Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry


# ELECTRONIC SUPPLEMENTARY INFORMATION

# Synthesis of sterically encumbered C10-arylated benzo[*h*]quinolines using *ortho*-substituted aryl boronic acids

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# Materials and Methods

All reagents and solvents were supplied from commercial sources (Sigma-Aldrich and Alfa Aesar) and used as received unless otherwise stated. THF was distilled from Na/benzophenone. Reactions requiring anhydrous conditions were conducted in flame-dried glassware under dry $N_2$.

Reactions were monitored by analytical thin-layer chromatography (TLC) performed on E. Merck silica gel 60 F254 plates (0.25 mm). TLC plates were visualized using UV light (254 nm). Purification of compounds was achieved by column chromatography using Merck Flash Silica Gel 60 (230-400 mesh). Solvents were removed by rotary evaporation and compounds further dried under vacuum.

$^1$H and $^{13}$C NMR spectra were recorded on a Bruker Advance 400 spectrometer at 400 MHz. Chemical shifts (δ H) are quoted in ppm (parts per million) and referenced to $CDCl_3$ residual chloroform signal $^1$H δ = 7.26, $^{13}$C δ = 77.0.

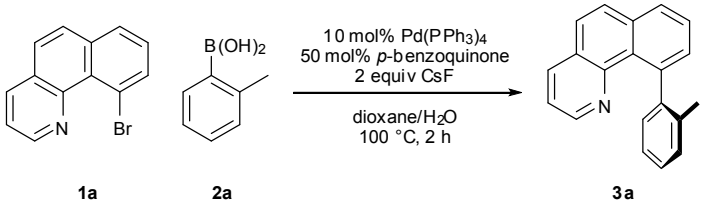
10-Bromobenzo[*h*]quinoline and 10-chlorobenzo[*h*]quinoline were prepared according to a literature procedure.[1]

[1] A. R. Dick, K. L. Hull, M. S. Sanford, *J. Am. Chem. Soc.*, 2004, **126**, 2300.

# Experimental Data

## Experimental Procedures and Compound Characterisation

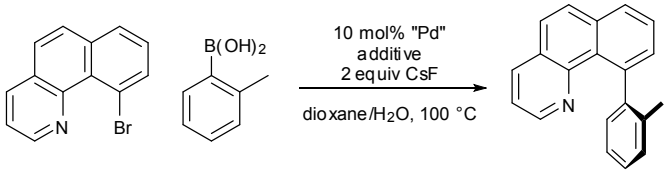
### Suzuki-Miyaura cross-coupling reaction with $Pd(PPh_3)_4$ and *p*-benzoquinone




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

To a degassed solution of 10-bromobenzo[*h*]quinoline (245 mg, 0.95 mmol) and CsF (288 mg, 1.90 mmol, 2.0 equiv) in dioxane/$H_2O$ 2:1 (7.5 ml) were added $Pd(PPh_3)_4$ (110 mg, 0.095 mmol, 0.1 equiv) and *o*-tolylboronic acid (136 mg, 1.00 mmol, 1.05 equiv). The yellow suspension was treated with *p*-benzoquinone (10 mg) (red solution), heated to reflux and when the solution turned yellow again treated with more *p*-benzoquinone (41 mg, 51 mg in total, 0.475 mmol, 0.5 equiv). After 2 h at reflux the mixture was cooled to rt followed by extractive work-up with $Et_2O$. Column chromatography on silica gel twice (petroleum ether/EtOAc 20:1) afforded **3a** (171 mg, 67 %) as colourless oil. For compound characterisation, see later.

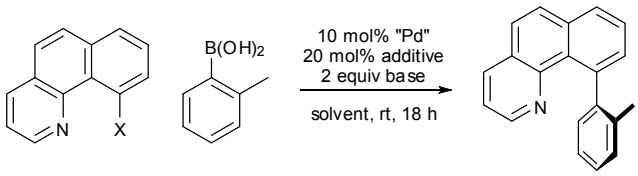
### General procedure for the initial screening of reaction conditions




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

10-Bromobenzo[*h*]quinoline (0.2 mmol) was dissolved in dioxane/$H_2O$ 2:1 (1.5 ml). After the addition of CsF (0.4 mmol, 2.0 equiv), the palladium source (0.02 mmol, 0.1 equiv), $P(O)Ph_3$ (0.04 mmol, 0.2 equiv), and *o*-toluylboronic acid (0.21 mmol, 1.05 equiv) it was stirred at 100 °C for the time indicated. After cooling to rt it was diluted with $Et_2O$ (5 ml), filtered over $MgSO_4$, evaporated and the conversion determined by NMR based on the ratio **1a**/**3a** present in the crude mixture.

## General procedure for the optimisation studies with *o*-tolylboronic acid 2a




**1a** or **1b** **2a** **3a**

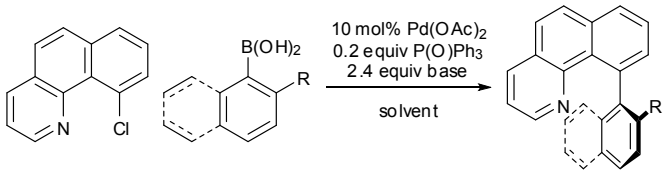
10-Halobenzo[*h*]quinoline (0.1 mmol) was dissolved in the appropriate solvent (0.5 ml) or solvent mixture (0.75 ml). After the addition of the adequate base (0.4 mmol, 2.0 equiv), catalyst (0.02 mmol, 0.1 equiv), $P(O)Ph_3$ (0.04 mmol, 0.2 equiv), and *o*-toluylboronic acid (0.21 mmol, 1.05 equiv) it was stirred at ambient temperature for the time indicated. It was then diluted with $Et_2O$ (5 ml), filtered over $MgSO_4$, evaporated and **3a** isolated by flash chromatography on silica gel (petroleum ether/EtOAc 50:1).

**Table S1.** Results of the optimization studies with 10-chlorobenzo[*h*]quinoline not shown in the article

| X | Catalyst/Additive | Base | Solvent | Time [h] | NMR Yield[a] |
|---|---|---|---|---|---|
| Br | $PdCl_2/P(O)Ph_3$ | $K_3PO_4$ | dioxane/$H_2O$ 2:1 | 18 | 43 % |
| Br | $PdCl_2/P(O)Ph_3$ | $Na_2CO_3$ | dioxane/$H_2O$ 2:1 | 18 | 72 % |
| Br | $PdCl_2/P(O)Ph_3$ | NaOH | dioxane/$H_2O$ 2:1 | 18 | 76 % |
| Br | $PdCl_2/P(O)Ph_3$ | CsF | dioxane/$H_2O$ 2:1 | 18 | 99 % |
| Br | $Pd(OAc)_2/P(O)Ph_3$ | $Na_2CO_3$ | dioxane/$H_2O$ 2:1 | 1.5 | 88 % |
| Cl | $Pd(OAc)_2/P(O)Ph_3$ | $Na_2CO_3$ | DMF | 18 | 23 % |
| Cl | $Pd(OAc)_2/P(O)Ph_3$ | $Na_2CO_3$ | THF | 18 | 33 % |
| Cl | $Pd(OAc)_2/P(O)Ph_3$ | $Na_2CO_3$ | THF/1 drop $H_2O$ | 18 | 68 % |
| Cl | $Pd(dba)_2/P(O)Ph_3$ | $Na_2CO_3$ | dioxane | 18 | 13 % |
| Cl | $Pd(dba)_2$ | $Na_2CO_3$ | dioxane | 18 | 12 % |
| Cl | $Pd(dba)_2$ | $Na_2CO_3$ | THF | 18 | 12 % |
| Cl | $Pd(dba)_2/P(O)Ph_3$ | $Na_2CO_3$ | MeOH | 18 | 16 % |

[a] As conversion determined by NMR based on the ratio **1a** or **1b** to **3a** present in the crude mixture.

## General procedure for the cross-coupling reaction of 10-chlorobenzo[*h*]quinoline 1b with sterically hindered boronic acids 2a-k

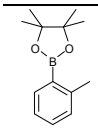
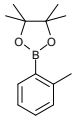
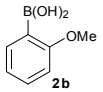



**1b** **2a-k** **3a-k**

10-Chlorobenzo[*h*]quinoline (21.4 mg, 0.1 mmol) was dissolved in the appropriate solvent (0.5 ml THF or 0.75 ml dioxane/$H_2O$ 2:1). After the addition of the adequate base (0.24

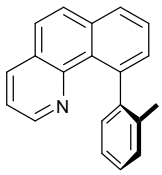
mmol, 2.4 equiv), $Pd(OAc)_2$ (2.25 mg, 0.01 mmol, 0.1 equiv), $P(O)Ph_3$ (5.57 mg, 0.02 mmol, 0.2 equiv), and boronic acid (0.12 mmol, 1.2 equiv) it was stirred at the corresponding temperature for the time indicated. It was then diluted with $Et_2O$ (2.5 ml), filtered over $MgSO_4$, evaporated and the coupling product isolated by flash chromatography on silica gel (petroleum ether/EtOAc 50:1).

**Table S2.** Results not shown in the article

| Boronic Acid | Solvent | Base | T [°C] | Time [h] | Isolated Yield [%] |
|---|---|---|---|---|---|
|  | THF | $Na_2CO_3$ | rt | 18 | 5[a] |
|  | dioxane/$H_2O$ 2:1 | $Na_2CO_3$ | rt | 18 | 100[a] |
|  **2b** | dioxane/$H_2O$ 2:1 | CsF | 100 | 1 | 89 |
|  **2d** | dioxane/$H_2O$ 2:1 | CsF | rt | 18 | 99 |
|  **2e** | THF | $Na_2CO_3$ | rt | 18 | 84 |
|  **2g** | THF | $Na_2CO_3$ | rt | 18 | 60 |

[a] NMR yield as conversion determined by NMR based on the ratio **1a** to **3** present in the crude mixture.

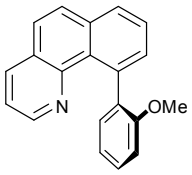
## 10-*o*-Tolylbenzo[*h*]quinoline (3a)[2]



The reaction in dioxane/$H_2O$ 2:1 as solvent, with CsF as base, and *o*-tolylboronic acid (14.3 mg) at ambient temperature for 0.5 h afforded the title compound (26.9 mg, 100 %) as colourless oil. IR (film): $\nu$ 3046, 2922, 1589, 1418, 837, 754, 732, 622 $cm^{-1}$. $^1H$ NMR (400 MHz, $CDCl_3$): $\delta$ 8.44 (dd, $J$ = 4.3, 1.9 Hz, 1 H), 8.08 (dd, $J$ = 8.0, 1.9 Hz, 1 H), 7.96 (dd, $J$ = 7.9, 1.3 Hz, 1 H), 7.89 (d, $J$ = 8.8 Hz, 1 H), 7.72 (dd, $J$ = 7.9, 7.2 Hz, 1 H), 7.70 (d, $J$ = 8.8 Hz, 1 H), 7.50 (dd, $J$ = 7.2, 1.3 Hz, 1 H), 7.35-7.26 (m, 4 H), 7.23-7.19 (m, 1 H), 1.88 (s, 3

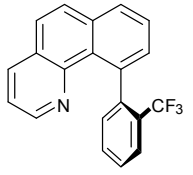
H). $^{13}$C NMR (100 MHz, $CDCl_3$): $\delta$ 147.41, 146.96, 146.39, 140.96, 135.83, 135.01, 134.58, 130.66, 129.38, 128.67, 128.37, 127.83 (2 C), 127.19, 126.88, 125.86, 125.78, 125.06, 120.91, 20.18. HRMS-ESI (m/z): Calcd for $[C_{20}H_{15}N + H]^+$, 270.1283. Found, 270.1283.

**10-(2'-Methoxyphenyl)benzo[*h*]quinoline (3b)[2,3]**




The reaction in dioxane/$H_2O$ 2:1 as solvent, with CsF as base, and 2-methoxyphenylboronic acid (18.2 mg) at ambient temperature for 18 h afforded the title compound (21.1 mg, 74 %) as colourless oil. IR (film): $\nu$ 3046, 2932, 2831, 1621, 1590, 1505, 1257, 1073, 836, 729 cm$^{-1}$. $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.43 (dd, $J$ = 4.3, 1.9 Hz, 1 H), 8.07 (dd, $J$ = 8.0, 1.9 Hz, 1 H), 7.93 (dd, $J$ = 7.9, 1.3 Hz, 1 H), 7.86 (d, $J$ = 8.8 Hz, 1 H), 7.71 (dd, $J$ = 7.9, 7.3 Hz, 1 H), 7.68 (d, $J$ = 8.8 Hz, 1 H), 7.55 (dd, $J$ = 7.3, 1.3 Hz, 1 H), 7.38 (ddd, $J$ = 8.1, 7.5, 1.7 Hz, 1 H), 7.31 (dd, $J$ = 8.0, 4.3 Hz, 1 H), 7.28 (dd, $J$ = 7.3, 1.7 Hz, 1 H), 7.07 (td, $J$ = 7.3, 1.0 Hz, 1 H), 6.92 (dd, $J$ = 8.1, 1.0 Hz, 1 H), 3.43 (s, 3 H). $^{13}$C NMR (100 MHz, $CDCl_3$): $\delta$ 157.45, 147.24, 146.95, 137.87, 136.03, 134.96, 134.50, 131.22, 129.73, 129.10, 128.40, 128.08, 127.37, 127.22, 126.74, 125.67, 120.83, 120.18, 109.81, 55.33. HRMS-ESI (m/z): Calcd for $[C_{20}H_{15}NO + H]^+$, 286.1232. Found, 286.1228.

