

Supporting Information

Photoinduced Cobalt-Catalyzed Site Selective Alkylation of 2-Pyridones

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1. General principles

All reactions dealing with air- or moisture-sensitive compound were performed by standard Schlenk techniques in oven-dried reaction vessels Under the argon atmosphere or in the argon-filled glove box. Unless otherwise noted, all solvents were dried by JC Meyer Solvent Drying System. Most reagents were purchased from commercial sources and used without further purification, unless otherwise stated. Reactions were monitored by thin layer chromatography (TLC) carried out on 0.2 mm commercial silica gel plates, using UV light as the visualizing agent or basic solution of KMnO₄ or acidic solution of *p*-anisaldehyde and heat as a developing agent. All NMR spectra were recorded on a Bruker spectrometer at 600 MHz (¹H NMR), 100 MHz (¹³C NMR), 565 MHz (¹⁹F NMR) and were calibrated using residual undeuterated solvent as an internal reference (CDCl₃ @ 7.26 ppm ¹H NMR, 77.16 ppm ¹³C NMR; DMSO @ 2.50 ppm ¹H NMR, 39.5 ppm ¹³C NMR; CD₃OD @ 3.30 ppm ¹H NMR, 49.00 ppm ¹³C NMR). The following abbreviations were used to explain multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, dd = doublet of doublets, dt = doublet of triplets, td = triplet of doublets, ddd = doublet of doublet of doublets, m = multiplet, br = broad. High resolution mass spectra (HRMS) were recorded on DIONEX UltiMate 3000 & Bruker Compact TOF mass spectrometer.

2. Optimization of reaction conditions

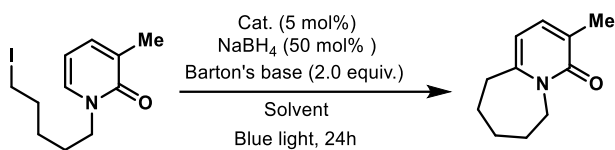
Table S1 Reaction conditions optimization for C3 alkylation of 2-pyridones



Entry	Solvent	Base	Cat.	T/h	Yield [%]
1	PhCl	Barton's base	Co-I	24	trace
2	MeOH	Barton's base	Co-I	24	29
3	THF	Barton's base	Co-I	24	trace
4	DME	Barton's base	Co-I	24	trace
5	Dioxane	Barton's base	Co-I	24	trace
6	<i>o</i> -Xylene	Barton's base	Co-I	24	trace
7	<i>n</i> -BuOH	Barton's base	Co-I	24	48
8	<i>n</i> -BuOH	Cs ₂ CO ₃	Co-I	24	42
9	<i>n</i> -BuOH	TEA	Co-I	24	trace
10	<i>n</i> -BuOH	CaCO ₃	Co-I	24	36
11	<i>n</i> -BuOH	CsF	Co-I	24	66
12	<i>n</i> -BuOH	CsF	Co-III	24	36
13	<i>n</i> -BuOH	CsF	Co-IV	24	36
14	<i>n</i>-BuOH	CsF	Co-I	36	74

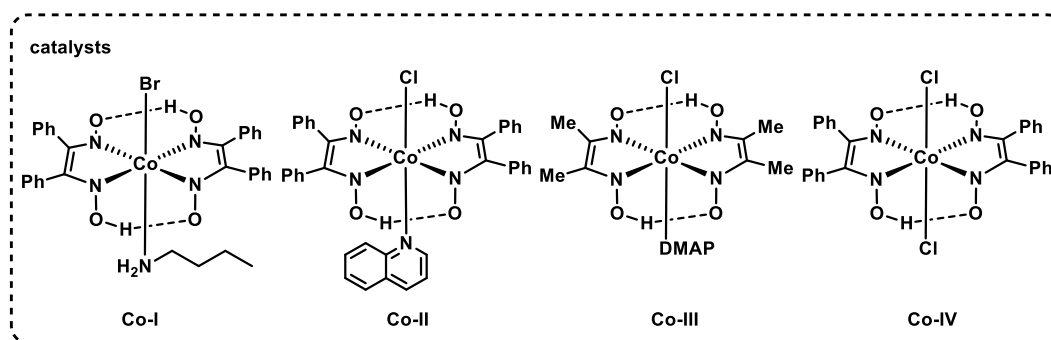
[a] The reaction was performed on a 0.2 mmol scale. [b] Isolated yield in parentheses.

Table S2 Reaction conditions optimization for C6 alkylation of 2-pyridones

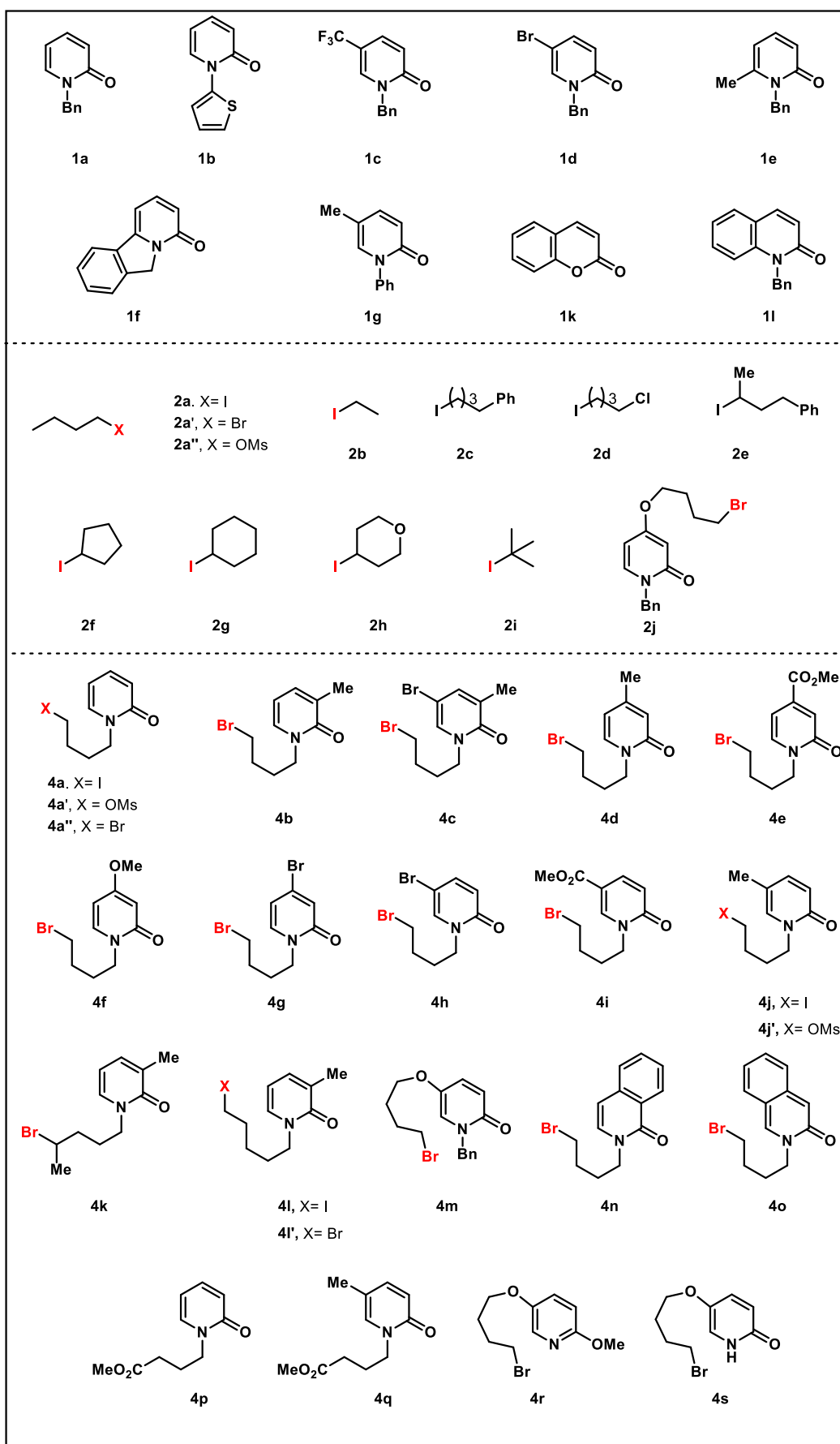


Entry	Cat.	solvent	2A Yield [%]
1	Co-I	PhCl	38
2	Co-II	PhCl	75
3	Co-III	PhCl	trace
4	Co-IV	PhCl	17
5	Co-II	Acetone	trace
6	Co-II	DCE	trace
7	Co-II	MeCN	trace
8	Co-II	DMF	trace
9	Co-II	PhMe	60
10	Co-II	Dioxane	57

[a] The reaction was performed on a 0.1 mmol scale. [b] Isolated yield in parentheses.

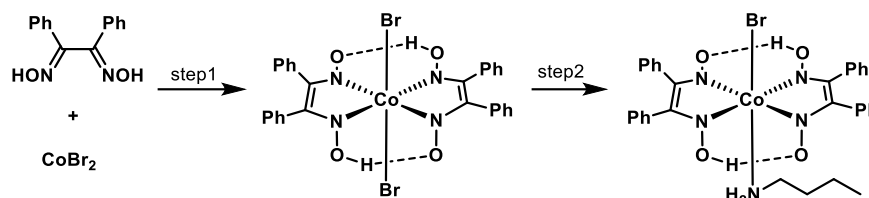


3. Substrates and catalysts involved in this work



Substrates **2a**, **2a''**, **2b**, **2d** and **2f-2i** were commercially available and were used without further purification. Substrates **2c**, **2e** and **1a-1l** were known compounds and prepared according to the reported literatures.^[1-10] Substrates **4a-q** are not known compounds, prepared with reference to other literatures.^[11-17]

Synthesis and characterization of Co(*n*-butylamine)(dmgH)₂Br (Co-I)



Step 1: In air, to a 150 mL round flask charged with CoBr₂ (2.187 g, 10 mmol, 1.0 equiv.) and acetone (50 mL, c = 0.2 M) was added 1,2-diphenylethane-1,2-dione dioxime (5.282 g, 22 mmol, 2.2 equiv.). A gentle stream of air was passed through the solution *via* a needle. After 1h, the reaction flask was placed on ice for 20min. The resulting brown solids were collected by filtration over Büchner funnel. The solids were rinsed with cold acetone and further dried (19%).

Step 2: Then the brown solid (2.084 g, 3 mmol, 1.0 equiv.) was placed in MeOH (25 mL, c = 0.12 M), then *n*-butylamine (0.439 g, 6 mmol, 2.0 equiv.) was added. The mixture was stirred for 30min at room temperature. Then water (42 mL) was added, and the flask was placed on ice for 10min. Filter the mixture and get the brown solid (94%).

Physical state: Brown solid;

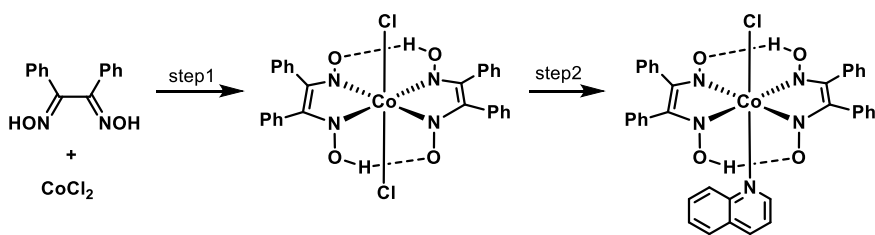
R_f = 0.4 (silica gel, DCM: MeOH = 20:1);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.41 – 7.34 (m, 12H), 7.28 (dd, *J* = 6.7, 3.2 Hz, 8H), 3.54 (t, *J* = 7.1 Hz, 2H), 2.02 – 1.94 (m, 2H), 1.52 – 1.42 (m, 2H), 1.22 – 1.11 (m, 2H), 0.78 (t, *J* = 7.3 Hz, 3H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 152.7, 130.0, 129.7, 129.4, 127.9, 31.5, 20.0, 13.6 ppm.

HRMS-ESI (m/z) calc'd for C₃₃H₃₆BrCoN₅NaO₄ [M+Na]⁺, 712.0937, found, 712.0940.

Synthesis and characterization of Co(quinoline)(dmgH)₂Cl (Co-II)



Step 1: In air, to a 150 mL round flask charged with CoCl_2 (1.298 g, 10 mmol, 1.0 equiv.) and acetone (50 mL, $c = 0.2$ M) was added 1,2-diphenylethane-1,2-dione dioxime (5.282 g, 22 mmol, 2.2 equiv.). A gentle stream of air was passed through the solution via a needle. After 1h, the reaction flask was placed on ice for 20min. The resulting brown solid were collected by filtration over Büchner funnel. The solid were rinsed with cold acetone and further dried (89%).

Step 2: Then the brown solid (1.821 g, 3 mmol, 1.0 equiv.) were placed in MeOH (25 mL, $c = 0.12$ M), then quinoline (0.774 g, 6 mmol, 2.0 equiv.) was added. The mixture was stirred for 30min at room temperature. Then water (42 mL) was added, and the flask was placed on ice for 10 min. Filter the mixture and get the brown solid (82%).

Physical state: Brown solid;

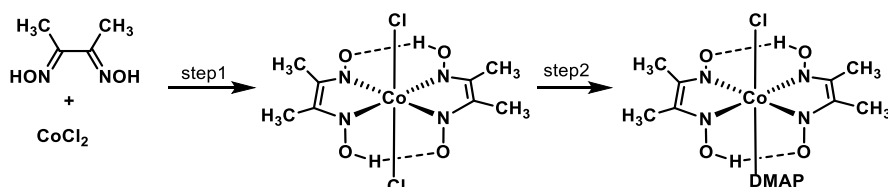
$R_f = 0.3$ (silica gel, DCM: MeOH = 20:1);

$^1\text{H NMR}$ (600 MHz, DMSO, 23°C, δ): 9.05 (s, 1H), 8.65 (s, 1H), 8.13 – 8.06 (m, 2H), 7.89 (t, $J = 7.6$ Hz, 1H), 7.72 (t, $J = 7.2$ Hz, 2H), 7.38 – 7.19 (m, 20H) ppm.

$^{13}\text{C NMR}$ (100 MHz, DMSO, 23°C, δ): 152.2, 149.9, 148.3, 144.1, 138.5, 130.4, 129.9, 129.0, 128.9, 128.9, 128.2, 127.8, 127.4, 127.3, 127.2, 126.9, 126.8, 125.9, 121.0 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_{37}\text{H}_{29}\text{ClCoN}_5\text{NaO}_4$ [$\text{M}+\text{Na}$] $^+$, 724.1132; found, 724.1132.

Synthesis and characterization of $\text{Co}(\text{DMAP})(\text{dmgH})_2\text{Cl}$ (Co-III)



Step 1: In air, to a 150 mL round flask charged with CoCl_2 (1.298 g, 10 mmol, 1.0 equiv.) and acetone (50 mL, $c = 0.2$ M) was added dimethylglyoxime (2.552 g, 22 mmol, 2.2 equiv.). A gentle stream of air was passed through the solution via a needle. After 1h, the reaction flask was placed on ice for 20min. The resulting green crystals were collected by filtration over Büchner funnel. The crystals were rinsed with cold acetone

and further dried (2.55 g, 71%).

Step 2: Then the green crystals (1.082 g, 3 mmol, 1.0 equiv.) were placed in MeOH (25 mL, $c = 0.12$ M), and DMAP (0.732 g, 6 mmol, 2.0 equiv.) was added. The mixture was stirred for 30 min at room temperature. Then water (42 mL) was added, and the flask was placed on ice for 10 min. Filter the mixture and get the brown crystals (1.31 g, 98%).

Physical state: Brown solid;

$R_f = 0.3$ (silica gel, DCM: MeOH = 20:1);

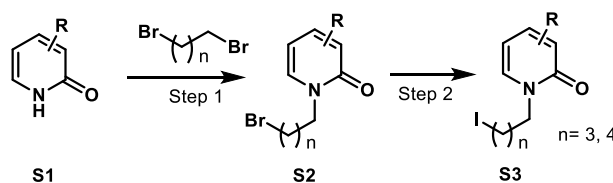
$^1\text{H NMR}$ (600 MHz, DMSO, 23°C, δ): 7.35 (d, $J = 7.3$ Hz, 2H), 6.59 – 6.57 (m, 2H), 2.91 (s, 6H), 2.30 (s, 12H) ppm.

$^{13}\text{C NMR}$ (100 MHz, DMSO, 23°C, δ): 154.4, 151.8, 147.6, 108.6, 38.6, 12.4 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_9\text{H}_{17}\text{ClCoN}_4\text{NaO}_4$ $[\text{M}+\text{Na}]^+$, 362.9265; found, 362.9263.

4. Synthesis and Characterization of material

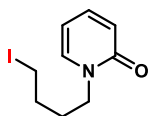
Synthesis of material (1)^{[11],[12]}



Step 1: 500 mg of **S1** was dissolved in 3 mL DMF. NaH (1.1 equiv.) was added to DMF to form a suspension and slowly added dropwise at 0 °C for 30 minutes. Alkyl halide (1.5 equiv.) was added and the resulting mixture was stirred overnight at room temperature. 20 mL water was added to the mixture and then the mixture was extracted with CH_2Cl_2 (50 mL x 3), an organic layer washed with water (50 mL), dried over Na_2SO_4 , and concentrated in vacuo to afford the compound **S2**.

Step 2: **S2** and NaI (6.0 equiv.) was dissolved in 3 mL acetone. The resulting mixture was stirred overnight at 70°C. 20 mL water was added to the mixture and then the mixture was extracted with CH_2Cl_2 (50 mL x 3), an organic layer washed with water (50 mL), dried over Na_2SO_4 , and concentrated in vacuo to afford the compounds **S3**.

1-(4-Iodobutyl)pyridin-2(1H)-one (**4a**)



Physical state: yellow oil;

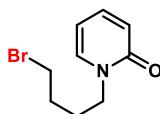
R_f = 0.4 (silica gel, PE: EtOAc = 1:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 7.33 (ddd, J = 8.9, 6.5, 2.0 Hz, 1H), 7.29 (d, J = 6.0 Hz, 1H), 6.55 (d, J = 9.1 Hz, 1H), 6.19 (t, J = 6.7 Hz, 1H), 3.96 (t, J = 6.6 Hz, 2H), 3.22 (t, J = 6.2 Hz, 2H), 1.88 (p, J = 3.4 Hz, 4H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 162.4, 139.4, 137.3, 120.9, 106.1, 48.3, 30.2, 30.1, 5.8 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_9\text{H}_{13}\text{INO}$ $[\text{M}+\text{H}]^+$, 278.0036; found, 278.0036.

1-(4-Bromobutyl)pyridin-2(1H)-one (4a'')



Physical state: yellow oil;

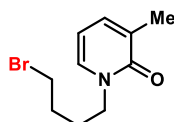
R_f = 0.4 (silica gel, PE: EtOAc = 1:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 7.34 – 7.30 (m, 1H), 7.26 (d, J = 8.4 Hz, 1H), 6.56 (d, J = 9.2 Hz, 1H), 6.17 (t, J = 6.8 Hz, 1H), 3.97 (t, J = 6.1 Hz, 2H), 3.45 (t, J = 5.9 Hz, 2H), 1.92 (p, J = 3.1 Hz, 4H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 162.7, 139.5, 137.4, 121.3, 106.3, 48.8, 33.1, 29.7, 28.1 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_9\text{H}_{12}\text{BrNNaO}$ $[\text{M}+\text{Na}]^+$, 251.9995; found, 251.9994.

5-Bromo-1-(4-bromobutyl)-3-methylpyridin-2(1H)-one (4b)



Physical state: yellow oil;

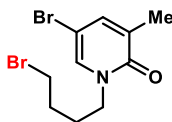
R_f = 0.5 (silica gel, PE: EtOAc = 2:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 7.11 (d, J = 6.4 Hz, 1H), 7.07 (d, J = 6.7 Hz, 1H), 6.02 (t, J = 6.8 Hz, 1H), 3.89 (d, J = 6.5 Hz, 2H), 3.38 – 3.32 (m, 2H), 2.05 (d, J = 1.4 Hz, 3H), 1.82 (p, J = 3.1 Hz, 4H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 162.8, 136.6, 134.6, 129.8, 105.7, 48.7, 32.9, 29.6, 27.8, 17.1 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_{10}\text{H}_{15}\text{BrNO}$ $[\text{M}+\text{H}]^+$, 244.0331; found, 244.0332.

5-Bromo-1-(4-bromobutyl)-3-methylpyridin-2(1H)-one (4c)



Physical state: yellow oil;

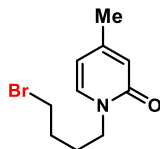
R_f = 0.5 (silica gel, PE: EtOAc = 2:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 7.28 (s, 1H), 7.26 (s, 1H), 3.95 – 3.93 (m, 2H), 3.46 – 3.44 (m, 2H), 2.14 (d, J = 1.2 Hz, 3H), 1.92 – 1.90 (m, 4H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 161.6, 139.6, 134.5, 131.9, 97.8, 49.2, 32.9, 29.7, 28.0, 17.4 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_{10}\text{H}_{14}\text{Br}_2\text{NO}$ $[\text{M}+\text{H}]^+$, 321.9436; found, 321.9437.

1-(4-Bromobutyl)-4-methylpyridin-2(1H)-one (4d)



Physical state: yellow oil;

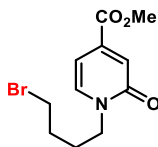
R_f = 0.5 (silica gel, PE: EtOAc = 2:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ) 7.11 (d, J = 6.9 Hz, 1H), 6.35 (s, 1H), 6.01 (dd, J = 7.0, 1.9 Hz, 1H), 3.90 (d, J = 5.5 Hz, 2H), 3.20 – 3.18 (m, 2H), 2.15 (s, 3H), 1.85 – 1.83 (m, 4H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 162.7, 151.2, 136.3, 119.6, 108.8, 48.1, 30.4, 21.3, 5.9 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_{10}\text{H}_{15}\text{BrNO}$ $[\text{M}+\text{H}]^+$, 244.0331; found, 244.0332.

Methyl 1-(4-bromobutyl)-2-oxo-1,2-dihydropyridine-4-carboxylate (4e)



Physical state: white solid;

Melting point: 82°C;

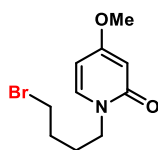
R_f = 0.3 (silica gel, PE: EtOAc = 1:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.32 (d, *J* = 6.6 Hz, 1H), 7.17 (d, *J* = 1.8 Hz, 1H), 6.65 (dd, *J* = 7.0, 1.9 Hz, 1H), 3.98 – 3.94 (m, 2H), 3.89 (s, 3H), 3.42 (t, *J* = 6.0 Hz, 2H), 1.93 – 1.89 (m, 4H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 165.1, 162.3, 140.6, 137.8, 122.9, 104.7, 52.9, 49.0, 32.8, 29.6, 27.9 ppm.

HRMS-ESI (m/z) calc'd for C₁₁H₁₅NO [M+H]⁺, 288.0229; found, 288.0230.

1-(4-Bromobutyl)-4-methoxypyridin-2(1*H*)-one (4f)



Physical state: yellow oil;

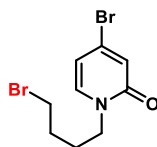
R_f = 0.3 (silica gel, PE: EtOAc = 2:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.09 (d, *J* = 7.4 Hz, 1H), 5.90 (dd, *J* = 7.4, 2.6 Hz, 1H), 5.88 (d, *J* = 2.7 Hz, 1H), 3.89 (t, *J* = 6.6 Hz, 2H), 3.75 (s, 3H), 3.44 – 3.42 (m, 2H), 1.89 – 1.86 (m, 4H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 168.1, 164.2, 137.2, 101.1, 97.5, 55.6, 47.9, 33.1, 29.7, 28.2 ppm.

HRMS-ESI (m/z) calc'd for C₁₀H₁₅BrNO₂ [M+H]⁺, 260.0281; found, 260.0281.

4-Bromo-1-(4-bromobutyl)pyridin-2(1*H*)-one (4g)



Physical state: yellow oil;

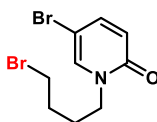
R_f = 0.5 (silica gel, PE: EtOAc = 1:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.10 (d, *J* = 7.3 Hz, 1H), 6.71 (d, *J* = 2.2 Hz, 1H), 6.27 (dd, *J* = 7.3, 2.2 Hz, 1H), 3.86 – 3.83 (m, 2H), 3.35 (t, *J* = 3.5 Hz, 2H), 1.81 (q, *J* = 3.5 Hz, 4H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 161.2, 137.2, 135.3, 122.9, 110.4, 48.4, 32.8, 29.4, 27.7 ppm.

HRMS-ESI (m/z) calc'd for C₉H₁₂Br₂NO [M+H]⁺, 307.9276; found, 307.9280.

5-Bromo-1-(4-bromobutyl)pyridin-2(1*H*)-one (4h)



Physical state: yellow oil;

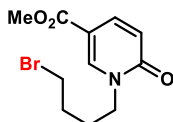
R_f = 0.5 (silica gel, PE: EtOAc = 1:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 7.37 (t, J = 2.1 Hz, 1H), 7.32 (d, J = 9.6 Hz, 1H), 6.46 (dd, J = 9.6, 5.4 Hz, 1H), 3.91 (t, J = 3.6 Hz, 2H), 3.42 – 3.41 (m, 2H), 1.89 (dd, J = 5.7, 3.1 Hz, 4H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 161.1, 142.5, 137.2, 122.4, 98.1, 49.0, 32.8, 29.5, 28.0 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_9\text{H}_{12}\text{Br}_2\text{NO}$ $[\text{M}+\text{H}]^+$, 307.9276; found, 307.9280.

Methyl 1-(4-bromobutyl)-6-oxo-1,6-dihydropyridine-3-carboxylate (4i)



Physical state: white solid;

Melting point: 74°C;

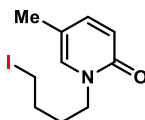
R_f = 0.3 (silica gel, PE: EtOAc = 1:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 8.14 (d, J = 2.5 Hz, 1H), 7.82 (dd, J = 9.5, 2.5 Hz, 1H), 6.52 (d, J = 9.5 Hz, 1H), 3.99 (t, J = 6.8 Hz, 2H), 3.85 (s, 3H), 3.43 (t, J = 6.1 Hz, 2H), 1.92 (dh, J = 8.1, 3.7 Hz, 4H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 164.8, 162.5, 142.7, 138.6, 120.0, 110.1, 52.2, 49.5, 32.7, 29.6, 28.1 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_{11}\text{H}_{14}\text{BrNNaO}_3$ $[\text{M}+\text{Na}]^+$, 310.0051; found, 310.0049.

1-(4-Iodobutyl)-5-methylpyridin-2(1H)-one (4j)



Physical state: yellow oil;

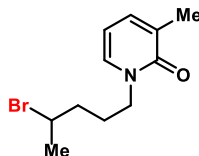
R_f = 0.3 (silica gel, PE: EtOAc = 2:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 7.16 (dd, J = 9.2, 2.6 Hz, 1H), 7.00 (s, 1H), 6.49 (d, J = 9.2 Hz, 1H), 3.92 – 3.89 (m, 2H), 3.20 (d, J = 6.8 Hz, 2H), 2.07 (s, 3H), 1.85 (p, J = 3.4 Hz, 4H) ppm.

^{13}C NMR (100 MHz, CDCl_3 , 23°C , δ): 162.0, 142.1, 134.8, 120.9, 115.2, 48.4, 30.4, 17.2, 6.0 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_{10}\text{H}_{14}\text{NNaO}$ [$\text{M}+\text{Na}$] $^+$, 314.0010; found, 314.0012.

1-(4-Bromopentyl)-3-methylpyridin-2(1H)-one (4k)



Physical state: yellow oil;

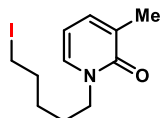
R_f = 0.5 (silica gel, PE: EtOAc = 2:1, v/v);

^1H NMR (600 MHz, CDCl_3 , 23°C , δ): 7.12 (d, J = 6.9 Hz, 1H), 7.09 – 7.07 (m, 2H), 6.02 (dd, J = 8.0, 6.0 Hz, 1H), 4.09 – 4.05 (m, 1H), 3.92 (dq, J = 12.1, 5.1 Hz, 1H), 3.88 – 3.83 (m, 1H), 2.07 – 2.05 (m, 3H), 1.94 – 1.87 (m, 1H), 1.84 – 1.79 (m, 1H), 1.79 – 1.72 (m, 2H), 1.63 – 1.61 (m, 3H) ppm.

^{13}C NMR (100 MHz, CDCl_3 , 23°C , δ): 162.7, 105.6, 136.5, 134.6, 129.7, 50.7, 48.8, 37.7, 27.5, 26.3, 17.1 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_{11}\text{H}_{16}\text{BrNNaO}$ [$\text{M}+\text{Na}$] $^+$, 280.0311; found 280.0307.

1-(5-Iodopentyl)-3-methylpyridin-2(1H)-one (4l)



Physical state: yellow oil;

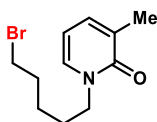
R_f = 0.5 (silica gel, PE: EtOAc = 2:1, v/v);

^1H NMR (600 MHz, CDCl_3 , 23°C , δ): 7.19 – 7.15 (m, 1H), 7.12 (dd, J = 6.8, 2.0 Hz, 1H), 6.07 (t, J = 6.7 Hz, 1H), 3.91 (t, J = 7.4 Hz, 2H), 3.17 (t, J = 6.9 Hz, 2H), 2.12 (s, 3H), 1.84 (p, J = 7.0 Hz, 2H), 1.75 (p, J = 7.6 Hz, 2H), 1.44 (qd, J = 9.0, 6.2 Hz, 2H) ppm.

^{13}C NMR (100 MHz, CDCl_3 , 23°C , δ): 163.0, 136.7, 134.9, 130.1, 105.7, 49.9, 33.0, 28.2, 27.6, 17.4, 6.7 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_{11}\text{H}_{17}\text{INO}$ [$\text{M}+\text{H}$] $^+$, 306.0346; found, 306.0349.

1-(5-Bromopentyl)-3-methylpyridin-2(1H)-one (4l')



Physical state: yellow oil;

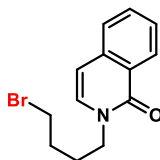
R_f = 0.5 (silica gel, PE: EtOAc = 2:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 7.17 (d, J = 6.3 Hz, 1H), 7.12 (d, J = 6.2 Hz, 1H), 6.07 (t, J = 6.7 Hz, 1H), 3.92 (t, J = 7.4 Hz, 2H), 3.39 (t, J = 6.7 Hz, 2H), 2.13 (s, 3H), 1.91 – 1.86 (m, 2H), 1.77 (p, J = 7.7 Hz, 2H), 1.49 (p, J = 7.6 Hz, 2H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 163.0, 136.7, 134.9, 130.1, 105.7, 50.0, 33.6, 32.3, 28.4, 25.3, 17.4 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_{11}\text{H}_{17}\text{BrNO}$ $[\text{M}+\text{H}]^+$, 258.0478; found, 258.0488.

2-(4-Bromobutyl)isoquinolin-1(2H)-one (4n)



Physical state: yellow oil;

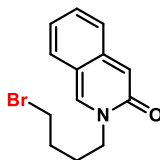
R_f = 0.3 (silica gel, PE: EtOAc = 5:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 8.42 (d, J = 8.0 Hz, 1H), 7.63 (t, J = 7.1 Hz, 1H), 7.52 – 7.47 (m, 2H), 7.06 (d, J = 7.3 Hz, 1H), 6.51 (d, J = 7.3 Hz, 1H), 4.07 – 4.03 (m, 2H), 3.45 (t, J = 6.1 Hz, 2H), 1.95 (q, J = 4.1 Hz, 4H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 162.3, 137.1, 132.3, 131.5, 128.0, 127.0, 126.4, 126.0, 106.4, 48.3, 33.2, 29.8, 28.1 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_{13}\text{H}_{15}\text{BrNO}$ $[\text{M}+\text{H}]^+$, 280.0322; found, 280.0305.

2-(4-Bromobutyl)isoquinolin-3(2H)-one (4o)



Physical state: White solid;

Melting point: 77°C;

R_f = 0.5 (silica gel, PE: EtOAc = 2:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C , δ): 8.94 (s, 1H), 7.88 (d, $J = 8.2$ Hz, 1H), 7.68 (d, $J = 8.4$ Hz, 1H), 7.57 (t, $J = 7.5$ Hz, 1H), 7.37 (t, $J = 7.5$ Hz, 1H), 6.99 (s, 1H), 4.39 (t, $J = 6.2$ Hz, 2H), 3.52 (t, $J = 6.7$ Hz, 2H), 2.12 (p, $J = 6.8$ Hz, 2H), 2.02 (h, $J = 7.3$ Hz, 2H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C , δ): 161.1, 150.9, 139.4, 130.6, 127.8, 125.7, 125.4, 124.5, 101.6, 65.9, 33.7, 29.7, 28.1 ppm.

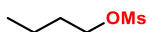
HRMS-ESI (m/z) calc'd for $\text{C}_{13}\text{H}_{15}\text{BrNO}$ $[\text{M}+\text{H}]^+$, 280.0322; found, 280.0305.

Synthesis of material (2)^[15]



Step 1: S4 and Et_3N (2.0 equiv.) were dissolved in 3mL CH_2Cl_2 , then added MsCl (1.1 equiv.). The resulting mixture was stirred for 3h at room temperature. 20 ml water was added to the mixture and then the mixture was extracted with CH_2Cl_2 (50 mL x 3), an organic layer washed with water (50 mL), dried over Na_2SO_4 , and concentrated in vacuo to afford the compounds 2a''.

Butyl methyl sulfate (2a'')



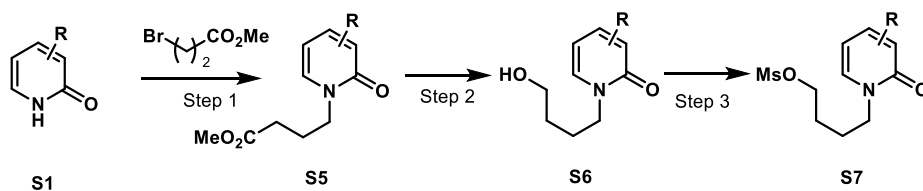
Physical state: yellow oil;

$R_f = 0.3$ (silica gel, PE: EtOAc = 50:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C , δ): 4.22 (t, $J = 6.7$ Hz, 2H), 2.99 (d, $J = 1.1$ Hz, 3H), 1.74 – 1.69 (m, 2H), 1.43 (h, $J = 7.4$ Hz, 2H), 0.96 – 0.92 (m, 3H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C , δ): 70.0, 37.5, 31.2, 18.8, 13.6 ppm.

Synthesis of material (3)^[13-15]

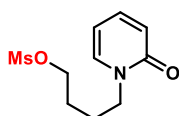


Step 1: 500 mg of S1 was dissolved in 3mL DMF. NaH (1.1 equiv.) Was added to DMF to form a suspension and slowly added dropwise at 0°C for 30 minutes. Methyl 4-bromobutanoate (1.5 equiv.) was added and the resulting mixture was stirred overnight at room temperature. 20 ml water was added to the mixture and then the mixture was extracted with CH_2Cl_2 (50 mL x 3), an organic layer washed with water (50 mL), dried over Na_2SO_4 , and concentrated in vacuo to afford the compounds S5.

Step 2: S5 and NaBH₄ (6.0 equiv.) were dissolved in MeOH. The resulting mixture was stirred overnight at room temperature. 20 ml water was added to the mixture and then the mixture was extracted with CH₂Cl₂ (50 mL x 3), an organic layer washed with water (50 mL), dried over Na₂SO₄, and concentrated in vacuo to afford the compounds S6.

Step 3: S6 and Et₃N (2.0 equiv.) were dissolved in 3mL CH₂Cl₂, then added MsCl (1.1 equiv.). The resulting mixture was stirred for 3h at room temperature. 20 ml water was added to the mixture and then the mixture was extracted with CH₂Cl₂ (50 mL x 3), an organic layer washed with water (50 mL), dried over Na₂SO₄, and concentrated in vacuo to afford the compounds S7.

Methyl (4-(2-oxopyridin-1(2H)-yl)butyl) sulfate (4a')



Physical state: yellow oil;

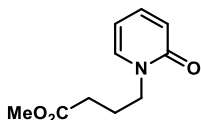
R_f = 0.3 (silica gel, EtOAc, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.30 (t, *J* = 7.7 Hz, 1H), 7.27 (d, *J* = 6.7 Hz, 1H), 6.51 (d, *J* = 9.1 Hz, 1H), 6.16 (t, *J* = 6.7 Hz, 1H), 4.25 (t, *J* = 6.2 Hz, 2H), 3.95 (t, *J* = 7.2 Hz, 2H), 3.00 (s, 3H), 1.89 – 1.85 (m, 2H), 1.80 – 1.76 (m, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 162.5, 139.5, 137.4, 120.9, 106.2, 69.4, 48.7, 37.2, 26.1, 25.3 ppm.

HRMS-ESI (m/z) calc'd for C₁₀H₁₅NNaO₄S [M+Na]⁺, 268.0615; found, 268.0614.

Methyl 4-(2-oxopyridin-1(2H)-yl)butanoate (4p)



Physical state: yellow oil;

R_f = 0.4 (silica gel, PE: EtOAc = 1:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.29 (ddd, *J* = 8.8, 6.5, 2.0 Hz, 1H), 7.25 (s, 1H), 6.54 (d, *J* = 9.1 Hz, 1H), 6.14 (t, *J* = 7.3 Hz, 1H), 3.97 (t, *J* = 7.2 Hz, 2H), 3.66 (s, 3H), 2.37 (t, *J* = 7.2 Hz, 2H), 2.07 (q, *J* = 7.2 Hz, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 173.4, 162.8, 139.6, 137.7, 121.3, 106.2, 51.9, 48.9, 30.8, 24.5 ppm.

HRMS-ESI (m/z) calc'd for C₁₀H₁₃NNaO₃ [M+Na]⁺, 218.0788; found, 218.0788.

Methyl (4-(5-methyl-2-oxopyridin-1(2H)-yl)butyl) sulfate (4j')



Physical state: yellow oil;

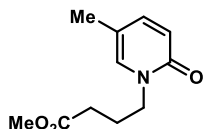
R_f = 0.4 (silica gel, EtOAc, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.14 (d, *J* = 8.2 Hz, 1H), 6.99 (s, 1H), 6.44 (d, *J* = 9.3 Hz, 1H), 4.22 (t, *J* = 6.2 Hz, 2H), 3.89 (t, *J* = 7.2 Hz, 2H), 2.97 (s, 3H), 2.02 (s, 3H), 1.82 (p, *J* = 7.1 Hz, 2H), 1.78 – 1.72 (m, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 161.9, 142.2, 134.8, 120.6, 115.4, 69.4, 48.6, 37.3, 26.2, 25.5, 17.1 ppm.

HRMS-ESI (m/z) calc'd for C₁₁H₁₇NNaO₄S [M+Na]⁺, 282.0769; found, 282.0770.

Methyl 4-(5-methyl-2-oxopyridin-1(2H)-yl)butanoate (4q)



Physical state: yellow oil;

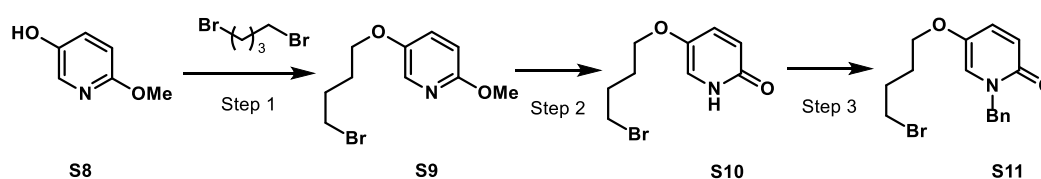
R_f = 0.4 (silica gel, PE: EtOAc = 1:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.17 (dd, *J* = 9.2, 2.5 Hz, 1H), 7.04 – 7.03 (m, 1H), 6.50 (d, *J* = 9.2 Hz, 1H), 3.94 (t, *J* = 7.3 Hz, 2H), 3.68 (s, 3H), 2.38 (t, *J* = 7.2 Hz, 2H), 2.06 (d, *J* = 4.3 Hz, 3H), 1.30 – 1.22 (m, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 173.5, 162.0, 142.2, 135.1, 120.9, 115.2, 51.9, 48.7, 30.9, 24.6, 17.2 ppm.

HRMS-ESI (m/z) calc'd for C₁₁H₁₅NNaO₃ [M+Na]⁺, 232.0945; found, 232.0944.

Synthesis of material (4)^[16-17]



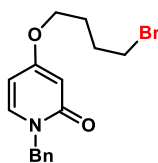
Step 1: 500 mg of **S8** was dissolved in 3mL DMF. NaH (1.1 equiv.) Was added to DMF to form a suspension and slowly added dropwise at 0°C for 30 minutes. 1,4-

Dibromobutane (1.5 equiv.) was added and the resulting mixture was stirred overnight at room temperature. 20 ml water was added to the mixture and then the mixture was extracted with CH₂Cl₂ (50 mL x 3), an organic layer washed with water (50 mL), dried over Na₂SO₄, and concentrated in vacuo to afford the compounds **S9**.

Step 2: **S9** was dissolved in 20 ml of solvent (HCl:Dioxane = 1:1). And was stirred for 3h at 100°C. 20 ml water was added to the mixture and then the mixture was extracted with CH₂Cl₂ (50 mL x 3), an organic layer washed with water (50 mL), dried over Na₂SO₄, and concentrated in vacuo to afford the compounds **S10**.

Step 3: **S10** and K₂CO₃ (2.0 equiv.) were dissolved in 3mL acetone, then added BrBn. The resulting mixture was stirred overnight at room temperature. 20 ml water was added to the mixture and then the mixture was extracted with CH₂Cl₂ (50 mL x 3), an organic layer washed with water (50 mL), dried over Na₂SO₄, and concentrated in vacuo to afford the compounds **S11**.

1-Benzyl-4-(4-bromobutoxy)pyridin-2(1H)-one (2e)



Physical state: yellow oil;

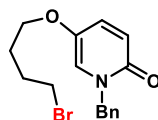
R_f = 0.4 (silica gel, PE: EtOAc = 2:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.32 (t, *J* = 7.3 Hz, 2H), 7.27 – 7.25 (m, 3H), 7.12 (d, *J* = 7.5 Hz, 1H), 5.91 (s, 1H), 5.87 (d, *J* = 8.0 Hz, 1H), 5.08 (s, 2H), 3.94 (t, *J* = 6.1 Hz, 2H), 3.45 (t, *J* = 6.6 Hz, 2H), 2.04 – 1.99 (m, 2H), 1.95 – 1.89 (m, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 167.1, 137.2, 136.7, 128.8, 127.9, 127.9, 101.3, 97.9, 67.2, 51.0, 33.1, 29.3, 27.4 ppm.

HRMS-ESI (m/z) calc'd for C₁₆H₁₉BrNO₂ [M+H]⁺, 336.0596; found, 336.0594.

1-Benzyl-5-(4-bromobutoxy)pyridin-2(1H)-one (4m)



Physical state: scarlet oil;

R_f = 0.3 (silica gel, PE: EtOAc = 1:1, v/v);

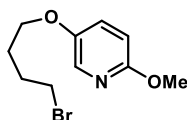
¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.34 (t, *J* = 7.4 Hz, 2H), 7.29 (dd, *J* = 12.6, 7.2 Hz, 3H), 7.16 (dd, *J* = 9.8, 3.2 Hz, 1H), 6.74 (d, *J* = 3.2 Hz, 1H), 6.60 (d, *J* = 9.8 Hz,

1H), 5.11 (s, 2H), 3.73 (t, $J = 6.1$ Hz, 2H), 3.43 (t, $J = 6.6$ Hz, 2H), 2.02 – 1.96 (m, 2H), 1.87 – 1.82 (m, 2H) ppm.

^{13}C NMR (100 MHz, CDCl_3 , 23°C, δ): 160.8, 142.5, 136.5, 134.3, 129.0, 128.1, 122.1, 119.4, 68.7, 52.2, 33.4, 29.3, 27.8 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_{16}\text{H}_{19}\text{BrNO}_2$ $[\text{M}+\text{H}]^+$, 336.0593; found, 336.0594.

5-(4-Bromobutoxy)-2-methoxypyridine (4r)



Physical state: yellow oil;

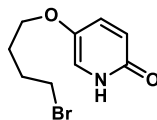
$R_f = 0.6$ (silica gel, PE: EtOAc = 30:1, v/v);

^1H NMR (600 MHz, CDCl_3 , 23°C, δ): 7.75 (d, $J = 3.1$ Hz, 1H), 7.15 (dd, $J = 9.0, 3.1$ Hz, 1H), 6.64 (d, $J = 8.9$ Hz, 1H), 3.93 (t, $J = 6.1$ Hz, 2H), 3.84 (s, 3H), 3.44 (t, $J = 6.7$ Hz, 2H), 2.02 (dt, $J = 14.8, 6.8$ Hz, 2H), 1.88 (dt, $J = 12.6, 6.3$ Hz, 2H) ppm.

^{13}C NMR (100 MHz, CDCl_3 , 23°C, δ): 158.8, 150.3, 131.8, 127.3, 111.1, 68.1, 53.5, 33.4, 29.4, 28.0 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_{10}\text{H}_{15}\text{BrNO}_2$ $[\text{M}+\text{H}]^+$, 260.0281; found, 260.0281.

5-(4-Bromobutoxy)pyridin-2(1H)-one (4s)



Physical state: white solid;

Melting point: 88°C;

$R_f = 0.3$ (silica gel, EtOAc = 1:1, v/v);

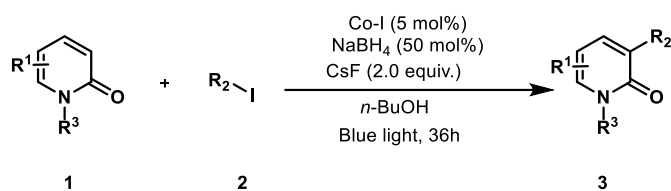
^1H NMR (600 MHz, CDCl_3 , 23°C, δ): 7.30 (d, $J = 6.9$ Hz, 1H), 6.94 (d, $J = 3.1$ Hz, 1H), 6.57 (d, $J = 9.7$ Hz, 1H), 3.82 (t, $J = 6.0$ Hz, 2H), 3.46 (t, $J = 6.6$ Hz, 2H), 2.03 (p, $J = 6.7$ Hz, 2H), 1.93 – 1.88 (m, 2H) ppm.

^{13}C NMR (100 MHz, CDCl_3 , 23°C, δ): 143.7, 136.1, 116.6, 68.6, 33.3, 29.4, 27.9 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_9\text{H}_{13}\text{BrNO}_2$ $[\text{M}+\text{H}]^+$, 246.0124; found, 246.0124.

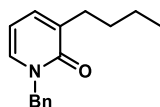
5. Experimental procedure and characterization for the synthesis

General procedure for synthesis of 3.



Under the argon atmosphere, a 4-mL borosilicate vial equipped with a magnetic stir bar was charged with Co(*n*-butylamine)(dmgH)₂Br (6.9 mg, 5 mol%). *n*-BuOH (500 μ L, $c = 0.40$ M) and CsF (60.8 mg, 2.0 equiv.) were added into the vial. Then **1** (0.2 mmol) and **2** (0.4 mmol) were added into the same vial. The vial was sealed with a septum cap. The reaction mixture that was irradiated with the white LED (2*5W) was stirred at approximately 30°C with the use of a cooling fan for 36 hours. Then the reaction mixture was transferred to a flask with ethyl acetate, and the volatiles were removed under vacuo. The residues were then purified by flash column chromatography on silica gel, eluting with hexanes to afford **3**.

1-Benzyl-3-butylpyridin-2(1H)-one (**3a**)



Physical state: colorless oil;

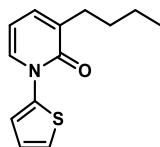
$R_f = 0.5$ (silica gel, PE: EtOAc = 5:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.31 (q, $J = 7.0$ Hz, 5H), 7.15 (d, $J = 6.8$ Hz, 2H), 6.09 (t, $J = 6.8$ Hz, 1H), 5.14 (s, 2H), 2.58 – 2.52 (m, 2H), 1.61 – 1.53 (m, 2H), 1.39 (q, $J = 7.4$ Hz, 2H), 0.93 (t, $J = 7.3$ Hz, 3H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 136.8, 135.8, 134.6, 134.5, 129.0, 128.3, 128.0, 106.0, 52.4, 30.8, 30.6, 22.8, 14.1 ppm.

HRMS-EI (m/z) calc'd for C₁₆H₂₀NO [M+H]⁺, 242.1538; found, 242.1539.

3-Butyl-1-(thiophen-2-yl)pyridin-2(1H)-one (**3b**)



Physical state: white solid;

Melting point: 81°C;

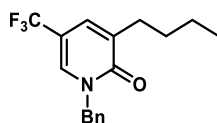
$R_f = 0.4$ (silica gel, PE: EtOAc = 5:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.32 (dd, *J* = 3.2, 1.4 Hz, 1H), 7.27 (dd, *J* = 5.2, 3.3 Hz, 1H), 7.21 (dd, *J* = 6.9, 2.0 Hz, 1H), 7.18 (t, *J* = 2.6 Hz, 1H), 7.12 (ddt, *J* = 6.8, 2.0, 1.0 Hz, 1H), 6.08 (t, *J* = 6.8 Hz, 1H), 2.50 – 2.44 (m, 2H), 1.50 (dq, *J* = 9.2, 7.6 Hz, 2H), 1.30 (h, *J* = 7.4 Hz, 2H), 0.85 (t, *J* = 7.3 Hz, 3H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 162.2, 139.4, 140.0, 136.0, 135.2, 135.1, 125.3, 119.7, 105.9, 30.9, 30.5, 22.7, 14.1 ppm.

HRMS-EI (*m/z*) calc'd for C₁₂H₁₅NNaOS [M+Na]⁺, 256.0762; found, 256.0767.

1-Benzyl-3-butyl-5-(trifluoromethyl)pyridin-2(1*H*)-one (3c)



Physical state: white solid;

Melting point: 87°C;

R_f = 0.4 (silica gel, PE: EtOAc = 5:1, v/v);

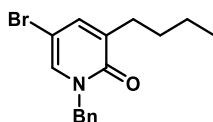
¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.48 (dd, *J* = 2.8, 1.4 Hz, 1H), 7.32 – 7.27 (m, 2H), 7.25 – 7.18 (m, 4H), 5.08 (s, 2H), 2.54 – 2.47 (m, 2H), 1.51 (dd, *J* = 15.3, 7.8 Hz, 2H), 1.33 (h, *J* = 7.4 Hz, 2H), 0.88 (t, *J* = 7.4 Hz, 3H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): δ 161.2, 134.5 (2C), 132.8 (q, *J* = 5.5 Hz), 129.8 (q, *J* = 5.6 Hz), 128.0, 127.4, 127.2, 122.5 (q, *J* = 269.7 Hz), 108.4 (q, *J* = 34.4 Hz), 51.9, 29.6, 29.1, 21.5, 12.9 ppm.

¹⁹F NMR (565 MHz, CDCl₃, 23°C, δ): -62.4 ppm.

HRMS-EI (*m/z*) calc'd for C₁₇H₁₉NOF₃ [M+H]⁺, 310.1413; found, 310.1413.

1-Benzyl-5-bromo-3-butylpyridin-2(1*H*)-one (3d)



Physical state: light yellow liquid;

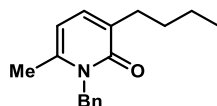
R_f = 0.4 (silica gel, PE: EtOAc = 5:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.31 – 7.25 (m, 2H), 7.25 – 7.18 (m, 4H), 7.12 (dd, *J* = 2.5, 1.3 Hz, 1H), 5.03 (s, 2H), 2.47 (t, *J* = 7.8 Hz, 2H), 1.55 – 1.45 (m, 2H), 1.32 (h, *J* = 7.4 Hz, 2H), 0.87 (t, *J* = 7.3 Hz, 3H) ppm.

^{13}C NMR (100 MHz, CDCl_3 , 23°C, δ): 161.2, 138.7, 136.3, 136.1, 134.2, 129.1, 128.4 (2), 98.2, 52.5, 30.7, 30.3, 22.7, 14.1 ppm.

HRMS-EI (m/z) calc'd for $\text{C}_{16}\text{H}_{19}\text{NOBr}$ $[\text{M}+\text{H}]^+$, 320.0643; found, 320.0645.

1-Benzyl-3-butyl-6-methylpyridin-2(1H)-one (3e)



Physical state: colorless oil;

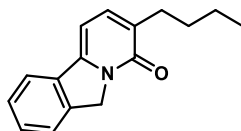
R_f = 0.5 (silica gel, PE: EtOAc = 5:1, v/v);

^1H NMR (600 MHz, CDCl_3 , 23°C, δ): 7.31 – 7.28 (m, 2H), 7.23 (td, J = 7.1, 1.4 Hz, 1H), 7.15 – 7.09 (m, 3H), 5.97 (dd, J = 6.9, 1.2 Hz, 1H), 5.36 (s, 2H), 2.57 – 2.52 (m, 2H), 2.25 (s, 3H), 1.61 – 1.57 (m, 2H), 1.41 – 1.37 (m, 2H), 0.95 – 0.92 (m, 3H) ppm.

^{13}C NMR (100 MHz, CDCl_3 , 23°C, δ): 164.1, 150.7, 139.2, 136.9, 128.9, 127.3, 126.4, 117.8, 105.9, 46.6, 33.0, 31.4, 28.4, 22.4, 14.0 ppm.

HRMS-EI (m/z) calc'd for $\text{C}_{17}\text{H}_{22}\text{NO}$ $[\text{M}+\text{H}]^+$, 256.1691; found, 256.1696.

3-Butylpyrido[2,1-a]isoindol-4(6H)-one (3f)



Physical state: white solid;

Melting point: 105°C;

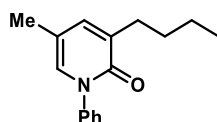
R_f = 0.2 (silica gel, PE: EtOAc = 10:1, v/v);

^1H NMR (600 MHz, CDCl_3 , 23°C, δ): 7.61 – 7.58 (m, 1H), 7.47 – 7.45 (m, 1H), 7.36 – 7.32 (m, 2H), 7.13 (s, 1H), 6.55 (d, J = 6.8 Hz, 1H), 5.01 (s, 2H), 2.52 (t, J = 7.9 Hz, 2H), 1.50 (d, J = 6.9 Hz, 2H), 1.29 (dt, J = 14.9, 7.4 Hz, 2H), 0.82 (t, J = 7.3 Hz, 3H) ppm.

^{13}C NMR (100 MHz, CDCl_3 , 23°C, δ): 161.7, 145.6, 137.9, 136.7, 134.2, 131.2, 129.8, 128.4, 123.5, 121.0, 98.4, 52.7, 31.0, 30.2, 22.7, 14.1 ppm.

HRMS-EI (m/z) calc'd for $\text{C}_{16}\text{H}_{17}\text{NNaO}$ $[\text{M}+\text{Na}]^+$, 262.1202; found, 262.1202.

3-Butyl-5-methyl-1-phenylpyridin-2(1H)-one (3g)



Physical state: yellow oil;

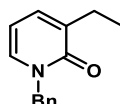
R_f = 0.4 (silica gel, PE: EtOAc = 5:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 7.48 – 7.43 (m, 2H), 7.40 – 7.34 (m, 3H), 7.11 (d, J = 2.5 Hz, 1H), 7.01 (dd, J = 2.6, 1.3 Hz, 1H), 2.58 – 2.51 (m, 2H), 2.08 (s, 3H), 1.64 – 1.56 (m, 2H), 1.39 (q, J = 7.4 Hz, 2H), 0.94 (t, J = 7.3 Hz, 3H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 161.8, 139.1, 134.5, 132.7, 129.2, 128.1, 126.8, 114.5, 30.8, 30.6, 22.8, 17.4, 14.1 ppm.

HRMS-EI (m/z) calc'd for $\text{C}_{16}\text{H}_{20}\text{NO}$ $[\text{M}+\text{H}]^+$, 242.1539; found, 242.1539.

1-Benzyl-3-ethylpyridin-2(1H)-one (3h)



Physical state: yellow oil;

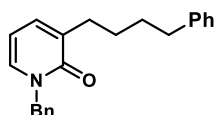
R_f = 0.4 (silica gel, PE: EtOAc = 5:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 7.35 – 7.33 (m, 1H), 7.33 – 7.32 (m, 1H), 7.31 – 7.28 (m, 3H), 7.16 (d, J = 6.8 Hz, 2H), 6.11 (t, J = 6.8 Hz, 1H), 5.16 (s, 2H), 2.59 (q, J = 7.5 Hz, 2H), 1.19 (d, J = 7.5 Hz, 3H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 162.7, 136.7, 135.7, 134.7, 134.4, 128.8, 128.2, 127.9, 105.9, 52.2, 23.8, 12.5 ppm.

HRMS-EI (m/z) calc'd for $\text{C}_{14}\text{H}_{15}\text{NNaO}$ $[\text{M}+\text{Na}]^+$, 236.1046; found, 236.1046.

1-Benzyl-3-(5-phenylpentyl)pyridin-2(1H)-one (3i)



Physical state: yellow oil;

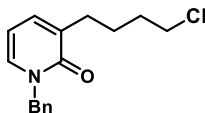
R_f = 0.6 (silica gel, PE: EtOAc = 5:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 7.27 – 7.23 (m, 2H), 7.23 – 7.17 (m, 5H), 7.11 – 7.05 (m, 5H), 6.01 (t, J = 6.9 Hz, 1H), 5.08 – 5.07 (m, 2H), 2.57 (d, J = 7.7 Hz, 2H), 2.51 (d, J = 7.2 Hz, 2H), 1.60 (h, J = 7.7 Hz, 4H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 162.8, 142.8, 136.8, 136.0, 134.7, 134.2, 128.9, 128.6, 128.4, 128.3, 128.0, 125.7, 106.0, 52.4, 35.9, 31.5, 30.9, 28.1 ppm.

HRMS-EI (m/z) calc'd for C₂₂H₂₄NO [M+H]⁺, 318.1851; found, 318.1852.

1-Benzyl-3-(4-chlorobutyl)pyridin-2(1H)-one (3j)



Physical state: yellow oil;

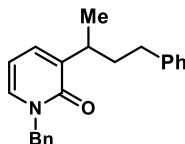
R_f = 0.3 (silica gel, PE: EtOAc = 5:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.35 – 7.32 (m, 2H), 7.31 – 7.28 (m, 3H), 7.18 (d, *J* = 7.0 Hz, 2H), 6.10 (t, *J* = 6.8 Hz, 1H), 5.15 (s, 2H), 3.57 (t, *J* = 6.6 Hz, 2H), 2.58 (t, *J* = 7.6 Hz, 2H), 1.87 – 1.82 (m, 2H), 1.78 – 1.72 (m, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 162.7, 136.7, 136.1, 135.0, 133.6, 129.0, 128.3, 128.1, 105.9, 52.4, 45.1, 32.5, 30.3, 25.7 ppm.

