Electronic Supplementary Material (ESI) for Reaction Chemistry & Engineering.

Supplementary Information

Photochemical Organocatalytic Heteroarylation of Anilines and Secondary Alicyclic Amines in Continuous-Flow

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1. Materials and Methods

Commercially available reagents were purchased from Sigma-Aldrich, Alfa Aesar, Abcr, Acros Organics and used without further purification. Other substrates were prepared by using the reported procedures and purified through column chromatography respectively. The catalyst 3DPAFIPN was prepared according to a modified published procedure. Solvents were purified according to standard procedures. Acetonitrile was purified by distillation over phosphorus(V) oxide and stored under argon.

Analytical thin layer chromatography (TLC) was performed on aluminium plates coated with 0.20 mm silica gel 60 with fluorescent indicator UV_{254} (Macherey-Nagel). Visualization of developed plates was performed under UV light (254 nm, 365 nm) and/or Vanillin stains. Column chromatography was performed using Silica 60 (0.063-0.2 mm, Macherey-Nagel).

^{1}H NMR spectra were recorded at 400 MHz (Agilent DD2 400) in $CDCl_3$ (δ = 7.26 ppm) and $(CD_3)_2SO$ (δ = 2.50 ppm) and referenced internally to corresponding residual solvent signals. ^{13}C NMR spectra were recorded at 101 MHz, chemical shifts were reported in ppm on the δ scale relative to $CDCl_3$ (δ = 77.16). Coupling constants are reported in Hz with multiplicities denoted as s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet) and br (broad).

HPLC-MS analysis was performed using Agilent LC 1200 (HPLC) and Agilent 6230 TOF LC/MS (Mass Spectrometer) system. The ionization source is an electrospray (ESI) with an Agilent Jet Stream ion beam focused in positive ion mode. Chromatographic separation was performed using an Agilent Poroshell 120 EC-C18 column (4.6 × 50 mm, 2.7 µm). The mobile phase was a mixture of acetonitrile/water (70:30 v/v), isocratic mode, flow rate 1 mL/min, column temperature 30 °C, injected sample volume 0.1 µL.

Photochemical experiments were carried out with a homemade setup (Figure S1).

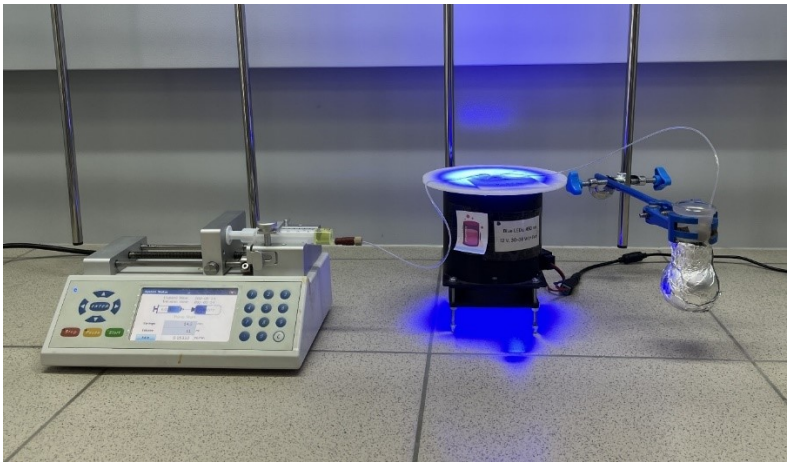


Figure S1. A homemade setup for photochemical reactions consisting of a syringe pump, a photoreactor and a flask for collecting of the product.

Syringe pumps were purchased from Chemix Inc., model Fusion 200 Touch. The photochemical reactor is typical[1] and consists of a blue diode strip 450 nm (120 diodes/meter SMD 5054 chip, 12 V, 82 klx, total electric power 30–36 W). The reactor supplied a powerful fan (FANOVER, FD9225S12M, 4.8 W, 3000 rpm). 3 m of LED strip were coiled in a 3D-printed (PLA) reactor with an inner diameter of 10 cm.

(*a*) 

(*b*) 

Figure S2. An inside of 3D-printed photoreactor with cooling fan in “off” (*a*) and “on” (*b*) states.

The temperature inside the reactor (Figure 3) is slightly higher (25.2 °C) than environment temperature (23.5°C).

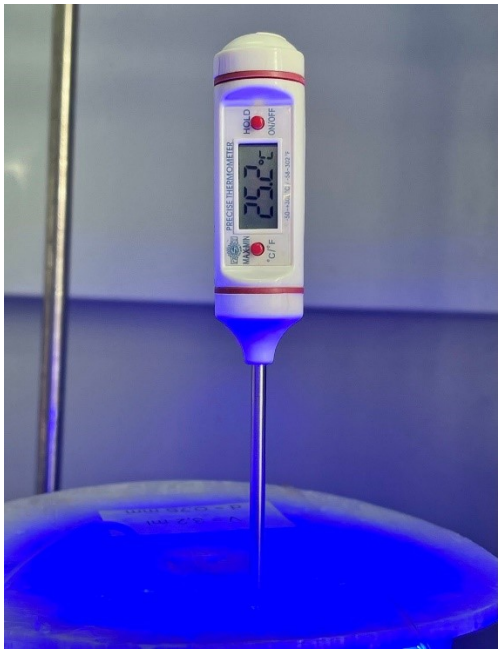


Figure S3. Temperature measurements inside the photoreactor.

PFA tubing (Inner Diameter (I.D.) = 0.75 mm or I.D. = 1.5 mm) coiled around 3D-printed reactor lid with cylinder (Figure S4). The distance between the light source and the tubes depends on the diameter of the cylinder, 25 mm for 0.75 mm I.D. tube reactor, and 10 mm for 1.5 mm I.D. tube reactor.

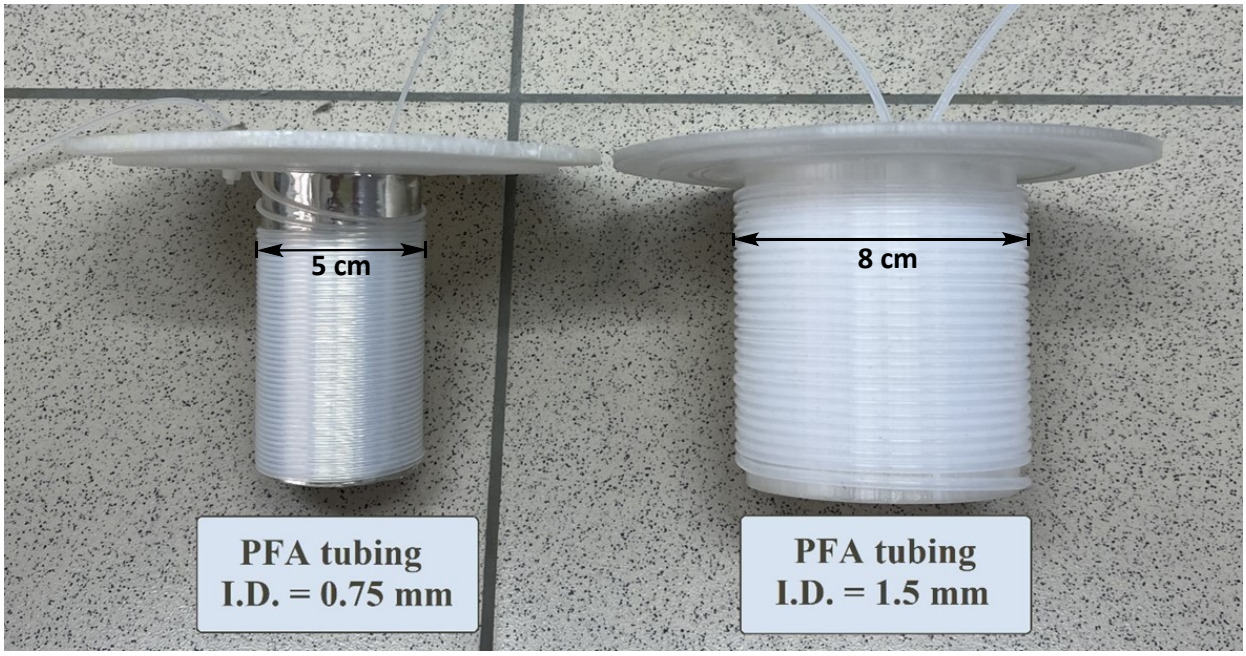


Figure S4. Flow microreactors made of perfluoroalkoxy alkanes (PFA) tubes.

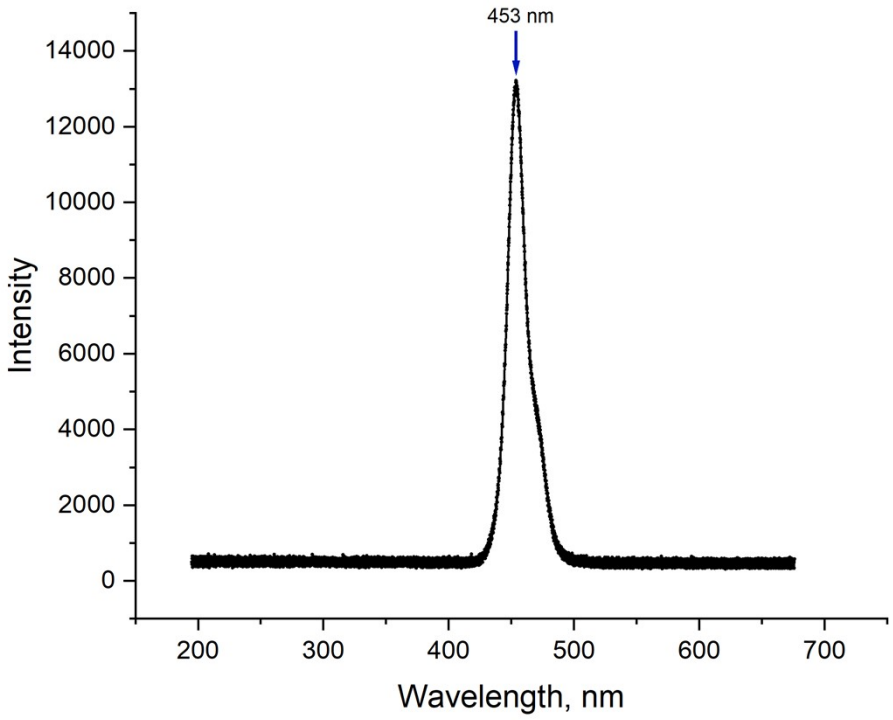
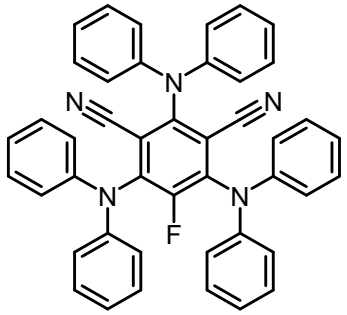


Figure S5. The emission spectrum of the blue LEDs strip (λ_{max}= 453 nm).

2. Experimental procedure for preparation of the photocatalyst and substrates

2.1 Preparation of the photocatalyst 3DPAFIPN

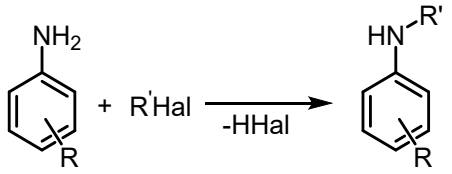
3DPAFIPN was synthesized according to the modified literature procedure.[2]



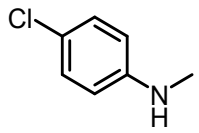
3DPAFIPN

Diphenylamine (845 mg, 5.0 mmol), NaH (600 mg, 60% in mineral oil, 15 mmol) were added into a dry Schlenk flask equipped with a magnetic stirring bar and then the atmosphere was changed to Ar. Then 20 mL of dry THF was added and the reaction mixture was stirred at 50 ℃ for 30 minutes. Finally, the flask was cooled to room temperature and tetrafluoroisophthalonitrile (200 mg, 1 mmol) was added. The resulting mixture was stirred at room temperature for 24 h. After the reaction was complete, 5 mL of water was carefully added dropwise to quench the excess NaH. After removal of THF, the residue was dissolved in DCM and washed with water. The organic phase was dried over Na_2SO_4 and the solvent was removed under reduced pressure. The crude product was purified by column chromatography (gradient from 5% to 50% DCM in petroleum ether) to give the corresponding product 3DPAFIPN (96%). The characterization data of 3DPAFIPN was the same as the reported.[2]

2.2 *N*-alkylation of anilines

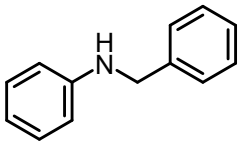


4-Chloro-*N*-methylaniline (27)



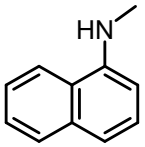
4-Chloroaniline (639 mg, 5 mmol) was dissolved in 5 mL of MeOH and then MeI (310 µL, 5 mmol) was added at room temperature. Then the reaction was stirred at 55 ℃ for 20 h. After that, a water solution of 10% NaOH was added. The mixture was extracted onto a separating funnel with cyclohexane. The organic layer was dried over Na_2SO_4 and the product was isolated by column chromatography (from *N*,*N*-dimethylanilines and starting reagents) using the gradient cyclohexane (100%) – EtOAc/cyclohexane (5:95), yield 49% (346 mg). The data matched that reported in the literature.[3]

***N*-Benzylaniline (27)**



Benzyl bromide (594 µL, 5 mmol) was added to a solution of aniline (912 µL, 10 mmol) in 15 mL of MeCN and then K_2CO_3 (1.38 g, 10 mmol) was added. The reaction was stirred for 48 h at room temperature. After that the suspension was filtered through a 10 mm pad of Celite®, the precipitate was washed with ethyl acetate. The product was isolated by column chromatography (from the double benzylation product and starting reagents) using the gradient petroleum ether (100%) – EtOAc/petroleum ether (5:95), yield 45% (411 mg). The data matched that reported in the literature.[4]

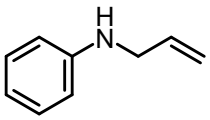
***N*-Methylnaphthalen-1-amine (28)**



The compound was synthesized according to the literary procedure.[5]

In a 100 mL round bottom flask, 1-aminonaphthalene (572 mg, 4 mmol) was dissolved in 10 mL dry acetonitrile. Then, methyl iodide (0.24 mL, 3.84 mmol, 0.96 equiv.) was added and the reaction mixture was stirred for 5 minutes at room temperature. Then, it was refluxed at 90 °C (oil bath) for 1 h. After completion of the reaction, the reaction mixture was cooled down to room temperature and neutralized to pH 7 with saturated $NaHCO_3$ solution. The mixture was extracted with dichloromethane and the combined organic layers were dried over anhydrous Na_2SO_4, filtered, and concentrated under reduced pressure. The product was purified by column chromatography with eluent EtOAc/petroleum ether (10:90) yield determined as 11% (69 mg). The data matched that reported in the literature.[5]

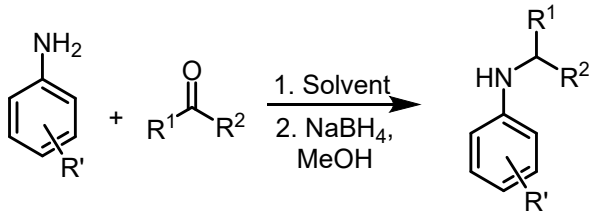
***N*-Allylaniline (29)**



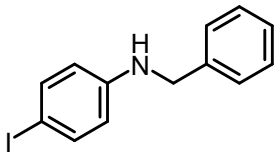
The compound was synthesized according to the literary procedure.[6]

A mixture of aniline (0.55 mL, 6.00 mmol) and allyl bromide (0.58 mL, 6.60 mmol) was refluxed overnight in dry DMF (20 mL) in the presence of K_2CO_3 (0.83 g, 6.00 mmol). The reaction mixture was then cooled to room temperature and filtered. The solvent was evaporated under reduced pressure. The product was purified by column chromatography with eluent EtOAc/petroleum ether (5:95), yield 60% (479 mg). The data matched that reported in the literature.[6]

2.3 Reductive amination

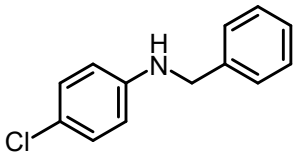


***N*-Benzyl-4-iodoaniline (30)**



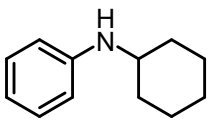
In a round bottom Schlenk flask with a magnetic stirring bar, 4-iodoaniline (657 mg, 3 mmol) was dissolved in 30 mL of anhydrous MeOH (under argon). Then 336 µL of benzaldehyde (350 mg, 3.3 mmol) was added to the mixture and stirred for 32 h at a room temperature without reducing agent. After that, $NaBH_4$ (114 mg, 3 mmol) was added and the reaction was stirred overnight. The reaction was quenched with a saturated solution of $NaHSO_3$, product was extracted with EtOAc, and organic layers were dried over Na_2SO_4. The product was purified by column chromatography with eluent EtOAC/cyclohexane (2:98). Upon cooling to ambient temperature, it crystallized yielding 525 mg (57%). The data matched that reported in the literature.[7]

***N*-Benzyl-4-chloroaniline (31)**



In a Schlenk flask with a magnetic stirring bar, 4-chloroaniline (150 mg, 1.18 mmol) was dissolved in 15 mL of anhydrous MeOH (under argon) and then benzaldehyde (125 µL, 1.22 mmol) was added. After 48 h of stirring at room temperature $NaBH_4$ (76 mg, 2 mmol) was added. After 2 h of stirring, reaction was quenched with a saturated solution of $NaHSO_3$, product was extracted with EtOAc, and organic layers were dried over Na_2SO_4. The product was purified by column chromatography with eluent EtOAc/cyclohexane (10:90), yield 156 mg (61%). The data matched that reported in the literature.[7]

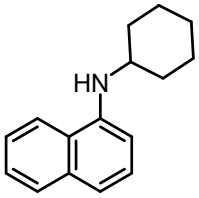
***N*-Cyclohexylaniline (32)**



Aniline (1.82 mL, 20 mmol), cyclohexanone (2.06 mL, 20 mmol) and *p*-toluenesulfonic acid monohydrate (115 mg, 0.6 mmol) were dissolved in 50 mL of toluene. The solution was boiled at 130 ℃ (oil bath) for 4 h, then cooled to ambient temperature. After that, $NaBH_4$ (760 mg, 20 mmol) and MeOH (10 mL) were added.

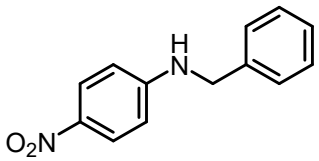
After 2 h, more MeOH (10 mL) was added. After 6 h, the reaction was quenched with a saturated solution of $NaHSO_3$, product was extracted with EtOAc, and organic layers were dried over Na_2SO_4. The product was purified by column chromatography with eluent EtOAC/cyclohexane (3:97), yield 430 mg (12%). The data matched that reported in the literature.[8]

_N_-Cyclohexylnaphthalen-1-amine (33)



1-Naphthylamine (1.5 g, 10.5 mmol), cyclohexanone (1.03 mL, 10 mmol) and *p*-toluenesulfonic acid monohydrate (57 mg, 0.3 mmol) were dissolved in 30 mL of distilled toluene. The solution was boiled at 130 ℃ (oil bath) for 4 h, then cooled to room temperature. $NaBH_4$ (380 mg, 10 mmol) was added and stirred for 2 h. After that, reaction was quenched with a saturated solution of $NaHSO_3$, product was extracted with EtOAc, and organic layers were dried over Na_2SO_4. The product was purified by column chromatography with gradient eluent EtOAc/cyclohexane (from 1% EtOAc to 10%), yield 190 mg (8%). The data matched that reported in the literature.[9]

_N_-Benzyl-4-nitroaniline (34)



4-Nitroaniline (138 mg, 1 mmol) and *p*-toluenesulfonic acid monohydrate (19 mg, 0.1 mmol) were dissolved in 5 mL of anhydrous THF, then benzaldehyde (100 µL, 1 mmol) was added. After 60 minutes of stirring at room temperature, $NaBH_4$ (38 mg, 1 mmol) was added and mixture was heated at 70 °C for 3 days. The reaction then was quenched with a saturated solution of $NaHSO_3$, product was extracted with EtOAc, and organic layers were dried over Na_2SO_4. The product was purified by column chromatography with gradient eluent EtOAc/cyclohexane (33:67), yield 102 mg (45%). The data matched that reported in the literature.[10]

3. General procedure for photochemical heteroarylation

General procedure for continuous-flow synthesis

A Schlenk flask equipped with a magnetic stirring bar and a rubber septum was charged with carbonitrile (0.8 mmol, 1 equiv.), 3DPAFIPN (6.2 mg, 9.6 µmol, 1.2 mol%), DABCO (89.6 mg, 0.8 mmol, 1 equiv.) and flushed with argon. Next, 12 mL of dry acetonitrile was added under argon, and finally the required amine (0.8 mmol, 1 equiv.) was added. The mixture was stirred until it became homogeneous. The solution was loaded into a 10 mL plastic syringe (BD Discardit). The syringe was then fitted to a syringe pump and connected to a 3.2 mL PFA microreactor coil (internal diameter of 750 µm) *via* Luer adapter, previously flushed with dry acetonitrile. The flowrate (mL/min) was set to obtain a residence time 60 minutes. After the photoirradiation zone, the reaction mixture was collected in a flask. When the syringe was fully empty, again dry acetonitrile was loaded into a syringe and injected to collect all in a round bottom flask. An isolated yield was obtained after purification by column chromatography.

Gram-scale synthesis of *N*-methyl-*N*-phenylpyridin-4-amine (3) in flow

A 250 mL Schlenk flask equipped with a magnetic stirring bar and a rubber septum was charged with 4-pyridinecarbonitrile (640 mg, 6.15 mmol, 1 equiv.), 3DPAFIPN (10 mg, 15.38 µmol, 0.25 mol%), DABCO (690 mg, 6.15 mmol, 1 equiv.) and flushed with argon. Next, 85 mL of dry acetonitrile was added under argon, and finally *N*-methylaniline (0.67 mL, 6.15 mmol, 1 equiv.) was added. The mixture was stirred until it became homogeneous. The solution was loaded into a 50 mL plastic syringe. The syringe was then fitted to a syringe pump and connected to a 11 mL PFA microreactor coil (I.D. = 1.50 mm) *via* Luer adapter, previously flushed with dry acetonitrile. The flowrate was set to 0.18333 mL/min to obtain a residence time 60 min. After the photoirradiation zone (blue LEDs 450 nm), the reaction mixture was collected in a 250 mL flask. When the first syringe was completely emptied, the rest of reaction mixture was loaded into the second syringe and reconnected to the flow reactor. After 7.7 h, 15 mL of dry acetonitrile was loaded into a syringe and injected (0.18333 mL/min) to collect all product at the end of the reactor in a round bottom flask. When reaction was finished, the resulting mixture was purified by chromatography on silica gel to get the 1.05 g of *N*-methyl-*N*-phenylpyridin-4-amine (3) with 93% yield, corresponding to a productivity of 5.7 mmol in almost 8 hours.

Figure S6. Product of photochemical gram-scale synthesis.

Gram-scale synthesis of *N*-methyl-*N*-phenylpyridin-4-amine (3) in batch (flask) using 0.25 mol% of photocatalyst

A 100 mL Schlenk flask equipped with a magnetic stirring bar and a rubber septum was charged with 4-pyridinecarbonitrile (640 mg, 6.15 mmol, 1 equiv.), 3DPAFIPN (10 mg, 15.4 µmol, 0.25 mol%), DABCO (690 mg, 6.15 mmol, 1 equiv.) and flushed with argon. Next, 85 mL of dry acetonitrile was added under argon, and finally *N*-methylaniline (0.67 mL, 6.15 mmol, 1 equiv.) was added. The rubber septum was replaced with a glass stopper. The mixture was stirred until it became homogeneous. The reaction flask was placed in the photoreactor zone (blue LEDs, λ = 450 nm) and covered with a lid sealed at the bottom with reflective aluminum foil. The reaction mixture was stirred for a total of 24 hours, after which the resulting mixture was purified by silica gel chromatography to obtain of *N*-methyl-*N*-phenylpyridin-4-amine (3) in 54% yield (616 mg).