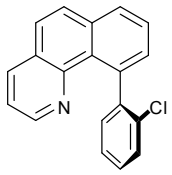
**10-(2-(Trifluoromethyl)phenyl)benzo[*h*]quinoline (3c)**




The reaction in dioxane/$H_2O$ 2:1 as solvent, with CsF as base, and 2-(trifluoromethyl)phenylboronic acid (22.8 mg) at ambient temperature for 18 h afforded the title compound (32.3 mg, 100 %) as white solid. Mp: 68-69 °C. IR (film): $\nu$ 3050, 1316, 1167, 1121, 837, 732 cm$^{-1}$. $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.34 (dd, $J$ = 4.3, 1.8 Hz, 1 H), 8.06 (dd, $J$ = 8.0, 1.8 Hz, 1 H), 7.99 (dd, $J$ = 7.9, 1.2 Hz, 1 H), 7.87 (d, $J$ = 8.8 Hz, 1 H), 7.79 (br d, $J$ =

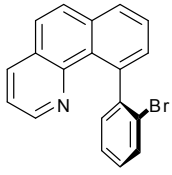
7.3 Hz, 1 H), 7.73-7.68 (m, 2 H), 7.57-7.47 (m, 3 H), 7.28 (dd, $J$ = 8.0, 4.3 Hz, 1 H), 7.26 (br d, $J$ = 7.3 Hz, 1 H). $^{13}$C NMR (100 MHz, $CDCl_3$): $\delta$ 147.00, 146.48, 145.10, 138.00, 135.02, 134.35, 130.59, 130.51, 130.39, 129.45, 128.46, 128.10, 127.64 (q, $J$ = 29.6 Hz), 127.12, 126.42, 125.93, 125.79, 125.41 (q, $J$ = 4.9 Hz), 123.18, 120.87. $^{19}$F NMR (300 MHz, $CDCl_3$): $\delta$ -58.99. HRMS-ESI (m/z): Calcd for $[C_{20}H_{12}F_3N + H]^+$, 324.1000. Found, 324.1001.

**10-(2-Chlorophenyl)benzo[*h*]quinoline (3d)**




The reaction in dioxane/$H_2O$ 2:1 as solvent, with CsF as base, and 2-chlorophenylboronic acid (18.8 mg) at ambient temperature for 10 min. afforded the title compound (27.0 mg, 93 %) as colourless oil. IR (film): $\nu$ 3048, 1419, 1036, 836, 753, 730, 618 cm$^{-1}$. $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.43 (dd, $J$ = 4.3, 1.9 Hz, 1 H), 8.09 (dd, $J$ = 8.0, 1.9 Hz, 1 H), 7.99 (dd, $J$ = 8.0, 1.3 Hz, 1 H), 7.88 (d, $J$ = 8.8 Hz, 1 H), 7.73 (dd, $J$ = 7.9, 7.2 Hz, 1 H), 7.71 (d, $J$ = 8.8 Hz, 1 H), 7.50 (dd, $J$ = 7.2, 1.3 Hz, 1 H), 7.47-7.44 (m, 1 H), 7.38-7.30 (m, 4 H). $^{13}$C NMR (100 MHz, $CDCl_3$): $\delta$ 147.38, 146.68, 145.33, 138.38, 135.12, 134.49, 133.41, 130.63, 129.72, 129.39, 128.56, 128.36, 128.23, 127.12 (2 C), 126.93, 126.12, 125.96, 121.10. HRMS-ESI (m/z): Calcd for $[C_{20}H_{12}ClN + H]^+$, 290.0737. Found, 290.0749.

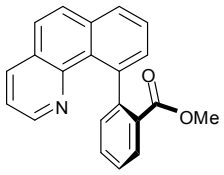
**10-(2-Bromophenyl)benzo[*h*]quinoline (3e)**




The reaction in dioxane/$H_2O$ 2:1 as solvent, with CsF as base, and 2-bromophenylboronic acid (24.1 mg) at ambient temperature for 2 min. afforded the title compound (33.1 mg, 99 %) as pale yellow solid. Mp: 74-76 °C. IR (film): $\nu$ 3051, 1588, 1511, 1419, 1020, 832, 755, 731, 619 cm$^{-1}$. $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.44 (dd, $J$ = 4.2, 1.7 Hz, 1 H), 8.09 (dd, $J$ = 8.0, 1.7 Hz, 1 H), 8.00 (dd, $J$ = 7.9, 0.8 Hz, 1 H), 7.88 (d, $J$ = 8.8 Hz, 1 H), 7.74 (t, $J$ = 7.5 Hz, 1 H),

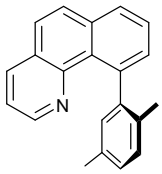
7.71 (d, $J$ = 8.8 Hz, 1 H), 7.66 (dd, $J$ = 7.9, 0.8 Hz, 1 H), 7.48 (dd, $J$ = 7.2, 1.0 Hz, 1 H), 7.40 (td, $J$ = 7.4, 1.0 Hz, 1 H), 7.33 (dd, $J$ = 8.0, 4.2 Hz, 1 H), 7.32 (dd, $J$ = 7.5, 1.7 Hz, 1 H), 7.28-7.23 (m, 1 H). $^{13}$C NMR (100 MHz, $CDCl_3$): $\delta$ 147.36, 147.23, 146.56, 140.01, 135.11, 134.44, 131.52, 130.51, 129.68, 129.19, 128.52, 128.21, 127.22, 127.09, 126.91, 126.69, 125.96, 123.90, 121.08. HRMS-ESI (m/z): Calcd for $[C_{20}H_{12}BrN + H]^+$, 334.0231. Found, 334.0229.

**Methyl 2-(benzo[*h*]quinolin-10-yl)benzoate (3f)**




The reaction in THF as solvent, with $Na_2CO_3$ as base, and 2-(methoxycarbonyl)phenylboronic acid (21.6 mg) at 60 °C for 18 h afforded the title compound (16.0 mg, 51 %) as colourless oil. IR (film): $\nu$ 3047, 2958, 1726, 1293, 1252, 837, 732 cm$^{-1}$. $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.36 (dd, $J$ = 4.3, 1.8 Hz, 1 H), 8.09-8.04 (m, 2 H), 7.94 (dd, $J$ = 7.9, 1.2 Hz, 1 H), 7.87 (d, $J$ = 8.8 Hz, 1 H), 7.70 (dd, $J$ = 7.9, 7.3 Hz, 1 H), 7.67 (d, $J$ = 8.8 Hz, 1 H), 7.55 (td, $J$ = 7.5, 1.4 Hz, 1 H), 7.47-7.42 (m, 2 H), 7.30-7.24 (m, 2 H), 3.27 (s, 3 H). $^{13}$C NMR (100 MHz, $CDCl_3$): $\delta$ 167.73, 147.98, 146.99, 146.69, 141.29, 135.10, 134.30, 131.32, 130.02, 129.75, 129.57, 129.42, 129.13, 128.39, 127.75, 126.92 (2 C), 125.83, 125.59, 120.81, 51.23. HRMS-ESI (m/z): Calcd for $[C_{21}H_{15}NO_2 + H]^+$, 314.1181. Found, 314.1186.

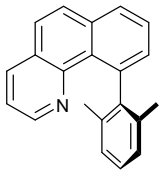
**10-(2,5-Dimethylphenyl)benzo[*h*]quinoline (3g)[3]**




The reaction in dioxane/$H_2O$ 2:1 as solvent, with CsF as base, and 2,5-dimethylphenylboronic acid (18.0 mg) at ambient temperature for 0.5 h afforded the title compound (28.3 mg, 100 %) as colourless oil. IR (film): $\nu$ 3044, 2918, 1589, 1568, 1511, 1422, 836, 809, 742, 724, 629 cm$^{-1}$. $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.45 (dd, $J$ = 4.3, 1.9 Hz, 1 H), 8.08 (dd, $J$ = 8.0, 1.9 Hz,

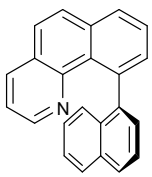
1 H), 7.94 (dd, *J* = 7.9, 1.3 Hz, 1 H), 7.87 (d, *J* = 8.8 Hz, 1 H), 7.73-7.68 (m, 2 H), 7.47 (dd, *J* = 7.2, 1.3 Hz, 1 H), 7.32 (dd, *J* = 8.0, 4.3 Hz, 1 H) 7.15-7.09 (m, 2 H), 7.03 (br s, 1 H), 2.38 (s, 3 H), 1.79 (s, 3 H). $^{13}$C NMR (100 MHz, $CDCl_3$): $\delta$ 147.44, 147.00, 146.18, 141.15, 134.99, 134.56, 134.29, 132.76, 130.81, 129.43, 128.61, 128.50, 128.41, 127.76, 127.18, 126.87, 126.48, 125.73, 120.91, 21.15, 19.67. HRMS-ESI (m/z): Calcd for $[C_{21}H_{17}N + H]^+$, 284.1439. Found, 284.1431.

**10-(2,6-Dimethylphenyl)benzo[*h*]quinoline (3h)**



The reaction in THF as solvent, with CsF as base, and 2,6-dimethylphenylboronic acid (18.0 mg) at 60 °C for 18 h afforded the title compound (23.8 mg, 84 %) as white solid. Mp: 108-109 °C. IR (film): *v* 3043, 2917, 1588, 1416, 836, 765, 734, 644 cm$^{-1}$. $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.40 (dd, *J* = 4.2, 1.7 Hz, 1 H), 8.07 (dd, *J* = 8.0, 1.7 Hz, 1 H), 7.95 (dd, *J* = 7.8, 1.1 Hz, 1 H), 7.88 (d, *J* = 8.8 Hz, 1 H), 7.73 (dd, *J* = 7.8, 7.2 Hz, 1 H), 7.69 (d, *J* = 8.8 Hz, 1 H), 7.39 (dd, *J* = 7.2, 1.1 Hz, 1 H), 7.30 (dd, *J* = 8.0, 4.2 Hz, 1 H) 7.23-7.18 (m, 1 H), 7.14-7.10 (m, 2 H), 1.81 (s, 6 H). $^{13}$C NMR (100 MHz, $CDCl_3$): $\delta$ 147.73, 147.16, 145.92, 139.94, 134.89, 134.84, 134.78, 130.09, 129.33, 128.45, 127.69, 127.61, 126.61, 126.45, 125.66, 125.50, 120.90, 20.71. HRMS-ESI (m/z): Calcd for $[C_{21}H_{17}N + H]^+$, 284.1439. Found, 284.1433.

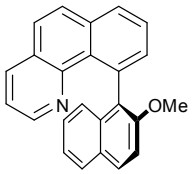
**10-(Naphthalen-1'-yl)benzo[*h*]quinoline (3i)[2]**



The reaction in dioxane/$H_2O$ 2:1 as solvent, with $Na_2CO_3$ as base, and naphthalen-1-ylboronic acid (20.6 mg) at ambient temperature for 18 h afforded the title compound (26.0 mg, 85 %) as colourless oil. IR (film): *v* 3042, 2923, 2848, 1586, 1567, 1388, 834, 795, 775, 729 cm$^{-1}$.

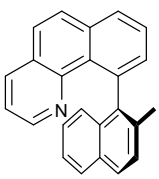
$^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.04 (dd, $J$ = 8.0, 1.3 Hz, 1 H), 8.02 (dd, $J$ = 4.5, 1.9 Hz, 1 H), 8.00 (s, 1 H), 7.93 (d, $J$ = 8.8 Hz, 1 H), 7.93-7.88 (m, 2 H), 7.77 (dd, $J$ = 7.9, 7.2 Hz, 1 H), 7.71 (d, $J$ = 8.8 Hz, 1 H), 7.62 (dd, $J$ = 7.2, 1.4 Hz, 1 H), 7.58 (dd, $J$ = 8.2, 6.9 Hz, 1 H), 7.39 (dd, $J$ = 6.9, 1.2 Hz, 1 H), 7.37 (ddd, $J$ = 8.2, 6.7, 1.2 Hz, 1 H), 7.23 (br d, $J$ = 8.5 Hz, 1 H), 7.16-7.12 (m, 1 H), 7.08 (ddd, $J$ = 8.5, 6.7, 1.2 Hz, 1 H). $^{13}$C NMR (100 MHz, $CDCl_3$): $\delta$ 147.16, 146.40, 144.89, 139.53, 134.89, 134.61, 133.15, 132.99, 131.61, 130.26, 128.28, 128.23, 127.83, 127.21, 127.04, 126.34, 126.14, 126.00, 125.50, 125.02, 124.94, 124.55, 120.78. HRMS-ESI (m/z): Calcd for $[C_{23}H_{15}N + H]^+$, 306.1283. Found, 306.1275.

**10-(2'-Methoxynaphthalen-1'-yl)benzo[*h*]quinoline (3j)**




The reaction in THF as solvent, with CsF as base, and 2-methoxynaphthalen-1-ylphenylboronic acid (24.2 mg) at 60 °C for 2 h afforded the title compound (29.5 mg, 88 %) as white solid. Mp: 118 °C. IR (film): $\nu$ 3046, 2932, 2831, 1495, 1269, 1239, 837, 750, 731, 618 cm$^{-1}$. $^1$H NMR (400 MHz, $CDCl_3$): $\delta$ 8.12 (dd, $J$ = 4.2, 1.8 Hz, 1 H), 8.04 (dd, $J$ = 8.0, 1.1 Hz, 1 H), 8.00 (dd, $J$ = 8.0, 1.8 Hz, 1 H), 7.93 (d, $J$ = 9.0 Hz, 1 H), 7.92 (d, $J$ = 8.8 Hz, 1 H), 7.87 (d, $J$ = 8.2 Hz, 1 H), 7.79 (dd, $J$ = 7.9, 7.2 Hz, 1 H), 7.69 (d, $J$ = 8.8 Hz, 1 H), 7.56 (dd, $J$ = 7.2, 1.1 Hz, 1 H), 7.43 (d, $J$ = 9.0 Hz, 1 H), 7.28-7.23 (m, 1 H), 7.16 (dd, $J$ = 8.0, 4.2 Hz, 1 H), 7.12-7.06 (m, 2 H), 3.65 (s, 3 H). $^{13}$C NMR (100 MHz, $CDCl_3$): $\delta$ 153.11, 147.40, 146.95, 135.38, 134.89, 134.78, 133.65, 131.87, 130.54, 130.38, 129.17, 128.40, 128.16, 127.58, 127.40, 127.37, 126.75, 125.72, 125.36 (2 C), 122.90, 120.76, 114.51, 56.98. HRMS-ESI (m/z): Calcd for $[C_{24}H_{17}NO + H]^+$, 336.1388. Found, 336.1380.