HRMS-EI (m/z) calc'd for C₁₆H₁₉ClNO [M+H]⁺, 276.1149; found, 276.1150

1-Benzyl-3-(5-phenylpentan-2-yl)pyridin-2(1H)-one (3k)



Physical state: yellow oil;

R_f = 0.6 (silica gel, PE: EtOAc = 5:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.31 (t, *J* = 7.5 Hz, 2H), 7.27 (d, *J* = 7.3 Hz, 3H), 7.24 – 7.20 (m, 3H), 7.13 (d, *J* = 7.5 Hz, 4H), 6.10 (t, *J* = 6.8 Hz, 1H), 5.14 (q, *J* = 14.5 Hz, 2H), 3.19 (p, *J* = 7.0 Hz, 1H), 2.62 (dq, *J* = 15.8, 5.5 Hz, 1H), 2.53 (td, *J* = 12.5, 5.4 Hz, 1H), 1.95 (td, *J* = 12.4, 6.2 Hz, 1H), 1.75 (tt, *J* = 12.6, 6.3 Hz, 1H), 1.21 (t, *J* = 8.2 Hz, 3H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 162.5, 142.9, 138.8, 136.8, 134.6, 134.1, 129.0, 128.5, 128.4, 128.3, 128.0, 125.7, 106.1, 52.5, 38.1, 34.1, 33.3, 20.0 ppm.

HRMS-EI (m/z) calc'd for C₂₂H₂₄NO [M+H]⁺, 318.1851; found, 318.1852.

1-Benzyl-3-cyclopentylpyridin-2(1H)-one (3l)



Physical state: yellow oil;

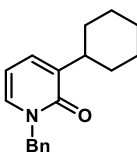
R_f = 0.5 (silica gel, PE: EtOAc = 5:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 7.35 – 7.32 (m, 2H), 7.31 – 7.27 (m, 3H), 7.18 (dd, J = 6.9, 2.0 Hz, 1H), 7.14 (dd, J = 6.8, 2.0 Hz, 1H), 6.10 (t, J = 6.8 Hz, 1H), 5.15 (s, 2H), 3.28 – 3.22 (m, 1H), 2.05 (dq, J = 13.0, 5.2 Hz, 2H), 1.75 (qd, J = 10.7, 5.7 Hz, 2H), 1.71 – 1.65 (m, 2H), 1.49 (dq, J = 11.6, 8.5 Hz, 2H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 162.8, 137.9, 136.9, 134.3, 133.3, 128.9, 128.30, 128.0, 105.9, 52.4, 40.4, 32.1, 25.3 ppm.

HRMS-EI (m/z) calc'd for $\text{C}_{17}\text{H}_{20}\text{NO}$ $[\text{M}+\text{H}]^+$, 254.1539; found, 254.1538.

1-Benzyl-3-cyclohexylpyridin-2(1H)-one (3m)



Physical state: yellow oil;

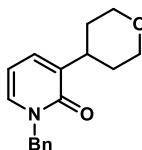
R_f = 0.5 (silica gel, PE: EtOAc = 5:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 7.35 - 7.32 (m, 2H), 7.31 – 7.28 (m, 3H), 7.15 (dd, J = 6.8, 2.0 Hz, 1H), 7.12 (dd, J = 6.9, 2.0 Hz, 1H), 6.12 (t, J = 6.8 Hz, 1H), 5.14 (s, 2H), 2.91 (tt, J = 12.0, 3.2 Hz, 1H), 1.90 (d, J = 12.5 Hz, 2H), 1.80 (dt, J = 13.5, 3.4 Hz, 2H), 1.77 – 1.68 (m, 2H), 1.49 – 1.40 (m, 2H), 1.26 – 1.17 (m, 2H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 162.4, 139.3, 136.9, 134.2, 133.4, 128.9, 128.3, 127.97, 106.1, 52.6, 37.8, 32.6, 26.9, 26.5 ppm.

HRMS-EI (m/z) calc'd for $\text{C}_{18}\text{H}_{22}\text{NO}$ $[\text{M}+\text{H}]^+$, 268.1694; found, 268.1696.

1-Benzyl-3-(tetrahydro-2H-pyran-4-yl)pyridin-2(1H)-one (3n)



Physical state: yellow oil;

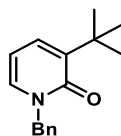
R_f = 0.3 (silica gel, PE: EtOAc = 5:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.31 (q, *J* = 6.8 Hz, 5H), 7.22 – 7.13 (m, 2H), 6.16 (t, *J* = 6.8 Hz, 1H), 5.14 (s, 2H), 4.07 – 4.01 (m, 2H), 3.56 (td, *J* = 11.8, 1.9 Hz, 2H), 3.16 (tt, *J* = 12.1, 3.5 Hz, 1H), 1.86 – 1.79 (m, 2H), 1.64 – 1.53 (m, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 162.3, 137.1, 136.6, 134.8, 133.8, 129.0, 128.3, 128.1, 106.1, 68.5, 52.6, 35.1, 32.0 ppm.

HRMS-EI (m/z) calc'd for C₁₇H₂₀NO₂ [M+H]⁺, 270.1489; found, 270.1489.

1-Benzyl-3-(*tert*-butyl)pyridin-2(1*H*)-one (3o)



Physical state: white solid;

Melting point: 74°C;

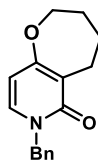
R_f = 0.5 (hexanes/ethyl acetate, 5:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.28 – 7.25 (m, 1H), 7.22 – 7.18 (m, 4H), 7.17 (dd, *J* = 7.1, 2.1 Hz, 1H), 7.09 (dd, *J* = 6.8, 2.0 Hz, 1H), 6.00 (t, *J* = 6.9 Hz, 1H), 5.07 (s, 2H), 1.30 (s, 9H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 161.8, 141.0, 137.1, 135.1, 133.6, 128.9, 128.2, 127.9, 105.4, 52.1, 35.3, 28.7 ppm.

HRMS-EI (m/z) calc'd for C₁₆H₂₀NO [M+H]⁺, 242.1539; found, 242.1539.

7-Benzyl-3,4,5,7-tetrahydrooxepino[3,2-*c*]pyridin-6(2*H*)-one (3p)



Physical state: colorless oil;

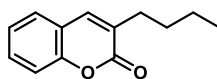
R_f = 0.5 (hexanes/ethyl acetate, 2:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.33 (d, *J* = 7.1 Hz, 2H), 7.30 - 7.26 (m, 3H), 7.02 (d, *J* = 7.5 Hz, 1H), 5.88 (d, *J* = 7.5 Hz, 1H), 5.09 (s, 2H), 4.20 (t, *J* = 5.6 Hz, 2H), 2.88 - 2.86 (m, 2H), 1.97 (q, *J* = 6.0 Hz, 2H), 1.85 - 1.81 (m, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 167.3, 164.3, 136.8, 134.0, 128.8, 128.1, 127.8, 118.0, 103.5, 72.4, 52.2, 30.2, 24.5, 24.3 ppm.

HRMS-EI (m/z) calc'd for C₁₆H₁₇NNaO₂ [M+Na]⁺, 278.7751; found, 278.7751.

3-Butyl-2*H*-chromen-2-one (3q)



Physical state: white solid;

Melting point: 79°C;

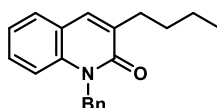
R_f = 0.5 (silica gel, PE: EtOAc = 10:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 7.50 – 7.42 (m, 3H), 7.34 – 7.23 (m, 2H), 2.62 – 2.54 (m, 2H), 1.69 – 1.59 (m, 2H), 1.48 – 1.38 (m, 2H), 0.96 (d, J = 7.4 Hz, 3H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 162.0, 153.2, 138.5, 130.6, 130.2, 127.2, 124.3, 119.7, 116.5, 30.7, 30.2, 22.5, 14.0 ppm.

HRMS-EI (m/z) calc'd for $\text{C}_{13}\text{H}_{14}\text{O}_2$ $[\text{M}+\text{Na}]^+$, 225.0086; found, 225.0086.

1-Benzyl-3-butylquinolin-2(1*H*)-one (3r)



Physical state: colorless oil;

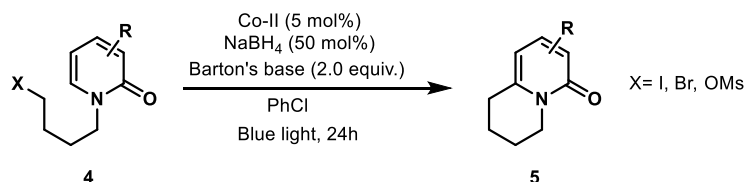
R_f = 0.4 (silica gel, PE: EtOAc = 5:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 7.57 (s, 1H), 7.52 – 7.50 (m, 1H), 7.35 (ddd, J = 8.7, 7.1, 1.6 Hz, 1H), 7.30 – 7.13 (m, 7H), 5.57 (s, 2H), 2.70 (t, J = 7.5 Hz, 2H), 1.68 (tt, J = 7.7, 6.3 Hz, 2H), 1.45 (h, J = 7.3 Hz, 2H), 0.97 (t, J = 7.4 Hz, 3H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 162.8, 138.5, 136.8, 135.4, 134.3, 129.4, 128.9, 128.2, 127.3, 126.8, 122.1, 121.1, 114.8, 46.4, 30.9, 30.6, 22.8, 14.1 ppm.

HRMS-EI (m/z) calc'd for $\text{C}_{20}\text{H}_{22}\text{NO}$ $[\text{M}+\text{H}]^+$, 292.1696; found, 292.1696.

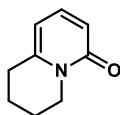
General procedure for synthesis of 5.



Under the argon atmosphere, a 4-mL borosilicate vial equipped with a magnetic stir bar was charged with Co(quinoline)(dmgH)₂Cl (3.5 mg, 5 mol%). PhCl (1.0 mL, c = 0.1 M) and Barton's base (34.3 mg, 2.0 equiv.) were then added into the vial. Then **4** (0.1 mmol) were added into the same vial. The vial was sealed with a septum cap. The

reaction mixture that was irradiated with the blue LED (2*5W) was stirred at room temperature for 24 hours. Then the reaction mixture was transferred to a flask with ethyl acetate, and the volatiles were removed under vacuo. The residues were then purified by flash column chromatography on silica gel, eluting with hexanes to afford **5**.

6,7,8,9-Tetrahydro-4*H*-quinolizin-4-one (**5a**)



Physical state: yellow oil;

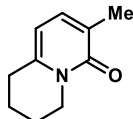
R_f = 0.4 (silica gel, EtOAc, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ) 7.24 (dd, J = 9.1, 6.9 Hz, 1H), 6.44 (d, J = 9.0 Hz, 1H), 6.00 (d, J = 6.9 Hz, 1H), 4.01 (t, J = 6.4 Hz, 2H), 2.78 (t, J = 6.7 Hz, 2H), 1.95 (p, J = 6.5 Hz, 2H), 1.80 (p, J = 6.7 Hz, 2H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 163.7, 147.8, 138.8, 116.8, 105.2, 41.7, 28.9, 22.3, 18.8 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_9\text{H}_{11}\text{NNaO}$ [$\text{M}+\text{Na}$] $^+$, 172.0730; found 172.0733.

3-Methyl-6,7,8,9-tetrahydro-4*H*-quinolizin-4-one (**5b**)



Physical state: yellow oil;

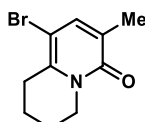
R_f = 0.3 (silica gel, PE: EtOAc = 1:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 7.10 (d, J = 7.0 Hz, 1H), 5.90 (d, J = 6.9 Hz, 1H), 4.01 (t, J = 6.4 Hz, 2H), 2.73 (t, J = 6.7 Hz, 2H), 2.11 (s, 3H), 1.92 (p, J = 6.5 Hz, 2H), 1.76 (p, J = 6.7 Hz, 2H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 163.8, 144.7, 136.3, 125.5, 104.6, 41.8, 28.7, 22.5, 18.9, 17.3 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_{10}\text{H}_{13}\text{NNaO}$ [$\text{M}+\text{Na}$] $^+$, 186.0888; found 186.0889.

1-Bromo-3-methyl-6,7,8,9-tetrahydro-4*H*-quinolizin-4-one (**5c**)



Physical state: yellow oil;

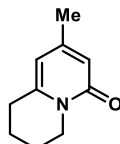
R_f = 0.3 (silica gel, PE: EtOAc = 2:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ) 7.30 (s, 1H), 3.98 (t, *J* = 6.2 Hz, 2H), 2.82 (t, *J* = 6.8 Hz, 2H), 2.11 (s, 3H), 1.92 – 1.88 (m, 2H), 1.81 (q, *J* = 6.5 Hz, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 162.94, 141.9, 139.9, 139.8, 127.1, 99.2, 43.9, 29.5, 22.3, 19.2, 17.0 ppm.

HRMS-ESI (*m/z*) calc'd for C₁₀H₁₂BrNNaO [M+Na]⁺, 263.9994; found, 263.9994.

2-Methyl-6,7,8,9-tetrahydro-4*H*-quinolizin-4-one (5d)



Physical state: yellow oil;

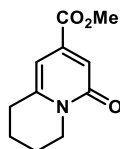
R_f = 0.5 (silica gel, EtOAc, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 6.24 (s, 1H), 5.84 (s, 1H), 3.95 (t, *J* = 6.4 Hz, 2H), 2.72 (t, *J* = 6.7 Hz, 2H), 2.11 (s, 3H), 1.92 (p, *J* = 6.5 Hz, 2H), 1.76 (q, *J* = 6.6 Hz, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 163.7, 150.3, 146.5, 115.6, 107.7, 41.5, 28.8, 22.4, 21.2, 18.9 ppm.

HRMS-ESI (*m/z*) calc'd for C₁₀H₁₄NO [M+H]⁺, 164.1070; found, 164.1070.

Methyl 6-oxo-1,3,4,6-tetrahydro-2*H*-quinolizine-8-carboxylate (5e)



Physical state: White solid;

Melting point: 110°C;

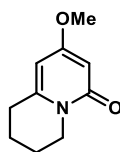
R_f = 0.4 (silica gel, EtOAc);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.02 – 7.01 (m, 1H), 6.48 (s, 1H), 3.99 (t, *J* = 6.4 Hz, 2H), 3.88 (s, 3H), 2.82 (t, *J* = 6.7 Hz, 2H), 1.95 (p, *J* = 6.6 Hz, 2H), 1.81 (p, *J* = 6.7 Hz, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 165.7, 163.5, 148.5, 139.5, 118.2, 103.6, 52.8, 42.2, 29.2, 22.2, 18.7 ppm.

HRMS-ESI (*m/z*) calc'd for C₁₁H₁₄NO₃ [M+H]⁺, 208.0966; found, 208.0968.

2-Methoxy-6,7,8,9-tetrahydro-4*H*-quinolizin-4-one (5f)



Physical state: White solid;

Melting point: 54°C;

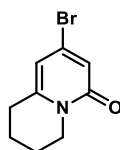
R_f = 0.2 (silica gel, PE: EtOAc = 2:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 5.82 (s, 1H), 5.71 – 5.70 (m, 1H), 3.92 (t, *J* = 6.4 Hz, 2H), 3.72 (s, 3H), 2.70 (t, *J* = 6.7 Hz, 2H), 1.90 (p, *J* = 6.6 Hz, 2H), 1.76 (p, *J* = 6.7 Hz, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 167.5, 165.3, 147.5, 99.1, 94.5, 55.3, 41.3, 28.9, 22.4, 18.9 ppm.

HRMS-ESI (m/z) calc'd for C₁₀H₁₄NO₂ [M+H]⁺, 180.1019; found, 180.1019.

2-Bromo-6,7,8,9-tetrahydro-4*H*-quinolizin-4-one (5g)



Physical state: White solid;

Melting point: 82°C;

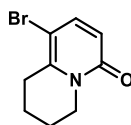
R_f = 0.3 (silica gel, PE: EtOAc = 1:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 6.65 (d, *J* = 2.1 Hz, 1H), 6.16 (d, *J* = 2.2 Hz, 1H), 3.91 (t, *J* = 6.4 Hz, 2H), 2.74 (t, *J* = 6.7 Hz, 2H), 1.95 – 1.90 (m, 2H), 1.79 (p, *J* = 6.7 Hz, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ) 162.5, 148.2, 135.1, 118.9, 109.3, 41.9, 28.7, 22.1, 18.6 ppm.

HRMS-ESI (m/z) calc'd for C₉H₁₁BrNO [M+H]⁺, 228.0015; found, 228.0019.

1-Bromo-6,7,8,9-tetrahydro-4*H*-quinolizin-4-one (5h)



Physical state: yellow oil;

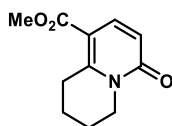
R_f = 0.3 (silica gel, PE: EtOAc = 1:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ) 7.40 (d, *J* = 9.2 Hz, 1H), 6.35 (d, *J* = 9.6 Hz, 1H), 3.97 (d, *J* = 6.3 Hz, 2H), 2.85 (t, *J* = 6.7 Hz, 2H), 1.91 (q, *J* = 6.3 Hz, 2H), 1.83 (q, *J* = 6.5 Hz, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 145.2, 142.5, 117.8, 99.6, 43.8, 29.8, 22.1, 19.1 ppm.

HRMS-ESI (m/z) calc'd for C₉H₁₁BrNO [M+H]⁺, 228.0015; found, 228.0019.

Methyl 6-oxo-1,3,4,6-tetrahydro-2*H*-quinolizine-9-carboxylate (5i)



Physical state: White solid;

Melting point: 93°C;

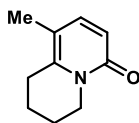
R_f = 0.6 (silica gel, EtOAc, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.90 (d, *J* = 9.7 Hz, 1H), 6.42 (d, *J* = 9.6 Hz, 1H), 4.05 (t, *J* = 6.3 Hz, 2H), 3.82 (s, 3H), 3.37 (t, *J* = 6.7 Hz, 2H), 1.93 (p, *J* = 6.5 Hz, 2H), 1.82 (p, *J* = 6.8 Hz, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 165.9, 163.1, 155.9, 139.8, 115.5, 107.7, 52.0, 42.7, 27.0, 21.5, 18.3 ppm.

HRMS-ESI (m/z) calc'd for C₁₁H₁₃NNaO₃ [M+Na]⁺, 230.0760; found, 230.0788.

1-Methyl-6,7,8,9-tetrahydro-4*H*-quinolizin-4-one (5j)



Physical state: yellow solid;

Melting point: 69°C;

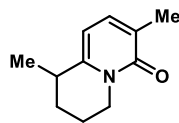
R_f = 0.5 (silica gel, EtOAc, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.14 (d, *J* = 9.1 Hz, 1H), 6.39 (d, *J* = 9.1 Hz, 1H), 3.99 (t, *J* = 6.2 Hz, 2H), 2.69 (t, *J* = 6.8 Hz, 2H), 2.01 (s, 3H), 1.90 (p, *J* = 6.3 Hz, 2H), 1.83 – 1.79 (m, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 163.2, 143.8, 142.2, 116.1, 112.2, 42.9, 26.4, 22.1, 19.0, 17.1 ppm.

HRMS-ESI (m/z) calc'd for C₁₀H₁₃NNaO [M+Na]⁺, 186.0888; found, 186.0889.

3,9-Dimethyl-6,7,8,9-tetrahydro-4*H*-quinolizin-4-one (5k)



Physical state: yellow oil;

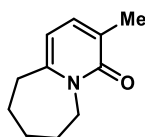
R_f = 0.5 (silica gel, PE: EtOAc = 1:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ) 7.15 (d, J = 6.9 Hz, 1H), 5.99 (d, J = 7.0 Hz, 1H), 4.51 (dt, J = 14.2, 5.3 Hz, 1H), 3.63 (ddd, J = 14.6, 9.4, 5.3 Hz, 1H), 2.81 (q, J = 7.8 Hz, 1H), 2.12 (s, 3H), 2.01 – 1.89 (m, 2H), 1.89 – 1.83 (m, 2H), 1.29 (d, J = 6.8 Hz, 3H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 163.6, 149.8, 136.2, 125.3, 102.7, 41.0, 32.1, 27.5, 20.6, 19.7, 17.3 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_{11}\text{H}_{15}\text{NNaO}$ [$\text{M}+\text{Na}$] $^+$, 200.1058; found, 200.1046.

3-Methyl-7,8,9,10-tetrahydropyrido[1,2-*a*]azepin-4(6*H*)-one (5l)



Physical state: yellow oil;

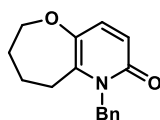
R_f = 0.6 (silica gel, PE:EtOAc = 2:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 7.05 (d, J = 6.9 Hz, 1H), 5.89 (d, J = 6.9 Hz, 1H), 4.40 – 4.34 (m, 2H), 2.75 – 2.72 (m, 2H), 2.10 (s, 3H), 1.77 – 1.73 (m, 6H) ppm.

$^{13}\text{C NMR}$ (100 MHz, CDCl_3 , 23°C, δ): 163.7, 149.5, 136.4, 126.3, 105.0, 43.8, 35.0, 29.9, 28.0, 27.6, 17.7 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_{11}\text{H}_{16}\text{NO}$ [$\text{M}+\text{H}$] $^+$, 178.1226; found, 178.1226.

1-Benzyl-6,7,8,9-tetrahydrooxepino[3,2-*b*]pyridin-2(1*H*)-one (5m)



Physical state: green liquid;

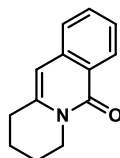
R_f = 0.4 (silica gel, PE: EtOAc = 2:1, v/v);

$^1\text{H NMR}$ (600 MHz, CDCl_3 , 23°C, δ): 7.32 – 7.28 (m, 2H), 7.25 – 7.19 (m, 2H), 7.11 (d, J = 7.6 Hz, 2H), 6.47 (d, J = 9.6 Hz, 1H), 5.42 (s, 2H), 3.89 (t, J = 4.6 Hz, 2H), 2.81 – 2.78 (m, 2H), 1.83 (t, J = 7.9 Hz, 2H), 1.40 – 1.36 (m, 2H) ppm.

^{13}C NMR (100 MHz, CDCl_3 , 23°C , δ): 162.3, 143.3, 142.9, 137.1, 136.8, 128.9, 127.4, 126.4, 117.5, 73.4, 47.6, 31.6, 29.3, 23.2 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_{16}\text{H}_{18}\text{NO}_2$ $[\text{M}+\text{H}]^+$, 256.2332; found, 256.2333.

1,2,3,4-Tetrahydro-6H-pyrido[1,2-b]isoquinolin-6-one (5n)



Physical state: White solid;

Melting point: 97°C ;

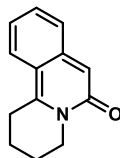
R_f = 0.4 (silica gel, PE: EtOAc = 5:1, v/v);

^1H NMR (600 MHz, CDCl_3 , 23°C , δ): 8.37 (d, J = 8.3 Hz, 1H), 7.56 (t, J = 7.4 Hz, 1H), 7.40 – 7.36 (m, 2H), 6.29 (s, 1H), 4.10 (t, J = 6.4 Hz, 2H), 2.80 (t, J = 6.1 Hz, 2H), 1.96 (q, J = 6.6 Hz, 2H), 1.81 (p, J = 6.8 Hz, 2H) ppm.

^{13}C NMR (100 MHz, CDCl_3 , 23°C , δ): 163.0, 141.1, 136.9, 132.1, 127.9, 125.6, 125.0, 124.4, 103.9, 41.1, 28.9, 22.5, 19.2 ppm.

HRMS-ESI (m/z) calc'd for $\text{C}_{13}\text{H}_{13}\text{NNaO}$ $[\text{M}+\text{Na}]^+$, 222.0889; found, 222.0889.

1,2,3,4-Tetrahydro-6H-pyrido[2,1-a]isoquinolin-6-one (5o)



Physical state: White solid;

Melting point: 87°C ;

R_f = 0.5 (silica gel, PE: EtOAc = 1:1, v/v);

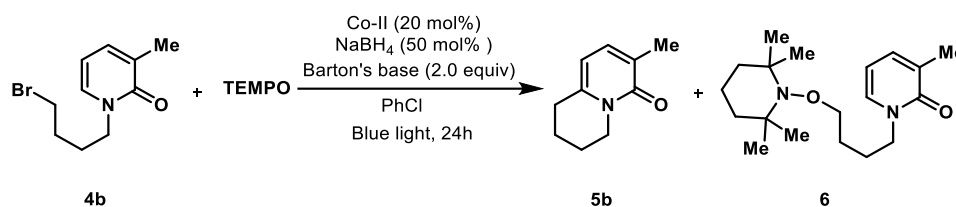
^1H NMR (600 MHz, CDCl_3 , 23°C , δ): 8.86 (s, 1H), 8.01 (d, J = 8.7 Hz, 1H), 7.93 (d, J = 8.1 Hz, 1H), 7.67 (t, J = 8.0 Hz, 1H), 7.48 – 7.45 (m, 1H), 4.27 – 4.24 (m, 2H), 3.22 – 3.19 (m, 2H), 2.12 – 2.08 (m, 2H), 1.91 (dd, J = 7.8, 3.8 Hz, 2H) ppm.

^{13}C NMR (100 MHz, CDCl_3 , 23°C , δ): 162.7, 149.4, 137.9, 130.3, 128.4, 126.7, 125.0, 122.6, 119.2, 72.2, 31.3, 25.6, 24.6 ppm.

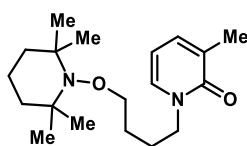
HRMS-ESI (m/z) calc'd for $\text{C}_{13}\text{H}_{14}\text{NO}$ $[\text{M}+\text{H}]^+$, 200.1069; found, 200.1070.

7. Experimental procedure and characterization of radical trapping experiments

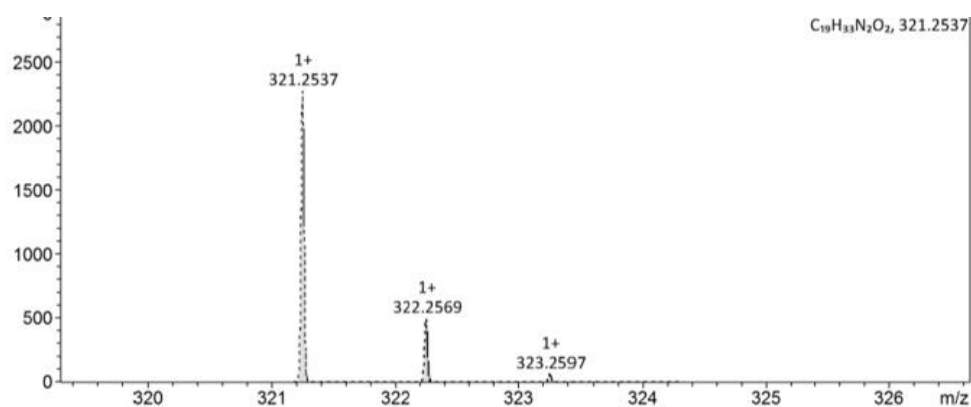
3-Methyl-1-(4-((2,2,6,6-tetramethylpiperidin-1-yl)oxy)butyl)pyridin-2(1H)-one (6)



Under the argon atmosphere, a 4-mL borosilicate vial equipped with a magnetic stir bar was charged with Co(quinoline)(dmgH)₂Cl (14.0 mg, 20 mol%). PhCl (1.0 mL, c = 0.1 M) and Barton's base (34.3 mg, 2.0 equiv.) were then added into the vial. Then 1-benzyl-5-(4-bromobutoxy)pyridin-2(1H)-one (33.5 mg, 0.1 mmol) and TEMPO (31.3 mg, 2.0 equiv.) were added into the same vial. The vial was sealed with a septum cap. The reaction mixture that was irradiated with the blue LED (2*5W) was stirred at room temperature for 24 hours. No product **5b** was found by detection, and the mass spectrum of **6** is shown below (detected by HRMS).

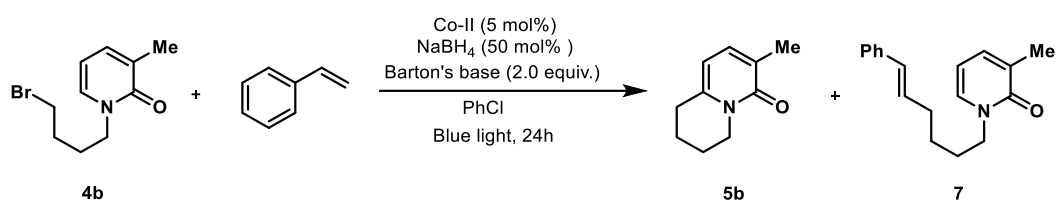


calc'd for C₁₉H₃₃N₂O₂⁺ [M+H]⁺, 321.2537



Meas. m/z	#	Ion Formula	Score	m/z	err [mDa]	err [ppm]	mSigma	rdb	e ⁻	Conf	N-Rule	Adduct
321.253885	1	C ₁₉ H ₃₃ N ₂ O ₂	100.00	321.253655	-0.2	-0.7	n.a.	4.5	even		ok	M+H

(E)-3-methyl-1-(6-phenylhex-5-en-1-yl)pyridin-2(1H)-one (7)



Under the argon atmosphere, a 4-mL borosilicate vial equipped with a magnetic stir bar was charged with Co(quinoline)(dmgH)₂Cl (3.5 mg, 5 mol%) PhCl (1.0 mL, c = 0.1 M) and Barton's base (34.3 mg, 2.0 equiv.) were then added into the vial. Then 1-(4-bromobutyl)-3-methylpyridin-2(1*H*)-one (24.4 mg, 0.1 mmol) and styrene (20.8mg, 0.2 equiv.) were added into the same vial. The vial was sealed with a septum cap. The reaction mixture that was irradiated with the blue LED (2*5W) was stirred at room temperature for 24 hours. Then the reaction mixture was transferred to a flask with ethyl acetate, and the volatiles were removed under vacuo. The residues were then purified by flash column chromatography on silica gel, eluting with hexanes to afford **5b** (6.5 mg, 40%) as a yellow oil and **7** (6.4 mg, 24%).

Physical state: yellow oil;

R_f = 0.7 (silica gel, PE:EtOAc = 2:1, v/v);

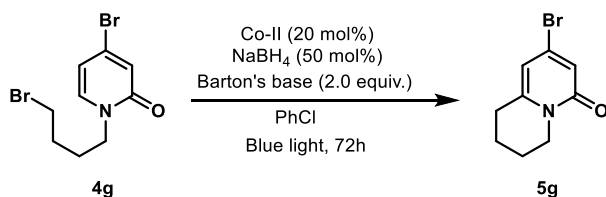
¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.34 – 7.32 (m, 2H), 7.30 – 7.27 (m, 2H), 7.20 – 7.17 (m, 2H), 7.12 (dd, *J* = 6.9, 2.1 Hz, 1H), 6.39 – 6.36 (m, 1H), 6.19 (dt, *J* = 15.8, 7.0 Hz, 1H), 6.07 (t, *J* = 6.7 Hz, 1H), 3.96 (t, *J* = 7.4 Hz, 2H), 2.26 (qd, *J* = 7.2, 1.5 Hz, 2H), 2.15 (s, 3H), 1.84 – 1.79 (m, 2H), 1.56 – 1.51 (m, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 163.1, 137.8, 136.6, 135.0, 130.5, 130.3, 130.2, 128.6, 127.1, 126.1, 105.7, 50.0, 32.8, 29.0, 26.6, 17.4 ppm.

HRMS-ESI (*m/z*) calc'd for C₁₈H₂₁NNaO [M+Na]⁺, 290.1515; found, 290.1515.

8. Experimental procedure and characterization of synthetic applications

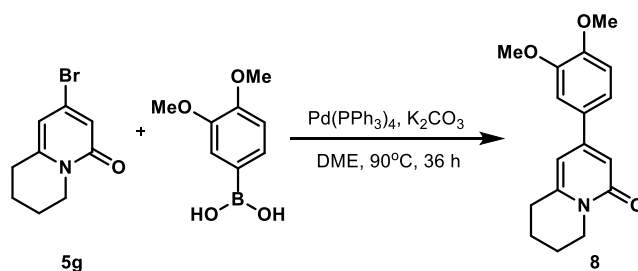
2-Bromo-6,7,8,9-tetrahydro-4*H*-quinolizin-4-one (**5g**)



Under the argon atmosphere, a 250-mL borosilicate vial equipped with a magnetic stir bar was charged with Co(quinoline)(dmgH)₂Cl (476 mg, 10 mol%). PhCl (68.0 mL, c = 0.1 M) and Barton's base (1.2 g, 2.0 equiv.) were then added into the vial. Then **4g**

(6.8 mmol) were added into the same vial. The vial was sealed with a septum cap. The reaction mixture that was irradiated with the blue LED (2*5W) was stirred at room temperature for 36 hours. Then add Co(quinoline)(dmgH)₂Cl (476 mg, 10 mol%) again with the blue LED (2*5W) was stirred at room temperature for 36 hours. the reaction mixture was transferred to a flask with ethyl acetate, and the volatiles were removed under vacuo. The residues were then purified by flash column chromatography on silica gel, eluting with hexanes to afford **5g** (1.35g, 87%).

2-(3,4-Dimethoxyphenyl)-6,7,8,9-tetrahydro-4H-quinolizin-4-one (**8**)



2-Bromo-6,7,8,9-tetrahydro-4H-quinolizin-4-one (**5g**, 1.35 g, 5.9 mmol) dissolved in ethylene glycol dimethyl ether (30 mL). Add (3,4-dimethoxyphenyl)boronic acid (1.2 equiv.) and K₂CO₃ (4.0 equiv.), Then tetrakis(triphenylphosphine)palladium (0.1 equiv.) was added. The resulting mixture was stirred at 90°C for 36 hours under a nitrogen atmosphere. TLC analysis indicated that the reaction was over. The reaction solution was cooled to room temperature. The mixture was extracted with methylene chloride, concentrated, and separated by chromatography to give compound **8** (1.32g, 78%).^[18]

Physical state: White solid;

Melting point: 93°C;

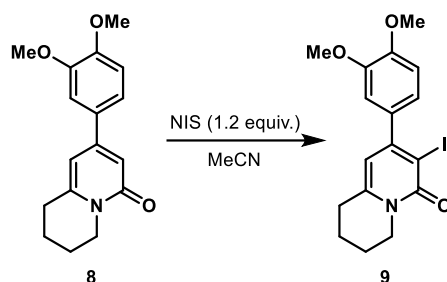
R_f = 0.5 (silica gel, EtOAc);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.15 (dd, *J* = 8.4, 2.1 Hz, 1H), 7.08 (d, *J* = 2.1 Hz, 1H), 6.91 (d, *J* = 8.3 Hz, 1H), 6.64 – 6.63 (m, 1H), 6.26 – 6.25 (m, 1H), 4.02 (t, *J* = 6.4 Hz, 2H), 3.92 (s, 3H), 3.91 (s, 3H), 2.84 (t, *J* = 6.7 Hz, 2H), 1.96 (q, *J* = 6.5 Hz, 2H), 1.82 (q, *J* = 6.6 Hz, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 163.9, 150.6, 150.2, 149.3, 147.4, 130.6, 119.5, 112.5, 111.4, 109.8, 104.6, 56.1, 41.7, 29.2, 22.4, 19.0 ppm.

HRMS-ESI (m/z) calc'd for C₁₇H₂₀NO₃ [M+H]⁺, 286.1437; found, 286.1438.

2-(3,4-Dimethoxyphenyl)-3-iodo-6,7,8,9-tetrahydro-4H-quinolizin-4-one (**9**)



2-(3,4-Dimethoxyphenyl)-6,7,8,9-tetrahydro-4*H*-quinolizin-4-one (**8**, 1.32 g, 4.6 mmol) dissolved in MeCN (10 mL). Add NIS (1.2 equiv.), The resulting mixture was stirred at room temperature for 12 hours. TLC analysis indicated that the reaction was over, the mixture was extracted with methylene chloride, concentrated, and separated by chromatography to give compound **9** (1.43 g, 75%).^[19]

Physical state: orange solid;

Melting point: 88°C;

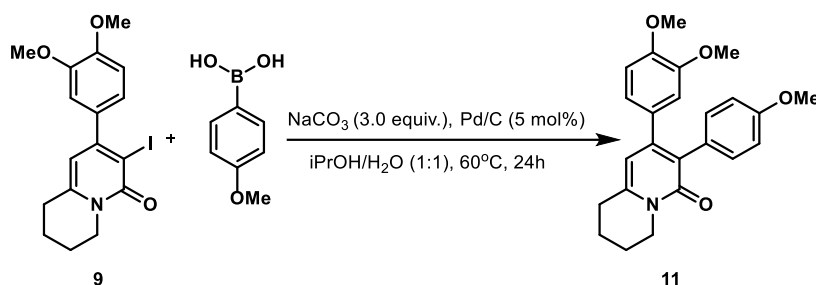
R_f = 0.5 (silica gel, PE: EtOAc = 1:1, v/v);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 6.90 (d, *J* = 1.8 Hz, 3H), 6.03 (s, 1H), 4.07 (t, *J* = 6.4 Hz, 2H), 3.91 (s, 3H), 3.90 (s, 3H), 2.77 (t, *J* = 6.7 Hz, 2H), 1.97 (m, 2H), 1.82 (m, 2H) ppm.

¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 177.7, 161.1, 156.8, 149.1, 148.4, 146.6, 135.1, 120.7, 111.8, 110.7, 107.7, 56.1, 43.9, 29.7, 28.6, 22.5, 18.7 ppm.

HRMS-ESI (m/z) calc'd for C₁₇H₁₈INNaO₃ [M+Na]⁺, 434.0221; found, 434.0224.

2-(3,4-Dimethoxyphenyl)-3-(4-methoxyphenyl)-6,7,8,9-tetrahydro-4*H*-quinolizin-4-one (**11**)



Na₂CO₃ (3.0 equiv.), (4-methoxyphenyl)boronic acid (1.2 equiv.), and Pd/C (5 mol%) were added to a solution of 2-(3,4-dimethoxyphenyl)-3-iodo-6,7,8,9-tetrahydro-4*H*-quinolizin-4-one (**9**, 1.43 g, 3.45 mmol) in iPrOH (6 mL) and H₂O (6 mL). The resulting mixture was stirred for 24 h at 60°C and then filtered. The catalyst was washed with H₂O (9 mL) and CH₂Cl₂ (15 mL). The aqueous phase was extracted twice with

CH₂Cl₂. The collected organic extracts were dried (MgSO₄), filtered, and concentrated under reduced pressure. The crude compound was purified by flash chromatography to give the cross-coupled product **11** (1.36g, 81%).^[20]

Physical state: White solid;

Melting point: 97°C;

R_f = 0.6 (silica gel, EtOAc);

¹H NMR (600 MHz, CDCl₃, 23°C, δ): 7.09 – 7.07 (m, 2H), 6.80 (dd, *J* = 8.3, 2.0 Hz, 1H), 6.75 (dd, *J* = 8.5, 4.7 Hz, 3H), 6.49 (d, *J* = 2.0 Hz, 1H), 6.14 (s, 1H), 4.06 (t, *J* = 6.4 Hz, 2H), 3.85 (s, 3H), 3.75 (s, 3H), 3.53 (s, 3H), 2.85 (t, *J* = 6.9 Hz, 2H), 2.01 (q, *J* = 6.4 Hz, 2H), 1.85 (p, *J* = 6.6 Hz, 2H) ppm.

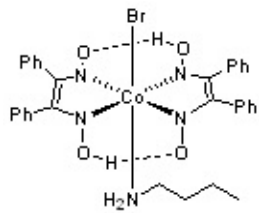
¹³C NMR (100 MHz, CDCl₃, 23°C, δ): 163.2, 158.4, 148.5, 148.4, 148.2, 145.3, 132.4, 132.3, 129.0, 125.3, 121.4, 113.5, 113.1, 110.7, 107.4, 55.9, 55.7, 55.3, 42.4, 29.1, 22.6, 19.0 ppm.

HRMS-ESI (m/z) calc'd for C₂₄H₂₅NNaO₄ [M+Na]⁺, 414.1672; found, 414.1676.

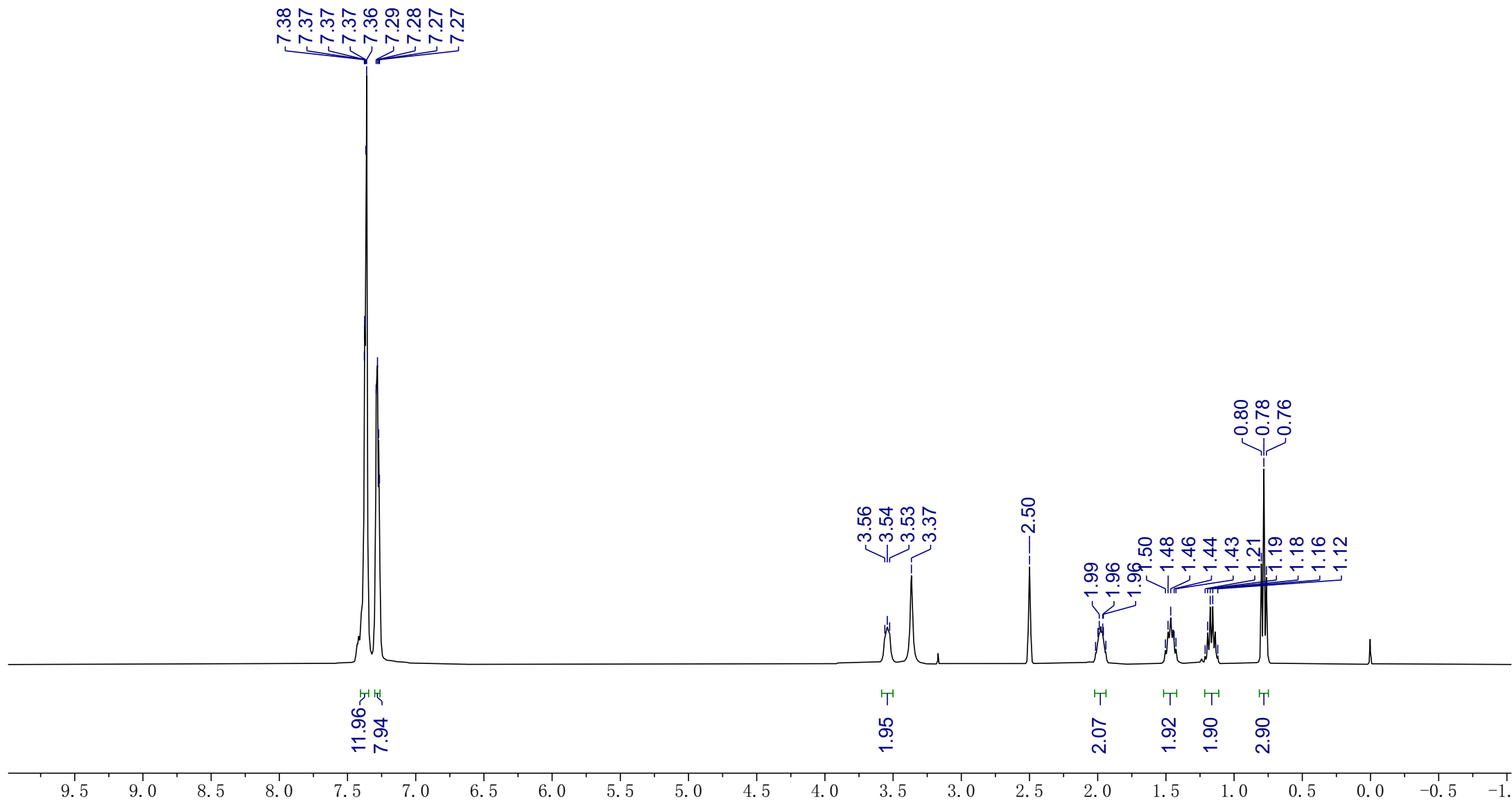
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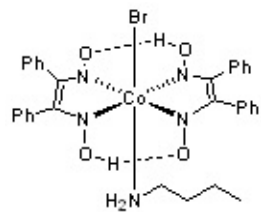
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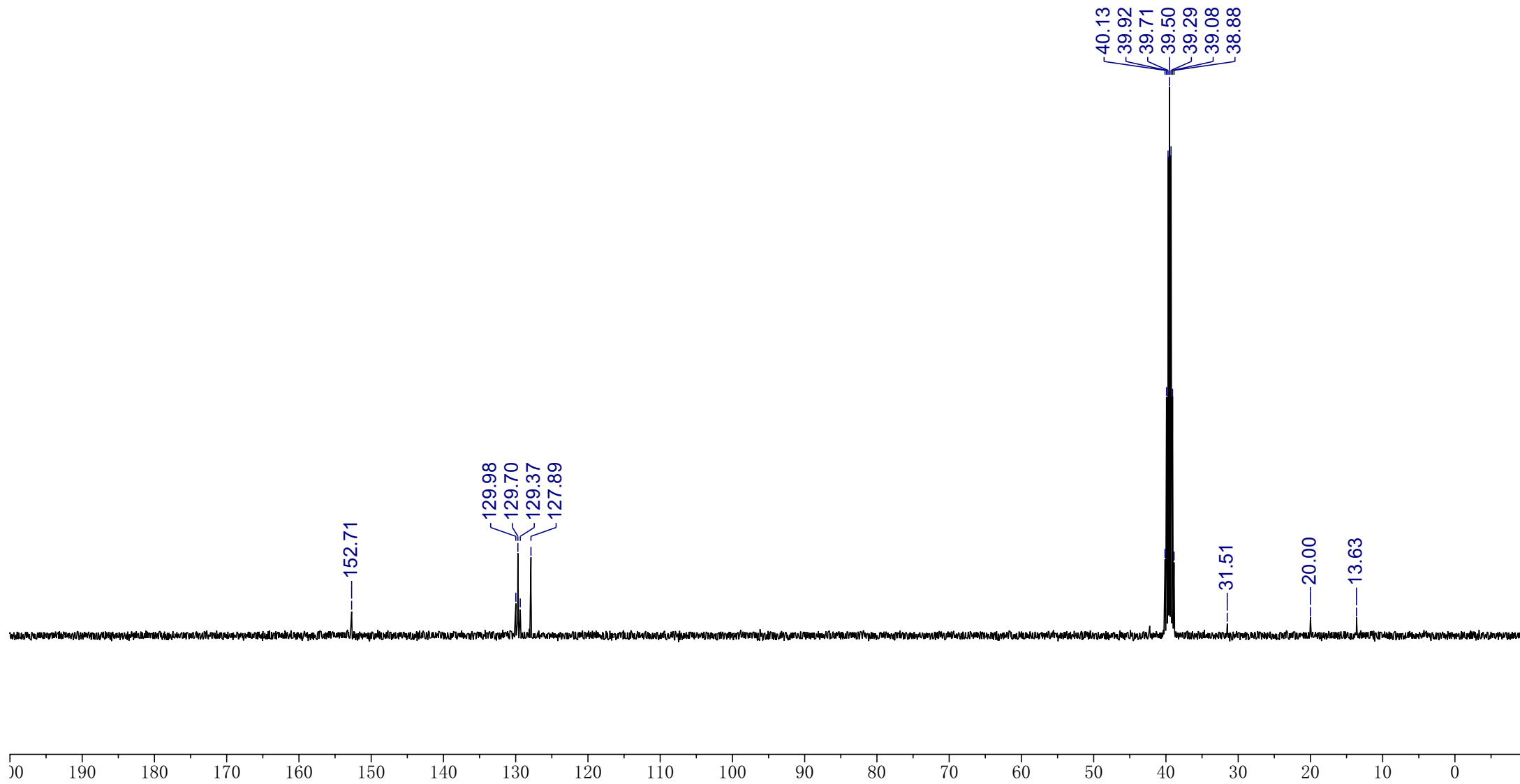
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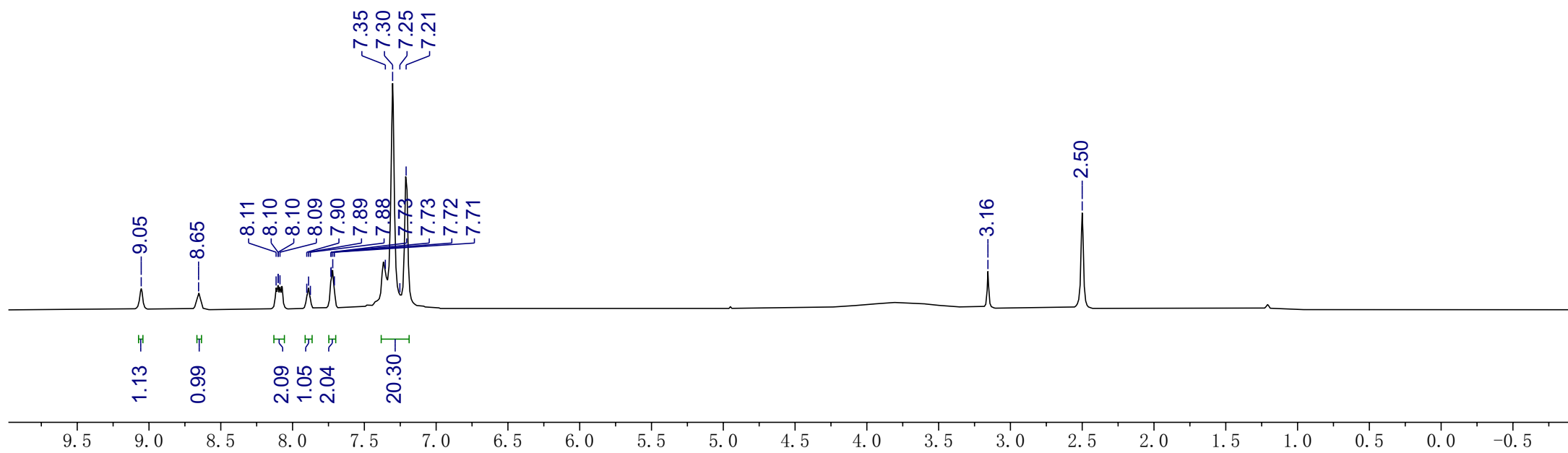
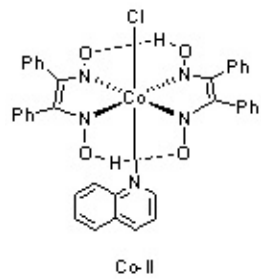


400 MHz, DMSO

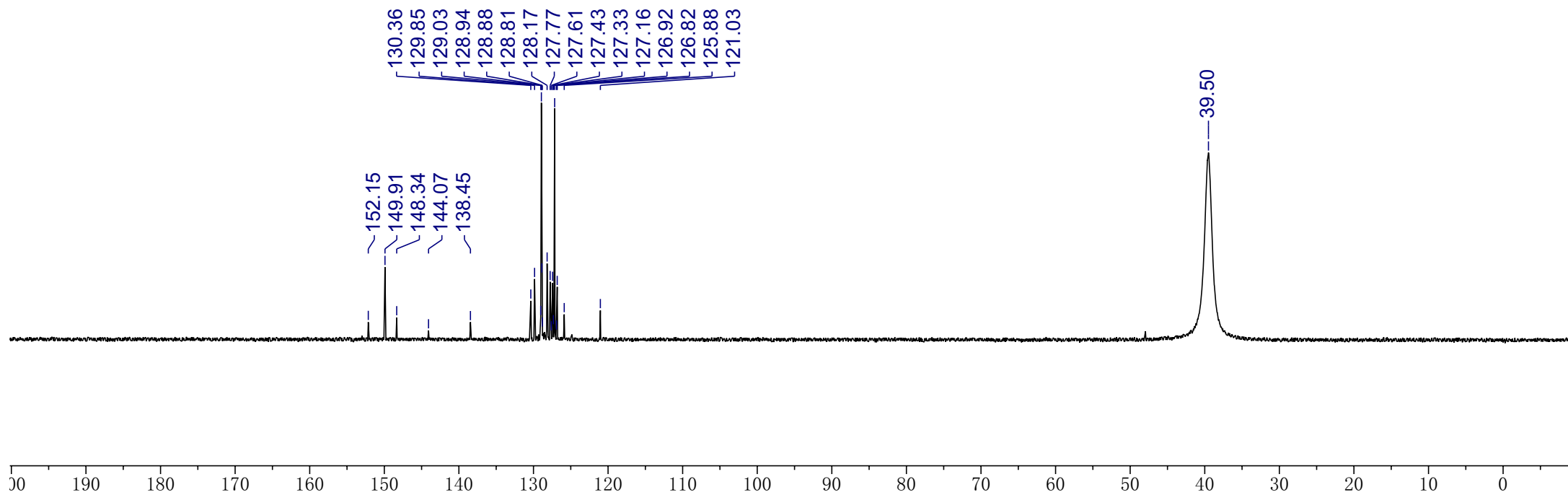
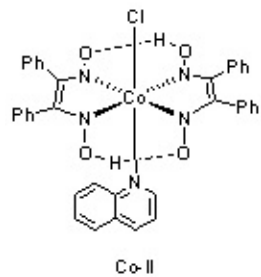


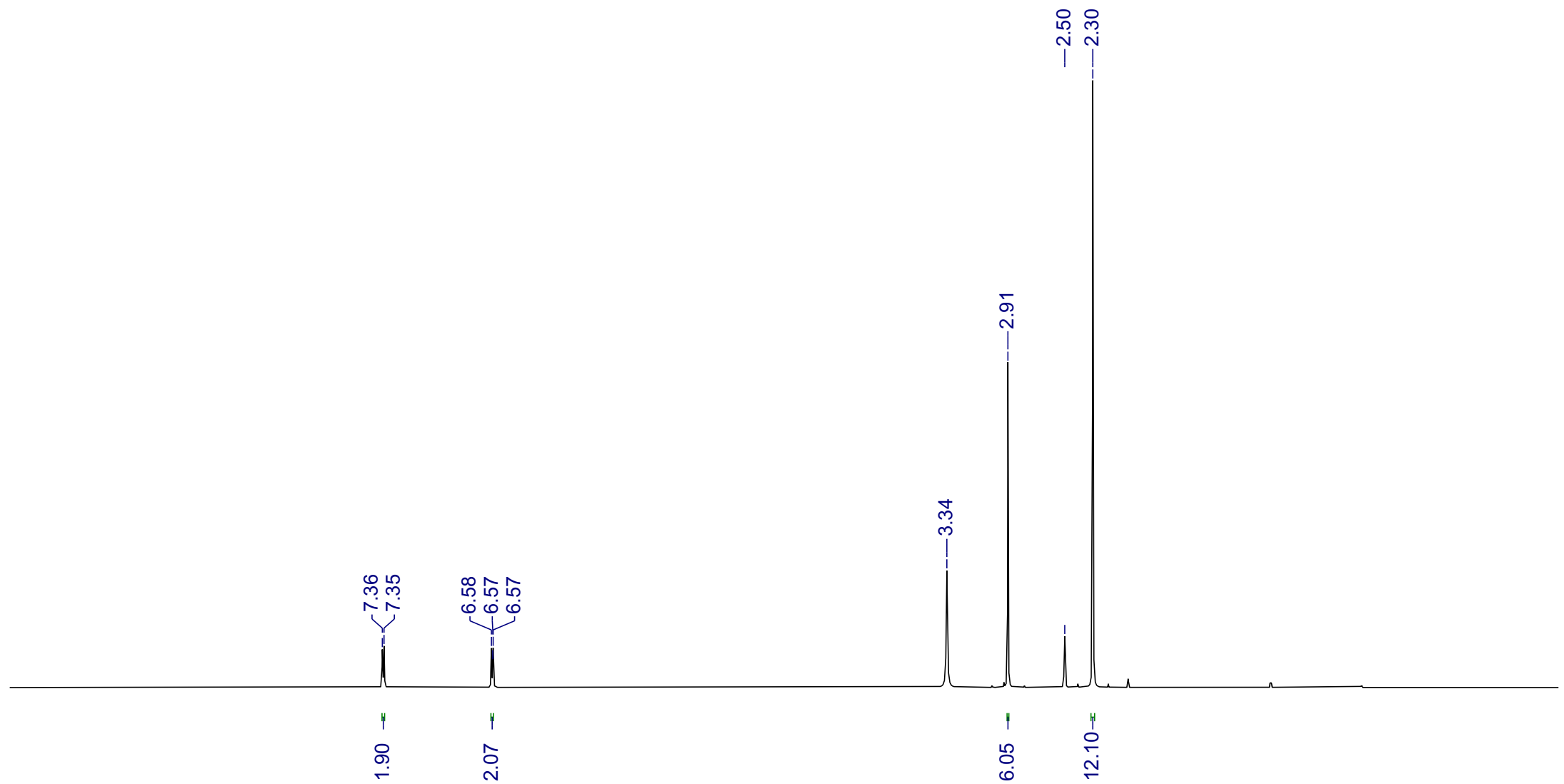
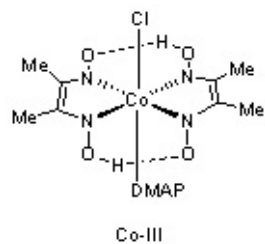
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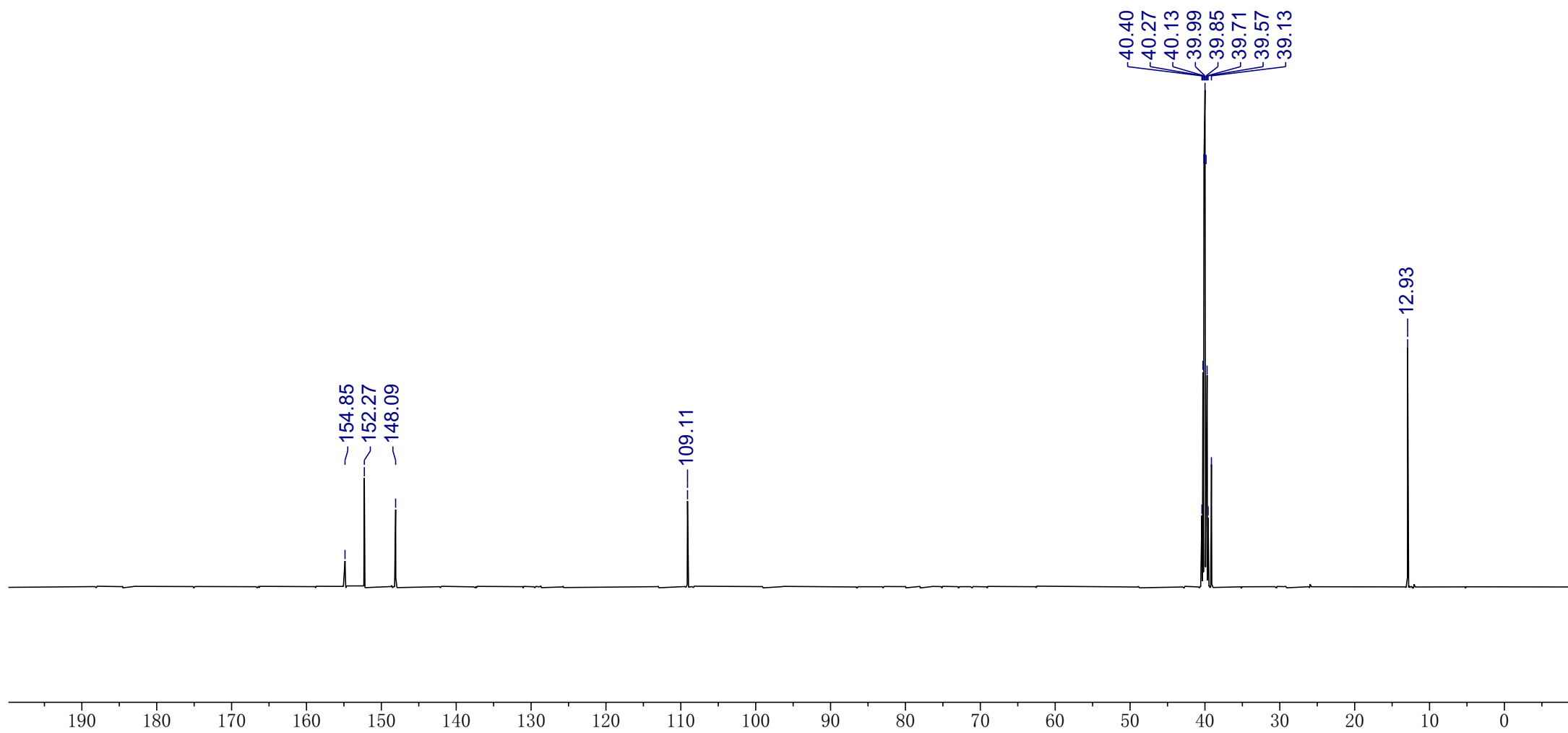
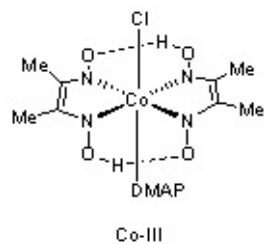


