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Supporting Information

Gold-catalyzed cascade cyclization of *N*-propargyl ynamides: rapid access to functionalized indeno[1,2-*c*]pyrroles

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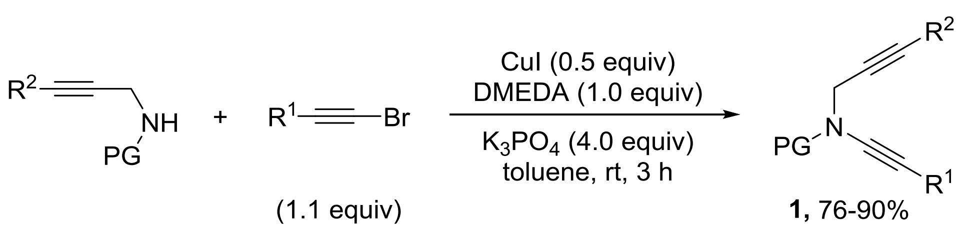
General Information. Ethyl acetate (ACS grade), hexanes (ACS grade) and anhydrous 1,2-dichloroethane (ACS grade) were obtained commercially and used without further purification. Methylene chloride, tetrahydrofuran and diethyl ether were purified according to standard methods unless otherwise noted. Commercially available reagents were used without further purification. Reactions were monitored by thin layer chromatography (TLC) using silicycle pre-coated silica gel plates. Flash column chromatography was performed over silica gel (300-400 mesh). Infrared spectra were recorded on a Nicolet AVATER FTIR330 spectrometer as thin film and are reported in reciprocal centimeter (cm^{-1}). Mass spectra were recorded with Micromass QTOF2 Quadrupole/Time-of-Flight Tandem mass spectrometer using electron spray ionization.

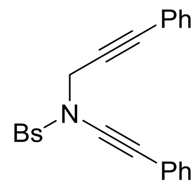
^{1}H NMR spectra were recorded on a Bruker AV-400 spectrometer and a Bruker AV-500 spectrometer in chloroform-d_3. Chemical shifts are reported in ppm with the internal TMS signal at 0.0 ppm as a standard. The data is being reported as (s = singlet, d = doublet, t = triplet, m = multiplet or unresolved, brs = broad singlet, coupling constant(s) in Hz, integration).

^{13}C NMR spectra were recorded on a Bruker AV-400 spectrometer and a Bruker AV-500 spectrometer in chloroform-d_3. Chemical shifts are reported in ppm with the internal chloroform signal at 77.0 ppm as a standard.

Representative synthetic procedures for the preparation of ynamides 1 (1a-1r):[1]



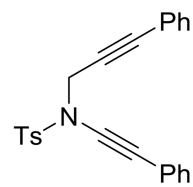
4-bromo-*N*-(phenylethynyl)-*N*-(3-phenylprop-2-yn-1-yl)benzenesulfonamide (1a)



1a

Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, *J* = 7.8 Hz, 2H), 7.63 (d, *J* = 7.9 Hz, 2H), 7.43 – 7.24 (m, 8H), 7.20 – 7.12 (m, 2H), 4.59 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 136.2, 132.2, 131.7, 131.6, 129.7, 129.2, 128.8, 128.3, 128.2, 122.2, 121.7, 86.9, 81.4, 80.7, 71.4, 43.1; IR (neat): 2922, 2235, 1573, 1489, 1442, 1390, 1372, 1276, 1171, 1087, 1068, 1009, 917, 756; HRESIMS Calcd for $[C_{23}H_{16}BrNNaO_2S]^+$ (M + Na^+) 471.9977, found 471.9979.

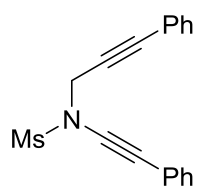
4-methyl-*N*-(phenylethynyl)-*N*-(3-phenylprop-2-yn-1-yl)benzenesulfonamide (1b)



1b

Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (d, *J* = 8.3 Hz, 2H), 7.40 – 7.38 (m, 2H), 7.29 – 7.23 (m, 8H), 7.17 – 7.15 (m, 2H), 4.56 (s, 2H), 2.35 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.9, 134.3, 131.6, 131.5, 129.6, 128.6, 128.2, 128.1, 127.9, 122.6, 122.0, 86.5, 82.0, 81.1, 71.2, 42.9, 21.5; IR (neat): 2920, 2233, 1597, 1573, 1490, 1368, 1169, 1089, 1050, 916, 755; HRESIMS Calcd for $[C_{24}H_{19}NNaO_2S]^+$ (M + Na^+) 408.1029, found 408.1032.

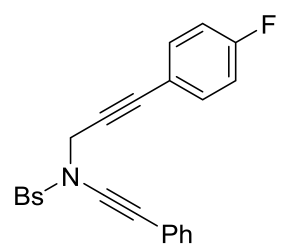
***N*-(phenylethynyl)-*N*-(3-phenylprop-2-yn-1-yl)methanesulfonamide (1c)**



1c

Yellow oil. ^1H NMR (400 MHz, $CDCl_3$) δ 7.47 – 7.44 (m, 4H), 7.36 – 7.30 (m, 6H), 4.61 (s, 2H), 3.27 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 131.8, 131.7, 129.0, 128.5, 128.3, 128.2, 122.2, 121.7, 87.0, 81.4, 81.2, 71.3, 43.0, 38.7; IR (neat): 22929, 2236, 1597, 1572, 1490, 1442, 1363, 1262, 1166, 1113, 1040, 917, 755; HRESIMS Calcd for $[C_{18}H_{15}NNaO_2S]^+$ (M + Na^+) 332.0716, found 332.0717.

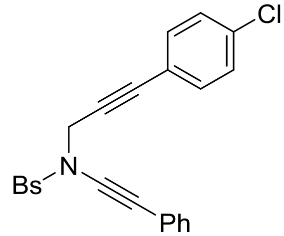
4-bromo-*N*-(3-(4-fluorophenyl)prop-2-yn-1-yl)-*N*-(phenylethynyl)benzenesulfonamide (1d)



1d

Yellow oil. ^1H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, *J* = 8.8 Hz, 2H), 7.63 (d, *J* = 8.8 Hz, 2H), 7.40 – 7.38 (m, 2H), 7.31 – 7.29 (m, 3H), 7.15 – 7.12 (m, 2H), 6.97 (t, *J* = 8.7 Hz, 2H), 4.56 (s, 2H).; ^{13}C NMR (125 MHz, $CDCl_3$) δ 162.7 (d, *J* = 248.8 Hz), 136.2, 133.5 (d, *J* = 8.8 Hz), 132.2, 131.6, 129.7, 129.2, 128.3, 128.2, 122.2, 117.7 (d, *J* = 3.8 Hz), 115.7 (d, *J* = 22.5 Hz), 85.8, 81.4, 80.5 (d, *J* = 1.3 Hz), 71.4, 43.0; IR (neat): 2928, 2236, 1600, 1573, 1506, 1442, 1371, 1231, 1173, 1088, 918, 757; HRESIMS Calcd for $[C_{23}H_{15}BrFNNaO_2S]^+$ (M + Na^+) 489.9883, found 489.9882.

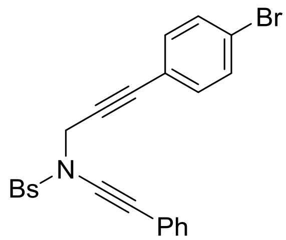
4-bromo-*N*-(3-(4-chlorophenyl)prop-2-yn-1-yl)-*N*-(phenylethynyl)benzenesulfonamide (1e)



1e

Yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.4 Hz, 2H), 7.63 (d, *J* = 8.4 Hz, 2H), 7.43 – 7.35 (m, 2H), 7.34 – 7.28 (m, 3H), 7.26 (d, *J* = 8.1 Hz, 2H), 7.07 (d, *J* = 8.3 Hz, 2H), 4.57 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 136.2, 134.9, 132.8, 132.3, 131.7, 129.7, 129.2, 128.7, 128.4, 128.3, 122.2, 120.1, 85.8, 81.8, 81.3, 71.5, 43.0; IR (neat): 2923, 2236, 1573, 1489, 1390, 1372, 1266, 1173, 1088, 1010, 918, 751; HRESIMS Calcd for $[C_{23}H_{15}BrClNNaO_2S]^+$ (M + Na^+) 505.9588, found 505.9594.

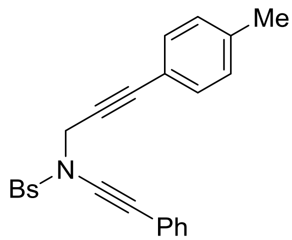
4-bromo-*N*-(3-(4-bromophenyl)prop-2-yn-1-yl)-*N*-(phenylethynyl)benzenesulfonamide (1f)



1f

Yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.3 Hz, 2H), 7.63 (d, *J* = 8.3 Hz, 2H), 7.43 – 7.35 (m, 4H), 7.31 – 7.28 (m, 3H), 7.00 (d, *J* = 8.2 Hz, 2H), 4.56 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 136.2, 133.0, 132.3, 131.7, 131.6, 129.7, 129.2, 128.4, 128.3, 123.2, 122.1, 120.6, 85.8, 82.0, 81.3, 71.5, 43.0; IR (neat): 2922, 2235, 1573, 1485, 1442, 1390, 1372, 1087, 1069, 1010, 918, 742; HRESIMS Calcd for $[C_{23}H_{15}Br_2NNaO_2S]^+$ (M + Na^+) 549.9082, found 549.9083.

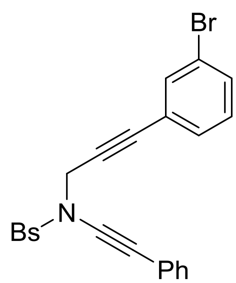
4-bromo-*N*-(phenylethynyl)-*N*-(3-(*p*-tolyl)prop-2-yn-1-yl)benzenesulfonamide (1g)



1g

Yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.5 Hz, 2H), 7.61 (d, *J* = 8.5 Hz, 2H), 7.43 – 7.35 (m, 2H), 7.33 – 7.28 (m, 3H), 7.09 – 7.03 (m, 4H), 4.57 (s, 2H), 2.33 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 139.0, 136.2, 132.2, 131.7, 131.5, 129.7, 129.1, 129.0, 128.3, 128.2, 122.2, 118.6, 87.1, 81.5, 80.1, 71.4, 43.2, 21.4; IR (neat): 2920, 2235, 1573, 1508, 1469, 1390, 1371, 1172, 1110, 1087, 1068, 917, 816, 757; HRESIMS Calcd for $[C_{24}H_{18}BrNNaO_2S]^+$ (M + Na^+) 486.0134, found 486.0138.

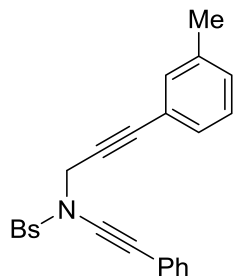
4-bromo-*N*-(3-(3-bromophenyl)prop-2-yn-1-yl)-*N*-(phenylethynyl)benzenesulfonamide (1h)



1h

Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.3 Hz, 2H), 7.63 (d, *J* = 8.3 Hz, 2H), 7.44 – 7.39 (m, 3H), 7.34 – 7.23 (m, 4H), 7.13 (t, *J* = 7.8 Hz, 1H), 7.06 (d, *J* = 7.7 Hz, 1H), 4.57 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 136.0, 134.2, 132.2, 131.9, 131.6, 130.1, 129.7, 129.6, 129.3, 128.3, 128.2, 123.5, 122.0, 121.9, 85.2, 82.2, 81.3, 71.4, 42.9; IR (neat): 2921, 2235, 1573, 1511, 1489, 1442, 1390, 1371, 1172, 1088, 1009, 918, 754; HRESIMS Calcd for $[C_{23}H_{15}Br_2NNaO_2S]^+$ (M + Na^+) 549.9082, found 549.9083.

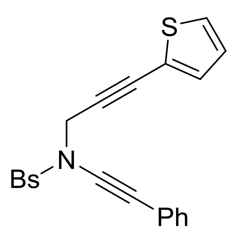
4-bromo-*N*-(phenylethynyl)-*N*-(3-(*m*-tolyl)prop-2-yn-1-yl)benzenesulfonamide (1i)



1i

Yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.89 (d, *J* = 8.4 Hz, 2H), 7.62 (d, *J* = 8.4 Hz, 2H), 7.43 – 7.38 (m, 2H), 7.34 – 7.27 (m, 3H), 7.17 – 7.10 (m, 2H), 7.00 – 6.90 (m, 2H), 4.57 (s, 2H), 2.30 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 138.0, 136.2, 132.2, 132.1, 131.7, 129.7, 129.1, 128.7, 128.3, 128.2, 122.2, 121.5, 87.1, 81.5, 80.3, 71.4, 43.1, 21.2; IR (neat): 2921, 2235, 1599, 1573, 1485, 1390, 1371, 1276, 1173, 1087, 1068, 1009, 919, 821, 757; HRESIMS Calcd for $[C_{24}H_{18}BrNNaO_2S]^+$ (M + Na^+) 486.0134, found 486.0137.

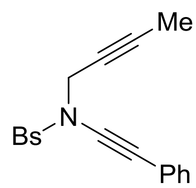
4-bromo-*N*-(phenylethynyl)-*N*-(3-(thiophen-2-yl)prop-2-yn-1-yl)benzenesulfonamide (1j)



1j

Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 8.6 Hz, 2H), 7.62 (d, *J* = 8.6 Hz, 2H), 7.43 – 7.36 (m, 2H), 7.32 – 7.27 (m, 3H), 7.23 – 7.22 (m, 1H), 7.05 – 6.98 (m, 1H), 6.95 – 6.88 (m, 1H), 4.58 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 136.0, 132.7, 132.2, 131.6, 129.5, 129.2, 128.2, 128.1, 127.8, 126.9, 122.1, 121.4, 84.7, 81.3, 80.2, 71.4, 43.2; IR (neat): 2925, 2235, 1709, 1573, 1489, 1390, 1364, 1278, 1169, 1068, 1009, 917, 820, 750; HRESIMS Calcd for $[C_{21}H_{14}BrNNaO_2S_2]^+$ (M + Na^+) 477.9542, found 477.9545.

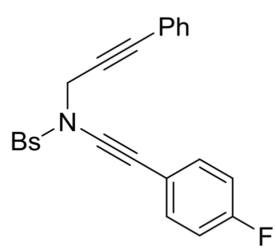
4-bromo-*N*-(but-2-yn-1-yl)-*N*-(phenylethynyl)benzenesulfonamide (1k)



1k

Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 8.7 Hz, 2H), 7.70 (d, *J* = 8.7 Hz, 2H), 7.40 – 7.38 (m, 2H), 7.32 – 7.30 (m, 3H), 4.30 (q, *J* = 2.4 Hz, 2H), 1.65 (t, *J* = 2.4 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 136.3, 132.1, 131.6, 129.7, 129.0, 128.3, 128.1, 122.3, 83.2, 81.5, 71.1, 70.9, 42.8, 3.4; IR (neat): 2920, 2236, 1573, 1489, 1390, 1369, 1276, 1172, 1110, 1087, 1009, 919, 820, 757; HRESIMS Calcd for $[C_{18}H_{14}BrNNaO_2S]^+$ (M + Na^+) 409.9821, found 409.9828.

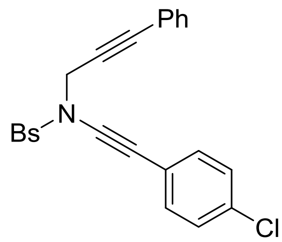
4-bromo-*N*-((4-fluorophenyl)ethynyl)-*N*-(3-phenylprop-2-yn-1-yl)benzenesulfonamide (1l)



1l

Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.7 Hz, 2H), 7.61 (d, *J* = 8.7 Hz, 2H), 7.38 – 7.34 (m, 2H), 7.30 – 7.24 (m, 3H), 7.17 – 7.11 (m, 2H), 6.97 (t, *J* = 8.7 Hz, 2H), 4.57 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 162.4 (d, *J* = 249.0 Hz), 136.1, 133.7 (d, *J* = 9.0 Hz), 132.2, 131.5, 129.5, 129.2, 128.7, 128.3, 121.5, 118.1 (d, *J* = 4.0 Hz), 115.5 (d, *J* = 22.0 Hz), 86.8, 81.1, 80.7, 70.3, 43.0; IR (neat): 2925, 2238, 1599, 1573, 1508, 1489, 1471, 1390, 1371, 1277, 1230, 1173, 1088, 1068, 1010, 918, 835, 755; HRESIMS Calcd for $[C_{23}H_{15}BrFNNaO_2S]^+$ (M + Na^+) 489.9883, found 489.9884.

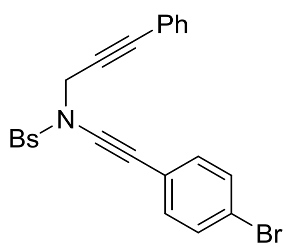
4-bromo-N-((4-chlorophenyl)ethynyl)-*N*-(3-phenylprop-2-yn-1-yl)benzenesulfonamide (1m)



1m

Yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.87 (d, *J* = 8.7 Hz, 2H), 7.63 (d, *J* = 8.7 Hz, 2H), 7.33 – 7.24 (m, 7H), 7.18 – 7.12 (m, 2H), 4.58 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 136.1, 134.2, 132.8, 132.3, 131.5, 129.6, 129.3, 128.8, 128.6, 128.3, 121.6, 120.7, 87.0, 82.3, 80.6, 70.4, 43.1; IR (neat): 2925, 2237, 1597, 1573, 1508, 1471, 1442, 1390, 1372, 1278, 1172, 1088, 1069, 1010, 918, 826, 744; HRESIMS Calcd for $[C_{23}H_{15}BrClNNaO_2S]^+$ (M + Na^+) 505.9588, found 505.9587.

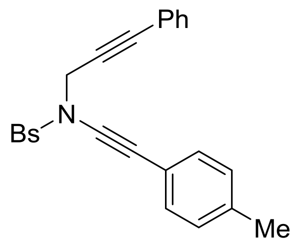
4-bromo-*N*-((4-bromophenyl)ethynyl)-*N*-(3-phenylprop-2-yn-1-yl)benzenesulfonamide (1n)



1n

Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 8.8 Hz, 2H), 7.63 (d, *J* = 8.8 Hz, 2H), 7.42 (d, *J* = 8.6 Hz, 2H), 7.32 – 7.22 (m, 5H), 7.18 – 7.11 (m, 2H), 4.58 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 136.1, 133.0, 132.3, 131.6, 131.5, 129.6, 129.3, 128.8, 128.3, 122.4, 121.5, 121.2, 87.0, 82.5, 80.6, 70.5, 43.0; IR (neat): 2925, 2236, 1573, 1508, 1488, 1470, 1391, 1371, 1277, 1172, 1109, 1087, 1009, 917, 756; HRESIMS Calcd for $[C_{23}H_{15}Br_2NNaO_2S]^+$ (M + Na^+) 549.9082, found 549.9085.

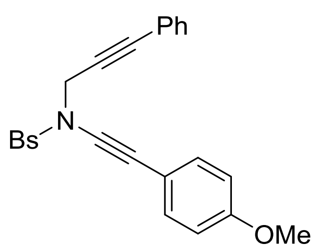
4-bromo-*N*-(3-phenylprop-2-yn-1-yl)-*N*-(*p*-tolylethynyl)benzenesulfonamide (1o)



1o

Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.6 Hz, 2H), 7.60 (d, *J* = 8.6 Hz, 2H), 7.32 – 7.26 (m, 5H), 7.17 – 7.13 (m, 2H), 7.10 (d, *J* = 7.9 Hz, 2H), 4.57 (s, 2H), 2.33 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.5, 136.2, 132.2, 131.8, 131.5, 129.7, 129.1, 129.0, 128.7, 128.3, 121.7, 119.0, 86.8, 80.8, 80.7, 71.4, 43.1, 21.4; IR (neat): 2921, 2235, 1573, 1489, 1470, 1390, 1370, 1276, 1172, 1087, 1009, 917, 755; HRESIMS Calcd for $[C_{24}H_{18}BrNNaO_2S]^+$ (M + Na^+) 486.0134, found 486.0134.

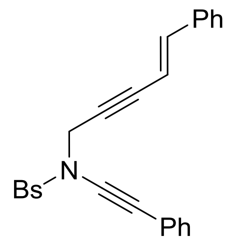
4-bromo-*N*-((4-methoxyphenyl)ethynyl)-*N*-(3-phenylprop-2-yn-1-yl)benzenesulfonamide (1p)



1p

Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.8 Hz, 2H), 7.62 (d, *J* = 8.8 Hz, 2H), 7.36 – 7.26 (m, 5H), 7.17 – 7.12 (m, 2H), 6.83 (d, *J* = 8.9 Hz, 2H), 4.57 (s, 2H), 3.80 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.8, 136.3, 133.7, 132.2, 131.6, 129.7, 129.1, 128.7, 128.3, 121.8, 114.1, 114.0, 86.8, 80.9, 80.1, 71.2, 55.3, 43.2; IR (neat): 2932, 2236, 1604, 1573, 1511, 1489, 1390, 1370, 1289, 1249, 1171, 1087, 1030, 918, 754 ; HRESIMS Calcd for $[C_{24}H_{18}BrNNaO_3S]^+$ (M + Na^+) 502.0083, found 502.0085.

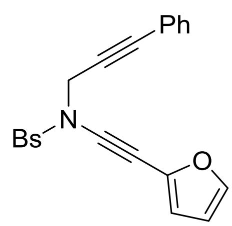
(*E*)-4-bromo-*N*-(phenylethynyl)-*N*-(5-phenylpent-4-en-2-yn-1-yl)benzenesulfonamide (1q)



1q

Yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.89 (d, *J* = 8.4 Hz, 2H), 7.70 (d, *J* = 8.4 Hz, 2H), 7.41 – 7.40 (m, 2H), 7.34 – 7.30 (m, 8H), 6.70 (d, *J* = 16.3 Hz, 1H), 5.93 (d, *J* = 16.3 Hz, 1H), 4.53 (s, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 142.6, 136.2, 135.6, 132.2, 131.7, 129.7, 129.1, 129.0, 128.7, 128.3, 128.2, 126.3, 122.2, 106.5, 86.0, 82.8, 81.5, 71.4, 43.3; IR (neat): 2236, 1573, 1485, 1469, 1442, 1391, 1372, 1173, 1087, 1069, 1010, 918, 823, 617; HRESIMS Calcd for $[C_{25}H_{18}BrNNaO_2S]^+$ (M + Na^+) 498.0134, found 498.0135.

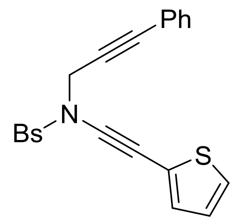
4-bromo-*N*-(furan-2-ylethynyl)-*N*-(3-phenylprop-2-yn-1-yl)benzenesulfonamide (1r)



1r

Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.6 Hz, 2H), 7.63 (d, *J* = 8.6 Hz, 2H), 7.45 – 7.37 (m, 1H), 7.34 – 7.25 (m, 3H), 7.22 – 7.12 (m, 2H), 6.70 – 6.59 (m, 1H), 6.46 – 6.34 (m, 1H), 4.58 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.3, 136.3, 136.2, 132.3, 131.6, 129.6, 129.4, 128.8, 128.3, 121.6, 117.8, 111.1, 87.1, 85.7, 80.6, 62.4, 43.2; IR (neat): 2926, 2231, 1599, 1573, 1489, 1471, 1391, 1372, 1278, 1172, 1069, 1010, 890, 751; HRESIMS Calcd for $[C_{21}H_{14}BrNNaO_3S]^+$ (M + Na^+) 461.9770, found 461.9776.

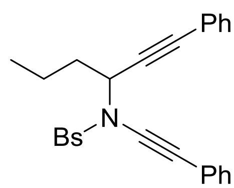
4-bromo-*N*-(3-phenylprop-2-yn-1-yl)-*N*-(thiophen-2-ylethynyl)benzenesulfonamide (1s)



1s

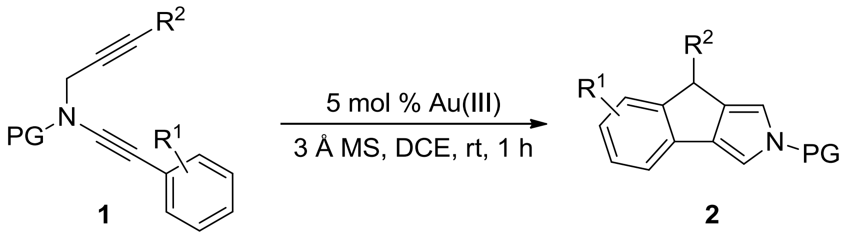
Yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.87 (d, *J* = 8.6 Hz, 2H), 7.63 (d, *J* = 8.6 Hz, 2H), 7.35 – 7.27 (m, 4H), 7.21 (d, *J* = 3.6 Hz, 1H), 7.16 (d, *J* = 6.9 Hz, 2H), 7.01 – 6.95 (m, 1H), 4.58 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 136.1, 133.5, 132.3, 131.6, 129.7, 129.3, 128.8, 128.3, 127.1, 122.2, 121.6, 87.0, 85.1, 80.7, 65.0, 43.3; IR (neat): 2920, 2232, 1573, 1489, 1390, 1371, 1278, 1172, 1087, 1009, 894, 753; HRESIMS Calcd for $[C_{21}H_{14}BrNNaO_2S_2]^+$ (M + Na^+) 477.9542, found 477.9543.

4-bromo-*N*-(phenylethynyl)-*N*-(1-phenylhex-1-yn-3-yl)benzenesulfonamide (1t)



1t

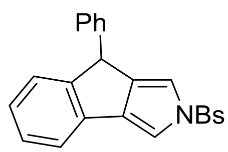
Yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.3 Hz, 2H), 7.59 (d, *J* = 8.3 Hz, 2H), 7.40 – 7.39 (m, 2H), 7.29 – 7.23 (m, 6H), 7.06 (d, *J* = 7.7 Hz, 2H), 4.90 (t, *J* = 7.6 Hz, 1H), 2.04 – 1.97 (m, 1H), 1.94 – 1.87 (m, 1H), 1.61 – 1.54 (m, 2H), 1.00 (t, *J* = 7.4 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 136.3, 132.1, 131.6, 131.4, 129.6, 129.0, 128.5, 128.3, 128.2, 128.1, 122.4, 121.7, 86.1, 84.5, 79.2, 73.1, 53.4, 36.4, 19.0, 13.3; IR (neat): 2921, 2235, 1573, 1471, 1390, 1371, 1277, 1172, 1109, 1068, 918, 817, 612; HRESIMS Calcd for $[C_{26}H_{22}BrNNaO_2S]^+$ (M + Na^+) 514.0447, found 514.0447.



General procedure for the synthesis of indeno[1,2-*c*]pyrroles 2:

Au(III) (0.01 mmol, 3.9 mg) was added in this order to the ynamide **1** (0.20 mmol) and 3 Å MS (40 mg) in DCE (4.0 mL) at room temperature. The reaction mixture was stirred at room temperature and the progress of the reaction was monitored by TLC. The reaction typically took 1 h. Upon completion, the mixture was then concentrated and the residue was purified by chromatography on silica gel (eluent: hexanes/ ethyl acetate) to afford the desired product **2**.

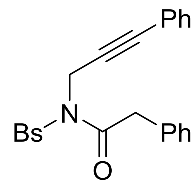
2-((4-bromophenyl)sulfonyl)-8-phenyl-2,8-dihydroindeno[1,2-*c*]pyrrole (2a)



2a

Compound **2a** was prepared in 84% yield (75.4 mg) according to the general procedure (Table 2, entry 1). Pale yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.5 Hz, 2H), 7.58 (d, *J* = 8.5 Hz, 2H), 7.51 (d, *J* = 7.6 Hz, 1H), 7.27 – 7.20 (m, 5H), 7.17 – 7.12 (m, 2H), 7.06 (d, *J* = 7.3 Hz, 2H), 6.94 (s, 1H), 4.96 (s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 151.5, 141.8, 138.8, 138.0, 135.6, 134.4, 132.6, 128.9, 128.6, 128.2, 127.7, 127.5, 127.2, 126.9, 125.8, 121.5, 114.3, 109.8, 48.3; IR (neat): 2920, 2344, 1731, 1642, 1573, 1492, 1371, 1317, 1265, 1174, 1089, 1052, 1008, 743; HRESIMS Calcd for $[C_{23}H_{16}BrNNaO_2S]^+$ (M + Na^+) 471.9977, found 471.9978.

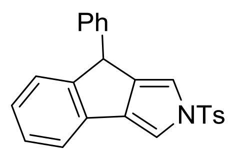
***N*-((4-bromophenyl)sulfonyl)-2-phenyl-*N*-(3-phenylprop-2-yn-1-yl)acetamide (2aa)**



2aa

Yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.8 Hz, 2H), 7.59 (d, *J* = 8.8 Hz, 2H), 7.37 – 7.26 (m, 8H), 7.19 – 7.12 (m, 2H), 4.88 (s, 2H), 4.01 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.3, 138.0, 132.5, 132.2, 131.7, 130.0, 129.2, 129.1, 129.0, 128.8, 128.5, 127.5, 121.7, 85.1, 83.1, 42.8, 36.6; IR (neat): 2923, 2232, 1600, 1582, 1571, 1486, 1350, 1271, 1149, 1089, 918, 854; HRESIMS Calcd for $[C_{23}H_{18}BrNNaO_3S]^+$ (M + Na^+) 490.0083, found 490.0086.

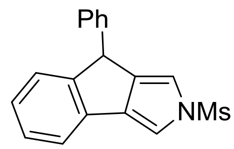
8-phenyl-2-tosyl-2,8-dihydroindeno[1,2-*c*]pyrrole (2b)



2b

Compound **2b** was prepared in 74% yield (57.0 mg) according to the general procedure (Table 2, entry 2). Pale yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74 (d, *J* = 8.3 Hz, 2H), 7.50 (d, *J* = 7.6 Hz, 1H), 7.29 (d, *J* = 1.5 Hz, 1H), 7.25 – 7.19 (m, 6H), 7.13 (d, *J* = 7.4 Hz, 2H), 7.07 (d, *J* = 6.6 Hz, 2H), 6.95 (d, *J* = 1.3 Hz, 1H), 4.94 (s, 1H), 2.36 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 151.5, 144.8, 142.0, 138.2, 136.2, 135.0, 134.7, 129.9, 128.6, 127.8, 127.4, 127.0, 126.8, 126.7, 125.8, 121.3, 114.3, 109.8, 48.3, 21.5; IR (neat): 2920, 2350, 1596, 1492, 1452, 1368, 1317, 1266, 1186, 1171, 1090, 1051, 753, 670; HRESIMS Calcd for $[C_{24}H_{19}NNaO_2S]^+$ (M + Na^+) 408.1029, found 408.1035.

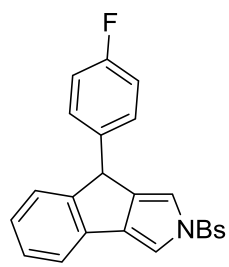
2-(methylsulfonyl)-8-phenyl-2,8-dihydroindeno[1,2-*c*]pyrrole (2c)



2c

Compound **2c** was prepared in 65% yield (40.2 mg) according to the general procedure (Table 2, entry 3). Yellow solid (mp 209-211 ℃). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.56 (d, *J* = 7.6 Hz, 1H), 7.31 – 7.19 (m, 7H), 7.15 (d, *J* = 7.6 Hz, 2H), 6.92 (s, 1H), 5.03 (s, 1H), 3.13 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 151.4, 141.9, 138.2, 134.9, 134.7, 128.7, 127.8, 127.5, 127.1, 126.9, 125.9, 121.4, 113.9, 109.5, 48.4, 42.7; IR (neat): 2922, 2346, 1732, 1598, 1493, 1363, 1266, 1170, 1052, 976, 763; HRESIMS Calcd for $[C_{18}H_{15}NNaO_2S]^+$ (M + Na^+) 332.0716, found 332.0718.

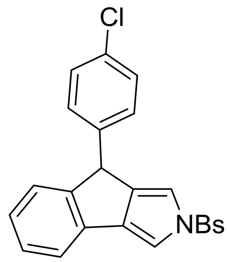
2-((4-bromophenyl)sulfonyl)-8-(4-fluorophenyl)-2,8-dihydroindeno[1,2-*c*]pyrrole (2d)



2d

Compound **2d** was prepared in 82% yield (76.6 mg) according to the general procedure (Table 2, entry 4). Pale yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.2 Hz, 2H), 7.57 (d, *J* = 8.2 Hz, 2H), 7.51 (d, *J* = 7.6 Hz, 1H), 7.32 – 7.22 (m, 2H), 7.17 – 7.10 (m, 2H), 7.06 – 6.97 (m, 2H), 6.93 – 6.90 (m, 3H), 4.93 (s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 161.7 (d, *J* = 243.8 Hz), 151.3, 138.7, 137.9, 137.5 (d, *J* = 3.8 Hz), 135.4, 134.4, 132.6, 129.2 (d, *J* = 8.8 Hz), 128.9, 128.2, 127.6, 127.3, 125.7, 121.5, 115.4 (d, *J* = 21.3 Hz), 114.2, 109.9, 47.5; IR (neat): 2921, 2346, 1602, 1573, 1507, 1470, 1390, 1371, 1318, 1222, 1174, 1089, 1050, 1009, 744; HRESIMS Calcd for $[C_{23}H_{15}BrFNNaO_2S]^+$ (M + Na^+) 489.9883, found 489.9890.

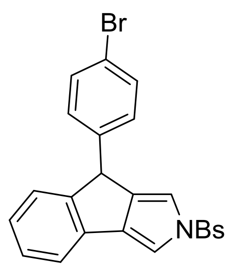
2-((4-bromophenyl)sulfonyl)-8-(4-chlorophenyl)-2,8-dihydroindeno[1,2-*c*]pyrrole (2e)



2e

Compound **2e** was prepared in 80% yield (77.3 mg) according to the general procedure (Table 2, entry 5). Pale yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.71 (d, *J* = 7.8 Hz, 2H), 7.58 (d, *J* = 7.5 Hz, 2H), 7.51 (d, *J* = 7.6 Hz, 1H), 7.29 – 7.25 (m, 2H), 7.20 (d, *J* = 7.5 Hz, 2H), 7.17 – 7.11 (m, 2H), 6.99 (d, *J* = 8.0 Hz, 2H), 6.93 (s, 1H), 4.92 (s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 151.0, 140.3, 138.4, 137.9, 135.3, 134.4, 132.6, 129.1, 129.0, 128.8, 128.2, 127.7, 127.3, 125.7, 121.5, 114.2, 109.9, 47.6; IR (neat): 2922, 1573, 1489, 1390, 1371, 1319, 1265, 1173, 1089, 1051, 1009, 744; HRESIMS Calcd for $[C_{23}H_{15}BrClNNaO_2S]^+$ (M + Na^+) 505.9588, found 505.9587.

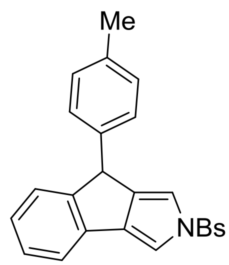
8-(4-bromophenyl)-2-((4-bromophenyl)sulfonyl)-2,8-dihydroindeno[1,2-*c*]pyrrole (2f)



2f

Compound **2f** was prepared in 75% yield (79.1 mg) according to the general procedure (Table 2, entry 6). Pale yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.71 (d, *J* = 8.4 Hz, 2H), 7.59 (d, *J* = 8.5 Hz, 2H), 7.51 (d, *J* = 7.6 Hz, 1H), 7.35 (d, *J* = 8.2 Hz, 2H), 7.30 – 7.23 (m, 2H), 7.19 – 7.09 (m, 2H), 6.93 (d, *J* = 8.7 Hz, 3H), 4.90 (s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 150.9, 140.9, 138.3, 137.9, 135.3, 134.4, 132.6, 131.7, 129.5, 129.0, 128.2, 127.7, 127.3, 125.7, 121.5, 120.7, 114.2, 109.9, 47.7; IR (neat): 2923, 1573, 1489, 1390, 1368, 1318, 1265, 1171, 1089, 1052, 1009, 744; HRESIMS Calcd for $[C_{23}H_{15}Br_2NNaO_2S]^+$ (M + Na^+) 549.9082, found 549.9084.

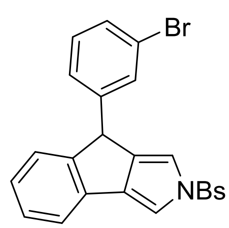
2-((4-bromophenyl)sulfonyl)-8-(*p*-tolyl)-2,8-dihydroindeno[1,2-*c*]pyrrole (2g)



2g

Compound **2g** was prepared in 72% yield (66.7 mg) according to the general procedure (Table 2, entry 7). Pale yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.69 (d, *J* = 8.7 Hz, 2H), 7.57 (d, *J* = 8.7 Hz, 2H), 7.50 (d, *J* = 7.6 Hz, 1H), 7.28 – 7.23 (m, 2H), 7.16 – 7.12 (m, 2H), 7.05 (d, *J* = 7.9 Hz, 2H), 6.96 – 6.90 (m, 3H), 4.92 (s, 1H), 2.29 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 151.7, 139.0, 138.8, 138.0, 136.5, 135.6, 134.4, 132.6, 129.3, 128.9, 128.1, 127.6, 127.4, 127.2, 125.8, 121.4, 114.2, 109.8, 48.0, 21.0; IR (neat): 2922, 1573, 1469, 1371, 1317, 1265, 1174, 1089, 1051, 1008, 798, 744; HRESIMS Calcd for $[C_{24}H_{18}BrNNaO_2S]^+$ (M + Na^+) 486.0134, found 486.0138.

8-(3-bromophenyl)-2-((4-bromophenyl)sulfonyl)-2,8-dihydroindeno[1,2-*c*]pyrrole (2h)

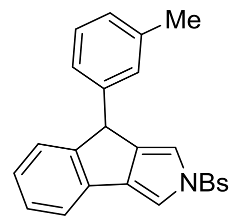


2h

Compound **2h** was prepared in 70% yield (73.8 mg) according to the general procedure (Table 2, entry 8). Pale yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, *J* = 8.6 Hz, 2H), 7.61 (d, *J* = 8.6 Hz, 2H), 7.51 (d, *J* = 7.6 Hz, 1H), 7.34 (d, *J* = 7.9 Hz, 1H), 7.29 –

7.24 (m, 2H), 7.19 – 7.10 (m, 4H), 7.03 (d, *J* = 7.6 Hz, 1H), 6.95 (s, 1H), 4.91 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.7, 144.2, 138.2, 137.9, 135.5, 134.4, 132.7, 130.6, 130.2, 130.1, 129.1, 128.1, 127.8, 127.4, 126.5, 125.8, 122.7, 121.6, 114.4, 110.0, 47.8; IR (neat): 2920, 1573, 1470, 1390, 1371, 1318, 1264, 1173, 1089, 1051, 1008, 744; HRESIMS Calcd for $[C_{23}H_{15}Br_2NNaO_2S]^+$ (M + Na^+) 549.9082, found 549.9091.

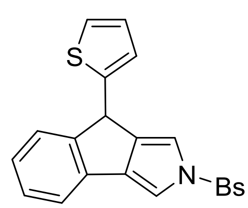
2-((4-bromophenyl)sulfonyl)-8-(*m*-tolyl)-2,8-dihydroindeno[1,2-*c*]pyrrole (2i)



2i

Compound **2i** was prepared in 74% yield (68.5 mg) according to the general procedure (Table 2, entry 9). Pale yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, *J* = 8.8 Hz, 2H), 7.55 (d, *J* = 8.8 Hz, 2H), 7.50 (d, *J* = 7.6 Hz, 1H), 7.28 – 7.21 (m, 2H), 7.17 – 7.09 (m, 3H), 7.01 (d, *J* = 7.6 Hz, 1H), 6.93 (t, *J* = 1.6 Hz, 1H), 6.88 (d, *J* = 7.6 Hz, 1H), 6.84 (s, 1H), 4.91 (s, 1H), 2.23 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.6, 141.7, 138.9, 138.3, 138.0, 135.6, 134.4, 132.5, 128.8, 128.5, 128.3, 128.1, 127.7, 127.4, 127.2, 125.8, 124.9, 121.4, 114.3, 109.8, 48.3, 21.3; IR (neat): 2921, 1681, 1573, 1470, 1371, 1317, 1265, 1174, 1089, 1052, 1008, 743; HRESIMS Calcd for $[C_{24}H_{18}BrNNaO_2S]^+$ (M + Na^+) 486.0134, found 486.0138.

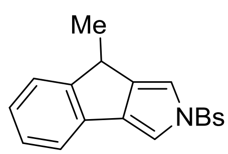
2-((4-bromophenyl)sulfonyl)-8-(thiophen-2-yl)-2,8-dihydroindeno[1,2-*c*]pyrrole (2j)



2j

Compound **2j** was prepared in 63% yield (57.3 mg) according to the general procedure (Table 2, entry 10). Pale yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.73 (d, *J* = 8.5 Hz, 2H), 7.63 (d, *J* = 8.5 Hz, 2H), 7.50 (d, *J* = 7.6 Hz, 1H), 7.36 (d, *J* = 7.6 Hz, 1H), 7.29 (t, *J* = 7.5 Hz, 1H), 7.26 (s, 1H), 7.21 (t, *J* = 7.5 Hz, 1H), 7.14 (d, *J* = 5.6 Hz, 1H), 7.08 (s, 1H), 6.95 – 6.90 (m, 2H), 5.27 (s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 150.4, 144.5, 138.1, 138.0, 135.0, 134.1, 132.7, 129.0, 128.2, 127.9, 127.3, 126.8, 125.8, 124.6, 124.2, 121.6, 114.7, 110.0, 43.1; IR (neat): 2920, 1693, 1537, 1470, 1371, 1365, 1173, 1089, 1052, 1008, 744; HRESIMS Calcd for $[C_{21}H_{14}BrNNaO_2S_2]^+$ (M + Na^+) 477.9542, found 477.9542.

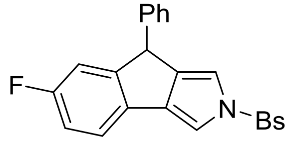
2-((4-bromophenyl)sulfonyl)-8-methyl-2,8-dihydroindeno[1,2-*c*]pyrrole (2k)



2k

Compound **2k** was prepared in 59% yield (45.7 mg) according to the general procedure (Table 2, entry 11). Pale yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 8.7 Hz, 2H), 7.61 (d, *J* = 8.7 Hz, 2H), 7.47 (d, *J* = 6.7 Hz, 1H), 7.35 (d, *J* = 7.0 Hz, 1H), 7.28 – 7.18 (m, 3H), 7.01 (t, *J* = 1.3 Hz, 1H), 3.86 (q, *J* = 7.3 Hz, 1H), 1.42 (d, *J* = 7.3 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 152.8, 140.2, 138.1, 135.1, 134.3, 132.6, 128.8, 128.2, 127.1, 127.0, 124.5, 121.4, 113.1, 109.7, 36.9, 19.5; IR (neat): 2921, 1644, 1576, 1468, 1390, 1371, 1320, 1258, 1170, 1088, 1008, 745; HRESIMS Calcd for $[C_{18}H_{14}BrNNaO_2S]^+$ (M + Na^+) 409.9821, found 409.9821.

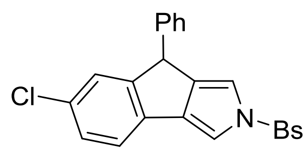
2-((4-bromophenyl)sulfonyl)-6-fluoro-8-phenyl-2,8-dihydroindeno[1,2-*c*]pyrrole (2l)



2l

Compound **2l** was prepared in 74% yield (69.1 mg) according to the general procedure (Table 2, entry 12). Pale yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, *J* = 8.7 Hz, 2H), 7.61 (d, *J* = 8.7 Hz, 2H), 7.46 – 7.43 (m, 1H), 7.29 – 7.21 (m, 4H), 7.07 – 7.05 (m, 2H), 6.99 – 6.93 (m, 2H), 6.87 – 6.85 (m, 1H), 4.94 (s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 162.3 (d, *J* = 245.0 Hz), 153.8 (d, *J* = 7.5 Hz), 141.1, 138.7, 138.0, 134.6, 132.7, 130.5 (d, *J* = 2.5 Hz), 129.0, 128.8, 128.2, 127.7, 127.2, 122.4 (d, *J* = 8.8 Hz), 114.7 (d, *J* = 22.5 Hz), 114.4, 113.3 (d, *J* = 22.5 Hz), 109.4 (d, *J* = 1.3 Hz), 48.5 (d, *J* = 2.5 Hz); IR (neat): 2924, 1733, 1589, 1573, 1465, 1372, 1318, 1262, 1174, 1089, 1052, 1009, 746; HRESIMS Calcd for $[C_{23}H_{15}BrFNNaO_2S]^+$ (M + Na^+) 489.9883, found 489.9883.

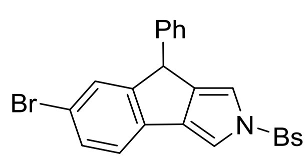
2-((4-bromophenyl)sulfonyl)-6-chloro-8-phenyl-2,8-dihydroindeno[1,2-*c*]pyrrole (2m)



2m

Compound **2m** was prepared in 85% yield (82.1 mg) according to the general procedure (Table 2, entry 13). Pale yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.8 Hz, 2H), 7.58 (d, *J* = 8.8 Hz, 2H), 7.41 (d, *J* = 8.1 Hz, 1H), 7.27 – 7.20 (m, 5H), 7.12 (s, 1H), 7.06 – 7.03 (m, 2H), 6.93 (t, *J* = 1.5 Hz, 1H), 4.92 (s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 153.2, 140.9, 138.4, 137.9, 134.3, 133.0, 132.8, 132.6, 129.0, 128.8, 128.2, 127.8, 127.7, 127.2, 126.1, 122.3, 114.4, 110.0, 48.3; IR (neat): 2921, 1573, 1469, 1372, 1315, 1259, 1174, 1089, 1052, 1008, 745; HRESIMS Calcd for $[C_{23}H_{15}BrClNNaO_2S]^+$ (M + Na^+) 505.9588, found 505.9592.

