

Supplementary Information

Enantioselective Synthesis of Chiral Cyclic Hydroxylamine Ethers via NiH-Catalyzed Cyclization of Alkyne-Oxime Ethers

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1. General Information

All reactions were carried out in glassware under ambient atmosphere unless otherwise noted. Reactions were concentrated under reduced pressure using a rotary evaporator unless otherwise noted. Commercial reagents, including all of solvents, were used as received or purified using the methods indicated herein. All ligands were obtained from commercial sources.

Chromatography: Analytical thin-layer chromatography (TLC) was carried out with silica gel pre-coated glass plates. The TLC was visualized with a UV lamp (254 or 365 nm). Flash Column chromatography was carried out on silica gel (200-300 mesh) with technical grade solvents as the eluent.

Nuclear magnetic resonance (NMR) spectroscopy: NMR spectra were recorded using CDCl_3 as the solvent and on the Bruker AVANCE spectrometer, operating at 400 MHz for ^1H NMR and 100 MHz for ^{13}C NMR. Chemical shifts (δ) were given in parts per million from tetramethylsilane (δ 0) and were measured relative to the signal of CDCl_3 (^1H NMR: δ 7.26 ppm and ^{13}C NMR: 77.0 ppm). Coupling constants (J values) were given in Hertz (Hz) and reported to the nearest 0.1 Hz. ^1H NMR spectral data are tabulated in the order: multiplicity (s, singlet; d, doublet; t, triplet; q, quartet; sept, septet; m, multiplet; br broad), coupling constants, number of protons.

High resolution mass spectrometry (HRMS): HRMS were recorded on a liquid chromatography/quadrupole time-of-flight mass spectrometer (MicroTof-Q II mass spectrometer, Bruker Daltonics) using electrospray ionization-time of flight (ESI-TOF). The calculated values are based on the most abundant isotope.

High performance liquid chromatography (HPLC): HPLC analysis was performed on a SHIMADZU LC-20AT equipped with a variable wavelength UV-Vis detector SPD-20A and Daicel Chiralpak chiral column.

Optical rotations: Optical rotations were measured on an Autopol IV-T polarimeter. The optical rotation values ($[\alpha]_D$) were reported at the indicated temperature in $\text{deg. mL g}^{-1} \text{ dm}^{-1}$.

X-ray crystallography: X-ray crystallography was performed on a BRUKERSMA

RTAPEXIICCD diffractometer.

2. More Reaction Conditions and Scopes

Table S1: Screening of PHOX ligand

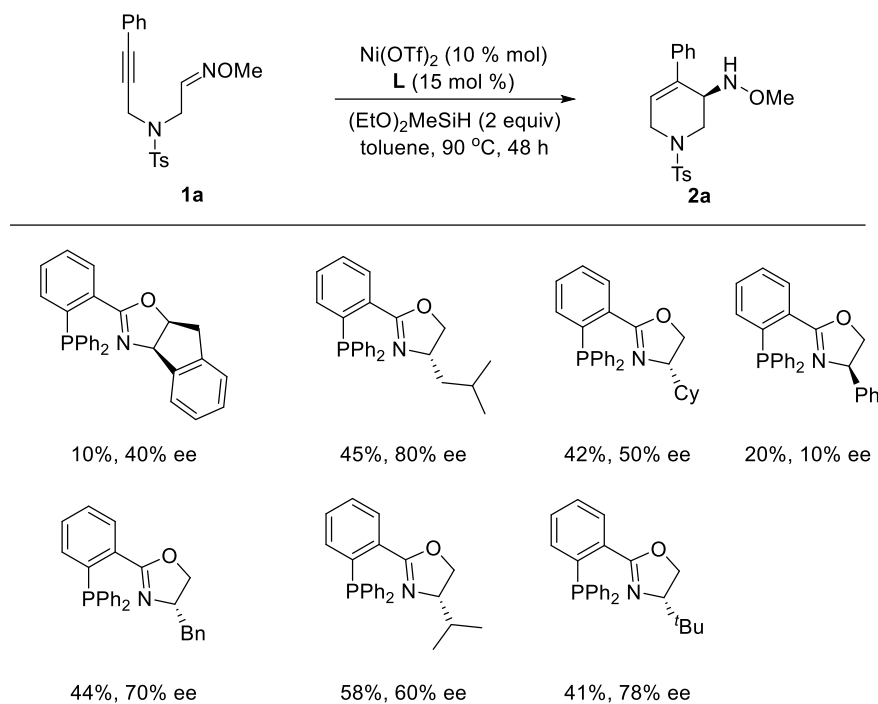
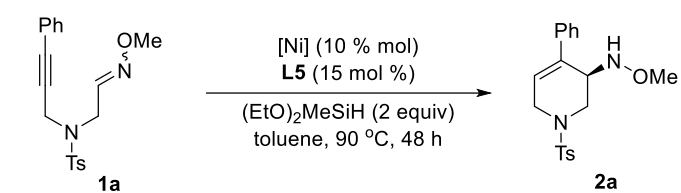
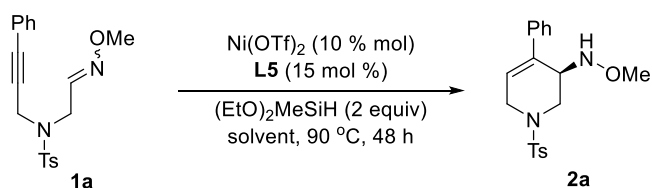


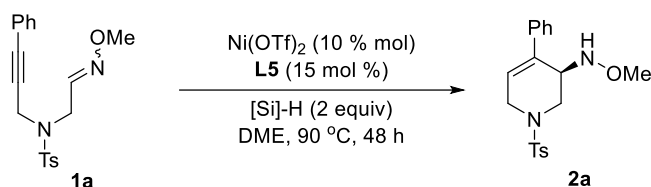
Table S2: Screening of nickel precursor



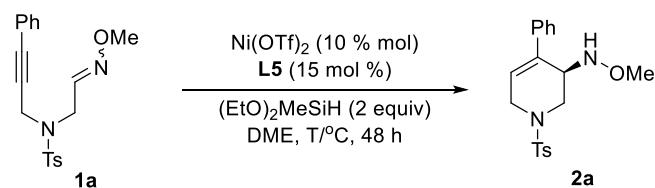
entry	[Ni]	yield (%)	ee (%)
1	$\text{Ni}(\text{OTf})_2$	53	94
2	$\text{Ni}(\text{TsO})_2 \cdot 6\text{H}_2\text{O}$	27	88
3	$\text{Ni}(\text{BF}_4)_2 \cdot 6\text{H}_2\text{O}$	58	92
4	$\text{Ni}(\text{ClO}_4)_2 \cdot 6\text{H}_2\text{O}$	62	93
5	$\text{Ni}(\text{TFA})_2 \cdot 6\text{H}_2\text{O}$	<10	-
6	$\text{Ni}(\text{OAc})_2 \cdot 6\text{H}_2\text{O}$	<10	-
7	NiI_2	29	36