**10-(2'-Methylnaphthalen-1'-yl)benzo[*h*]quinoline (3k)**



The reaction in THF as solvent, with CsF as base, and 2-methylnaphthalen-1-ylboronic acid (22.3 mg) at 60 °C for 18 h afforded the title compound (23.0 mg, 72 %) as white solid. Mp: 94-95 °C. IR (film): *v* 3046, 2918, 2855, 1588, 1566, 1510, 1416, 908, 837, 809, 731 $cm^{-1}$. $^{1}H$ NMR (400 MHz, $CDCl_3$): $\delta$ 8.11-8.08 (m, 1 H), 8.04 (d, $J$ = 8.2 Hz, 1 H), 8.01 (dd, $J$ = 8.1, 1.3 Hz, 1 H), 7.93 (d, $J$ = 8.8 Hz, 1 H), 7.88 (d, $J$ = 8.2 Hz, 1 H), 7.83 (d, $J$ = 8.4 Hz, 1 H), 7.79 (dd, $J$ = 7.9, 7.3 Hz, 1 H), 7.71 (d, $J$ = 8.8 Hz, 1 H), 7.50-7.44 (m, 2 H), 7.34-7.30 (m, 1 H), 7.16 (dd, $J$ = 7.9, 4.2 Hz, 1 H), 7.12-7.07 (m, 2 H), 2.01 (s, 3 H). $^{13}C$ NMR (100 MHz, $CDCl_3$): $\delta$ 147.63, 146.82, 142.42, 138.63, 134.88, 134.79, 133.00, 131.95, 131.42, 131.23, 130.25, 128.53, 128.34, 128.00, 127.53 (2 C), 126.73, 126.11, 125.89, 125.61, 124.87, 123.95, 120.79, 20.69. HRMS-ESI (m/z): Calcd for $[C_{24}H_{17}N + H]^+$, 320.1439. Found, 320.1435.

**Gram scale synthesis of 10-(2'-methoxynaphthalen-1'-yl)benzo[*h*]quinoline 3j**

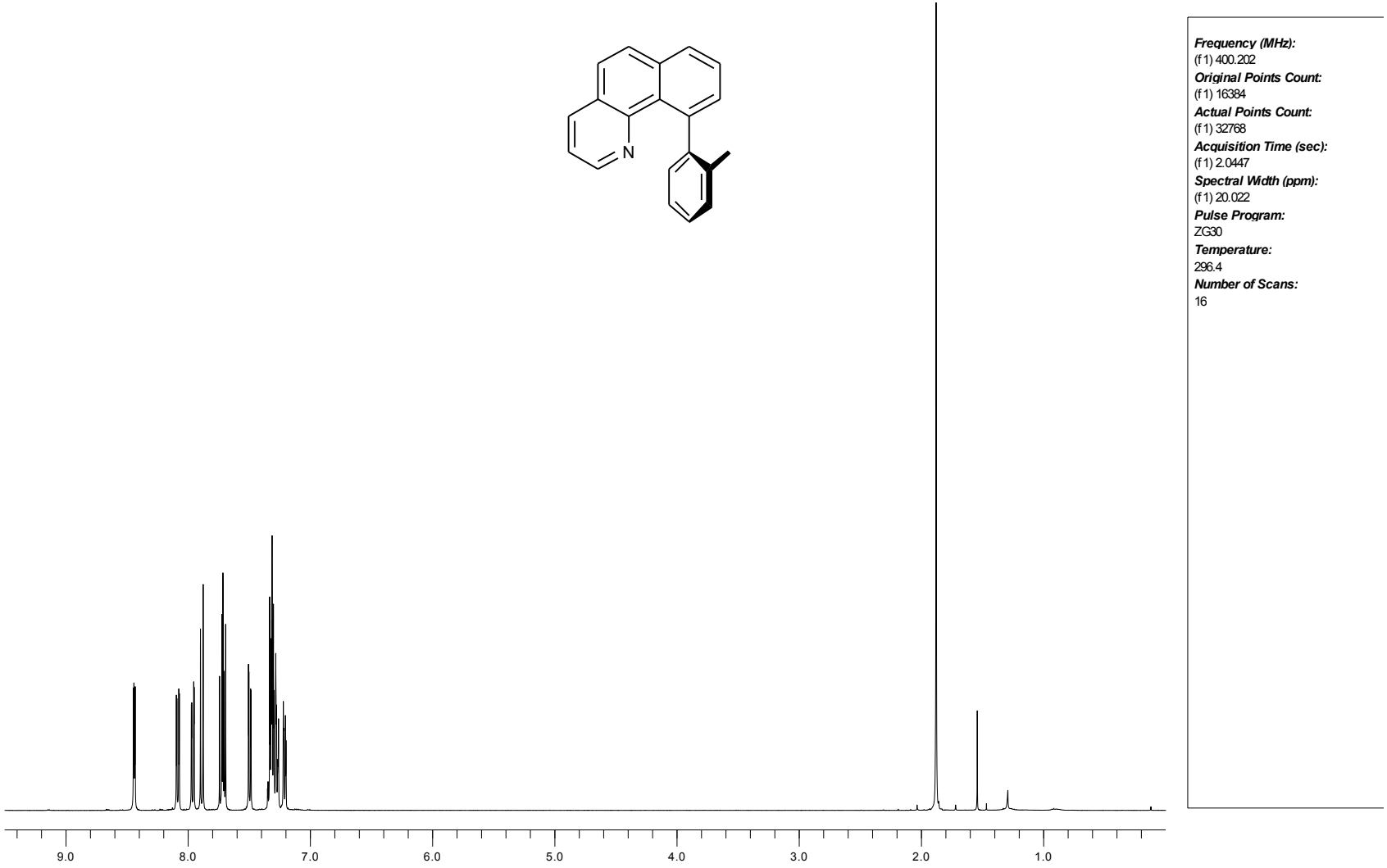
10-Chlorobenzo[*h*]quinoline (898 mg, 4.2 mmol) was dissolved in 15 ml THF and CsF (1.53 g, 10.08 mmol, 2.4 equiv), $Pd(OAc)_2$ (94.3 mg, 0.42 mmol, 0.1 equiv), $P(O)Ph_3$ (234 mg, 0.84 mmol, 0.2 equiv), and 2-methoxynaphthalen-1-ylboronic acid (1.018 g, 5.04 mmol, 1.2 equiv) were added. It was heated to 60 °C for 2 h, then cooled to rt, diluted with 75 ml $Et_2O$, and filtered over $MgSO_4$. After evaporation of the solvents and column chromatography on silica gel (petroleum ether/EtOAc 20:1 to 10:1) the title compound (1.30 g, 92 %) was obtained as white solid.

[2] N. Luo, Z. Yu, *Chem. Eur. J.*, 2010, **16**, 787.

[3] K. L. Hull, M. S. Sanford, *J. Am. Chem. Soc.*, 2007, **129**, 11904.

# Spectroscopic Data

## $^1$H NMR of 3a

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***Number of Scans:***
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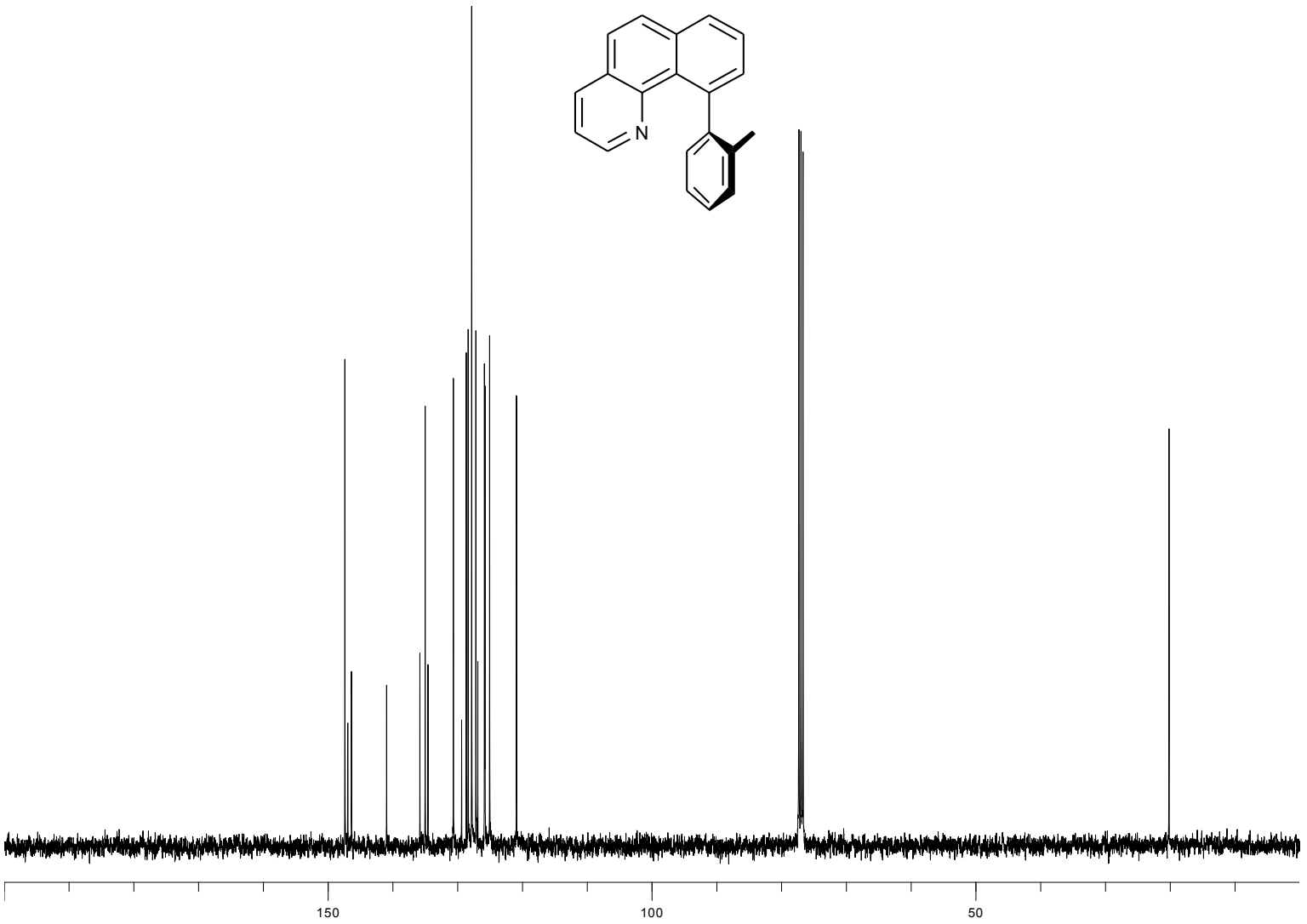
**$^{13}$C NMR of 3a**

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***Number of Scans:***
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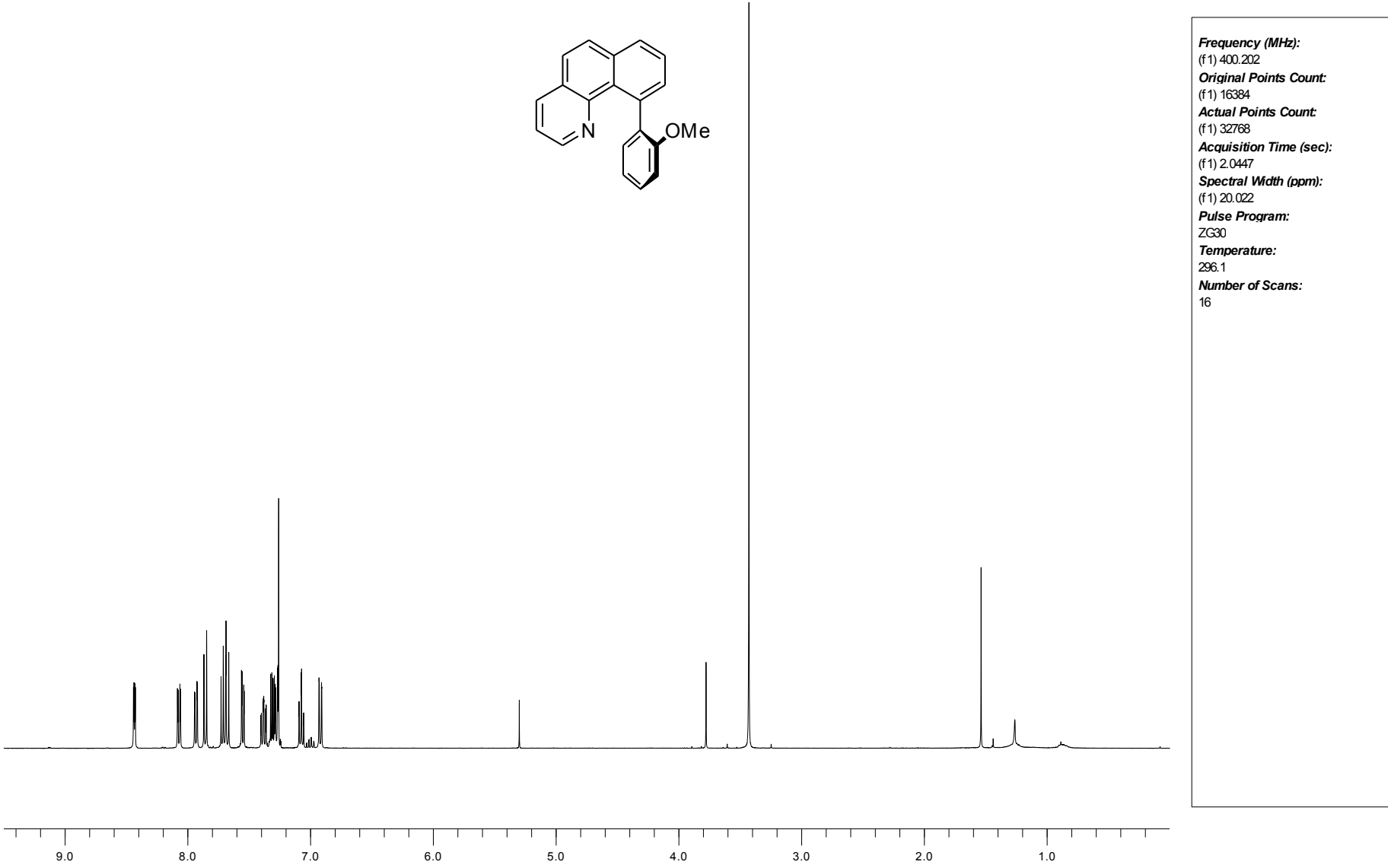
**$^1$H NMR of 3b**