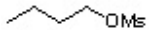


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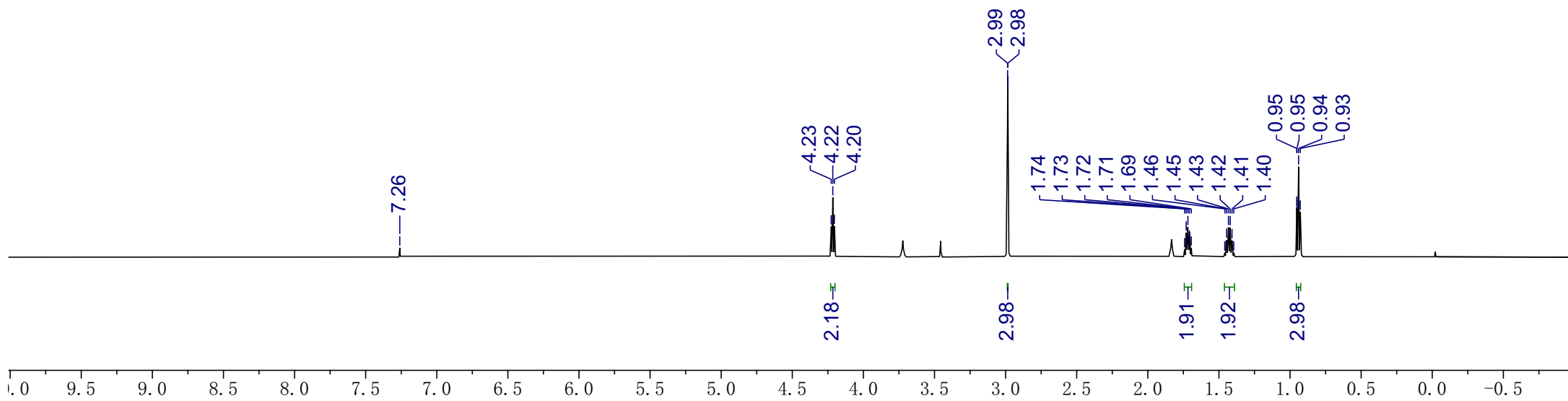






2a'

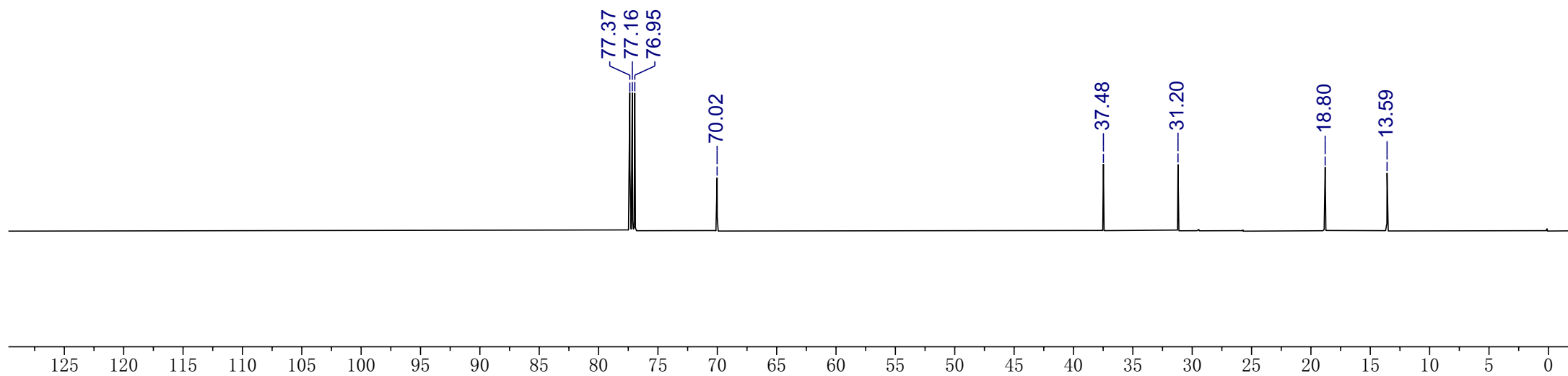
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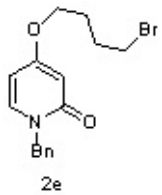




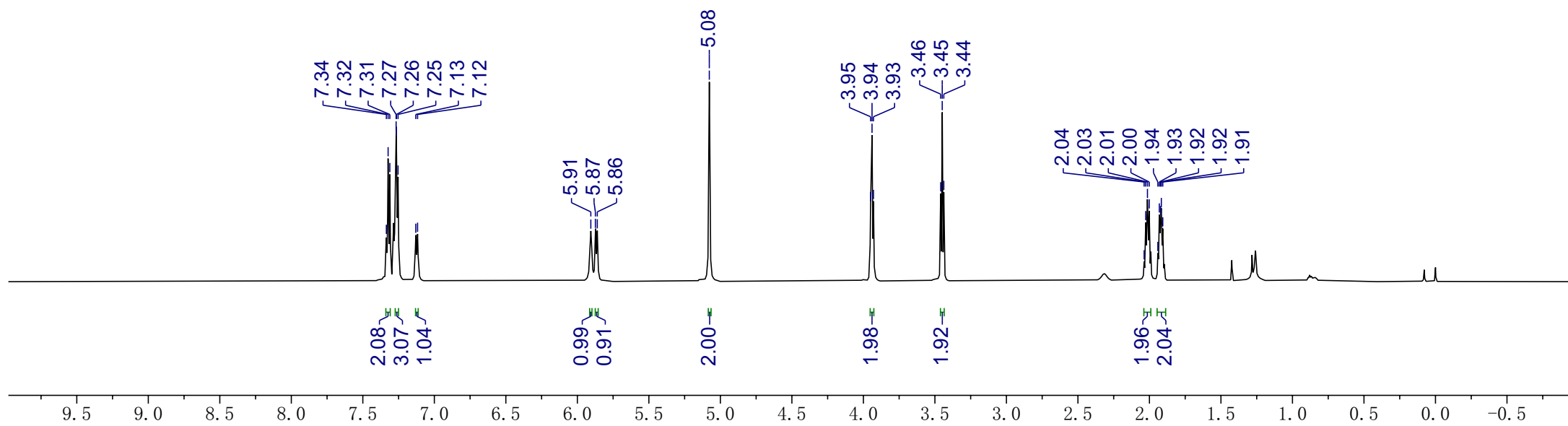
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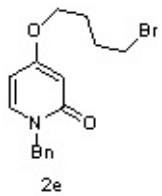
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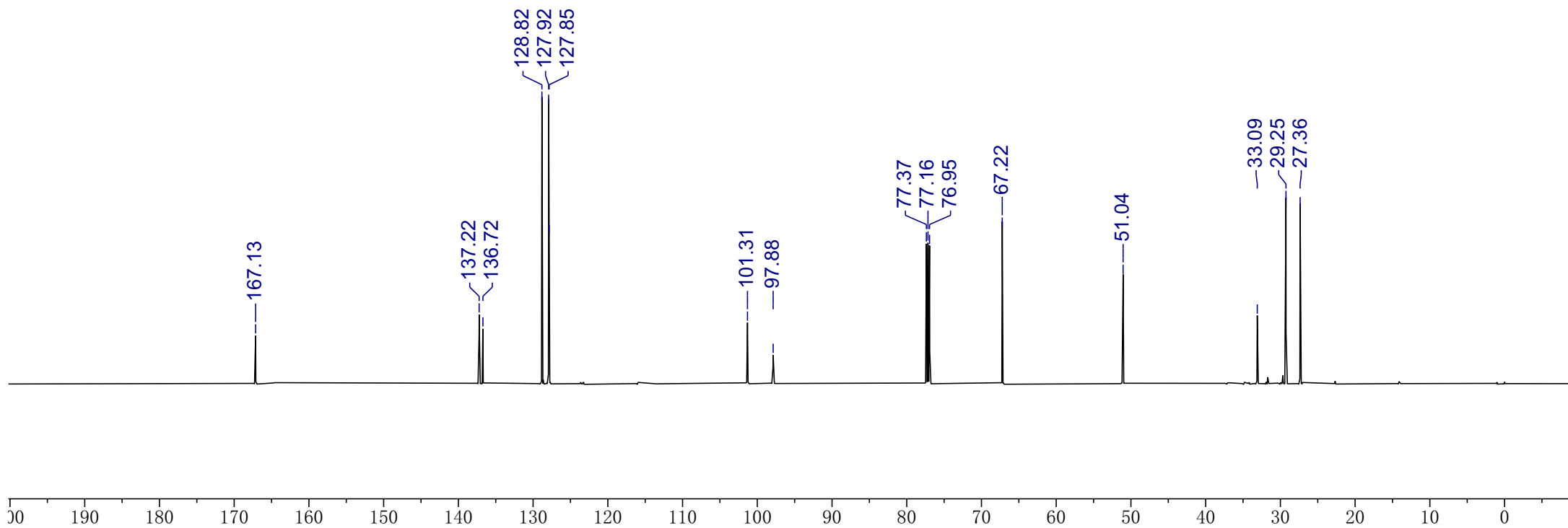


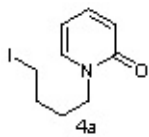
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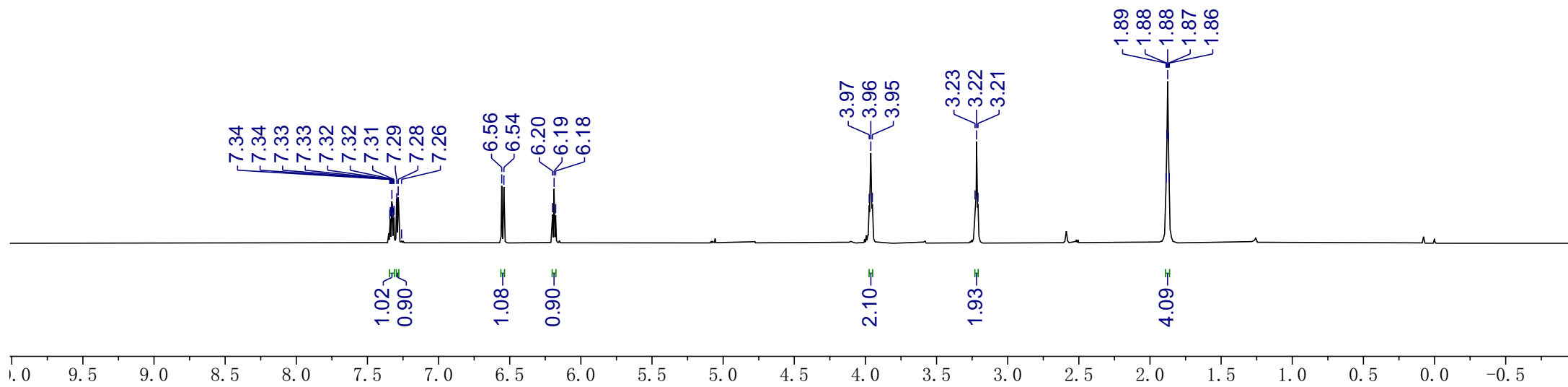


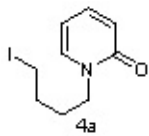
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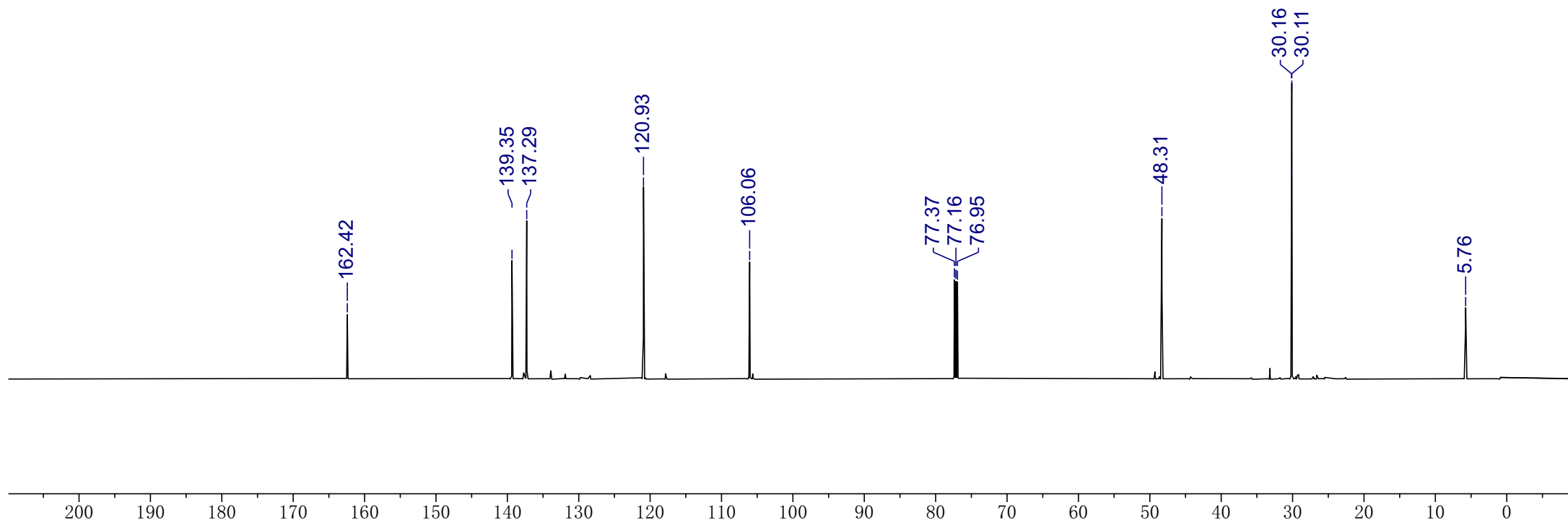


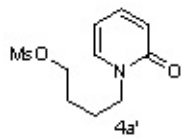
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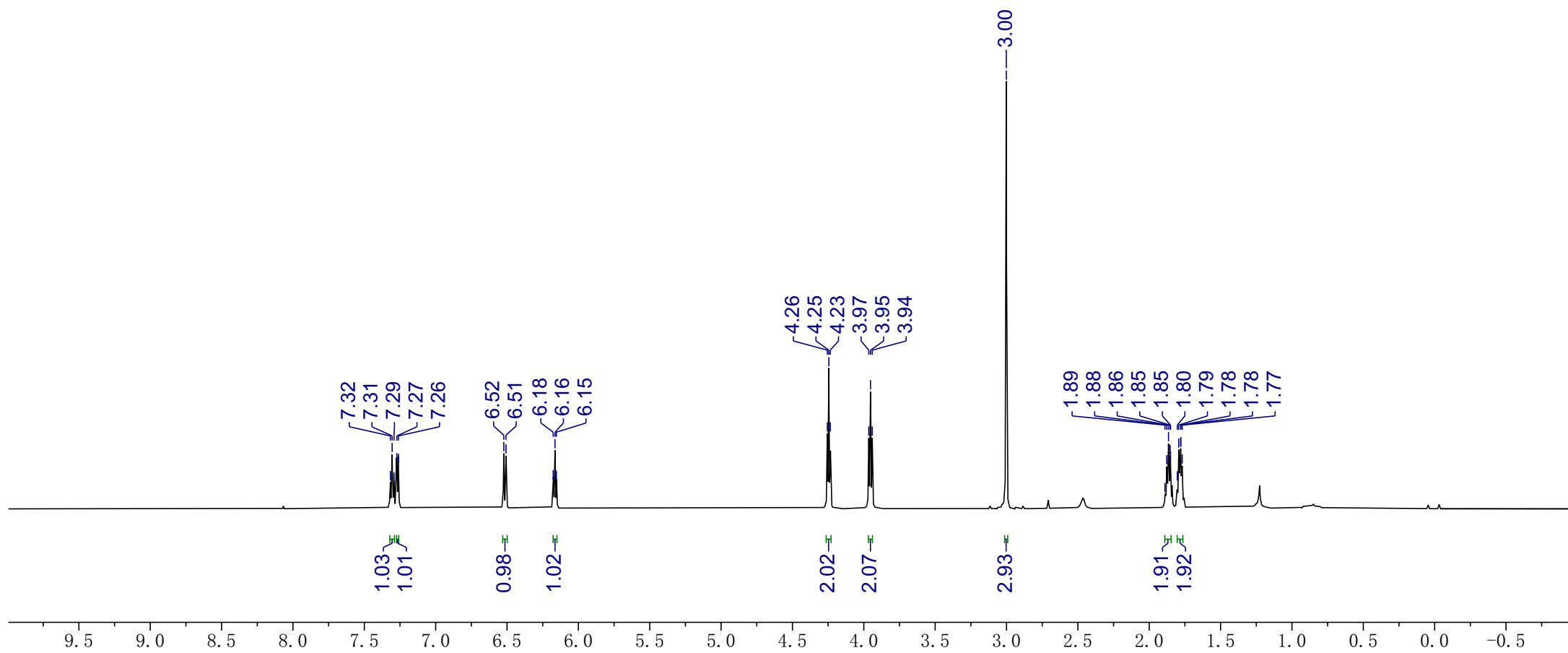


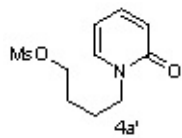
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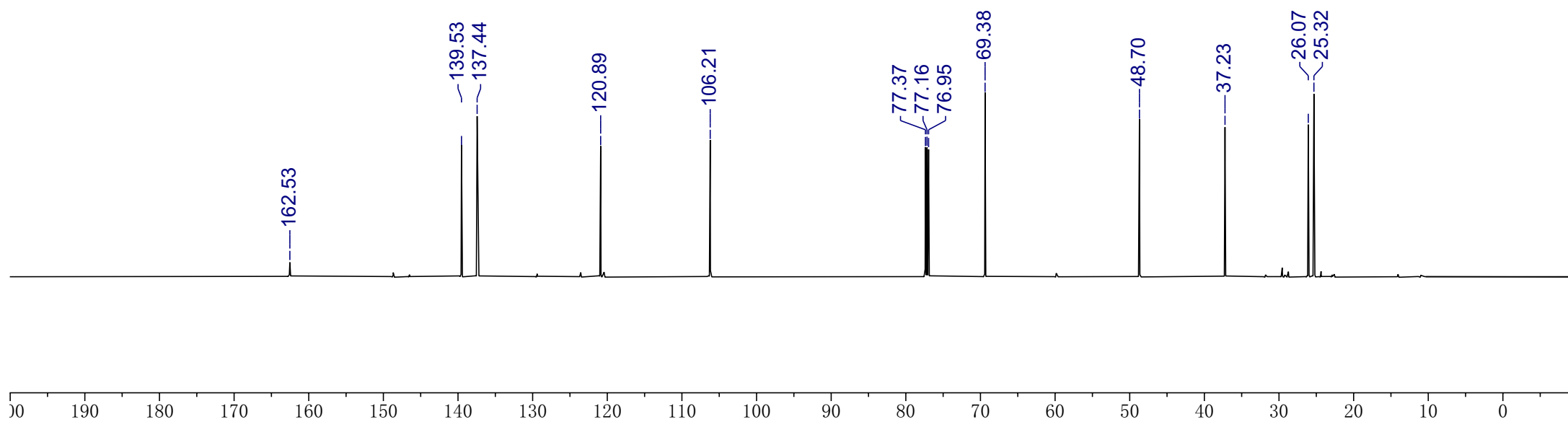


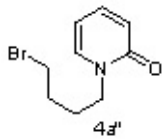
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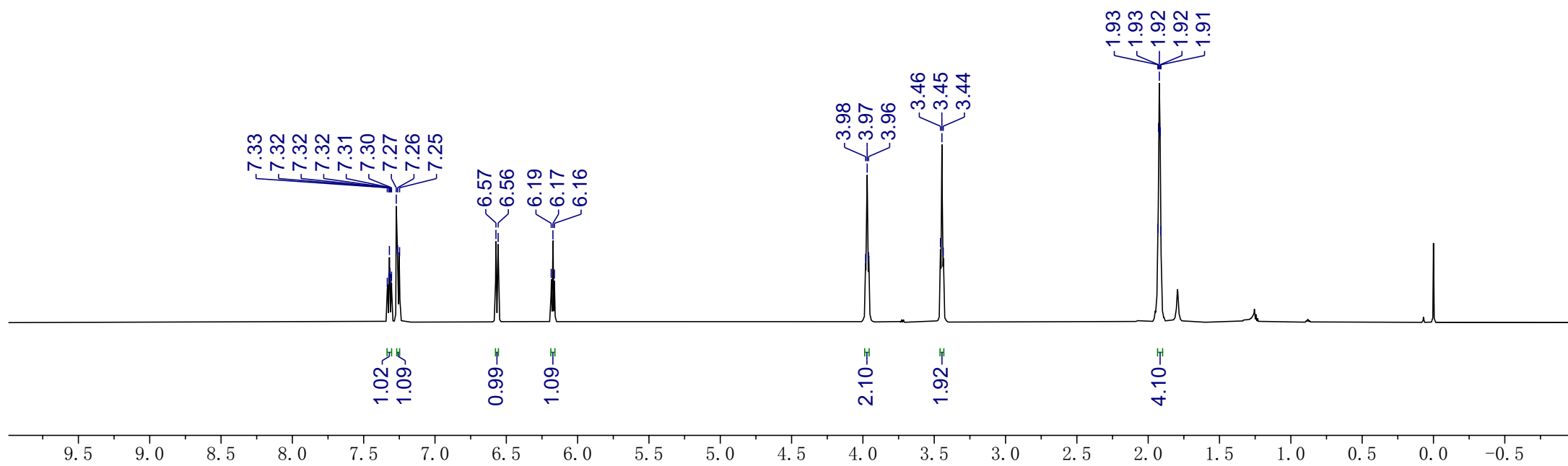


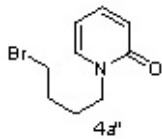
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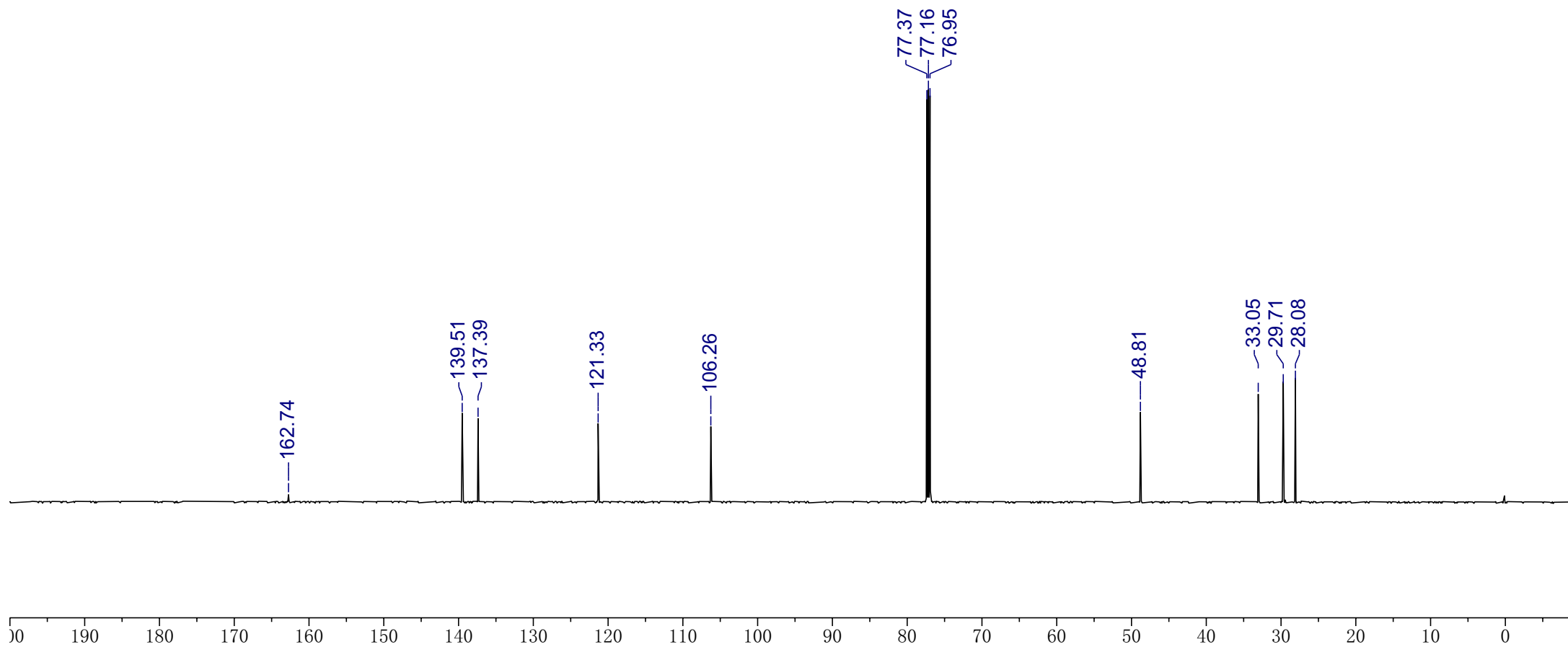


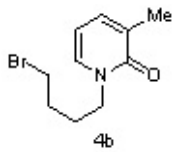
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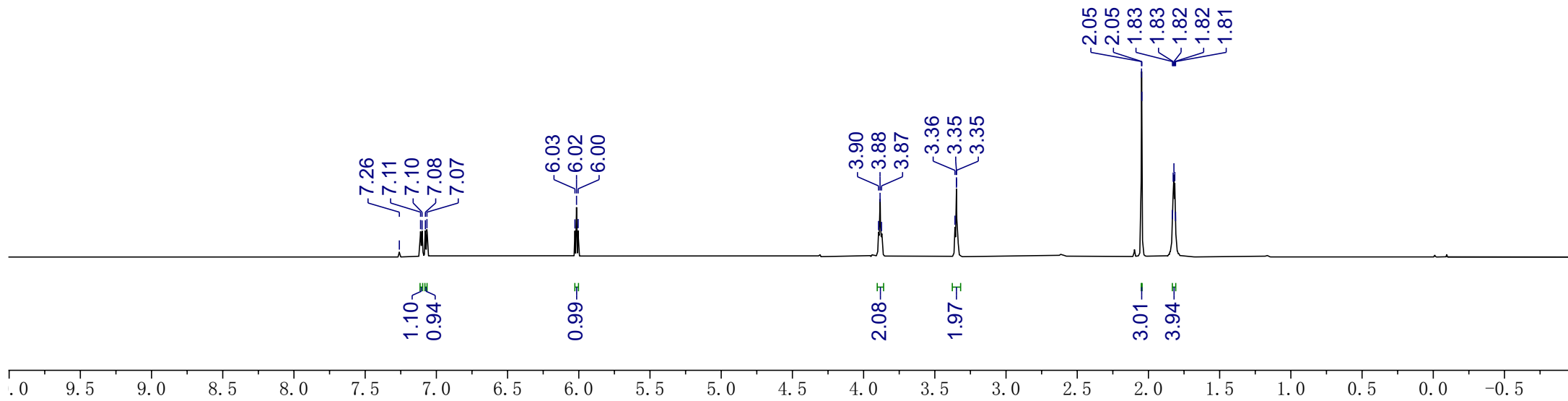


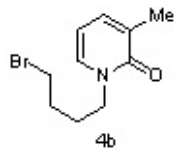
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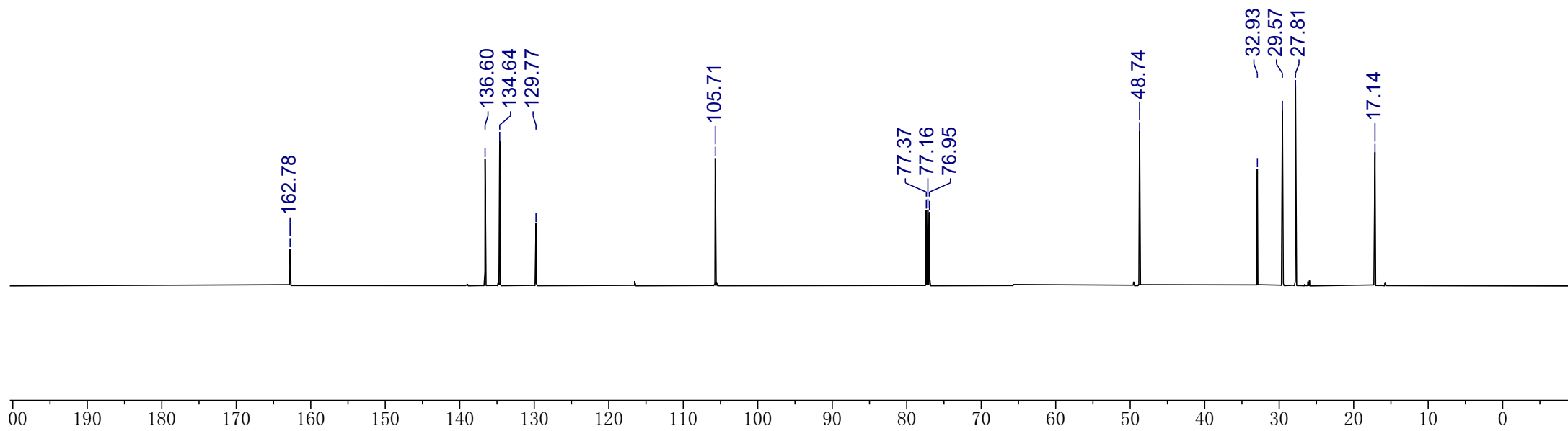


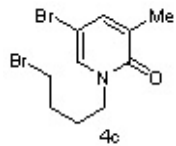
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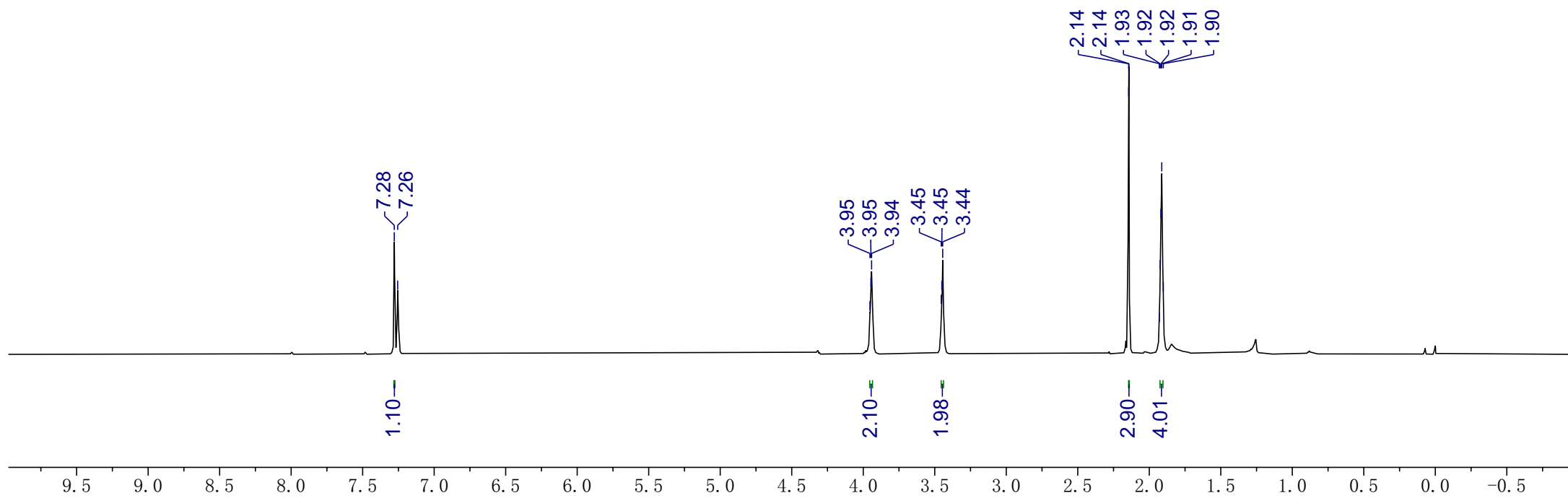


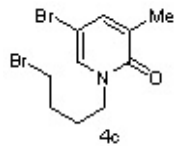
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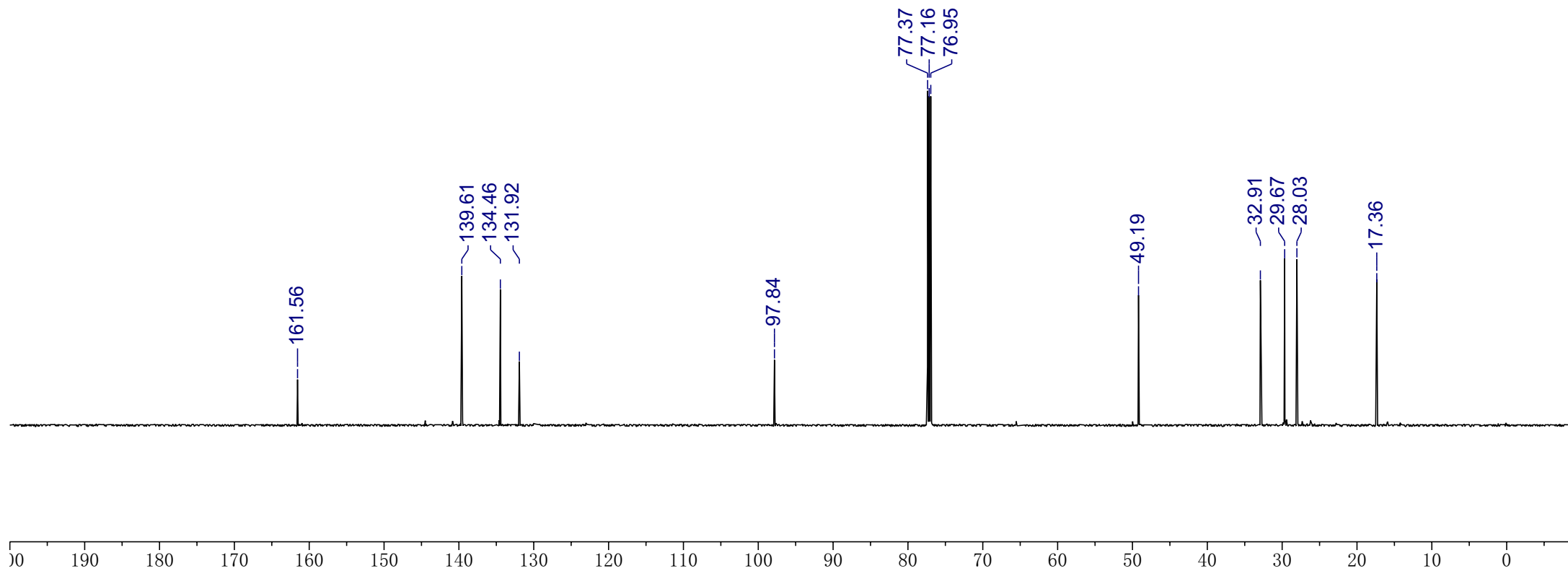


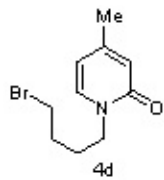
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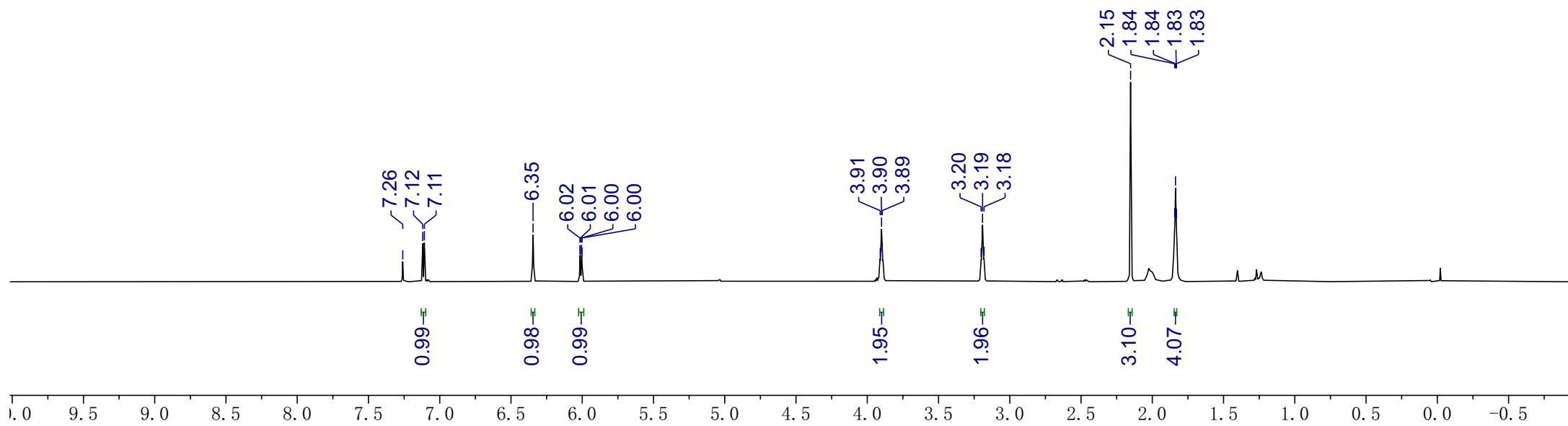


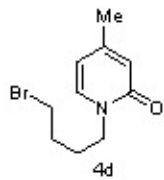
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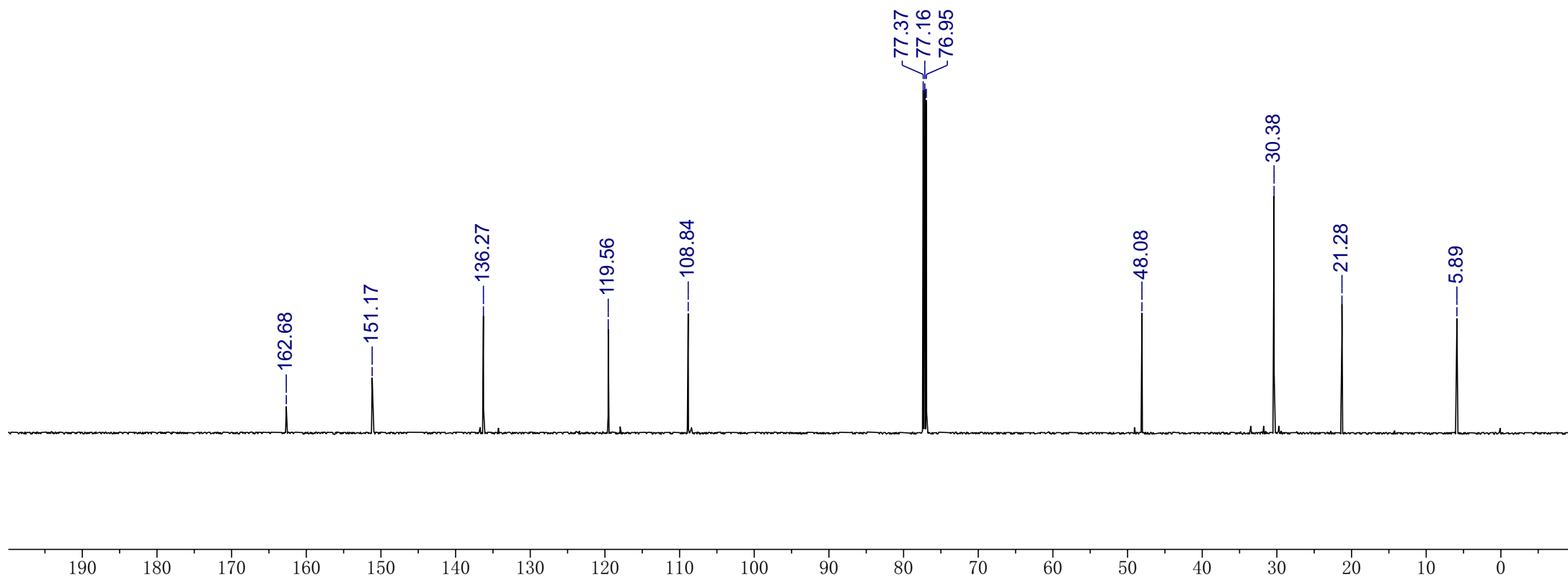


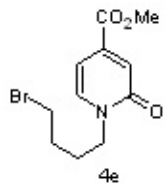
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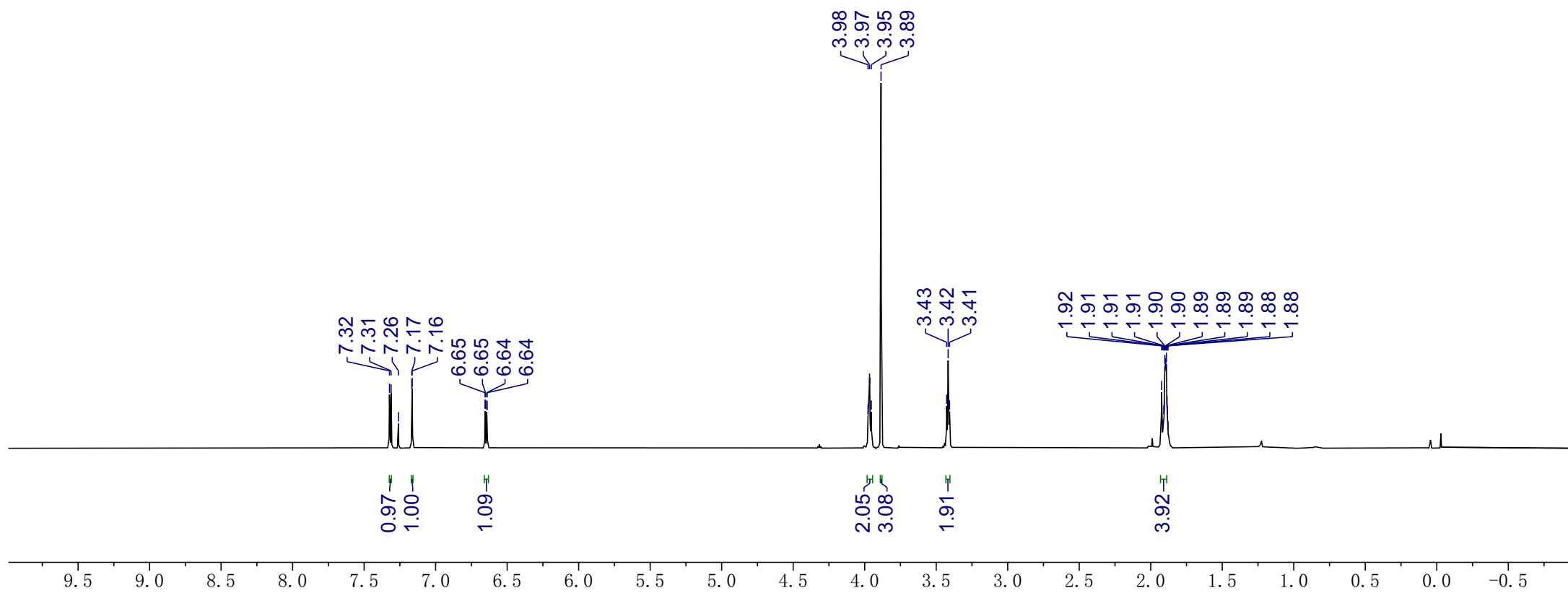


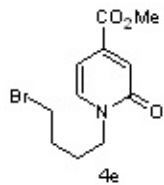
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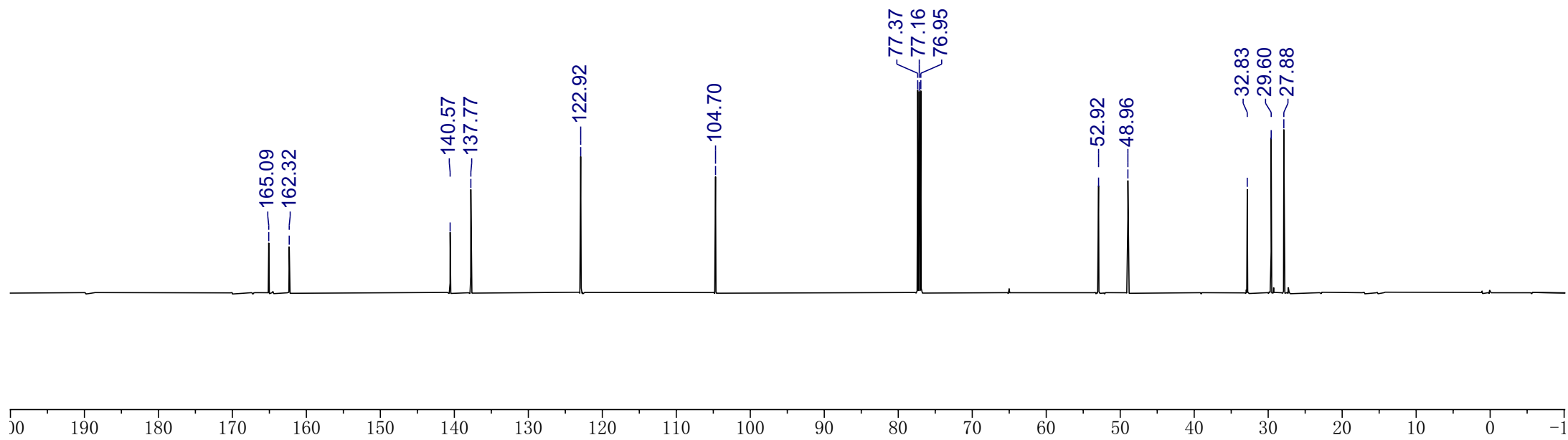


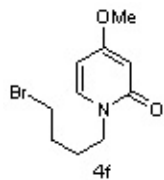
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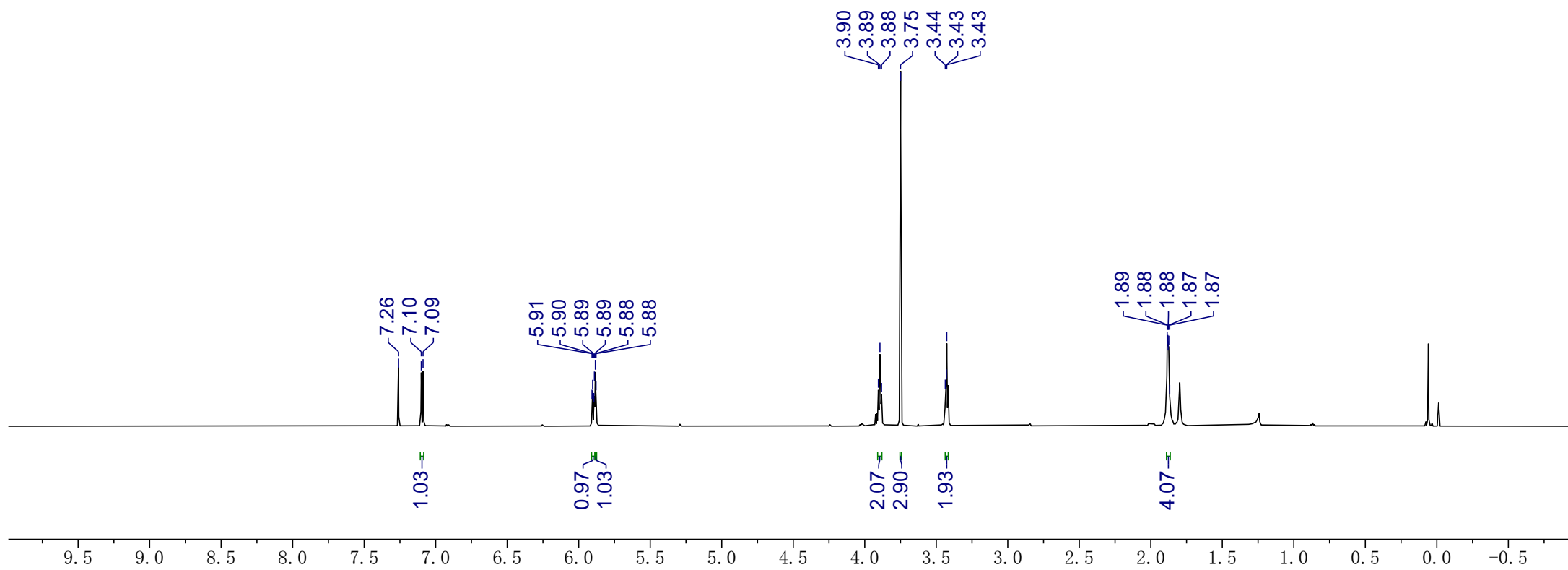


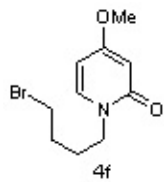
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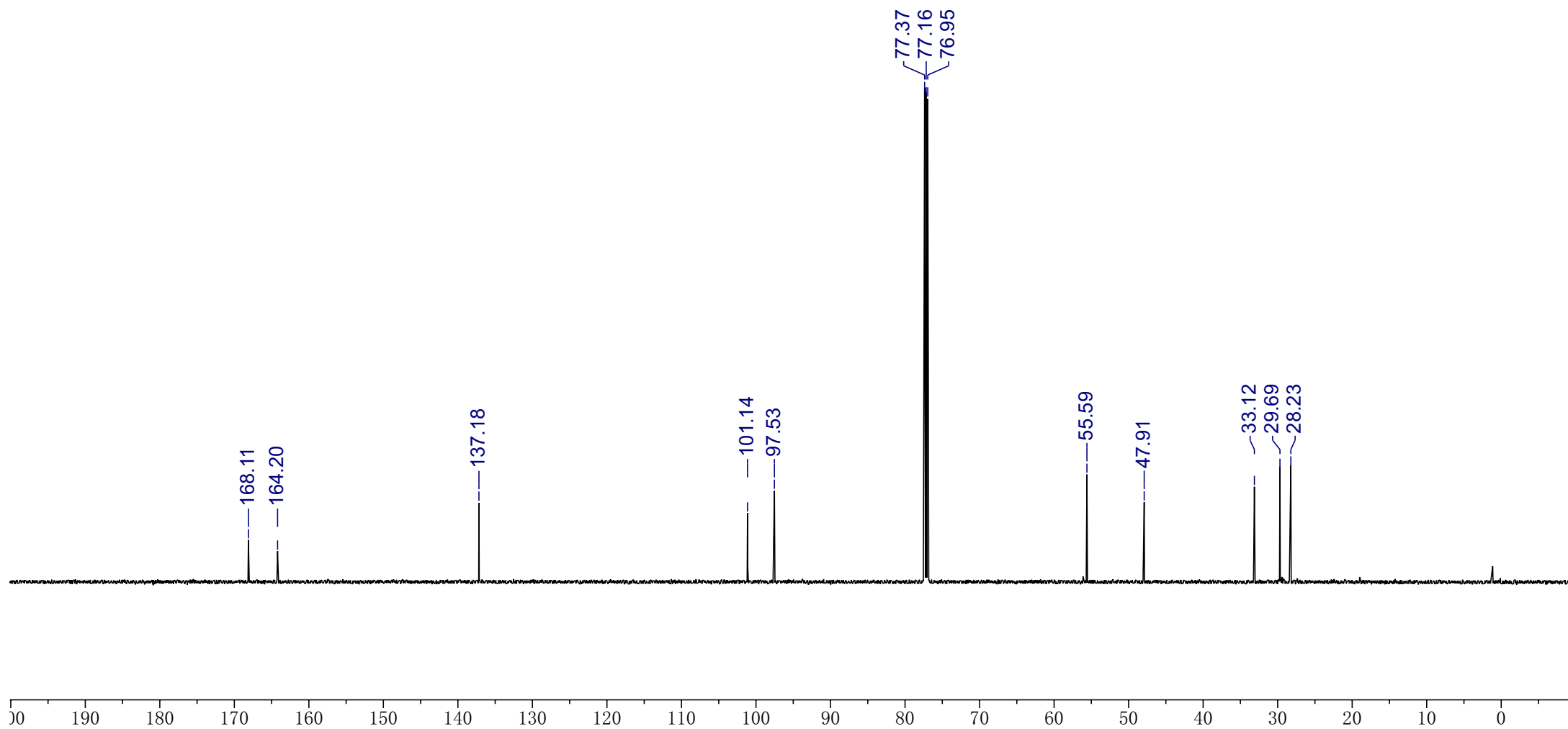


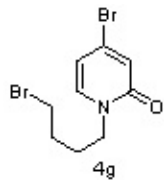
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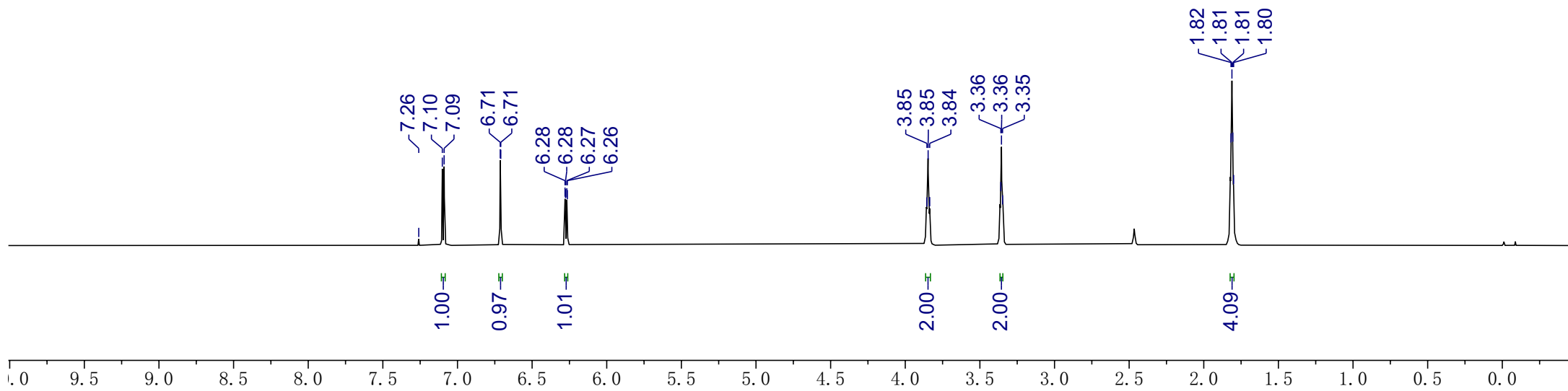


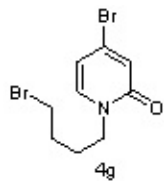
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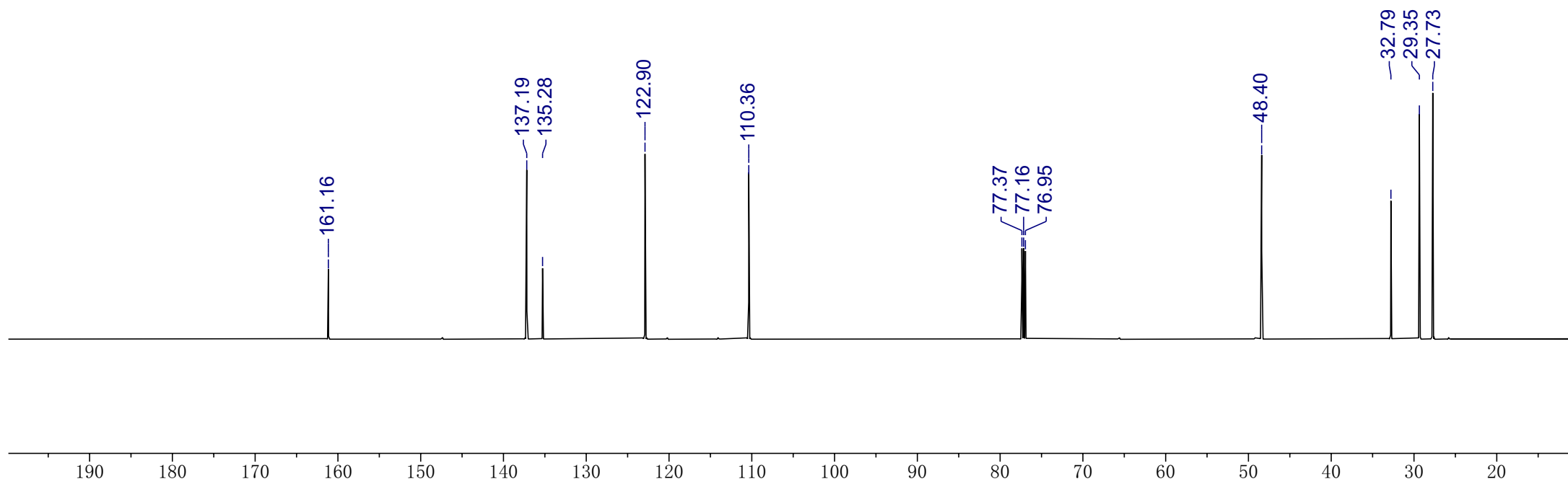