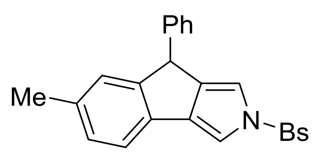
6-bromo-2-((4-bromophenyl)sulfonyl)-8-phenyl-2,8-dihydroindeno[1,2-*c*]pyrrole (2n)



2n

Compound **2n** was prepared in 78% yield (82.2 mg) according to the general procedure (Table 2, entry 14). Pale yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.71 (d, *J* = 8.4 Hz, 2H), 7.60 (d, *J* = 8.5 Hz, 2H), 7.39 – 7.35 (m, 2H), 7.27 – 7.21 (m, 5H), 7.05 (d, *J* = 7.2 Hz, 2H), 6.93 (s, 1H), 4.93 (s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 153.5, 140.9, 138.3, 137.9, 134.4, 133.5, 132.7, 130.6, 129.1, 129.0, 128.8, 128.2, 127.7, 127.2, 122.6, 120.9, 114.3, 110.1, 48.3; IR (neat): 2921, 1573, 1469, 1372, 1314, 1261, 1174, 1089, 1051, 1008, 744; HRESIMS Calcd for $[C_{23}H_{15}Br_2NNaO_2S]^+$ (M + Na^+) 549.9082, found 549.9090.

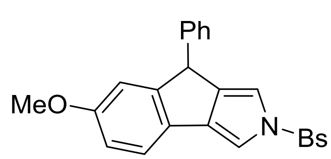
2-((4-bromophenyl)sulfonyl)-6-methyl-8-phenyl-2,8-dihydroindeno[1,2-*c*]pyrrole (2o)



2o

Compound **2o** was prepared in 64% yield (59.3 mg) according to the general procedure (Table 2, entry 15). Pale yellow oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, *J* = 8.7 Hz, 2H), 7.60 (d, *J* = 8.7 Hz, 2H), 7.40 (d, *J* = 7.7 Hz, 1H), 7.26 – 7.21 (m, 4H), 7.08 – 7.06 (m, 3H), 6.97 (s, 1H), 6.91 (t, *J* = 1.5 Hz, 1H), 4.92 (s, 1H), 2.28 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 151.8, 142.0, 139.1, 138.1, 137.3, 135.7, 132.6, 131.7, 128.9, 128.7, 128.3, 128.2, 127.8, 126.9, 126.5, 121.2, 114.3, 109.3, 48.3, 21.5; IR (neat): 2921, 1573, 1469, 1371, 1317, 1268, 1174, 1089, 1051, 1008, 820, 745; HRESIMS Calcd for $[C_{24}H_{18}BrNNaO_2S]^+$ (M + Na^+) 486.0134, found 486.0134.

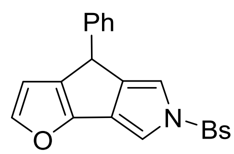
2-((4-bromophenyl)sulfonyl)-6-methoxy-8-phenyl-2,8-dihydroindeno[1,2-*c*]pyrrole (2p)



2p

Compound **2p** was prepared in 66% yield (63.2 mg) according to the general procedure (Table 2, entry 16). Pale yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.68 (d, *J* = 8.4 Hz, 2H), 7.57 (d, *J* = 8.3 Hz, 2H), 7.41 (d, *J* = 8.4 Hz, 1H), 7.26 – 7.20 (m, 3H), 7.15 (s, 1H), 7.06 (d, *J* = 7.5 Hz, 2H), 6.89 (s, 1H), 6.81 (d, *J* = 8.4 Hz, 1H), 6.70 (s, 1H), 4.91 (s, 1H), 3.70 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 159.4, 153.4, 141.8, 139.1, 138.0, 135.4, 132.5, 128.8, 128.7, 128.1, 127.7, 127.2, 126.9, 122.1, 114.3, 113.3, 111.6, 108.6, 55.4, 48.5; IR (neat): 2922, 1573, 1471, 1389, 1371, 1272, 1174, 1089, 1052, 1008, 820, 745; HRESIMS Calcd for $[C_{24}H_{18}BrNNaO_3S]^+$ (M + Na^+) 502.0083, found 502.0086.

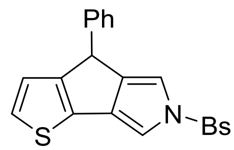
6-((4-bromophenyl)sulfonyl)-4-phenyl-4,6-dihydrofuro[2',3':3,4]cyclopenta[1,2-*c*]pyrrole (2r)



2r

Compound **2r** was prepared in 65% yield (57.1 mg) according to the general procedure (eqn (1)). Pale yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.69 (d, *J* = 8.4 Hz, 2H), 7.61 (d, *J* = 8.3 Hz, 2H), 7.43 (s, 1H), 7.29 – 7.21 (m, 3H), 7.14 (d, *J* = 7.6 Hz, 2H), 6.99 (s, 1H), 6.90 (s, 1H), 6.38 (s, 1H), 4.76 (s, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 151.8, 146.6, 142.7, 140.0, 137.9, 137.0, 132.6, 128.9, 128.7, 128.2, 127.2, 127.0, 125.7, 115.1, 109.1, 106.2, 42.6; IR (neat): 2920, 1643, 1573, 1469, 1389, 1371, 1272, 1174, 1088, 1051, 1008, 745; HRESIMS Calcd for $[C_{21}H_{14}BrNNaO_3S]^+$ (M + Na^+) 461.9770, found 461.9770.

6-((4-bromophenyl)sulfonyl)-4-phenyl-4,6-dihydrothieno[2',3':3,4]cyclopenta[1,2-*c*]pyrrole (2s)



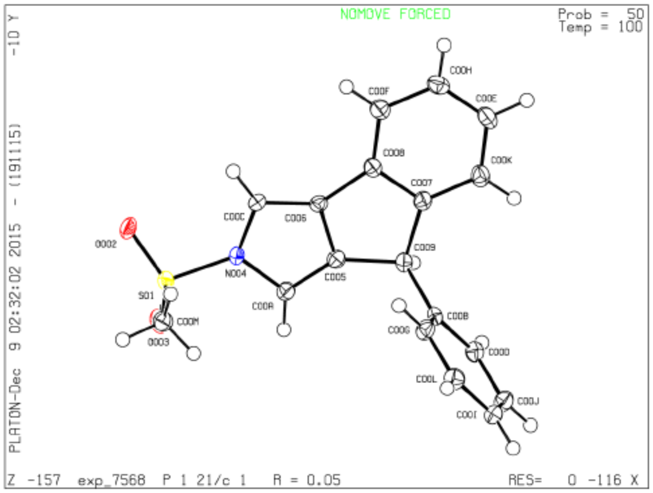
2s

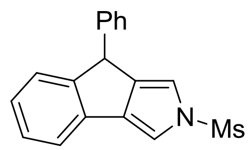
Compound **2s** was prepared in 76% yield (69.2 mg) according to the general procedure (eqn (2)). Pale yellow oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.5 Hz, 2H), 7.60 (d, *J* = 8.6 Hz, 2H), 7.27 – 7.20 (m, 4H), 7.10 (d, *J* = 7.2 Hz, 2H), 7.05 (s, 1H), 6.92 (s, 1H), 6.84 (d, *J* = 4.9 Hz, 1H), 4.88 (s, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 155.8, 142.5, 140.5, 138.0, 134.3, 132.6, 130.9, 128.9, 128.7, 128.6, 128.2, 127.3, 127.0, 122.8, 114.6, 107.7, 46.3; IR (neat): 2920, 1633, 1573, 1494, 1390, 1372, 1273, 1174, 1089, 1051, 1008, 745; HRESIMS Calcd for $[C_{21}H_{14}BrNNaO_2S_2]^+$ (M + Na^+) 477.9542, found 477.9542.

Reference:

1. B. Prabagar, S. Nayak, R. Prasad, A. K. Sahoo, *Org. Lett.* **2016**, *18*, 3066.

Compound 2c (CCDC Number = 1846072)





Bond precision: C-C = 0.0031 A Wavelength=1.54184

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	alpha=90	beta=92.936(4)	gamma=90
Temperature:	100 K		

	Calculated	Reported
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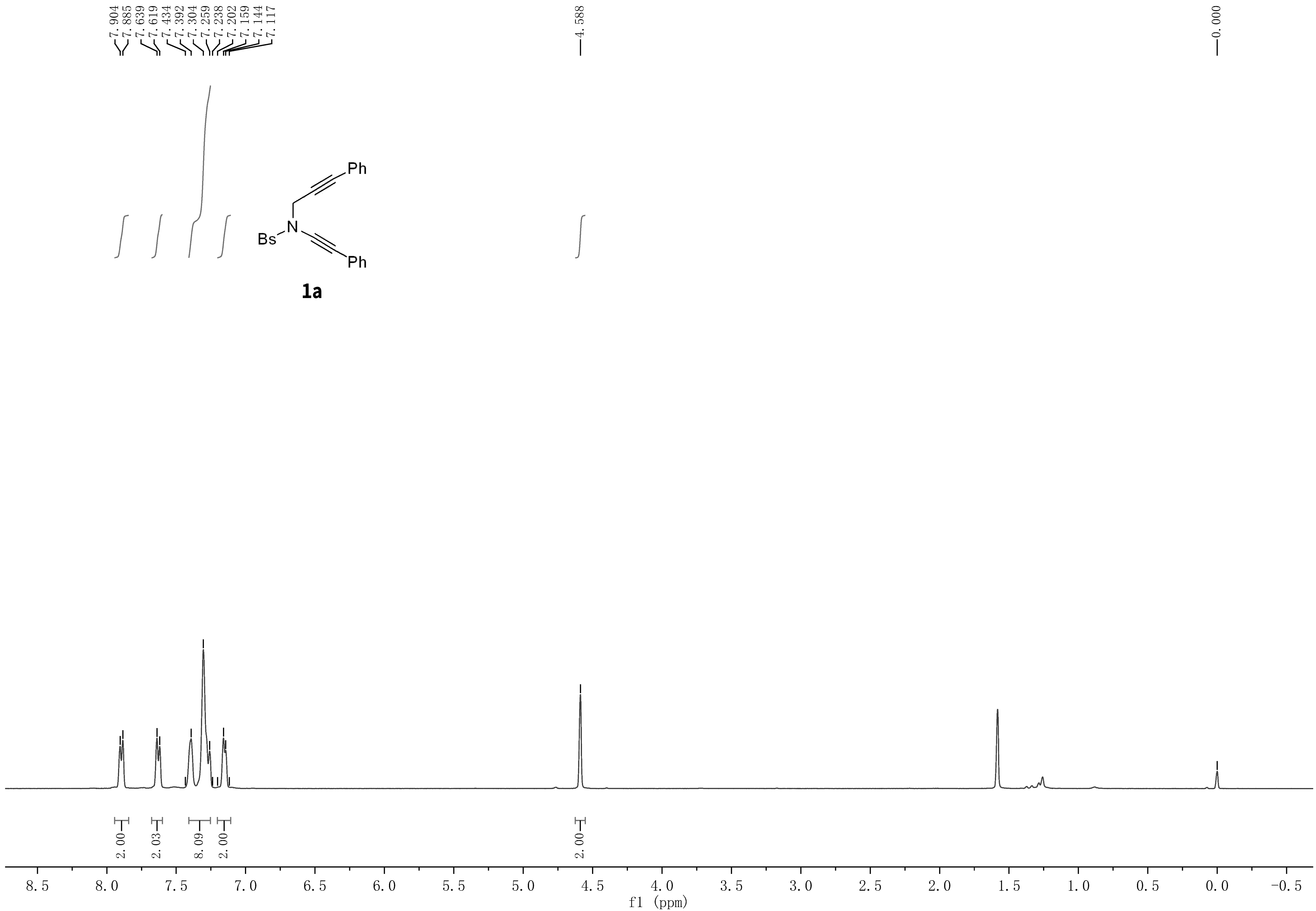
Space group	P 21/c	P 1 21/c 1
Hall group	-P 2ybc	-P 2ybc
Moiety formula	C18 H15 N O2 S	C18 H15 N O2 S
Sum formula	C18 H15 N O2 S	C18 H15 N O2 S
Mr	309.37	309.37
Dx,g cm-3	1.391	1.391
Z	4	4
Mu (mm-1)	1.997	1.997
F000	648.0	648.0
F000'	651.07	
h,k,lmax	22,6,17	21,6,16
Nref	2574	2493
Tmin,Tmax	0.465,0.538	0.684,1.000
Tmin'	0.420	

Correction method= # Reported T Limits: Tmin=0.684 Tmax=1.000
AbsCorr = MULTI-SCAN

Data completeness= 0.969 Theta(max)= 65.820

R(reflections)= 0.0457(2385) wR2(reflections)= 0.1198(2493)

S = 1.081 Npar= 200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Ph
N
Bs
Ph
1a
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8.09
2.00
2.00
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8.0
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6.0
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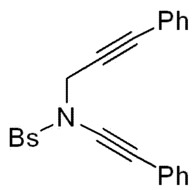
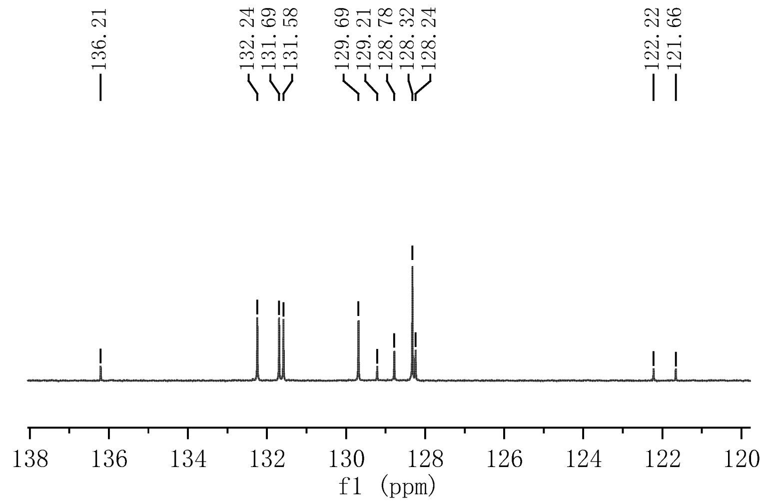
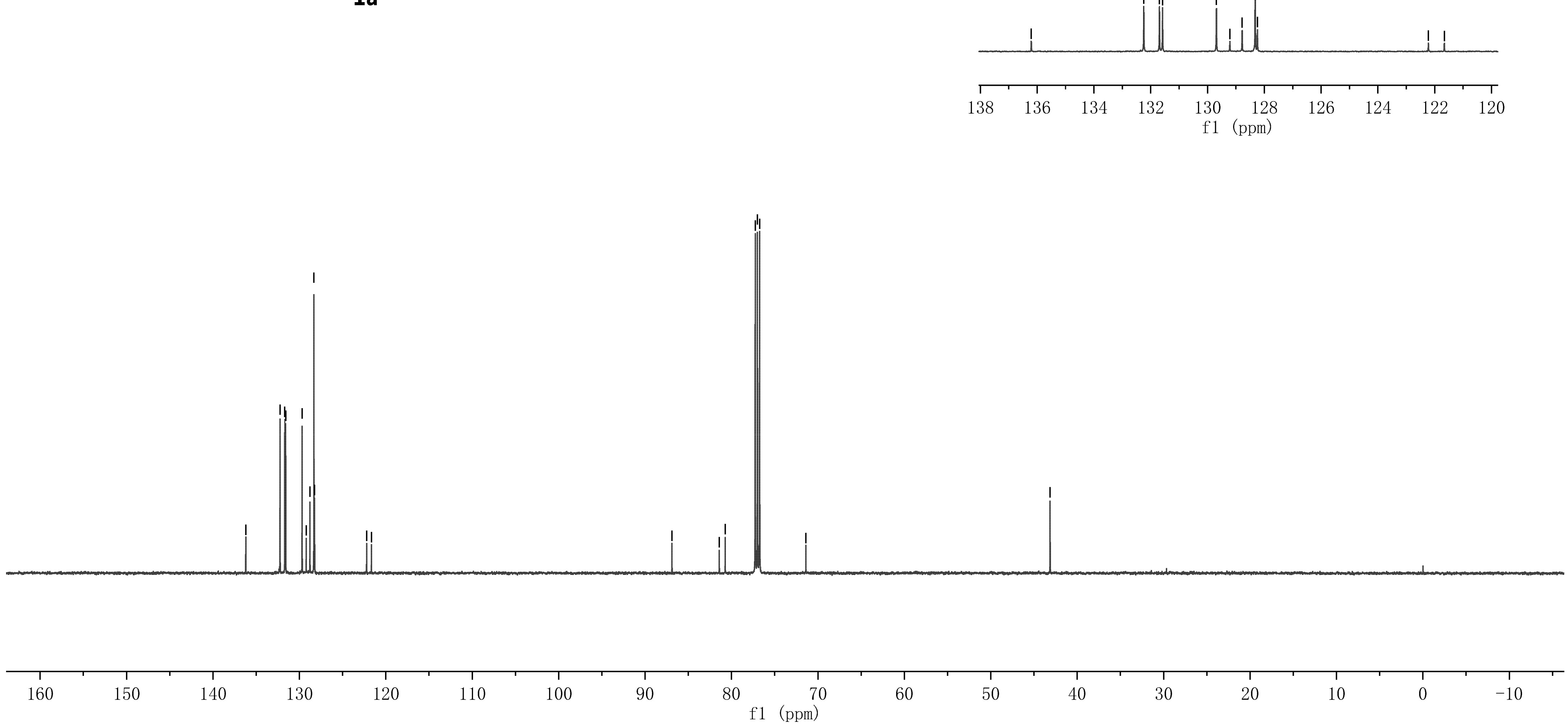
f1 (ppm)


Ph
N
Bs
Ph

1a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128.32
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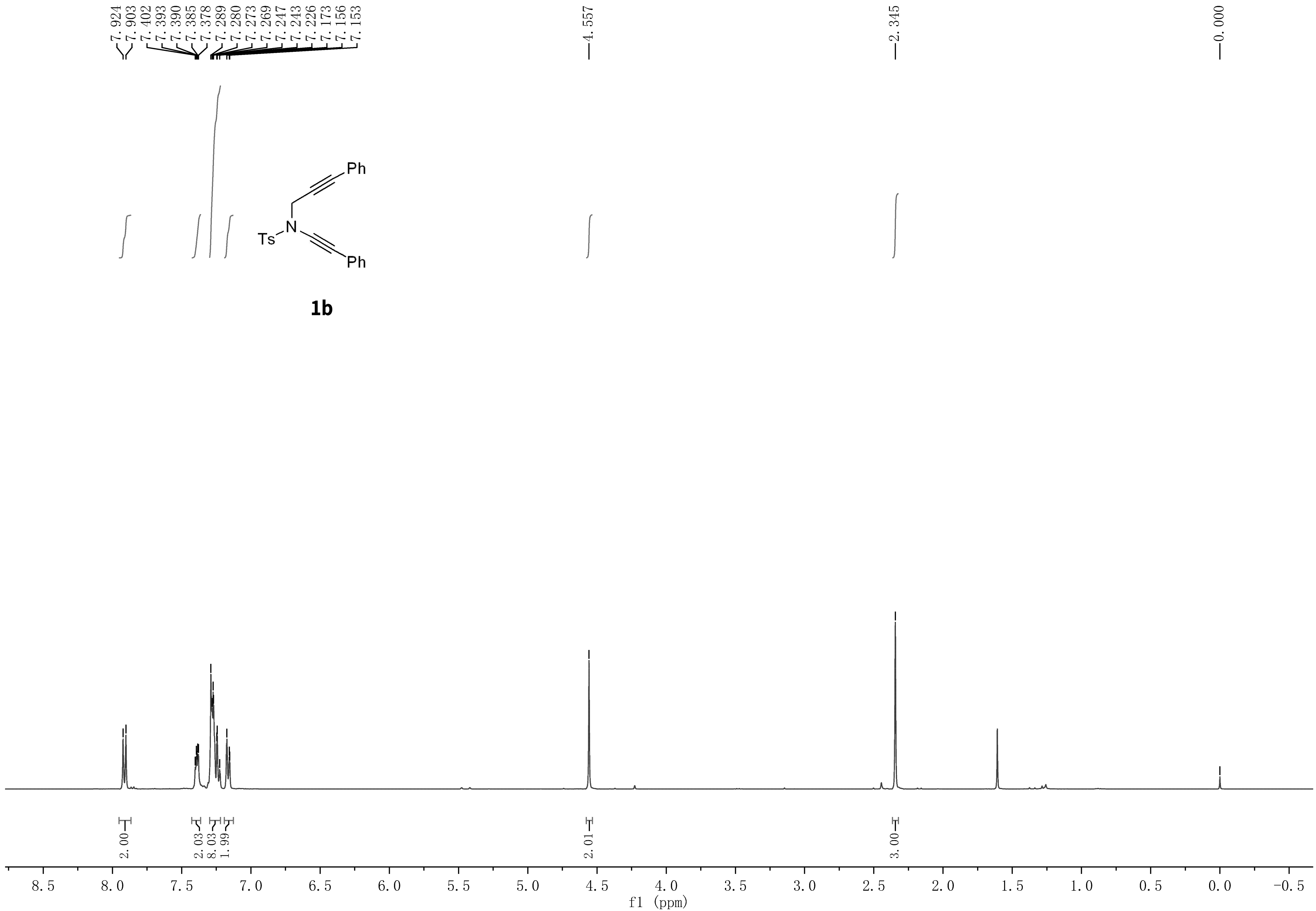
f1 (ppm)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7.156
7.153
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Ts
N
Ph
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2.03
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1.99
2.01
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
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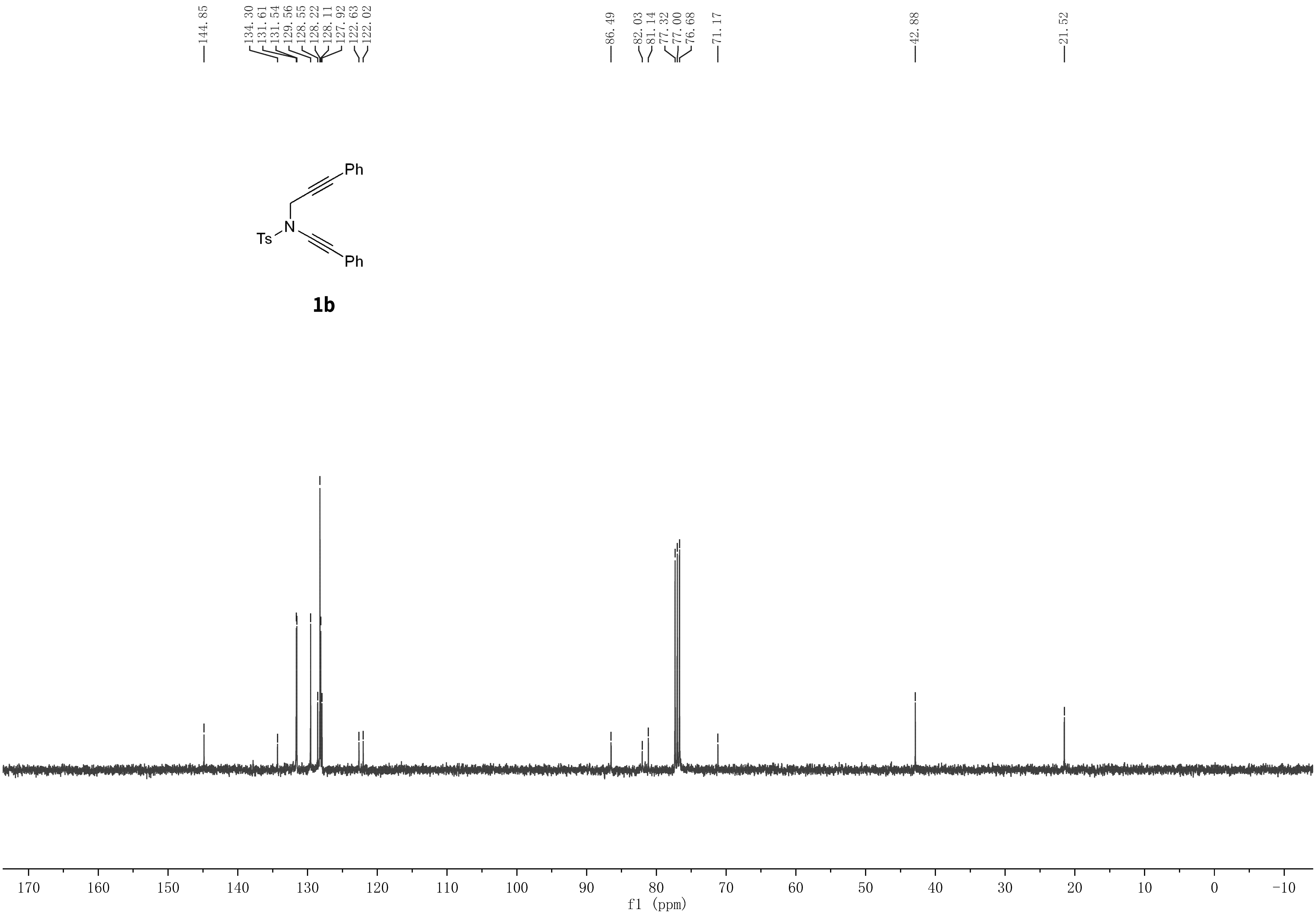
f1 (ppm)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77.32
77.00
76.68
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Ts
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Ph
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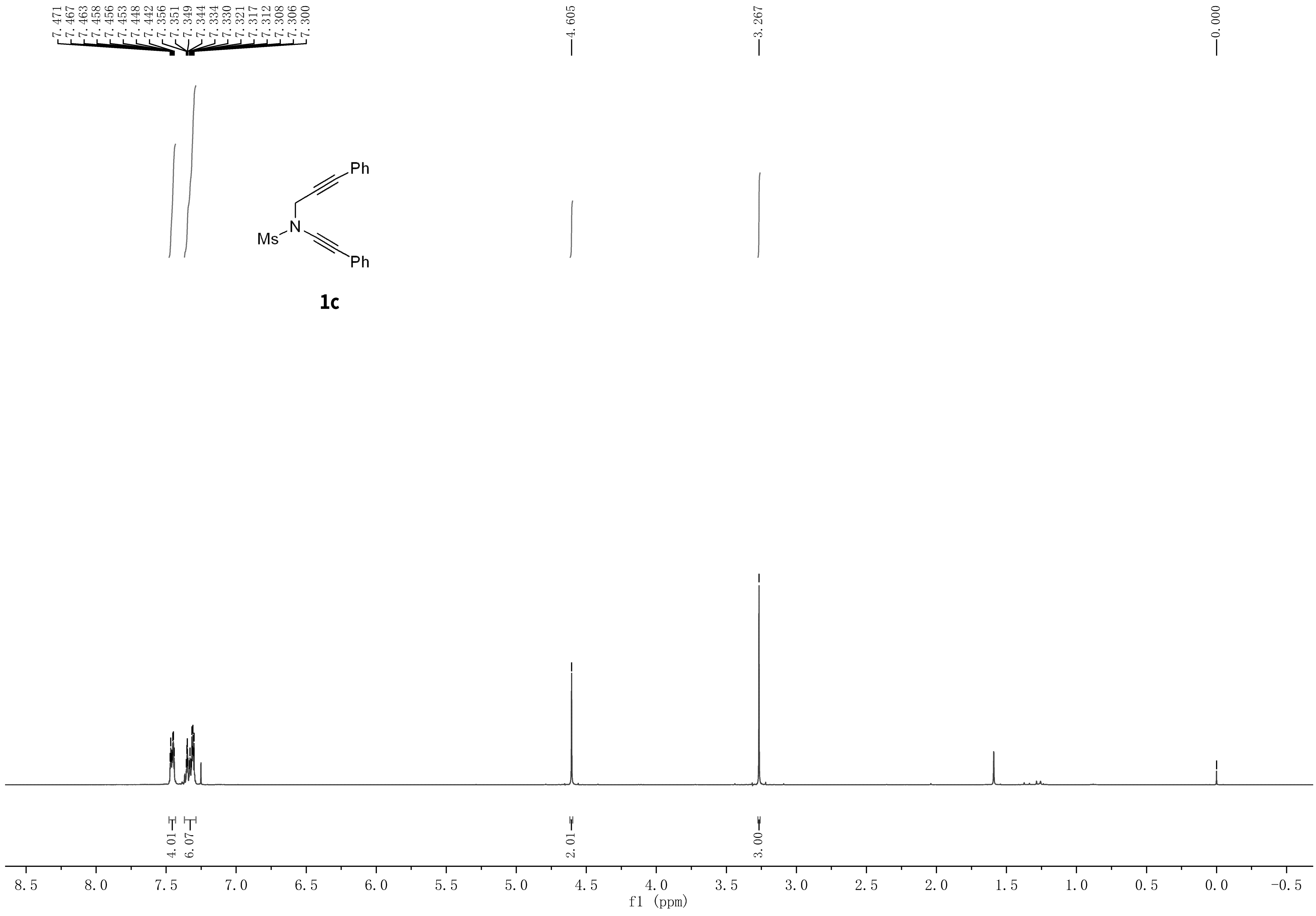
f1 (ppm)

1b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7.321
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7.312
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7.300
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Ms
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Ph
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6.07
2.01
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8.0
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6.0
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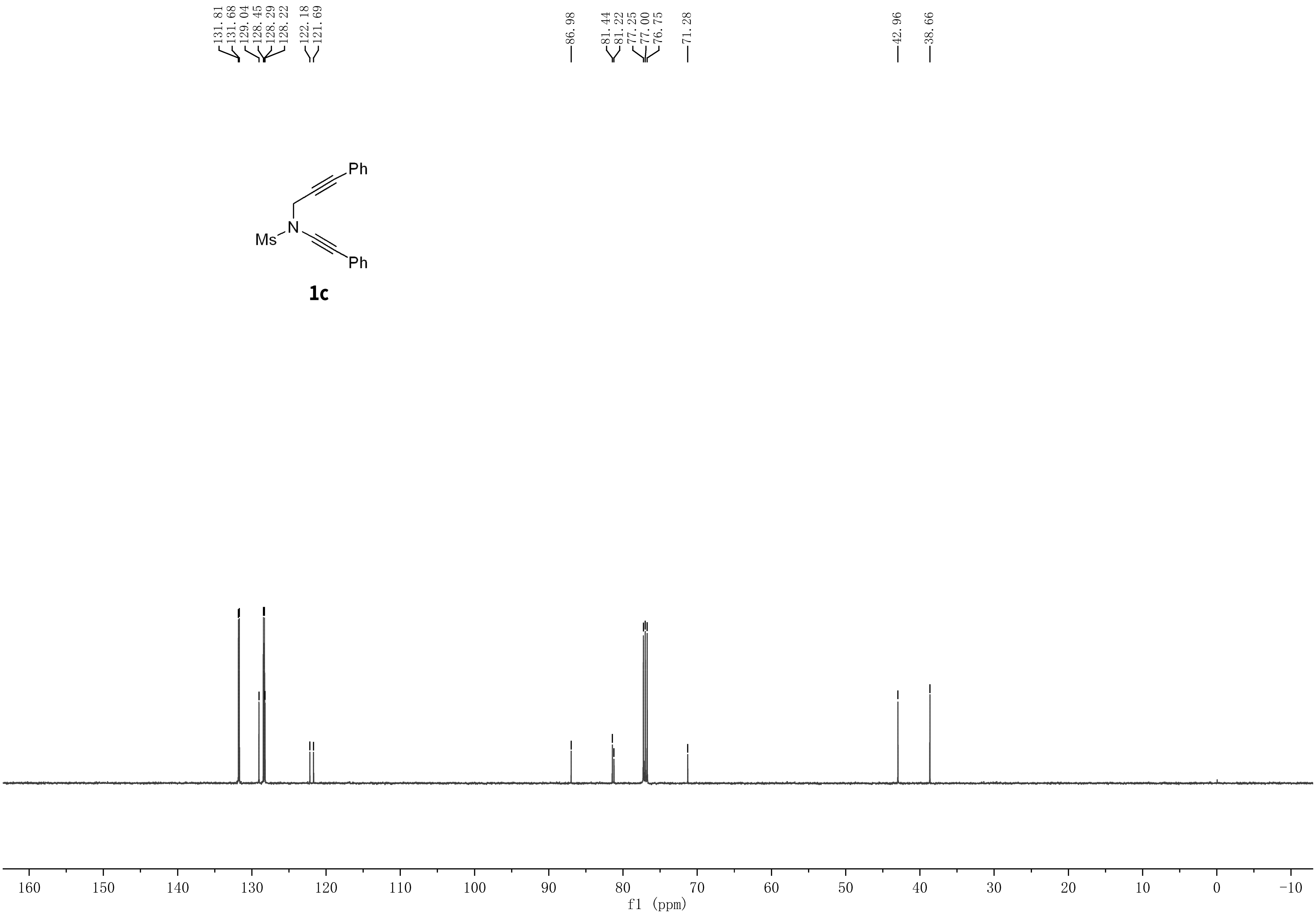
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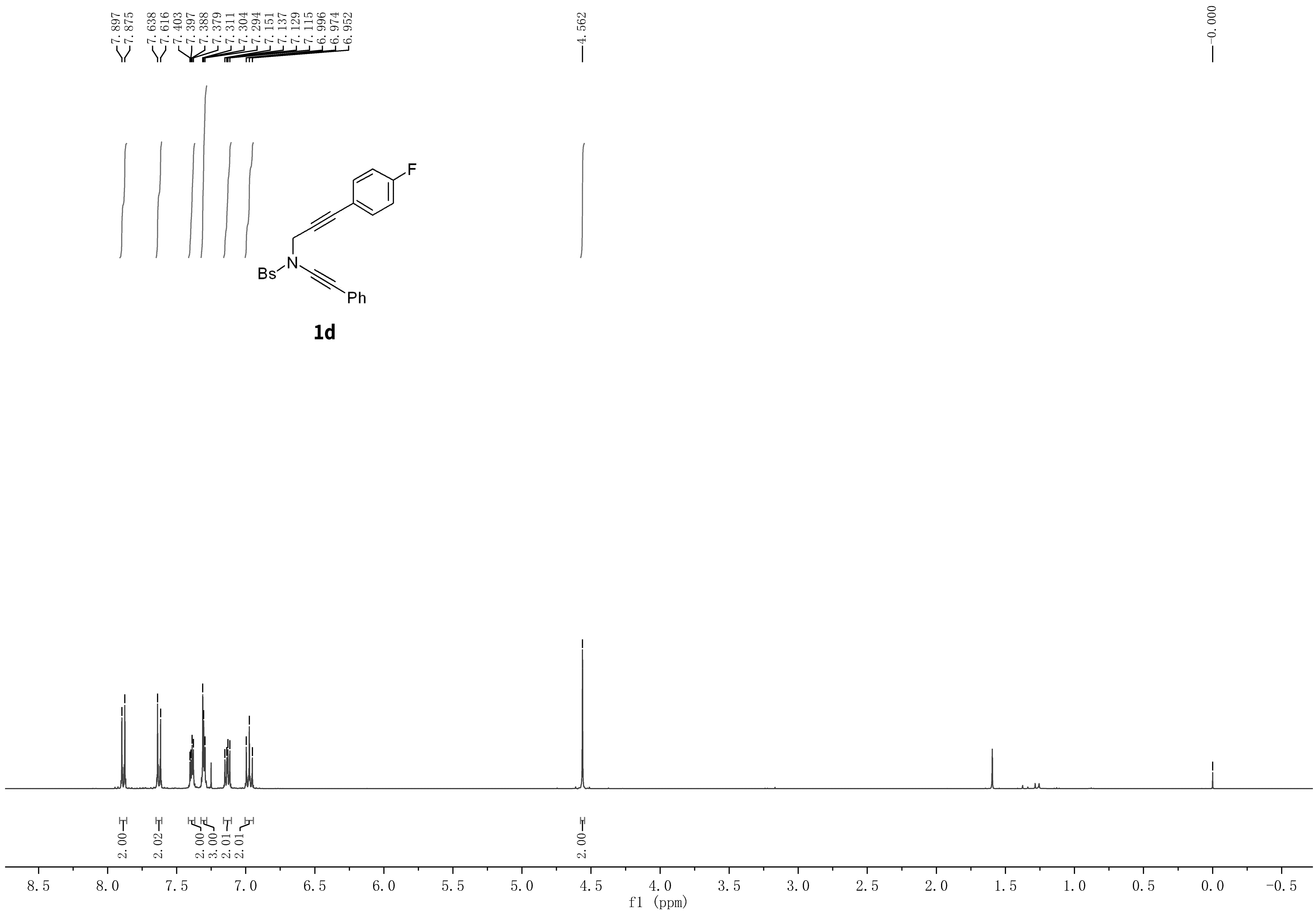
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N
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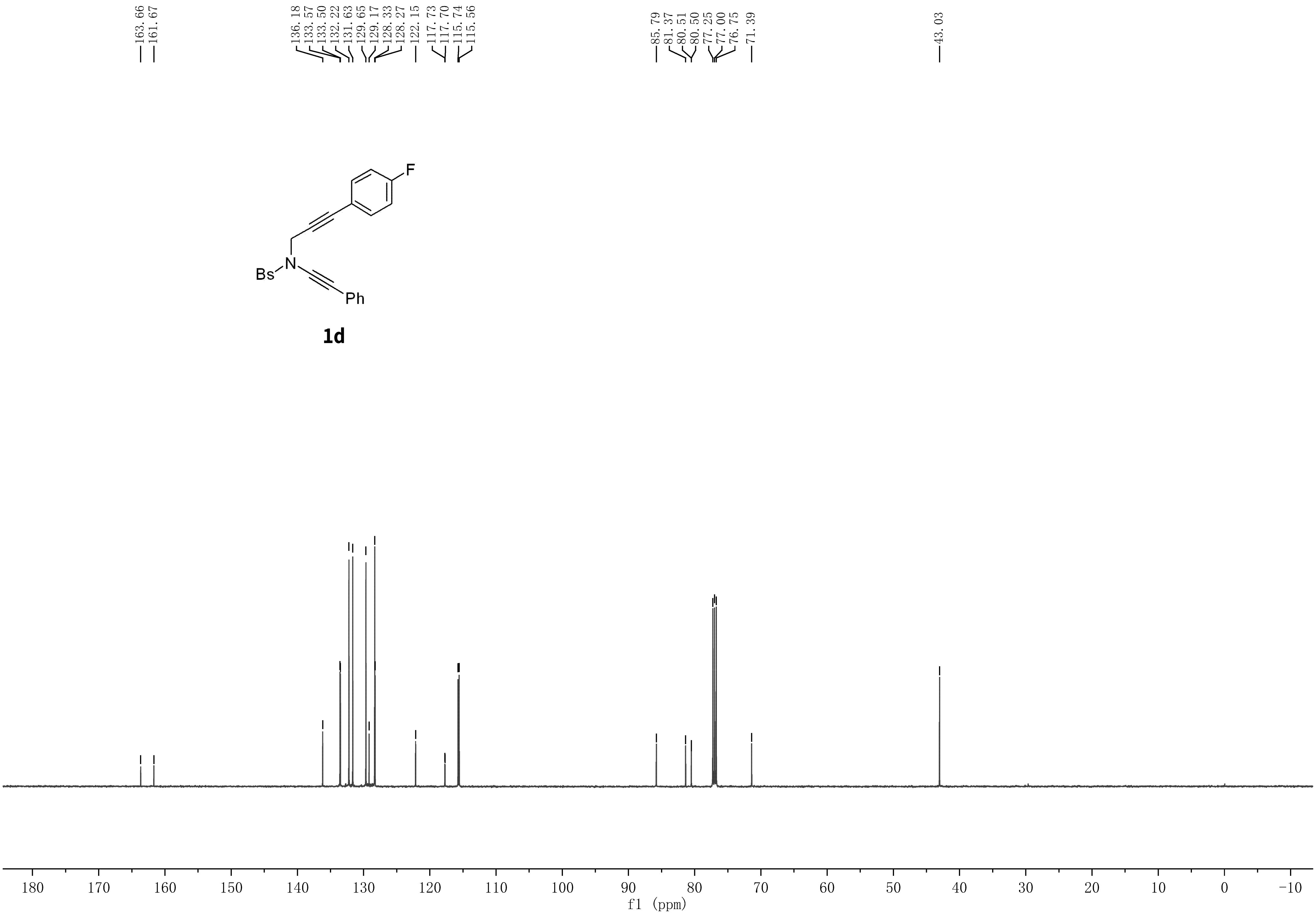
f1 (ppm)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115.74
115.56
85.79
81.37
80.51
80.50
77.25
77.00
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F
Bs
N
Ph
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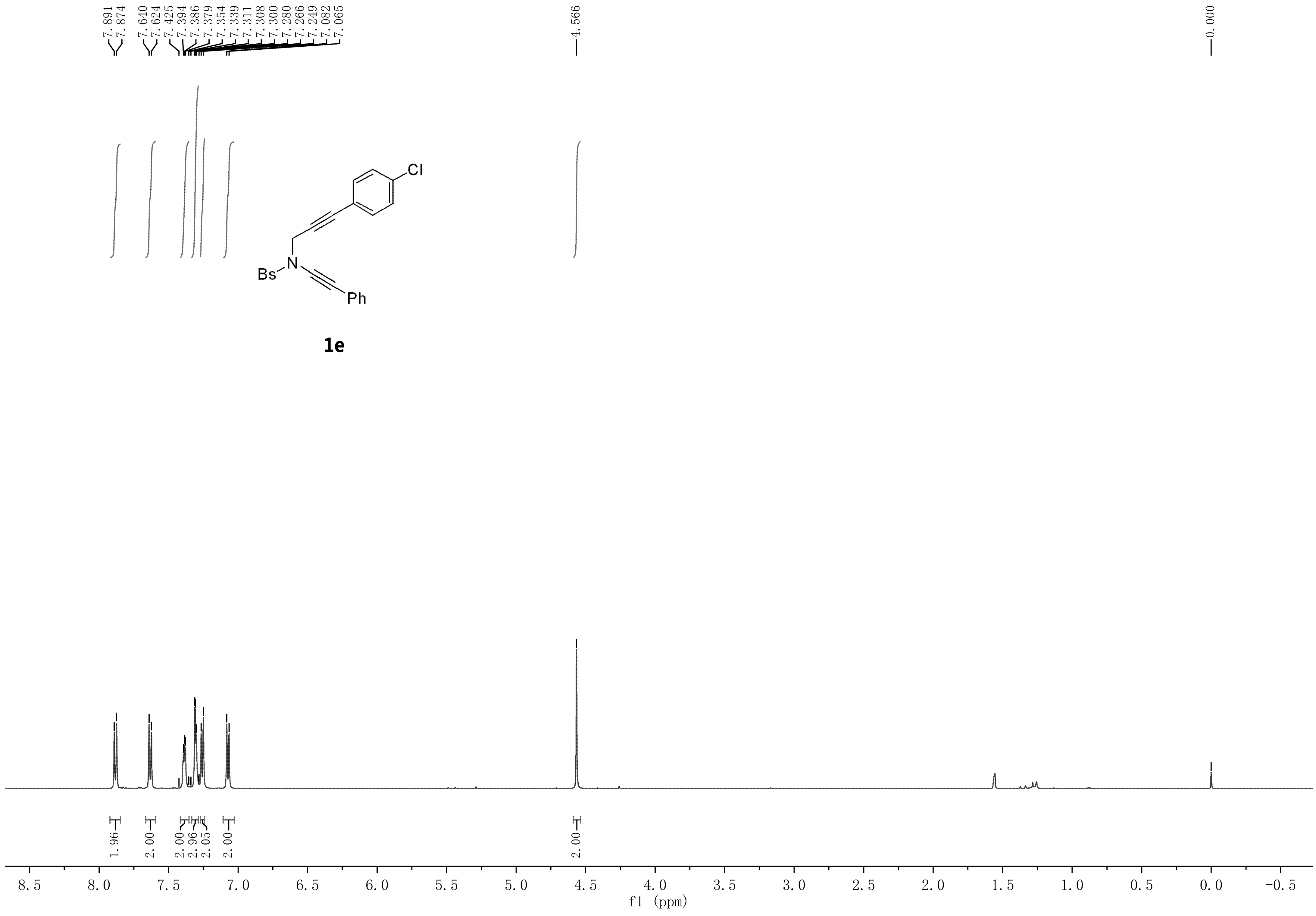
f1 (ppm)



