Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.


# Formation of Ylidenehydrazines Enabled by Manganese-Catalyzed Acceptorless Dehydrogenative Coupling

Fangchao Wang,[b] Ding Ding,[b] Chunyan Zhang,[a]* & Guoying Zhang[b]*

[a] *College of Ecology, Taiyuan University of Technology, Taiyuan 030001, China*
[b] *State Key Laboratory of Coal Conversion, Institute of Coal Chemistry, Chinese Academy of Sciences, Taiyuan 030001, China; University of Chinese Academy of Sciences, Beijing 100049, China*

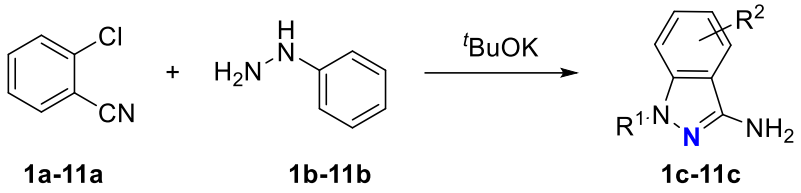
E-mail: zhangchunyan@tyut.edu.cn; zhanggy@sxicc.ac.cn

# Contents

# 1. General

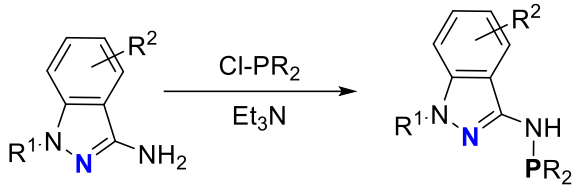
**Experimental:** All reactions and manipulations with air sensitive compounds being present were performed under dry argon (Ar 5.0) or nitrogen ($N_2$ 5.0), using Schlenk and glove box techniques. Deuterated solvents were bought from Cambridge Isotope Laboratories, distilled accordingly, and stored over molecular sieves (3 Å). Other chemicals were purchased from commercial vendors and used without further purification. NMR spectra were collected on a Varian INOVA 300 and 400 MHz spectrometer. Chemical shifts (δ) are reported in ppm relative to residual solvent signal. Coupling constants (J) are given in Hz (coupling patterns: s: singlet, s_br: broad singlet, d: doublet, t: triplet, q: quartet, m: multiplet). GC analyses were carried out using an Agilent Technologies 6890N system equipped with a Machinery-Nagel (MN) Optima 5 HT column (30 m, 320 µm, 0.25 µm) or an Agilent Technologies 6850 system equipped with a MN Optima 17 column (30 m, 320 µm, 0.25 µm). GC/MS analyses were carried out on an Agilent 7890A/MSD 5975C system equipped with a HP-5MS column (30 m, 320 µm, 0.25 µm). High resolution mass spectra (HRMS) were recorded on Bruker MicroTOF-QII mass (ESI). MN silica gel 60 (0.040 – 0.063 mm particle size) was used for flash column chromatography.

## 2. Synthesis of NNP-Ligands



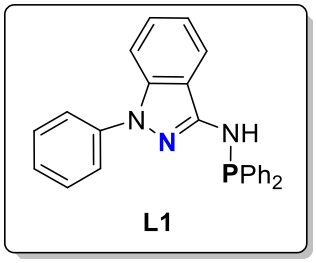

**1a-11a** **1b-11b** **1c-11c**

Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, base, hydrazines (**1b-11b)** and diglyme. After stirring of five minutes, nitriles (**1a-11a**) were added the mixture reaction. Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated oil bath (design temperature). After design time the reaction was cooled, quenched with half-saturated brine and extracted with dichloromethane (4 x 15 mL). The combined organic phase was dried over $Na_2SO_4$ and concentrated. A small aliquot of the organic phase was analyzed by GC or GC-MS to monitor product formation. Purification of the remainder by column chromatography on silica gel gave the corresponding products **1c-11c** (pentane/ethyl ether = 15/1 – 5/1).[1]




**1c-11c** **L1-L11**

Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, catalyst, ligand, solvent, amines (**1c-11c**, 1.0 mmol), Cl-$PR_2$ (1.2 mmol), $Et_3N$ (1.5 mmol) and THF (2.0 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (30 °C) for 12 hours. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase was analyzed by GC and GC-MS to monitor product formation. The solvent was evaporated under reduced pressure and the residue was purified by flash column chromatography (petroleum ether/ethoxyethane = 20:1 – 1:1) on $Al_2O_3$ to give the product **L1-L11** in the reported yields.




L1

***N*-(diphenylphosphanyl)-1-phenyl-1H-indazol-3-amine (L1)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a white solid 349.9 mg, 89% yield.

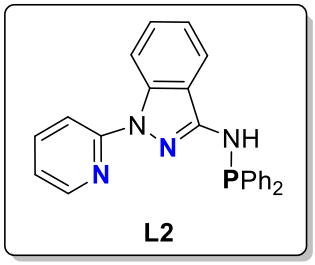
**$^{1}$H NMR** (400 MHz, $CDCl_3$) δ 8.05 (d, *J* = 8.1 Hz, 1H), 7.62 (dd, J = 8.2, 2.5 Hz, 3H), 7.52 (td, *J* = 7.6, 1.8 Hz, 4H), 7.40 (t, *J* = 7.9 Hz, 2H), 7.34 – 7.31 (m, 7H), 7.17 (t, *J* = 7.5 Hz, 1H), 7.06 (t, *J* = 7.5 Hz, 1H), 5.20 (d, *J* = 7.2 Hz, 1H) ppm.

**$^{13}$C NMR** (101 MHz, $CDCl_3$) δ 148.98, 148.79, 140.35, 140.33, 140.23, 140.07, 131.27, 131.06, 129.14, 129.10, 128.49, 128.43, 127.61, 125.08, 121.72, 121.64, 121.60, 119.83, 116.69, 116.67, 110.13 ppm.

**$^{31}$P NMR** (162 MHz, $CDCl_3$) δ 32.45 ppm.

**HRMS** (ESI) calcd. for $C_{25}H_{21}N_3P$ [M+H]: 394.1473, found: 394.1474.

**Elemental Analysis** calcd for $C_{25}H_{20}N_3P$: C, 76.32; H, 5.12; N, 10.68; found: C, 76.34; H, 5.16; N, 10.63.




L2

***N*-(diphenylphosphanyl)-1-(pyridin-2-yl)-1H-indazol-3-amine (L2)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a white solid 323.2 mg, 82% yield.

**$^{1}$H NMR** (400 MHz, $CDCl_3$) δ 8.82 (d, *J* = 8.6 Hz, 1H), 8.44 (dd, *J* = 4.9, 1.2 Hz, 1H), 7.98 (d, *J* = 8.1 Hz, 1H), 7.81 (d, *J* = 8.4 Hz, 1H), 7.72 – 7.67 (m, 1H), 7.59 – 7.55 (m, 4H), 7.52 – 7.48 (m, 1H), 7.43 – 7.40 (m, 6H), 7.20 (t, *J* = 7.5 Hz, 1H), 7.01

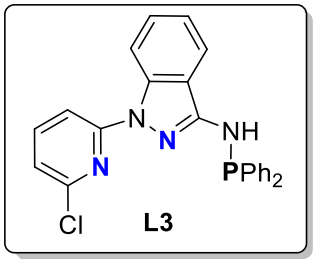
– 6.98 (m, 1H), 5.14 (d, *J* = 6.4 Hz, 1H) ppm.

**$^{13}$C NMR** (101 MHz, $CDCl_3$) δ 154.42, 149.82, 149.66, 147.58, 140.42, 140.22, 140.10, 138.00, 131.60, 131.39, 129.45, 128.77, 128.71, 128.64, 121.32, 120.65, 120.55, 118.36, 118.10, 118.09, 115.56, 112.71 ppm.

**$^{31}$P NMR** (162 MHz, $CDCl_3$) δ 32.08 ppm.

**HRMS** (ESI) calcd. for $C_{24}H_{20}N_4P$ [M+H]: 395.1425, found: 395.1422.

**Elemental Analysis** calcd for $C_{24}H_{19}N_4P$: C, 73.09; H, 4.86; N, 14.2; found: C, 73.04; H, 4.88; N, 14.19.




**1-(6-chloropyridin-2-yl)-*N*-(diphenylphosphanyl)-1H-indazol-3-amine (L3)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a white solid 325.4 mg,76% yield.

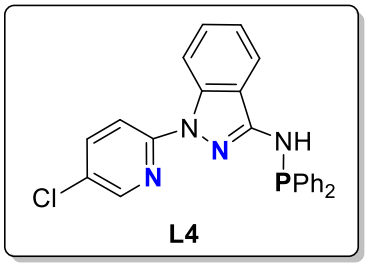
**$^{1}$H NMR** (400 MHz, $CDCl_3$) δ 8.77 (d, *J* = 8.6 Hz, 1H), 7.94 (d, *J* = 8.0 Hz, 1H), 7.70 (d, *J* = 8.1 Hz, 1H), 7.61 (t, *J* = 7.9 Hz, 1H), 7.57 – 7.51 (m, 5H), 7.43 – 7.40 (m, 6H), 7.22 (t, *J* = 7.5 Hz, 1H), 6.98 (d, *J* = 7.6 Hz, 1H), 5.13 (d, J = 6.2 Hz, 1H) ppm.

**$^{13}$C NMR** (101 MHz, $CDCl_3$) δ 153.58, 150.29, 150.13, 148.76, 140.21, 140.09, 139.82, 139.70, 131.45, 131.24, 129.38, 128.93, 128.65, 128.59, 121.74, 120.39, 120.30, 118.34, 117.56, 115.68, 110.31 ppm.

**$^{31}$P NMR** (162 MHz, $CDCl_3$) δ 32.1 ppm.

**HRMS** (ESI) calcd. for $C_{24}H_{19}ClN_4P$ [M+H]: 429.1036, found: 429.1031.

**Elemental Analysis** calcd for $C_{24}H_{18}ClN_4P$: C, 67.22; H, 4.23; N, 13.06; found: C, 67.28; H, 4.28; N, 13.07.




L4

**1-(5-chloropyridin-2-yl)-*N*-(diphenylphosphanyl)-1H-indazol-3-amine (L4)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a white solid 346.8 mg, 81% yield.

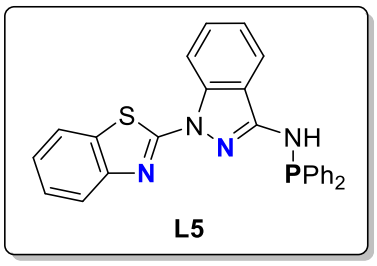
**$^{1}$H NMR** (400 MHz, $CDCl_3$) δ 8.69 (d, *J* = 8.6 Hz, 1H), 8.32 (d, *J* = 2.3 Hz, 1H), 7.92 (d, *J* = 8.1 Hz, 1H), 7.72 (d, *J* = 8.9 Hz, 1H), 7.57 (dd, *J* = 8.9, 2.5 Hz, 1H), 7.55 – 7.49 (m, 4H), 7.47 – 7.44 (m, 1H), 7.39 – 7.35 (m, 6H), 7.16 (t, *J* = 7.5 Hz, 1H), 5.15 (d, *J* = 6.2 Hz, 1H) ppm.

**$^{13}$C NMR** (101 MHz, $CDCl_3$) δ 152.50, 150.09, 149.93, 145.89, 140.20, 139.95, 139.83, 137.65, 131.52, 131.31, 129.42, 128.76, 128.71, 128.65, 125.38, 121.55, 120.57, 120.48, 118.26, 118.25, 115.47, 113.46 ppm.

**$^{31}$P NMR** (162 MHz, $CDCl_3$) δ 32.26 ppm.

**HRMS** (ESI) calcd. for $C_{24}H_{19}ClN_4P$ [M+H]: 429.1036, found: 429.1032.

**Elemental Analysis** calcd for $C_{24}H_{18}ClN_4P$: C, 67.22; H, 4.23; N, 13.06; found: C, C, 67.26; H, 4.27; N, 13.08.




L5

**1-(benzo[d]thiazol-2-yl)-*N*-(diphenylphosphanyl)-1H-indazol-3-amine (L5)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a white solid 387.1 mg, 86% yield.

**$^{1}$H NMR** (400 MHz, $CDCl_3$) δ 8.72 (d, *J* = 8.5 Hz, 1H), 8.09 (d, *J* = 8.1 Hz, 1H), 7.85 (d, *J* = 8.1 Hz, 1H), 7.73 (d, *J* = 7.9 Hz, 1H), 7.58 – 7.51 (m, 5H), 7.41 – 7.36 (m,

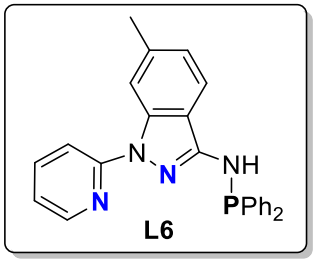
7H), 7.24 – 7.20 (m, 2H), 5.35 (d, *J* = 5.3 Hz, 1H) ppm**.**

**$^{13}$C NMR** (101 MHz, $CDCl_3$) δ 160.81, 152.26, 151.35, 151.17, 140.13, 139.39, 139.27, 132.02, 131.50, 131.29, 129.56, 129.48, 128.66, 128.59, 126.01, 123.28, 122.69, 121.69, 121.55, 121.34, 121.07, 118.74, 114.58 ppm.

**$^{31}$P NMR** (162 MHz, $CDCl_3$) δ 33.08 ppm.

**HRMS** (ESI) calcd. for $C_{26}H_{20}N_4PS$ [M+H]: 451.1146, found: 451.1143.

**Elemental Analysis** calcd for $C_{26}H_{19}N_4PS$: C, 69.32; H, 4.25; N, 12.44; found: C, 69.37; H, 4.27; N, 12.47.



**L6**

***N*-(diphenylphosphanyl)-6-methyl-1-(pyridin-2-yl)-1H-indazol-3-amine (L6)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a white solid 355.1 mg, 87% yield.

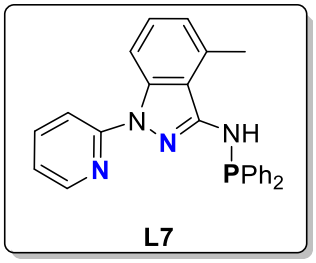
**$^{1}$H NMR** (400 MHz, $CDCl_3$) δ 8.61 (s, 1H), 8.37 (d, *J* = 3.9 Hz, 1H), 7.78 (dd, *J* = 27.5, 8.3 Hz, 2H), 7.51 – 7.48 (m, 5H), 7.30 – 7.28 (m, 6H), 6.94 (d, *J* = 8.2 Hz, 1H), 6.86 (dd, *J* = 6.6, 5.3 Hz, 1H), 5.24 (d, *J* = 6.5 Hz, 1H), 2.46 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, $CDCl_3$) δ 153.24, 148.62, 148.45, 146.25, 139.76, 139.03, 138.91, 137.86, 136.68, 130.34, 130.13, 128.13, 127.48, 127.42, 122.06, 119.15, 119.04, 116.91, 115.06, 115.05, 113.92, 111.50, 21.09 ppm.

**$^{31}$P NMR** (162 MHz, $CDCl_3$) δ 32.13 ppm.

**HRMS** (ESI) calcd. for $C_{25}H_{22}N_4P$ [M+H]: 409.1582, found: 409.1586.

**Elemental Analysis** calcd for $C_{25}H_{21}N_4P$: C, 73.52; H, 5.18; N, 13.72; found: C, 73.53; H, 5.13; N, 13.78.




L7

***N*-(diphenylphosphanyl)-4-methyl-1-(pyridin-2-yl)-1H-indazol-3-amine (L7)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a white solid 338.8 mg, 83% yield.

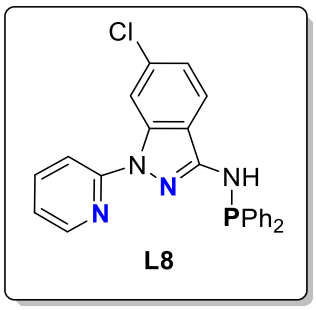
**$^{1}$H NMR** (400 MHz, $CDCl_3$) δ 8.70 (d, *J* = 8.6 Hz, 1H), 8.42 (dd, *J* = 4.9, 1.0 Hz, 1H), 7.82 (d, *J* = 8.4 Hz, 1H), 7.67 – 7.60 (m, 5H), 7.45 – 7.40 (m, 6H), 7.35 (dd, *J* = 8.3, 7.3 Hz, 1H), 6.99 – 6.90 (m, 1H), 6.91 (d, *J* = 7.1 Hz, 1H), 5.05 (d, *J* = 4.9 Hz, 1H), 2.70 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, $CDCl_3$) δ 154.32, 150.05, 149.95, 147.18, 140.34, 140.32, 140.18, 140.03, 137.70, 131.43, 131.22, 130.40, 129.13, 128.53, 128.47, 122.71, 118.09, 117.54, 117.53, 113.40, 112.91, 19.44 ppm.

**$^{31}$P NMR** (162 MHz, $CDCl_3$) δ 32.67 ppm.

**HRMS** (ESI) calcd. for $C_{25}H_{22}N_4P$ [M+H]: 409.1582, found: 409.1584.

**Elemental Analysis** calcd for $C_{25}H_{21}N_4P$: C, 73.52; H, 5.18; N, 13.72; found: C, 73.58; H, 5.14; N, 13.76.




L8

**6-chloro-*N*-(diphenylphosphanyl)-1-(pyridin-2-yl)-1H-indazol-3-amine (L8)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a white solid 338.2 mg, 79% yield.

**$^{1}$H NMR** (400 MHz, $CDCl_3$) δ 8.86 (s, 1H), 8.44 – 8.38 (m, 1H), 7.90 (d, *J* = 8.5 Hz,

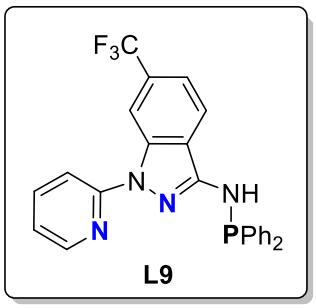
1H), 7.75 (d, *J* = 8.4 Hz, 1H), 7.67 (d, *J* = 7.4 Hz, 1H), 7.52 – 7.36 (m, 11H), 7.12 (d, *J* = 8.5 Hz, 1H), 6.99 – 6.96 (m, 1H), 5.19 (d, *J* = 6.0 Hz, 1H) ppm.

**$^{13}$C NMR** (101 MHz, $CDCl_3$) δ 153.85, 149.51, 149.34, 147.44, 140.43, 139.80, 139.68, 137.95, 134.72, 131.39, 131.19, 129.38, 128.65, 128.58, 121.94, 121.60, 121.49, 118.59, 115.26, 112.42 ppm.

**$^{31}$P NMR** (162 MHz, $CDCl_3$) δ 32.64 ppm.

**HRMS** (ESI) calcd. for $C_{24}H_{19}ClN_4P$ [M+H]: 429.1036, found: 429.1039.

**Elemental Analysis** calcd for $C_{24}H_{18}ClN_4P$: C, 67.22; H, 4.23; N, 13.06; found: C, 67.25; H, 4.27; N, 13.08.




**L9**

***N*-(diphenylphosphanyl)-1-(pyridin-2-yl)-6-(trifluoromethyl)-1H-indazol-3-amine (L9)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a white solid 342 mg, 74% yield.

**$^{1}$H NMR** (400 MHz, $CDCl_3$) δ 9.20 (s, 1H), 8.48 – 8.46 (m, 1H), 8.13 (d, *J* = 8.5 Hz, 1H), 7.82 (d, *J* = 8.4 Hz, 1H), 7.73 – 7.69 (m, 1H), 7.59 – 7.55 (m, 4H), 7.42 – 7.40 (M, 7H), 7.04 (ddd, *J* = 7.1, 4.9, 0.9 Hz, 1H), 5.26 (d, *J* = 6.3 Hz, 1H) ppm.

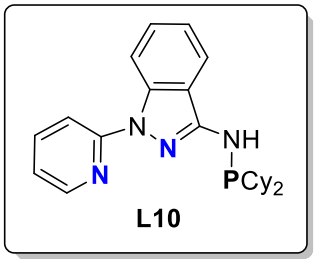
**$^{13}$C NMR** (101 MHz, $CDCl_3$) δ 153.80, 149.43, 149.26, 147.55, 139.66, 139.54, 139.23, 138.05, 131.41, 131.20, 130.40, 130.09, 129.45, 128.68, 128.62, 125.84, 123.13, 121.54, 121.43, 119.58, 118.89, 117.55, 113.33, 113.29, 112.52 ppm.

**$^{31}$P NMR** (162 MHz, $CDCl_3$) δ 32.97 ppm.

**$^{19}$F NMR** (376 MHz, $CDCl_3$) δ -61.48 ppm.

**HRMS** (ESI) calcd. for $C_{25}H_{19}F_3N_4P$ [M+H]: 463.1299, found: 463.1296.

**Elemental Analysis** calcd for $C_{25}H_{18}F_3N_4P$: C, 64.94; H, 3.92; N, 12.12; found: C, 64.97; H, 3.95; N, 12.17.




L10

***N*-(dicyclohexylphosphanyl)-1-(pyridin-2-yl)-1H-indazol-3-amine (L10)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a white solid 325.1 mg, 80% yield.

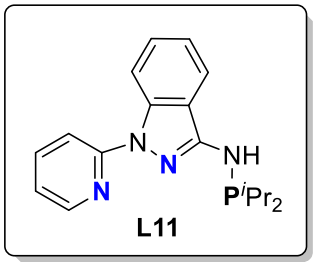
**$^{1}$H NMR** (400 MHz, $CDCl_3$) δ 8.78 (d, *J* = 8.5 Hz, 1H), 8.43 – 8.42 (m, 1H), 8.17 (d, *J* = 7.7 Hz, 1H), 7.82 (d, *J* = 8.3 Hz, 1H), 7.73 – 7.69 (m, 1H), 7.46 (t, *J* = 7.8 Hz, 1H), 7.17 (t, *J* = 7.5 Hz, 1H), 6.99 – 6.96 (m, 1H), 4.60 (d, *J* = 4.9 Hz, 1H), 1.87 – 1.67 (m, 12H), 1.32 – 1.19 (m, 10H) ppm.

**$^{13}$C NMR** (101 MHz, $CDCl_3$) δ 154.33, 147.52, 140.45, 137.81, 128.28, 121.92, 121.78, 120.74, 117.98, 115.16, 112.41, 36.68, 36.56, 29.08, 28.90, 27.19, 27.12, 26.83, 26.75 ppm.

**$^{31}$P NMR** (162 MHz, $CDCl_3$) δ 48.74 ppm.

**HRMS** (ESI) calcd. for $C_{24}H_{32}N_4P$ [M+H]: 407.2364, found: 407.2369.

**Elemental Analysis** calcd for $C_{24}H_{31}N_4P$: C, 70.91; H, 7.69; N, 13.78; found: C, 70.95; H, 7.67; N, 13.74.




L11

***N*-(diisopropylphosphanyl)-1-(pyridin-2-yl)-1H-indazol-3-amine (L11)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a white solid 264.2 mg, 81% yield.

**$^{1}$H NMR** (400 MHz, $CDCl_3$) δ 8.83 (d, *J* = 8.6 Hz, 1H), 8.46 – 8.44 (m, 1H), 8.15 (d, *J* = 8.1 Hz, 1H), 7.86 (d, *J* = 8.4 Hz, 1H), 7.71 (ddd, *J* = 8.5, 7.3, 1.9 Hz, 1H), 7.49

(ddd, $J$ = 8.3, 7.1, 1.0 Hz, 1H), 7.21 – 7.18 (m, 1H), 6.97 (ddd, $J$ = 7.2, 4.9, 0.9 Hz, 1H), 4.62 (d, $J$ = 5.7 Hz, 1H), 2.00 – 1.90 (m, 2H), 1.19 – 1.13 (m, 12H) ppm.

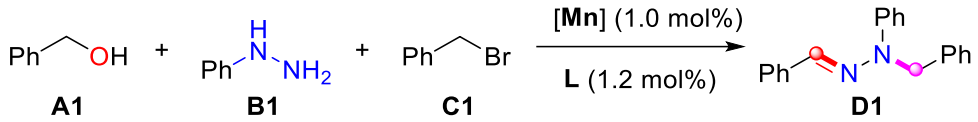
**$^{13}$C NMR** (101 MHz, $CDCl_3$) δ 154.21, 151.32, 151.18, 147.37, 140.27, 137.67, 128.17, 121.48, 121.35, 120.70, 117.91, 117.86, 115.13, 112.27, 26.79, 26.66, 18.83, 18.63, 17.25, 17.17 ppm.

**$^{31}$P NMR** (162 MHz, $CDCl_3$) δ 55.61 ppm.

**HRMS** (ESI) calcd. for $C_{18}H_{24}N_4P$ [M+H]: 327.1738, found: 327.1734.

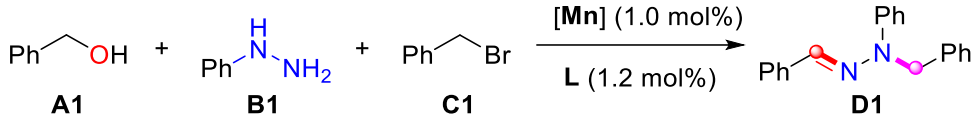
**Elemental Analysis** calcd for $C_{18}H_{23}N_4P$: C, 66.24; H, 7.10; N, 17.17; found: C, 66.26; H, 7.13; N, 17.15.

## 3. Screening of reaction parameters




Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, catalyst, ligand, solvent, phenyl methanol (**A1**), phenyl hydrazine (**B1**) and (bromomethyl)benzene (**C1**). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (design temperature) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase was analyzed by GC and GC-MS to monitor product formation. The solvent was evaporated under reduced pressure and the residue was purified by flash column chromatography (petroleum ether/dichloromethane = 20:1 – 5:1) on silica gel to give the product **D1** in the reported yields.

**Table S1. The difference of ligand screening [a]**




| Entry | Ligand | **D1** (%) | **D1:E1** |
|---|---|---|---|
| 1 | **L1** | <5 | 8:1 |
| 2 | **L2** | 62 | >20:1 |
| 3 | **L3** | 41 | >20:1 |
| 4 | **L4** | 54 | 18:1 |
| 5 | **L5** | 22 | 19:1 |
| 6 | **L6** | 60 | 18:1 |
| 7 | **L7** | 63 | 18:1 |
| 8 | **L8** | 51 | 17:1 |
| 9 | **L9** | 47 | 18:1 |
| 10 | **L10** | 82 | 19:1 |
| **11** | **L11** | **91** | **>20:1** |
| 12 | - | 0 | - |

[a] Reaction condition: **A1** (0.8 mmol), **B1** (0.5 mmol), **C1** (0.7 mmol), $MnBr(CO)_5$ (1.0 mol%), **L1-L11** (1.2 mol%), $^t$BuOK (1.0 mmol), THF (3.0 mL), 100 °C, 6 h. Yields of **D1** was determined by GC analysis using *n*-cetane as the internal standard.

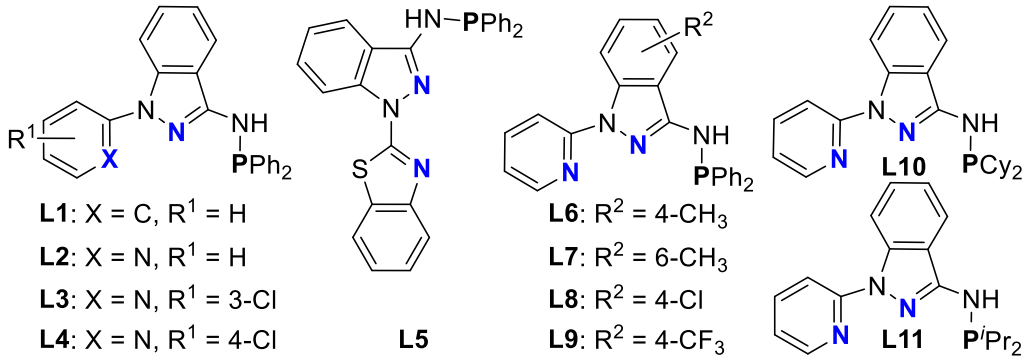
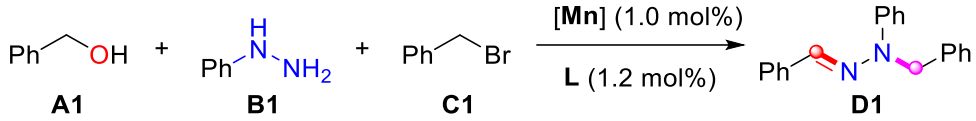


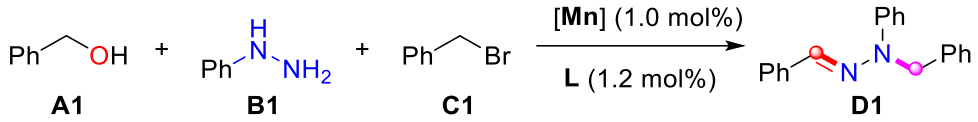
**Table S2. The difference of catalyst screening**[a]




| Entry | Catalyst | **D1** (%) |
|---|---|---|
| 1 | $MnBr(CO)_5$ | 91 |
| 2 | Mn | 0 |
| 3 | MnO | 0 |
| 4 | $MnO_2$ | 0 |
| **5** | $Mn_3O_4$ | 0 |
| 6 | MnS | 0 |
| 7 | $Mn(acac)_3$ | 0 |
| 8 | $Mn(OTf)_2$ | 0 |
| 9 | $Mn(NO_3)_2$ | 0 |
| 10 | $Mn(NO_3)_2•4H_2O$ | 0 |
| 11 | $MnSO_4•H_2O$ | 0 |
| 12[b] | $Mn(OAc)_3•4H_2O$ | 0 |
| 13[b] | $MnTe_2$ | 0 |
| 14 | $MnCO_3$ | 0 |
| 15 | $MnF_2$ | 0 |
| 16 | $MnF_3$ | 0 |
| 17 | $MnCl_2$ | 0 |
| 18 | $MnCl_2•4H_2O$ | 0 |
| 19 | $MnBr_2$ | 0 |
| 20 | $MnBr_2•4H_2O$ | 0 |
| 21 | - | 0 |

[a] Reaction condition: **A1** (0.8 mmol), **B1** (0.5 mmol), **C1** (0.7 mmol), Catalyst (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), THF (3.0 mL), 100 °C, 6 h. Yields of **D1** was determined by GC analysis using *n*-cetane as the internal standard.

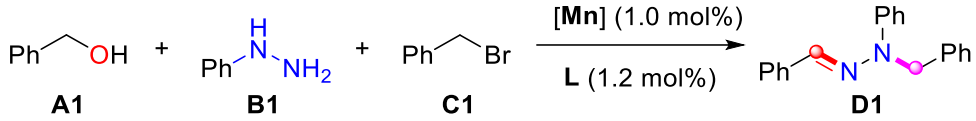
**Table S3. The difference of base screening**[a]




| Entry | Base (5 mol%) | **D1** (%) |
|---|---|---|
| 1 | LiOH | 0 |
| 2 | *t*-BuOLi | 11 |
| 3 | LiHMDS | 9 |
| 4 | $Na_2CO_3$ | 0 |
| 5 | NaOH | <5 |
| 6 | *t*-BuONa | 63 |
| 7 | NaHMDS | 64 |
| 8 | NaH | 41 |
| 9 | $K_2CO_3$ | 0 |
| 10 | $K_3PO_4$ | 0 |
| 11 | KOH | <5 |
| **12** | ***t*-BuOK** | **91** |
| 13 | KHMDS | 82 |
| 14 | KH | 43 |
| 15 | $Cs_2CO_3$ | 0 |
| 16 | CsOH | <5 |
| 17 | *t*-BuOCs | 26 |
| 18 | $Et_3N$ | 0 |
| 19 | Pyridine | 0 |
| 20 | DBU | 0 |
| 21 | TMEDA | 0 |

[a] Reaction condition: **A1** (0.8 mmol), **B1** (0.5 mmol), **C1** (0.7 mmol), $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), Base (1.0 mmol), THF (3.0 mL), 100 °C, 6 h. Yields of **D1** was determined by GC analysis using *n*-cetane as the internal standard.

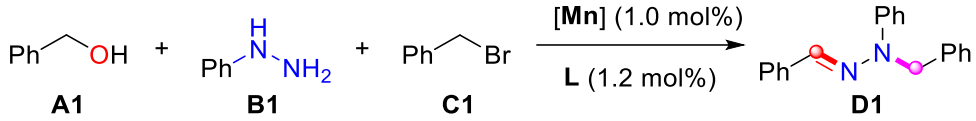
**Table S4. The difference of solvent screening[a]**




| Entry | Solvent (3 mL) | **D1** (%) |
|---|---|---|
| 1 | anisole | 72 |
| **2** | **THF** | **91** |
| 3 | 1,4-dioxane | 80 |
| 4 | DME | 12 |
| 5 | toluene | 67 |
| 6 | xylene | 61 |
| 7 | mesitylene | 52 |
| 8 | DCM | <5 |
| 9 | $CH_3CN$ | <5 |
| 10 | pyridine | 13 |
| 11 | methanol | <5 |
| 12 | ethanol | <5 |
| 13 | isopropanol | <5 |
| 14 | *t*-AmOH | 26 |
| 15 | DMF | <5 |
| 16 | DMAc | <5 |
| 17 | NMP | <5 |
| 18 | DMSO | <5 |

[a] Reaction condition: **A1** (0.8 mmol), **B1** (0.5 mmol), **C1** (0.7 mmol), $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), solvent (3.0 mL), 100 °C, 6 h. Yields of **D1** was determined by GC analysis using *n*-cetane as the internal standard.

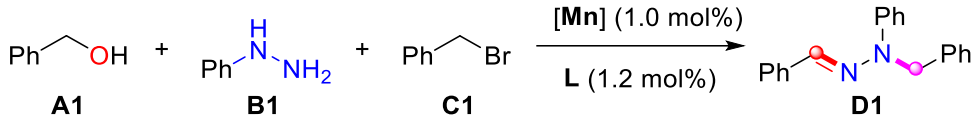
**Table S5. The ratio of substrates screening[a]**




| Entry | **A1**(mmol) | **B1**(mmol) | **C1**(mmol) | **D1** (%) |
|---|---|---|---|---|
| 1 | 0.5 | 0.5 | 0 | 0 |
| 2 | 0.5 | 0.5 | 0.5 | 51 |
| 3 | 0.5 | 0.5 | 0.6 | 60 |
| 4 | 0.5 | 0.5 | 0.7 | 63 |
| 5 | 0.5 | 0.5 | 0.8 | 63 |
| 6 | 0 | 0.5 | 0.7 | 0 |
| 7 | 0.6 | 0.5 | 0.7 | 77 |
| 8 | 0.7 | 0.5 | 0.7 | 86 |
| **9** | **0.8** | **0.5** | **0.7** | **91** |
| 10 | 0.9 | 0.5 | 0.7 | 91 |
| 11 | 0.8 | 0.4 | 0.7 | 87 |
| 12 | 0.8 | 0.6 | 0.7 | 90 |
| 13 | 0.8 | 0.7 | 0.7 | 90 |

[a] Reaction condition: **A1** (x mmol), **B1** (x mmol), **C1** (x mmol), $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), THF (3.0 mL), 100 °C, 6 h. Yields of **D1** was determined by GC analysis using *n*-cetane as the internal standard.

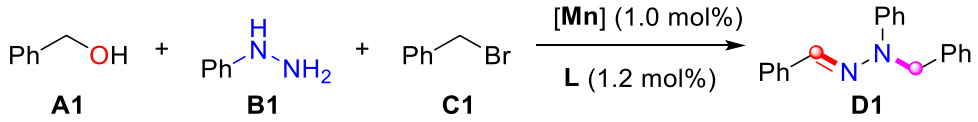
**Table S6. Screening the loading of *t*-BuOK[a]**




| Entry | *t*-BuOK (mmol) | **D1** (%) |
|---|---|---|
| 1 | 0 | 0 |
| 2 | 0.25 | 0 |
| 3 | 0.5 | <5 |
| 4 | 0.75 | 86 |
| **5** | **1.0** | **91** |
| 6 | 1.25 | 91 |
| 7 | 2.0 | 90 |

[a] Reaction condition: **A1** (0.8 mmol), **B1** (0.5 mmol), **C1** (0.7 mmol), $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (X mmol), THF (3.0 mL), 100 °C, 6 h. Yields of **D1** was determined by GC analysis using *n*-cetane as the internal standard.

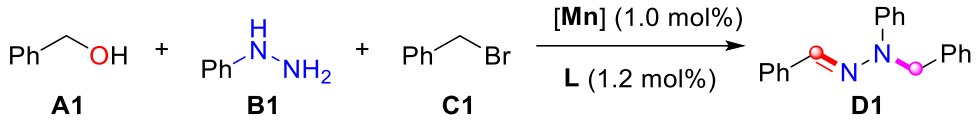
**Table S7. The loading of solvent screening[a]**




| Entry | THF (mL) | **D1** (%) |
|---|---|---|
| 1 | 0 | 23 |
| 2 | 0.5 | 61 |
| 3 | 1.0 | 76 |
| 4 | 1.5 | 80 |
| 5 | 2.0 | 88 |
| **6** | **3.0** | **91** |
| 7 | 4.0 | 90 |

[a] Reaction condition: **A1** (0.8 mmol), **B1** (0.5 mmol), **C1** (0.7 mmol), $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), THF (x mL), 100 °C, 6 h. Yields of **D1** was determined by GC analysis using *n*-cetane as the internal standard.

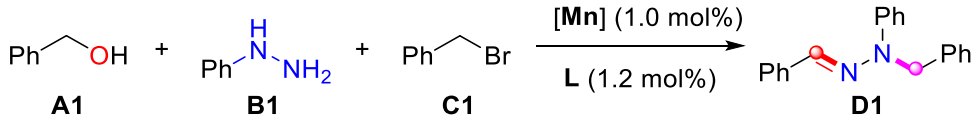
**Table S8. The Pd-catalyst loading screening[a]**




| Entry | $MnBr(CO)_5$ | **L11** | **D1** (%) |
|---|---|---|---|
| 1 | 0 | | 0 |
| 2 | 0.0005 | 0.0006 | 13 |
| 3 | 0.001 | 0.0012 | 42 |
| 4 | 0.005 | 0.006 | 76 |
| 5 | **0.01** | **0.012** | **91** |
| **6** | 0.02 | 0.024 | 91 |

[a] Reaction condition: **A1** (0.8 mmol), **B1** (0.5 mmol), **C1** (0.7 mmol), $MnBr(CO)_5$ (x mol%), **L11** (x mol%), $^t$BuOK (1.0 mmol), solvent (3.0 mL), 100 °C, 6 h. Yields of **D1** was determined by GC analysis using *n*-cetane as the internal standard.

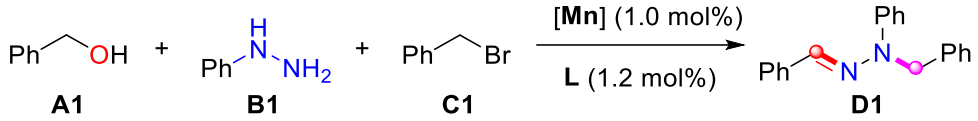
**Table S9. Reaction temperature screening[a]**




| Entry | T (° C) | **D1** (%) |
|---|---|---|
| 1 | RT | 0 |
| 2 | 80 | 61 |
| 3 | 90 | 80 |
| **4** | **100** | **91** |
| 5 | 110 | 89 |
| 6 | 120 | 82 |

[a] Reaction condition: **A1** (0.8 mmol), **B1** (0.5 mmol), **C1** (0.7 mmol), $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), THF (3.0 mL), x °C, 6 h. Yields of **D1** was determined by GC analysis using *n*-cetane as the internal standard.

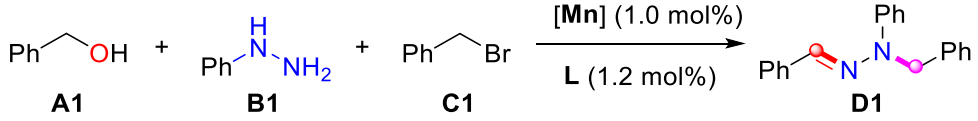
**Table S10. Reaction time screening[a]**




| Entry | t (h) | **D1** (%) |
|---|---|---|
| 1 | 3 | 65 |
| 2 | 6 | 91 |
| 3 | 10 | 93 |
| **4** | **12** | **96** |
| 5 | 14 | 96 |

[a] Reaction condition: **A1** (0.8 mmol), **B1** (0.5 mmol), **C1** (0.7 mmol), $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), THF (3.0 mL), 100 °C, x h. Yields of **D1** was determined by GC analysis using *n*-cetane as the internal standard.

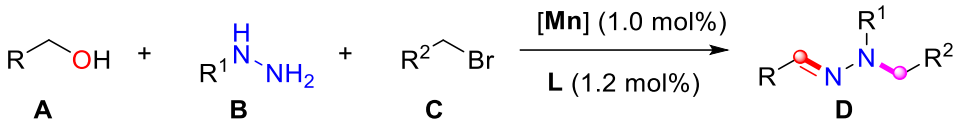
**Table S11. The reaction system screening[a]**




| Entry | System | atmosphere | D1 (%) |
|---|---|---|---|
| 1 | open | $N_2$ | 93 |
| 2 | open | $O_2$ | <5 |
| 3 | open | air | 36 |
| **4** | **seal** | **$N_2$** | **96** |
| 5 | seal | $O_2$ | <5 |
| 6 | seal | air | 46 |

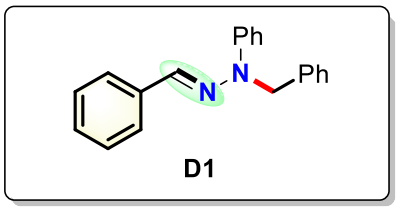
[a] Reaction condition: **A1** (0.8 mmol), **B1** (0.5 mmol), **C1** (0.7 mmol), $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), THF (3.0 mL), 100 °C, 12 h. Yields of **D1** was determined by GC analysis using *n*-cetane as the internal standard.

## 4. General Procedure for the products




Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^tBuOK$ (1.0 mmol), alcohols (**A**, 0.8 mmol), hydrazines (**B**, 0.5 mmol) and alkyl halides (**C**, 0.7 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for 12 hours. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase was analyzed by GC and GC-MS to monitor product formation. The solvent was evaporated under reduced pressure and the residue was purified by flash column chromatography (petroleum ether/dichloromethane = 20:1 – 5:1) on silica gel to give the products **D** in the reported yields.

## 5. Characterization Data [2]




D1

**1-benzyl-2-benzylidene-1-phenylhydrazine (D1)**

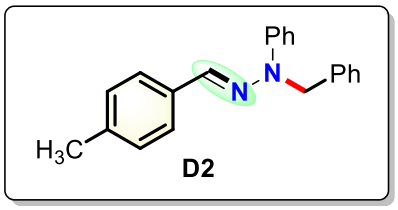
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 131.7 mg, 92% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.64 – 7.55 (m, 2H), 7.42 – 7.36 (m, 2H), 7.35 – 7.24 (m, 7H), 7.20 (q, *J* = 7.3 Hz, 4H), 6.96 – 6.88 (m, 1H), 5.10 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.99, 136.67, 135.78, 132.59, 129.33, 129.17, 128.68, 128.02, 127.45, 126.35, 126.17, 120.90, 114.92, 50.48 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{19}N_2$ [M+H]: 287.1548, found: 287.1549.

**Elemental Analysis** calcd for $C_{20}H_{18}N_2$: C, 83.88; H, 6.34; N, 9.78; found: C, 83.86; H, 6.36; N, 9.76.




D2

**1-benzyl-2-(4-methylbenzylidene)-1-phenylhydrazine (D2)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 144.2 mg, 96% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

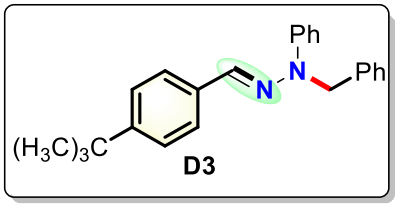
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.52 (d, *J* = 8.1 Hz, 2H), 7.44 – 7.31 (m, 6H), 7.28 – 7.20 (m, 4H), 7.14 (d, *J* = 8.0 Hz, 2H), 6.94 (t, *J* = 7.2 Hz, 1H), 5.17 (s, 2H), 2.34 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.90, 137.82, 135.78, 133.77, 132.73,

129.20, 129.11, 128.96, 127.22, 126.12, 126.03, 120.52, 114.66, 50.41, 21.30 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{21}N_2$ [M+H]: 301.1705, found: 301.1705.

**Elemental Analysis** calcd for $C_{21}H_{20}N_2$: C, 83.96; H, 6.71; N, 9.33; found: C, 83.92; H, 6.72; N, 9.32.




**1-benzyl-2-(4-(tert-butyl)benzylidene)-1-phenylhydrazine (D3)**

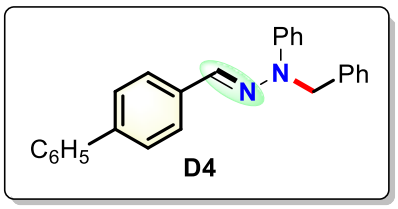
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 164.4 mg, 96% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.57 (d, $J$ = 8.4 Hz, 2H), 7.46 – 7.26 (m, 10H), 7.23 (d, $J$ = 7.0 Hz, 2H), 6.94 (t, $J$ = 7.2 Hz, 1H), 5.18 (s, 2H), 1.31 (s, 9H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 151.11, 147.92, 135.72, 133.81, 132.63, 129.13, 128.97, 127.24, 126.07, 125.94, 125.46, 120.56, 114.72, 50.35, 34.66, 31.28 ppm.

**HRMS** (ESI) calcd. for $C_{24}H_{27}N_2$ [M+H]: 343.2174, found: 343.2176.

**Elemental Analysis** calcd for $C_{24}H_{26}N_2$: C, 84.17; H, 7.65; N, 8.18; found: C, 84.12; H, 7.64; N, 8.14.




**2-([1,1'-biphenyl]-4-ylmethylene)-1-benzyl-1-phenylhydrazine (D4)**

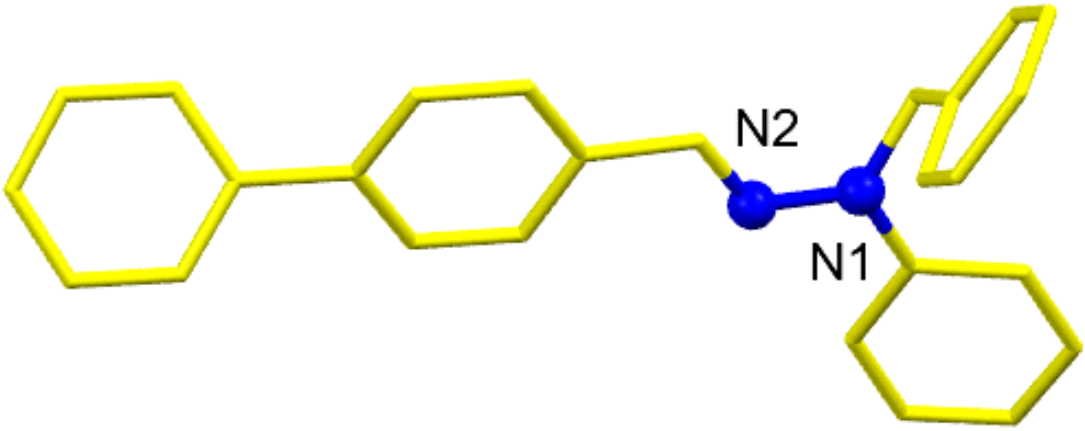
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 146.8 mg, 81% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

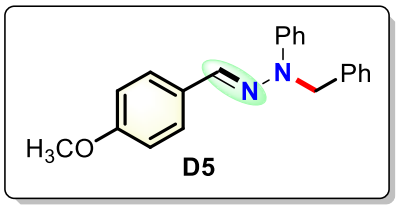
**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.70 (d, *J* = 8.4 Hz, 2H), 7.65 – 7.50 (m, 4H), 7.46 – 7.42 (m, 4H), 7.37 – 7.31 (m, 5H), 7.31 – 7.26 (m, 3H), 7.25 (d, *J* = 1.4 Hz, 1H), 6.97 (t, *J* = 7.2 Hz, 1H), 5.21 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.85, 140.77, 135.61, 132.09, 129.18, 129.04, 128.80, 127.89, 127.33, 127.22, 126.94, 126.58, 126.05, 120.83, 114.86, 50.50 ppm.

**HRMS** (ESI) calcd. for $C_{26}H_{23}N_2$ [M+H]: 363.1861, found: 363.1860.

**Elemental Analysis** calcd for $C_{26}H_{22}N_2$: C, 86.15; H, 6.12; N, 7.73; found: C, 86.16; H, 6.16; N, 7.76.




**1-benzyl-2-(4-methoxybenzylidene)-1-phenylhydrazine (D5)**

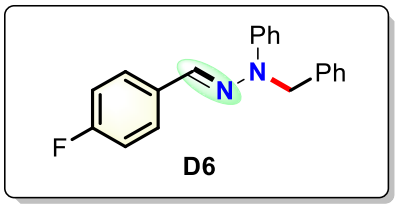
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 151.9mg, 96% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.56 (d, *J* = 8.7 Hz, 2H), 7.40 – 7.23 (m, 10H), 6.90 (dd, *J* = 26.3, 7.9 Hz, 3H), 5.16 (s, 2H), 3.81 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 159.59, 147.94, 135.90, 132.54, 129.39, 129.10, 128.96, 127.48, 127.21, 126.05, 120.37, 114.55, 113.97, 55.32, 50.47 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{21}N_2O$ [M+H]: 317.1654, found: 317.1653.

**Elemental Analysis** calcd for $C_{21}H_{20}N_2O$: C, 79.72; H, 6.37; N, 8.85; O, 5.06; found: C, 79.74; H, 6.36; N, 8.84.



**D6**

**1-benzyl-2-(4-fluorobenzylidene)-1-phenylhydrazine (D6)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 141.5 mg, 93% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

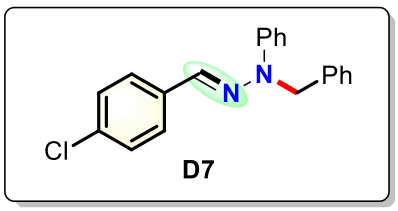
**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.67 – 7.52 (m, 2H), 7.40 – 7.20 (m, 10H), 7.09 – 6.88 (m, 3H), 5.17 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 163.75, 161.29, 147.79, 135.57, 132.74, 131.30, 129.16, 129.02, 127.70, 127.62, 127.32, 125.99, 120.80, 115.58, 115.36, 114.77, 50.55 ppm.

**$^{19}$F NMR** (377 MHz, 23.0 °C, $CDCl_3$) δ -113.75 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}FN_2$ [M+H]: 305.1454, found: 305.1455.

**Elemental Analysis** calcd for $C_{20}H_{17}FN_2$: C, 78.92; H, 5.63; F, 6.24; N, 9.20; found: C, 78.93; H, 5.64; N, 9.23.



**D7**

**1-benzyl-2-(4-chlorobenzylidene)-1-phenylhydrazine (D7)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 150.8 mg, 94% yield. Purification by

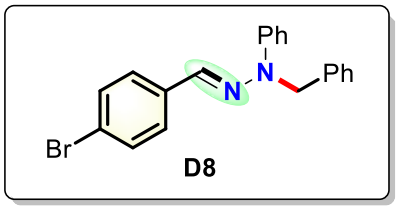
column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.59 – 7.50 (m, 2H), 7.44 – 7.24 (m, 12H), 6.97 (t, *J* = 7.2 Hz, 1H), 5.18 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.69, 135.39, 135.06, 133.32, 131.13, 129.18, 129.05, 128.66, 127.37, 127.25, 125.98, 121.03, 114.91, 50.61 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}ClN_2$ [M+H]: 321.1159, found: 321.1155.

**Elemental Analysis** calcd for $C_{20}H_{17}ClN_2$: C, 74.88; H, 5.34; Cl, 11.05; N, 8.73; found: C, 74.85; H, 5.33; N, 8.74.



D8

**1-benzyl-2-(4-bromobenzylidene)-1-phenylhydrazine (D8)**

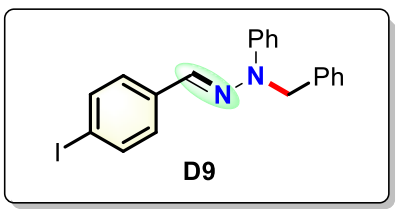
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 166.2 mg, 91% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.46 (q, *J* = 8.7 Hz, 4H), 7.41 – 7.29 (m, 7H), 7.23 (d, *J* = 7.1 Hz, 2H), 6.97 (t, *J* = 7.2 Hz, 1H), 5.18 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.70, 135.52, 135.38, 131.61, 131.13, 129.21, 129.07, 127.57, 127.40, 125.99, 121.52, 121.09, 114.95, 99.99, 50.63 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}BrN_2$ [M+H]: 365.0653, found: 365.0655.

**Elemental Analysis** calcd for $C_{20}H_{17}BrN_2$: C, 65.76; H, 4.69; Br, 21.88; N, 7.67; found: C, 65.74; H, 4.66; N, 7.64.



D9

**1-benzyl-2-(4-iodobenzylidene)-1-phenylhydrazine (D9)**

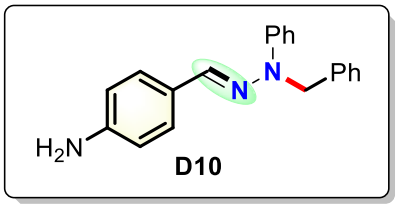
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 152.5 mg, 74% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.72 (d, *J* = 8.4 Hz, 2H), 7.57 (s, 1H), 7.49 – 7.38 (m, 4H), 7.33 (q, *J* = 11.7, 8.0 Hz, 4H), 7.25 (t, *J* = 7.3 Hz, 1H), 7.19 (d, *J* = 7.2 Hz, 2H), 6.92 (t, *J* = 7.2 Hz, 1H), 5.32 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.42, 137.86, 136.38, 136.22, 132.02, 129.68, 129.24, 128.30, 127.48, 126.70, 120.93, 114.71, 94.11, 48.67, 40.61, 40.40, 40.19, 39.98, 39.77, 39.56, 39.36 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}IN_2$ [M+H]: 413.0515, found: 413.0517.

**Elemental Analysis** calcd for $C_{20}H_{17}IN_2$: C, 58.27; H, 4.16; I, 30.78; N, 6.79; found: C, 58.21; H, 4.15; N, 6.73.



**D10**

**4-((2-benzyl-2-phenylhydrazineylidene)methyl)aniline (D10)**

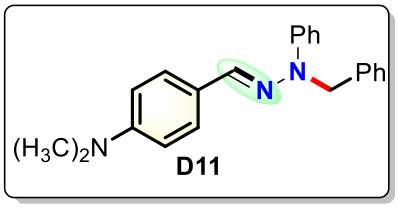
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 135.6 mg, 90% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.44 (s, 1H), 7.42 (s, 1H), 7.37 (d, *J* = 7.9 Hz, 2H), 7.34 – 7.28 (m, 5H), 7.26 (d, *J* = 4.4 Hz, 1H), 7.22 (dd, *J* = 7.4, 3.6 Hz, 3H), 6.90 (t, *J* = 7.2 Hz, 1H), 6.62 (d, *J* = 8.5 Hz, 2H), 5.12 (s, 2H), 3.69 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.12, 146.57, 136.21, 133.29, 129.14, 128.98, 127.60, 127.30, 127.20, 126.11, 120.10, 115.05, 114.42, 50.41 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{20}N_3$ [M+H]: 302.1657, found: 302.1656.

**Elemental Analysis** calcd for $C_{20}H_{19}N_3$: C, 79.70; H, 6.35; N, 13.94; found: C, 79.74; H, 6.35; N, 13.93.




**4-((2-benzyl-2-phenylhydrazineylidene)methyl)-N,N-dimethylaniline (D11)**

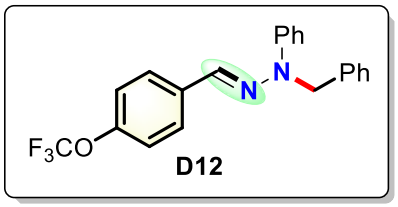
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 135.1 mg, 82% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.51 (d, *J* = 8.8 Hz, 2H), 7.37 (d, *J* = 8.9 Hz, 3H), 7.34 – 7.26 (m, 4H), 7.26 – 7.17 (m, 3H), 6.96 – 6.82 (m, 1H), 6.68 (d, *J* = 8.7 Hz, 2H), 5.14 (s, 2H), 2.95 (s, 6H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 150.48, 148.18, 136.35, 133.62, 129.12, 128.96, 127.41, 127.16, 126.14, 125.09, 119.92, 114.34, 112.34, 50.37, 40.53 ppm.

**HRMS** (ESI) calcd. for $C_{22}H_{24}N_3$ [M+H]: 330.1970, found: 330.1972.

**Elemental Analysis** calcd for $C_{22}H_{23}N_3$: C, 80.21; H, 7.04; N, 12.76; found: C, 80.23; H, 7.05; N, 12.75.




**1-benzyl-1-phenyl-2-(4-(trifluoromethoxy)benzylidene)hydrazine (D12)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 179.6 mg, 97% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

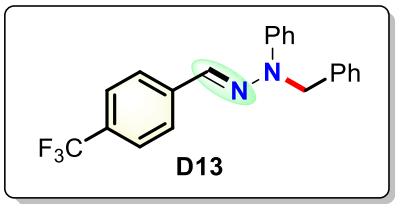
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.59 (d, *J* = 8.8 Hz, 2H), 7.38 (d, *J* = 7.8 Hz, 2H), 7.31 (t, *J* = 8.3, 6.1, 3.0 Hz, 5H), 7.26 (d, *J* = 7.2 Hz, 1H), 7.22 – 7.17 (m, 2H), 7.14 (d, *J* = 8.2 Hz, 2H), 6.96 (t, *J* = 7.2 Hz, 1H), 5.14 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.67, 148.66, 147.77, 135.42, 130.79, 129.29, 129.15, 127.48, 127.35, 126.05, 121.18, 121.15, 115.03, 50.61 ppm.

**$^{19}$F NMR** (377 MHz, 23.0 °C, $CDCl_3$) δ -57.73 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{18}F_3N_2O$ [M+H]: 371.1371, found: 371.1373.

**Elemental Analysis** calcd for $C_{21}H_{17}F_3N_2O$: C, 68.10; H, 4.63; F, 15.39; N, 7.56; O, 4.32; found: C, 68.17; H, 4.65; N, 7.51.



**D13**

**1-benzyl-1-phenyl-2-(4-(trifluoromethyl)benzylidene)hydrazine (D13)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 164.8 mg, 93% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

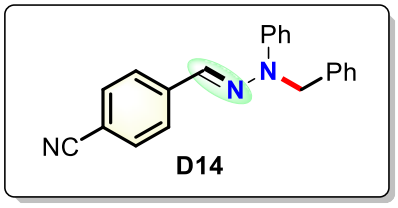
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.70 (d, $J$ = 8.2 Hz, 2H), 7.56 (d, $J$ = 8.2 Hz, 2H), 7.42 (dd, $J$ = 8.9, 1.1 Hz, 2H), 7.38 – 7.32 (m, 5H), 7.29 (d, $J$ = 7.3 Hz, 1H), 7.24 (d, $J$ = 7.0 Hz, 2H), 7.00 (t, $J$ = 7.2 Hz, 1H), 5.21 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.58, 137.05, 135.11, 133.92, 130.58, 129.81, 129.25, 129.19, 129.12, 128.12, 127.48, 127.00, 126.11, 125.98, 125.74, 125.42, 122.25, 121.48, 118.91, 115.21, 101.79, 99.99, 50.72 ppm.

**$^{19}$F NMR** (377 MHz, 23.0 °C, $CDCl_3$) δ -62.42 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{18}F_3N_2$ [M+H]: 355.1422, found: 355.1425.

**Elemental Analysis** calcd for $C_{21}H_{17}F_3N_2$: C, 71.18; H, 4.84; F, 16.08; N, 7.91; found: C, 71.14; H, 4.86; N, 7.93.



**D14**

**4-((2-benzyl-2-phenylhydrazineylidene)methyl)benzonitrile (D14)**

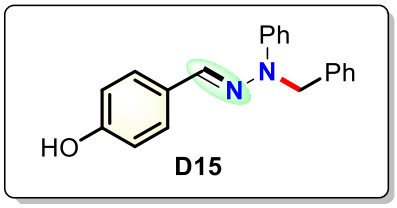
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 133.9 mg, 86% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.67 (d, *J* = 8.3 Hz, 2H), 7.58 (d, *J* = 8.3 Hz, 2H), 7.41 (d, *J* = 8.1 Hz, 2H), 7.37 – 7.30 (m, 5H), 7.22 (d, *J* = 7.4 Hz, 2H), 7.02 (t, *J* = 7.2 Hz, 1H), 5.21 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.40, 140.96, 134.84, 132.32, 129.96, 129.30, 129.18, 127.58, 126.31, 125.96, 121.90, 119.23, 115.43, 110.35, 50.89 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{18}N_3$ [M+H]: 312.1501, found: 312.1500.

**Elemental Analysis** calcd for $C_{21}H_{17}N_3$: C, 81.00; H, 5.50; N, 13.49; found: C, 81.02; H, 5.55; N, 13.42.



D15

**4-((2-benzyl-2-phenylhydrazineylidene)methyl)phenol (D15)**

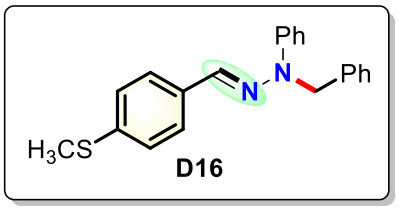
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 137.6 mg, 91% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.50 (d, *J* = 8.6 Hz, 2H), 7.41 – 7.19 (m, 11H), 6.92 (t, *J* = 7.2 Hz, 1H), 6.77 (d, *J* = 8.6 Hz, 2H), 5.13 (s, 2H), 4.92 (s, 1H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 155.53, 148.00, 135.95, 132.46, 129.66, 129.19, 129.03, 127.74, 127.29, 126.08, 120.47, 115.54, 114.64, 50.50 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{19}N_2O$ [M+H]: 303.1497, found: 303.1498.

**Elemental Analysis** calcd for $C_{20}H_{18}N_2O$: C, 79.44; H, 6.00; N, 9.26; O, 5.29; found: C, 79.43; H, 6.02; N, 9.24.




**1-benzyl-2-(4-(methylthio)benzylidene)-1-phenylhydrazine (D16)**

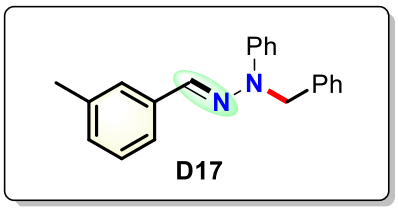
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 151.3 mg, 91% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.57 – 7.46 (m, 2H), 7.43 – 7.36 (m, 2H), 7.36 – 7.29 (m, 5H), 7.26 – 7.15 (m, 5H), 6.99 – 6.86 (m, 1H), 5.15 (s, 2H), 2.46 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.86, 138.14, 135.70, 133.63, 132.04, 129.20, 129.06, 128.47, 127.84, 127.34, 126.75, 126.60, 126.59, 126.07, 120.77, 114.80, 50.49, 15.89 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{21}N_2S$ [M+H]: 333.1425, found: 333.1423.

**Elemental Analysis** calcd for $C_{21}H_{20}N_2S$: C, 75.87; H, 6.06; N, 8.43; S, 9.64; found: C, 75.84; H, 6.03; N, 8.45.




**1-benzyl-2-(3-methylbenzylidene)-1-phenylhydrazine (D17)**

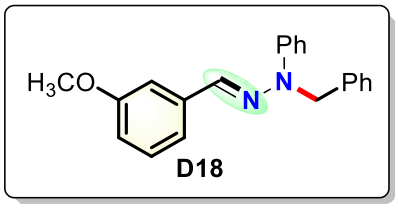
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 139.7 mg, 93% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.80 (d, $J$ = 7.6 Hz, 1H), 7.51 (s, 1H), 7.36 (d, $J$ = 7.9 Hz, 2H), 7.27 (t, $J$ = 8.8, 3.8, 3.2 Hz, 4H), 7.21 – 7.18 (m, 3H), 7.16 – 6.97 (m, 3H), 6.89 (t, $J$ = 7.2 Hz, 1H), 5.13 (s, 2H), 2.15 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.06, 135.66, 135.34, 134.35, 131.82, 130.64, 129.19, 129.01, 127.66, 127.32, 126.15, 126.09, 125.72, 120.73, 114.88, 50.68, 19.74 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{21}N_2$ [M+H]: 301.1705, found: 301.1707.

**Elemental Analysis** calcd for $C_{21}H_{20}N_2$: C, 83.96; H, 6.71; N, 9.33; found: C, 83.93; H, 6.73; N, 9.32.




**1-benzyl-2-(3-methoxybenzylidene)-1-phenylhydrazine (D18)**

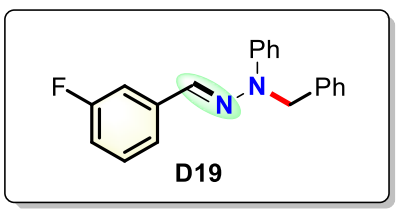
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 153.5 mg, 97% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.40 (d, $J$ = 7.9 Hz, 2H), 7.38 – 7.28 (m, 5H), 7.25 (q, $J$ = 5.0, 4.6 Hz, 5H), 7.15 (d, $J$ = 7.7 Hz, 1H), 6.96 (t, $J$ = 7.2 Hz, 1H), 6.80 (dd, $J$ = 8.0, 2.0 Hz, 1H), 5.19 (s, 2H), 3.84 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 159.84, 147.82, 137.98, 135.59, 132.36, 129.48, 129.17, 129.03, 127.32, 126.04, 120.84, 119.28, 114.86, 113.96, 110.63, 55.29, 50.54 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{21}N_2O$ [M+H]: 317.1654, found: 317.1658.

**Elemental Analysis** calcd for $C_{21}H_{20}N_2O$: C, 79.72; H, 6.37; N, 8.85; O, 5.06; found: C, 79.76; H, 6.34; N, 8.86.




**1-benzyl-2-(3-fluorobenzylidene)-1-phenylhydrazine (D19)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 135.4 mg, 89% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

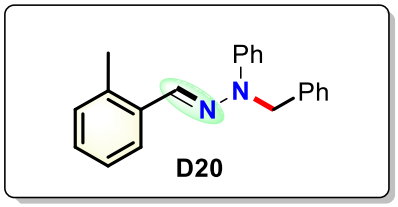
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.42 – 7.22 (m, 13H), 7.05 – 6.85 (m, 2H), 5.18 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 164.40, 161.97, 147.67, 139.02, 138.94, 135.33, 131.04, 131.01, 129.96, 129.88, 129.22, 129.08, 127.41, 126.00, 122.22, 122.19, 121.18, 115.02, 114.69, 114.48, 112.27, 112.04, 50.64 ppm.

**$^{19}$F NMR** (377 MHz, 23.0 °C, $CDCl_3$) δ -113.45 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}FN_2$ [M+H]: 305.1454, found: 305.1454.

**Elemental Analysis** calcd for $C_{20}H_{17}FN_2$: C, 78.92; H, 5.63; F, 6.24; N, 9.20; found: C, 78.94; H, 5.65; N, 9.23.




**1-benzyl-2-(2-methylbenzylidene)-1-phenylhydrazine (D20)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 138.2 mg, 92% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

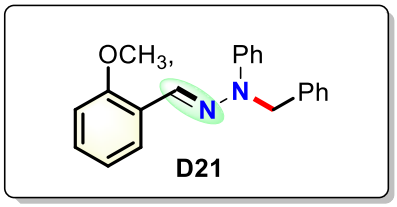
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.87 (d, $J$ = 7.4 Hz, 1H), 7.58 (s, 1H), 7.43 (d, $J$ = 8.0 Hz, 2H), 7.36 – 7.30 (m, 4H), 7.26 (t, $J$ = 3.1 Hz, 2H), 7.23 – 7.11 (m, 3H), 7.09 (d, $J$ = 7.2 Hz, 1H), 6.95 (t, $J$ = 7.2 Hz, 1H), 5.19 (s, 2H), 2.22 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.07, 135.67, 135.35, 134.36, 131.82, 130.65, 129.21, 129.02, 128.77, 128.25, 127.67, 127.33, 126.16, 126.10, 125.73, 120.74, 114.88, 77.37, 77.05, 76.73, 50.68, 19.75, 0.04 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{21}N_2$ [M+H]: 301.1705, found: 301.1704.

**Elemental Analysis** calcd for $C_{21}H_{20}N_2$: C, 83.96; H, 6.71; N, 9.33; found: C, 83.92;

H, 6.73; N, 9.32.




**1-benzyl-2-(2-methoxybenzylidene)-1-phenylhydrazine (D21)**

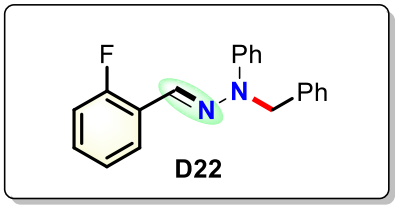
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 147.1 mg, 93% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 8.04 (dd, *J* = 7.7, 1.6 Hz, 1H), 7.82 (s, 1H), 7.41 (d, *J* = 8.0 Hz, 2H), 7.34 – 7.20 (m, 8H), 6.98 (t, *J* = 7.5 Hz, 1H), 6.93 (t, *J* = 7.2 Hz, 1H), 6.83 (d, *J* = 8.2 Hz, 1H), 5.19 (s, 2H), 3.72 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 156.99, 148.01, 135.96, 129.11, 128.87, 128.48, 127.14, 126.28, 125.50, 125.24, 120.90, 120.45, 114.69, 111.17, 55.63, 50.27 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{21}N_2O$ [M+H]: 317.1654, found: 317.1655.

**Elemental Analysis** calcd for $C_{21}H_{20}N_2O$: C, 79.72; H, 6.37; N, 8.85; O, 5.06; found: C, 79.73; H, 6.35; N, 8.83.




**1-benzyl-2-(2-fluorobenzylidene)-1-phenylhydrazine (D22)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 121.7 mg, 80% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

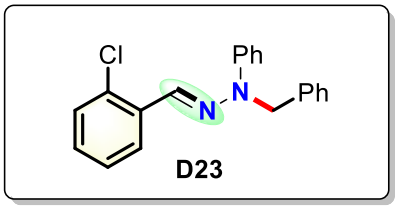
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 8.03 (t, *J* = 7.6, 2.0 Hz, 1H), 7.60 (s, 1H), 7.42 (d, *J* = 7.8 Hz, 2H), 7.34 (dd, *J* = 5.7, 5.2, 3.3 Hz, 4H), 7.27 – 7.10 (m, 6H), 7.04 – 6.91 (m, 2H), 5.20 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 161.71, 147.76, 135.26, 129.17, 129.00, 128.92, 128.84, 127.35, 126.10, 125.93, 125.38, 125.32, 124.16, 121.05, 115.59, 115.38, 114.96, 50.46 ppm.

**$^{19}$F NMR** (377 MHz, 23.0 °C, $CDCl_3$) δ -122.56 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}FN_2$ [M+H]: 305.1454, found: 305.1456.

**Elemental Analysis** calcd for $C_{20}H_{17}FN_2$: C, 78.92; H, 5.63; F, 6.24; N, 9.20; found: C, 78.94; H, 5.63; N, 9.23.



**D23**

**1-benzyl-2-(2-chlorobenzylidene)-1-phenylhydrazine (D23)**

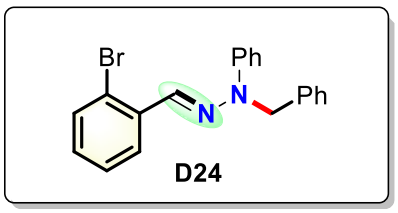
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 128.3 mg, 80% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 8.08 (dd, $J$ = 7.8, 1.5 Hz, 1H), 7.76 (s, 1H), 7.44 (d, $J$ = 7.9 Hz, 2H), 7.40 – 7.30 (m, 4H), 7.27 (d, $J$ = 6.8 Hz, 6H), 7.15 (t, $J$ = 7.6, 1.7 Hz, 1H), 6.99 (t, $J$ = 7.2 Hz, 1H), 5.21 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.82, 135.28, 133.79, 132.82, 129.60, 129.38, 129.22, 129.01, 128.54, 127.41, 126.79, 126.31, 126.25, 121.20, 115.14, 50.91 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}ClN_2$ [M+H]: 321.1159, found: 321.1158.

**Elemental Analysis** calcd for $C_{20}H_{17}ClN_2$: C, 74.88; H, 5.34; Cl, 11.05; N, 8.73; found: C, 74.86; H, 5.34; N, 8.74.



**D24**

**1-benzyl-2-(2-bromobenzylidene)-1-phenylhydrazine (D24)**

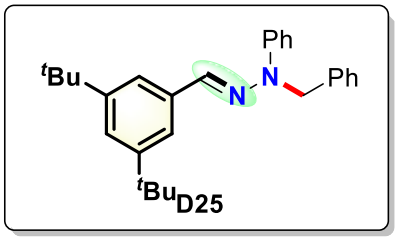
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 138.8 mg, 76% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 8.06 (dd, *J* = 7.9, 1.6 Hz, 1H), 7.71 (s, 1H), 7.50 – 7.42 (m, 3H), 7.37 – 7.31 (m, 4H), 7.30 – 7.24 (m, 4H), 7.12 – 7.03 (m, 1H), 6.99 (t, *J* = 7.2 Hz, 1H), 5.20 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.86, 135.28, 135.21, 132.85, 132.04, 129.24, 129.02, 128.87, 127.44, 127.39, 126.68, 126.32, 123.19, 121.24, 115.20, 51.09 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}BrN_2$ [M+H]: 365.0653, found: 365.0653.

**Elemental Analysis** calcd for $C_{20}H_{17}BrN_2$: C, 65.76; H, 4.69; Br, 21.88; N, 7.67; found: C, 65.74; H, 4.63; N, 7.64.




**1-benzyl-2-(3,5-di-tert-butylbenzylidene)-1-phenylhydrazine (D25)**

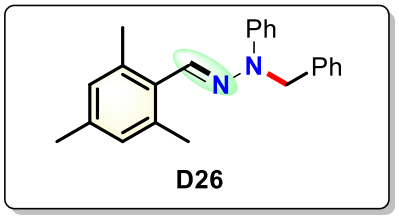
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 187.3 mg, 94% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.48 (d, *J* = 1.8 Hz, 2H), 7.43 (s, 1H), 7.39 (d, *J* = 7.8 Hz, 2H), 7.36 – 7.31 (m, 4H), 7.31 – 7.24 (m, 4H), 6.94 (t, *J* = 7.2 Hz, 1H), 5.19 (s, 2H), 1.34 (s, 18H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 150.98, 147.95, 135.89, 135.73, 133.55, 129.15, 129.00, 127.22, 126.09, 122.42, 120.58, 120.50, 114.66, 50.40, 34.86, 31.45 ppm.

**HRMS** (ESI) calcd. for $C_{28}H_{35}N_2$ [M+H]: 399.2800, found: 399.2803.

**Elemental Analysis** calcd for $C_{28}H_{34}N_2$: C, 84.37; H, 8.60; N, 7.03; found: C, 84.34; H, 8.62; N, 7.04.




D26

**1-benzyl-1-phenyl-2-(2,4,6-trimethylbenzylidene)hydrazine (D26)**

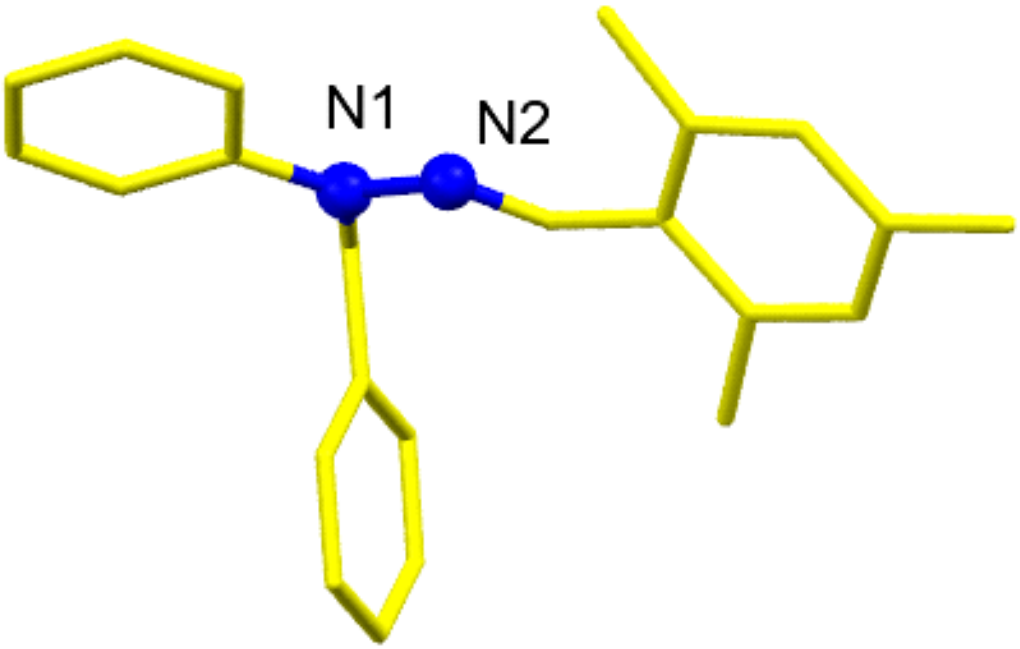
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 136.3 mg, 83% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

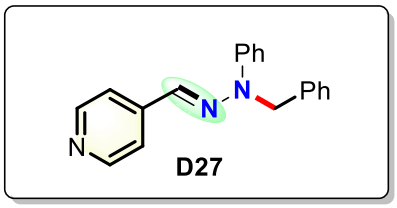
**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.58 (s, 1H), 7.38 – 7.24 (m, 10H), 6.93 (t, $J$ = 7.1 Hz, 1H), 6.83 (s, 2H), 5.21 (s, 2H), 2.27 (s, 6H), 2.25 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.25, 136.95, 136.50, 135.75, 133.64, 130.06, 129.40, 129.18, 128.99, 127.27, 126.14, 120.37, 114.51, 50.19, 21.45, 21.01 ppm.

**HRMS** (ESI) calcd. for $C_{23}H_{25}N_2$ [M+H]: 329.2018, found: 329.2017.

**Elemental Analysis** calcd for $C_{23}H_{24}N_2$: C, 84.11; H, 7.37; N, 8.53; found: C, 84.14; H, 7.34; N, 8.52.




**4-((2-benzyl-2-phenylhydrazineylidene)methyl)pyridine (D27)**

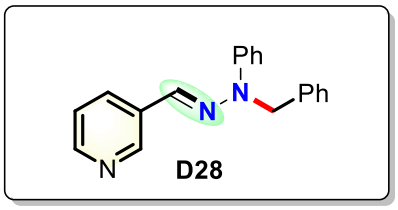
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 102.1 mg, 71% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 8.53 (d, *J* = 4.9 Hz, 2H), 7.48 – 7.21 (m, 12H), 7.03 (t, *J* = 7.2 Hz, 1H), 5.21 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 149.71, 147.34, 134.70, 129.30, 129.18, 127.60, 125.95, 122.05, 120.26, 115.53, 50.92 ppm.

**HRMS** (ESI) calcd. for $C_{19}H_{18}N_3$ [M+H]: 288.1501, found: 288.1500.

**Elemental Analysis** calcd for $C_{19}H_{17}N_3$: C, 79.41; H, 5.96; N, 14.62; found: C, 79.42; H, 5.94; N, 14.67.




**3-((2-benzyl-2-phenylhydrazineylidene)methyl)pyridine (D28)**

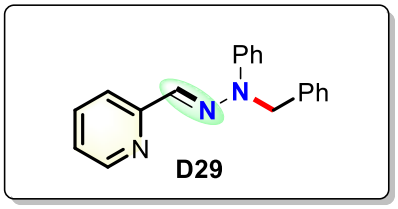
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid120.7 mg, 84% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 8.71 (s, 1H), 8.46 (d, *J* = 3.9 Hz, 1H), 8.02 (d, *J* = 7.9, 1.8 Hz, 1H), 7.44 – 7.33 (m, 6H), 7.26 (d, *J* = 4.3 Hz, 5H), 7.00 (t, *J* = 7.2 Hz, 1H), 5.21 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.49, 148.12, 147.57, 135.10, 132.44, 129.26, 129.14, 128.76, 127.51, 125.98, 123.55, 121.42, 115.10, 50.66 ppm.

**HRMS** (ESI) calcd. for $C_{19}H_{18}N_3$ [M+H]: 288.1501, found: 288.1501.

**Elemental Analysis** calcd for $C_{19}H_{17}N_3$: C, 79.41; H, 5.96; N, 14.62; found: C, 79.48; H, 5.94; N, 14.63.




**2-((2-benzyl-2-phenylhydrazineylidene)methyl)pyridine (D29)**

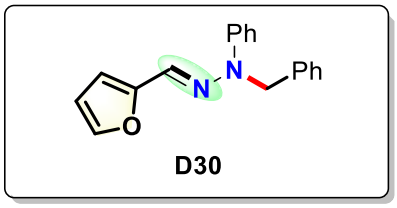
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 137.9 mg, 96% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 8.45 (dd, *J* = 4.9, 1.7, 0.9 Hz, 1H), 8.04 (dd, *J* = 8.1, 0.9 Hz, 1H), 7.65 (t, *J* = 7.5, 1.3 Hz, 1H), 7.43 (d, *J* = 9.0, 1.6 Hz, 2H), 7.39 – 7.29 (m, 4H), 7.26 – 7.20 (m, 3H), 7.10 (dd, *J* = 7.4, 4.9, 1.2 Hz, 1H), 7.06 – 6.92 (m, 1H), 5.22 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 155.72, 149.00, 147.59, 136.17, 134.92, 133.25, 129.24, 129.05, 127.42, 126.05, 122.10, 121.51, 119.31, 115.27, 50.80 ppm.

**HRMS** (ESI) calcd. for $C_{19}H_{18}N_3$ [M+H]: 288.1501, found: 288.1505.

**Elemental Analysis** calcd for $C_{19}H_{17}N_3$: C, 79.41; H, 5.96; N, 14.62; found: C, 79.45; H, 5.94; N, 14.63.



D30

**1-benzyl-2-(furan-2-ylmethylene)-1-phenylhydrazine (D30)**

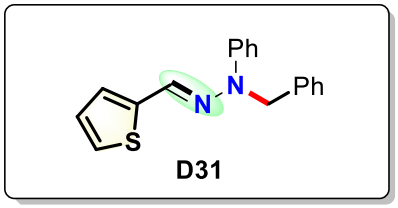
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 99.5 mg, 72% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.46 – 7.26 (m, 9H), 7.23 (d, $J$ = 7.0 Hz, 2H), 6.96 (t, $J$ = 7.2 Hz, 1H), 6.46 (d, $J$ = 3.3 Hz, 1H), 6.41 (d, $J$ = 1.8 Hz, 1H), 5.14 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 151.99, 147.61, 142.33, 135.31, 129.18, 129.06, 127.40, 126.02, 123.42, 121.04, 115.06, 111.49, 108.03, 50.72 ppm.

**HRMS** (ESI) calcd. for $C_{18}H_{17}N_2O$ [M+H]: 277.1341, found: 277.1340.

**Elemental Analysis** calcd for $C_{18}H_{16}N_2O$: C, 78.24; H, 5.84; N, 10.14; O, 5.79; found: C, 78.22; H, 5.88; N, 10.19.



D31

**1-benzyl-1-phenyl-2-(thiophen-2-ylmethylene)hydrazine (D31)**

The title compound was prepared according to the general procedure and purified by

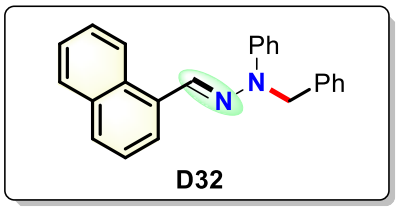
column chromatography to give a yellow solid 133.1 mg, 91% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.55 (s, 1H), 7.38 – 7.24 (m, 9H), 7.21 – 7.15 (m, 1H), 6.95 (t, *J* = 3.9 Hz, 3H), 5.15 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.47, 142.42, 135.45, 129.18, 129.07, 127.58, 127.39, 127.14, 126.02, 125.83, 125.09, 120.84, 114.74, 50.76 ppm.

**HRMS** (ESI) calcd. for $C_{18}H_{17}N_2S$ [M+H]: 293.1112, found: 293.1110.

**Elemental Analysis** calcd for $C_{18}H_{16}N_2S$: C, 73.94; H, 5.52; N, 9.58; S, 10.96; found: C, 73.99; H, 5.51; N, 9.57.




**(1-benzyl-2-(naphthalen-1-ylmethylene)-1-phenylhydrazine (D32)**

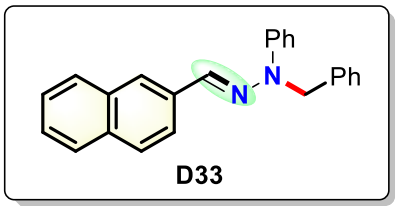
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 1146.4 mg, 87% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 8.28 (dd, *J* = 6.3, 3.5 Hz, 1H), 8.07 (s, 1H), 7.97 – 7.88 (m, 1H), 7.83 (dd, *J* = 6.2, 3.4 Hz, 1H), 7.76 (d, *J* = 8.2 Hz, 1H), 7.52 – 7.41 (m, 5H), 7.42 – 7.26 (m, 7H), 7.06 – 6.91 (m, 1H), 5.30 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 164.65, 162.19, 147.69, 138.58, 138.51, 136.33, 132.68, 130.70, 130.62, 129.23, 128.56, 128.04, 126.24, 121.65, 121.62, 121.01, 114.86, 114.48, 114.27, 113.24, 113.02, 50.14 ppm.

**HRMS** (ESI) calcd. for $C_{24}H_{21}N_2$ [M+H]: 337.1705, found: 337.1704.

**Elemental Analysis** calcd for $C_{24}H_{20}N_2$: C, 85.68; H, 5.99; N, 8.33; found: C, 85.65; H, 5.98; N, 8.36.




D33

**1-benzyl-2-(naphthalen-2-ylmethylene)-1-phenylhydrazine (D33)**

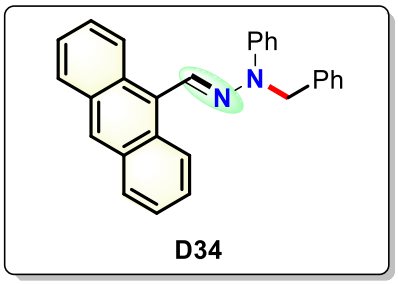
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 156.4 mg, 93% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 8.06 (dd, *J* = 8.6, 1.5 Hz, 1H), 7.87 – 7.71 (m, 4H), 7.56 (s, 1H), 7.52 – 7.39 (m, 4H), 7.36 (q, *J* = 8.8, 6.9, 4.7 Hz, 4H), 7.29 (t, *J* = 6.0 Hz, 3H), 6.98 (t, *J* = 7.2 Hz, 1H), 5.24 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.93, 135.73, 134.35, 133.57, 133.34, 132.74, 129.27, 129.12, 128.30, 127.95, 127.86, 127.40, 126.61, 126.32, 126.11, 125.96, 123.15, 120.92, 114.95, 50.60 ppm.

**HRMS** (ESI) calcd. for $C_{24}H_{21}N_2$ [M+H]: 337.1705, found: 337.1705.

**Elemental Analysis** calcd for $C_{24}H_{20}N_2$: C, 85.68; H, 5.99; N, 8.33; found: C, 85.67; H, 5.96; N, 8.34.




D34

**2-(anthracen-9-ylmethylene)-1-benzyl-1-phenylhydrazine (D34)**

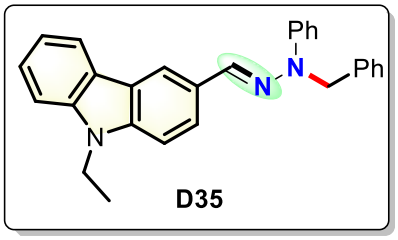
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 160.4 mg, 83% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 8.57 (s, 1H), 8.48 (s, 1H), 8.24 (d, *J* = 8.8 Hz, 2H), 8.09 (d, *J* = 8.1 Hz, 2H), 7.64 – 7.20 (m, 12H), 6.95 (t, *J* = 7.2 Hz, 1H), 5.64 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.01, 136.52, 131.98, 131.52, 129.83, 129.52, 129.45, 129.20, 128.40, 127.78, 127.64, 126.97, 126.68, 126.33, 125.81, 125.51, 123.96, 120.99, 114.69, 48.88, 40.61, 40.40, 40.19, 39.98, 39.77, 39.57, 39.36 ppm.

**HRMS** (ESI) calcd. for $C_{28}H_{23}N_2$ [M+H]: 387.1861, found: 387.1863.

**Elemental Analysis** calcd for $C_{28}H_{22}N_2$: C, 87.01; H, 5.74; N, 7.25; found: C, 87.04; H, 5.75; N, 7.27.




**3-((2-benzyl-2-phenylhydrazineylidene)methyl)-9-ethyl-9H-carbazole (D35)**

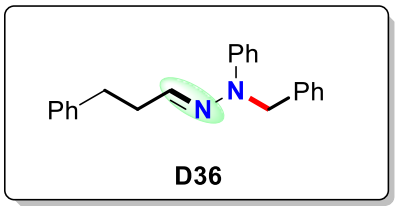
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 185.6 mg, 92% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 8.35 – 8.17 (m, 1H), 8.09 (d, *J* = 7.7 Hz, 1H), 7.88 (dd, *J* = 8.6, 1.5 Hz, 1H), 7.63 (s, 1H), 7.51 – 7.42 (m, 3H), 7.41 – 7.28 (m, 8H), 7.22 (t, *J* = 7.4 Hz, 1H), 6.94 (t, *J* = 7.2 Hz, 1H), 5.23 (s, 2H), 4.35 (q, *J* = 7.2 Hz, 2H), 1.42 (t, *J* = 7.2 Hz, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.16, 140.33, 140.01, 136.20, 134.21, 129.17, 129.01, 127.83, 127.23, 126.15, 125.77, 124.07, 123.11, 123.04, 120.59, 120.24, 119.04, 118.92, 114.60, 108.62, 50.62, 37.66, 13.84 ppm.

**HRMS** (ESI) calcd. for $C_{28}H_{26}N_3$ [M+H]: 404.2127, found: 404.2126.

**Elemental Analysis** calcd for $C_{28}H_{25}N_3$: C, 83.34; H, 6.24; N, 10.41; found: C, 83.38; H, 6.29; N, 10.47.




D36

**1-benzyl-1-phenyl-2-(3-phenylpropylidene)hydrazine (D36)**

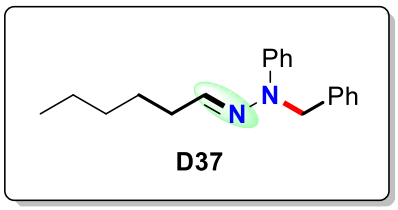
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 111.6 mg, 71% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.46 – 7.26 (m, 6H), 7.25 – 7.21 (m, 3H), 7.19 – 7.12 (m, 3H), 7.12 – 7.06 (m, 2H), 6.92 – 6.81 (m, 1H), 6.72 (t, *J* = 5.0 Hz, 1H), 4.98 (s, 2H), 2.81 (t,*J* = 7.7 Hz, 2H), 2.67 – 2.51 (m, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.22, 141.49, 136.19, 135.35, 129.12, 128.99, 128.90, 128.55, 128.51, 128.45, 128.36, 128.32, 127.12, 126.09, 125.87, 119.97, 114.25, 50.47, 34.74, 33.78 ppm.

**HRMS** (ESI) calcd. for $C_{22}H_{23}N_2$ [M+H]: 315.1861, found: 315.1863.

**Elemental Analysis** calcd for $C_{22}H_{22}N_2$: C, 84.04; H, 7.05; N, 8.91; found: C, 84.08; H, 7.02; N, 8.95.




D37

**1-benzyl-2-pentylidene-1-phenylhydrazine (D37)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 83.9 mg, 63% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

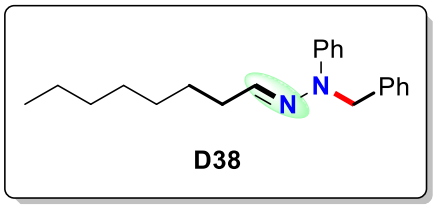
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.31 (t, *J* = 7.3 Hz, 2H), 7.27 – 7.21 (m, 5H), 7.16 (d, *J* = 7.1 Hz, 2H), 6.86 (dd, *J* = 8.4, 5.3, 3.2 Hz, 1H), 6.70 (t, *J* = 5.3 Hz, 1H), 4.98 (s, 2H), 2.32 – 2.23 (m, 2H), 1.44 (p, *J* = 7.2 Hz, 2H), 1.30 (p, *J* = 14.7, 7.2 Hz,

2H), 0.88 (t, $J$ = 7.3 Hz, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.57, 137.14, 136.67, 129.39, 129.13, 127.35, 126.37, 120.06, 114.43, 50.73, 32.95, 29.83, 22.51, 14.24 ppm.

**HRMS** (ESI) calcd. for $C_{18}H_{23}N_2$ [M+H]: 267.1861, found: 267.1860.

**Elemental Analysis** calcd for $C_{18}H_{22}N_2$: C, 81.16; H, 8.32; N, 10.52; found: C, 81.17; H, 8.34; N, 10.51.




**D38**

**1-benzyl-2-octylidene-1-phenylhydrazine (D38)**

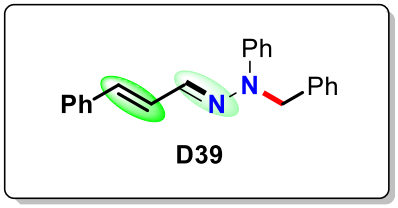
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 100.1 mg, 68% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.53 – 7.07 (m, 13H), 6.85 (dd, $J$ = 6.4, 2.9 Hz, 1H), 6.69 (t, $J$ = 5.2 Hz, 1H), 4.98 (s, 2H), 2.37 – 2.12 (m, 2H), 1.49 – 1.41 (m, 2H), 1.26 (d, $J$ = 13.8 Hz, 10H), 0.87 (t, $J$ = 6.8 Hz, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.30, 136.92, 136.39, 129.10, 128.97, 128.85, 128.51, 128.26, 128.03, 127.44, 127.07, 126.09, 119.77, 114.16, 113.53, 50.44, 32.97, 31.83, 29.16, 29.08, 27.45, 22.68, 14.15 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{27}N_2$ [M+H]: 295.2174, found: 295.2172.

**Elemental Analysis** calcd for $C_{20}H_{26}N_2$: C, 81.58; H, 8.90; N, 9.51; found: C, 81.59; H, 8.93; N, 9.56.




**D39**

**1-benzyl-1-phenyl-2-(3-phenylallylidene)hydrazine (D39)**

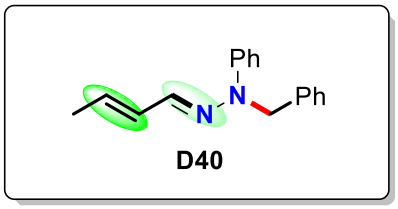
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 126.5 mg, 81% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.42 – 7.28 (m, 12H), 7.24 – 7.18 (m, 3H), 7.10 – 7.01 (m, 1H), 6.95 (t, *J* = 6.8 Hz, 1H), 6.56 (d, *J* = 16.0 Hz, 1H), 5.13 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.56, 137.04, 135.63, 135.41, 133.35, 129.17, 129.05, 128.67, 127.66, 127.39, 127.34, 126.34, 126.01, 120.93, 114.90, 50.70 ppm.

**HRMS** (ESI) calcd. for $C_{22}H_{21}N_2$ [M+H]: 313.1705, found: 313.1704.

**Elemental Analysis** calcd for $C_{22}H_{20}N_2$: C, 84.58; H, 6.45; N, 8.97; found: C, 84.57; H, 6.44; N, 8.91.




**D40**

**1-benzyl-2-but-2-en-1-ylidene)-1-phenylhydrazine (D40)**

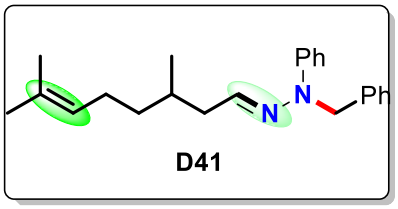
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 100.1 mg, 80% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.31 – 7.19 (m, 7H), 7.16 (t, *J* = 6.8 Hz, 2H), 7.09 (d, *J* = 8.8 Hz, 1H), 6.88 (t, *J* = 8.4, 5.9, 2.4 Hz, 1H), 6.31 (dd, *J* = 15.5, 8.8, 1.6 Hz, 1H), 5.71 (dd, *J* = 15.5, 6.8 Hz, 1H), 5.01 (s, 2H), 1.77 (d, *J* = 6.8 Hz, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.86, 136.09, 135.78, 131.68, 130.33, 129.16, 129.01, 127.25, 126.07, 120.40, 114.59, 50.45, 18.39 ppm.

**HRMS** (ESI) calcd. for $C_{17}H_{19}N_2$ [M+H]: 251.1548, found: 251.1546.

**Elemental Analysis** calcd for $C_{17}H_{18}N_2$: C, 81.56; H, 7.25; N, 11.19; found: C, 81.58; H, 7.22; N, 11.15.




D41

**1-benzyl-2-(3,7-dimethyloct-6-en-1-ylidene)-1-phenylhydrazine (D41)**

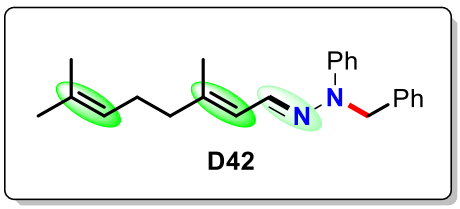
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 118.8 mg, 71% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.48 – 7.26 (m, 8H), 7.17 (d, *J* = 7.1 Hz, 2H), 6.93 – 6.80 (m, 1H), 6.67 (t, *J* = 5.6 Hz, 1H), 5.00 (s, 2H), 2.27 (d, *J* = 14.1, 5.7 Hz, 1H), 2.13 (dd, *J* = 14.0, 7.4, 5.9 Hz, 1H), 1.94 (d, *J* = 16.4, 8.7 Hz, 2H), 1.67 – 1.64 (m, 3H), 1.57 (s, 3H), 1.34 – 1.21 (m, 2H), 1.16 – 1.08 (m, 1H), 0.82 (d, *J* = 6.7 Hz, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 163.3, 160.0, 141.5, 141.5, 127.1, 127.0, 115.4, 115.2, 69.8, 25.3 ppm.

**HRMS** (ESI) calcd. for $C_{23}H_{31}N_2$ [M+H]: 335.2487, found: 335.2485.

**Elemental Analysis** calcd for $C_{23}H_{30}N_2$: C, 82.59; H, 9.04; N, 8.37; found: C, 82.57; H, 9.05; N, 8.36.




D42

**1-benzyl-2-(3,7-dimethylocta-2,6-dien-1-ylidene)-1-phenylhydrazine (D42)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 136.3 mg, 82% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

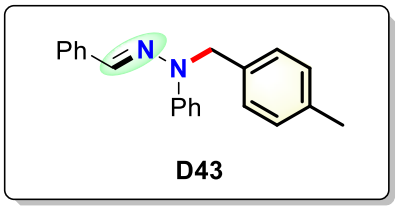
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.39 – 7.13 (m, 11H), 6.94 – 6.80 (m, 1H), 5.13

– 5.07 (m, 1H), 5.03 (d, $J$ = 5.0 Hz, 2H), 2.09 (q, $J$ = 11.7, 8.4 Hz, 2H), 2.05 – 1.97 (m, 1H), 1.92 (q, $J$ = 7.2 Hz, 1H), 1.85 – 1.76 (m, 2H), 1.67 (s, 2H), 1.61 (s, 3H), 1.59 (s, 1H), 1.46 (s, 1H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.03, 141.79, 141.49, 136.26, 136.24, 133.53, 132.09, 131.94, 129.17, 129.04, 129.02, 128.49, 127.86, 127.28, 127.26, 126.18, 126.11, 123.93, 123.89, 123.66, 123.05, 120.36, 120.32, 114.68, 114.66, 50.88, 50.83, 40.14, 32.81, 26.78, 26.54, 25.81, 25.80, 24.23, 17.80, 17.67, 17.06 ppm.

**HRMS** (ESI) calcd. for $C_{23}H_{29}N_2$ [M+H]: 333.2331, found: 333.2330.

**Elemental Analysis** calcd for $C_{23}H_{28}N_2$: C, 83.09; H, 8.49; N, 8.43; found: C, 83.08; H, 8.45; N, 8.41.




**D43**

**2-benzylidene-1-(4-methylbenzyl)-1-phenylhydrazine (D43)**

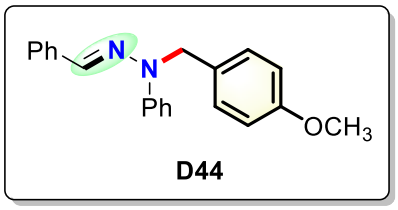
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 136.7 mg, 91% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.60 (d, $J$ = 7.9 Hz, 2H), 7.42 – 7.34 (m, 3H), 7.30 (t, $J$ = 7.1 Hz, 4H), 7.25 – 7.19 (m, 1H), 7.11 (s, 4H), 7.03 – 6.87 (m, 1H), 5.11 (s, 2H), 2.30 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.00, 137.01, 136.70, 132.63, 132.51, 129.79, 129.25, 128.60, 126.29, 126.08, 120.77, 114.88, 50.27, 21.16 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{21}N_2$ [M+H]: 301.1705, found: 301.1705.

**Elemental Analysis** calcd for $C_{21}H_{20}N_2$: C, 83.96; H, 6.71; N, 9.33; found: C, 83.97; H, 6.74; N, 9.31.




D44

**2-benzylidene-1-(4-methoxybenzyl)-1-phenylhydrazine (D44)**

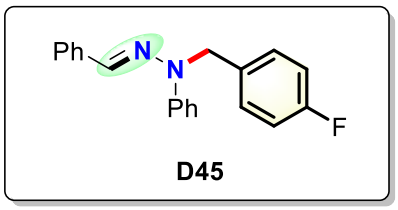
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 142.4 mg, 90% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.62 (d, *J* = 7.7 Hz, 2H), 7.43 – 7.37 (m, 3H), 7.32 (td, *J* = 8.8, 8.1, 2.6 Hz, 4H), 7.26 – 7.20 (m, 1H), 7.14 (d, *J* = 8.5 Hz, 2H), 6.94 (t, *J* = 7.2 Hz, 1H), 6.86 (d, *J* = 8.6 Hz, 2H), 5.11 (s, 2H), 3.77 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 166.49, 158.84, 147.88, 136.59, 132.49, 129.15, 128.51, 127.82, 127.40, 127.20, 126.17, 122.34, 120.70, 115.01, 114.82, 114.43, 99.99, 55.31, 49.92 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{21}N_2O$ [M+H]: 317.1654, found: 317.1653.

**Elemental Analysis** calcd for $C_{21}H_{20}N_2O$: C, 79.72; H, 6.37; N, 8.85; O, 5.06; found: C, 79.74; H, 6.35; N, 8.86.




D45

**2-benzylidene-1-(4-fluorobenzyl)-1-phenylhydrazine (D45)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 146.1 mg, 96% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.64 – 7.53 (m, 2H), 7.37 (dd, *J* = 8.9, 1.1 Hz, 2H), 7.33 – 7.26 (m, 5H), 7.26 – 7.15 (m, 2H), 7.03 – 6.83 (m, 4H), 5.07 (s, 2H) ppm.

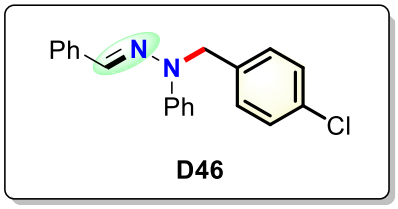
**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 164.75, 162.29, 147.80, 138.72, 138.65,

136.47, 132.78, 130.83, 130.74, 129.37, 128.70, 128.17, 126.38, 121.78, 121.75, 121.14, 114.97, 114.58, 114.37, 113.35, 113.13, 50.15, 50.13 ppm.

**$^{19}$F NMR** (377 MHz, 23.0 °C, $CDCl_3$) δ -111.83 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}FN_2$ [M+H]: 305.1454, found: 305.1455.

**Elemental Analysis** calcd for $C_{20}H_{17}FN_2$: C, 78.92; H, 5.63; F, 6.24; N, 9.20; found: C, 78.94; H, 5.65; N, 9.24.




**D46**

**2-benzylidene-1-(4-chlorobenzyl)-1-phenylhydrazine (D46)**

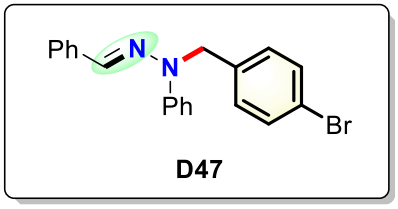
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 150.8 mg, 94% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.65 – 7.54 (m, 2H), 7.37 – 7.23 (m, 10H), 7.12 (d, *J* = 8.4 Hz, 2H), 6.94 (t, *J* = 7.1 Hz, 1H), 5.07 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.73, 136.40, 134.25, 133.16, 132.72, 129.34, 129.28, 129.15, 128.70, 128.66, 128.13, 127.58, 126.31, 121.09, 114.93, 49.92 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}ClN_2$ [M+H]: 321.1159, found: 321.1155.

**Elemental Analysis** calcd for $C_{20}H_{17}ClN_2$: C, 74.88; H, 5.34; Cl, 11.05; N, 8.73; found: C, 74.87; H, 5.35; N, 8.74.




**D47**

**2-benzylidene-1-(4-bromobenzyl)-1-phenylhydrazine (D47)**

The title compound was prepared according to the general procedure and purified by

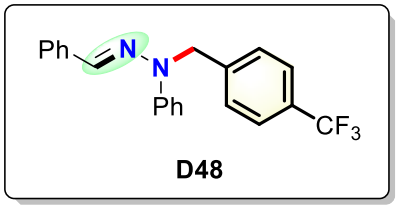
column chromatography to give a yellow solid 164.4 mg, 90% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.59 (dd, *J* = 8.2, 1.1 Hz, 2H), 7.44 – 7.39 (m, 2H), 7.35 – 7.28 (m, 6H), 7.24 – 7.20 (m, 1H), 7.06 (d, *J* = 8.5 Hz, 2H), 6.97 – 6.91 (m, 1H), 5.04 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.72, 136.39, 134.80, 132.74, 132.23, 129.35, 128.67, 128.15, 127.96, 126.33, 121.22, 121.11, 114.93, 49.98 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}BrN_2$ [M+H]: 365.0653, found: 365.0653.

**Elemental Analysis** calcd for $C_{20}H_{17}BrN_2$: C, 65.76; H, 4.69; Br, 21.88; N, 7.67; found: C, 65.73; H, 4.64; N, 7.63.




**D48**

**2-benzylidene-1-phenyl-1-(4-(trifluoromethyl)benzyl)hydrazine (D48)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 166.6 mg, 94% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

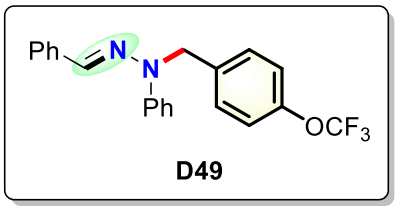
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.64 – 7.55 (m, 4H), 7.38 – 7.27 (m, 9H), 7.27 – 7.21 (m, 1H), 6.96 (t, *J* = 7.1 Hz, 1H), 5.16 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.66, 140.04, 140.03, 136.27, 132.78, 129.99, 129.67, 129.37, 128.67, 128.59, 128.22, 126.53, 126.33, 126.26, 126.16, 126.13, 126.09, 126.05, 125.52, 122.82, 121.23, 114.94, 50.15 ppm.

**$^{19}$F NMR** (377 MHz, 23.0 °C, $CDCl_3$) δ -62.35 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{18}F_3N_2$ [M+H]: 355.1422, found: 355.1425.

**Elemental Analysis** calcd for $C_{21}H_{17}F_3N_2$: C, 71.18; H, 4.84; F, 16.08; N, 7.91; found: C, 71.16; H, 4.86; N, 7.93.




D49

**2-benzylidene-1-phenyl-1-(4-(trifluoromethoxy)benzyl)hydrazine (D49)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 159.3 mg, 86% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

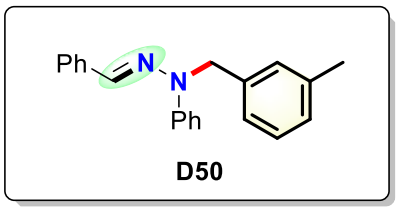
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.63 (d, *J* = 7.3 Hz, 2H), 7.40 – 7.32 (m, 6H), 7.27 (d, *J* = 9.3 Hz, 4H), 7.19 (d, *J* = 8.3 Hz, 2H), 6.97 (t, *J* = 7.1 Hz, 1H), 5.18 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.44, 147.63, 136.30, 134.37, 132.65, 129.26, 128.58, 128.08, 127.49, 126.24, 121.63, 121.06, 114.86, 53.44, 49.83 ppm.

**$^{19}$F NMR** (377 MHz, 23.0 °C, $CDCl_3$) δ -57.86 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{18}F_3N_2O$ [M+H]: 371.1371, found: 371.1373.

**Elemental Analysis** calcd for $C_{21}H_{17}F_3N_2O$: C, 68.10; H, 4.63; F, 15.39; N, 7.56; O, 4.32; found: C, 68.15; H, 4.64; N, 7.53.




D50

**2-benzylidene-1-(3-methylbenzyl)-1-phenylhydrazine (D50)**

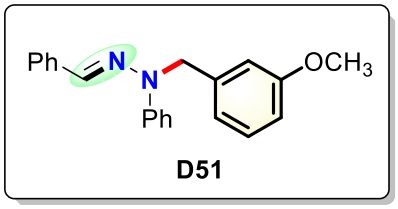
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 132.2 mg, 88% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.61 (d, *J* = 7.5 Hz, 2H), 7.40 (d, *J* = 8.0 Hz, 2H), 7.36 (s, 1H), 7.30 (t, *J* = 7.7 Hz, 4H), 7.24 – 7.16 (m, 2H), 7.03 (q, *J* = 8.1 Hz, 3H), 6.93 (t, *J* = 7.2 Hz, 1H), 5.10 (s, 2H), 2.29 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.17, 139.00, 136.83, 135.92, 132.65, 129.39, 129.14, 128.74, 128.32, 128.06, 126.77, 126.44, 123.32, 120.93, 115.02, 50.75, 21.73 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{21}N_2$ [M+H]: 301.1705, found: 301.1705.

**Elemental Analysis** calcd for $C_{21}H_{20}N_2$: C, 83.96; H, 6.71; N, 9.33; found: C, 83.98; H, 6.75; N, 9.32.




**D51**

**2-benzylidene-1-(3-methoxybenzyl)-1-phenylhydrazine (D51)**

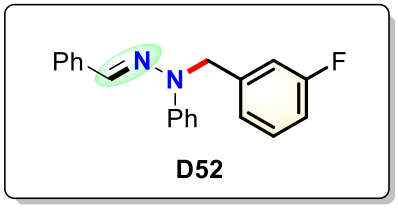
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 144.1 mg, 91% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.65 – 7.59 (m, 2H), 7.43 – 7.36 (m, 3H), 7.34 – 7.27 (m, 4H), 7.26 – 7.20 (m, 2H), 6.98 – 6.91 (m, 1H), 6.85 – 6.75 (m, 3H), 5.13 (s, 2H), 3.74 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 160.29, 147.95, 137.54, 136.57, 132.59, 130.16, 129.20, 128.56, 127.92, 126.26, 120.82, 118.30, 114.89, 112.58, 111.72, 55.27, 50.63 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{21}N_2O$ [M+H]: 317.1654, found: 317.1653.

**Elemental Analysis** calcd for $C_{21}H_{20}N_2O$: C, 79.72; H, 6.37; N, 8.85; O, 5.06; found: C, 79.73; H, 6.34; N, 8.82.




**D52**

**2-benzylidene-1-(3-fluorobenzyl)-1-phenylhydrazine (D52)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 140.2 mg, 92% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

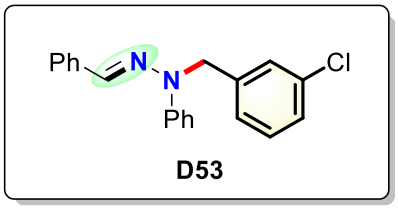
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 8.28 (q, *J* = 6.8, 3.3 Hz, 1H), 8.07 (s, 1H), 7.96 – 7.89 (m, 1H), 7.83 (dd, *J* = 6.2, 3.4 Hz, 1H), 7.76 (d, *J* = 8.2 Hz, 1H), 7.49 – 7.44 (m, 4H), 7.38 – 7.32 (m, 5H), 6.98 (t, *J* = 7.3 Hz, 1H), 5.30 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 164.65, 162.19, 147.69, 138.58, 138.52, 136.33, 132.68, 130.70, 130.62, 129.23, 128.56, 128.04, 126.24, 121.65, 121.62, 121.01, 114.87, 114.48, 114.27, 113.24, 113.02, 50.15 ppm.

**$^{19}$F NMR** (377 MHz, 23.0 °C, $CDCl_3$) δ -112.10 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}FN_2$ [M+H]: 305.1454, found: 305.1455.

**Elemental Analysis** calcd for $C_{20}H_{17}FN_2$: C, 78.92; H, 5.63; F, 6.24; N, 9.20; found: C, 78.93; H, 5.65; N, 9.22.




**D53**

**2-benzylidene-1-(3-chlorobenzyl)-1-phenylhydrazine (D53)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 146.1 mg, 91% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

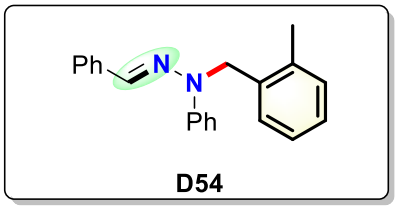
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.61 (d, *J* = 7.7 Hz, 2H), 7.38 – 7.28 (m, 7H), 7.22 (t, *J* = 7.2 Hz, 4H), 7.09 – 7.03 (m, 1H), 6.95 (t, *J* = 7.1 Hz, 1H), 5.08 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.74, 138.07, 136.39, 135.11, 132.75, 130.45, 129.34, 128.66, 128.15, 127.74, 126.35, 126.25, 124.30, 121.13, 114.94, 50.14 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}ClN_2$ [M+H]: 321.1159, found: 321.1155.

**Elemental Analysis** calcd for $C_{20}H_{17}ClN_2$: C, 74.88; H, 5.34; Cl, 11.05; N, 8.73; found:

C, 74.85; H, 5.31; N, 8.73.




D54

**2-benzylidene-1-(2-methylbenzyl)-1-phenylhydrazine (D54)**

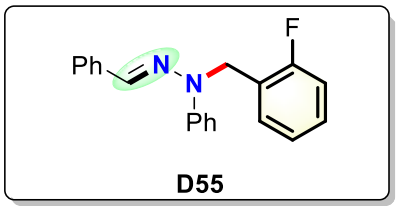
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 124.7 mg, 83% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.73 – 7.51 (m, 2H), 7.40 – 7.28 (m, 6H), 7.26 – 7.17 (m, 4H), 7.08 (t, *J* = 7.4 Hz, 1H), 7.01 – 6.84 (m, 2H), 5.06 (s, 2H), 2.44 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.80, 136.56, 134.68, 132.62, 132.24, 130.54, 129.14, 128.53, 127.86, 127.26, 126.57, 126.22, 125.80, 125.60, 120.73, 114.77, 77.36, 77.05, 76.73, 49.02, 19.09, 0.03 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{21}N_2$ [M+H]: 301.1705, found: 301.1705.

**Elemental Analysis** calcd for $C_{21}H_{20}N_2$: C, 83.96; H, 6.71; N, 9.33; found: C, 83.99; H, 6.76; N, 9.32.




D55

**2-benzylidene-1-(2-fluorobenzyl)-1-phenylhydrazine (D55)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 124.7 mg, 83% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.68 – 7.55 (m, 2H), 7.37 (d, *J* = 7.9 Hz, 2H), 7.34 – 7.26 (m, 5H), 7.22 – 7.16 (m, 2H), 7.09 (dd, *J* = 10.6, 7.0 Hz, 1H), 7.01 – 6.90

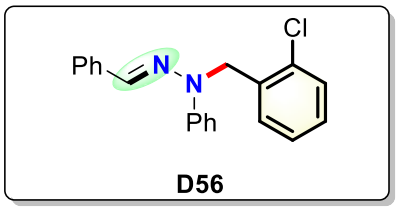
(m, 3H), 5.15 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 161.79, 159.36, 147.74, 136.54, 132.61, 130.23, 129.39, 129.21, 129.13, 128.71, 128.59, 128.16, 128.09, 128.05, 127.93, 126.43, 124.76, 124.72, 122.53, 122.39, 121.08, 115.76, 115.56, 114.92, 44.45, 44.40 ppm.

**$^{19}$F NMR** (377 MHz, 23.0 °C, $CDCl_3$) δ -117.56 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}FN_2$ [M+H]: 305.1454, found: 305.1455.

**Elemental Analysis** calcd for $C_{20}H_{17}FN_2$: C, 78.92; H, 5.63; F, 6.24; N, 9.20; found: C, 78.95; H, 5.67; N, 9.23.




**D56**

**2-benzylidene-1-(2-chlorobenzyl)-1-phenylhydrazine (D56)**

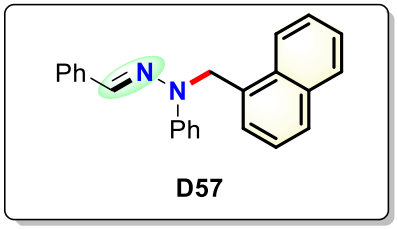
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 138.1 mg, 86% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.61 (d, $J$ = 7.4 Hz, 2H), 7.43 (d, $J$ = 7.4 Hz, 1H), 7.38 – 7.28 (m, 6H), 7.26 – 7.17 (m, 3H), 7.09 (t, $J$ = 7.4 Hz, 1H), 7.04 – 6.97 (m, 1H), 6.94 (t, $J$ = 7.1 Hz, 1H), 5.16 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.58, 136.43, 132.65, 132.58, 132.41, 129.89, 129.31, 128.81, 128.64, 128.11, 127.68, 127.43, 126.38, 121.01, 114.77, 48.59 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}ClN_2$ [M+H]: 321.1159, found: 321.1155.

**Elemental Analysis** calcd for $C_{20}H_{17}ClN_2$: C, 74.88; H, 5.34; Cl, 11.05; N, 8.73; found: C, 74.89; H, 5.36; N, 8.71.




D57

**2-benzylidene-1-(naphthalen-1-ylmethyl)-1-phenylhydrazine (D57)**

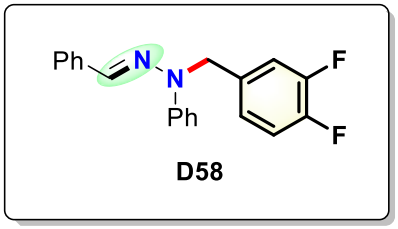
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 136.3 mg, 81% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 8.27 (d, *J* = 8.3 Hz, 1H), 8.02 (d, *J* = 7.6 Hz, 1H), 7.84 (d, *J* = 8.2 Hz, 1H), 7.79 – 7.58 (m, 4H), 7.52 (s, 1H), 7.50 – 7.22 (m, 8H), 7.03 – 6.81 (m, 2H), 5.76 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.52, 136.73, 134.15, 133.08, 130.81, 130.07, 129.67, 129.16, 129.09, 128.35, 127.88, 126.73, 126.54, 126.44, 126.01, 123.92, 122.74, 120.71, 114.60, 47.37, 40.62, 40.41, 40.21, 40.00, 39.79, 39.58, 39.37 ppm.

**HRMS** (ESI) calcd. for $C_{24}H_{21}N_2$ [M+H]: 337.1705, found: 337.1705.

**Elemental Analysis** calcd for $C_{24}H_{20}N_2$: C, 85.68; H, 5.99; N, 8.33; found: C, 85.67; H, 5.95; N, 8.37.




D58

**2-benzylidene-1-(3,4-difluorobenzyl)-1-phenylhydrazine (D58)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 148.3 mg, 92% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

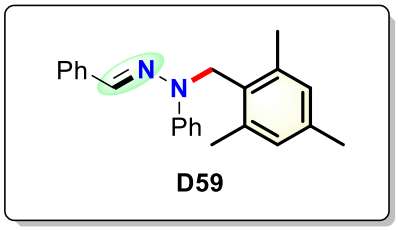
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.71 – 7.53 (m, 2H), 7.41 – 7.27 (m, 7H), 7.27 – 7.19 (m, 1H), 7.13 – 6.90 (m, 4H), 5.06 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 152.19, 152.06, 150.94, 150.81, 149.71, 149.59, 148.48, 148.35, 147.60, 136.28, 132.85, 132.82, 129.38, 128.68, 128.24, 126.34, 122.11, 122.07, 122.05, 122.01, 121.26, 118.07, 117.90, 115.32, 115.15, 114.97, 49.62 ppm.

**$^{19}$F NMR** (377 MHz, 23.0 °C, $CDCl_3$) δ -136.32, -136.37, -139.38, -139.43 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{17}F_2N_2$ [M+H]: 323.1360, found: 323.1359.

**Elemental Analysis** calcd for $C_{20}H_{16}F_2N_2$: C, 74.52; H, 5.00; F, 11.79; N, 8.69; found: C, 74.54; H, 5.05; N, 8.66.




**2-benzylidene-1-phenyl-1-(2,4,6-trimethylbenzyl)hydrazine (D59)**

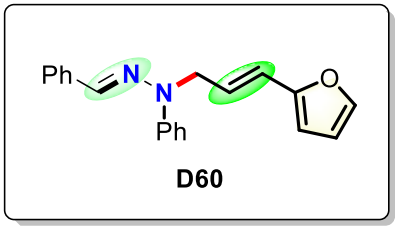
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 124.8 mg, 76% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.54 (d, $J$ = 8.0 Hz, 2H), 7.25 (dd, $J$ = 22.7, 15.4, 8.6 Hz, 8H), 7.06 – 6.95 (m, 1H), 6.80 (s, 2H), 4.90 (s, 2H), 2.23 (s, 9H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.41, 136.81, 136.78, 136.76, 133.69, 130.05, 129.91, 129.15, 128.57, 127.80, 126.17, 122.80, 119.77, 50.72, 20.95, 20.42 ppm.

**HRMS** (ESI) calcd. for $C_{23}H_{25}N_2$ [M+H]: 329.2018, found: 329.2017.

**Elemental Analysis** calcd for $C_{23}H_{24}N_2$: C, 84.11; H, 7.37; N, 8.53; found: C, 84.12; H, 7.35; N, 8.56.




D60

**2-((*E*)-benzylidene)-1-((*E*)-3-(furan-2-yl)allyl)-1-phenylhydrazine (D60)**

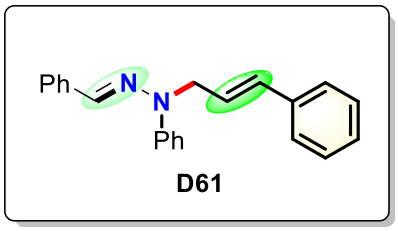
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 110.4 mg, 73% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, $CDCl_3$) δ 7.74 – 7.64 (m, 2H), 7.44 (s, 1H), 7.42 – 7.28 (m, 7H), 7.27 – 7.18 (m, 1H), 6.98 – 6.90 (m, 1H), 6.33 – 6.26 (m, 1H), 6.24 – 6.17 (m, 2H), 6.12 – 6.06 (m, 1H), 4.68 – 4.58 (m, 2H).

**$^{13}$C NMR** (101 MHz, $CDCl_3$) δ 152.2, 147.6, 142.0, 136.6, 132.5, 129.2, 128.6, 128.0, 126.3, 120.8, 120.3, 119.6, 114.8, 111.4, 108.3, 48.1.

**HRMS** (ESI) calcd. for $C_{20}H_{19}N_2O$ [M+H]: 303.1491, found: 303.1486.

**Elemental Analysis** calcd for $C_{20}H_{18}N_2O$: C, 79.44; H, 6.00; N, 9.26; found: C, 79.45; H, 6.04; N, 9.24.




D61

**2-(benzylidene)-1-cinnamyl-1-phenylhydrazine (D61)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 126.5 mg, 81% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

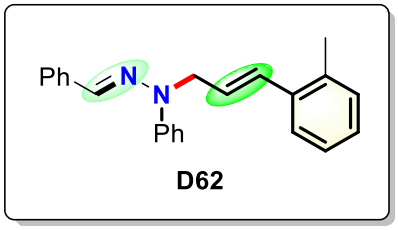
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.72 – 7.61 (m, 2H), 7.48 (s, 1H), 7.45 – 7.39 (m, 2H), 7.37 – 7.29 (m, 6H), 7.28 – 7.18 (m, 4H), 6.94 (t, $J$ = 7.2 Hz, 1H), 6.44 (d, $J$ = 16.1 Hz, 1H), 6.32 – 6.17 (m, 1H), 4.66 (dd, $J$ = 3.8, 1.7 Hz, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.67, 136.69, 136.43, 132.49, 131.38,

129.21, 128.65, 127.95, 127.78, 126.48, 126.28, 121.80, 120.77, 114.96, 48.54 ppm.

**HRMS** (ESI) calcd. for $C_{22}H_{21}N_2$ [M+H]: 313.1705, found: 313.1704.

**Elemental Analysis** calcd for $C_{22}H_{20}N_2$: C, 84.58; H, 6.45; N, 8.97; found: C, 84.57; H, 6.44; N, 8.94.




**D62**

**2-(benzylidene)-1-phenyl-1-3-(p-tolyl)allyl)hydrazine (D62)**

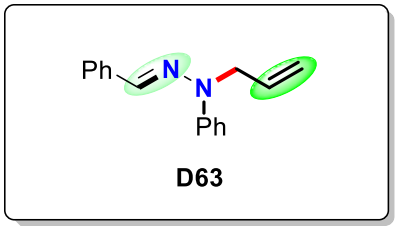
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 133.8 mg, 82% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.80 – 7.58 (m, 1H), 7.44 – 7.37 (m, 1H), 7.37 – 7.27 (m, 3H), 7.26 – 7.16 (m, 3H), 7.05 (d, $J$ = 7.9 Hz, 2H), 7.01 – 6.84 (m, 3H), 6.40 (d, $J$ = 16.1 Hz, 1H), 6.27 – 6.06 (m, 1H), 4.63 (dd, $J$ = 4.2, 2.0 Hz, 2H), 2.27 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.70, 137.63, 136.75, 133.67, 132.47, 131.27, 129.35, 129.22, 128.65, 127.93, 126.39, 126.29, 120.73, 120.71, 114.96, 48.56, 29.84, 21.28 ppm.

**HRMS** (ESI) calcd. for $C_{23}H_{23}N_2$ [M+H]: 327.1861, found: 327.1863.

**Elemental Analysis** calcd for $C_{23}H_{22}N_2$: C, 84.63; H, 6.79; N, 8.58; found: C, 84.64; H, 6.78; N, 8.56.




**D63**

**1-allyl-2-benzylidene-1-phenylhydrazine (D63)**

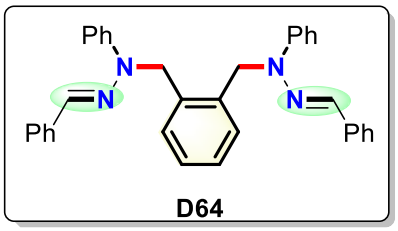
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 106.3 mg, 90% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.68 (d, *J* = 7.4 Hz, 2H), 7.42 (s, 1H), 7.39 – 7.23 (m, 8H), 6.93 (t, *J* = 7.1 Hz, 1H), 5.24 – 5.11 (m, 2H), 4.55 – 4.52 (m, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.61, 136.71, 132.28, 129.98, 129.07, 128.58, 127.83, 126.16, 120.60, 116.93, 114.80, 48.77 ppm.

**HRMS** (ESI) calcd. for $C_{16}H_{17}N_2$ [M+H]: 237.1392, found: 237.1391.

**Elemental Analysis** calcd for $C_{16}H_{16}N_2$: C, 81.32; H, 6.82; N, 11.85; found: C, 81.34; H, 6.83; N, 11.84.




**D64**

**1,2-bis((2-(benzylidene)-1-phenylhydrazineyl)methyl)benzene (D64)**

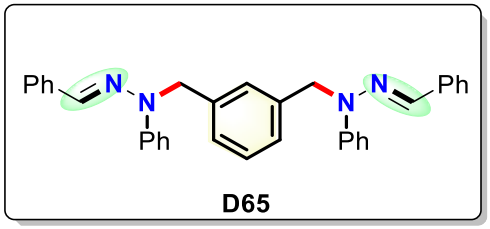
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 183.1 mg, 74% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.63 (d, *J* = 7.8 Hz, 4H), 7.41 (d, *J* = 8.6 Hz, 4H), 7.38 – 7.30 (m, 10H), 7.25 (dd, *J* = 14.8, 7.7 Hz, 3H), 7.16 (q, *J* = 12.7, 9.1, 4.0 Hz, 4H), 6.99 (t, *J* = 7.1 Hz, 2H), 5.16 (s, 4H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.65, 136.29, 132.67, 131.66, 129.34, 128.66, 128.16, 128.13, 126.79, 126.32, 121.34, 115.31, 48.60 ppm.

**HRMS** (ESI) calcd. for $C_{34}H_{31}N_4$ [M+H]: 495.2549, found: 495.2548.

**Elemental Analysis** calcd for $C_{34}H_{30}N_4$: C, 82.56; H, 6.11; N, 11.33; found: C, 82.55; H, 6.12; N, 11.34.




D65

**1,3-bis((2-(benzylidene)-1-phenylhydrazineyl)methyl)benzene (D65)**

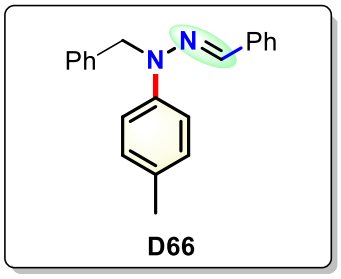
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 188.1 mg, 76% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.58 – 7.52 (m, 4H), 7.40 (d, *J* = 7.8 Hz, 4H), 7.33 – 7.22 (m, 14H), 7.15 – 7.11 (m, 3H), 6.95 (t, *J* = 7.2 Hz, 2H), 5.12 (s, 4H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.88, 136.80, 136.44, 132.67, 129.90, 129.25, 128.58, 127.94, 126.23, 125.22, 123.79, 120.89, 114.90, 50.45 ppm.

**HRMS** (ESI) calcd. for $C_{34}H_{31}N_4$ [M+H]: 495.2549, found: 495.2547.

**Elemental Analysis** calcd for $C_{34}H_{30}N_4$: C, 82.56; H, 6.11; N, 11.33; found: C, 82.56; H, 6.11; N, 11.33.




D66

**1-benzyl-2-benzylidene-1-(p-tolyl)hydrazine (D66)**

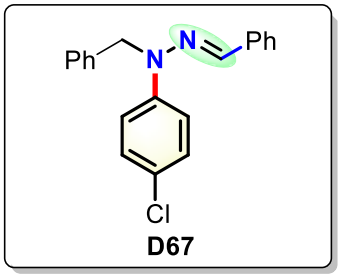
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 129.2 mg, 86% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.60 (d, *J* = 7.3 Hz, 2H), 7.34 – 7.27 (m, 7H), 7.23 (dd, *J* = 12.7, 7.1 Hz, 4H), 7.11 (d, *J* = 8.4 Hz, 2H), 5.13 (s, 2H), 2.30 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 163.3, 160.0, 141.5, 141.5, 127.1, 127.0, 115.4, 115.2, 69.8, 25.3 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{21}N_2$ [M+H]: 301.1705, found: 301.1708.

**Elemental Analysis** calcd for $C_{21}H_{20}N_2$: C, 83.96; H, 6.71; N, 9.33; found: C, 83.95; H, 6.73; N, 9.32.



**D67**

**1-benzyl-2-benzylidene-1-(4-chlorophenyl)hydrazine (D67)**

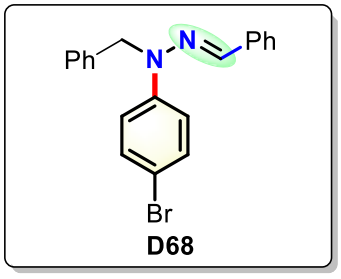
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 147.6 mg, 92% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.59 (s, 1H), 7.57 (s, 1H), 7.36 (s, 1H), 7.31 (q, *J* = 9.2, 8.1, 3.7 Hz, 6H), 7.26 – 7.20 (m, 4H), 7.17 (d, *J* = 7.2 Hz, 2H), 5.11 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 146.67, 136.45, 135.44, 133.45, 129.36, 129.28, 128.83, 128.41, 127.72, 126.54, 126.20, 125.85, 116.06, 50.52 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}ClN_2$ [M+H]: 321.1159, found: 321.1155.

**Elemental Analysis** calcd for $C_{20}H_{17}ClN_2$: C, 74.88; H, 5.34; Cl, 11.05; N, 8.73; found: C, 74.87; H, 5.36; N, 8.71.



**D68**

**1-benzyl-2-benzylidene-1-(4-bromophenyl)hydrazine (D68)**

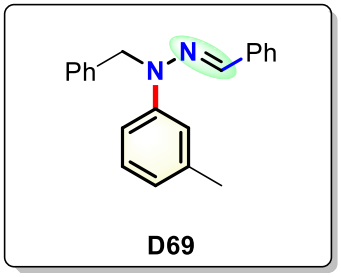
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 153.4 mg, 84% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.60 (d, *J* = 7.5 Hz, 2H), 7.38 (d, *J* = 6.1 Hz, 3H), 7.33 (t, *J* = 7.1 Hz, 4H), 7.29 – 7.22 (m, 4H), 7.19 (d, *J* = 7.4 Hz, 2H), 5.13 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 146.87, 136.18, 135.15, 133.35, 131.96, 129.13, 128.60, 128.22, 127.50, 126.33, 125.97, 116.26, 113.01, 50.18 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}BrN_2$ [M+H]: 365.0653, found: 365.0653.

**Elemental Analysis** calcd for $C_{20}H_{17}BrN_2$: C, 65.76; H, 4.69; Br, 21.88; N, 7.67; found: C, 65.74; H, 4.65; N, 7.63.




**D69**

**1-benzyl-2-benzylidene-1-(m-tolyl)hydrazine (D69)**

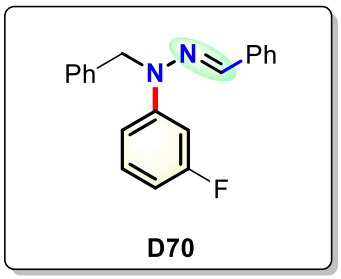
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 120.2 mg, 80% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.61 (d, *J* = 1.2 Hz, 1H), 7.59 (s, 1H), 7.34 (s, 1H), 7.31 (q, *J* = 7.7, 3.7 Hz, 4H), 7.22 (dd, *J* = 11.0, 3.7 Hz, 5H), 7.20 – 7.17 (m, 2H), 6.78 – 6.75 (m, 1H), 5.14 (s, 2H), 2.35 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 147.93, 138.97, 136.59, 135.77, 132.36, 128.99, 128.49, 127.78, 127.24, 126.16, 126.04, 121.69, 115.51, 112.05, 50.57, 21.87 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{21}N_2$ [M+H]: 301.1705, found: 301.1705.

**Elemental Analysis** calcd for $C_{21}H_{20}N_2$: C, 83.96; H, 6.71; N, 9.33; found: C, 83.94; H, 6.70; N, 9.31.




D70

**1-benzyl-2-benzylidene-1-(3-fluorophenyl)hydrazine (D70)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 132.4 mg, 87% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

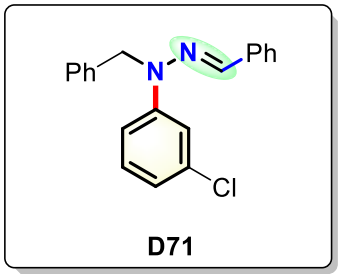
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.62 (d, *J* = 7.5 Hz, 2H), 7.41 (s, 1H), 7.33 (t, *J* = 7.1 Hz, 4H), 7.22 (t, *J* = 11.5 Hz, 6H), 7.04 (d, *J* = 8.3 Hz, 1H), 6.62 (t, *J* = 8.0 Hz, 1H), 5.15 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 165.13, 162.71, 149.58, 149.48, 136.12, 135.19, 133.60, 130.29, 130.19, 129.13, 128.61, 128.30, 127.49, 126.41, 125.97, 109.75, 109.73, 107.27, 107.05, 102.30, 102.03, 50.24 ppm.

**$^{19}$F NMR** (377 MHz, 23.0 °C, $CDCl_3$) δ -112.11 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}FN_2$ [M+H]: 305.1454, found: 305.1455.

**Elemental Analysis** calcd for $C_{20}H_{17}FN_2$: C, 78.92; H, 5.63; F, 6.24; N, 9.20; found: C, 78.90; H, 5.61; N, 9.24.




D71

**1-benzyl-2-benzylidene-1-(3-chlorophenyl)hydrazine (D71)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 131.5 mg, 82% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

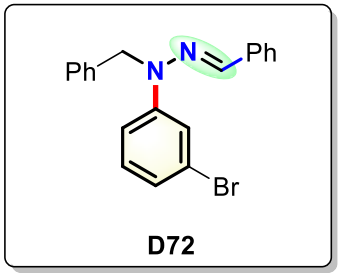
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.66 (dd, *J* = 8.0, 1.3 Hz, 1H), 7.55 – 7.51 (m,

2H), 7.41 (d, $J$ = 7.3 Hz, 2H), 7.35 – 7.27 (m, 6H), 7.25 – 7.21 (m, 2H), 7.18 (s, 1H), 7.10 (t, $J$ = 7.9, 1.6 Hz, 1H), 4.95 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.91, 136.08, 135.13, 135.10, 133.81, 130.13, 129.16, 128.62, 128.33, 127.52, 126.44, 125.96, 120.52, 114.85, 112.53, 50.23 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}ClN_2$ [M+H]: 321.1159, found: 321.1155.

**Elemental Analysis** calcd for $C_{20}H_{17}ClN_2$: C, 74.88; H, 5.34; Cl, 11.05; N, 8.73; found: C, 74.84; H, 5.35; N, 8.74.




**D72**

**1-benzyl-2-benzylidene-1-(3-bromophenyl)hydrazine (D72)**

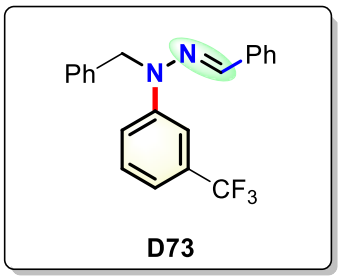
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 135.1 mg, 74% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.63 (t, $J$ = 2.0 Hz, 1H), 7.61 (s, 1H), 7.59 (s, 1H), 7.39 (s, 1H), 7.33 (t, $J$ = 7.3 Hz, 4H), 7.28 – 7.18 (m, 5H), 7.13 (t, $J$ = 8.0 Hz, 1H), 7.04 (d, $J$ = 8.2 Hz, 1H), 5.11 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 149.02, 136.07, 135.08, 133.90, 130.43, 129.18, 128.63, 128.36, 127.54, 126.45, 125.97, 123.46, 123.36, 117.73, 113.01, 50.23 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}BrN_2$ [M+H]: 365.0653, found: 365.0653.