Table S3: Screening of solvent

entry	solvent	yield (%)	ee (%)
1	toluene	53	94
2	DME	58	94
3	THF	50	93
4	1,4-dioxane	54	92
5	DCE	16	94
6	TFE	-	-
7	HFIP	-	-

Table S4: Screening of silane

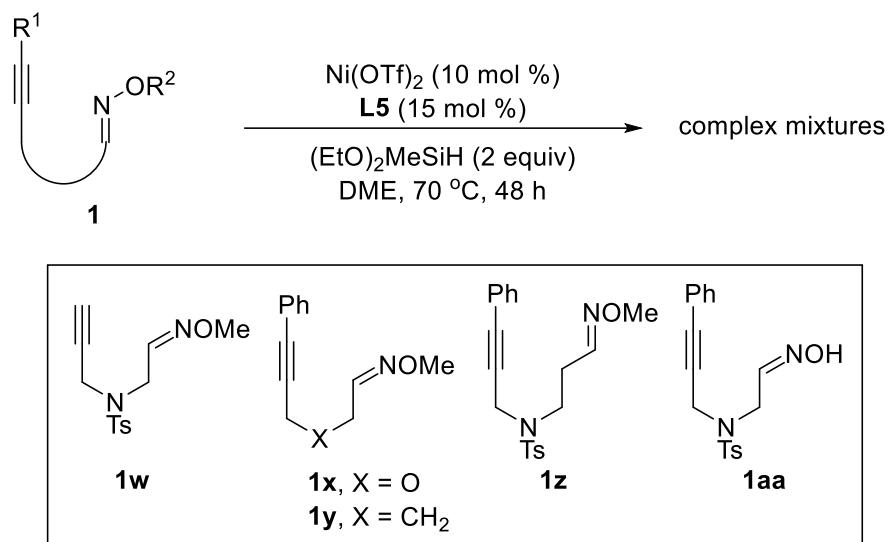
entry	[Si]-H	yield (%)	ee (%)
1	$(\text{EtO})_2\text{MeSiH}$	58	94
2	$(\text{EtO})_3\text{SiH}$	51	94
3	$(\text{MeO})_3\text{SiH}$	45	94
4	Et_3SiH	<1	-
5	PMMS	54	92

Table S5: Screening of reaction temperature

entry	T/°C	yield (%)	ee (%)
1	90	58	94
2	80	60	95
3	70	60	95
4	60	58	95

Scheme S1: The reactions of substrates 1w–1aa

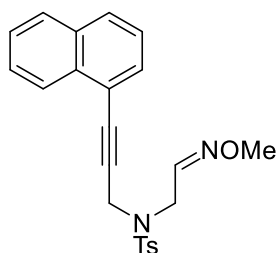
When substrates **1w–1aa** were employed under the optimal reaction conditions, the reaction failed to afford the desired products and only produced complex mixtures.



Scheme S1

3. Preparation of starting materials

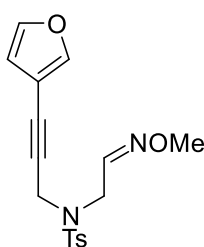
All substrates (**1a–1aa**) were prepared according to the known procedures.¹⁻² Among them, substrates **1a–1m**, **1o**, **1q**, **1r**, and **1x–1z** are known compounds.¹



1n

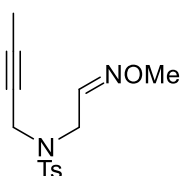
Substrate **1n** was prepared according to the known procedure¹⁻² (1.63 g, 80%) and purified by chromatography (petroleum ether/ethyl acetate = 10:1). White solid. *E/Z* = 1.5:1. ¹H NMR (400 MHz, CDCl₃) δ 7.96 – 7.88 (m, 1H), 7.85 – 7.75 (m, 4H), 7.55 – 7.34 (m, 4.71H), 7.22 – 7.11 (m, 2H), 6.88 (t, *J* = 4.4 Hz, 0.39H), 4.51 (s, 0.79H), 4.93 (s, 1.18H), 4.27 (d, *J* = 4.4 Hz, 0.79H), 4.10 (d, *J* = 6.0 Hz, 1.20H), 3.87 (s,

1.17H), 3.85 (s, 1.81H), 2.18 (s, 1.18H), 2.16 (s, 1.75H); ^{13}C NMR (100 MHz, CDCl_3) δ 147.2, 144.9, 144.0, 143.9, 135.6, 135.3, 132.9(8), 132.9(5), 130.7, 130.6, 129.7, 129.6, 129.0, 128.9, 128.2(0), 128.1(5), 127.7, 126.7(1), 126.6(7), 126.3(8), 126.3(5), 125.9, 125.8, 124.9(2), 124.9(0), 119.8, 119.6, 86.3, 86.1, 84.2, 62.2, 61.9, 45.9, 42.9, 39.3, 38.1, 21.3, 21.2; HRMS-ESI Calcd for $[\text{C}_{23}\text{H}_{23}\text{N}_2\text{O}_3\text{S}]^+$ ($\text{M} + \text{H}^+$) 407.1424, found 407.1426.



1p

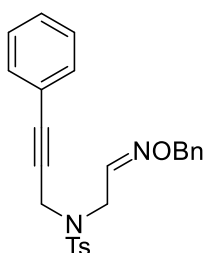
Substrate **1p** was prepared according to the known procedure¹⁻² (0.87 g, 50%) and purified by chromatography (petroleum ether/ethyl acetate = 8:1). Pale yellow oil. *E/Z* = 1.4:1. ^1H NMR (400 MHz, CDCl_3) δ 7.75 (d, $J = 8.0$ Hz, 2H), 7.38 – 7.23 (m, 4.73H), 6.78 (t, $J = 4.0$ Hz, 0.39H), 6.22 – 6.14 (m, 1H), 4.28 (s, 0.83H), 4.26 (s, 1.19H), 4.12 (d, $J = 4.0$ Hz, 1H), 3.96 (d, $J = 5.6$ Hz, 1H), 3.86 (s, 1.23H), 3.82 (s, 1.77H), 2.38 (s, 1.22H), 2.37 (s, 1.76H); ^{13}C NMR (100 MHz, CDCl_3) δ 147.4, 145.8(2), 145.8(0), 145.1, 143.8(4), 143.7(5), 142.7, 142.6, 135.7, 135.4, 129.6, 129.5, 127.7, 112.2(2), 112.1(6), 106.5, 106.4, 83.5, 83.3, 76.7, 62.1, 61.8, 45.8, 43.0, 39.2, 37.9, 21.4(4), 21.4(2); HRMS-ESI Calcd for $[\text{C}_{17}\text{H}_{19}\text{N}_2\text{O}_4\text{S}]^+$ ($\text{M} + \text{H}^+$) 347.1060, found 347.1060.



