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Supplementary Information

Manganese/cobalt-catalyzed oxidative C(sp^3)–H /C(sp^3)–H coupling: a route to α-tertiary β-arylethylamines

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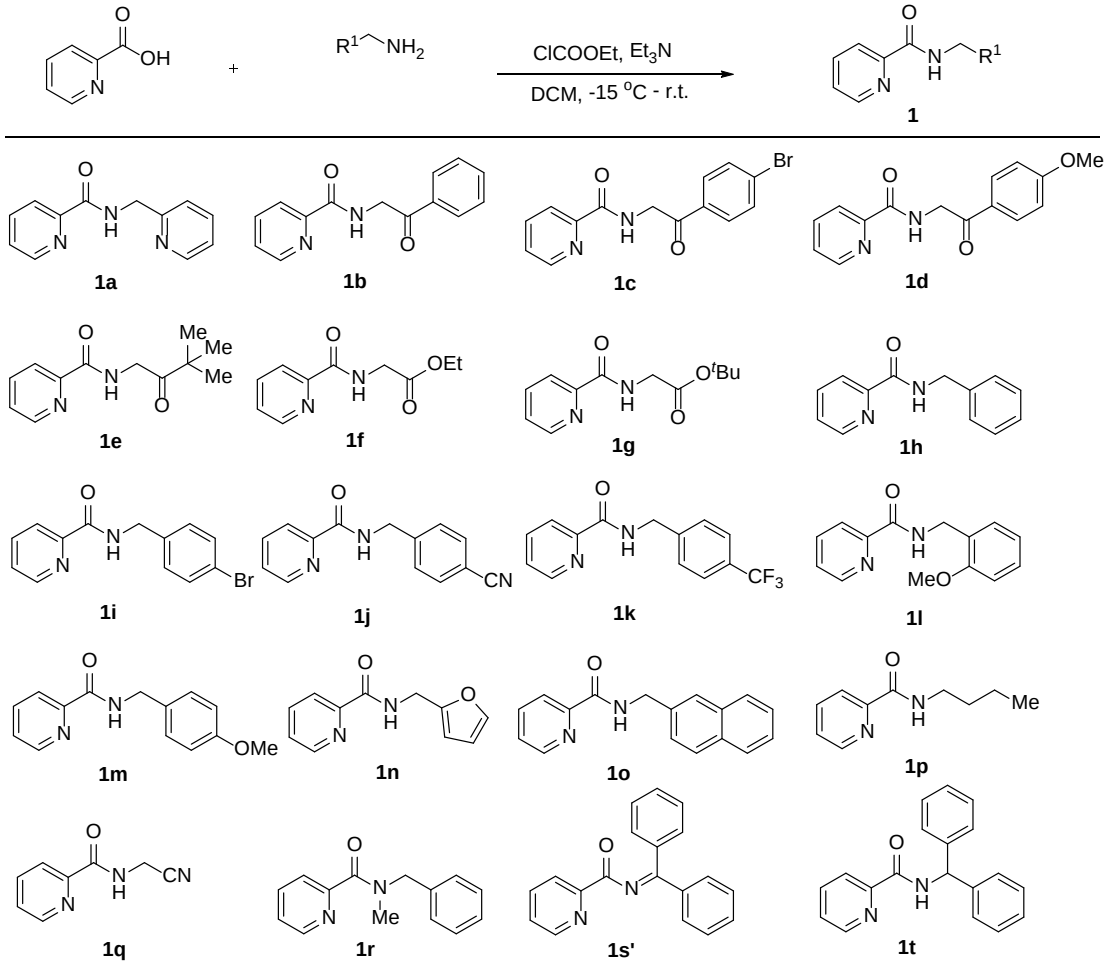
Contents

I. General remarks

All NMR spectra were obtained on a Varian Inova 400 MHz or a Bruker AV II-400 MHz spectrometer. The ^{1}H NMR (400 MHz) chemical shifts were measured relative to $CDCl_3$ or DMSO-d_6 which acted as the internal reference ($CDCl_3$: δ = 7.26 ppm; DMSO-d_6: δ = 2.50 ppm; TMS: δ = 0.00 ppm;). The ^{13}C NMR (100 MHz) chemical shifts were obtained by using $CDCl_3$ or DMSO-d_6 as the internal standard ($CDCl_3$: δ = 77.16 ppm; DMSO-d_6: δ = 39.52 ppm). High-resolution mass spectra (HRMS) were gained with a Waters-Q-TOF-Premier (ESI). Melting points were determined by XRC-1 and are uncorrected. The solvent (toluene) was dried by Innovative Technology PS-MD-5 Solvent Purification System.



II. Synthesis of *N*-(pyridin-2-ylmethyl)picolinamides

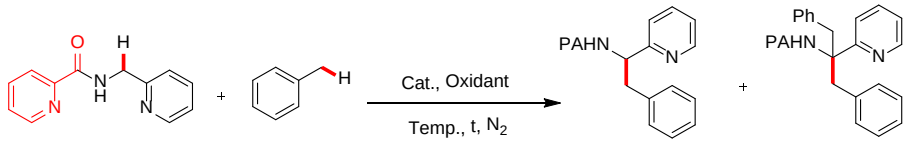
General procedure: Carboxylic acid (3.5 mmol, 0.43 g) was dissolved in dry dichloromethane (10.0 mL) in 50.0 mL round-bottom flask, and then triethylamine (7.0 mmol, 0.97 mL) was added under an N_2 atmosphere at -15 °C. After ethyl chloroformate (3.5 mmol, 0.33 mL) was added to the solution, the mixture was stirred at the same temperature for half an hour, and then a solution of amine (2.0 mmol) in DCM (2.0 mL) was added dropwise at -15 °C. The suspension was stirred at the same temperature for an hour, and then the mixture was warmed to room temperature and stirred for overnight.

Water (10.0 mL) was added to the suspension and the organic phase was separated. The aqueous phase was extracted with dichloromethane (2 × 10.0 mL), and the combined organic phases were dried over by anhydrous $MgSO_4$ and concentrated. The residue was purified by column chromatography on silica gel employing hexane/ethyl acetate as the eluent to get the desired *N*-(pyridin-2-ylmethyl)picolinamides.

III. Optimization of oxidative coupling reaction

A magnetic stirrer and amine derivative **1a** (0.25 mmol), toluene **2a** (1.0 mL) were added into an oven-dried Schlenk tube with catalyst under an N_2 atmosphere. The reaction mixture was stirred for several minutes at room temperature, and then DTBP (184.2 μL, 1.0 mmol) was added. The tube was sealed with a teflon-coated cap, and then the solution was stirred at 140 °C for 24 h. The solution was cooled to ambient temperature when the reaction was finished. Then the mixture was diluted with 10.0 mL of CH_2Cl_2, filtered by celite, and washed with 20.0 mL of CH_2Cl_2. The combined organic phases were concentrated and the residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate =2/1, v/v) to get **3a**. The reaction condition was optimizated as showed in Table S1. 1.0 mL of toluene was more suitable than 0.5 mL and 2.0 mL.

Table S1. Optimization of the oxidative coupling of *N*-(pyridin-2-ylmethyl)picolinamide with toluene[a]



1a **2a** **3a** **3ab**

Entry	Cat. (mol %)	Oxidant(equiv)	Temp (°C)	T (h)	Yield[b]
1	$Cu(OAc)_2·H_2O$ (20.0)	DTBP(4.0)	140	24	ND
2	$FeCl_3·6H_2O$ (20.0)	DTBP(4.0)	140	24	ND
3	$Ni(acac)_2$ (20.0)	DTBP(4.0)	140	24	40[c]
4	$Co(OAc)_2·4H_2O$ (20.0)	DTBP(4.0)	140	24	20[c]
5	$MnCl_2·4H_2O$ (20.0)	DTBP(4.0)	140	24	56
6	$Mn(acac)_2·2H_2O$ (20.0)	DTBP(4.0)	140	24	19
7	$Mn(acac)_3$ (20.0)	DTBP(4.0)	140	24	20
8	$Mn(OAc)_2·4H_2O$ (20.0)	DTBP(4.0)	140	24	40
9[d]	$MnCl_2·4H_2O$ (20.0)	DTBP(4.0)	140	24	50
10	none	DTBP(4.0)	140	24	ND
11	$MnCl_2·4H_2O$ (10.0)	DTBP(4.0)	140	24	45
12	$MnCl_2·4H_2O$ (20.0)	DTBP(4.0)	140	24	56
13	$MnCl_2·4H_2O$ (20.0)	TBHP (4.0)	140	24	ND
14	$MnCl_2·4H_2O$ (20.0)	TBPB (4.0)	140	24	ND
15	$MnCl_2·4H_2O$ (20.0)	$K_2S_2O_8$ (4.0)	140	24	ND
16	$MnCl_2·4H_2O$ (20.0)	H_2O_2 (4.0)	140	24	ND

17	$MnCl_2·4H_2O$ (20.0)	DCP (4.0)	140	24	42
18	$MnCl_2·4H_2O$ (20.0)	none	140	24	ND
19[e]	$MnCl_2·4H_2O$ (20.0)	DTBP(4.0)	140	24	17
20	$MnCl_2·4H_2O$ (20.0)	DTBP(4.0)	140	24	56
21	$MnCl_2·4H_2O$ (20.0)	DTBP(3.0)	140	24	45
22	$MnCl_2·4H_2O$ (20.0)	DTBP(5.0)	140	24	44
23	$MnCl_2·4H_2O$ (20.0)	DTBP(4.0)	130	24	53
24	$MnCl_2·4H_2O$ (20.0)	DTBP(4.0)	150	24	57
25	$Mn(OAc)_2·4H_2O$ (20.0)	DTBP(4.0)	150	24	53
26	**$Mn(OAc)_2·4H_2O$ (20.0)**	**DTBP(4.0)**	**150**	**18**	**62**
27	$Mn(OAc)_2·4H_2O$ (20.0)	DTBP(4.0)	150	12	43

[a]Reaction condition: **1a** (0.25 mmol), **2a** (1.0 mL), catalyst, and oxidant under an N_2 atmosphere for 24 hours. [b]Isolated yield. [c]**3ab** was obtained. [d]H_2O (20.0 equiv) was used as the additive. [e]Under air. [f]DTBP = Di-*t*ert-butyl peroxide, TBHP = *t*ert-butyl hydroperoxide, TBPB = *t*ert-butyl peroxybenzoate, and DCP = dicumyl peroxide. PAHN = picolinamido group.

IV. General procedure for the oxidative coupling reactions of amines with toluene derivatives

General procedure A: A magnetic stirrer and amine derivative **1a** (0.25 mmol), toluene derivative **2** (1.0 mL) were added into an oven-dried Schlenk tube under an N_2 atmosphere. The reaction mixture was stirred for several minutes at room temperature, and then DTBP (184.2 μL, 1.0 mmol) was added. The tube was sealed with a teflon-coated cap, and then the solution was stirred at 150 °C for 18 h. The solution was cooled to ambient temperature when the reaction was finished. Then the mixture was diluted with 10.0 mL of CH_2Cl_2, filtered by celite, and washed with 20.0 mL of CH_2Cl_2. The combined organic phases were concentrated and the residue was purified by column chromatography on silica gel to get the desired product.

General procedure B: A magnetic stirrer and amine derivative **1** (0.25 mmol), **2** (10.0 equiv) were added into an oven-dried Schlenk tube under an N_2 atmosphere, and benzene (0.5 mL) was used as the solvent. The reaction mixture was stirred for several minutes at room temperature, and then DTBP (184.2 μL, 1.0 mmol) was added. The tube was sealed with a teflon-coated cap, and then the solution was stirred at 150 °C for 18 h. The solution was cooled to ambient temperature when the reaction was finished. Then the mixture was diluted with 10.0 mL of CH_2Cl_2, filtered by celite, and washed with 20.0 mL of CH_2Cl_2. The combined organic phases were concentrated and the residue was purified by column chromatography on silica gel to get the desired product.

V. General procedure for removal of coordinating group and preparation of 3-(pyridin-2-yl)isoquinoline

(1) Removal of coordinating group

A magnetic stirrer and product **3a** (75.8 mg, 0.25 mmol,), ethanol (2.0 mL) were added into an oven-dried Schlenk tube, and then $BF_3·Et_2O$ (315.4 μL, 2.5 mmol) was added drop by

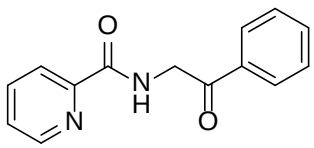
drop under an N_2 atmosphere. The tube was sealed with a teflon-coated cap, and the reaction mixture was stirred for several minutes at room temperature. The solution was stirred at 140 °C for 32 h. The solution was cooled to ambient temperature when the reaction was finished. Saturated Na_2CO_3 aqueous solution was dropped slowly. Subsequently, the mixture was washed by ethyl acetate (3 × 10.0 mL), and then the organic phases were combined and anhydrous Na_2SO_4 was used for desiccation. Thereafter, the solution was filtered by celite, and the residue was obtained after the solvent was removed by rotary evaporateion. The residue was dissolve in DCM (3.0 mL), and Et_3N (70.0 μL, 0.5 mmol) and Boc_2O (109.1 mg, 0.5 mmol) was next add to the reaction mixture. The reaction was stirred under room temperature overnight. The solvent was removed after the reaction was finished, and the residue was purified by column chromatography on silica gel to get the desired product **5a**.

(2) Preparation of 3-(pyridin-2-yl)isoquinoline

A magnetic stirrer and product **3a** (75.8 mg, 0.25 mmol,), ethanol (2.0 mL) were added into an oven-dried Schlenk tube, and then $BF_3{\cdot}Et_2O$ (315.4 μL, 2.5 mmol) was added drop by drop under an N_2 atmosphere. The tube was sealed with a teflon-coated cap, and the reaction mixture was stirred for several minutes at room temperature. Next, the solution was stirred at 140 °C for 32 h. The solution was cooled to ambient temperature when the reaction was finished, and then saturated Na_2CO_3 aqueous solution was dropped slowly. Subsequently, the mixture was washed by ethyl acetate (3 × 10.0 mL), and then the organic phases were combined and anhydrous Na_2SO_4 was used for desiccation. Thereafter, the solution was filtered by celite, and the residue was gotten after the solvent was removed by rotary evaporateion.

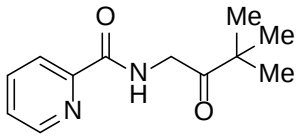
Concentrated HCl (0.75 mL) was added to the mixture of the residue in $CHCl_3$ (1.0 mL) and HCHO (0.45 mL), and the mixture was stirred under an N_2 atmosphere and 80~90 °C for 10 hours .The solution was cooled to ambient temperature when the reaction was finished. Saturated Na_2CO_3 aqueous solution was dropped slowly. Subsequently, the mixture was washed by ethyl acetate (3 × 10.0 mL), and then the organic phases were combined and anhydrous Na_2SO_4 was used for desiccation. Thereafter, the solution was filtered by celite, and the residue was gotten after the solvent was removed by rotary evaporateion. The residue was add to DMF (2.0 mL), and then $KMnO_4$ (0.25 mmol) was added for several times. The reaction was next stirred under room temperature. The solvent was removed after the reaction was finished, and the residue was purified by column chromatography on silica gel to get the desired product **5b**.

VI. Experimental data of the described compounds



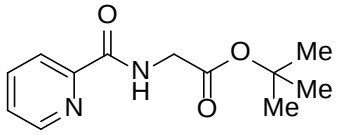
***N*-(2-Oxo-2-phenylethyl)picolinamide (1b)**

^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.96 (s, 1H), 8.62 (s, 1H), 8.19 (d, J = 7.6 Hz, 1H), 8.03 (d, J = 7.6 Hz, 2H), 7.85 (t, J = 7.6 Hz, 1H), 7.62 (t, J = 7.2 Hz, 1H), 7.51 (t, J = 7.2 Hz, 2H), 7.44 (s, 1H), 4.97 (s, 2H) ppm. ^{3}C NMR (100 MHz, $CDCl_3$): δ = 193.93, 164.72, 149.58, 148.52, 137.34, 134.67, 134.13, 129.01, 128.06, 126.46, 122.30, 46.49 ppm.



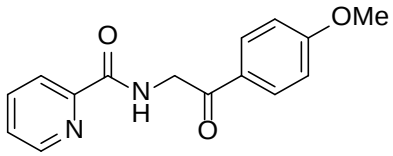
***N*-(3,3-Dimethyl-2-oxobutyl)picolinamide (1e)**

^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.69 (s, 1H), 8.58 (s, 1H), 8.15 (d, J = 7.6 Hz, 1H), 7.82 (t, J = 7.6 Hz, 1H), 7.42 (s, 1H), 4.47 (s, 2H), 1.23 (s, 9H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 210.28, 164.66, 149.61, 148.48, 137.31, 126.39, 122.20, 44.77, 43.31, 26.50 ppm.



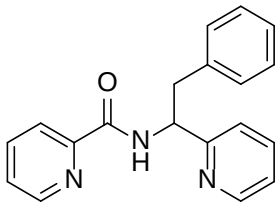
***t*ert-Butyl picolinoylglycinate (1g)**

^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.57 (d, J = 4.8 Hz, 1H), 8.46 (s, 1H), 8.17 (d, J = 8.0 Hz, 1H), 7.83 (t, J = 7.6 Hz, 1H), 7.44-7.40 (m, 1H), 4.15 (d, J = 5.6 Hz, 2H), 1.49 (s, 9H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 169.02, 164.60, 149.60, 148.41, 137.37, 126.43, 122.35, 82.41, 42.16, 28.21 ppm.



***N*-(2-(4-Methoxyphenyl)-2-oxoethyl)picolinamide (1m)**

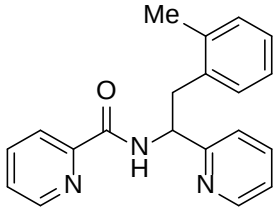
^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.97 (s, 1H), 8.63 (s, 1H), 8.20 (d, J = 8.0 Hz, 1H), 8.02 (d, J = 8.4 Hz, 2H), 7.85 (t, J = 7.4 Hz, 1H), 7.44 (s, 1H), 6.98 (d, J = 8.4 Hz, 2H), 4.92 (s, 2H), 3.88 (s, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 192.35, 164.73, 164.28, 149.70, 148.55, 137.34, 130.41, 127.75, 126.43, 122.28, 114.21, 55.69, 46.11 ppm.



***N*-(2-Phenyl-1-(pyridin-2-yl)ethyl)picolinamide (3a)**

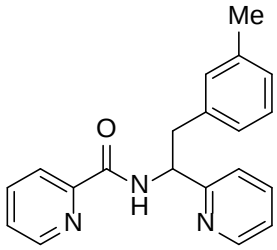
Following the general procedure A. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 2/1, v/v) afforded **3a** as yellow oil (46.9 mg, 62% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.11 (d, J = 7.6 Hz, 1H), 8.61 (dd, J = 23.6, 3.6 Hz, 2H), 8.17 (d, J = 8.0 Hz, 1H), 7.80 (t, J = 7.6 Hz, 1H), 7.48 (t, J = 7.6 Hz, 1H), 7.40 – 7.38 (m, 1H), 7.17 - 7.15 (m, 4H), 7.03 (d, J = 6.8 Hz, 2H), 6.92 (d, J = 7.6 Hz, 1H), 5.49-5.44 (m, 1H), 3.41-3.36 (m, 1H), 3.24-3.18 (m, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.78, 159.18, 150.05, 149.59, 148.36, 137.52, 137.26, 136.25, 129.59, 128.28, 126.49, 126.16, 122.66, 122.49, 122.24, 55.93, 42.50 ppm. HRMS (ESI$^+$): calcd for $C_{19}H_{18}N_3O$ $[M+H]^+$

304.1444, found 304.1441.



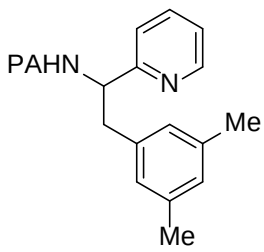
***N*-(1-(Pyridin-2-yl)-2-(*o*-tolyl)ethyl)picolinamide (3b)**

Following the standard procedure A. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 2/1, v/v) afforded **3b** as yellow oil (53.9 mg, 68% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.24 (d, *J* = 7.6 Hz, 1H), 8.64 (dd, *J* = 23.6, 4.4 Hz, 2H), 8.18 (d, *J* = 8.0 Hz, 1H), 7.82 (t, *J* = 7.6 Hz, 1H), 7.48 – 7.38 (m, 2H), 7.19 – 7.13 (m, 1H), 7.11 – 7.03 (m, 2H), 6.98 (t, *J* = 8.0 Hz, 1H), 6.89 (d, *J* = 7.6 Hz, 1H), 6.74 (d, *J* = 8.0 Hz, 1H), 5.38-5.44 (m, 1H), 3.46-3.41 (m, 1H), 3.17-3.11 (m, 1H), 2.23 (s, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.86, 159.10, 150.18, 149.71, 148.43, 137.32, 137.00, 136.17, 135.85, 130.54, 130.31, 126.69, 126.19, 125.76, 122.90, 122.62, 122.28, 55.35, 40.18, 19.35. ppm. HRMS (ESI$^+$): calcd for $C_{20}H_{20}N_3O$ $[M+H]^+$ 318.1601, found 318.1606.



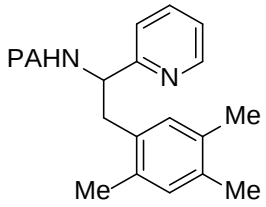
***N*-(1-(Pyridin-2-yl)-2-(*m*-tolyl)ethyl)picolinamide (3c)**

Following the standard procedure A. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 2/1, v/v) afforded **3c** as yellow oil (40.2 mg, 51% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.09 (d, *J* = 7.6 Hz, 1H), 8.63 (dd, *J* = 22.2, 3.8 Hz, 2H), 8.18 (d, *J* = 7.6 Hz, 1H), 7.82 (t, *J* = 7.6 Hz, 1H), 7.50 (t, *J* = 7.6 Hz, 1H), 7.43 – 7.38 (m, 1H), 7.19 – 7.13 (m, 1H), 7.06 (t, *J* = 7.6 Hz, 1H), 6.96 (d, *J* = 7.2 Hz, 1H), 6.94 – 6.88 (m, 2H), 6.80 (d, *J* = 7.6 Hz, 1H), 5.47-5.41 (m, 1H), 3.35-3.34 (m, 1H), 3.19-3.13 (m, 1H), 2.23 (s, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.85, 159.38, 150.17, 149.62, 148.40, 137.88, 137.45, 137.31, 136.24, 130.50, 128.18, 127.27, 126.65, 126.19, 122.76, 122.50, 122.31, 56.07, 42.51, 21.41 ppm. HRMS (ESI$^+$): calcd for $C_{20}H_{20}N_3O$ $[M+H]^+$ 318.1601, found 318.1597.



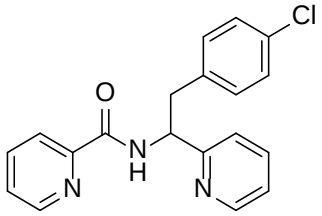
***N*-(2-(3,5-Dimethylphenyl)-1-(pyridin-2-yl)ethyl)picolinamide (3d)**

Following the general procedure A. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 2/1, v/v) afforded **3d** as yellow oil (42.6 mg, 51% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.08 (d, J = 7.6 Hz, 1H), 8.63 (dd, J = 22.6, 3.8 Hz, 2H), 8.18 (d, J = 7.6 Hz, 1H), 7.83 (t, J = 7.6 Hz, 1H), 7.50 (t, J = 7.6 Hz, 1H), 7.44 – 7.39 (m, 1H), 7.19 – 7.13 (m, 1H), 6.92 (d, J = 7.6 Hz, 1H), 6.79 (s, 1H), 6.65 (s, 2H), 5.44-5.38 (m, 1H), 3.32-3.30 (m, Hz, 1H), 3.14-3.08 (m, 1H), 2.19 (s, 6H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.86, 159.51, 150.22, 149.60, 148.40, 137.72, 137.32, 136.17, 128.16, 127.54, 126.19, 122.79, 122.47, 122.32, 56.14, 42.47, 21.29 ppm. HRMS (ESI$^+$): calcd for $C_{21}H_{21}N_3NaO$ $[M+Na]^+$ 354.1577, found 354.1580.



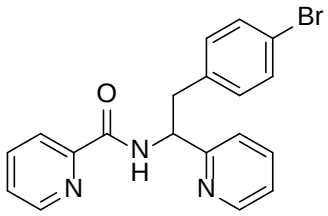
***N*-(1-(Pyridin-2-yl)-2-(2,4,5-trimethylphenyl)ethyl)picolinamide (3e)**

Following the general procedure B. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 2/1, v/v) afforded **3e** as yellow oil (45.9 mg, 54% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.24 (d, J = 7.6 Hz, 1H), 8.64 (dd, J = 20.6, 3.8 Hz, 2H), 8.19 (d, J = 8.0 Hz, 1H), 7.83 (t, J = 7.6 Hz, 1H), 7.48-7.40 (m, 2H), 7.19 – 7.14 (m, 1H), 6.83 (s, 1H), 6.77 (d, J = 7.6 Hz, 1H), 6.72 (s, 1H), 5.40-5.35 (m, 1H), 3.37-3.32 (m, 1H), 3.10-3.05 (m, 1H), 2.15 (s, 3H), 2.07 (d, J = 5.2 Hz, 6H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.83, 159.29, 150.23, 149.61, 148.40, 137.29, 136.08, 134.59, 134.05, 133.67, 132.92, 131.91, 131.61, 126.15, 122.91, 122.51, 122.25, 55.66, 39.62, 19.32, 19.09, 18.65 ppm. HRMS (ESI$^+$): calcd for $C_{22}H_{24}N_3O$ $[M+H]^+$ 346.1914, found 346.1914.



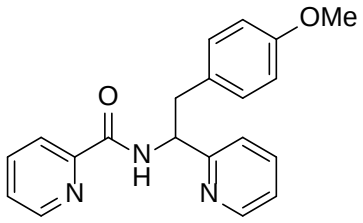
***N*-(2-(4-Chlorophenyl)-1-(pyridin-2-yl)ethyl)picolinamide (3f)**

Following the general procedure A. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 2/1, v/v) afforded **3f** as yellow oil (40.4 mg, 48% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.10 (d, J = 6.4 Hz, 1H), 8.62 (d, J = 20.4 Hz, 2H), 8.17 (d, J = 7.6 Hz, 1H), 7.85-7.82 (m, 1H), 7.52-7.52 (m, 1H), 7.42 (s, 1H), 7.20 – 7.11 (m, 3H), 6.94 (d, J = 7.6 Hz, 3H), 5.48-5.48 (m, 1H), 3.35-3.33 (m, 1H), 3.25 – 3.12 (m, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.85, 158.77, 149.93, 149.71, 148.43, 137.36, 136.46, 136.02, 132.36, 130.96, 128.45, 126.30, 122.71, 122.30, 55.69, 41.77 ppm. HRMS (ESI$^+$): calcd for $C_{19}H_{17}ClN_3O$ $[M+H]^+$ 338.1055, found 338.1063.



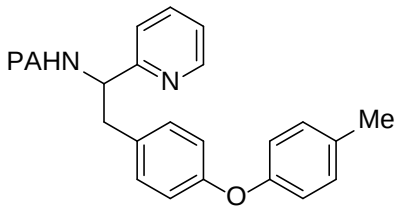
***N*-(2-(4-Bromophenyl)-1-(pyridin-2-yl)ethyl)picolinamide (3g)**

Following the general procedure B. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 2/1, v/v) afforded **3g** as yellow oil (30.9 mg, 32% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.09 (d, J = 7.6 Hz, 1H), 8.62 (d, J = 18.8, 2.8 Hz, 2H), 8.17 (d, J = 7.6 Hz, 1H), 7.83 (t, J = 7.6 Hz, 1H), 7.53 (t, J = 7.4 Hz, 1H), 7.44 – 7.39 (m, 1H), 7.29 (d, J = 7.6 Hz, 2H), 7.20 – 7.16 (m, 1H), 6.95 (d, J = 7.6 Hz, 1H), 6.90 (d, J = 7.6 Hz, 2H), 5.46-5.41 (m, 1H), 3.35-3.30 (m, 1H), 3.21-3.16 (m, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.89, 158.83, 149.99, 149.75, 148.46, 137.39, 136.58, 136.50, 131.44, 131.38, 126.32, 122.75, 122.72, 122.35, 120.54, 55.67, 41.85 ppm. HRMS (ESI$^+$): calcd for $C_{19}H_{17}{}^{79}BrN_3O$ $[M+H]^+$ 382.0550, found 382.0541; calcd for $C_{19}H_{17}{}^{81}BrN_3O$ $[M+H]^+$ 384.0529, found 384.0536.



***N*-(2-(4-Methoxyphenyl)-1-(pyridin-2-yl)ethyl)picolinamide (3h)**

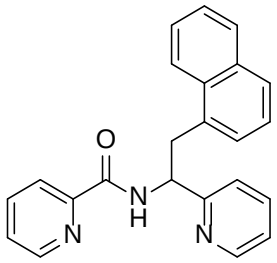
Following the general procedure A. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 2/1, v/v) afforded **3h** as yellow oil (35.8 mg, 43% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.11 (d, J = 6.4 Hz, 1H), 8.62 (d, J = 20.4 Hz, 2H), 8.17 (d, J = 7.6 Hz, 1H), 7.83-7.81 (m, 1H), 7.51-7.49 (m, 1H), 7.40 (s, 1H), 7.15 (s, 1H), 6.93 (d, J = 6.8 Hz, 3H), 6.71 (d, J = 8.0 Hz, 2H), 5.42-5.40 (m, 1H), 3.73 (s, 3H), 3.36-3.30 (m, 1H), 3.19 – 3.10 (m, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.80, 159.27, 158.21, 150.06, 149.59, 148.40, 137.29, 136.27, 130.58, 129.51, 126.19, 122.74, 122.48, 122.25, 113.69, 56.04, 55.23, 41.62 ppm. HRMS (ESI$^+$): calcd for $C_{20}H_{20}N_3O_2$ $[M+H]^+$ 334.1550, found 334.1550.



***N*-(1-(Pyridin-2-yl)-2-(4-(*p*-tolyloxy)phenyl)ethyl)picolinamide (3i)**

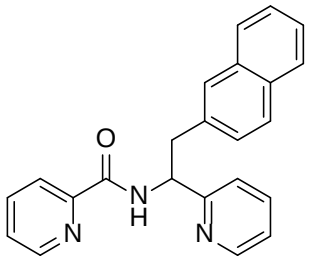
Following the general procedure B. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 2/1, v/v) afforded **3i** as yellow oil (47.3 mg, 46% yield). ^{1}H

NMR (400 MHz, $CDCl_3$): δ = 9.11 (d, *J* = 8.4 Hz, 1H), 8.62 (dd, *J* = 21.6, 3.6 Hz, 2H), 8.18 (d, *J* = 7.6 Hz, 1H), 7.82 (t, *J* = 7.6 Hz, 1H), 7.52 (t, *J* = 7.6 Hz, 1H), 7.43 – 7.38 (m, 1H), 7.19 – 7.14 (m, 1H), 7.10 (d, *J* = 8.0 Hz, 2H), 6.97 (d, *J* = 7.6 Hz, 3H), 6.85 (d, *J* = 7.6 Hz, 2H), 6.80 (d, *J* = 7.6 Hz, 2H), 5.47-5.42 (m, 1H), 3.36-3.34 (m, 1H), 3.22-3.17 (m, 1H), 2.31 (s, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.83, 159.21, 156.33, 154.99, 150.07, 149.65, 148.41, 137.31, 136.31, 132.77, 132.08, 130.81, 130.25, 126.21, 122.74, 122.55, 122.28, 118.94, 118.38, 55.99, 41.74, 20.79 ppm. HRMS (ESI^+): calcd for $C_{26}H_{24}N_3O_2$ $[M+H]^+$ 410.1863, found 410.1863.



***N*-(2-(Naphthalen-1-yl)-1-(pyridin-2-yl)ethyl)picolinamide (3j)**

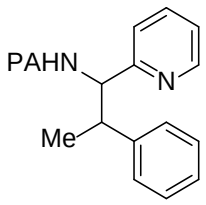
Following the general procedure B. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 2/1, v/v) afforded **3j** as yellow oil (41.4 mg, 47% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.38 (d, *J* = 6.8 Hz, 1H), 8.66 (d, *J* = 29.6 Hz, 2H), 7.58 (t, *J* = 7.6 Hz, 1H), 8.47 (d, *J* = 8.4 Hz, 1H), 8.24 (d, *J* = 8.0 Hz, 1H), 7.87-7.82 (m, 2H), 7.68 (d, *J* = 8.0 Hz, 1H), 7.48 (t, *J* = 7.2 Hz, 1H), 7.45 – 7.41 (m, 1H), 7.30 (t, *J* = 7.6 Hz, 1H), 7.19 (t, *J* = 7.6 Hz, 1H), 7.15 – 7.11 (m, 1H), 6.88 (d, *J* = 6.8 Hz, 1H), 6.44 (d, *J* = 7.6 Hz, 1H), 5.64-5.59 (m, 1H), 4.07 (d, *J* = 13.2 Hz, 1H), 3.46 – 3.37 (m, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 164.16, 158.74, 150.21, 149.71, 148.48, 137.37, 135.95, 133.88, 133.76, 132.41, 128.67, 128.02, 127.43, 126.45, 126.25, 125.74, 125.19, 124.38, 123.08, 122.62, 122.27, 55.51, 40.32 ppm. HRMS (ESI^+): calcd for $C_{23}H_{20}N_3O$ $[M+H]^+$ 354.1601, found 354.1607.



***N*-(2-(Naphthalen-2-yl)-1-(pyridin-2-yl)ethyl)picolinamide (3k)**

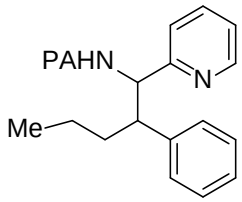
Following the general procedure B. Purification via column chromatography on silica gel (petroleum ether / ethyl acetate = 2/1, v/v) afforded **3k** as yellow oil (39.6 mg, 45% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.18 (d, *J* = 7.6 Hz, 1H), 8.63 (dd, *J* = 31.8, 3.4 Hz, 2H), 8.18 (d, *J* = 7.6 Hz, 1H), 7.82 (t, *J* = 7.6 Hz, 1H), 7.78 – 7.74 (m, 1H), 7.68 (d, *J* = 8.0 Hz, 2H), 7.50 (s, 1H), 7.45 – 7.38 (m, 4H), 7.19-7.14 (m, 2H), 6.89 (d, *J* = 7.6 Hz, 1H), 5.60-5.54 (m, 1H), 3.59-3.55 (m, 1H), 3.40-3.34 (m, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.91, 159.15, 150.11, 149.70, 148.42, 137.33, 136.34, 135.16, 133.54, 132.34,

128.25, 128.02, 127.90, 127.69, 126.23, 125.93, 125.49, 122.78, 122.59, 122.32, 56.00, 42.72 ppm. HRMS (ESI^+): calcd for $C_{23}H_{20}N_3O$ $[M+H]^+$ 354.1601, found 354.1601.



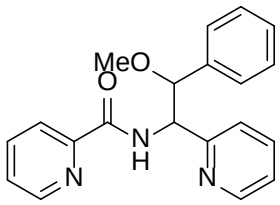
***N*-(2-Phenyl-1-(pyridin-2-yl)propyl)picolinamide (3l)**

Following the general procedure A. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 2/1, v/v) afforded **3l** as yellow oil (53.1 mg, 67% yield). **3l** was obtained as a mixture of two diastereomers, dr (anti/syn) ≈ 1:1. ^1H NMR (400 MHz, $CDCl_3$): δ = 9.11(d, J = 9.2 Hz, 1H), 9.02 (d, J = 8.0 Hz, 1H), 8.66 – 8.59 (m, 2H), 8.57-8.55 (m, 2H), 8.19 (d, J = 8.0 Hz, 1H), 8.10 (d, J = 7.6 Hz, 1H), 7.83 (t, J = 7.6 Hz, 1H), 7.77 (t, J = 7.6 Hz, 1H), 7.52 (t, J = 7.6 Hz, 1H), 7.44 – 7.39 (m, 1H), 7.39 – 7.34 (m, 1H), 7.25 (d, J = 5.2 Hz, 2H), 7.21 – 7.08 (m, 8H), 7.04-7.03 (m, 3H), 6.94 (d, J = 8.0 Hz, 1H), 6.73 (d, J = 7.6 Hz, 1H), 5.45 (t, J = 7.8 Hz, 1H), 5.38 (t, J = 9.2 Hz, 1H), 3.69-3.62 (m, 1H), 3.42-3.35 (m, 1H), 1.48 (d, J = 6.8 Hz, 3H), 1.22 (d, J = 7.0 Hz, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 164.09, 163.80, 159.35, 158.86, 150.12, 150.04, 149.44, 148.41, 148.36, 143.35, 142.70, 137.32, 137.22, 136.12, 135.85, 128.35, 128.26, 128.15, 128.00, 126.71, 126.51, 126.20, 126.09, 123.24, 123.18, 122.45, 122.24, 122.21, 60.00, 59.48, 46.46, 44.47, 18.35, 17.27 ppm. HRMS (ESI^+): calcd for $C_{20}H_{20}N_3O$ $[M+H]^+$ 318.1601, found 318.1604.