**Elemental Analysis** calcd for $C_{20}H_{17}BrN_2$: C, 65.76; H, 4.69; Br, 21.88; N, 7.67; found: C, 65.74; H, 4.64; N, 7.64.




D73

**1-benzyl-2-benzylidene-1-(3-(trifluoromethyl)phenyl)hydrazine (D73)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 148.8 mg, 84% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

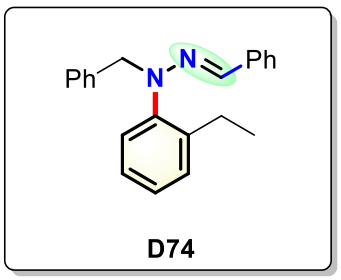
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.73 (s, 1H), 7.63 (d, $J$ = 1.4 Hz, 1H), 7.61 (s, 1H), 7.45 (d, $J$ = 9.5 Hz, 2H), 7.36 (t, $J$ = 14.7, 7.7 Hz, 5H), 7.30 – 7.24 (m, 2H), 7.23 – 7.15 (m, 3H), 5.18 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.10, 135.97, 134.97, 134.17, 132.09, 131.77, 131.45, 131.14, 129.66, 129.21, 128.65, 128.45, 127.60, 126.47, 125.94, 125.71, 123.00, 117.32, 117.31, 117.07, 117.03, 116.99, 116.95, 111.44, 111.40, 111.36, 111.32, 50.22 ppm.

**$^{19}$F NMR** (377 MHz, 23.0 °C, $CDCl_3$) δ -62.54 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{18}F_3N_2$ [M+H]: 355.1422, found: 355.1425.

**Elemental Analysis** calcd for $C_{21}H_{17}F_3N_2$: C, 71.18; H, 4.84; F, 16.08; N, 7.91; found: C, 71.14; H, 4.86; N, 7.91.




D74

**1-benzyl-2-benzylidene-1-(2-ethylphenyl)hydrazine (D74)**

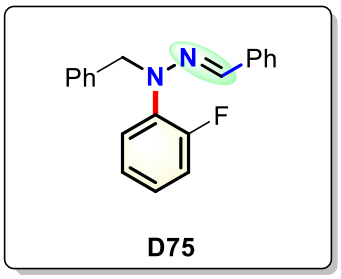
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 113.2 mg, 72% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.50 – 7.45 (m, 2H), 7.35 (d, *J* = 7.2 Hz, 2H), 7.32 – 7.23 (m, 6H), 7.22 (s, 1H), 7.18 (dd, *J* = 10.2, 4.9, 2.1 Hz, 2H), 7.01 (dd, *J* = 7.5, 1.6 Hz, 1H), 6.93 (s, 1H), 4.86 (s, 2H), 2.58 (q, *J* = 7.6 Hz, 2H), 1.13 (t, *J* = 7.6 Hz, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 144.14, 141.97, 138.07, 136.77, 133.41, 129.37, 128.43, 128.39, 128.32, 127.35, 127.22, 127.16, 127.11, 126.72, 125.73, 60.53, 24.22, 14.83 ppm.

**HRMS** (ESI) calcd. for $C_{22}H_{23}N_2$ [M+H]: 315.1861, found: 315.1864.

**Elemental Analysis** calcd for $C_{22}H_{22}N_2$: C, 84.04; H, 7.05; N, 8.91; found: C, 84.02; H, 7.03; N, 8.90.




**D75**

**1-benzyl-2-benzylidene-1-(2-fluorophenyl)hydrazine (D75)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 121.7 mg, 80% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

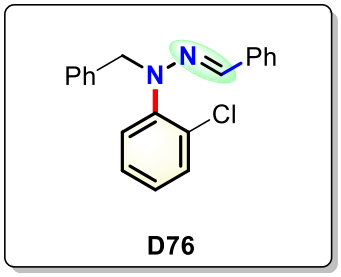
**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.56 – 7.49 (m, 3H), 7.31 (dd, *J* = 15.6, 7.5, 5.7 Hz, 7H), 7.26 – 7.19 (m, 2H), 7.16 – 7.10 (m, 1H), 7.10 – 7.04 (m, 2H), 5.02 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 155.81, 153.36, 136.83, 136.46, 136.38, 136.24, 134.80, 128.71, 128.51, 127.99, 127.17, 126.66, 126.16, 124.82, 124.75, 124.70, 124.68, 124.63, 124.60, 116.73, 116.52, 56.48 ppm.

**$^{19}$F NMR** (377 MHz, 23.0 °C, $CDCl_3$) δ -122.78 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}FN_2$ [M+H]: 305.1454, found: 305.1455.

**Elemental Analysis** calcd for $C_{20}H_{17}FN_2$: C, 78.92; H, 5.63; F, 6.24; N, 9.20; found: C, 78.91; H, 5.61; N, 9.22.




D76

**1-benzyl-2-benzylidene-1-(2-chlorophenyl)hydrazine (D76)**

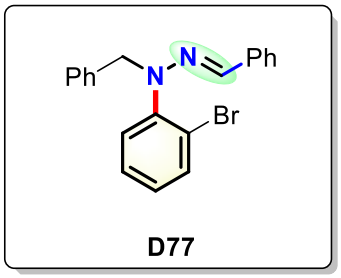
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 117.1 mg, 73% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.51 (d, *J* = 7.2 Hz, 2H), 7.42 (dd, *J* = 8.0, 1.3 Hz, 1H), 7.38 (d, *J* = 7.4 Hz, 2H), 7.33 – 7.17 (m, 9H), 7.12 (t, *J* = 7.9, 1.8 Hz, 1H), 4.94 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 144.74, 137.18, 136.27, 135.50, 130.71, 130.09, 128.52, 128.50, 127.95, 127.84, 127.69, 127.55, 127.18, 126.86, 126.12, 58.27 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}ClN_2$ [M+H]: 321.1159, found: 321.1155.

**Elemental Analysis** calcd for $C_{20}H_{17}ClN_2$: C, 74.88; H, 5.34; Cl, 11.05; N, 8.73; found: C, 74.87; H, 5.37; N, 8.72.




D77

**1-benzyl-2-benzylidene-1-(2-bromophenyl)hydrazine (D77)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 122.4 mg, 67% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

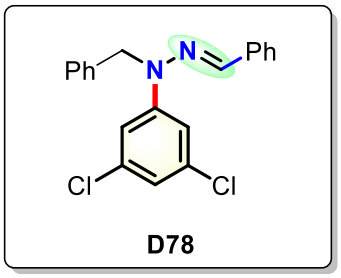
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.65 (dd, *J* = 8.0, 1.3 Hz, 1H), 7.55 – 7.49 (m, 2H), 7.40 (d, *J* = 7.3 Hz, 2H), 7.32 – 7.19 (m, 8H), 7.16 (s, 1H), 7.09 (t, *J* = 7.9, 1.6 Hz,

1H), 4.94 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 145.69, 137.19, 136.24, 135.47, 133.87, 128.45, 128.44, 128.41, 128.35, 127.87, 127.55, 127.15, 126.05, 121.11, 58.77 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{18}BrN_2$ [M+H]: 365.0653, found: 365.0653.

**Elemental Analysis** calcd for $C_{20}H_{17}BrN_2$: C, 65.76; H, 4.69; Br, 21.88; N, 7.67; found: C, 65.72; H, 4.64; N, 7.63.



**D78**

**1-benzyl-2-benzylidene-1-(3,5-dichlorophenyl)hydrazine (D78)**

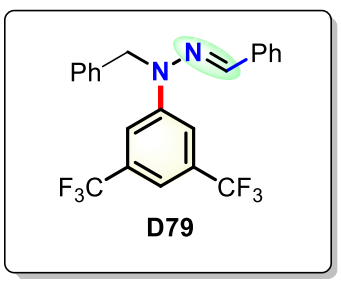
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 152.8 mg, 86% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.58 (d, $J$ = 7.2 Hz, 2H), 7.39 (s, 1H), 7.31 (t, $J$ = 7.4 Hz, 4H), 7.28 – 7.22 (m, 4H), 7.14 (t, $J$ = 6.8 Hz, 2H), 6.87 (t, $J$ = 1.6 Hz, 1H), 5.04 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 149.36, 135.66, 135.60, 135.08, 134.54, 129.33, 128.80, 128.73, 127.77, 126.69, 125.91, 120.21, 112.84, 50.04 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{17}Cl_2N_2$ [M+H]: 355.0769, found: 355.0767.

**Elemental Analysis** calcd for $C_{20}H_{16}Cl_2N_2$: C, 67.62; H, 4.54; Cl, 19.96; N, 7.89; found: C, 67.63; H, 4.55; N, 7.84.



**D79**

**1-benzyl-2-benzylidene-1-(3,5-bis(trifluoromethyl)phenyl)hydrazine (D79)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 192.2 mg, 91% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

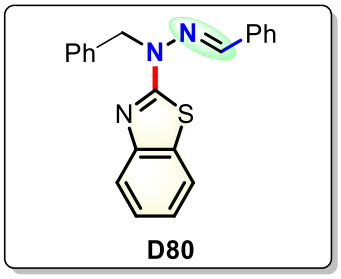
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.78 (s, 2H), 7.65 – 7.60 (m, 2H), 7.52 (s, 1H), 7.40 (s, 1H), 7.38 (s, 1H), 7.35 (d, *J* = 7.7 Hz, 3H), 7.33 – 7.27 (m, 2H), 7.20 (d, *J* = 7.2 Hz, 2H), 5.20 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 148.60, 136.00, 135.35, 134.14, 133.00, 132.67, 132.34, 132.02, 129.39, 129.03, 128.76, 127.90, 127.65, 126.72, 125.81, 124.94, 122.23, 119.52, 113.87, 113.84, 113.50, 113.46, 113.42, 113.38, 113.35, 50.03 ppm.

**$^{19}$F NMR** (377 MHz, 23.0 °C, $CDCl_3$) δ -62.88 ppm.

**HRMS** (ESI) calcd. for $C_{22}H_{17}F_6N_2$ [M+H]: 423.1296, found: 423.1299.

**Elemental Analysis** calcd for $C_{22}H_{16}F_6N_2$: C, 62.56; H, 3.82; F, 26.99; N, 6.63; found: C, 62.53; H, 3.83; N, 6.65.




**D80**

**2-(1-benzyl-2-benzylidenehydrazineyl)benzo[d]thiazole (D80)**

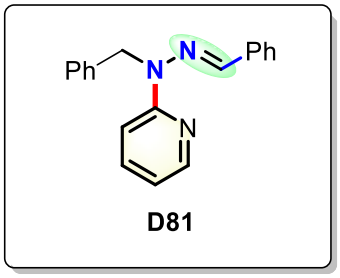
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 138.9 mg, 81% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.70 (d, *J* = 7.7 Hz, 1H), 7.67 – 7.56 (m, 4H), 7.38 – 7.21 (m, 10H), 7.16 (t, *J* = 7.9 Hz, 1H), 5.59 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 169.69, 152.22, 138.19, 134.49, 132.79, 129.50, 129.07, 128.71, 127.63, 126.94, 126.49, 125.82, 122.38, 120.97, 120.42, 49.25 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{18}N_3S$ [M+H]: 344.1221, found: 344.1223.

**Elemental Analysis** calcd for $C_{21}H_{17}N_3S$: C, 73.44; H, 4.99; N, 12.24; S, 9.33; found: C, 73.45; H, 4.96; N, 12.22.




**D81**

**2-(1-benzyl-2-benzylidenehydrazineyl)pyridine (D81)**

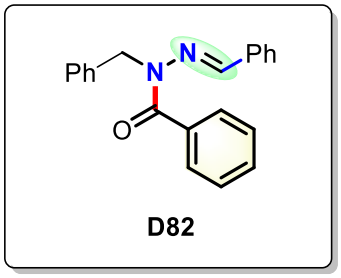
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 133.6 mg, 93% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 8.21 (dd, $J$ = 5.4, 1.2 Hz, 1H), 7.84 (d, $J$ = 8.6 Hz, 1H), 7.68 – 7.58 (m, 3H), 7.52 (s, 1H), 7.36 – 7.17 (m, 8H), 6.80 (t, $J$ = 7.0, 5.0, 0.8 Hz, 1H), 5.62 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 157.87, 147.32, 137.69, 136.38, 136.10, 135.09, 128.84, 128.58, 128.38, 126.99, 126.43, 126.35, 115.89, 109.68, 46.14 ppm.

**HRMS** (ESI) calcd. for $C_{19}H_{18}N_3$ [M+H]: 288.1501, found: 288.1501.

**Elemental Analysis** calcd for $C_{19}H_{17}N_3$: C, 79.41; H, 5.96; N, 14.62; found: C, 79.44; H, 5.94; N, 14.61.




**D82**

**N-benzyl-N'-benzylidenebenzohydrazide (D82)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 100.5 mg, 64% yield. Purification by

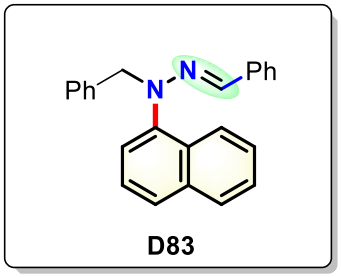
column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.89 – 7.77 (m, 2H), 7.68 (s, 1H), 7.55 – 7.40 (m, 3H), 7.41 – 7.19 (m, 10H), 5.43 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 171.51, 140.20, 135.19, 135.08, 134.62, 130.51, 130.05, 129.69, 129.10, 128.68, 127.54, 127.52, 127.23, 126.50, 45.54 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{19}N_2O$ [M+H]: 315.1497, found: 315.1498.

**Elemental Analysis** calcd for $C_{21}H_{18}N_2O$: C, 80.23; H, 5.77; N, 8.91; O, 5.09; found: C, 80.20; H, 5.76; N, 8.94.




D83

**1-benzyl-2-benzylidene-1-(naphthalen-1-yl)hydrazine (D83)**

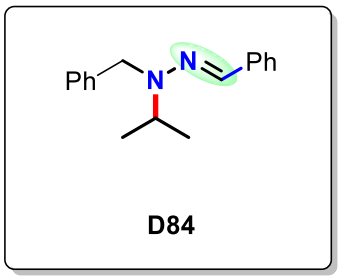
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 122.8 mg, 73% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 8.04 (d, $J$ = 8.2 Hz, 1H), 7.88 (d, $J$ = 7.6 Hz, 1H), 7.75 (d, $J$ = 8.2 Hz, 1H), 7.51 – 7.39 (m, 7H), 7.34 – 7.23 (m, 6H), 7.21 – 7.16 (m, 1H), 7.06 (s, 1H), 5.06 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 143.49, 138.27, 136.83, 135.02, 134.95, 130.10, 128.76, 128.70, 128.67, 128.22, 127.80, 127.42, 127.21, 126.69, 126.46, 126.13, 126.10, 124.20, 123.72, 60.51 ppm.

**HRMS** (ESI) calcd. for $C_{24}H_{21}N_2$ [M+H]: 337.1705, found: 337.1704.

**Elemental Analysis** calcd for $C_{24}H_{20}N_2$: C, 85.68; H, 5.99; N, 8.33; found: C, 85.64; H, 5.94; N, 8.35.




D84

**1-benzyl-2-benzylidene-1-isopropylhydrazine (D84)**

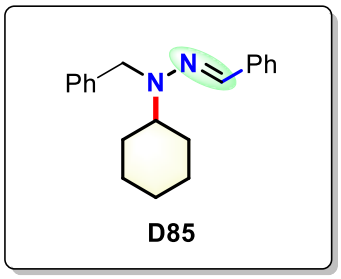
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 64.3 mg, 51% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.49 – 7.43 (m, 2H), 7.33 – 7.23 (m, 7H), 7.14 (t, *J* = 7.3 Hz, 1H), 7.07 (s, 1H), 4.36 (s, 2H), 3.80 (t, *J* = 6.6 Hz, 1H), 1.29 (d, *J* = 6.6 Hz, 6H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 138.19, 137.51, 130.69, 128.70, 128.33, 126.86, 126.80, 126.43, 125.32, 57.76, 52.61, 20.41 ppm.

**HRMS** (ESI) calcd. for $C_{17}H_{21}N_2$ [M+H]: 253.1705, found: 253.1706.

**Elemental Analysis** calcd for $C_{17}H_{20}N_2$: C, 80.91; H, 7.99; N, 11.10; found: C, 80.96; H, 7.95; N, 11.12.




D85

**1-benzyl-2-benzylidene-1-cyclohexylhydrazine (D85)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 81.8 mg, 56% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

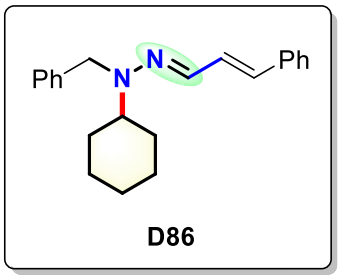
**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.47 – 7.42 (m, 2H), 7.35 – 7.22 (m, 7H), 7.16 – 7.09 (m, 1H), 7.03 (s, 1H), 4.44 (s, 2H), 3.36 (t, *J* = 11.6, 3.7 Hz, 1H), 2.05 – 1.97 (m, 2H), 1.84 (d, *J* = 13.2 Hz, 2H), 1.66 (d, *J* = 14.3 Hz, 1H), 1.58 (t, *J* = 12.3, 3.4 Hz, 2H),

1.38 – 1.28 (m, 2H), 1.18 (t, $J$ = 12.8, 3.4 Hz, 1H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 138.25, 137.66, 129.66, 128.65, 128.31, 126.80, 126.59, 126.36, 125.23, 66.30, 52.97, 31.27, 25.91 ppm.

**HRMS** (ESI) calcd. for $C_{20}H_{25}N_2$ [M+H]: 293.2018, found: 293.2017.

**Elemental Analysis** calcd for $C_{20}H_{24}N_2$: C, 82.15; H, 8.27; N, 9.58; found: C, 82.14; H, 8.23; N, 9.56.




D86

**2-((*E*)-benzylidene)-1-cinnamyl-1-cyclohexylhydrazine (D86)**

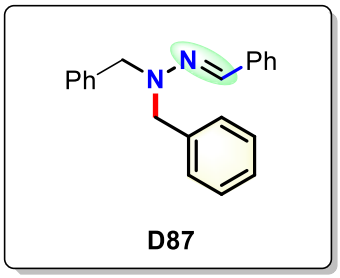
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 79.6 mg, 50% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, $CDCl_3$) δ 7.57 – 7.47 (m, 2H), 7.39 – 7.10 (m, 9H), 6.58 – 6.49 (m, 1H), 6.29 – 6.17 (m, 1H), 4.07 – 3.96 (m, 2H), 3.38 – 3.22 (m, 1H), 2.02 – 1.90 (m, 2H), 1.88 – 1.78 (m, 2H), 1.72 – 1.48 (m, 3H), 1.42 – 1.06 (m, 3H).

**$^{13}$C NMR** (101 MHz, $CDCl_3$) δ 137.8, 137.0, 130.8, 129.4, 128.6, 128.4, 127.4, 126.6, 126.3, 125.3, 125.2, 65.7, 50.6, 31.3, 26.0.

**HRMS** (ESI) calcd. for $C_{22}H_{27}N_2$ [M+H]: 319.2169, found: 319.2170.

**Elemental Analysis** calcd for $C_{22}H_{26}N_2$: C.97; H, 8.23; N, 8.80; found: C, 82.94; H, 8.22; N, 8.82.




D87

**1,1-dibenzyl-2-benzylidenehydrazine (D87)**

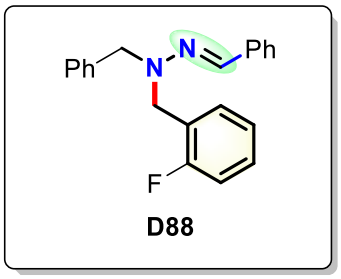
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 109.6 mg, 73% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.49 (d, *J* = 7.3 Hz, 2H), 7.34 – 7.25 (m, 10H), 7.24 – 7.16 (m, 3H), 4.51 (s, 4H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 137.67, 137.01, 131.88, 128.63, 128.49, 127.87, 127.71, 127.26, 125.62, 57.96 ppm.

**HRMS** (ESI) calcd. for $C_{21}H_{21}N_2$ [M+H]: 301.1705, found: 301.1704.

**Elemental Analysis** calcd for $C_{21}H_{20}N_2$: C, 83.96; H, 6.71; N, 9.33; found: C, 83.94; H, 6.73; N, 9.32.




**D88**

**2-((*E*)-benzylidene)-1-cinnamyl-1-(2-fluorobenzyl)hydrazine (D88)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 119.3 mg, 75% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

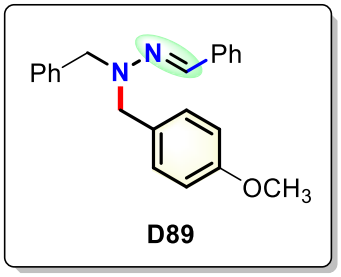
**$^{1}$H NMR** (400 MHz, $CDCl_3$) δ 7.52 (d, *J* = 7.2 Hz, 2H), 7.39 – 7.21 (m, 8H), 7.20 – 7.10 (m, 3H), 7.08 – 6.95 (m, 2H), 6.49 (d, *J* = 16.0 Hz, 1H), 6.31 – 6.15 (m, 1H), 4.56 (s, 2H), 4.16 – 4.03 (m, 2H).

**$^{13}$C NMR** (101 MHz, $CDCl_3$) δ 162.0, 159.6, 137.1, 137.0, 132.8, 132.3, 130.2, 129.1, 129.0, 128.8, 128.7, 127.8, 127.5, 126.6, 125.8, 125.0, 124.8, 124.4, 124.4, 115.6, 115.4, 56.5, 51.0.

**$^{19}$F NMR** (376 MHz, CDCl3) δ = -117.8.

**HRMS** (ESI) calcd. for $C_{23}H_{21}FN_2$ [M+H]: 345.1761, found: 345.1762.

**Elemental Analysis** calcd for $C_{23}H_{20}FN_2$: C, 79.22; H, 6.02; F, 5.97; N, 8.80; found: C, 79.25; H, 6.04; N, 8.84.




D89

**2-((*E*)-benzylidene)-1-cinnamyl-1-(4-methoxybenzyl)hydrazine (D89)**

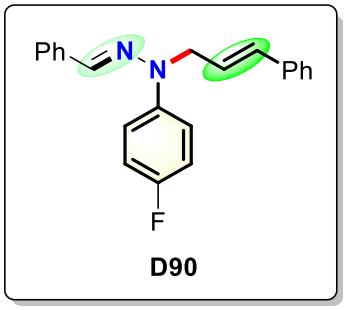
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 117.2 mg, 71% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^1$H NMR** (400 MHz, $CDCl_3$) δ 7.60 – 7.47 (m, 2H), 7.38 – 7.11 (m, 11H), 6.87 – 6.78 (m, 2H), 6.52 – 6.39 (m, 1H), 6.28 – 6.15 (m, 1H), 4.45 (s, 2H), 4.08 – 3.98 (m, 2H), 3.72 (s, 3H).

**$^{13}$C NMR** (101 MHz, $CDCl_3$) δ 156.0, 137.2, 137.0, 132.6, 132.1, 129.8, 129.1, 128.7, 128.6, 127.7, 127.4, 126.5, 125.7, 125.1, 114.1, 57.3, 55.5, 55.4.

**HRMS** (ESI) calcd. for $C_{24}H_{25}N_2O$ [M+H]: 357.1961, found: 357.1961.

**Elemental Analysis** calcd for $C_{24}H_{24}N_2O$: C, 79.97; H, 6.71; N, 8.48; O, 4.84; found: C, 79.96; H, 6.74; N, 8.42.




D90

**2-(benzylidene)-1-cinnamyl-1-(4-fluorophenyl)hydrazine (D90)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 189.2 mg, 74% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

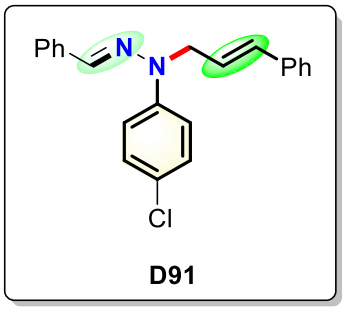
**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.43 (s, 1H), 7.37 – 7.12 (m, 8H), 7.08 – 6.93 (m, 3H), 6.40 (d, $J$ = 16.1 Hz, 1H), 6.29 – 6.09 (m, 2H), 4.72 – 4.45 (m, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 159.07, 156.70, 144.20, 144.18, 136.58, 136.35, 132.60, 131.47, 128.71, 128.64, 128.04, 127.90, 126.51, 126.26, 121.68, 116.31, 116.24, 115.82, 115.60, 49.08 ppm.

**$^{19}$F NMR** (377 MHz, 23.0 °C, $CDCl_3$) δ -123.94 ppm.

**HRMS** (ESI) calcd. for $C_{22}H_{20}FN_2$ [M+H]: 331.1610, found: 331.1613.

**Elemental Analysis** calcd for $C_{22}H_{19}FN_2$: C, 79.97; H, 5.80; F, 5.75; N, 8.48; found: C, 79.94; H, 5.82; N, 8.45.




**D91**

**2-(benzylidene)-1-(4-chlorophenyl)-1-cinnamylhydrazine (D91)**

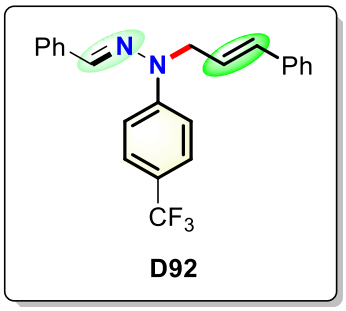
The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 140.5 mg, 81% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.77 – 7.57 (m, 2H), 7.47 (s, 1H), 7.42 – 7.04 (m, 12H), 6.38 (d, $J$ = 16.1, 2.0 Hz, 1H), 6.18 (d, $J$ = 16.0, 4.0 Hz, 1H), 4.59 (dd, $J$ = 4.0, 2.0 Hz, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 146.21, 136.36, 136.25, 133.20, 131.53, 129.09, 128.72, 128.70, 128.25, 127.93, 126.50, 126.46, 126.39, 125.58, 121.31, 115.95, 48.36 ppm.

**HRMS** (ESI) calcd. for $C_{22}H_{20}ClN_2$ [M+H]: 347.1315, found: 347.1316.

**Elemental Analysis** calcd for $C_{22}H_{19}ClN_2$: C, 76.18; H, 5.52; Cl, 10.22; N, 8.08; found: C, 76.14; H, 5.55; N, 8.03.




**D92**

**2-(benzylidene)-1-cinnamyl-1-(4-(trifluoromethoxy)phenyl)hydrazine (D92)**

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 171.1 mg, 90% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 20 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.66 (d, *J* = 7.7 Hz, 1H), 7.48 (s, 1H), 7.42 – 7.05 (m, 9H), 6.39 (d, *J* = 16.0 Hz, 1H), 6.19 (d, *J* = 16.0, 4.0 Hz, 2H), 4.78 – 4.43 (m, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 146.34, 142.99, 142.98, 136.33, 136.24, 133.44, 131.59, 128.73, 128.72, 128.32, 127.97, 126.51, 126.41, 122.16, 122.10, 121.26, 115.44, 48.44 ppm.

**$^{19}$F NMR** (377 MHz, 23.0 °C, $CDCl_3$) δ -58.05 ppm.

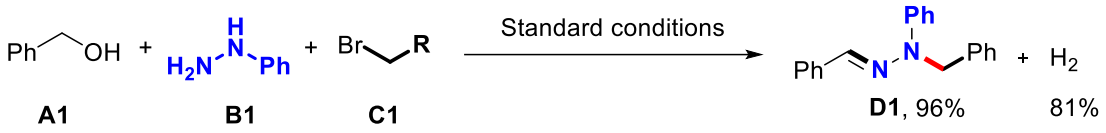
**HRMS** (ESI) calcd. for $C_{23}H_{20}F_3N_2O$ [M+H]: 397.1528, found: 397.1527.

**Elemental Analysis** calcd for $C_{23}H_{19}F_3N_2O$: C, 69.69; H, 4.83; F, 14.38; N, 7.07; O, 4.04; found: C, 69.66; H, 4.86; N, 7.05.

# 6. Mechanism investigations

## 6.1 Control experiments

### 6.1.1




Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), **A1** (0.8 mmol), **B1** (0.5 mmol), **C1** (0.7 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

### 6.1.2


Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), **A1** (0.8 mmol), **B1** (0.5 mmol), **C1** (0.7 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

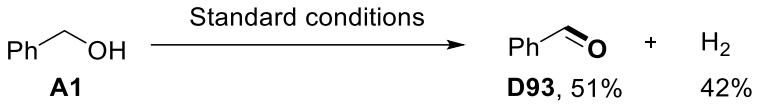
## 6.1.3


Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), $^tBuOK$ (1.0 mmol), **A1** (0.8 mmol), **B1** (0.5 mmol), **C1** (0.7 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

## 6.1.4

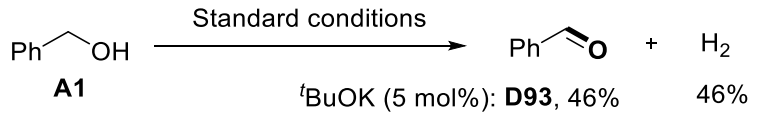

Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), **A1** (0.8 mmol), **B1** (0.5 mmol), **C1** (0.7 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

## 6.1.5




Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), **A1** (0.8 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 $^o$C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

## 6.1.6

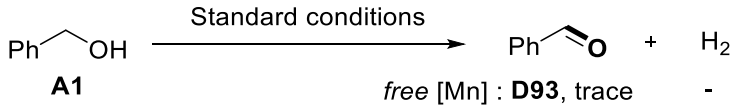



Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (0.025 mmol), **A1** (0.8 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 $^o$C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

## 6.1.7

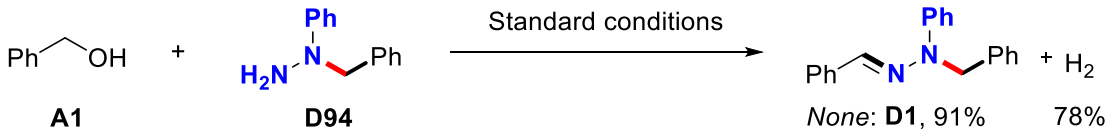

Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), $^tBuOK$ (1.0 mmol), **A1** (0.8 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

## 6.1.8




Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, **L11** (1.2 mol%), $^tBuOK$ (1.0 mmol), **A1** (0.8 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

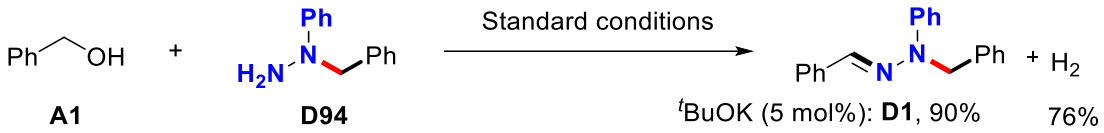
## 6.2.1




Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^tBuOK$ (1.0 mmol), **A1** (0.8 mmol), **D94** (0.5 mmol) and THF (3 mL). Then the seal tube was

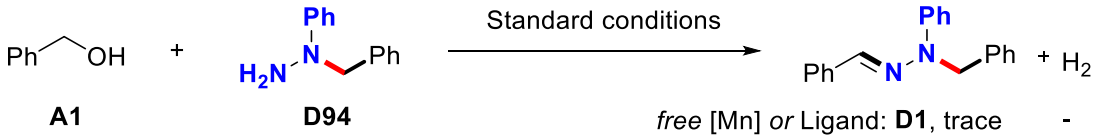
closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

## 6.2.2




Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), **A1** (0.8 mmol), **D94** (0.5 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

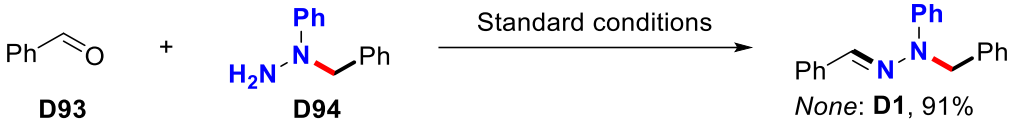
## 6.2.3




Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), **A1** (0.8 mmol), **D94** (0.5 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic

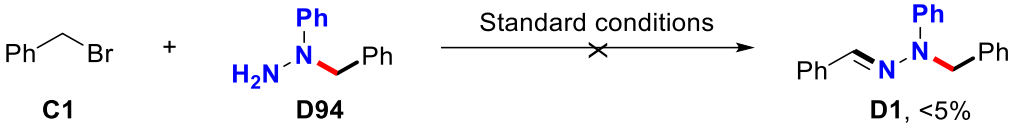
phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

## 6.2.4



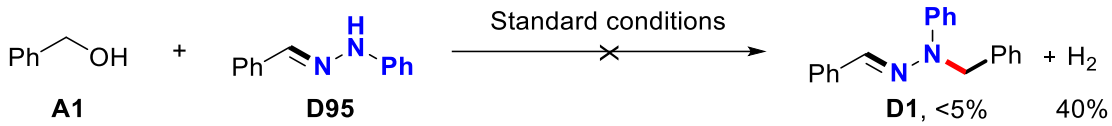

Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), **D93** (0.8 mmol), **D94** (0.5 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

## 6.2.5




Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), **A1** (0.8 mmol), **D94** (0.5 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

## 6.2.6




Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), **A1** (0.8 mmol), **D95** (0.5 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

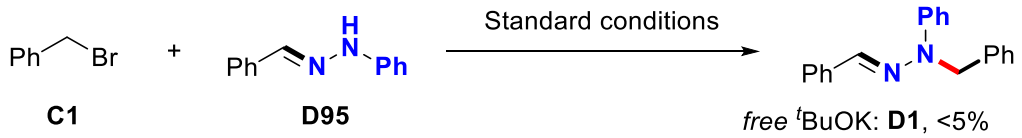
## 6.2.7


Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), **C1** (0.8 mmol), **D95** (0.5 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

## 6.2.8


Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), **C1** (0.8 mmol), **D95** (0.5 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

## 6.2.9




Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), **C1** (0.8 mmol), **D95** (0.5 mmol) and **C1** (0.7 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

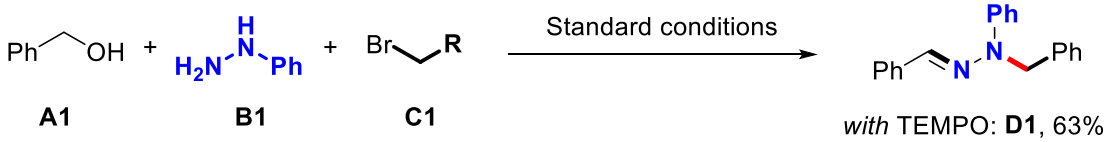
## 6.2.10


Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), mercury (2 drops), **A1** (0.8 mmol), **B1** (0.5 mmol), **C1** (0.7 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

## 6.2.11


Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), $(O)PPh_3$ (1.0 mmol) **A1** (0.8 mmol), **B1** (0.5 mmol), **C1** (0.7 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

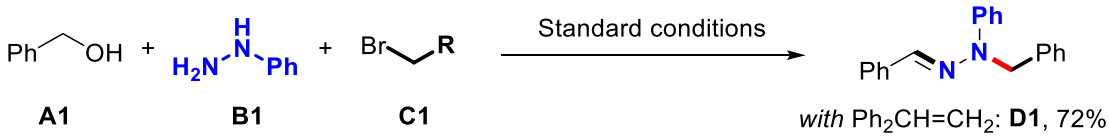
## 6.2.12




Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was

charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), TEMPO (1.0 mmol), **A1** (0.8 mmol), **B1** (0.5 mmol), **C1** (0.7 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

## 6.2.13



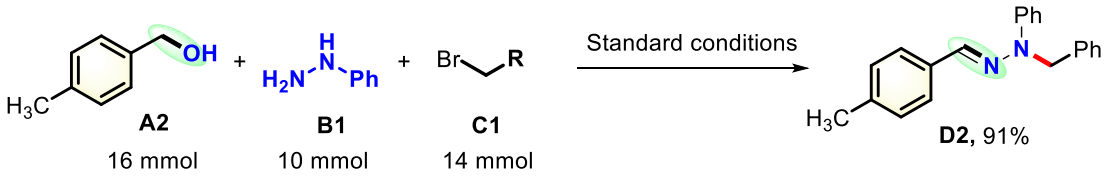

Using a nitrogen-filled glove box, an oven-dried pressure tube (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (1.0 mmol), $Ph_2CHCH_2$ (1.0 mmol), **A1** (0.8 mmol), **B1** (0.5 mmol) and **C1** (0.7 mmol) and THF (3 mL). Then the seal tube was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) for design time. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation in the reported yield.

# 7. Gram-Scale Synthesis

## 7.1 Gram-Scale Synthesis of D1


Using a nitrogen-filled glove box, an oven-dried Schlenk Flask (1000 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (100.0 mmol), **A1** (80 mmol), **B1** (50 mmol), **C1** (70 mmol) and THF (300 mL). Then the Schlenk Flask was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) condensation reflux 24 hours under $N_2$ atmosphere. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation. The solvent was evaporated under reduced pressure and the residue was purified by flash column chromatography (petroleum ether/dichloromethane = 20:1 – 5:1) on silica gel to give the desired product **D1** 11.88 g, the yield is 83%.

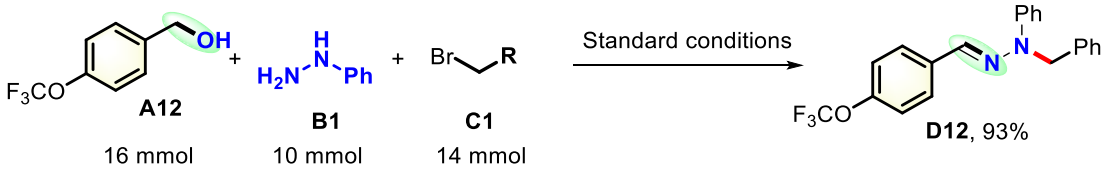
## 7.2 Gram-Scale Synthesis of D2




Using a nitrogen-filled glove box, an oven-dried Schlenk Flask (200 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (100.0 mmol), **A2** (16 mmol), **B1** (10 mmol), **C1** (14 mmol) and THF (60 mL). Then the Schlenk Flask was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) condensation reflux 24 hours under $N_2$ atmosphere. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas

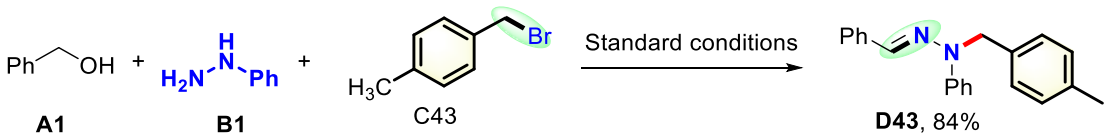
were analyzed by GC and GC-MS to monitor product formation. The solvent was evaporated under reduced pressure and the residue was purified by flash column chromatography (petroleum ether/dichloromethane = 20:1 – 5:1) on silica gel to give the desired product **D2** in 91% (2.73 g).

## 7.3 Gram-Scale Synthesis of D12




Using a nitrogen-filled glove box, an oven-dried Schlenk Flask (200 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (100.0 mmol), **A12** (16 mmol), **B1** (10 mmol), **C1** (14 mmol) and THF (60 mL). Then the Schlenk Flask was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) condensation reflux 24 hours under $N_2$ atmosphere. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation. The solvent was evaporated under reduced pressure and the residue was purified by flash column chromatography (petroleum ether/dichloromethane = 20:1 – 5:1) on silica gel to give the desired product **D12** in 93% (3.44 g).

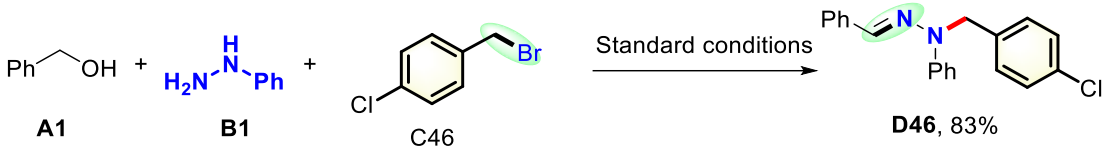
## 7.4 Gram-Scale Synthesis of D43




Using a nitrogen-filled glove box, an oven-dried Schlenk Flask (200 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (100.0 mmol), **A1** (16 mmol), **B1** (10 mmol), **C43** (14 mmol) and THF (60 mL). Then the Schlenk Flask was closed tightly with a teflon cap, removed from the glove

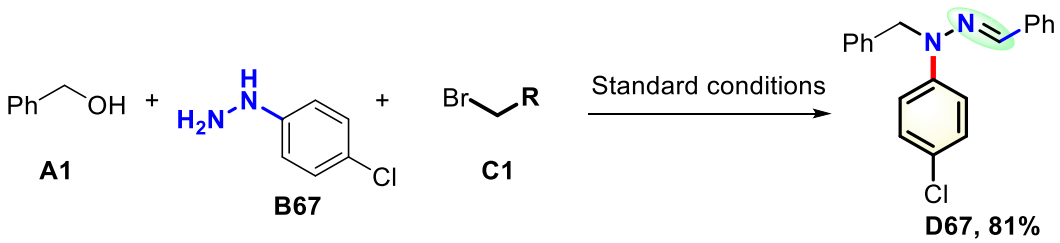
box and immersed into a pre-heated metal bath (100 °C) condensation reflux 24 hours under $N_2$ atmosphere. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation. The solvent was evaporated under reduced pressure and the residue was purified by flash column chromatography (petroleum ether/dichloromethane = 20:1 – 5:1) on silica gel to give the desired product **D43** in 84% (2.52 g).

## 7.5 Gram-Scale Synthesis of D46



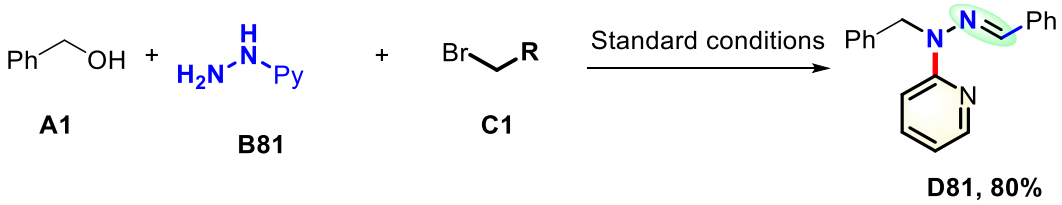

Using a nitrogen-filled glove box, an oven-dried Schlenk Flask (200 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (100.0 mmol), **A1** (16 mmol), **B1** (10 mmol), **C46** (14 mmol) and THF (60 mL). Then the Schlenk Flask was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) condensation reflux 24 hours under $N_2$ atmosphere. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation. The solvent was evaporated under reduced pressure and the residue was purified by flash column chromatography (petroleum ether/dichloromethane = 20:1 – 5:1) on silica gel to give the desired product **D46** in 84% (2.66 g).

## 7.6 Gram-Scale Synthesis of D67



Using a nitrogen-filled glove box, an oven-dried Schlenk Flask (200 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (100.0 mmol), **A1** (16 mmol), **B67**(10 mmol), **C1** (14 mmol) and THF (60 mL). Then the Schlenk Flask was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) condensation reflux 24 hours under $N_2$ atmosphere. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation. The solvent was evaporated under reduced pressure and the residue was purified by flash column chromatography (petroleum ether/dichloromethane = 20:1 – 5:1) on silica gel to give the desired product **D67** in 81% (2.59 g).

## 7.7 Gram-Scale Synthesis of D81




Using a nitrogen-filled glove box, an oven-dried Schlenk Flask (200 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (10.0 mmol), **A1** (16 mmol), **B81** (10 mmol), **C1** (14 mmol) and THF (60 mL). Then the Schlenk Flask was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) condensation reflux 24 hours under $N_2$ atmosphere. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase and gas were analyzed by GC and GC-MS to monitor product formation. The solvent was evaporated under reduced pressure and the residue was purified by flash column chromatography (petroleum ether/dichloromethane = 20:1 – 5:1) on silica gel to give the desired product **D81** in 80% (2.29 g).

## 8. Time-conversion-plot reaction


Using a nitrogen-filled glove box, an oven-dried Schlenk Flask (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^t$BuOK (10.0 mmol), **A1** (0.8 mmol), **B1**(0.5 mmol), **C1** (0.7 mmol) and THF (3 mL). Then the Schlenk Flask was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 °C) condensation reflux 24 hours under $N_2$ atmosphere. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase was analyzed by GC to monitor product formation. Composition of **D1**, **d93** and **D94** were determined by GC-analysis using *n*-Cetane as internal standard.

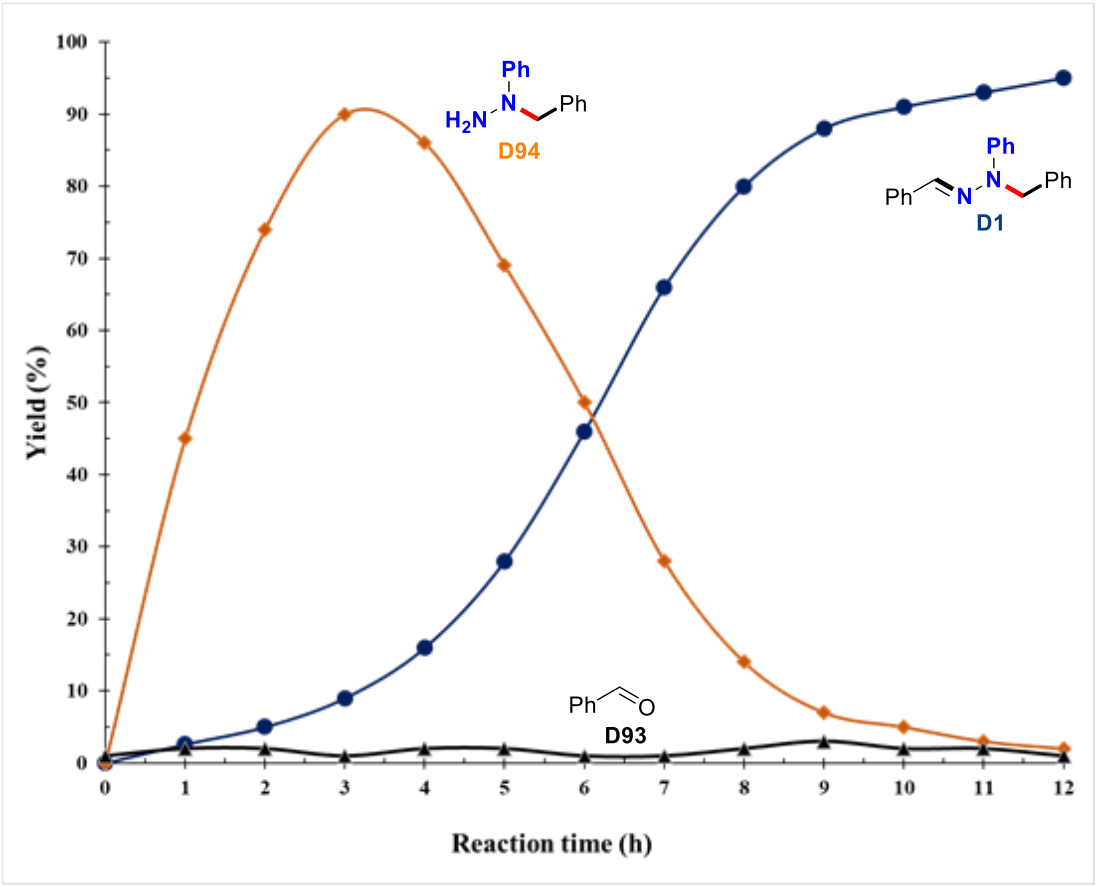
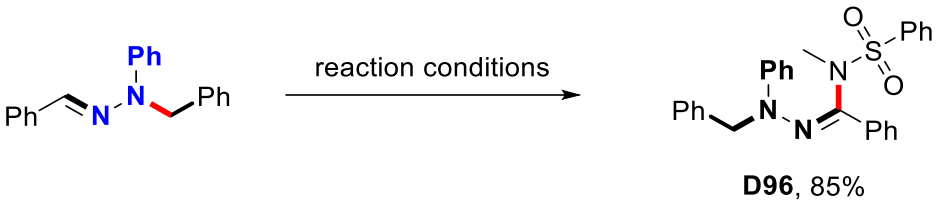


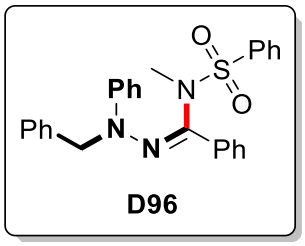

**Figure S4** Time-conversion-plot for the reaction

## 9. Possible reactions in combination with hydrazone

### 9.1 Synthesis of D96 from hydrazone D1




Using a nitrogen-filled glove box, an oven-dried yang-type tube (50 mL volume) was charged with a magnetic stirring bar, **D1** (0.1 mmol**)**, *N*-methyl-*N*-((phenylsulfonyl)oxy)benzenesulfonamide (0.2 mmol), fac-Ir(ppy)$_3$ (0.002 mmol), $Na_2HPO_4$ (0.2 mmol), and DCE (1.0 mL) were added in sequence under magnetic stirring. Then the seal tube was closed tightly with a teflon cap, immersed into a pre-cooled metal sand bath (25 °C) under visible-light irradiation. After 90 hours, a small aliquot of the organic phase was analyzed by GC and GC-MS to monitor product formation, respectively. Purification of the remainder by column chromatography on silica gel gave the corresponding product **D96** (pentane/ethyl acetate = 50/1-5/1) in the reported yield.



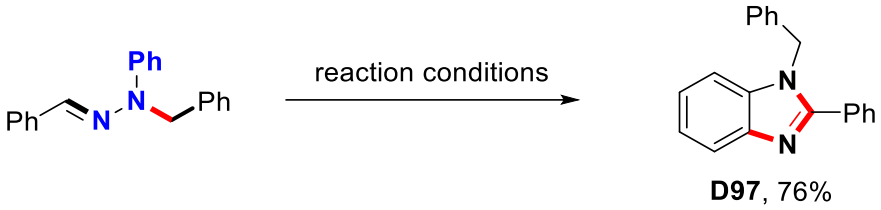

***N*'-benzyl-*N*-methyl-*N*'-phenyl-*N*-(phenylsulfonyl)benzohydrazonamide (Z:E = 1.9:1.0)**[3]

The title compound was prepared according to the general procedure and purified by column chromatography to give the yellow oil 38.7 mg, 85% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 50 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.89 (d, *J* = 8.4 Hz, 1.32H), 7.67 – 7.55 (m, 1.82H), 7.51 (d, *J* = 8.0 Hz, 1.45H), 7.45 – 7.36 (m, 1.55H), 7.30 – 7.17 (m, 6.98H), 7.17 – 7.04 (m, 3.85H), 6.99 – 6.92 (m, 1.63H), 6.83 (t, *J* = 4.4 Hz, 0.66H), 6.73 (d, *J* = 8.4 Hz, 1.26H), 4.99 (s, 0.68H), 4.43 (s, 1.31H), 3.07 (s, 1.95H), 2.79 (s, 1.04H) ppm.

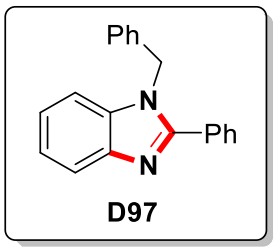
**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 157.34, 150.24, 149.28, 141.69, 139.09, 138.76, 137.51, 136.82, 135.04, 132.95, 132.81, 132.68, 129.90, 129.38, 128.81, 128.76, 128.64, 128.35, 128.29, 128.22, 128.03, 127.92, 127.83, 127.62, 126.92, 126.81, 60.06, 56.53, 37.98, 35.12 ppm.

### 9.2 Synthesis of D97 from hydrazone D1




**D97**, 76%

Under the nitrogen, an oven-dried yang-type tube (50 mL volume) was charged with a magnetic stirring bar, **D1** (0.5 mmol**)**, $Cu(OTf)_2$ (0.5 mmol**)** and toluene (2 mL) were added in sequence under magnetic stirring. Then the seal tube was closed tightly with a teflon cap, immersed into a pre-heated metal sand bath (110 °C). After 12 hours the reaction was cooled, a small aliquot of the organic phase was analyzed by GC and GC-MS to monitor product formation, respectively. Purification of the remainder by column chromatography on silica gel gave the corresponding product **D97** (pentane/ethyl acetate = 50/1-5/1) in the reported yield.



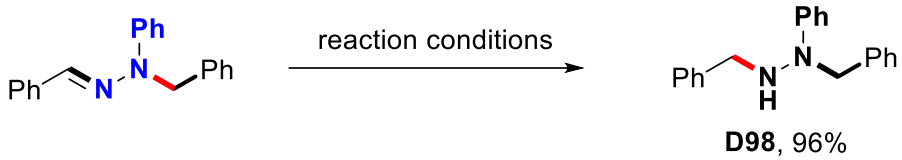

**1-benzyl-2-phenyl-1H-benzo[d]imidazole**[4]

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow soild 108.1 mg, 76% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 50 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.91 (d, $J$ = 8.0 Hz, 1H), 7.70 (d, $J$ = 7.6 Hz, 2H), 7.47 (d, $J$ = 7.2 Hz, 3H), 7.36-7.30 (m, 4H), 7.26-7.21 (m, 2H), 7.12 (d, $J$ = 6.8 Hz, 2H), 5.47 (s, 2H) ppm.

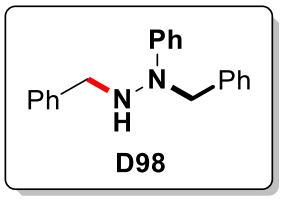
**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 154.32, 143.01, 136.53, 136.11, 132.72, 130.23, 129.51, 129.22, 128.93, 128.02, 126.11, 123.32, 123.01, 120.12, 110.71, 48.52 ppm.

### 9.3 Synthesis of D98 from hydrazone D1




**D98**, 96%

Under the nitrogen, an oven-dried yang-type tube (50 mL volume) was charged with a magnetic stirring bar, **D1** (0.5 mmol**)**, and EtOH (2 mL) were added in sequence under magnetic stirring. Then sodium amalgam (1.0 mmol) was added and the seal tube was closed tightly with a teflon cap, immersed into a pre-cooled metal sand bath (0 °C). After 12 hours the reaction was cooled, a small aliquot of the organic phase was analyzed by GC and GC-MS to monitor product formation, respectively. Purification of the remainder by column chromatography on silica gel gave the corresponding product **D98** (pentane/ethyl acetate = 50/1-5/1) in the reported yield.



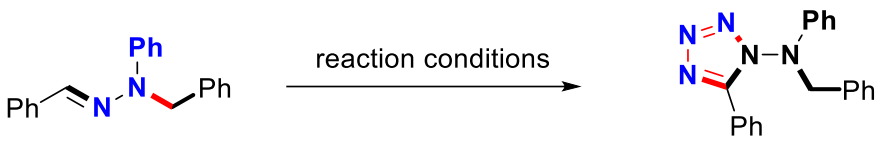

**1,2-dibenzyl-1-phenylhydrazine**[5]

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 138.4 mg, 96% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 50 : 1 – 5:1).

**$^{1}$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.20−7.35 (m, 9H), 7.02 (d, $J$ = 8.4 Hz, 2H), 6.77−6.88 (m, 4H), 5.68 (s, 1H), 4.77 (s, 2H) ppm.

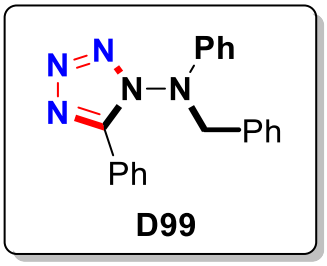
**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 151.72, 151.21, 140.52,129.62, 128.91, 126.53, 126.11, 123.33, 113.23, 65.52 ppm.

### 9.4 Synthesis of D99 from hydrazone D1




**D99**, 32%

An oven-dried three-necked round-bottomed flask (25 mL) was charged with hydrazone **D1** (0.5 mmol), $LiClO_4$ (0.5 mmol) and $TMSN_3$ (2.5 mmol). Then the flask was equipped with a condenser, a reticulated vitreous carbon (RVC) anode (100 PPI, 1 cm x 1 cm x 1 cm), and a platinum plate (1 cm x 1 cm) cathode. After MeOH (2 mL) and MeCN (4 mL) were added, the reaction mixture was stirred and electrolyzed at a constant current of 10 mA under 0 °C for 2 hours (2.5 F). When the reaction was finished, a small aliquot of the organic phase was analyzed by GC and GC-MS to monitor product formation, respectively. Purification of the remainder by column chromatography on silica gel gave the corresponding product **D99** (pentane/ethyl acetate = 50/1-5/1) in the reported yield.



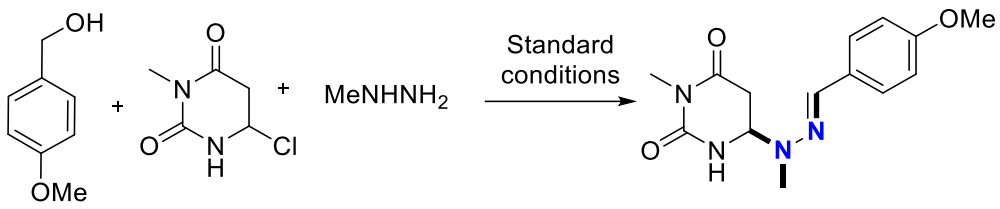

***N*-benzyl-*N*,5-diphenyl-1H-tetrazol-1-amine**[6]

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow soild 52.4 mg, 32% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 50 : 1 – 5:1).

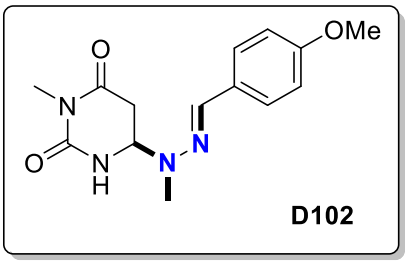
**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 7.72 (dd, *J* = 8.4, 1.2 Hz, 2H), 7.50 – 7.47 (m, 1H), 7.42 – 7.37 (m, 4H), 7.20 – 7.14 (m, 2H), 7.06 (dd, *J* = 8.4, 6.8 Hz, 2H), 6.99 (ddt, *J* = 8.8, 7.6, 1.2 Hz, 4H), 4.97 (s, 2H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 153.21, 147.62, 133.11, 131.42, 129.82, 129.21, 128.61, 128.41, 128.40, 124.12, 122.81, 117.00, 60.82 ppm.

### 9.5. Synthesis of D102



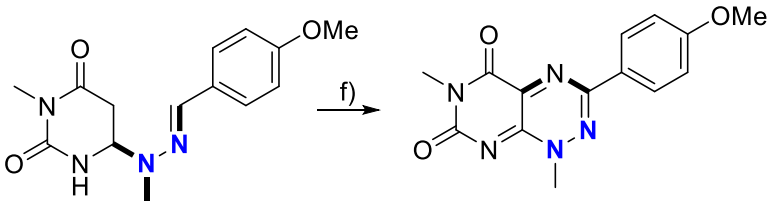

Using a nitrogen-filled glove box, an oven-dried Schlenk Flask (38 mL volume) was charged with a magnetic stirring bar, $MnBr(CO)_5$ (1.0 mol%), **L11** (1.2 mol%), $^tBuOK$ (1.0 mmol), $PMPCH_2OH$ (0.8 mmol), $MeNHNH_2$ (0.5 mmol), 6-chloro-3-methyldihydropyrimidine-2,4(1H,3H)-dione (0.5 mmol**)** (0.7 mmol) and THF (3 mL). Then the Schlenk Flask was closed tightly with a teflon cap, removed from the glove box and immersed into a pre-heated metal bath (100 ºC) condensation reflux 24 hours under $N_2$ atmosphere. After the reaction was finished, the reaction was analyzed by TLC to monitor product formation. Then a small aliquot of the organic phase was analyzed by GC and GC-MS to monitor product formation. Purification of the remainder by column chromatography on silica gel gave the corresponding product **D102** (pentane/ethyl acetate) in the reported yield.




**6-(2-(4-methoxybenzylidene)-1-methylhydrazinyl)-3-methyldihydropyrimidine-2,4(1H,3H)-dione**[7]

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow soild 124.8 mg, 86% yield. Purification by column chromatography on silica gel (pentane/ethyl ether = 50 : 1 – 1:1, $CH_3OH$ 5%). **$^1$H NMR** (400 MHz, 23.0 °C, DMSO-$d_6$) δ 10.62 (s, 1H), 7.90–7.97 (m, 3H), 6.99 (d, $J$ = 8.4 Hz, 2H), 5.18 (s, 1H), 3.81 (s, 3H), 3.12 (s, 3H), ppm.

**9.6 Synthesis of Toxoflavin D103**

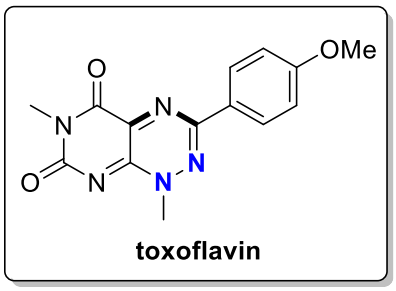



**D102**, 86%

**D103, toxoflavin**, 18%

**KDM4C** inhibitors

Using a nitrogen-filled glove box, an oven-dried pressure tube (50 mL volume) was charged with a magnetic stirring bar, **D102** (0.5 mmol**)**, $CH_3COOH$ (4 mL) and $H_2O$ (0.4 mL) were added in sequence under magnetic stirring. Then $NaNO_2$ (0.75 mmol) was added the seal tube was closed tightly with a teflon cap, removed from the glove box, immersed into a pre-cooled metal sand bath (0 °C). After 6 hours, the reaction mixture was diluted with water and extracted with DCM. Organic layers were combined, dried over sodium sulphate, filtered and evaporated under reduced pressure to obtain crude product. A small aliquot of the organic phase was analyzed by GC and GC-MS to monitor product formation. Purification of the remainder by column chromatography on silica gel gave the corresponding product **toxoflavin** (MeOH/EtOAc) in the reported yield.




**toxoflavin**

**3-(4-methoxyphenyl)-1,6-dimethylpyrimido[5,4-e][1,2,4]triazine-5,7(1H,6H)-dione**[7]

The title compound was prepared according to the general procedure and purified by column chromatography to give a yellow solid 26.9 mg, 18% yield. Purification by column chromatography on silica gel (MeOH/EtOAc = 50 : 1 – 5:1).

**$^1$H NMR** (400 MHz, 23.0 °C, $CDCl_3$) δ 8.13 (d, 2H, *J* = 8.4 Hz), 7.14 (d, 2H, *J* = 8.8 Hz), 4.03 (s, 3H), 3.85 (s, 3H), 3.27 (s, 3H) ppm.

**$^{13}$C NMR** (101 MHz, 23.0 °C, $CDCl_3$) δ 162.32, 159.51, 154.52, 151.71, 149.72,

146.81, 128.82, 125.52, 115.21, 55.92, 43.22, 28.73 ppm.

## 9. References


[1] C. Zhang, H. Zhao, Z. Li, Z. Liang, S. Qi, M. Cai, S. Zhang, X. Jia, G. Zhang and M. -L. Hu, *Chem. Commun*., 2020, **56**, 9521-9524.

[2] *a*) J.-R. Hu, W.-J. Zhang and D.-G. Zheng, *Tetrahedron*, 2013, **69**, 9865 – 9869; *b*) M. Taddei, M. G. Mura, S. Rajamäki, L. De Luca and P A. orcheddu, *Adv. Synth. Catal.,* 2013, **355**, 3002 – 3013.

[3] M. Zhang, Y. Duan, W. Li, P. Xu, J. Cheng, S. Yu and C. Zhu, *Org. Lett,* 2016, **18**, 5356 – 5359.

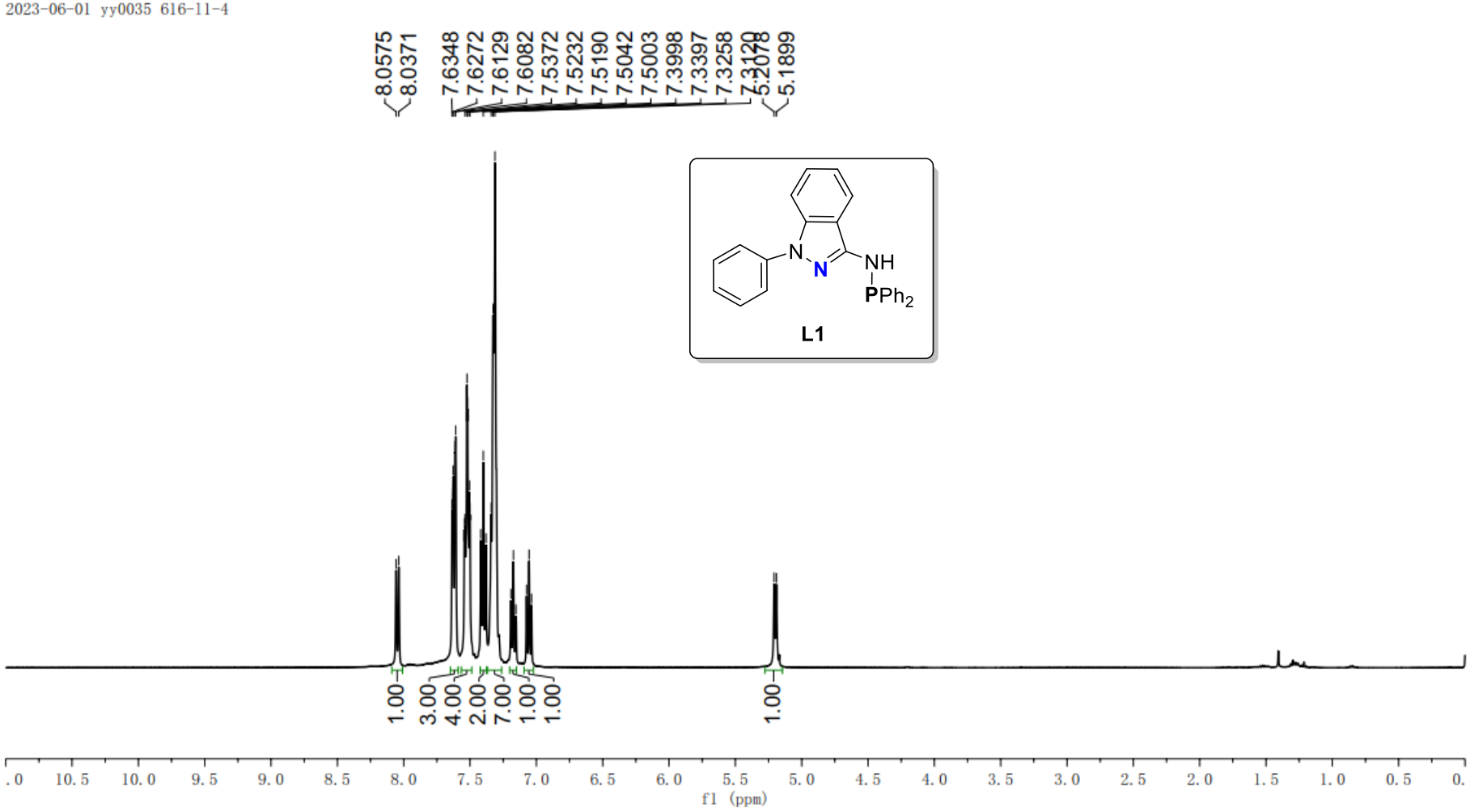
[4] M. M. Guru, M. A. Ali and T. Punniyamurthy, *J. Org. Chem.* 2011, **76**, 5295–5308.

[5] Y. Zhang, Q. Tang and M. Luo, *Org. Biomol. Chem.*, 2011, **9**, 4977-4982

[6] Z. Ye, F. Wang, Y. Li and F. Zhang, *Green Chem.*, 2018, **20**, 5271-5275.

[7] V. Letfus, D. Jelić, A. Bokulić, A. Petrinić and G. Koštrun, *Bioorgan. Med. Chem.*, 2020, **28***,* 115128.


## 10. NMR Spectra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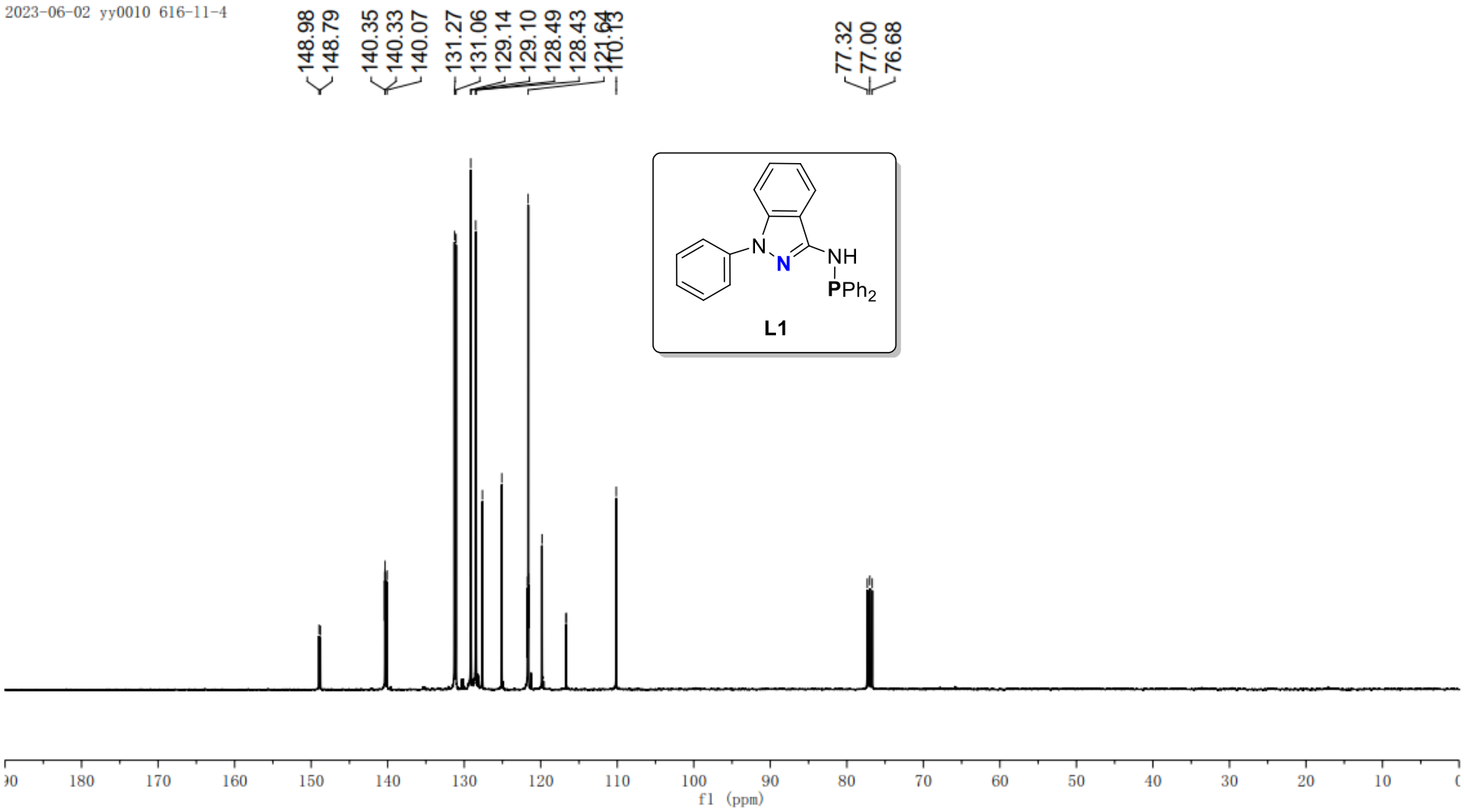
8.0371
7.6348
7.6272
7.6129
7.6082
7.5372
7.5232
7.5190
7.5042
7.5003
7.3998
7.3397
7.3258
5.2078
5.1899
N
N
NH
PPh2
L1
1.00
3.00
4.00
2.00
7.00
1.00
1.00
1.00
f1 (ppm)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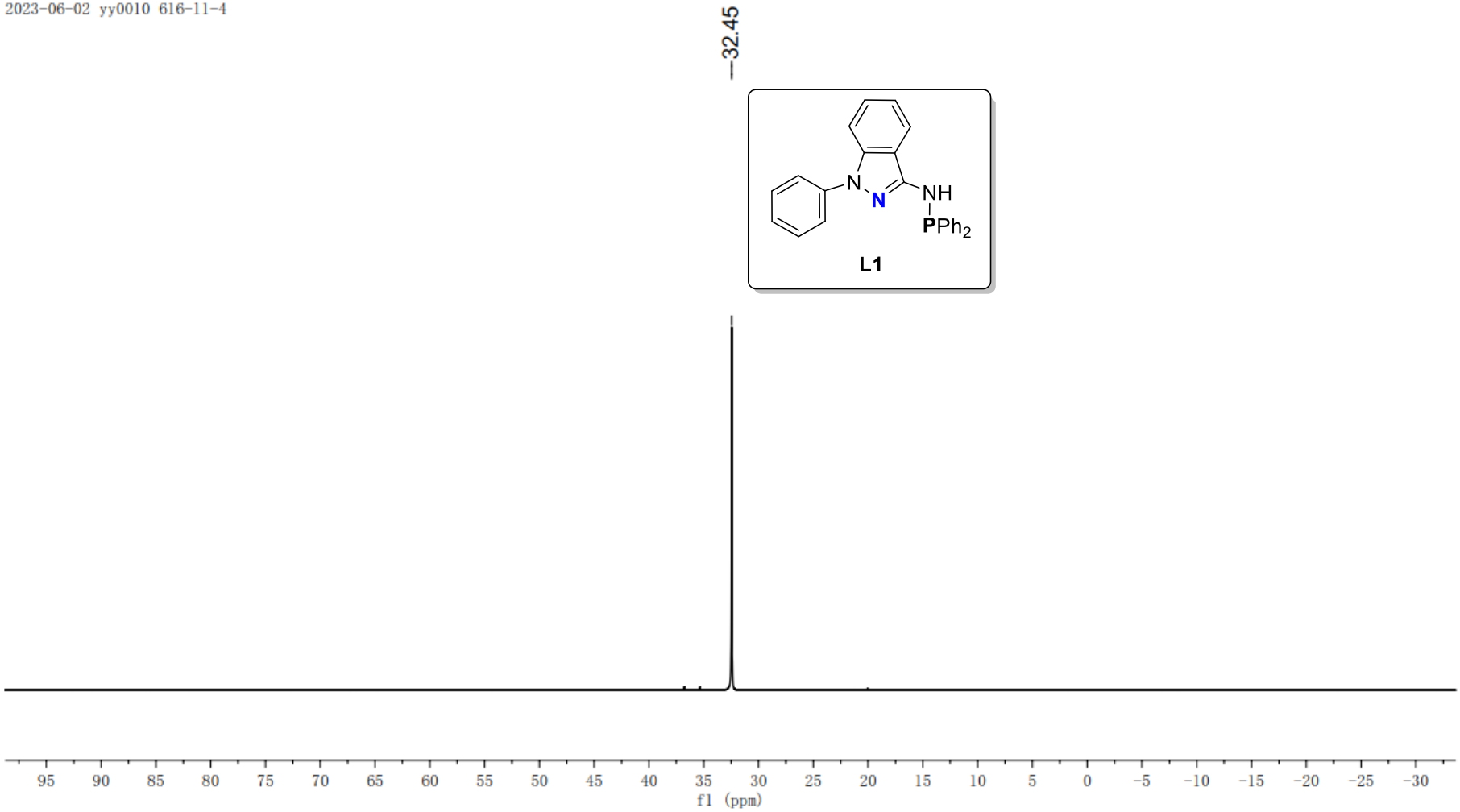
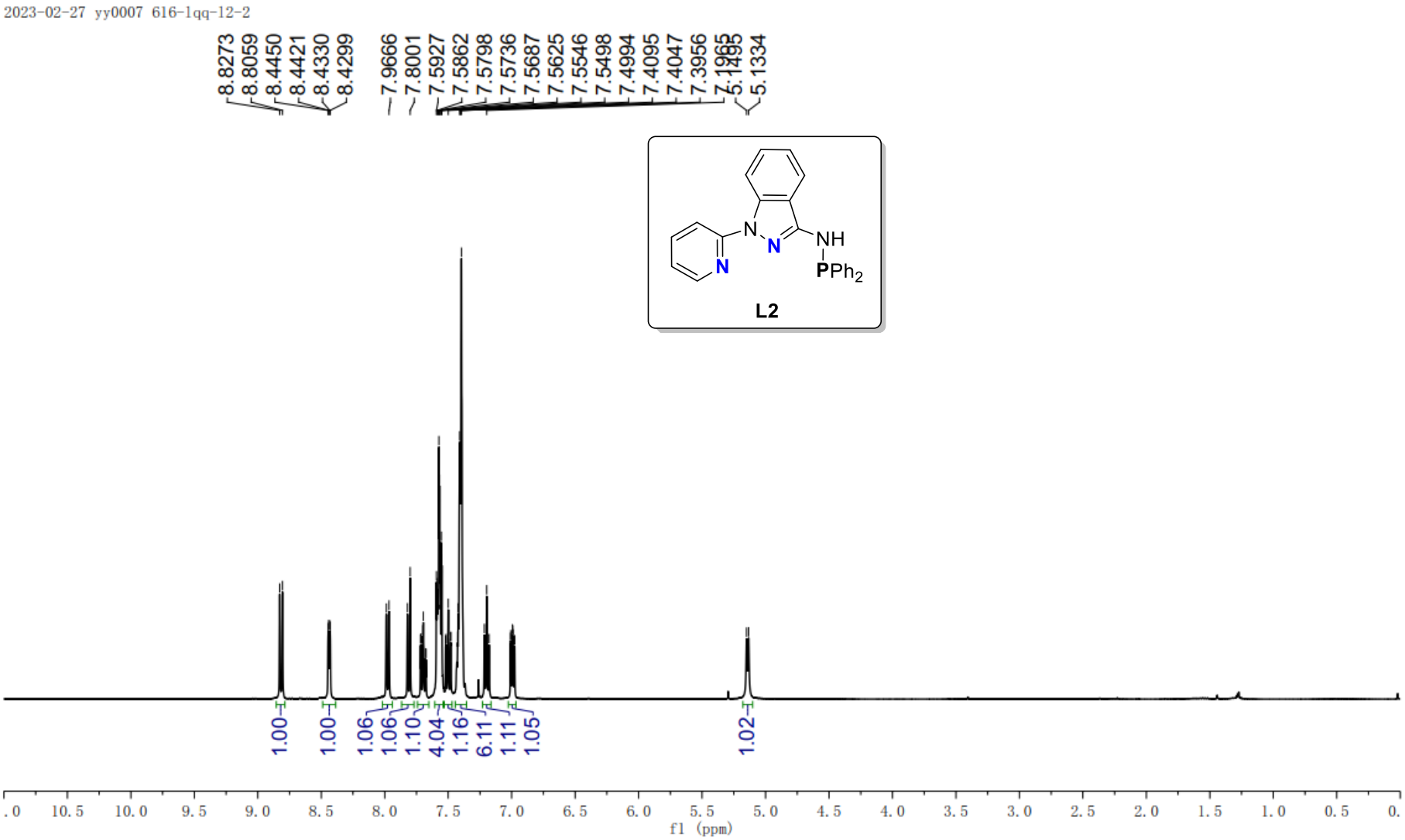
140.35
140.33
140.07
131.27
131.06
129.14
129.10
128.49
128.43
121.64
110.13
77.32
77.00
76.68
N
N
NH
PPh2
L1
f1 (ppm)

2023-06-02 yy0010 616-11-4




2023-02-27 yy0007 616-1qq-12-2
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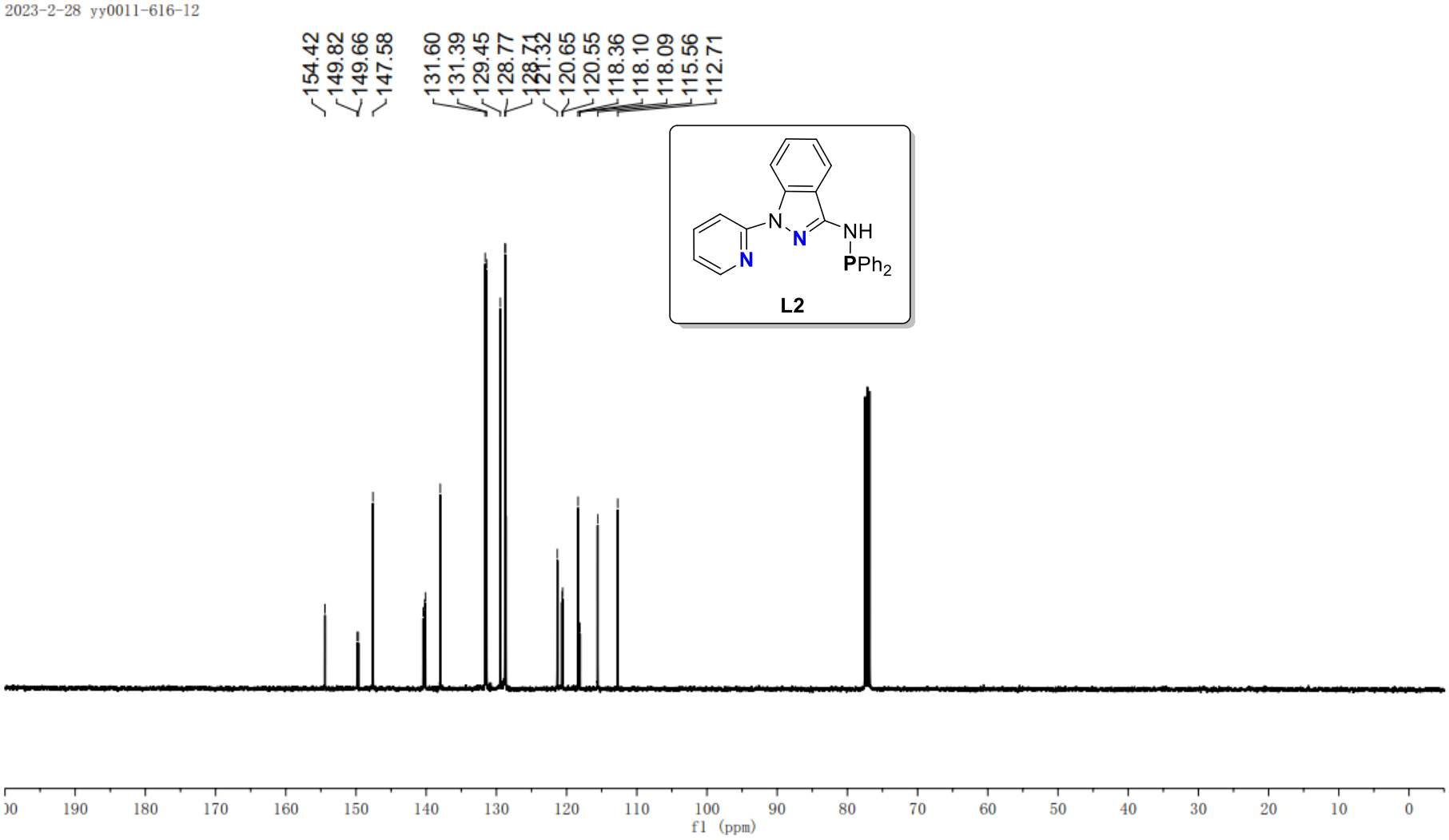
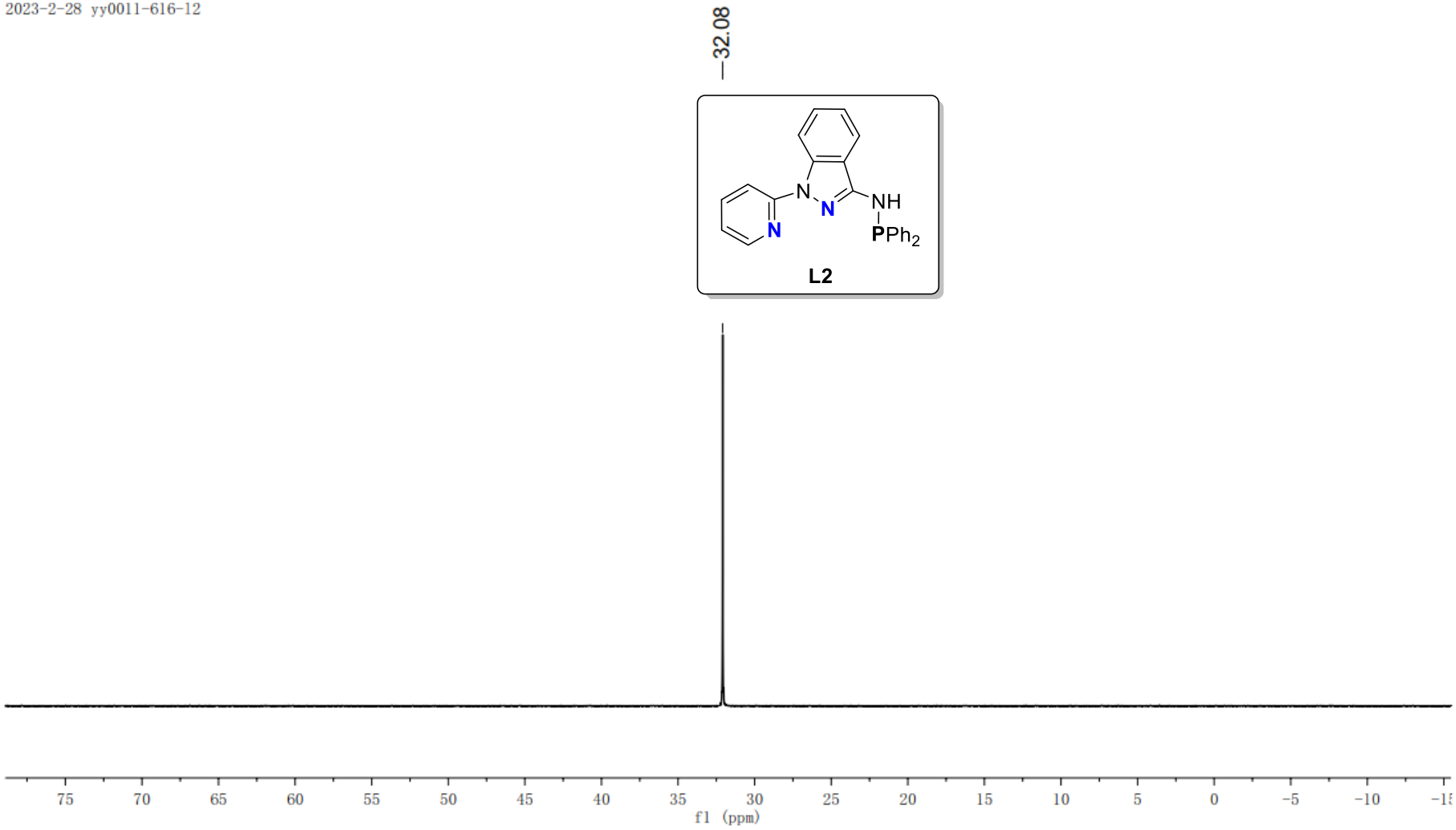
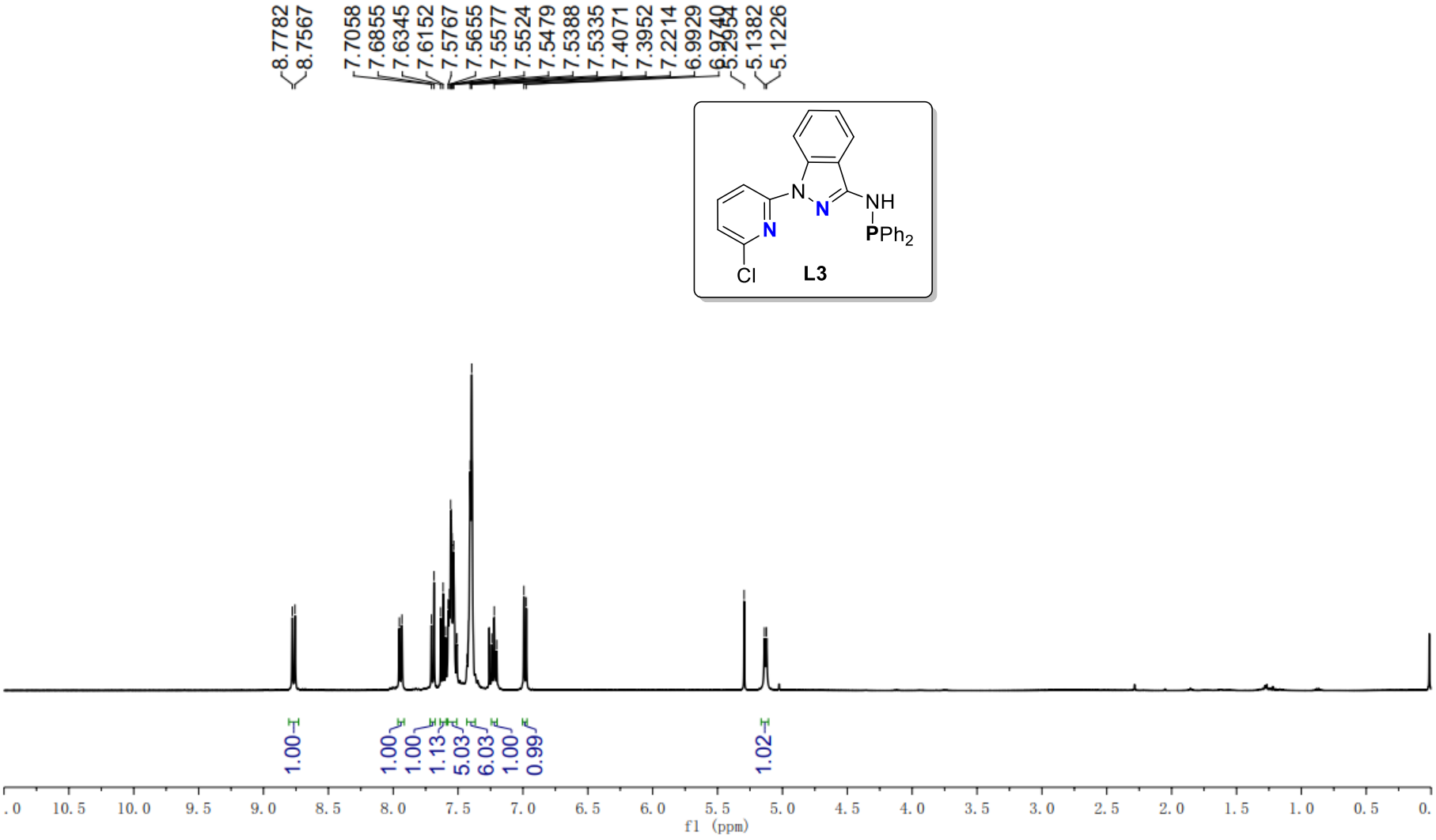
8.8059
8.4450
8.4421
8.4330
8.4299
7.9666
7.8001
7.5927
7.5862
7.5798
7.5736
7.5687
7.5625
7.5546
7.5498
7.4994
7.4095
7.4047
7.3956
5.1334
N
N
NH
PPh2
L2
1.00
1.00
1.06
1.06
1.10
4.04
1.16
6.11
1.11
1.05
1.02
f1 (ppm)


2023-2-28 yy0011-616-12
154.42
149.82
149.66
147.58
131.60
131.39
129.45
128.77
128.71
121.32
120.65
120.55
118.36
118.10
118.09
115.56
112.71
N
N
N
NH
PPh2
L2
f1 (ppm)

2023-2-28 yy0011-616-12

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8.7567
7.7058
7.6855
7.6345
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7.5767
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7.5577
7.5524
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7.5388
7.5335
7.4071
7.3952
7.2214
6.9929
6.9740
5.2954
5.1382
5.1226
N
N
NH
PPh2
N
Cl
L3
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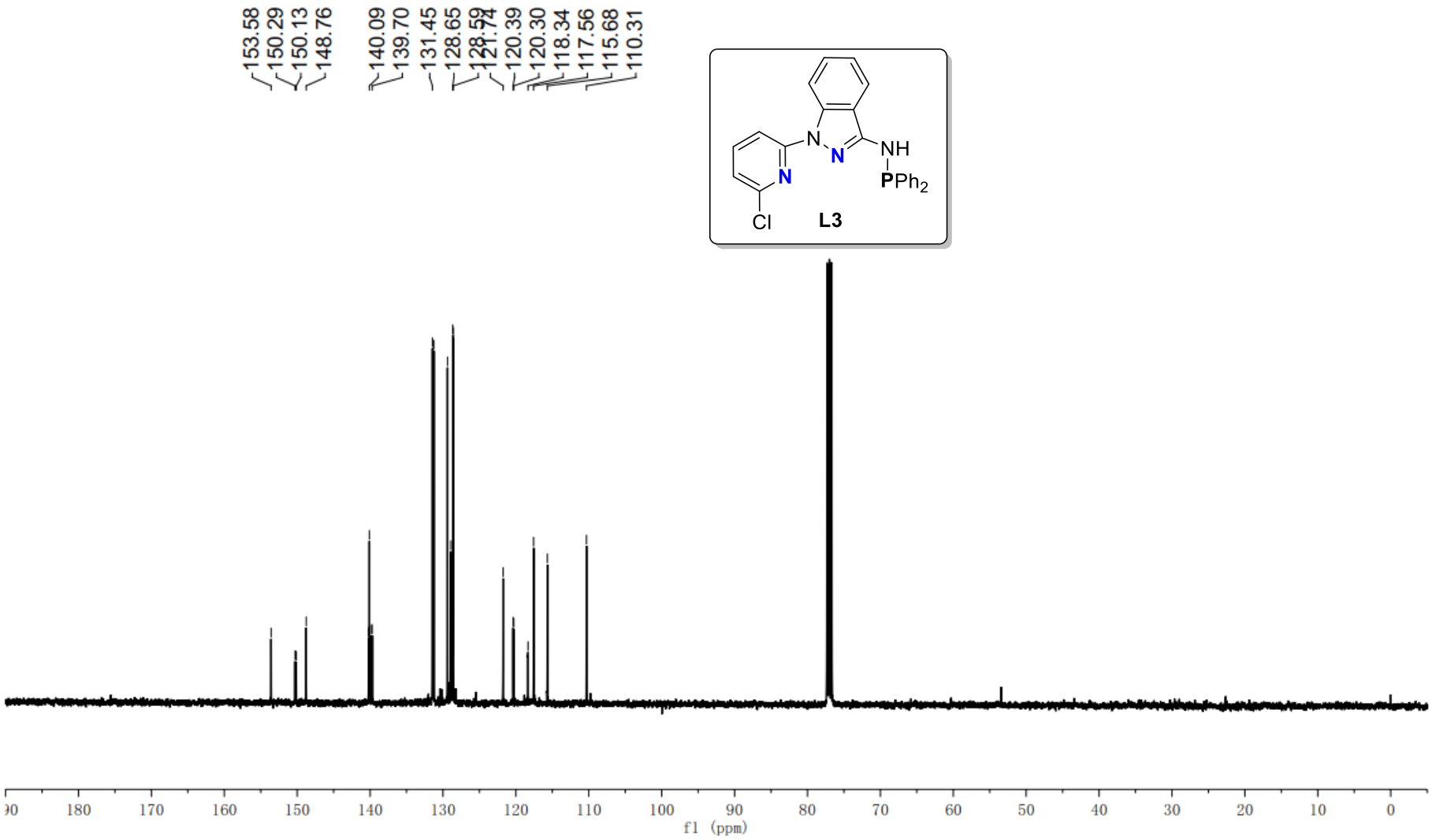
1.00
1.00
1.13
5.03
6.03
1.00
0.99
1.02
f1 (ppm)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150.13
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118.34
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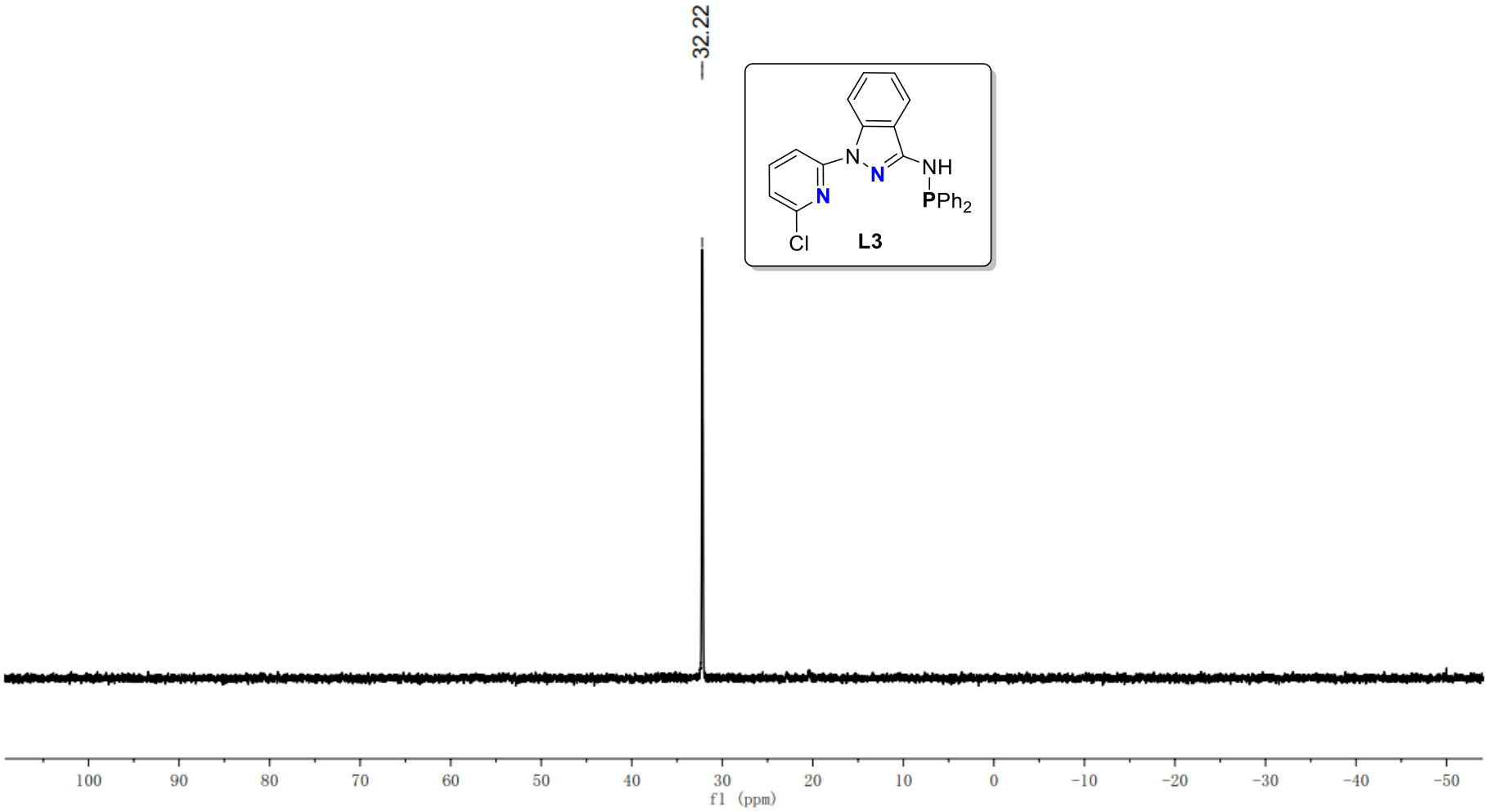
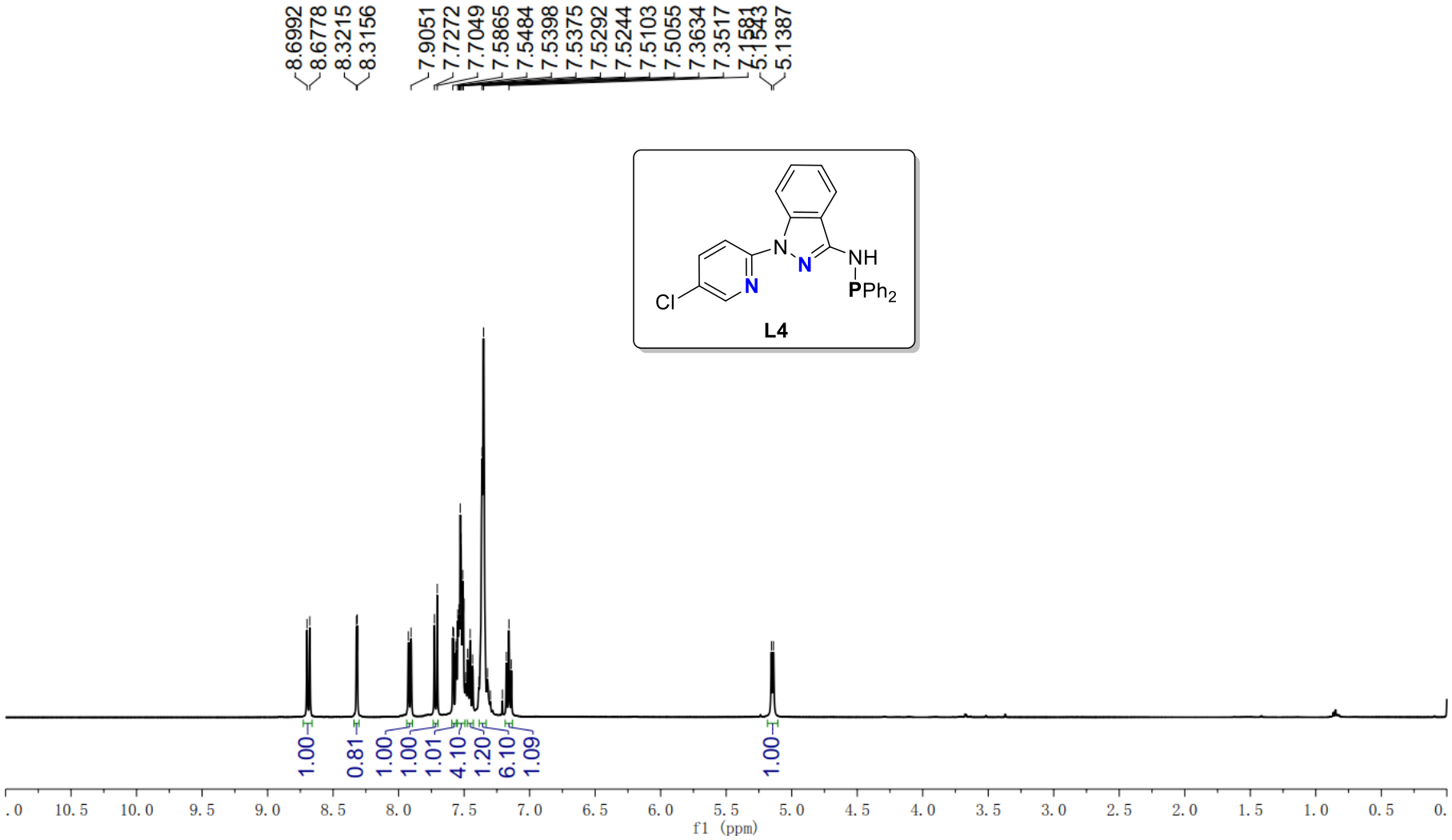
115.68
110.31
N
N
NH
PPh2
Cl
L3
f1 (ppm)


32.22
N
N
NH
PPh2
N
Cl
L3
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
f1 (ppm)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8.3156
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7.7049
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7.5484
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7.5375
7.5292
7.5244
7.5103
7.5055
7.3634
7.3517
7.1581
7.1543
5.1387
N
N
NH
Cl
N
PPh2
L4
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1.00
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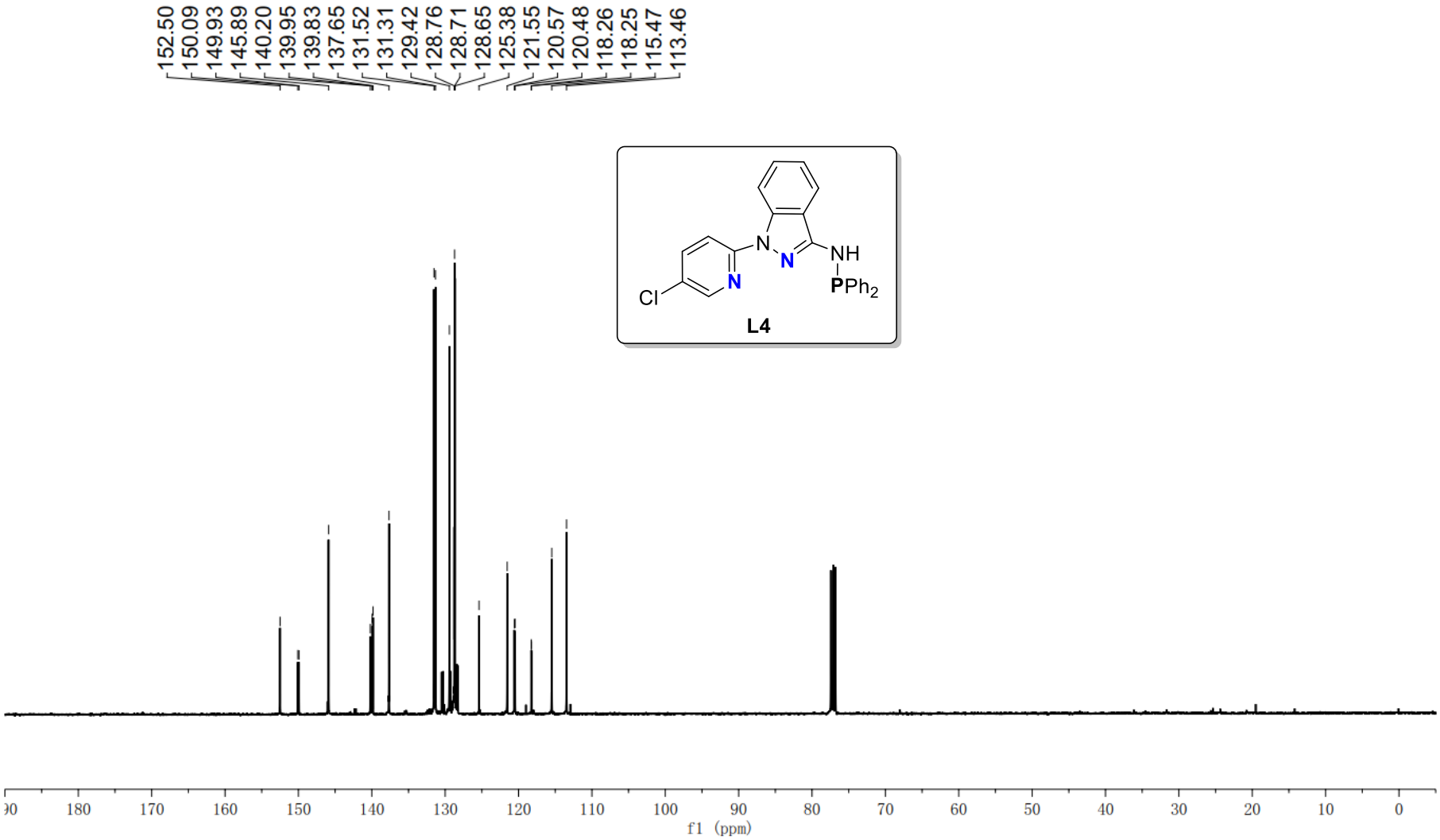
4.10
1.20
6.10
1.09
1.00
f1 (ppm)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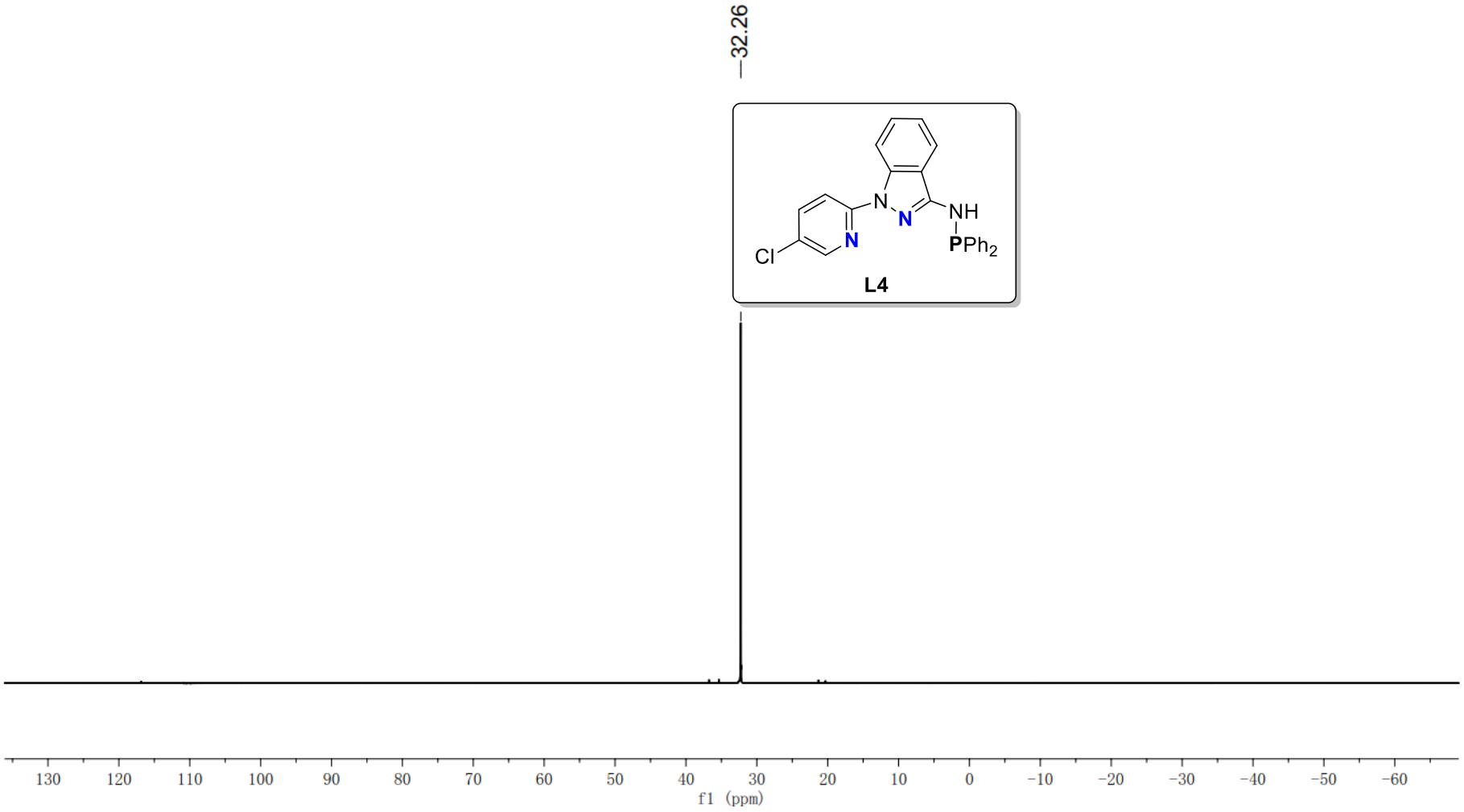
140.20
139.95
139.83
137.65
131.52
131.31
129.42
128.76
128.71
128.65
125.38
121.55
120.57
120.48
118.26
118.25
115.47
113.46
N
N
NH
Cl
N
PPh2
L4
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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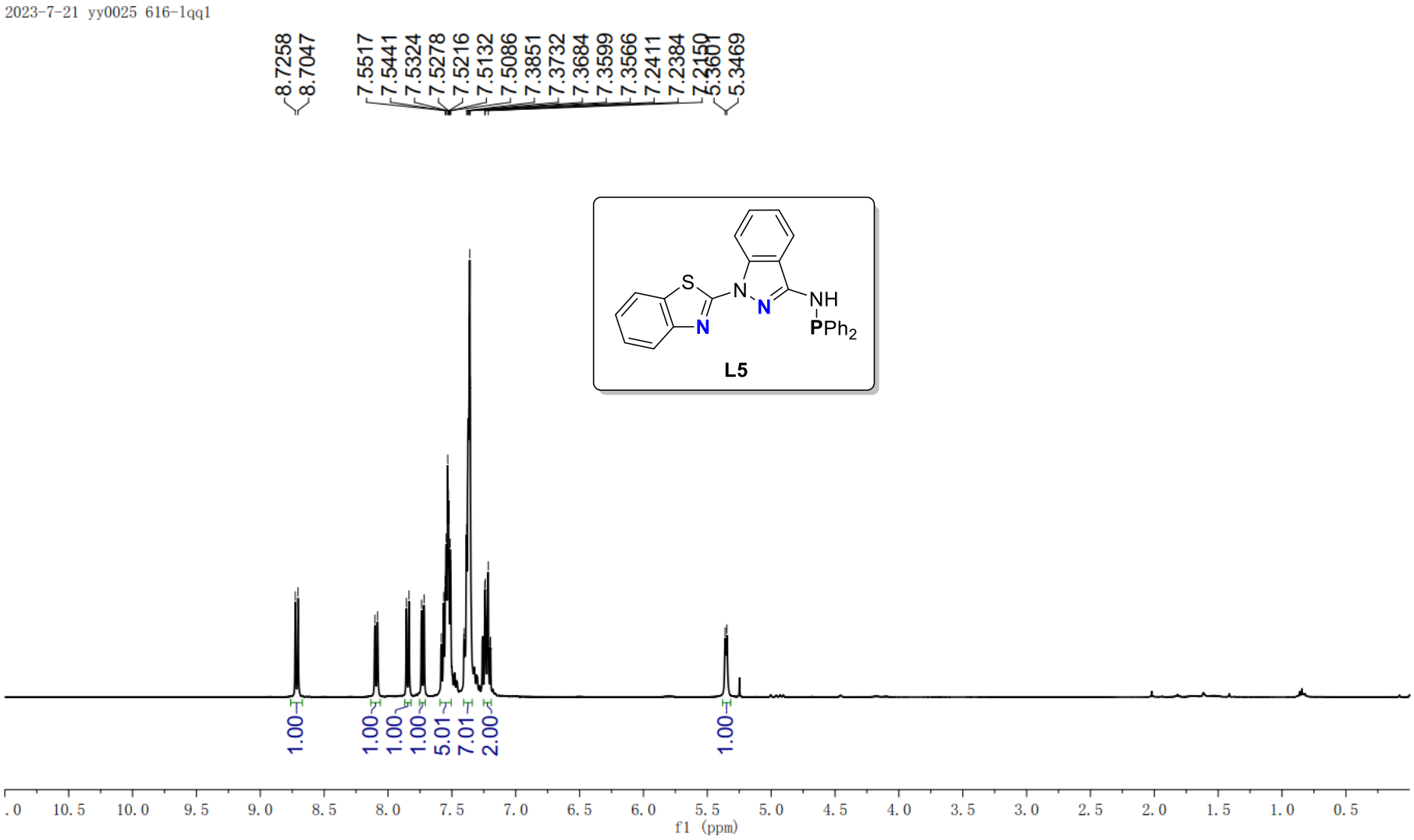
N
N
NH
N
Cl
PPh2
L4
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
−20
−30
−40
−50
−60
f1 (ppm)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7.5278
7.5216
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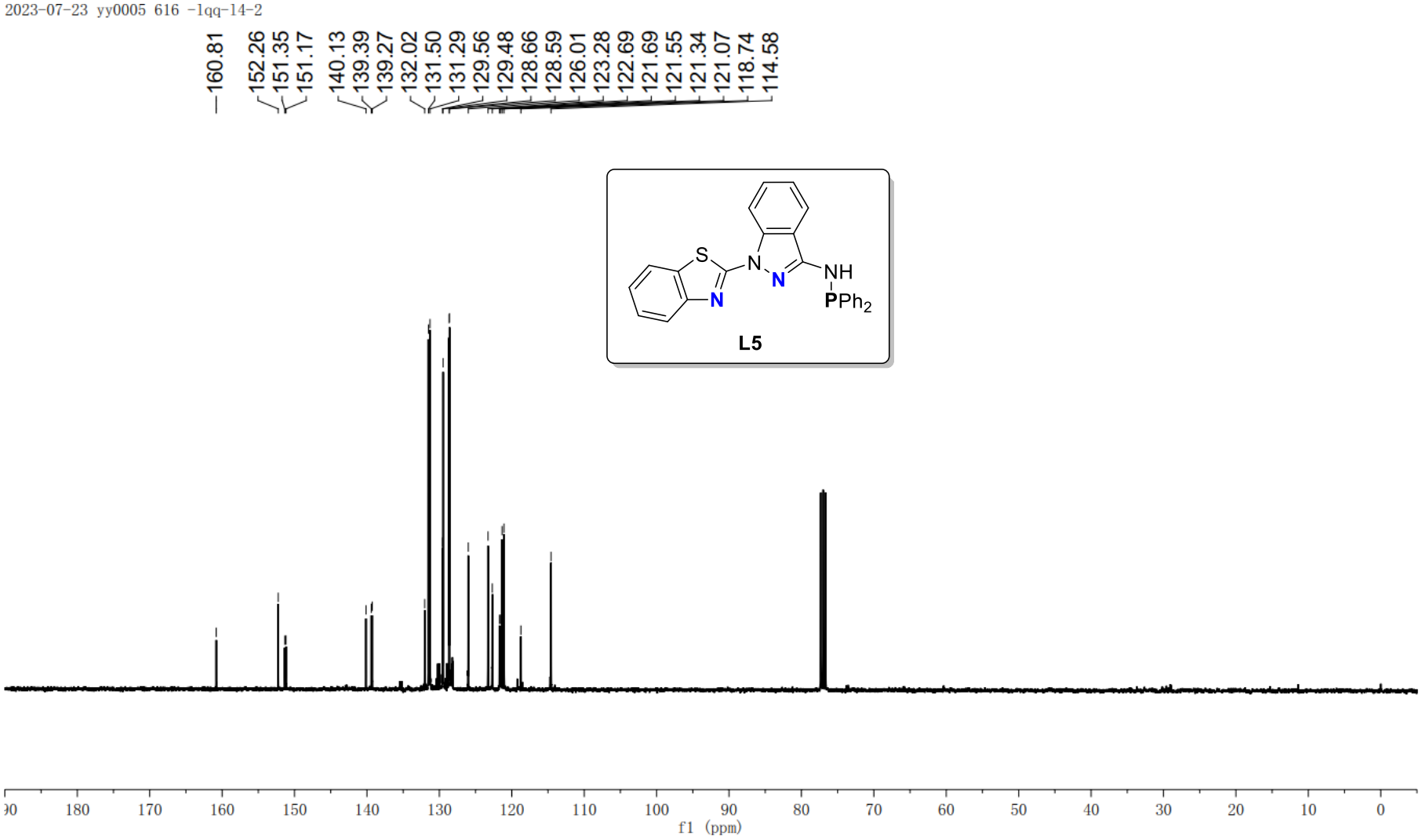
7.3851
7.3732
7.3684
7.3599
7.3566
7.2411
7.2384
7.2150
5.3601
5.3469
S
N
N
N
NH
PPh2
L5
1.00
1.00
1.00
1.00
5.01
7.01
2.00
1.00
f1 (ppm)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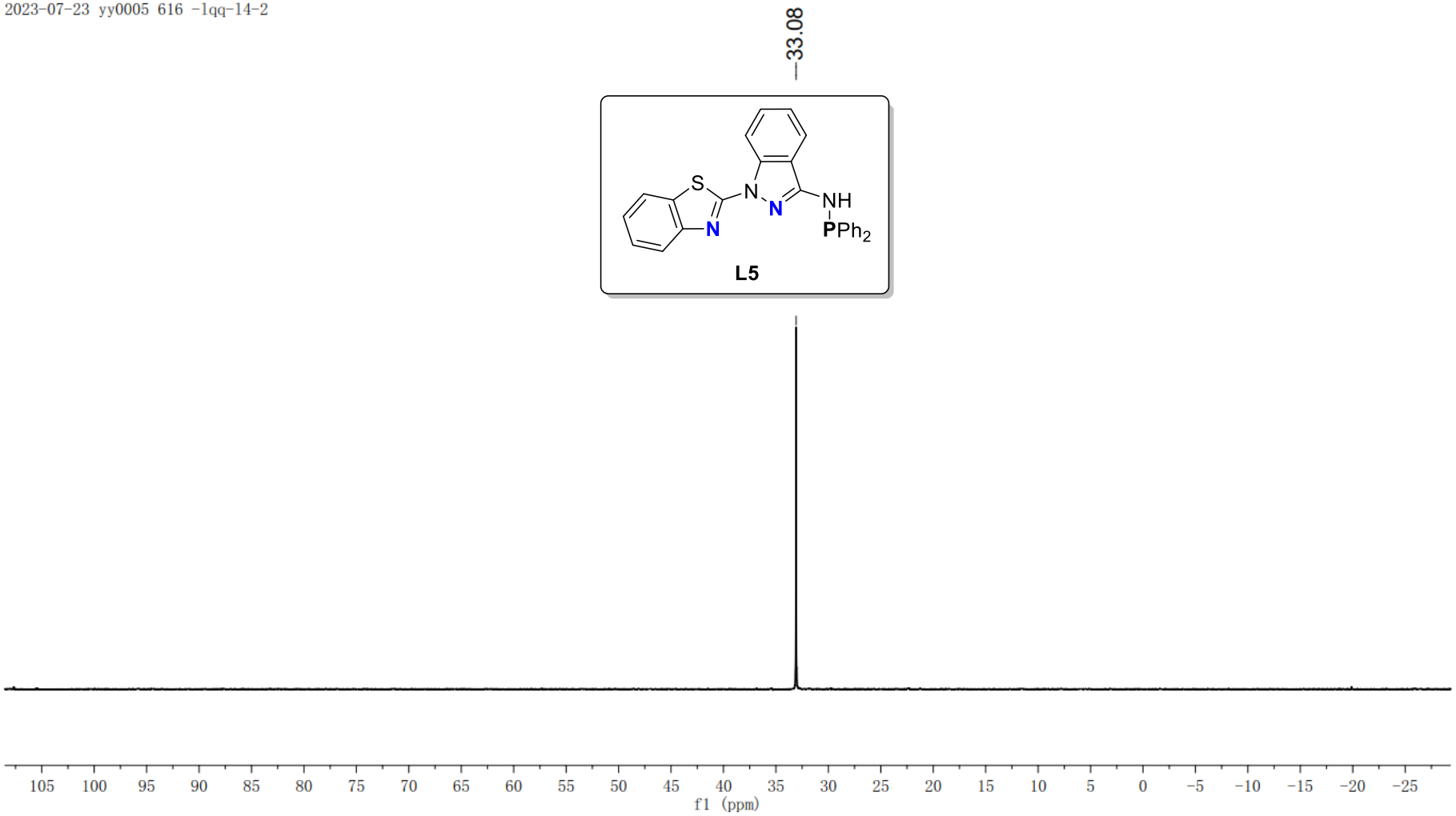
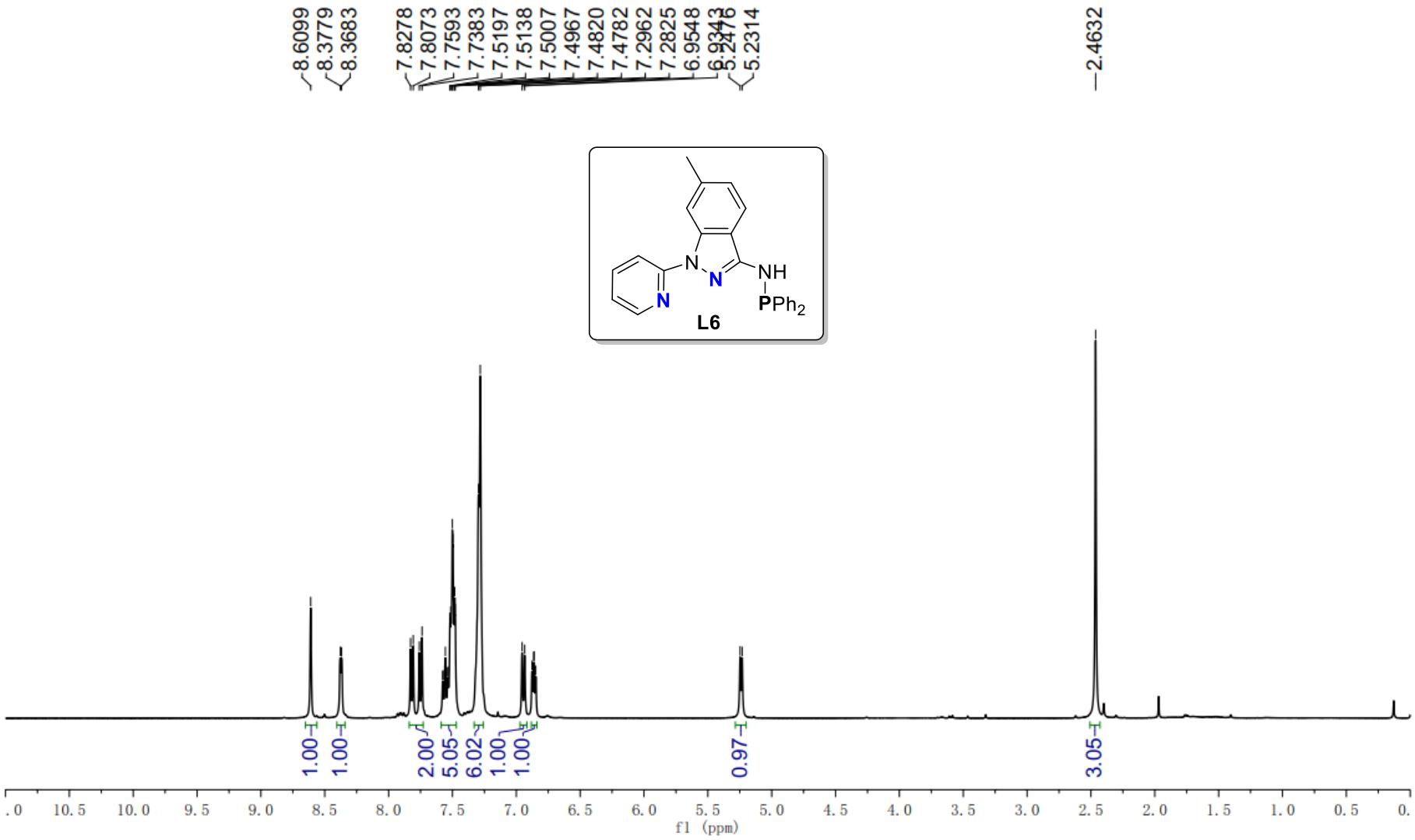
151.35
151.17
140.13
139.39
139.27
132.02
131.50
131.29
129.56
129.48
128.66
128.59
126.01
123.28
122.69
121.69
121.55
121.34
121.07
118.74
114.58
S
N
N
N
NH
PPh2
L5
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

2023-07-23 yy0005 616 -1qq-14-2

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8.3779
8.3683
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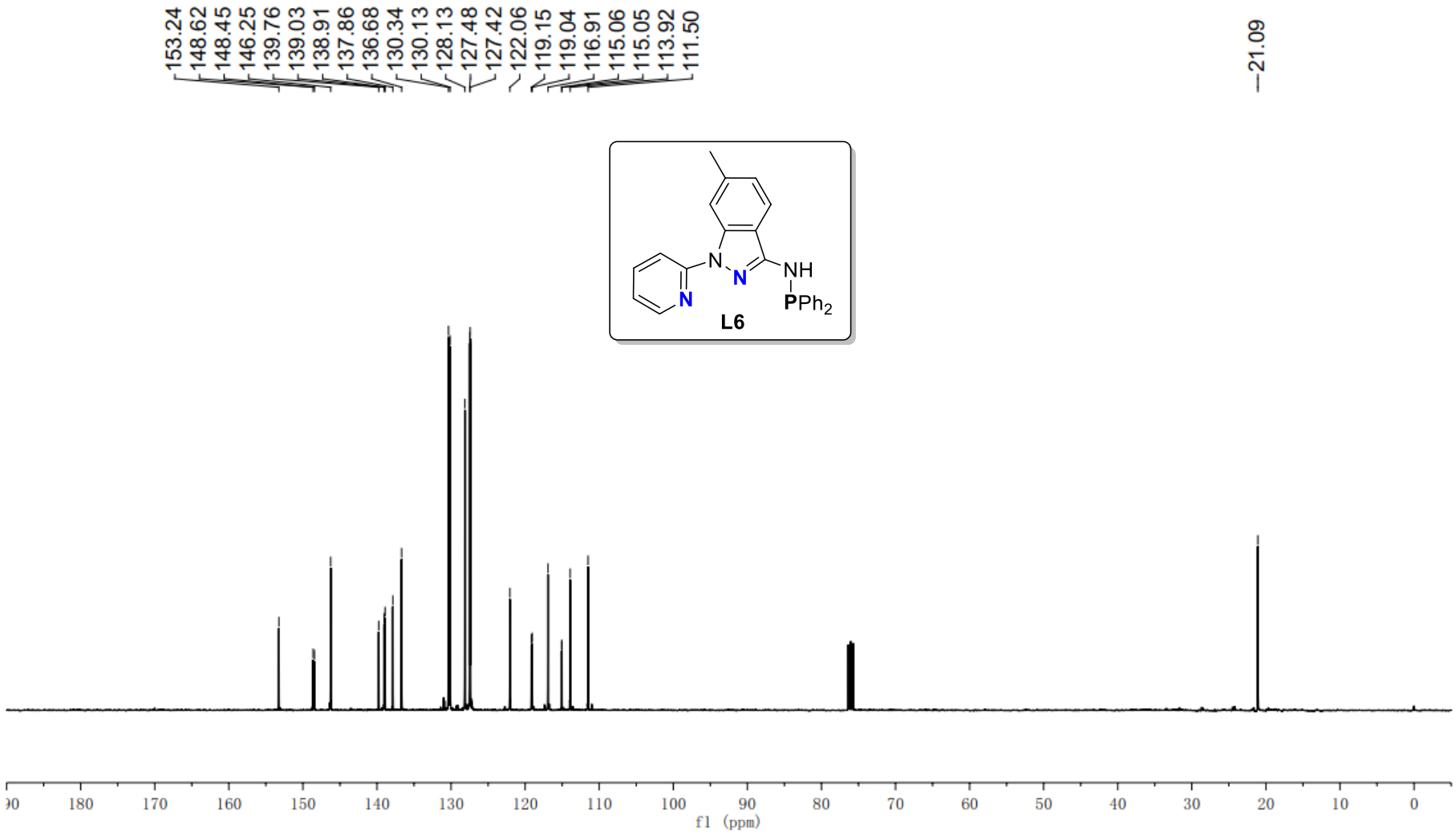
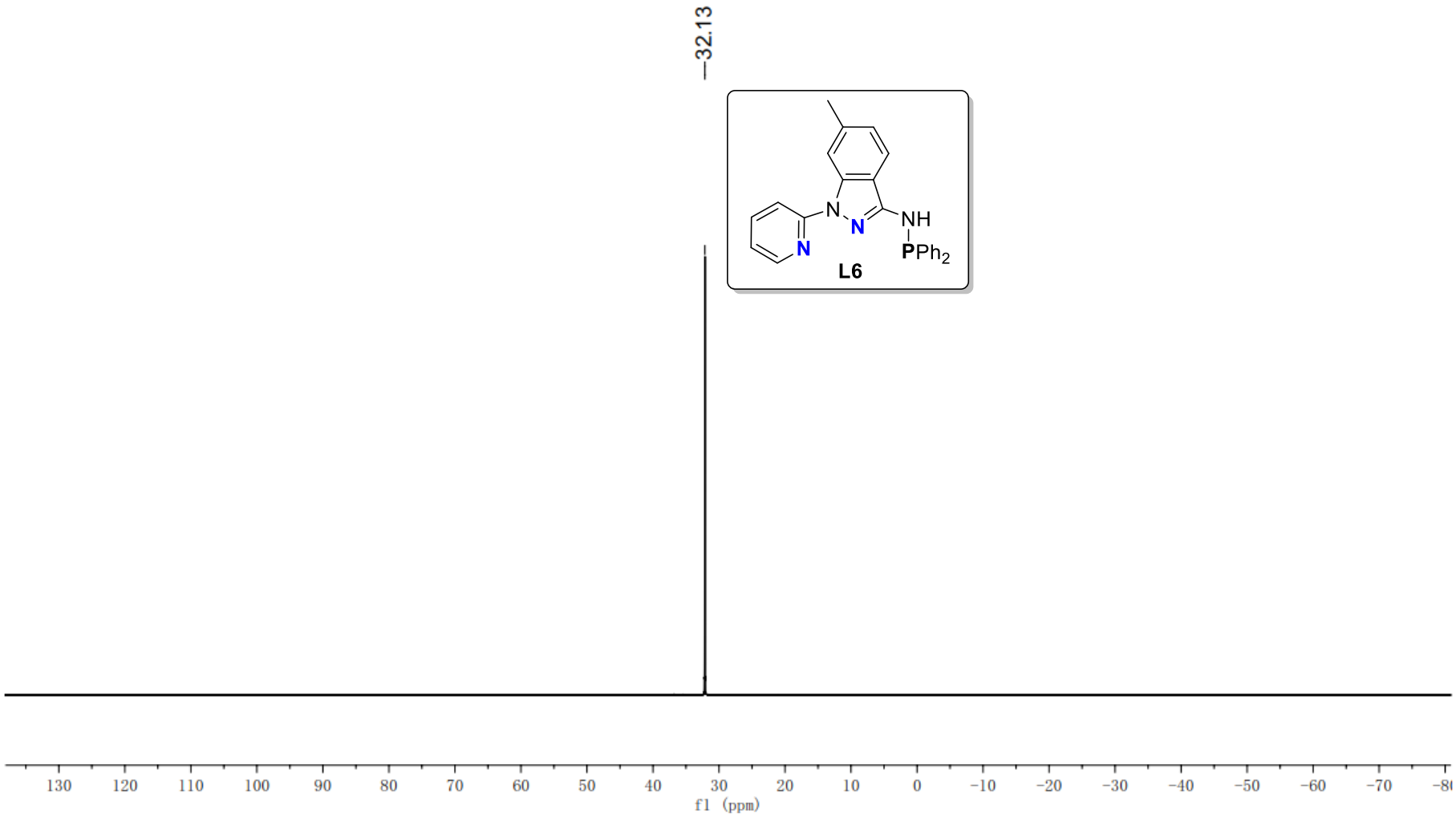
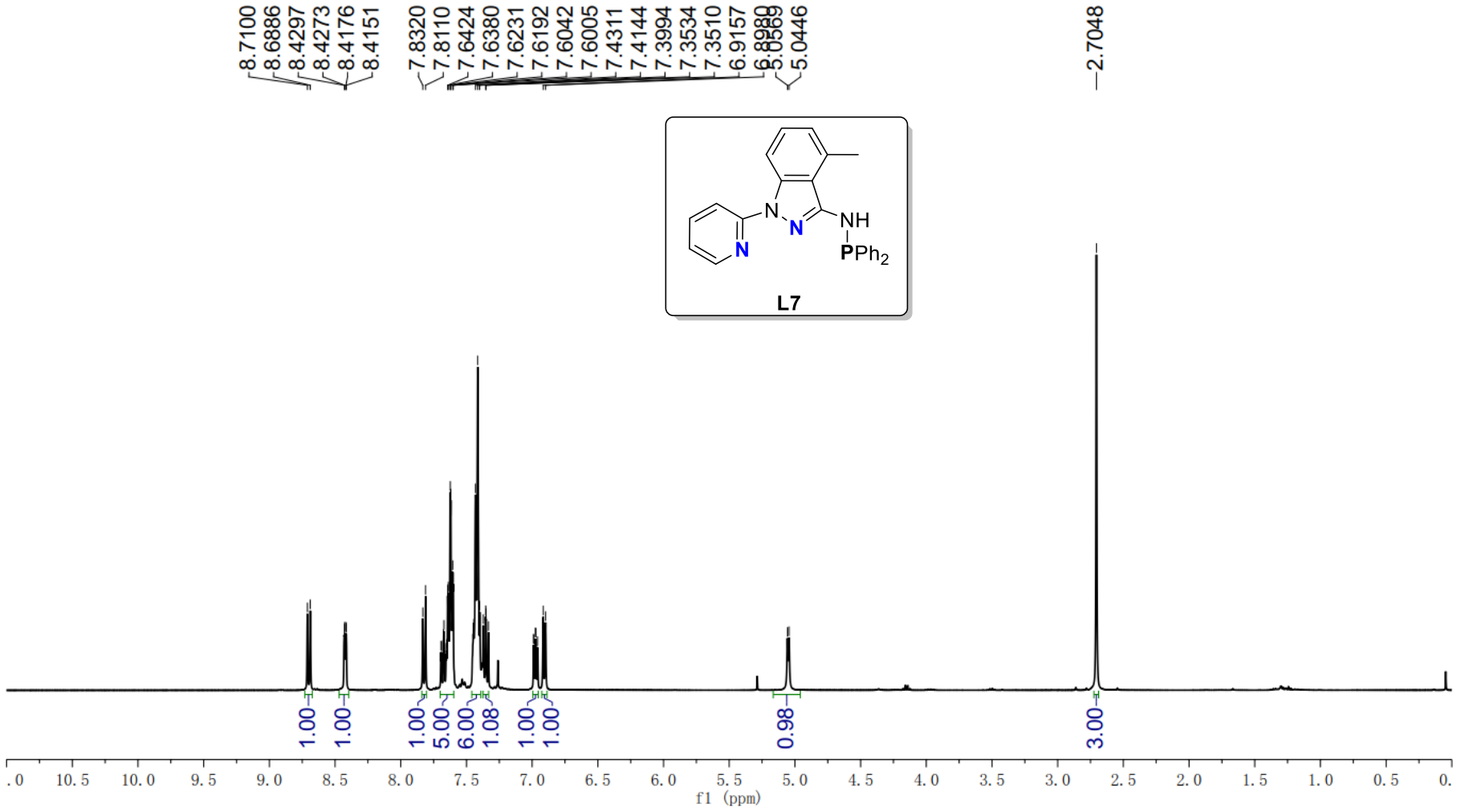
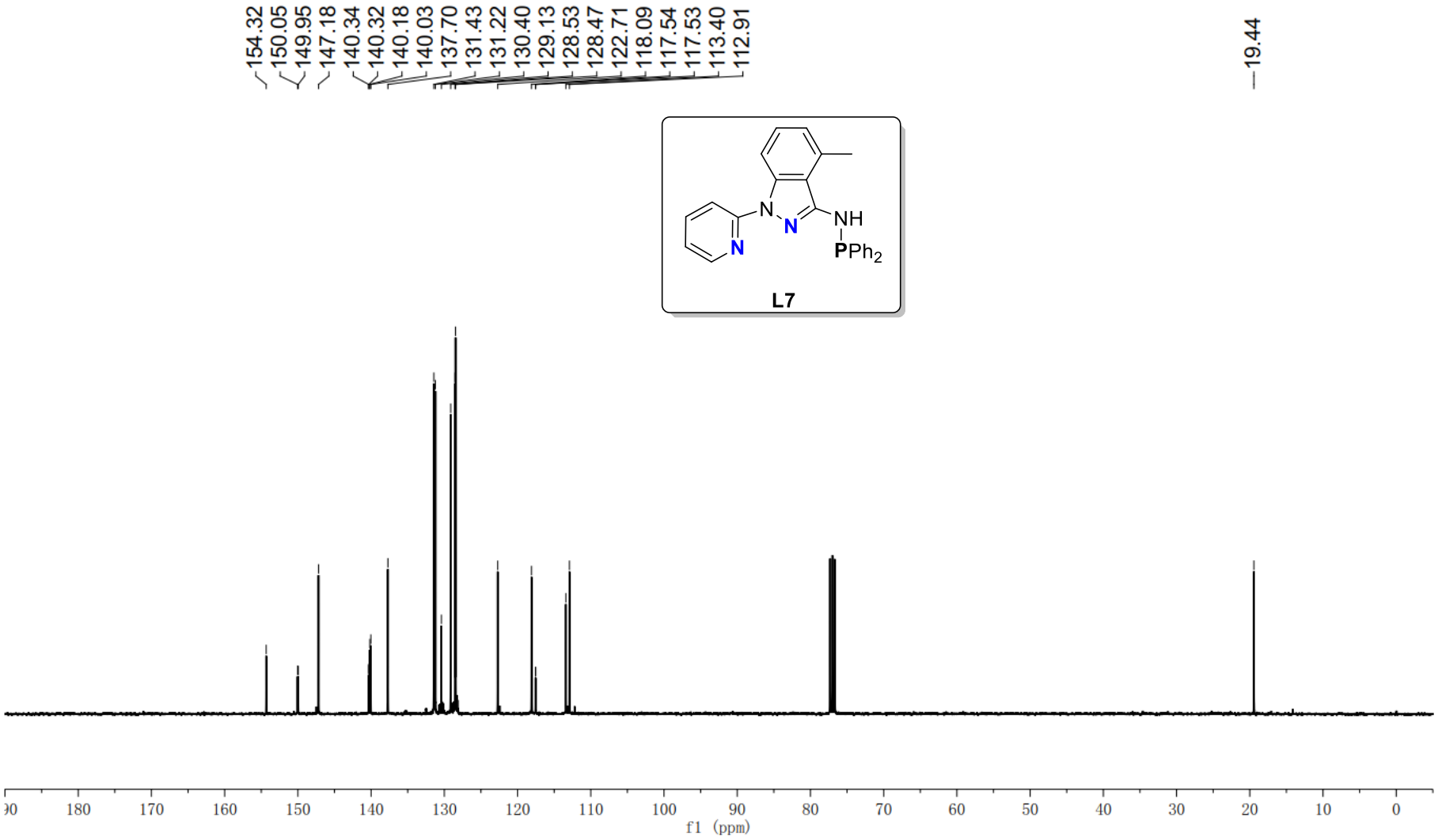
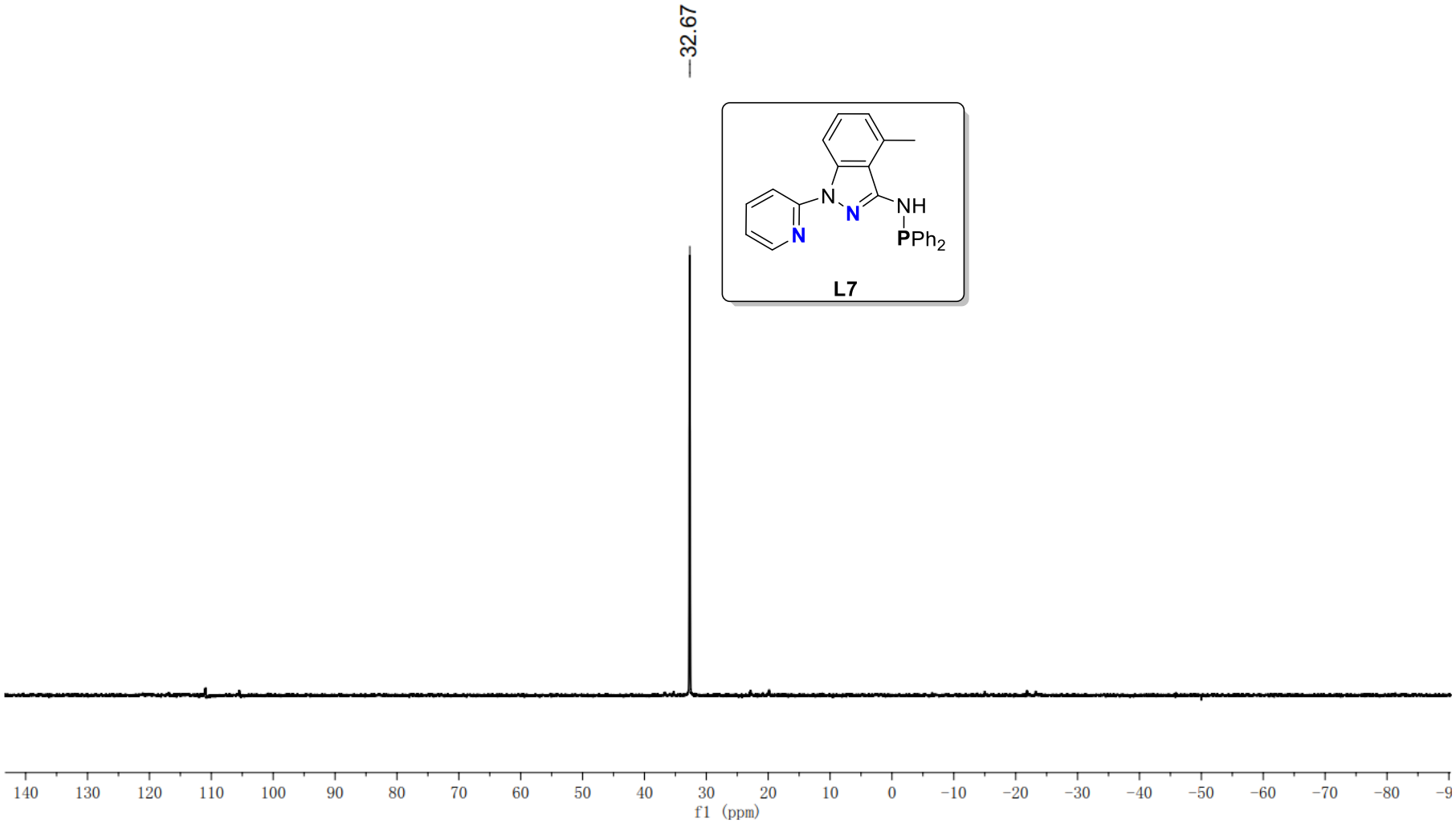
7.5138
7.5007
7.4967
7.4820
7.4782
7.2962
7.2825
6.9548
5.2476
5.2314
2.4632
N
N
NH
PPh2
L6
1.00
1.00
2.00
5.05
6.02
1.00
1.00
0.97
3.05
f1 (ppm)