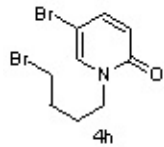
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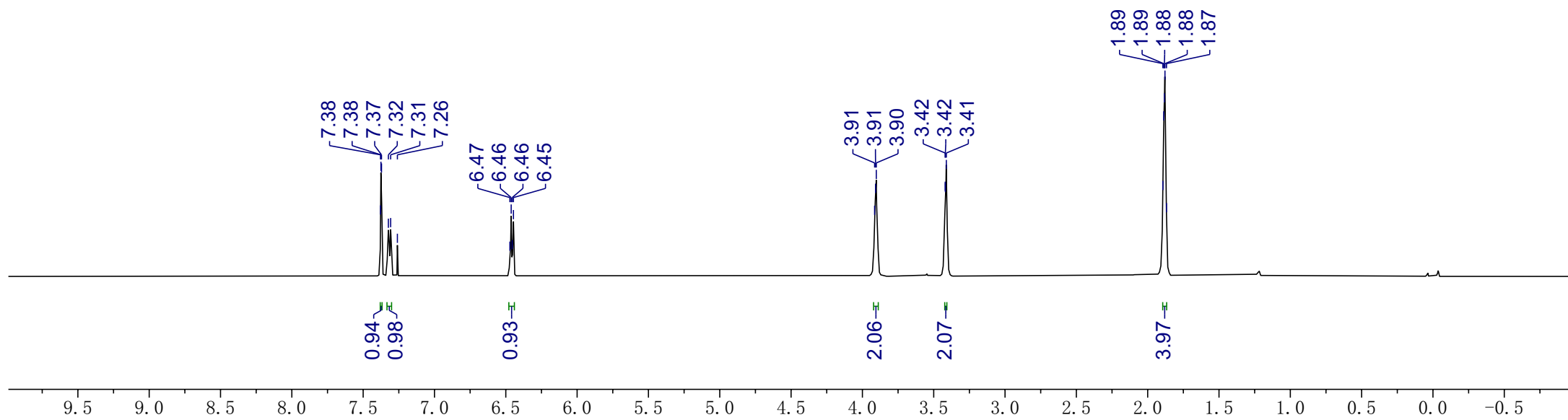


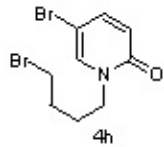
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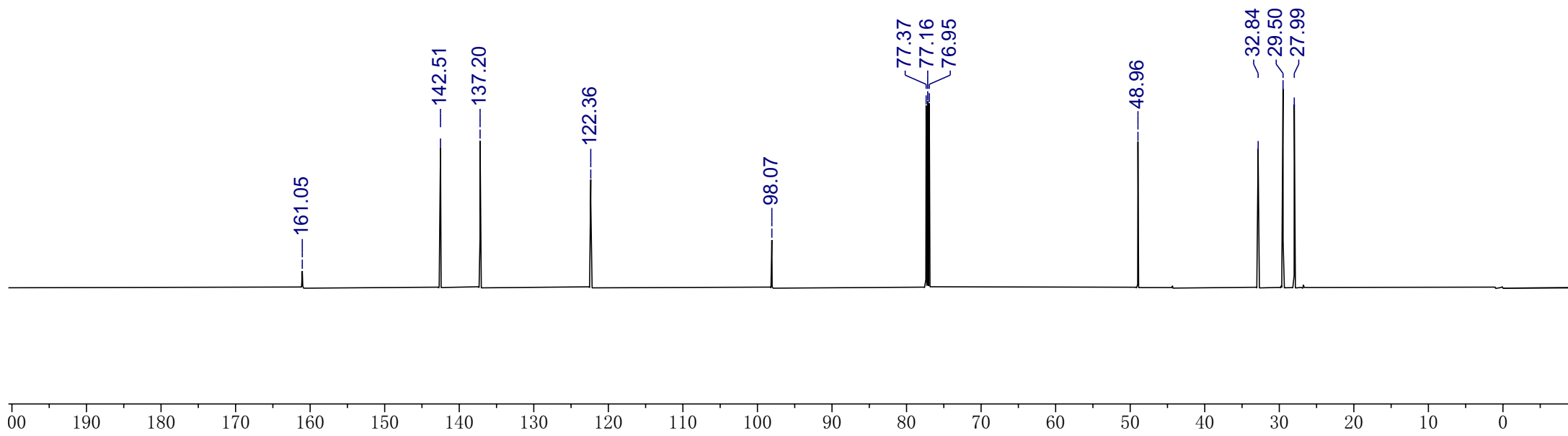


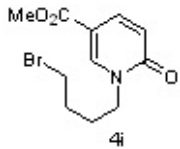
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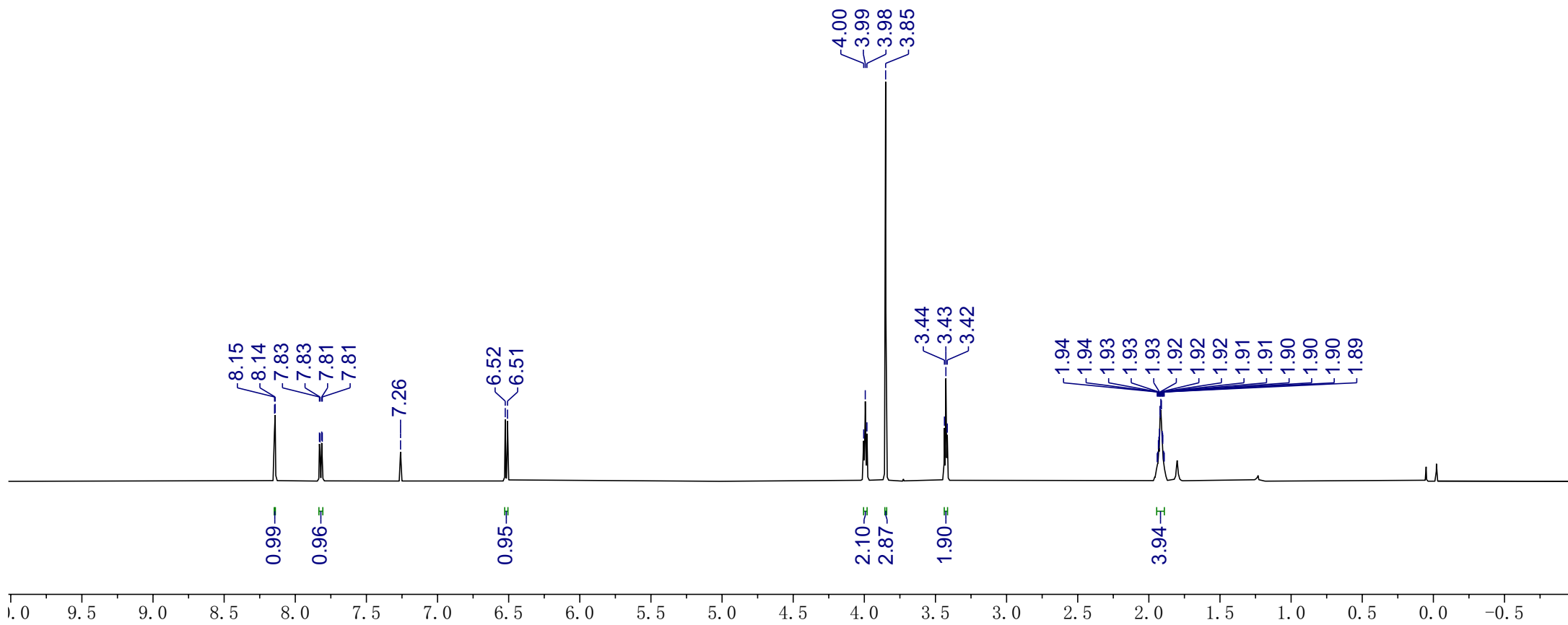


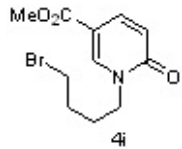
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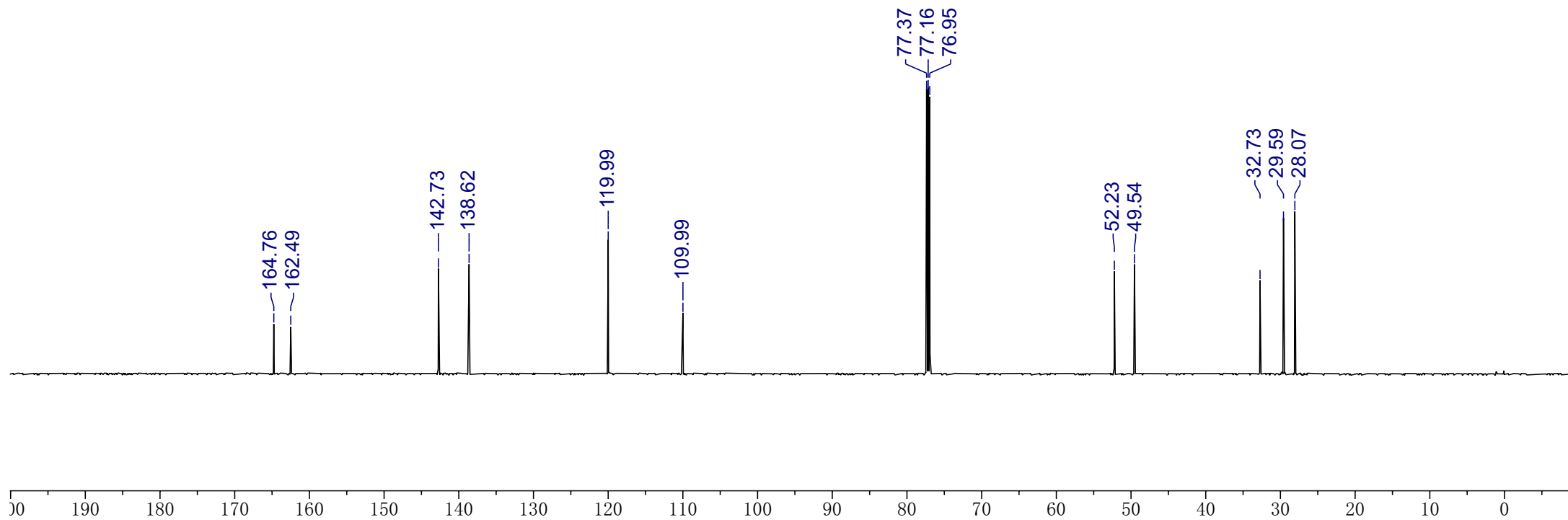


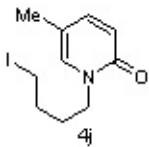
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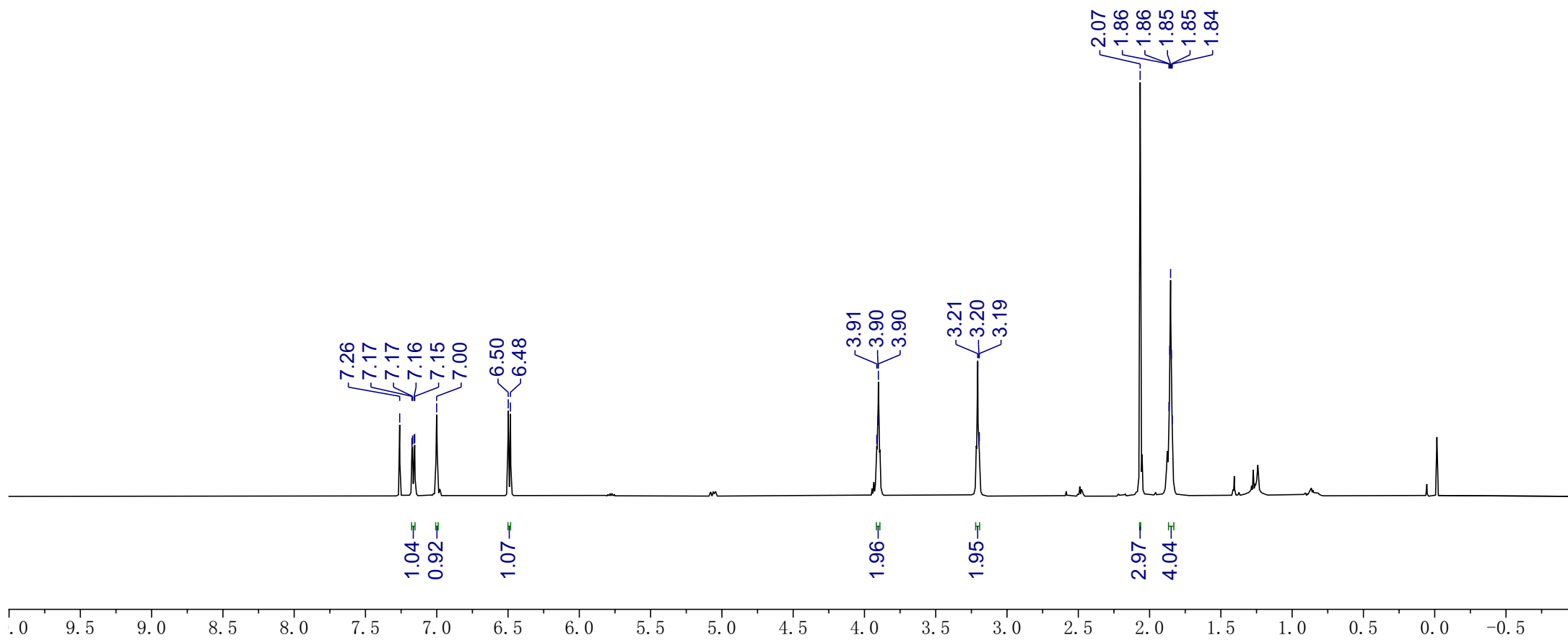


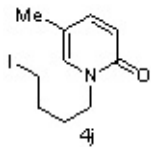
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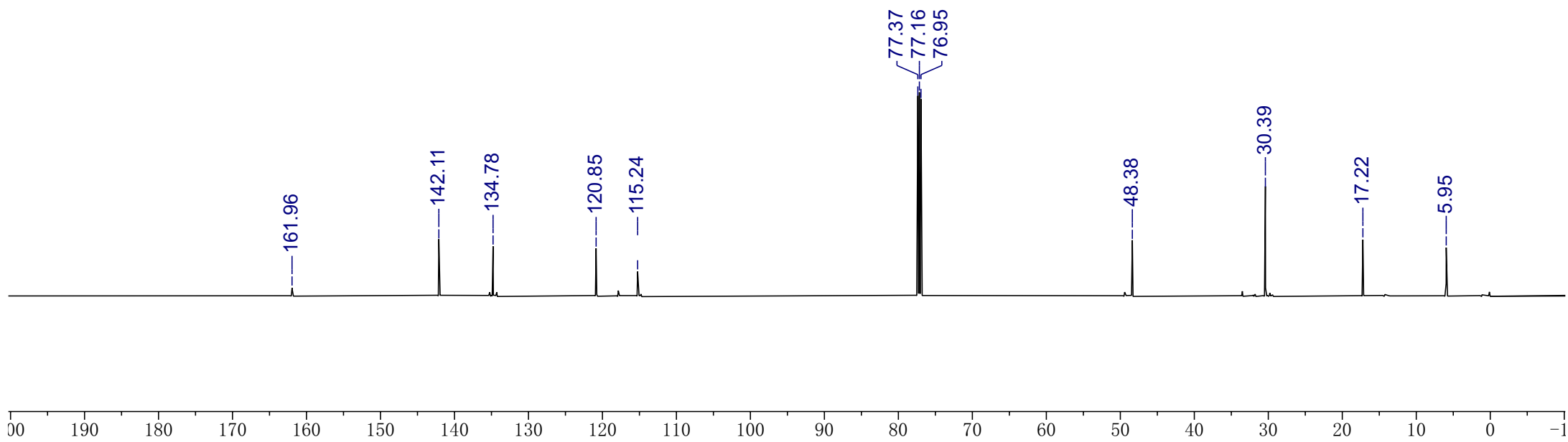


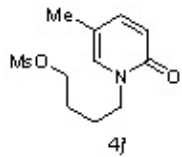
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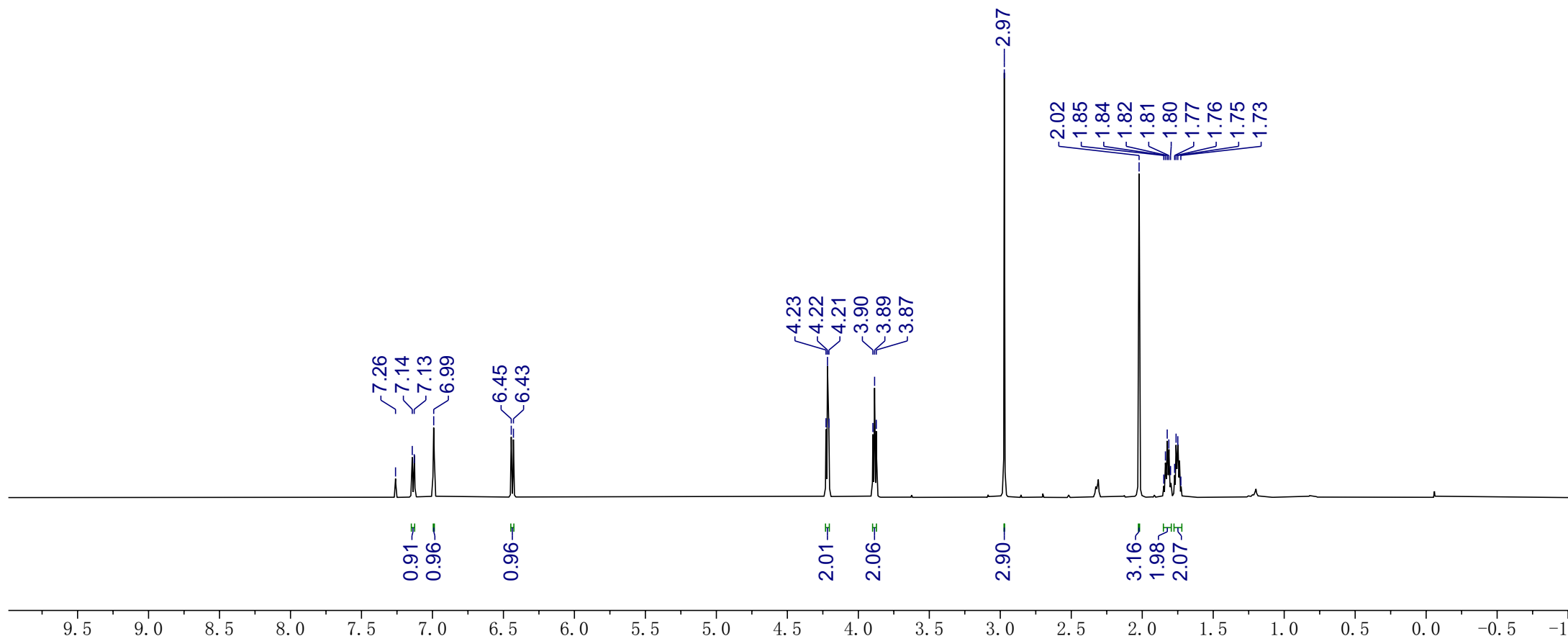


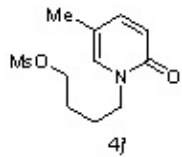
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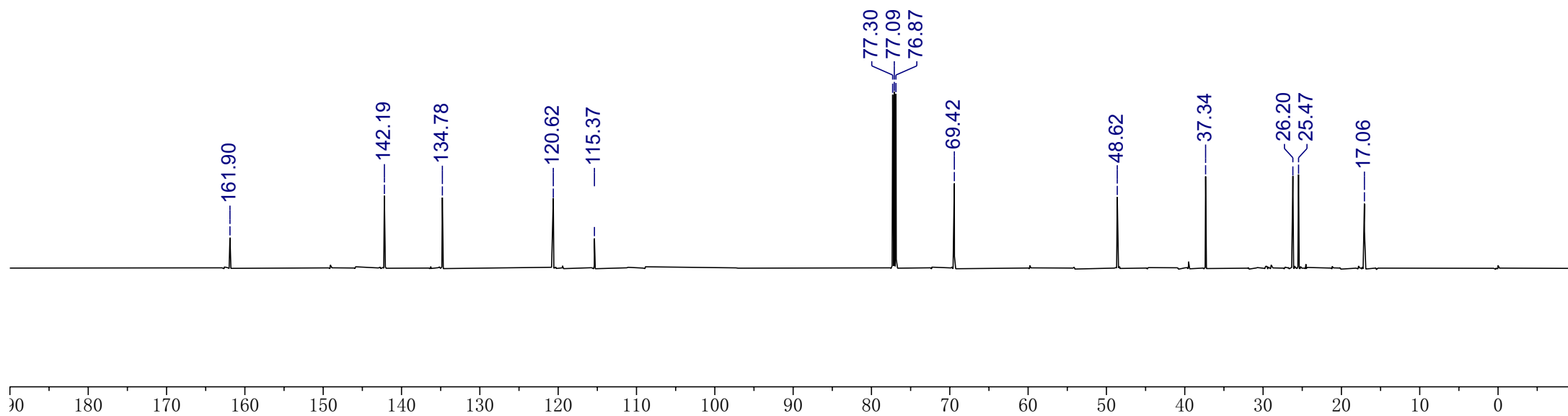


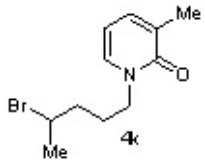
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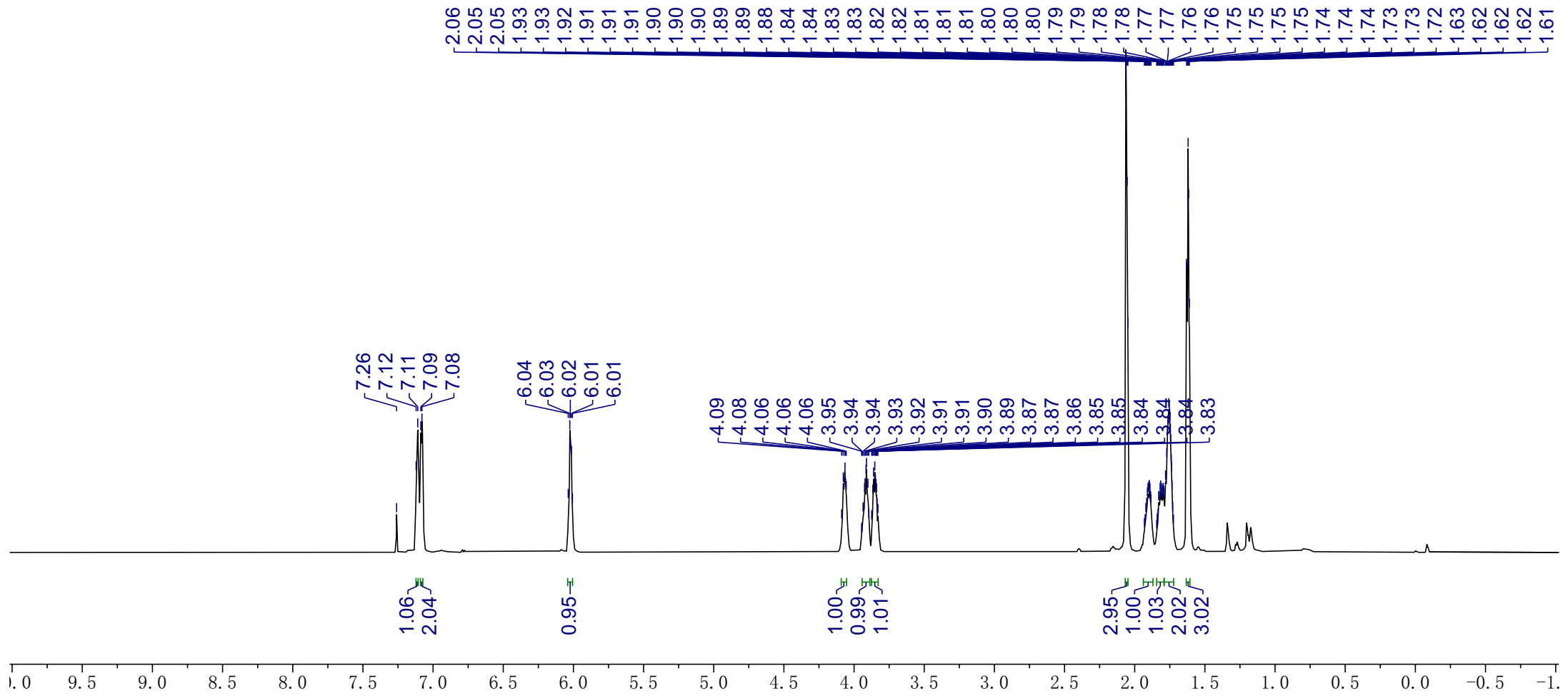


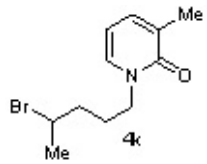
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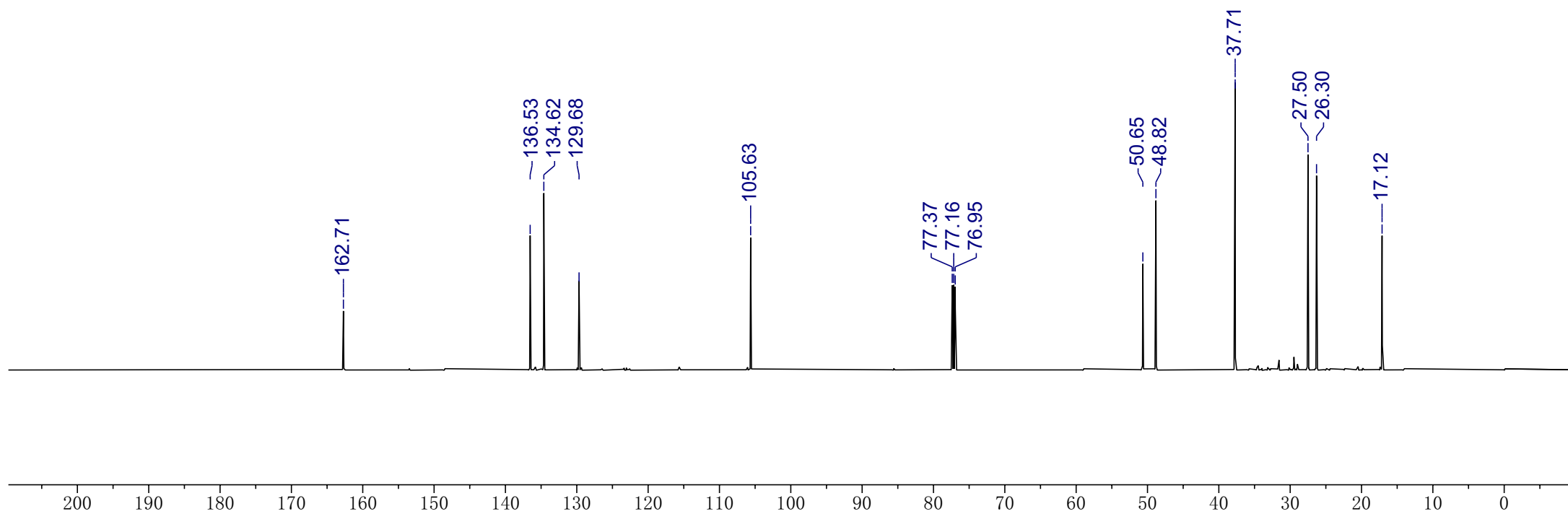


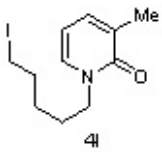
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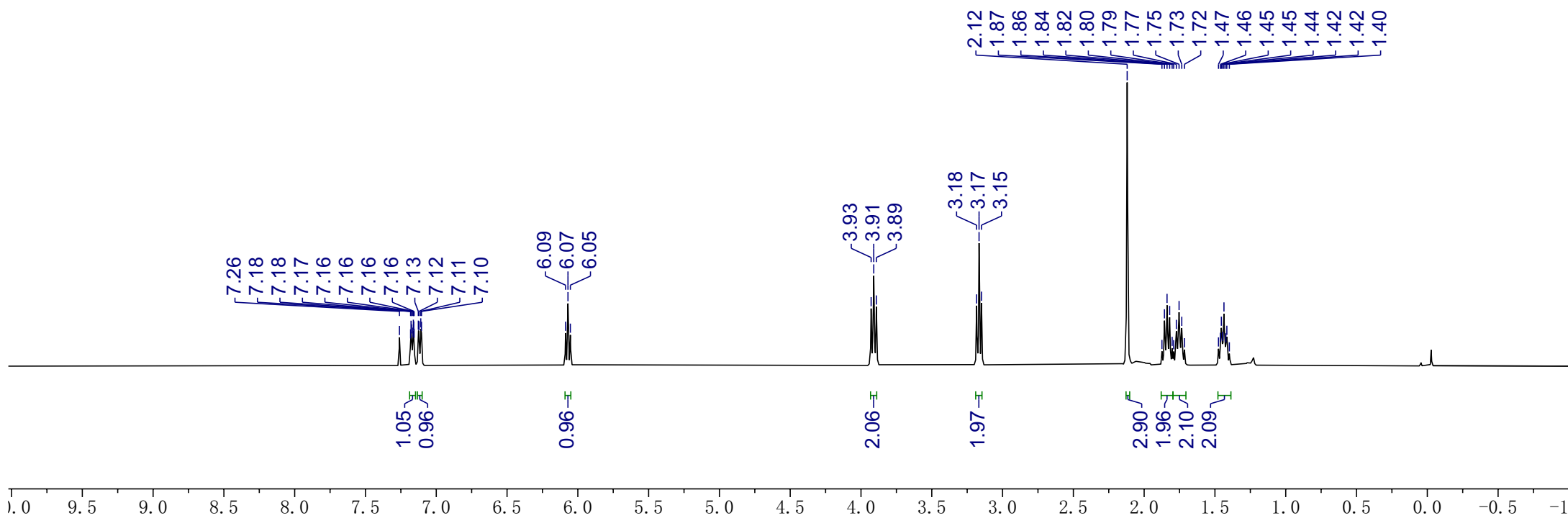


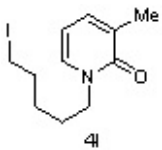
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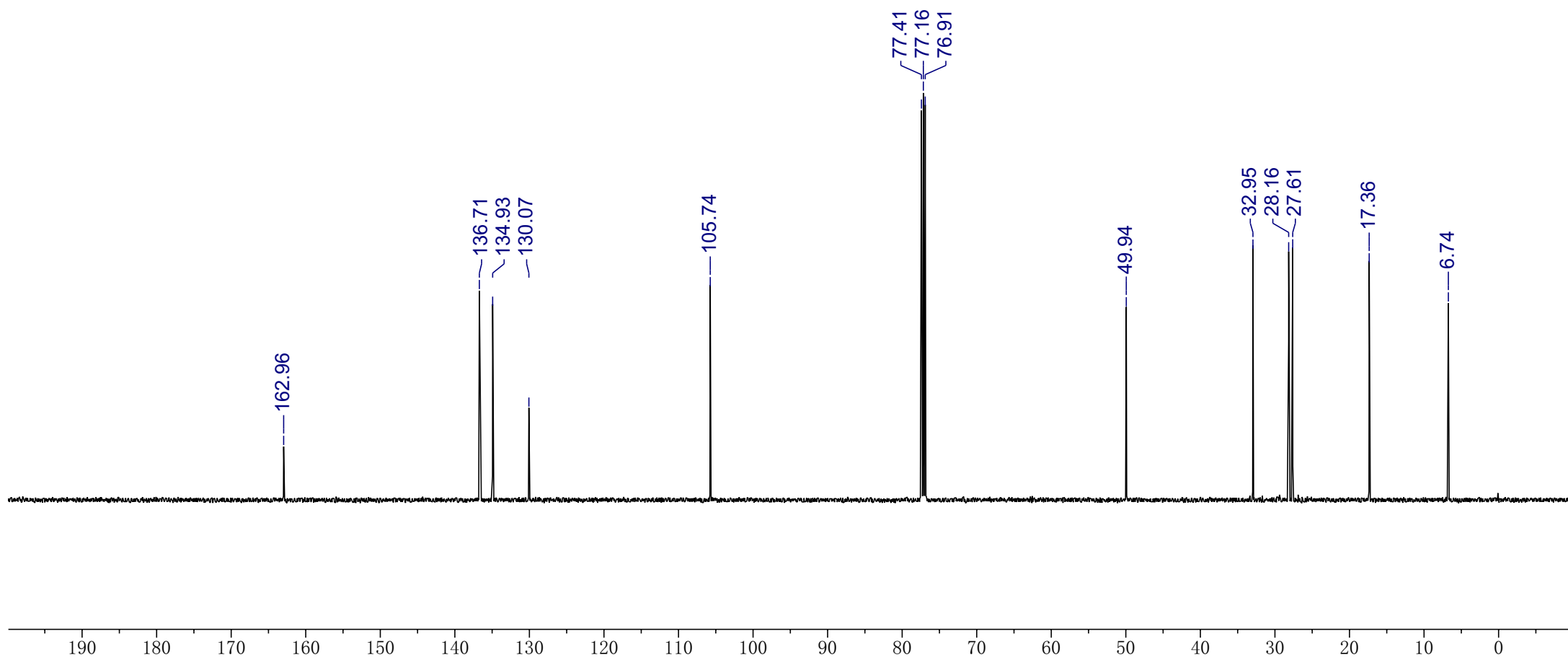


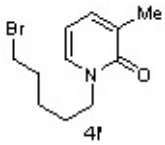
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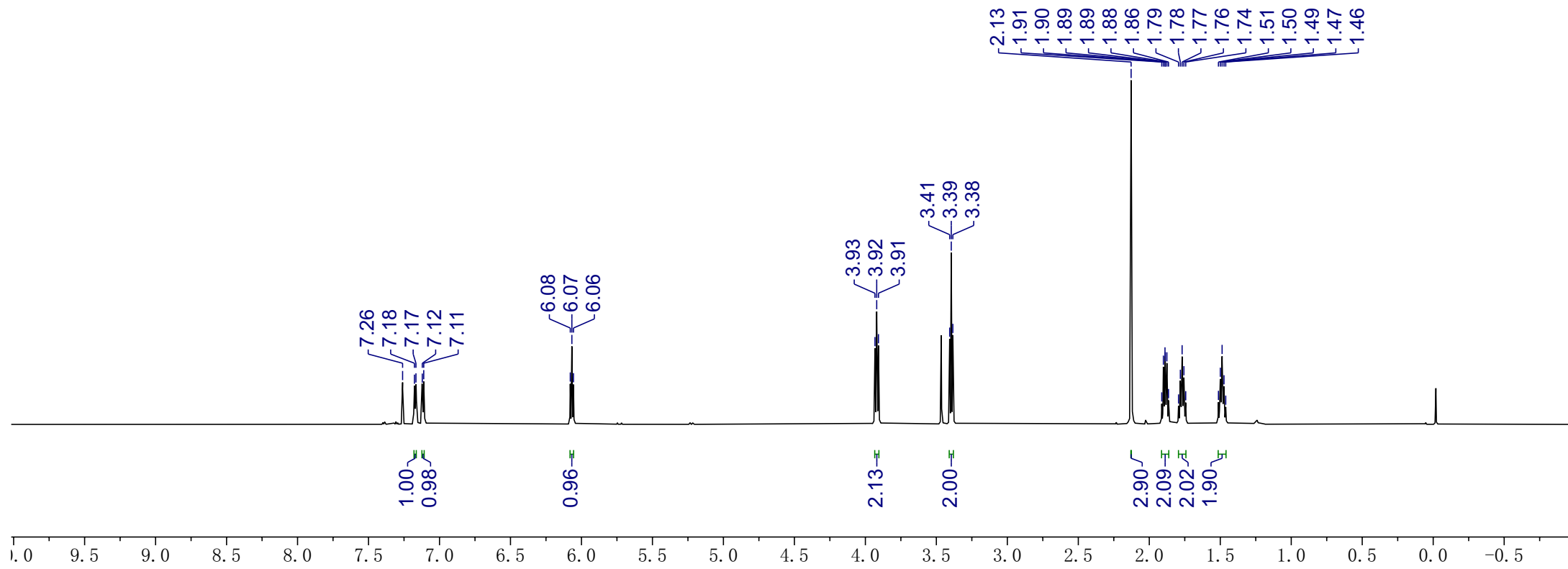


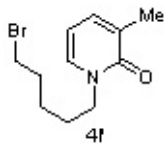
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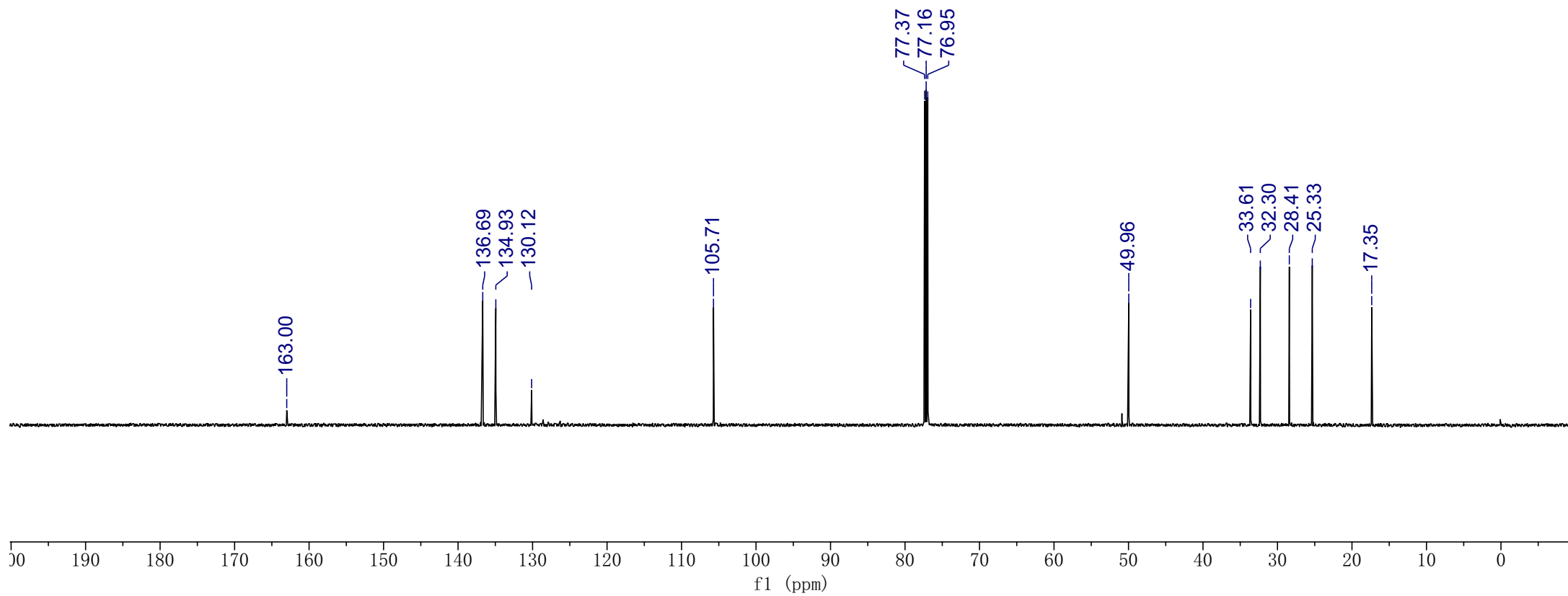


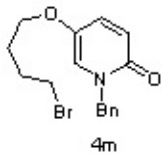
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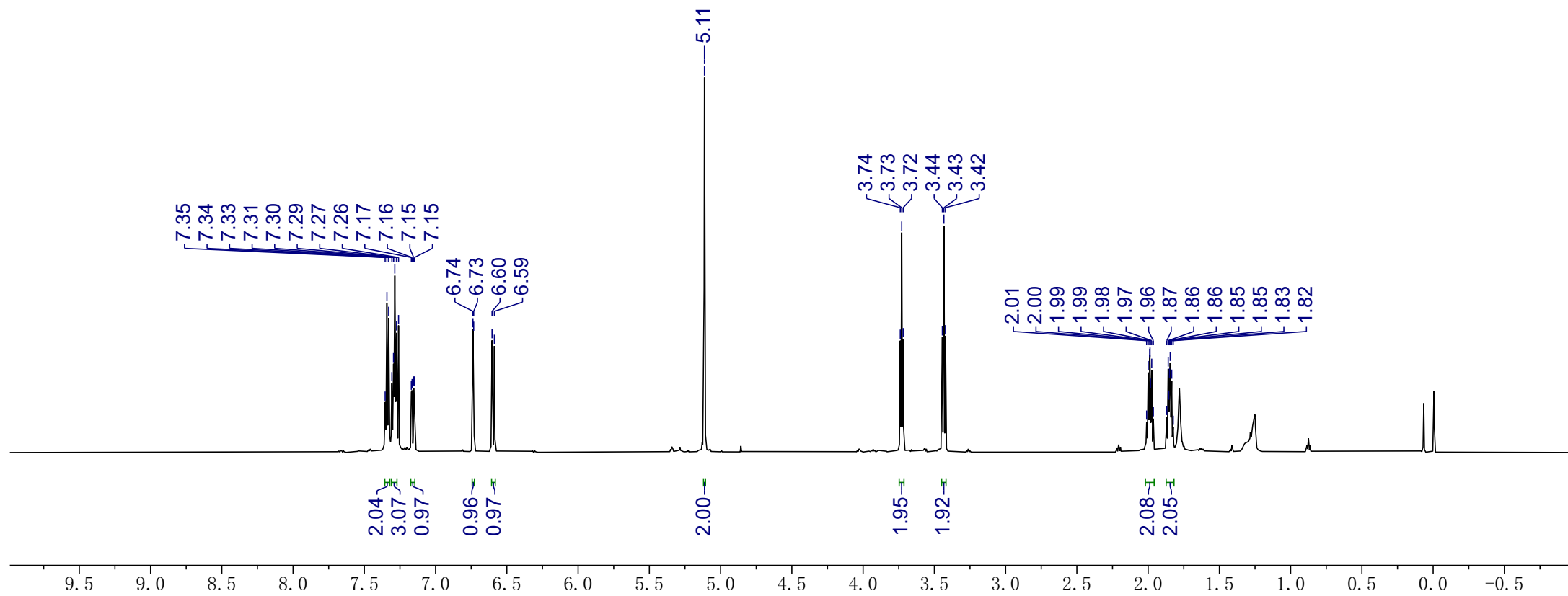


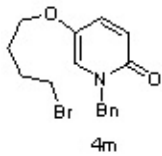
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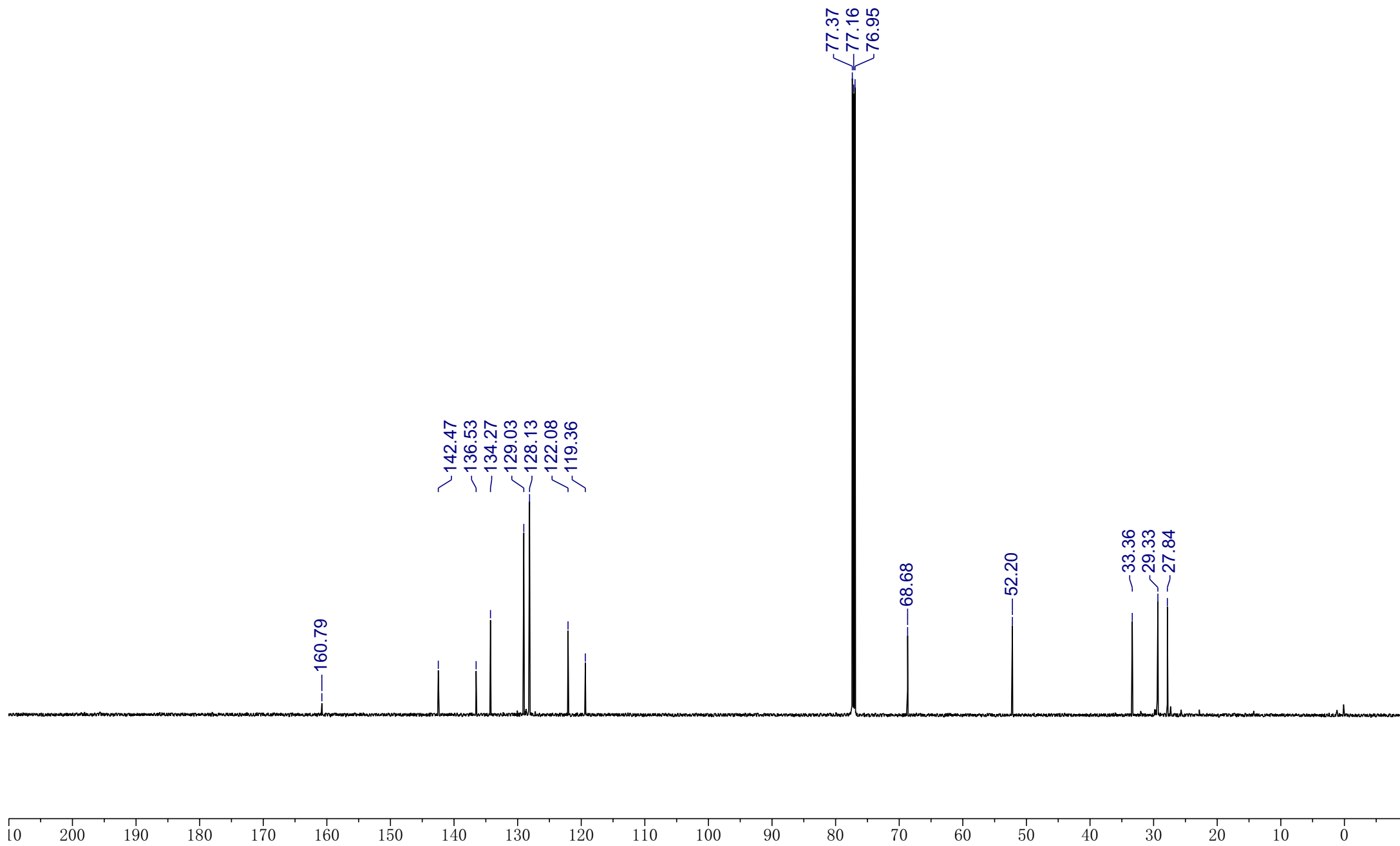


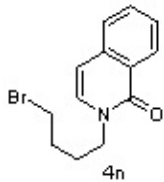
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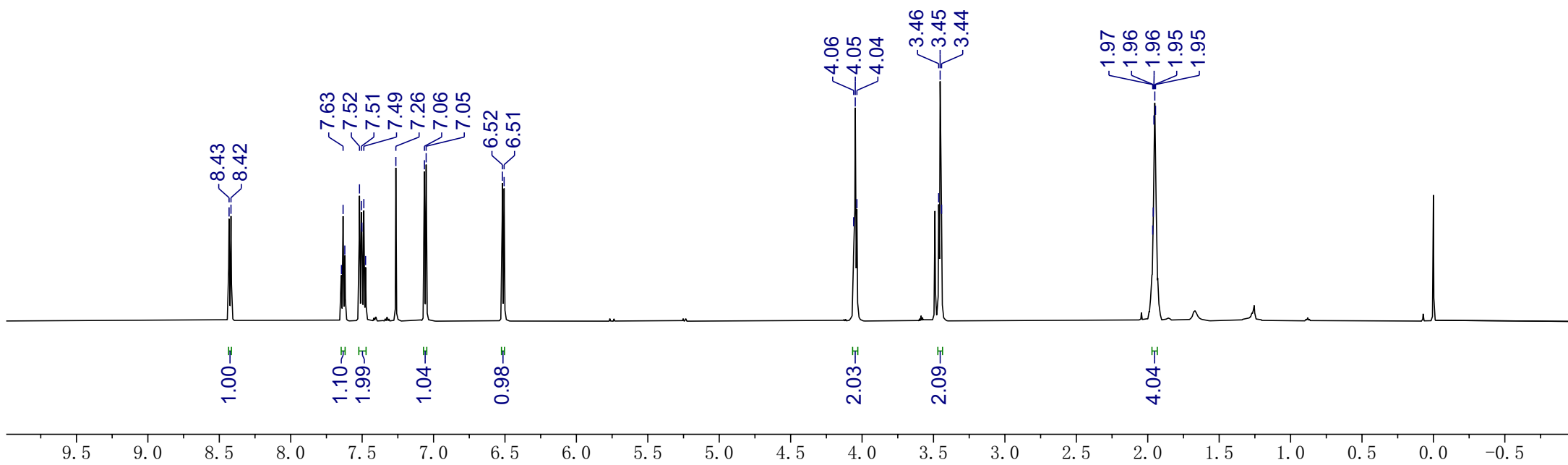


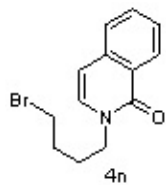
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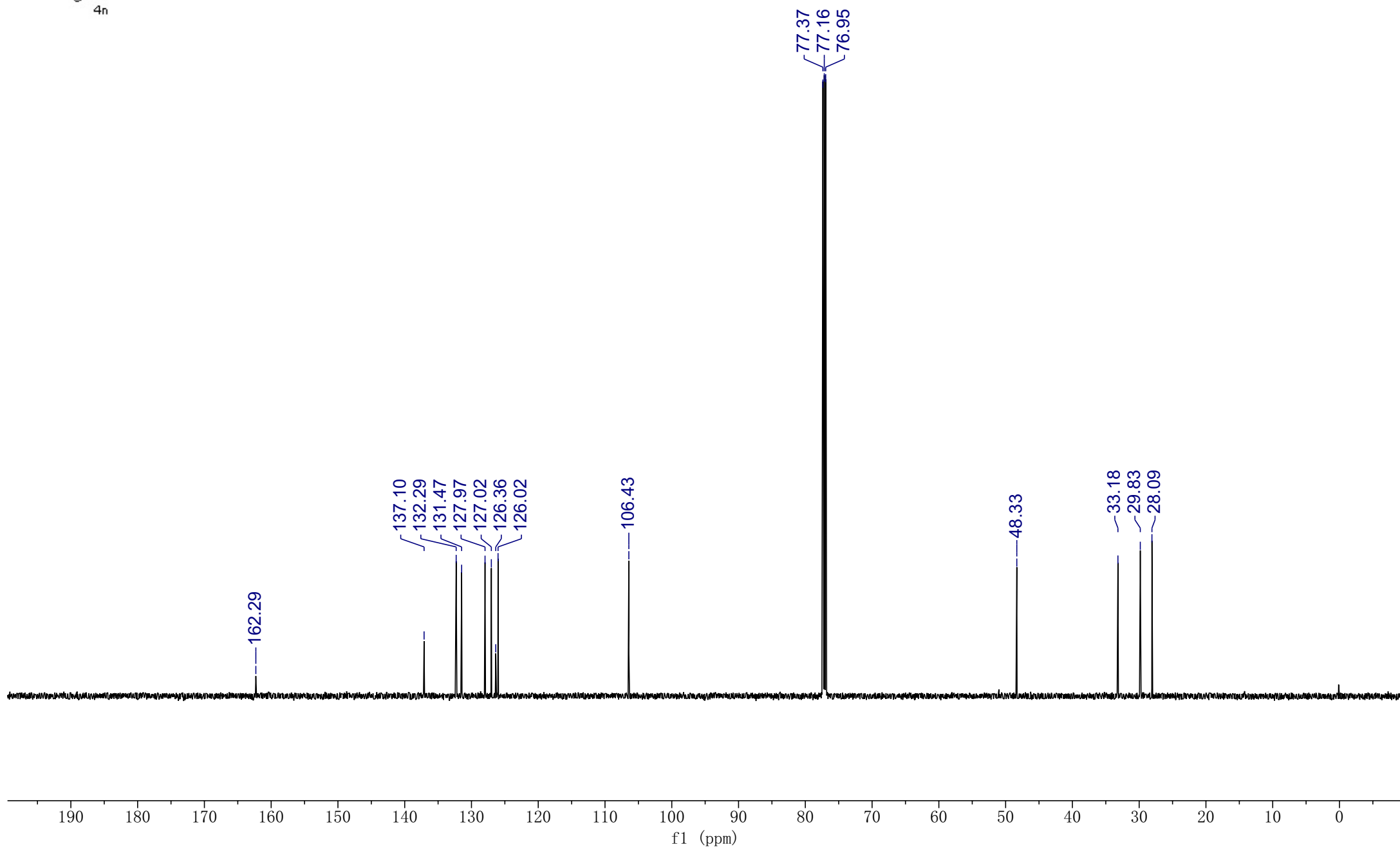


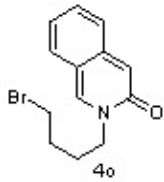
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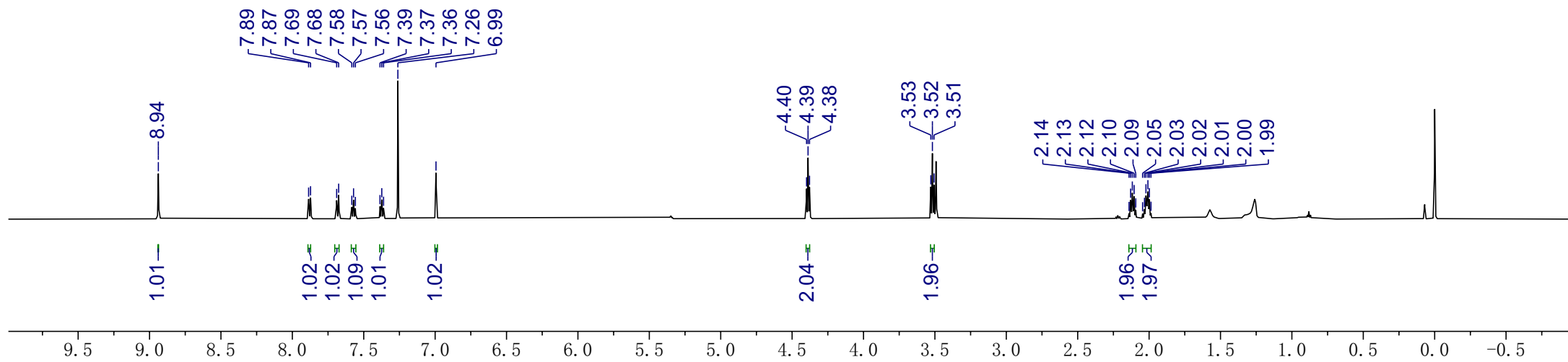


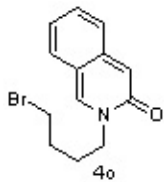
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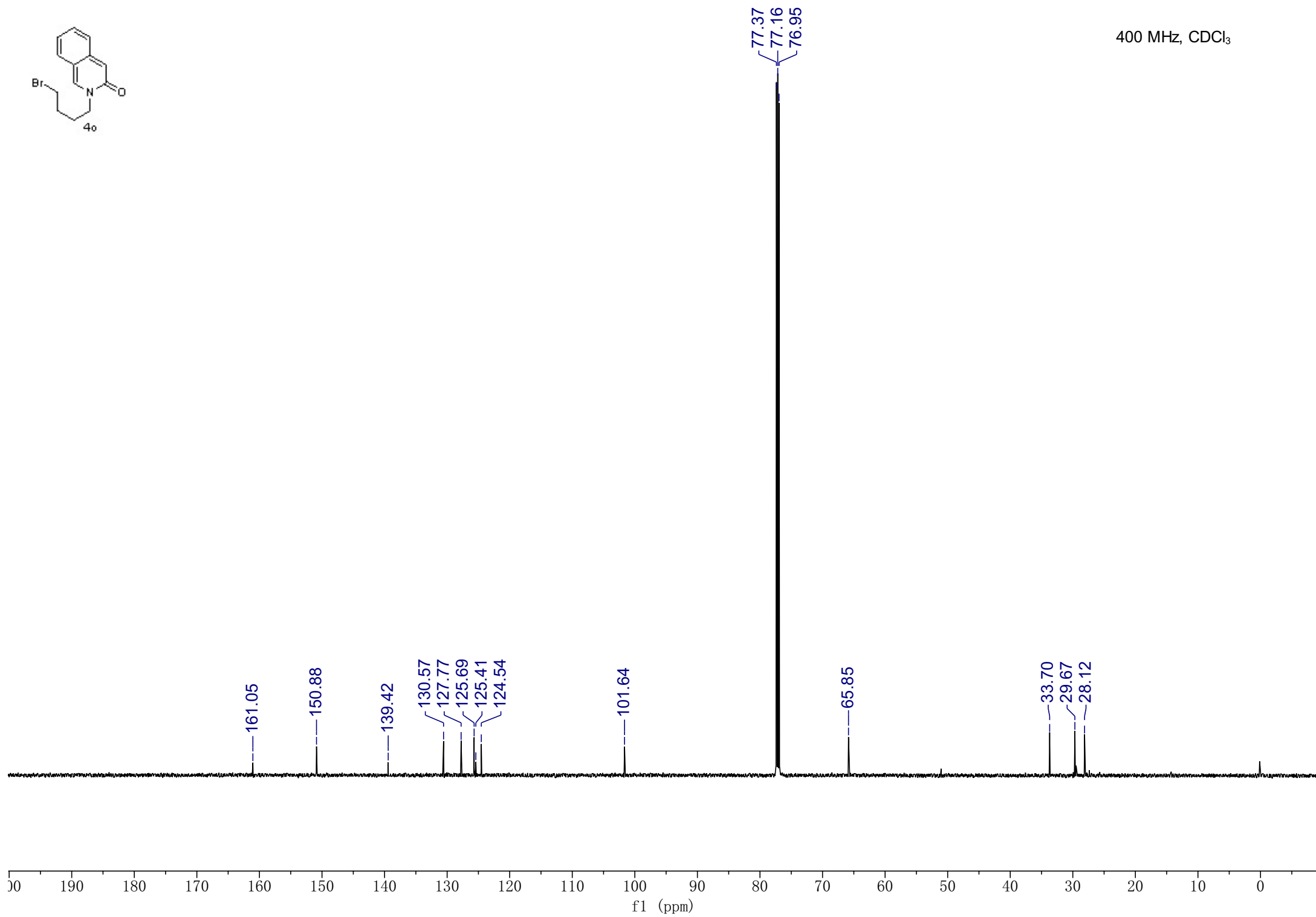


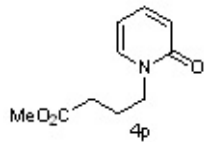
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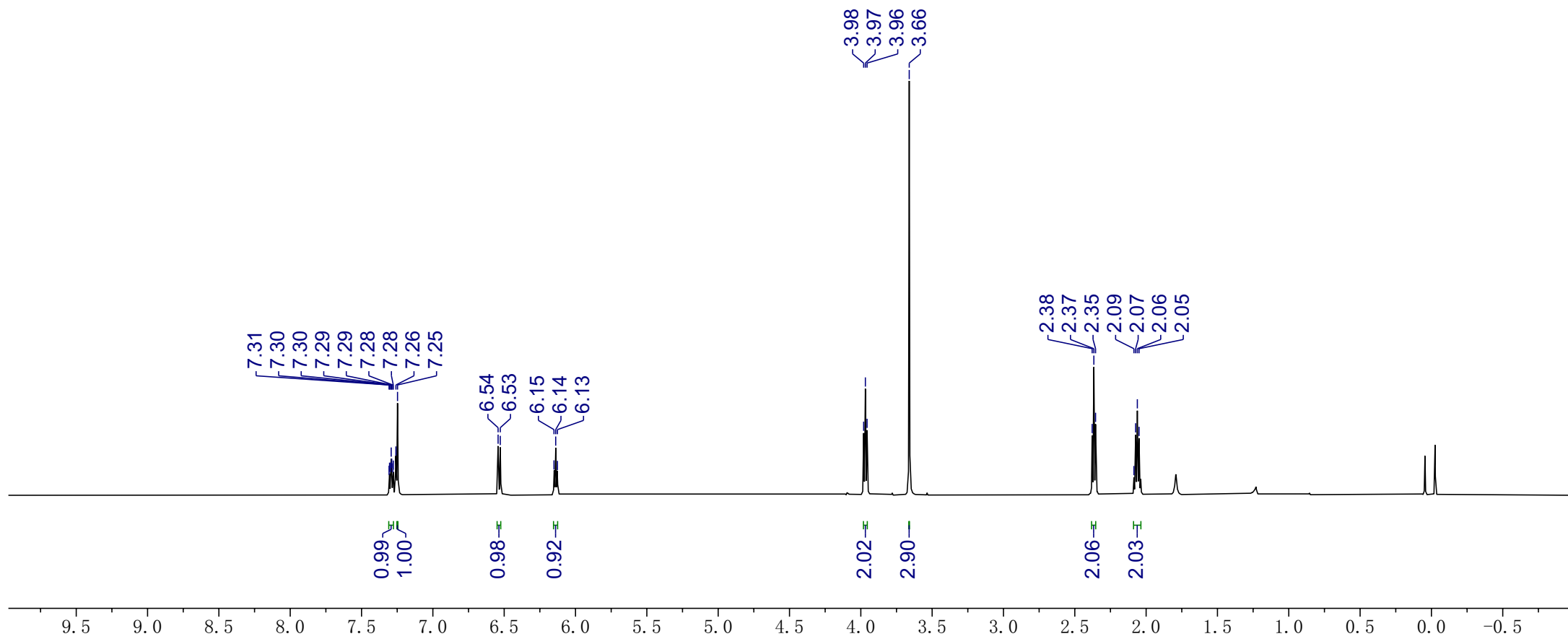


