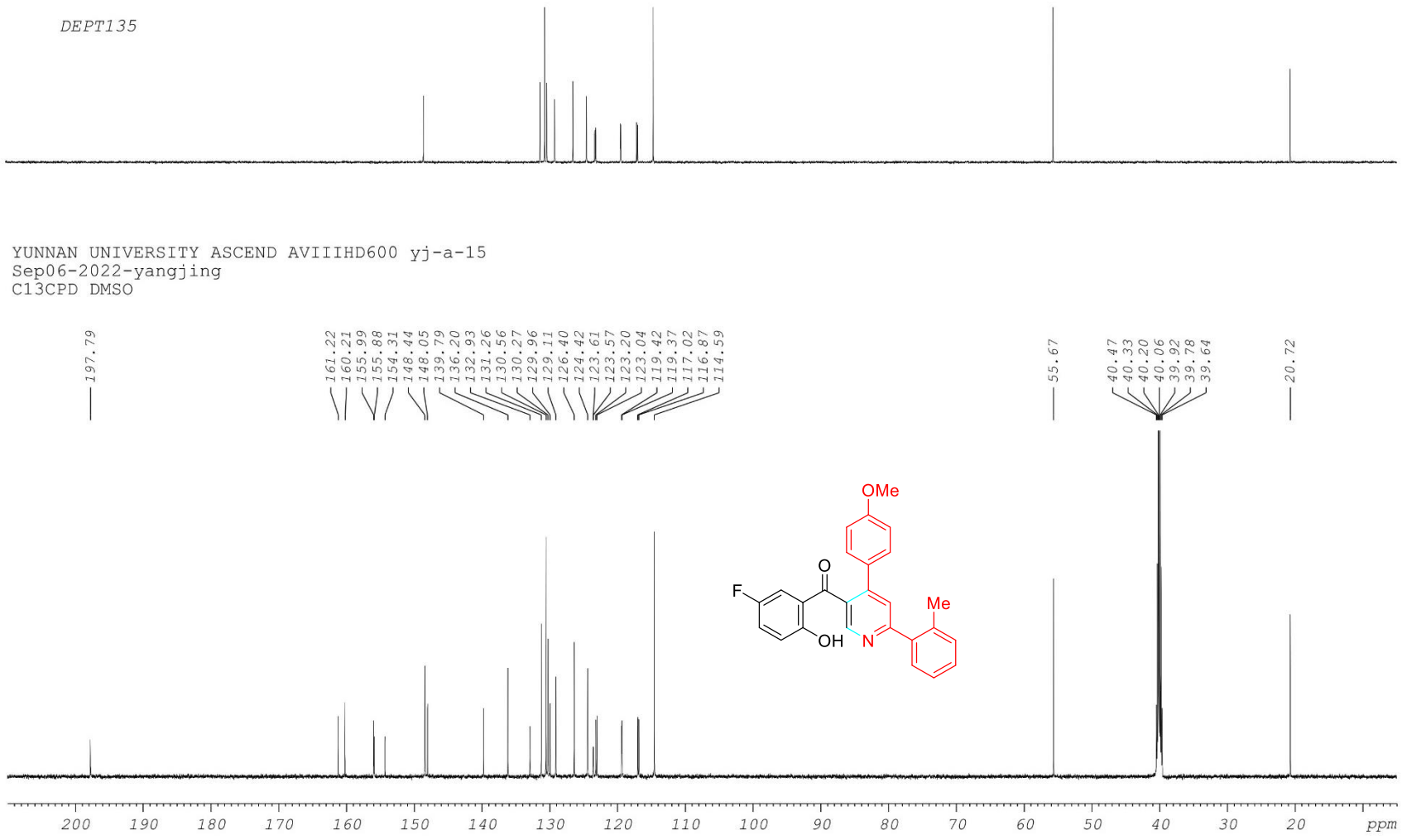


Figure S18. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3f**

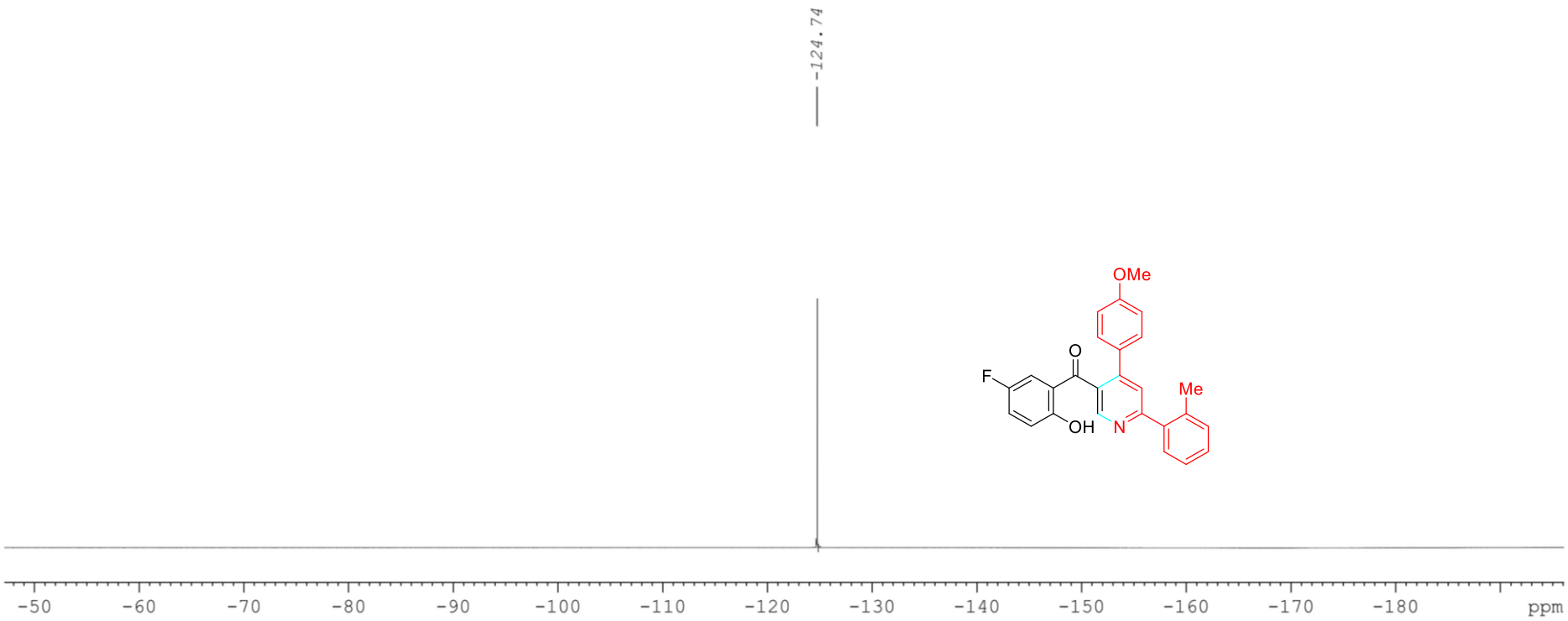


Figure S19. ^{19}F NMR (564 MHz, DMSO-d_6) spectra of compound **3f**

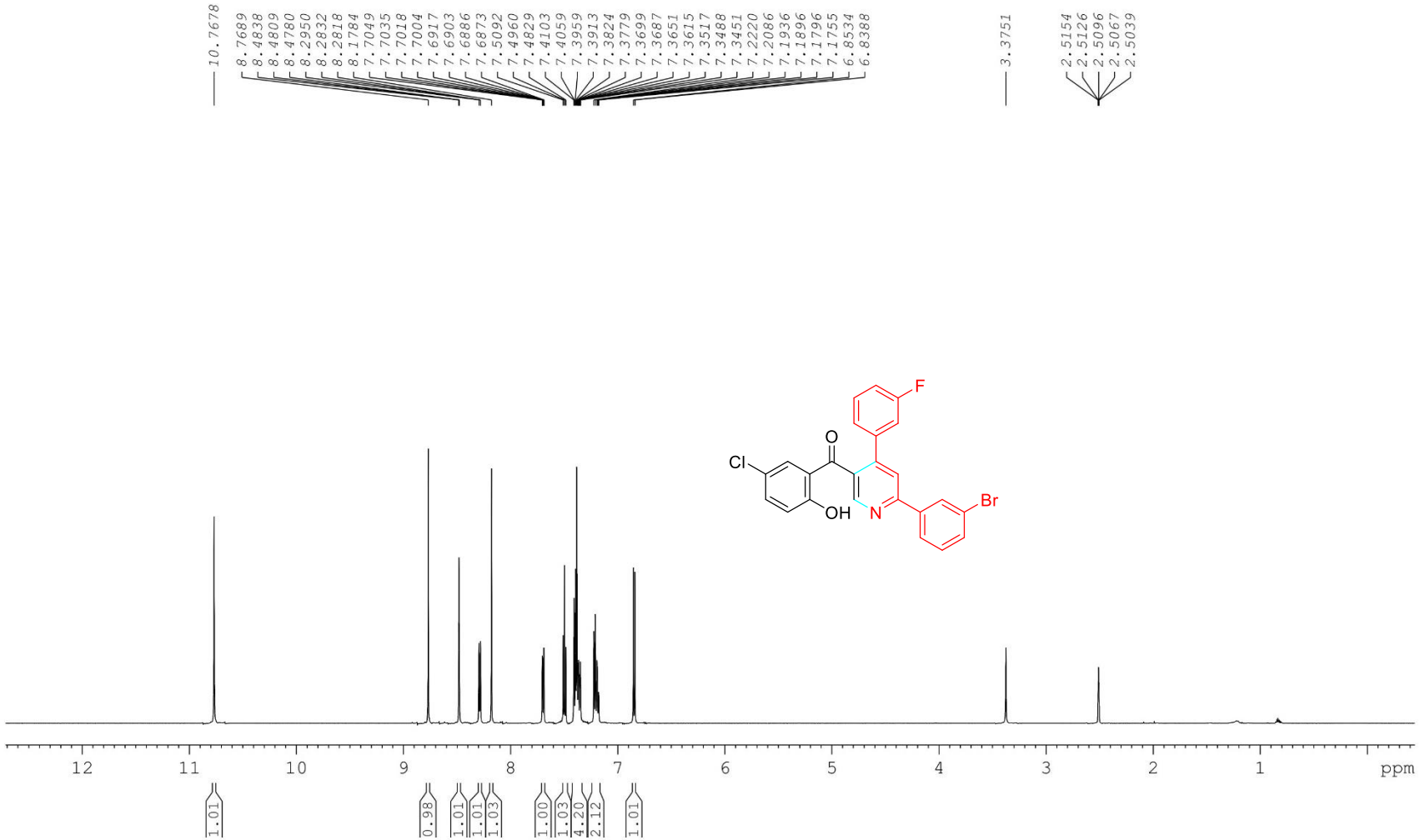


Figure S20. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3g**

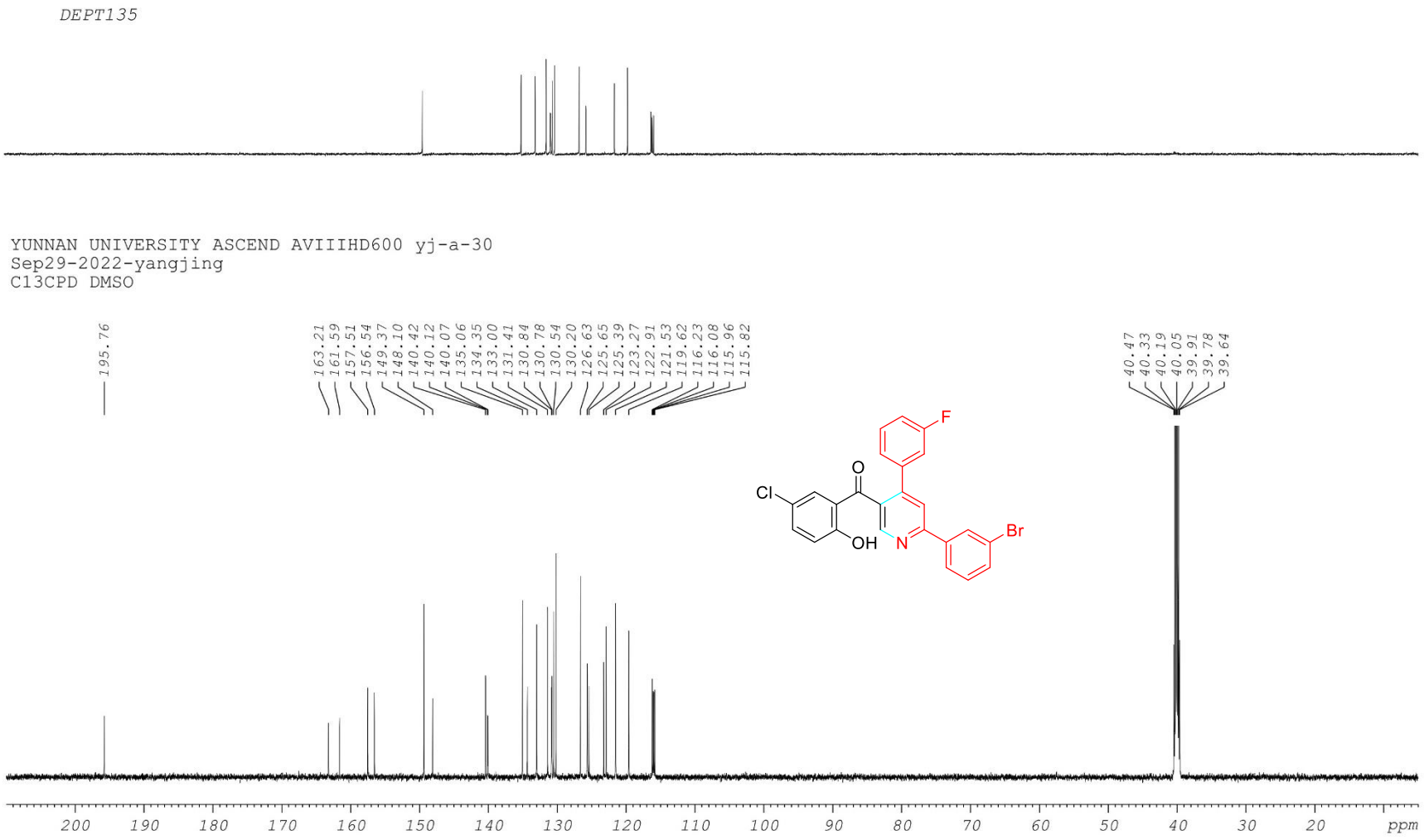


Figure S21. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3g**

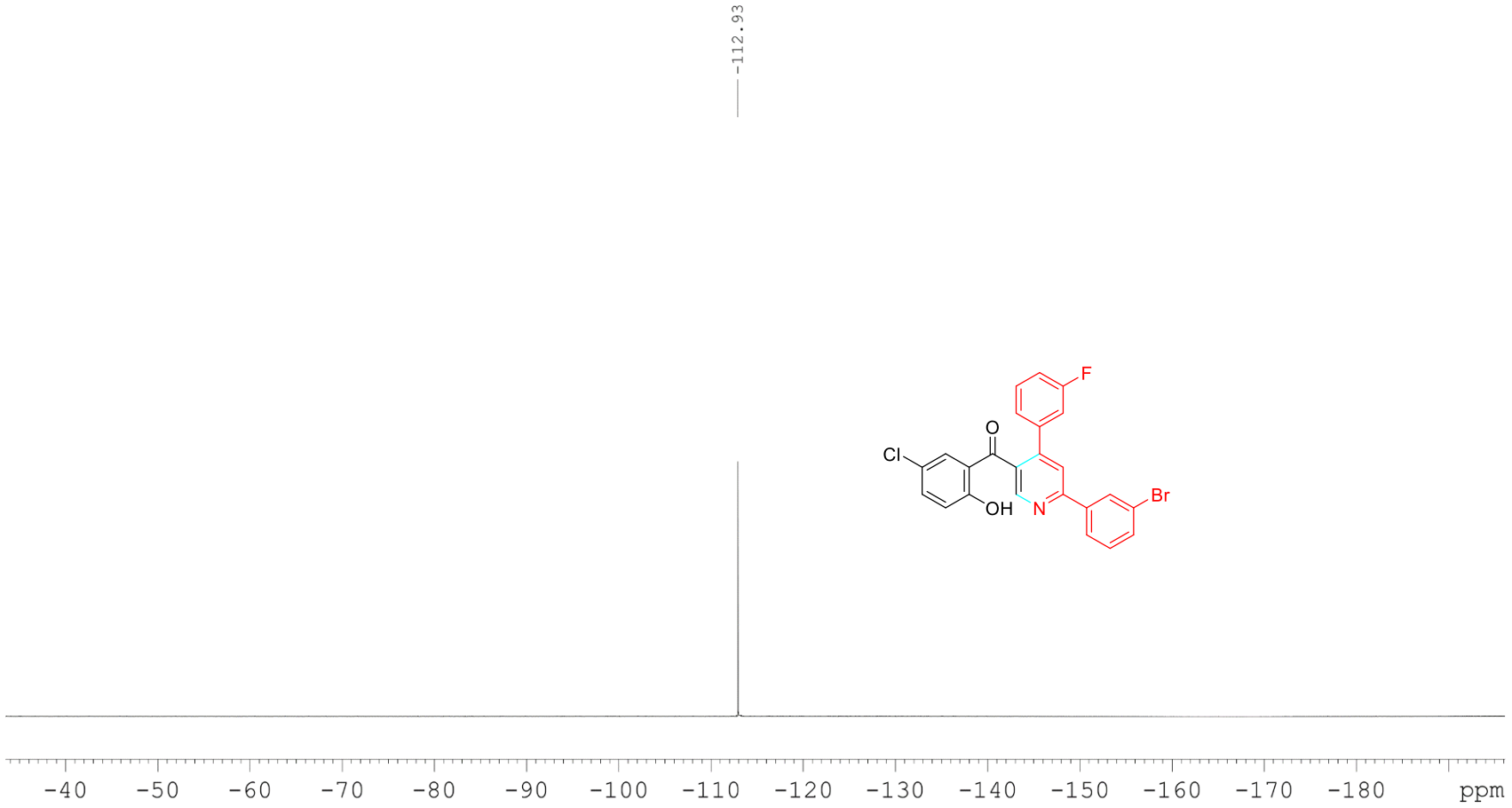


Figure S22. ^{19}F NMR (470 MHz, DMSO-d_6) spectra of compound **3g**

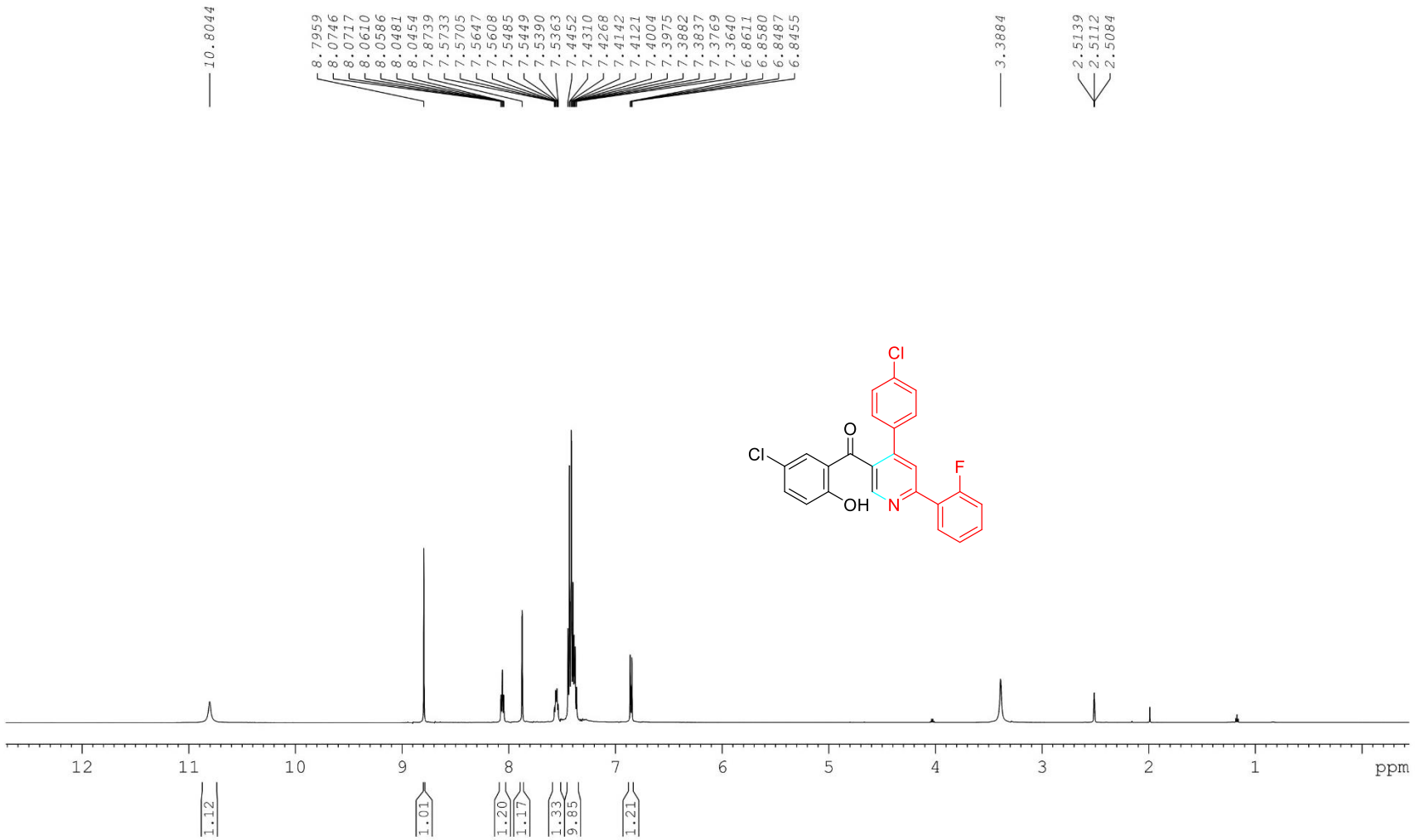


Figure S23. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3h**

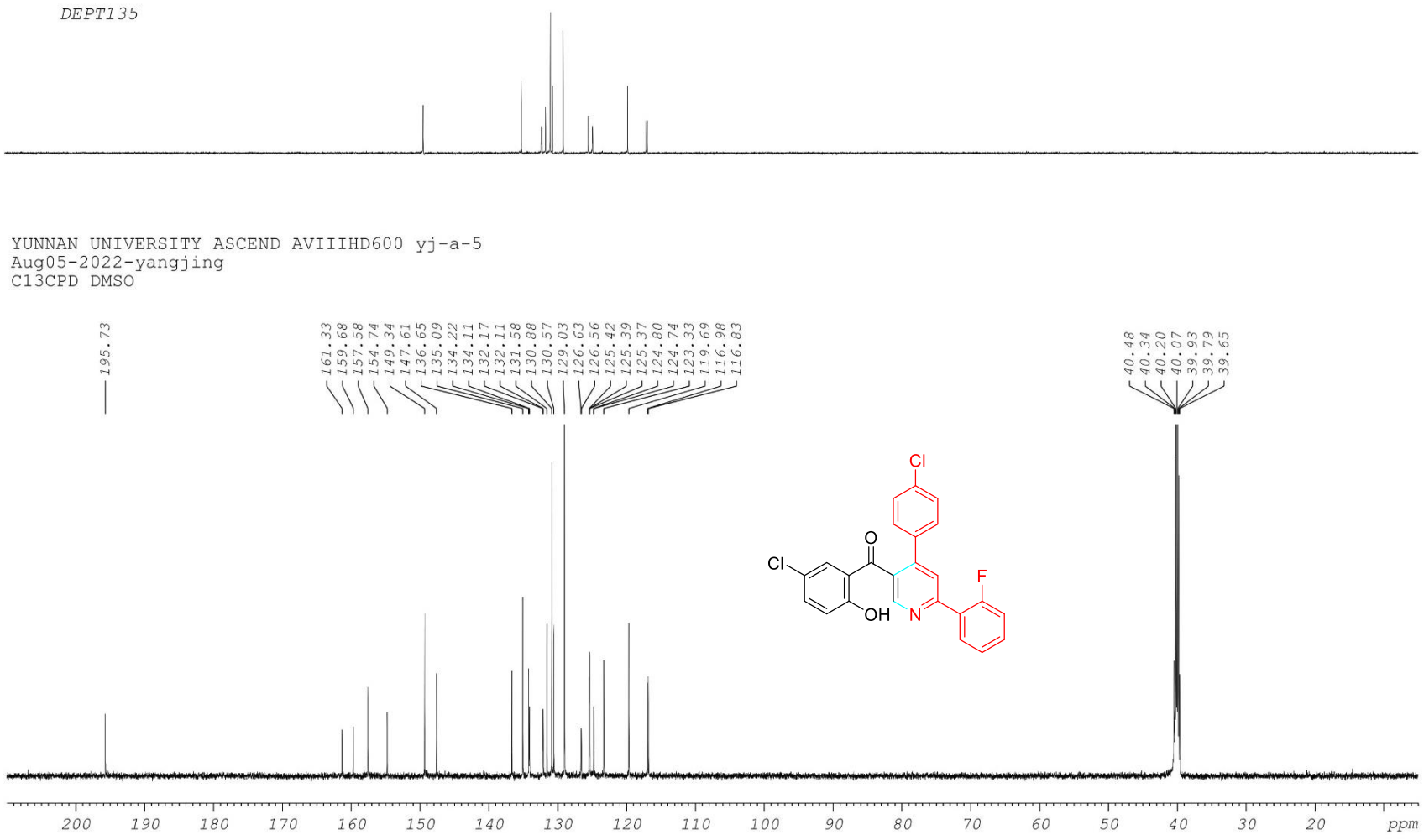


Figure S24. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3h**

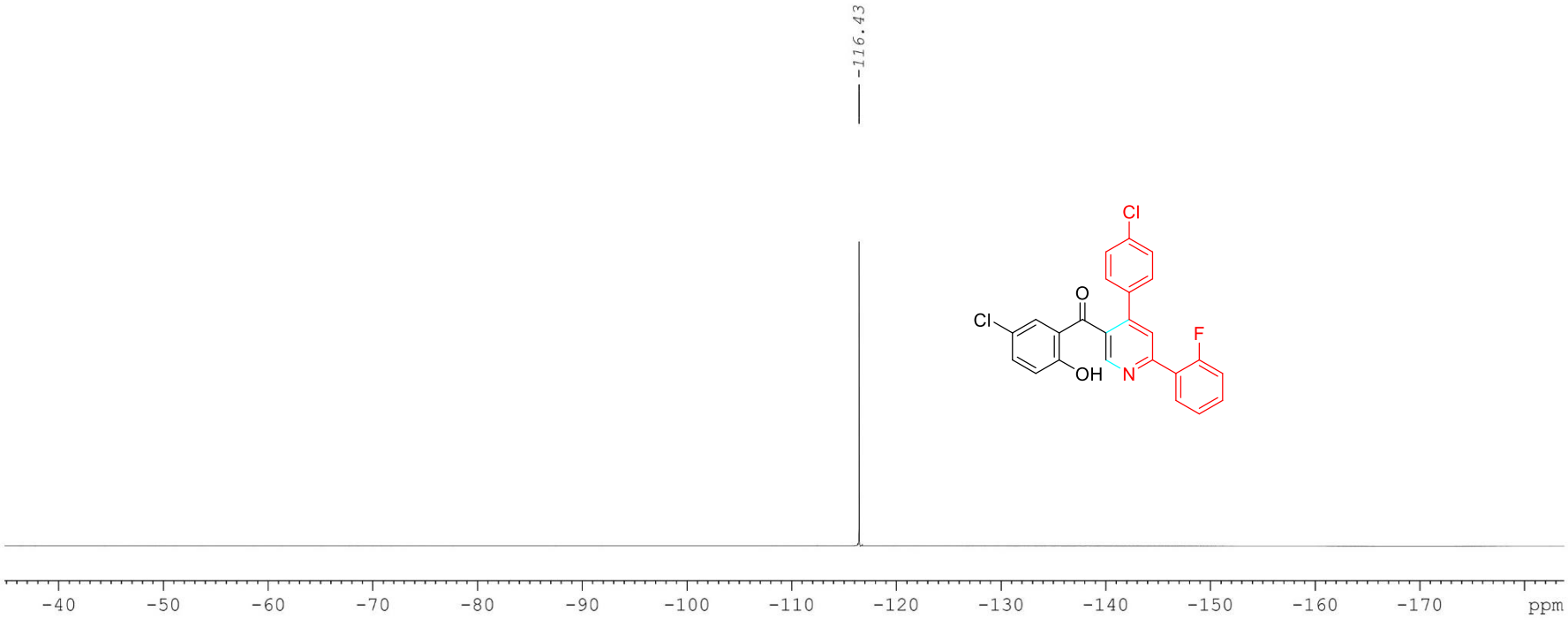


Figure S25. ^{19}F NMR (564 MHz, DMSO-d_6) spectra of compound **3h**

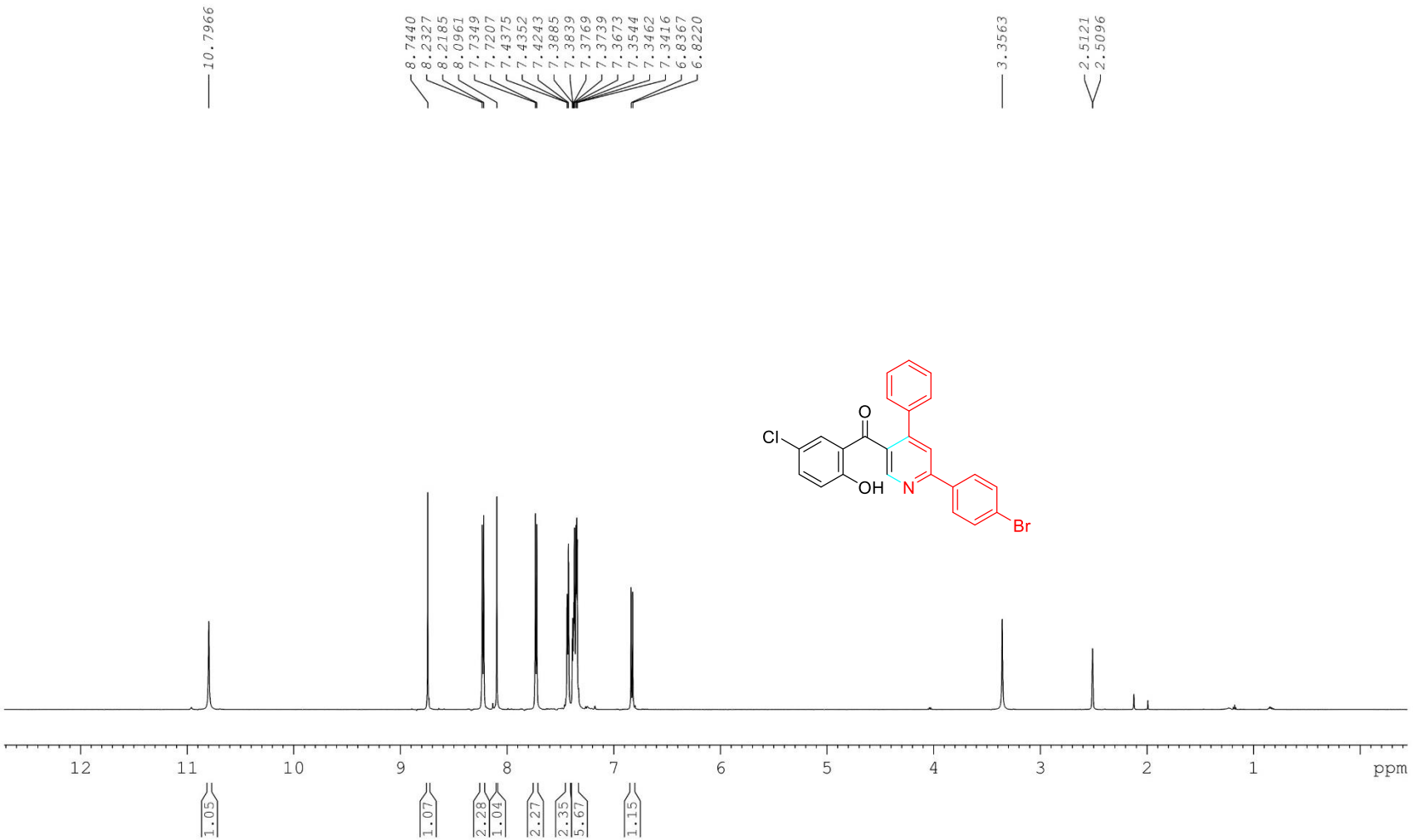


Figure S26. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3i**

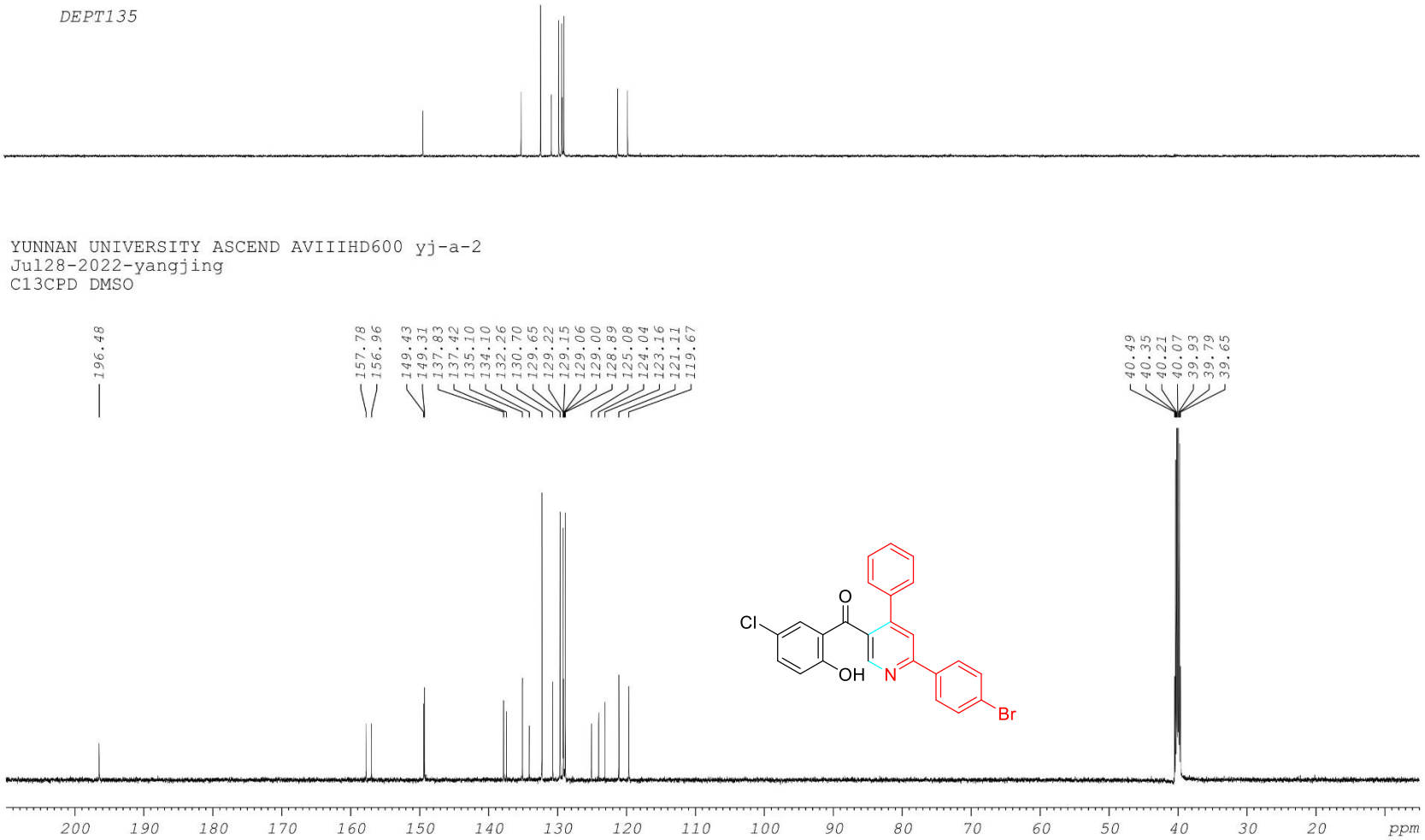