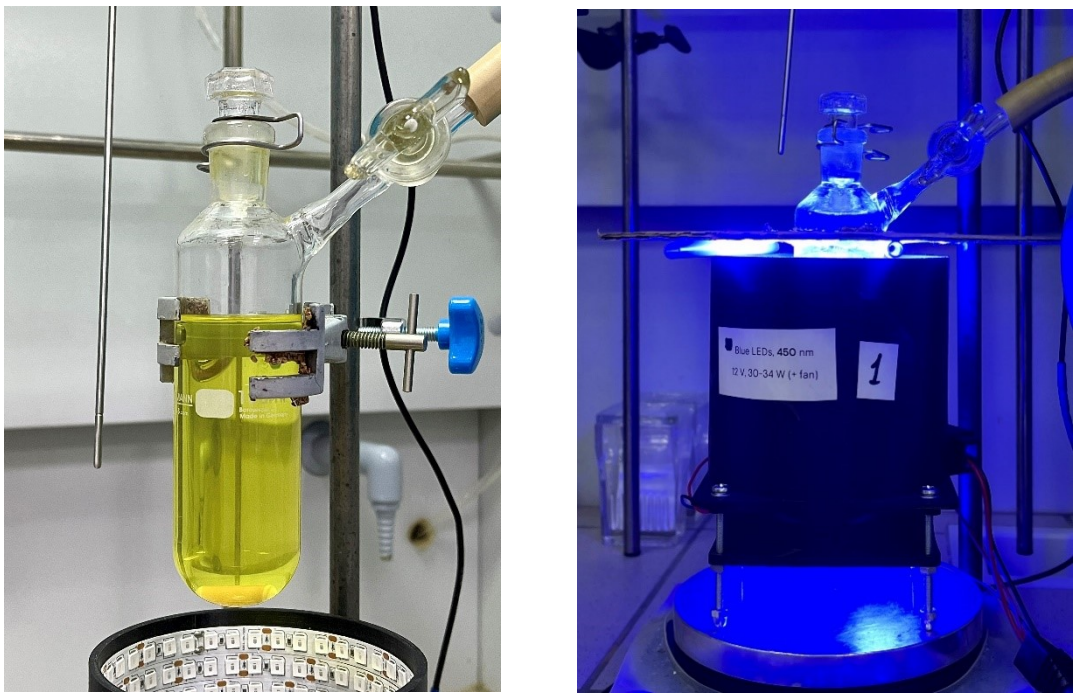


Figure S7. Synthesis of *N*-methyl-*N*-phenylpyridin-4-amine in batch (100 mL flask).

Synthesis of *N*-methyl-*N*-phenylpyridin-4-amine (3) in vial using 0.25% of photocatalyst

A 7.5 mL Pyrex tube (No. 99447) equipped with a magnetic stir bar was charged with 4-pyridinecarbonitrile (20.8 mg, 0.2 mmol), DABCO (22.4 mg, 0.2 mmol). Next, 3 mL of a previously prepared solution of 3DPAFIPN (c = 0.16 mmol/L) in dry acetonitrile was added. And finally, *N*-methylaniline (21.7 µL, 0.2 mmol) was added. A stream of argon was bubbled through the reaction mixture for 1 minute in an ultrasonic bath. The reaction vial was placed in the photoreactor zone (blue LEDs, λ = 450 nm) and covered with a lid sealed at the bottom with reflective aluminum foil. The reaction mixture was stirred for 5 hours at room temperature. When reaction was finished, the residue was purified by chromatography on silica gel to get isolated product in 90% yield (33 mg).

Figure S8. Synthesis of *N*-methyl-*N*-phenylpyridin-4-amine in vial.

4. Green metrics

The adopted green metrics have been calculated employing the following equations[11–13]

$$\%\ Yield\ = \frac{Actual\ (isolated)\ yield}{Theoretical\ yield} \times 100\%$$

$$\%\ AE\ (Atom\ Economy) = \frac{MW\ of\ desired\ product}{MW\ of\ all\ reactants} \times 100\%$$

$$\frac{1}{SF\ (Stoichiometric\ Factor)} = \frac{1}{1 + \frac{Total\ mass\ of\ excess\ reagents}{Total\ mass\ of\ stoichiometric\ reagents}} \times 100\%$$

$$STY\ (Space\ Time\ Yield)\ = \frac{mass\ of\ product}{reactor\ volume \times reaction\ time}$$

$$E\text{-}factor\ (Environmental\ Factor) = \frac{mass\ of\ total\ waste}{mass\ of\ product}$$

$$PMI\ (Process\ Mass\ Intensity) = \frac{total\ mass\ used\ in\ the\ process}{mass\ of\ isolated\ product} == \frac{mass\ of\ reactants\ +\ mass\ of\ reage}{mass\ of\ is}$$

$$RME\ (Reaction\ Mass\ Efficiency) = \frac{mass\ of\ product}{mass\ of\ reactants} \times 100\%$$

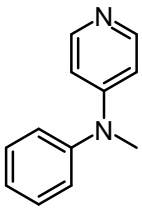
$$Productivity\ = \frac{mass\ of\ isolated\ product}{reaction\ time}$$

Table S1. Calculated green metrics

Parameter	Flow setup	Vial	*Gain/loss of flow vs vial*	Flask	*Gain/loss of flow vs flask*
Yield (%)	93	90	*3%*	54	*72%*
AE (%)	87	87	-	87	-
1/SF (%)	100	100	-	100	-
STY (g L^{-1} h^{-1})	11.93	0.88	*1265%*	0.2567	*4547%*
E-factor (-)	64.65	72.51	*-11%*	110.9	*-42%*
PMI (-)	65.65	73.51	*-11%*	111.9	*-41%*
RME (%)	81	78	*4%*	47	*72%*
Productivity (mg/h)	131.2	6.60	*1888%*	25.67	*411%*

5. Characterization of photochemical heteroarylation products

N-Methyl-*N*-phenylpyridin-4-amine (3)



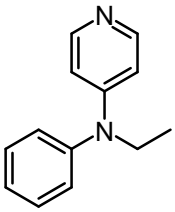
The compound was prepared according to the **General procedure for continuous-flow photochemical heteroarylation** using 4-pyridinecarbonitrile (83.2 mg, 0.8 mmol, 1 equiv.), DABCO (89.7 mg, 0.8 mmol, 1 equiv.), 3DPAFIPN (6.2 mg, 9.6 µmol, 1.2 mol%), MeCN (12 mL) and *N*-methylaniline (87 µL, 0.8 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (50:50) for purification from starting reagents and then with an eluent EtOAc/MeOH/Et_3N (90:9:1) to isolate the desire product. The compound was isolated as a brown solid (138 mg, 94%).

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.15 (dd, *J* = 5.0, 1.5 Hz, 2H), 7.43 – 7.33 (m, 2H), 7.25 – 7.19 (m, 1H), 7.18 – 7.12 (m, 2H), 6.50 (dd, *J* = 5.0, 1.6 Hz, 2H), 3.26 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 154.00, 149.32, 146.05, 130.07, 126.71, 126.58, 108.30, 39.51.

The data matched that reported in the literature.[14]

N-Ethyl-*N*-phenylpyridin-4-amine (4)



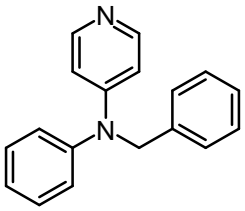
The compound was prepared according to the **General procedure for continuous-flow photochemical heteroarylation** using 4-pyridinecarbonitrile (83.2 mg, 0.8 mmol, 1 equiv.), DABCO (89.7 mg, 0.8 mmol, 1 equiv.), 3DPAFIPN (6.2 mg, 9.6 µmol, 1.2 mol%), MeCN (12 mL) and *N*-ethylaniline (101 µL, 0.8 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (50:50) for purification from starting reagents and then with an eluent EtOAc/MeOH/Et_3N (90:9:1) to isolate the desire product. The compound was isolated as a brown oil (121 mg, 76%).

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.13 (dd, *J* = 5.0, 1.6 Hz, 2H), 7.45 – 7.35 (m, 2H), 7.31 – 7.22 (m, 1H), 7.16 (ddd, *J* = 4.4, 3.4, 1.8 Hz, 2H), 6.44 (dd, *J* = 5.0, 1.6 Hz, 2H), 3.71 (q, *J* = 7.1 Hz, 2H), 1.20 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 153.18, 149.46, 144.53, 130.14, 127.86, 126.85, 108.18, 46.19, 12.24.

The data matched that reported in the literature.[15]

***N*-Benzyl-*N*-phenylpyridin-4-amine (5)**



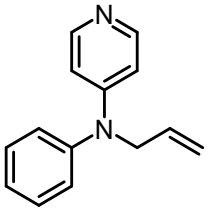
The compound was prepared according to the **General procedure for continuous-flow photochemical heteroarylation** using 4-pyridinecarbonitrile (83.2 mg, 0.8 mmol, 1 equiv.), DABCO (89.7 mg, 0.8 mmol, 1 equiv.), 3DPAFIPN (6.2 mg, 9.6 µmol, 1.2 mol%), MeCN (12 mL) and *N*-benzylaniline (138 µL, 0.8 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (50:50) for purification from starting reagents and then with an eluent EtOAc/MeOH/Et_3N (90:9:1) to isolate the desire product. The compound was isolated as a brown oil (183 mg, 88%).

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.15 (d, *J* = 6.5 Hz, 2H), 7.48 – 7.38 (m, 2H), 7.38 – 7.21 (m, 8H), 6.58 (dd, *J* = 5.2, 1.3 Hz, 2H), 4.97 (s, 2H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 153.94, 148.90, 145.26, 137.10, 130.26, 128.94, 127.49, 127.00, 126.92, 126.54, 108.94, 56.09.

The data matched that reported in the literature.[16]

***N*-Allyl-*N*-phenylpyridin-4-amine (6)**



The compound was prepared according to the **General procedure for continuous-flow photochemical heteroarylation** using 4-pyridinecarbonitrile (83.2 mg, 0.8 mmol, 1 equiv.), DABCO (89.7 mg, 0.8 mmol, 1 equiv.), 3DPAFIPN (6.2 mg, 9.6 µmol, 1.2 mol%), MeCN (12 mL) and *N*-allylaniline (109 µL, 0.8 mmol). Column chromatography was carried out with an eluent EtOAc/petroleum ether (50:50) for purification from starting reagents and then with an eluent EtOAc/MeOH/Et_3N (90:9:1) to isolate the desire product. The compound was isolated as a brown oil (128 mg, 76%).

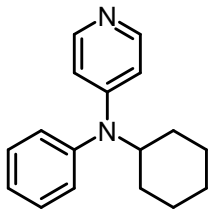
New compound.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.15 (dd, *J* = 5.0, 1.6 Hz, 2H), 7.45 – 7.38 (m, 2H), 7.27 (tt, *J* = 7.4, 1.4 Hz, 1H), 7.21 (m, 2H), 6.52 (dd, *J* = 5.0, 1.6 Hz, 2H), 5.96 – 5.82 (m, 1H), 5.28 – 5.19 (m, 2H), 4.31 (dt, *J* = 4.9, 1.8 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 153.37, 149.05, 144.94, 132.24, 130.04, 127.09, 126.73, 117.27, 108.59, 54.44.

ESI-MS: Calcd.for $C_{14}H_{14}N_2$ $[M+H]^+$: 211.1235; found: 211.1239.

***N*-Cyclohexyl-*N*-phenylpyridin-4-amine (7)**



The compound was prepared according to the **General procedure for continuous-flow photochemical heteroarylation** using 4-pyridinecarbonitrile (83.2 mg, 0.8 mmol, 1 equiv.), DABCO (89.7 mg, 0.8 mmol, 1 equiv.), 3DPAFIPN (6.2 mg, 9.6 µmol, 1.2 mol%), MeCN (12 mL) and *N*-cyclohexylaniline (141 µL, 0.8 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (50:50) for purification from starting reagents and then with an eluent EtOAc/MeOH/Et_3N (90:9:1) to isolate the desire product. The compound was isolated as a brown oil (65 mg, 32%).

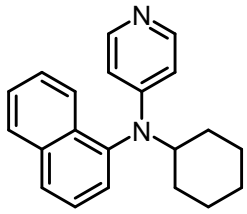
New compound.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.08 (dd, *J* = 5.3, 1.4 Hz, 2H), 7.47 – 7.40 (m, 2H), 7.40 – 7.33 (m, 1H), 7.11 – 7.04 (m, 2H), 6.28 (dd, *J* = 5.2, 1.5 Hz, 2H), 3.88 – 3.76 (m, 1H), 1.96 (d, *J* = 11.7 Hz, 2H), 1.78 (d, *J* = 14.3 Hz, 2H), 1.62 (d, *J* = 13.2 Hz, 1H), 1.43 – 1.31 (m, 2H), 1.15 – 1.05 (m, 2H), 1.04 – 0.92 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 153.96, 149.10, 140.58, 131.13, 129.88, 127.90, 107.83, 56.75, 31.50, 25.95, 25.49.

ESI-MS: Calcd.for $C_{17}H_{20}N_2$ $[M+H]^+$: 253.1705; found: 253.1724.

***N*-Cyclohexyl-*N*-(naphthalen-1-yl)pyridin-4-amine (8)**



The compound was prepared according to the **General procedure for continuous-flow photochemical heteroarylation** using 4-pyridinecarbonitrile (83.2 mg, 0.8 mmol, 1 equiv.), DABCO (89.7 mg, 0.8 mmol, 1 equiv.), 3DPAFIPN (6.2 mg, 9.6 µmol, 1.2 mol%), MeCN (12 mL) and *N*-cyclohexylnaphthalen-1-amine (185 µL, 0.8 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (50:50) for purification from starting reagents and then with an eluent EtOAc/MeOH/Et_3N (90:9:1) to isolate the desire product. The compound was isolated as a brown solid (109 mg, 45%).

New compound.

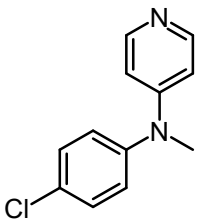
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.07 (d, *J* = 6.3 Hz, 2H), 7.93 (d, *J* = 8.3 Hz, 2H), 7.68 (d, *J* = 8.4 Hz, 1H), 7.58 – 7.48 (m, 1H), 7.44 (ddd, *J* = 8.1, 6.8, 1.2 Hz, 1H), 7.30 (dd, *J* = 7.2, 0.9 Hz, 1H), 6.30 (d, *J* = 5.8 Hz, 1H), 4.08 (ddd, *J* = 11.3, 8.0, 3.9 Hz, 1H), 2.27 (d, *J* = 9.2 Hz, 1H), 1.85 (t, *J* = 13.5 Hz, 2H), 1.64 (t, *J* = 12.3 Hz, 1H), 1.51 – 1.20 (m, 3H), 1.07 – 0.82 (m, 2H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 154.22, 148.44, 137.24, 135.00, 132.48, 128.76, 128.64, 128.11, 126.97, 126.62, 126.13, 124.03, 107.99, 58.13, 31.22, 30.95, 26.05, 25.83, 25.53. The cyclohexyl

fragment gives 6 different peaks in the carbon spectrum, apparently due to the hindered spatial rotation around the C-N bond.

ESI-MS: Calcd.for $C_{21}H_{22}N_2$ $[M+H]^+$: 303.1861; found: 303.1885.

***N*-(4-Chlorophenyl)-*N*-methylpyridin-4-amine (9)**



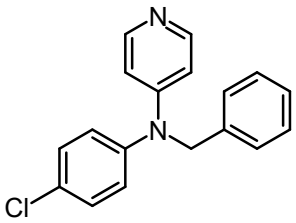
The compound was prepared according to the **General procedure for continuous-flow photochemical heteroarylation** using 4-pyridinecarbonitrile (83.2 mg, 0.8 mmol, 1 equiv.), DABCO (89.7 mg, 0.8 mmol, 1 equiv.), 3DPAFIPN (6.2 mg, 9.6 µmol, 1.2 mol%), MeCN (12 mL) and 4-chloro-*N*-methylaniline (97 µL, 0.8 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (50:50) for purification from starting reagents and then with an eluent EtOAc/MeOH/Et_3N (90:9:1) to isolate the desire product. Product was isolated as a brown oil (150 mg, 86%).

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.17 (dd, *J* = 5.1, 1.5 Hz, 2H), 7.41 – 7.30 (m, 2H), 7.17 – 7.06 (m, 2H), 6.51 (dd, *J* = 5.0, 1.5 Hz, 2H), 3.26 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 153.62, 149.57, 144.58, 131.75, 130.14, 127.90, 108.46, 39.42.

The data matched that reported in the literature.[17]

***N*-Benzyl-*N*-(4-chlorophenyl)pyridin-4-amine (10)**



The compound was prepared according to the **General procedure for continuous-flow photochemical heteroarylation** using 4-pyridinecarbonitrile (83.2 mg, 0.8 mmol, 1 equiv.), DABCO (89.7 mg, 0.8 mmol, 1 equiv.), 3DPAFIPN (6.2 mg, 9.6 µmol, 1.2 mol%), MeCN (12 mL) and *N*-benzyl-4-chloroaniline (174 mg, 0.8 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (50:50) for purification from starting reagents and then with an eluent EtOAc/MeOH/Et_3N (90:9:1) to isolate the desire product. The compound was isolated as a brown oil (146 mg, 62%).

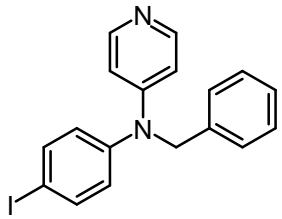
New compound.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.18 (d, *J* = 6.5 Hz, 2H), 7.43 – 7.17 (m, 9H), 6.58 (dd, *J* = 5.1, 1.5 Hz, 2H), 4.94 (s, 2H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 153.52, 149.50, 143.82, 136.88, 132.12, 130.36, 128.98, 128.23, 127.59, 126.53, 109.11, 55.90.

ESI-MS: Calcd.for $C_{18}H_{15}ClN_2$ $[M+H]^+$: 295.1002; found: 295.1005.

_N_-Benzyl-_N_-(4-iodophenyl)pyridin-4-amine (11)



The compound was prepared according to the **General procedure for continuous-flow photochemical heteroarylation** using 4-pyridinecarbonitrile (83.2 mg, 0.8 mmol, 1 equiv.), DABCO (89.7 mg, 0.8 mmol, 1 equiv.), 3DPAFIPN (6.2 mg, 9.6 µmol, 1.2 mol%), MeCN (12 mL) and _N_-benzyl-4-iodoaniline (242 mg, 0.8 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (50:50) for purification from starting reagents and then with an eluent EtOAc/MeOH/Et_3N (90:9:1) to isolate the desire product. The compound was isolated as a brown solid (130 mg, 42%).

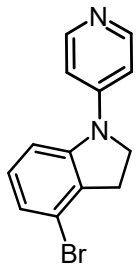
New compound.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.18 (d, _J_ = 5.3 Hz, 2H), 7.71 (d, _J_ = 8.6 Hz, 2H), 7.37 – 7.29 (m, 2H), 7.29 – 7.20 (m, 3H), 7.04 (d, _J_ = 8.6 Hz, 2H), 6.60 (d, _J_ = 5.6 Hz, 2H), 4.94 (s, 2H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 153.30, 149.51, 145.07, 139.26, 136.85, 128.96, 128.58, 127.56, 126.46, 109.33, 90.81, 55.76.

ESI-MS: Calcd.for $C_{18}H_{15}IN_2$ $[M+H]^+$: 387.0358; found: 387.0443.

4-Bromo-1-(pyridin-4-yl)indoline (12)



The compound was prepared according to the **General procedure for continuous-flow photochemical heteroarylation** using 4-pyridinecarbonitrile (83.2 mg, 0.8 mmol, 1 equiv.), DABCO (89.7 mg, 0.8 mmol, 1 equiv.), 3DPAFIPN (6.2 mg, 9.6 µmol, 1.2 mol%), MeCN (12 mL) and 4-bromoindoline (106 µL, 0.8 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (50:50) for purification from starting reagents and then with an eluent EtOAc/MeOH/Et_3N (90:9:1) to isolate the desire product. The compound was isolated as an orange solid (152 mg, 69%).

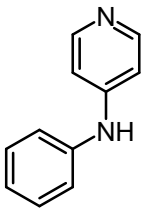
New compound.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.40 (d, _J_ = 5.9 Hz, 2H), 7.24 – 7.18 (m, 1H), 7.01 (d, _J_ = 4.4 Hz, 4H), 4.00 (t, _J_ = 8.5 Hz, 2H), 3.15 (t, _J_ = 8.5 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 150.10, 149.48, 145.44, 132.73, 128.97, 124.10, 120.44, 110.41, 109.30, 50.49, 29.34.

ESI-MS: Calcd.for $C_{13}H_{12}BrN_2$ $[M+H]^+$: 275.0184; found: 275.0234.

_N_-Phenylpyridin-4-amine (13)

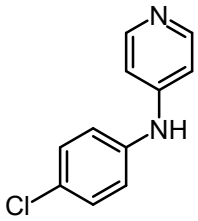


The compound was prepared according to the modified **General procedure for continuous-flow photochemical heteroarylation** using 4-pyridinecarbonitrile (83.2 mg, 0.8 mmol, 1 equiv.), DABCO (89.7 mg, 0.8 mmol, 1 equiv.), 3DPAFIPN (10.4 mg, 16 µmol, 2 mol%), MeCN (12 mL) and aniline (110 µL, 1.2 mmol, 1.5 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (50:50) for purification from starting reagents and then with an eluent EtOAc/MeOH/Et_3N (90:9:1) to isolate the desire product. The compound was isolated as a yellow solid (11 mg, 8%).

^{1}H NMR (400 MHz, DMSO-d_6): δ 8.90 (br s, 1H), 8.18 (dd, *J* = 5.0, 1.4 Hz, 2H), 7.38 – 7.32 (m, 2H), 7.24 – 7.16 (m, 2H), 7.04 (tt, *J* = 7.6, 1.1 Hz, 1H), 6.90 (d, *J* = 4.86, 2H).

The data matched that reported in the literature.[16]

_N_-Phenylpyridin-4-amine (14)

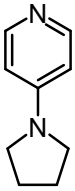


The compound was prepared according to the modified **General procedure for continuous-flow photochemical heteroarylation** using 4-pyridinecarbonitrile (83.2 mg, 0.8 mmol, 1 equiv.), DABCO (89.7 mg, 0.8 mmol, 1 equiv.), 3DPAFIPN (10.4 mg, 16 µmol, 2 mol%), MeCN (12 mL) and 4-chloroaniline (153 mg, 1.2 mmol, 1.5 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (50:50) for purification from starting reagents and then with an eluent EtOAc/MeOH/Et_3N (90:9:1) to isolate the desire product. The compound was isolated as a yellow solid (crystals) (8 mg, 5%).

^{1}H NMR (400 MHz, $CDCl_3$): δ 9.65 (br s, 1H), 8.04 (d, *J* = 5.7 Hz, 2H), 7.34 (d, *J* = 8.7 Hz, 2H), 7.22 (d, *J* = 8.7 Hz, 2H), 7.14 (d, *J* = 6.3 Hz, 2H).

The data matched that reported in the literature.[16]

4-Pyrrolidinopyridine (15)



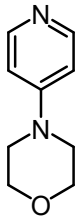
The compound was prepared according to the **General procedure for continuous-flow photochemical heteroarylation** using 4-pyridinecarbonitrile (83.2 mg, 0.8 mmol, 1 equiv.), DABCO (89.7 mg, 0.8 mmol, 1 equiv.), 3DPAFIPN (6.2 mg, 9.6 µmol, 1.2 mol%), MeCN (12 mL) and pyrrolidine (103 µL, 0.8 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (50:50) for purification from starting reagents and then with an eluent EtOAc/MeOH/Et_3N (90:9:1) to isolate the desire product. The compound was isolated as a yellow solid (crystals) (29 mg, 24%).

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.14 (dd, *J* = 4.9, 1.6 Hz, 2H), 6.32 (dd, *J* = 4.9, 1.6 Hz, 2H), 3.34 – 3.15 (m, 4H), 2.09 – 1.87 (m, 4H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 151.72, 149.48, 106.93, 46.91, 25.33.