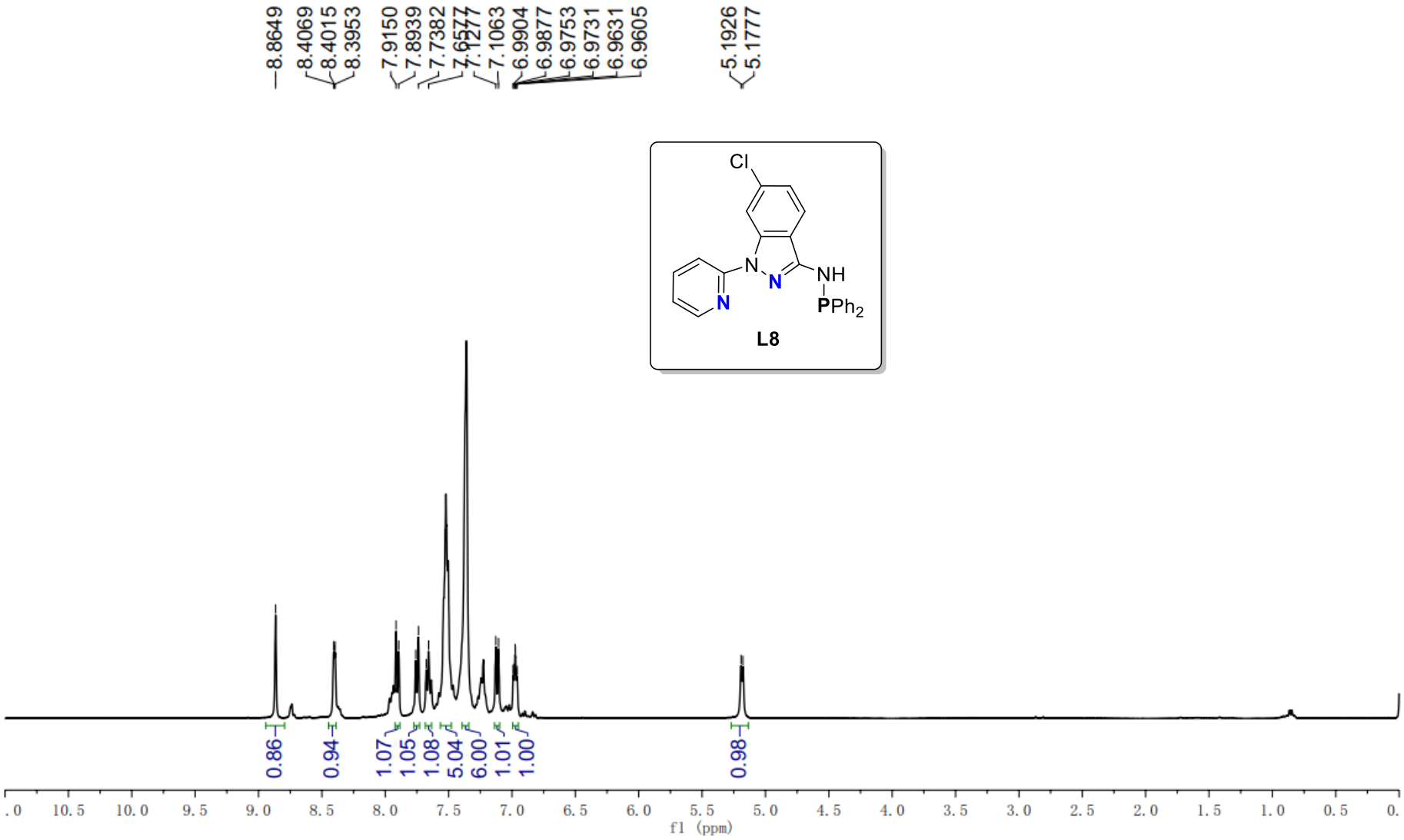

153.24
148.62
148.45
146.25
139.76
139.03
138.91
137.86
136.68
130.34
130.13
128.13
127.48
127.42
122.06
119.15
119.04
116.91
115.06
115.05
113.92
111.50
21.09
N
N
N
NH
PPh2
L6
f1 (ppm)

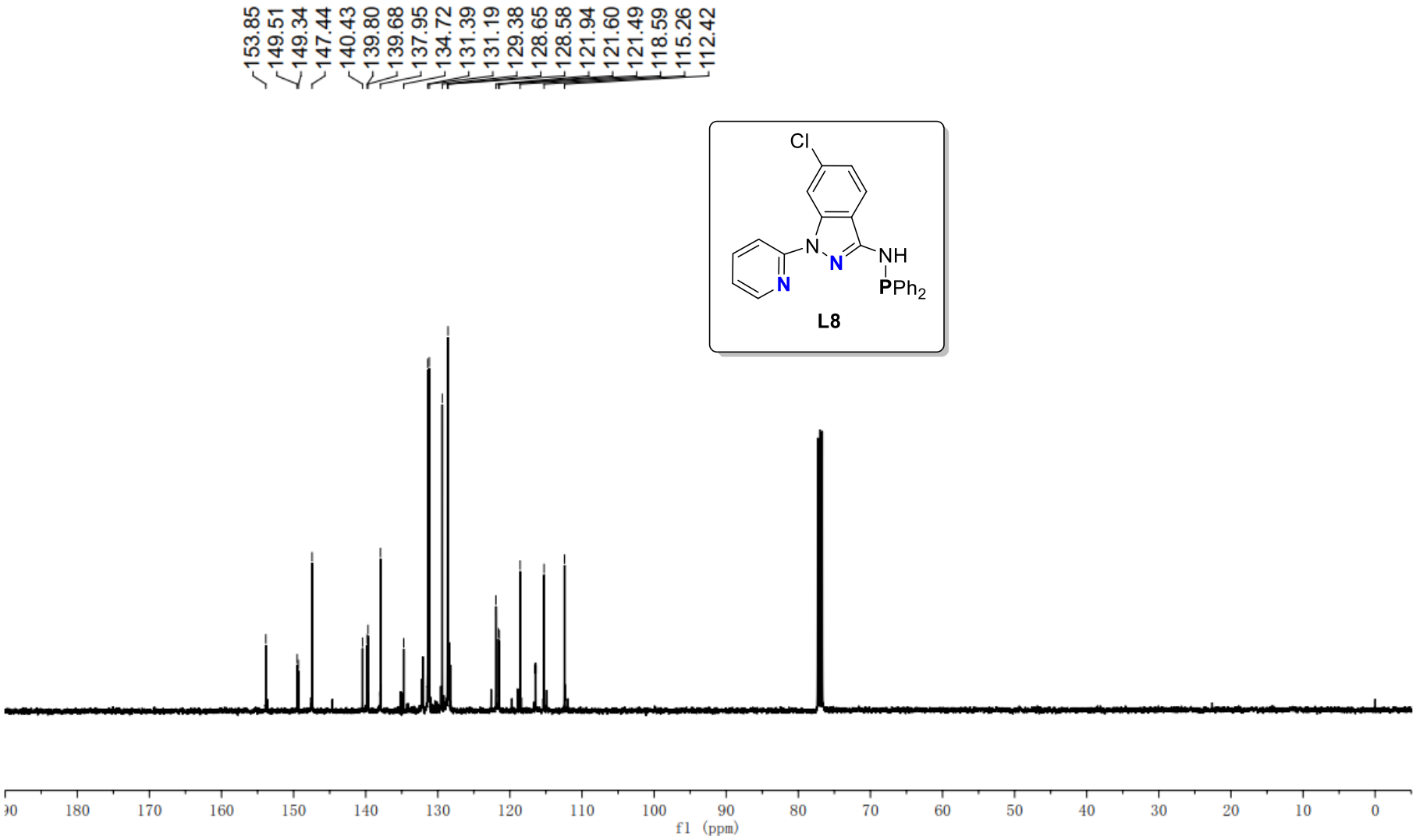

−32.13
N
N
NH
PPh2
L6
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
−20
−30
−40
−50
−60
−70
f1 (ppm)

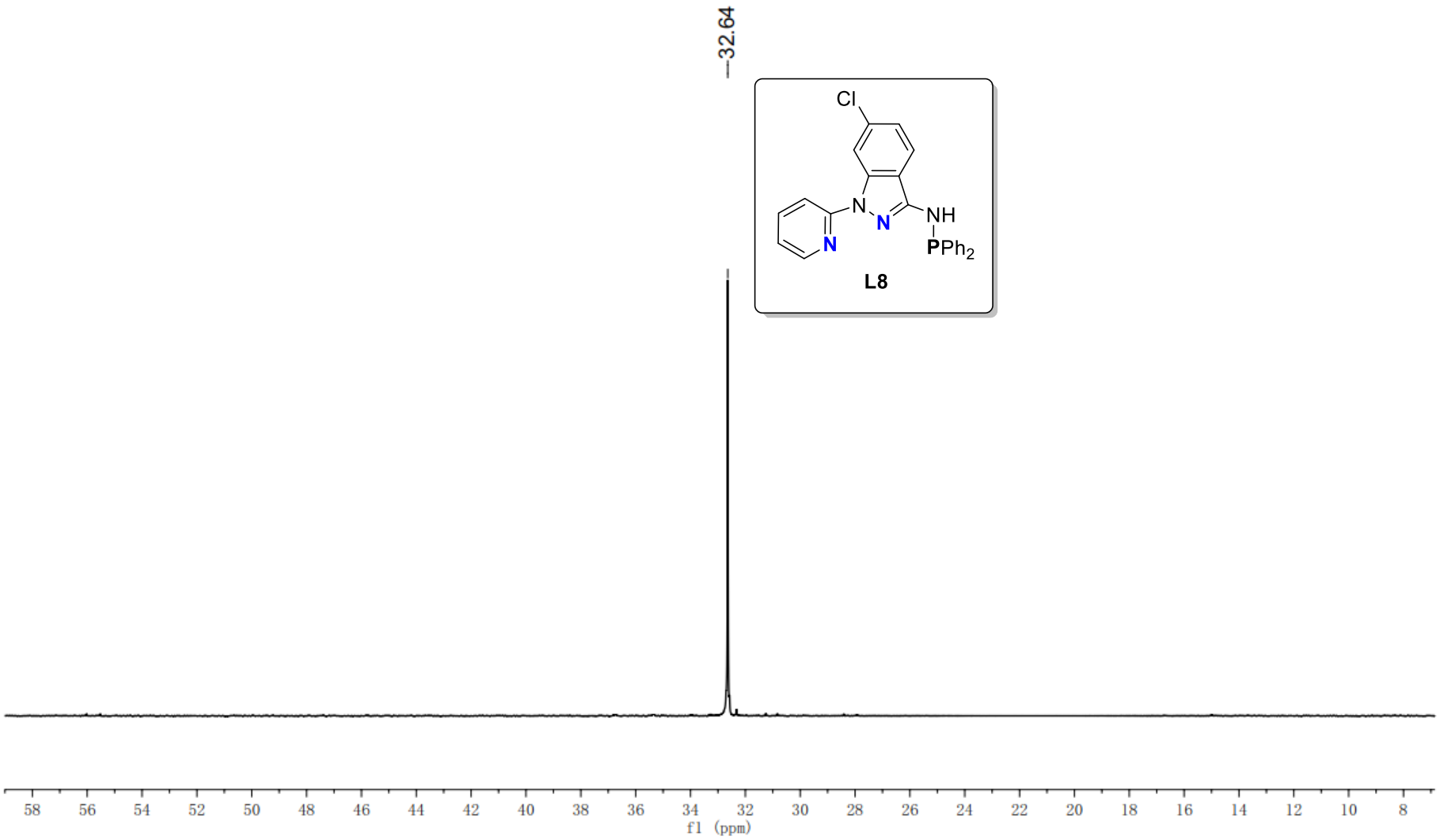

8.7100
8.6886
8.4297
8.4273
8.4176
8.4151
7.8320
7.8110
7.6424
7.6380
7.6231
7.6192
7.6042
7.6005
7.4311
7.4144
7.3994
7.3534
7.3510
6.9157
5.0446
2.7048
N
N
NH
PPh2
L7
1.00
1.00
1.00
5.00
6.00
1.08
1.00
1.00
0.98
3.00
f1 (ppm)

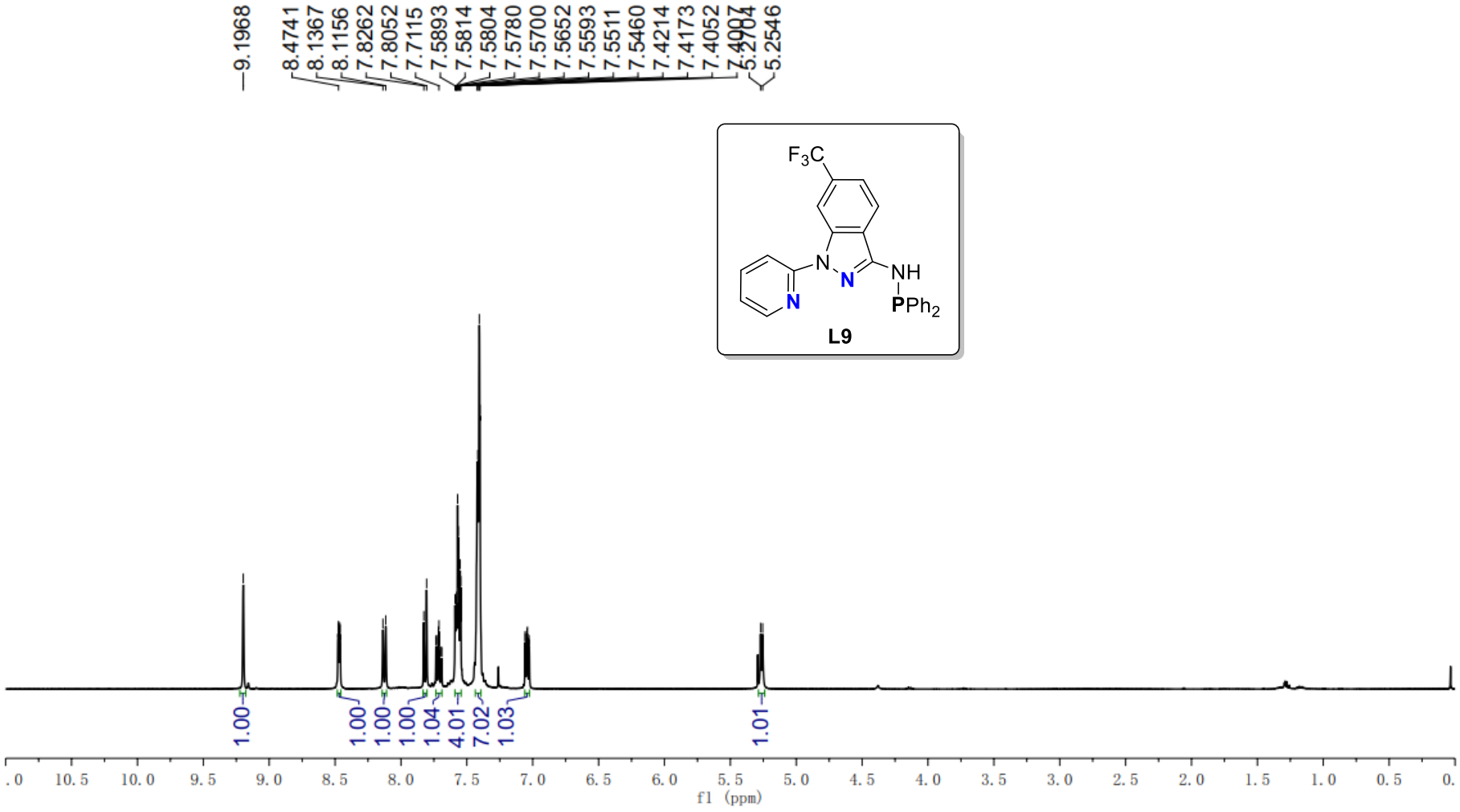

154.32
150.05
149.95
147.18
140.34
140.32
140.18
140.03
137.70
131.43
131.22
130.40
129.13
128.53
128.47
122.71
118.09
117.54
117.53
113.40
112.91
19.44
N
N
N
NH
PPh2
L7
f1 (ppm)

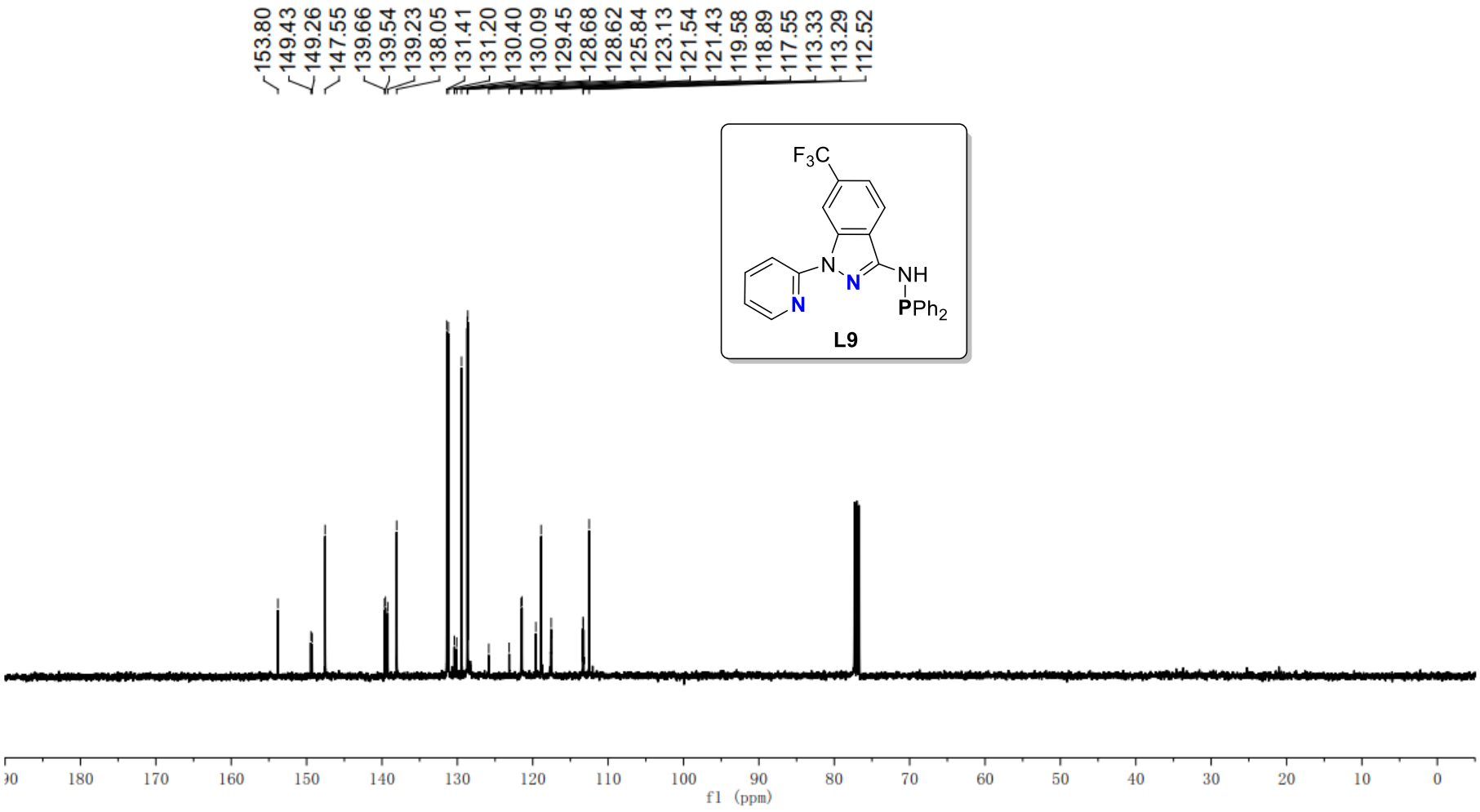

32.67
N
N
NH
PPh2
L7
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
−20
−30
−40
−50
−60
−70
−80
−9
f1 (ppm)

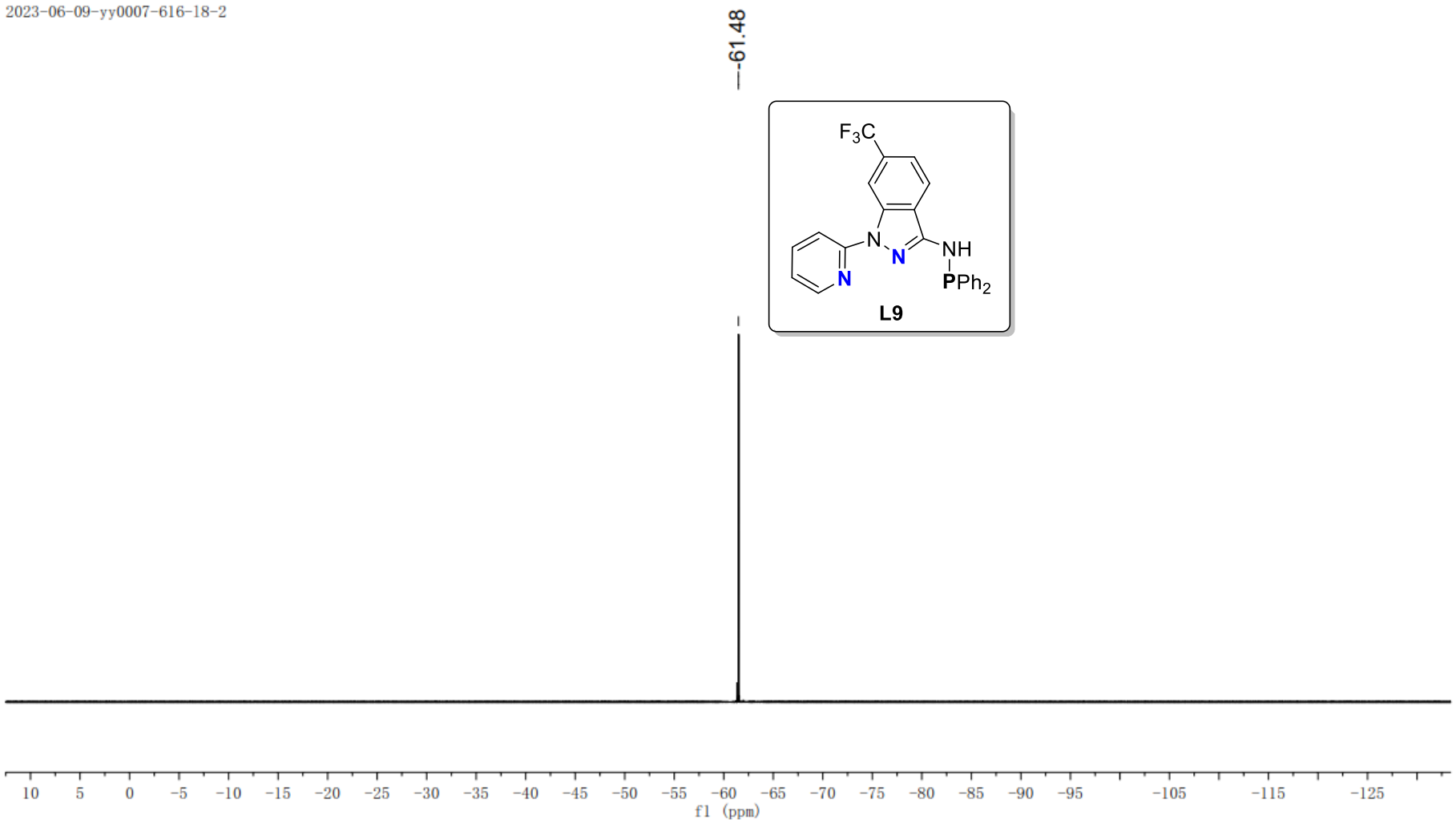

8.8649
8.4069
8.4015
8.3953
7.9150
7.8939
7.7382
7.6577
7.6277
7.1277
7.1063
6.9904
6.9877
6.9753
6.9731
6.9631
6.9605
5.1926
5.1777
Cl
N
N
NH
PPh2
L8
0.86
0.94
1.07
1.05
1.08
5.04
6.00
1.01
1.00
0.98
f1 (ppm)

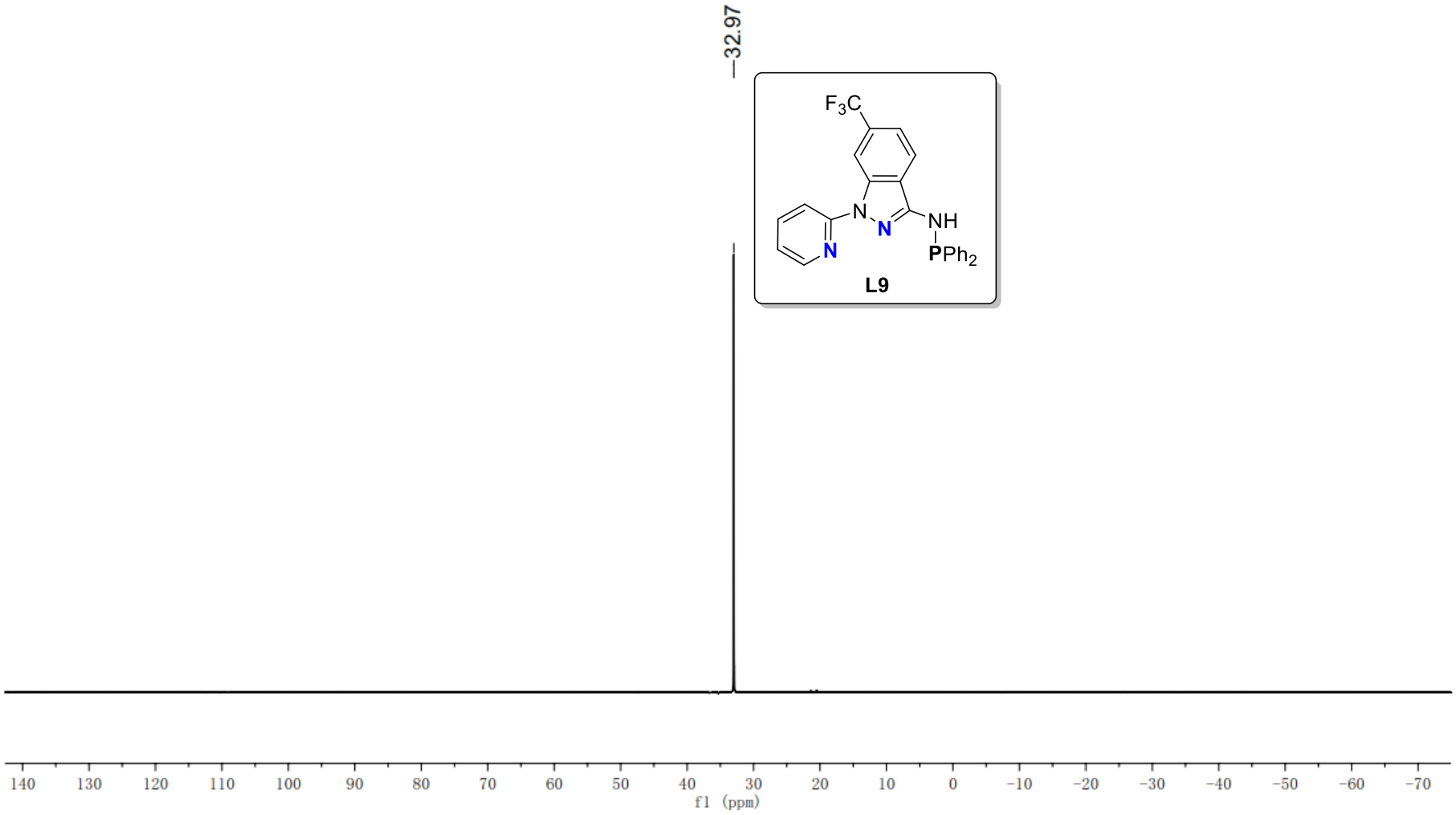

153.85
149.51
149.34
147.44
140.43
139.80
139.68
137.95
134.72
131.39
131.19
129.38
128.65
128.58
121.94
121.60
121.49
118.59
115.26
112.42
Cl
N
N
N
NH
PPh2
L8
f1 (ppm)

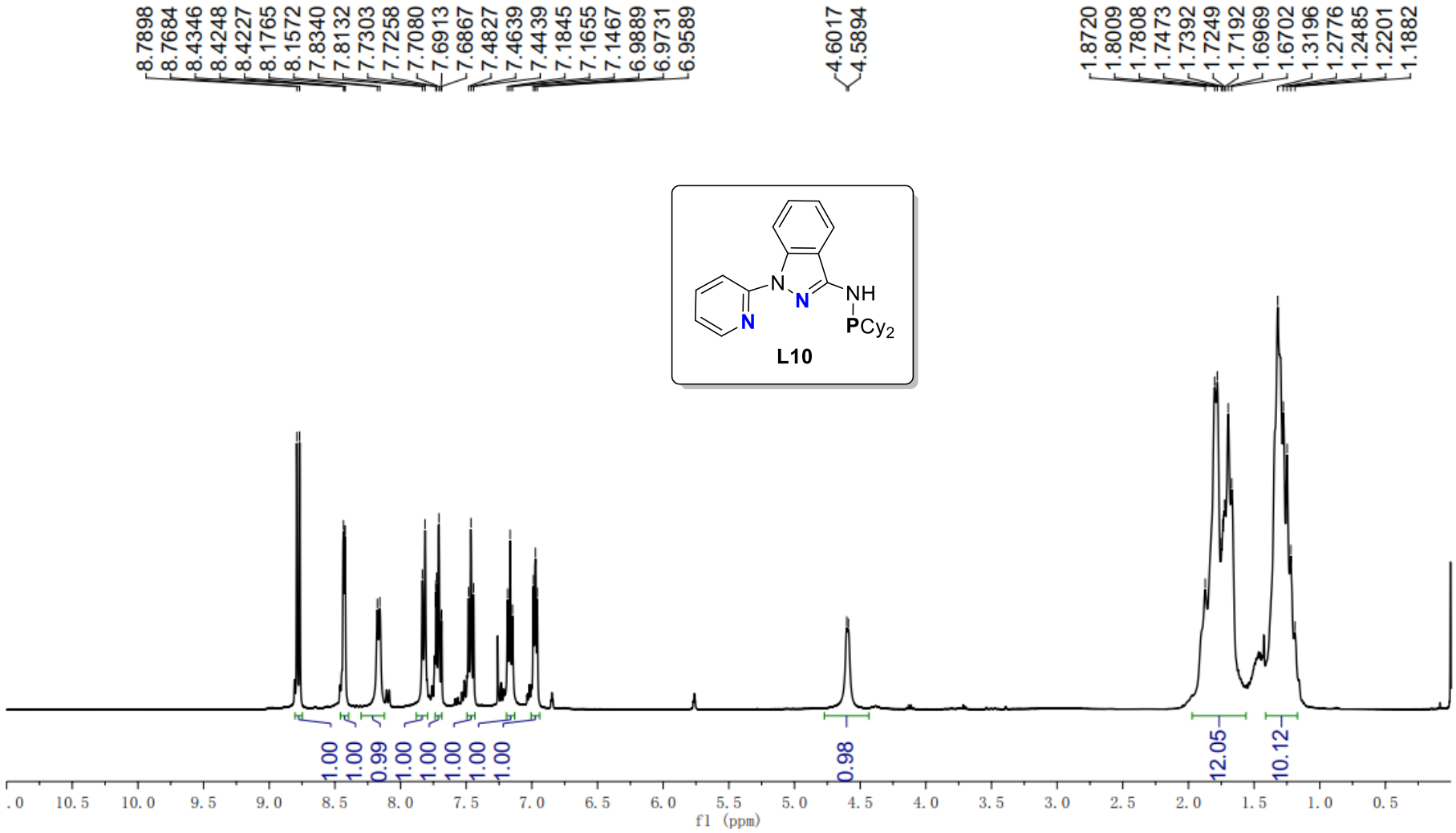

32.64
Cl
N
N
NH
N
PPh2
L8
58 56 54 52 50 48 46 44 42 40 38 36 34 32 30 28 26 24 22 20 18 16 14 12 10 8
f1 (ppm)

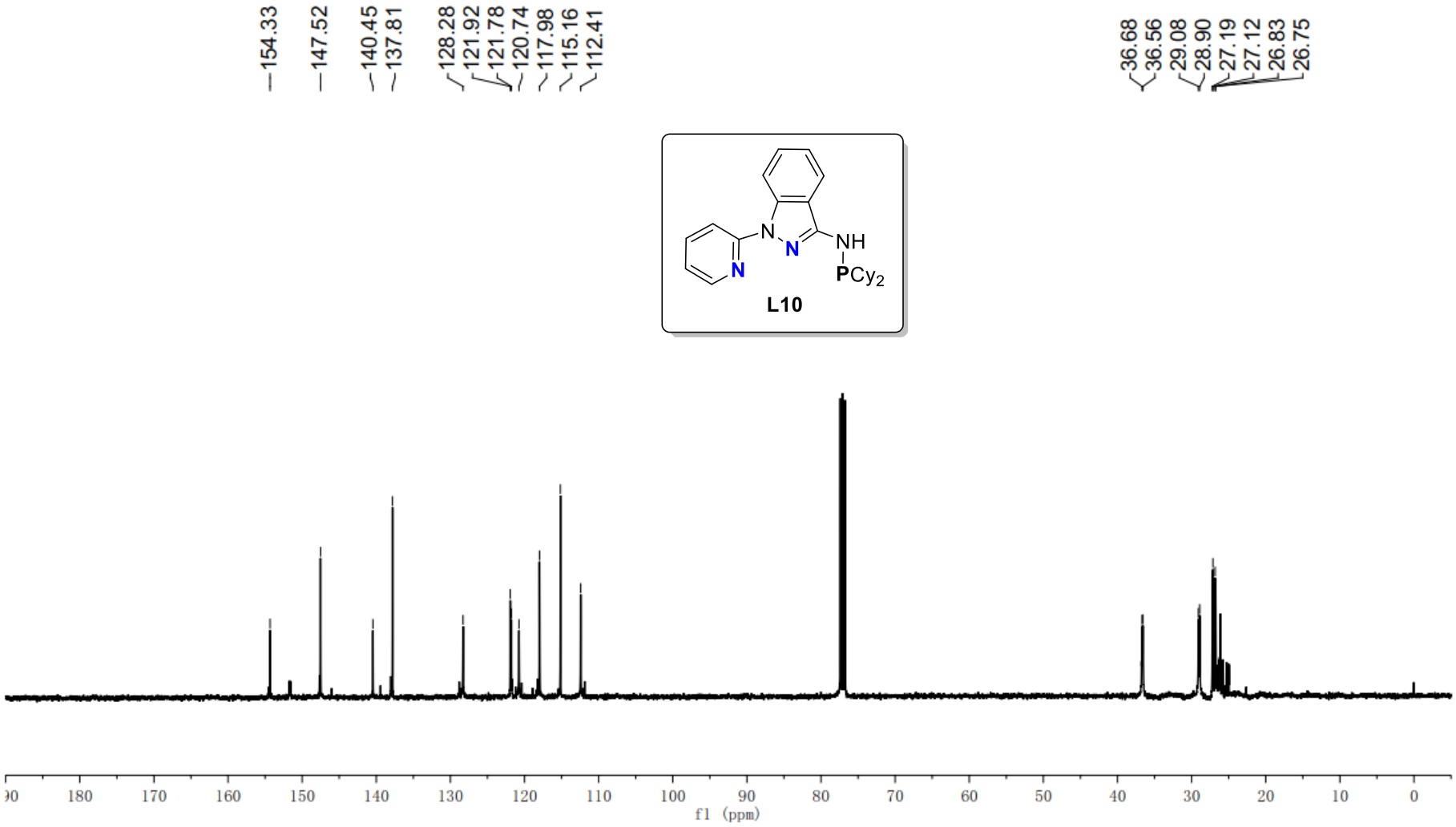

9.1968
8.4741
8.1367
8.1156
7.8262
7.8052
7.7115
7.5893
7.5814
7.5804
7.5780
7.5700
7.5652
7.5593
7.5511
7.5460
7.4214
7.4173
7.4052
7.4007
5.2704
5.2546
F3C
N
N
NH
PPh2
L9
1.00
1.00
1.00
1.00
1.04
4.01
7.02
1.03
1.01
f1 (ppm)

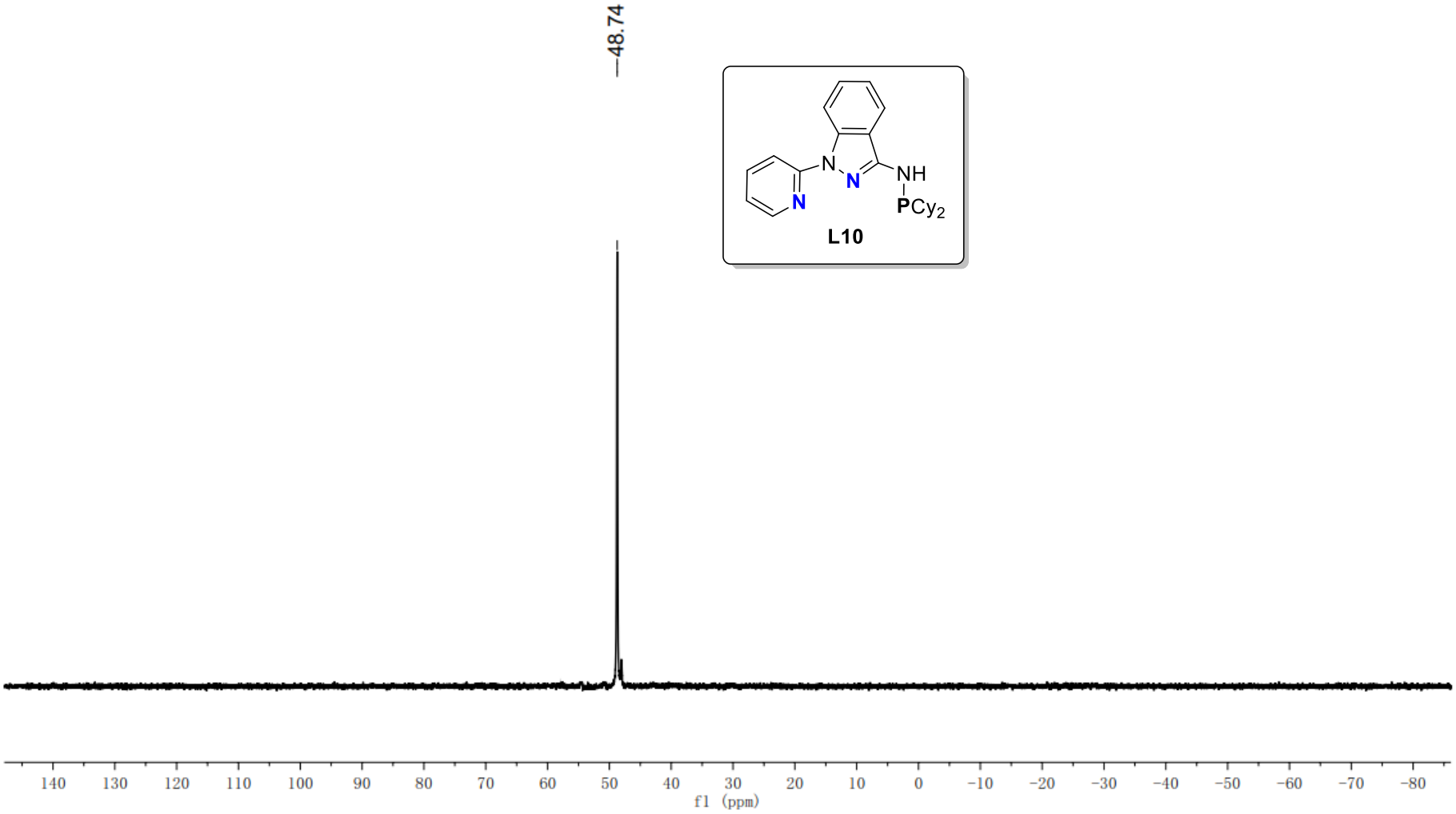

153.80
149.43
149.26
147.55
139.66
139.54
139.23
138.05
131.41
131.20
130.40
130.09
129.45
128.68
128.62
125.84
123.13
121.54
121.43
119.58
118.89
117.55
113.33
113.29
112.52
F3C
N
N
NH
PPh2
N
L9
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

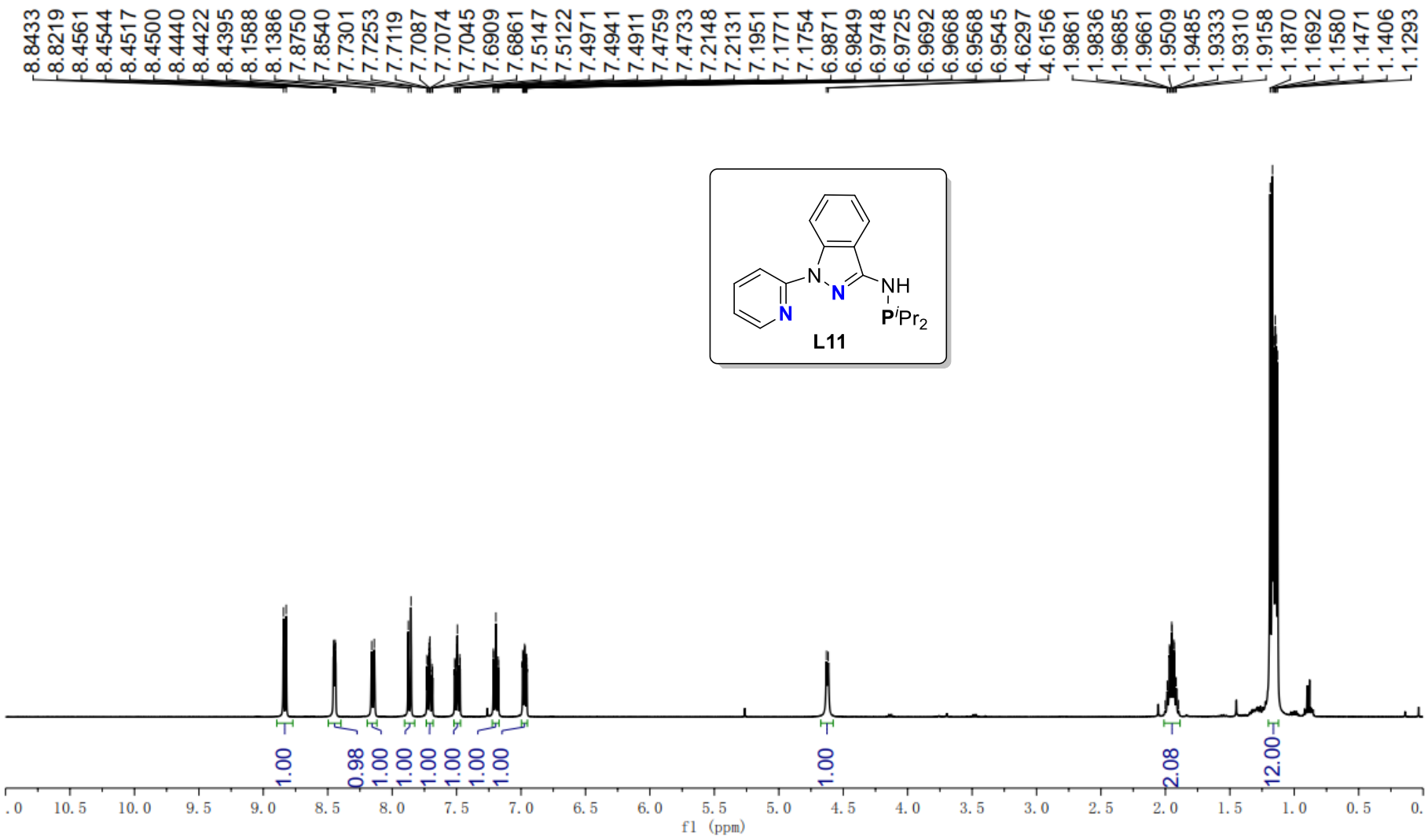

2023-06-09-yy0007-616-18-2
-61.48
F3C
N
N
NH
N
PPh2
L9
10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85 -90 -95 -105 -115 -125
f1 (ppm)

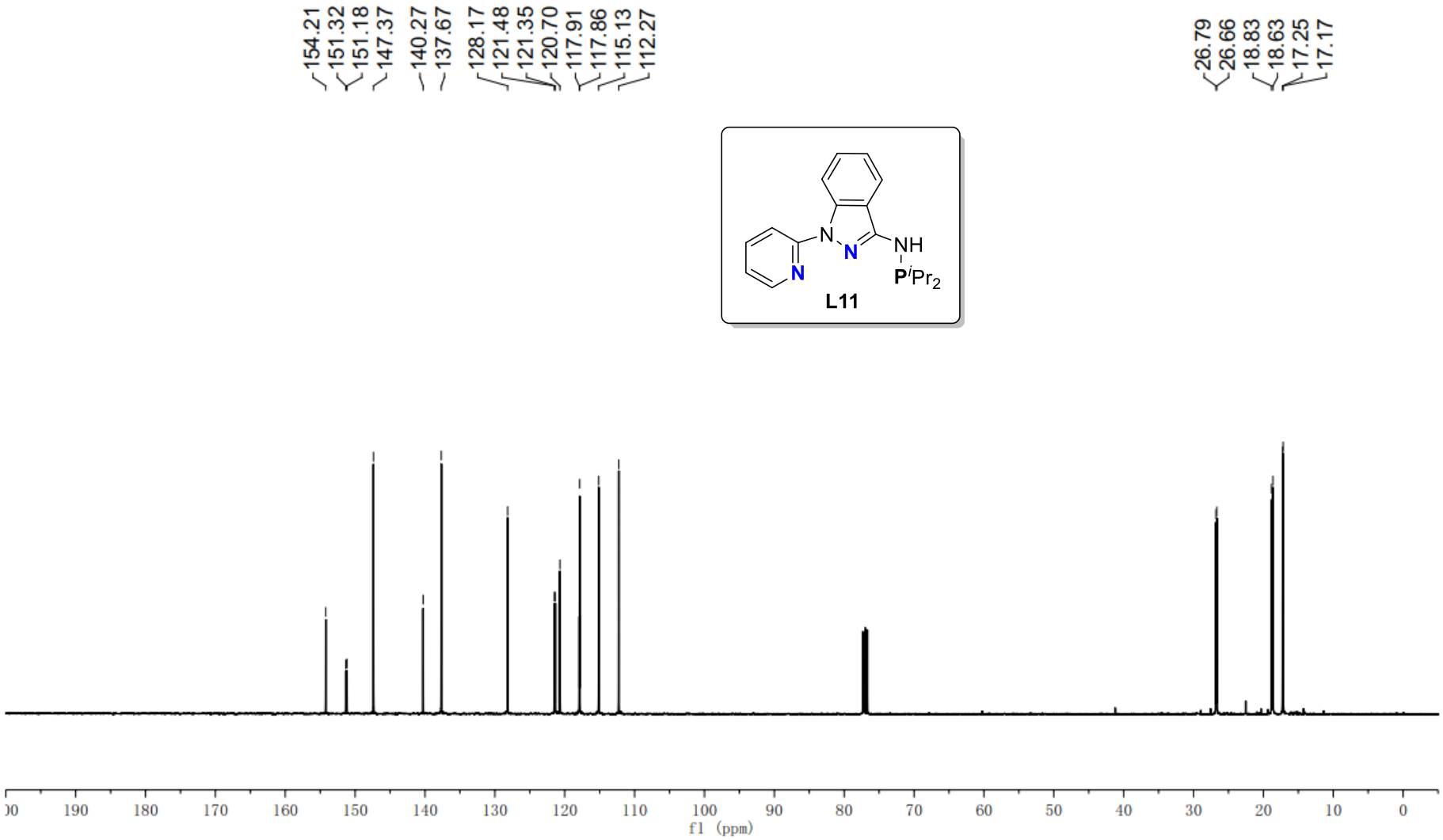

32.97
F3C
N
N
NH
N
PPh2
L9
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
−20
−30
−40
−50
−60
−70
f1 (ppm)

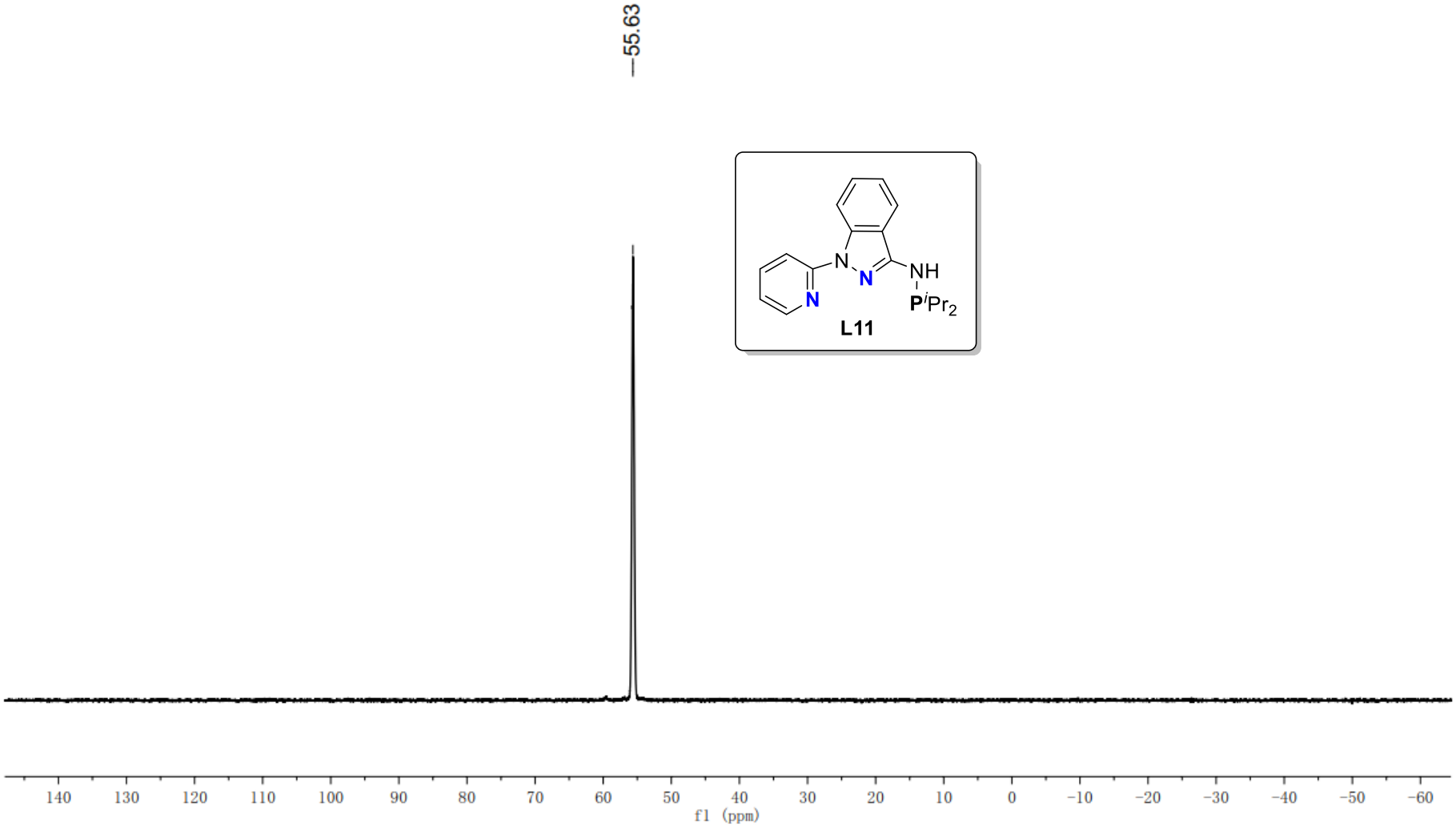

8.7898
8.7684
8.4346
8.4248
8.4227
8.1765
8.1572
7.8340
7.8132
7.7303
7.7258
7.7080
7.6913
7.6867
7.4827
7.4639
7.4439
7.1845
7.1655
7.1467
6.9889
6.9731
6.9589
4.6017
4.5894
1.8720
1.8009
1.7808
1.7473
1.7392
1.7249
1.7192
1.6969
1.6702
1.3196
1.2776
1.2485
1.2201
1.1882
N
N
NH
PCy2
L10
1.00
1.00
0.99
1.00
1.00
1.00
1.00
1.00
0.98
12.05
10.12
f1 (ppm)

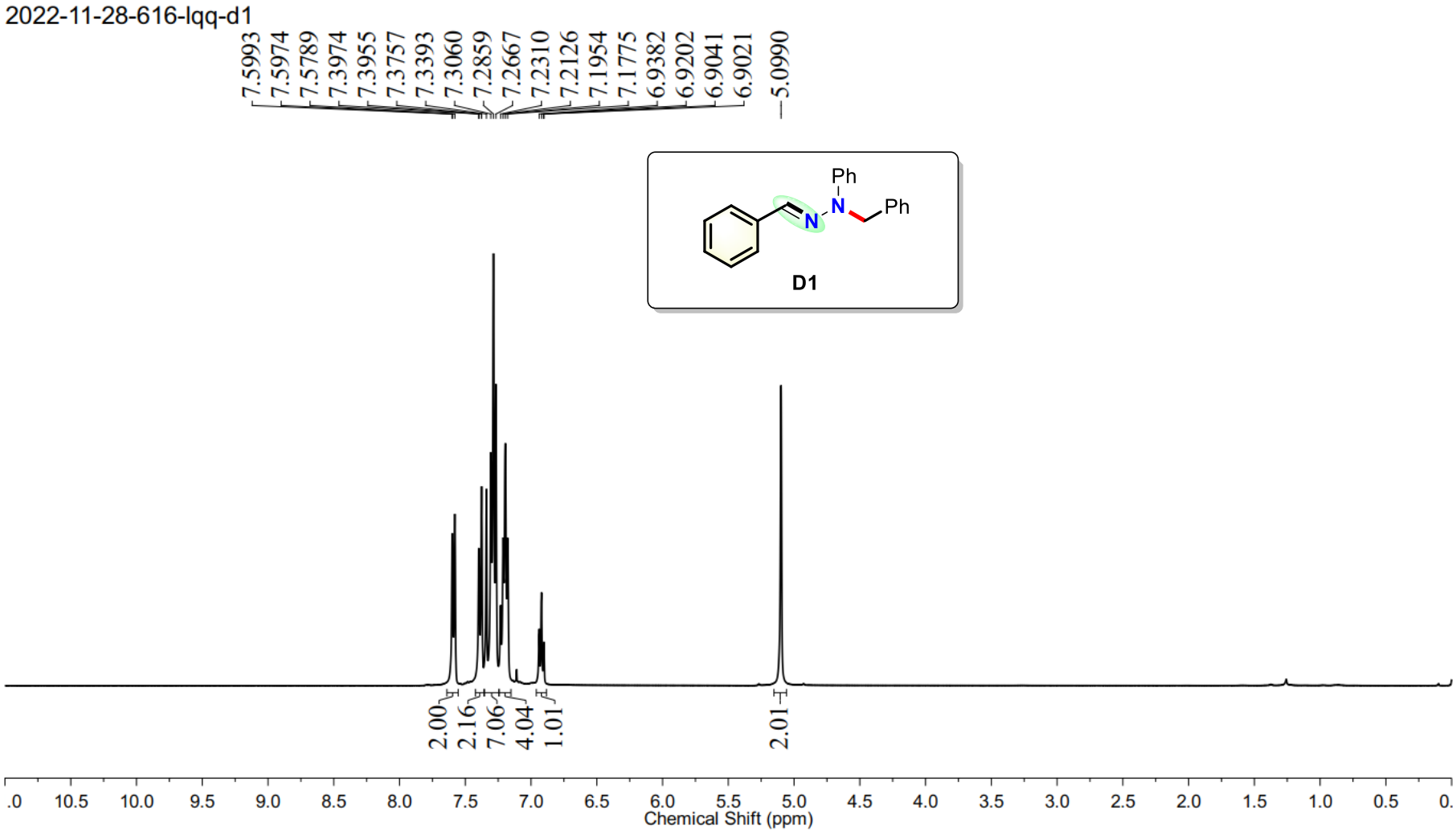

154.33
147.52
140.45
137.81
128.28
121.92
121.78
120.74
117.98
115.16
112.41
36.68
36.56
29.08
28.90
27.19
27.12
26.83
26.75
N
N
NH
PCy2
L10
f1 (ppm)

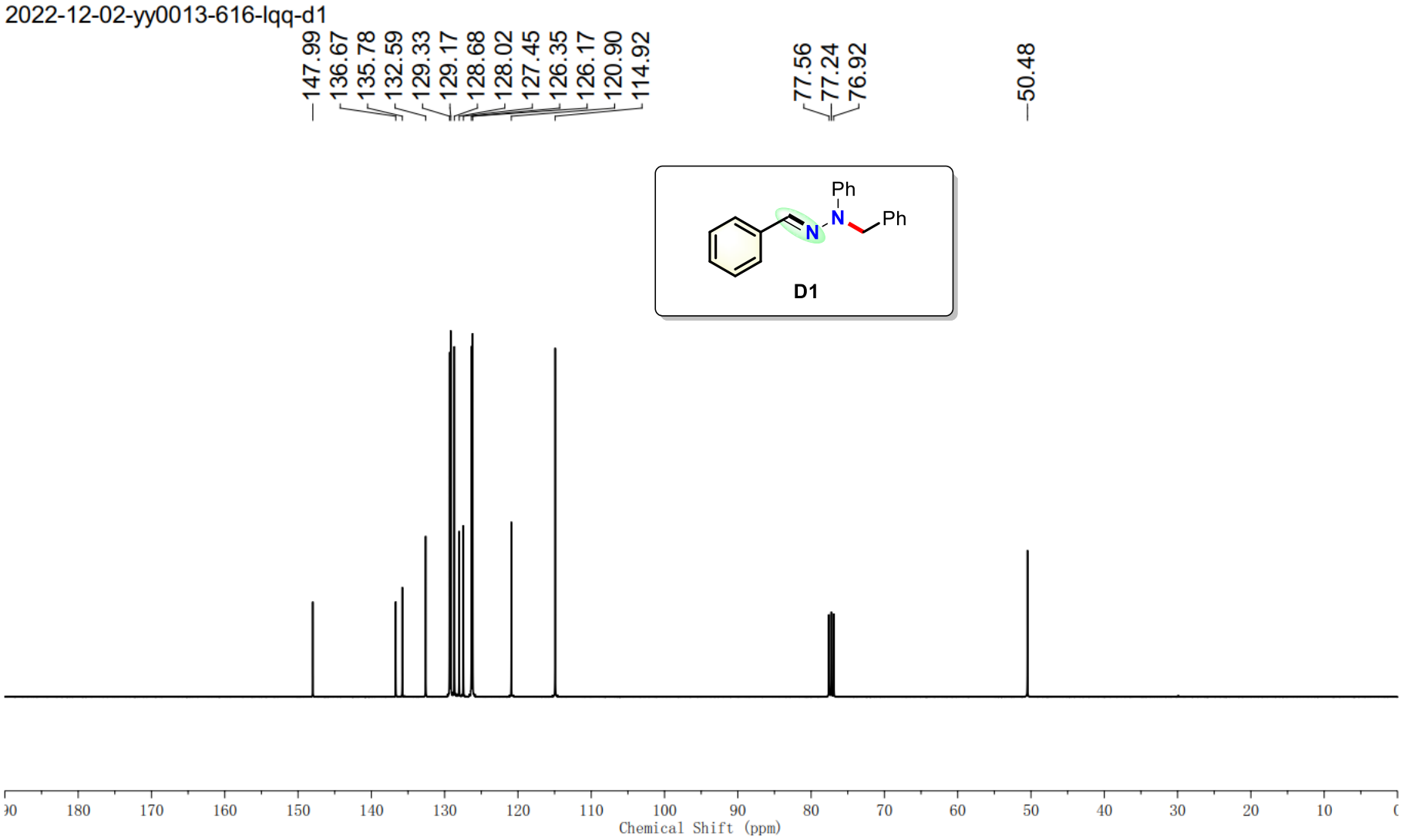

48.74
N
N
NH
PCy2
L10
140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80
f1 (ppm)

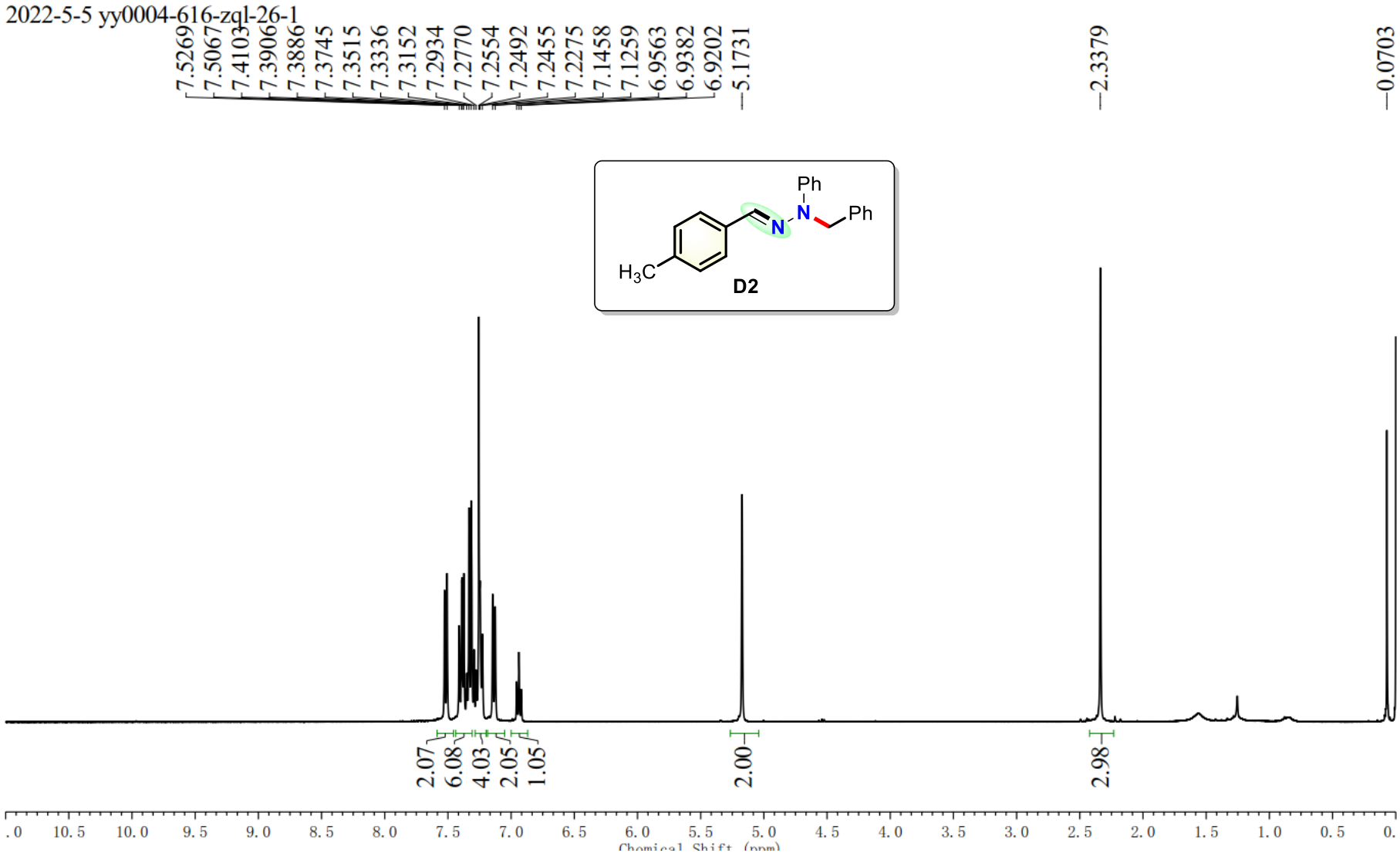

8.8433
8.8219
8.4561
8.4544
8.4517
8.4500
8.4440
8.4422
8.4395
8.1588
8.1386
7.8750
7.8540
7.7301
7.7253
7.7119
7.7087
7.7074
7.7045
7.6909
7.6861
7.5147
7.5122
7.4971
7.4941
7.4911
7.4759
7.4733
7.2148
7.2131
7.1951
7.1771
7.1754
6.9871
6.9849
6.9748
6.9725
6.9692
6.9668
6.9568
6.9545
4.6297
4.6156
1.9861
1.9836
1.9685
1.9661
1.9509
1.9485
1.9333
1.9310
1.9158
1.1870
1.1692
1.1580
1.1471
1.1406
1.1293
N
N
NH
N
P$^{i}$Pr$_2$
L11
1.00
0.98
1.00
1.00
1.00
1.00
1.00
1.00
1.00
2.08
12.00
f1 (ppm)

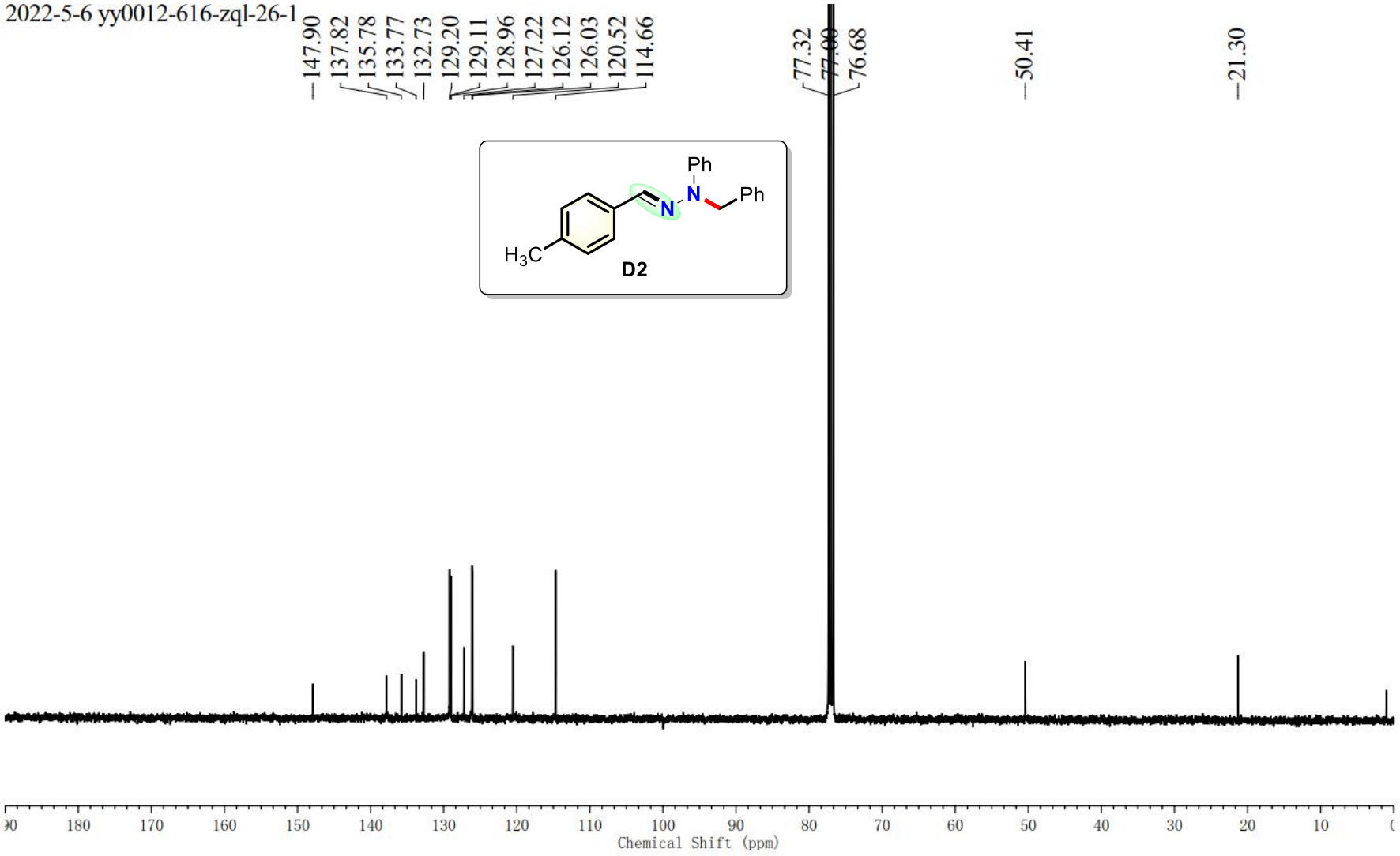

154.21
151.32
151.18
147.37
140.27
137.67
128.17
121.48
121.35
120.70
117.91
117.86
115.13
112.27
26.79
26.66
18.83
18.63
17.25
17.17
N
N
N
NH
P$^{i}$Pr$_2$
L11
f1 (ppm)

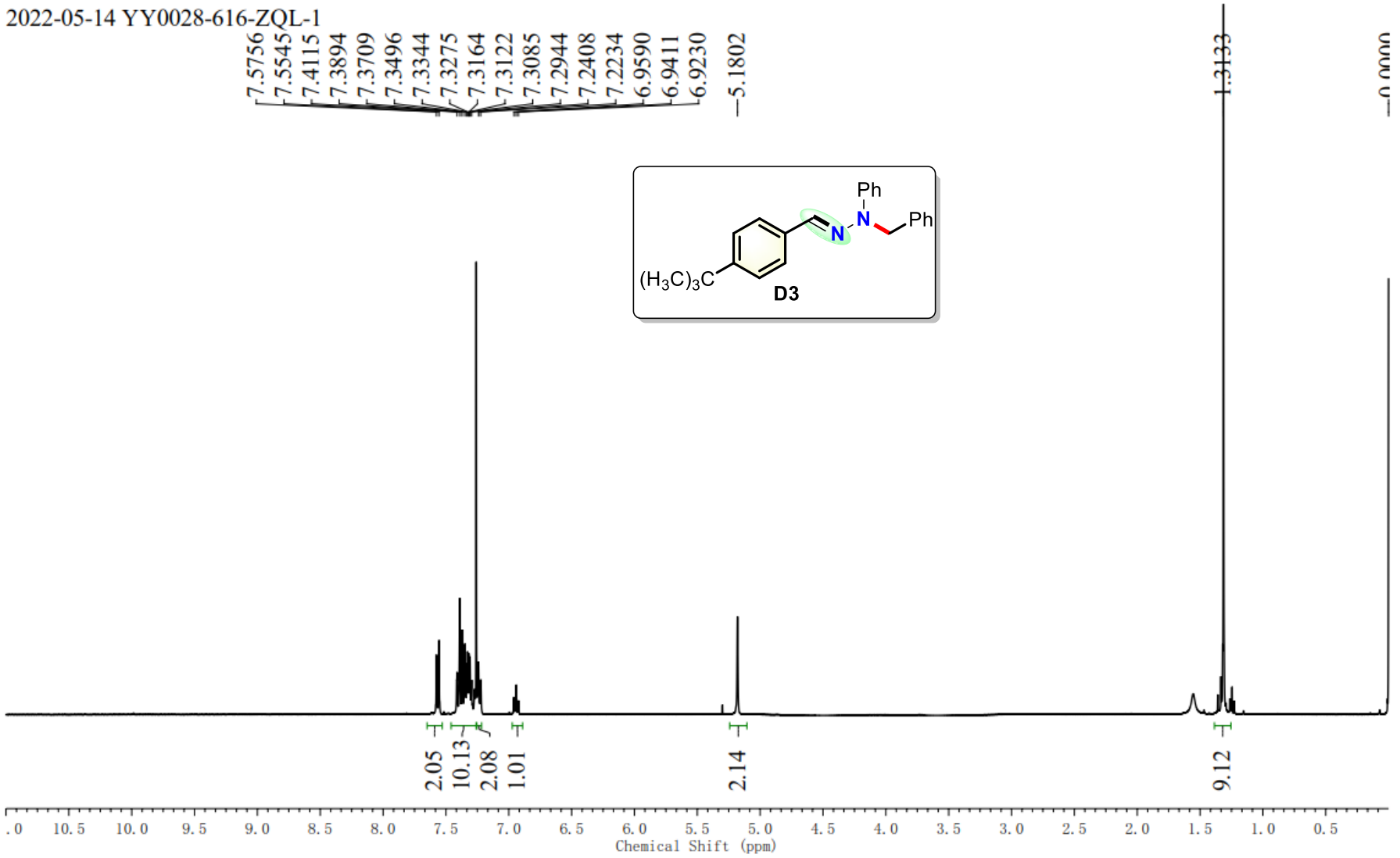

55.63
N
N
NH
P$^i$Pr$_2$
L11
140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10 −20 −30 −40 −50 −60
f1 (ppm)

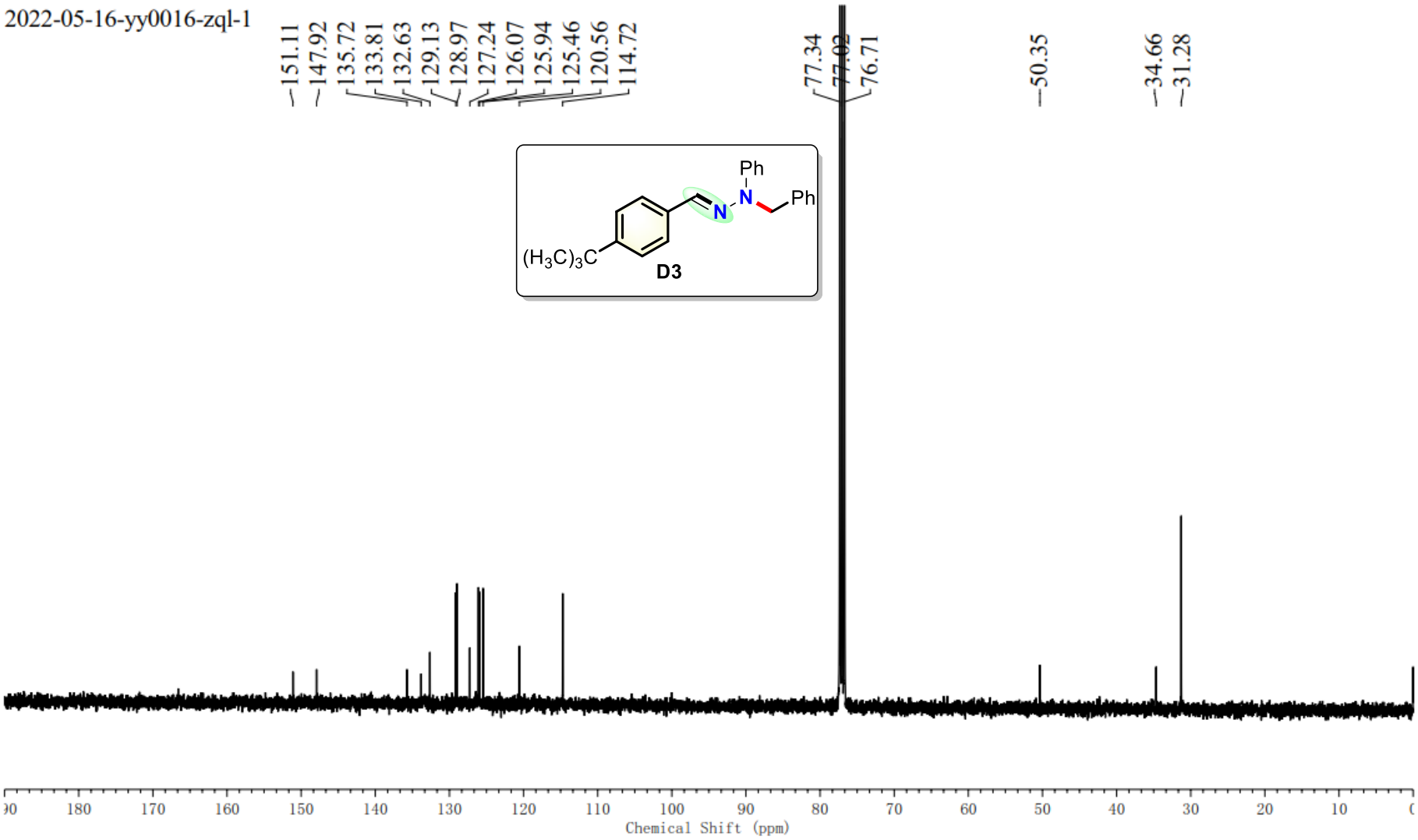

2022-11-28-616-lqq-d1
7.5993
7.5974
7.5789
7.3974
7.3955
7.3757
7.3393
7.3060
7.2859
7.2667
7.2310
7.2126
7.1954
7.1775
6.9382
6.9202
6.9041
6.9021
5.0990
Ph
N
N
Ph
D1
2.00
2.16
7.06
4.04
1.01
2.01
Chemical Shift (ppm)

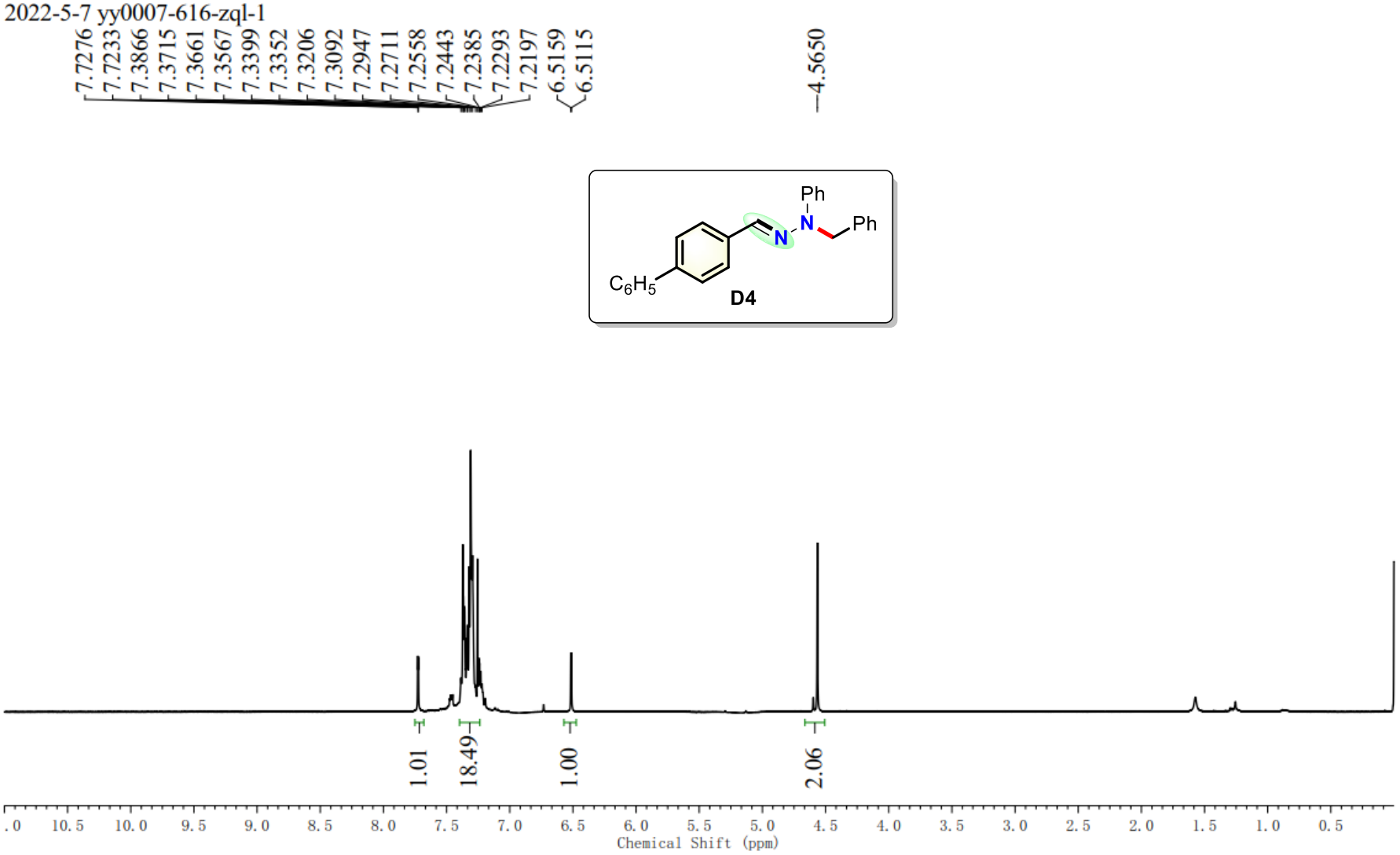

2022-12-02-yy0013-616-lqq-d1
147.99
136.67
135.78
132.59
129.33
129.17
128.68
128.02
127.45
126.35
126.17
120.90
114.92
77.56
77.24
76.92
50.48
Ph
N
N
Ph
D1
Chemical Shift (ppm)

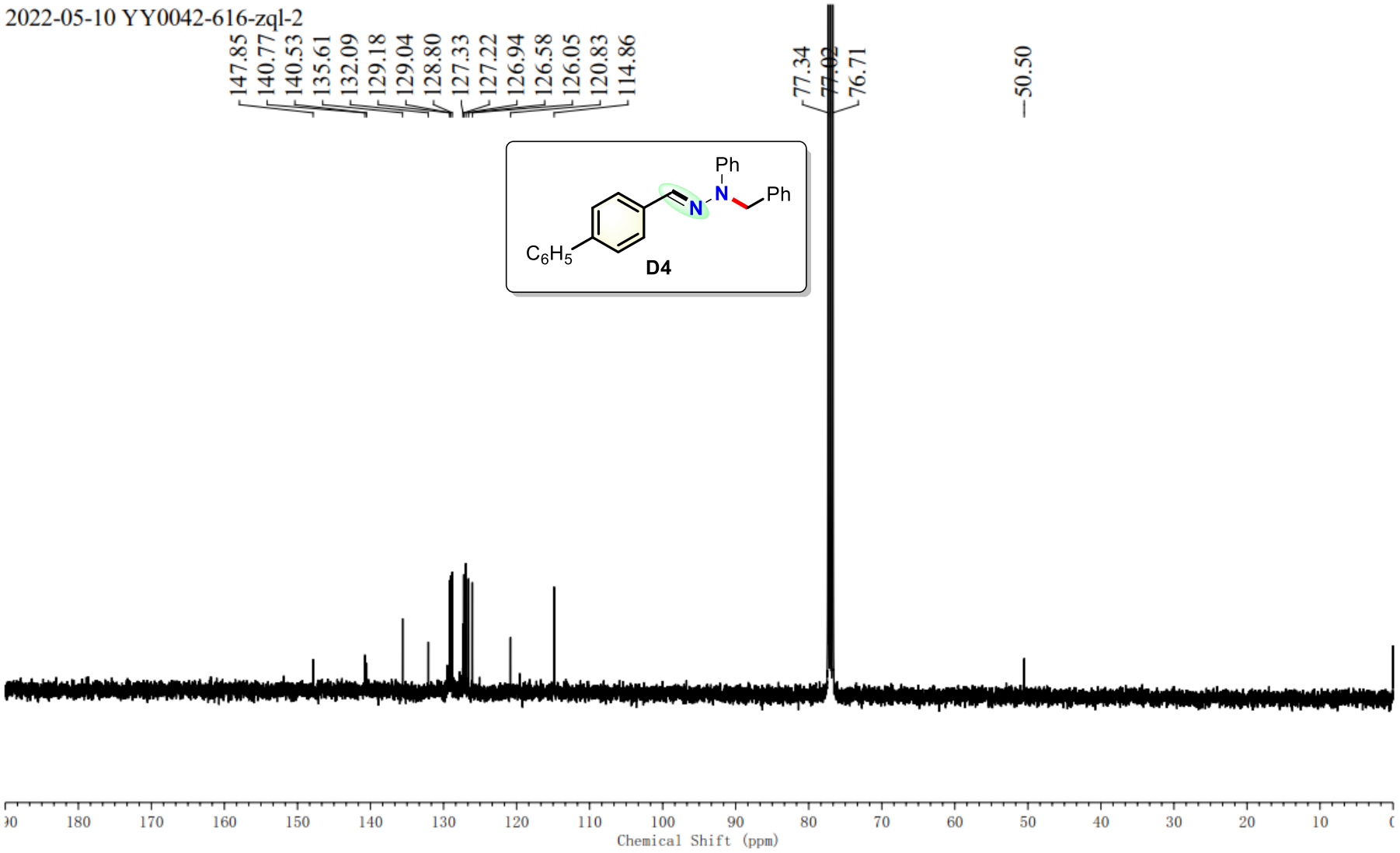

2022-5-5 yy0004-616-zql-26-1
7.5269
7.5067
7.4103
7.3906
7.3886
7.3745
7.3515
7.3336
7.3152
7.2934
7.2770
7.2554
7.2492
7.2455
7.2275
7.1458
7.1259
6.9563
6.9382
6.9202
5.1731
2.3379
0.0703
Ph
N
N
Ph
H3C
D2
2.07
6.08
4.03
2.05
1.05
2.00
2.98
Chemical Shift (ppm)

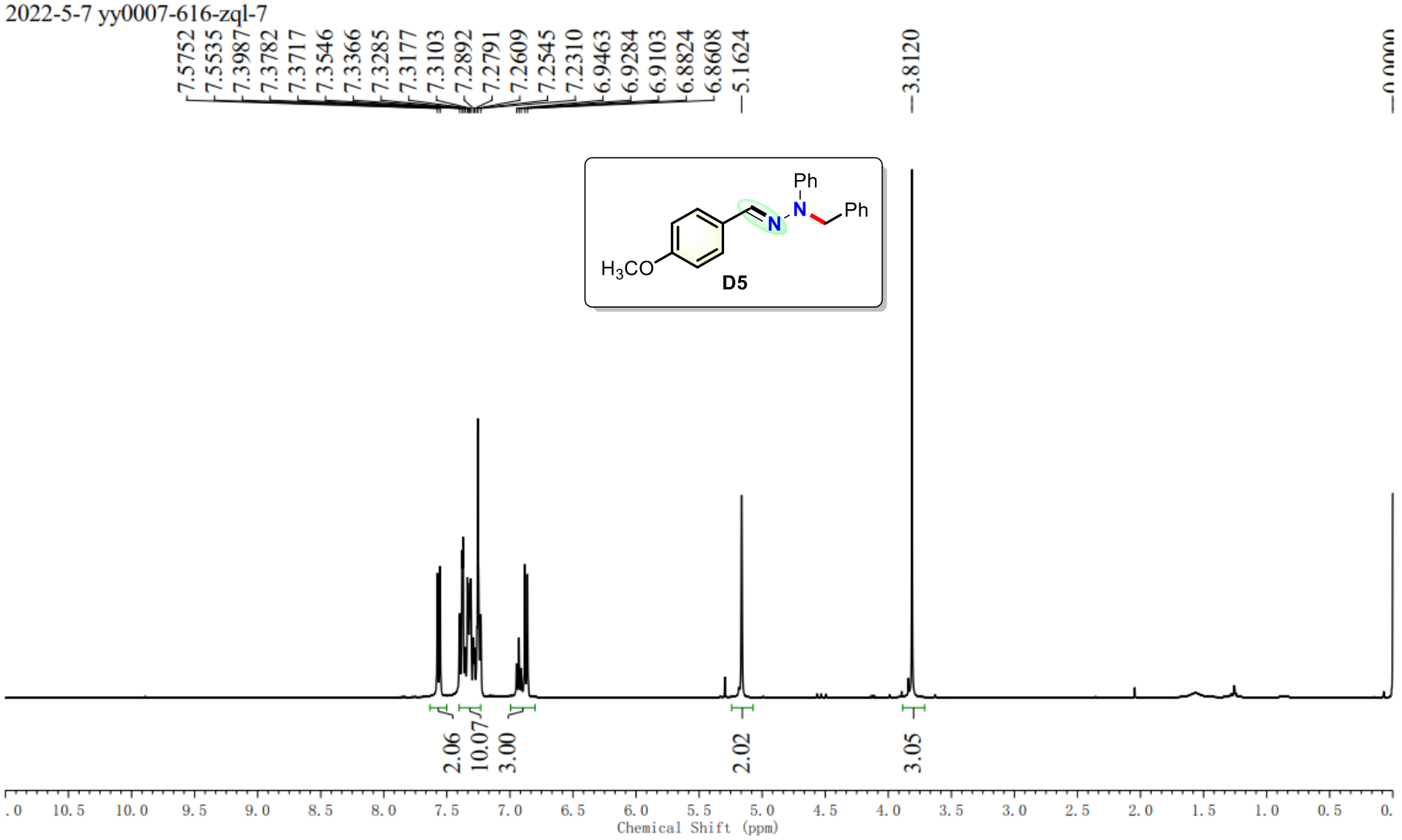

2022-5-6 yy0012-616-zql-26-1
147.90
137.82
135.78
133.77
132.73
129.20
129.11
128.96
127.22
126.12
126.03
120.52
114.66
77.32
77.00
76.68
50.41
21.30
Ph
N
N
Ph
H3C
D2
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

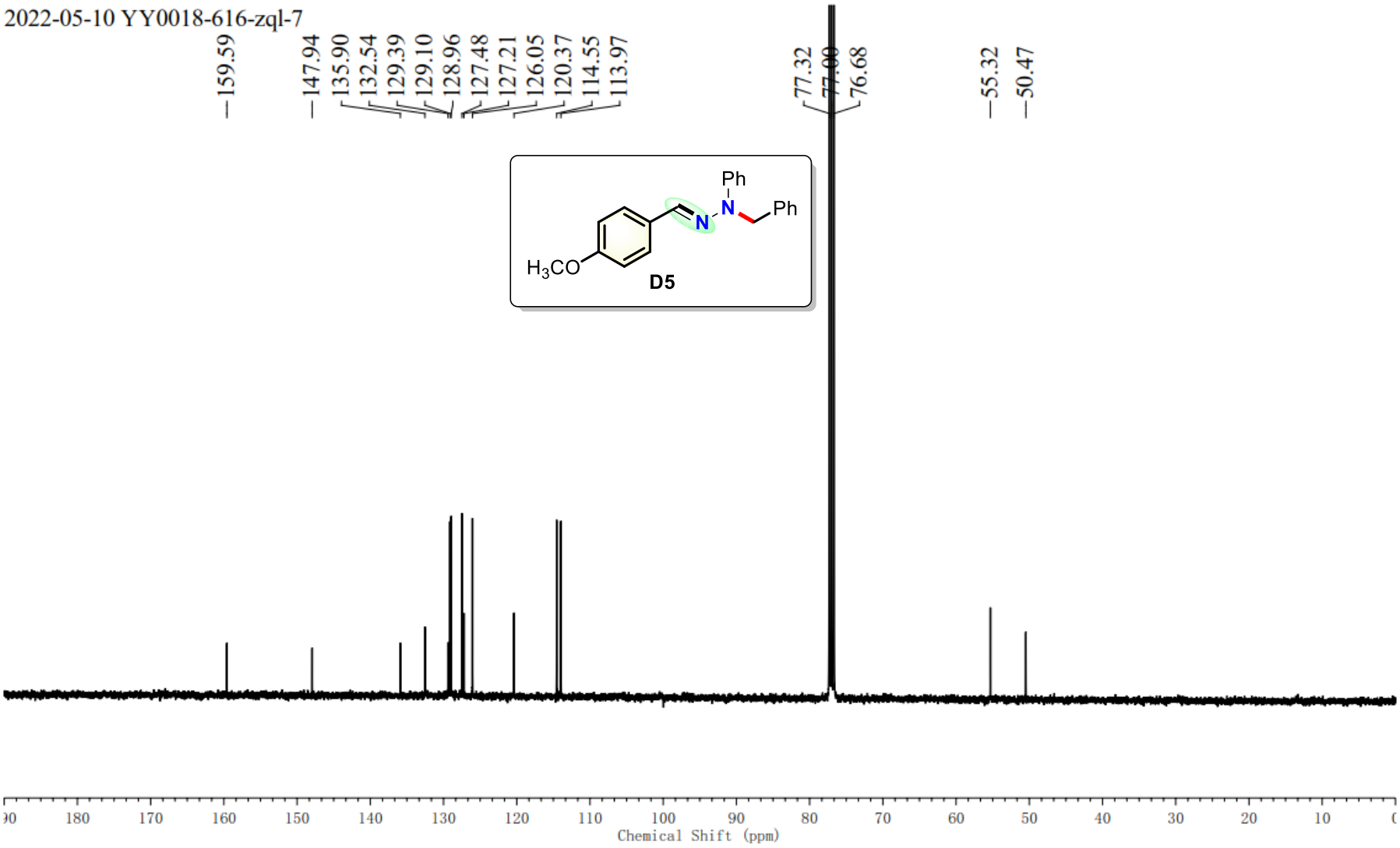

2022-05-14 YY0028-616-ZQL-1
7.5756
7.5545
7.4115
7.3894
7.3709
7.3496
7.3344
7.3275
7.3164
7.3122
7.3085
7.2944
7.2408
7.2234
6.9590
6.9411
6.9230
5.1802
1.3133
0.0000
Ph
N
N
Ph
(H3C)3C
D3
2.05
10.13
2.08
1.01
2.14
9.12
Chemical Shift (ppm)

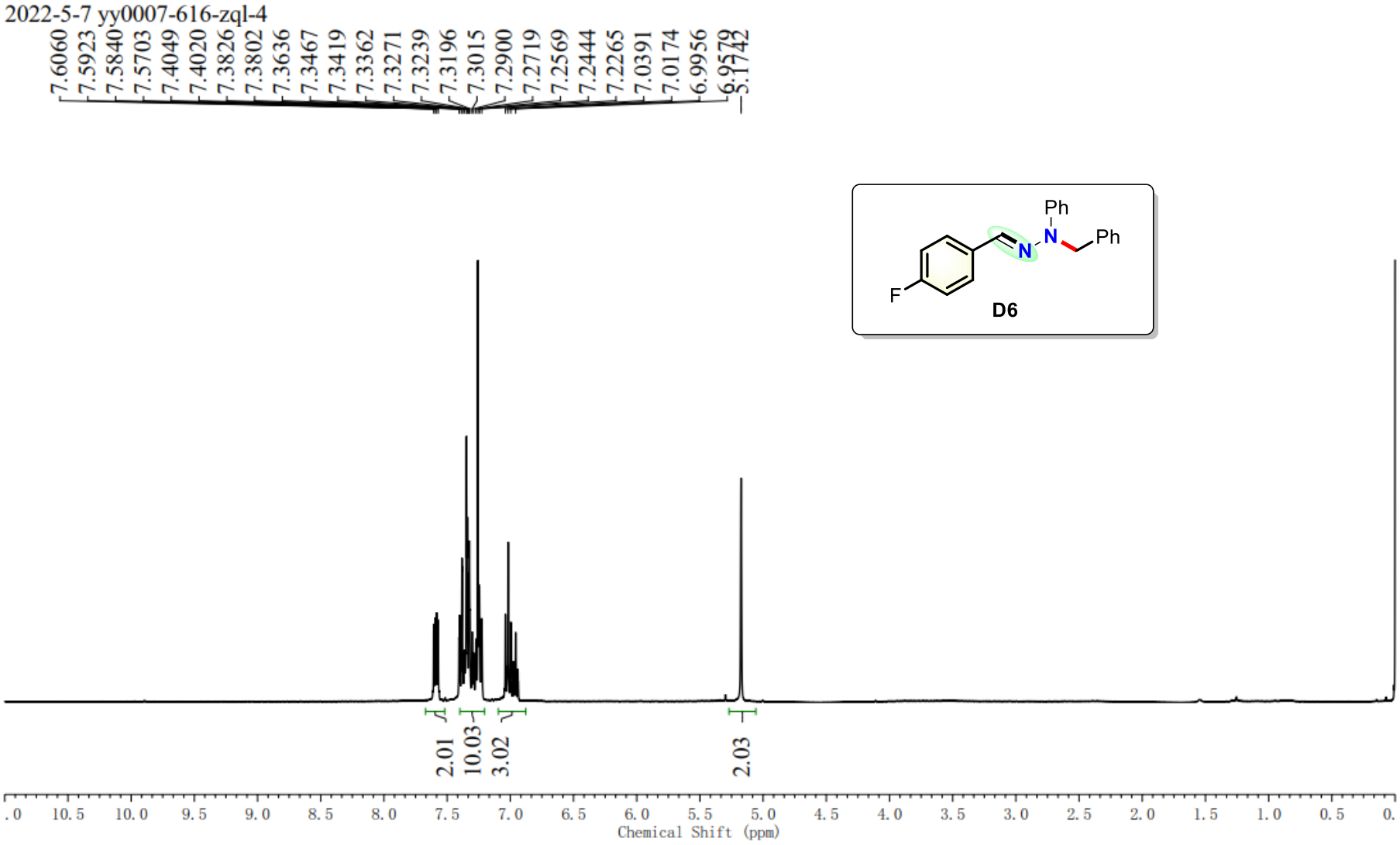

2022-05-16-yy0016-zql-1
151.11
147.92
135.72
133.81
132.63
129.13
128.97
127.24
126.07
125.94
125.46
120.56
114.72
77.34
77.02
76.71
50.35
34.66
31.28
Ph
N
N
Ph
(H3C)3C
D3
Chemical Shift (ppm)

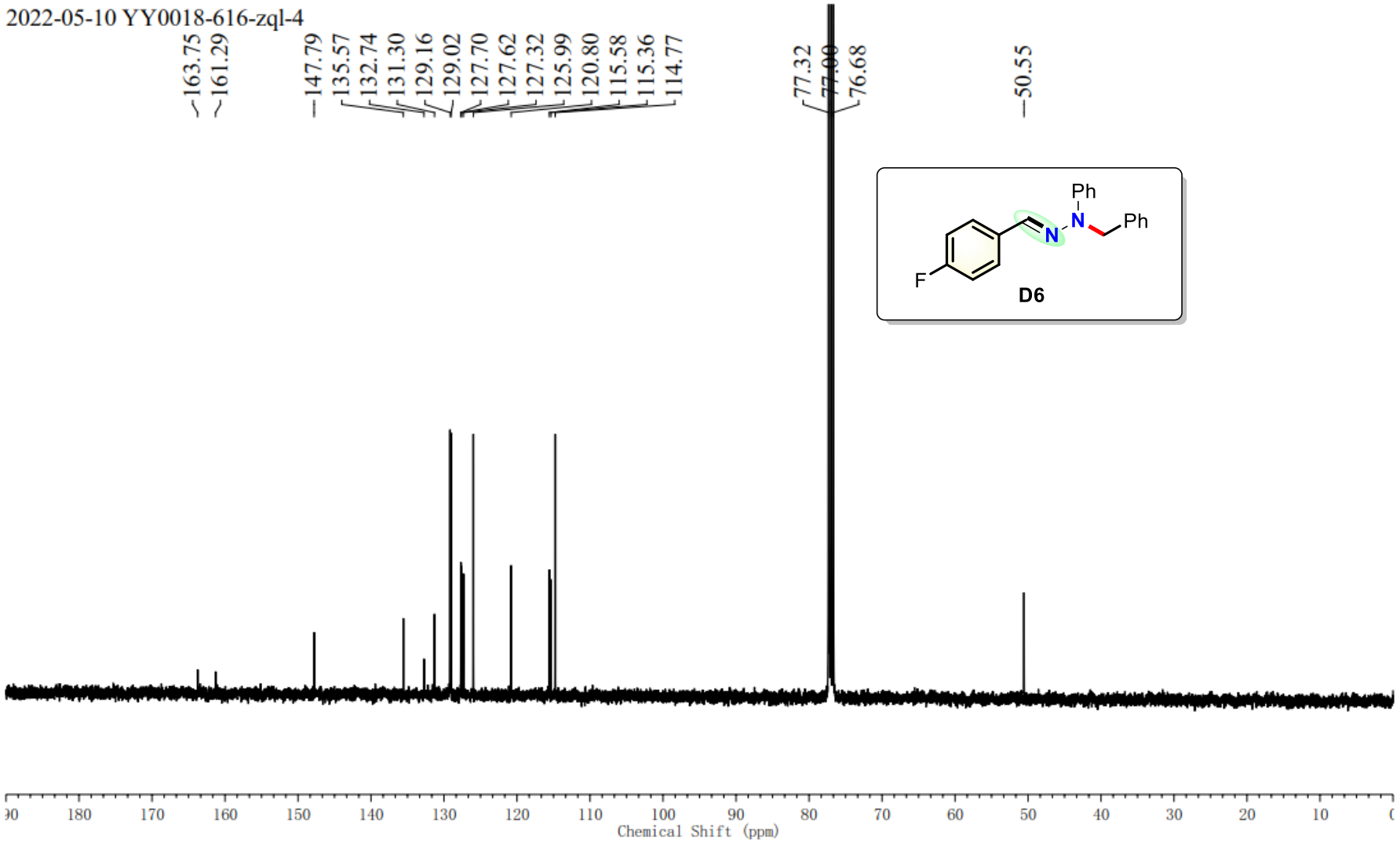

2022-5-7 yy0007-616-zql-1
7.7276
7.7233
7.3866
7.3715
7.3661
7.3567
7.3399
7.3352
7.3206
7.3092
7.2947
7.2711
7.2558
7.2443
7.2385
7.2293
7.2197
6.5159
6.5115
4.5650
Ph
N
N
Ph
C6H5
D4
1.01
18.49
1.00
2.06
Chemical Shift (ppm)


2022-05-10 YY0042-616-zql-2
147.85
140.77
140.53
135.61
132.09
129.18
129.04
128.80
127.33
127.22
126.94
126.58
126.05
120.83
114.86
77.34
77.02
76.71
50.50
Ph
N
N
Ph
C6H5
D4
Chemical Shift (ppm)

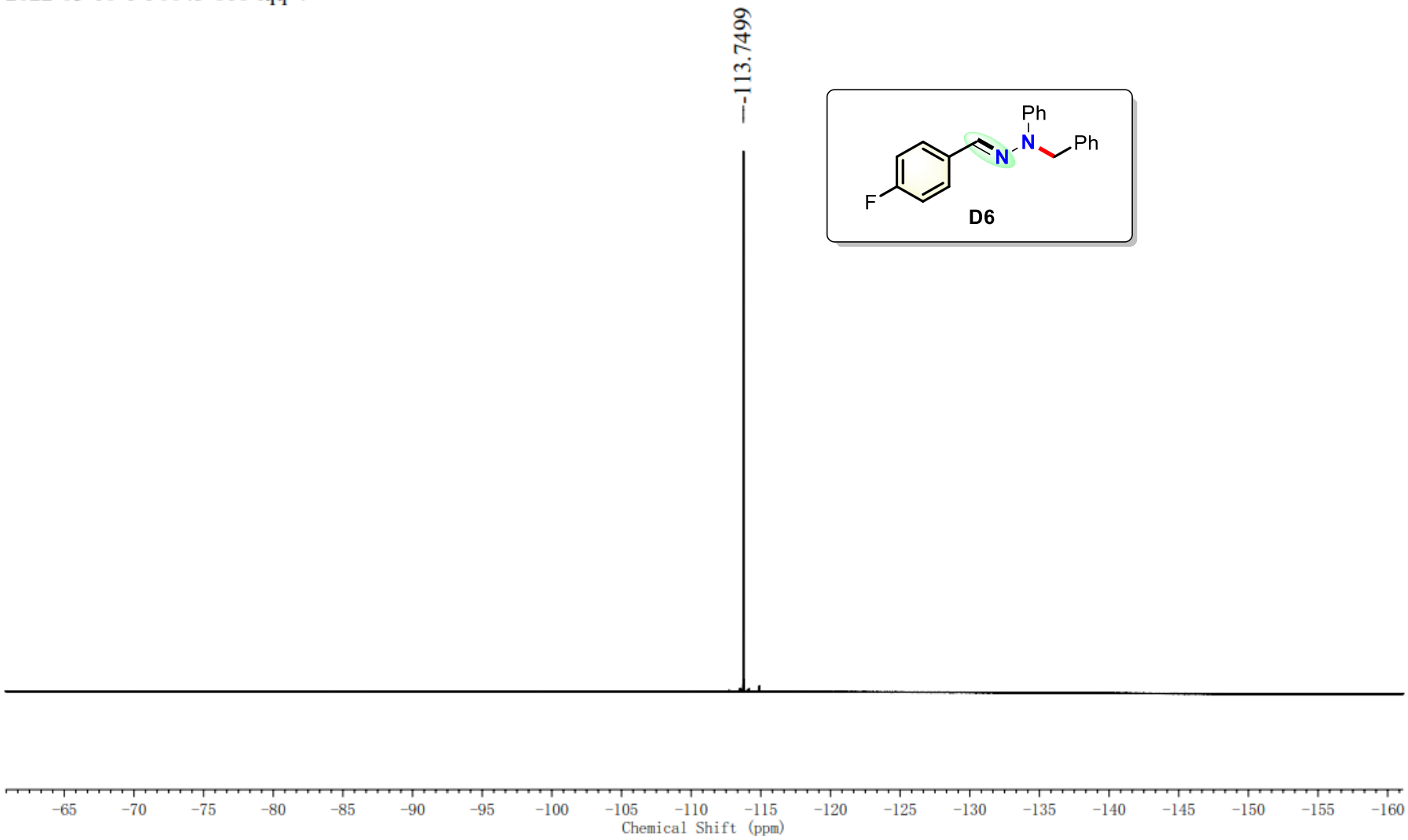

2022-5-7 yy0007-616-zql-7
7.5752
7.5535
7.3987
7.3782
7.3717
7.3546
7.3366
7.3285
7.3177
7.3103
7.2892
7.2791
7.2609
7.2545
7.2310
6.9463
6.9284
6.9103
6.8824
6.8608
5.1624
3.8120
0.0000
Ph
N
Ph
N
H3CO
D5
2.06
10.07
3.00
2.02
3.05
Chemical Shift (ppm)

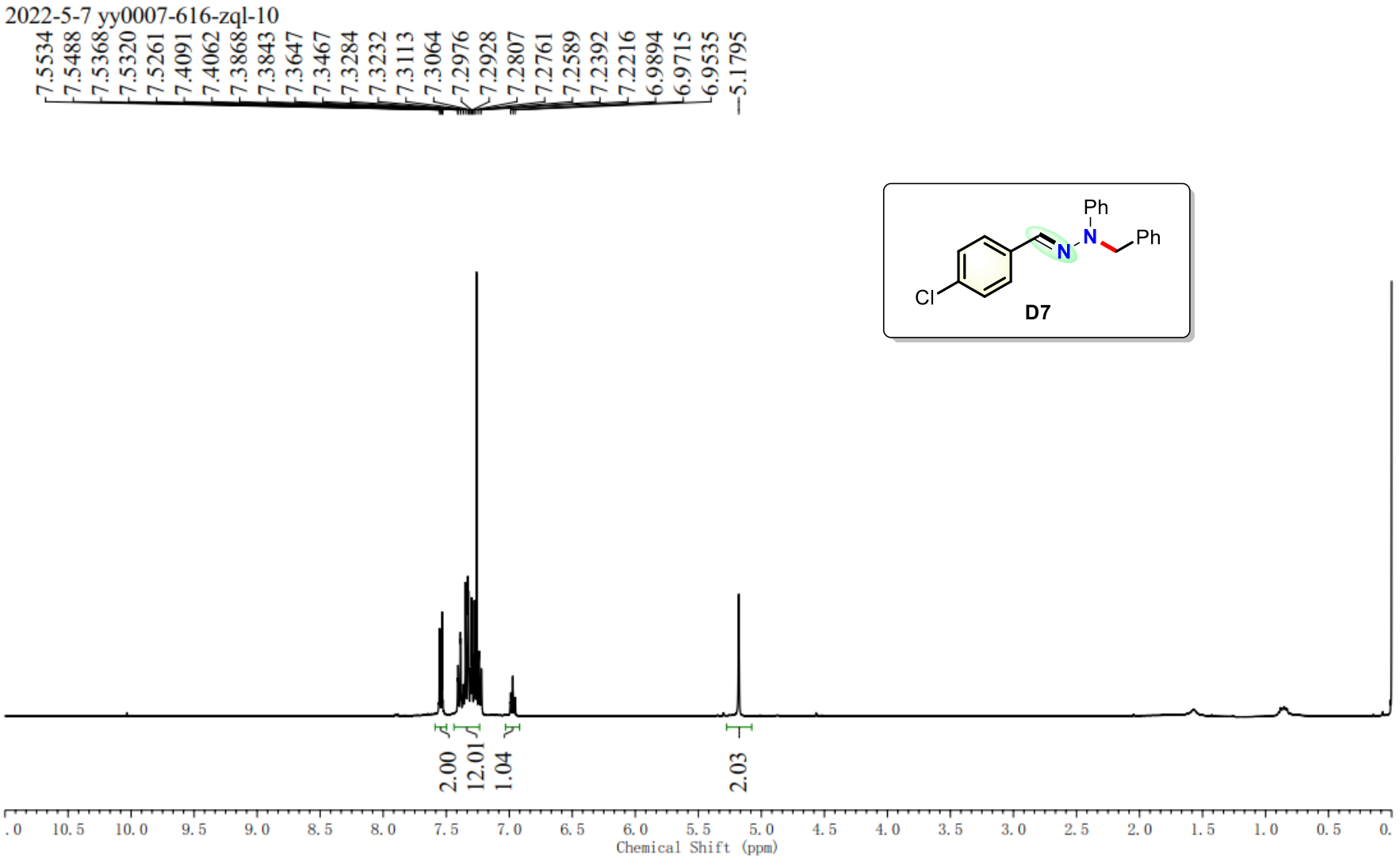

2022-05-10 YY0018-616-zql-7
159.59
147.94
135.90
132.54
129.39
129.10
128.96
127.48
127.21
126.05
120.37
114.55
113.97
77.32
77.00
76.68
55.32
50.47
Ph
N
N
Ph
H3CO
D5
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

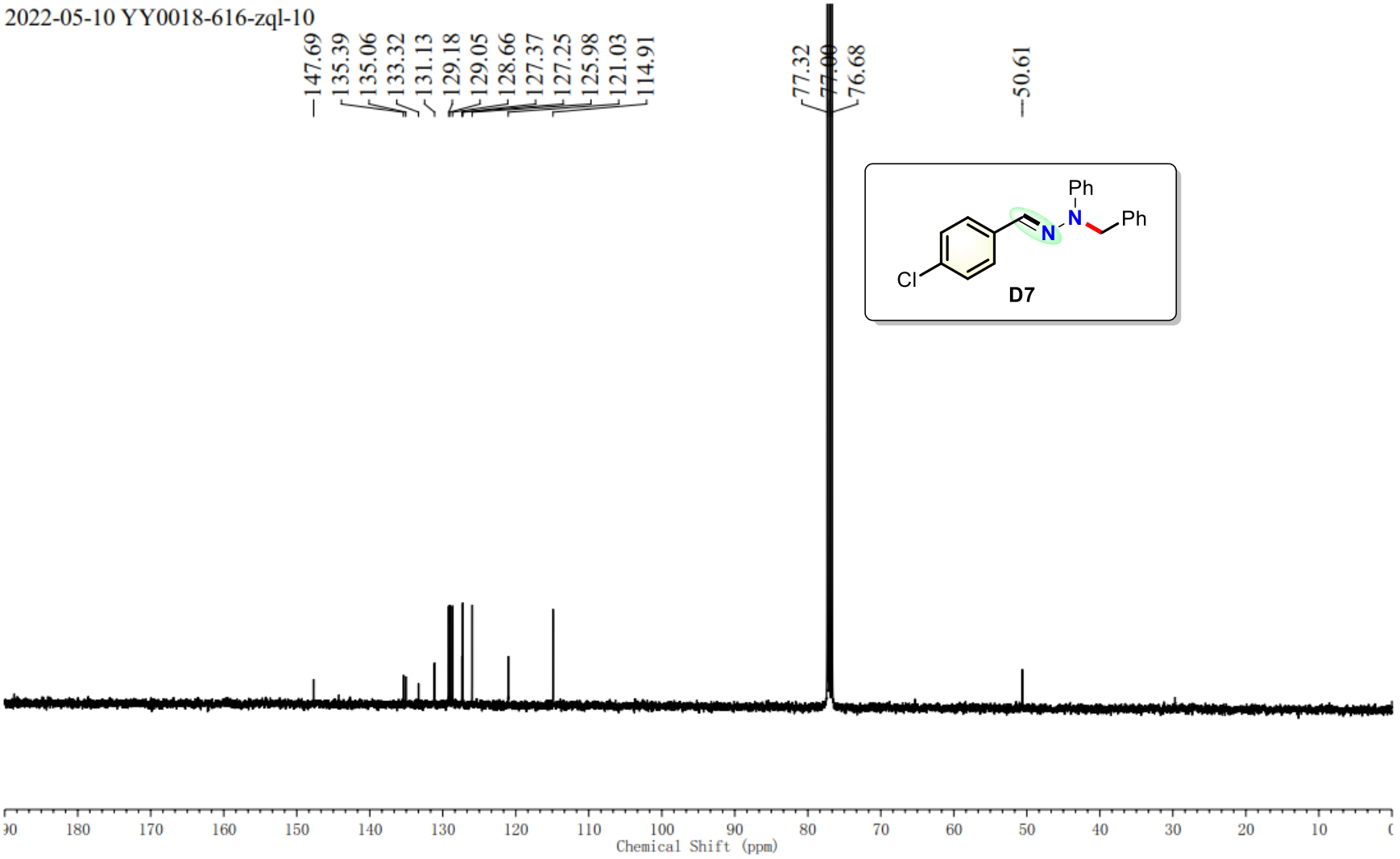

2022-5-7 yy0007-616-zql-4
7.6060
7.5923
7.5840
7.5703
7.4049
7.4020
7.3826
7.3802
7.3636
7.3467
7.3419
7.3362
7.3271
7.3239
7.3196
7.3015
7.2900
7.2719
7.2569
7.2444
7.2265
7.0391
7.0174
6.9956
6.9579
5.1742
Ph
N
N
Ph
F
D6
2.01
10.03
3.02
2.03
Chemical Shift (ppm)


2022-05-10 YY0018-616-zql-4
163.75
161.29
147.79
135.57
132.74
131.30
129.16
129.02
127.70
127.62
127.32
125.99
120.80
115.58
115.36
114.77
77.32
77.00
76.68
50.55
Ph
N
N
Ph
F
D6
Chemical Shift (ppm)

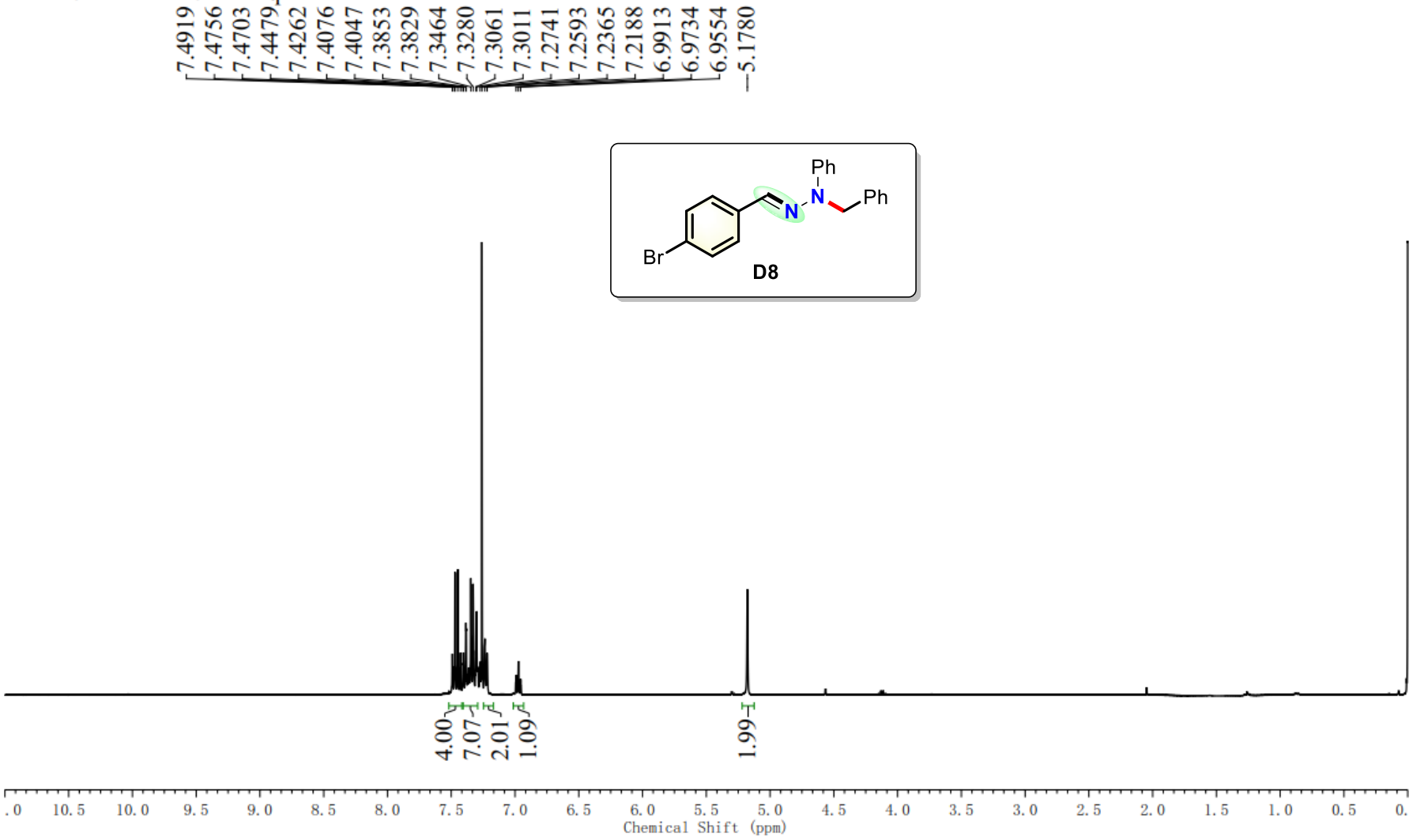
2022-05-10 YY0043-616-lqq-4

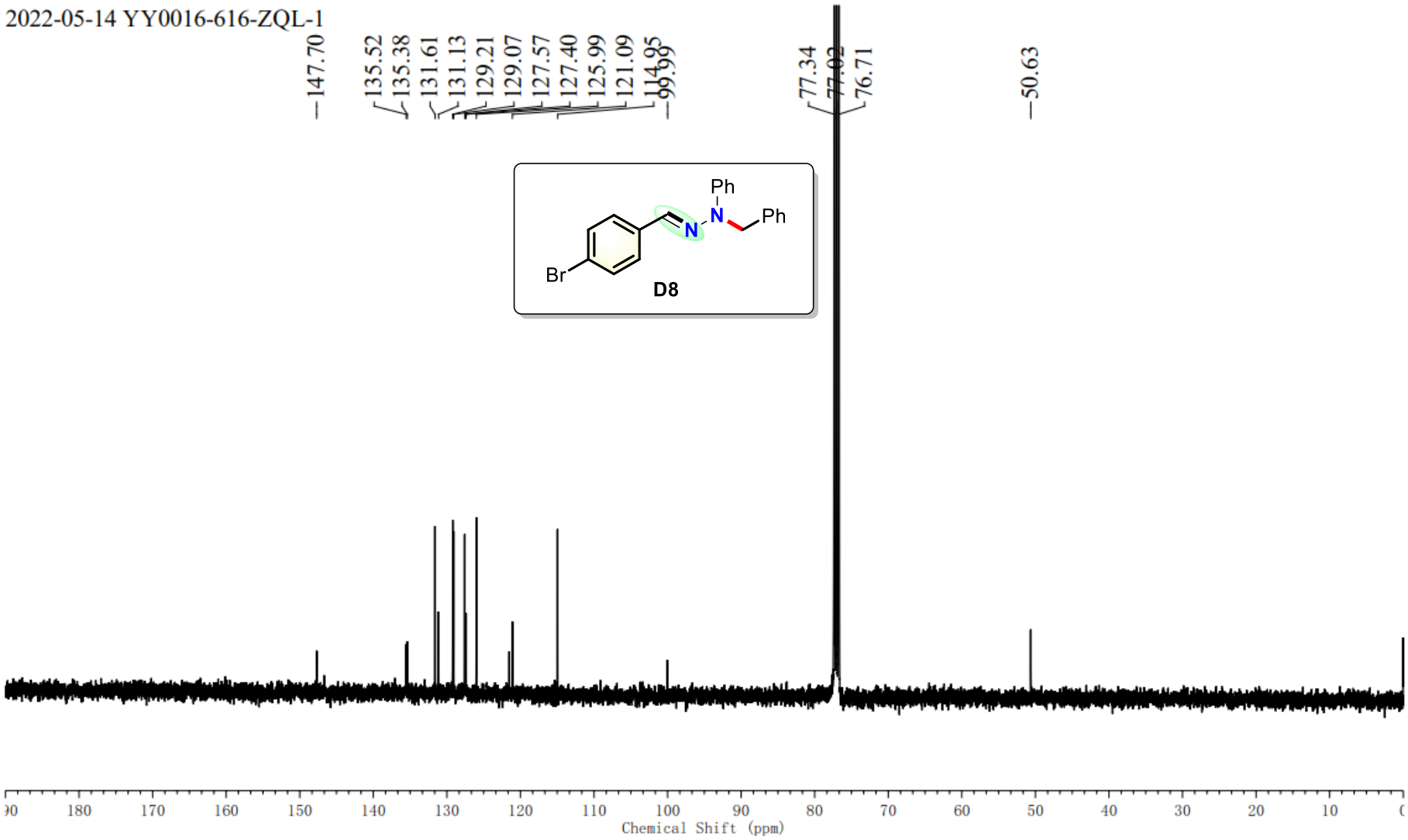


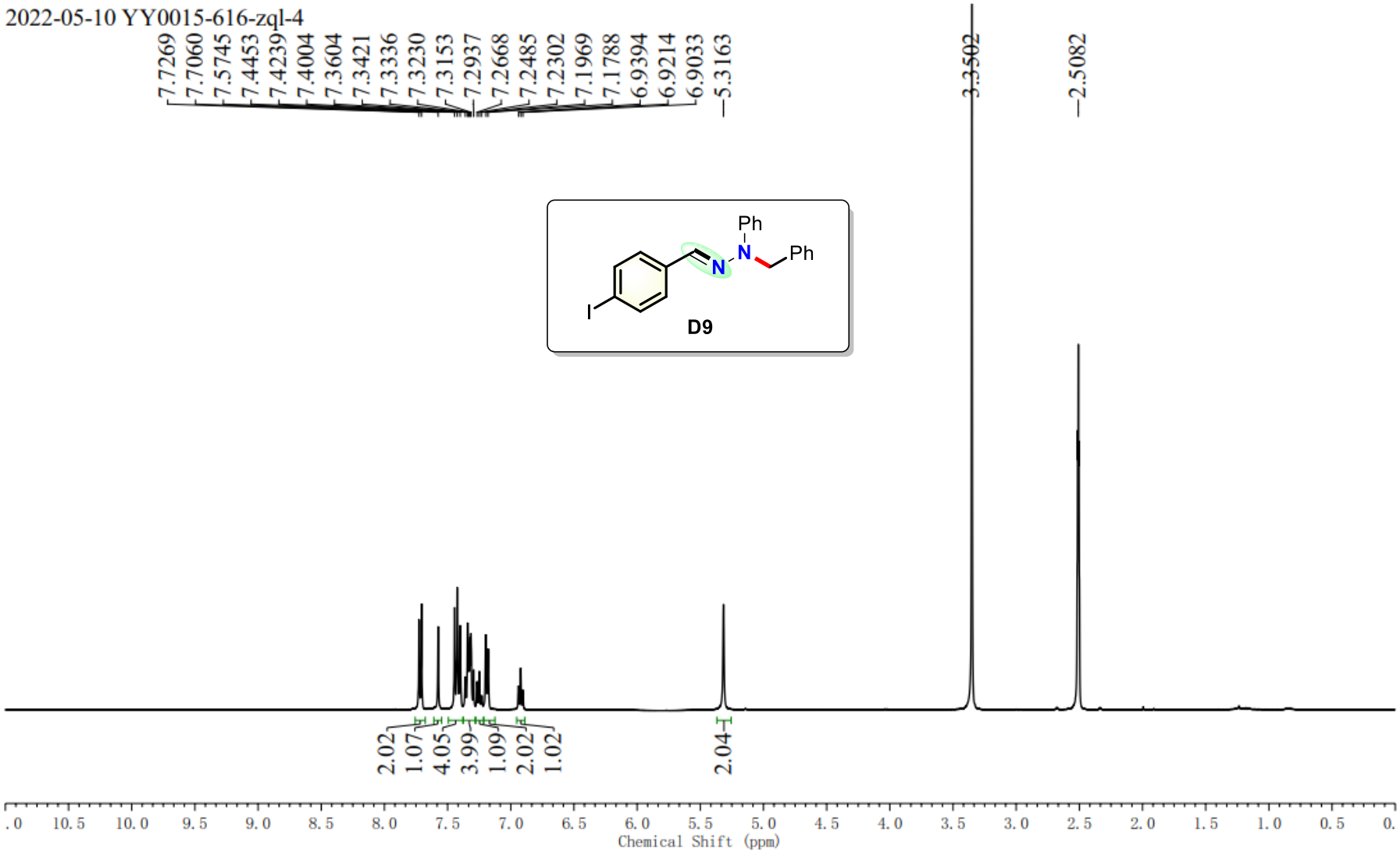

2022-5-7 yy0007-616-zql-10
7.5534
7.5488
7.5368
7.5320
7.5261
7.4091
7.4062
7.3868
7.3843
7.3647
7.3467
7.3284
7.3232
7.3113
7.3064
7.2976
7.2928
7.2807
7.2761
7.2589
7.2392
7.2216
6.9894
6.9715
6.9535
5.1795
Ph
N
N
Ph
Cl
D7
2.00
12.01
1.04
2.03
Chemical Shift (ppm)

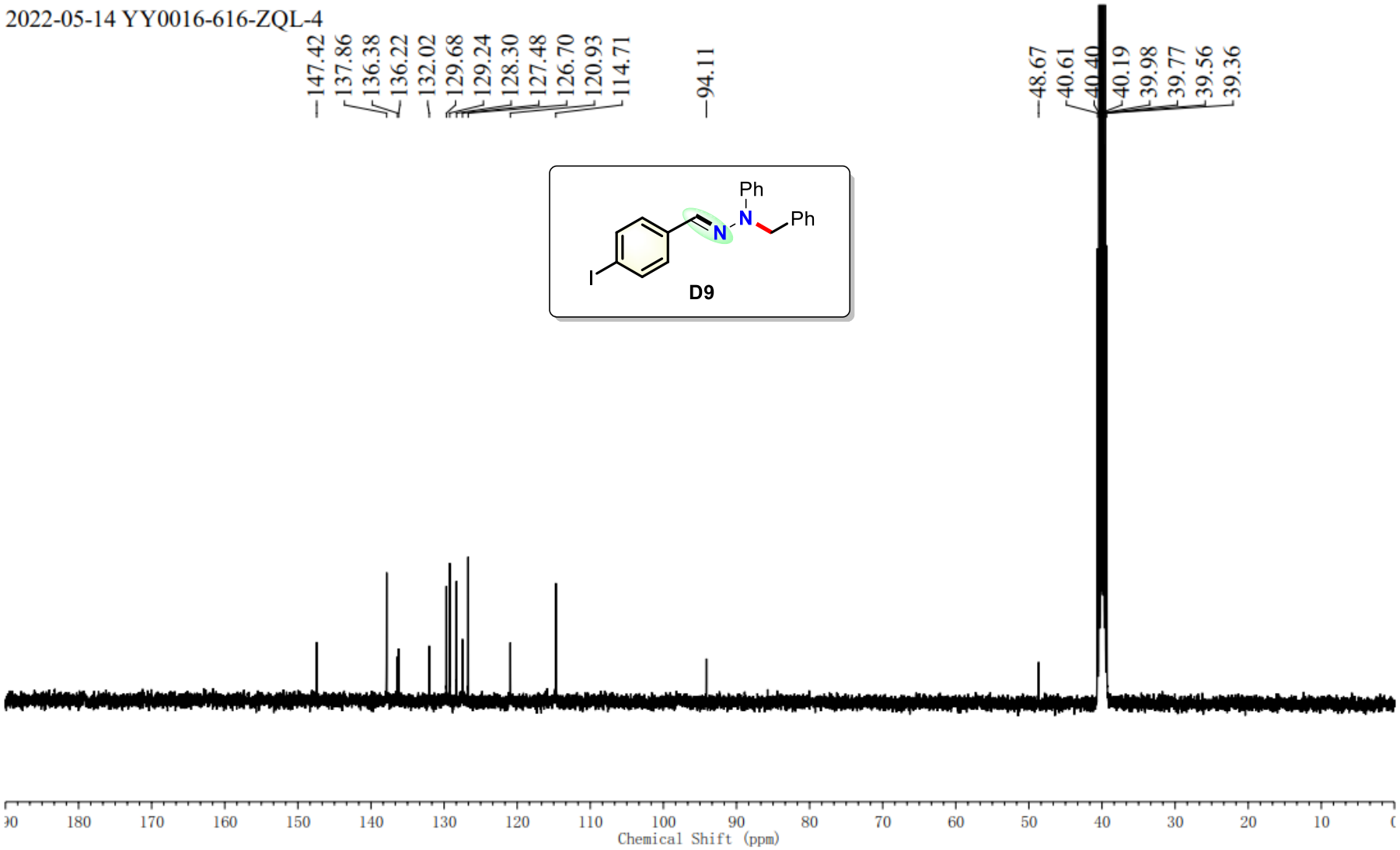

2022-05-10 YY0018-616-zql-10
147.69
135.39
135.06
133.32
131.13
129.18
129.05
128.66
127.37
127.25
125.98
121.03
114.91
77.32
77.00
76.68
50.61
Ph
N
N
Ph
Cl
D7
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