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***Number of Scans:***
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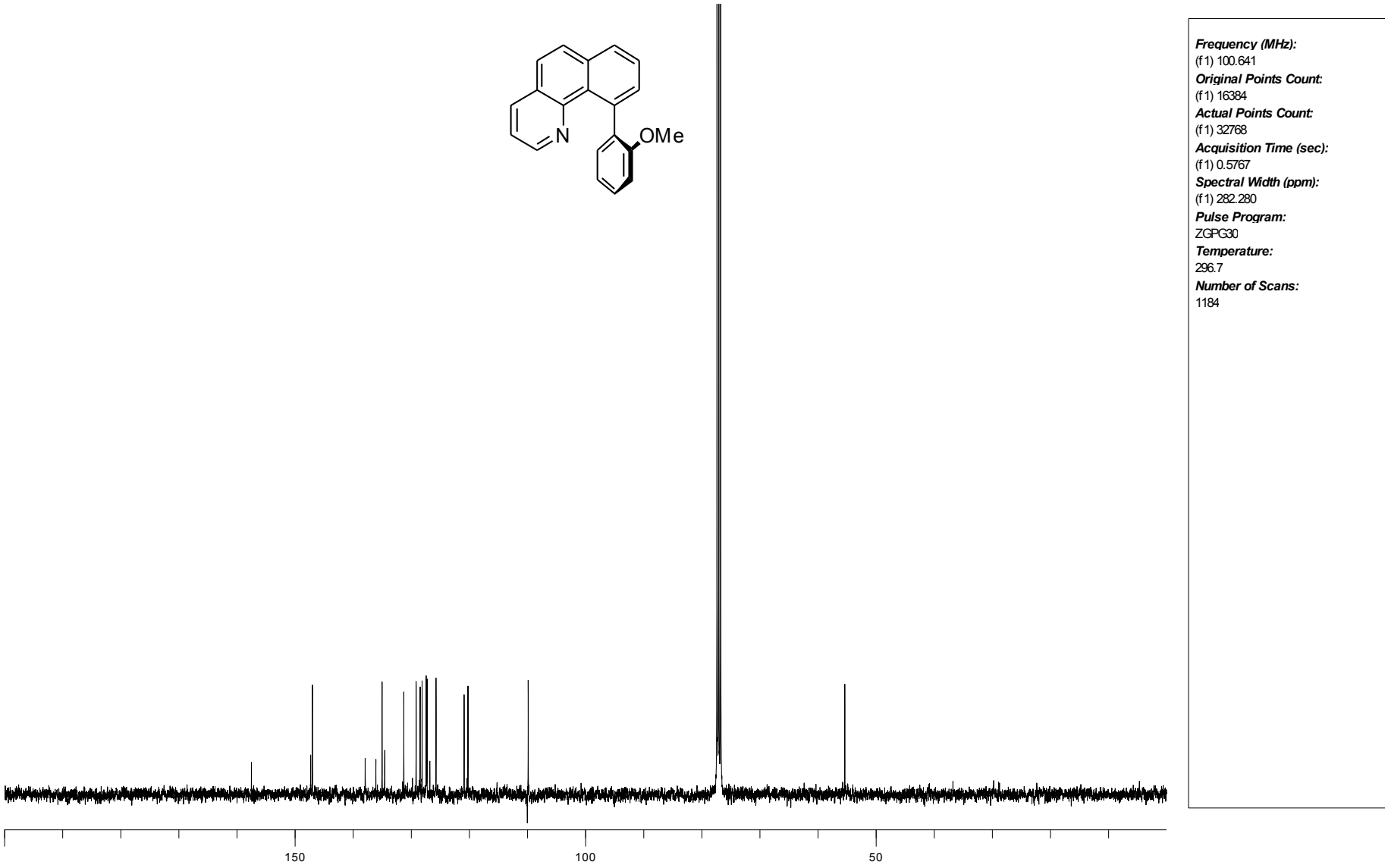
**$^{13}$C NMR of 3b**

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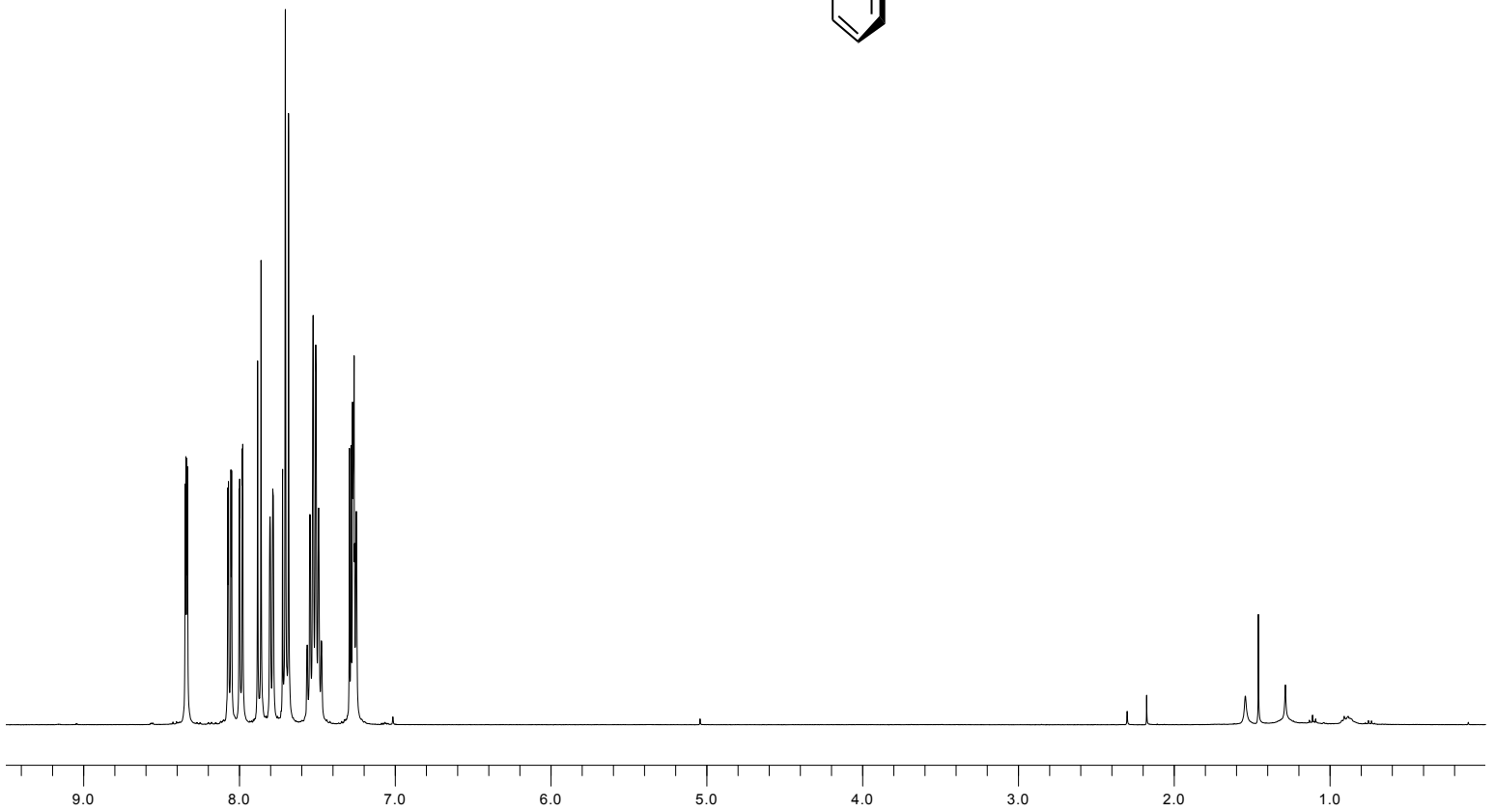
1184

**$^1$H NMR of 3c**

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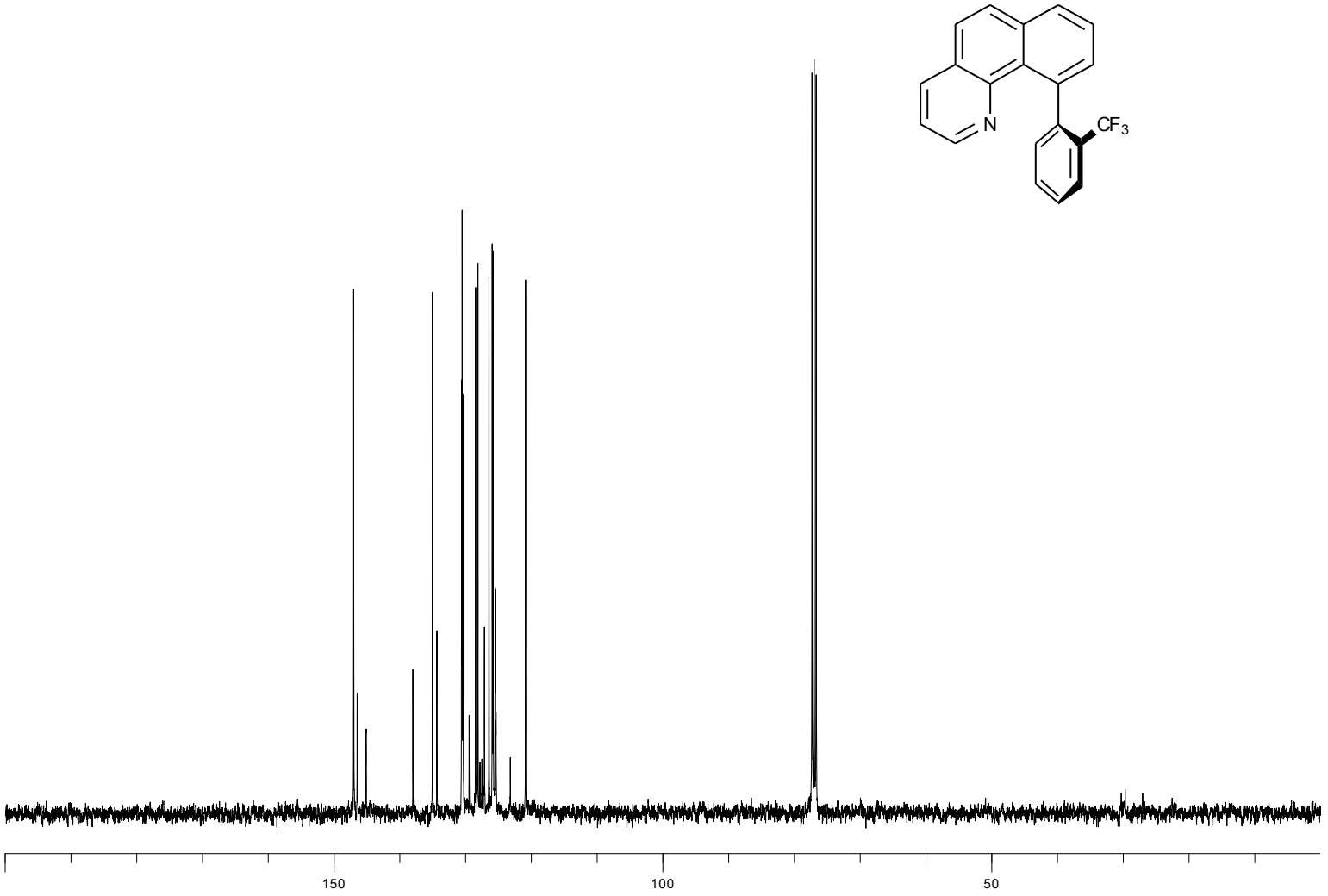
**$^{13}$C NMR of 3c**

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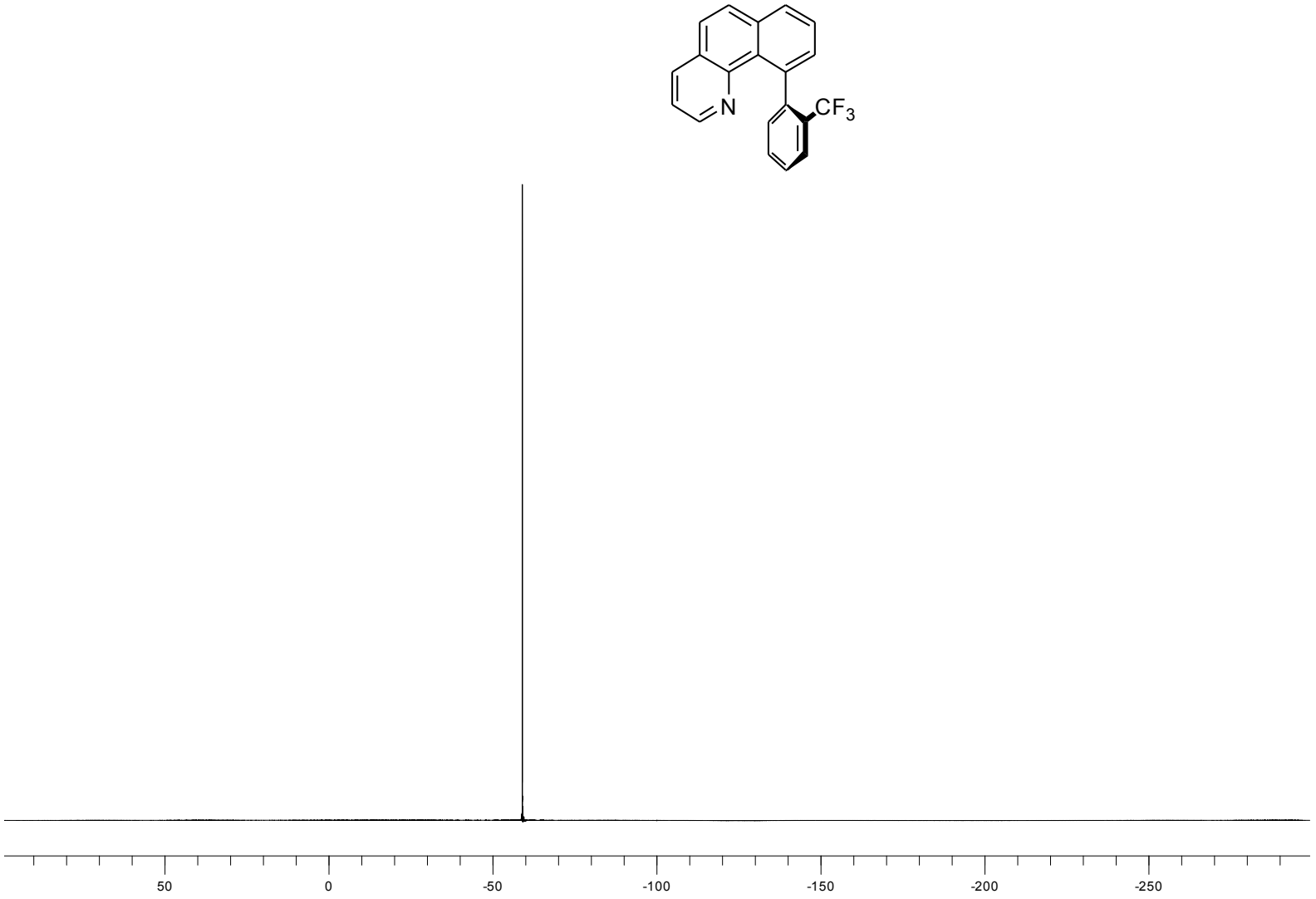
**$^{19}$F NMR of 3c**