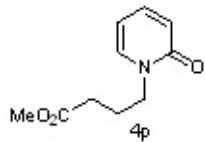
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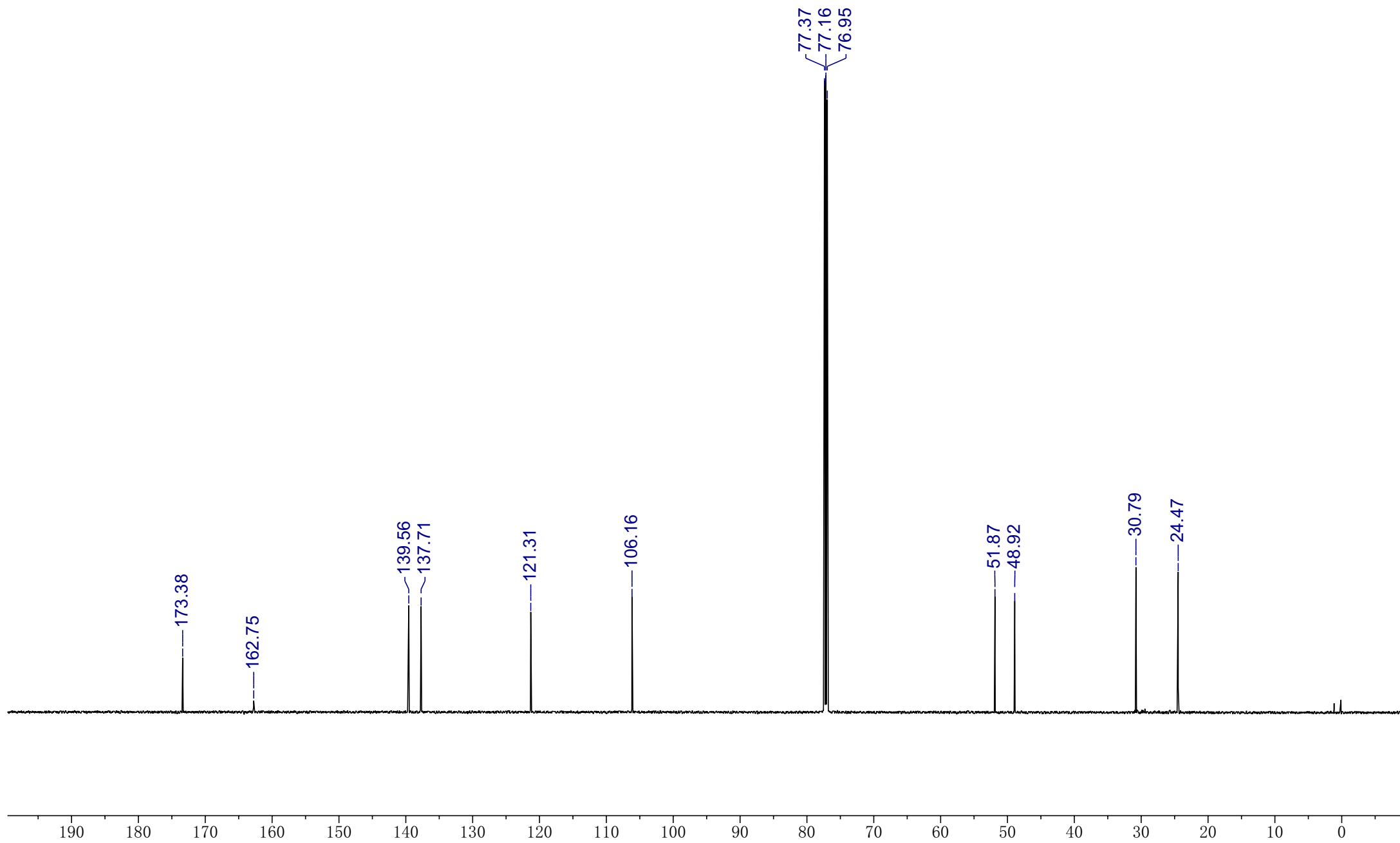


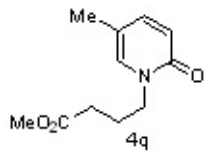
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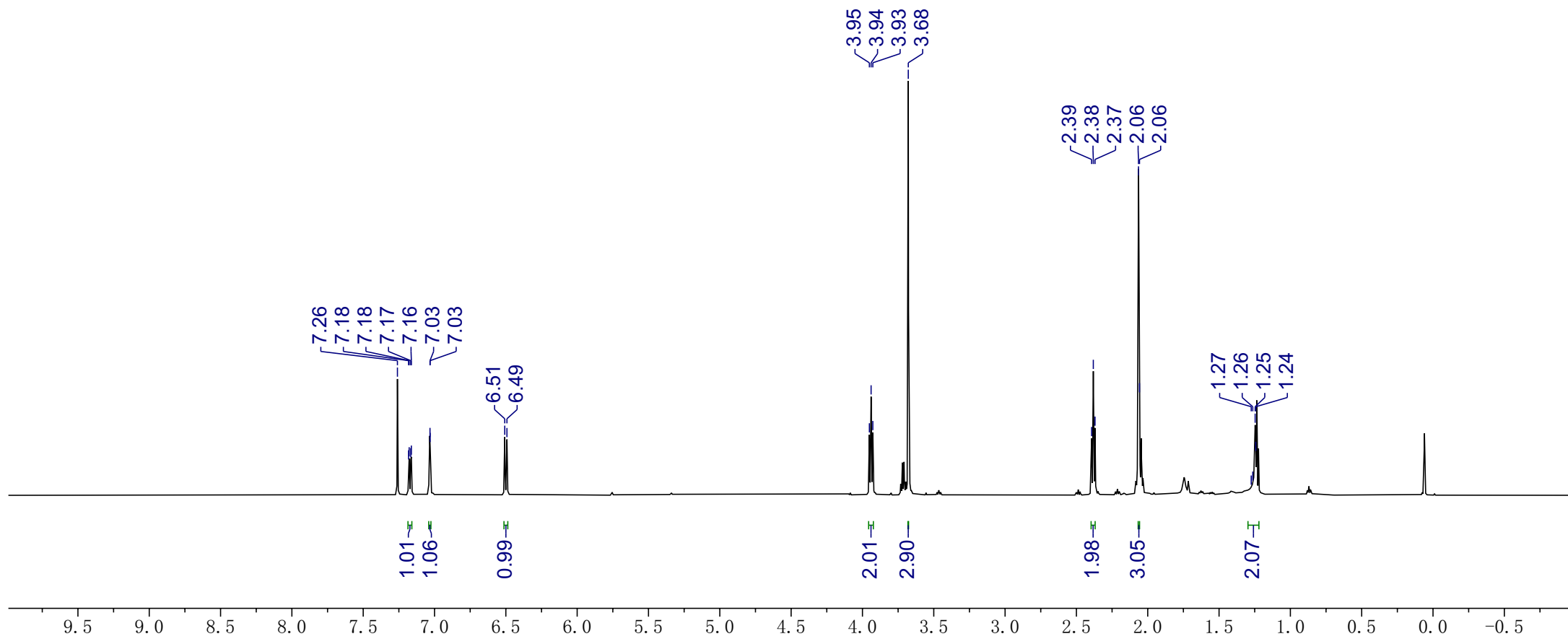


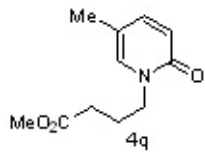
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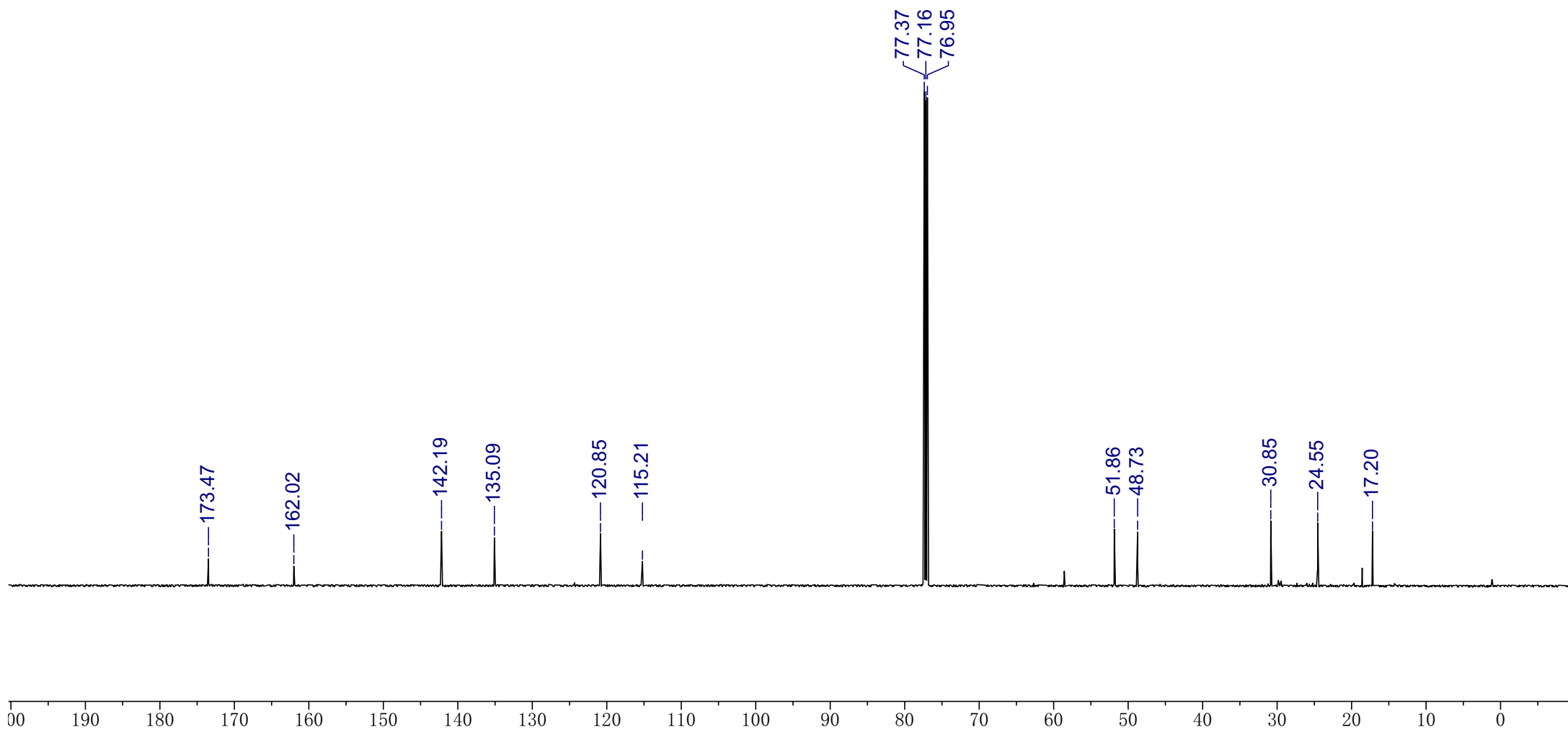


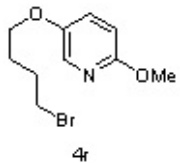
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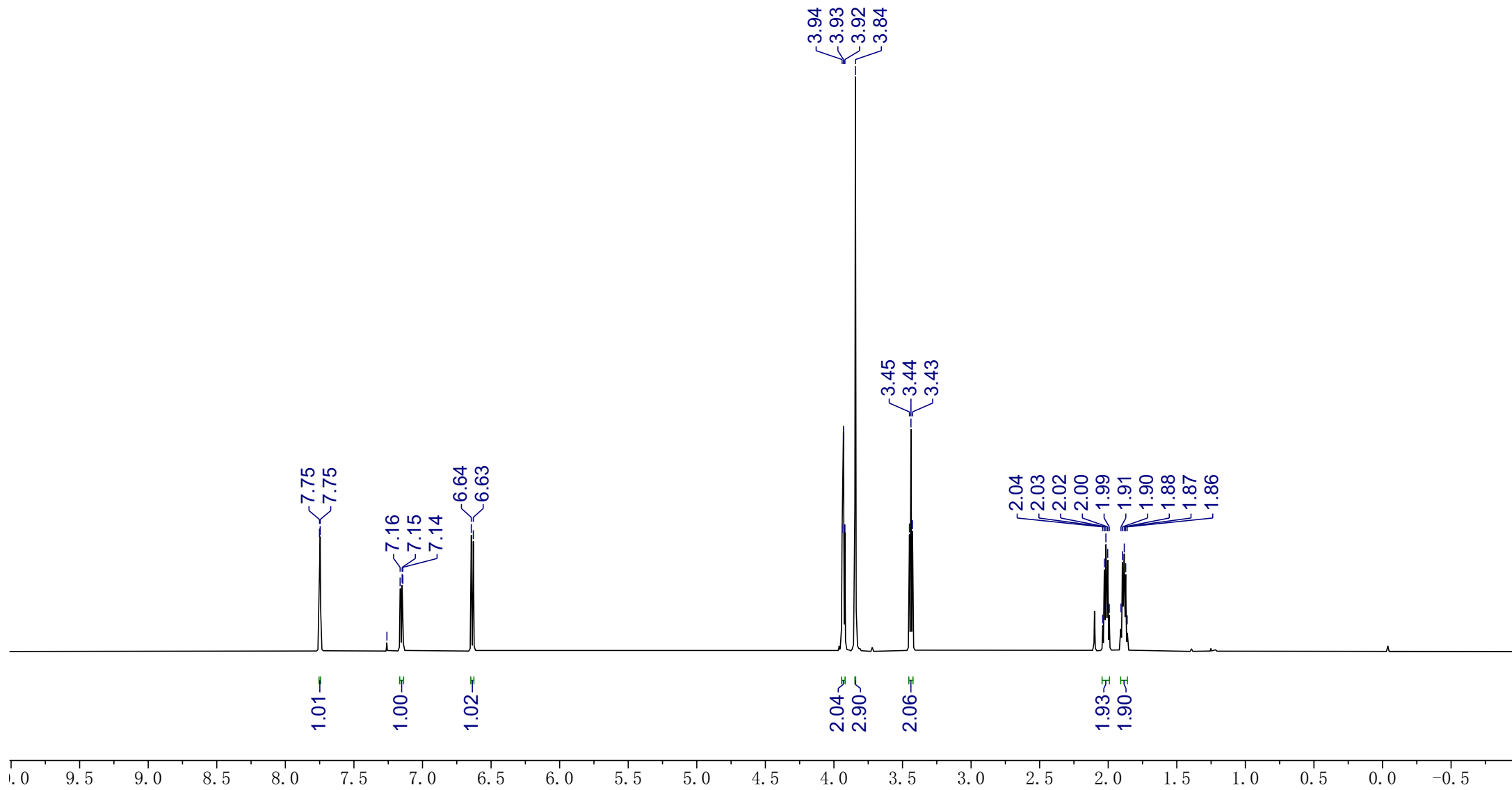


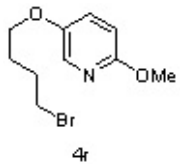
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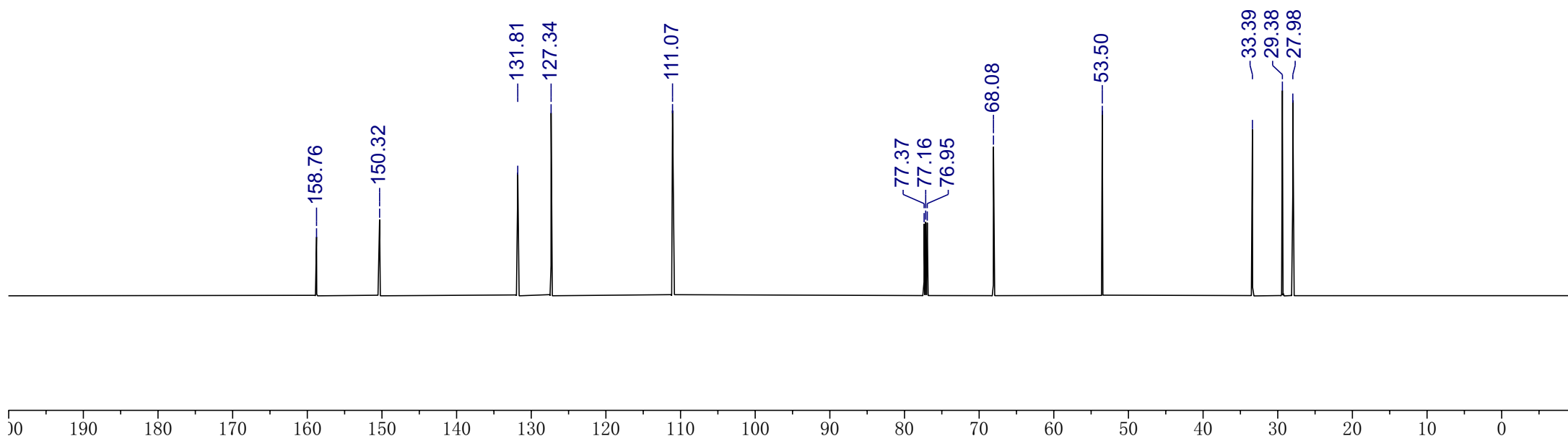


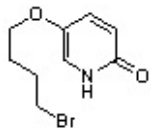
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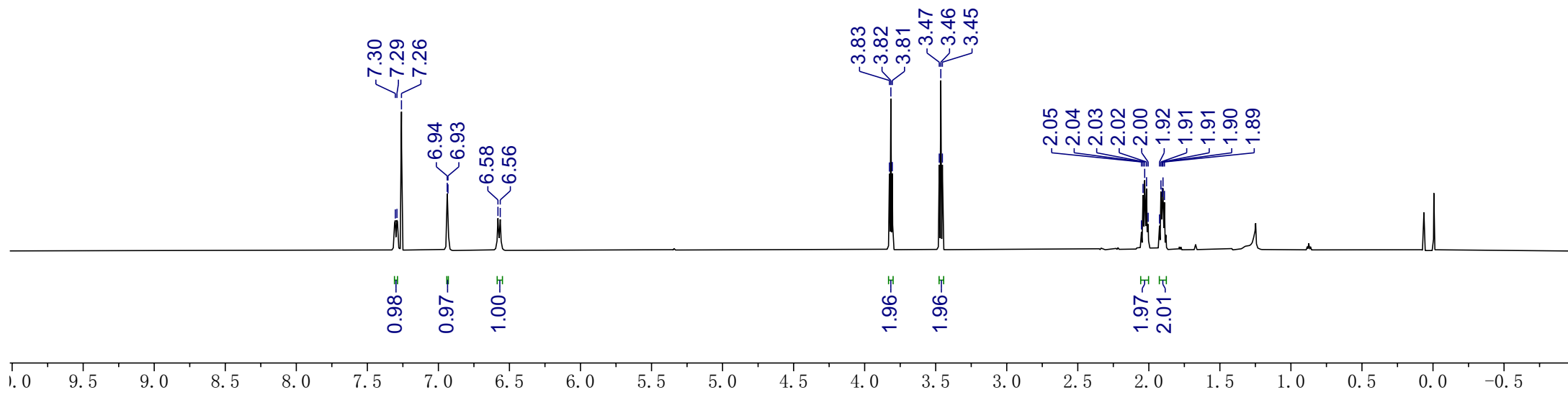
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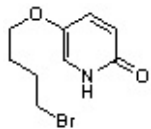




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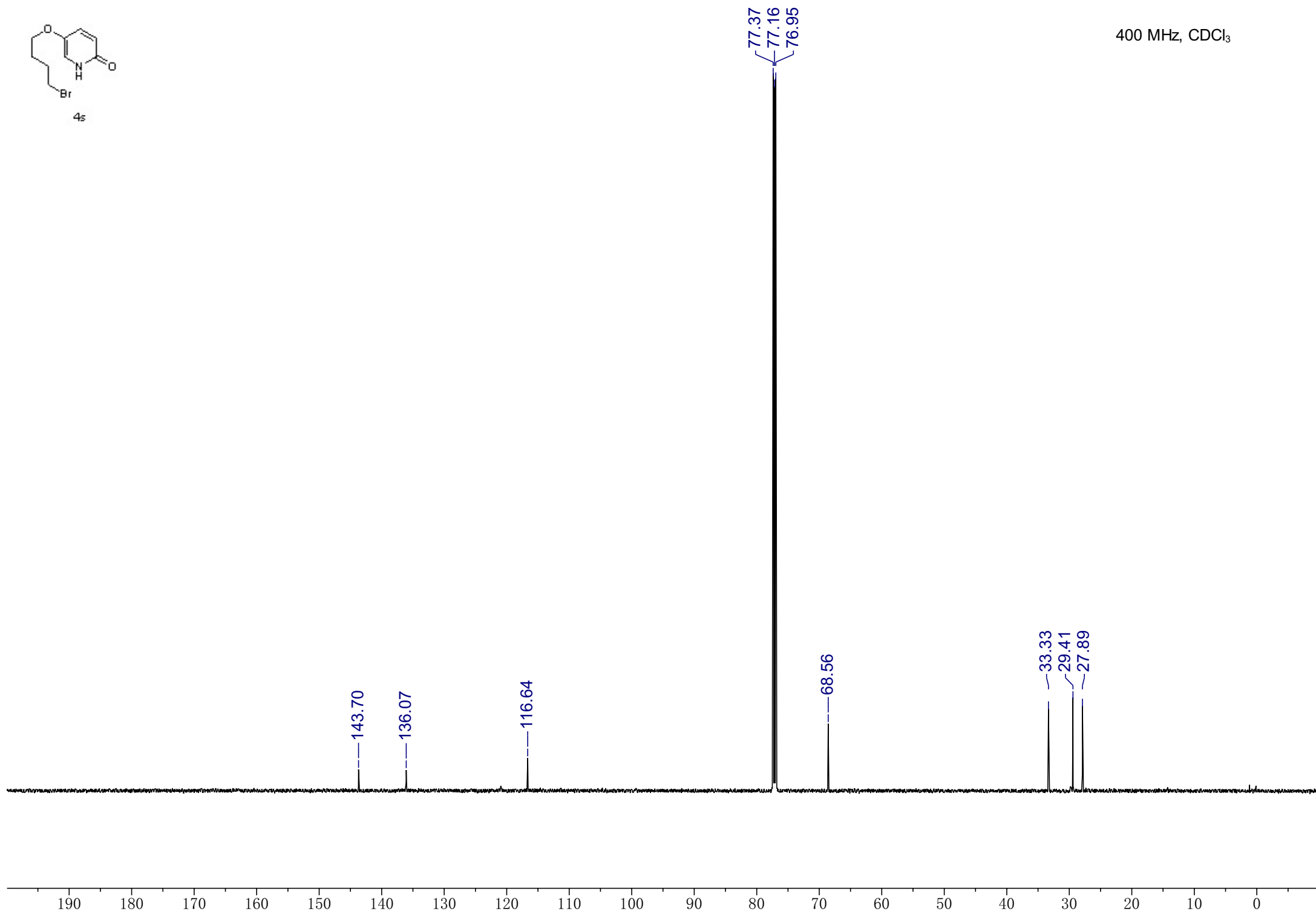
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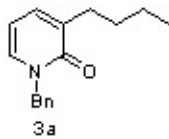




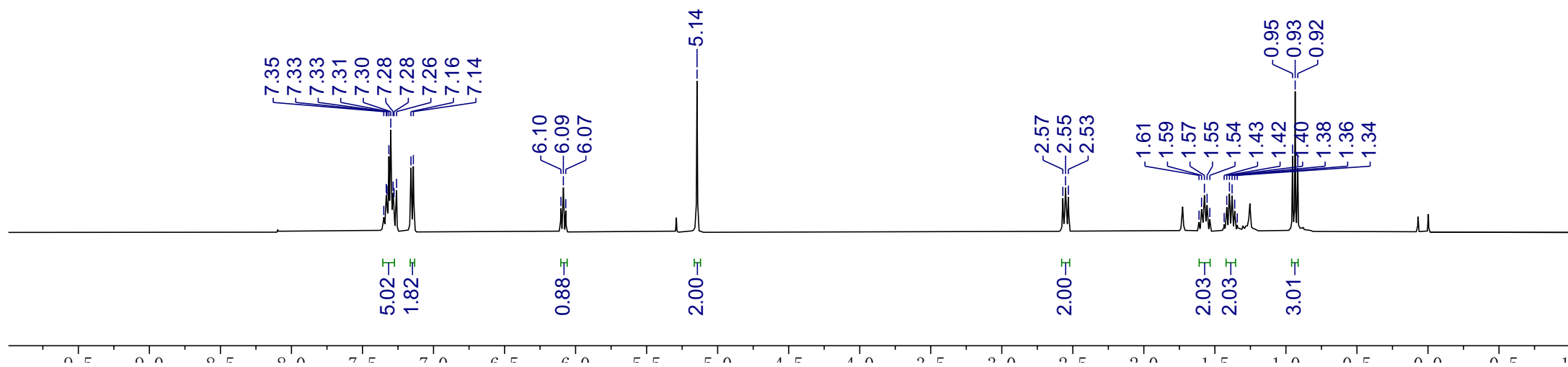
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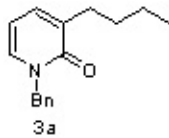
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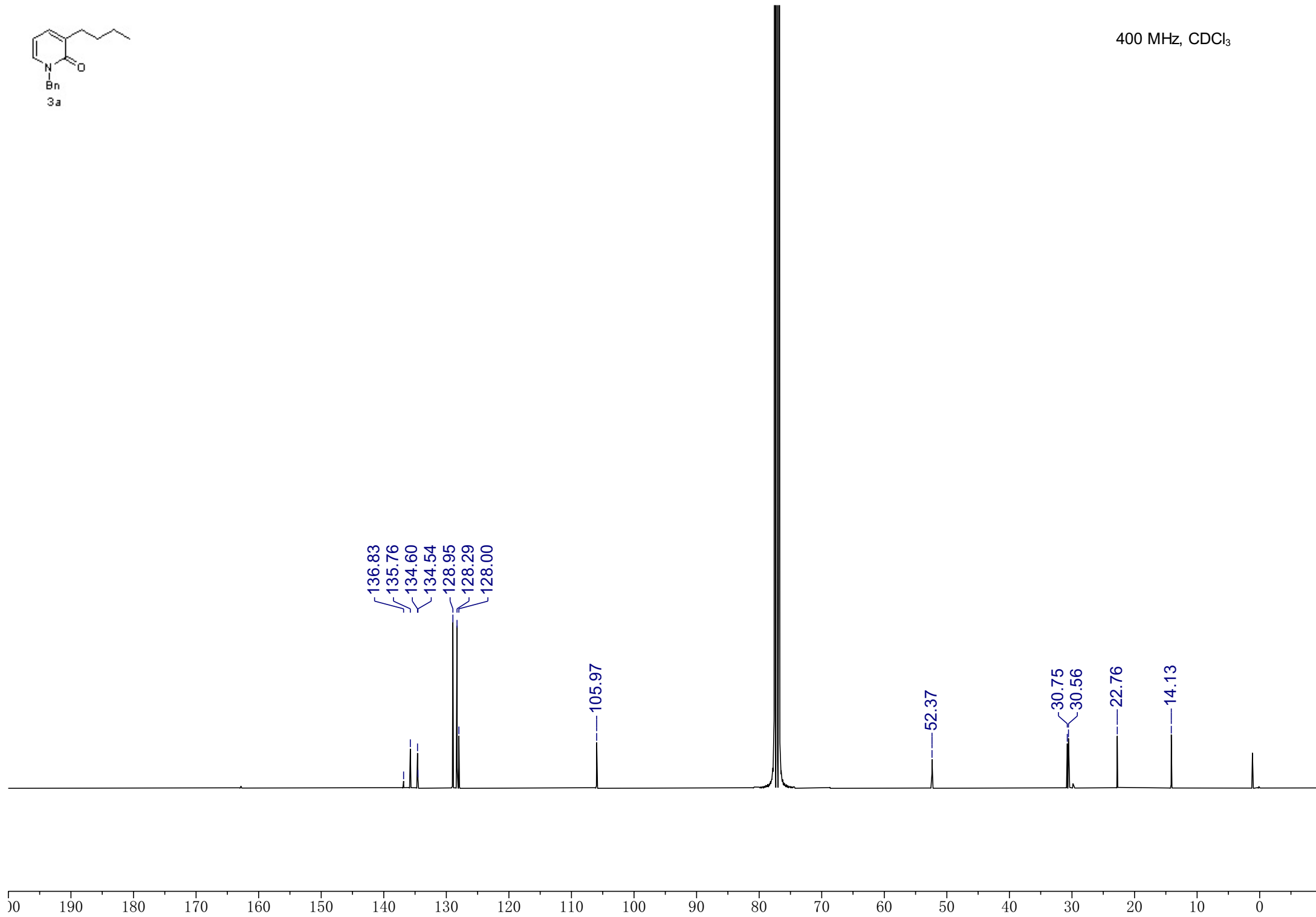


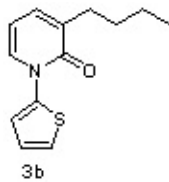
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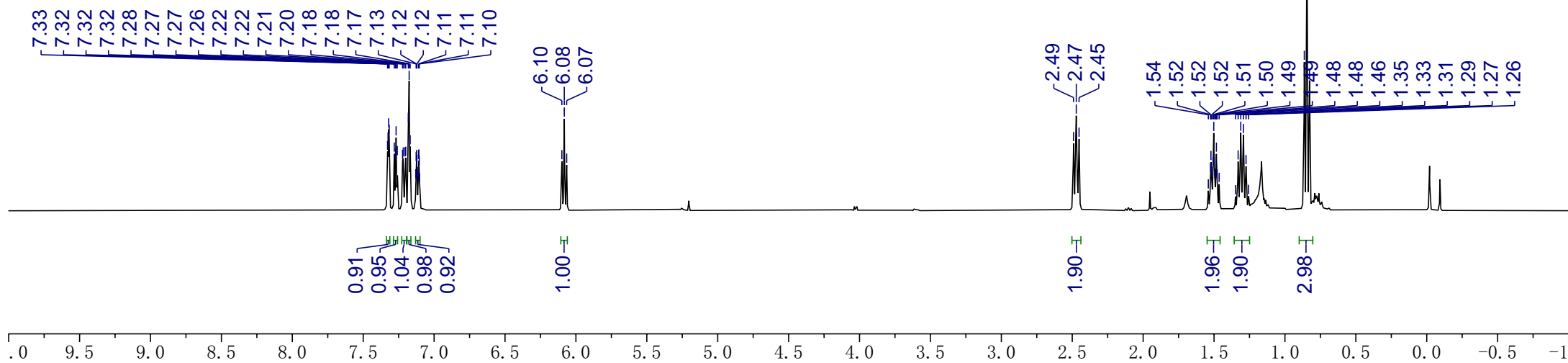


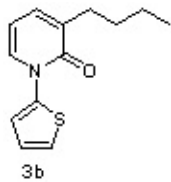
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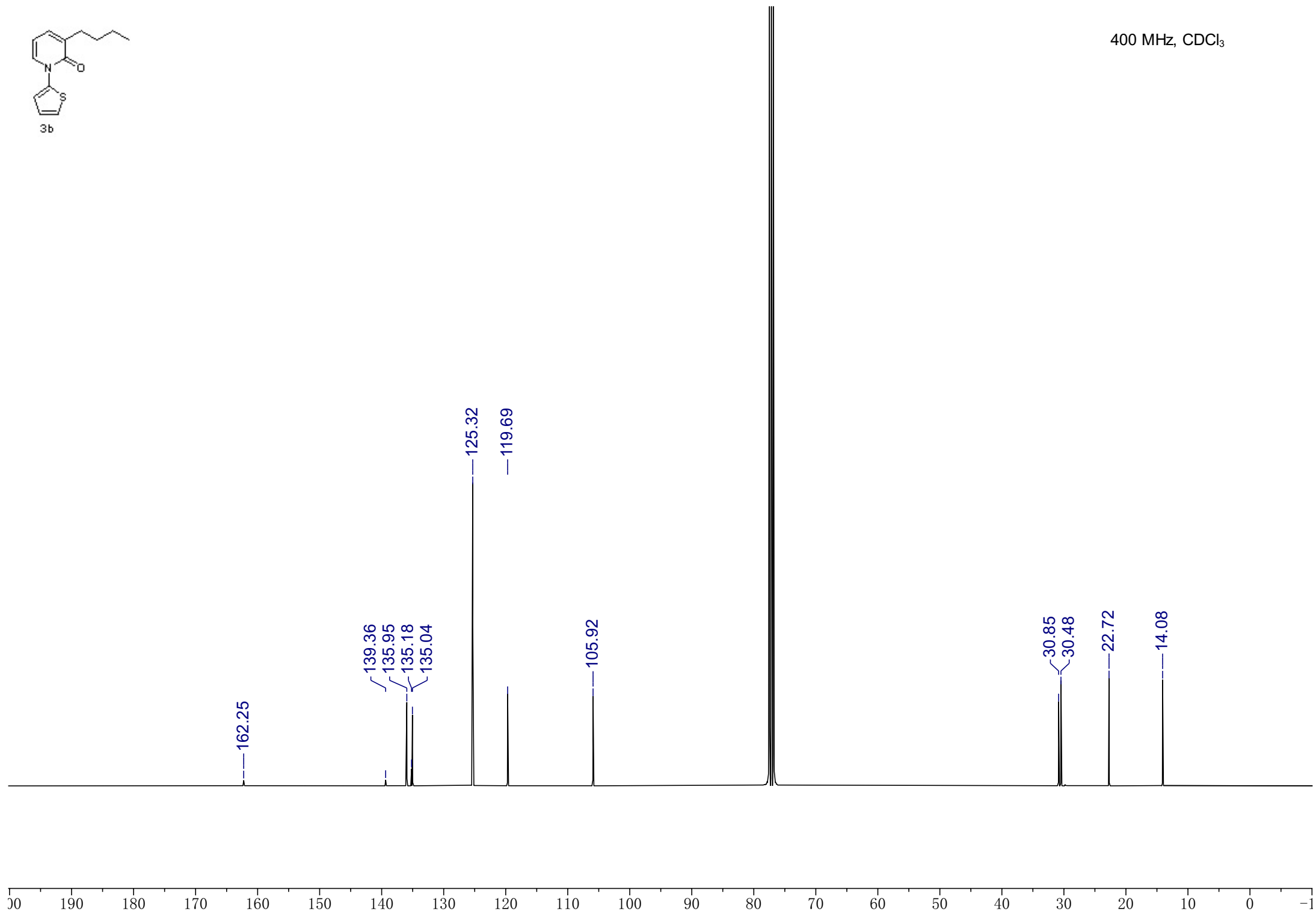


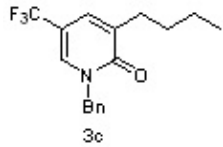
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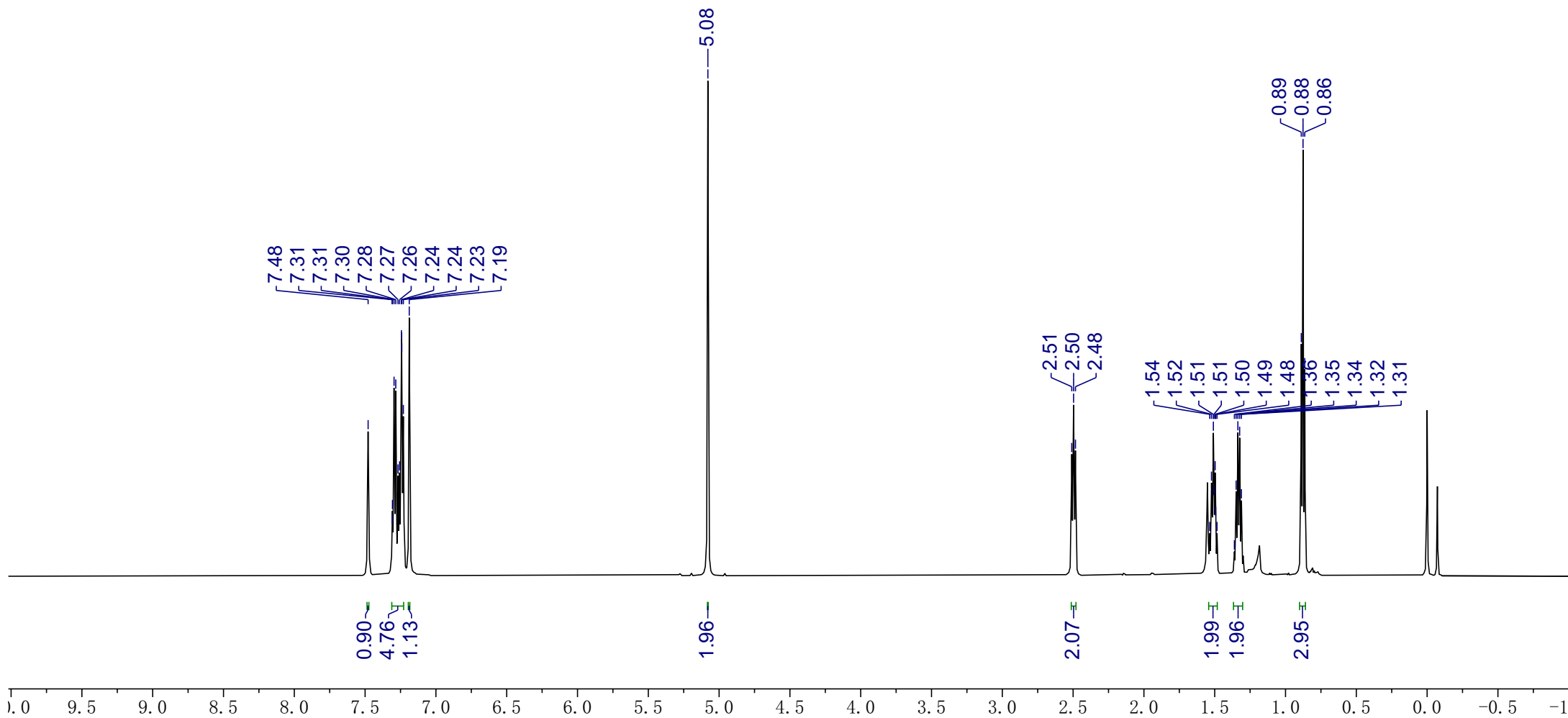


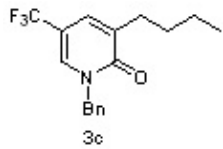
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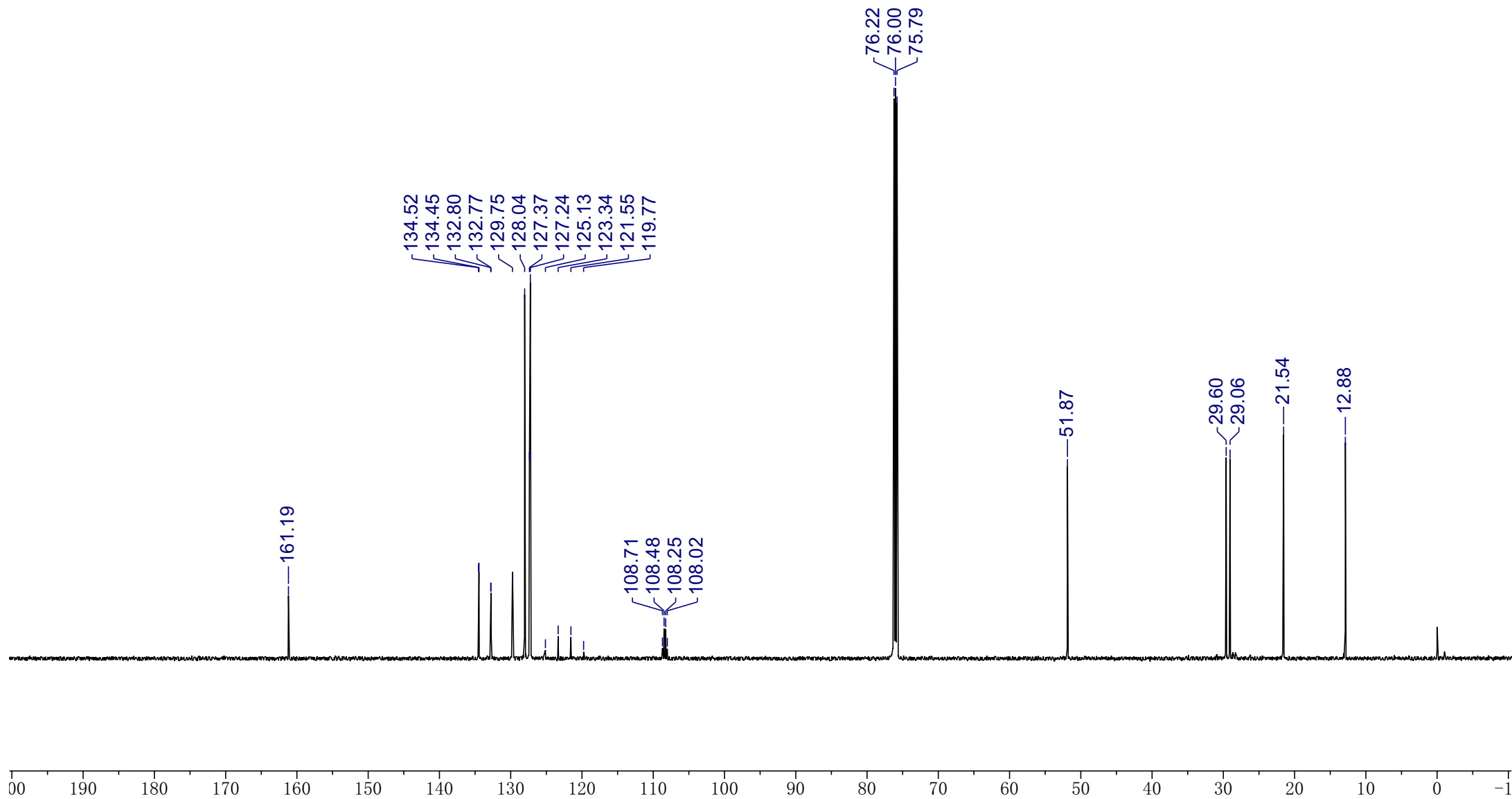


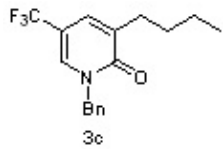
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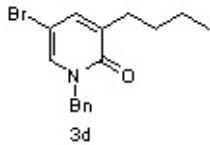




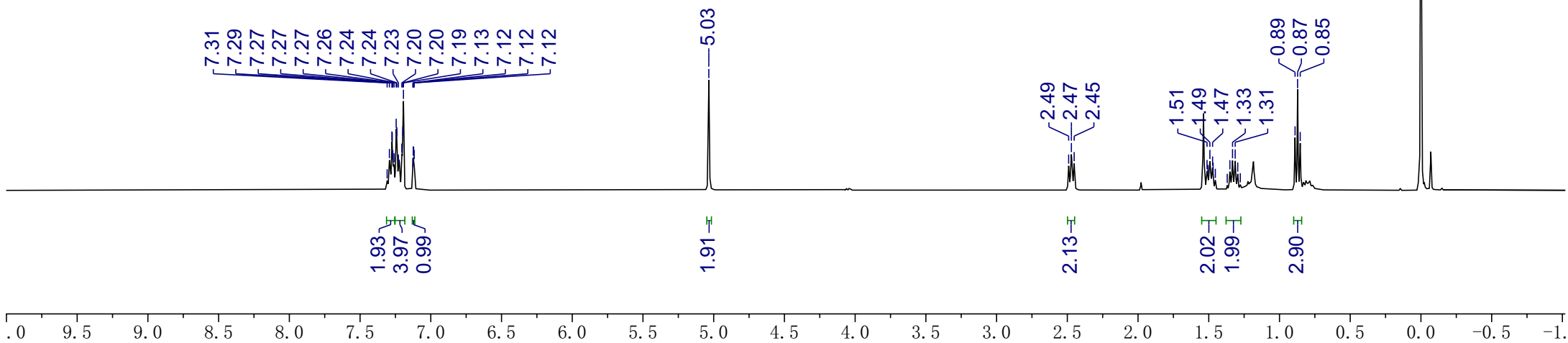
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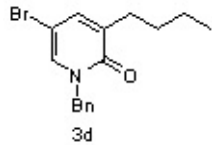
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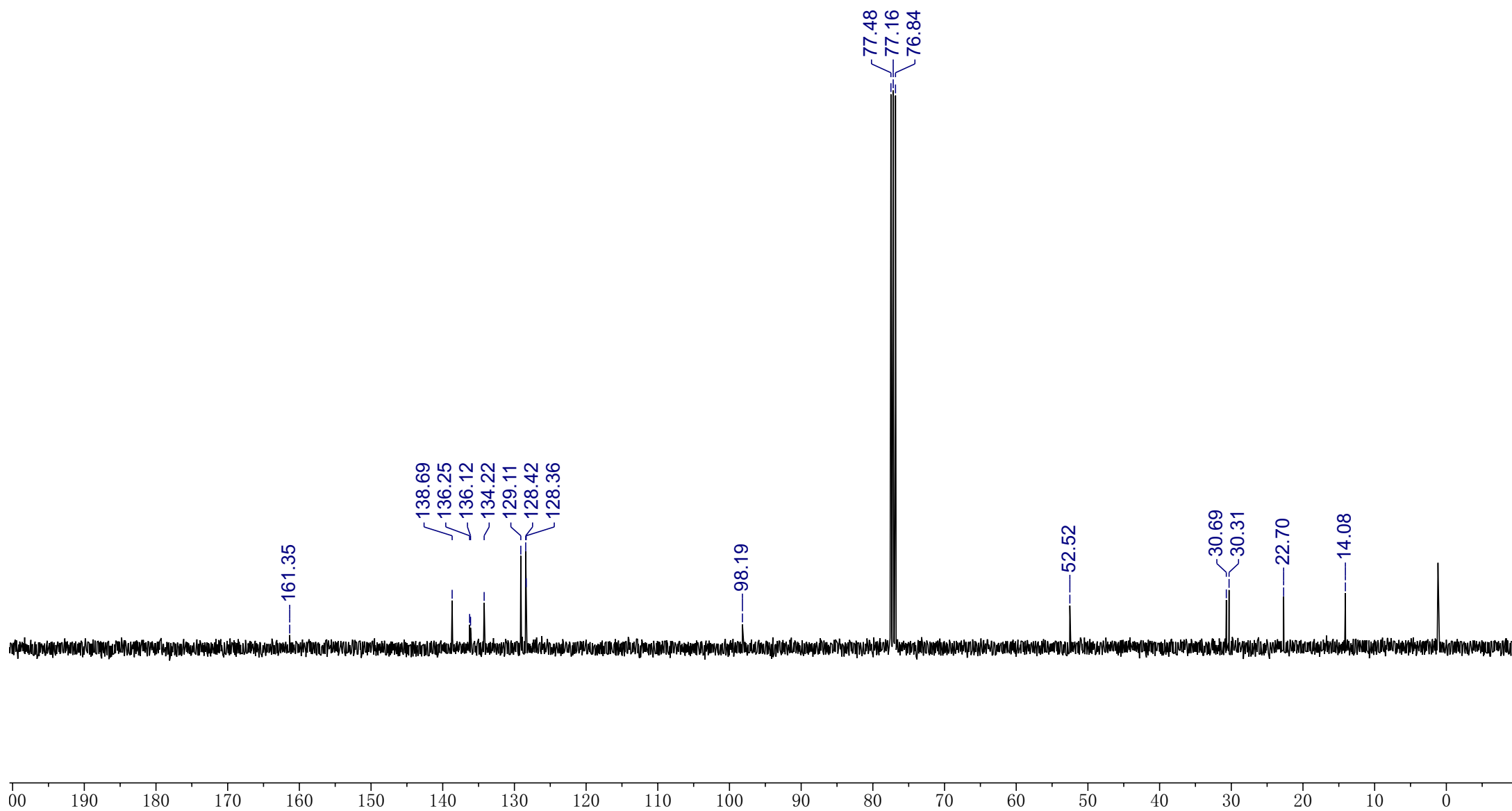


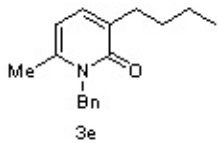
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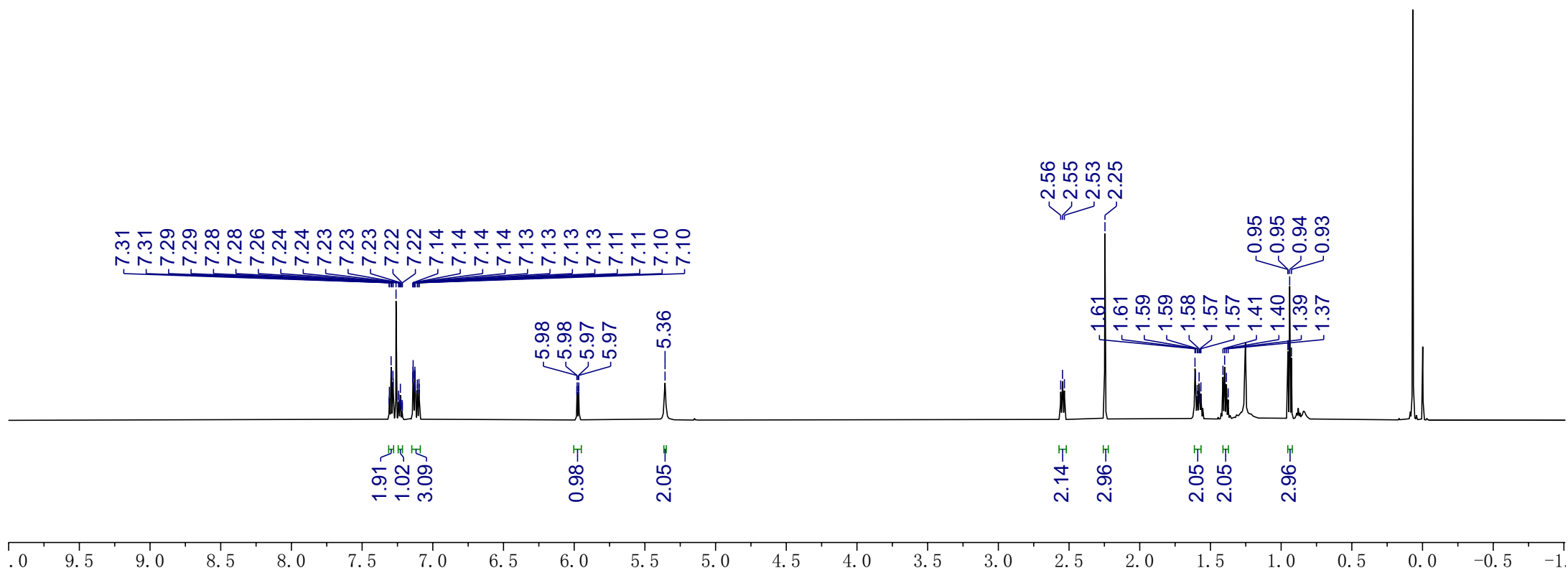


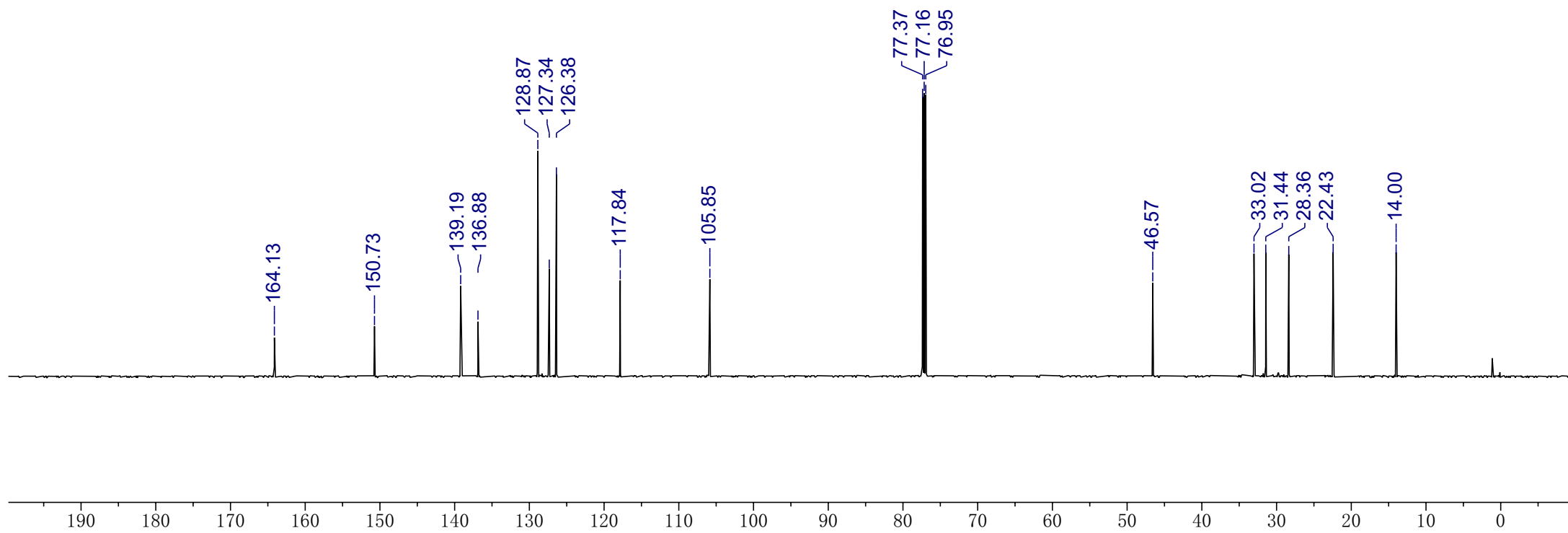
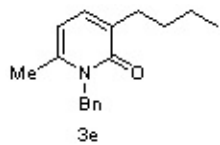
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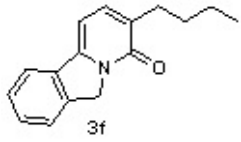




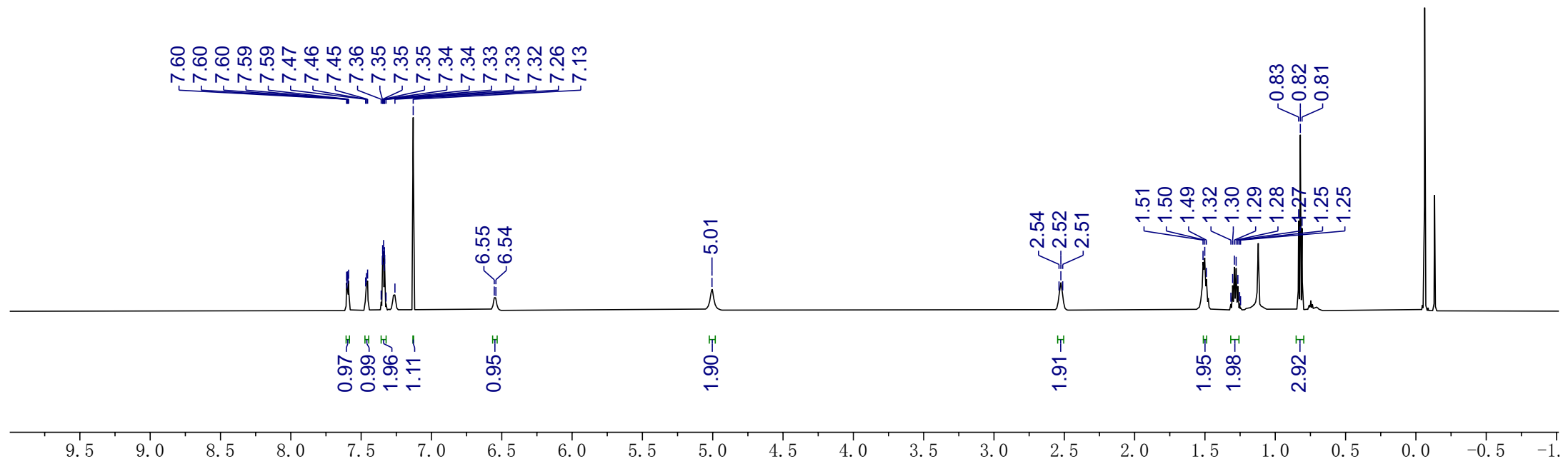
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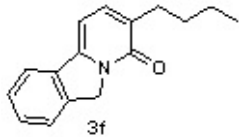