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7.280
7.266
7.249
7.082
7.065
4.566
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Cl
Bs
N
Ph
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2.00
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6.5
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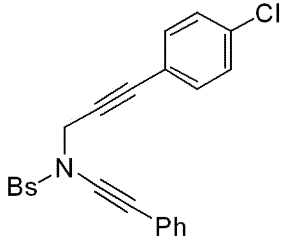
Cl
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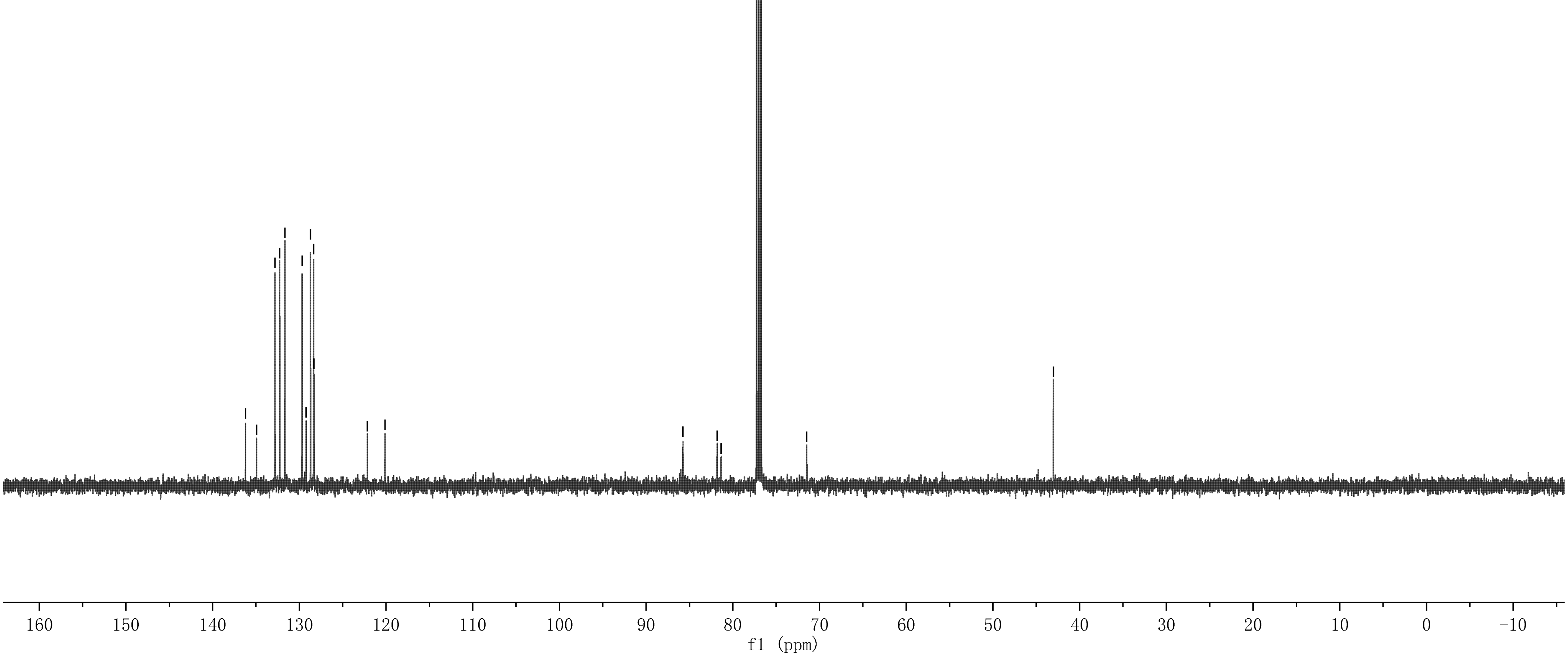
1e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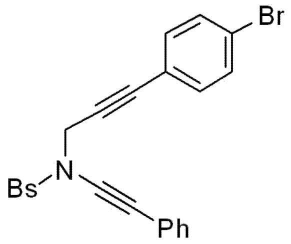
f1 (ppm)


Br
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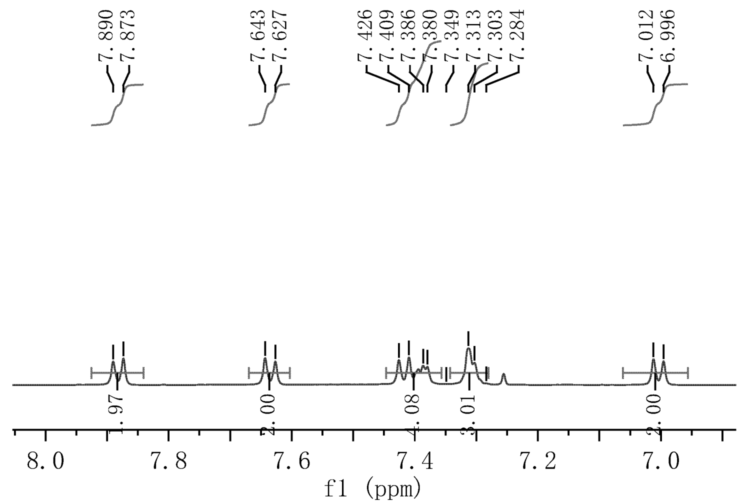
Ph

1f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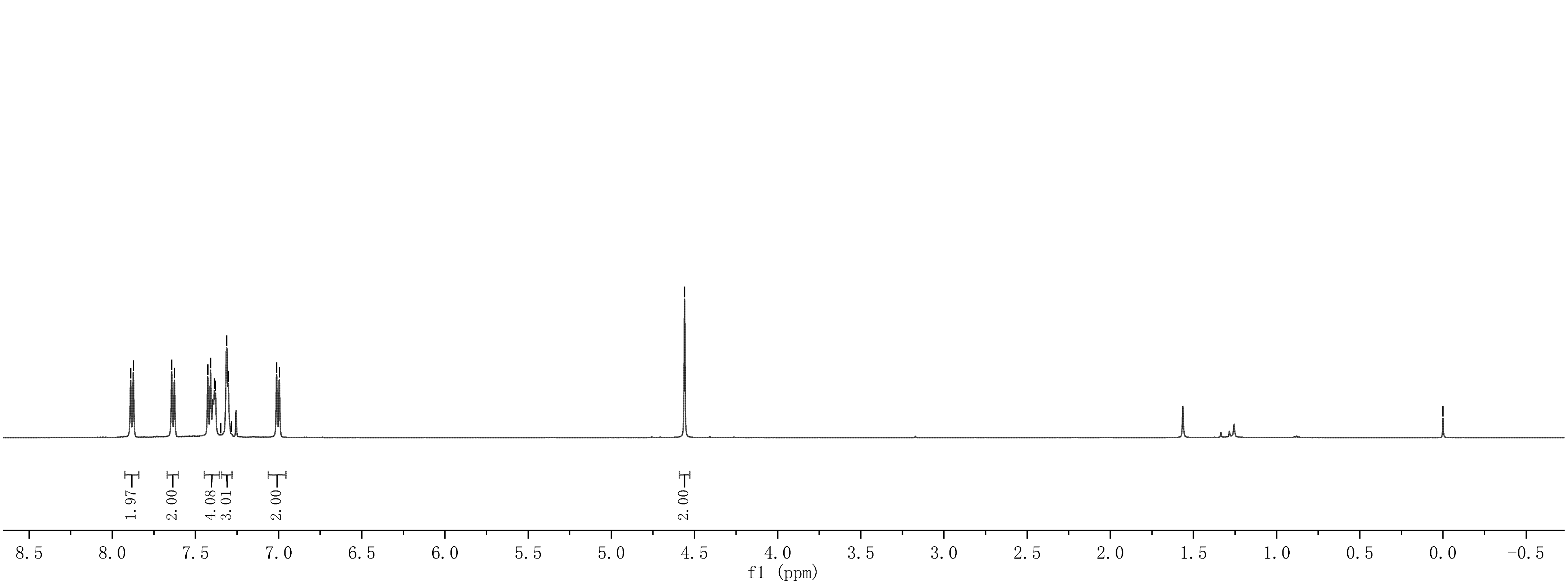
7.643
7.627
7.426
7.409
7.386
7.380
7.349
7.313
7.303
7.284
7.012
6.996
1.97
2.00
4.08
3.01
2.00
f1 (ppm)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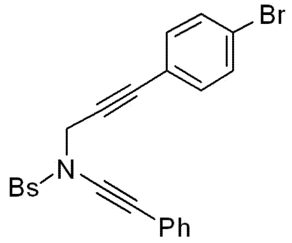
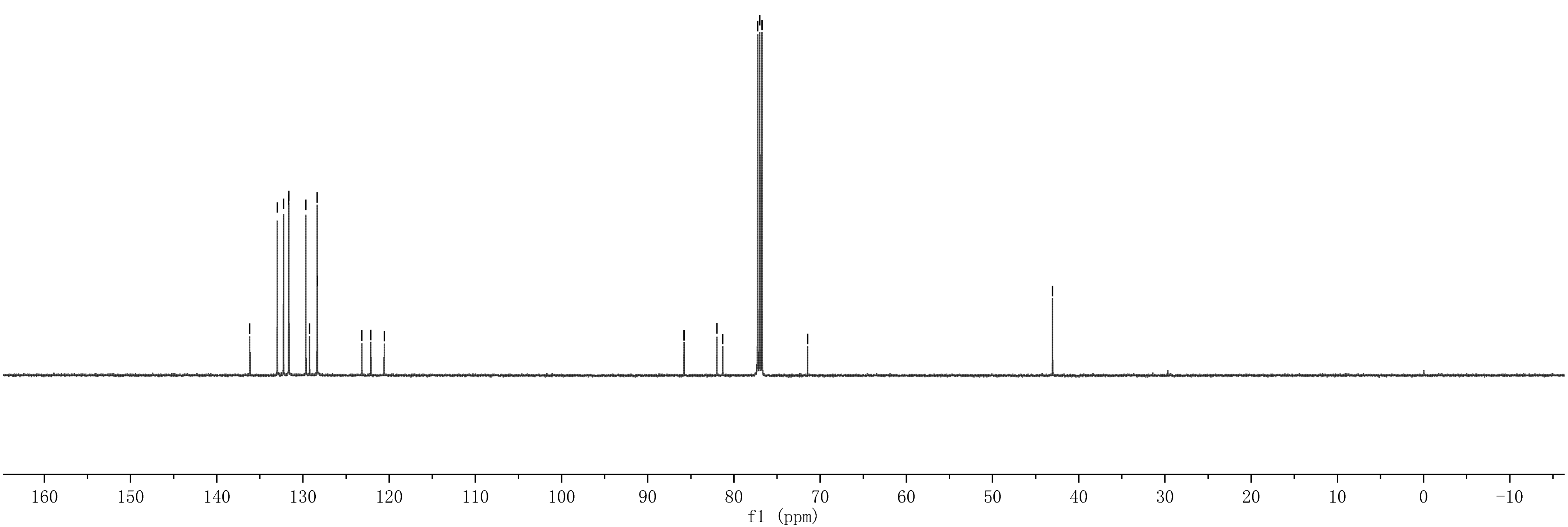
7.873
7.643
7.627
7.426
7.409
7.313
7.303
7.012
6.996
4.559
0.000
1.97
2.00
4.08
3.01
2.00
2.00
f1 (ppm)


Br
Bs
N
Ph

1f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131.67
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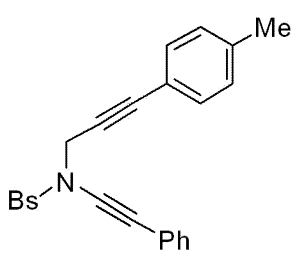
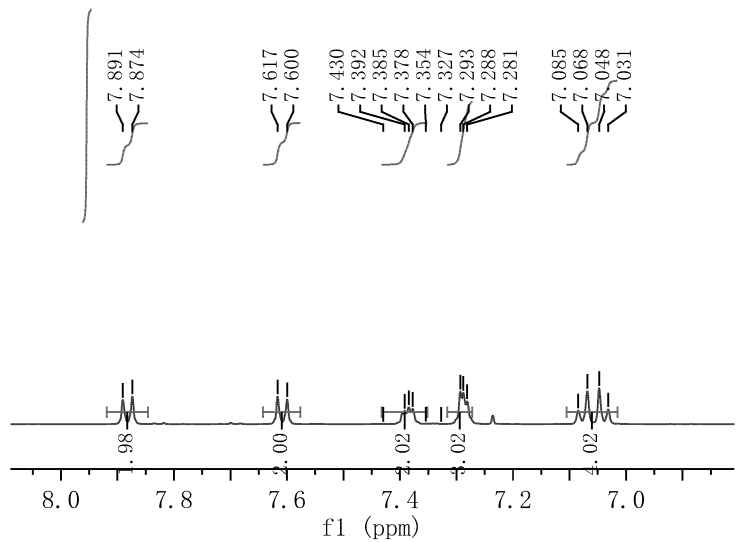
129.67
129.23
128.36
128.32
123.17
122.12
120.57
85.80
81.98
81.31
77.25
77.00
76.75
71.45
43.04
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)


Me
N
Bs
Ph

1g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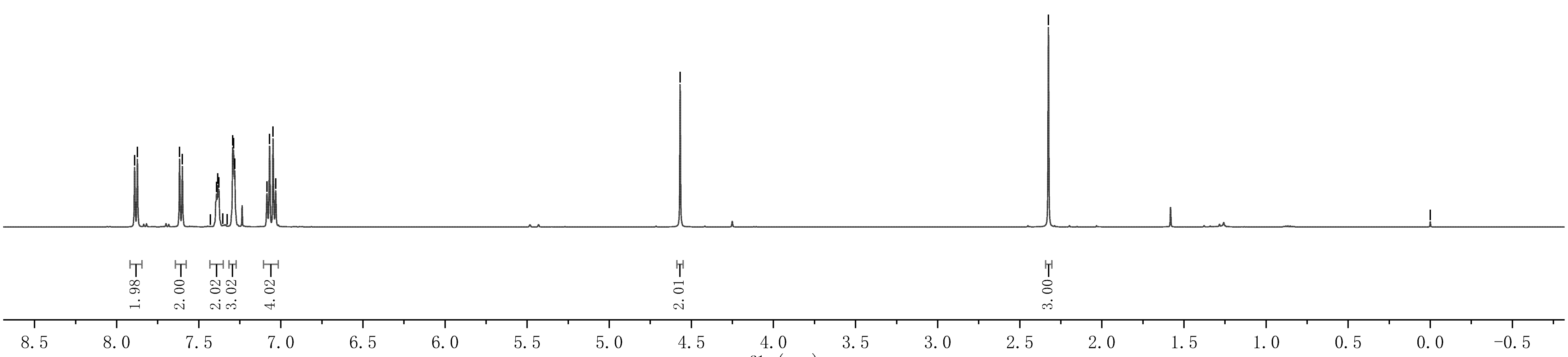
7.600
7.430
7.392
7.385
7.378
7.354
7.327
7.293
7.288
7.281
7.085
7.068
7.048
7.031
1.98
2.00
2.02
3.02
4.02
8.0
7.8
7.6
7.4
7.2
7.0
f1 (ppm)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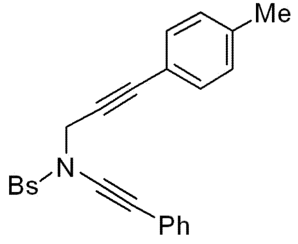
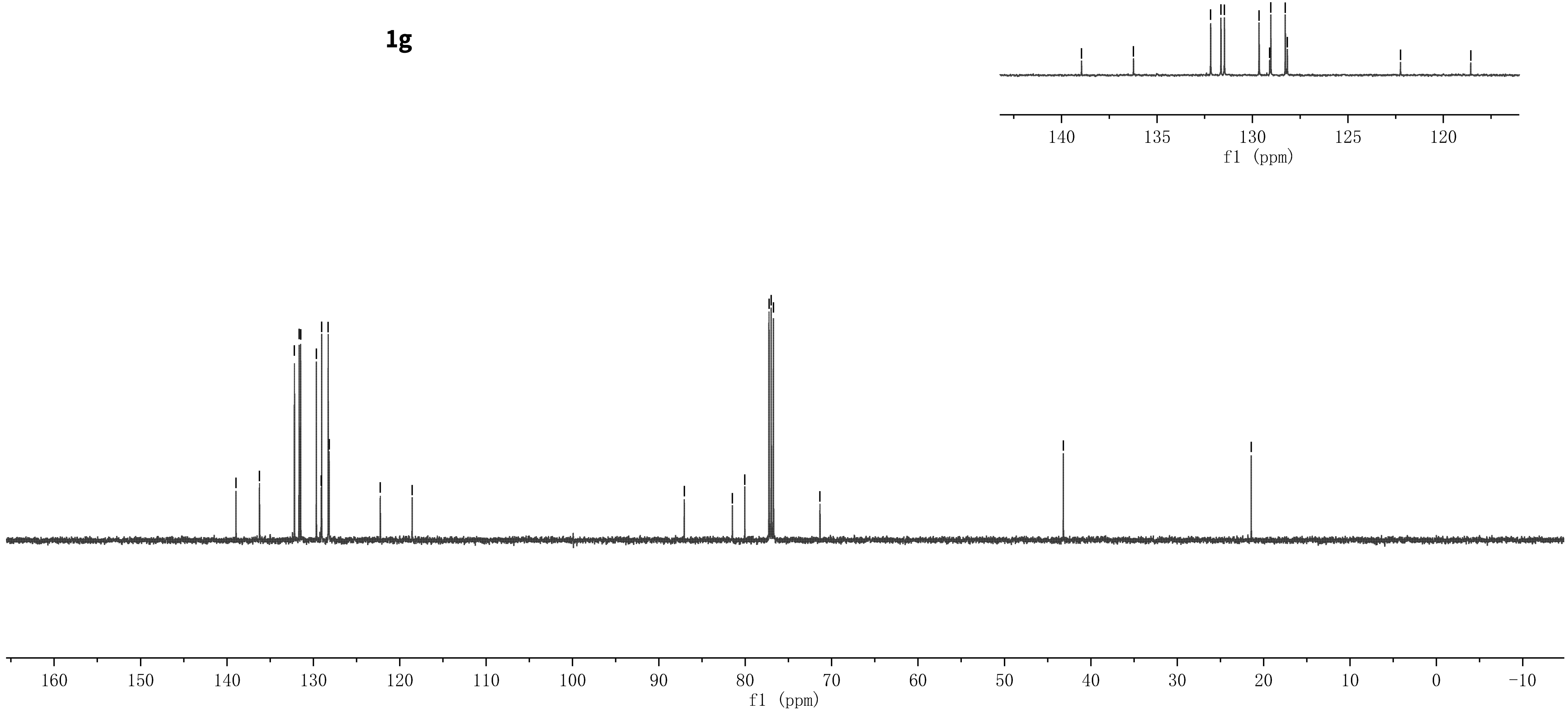
2.02
3.02
4.02
2.01
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


Me
Bs
N
Ph

1g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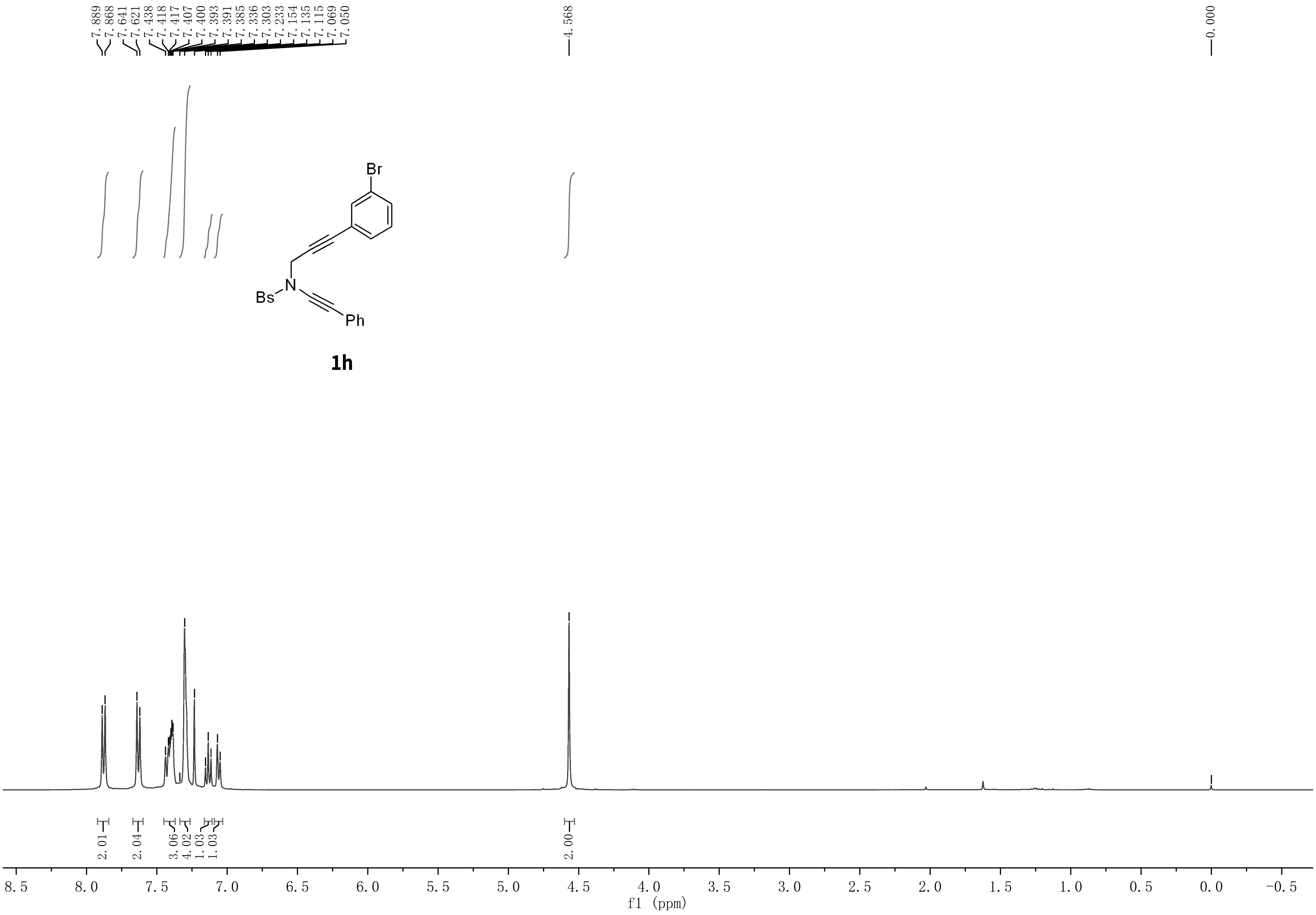
129.65
129.04
128.28
128.17
122.24
118.57
87.06
81.49
80.06
77.25
77.00
76.75
71.35
43.18
21.43
138.95
136.23
132.19
131.65
131.47
129.65
129.09
129.04
128.28
128.17
122.24
118.57
140
135
130
125
120
f1 (ppm)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)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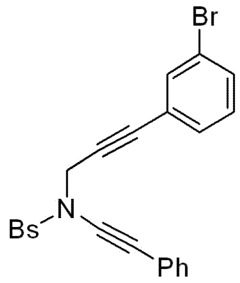
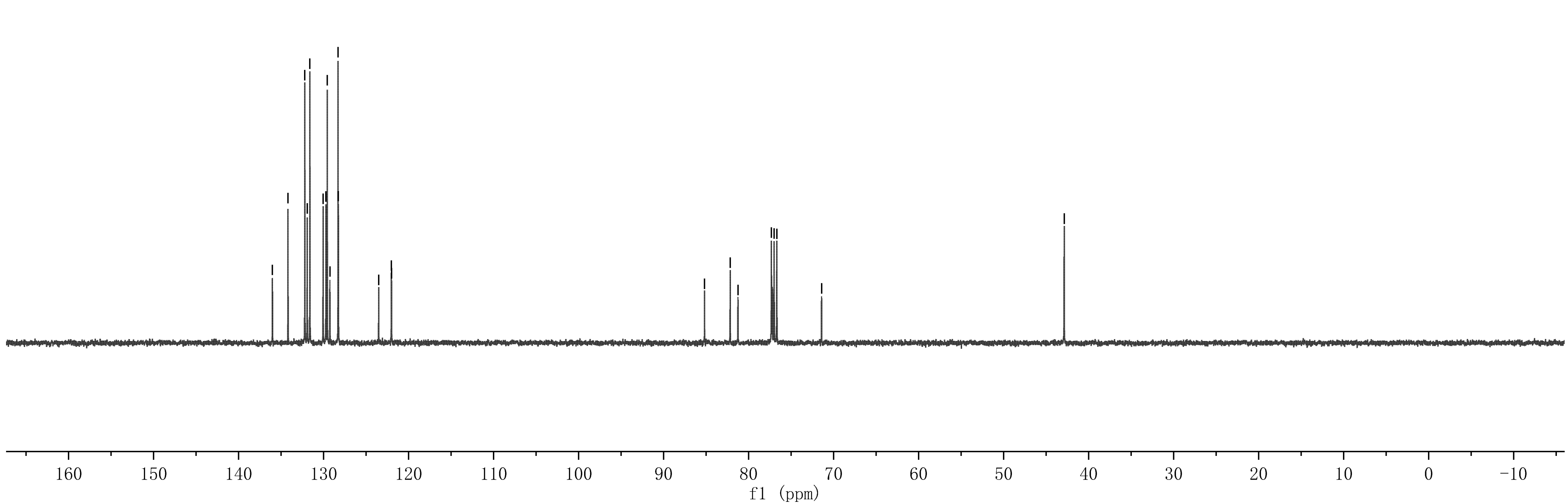
7.417
7.407
7.400
7.393
7.391
7.385
7.336
7.303
7.233
7.154
7.135
7.115
7.069
7.050
4.568
0.000
Br
Bs
N
Ph
1h
2.01
2.04
3.06
4.02
1.03
1.03
2.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)



Br
Bs
N
Ph

1h



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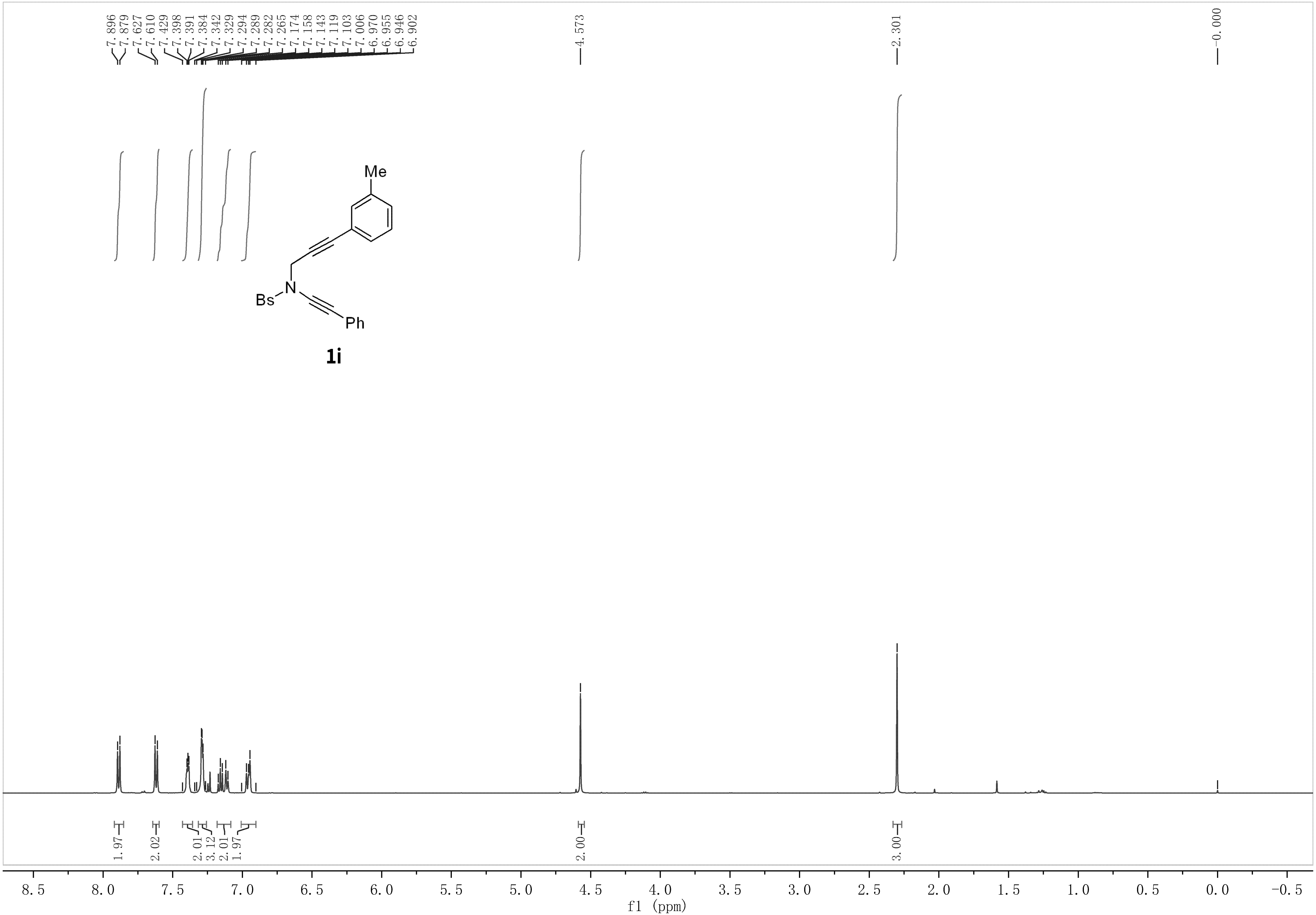
134.19
132.21
131.92
131.61
130.06
129.73
129.56
129.26
128.29
128.26
123.52
122.03
122.01
85.18
82.17
81.25
77.32
77.00
76.68
71.42
42.87
135
130
125
120
f1 (ppm)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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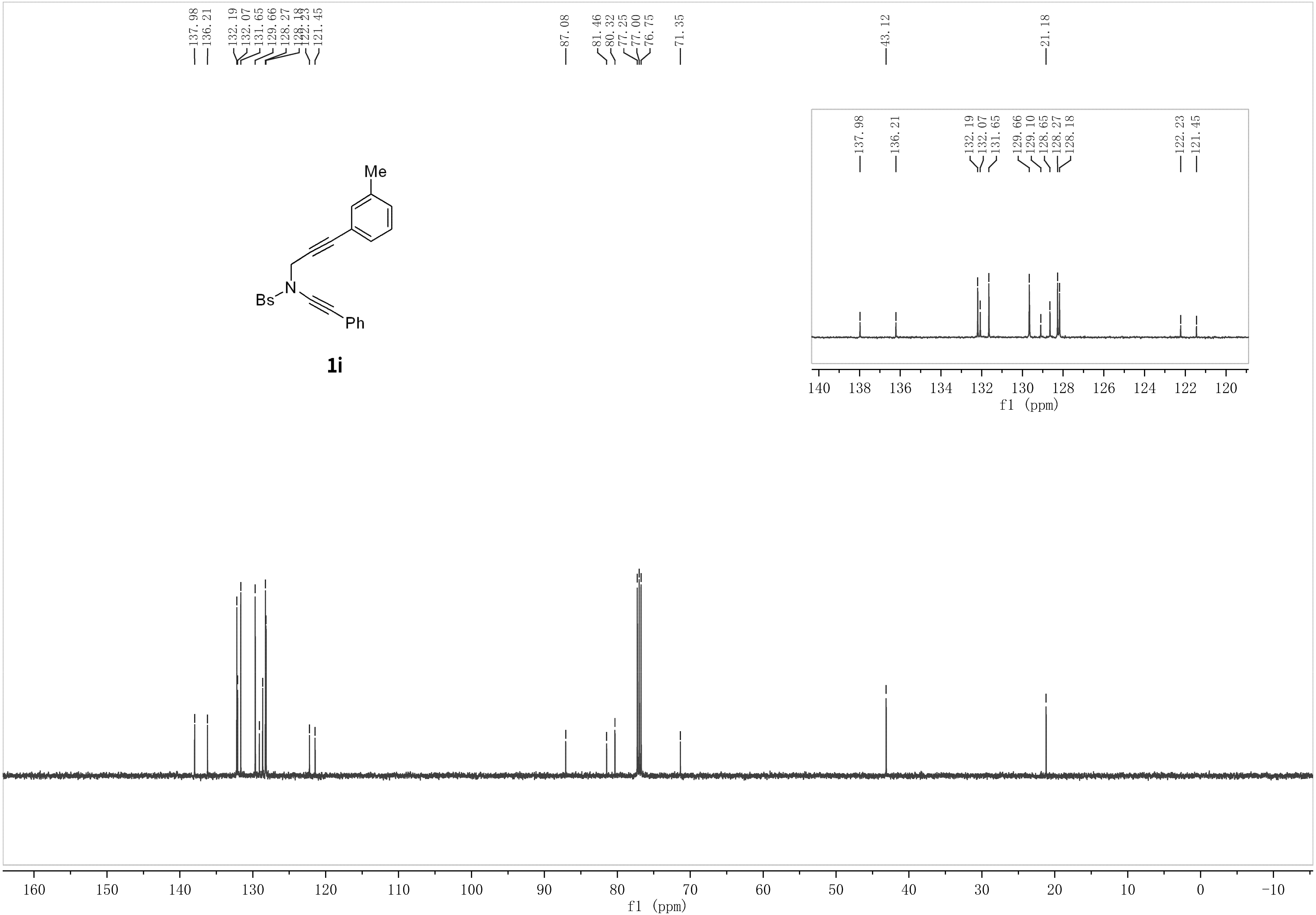
7.627
7.610
7.429
7.398
7.391
7.384
7.342
7.329
7.294
7.289
7.282
7.265
7.174
7.158
7.143
7.119
7.103
7.006
6.970
6.955
6.946
6.902
4.573
2.301
0.000
Me
Bs
N
Ph
1i
1.97
2.02
2.01
3.12
2.01
1.97
2.00
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)



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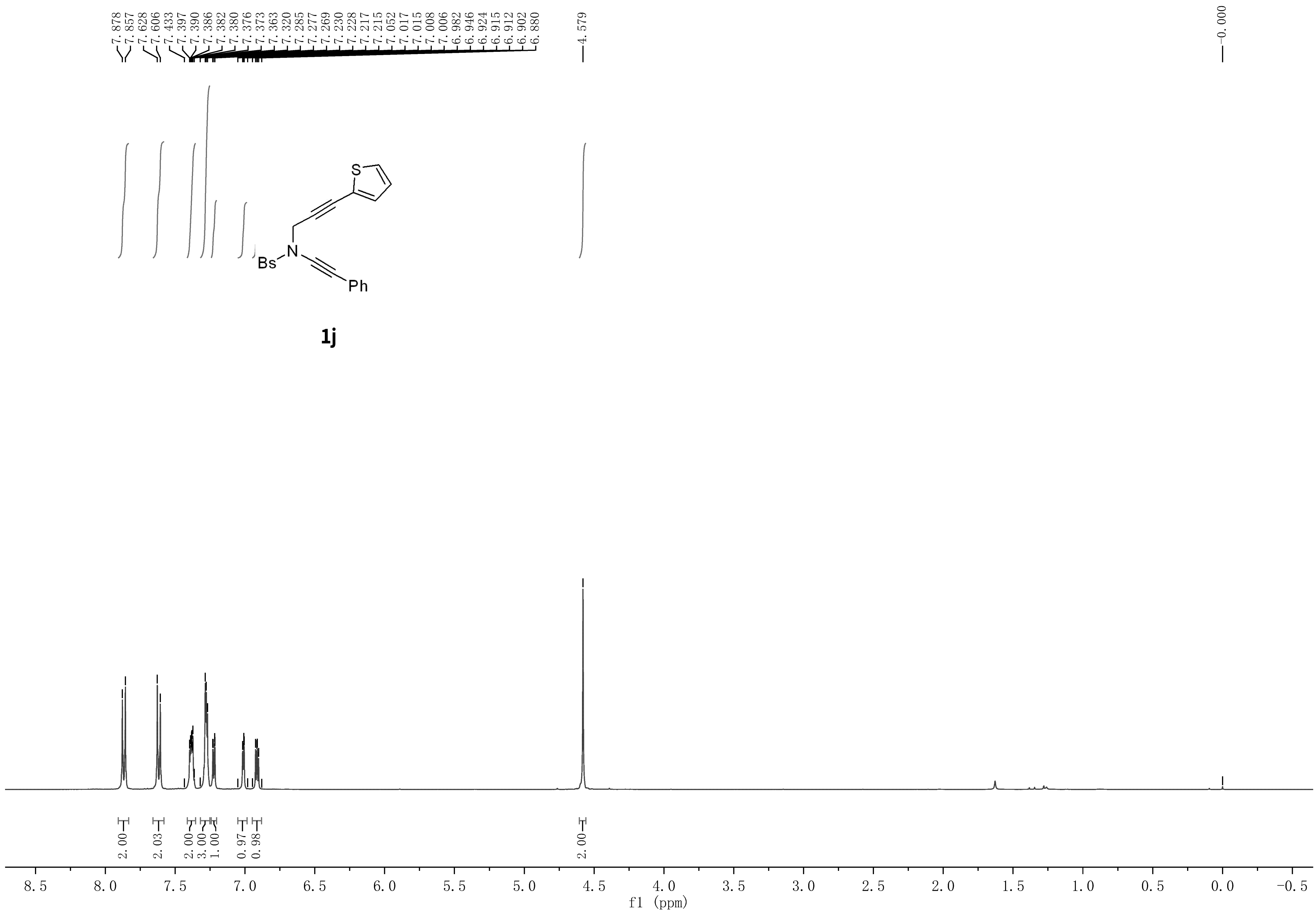
136.21
132.19
132.07
131.65
129.66
128.27
128.18
122.23
121.45
87.08
81.46
80.32
77.25
77.00
76.75
71.35
43.12
21.18
Me
N
Bs
Ph
1i
137.98
136.21
132.19
132.07
131.65
129.66
129.10
128.65
128.27
128.18
122.23
121.45
140 138 136 134 132 130 128 126 124 122 120
f1 (ppm)
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)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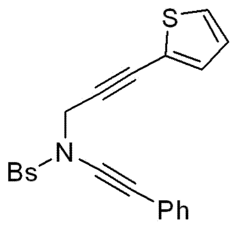
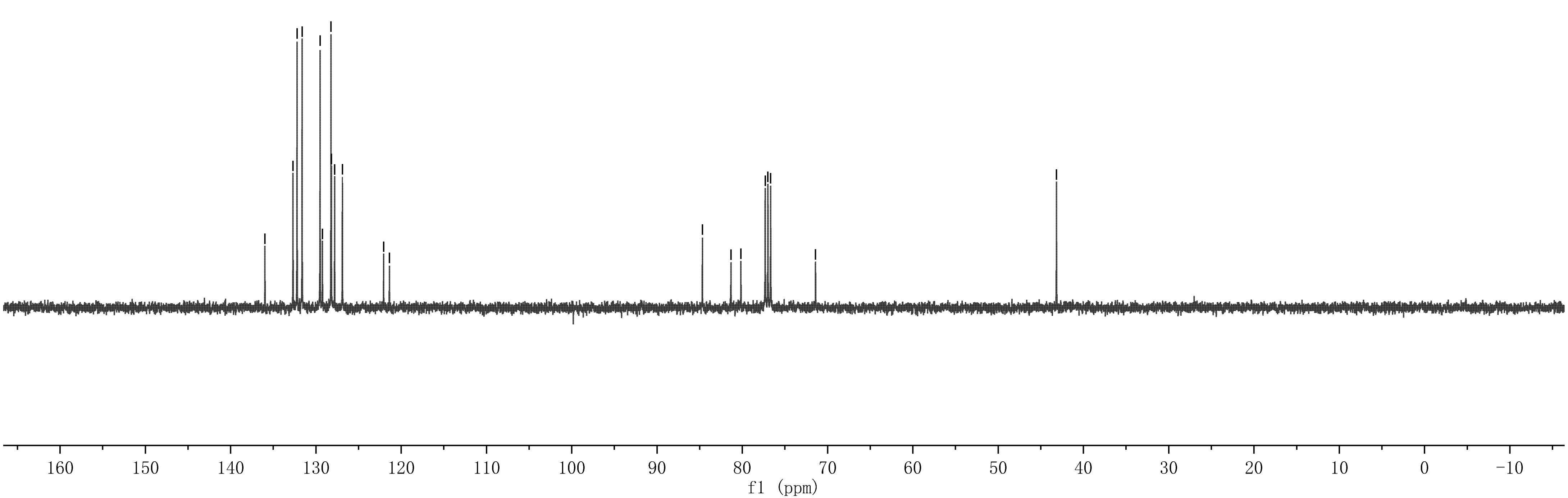
7.433
7.397
7.390
7.386
7.382
7.380
7.376
7.373
7.363
7.320
7.285
7.277
7.269
7.230
7.228
7.217
7.215
7.052
7.017
7.015
7.008
7.006
6.982
6.946
6.924
6.915
6.912
6.902
6.880
4.579
0.000
S
Bs
N
Ph
1j
2.00
2.03
2.00
3.00
1.00
0.97
0.98
2.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


S
Bs
N
Ph

1j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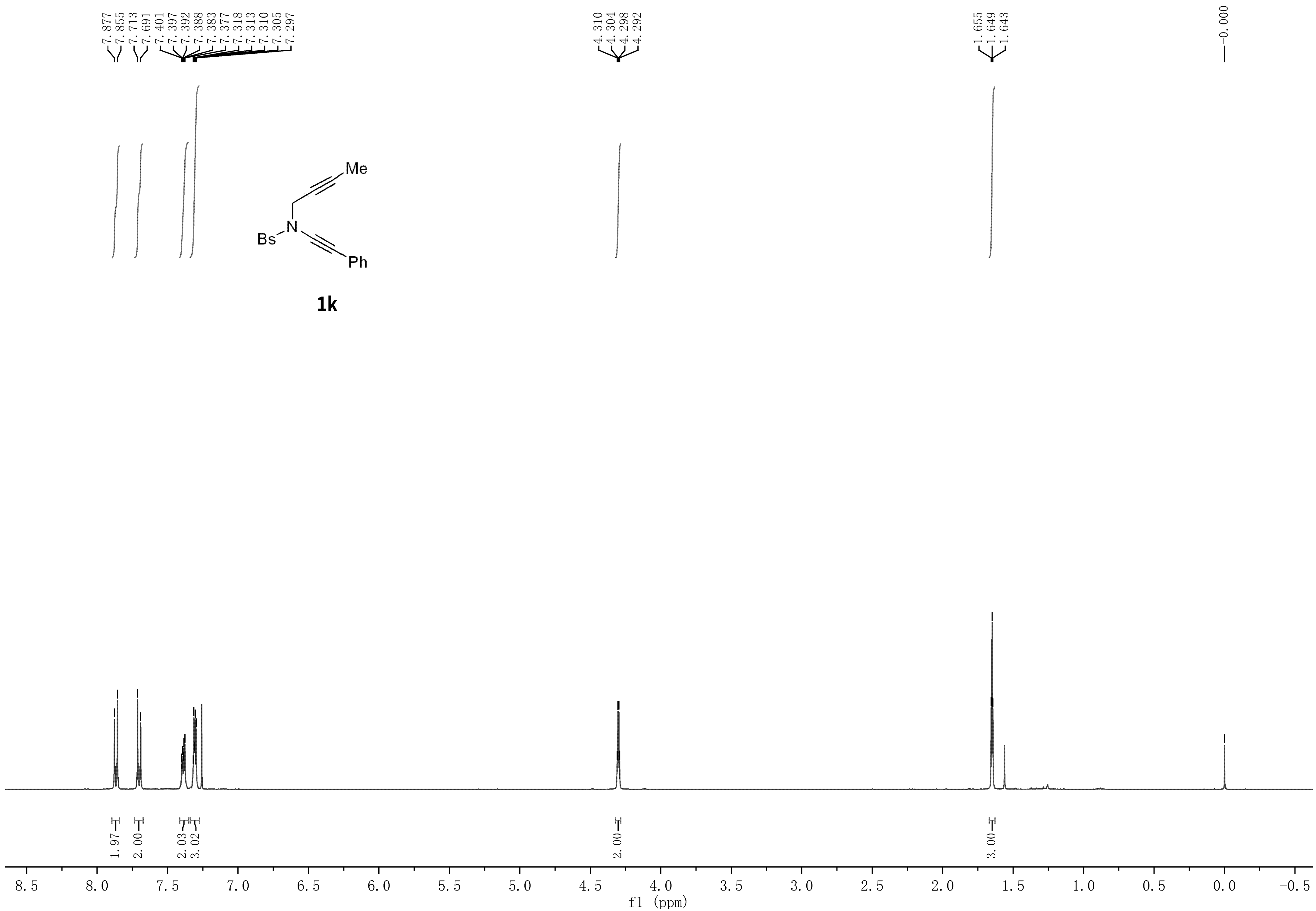
129.23
128.23
128.18
127.80
126.90
122.06
121.38
84.68
81.33
80.16
77.32
77.00
76.68
71.41
43.16
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)