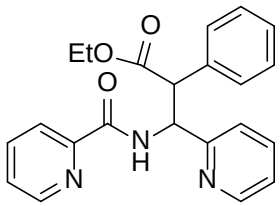
***N*-(2-Phenyl-1-(pyridin-2-yl)pentyl)picolinamide(3m)**

Following the general procedure A. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 2/1, v/v) afforded **3m** as yellow oil (56.1 mg, 65% yield). **3m** was obtained as a mixture of two diastereomers, dr (anti/syn) ≈ 1:1. ^1H NMR (400 MHz, DMSO-d_6): δ = 9.05 (d, J = 9.2 Hz, 1H), 8.80 (d, J = 9.2 Hz, 1H), 8.69 (s, 1H), 8.60 (s, 1H), 8.55 (s, 1H), 8.48 (s, 1H), 8.08 (d, J = 7.6 Hz, 1H), 8.01 (t, J = 7.2 Hz, 1H), 7.92 (s, 2H), 7.74 (t, J = 7.4 Hz, 1H), 7.63-7.61 (m, 1H), 7.57 – 7.48 (m, 2H), 7.39 (d, J = 7.2 Hz, 1H), 7.29-7.27 (m, 1H), 7.20 (d, J = 6.8 Hz, 2H), 7.15-7.12 (m, 6H), 7.08 (d, J = 6.4 Hz, 1H), 7.01 - 6.95 (m, 3H), 5.45-5.41 (m, 1H), 5.38-5.33 (m, 1H), 3.33-3.32 (m, 1H), 3.22-3.17 (m, 1H), 1.82 (d, J = 10.0 Hz, 1H), 1.76-1.72 (m, 1H), 1.58-1.57 (m, 1H), 1.36-1.35 (m, 1H), 1.05 – 0.96 (m, 4H), 0.74 (t, J = 6.8 Hz, 3H), 0.68 (t, J = 6.8 Hz, 3H) ppm. ^{13}C NMR (100 MHz, DMSO-d_6): δ = 162.89, 162.43, 159.67, 158.97, 149.40, 149.24, 149.01, 148.91, 148.64, 148.51, 141.11, 140.99, 138.05, 137.90, 136.58, 136.09, 128.35, 128.02, 128.00, 126.80, 126.66, 126.41, 126.27, 122.77, 122.63, 122.55, 122.31, 121.95, 121.74, 58.37, 57.92, 50.95, 49.98, 33.91, 33.71, 20.08, 19.96, 13.86, 13.78 ppm. HRMS (ESI^+): calcd for $C_{22}H_{23}N_3NaO$ $[M+Na]^+$ 368.1733, found 368.1732.



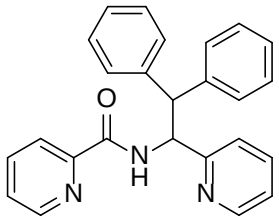
***N*-(2-Methoxy-2-phenyl-1-(pyridin-2-yl)ethyl)picolinamide (3n)**

Following the general procedure B. Purification via column chromatography on silica gel (petroleum ether / ethyl acetate = 2/1, v/v) afforded **3n** as yellow oil (43.3 mg, 52% yield). **3n** was obtained as a mixture of two diastereomers, dr (anti/syn) = 1:1. ^{1}H NMR (400 MHz, DMSO-d_6): δ = 9.09 (d, J = 8.8 Hz, 1H)，8.96 (d, J = 9.2 Hz, 1H), 8.73 (s, 1H), 8.64 (s, 1H), 8.56 (s, 1H), 8.52 (s, 1H), 8.00 (s, 2H), 7.97-7.93 (m, 2H), 7.71 (t, J = 7.2 Hz, 2H), 7.66-7.64 (m, 1H), 7.60-7.58 (m, 1H), 7.26-7.22 (m, 12H), 7.16-7.14 (m, 2H), 5.48-5.44 (m, 1H), 5.35 – 5.30 (m, 1H), 4.90 (s, 1H), 4.76 (d, J = 6.4 Hz, 1H), 3.14 (s, 3H), 3.07 (s, 3H) ppm. ^{13}C NMR (100 MHz, DMSO-d_6): δ = 163.01, 162.41, 157.82, 157.71, 149.15, 148.88, 148.74, 148.58, 138.34, 138.08, 138.01, 137.96, 136.53, 136.33, 128.09, 127.99, 127.88, 127.75, 127.41, 126.91, 126.79, 123.16, 122.73, 122.59, 122.23, 121.84, 121.81, 84.78, 84.15, 58.87, 57.83, 56.94, 56.62 ppm. HRMS (ESI$^+$): calcd for $C_{20}H_{20}N_3O_2$ [M+H]$^+$ 334.1550, found 334.1550.



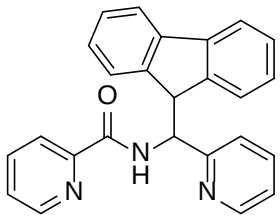
Ethyl 2-phenyl-3-(picolinamido)-3-(pyridin-2-yl)propanoate (3o)

Following the general procedure A. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 3/1, v/v) afforded **3o** as yellow oil (70.3 mg, 75% yield). **3o** was obtained as a mixture of two diastereomers, dr (anti/syn) = 1:1. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.50 (d, J = 9.6 Hz, 1H), 8.64-8.60 (m, 3H), 8.55 (d, J = 4.8 Hz, 1H), 8.46 (d, J = 4.8 Hz, 1H), 8.11 (d, J = 8.0 Hz, 1H), 7.99 (d, J = 8.0 Hz, 1H), 7.80 (t, J = 8.0 Hz, 1H), 7.72 (t, J = 7.2 Hz,1H), 7.63 (t, J = 7.6 Hz,1H), 7.51 – 7.43 (m, 4H), 7.43-7.40 (m, 1H), 7.34 – 7.30 (m, 3H), 7.29 – 7.26 (m, 1H), 7.25-7.24 (m, 1H), 7.22-7.17 (m, 6H), 7.11-7.08 (m, 1H), 6.05 (t, J = 10.2 Hz, 1H), 5.84-5.80 (m, 1H), 4.63 (d, J = 6.8 Hz, 1H), 4.48 (d, J = 10.2 Hz, 1H), 4.19-4.06 (m, 2H), 4.03-3.92 (m, 2H), 1.15 (t, J = 7.2 Hz, 3H), 1.04 (t, J = 7.2 Hz, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 172.54, 171.70, 164.12, 163.54, 159.01, 158.76, 149.84, 149.59, 149.56, 149.28, 148.51, 148.18, 137.27, 137.19, 136.73, 136.54, 135.79, 135.53, 129.07, 128.78, 128.62, 128.60, 127.83, 127.66, 126.28, 126.16, 123.87, 122.89, 122.69, 122.52, 122.49, 122.31, 61.17, 60.97, 57.07, 56.47, 55.63, 55.27, 14.14, 14.03 ppm. HRMS (ESI$^+$): calcd for $C_{22}H_{22}N_3O_3$ [M+H]$^+$ 376.1656, found 376.1663.



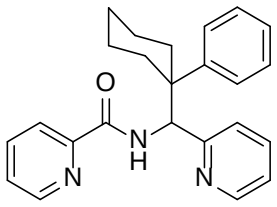
***N*-(2,2-Diphenyl-1-(pyridin-2-yl)ethyl)picolinamide (3p)**

Following the general procedure B. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 2/1, v/v) afforded **3p** as a white solid (58.7 mg, 62% yield), melting point: 140~142 °C. ^{1}H NMR (400 MHz, DMSO-d_6): δ = 8.86 (d, J = 9.2 Hz, 1H), 8.52 (d, J = 27.2 Hz, 2H), 7.93-7.91 (m, 2H), 7.53-7.51 (m, 4H), 7.29-7.21 (m, 5H), 7.11-7.09 (m, 4H), 7.02-6.98 (m, 1H), 6.12 (t, J = 10.4 Hz, 1H), 4.81 (d, J = 11.2 Hz, 1H) ppm. ^{13}C NMR (100 MHz, DMSO-d_6): δ = 162.45, 159.70, 149.12, 148.46, 142.19, 141.91, 137.93, 136.25, 128.32, 128.29, 128.21, 128.17, 126.72, 126.39, 126.20, 123.33, 122.43, 121.82, 56.42, 56.22 ppm. HRMS (ESI$^+$): calcd for $C_{25}H_{22}N_3O$ [M+H]$^+$ 380.1757, found 380.1763.



***N*-((9H-Fluoren-9-yl)(pyridin-2-yl)methyl)picolinamide (3q)**

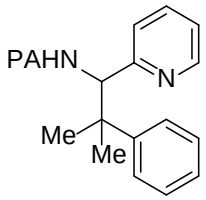
Following the general procedure B. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 2/1, v/v) afforded **3q** as yellow oil (53.6 mg, 57% yield). ^{1}H NMR (400 MHz, DMSO-d_6): δ = 9.08 (d, J = 8.8 Hz, 1H), 8.60 (d, J = 27.6 Hz, 2H), 8.03-7.96 (m, 2H), 7.83 (d, J = 7.6 Hz, 1H), 7.75 (d, J = 7.2 Hz, 1H), 7.66 (t, J = 7.2 Hz, 1H), 7.61-7.59 (m, 1H), 7.39 (t, J = 7.2 Hz, 1H), 7.28-7.25 (m, 4H), 7.19 (d, J = 8.4 Hz, 2H), 7.13 (d, J = 7.6 Hz, 1H), 5.86-5.84 (m, 1H), 4.93 (d, J = 2.0 Hz, 1H) ppm. ^{13}C NMR (100 MHz, DMSO-d_6): δ = 162.97, 157.57, 149.10, 148.71, 143.36, 142.81, 141.35, 140.71, 138.04, 136.57, 127.81, 127.42, 126.92, 126.74, 125.24, 125.06, 122.86, 121.90, 120.19, 119.83, 55.83, 51.04 ppm. HRMS (ESI$^+$): calcd for $C_{25}H_{20}N_3O$ [M+H]$^+$ 378.1601, found 378.1608.



***N*-((1-Phenylcyclohexyl)(pyridin-2-yl)methyl)picolinamide (3r)**

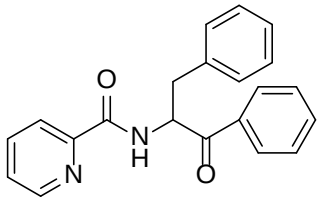
Following the general procedure A. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 2/1, v/v) afforded **3r** as yellow oil (53.8 mg, 58% yield). ^{1}H NMR (400 MHz, DMSO-d_6): δ = 9.05 (d, J = 10.0 Hz, 1H), 8.68 (s, 1H), 8.43 (s, 1H), 8.05 (d, J = 7.6 Hz, 1H), 7.99 (t, J = 7.4 Hz, 1H), 7.62-7.60 (m, 1H), 7.50 (t, J = 7.4 Hz, 1H),

7.25-7.17 (m, 4H), 7.00 (d, J = 7.2 Hz, 2H), 6.64 (d, J = 7.6 Hz, 1H), 5.23 (d, J = 9.6 Hz, 1H), 2.27 (t, J = 13.8 Hz, 2H), 1.73 (t, J = 12.6 Hz, 1H), 1.60 (t, J = 11.8 Hz, 1H), 1.51-1.40 (m, 4H), 1.12-1.02 (m, 2H) ppm. ^{13}C NMR (100 MHz, DMSO-d_6): δ = 162.69, 156.97, 149.34, 148.68, 148.16, 140.63, 138.03, 135.39, 127.96, 127.93, 126.78, 126.06, 123.60, 122.36, 121.91, 61.88, 47.44, 33.06, 31.09, 25.81, 21.64, 21.50 ppm. HRMS (ESI$^+$): calcd for $C_{24}H_{26}N_3O$ [M+H]$^+$ 372.2070, found 372.2072.



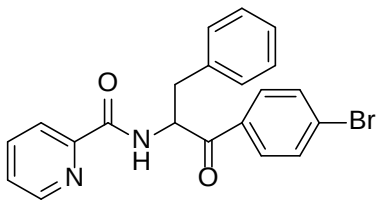
***N*-(2-Methyl-2-phenyl-1-(pyridin-2-yl)propyl)picolinamide (3s)**

Following the general procedure A. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 2/1, v/v) afforded **3s** as yellow oil (73.6 mg, 77% yield). ^{1}H NMR (400 MHz, DMSO-d_6): δ = 9.17 (d, J = 9.6 Hz, 1H), 8.70 (s, 1H), 8.53 (s, 1H), 8.05 – 7.95 (m, 2H), 7.62 (s, 1H), 7.51 (t, J = 7.4 Hz, 1H), 7.28 – 7.15 (m, 6H), 6.73 (d, J = 7.6 Hz, 1H), 5.47 (d, J = 10.0 Hz, 1H), 1.39 (s, 3H), 1.27 (s, 3H) ppm. ^{13}C NMR (100 MHz, DMSO-d_6): δ = 162.68, 157.43, 149.29, 148.69, 148.37, 145.83, 138.06, 135.60, 127.88, 126.82, 126.49, 126.19, 123.64, 122.47, 121.88, 60.87, 43.21, 26.07, 23.76 ppm. HRMS (ESI$^+$): calcd for $C_{21}H_{22}N_3O$ [M+H]$^+$ 332.1757, found 332.1765.



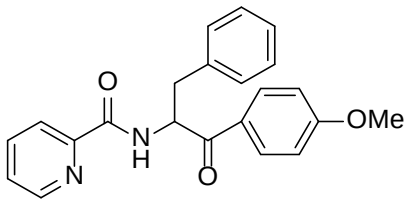
***N*-(1-Oxo-1,3-diphenylpropan-2-yl)picolinamide (4a)**

Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 3/1, v/v) afforded **4a** as yellow oil (65.3 mg, 80% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.82 (d, J = 7.6 Hz, 1H),8.57 (s, 1H), 8.16 (d, J = 8.0 Hz, 1H), 8.01 (d, J = 7.6 Hz, 2H), 7.82 (t, J = 7.6 Hz, 1H), 7.58 (t, J = 7.2 Hz, 1H), 7.47 (t, J = 7.4 Hz, 2H), 7.43-7.41 (m, 1H), 7.19-7.16 (m, 3H), 7.08 (d, J = 6.4 Hz, 2H), 6.06-6.01 (m, 1H), 3.41-3.36 (m, 1H), 3.19-3.14 (m, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 197.97, 163.97, 149.57, 148.48, 137.30, 136.07, 135.16, 133.82, 129.56, 128.94, 128.86, 128.49, 127.00, 126.41, 122.31, 54.86, 39.10 ppm. HRMS (ESI$^+$): calcd for $C_{21}H_{19}N_2O_2$ [M+H]$^+$ 331.1441, found 331.1443.



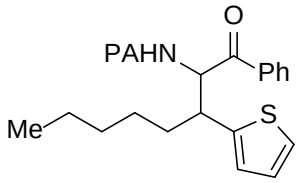
***N*-(1-(4-Bromophenyl)-1-oxo-3-phenylpropan-2-yl)picolinamide (4b)**

Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 3/1, v/v) afforded **4b** as yellow oil (47.7 mg, 77% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.78 (d, J = 4.4 Hz, 1H), 8.56 (s, 1H), 8.15 (d, J = 6.0 Hz, 1H), 7.85-7.83 (m, 3H), 7.59 (d, J = 6.4 Hz, 2H), 7.42 (s, 1H), 7.18 (s, 3H), 7.09 (s, 2H), 5.95-5.94 (m, 1H), 3.34 (d, J = 6.4 Hz, 1H), 3.16 (d, J = 8.4 Hz, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 197.21, 163.96, 149.40, 148.47, 137.35, 135.91, 133.99, 132.23, 130.30, 129.50, 129.09, 128.57, 127.10, 126.50, 122.34, 54.77, 39.02 ppm. HRMS (ESI$^+$): calcd for $C_{21}H_{17}{}^{79}BrN_2NaO_2$ $[M+Na]^+$ 431.0366, found 431.0365; calcd for $C_{21}H_{17}{}^{81}BrN_2NaO_2$ $[M+Na]^+$ 433.0345, found 433.0337.



***N*-(1-(4-Methoxyphenyl)-1-oxo-3-phenylpropan-2-yl)picolinamide (4c)**

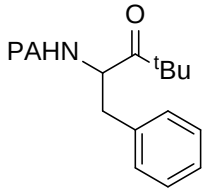
Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 3/1, v/v) afforded **4c** as yellow oil (66.0 mg, 73% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.83 (d, J = 8.0 Hz, 1H), 8.57 (s, 1H), 8.15 (d, J = 7.6 Hz, 1H), 7.99 (d, J = 8.0 Hz, 2H), 7.82 (t, J = 7.6 Hz, 1H), 7.42-7.39 (m, 1H), 7.19-7.17 (m, 3H), 7.09 (d, J = 6.4 Hz, 2H), 6.93 (d, J = 8.4 Hz, 2H), 6.00-5.95 (m, 1H), 3.87 (s, 3H), 3.39-3.34 (m, 1H), 3.18-3.13 (m, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 196.26, 164.13, 163.92, 149.67, 148.48, 137.28, 136.31, 131.25, 129.59, 128.46, 128.05, 126.93, 126.37, 122.29, 114.15, 55.65, 54.45, 39.42 ppm. HRMS (ESI$^+$): calcd for $C_{22}H_{21}N_2O_3$ $[M+H]^+$ 361.1547, found 361.1547.



***N*-(1-Oxo-1-phenyl-3-(thiophen-2-yl)octan-2-yl)picolinamide (4d)**

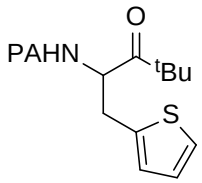
Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 4/1, v/v) afforded **4d** as yellow oil (51.7 mg, 51% yield). **4d** was obtained as a mixture of two diastereomers, dr (anti/syn) = 1:1. ^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.88 (d, J = 9.2 Hz, 1H), 8.79 (d, J = 10.0 Hz, 1H), 8.61 (d, J = 4.4 Hz, 2H), 8.17 (d, J = 8.0 Hz, 2H), 8.00 (d, J = 8.0 Hz, 2H), 7.93 (d, J = 8.0 Hz, 2H), 7.87 – 7.80 (m, 2H), 7.62 (t, J = 7.6 Hz, 1H), 7.52 (t, J = 7.6 Hz, 3H), 7.46-7.38 (m, 4H), 7.16 (d, J = 5.2 Hz, 1H), 7.04 (d, J = 4.8 Hz, 1H), 6.91 – 6.86 (m, 1H), 6.80-6.77 (m, 2H), 6.62 (d, J = 3.2 Hz, 1H), 6.10-6.06 (m, 1H), 6.01 – 5.97 (m, 1H), 3.68-3.64 (m, 1H), 3.59 - 3.53 (m, 1H), 1.79 – 1.68 (m, 4H), 1.29 – 1.12 (m, 12H), 0.85 – 0.76 (m, 6H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 199.19, 197.65, 164.47, 164.23, 149.58, 149.43, 148.58, 148.46, 143.69, 142.18, 137.43, 137.28, 135.96, 135.60, 133.74, 133.58, 129.04, 128.81, 128.74, 128.68, 126.67, 126.63, 126.55, 126.40, 126.00, 125.76, 124.38, 124.19, 122.55, 122.42, 57.81, 57.70, 44.72,

44.37, 34.36, 32.37, 31.68, 31.62, 27.31, 26.95, 22.58, 22.54, 14.15, 14.10 ppm. HRMS (ESI^+): calcd for $C_{24}H_{27}N_2O_2S$ $[M+H]^+$ 407.1788, found 407.1797.



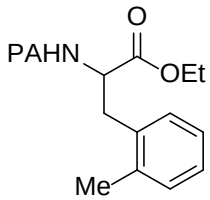
***N*-(4,4-Dimethyl-3-oxo-1-phenylpentan-2-yl)picolinamide (4e)**

Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 3/1, v/v) afforded **4e** as yellow oil (68.7 mg, 88% yield). ^1H NMR (400 MHz, DMSO-d_6): δ = 8.68-8.64 (m, 2H), 7.95 (s, 2H), 7.59 (s, 1H), 7.25 (s, 4H), 7.17 (s, 1H), 5.35-5.32 (m, 1H), 3.09 (d, J = 13.2 Hz, 1H), 2.97 – 2.89 (m, 1H), 1.11 (s, 9H) ppm. ^{13}C NMR (100 MHz, DMSO-d_6): δ = 213.34, 162.74, 149.03, 148.56, 137.94, 137.28, 129.27, 128.26, 126.84, 126.55, 121.96, 53.06, 43.56, 37.05, 25.85 ppm. HRMS (ESI^+): calcd for $C_{19}H_{22}N_2NaO_2$ $[M+Na]^+$ 333.1573, found 333.1578.



***N*-(4,4-Dimethyl-3-oxo-1-(thiophen-2-yl)pentan-2-yl)picolinamide (4f)**

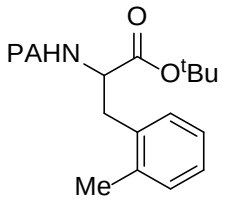
Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 5/1, v/v) afforded **4f** as yellow oil (46.6 mg, 59% yield).^1H NMR (400 MHz, $CDCl_3$): δ = 8.56 (d, J = 2.8 Hz, 1H), 8.46 (d, J = 9.6 Hz, 1H), 8.13 (d, J = 8.0 Hz, 1H), 7.82 (t, J = 8.0 Hz, 1H), 7.44-7.40 (m, 1H), 7.12 (d, J = 5.2 Hz, 1H), 6.89-6.87 (m, 1H), 6.84-6.83 (m, 1H), 5.56-5.50 (m, 1H), 3.42-3.37 (m, 1H), 3.18-3.13 (m, 1H), 1.11 (s, 9H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 213.60, 163.38, 149.37, 148.38, 138.36, 137.40, 127.05, 126.84, 126.51, 124.74, 122.43, 59.96, 52.72, 44.38, 33.18, 25.76 ppm. HRMS (ESI^+): calcd for $C_{17}H_{21}N_2O_2S$ $[M+H]^+$ 317.1318, found 317.1321.



Ethyl 2-(picolinamido)-3-*o*-tolylpropanoate (4g)

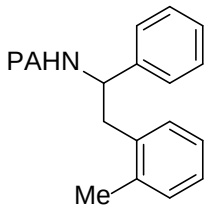
Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 4/1, v/v) afforded **4g** as yellow oil (41.4 mg, 52% yield). ^1H NMR (400 MHz, $CDCl_3$): δ = 8.61 – 8.43 (m, 2H), 8.13 (d, J = 7.6 Hz, 1H), 7.82 (t, J = 7.2 Hz, 1H), 7.43-7.41 (m, 1H), 7.15-7.12 (m, 4H), 5.04-4.98 (m, 1H), 4.20 – 4.09 (m, 2H), 3.22 (t, J = 6.8 Hz, 2H), 2.39 (s, 3H), 1.17 (t, J = 6.8 Hz, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 171.96, 164.11, 149.45, 148.39, 137.38, 136.86, 134.66, 130.63, 130.04, 127.23,

126.45, 126.06, 122.37, 61.52, 52.89, 36.41, 19.56, 14.14 ppm. HRMS (ESI^+): calcd for $C_{18}H_{20}N_2NaO_3$ $[M+Na]^+$ 335.1366, found 335.1372.



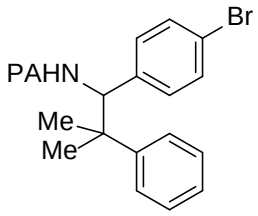
***t*ert-Butyl 2-(picolinamido)-3-(*o*-tolyl)propanoate (4h)**

Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 5/1, v/v) afforded **4h** as light yellow oil (45.0 mg, 53% yield).^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.58 – 8.50 (m, 2H), 8.13 (d, J = 8.0 Hz, 1H), 7.81 (t, J = 7.6 Hz, 1H), 7.42-7.39 (m, 1H), 7.19 – 7.16 (m, 1H), 7.15 – 7.11 (m, 2H), 7.10-7.08 (m, 1H), 4.97-4.91 (m, 1H), 3.18 (d, J = 7.6 Hz, 2H), 2.41 (s, 3H), 1.36 (s, 9H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 171.02, 163.96, 149.54, 148.35, 137.31, 136.87, 134.93, 130.48, 130.26, 127.07, 126.34, 125.90, 122.26, 82.19, 53.17, 36.69, 27.94, 19.63 ppm. HRMS (ESI^+): calcd for $C_{20}H_{24}N_2NaO_3$ $[M+Na]^+$ 363.1679, found 363.1685.



***N*-(1-Phenyl-2-(*o*-tolyl)ethyl)picolinamide (4i)**

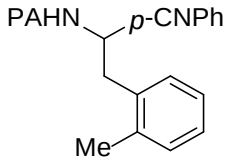
Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 5/1, v/v) afforded **4i** as yellow oil (40.2 mg, 51% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.57-8.55 (m, 2H), 8.14 (d, J = 8.0 Hz, 1H), 7.81 (t, J = 7.6 Hz, 1H), 7.43 – 7.39 (m, 1H), 7.31-7.26 (m, 5H), 7.13-7.09 (m, 2H), 7.03 (s, 2H), 5.43-5.37 (m, 1H), 3.32-3.28 (m, 1H), 3.21-3.16 (m, 1H), 2.30 (s, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.65, 149.91, 148.17, 141.93, 137.43, 136.82, 135.88, 130.40, 130.23, 128.68, 127.53, 126.76, 126.72, 126.28, 125.85, 122.34, 54.26, 40.69, 19.58 ppm. HRMS (ESI^+): calcd for $C_{21}H_{21}N_2O$ $[M+H]^+$ 317.1648, found 317.1653.



***N*-(1-(4-Bromophenyl)-2-methyl-2-phenylpropyl)picolinamide (4j)**

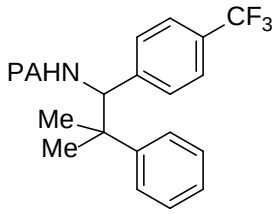
Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 4/1, v/v) afforded **4j** as light yellow oil (57.1 mg, 56% yield).^{1}H NMR (400 MHz, DMSO-d_6): δ = 8.68 (d, J = 9.6 Hz, 1H), 8.64 (d, J = 4.8 Hz, 1H),

7.97 – 7.90 (m, 2H), 7.60-7.57 (m, 1H), 7.40 (d, *J* = 8.4 Hz, 2H), 7.33-7.27 (m, 4H), 7.20 (t, *J* = 6.8 Hz, 1H), 7.01 (d, *J* = 8.4 Hz, 2H), 5.31 (d, *J* = 9.6 Hz, 1H), 1.33 (s, 3H), 1.31 (s, 3H) ppm. ^{13}C NMR (100 MHz, DMSO-d_6): δ = 162.77, 149.22, 148.59, 145.18, 139.14, 138.02, 130.45, 130.29, 128.03, 126.81, 126.57, 126.41, 121.80, 120.21, 60.71, 41.59, 25.98, 24.41 ppm. HRMS (ESI$^+$): calcd for $C_{22}H_{22}{}^{79}BrN_2O$ [M+H]$^+$ 409.0910, found 409.0901; calcd for $C_{22}H_{22}{}^{81}BrN_2O$ [M+H]$^+$ 411.0890, found 411.0881.



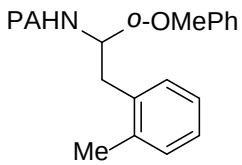
***N*-(1-(4-Cyanophenyl)-2-(*o*-tolyl)ethyl)picolinamide (4k)**

Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 4/1, v/v) afforded **4k** as yellow oil (38.0 mg, 48% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.62-8.53 (m, 2H), 8.11 (d, *J* = 7.6 Hz, 1H), 7.83 (t, *J* = 7.2 Hz, 1H), 7.58 (d, *J* = 7.6 Hz, 2H), 7.45-7.43 (m, 1H), 7.37 (d, *J* = 7.2 Hz, 2H), 7.13 (s, 2H), 7.07-7.05 (m, 1H), 6.97 (d, *J* = 6.8 Hz, 1H), 5.41-5.36 (m, 1H), 3.27-3.24 (m, 1H), 3.16-3.13 (m, 1H), 2.26 (s, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.94, 149.43, 148.29, 147.57, 137.61, 136.65, 134.80, 132.48, 130.71, 130.13, 127.50, 127.23, 126.62, 126.15, 122.41, 118.88, 111.35, 54.13, 40.31, 19.55 ppm. HRMS (ESI$^+$): calcd for $C_{22}H_{20}N_3O$ [M+H]$^+$ 342.1601, found 342.1607.



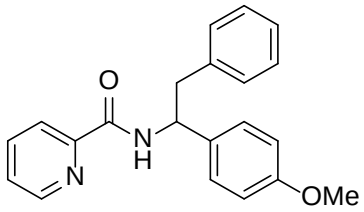
***N*-(2-Methyl-2-phenyl-1-(4-(trifluoromethyl)phenyl)propyl)picolinamide (4l)**

Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 5/1, v/v) afforded **4l** as colourless oil (55.7 mg, 56% yield).^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.77 (d, *J* = 9.6 Hz, 1H), 8.57 (d, *J* = 4.8 Hz, 1H), 8.11 (d, *J* = 8.0 Hz, 1H), 7.81 (t, *J* = 7.2 Hz, 1H), 7.45 – 7.38 (m, 3H), 7.36 – 7.30 (m, 2H), 7.28-7.27 (m, 3H), 7.01 (d, *J* = 8.4 Hz, 2H), 5.37 (d, *J* = 9.6 Hz, 1H), 1.48 (s, 3H), 1.44 (s, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.72, 149.64, 148.32, 144.29, 143.62, 137.49, 129.35 (q, *J* = 32.3 Hz), 128.79, 128.31, 127.18, 126.88, 126.42, 124.48 (q, *J* = 3.8 Hz), 124.25 (q, *J* = 270.4 Hz), 122.39, 61.87, 42.28, 26.10, 25.95 ppm. HRMS (ESI$^+$): calcd for $C_{23}H_{22}F_3N_2O$ [M+H]$^+$ 399.1679, found 399.1681.



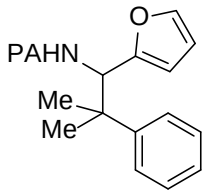
***N*-(1-(2-Methoxyphenyl)-2-(*o*-tolyl)ethyl)picolinamide (4m)**

Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 5/1, v/v) afforded **4m** as yellow oil (43.6 mg, 50% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.09 (d, J = 8.8 Hz, 1H), 8.57 (s, 1H), 8.14 (d, J = 7.6 Hz, 1H), 7.80 (t, J = 7.6 Hz, 1H), 7.42 – 7.36 (m, 1H), 7.22 (t, J = 7.8 Hz, 1H), 7.07-6.99 (m, 5H), 6.91 (d, J = 8.0 Hz, 1H), 6.82 (t, J = 7.4 Hz, 1H), 5.62-5.56 (m, 1H), 3.94 (s, 3H), 3.31 – 3.18 (m, 2H), 2.32 (s, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.41, 157.37, 150.39, 148.23, 137.30, 136.91, 136.67, 130.41, 130.19, 129.29, 128.78, 128.57, 126.45, 126.04, 125.63, 122.39, 120.75, 111.06, 55.59, 52.06, 39.24, 19.39 ppm. HRMS (ESI$^+$): calcd for $C_{22}H_{23}N_2O_2$ $[M+H]^+$ 347.1754, found 347.1751.



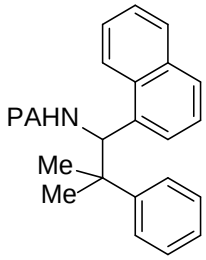
***N*-(1-(4-Methoxyphenyl)-2-phenylethyl)picolinamide (4n)**

Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 5/1, v/v) afforded **4n** as yellow oil (40.8 mg, 49% yield). ^{1}H NMR (400 MHz, DMSO-d_6): δ = 9.15 (d, J = 8.8 Hz, 1H), 8.65 (s, 1H), 7.93 (s, 2H), 7.57 (s, 1H), 7.40 (d, J = 8.0 Hz, 2H), 7.27 – 7.18 (m, 4H), 7.14-7.12 (m, 1H), 6.87 (d, J = 8.0 Hz, 2H), 5.27-5.25 (m, 1H), 3.71 (s, 3H), 3.35 – 3.26 (m, 1H), 3.09 (d, J = 9.8 Hz, 1H) ppm. ^{13}C NMR (100 MHz, DMSO-d_6): δ = 163.03, 158.19, 149.91, 148.41, 138.94, 137.82, 135.18, 129.16, 128.08, 128.06, 126.54, 126.10, 121.97, 113.60, 55.04, 53.97, 41.42 ppm. HRMS (ESI$^+$): calcd for $C_{21}H_{20}N_2NaO_2$ $[M+Na]^+$ 355.1417, found 355.1423.



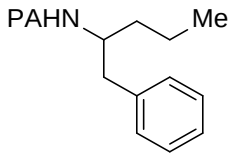
***N*-(1-(Furan-2-yl)-2-methyl-2-phenylpropyl)picolinamide (4o)**

Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 4/1, v/v) afforded **4o** as yellow oil (40.7 mg, 51% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.61 (d, J = 9.2 Hz, 1H), 8.56 (s, 1H), 8.15 (d, J = 7.6 Hz, 1H), 7.81 (t, J = 6.8 Hz, 1H), 7.41 (s, 1H), 7.32-7.29 (m, 4H), 7.23-7.21 (m, 2H), 6.18 (s, 1H), 5.80 (s, 1H), 5.53 (d, J = 10.0 Hz, 1H), 1.49 (s, 3H), 1.47 (s, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.63, 152.74, 149.79, 148.30, 145.53, 141.37, 137.38, 128.06, 126.78, 126.43, 126.30, 122.53, 110.03, 107.66, 56.23, 43.24, 26.15, 25.04 ppm. HRMS (ESI$^+$): calcd for $C_{20}H_{21}N_2O_2$ $[M+H]^+$ 321.1598, found 321.1598.



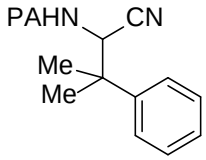
***N*-(2-Methyl-1-(naphthalen-1-yl)-2-phenylpropyl)picolinamide (4p)**

Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 4/1, v/v) afforded **4p** as yellow oil (51.3 mg, 54% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.85 (d, J = 10.0 Hz, 1H), 8.58 – 8.56 (m, 1H), 8.43 (d, J = 8.6 Hz, 1H), 8.14 – 8.10 (m, 1H), 7.82 (d, J = 8.4 Hz, 1H), 7.80 – 7.75 (m, 1H), 7.72 (d, J = 8.4 Hz, 1H), 7.57-7.53 (m, 1H), 7.48-7.44 (m, 1H), 7.40-7.37 (m, 1H), 7.34-7.33 (m,4H), 7.30 – 7.27 (m, 1H), 7.24 (d, J = 8.0 Hz, 1H), 6.71 (d, J = 7.6 Hz, 1H), 6.41 (d, J = 9.6 Hz, 1H), 1.62 (s, 3H), 1.42 (s, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.51, 150.03, 148.28, 144.49, 137.36, 136.53, 133.50, 132.52, 128.78, 128.04, 127.89, 127.75, 126.69, 126.19, 126.17, 125.74, 125.44, 124.54, 123.94, 122.43, 55.23, 43.54, 27.93, 26.09 ppm. HRMS (ESI$^+$): calcd for $C_{26}H_{25}N_2O$ $[M+H]^+$ 381.1961, found 381.1968.