The data matched that reported in the literature.[16]

4-(Pyridin-4-yl)morpholine (16)

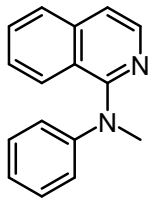


The compound was prepared according to the modified **General procedure for continuous-flow photochemical heteroarylation** using 4-pyridinecarbonitrile (83.2 mg, 0.8 mmol, 1 equiv.), DABCO (89.7 mg, 0.8 mmol, 1 equiv.), 3DPAFIPN (6.2 mg, 9.6 µmol, 1.2 mol%), MeCN (12 mL) and morpholine (303 µL, 2.4 mmol, 3 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (50:50) for purification from starting reagents and then with an eluent EtOAc/MeOH/Et_3N (90:9:1) to isolate the desire product. Product was isolated as a white solid (crystals) (5 mg, 5%).

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.29 (dd, *J* = 5.0, 1.5 Hz, 2H), 6.66 (dd, *J* = 5.0, 1.6 Hz, 2H), 3.86 – 3.81 (m, 4H), 3.31 – 3.27 (m, 4H).

The data matched that reported in the literature.[16]

***N*-Methyl-*N*-phenylisoquinolin-1-amine (17)**

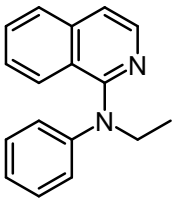


The compound was prepared according to the **General procedure for continuous-flow photochemical heteroarylation** using isoquinoline-1-carbonitrile (61.6 mg, 0.4 mmol, 1 equiv.), DABCO (44.8 mg, 0.4 mmol, 1 equiv.), 3DPAFIPN (3.1 mg, 4.8 µmol, 1.2 mol%), MeCN (6 mL) and *N*-methylaniline (43.5 µL, 0.4 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (2:98). The product was isolated as a white solid (79 mg, 84%).

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.29 (d, *J* = 5.8 Hz, 1H), 7.74 (d, *J* = 8.2 Hz, 1H), 7.66 (d, *J* = 8.6 Hz, 1H), 7.58 – 7.49 (m, 1H), 7.34 (d, *J* = 5.8 Hz, 1H), 7.30 – 7.20 (m, 3H), 7.01 (t, *J* = 7.4 Hz, 1H), 6.94 (d, *J* = 7.7 Hz, 2H), 3.64 (s, 3H).

The data matched that reported in the literature.[14]

_N_-Ethyl-_N_-phenylisoquinolin-1-amine (18)

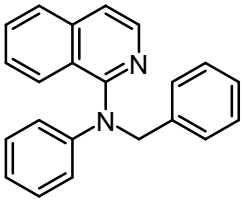


The compound was prepared according to the **General procedure for continuous-flow photochemical heteroarylation** using isoquinoline-1-carbonitrile (61.6 mg, 0.4 mmol, 1 equiv.), DABCO (44.8 mg, 0.4 mmol, 1 equiv.), 3DPAFIPN (3.1 mg, 4.8 µmol, 1.2 mol%), MeCN (6 mL) and *N*-ethylaniline (51 µL, 0.4 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (2:98). The product was isolated as a white solid (71 mg, 71%).

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.30 (d, *J* = 5.8 Hz, 1H), 7.72 (d, *J* = 8.2 Hz, 1H), 7.67 (d, *J* = 8.6 Hz, 1H), 7.51 (ddd, *J* = 8.1, 6.9, 1.1 Hz, 1H), 7.26 – 7.19 (m, 3H), 6.97 (t, *J* = 7.4 Hz, 1H), 6.90 (dt, *J* = 8.8, 1.7 Hz, 2H), 4.20 (q, *J* = 7.0 Hz, 2H), 1.35 (t, *J* = 7.0 Hz, 3H).

The data matched that reported in the literature.[14]

N-Benzyl-N-phenylisoquinolin-1-amine (19)

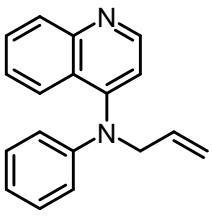


The compound was prepared according to the **General procedure for continuous-flow photochemical heteroarylation** using isoquinoline-1-carbonitrile (61.6 mg, 0.4 mmol, 1 equiv.), DABCO (44.8 mg, 0.4 mmol, 1 equiv.), 3DPAFIPN (3.1 mg, 4.8 µmol, 1.2 mol%), MeCN (6 mL) and *N*-benzylaniline (70 mg, 0.4 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (5:95). The product was isolated as a white solid (77 mg, 62%).

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.32 (d, *J* = 5.7 Hz, 1H), 7.90 – 7.85 (m, 1H), 7.77 (d, *J* = 8.2 Hz, 1H), 7.56 (ddd, *J* = 8.2, 6.9, 1.2 Hz, 1H), 7.54 – 7.50 (m, 2H), 7.37 (d, *J* = 5.8 Hz, 1H), 7.35 – 7.28 (m, 4H), 7.25 – 7.16 (m, 3H), 7.00 – 6.95 (m, 1H), 6.94 – 6.90 (m, 2H), 5.51 (s, 2H).

The data matched that reported in the literature.[14]

_N_-Allyl-_N_-phenylisoquinolin-1-amine (20)



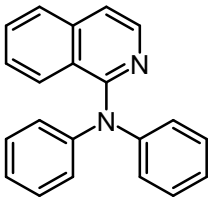
The compound was prepared according to the **General procedure for continuous-flow photochemical heteroarylation** using isoquinoline-1-carbonitrile (61.6 mg, 0.4 mmol, 1 equiv.), DABCO (44.8 mg, 0.4 mmol, 1 equiv.), 3DPAFIPN (3.1 mg, 4.8 µmol, 1.2 mol%), MeCN (6 mL) and *N*-allylaniline (54 µL, 0.4 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (2:98). The product was isolated as a white solid (48 mg, 46%).

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.27 (d, *J* = 5.9 Hz, 1H), 7.75 (d, *J* = 8.2 Hz, 1H), 7.68 (d, *J* = 8.6 Hz, 1H), 7.56 (t, *J* = 7.5 Hz, 1H), 7.35 (d, *J* = 5.9 Hz, 1H), 7.29 – 7.19 (m, 3H), 7.01 (t, *J* = 7.2 Hz, 1H),

6.93 (d, *J* = 7.9 Hz, 2H), 6.14 (ddt, *J* = 17.1, 10.3, 5.1 Hz, 1H), 5.38 – 5.30 (m, 1H), 5.17 – 5.11 (m, 1H), 4.88 (s, 2H).

The data matched that reported in the literature.[14]

_N,N_-Diphenylisoquinolin-1-amine (21)

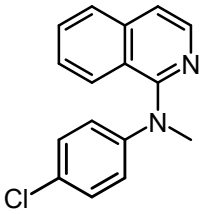


The compound was prepared according to the **General procedure for continuous-flow photochemical heteroarylation** using isoquinoline-1-carbonitrile (61.6 mg, 0.4 mmol, 1 equiv.), DABCO (44.8 mg, 0.4 mmol, 1 equiv.), 3DPAFIPN (3.1 mg, 4.8 µmol, 1.2 mol%), MeCN (6 mL) and diphenylamine (67.6 mg, 0.4 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (5:95). The product was isolated as a white solid (118 mg, 99%).

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.36 (d, *J* = 5.7 Hz, 1H), 7.96 (d, *J* = 8.5 Hz, 1H), 7.82 (d, *J* = 8.2 Hz, 1H), 7.64 – 7.56 (m, 1H), 7.49 (d, *J* = 5.7 Hz, 1H), 7.36 (ddd, *J* = 8.2, 7.0, 1.0 Hz, 1H), 7.30 – 7.24 (m, 4H), 7.10 – 7.04 (m, 6H).

The data matched that reported in the literature.[14]

_N_-(4-Chlorophenyl)-_N_-methylisoquinolin-1-amine (22)

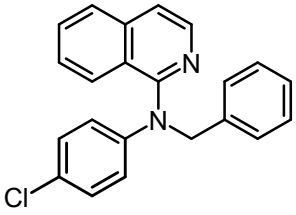


The compound was prepared according to the modified **General procedure for continuous-flow photochemical heteroarylation** using isoquinoline-1-carbonitrile (61.6 mg, 0.4 mmol, 1 equiv.), 3DPAFIPN (3.1 mg, 4.8 µmol, 1.2 mol%), MeCN (6 mL) and 4-chloro-*N*-methylaniline (49 µL, 0.4 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (10:90). The product was isolated as a yellow solid (56 mg, 52%).

^{1}H NMR (400 MHz, Chloroform-*d*): δ 8.30 (d, *J* = 5.8 Hz, 1H), 7.77 (d, *J* = 8.2 Hz, 1H), 7.69 (d, *J* = 8.6 Hz, 1H), 7.61 – 7.53 (m, 1H), 7.39 (dd, *J* = 5.8, 0.9 Hz, 1H), 7.33 (ddd, *J* = 8.3, 6.8, 1.3 Hz, 1H), 7.21 – 7.15 (m, 2H), 6.84 – 6.78 (m, 2H), 3.58 (s, 3H).

The data matched that reported in the literature.[14]

_N_-Benzyl-_N_-(4-chlorophenyl)naphthalen-1-amine (23)



The compound was prepared according to the modified **General procedure for continuous-flow photochemical heteroarylation** using isoquinoline-1-carbonitrile (61.6 mg, 0.4 mmol, 1 equiv.), 3DPAFIPN (3.1 mg, 4.8 µmol, 1.2 mol%), MeCN (6 mL) and 4-chloro-*N*-methylaniline (87

mg, 0.4 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (5:95). The product was isolated as a yellow solid (104 mg, 74%).

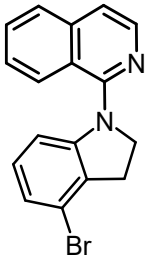
New compound.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.29 (d, *J* = 5.8 Hz, 1H), 7.85 – 7.74 (m, 2H), 7.67 – 7.56 (m, 1H), 7.45 (d, *J* = 7.4 Hz, 2H), 7.40 (d, *J* = 5.7 Hz, 1H), 7.36 (ddd, *J* = 8.3, 6.9, 1.2 Hz, 1H), 7.31 – 7.24 (m, 2H), 7.20 (t, *J* = 7.3 Hz, 1H), 7.14 – 7.07 (m, 2H), 6.81 – 6.74 (m, 2H), 5.44 (s, 2H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 156.68, 148.48, 140.38, 139.43, 138.81, 130.32, 129.32, 128.64, 127.45, 127.31, 127.08, 126.99, 126.68, 123.14, 122.12, 121.82, 117.82, 57.28.

ESI-MS: Calcd.for $C_{22}H_{17}ClN_2$ $[M+H]^+$: 345.1159; found: 345.1199.

1-(4-Bromoindolin-1-yl)isoquinoline (24)



The compound was prepared according to the modified **General procedure for continuous-flow photochemical heteroarylation** using isoquinoline-1-carbonitrile (61.6 mg, 0.4 mmol, 1 equiv.), 3DPAFIPN (3.1 mg, 4.8 µmol, 1.2 mol%), MeCN (6 mL) and 4-bromoindoline (53 µL, 0.4 mmol, 1 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (10:90). The product was isolated as an orange solid (100 mg, 77%).

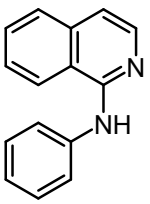
New compound.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.27 (d, *J* = 5.7 Hz, 1H), 8.04 (d, *J* = 8.5 Hz, 1H), 7.84 (d, *J* = 8.2 Hz, 1H), 7.69 (ddd, *J* = 8.1, 6.9, 1.1 Hz, 1H), 7.51 (ddd, *J* = 8.3, 6.9, 1.2 Hz, 1H), 7.44 (d, *J* = 5.7 Hz, 1H), 6.96 (d, *J* = 8.0 Hz, 1H), 6.81 (t, *J* = 8.0 Hz, 1H), 6.39 (d, *J* = 7.9 Hz, 1H), 4.33 (t, *J* = 8.2 Hz, 2H), 3.23 (t, *J* = 8.2 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$): δ 154.92, 149.45, 140.91, 138.27, 132.40, 130.63, 128.26, 127.22, 126.52, 126.36, 123.12, 122.55, 119.89, 117.78, 109.59, 52.76, 30.01.

ESI-MS: Calcd.for $C_{17}H_{13}BrN_2$ $[M+H]^+$: 325.0340; found: 325.0390.

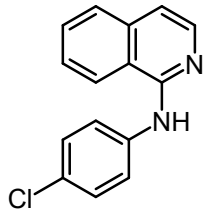
***N*-Phenylisoquinolin-1-amine (25)**



The compound was prepared according to the modified **General procedure for continuous-flow photochemical heteroarylation** using isoquinoline-1-carbonitrile (61.6 mg, 0.4 mmol, 1 equiv.), DABCO (44.8 mg, 0.4 mmol, 1 equiv.), 3DPAFIPN (3.1 mg, 4.8 µmol, 1.2 mol%), MeCN (6 mL) and aniline (55 µL, 0.6 mmol, 1.5 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (50:50). The product was isolated as a white solid (17 mg, 17%).

The data matched that reported in the literature.[14]

_N_-(4-Chlorophenyl)isoquinolin-1-amine (26)



The compound was prepared according to the modified **General procedure for continuous-flow photochemical heteroarylation** using isoquinoline-1-carbonitrile (61.6 mg, 0.4 mmol, 1 equiv.), DABCO (44.8 mg, 0.4 mmol, 1 equiv.), 3DPAFIPN (3.1 mg, 4.8 µmol, 1.2 mol%), MeCN (6 mL) and 4-chloroaniline (76.5 mg, 0.6 mmol, 1.5 equiv.). Column chromatography was carried out with an eluent EtOAc/petroleum ether (50:50). The product was isolated as a white solid (19 mg, 17%). The data matched that reported in the literature.[14]

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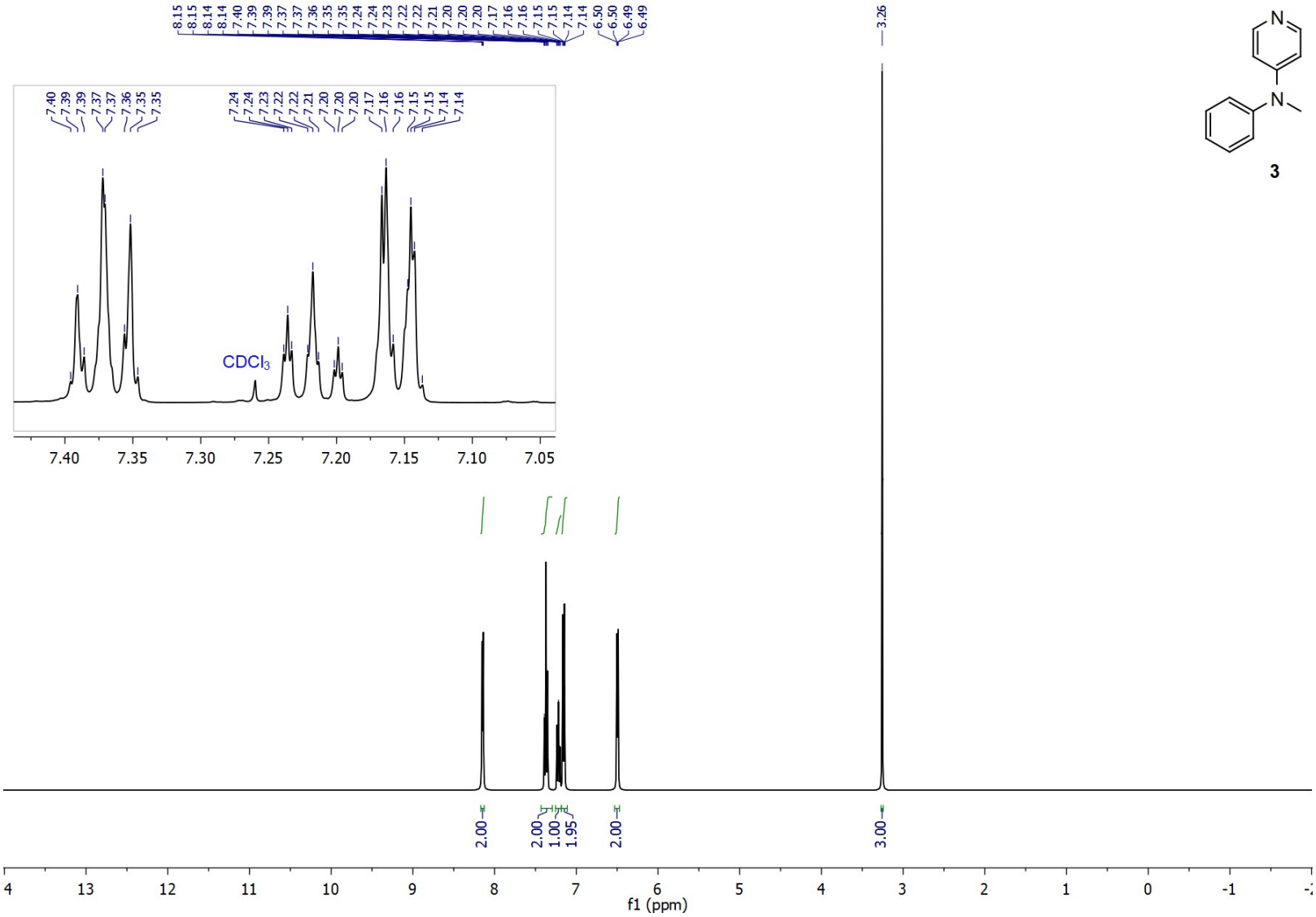
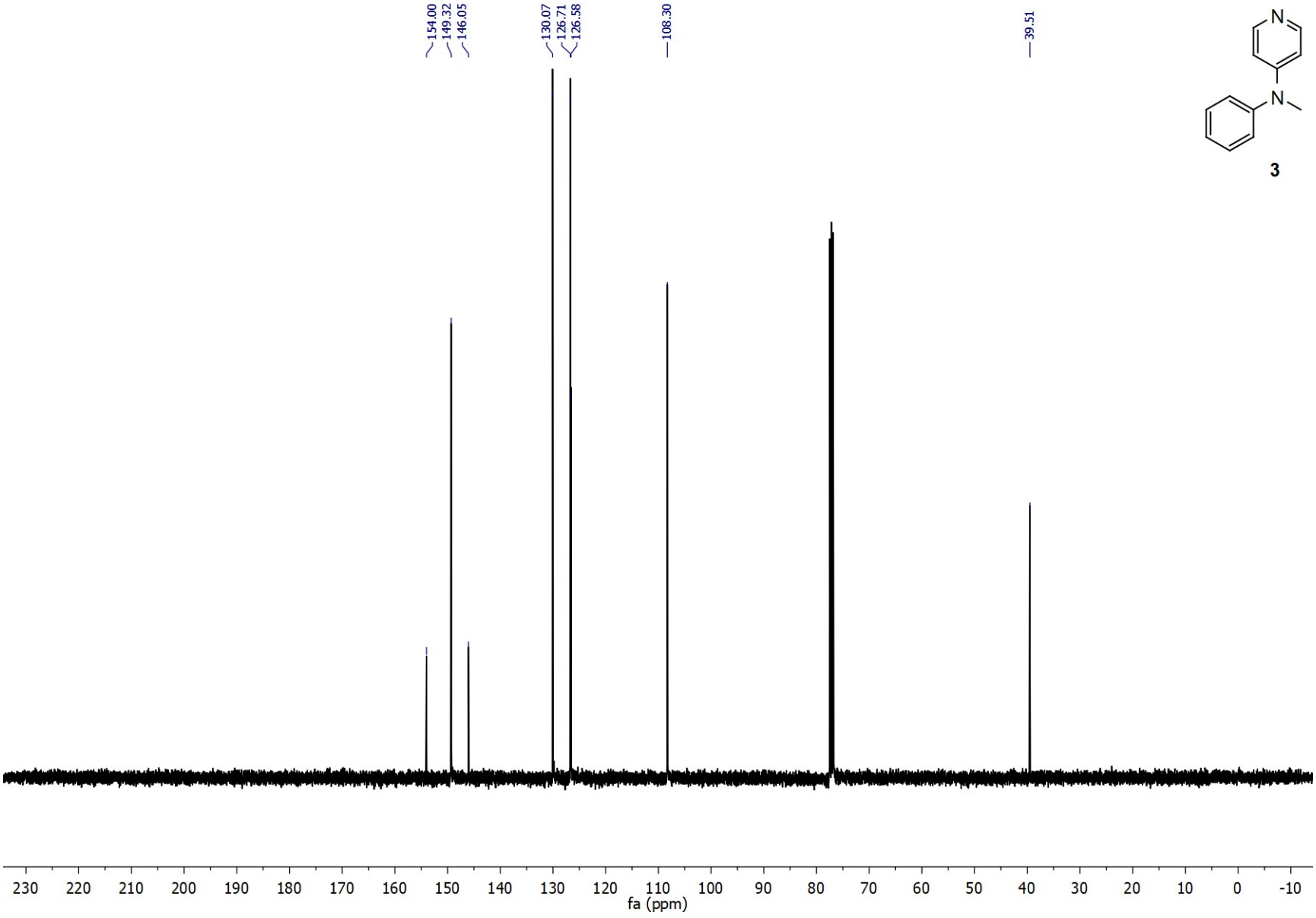
7. ^{1}H and ^{13}C spectra

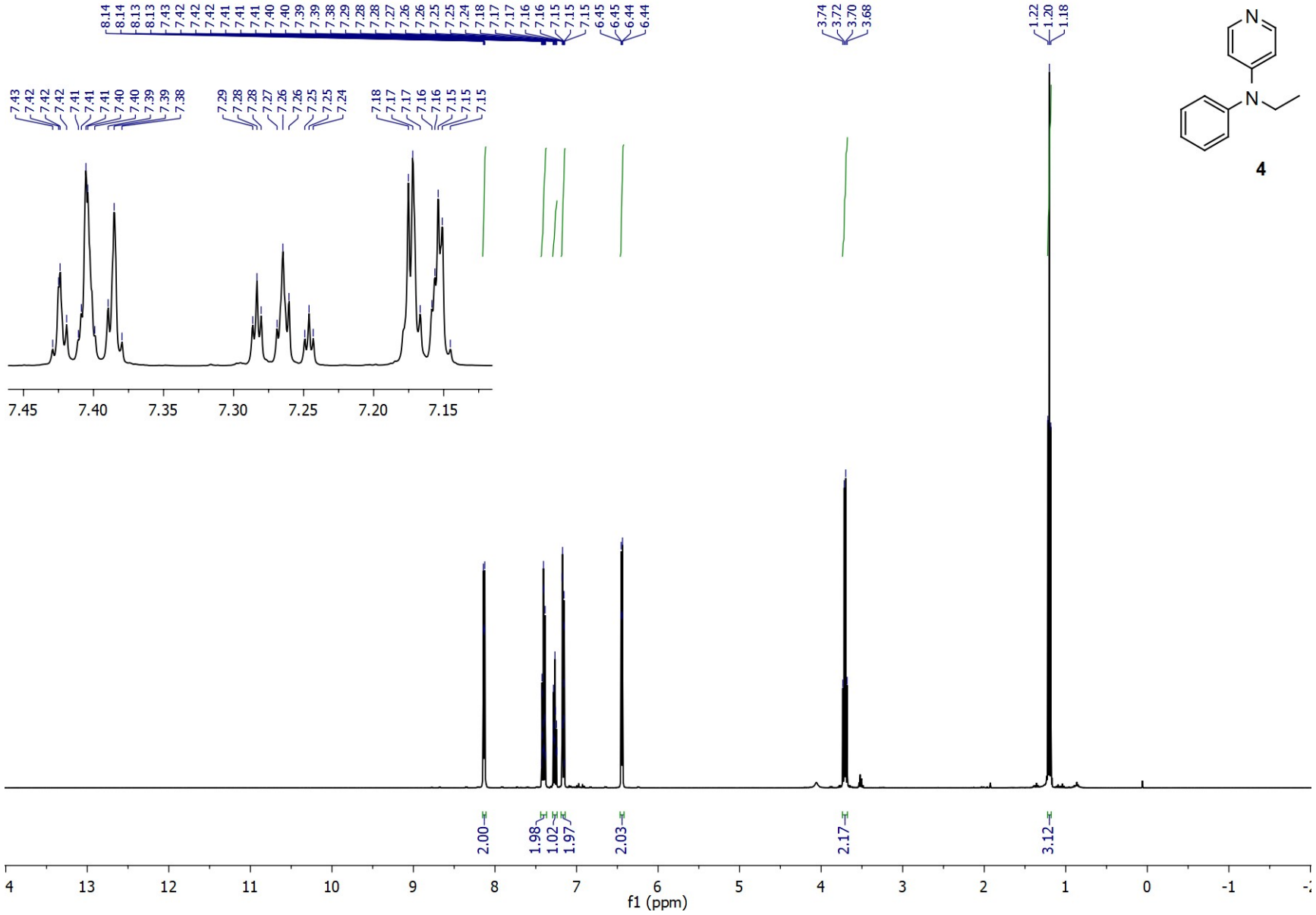
^{1}H MNR (400 MHz, $CDCl_3$) for N-methyl-N-phenylpyridin-4-amine (3)