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7.855
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7.691
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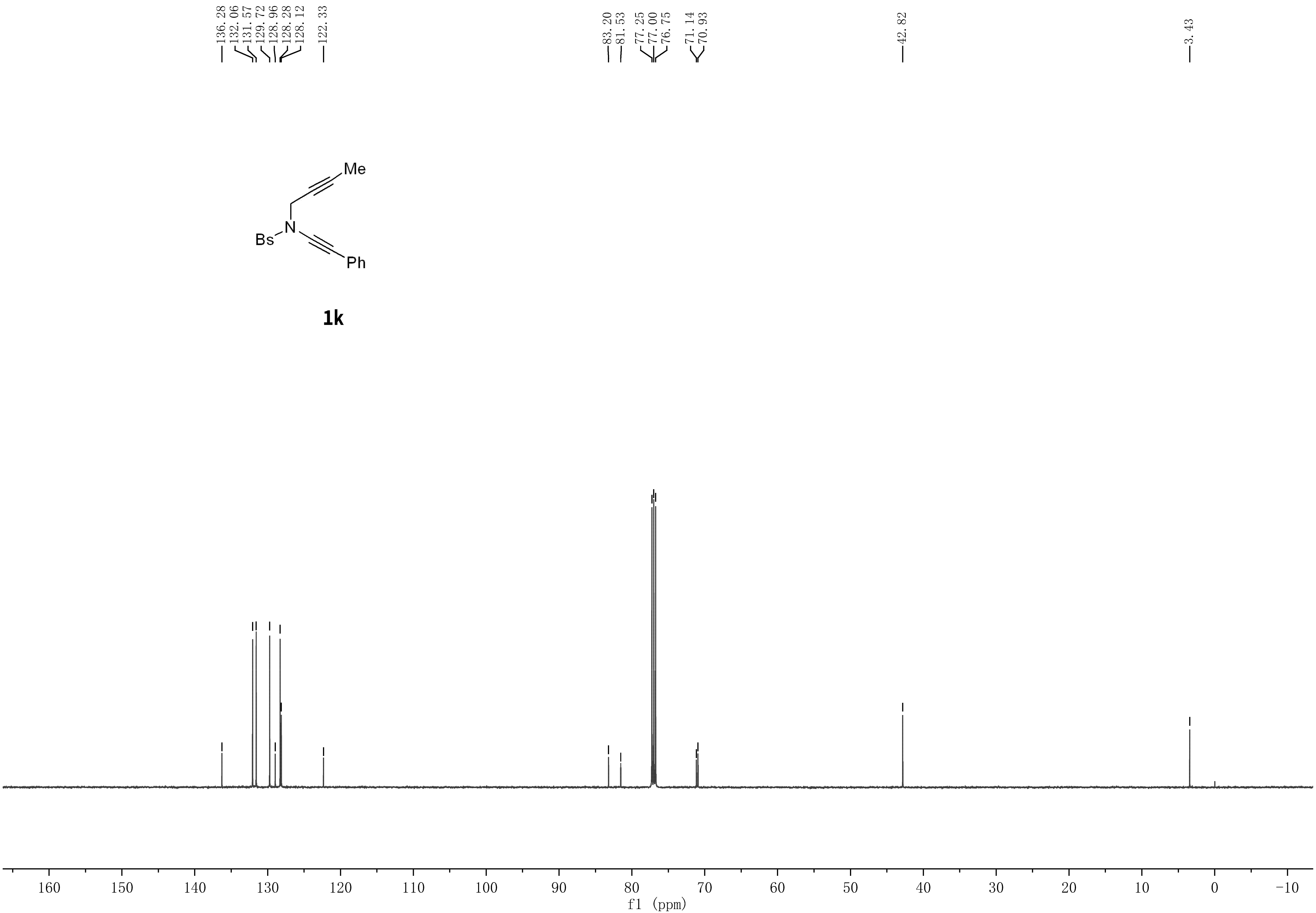
7.397
7.392
7.388
7.383
7.377
7.318
7.313
7.310
7.305
7.297
4.310
4.304
4.298
4.292
1.655
1.649
1.643
0.000
Me
Bs
N
Ph
1k
1.97
2.00
2.03
3.02
2.00
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


136.28
132.06
131.57
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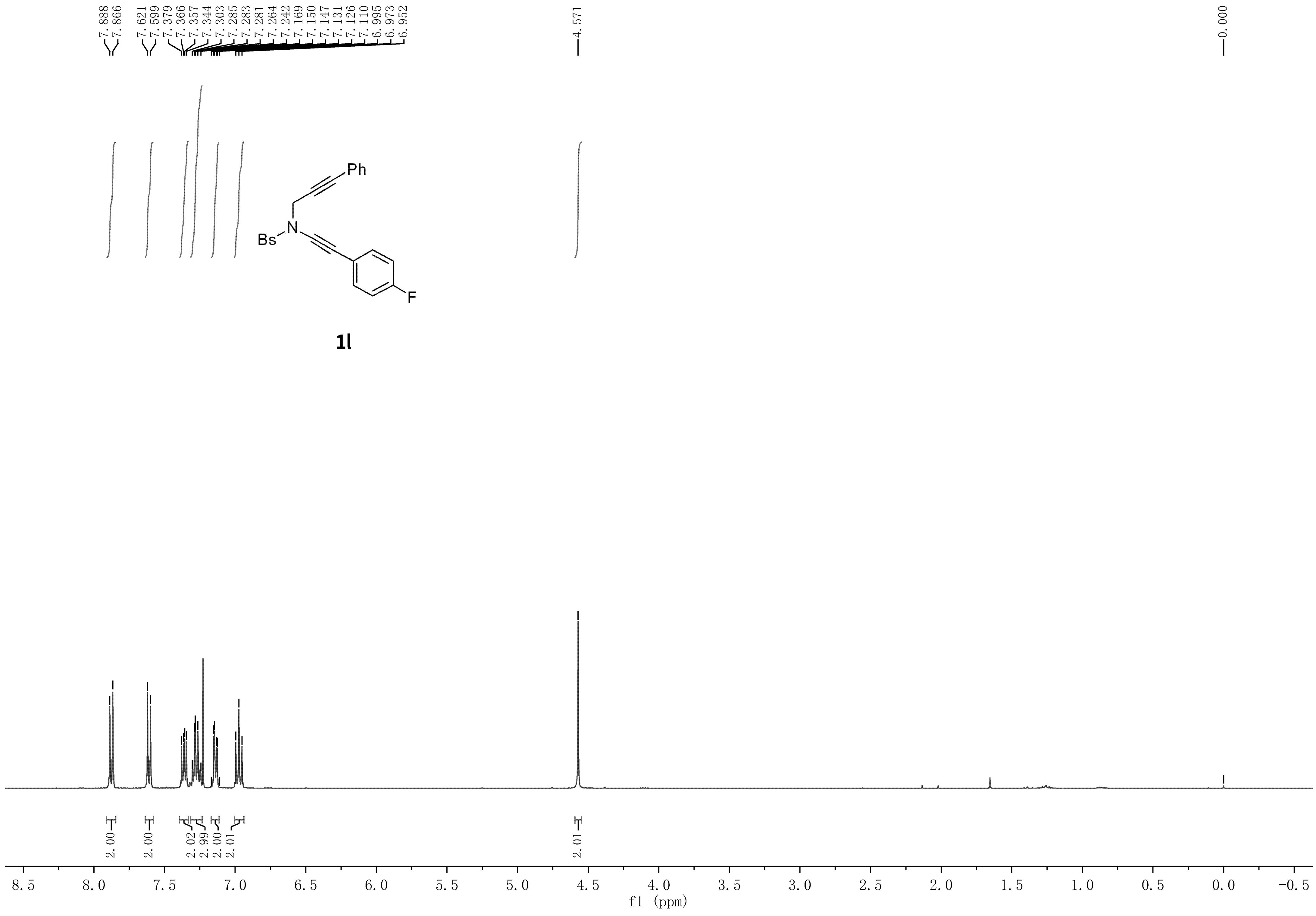
128.96
128.28
128.12
122.33
83.20
81.53
77.25
77.00
76.75
71.14
70.93
42.82
3.43
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)
Me
Bs
N
Ph

1k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7.357
7.344
7.303
7.285
7.283
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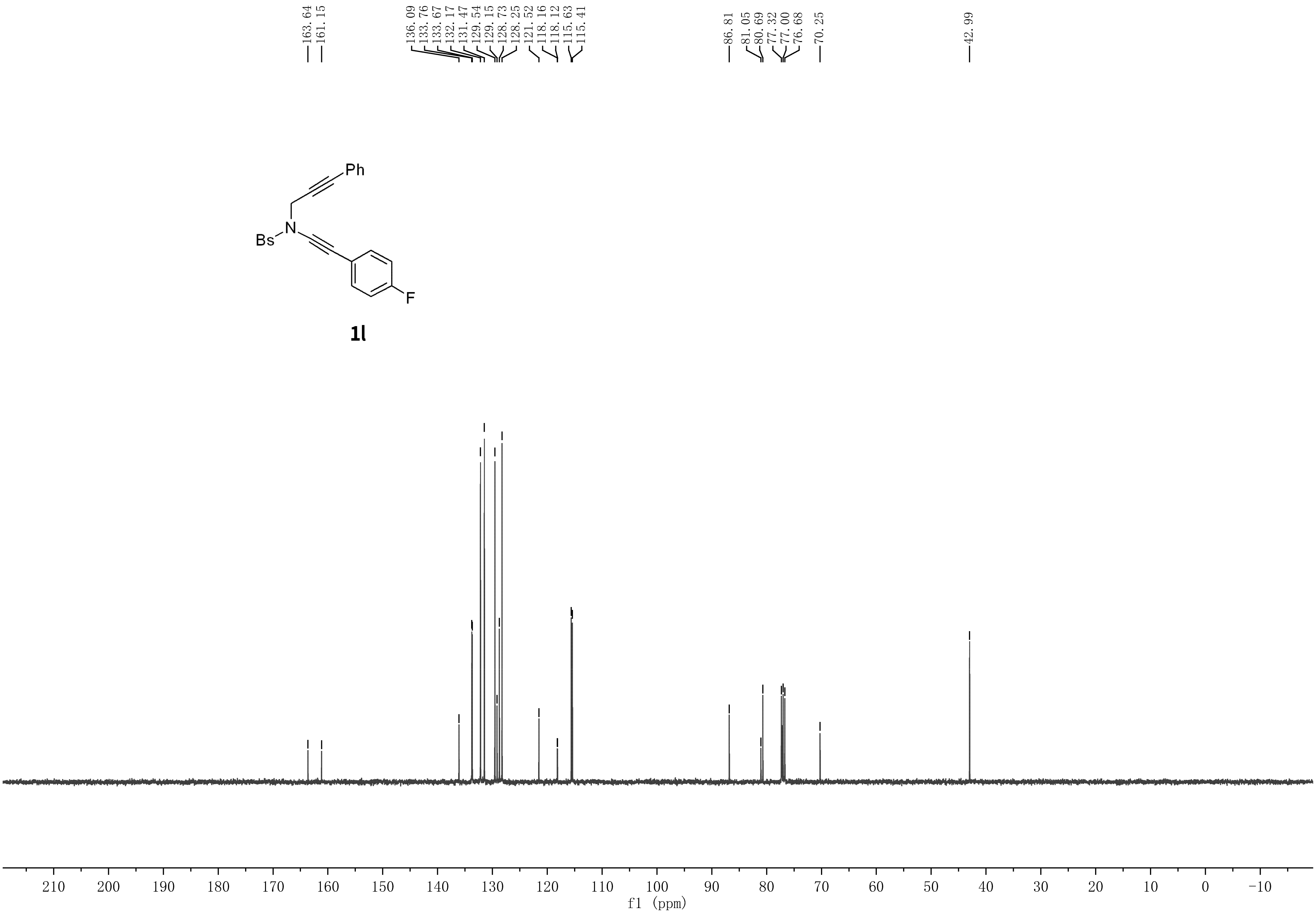
7.264
7.242
7.169
7.150
7.147
7.131
7.126
7.110
6.995
6.973
6.952
4.571
0.000
Ph
N
Bs
F
1l
2.00
2.00
2.02
2.99
2.00
2.01
2.01
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)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161.15
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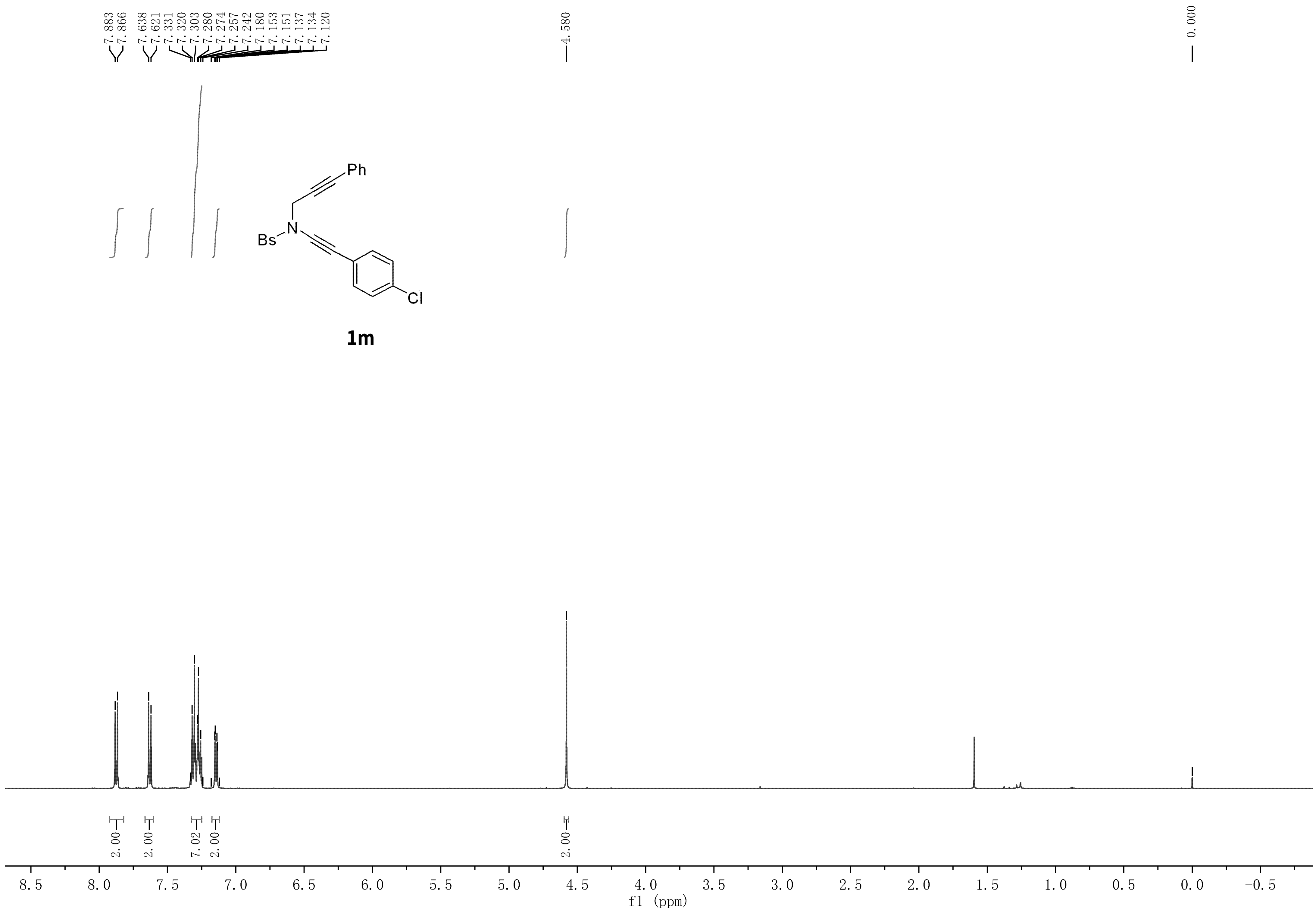
133.67
132.17
131.47
129.54
129.15
128.73
128.25
121.52
118.16
118.12
115.63
115.41
86.81
81.05
80.69
77.32
77.00
76.68
70.25
42.99
Ph
Bs
N
F
1l
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)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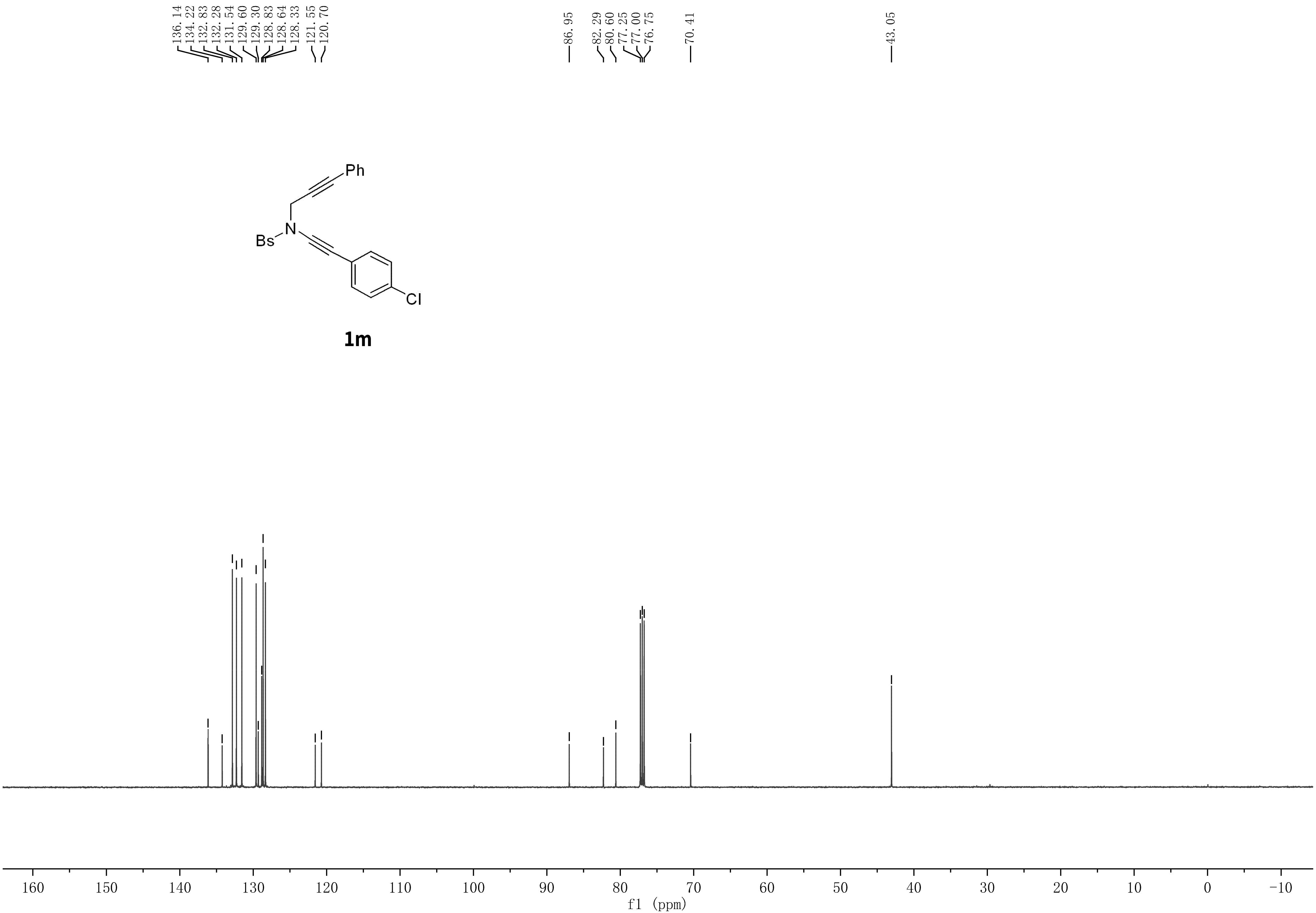
7.621
7.331
7.320
7.303
7.280
7.274
7.257
7.242
7.180
7.153
7.151
7.137
7.134
7.120
4.580
0.000
Ph
Bs
N
Cl
1m
2.00
2.00
7.02
2.00
2.00
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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134.22
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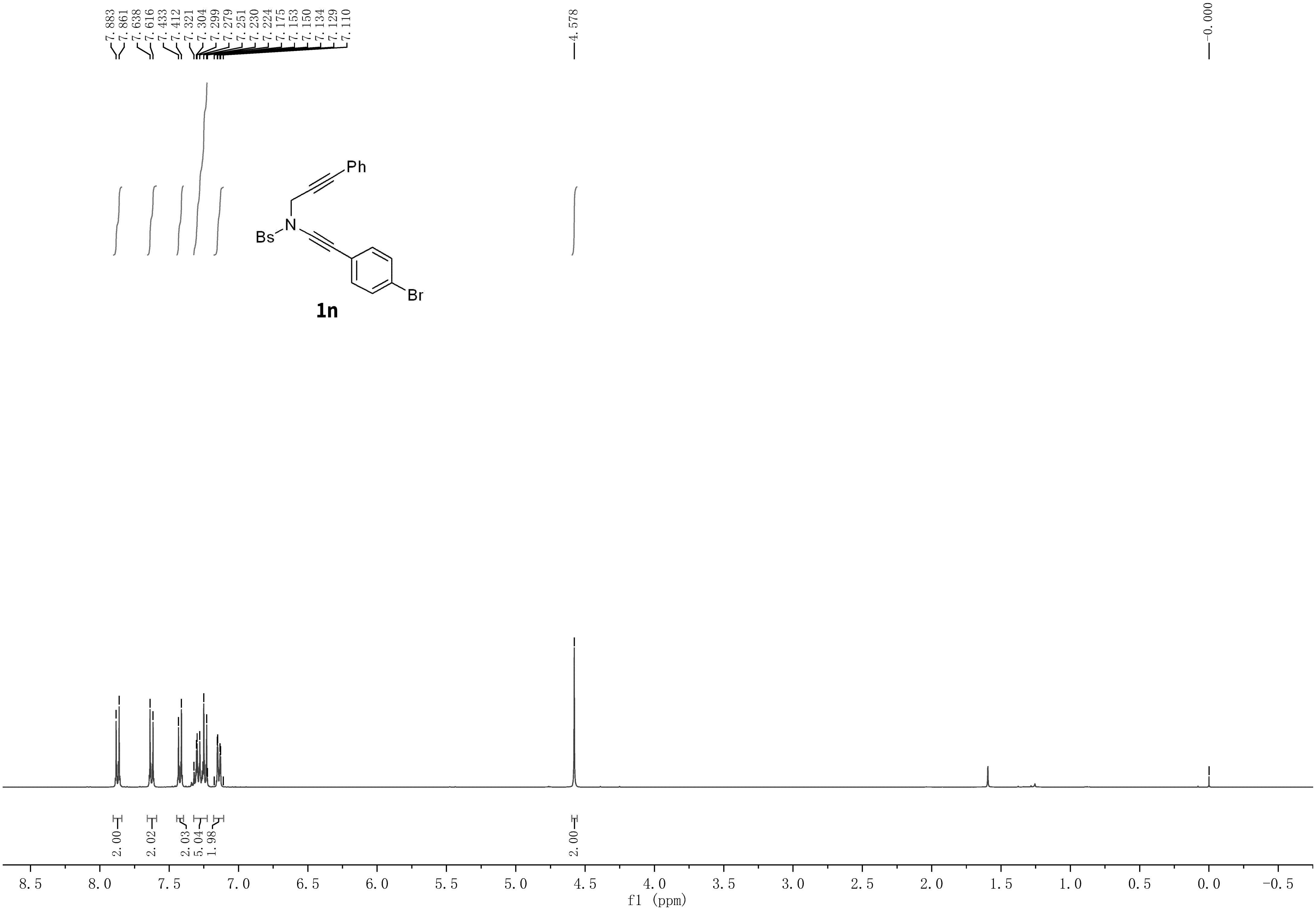
131.54
129.60
129.30
128.83
128.64
128.33
121.55
120.70
86.95
82.29
80.60
77.25
77.00
76.75
70.41
43.05
Ph
Bs
N
Cl
1m
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)



7.883
7.861
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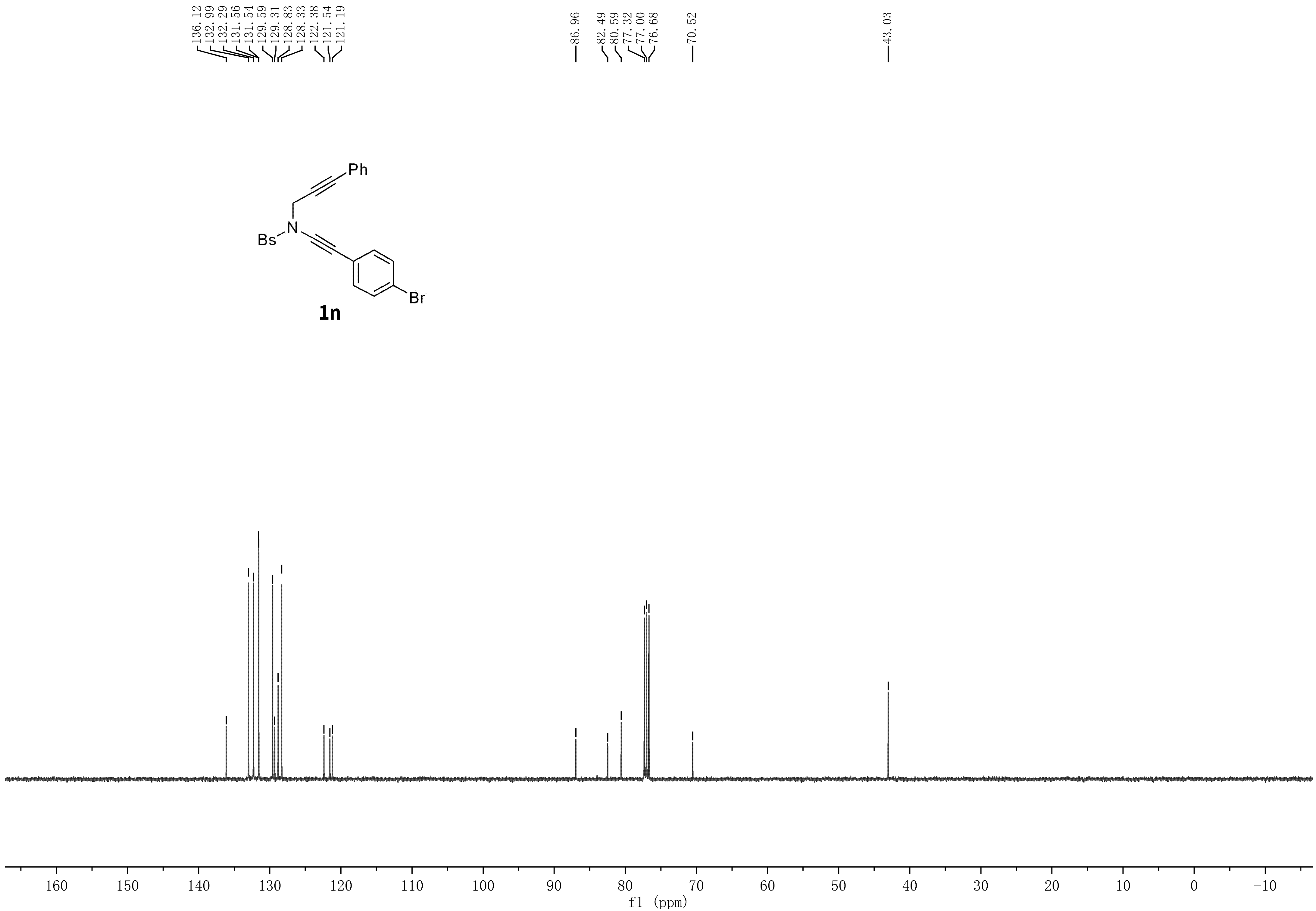
7.616
7.433
7.412
7.321
7.304
7.299
7.279
7.251
7.230
7.224
7.175
7.153
7.150
7.134
7.129
7.110
4.578
0.000
Ph
Bs
N
Br
1n
2.00
2.02
2.03
5.04
1.98
2.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)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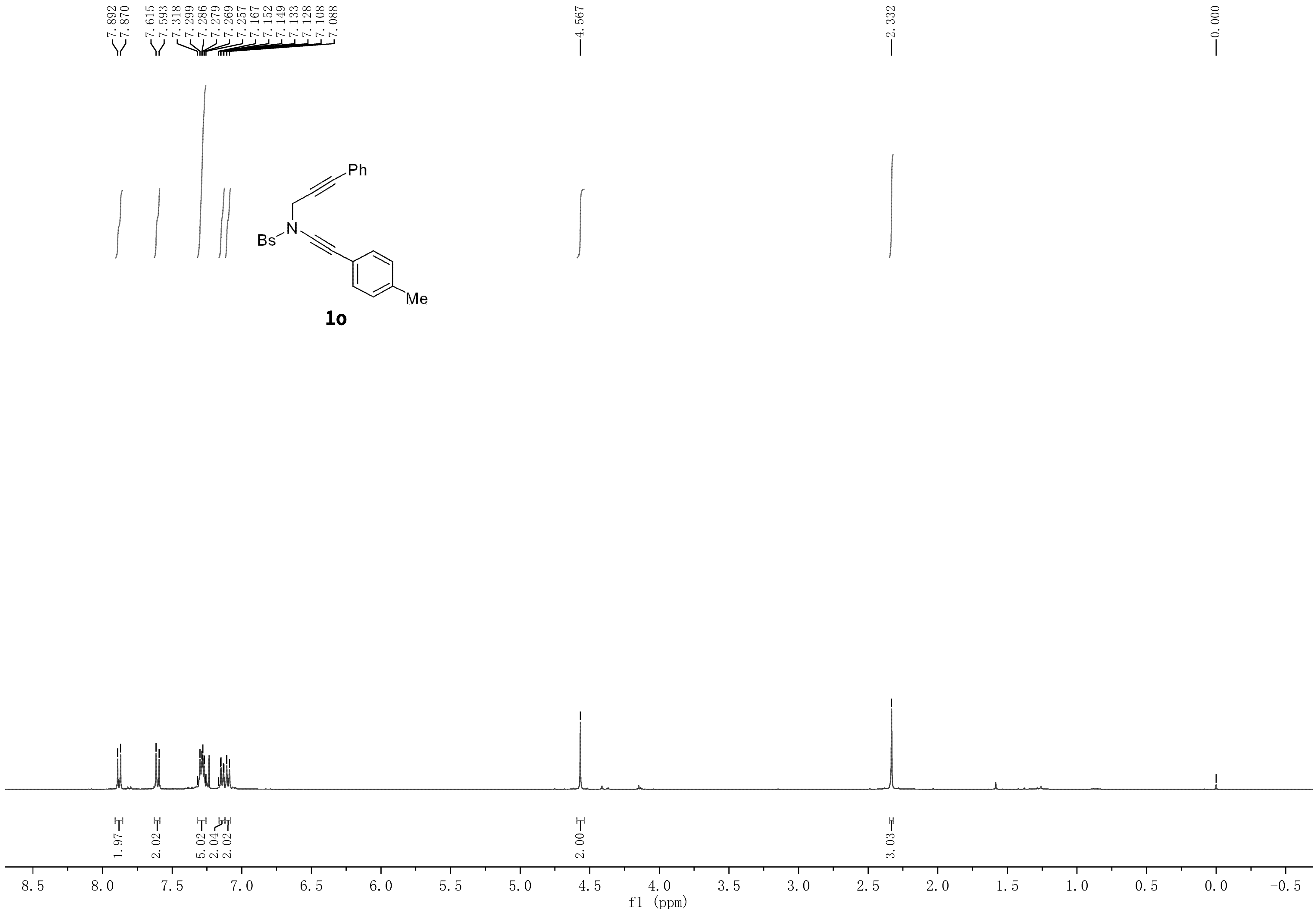
128.83
128.33
122.38
121.54
121.19
86.96
82.49
80.59
77.32
77.00
76.68
70.52
43.03
Ph
Bs
N
Br
1n
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)



7.892
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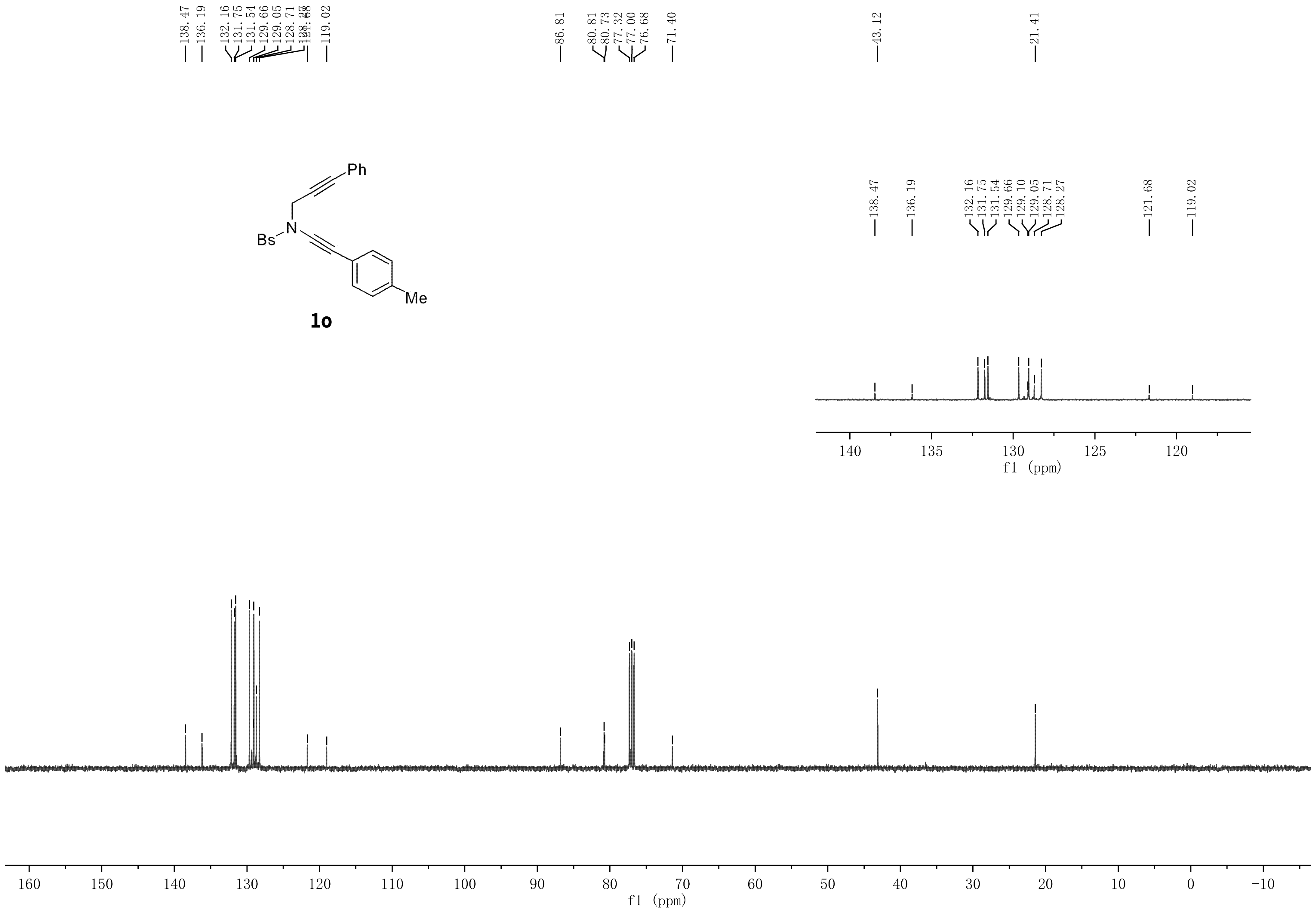
7.615
7.593
7.318
7.299
7.286
7.279
7.269
7.257
7.167
7.152
7.149
7.133
7.128
7.108
7.088
4.567
2.332
0.000
Ph
Bs
N
Me
1o
1.97
2.02
5.02
2.04
2.02
2.00
3.03
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)



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132.16
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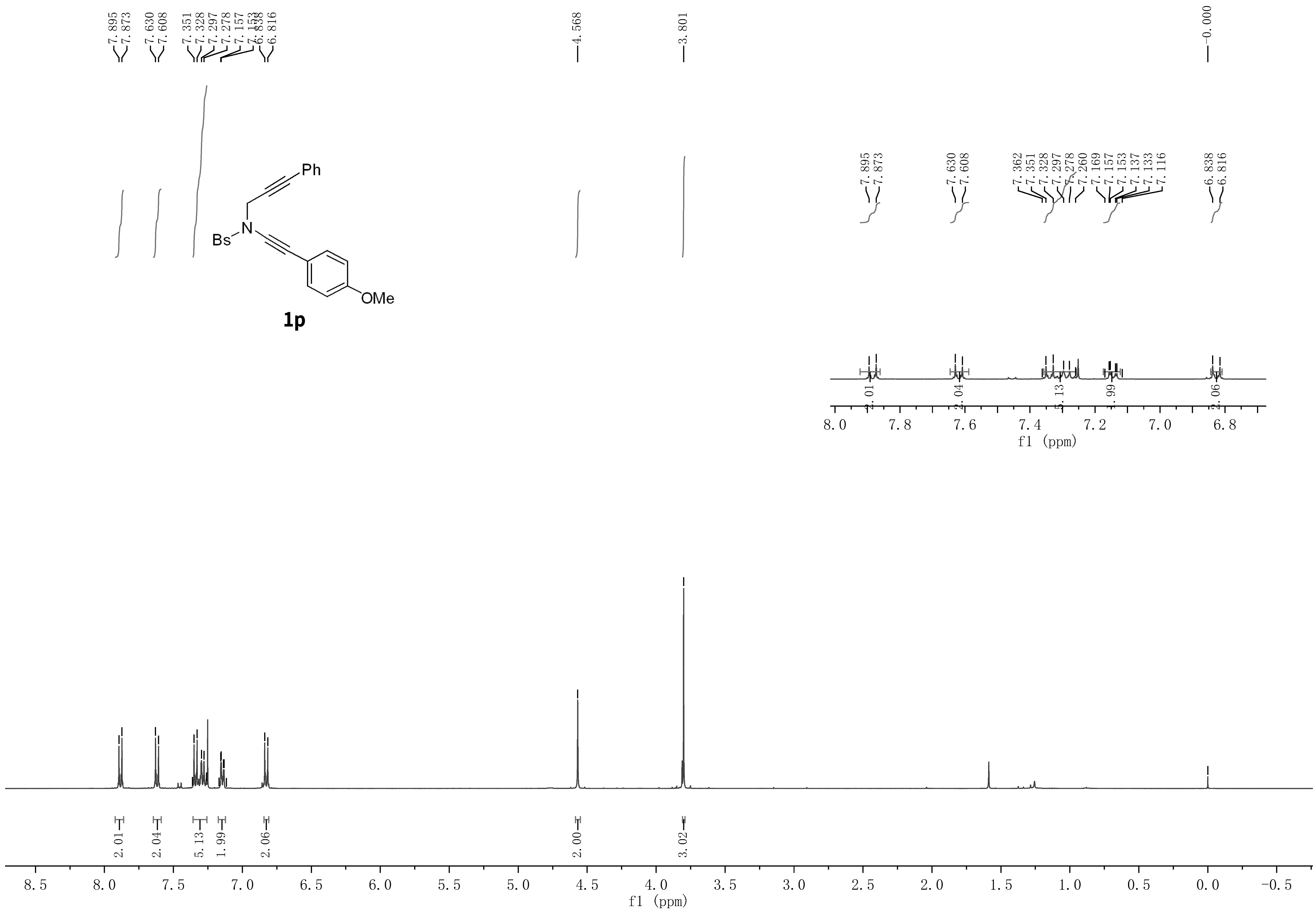
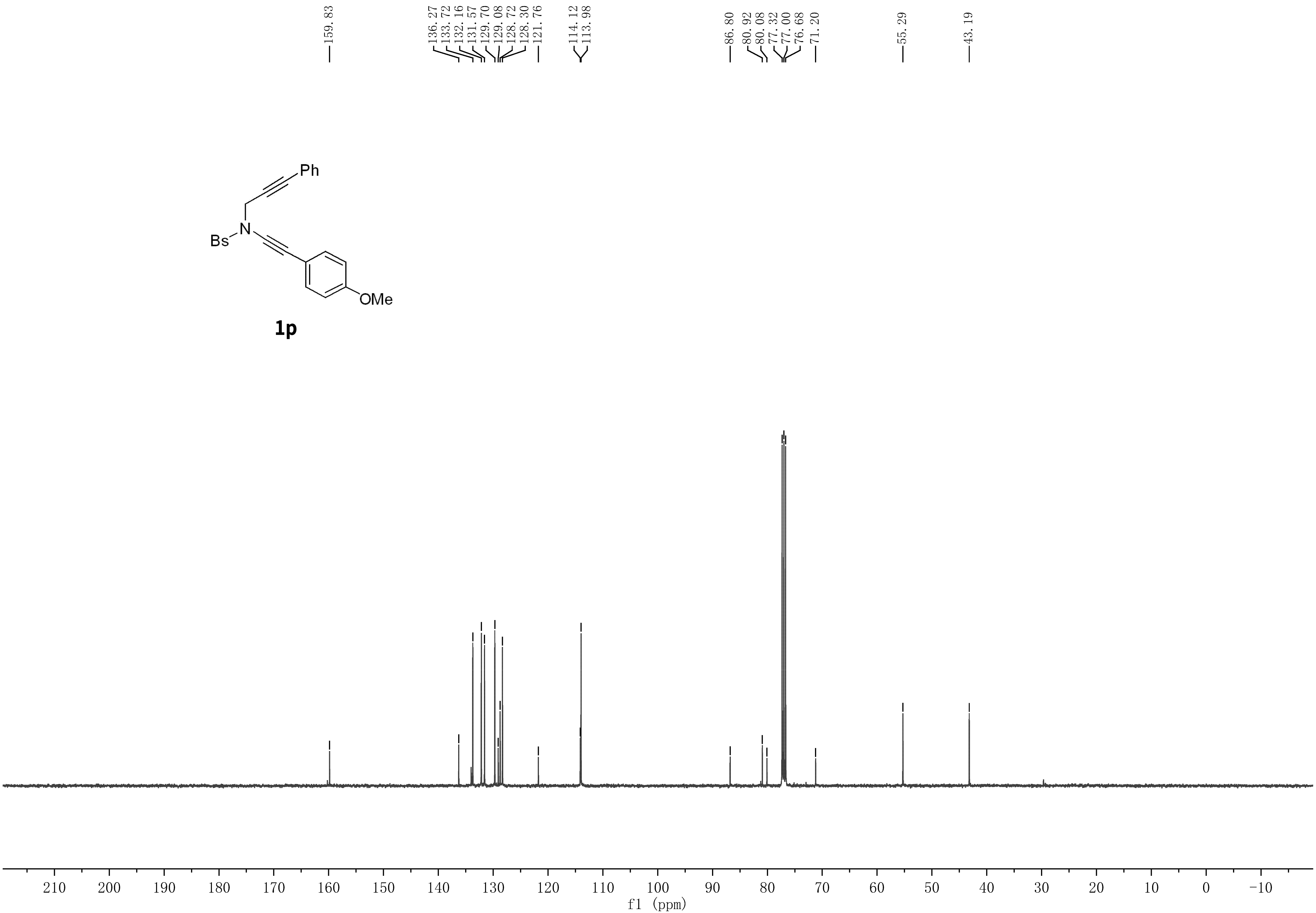
131.54
129.66
129.05
128.71
86.81
80.81
80.73
77.32
77.00
76.68
71.40
43.12
21.41
Ph
Bs
N
Me
138.47
136.19
132.16
131.75
131.54
129.66
129.10
129.05
128.71
128.27
121.68
119.02
140
135
130
125
120
f1 (ppm)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

1o



7.895
7.873
7.630
7.608
7.351
7.328
7.297
7.278
7.157
7.153
6.838
6.816
4.568
3.801
0.000
Ph
Bs
N
OMe
1p
7.895
7.873
7.630
7.608
7.362
7.351
7.328
7.297
7.278
7.260
7.169
7.157
7.153
7.137
7.133
7.116
6.838
6.816
2.01
2.04
5.13
1.99
2.06
8.0
7.8
7.6
7.4
7.2
7.0
6.8
f1 (ppm)
2.01
2.04
5.13
1.99
2.06
2.00
3.02
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
-0.5
f1 (ppm)