***N*-(1-Phenylpentan-2-yl)picolinamide (4q)**

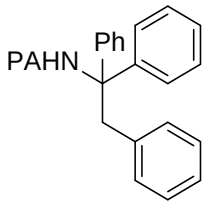
Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 6/1, v/v) afforded **4q** as yellow oil (26.8 mg, 40% yield). ^{1}H NMR (400 MHz, DMSO-d_6): δ = 8.62 (s, 1H), 8.49 (d, J = 9.2 Hz, 1H), 7.96 (s, 2H), 7.57 (s, 1H), 7.24-7.20 (m, 4H), 7.14-7.13 (m, 1H), 4.22-4.21 (m, 1H), 2.94 – 2.86 (m, 1H), 2.83-2.78 (m, 1H), 1.64 – 1.44 (m, 2H), 1.39 – 1.19 (m, 2H), 0.84 (t, J = 7.2 Hz, 3H) ppm. ^{13}C NMR (100 MHz, DMSO-d_6): δ = 163.24, 149.99, 148.29, 139.17, 137.75, 129.06, 128.09, 126.37, 125.93, 121.85, 50.00, 40.45, 36.19, 18.95, 13.82 ppm. HRMS (ESI$^+$): calcd for $C_{17}H_{20}N_2NaO$ $[M+Na]^+$ 291.1468, found 291.1466.



***N*-(1-Cyano-2-methyl-2-phenylpropyl)picolinamide (4r)**

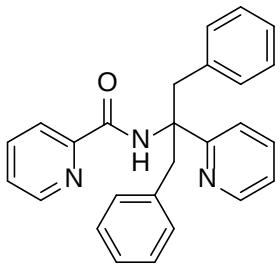
Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 7/1, v/v) afforded **4r** as yellow oil (37.6 mg, 54% yield).^{1}H NMR (400 MHz, $CDCl_3$): δ = 8.53 (d, J = 4.8 Hz, 1H), 8.31 (d, J = 10.0 Hz, 1H), 8.15 (d, J = 7.6 Hz, 1H), 7.86 (t, J = 7.6 Hz, 1H), 7.53 – 7.49 (m, 2H), 7.46-7.44 (m, 1H), 7.43 – 7.38 (m, 2H), 7.34 – 7.29 (m, 1H), 5.33 (d, J = 10.0 Hz, 1H), 1.62 (s, 3H), 1.57 (s, 3H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.91, 148.48, 148.45, 142.34, 137.65, 128.89, 127.70,

127.03, 126.55, 122.82, 117.59, 59.03, 57.42, 50.74, 41.91, 25.45, 24.96 ppm. HRMS (ESI^+): calcd for $C_{17}H_{18}N_3O$ $[M+H]^+$ 280.1444, found 280.1444.



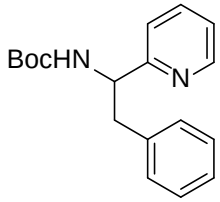
***N*-(2-phenyl-1,1-diphenylethyl)picolinamide (4s)**

Following the general procedure. Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 6/1, v/v) afforded **4s** as yellow oil (23.6 mg, 25% yield). ^1H NMR (400 MHz, $CDCl_3$): δ = 9.20 (s, 1H), 8.53 (d, J = 4.8 Hz, 1H), 8.16 (dt, J = 8.0, 1.2 Hz, 1H), 7.85 – 7.81 (m, 1H), 7.44 – 7.41 (m, 1H), 7.31 – 7.27 (m, 8H), 7.26 – 7.24 (m, 1H), 7.11 (dd, J = 10.3, 4.3 Hz, 2H), 7.02 (t, J = 7.4 Hz, 2H), 6.67 – 6.64 (m, 2H), 4.09 (s, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 163.50, 150.46, 148.09, 145.31, 137.43, 136.68, 131.09, 128.13, 127.49, 127.18, 127.03, 126.32, 126.25, 121.97, 64.98, 43.39 ppm. HRMS (ESI^+): calcd for $C_{26}H_{22}N_2NaO$ $[M+Na]^+$ 401.1624, found 401.1621.



***N*-(1,3-Diphenyl-2-(pyridin-2-yl)propan-2-yl)picolinamide (3ab)**

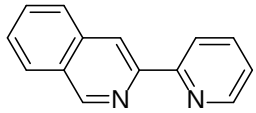
Melting point: 132~134 °C. ^1H NMR (400 MHz, $CDCl_3$): δ = 9.93 (s, 1H), 8.52 (s, 1H), 8.45 (s, 1H), 8.31 (d, J = 7.6 Hz, 1H), 7.87 (t, J = 7.6 Hz, 1H), 7.73 (t, J = 7.6 Hz, 1H), 7.54 (d, J = 7.6 Hz, 1H), 7.39-7.37 (m, 1H), 7.16-7.14 (m, 1H), 7.02 – 6.94 (m, 6H), 6.77 (d, J = 6.4 Hz, 4H), 4.32 (d, J = 13.6 Hz, 2H), 3.50 (d, J = 13.6 Hz, 2H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 164.34, 159.81, 151.17, 148.51, 148.05, 137.19, 136.88, 136.10, 130.25, 127.77, 126.30, 125.90, 121.86, 121.83, 121.67, 64.90, 43.84 ppm. HRMS (ESI^+): calcd for $C_{26}H_{24}N_3O$ $[M+H]^+$ 394.1914, found 394.1912.



***t*ert-Butyl (2-phenyl-1-(pyridin-2-yl)ethyl)carbamate (5a)**

Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 3/1, v/v) afforded **5a** as a white solid (63.5 mg, 85% yield), melting point: 78~80 °C. ^1H NMR (400 MHz, $CDCl_3$): δ = 8.55 (s, 1H), 7.50-7.46 (m, 1H), 7.17-7.15 (m, 4H), 6.99-6.96 (m,

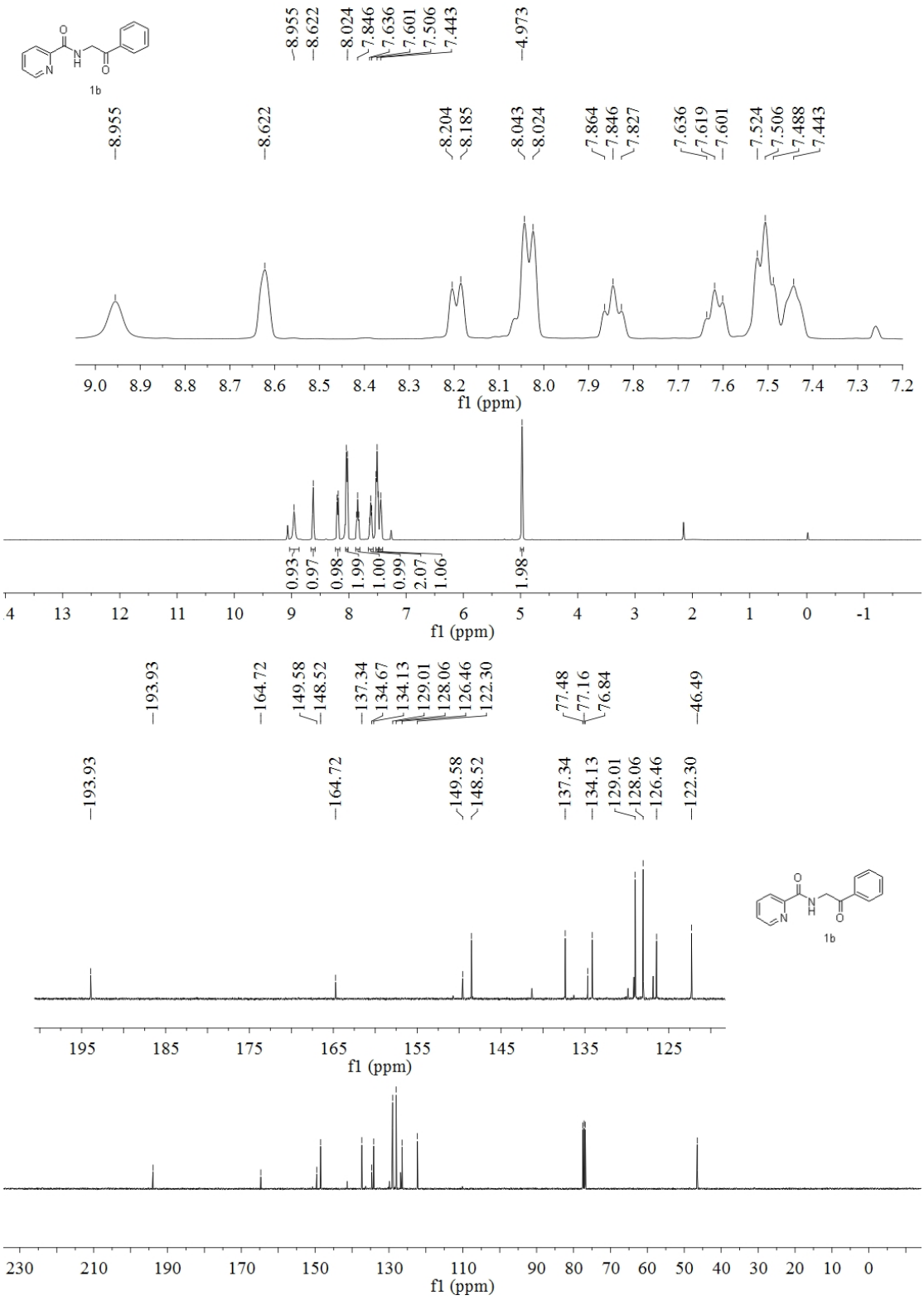
2H), 6.85 (d, J = 6.8 Hz, 1H), 5.81-5.79 (m, 1H), 4.97-4.95 (m, 1H), 3.21 (d, J = 8.0 Hz, 1H), 3.06 (d, J = 8.0 Hz, 1H), 1.42 (s, 9H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 159.54, 155.34, 149.30, 137.57, 136.20, 129.61, 128.24, 126.42, 122.50, 122.37, 79.39, 56.90, 42.96, 28.50 ppm. HRMS (ESI^+): calcd for $C_{18}H_{22}N_2NaO_2$ $[M+Na]^+$ 321.1573, found 321.1575.

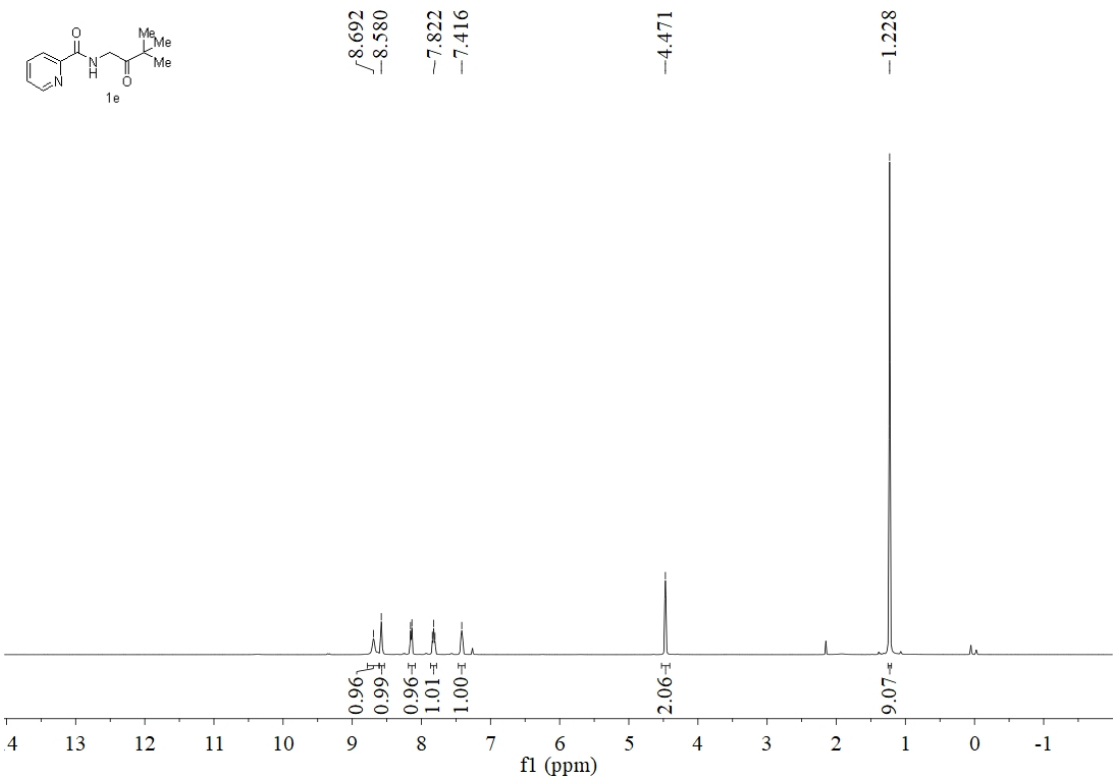


3-(Pyridin-2-yl)isoquinoline (5b)

Purification via column chromatography on silica gel (petroleum ether/ethyl acetate = 4/1, v/v) afforded **5b** as yellow oil (21.6 mg, 42% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.33 (s, 1H), 8.79 (s, 1H), 8.73 (s, 1H), 8.52 (d, J = 7.6 Hz, 1H), 8.01 (d, J = 8.0 Hz, 1H), 7.97 (d, J = 8.0 Hz, 1H), 7.86 (t, J = 7.4 Hz, 1H), 7.71 (t, J = 7.0 Hz, 1H), 7.62 (t, J = 6.8 Hz, 1H), 7.31 (s, 1H) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ = 156.59, 152.24, 149.97, 149.49, 137.18, 136.75, 130.71, 128.86, 127.83, 127.77, 127.67, 123.47, 121.40, 117.81 ppm. HRMS (ESI^+): calcd for $C_{14}H_{11}N_2$ $[M+H]^+$ 207.0917, found 207.0912.

VII. Copies of ^{1}H NMR and ^{13}C NMR spectra

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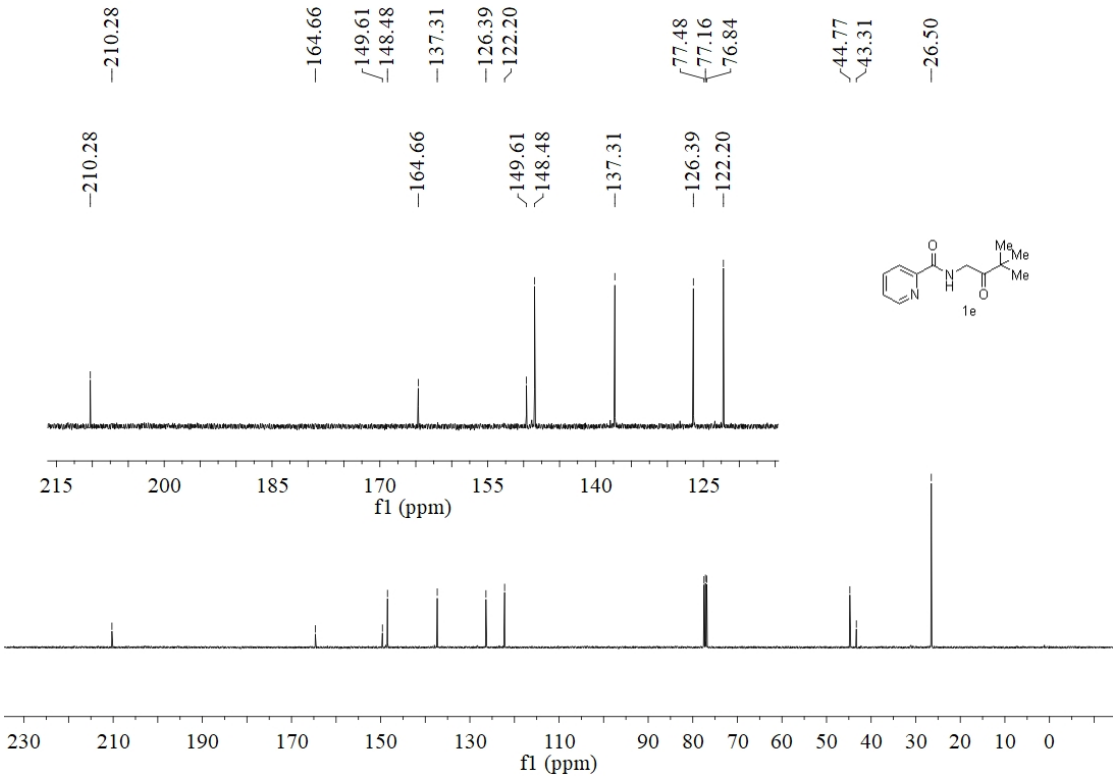
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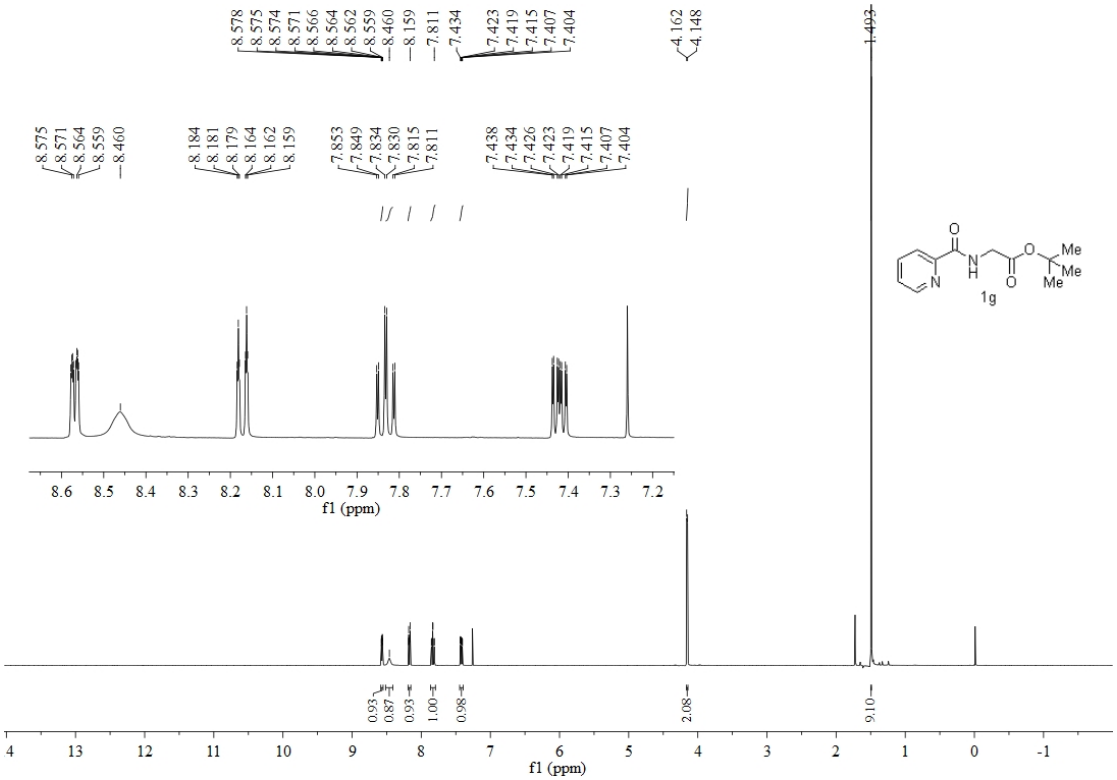
1e
f1 (ppm)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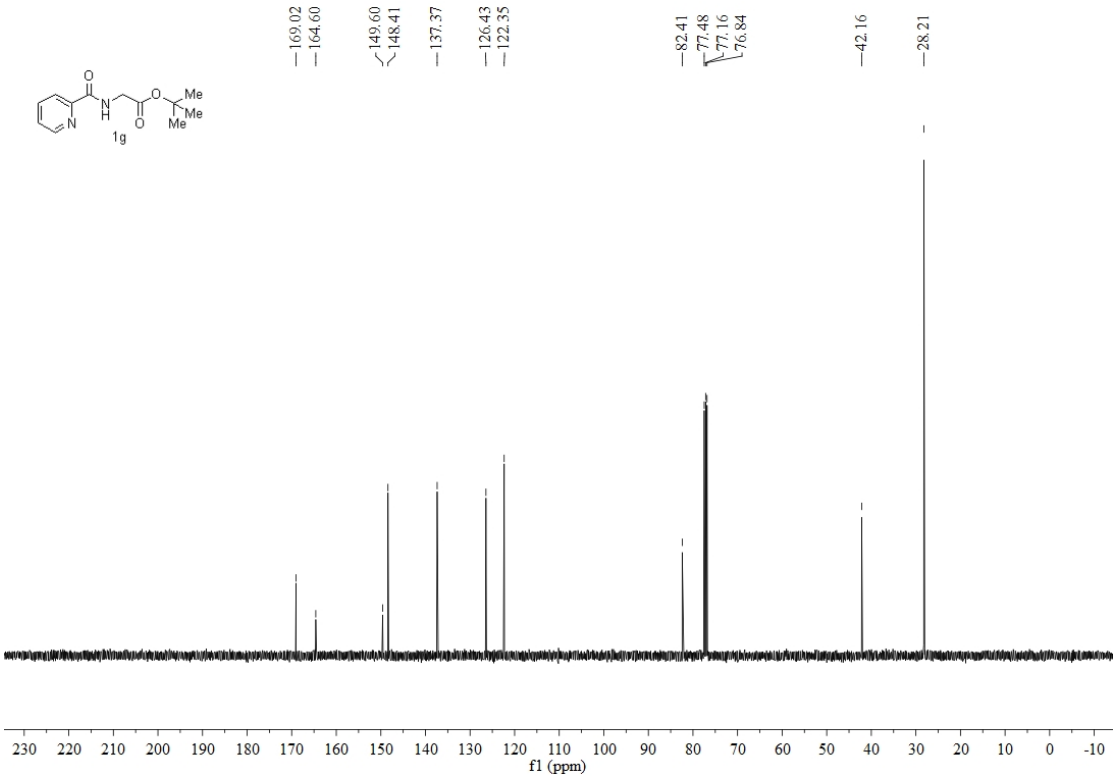
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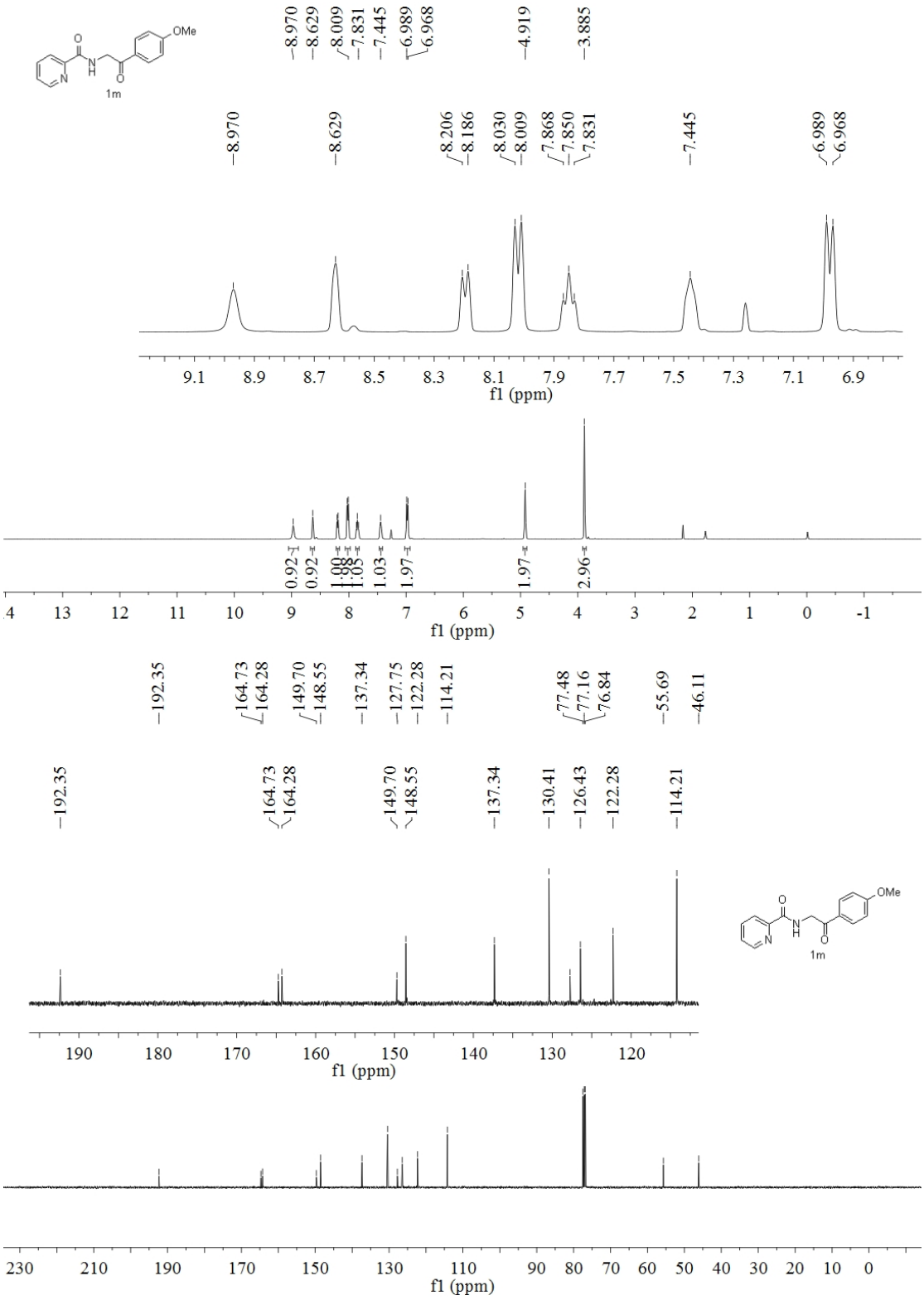
f1 (ppm)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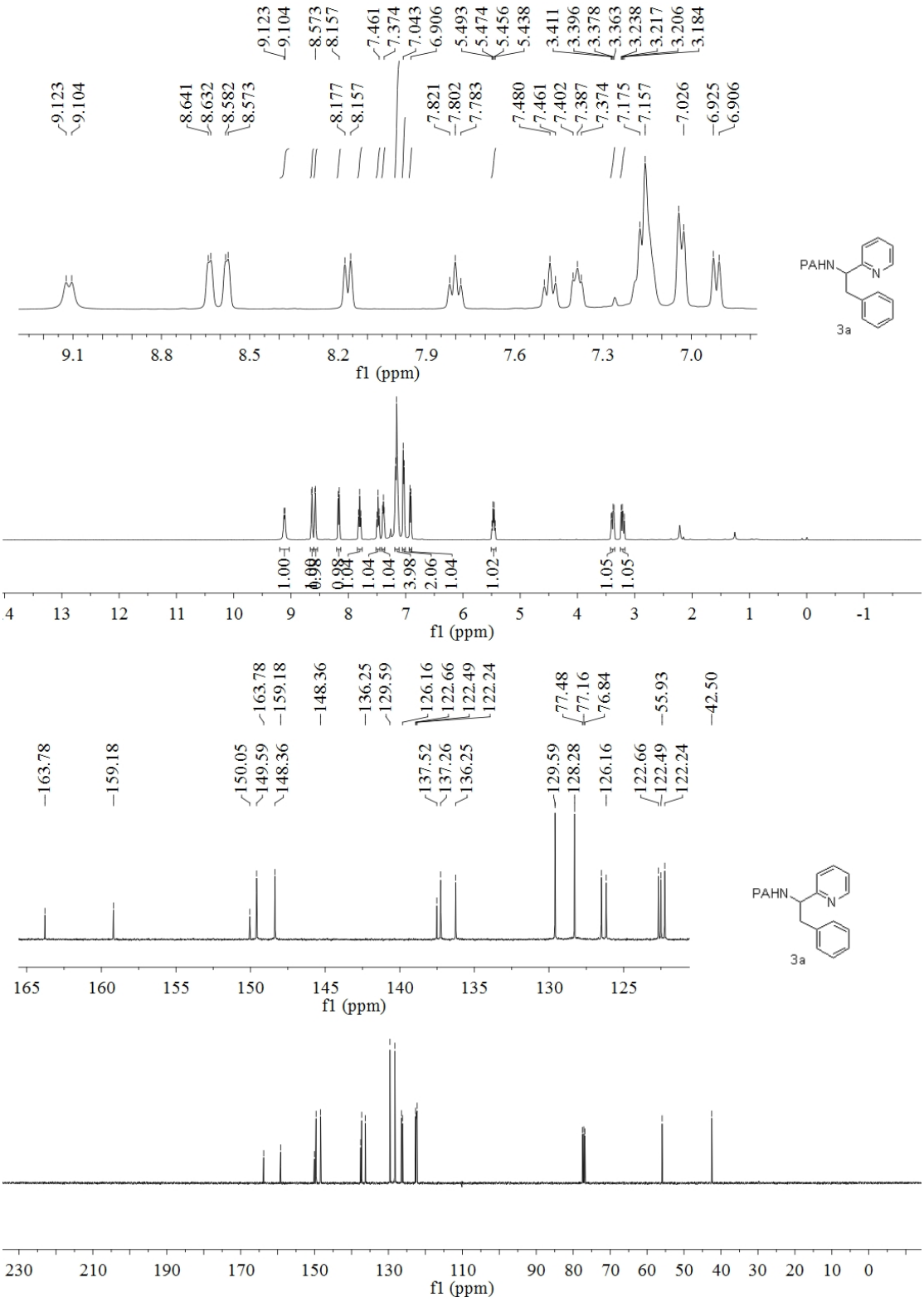
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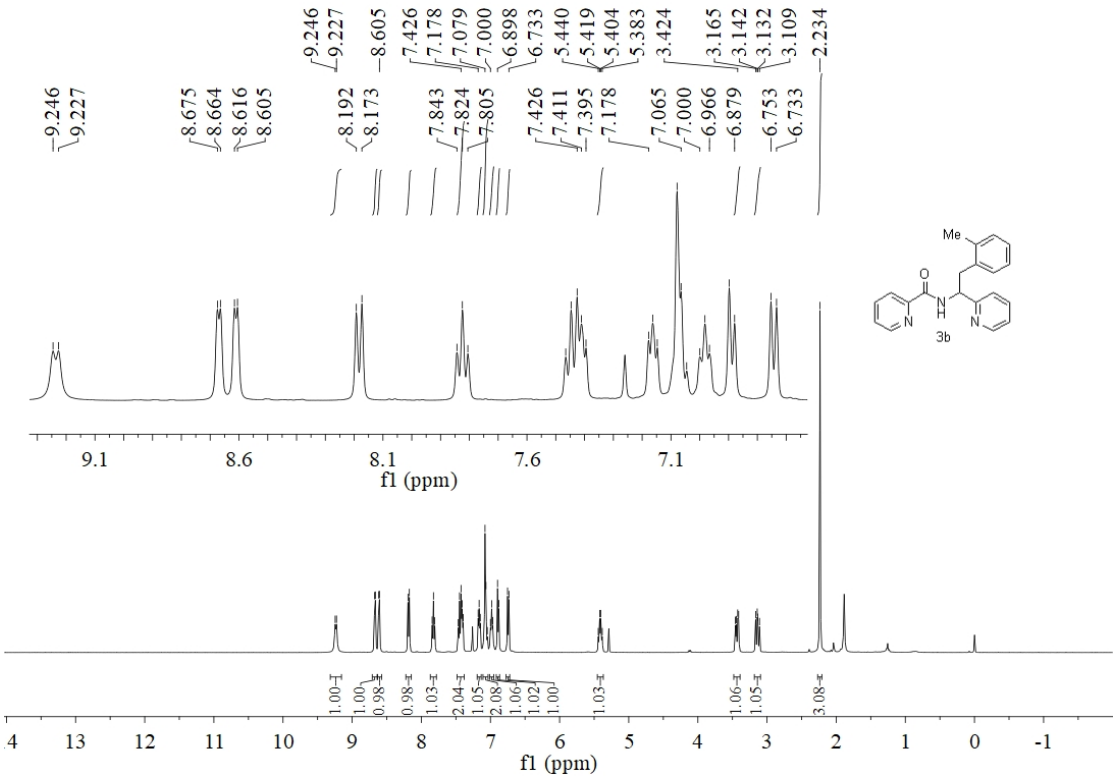
f1 (ppm)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7.1
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1.05
2.08
1.06
1.02
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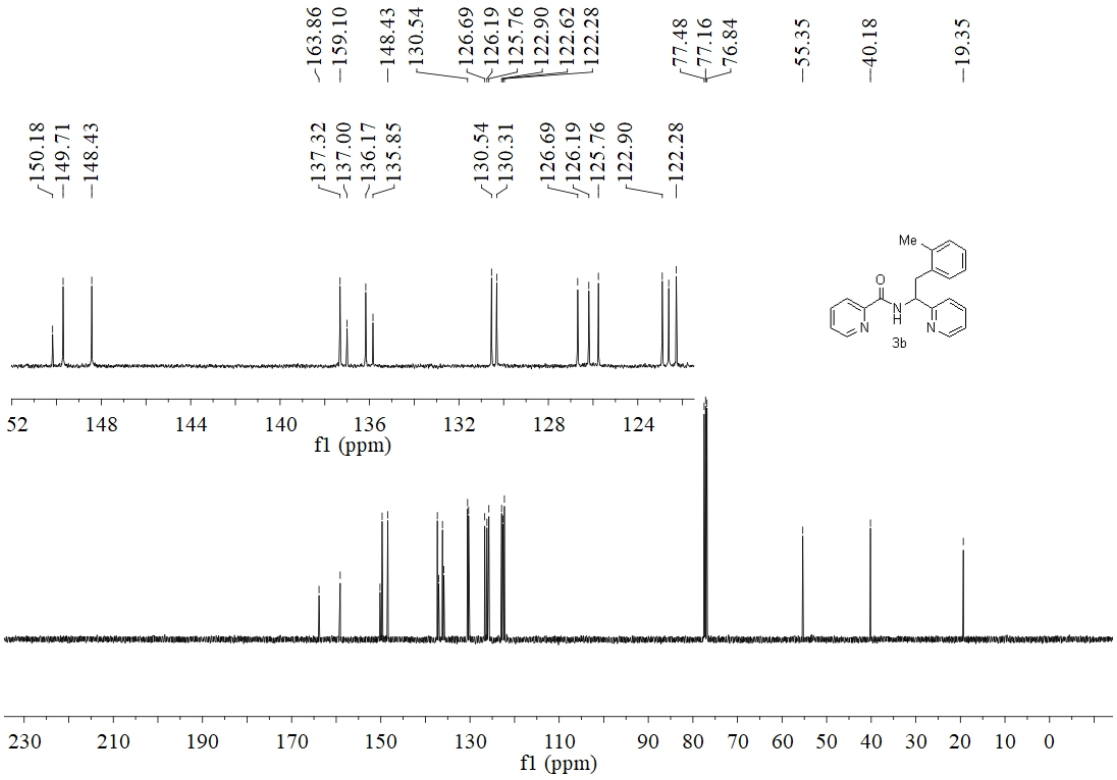
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144
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132
128
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150
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110
90
80
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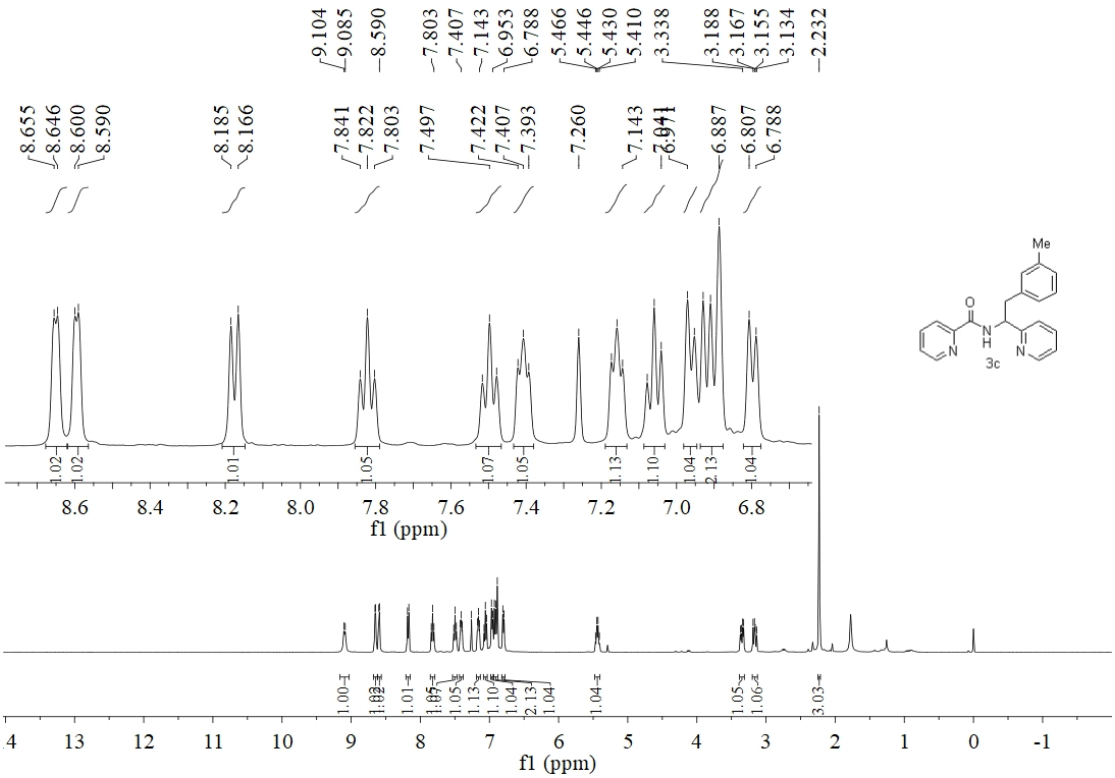
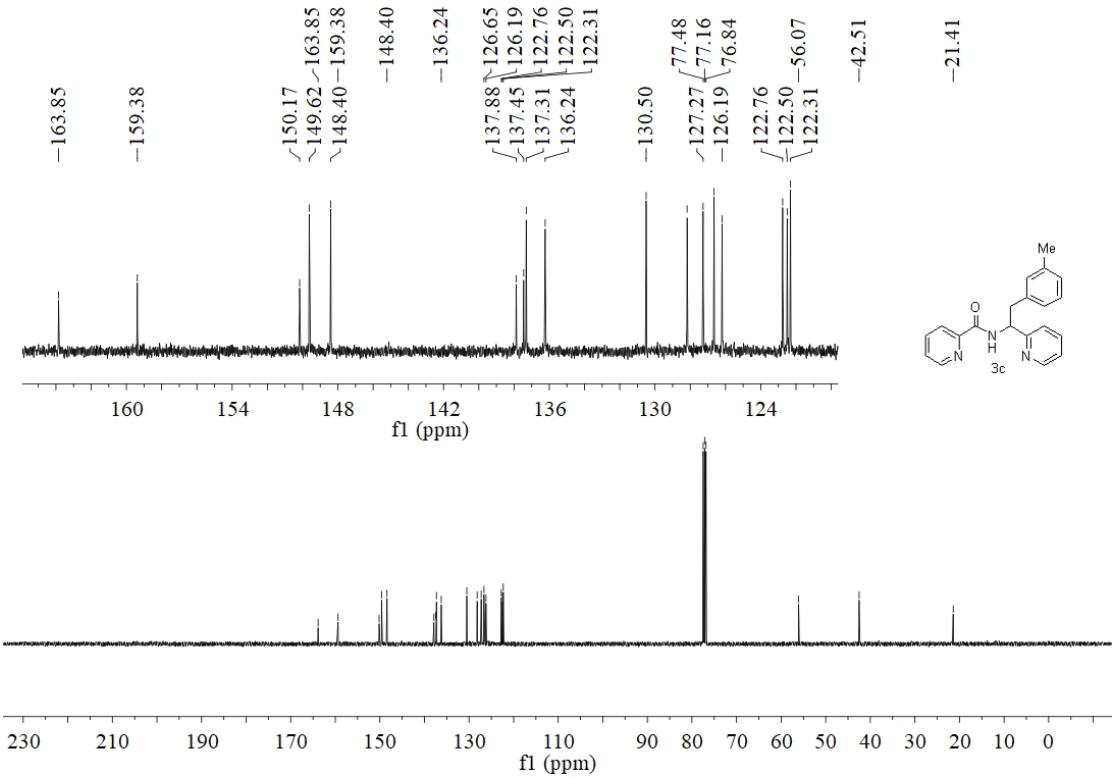
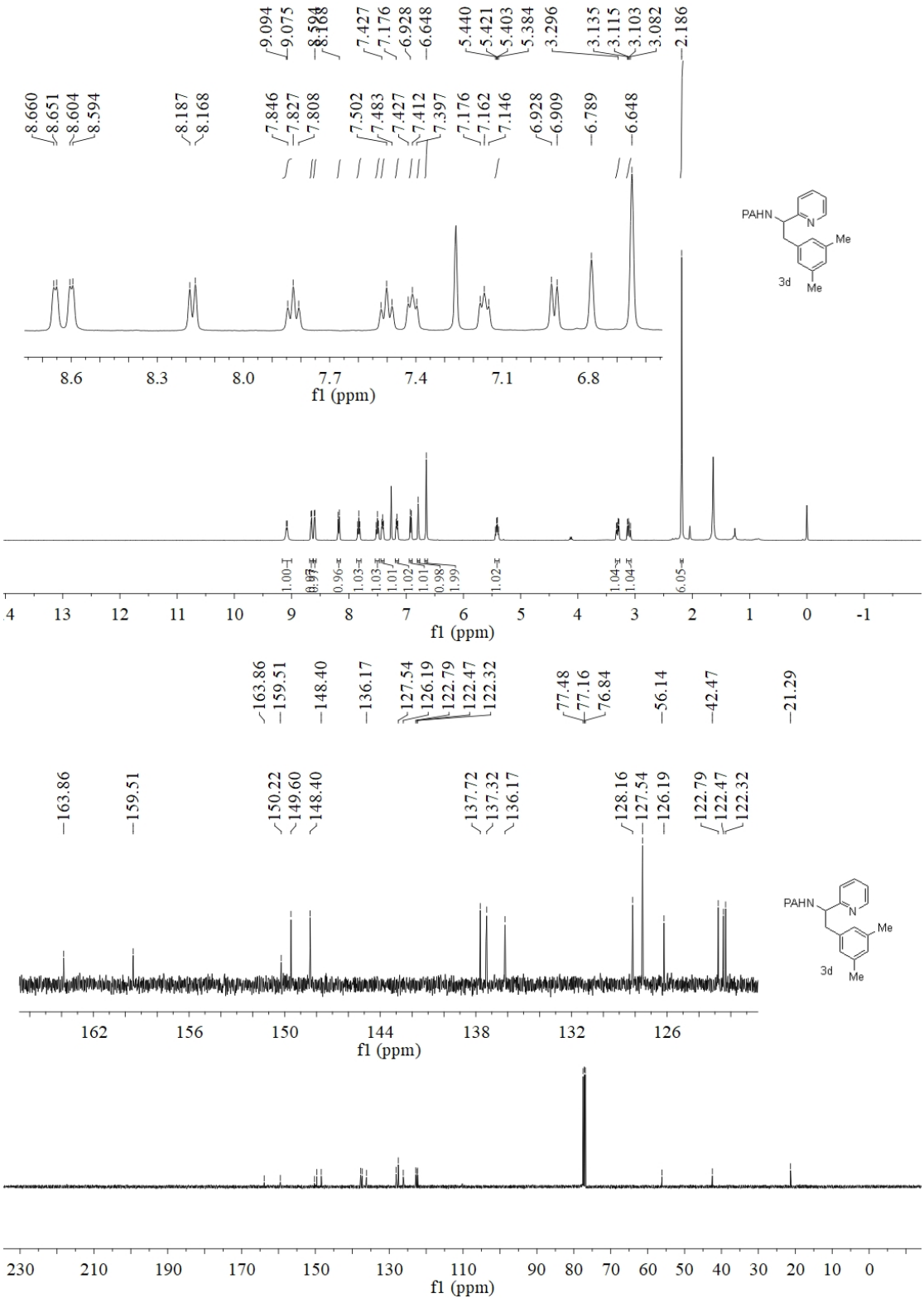
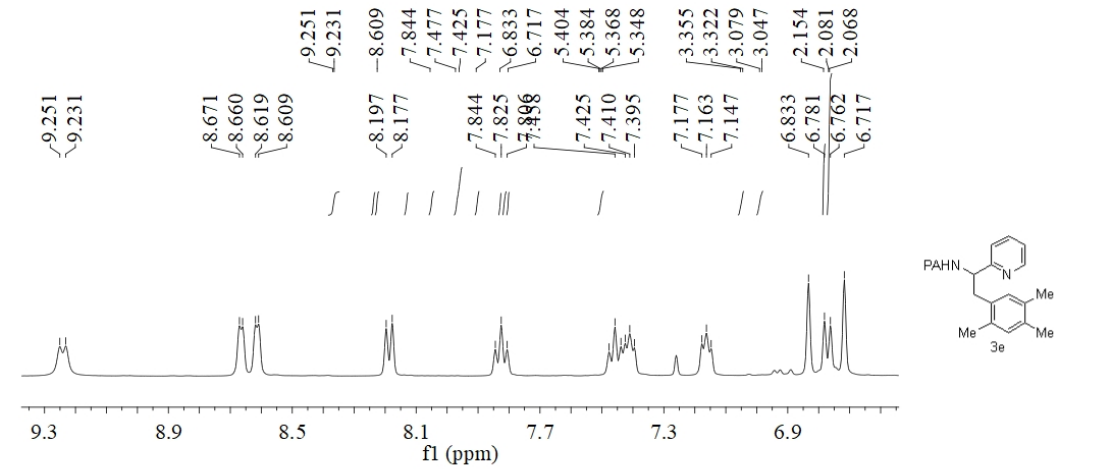
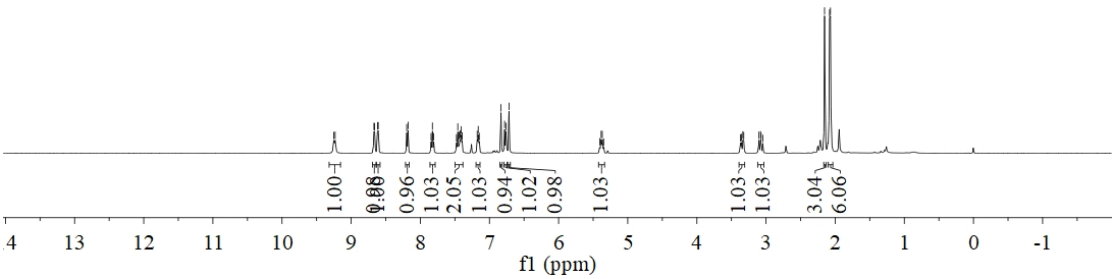
50
40
30
20
10
0
f1 (ppm)