Figure S27. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3i**

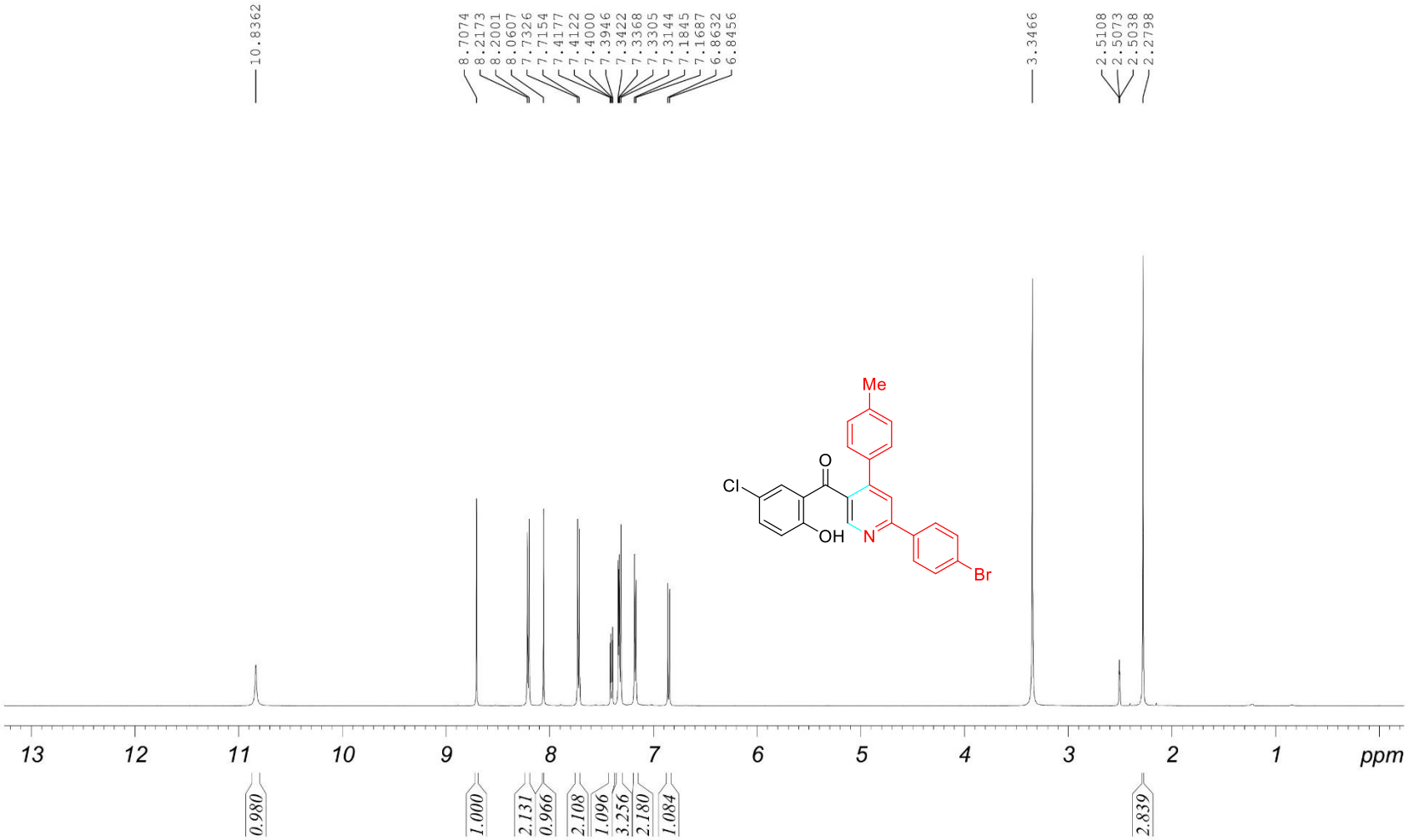


Figure S28. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3j**

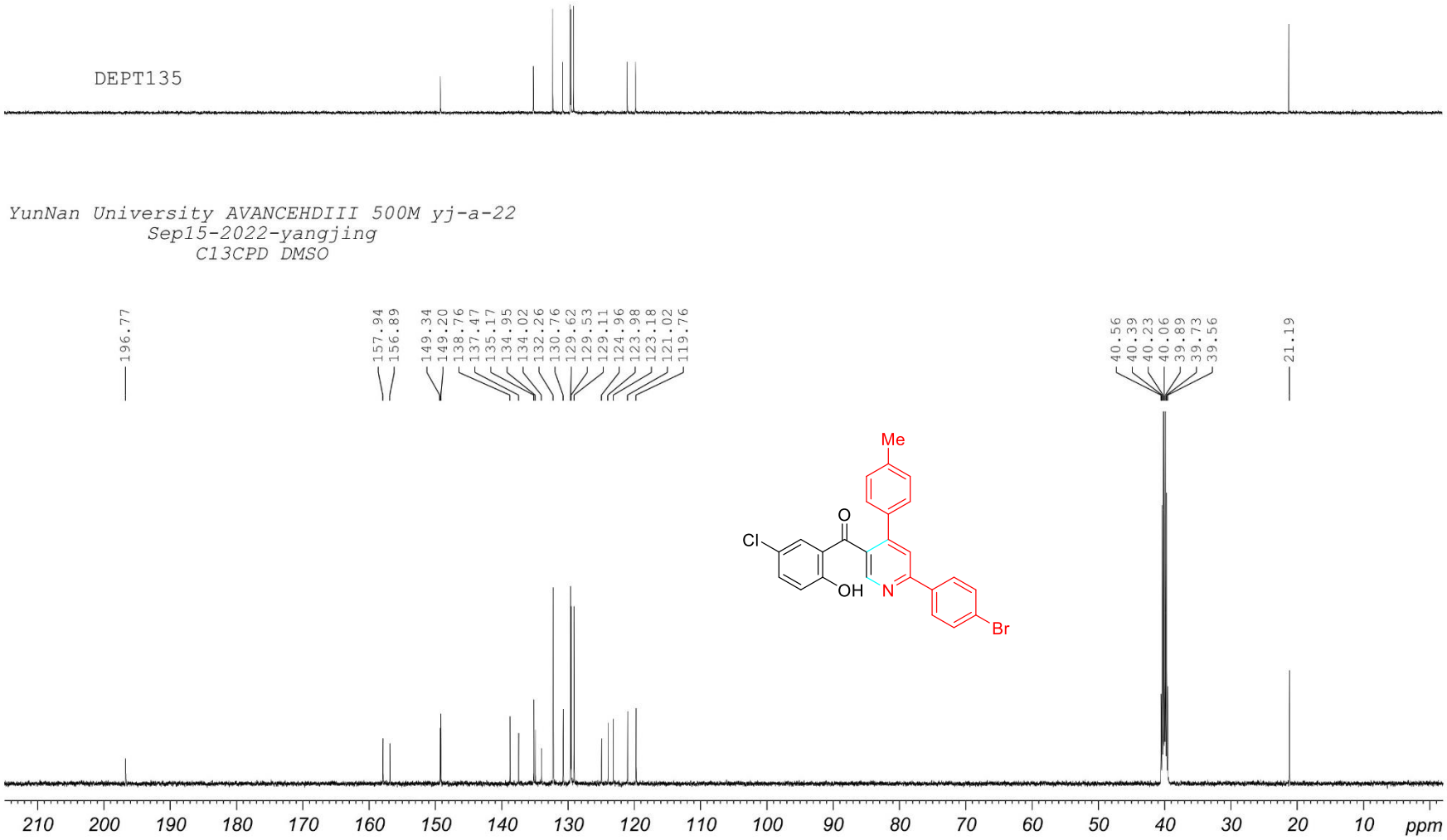


Figure S29. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3j**

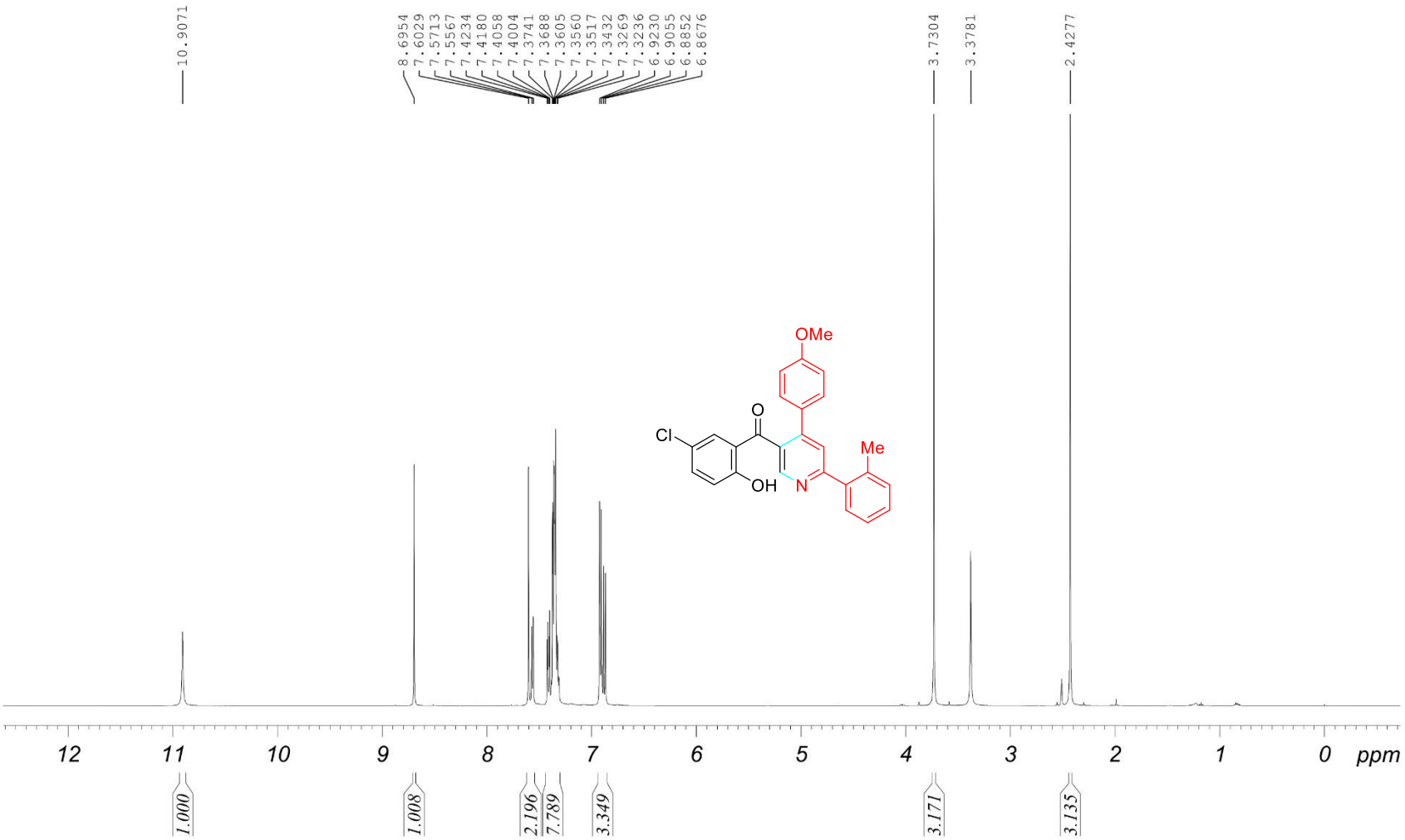


Figure S30. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3k**

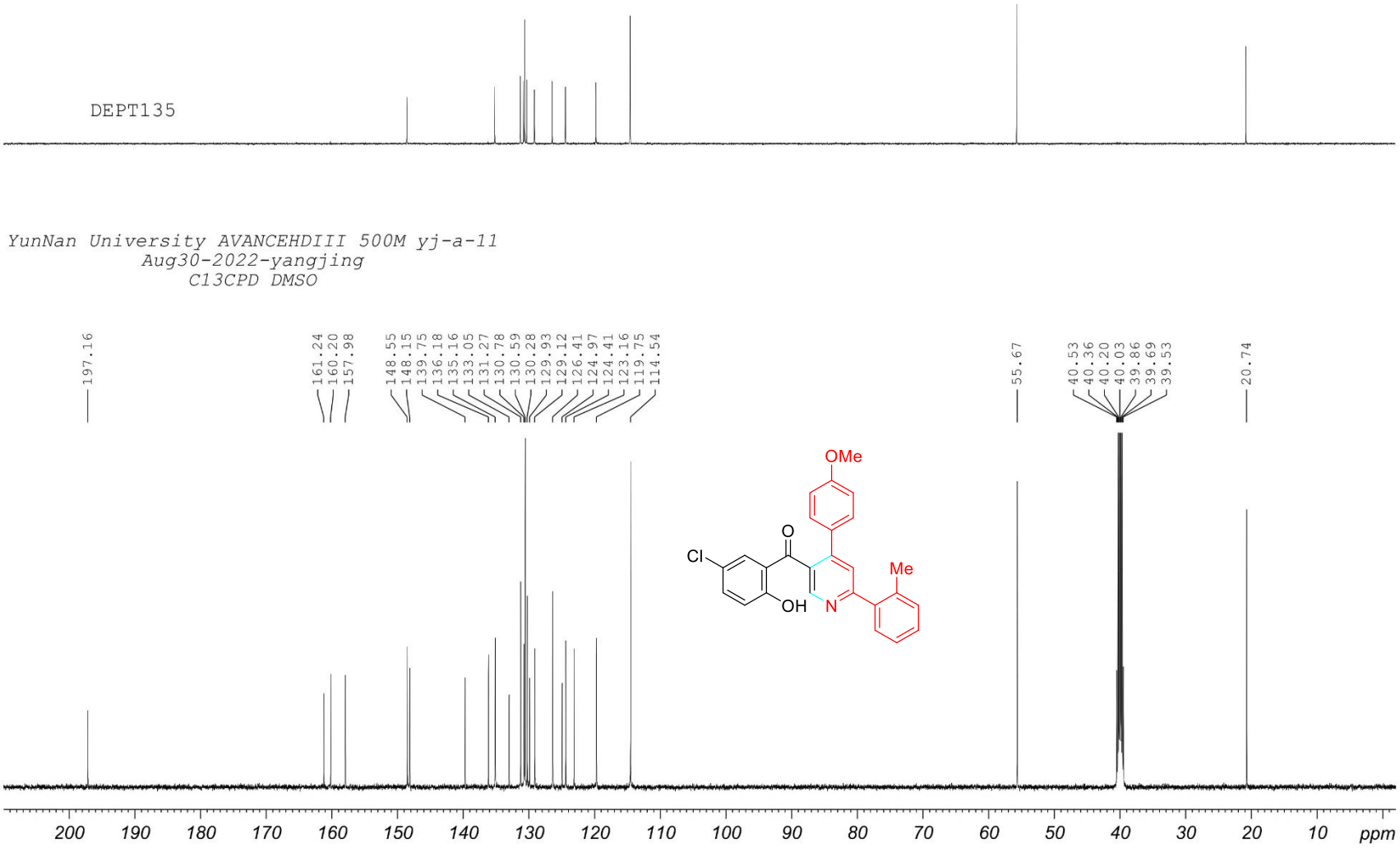


Figure S31. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3k**

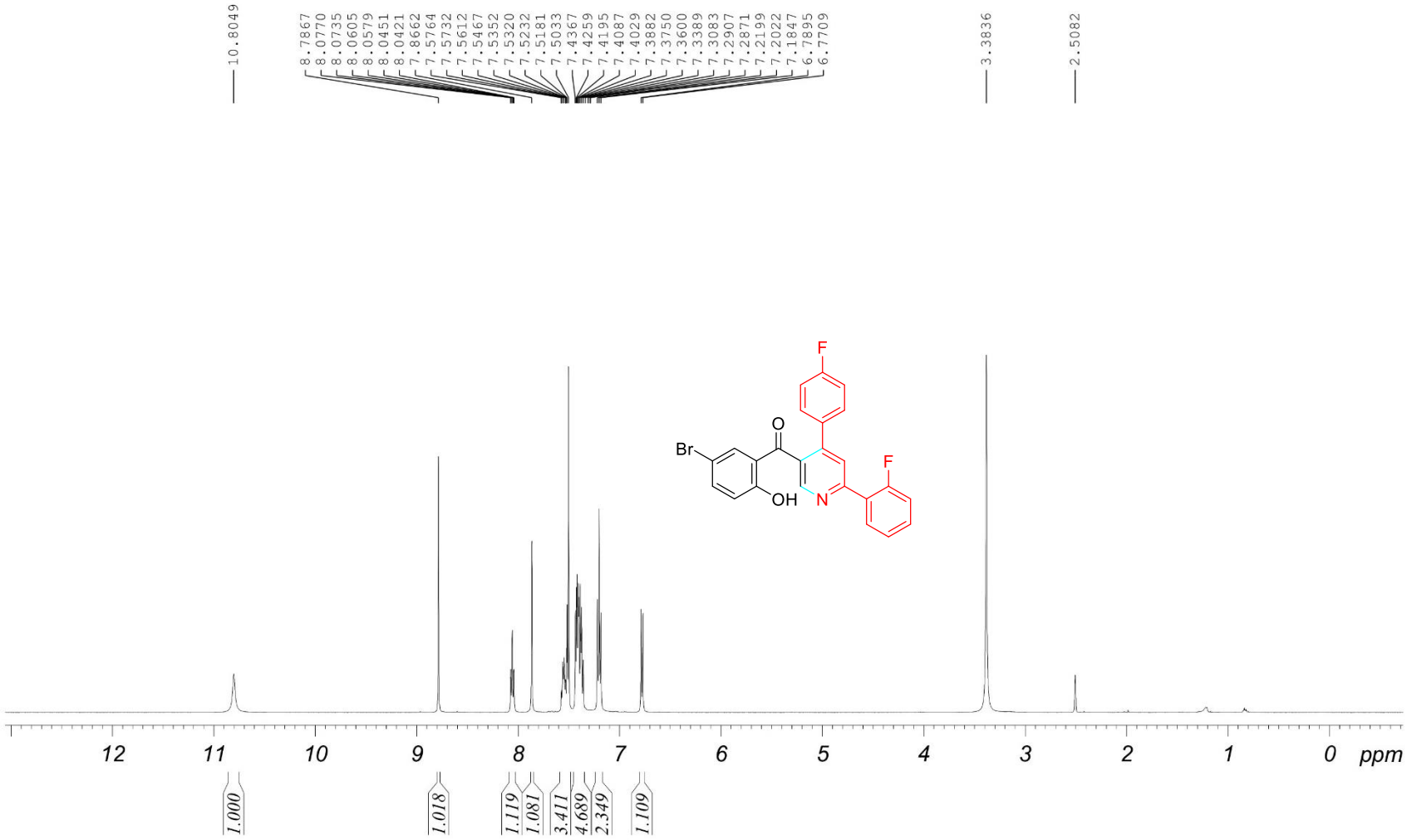


Figure S32. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3l**

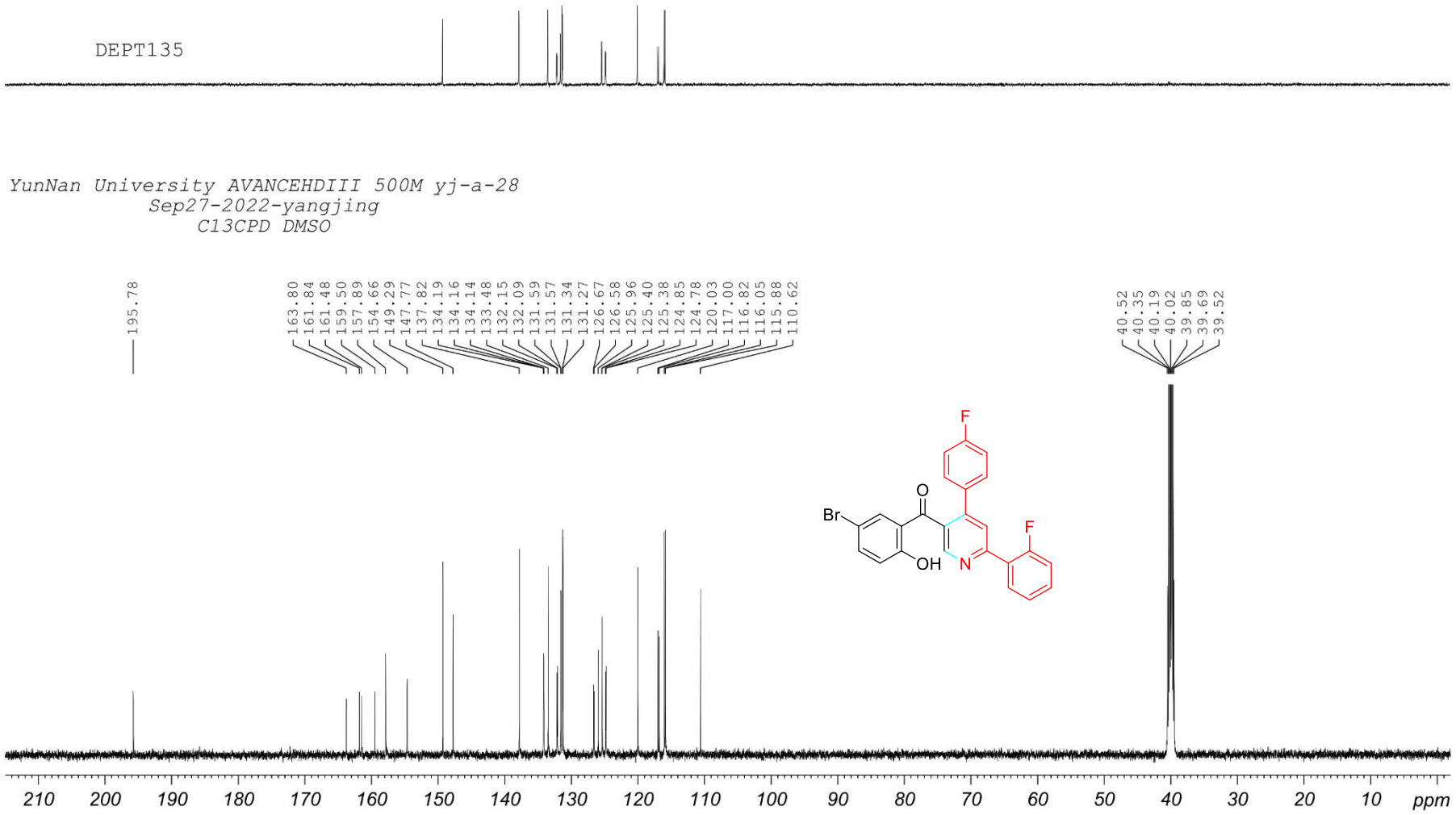


Figure S33. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3l**

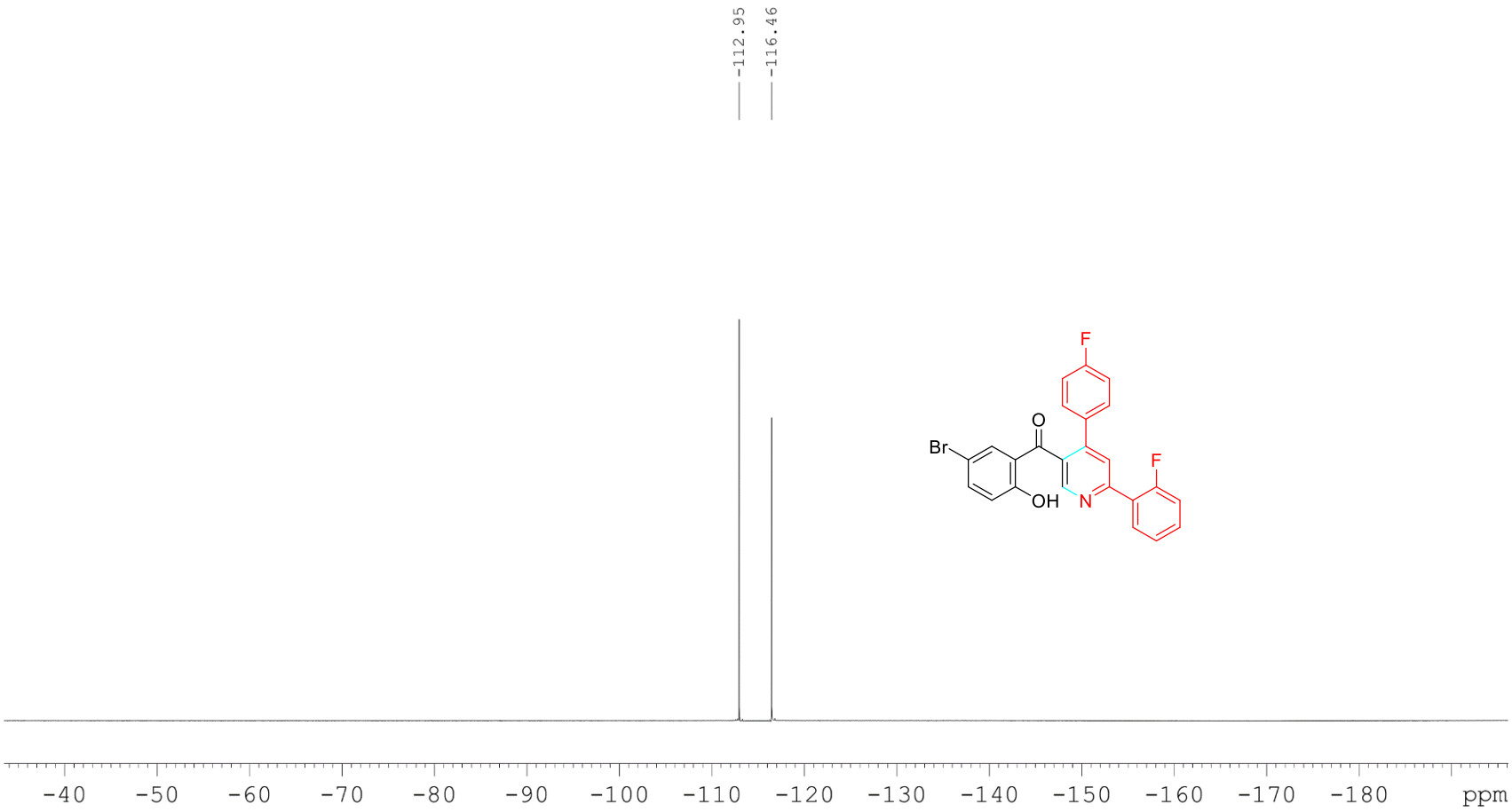


Figure S34. ^{19}F NMR (470 MHz, DMSO-d_6) spectra of compound **3l**

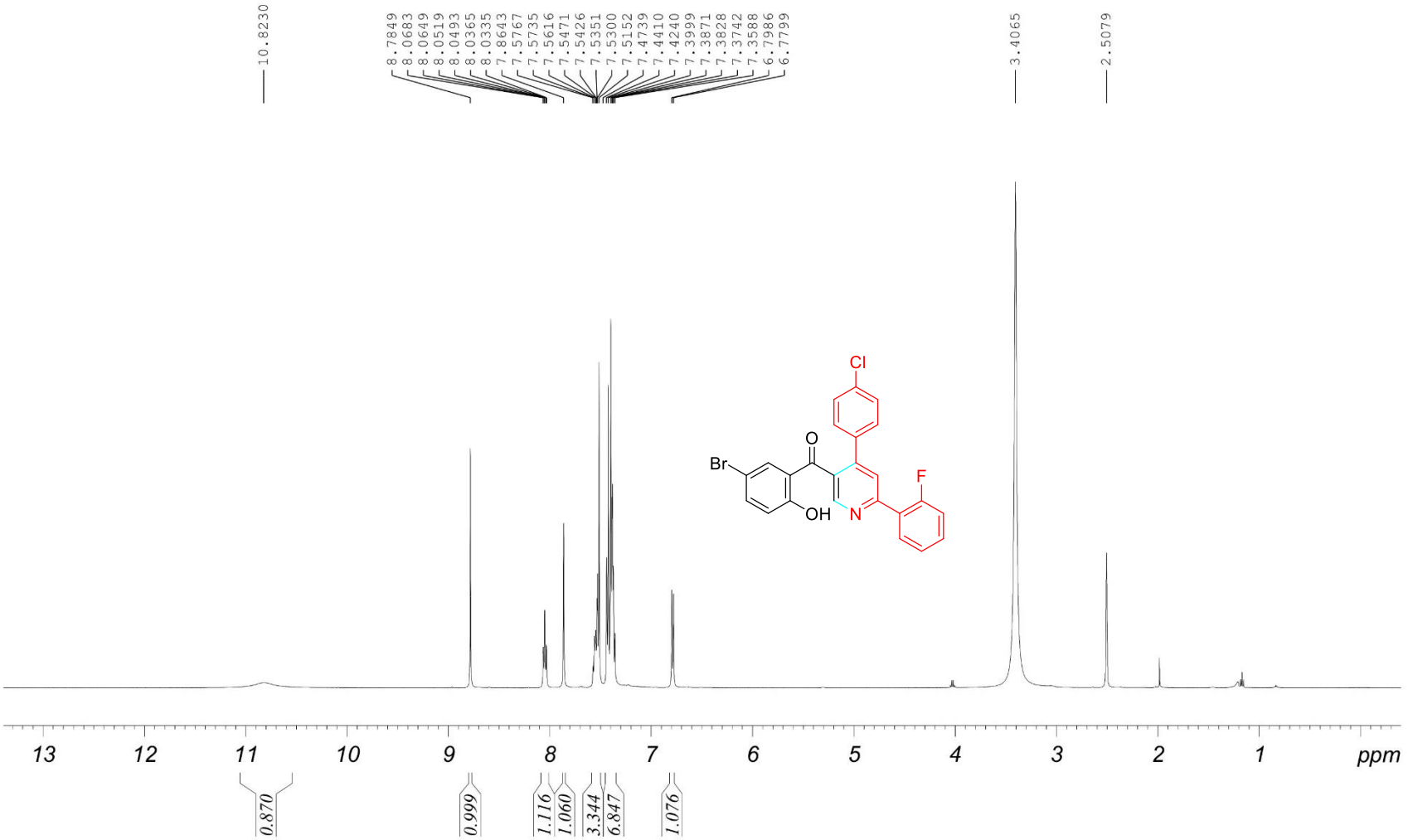


Figure S35. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3m**

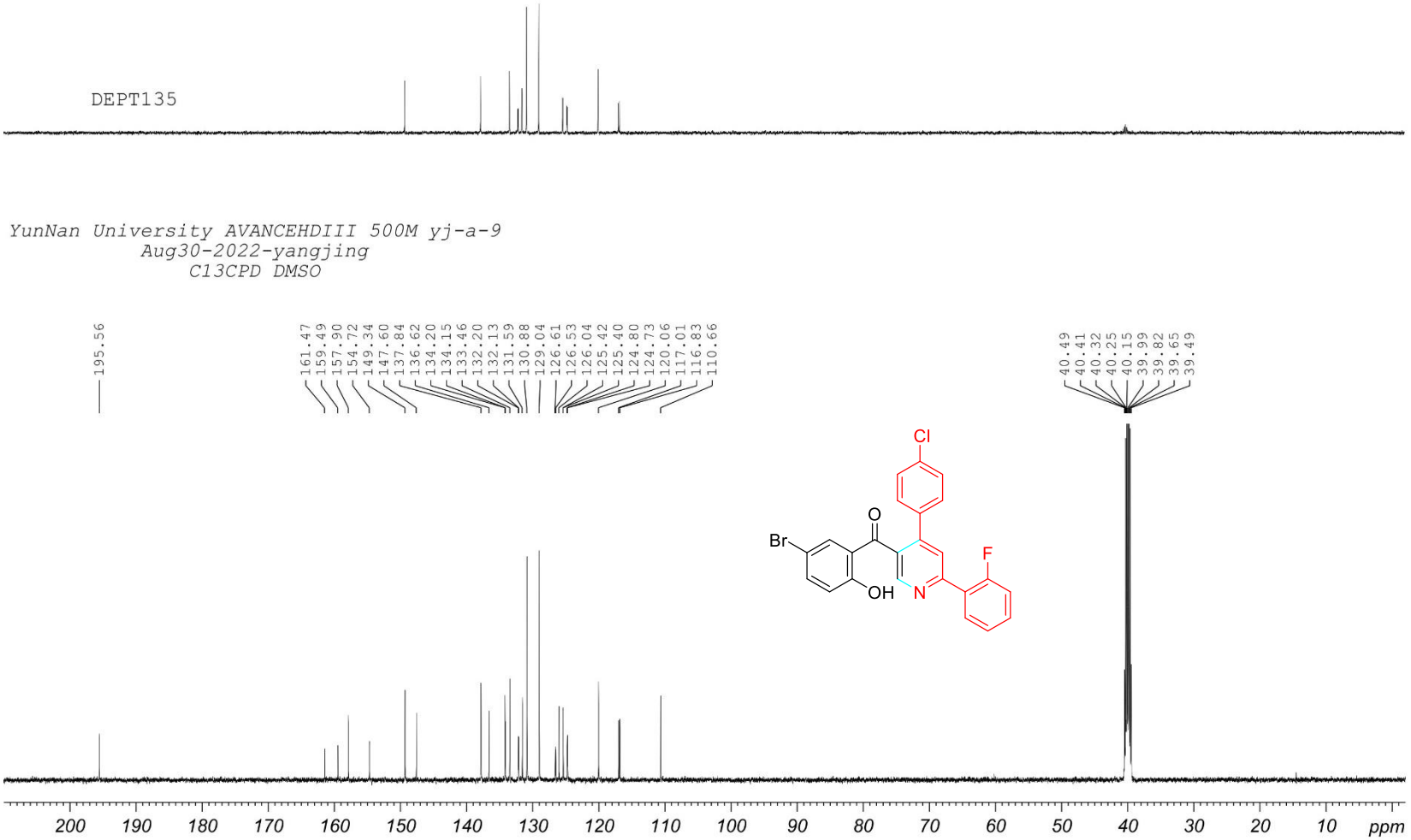