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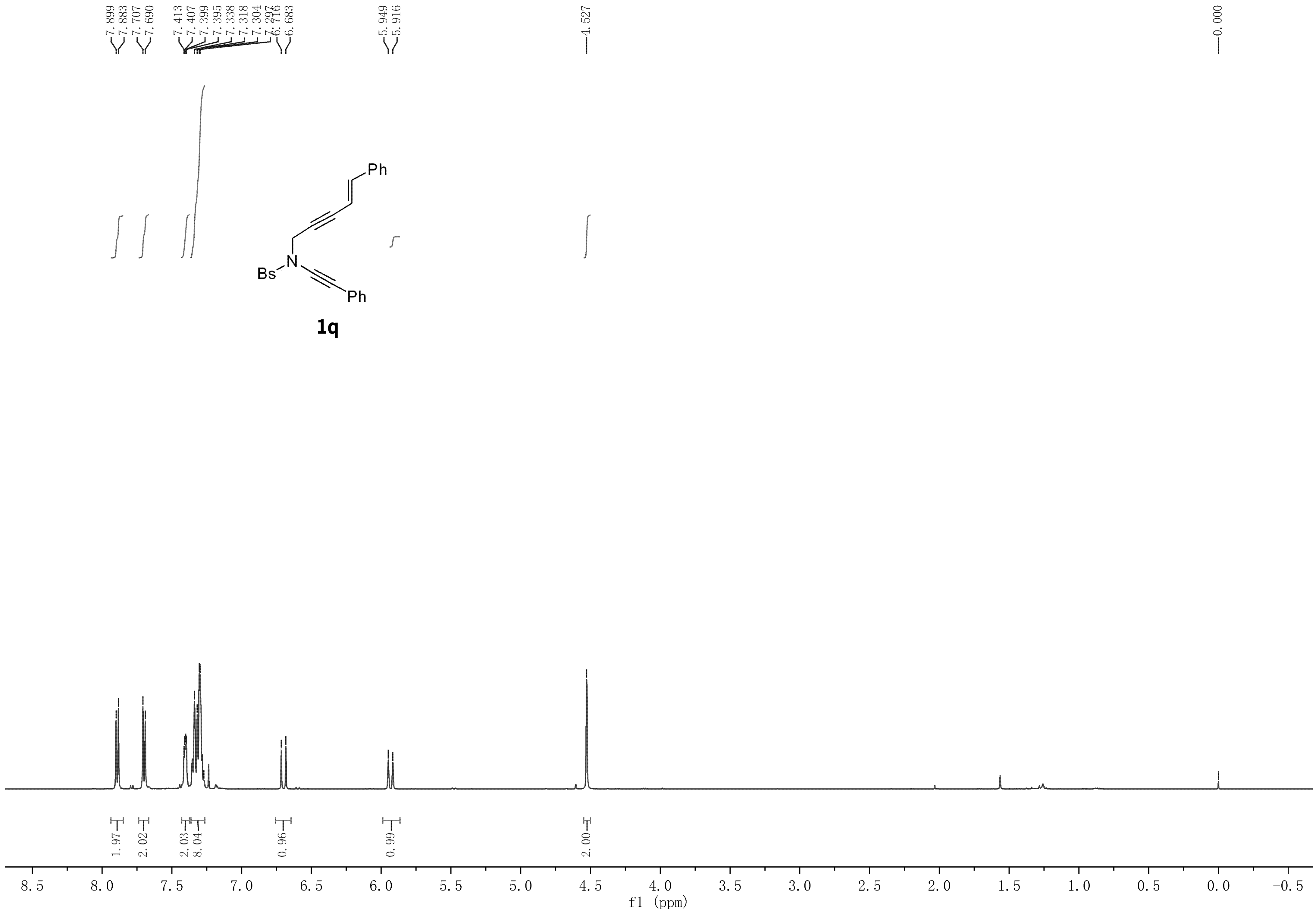
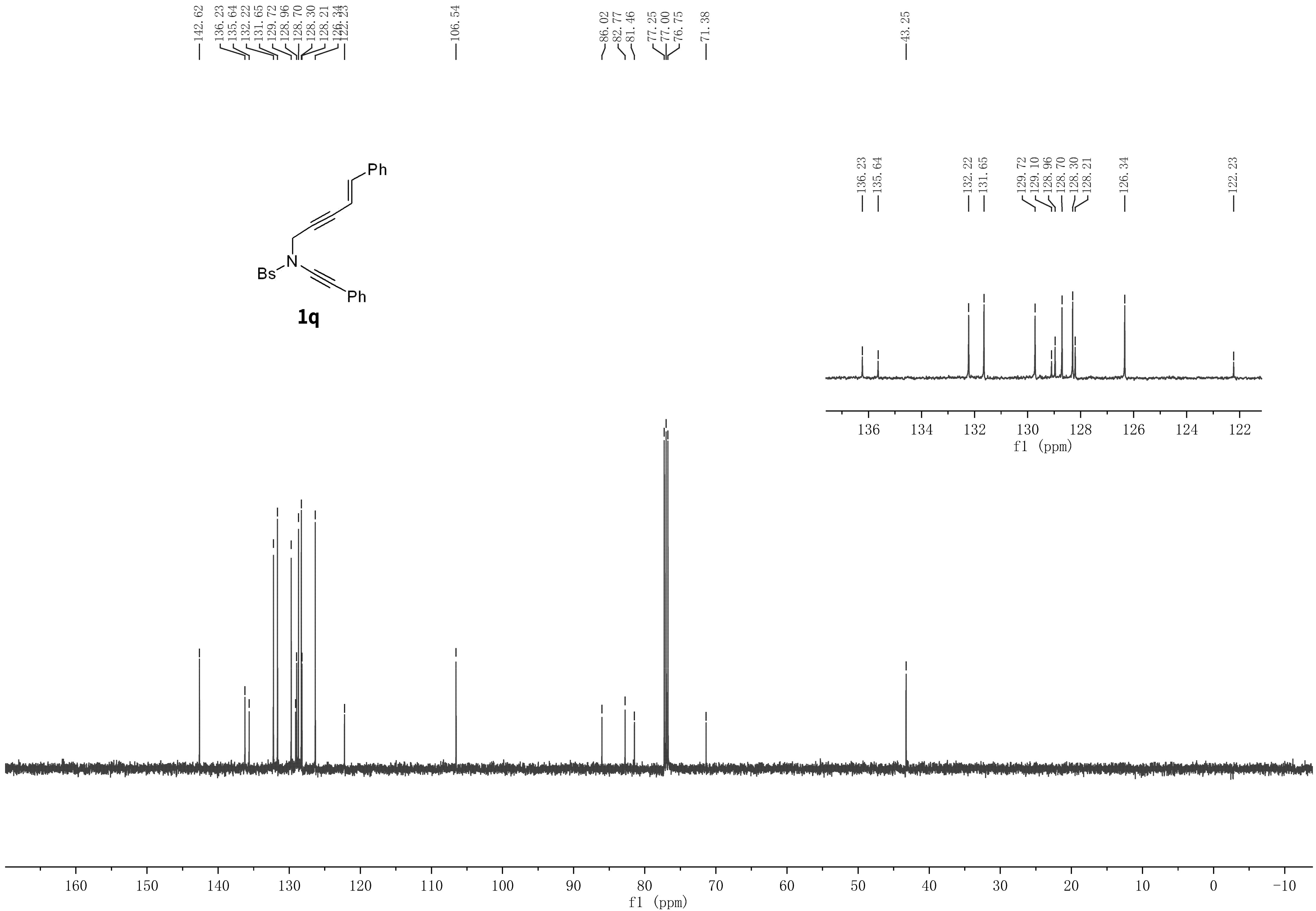
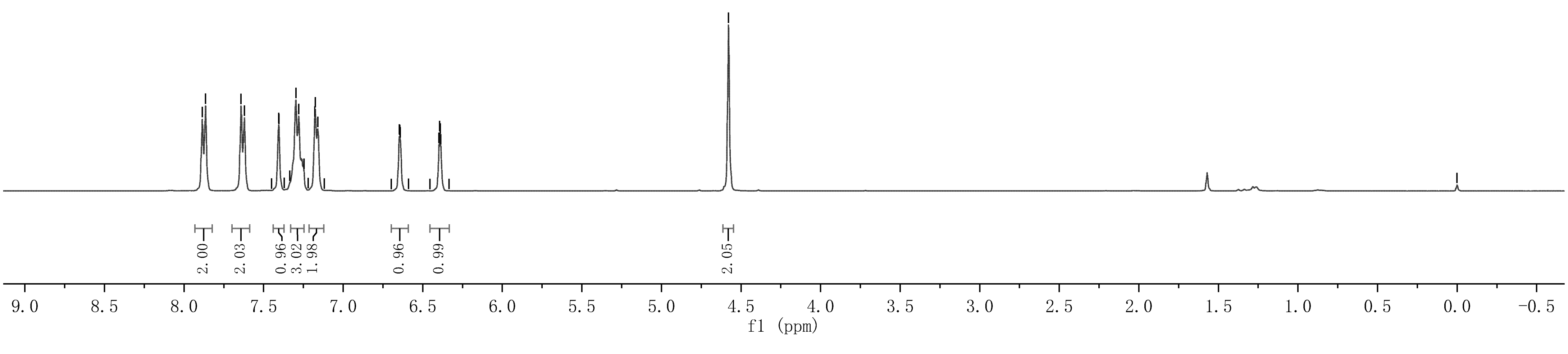
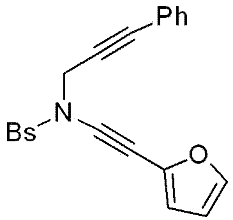
128.72
128.30
121.76
114.12
113.98
86.80
80.92
80.08
77.32
77.00
76.68
71.20
55.29
43.19
Ph
Bs
N
OMe
1p
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.899
7.883
7.707
7.690
7.413
7.407
7.399
7.395
7.338
7.318
7.304
7.297
6.716
6.683
5.949
5.916
4.527
0.000
Ph
Bs
N
Ph
1q
1.97
2.02
2.03
8.04
0.96
0.99
2.00
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 -0.5
f1 (ppm)

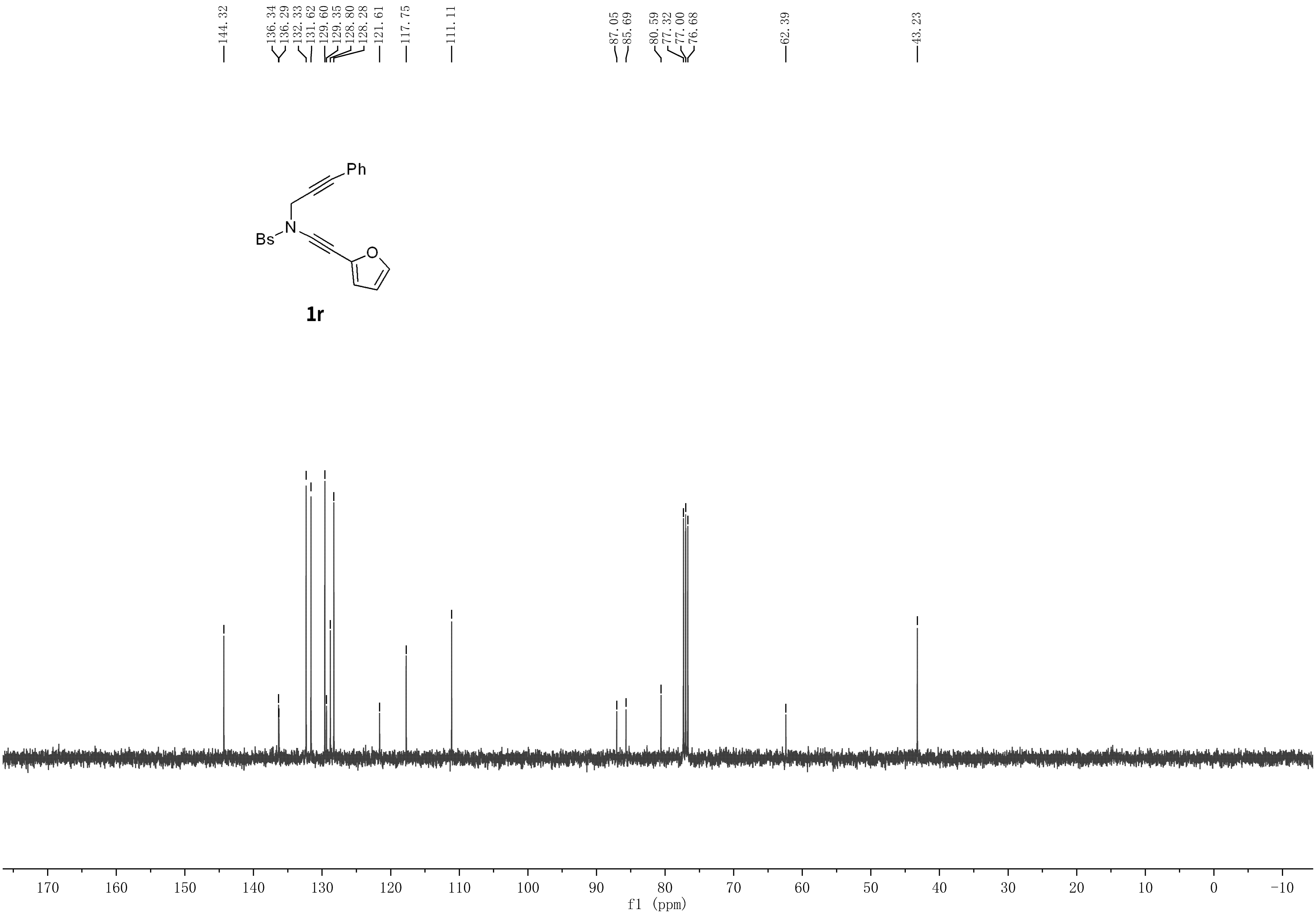


142.62
136.23
135.64
132.22
131.65
129.72
128.96
128.70
128.30
128.21
126.34
122.23
106.54
86.02
82.77
81.46
77.25
77.00
76.75
71.38
43.25
Ph
Bs
N
Ph
1q
136.23
135.64
132.22
131.65
129.72
129.10
128.96
128.70
128.30
128.21
126.34
122.23
136 134 132 130 128 126 124 122
f1 (ppm)
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)

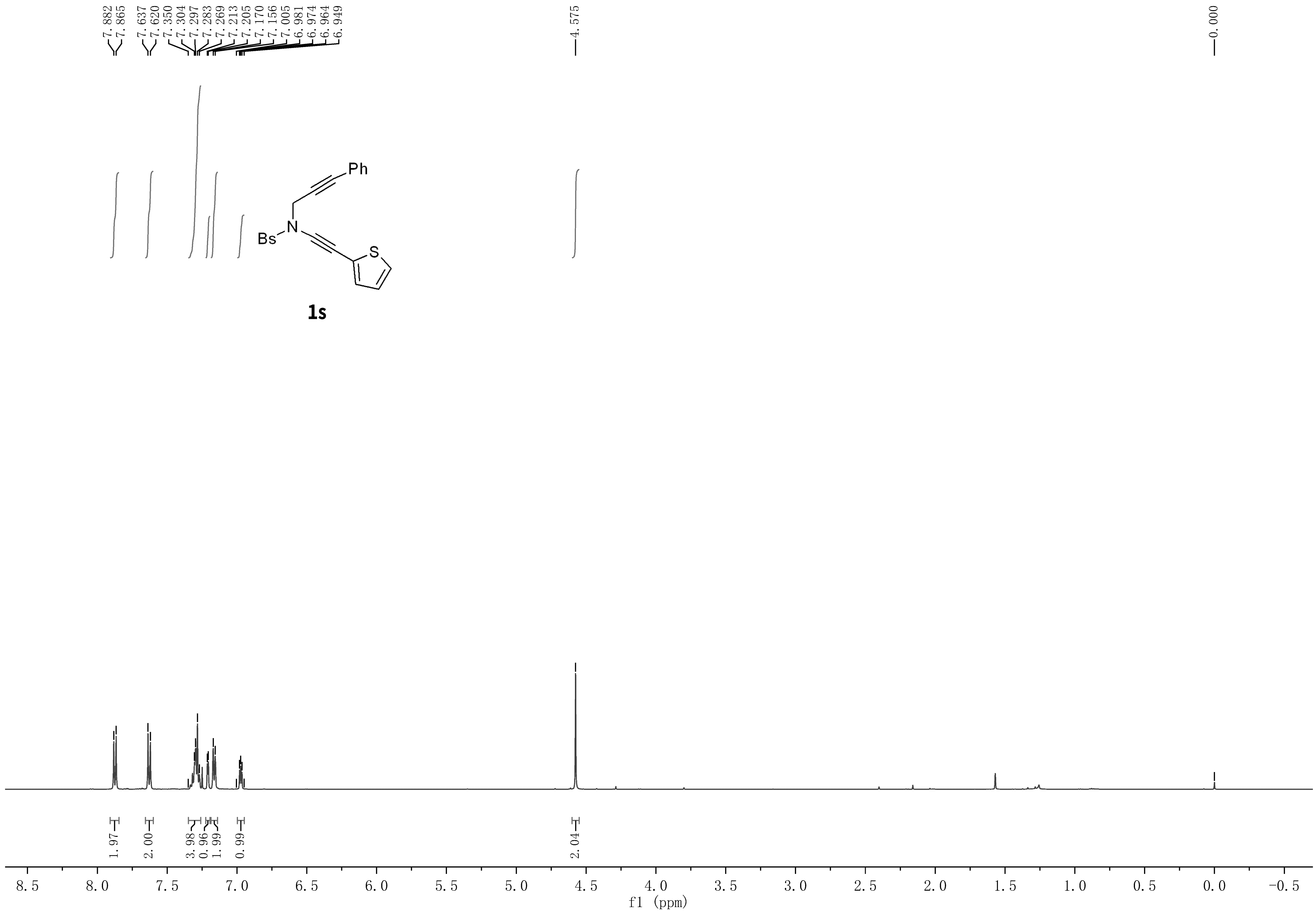

7.886
7.864
7.642
7.620
7.405
7.403
7.297
7.279
7.179
7.176
6.698
6.647
6.644
6.641
6.589
6.455
6.398
6.394
6.390
6.386
6.335
4.579
0.000
2.00
2.03
0.96
3.02
1.98
0.96
0.99
2.05
f1 (ppm)

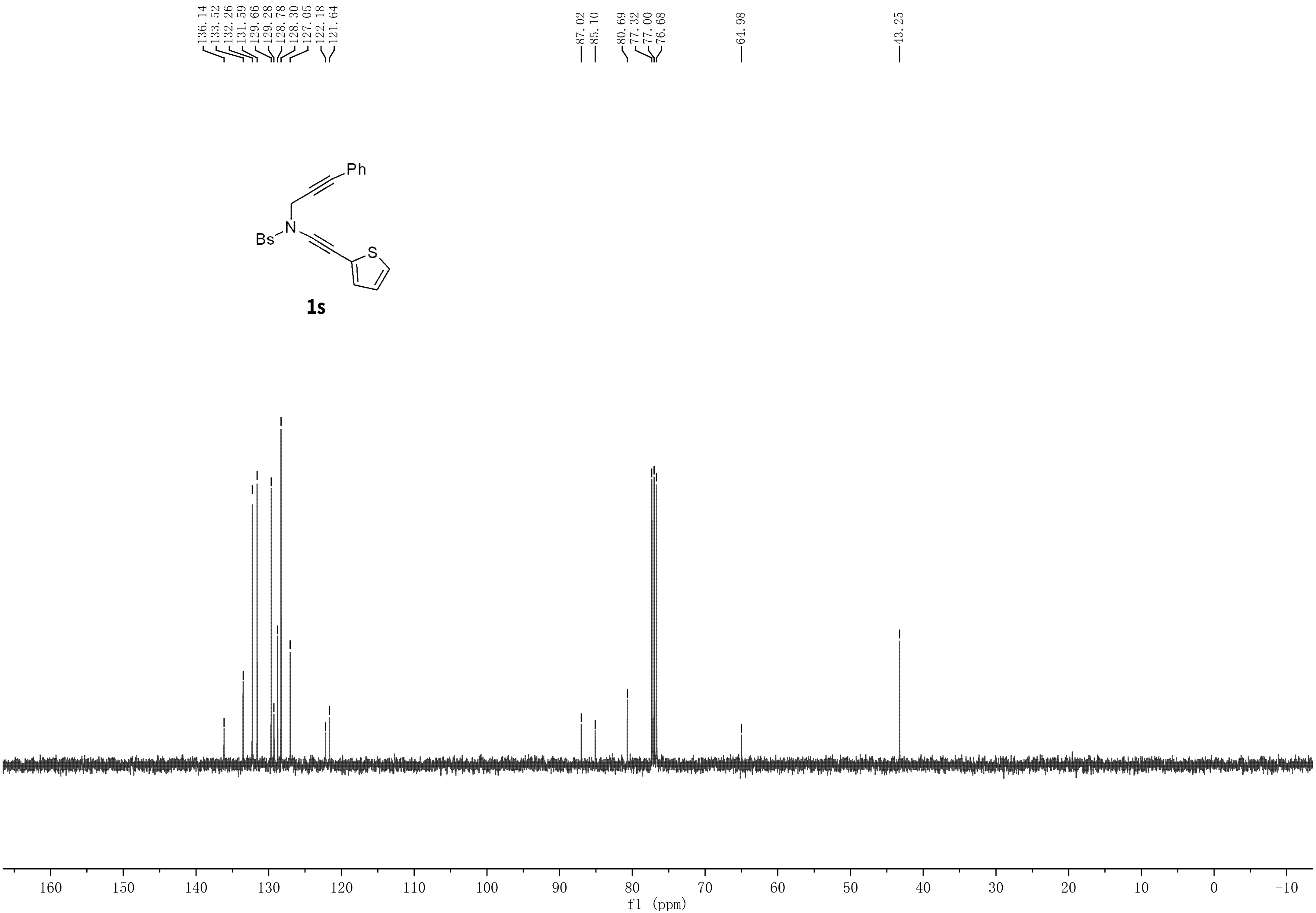

Ph
Bs
N
O

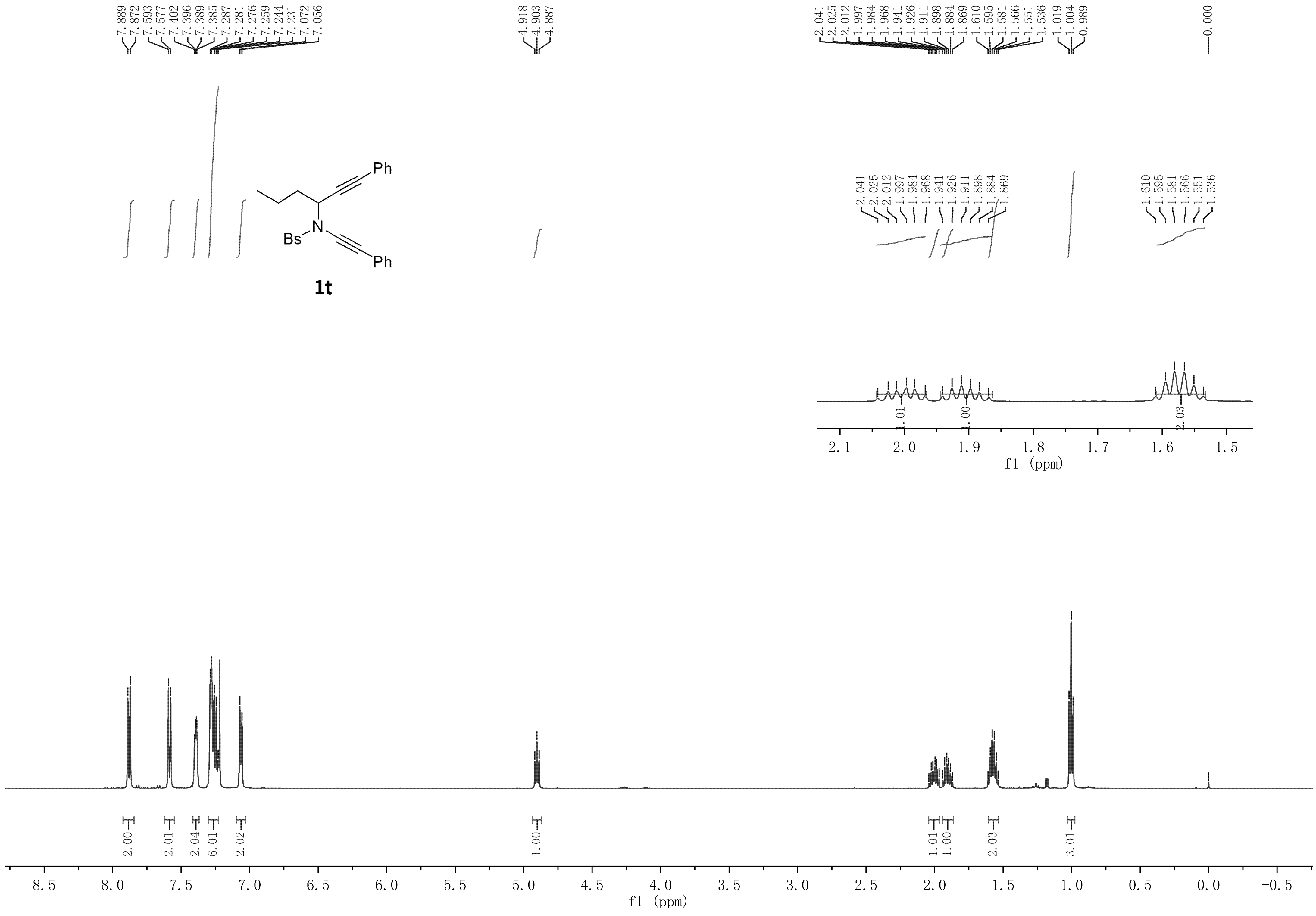
1r

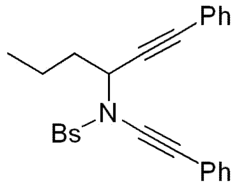


144.32
136.34
136.29
132.33
131.62
129.60
129.35
128.80
128.28
121.61
117.75
111.11
87.05
85.69
80.59
77.32
77.00
76.68
62.39
43.23
Ph
Bs
N
O
1r
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

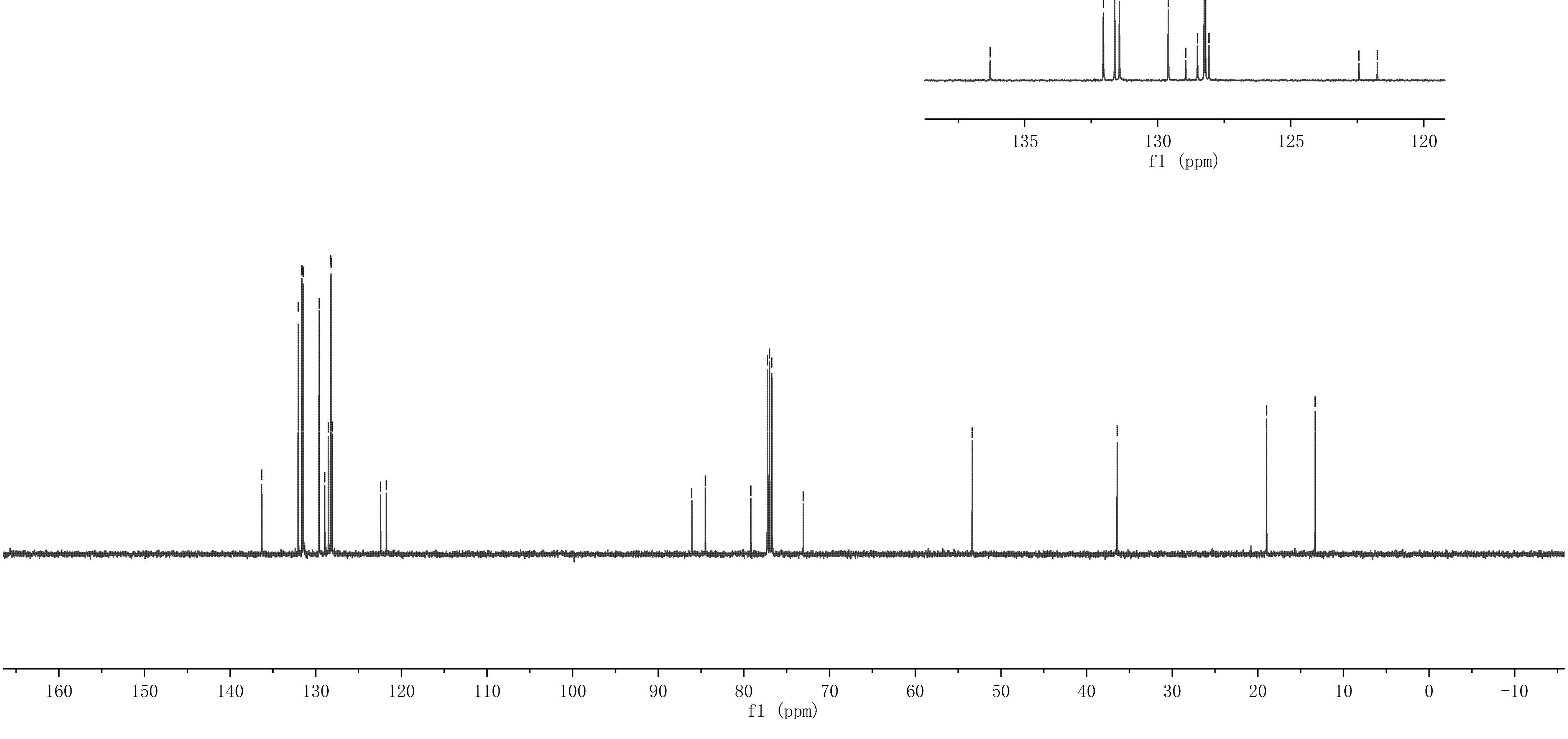

7.882
7.865
7.637
7.620
7.350
7.304
7.297
7.283
7.269
7.213
7.205
7.170
7.156
7.005
6.981
6.974
6.964
6.949
4.575
0.000
Ph
Bs
N
S
1s
1.97
2.00
3.98
0.96
1.99
0.99
2.04
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

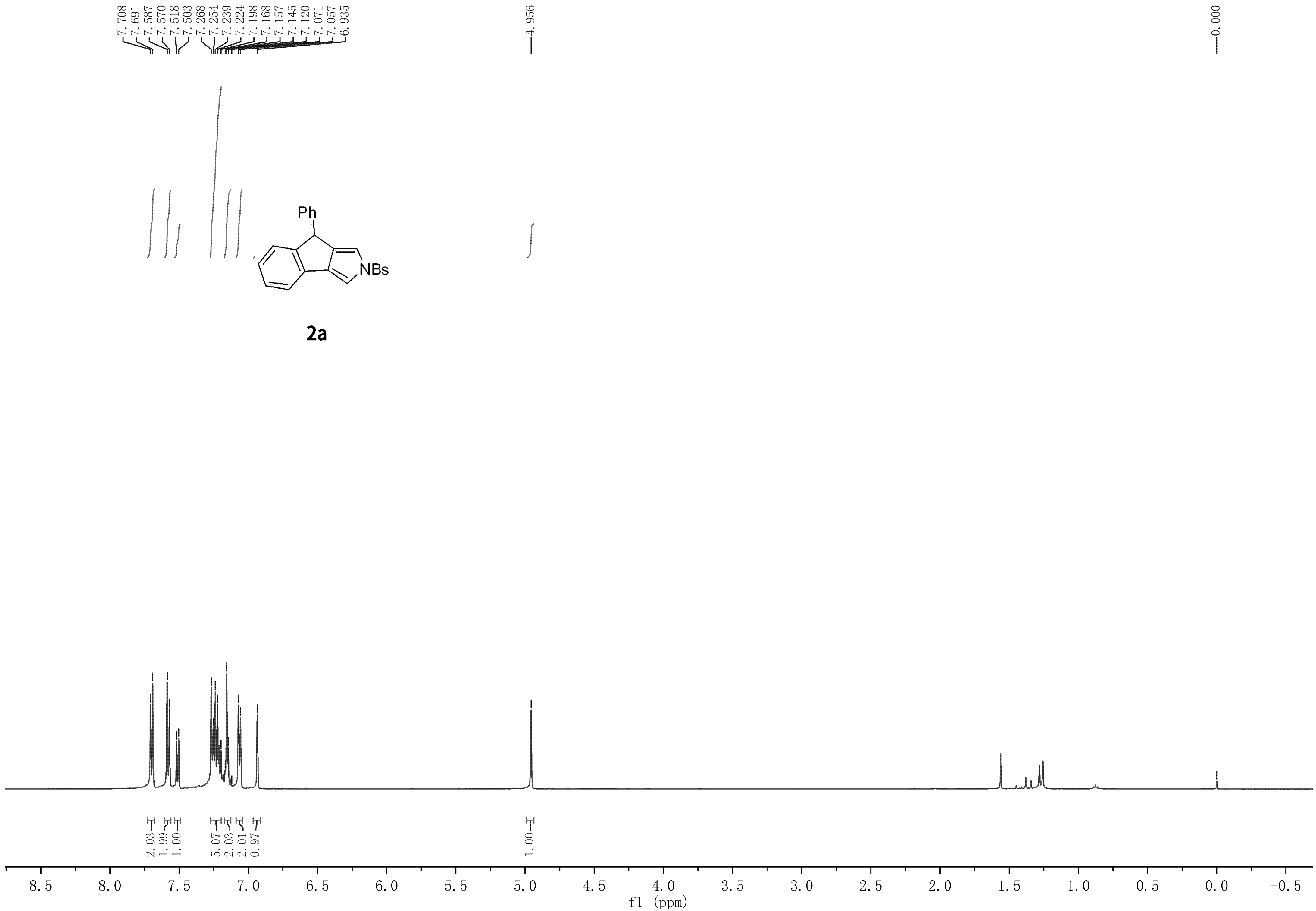

136.14
133.52
132.26
131.59
129.66
129.28
128.78
128.30
127.05
122.18
121.64
87.02
85.10
80.69
77.32
77.00
76.68
64.98
43.25
Ph
Bs
N
S
1s
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

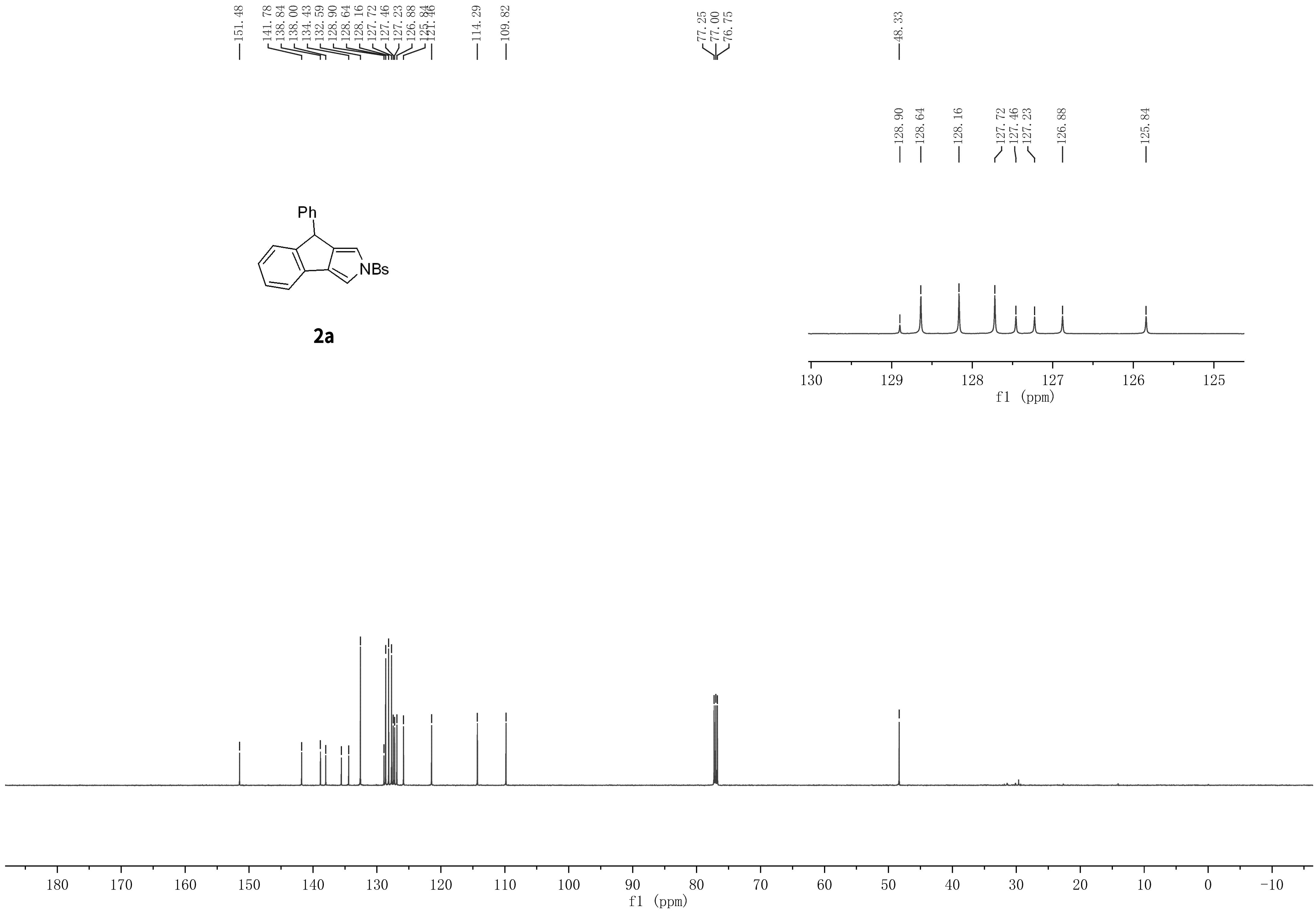

7.889 7.872 7.593 7.577 7.402 7.396 7.389 7.385 7.287 7.281 7.276 7.259 7.244 7.231 7.072 7.056
4.918 4.903 4.887
2.041 2.025 2.012 1.997 1.984 1.968 1.941 1.926 1.911 1.898 1.884 1.869 1.610 1.595 1.581 1.566 1.551 1.536 1.019 1.004 0.989
0.000
Ph
Bs
N
Ph
1t
1.01
1.00
2.03
2.1 2.0 1.9 1.8 1.7 1.6 1.5
f1 (ppm)
2.00 2.01 2.04 6.01 2.02 1.00 1.01 1.00 2.03 3.01
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 -0.5
f1 (ppm)


Ph
Bs
N
Ph

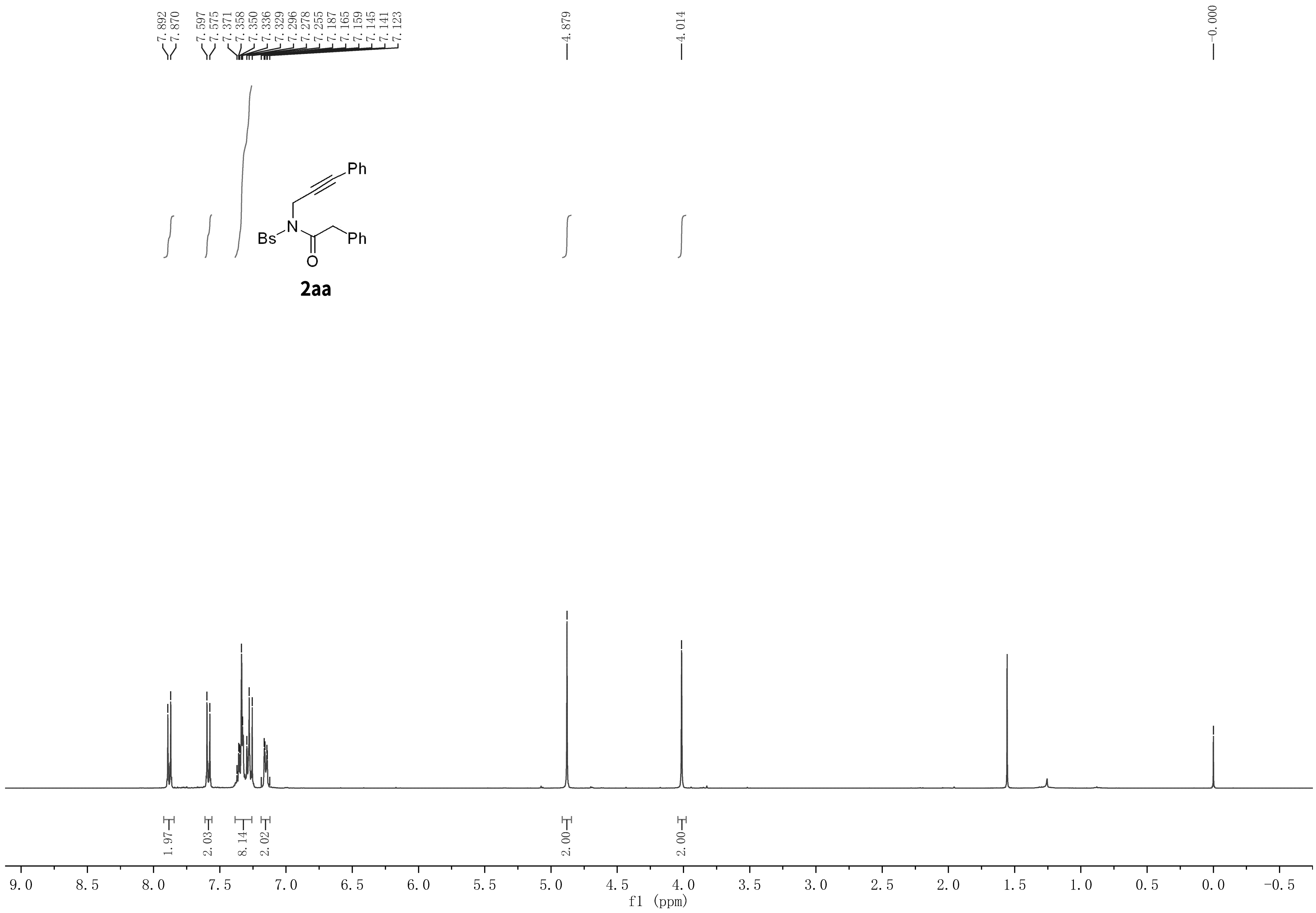
1t


136.30
132.05
131.62
131.44
129.60
128.25
128.21
122.44
121.74
86.10
84.50
79.20
77.25
77.00
76.75
73.08
53.35
36.42
18.97
13.30
136.30
132.05
131.62
131.44
129.60
128.95
128.51
128.25
128.21
128.07
122.44
121.74
135
130
125
120
f1 (ppm)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)

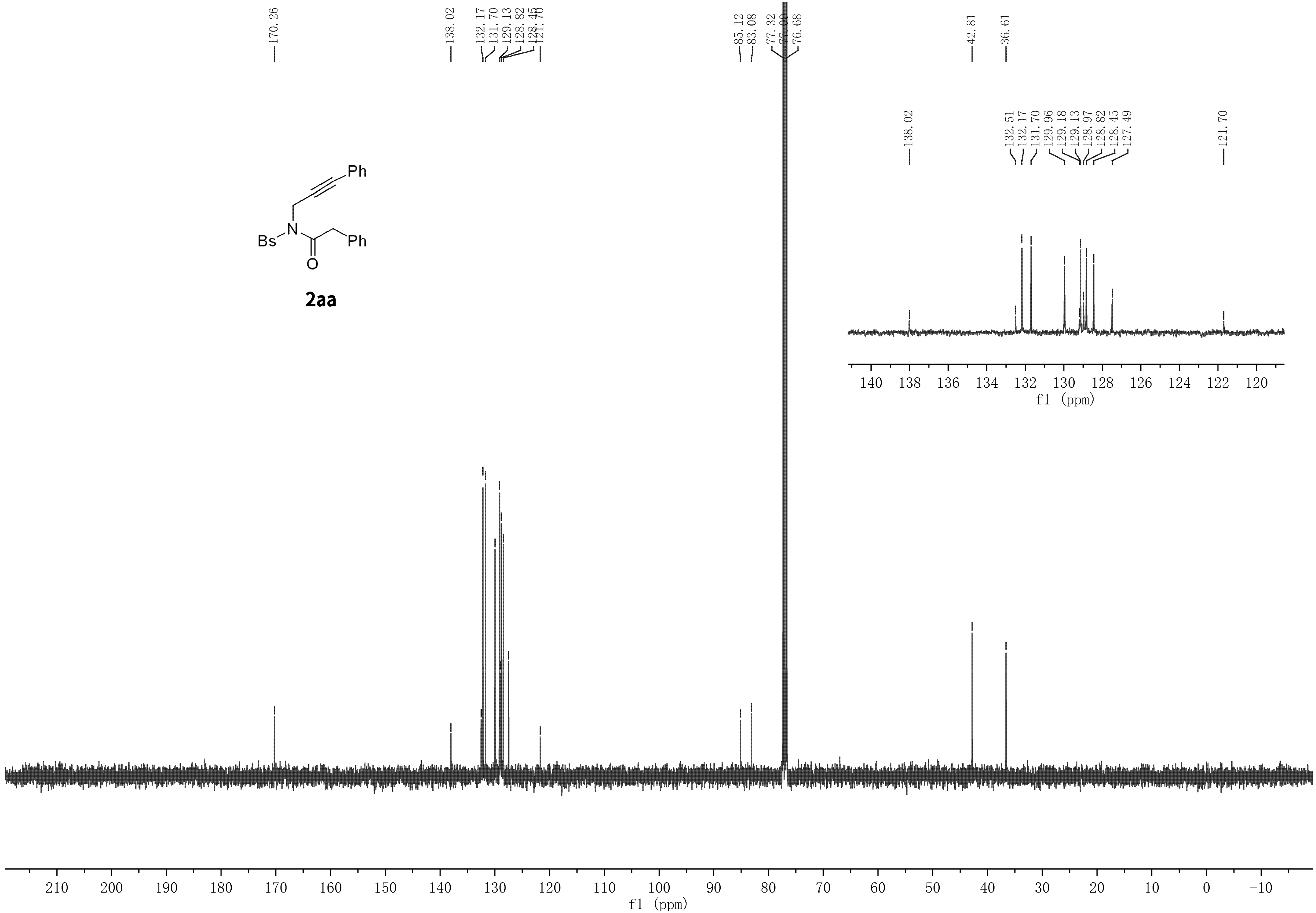

7.708
7.691
7.587
7.570
7.518
7.503
7.268
7.254
7.239
7.224
7.198
7.168
7.157
7.145
7.120
7.071
7.057
6.935
4.956
0.000
Ph
NBs
2a
2.03
1.99
1.00
5.07
2.03
2.01
0.97
1.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