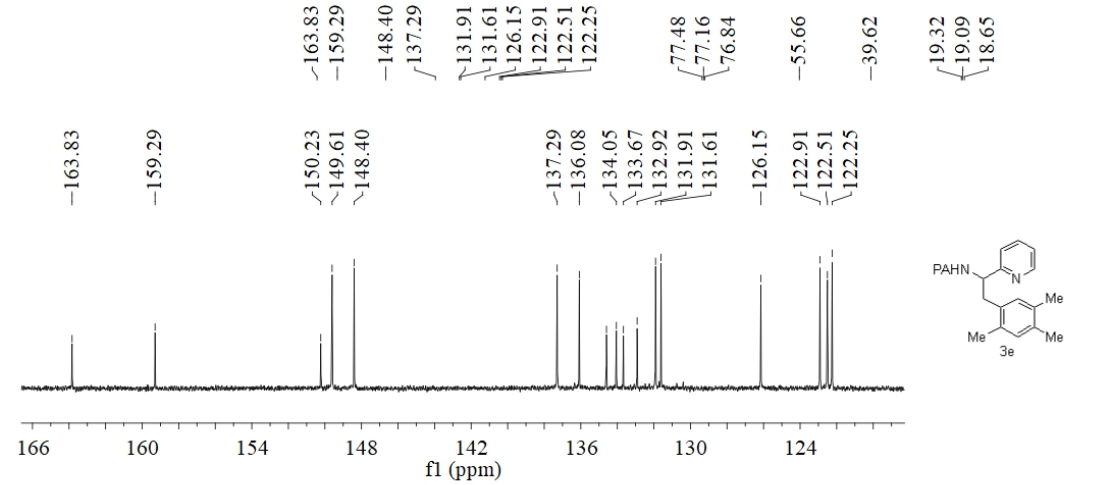

9.104
9.085
8.590
7.803
7.407
7.143
6.953
6.788
5.466
5.446
5.430
5.410
3.338
3.188
3.167
3.155
3.134
2.232
8.655
8.646
8.600
8.590
8.185
8.166
7.841
7.822
7.803
7.497
7.422
7.407
7.393
7.260
7.143
6.887
6.807
6.788
Me
3c
f1 (ppm)
f1 (ppm)

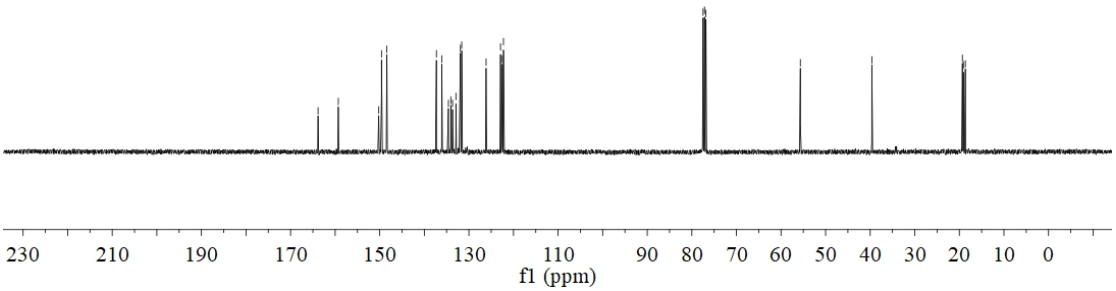

163.85
159.38
150.17
149.62
148.40
163.85
159.38
148.40
136.24
126.65
126.19
122.76
122.50
122.31
137.88
137.45
137.31
136.24
130.50
77.48
77.16
76.84
127.27
126.19
122.76
122.50
122.31
56.07
42.51
21.41
Me
3c
f1 (ppm)
f1 (ppm)

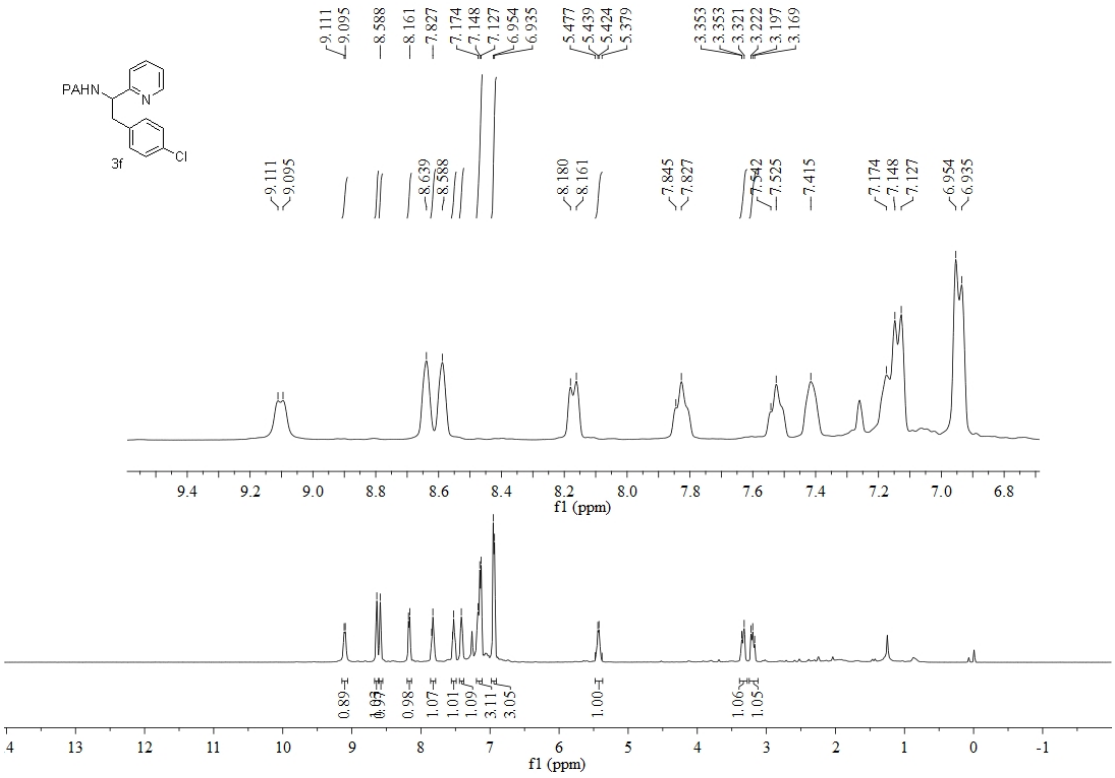

9.094
9.075
8.594
8.588
7.427
7.176
6.928
6.648
5.440
5.421
5.403
5.384
3.296
3.135
3.115
3.103
3.082
2.186
8.660
8.651
8.604
8.594
8.187
8.168
7.846
7.827
7.808
7.502
7.483
7.427
7.412
7.397
7.176
7.162
7.146
6.928
6.909
6.789
6.648
PAHN
N
Me
3d
Me
8.6
8.3
8.0
7.7
7.4
7.1
6.8
f1 (ppm)
1.00
0.97
0.96
1.03
1.03
1.01
1.02
1.01
0.98
1.99
1.02
1.04
1.04
6.05
4
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
f1 (ppm)
163.86
159.51
148.40
136.17
127.54
126.19
122.79
122.47
122.32
77.48
77.16
76.84
56.14
42.47
21.29
163.86
159.51
150.22
149.60
148.40
137.72
137.32
136.17
128.16
127.54
126.19
122.79
122.47
122.32
PAHN
N
Me
3d
Me
162
156
150
144
138
132
126
f1 (ppm)
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

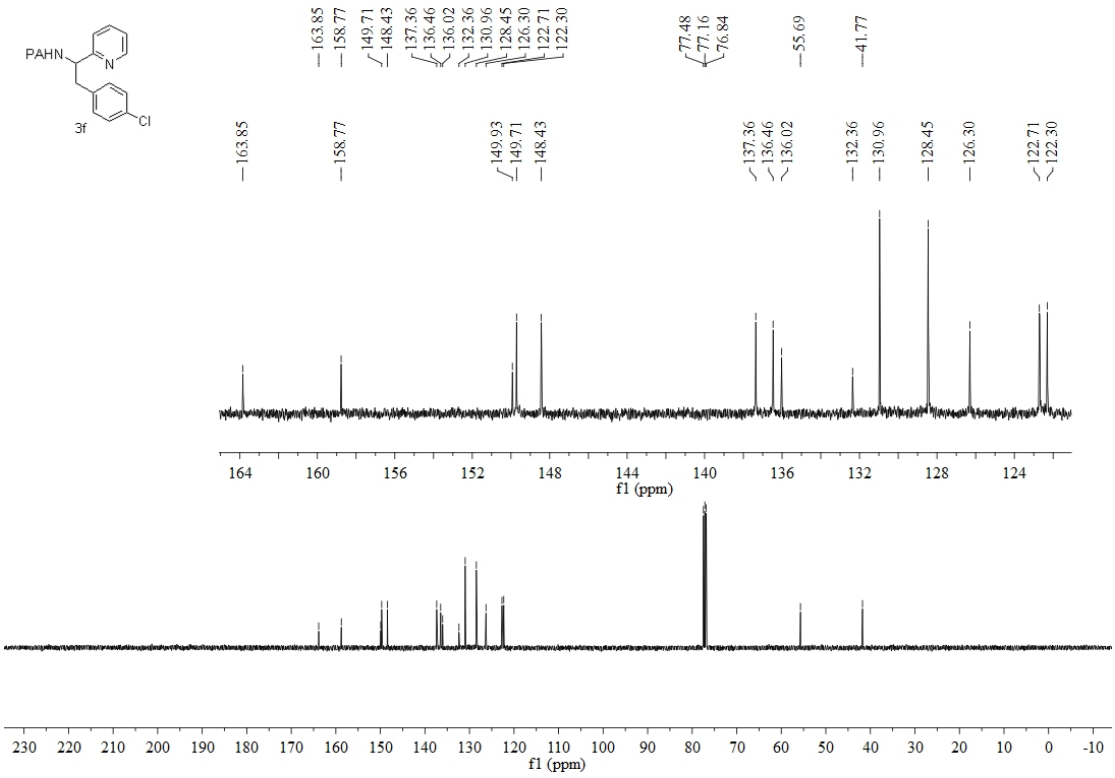

9.251
9.231
8.609
7.844
7.477
7.425
7.177
6.833
6.717
5.404
5.384
5.368
5.348
3.355
3.322
3.079
3.047
2.154
2.081
2.068
8.671
8.660
8.619
8.609
8.197
8.177
7.844
7.825
7.425
7.410
7.395
7.177
7.163
7.147
6.833
6.781
6.762
6.717
PAHN
Me
Me
Me
3e
9.3
8.9
8.5
8.1
7.7
7.3
6.9
f1 (ppm)

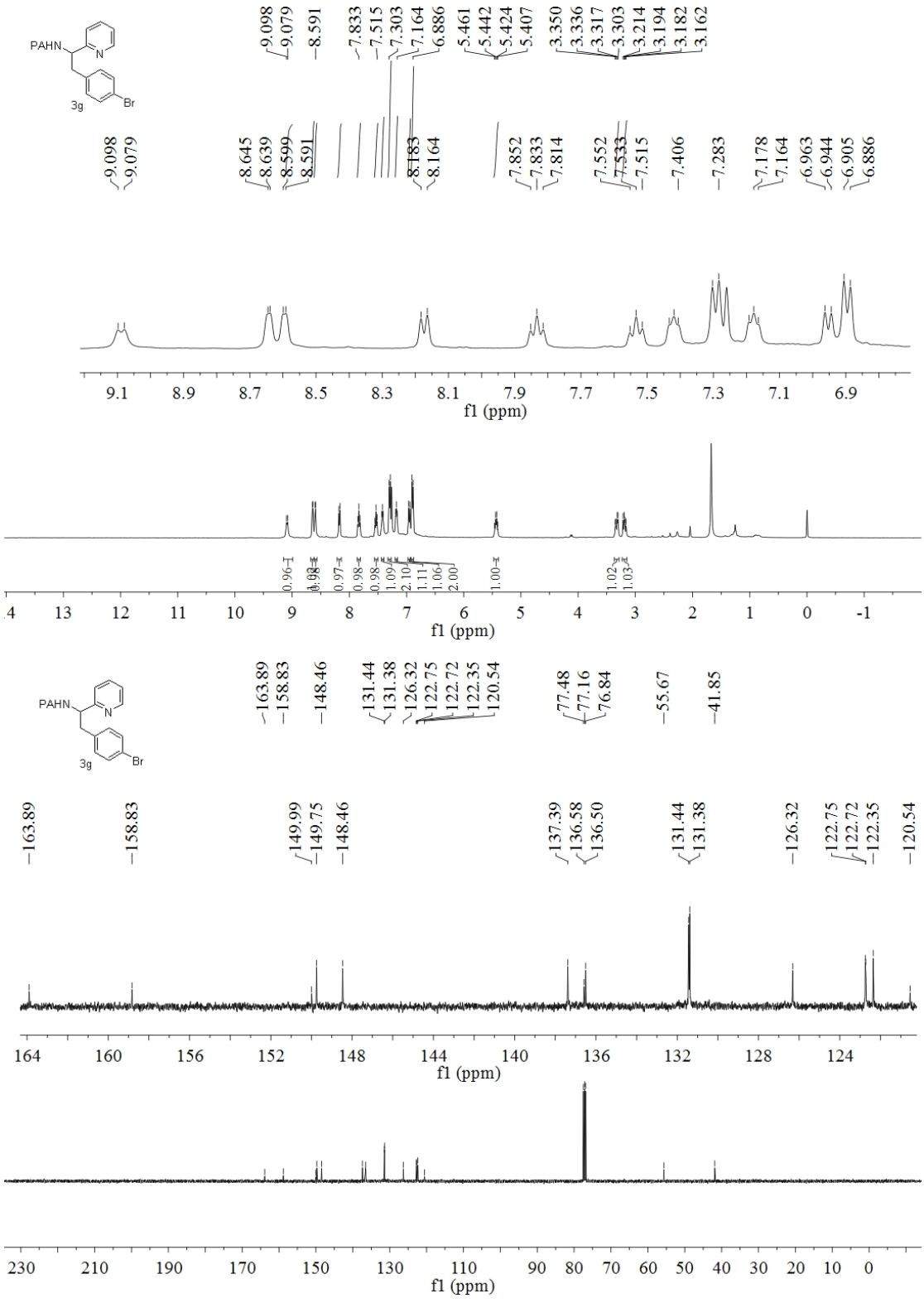

1.00
0.96
1.03
2.05
1.03
0.94
1.02
0.98
1.03
1.03
1.03
3.04
6.06
4
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
f1 (ppm)

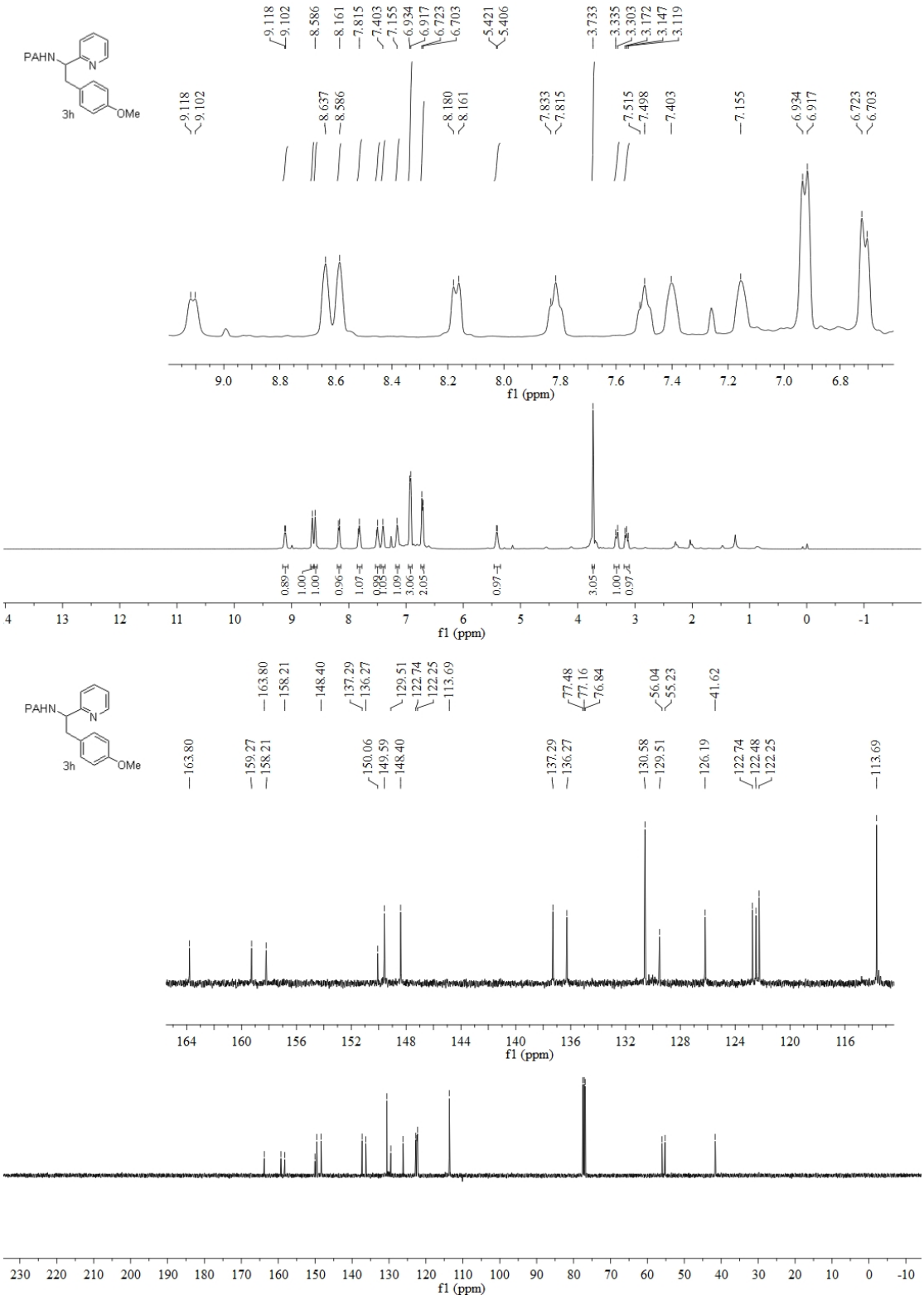

163.83
159.29
148.40
137.29
131.91
131.61
126.15
122.91
122.51
122.25
77.48
77.16
76.84
55.66
39.62
19.32
19.09
18.65
PAHN
Me
Me
Me
3e
166
160
154
148
142
136
130
124
f1 (ppm)

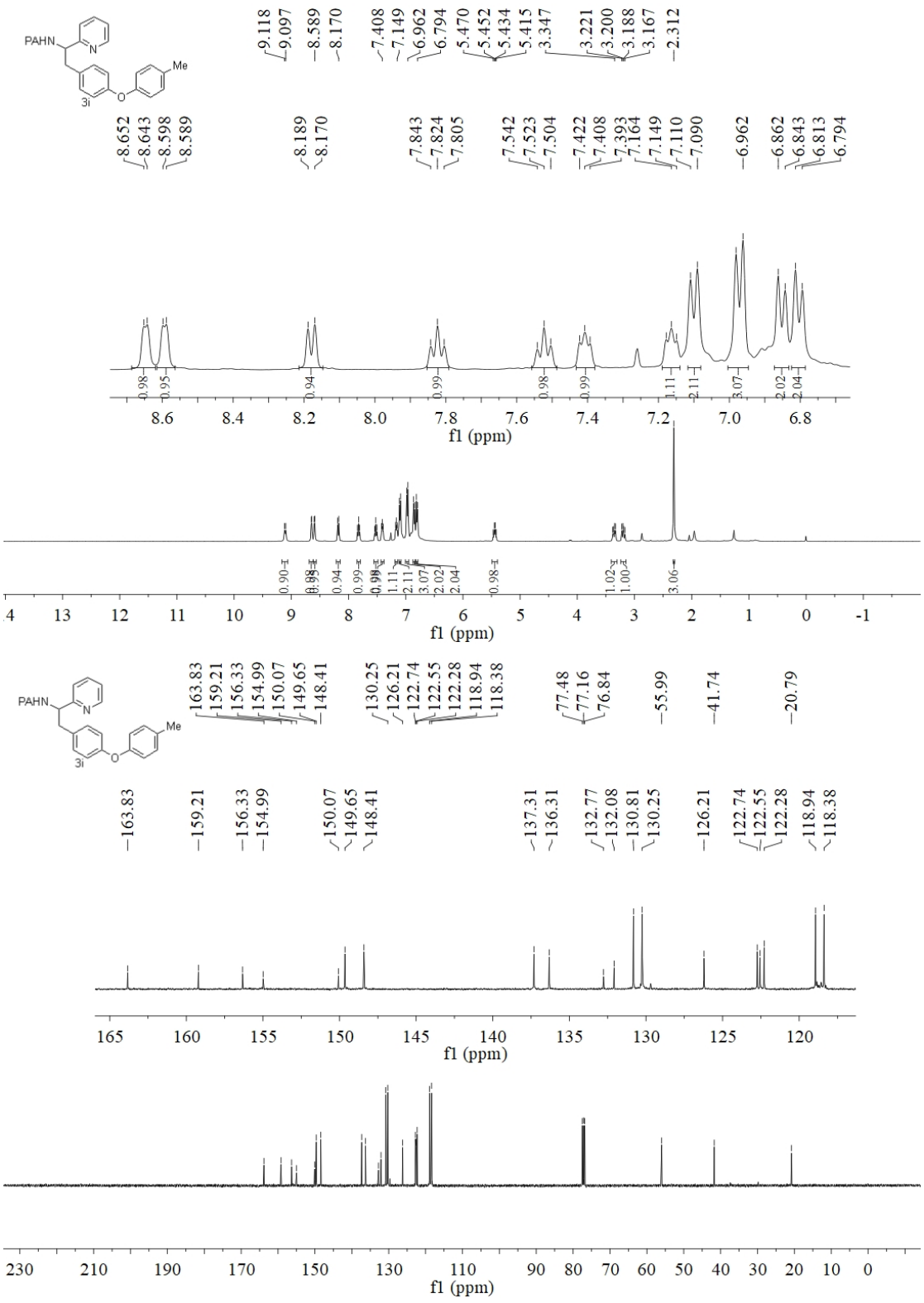

230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

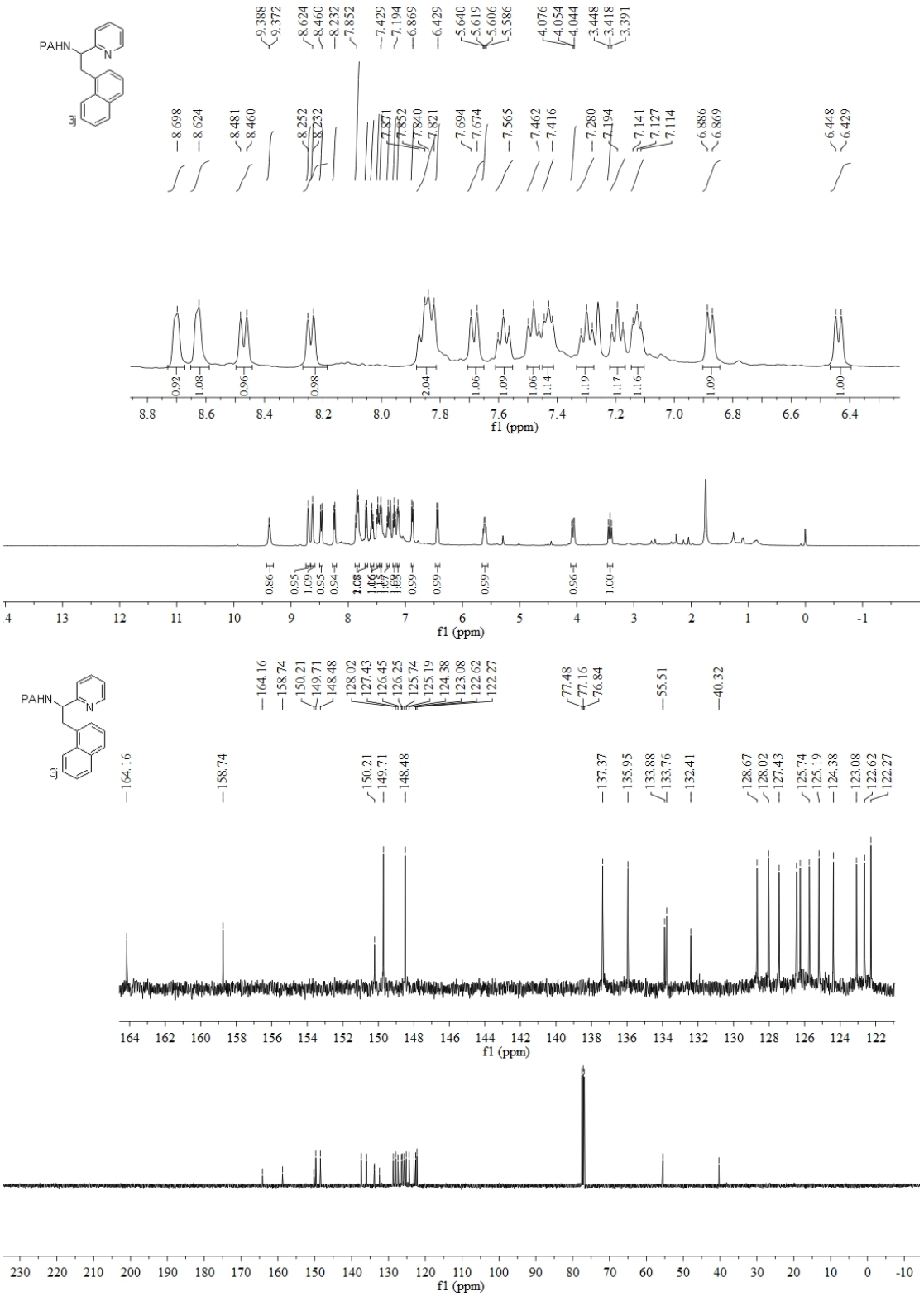

PAHN
N
Cl
3f
9.111
9.095
8.588
8.161
7.827
7.174
7.148
7.127
6.954
6.935
5.477
5.439
5.424
5.379
3.353
3.353
3.321
3.222
3.197
3.169
8.639
8.588
8.180
8.161
7.845
7.827
7.542
7.525
7.415
7.174
7.148
7.127
6.954
6.935
f1 (ppm)
0.89
1.07
1.01
1.09
3.11
3.05
1.00
1.06
1.05
f1 (ppm)