Figure S36. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3m**

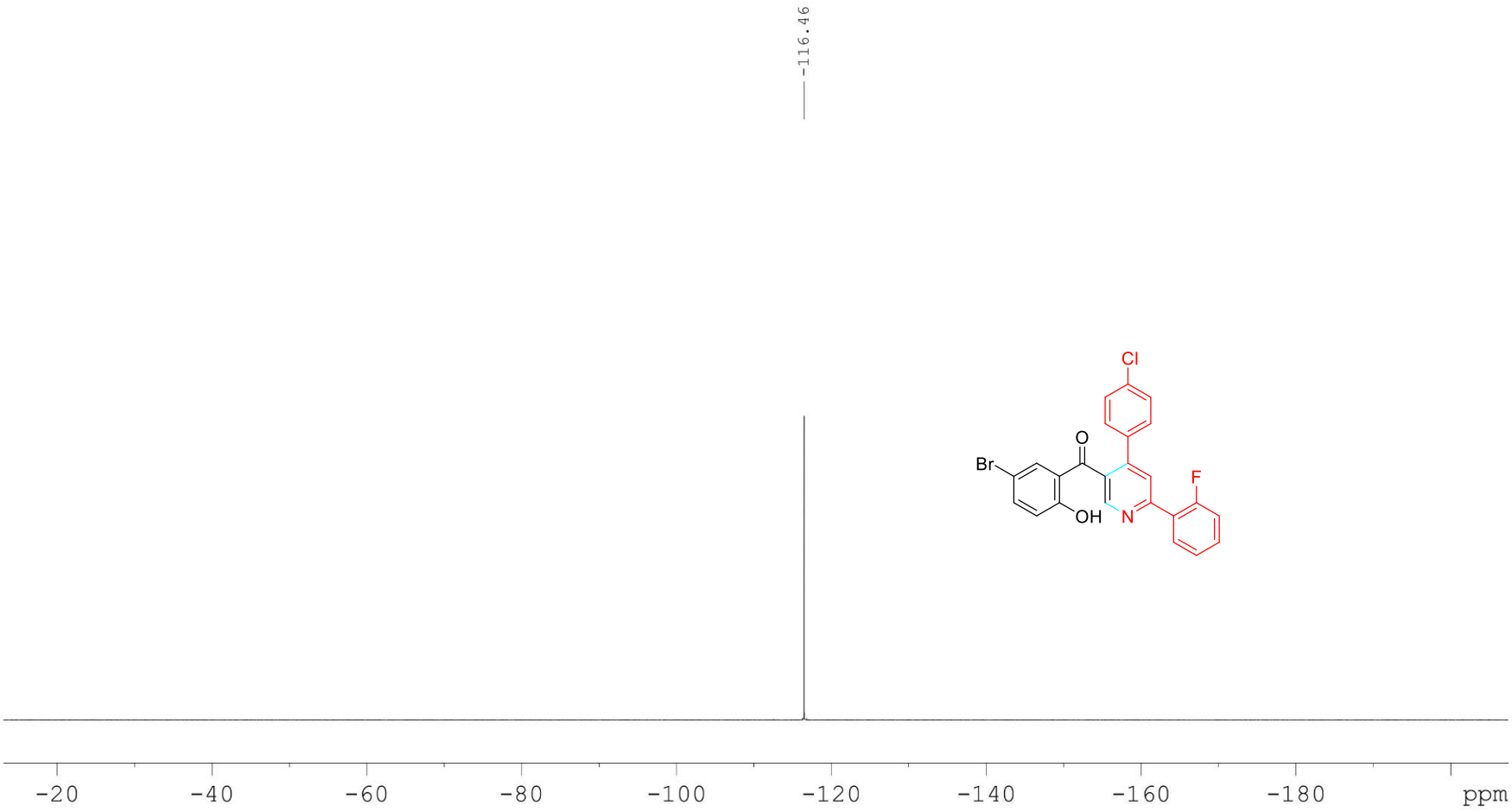


Figure S37. ^{19}F NMR (470 MHz, DMSO-d_6) spectra of compound **3m**

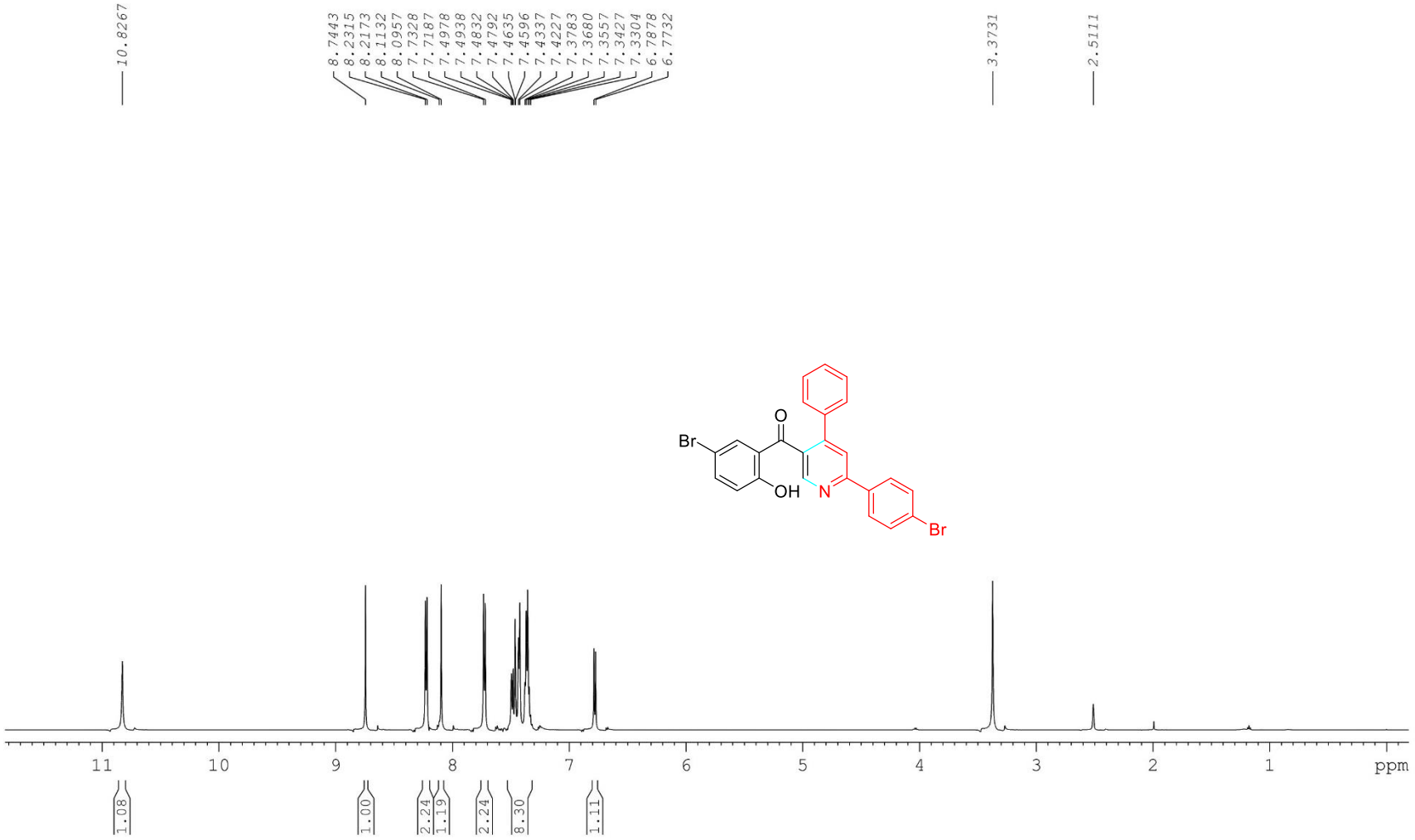


Figure S38. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3n**

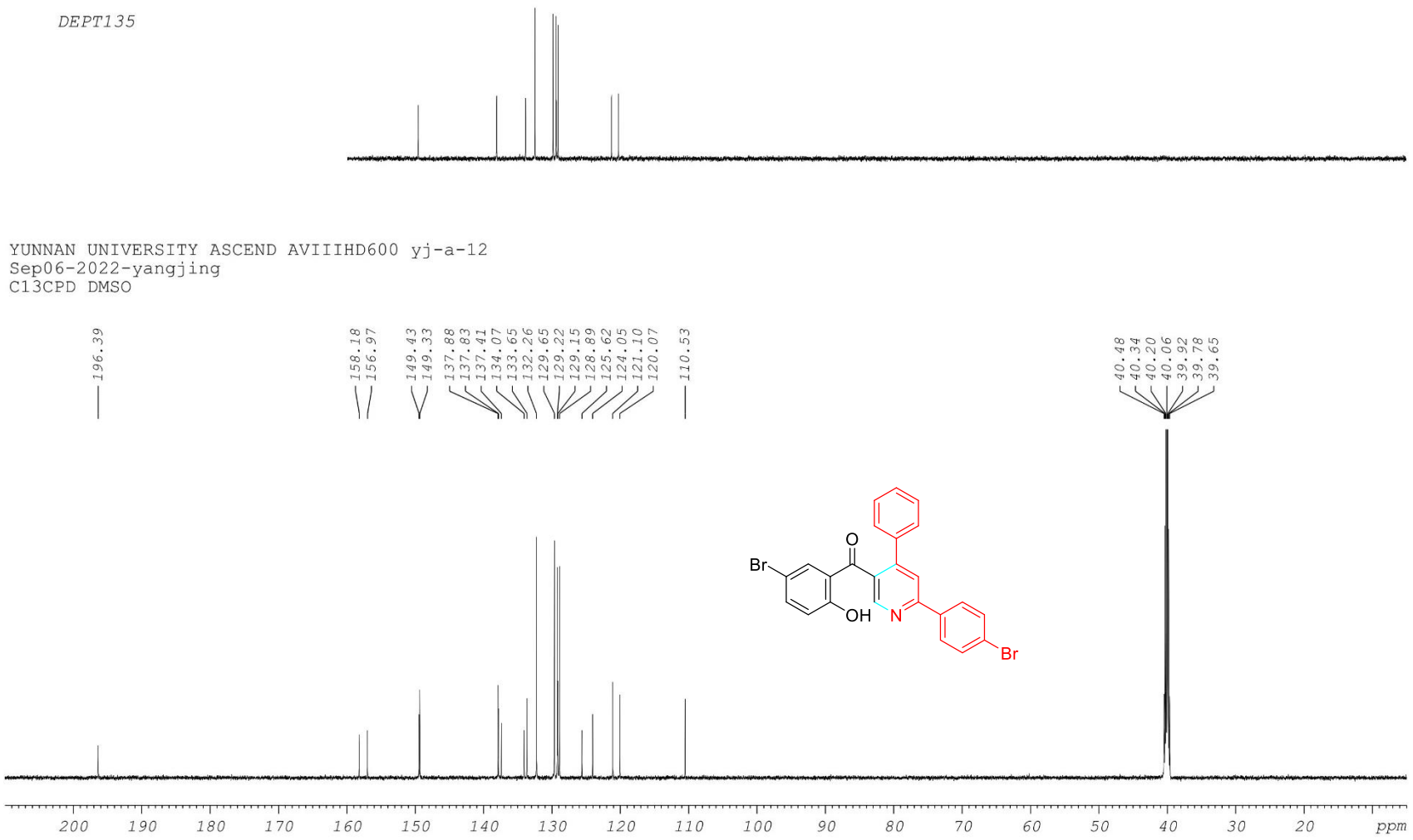


Figure S39. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3n**

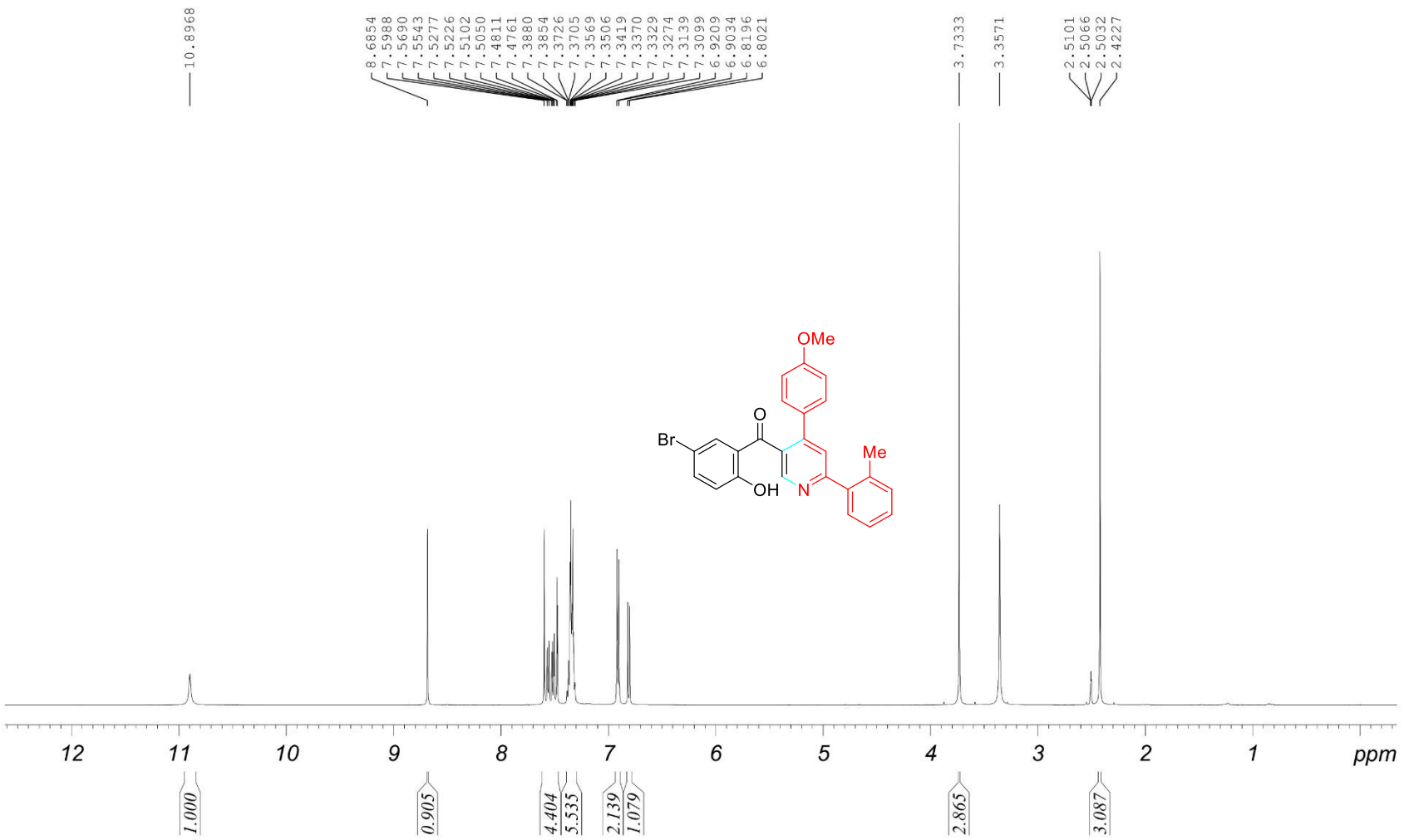


Figure S40. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3o**

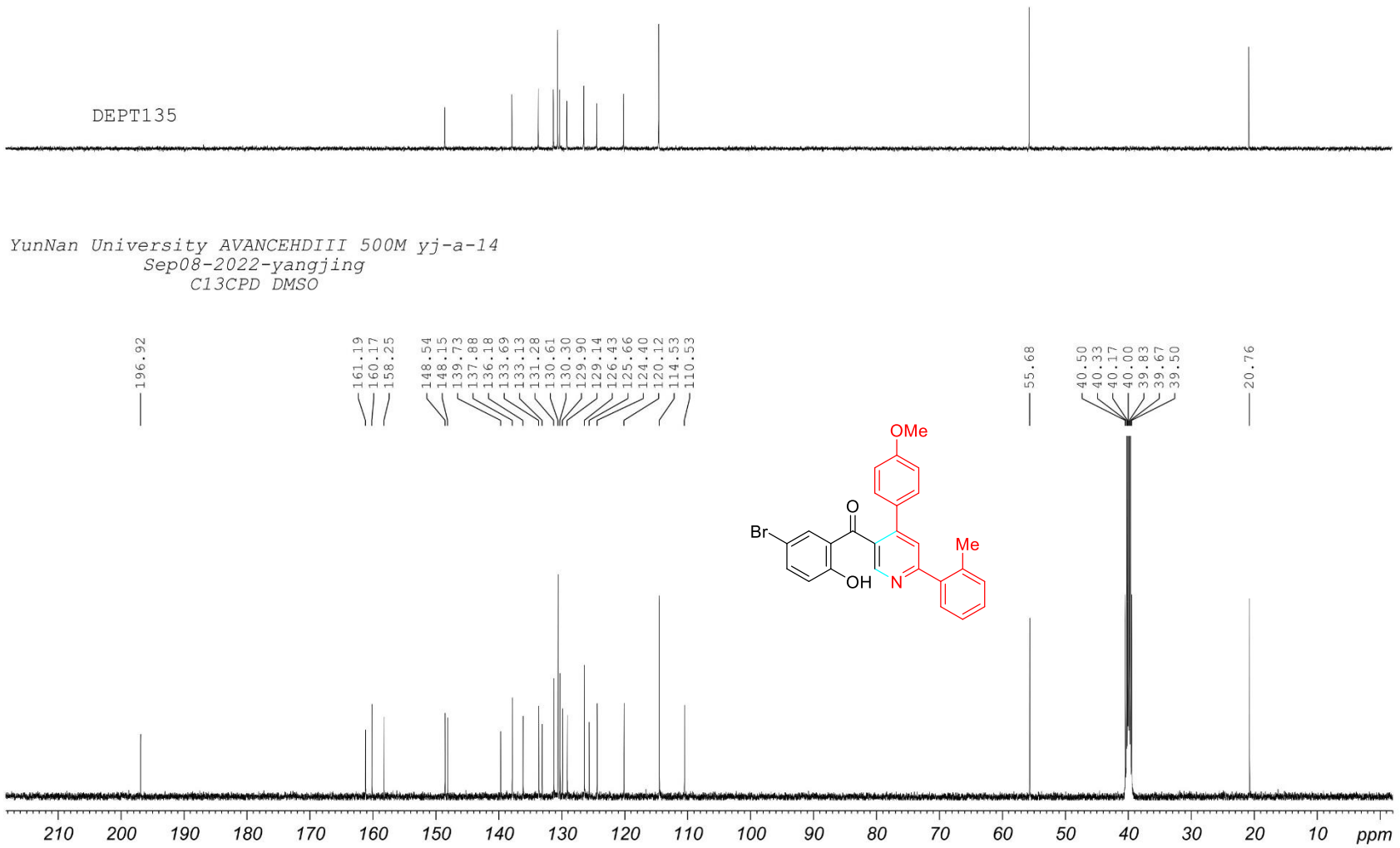


Figure S41. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3o**

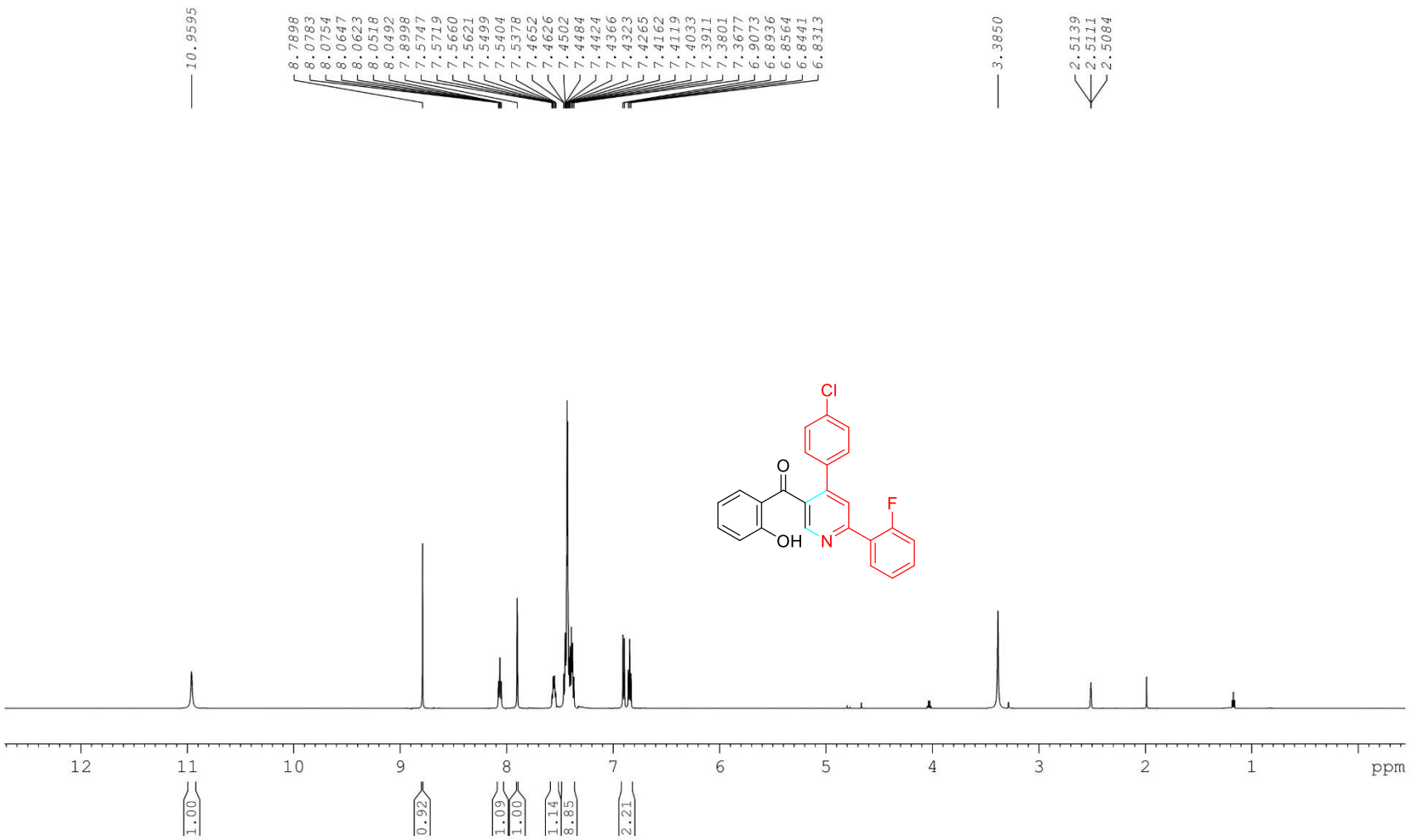


Figure S42. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3p**

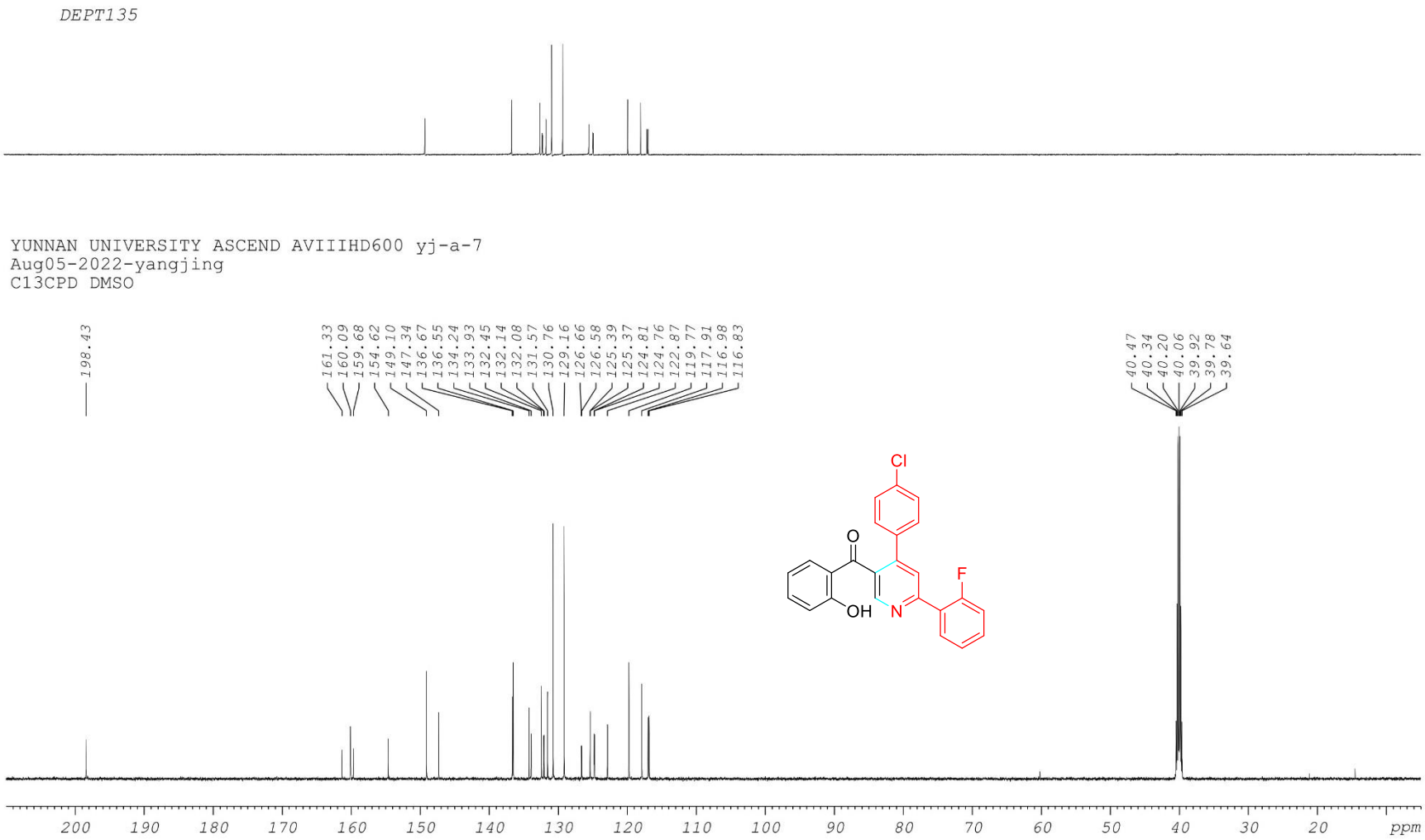


Figure S43. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3p**

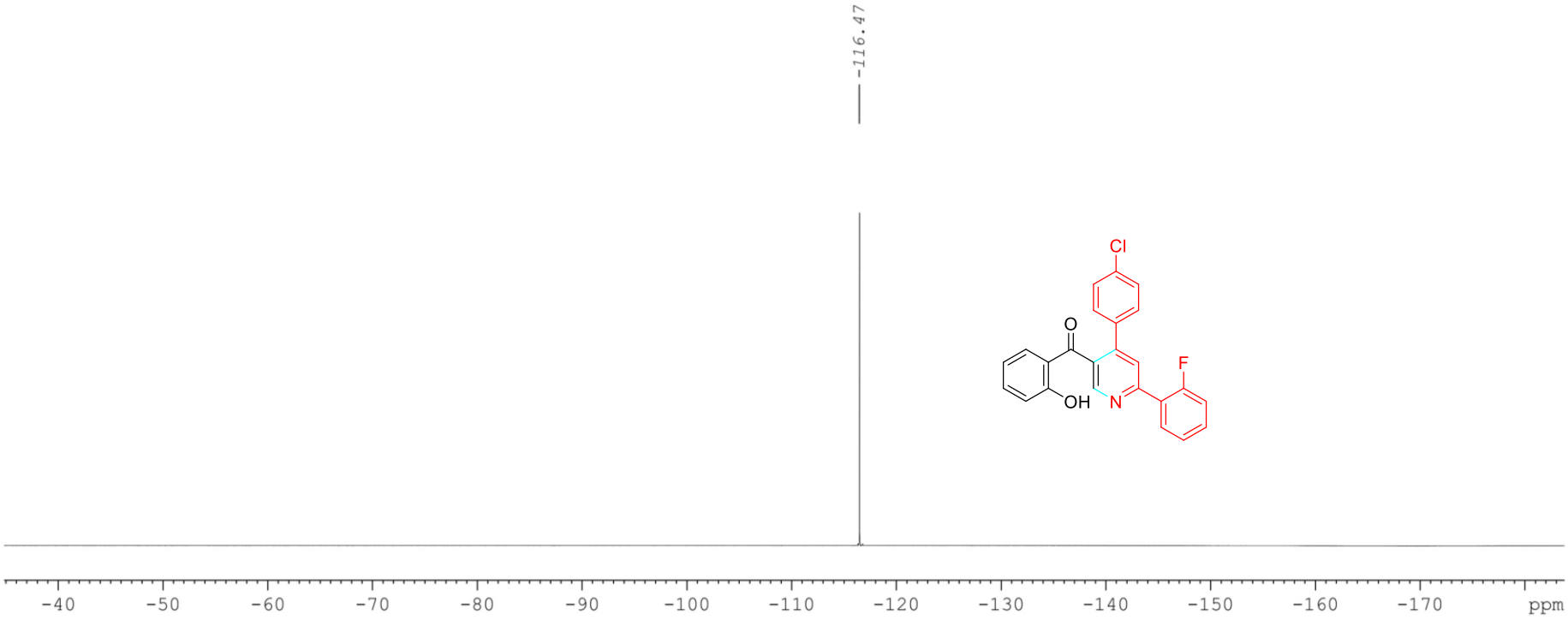


Figure S44. ^{19}F NMR (564 MHz, DMSO-d_6) spectra of compound **3p**

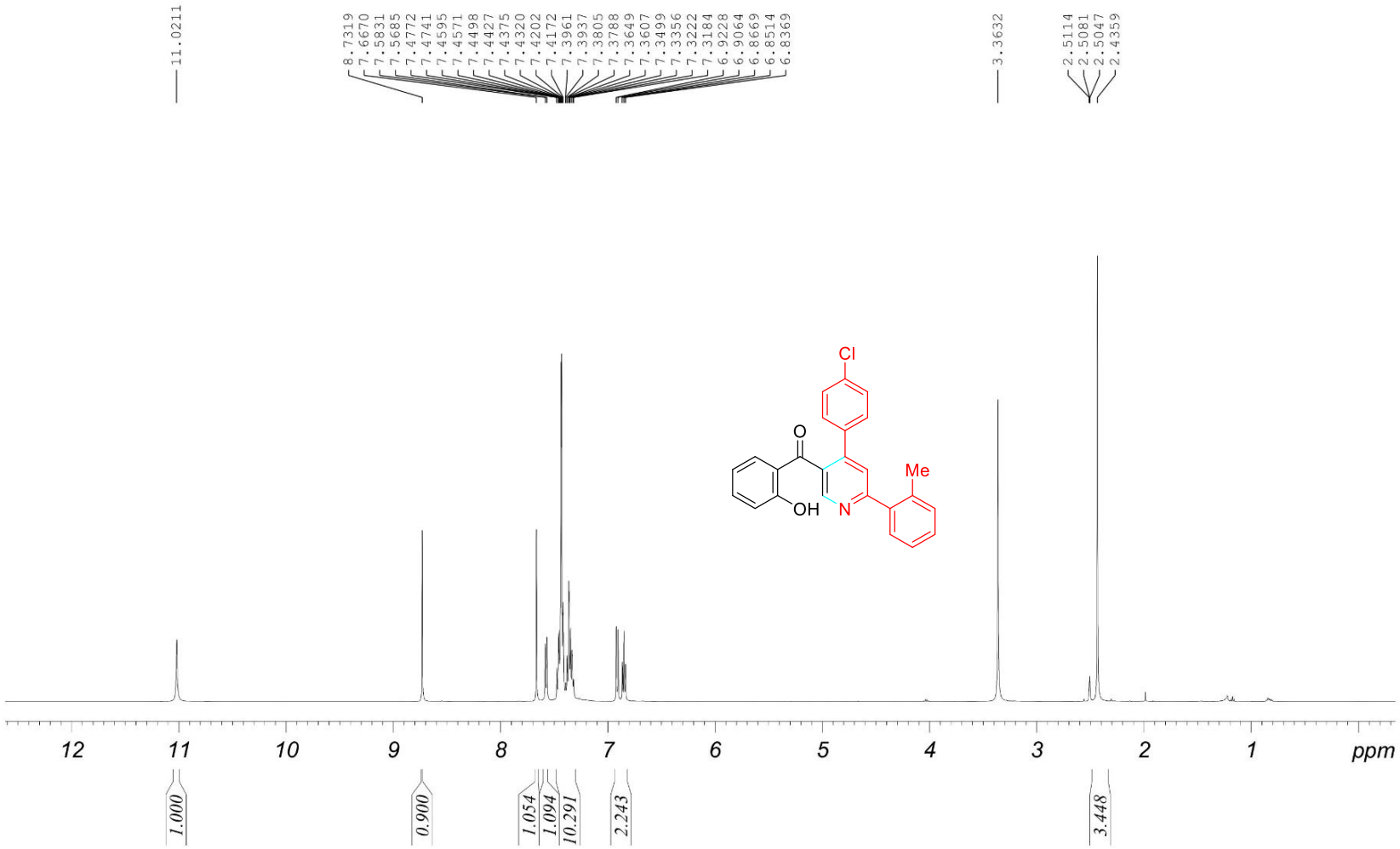


Figure S45. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3q**