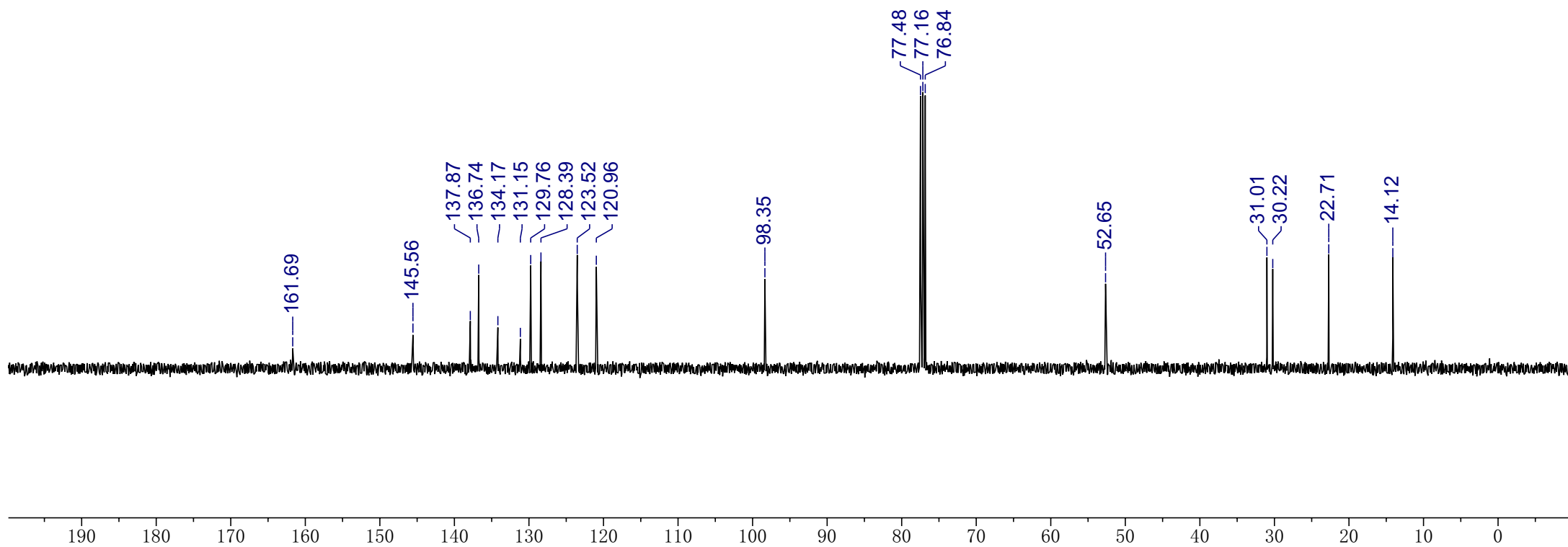


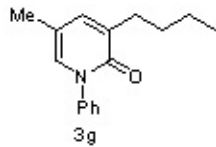
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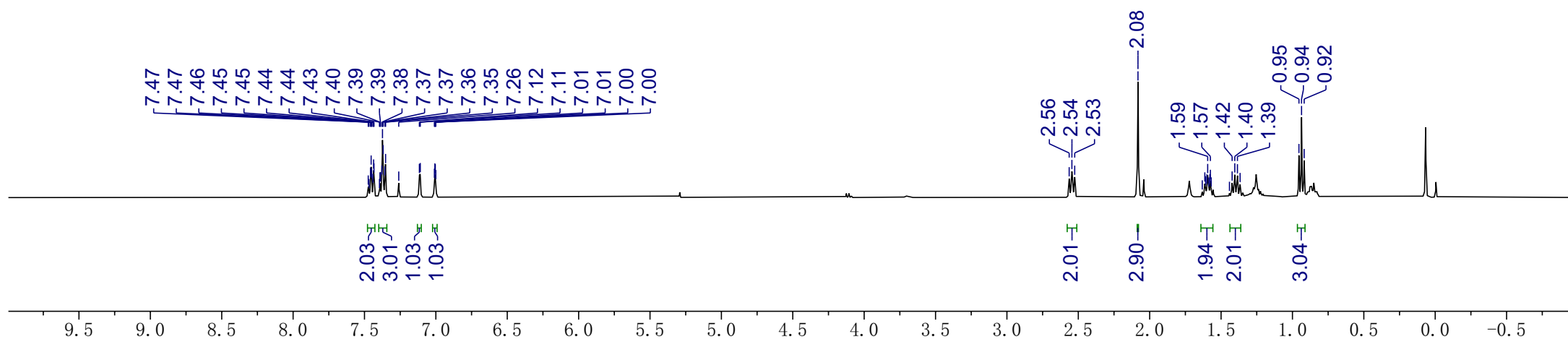


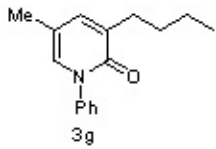
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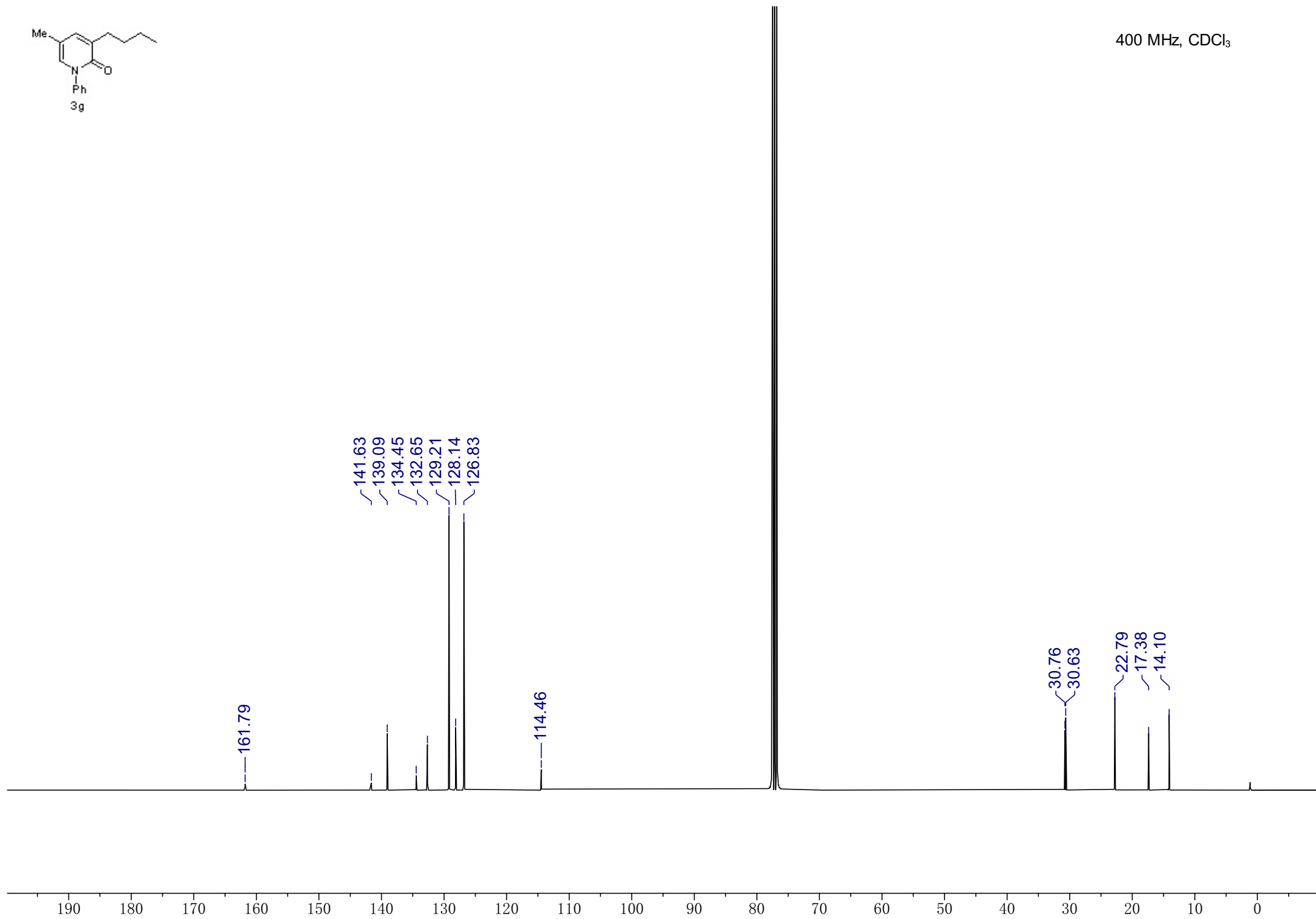


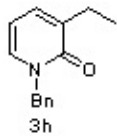
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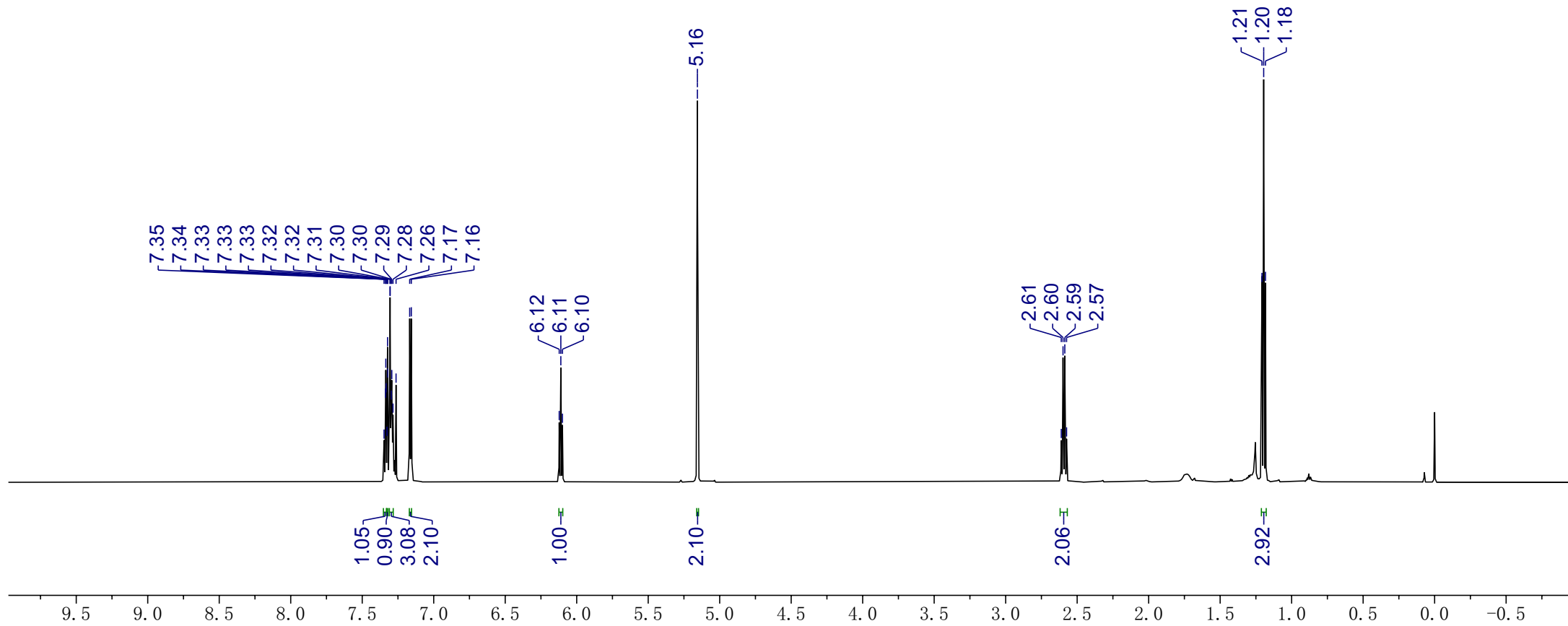


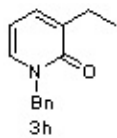
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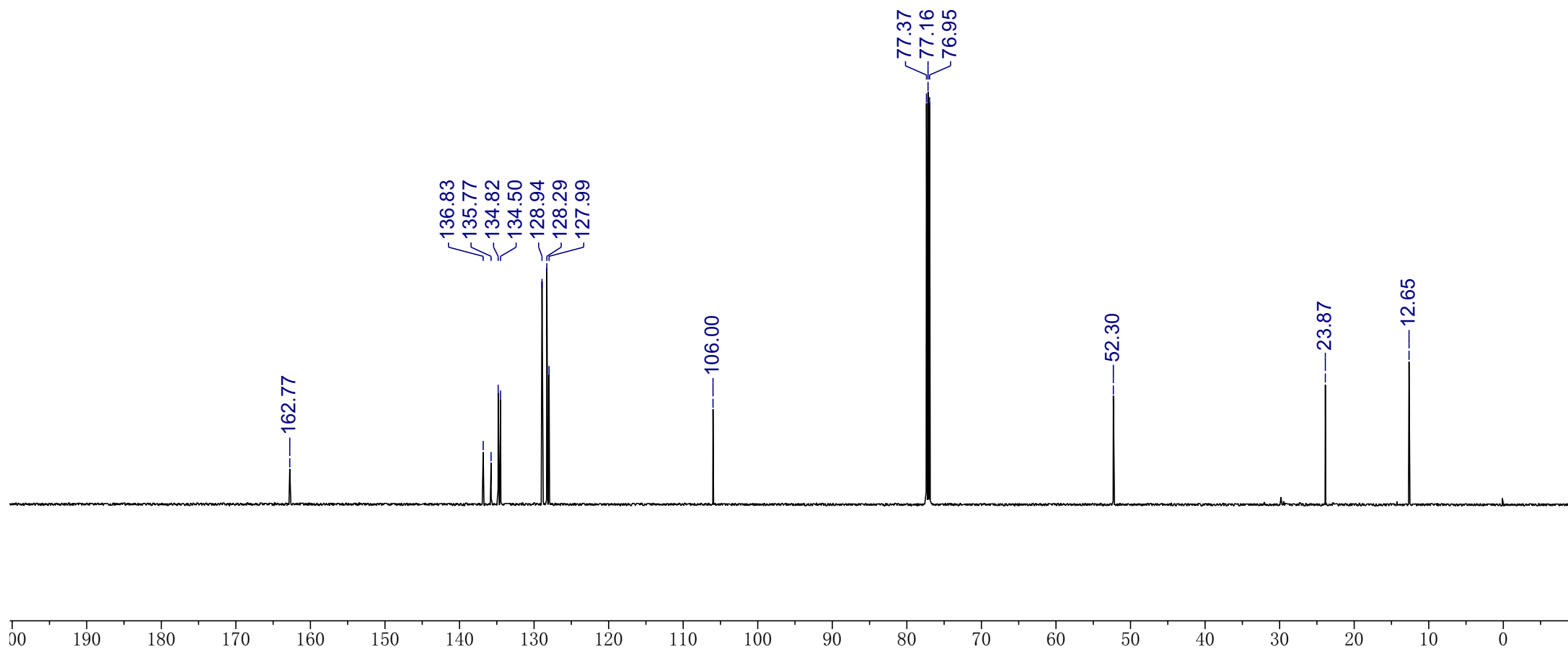


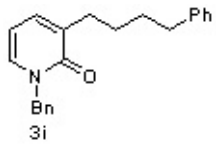
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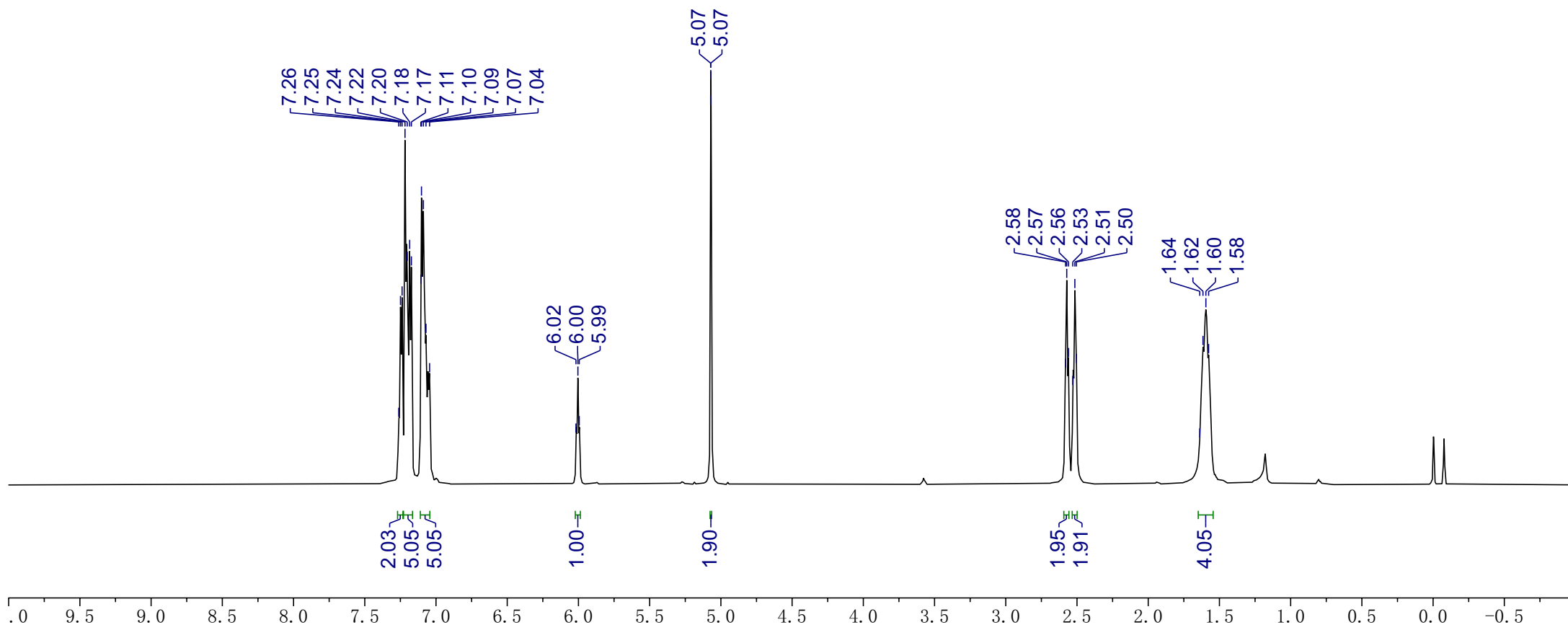


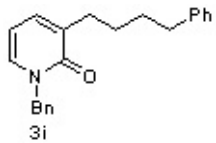
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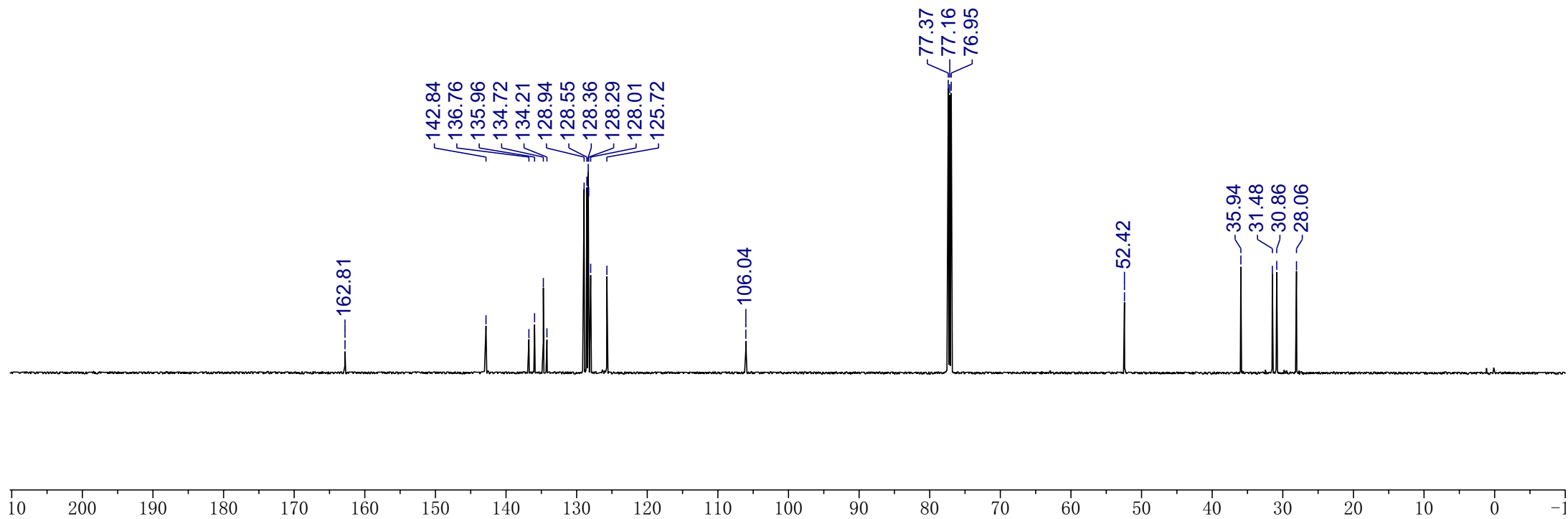


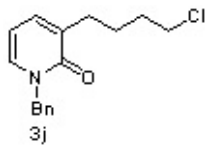
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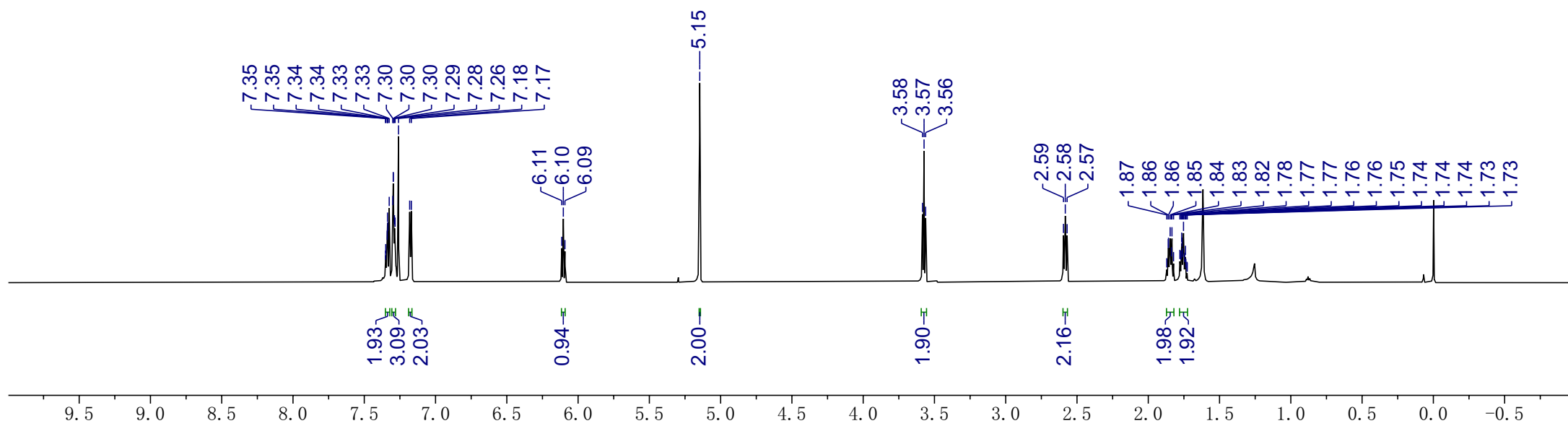


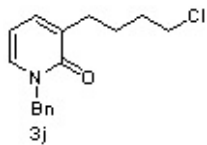
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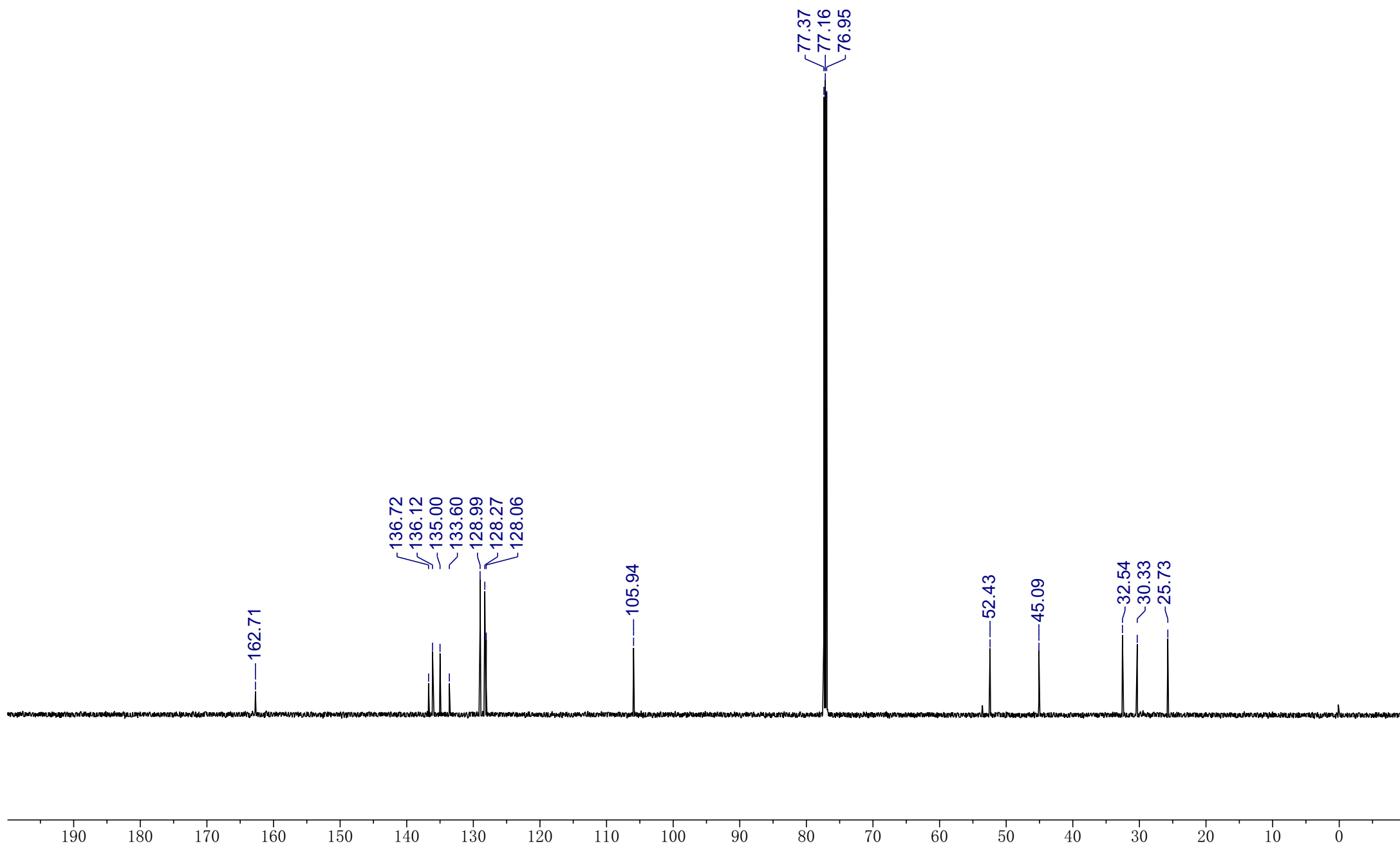


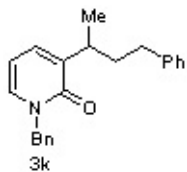
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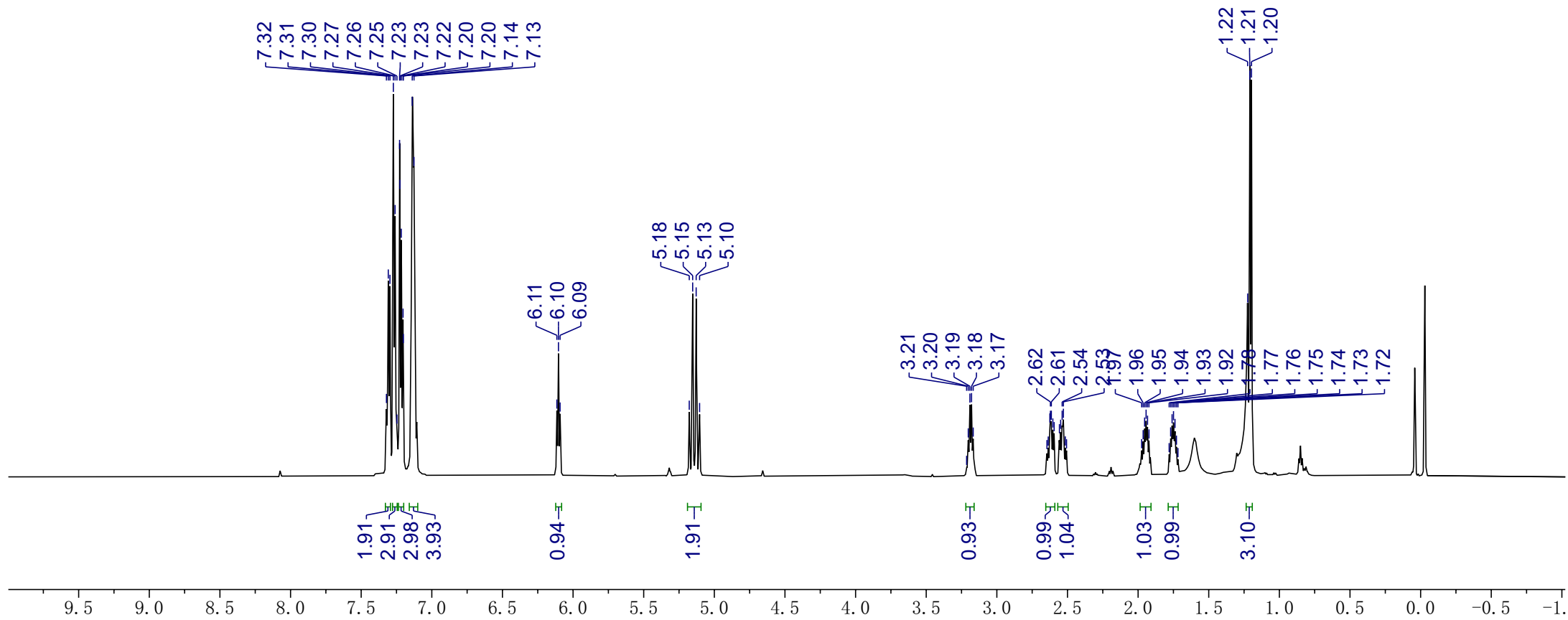


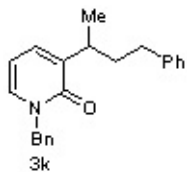
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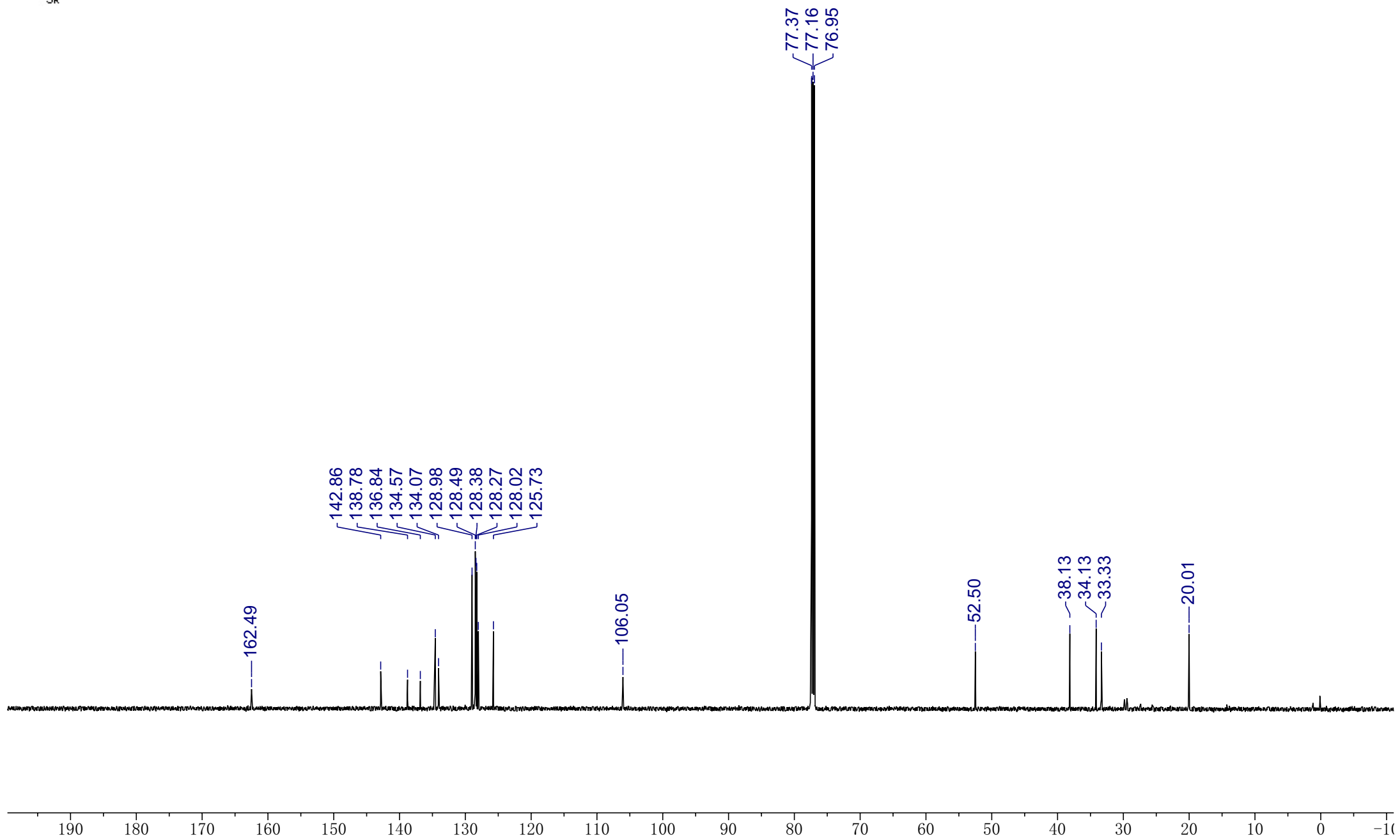


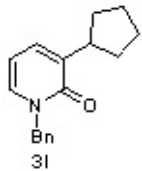
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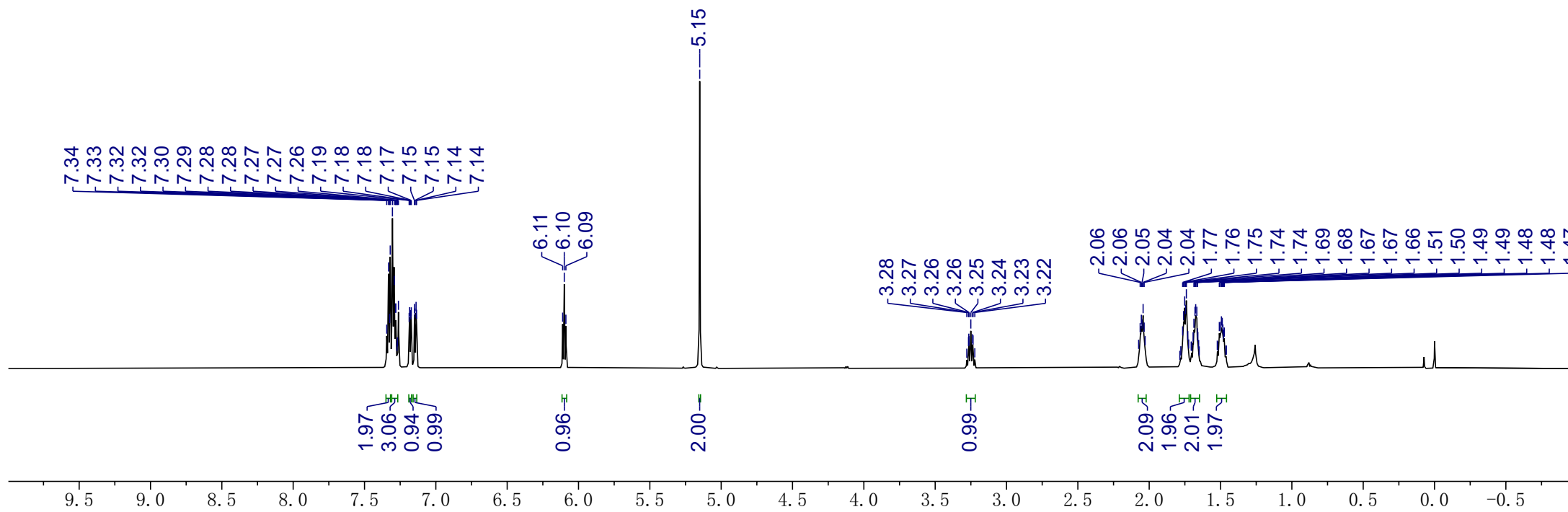


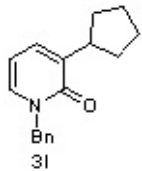
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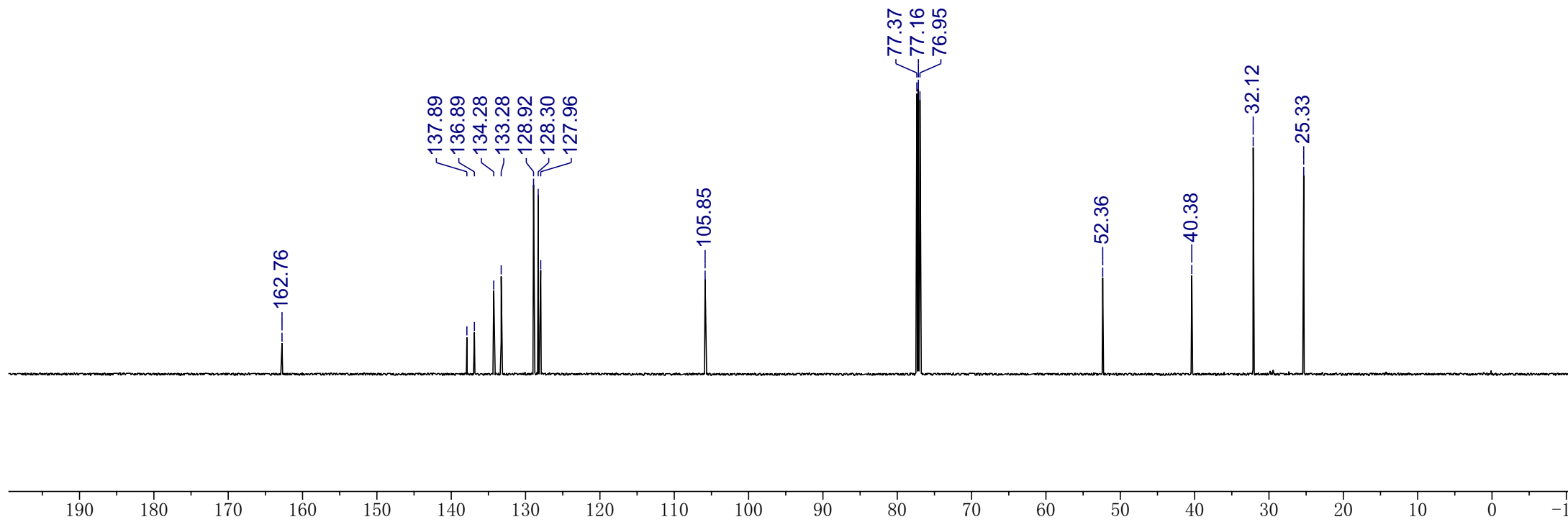


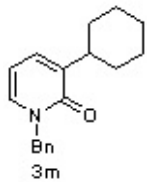
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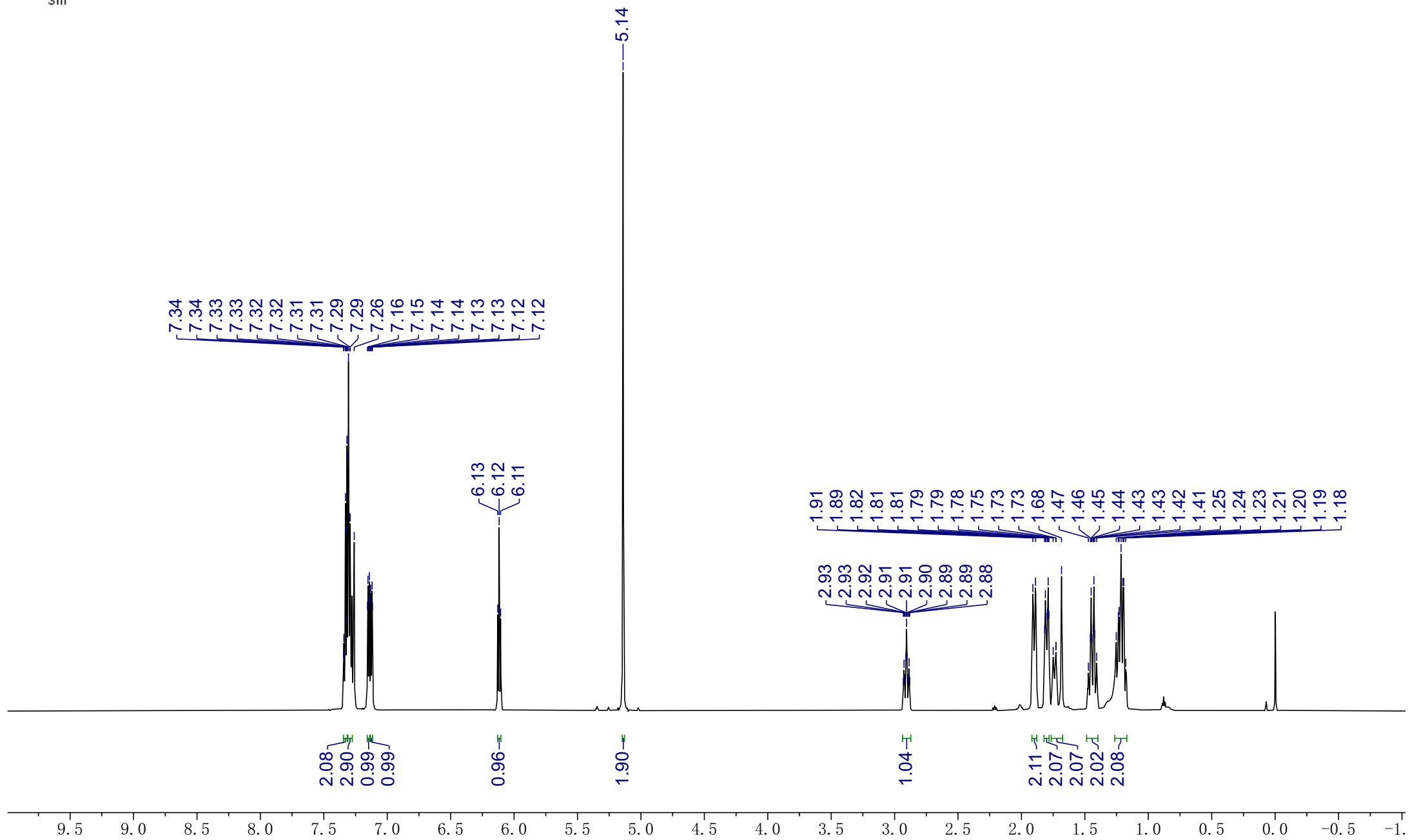


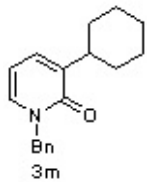
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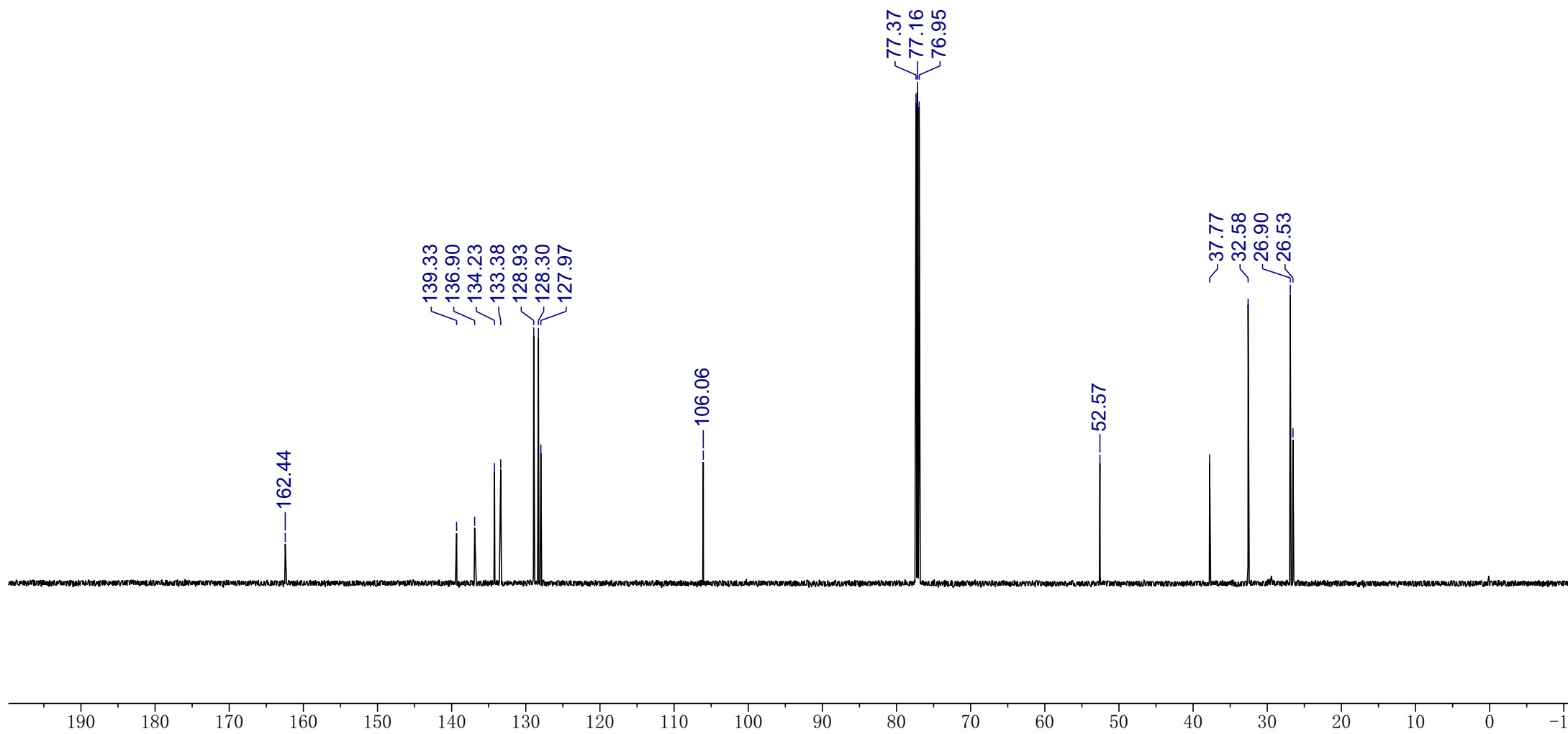


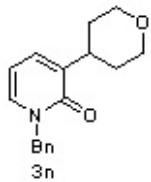
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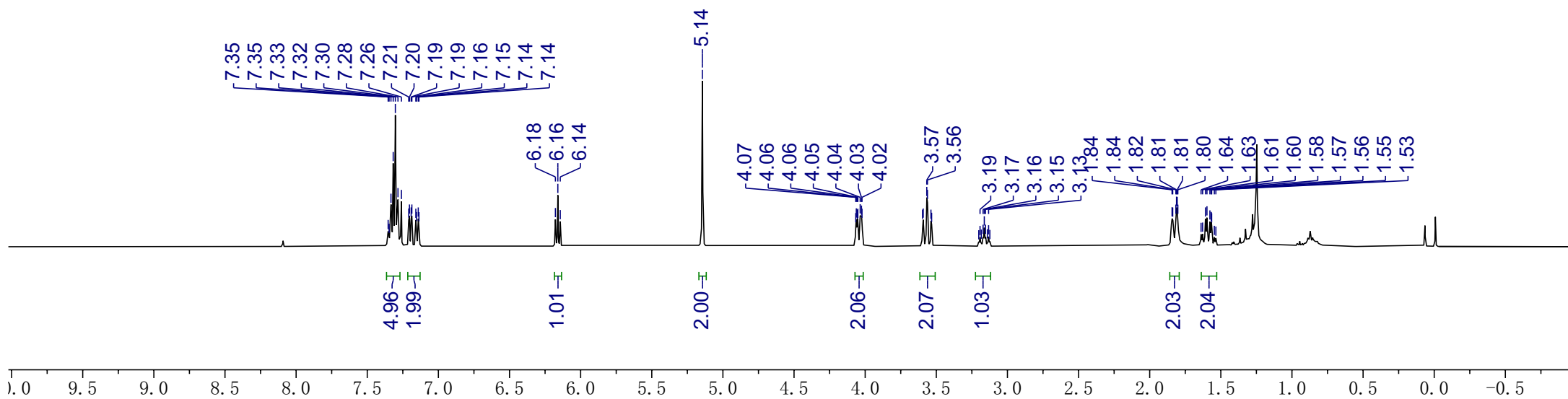


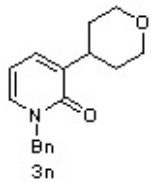
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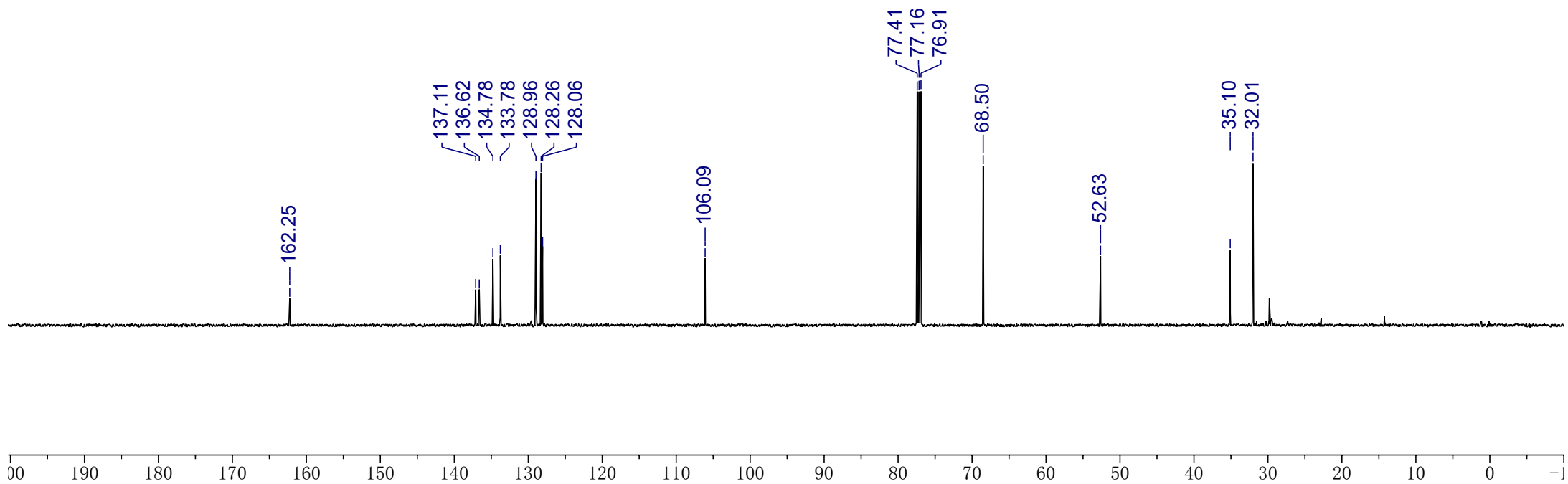


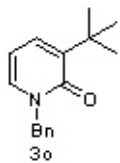
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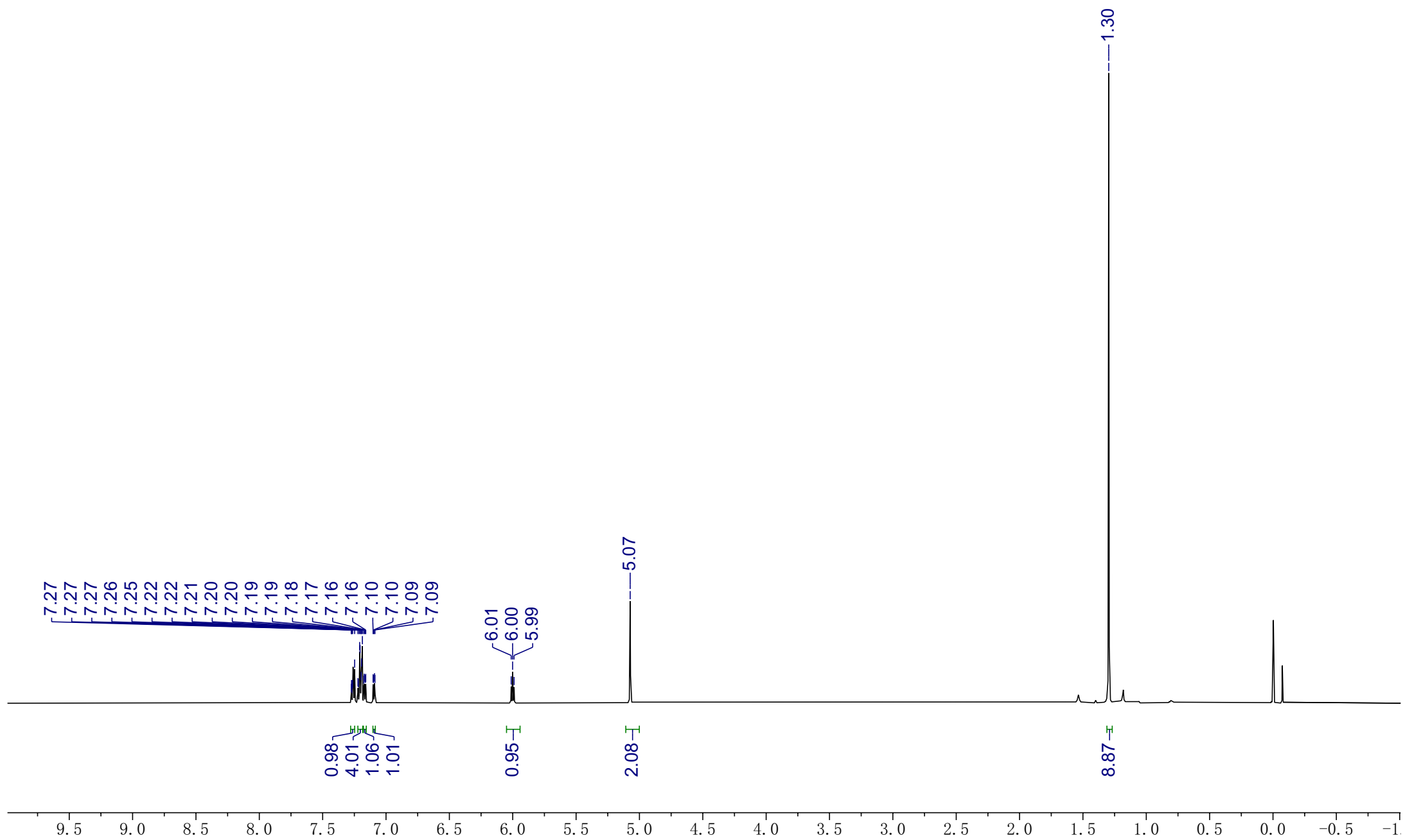


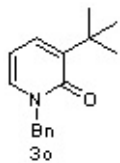
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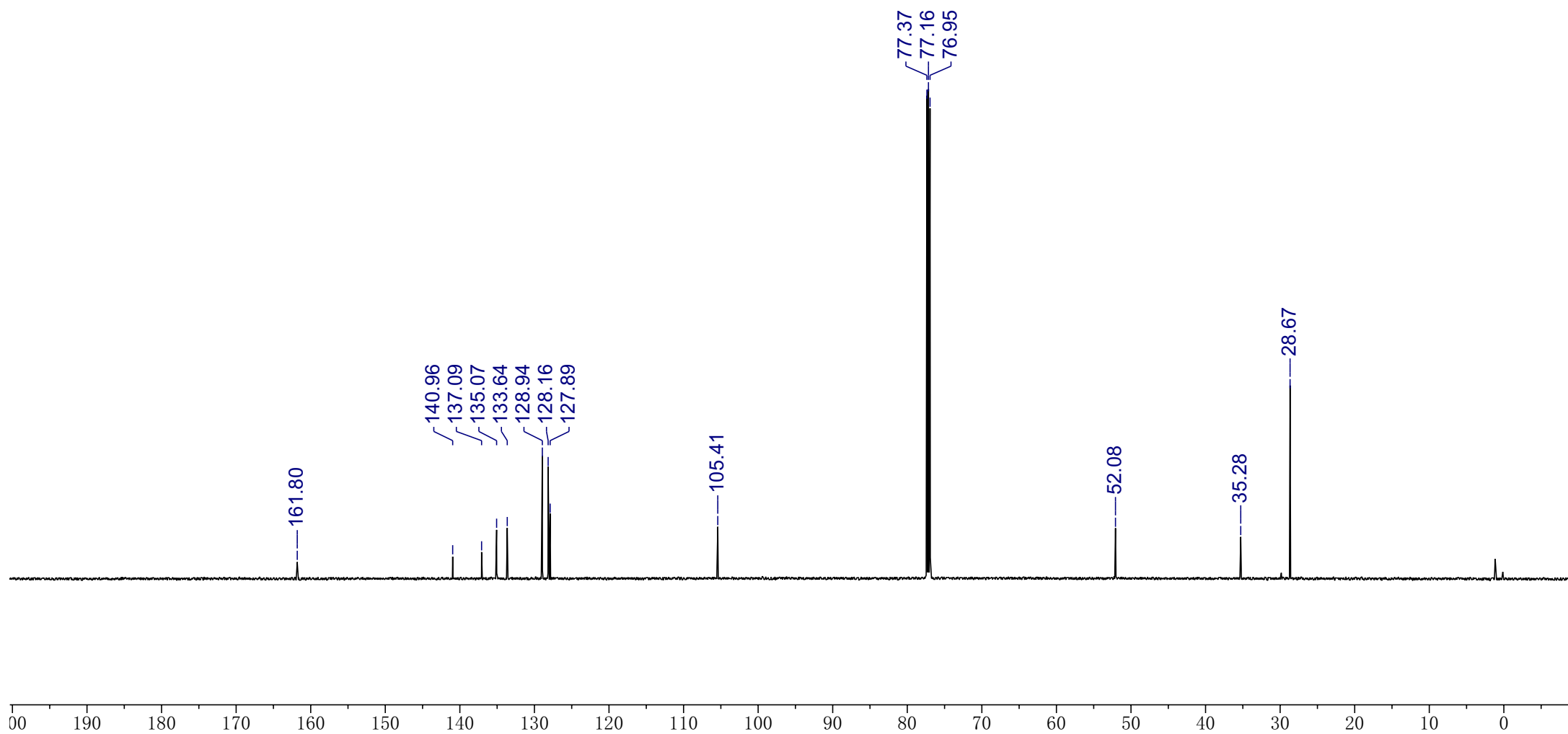