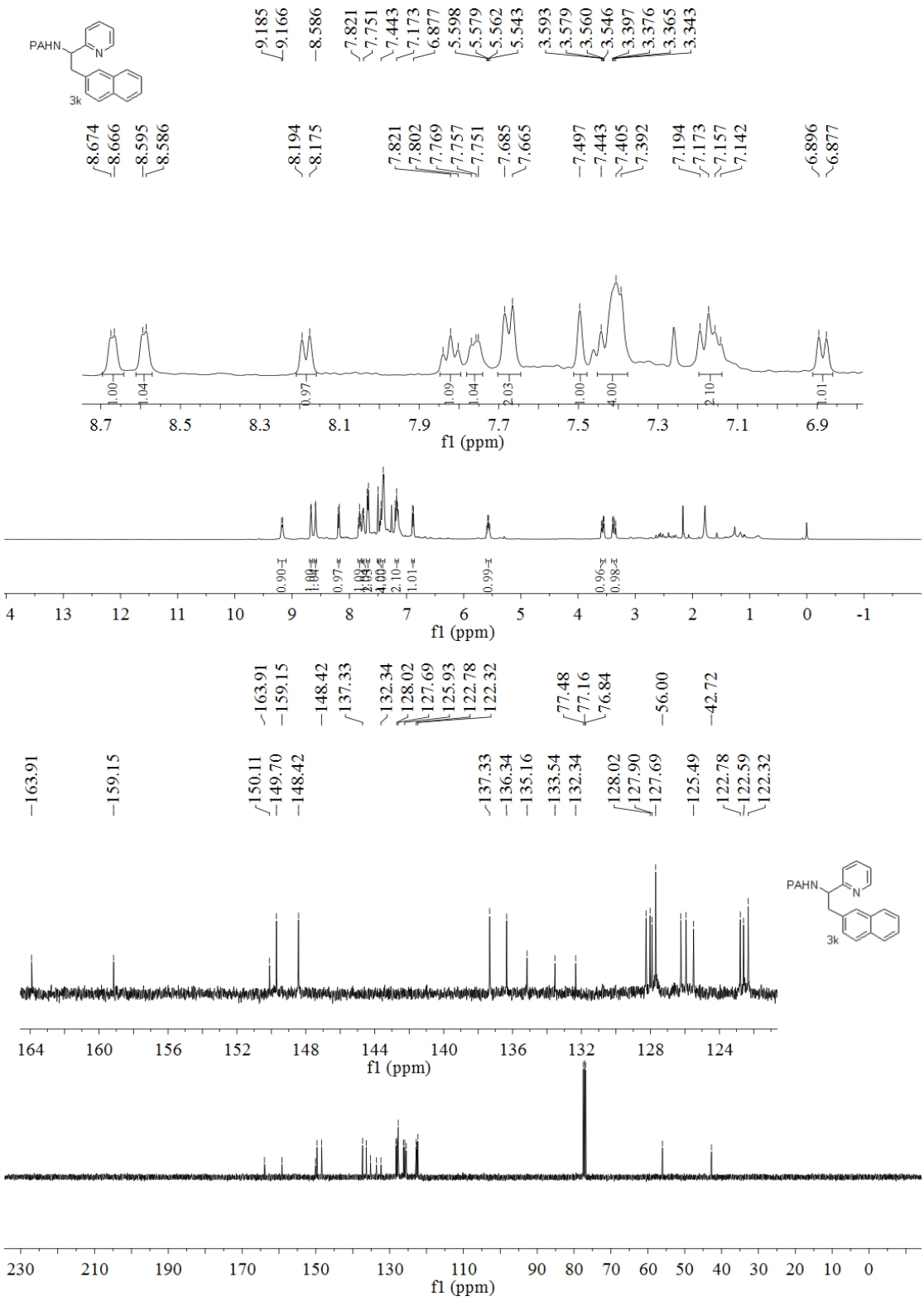

PAHN
N
Cl
3f
163.85
158.77
149.71
148.43
137.36
136.46
136.02
132.36
130.96
128.45
126.30
122.71
122.30
77.48
77.16
76.84
55.69
41.77
f1 (ppm)
f1 (ppm)

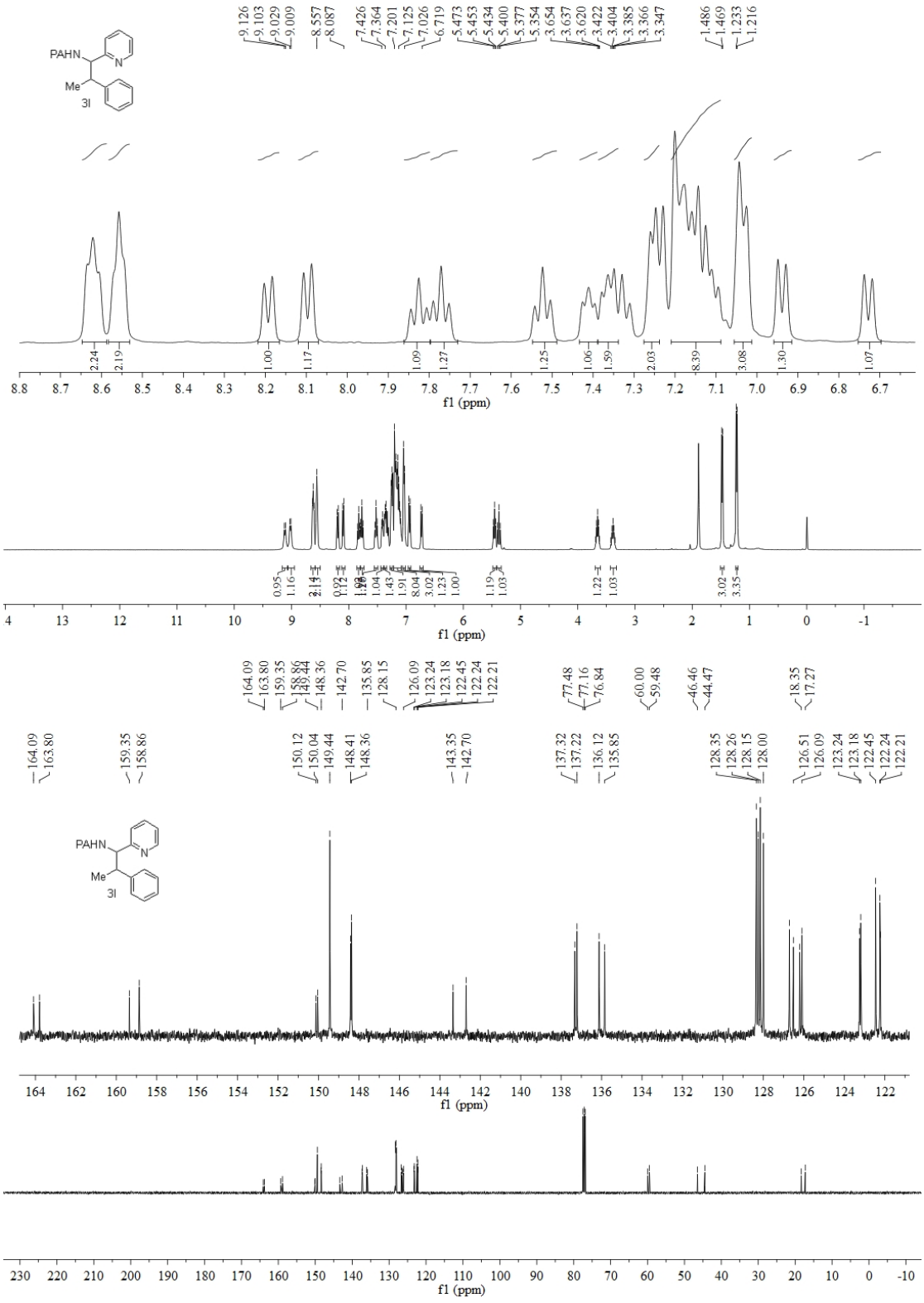

PAHN
3g
Br
9.098
9.079
8.591
7.833
7.515
7.303
7.164
6.886
5.461
5.442
5.424
5.407
3.350
3.336
3.317
3.303
3.214
3.194
3.182
3.162
8.645
8.639
8.599
8.591
8.183
8.164
7.852
7.833
7.814
7.552
7.533
7.515
7.406
7.283
7.178
7.164
6.963
6.944
6.905
6.886
f1 (ppm)
f1 (ppm)
PAHN
3g
Br
163.89
158.83
148.46
131.44
131.38
126.32
122.75
122.72
122.35
120.54
77.48
77.16
76.84
55.67
41.85
163.89
158.83
149.99
149.75
148.46
137.39
136.58
136.50
131.44
131.38
126.32
122.75
122.72
122.35
120.54
f1 (ppm)
f1 (ppm)

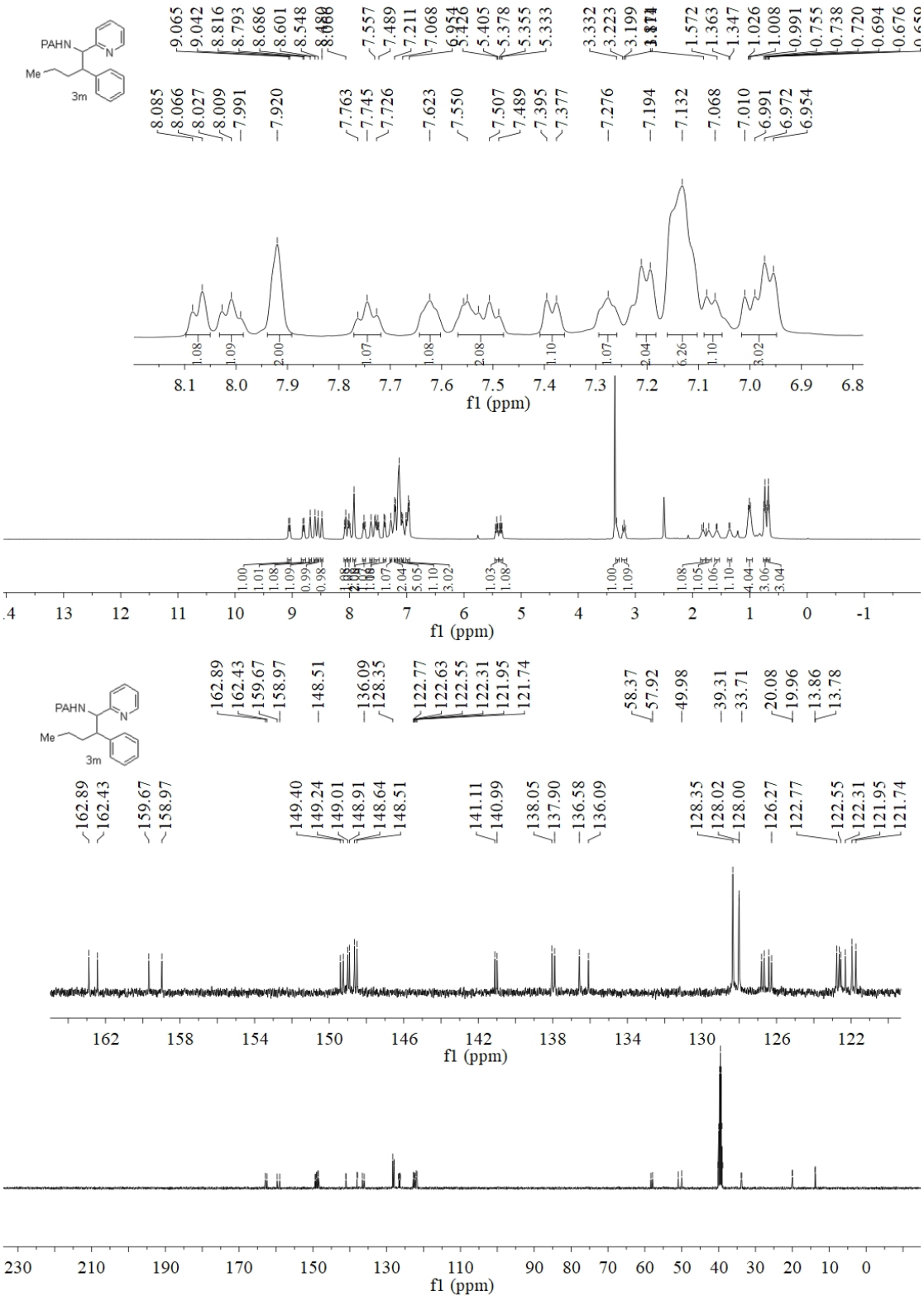

PAHN
3h
OMe
9.118
9.102
8.586
8.161
7.815
7.403
7.155
6.934
6.917
6.723
6.703
5.421
5.406
3.733
3.335
3.303
3.172
3.147
3.119
8.637
8.180
7.833
7.515
7.498
f1 (ppm)
163.80
158.21
148.40
137.29
136.27
129.51
122.74
122.25
113.69
77.48
77.16
76.84
56.04
55.23
41.62
159.27
150.06
149.59
130.58
126.19
122.48

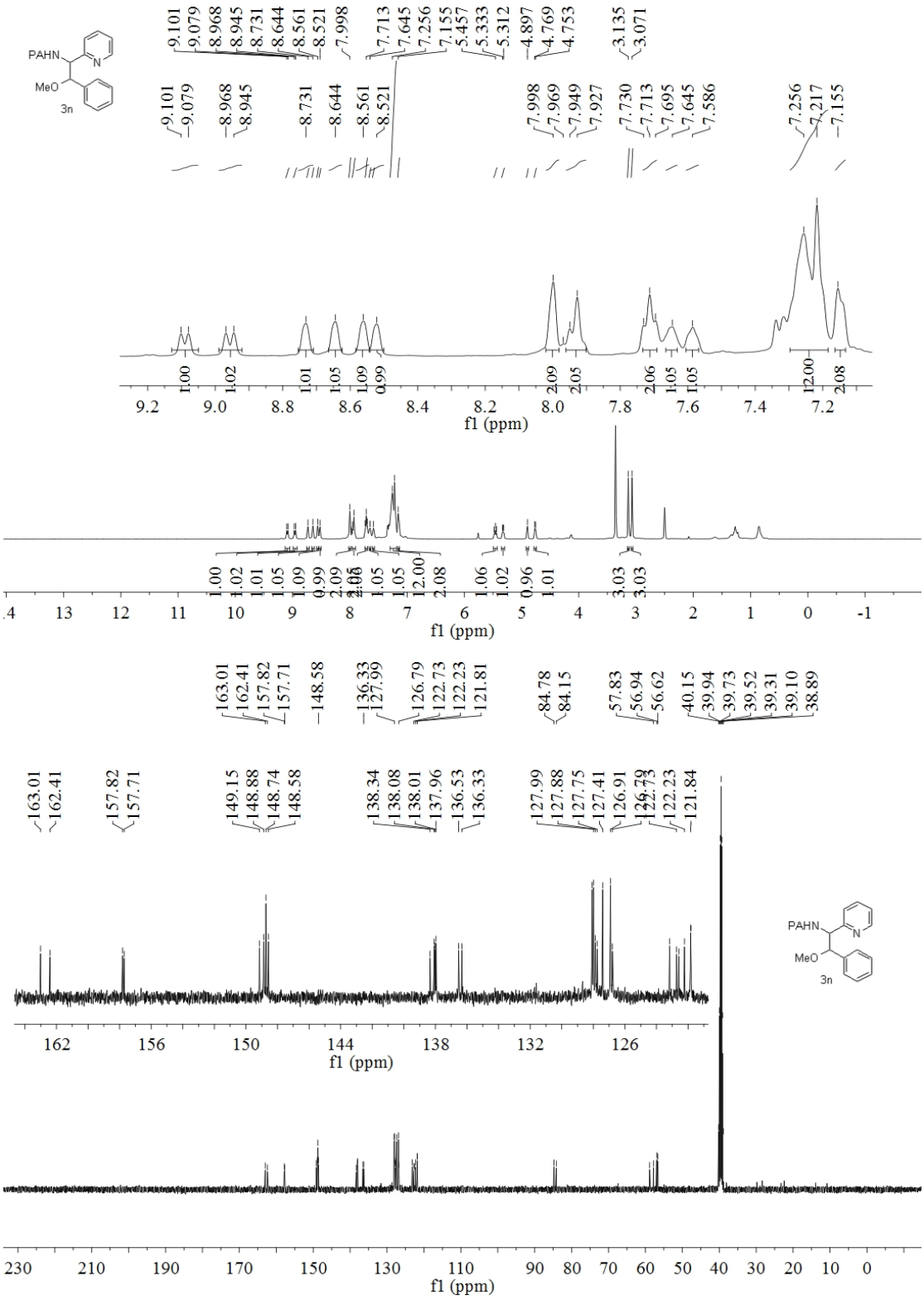

PAHN
Me
3i
9.118
9.097
8.589
8.170
7.408
7.149
6.962
6.794
5.470
5.452
5.434
5.415
3.347
3.221
3.200
3.188
3.167
2.312
8.652
8.643
8.598
8.589
8.189
8.170
7.843
7.824
7.805
7.542
7.523
7.504
7.422
7.408
7.393
7.164
7.149
7.110
7.090
6.962
6.862
6.843
6.813
6.794
0.98
0.95
0.94
0.99
0.98
0.99
1.11
2.11
3.07
2.02
2.04
f1 (ppm)
0.90
0.94
0.99
1.11
2.11
3.07
2.02
2.04
0.98
1.02
1.00
3.06
f1 (ppm)
PAHN
Me
3i
163.83
159.21
156.33
154.99
150.07
149.65
148.41
130.25
126.21
122.74
122.55
122.28
118.94
118.38
77.48
77.16
76.84
55.99
41.74
20.79
163.83
159.21
156.33
154.99
150.07
149.65
148.41
137.31
136.31
132.77
132.08
130.81
130.25
126.21
122.74
122.55
122.28
118.94
118.38
f1 (ppm)
f1 (ppm)

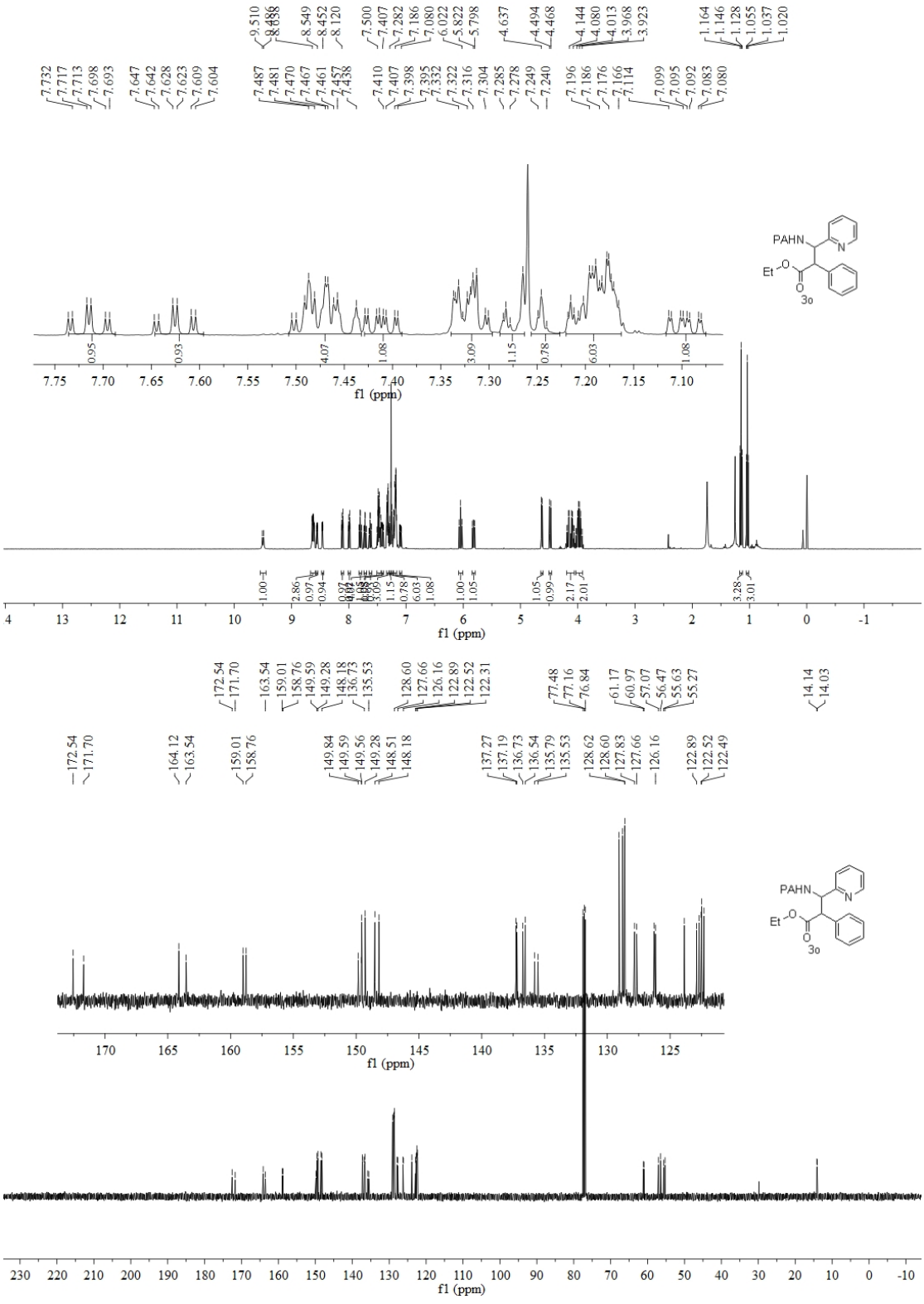

PAHN
9.388
9.372
8.624
8.460
8.232
7.852
7.429
7.194
6.869
6.429
5.640
5.619
5.606
5.586
4.076
4.054
4.044
3.448
3.418
3.391
8.698
8.624
8.481
8.460
8.252
8.232
7.871
7.852
7.840
7.821
7.694
7.674
7.565
7.462
7.416
7.280
7.194
7.141
7.127
7.114
6.886
6.869
6.448
6.429
0.92
1.08
0.96
0.98
2.04
1.06
1.09
1.06
1.14
1.19
1.17
1.16
1.09
1.00
f1 (ppm)
0.86
0.95
1.09
0.95
0.94
0.99
0.99
0.99
0.96
1.00
f1 (ppm)
PAHN
164.16
158.74
150.21
149.71
148.48
128.02
127.43
126.45
126.25
125.74
125.19
124.38
123.08
122.62
122.27
77.48
77.16
76.84
55.51
40.32
164.16
158.74
150.21
149.71
148.48
137.37
135.95
133.88
133.76
132.41
128.67
128.02
127.43
125.74
125.19
124.38
123.08
122.62
122.27
f1 (ppm)
f1 (ppm)

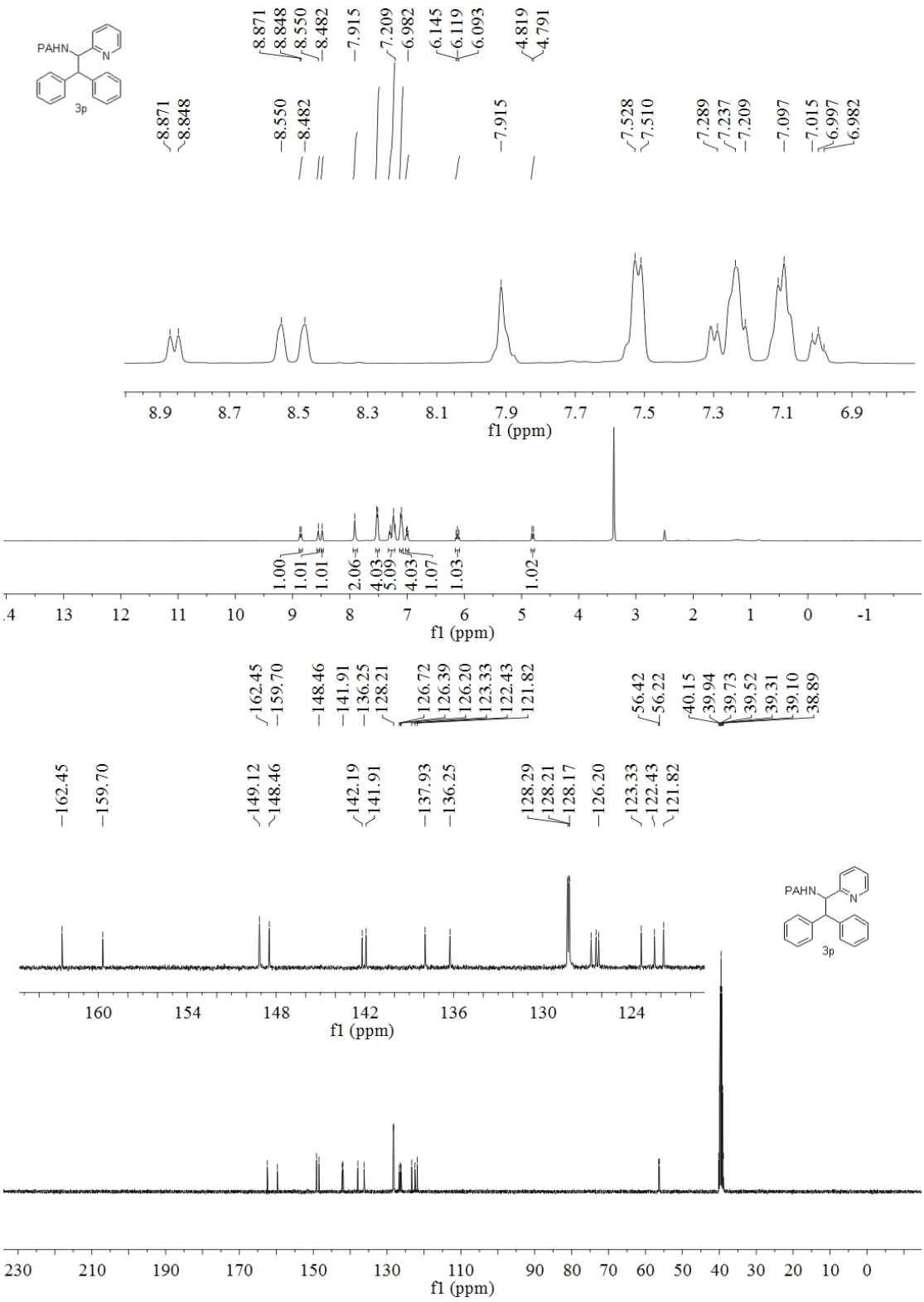

PAHN
3k
9.185
9.166
8.586
7.821
7.751
7.443
7.173
6.877
5.598
5.579
5.562
5.543
3.593
3.579
3.560
3.546
3.397
3.376
3.365
3.343
8.674
8.666
8.595
8.586
8.194
8.175
7.821
7.802
7.769
7.757
7.751
7.685
7.665
7.497
7.443
7.405
7.392
7.194
7.173
7.157
7.142
6.896
6.877
1.00
1.04
0.97
1.09
1.04
2.03
1.00
4.00
2.10
1.01
f1 (ppm)
0.90
0.97
2.10
1.01
0.99
0.96
0.98
f1 (ppm)
163.91
159.15
148.42
137.33
132.34
128.02
127.69
125.93
122.78
122.32
77.48
77.16
76.84
56.00
42.72
163.91
159.15
150.11
149.70
148.42
137.33
136.34
135.16
133.54
132.34
128.02
127.90
127.69
125.49
122.78
122.59
122.32
PAHN
3k
f1 (ppm)
f1 (ppm)

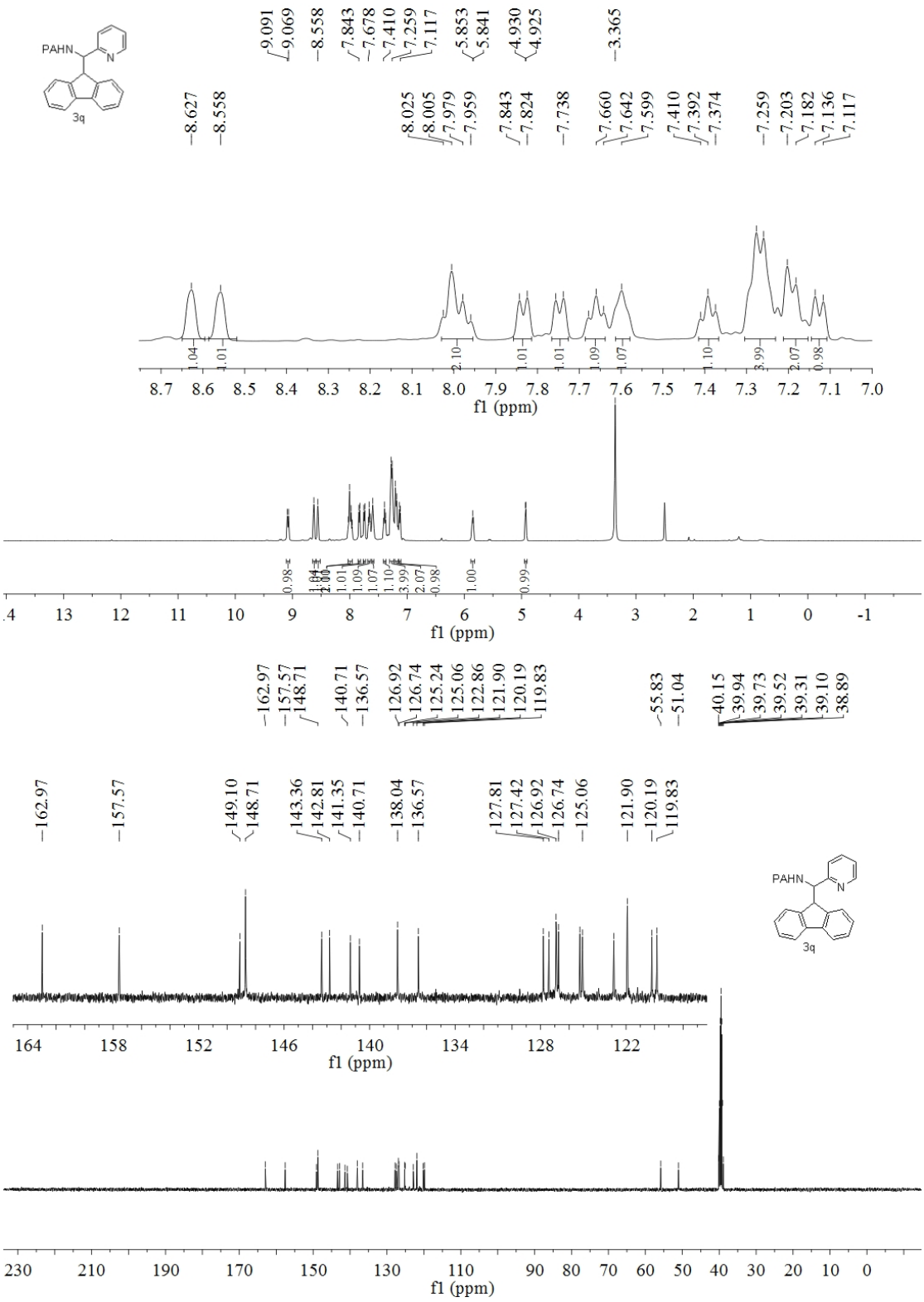

PAHN
Me
3l
f1 (ppm)
f1 (ppm)
f1 (ppm)
f1 (ppm)

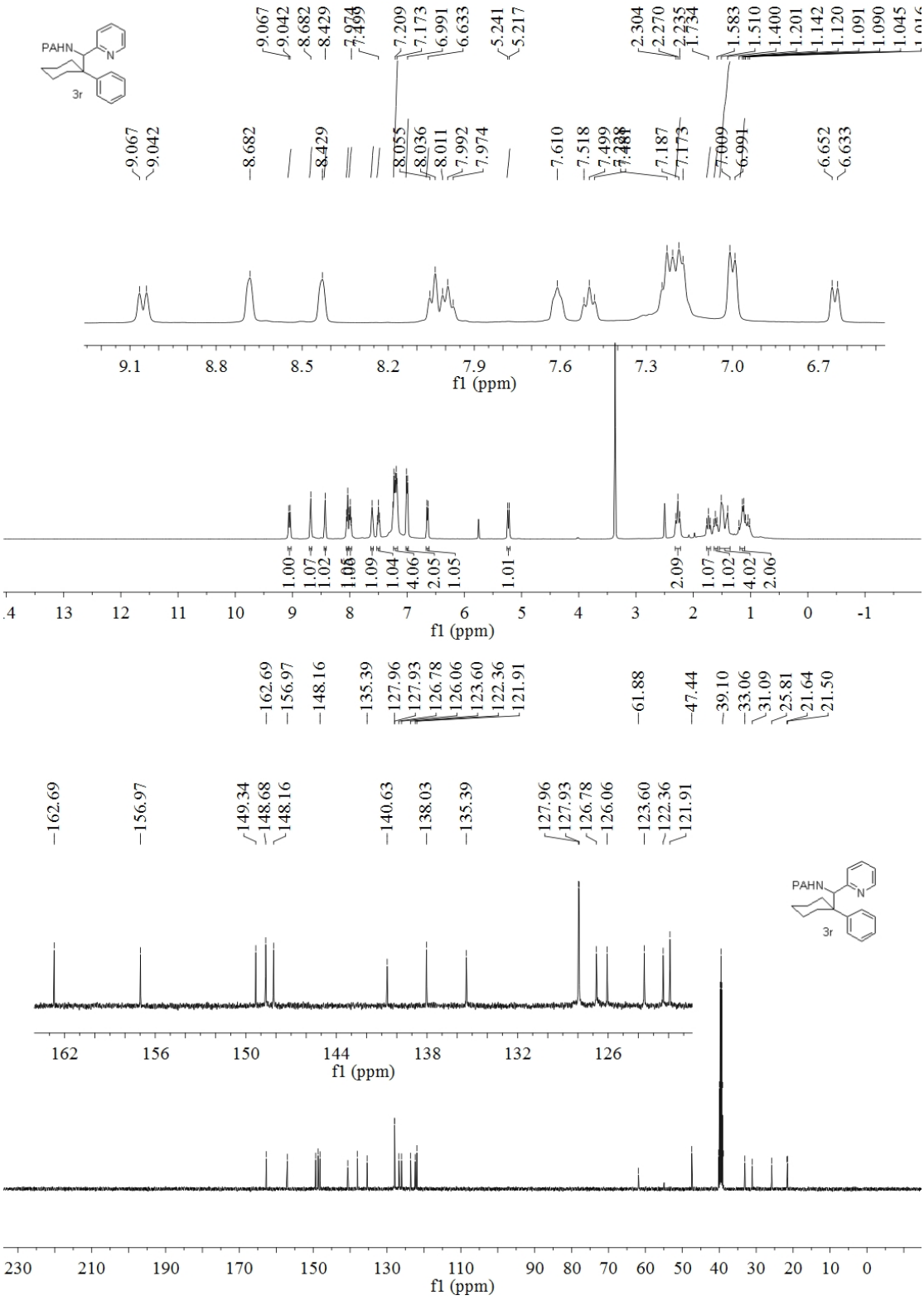

PAHN
Me
3m
f1 (ppm)

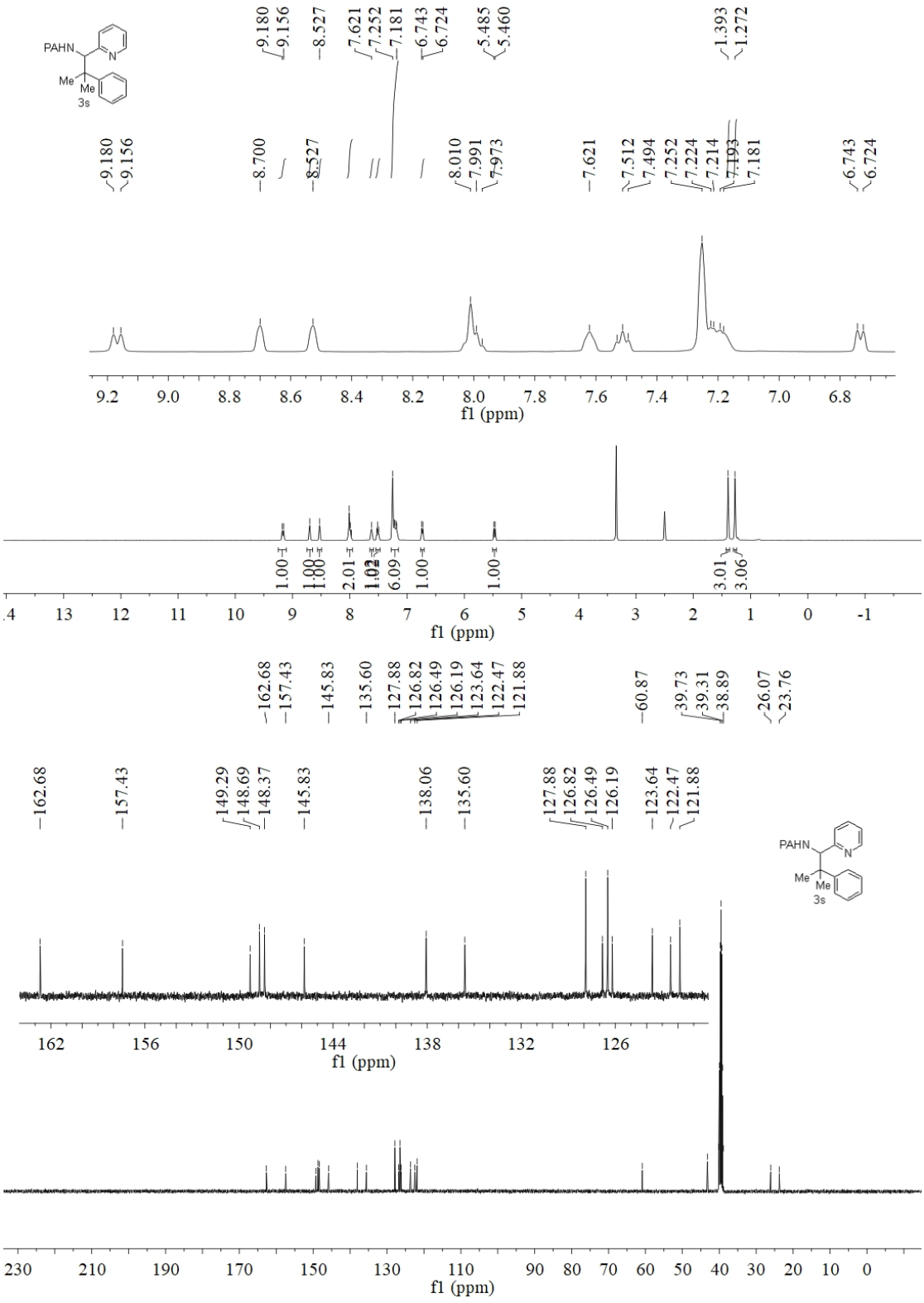

PAHN
MeO
3n
f1 (ppm)
f1 (ppm)
f1 (ppm)
f1 (ppm)