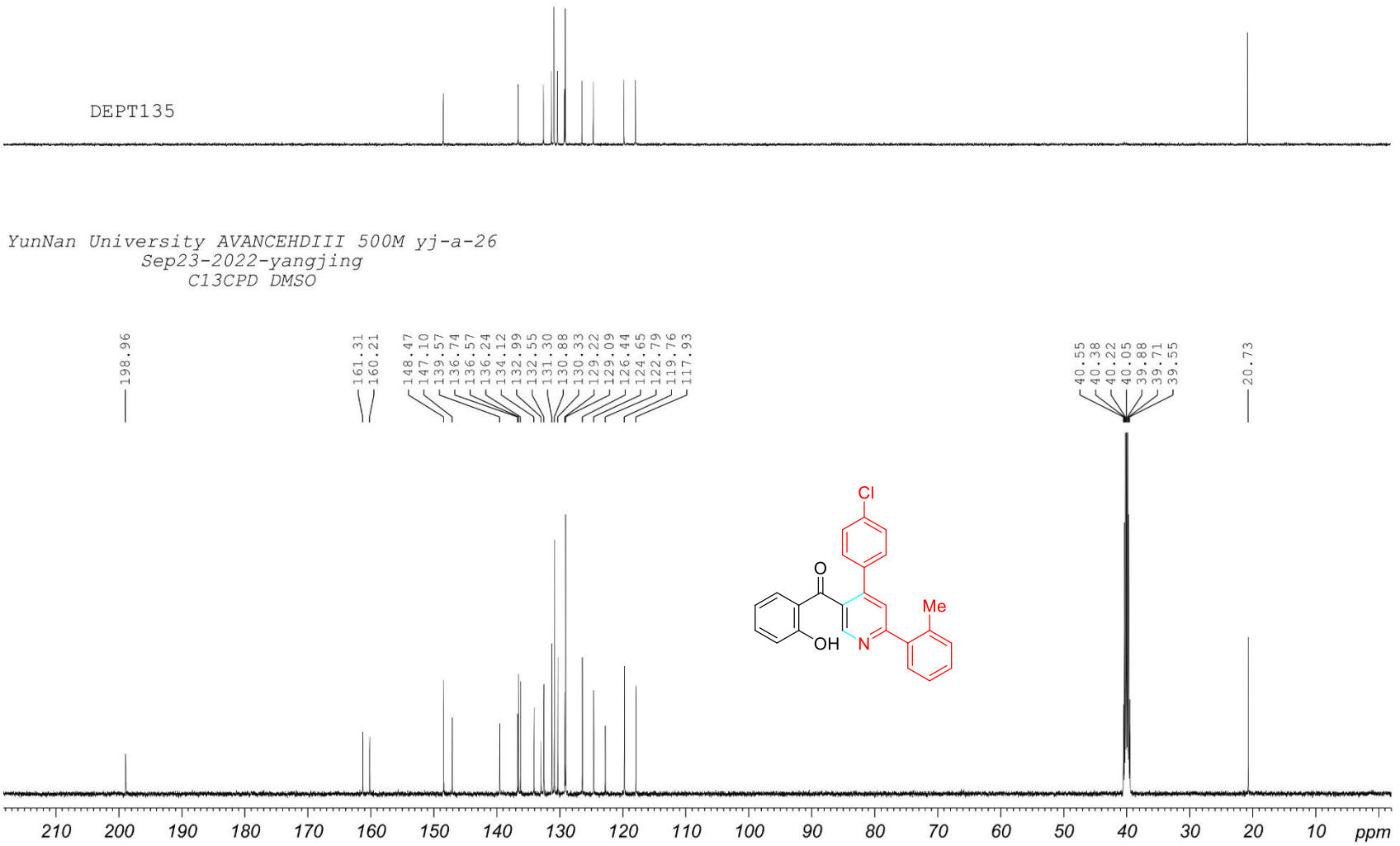


Figure S46. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3q**

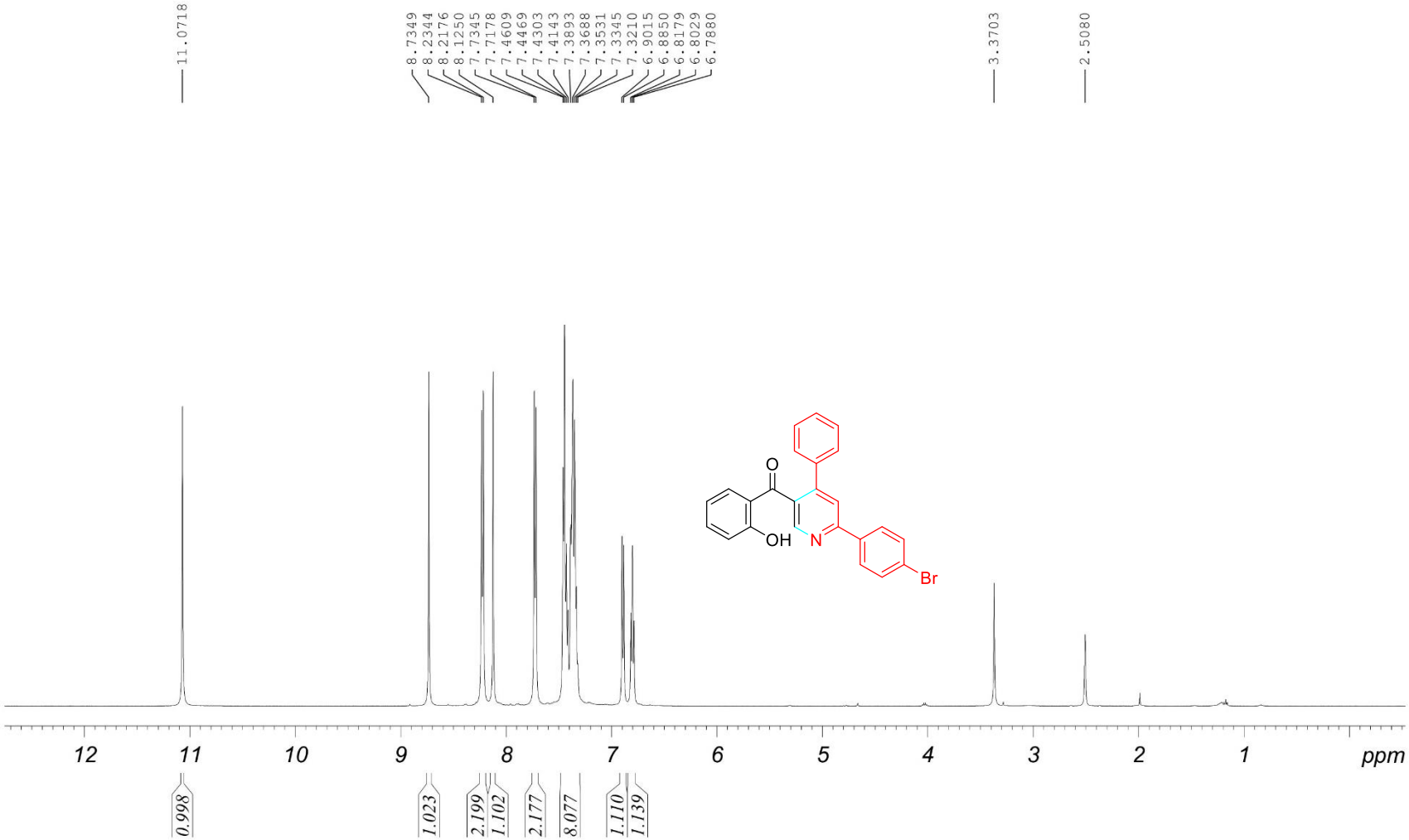


Figure S47. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3r**

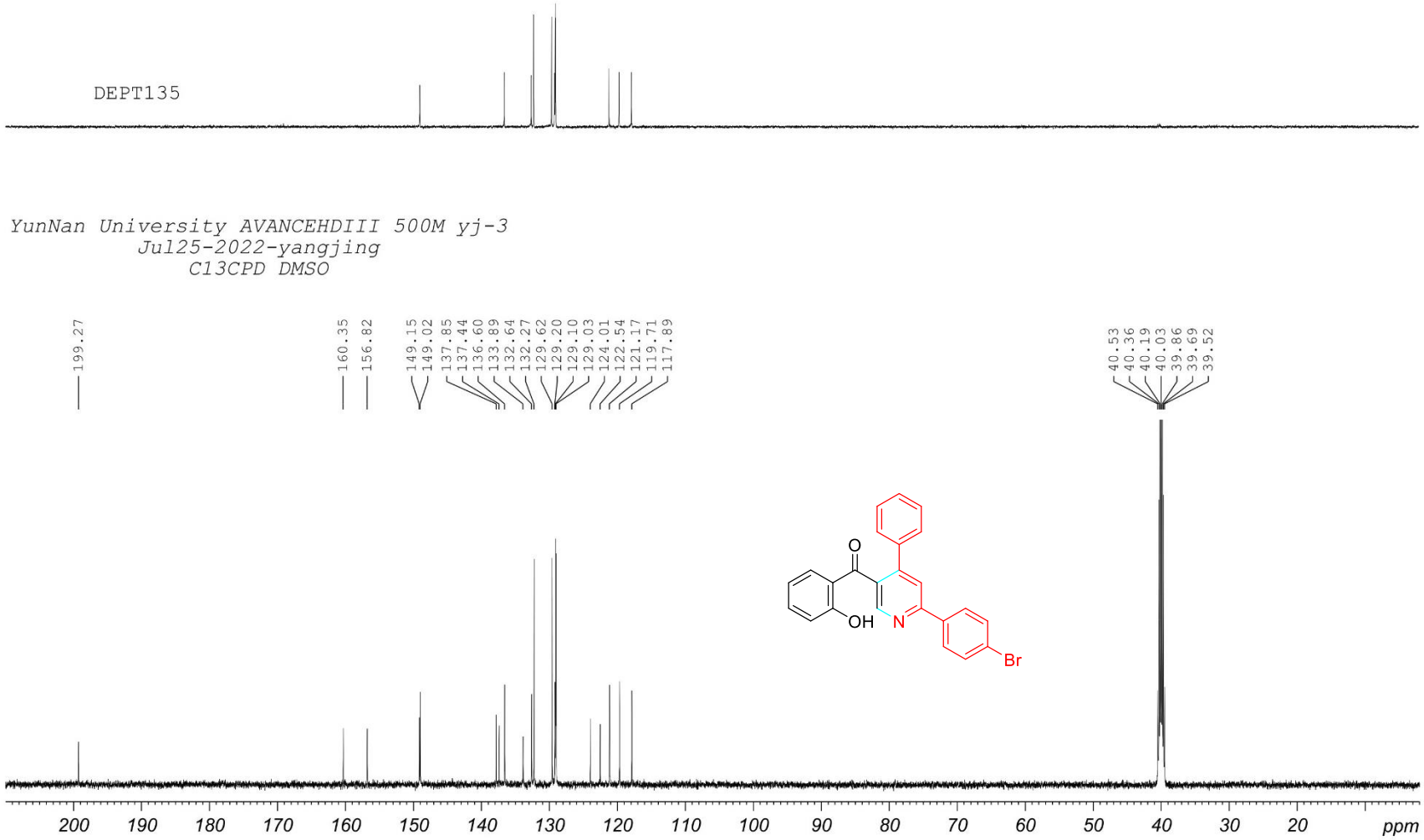


Figure S48. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3r**

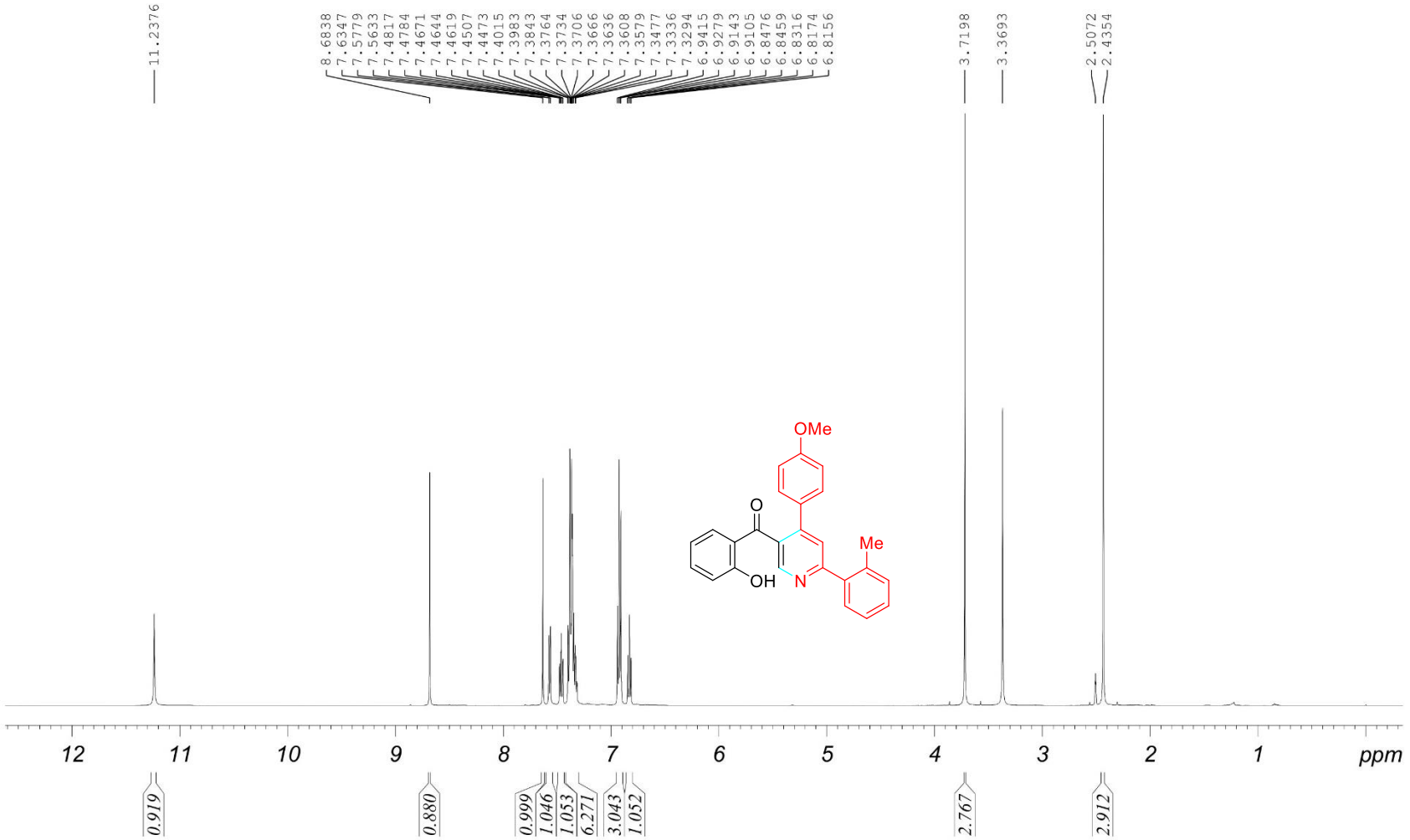


Figure S49. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3s**

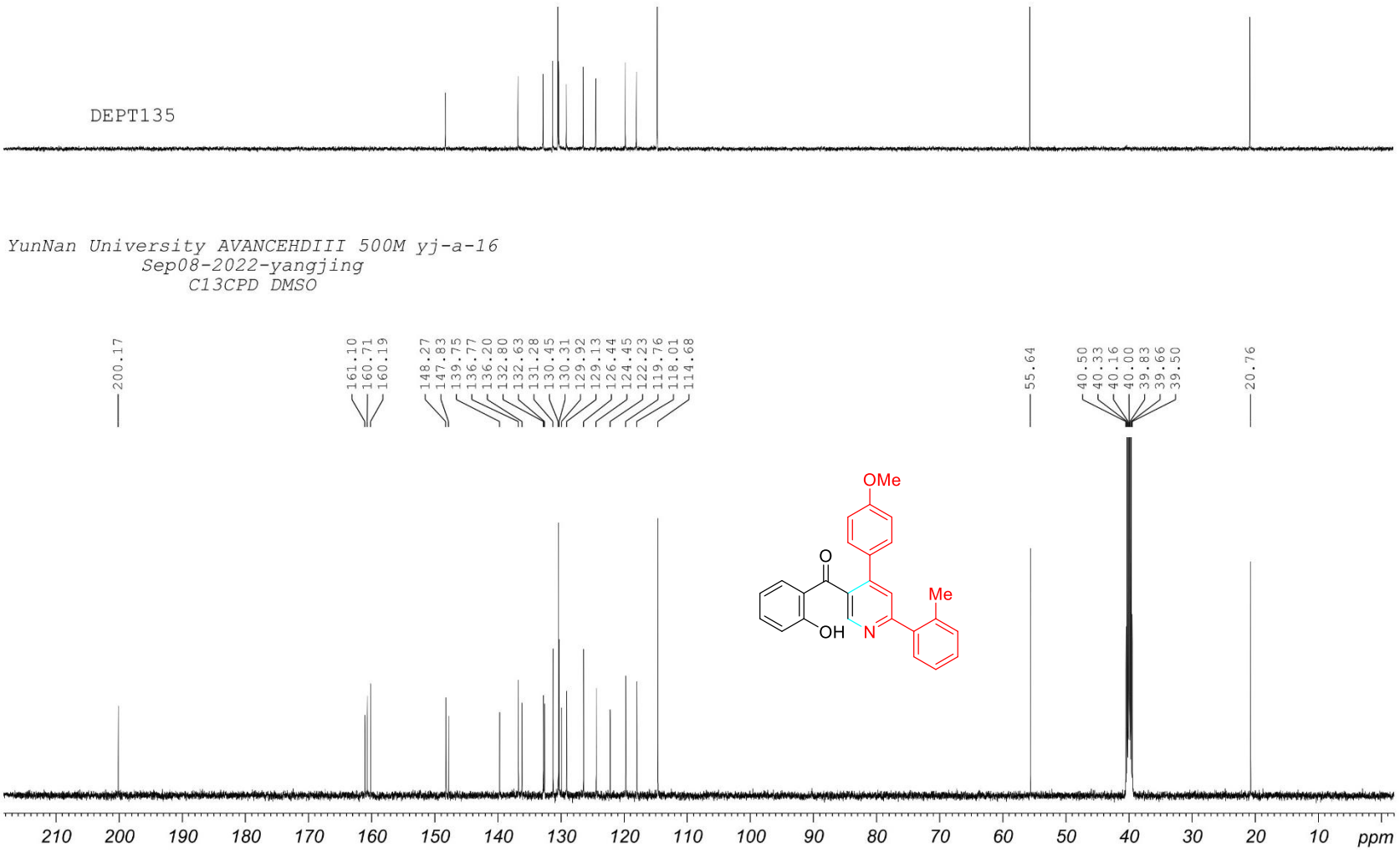


Figure S50. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3s**

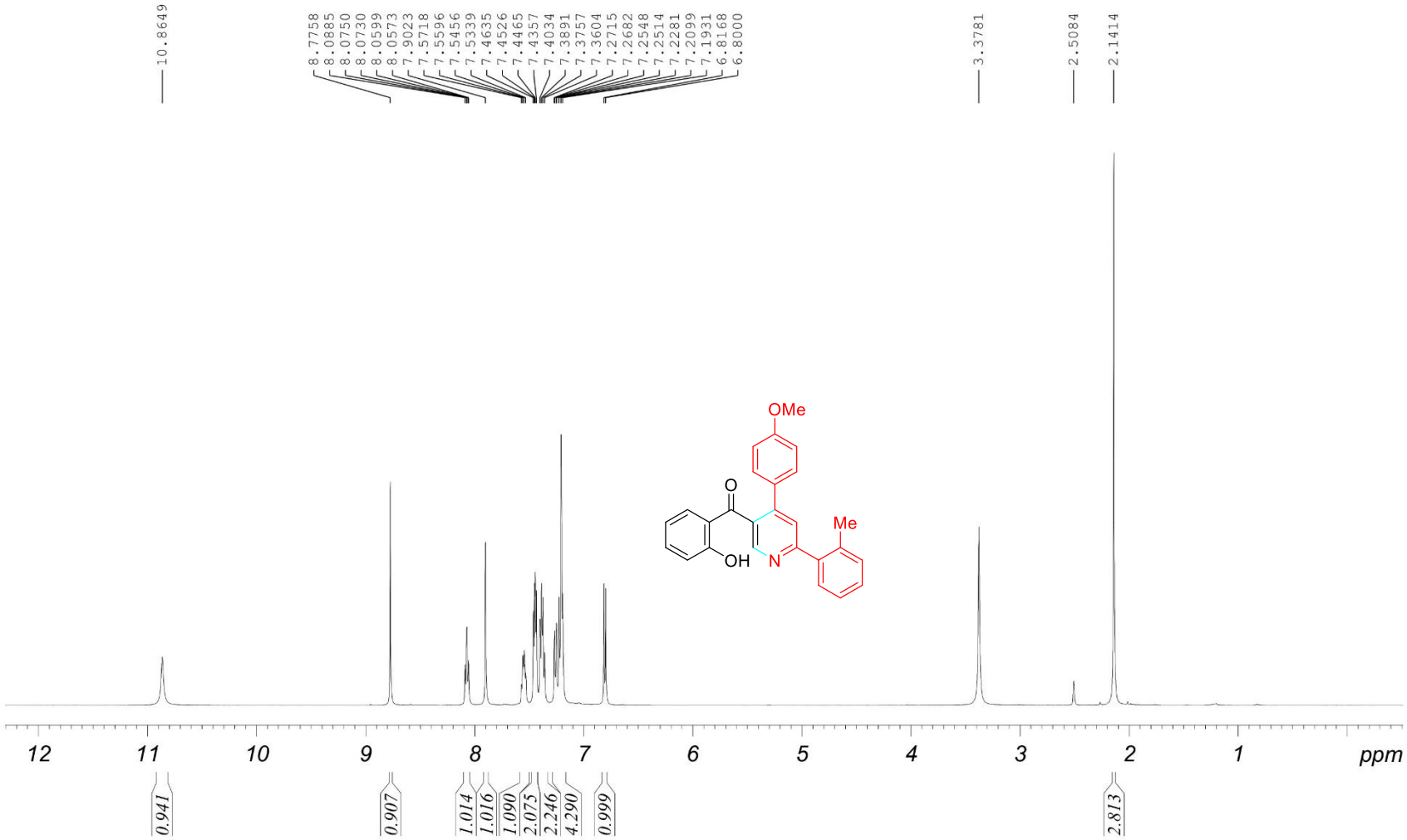


Figure S51. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3t**

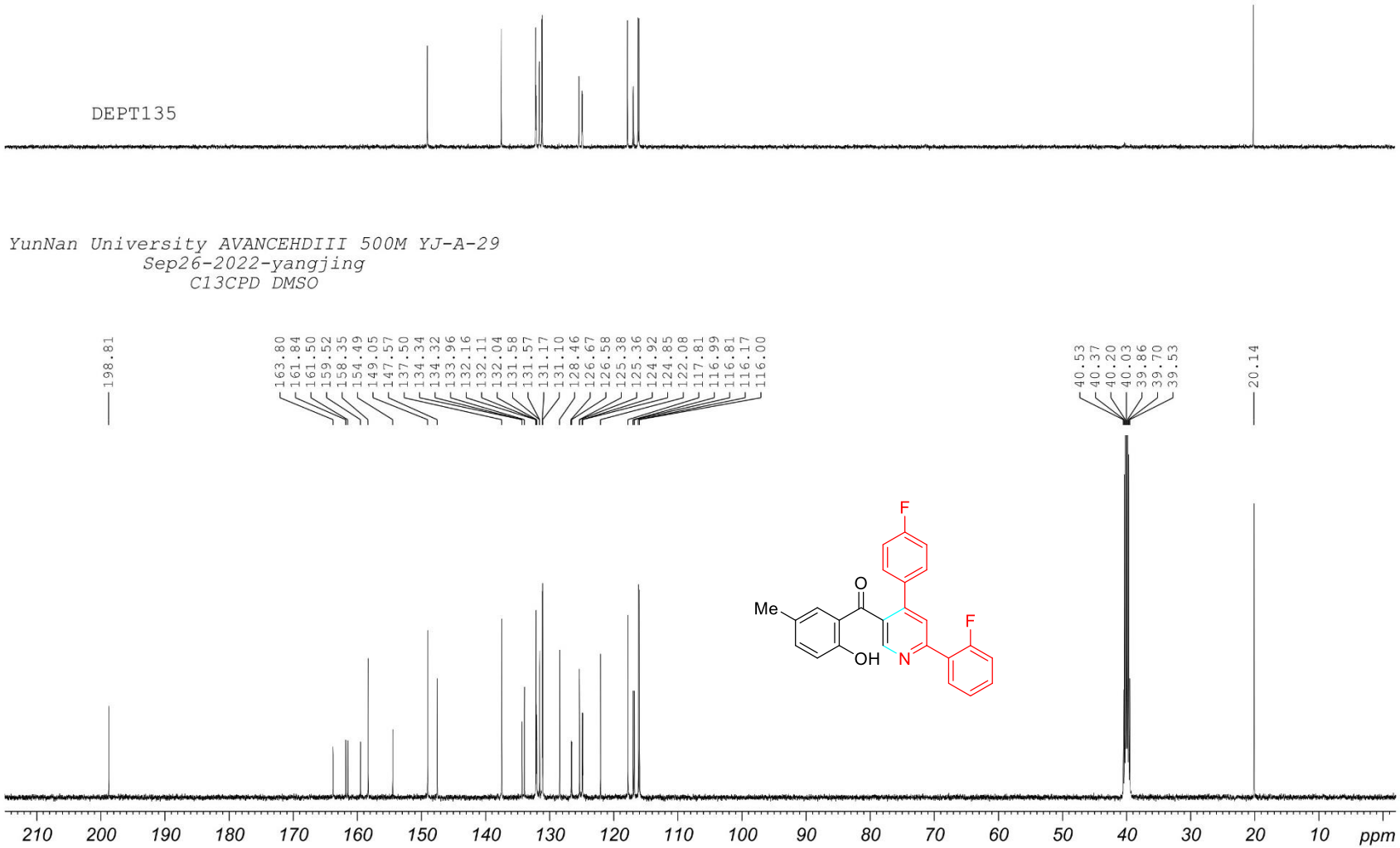


Figure S52. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3t**

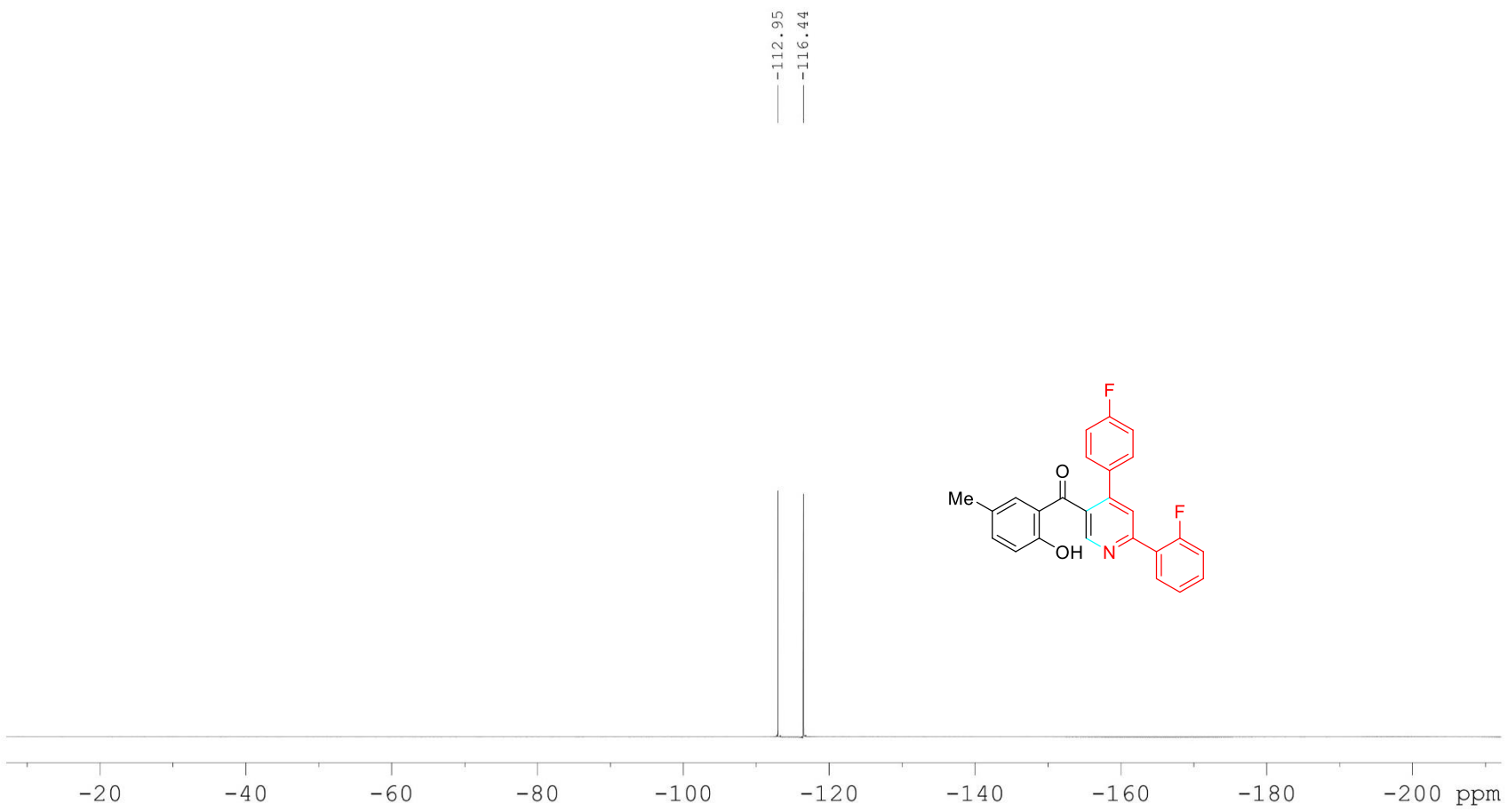


Figure S53. ^{19}F NMR (470 MHz, DMSO-d_6) spectra of compound **3t**

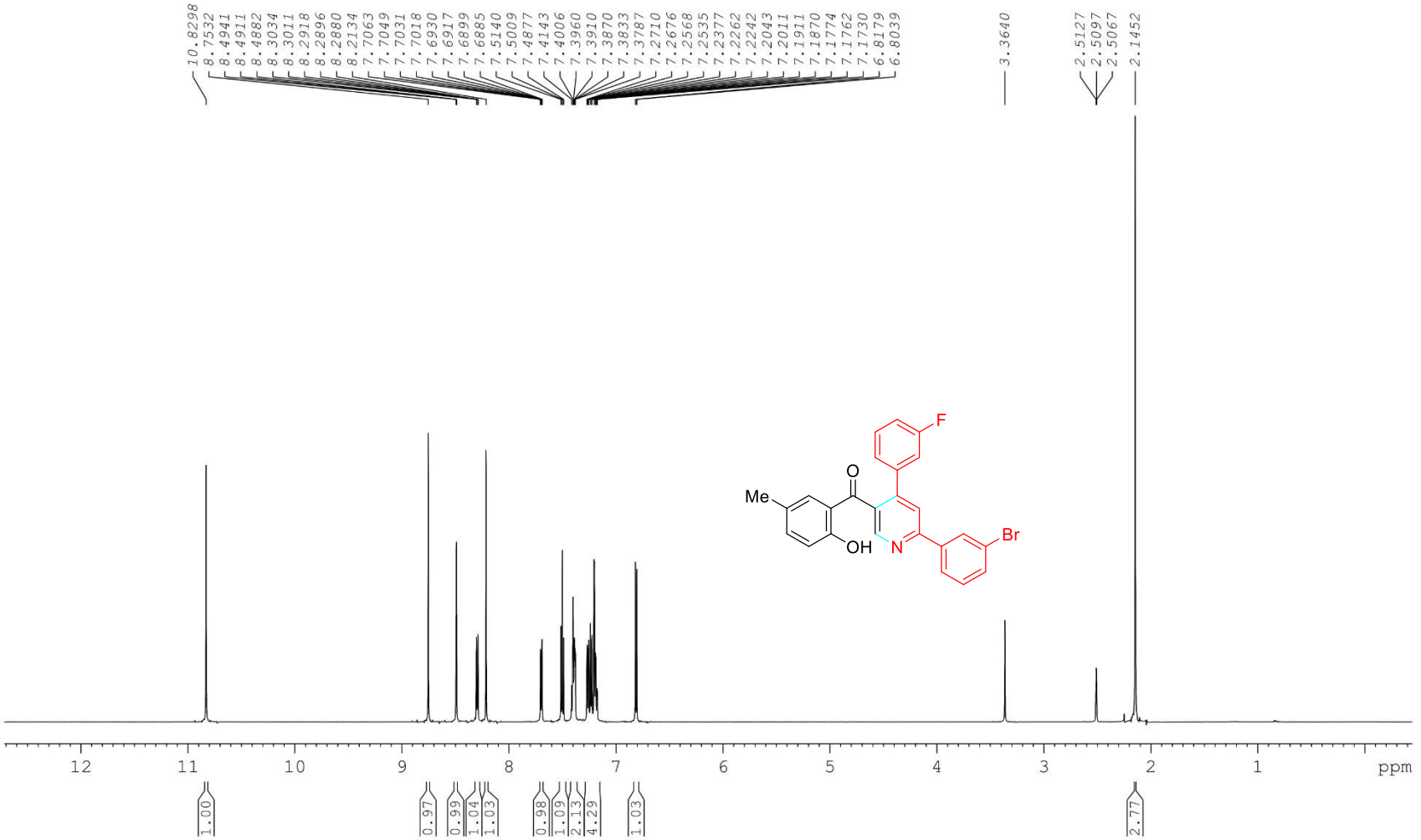


Figure S54. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3u**

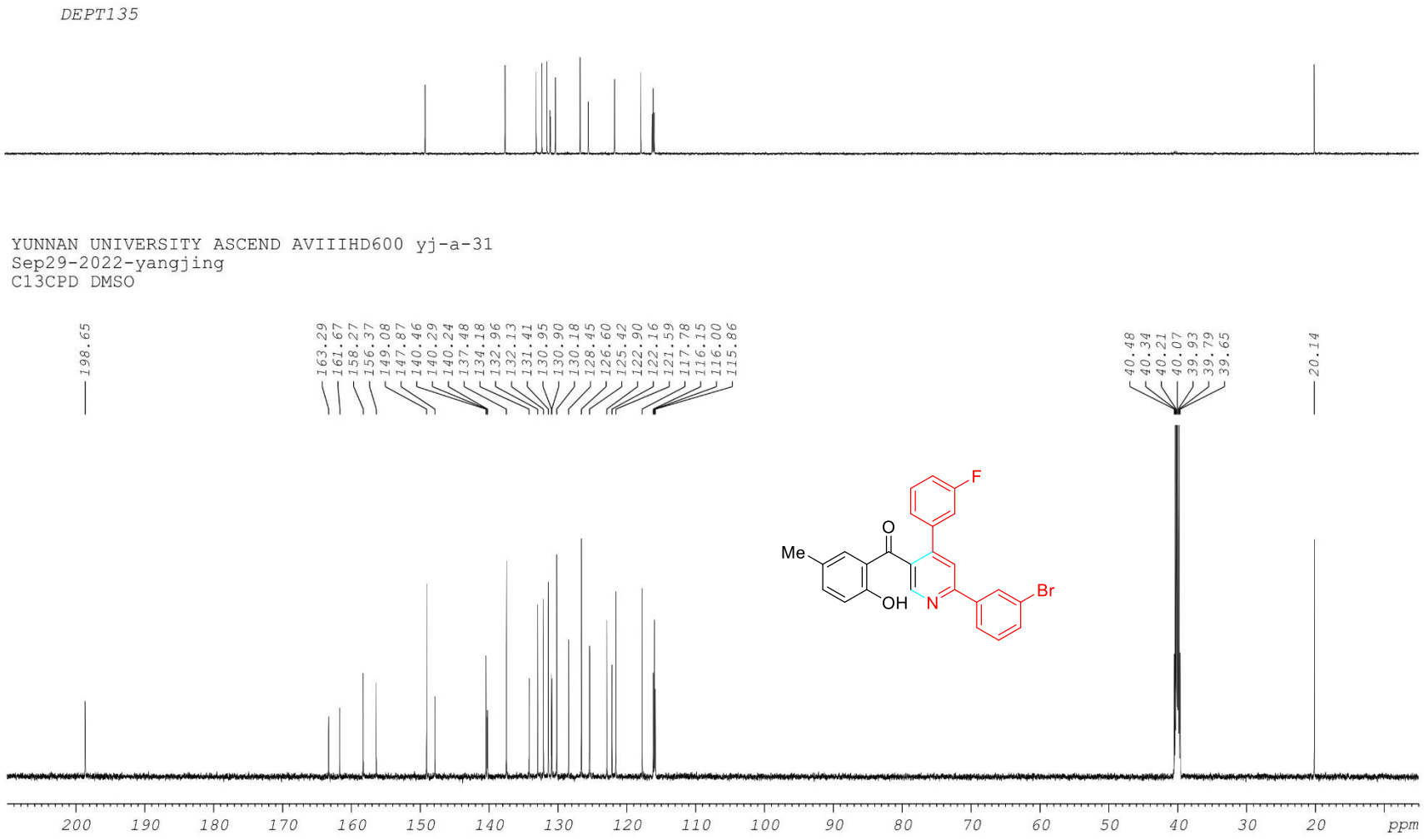