1s

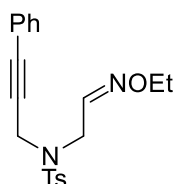
Substrate **1s** was prepared according to the known procedure¹⁻² (1.06 g, 72%) and purified by chromatography (petroleum ether/ethyl acetate = 12:1). White solid. *E/Z* =

1.5:1. ^1H NMR (400 MHz, CDCl_3) δ 7.68 – 7.56 (m, 2H), 7.28 – 7.16 (m, 2.71H), 6.66 (t, $J = 4.0$ Hz, 0.38H), 4.00 – 3.91 (m, 2.79H), 3.82 (d, $J = 5.6$ Hz, 1.17H), 3.77 (s, 1.20H), 3.71 (s, 1.78H), 2.32 (s, 3H), 1.48 (s, 1.20H), 1.46 (s, 1.74H); ^{13}C NMR (100 MHz, CDCl_3) δ 147.4, 144.9, 143.5, 143.4, 135.4, 135.1, 129.2, 129.1, 127.5(0), 127.4(5), 82.0, 81.9, 71.2, 71.1, 61.8, 61.4, 45.2, 42.7, 38.6, 37.2, 21.2, 3.0; HRMS-ESI Calcd for $[\text{C}_{14}\text{H}_{19}\text{N}_2\text{O}_3\text{S}]^+$ ($\text{M} + \text{H}^+$) 295.1111, found 295.1112.



1t

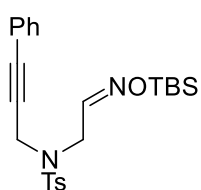
Substrate **1t** was prepared according to the known procedure¹⁻² (1.54 g, 71%) and purified by chromatography (petroleum ether/ethyl acetate = 10:1). White solid. *E/Z* = 1.3:1. ^1H NMR (400 MHz, CDCl_3) δ 7.79 (d, $J = 8.4$ Hz, 2H), 7.46 (t, $J = 6.0$ Hz, 0.59H), 7.38 – 7.23 (m, 10H), 7.17 – 7.10 (m, 2H), 6.89 (t, $J = 4.4$ Hz, 0.41H), 5.14 (s, 0.84H), 5.10 (s, 1.16H), 4.35 (s, 0.84H), 4.30 (s, 1.13H), 4.27 (d, $J = 4.4$ Hz, 0.86H), 4.05 (d, $J = 6.0$ Hz, 1.16H), 2.37 (s, 1.30H), 2.36 (s, 1.67H); ^{13}C NMR (100 MHz, CDCl_3) δ 147.9, 145.6, 143.9, 143.8, 137.3, 137.1, 135.6, 135.4, 131.5(0), 131.4(7), 129.7, 129.6, 128.5, 128.4(1), 128.3(6), 128.2, 128.1(1), 128.0(6), 127.9(9), 127.9(5), 127.9, 127.7, 122.0, 121.9, 86.0, 85.9, 81.6, 81.3, 76.4, 76.1, 45.9, 43.0, 39.1, 37.8, 21.4; HRMS-ESI Calcd for $[\text{C}_{25}\text{H}_{25}\text{N}_2\text{O}_3\text{S}]^+$ ($\text{M} + \text{H}^+$) 433.1580, found 433.1578.



1u

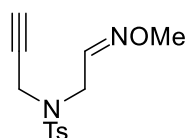
Substrate **1u** was prepared according to the known procedure¹⁻² (1.52 g, 82%) and purified by chromatography (petroleum ether/ethyl acetate = 10:1). Colorless oil. *E/Z*

= 1.5:1. ^1H NMR (400 MHz, CDCl_3) δ 7.80 (d, $J = 8.0$ Hz, 2H), 7.38 (t, $J = 6.0$ Hz, 0.6H), 7.33 – 7.22 (m, 5H), 7.17 – 7.09 (m, 2H), 6.83 (t, $J = 4.0$ Hz, 0.41H), 4.36 (s, 0.82H), 4.34 (s, 1.21H), 4.21 (d, $J = 4.0$ Hz, 0.82H), 4.17 – 1.05 (m, 2H), 4.03 (d, $J = 6.0$ Hz, 1.19H), 2.38 (s, 1.22H), 2.36 (s, 1.82H), 1.25 (t, $J = 6.8$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 147.0, 144.7, 143.9, 143.8, 135.6, 135.4, 131.5(2), 131.4(7), 129.7, 129.6, 128.5, 128.4, 128.1(2), 128.0(6), 127.8, 122.1, 121.9, 85.9, 81.5, 81.4, 70.0, 69.6, 46.0, 43.0, 39.1, 37.8, 21.4(4), 21.4(1), 14.5, 14.4; HRMS-ESI Calcd for $[\text{C}_{20}\text{H}_{23}\text{N}_2\text{O}_3]^+$ ($\text{M} + \text{H}^+$) 371.1424, found 371.1427.



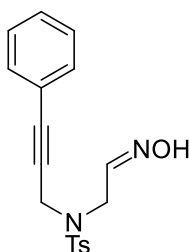
1v

Substrate **1v** was prepared according to the known procedure¹⁻² (1.32 g, 58%) and purified by chromatography (petroleum ether/ethyl acetate = 15:1). White solid. *E/Z* = 1.5:1. ^1H NMR (400 MHz, CDCl_3) δ 7.63 (d, $J = 8.4$ Hz, 2H), 7.36 (t, $J = 6.0$ Hz, 0.57H), 7.16 – 7.06 (m, 5H), 7.00 – 6.93 (m, 2H), 6.88 (t, $J = 4.0$ Hz, 1H), 4.19 (s, 0.78H), 4.16 (s, 1.14H), 4.11 (d, $J = 4.0$ Hz, 0.81H), 3.90 (d, $J = 5.6$ Hz, 1.19H), 2.20 (s, 1.26H), 2.19 (s, 1.67H), 0.77 (s, 5.39H), 0.75 (s, 3.56H), 0.007 (s, 2.54H), 0.000 (s, 3.44H); ^{13}C NMR (100 MHz, CDCl_3) δ 151.8, 149.7, 143.9, 143.8, 135.6, 135.5, 131.5(0), 131.4(6), 129.7, 129.6, 128.5, 128.4, 128.1, 128.0, 127.7(4), 127.6(8), 122.1, 85.9, 81.5, 81.4, 45.9, 42.8, 39.1, 37.7, 25.9(4), 25.8(6), 21.3(9), 21.3(7), 18.1, 18.0, -5.4, -5.4; HRMS-ESI Calcd for $[\text{C}_{24}\text{H}_{33}\text{N}_2\text{O}_3\text{SSi}]^+$ ($\text{M} + \text{H}^+$) 457.1976, found 457.1974.