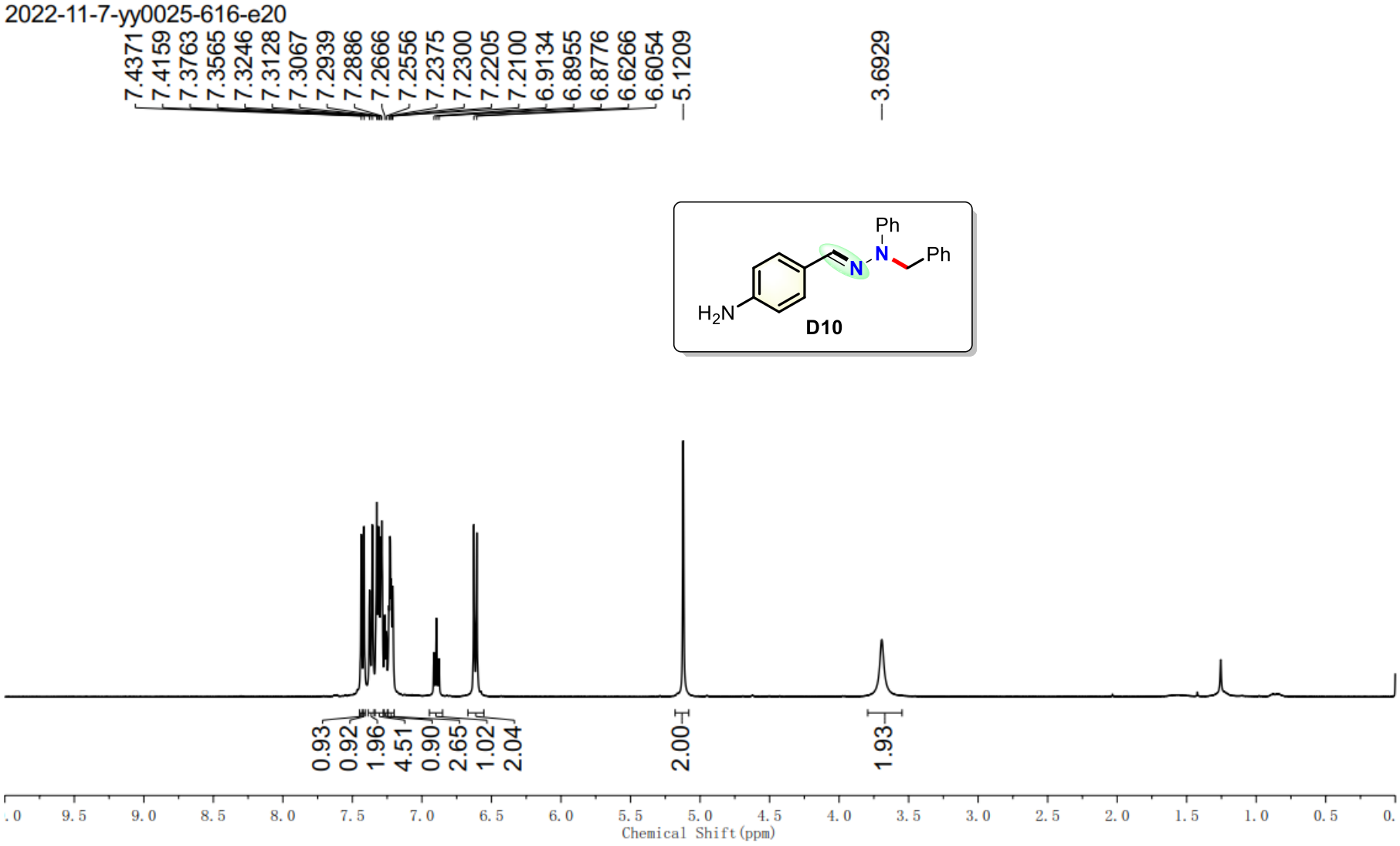
2022-05-10 YY0015-616-zql-1



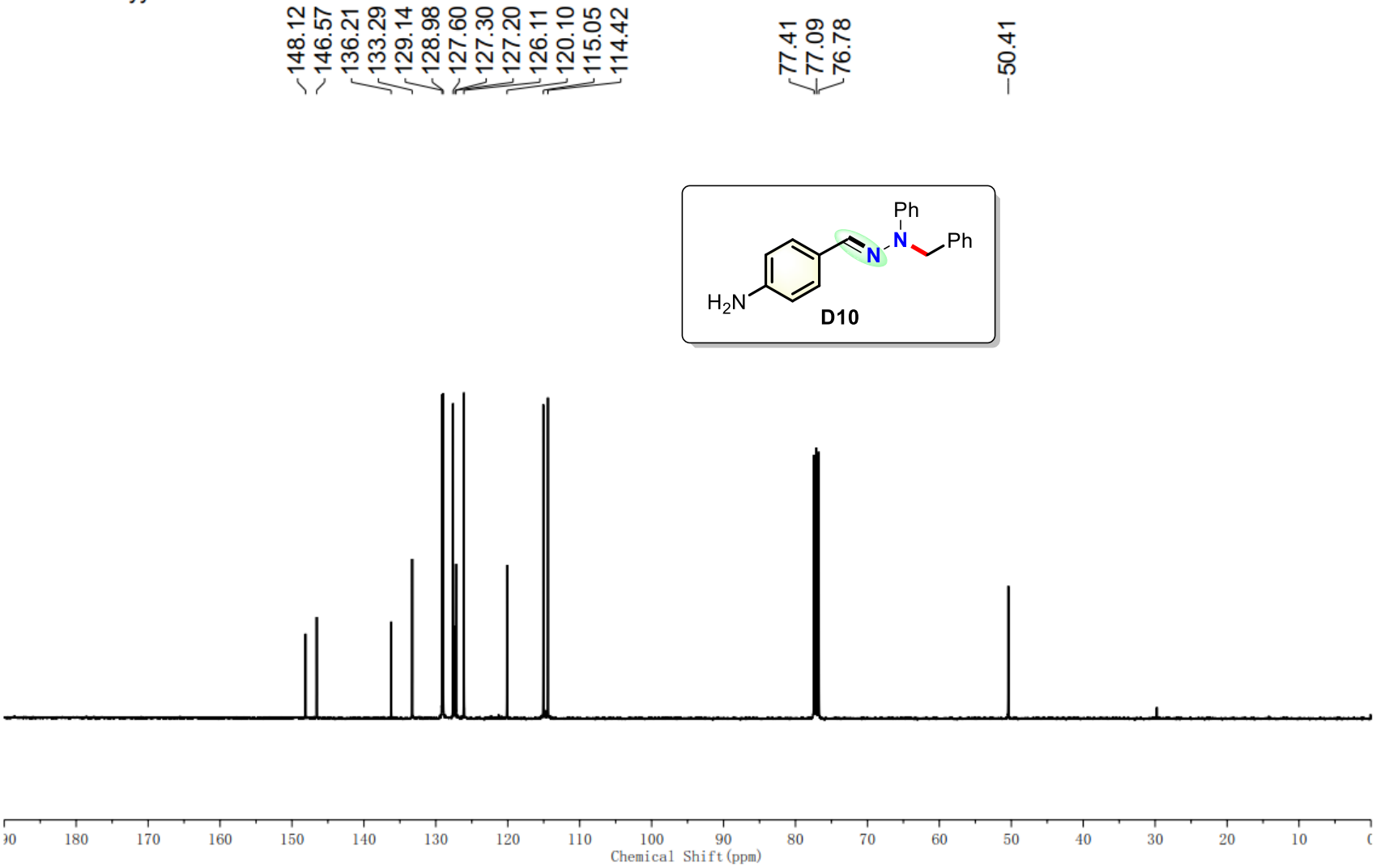

2022-05-14 YY0016-616-ZQL-1
147.70
135.52
135.38
131.61
131.13
129.21
129.07
127.57
127.40
125.99
121.09
114.95
99.99
77.34
77.02
76.71
50.63
Ph
N
Ph
N
Br
D8
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

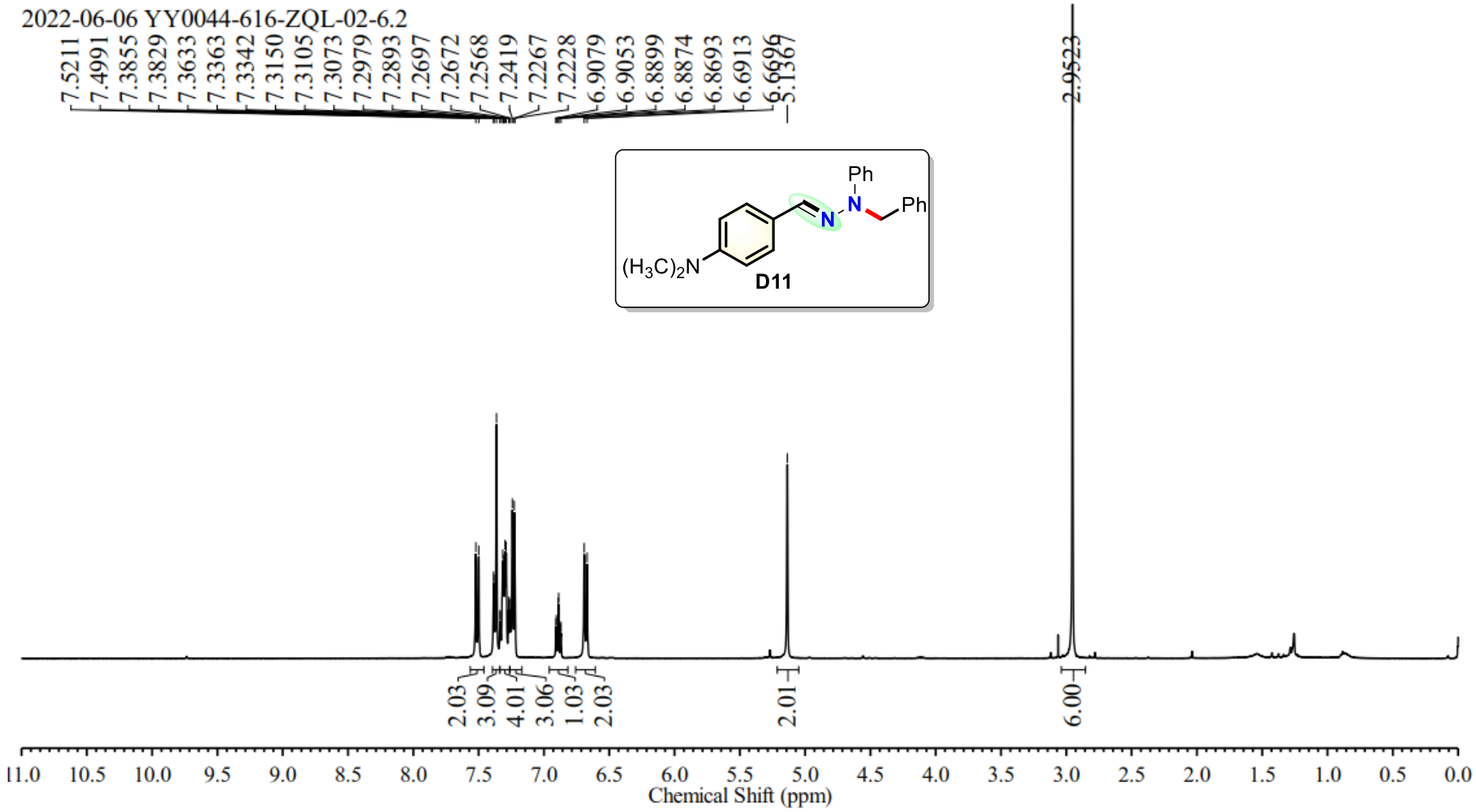

2022-05-10 YY0015-616-zql-4
7.7269
7.7060
7.5745
7.4453
7.4239
7.4004
7.3604
7.3421
7.3336
7.3230
7.3153
7.2937
7.2668
7.2485
7.2302
7.1969
7.1788
6.9394
6.9214
6.9033
5.3163
3.3502
2.5082
Ph
N
N
Ph
I
D9
2.02
1.07
4.05
3.99
1.09
2.02
1.02
2.04
Chemical Shift (ppm)

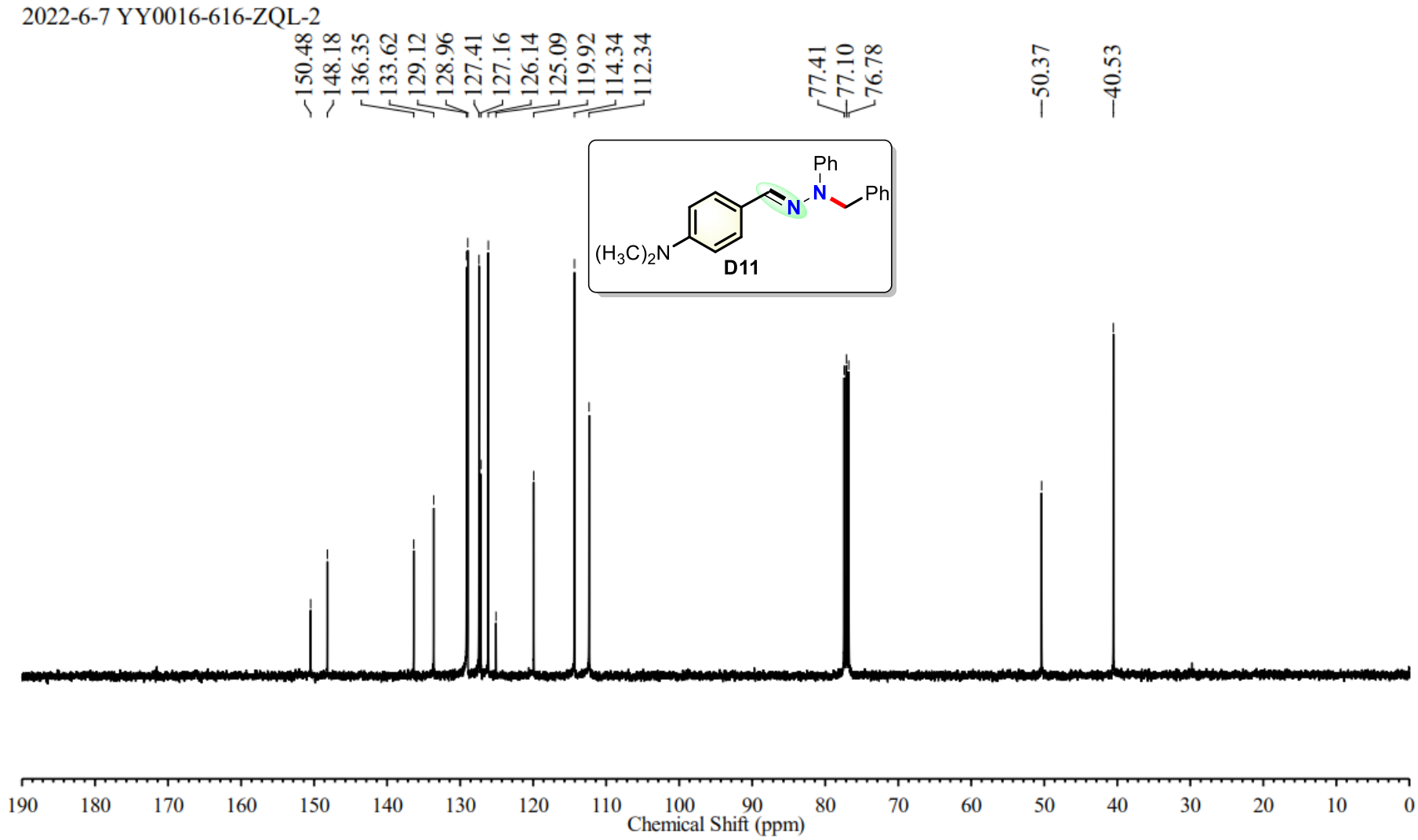

2022-05-14 YY0016-616-ZQL-4
147.42
137.86
136.38
136.22
132.02
129.68
129.24
128.30
127.48
126.70
120.93
114.71
94.11
48.67
40.61
40.40
40.19
39.98
39.77
39.56
39.36
Ph
N
N
Ph
I
D9
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

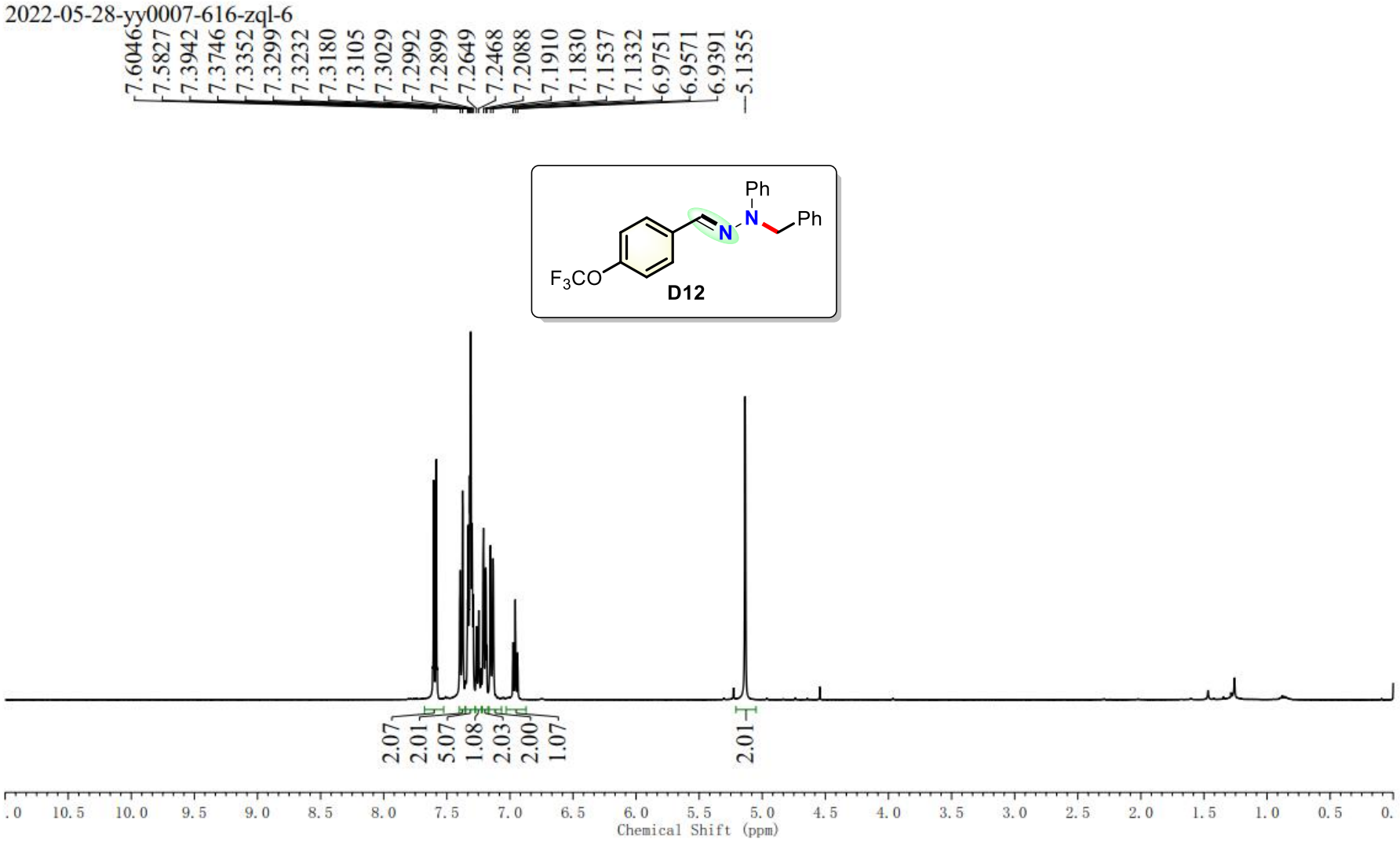

2022-11-7-yy0025-616-e20
7.4371
7.4159
7.3763
7.3565
7.3246
7.3128
7.3067
7.2939
7.2886
7.2666
7.2556
7.2375
7.2300
7.2205
7.2100
6.9134
6.8955
6.8776
6.6266
6.6054
5.1209
3.6929
Ph
N
N
Ph
H2N
D10
0.93
0.92
1.96
4.51
0.90
2.65
1.02
2.04
2.00
1.93
Chemical Shift(ppm)

2022-11-10-yy0031-616-E20



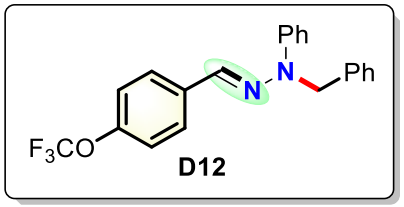

2022-06-06 YY0044-616-ZQL-02-6.2
7.5211
7.4991
7.3855
7.3829
7.3633
7.3363
7.3342
7.3150
7.3105
7.3073
7.2979
7.2893
7.2697
7.2672
7.2568
7.2419
7.2267
7.2228
6.9079
6.9053
6.8899
6.8874
6.8693
6.6913
5.1367
2.9523
Ph
N
N
Ph
(H3C)2N
D11
2.03
3.09
4.01
3.06
1.03
2.03
2.01
6.00
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Chemical Shift (ppm)


2022-6-7 YY0016-616-ZQL-2
150.48
148.18
136.35
133.62
129.12
128.96
127.41
127.16
126.14
125.09
119.92
114.34
112.34
77.41
77.10
76.78
50.37
40.53
Ph
N
N
Ph
(H3C)2N
D11
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Chemical Shift (ppm)

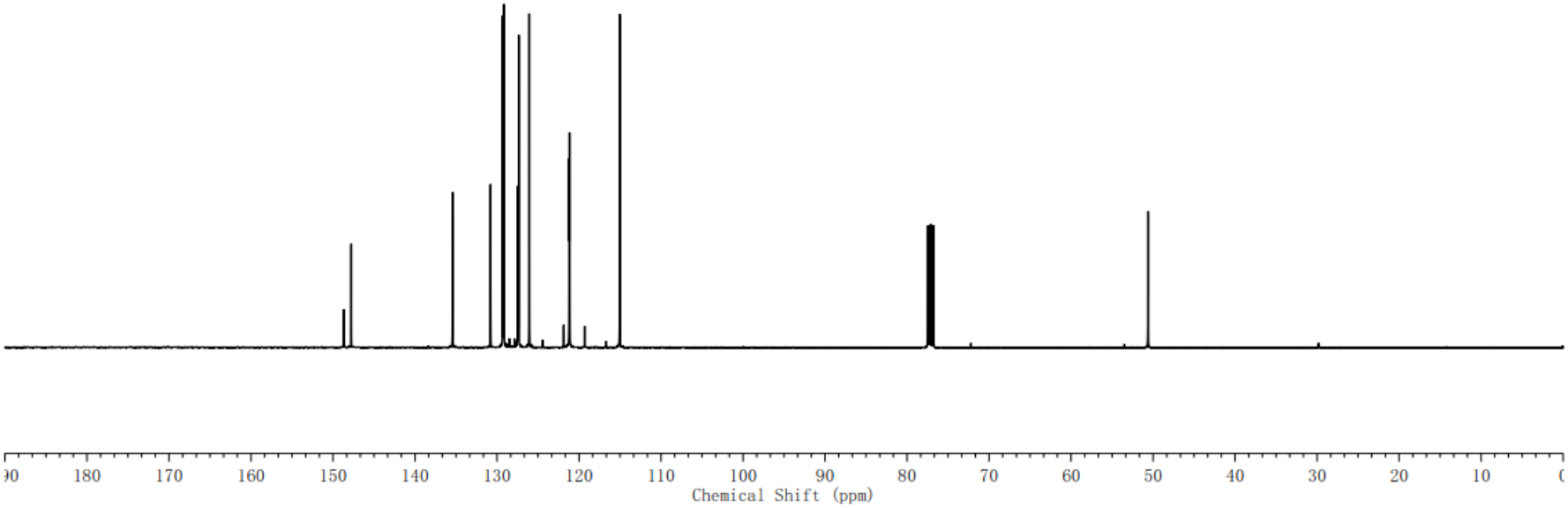

2022-05-28-yy0007-616-zql-6
7.6046
7.5827
7.3942
7.3746
7.3352
7.3299
7.3232
7.3180
7.3105
7.3029
7.2992
7.2899
7.2649
7.2468
7.2088
7.1910
7.1830
7.1537
7.1332
6.9751
6.9571
6.9391
5.1355
Ph
N
N
Ph
F3CO
D12
2.07
2.01
5.07
1.08
2.03
2.00
1.07
2.01
Chemical Shift (ppm)

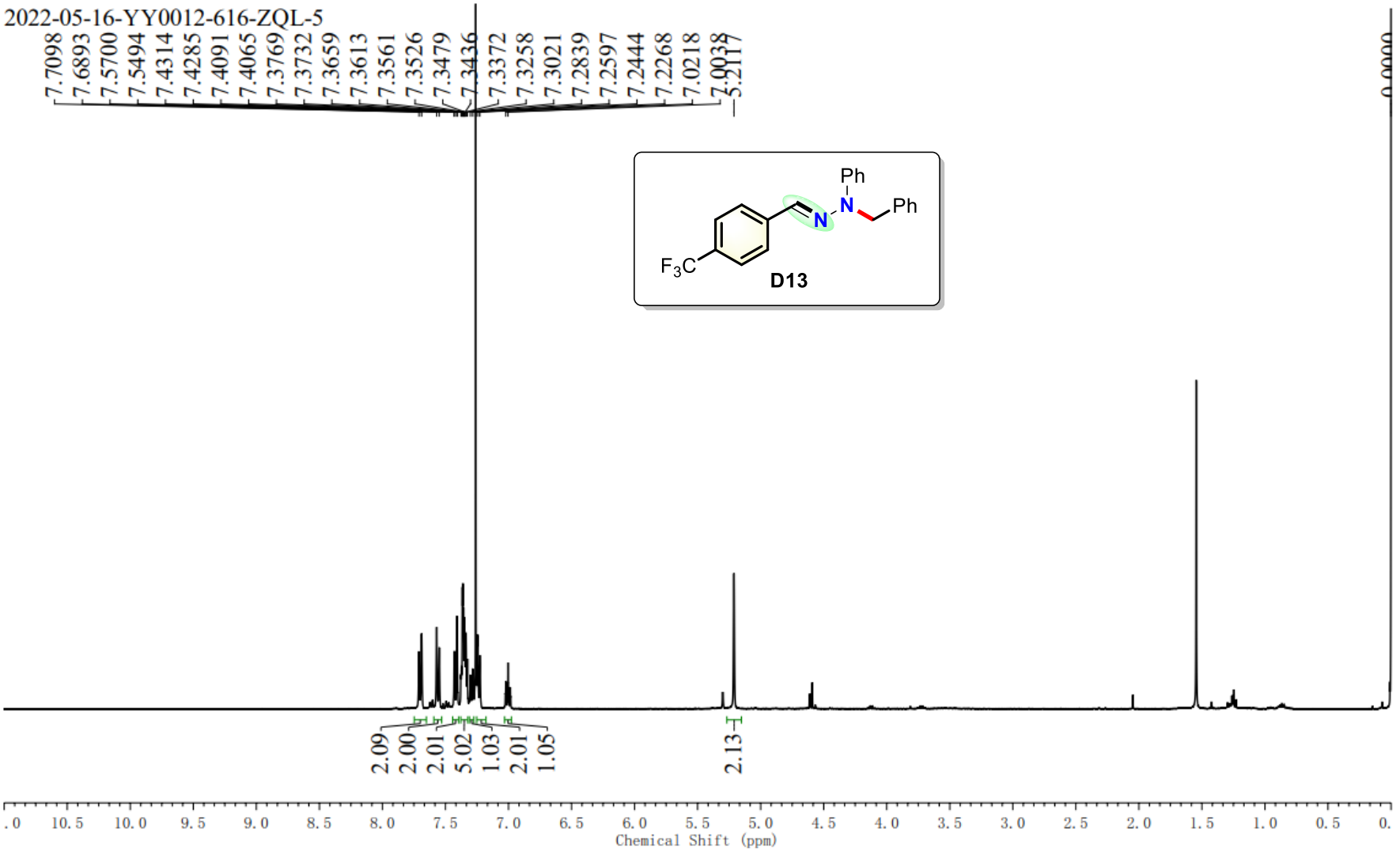
2022-05-30 YY0021 616-ZQL-0527-6

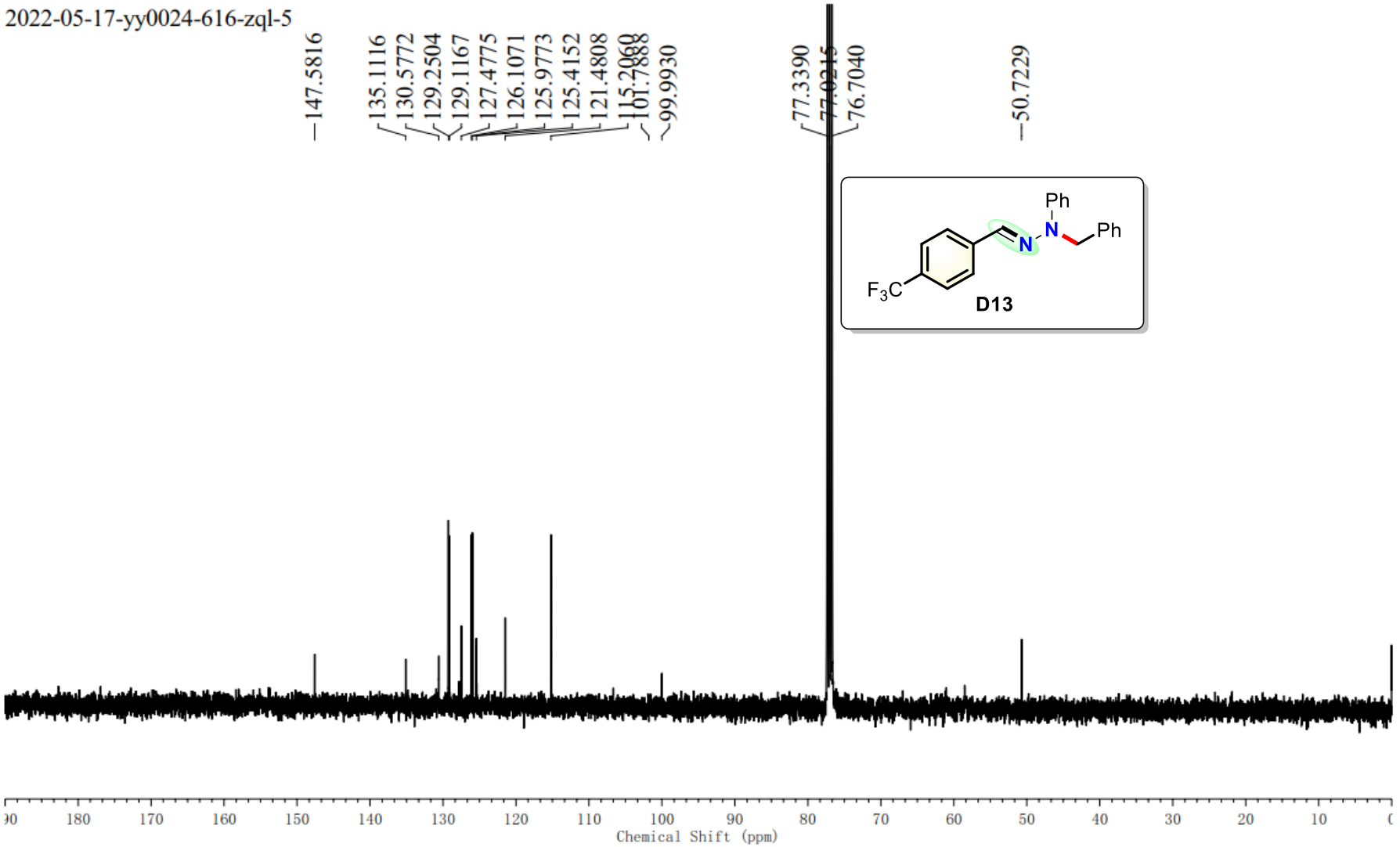
148.67
148.66
147.77
135.42
130.79
129.29
129.15
127.48
127.35
126.05
121.18
121.15
115.03
77.43
77.11
76.79
50.61



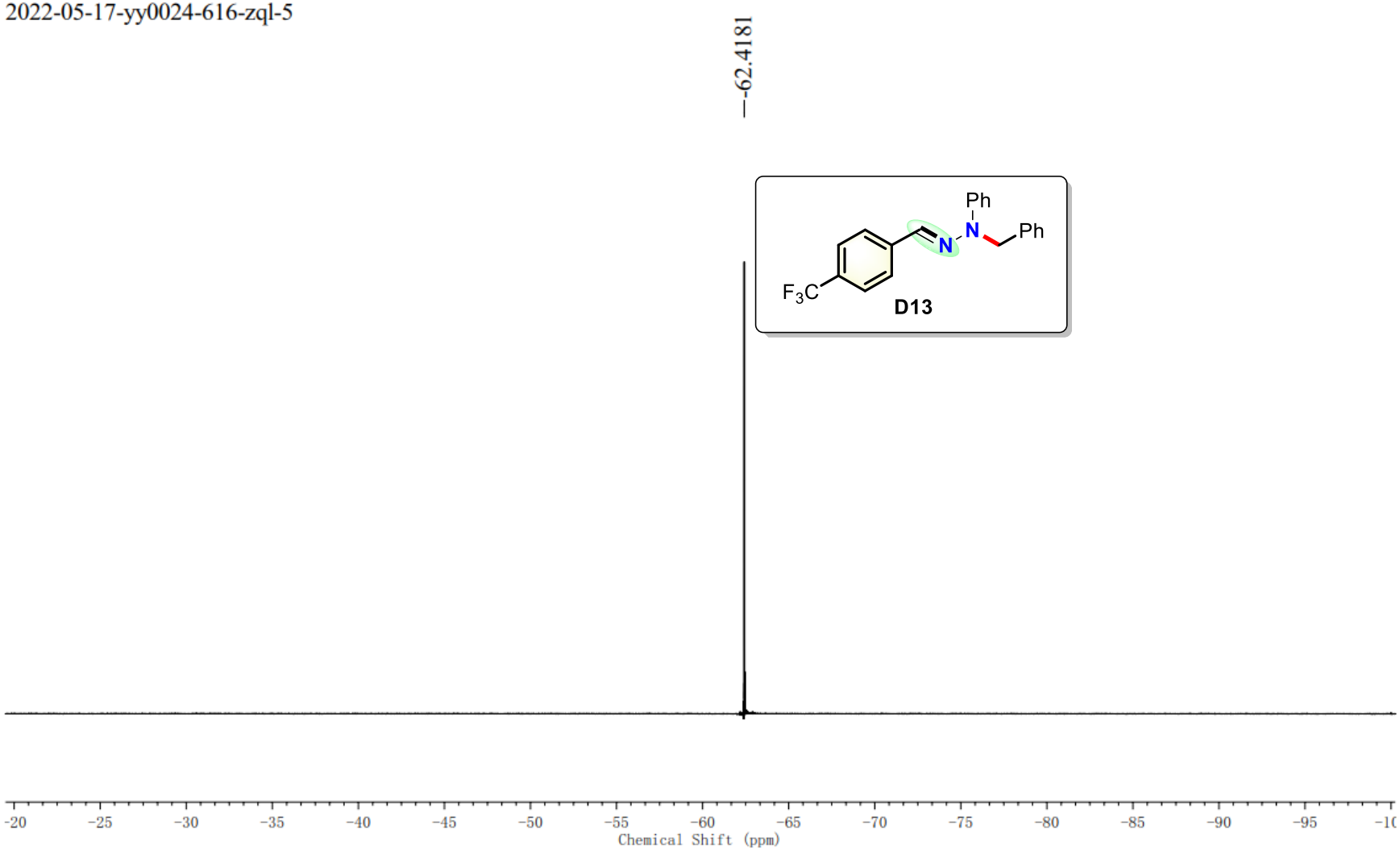

D12



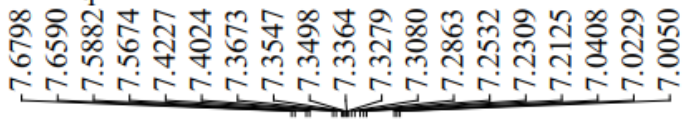

2022-05-16-YY0012-616-ZQL-5
7.7098
7.6893
7.5700
7.5494
7.4314
7.4285
7.4091
7.4065
7.3769
7.3732
7.3659
7.3613
7.3561
7.3526
7.3479
7.3436
7.3372
7.3258
7.3021
7.2839
7.2597
7.2444
7.2268
7.0218
7.0038
5.2117
0.0000
Ph
N
N
Ph
F3C
D13
2.09
2.00
2.01
5.02
1.03
2.01
1.05
2.13
Chemical Shift (ppm)

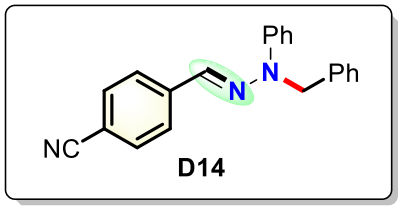

2022-05-17-yy0024-616-zql-5
147.5816
135.1116
130.5772
129.2504
129.1167
127.4775
126.1071
125.9773
125.4152
121.4808
115.2060
101.7888
99.9930
77.3390
77.0215
76.7040
50.7229
Ph
N
N
Ph
F3C
D13
Chemical Shift (ppm)

2022-05-17-yy0024-616-zql-5

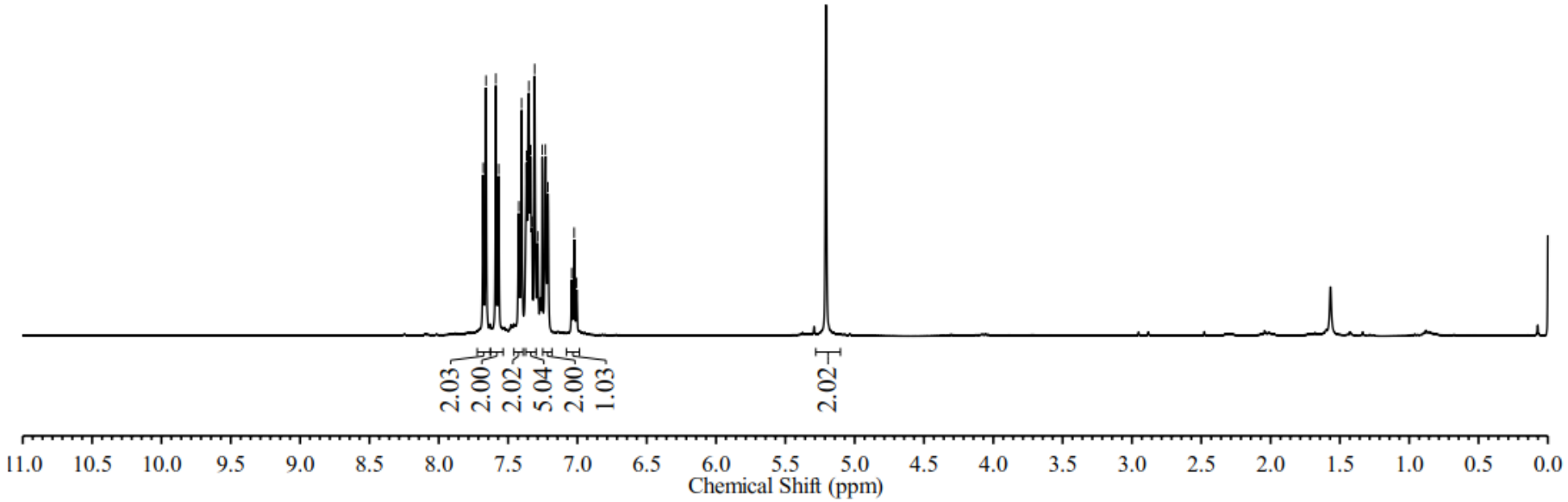


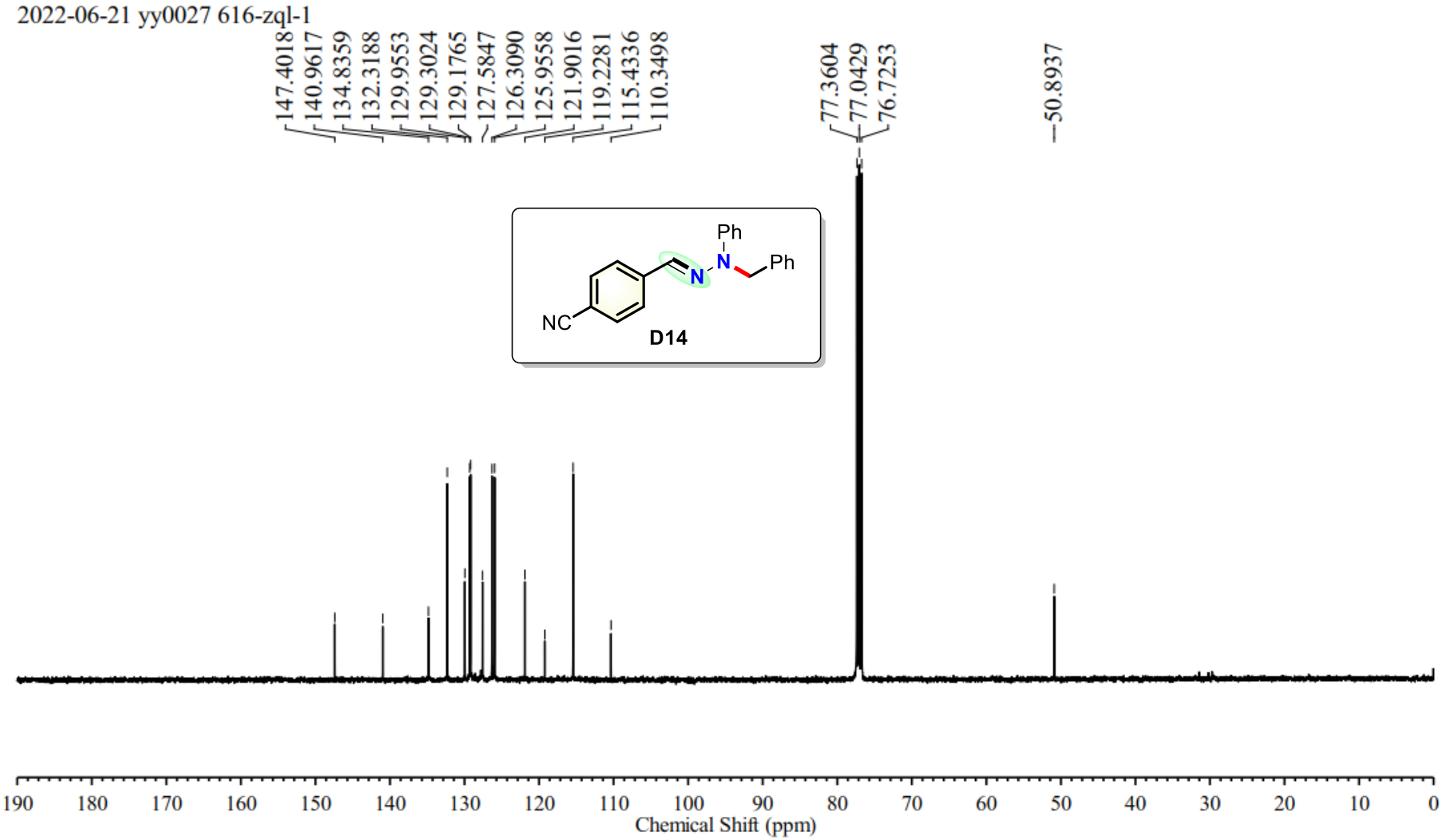
2022-06-20 yy0003-616-zql-1



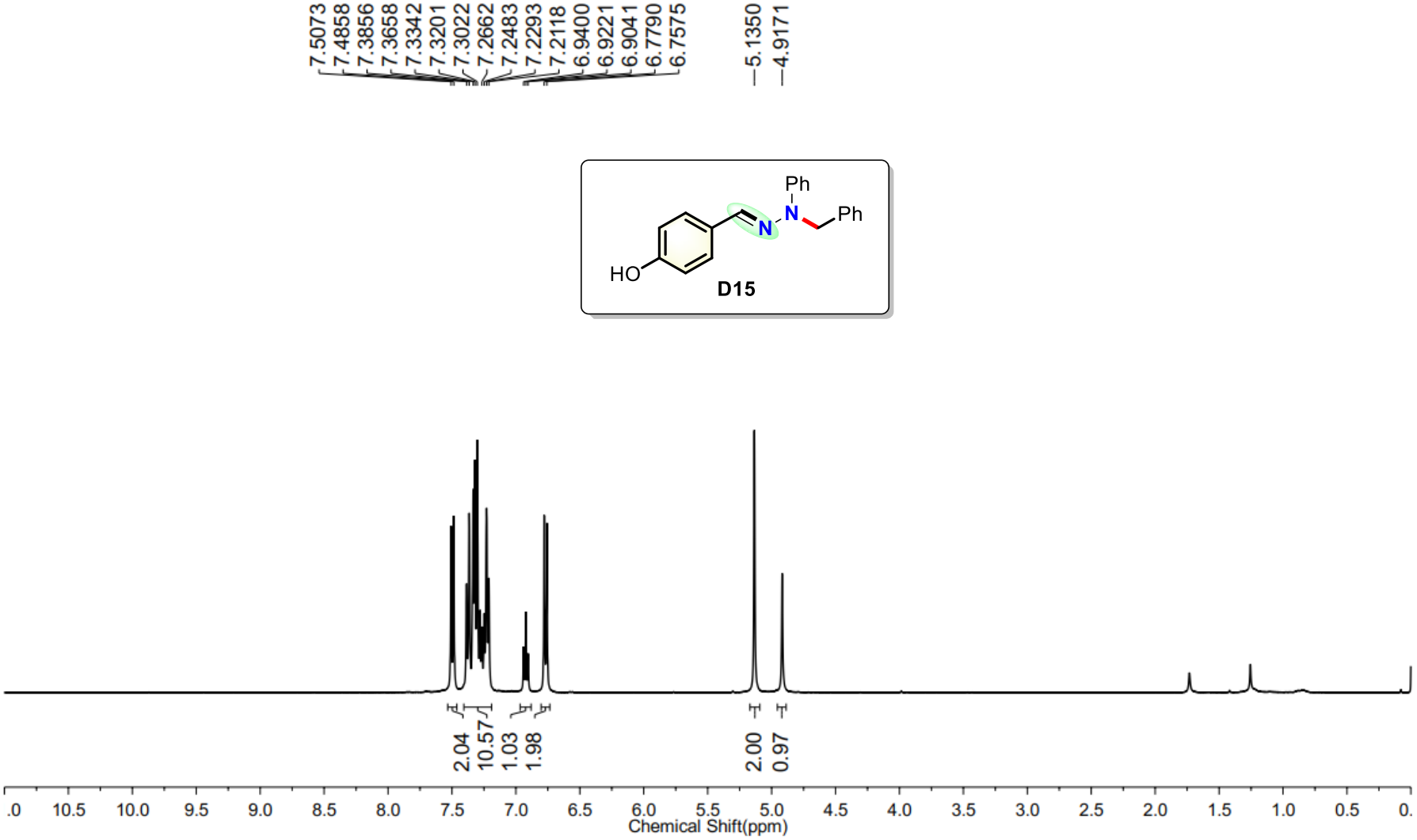




**D14**



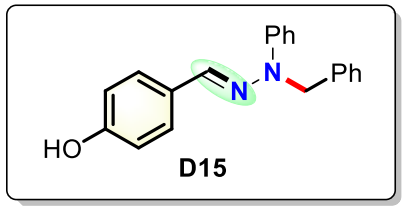

2022-06-21 yy0027 616-zql-1
147.4018
140.9617
134.8359
132.3188
129.9553
129.3024
129.1765
127.5847
126.3090
125.9558
121.9016
119.2281
115.4336
110.3498
77.3604
77.0429
76.7253
50.8937
Ph
N
N
Ph
NC
D14
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Chemical Shift (ppm)

2022-11-7-yy0025-616-e26

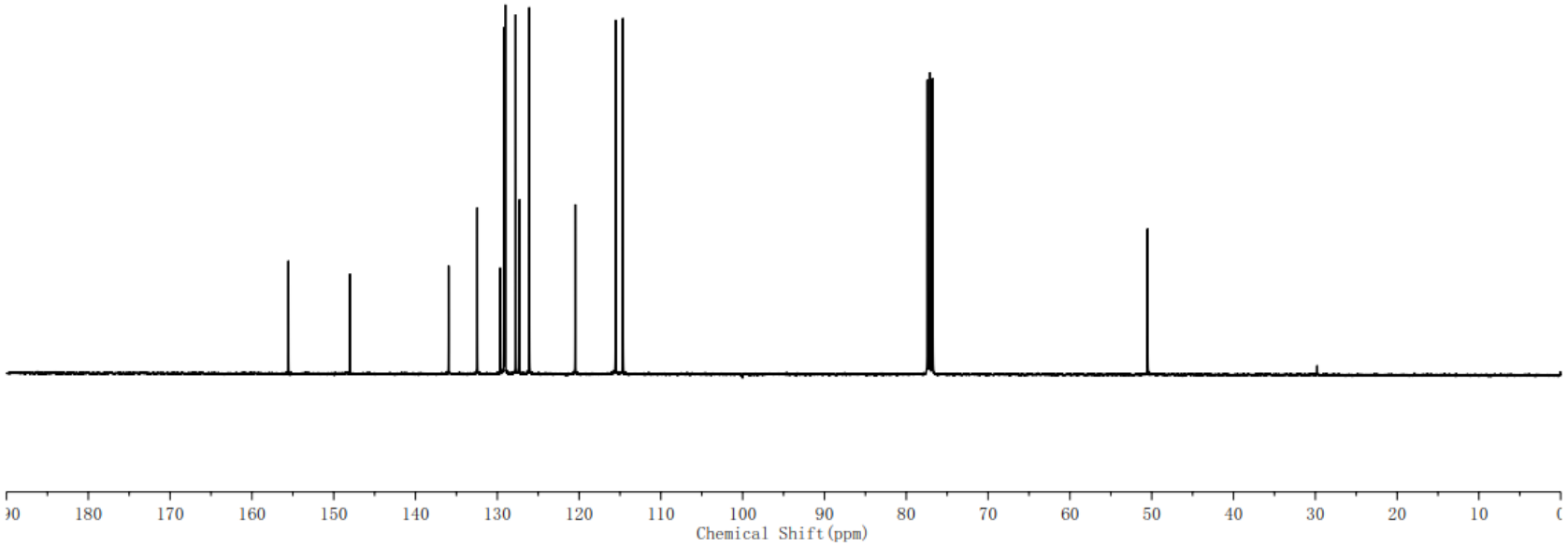


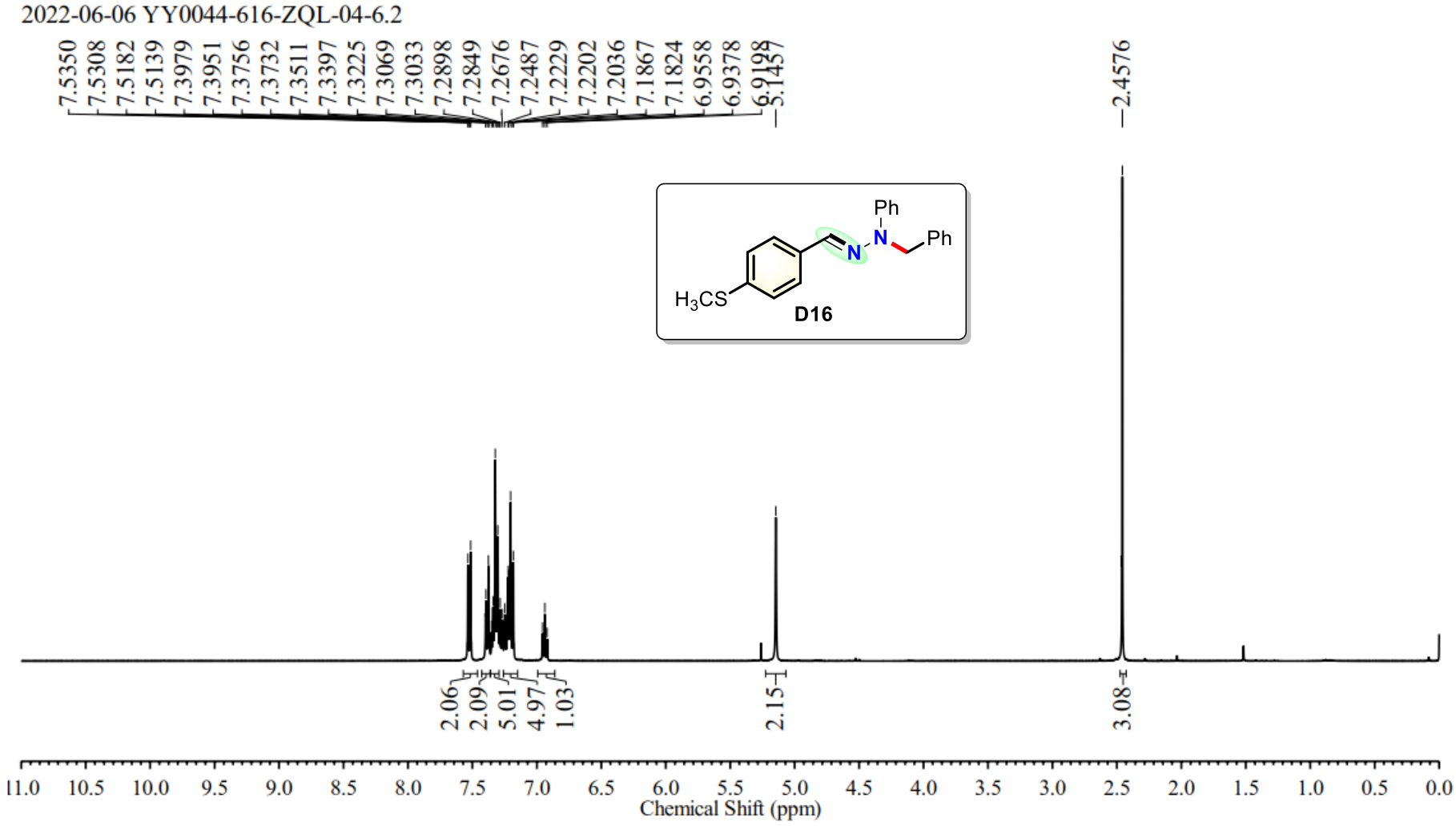
2022-11-10-yy0031-616-E26

155.53
148.00
135.95
132.46
129.66
129.19
129.03
127.74
127.29
126.08
120.47
115.54
114.64
77.40
77.09
76.77
50.50

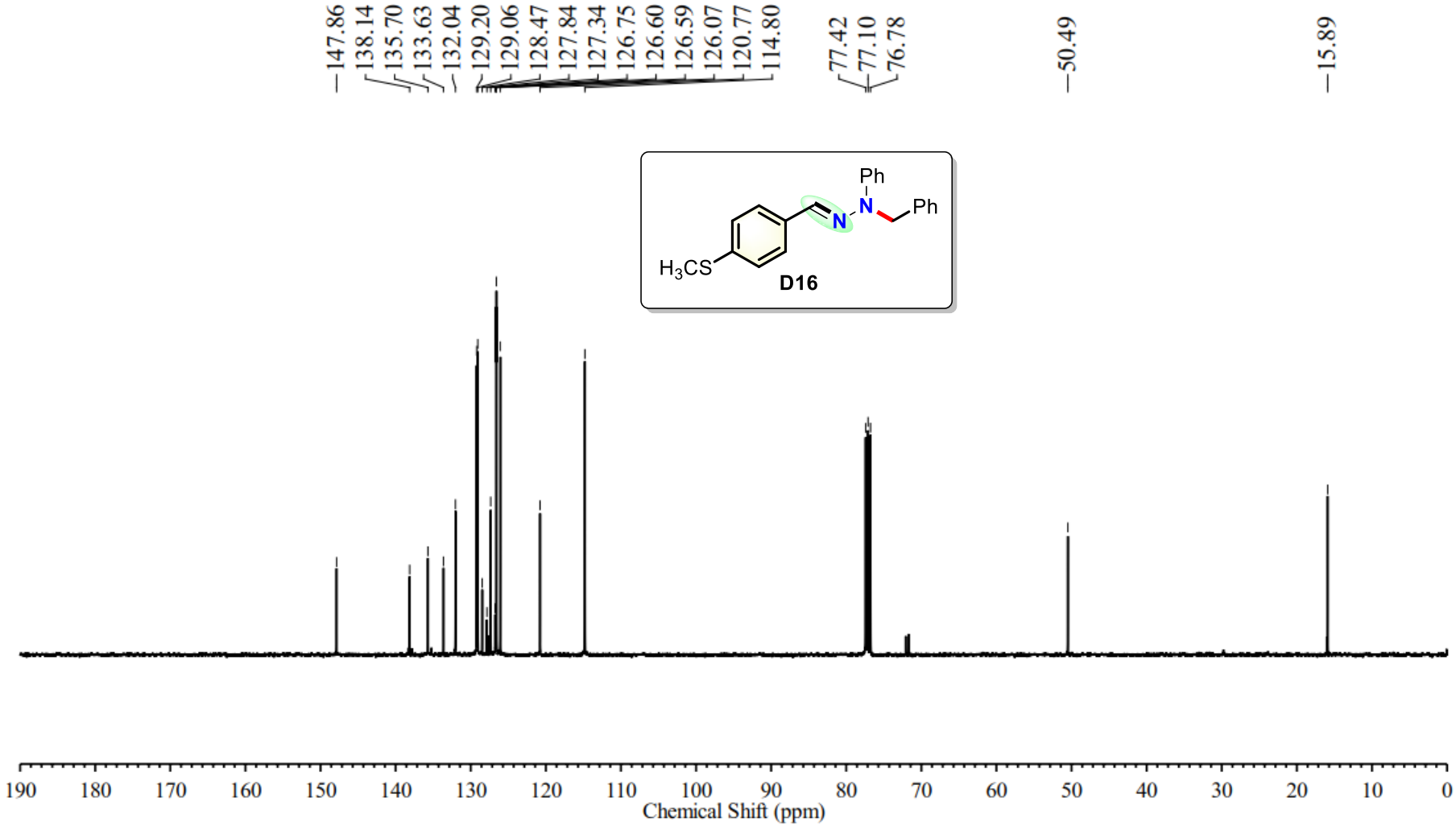


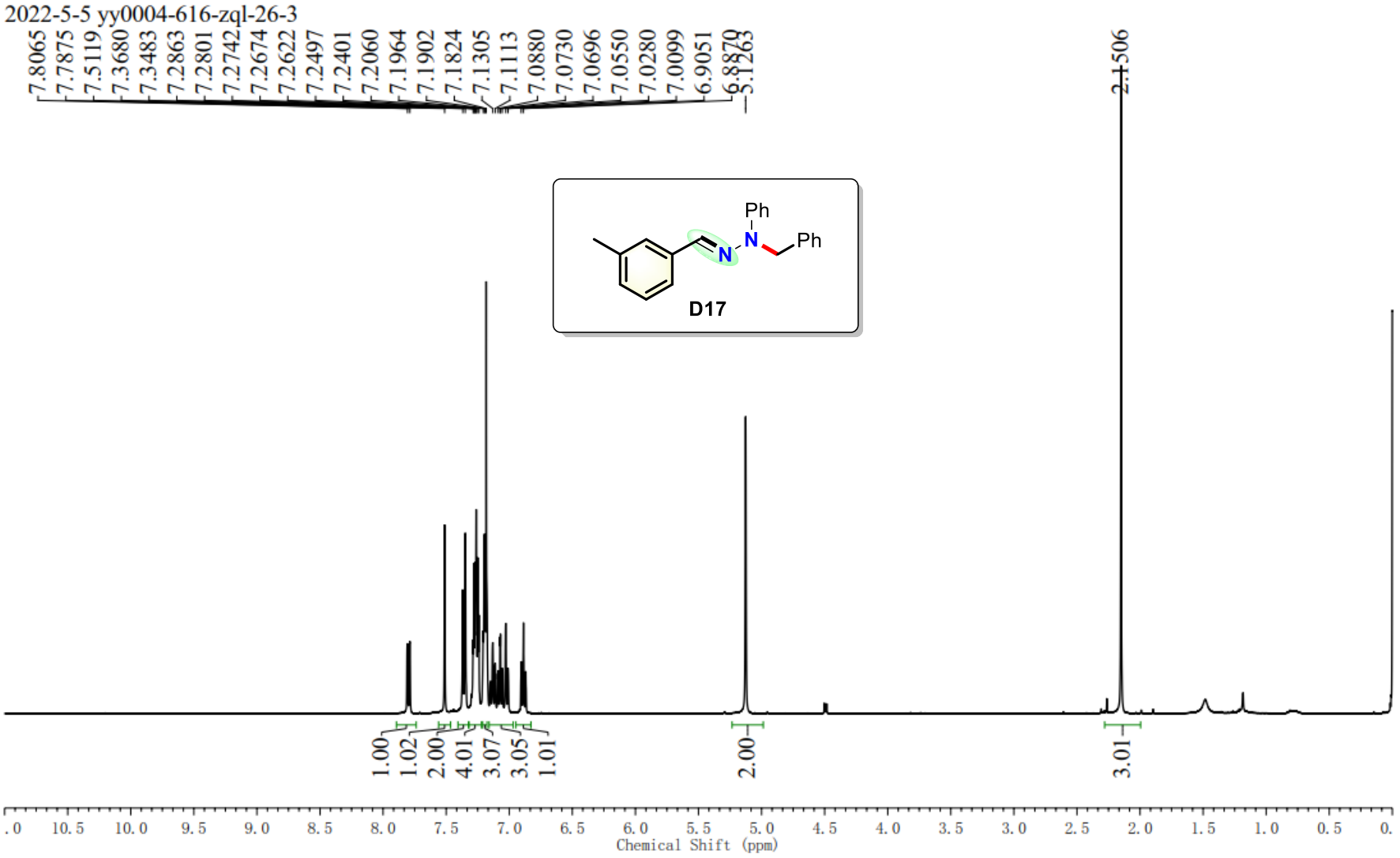

D15

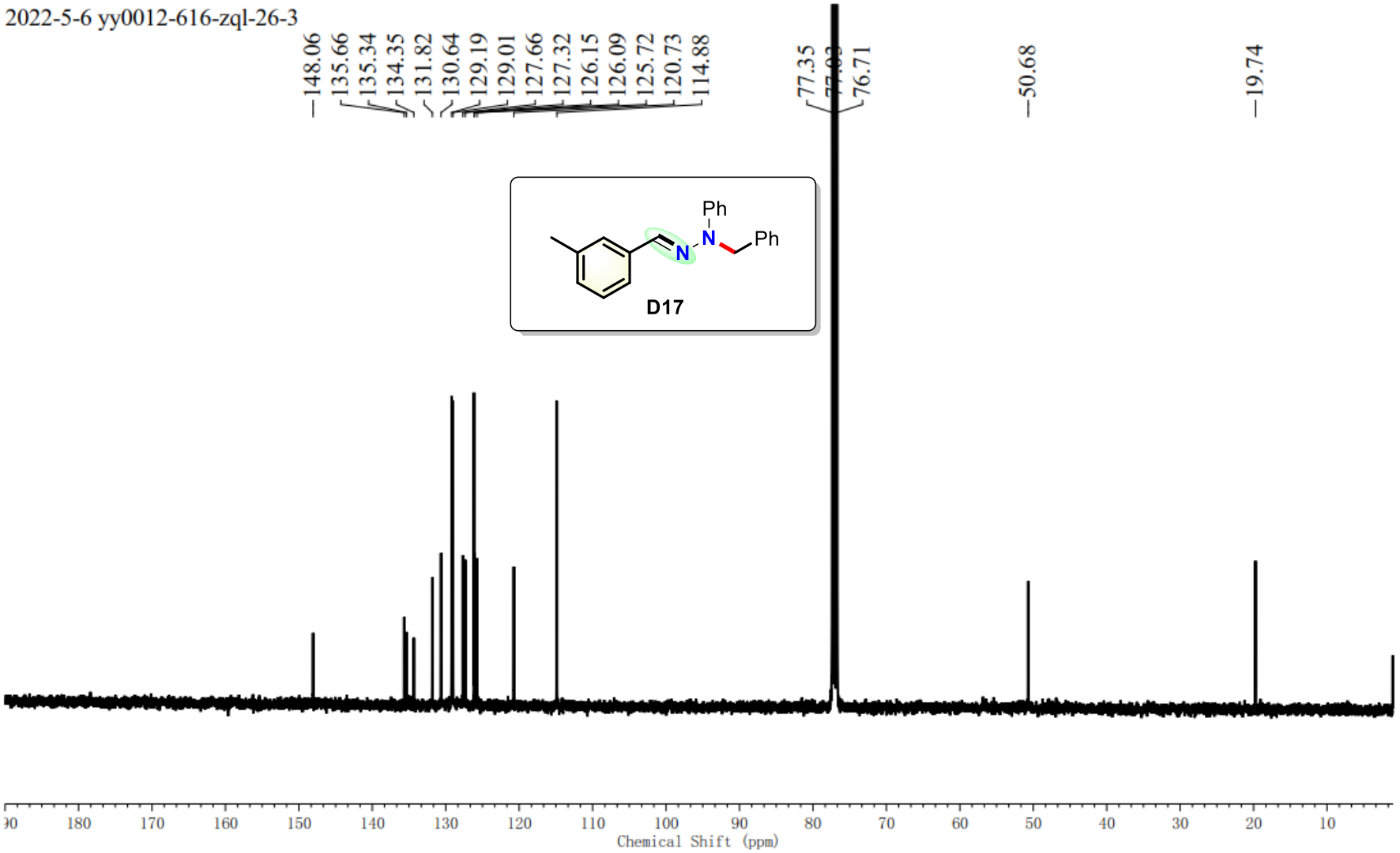


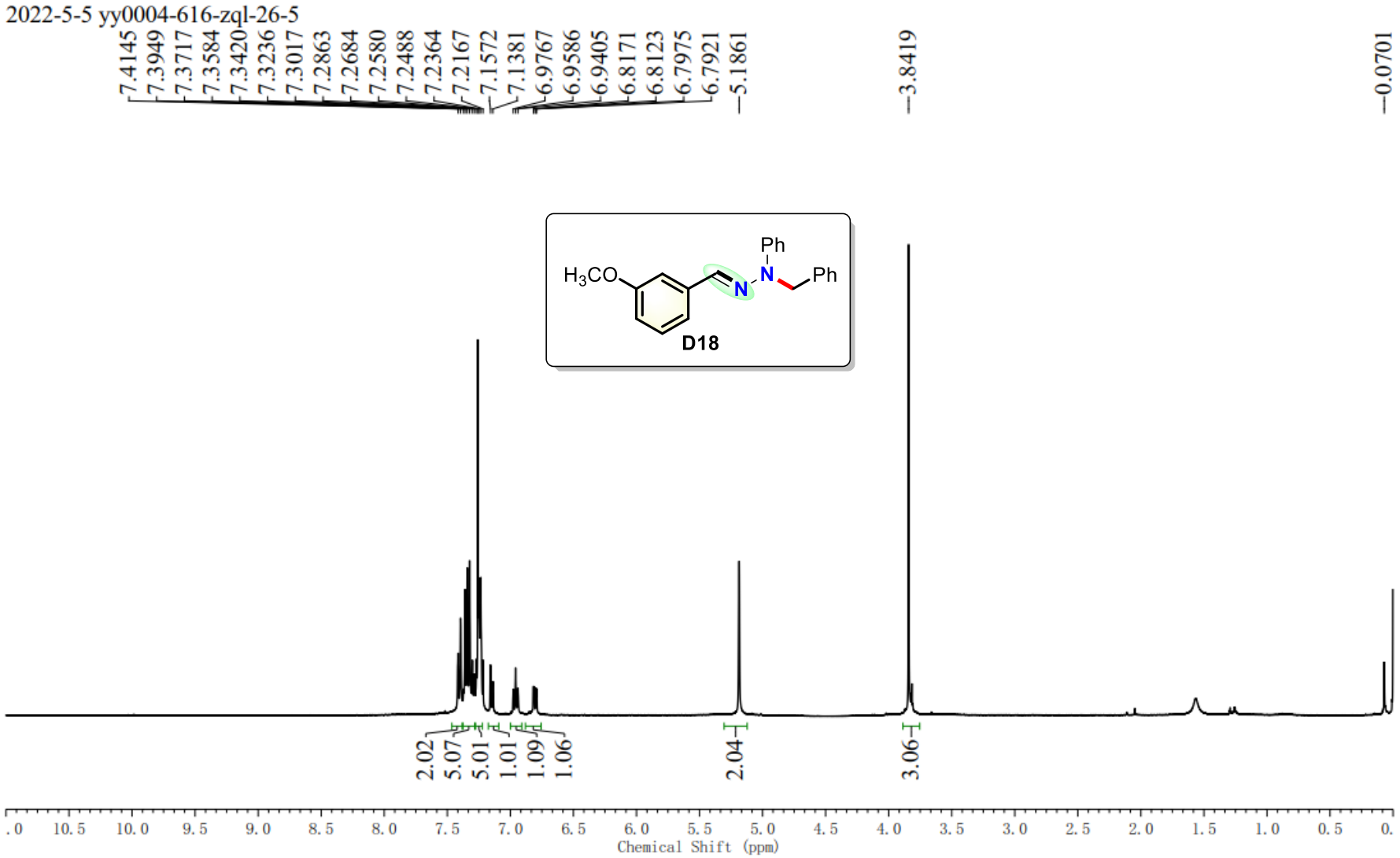

2022-06-06 YY0044-616-ZQL-04-6.2
7.5350
7.5308
7.5182
7.5139
7.3979
7.3951
7.3756
7.3732
7.3511
7.3397
7.3225
7.3069
7.3033
7.2898
7.2849
7.2676
7.2487
7.2229
7.2202
7.2036
7.1867
7.1824
6.9558
6.9378
6.9198
6.9198
5.1457
2.4576
Ph
N
Ph
N
H3CS
D16
2.06
2.09
5.01
4.97
1.03
2.15
3.08
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Chemical Shift (ppm)

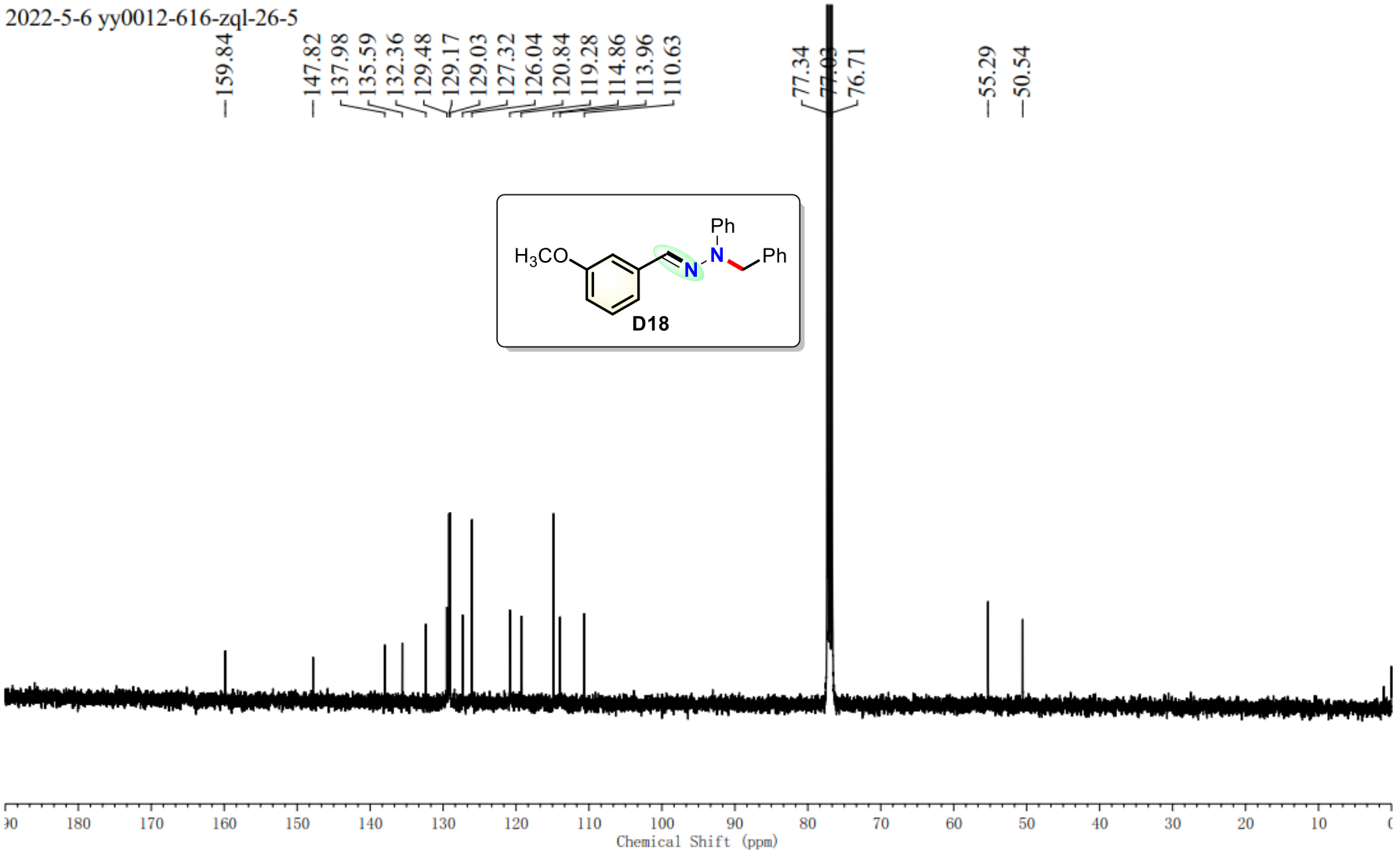
2022-6-7 YY0016-616-ZQL-4

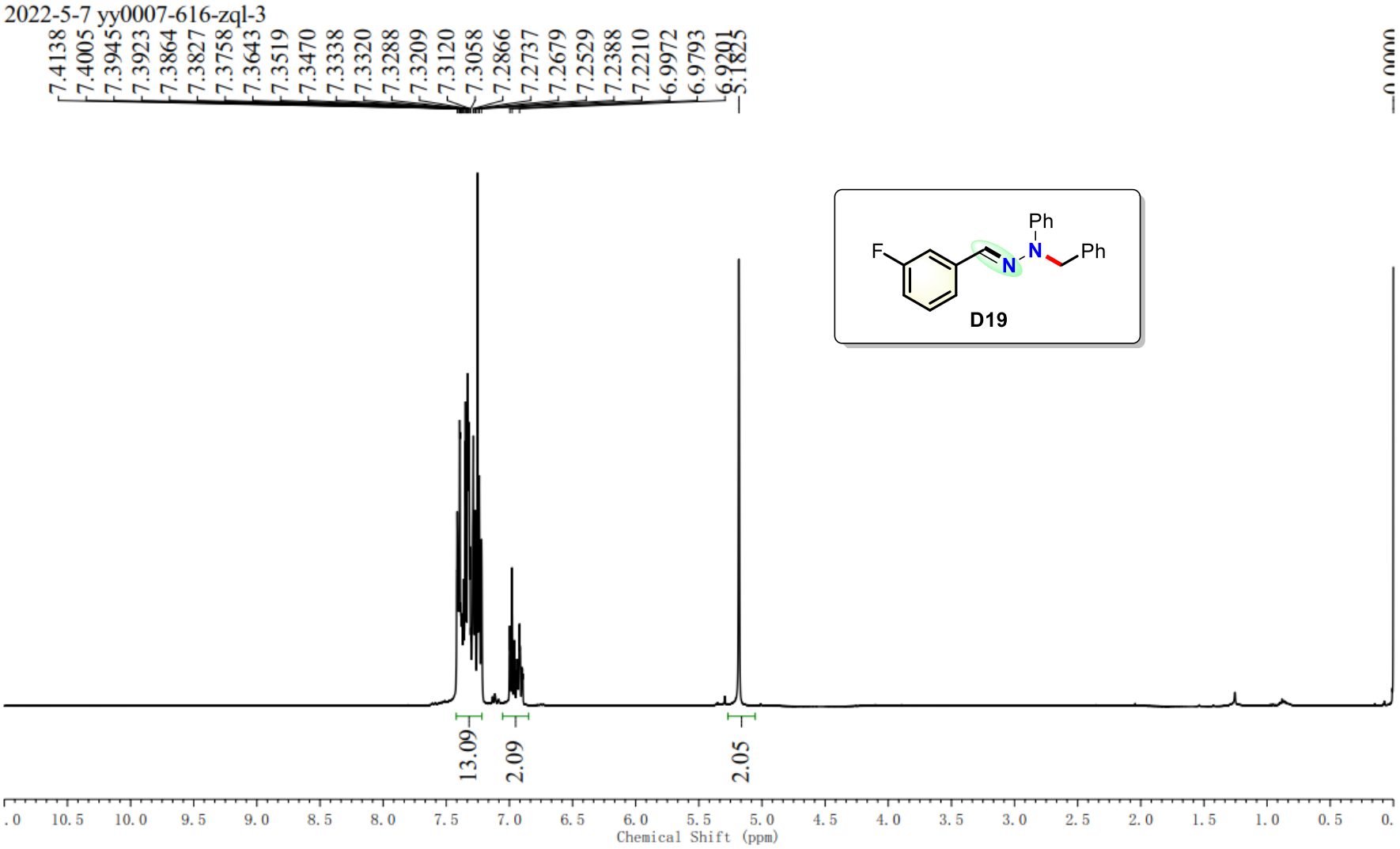


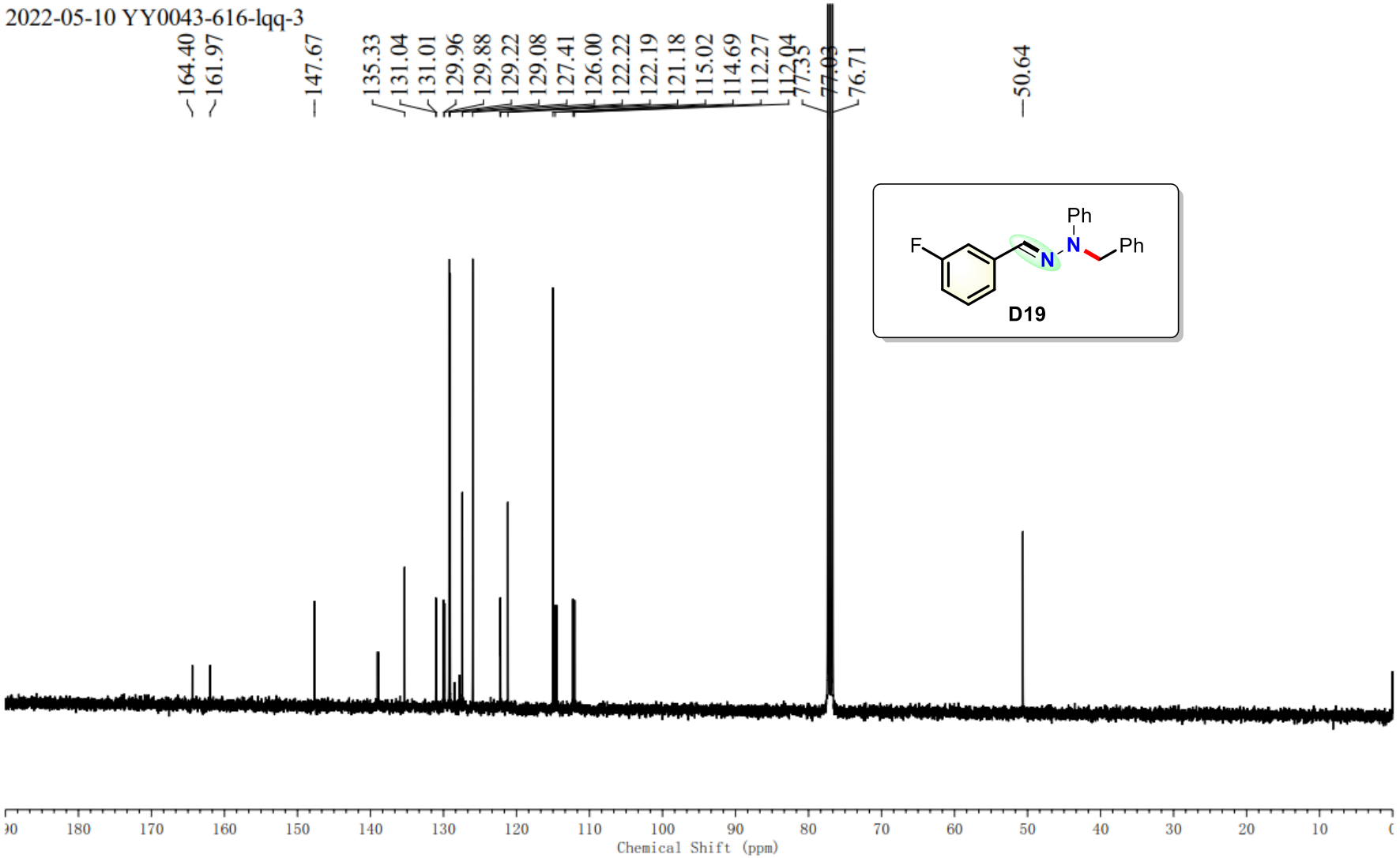

2022-5-5 yy0004-616-zql-26-3
7.8065
7.7875
7.5119
7.3680
7.3483
7.2863
7.2801
7.2742
7.2674
7.2622
7.2497
7.2401
7.2060
7.1964
7.1902
7.1824
7.1305
7.1113
7.0880
7.0730
7.0696
7.0550
7.0280
7.0099
6.9051
6.8870
5.1263
2.1506
Ph
N
N
Ph
D17
1.00
1.02
2.00
4.01
3.07
3.05
1.01
2.00
3.01
Chemical Shift (ppm)


2022-5-6 yy0012-616-zql-26-3
148.06
135.66
135.34
134.35
131.82
130.64
129.19
129.01
127.66
127.32
126.15
126.09
125.72
120.73
114.88
77.35
77.03
76.71
50.68
19.74
Ph
N
N
Ph
D17
Chemical Shift (ppm)

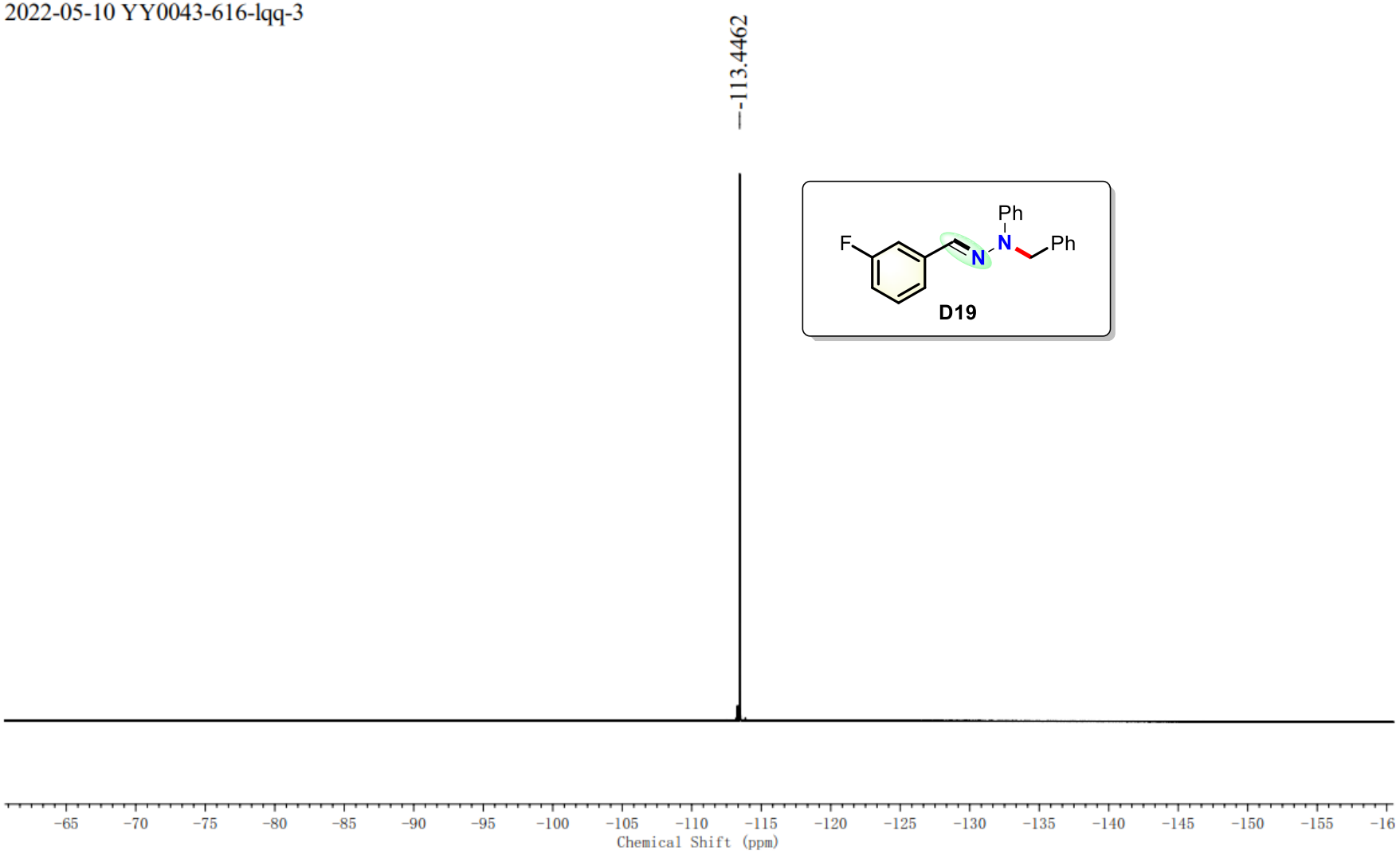

2022-5-5 yy0004-616-zql-26-5
7.4145
7.3949
7.3717
7.3584
7.3420
7.3236
7.3017
7.2863
7.2684
7.2580
7.2488
7.2364
7.2167
7.1572
7.1381
6.9767
6.9586
6.9405
6.8171
6.8123
6.7975
6.7921
5.1861
3.8419
0.0701
H3CO
Ph
N
N
Ph
D18
2.02
5.07
5.01
1.01
1.09
1.06
2.04
3.06
Chemical Shift (ppm)

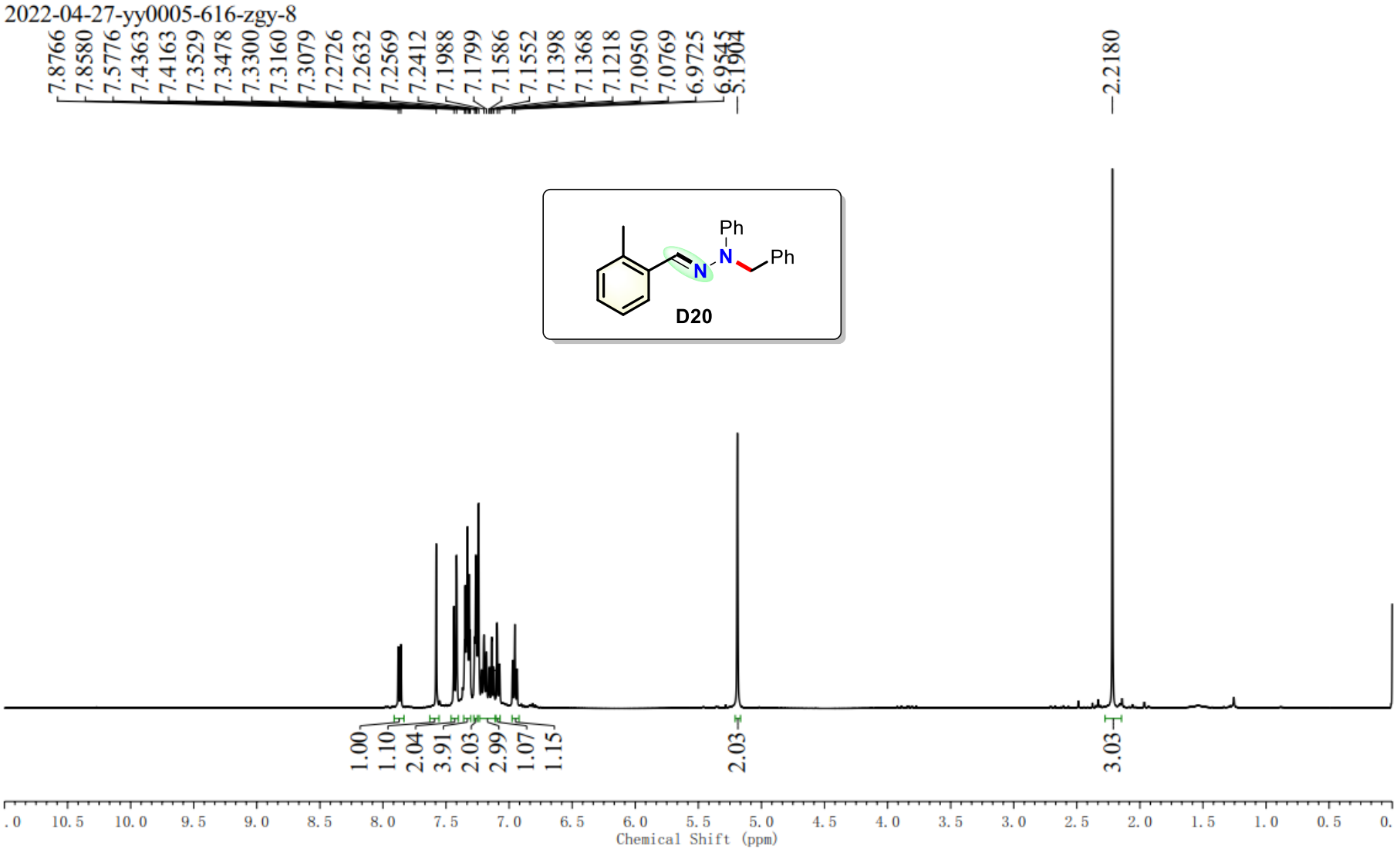

2022-5-6 yy0012-616-zql-26-5
159.84
147.82
137.98
135.59
132.36
129.48
129.17
129.03
127.32
126.04
120.84
119.28
114.86
113.96
110.63
77.34
77.03
76.71
55.29
50.54
H3CO
N
N
Ph
Ph
D18
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)


2022-5-7 yy0007-616-zql-3
7.4138
7.4005
7.3945
7.3923
7.3864
7.3827
7.3758
7.3643
7.3519
7.3470
7.3338
7.3320
7.3288
7.3209
7.3120
7.3058
7.2866
7.2737
7.2679
7.2529
7.2388
7.2210
6.9972
6.9793
6.9201
5.1825
Ph
N
Ph
F
N
D19
13.09
2.09
2.05
Chemical Shift (ppm)

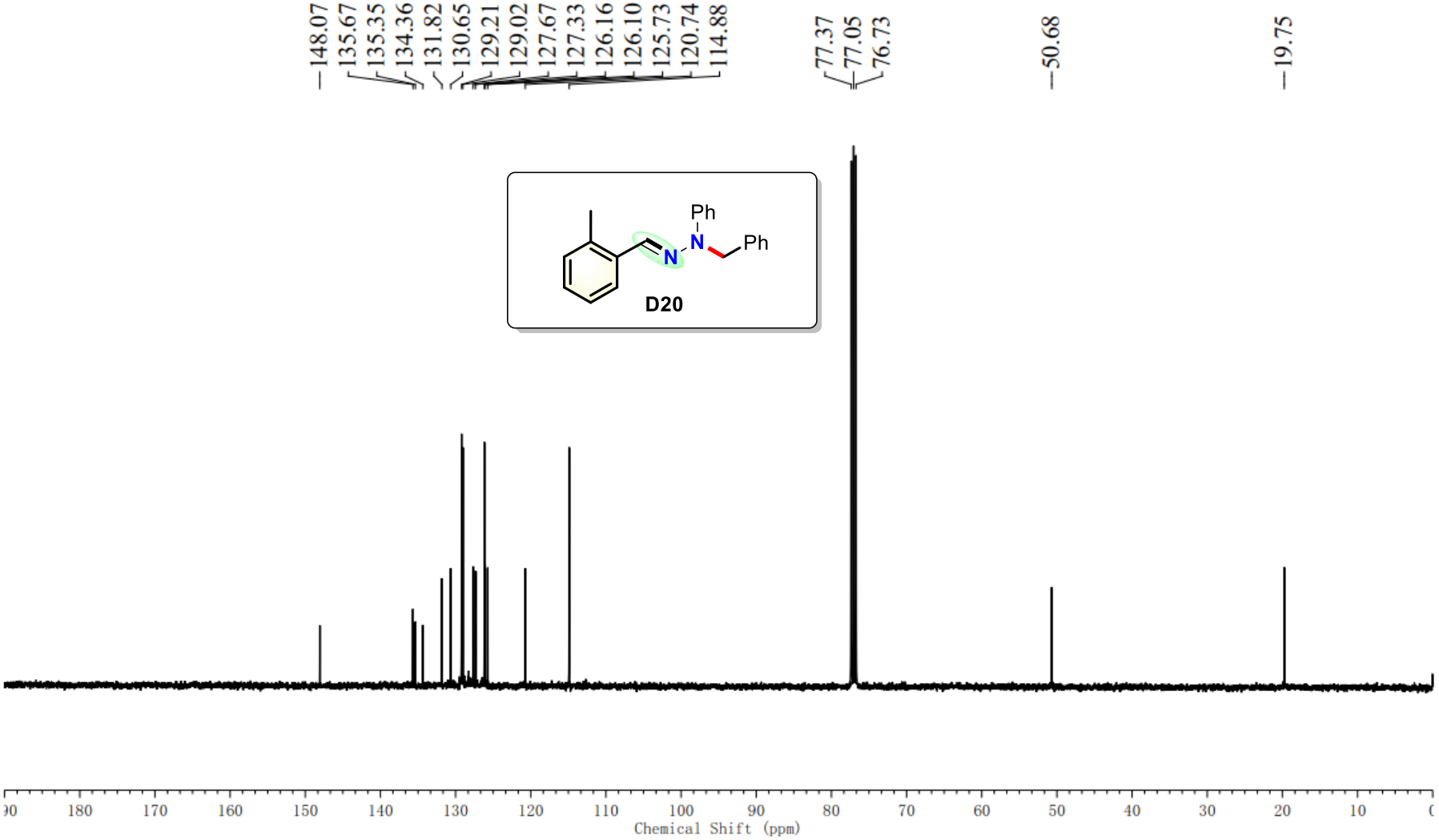

2022-05-10 YY0043-616-lqq-3
164.40
161.97
147.67
135.33
131.04
131.01
129.96
129.88
129.22
129.08
127.41
126.00
122.22
122.19
121.18
115.02
114.69
112.27
112.04
77.35
77.03
76.71
50.64
F
N
N
Ph
Ph
D19
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

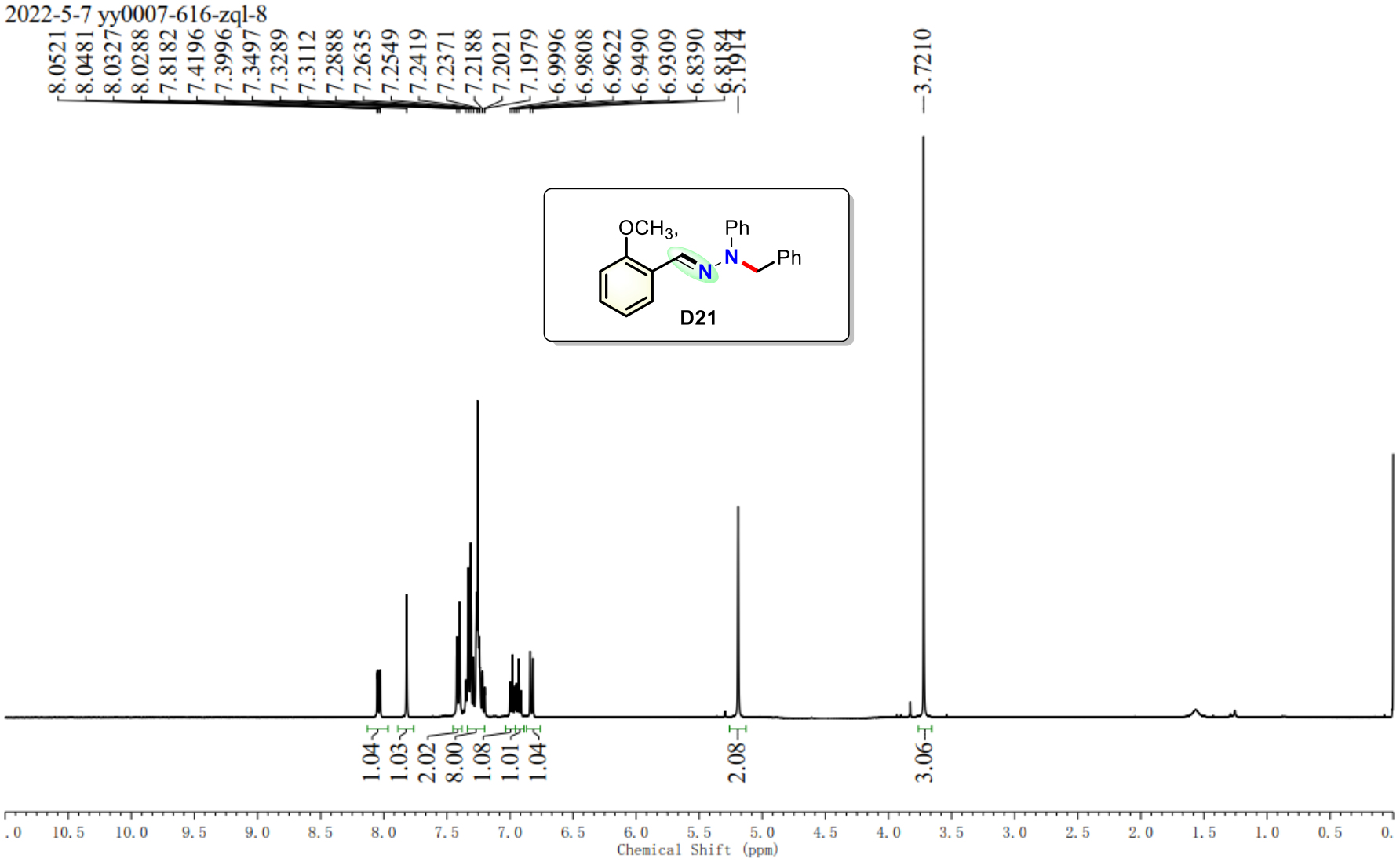
2022-05-10 YY0043-616-lqq-3

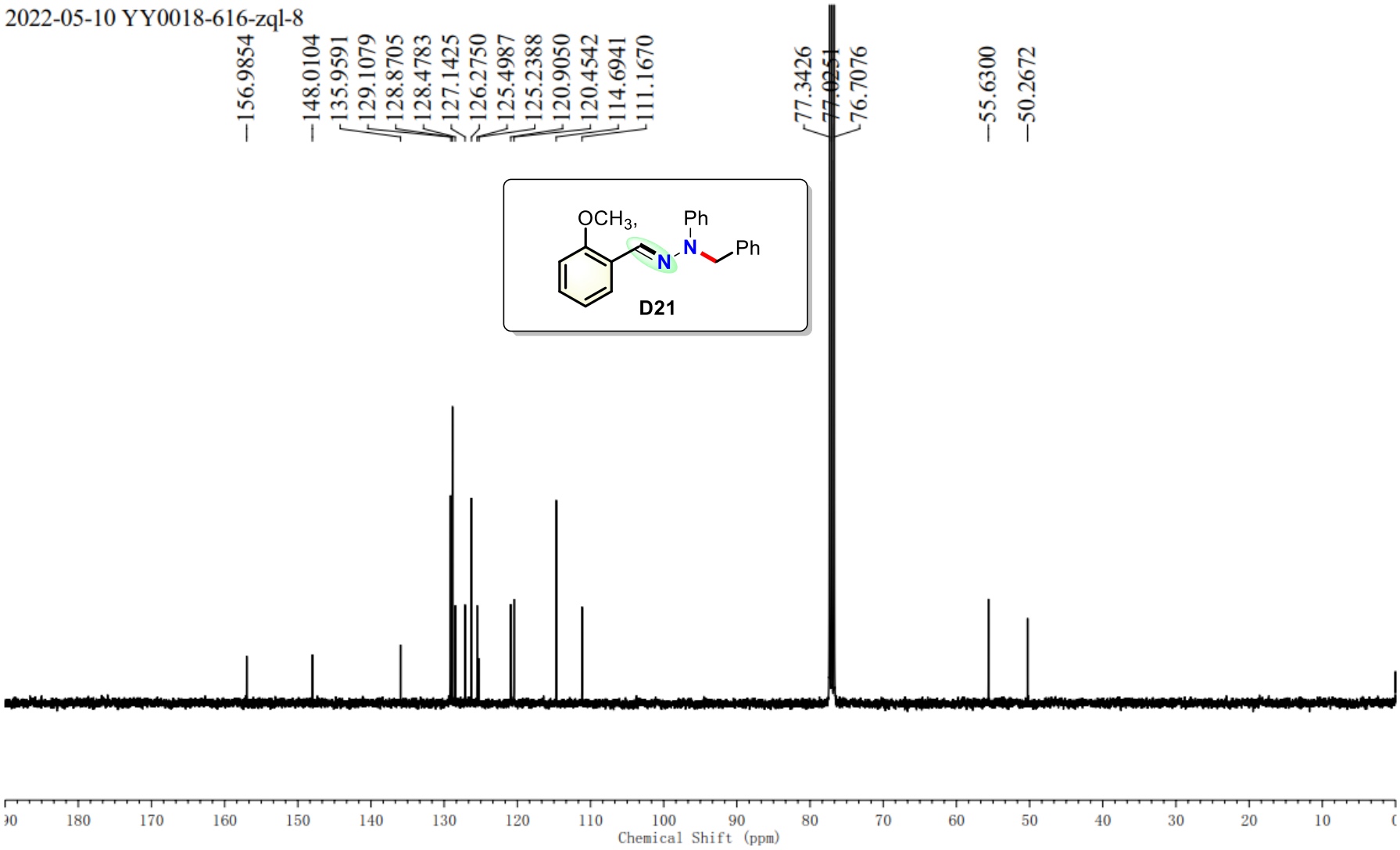


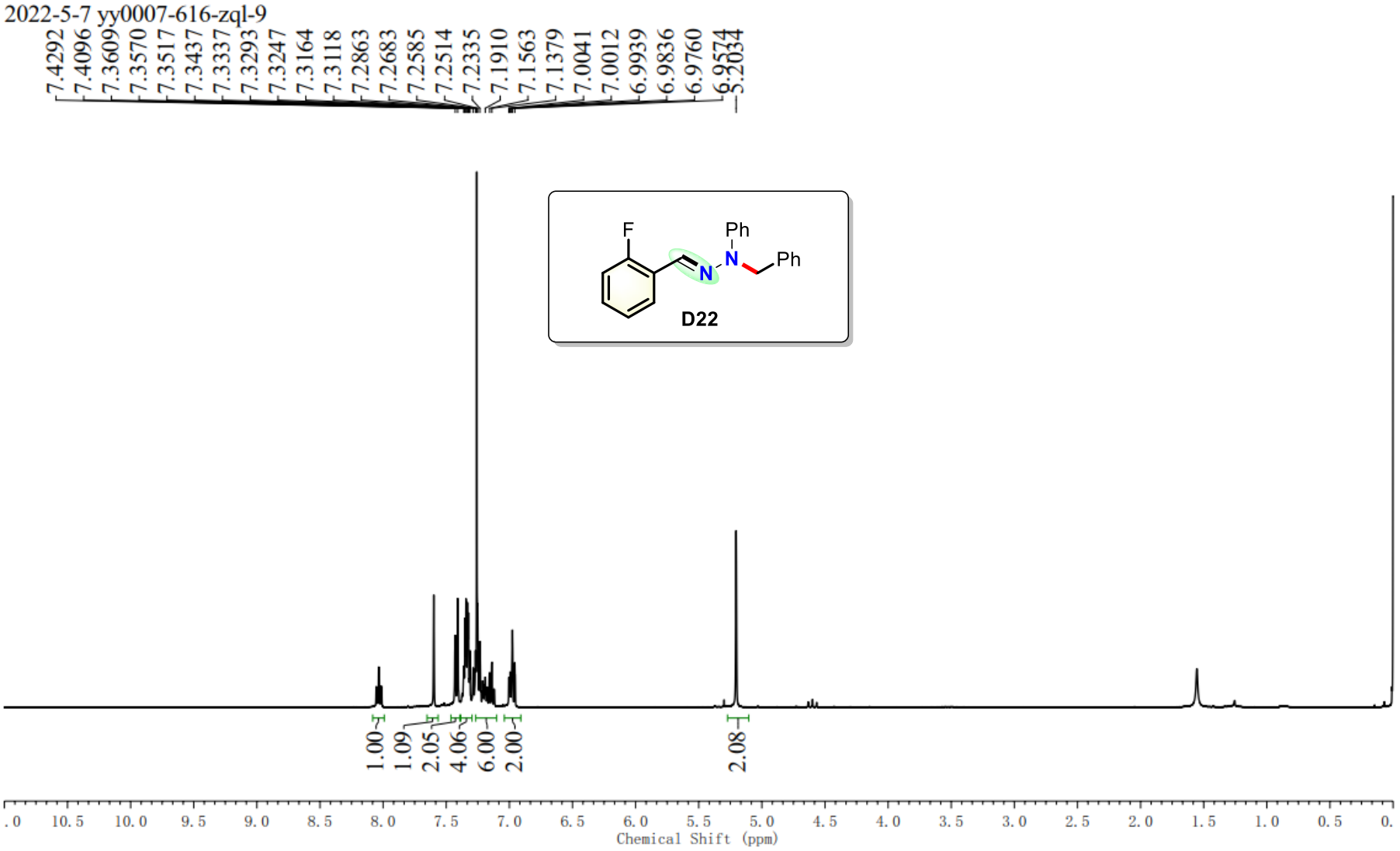

2022-04-27-yy0005-616-zgy-8
7.8766
7.8580
7.5776
7.4363
7.4163
7.3529
7.3478
7.3300
7.3160
7.3079
7.2726
7.2632
7.2569
7.2412
7.1988
7.1799
7.1586
7.1552
7.1398
7.1368
7.1218
7.0950
7.0769
6.9725
6.9545
5.1904
2.2180
Ph
N
N
Ph
D20
1.00
1.10
2.04
3.91
2.03
2.99
1.07
1.15
2.03
3.03
Chemical Shift (ppm)

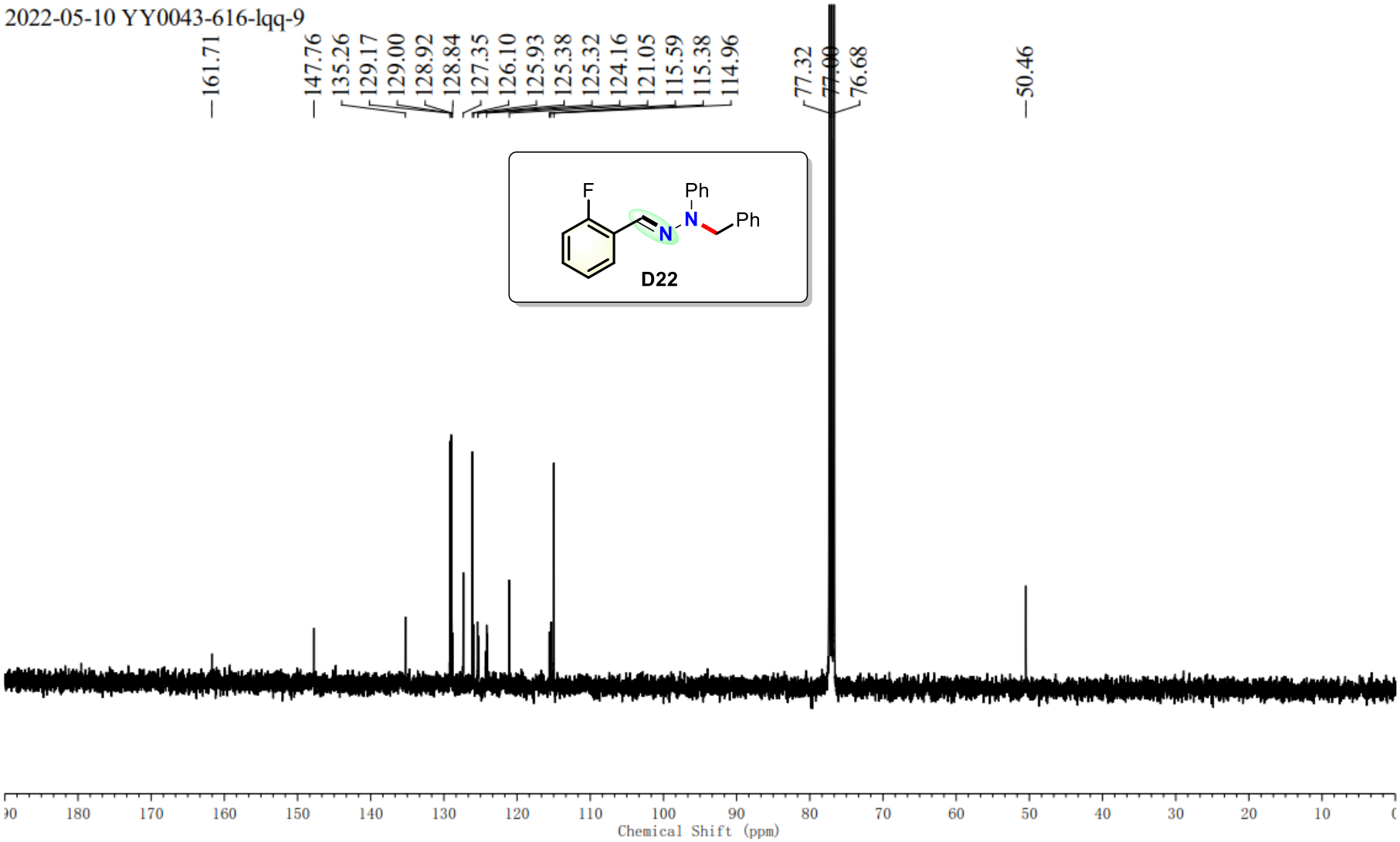
2022-04-29-YY0034-616-ZGY-8



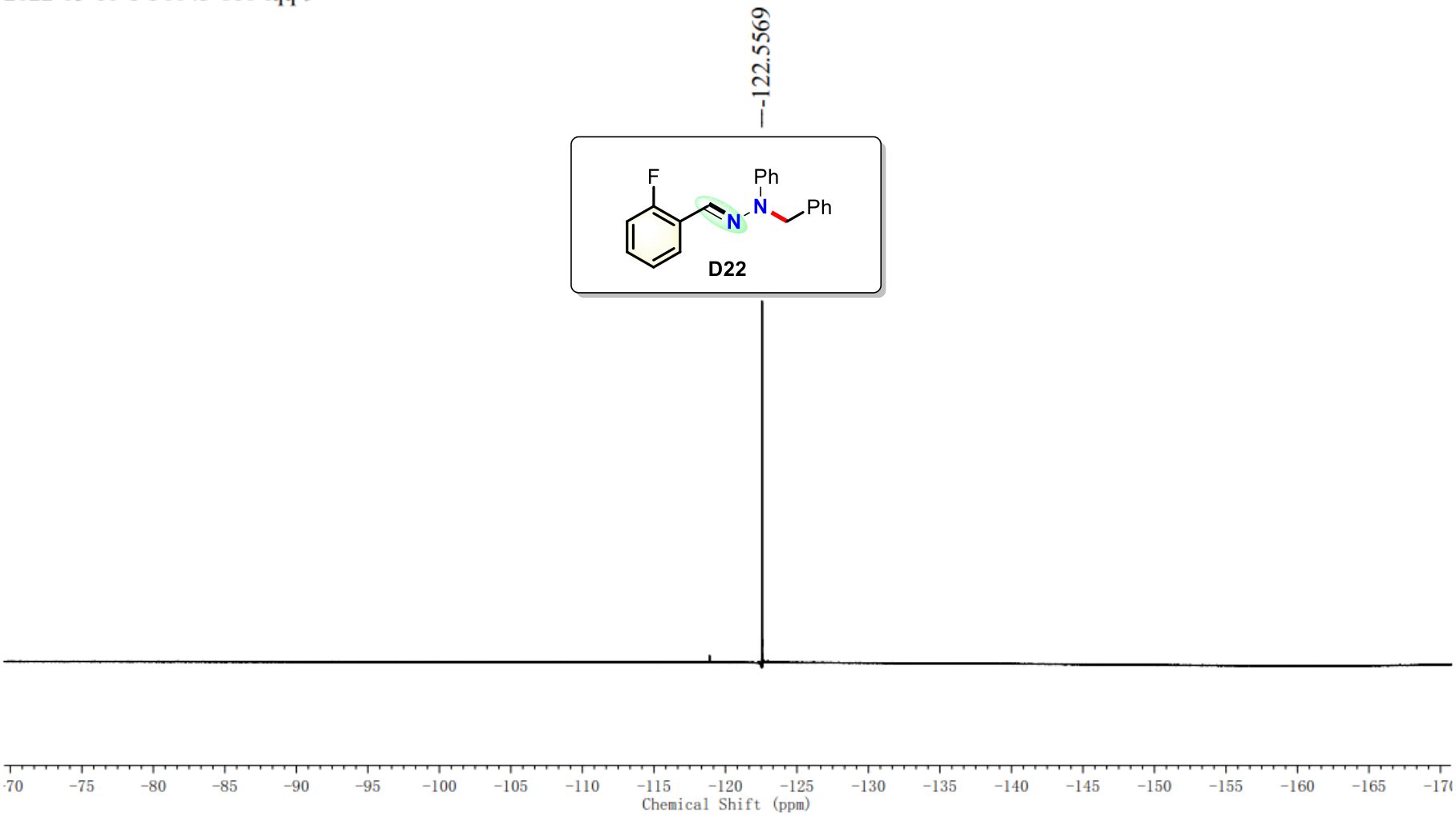

2022-5-7 yy0007-616-zql-8
8.0521
8.0481
8.0327
8.0288
7.8182
7.4196
7.3996
7.3497
7.3289
7.3112
7.2888
7.2635
7.2549
7.2419
7.2371
7.2188
7.2021
7.1979
6.9996
6.9808
6.9622
6.9490
6.9309
6.8390
6.8184
5.1914
3.7210
OCH3,
Ph
N
N
Ph
D21
1.04
1.03
2.02
8.00
1.08
1.01
1.04
2.08
3.06
Chemical Shift (ppm)

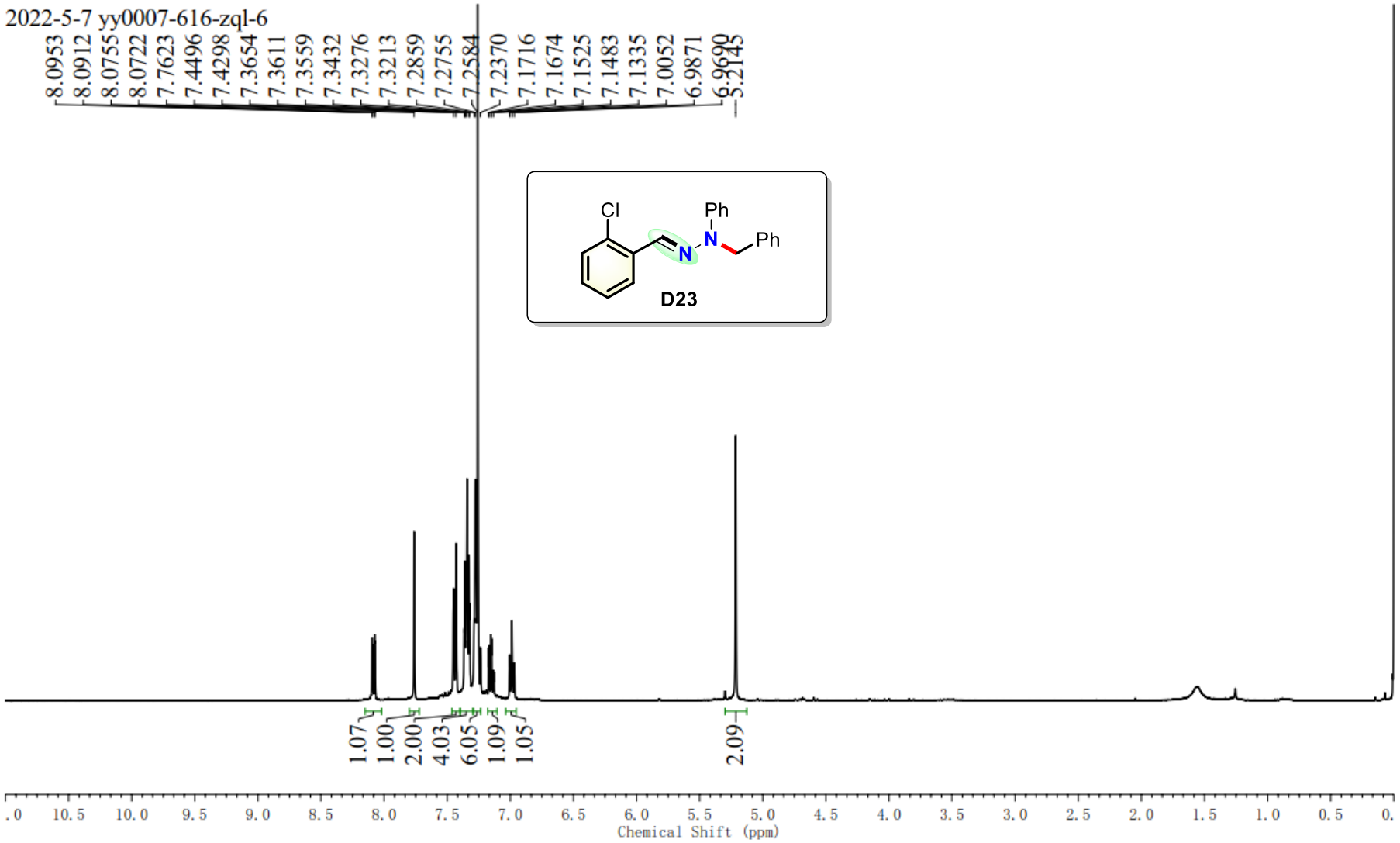

2022-05-10 YY0018-616-zql-8
156.9854
148.0104
135.9591
129.1079
128.8705
128.4783
127.1425
126.2750
125.4987
125.2388
120.9050
120.4542
114.6941
111.1670
77.3426
77.0251
76.7076
55.6300
50.2672
OCH3
Ph
N
N
Ph
D21
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

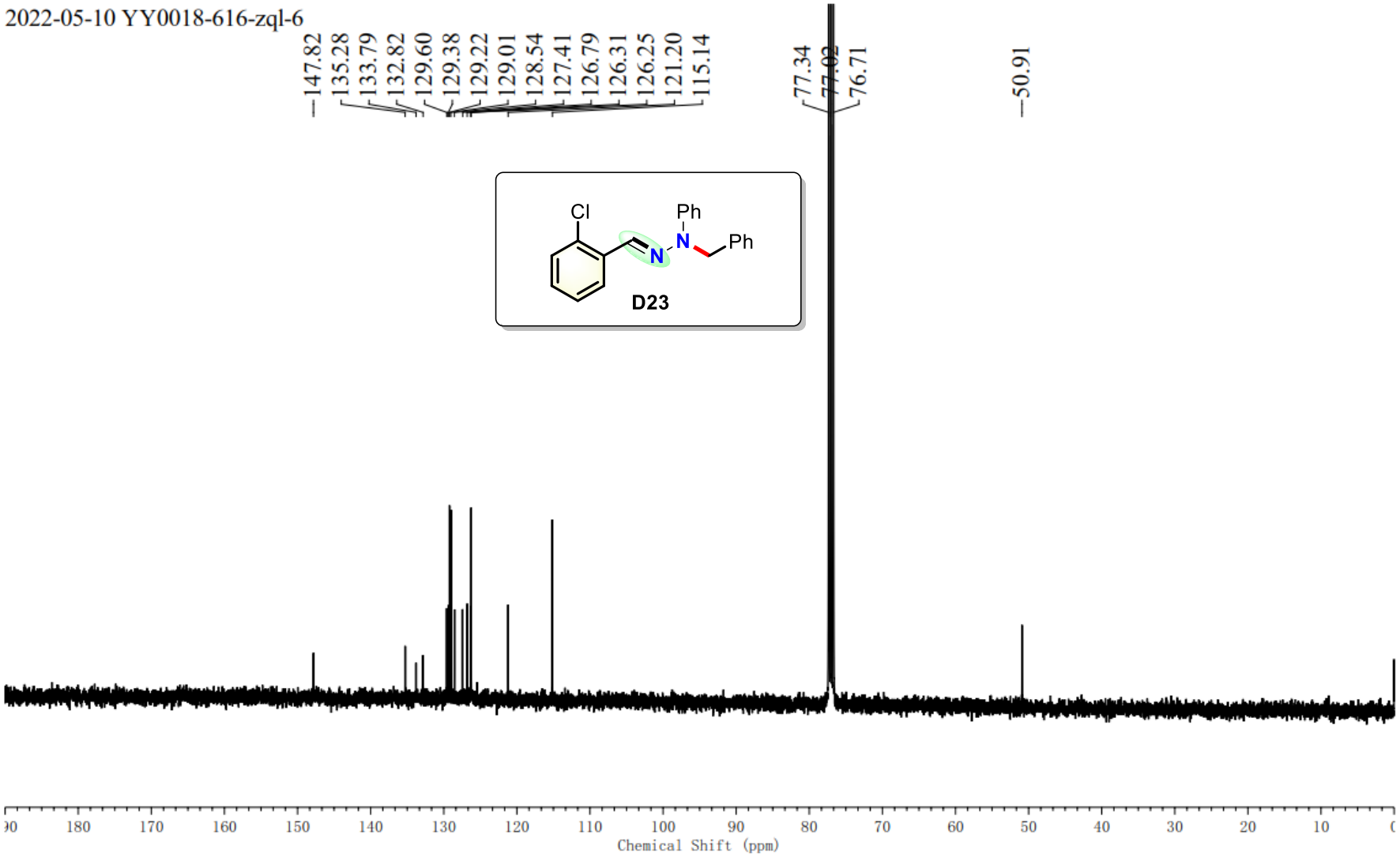

2022-5-7 yy0007-616-zql-9
7.4292
7.4096
7.3609
7.3570
7.3517
7.3437
7.3337
7.3293
7.3247
7.3164
7.3118
7.2863
7.2683
7.2585
7.2514
7.2335
7.1910
7.1563
7.1379
7.0041
7.0012
6.9939
6.9836
6.9760
5.2034
F
Ph
N
N
Ph
D22
1.00
1.09
2.05
4.06
6.00
2.00
2.08
Chemical Shift (ppm)

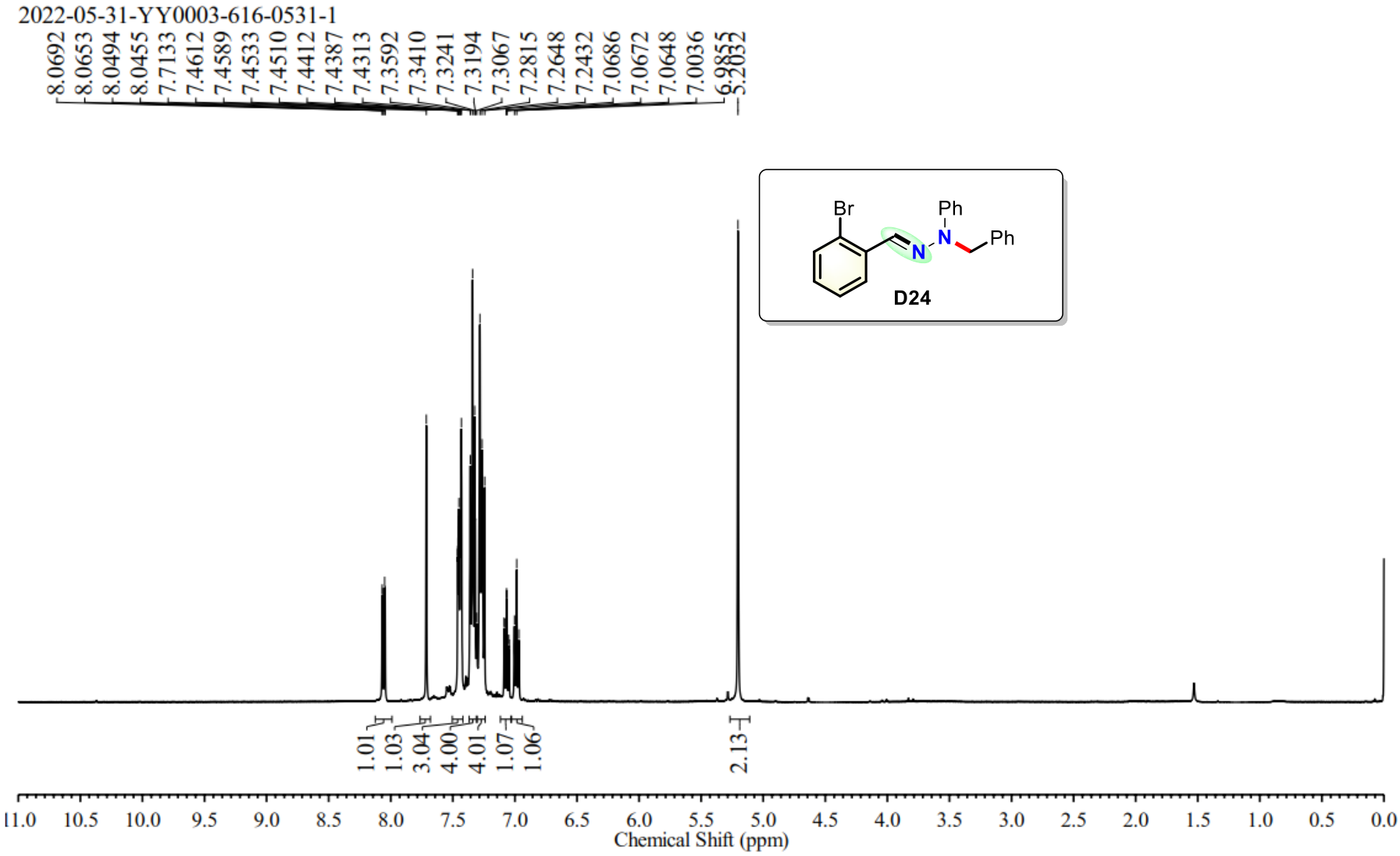

2022-05-10 YY0043-616-lqq-9
161.71
147.76
135.26
129.17
129.00
128.92
128.84
127.35
126.10
125.93
125.38
125.32
124.16
121.05
115.59
115.38
114.96
77.32
77.00
76.68
50.46
F
Ph
N
N
Ph
D22
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

2022-05-10 YY0043-616-lqq-9

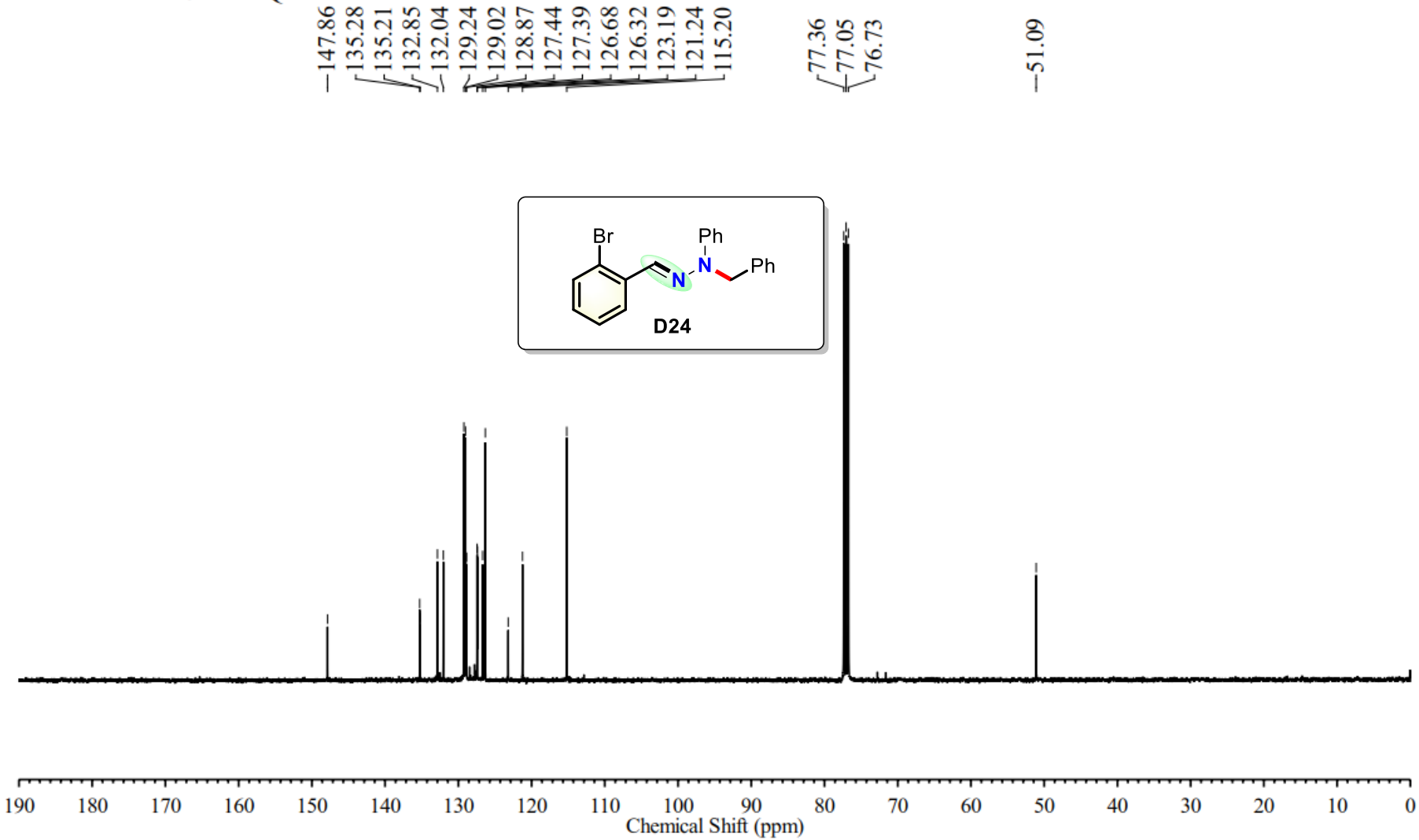


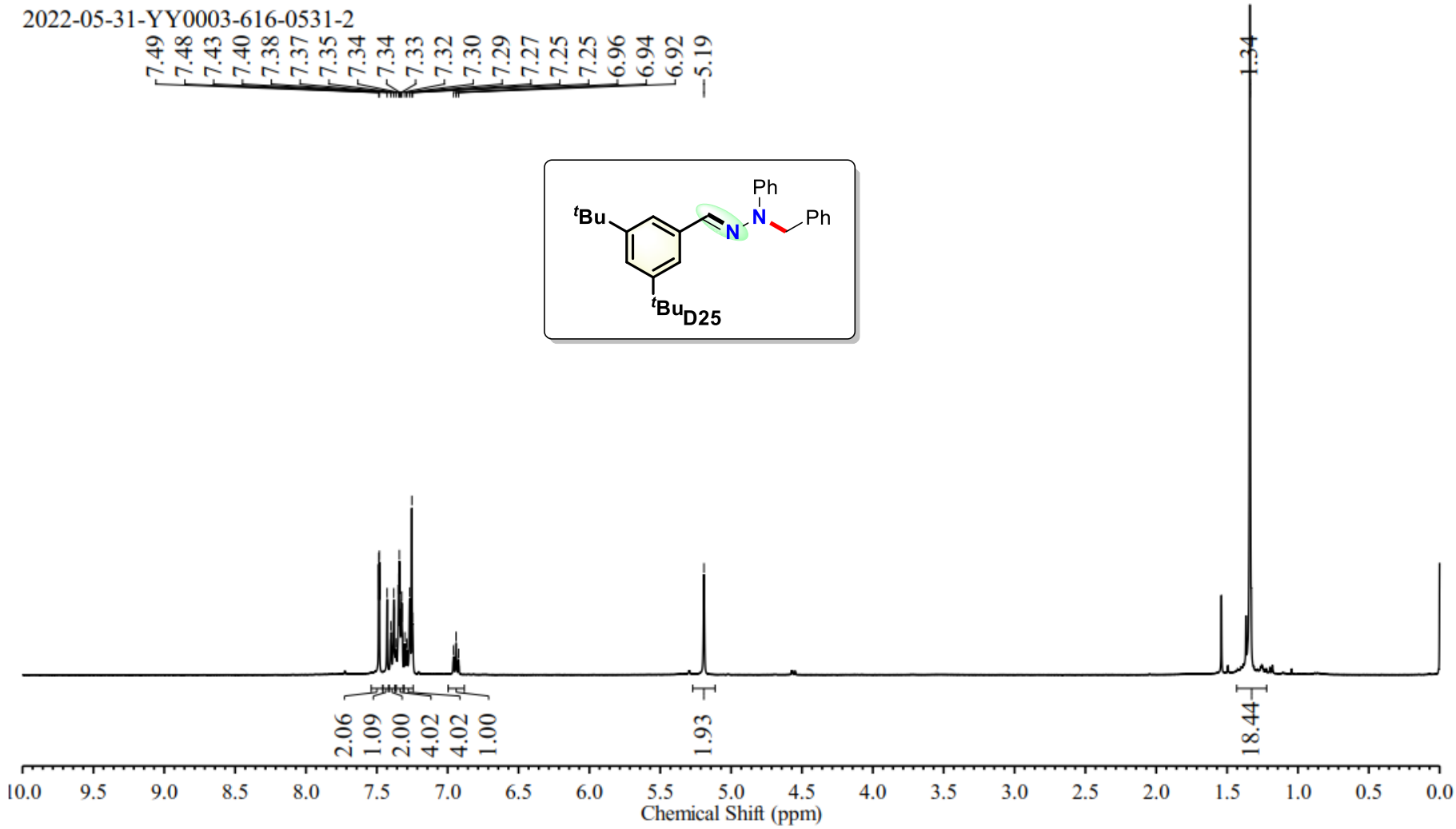

2022-5-7 yy0007-616-zql-6
8.0953
8.0912
8.0755
8.0722
7.7623
7.4496
7.4298
7.3654
7.3611
7.3559
7.3432
7.3276
7.3213
7.2859
7.2755
7.2584
7.2370
7.1716
7.1674
7.1525
7.1483
7.1335
7.0052
6.9871
6.9690
5.2145
Cl
Ph
N
N
Ph
D23
1.07
1.00
2.00
4.03
6.05
1.09
1.05
2.09
Chemical Shift (ppm)

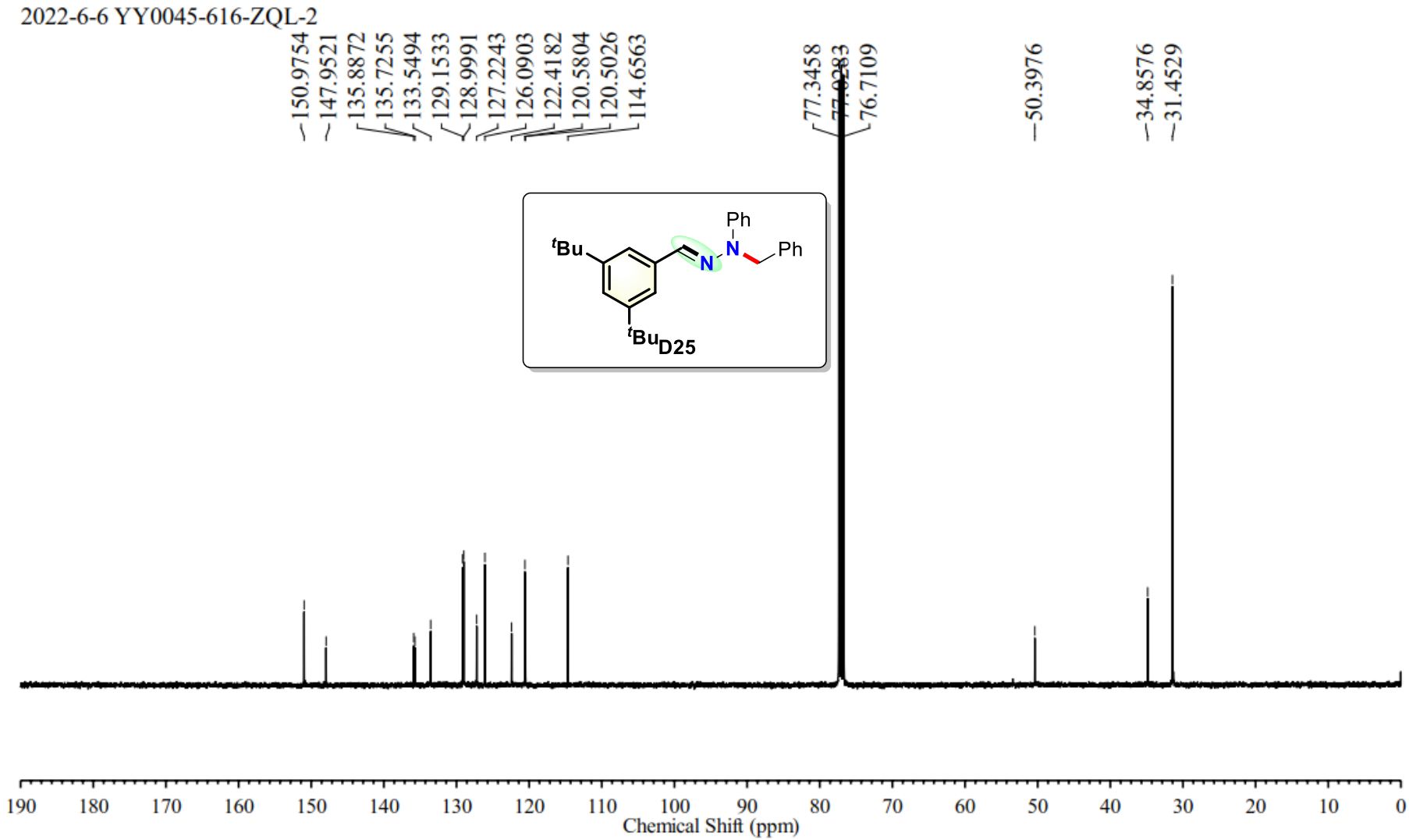

2022-05-10 YY0018-616-zql-6
147.82
135.28
133.79
132.82
129.60
129.38
129.22
129.01
128.54
127.41
126.79
126.31
126.25
121.20
115.14
77.34
77.02
76.71
50.91
Cl
Ph
N
N
Ph
D23
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)


2022-05-31-YY0003-616-0531-1
8.0692
8.0653
8.0494
8.0455
7.7133
7.4612
7.4589
7.4533
7.4510
7.4412
7.4387
7.4313
7.3592
7.3410
7.3241
7.3194
7.3067
7.2815
7.2648
7.2432
7.0686
7.0672
7.0648
7.0036
5.2032
Br
Ph
N
N
Ph
D24
1.01
1.03
3.04
4.00
4.01
1.07
1.06
2.13
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Chemical Shift (ppm)