Figure S55. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3u**

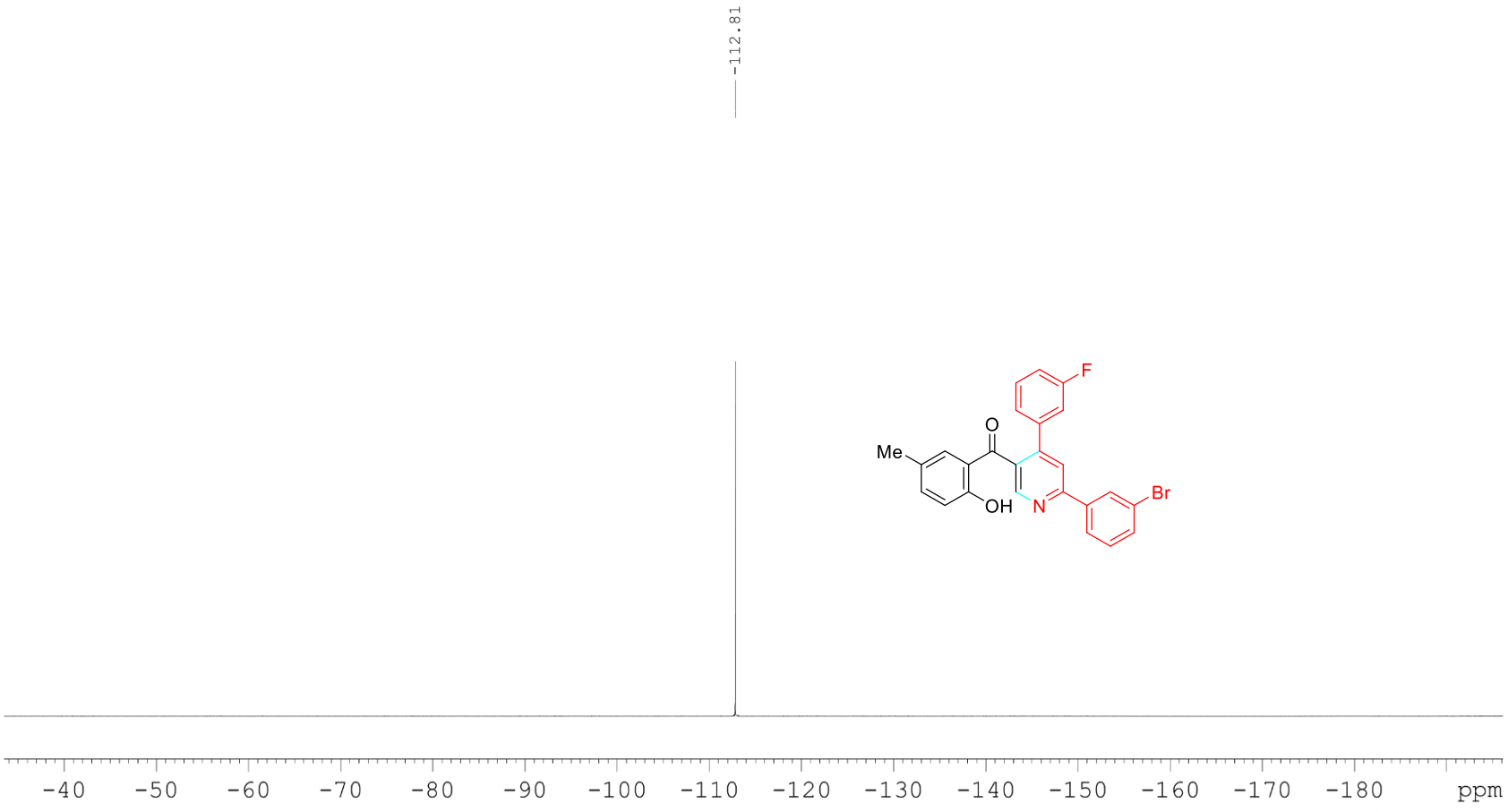


Figure S56. ^{19}F NMR (470 MHz, DMSO-d_6) spectra of compound **3u**

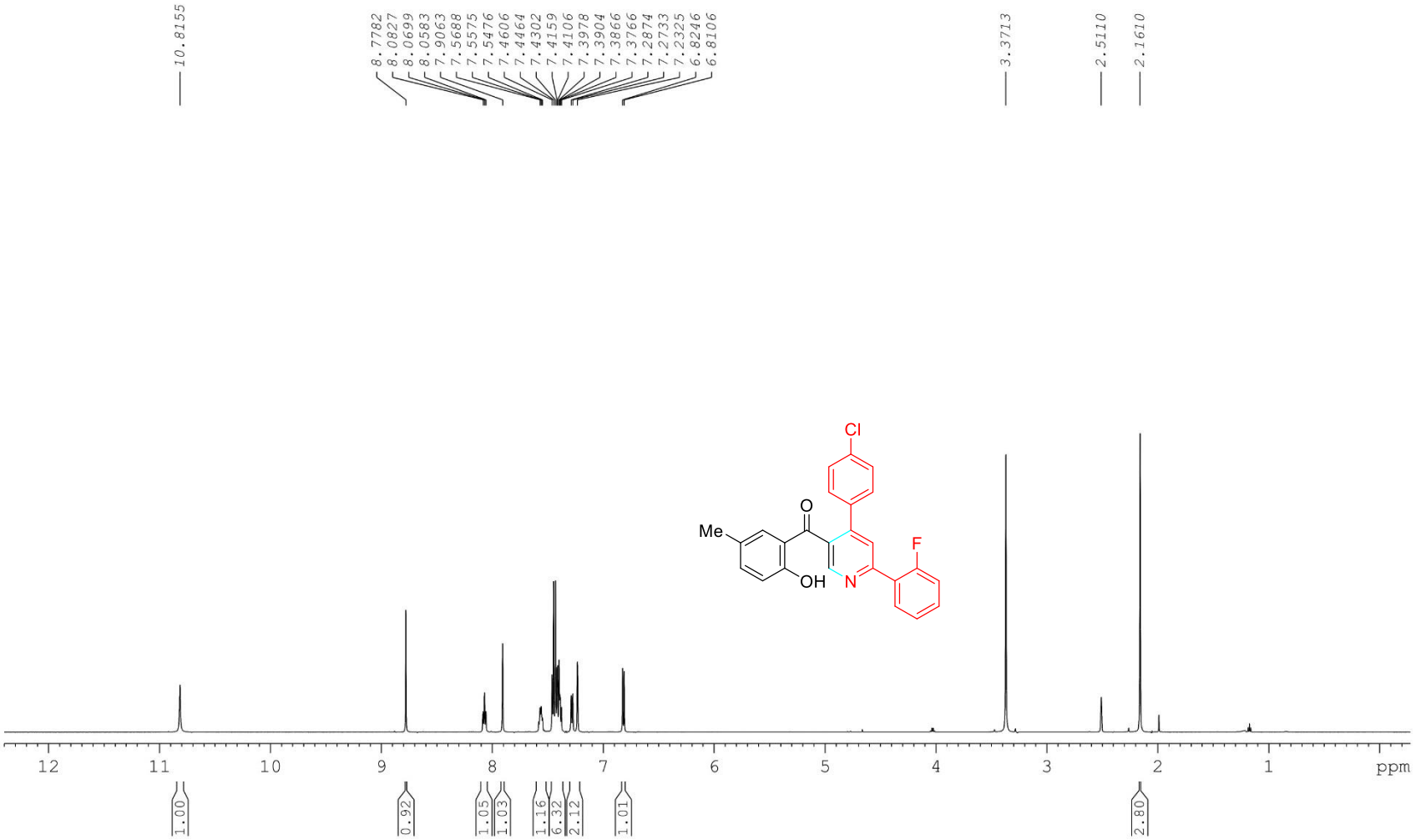


Figure S57. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3v**

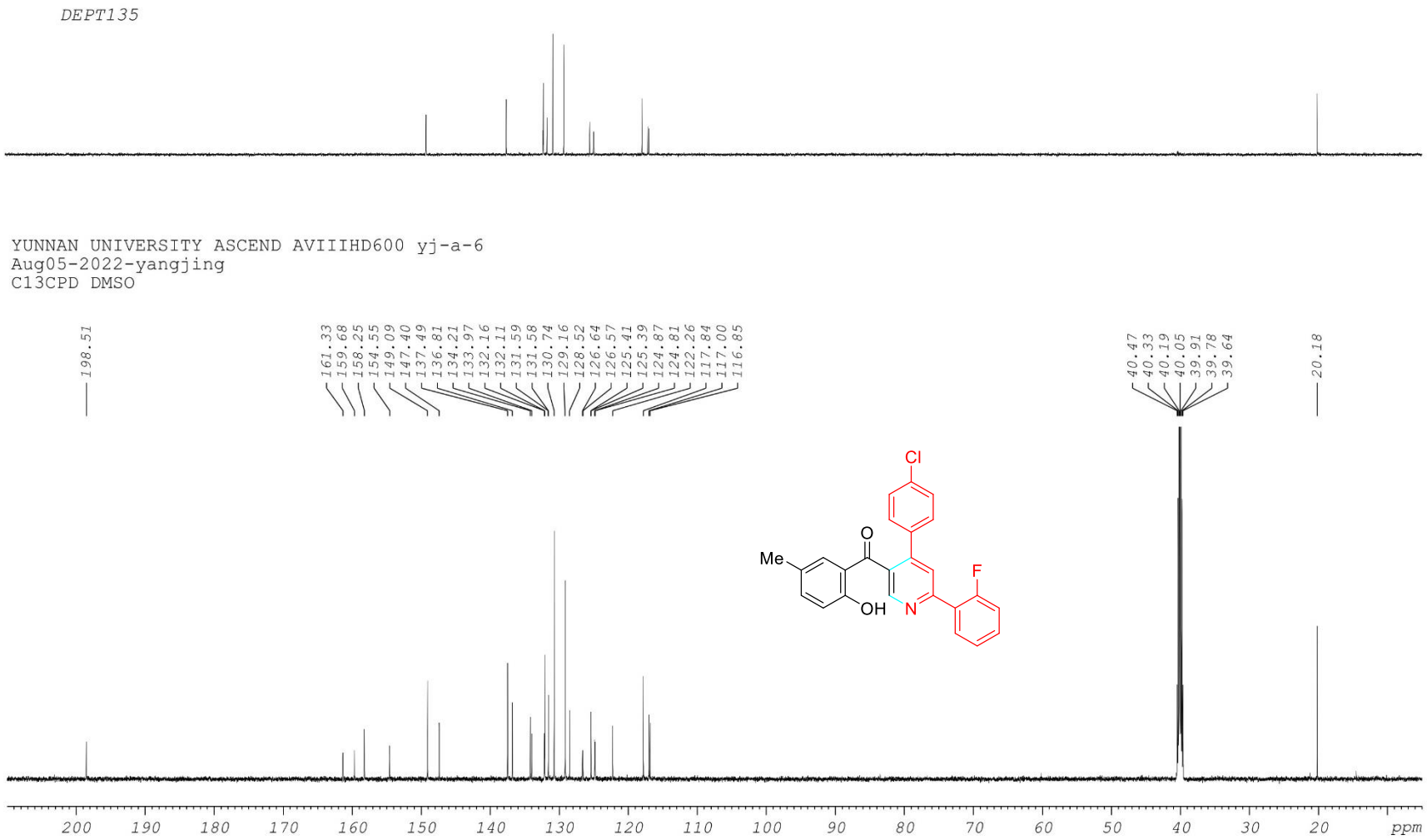


Figure S58. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3v**

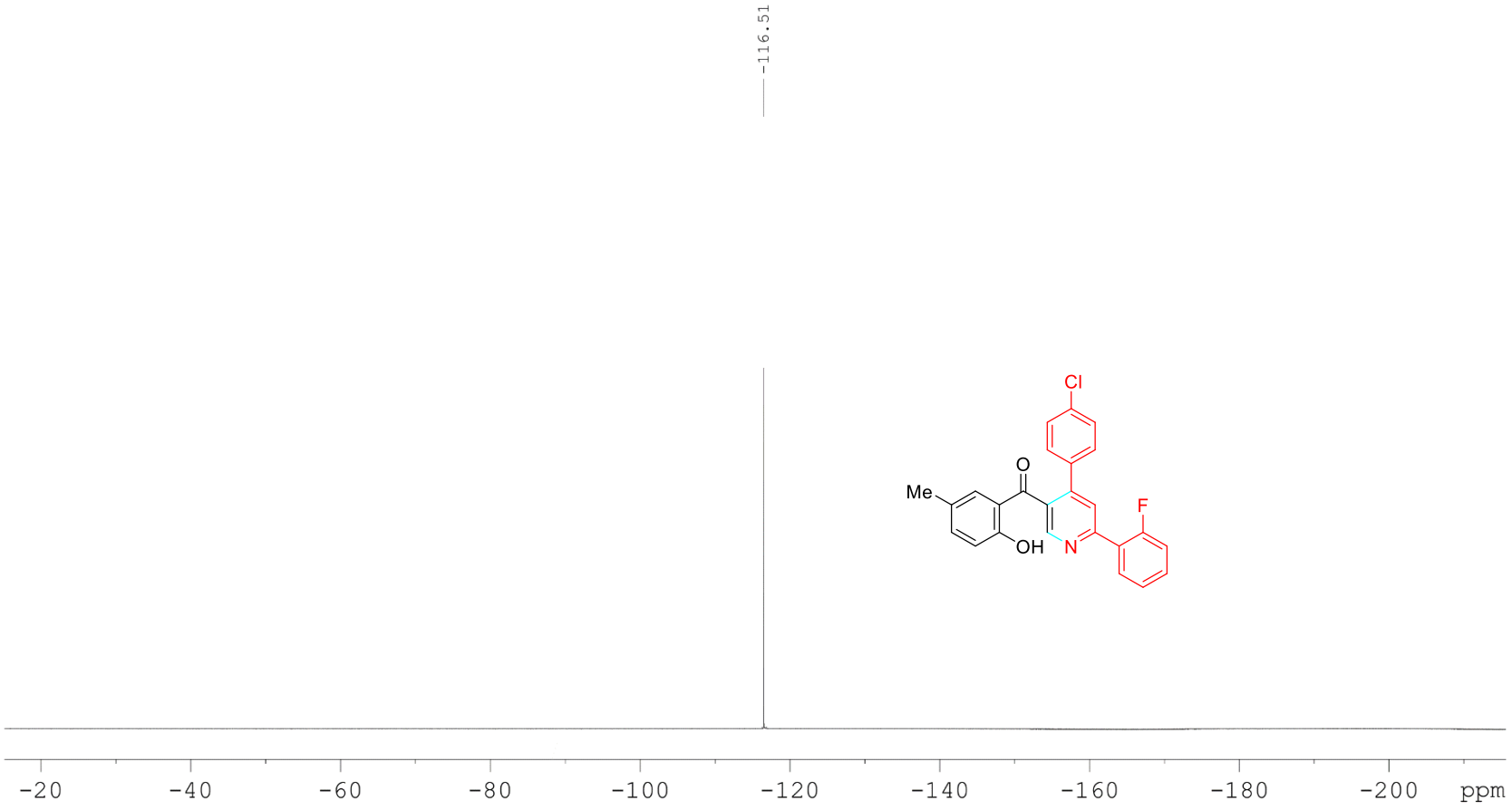


Figure S59. ^{19}F NMR (470 MHz, DMSO-d_6) spectra of compound **3v**

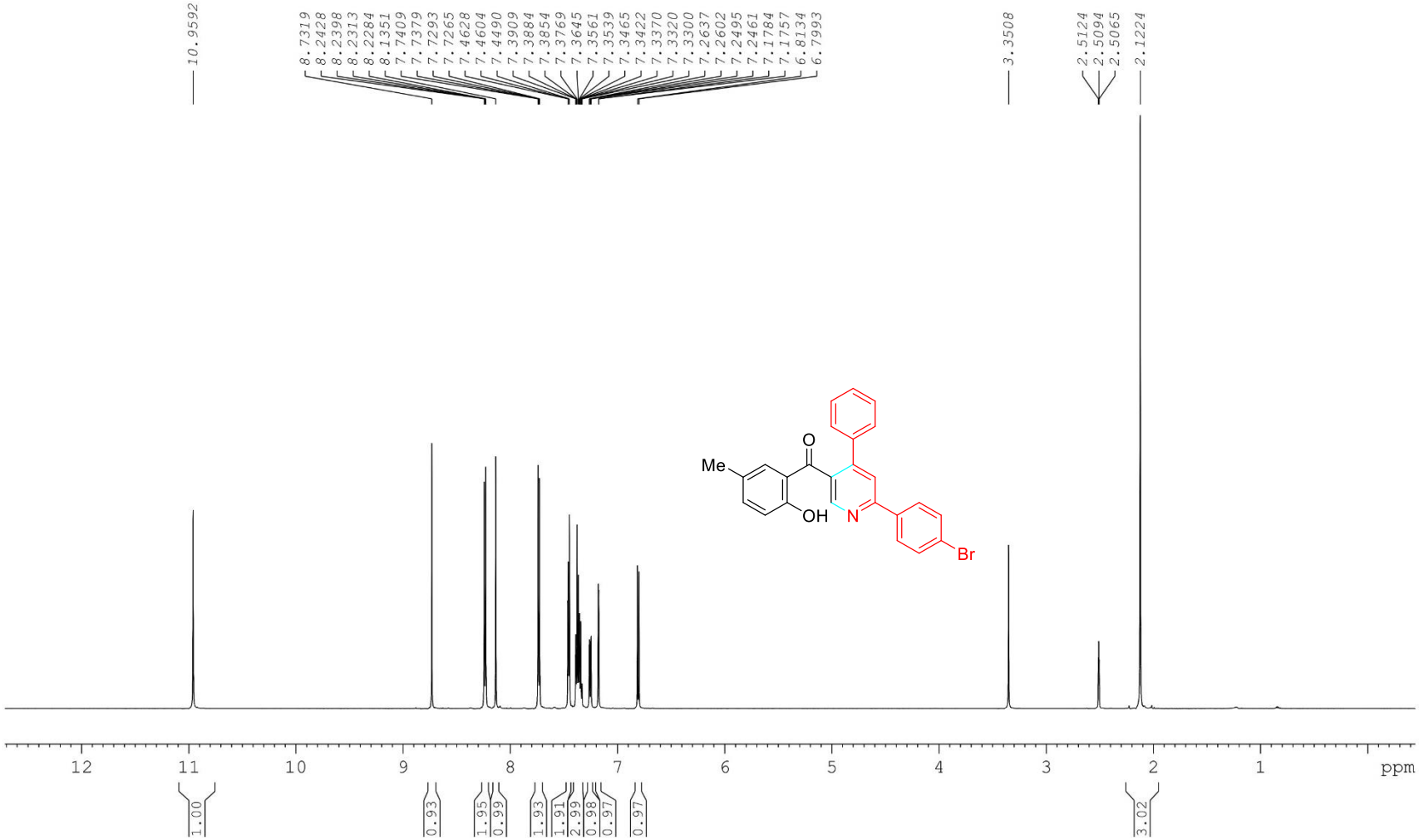


Figure S60. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3w**

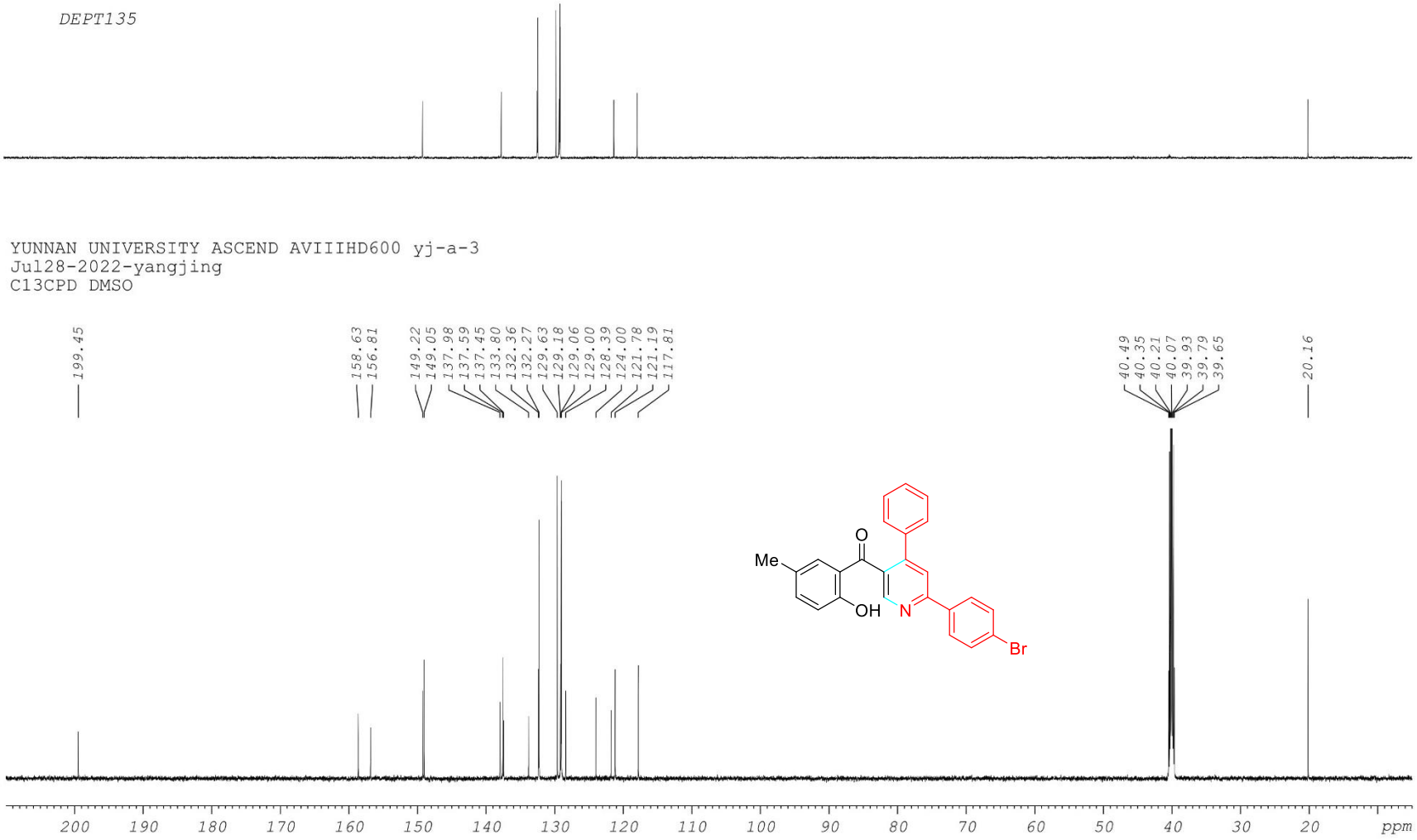


Figure S61. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3w**

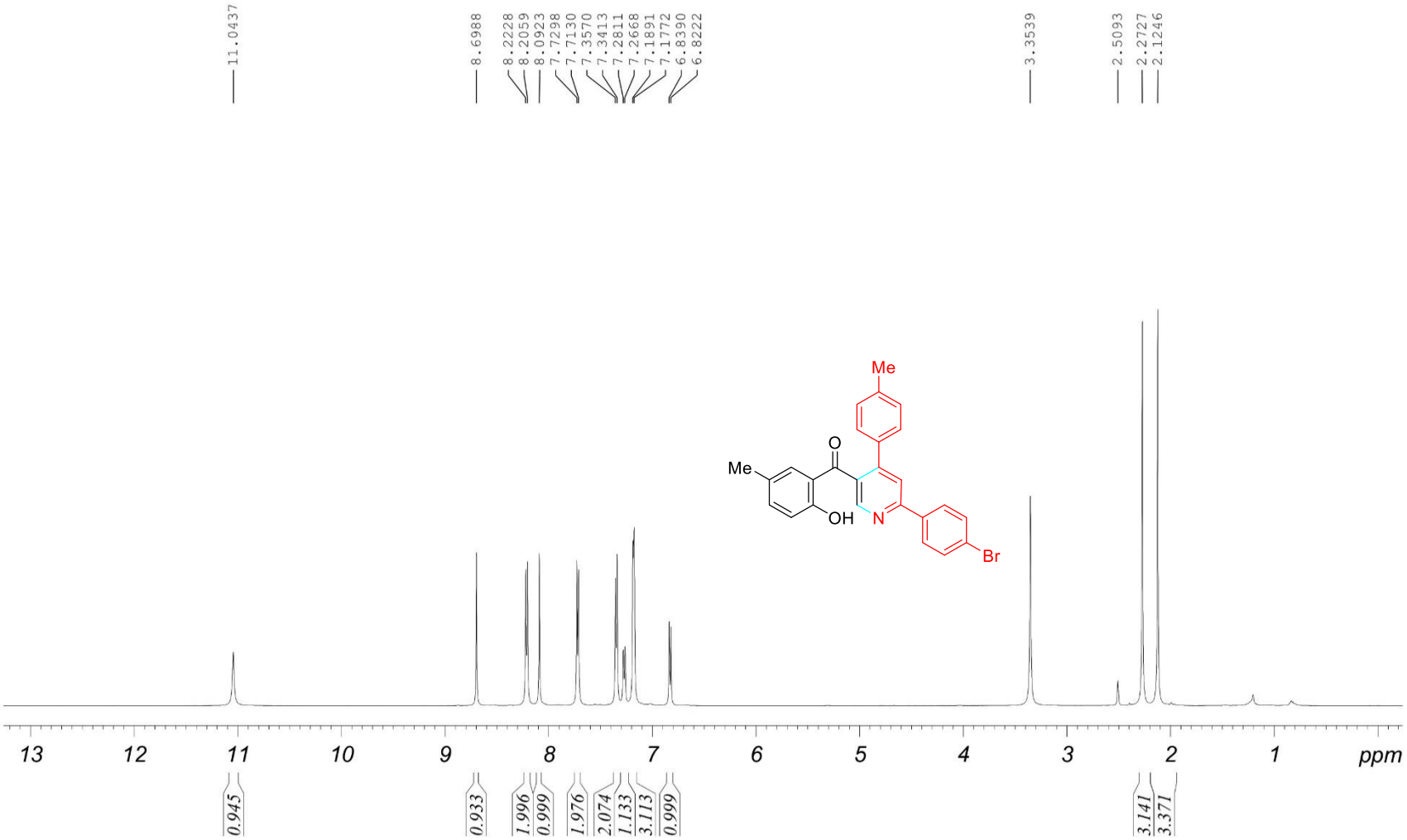


Figure S62. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3x**

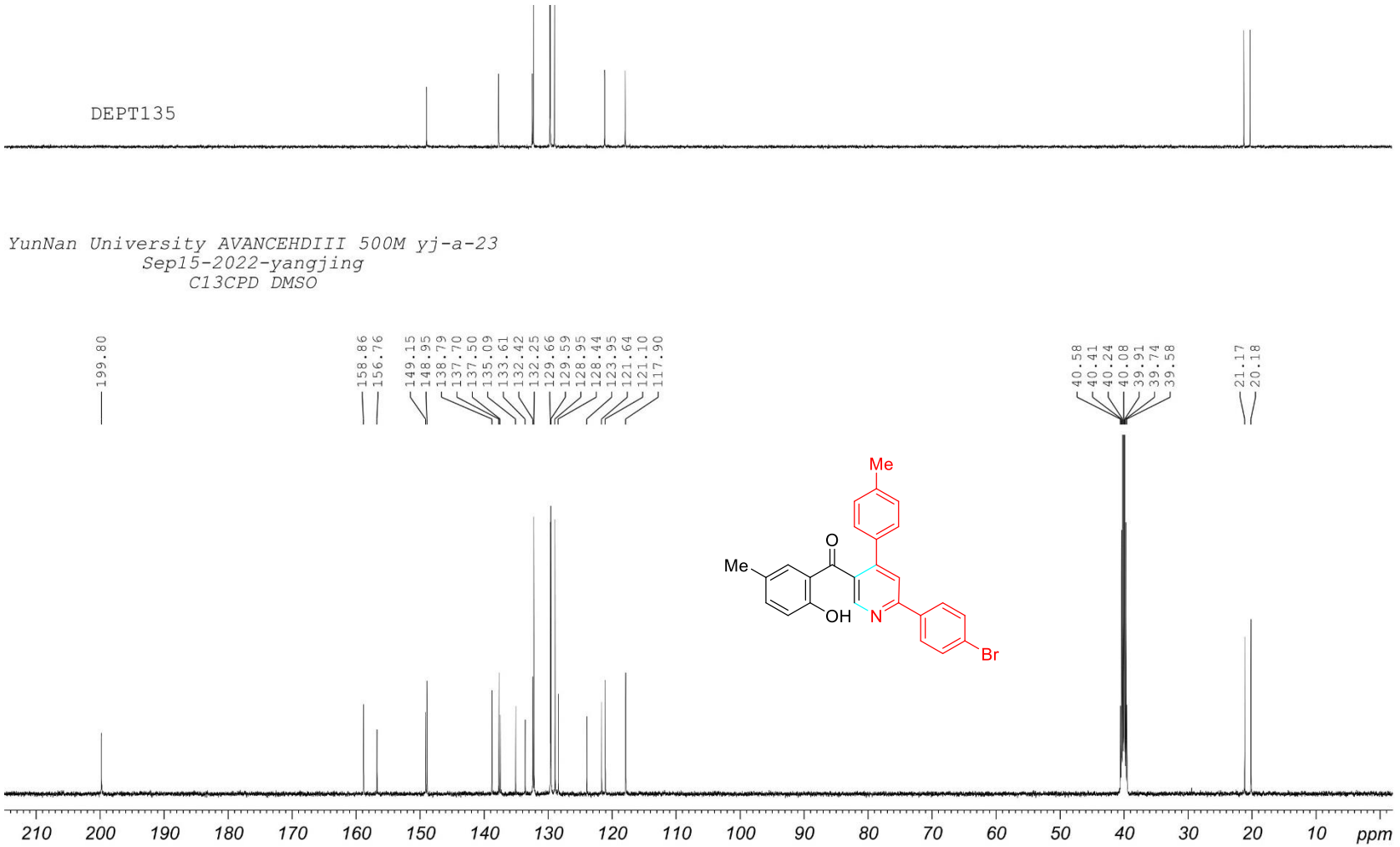


Figure S63. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3x**

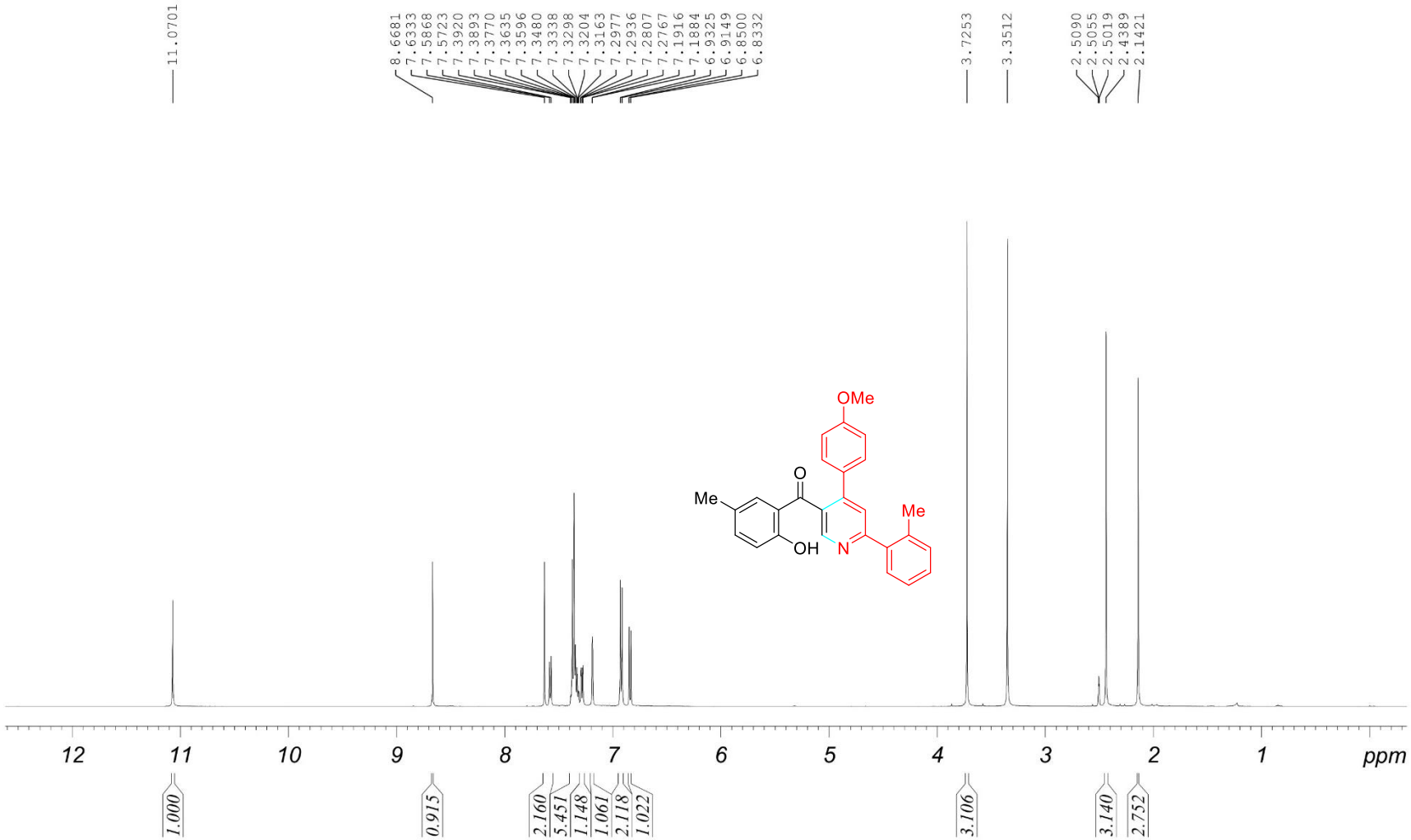