1w

Substrate **1w** was prepared according to the known procedure¹⁻² (0.84 g, 60%) and purified by chromatography (petroleum ether/ethyl acetate = 10:1). Pale yellow oil. *E/Z* = 1.5:1. ¹H NMR (400 MHz, CDCl₃) δ 7.77 – 7.68 (m, 2H), 7.35 – 7.26 (m, 2.68H), 6.76 (t, *J* = 4.0 Hz, 0.39H), 4.15 – 4.08 (m, 2.89H), 3.95 (d, *J* = 6.0 Hz, 1.21H), 3.88 (s, 1.21H), 3.83 (s, 1.77H), 2.44 (s, 3H), 2.12 (t, *J* = 2.0 Hz, 0.38H), 2.09 (t, *J* = 2.0 Hz, 0.54H); ¹³C NMR (100 MHz, CDCl₃) δ 147.2, 144.8, 144.0, 143.9, 135.6, 135.2, 129.7, 129.6, 127.6(4), 127.6(3), 76.3, 76.2, 74.3, 74.1, 62.1, 61.8, 45.5, 42.8, 38.3, 36.8, 21.5; HRMS-ESI Calcd for [C₁₃H₁₇N₂O₃S]⁺ (M + H⁺) 281.0954, found 281.0954.

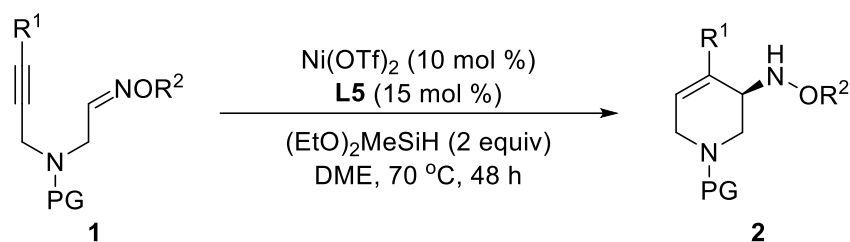


1aa

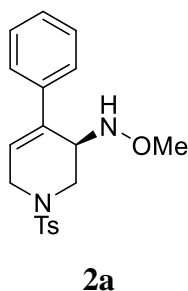
Substrate **1aa** was prepared according to the known procedure¹⁻² (1.42 g, 83%) and purified by chromatography (petroleum ether/ethyl acetate = 8:1). White solid. *E/Z* = 1.3:1. ¹H NMR (400 MHz, CDCl₃) δ 8.79 (s, 0.40H), 8.40 (s, 0.56H), 7.71 – 7.65 (m, 2H), 7.34 (t, *J* = 6.0 Hz, 1H), 7.21 – 7.10 (m, 5H), 7.07 – 6.97 (m, 2H), 6.83 (s, 0.41H), 4.25 (s, 0.85H), 4.22 (s, 1.12H), 4.14 (d, *J* = 4.0 Hz, 0.84H), 3.94 (d, *J* = 6.0 Hz, 1.12H), 2.26 (s, 1.30H), 2.24 (s, 1.69H); ¹³C NMR (100 MHz, CDCl₃) δ 148.7, 146.6, 144.0, 143.9, 135.5, 135.2, 131.5(0), 131.4(6), 129.7, 129.6, 128.5(2), 128.4(5), 128.1, 128.0, 127.7(3), 127.7(0), 121.9, 121.8, 86.1, 86.0, 81.3, 81.2, 45.7, 42.6, 39.3, 37.8, 21.3(8), 21.3(6); HRMS-ESI Calcd for [C₁₈H₁₉N₂O₃S]⁺ (M + H⁺) 343.1111, found 343.1112.

4. General Procedure and Data for Products

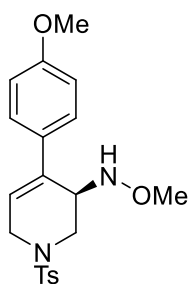
4.1 General procedure for the synthesis of chiral hydroxylamine ethers **2**:



Ni(OTf)₂ (0.02 mmol, 7.1 mg), **L5** (0.03 mmol, 10.0 mg) and DME (4 mL) were introduced into an oven-dried Schlenk tube under nitrogen atmosphere. The resultant solution was stirred at 25 °C under the N₂ atmosphere for 0.5 h. Then, alkyne-oxime ethers **1** (0.2 mmol) and (EtO)₂MeSiH (0.4 mmol, 64 uL) were introduced into the system. The resulting mixture was stirred at 70 °C (oil bath) for 48 h. Upon completion, the mixture was concentrated and the residue was purified by chromatography on silica gel (eluent: hexanes/ethyl acetate) to afford the desired products **2**.

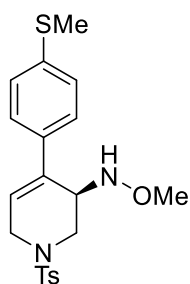


Compound **2a** was obtained in 62% yield (44.5 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 10:1). Pale yellow oil. $[\alpha]_D^{20} = -49.4^\circ$ ($c = 2.0$, CH₂Cl₂). 95% ee (determined by HPLC: Chiralpak OZH Column, 20/80 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 16.927 min (major), 23.226 min (minor)). ¹H NMR (400 MHz, CDCl₃) δ 7.57 (d, $J = 8.0$ Hz, 2H), 7.29 (d, $J = 7.2$ Hz, 2H), 7.20 – 7.09 (m, 5H), 5.91 (dd, $J = 4.4, 2.4$ Hz, 1H), 5.55 (s, 1H), 4.09 (dd, $J = 11.6, 1.2$ Hz, 1H), 3.98 (dd, $J = 17.6, 4.4$ Hz, 1H), 3.89 (s, 1H), 3.43 (s, 3H), 3.13 (d, $J = 17.2$ Hz, 1H), 2.36 (dd, $J = 11.6, 2.4$ Hz, 1H), 2.26 (s, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 143.8, 138.4, 133.7, 132.9, 129.7, 128.6, 127.9, 127.7, 125.6, 124.0, 62.0, 56.4, 45.4, 44.8, 21.5; HRMS-ESI Calcd for [C₁₉H₂₃N₂O₃S]⁺ (M + H⁺) 359.1424, found 359.1423.