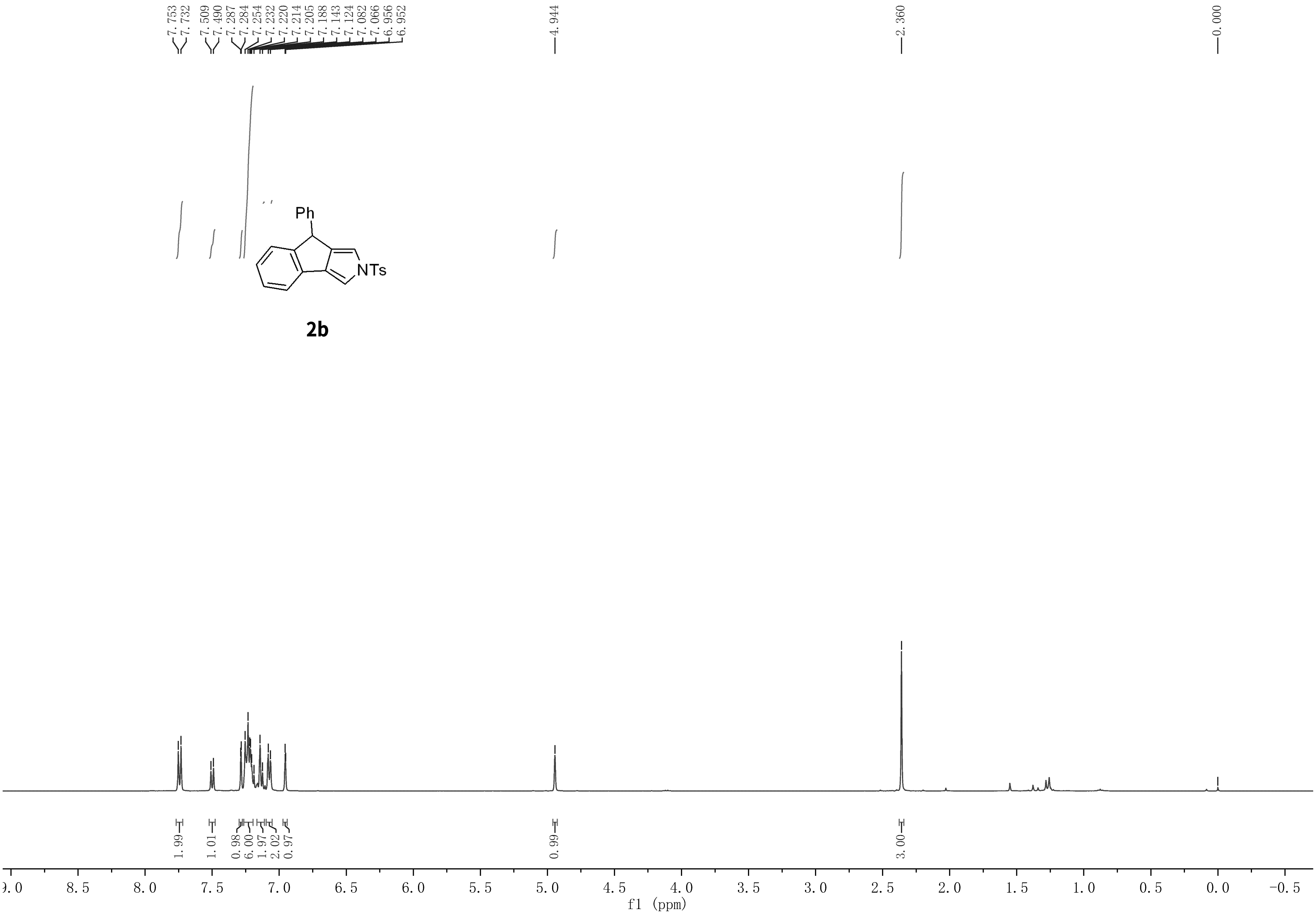

151.48
141.78
138.84
138.00
134.43
132.59
128.90
128.64
128.16
127.72
127.46
127.23
126.88
125.84
121.46
114.29
109.82
77.25
77.00
76.75
48.33
128.90
128.64
128.16
127.72
127.46
127.23
126.88
125.84
130 129 128 127 126 125
f1 (ppm)
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)
Ph
NBs

2a

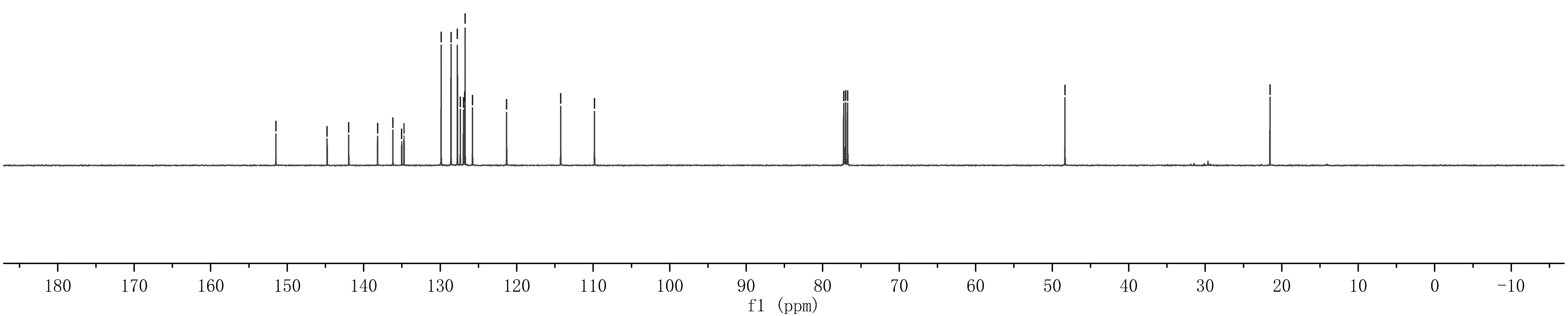


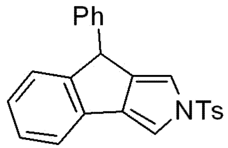
7.892
7.870
7.597
7.575
7.371
7.358
7.350
7.336
7.329
7.296
7.278
7.255
7.187
7.165
7.159
7.145
7.141
7.123
4.879
4.014
0.000
Ph
Bs
N
Ph
O
2aa
1.97
2.03
8.14
2.02
2.00
2.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
f1 (ppm)


Ph
Bs
N
Ph
O
170.26
138.02
132.17
131.70
129.13
128.82
128.45
121.70
85.12
83.08
77.32
77.00
76.68
42.81
36.61
138.02
132.51
132.17
131.70
129.96
129.18
129.13
128.97
128.82
128.45
127.49
121.70
140 138 136 134 132 130 128 126 124 122 120
f1 (ppm)
2aa
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

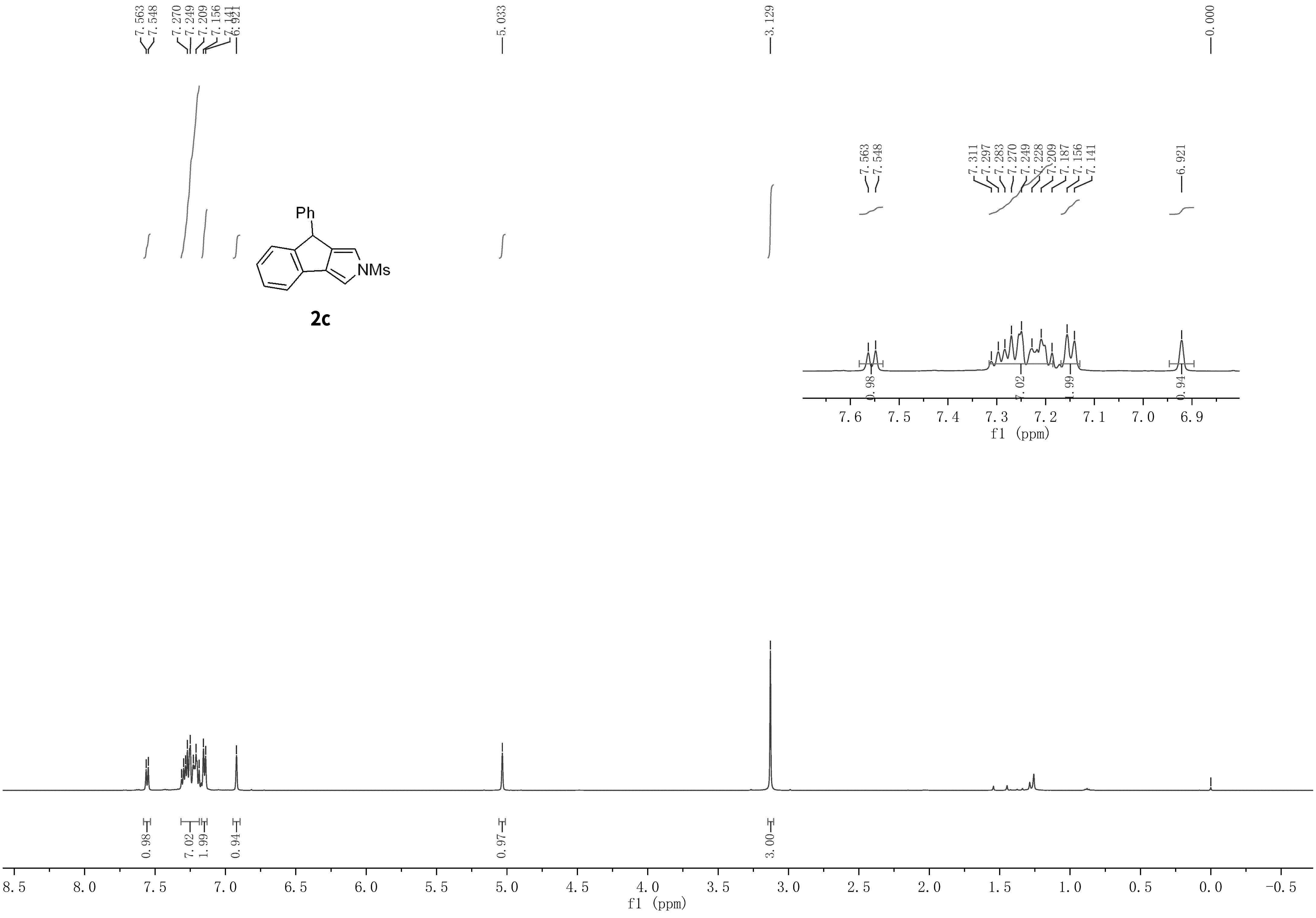

7.753
7.732
7.509
7.490
7.287
7.284
7.254
7.232
7.220
7.214
7.205
7.188
7.143
7.124
7.082
7.066
6.956
6.952
4.944
2.360
0.000
1.99
1.01
0.98
6.00
1.97
2.02
0.97
0.99
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)
Ph
NTs

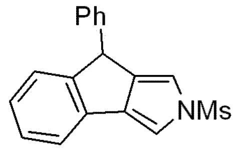
2b


151.47
144.78
141.96
138.18
136.18
135.03
134.73
129.88
128.59
127.75
126.79
126.74
121.32
114.25
109.83
77.25
77.00
76.75
48.34
21.54
138.18
136.18
135.03
134.73
129.88
128.59
127.75
127.37
126.96
126.79
126.74
125.78
135
130
125
f1 (ppm)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

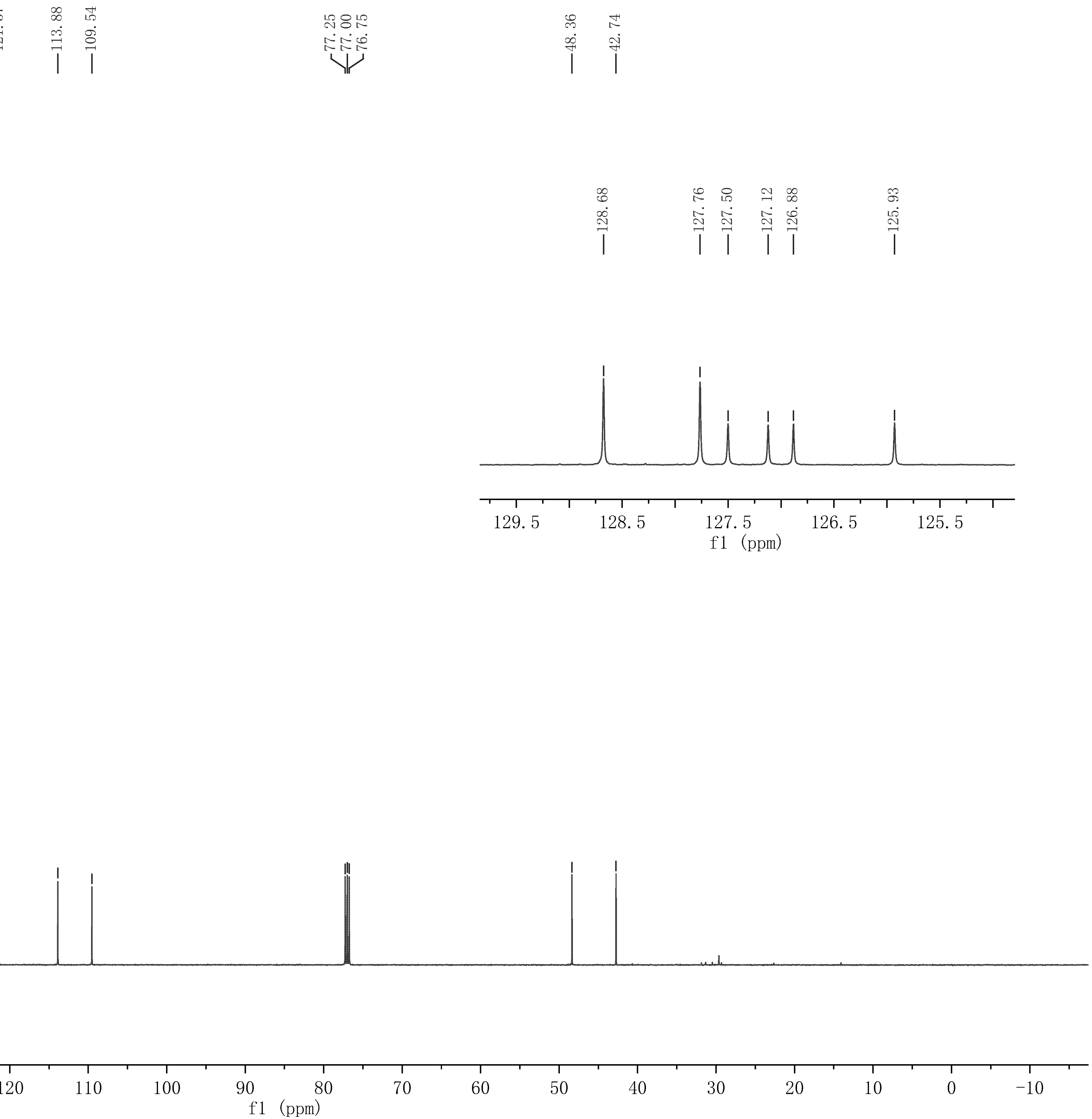

Ph
NTs

2b

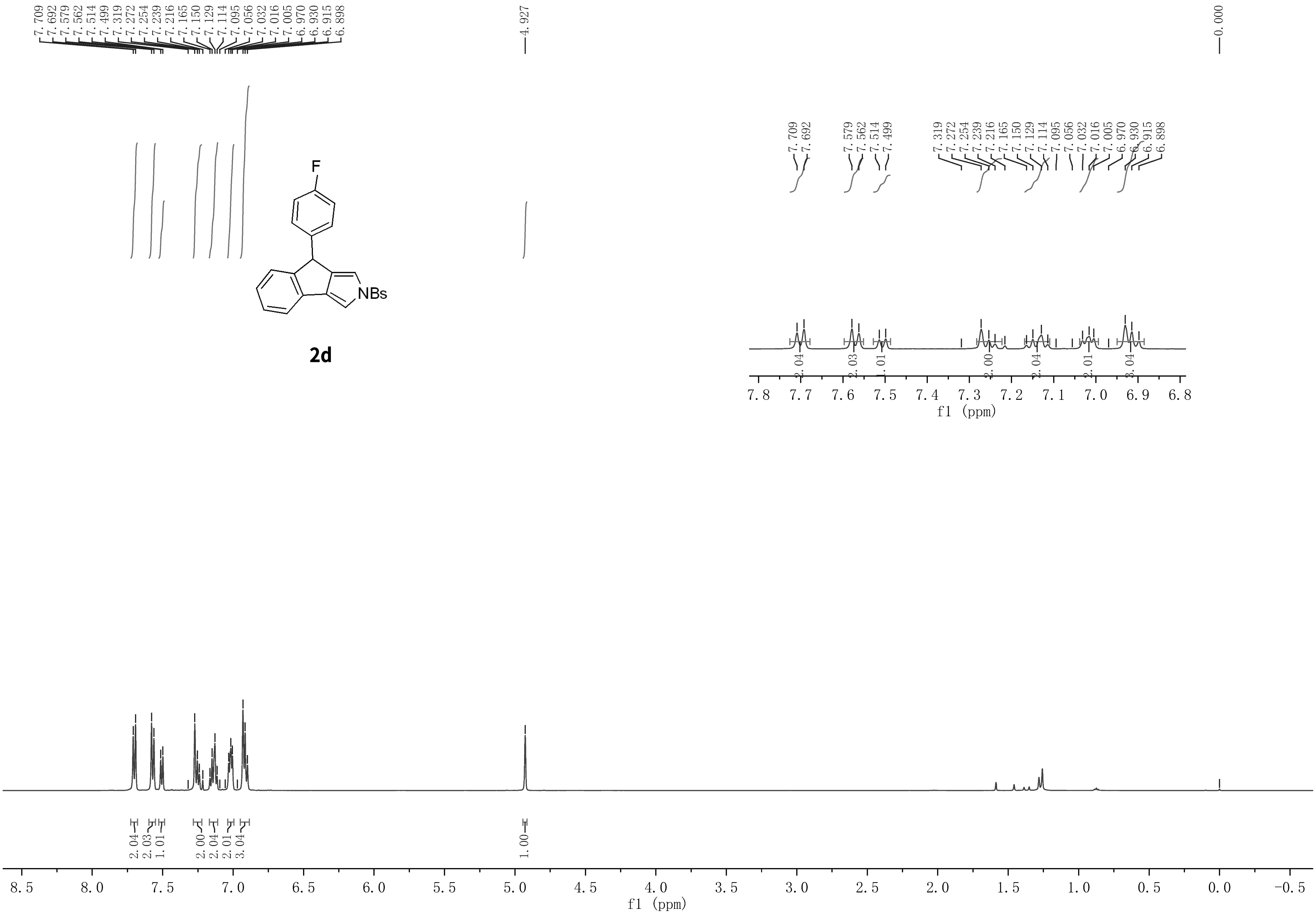

7.563
7.548
7.270
7.249
7.209
7.156
7.141
6.921
5.033
3.129
0.000
Ph
NMs
2c
7.563
7.548
7.311
7.297
7.283
7.270
7.249
7.228
7.209
7.187
7.156
7.141
6.921
0.98
7.02
1.99
0.94
7.6 7.5 7.4 7.3 7.2 7.1 7.0 6.9
f1 (ppm)
0.98
7.02
1.99
0.94
0.97
3.00
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)



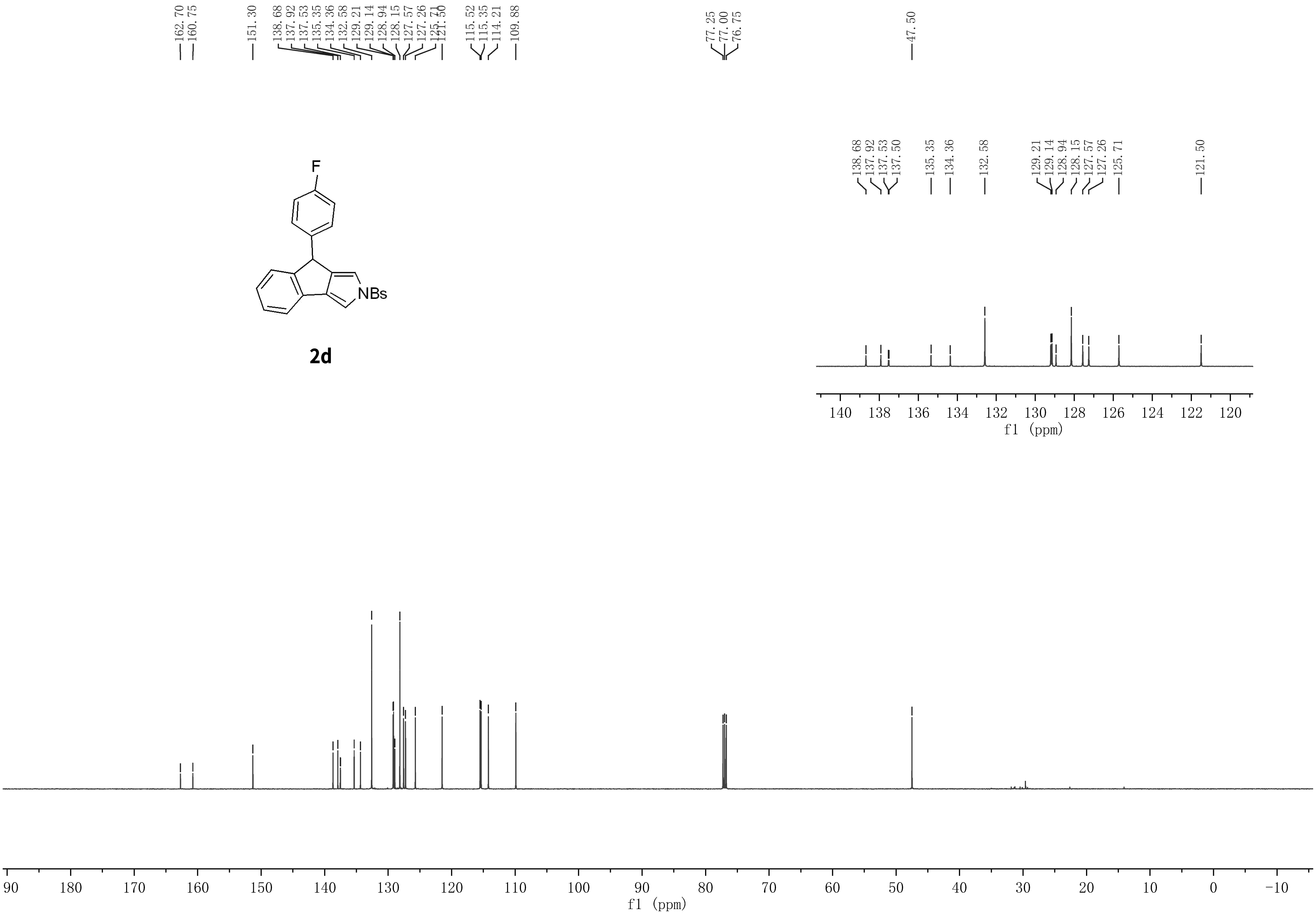
2c



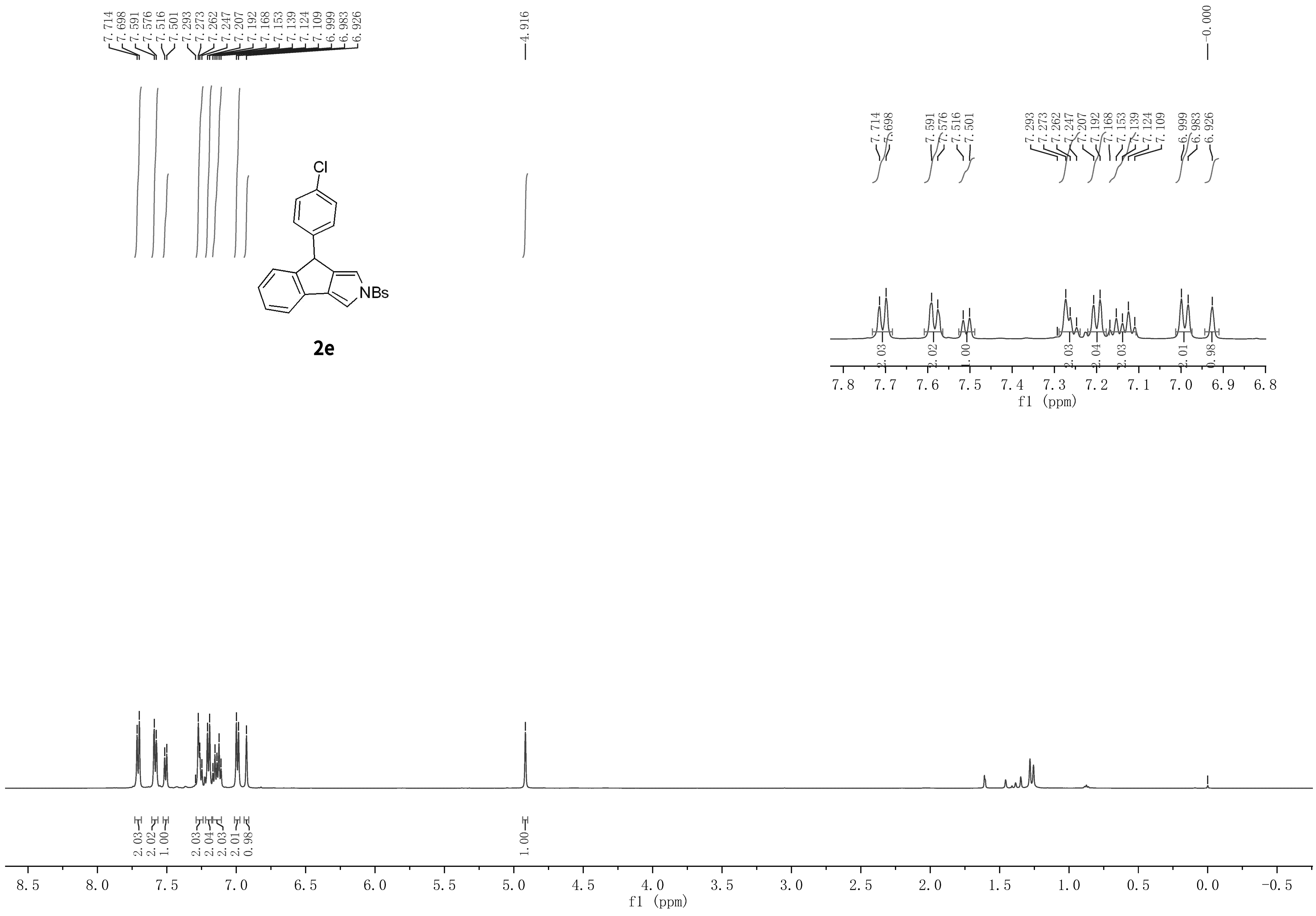
151.40
141.90
138.18
134.87
134.70
128.68
127.76
127.50
126.88
125.93
121.37
113.88
109.54
77.25
77.00
76.75
48.36
42.74
128.68
127.76
127.50
127.12
126.88
125.93
129.5
128.5
127.5
126.5
125.5
f1 (ppm)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

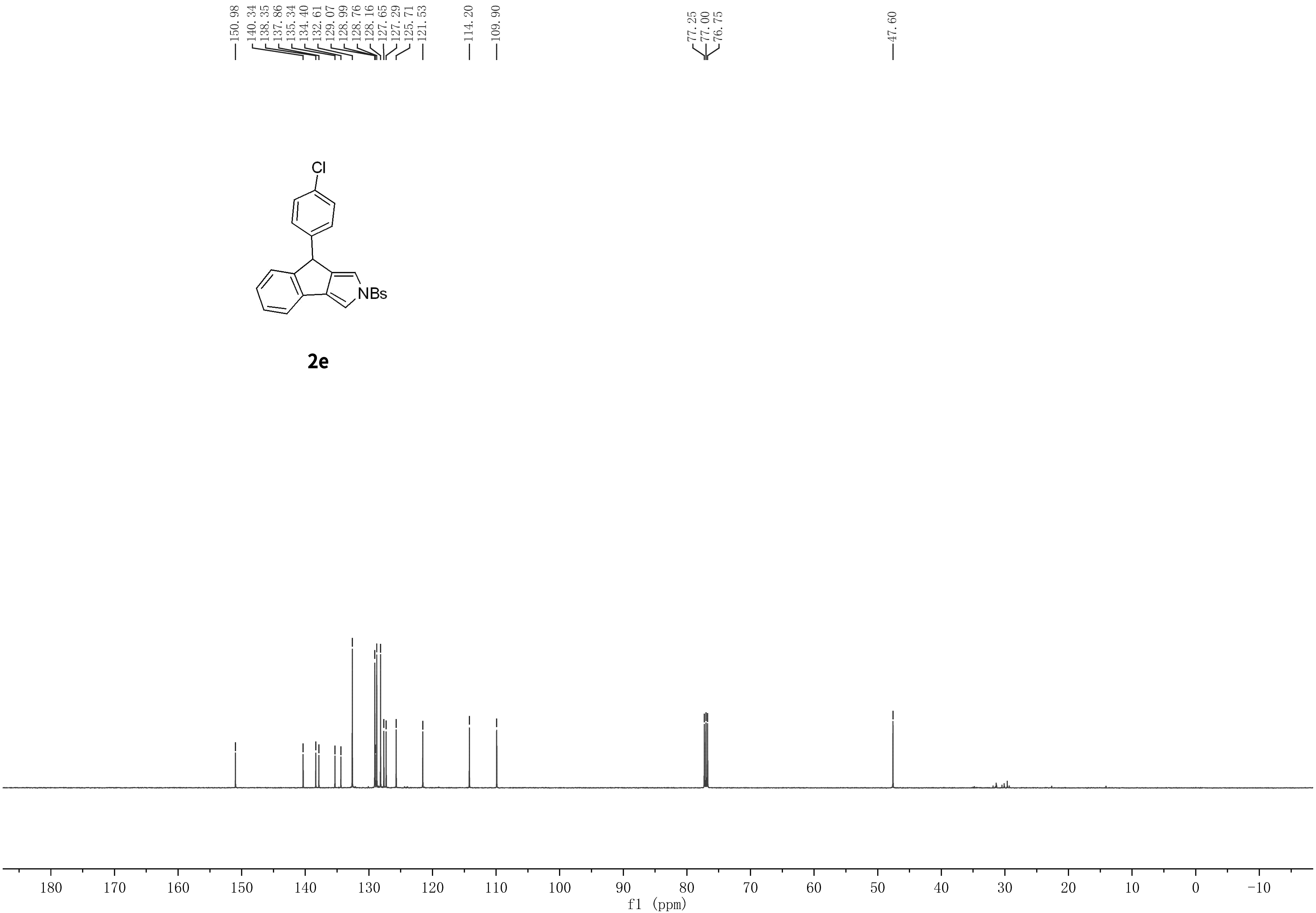


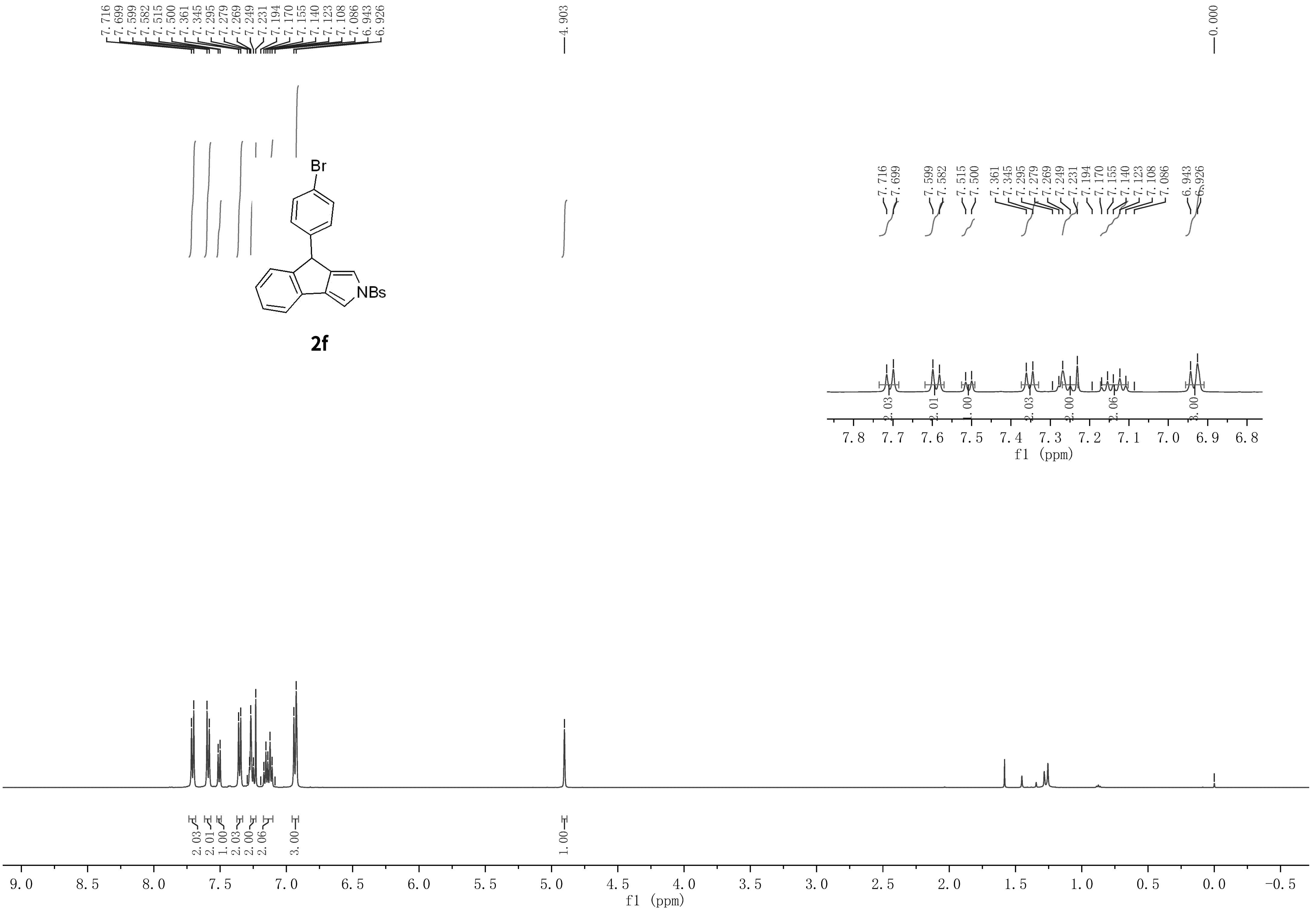
7.709
7.692
7.579
7.562
7.514
7.499
7.319
7.272
7.254
7.239
7.216
7.165
7.150
7.129
7.114
7.095
7.056
7.032
7.016
7.005
6.970
6.930
6.915
6.898
4.927
0.000
F
NBs
2d
2.04
2.03
1.01
2.00
2.04
2.01
3.04
1.00
7.8 7.7 7.6 7.5 7.4 7.3 7.2 7.1 7.0 6.9 6.8
f1 (ppm)
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


162.70
160.75
151.30
138.68
137.92
137.53
135.35
134.36
132.58
129.21
129.14
128.94
128.15
127.57
127.26
125.71
121.50
115.52
115.35
114.21
109.88
77.25
77.00
76.75
47.50
138.68
137.92
137.53
137.50
135.35
134.36
132.58
129.21
129.14
128.94
128.15
127.57
127.26
125.71
121.50
140 138 136 134 132 130 128 126 124 122 120
f1 (ppm)
90 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)
F
NBs

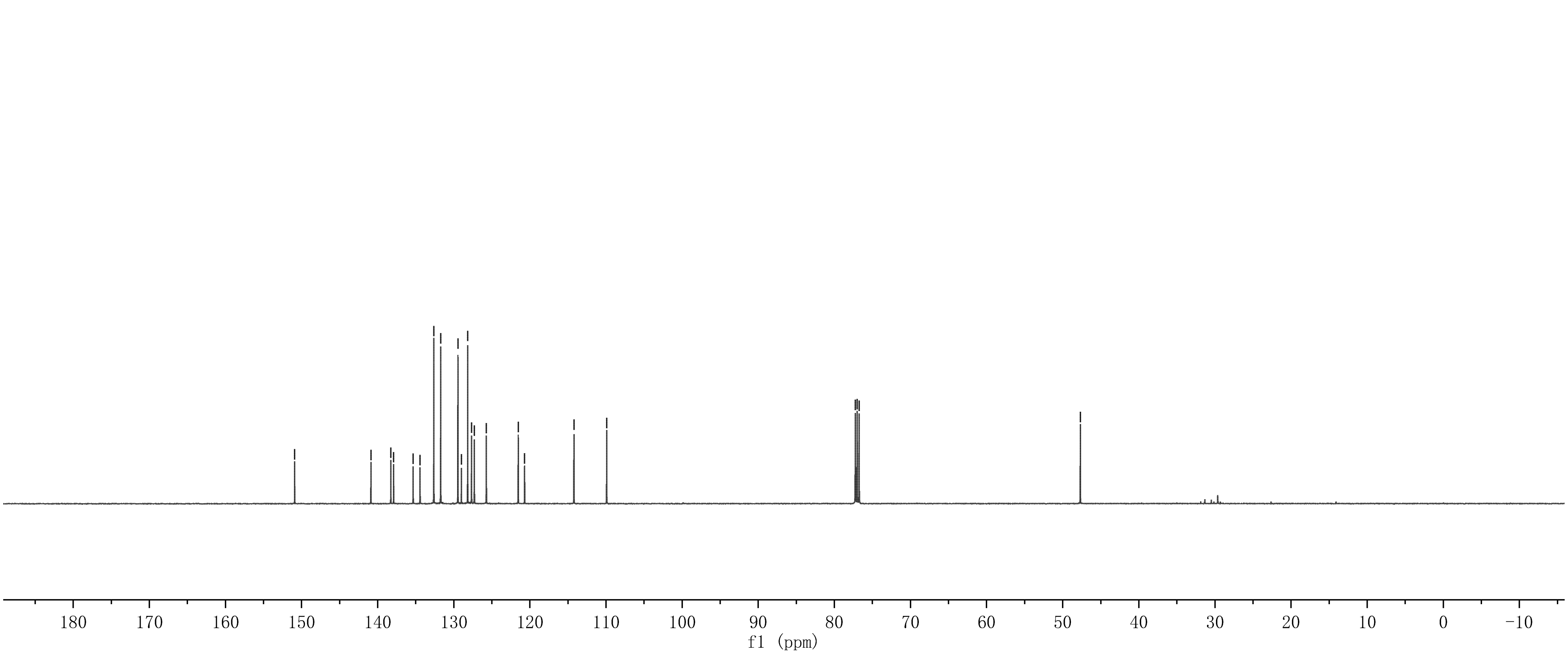
2d

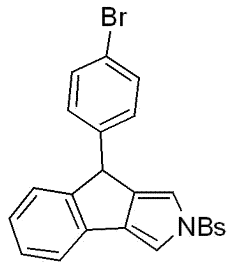

7.714
7.698
7.591
7.576
7.516
7.501
7.293
7.273
7.262
7.247
7.207
7.192
7.168
7.153
7.139
7.124
7.109
6.999
6.983
6.926
4.916
0.000
Cl
NBs
2e
2.03
2.02
1.00
2.03
2.04
2.03
2.01
0.98
1.00
f1 (ppm)


150.98
140.34
138.35
137.86
135.34
134.40
132.61
129.07
128.99
128.76
128.16
127.65
127.29
125.71
121.53
114.20
109.90
77.25
77.00
76.75
47.60
Cl
NBs
2e
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)

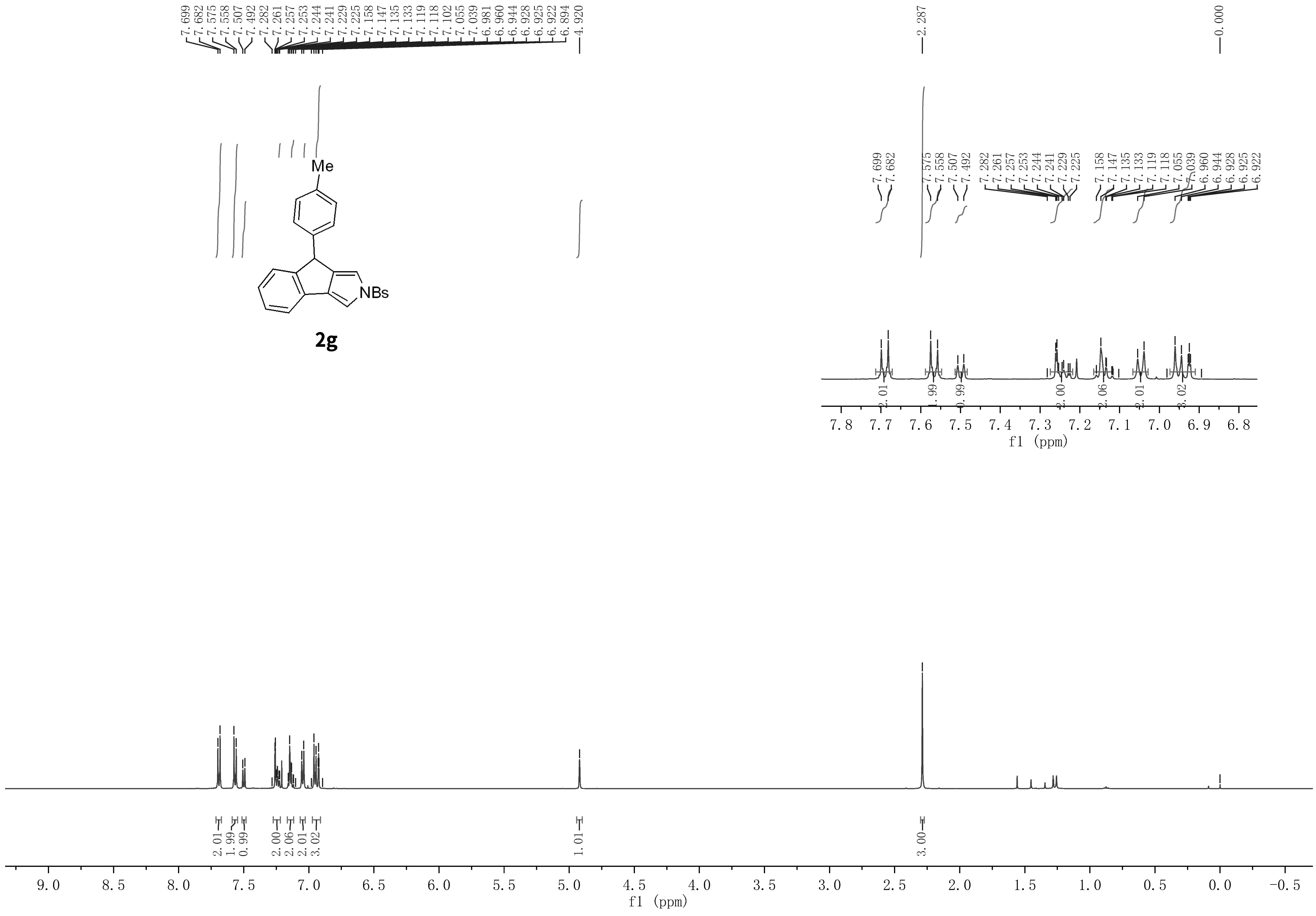


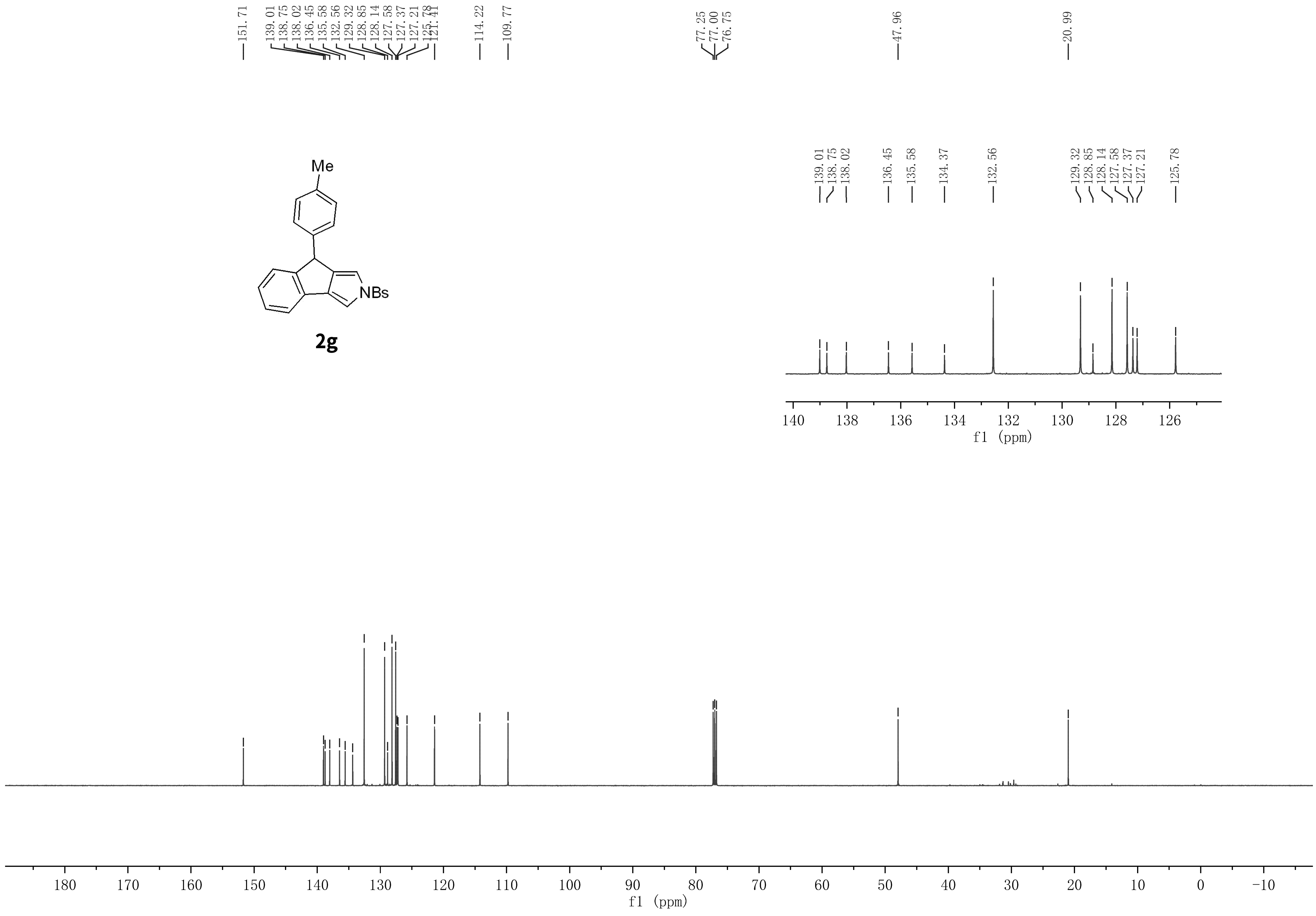
Br
NBs
2f
7.716
7.699
7.599
7.582
7.515
7.500
7.361
7.345
7.295
7.279
7.269
7.249
7.231
7.194
7.170
7.155
7.140
7.123
7.108
7.086
6.943
6.926
4.903
0.000
2.03
2.01
1.00
2.03
2.00
2.06
3.00
1.00
f1 (ppm)