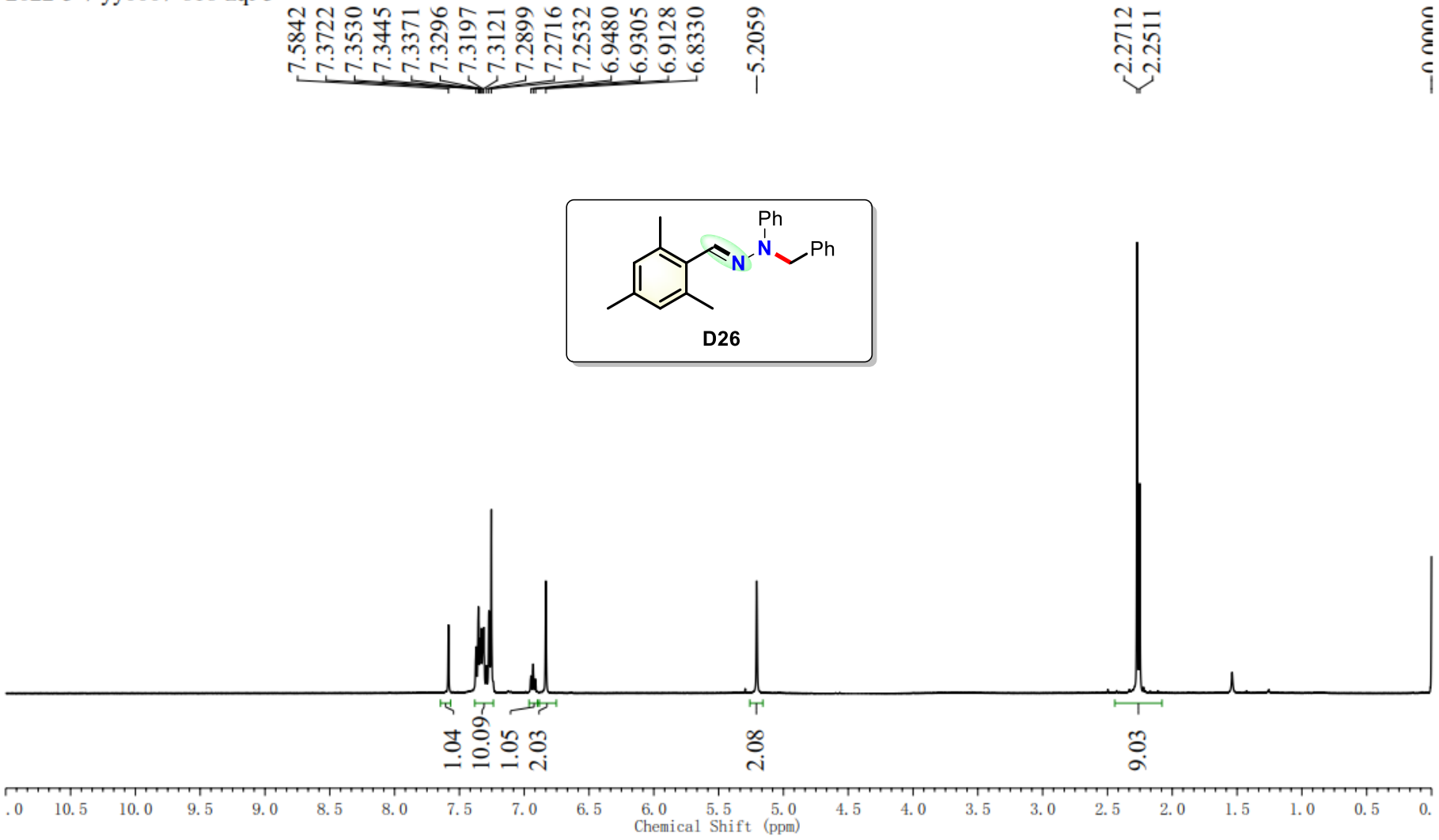
2022-6-6 YY0045-616-ZQL-1

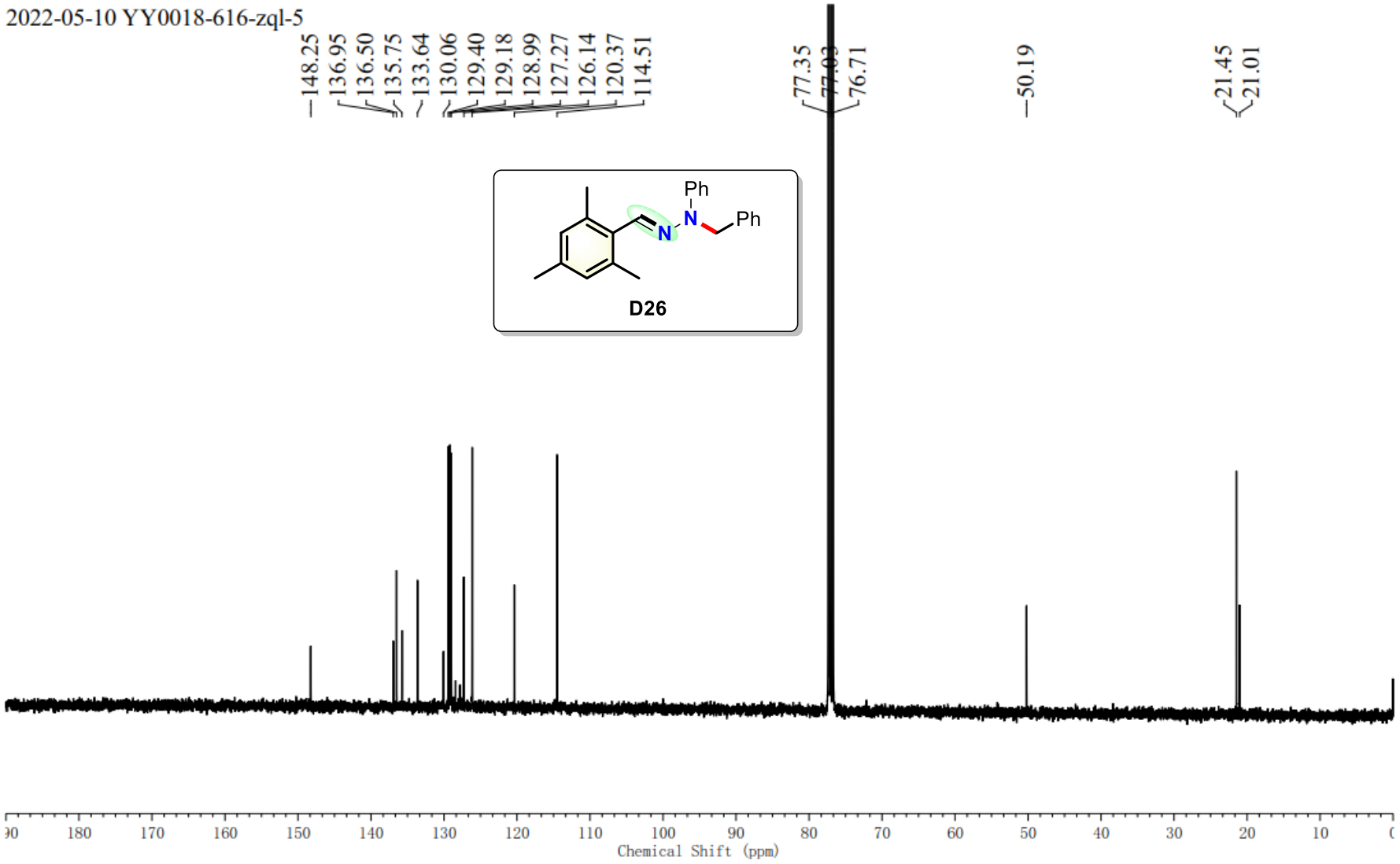



2022-05-31-YY0003-616-0531-2
7.49
7.48
7.43
7.40
7.38
7.37
7.35
7.34
7.34
7.33
7.32
7.30
7.29
7.27
7.25
7.25
6.96
6.94
6.92
5.19
1.34
tBu
Ph
N
N
Ph
tBuD25
2.06
1.09
2.00
4.02
4.02
1.00
1.93
18.44
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Chemical Shift (ppm)

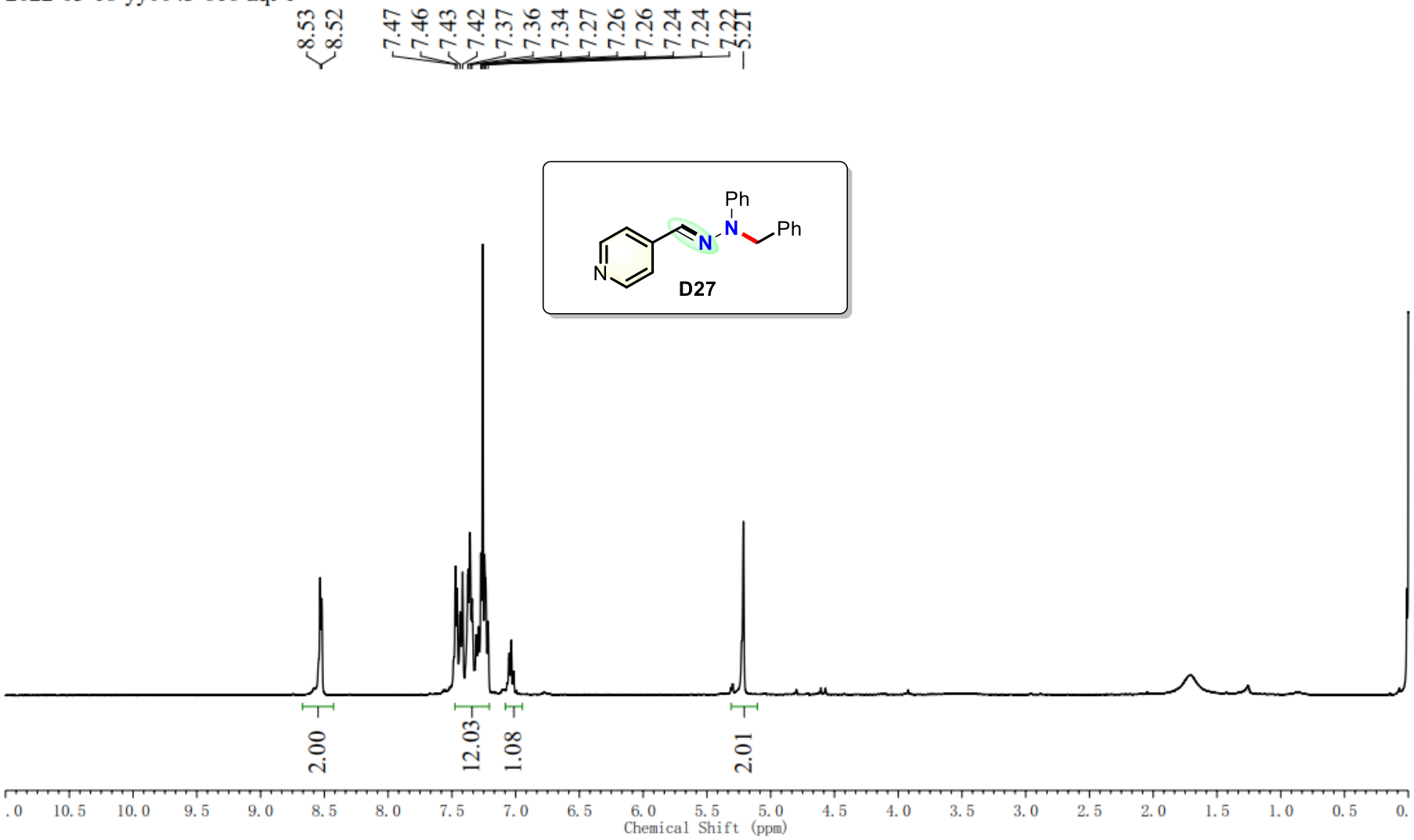

2022-6-6 YY0045-616-ZQL-2
150.9754
147.9521
135.8872
135.7255
133.5494
129.1533
128.9991
127.2243
126.0903
122.4182
120.5804
120.5026
114.6563
77.3458
77.0283
76.7109
50.3976
34.8576
31.4529
Ph
tBu
N
N
Ph
tBuD25
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Chemical Shift (ppm)

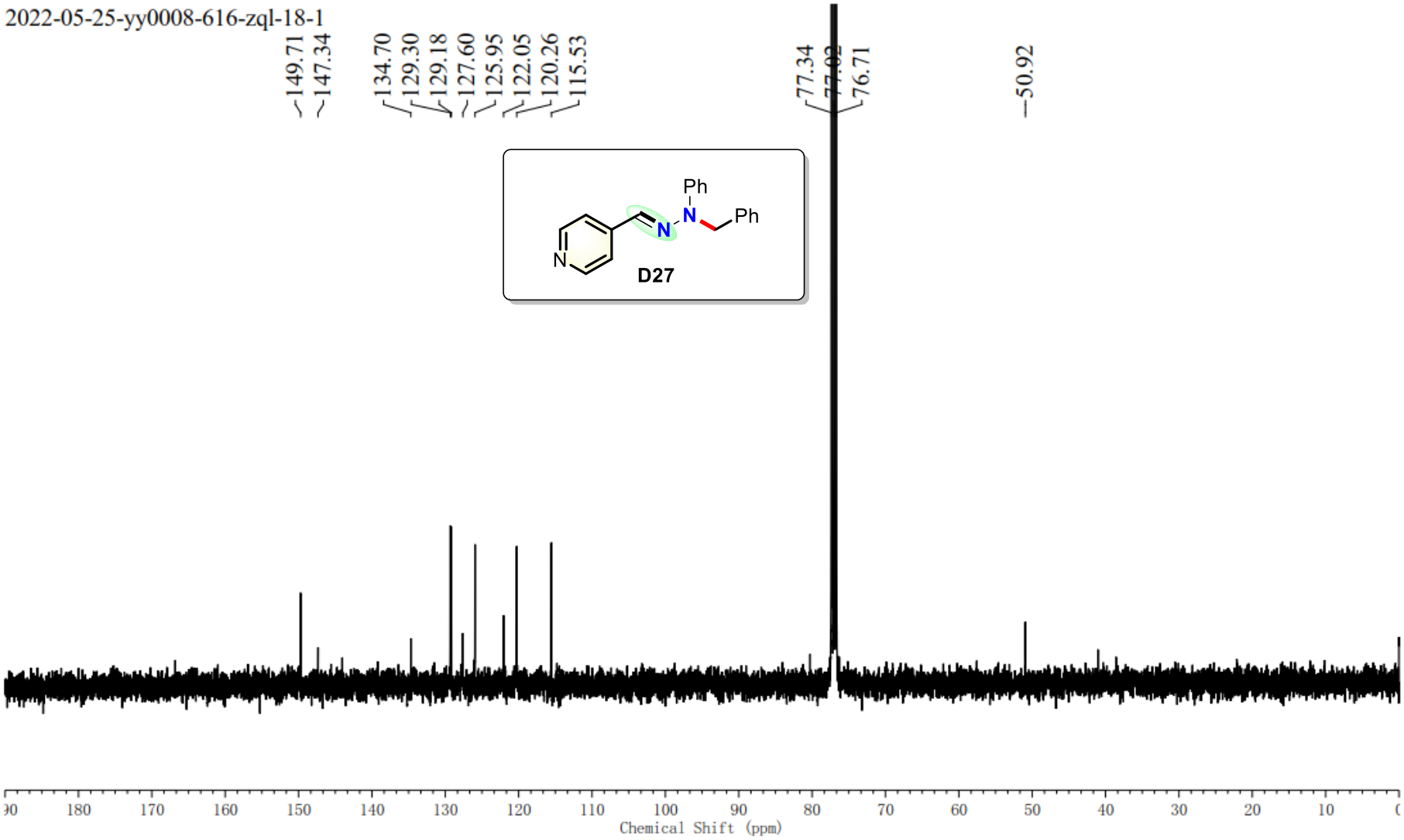
2022-5-7 yy0007-616-zql-5

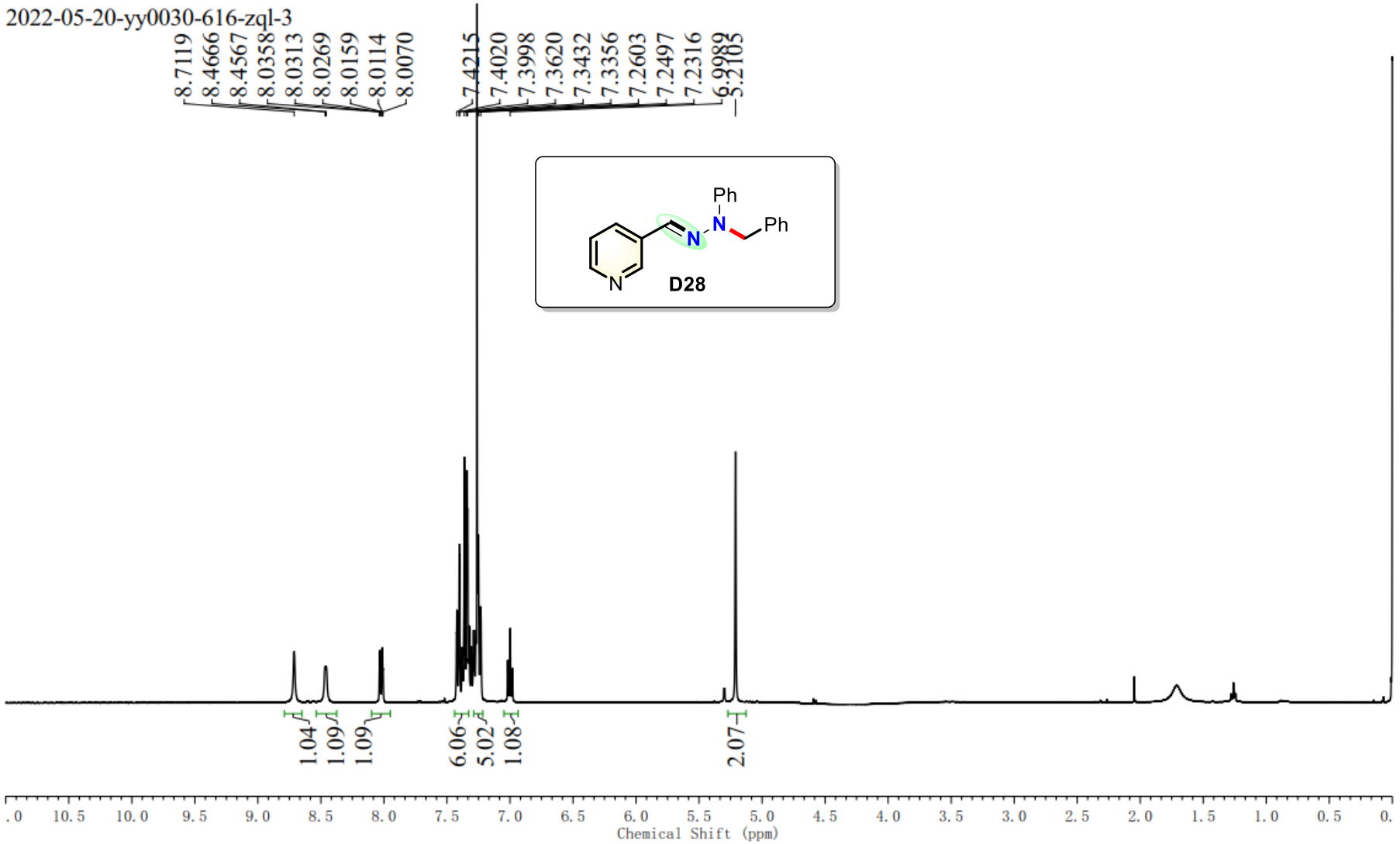


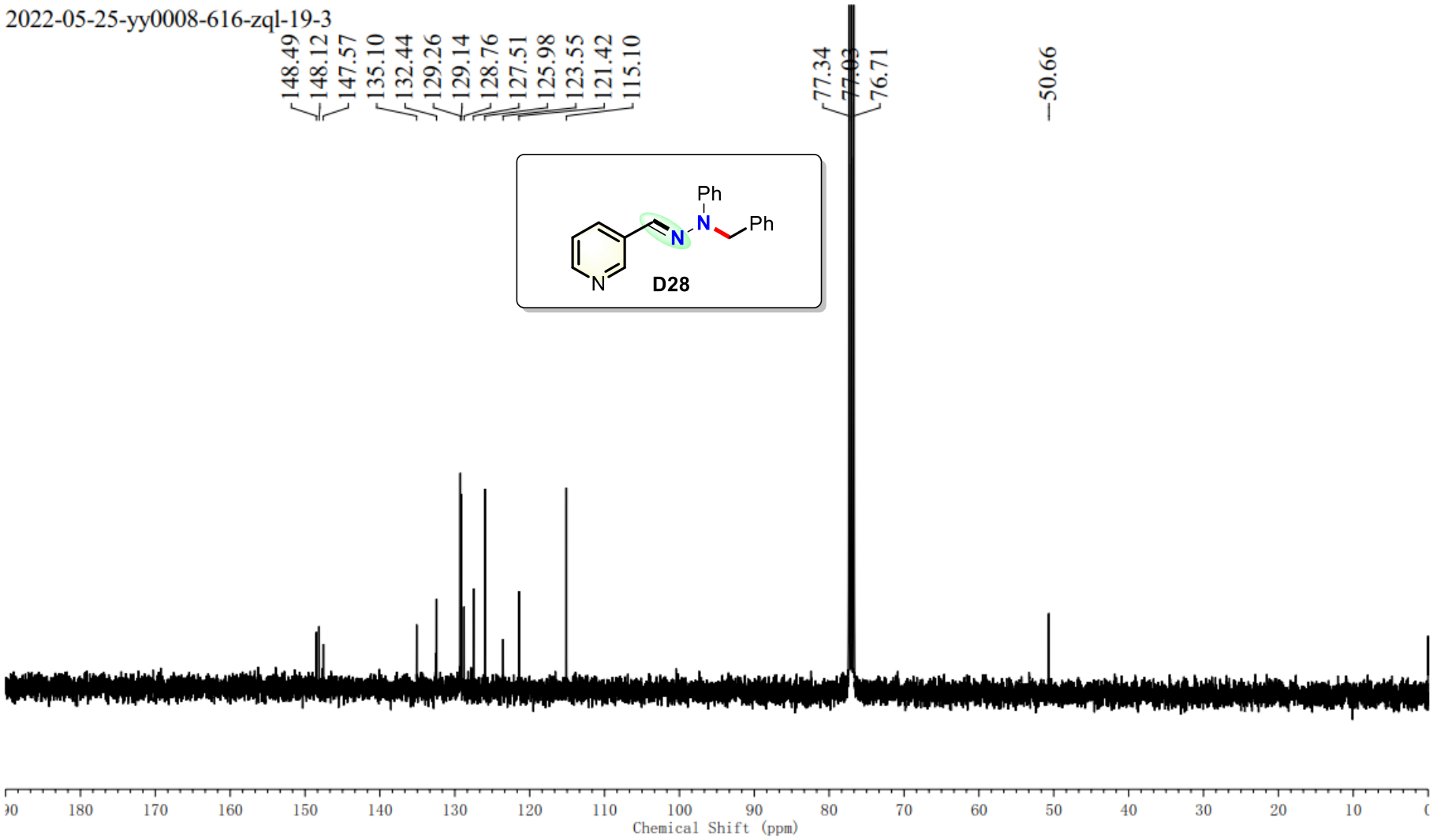

2022-05-10 YY0018-616-zql-5
148.25
136.95
136.50
135.75
133.64
130.06
129.40
129.18
128.99
127.27
126.14
120.37
114.51
77.35
77.03
76.71
50.19
21.45
21.01
Ph
N
N
Ph
D26
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

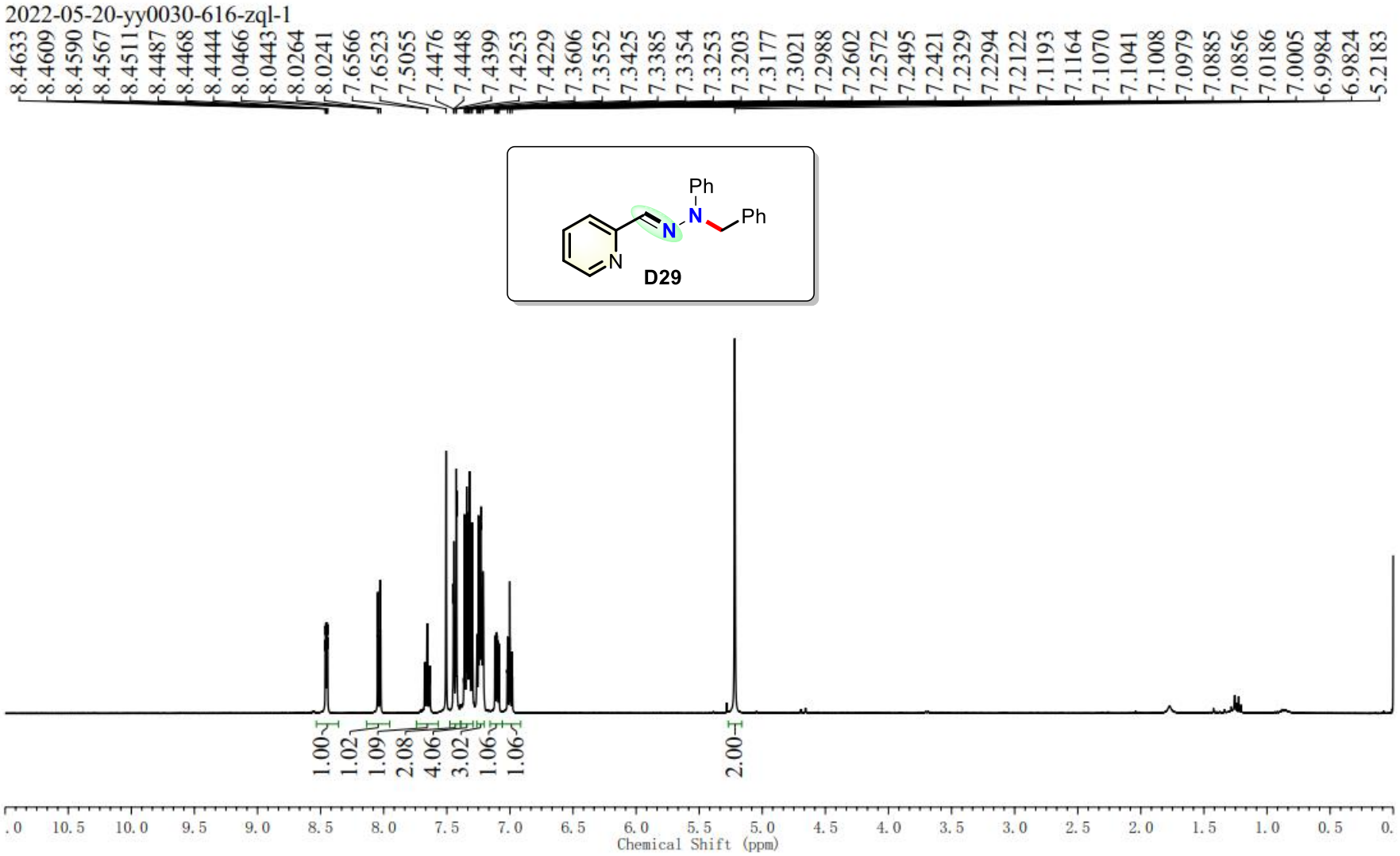
2022-05-18-yy0043-616-zql-1




2022-05-25-yy0008-616-zql-18-1
149.71
147.34
134.70
129.30
129.18
127.60
125.95
122.05
120.26
115.53
77.34
77.02
76.71
50.92
Ph
N
N
Ph
D27
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

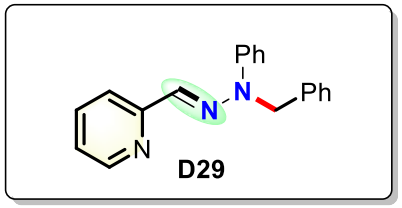

2022-05-20-yy0030-616-zql-3
8.7119
8.4666
8.4567
8.0358
8.0313
8.0269
8.0159
8.0114
8.0070
7.4215
7.4020
7.3998
7.3620
7.3432
7.3356
7.2603
7.2497
7.2316
6.9989
5.2185
Ph
N
Ph
N
N
D28
1.04
1.09
1.09
6.06
5.02
1.08
2.07
Chemical Shift (ppm)


2022-05-25-yy0008-616-zql-19-3
148.49
148.12
147.57
135.10
132.44
129.26
129.14
128.76
127.51
125.98
123.55
121.42
115.10
77.34
77.03
76.71
50.66
Ph
N
Ph
N
D28
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

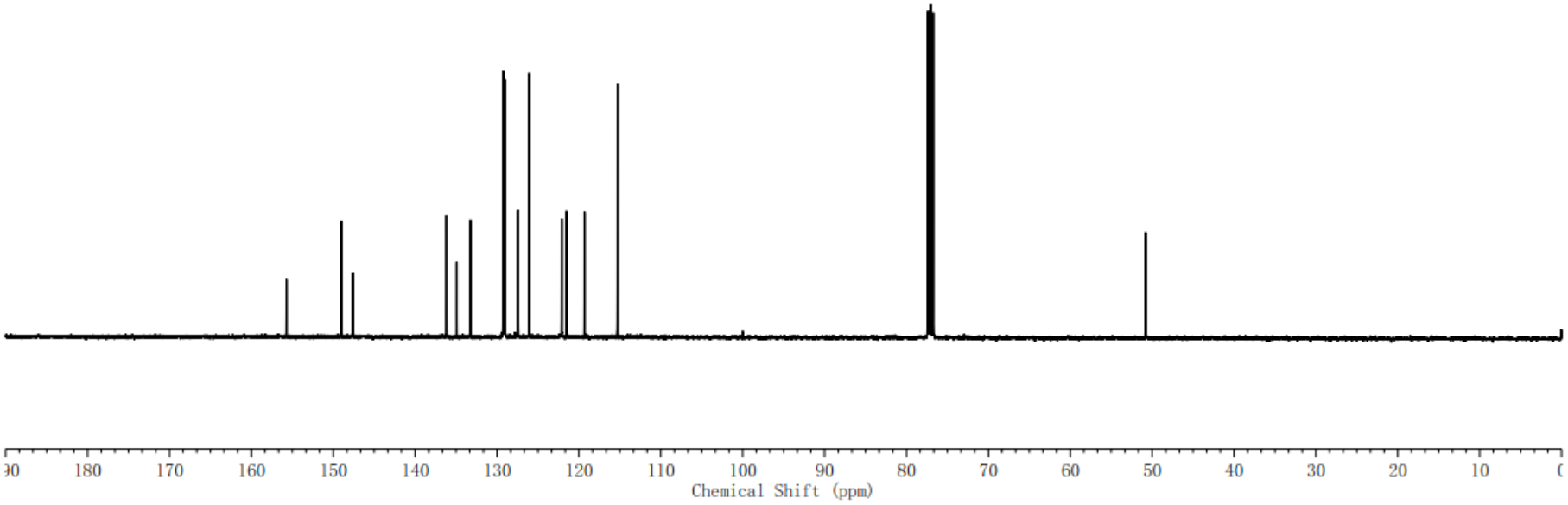

2022-05-20-yy0030-616-zql-1
8.4633
8.4609
8.4590
8.4567
8.4511
8.4487
8.4468
8.4444
8.0466
8.0443
8.0264
8.0241
7.6566
7.6523
7.5055
7.4476
7.4448
7.4399
7.4253
7.4229
7.3606
7.3552
7.3425
7.3385
7.3354
7.3253
7.3203
7.3177
7.3021
7.2988
7.2602
7.2572
7.2495
7.2421
7.2329
7.2294
7.2122
7.1193
7.1164
7.1070
7.1041
7.1008
7.0979
7.0885
7.0856
7.0186
7.0005
6.9984
6.9824
5.2183
Ph
N
Ph
N
D29
1.00
1.02
1.09
2.08
4.06
3.02
1.06
1.06
2.00
Chemical Shift (ppm)

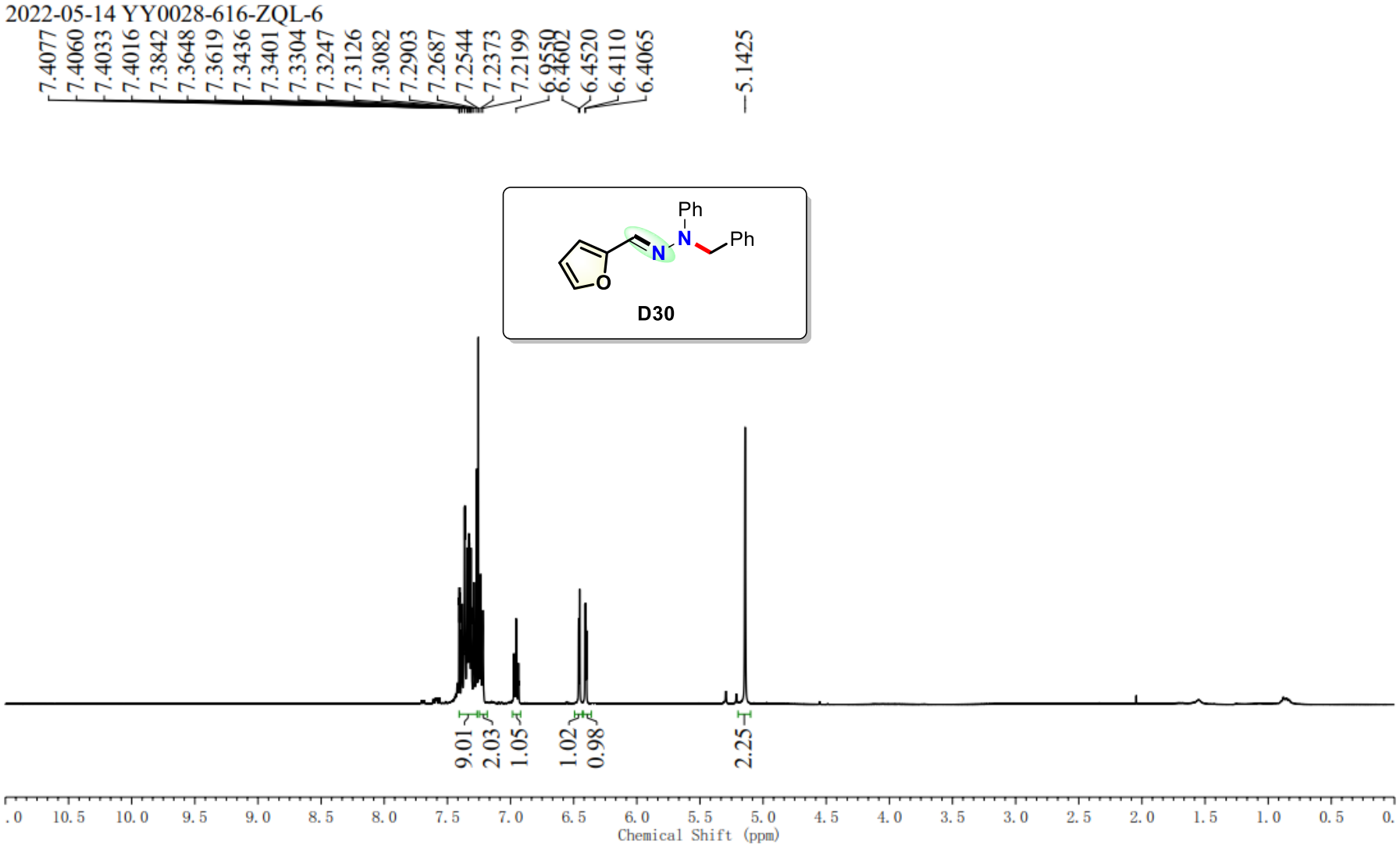
2022-05-25-yy0008-616-zql-19-1

155.72
149.00
147.59
136.17
134.92
133.25
129.24
129.05
127.42
126.05
122.10
121.51
119.31
115.27
77.38
77.06
76.74
50.80

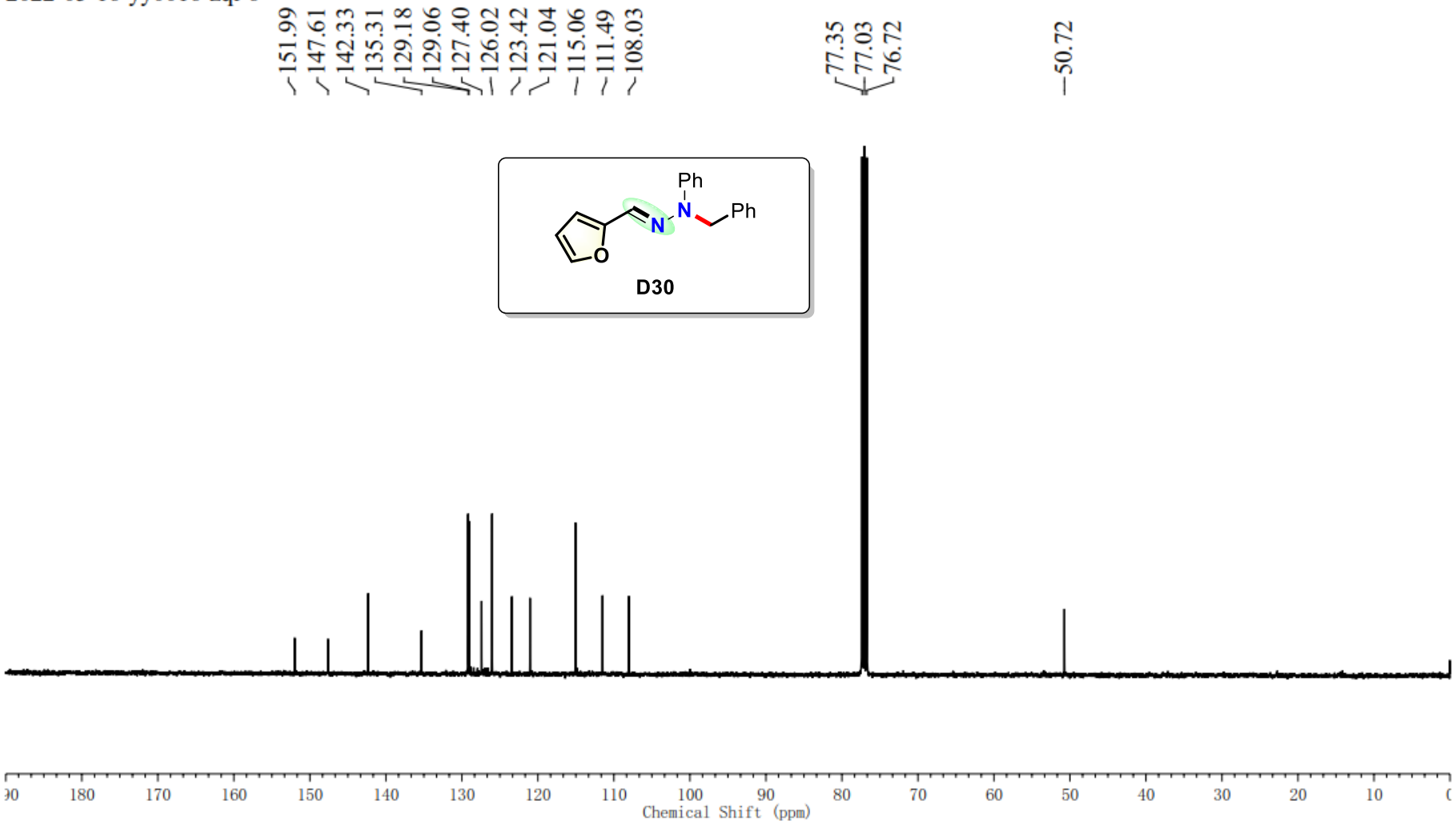



D29



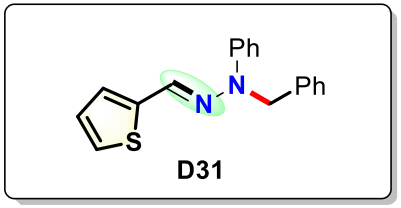

2022-05-14 YY0028-616-ZQL-6
7.4077
7.4060
7.4033
7.4016
7.3842
7.3648
7.3619
7.3436
7.3401
7.3304
7.3247
7.3126
7.3082
7.2903
7.2687
7.2544
7.2373
7.2199
6.4602
6.4520
6.4110
6.4065
5.1425
Ph
N
Ph
O
D30
9.01
2.03
1.05
1.02
0.98
2.25
Chemical Shift (ppm)

2022-05-16-yy0016-zql-6

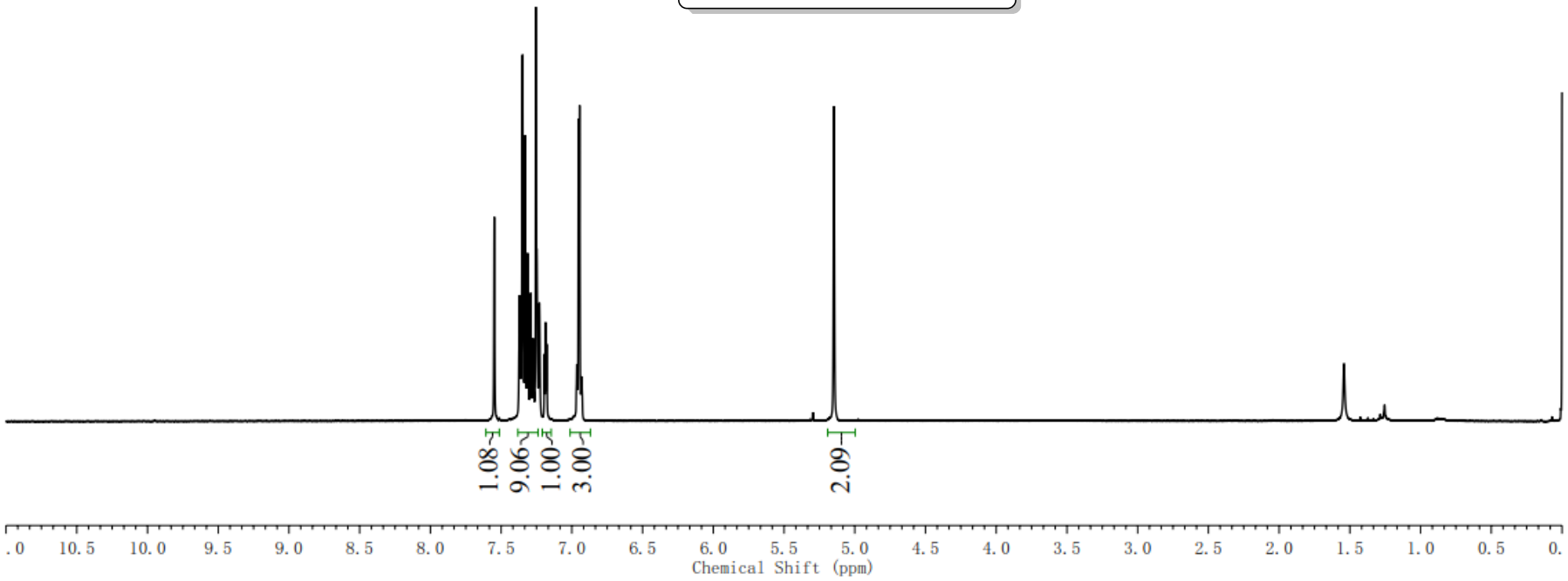


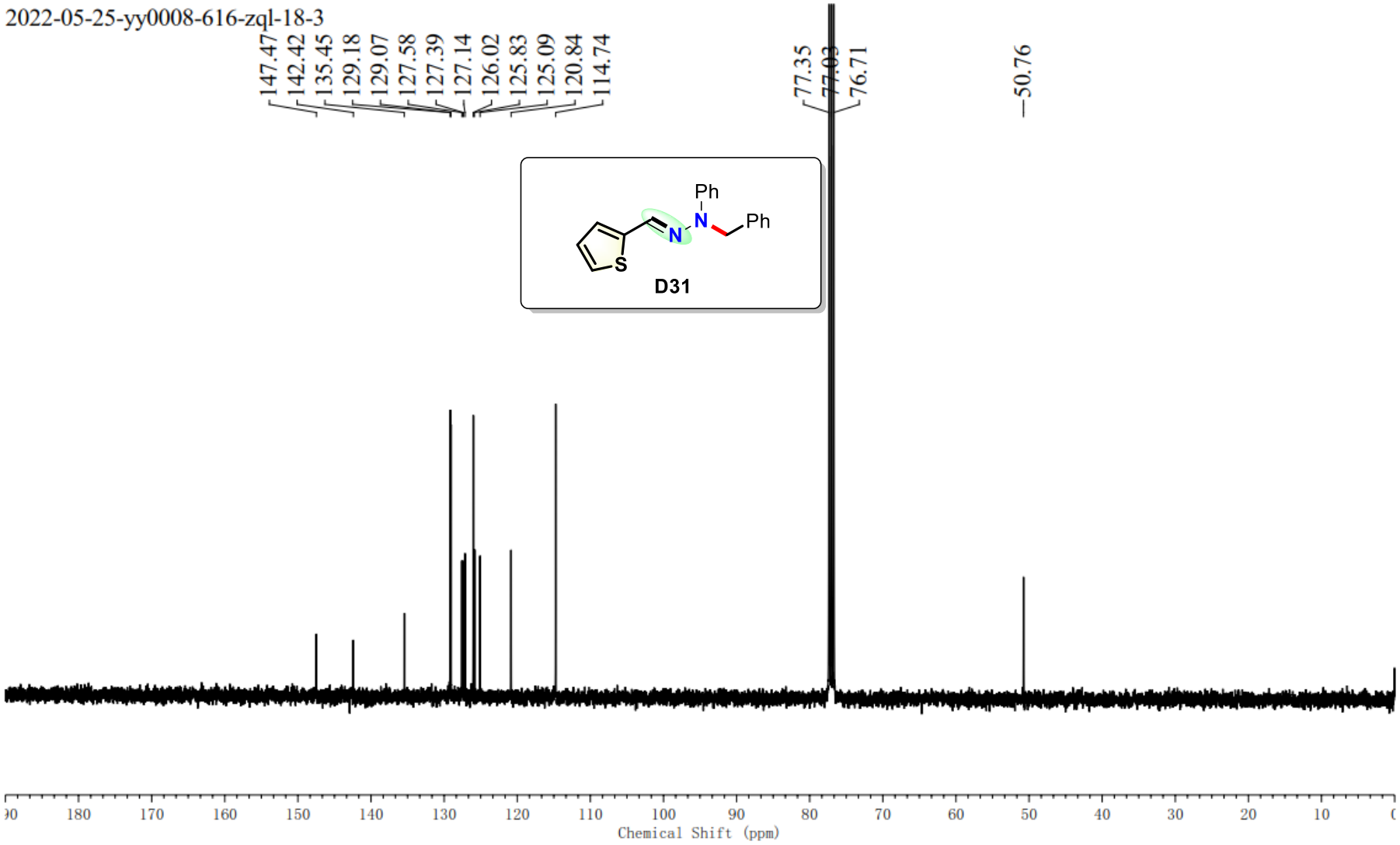
2022-05-18-yy0043-616-zql-3

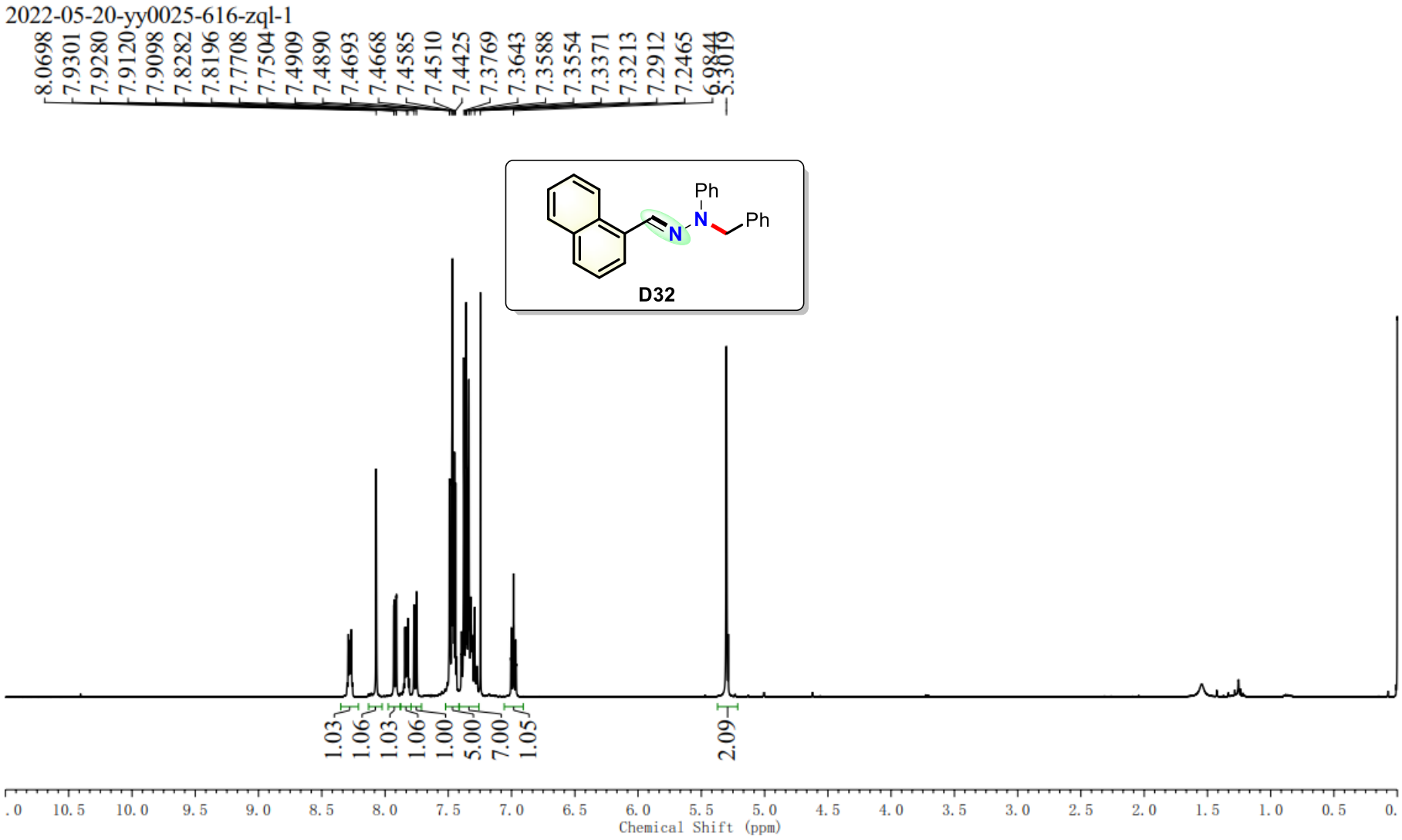
7.5485
7.3695
7.3486
7.3302
7.3129
7.2913
7.2746
7.2550
7.2480
7.2294
7.1934
7.1855
7.1775
6.9645
6.9528
6.9451
6.9300
5.1474

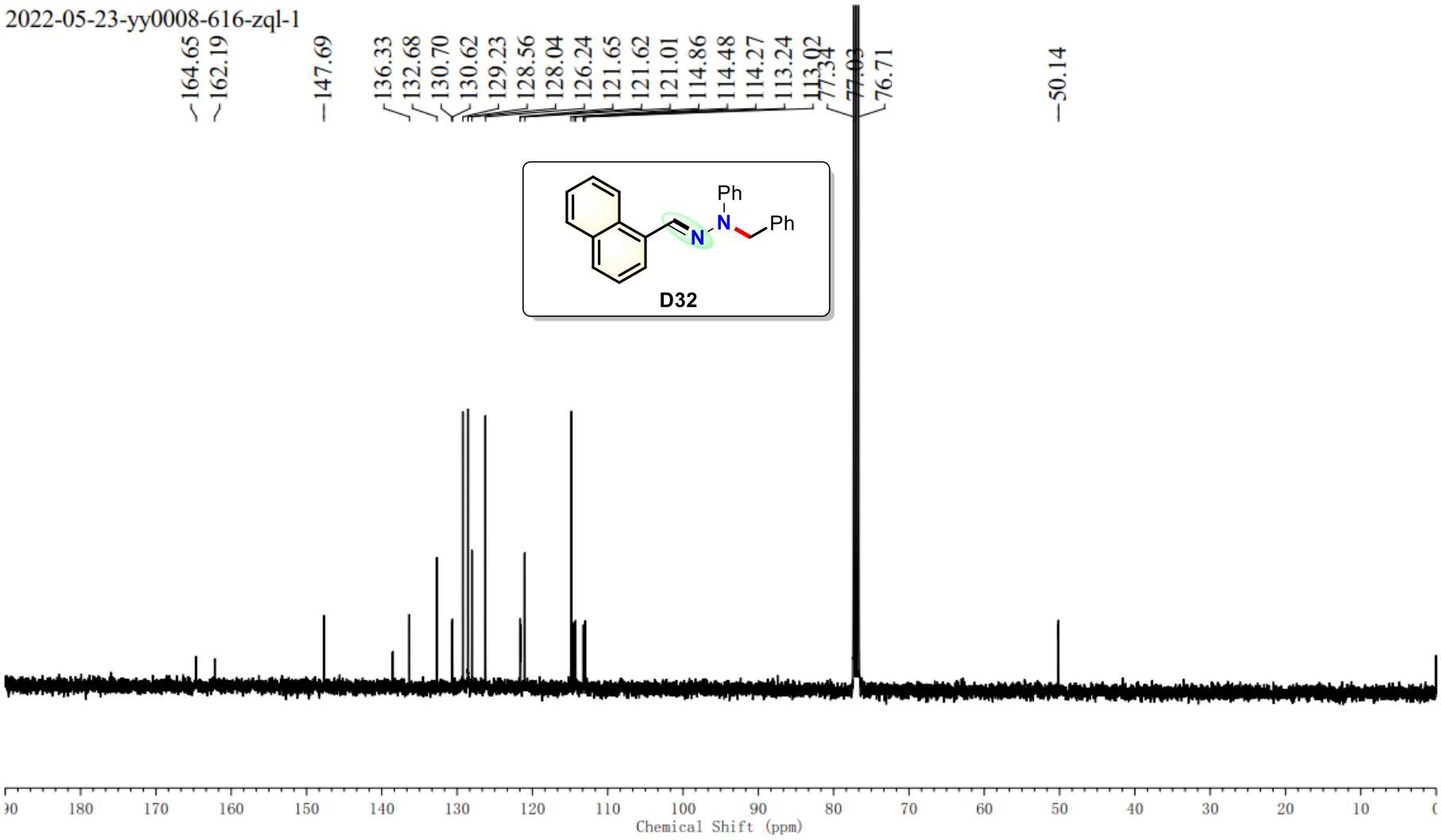


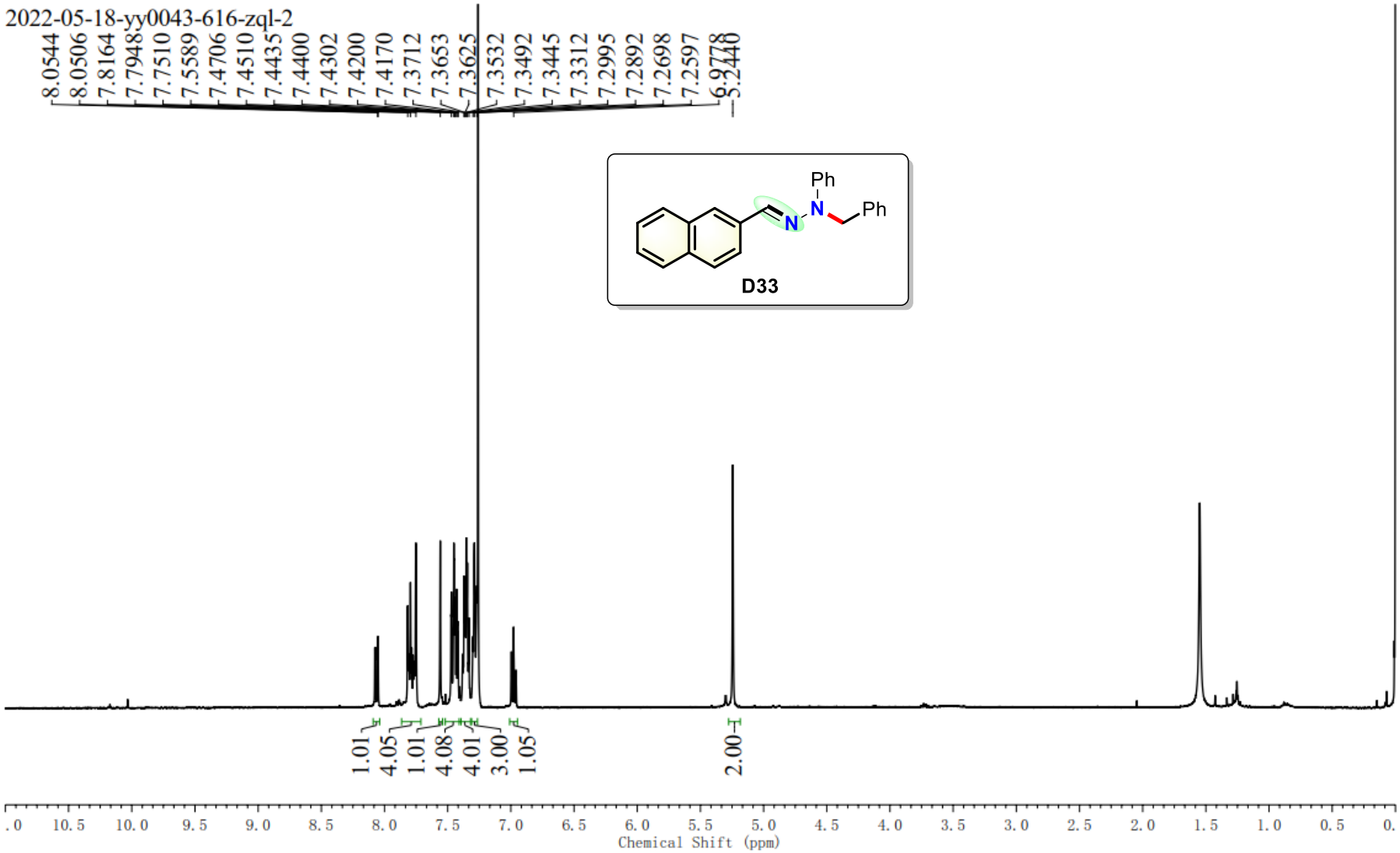

D31

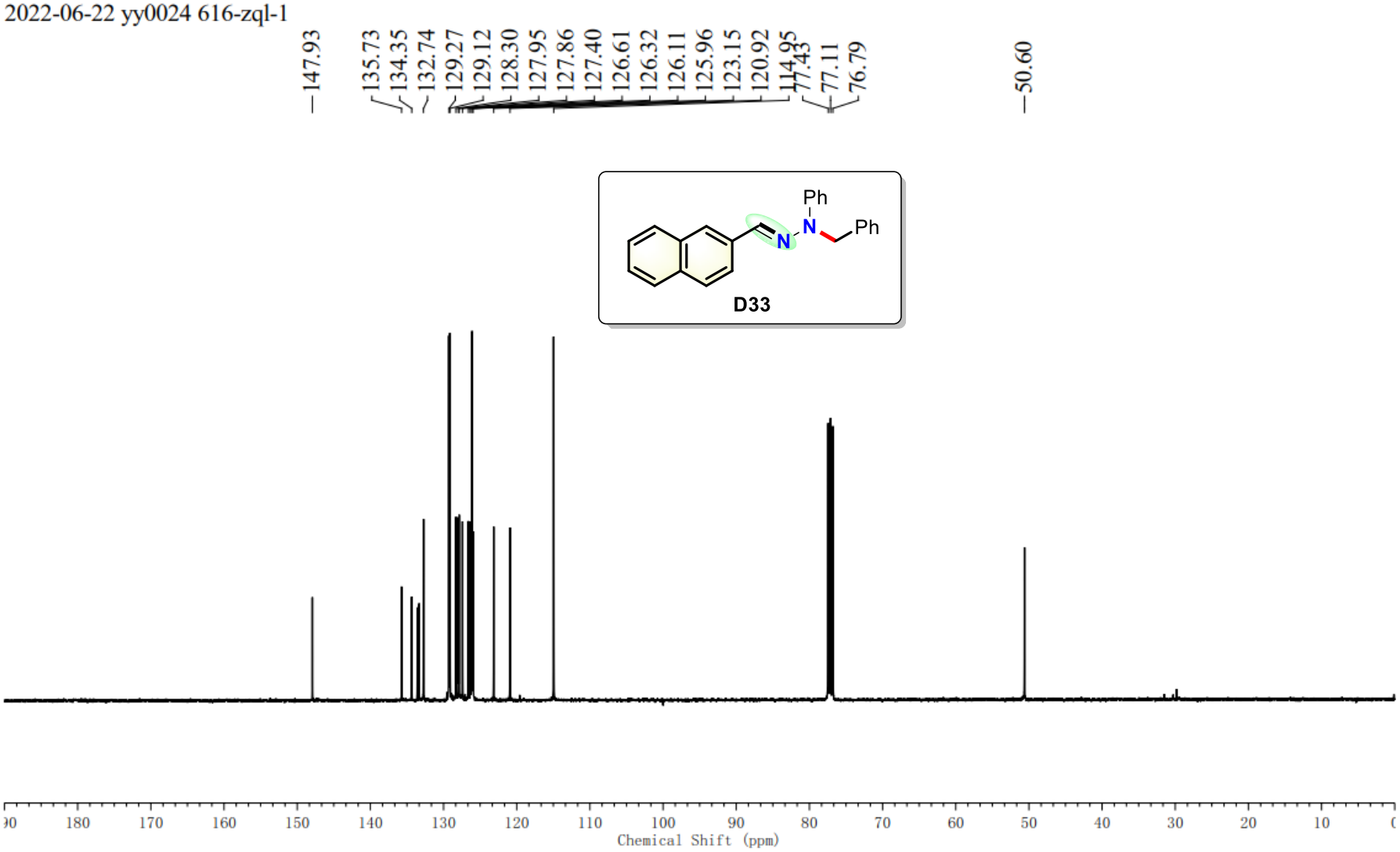



2022-05-25-yy0008-616-zql-18-3
147.47
142.42
135.45
129.18
129.07
127.58
127.39
127.14
126.02
125.83
125.09
120.84
114.74
77.35
77.03
76.71
50.76
Ph
N
Ph
N
S
D31
Chemical Shift (ppm)

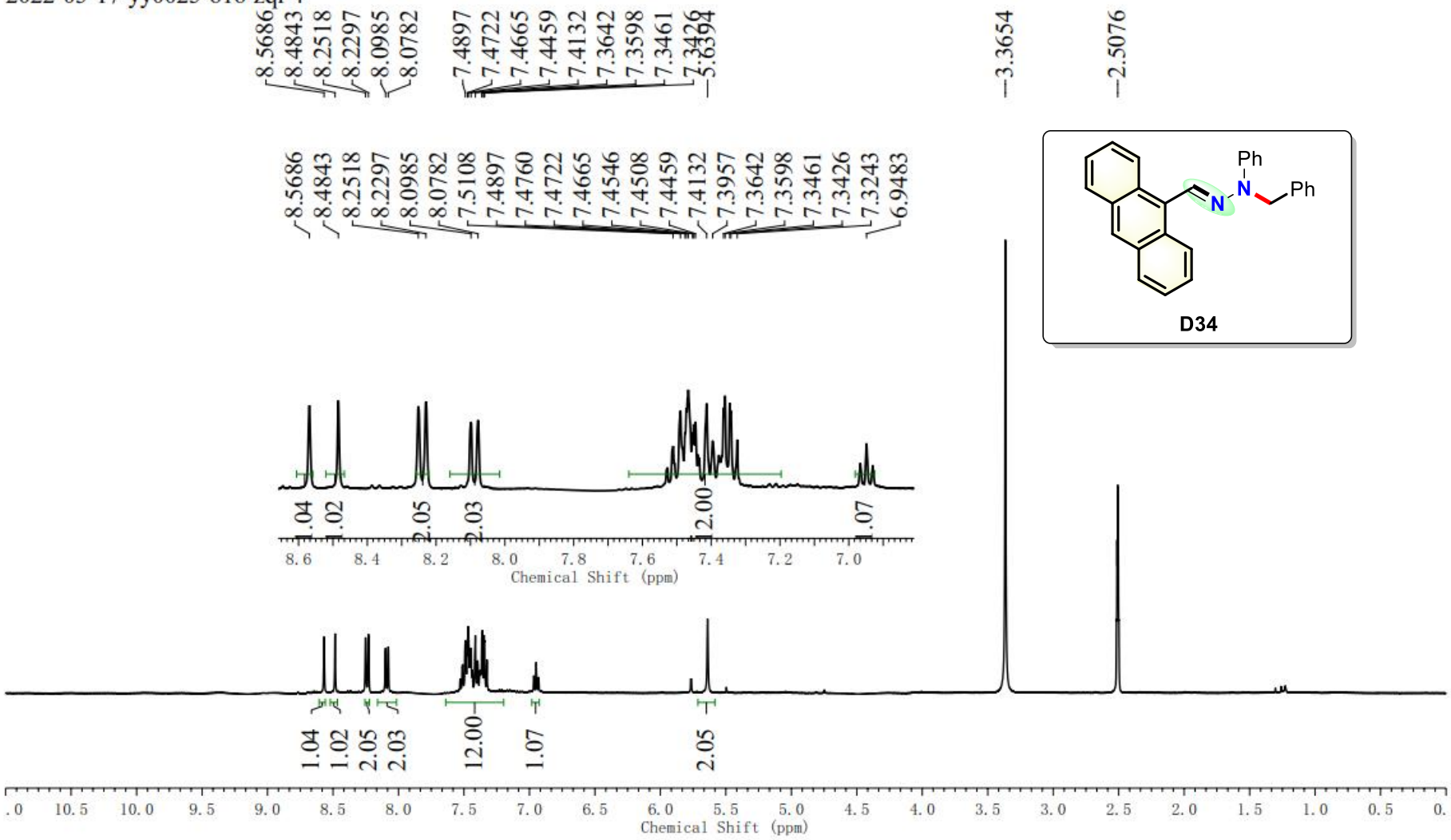

2022-05-20-yy0025-616-zql-1
8.0698
7.9301
7.9280
7.9120
7.9098
7.8282
7.8196
7.7708
7.7504
7.4909
7.4890
7.4693
7.4668
7.4585
7.4510
7.4425
7.3769
7.3643
7.3588
7.3554
7.3371
7.3213
7.2912
7.2465
6.9844
5.3019
Ph
N
N
Ph
D32
1.03
1.06
1.03
1.06
1.00
5.00
7.00
1.05
2.09
Chemical Shift (ppm)

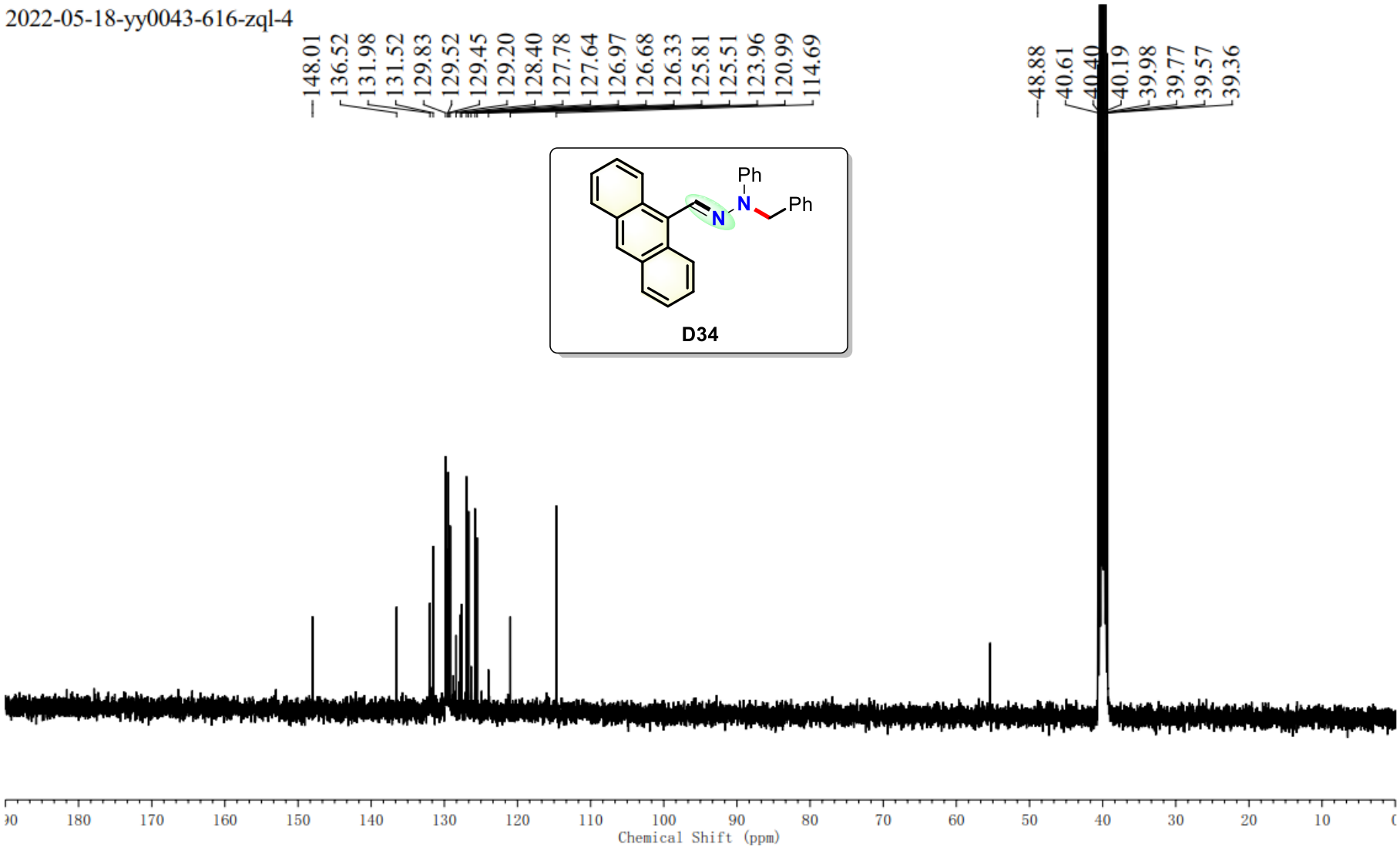

2022-05-23-yy0008-616-zql-1
164.65
162.19
147.69
136.33
132.68
130.70
130.62
129.23
128.56
128.04
126.24
121.65
121.62
121.01
114.86
114.48
114.27
113.24
113.02
77.34
77.03
76.71
50.14
Ph
N
N
Ph
D32
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

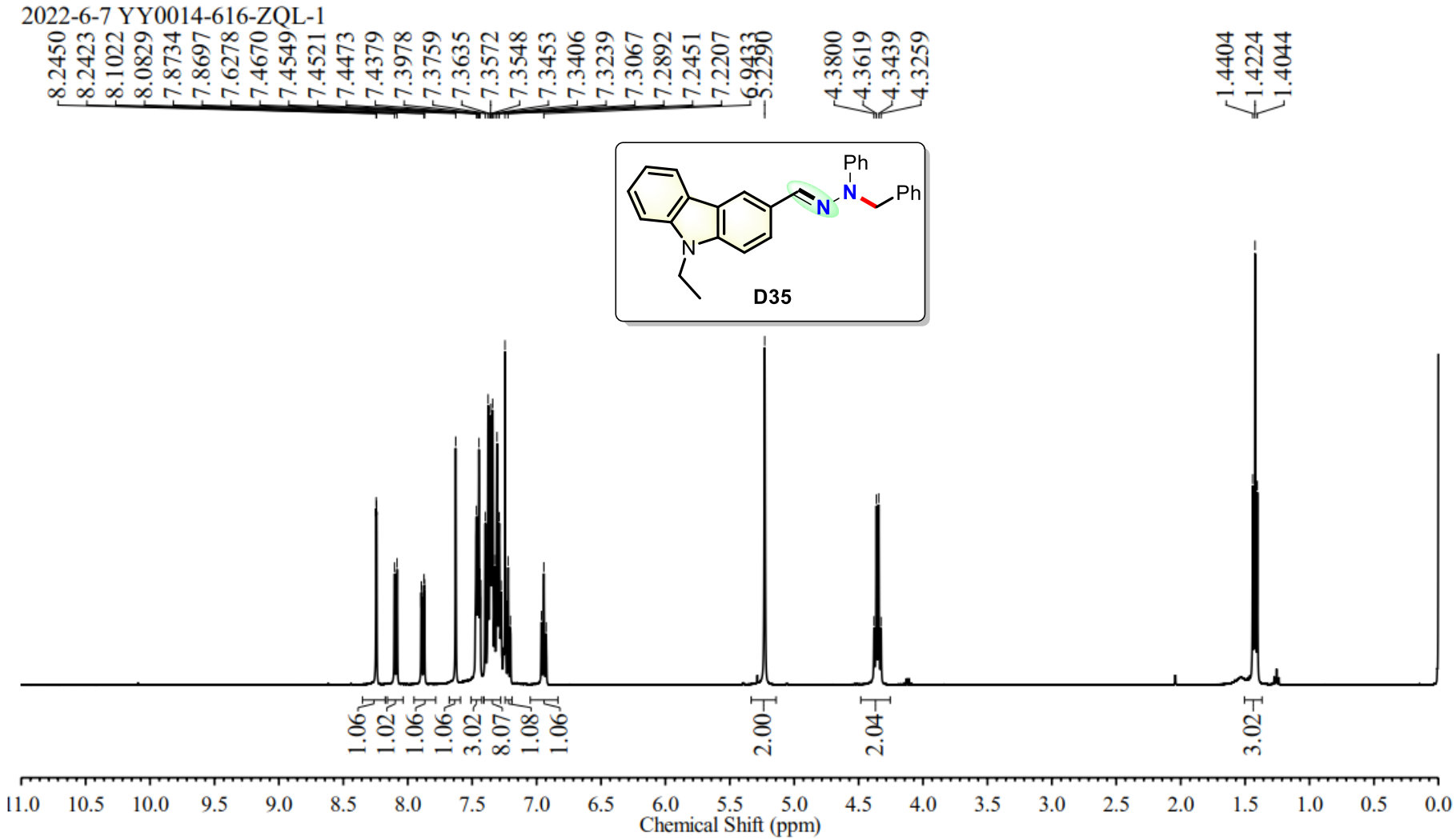

2022-05-18-yy0043-616-zql-2
8.0544
8.0506
7.8164
7.7948
7.7510
7.5589
7.4706
7.4510
7.4435
7.4400
7.4302
7.4200
7.4170
7.3712
7.3653
7.3625
7.3532
7.3492
7.3445
7.3312
7.2995
7.2892
7.2698
7.2597
6.9778
5.2440
Ph
N
N
Ph
D33
1.01
4.05
1.01
4.08
4.01
3.00
1.05
2.00
Chemical Shift (ppm)

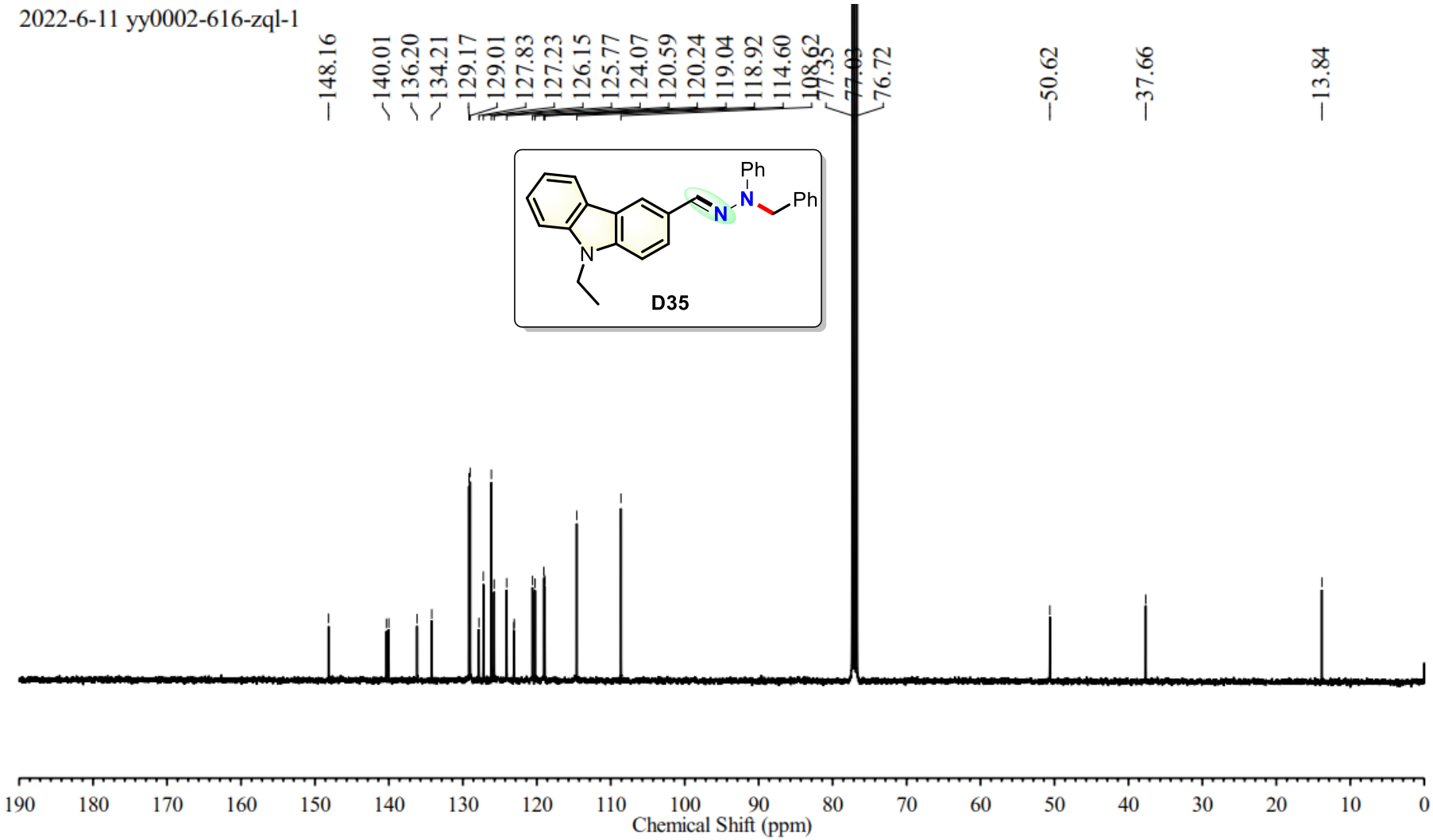

2022-06-22 yy0024 616-zql-1
147.93
135.73
134.35
132.74
129.27
129.12
128.30
127.95
127.86
127.40
126.61
126.32
126.11
125.96
123.15
120.92
114.95
77.43
77.11
76.79
50.60
Ph
N
N
Ph
D33
Chemical Shift (ppm)

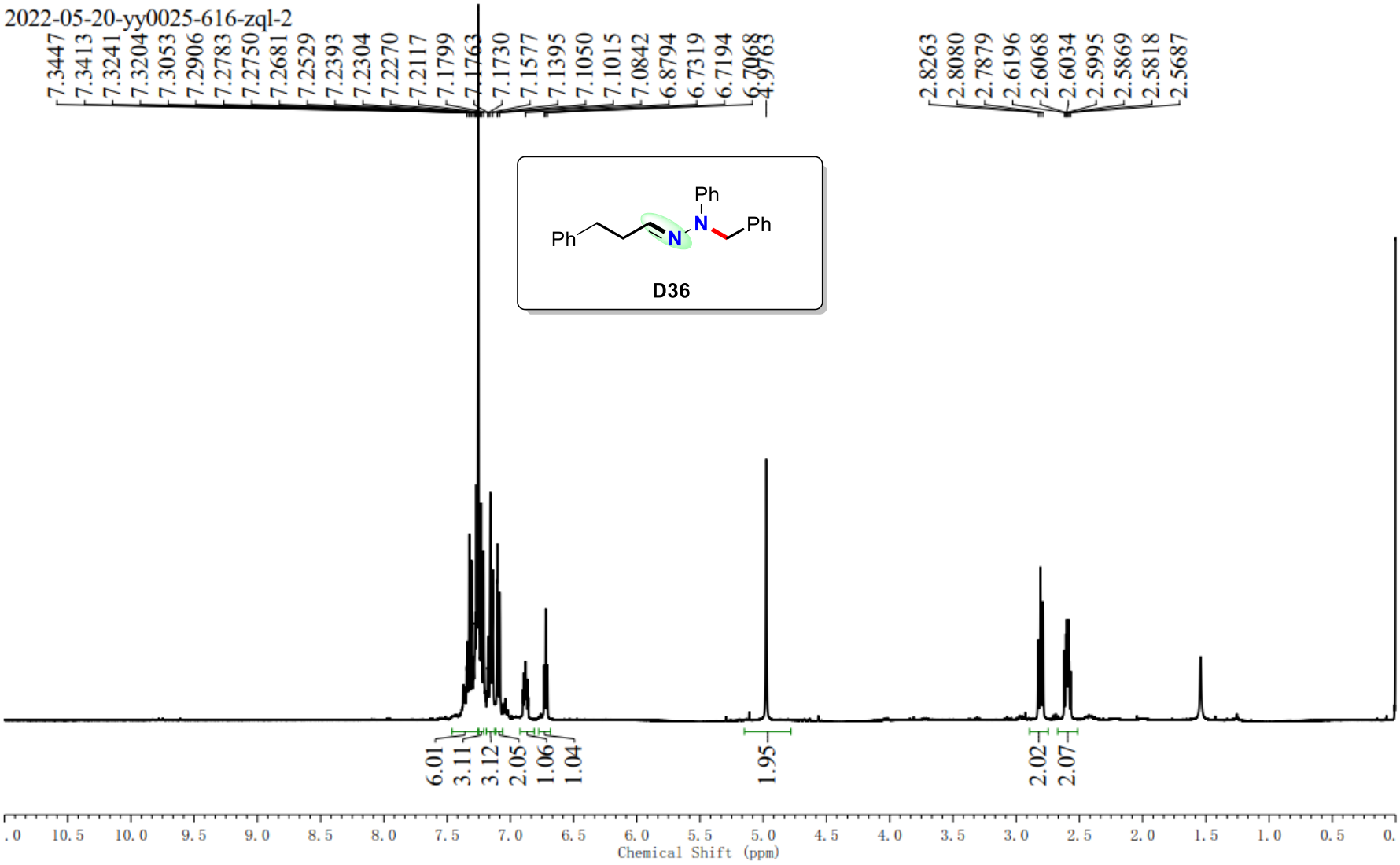
2022-05-17-yy0025-616-zql-4




2022-05-18-yy0043-616-zql-4
148.01
136.52
131.98
131.52
129.83
129.52
129.45
129.20
128.40
127.78
127.64
126.97
126.68
126.33
125.81
125.51
123.96
120.99
114.69
48.88
40.61
40.40
40.19
39.98
39.77
39.57
39.36
Ph
N
N
Ph
D34
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)


2022-6-7 YY0014-616-ZQL-1
8.2450
8.2423
8.1022
8.0829
7.8734
7.8697
7.6278
7.4670
7.4549
7.4521
7.4473
7.4379
7.3978
7.3759
7.3635
7.3572
7.3548
7.3453
7.3406
7.3239
7.3067
7.2892
7.2451
7.2207
4.3800
4.3619
4.3439
4.3259
1.4404
1.4224
1.4044
Ph
N
Ph
N
N
D35
1.06
1.02
1.06
1.06
3.02
8.07
1.08
1.06
2.00
2.04
3.02
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Chemical Shift (ppm)


2022-6-11 yy0002-616-zql-1
148.16
140.01
136.20
134.21
129.17
129.01
127.83
127.23
126.15
125.77
124.07
120.59
120.24
119.04
118.92
114.60
108.62
77.35
77.03
76.72
50.62
37.66
13.84
Ph
N
N
Ph
N
D35
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Chemical Shift (ppm)


2022-05-20-yy0025-616-zql-2
7.3447
7.3413
7.3241
7.3204
7.3053
7.2906
7.2783
7.2750
7.2681
7.2529
7.2393
7.2304
7.2270
7.2117
7.1799
7.1763
7.1730
7.1577
7.1395
7.1050
7.1015
7.0842
6.8794
6.7319
6.7194
6.7068
4.9763
2.8263
2.8080
2.7879
2.6196
2.6068
2.6034
2.5995
2.5869
2.5818
2.5687
Ph
N
Ph
Ph
N
D36
6.01
3.11
3.12
2.05
1.06
1.04
1.95
2.02
2.07
Chemical Shift (ppm)

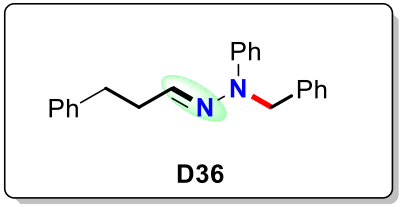
2022-06-22 yy0024 616-zql-2

148.22
141.49
136.19
135.35
129.12
128.99
128.90
128.55
128.51
128.45
128.36
128.32
127.12
126.09
125.87
119.97
114.25

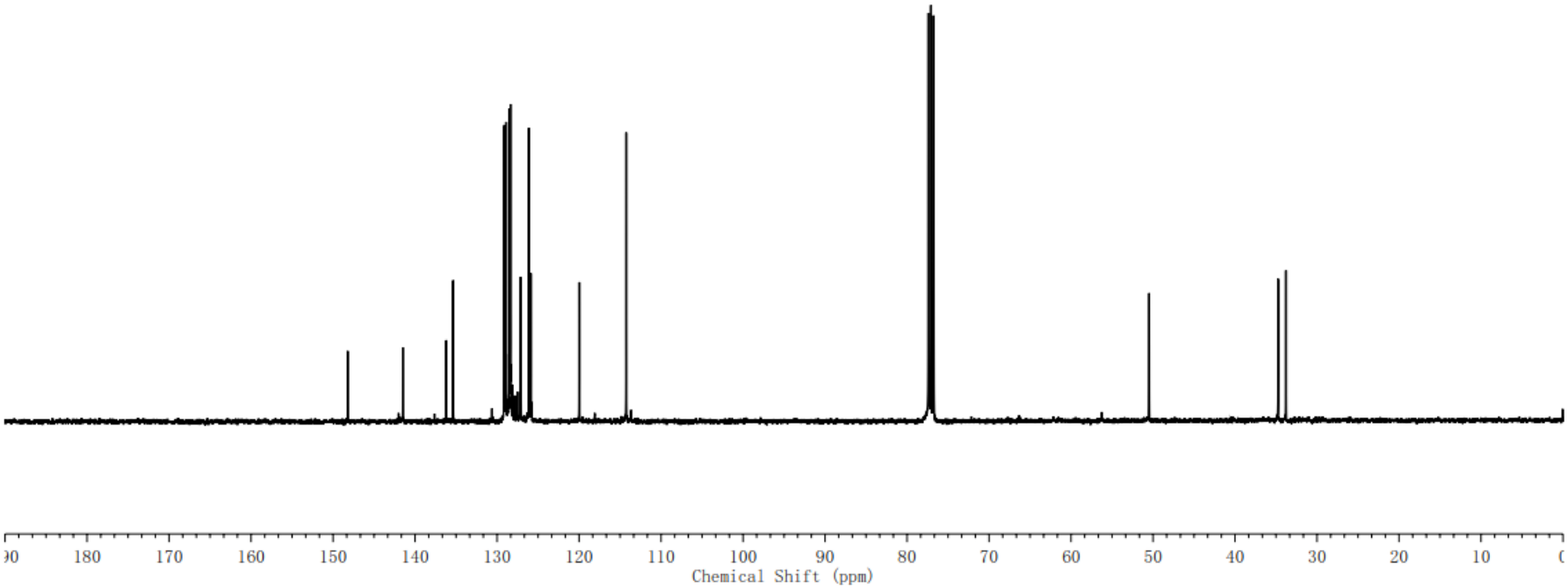
77.38
77.07
76.75

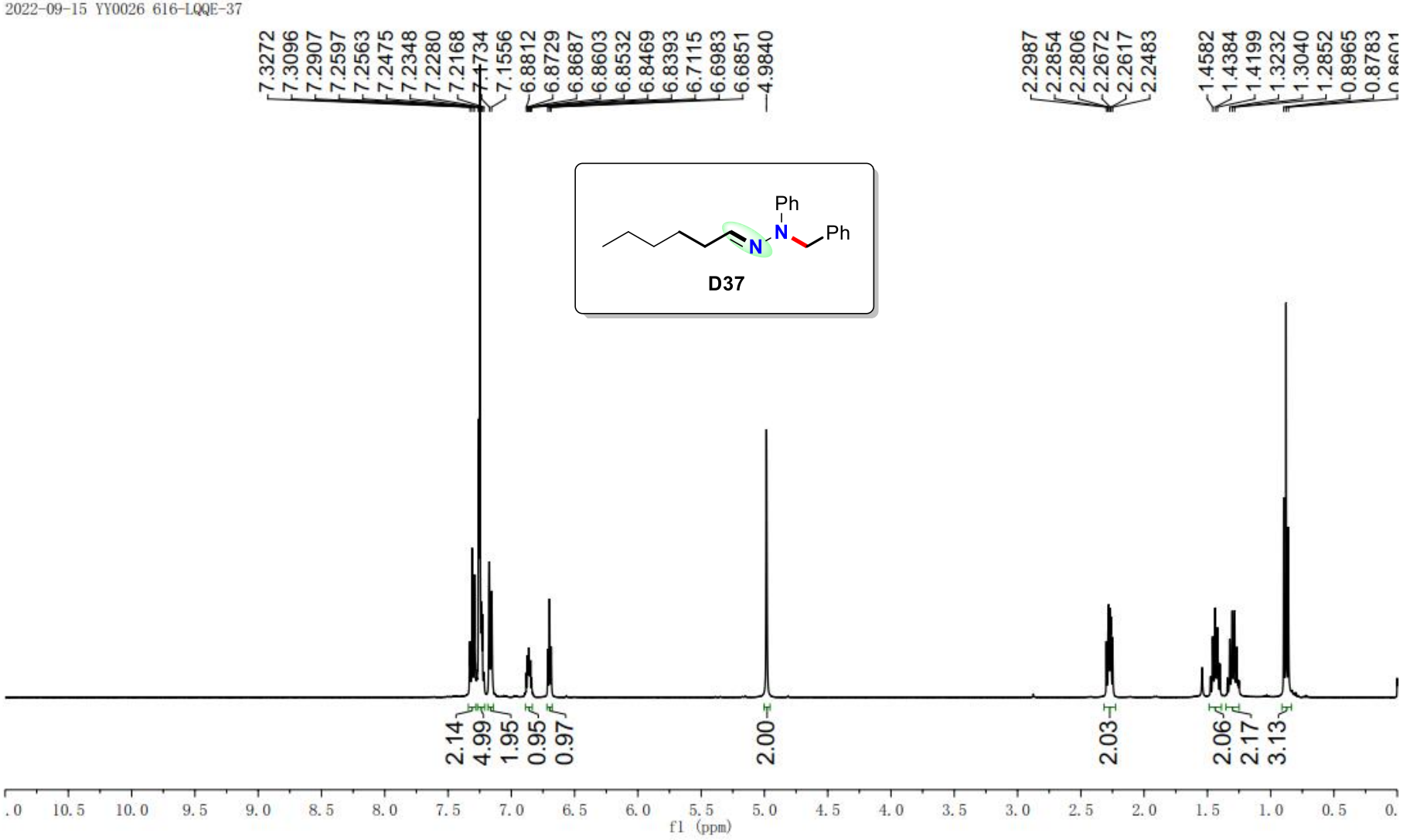
50.47

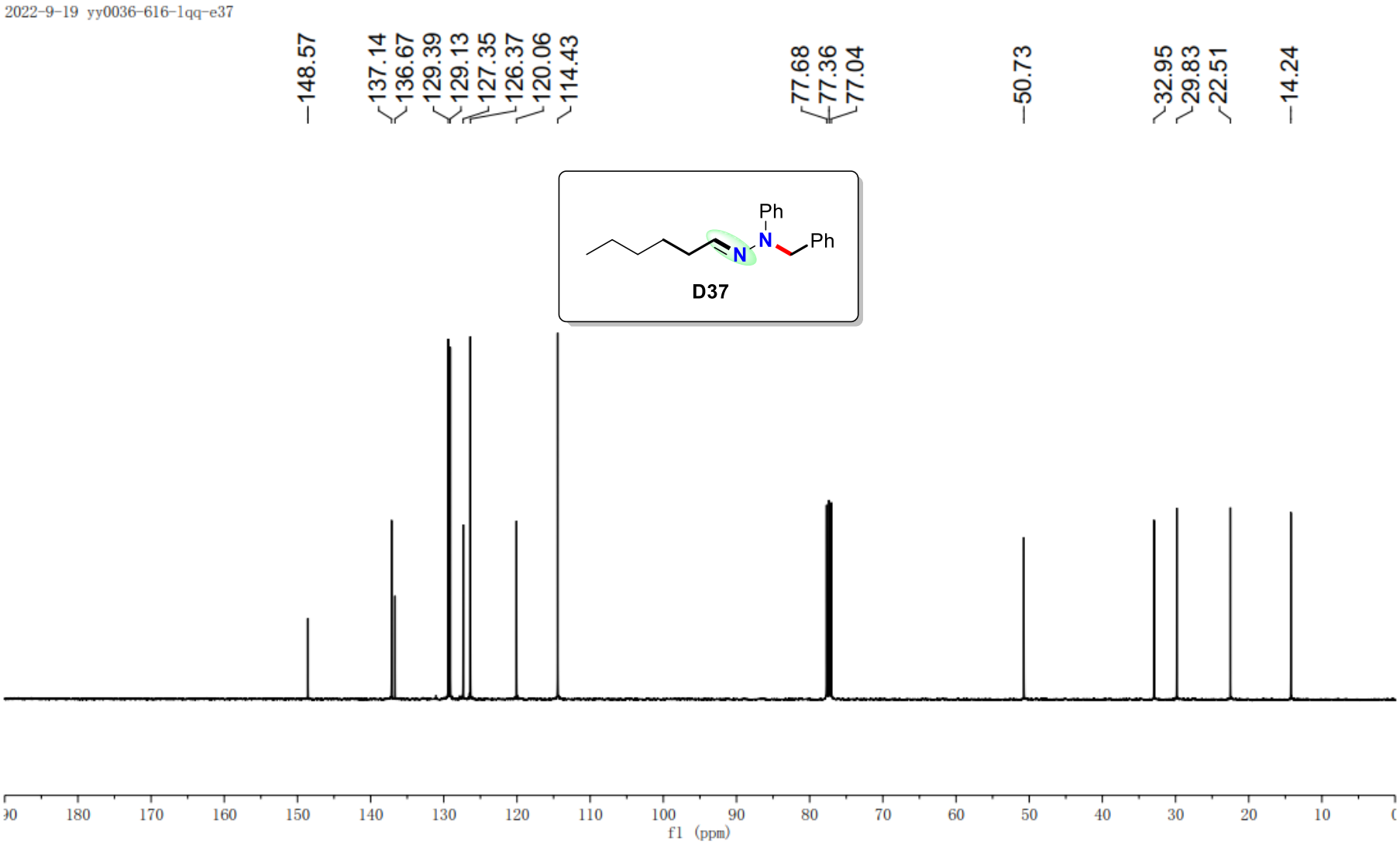
34.74
33.78

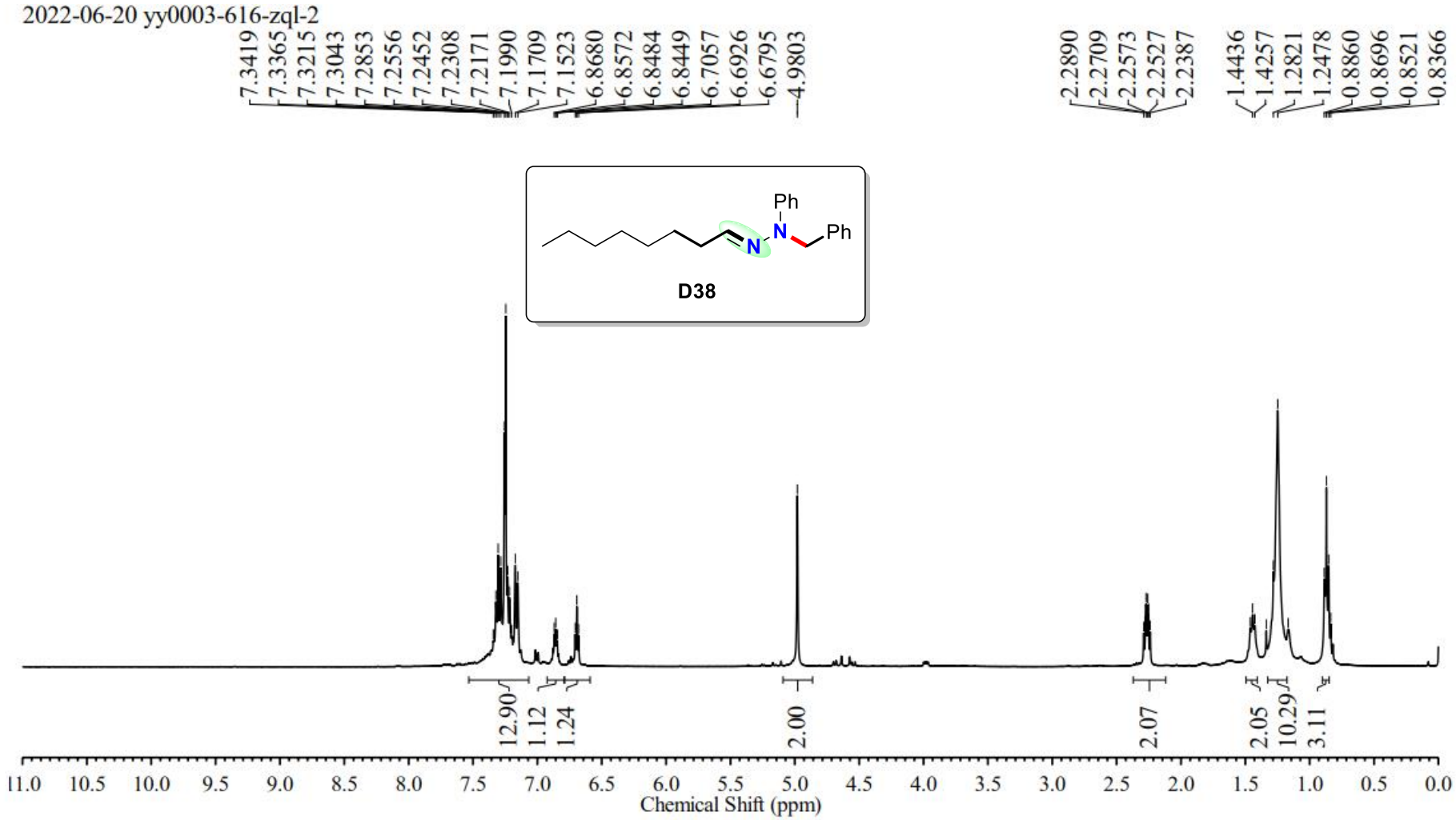



**D36**

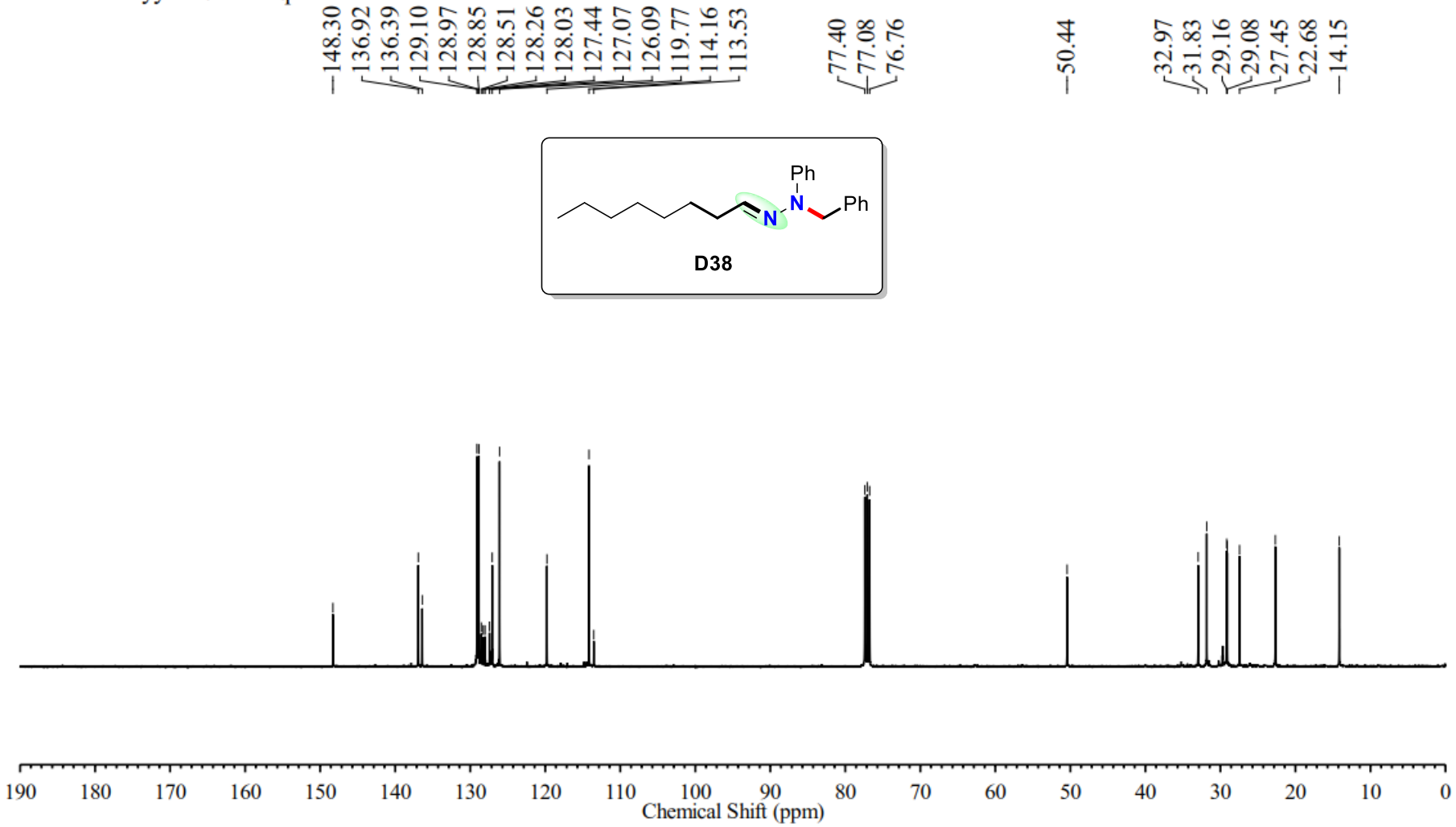


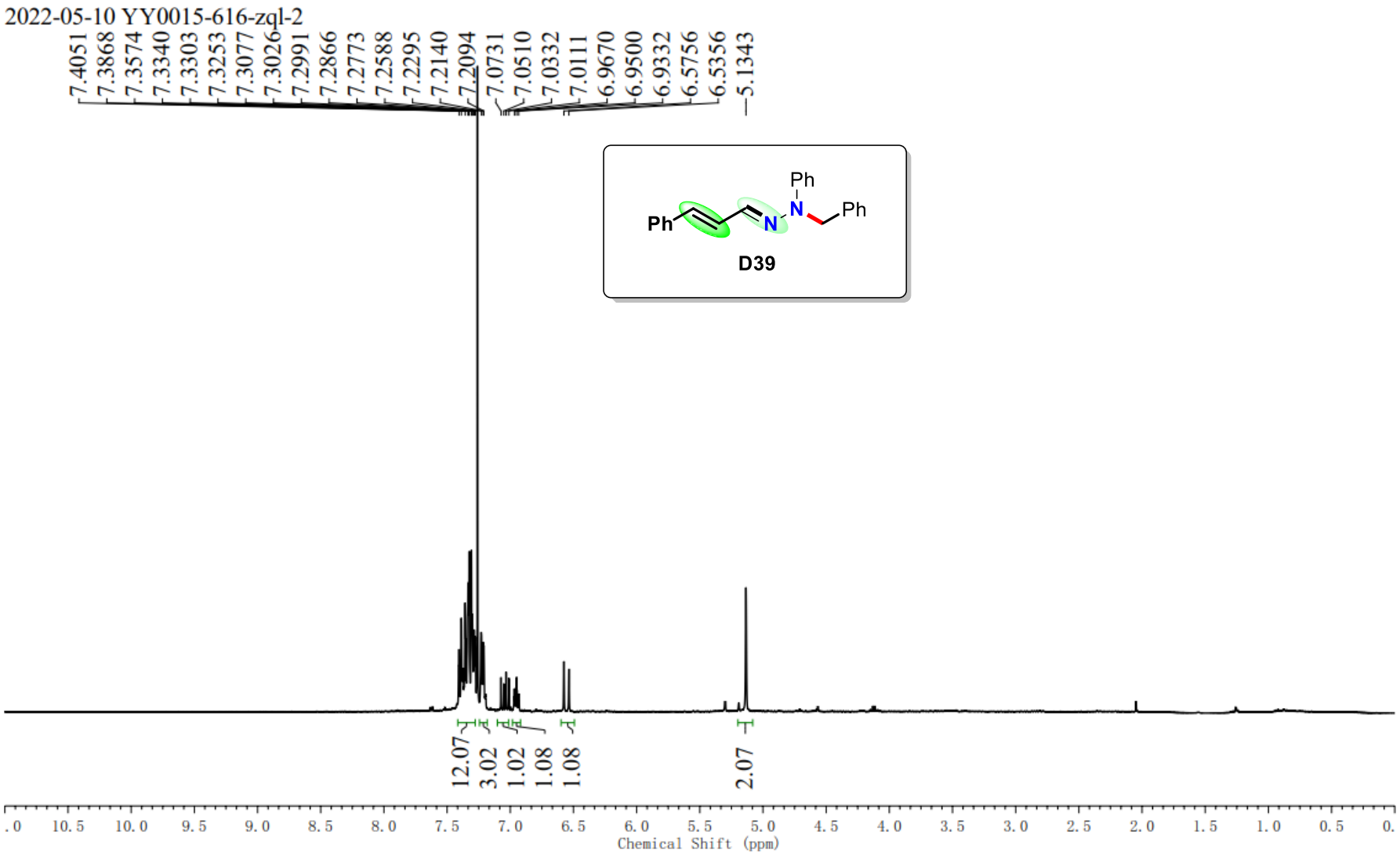

2022-09-15 YY0026 616-LQQE-37
7.3272
7.3096
7.2907
7.2597
7.2563
7.2475
7.2348
7.2280
7.2168
7.4734
7.1556
6.8812
6.8729
6.8687
6.8603
6.8532
6.8469
6.8393
6.7115
6.6983
6.6851
4.9840
2.2987
2.2854
2.2806
2.2672
2.2617
2.2483
1.4582
1.4384
1.4199
1.3232
1.3040
1.2852
0.8965
0.8783
Ph
N
N
Ph
D37
2.14
4.99
1.95
0.95
0.97
2.00
2.03
2.06
2.17
3.13
f1 (ppm)

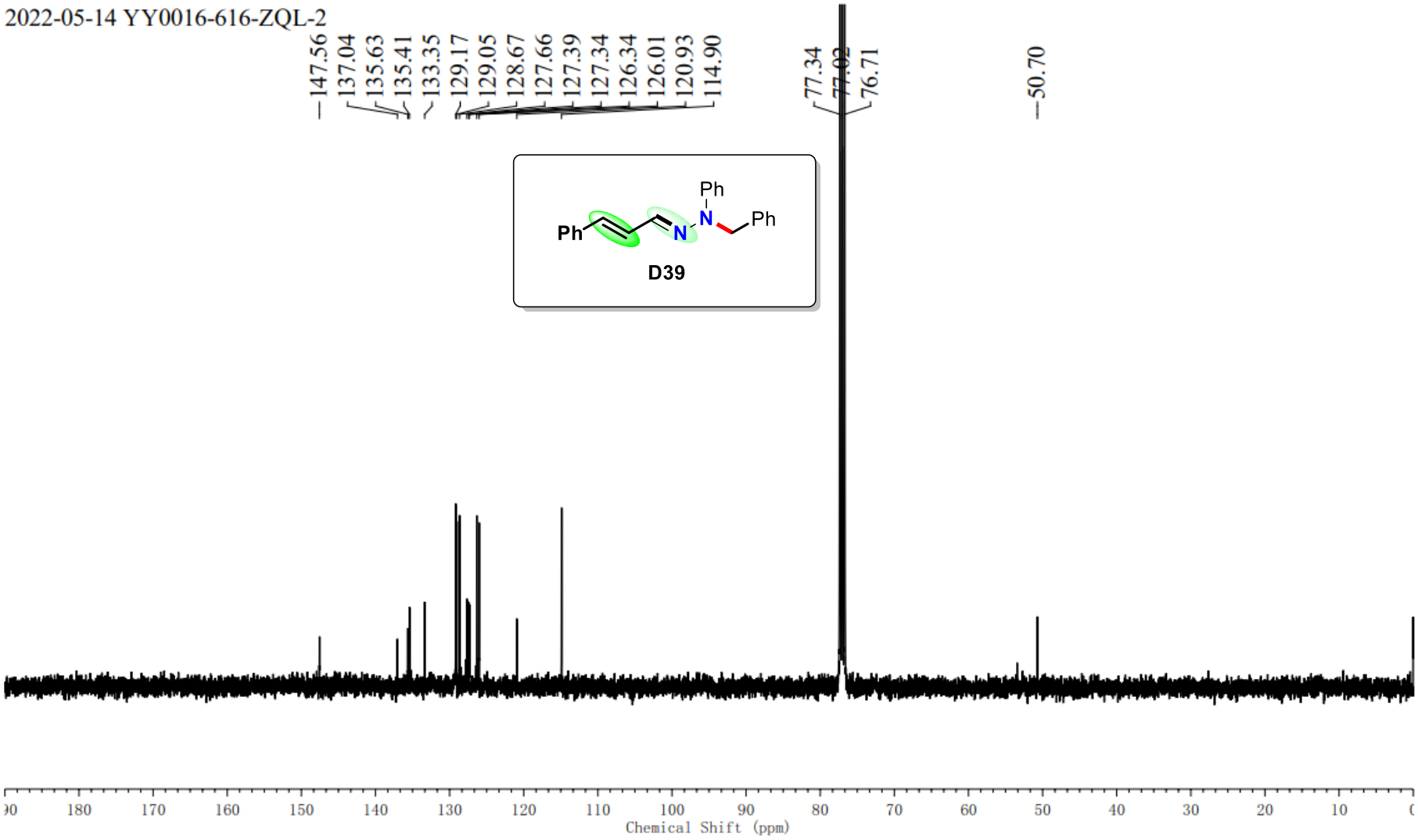

2022-9-19 yy0036-616-1qq-e37
148.57
137.14
136.67
129.39
129.13
127.35
126.37
120.06
114.43
77.68
77.36
77.04
50.73
32.95
29.83
22.51
14.24
Ph
N
N
Ph
D37
f1 (ppm)

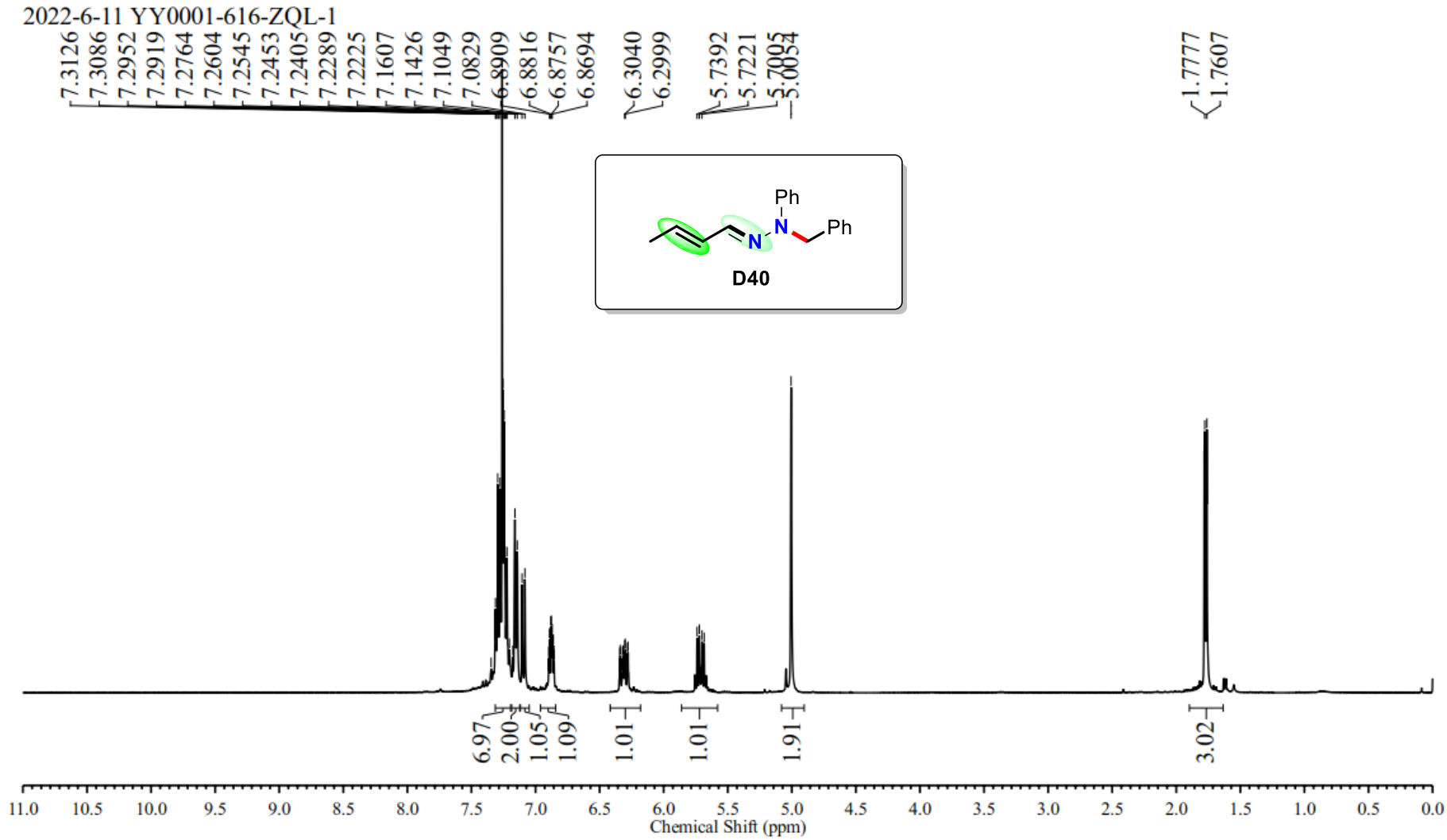

2022-06-20 yy0003-616-zql-2
7.3419
7.3365
7.3215
7.3043
7.2853
7.2556
7.2452
7.2308
7.2171
7.1990
7.1709
7.1523
6.8680
6.8572
6.8484
6.8449
6.7057
6.6926
6.6795
4.9803
2.2890
2.2709
2.2573
2.2527
2.2387
1.4436
1.4257
1.2821
1.2478
0.8860
0.8696
0.8521
0.8366
Ph
N
Ph
N
D38
12.90
1.12
1.24
2.00
2.07
2.05
10.29
3.11
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Chemical Shift (ppm)

2022-06-21 yy0027 616-zql-2

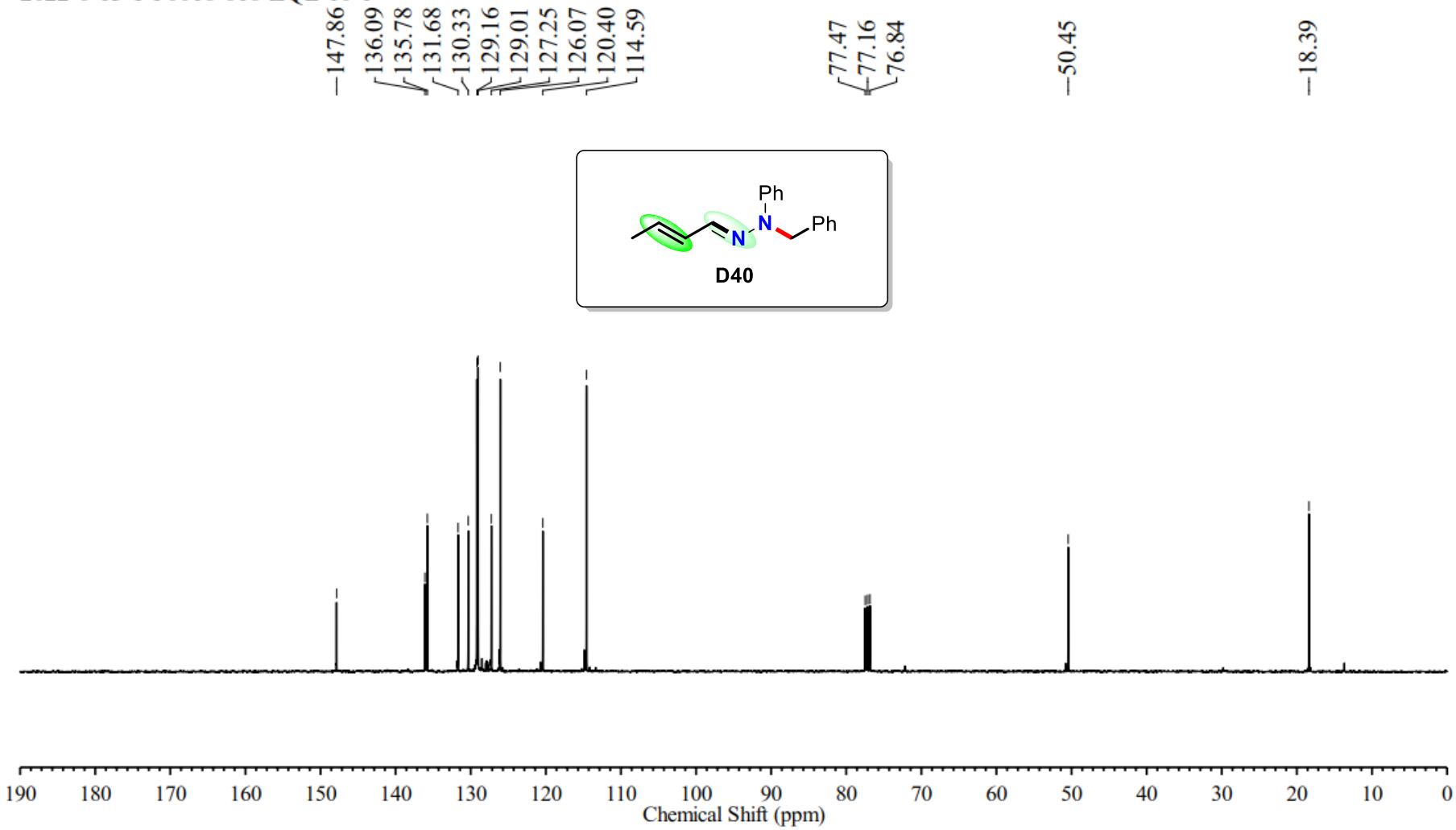


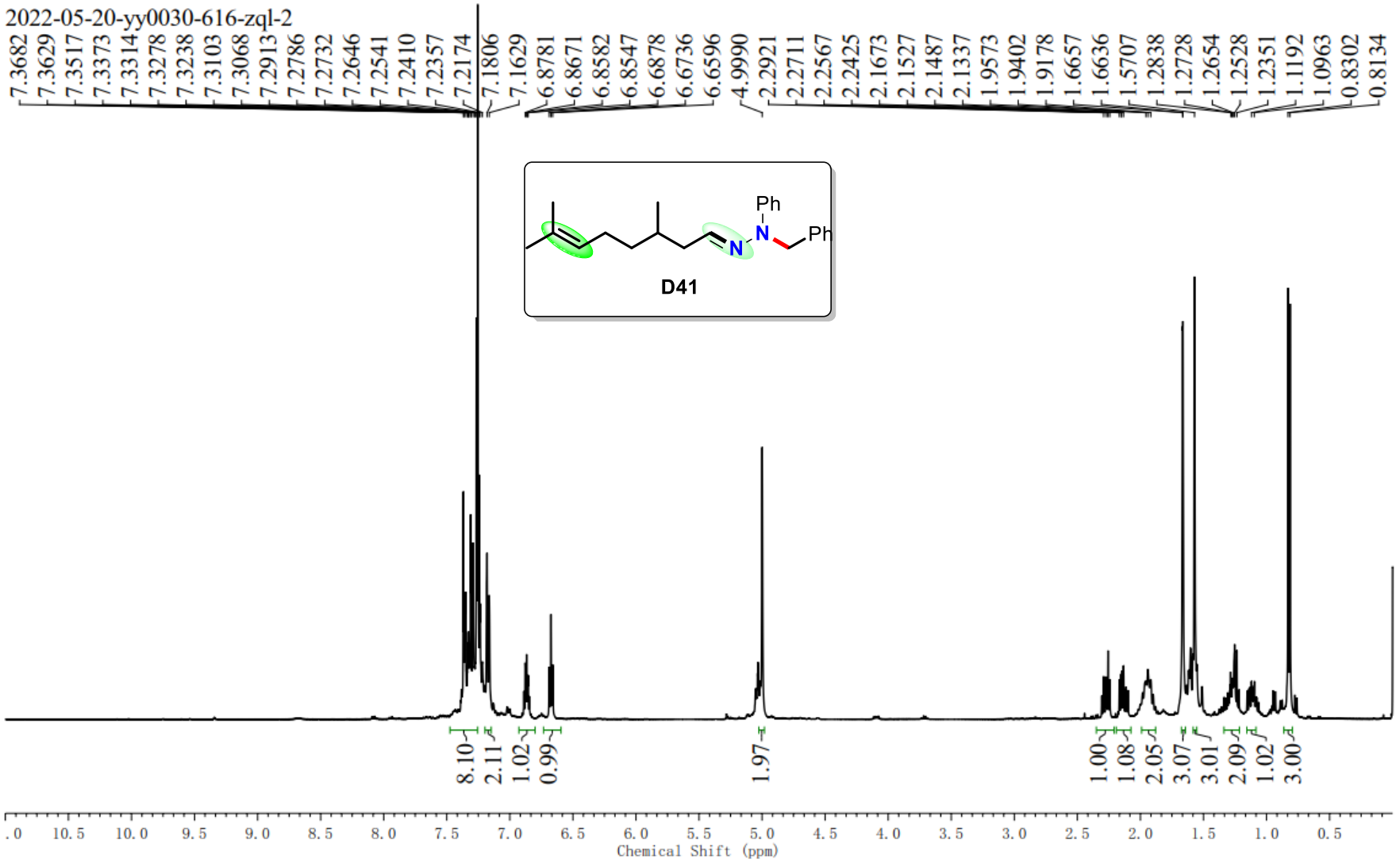

2022-05-10 YY0015-616-zql-2
7.4051
7.3868
7.3574
7.3340
7.3303
7.3253
7.3077
7.3026
7.2991
7.2866
7.2773
7.2588
7.2295
7.2140
7.2094
7.0731
7.0510
7.0332
7.0111
6.9670
6.9500
6.9332
6.5756
6.5356
5.1343
Ph
N
Ph
Ph
D39
12.07
3.02
1.02
1.08
1.08
2.07
Chemical Shift (ppm)


2022-05-14 YY0016-616-ZQL-2
147.56
137.04
135.63
135.41
133.35
129.17
129.05
128.67
127.66
127.39
127.34
126.34
126.01
120.93
114.90
77.34
77.02
76.71
50.70
Ph
N
N
Ph
Ph
D39
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

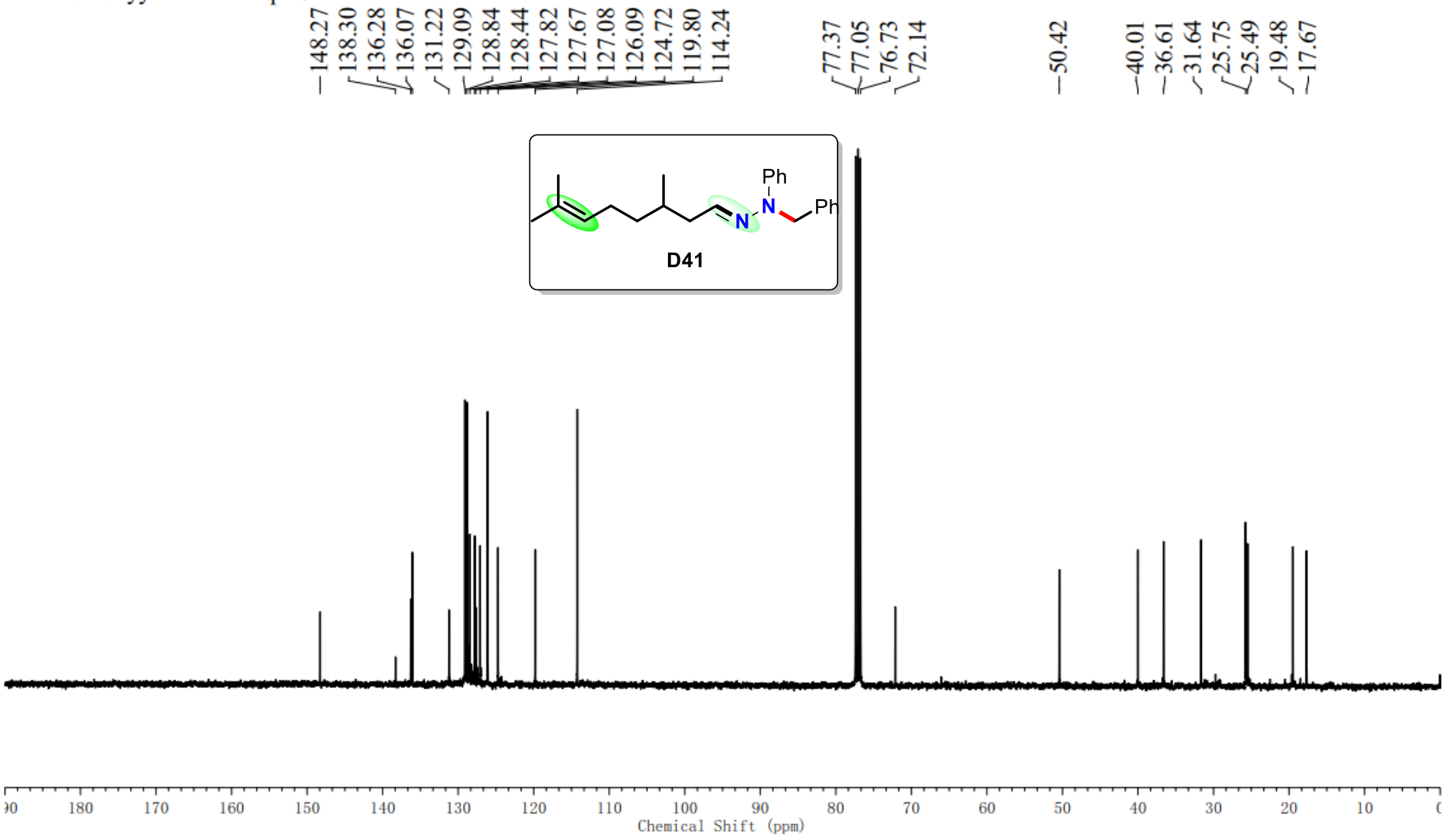

2022-6-11 YY0001-616-ZQL-1
7.3126
7.3086
7.2952
7.2919
7.2764
7.2604
7.2545
7.2453
7.2405
7.2289
7.2225
7.1607
7.1426
7.1049
7.0829
6.8909
6.8816
6.8757
6.8694
6.3040
6.2999
5.7392
5.7221
1.7777
1.7607
Ph
N
Ph
N
D40
6.97
2.00
1.05
1.09
1.01
1.01
1.91
3.02
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Chemical Shift (ppm)

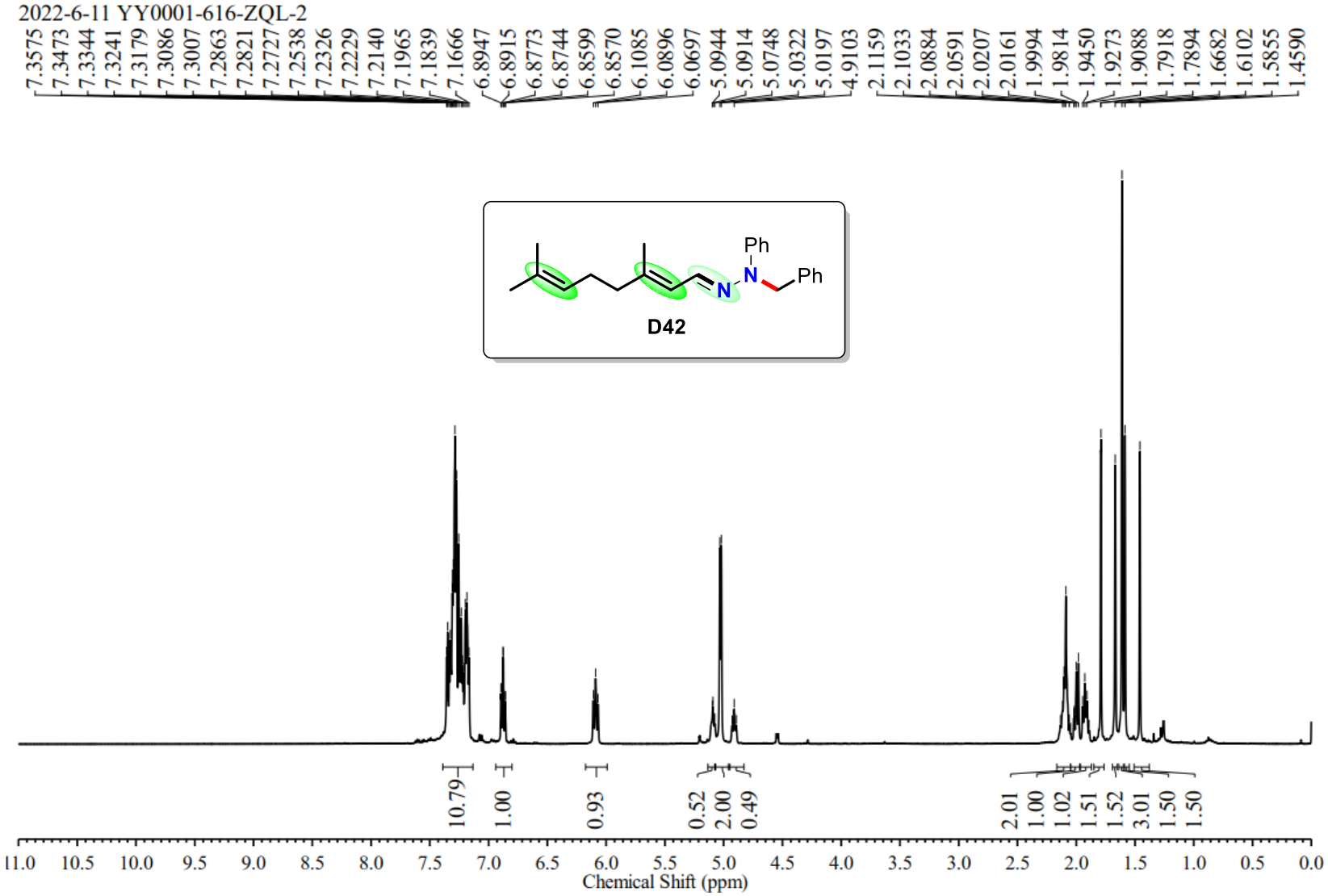
2022-6-13 YY0016-616-ZQL-10-1

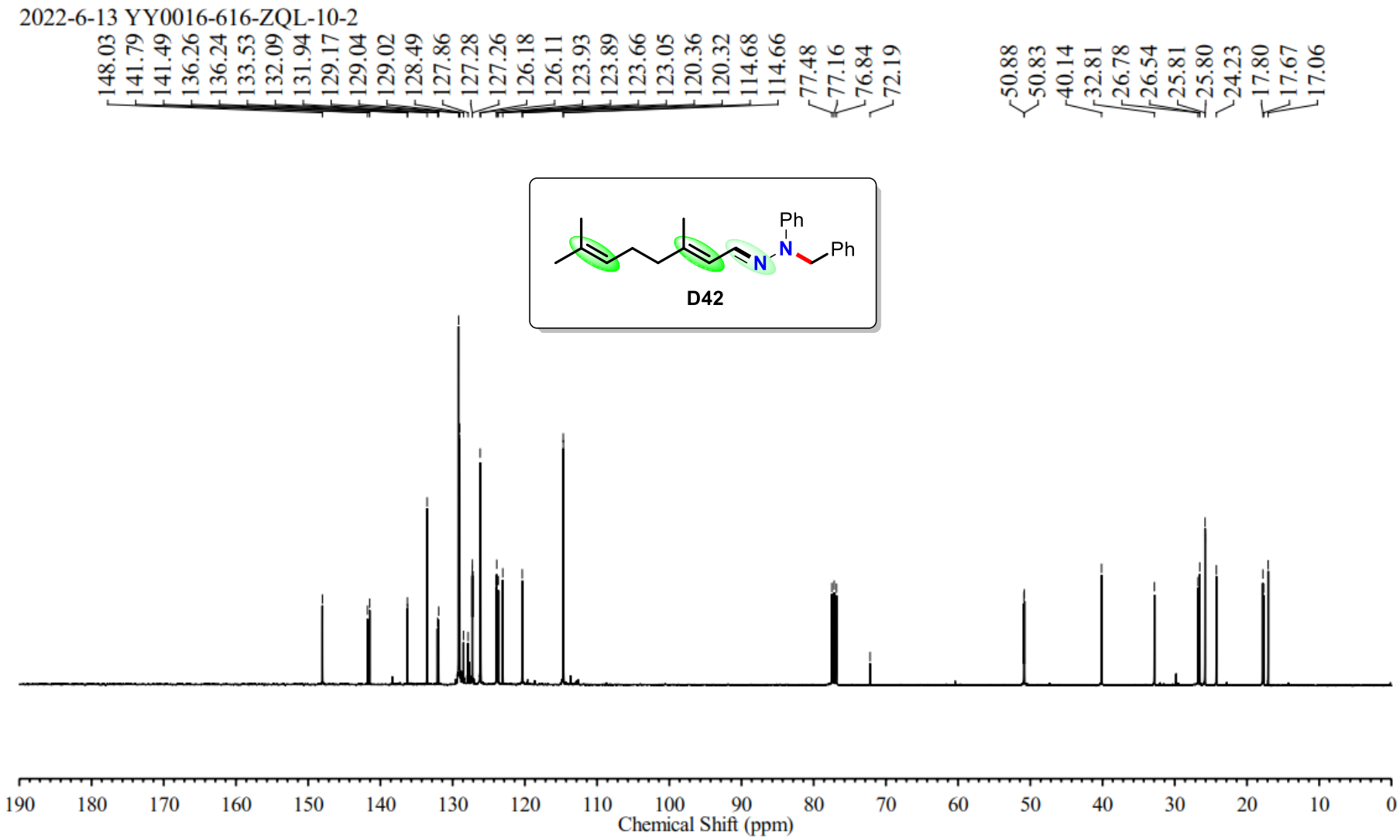


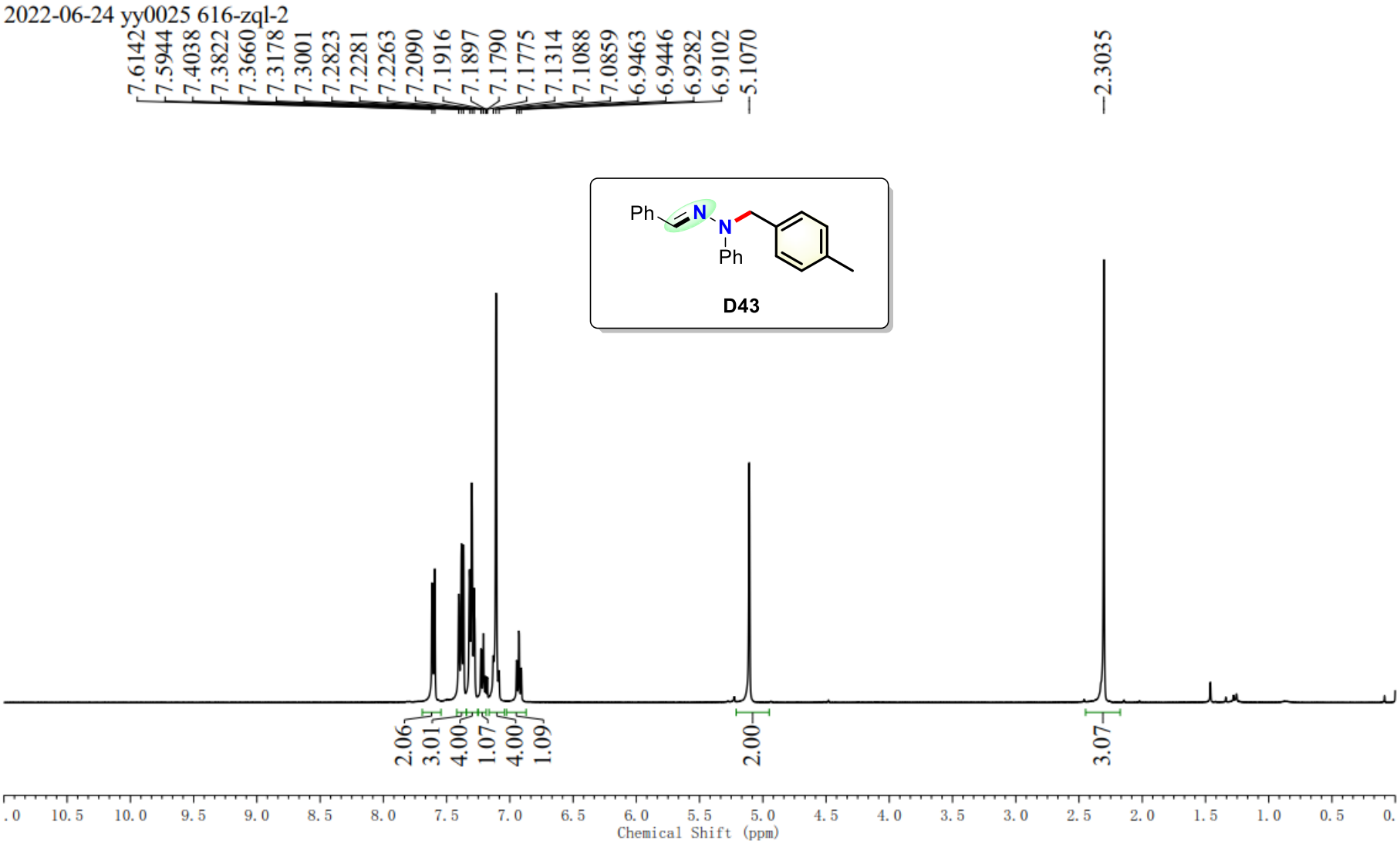

2022-05-20-yy0030-616-zql-2
7.3682
7.3629
7.3517
7.3373
7.3314
7.3278
7.3238
7.3103
7.3068
7.2913
7.2786
7.2732
7.2646
7.2541
7.2410
7.2357
7.2174
7.1806
7.1629
6.8781
6.8671
6.8582
6.8547
6.6878
6.6736
6.6596
4.9990
2.2921
2.2711
2.2567
2.2425
2.1673
2.1527
2.1487
2.1337
1.9573
1.9402
1.9178
1.6657
1.6636
1.5707
1.2838
1.2728
1.2654
1.2528
1.2351
1.1192
1.0963
0.8302
0.8134
Ph
N
N
Ph
D41
8.10
2.11
1.02
0.99
1.97
1.00
1.08
2.05
3.07
3.01
2.09
1.02
3.00
Chemical Shift (ppm)