2b

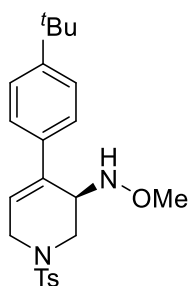
Compound **2b** was obtained in 53% yield (41.2 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 5:1). Colorless oil. $[\alpha]_D^{20} = -59.3^\circ$ ($c = 1.6$, CH_2Cl_2). 94% ee (determined by HPLC: Chiralpak OZH Column, 30/70 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 19.224 min (major), 25.247 min (minor)). ^1H NMR (400 MHz, CDCl_3) δ 7.74 (d, $J = 8.0$ Hz, 2H), 7.40 (d, $J = 8.8$ Hz, 2H), 7.35 (d, $J = 8.0$ Hz, 2H), 6.86 (d, $J = 8.8$ Hz, 2H), 5.99 (dd, $J = 4.4, 2.4$ Hz, 1H), 5.72 (s, 1H), 4.26 (dd, $J = 11.6, 1.2$ Hz, 1H), 4.14 (dd, $J = 17.2, 4.4$ Hz, 1H), 4.03 (s, 1H), 3.80 (s, 3H), 3.61 (s, 3H), 3.28 (d, $J = 17.2$ Hz, 1H), 2.51 (dd, $J = 11.6, 2.4$ Hz, 1H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 159.4, 143.7, 133.1, 133.0, 130.9, 129.7, 127.8, 126.7, 122.3, 114.0, 62.1, 56.5, 55.3, 45.4, 44.8, 21.5; HRMS-ESI Calcd for $[\text{C}_{20}\text{H}_{25}\text{N}_2\text{O}_4\text{S}]^+$ ($\text{M} + \text{H}^+$) 389.1530, found 389.1532.



2c

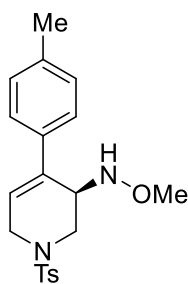
Compound **2c** was obtained in 69% yield (55.8 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 5:1). Pale yellow oil. $[\alpha]_D^{20} = -45.2^\circ$ ($c = 2.3$, CH_2Cl_2). 95% ee (determined by HPLC: Chiralpak OZH Column, 30/70 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 22.970

min (major), 28.836 min (minor)). ^1H NMR (400 MHz, CDCl_3) δ 7.73 (d, $J = 8.0$ Hz, 2H), 7.39 (d, $J = 8.4$ Hz, 2H), 7.34 (d, $J = 8.0$ Hz, 2H), 7.20 (d, $J = 8.4$ Hz, 2H), 6.06 (dd, $J = 4.4, 2.4$ Hz, 1H), 5.68 (s, 1H), 4.26 (dd, $J = 11.6, 1.2$ Hz, 1H), 4.14 (dd, $J = 17.6, 4.4$ Hz, 1H), 4.02 (s, 1H), 3.59 (s, 3H), 3.29 (d, $J = 17.2$ Hz, 1H), 2.50 (dd, $J = 11.6, 2.4$ Hz, 1H), 2.46 (s, 3H), 2.43 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 143.8, 138.3, 135.1, 133.1, 132.9, 129.7, 127.7, 126.5, 125.9, 123.4, 62.0, 56.3, 45.4, 44.7, 21.5, 15.6; HRMS-ESI Calcd for $[\text{C}_{20}\text{H}_{25}\text{N}_2\text{O}_3\text{S}_2]^+$ ($\text{M} + \text{H}^+$) 405.1301, found 405.1301.



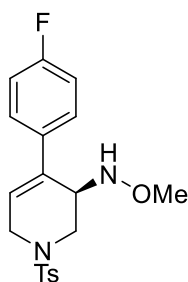
2d

Compound **2d** was obtained in 62% yield (51.4 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 10:1). Colorless oil. $[\alpha]_{\text{D}}^{20} = -51.9^\circ$ ($c = 2.0$, CH_2Cl_2). 92% ee (determined by HPLC: Chiralpak ASH Column, 5/95 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 23.222 min (major), 26.083 min (minor)). ^1H NMR (400 MHz, CDCl_3) δ 7.74 (d, $J = 8.0$ Hz, 2H), 7.42 (d, $J = 8.0$ Hz, 2H), 7.38 – 7.31 (m, 4H), 6.13 – 6.02 (m, 1H), 5.73 (s, 1H), 4.28 (d, $J = 11.6$ Hz, 1H), 4.16 (dd, $J = 17.2, 4.4$ Hz, 1H), 4.07 (s, 1H), 3.62 (s, 3H), 3.30 (d, $J = 17.2$ Hz, 1H), 2.51 (dd, $J = 11.6, 1.6$ Hz, 1H), 2.44 (s, 3H), 1.31 (s, 9H); ^{13}C NMR (100 MHz, CDCl_3) δ 150.9, 143.7, 135.3, 133.3, 133.0, 129.7, 127.8, 125.5, 125.2, 123.2, 62.0, 56.4, 45.5, 44.8, 34.5, 31.2, 21.5; HRMS-ESI Calcd for $[\text{C}_{23}\text{H}_{31}\text{N}_2\text{O}_3\text{S}]^+$ ($\text{M} + \text{H}^+$) 415.2050, found 415.2049.



2e

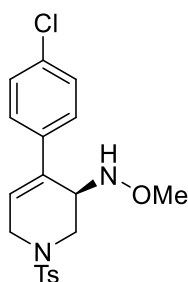
Compound **2e** was obtained in 60% yield (44.7 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 10:1). Pale yellow solid. $[\alpha]_D^{20} = -57.8^\circ$ ($c = 1.8$, CH_2Cl_2). 95% ee (determined by HPLC: Chiralpak OZH Column, 30/70 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 12.151 min (major), 14.457 min (minor)). ^1H NMR (400 MHz, CDCl_3) δ 7.74 (d, $J = 8.0$ Hz, 2H), 7.40 – 7.30 (m, 4H), 7.14 (d, $J = 8.0$ Hz, 2H), 6.05 (dd, $J = 4.0, 2.4$ Hz, 1H), 5.72 (s, 1H), 4.26 (dd, $J = 11.6, 1.2$ Hz, 1H), 4.14 (dd, $J = 17.2, 4.0$ Hz, 1H), 4.05 (s, 1H), 3.60 (s, 3H), 3.30 (d, $J = 17.2$ Hz, 1H), 2.53 (dd, $J = 11.6, 2.4$ Hz, 1H), 2.44 (s, 3H), 2.33 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 143.7, 137.7, 135.5, 133.5, 132.9, 129.7, 129.3, 127.8, 125.4, 123.2, 62.0, 56.4, 45.4, 44.9, 21.5, 21.0; HRMS-ESI Calcd for $[\text{C}_{20}\text{H}_{25}\text{N}_2\text{O}_3\text{S}]^+$ ($\text{M} + \text{H}^+$) 373.1580, found 373.1578.