150.91
140.89
138.28
137.90
135.34
134.43
132.63
131.73
129.46
129.00
128.18
127.67
127.30
125.72
121.54
120.69
114.22
109.92
77.25
77.00
76.75
47.69
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
f1 (ppm)


Br
NBs

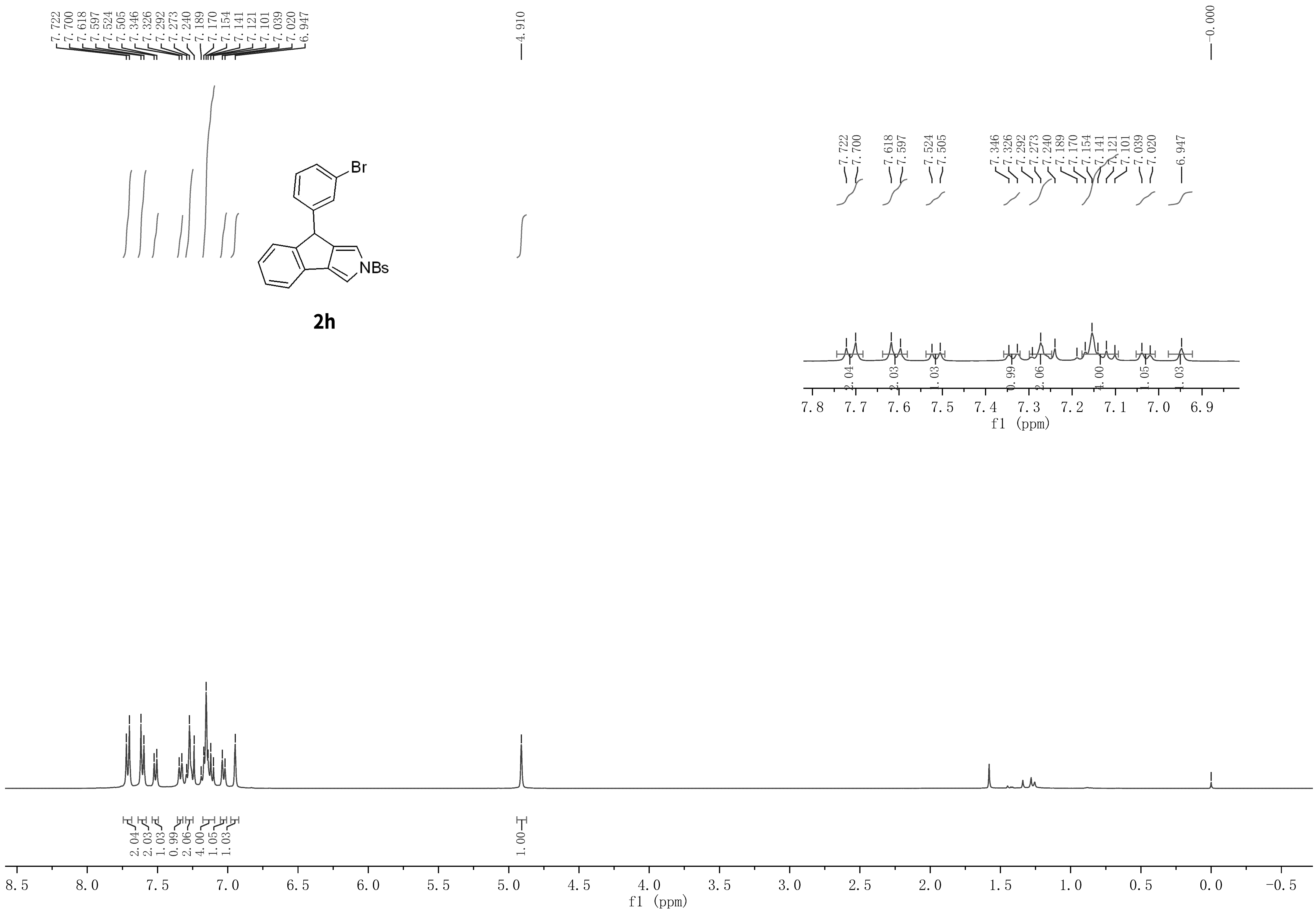
2f


Me
NBs
2g
f1 (ppm)



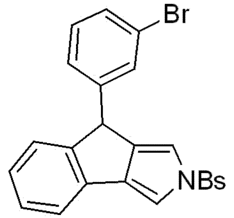
151.71
139.01
138.75
138.02
136.45
135.58
132.56
129.32
128.85
128.14
127.58
127.37
127.21
125.78
121.41
114.22
109.77
77.25
77.00
76.75
47.96
20.99
139.01
138.75
138.02
136.45
135.58
134.37
132.56
129.32
128.85
128.14
127.58
127.37
127.21
125.78
Me
NBs
f1 (ppm)
f1 (ppm)

2g

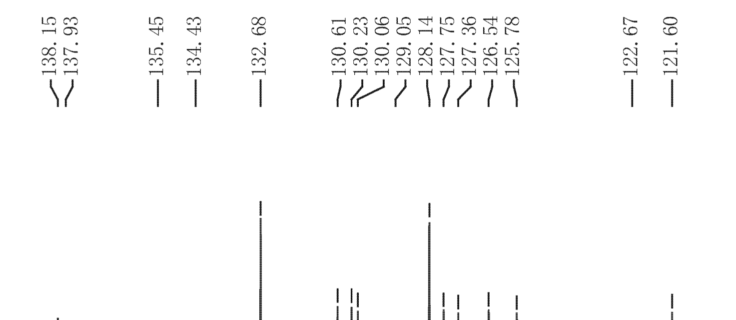

7.722
7.700
7.618
7.597
7.524
7.505
7.346
7.326
7.292
7.273
7.240
7.189
7.170
7.154
7.141
7.121
7.101
7.039
7.020
6.947
4.910
0.000
Br
NBs
2.04
2.03
1.03
0.99
2.06
4.00
1.05
1.03
1.00
f1 (ppm)

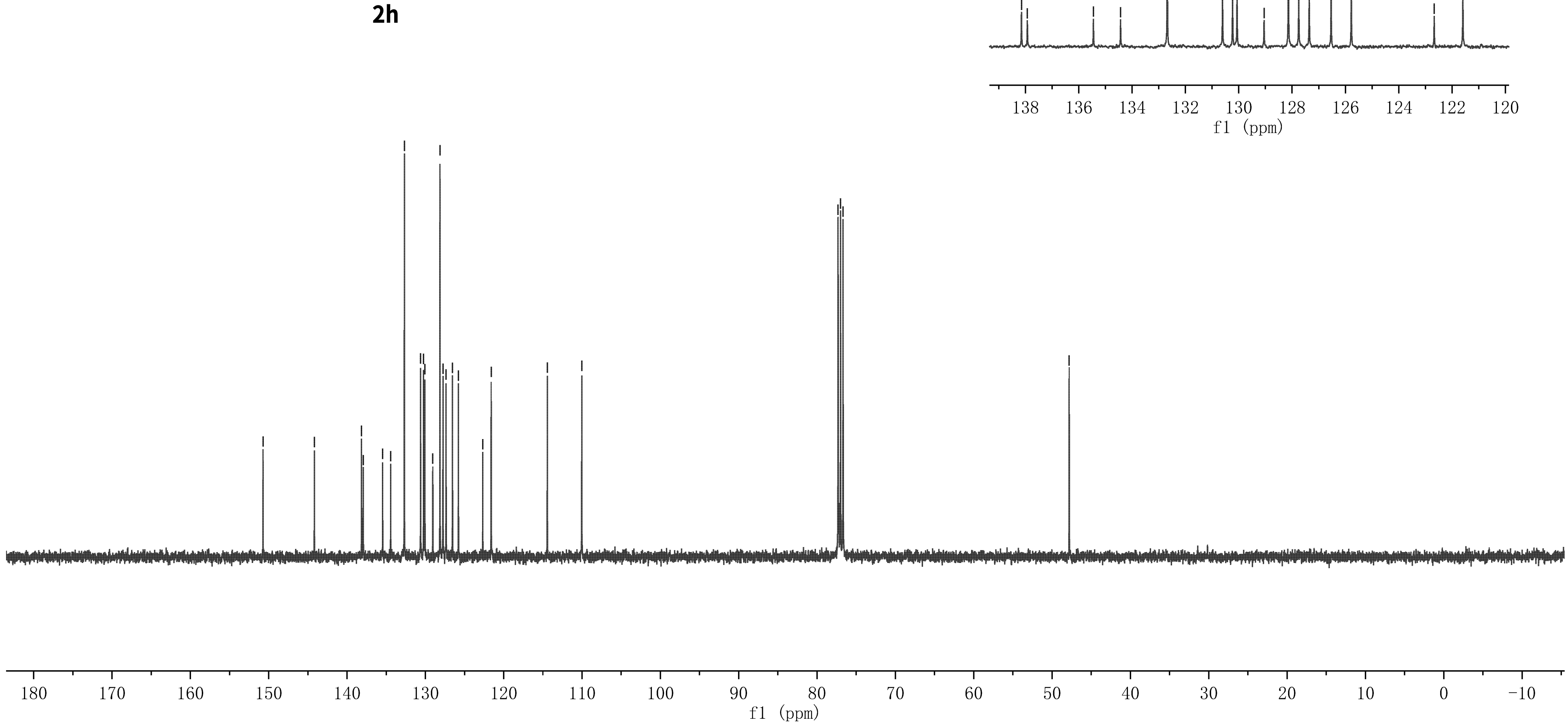
2h

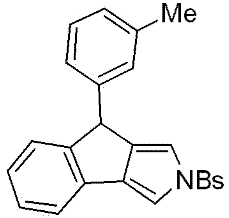
150.72
144.17
138.15
135.45
132.68
130.61
130.23
130.06
128.14
127.75
127.36
126.54
125.78
122.67
121.60
114.43
110.04
77.32
77.00
76.68
47.81



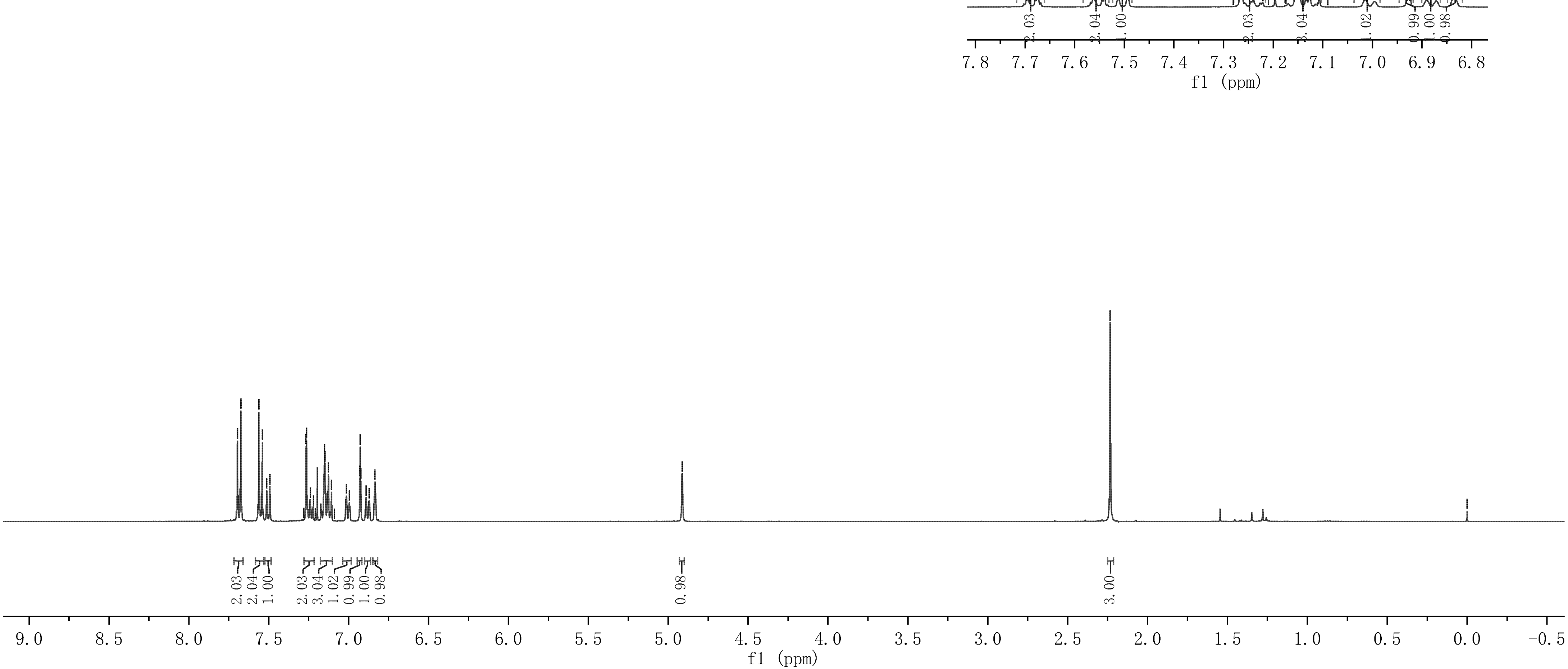
2h


138.15
137.93
135.45
134.43
132.68
130.61
130.23
130.06
129.05
128.14
127.75
127.36
126.54
125.78
122.67
121.60


f1 (ppm)
f1 (ppm)


Me
NBs

2i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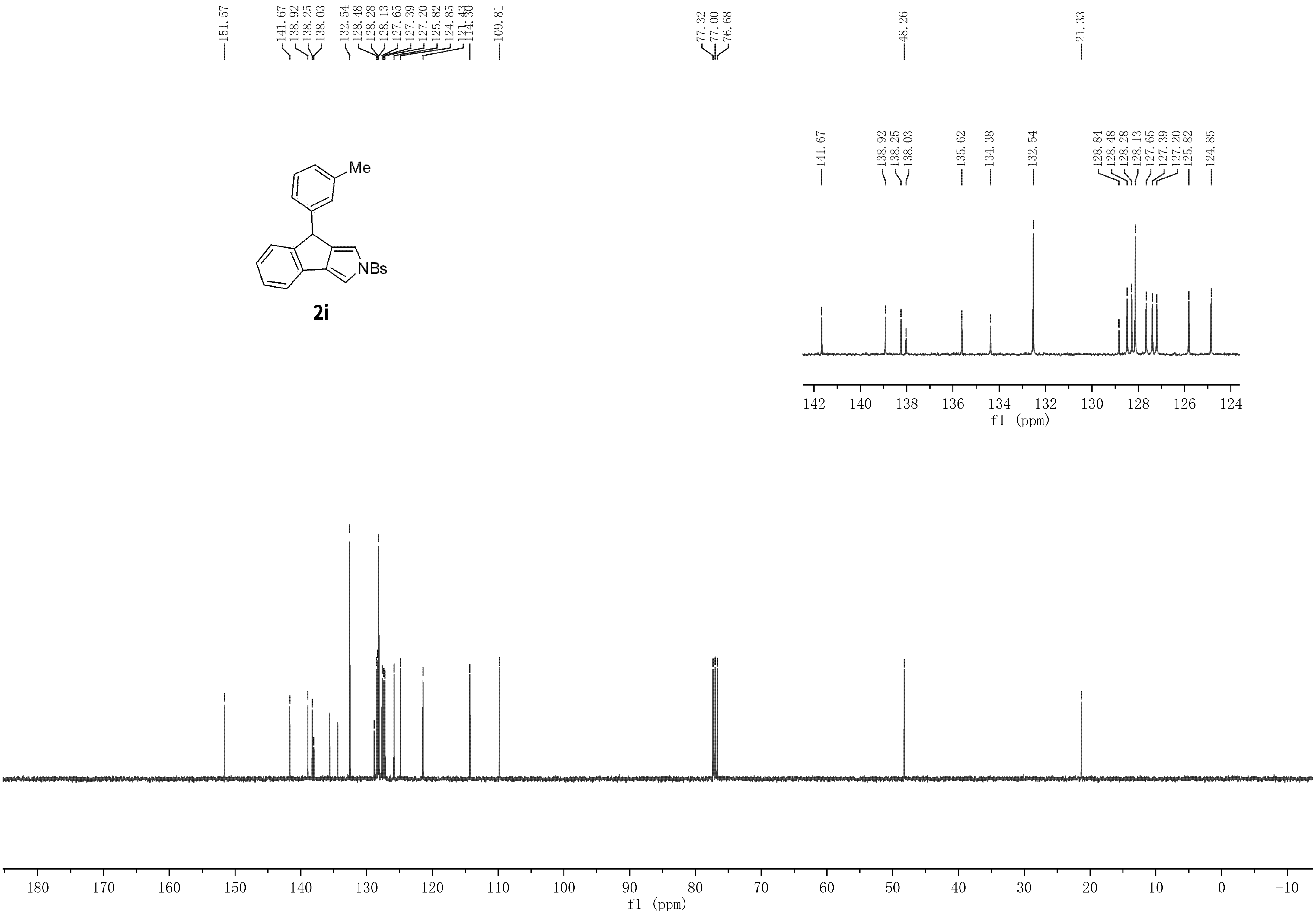
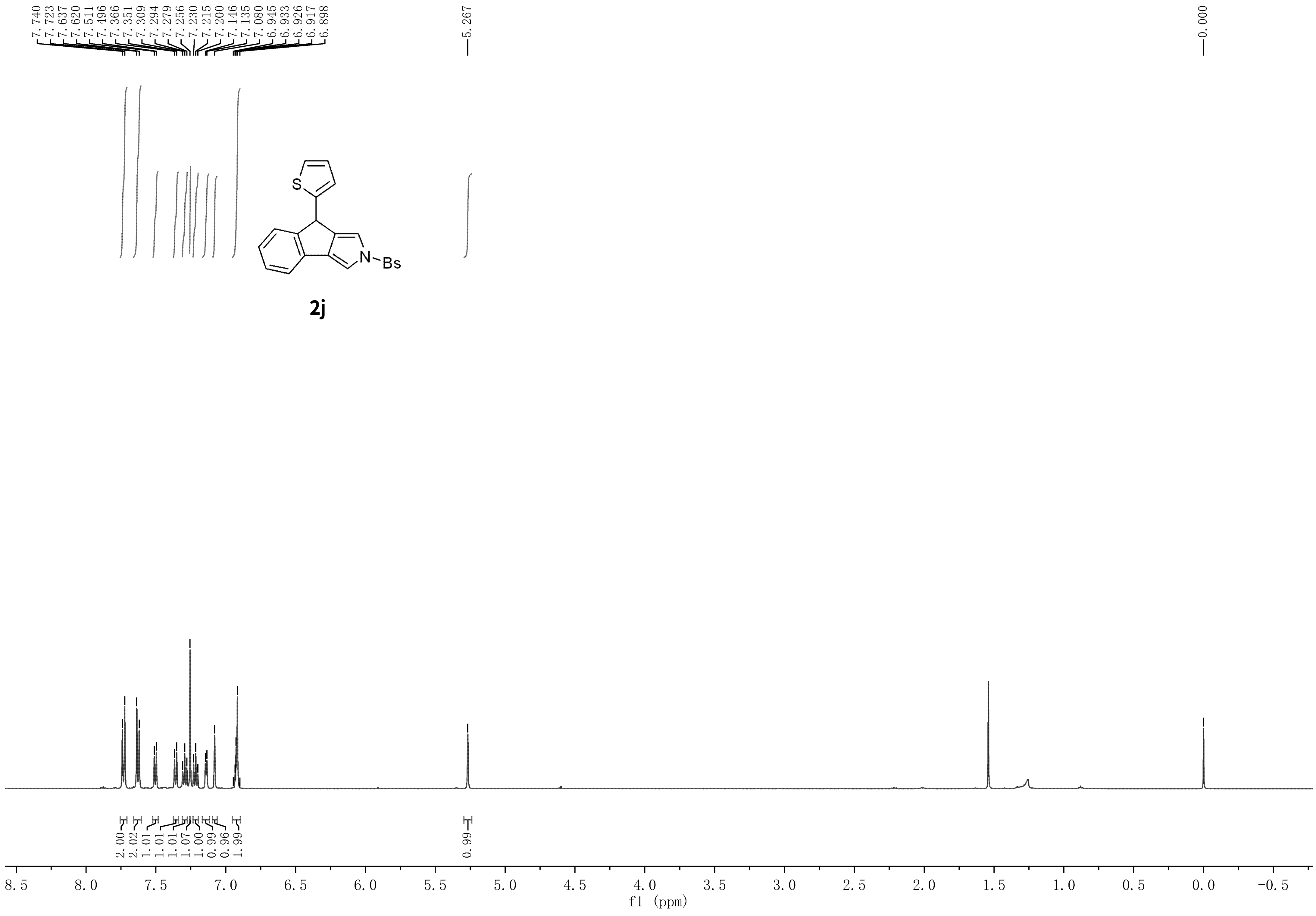
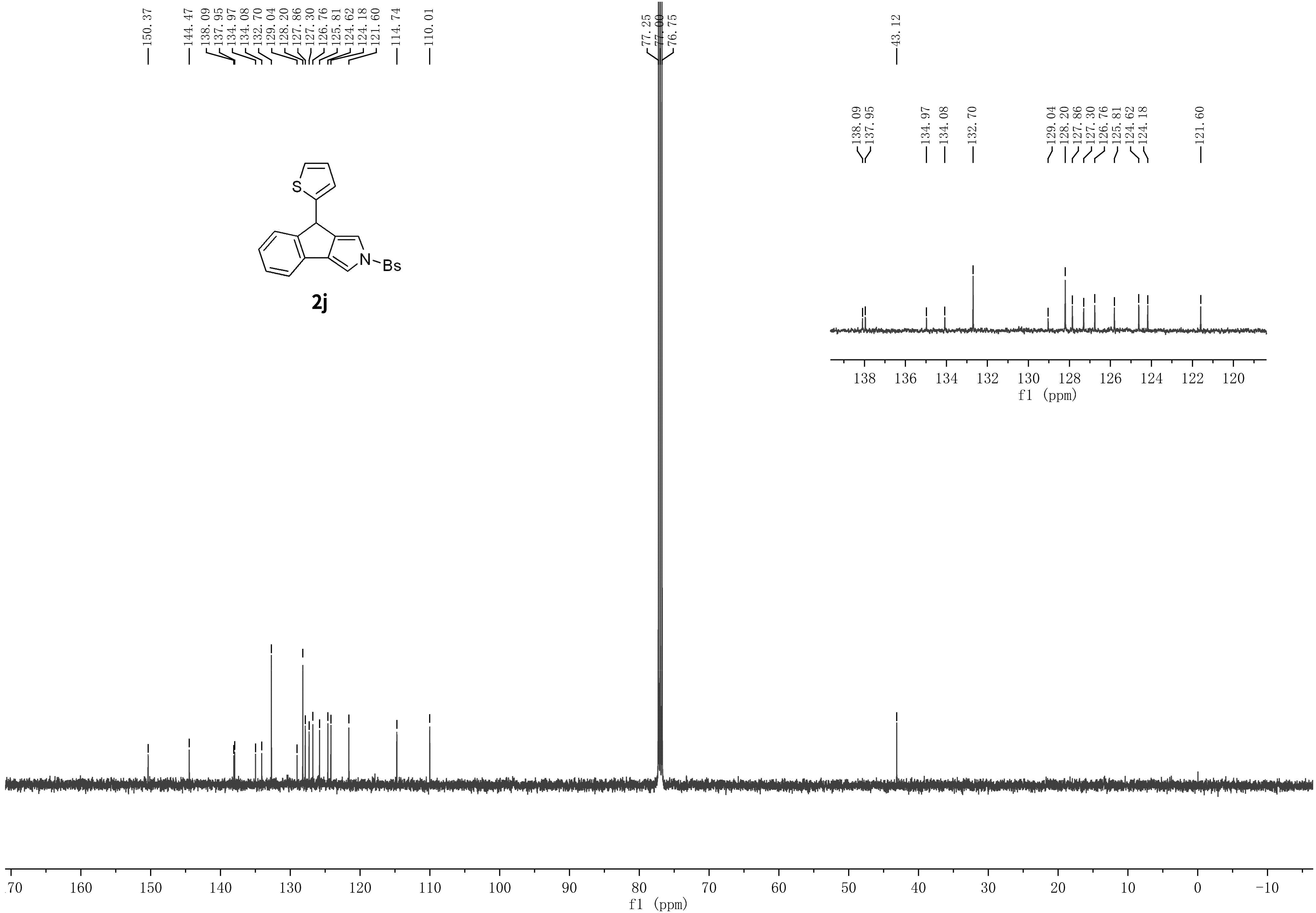
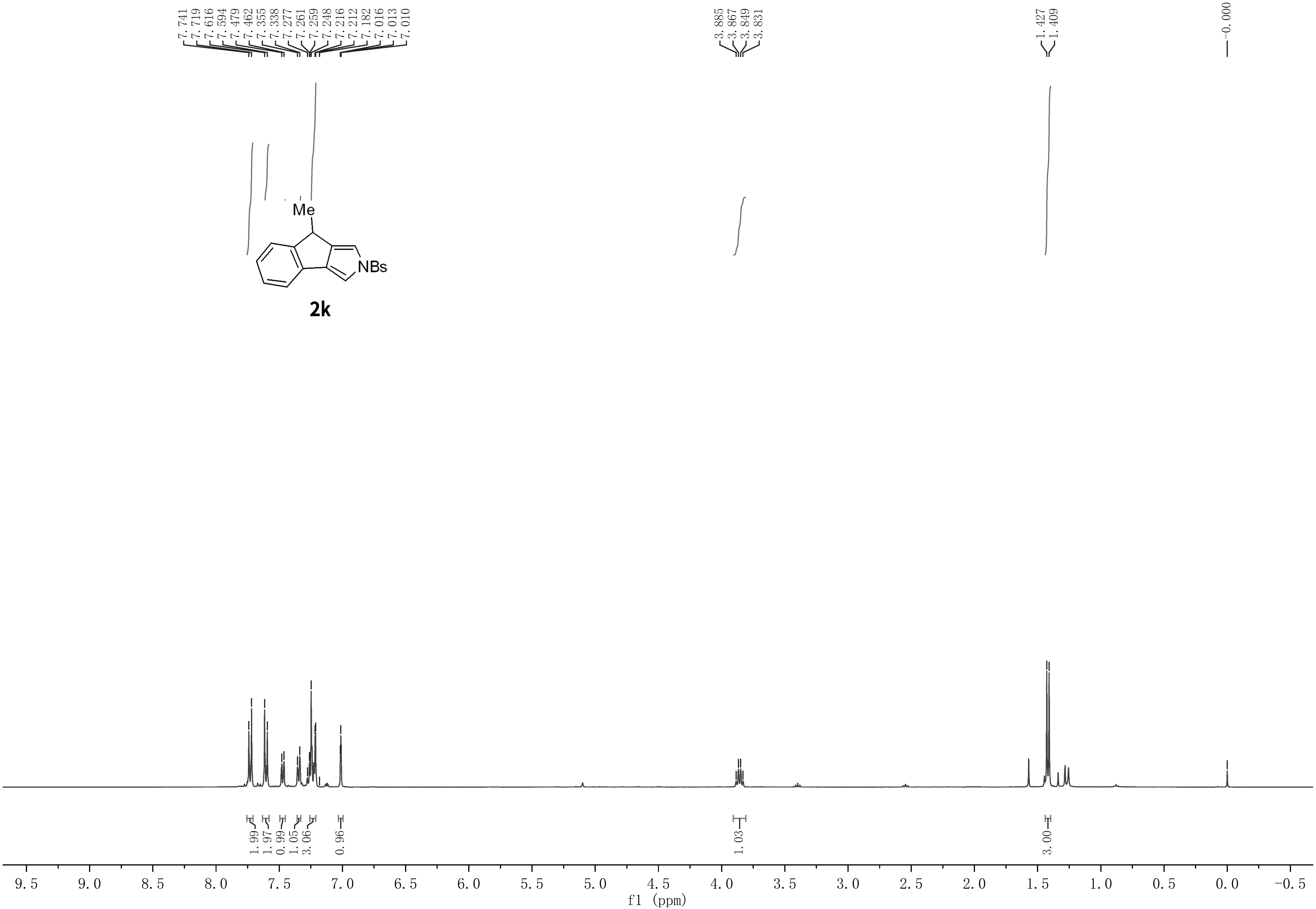
7.674
7.562
7.540
7.512
7.493
7.280
7.267
7.263
7.239
7.221
7.209
7.174
7.151
7.149
7.126
7.107
7.090
7.014
6.996
6.931
6.927
6.923
6.890
6.871
6.835
4.913
2.234
0.000
2.03
2.04
1.00
2.03
3.04
1.02
0.99
1.00
0.98
0.98
3.00
7.8 7.7 7.6 7.5 7.4 7.3 7.2 7.1 7.0 6.9 6.8
f1 (ppm)
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

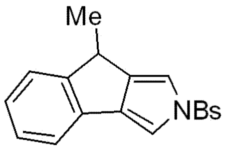

Me
NBs
2i
151.57
141.67
138.92
138.25
138.03
132.54
128.48
128.28
128.13
127.65
127.39
127.20
125.82
124.85
121.43
114.30
109.81
77.32
77.00
76.68
48.26
21.33
141.67
138.92
138.25
138.03
135.62
134.38
132.54
128.84
128.48
128.28
128.13
127.65
127.39
127.20
125.82
124.85
142 140 138 136 134 132 130 128 126 124
f1 (ppm)
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.740
7.723
7.637
7.620
7.511
7.496
7.366
7.351
7.309
7.294
7.279
7.256
7.230
7.215
7.200
7.146
7.135
7.080
6.945
6.933
6.926
6.917
6.898
5.267
0.000
S
N
Bs
2j
2.00
2.02
1.01
1.01
1.07
1.00
0.99
0.96
1.99
0.99
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
-0.5
f1 (ppm)

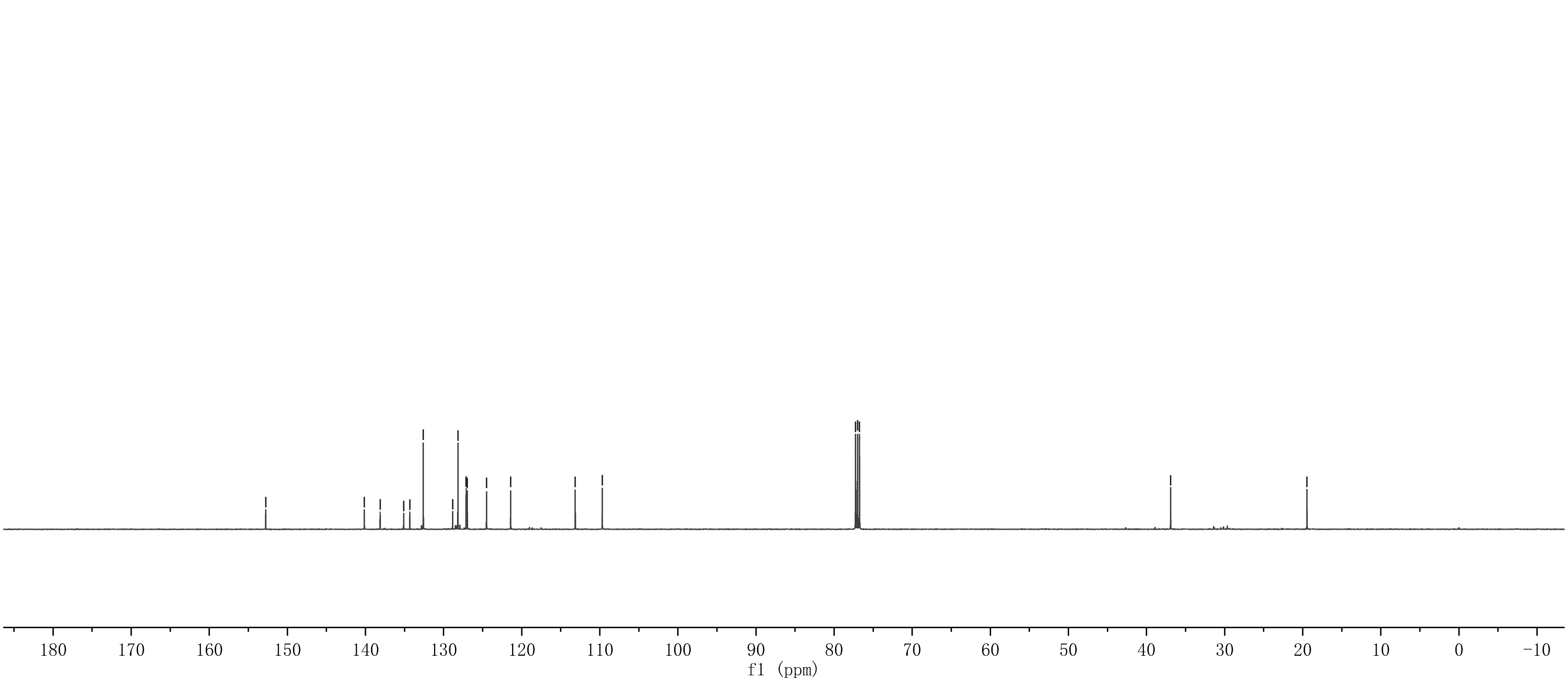

150.37
144.47
138.09
137.95
134.97
134.08
132.70
129.04
128.20
127.86
127.30
126.76
125.81
124.62
124.18
121.60
114.74
110.01
77.25
77.00
76.75
43.12
f1 (ppm)
S
N
Bs

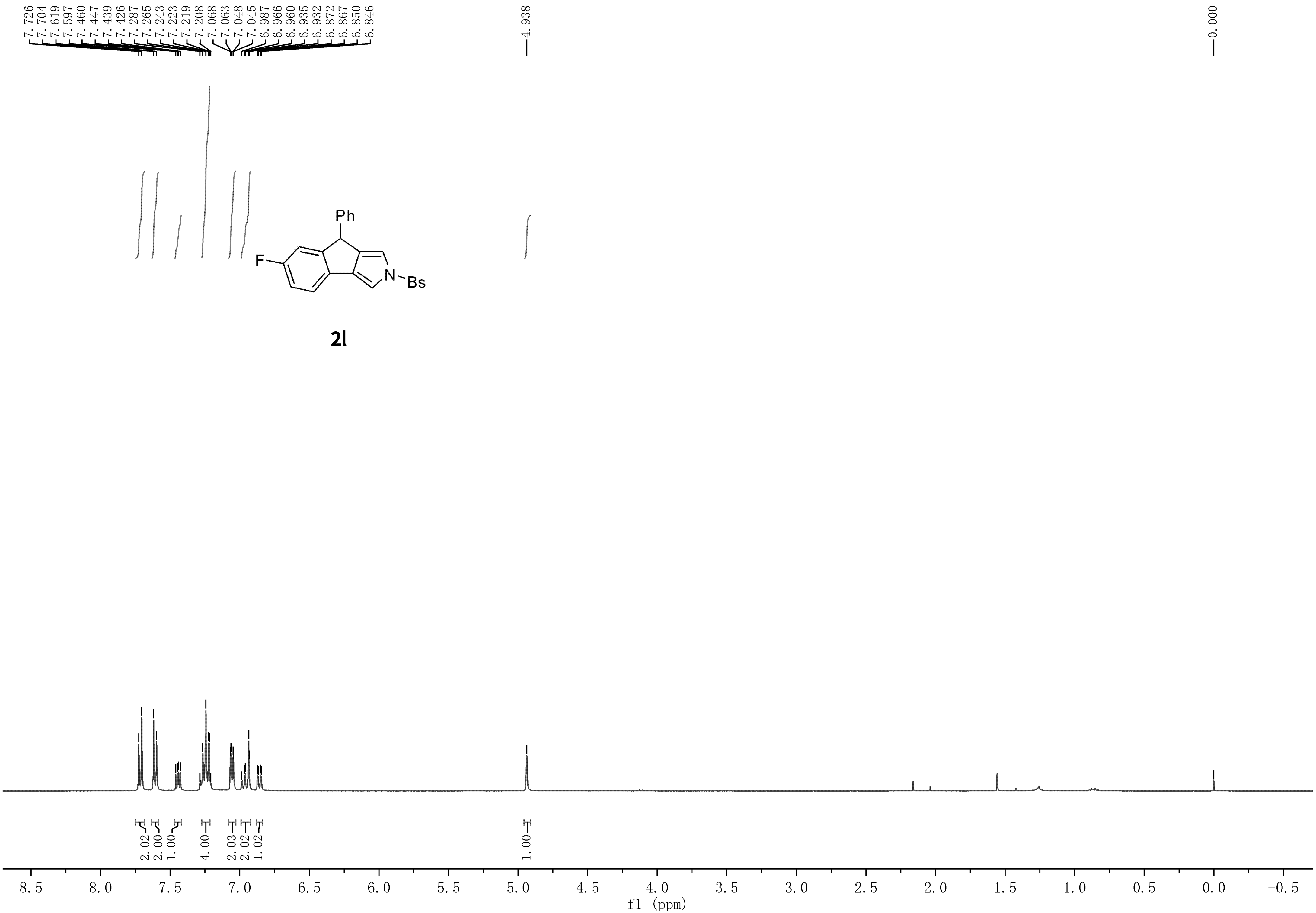
2j


7.741
7.719
7.616
7.594
7.479
7.462
7.355
7.338
7.277
7.261
7.259
7.248
7.216
7.212
7.182
7.016
7.013
7.010
3.885
3.867
3.849
3.831
1.427
1.409
-0.000
Me
NBs
2k
1.99
1.97
0.99
1.05
3.06
0.96
1.03
3.00
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 -0.5
f1 (ppm)

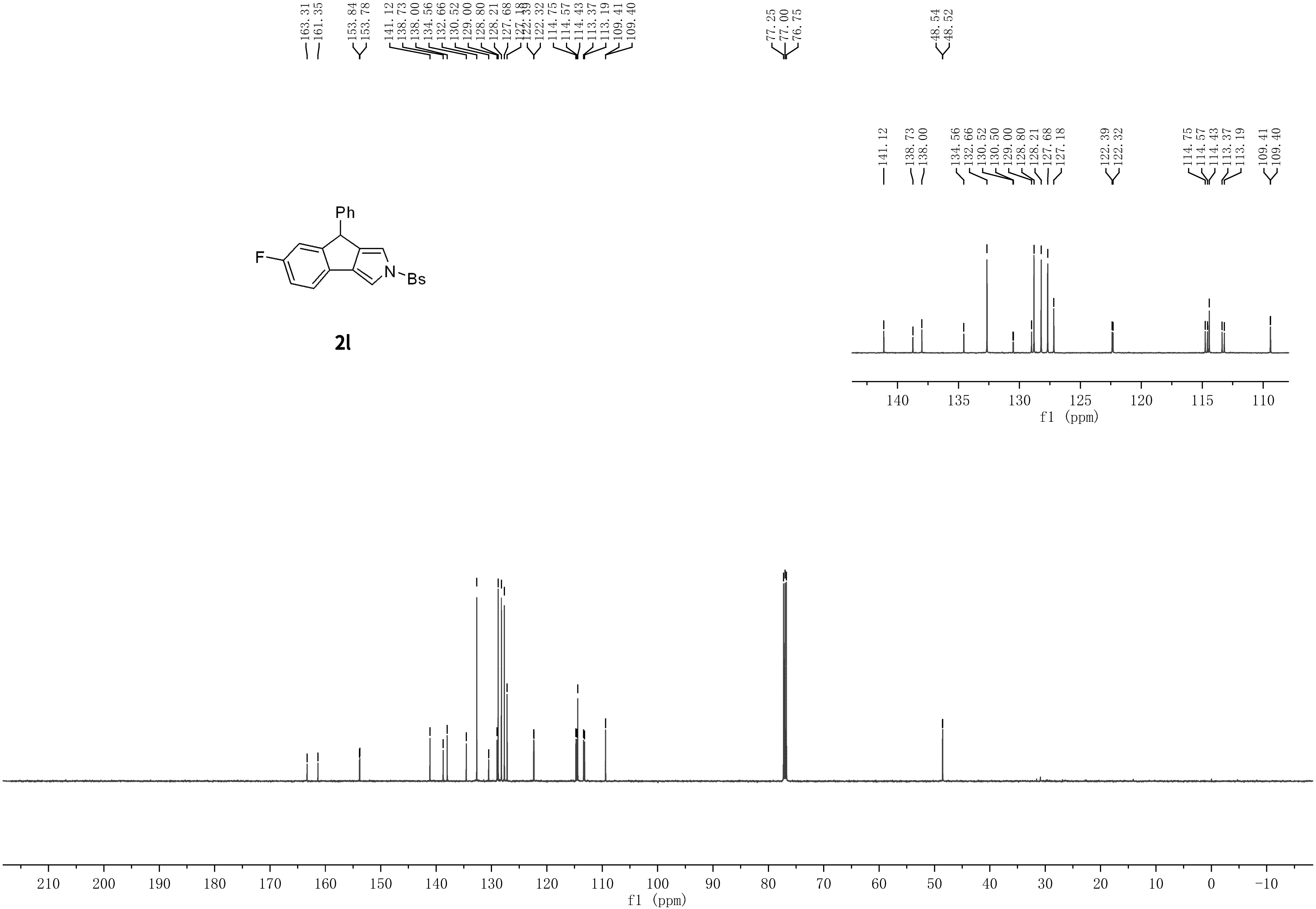

Me
NBs

2k

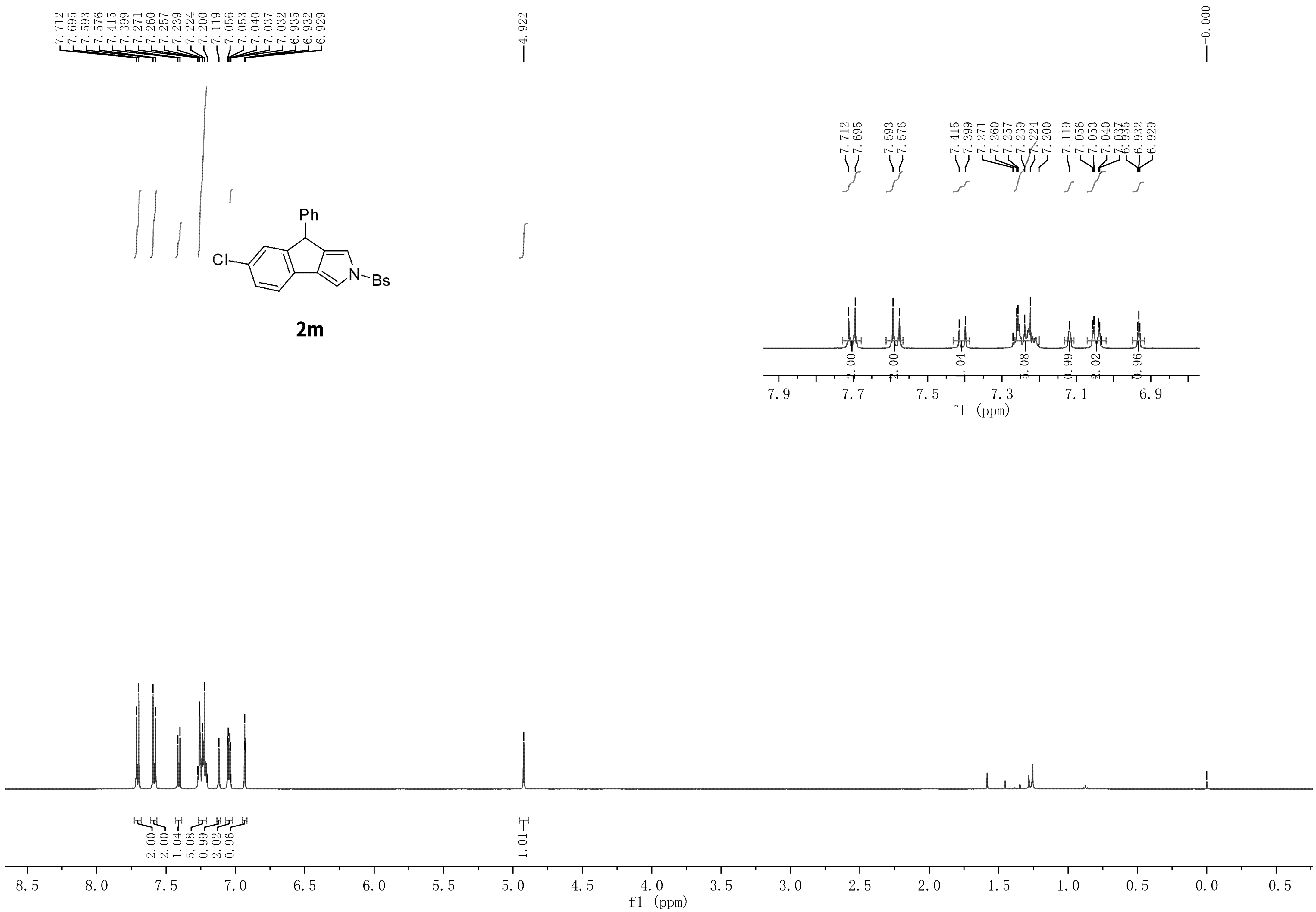

152.78
140.15
138.13
135.12
134.33
132.60
128.84
128.16
127.11
126.97
124.50
121.41
113.14
109.68
77.25
77.00
76.75
36.91
19.46
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)