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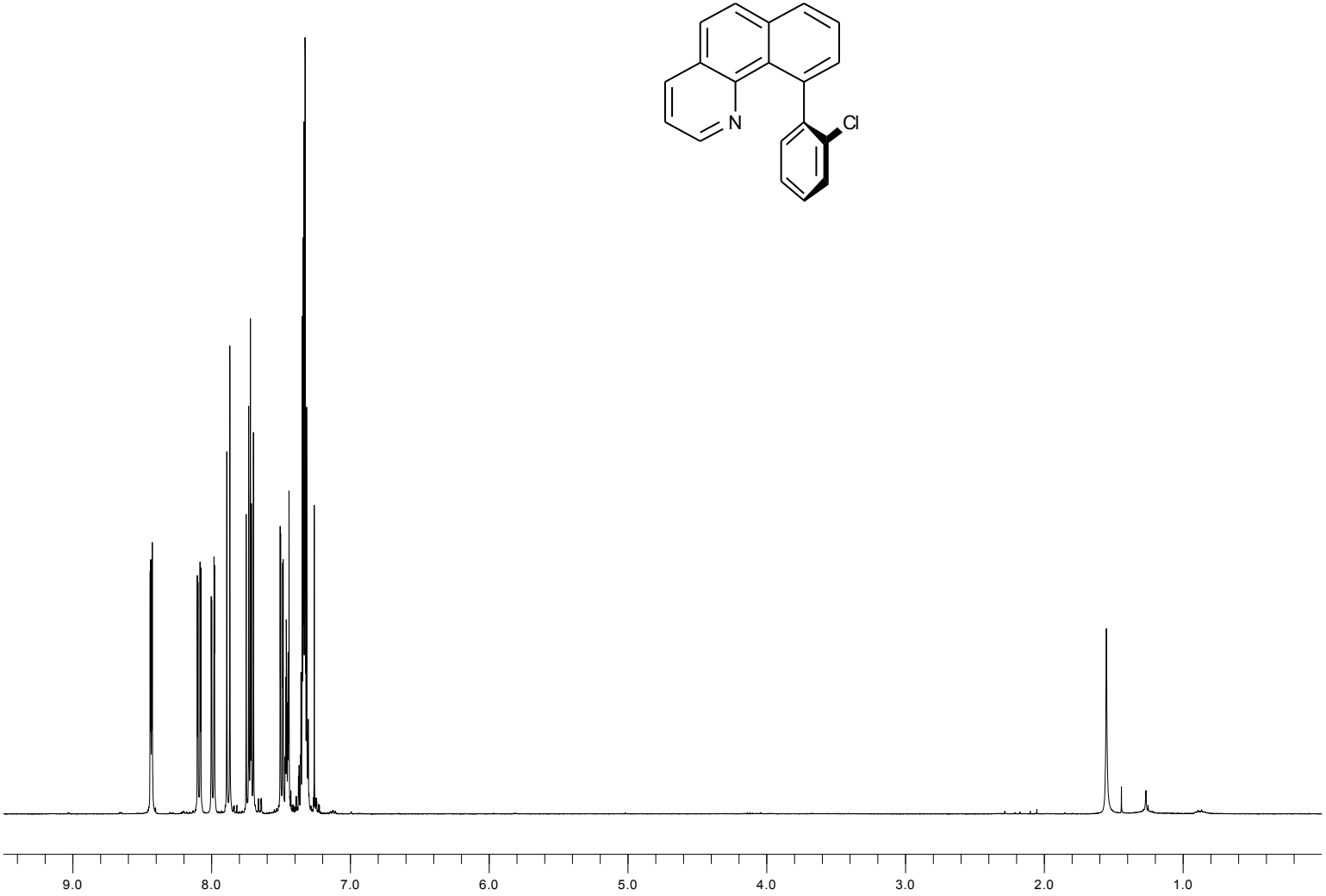
**$^{1}$H NMR of 3d**

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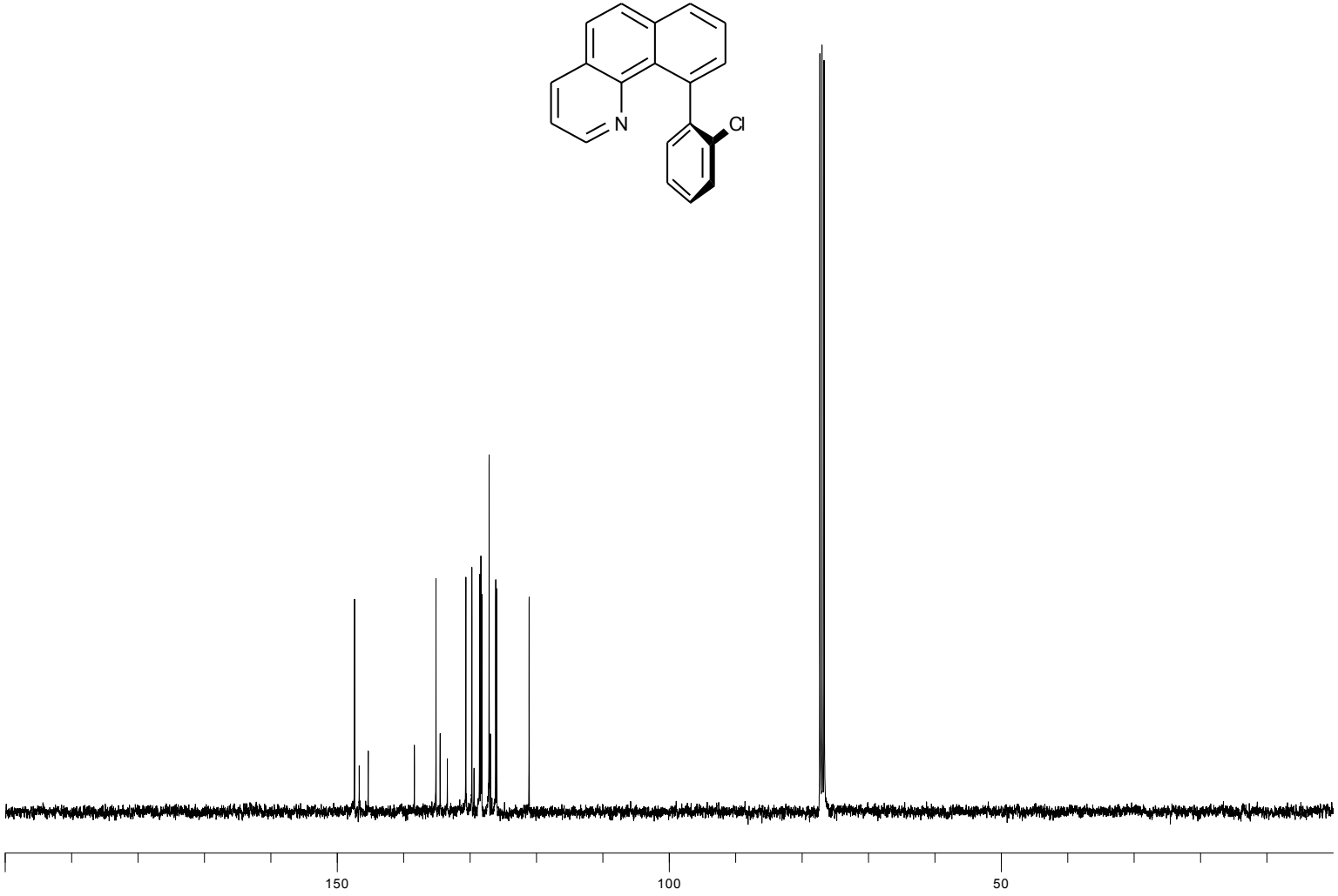
297.2
***Number of Scans:***
16

**$^{13}$C NMR of 3d**

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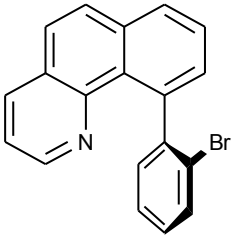
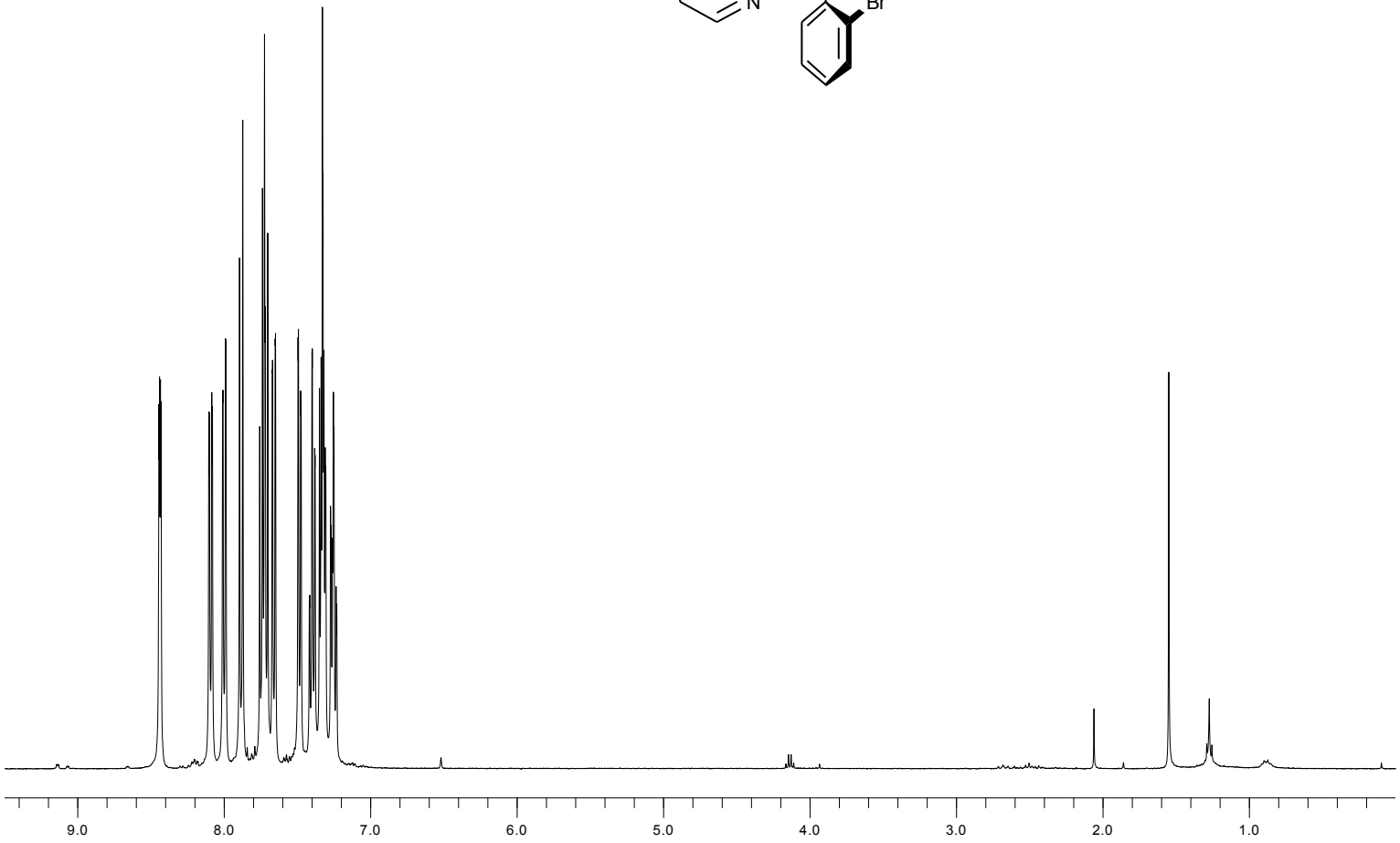
1184