2f

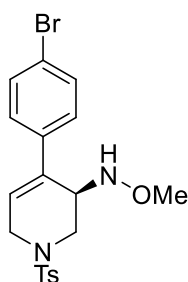
Compound **2f** was obtained in 61% yield (45.9 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 10:1). Pale yellow oil. $[\alpha]_D^{20} = -31.9^\circ$ ($c = 1.9$, CH_2Cl_2). 89% ee (determined by HPLC: Chiralpak OZH Column, 20/80 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 18.339 min (major), 25.085 min (minor)). ^1H NMR (400 MHz, CDCl_3) δ 7.73 (d, $J = 8.0$ Hz, 2H), 7.45 (dd, $J = 8.8, 5.2$ Hz, 2H), 7.34 (d, $J = 8.0$ Hz, 2H), 7.00 (t, $J = 8.8$ Hz, 2H),

6.02 (dd, $J = 4.4, 2.4$ Hz, 1H), 5.72 (s, 1H), 4.27 (dd, $J = 11.6, 1.6$ Hz, 1H), 4.14 (dd, $J = 17.2, 4.4$ Hz, 1H), 3.99 (s, 1H), 3.58 (s, 3H), 3.28 (d, $J = 17.2$ Hz, 1H), 2.50 (dd, $J = 12.0, 2.4$ Hz, 1H), 2.43 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) 162.4 (d, $J = 246.0$ Hz), 143.8, 134.7 (d, $J = 4.0$ Hz), 132.9, 132.8, 129.7, 127.7, 127.1 (d, $J = 8.0$ Hz), 123.9, 115.4 (d, $J = 21.0$ Hz), 61.9, 56.6, 45.4, 44.7, 21.5; HRMS-ESI Calcd for $[\text{C}_{19}\text{H}_{22}\text{FN}_2\text{O}_3\text{S}]^+$ ($\text{M} + \text{H}^+$) 377.1330, found 377.1331.



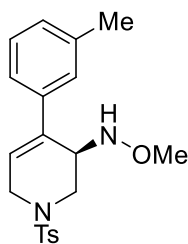
2g

Compound **2g** was obtained in 55% yield (43.2 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 10:1). White solid. $[\alpha]_{\text{D}}^{20} = -46.9^\circ$ ($c = 1.7, \text{CH}_2\text{Cl}_2$). 88% ee (determined by HPLC: Chiralpak OZH Column, 20/80 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 22.088 min (major), 27.826 min (minor)). ^1H NMR (400 MHz, CDCl_3) δ 7.73 (d, $J = 8.0$ Hz, 2H), 7.41 (d, $J = 8.8$ Hz, 2H), 7.35 (d, $J = 8.0$ Hz, 2H), 7.29 (d, $J = 8.8$ Hz, 2H), 6.07 (dd, $J = 4.4, 2.4$ Hz, 1H), 5.71 (s, 1H), 4.27 (dd, $J = 12.0, 1.2$ Hz, 1H), 4.15 (dd, $J = 17.2, 4.4$ Hz, 1H), 3.99 (s, 1H), 3.58 (s, 3H), 3.28 (d, $J = 17.6$ Hz, 1H), 2.50 (dd, $J = 12.0, 2.4$ Hz, 1H), 2.43 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 143.9, 137.1, 133.6, 132.9, 132.8, 129.7, 128.7, 127.7, 126.9, 124.5, 61.9, 56.4, 45.4, 44.7, 21.5; HRMS-ESI Calcd for $[\text{C}_{19}\text{H}_{22}\text{ClN}_2\text{O}_3\text{S}]^+$ ($\text{M} + \text{H}^+$) 393.1034, found 393.1034.



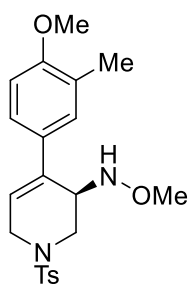
2h

Compound **2h** was obtained in 66% yield (57.7 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 10:1). White solid. $[\alpha]_D^{20} = -49.5^\circ$ ($c = 2.4$, CH_2Cl_2). 92% ee (determined by HPLC: Chiralpak OZH Column, 20/80 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 24.526 min (major), 29.867 min (minor)). ^1H NMR (400 MHz, CDCl_3) δ 7.72 (d, $J = 8.0$ Hz, 2H), 7.44 (d, $J = 8.4$ Hz, 2H), 7.38 – 7.30 (m, 4H), 6.08 (dd, $J = 4.4, 2.4$ Hz, 1H), 5.70 (s, 1H), 4.27 (dd, $J = 11.6, 1.2$ Hz, 1H), 4.14 (dd, $J = 17.6, 4.4$ Hz, 1H), 3.98 (s, 1H), 3.58 (s, 3H), 3.27 (d, $J = 17.6$ Hz, 1H), 2.49 (dd, $J = 11.6, 2.4$ Hz, 1H), 2.43 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 143.9, 137.5, 132.9, 132.8, 131.6, 129.7, 127.7, 127.3, 124.6, 121.8, 61.9, 56.3, 45.4, 44.6, 21.5; HRMS-ESI Calcd for $[\text{C}_{19}\text{H}_{22}\text{BrN}_2\text{O}_3\text{S}]^+$ ($\text{M} + \text{H}^+$) 437.0529, found 437.0530.



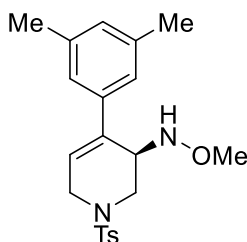
2i

Compound **2i** was obtained in 61% yield (45.4 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 10:1). Colorless oil. $[\alpha]_D^{20} = -56.7^\circ$ ($c = 1.9$, CH_2Cl_2). 94% ee (determined by HPLC: Chiralpak OZH Column, 25/75 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 12.105 min (major), 16.925 min (minor)). ^1H NMR (400 MHz, CDCl_3) δ 7.74 (d, $J = 8.4$ Hz, 2H), 7.35 (d, $J = 8.0$ Hz, 2H), 7.27 – 7.19 (m, 3H), 7.09 (d, $J = 6.8$ Hz, 1H), 6.06 (dd, $J = 4.0, 2.4$ Hz, 1H), 5.72 (s, 1H), 4.25 (dd, $J = 11.6, 2.4$ Hz, 1H), 4.14 (dd, $J = 17.2, 4.0$ Hz, 1H), 4.06 (s, 1H), 3.60 (s, 3H), 3.30 (d, $J = 17.2$ Hz, 1H), 2.53 (dd, $J = 11.6, 2.4$ Hz, 1H), 2.43 (s, 3H), 2.33 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 143.7, 138.4, 138.2, 133.8, 132.9, 129.7, 128.6, 128.5, 127.7, 126.4, 123.8, 122.6, 62.0, 56.4, 45.4, 44.8, 21.4(7), 21.4(5); HRMS-ESI Calcd for $[\text{C}_{20}\text{H}_{25}\text{N}_2\text{O}_3\text{S}]^+$ ($\text{M} + \text{H}^+$) 373.1580, found 373.1582.