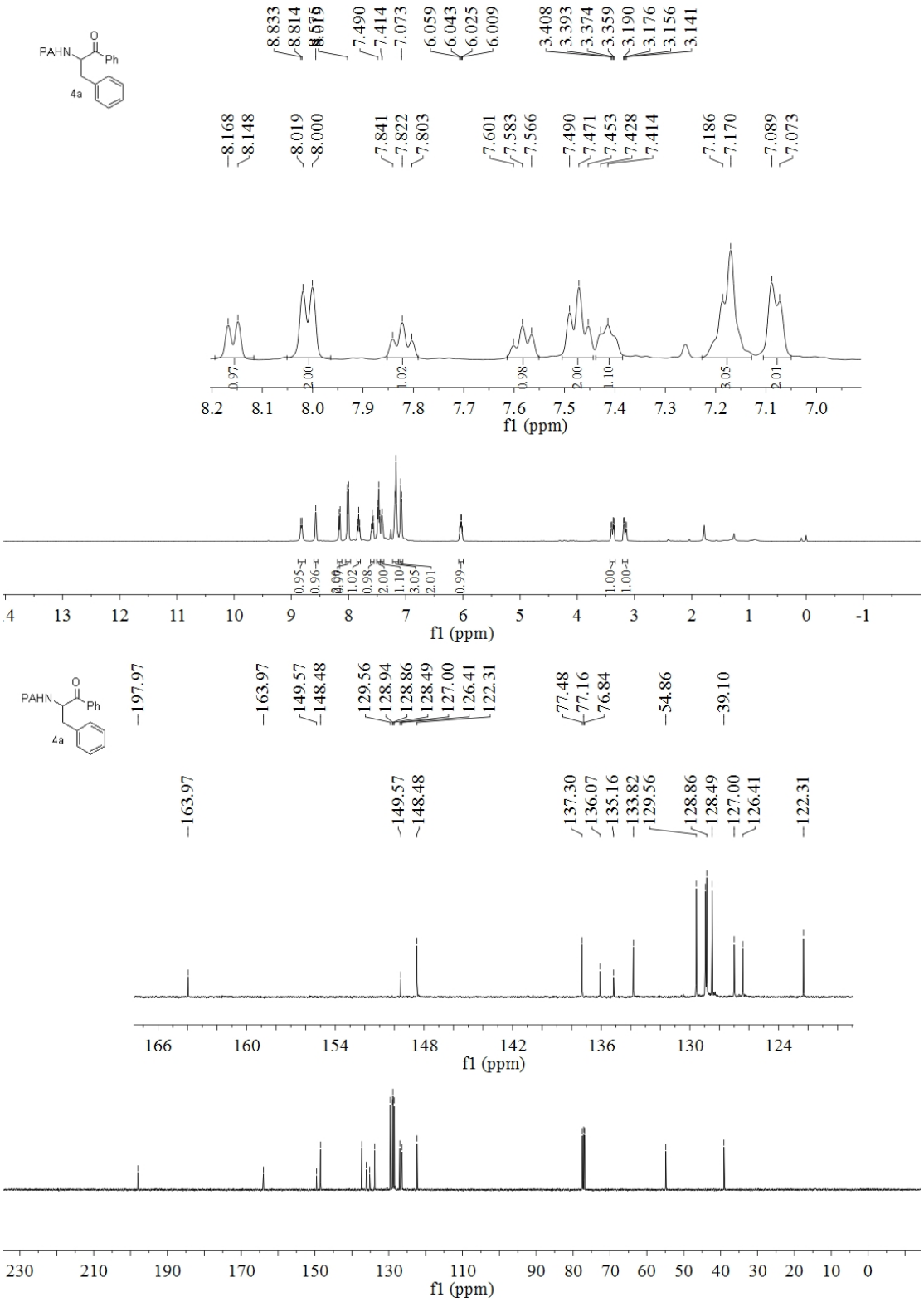

PAHN
Et
O
3o
f1 (ppm)

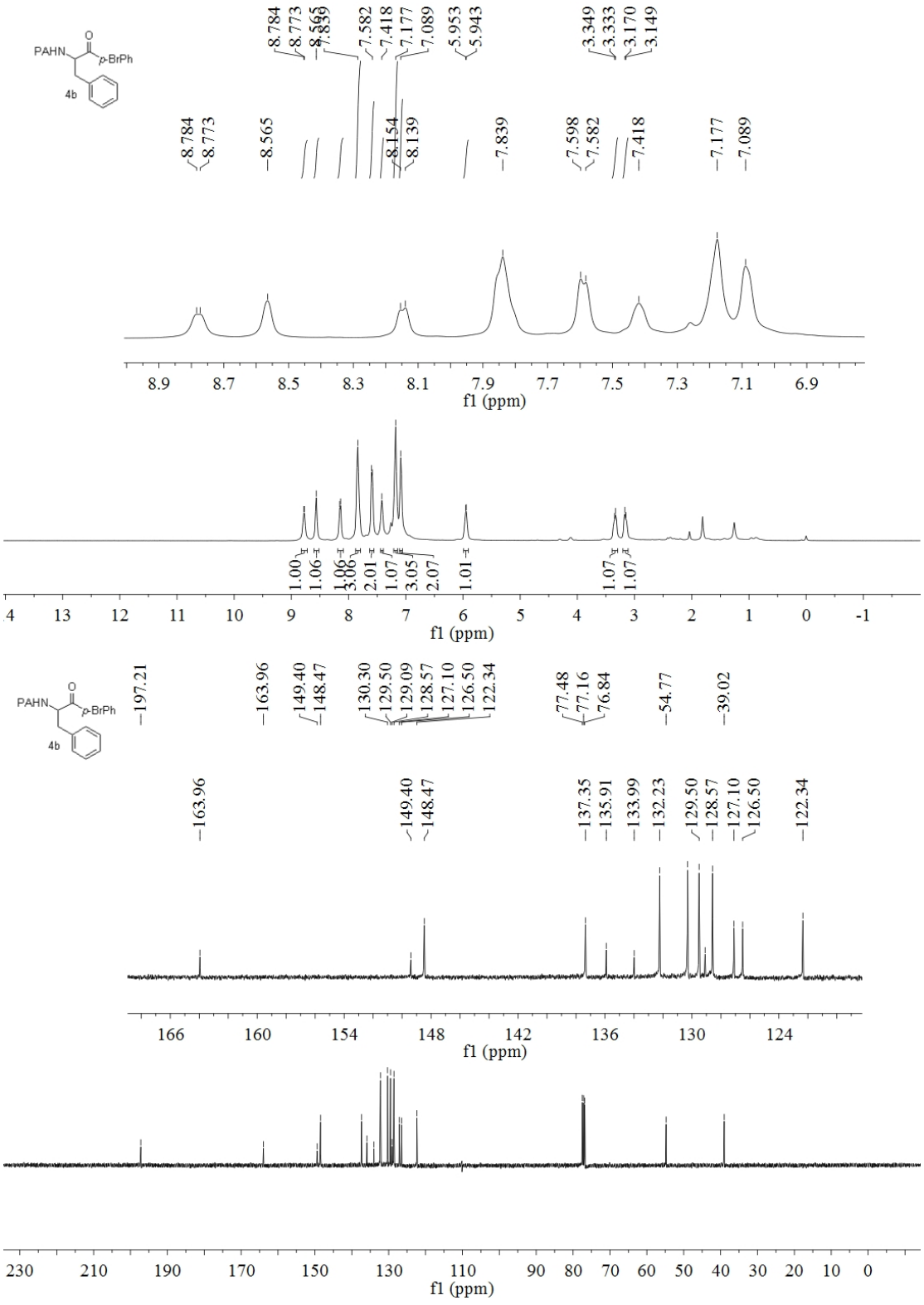

PAHN
3p
8.871
8.848
8.550
8.482
7.915
7.209
6.982
6.145
6.119
6.093
4.819
4.791
7.528
7.510
7.289
7.237
7.209
7.097
7.015
6.997
6.982
f1 (ppm)
1.00
1.01
1.01
2.06
4.03
5.09
4.03
1.07
1.03
1.02
f1 (ppm)
162.45
159.70
148.46
141.91
136.25
128.21
126.72
126.39
126.20
123.33
122.43
121.82
56.42
56.22
40.15
39.94
39.73
39.52
39.31
39.10
38.89
149.12
148.46
142.19
141.91
137.93
136.25
128.29
128.21
128.17
126.20
123.33
122.43
121.82
PAHN
3p
f1 (ppm)
f1 (ppm)

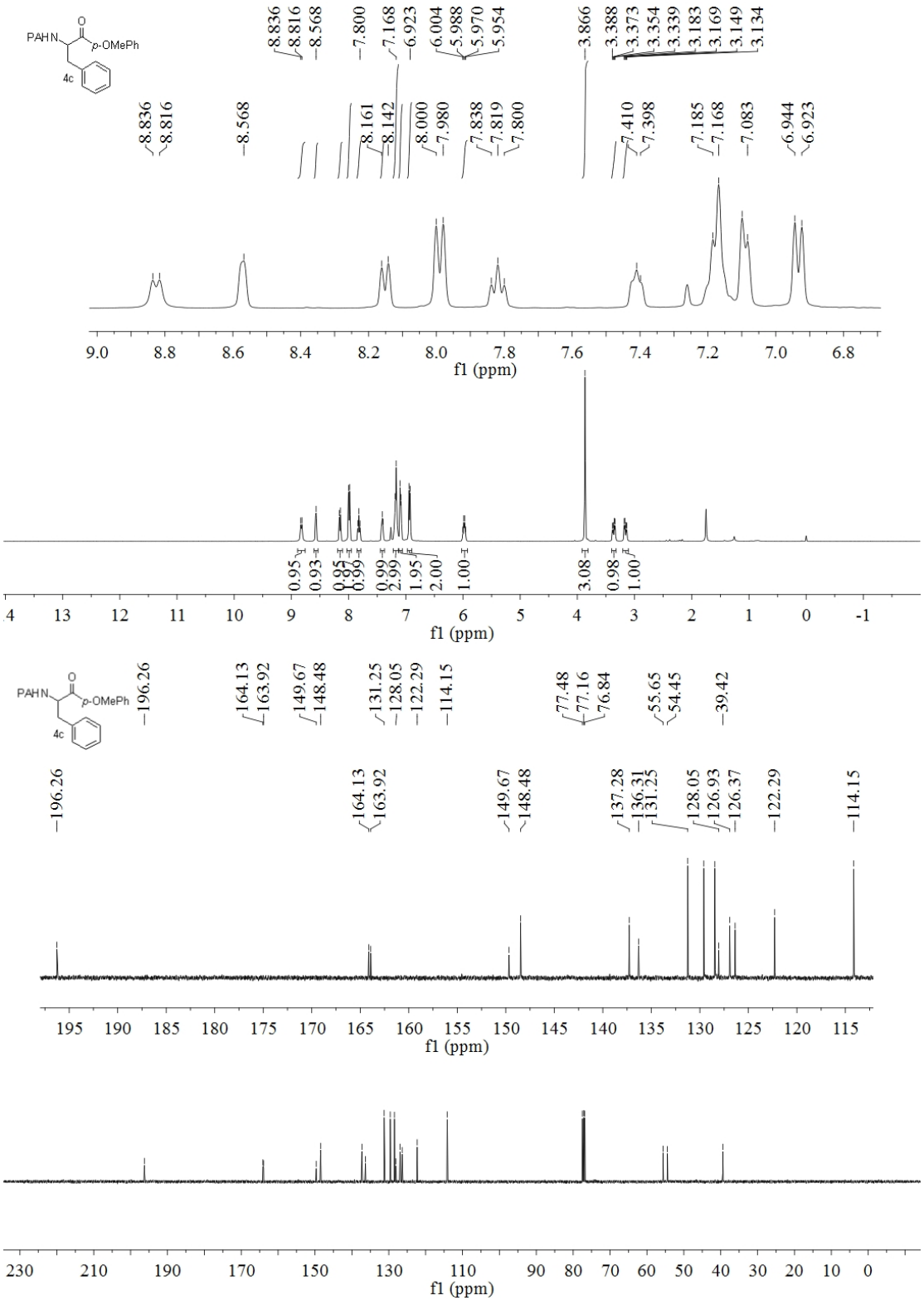

PAHN
3q
9.091
9.069
8.558
7.843
7.678
7.410
7.259
7.117
5.853
5.841
4.930
4.925
3.365
8.627
8.558
8.025
8.005
7.979
7.959
7.843
7.824
7.738
7.660
7.642
7.599
7.410
7.392
7.374
7.259
7.203
7.182
7.136
7.117
f1 (ppm)
162.97
157.57
148.71
140.71
136.57
126.92
126.74
125.24
125.06
122.86
121.90
120.19
119.83
55.83
51.04
40.15
39.94
39.73
39.52
39.31
39.10
38.89
149.10
143.36
142.81
141.35
138.04
127.81
127.42
126.92
126.74
125.06
121.90
f1 (ppm)

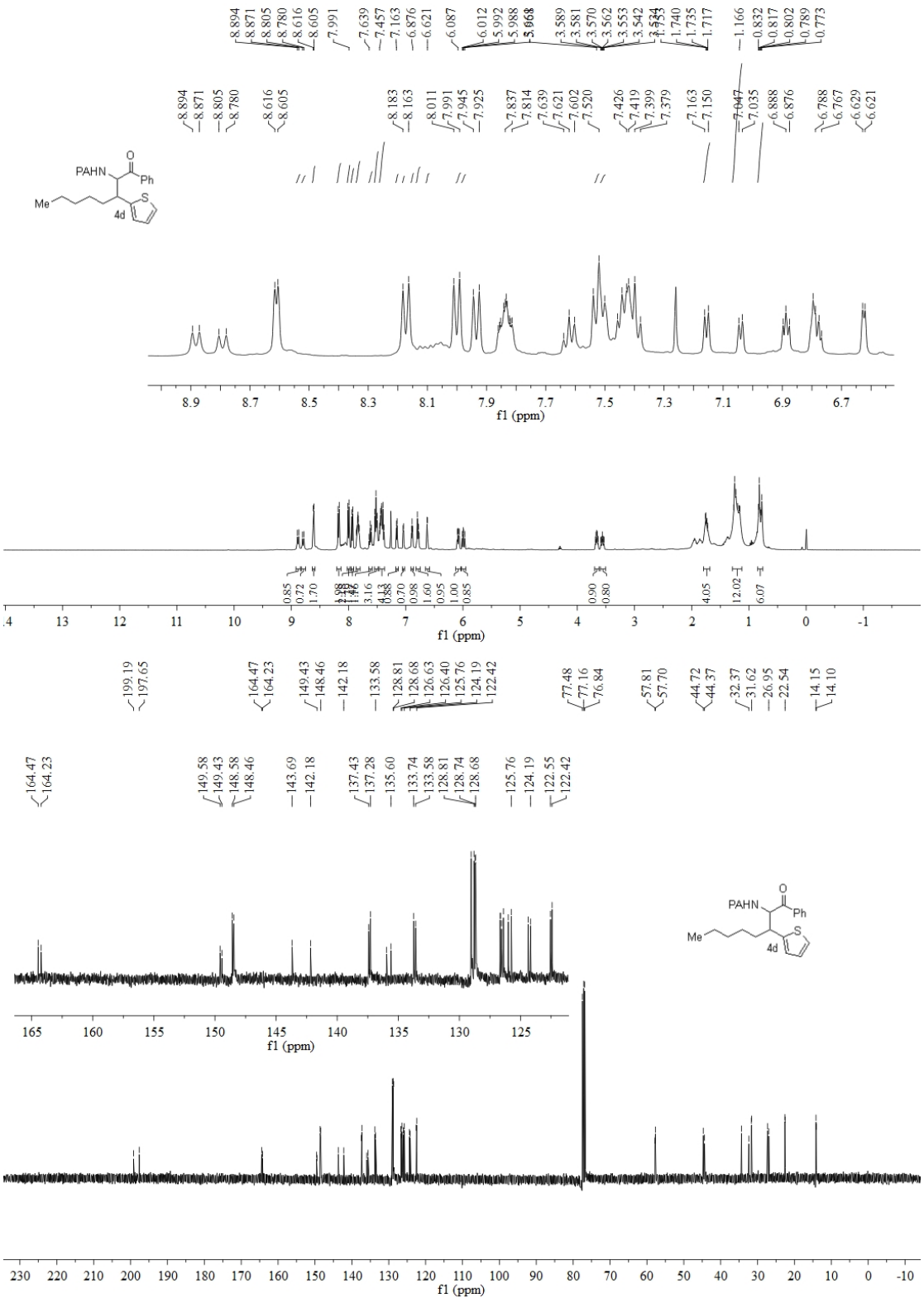

PAHN
3r
f1 (ppm)
PAHN
3r
f1 (ppm)
f1 (ppm)

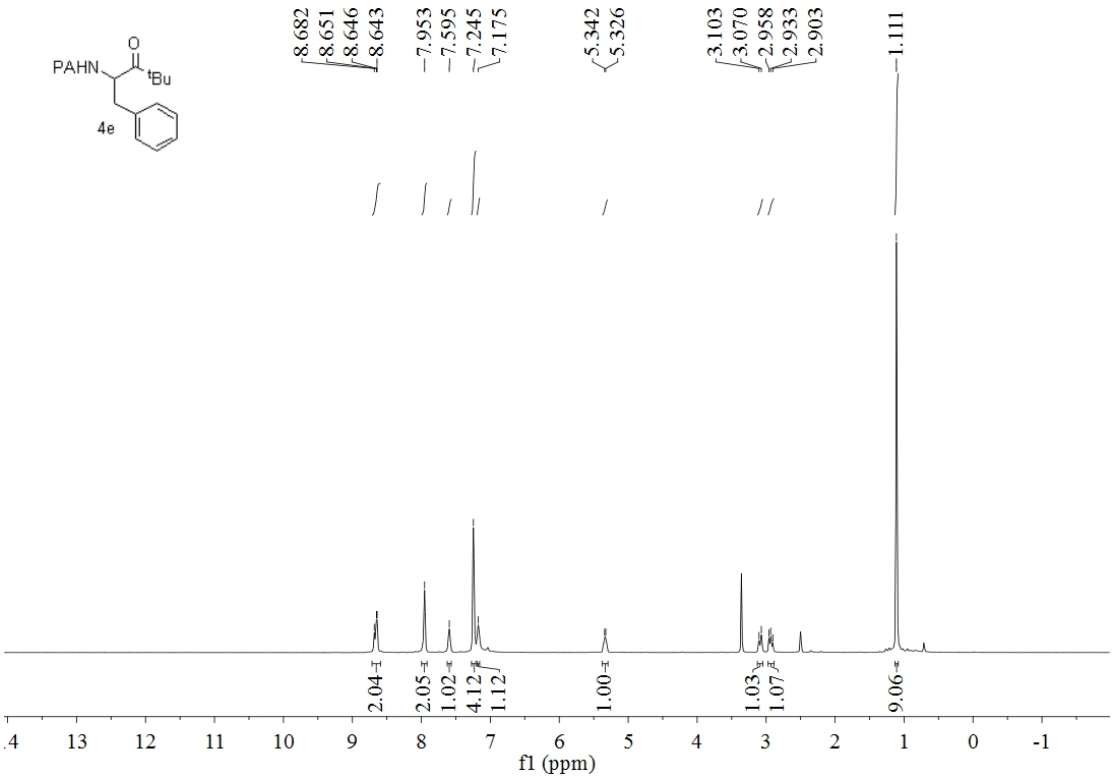

PAHN
Me
Me
3s
9.180
9.156
8.527
7.621
7.252
7.181
6.743
6.724
5.485
5.460
1.393
1.272
f1 (ppm)
162.68
157.43
145.83
135.60
127.88
126.82
126.49
126.19
123.64
122.47
121.88
60.87
39.73
39.31
38.89
26.07
23.76
149.29
148.69
148.37
138.06
f1 (ppm)

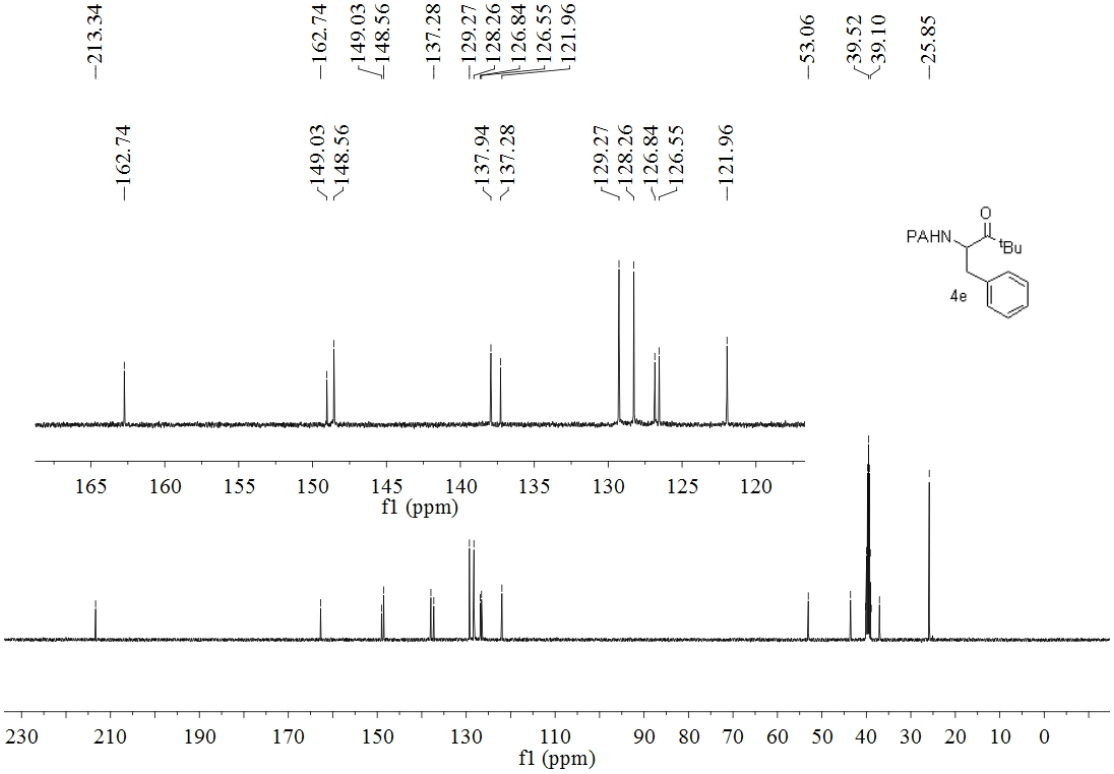

PAHN
Ph
4a
8.833
8.814
8.490
7.414
7.073
6.059
6.043
6.025
6.009
3.408
3.393
3.374
3.359
3.190
3.176
3.156
3.141
8.168
8.148
8.019
8.000
7.841
7.822
7.803
7.601
7.583
7.566
7.490
7.471
7.453
7.428
7.414
7.186
7.170
7.089
7.073
0.97
2.00
1.02
0.98
2.00
1.10
3.05
2.01
f1 (ppm)
0.95
0.96
1.00
1.00
f1 (ppm)
PAHN
Ph
4a
197.97
163.97
149.57
148.48
129.56
128.94
128.86
128.49
127.00
126.41
122.31
77.48
77.16
76.84
54.86
39.10
163.97
149.57
148.48
137.30
136.07
135.16
133.82
129.56
128.86
128.49
127.00
126.41
122.31
f1 (ppm)
f1 (ppm)

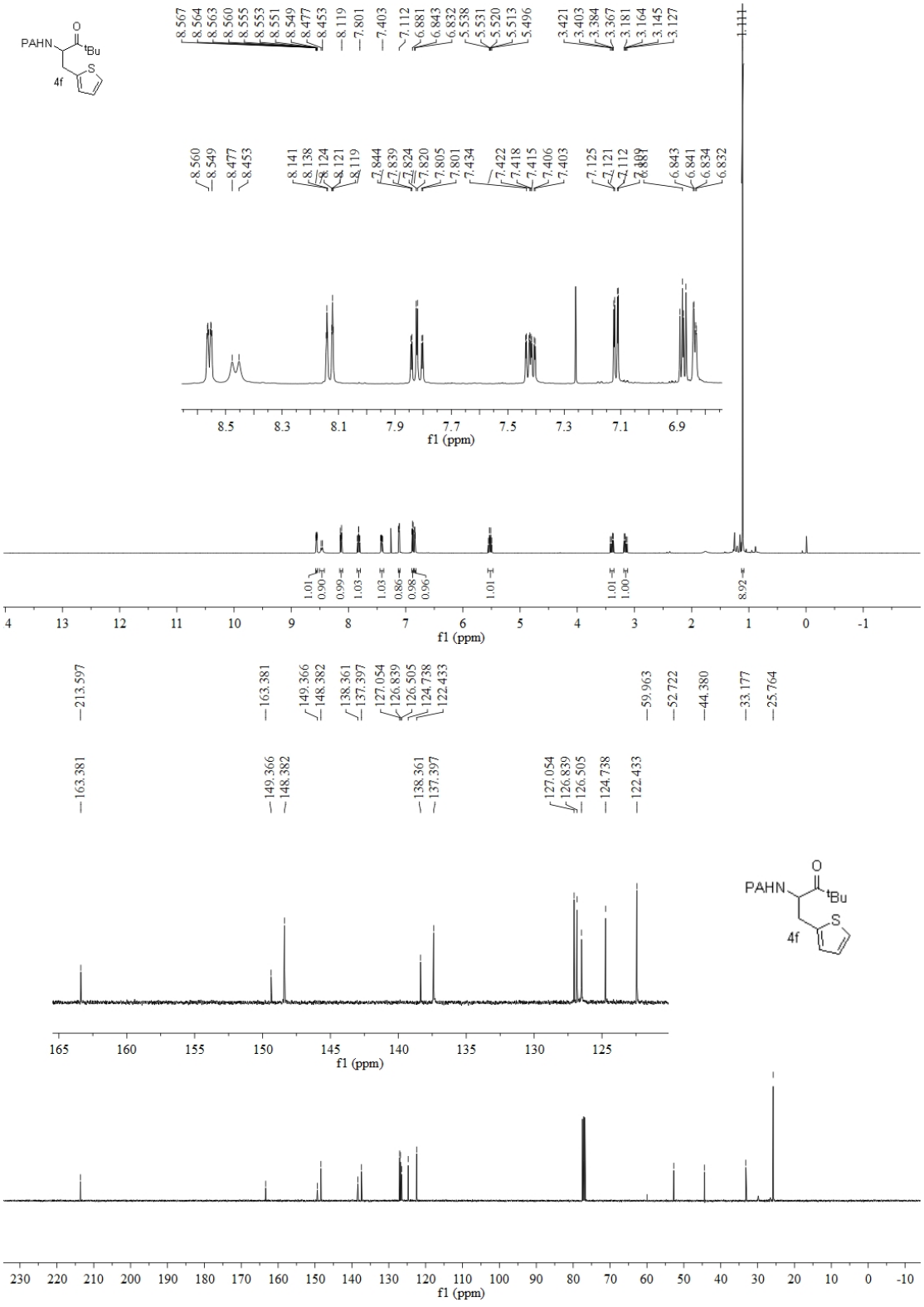

PAHN
p-BrPh
4b
8.784
8.773
8.565
7.582
7.418
7.177
7.089
5.953
5.943
3.349
3.333
3.170
3.149
8.784
8.773
8.565
8.154
8.139
7.839
7.598
7.582
7.418
7.177
7.089
8.9 8.7 8.5 8.3 8.1 7.9 7.7 7.5 7.3 7.1 6.9
f1 (ppm)
1.00
1.06
1.06
3.08
2.01
1.07
3.05
2.07
1.01
1.07
1.07
4 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1
f1 (ppm)
PAHN
p-BrPh
4b
197.21
163.96
149.40
148.47
130.30
129.50
129.09
128.57
127.10
126.50
122.34
77.48
77.16
76.84
54.77
39.02
163.96
149.40
148.47
137.35
135.91
133.99
132.23
129.50
128.57
127.10
126.50
122.34
166 160 154 148 142 136 130 124
f1 (ppm)
230 210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

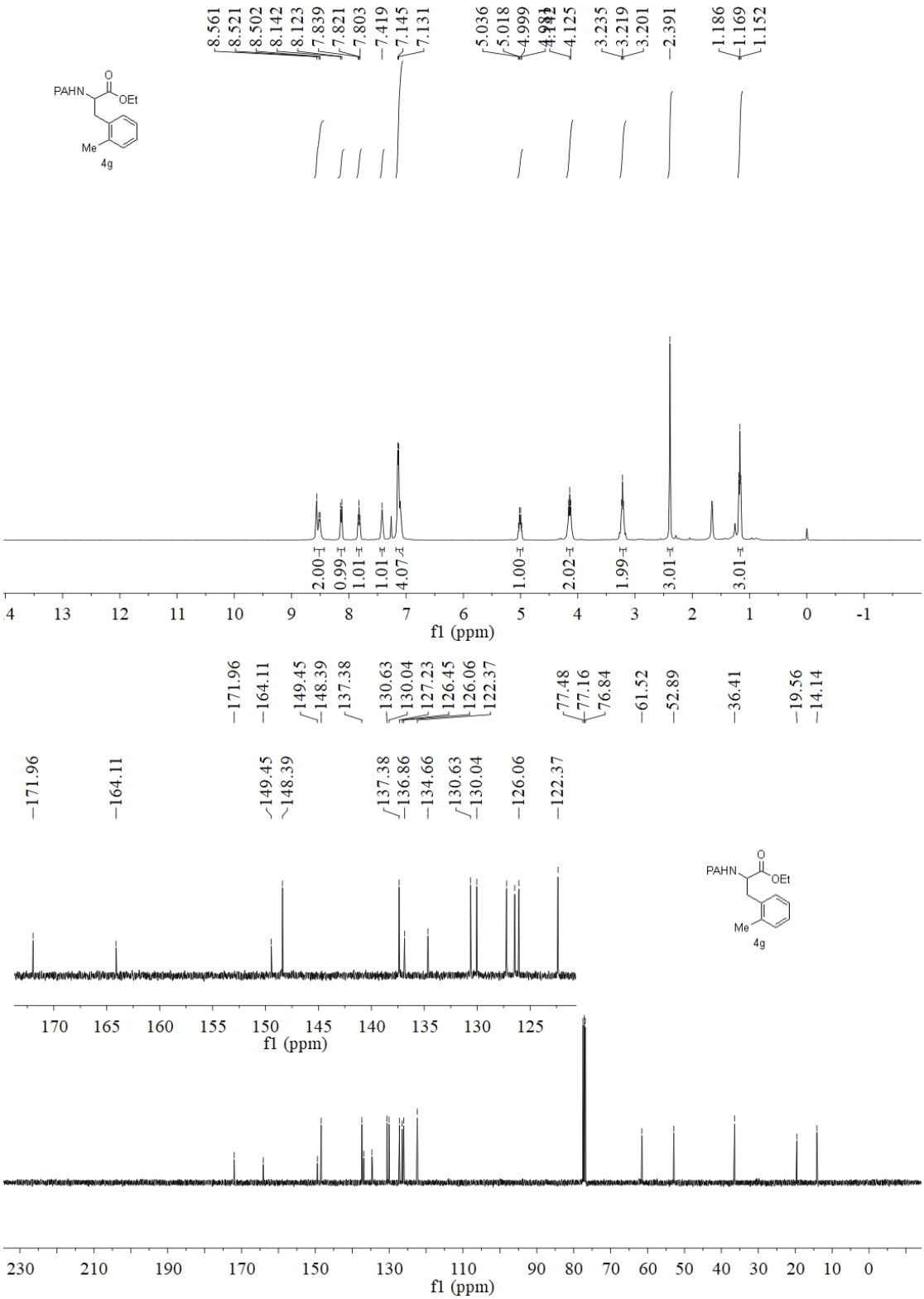

PAHN
p-OMePh
4c
8.836
8.816
8.568
7.800
7.168
6.923
6.004
5.988
5.970
5.954
3.866
3.388
3.373
3.354
3.339
3.183
3.169
3.149
3.134
8.161
8.142
8.000
7.980
7.838
7.819
7.800
7.410
7.398
7.185
7.168
7.083
6.944
6.923
f1 (ppm)
0.95
0.93
0.95
0.97
0.99
0.99
2.99
1.95
2.00
1.00
3.08
0.98
1.00
f1 (ppm)
196.26
164.13
163.92
149.67
148.48
131.25
128.05
122.29
114.15
77.48
77.16
76.84
55.65
54.45
39.42
137.28
136.31
126.93
126.37
f1 (ppm)
f1 (ppm)

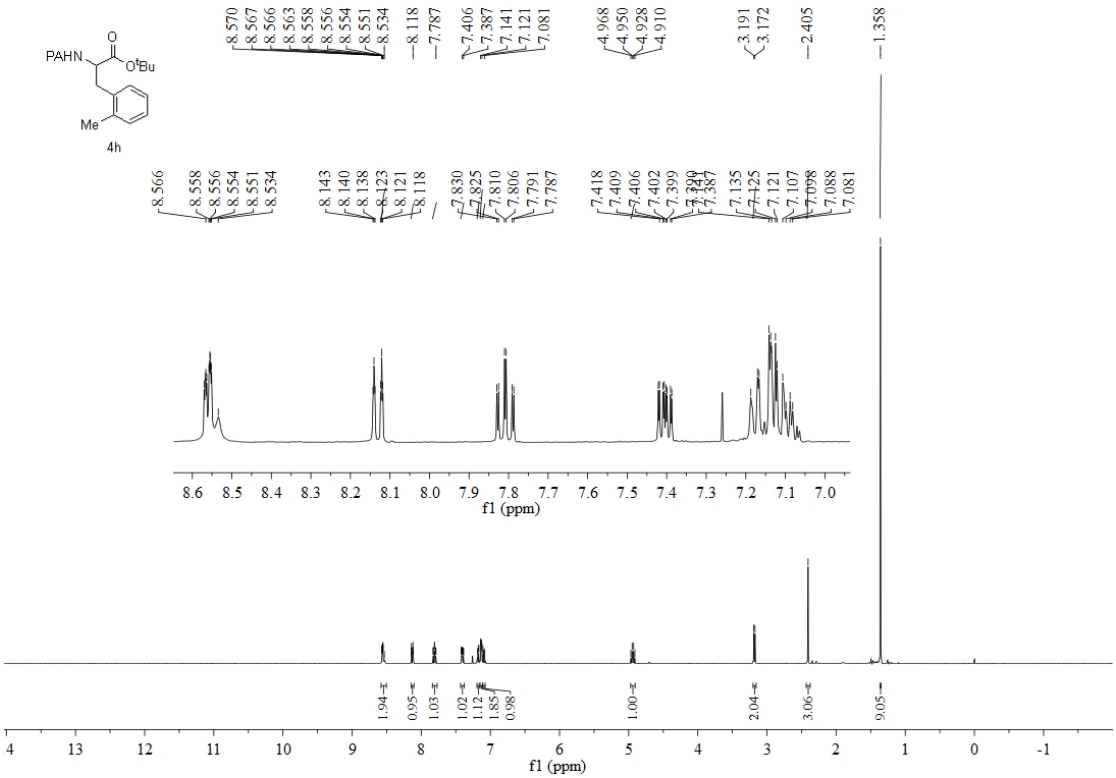

PAHN
O
Ph
Me
S
4d
f1 (ppm)