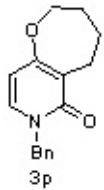
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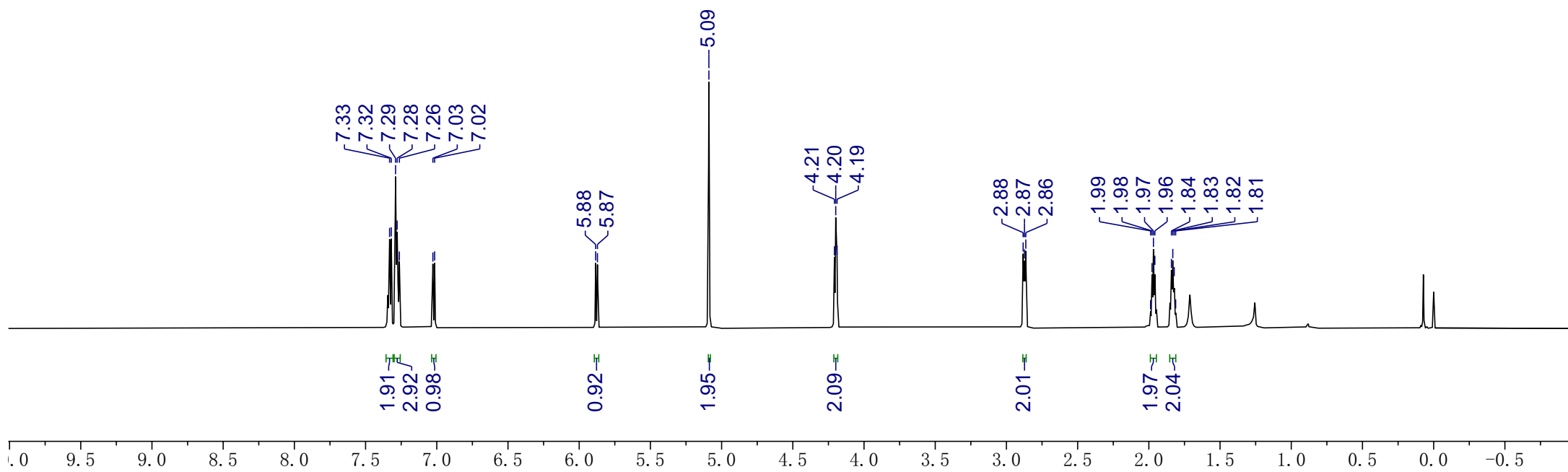


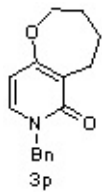
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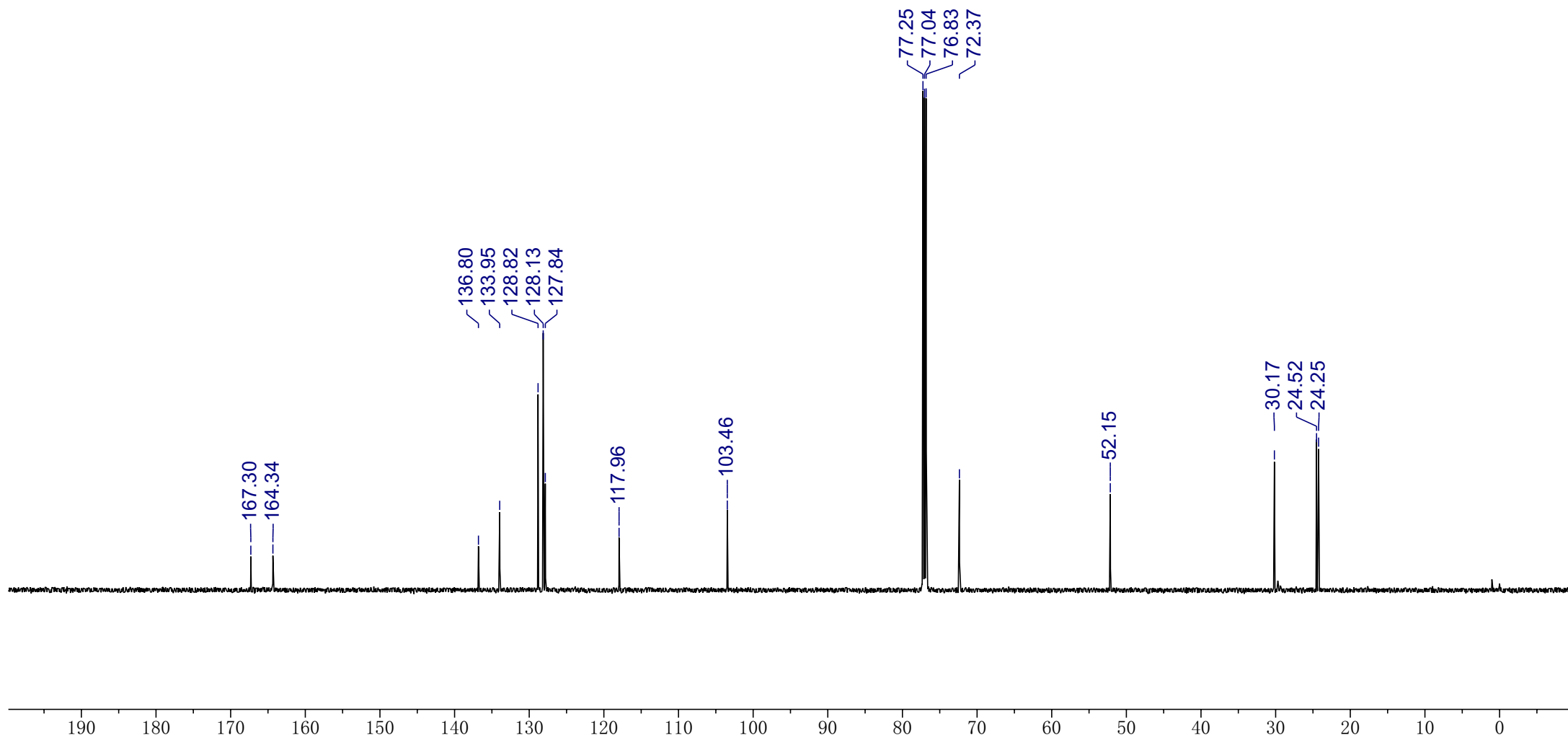


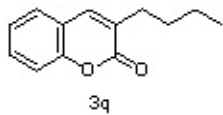
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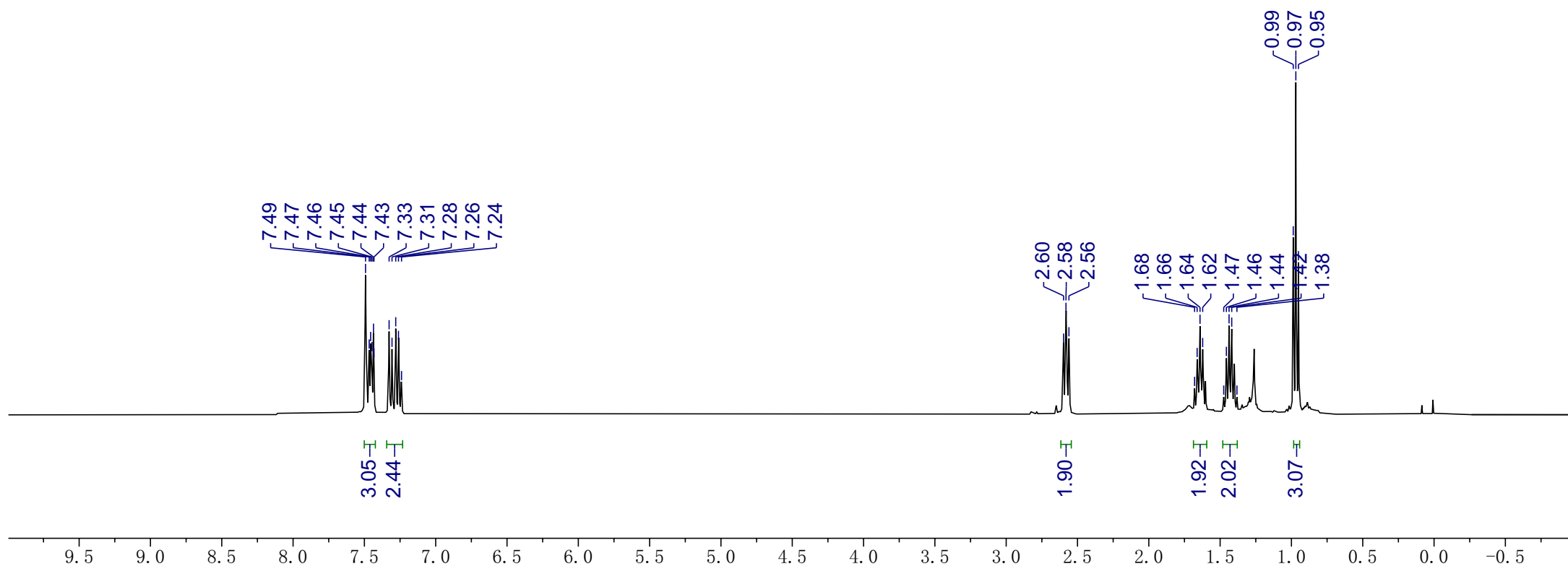


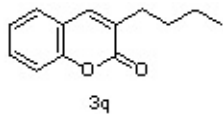
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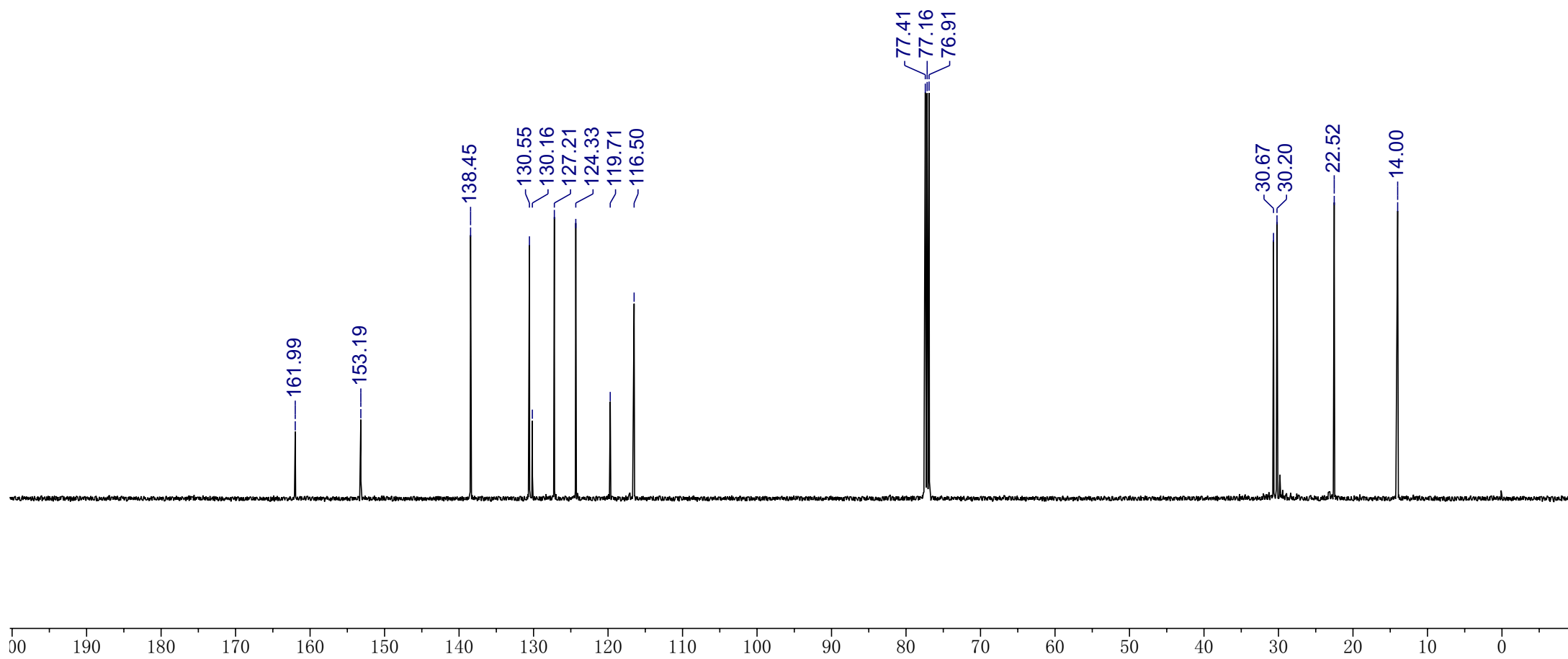


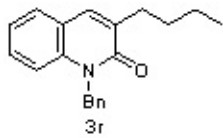
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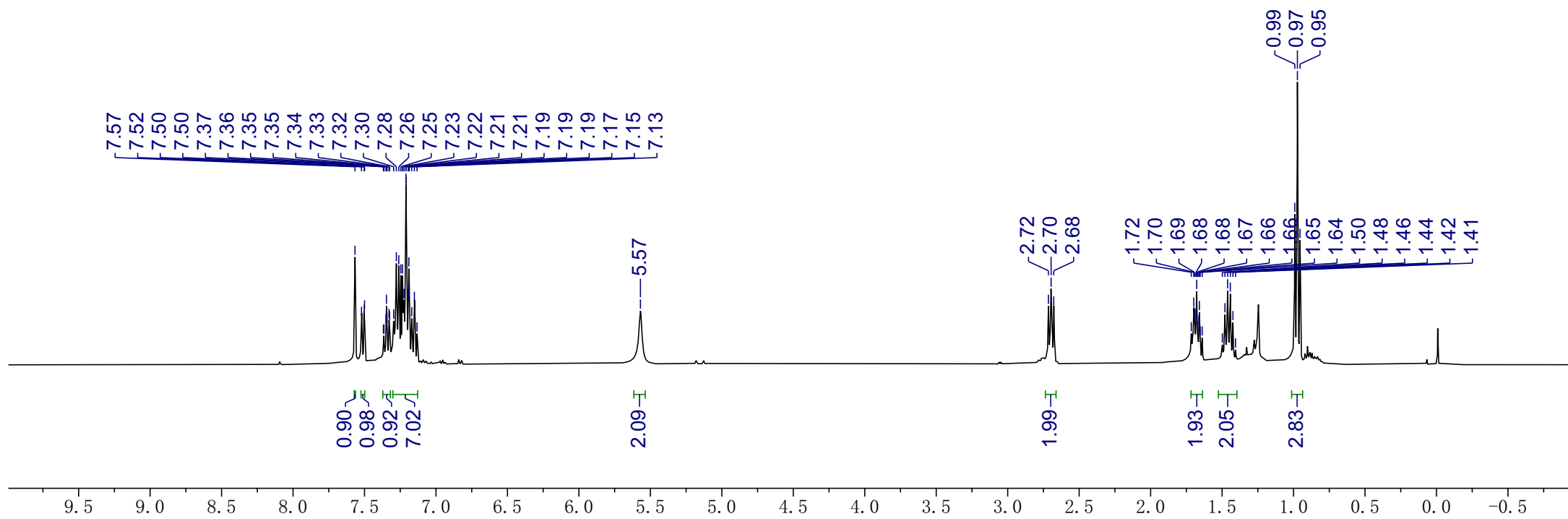


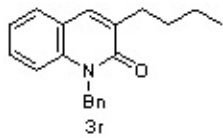
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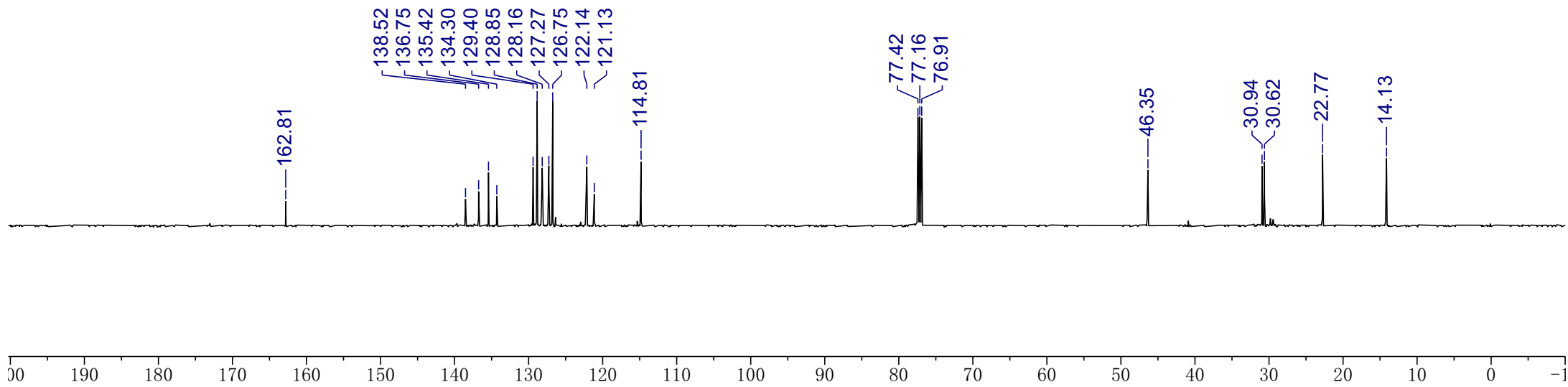


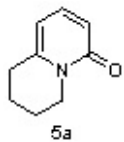
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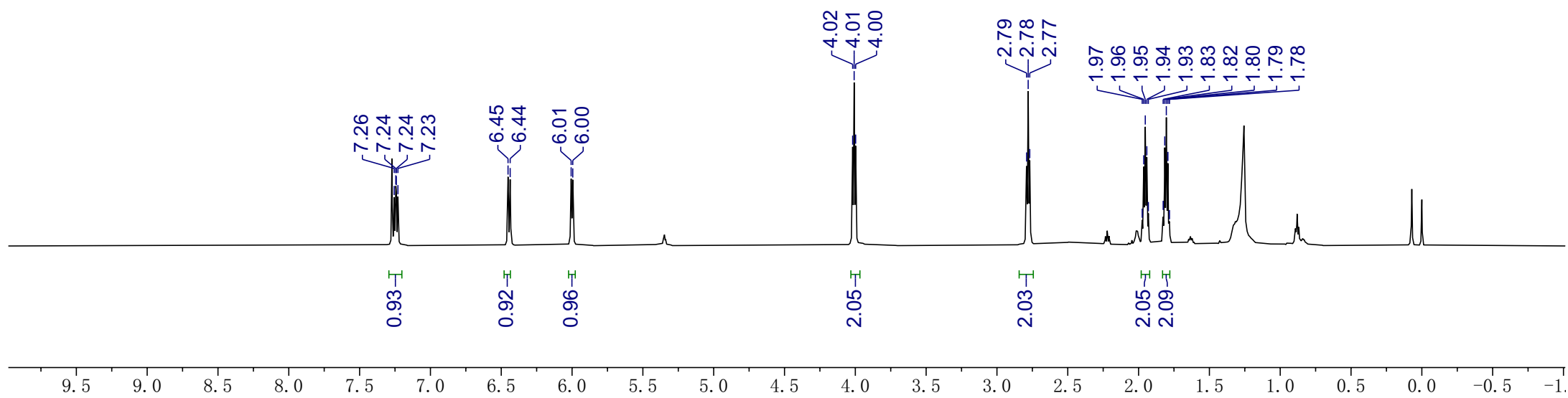


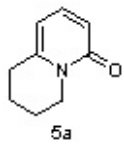
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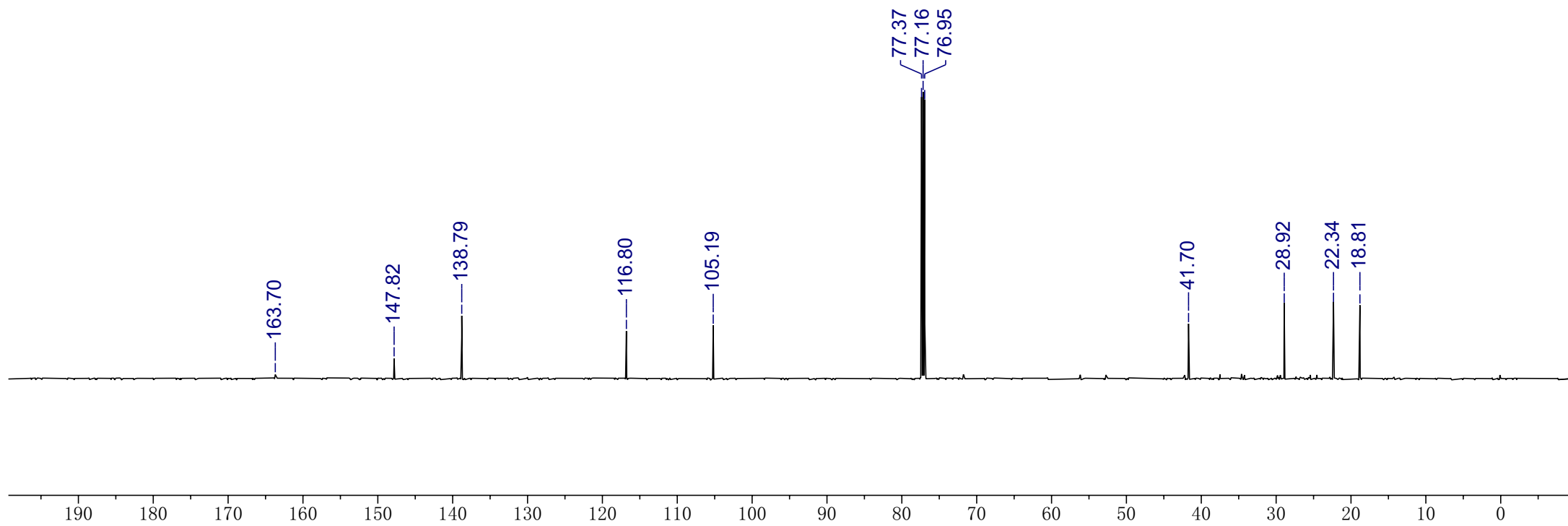


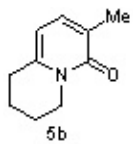
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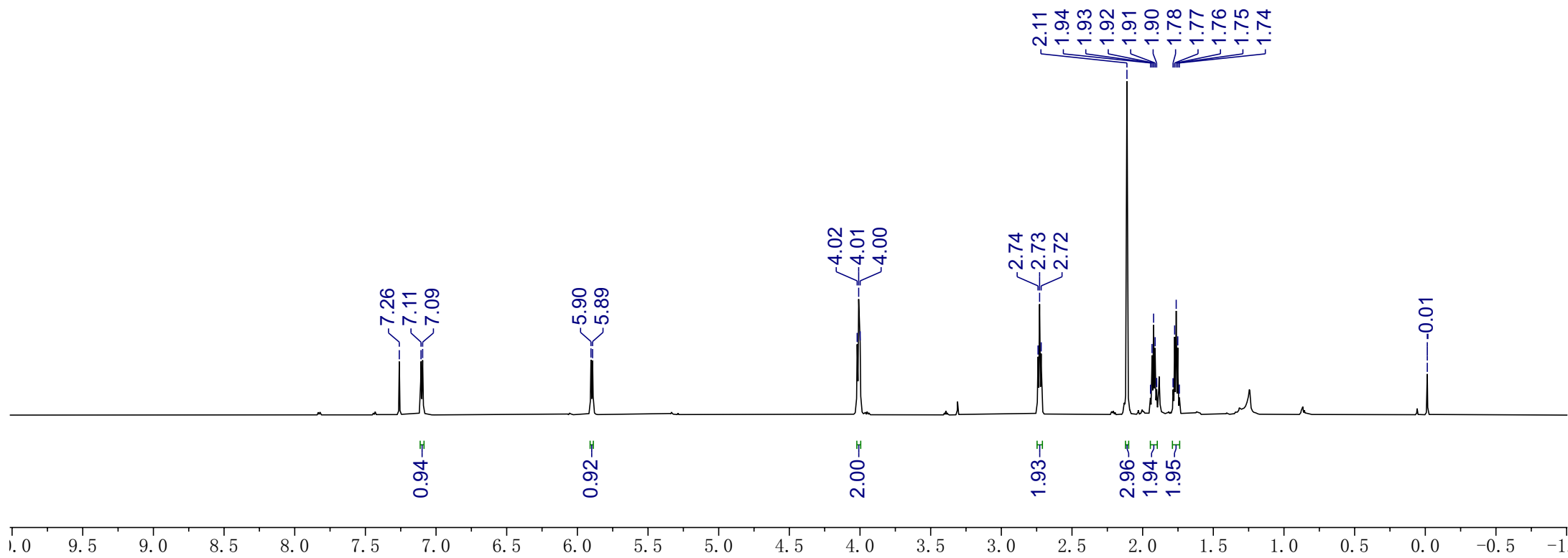


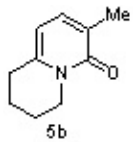
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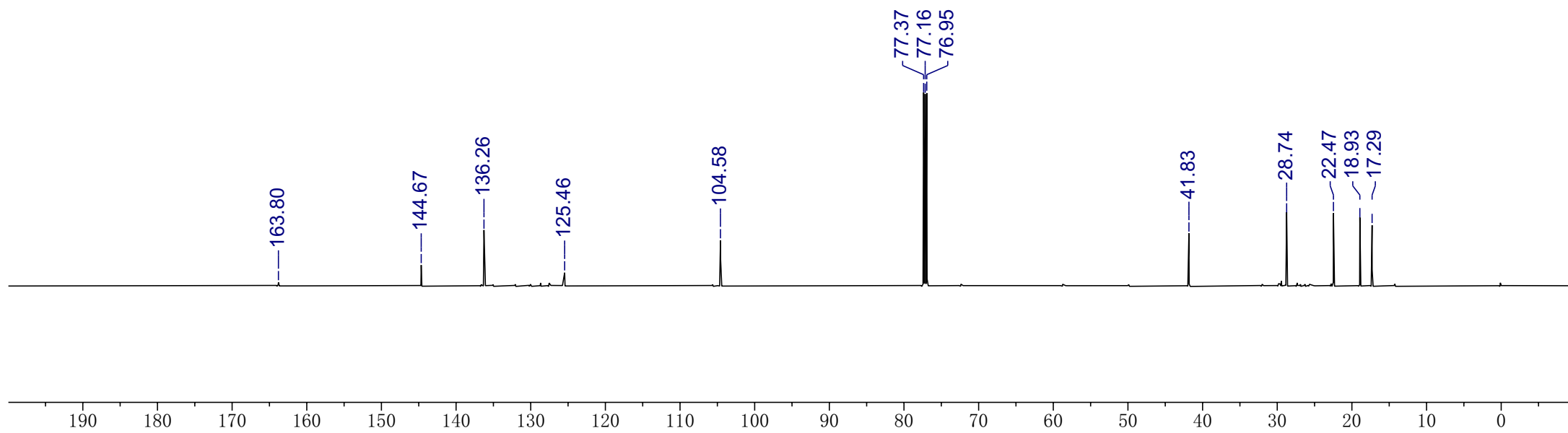


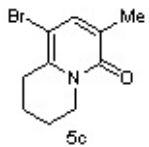
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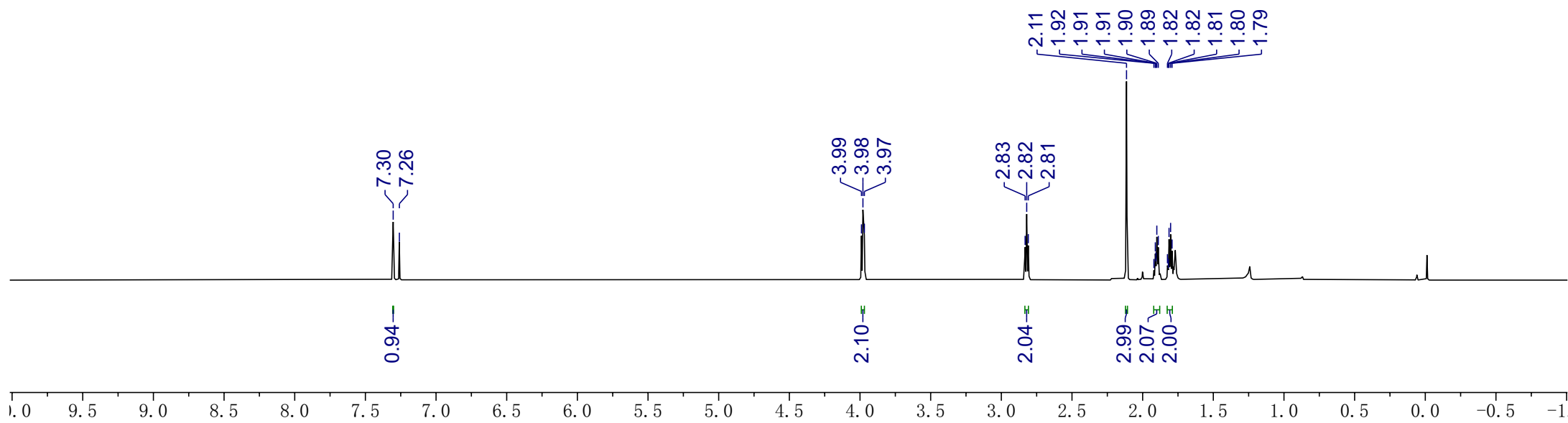


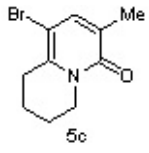
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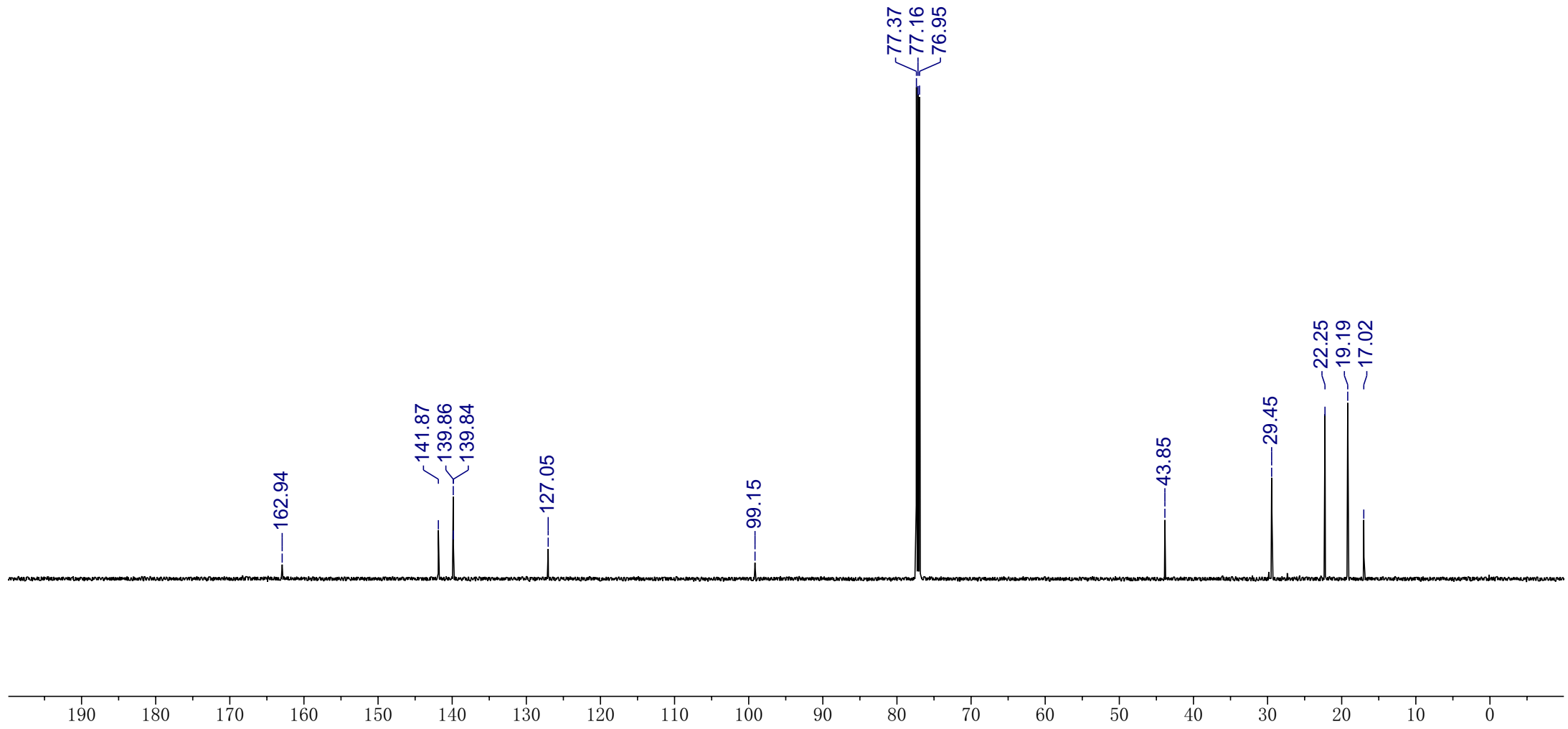


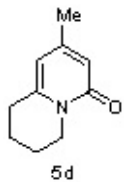
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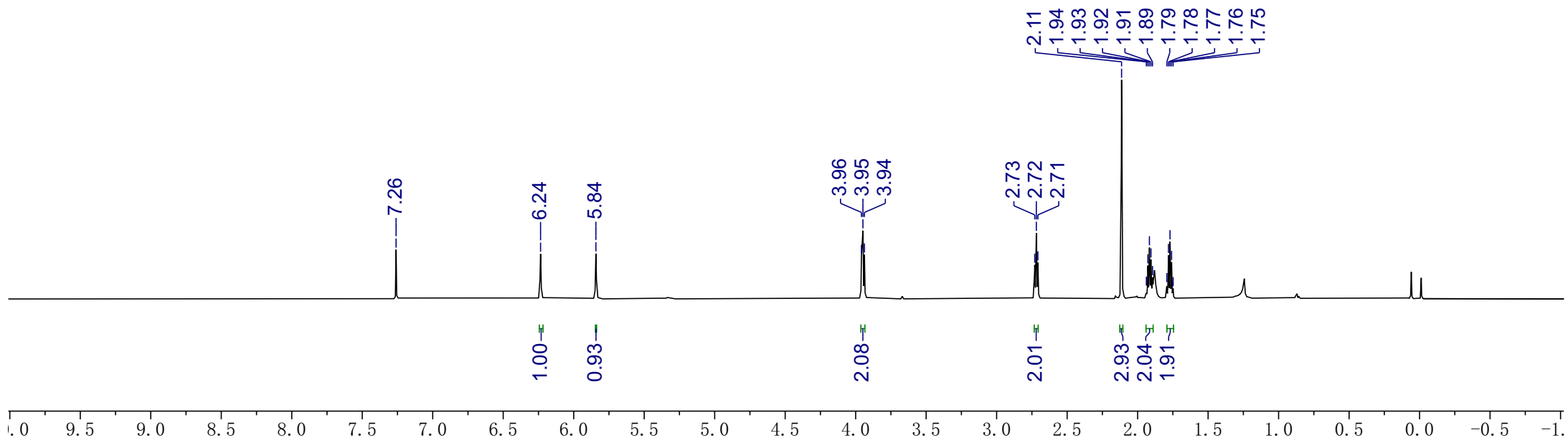


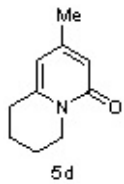
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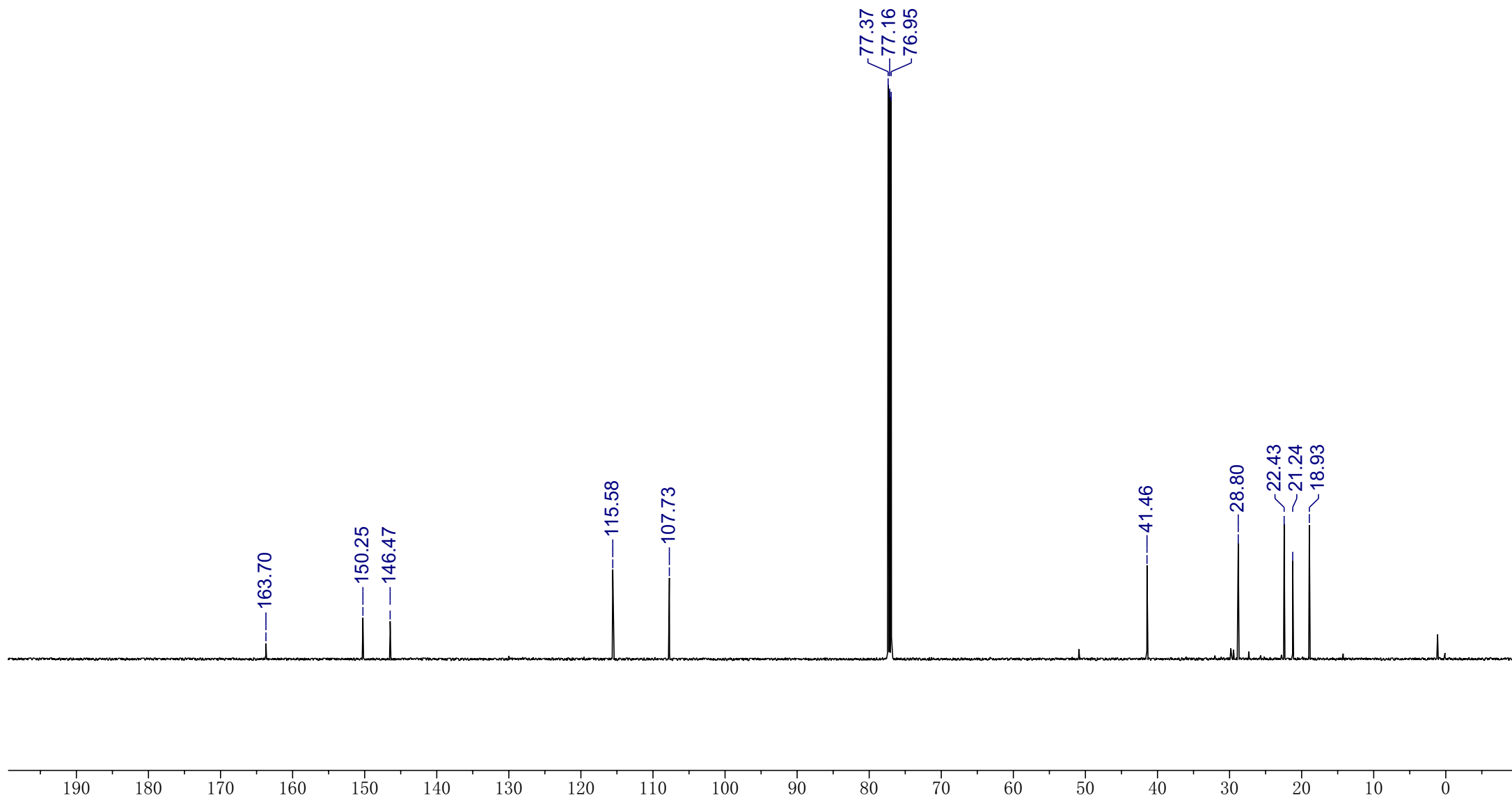


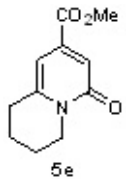
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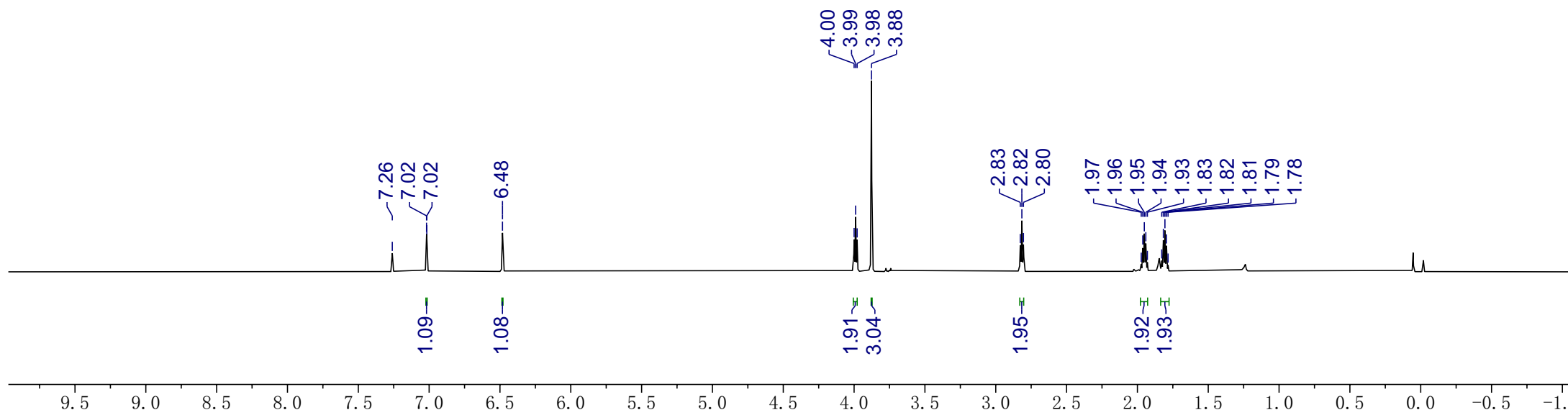


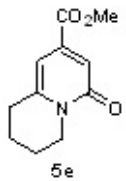
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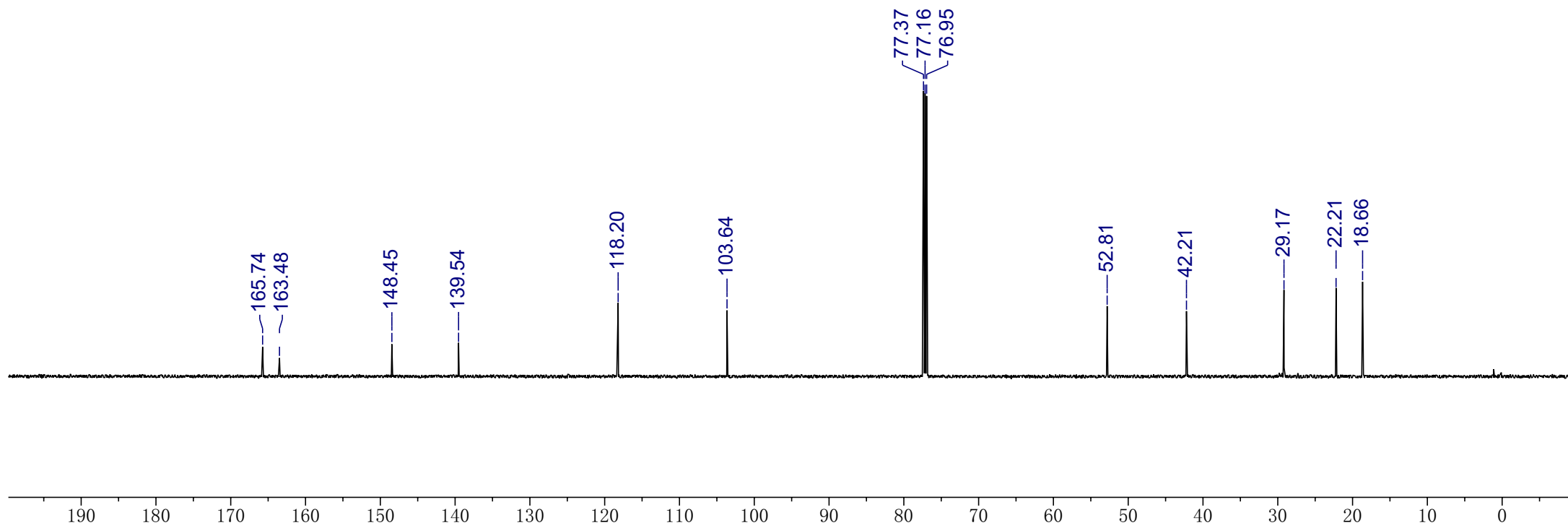


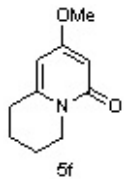
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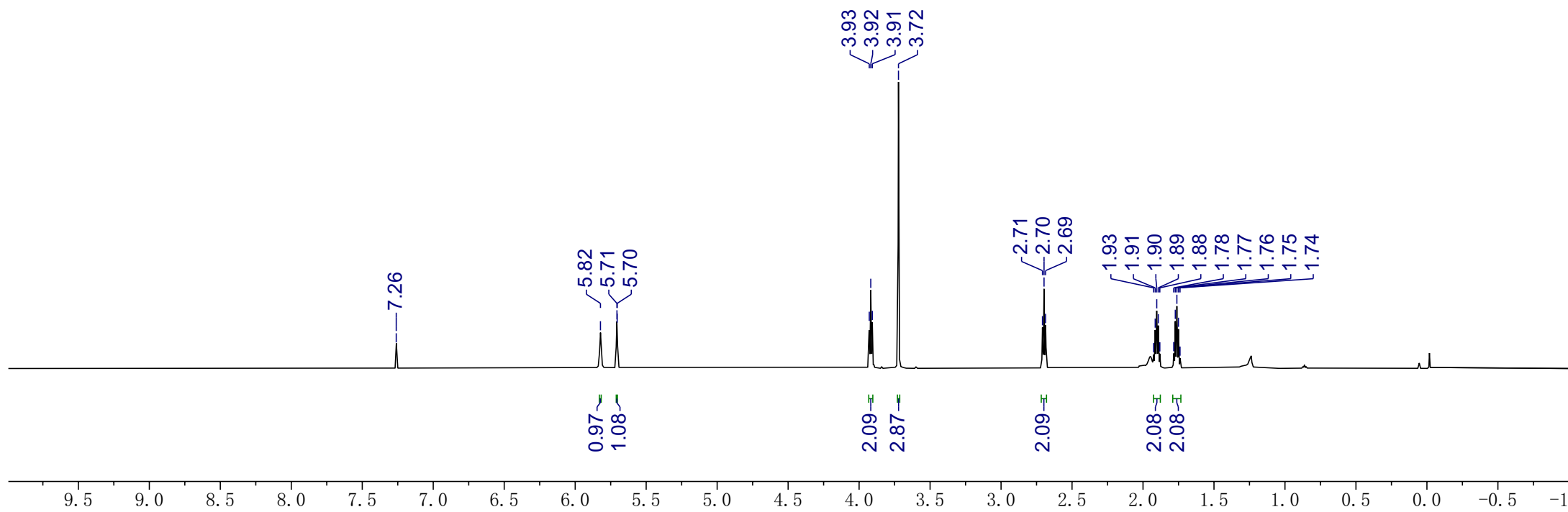


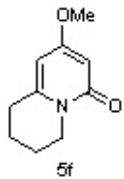
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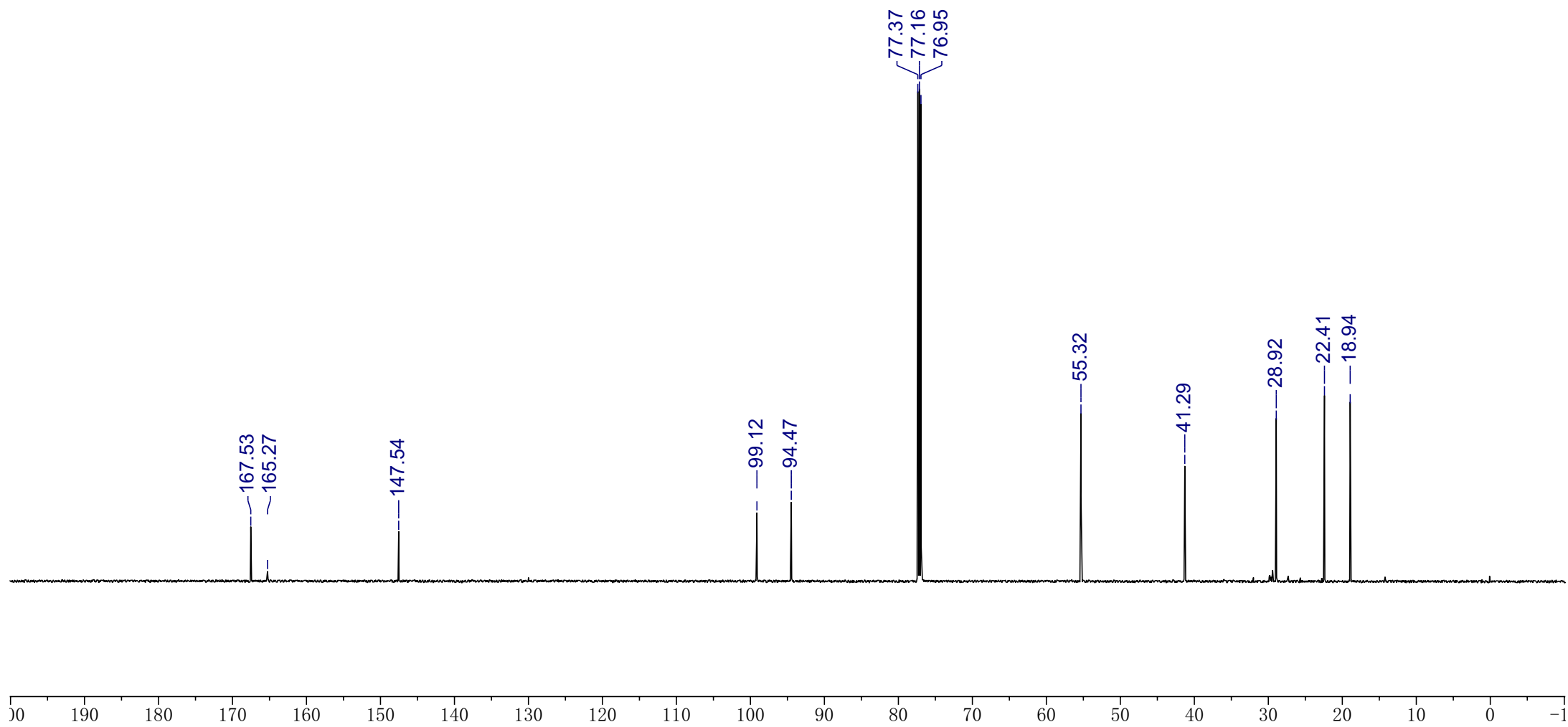


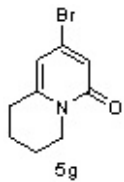
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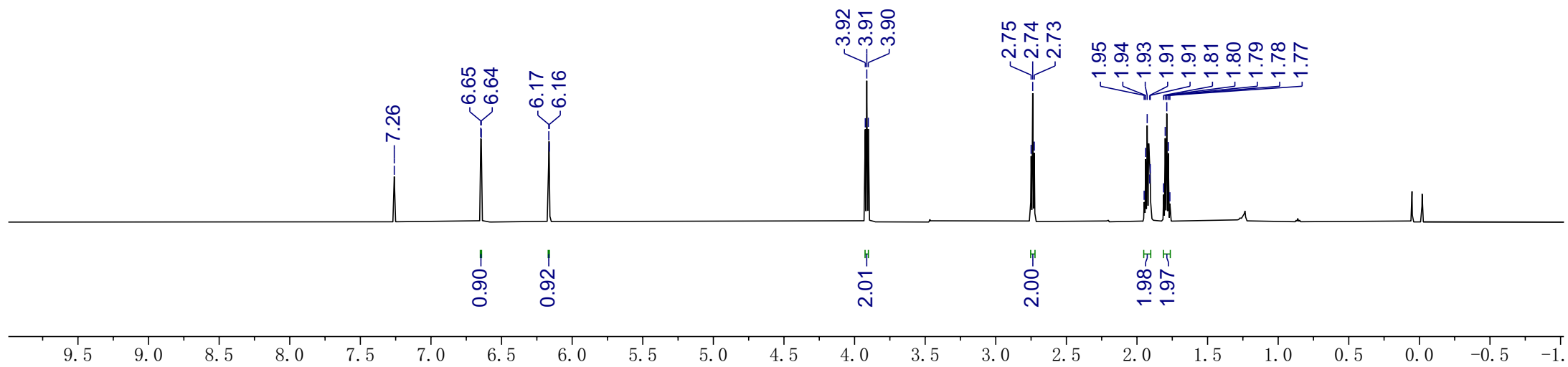


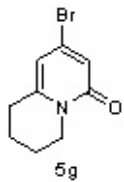
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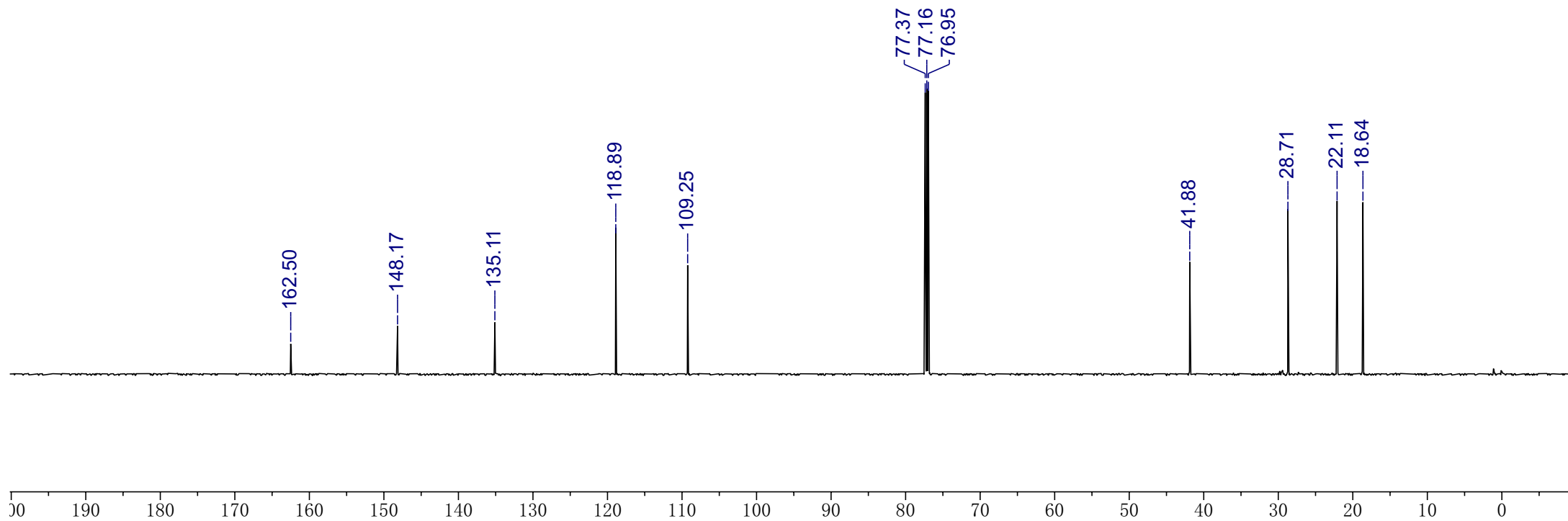


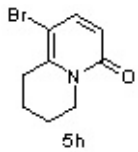
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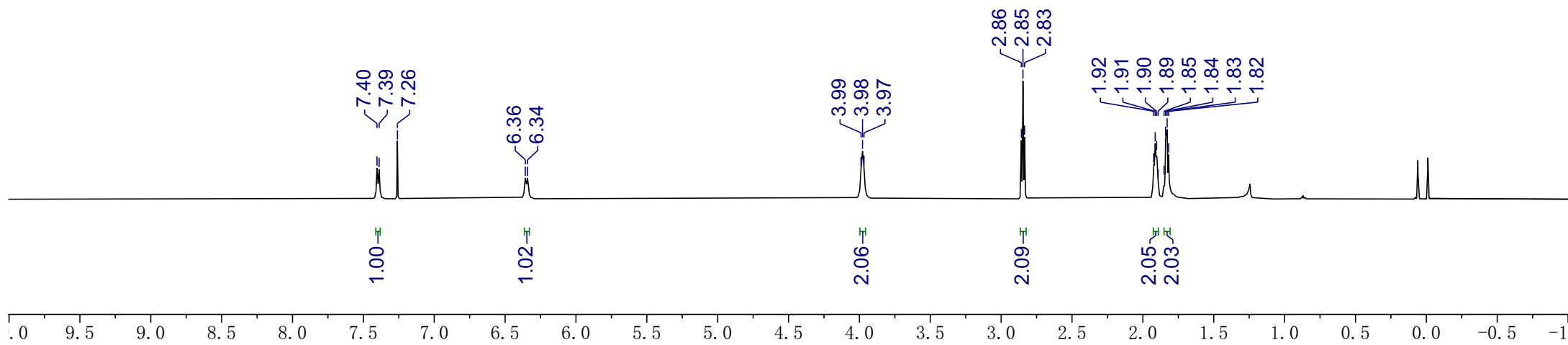


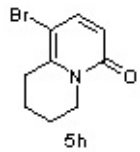
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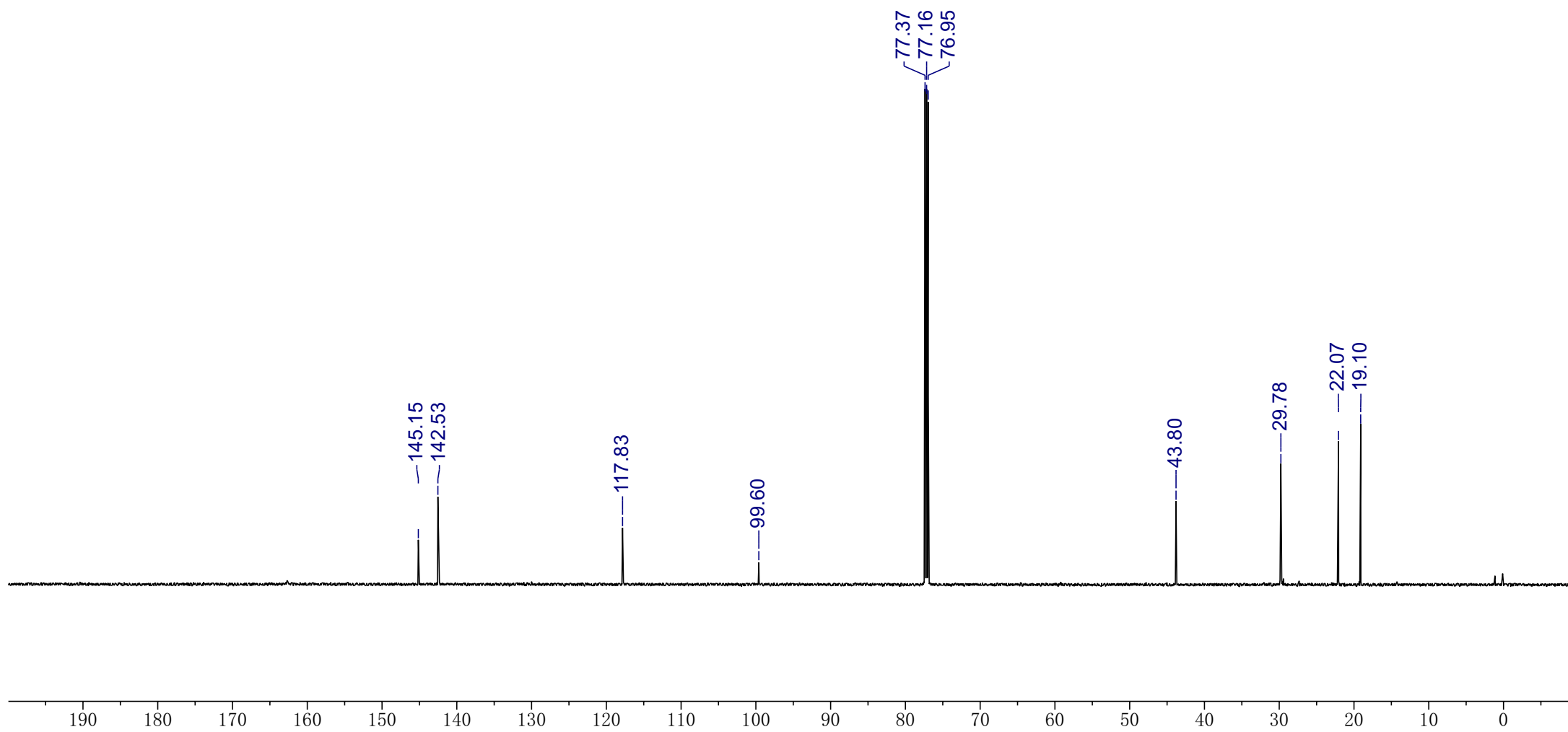