2j

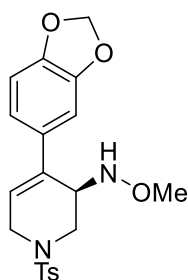
Compound **2j** was obtained in 60% yield (48.3 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 5:1). Pale yellow oil. $[\alpha]_D^{20} = -52.3^\circ$ ($c = 2.0$, CH_2Cl_2). 88% ee (determined by HPLC: Chiralpak OZH Column, 35/65 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 12.677 min (major), 15.840 min (minor)). ^1H NMR (400 MHz, CDCl_3) δ 7.58 (d, $J = 8.0$ Hz, 2H), 7.18 (d, $J = 8.0$ Hz, 2H), 7.14 – 7.04 (m, 2H), 6.62 (d, $J = 8.4$ Hz, 1H), 5.82 (dd, $J = 4.0, 2.4$ Hz, 1H), 5.56 (s, 1H), 4.09 (d, $J = 12.0$ Hz, 1H), 3.97 (dd, $J = 17.2, 4.4$ Hz, 1H), 3.88 (s, 1H), 3.65 (s, 3H), 3.45 (s, 3H), 3.12 (d, $J = 17.2$ Hz, 1H), 2.35 (dd, $J = 12.0, 2.0$ Hz, 1H), 2.27 (s, 3H), 2.03 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 157.6, 143.7, 133.1, 132.9, 130.3, 129.7, 127.9, 127.8, 126.7, 124.0, 122.1, 109.8, 62.1, 56.5, 55.3, 45.4, 44.9, 21.5, 16.3; HRMS-ESI Calcd for $[\text{C}_{21}\text{H}_{27}\text{N}_2\text{O}_4\text{S}]^+$ ($\text{M} + \text{H}^+$) 403.1686, found 403.1685.



2k

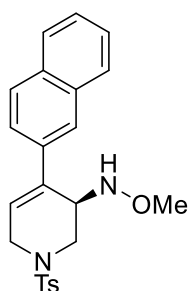
Compound **2k** was obtained in 62% yield (47.9 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 10:1). Pale yellow oil. $[\alpha]_D^{20} = -43.7^\circ$ ($c = 2.0$, CH_2Cl_2). 93% ee (determined by HPLC: Chiralpak OZH Column, 20/80 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 12.380 min (major), 17.236 min (minor)). ^1H NMR (400 MHz, CDCl_3) δ 7.75 (d, $J = 8.0$ Hz,

2H), 7.35 (d, $J = 8.0$ Hz, 2H), 7.06 (s, 2H), 6.93 (s, 1H), 6.05 (dd, $J = 4.4, 2.4$ Hz, 1H), 5.70 (s, 1H), 4.24 (dd, $J = 11.6, 2.4$ Hz, 1H), 4.13 (dd, $J = 17.2, 4.4$ Hz, 1H), 4.06 (s, 1H), 3.61 (s, 3H), 3.30 (d, $J = 17.2$ Hz, 1H), 2.55 (dd, $J = 11.6, 2.4$ Hz, 1H), 2.44 (s, 3H), 2.30 (s, 6H); ^{13}C NMR (100 MHz, CDCl_3) δ 143.7, 138.3, 138.1, 133.9, 133.0, 129.7, 129.6, 127.8, 123.7, 123.5, 62.1, 56.5, 45.4, 44.9, 21.5, 21.3; HRMS-ESI Calcd for $[\text{C}_{21}\text{H}_{27}\text{N}_2\text{O}_3\text{S}]^+$ ($\text{M} + \text{H}^+$) 387.1737, found 387.1739.



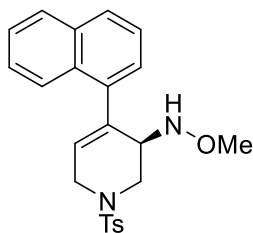
2l

Compound **2l** was obtained in 61% yield (49.1 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 5:1). White solid. $[\alpha]_{\text{D}}^{20} = -53.2^\circ$ ($c = 2.0, \text{CH}_2\text{Cl}_2$). 94% ee (determined by HPLC: Chiralpak OZH Column, 30/70 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 32.564 min (major), 46.478 min (minor)). ^1H NMR (400 MHz, CDCl_3) δ 7.73 (d, $J = 8.0$ Hz, 2H), 7.34 (d, $J = 8.0$ Hz, 2H), 7.01 – 6.91 (m, 2H), 6.76 (d, $J = 8.0$ Hz, 1H), 5.99 – 5.90 (m, 3H), 5.72 (s, 1H), 4.24 (d, $J = 11.6$ Hz, 1H), 4.12 (dd, $J = 17.2, 4.0$ Hz, 1H), 3.96 (s, 1H), 3.60 (s, 3H), 3.26 (d, $J = 17.2$ Hz, 1H), 2.49 (dd, $J = 11.6, 2.0$ Hz, 1H), 2.43 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 147.9, 147.3, 143.8, 133.3, 132.9, 129.7, 127.7, 123.0, 119.2, 108.3, 106.2, 101.1, 62.0, 56.7, 45.4, 44.7, 21.5; HRMS-ESI Calcd for $[\text{C}_{20}\text{H}_{23}\text{N}_2\text{O}_5\text{S}]^+$ ($\text{M} + \text{H}^+$) 403.1322, found 403.1321.