^{13}C NMR (101 MHz, $CDCl_3$) for *N*-methyl-*N*-phenylpyridin-4-amine (**3**)

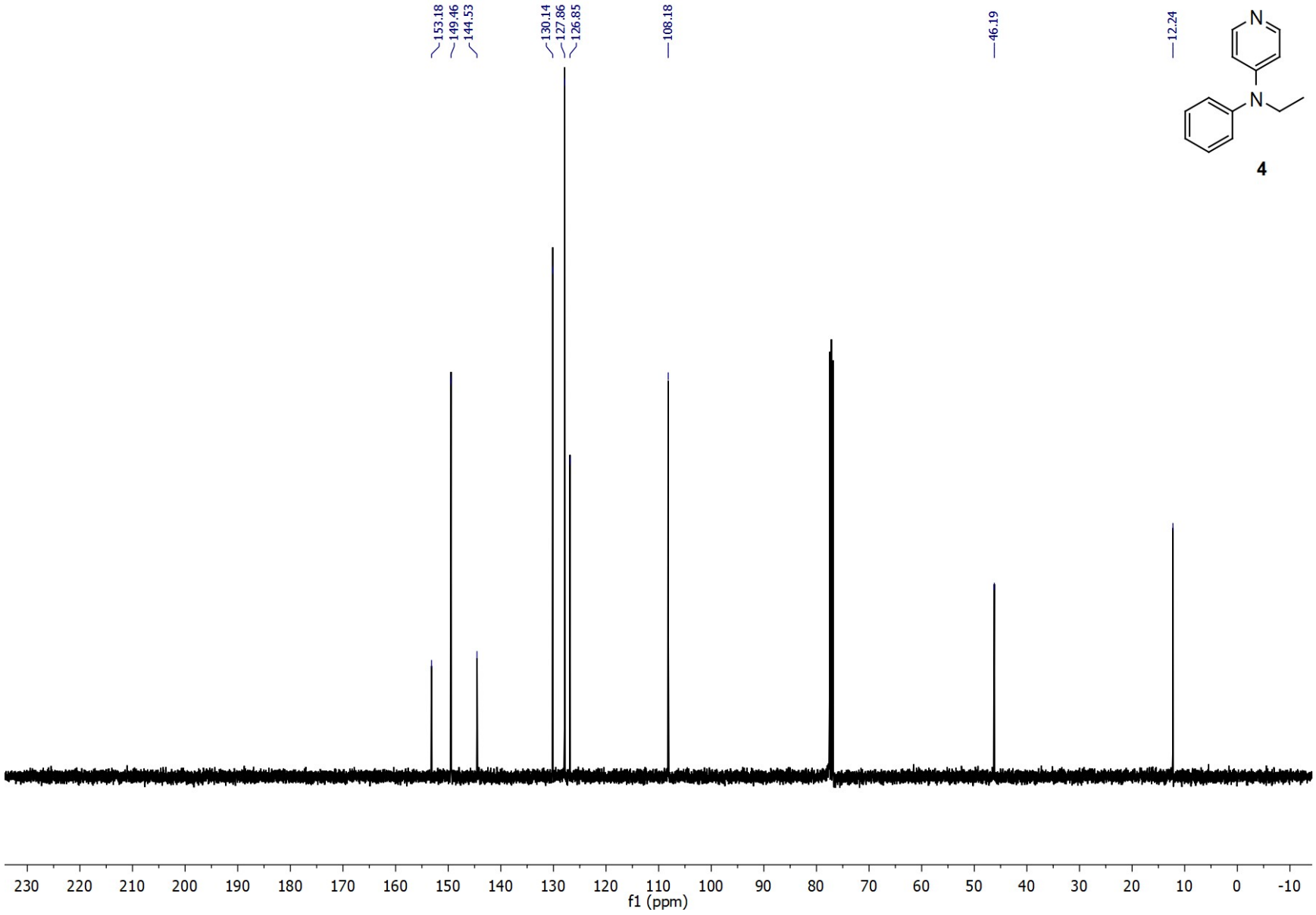


^{1}H MNR (400 MHz, $CDCl_3$) for *N*-ethyl-*N*-phenylpyridin-4-amine (**4**)

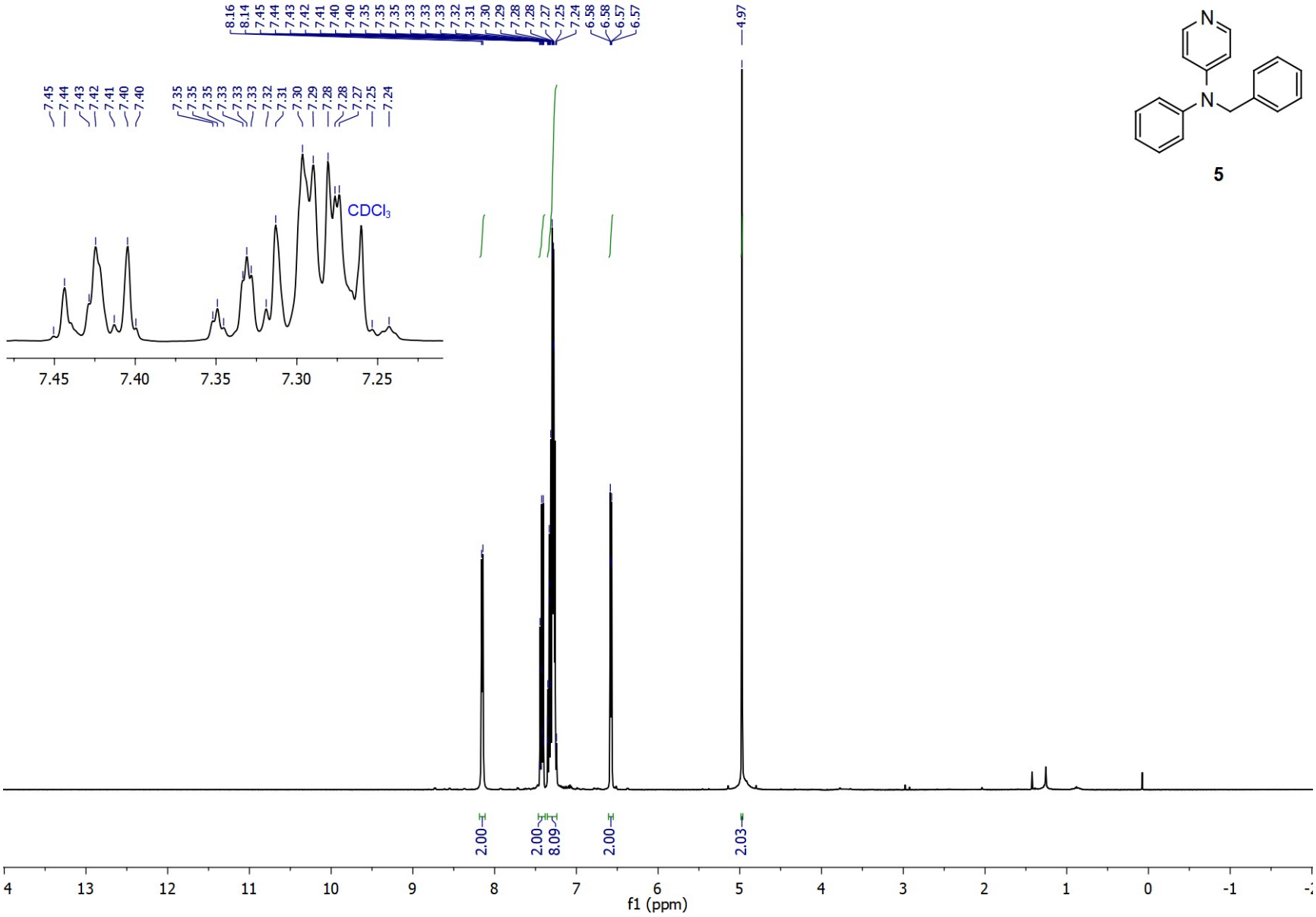


4

^{13}C NMR (101 MHz, $CDCl_3$) for *N*-ethyl-*N*-phenylpyridin-4-amine (**4**)

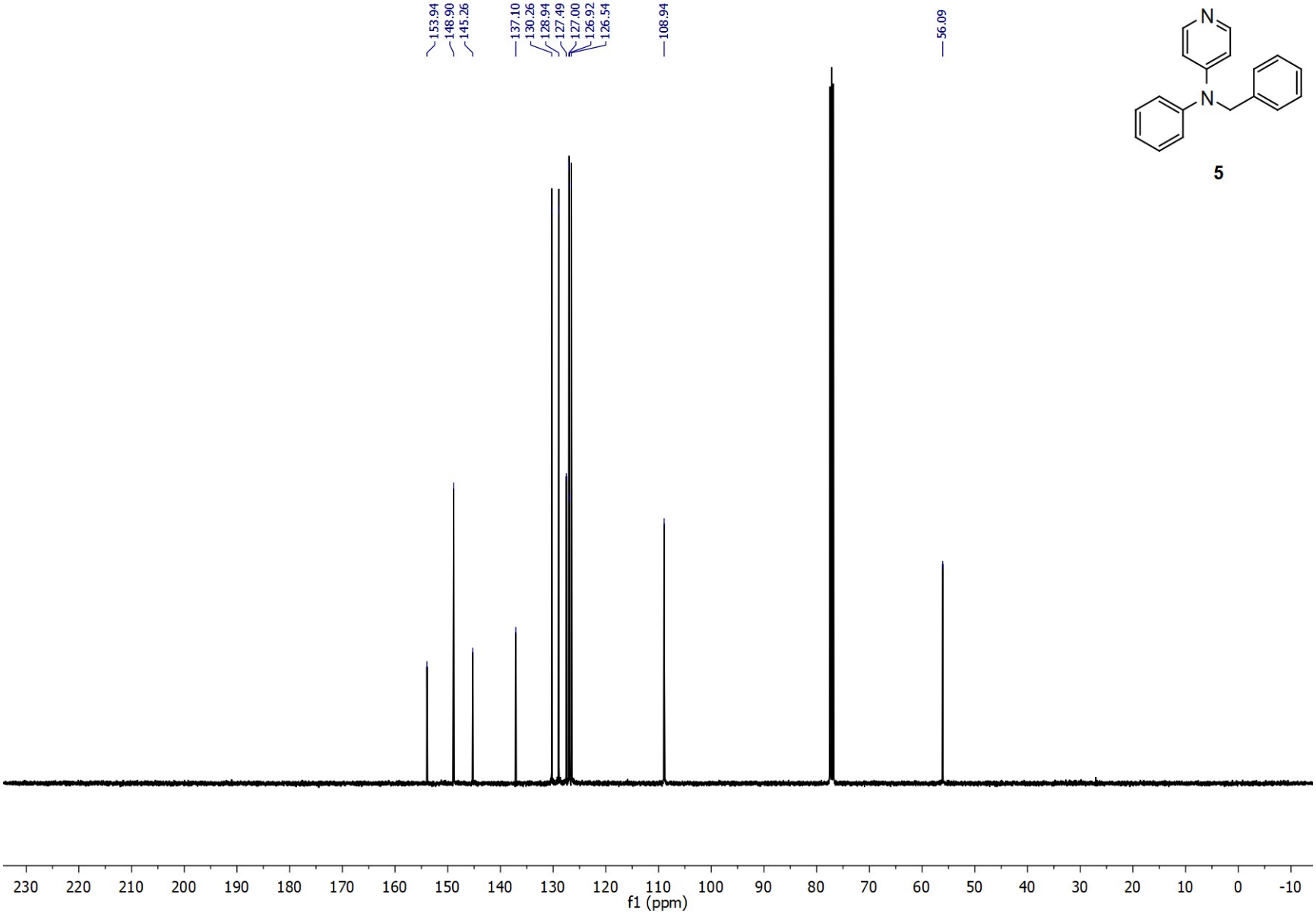


^{1}H MNR (400 MHz, $CDCl_3$) for *N*-benzyl-*N*-phenylpyridin-4-amine (**5**)

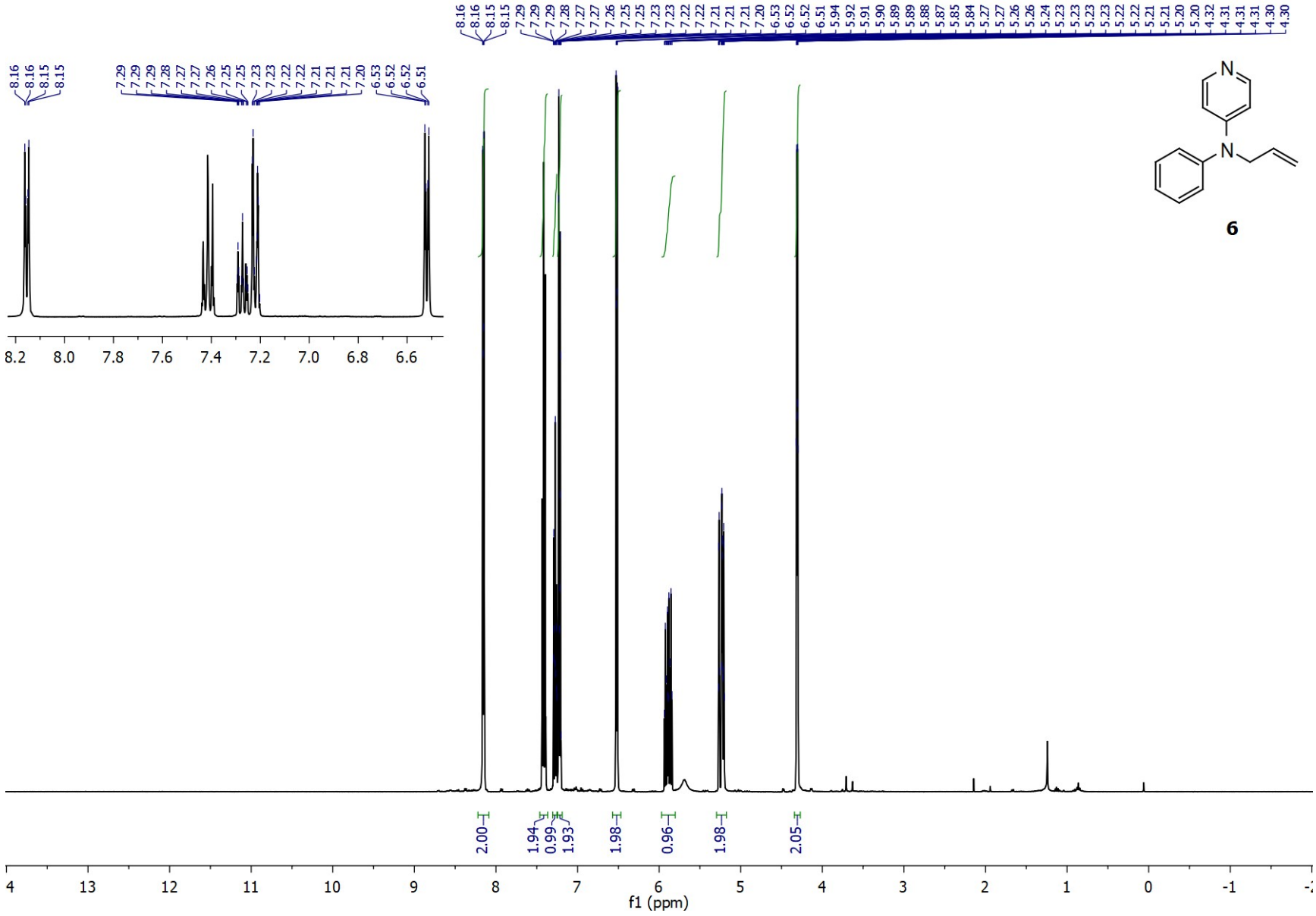


5

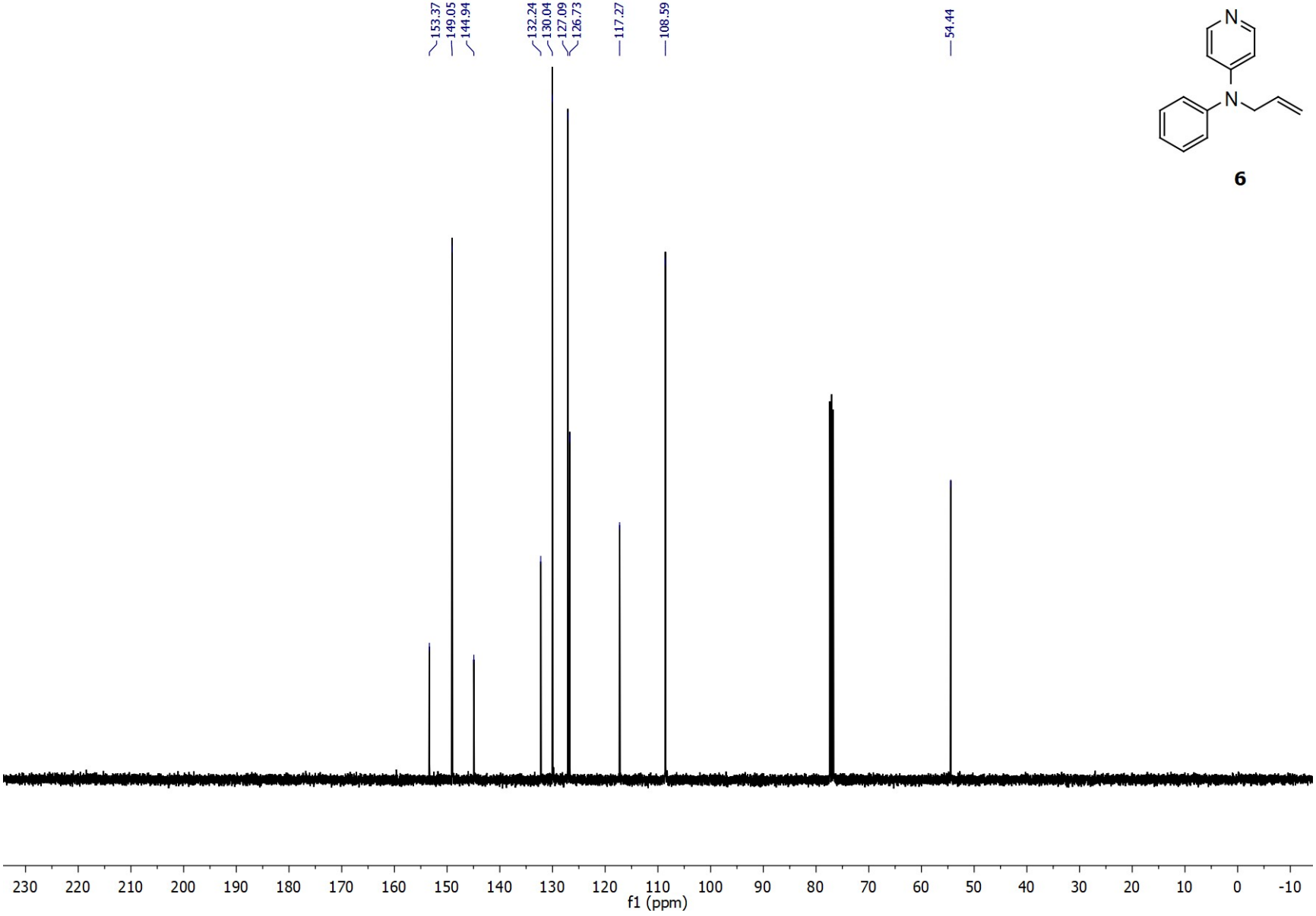
^{13}C NMR (101 MHz, $CDCl_3$) for *N*-benzyl-*N*-phenylpyridin-4-amine (**5**)



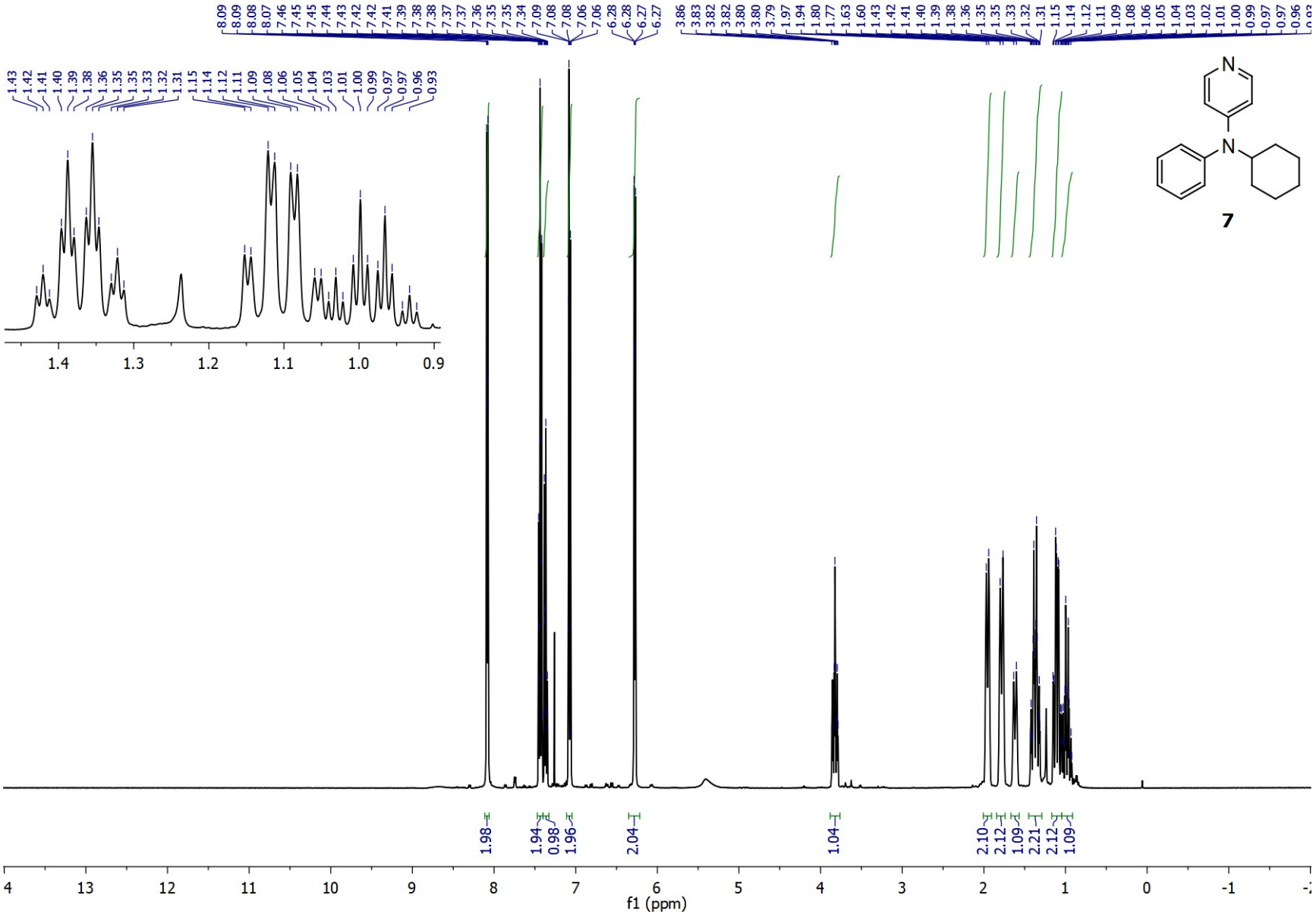
^{1}H MNR (400 MHz, $CDCl_3$) for *N*-allyl-*N*-phenylpyridin-4-amine (**6**)