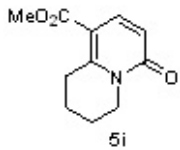
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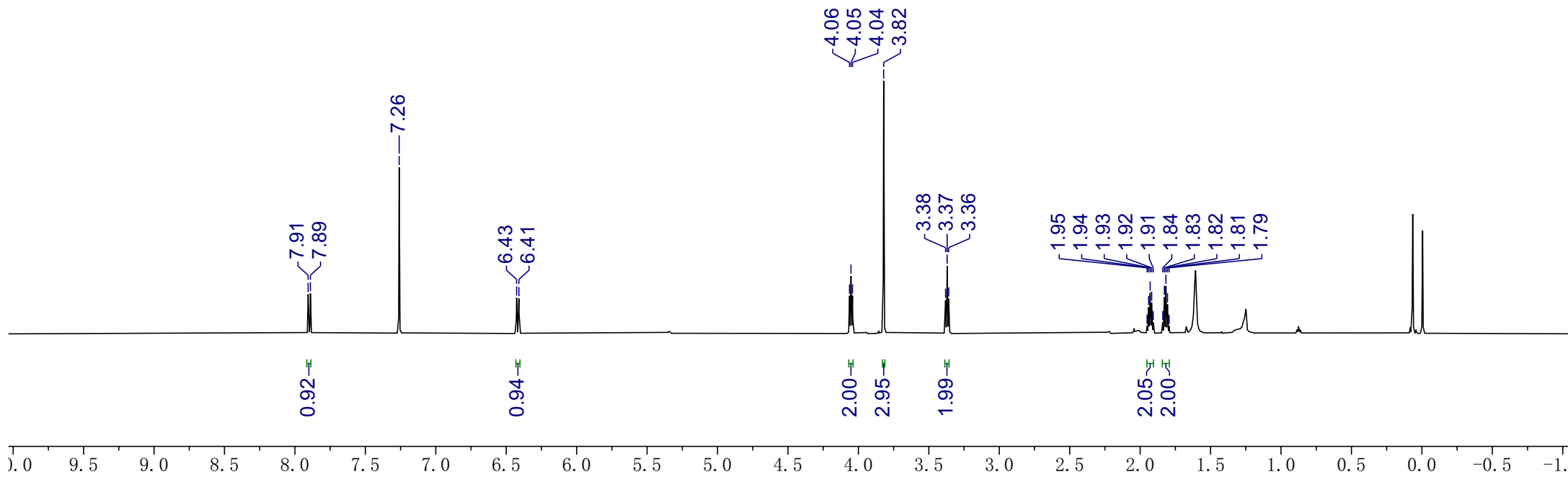


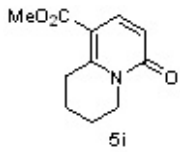
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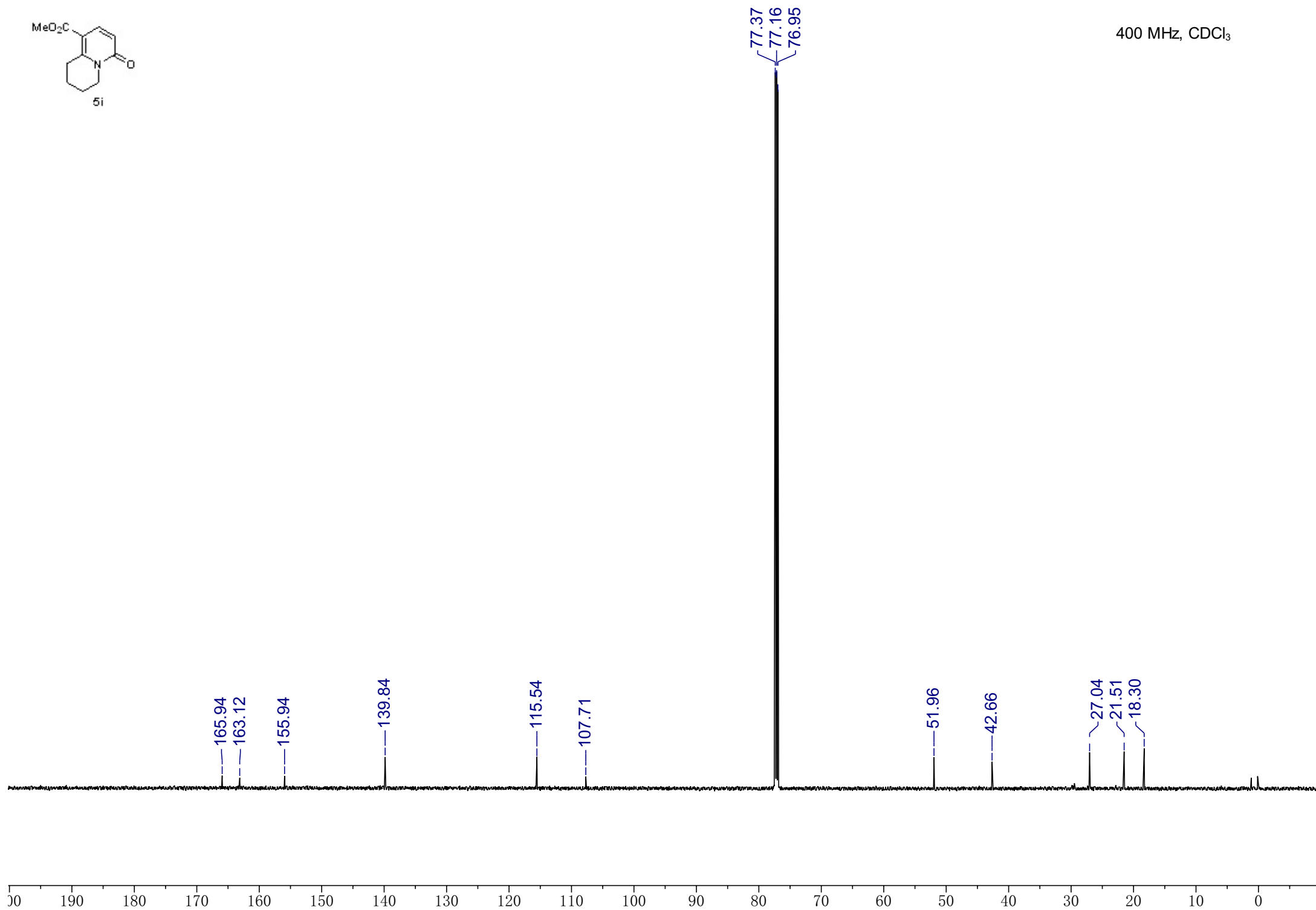


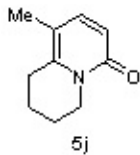
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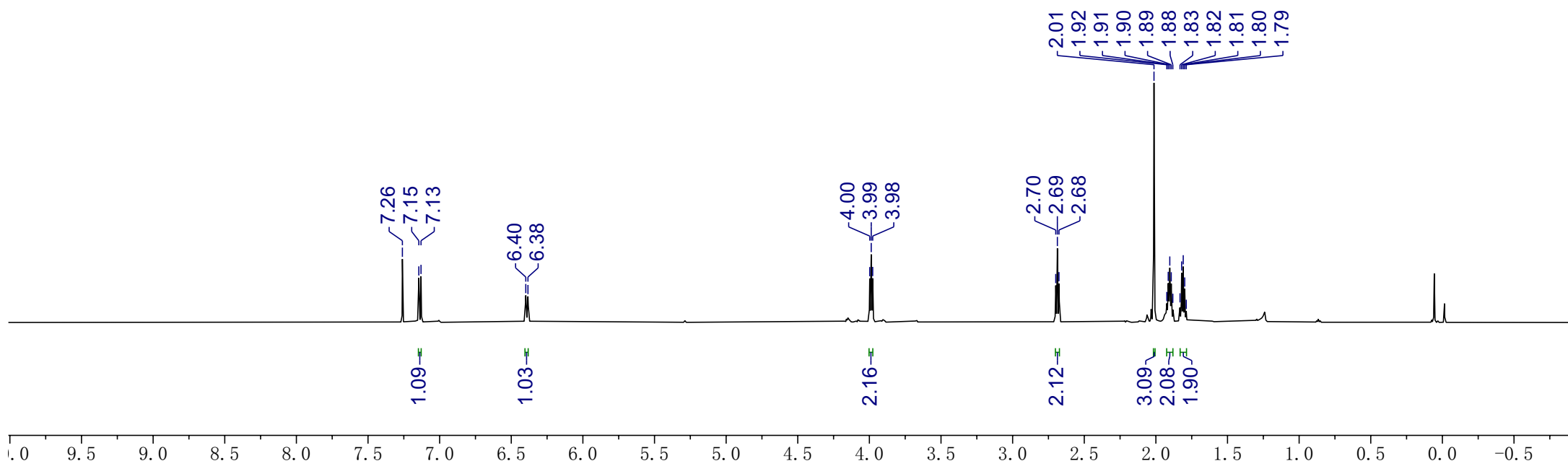


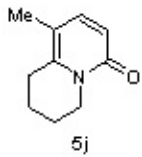
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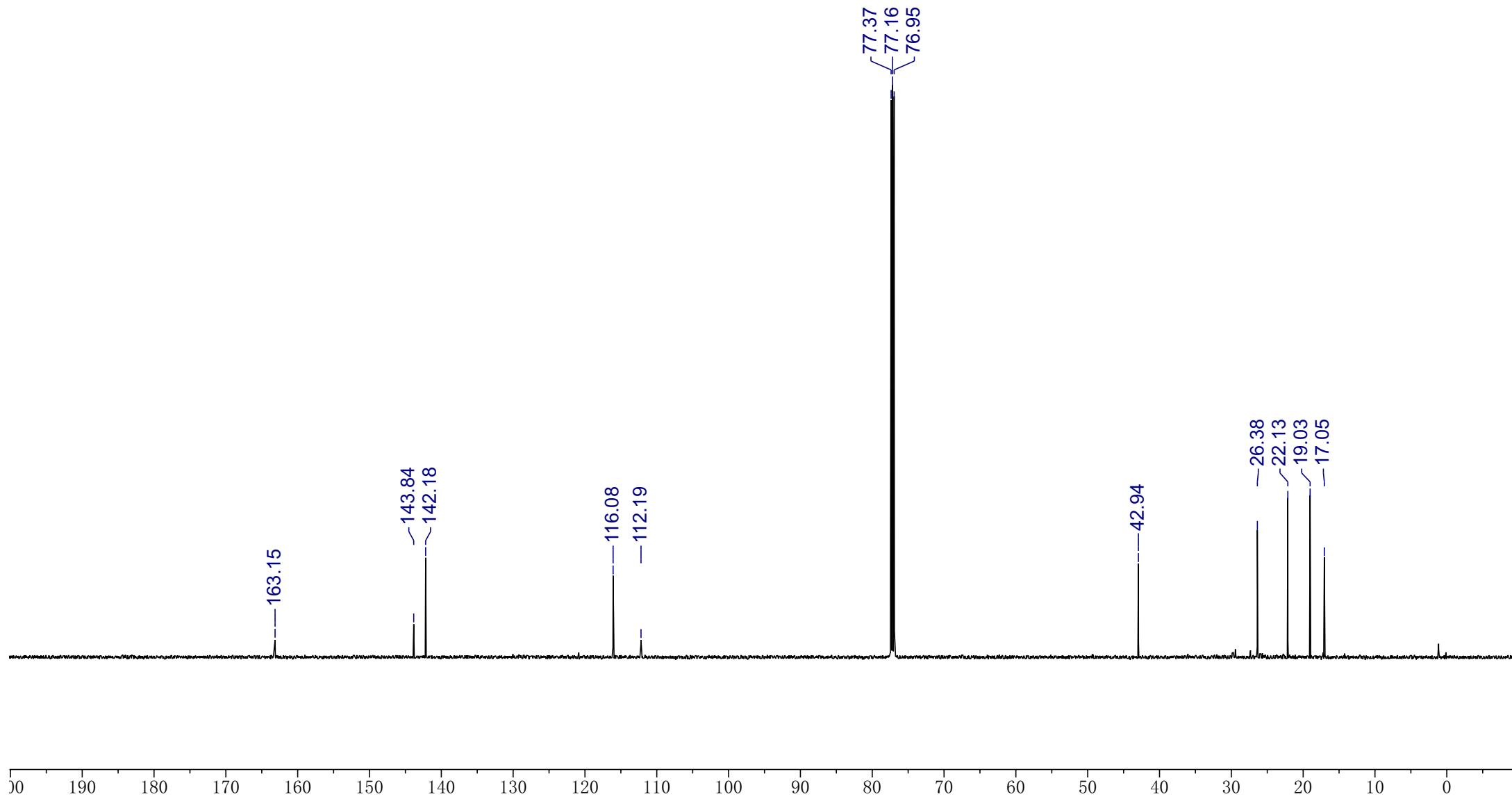


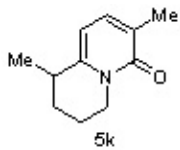
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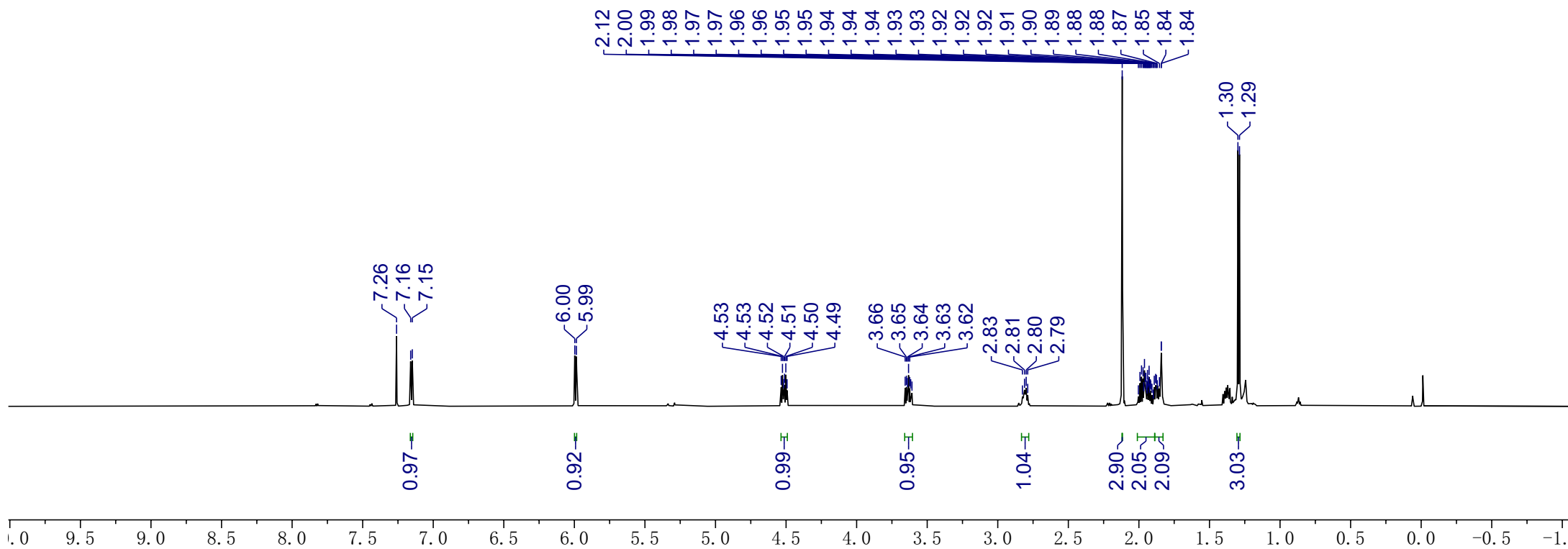


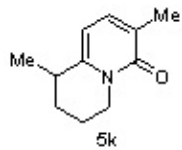
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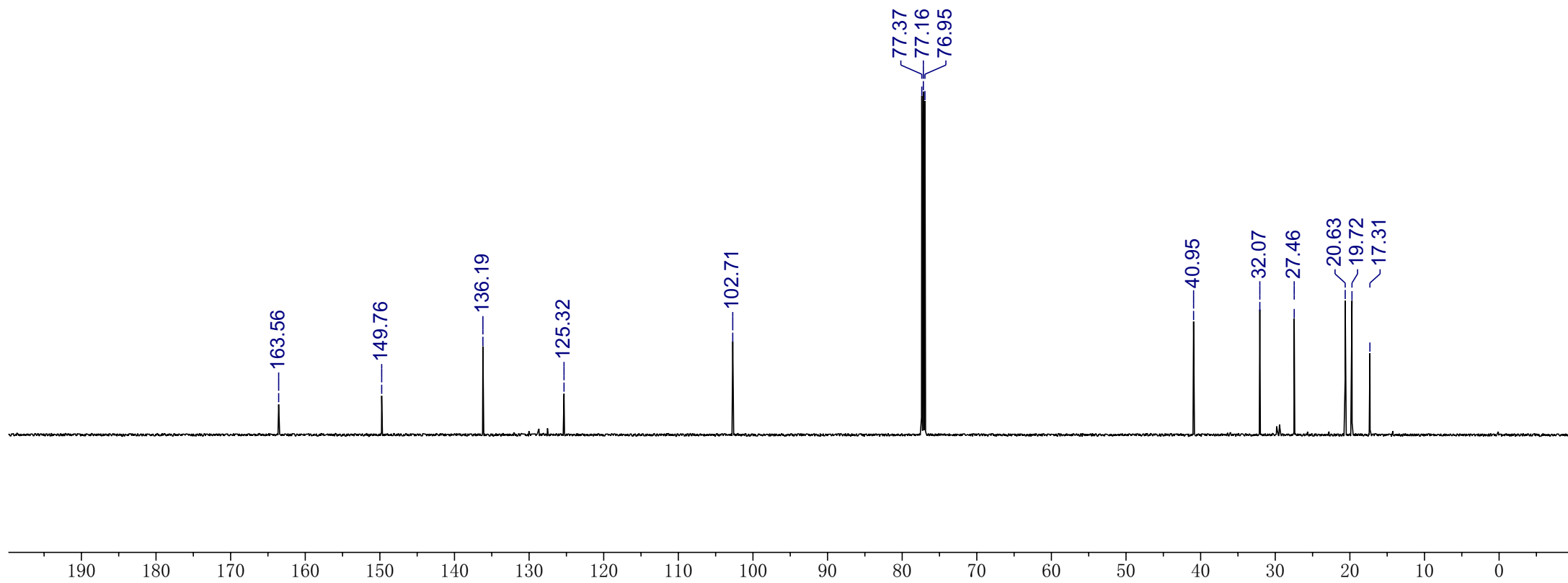


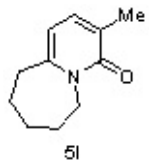
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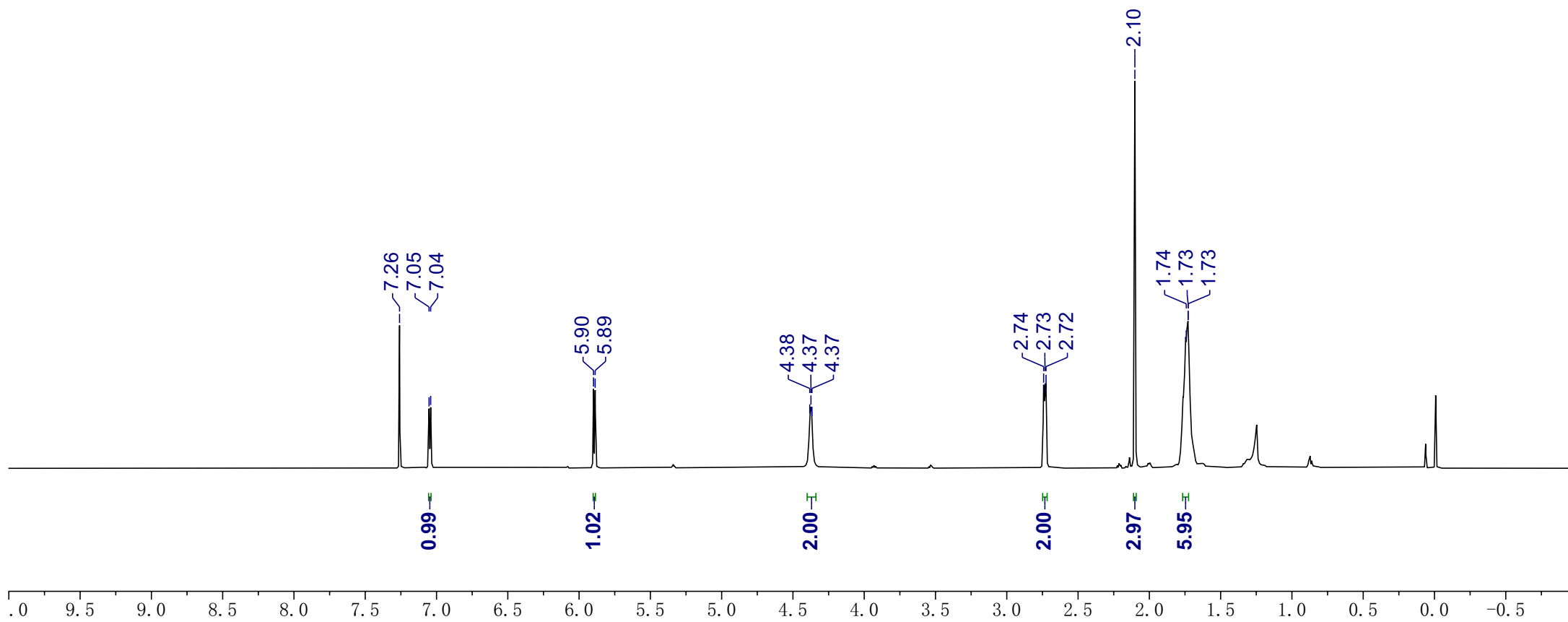


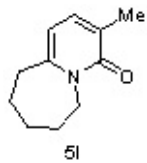
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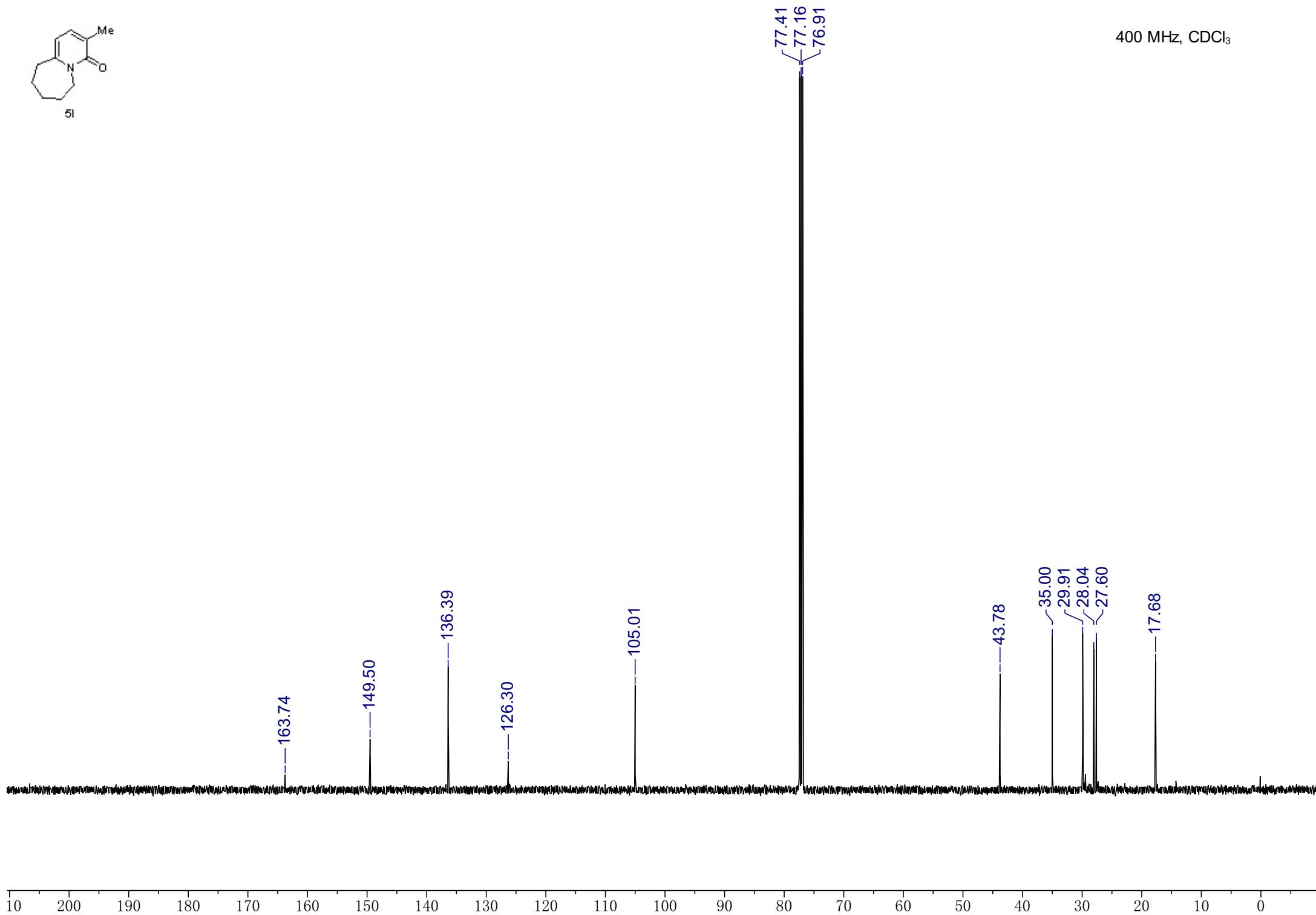


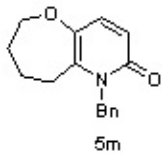
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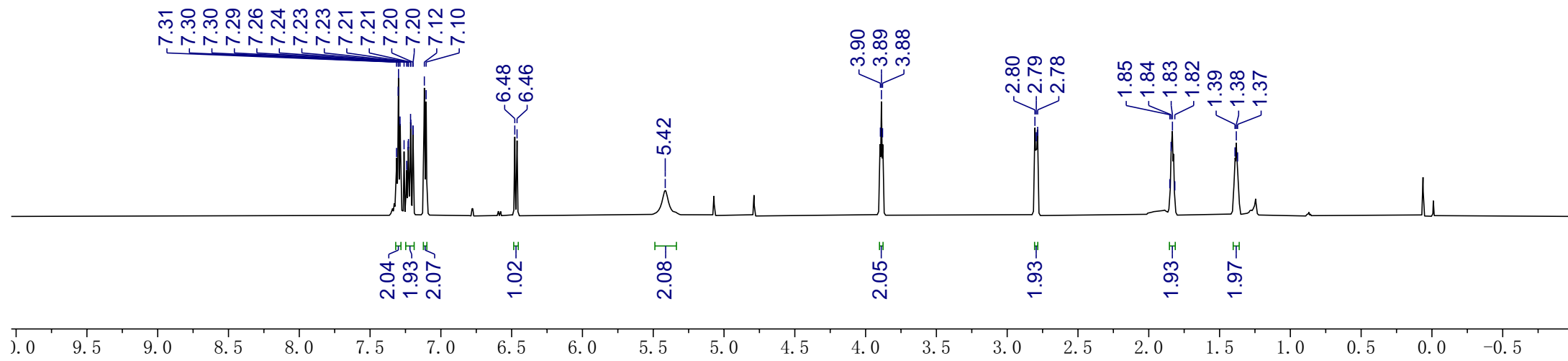


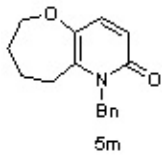
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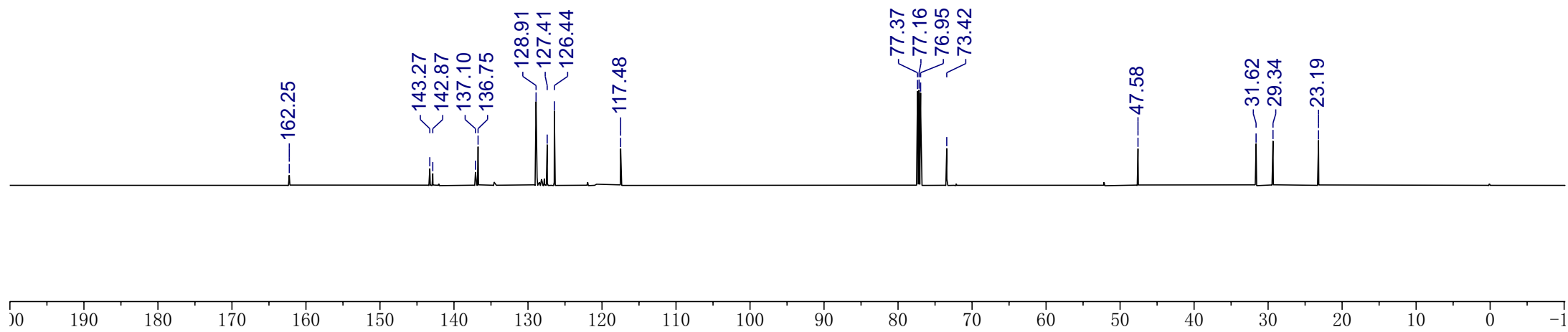


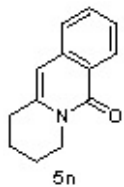
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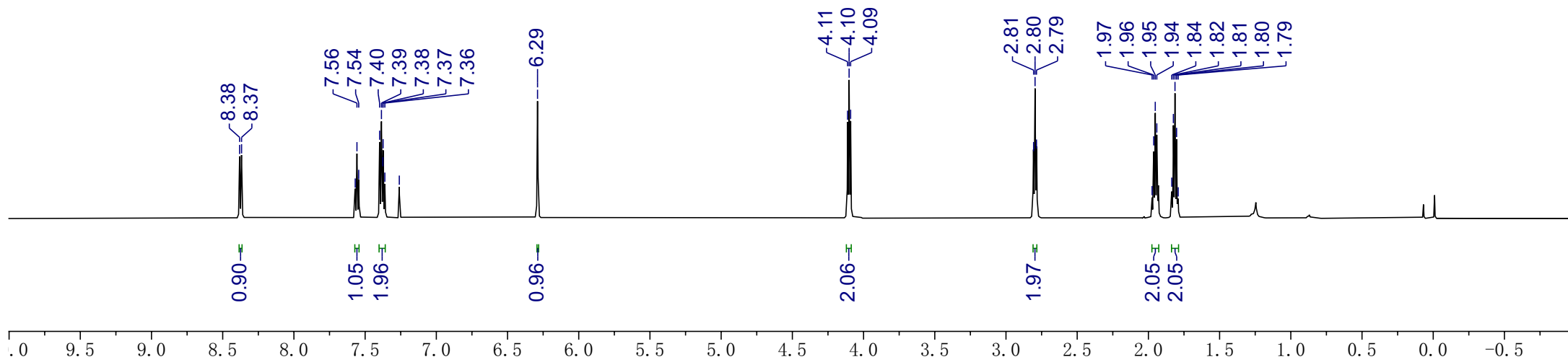


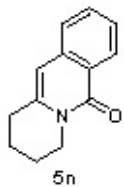
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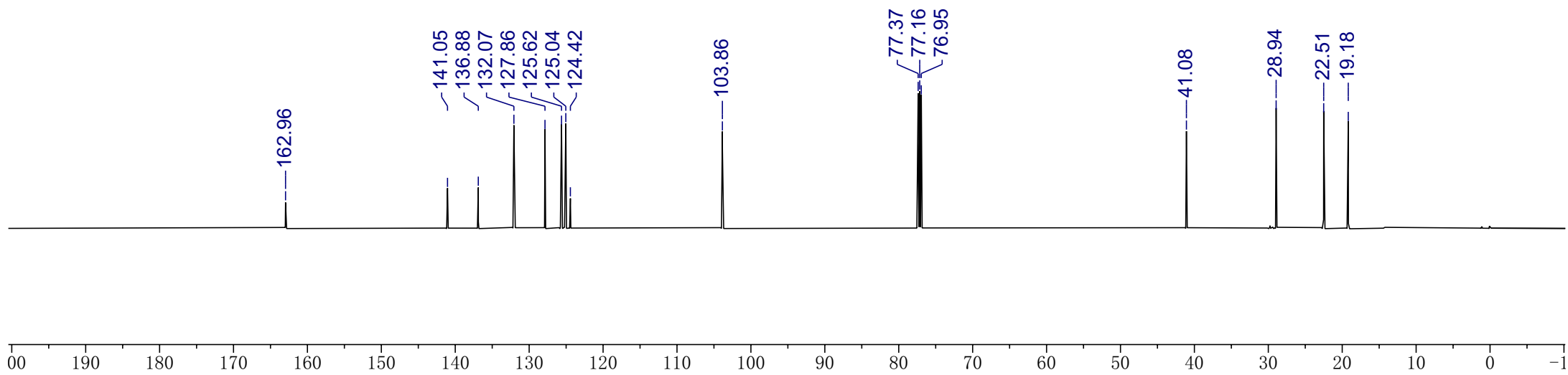


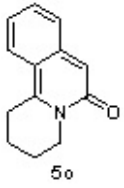
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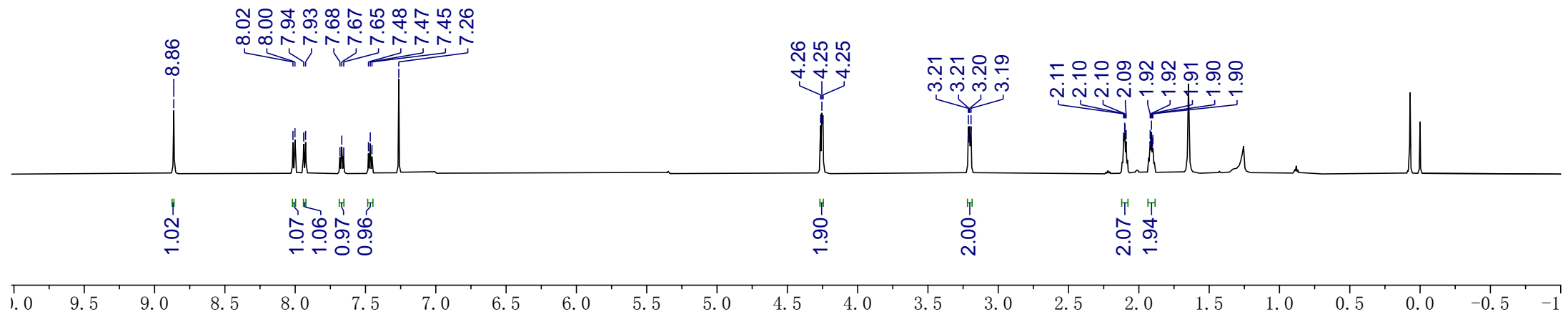


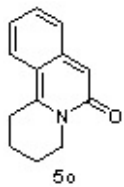
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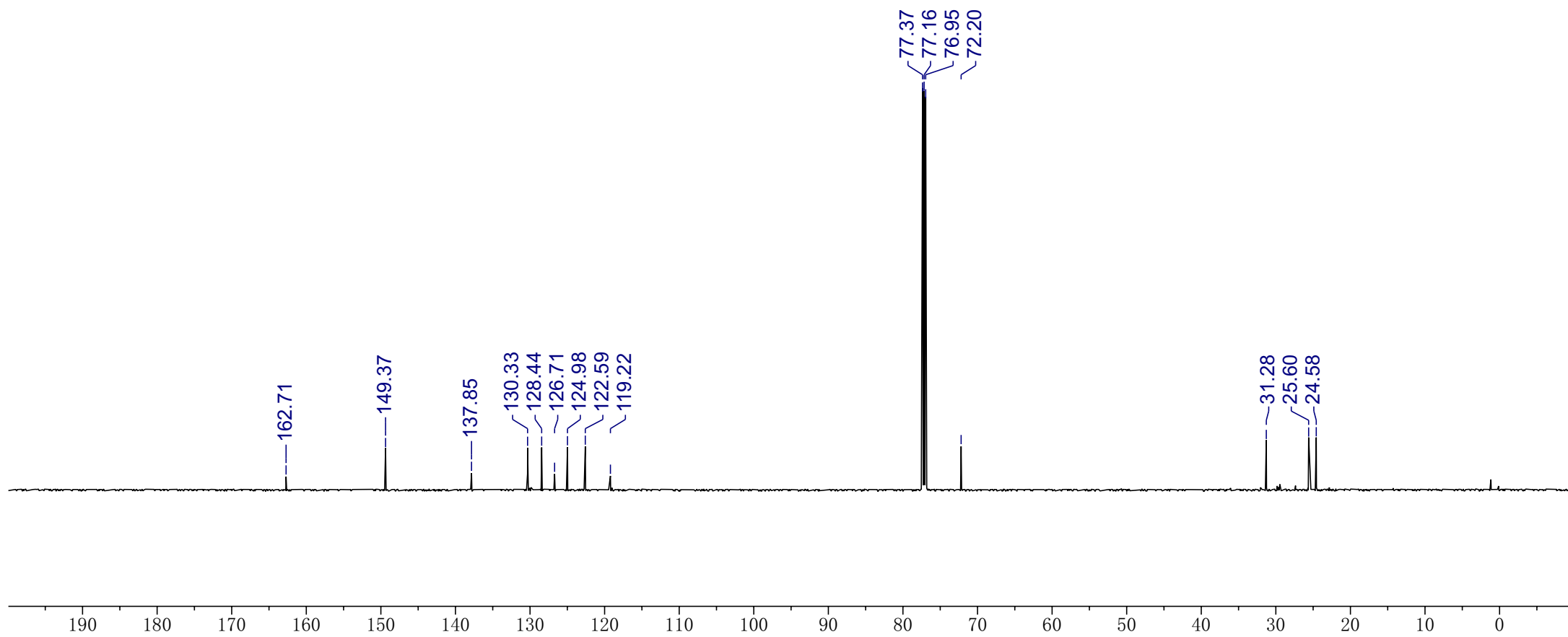


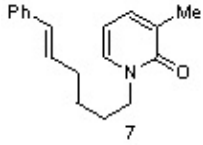
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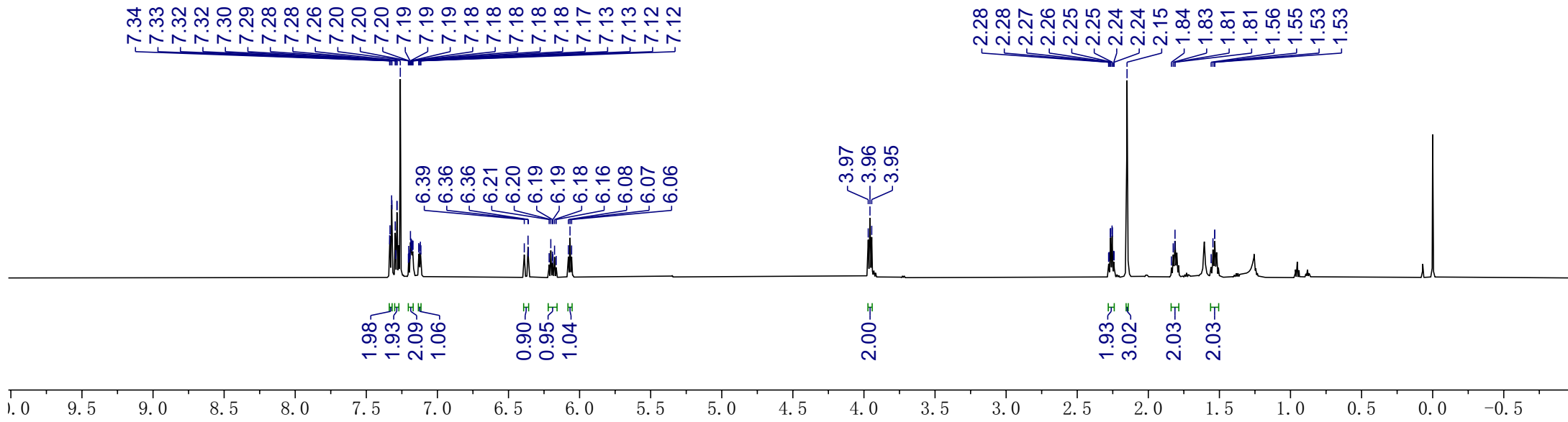


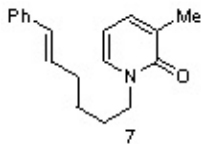
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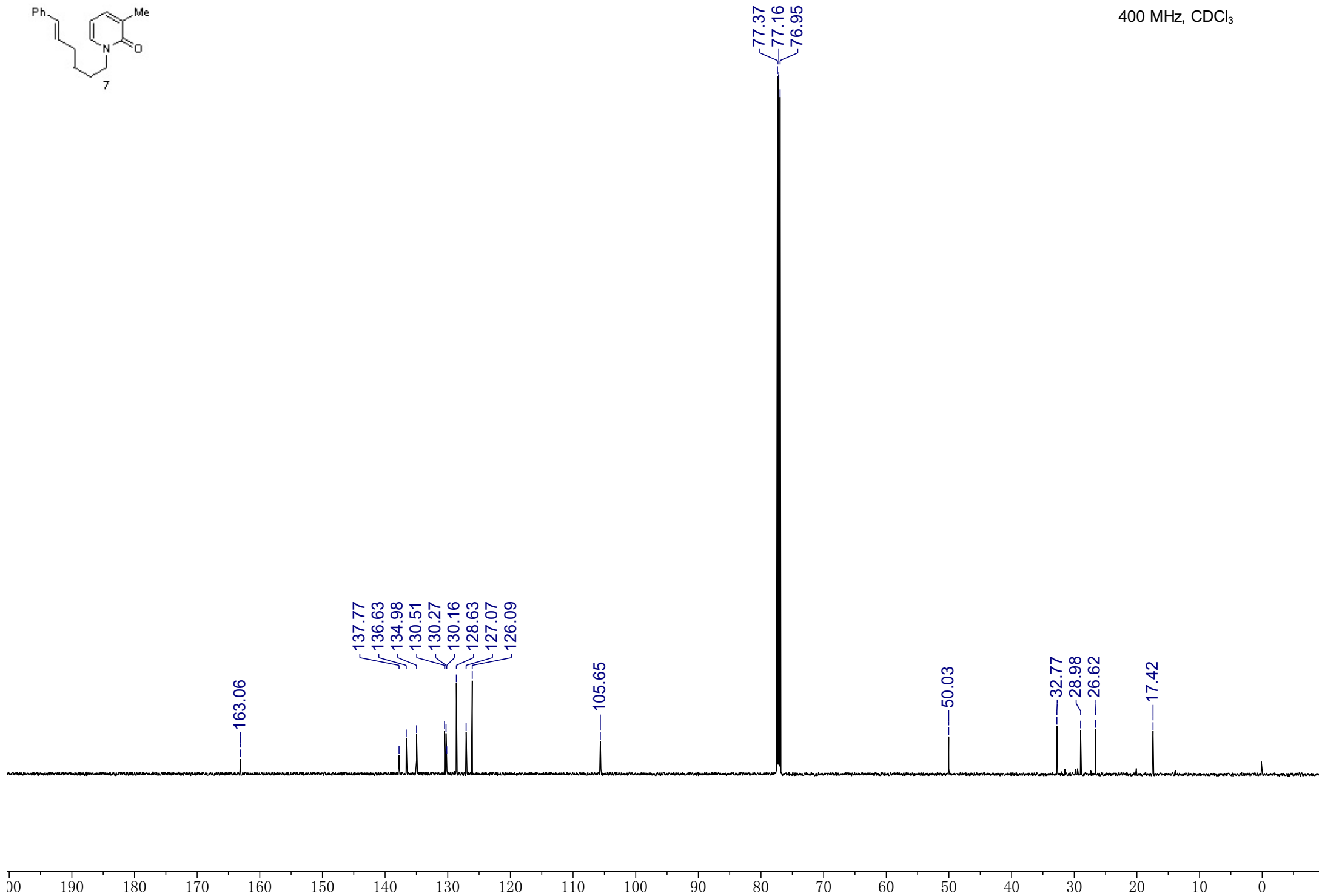


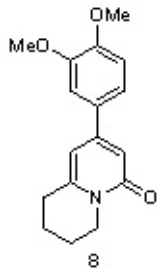
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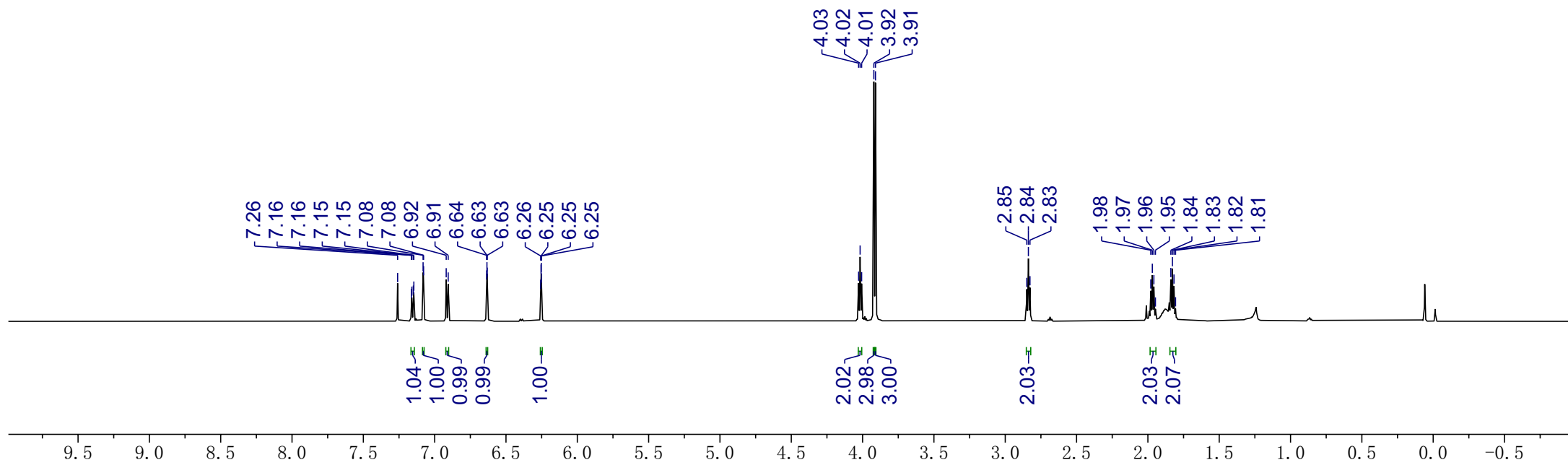


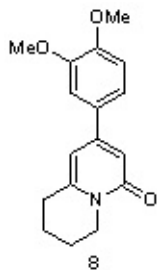
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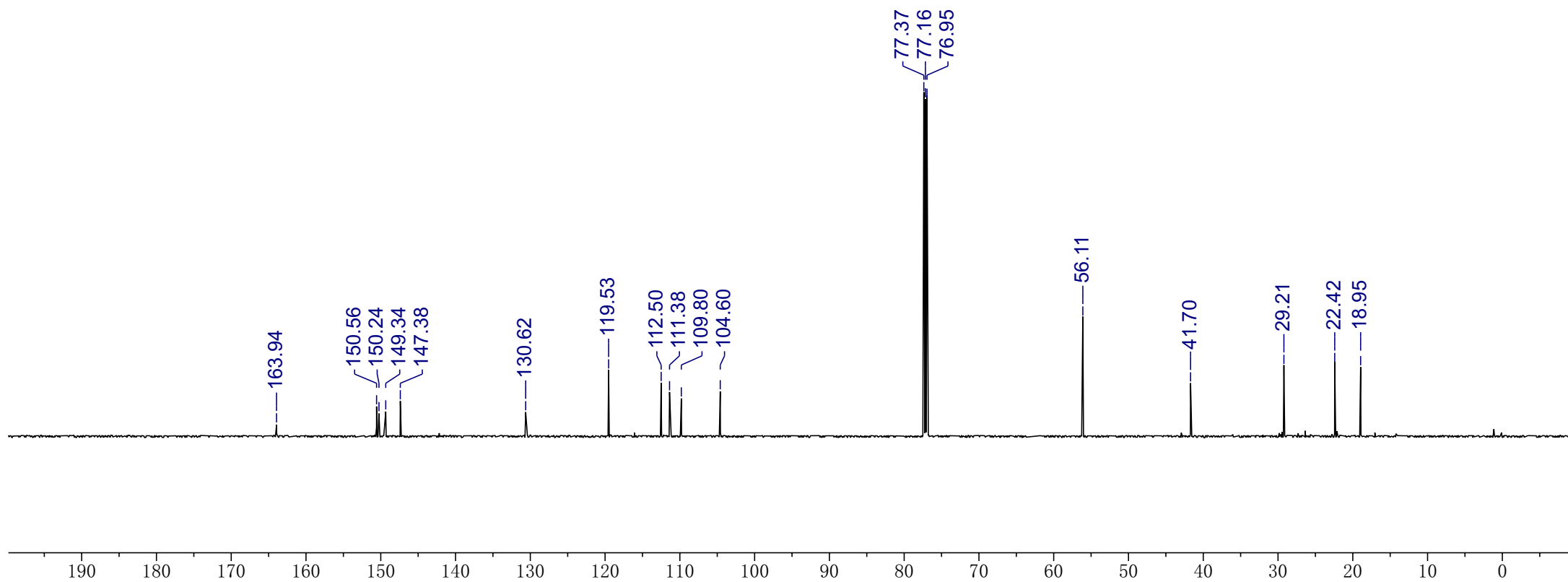


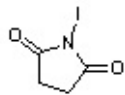
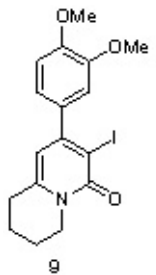
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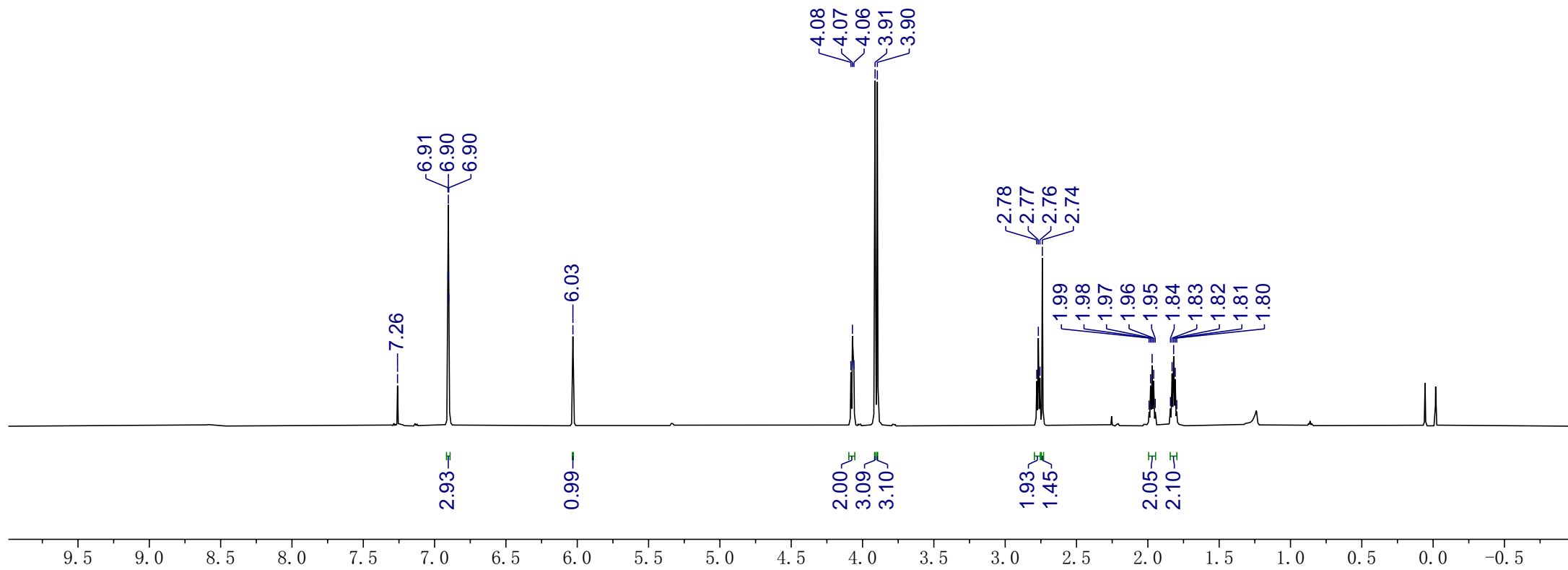
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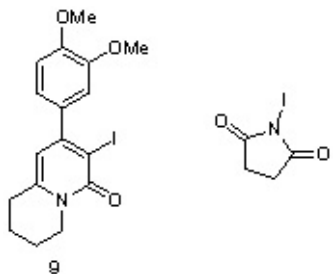


2.7 : 1

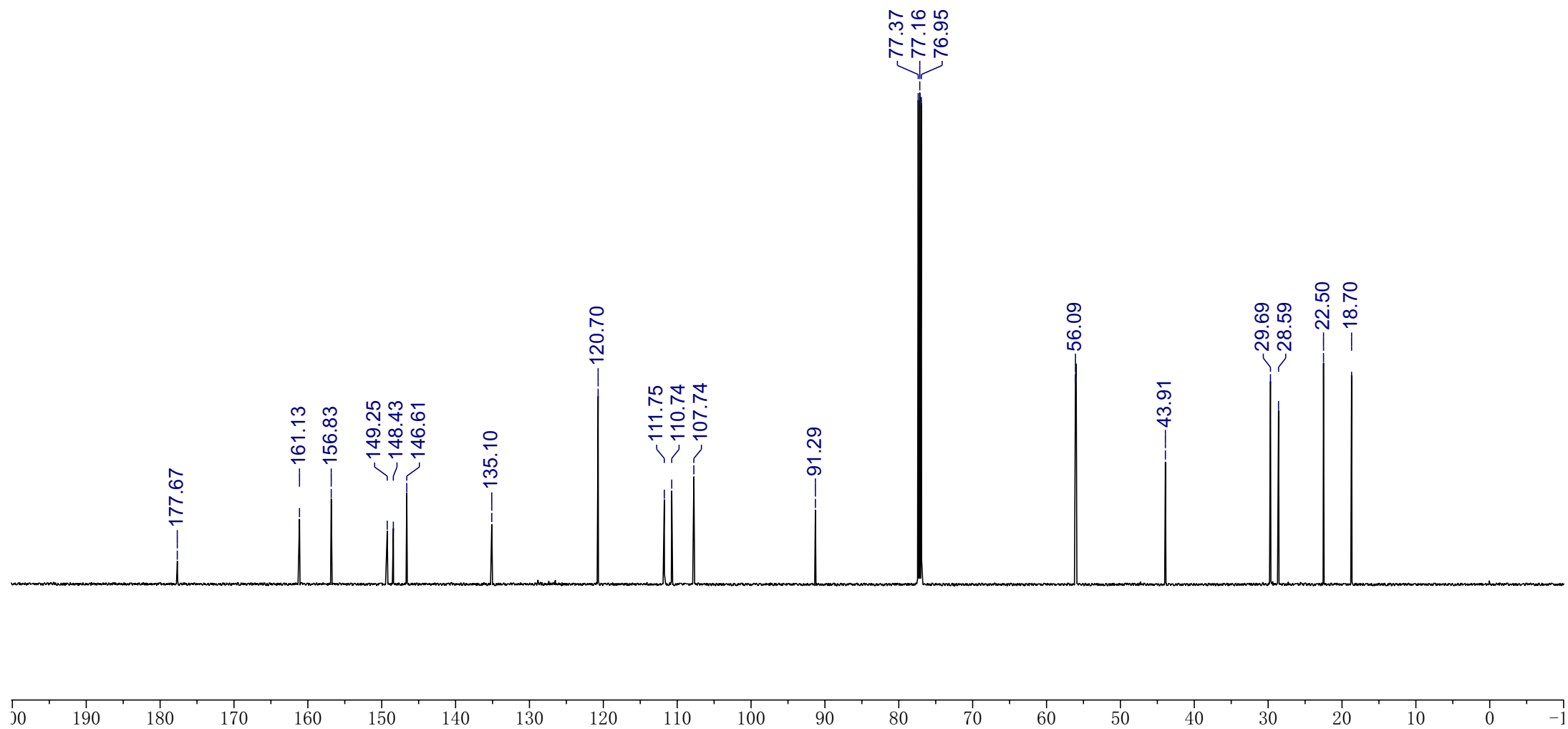
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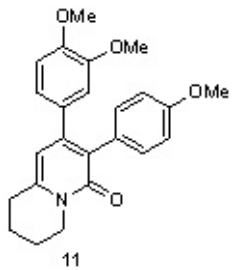


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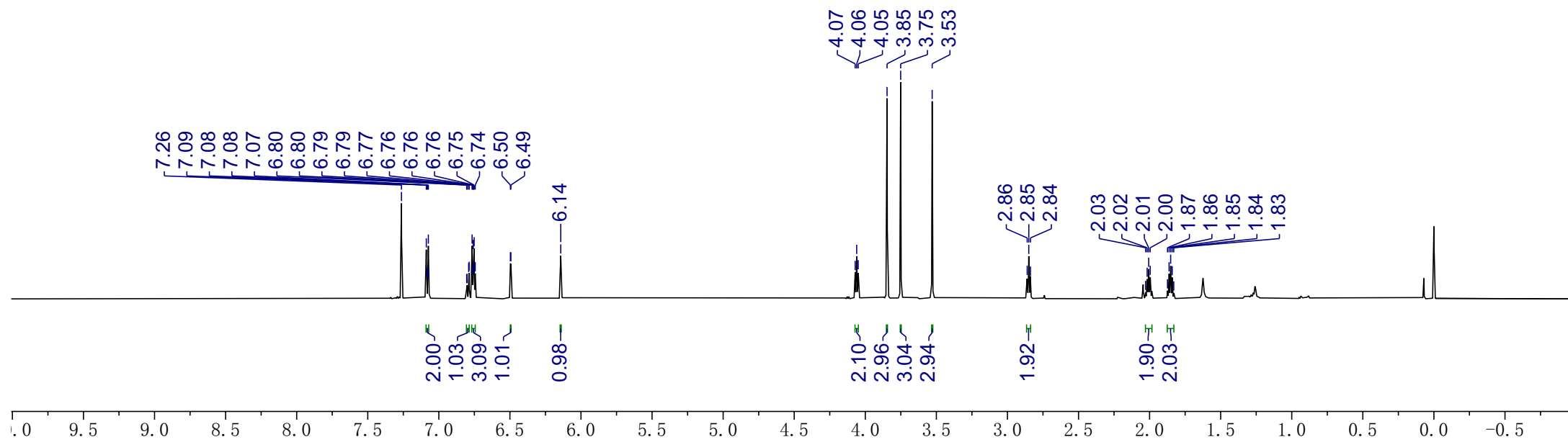


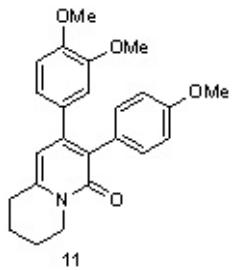
2.7 : 1





400 MHz, CDCl₃





400 MHz, CDCl₃