7.726
7.704
7.619
7.597
7.460
7.447
7.439
7.426
7.287
7.265
7.243
7.223
7.219
7.208
7.068
7.063
7.048
7.045
6.987
6.966
6.960
6.935
6.932
6.872
6.867
6.850
6.846
4.938
0.000
Ph
F
N
Bs
2.02
2.00
1.00
4.00
2.03
2.02
1.02
1.00
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
-0.5
f1 (ppm)

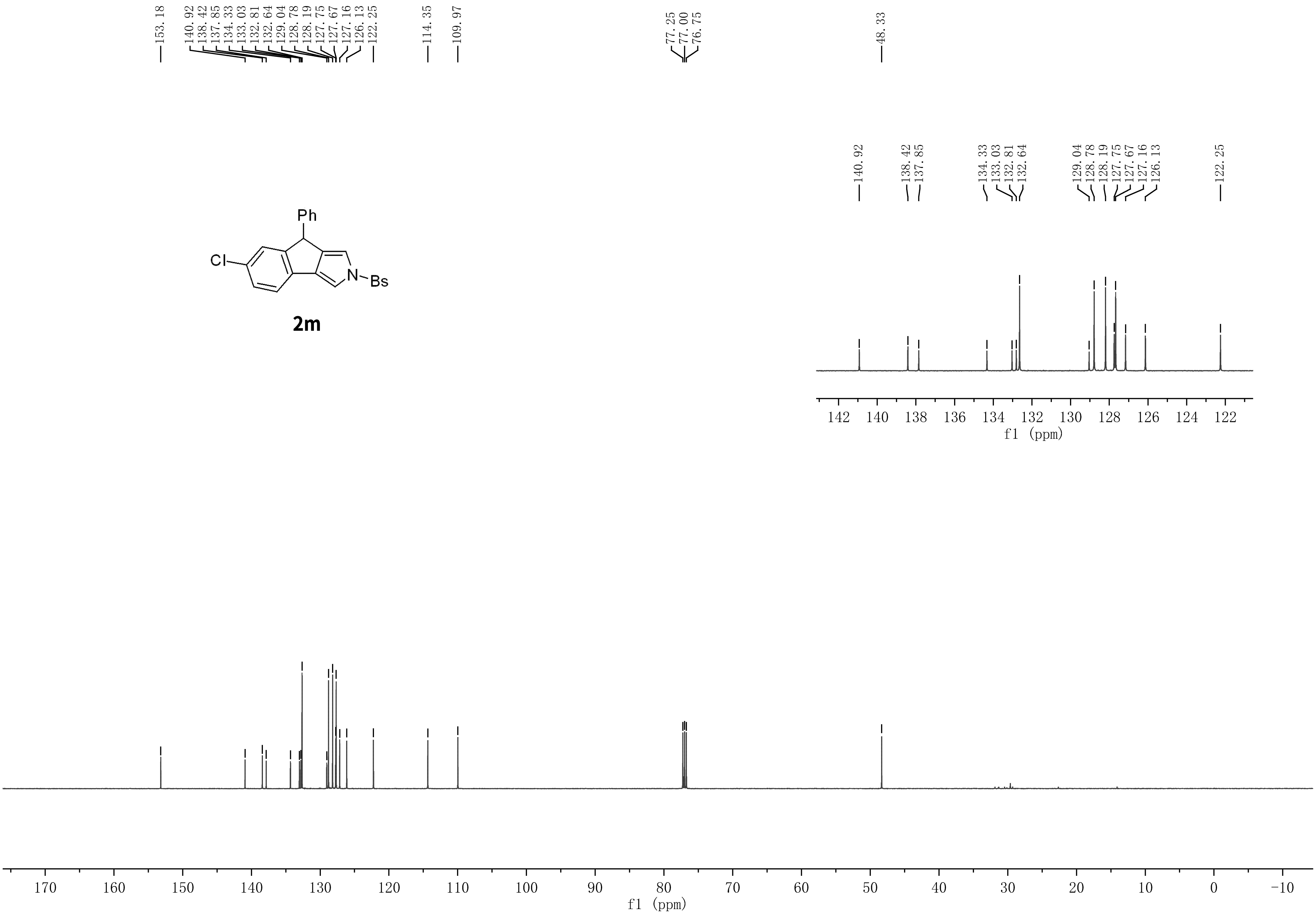
2l


163.31
161.35
153.84
153.78
141.12
138.73
138.00
134.56
132.66
130.52
129.00
128.80
128.21
127.68
127.18
122.39
122.32
114.75
114.57
114.43
113.37
113.19
109.41
109.40
77.25
77.00
76.75
48.54
48.52
141.12
138.73
138.00
134.56
132.66
130.52
130.50
129.00
128.80
128.21
127.68
127.18
122.39
122.32
114.75
114.57
114.43
113.37
113.19
109.41
109.40
f1 (ppm)
f1 (ppm)
Ph
F
N
Bs

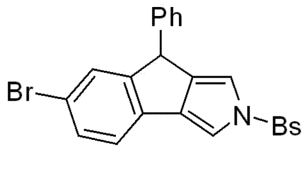
2l



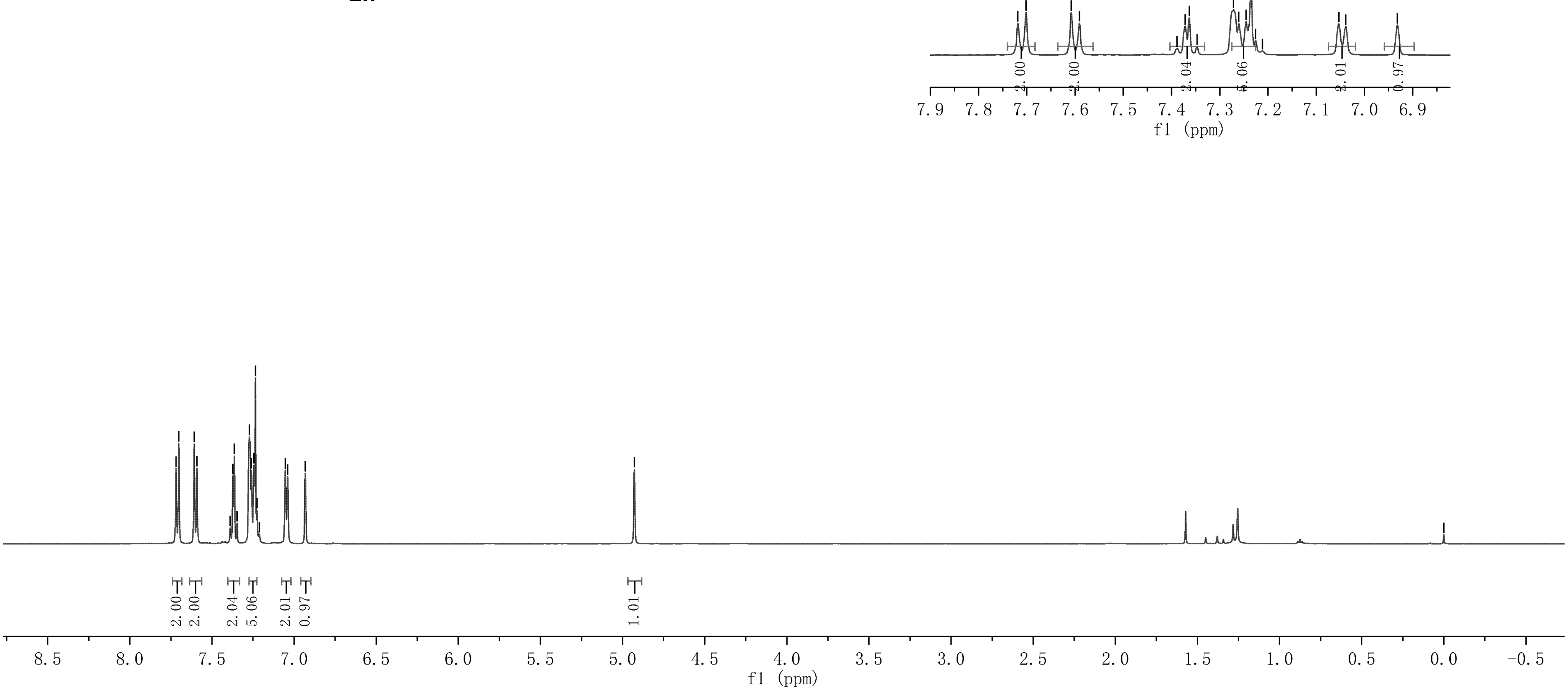
7.712
7.695
7.593
7.576
7.415
7.399
7.271
7.260
7.257
7.239
7.224
7.200
7.119
7.056
7.053
7.040
7.037
7.032
6.935
6.932
6.929
4.922
0.000
Ph
Cl
N
Bs
2m
2.00
2.00
1.04
5.08
0.99
2.02
0.96
1.01
7.9
7.7
7.5
7.3
7.1
6.9
f1 (ppm)
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)



153.18
140.92
138.42
137.85
134.33
133.03
132.81
132.64
129.04
128.78
128.19
127.75
127.67
127.16
126.13
122.25
114.35
109.97
77.25
77.00
76.75
48.33
Ph
Cl
N
Bs
2m
142 140 138 136 134 132 130 128 126 124 122
f1 (ppm)
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


Ph
Br
N
Bs

2n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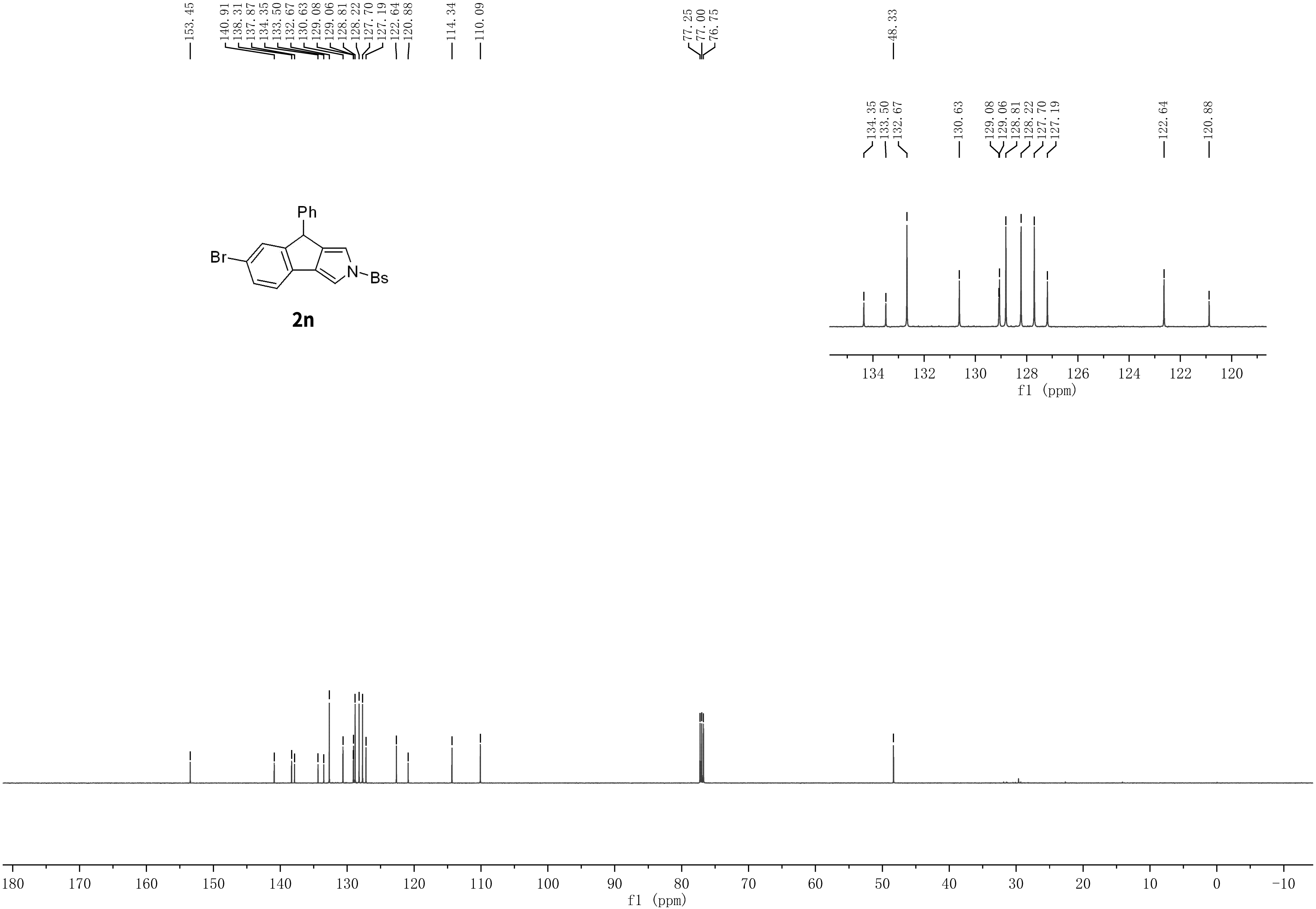
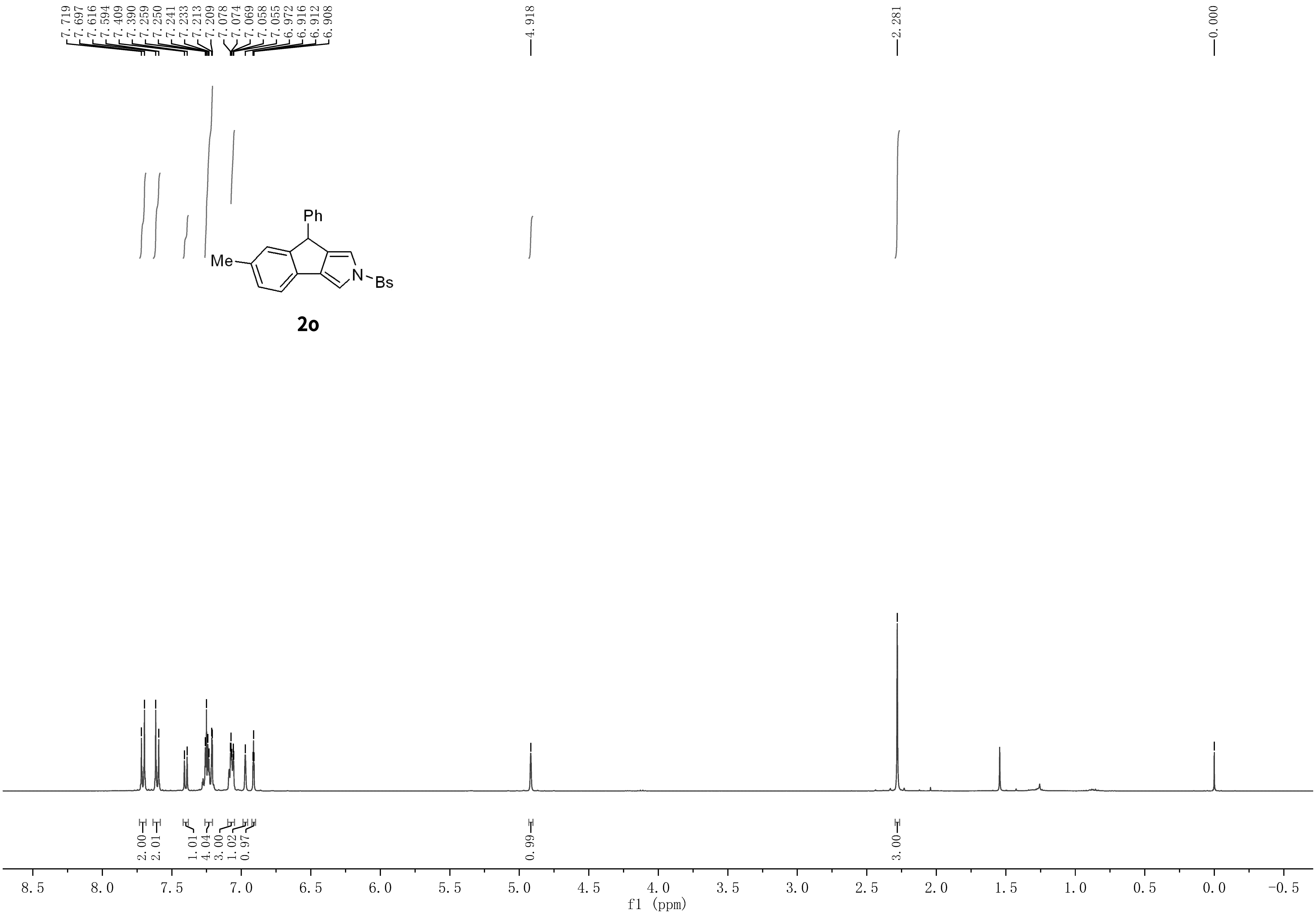
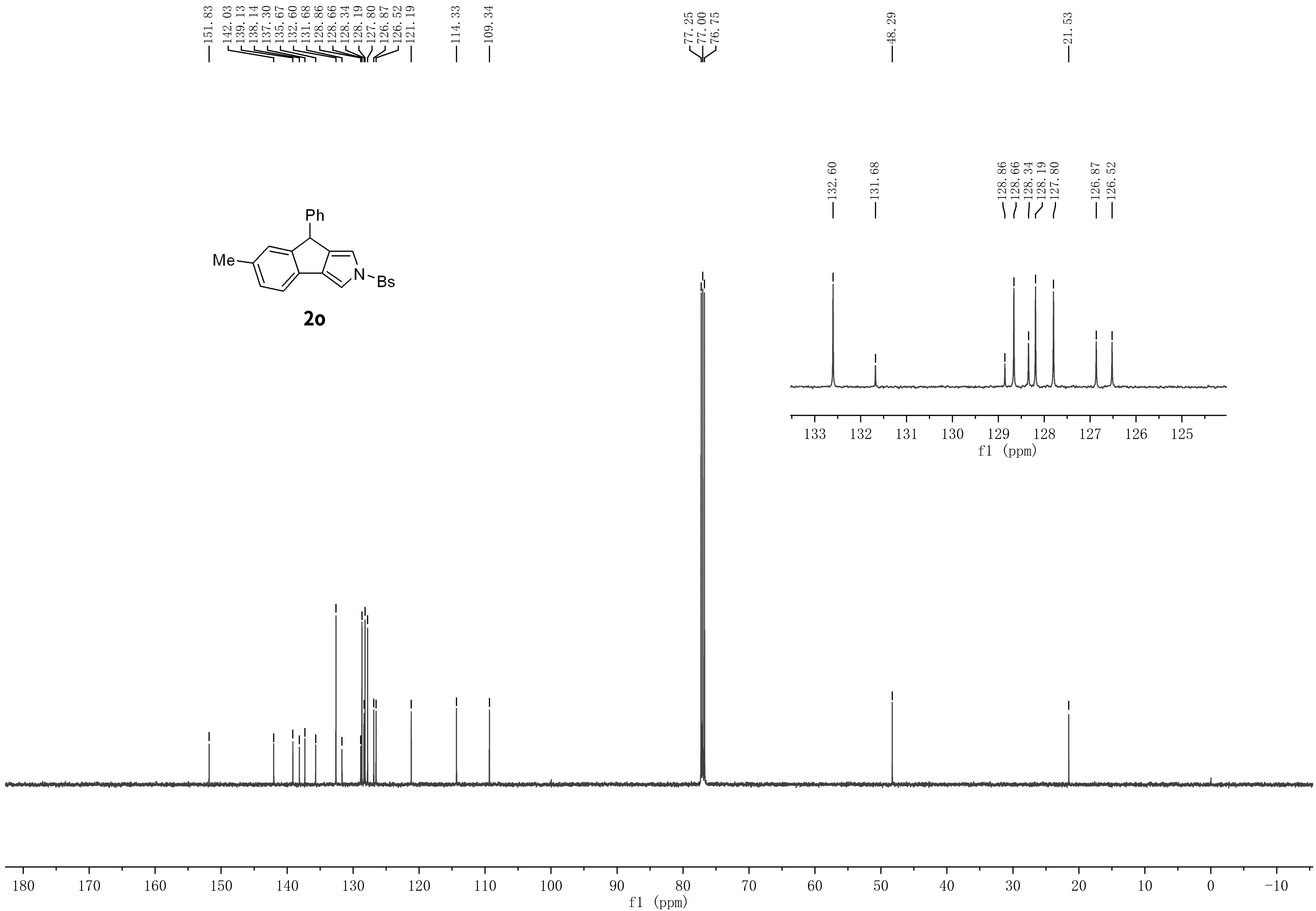
7.608
7.591
7.389
7.372
7.363
7.347
7.271
7.261
7.245
7.235
7.226
7.212
7.053
7.039
6.932
4.928
0.000
2.00
2.00
2.04
5.06
2.01
0.97
1.01
f1 (ppm)


153.45
140.91
138.31
137.87
134.35
133.50
132.67
130.63
129.08
129.06
128.81
128.22
127.70
127.19
122.64
120.88
114.34
110.09
77.25
77.00
76.75
48.33
134.35
133.50
132.67
130.63
129.08
129.06
128.81
128.22
127.70
127.19
122.64
120.88
134 132 130 128 126 124 122 120
f1 (ppm)
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)
Ph
Br
N
Bs

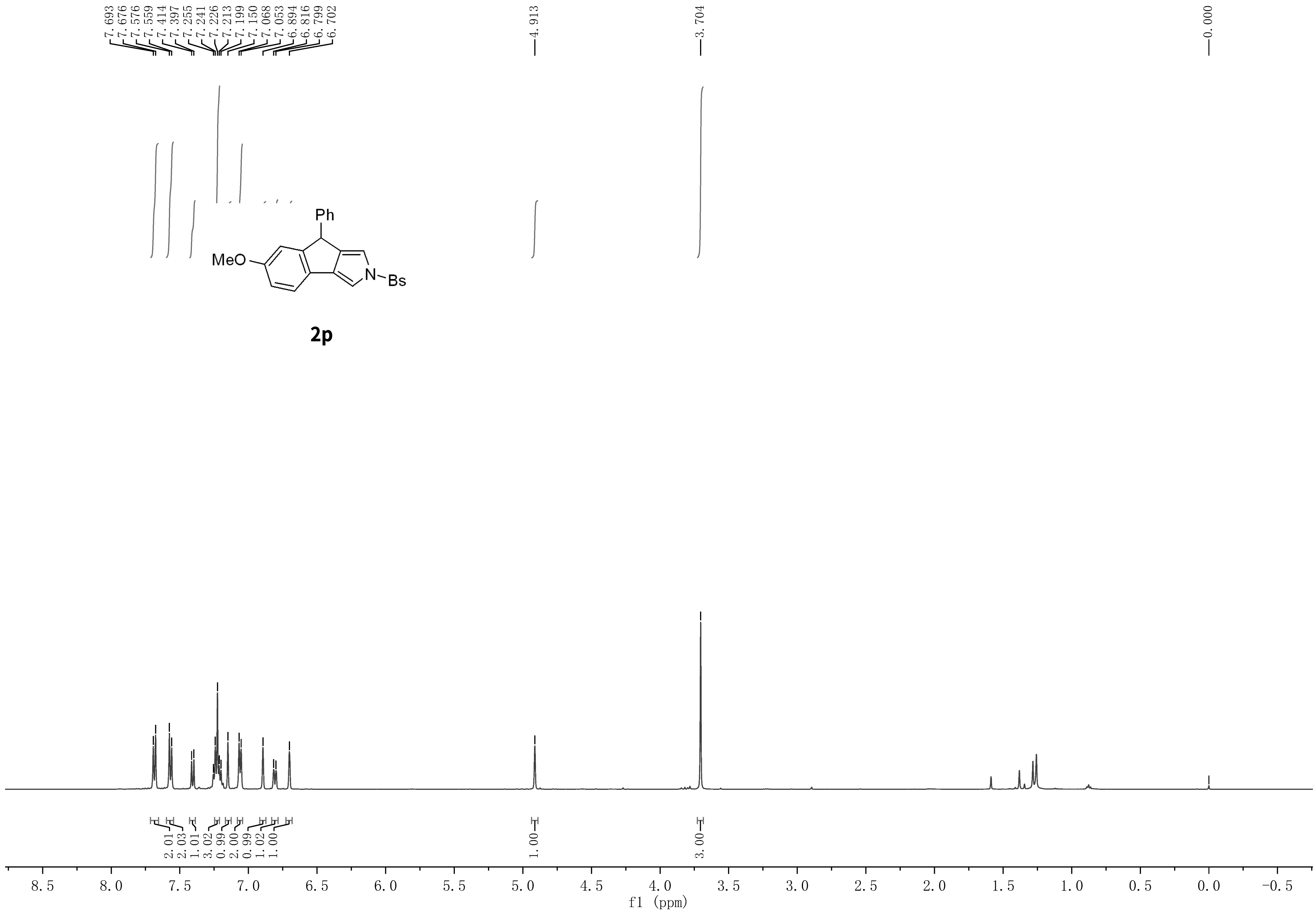
2n


7.719
7.697
7.616
7.594
7.409
7.390
7.259
7.250
7.241
7.233
7.213
7.209
7.078
7.074
7.069
7.058
7.055
6.972
6.916
6.912
6.908
4.918
2.281
0.000
Ph
Me
N
Bs
2o
2.00
2.01
1.01
4.04
3.00
1.02
0.97
0.99
3.00
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
-0.5
f1 (ppm)



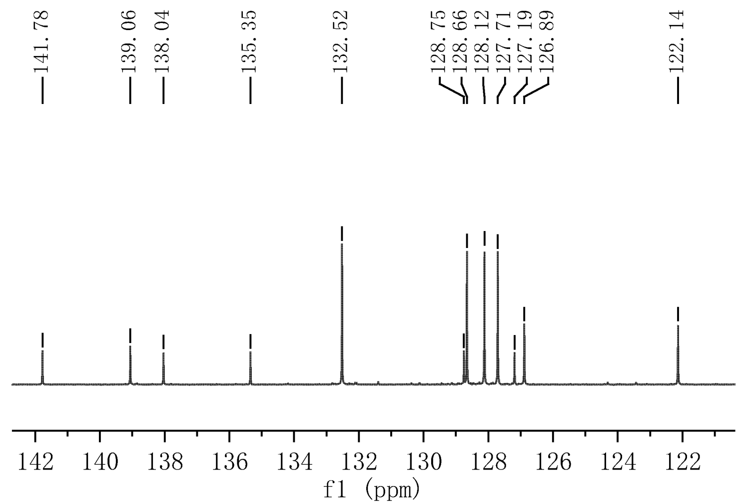
151.83
142.03
139.13
138.14
137.30
135.67
132.60
131.68
128.86
128.66
128.34
128.19
127.80
126.87
126.52
121.19
114.33
109.34
77.25
77.00
76.75
48.29
21.53
Ph
Me
N
Bs
132.60
131.68
128.86
128.66
128.34
128.19
127.80
126.87
126.52
133 132 131 130 129 128 127 126 125
f1 (ppm)
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)

2o

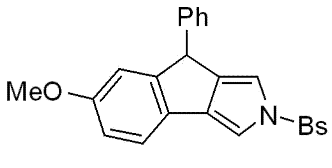


7.693
7.676
7.576
7.559
7.414
7.397
7.255
7.241
7.226
7.213
7.199
7.150
7.068
7.053
6.894
6.816
6.799
6.702
4.913
3.704
0.000
Ph
MeO
N
Bs
2p
2.01
2.03
1.01
3.02
0.99
2.00
0.99
1.02
1.00
1.00
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

159.39
153.39
141.78
139.06
138.04
135.35
132.52
128.75
128.66
128.12
127.71
127.19
126.89
122.14
114.30
113.33
111.57
108.60
77.25
77.00
76.75
55.36
48.45

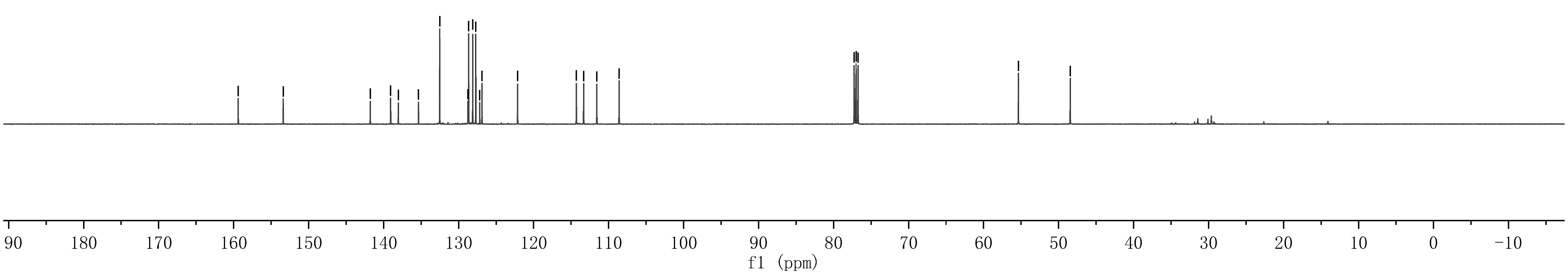


141.78
139.06
138.04
135.35
132.52
128.75
128.66
128.12
127.71
127.19
126.89
122.14
142 140 138 136 134 132 130 128 126 124 122
f1 (ppm)

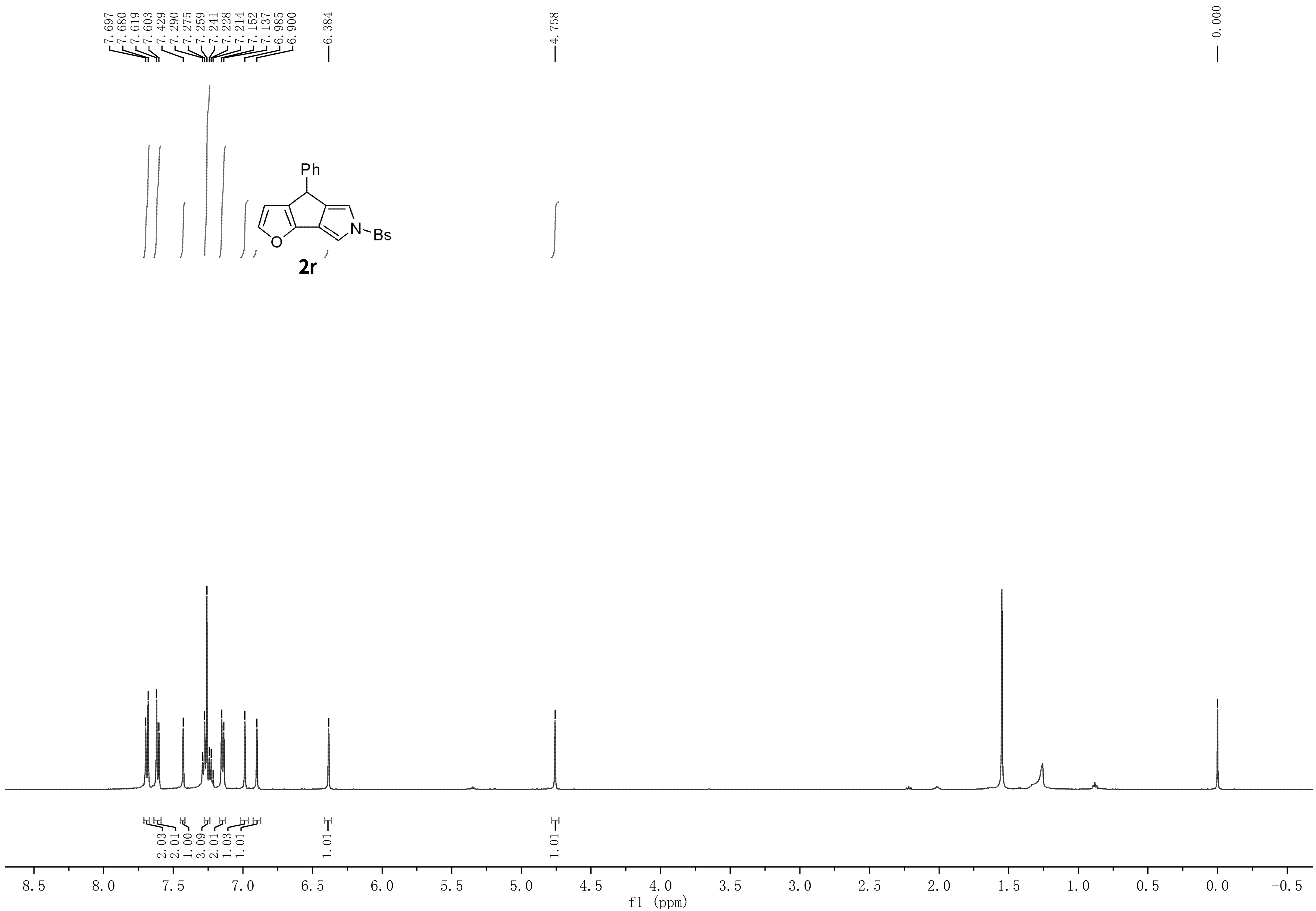


Ph
MeO
N
Bs

2p



90 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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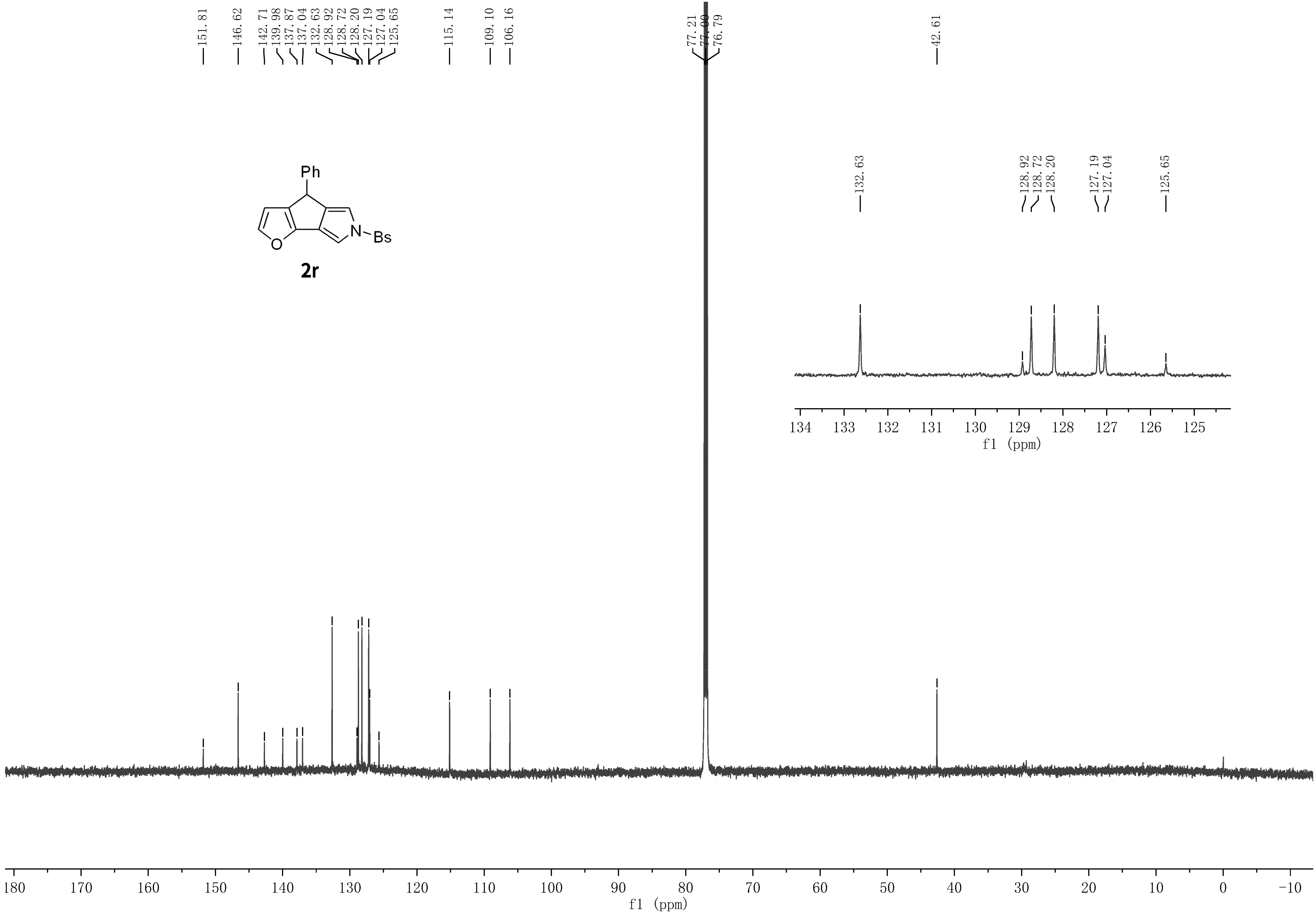
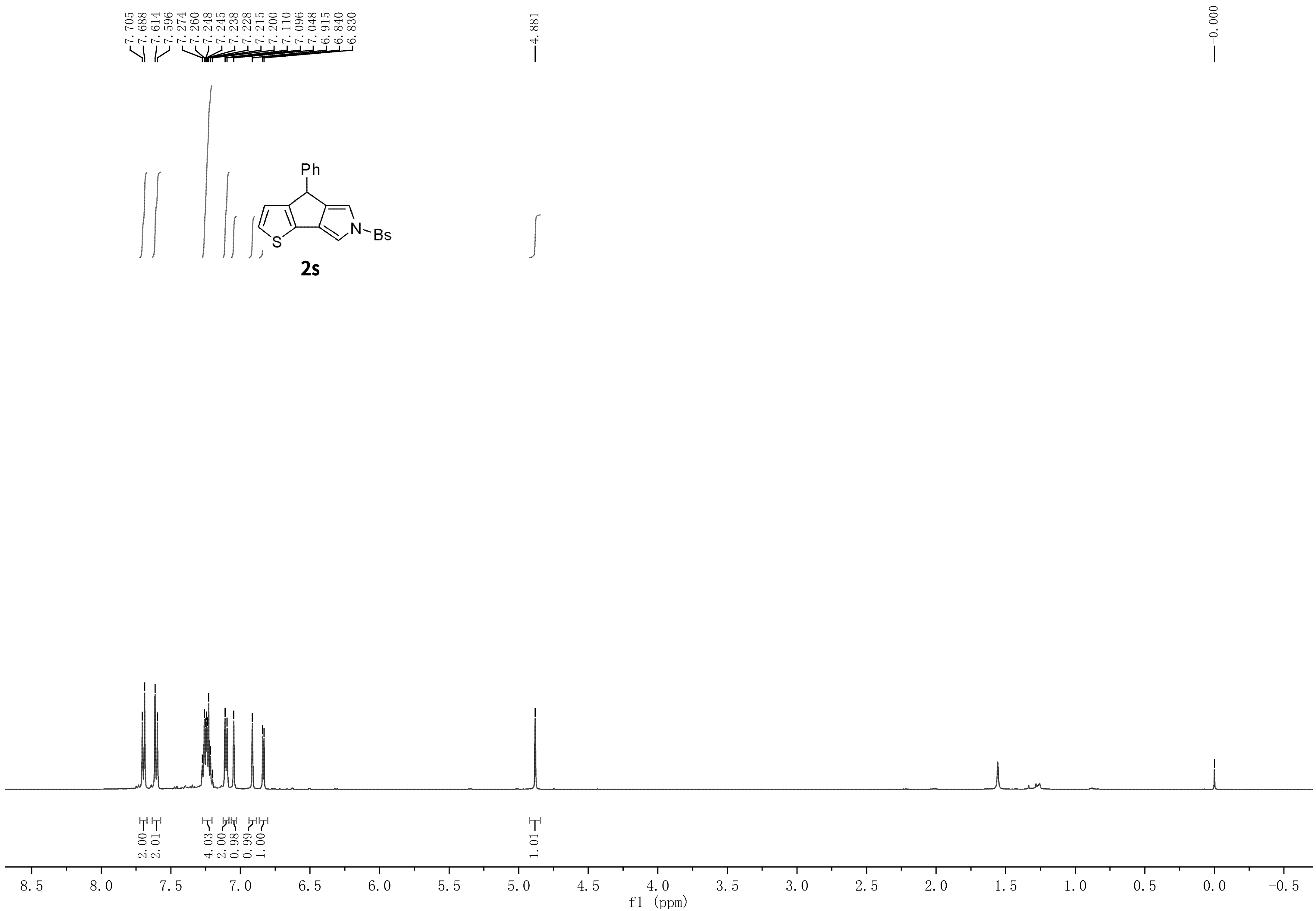
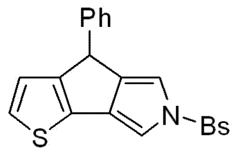
7.619
7.603
7.429
7.290
7.275
7.259
7.241
7.228
7.214
7.152
7.137
6.985
6.900
6.384
4.758
0.000
Ph
O
N
Bs
2r
2.03
2.01
1.00
3.09
2.01
1.03
1.01
1.01
1.01
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


151.81
146.62
142.71
139.98
137.87
137.04
132.63
128.92
128.72
128.20
127.19
127.04
125.65
115.14
109.10
106.16
77.21
77.00
76.79
42.61
Ph
N
Bs
O
132.63
128.92
128.72
128.20
127.19
127.04
125.65
134 133 132 131 130 129 128 127 126 125
f1 (ppm)
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

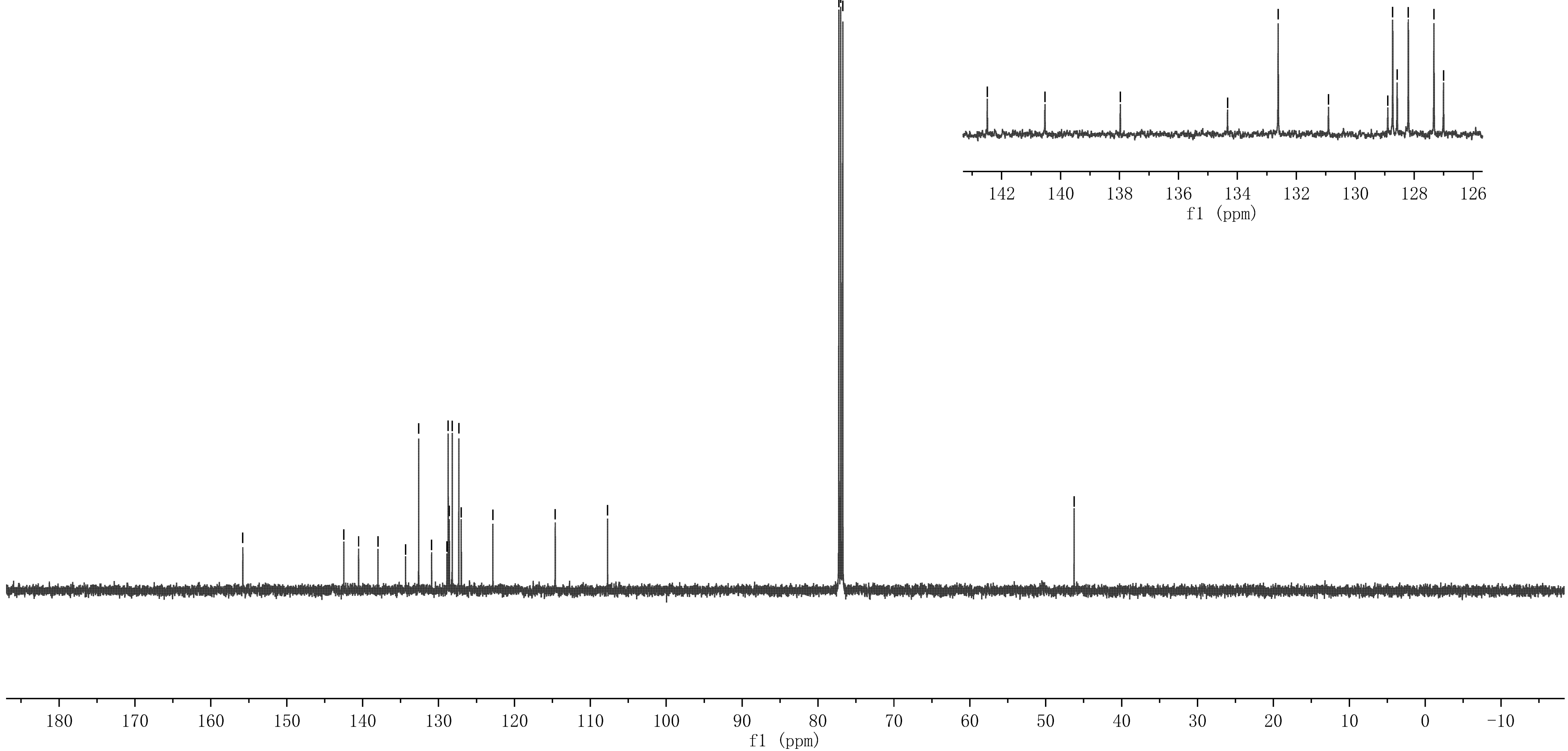
2r



7.705
7.688
7.614
7.596
7.274
7.260
7.248
7.245
7.238
7.228
7.215
7.200
7.110
7.096
7.048
6.915
6.840
6.830
4.881
-0.000
Ph
S
N
Bs
2s
2.00
2.01
4.03
2.00
0.98
0.99
1.00
1.01
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 -0.5
f1 (ppm)


Ph
N
Bs
S

2s


155.79
142.49
140.53
137.97
134.33
132.62
130.91
128.90
128.73
128.58
128.20
127.33
127.00
122.84
114.62
107.73
77.25
77.00
76.75
46.26
142.49
140.53
137.97
134.33
132.62
130.91
128.90
128.73
128.58
128.20
127.33
127.00
142 140 138 136 134 132 130 128 126
f1 (ppm)
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)