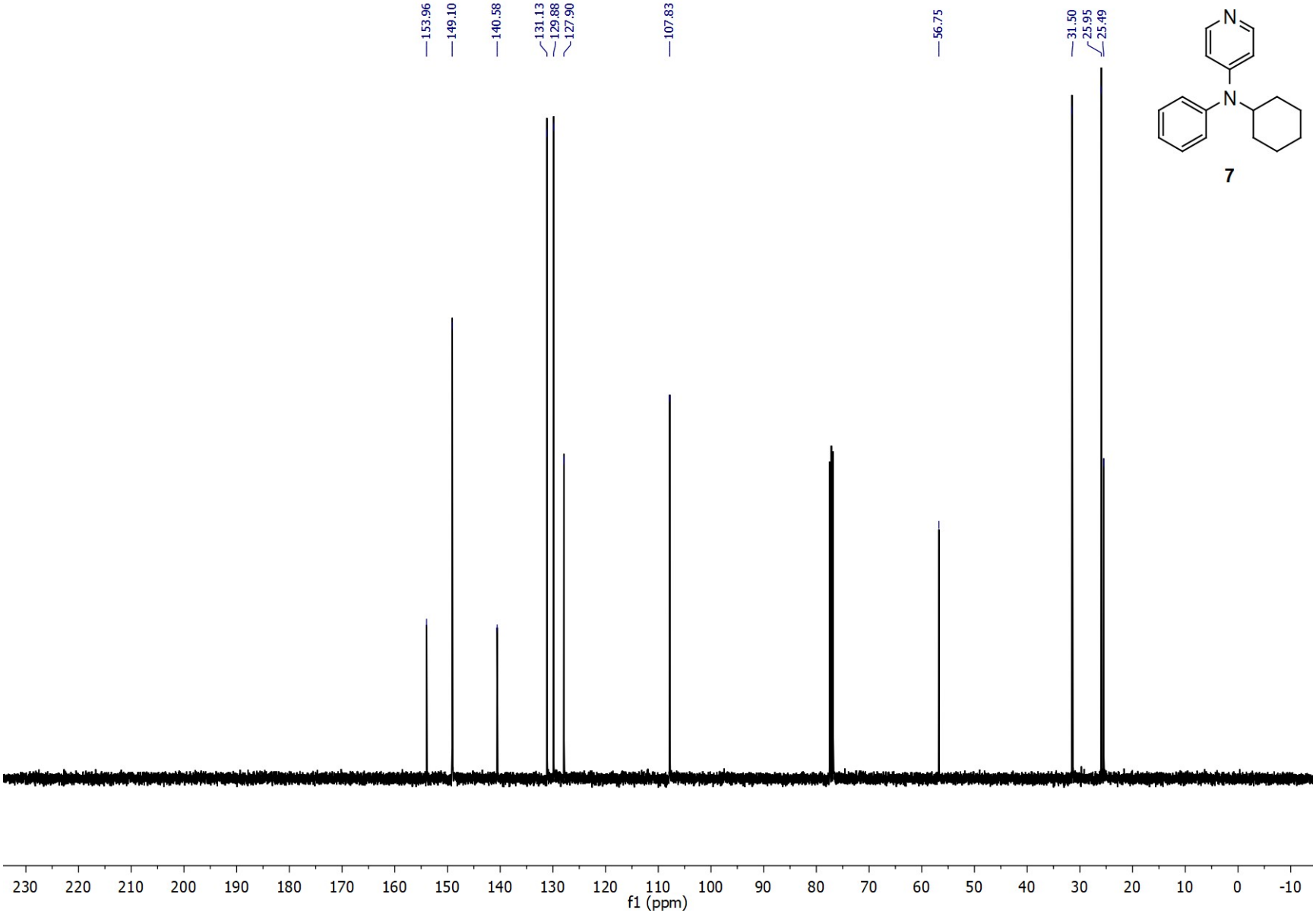
^{13}C NMR (101 MHz, $CDCl_3$) for *N*-allyl-*N*-phenylpyridin-4-amine (**6**)



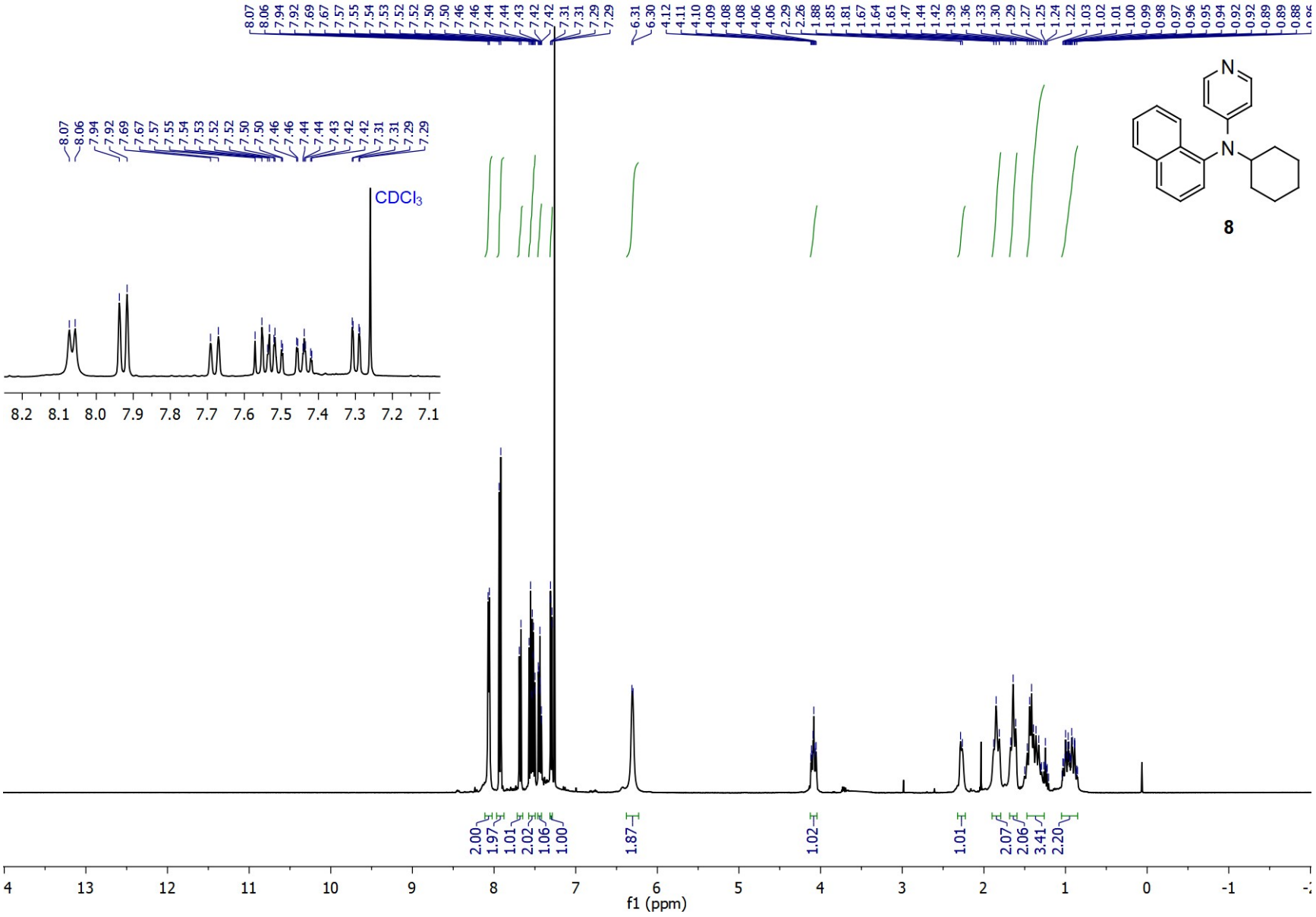
^{1}H MNR (400 MHz, $CDCl_3$) for *N*-cyclohexyl-*N*-phenylpyridin-4-amine (**7**)



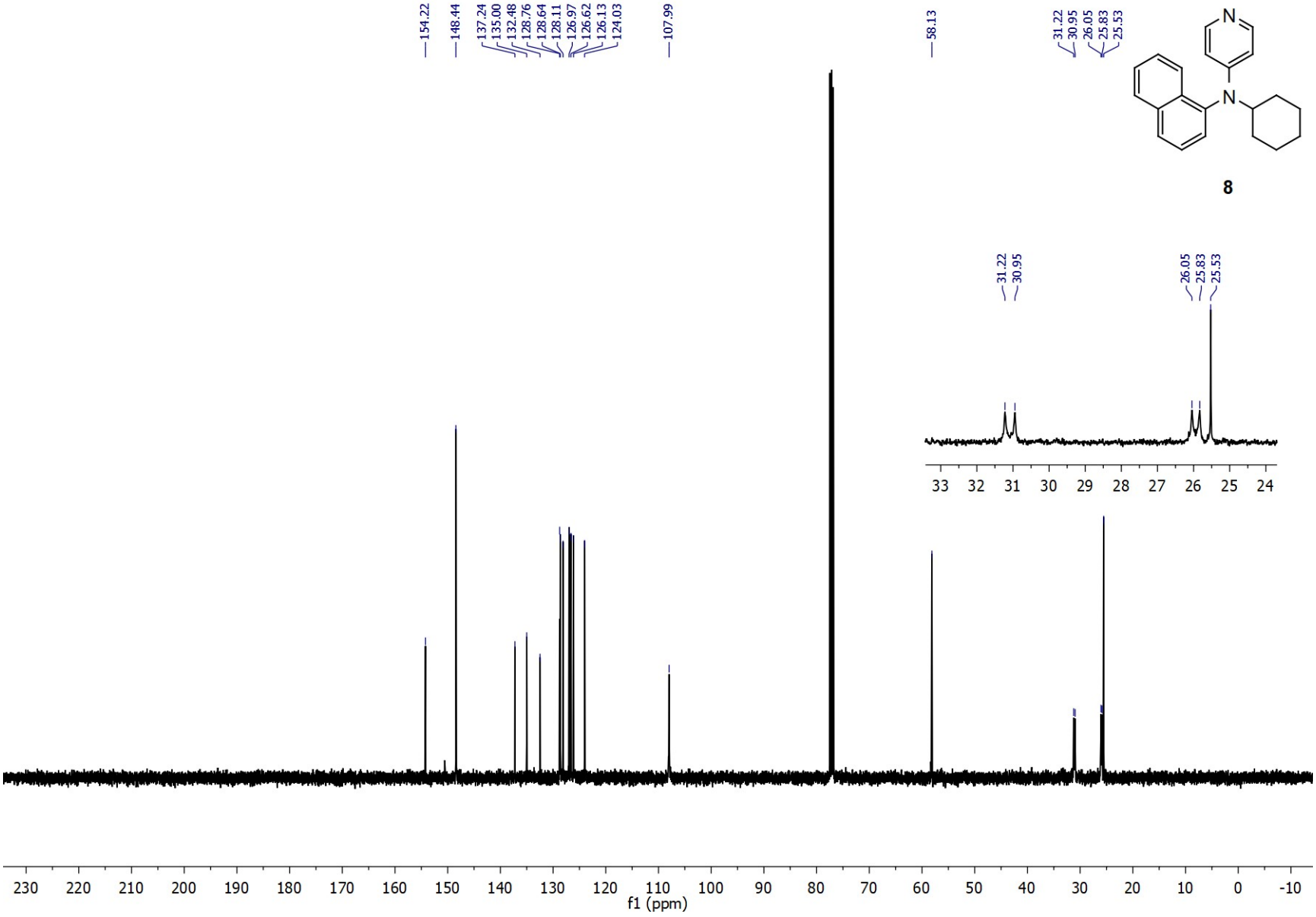
^{13}C NMR (101 MHz, $CDCl_3$) for *N*-cyclohexyl-*N*-phenylpyridin-4-amine (**7**)



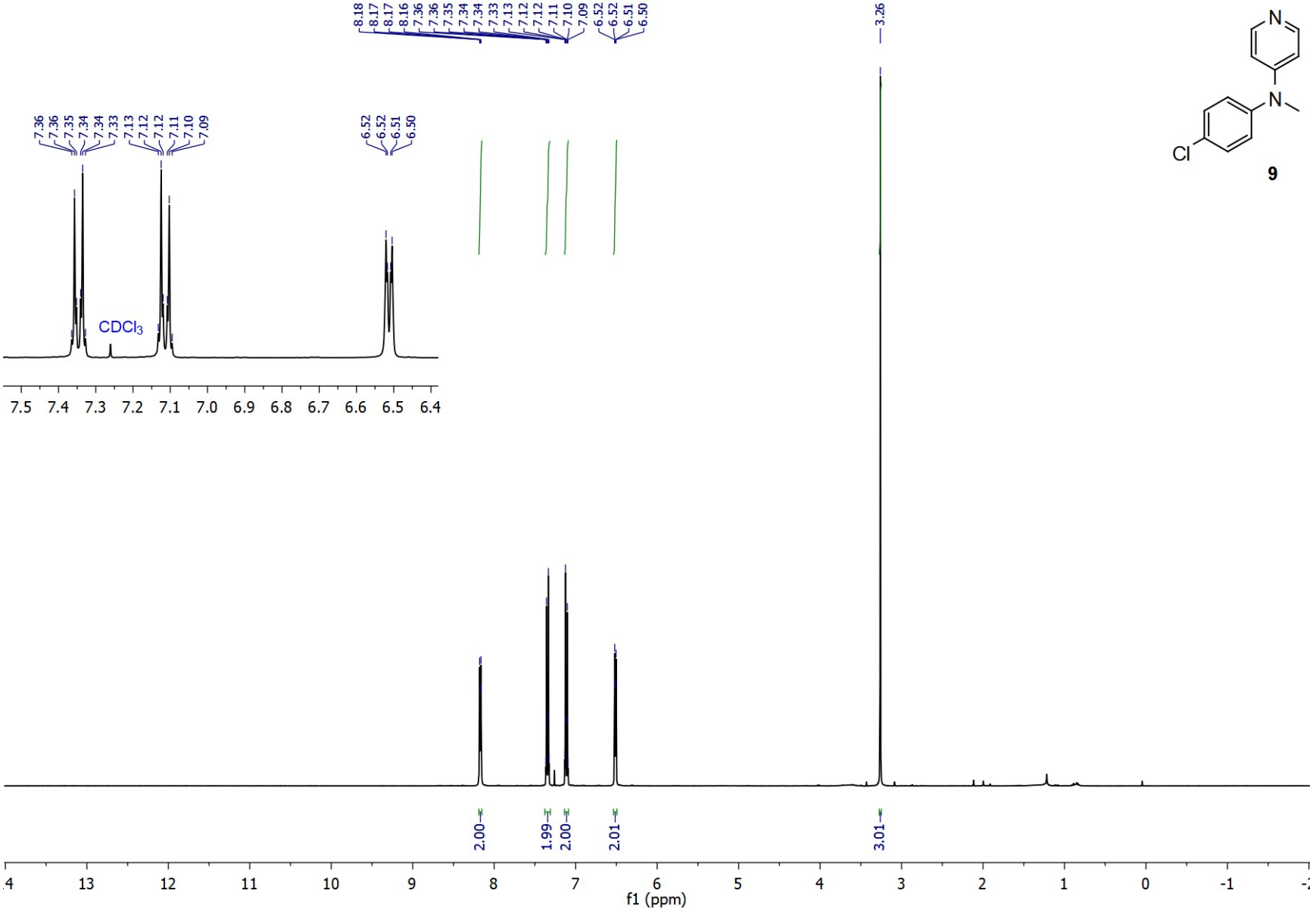
^{1}H MNR (400 MHz, $CDCl_3$) for *N*-cyclohexyl-*N*-(naphthalen-1-yl)pyridin-4-amine (**8**)



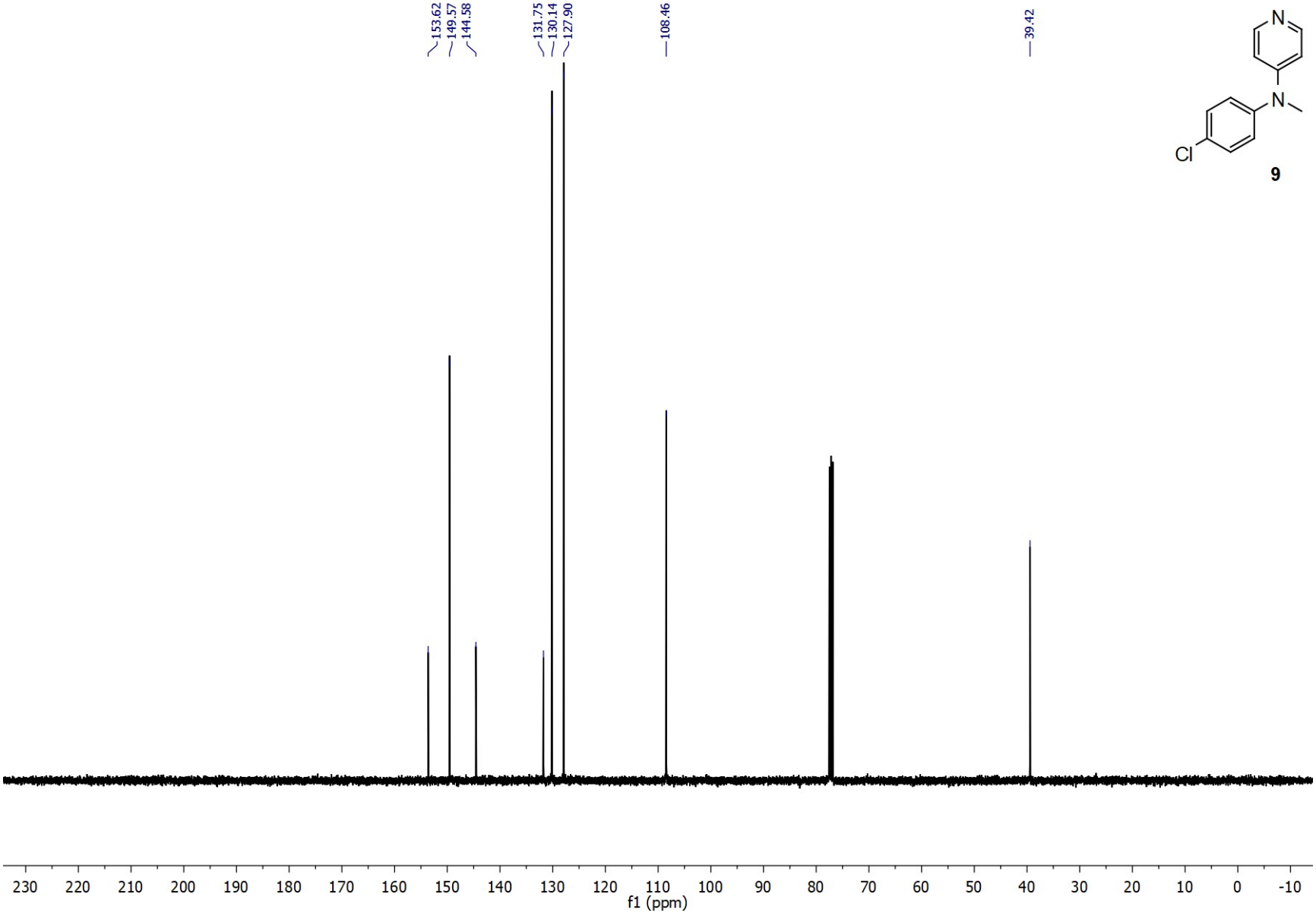
^{13}C NMR (101 MHz, $CDCl_3$) for *N*-cyclohexyl-*N*-(naphthalen-1-yl)pyridin-4-amine (**8**)



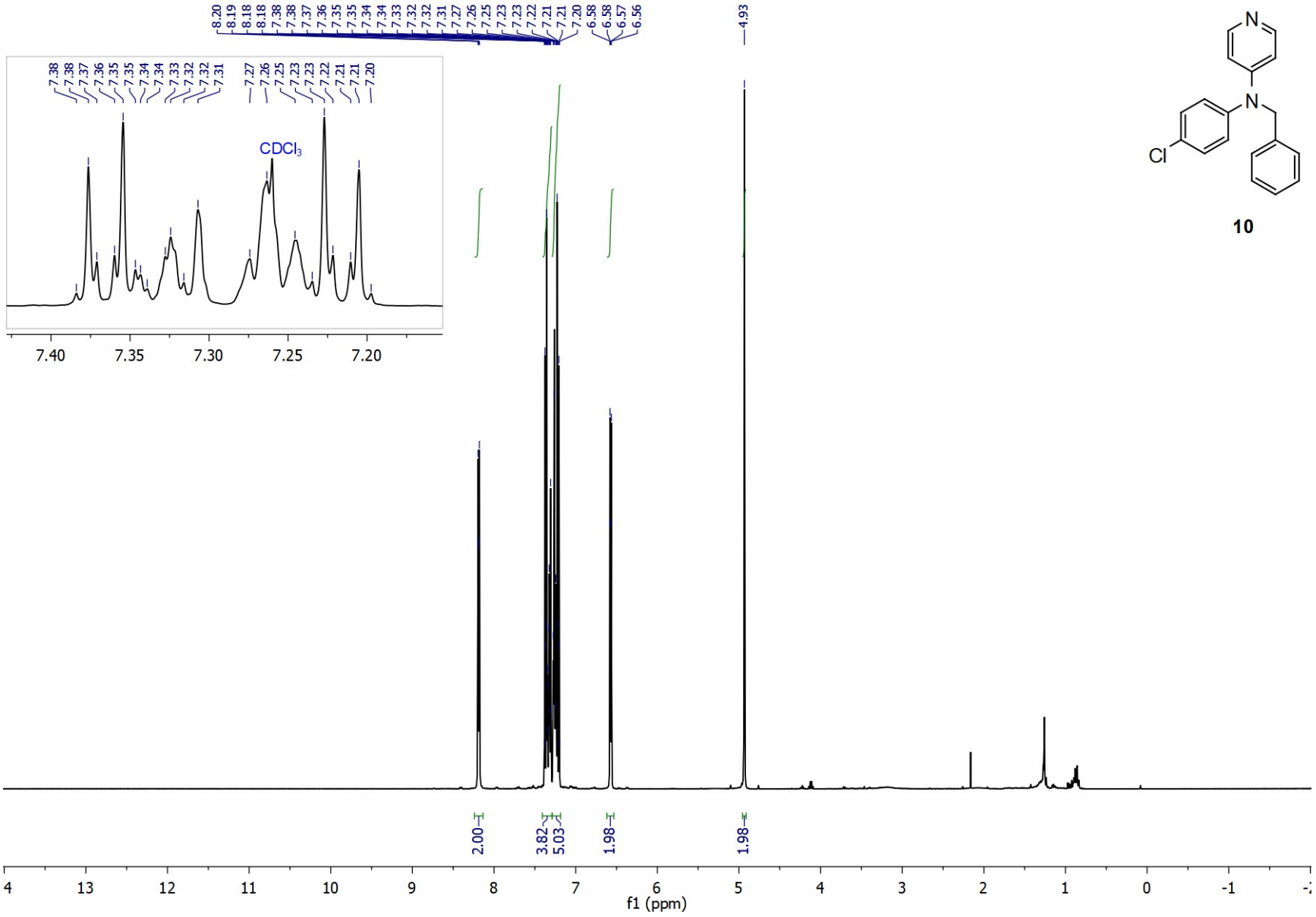
^{1}H MNR (400 MHz, $CDCl_3$) for *N*-(4-chlorophenyl)-*N*-methylpyridin-4-amine (**9**)