Figure S64. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3y**

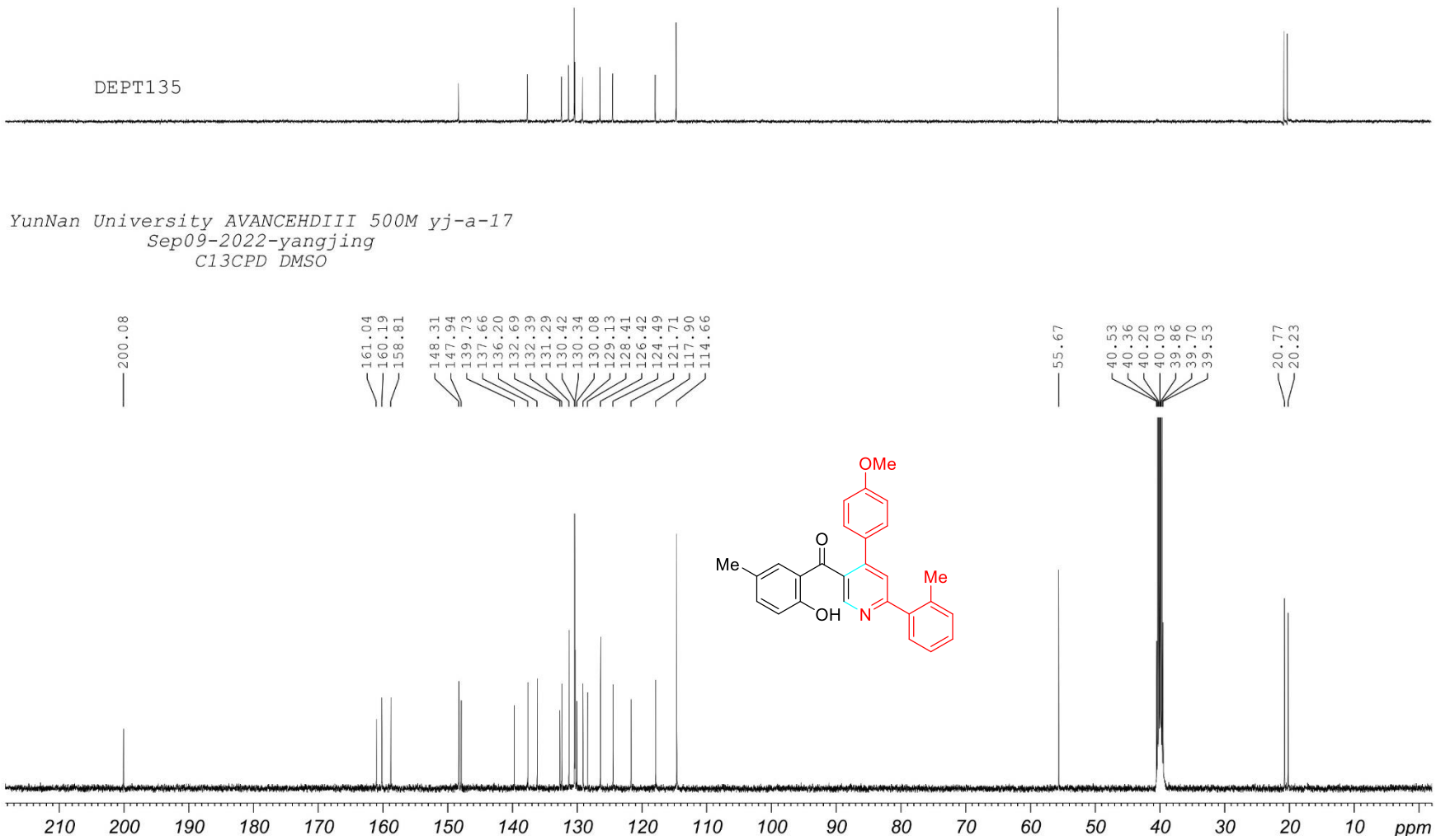


Figure S65. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3y**

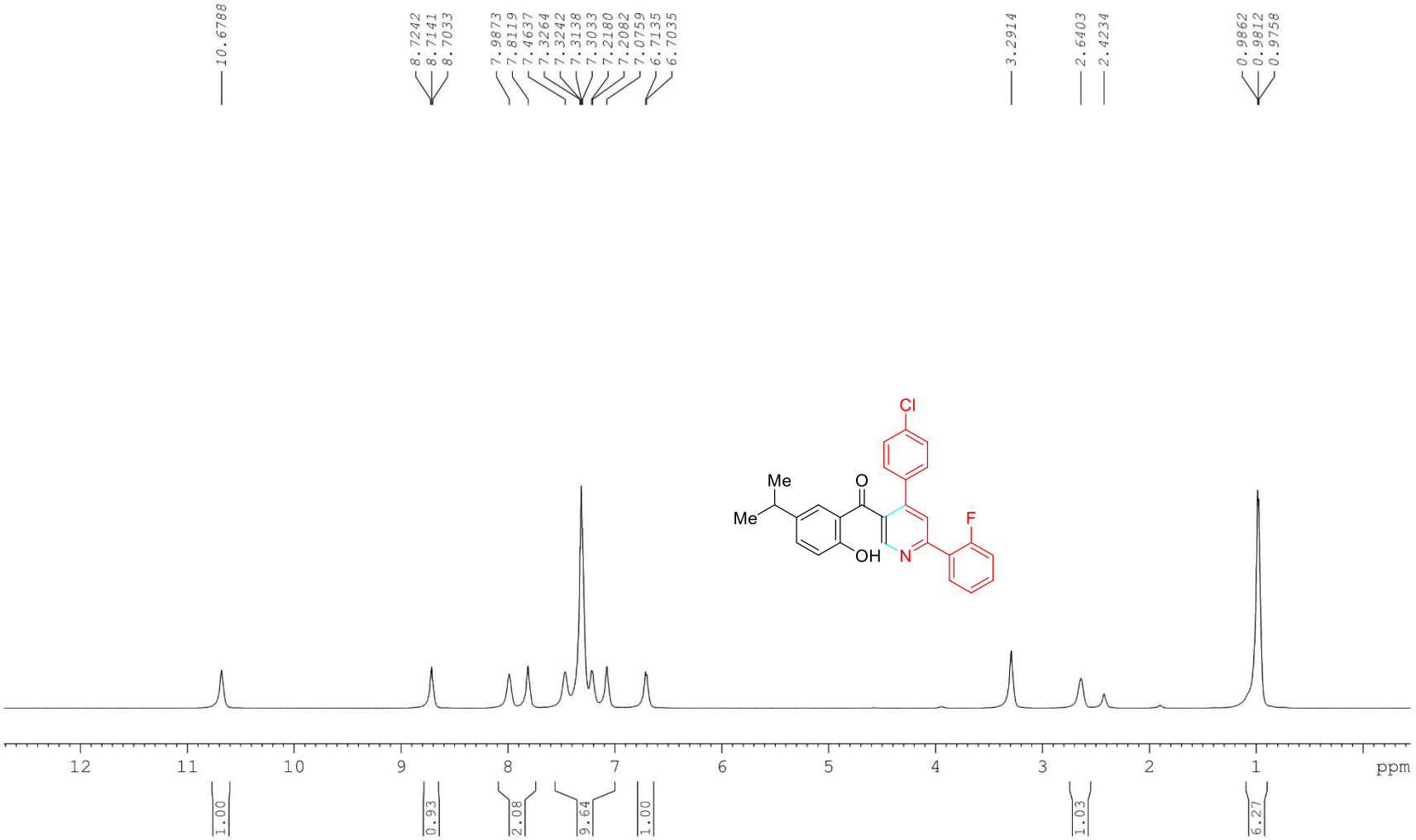


Figure S66. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3z**

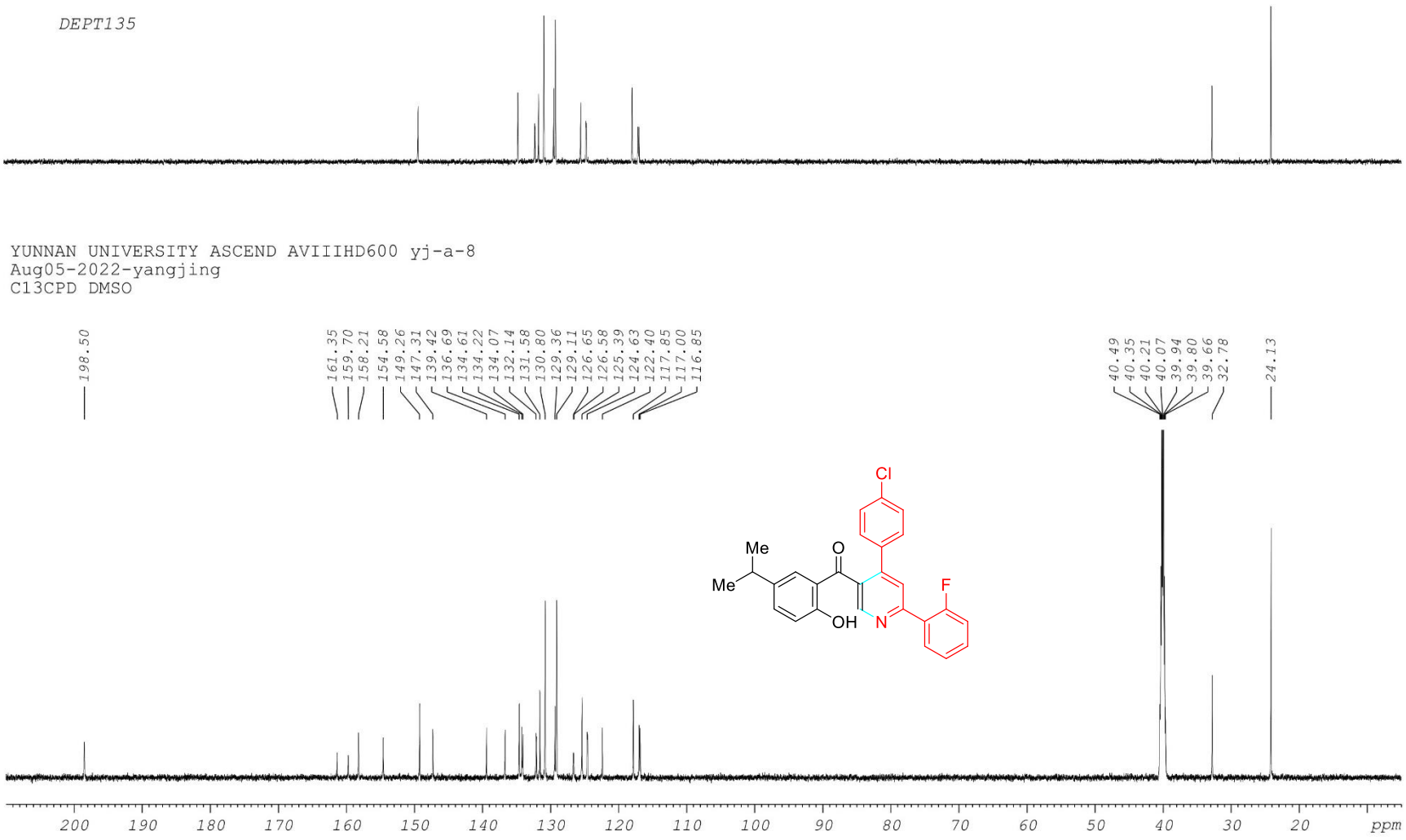


Figure S67. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3z**

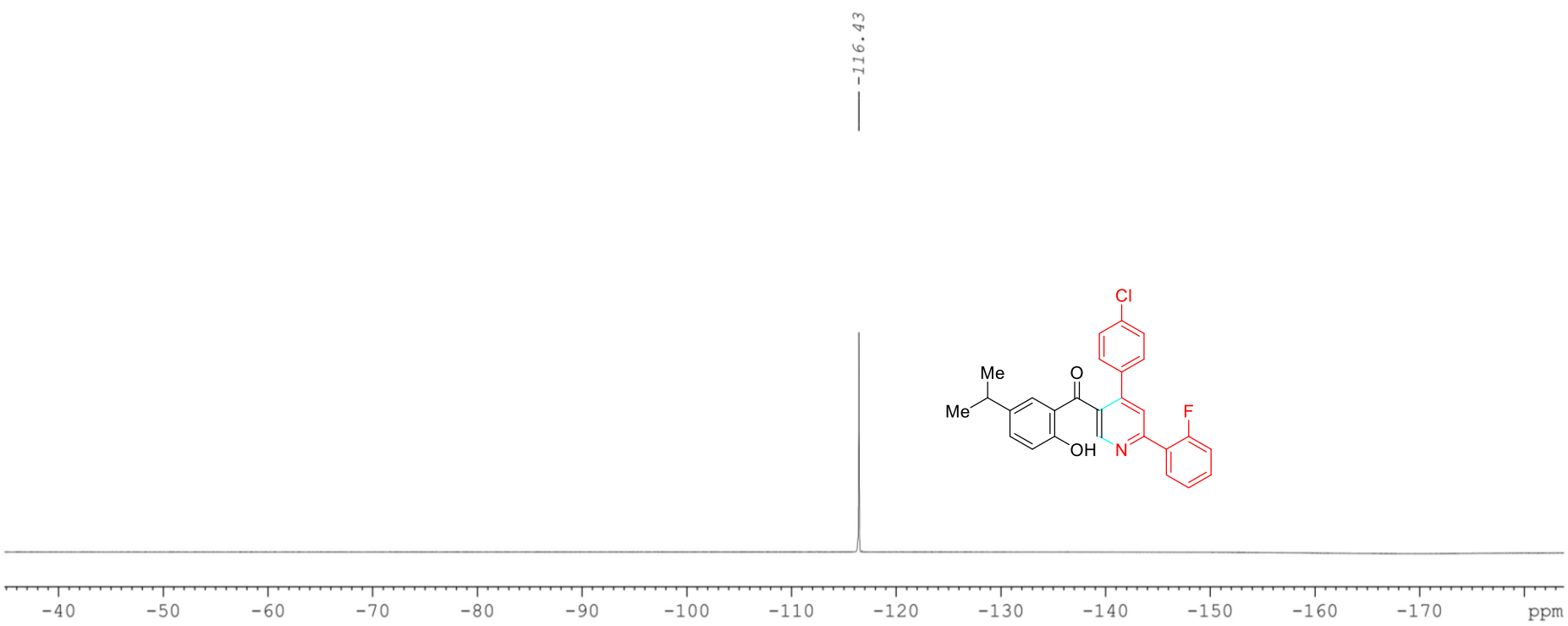


Figure S68. ^{19}F NMR (564 MHz, DMSO-d_6) spectra of compound **3z**

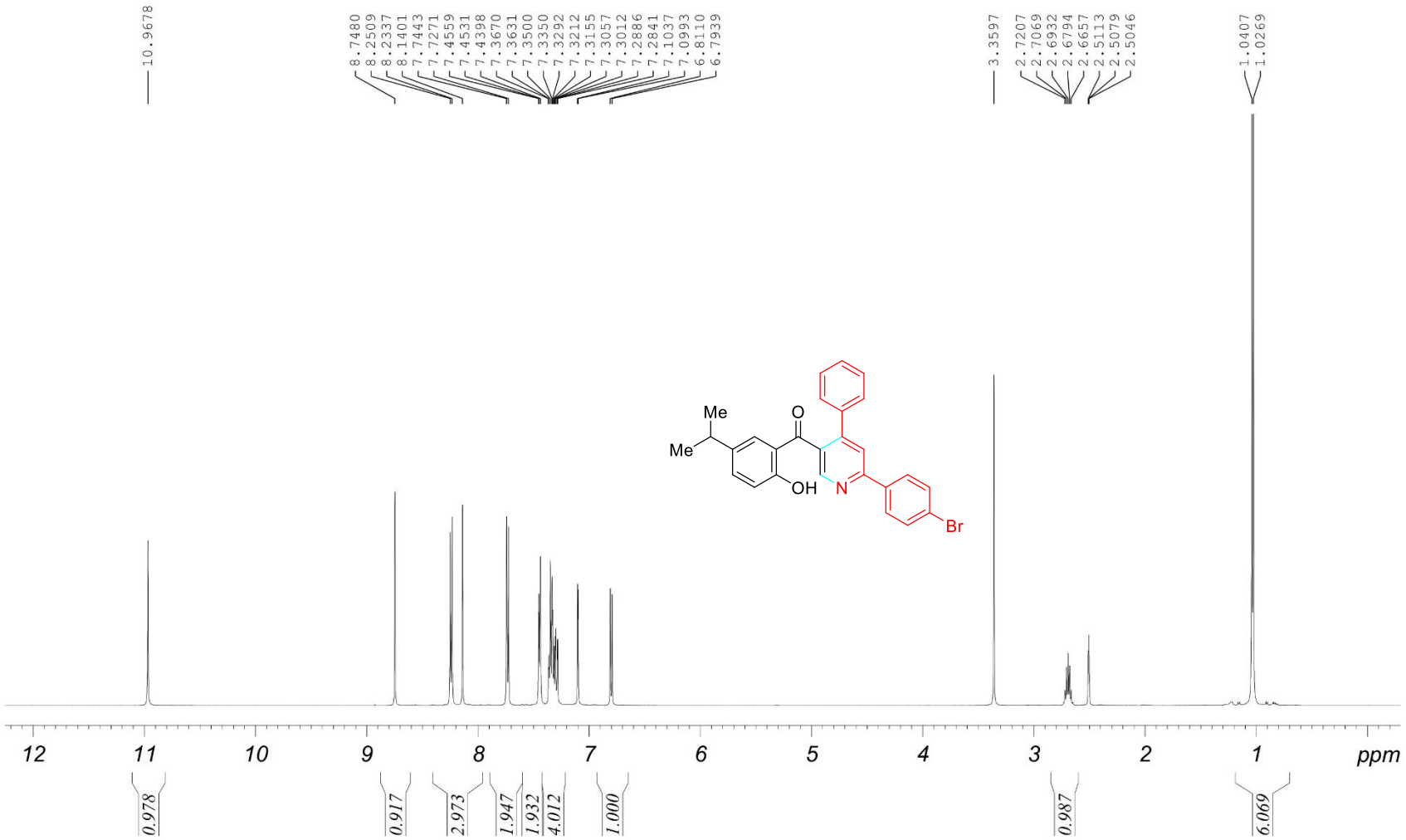


Figure S69. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3a'**

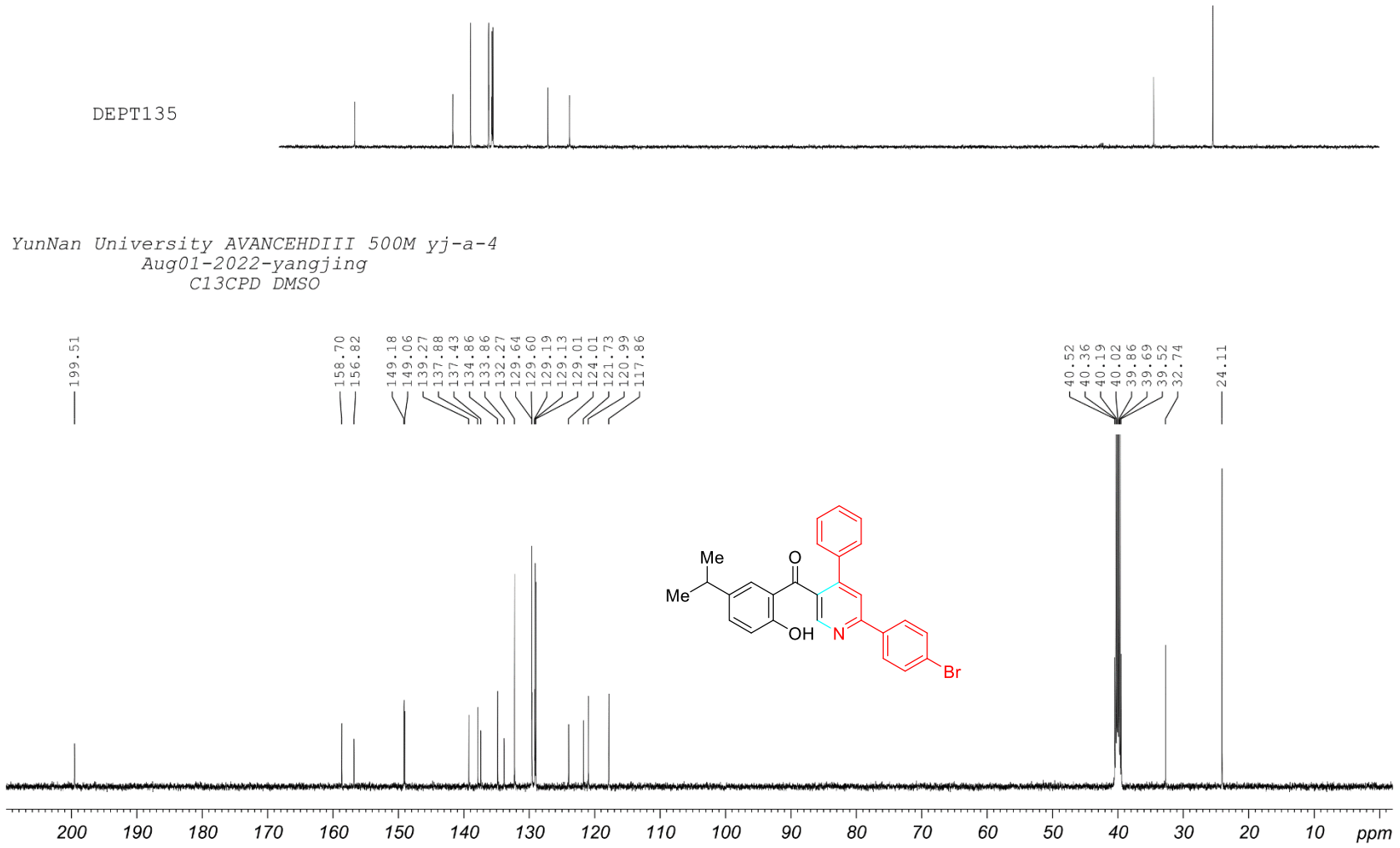


Figure S70. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3a'**

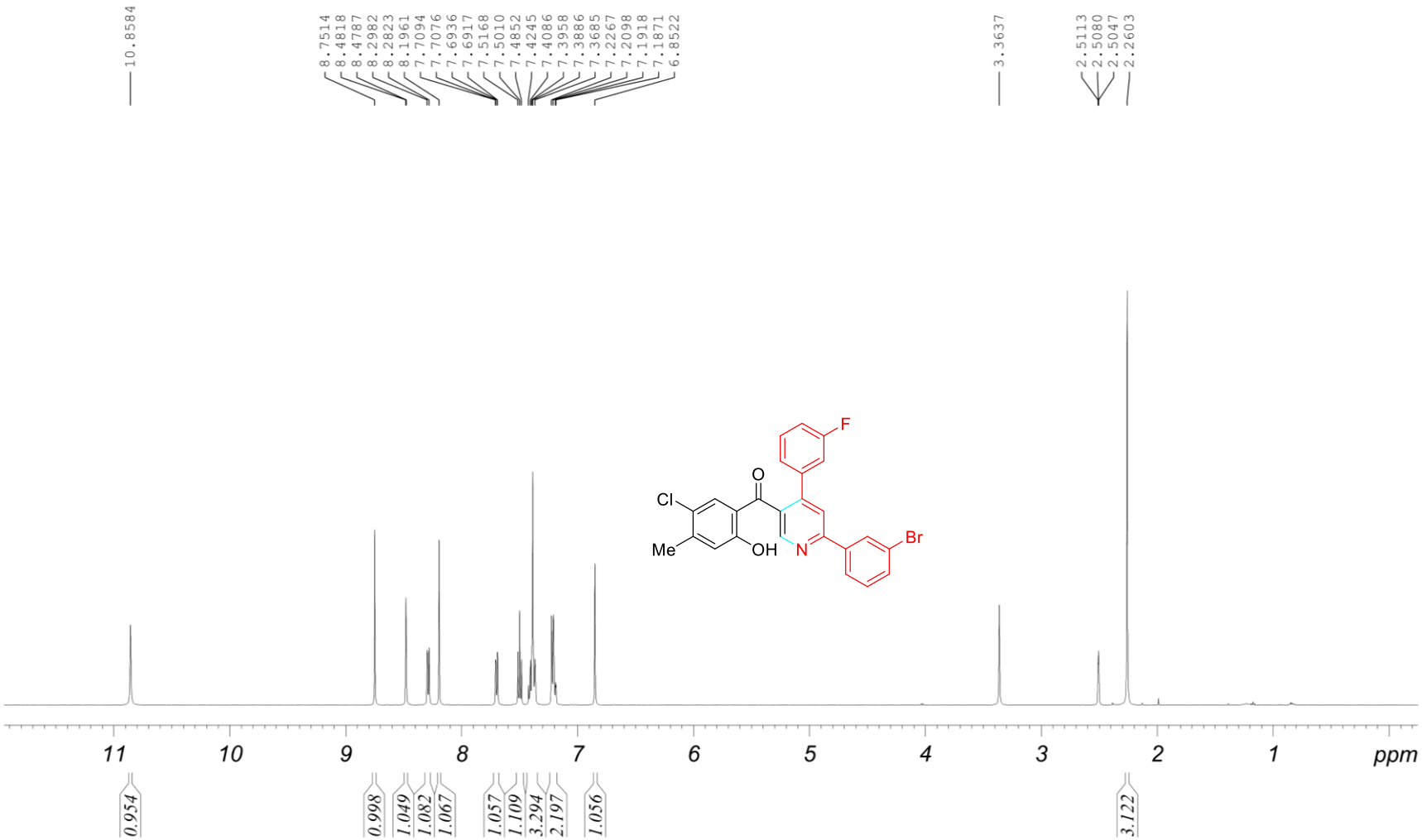


Figure S71. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3b'**

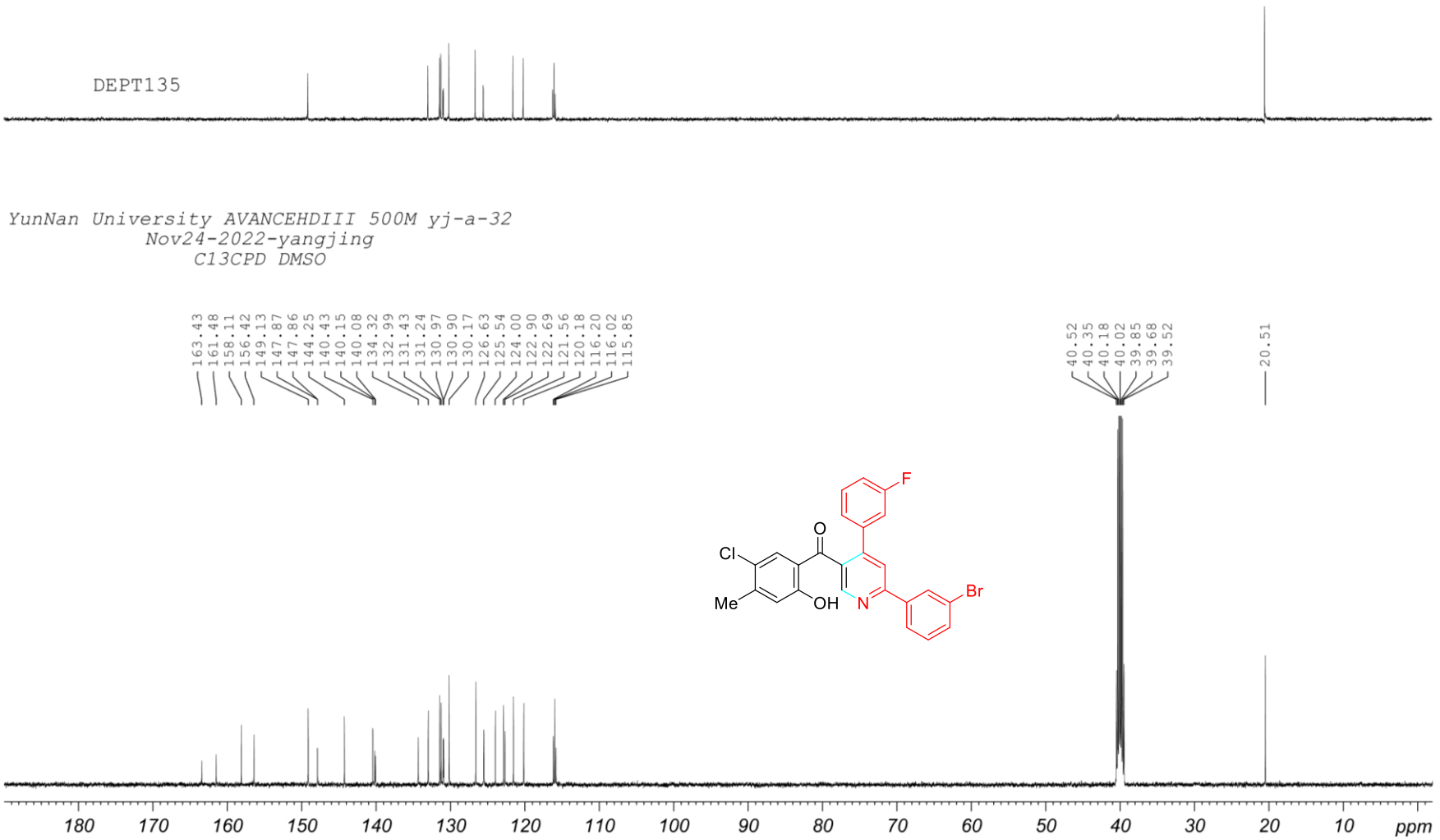


Figure S72. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3b'**

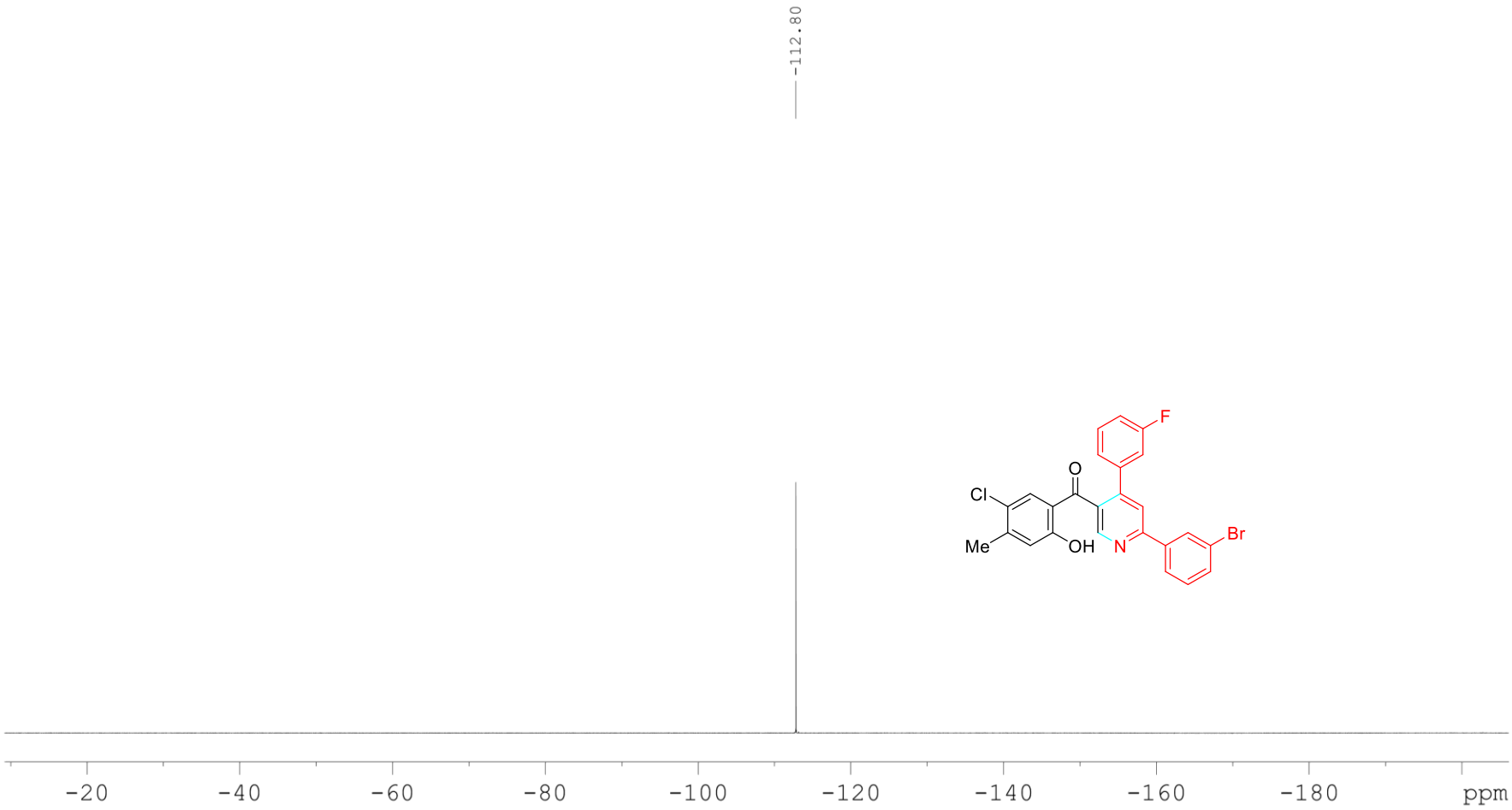


Figure S73. ^{19}F NMR (564 MHz, DMSO-d_6) spectra of compound **3b'**