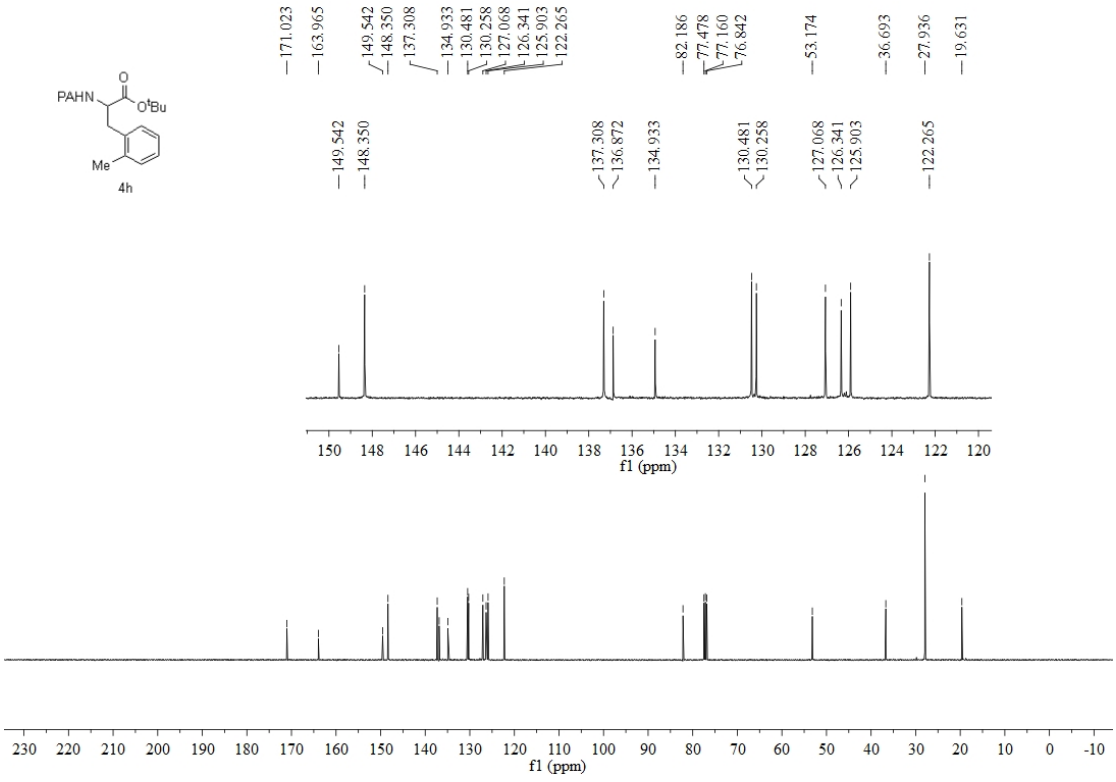

PAHN
O
tBu
4e
8.682
8.651
8.646
8.643
7.953
7.595
7.245
7.175
5.342
5.326
3.103
3.070
2.958
2.933
2.903
1.111
2.04
2.05
1.02
4.12
1.12
1.00
1.03
1.07
9.06
f1 (ppm)

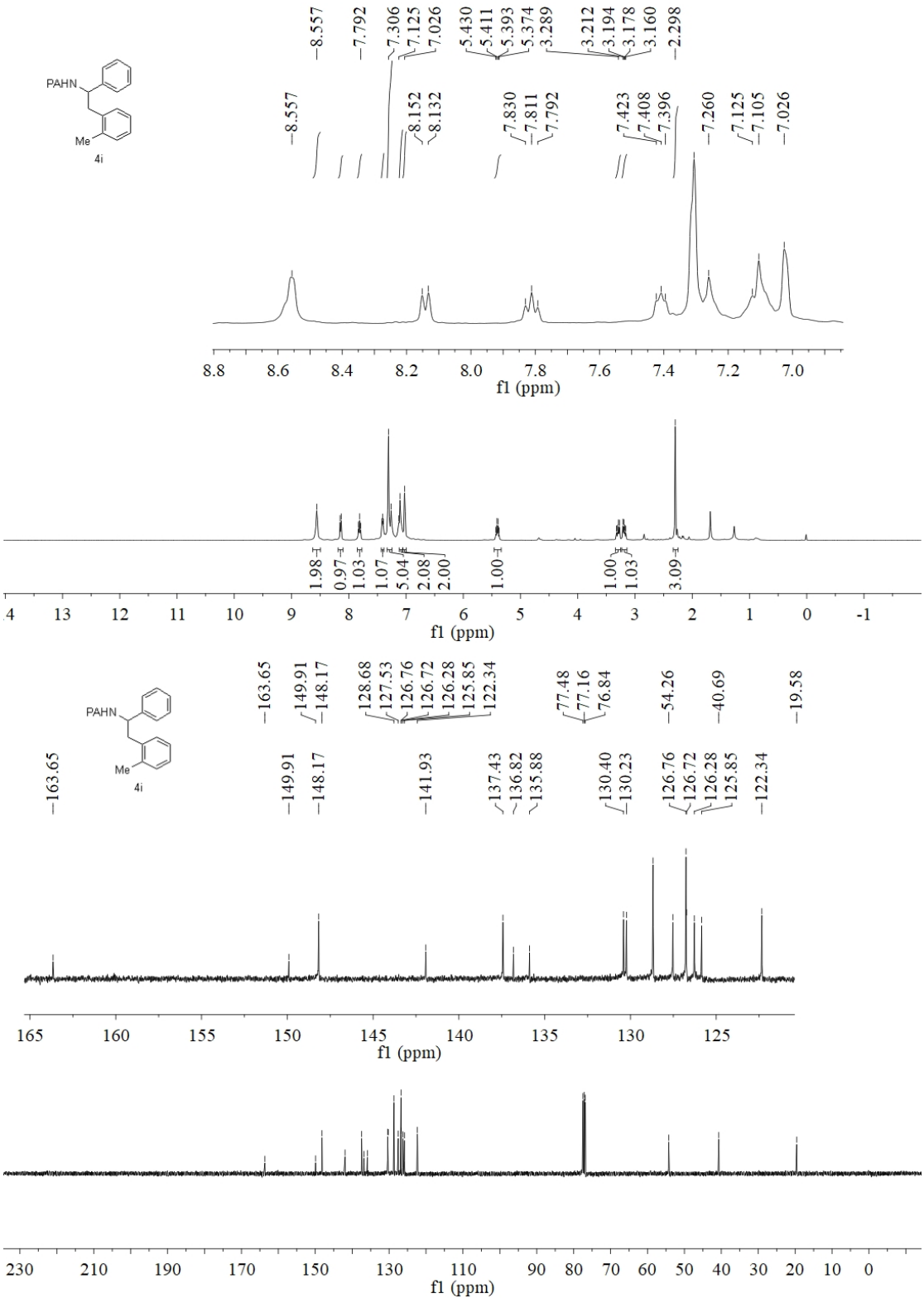

213.34
162.74
149.03
148.56
137.28
129.27
128.26
126.84
126.55
121.96
53.06
39.52
39.10
25.85
162.74
149.03
148.56
137.94
137.28
129.27
128.26
126.84
126.55
121.96
PAHN
O
tBu
4e
f1 (ppm)
f1 (ppm)

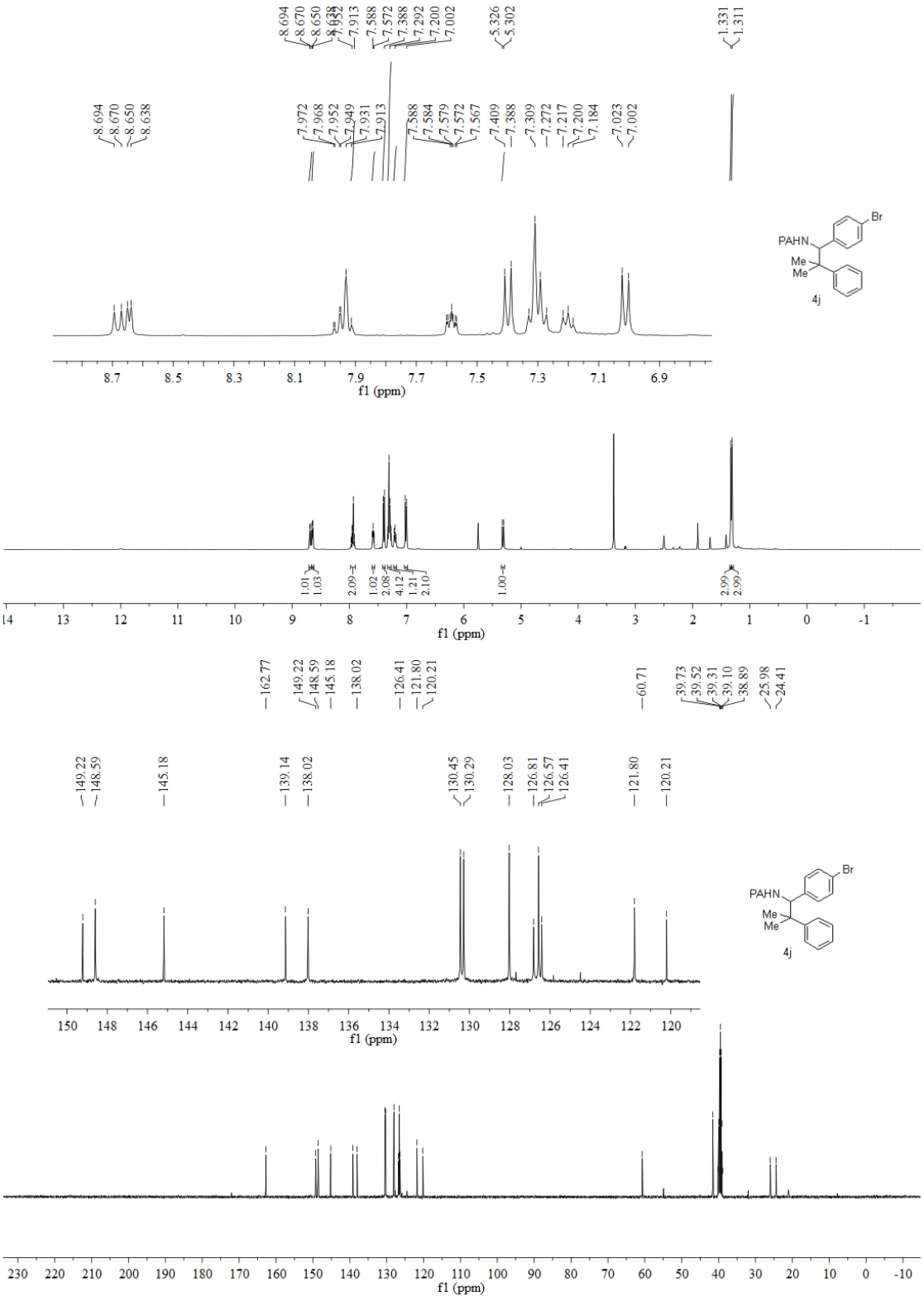

PAHN
tBu
S
4f
f1 (ppm)

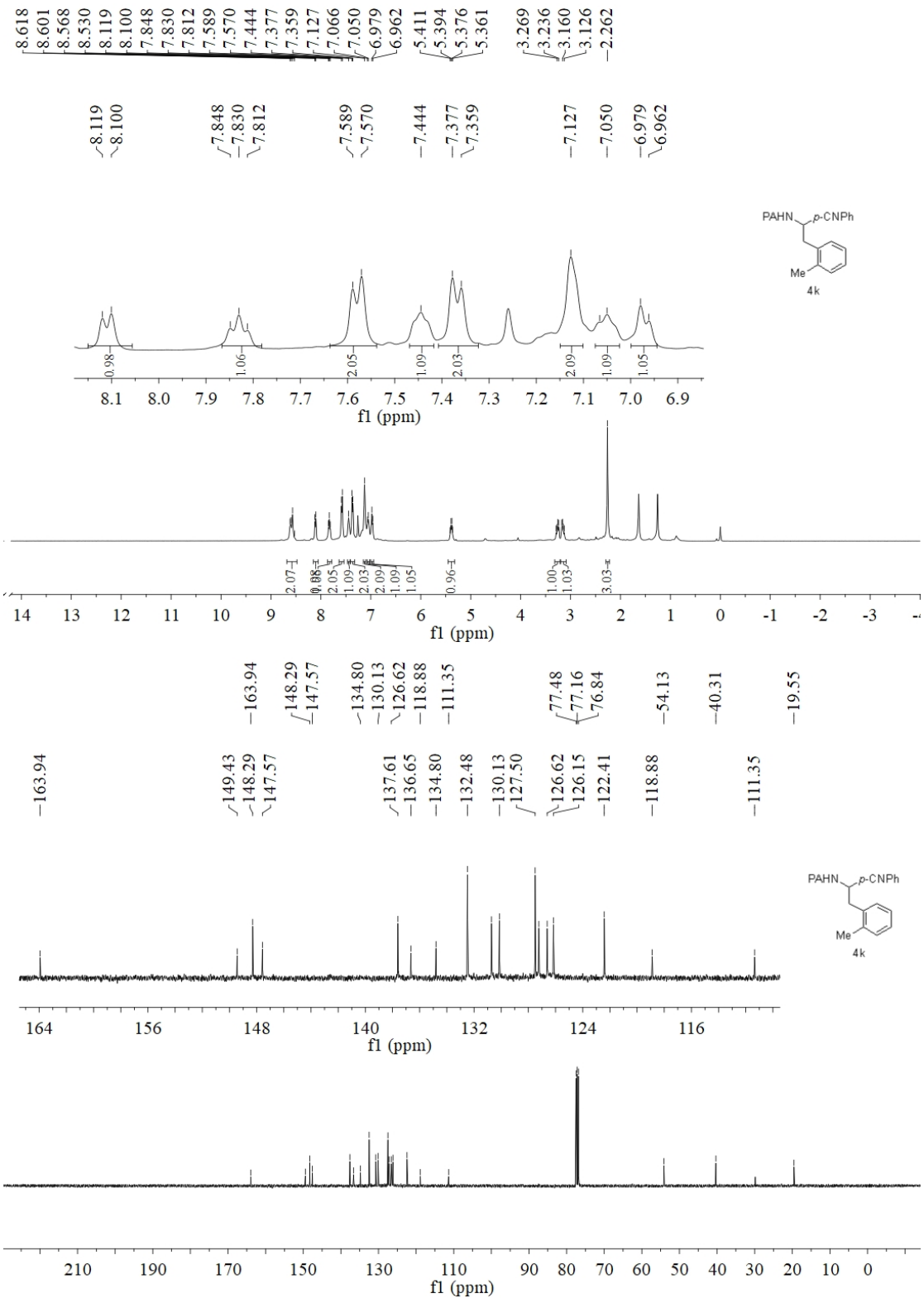

8.561
8.521
8.502
8.142
8.123
7.839
7.821
7.803
7.419
7.145
7.131
5.036
5.018
4.999
4.125
3.235
3.219
3.201
2.391
1.186
1.169
1.152
PAHN
O
OEt
Me
4g
2.00
0.99
1.01
1.01
4.07
1.00
2.02
1.99
3.01
3.01
f1 (ppm)
171.96
164.11
149.45
148.39
137.38
130.63
130.04
127.23
126.45
126.06
122.37
77.48
77.16
76.84
61.52
52.89
36.41
19.56
14.14
f1 (ppm)
f1 (ppm)

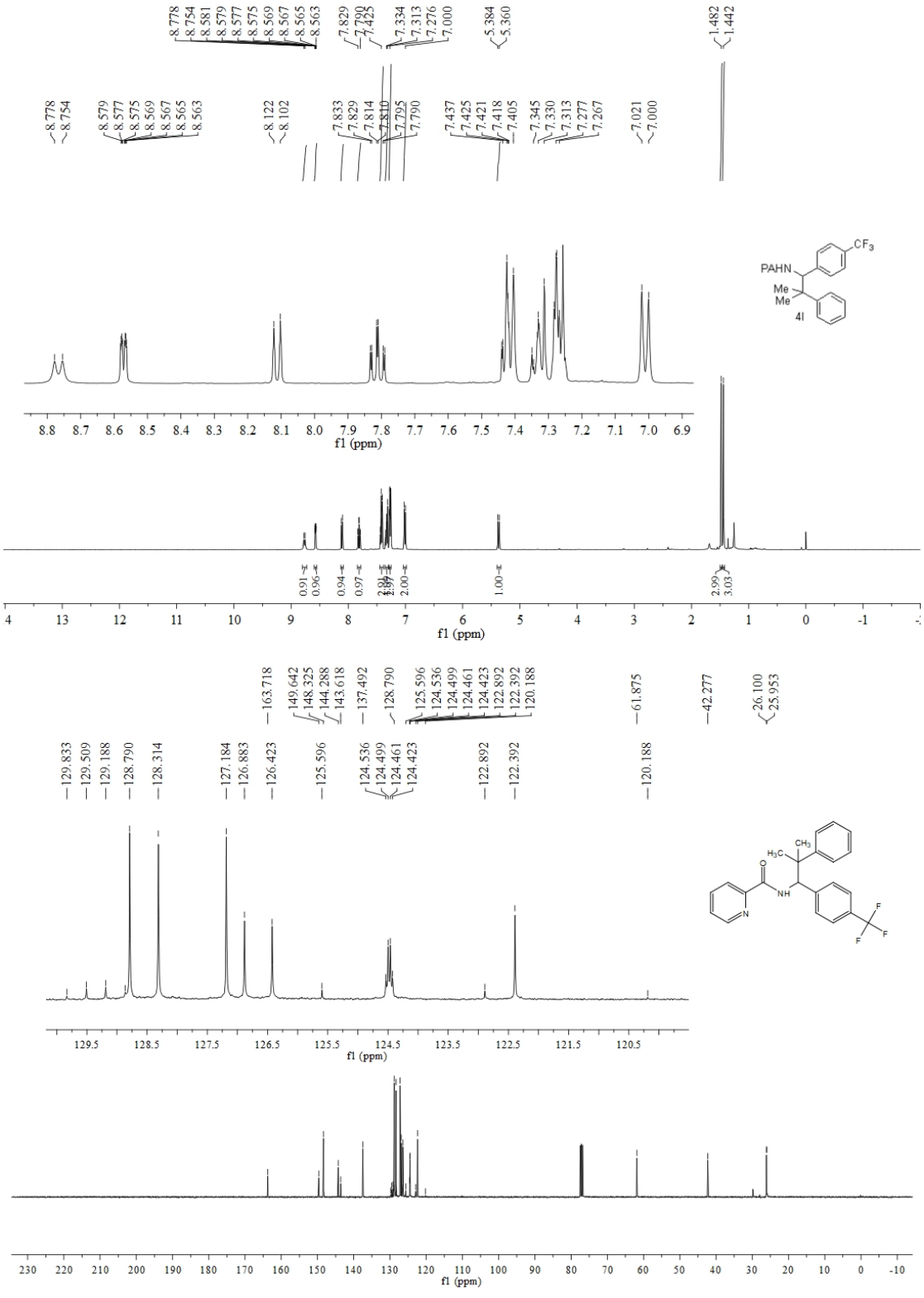

PAHN
O
O^{t}Bu
Me
4h
8.570
8.567
8.566
8.563
8.558
8.556
8.554
8.551
8.534
8.118
7.787
7.406
7.387
7.141
7.121
7.081
4.968
4.950
4.928
4.910
3.191
3.172
2.405
1.358
8.566
8.558
8.556
8.554
8.551
8.534
8.143
8.140
8.138
8.123
8.121
8.118
7.830
7.825
7.810
7.806
7.791
7.787
7.418
7.409
7.406
7.402
7.399
7.135
7.125
7.121
7.107
7.098
7.088
7.081
8.6 8.5 8.4 8.3 8.2 8.1 8.0 7.9 7.8 7.7 7.6 7.5 7.4 7.3 7.2 7.1 7.0
f1 (ppm)
1.94
0.95
1.03
1.02
1.12
1.85
0.98
1.00
2.04
3.06
9.05
4 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1
f1 (ppm)

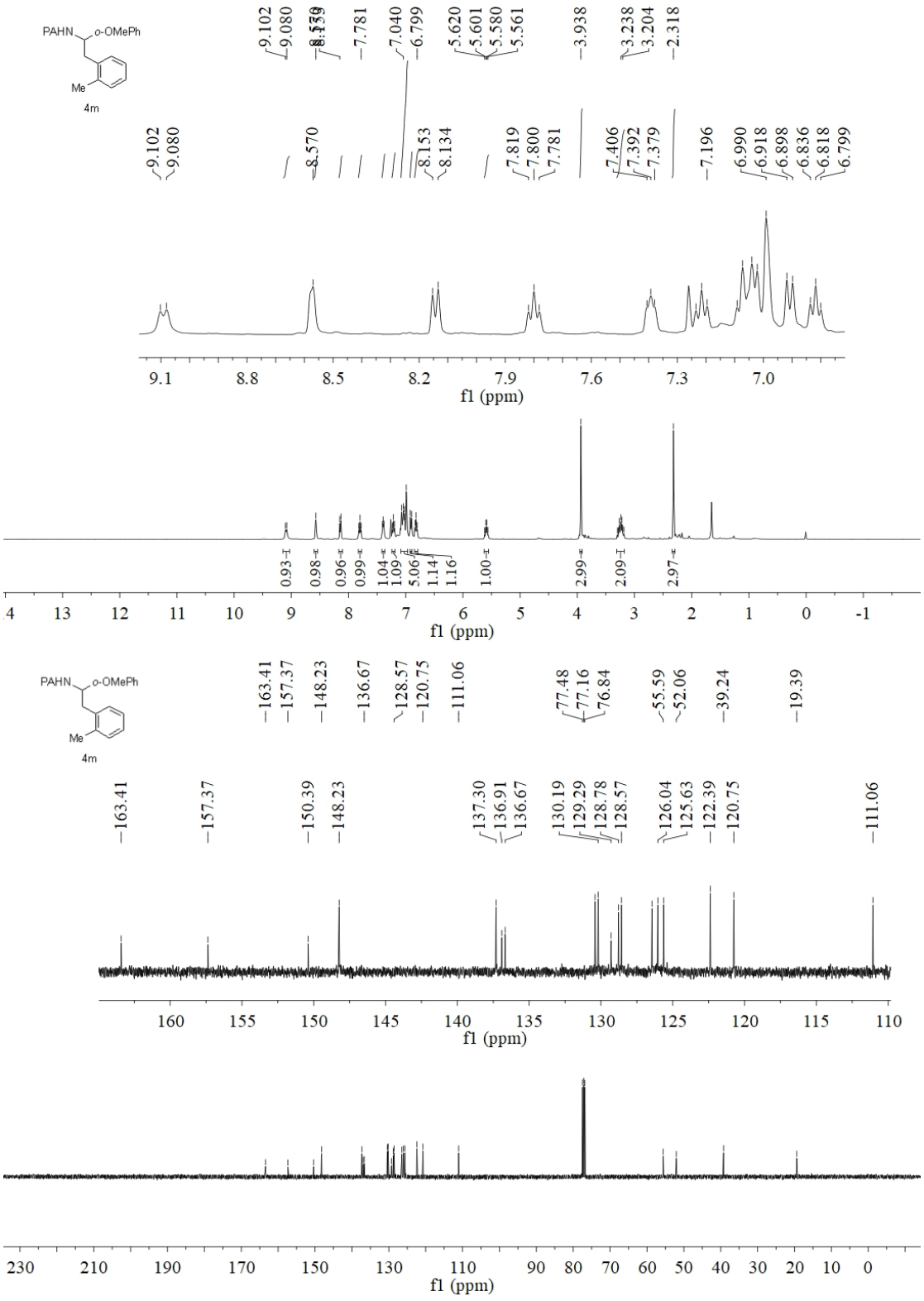

PAHN
O
O^{t}Bu
Me
4h
171.023
163.965
149.542
148.350
137.308
134.933
130.481
130.258
127.068
126.341
125.903
122.265
82.186
77.478
77.160
76.842
53.174
36.693
27.936
19.631
149.542
148.350
137.308
136.872
134.933
130.481
130.258
127.068
126.341
125.903
122.265
150 148 146 144 142 140 138 136 134 132 130 128 126 124 122 120
f1 (ppm)
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

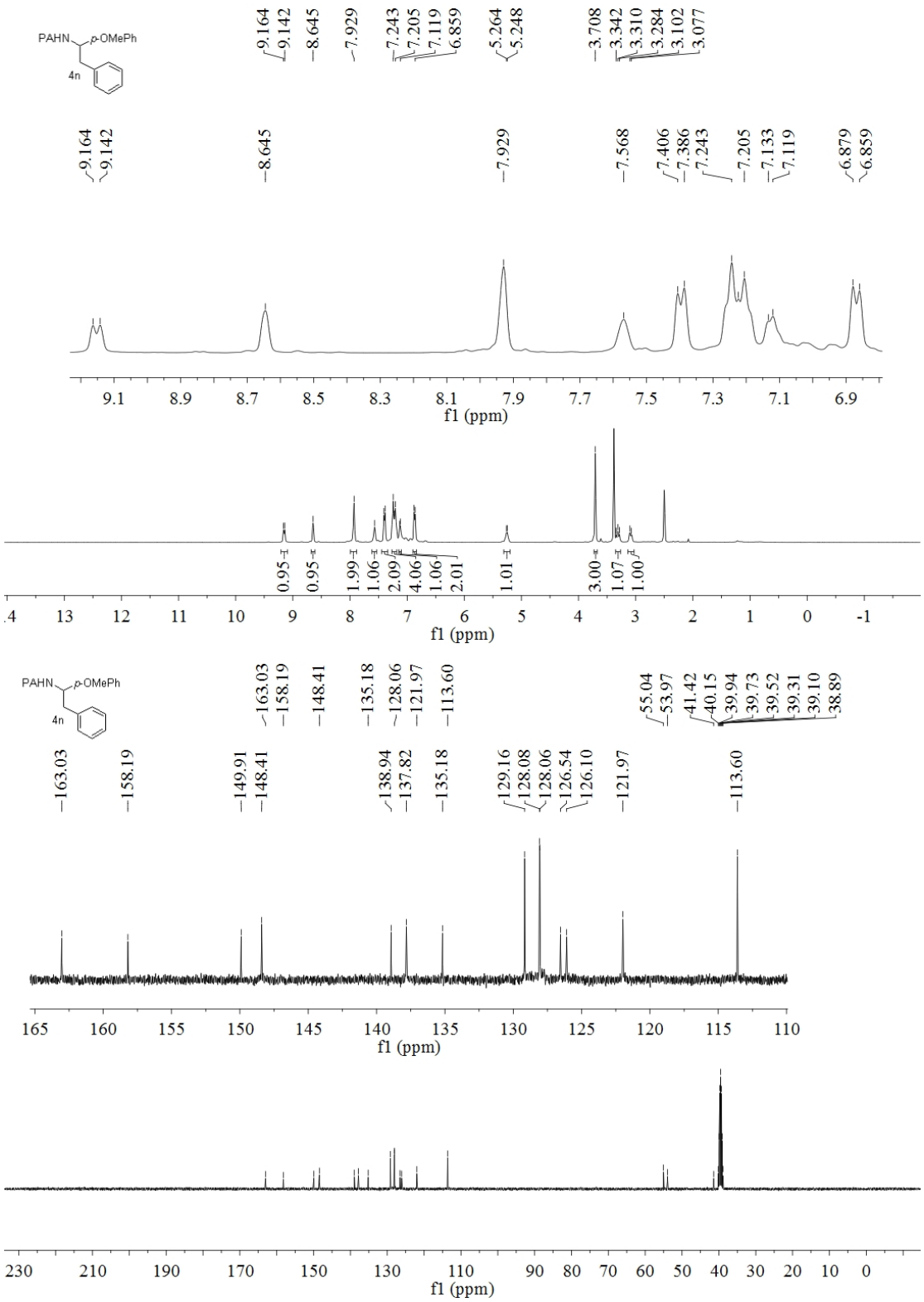

PAHN
Me
4i
8.557
7.792
7.306
7.125
7.026
5.430
5.411
5.393
5.374
3.289
3.212
3.194
3.178
3.160
2.298
8.152
8.132
7.830
7.811
7.792
7.423
7.408
7.396
7.260
7.125
7.105
7.026
f1 (ppm)
1.98
0.97
1.03
1.07
5.04
2.08
2.00
1.00
1.00
1.03
3.09
f1 (ppm)
163.65
149.91
148.17
128.68
127.53
126.76
126.72
126.28
125.85
122.34
77.48
77.16
76.84
54.26
40.69
19.58
141.93
137.43
136.82
135.88
130.40
130.23
f1 (ppm)
f1 (ppm)

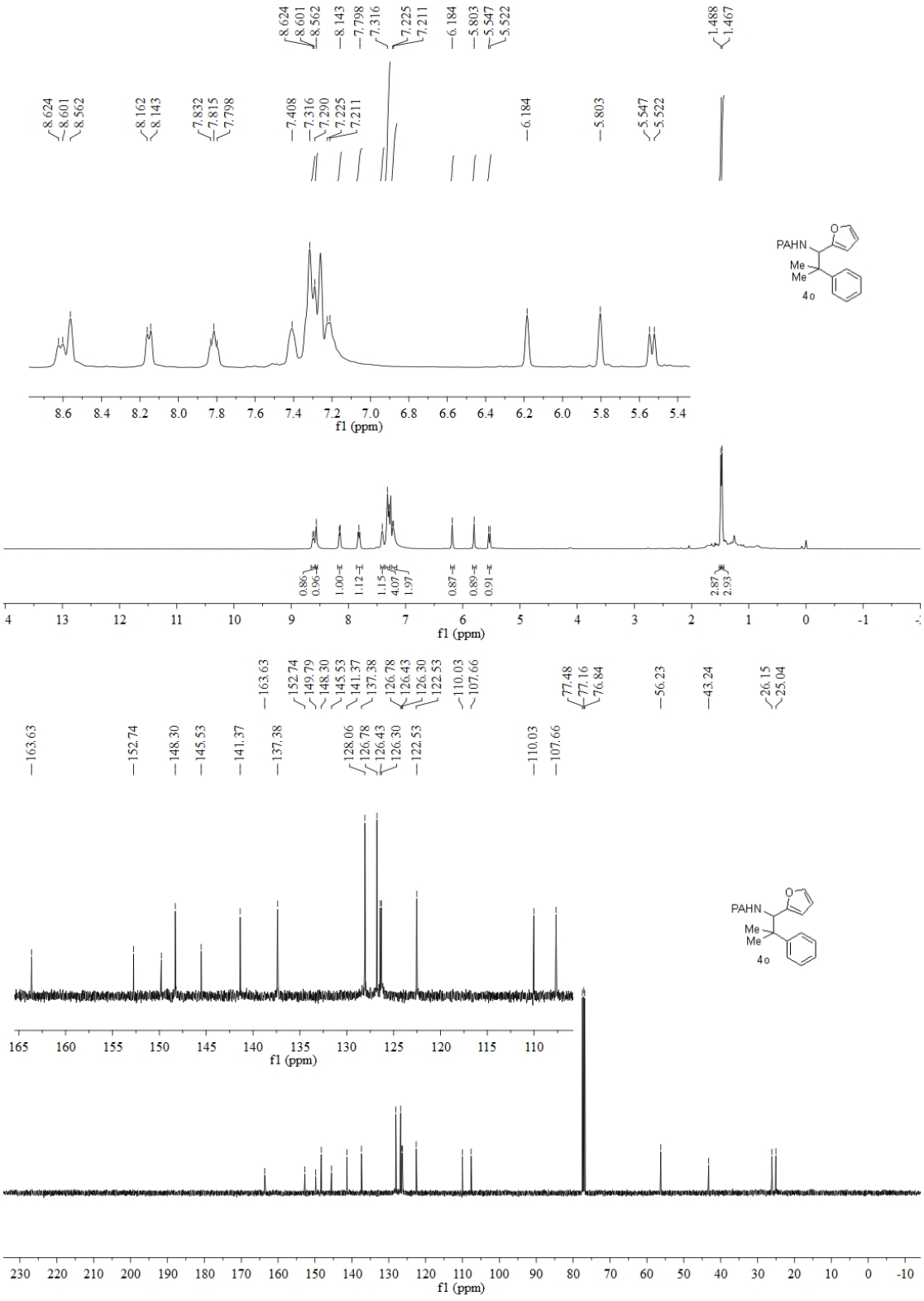

8.694
8.670
8.650
8.638
7.972
7.968
7.952
7.949
7.931
7.913
7.588
7.572
7.388
7.584
7.579
7.572
7.567
7.409
7.388
7.309
7.272
7.217
7.200
7.184
7.023
7.002
5.326
5.302
1.331
1.311
f1 (ppm)
PAHN
Me
Me
Br
4j
1.01
1.03
2.09
1.02
2.08
4.12
1.21
2.10
1.00
2.99
2.99
162.77
149.22
148.59
145.18
138.02
126.41
121.80
120.21
60.71
39.73
39.52
39.31
39.10
38.89
25.98
24.41
130.45
130.29
128.03
126.81
126.57
126.41

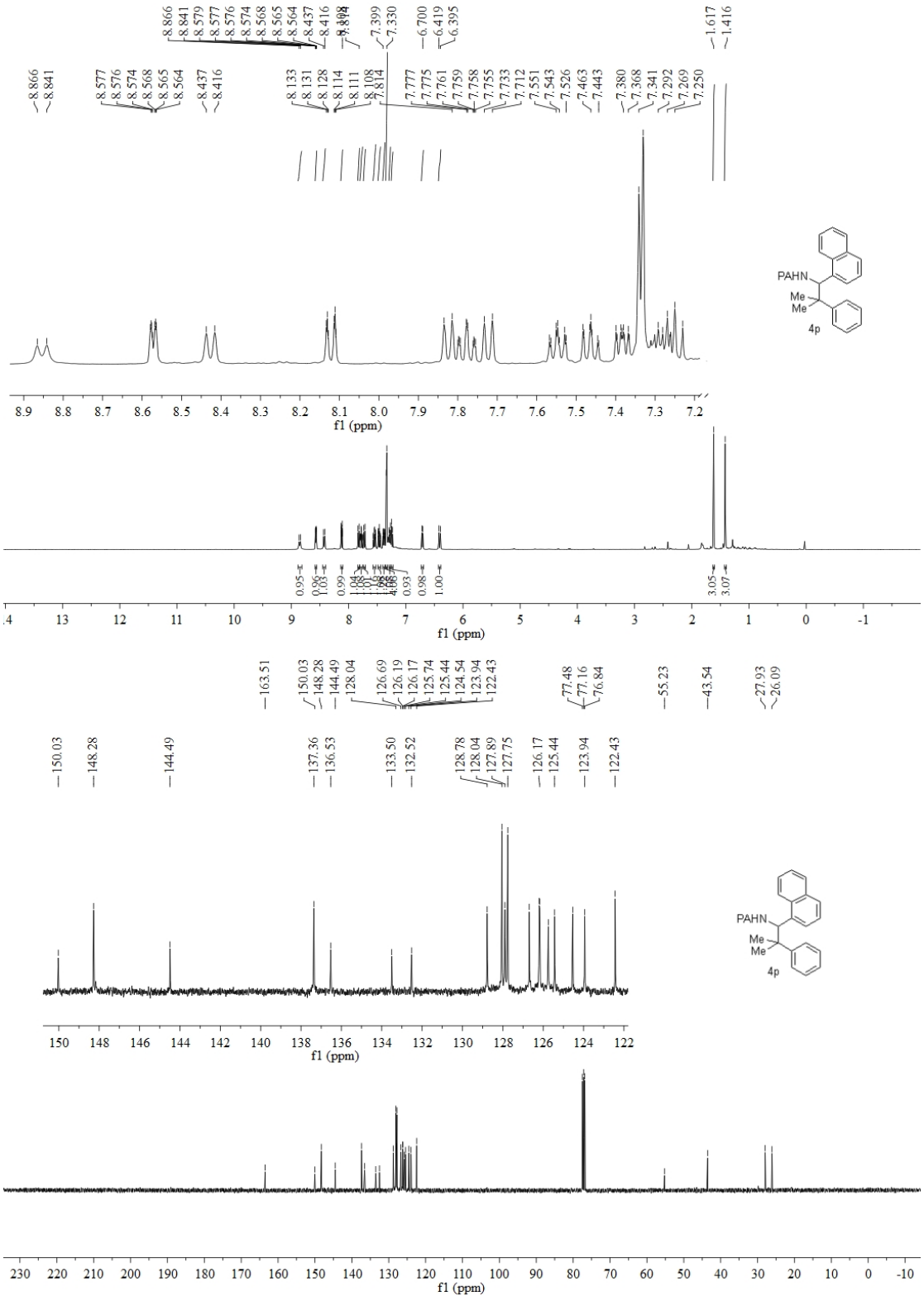

8.618
8.601
8.568
8.530
8.119
8.100
7.848
7.830
7.812
7.589
7.570
7.444
7.377
7.359
7.127
7.066
7.050
6.979
6.962
5.411
5.394
5.376
5.361
3.269
3.236
3.160
3.126
2.262
PAHN
p-CNPh
Me
4k
f1 (ppm)
163.94
148.29
147.57
134.80
130.13
126.62
118.88
111.35
77.48
77.16
76.84
54.13
40.31
19.55
149.43
137.61
136.65
132.48
130.13
127.50
126.62
126.15
122.41
f1 (ppm)
f1 (ppm)