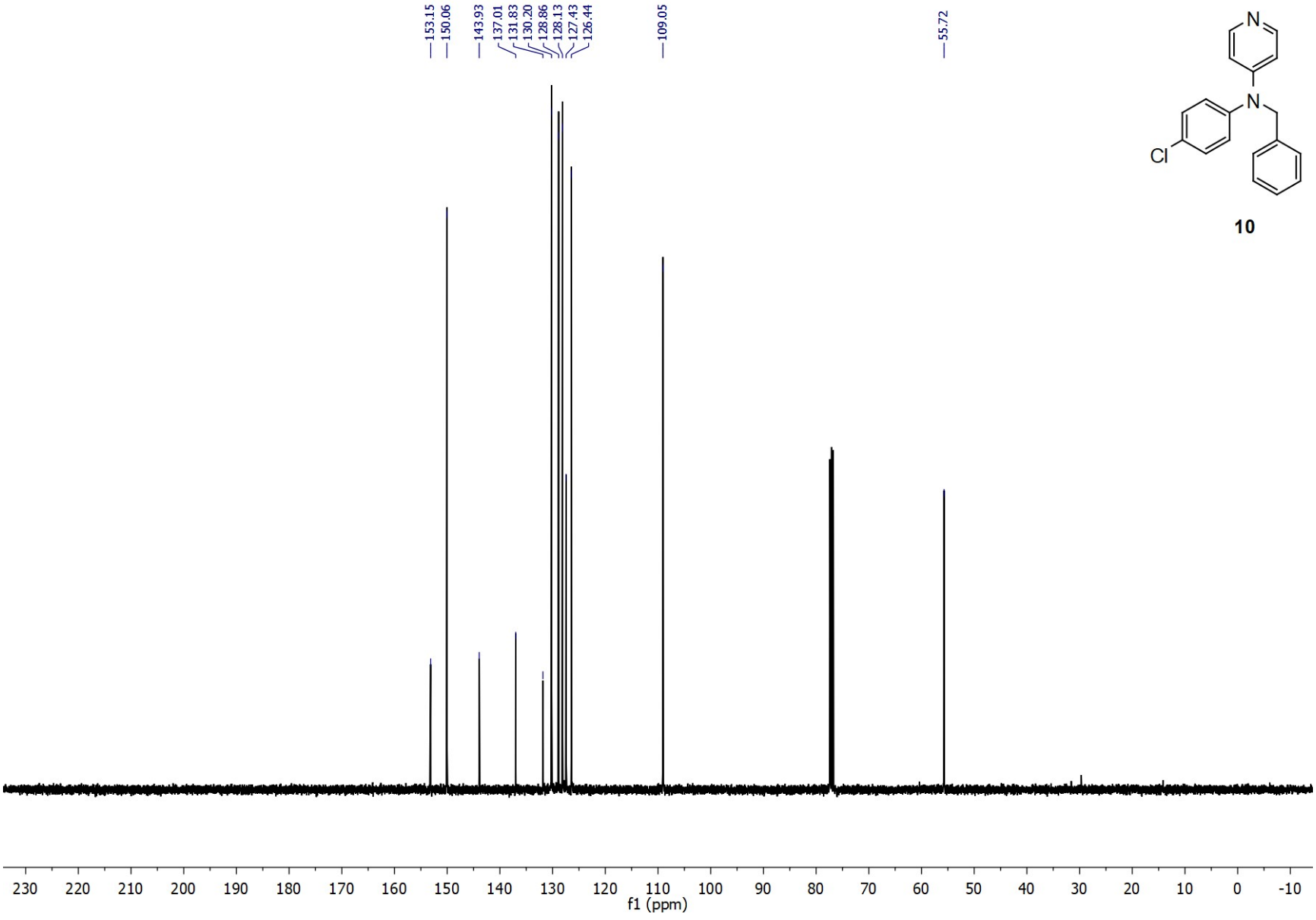
^{13}C NMR (101 MHz, $CDCl_3$) for *N*-(4-chlorophenyl)-*N*-methylpyridin-4-amine (**9**)



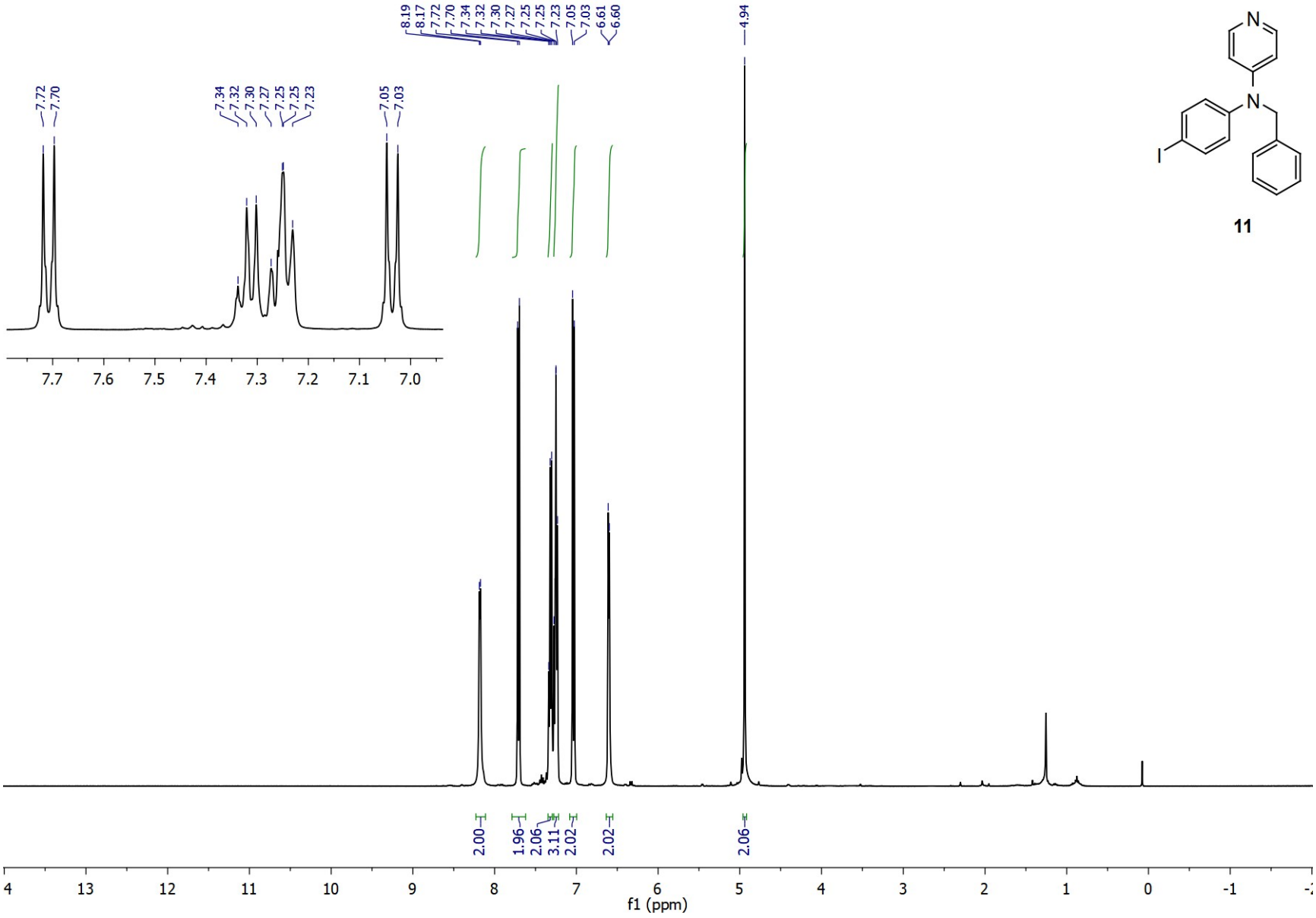
^{1}H MNR (400 MHz, $CDCl_3$) for *N*-benzyl-*N*-(4-chlorophenyl)pyridin-4-amine (**10**)



^{13}C NMR (101 MHz, $CDCl_3$) for *N*-benzyl-*N*-(4-chlorophenyl)pyridin-4-amine (**10**)

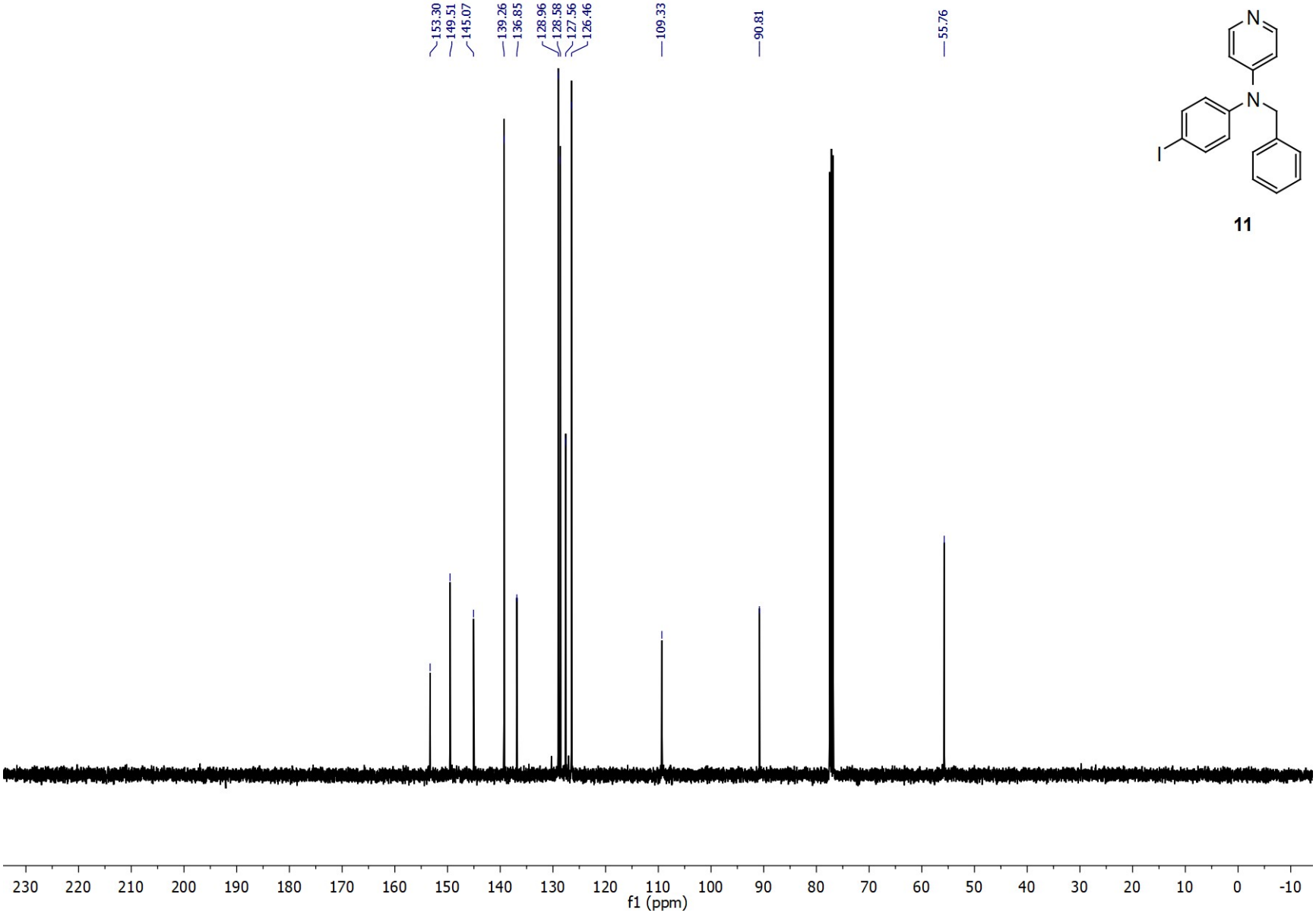


^{1}H MNR (400 MHz, $CDCl_3$) for *N*-benzyl-*N*-(4-iodophenyl)pyridin-4-amine (**11**)

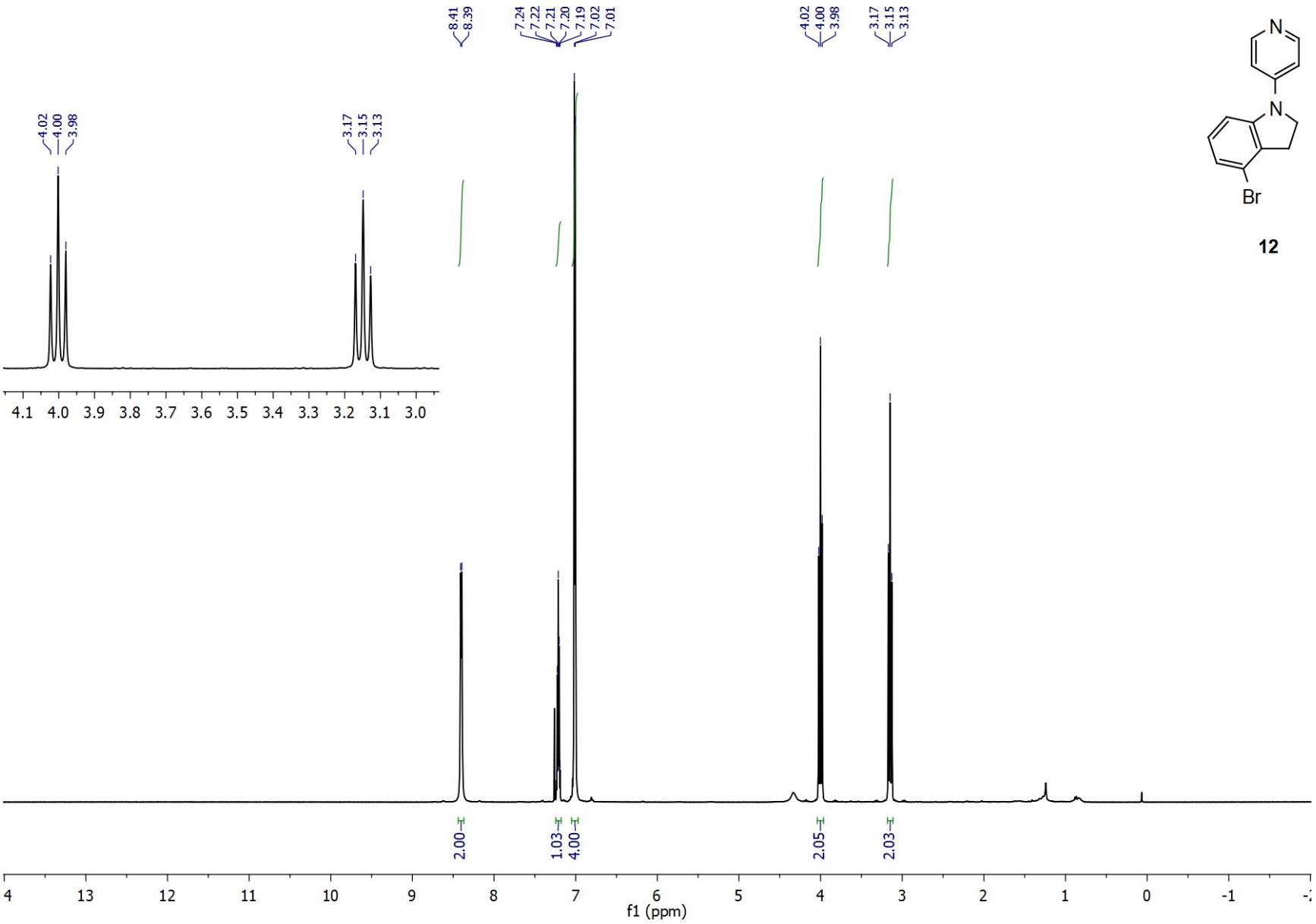


11

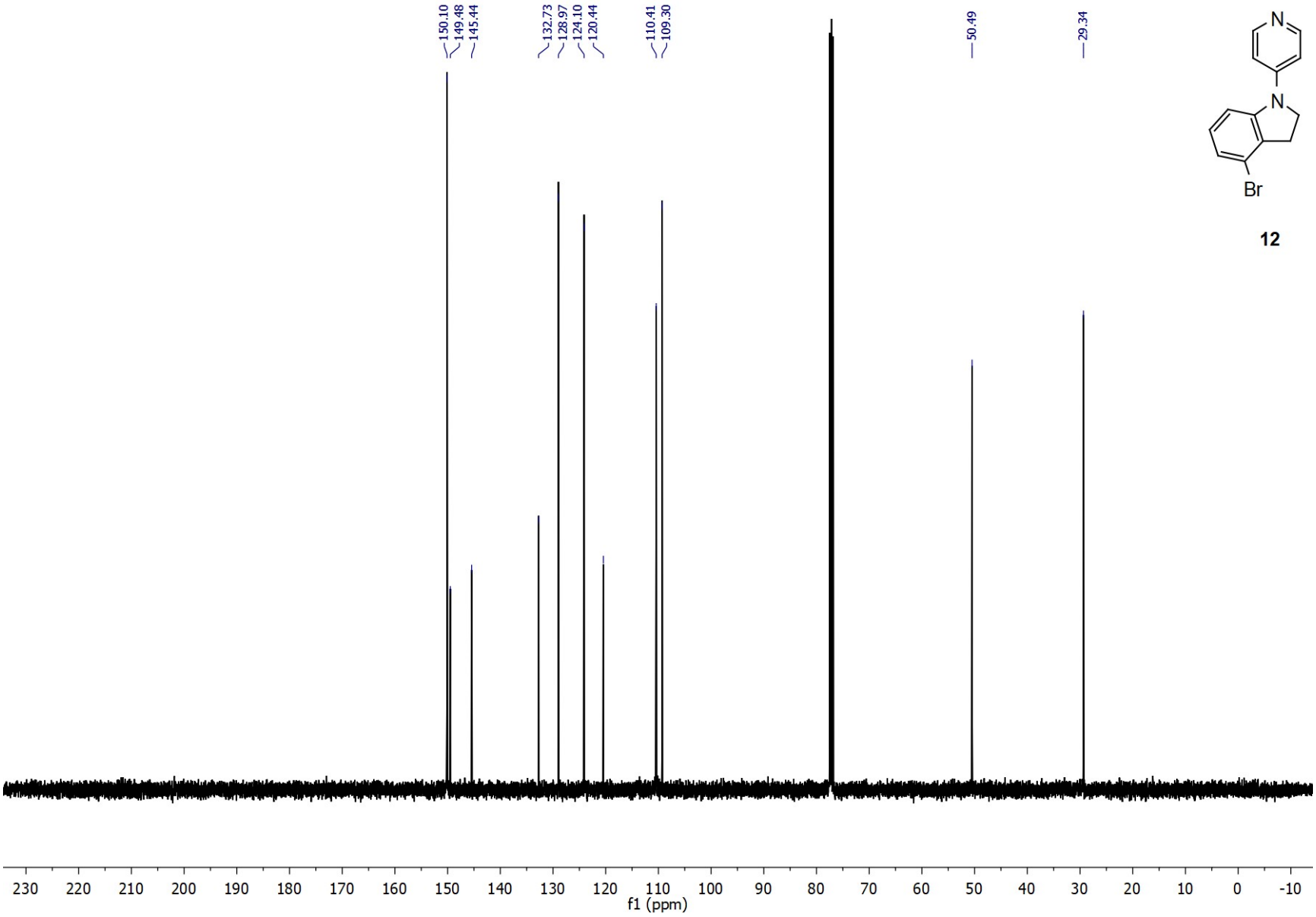
^{13}C NMR (101 MHz, $CDCl_3$) for *N*-benzyl-*N*-(4-iodophenyl)pyridin-4-amine (**11**)



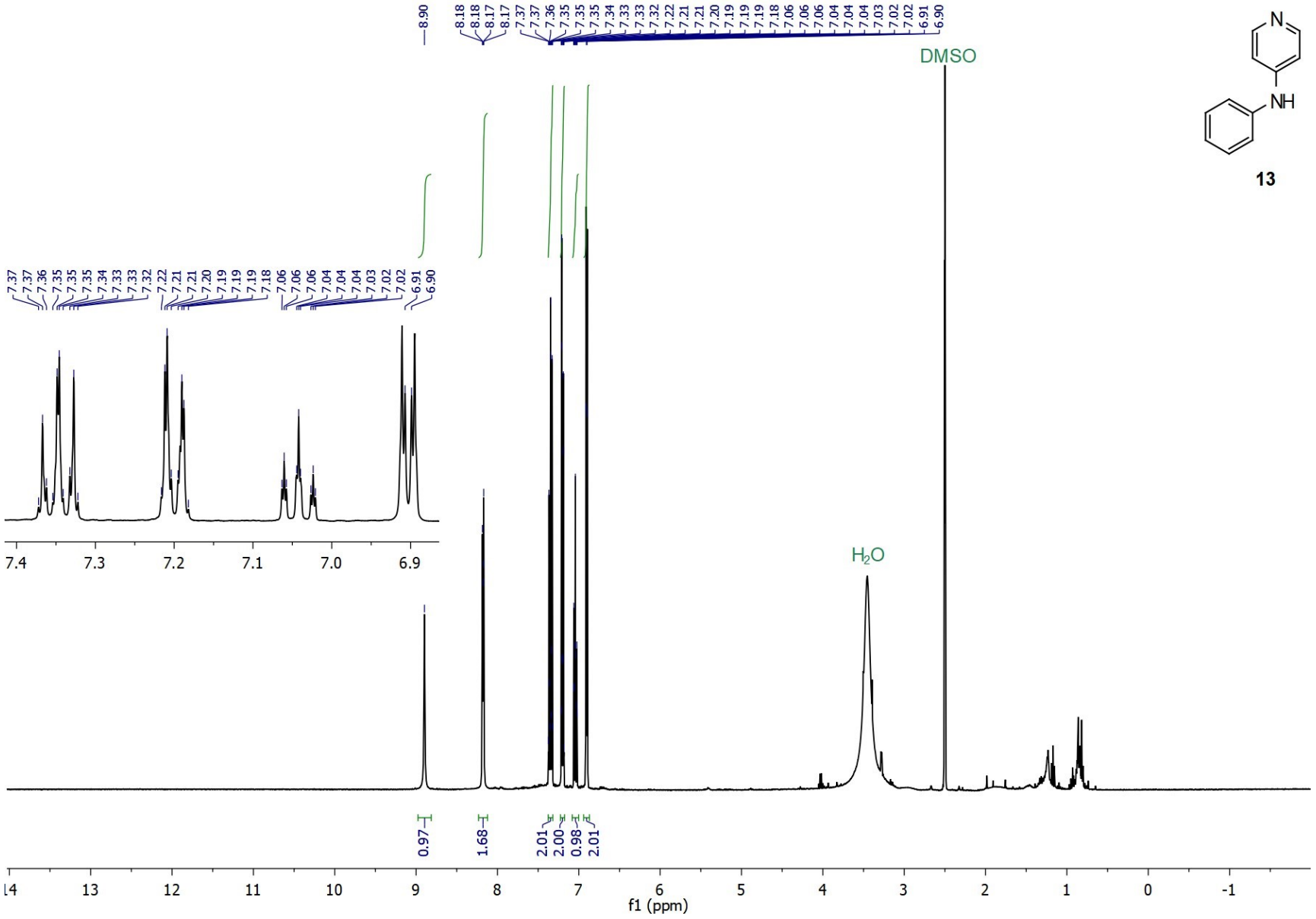
^{1}H MNR (400 MHz, $CDCl_3$) for 4-bromo-1-(pyridin-4-yl)indoline (**12**)



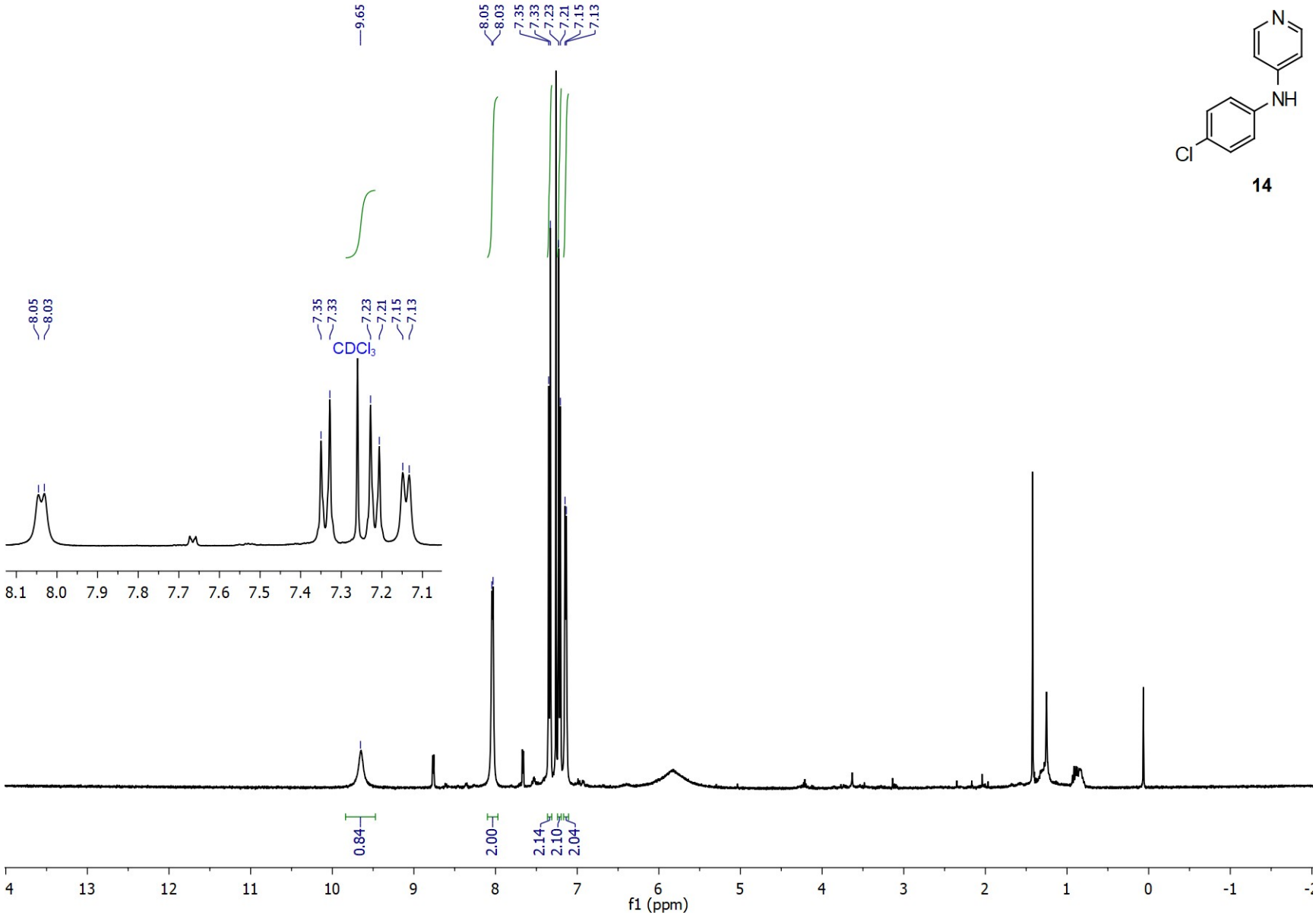
^{13}C NMR (101 MHz, $CDCl_3$) for 4-bromo-1-(pyridin-4-yl)indoline (**12**)