2022-05-25-yy0008-616-zql-19-2

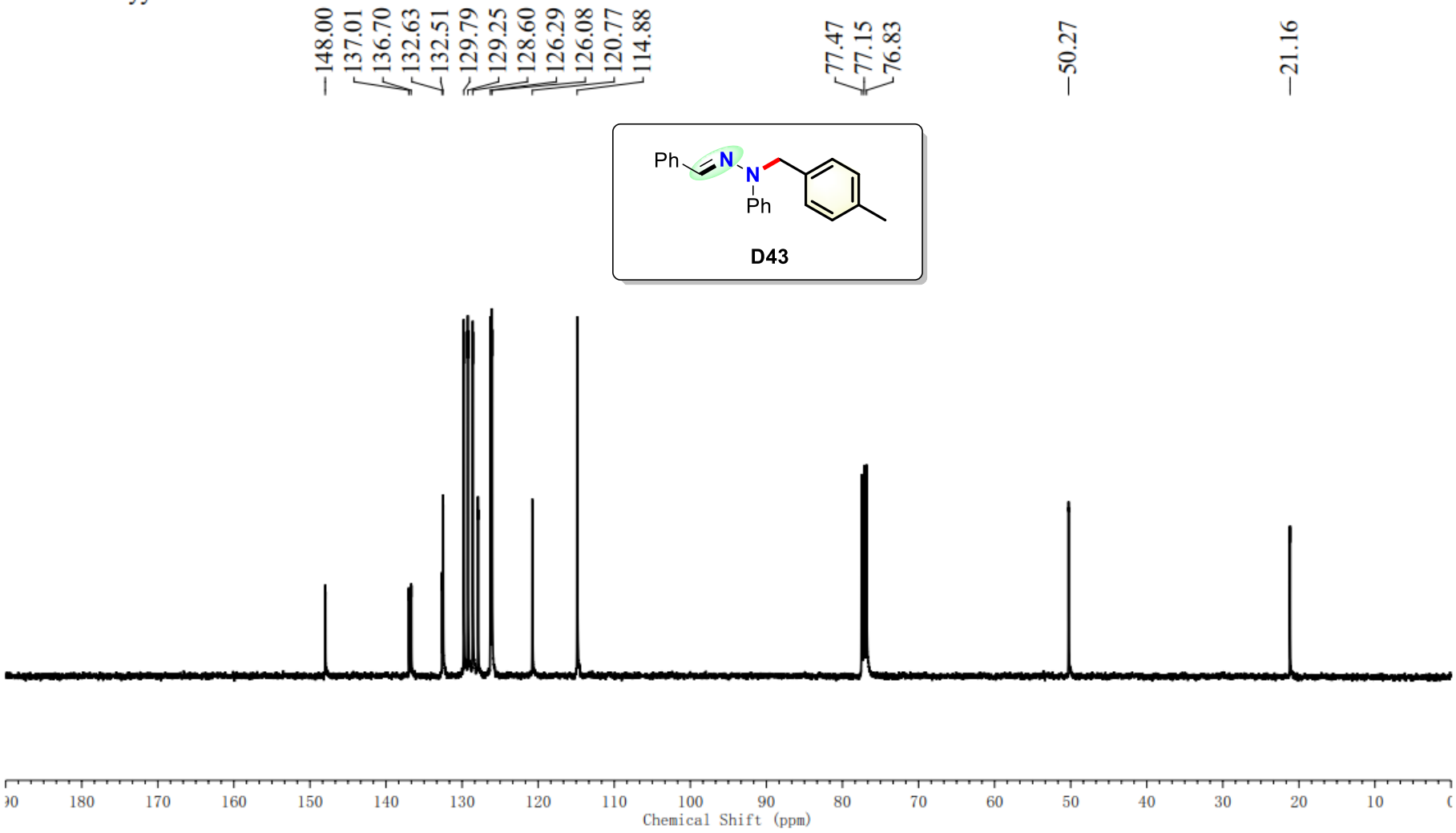


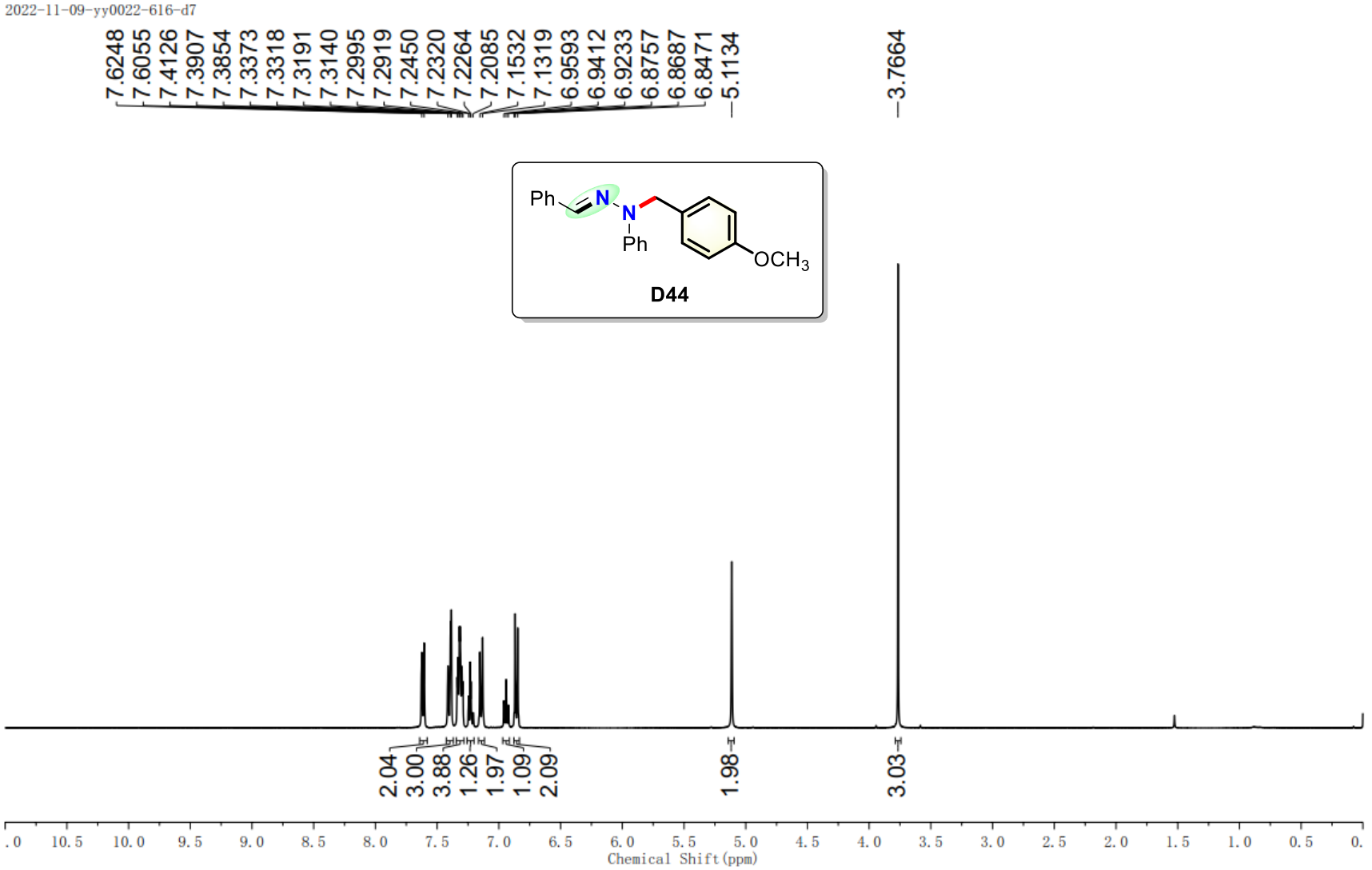

2022-6-11 YY0001-616-ZQL-2
7.3575
7.3473
7.3344
7.3241
7.3179
7.3086
7.3007
7.2863
7.2821
7.2727
7.2538
7.2326
7.2229
7.2140
7.1965
7.1839
7.1666
6.8947
6.8915
6.8773
6.8744
6.8599
6.8570
6.1085
6.0896
6.0697
5.0944
5.0914
5.0748
5.0322
5.0197
4.9103
2.1159
2.1033
2.0884
2.0591
2.0207
2.0161
1.9994
1.9814
1.9450
1.9273
1.9088
1.7918
1.7894
1.6682
1.6102
1.5855
1.4590
Ph
N
N
Ph
D42
10.79
1.00
0.93
0.52
2.00
0.49
2.01
1.00
1.02
1.51
1.52
3.01
1.50
1.50
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Chemical Shift (ppm)

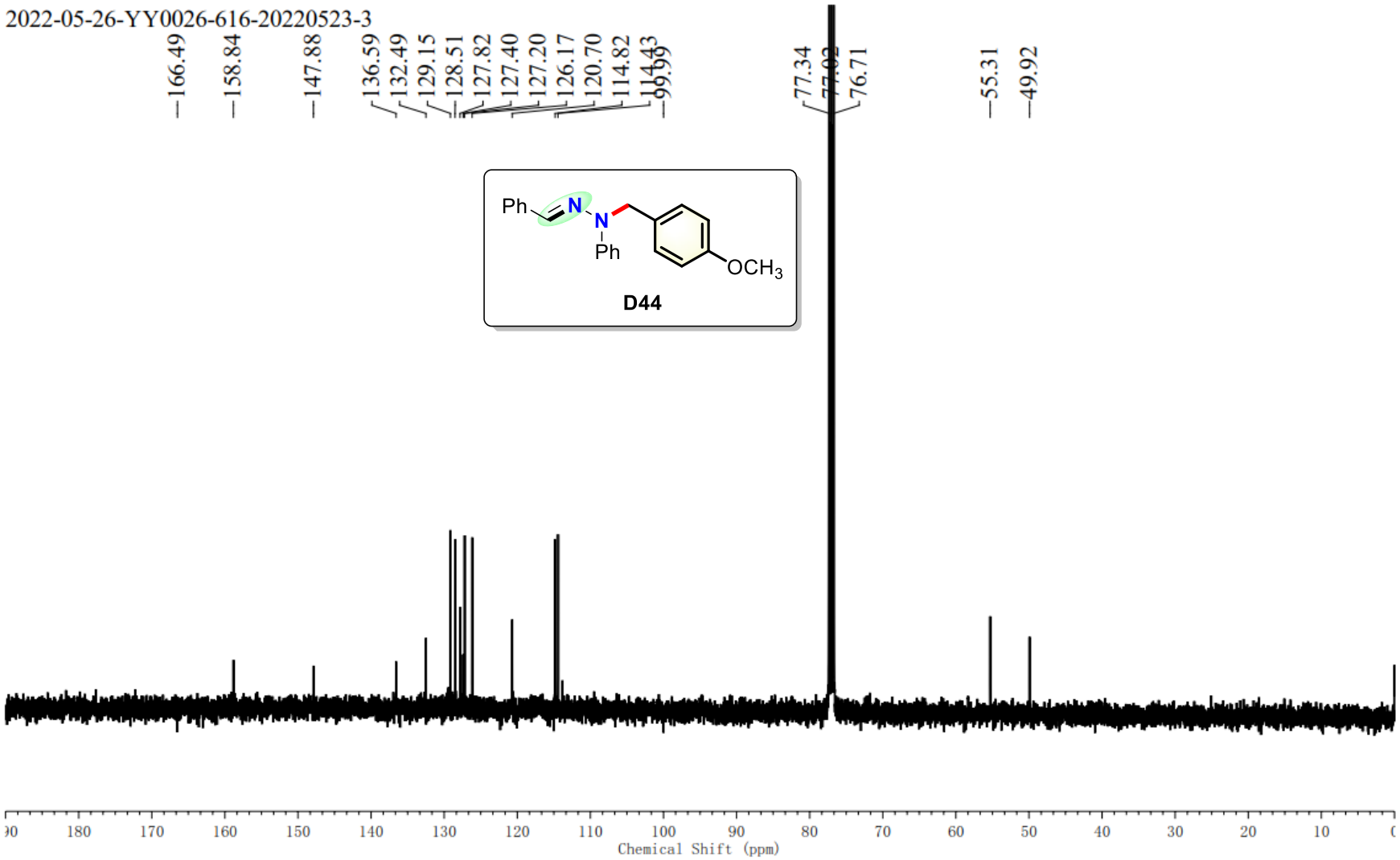

2022-6-13 YY0016-616-ZQL-10-2
148.03
141.79
141.49
136.26
136.24
133.53
132.09
131.94
129.17
129.04
129.02
128.49
127.86
127.28
127.26
126.18
126.11
123.93
123.89
123.66
123.05
120.36
120.32
114.68
114.66
77.48
77.16
76.84
72.19
50.88
50.83
40.14
32.81
26.78
26.54
25.81
25.80
24.23
17.80
17.67
17.06
Ph
N
N
Ph
D42
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Chemical Shift (ppm)


2022-06-24 yy0025 616-zql-2
7.6142
7.5944
7.4038
7.3822
7.3660
7.3178
7.3001
7.2823
7.2281
7.2263
7.2090
7.1916
7.1897
7.1790
7.1775
7.1314
7.1088
7.0859
6.9463
6.9446
6.9282
6.9102
5.1070
2.3035
Ph
N
N
Ph
D43
2.06
3.01
4.00
1.07
4.00
1.09
2.00
3.07
Chemical Shift (ppm)

2022-06-28-yy0028-616-20220624-2

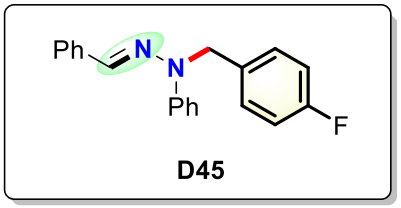



2022-11-09-yy0022-616-d7
7.6248
7.6055
7.4126
7.3907
7.3854
7.3373
7.3318
7.3191
7.3140
7.2995
7.2919
7.2450
7.2320
7.2264
7.2085
7.1532
7.1319
6.9593
6.9412
6.9233
6.8757
6.8687
6.8471
5.1134
3.7664
Ph
N
N
Ph
OCH3
D44
2.04
3.00
3.88
1.26
1.97
1.09
2.09
1.98
3.03
Chemical Shift(ppm)

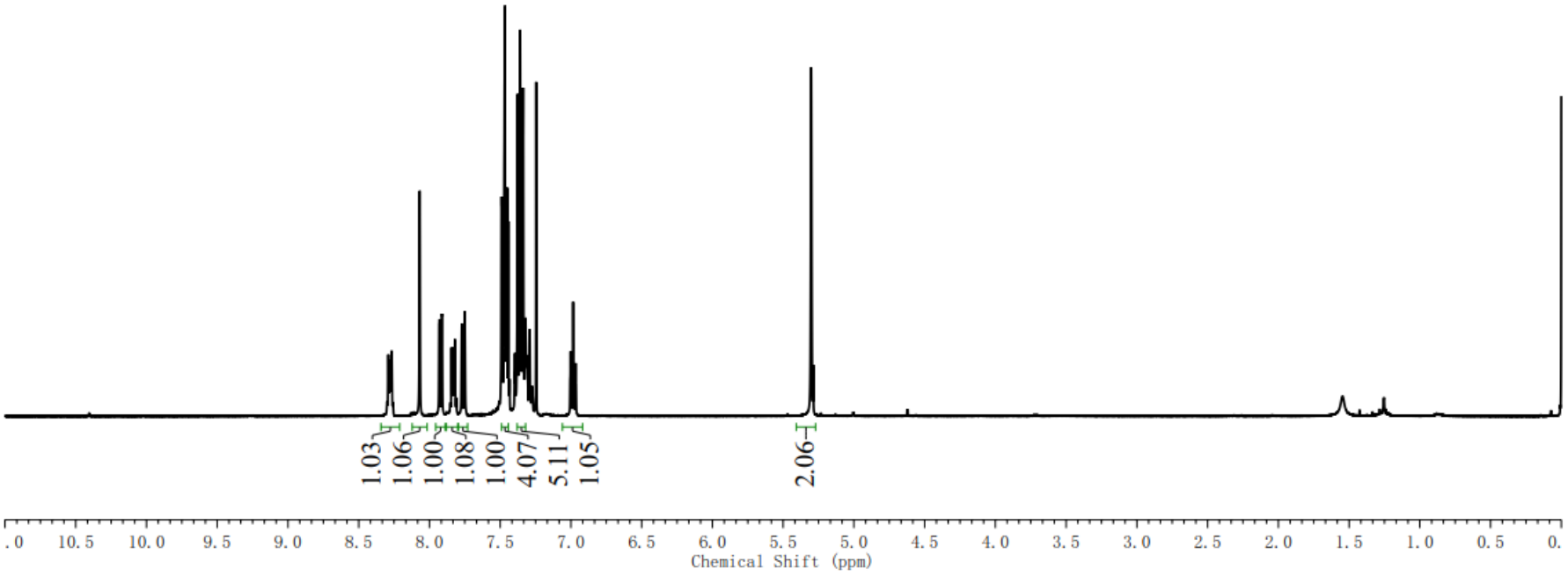

2022-05-26-YY0026-616-20220523-3
166.49
158.84
147.88
136.59
132.49
129.15
128.51
127.82
127.40
127.20
126.17
120.70
114.82
114.43
99.99
77.34
77.02
76.71
55.31
49.92
Ph
N
N
Ph
OCH3
D44
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

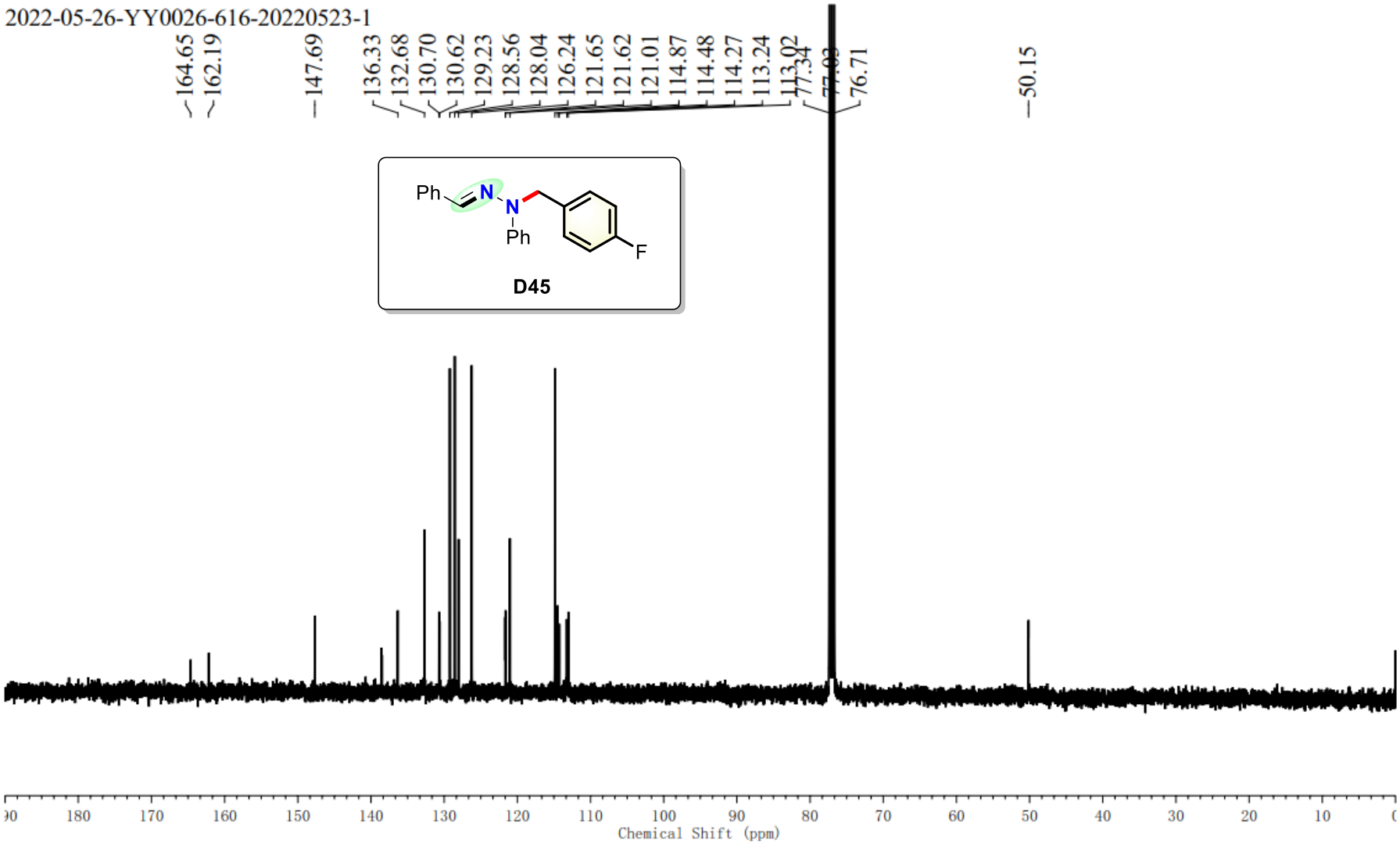
2022-05-23-yy0007-616-zql-1

8.27 8.07 7.93 7.91 7.91 7.84 7.83 7.82 7.77 7.75 7.49 7.47 7.47 7.46 7.45 7.44 7.38 7.36 7.36 7.34 7.32 7.29 7.25 7.00 6.98 5.30

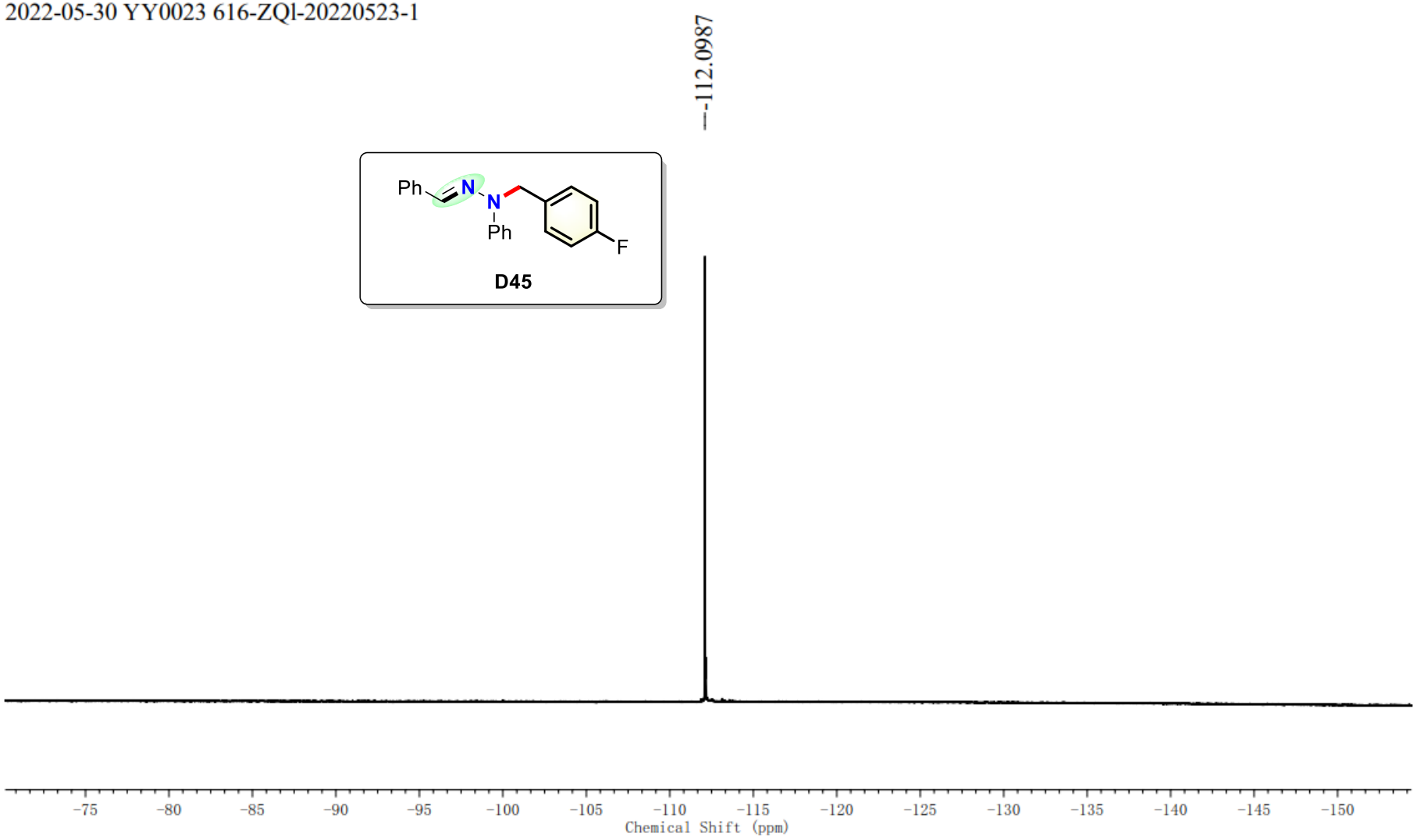


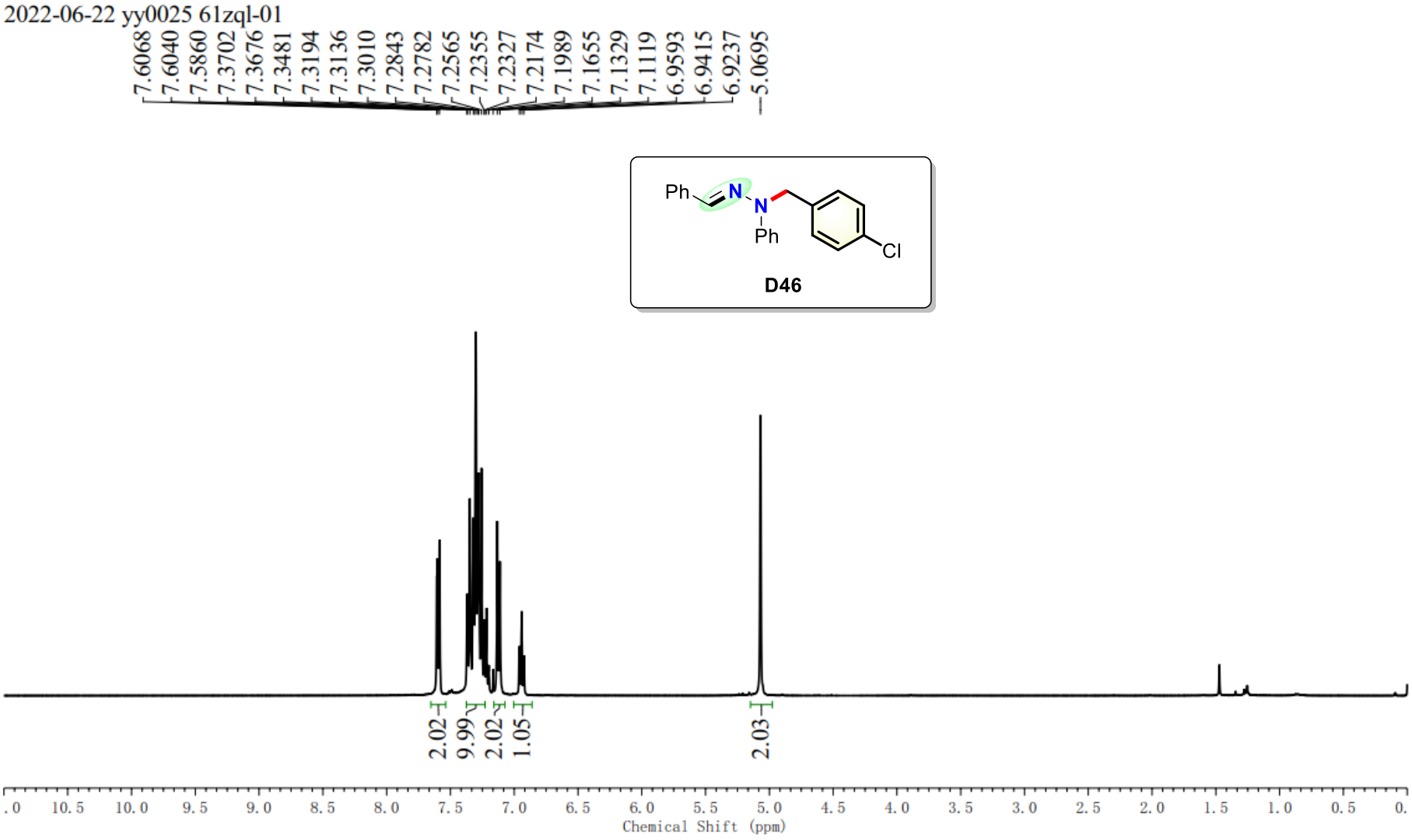

**D45**

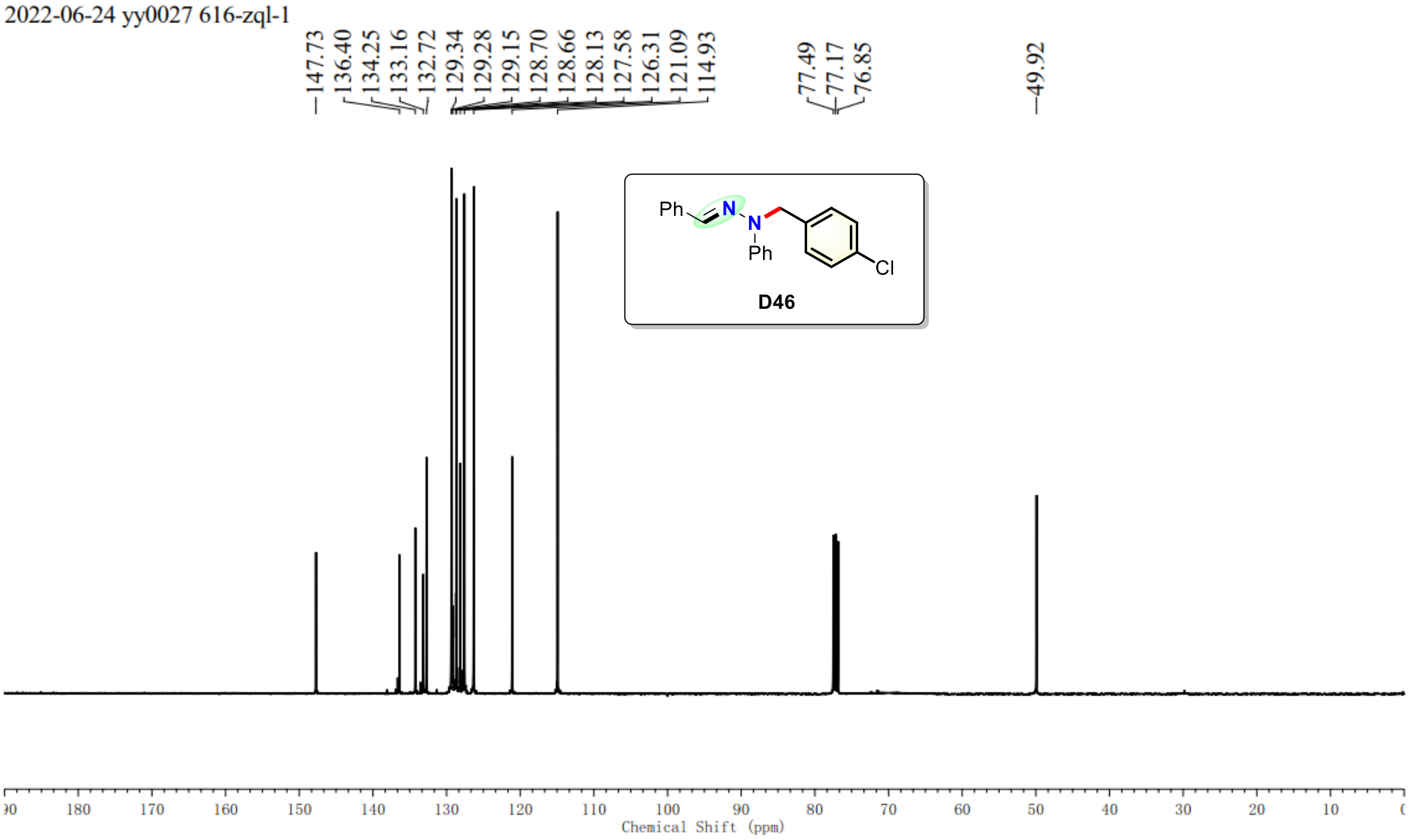


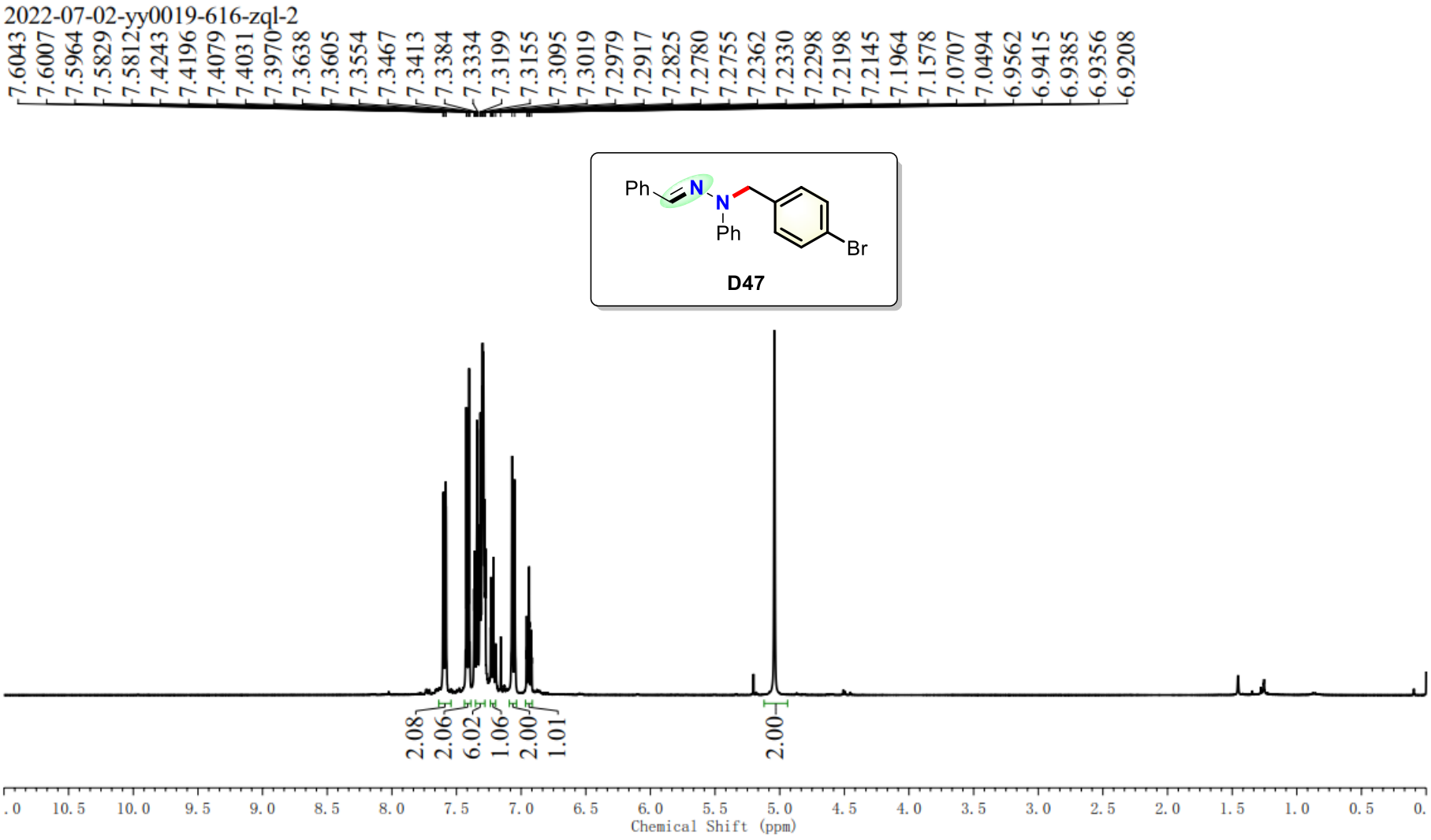

2022-05-26-YY0026-616-20220523-1
164.65
162.19
147.69
136.33
132.68
130.70
130.62
129.23
128.56
128.04
126.24
121.65
121.62
121.01
114.87
114.48
114.27
113.24
113.02
77.34
77.03
76.71
50.15
Ph
N
N
Ph
F
D45
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

2022-05-30 YY0023 616-ZQl-20220523-1

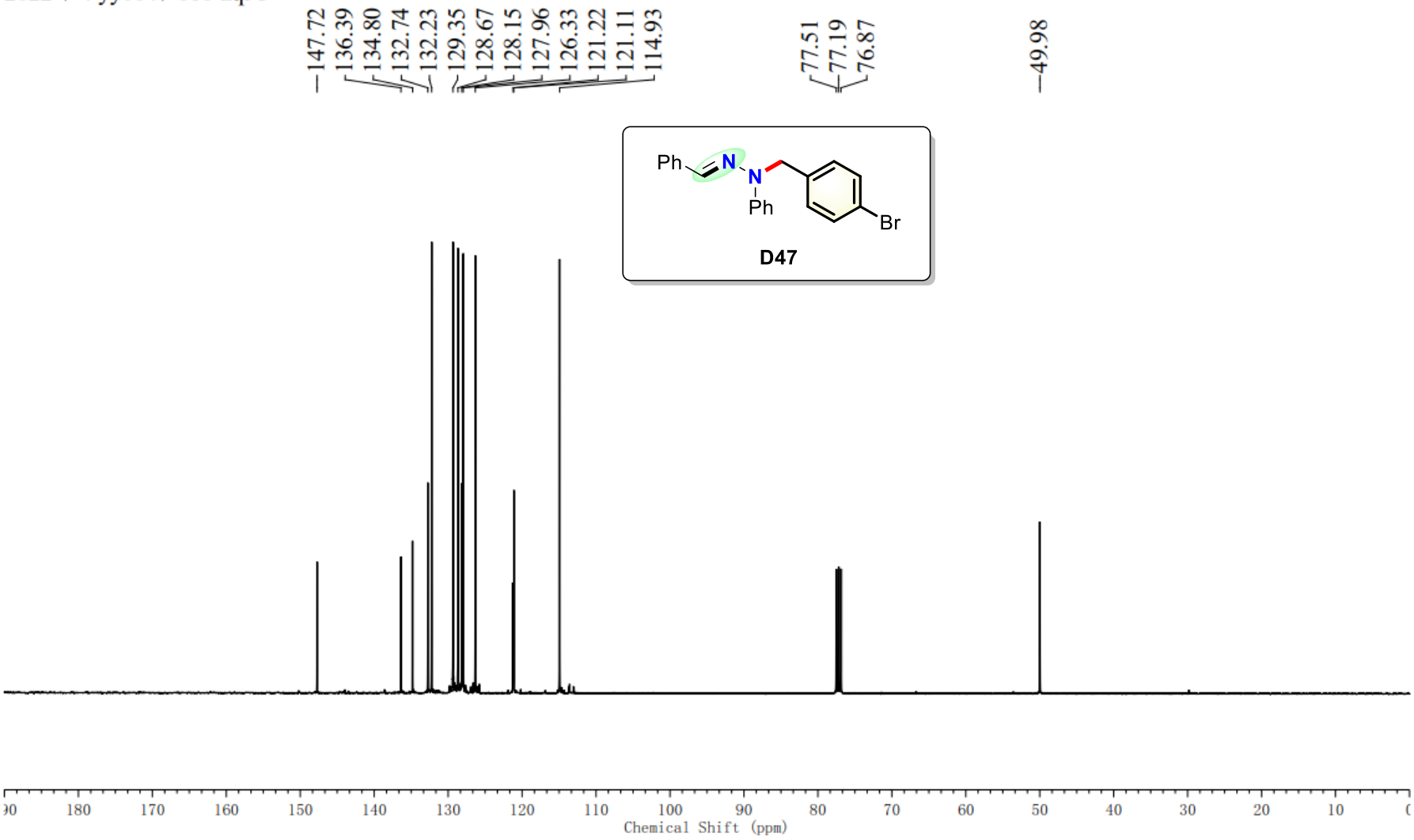


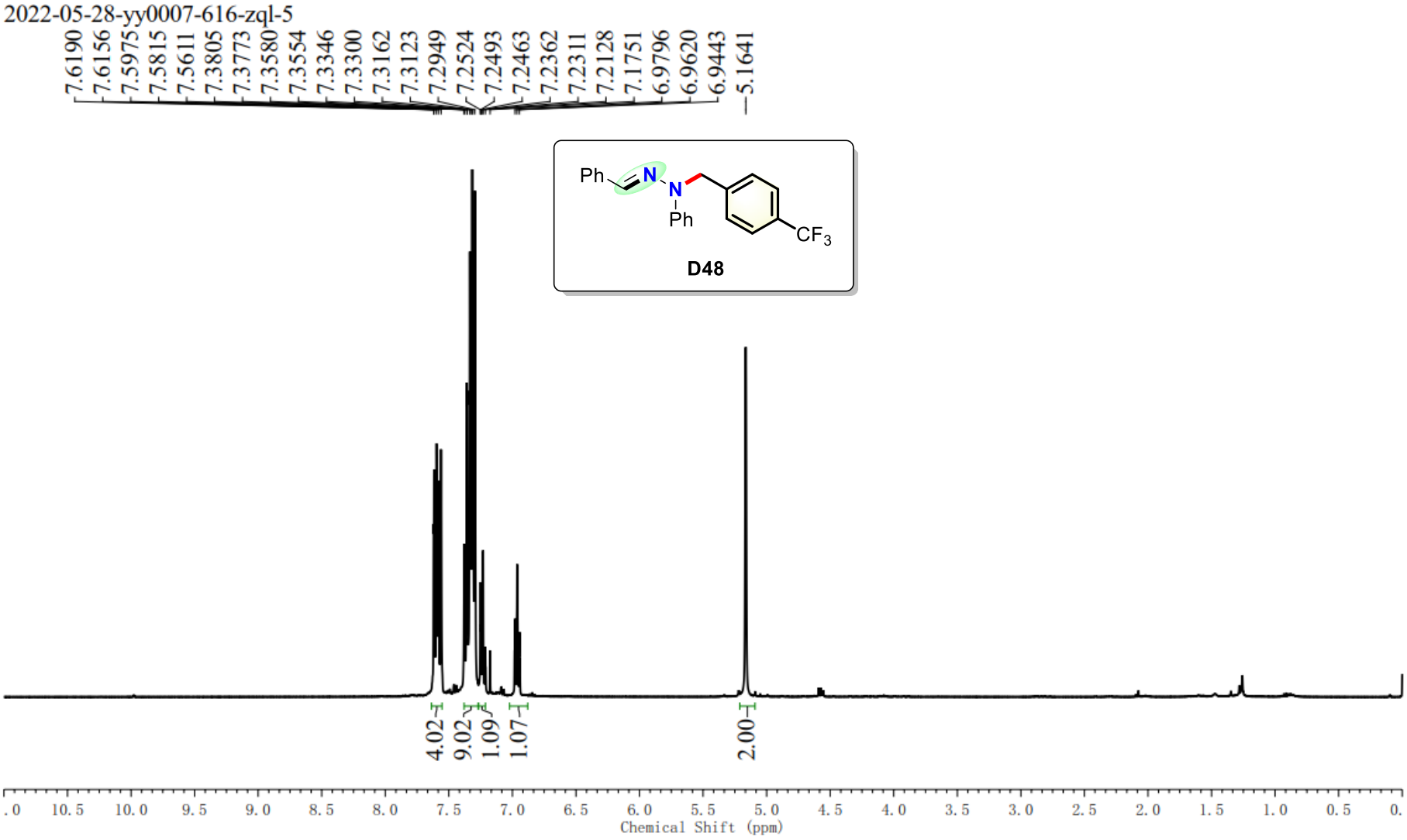

2022-06-22 yy0025 61zql-01
7.6068
7.6040
7.5860
7.3702
7.3676
7.3481
7.3194
7.3136
7.3010
7.2843
7.2782
7.2565
7.2355
7.2327
7.2174
7.1989
7.1655
7.1329
7.1119
6.9593
6.9415
6.9237
5.0695
Ph
N
N
Ph
Cl
D46
2.02
9.99
2.02
1.05
2.03
Chemical Shift (ppm)


2022-06-24 yy0027 616-zql-1
147.73
136.40
134.25
133.16
132.72
129.34
129.28
129.15
128.70
128.66
128.13
127.58
126.31
121.09
114.93
77.49
77.17
76.85
49.92
Ph
N
N
Ph
Cl
D46
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

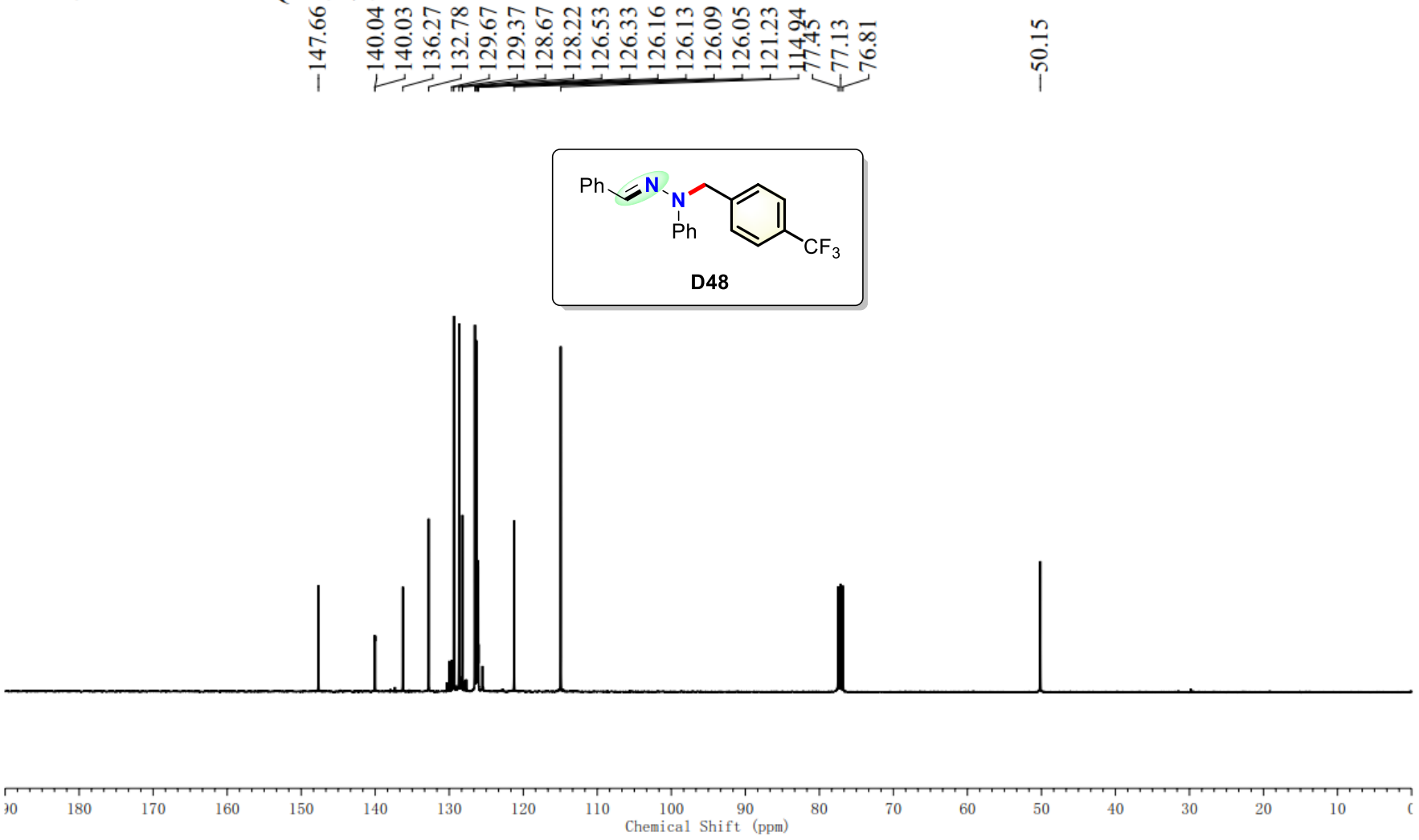

2022-07-02-yy0019-616-zql-2
7.6043
7.6007
7.5964
7.5829
7.5812
7.4243
7.4196
7.4079
7.4031
7.3970
7.3638
7.3605
7.3554
7.3467
7.3413
7.3384
7.3334
7.3199
7.3155
7.3095
7.3019
7.2979
7.2917
7.2825
7.2780
7.2755
7.2362
7.2330
7.2298
7.2198
7.2145
7.1964
7.1578
7.0707
7.0494
6.9562
6.9415
6.9385
6.9356
6.9208
Ph
N
N
Ph
Br
D47
2.08
2.06
6.02
1.06
2.00
1.01
2.00
Chemical Shift (ppm)

2022-7-4 yy0047-616-zql-3



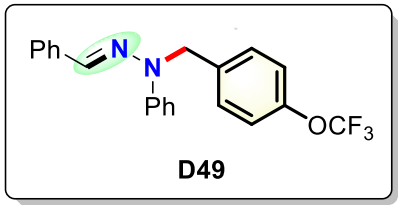

2022-05-28-yy0007-616-zql-5
7.6190
7.6156
7.5975
7.5815
7.5611
7.3805
7.3773
7.3580
7.3554
7.3346
7.3300
7.3162
7.3123
7.2949
7.2524
7.2493
7.2463
7.2362
7.2311
7.2128
7.1751
6.9796
6.9620
6.9443
5.1641
Ph
N
N
Ph
CF3
D48
4.02
9.02
1.09
1.07
2.00
Chemical Shift (ppm)

2022-05-30 YY0021 616-ZQL-0527-5

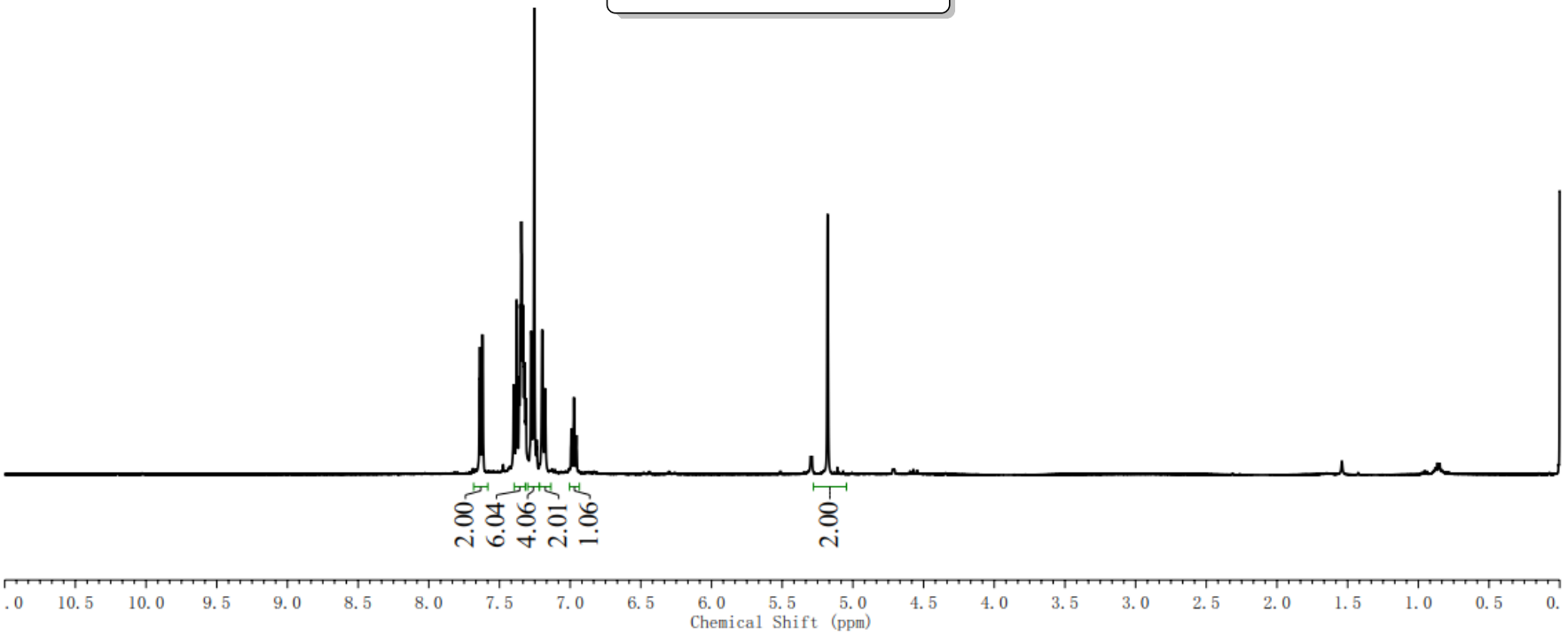


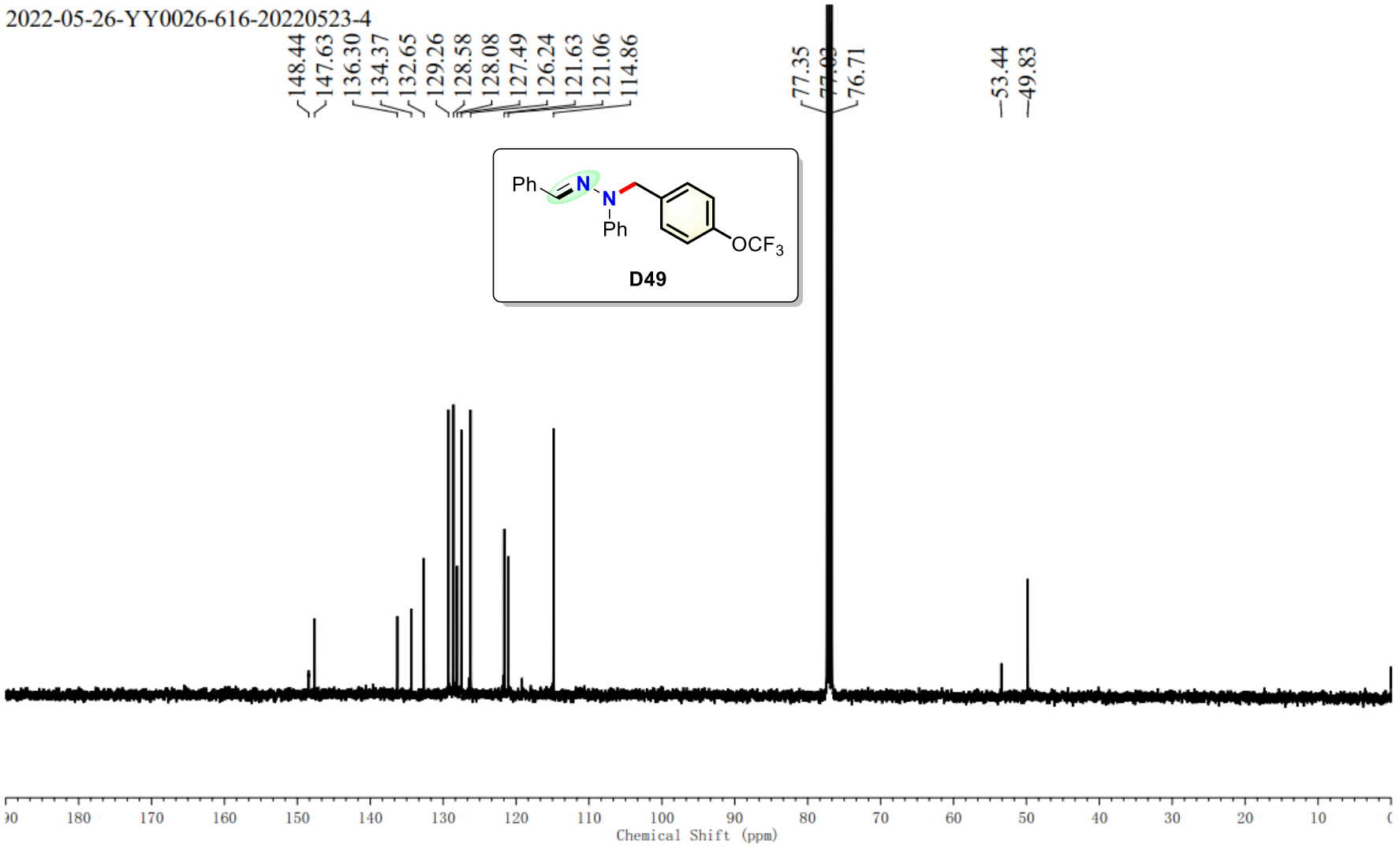
2022-05-23-yy0007-616-zql-4

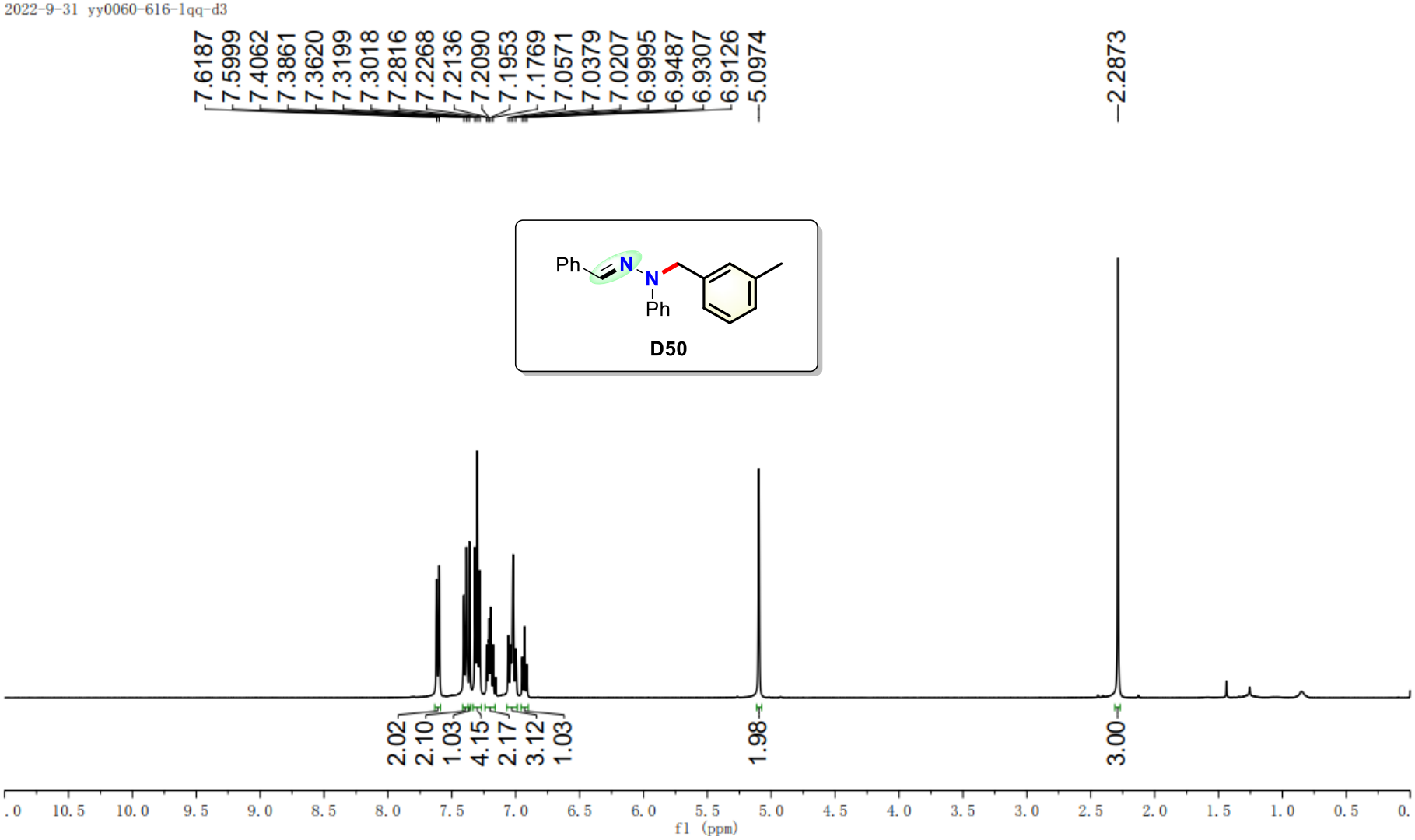
7.6380
7.6198
7.3975
7.3781
7.3757
7.3598
7.3515
7.3457
7.3339
7.3297
7.3224
7.3171
7.3119
7.2768
7.2534
7.2377
7.1977
7.1770
6.9914
6.9737
6.9559
5.1786

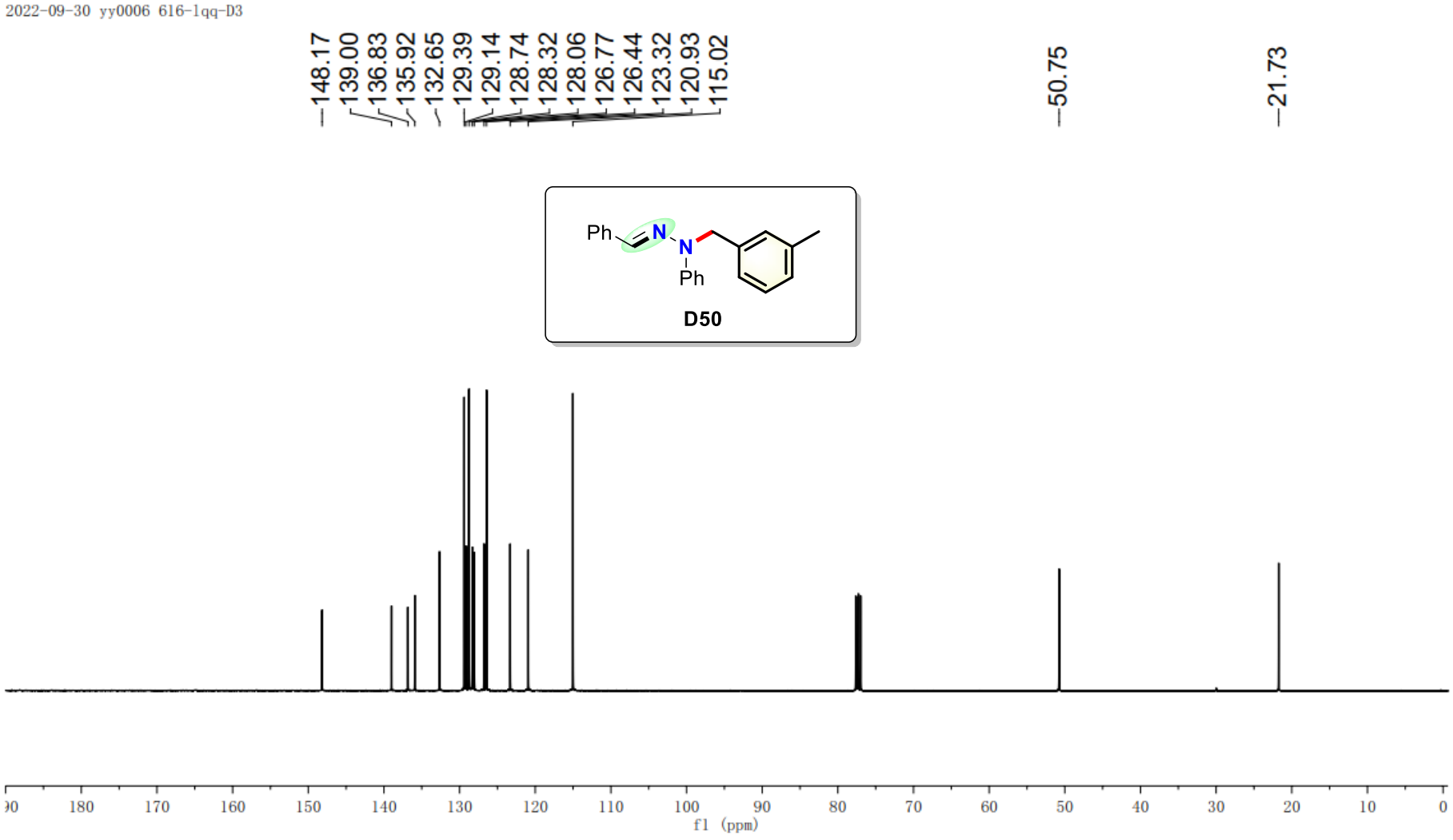


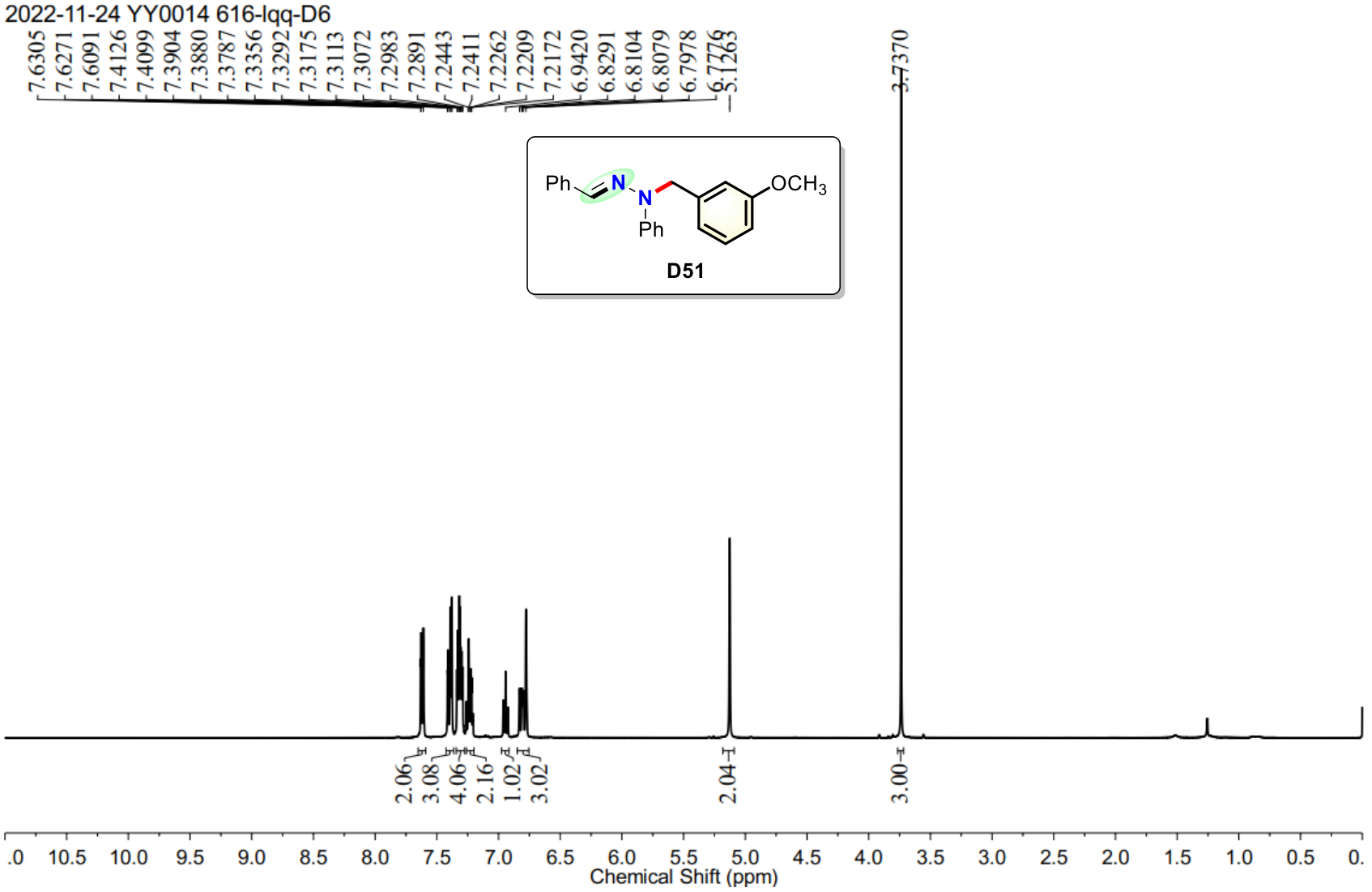

**D49**

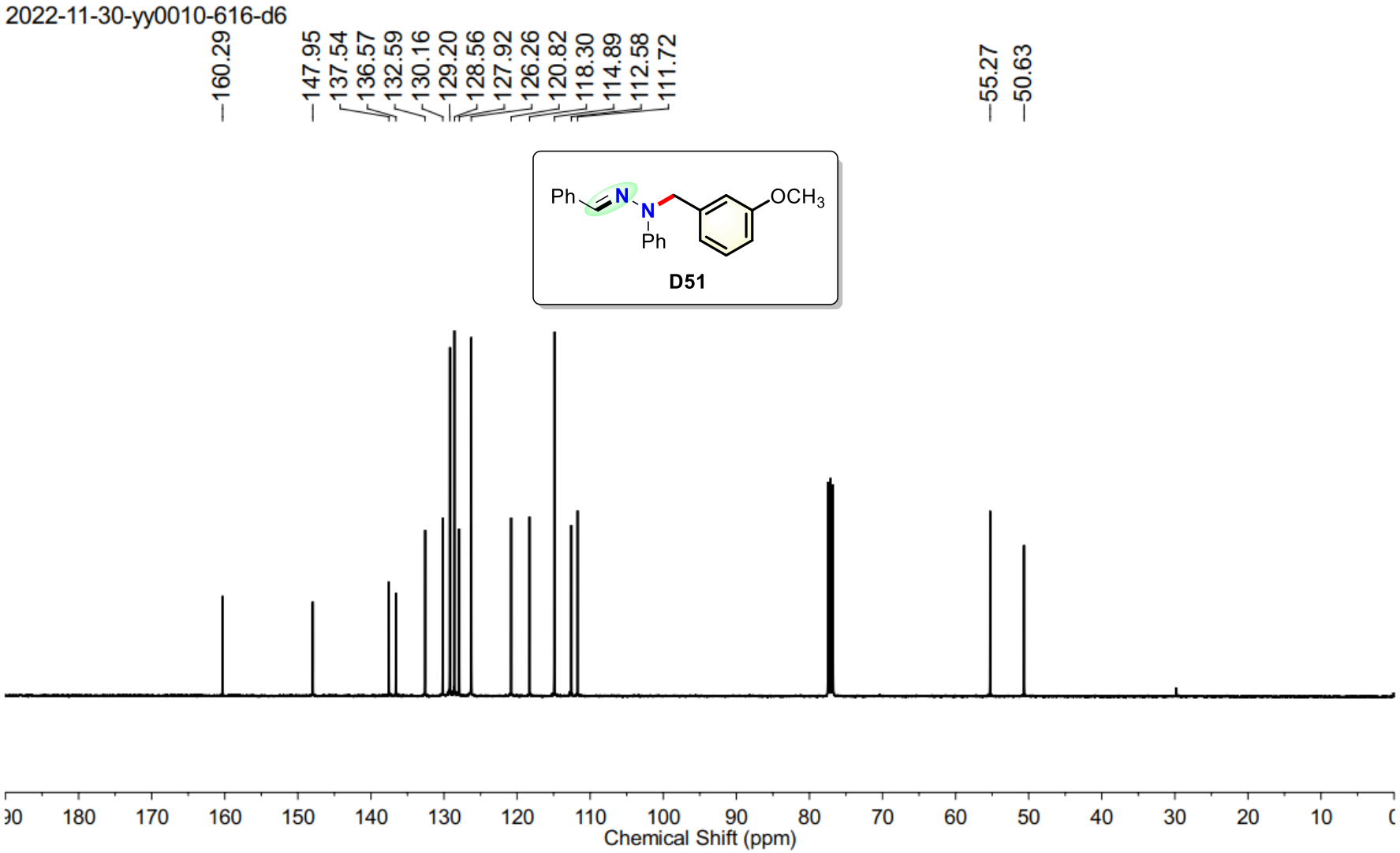



2022-05-26-YY0026-616-20220523-4
148.44
147.63
136.30
134.37
132.65
129.26
128.58
128.08
127.49
126.24
121.63
121.06
114.86
77.35
77.03
76.71
53.44
49.83
Ph
N
N
Ph
OCF3
D49
Chemical Shift (ppm)

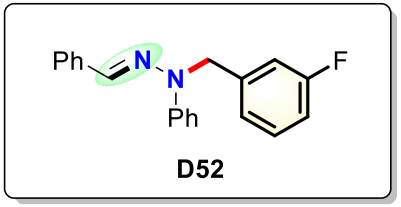

2022-9-31 yy0060-616-1qq-d3
7.6187
7.5999
7.4062
7.3861
7.3620
7.3199
7.3018
7.2816
7.2268
7.2136
7.2090
7.1953
7.1769
7.0571
7.0379
7.0207
6.9995
6.9487
6.9307
6.9126
5.0974
2.2873
Ph
N
N
Ph
D50
2.02
2.10
1.03
4.15
2.17
3.12
1.03
1.98
3.00
f1 (ppm)


2022-09-30 yy0006 616-1qq-D3
148.17
139.00
136.83
135.92
132.65
129.39
129.14
128.74
128.32
128.06
126.77
126.44
123.32
120.93
115.02
50.75
21.73
Ph
N
N
Ph
D50
f1 (ppm)

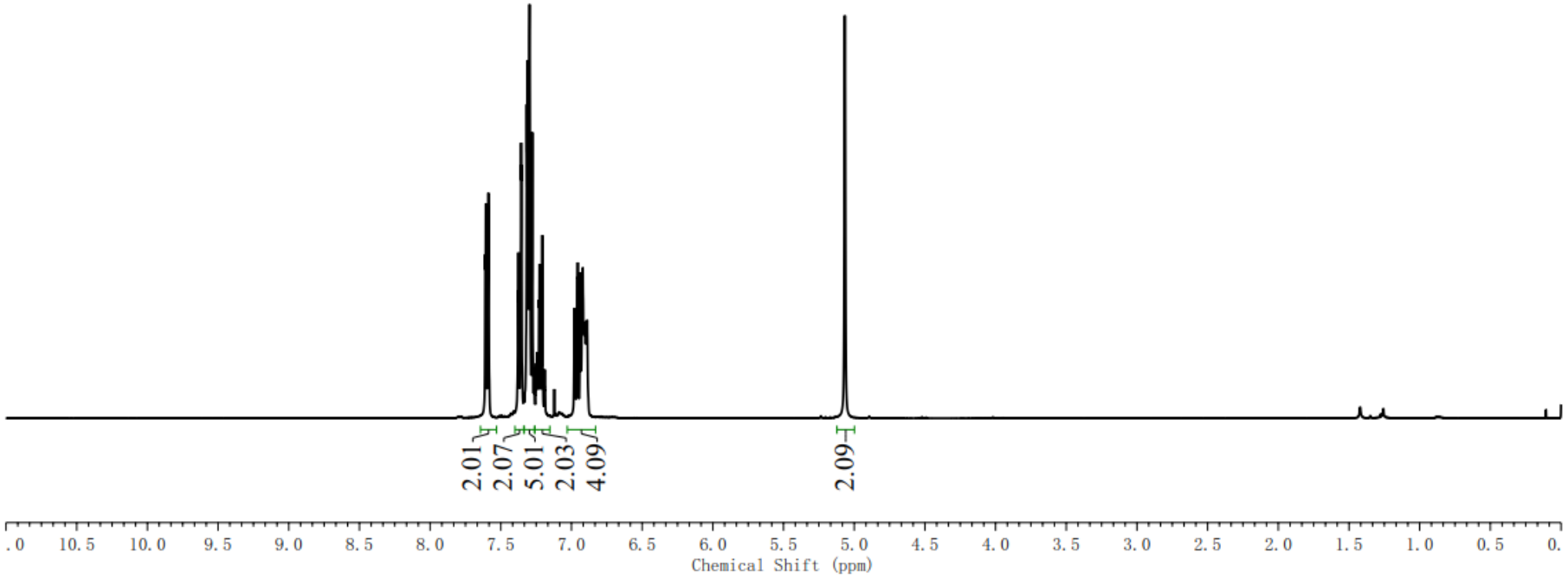

2022-11-24 YY0014 616-lqq-D6
7.6305
7.6271
7.6091
7.4126
7.4099
7.3904
7.3880
7.3787
7.3356
7.3292
7.3175
7.3113
7.3072
7.2983
7.2891
7.2443
7.2411
7.2262
7.2209
7.2172
6.9420
6.8291
6.8104
6.8079
6.7978
3.7370
Ph
N
N
Ph
OCH3
D51
2.06
3.08
4.06
2.16
1.02
3.02
2.04
3.00
Chemical Shift (ppm)


2022-11-30-yy0010-616-d6
160.29
147.95
137.54
136.57
132.59
130.16
129.20
128.56
127.92
126.26
120.82
118.30
114.89
112.58
111.72
55.27
50.63
Ph
N
N
Ph
OCH3
D51
Chemical Shift (ppm)

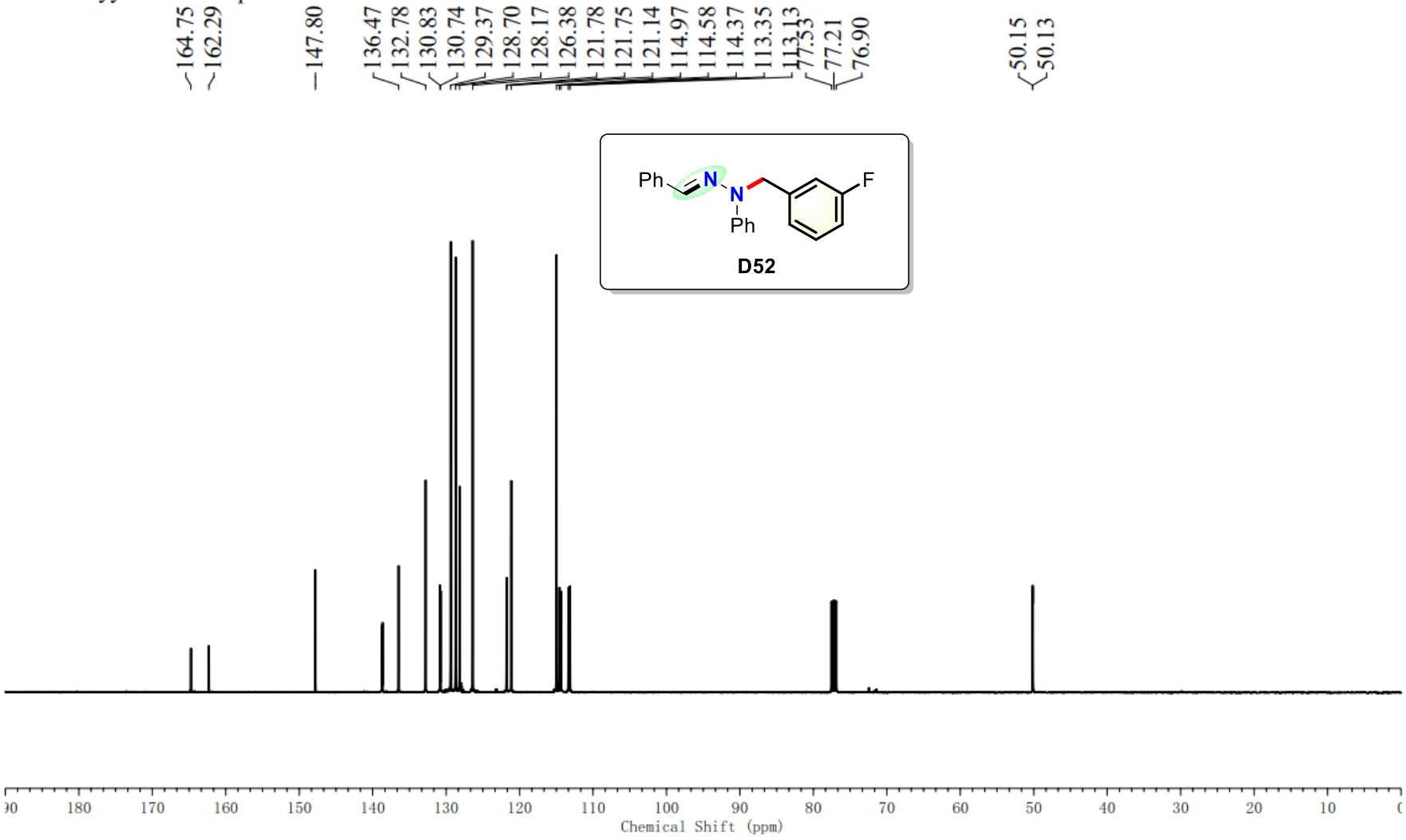
2022-07-02-yy0019-616-zql-1

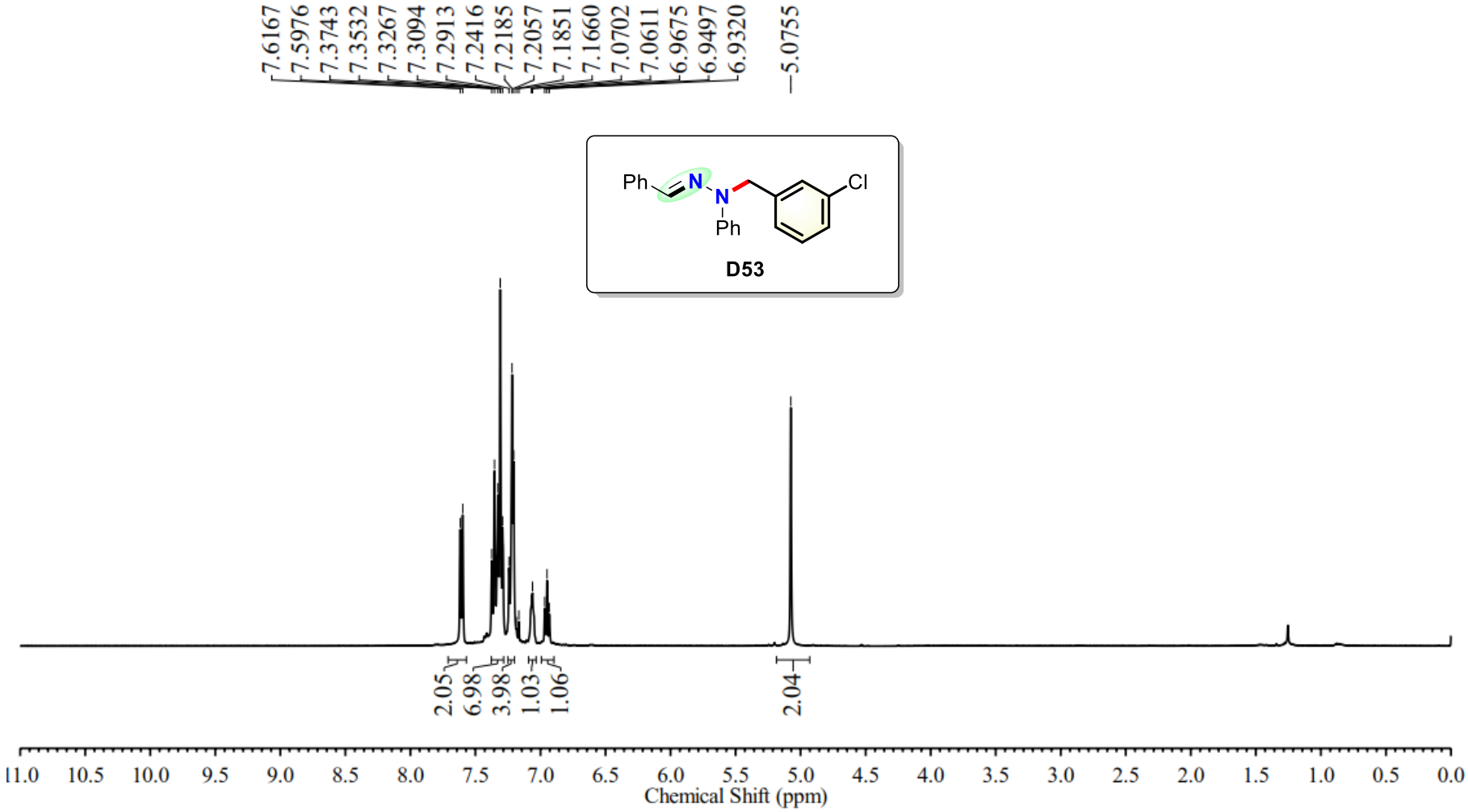

**D52**



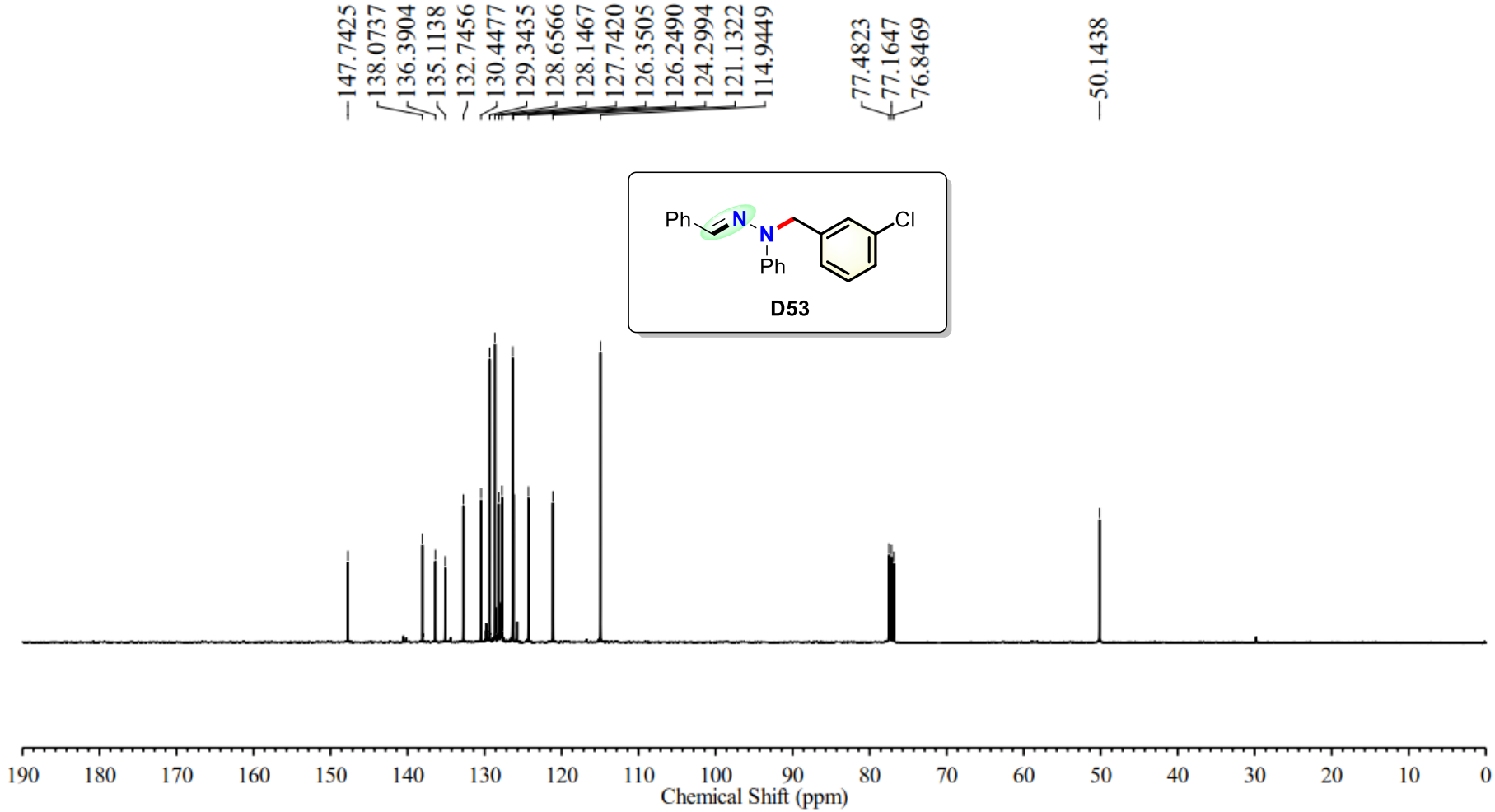
2022-7-4 yy0046-616-zql-2

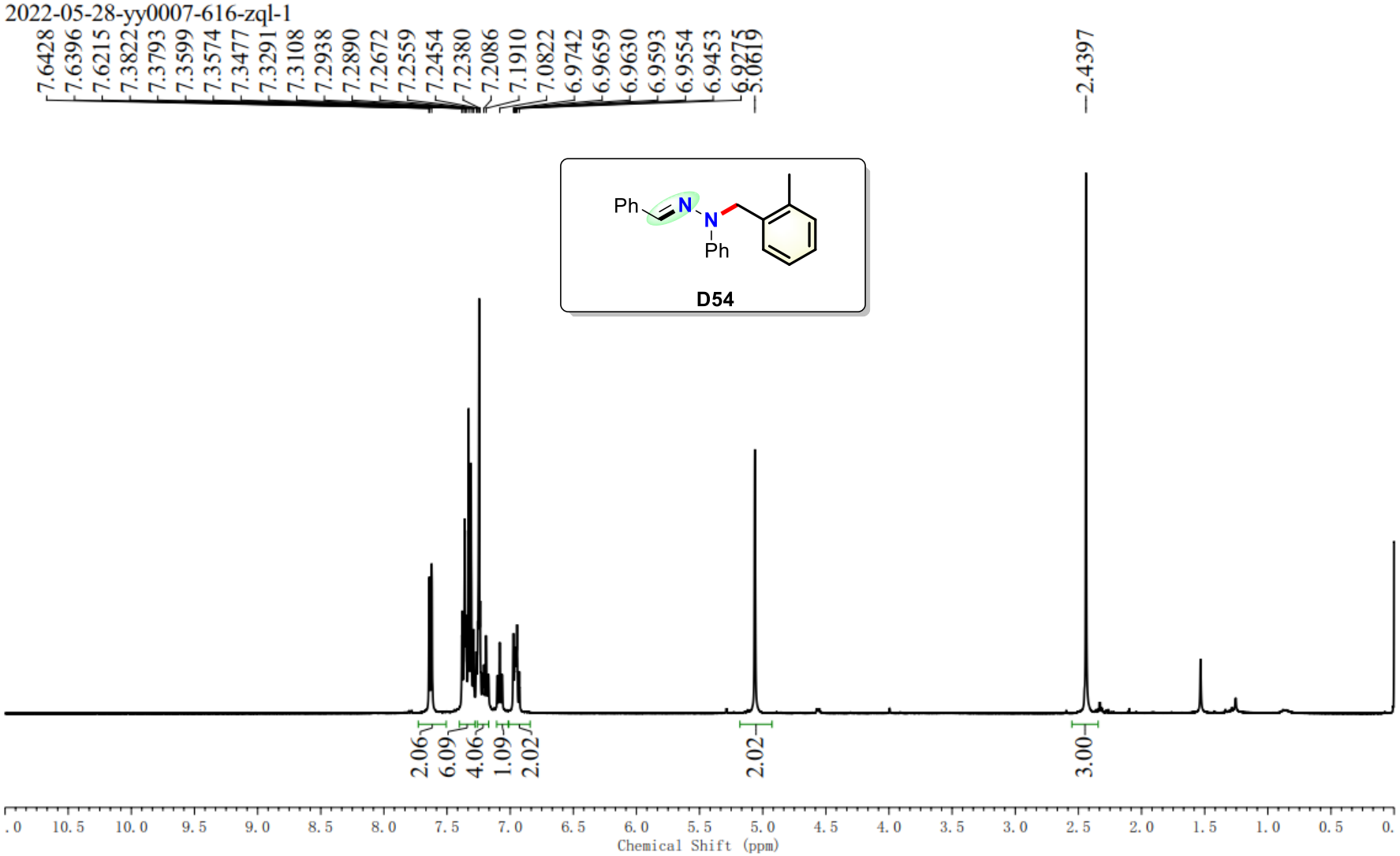


2022-6-13 YY0018-616-ZQL-13-1

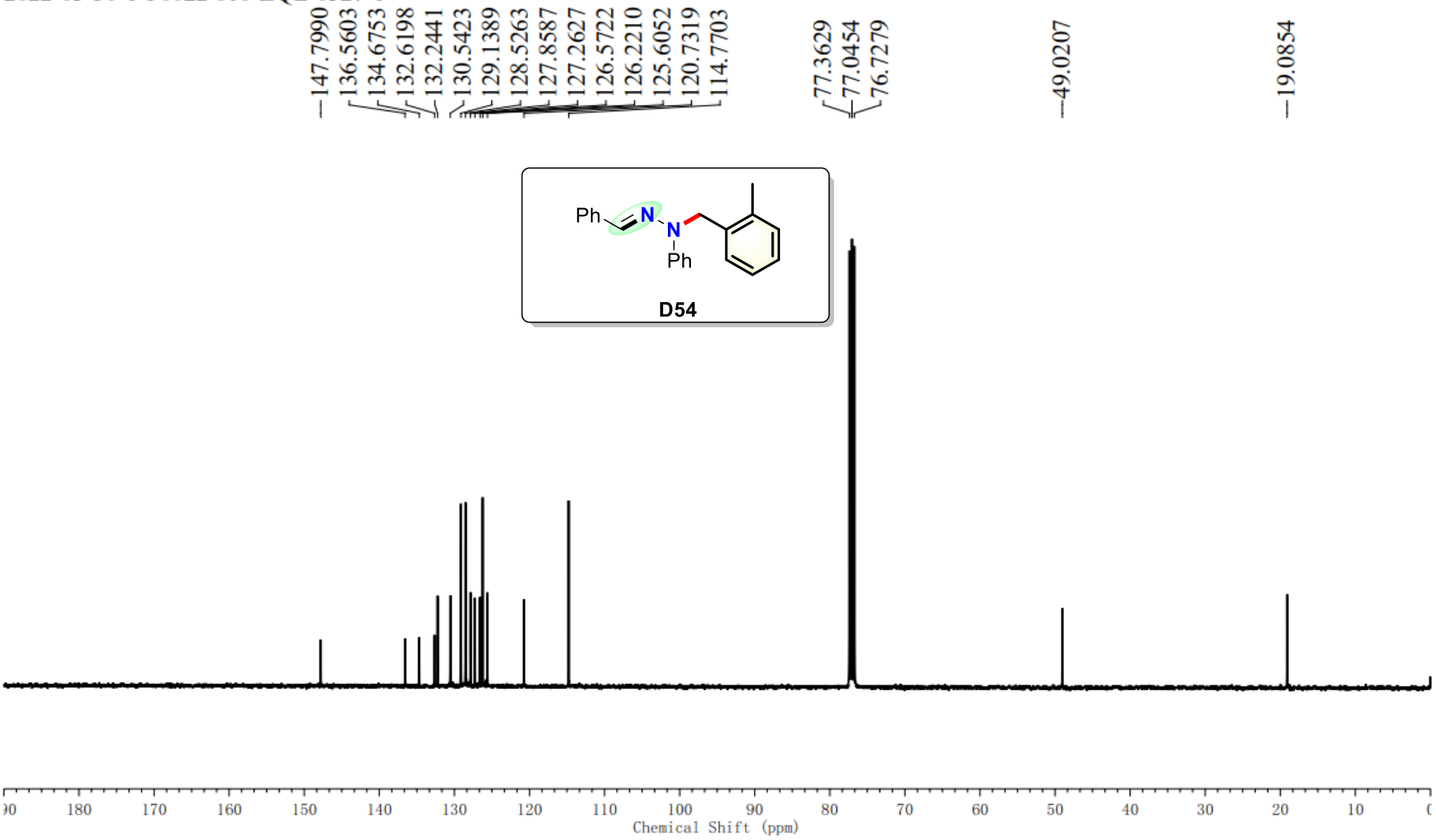


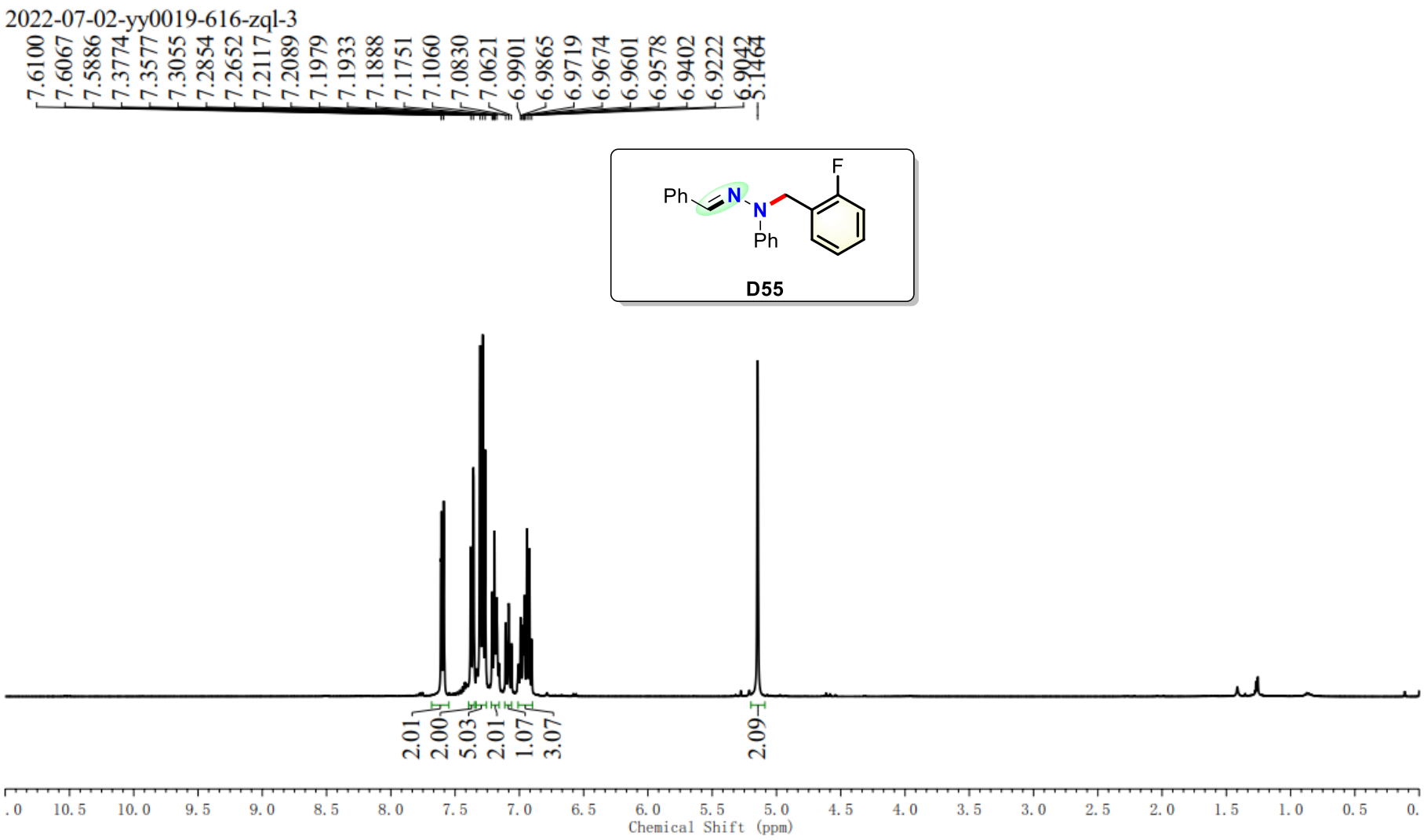
2022-6-16 yy0005-616-zql-613-1




2022-05-28-yy0007-616-zql-1
7.6428
7.6396
7.6215
7.3822
7.3793
7.3599
7.3574
7.3477
7.3291
7.3108
7.2938
7.2890
7.2672
7.2559
7.2454
7.2380
7.2086
7.1910
7.0822
6.9742
6.9659
6.9630
6.9593
6.9554
6.9453
6.9275
3.0619
2.4397
Ph
N
N
Ph
D54
2.06
6.09
4.06
1.09
2.02
2.02
3.00
Chemical Shift (ppm)

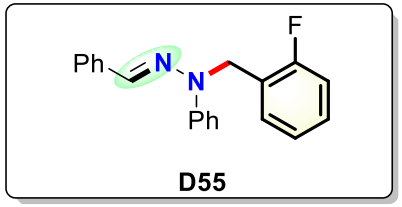
2022-05-30 YY0022 616-ZQL-0527-1



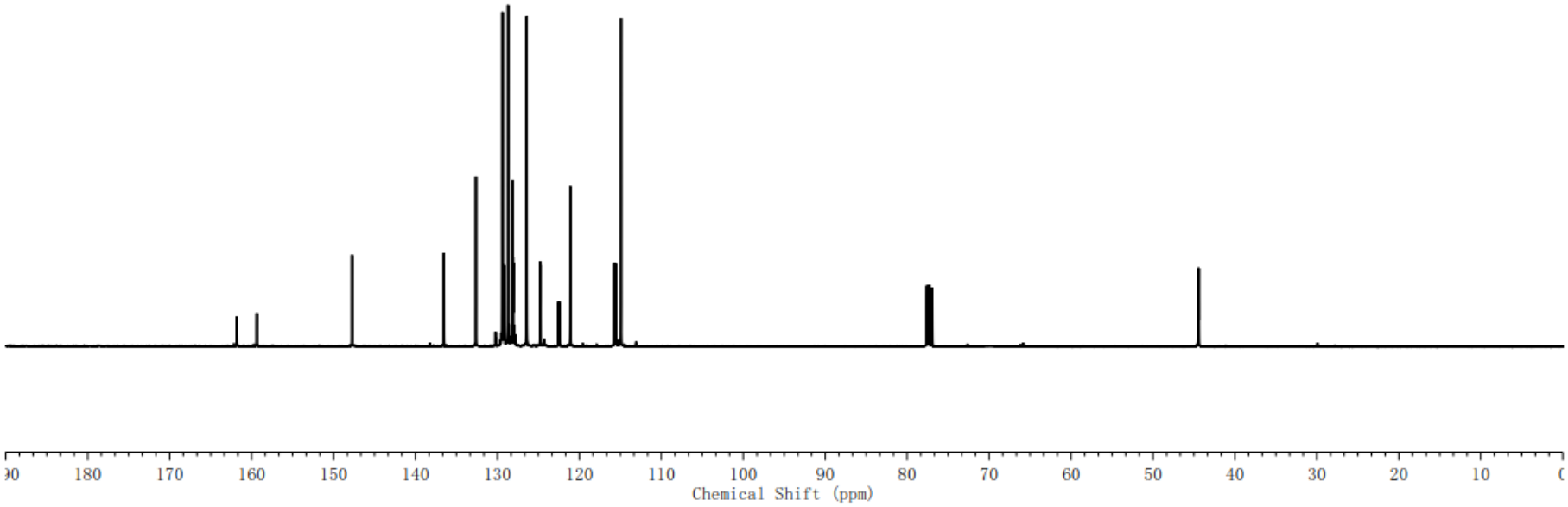

2022-07-02-yy0019-616-zql-3
7.6100
7.6067
7.5886
7.3774
7.3577
7.3055
7.2854
7.2652
7.2117
7.2089
7.1979
7.1933
7.1888
7.1751
7.1060
7.0830
7.0621
6.9901
6.9865
6.9719
6.9674
6.9601
6.9578
6.9402
6.9222
6.9042
5.1464
Ph
N
N
Ph
F
D55
2.01
2.00
5.03
2.01
1.07
3.07
2.09
Chemical Shift (ppm)

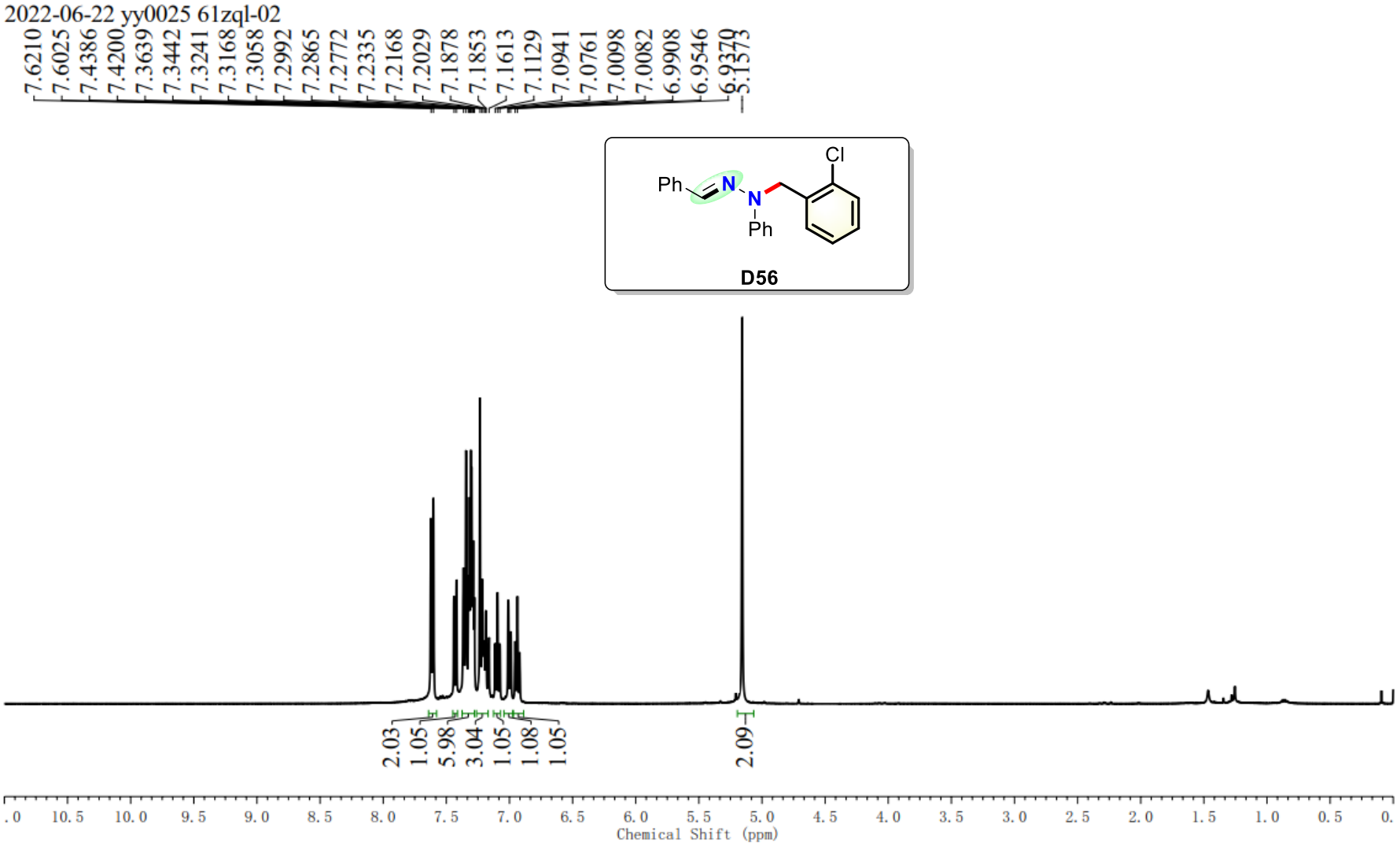
2022-7-4 yy0046-616-zql-1

161.7939
159.3575
147.7362
136.5355
132.6088
129.3860
129.2073
129.1287
128.7079
128.1576
128.0926
128.0528
126.4254
124.7587
124.7239
121.0843
115.7618
115.5574
114.9248
77.5752
77.2573
76.9395
44.4473
44.3982

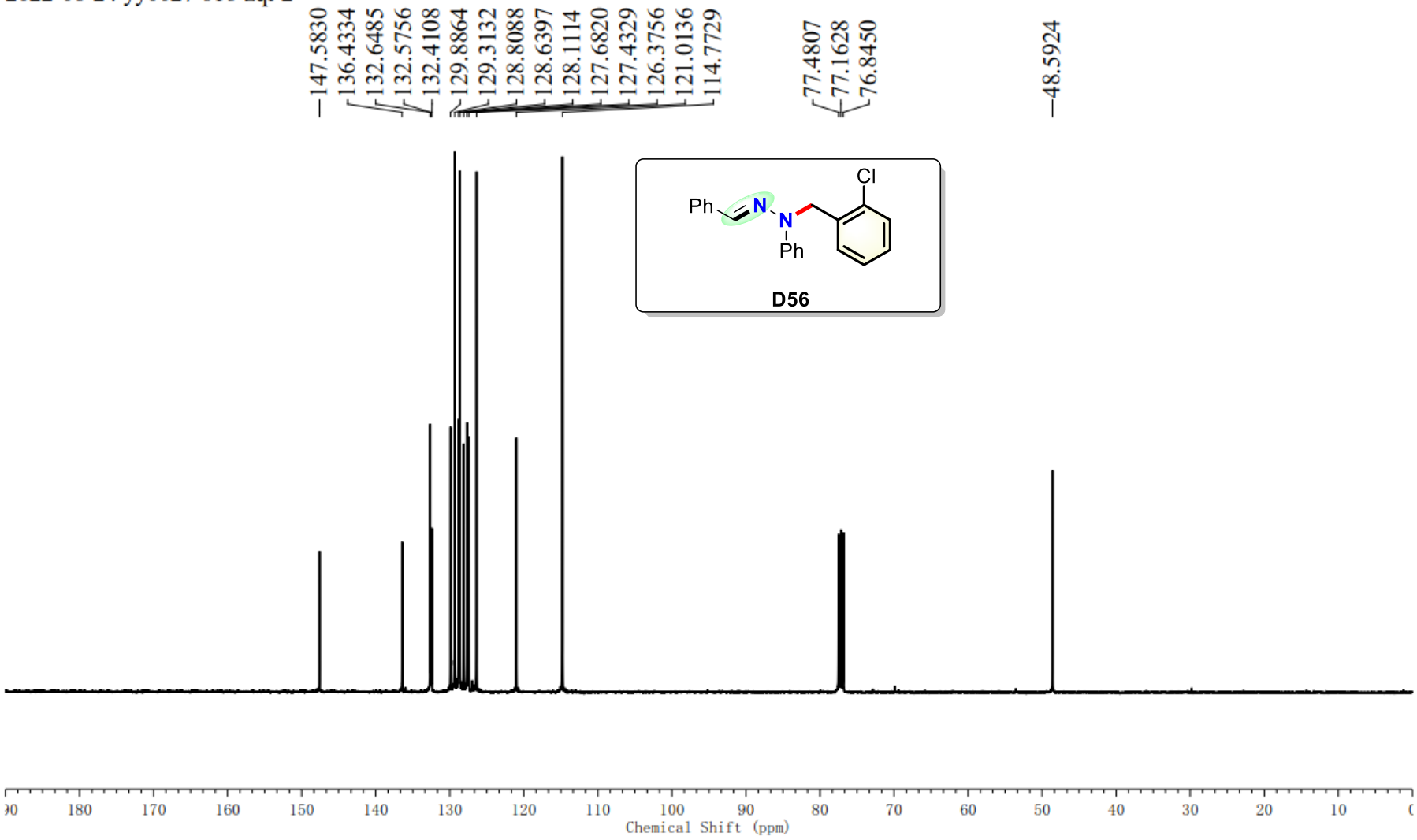


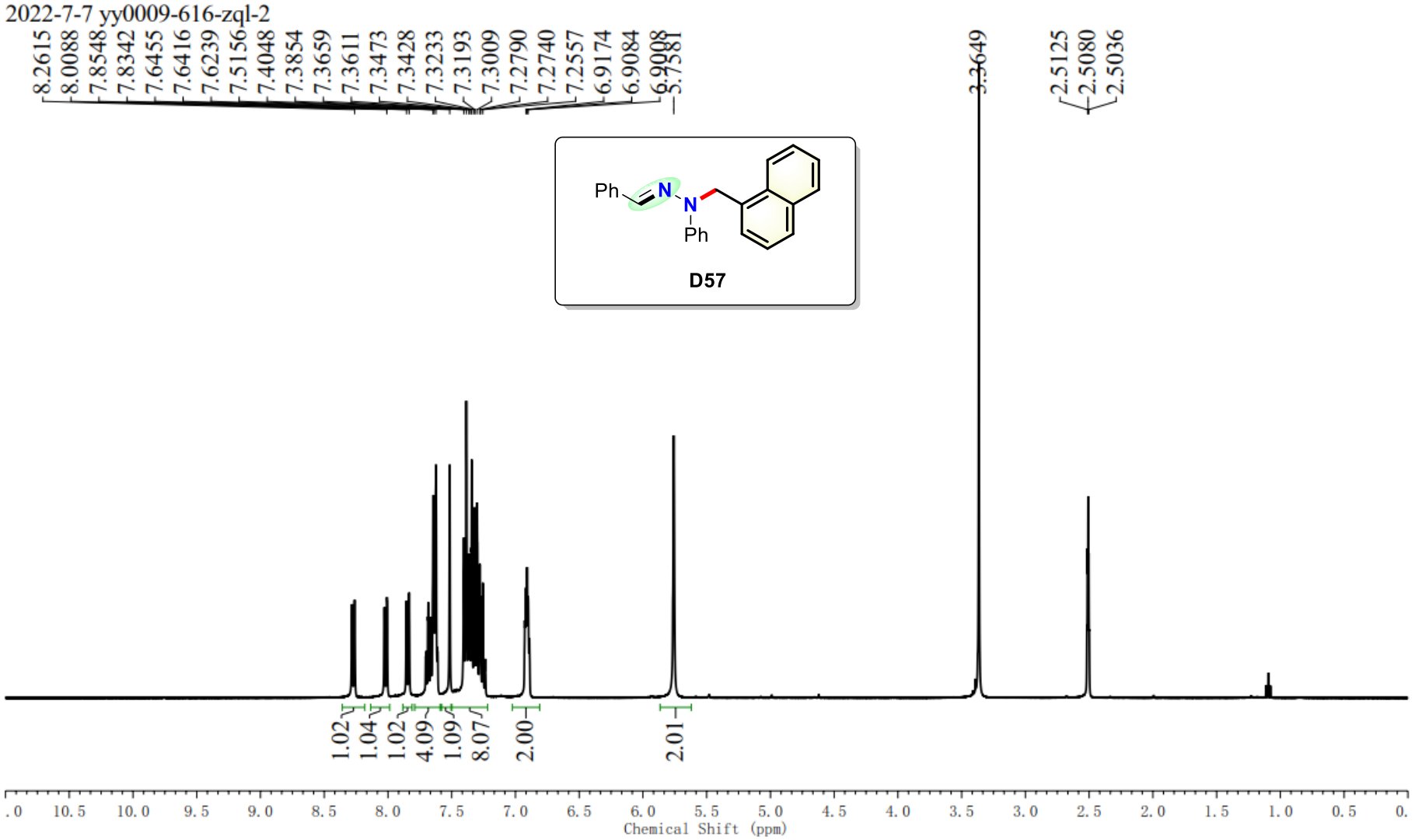

D55

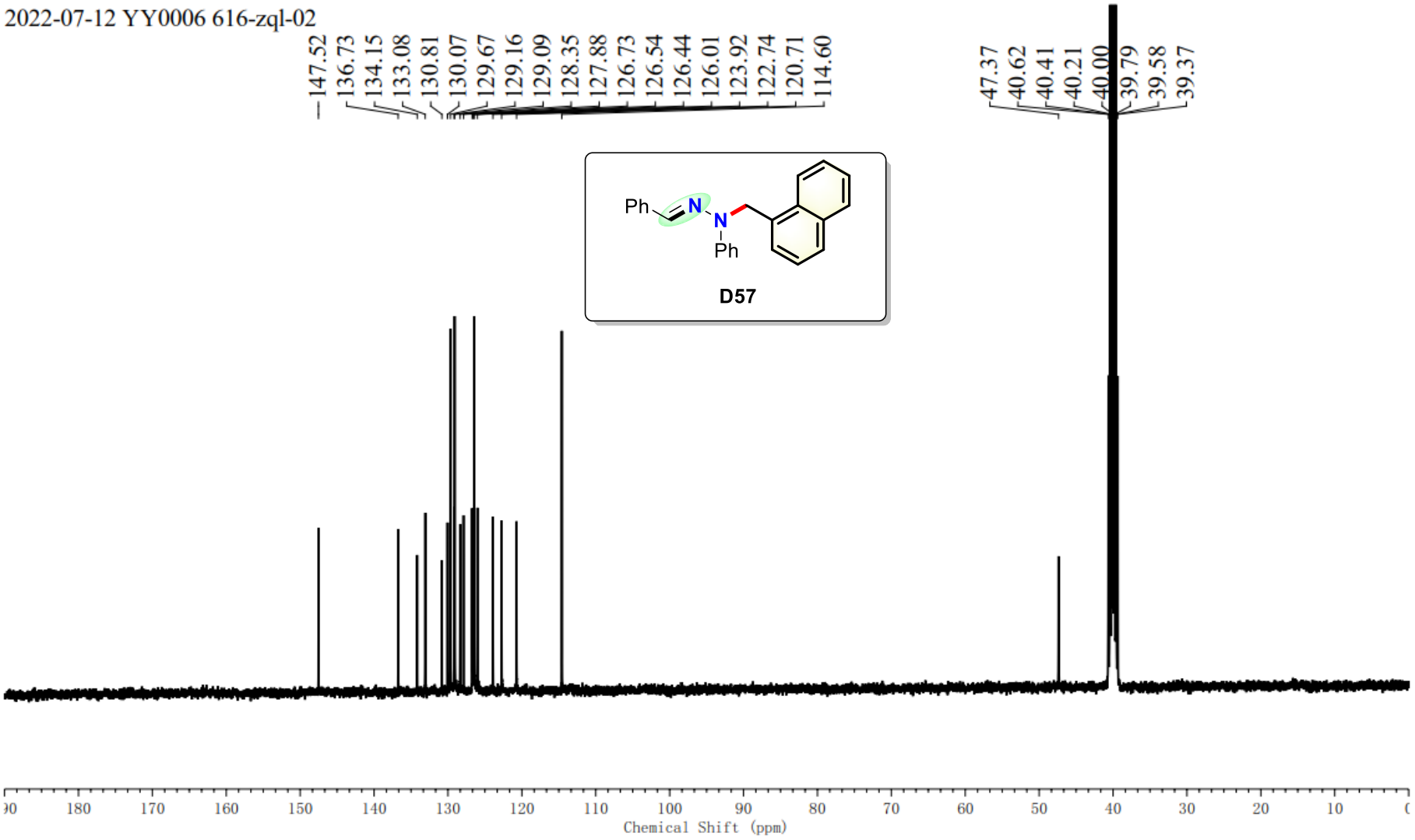


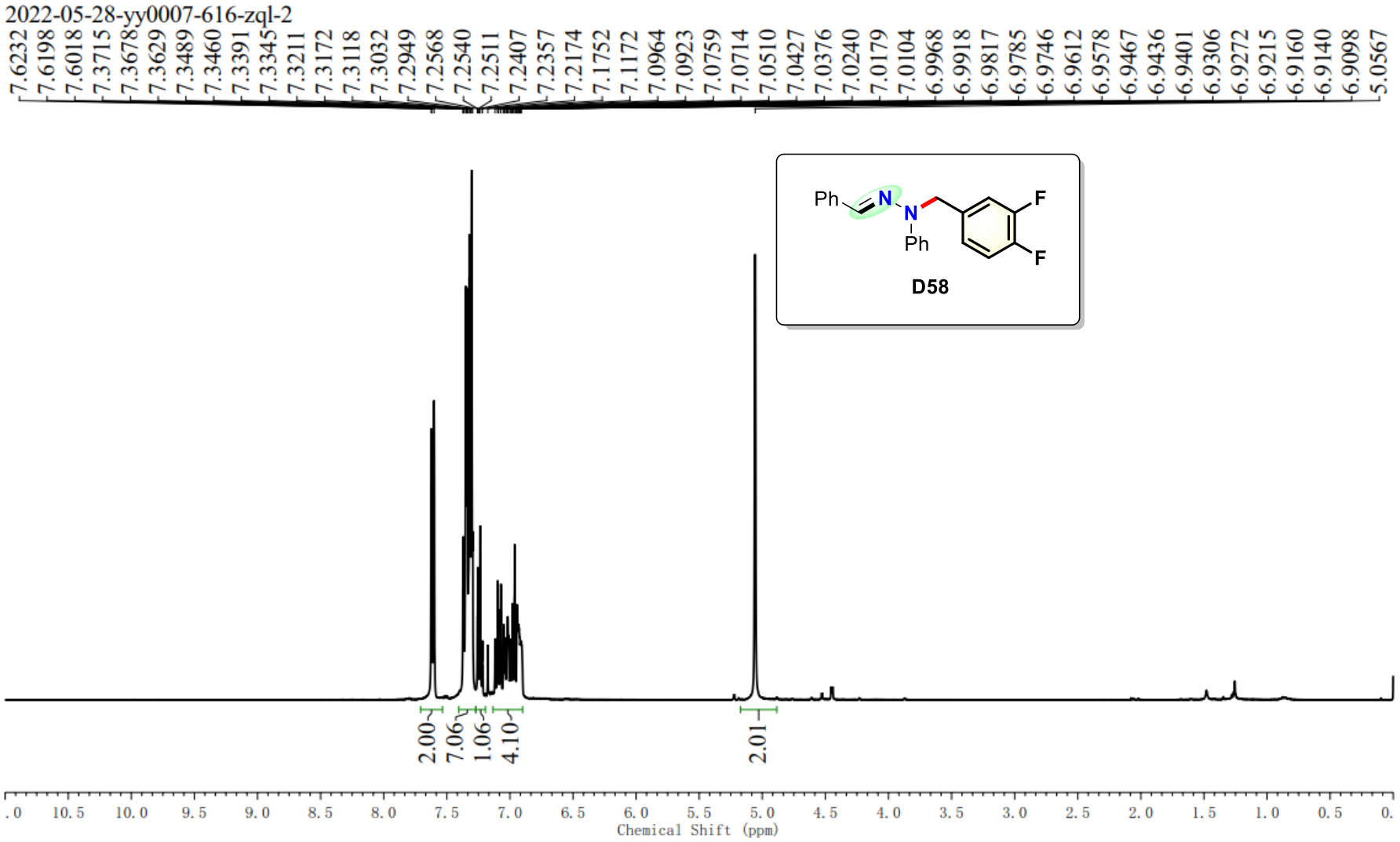

2022-06-22 yy0025 61zql-02
7.6210
7.6025
7.4386
7.4200
7.3639
7.3442
7.3241
7.3168
7.3058
7.2992
7.2865
7.2772
7.2335
7.2168
7.2029
7.1878
7.1853
7.1613
7.1129
7.0941
7.0761
7.0098
7.0082
6.9908
6.9546
6.9370
5.1573
Ph
N
N
Ph
Cl
D56
2.03
1.05
5.98
3.04
1.05
1.08
1.05
2.09
Chemical Shift (ppm)

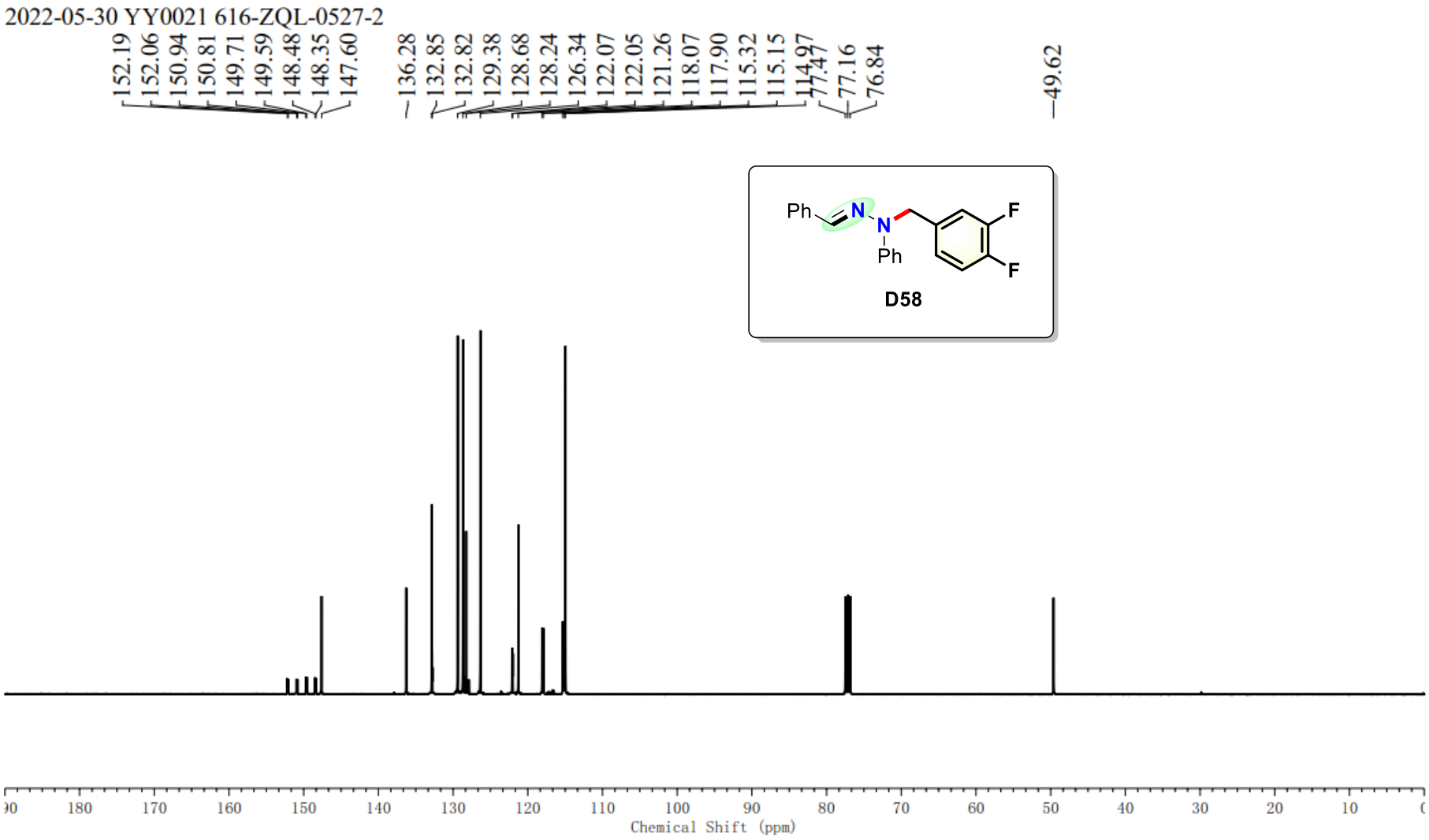
2022-06-24 yy0027 616-zql-2



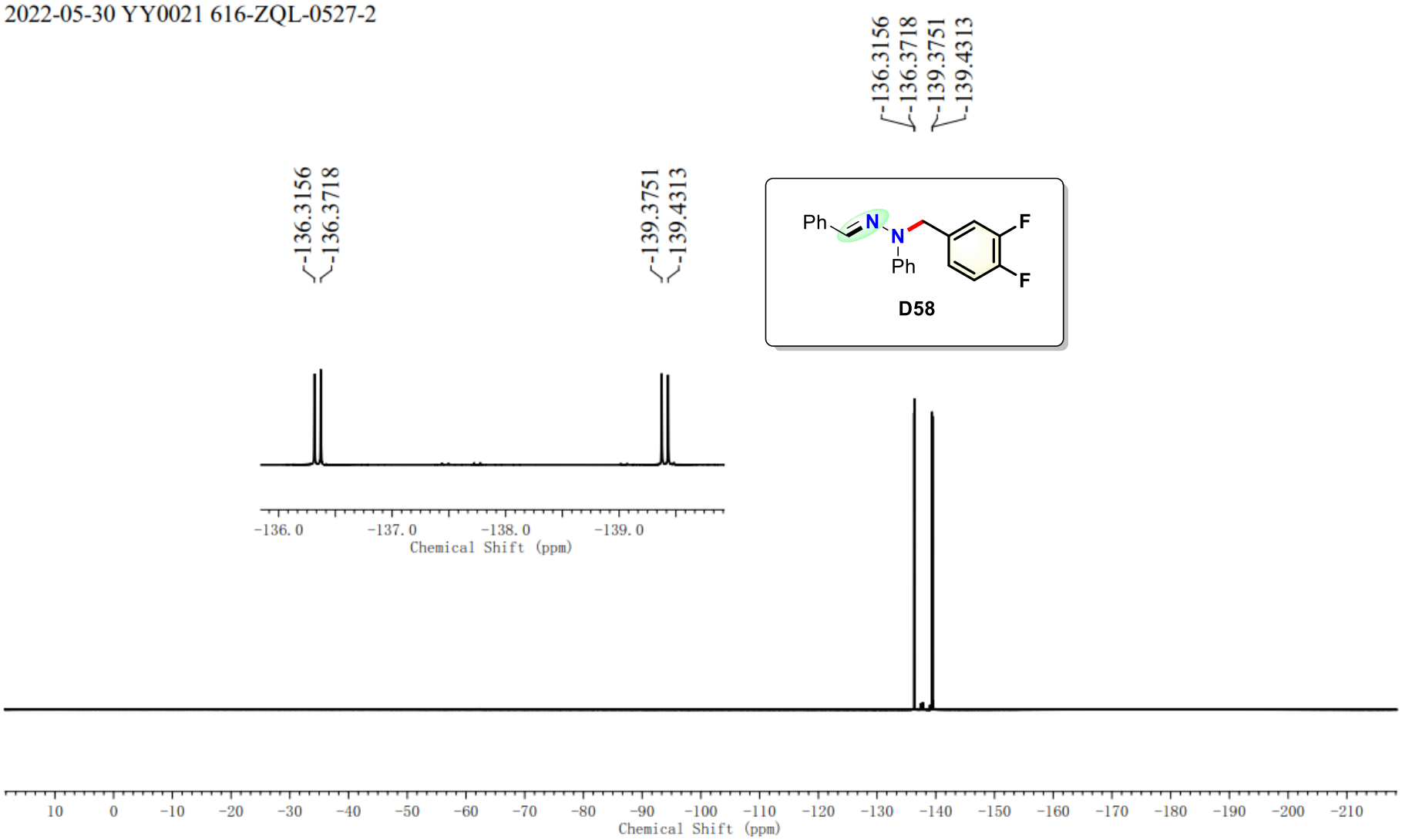

2022-7-7 yy0009-616-zql-2
8.2615
8.0088
7.8548
7.8342
7.6455
7.6416
7.6239
7.5156
7.4048
7.3854
7.3659
7.3611
7.3473
7.3428
7.3233
7.3193
7.3009
7.2790
7.2740
7.2557
6.9174
6.9084
6.9008
5.7581
3.3649
2.5125
2.5080
2.5036
Ph
N
N
Ph
D57
1.02
1.04
1.02
4.09
1.09
8.07
2.00
2.01
Chemical Shift (ppm)

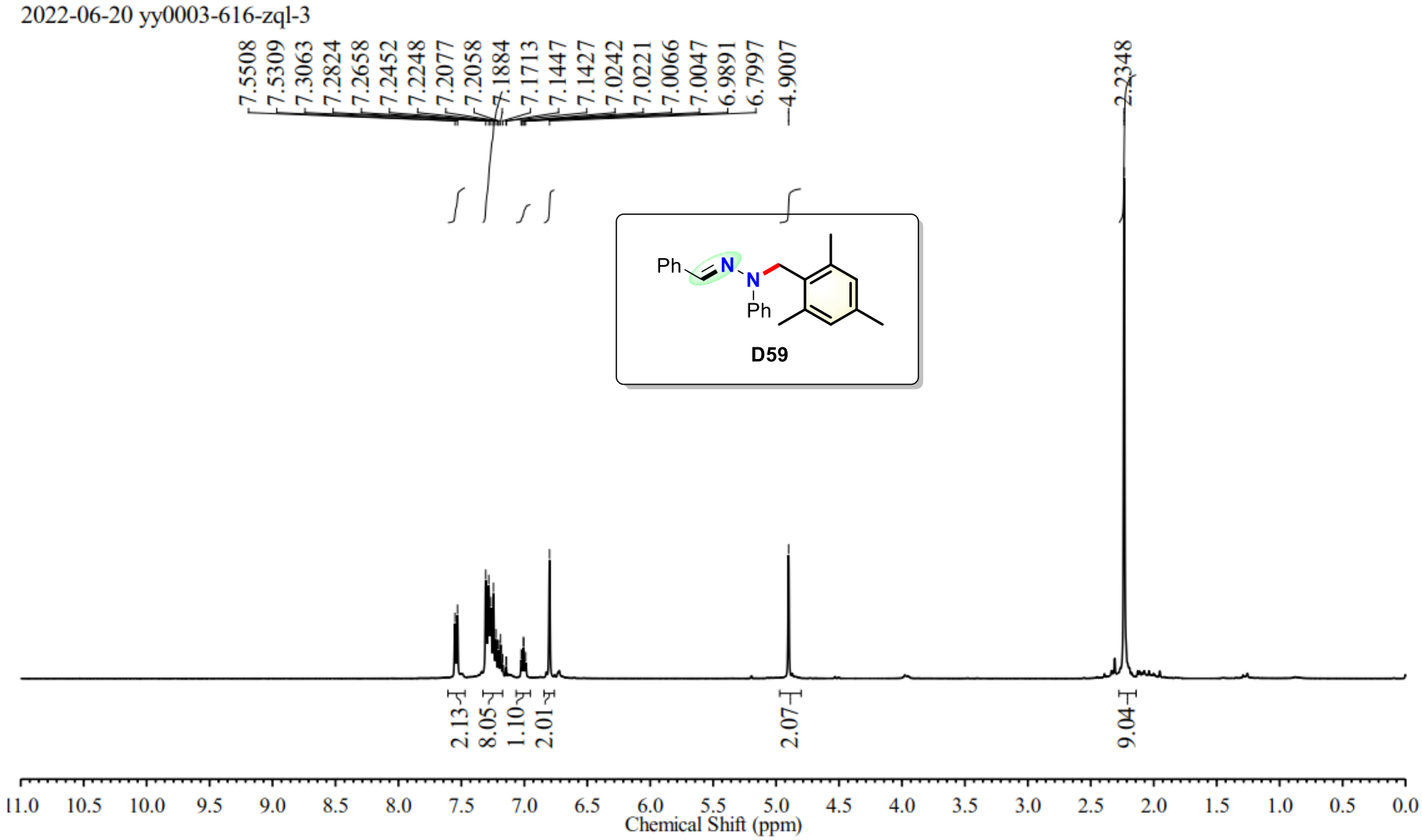

2022-07-12 YY0006 616-zql-02
147.52
136.73
134.15
133.08
130.81
130.07
129.67
129.16
129.09
128.35
127.88
126.73
126.54
126.44
126.01
123.92
122.74
120.71
114.60
47.37
40.62
40.41
40.21
40.00
39.79
39.58
39.37
Ph
N
N
Ph
D57
Chemical Shift (ppm)


2022-05-28-yy0007-616-zql-2
7.6232
7.6198
7.6018
7.3715
7.3678
7.3629
7.3489
7.3460
7.3391
7.3345
7.3211
7.3172
7.3118
7.3032
7.2949
7.2568
7.2540
7.2511
7.2407
7.2357
7.2174
7.1752
7.1172
7.0964
7.0923
7.0759
7.0714
7.0510
7.0427
7.0376
7.0240
7.0179
7.0104
6.9968
6.9918
6.9817
6.9785
6.9746
6.9612
6.9578
6.9467
6.9436
6.9401
6.9306
6.9272
6.9215
6.9160
6.9140
6.9098
5.0567
Ph
N
N
Ph
F
F
D58
2.00
7.06
1.06
4.10
2.01
Chemical Shift (ppm)

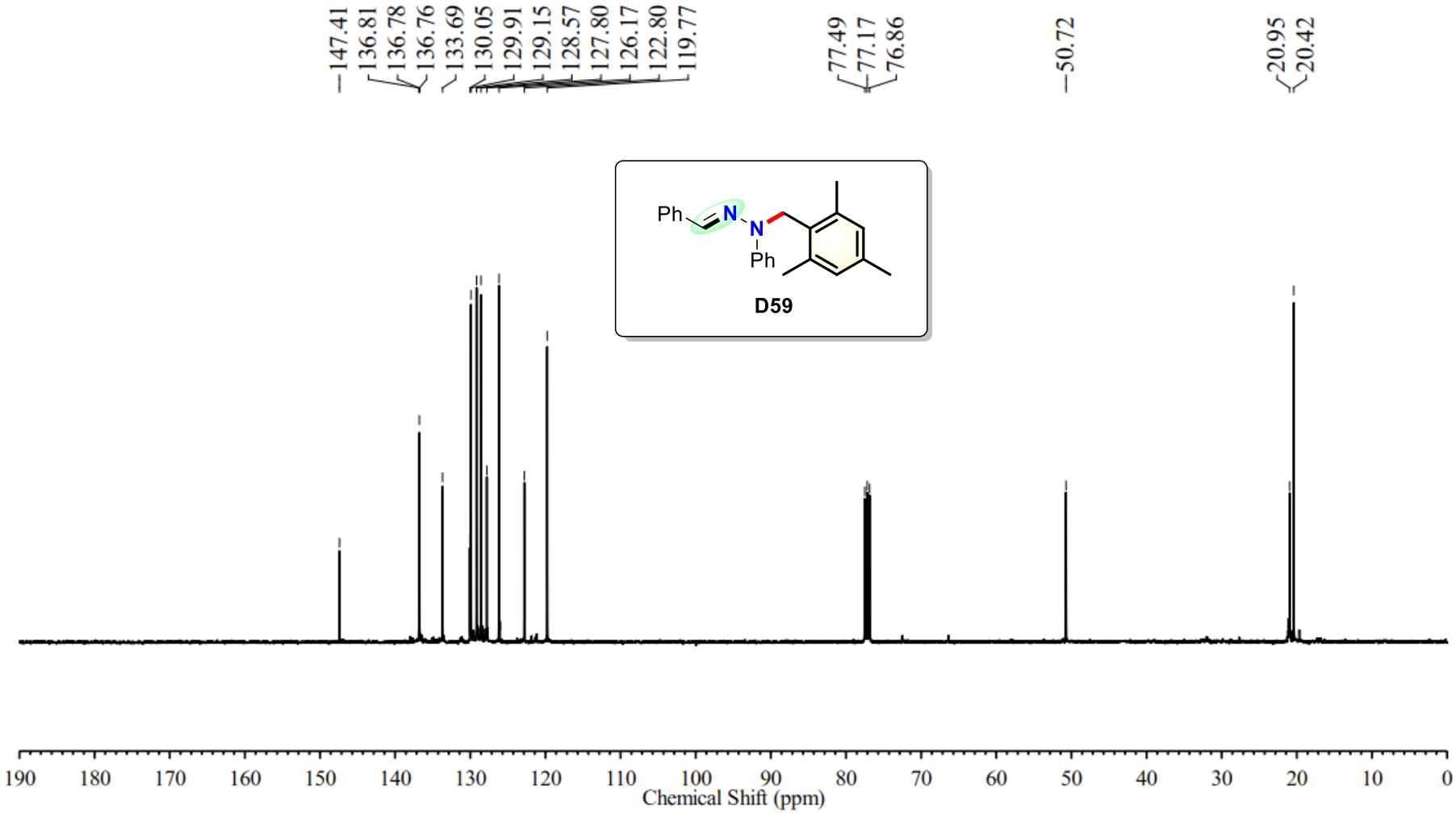

2022-05-30 YY0021 616-ZQL-0527-2
152.19
152.06
150.94
150.81
149.71
149.59
148.48
148.35
147.60
136.28
132.85
132.82
129.38
128.68
128.24
126.34
122.07
122.05
121.26
118.07
117.90
115.32
115.15
114.97
77.47
77.16
76.84
49.62
Ph
N
N
Ph
F
F
D58
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