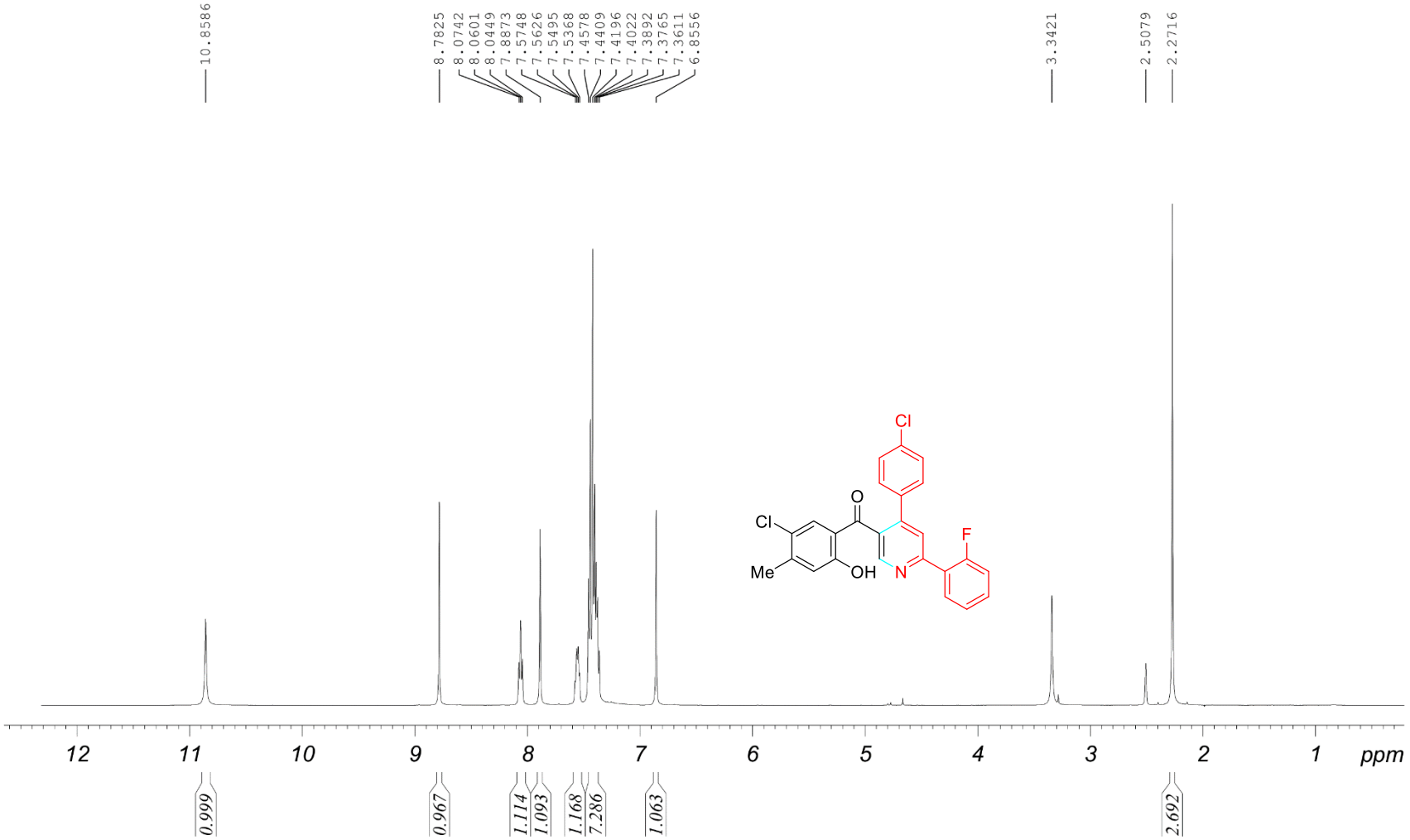


Figure S74. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3c'**

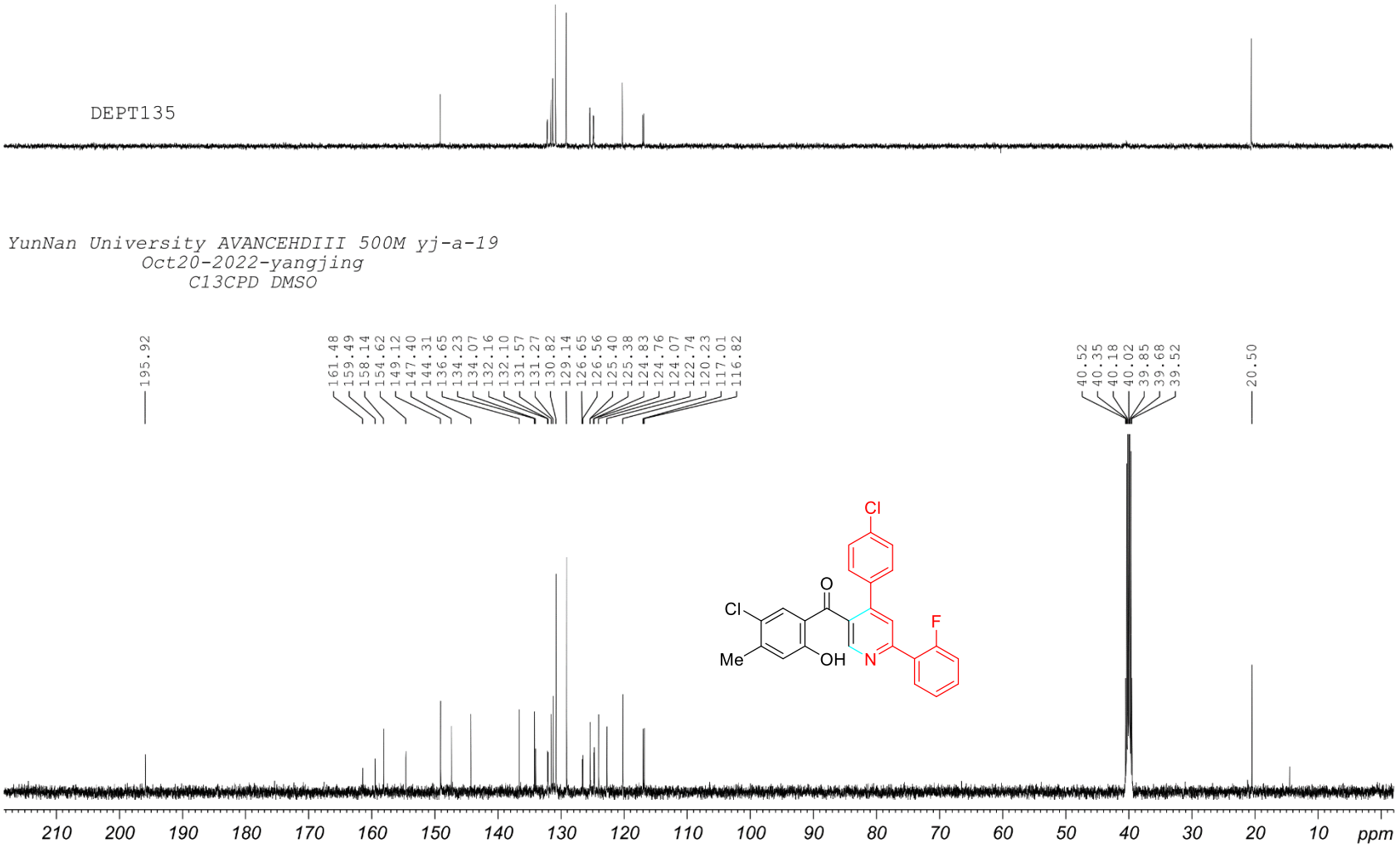


Figure S75. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3c'**

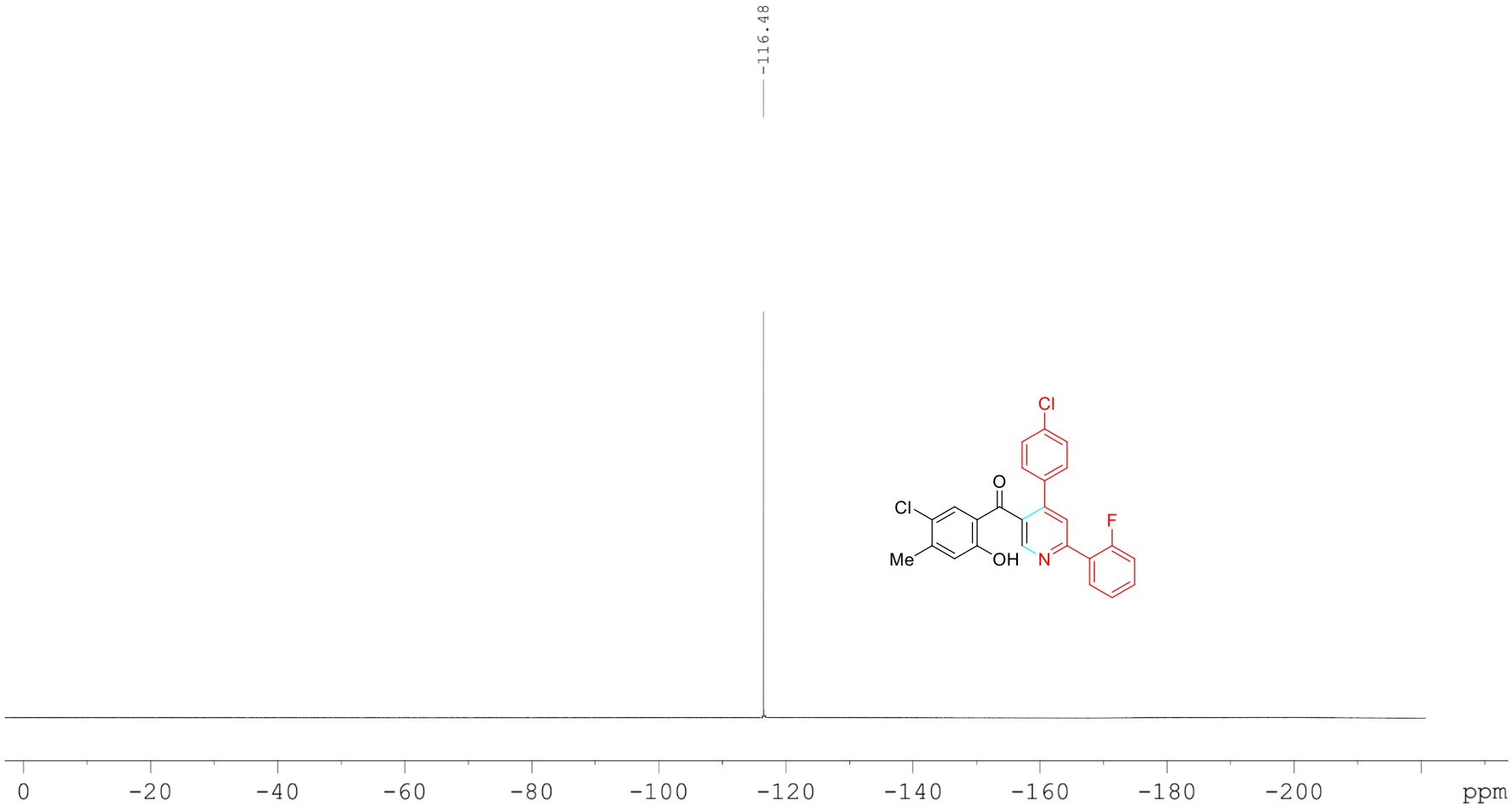


Figure S76. ^{19}F NMR (470 MHz, DMSO-d_6) spectra of compound **3c'**

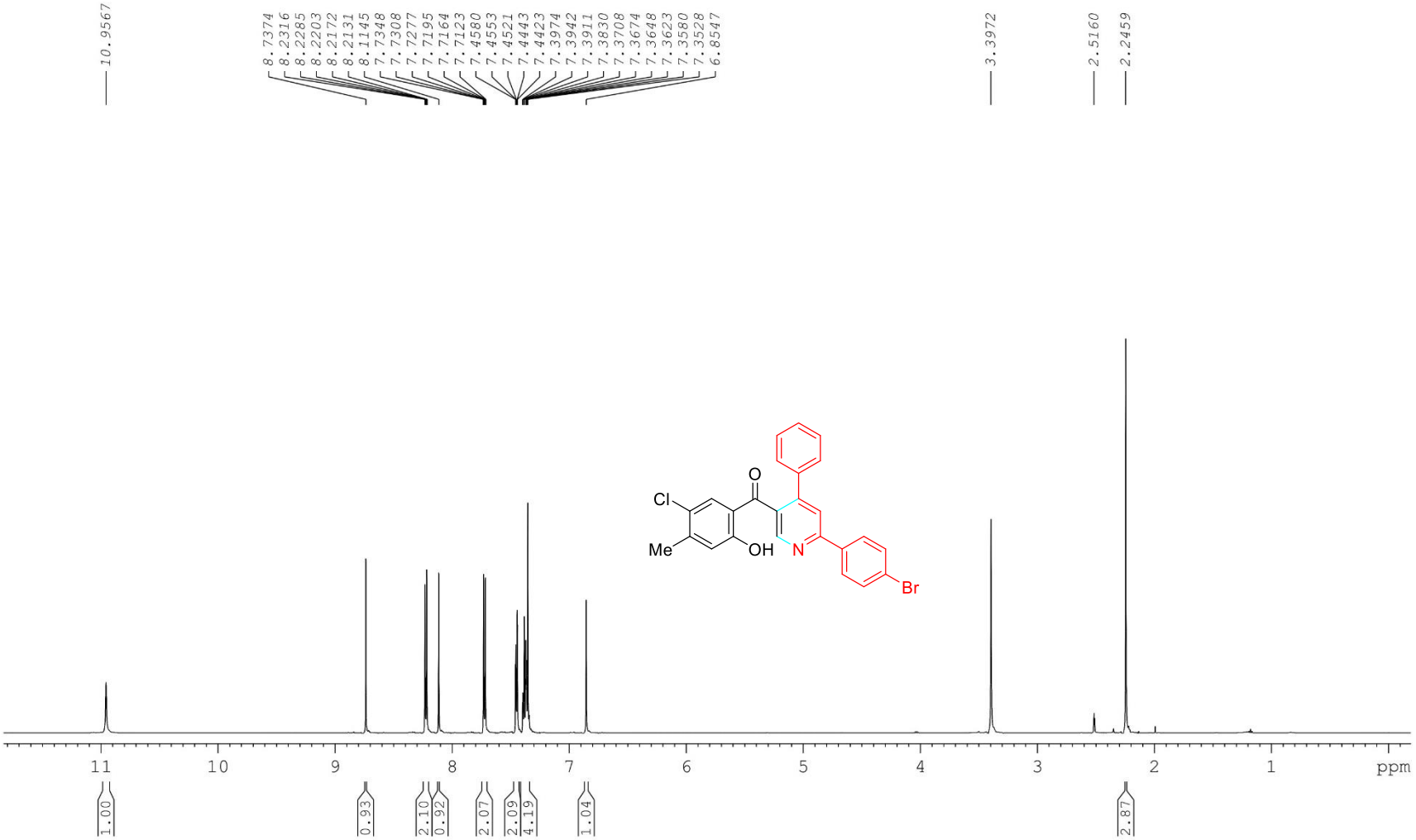


Figure S77. ^{1}H NMR (600 MHz, DMSO-d_6) spectra of compound **3d'**

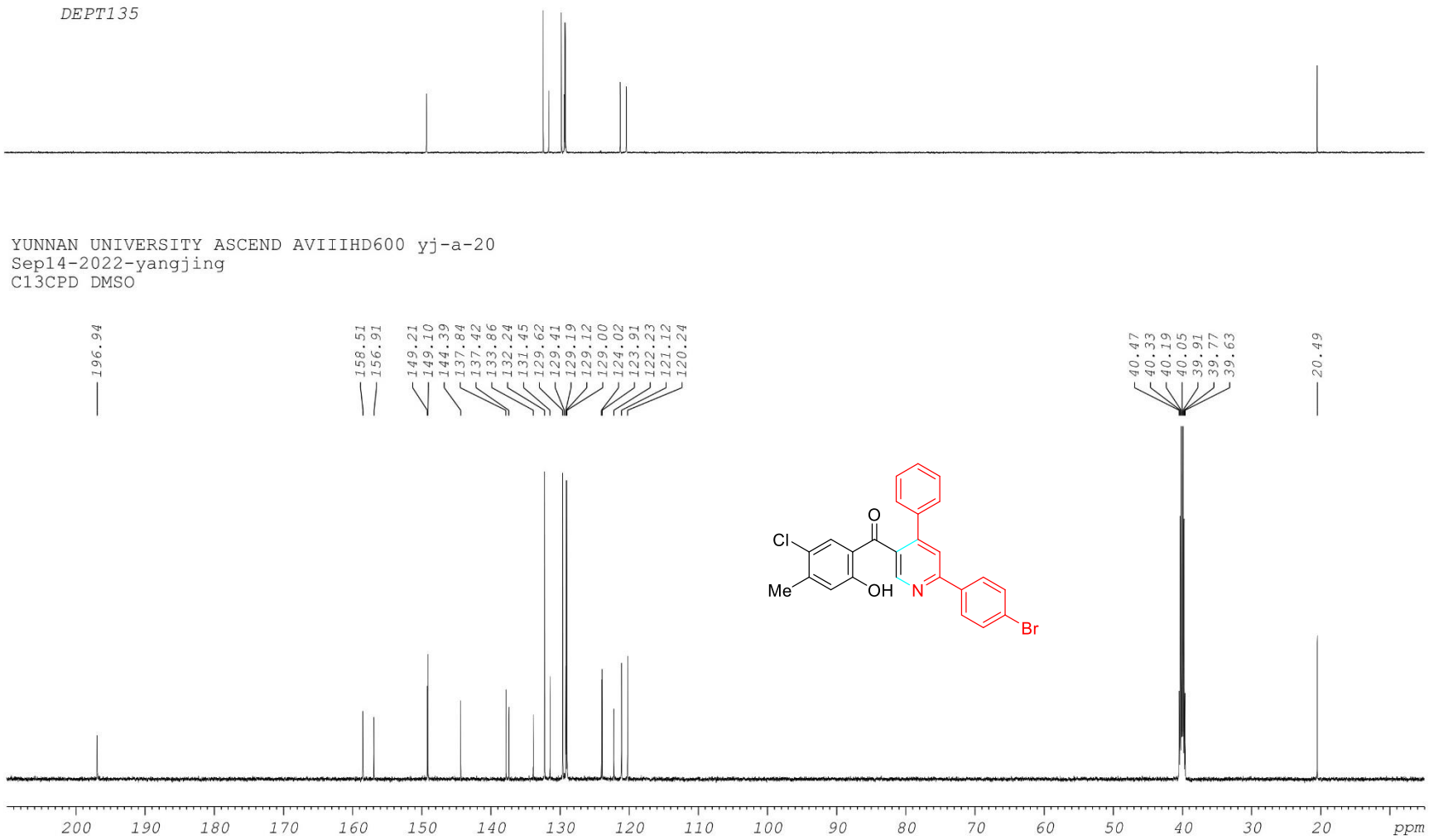


Figure S78. ^{13}C NMR (150 MHz, DMSO-d_6) spectra of compound **3d'**

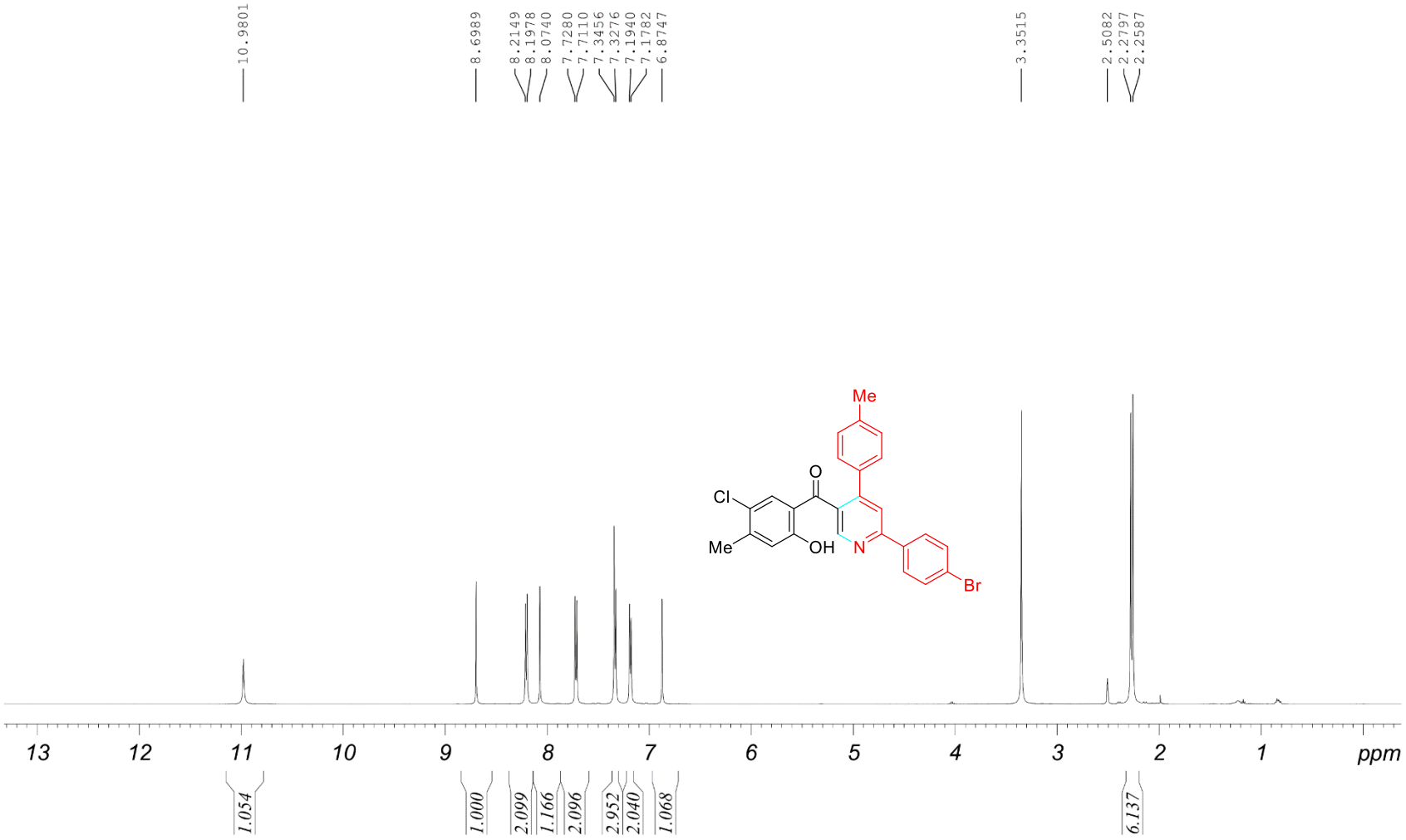


Figure S79. ^{1}H NMR (500 MHz, DMSO-d_6) spectra of compound **3e'**

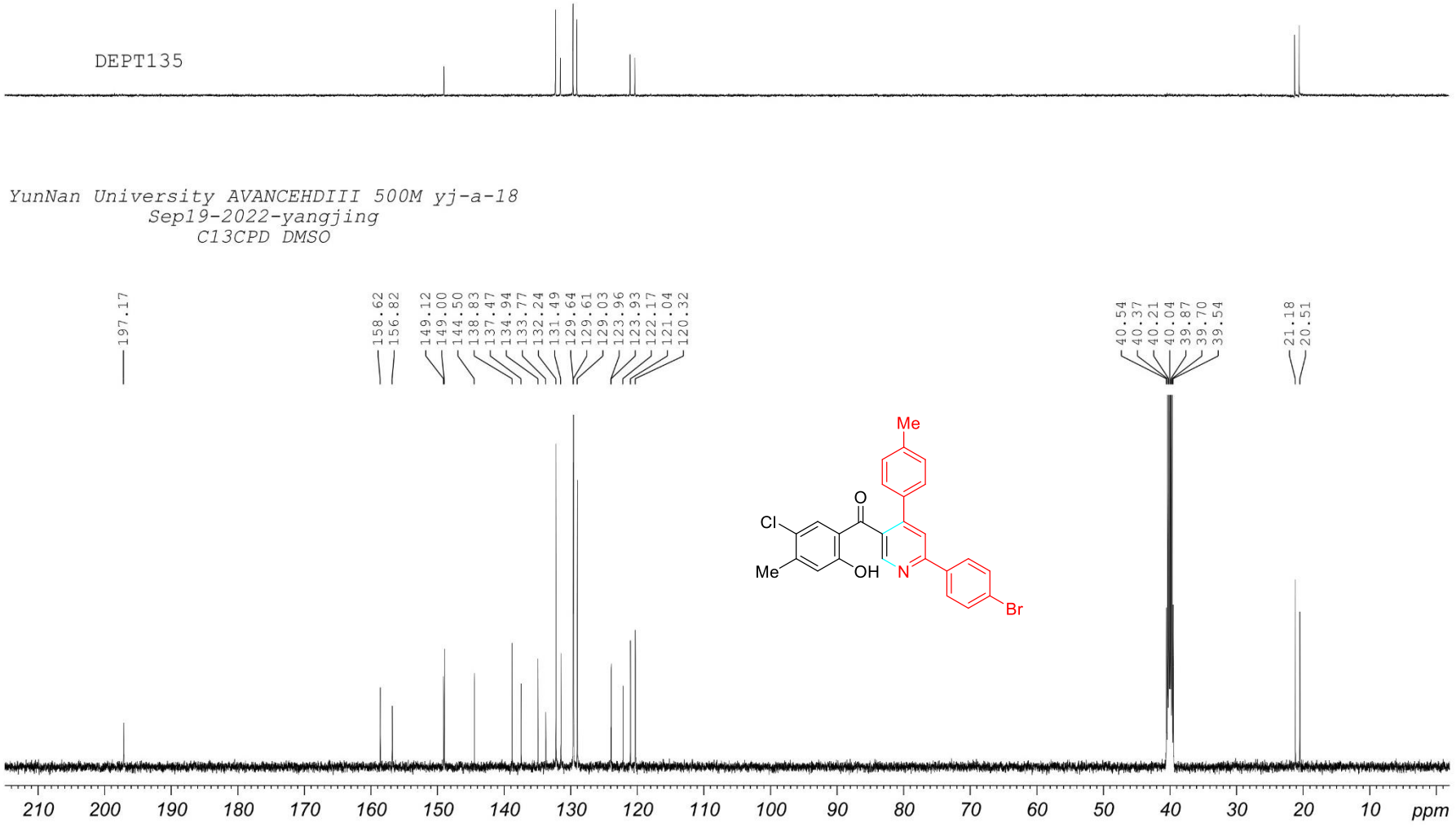


Figure S80. ^{13}C NMR (125 MHz, DMSO-d_6) spectra of compound **3e'**

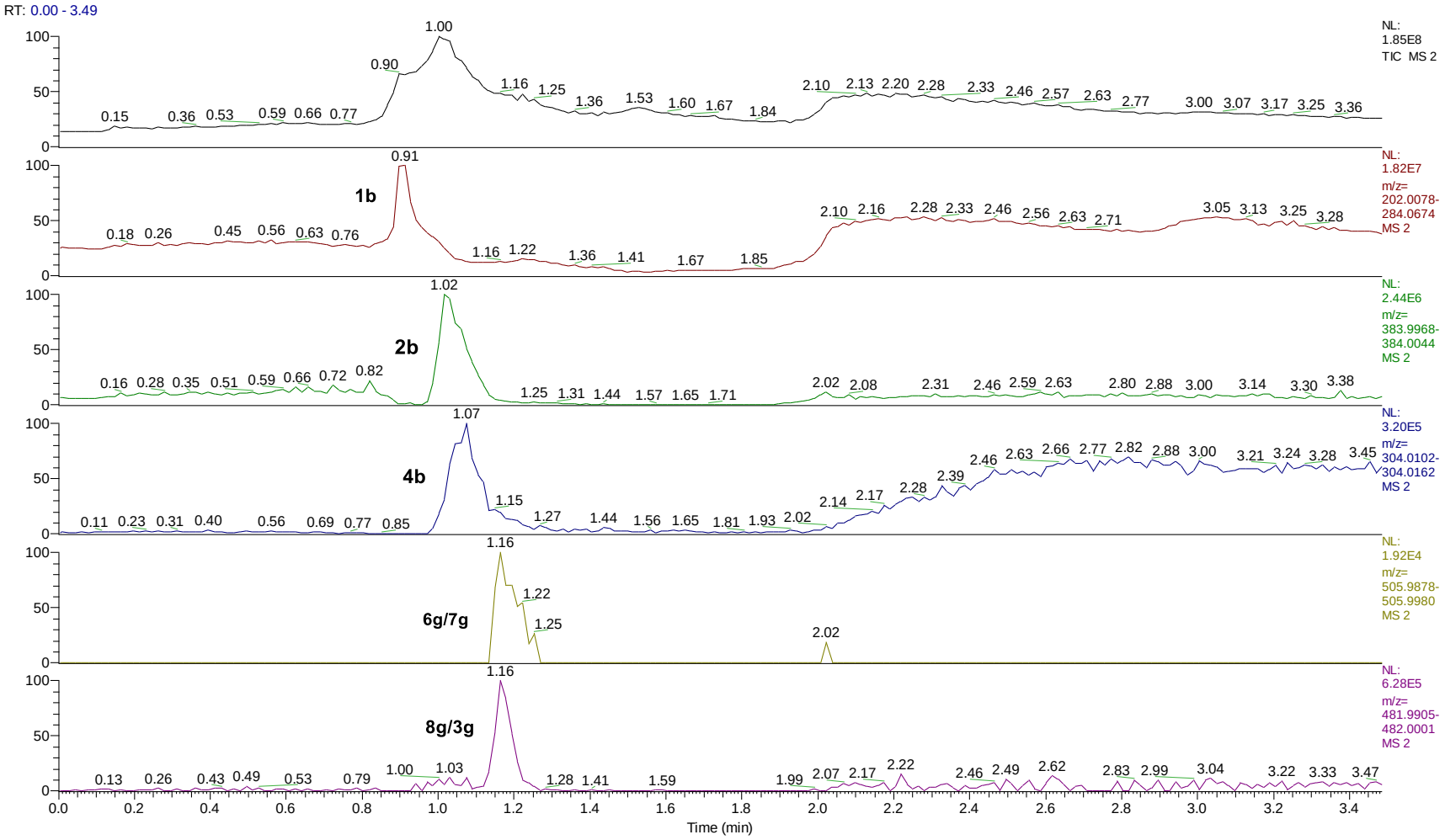


Figure S81. HPLC of the reaction mixture

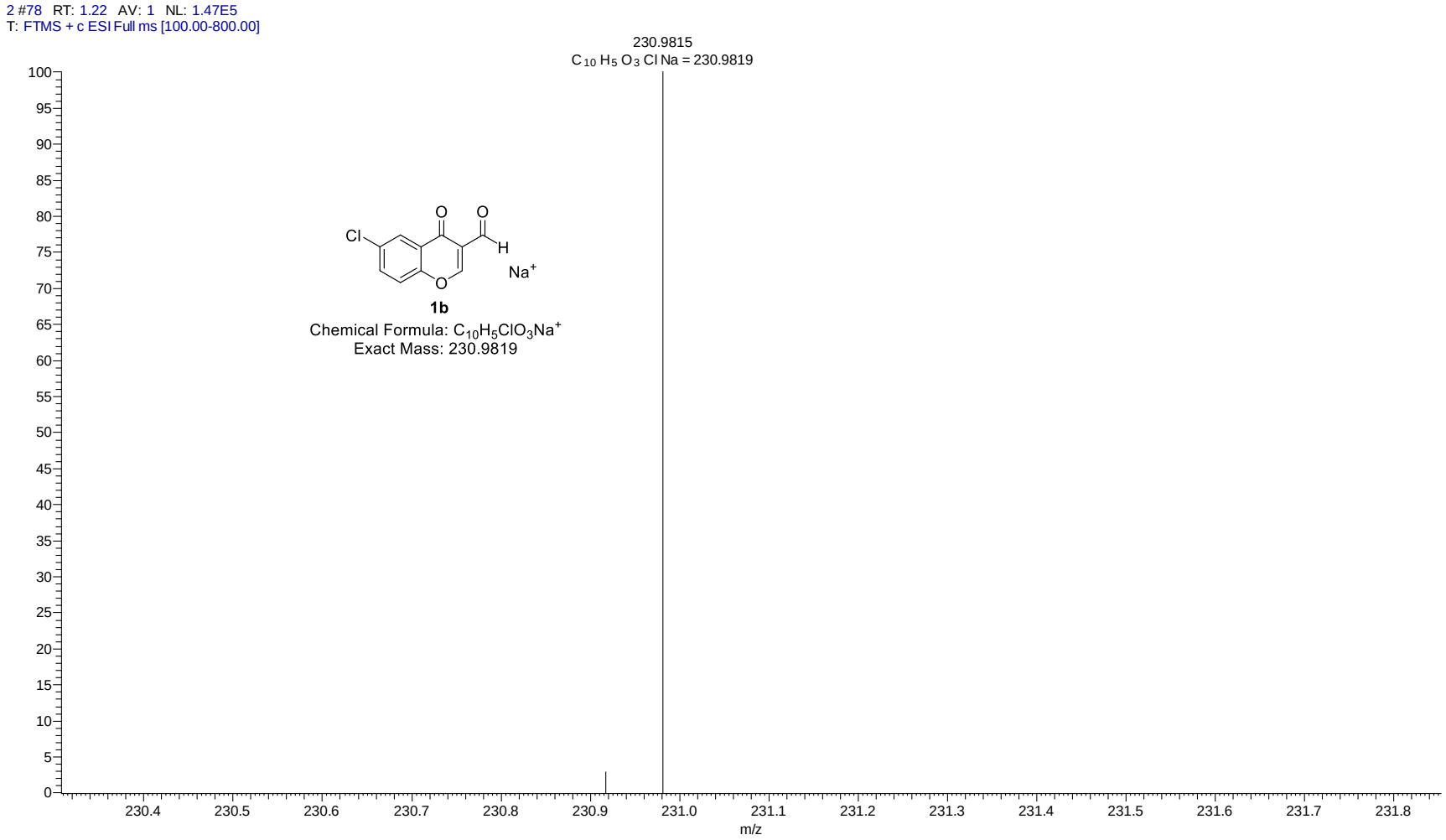


Figure S82. HRMS of substrate **1b**

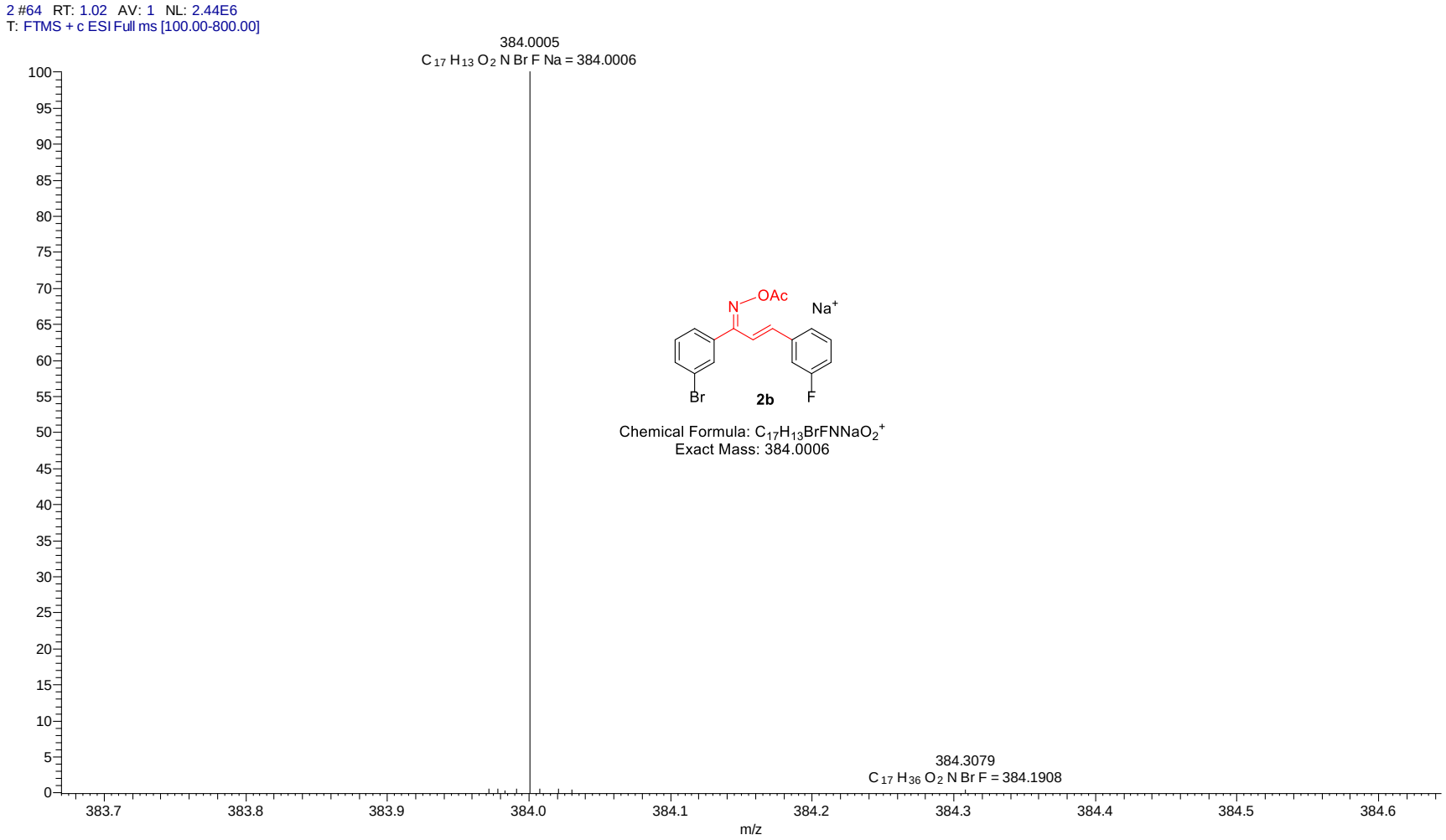


Figure S83. HRMS of substrate **2b**