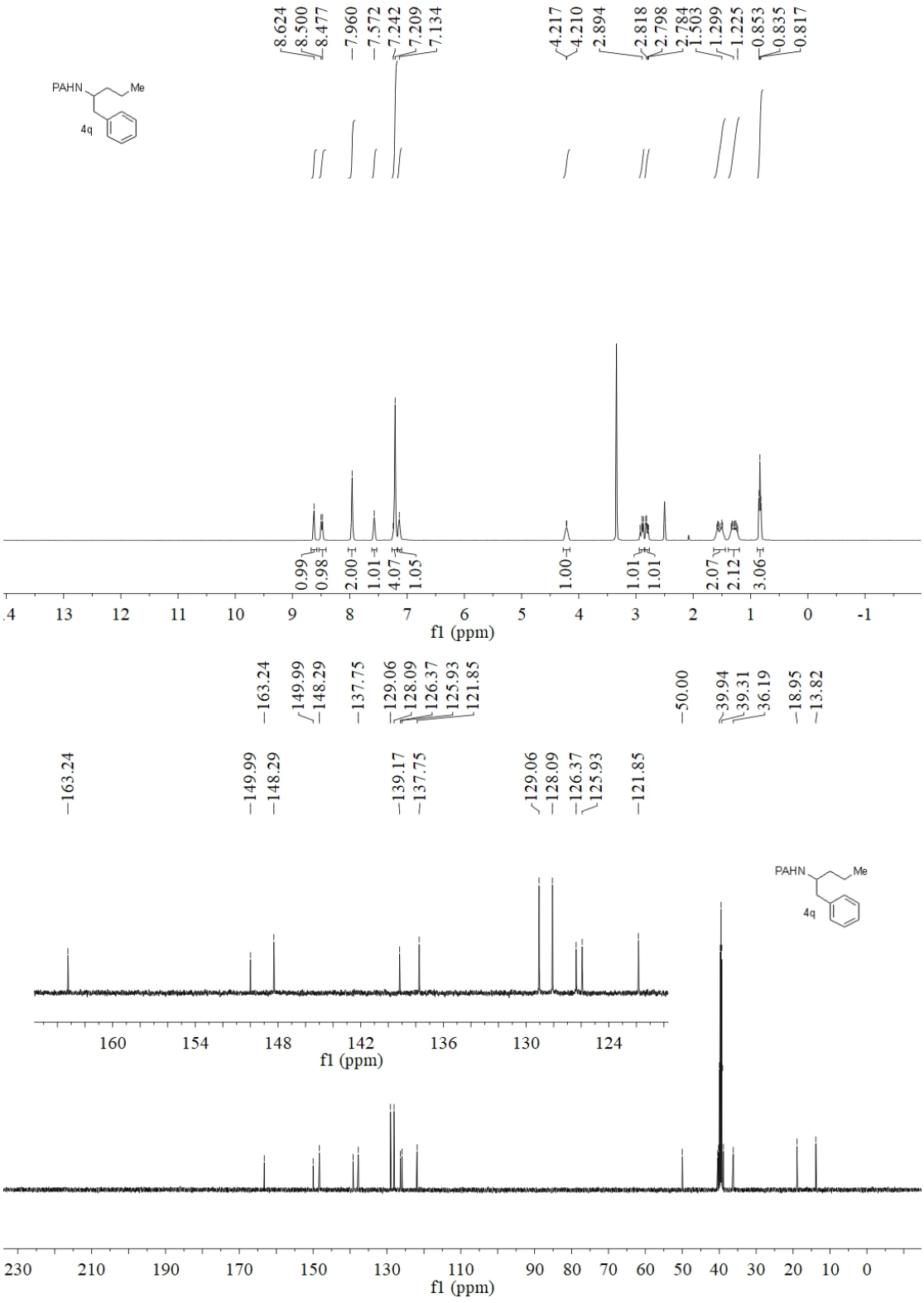

8.778
8.754
8.581
8.579
8.577
8.575
8.569
8.567
8.565
8.563
7.829
7.790
7.425
7.334
7.313
7.276
7.000
5.384
5.360
1.482
1.442
8.122
8.102
7.833
7.814
7.810
7.795
7.790
7.437
7.425
7.421
7.418
7.405
7.345
7.330
7.313
7.277
7.267
7.021
7.000
CF3
PAHN
Me
Me
4l
f1 (ppm)
0.91
0.96
0.94
0.97
2.81
2.89
2.00
1.00
2.99
3.03
163.718
149.642
148.325
144.288
143.618
137.492
128.790
125.596
124.536
124.499
124.461
124.423
122.892
122.392
120.188
61.875
42.277
26.100
25.953
129.833
129.509
129.188
128.790
128.314
127.184
126.883
126.423
125.596
124.536
124.499
124.461
124.423
122.892
122.392
120.188
CH3
H3C
O
NH
N
F
F
F
f1 (ppm)
f1 (ppm)

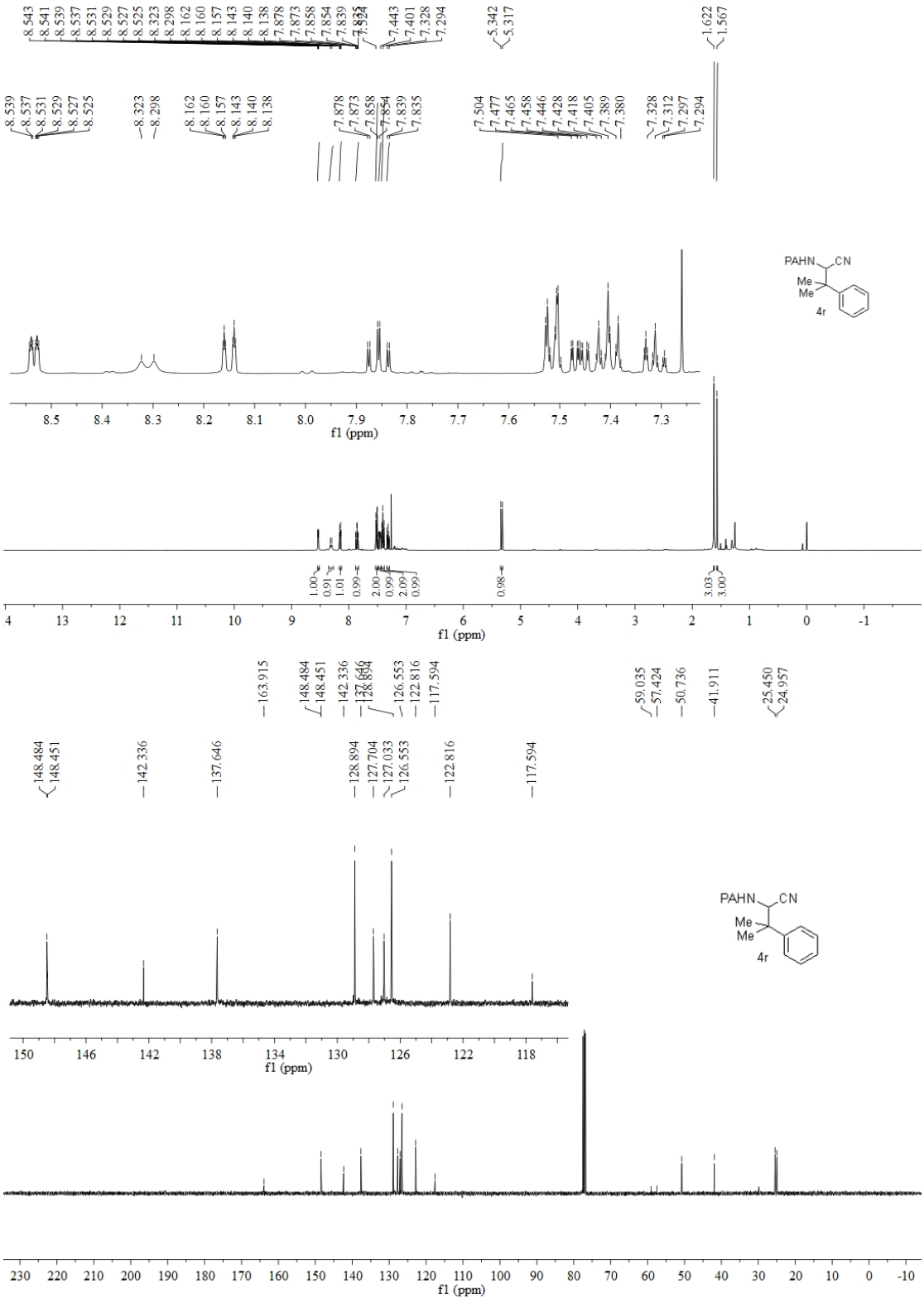

PAHN
o-OMePh
Me
4m
9.102
9.080
8.570
8.153
8.134
7.819
7.800
7.781
7.406
7.392
7.379
7.196
6.990
6.918
6.898
6.836
6.818
6.799
f1 (ppm)
0.93
0.98
0.96
0.99
1.04
1.09
5.06
1.14
1.16
1.00
2.99
2.09
2.97
f1 (ppm)
PAHN
o-OMePh
Me
4m
163.41
157.37
150.39
148.23
137.30
136.91
136.67
130.19
129.29
128.78
128.57
126.04
125.63
122.39
120.75
111.06
f1 (ppm)
f1 (ppm)

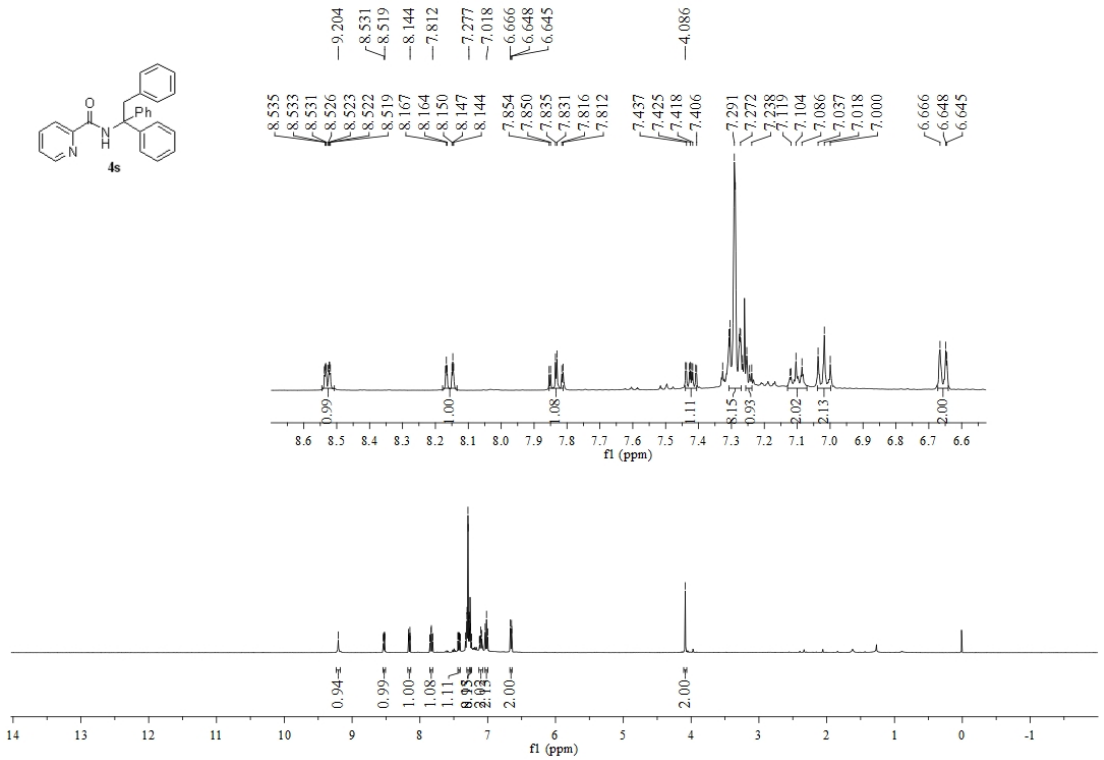

PAHN
p-OMePh
4n
9.164
9.142
8.645
7.929
7.243
7.205
7.119
6.859
5.264
5.248
3.708
3.342
3.310
3.284
3.102
3.077
7.568
7.406
7.386
7.133
6.879
f1 (ppm)
0.95
0.95
1.99
1.06
2.09
4.06
1.06
2.01
1.01
3.00
1.07
1.00
163.03
158.19
148.41
135.18
128.06
121.97
113.60
55.04
53.97
41.42
40.15
39.94
39.73
39.52
39.31
39.10
38.89
149.91
138.94
137.82
129.16
128.08
128.06
126.54
126.10

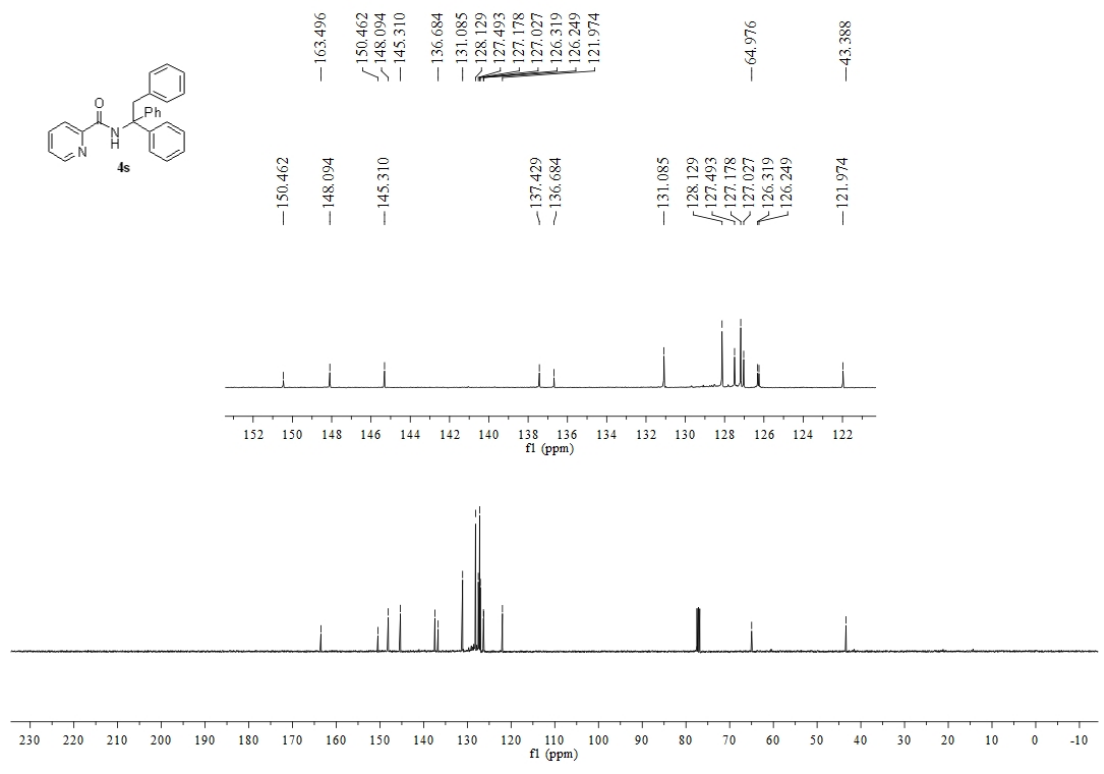

8.624
8.601
8.562
8.143
7.798
7.316
7.225
7.211
6.184
5.803
5.547
5.522
1.488
1.467
PAHN
Me
Me
4o
f1 (ppm)
0.86
0.96
1.00
1.12
1.15
4.07
1.97
0.87
0.89
0.91
2.87
2.93
163.63
152.74
149.79
148.30
145.53
141.37
137.38
126.78
126.43
126.30
122.53
110.03
107.66
77.48
77.16
76.84
56.23
43.24
26.15
25.04
128.06

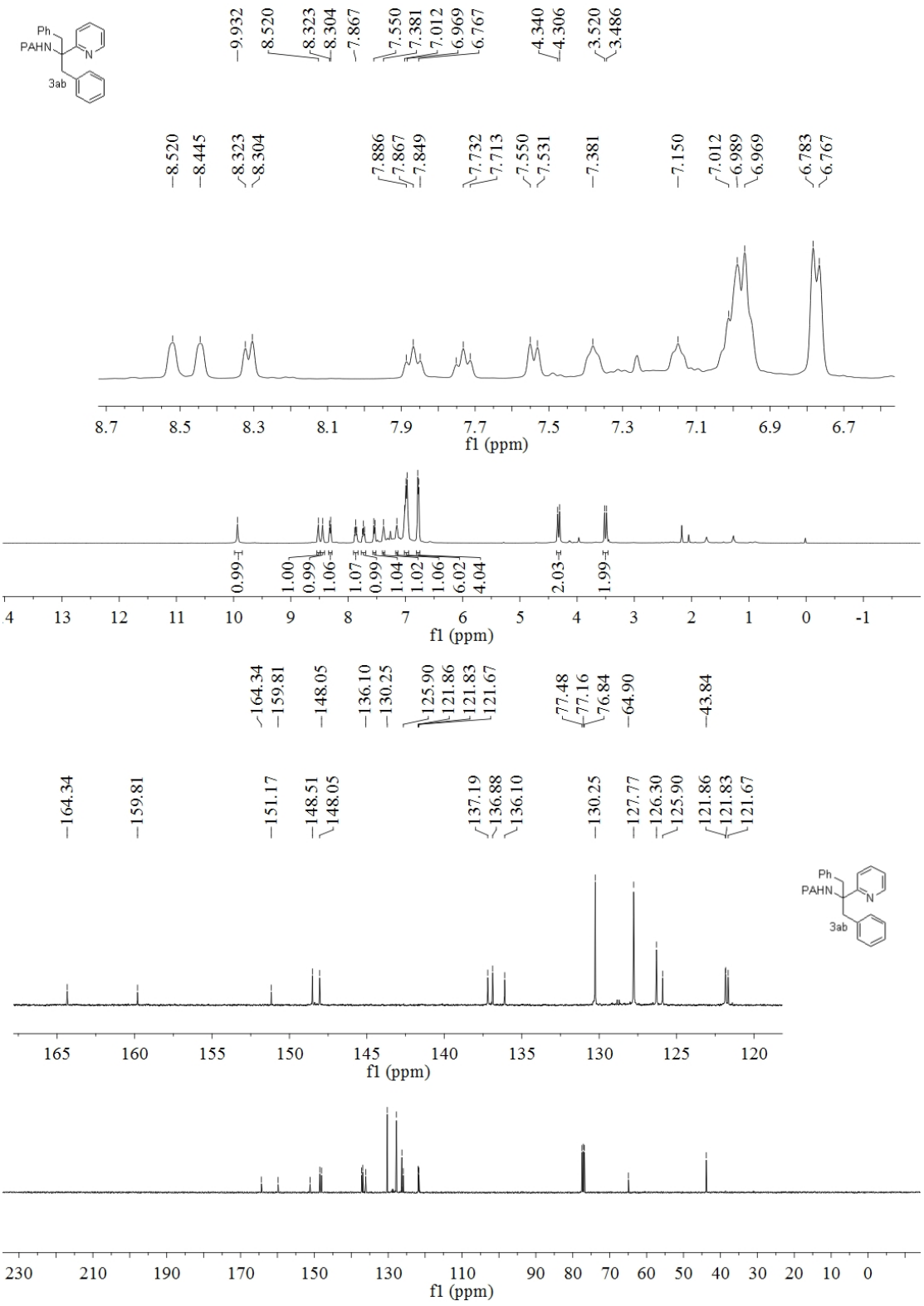

8.866
8.841
8.579
8.577
8.576
8.574
8.568
8.565
8.564
8.437
8.416
8.399
8.330
6.700
6.419
6.395
1.617
1.416
PAHN
Me
Me
4p
f1 (ppm)
163.51
150.03
148.28
144.49
128.04
126.69
126.19
126.17
125.74
125.44
124.54
123.94
122.43
77.48
77.16
76.84
55.23
43.54
27.93
26.09
137.36
136.53
133.50
132.52
128.78
128.04
127.89
127.75
126.17
125.44
123.94
122.43

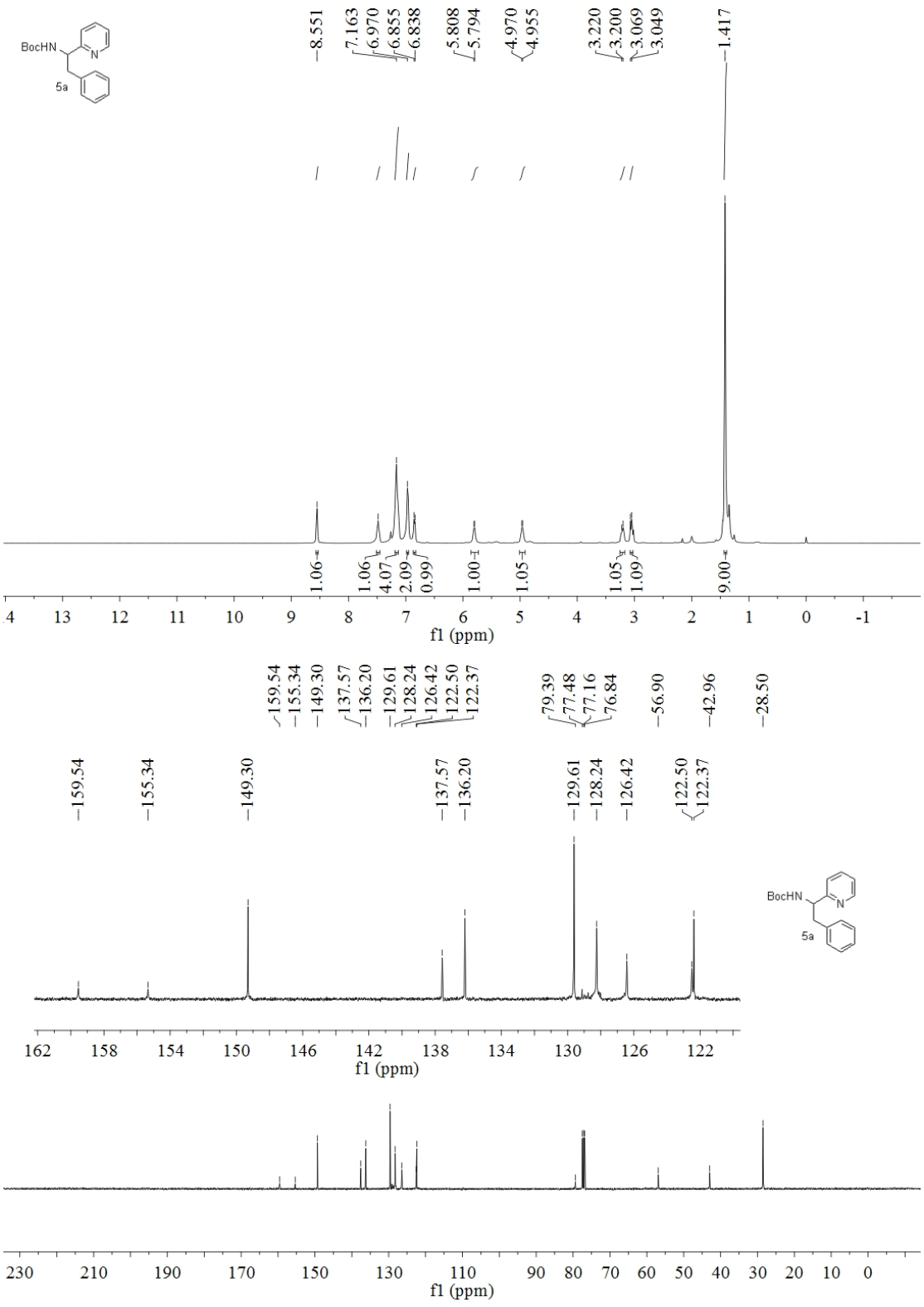

PAHN
Me
4q
8.624
8.500
8.477
7.960
7.572
7.242
7.209
7.134
4.217
4.210
2.894
2.818
2.798
2.784
1.503
1.299
1.225
0.853
0.835
0.817
0.99
0.98
2.00
1.01
4.07
1.05
1.00
1.01
1.01
2.07
2.12
3.06
f1 (ppm)
163.24
149.99
148.29
137.75
129.06
128.09
126.37
125.93
121.85
50.00
39.94
39.31
36.19
18.95
13.82
139.17
f1 (ppm)

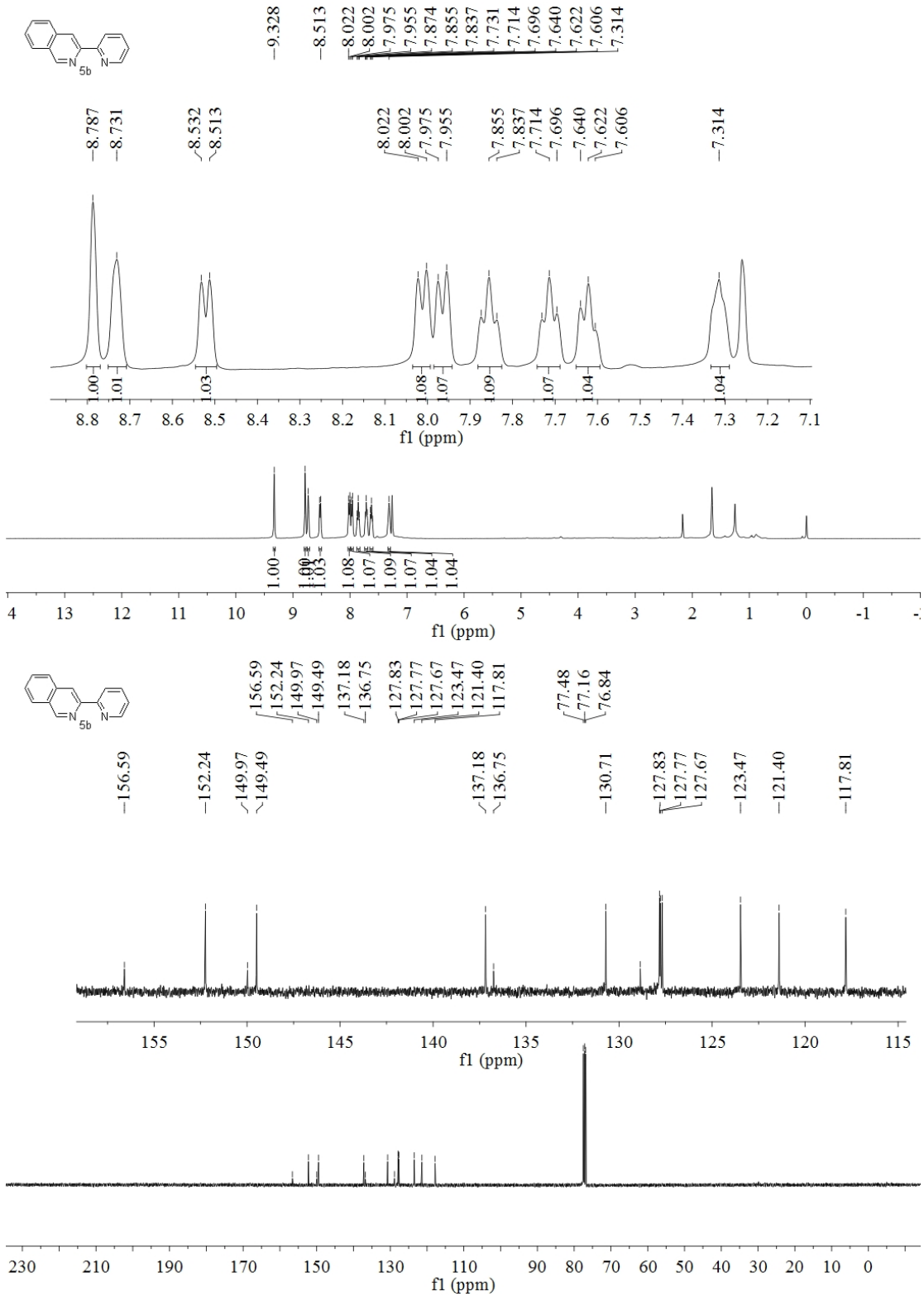

PAHN
CN
Me
Me
4r
f1 (ppm)

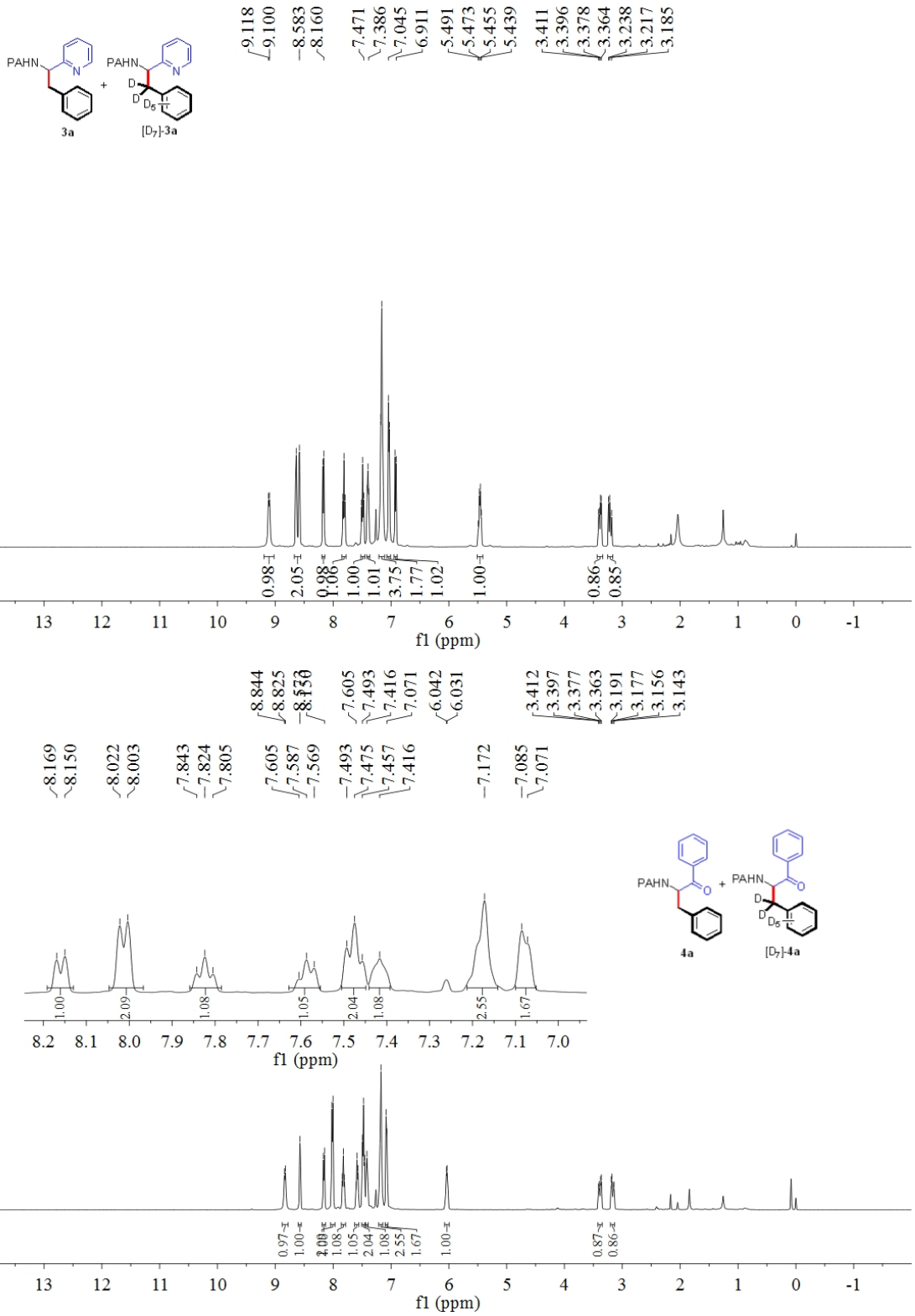

4s
9.204
8.535
8.533
8.531
8.526
8.523
8.522
8.519
8.531
8.519
8.167
8.164
8.150
8.147
8.144
8.144
7.854
7.850
7.835
7.831
7.816
7.812
7.812
7.277
7.018
6.666
6.648
6.645
4.086
7.437
7.425
7.418
7.406
7.291
7.272
7.238
7.119
7.104
7.086
7.037
7.018
7.000
6.666
6.648
6.645
0.99
1.00
1.08
1.11
8.15
0.93
2.02
2.13
2.00
f1 (ppm)
0.94
0.99
1.00
1.08
1.11
2.00
2.00
f1 (ppm)


4s
163.496
150.462
148.094
145.310
136.684
131.085
128.129
127.493
127.178
127.027
126.319
126.249
121.974
64.976
43.388
150.462
148.094
145.310
137.429
136.684
131.085
128.129
127.493
127.178
127.027
126.319
126.249
121.974
f1 (ppm)
f1 (ppm)


Ph
PAHN
3ab
9.932
8.520
8.323
8.304
7.867
7.550
7.381
7.012
6.969
6.767
4.340
4.306
3.520
3.486
8.520
8.445
8.323
8.304
7.886
7.867
7.849
7.732
7.713
7.550
7.531
7.381
7.150
7.012
6.989
6.969
6.783
6.767
f1 (ppm)
0.99
1.00
0.99
1.06
1.07
0.99
1.04
1.02
1.06
6.02
4.04
2.03
1.99
f1 (ppm)
164.34
159.81
148.05
136.10
130.25
125.90
121.86
121.83
121.67
77.48
77.16
76.84
64.90
43.84
164.34
159.81
151.17
148.51
148.05
137.19
136.88
136.10
130.25
127.77
126.30
125.90
121.86
121.83
121.67
Ph
PAHN
3ab
f1 (ppm)
f1 (ppm)


BocHN
5a
8.551
7.163
6.970
6.855
6.838
5.808
5.794
4.970
4.955
3.220
3.200
3.069
3.049
1.417
1.06
1.06
4.07
2.09
0.99
1.00
1.05
1.05
1.09
9.00
f1 (ppm)
159.54
155.34
149.30
137.57
136.20
129.61
128.24
126.42
122.50
122.37
79.39
77.48
77.16
76.84
56.90
42.96
28.50
f1 (ppm)
f1 (ppm)


5b
9.328
8.513
8.022
8.002
7.975
7.955
7.874
7.855
7.837
7.731
7.714
7.696
7.640
7.622
7.606
7.314
8.787
8.731
8.532
8.513
1.00
1.01
1.03
1.08
1.07
1.09
1.07
1.04
1.04
f1 (ppm)
156.59
152.24
149.97
149.49
137.18
136.75
127.83
127.77
127.67
123.47
121.40
117.81
77.48
77.16
76.84
130.71
f1 (ppm)


PAHN
PAHN
D
D
D5
3a
[D7]-3a
9.118
9.100
8.583
8.160
7.471
7.386
7.045
6.911
5.491
5.473
5.455
5.439
3.411
3.396
3.378
3.364
3.238
3.217
3.185
0.98
2.05
0.98
1.06
1.00
1.01
3.75
1.77
1.02
1.00
0.86
0.85
f1 (ppm)
8.844
8.825
7.605
7.493
7.416
7.071
6.042
6.031
3.412
3.397
3.377
3.363
3.191
3.177
3.156
3.143
8.169
8.150
8.022
8.003
7.843
7.824
7.805
7.605
7.587
7.569
7.493
7.475
7.457
7.416
7.172
7.085
7.071
PAHN
PAHN
D
D
D5
4a
[D7]-4a
1.00
2.09
1.08
1.05
2.04
1.08
2.55
1.67
f1 (ppm)
0.97
1.00
1.08
1.05
2.04
1.08
2.55
1.67
1.00
0.87
0.86
f1 (ppm)