**$^1$H NMR of 3e**

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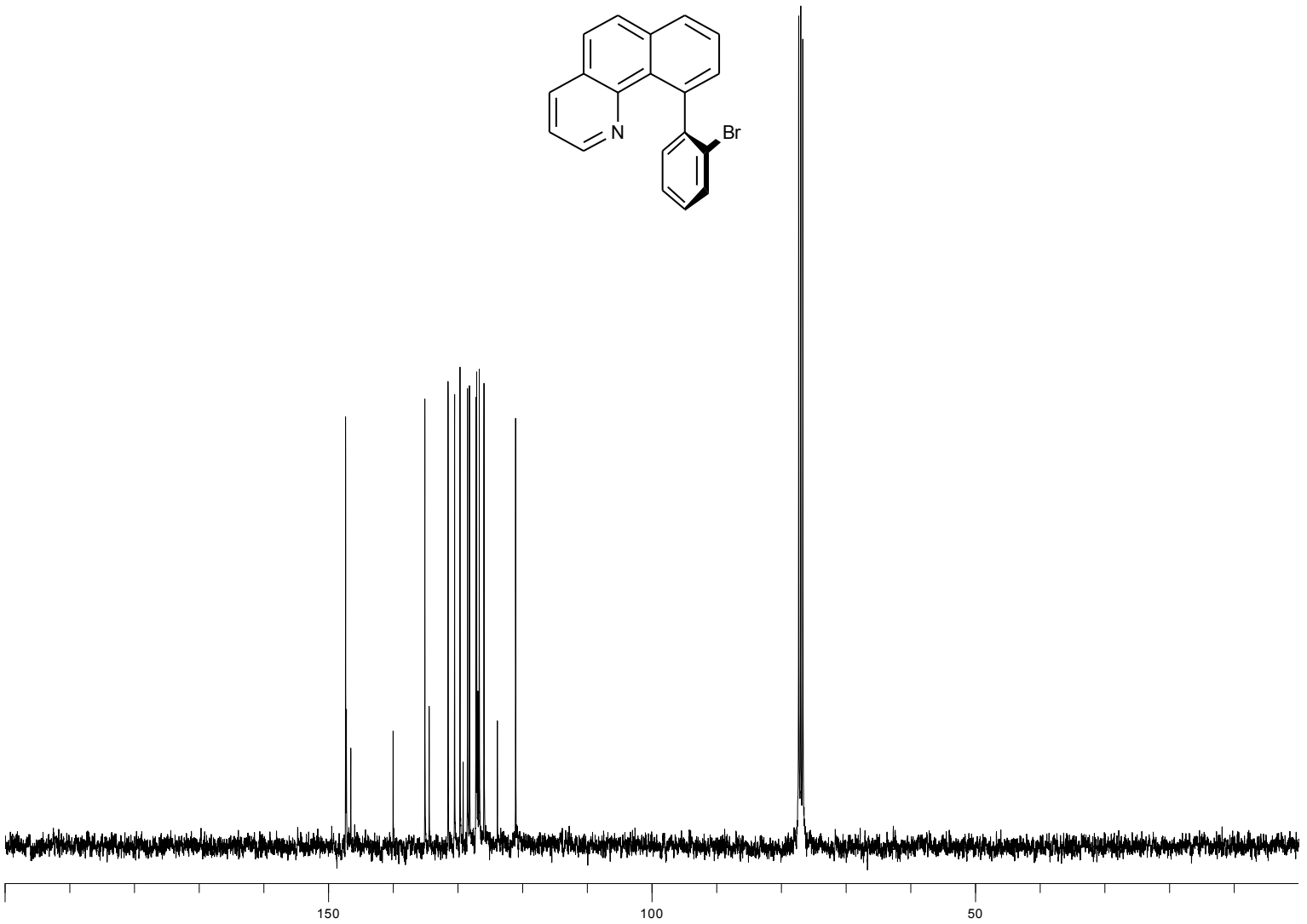
16

**$^{13}$C NMR of 3e**

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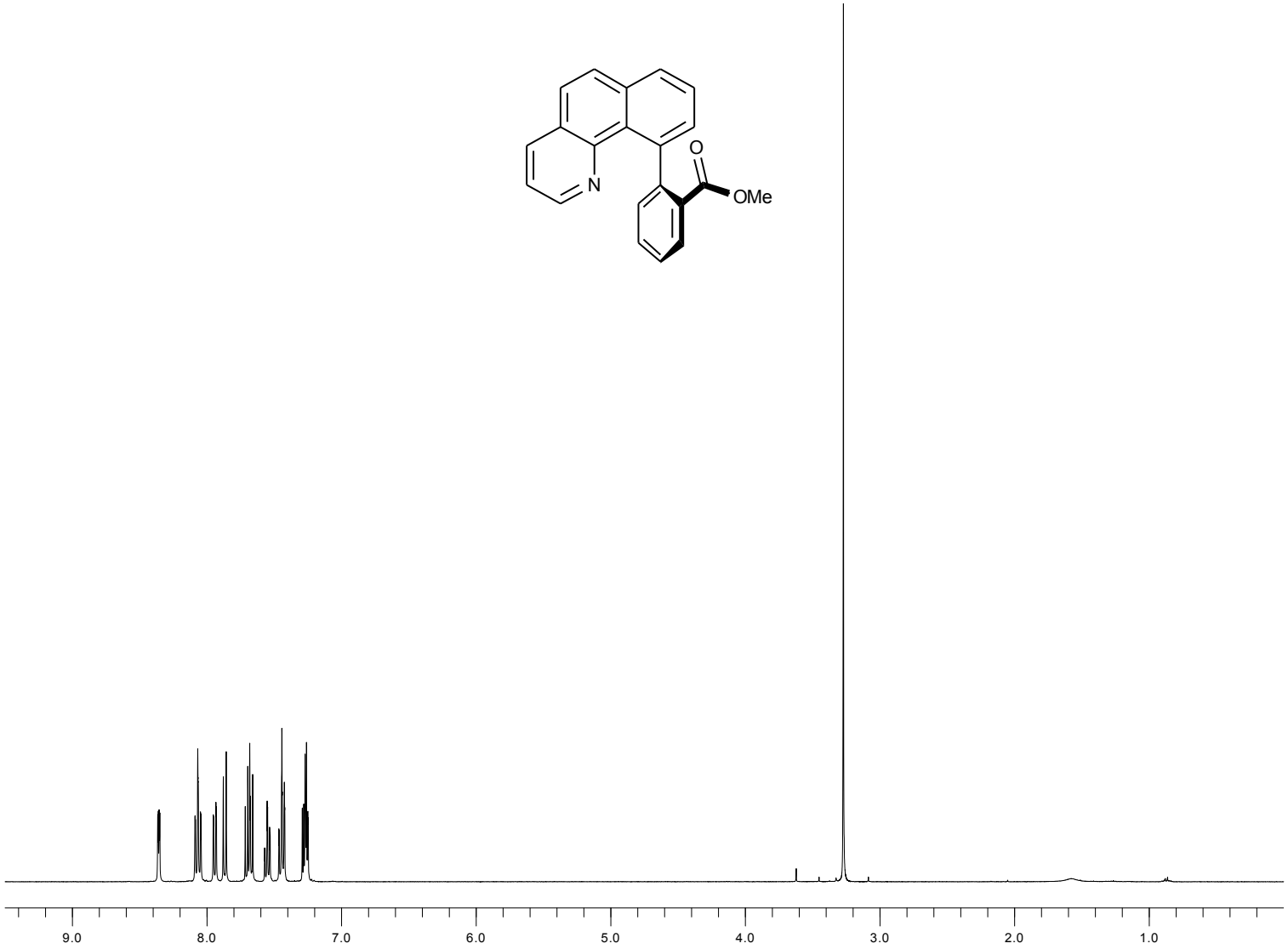
**$^1$H NMR of 3f**

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***Pulse Program:***
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***Temperature:***
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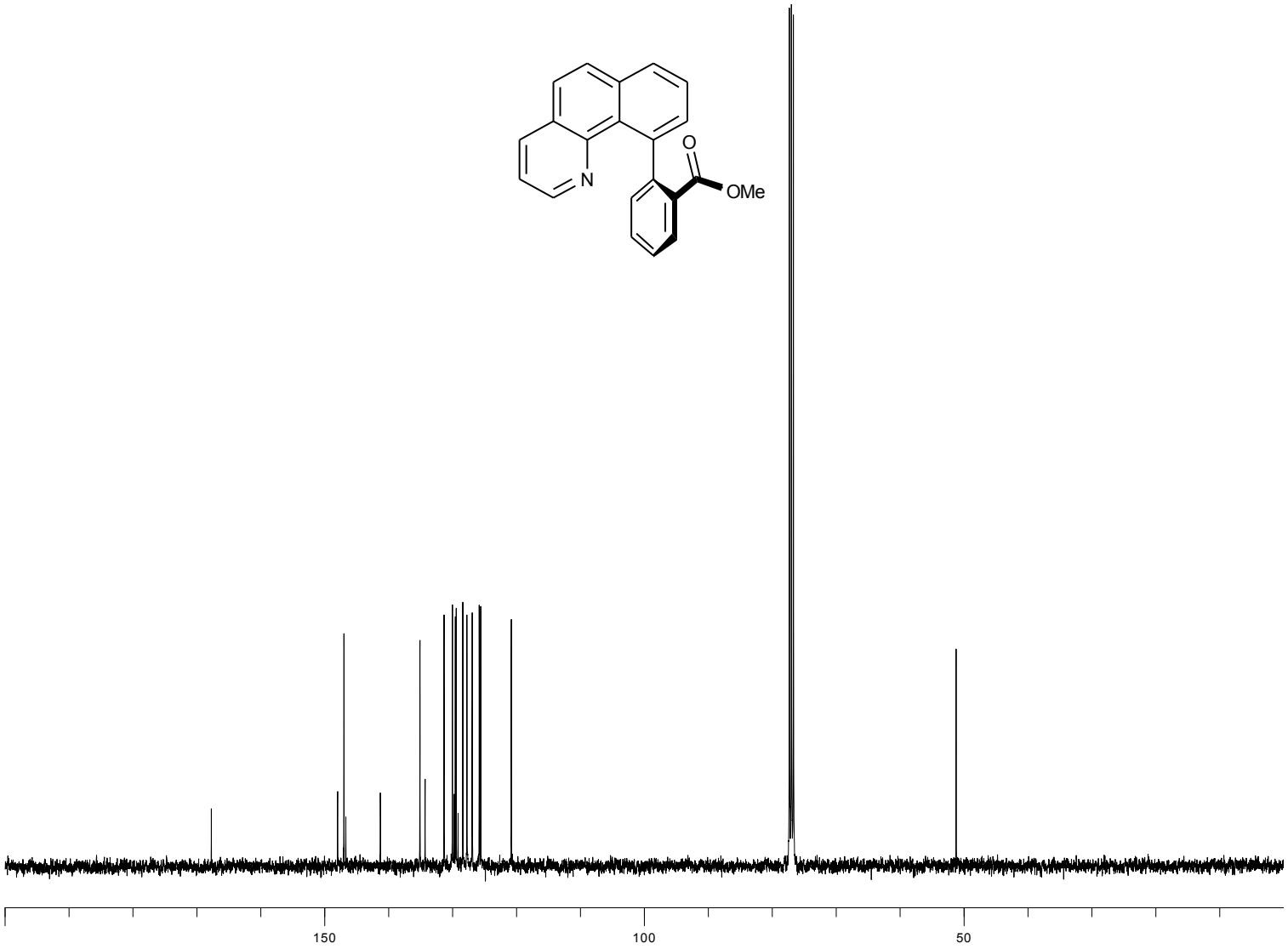
***Number of Scans:***
16

**$^{13}$C NMR of 3f**

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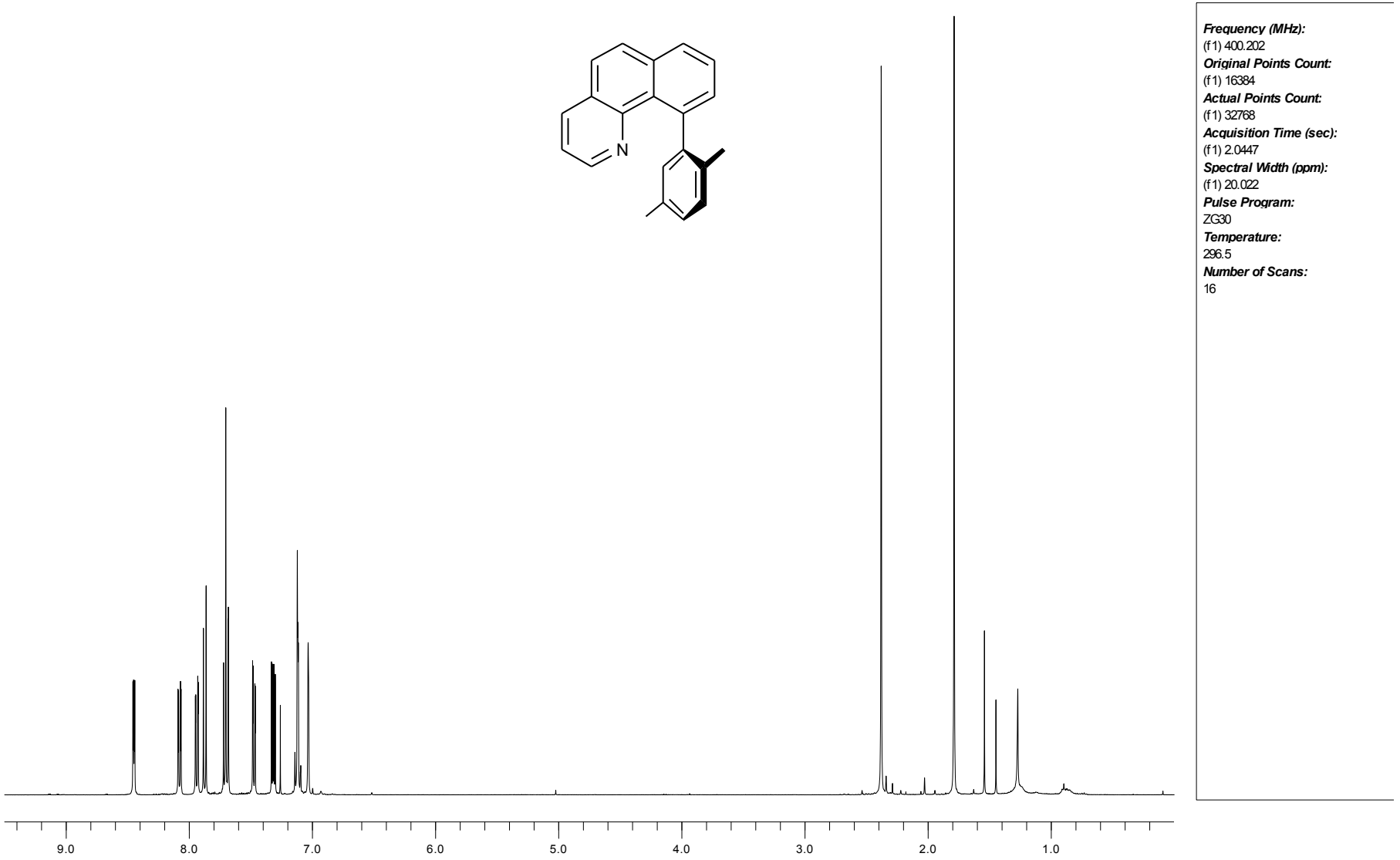
1184