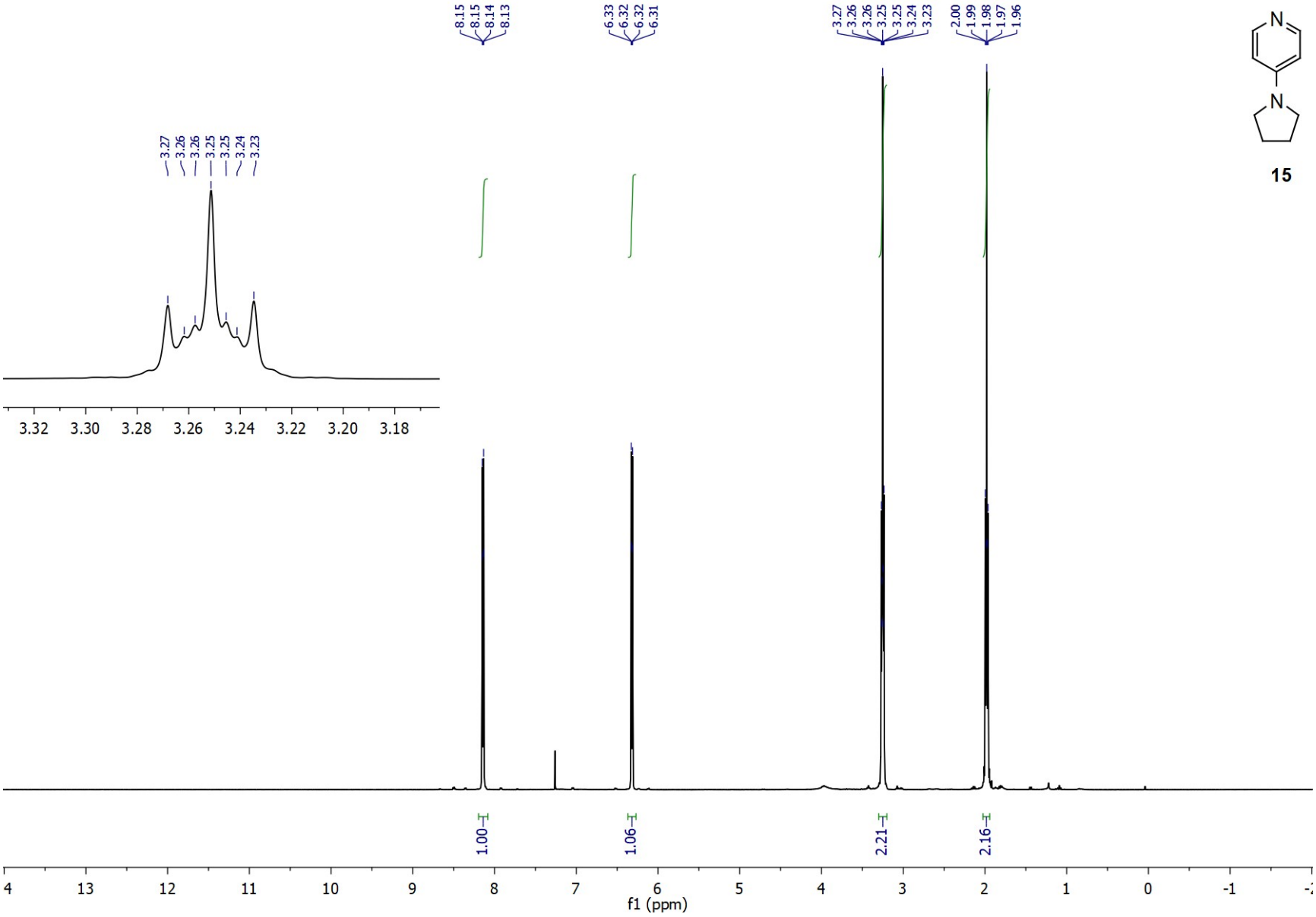
^{1}H MNR (400 MHz, DMSO-d_6) for *N*-phenylpyridin-4-amine (**13**)



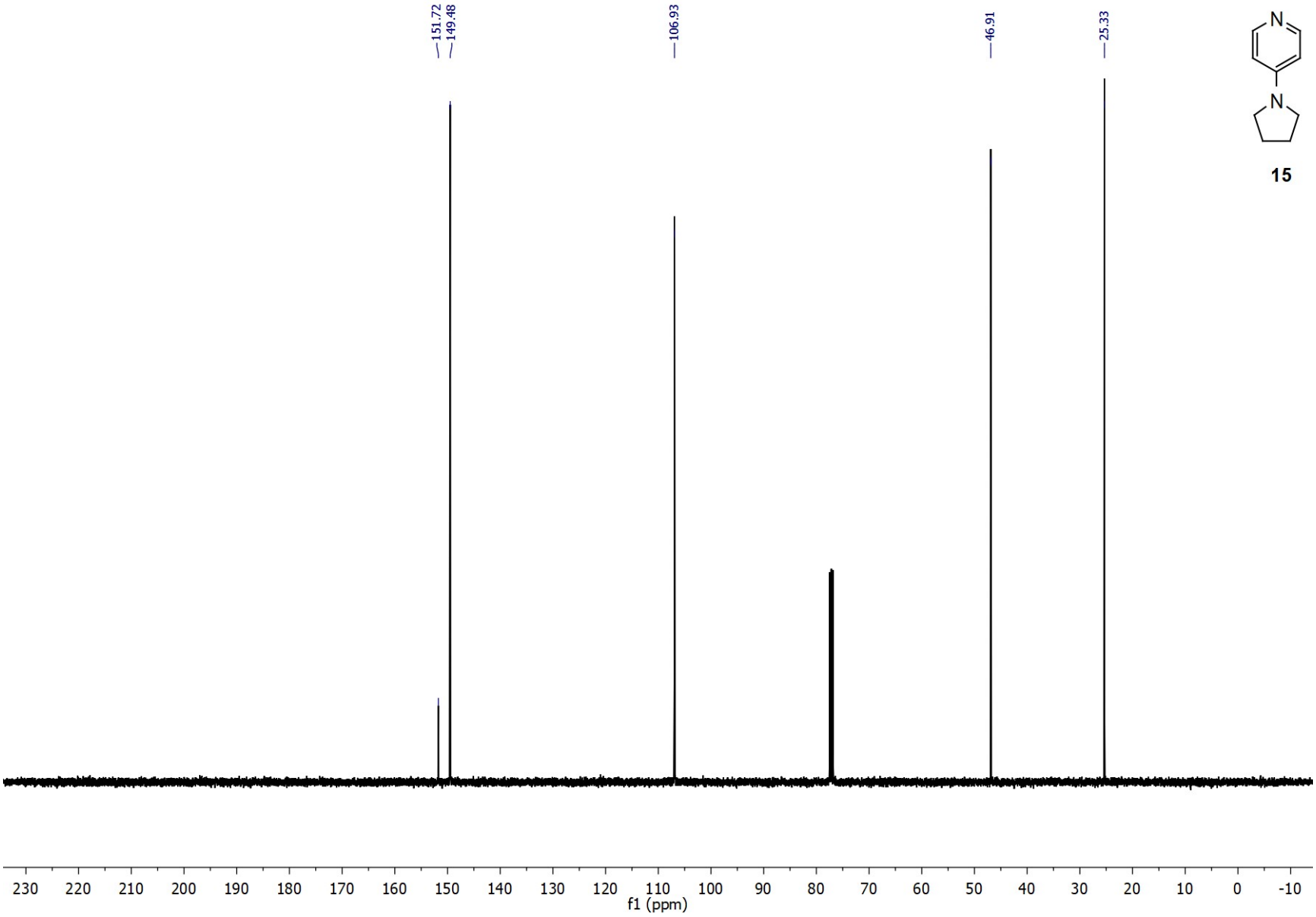
^{1}H MNR (400 MHz, $CDCl_3$) for *N*-phenylpyridin-4-amine (**14**)



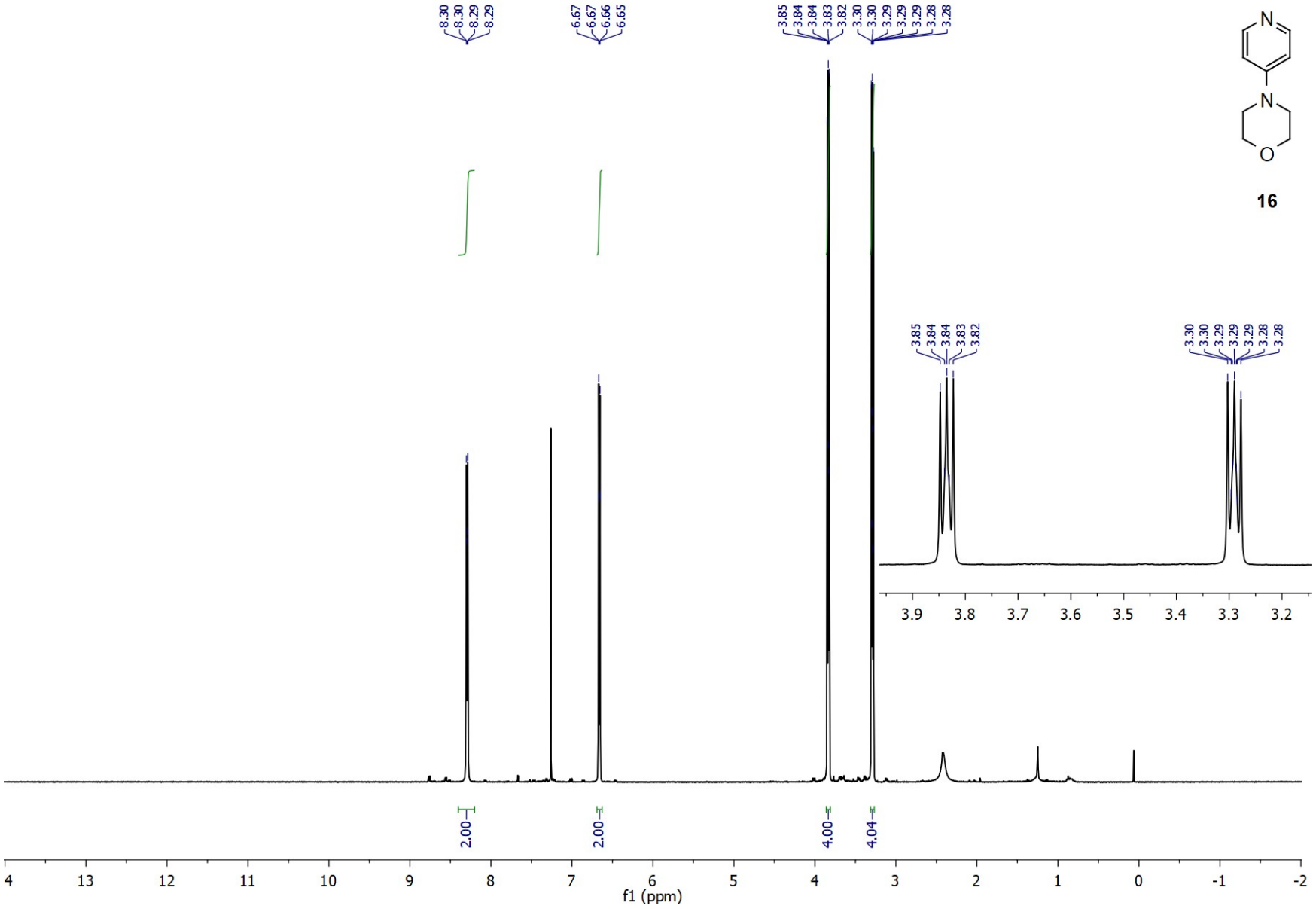
^{1}H MNR (400 MHz, $CDCl_3$) for 4-pyrrolidinopyridine (**15**)



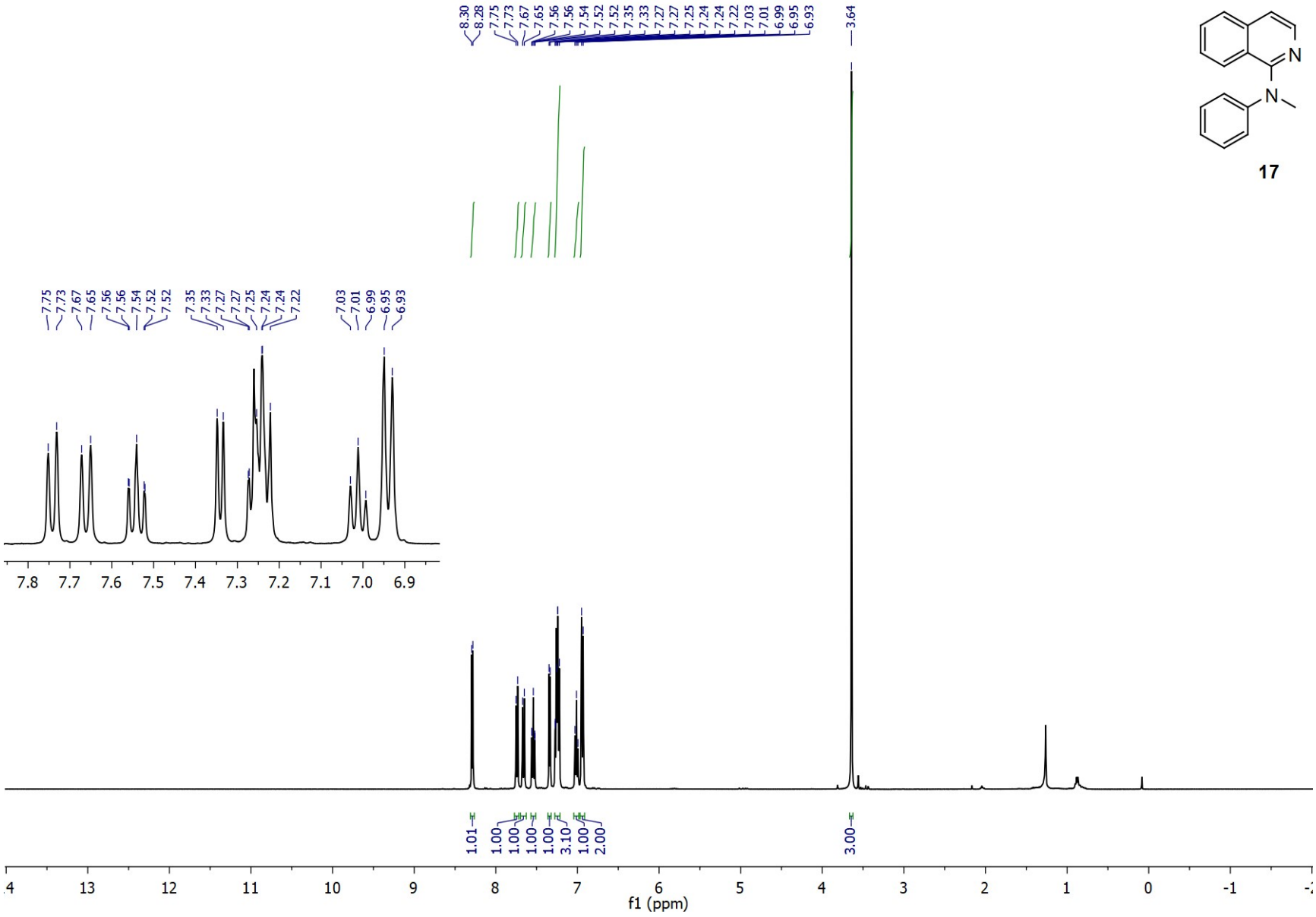
^{13}C NMR (101 MHz, $CDCl_3$) for 4-pyrrolidinopyridine (**15**)



^{1}H MNR (400 MHz, $CDCl_3$) for 4-(pyridin-4-yl)morpholine (**16**)



^{1}H MNR (400 MHz, $CDCl_3$) for *N*-methyl-*N*-phenylisoquinolin-1-amine (**17**)



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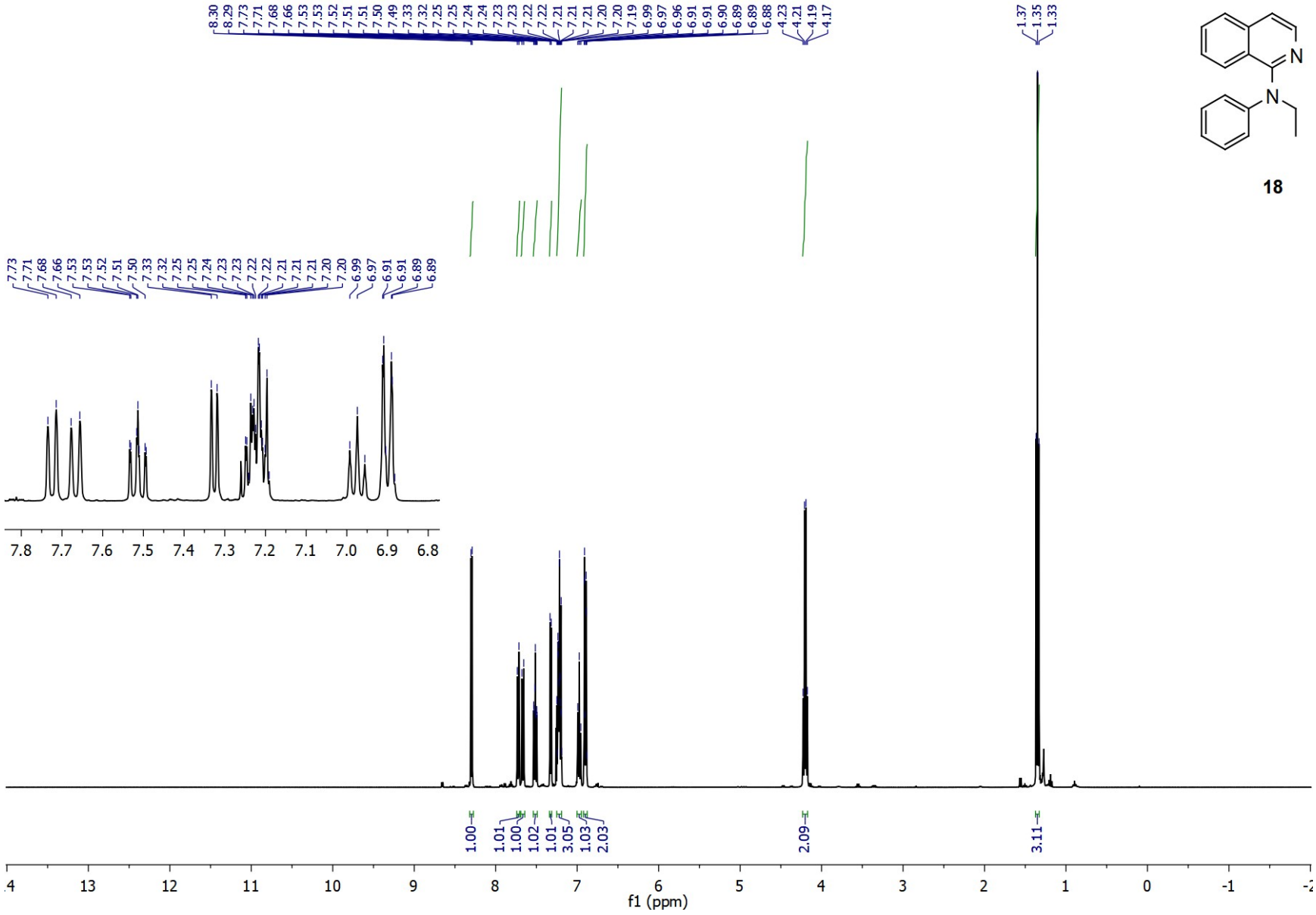
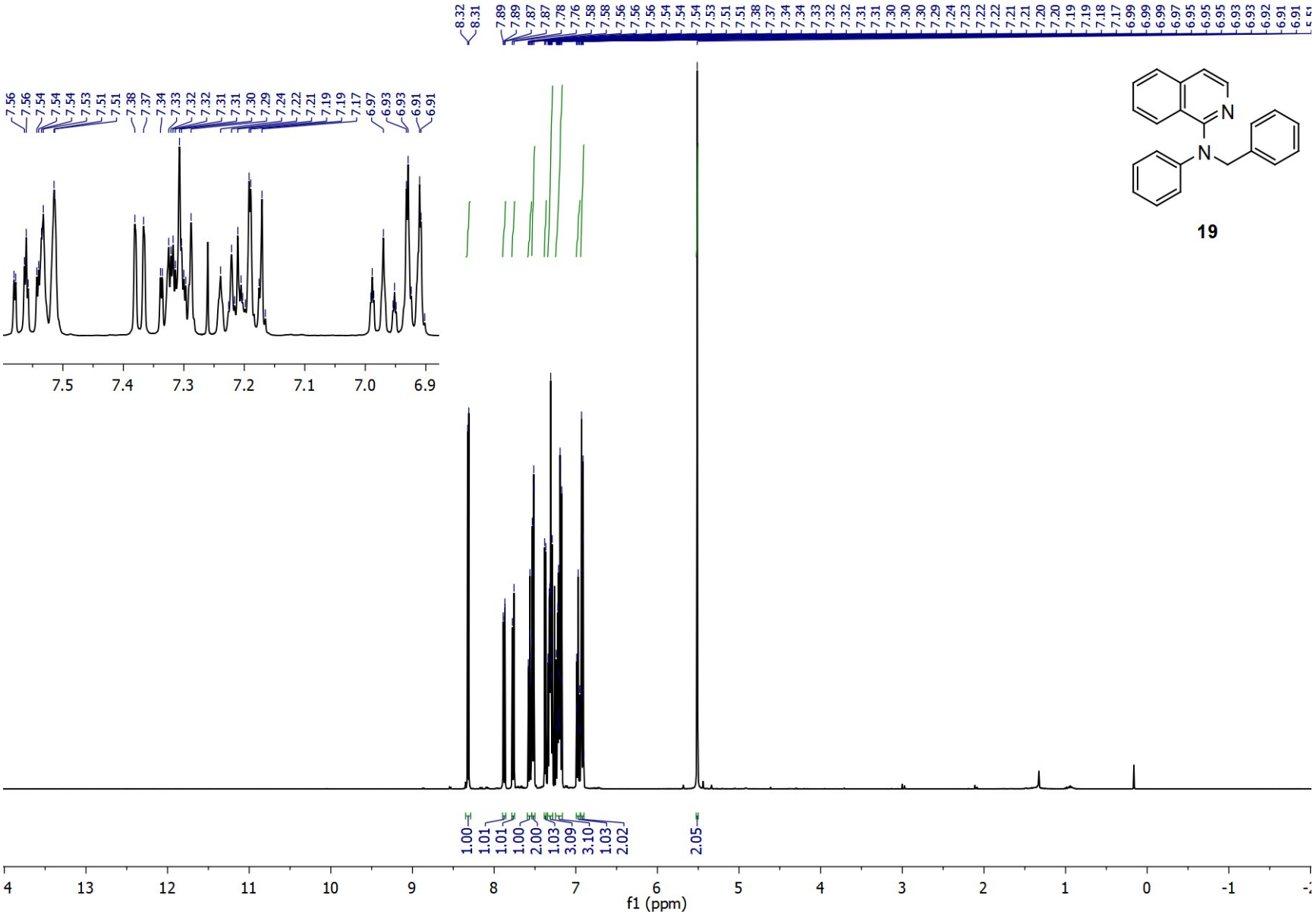
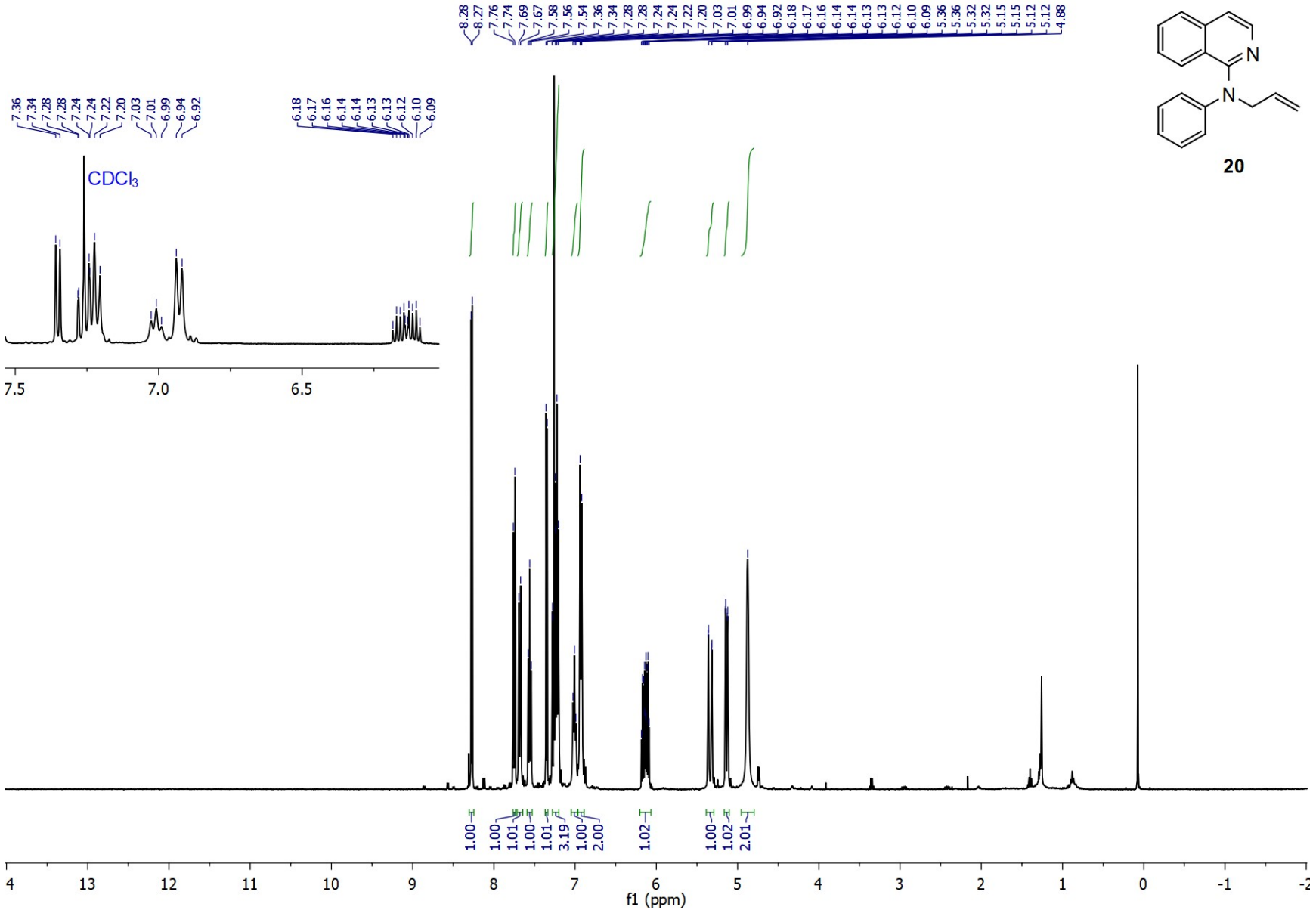
^{1}H MNR (400 MHz, $CDCl_3$) for *N*-ethyl-*N*-phenylisoquinolin-1-amine (**18**)