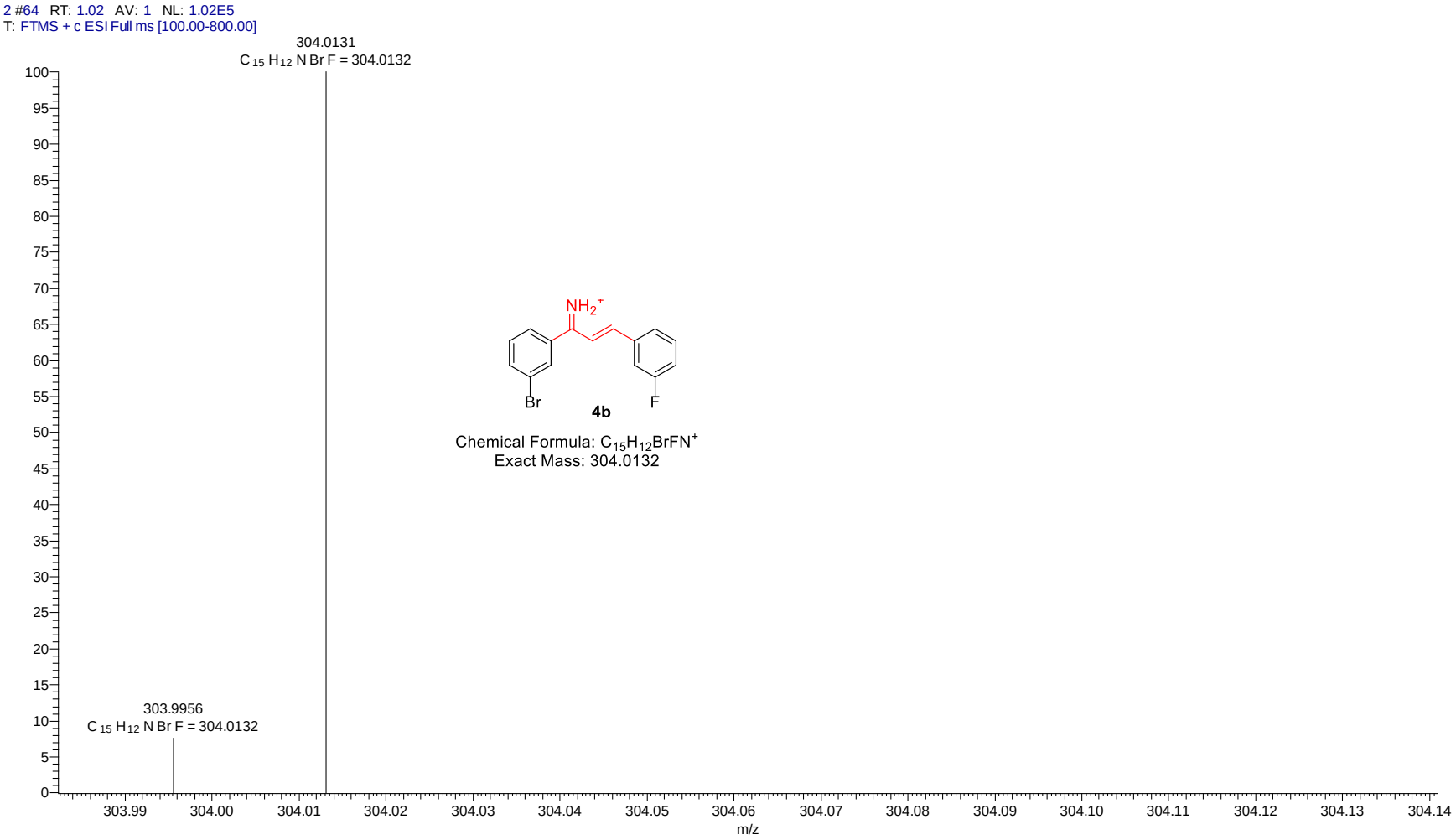


Figure S84. HRMS of intermediate **4b**

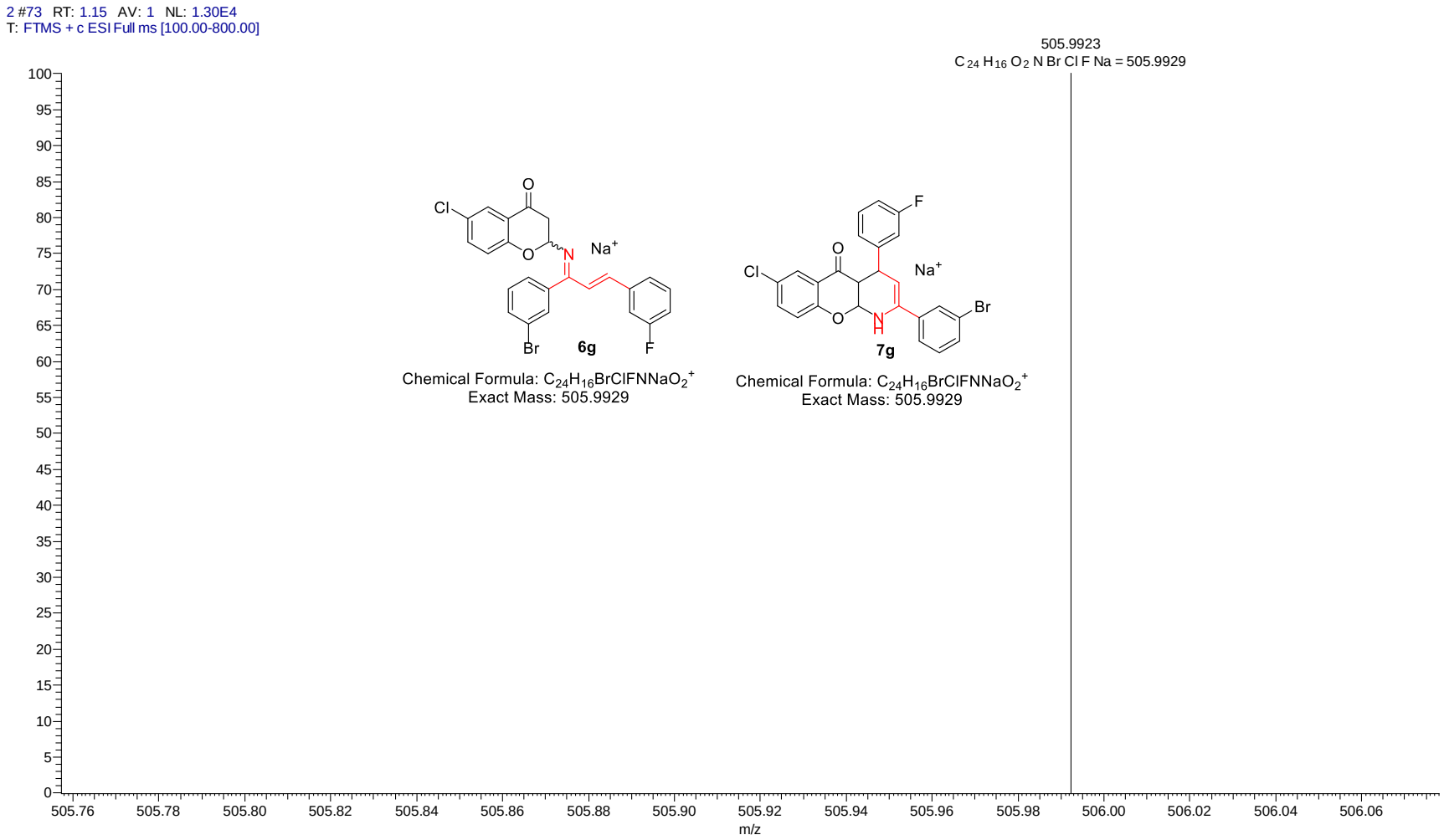


Figure S85. HRMS of intermediate **6g/7g**

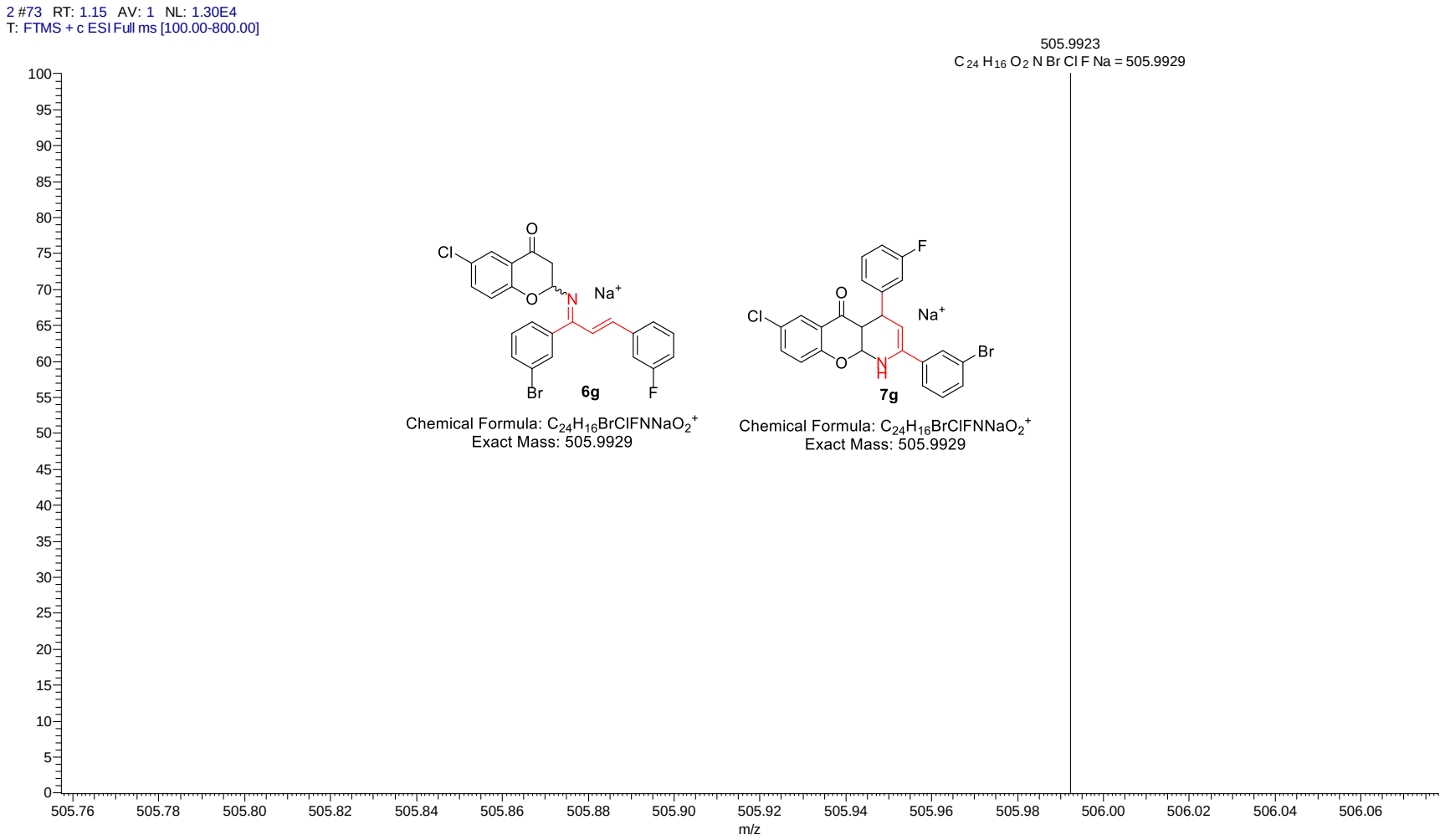


Figure S86. HRMS of intermediate **6g/7g**

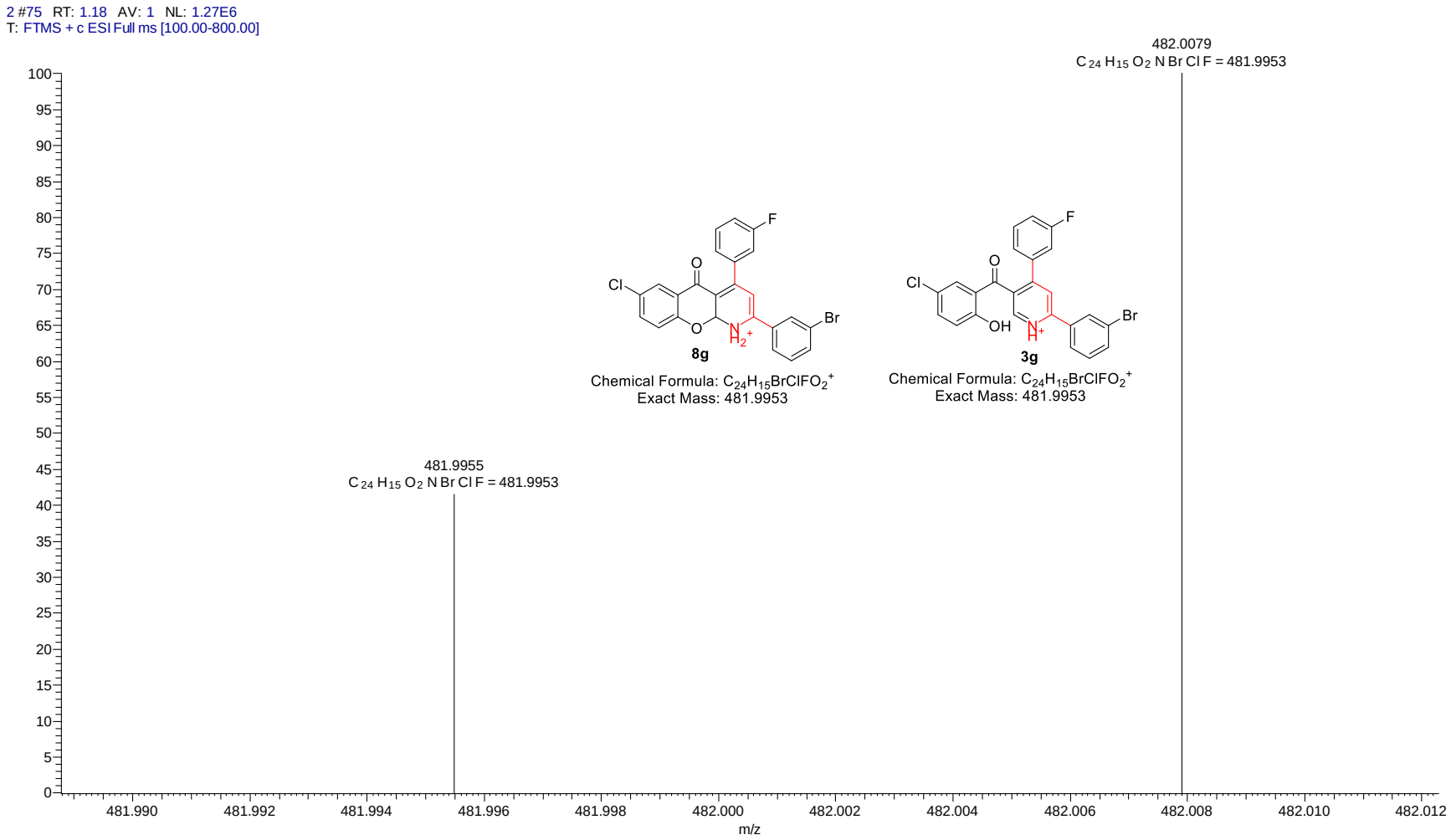


Figure S87. HRMS of intermediate **8g** or the target compound **3g**

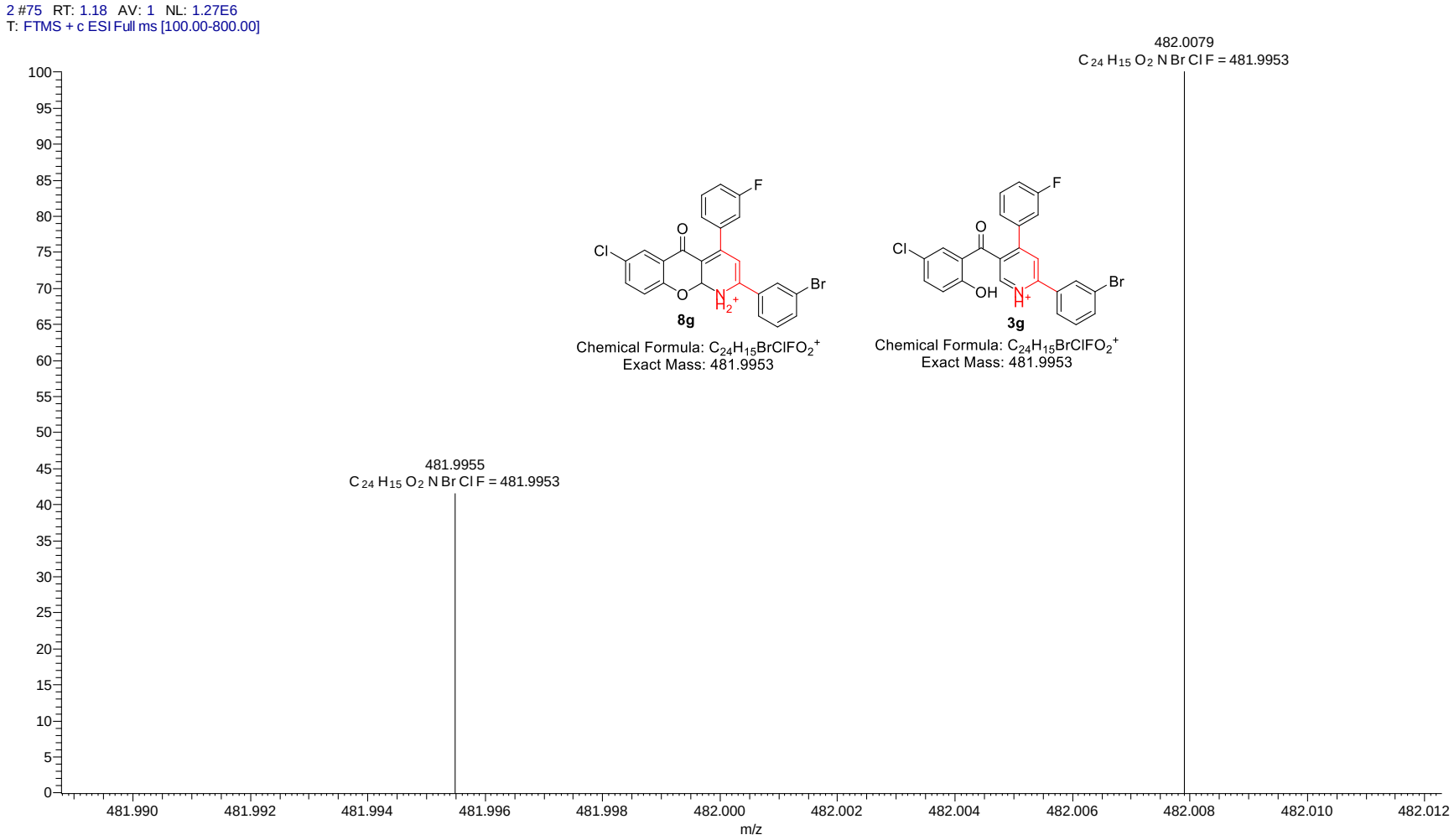


Figure S88. HRMS of intermediate **8g** or the target compound **3g**

References and Notes

1. Miao, C.-B.; Qiang, X.-Q.; Xu, X.; Song, X.-Q.; Zhou, S.-Q.; Lu, X.; Yang, H.-T. Synthesis of Stable N–H Imines with a Benzo[7,8]indolizine Core and Benzo[7,8]indolizino[1,2-c]quinolines via Copper-Catalyzed Annulation of *α,β*-Unsaturated O-Acyl Ketoximes with Isoquinolinium N-Ylides. *Org. Lett.* **2022,** *24*, 3828–3833.

2. CCDC 2260765 contains the supplementary crystallographic data for compounds **3a'**. These data can be obtained free of charge from The Cambridge Crystallographic Data Center *via* www.ccdc.cam.ac.uk/data_request/cif.