**$^{1}$H NMR of 3g**

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***Spectral Width (ppm):***
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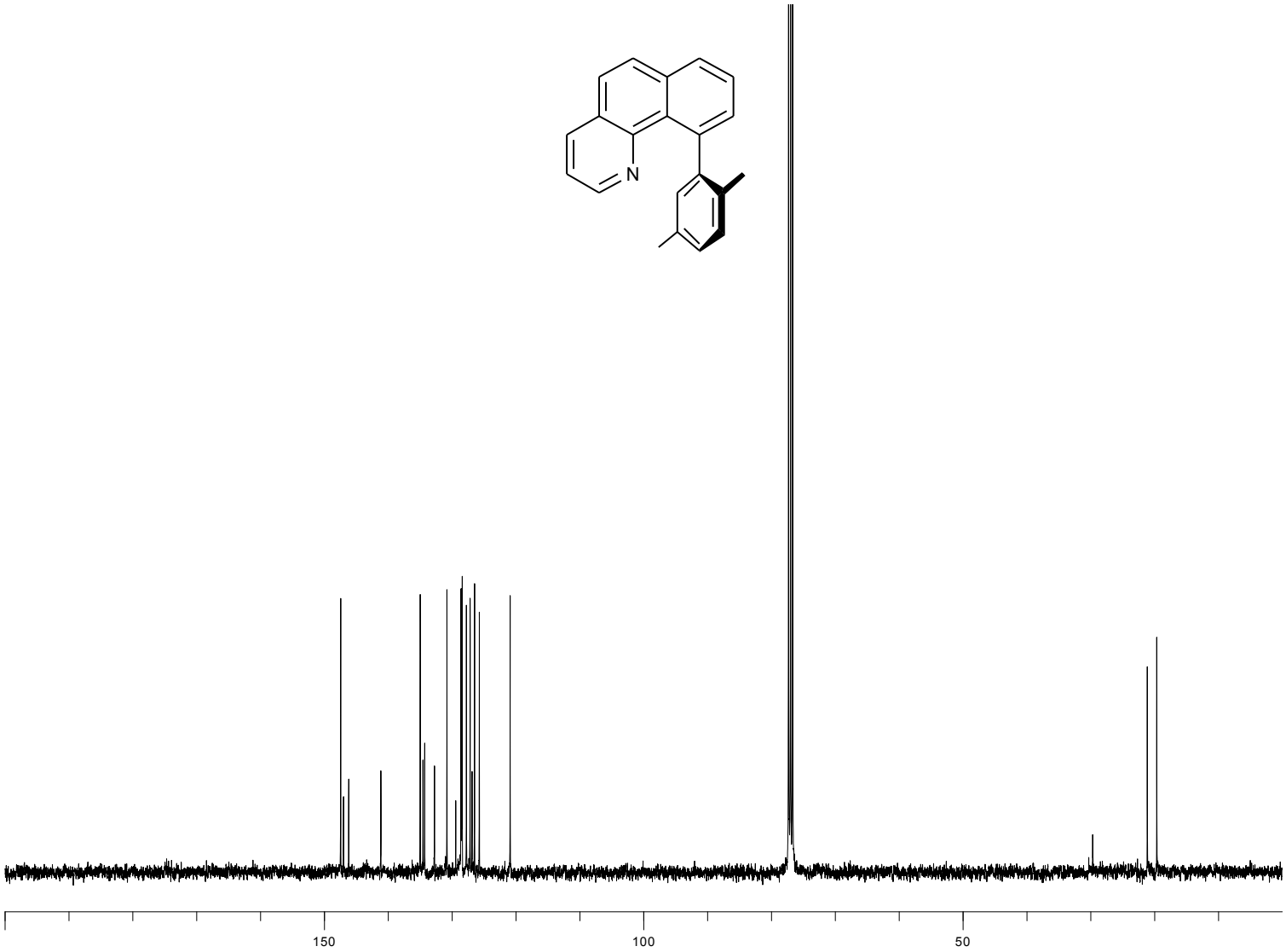
***Temperature:***
296.5
***Number of Scans:***
16

**$^{13}$C NMR of 3g**

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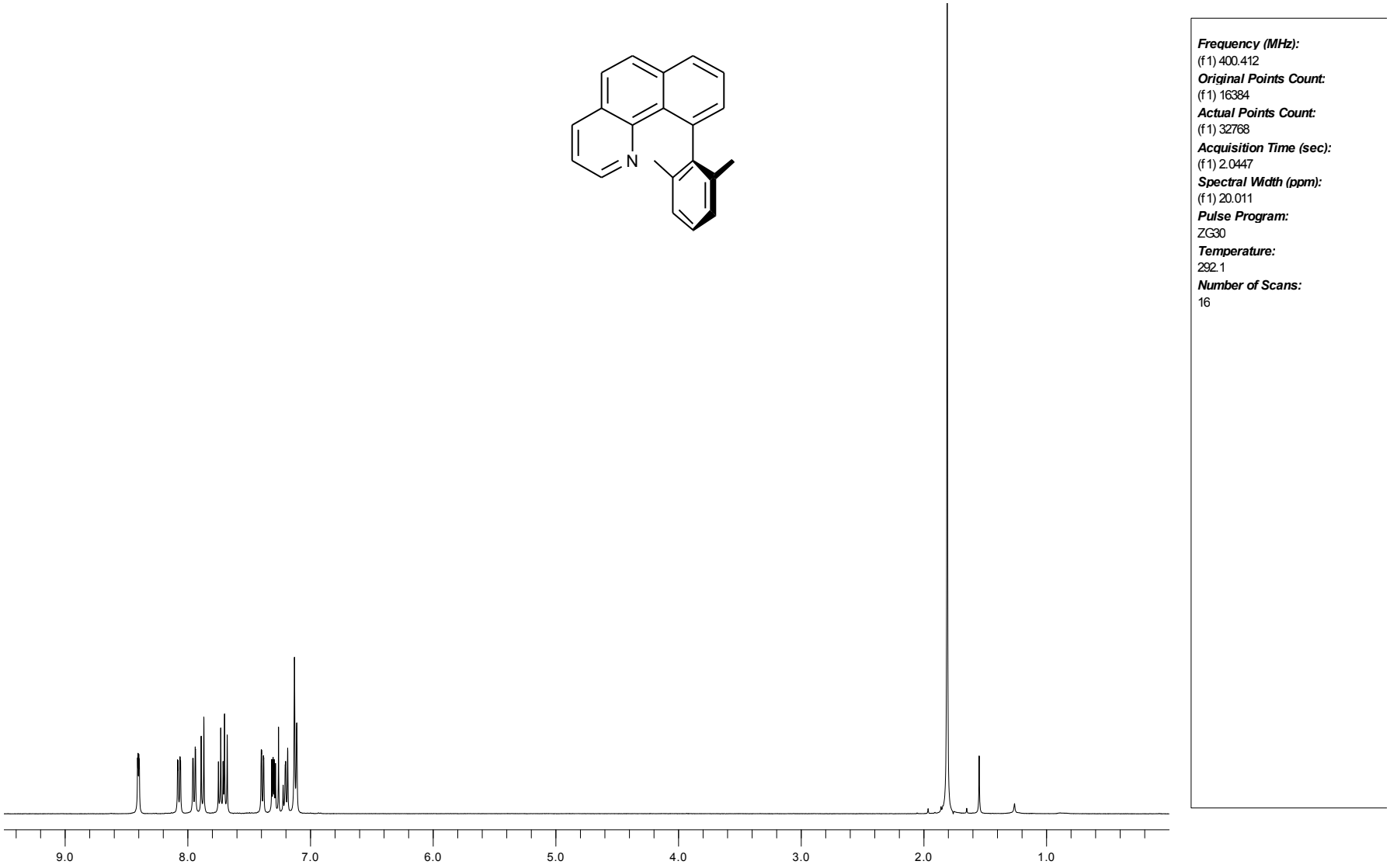
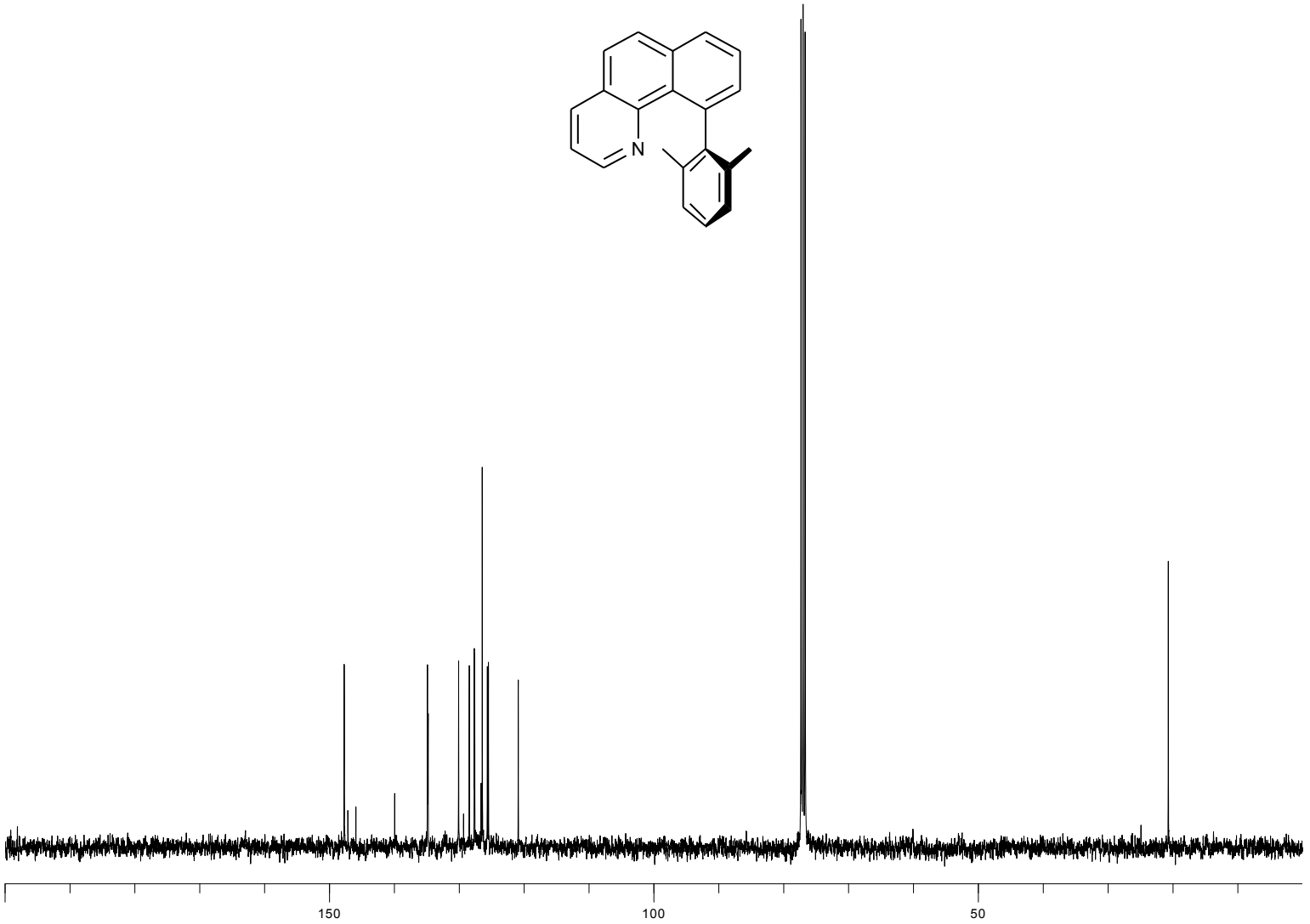
***Number of Scans:***
1184