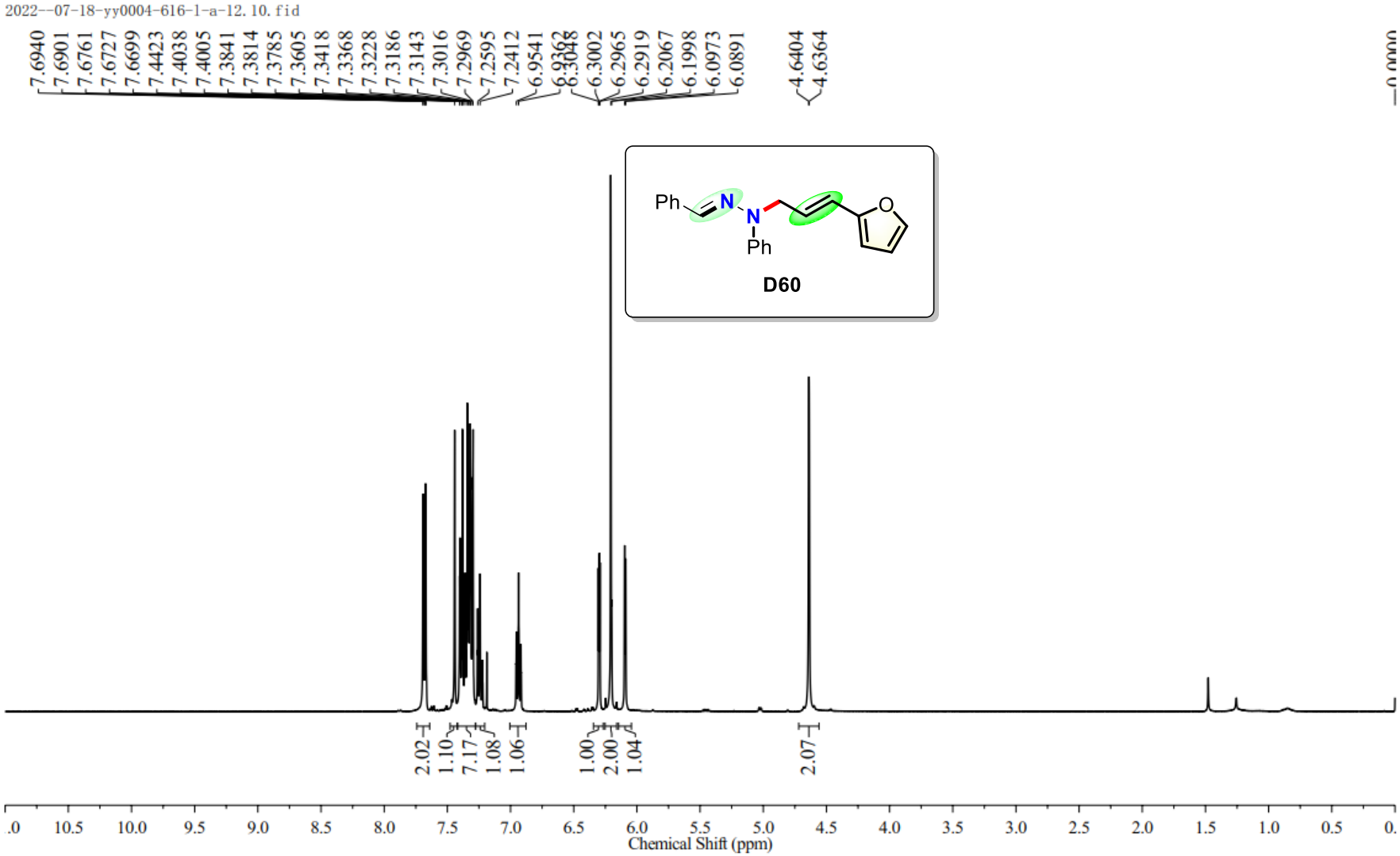
2022-05-30 YY0021 616-ZQL-0527-2



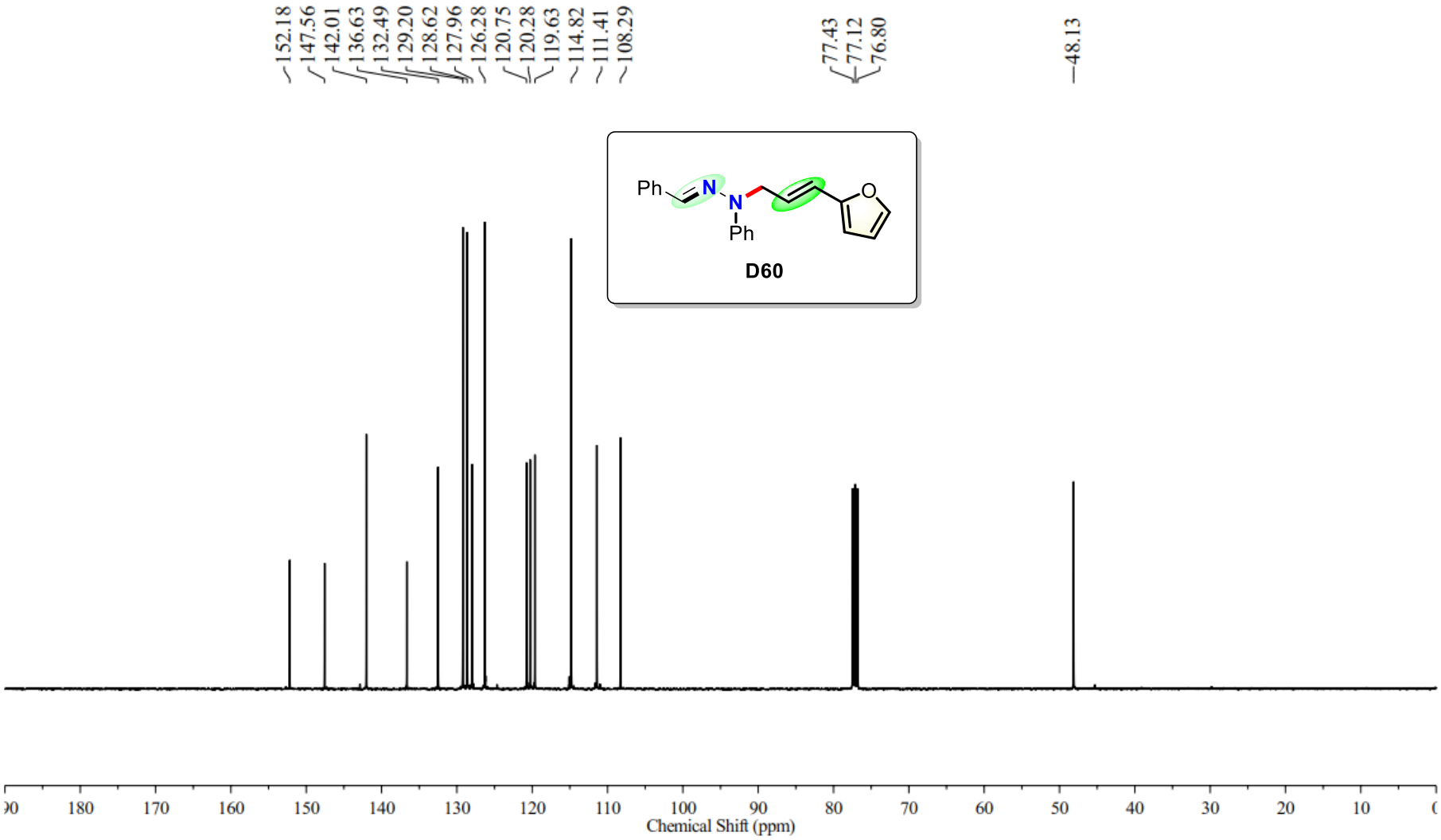

2022-06-20 yy0003-616-zql-3
7.5508
7.5309
7.3063
7.2824
7.2658
7.2452
7.2248
7.2077
7.2058
7.1884
7.1713
7.1447
7.1427
7.0242
7.0221
7.0066
7.0047
6.9891
6.7997
4.9007
2.2348
Ph
N
N
Ph
D59
2.13
8.05
1.10
2.01
2.07
9.04
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Chemical Shift (ppm)

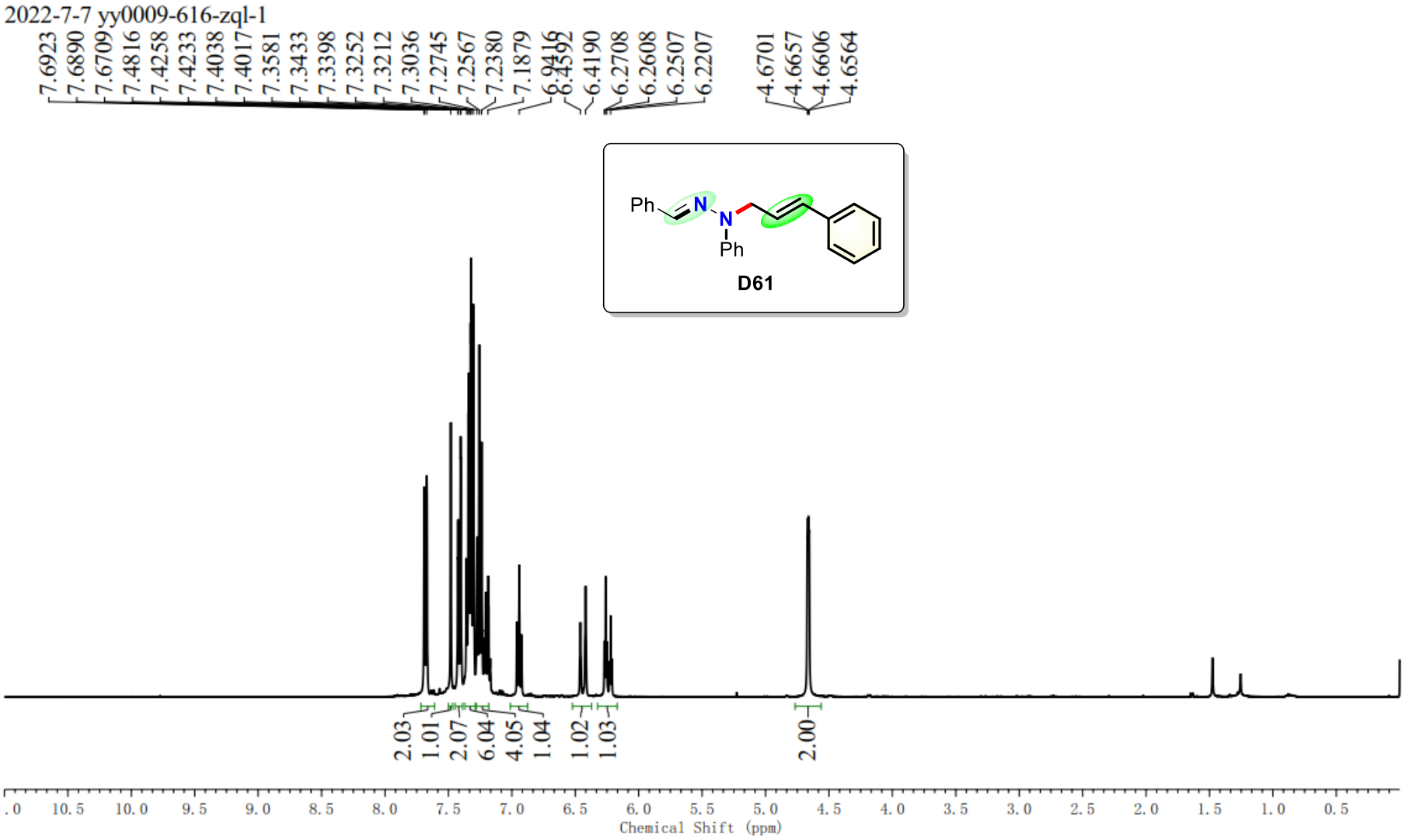
2022-06-21 yy0027 616-zql-3



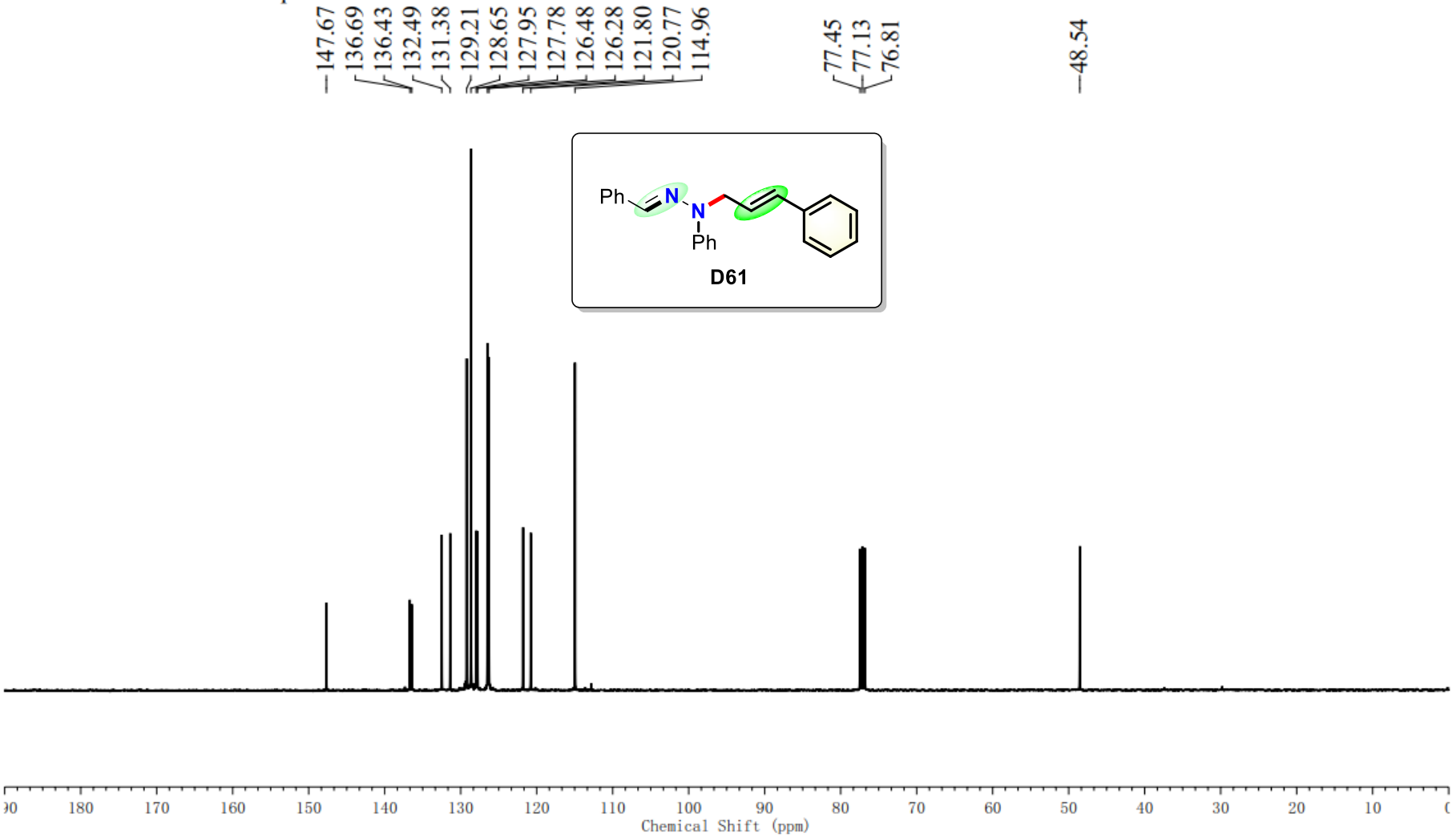

2022--07-18-yy0004-616-1-a-12.10.fid
7.6940
7.6901
7.6761
7.6727
7.6699
7.4423
7.4038
7.4005
7.3841
7.3814
7.3785
7.3605
7.3418
7.3368
7.3228
7.3186
7.3143
7.3016
7.2969
7.2595
7.2412
6.9541
6.3002
6.2965
6.2919
6.2067
6.1998
6.0973
6.0891
4.6404
4.6364
Ph
N
N
Ph
O
D60
2.02
1.10
7.17
1.08
1.06
1.00
2.00
1.04
2.07
Chemical Shift (ppm)

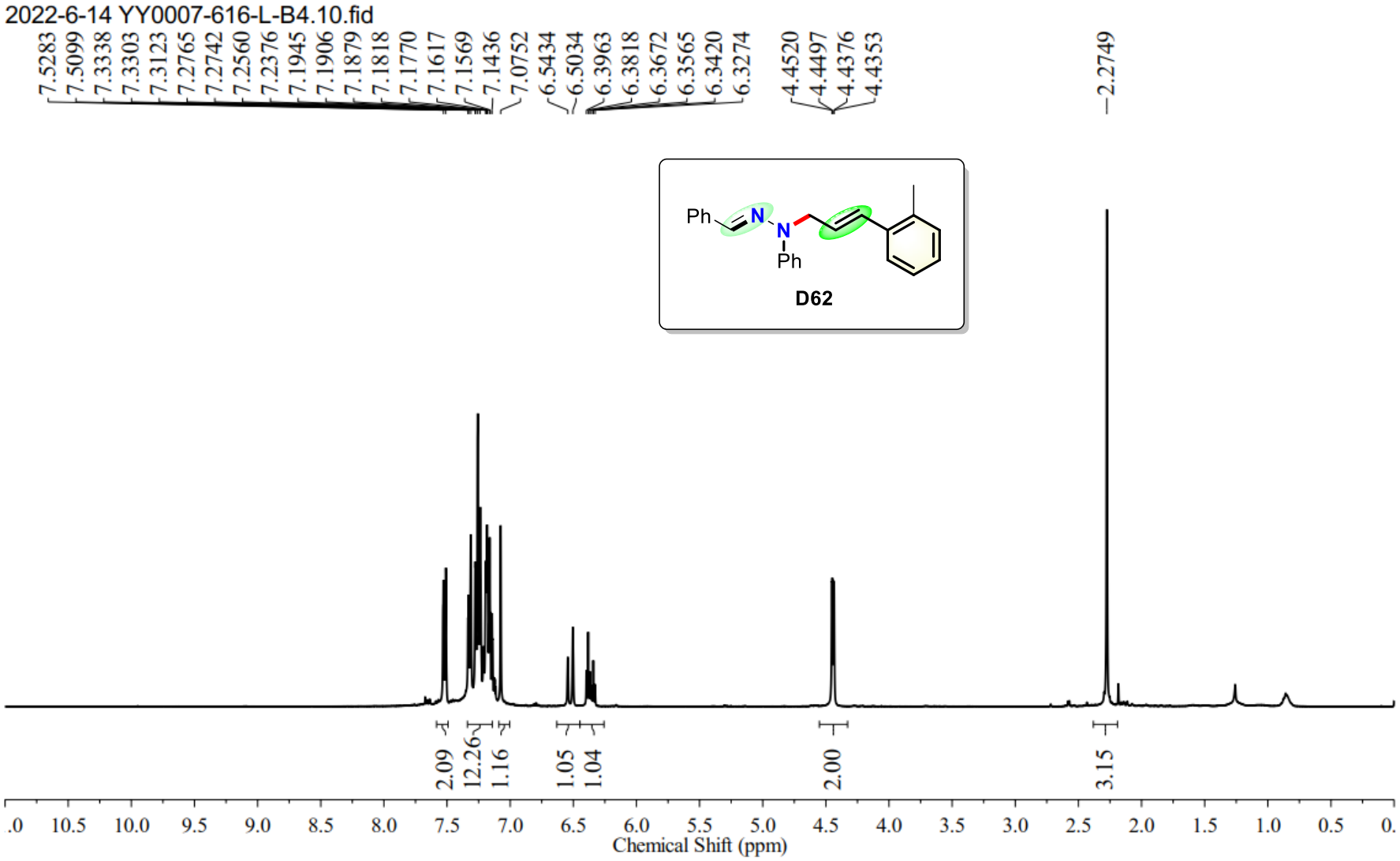
2022-07-19-YY0059-616-L-A12.10.fid

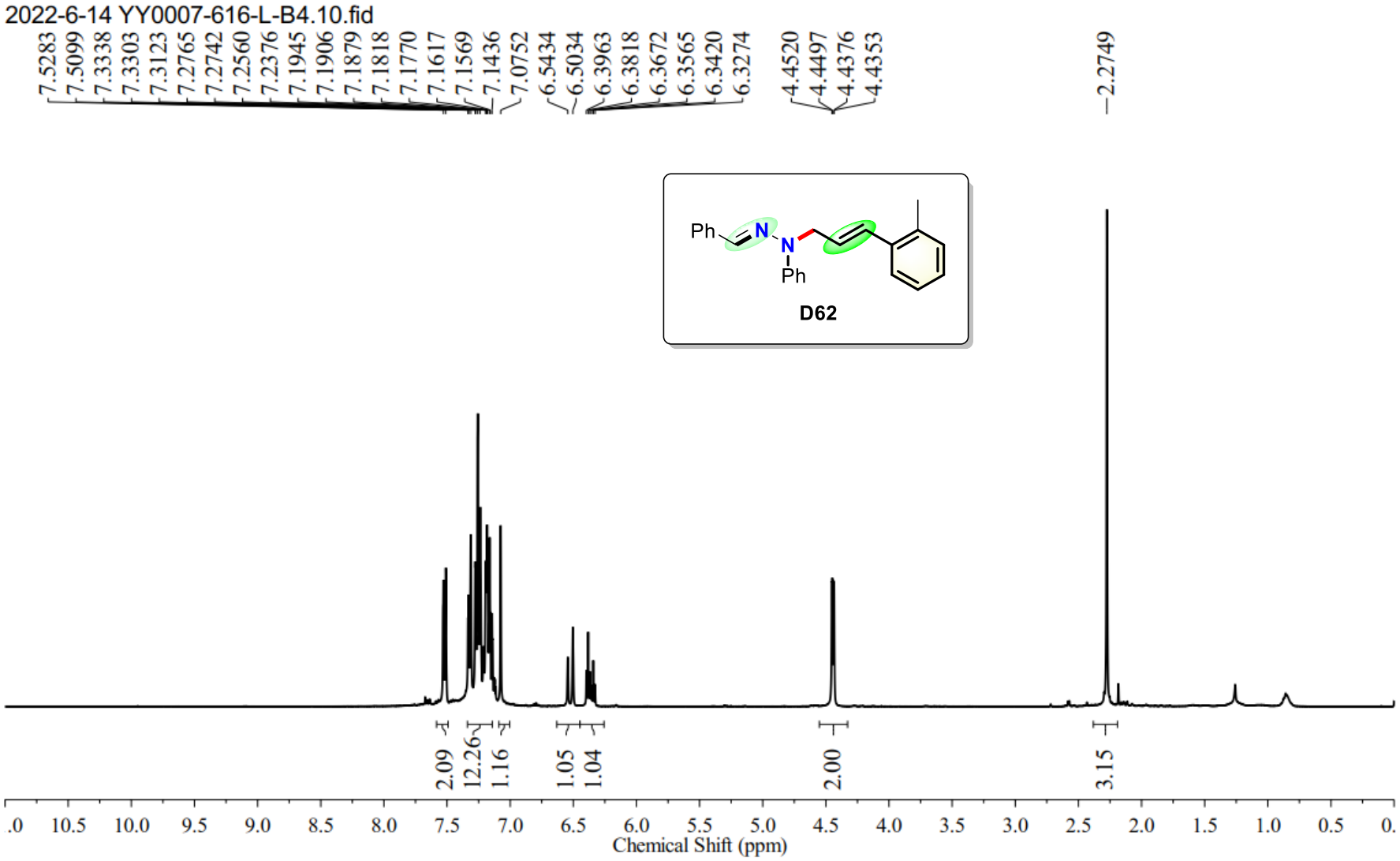


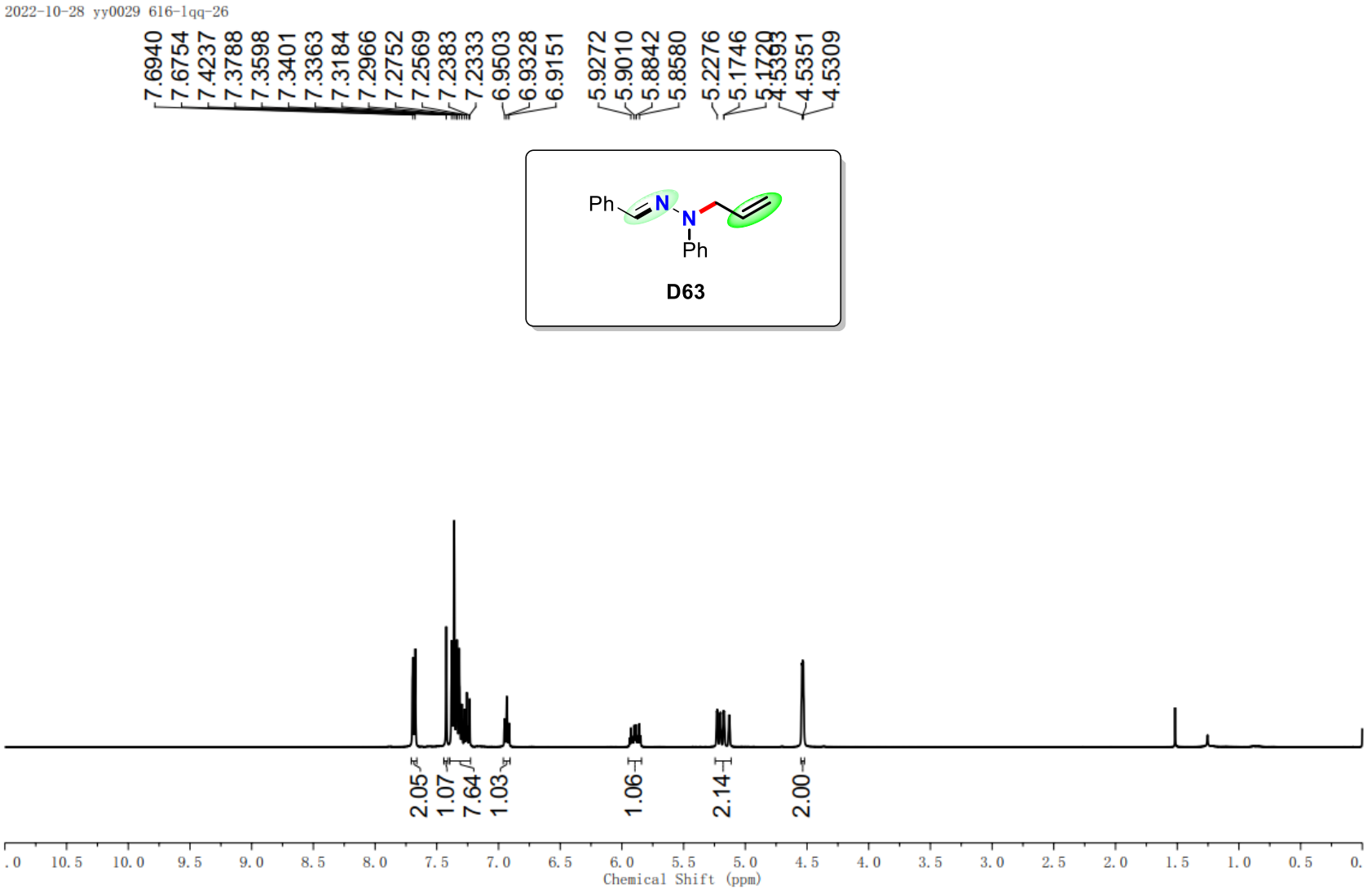

2022-7-7 yy0009-616-zql-1
7.6923
7.6890
7.6709
7.4816
7.4258
7.4233
7.4038
7.4017
7.3581
7.3433
7.3398
7.3252
7.3212
7.3036
7.2745
7.2567
7.2380
7.1879
6.9416
6.4592
6.4190
6.2708
6.2608
6.2507
6.2207
4.6701
4.6657
4.6606
4.6564
Ph
N
N
Ph
D61
2.03
1.01
2.07
6.04
4.05
1.04
1.02
1.03
2.00
Chemical Shift (ppm)

2022-07-12 YY0006 616-zql-01

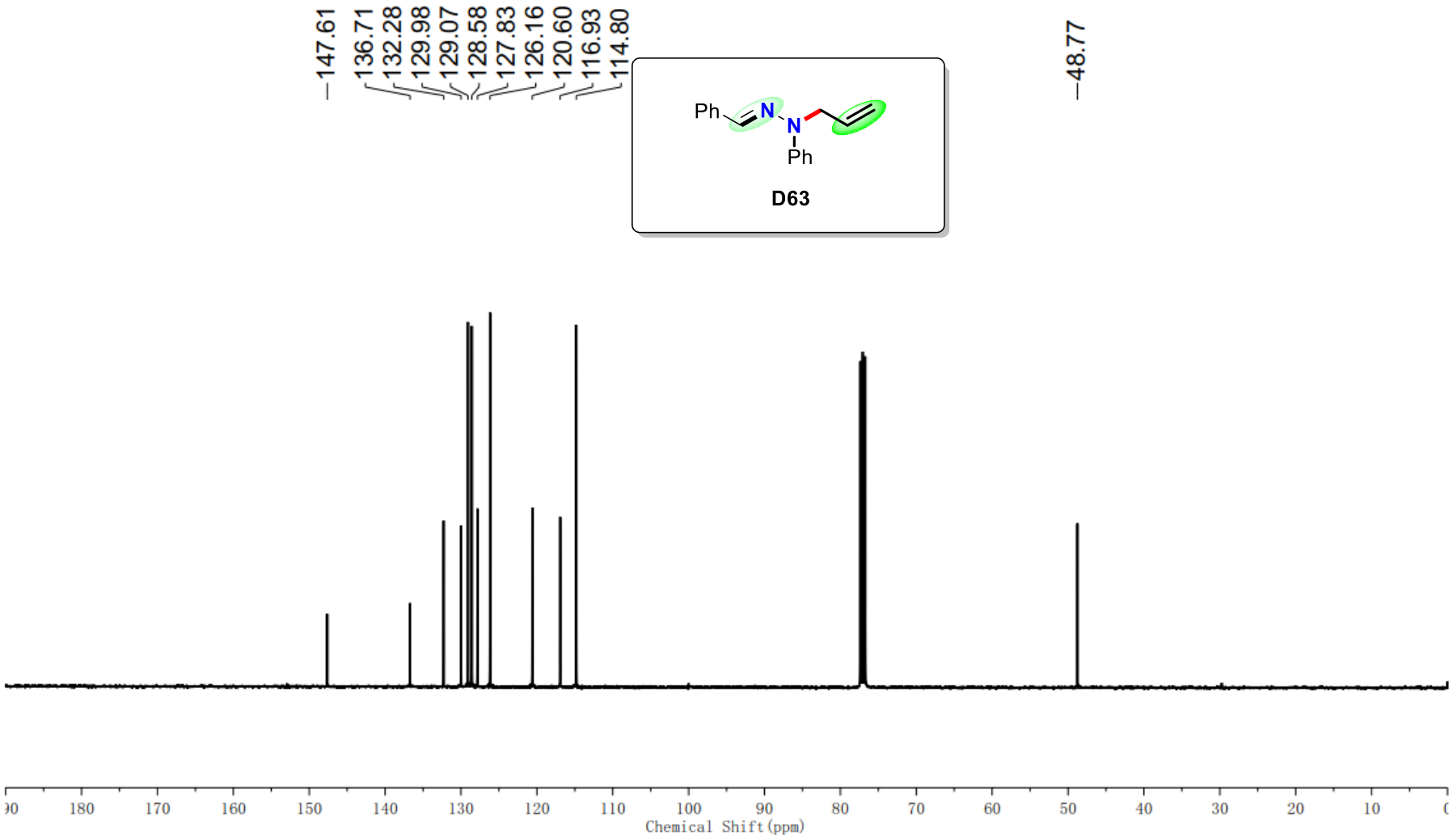


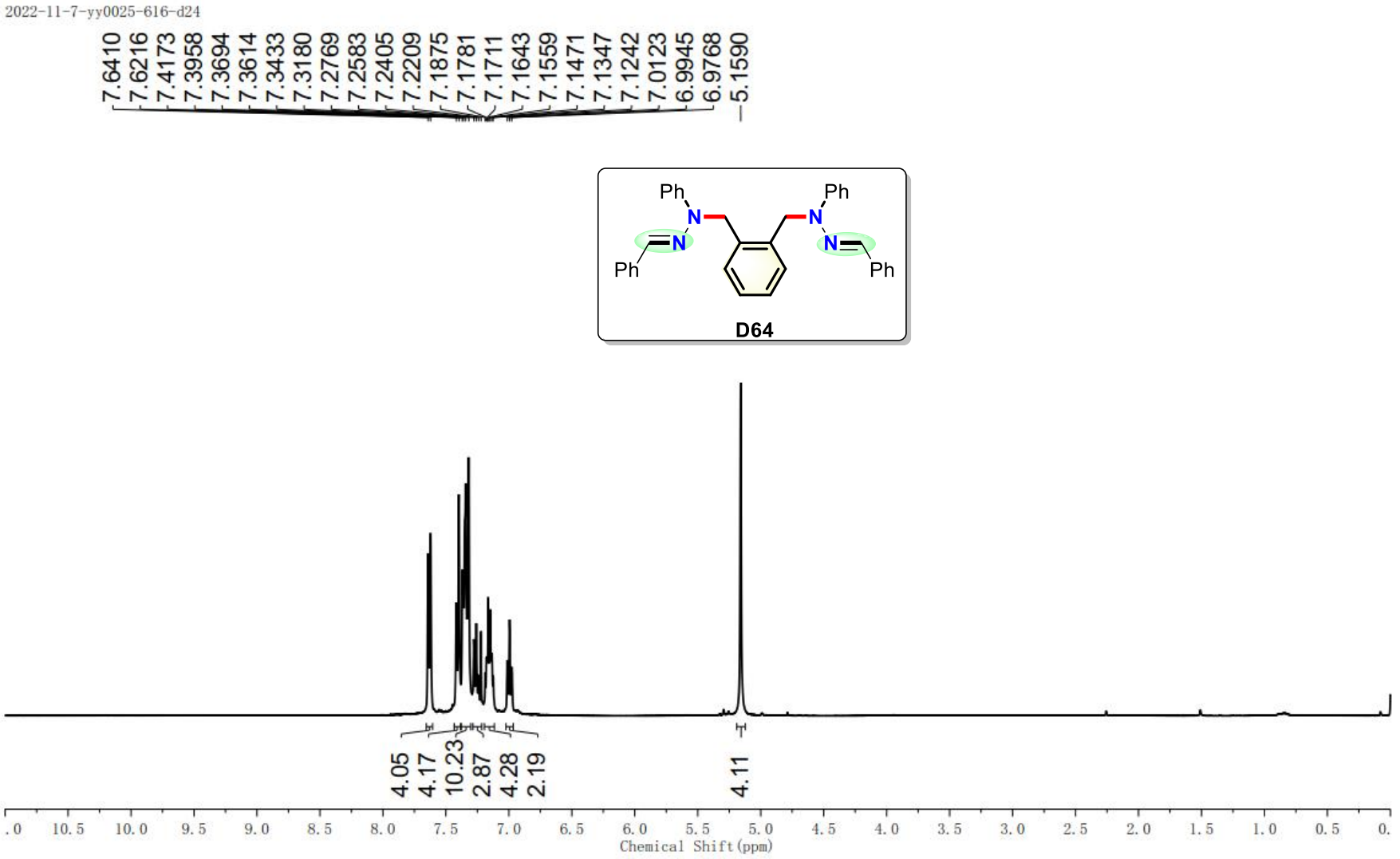

2022-6-14 YY0007-616-L-B4.10.fid
7.5283
7.5099
7.3338
7.3303
7.3123
7.2765
7.2742
7.2560
7.2376
7.1945
7.1906
7.1879
7.1818
7.1770
7.1617
7.1569
7.1436
7.0752
6.5434
6.5034
6.3963
6.3818
6.3672
6.3565
6.3420
6.3274
4.4520
4.4497
4.4376
4.4353
2.2749
Ph
N
N
Ph
D62
2.09
12.26
1.16
1.05
1.04
2.00
3.15
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.
Chemical Shift (ppm)

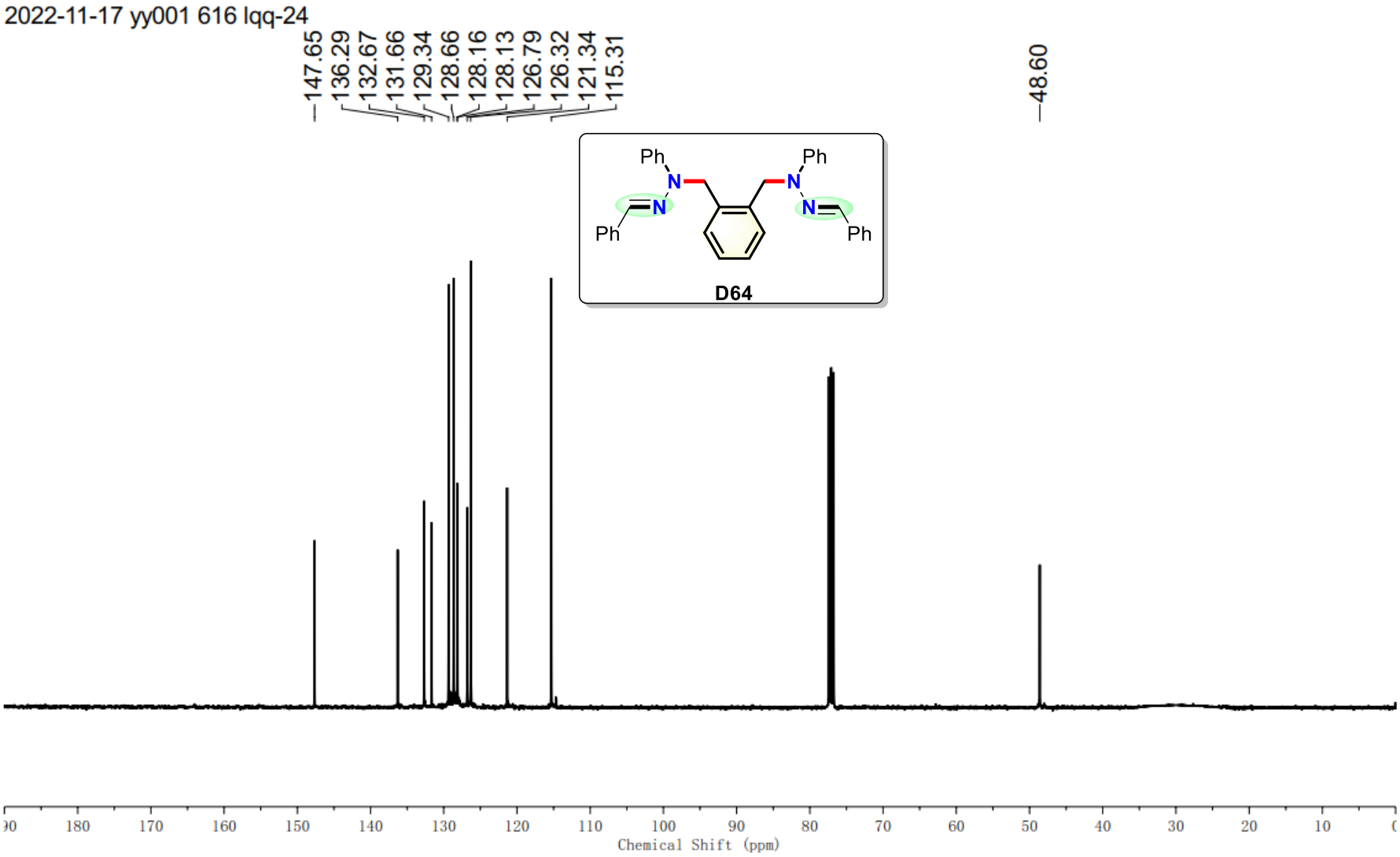

2022-6-14 YY0007-616-L-B4.10.fid
7.5283
7.5099
7.3338
7.3303
7.3123
7.2765
7.2742
7.2560
7.2376
7.1945
7.1906
7.1879
7.1818
7.1770
7.1617
7.1569
7.1436
7.0752
6.5434
6.5034
6.3963
6.3818
6.3672
6.3565
6.3420
6.3274
4.4520
4.4497
4.4376
4.4353
2.2749
Ph
N
N
Ph
D62
2.09
12.26
1.16
1.05
1.04
2.00
3.15
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.
Chemical Shift (ppm)

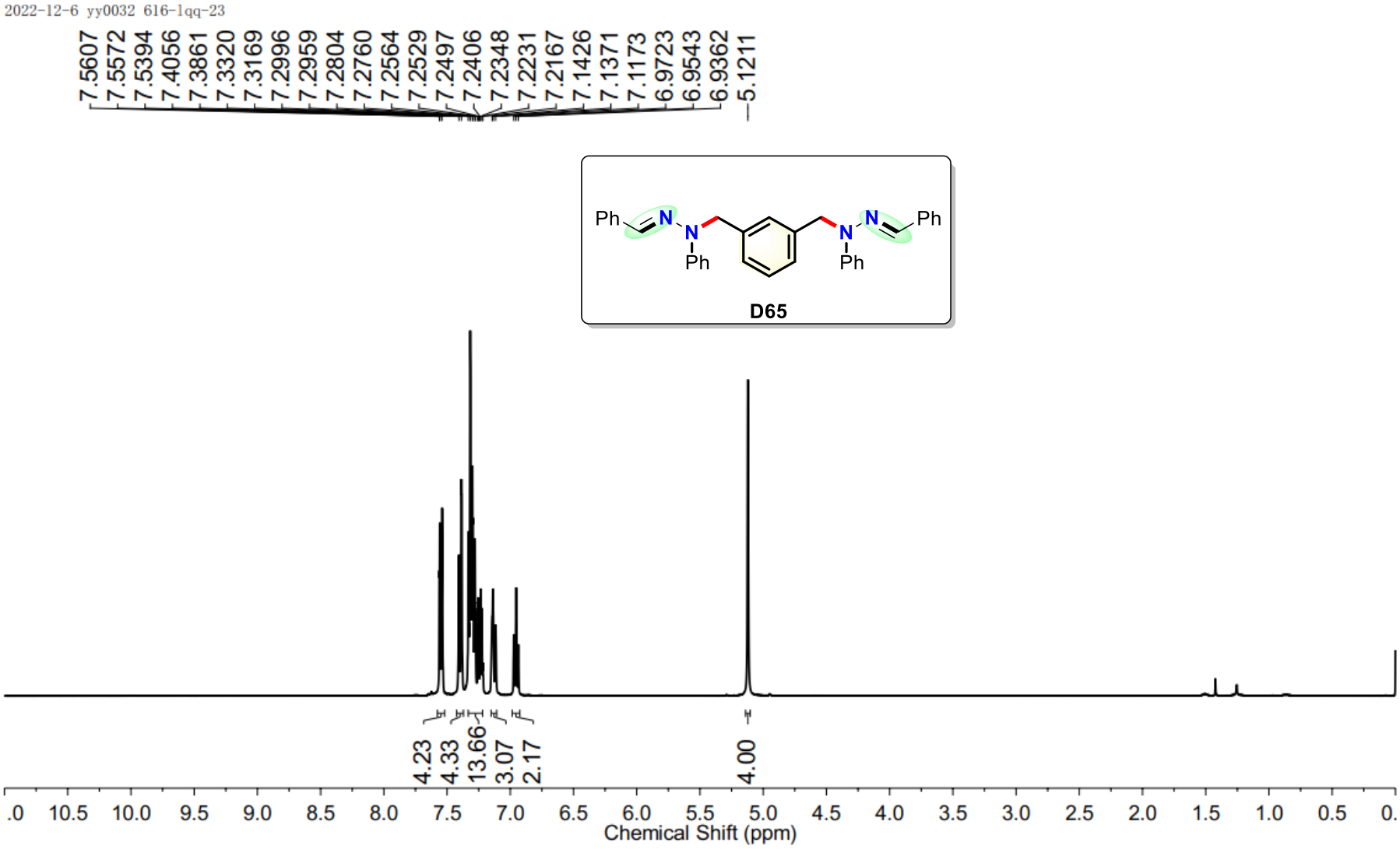

2022-10-28 yy0029 616-1qq-26
7.6940
7.6754
7.4237
7.3788
7.3598
7.3401
7.3363
7.3184
7.2966
7.2752
7.2569
7.2383
7.2333
6.9503
6.9328
6.9151
5.9272
5.9010
5.8842
5.8580
5.2276
5.1746
4.5393
4.5351
4.5309
Ph
N
N
Ph
D63
2.05
1.07
7.64
1.03
1.06
2.14
2.00
Chemical Shift (ppm)

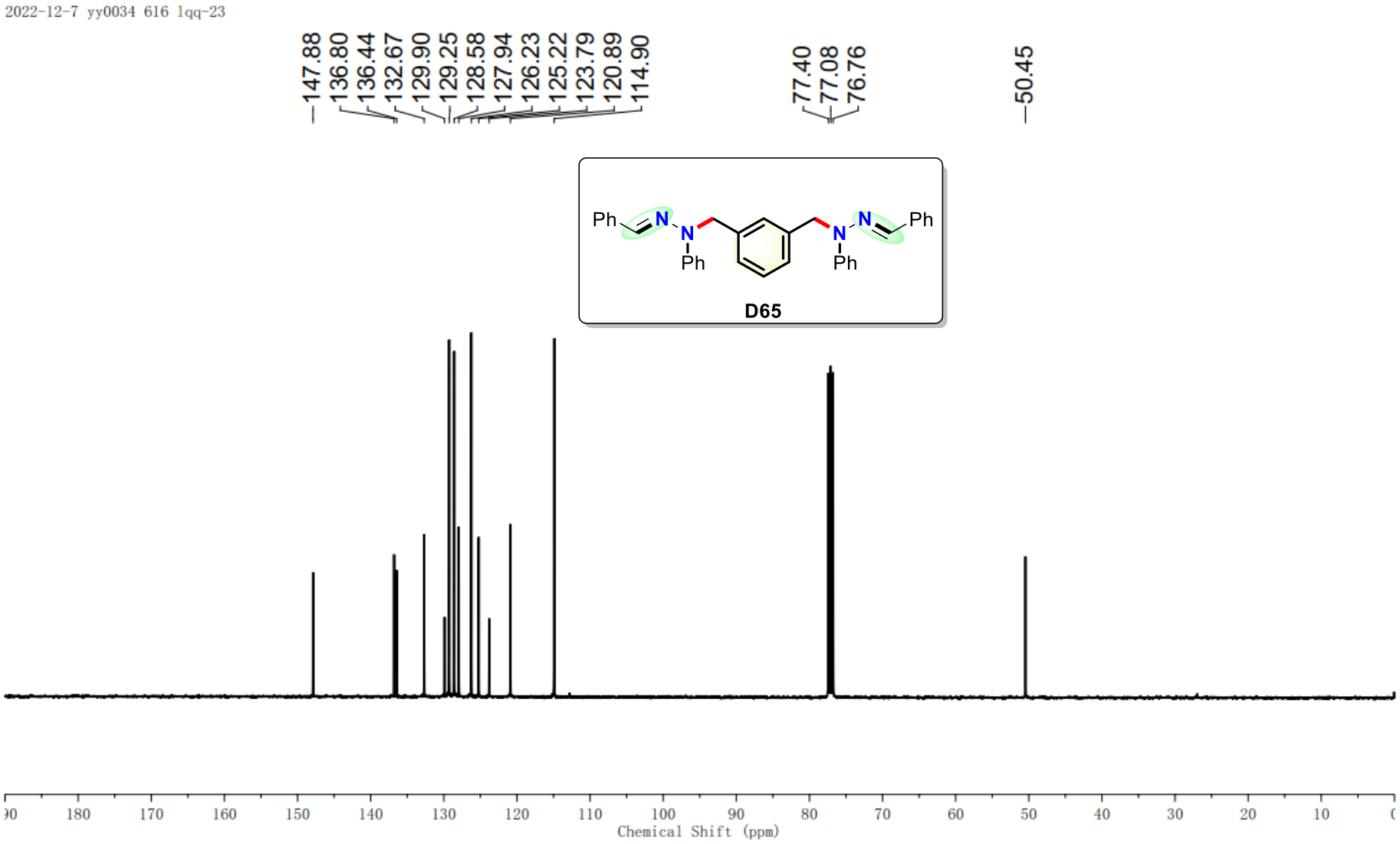
2022-11-08-yy0037-616-d26

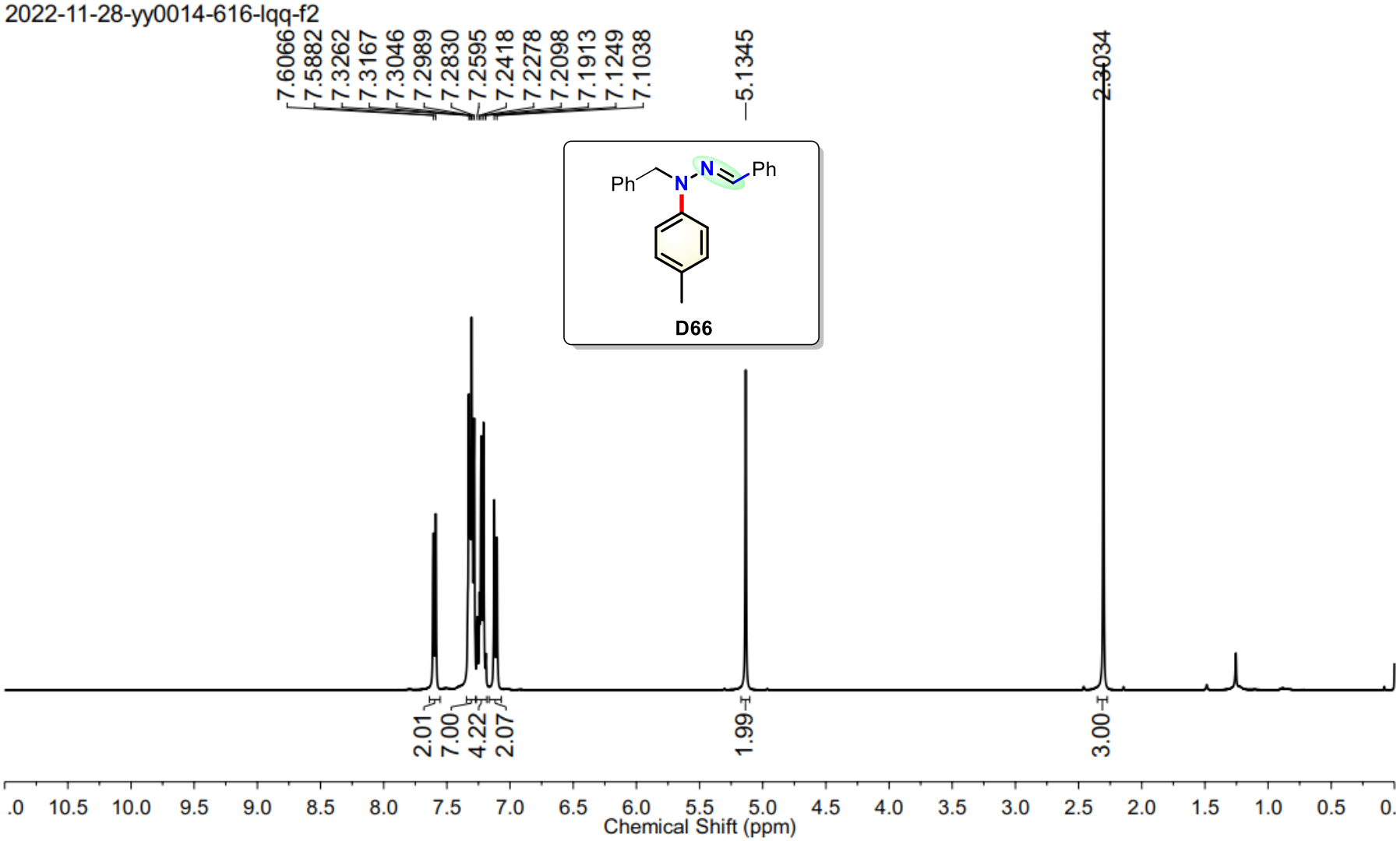


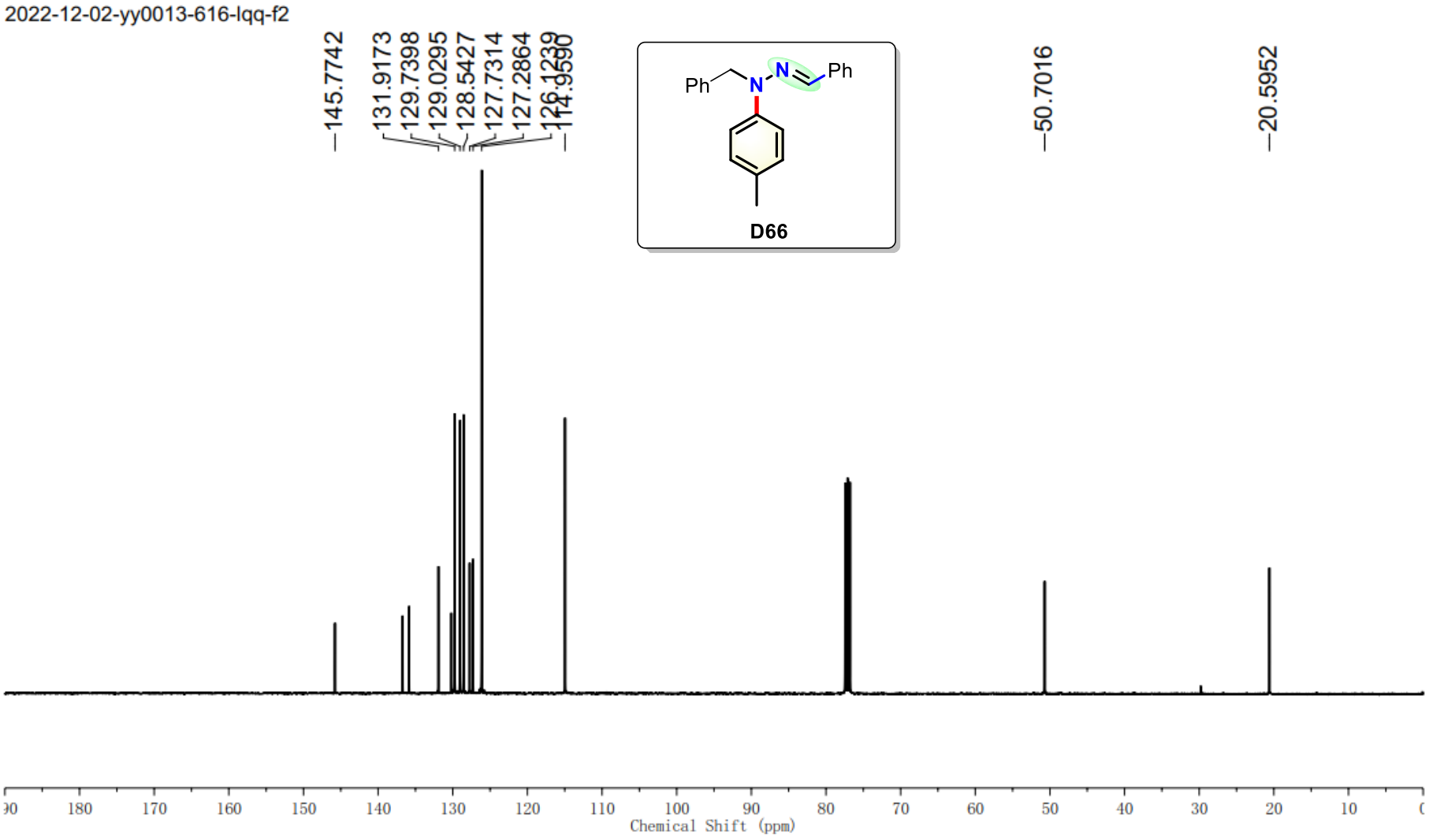

2022-11-7-yy0025-616-d24
7.6410
7.6216
7.4173
7.3958
7.3694
7.3614
7.3433
7.3180
7.2769
7.2583
7.2405
7.2209
7.1875
7.1781
7.1711
7.1643
7.1559
7.1471
7.1347
7.1242
7.0123
6.9945
6.9768
5.1590
Ph
N
N
Ph
N
N
Ph
Ph
D64
4.05
4.17
10.23
2.87
4.28
2.19
4.11
Chemical Shift(ppm)

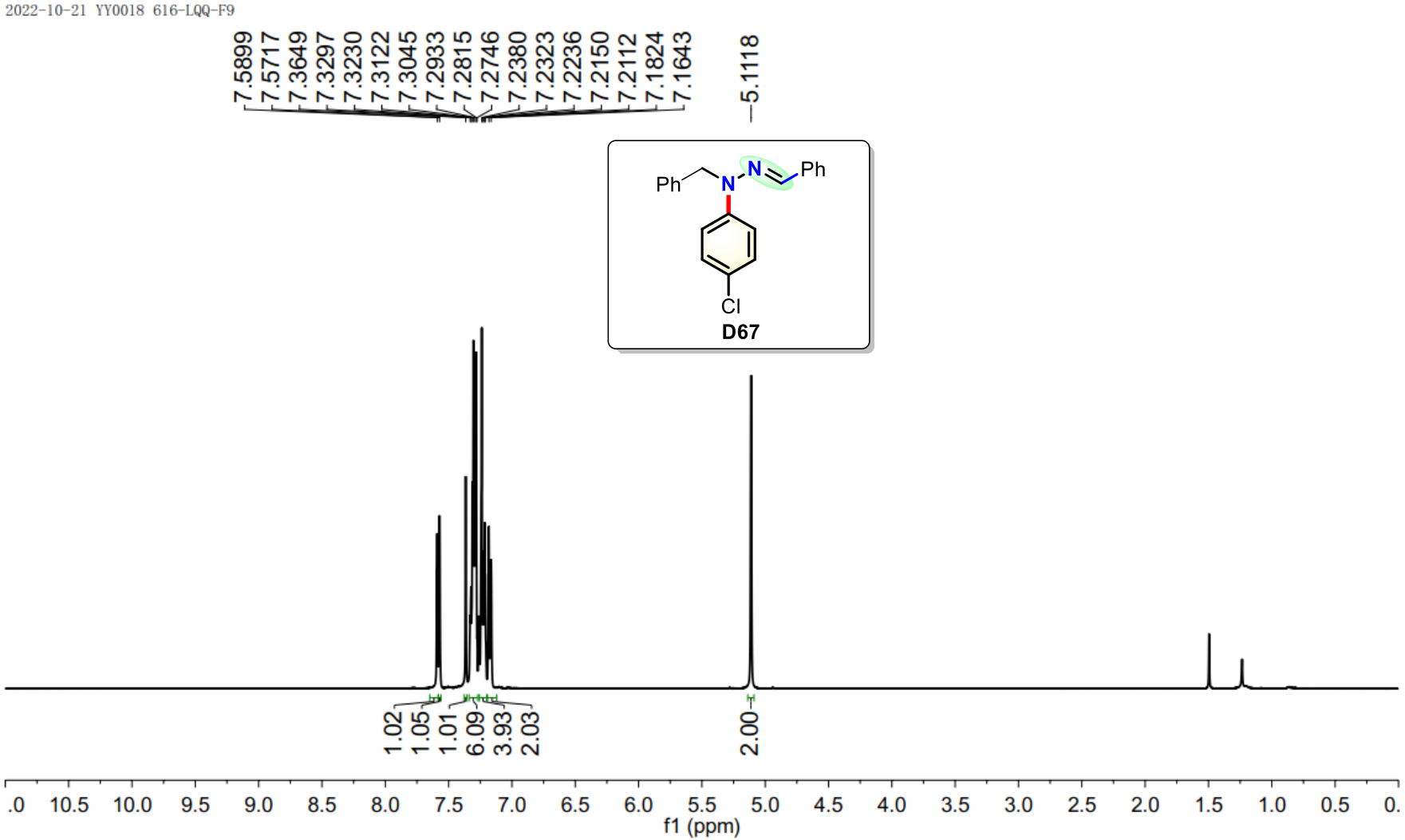

2022-11-17 yy001 616 lqq-24
147.65
136.29
132.67
131.66
129.34
128.66
128.16
128.13
126.79
126.32
121.34
115.31
48.60
Ph
N
N
Ph
N
N
Ph
Ph
D64
90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

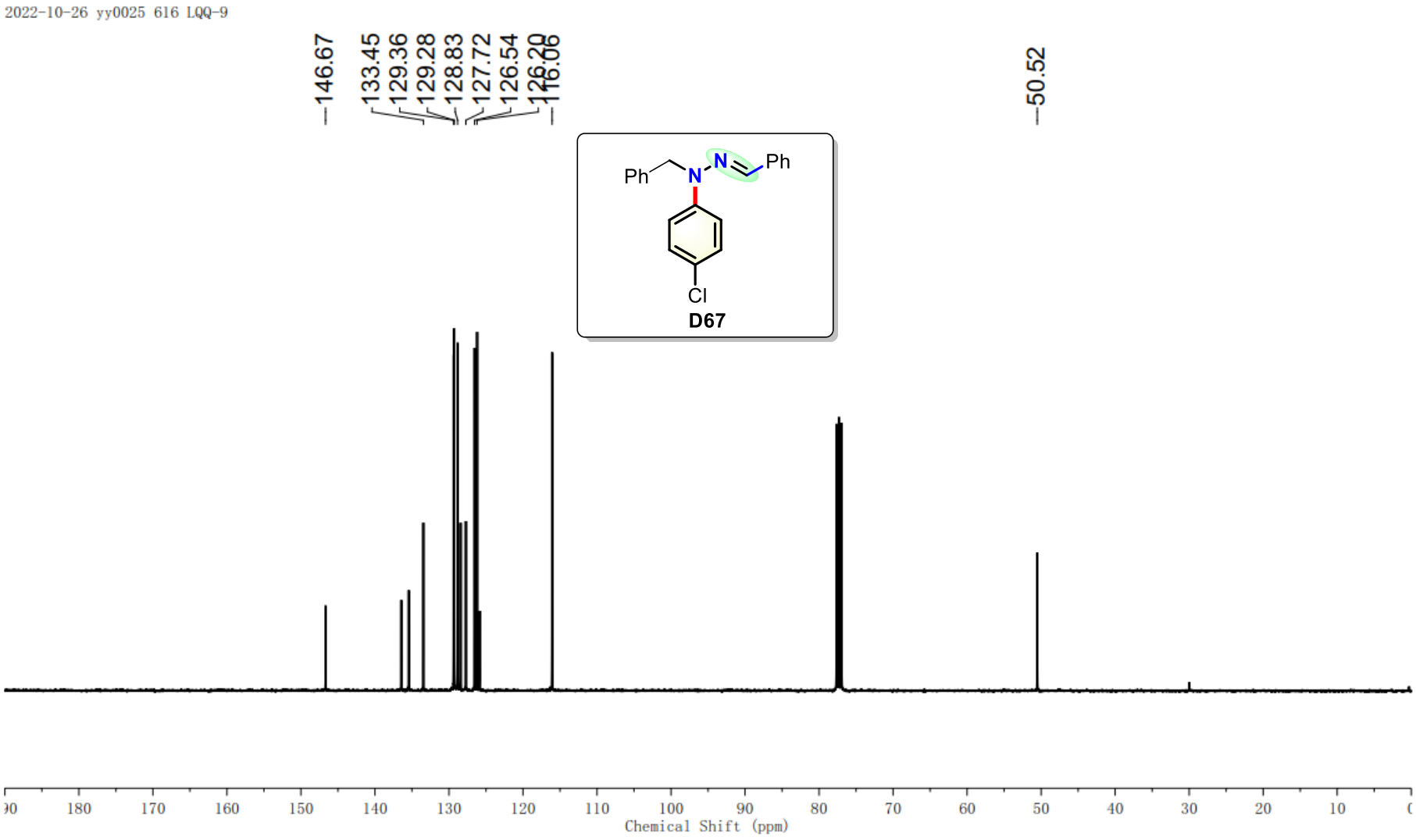

2022-12-6 yy0032 616-1qq-23
7.5607
7.5572
7.5394
7.4056
7.3861
7.3320
7.3169
7.2996
7.2959
7.2804
7.2760
7.2564
7.2529
7.2497
7.2406
7.2348
7.2231
7.2167
7.1426
7.1371
7.1173
6.9723
6.9543
6.9362
5.1211
Ph
N
N
Ph
N
N
Ph
Ph
D65
4.23
4.33
13.66
3.07
2.17
4.00
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.
Chemical Shift (ppm)

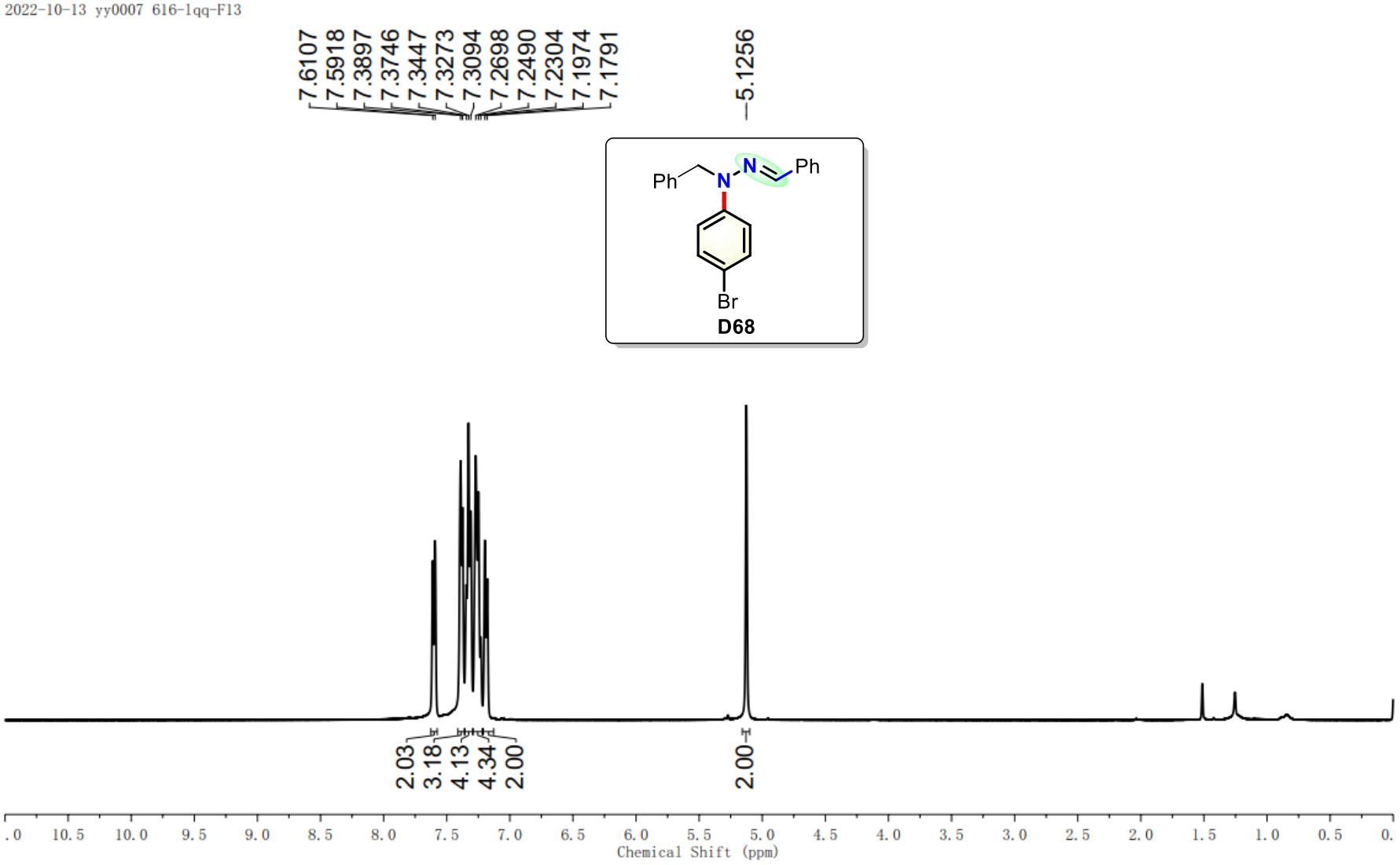

2022-12-7 yy0034 616 lqq-23
147.88
136.80
136.44
132.67
129.90
129.25
128.58
127.94
126.23
125.22
123.79
120.89
114.90
77.40
77.08
76.76
50.45
Ph
N
N
Ph
N
N
Ph
Ph
D65
Chemical Shift (ppm)


2022-11-28-yy0014-616-lqq-f2
7.6066
7.5882
7.3262
7.3167
7.3046
7.2989
7.2830
7.2595
7.2418
7.2278
7.2098
7.1913
7.1249
7.1038
5.1345
2.3034
Ph
N
N
Ph
D66
2.01
7.00
4.22
2.07
1.99
3.00
Chemical Shift (ppm)

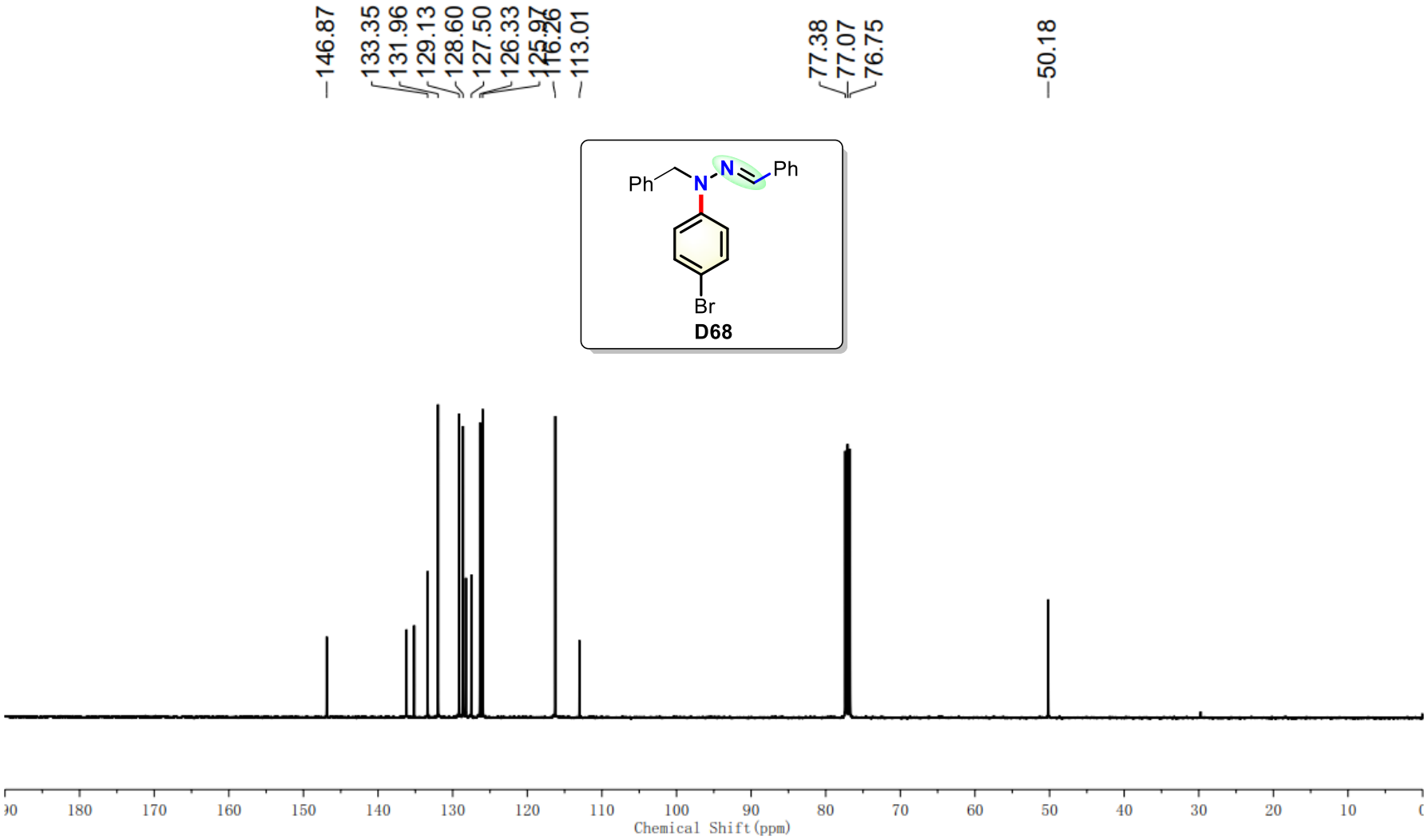

2022-12-02-yy0013-616-lqq-f2
145.7742
131.9173
129.7398
129.0295
128.5427
127.7314
127.2864
126.1239
114.9590
50.7016
20.5952
Ph
N
N
Ph
D66
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

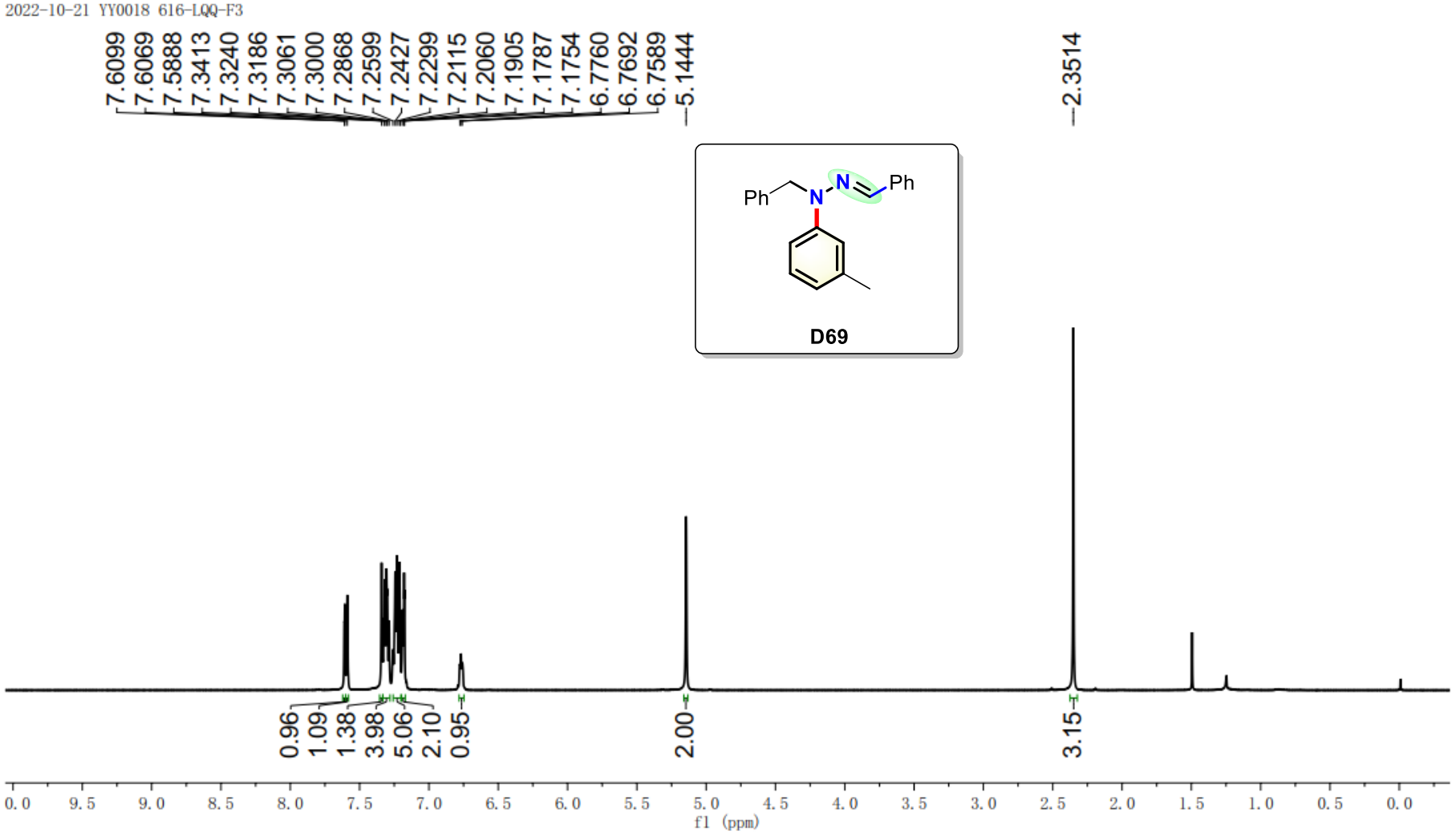

2022-10-21 YY0018 616-LQQ-F9
7.5899
7.5717
7.3649
7.3297
7.3230
7.3122
7.3045
7.2933
7.2815
7.2746
7.2380
7.2323
7.2236
7.2150
7.2112
7.1824
7.1643
5.1118
Ph
N
N
Ph
Cl
D67
1.02
1.05
1.01
6.09
3.93
2.03
2.00
f1 (ppm)

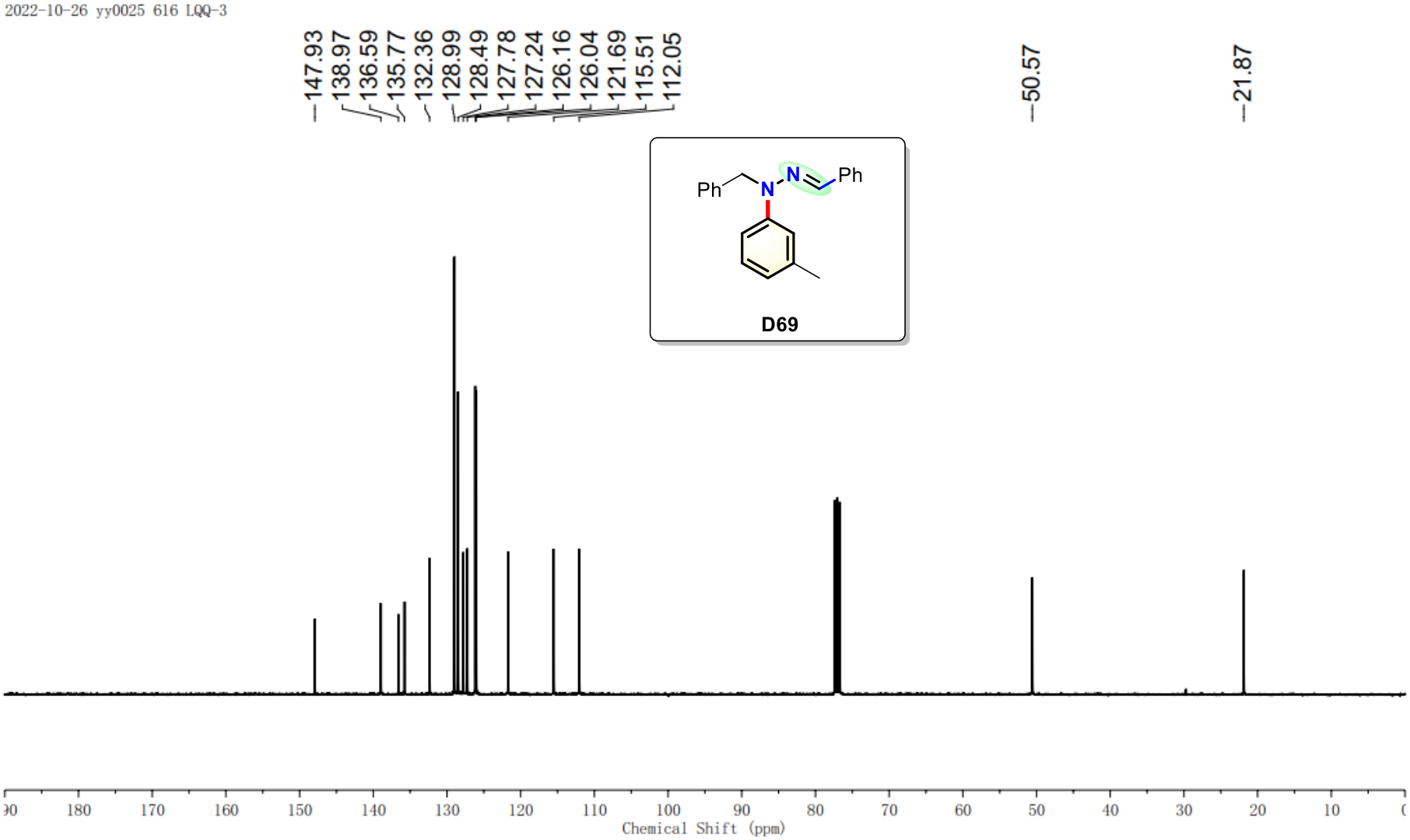

2022-10-26 yy0025 616 LQQ-9
146.67
133.45
129.36
129.28
128.83
127.72
126.54
126.20
126.06
50.52
Ph
N
N
Ph
Cl
D67
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)


2022-10-13 yy0007 616-1qq-F13
7.6107
7.5918
7.3897
7.3746
7.3447
7.3273
7.3094
7.2698
7.2490
7.2304
7.1974
7.1791
5.1256
Ph
N
N
Ph
Br
D68
2.03
3.18
4.13
4.34
2.00
2.00
Chemical Shift (ppm)

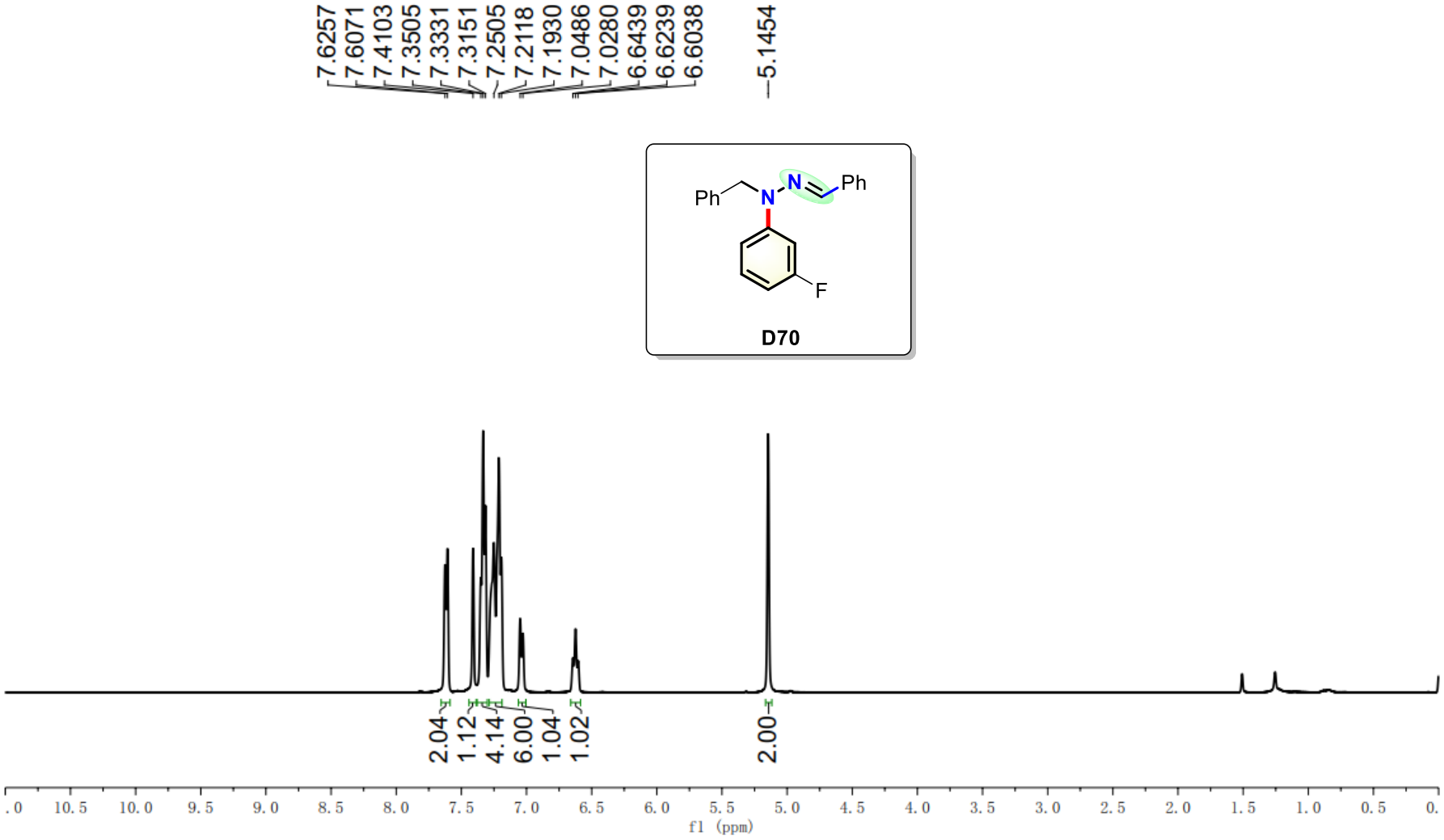
2022-11-7-yy0026-616-f13

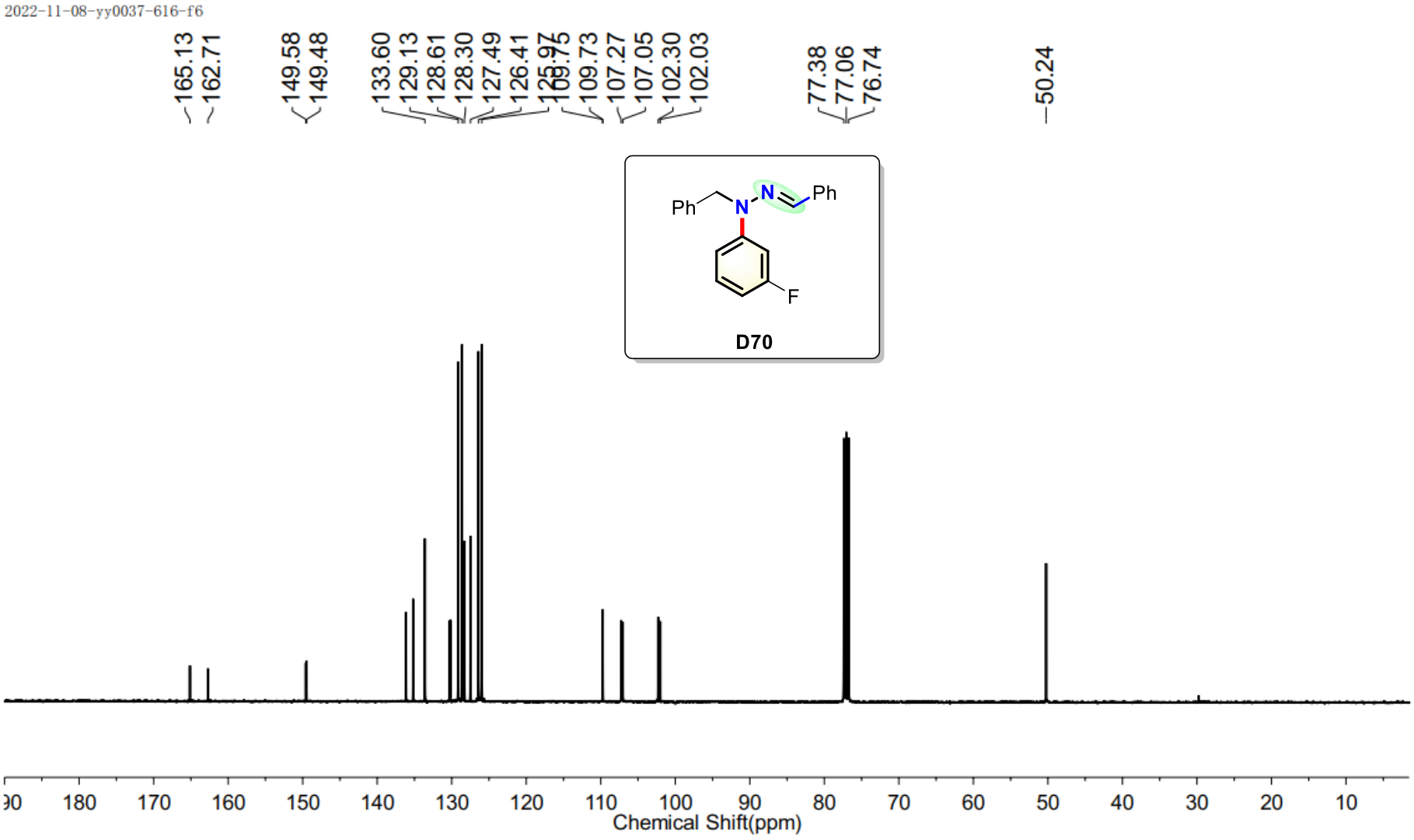



2022-10-21 YY0018 616-LQQ-F3
7.6099
7.6069
7.5888
7.3413
7.3240
7.3186
7.3061
7.3000
7.2868
7.2599
7.2427
7.2299
7.2115
7.2060
7.1905
7.1787
7.1754
7.1760
6.7692
6.7589
5.1444
2.3514
Ph
N
N
Ph
D69
0.96
1.09
1.38
3.98
5.06
2.10
0.95
2.00
3.15
0.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

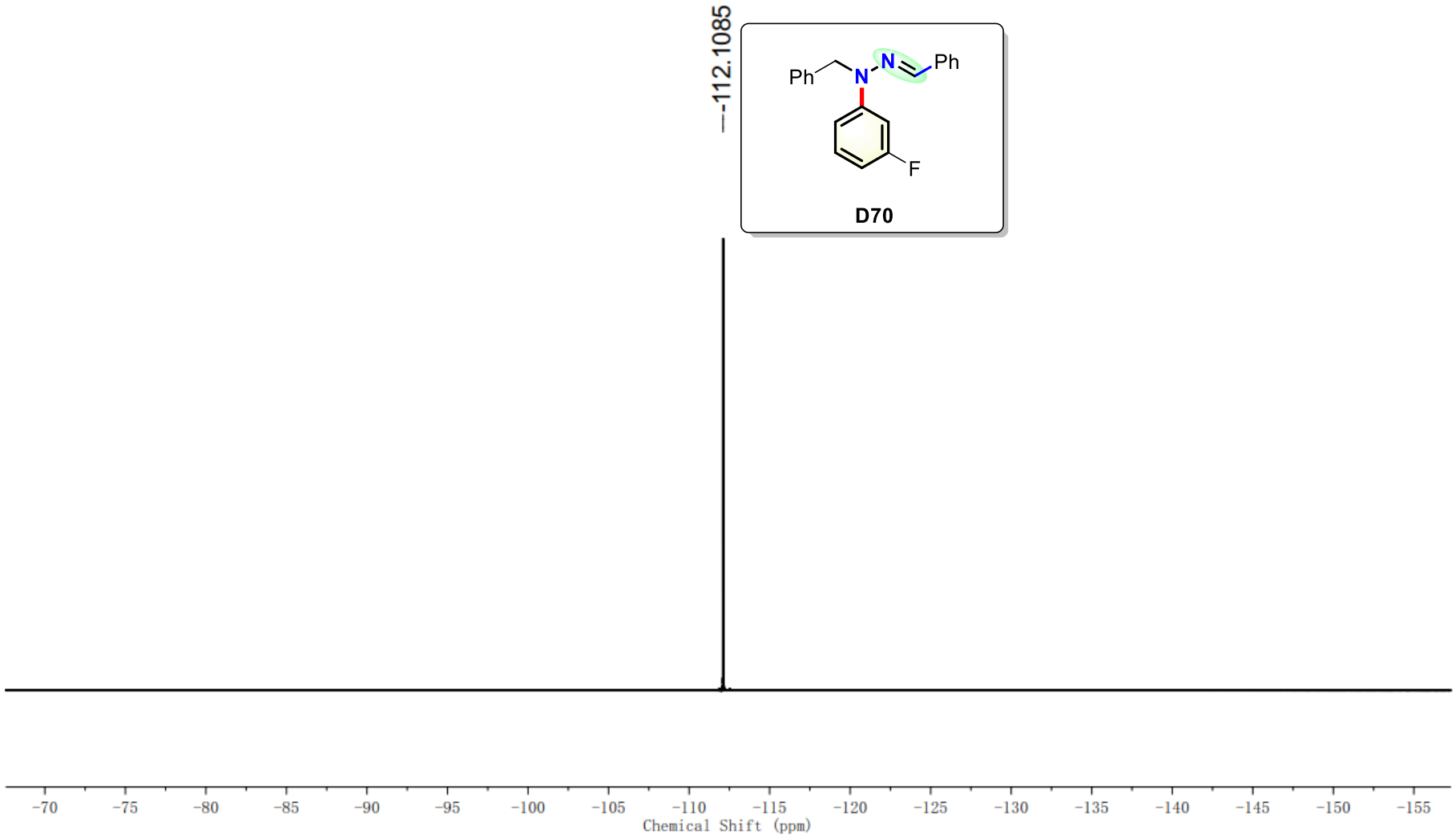

2022-10-26 yy0025 616 LQQ-3
147.93
138.97
136.59
135.77
132.36
128.99
128.49
127.78
127.24
126.16
126.04
121.69
115.51
112.05
50.57
21.87
Ph
N
N
Ph
D69
Chemical Shift (ppm)

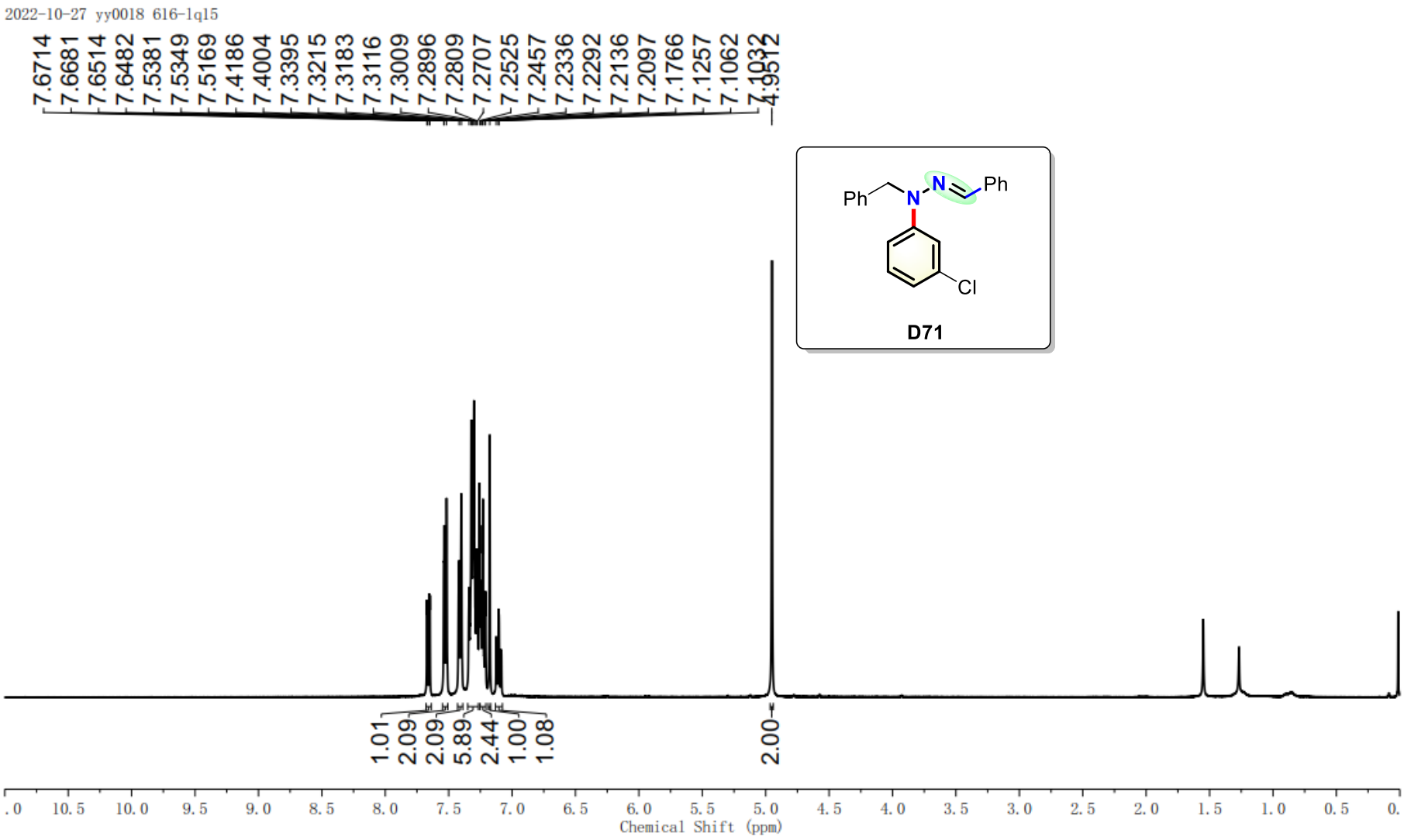
2022-10-17-YY0007-616-ZGH-f6

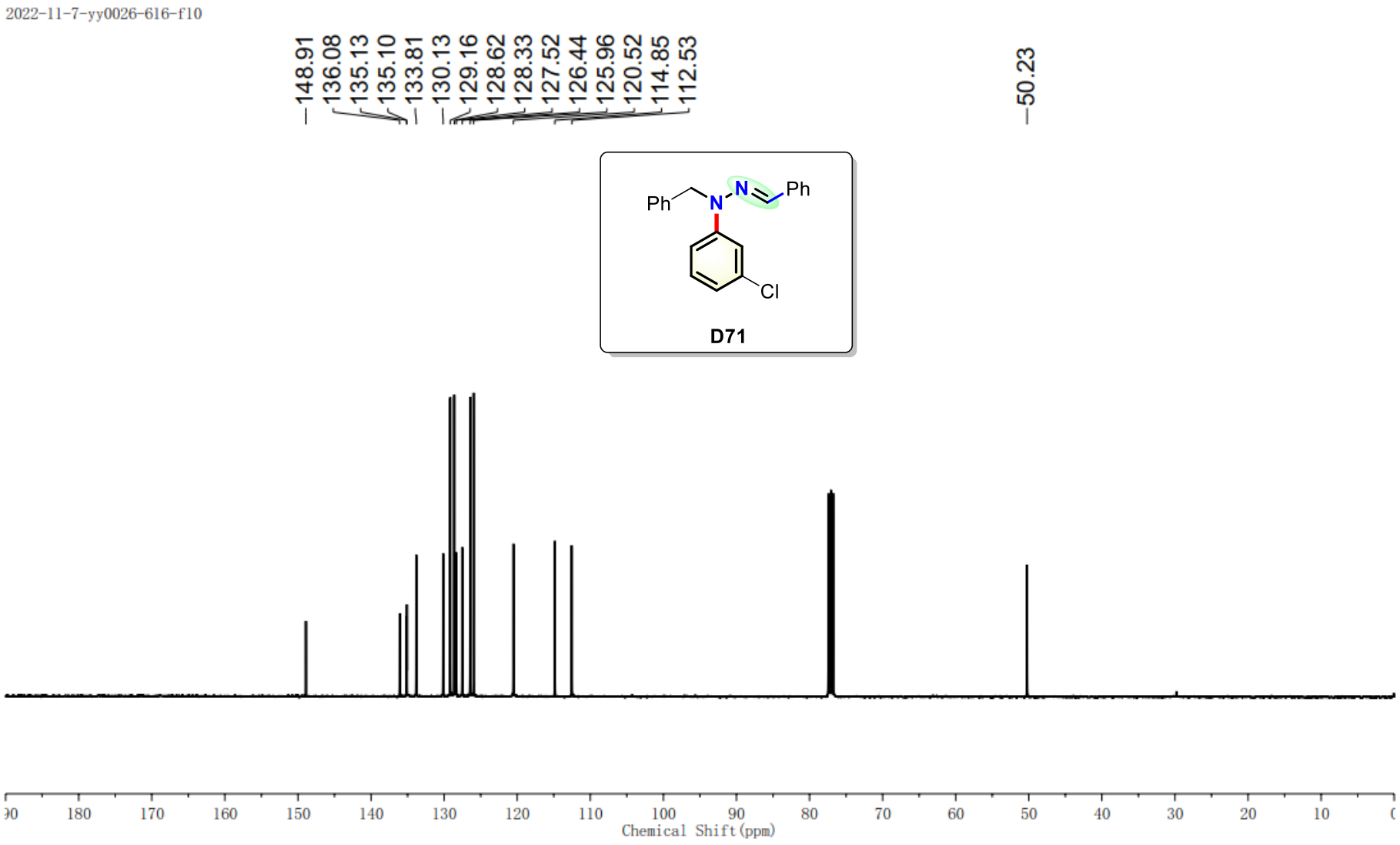


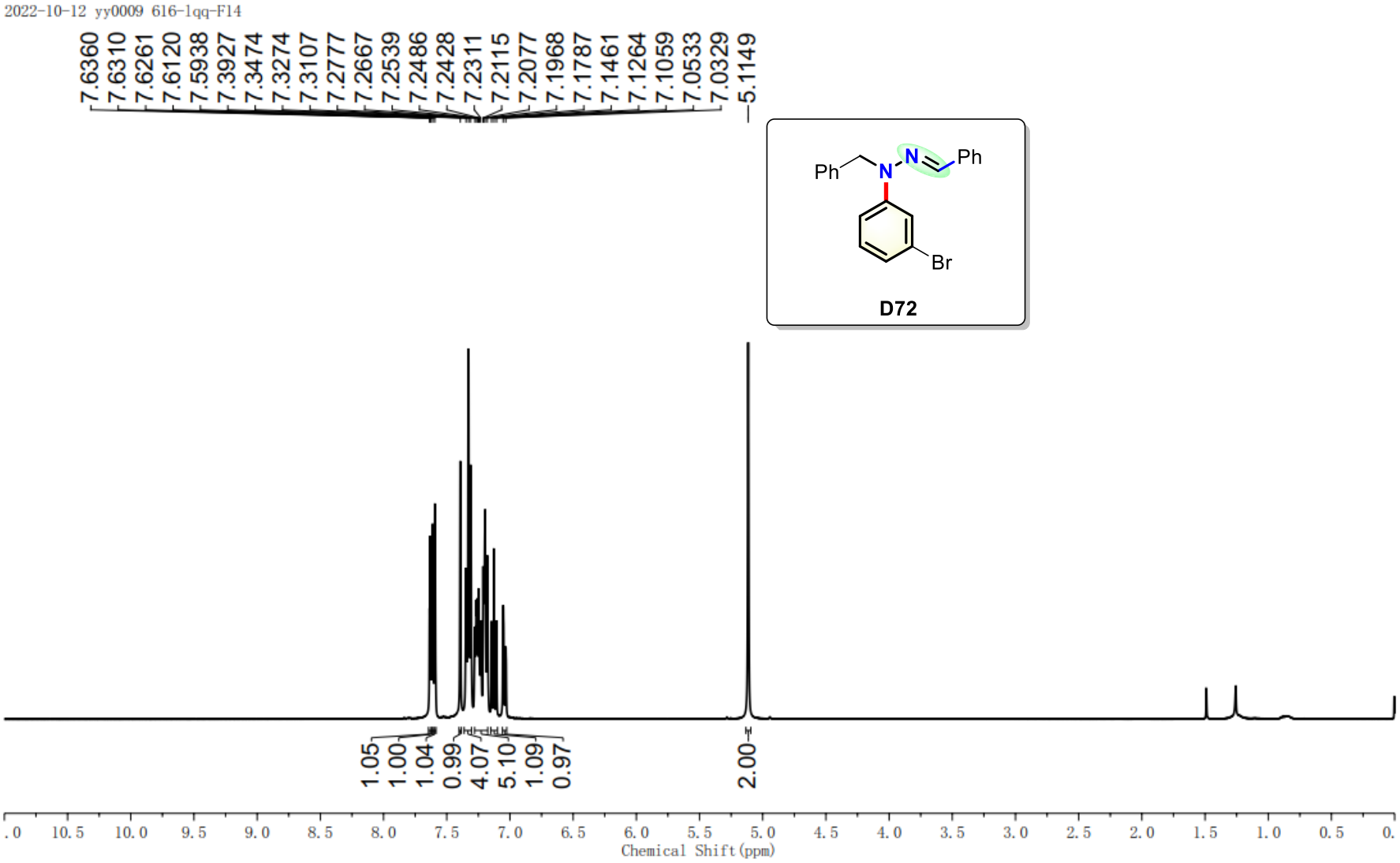

2022-11-08-yy0037-616-f6
165.13
162.71
149.58
149.48
133.60
129.13
128.61
128.30
127.49
126.41
109.73
107.27
107.05
102.30
102.03
77.38
77.06
76.74
50.24
Ph
N
N
Ph
F
D70
Chemical Shift(ppm)

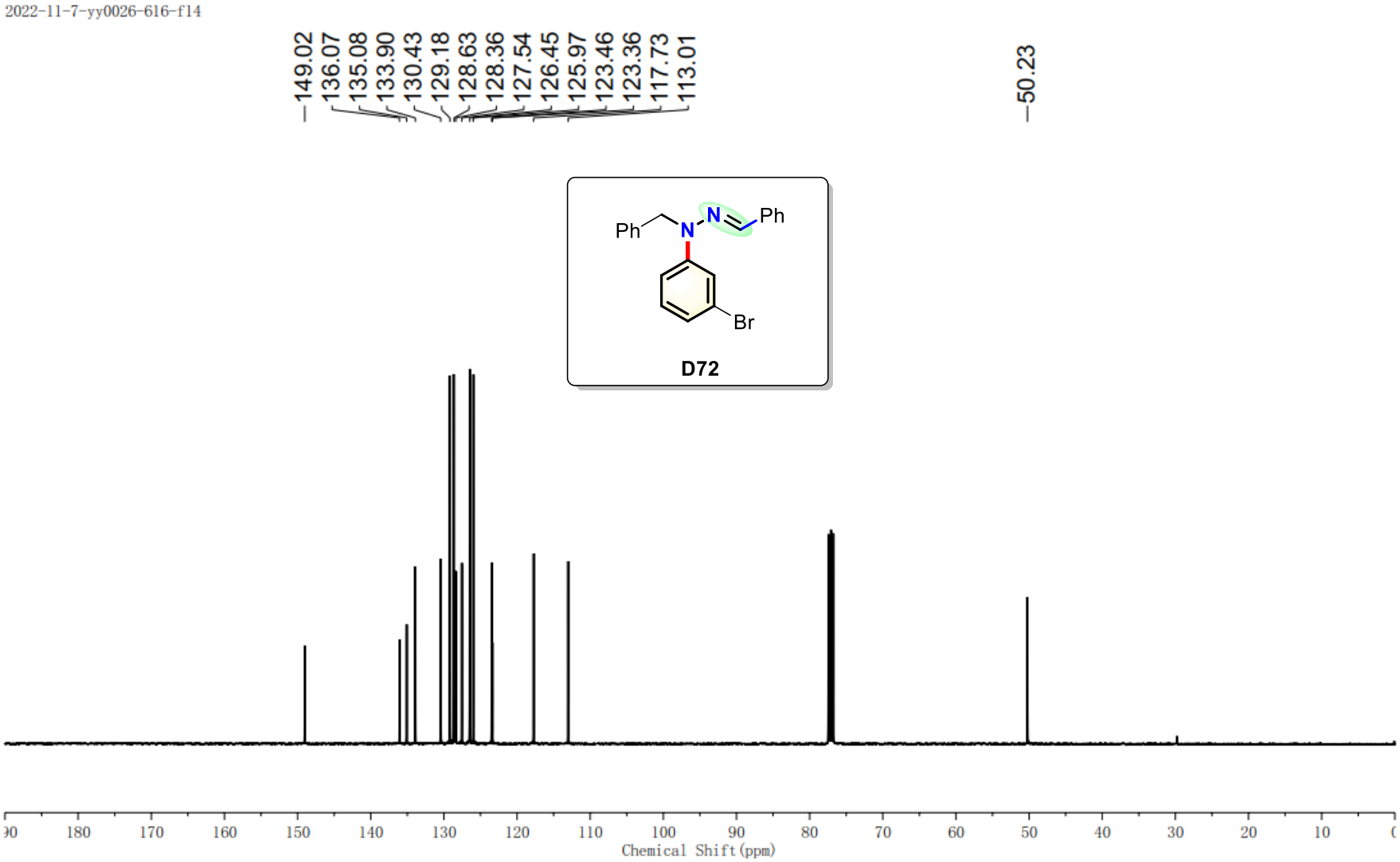
2022-12-7 yy0035 616-1qq-6

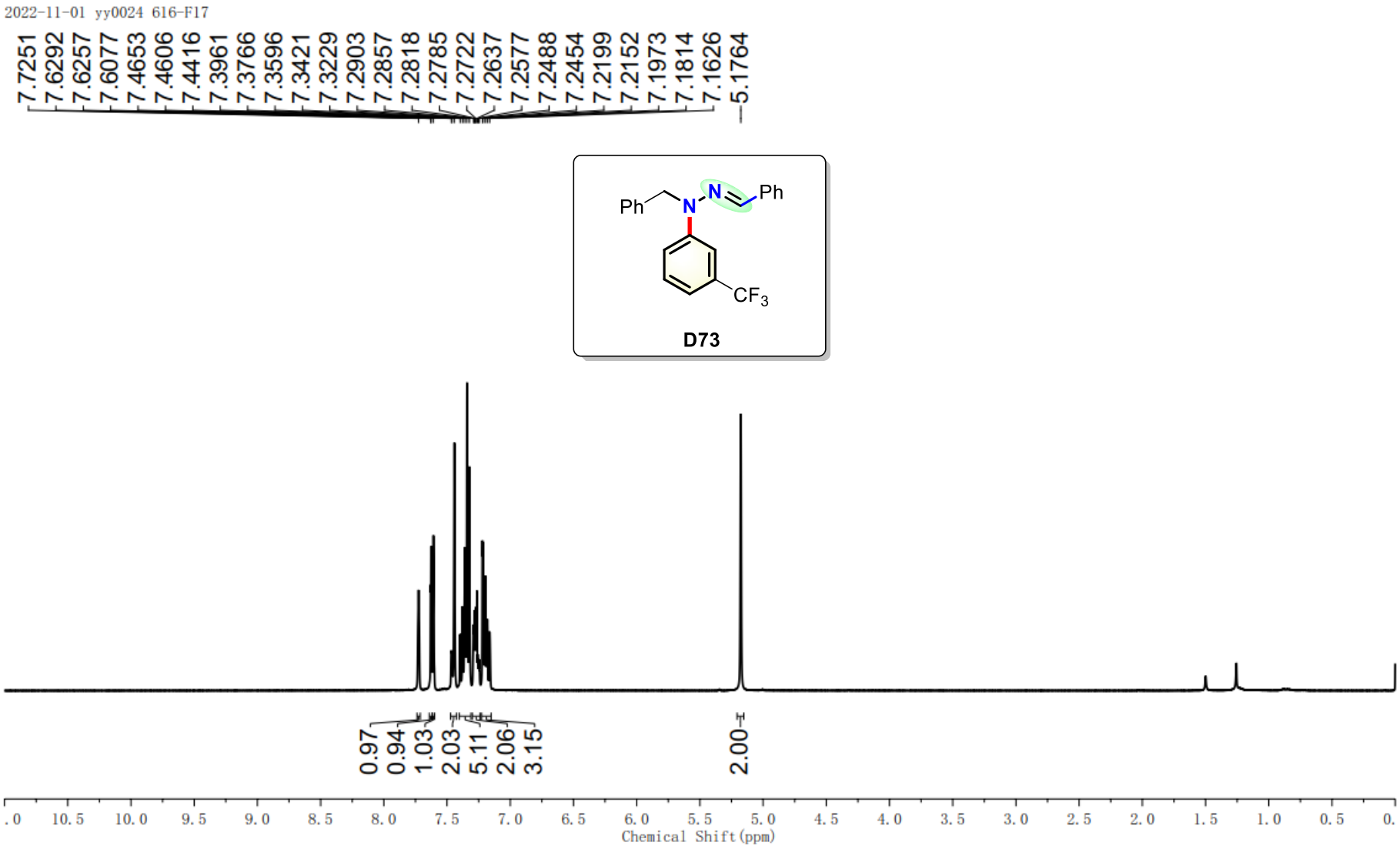


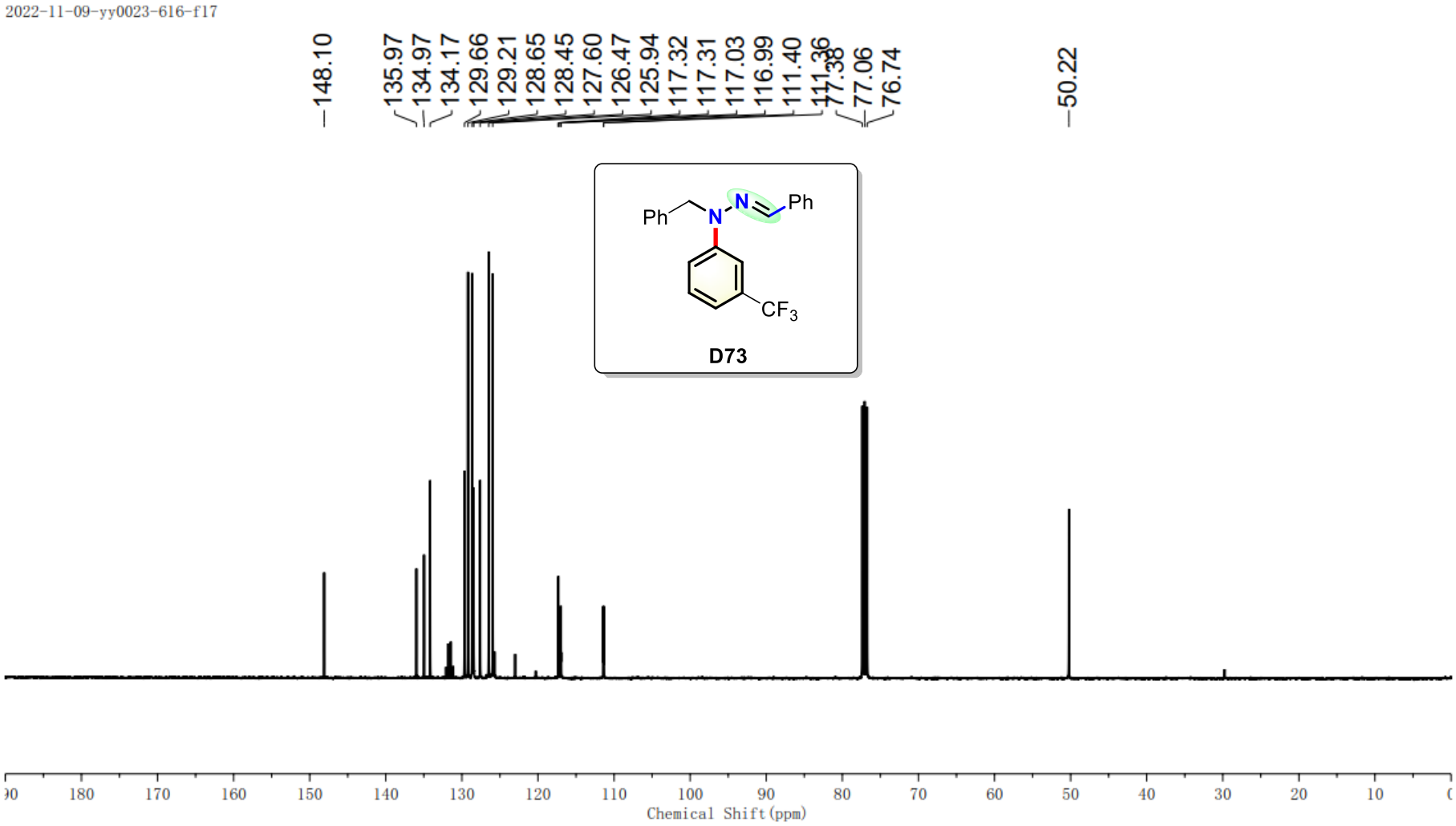

2022-10-27 yy0018 616-1q15
7.6714
7.6681
7.6514
7.6482
7.5381
7.5349
7.5169
7.4186
7.4004
7.3395
7.3215
7.3183
7.3116
7.3009
7.2896
7.2809
7.2707
7.2525
7.2457
7.2336
7.2292
7.2136
7.2097
7.1766
7.1257
7.1062
7.1032
4.9512
Ph
N
N
Ph
Cl
D71
1.01
2.09
2.09
5.89
2.44
1.00
1.08
2.00
Chemical Shift (ppm)

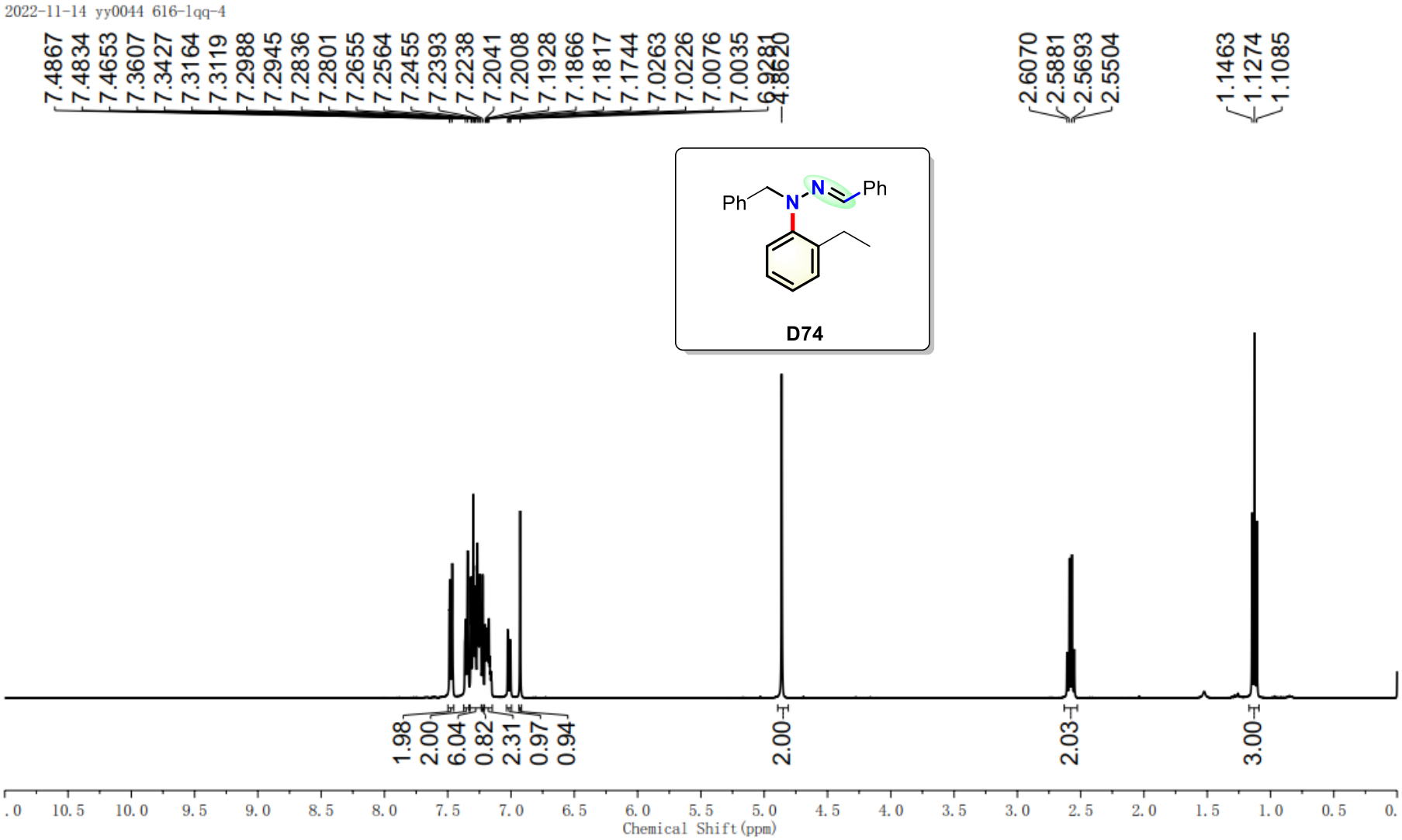

2022-11-7-yy0026-616-f10
148.91
136.08
135.13
135.10
133.81
130.13
129.16
128.62
128.33
127.52
126.44
125.96
120.52
114.85
112.53
50.23
Ph
N
N
Ph
Cl
D71
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift(ppm)

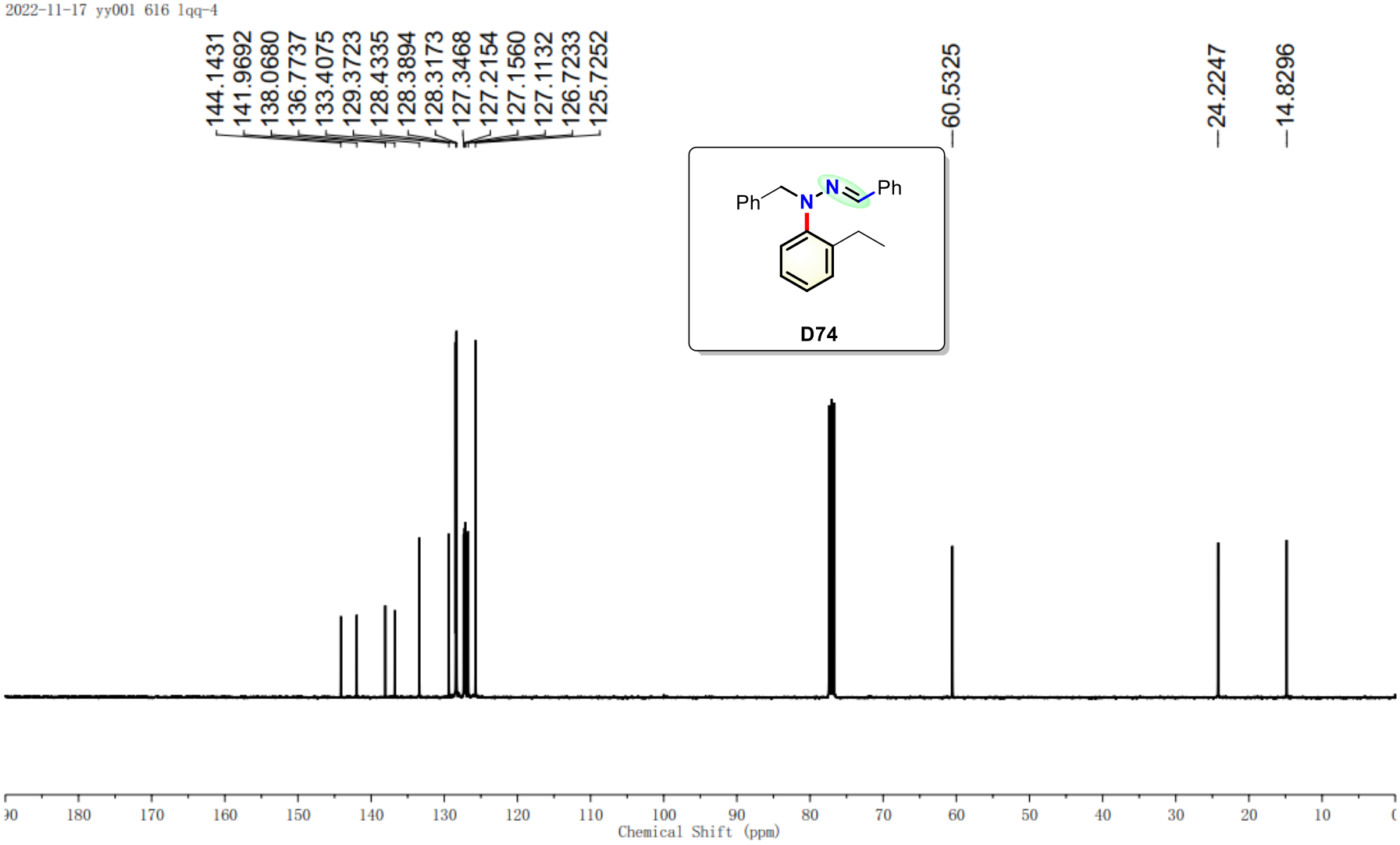

2022-10-12 yy0009 616-1qq-F14
7.6360
7.6310
7.6261
7.6120
7.5938
7.3927
7.3474
7.3274
7.3107
7.2777
7.2667
7.2539
7.2486
7.2428
7.2311
7.2115
7.2077
7.1968
7.1787
7.1461
7.1264
7.1059
7.0533
7.0329
5.1149
Ph
N
N
Ph
Br
D72
1.05
1.00
1.04
0.99
4.07
5.10
1.09
0.97
2.00
Chemical Shift (ppm)

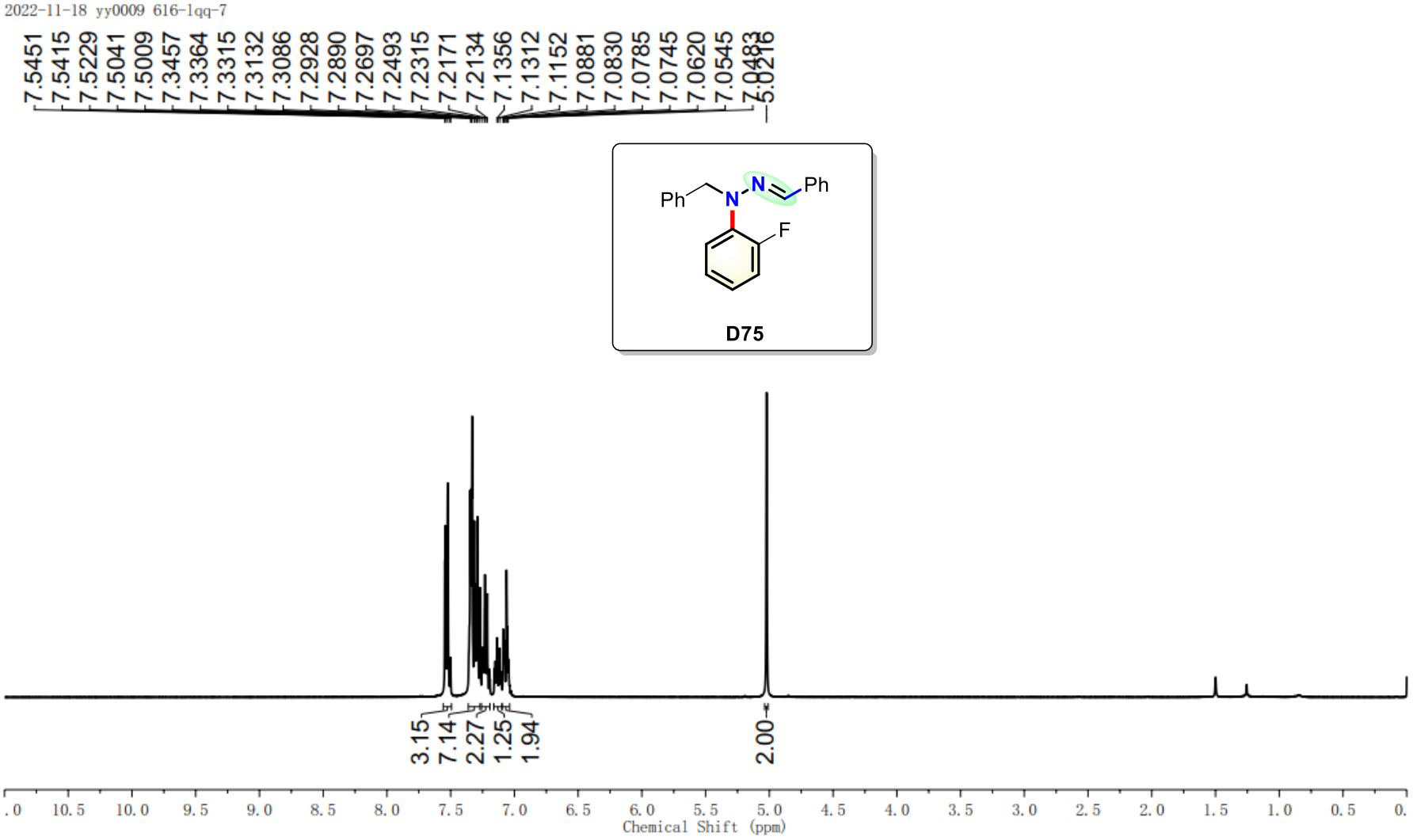

2022-11-7-yy0026-616-f14
149.02
136.07
135.08
133.90
130.43
129.18
128.63
128.36
127.54
126.45
125.97
123.46
123.36
117.73
113.01
50.23
Ph
N
N
Ph
Br
D72
Chemical Shift(ppm)

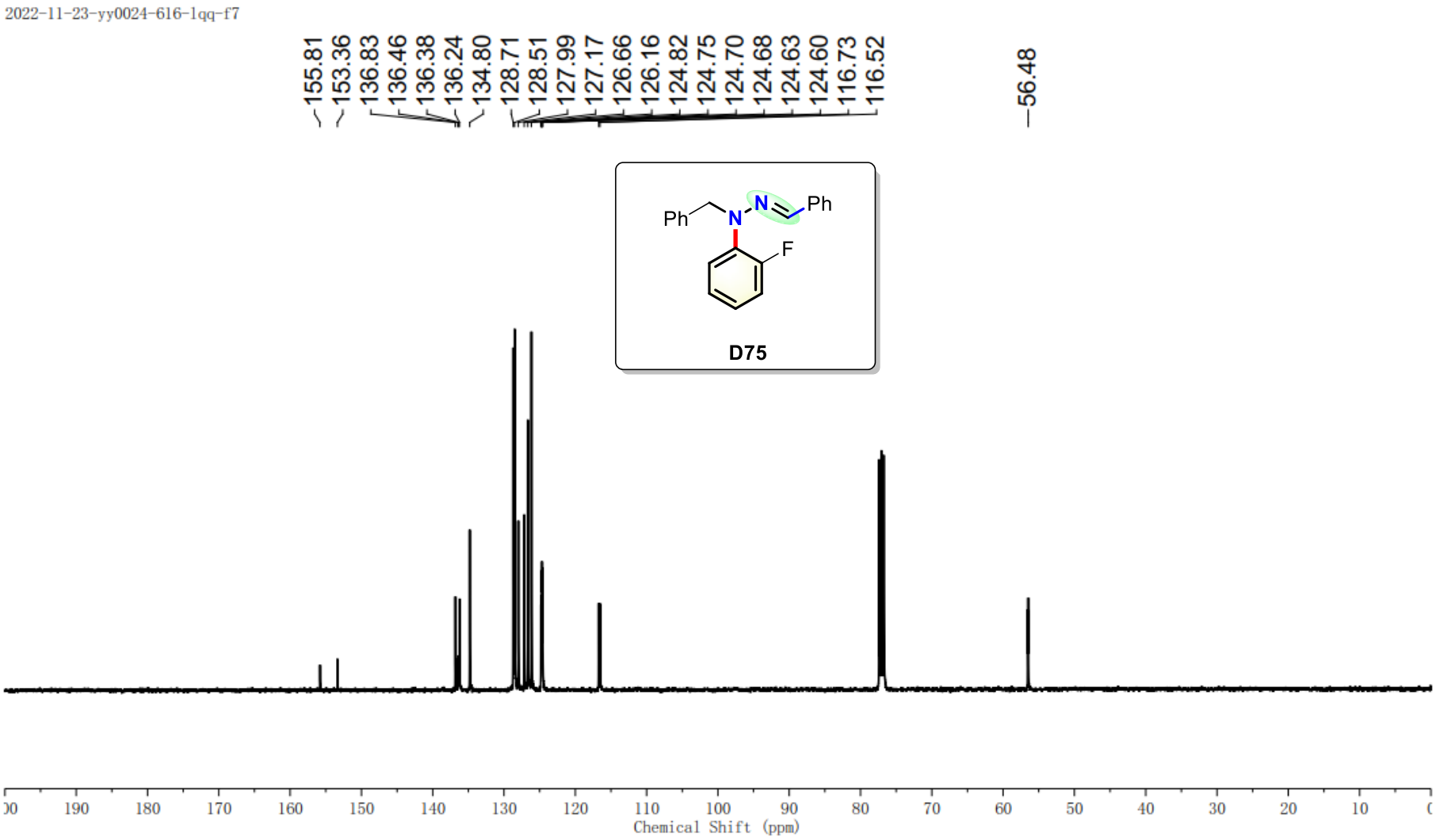

2022-11-01 yy0024 616-F17
7.7251
7.6292
7.6257
7.6077
7.4653
7.4606
7.4416
7.3961
7.3766
7.3596
7.3421
7.3229
7.2903
7.2857
7.2818
7.2785
7.2722
7.2637
7.2577
7.2488
7.2454
7.2199
7.2152
7.1973
7.1814
7.1626
5.1764
Ph
N
N
Ph
CF3
D73
0.97
0.94
1.03
2.03
5.11
2.06
3.15
2.00
Chemical Shift (ppm)

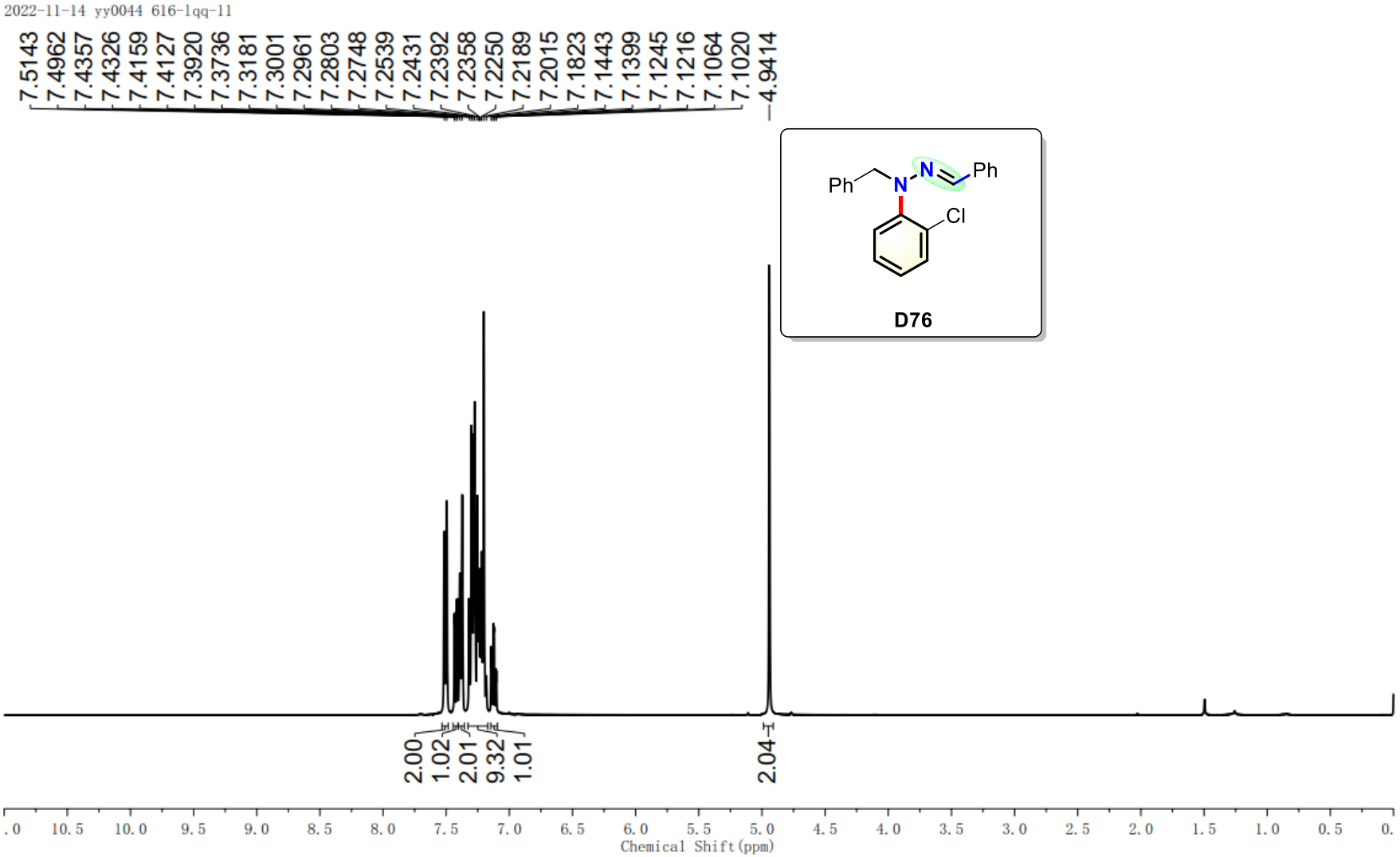

2022-11-09-yy0023-616-f17
148.10
135.97
134.97
134.17
129.66
129.21
128.65
128.45
127.60
126.47
125.94
117.32
117.31
117.03
116.99
111.40
111.36
77.38
77.06
76.74
50.22
Ph
N
N
Ph
CF3
D73
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift(ppm)

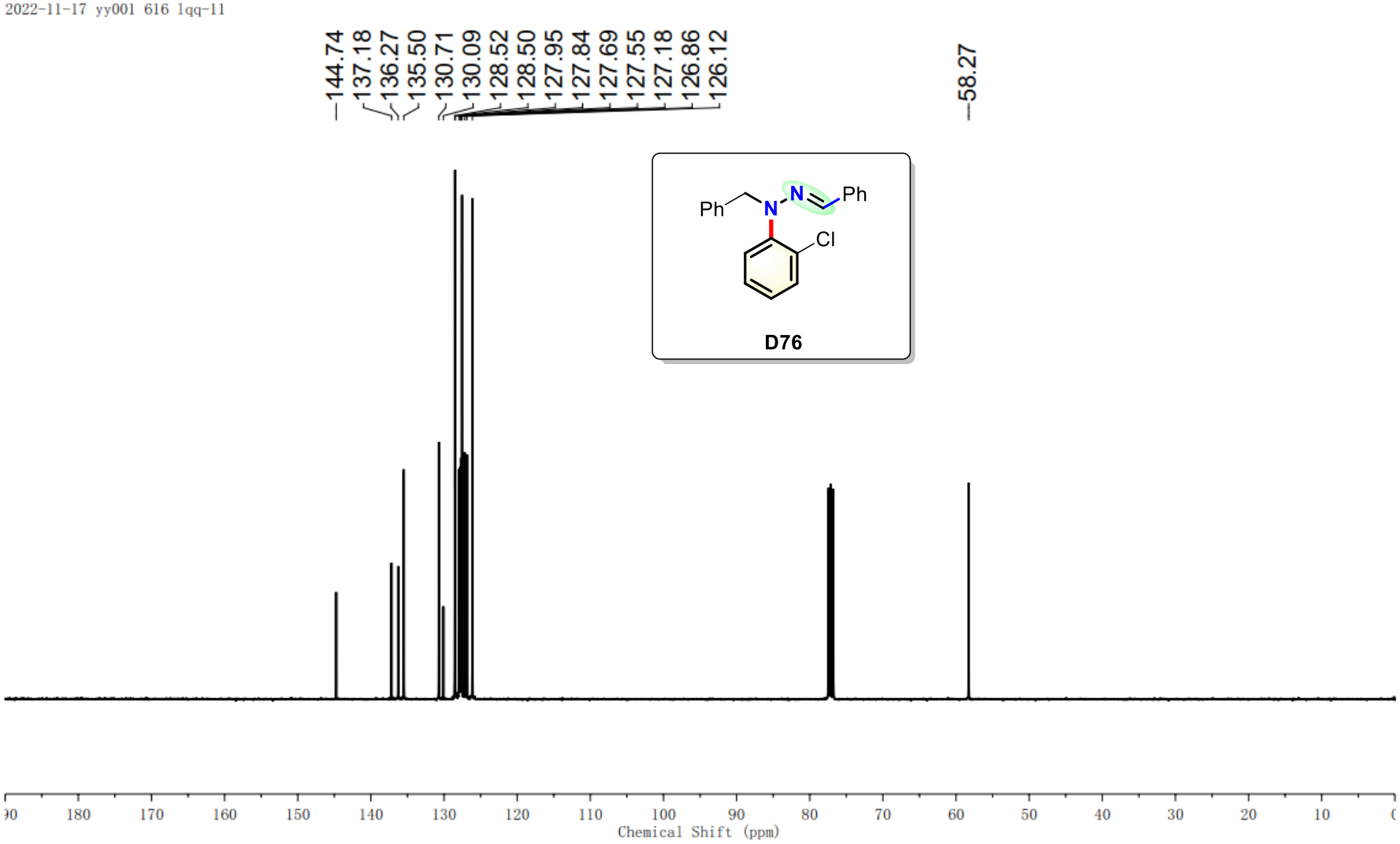

2022-11-14 yy0044 616-lqq-4
7.4867
7.4834
7.4653
7.3607
7.3427
7.3164
7.3119
7.2988
7.2945
7.2836
7.2801
7.2655
7.2564
7.2455
7.2393
7.2238
7.2041
7.2008
7.1928
7.1866
7.1817
7.1744
7.0263
7.0226
7.0076
7.0035
6.9281
4.8620
2.6070
2.5881
2.5693
2.5504
1.1463
1.1274
1.1085
Ph
N
N
Ph
D74
1.98
2.00
6.04
0.82
2.31
0.97
0.94
2.00
2.03
3.00
Chemical Shift(ppm)