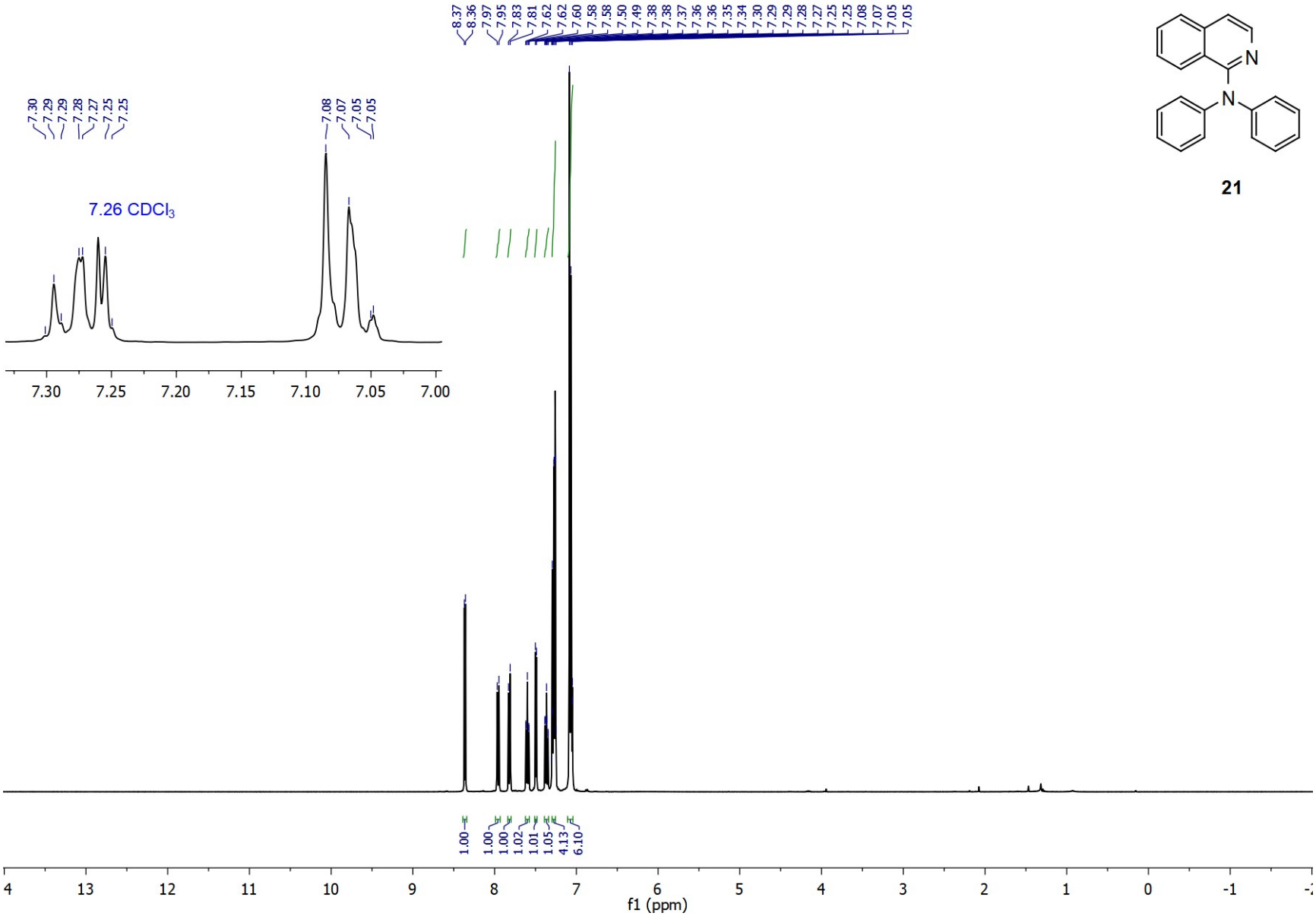
^{1}H MNR (400 MHz, $CDCl_3$) for *N*-benzyl-*N*-phenylisoquinolin-1-amine (**19**)



^{1}H MNR (400 MHz, $CDCl_3$) for *N*-allyl-*N*-phenylisoquinolin-1-amine (**20**)



^{1}H MNR (400 MHz, $CDCl_3$) for *N,N*-diphenylisoquinolin-1-amine (**21**)



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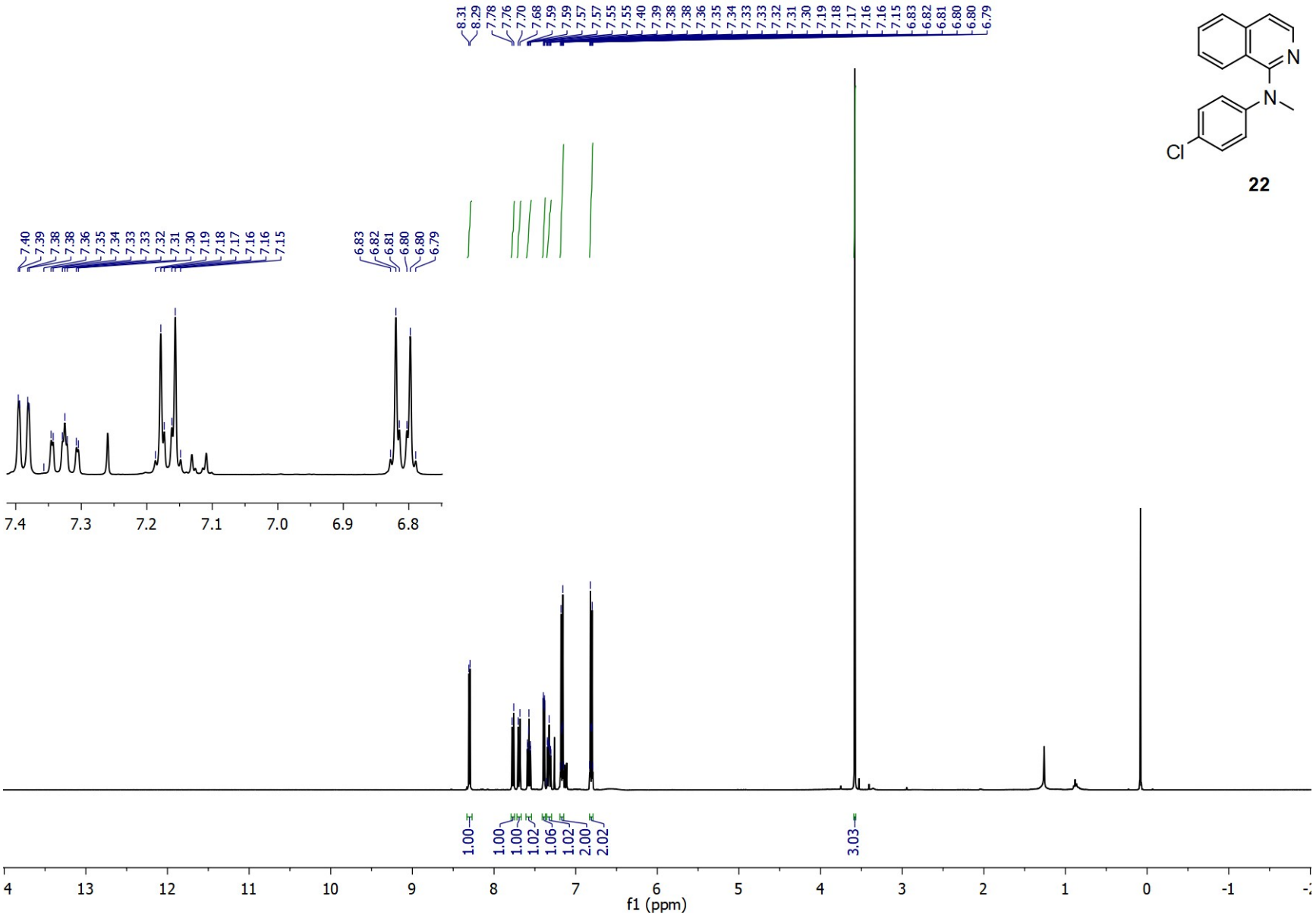
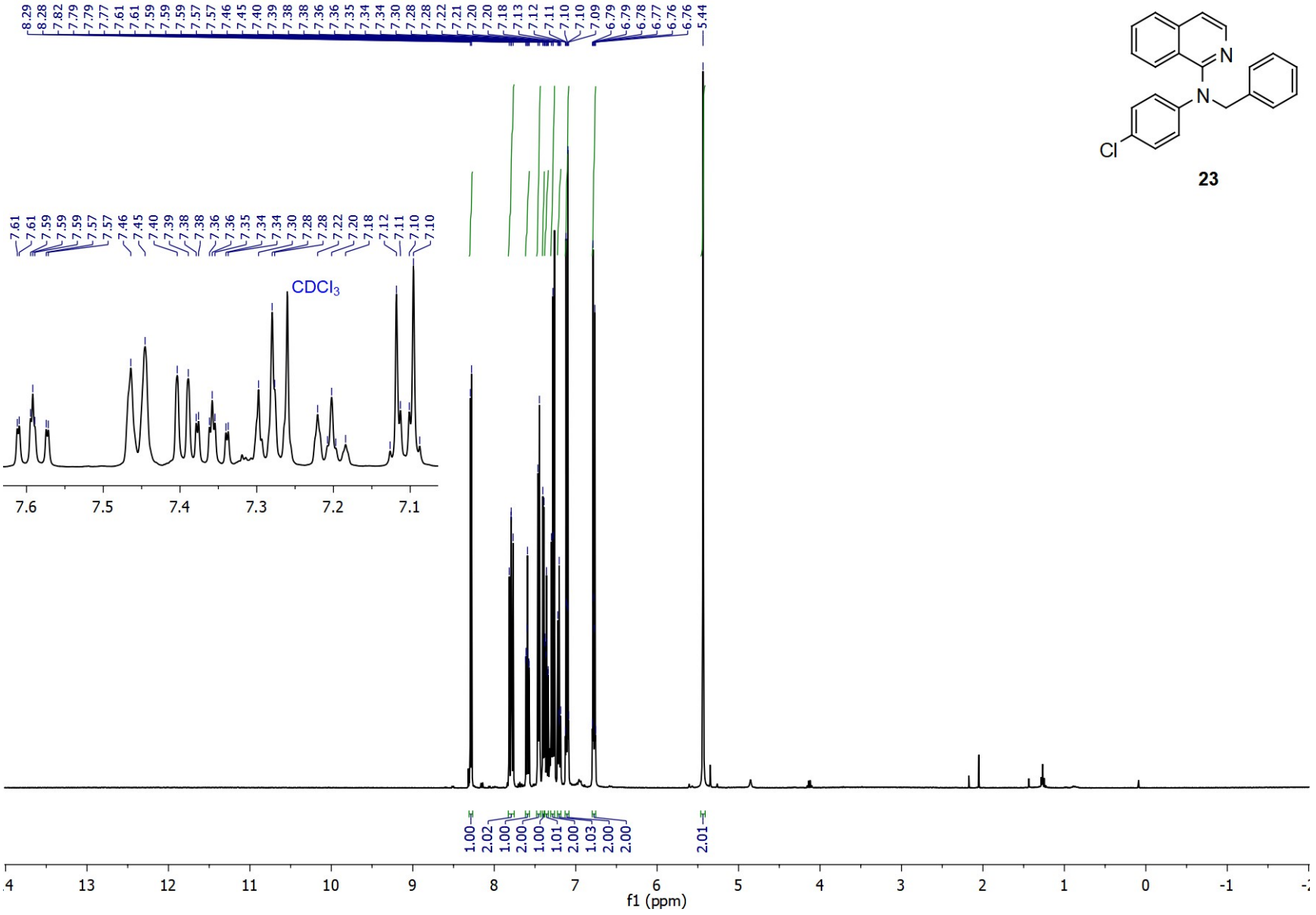
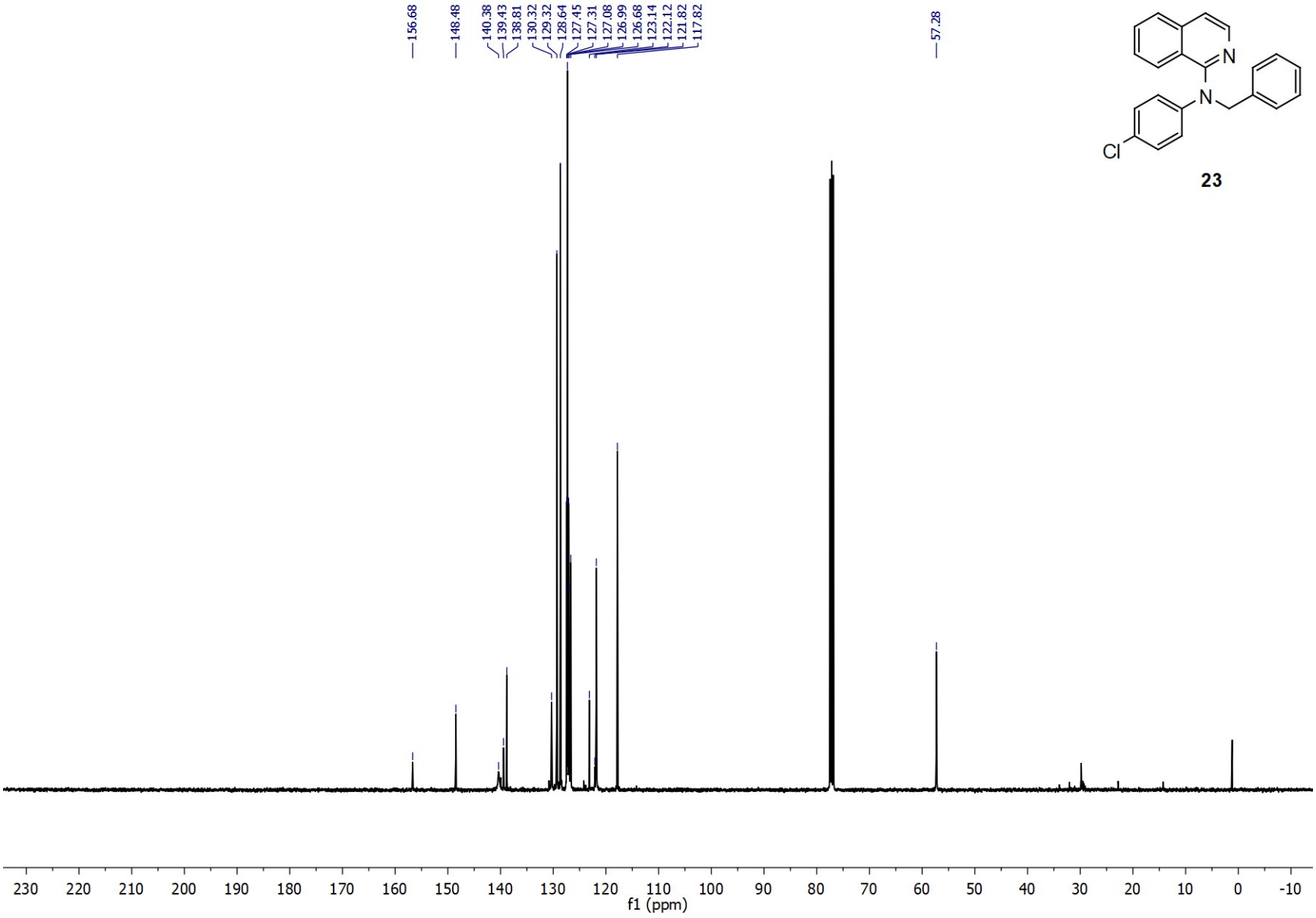
^{1}H MNR (400 MHz, $CDCl_3$) for *N*-(4-chlorophenyl)-*N*-methylisoquinolin-1-amine (**22**)



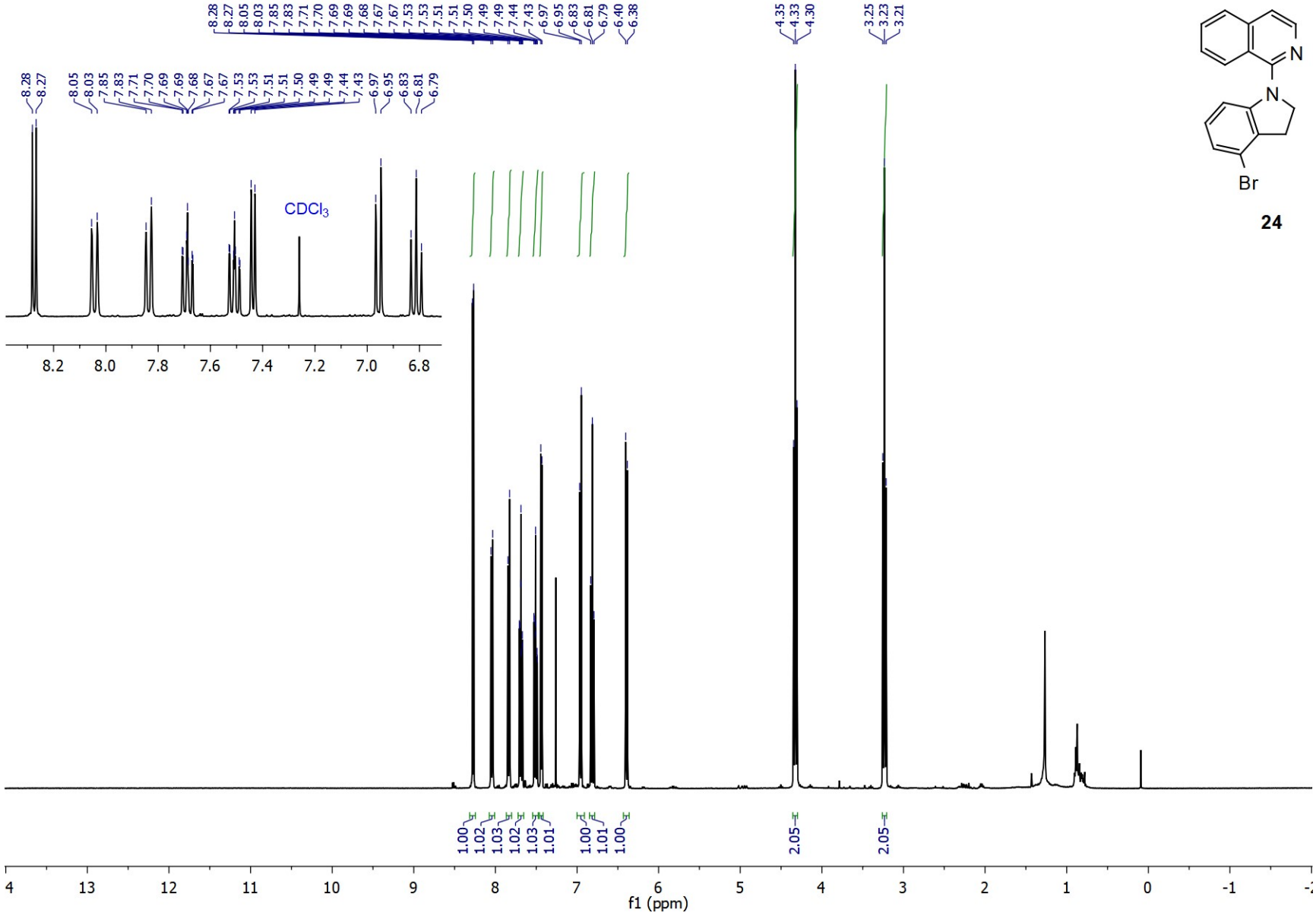
^{1}H MNR (400 MHz, $CDCl_3$) for *N*-benzyl-*N*-(4-chlorophenyl)naphthalen-1-amine (**23**)



^{13}C NMR (101 MHz, $CDCl_3$) *N*-benzyl-*N*-(4-chlorophenyl)naphthalen-1-amine (**23**)



^{1}H MNR (400 MHz, $CDCl_3$) for 1-(4-bromoindolin-1-yl)isoquinoline (**24**)



^{13}C NMR (101 MHz, $CDCl_3$) for 1-(4-bromoindolin-1-yl)isoquinoline (**24**)