**$^1$H NMR of 3h**



**$^{13}$C NMR of 3h**

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***Number of Scans:***
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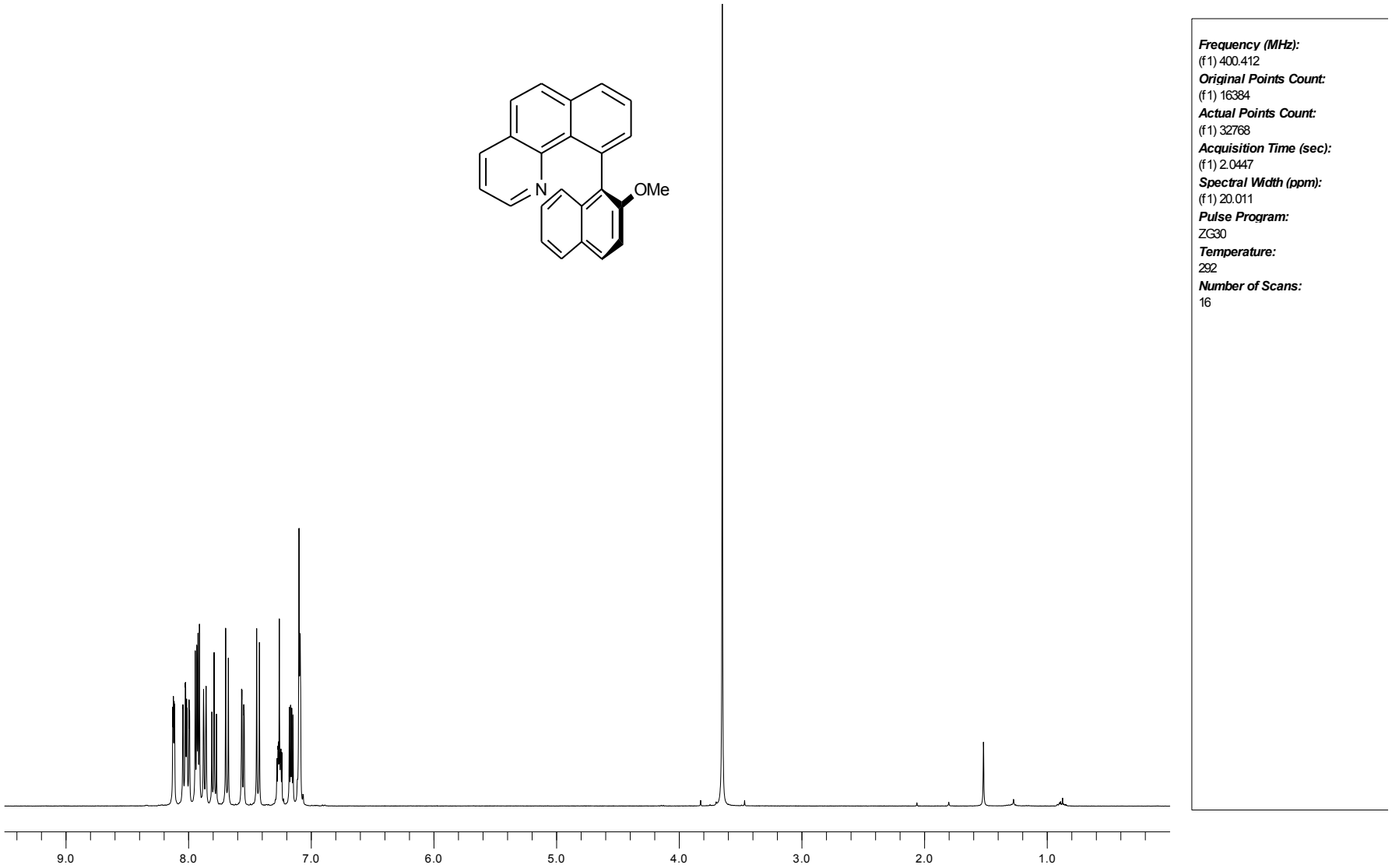
**$^1$H NMR of 3j**

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***Number of Scans:***
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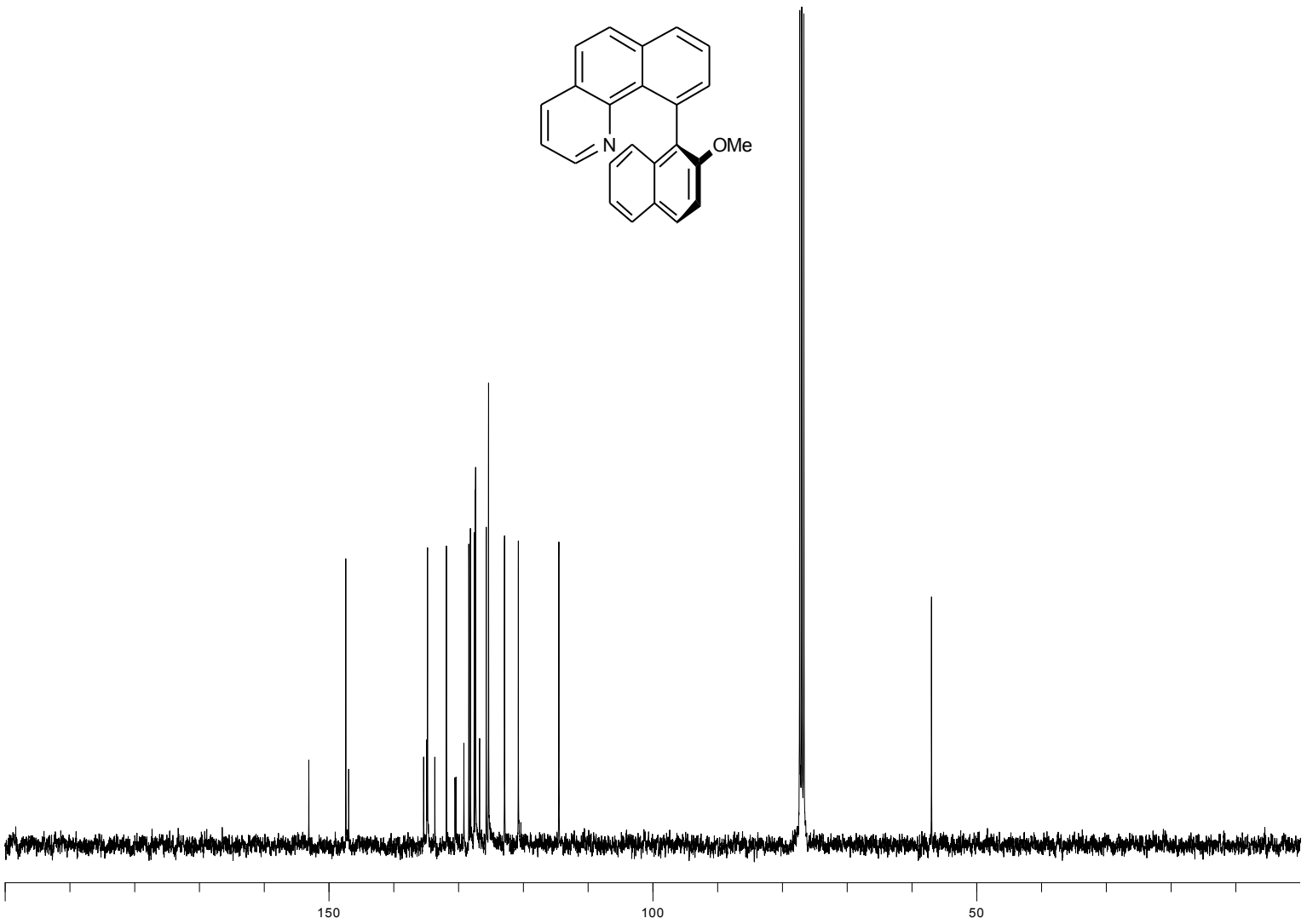
**$^{13}$C NMR of 3j**

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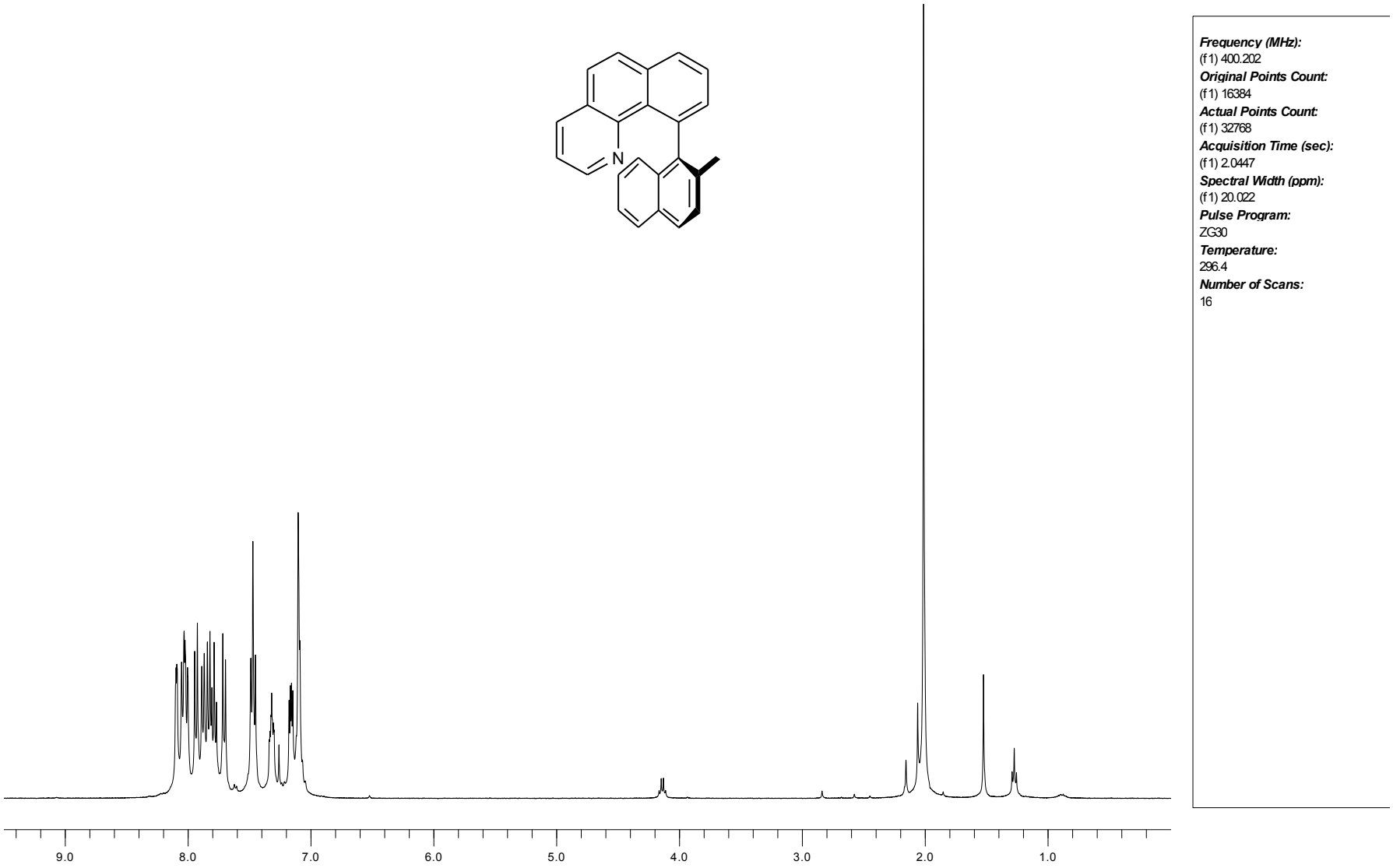
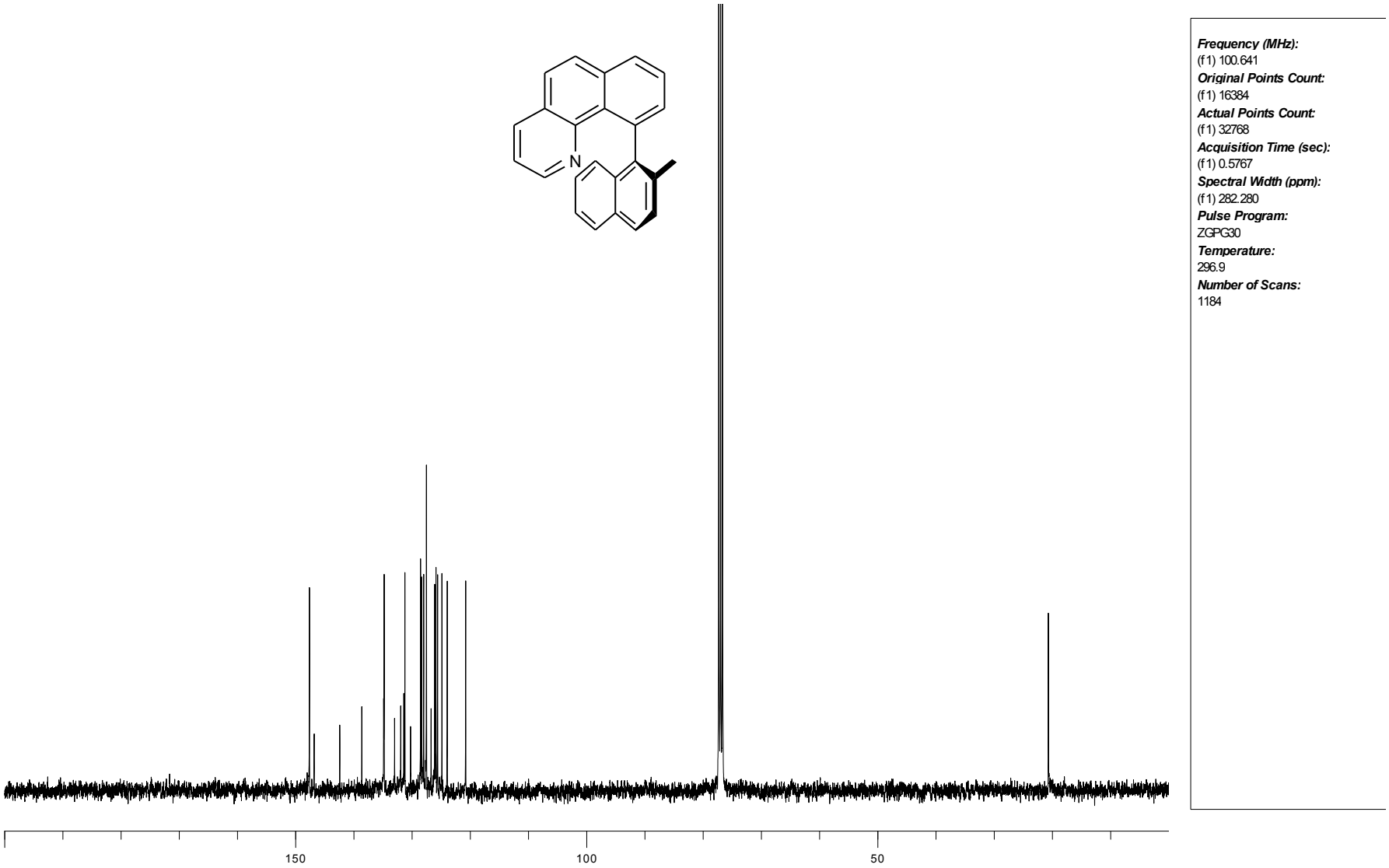
**$^1$H NMR of 3k**



**$^{13}$C NMR of 3k**




***Frequency (MHz):***
(f1) 100.641
***Original Points Count:***
(f1) 16384
***Actual Points Count:***
(f1) 32768
***Acquisition Time (sec):***
(f1) 0.5767
***Spectral Width (ppm):***
(f1) 282.280
***Pulse Program:***
ZGPG30
***Temperature:***
296.9
***Number of Scans:***
1184