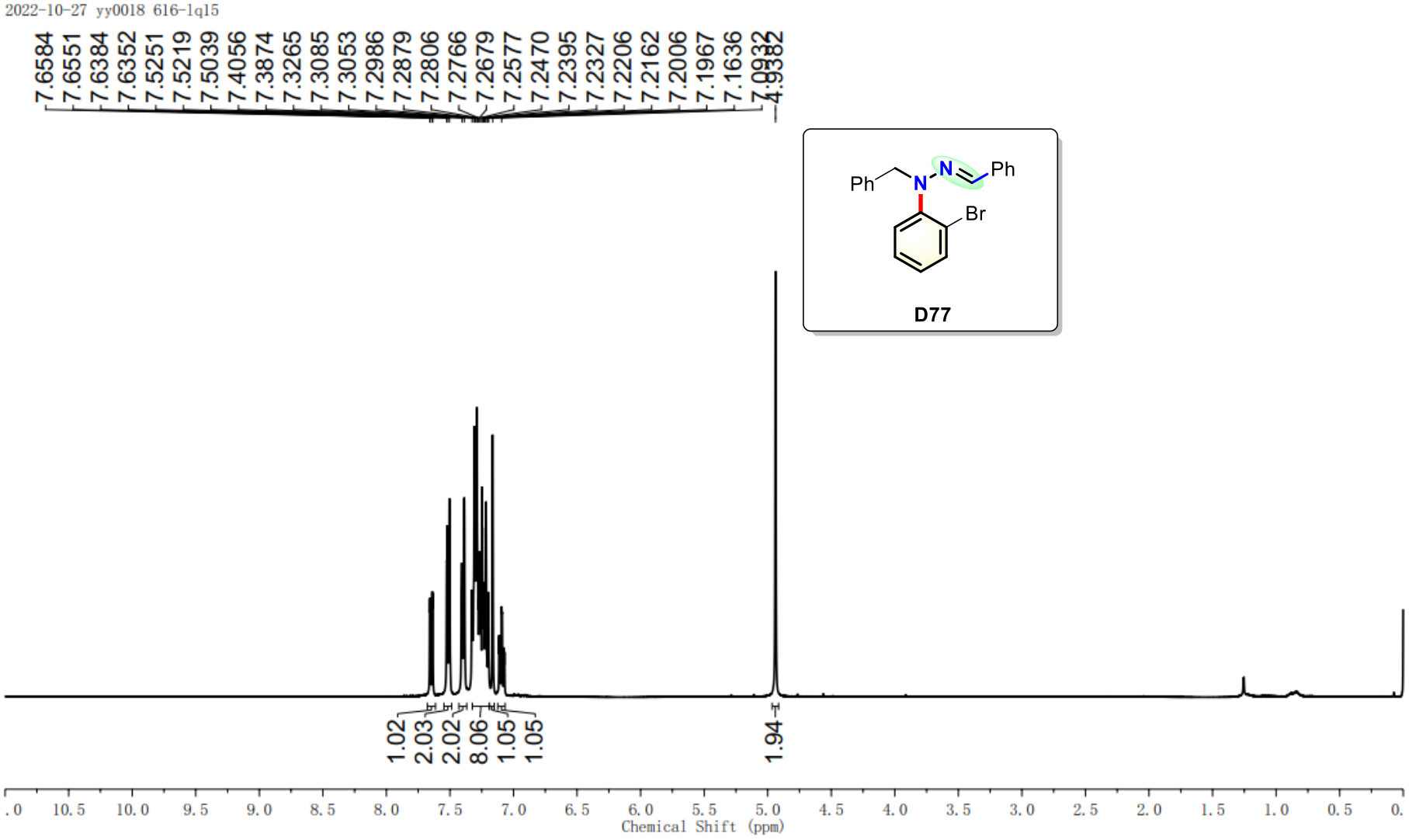

2022-11-17 yy001 616 lqq-4
144.1431
141.9692
138.0680
136.7737
133.4075
129.3723
128.4335
128.3894
128.3173
127.3468
127.2154
127.1560
127.1132
126.7233
125.7252
60.5325
24.2247
14.8296
Ph
N
N
Ph
D74
Chemical Shift (ppm)


2022-11-18 yy0009 616-lqq-7
7.5451
7.5415
7.5229
7.5041
7.5009
7.3457
7.3364
7.3315
7.3132
7.3086
7.2928
7.2890
7.2697
7.2493
7.2315
7.2171
7.2134
7.1356
7.1312
7.1152
7.0881
7.0830
7.0785
7.0745
7.0620
7.0545
7.0483
5.0216
Ph
N
N
Ph
F
D75
3.15
7.14
2.27
1.25
1.94
2.00
Chemical Shift (ppm)

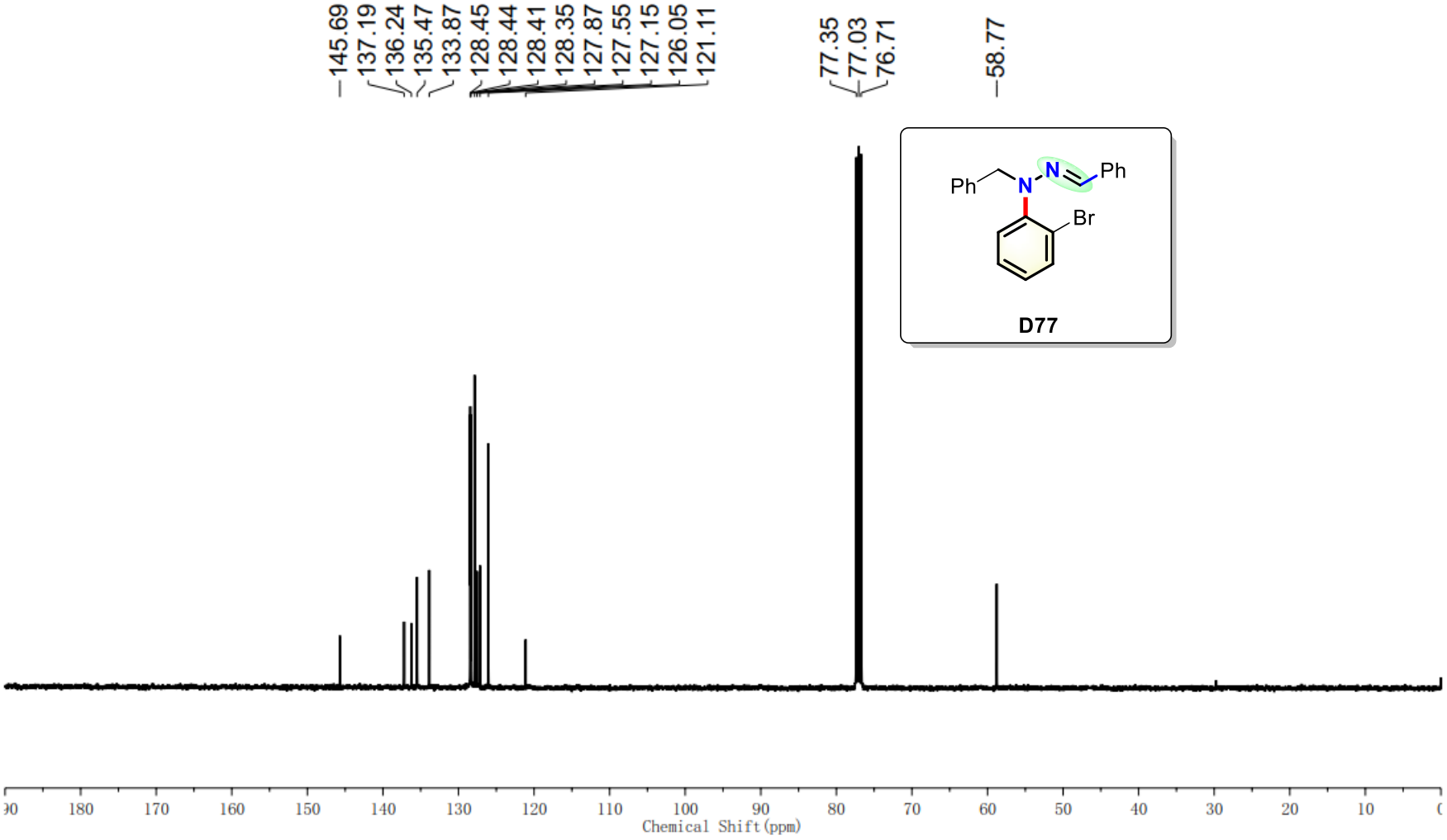

2022-11-23-yy0024-616-lqq-f7
155.81
153.36
136.83
136.46
136.38
136.24
134.80
128.71
128.51
127.99
127.17
126.66
126.16
124.82
124.75
124.70
124.68
124.63
124.60
116.73
116.52
56.48
Ph
N
N
Ph
F
D75
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

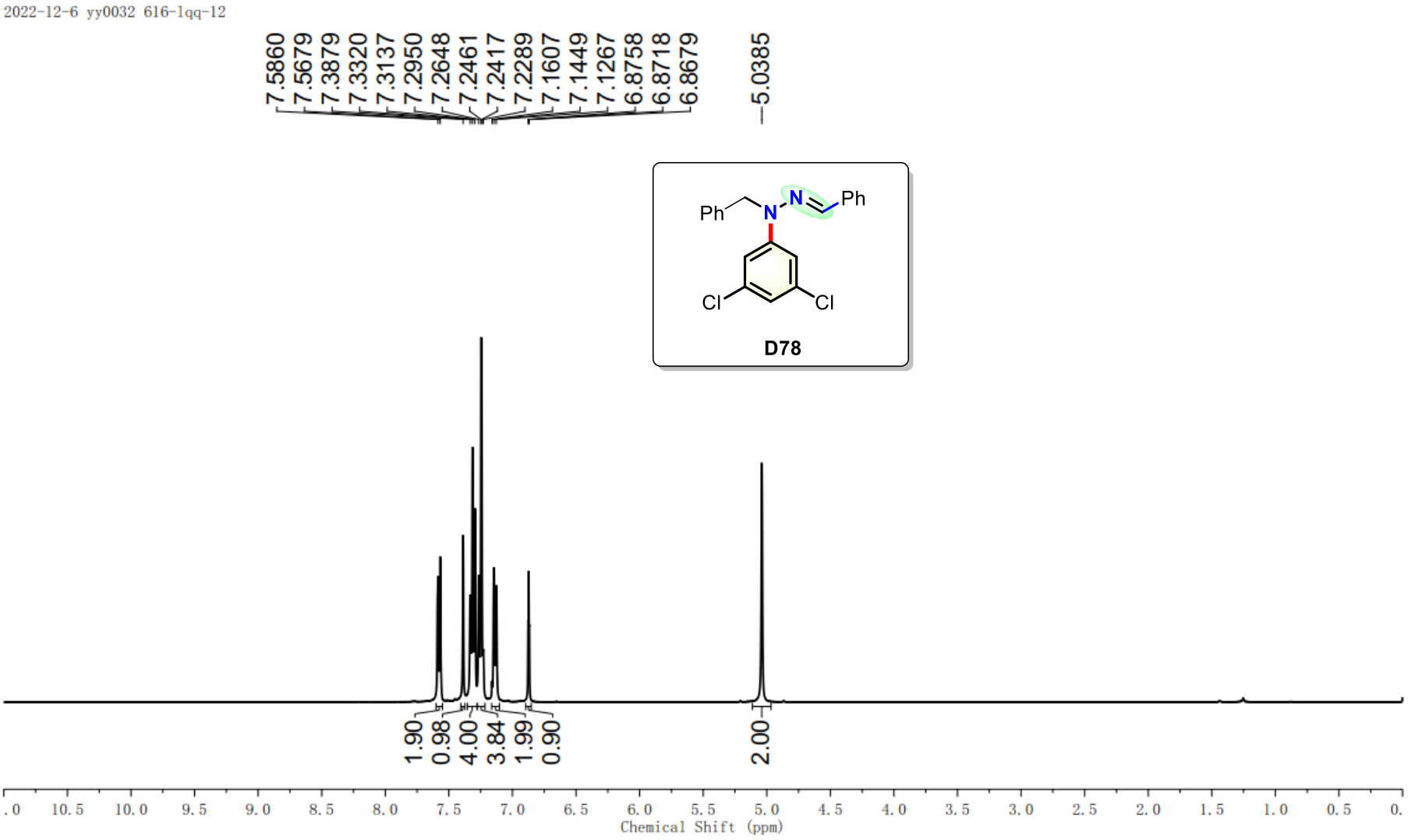

2022-11-14 yy0044 616-lqq-11
7.5143
7.4962
7.4357
7.4326
7.4159
7.4127
7.3920
7.3736
7.3181
7.3001
7.2961
7.2803
7.2748
7.2539
7.2431
7.2392
7.2358
7.2250
7.2189
7.2015
7.1823
7.1443
7.1399
7.1245
7.1216
7.1064
7.1020
4.9414
Ph
N
N
Ph
Cl
D76
2.00
1.02
2.01
9.32
1.01
2.04
Chemical Shift(ppm)

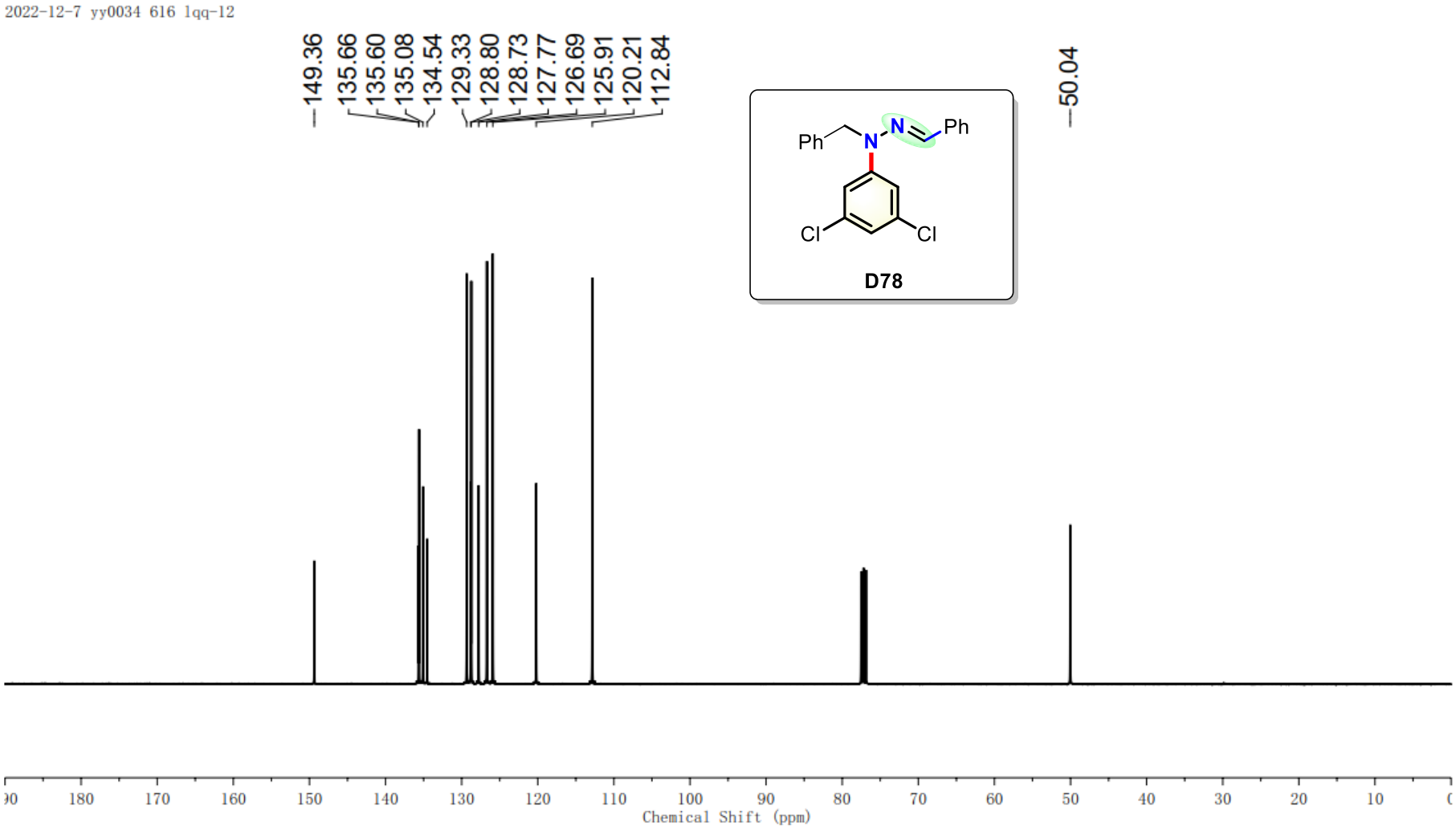

2022-11-17 yy001 616 lqq-11
144.74
137.18
136.27
135.50
130.71
130.09
128.52
128.50
127.95
127.84
127.69
127.55
127.18
126.86
126.12
58.27
Ph
N
N
Ph
Cl
D76
Chemical Shift (ppm)

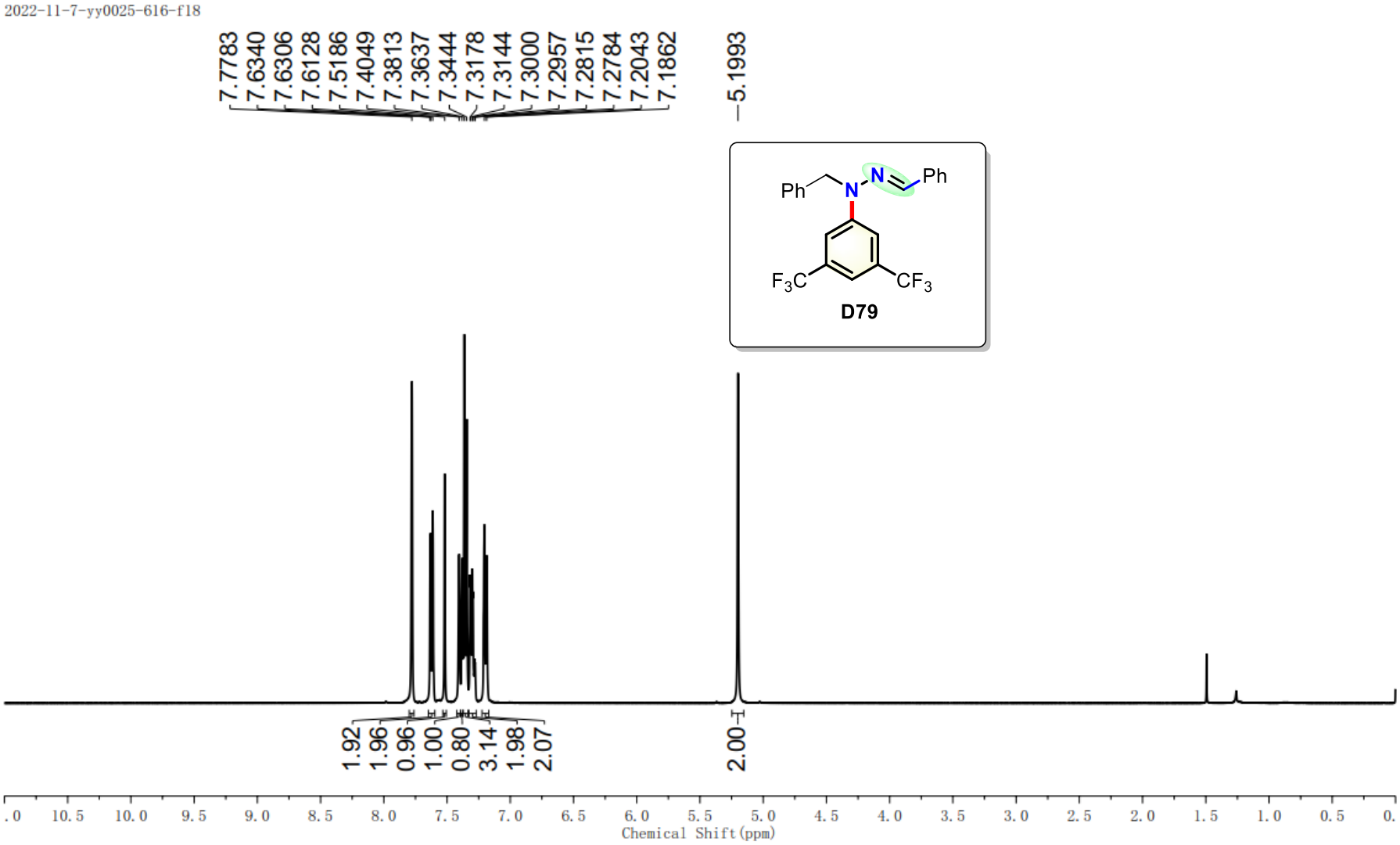

2022-10-27 yy0018 616-lql5
7.6584
7.6551
7.6384
7.6352
7.5251
7.5219
7.5039
7.4056
7.3874
7.3265
7.3085
7.3053
7.2986
7.2879
7.2806
7.2766
7.2679
7.2577
7.2470
7.2395
7.2327
7.2206
7.2162
7.2006
7.1967
7.1636
Ph
N
Ph
Br
D77
1.02
2.03
2.02
8.06
1.05
1.05
1.94
Chemical Shift (ppm)

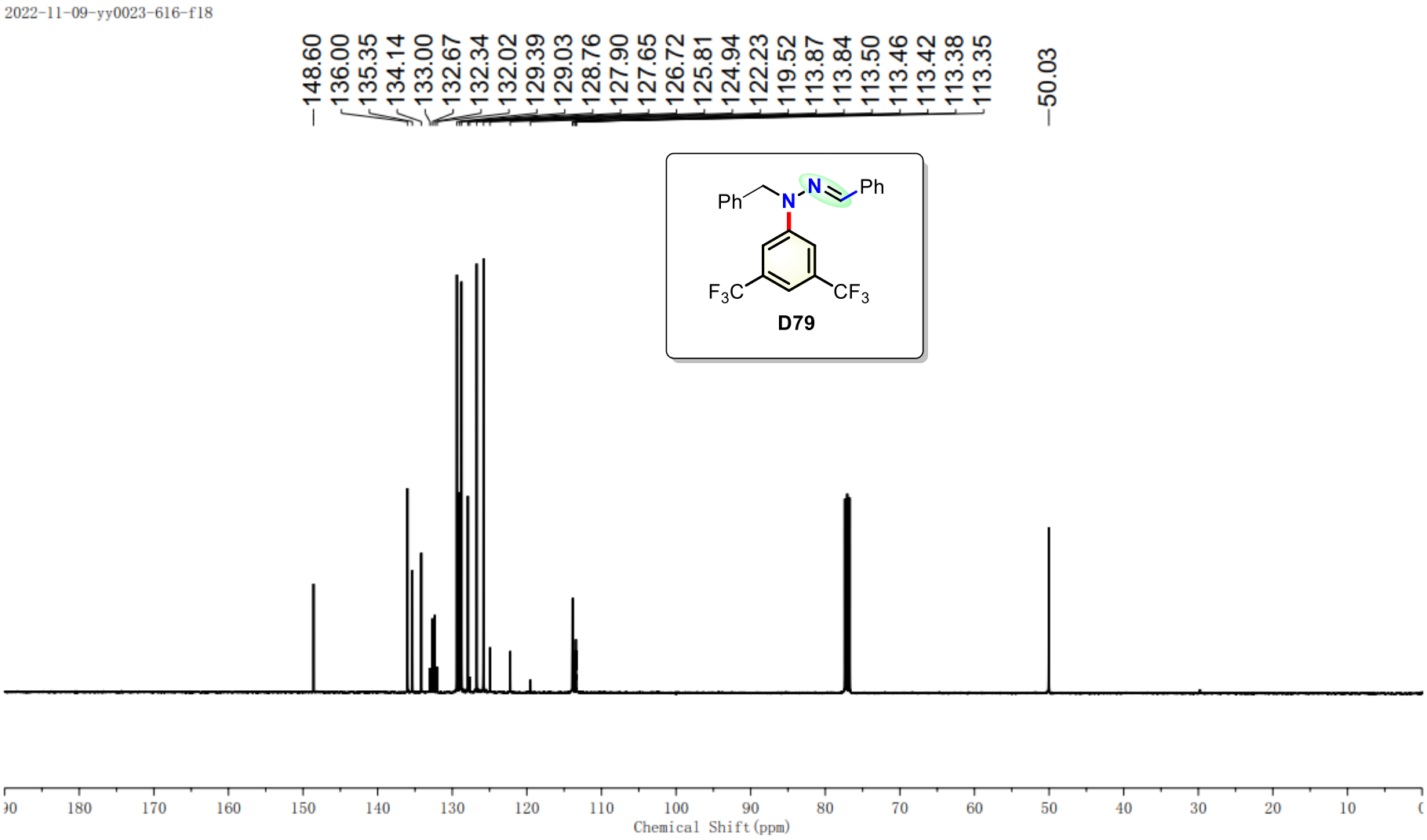
2022-11-09-yy0023-616-f15

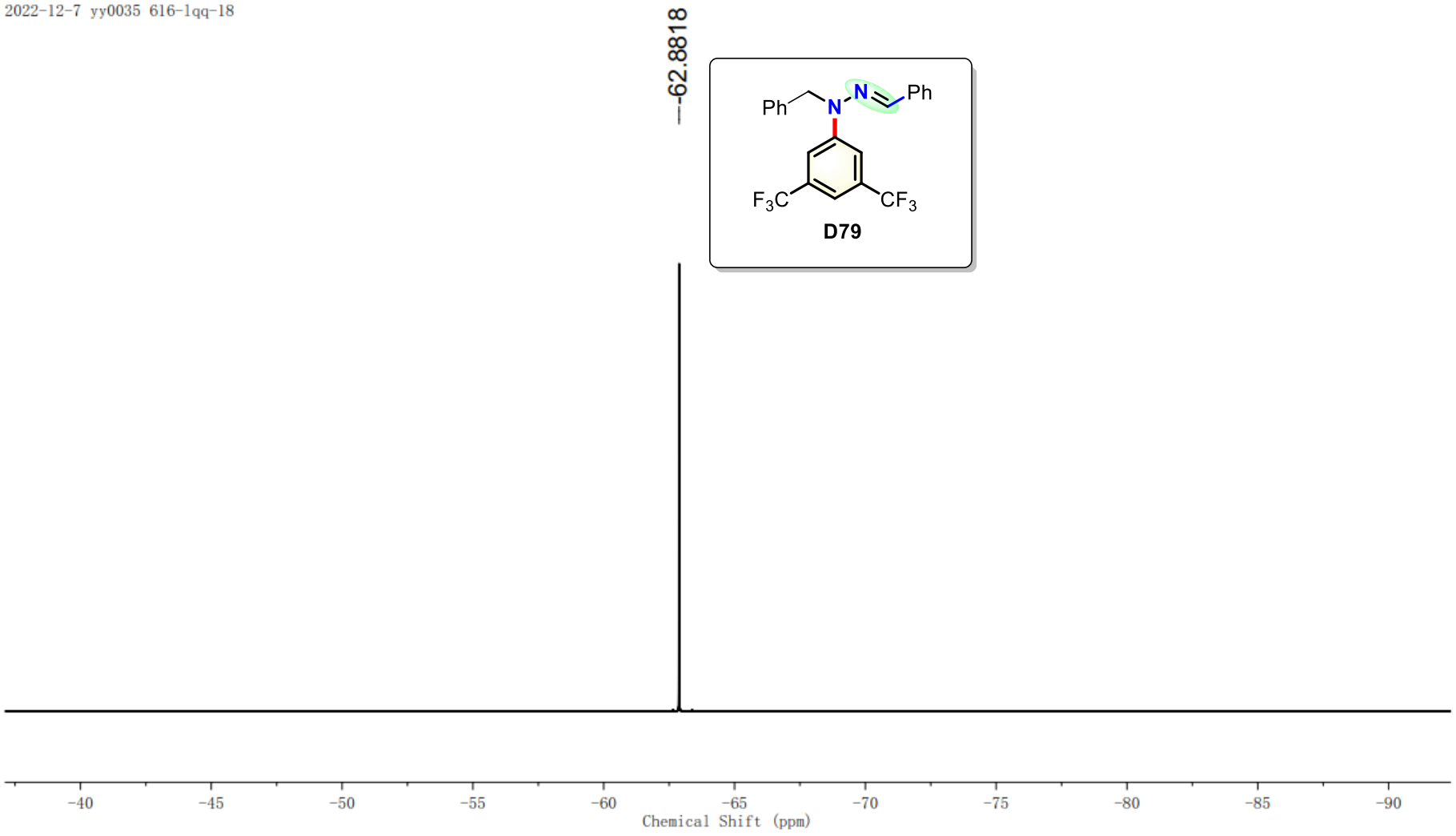


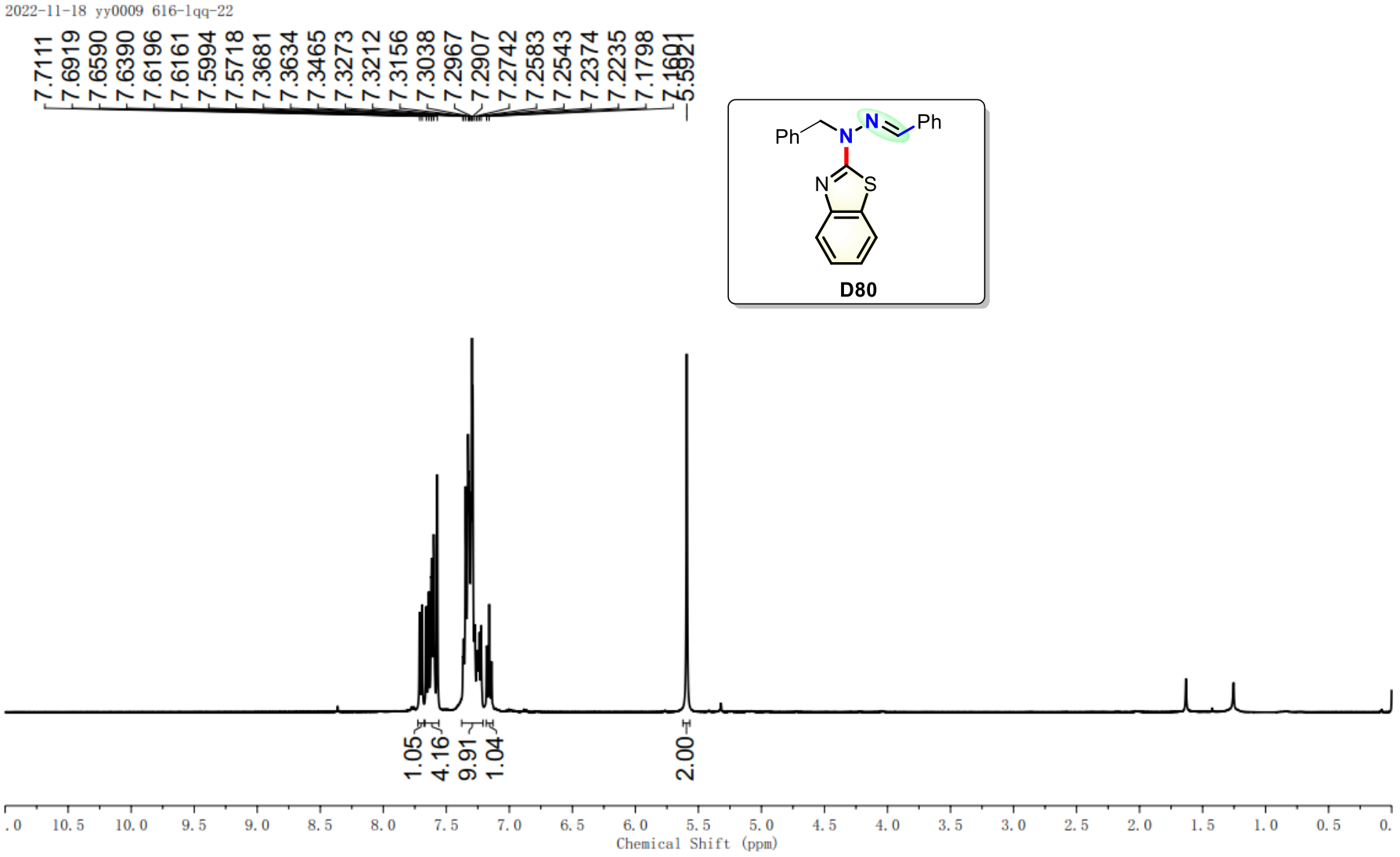

2022-12-6 yy0032 616-1qq-12
7.5860
7.5679
7.3879
7.3320
7.3137
7.2950
7.2648
7.2461
7.2417
7.2289
7.1607
7.1449
7.1267
6.8758
6.8718
6.8679
5.0385
Ph
N
N
Ph
Cl
Cl
D78
1.90
0.98
4.00
3.84
1.99
0.90
2.00
Chemical Shift (ppm)


2022-12-7 yy0034 616 lqq-12
149.36
135.66
135.60
135.08
134.54
129.33
128.80
128.73
127.77
126.69
125.91
120.21
112.84
50.04
Ph
N
N
Ph
Cl
Cl
D78
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)


2022-11-7-yy0025-616-f18
7.7783
7.6340
7.6306
7.6128
7.5186
7.4049
7.3813
7.3637
7.3444
7.3178
7.3144
7.3000
7.2957
7.2815
7.2784
7.2043
7.1862
5.1993
Ph
N
N
Ph
F3C
CF3
D79
1.92
1.96
0.96
1.00
0.80
3.14
1.98
2.07
2.00
Chemical Shift(ppm)

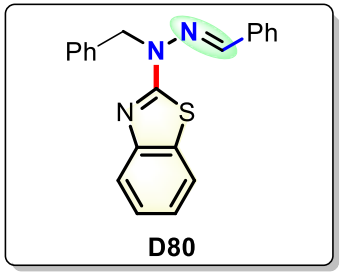

2022-11-09-yy0023-616-f18
148.60
136.00
135.35
134.14
133.00
132.67
132.34
132.02
129.39
129.03
128.76
127.90
127.65
126.72
125.81
124.94
122.23
119.52
113.87
113.84
113.50
113.46
113.42
113.38
113.35
50.03
Ph
N
N
Ph
F3C
CF3
D79
Chemical Shift(ppm)


2022-12-7 yy0035 616-1qq-18
-62.8818
Ph
N
N
Ph
F3C
CF3
D79
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
-90
Chemical Shift (ppm)

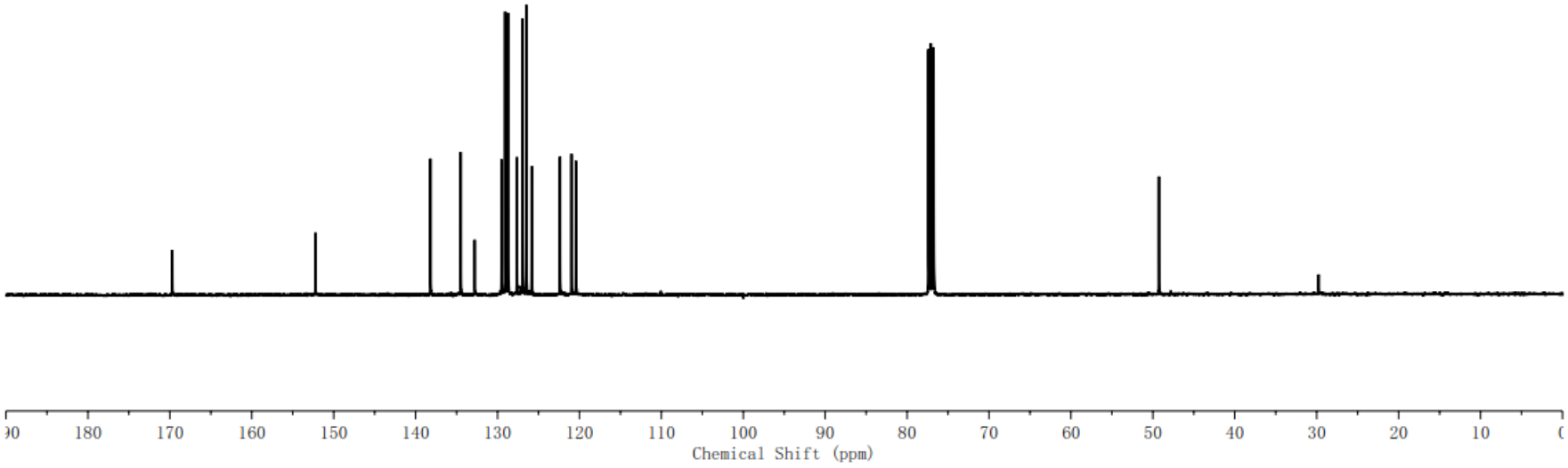

2022-11-18 yy0009 616-lqq-22
7.7111
7.6919
7.6590
7.6390
7.6196
7.6161
7.5994
7.5718
7.3681
7.3634
7.3465
7.3273
7.3212
7.3156
7.3038
7.2967
7.2907
7.2742
7.2583
7.2543
7.2374
7.2235
7.1798
7.1601
5.5921
Ph
N
N
Ph
N
S
D80
1.05
4.16
9.91
1.04
2.00
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.
Chemical Shift (ppm)

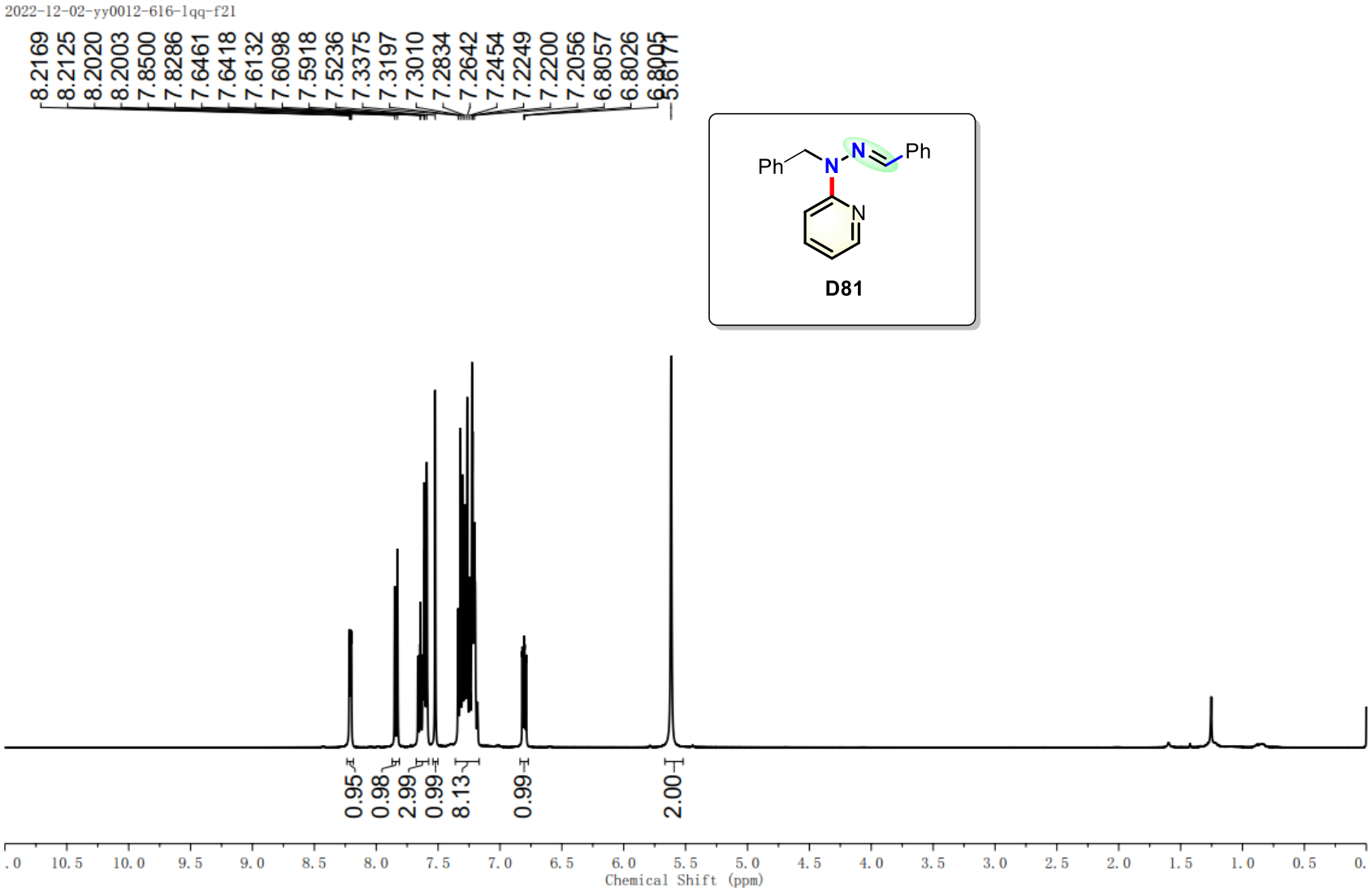
2022-11-23-yy0024-616-lqq-f22

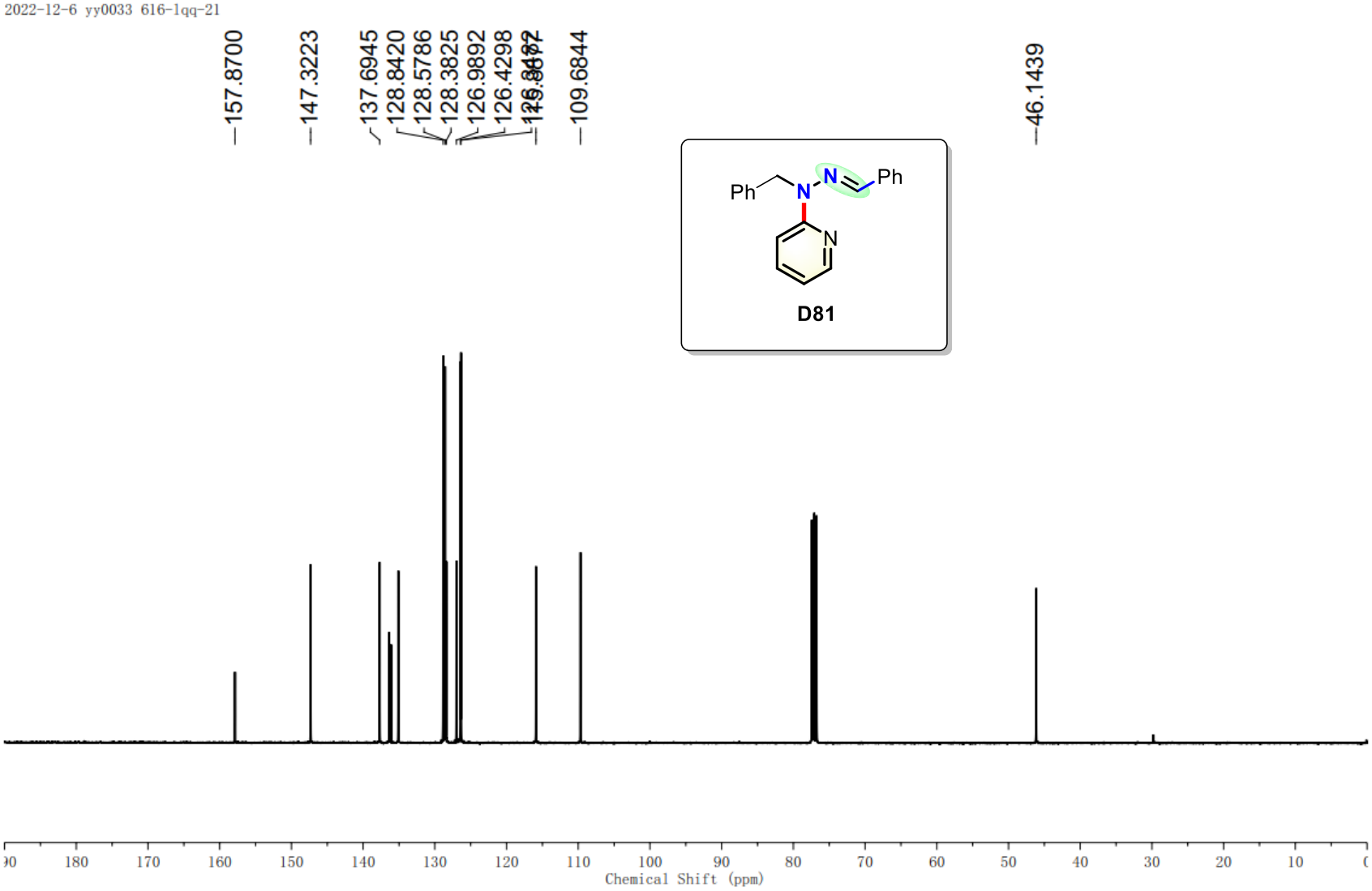
169.6945
152.2229
138.1863
134.4885
132.7853
129.4981
129.0657
128.7150
127.6277
126.9436
126.4866
125.8247
122.3753
120.9746
120.4195
49.2548



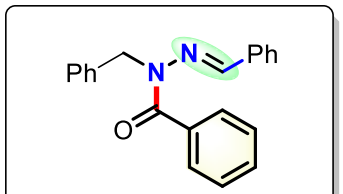

D80



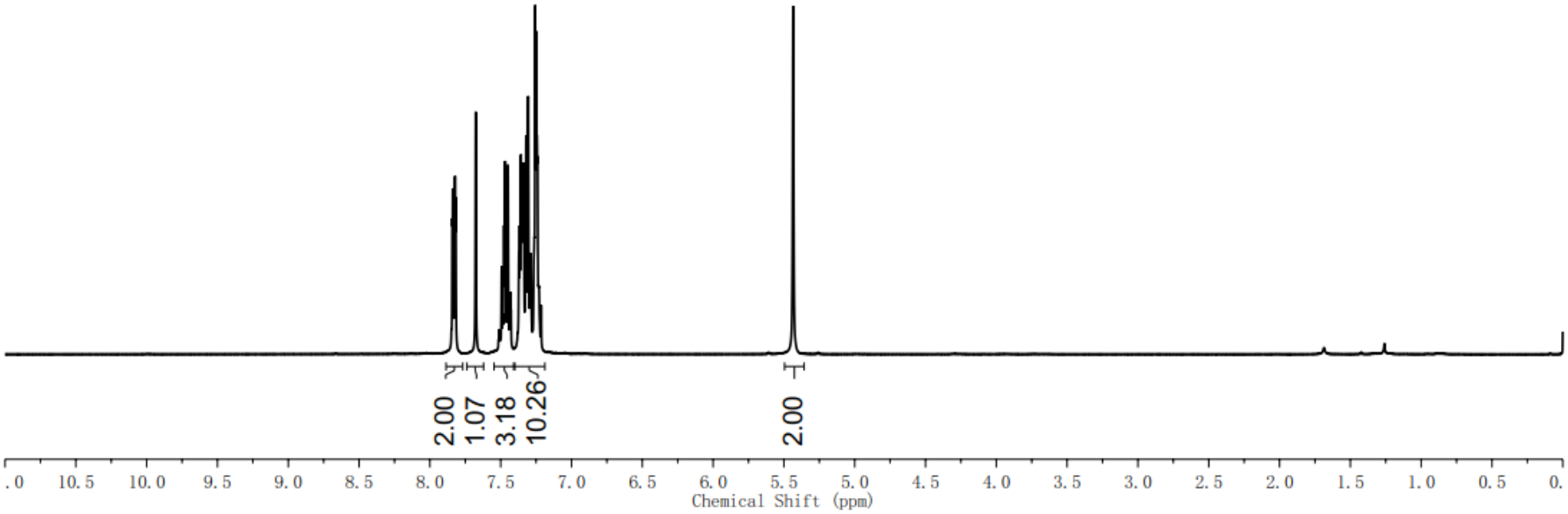

2022-12-02-yy0012-616-1qq-f21
8.2169
8.2125
8.2020
8.2003
7.8500
7.8286
7.6461
7.6418
7.6132
7.6098
7.5918
7.5236
7.3375
7.3197
7.3010
7.2834
7.2642
7.2454
7.2249
7.2200
7.2056
6.8057
6.8026
6.8005
5.6171
Ph
N
N
Ph
N
D81
0.95
0.98
2.99
0.99
8.13
0.99
2.00
Chemical Shift (ppm)

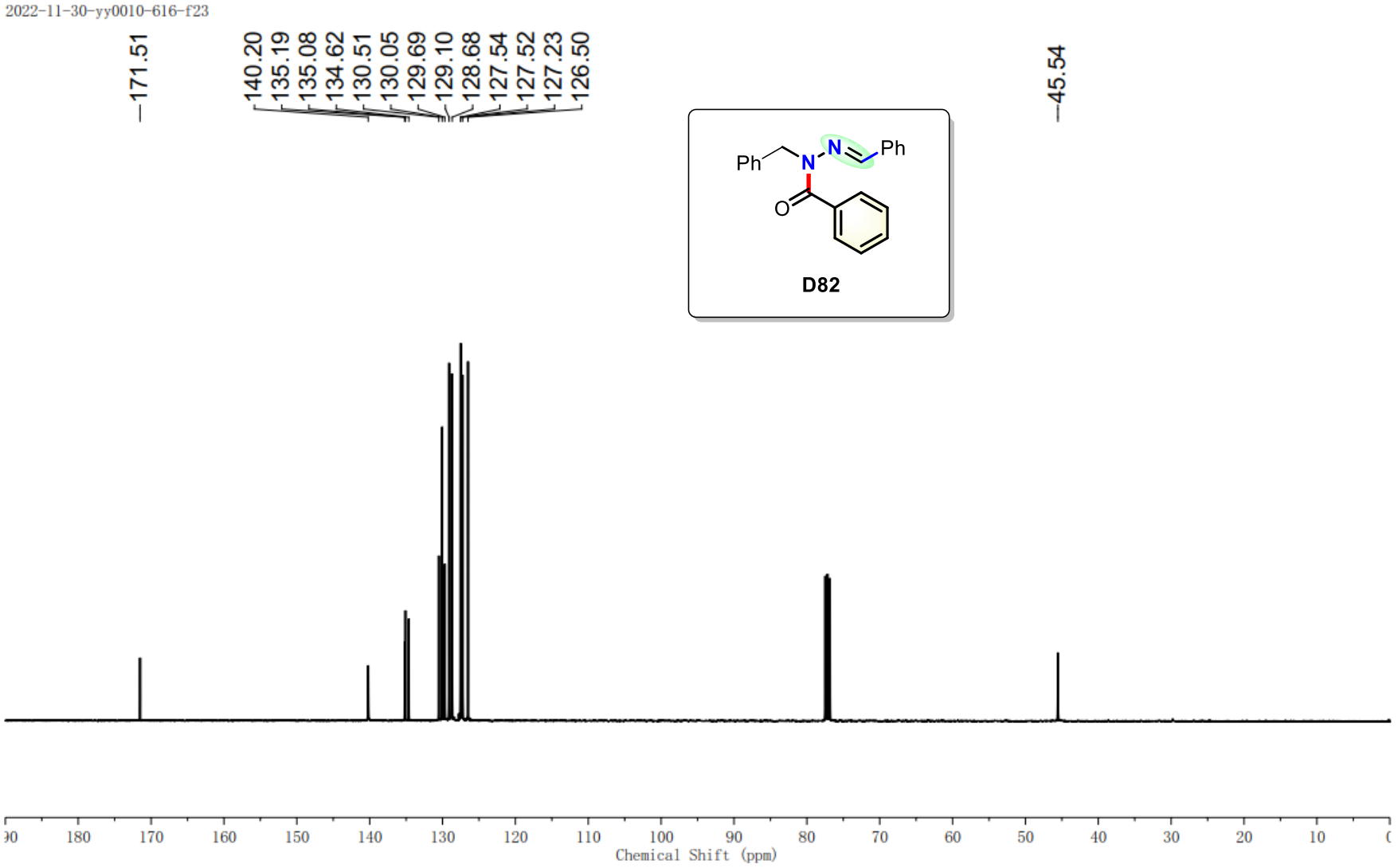

2022-12-6 yy0033 616-1qq-21
157.8700
147.3223
137.6945
128.8420
128.5786
128.3825
126.9892
126.4298
109.6844
46.1439
Ph
N
N
Ph
N
D81
90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

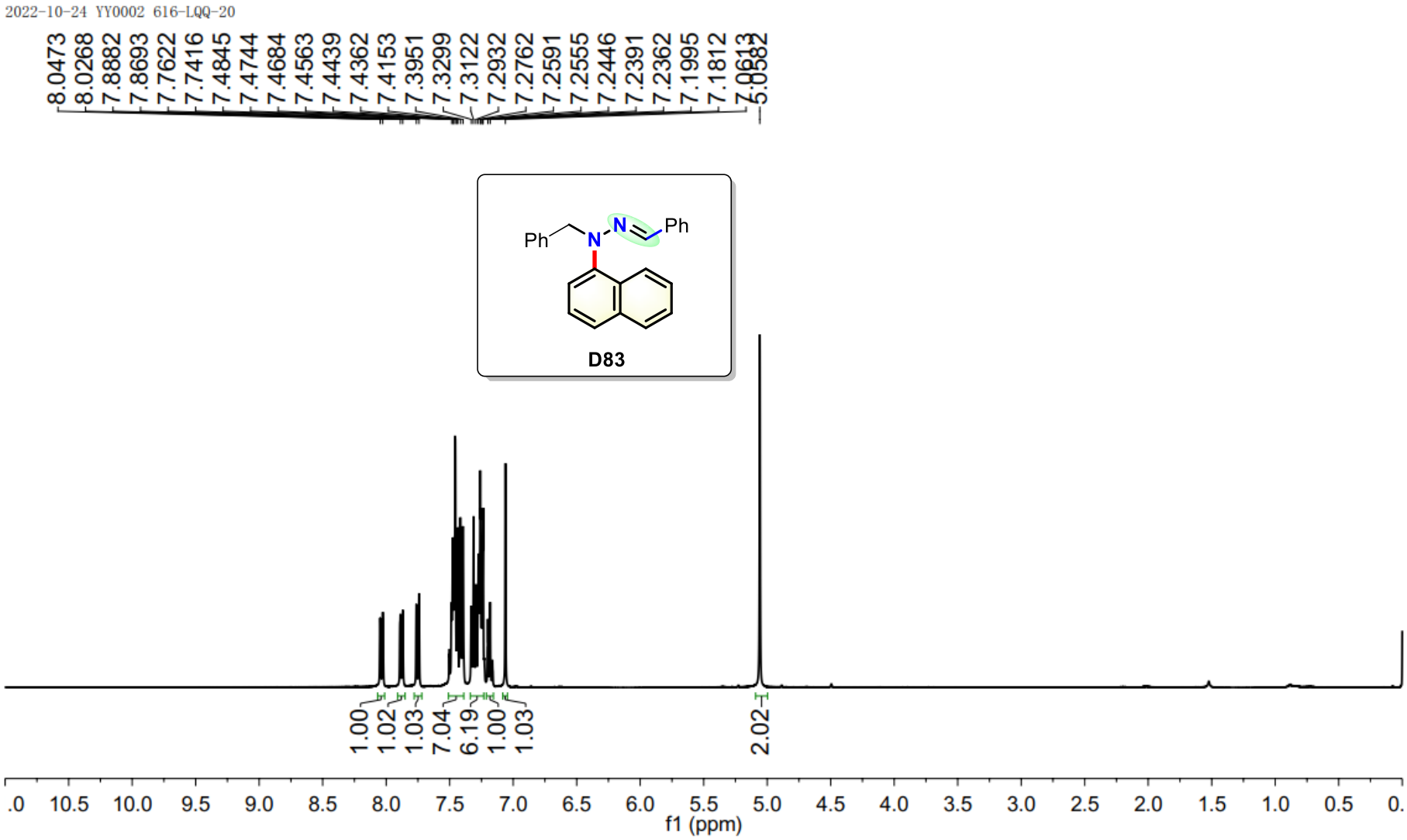
2022-11-24 YY0014 616-1qq-F23

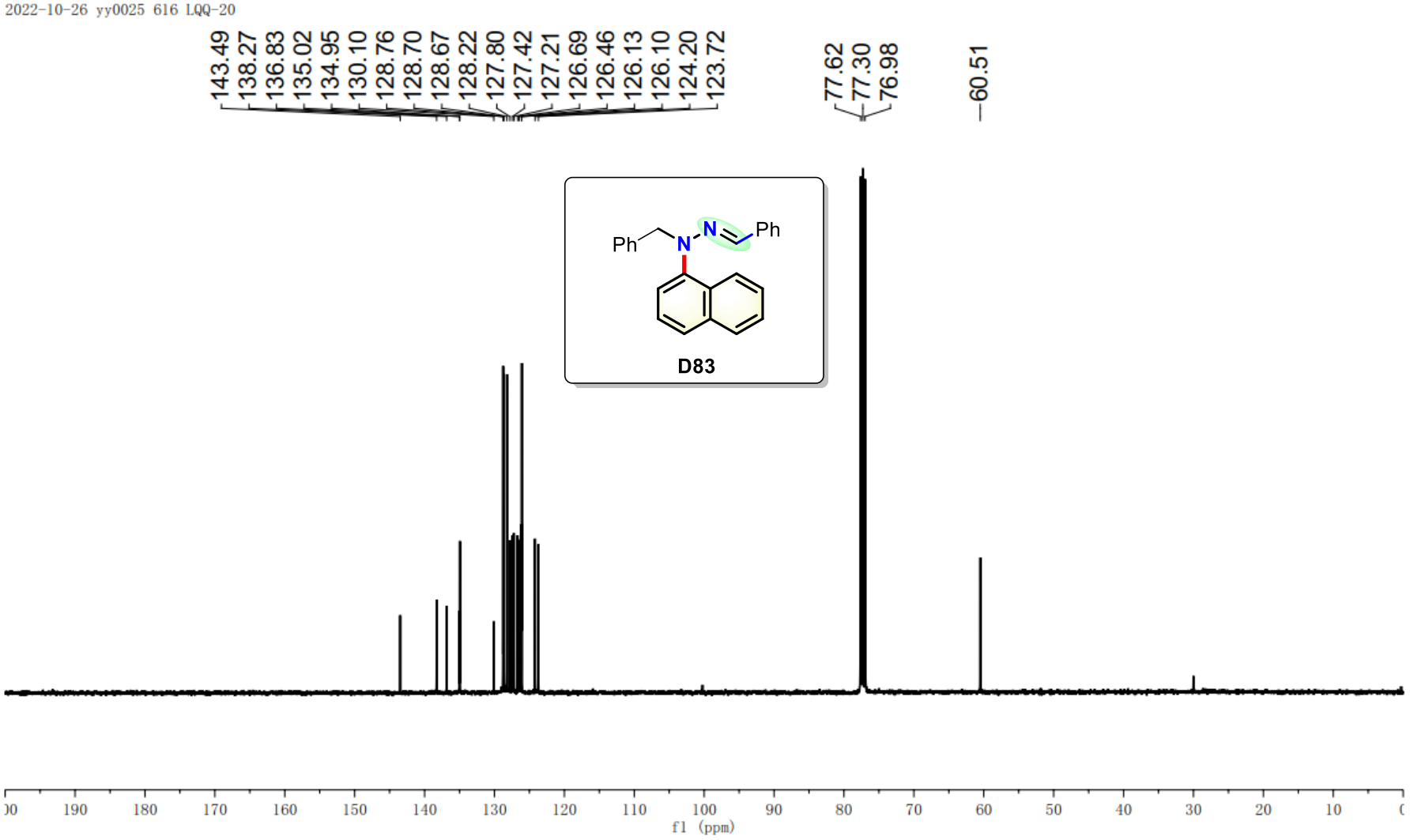



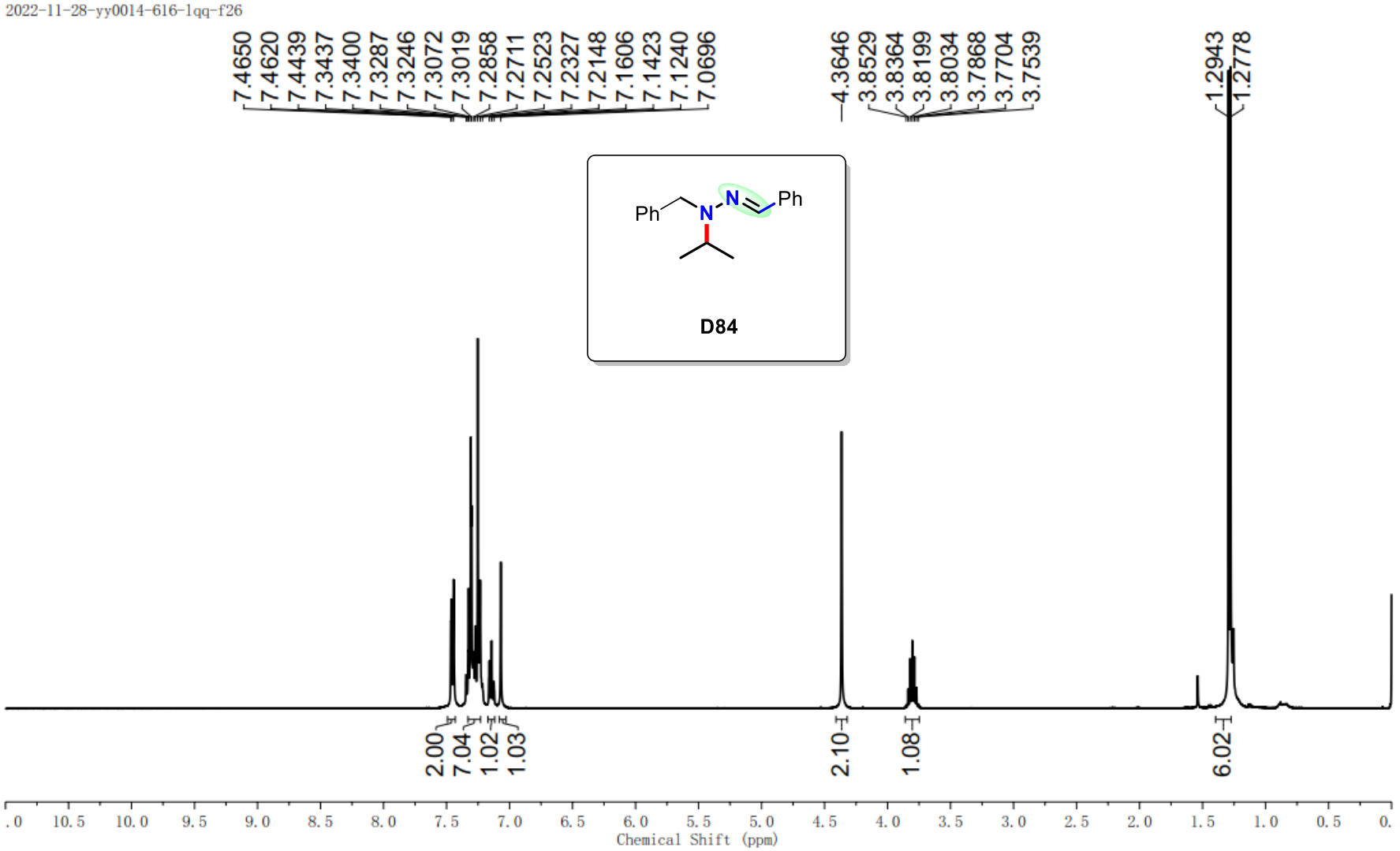

**D82**

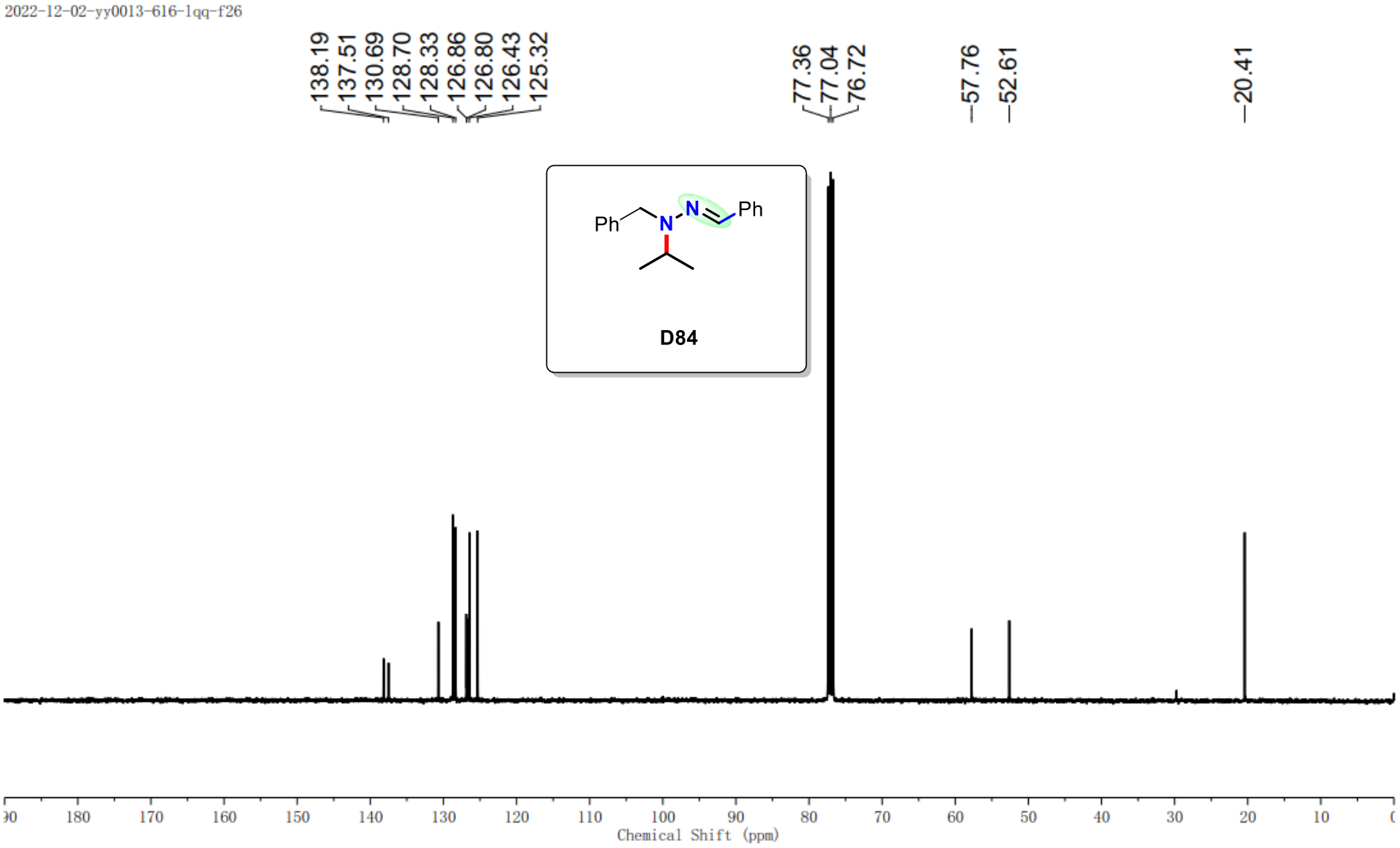


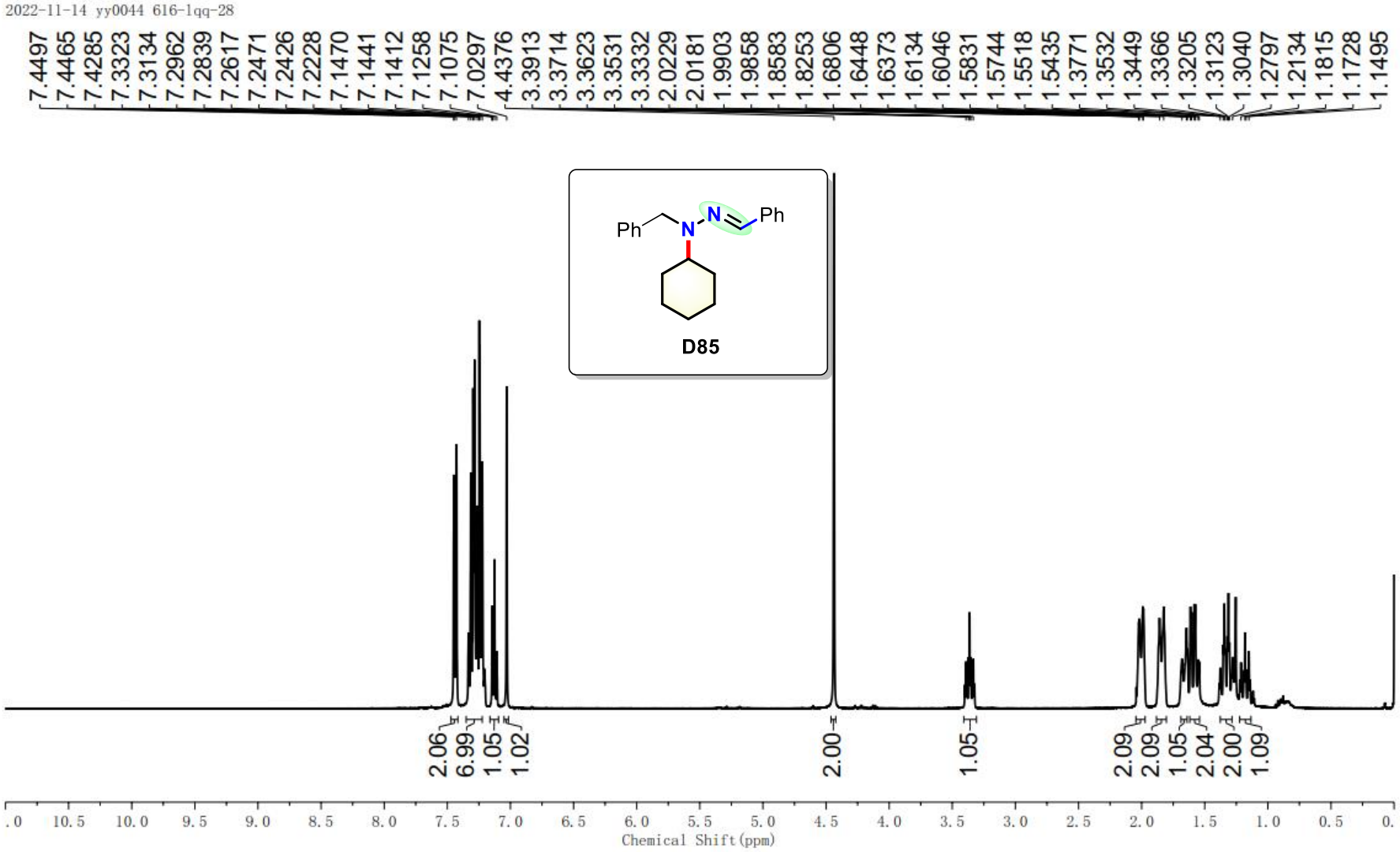

2022-11-30-yy0010-616-f23
171.51
140.20
135.19
135.08
134.62
130.51
130.05
129.69
129.10
128.68
127.54
127.52
127.23
126.50
45.54
Ph
N
N
Ph
O
D82
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

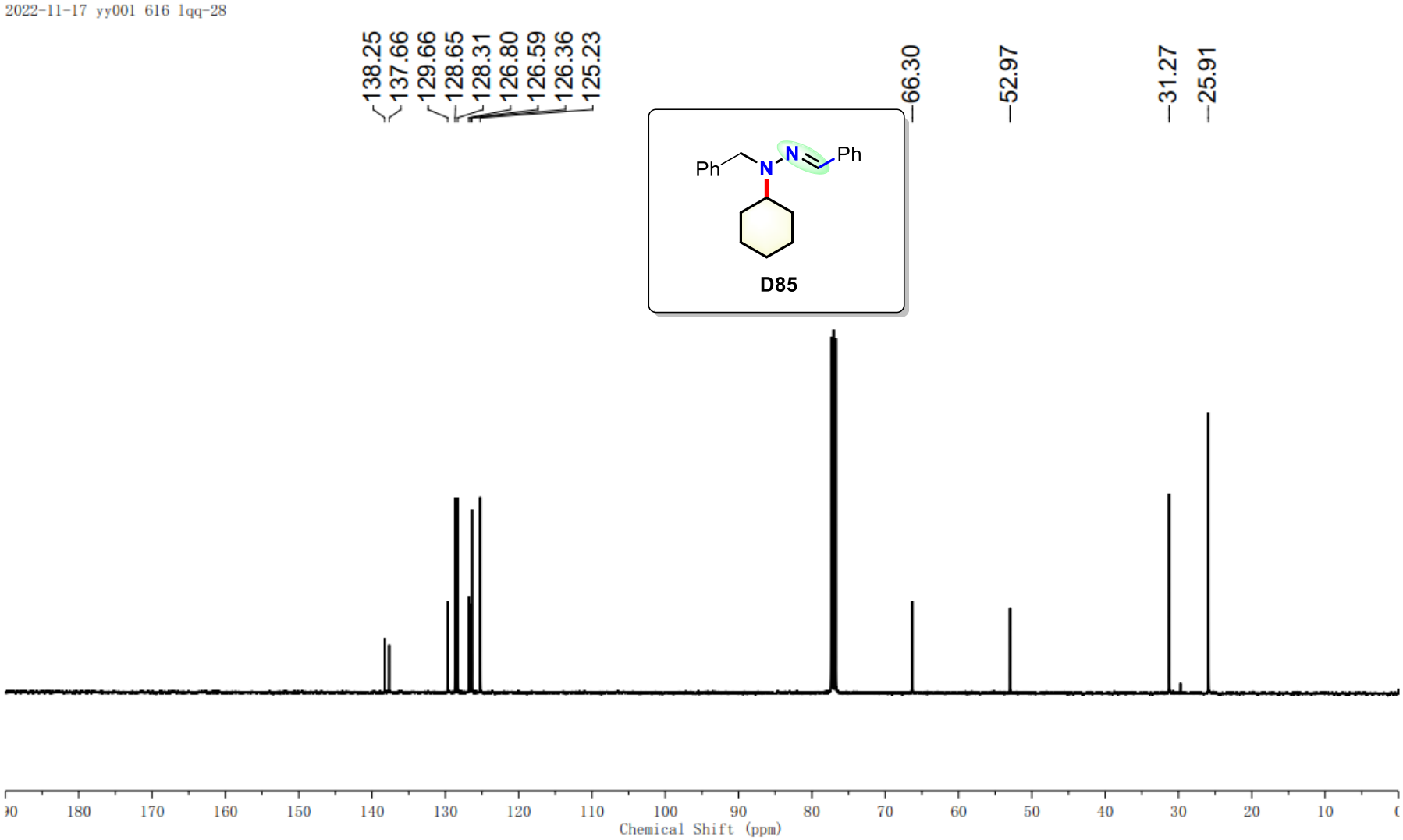

2022-10-24 YY0002 616-LQQ-20
8.0473
8.0268
7.8882
7.8693
7.7622
7.7416
7.4845
7.4744
7.4684
7.4563
7.4439
7.4362
7.4153
7.3951
7.3299
7.3122
7.2932
7.2762
7.2591
7.2555
7.2446
7.2391
7.2362
7.1995
7.1812
7.0613
5.0582
Ph
N
N
Ph
D83
1.00
1.02
1.03
7.04
6.19
1.00
1.03
2.02
f1 (ppm)

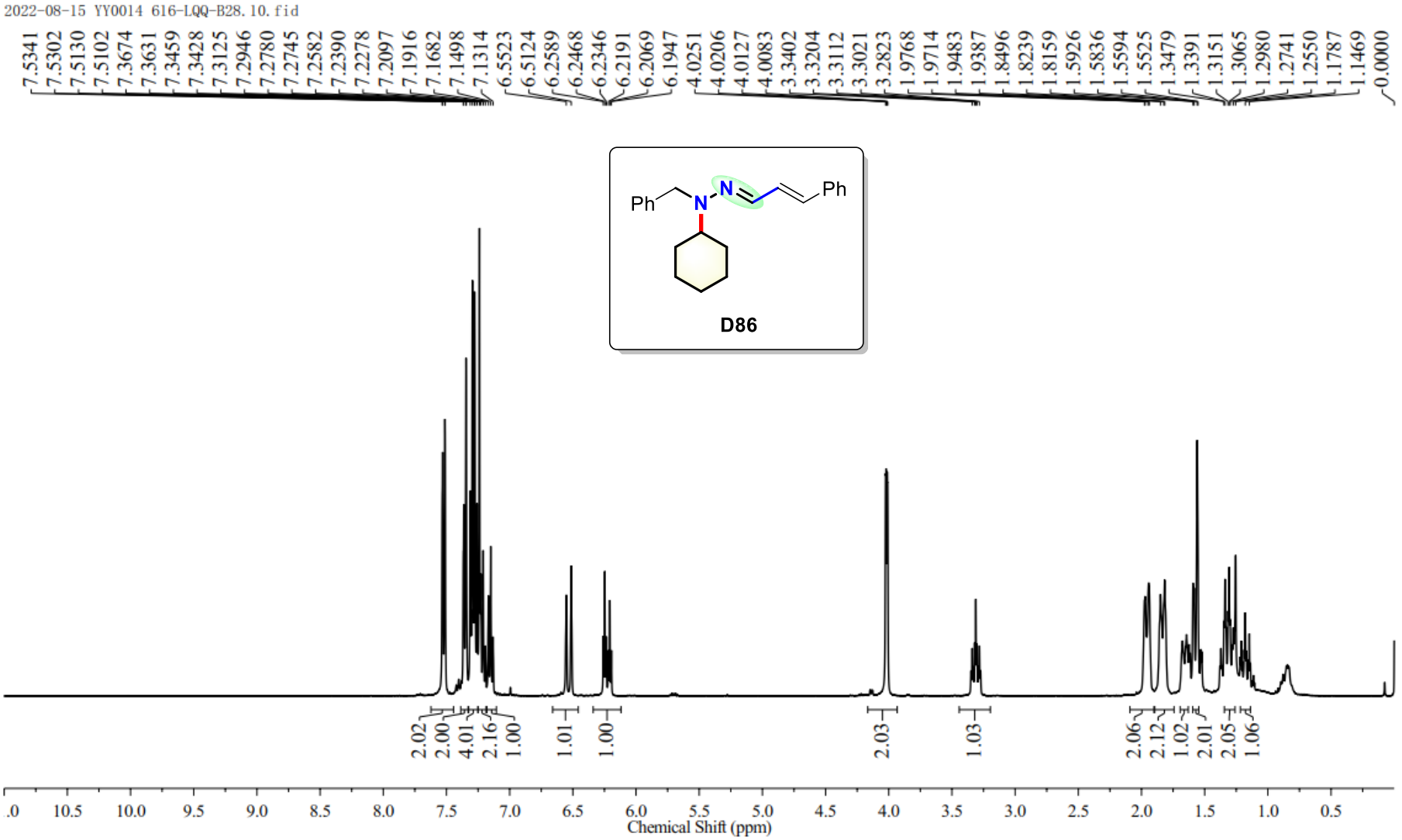

2022-10-26 yy0025 616 LQQ-20
143.49
138.27
136.83
135.02
134.95
130.10
128.76
128.70
128.67
128.22
127.80
127.42
127.21
126.69
126.46
126.13
126.10
124.20
123.72
77.62
77.30
76.98
60.51
Ph
N
N
Ph
D83
f1 (ppm)

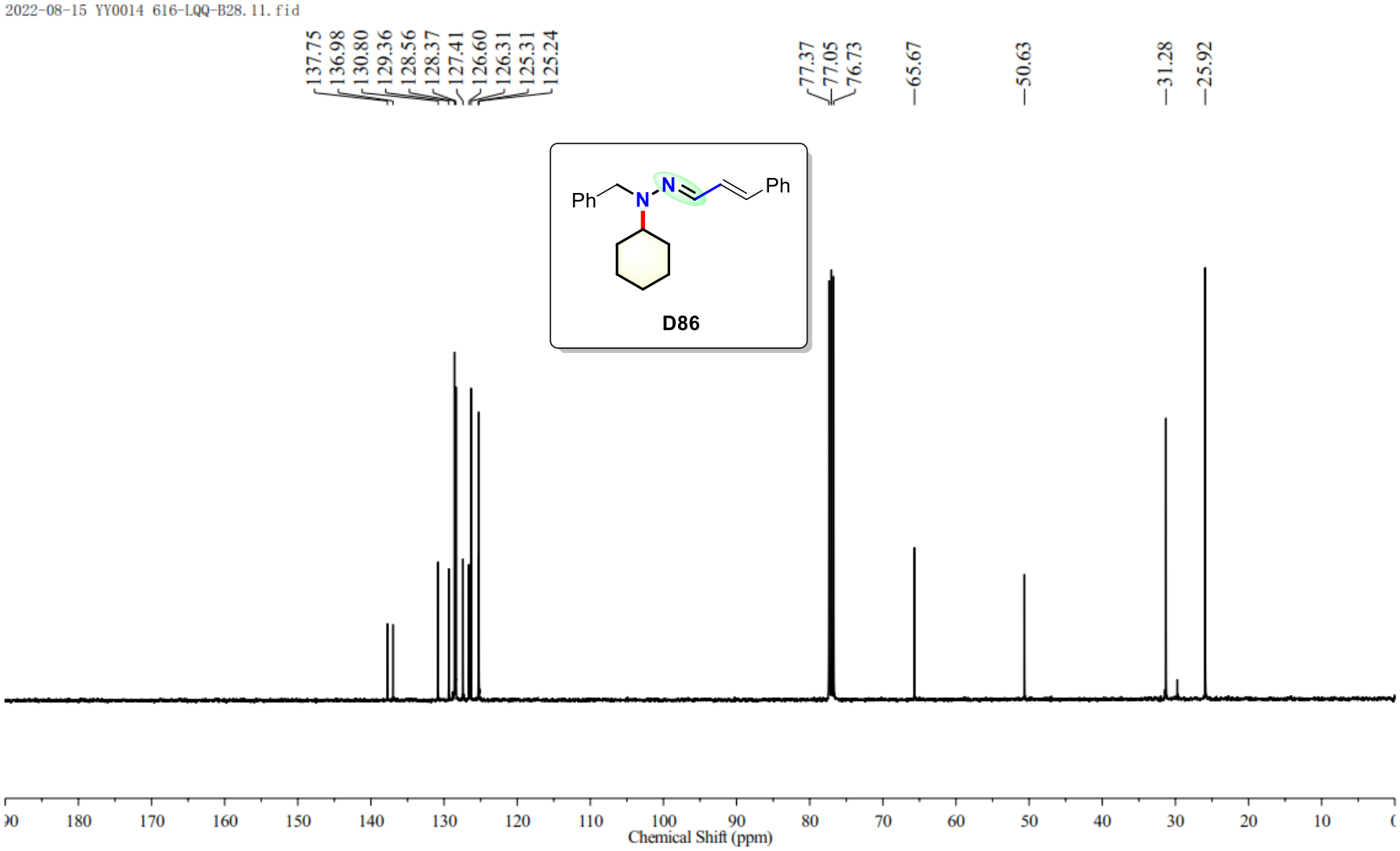

2022-11-28-yy0014-616-1qq-f26
7.4650
7.4620
7.4439
7.3437
7.3400
7.3287
7.3246
7.3072
7.3019
7.2858
7.2711
7.2523
7.2327
7.2148
7.1606
7.1423
7.1240
7.0696
4.3646
3.8529
3.8364
3.8199
3.8034
3.7868
3.7704
3.7539
1.2943
1.2778
Ph
N
N
Ph
D84
2.00
7.04
1.02
1.03
2.10
1.08
6.02
Chemical Shift (ppm)

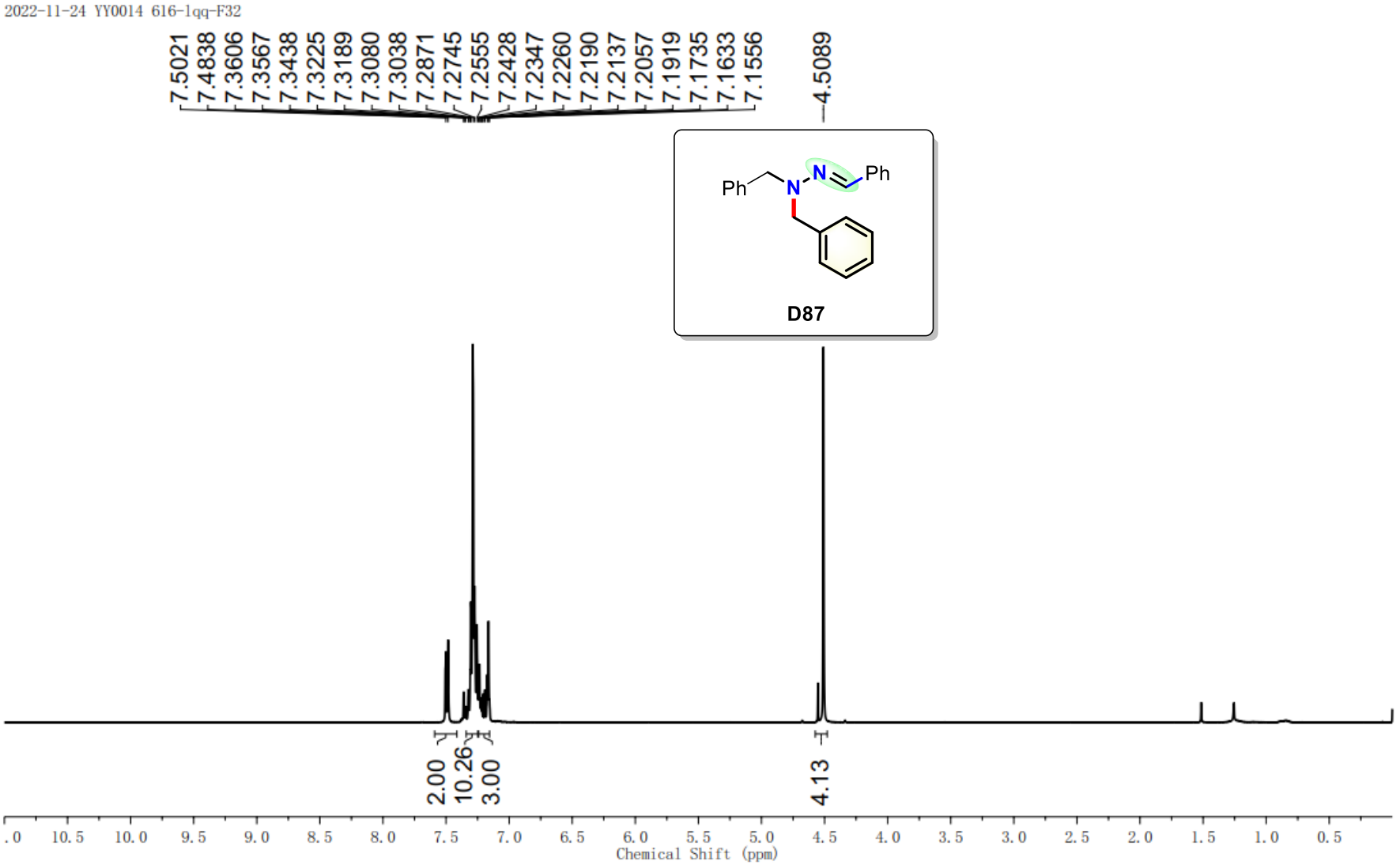

2022-12-02-yy0013-616-1qq-f26
138.19
137.51
130.69
128.70
128.33
126.86
126.80
126.43
125.32
77.36
77.04
76.72
57.76
52.61
20.41
Ph
N
N
Ph
D84
Chemical Shift (ppm)

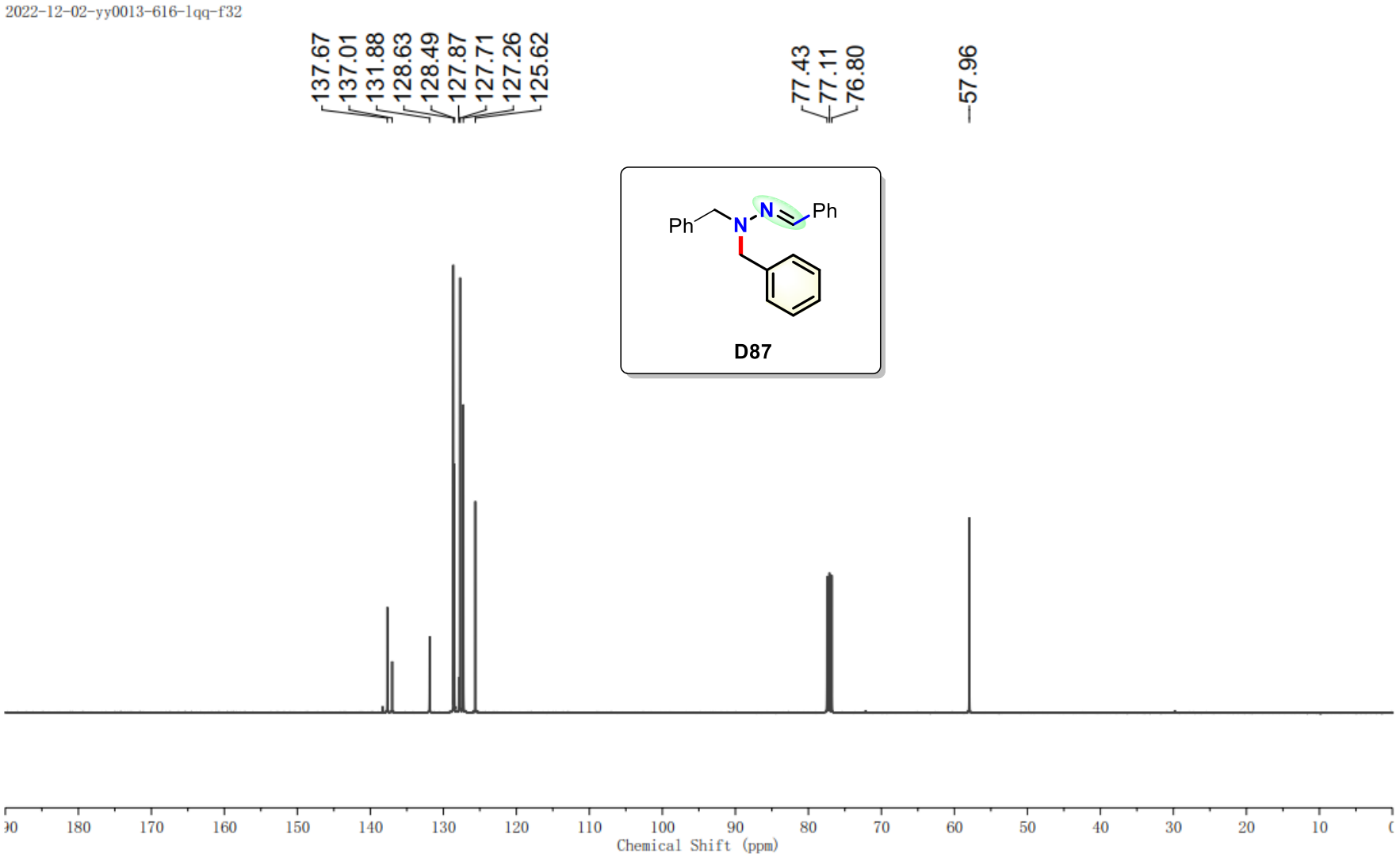

2022-11-14 yy0044 616-lqq-28
7.4497
7.4465
7.4285
7.3323
7.3134
7.2962
7.2839
7.2617
7.2471
7.2426
7.2228
7.1470
7.1441
7.1412
7.1258
7.1075
7.0297
4.4376
3.3913
3.3714
3.3623
3.3531
3.3332
2.0229
2.0181
1.9903
1.9858
1.8583
1.8253
1.6806
1.6448
1.6373
1.6134
1.6046
1.5831
1.5744
1.5518
1.5435
1.3771
1.3532
1.3449
1.3366
1.3205
1.3123
1.3040
1.2797
1.2134
1.1815
1.1728
1.1495
Ph
N
N
Ph
D85
2.06
6.99
1.05
1.02
2.00
1.05
2.09
2.09
1.05
2.04
2.00
1.09
Chemical Shift(ppm)

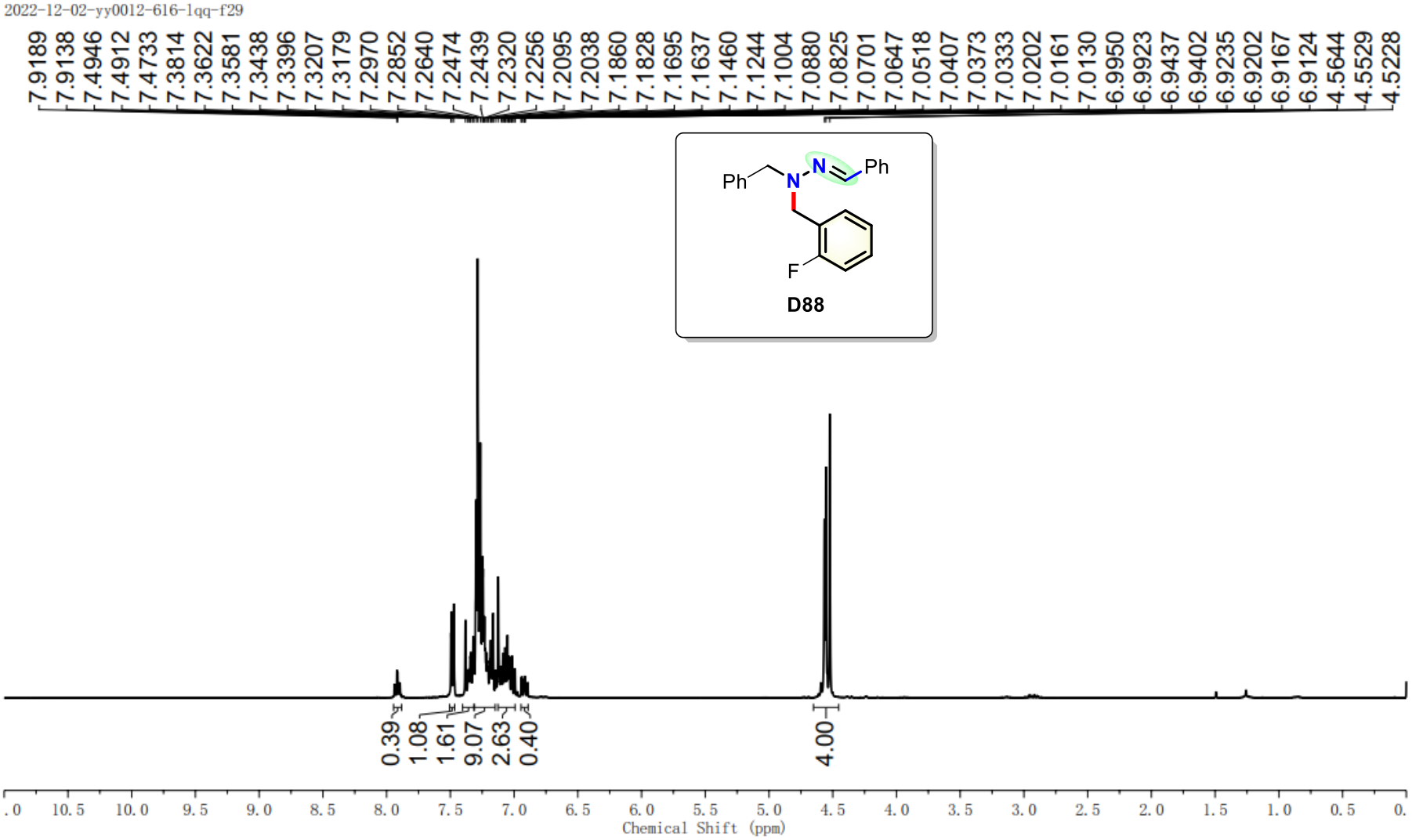

2022-11-17 yy001 616 lqq-28
138.25
137.66
129.66
128.65
128.31
126.80
126.59
126.36
125.23
66.30
52.97
31.27
25.91
Ph
N
N
Ph
D85
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

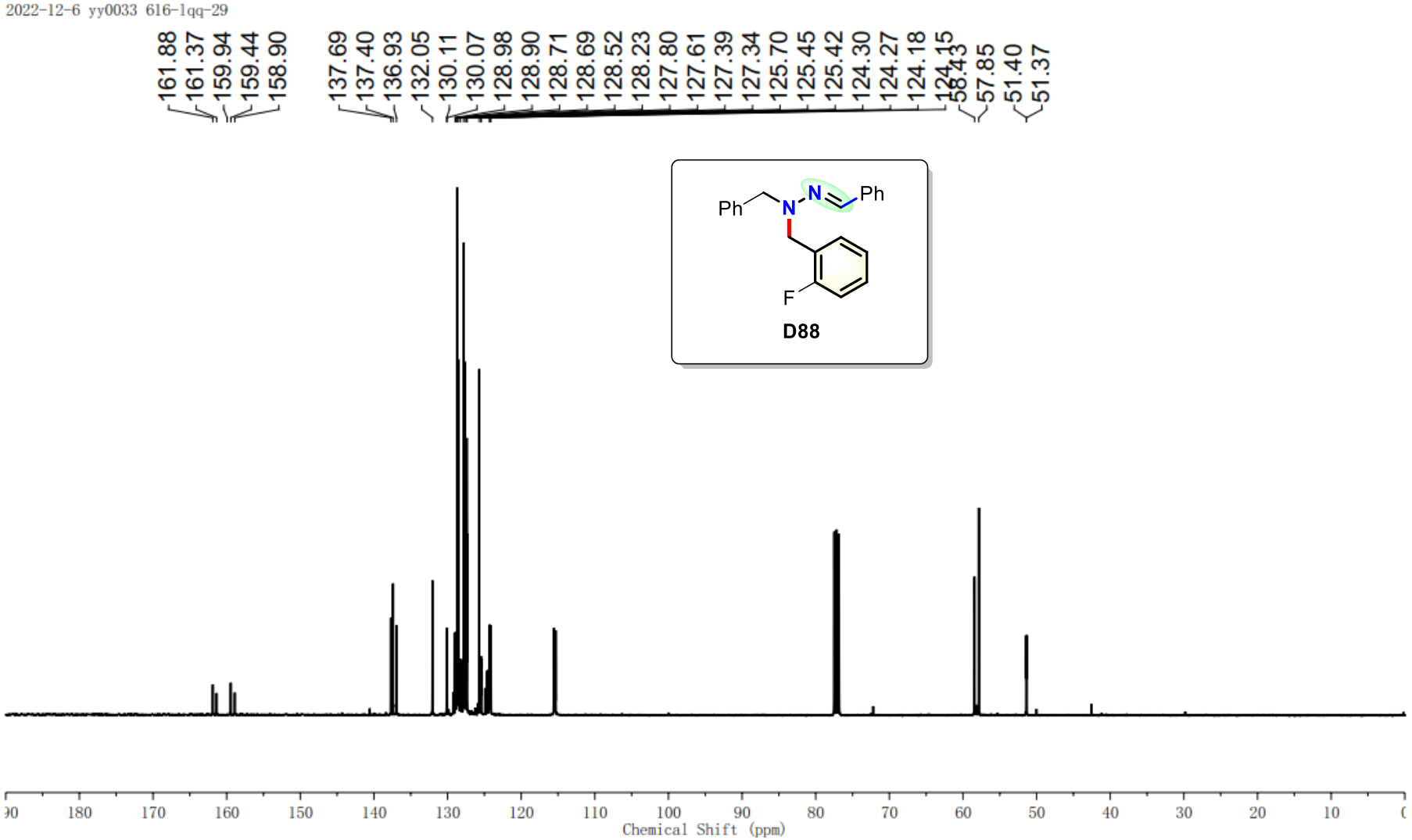

2022-08-15 YY0014 616-LQQ-B28.10.fid
7.5341
7.5302
7.5130
7.5102
7.3674
7.3631
7.3459
7.3428
7.3125
7.2946
7.2780
7.2745
7.2582
7.2390
7.2278
7.2097
7.1916
7.1682
7.1498
7.1314
6.5523
6.5124
6.2589
6.2468
6.2346
6.2191
6.2069
6.1947
4.0251
4.0206
4.0127
4.0083
3.3402
3.3204
3.3112
3.3021
3.2823
1.9768
1.9714
1.9483
1.9387
1.8496
1.8239
1.8159
1.5926
1.5836
1.5594
1.5525
1.3479
1.3391
1.3151
1.3065
1.2980
1.2741
1.2550
1.1787
1.1469
0.0000
Ph
N
N
Ph
D86
2.02
2.00
4.01
2.16
1.00
1.01
1.00
2.03
1.03
2.06
2.12
1.02
2.01
2.05
1.06
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
Chemical Shift (ppm)

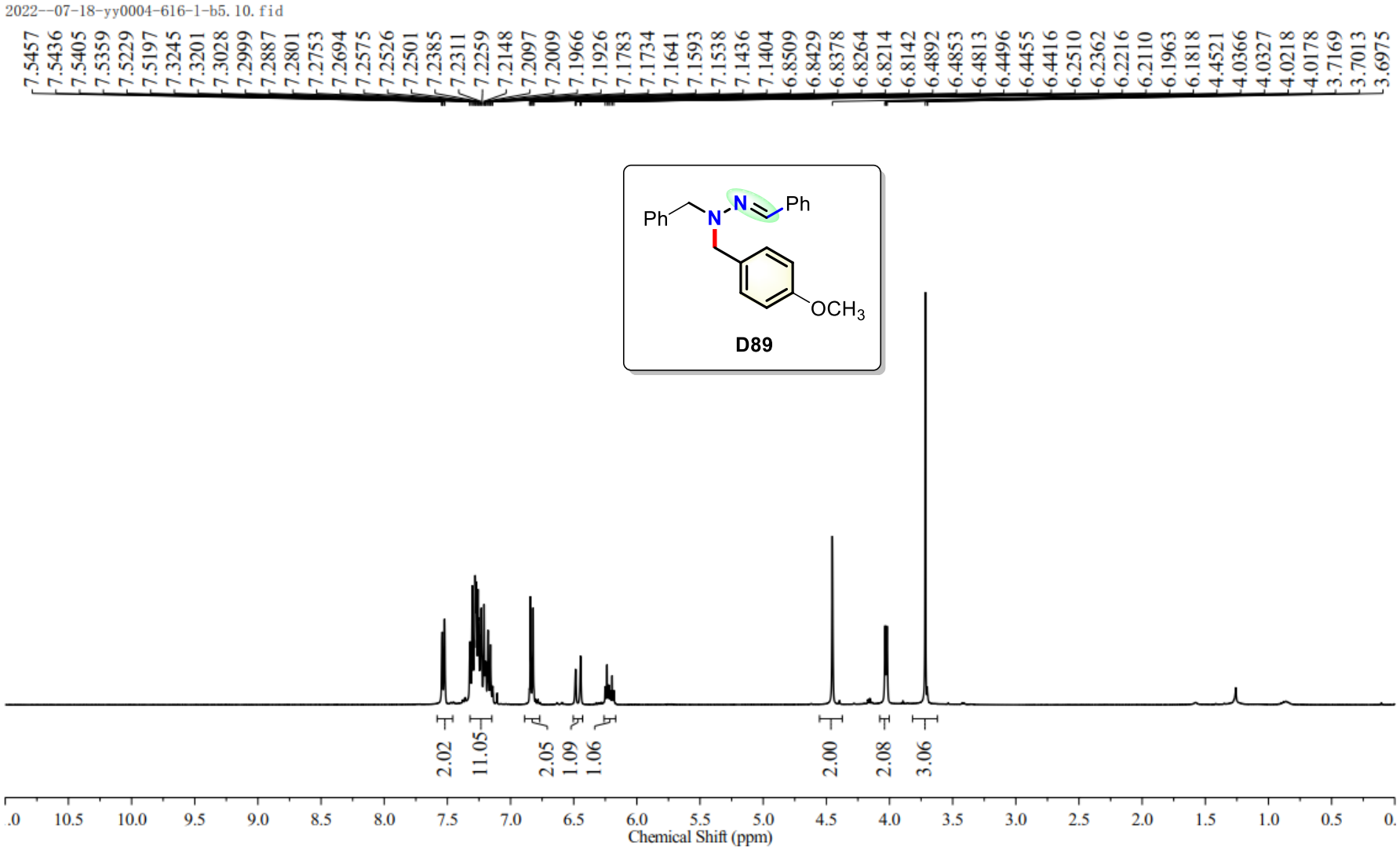

2022-08-15 YY0014 616-LQQ-B28.11.fid
137.75
136.98
130.80
129.36
128.56
128.37
127.41
126.60
126.31
125.31
125.24
77.37
77.05
76.73
65.67
50.63
31.28
25.92
Ph
N
N
Ph
D86
Chemical Shift (ppm)

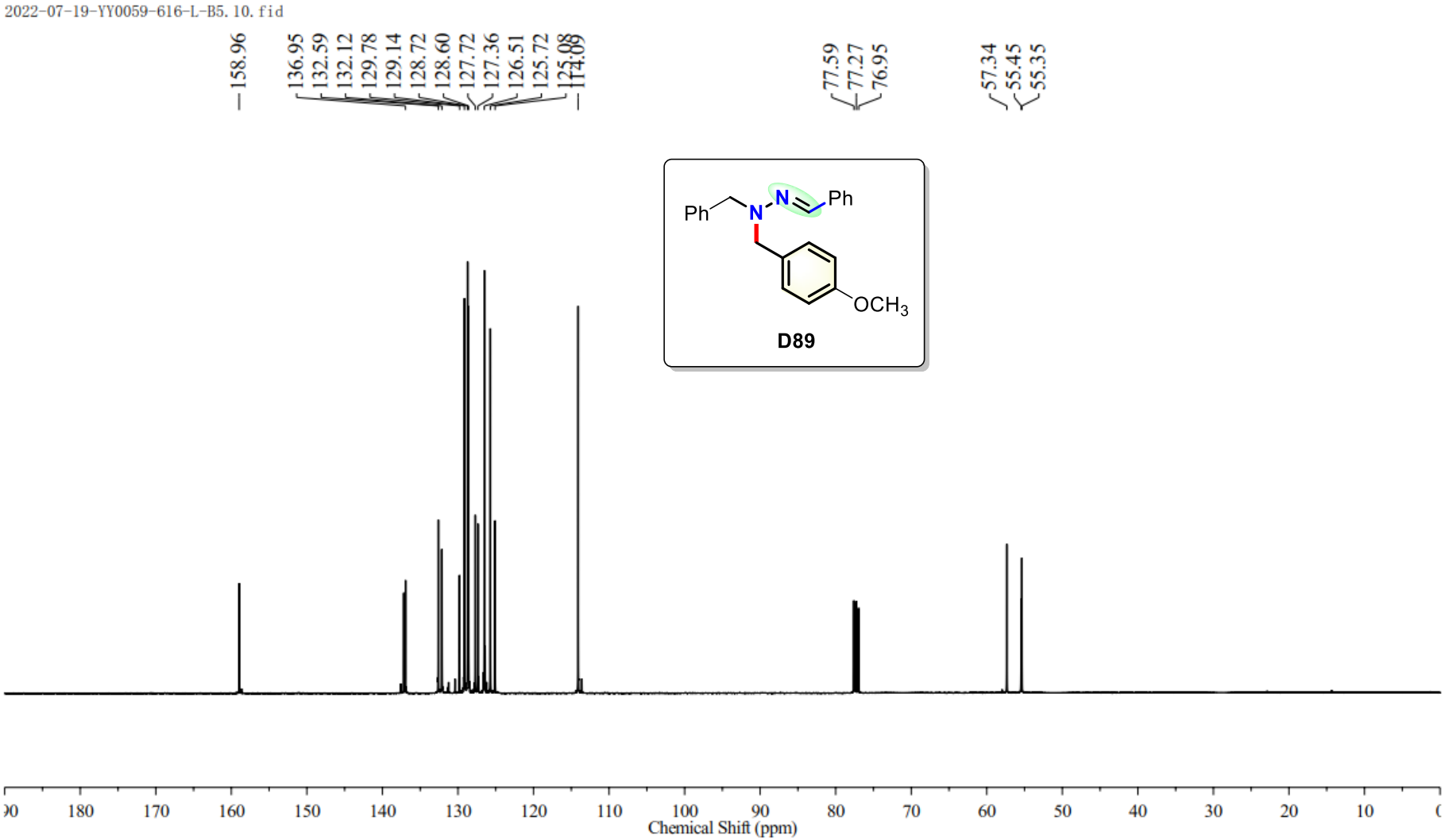

2022-11-24 YY0014 616-1qq-F32
7.5021
7.4838
7.3606
7.3567
7.3438
7.3225
7.3189
7.3080
7.3038
7.2871
7.2745
7.2555
7.2428
7.2347
7.2260
7.2190
7.2137
7.2057
7.1919
7.1735
7.1633
7.1556
4.5089
Ph
N
N
Ph
D87
2.00
10.26
3.00
4.13
Chemical Shift (ppm)

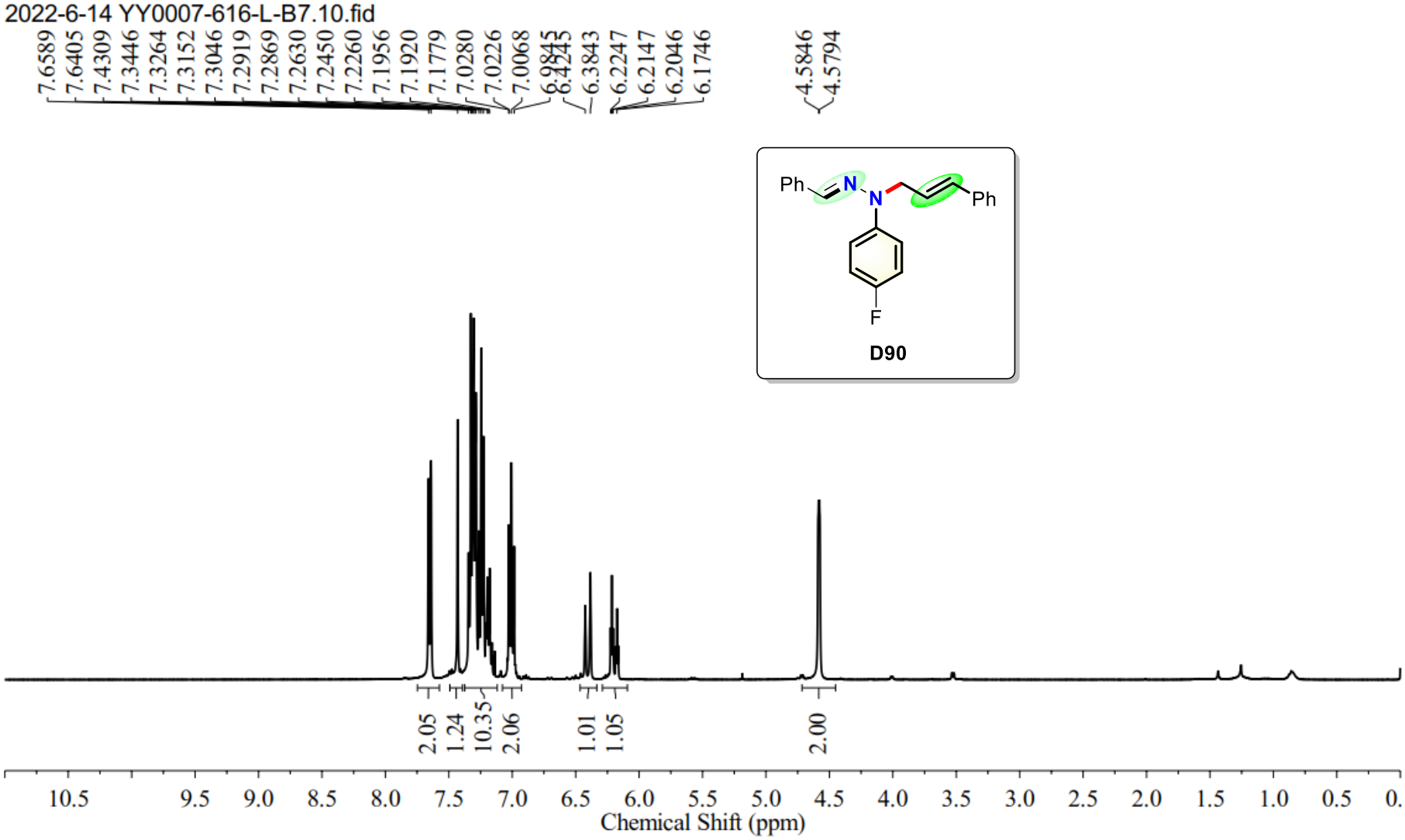

2022-12-02-yy0013-616-1qq-f32
137.67
137.01
131.88
128.63
128.49
127.87
127.71
127.26
125.62
77.43
77.11
76.80
57.96
Ph
N
N
Ph
D87
Chemical Shift (ppm)

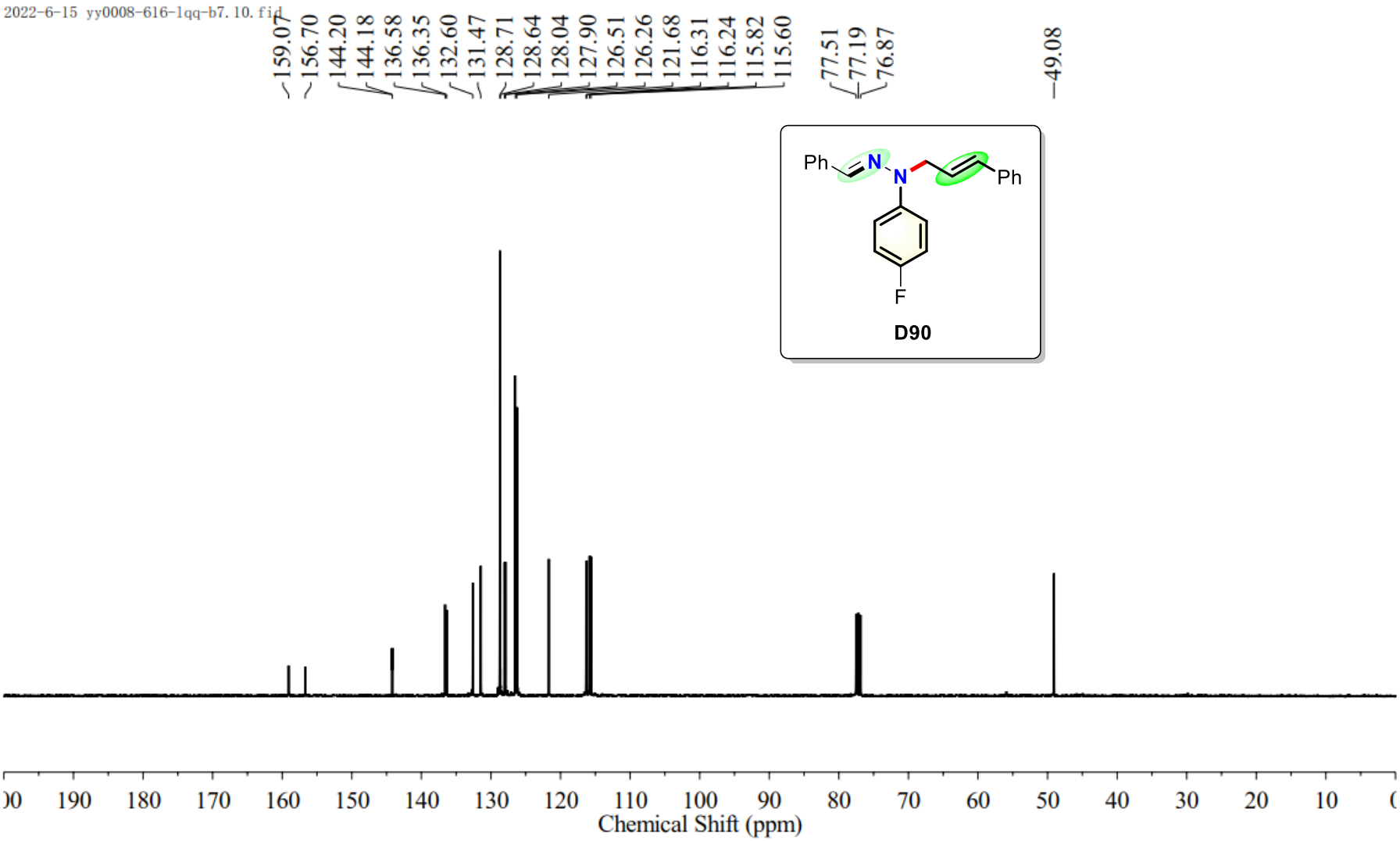

2022-12-02-yy0012-616-lqq-f29
7.9189
7.9138
7.4946
7.4912
7.4733
7.3814
7.3622
7.3581
7.3438
7.3396
7.3207
7.3179
7.2970
7.2852
7.2640
7.2474
7.2439
7.2320
7.2256
7.2095
7.2038
7.1860
7.1828
7.1695
7.1637
7.1460
7.1244
7.1004
7.0880
7.0825
7.0701
7.0647
7.0518
7.0407
7.0373
7.0333
7.0202
7.0161
7.0130
6.9950
6.9923
6.9437
6.9402
6.9235
6.9202
6.9167
6.9124
4.5644
4.5529
4.5228
Ph
N
N
Ph
F
D88
0.39
1.08
1.61
9.07
2.63
0.40
4.00
Chemical Shift (ppm)

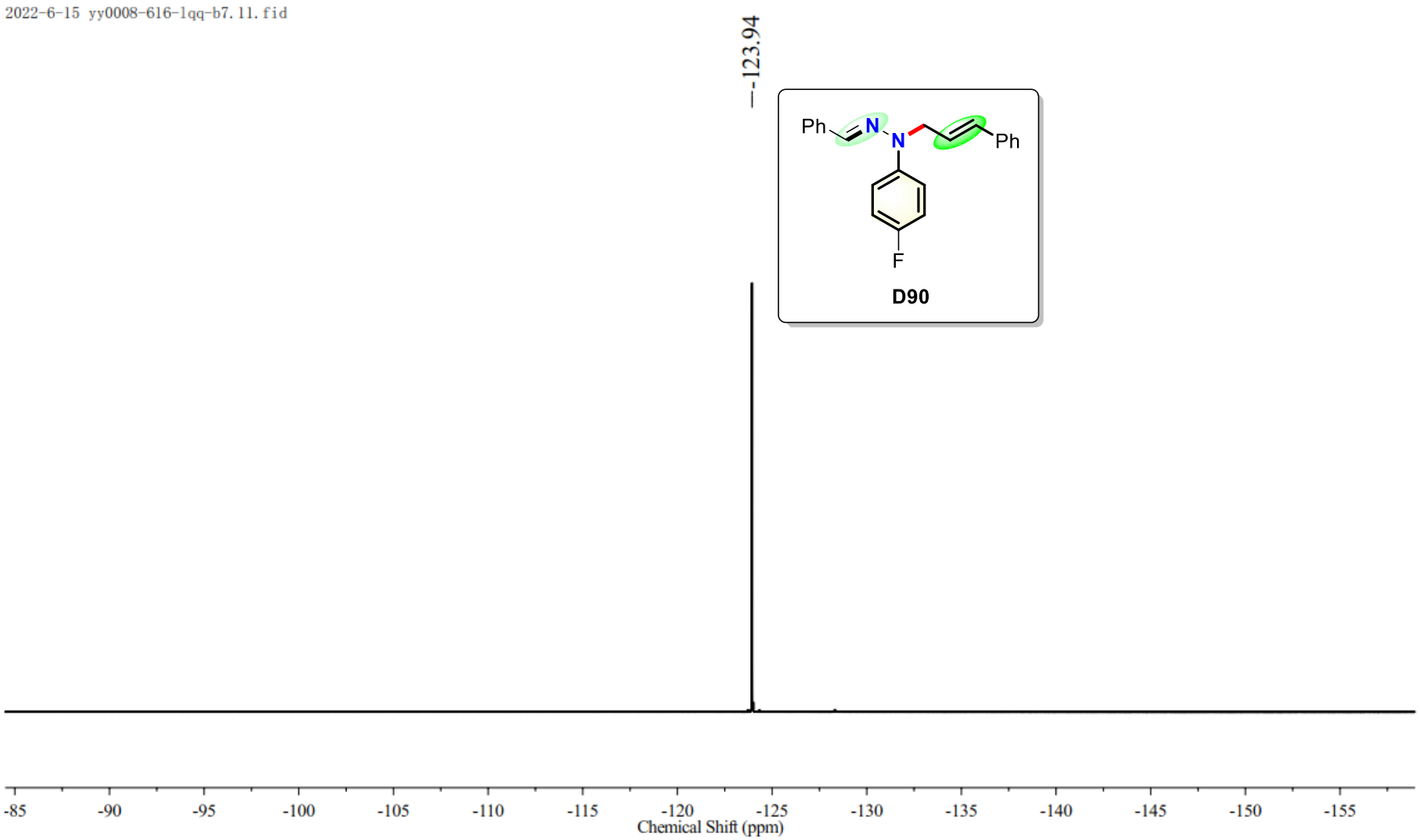

2022-12-6 yy0033 616-1qq-29
161.88
161.37
159.94
159.44
158.90
137.69
137.40
136.93
132.05
130.11
130.07
128.98
128.90
128.71
128.69
128.52
128.23
127.80
127.61
127.39
127.34
125.70
125.45
125.42
124.30
124.27
124.18
124.15
58.43
57.85
51.40
51.37
Ph
N
N
Ph
F
D88
Chemical Shift (ppm)

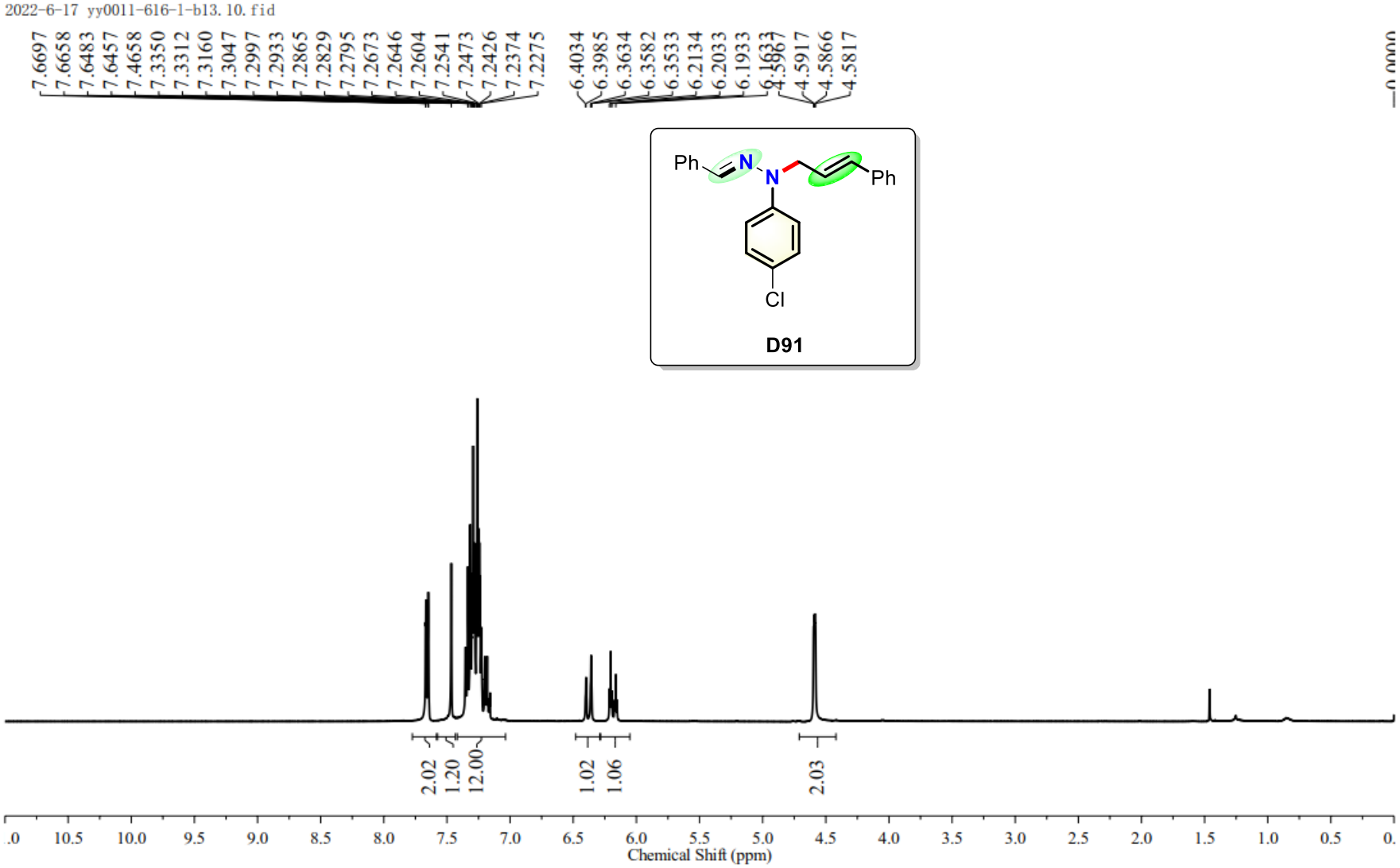

2022--07-18-yy0004-616-1-b5.10.fid
7.5457
7.5436
7.5405
7.5359
7.5229
7.5197
7.3245
7.3201
7.3028
7.2999
7.2887
7.2801
7.2753
7.2694
7.2575
7.2526
7.2501
7.2385
7.2311
7.2259
7.2148
7.2097
7.2009
7.1966
7.1926
7.1783
7.1734
7.1641
7.1593
7.1538
7.1436
7.1404
6.8509
6.8429
6.8378
6.8264
6.8214
6.8142
6.4892
6.4853
6.4813
6.4496
6.4455
6.4416
6.2510
6.2362
6.2216
6.2110
6.1963
6.1818
4.4521
4.0366
4.0327
4.0218
4.0178
3.7169
3.7013
3.6975
Ph
N
N
Ph
OCH3
D89
2.02
11.05
2.05
1.09
1.06
2.00
2.08
3.06
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.
Chemical Shift (ppm)

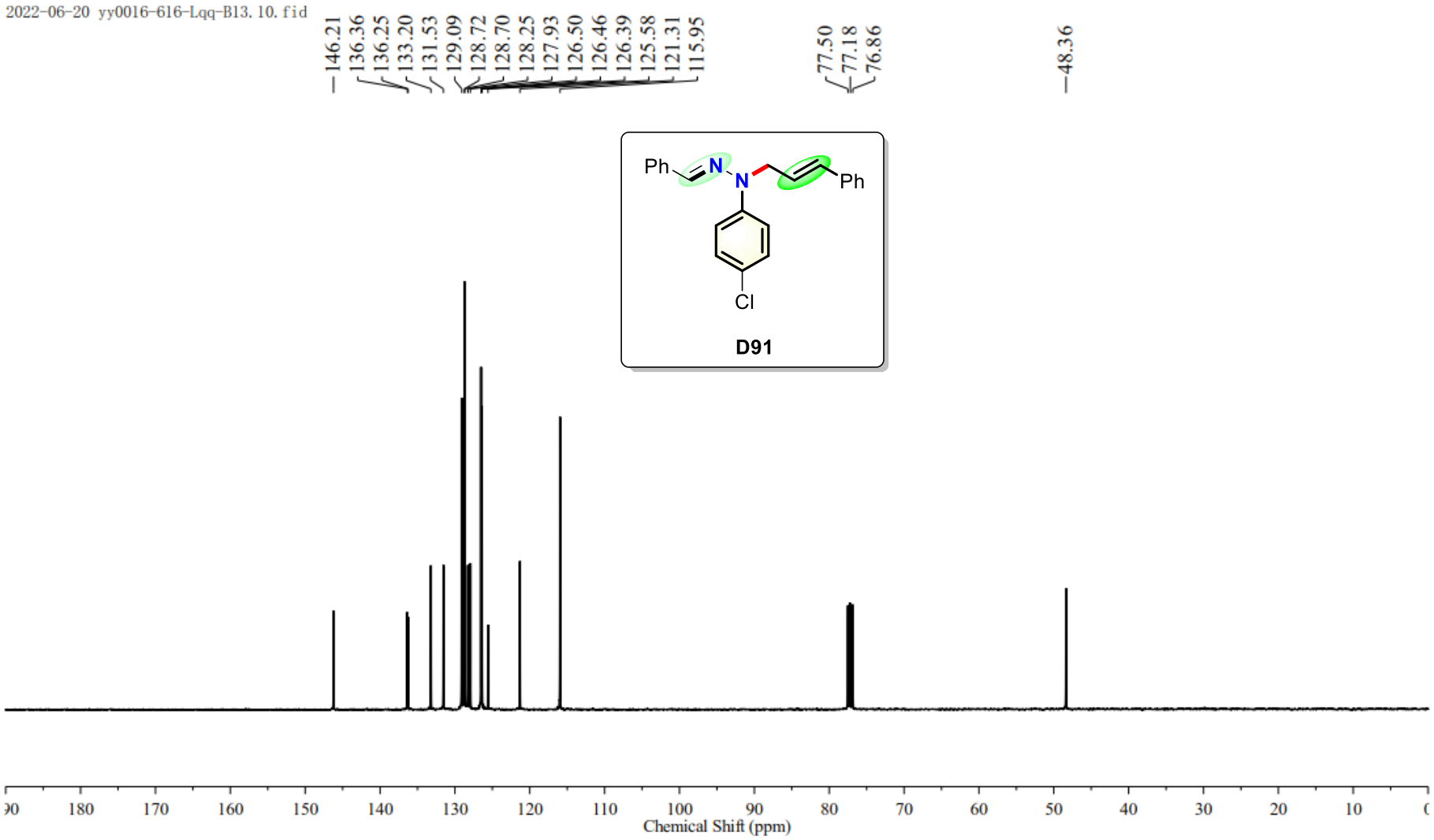

2022-07-19-YY0059-616-L-B5.10.fid
158.96
136.95
132.59
132.12
129.78
129.14
128.72
128.60
127.72
127.36
126.51
125.72
125.08
114.09
77.59
77.27
76.95
57.34
55.45
55.35
Ph
N
N
Ph
OCH3
D89
90
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

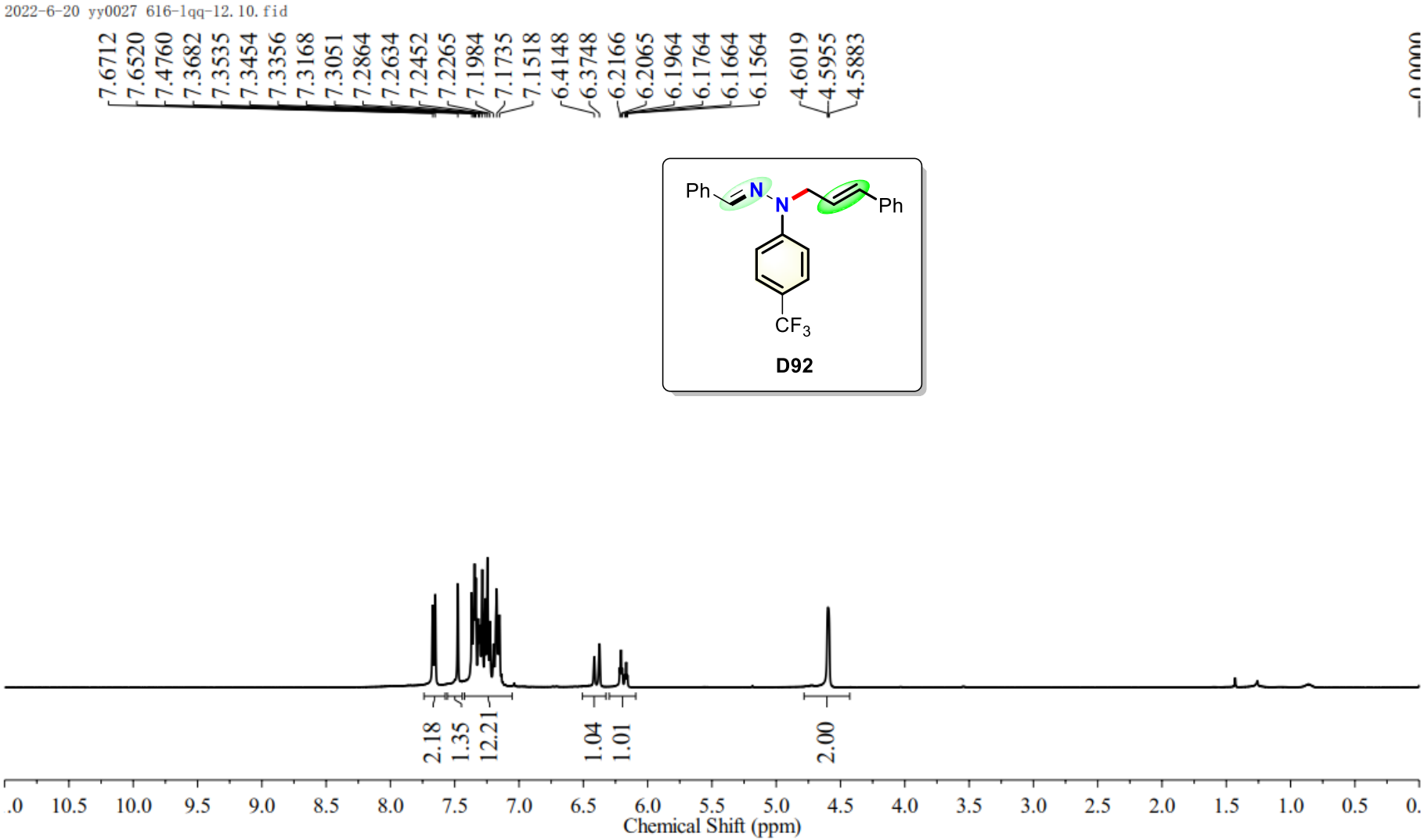

2022-6-14 YY0007-616-L-B7.10.fid
7.6589
7.6405
7.4309
7.3446
7.3264
7.3152
7.3046
7.2919
7.2869
7.2630
7.2450
7.2260
7.1956
7.1920
7.1779
7.0280
7.0226
7.0068
6.9845
6.4245
6.3843
6.2247
6.2147
6.2046
6.1746
4.5846
4.5794
Ph
N
N
Ph
F
D90
2.05
1.24
10.35
2.06
1.01
1.05
2.00
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.
Chemical Shift (ppm)

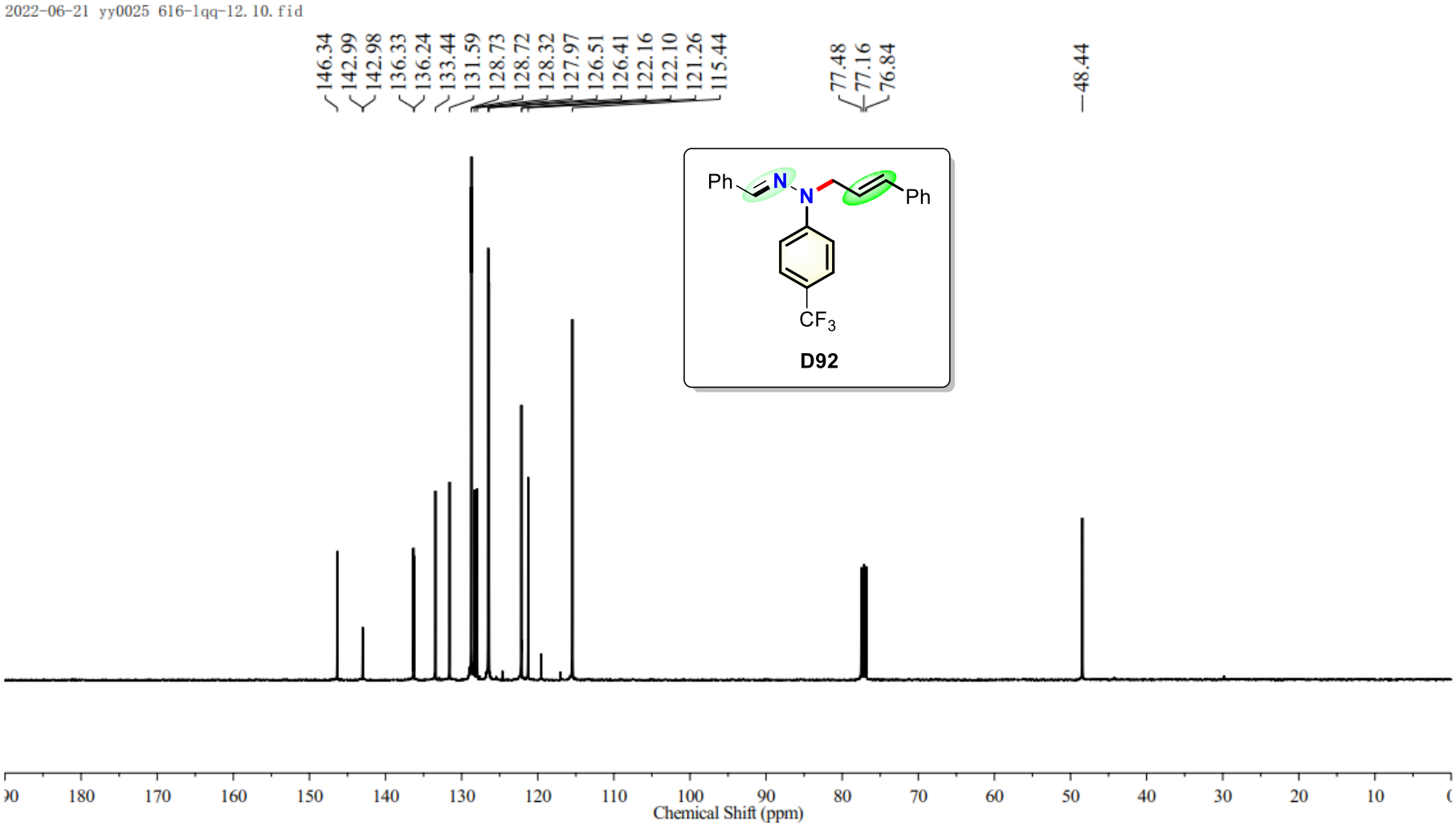

2022-6-15 yy0008-616-lqq-b7.10.fid
159.07
156.70
144.20
144.18
136.58
136.35
132.60
131.47
128.71
128.64
128.04
127.90
126.51
126.26
121.68
116.31
116.24
115.82
115.60
77.51
77.19
76.87
49.08
Ph
N
N
Ph
F
D90
Chemical Shift (ppm)


2022-6-15 yy0008-616-1qq-b7.11.fid
-123.94
Ph
N
N
Ph
F
D90
-85
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
-145
-150
-155
Chemical Shift (ppm)

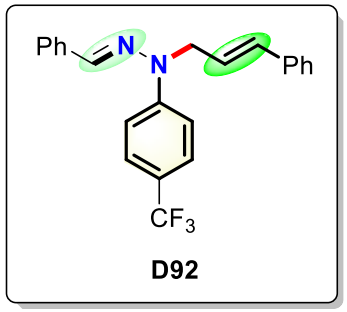

2022-6-17 yy0011-616-1-b13.10.fid
7.6697
7.6658
7.6483
7.6457
7.4658
7.3350
7.3312
7.3160
7.3047
7.2997
7.2933
7.2865
7.2829
7.2795
7.2673
7.2646
7.2604
7.2541
7.2473
7.2426
7.2374
7.2275
6.4034
6.3985
6.3634
6.3582
6.3533
6.2134
6.2033
6.1933
4.5917
4.5866
4.5817
Ph
N
N
Ph
Cl
D91
2.02
1.20
12.00
1.02
1.06
2.03
Chemical Shift (ppm)


2022-06-20 yy0016-616-Lqq-B13.10.fid
146.21
136.36
136.25
133.20
131.53
129.09
128.72
128.70
128.25
127.93
126.50
126.46
126.39
125.58
121.31
115.95
77.50
77.18
76.86
48.36
Ph
N
N
Ph
Cl
D91
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)


2022-6-20 yy0027 616-lqq-12.10.fid
7.6712
7.6520
7.4760
7.3682
7.3535
7.3454
7.3356
7.3168
7.3051
7.2864
7.2634
7.2452
7.2265
7.1984
7.1735
7.1518
6.4148
6.3748
6.2166
6.2065
6.1964
6.1764
6.1664
6.1564
4.6019
4.5955
4.5883
Ph
N
N
Ph
CF3
D92
2.18
1.35
12.21
1.04
1.01
2.00
.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.
Chemical Shift (ppm)


2022-06-21 yy0025 616-lqq-12.10.fid
146.34
142.99
142.98
136.33
136.24
133.44
131.59
128.73
128.72
128.32
127.97
126.51
126.41
122.16
122.10
121.26
115.44
77.48
77.16
76.84
48.44
Ph
N
N
Ph
CF3
D92
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Chemical Shift (ppm)

2022-06-21 yy0025 616-lqq-12.11.fid




D92

-58.05

-15 -20 -25 -30 -35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85 -90 -95 -100

Chemical Shift (ppm)