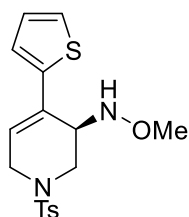
2m

Compound **2m** was obtained in 65% yield (53.1 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 10:1). White solid. $[\alpha]_D^{20} = -44.8^\circ$ ($c = 2.2$, CH_2Cl_2). 94% ee (determined by HPLC: Chiralpak OZH Column, 20/80 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 26.268 min (major), 31.998 min (minor)). ^1H NMR (400 MHz, CDCl_3) δ 7.95 (s, 1H), 7.83 – 7.73 (m, 5H), 7.57 (dd, $J = 8.4, 1.6$ Hz, 1H), 7.51 – 7.43 (m, 2H), 7.36 (d, $J = 8.0$ Hz, 2H), 6.22 (dd, $J = 4.0, 2.4$ Hz, 1H), 5.80 (s, 1H), 4.32 (d, $J = 12.0$ Hz, 1H), 4.26 – 4.16 (m, 2H), 3.64 (s, 3H), 3.36 (d, $J = 17.6$ Hz, 1H), 2.59 (dd, $J = 12.0, 2.1$ Hz, 1H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 143.8, 135.7, 133.6, 133.3, 132.9, 132.9, 129.7, 128.2(1), 128.1(7), 127.8, 127.5, 126.3, 126.1, 124.5, 123.7, 62.1, 56.5, 45.5, 44.9, 21.5; HRMS-ESI Calcd for $[\text{C}_{23}\text{H}_{25}\text{N}_2\text{O}_3\text{S}]^+$ ($\text{M} + \text{H}^+$) 409.1580, found 409.1580.



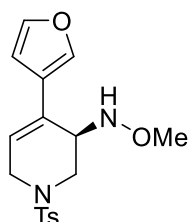
2n

Compound **2n** was obtained in 48% yield (39.2 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 10:1). White solid. $[\alpha]_D^{20} = -38.7^\circ$ ($c = 1.5$, CH_2Cl_2). 90% ee (determined by HPLC: Chiralpak OZH Column, 20/80 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 12.803 min (major), 16.874 min (minor)). ^1H NMR (400 MHz, CDCl_3) δ 7.90 – 7.72 (m, 5H), 7.50 – 7.36 (m, 5H), 7.30 (d, $J = 7.2$ Hz, 1H), 5.87 (t, $J = 3.2$ Hz, 1H), 5.63 (s, 1H), 4.20 – 4.06 (m, 2H), 3.97 (s, 1H), 3.49 (d, $J = 16.8$ Hz, 1H), 3.44 (s, 3H), 2.97 (dd, $J = 11.6, 2.8$ Hz, 1H), 2.48 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 143.8, 137.3, 134.3, 133.7, 133.1, 131.4, 129.8, 128.4, 128.1, 127.8, 127.5, 126.1, 126.0, 125.8, 125.2, 125.1, 62.2, 58.9, 45.4, 45.2, 21.5; HRMS-ESI Calcd for $[\text{C}_{23}\text{H}_{25}\text{N}_2\text{O}_3\text{S}]^+$ ($\text{M} + \text{H}^+$) 409.1580, found 409.1579.



2o

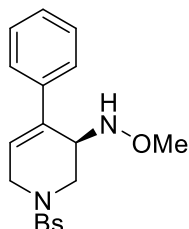
Compound **2o** was obtained in 51% yield (37.2 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 8:1). Yellow solid. $[\alpha]_D^{20} = -48.3^\circ$ ($c = 1.5$, CH_2Cl_2). 96% ee (determined by HPLC: Chiralpak OZH Column, 25/75 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 15.348 min (major), 19.304 min (minor)). $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.72 (d, $J = 8.0$ Hz, 2H), 7.34 (d, $J = 8.0$ Hz, 2H), 7.21 – 7.12 (m, 2H), 6.97 (dd, $J = 4.8, 3.6$ Hz, 1H), 6.11 (dd, $J = 4.4, 2.4$ Hz, 1H), 5.82 (s, 1H), 4.30 (d, $J = 11.6$ Hz, 1H), 4.16 (dd, $J = 17.6, 4.4$ Hz, 1H), 3.99 (s, 1H), 3.65 (s, 3H), 3.25 (d, $J = 17.6$ Hz, 1H), 2.48 – 2.40 (m, 4H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 143.9, 142.6, 132.9, 129.7, 128.2, 127.7, 127.4, 124.5, 123.4, 122.4, 62.0, 57.2, 45.1, 44.4, 21.5; HRMS-ESI Calcd for $[\text{C}_{17}\text{H}_{21}\text{N}_2\text{O}_3\text{S}_2]^+$ ($\text{M} + \text{H}^+$) 365.0988, found 365.0990.



2p

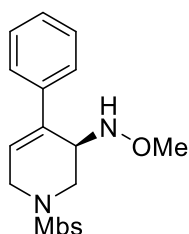
Compound **2p** was obtained in 51% yield (35.5 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 8:1). Yellow solid. $[\alpha]_D^{20} = -48.9^\circ$ ($c = 1.7$, CH_2Cl_2). 94% ee (determined by HPLC: Chiralpak OZH Column, 20/80 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 19.653 min (major), 22.737 min (minor)). $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.71 (d, $J = 8.0$ Hz, 2H), 7.63 (s, 1H), 7.37 – 7.30 (m, 3H), 6.45 (d, $J = 0.8$ Hz, 1H), 5.94 (dd, $J = 4.4, 2.4$ Hz, 1H), 5.78 (s, 1H), 4.26 (d, $J = 11.6$ Hz, 1H), 4.13 (dd, $J = 17.2, 4.4$ Hz, 1H), 3.82

(s, 1H), 3.62 (s, 3H), 3.22 (d, $J = 17.2$ Hz, 1H), 2.46 – 2.37 (m, 4H); ^{13}C NMR (100 MHz, CDCl_3) δ 143.8, 143.3, 139.0, 132.9, 129.7, 127.7, 125.9, 124.7, 121.7, 107.5, 61.9, 56.7, 45.1, 44.3, 21.5; HRMS-ESI Calcd for $[\text{C}_{17}\text{H}_{21}\text{N}_2\text{O}_4\text{S}]^+$ ($\text{M} + \text{H}^+$) 349.1217, found 349.1218.



2q

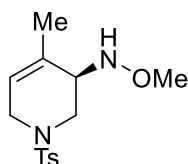
Compound **2q** was obtained in 70% yield (59.3 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 10:1). Yellow solid. $[\alpha]_{\text{D}}^{20} = -47.0^\circ$ ($c = 2.0$, CH_2Cl_2). 95% ee (determined by HPLC: Chiralpak OZH Column, 20/80 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 13.544 min (major), 17.459 min (minor)). ^1H NMR (400 MHz, CDCl_3) δ 7.61 – 7.50 (m, 4H), 7.33 – 7.28 (m, 2H), 7.21 – 7.09 (m, 3H), 5.92 (dd, $J = 4.4, 2.4$ Hz, 1H), 5.52 (s, 1H), 4.11 (dd, $J = 12.0, 2.4$ Hz, 1H), 4.00 (dd, $J = 17.2, 4.4$ Hz, 1H), 3.91 (s, 1H), 3.43 (s, 3H), 3.18 (dt, $J = 17.6, 2.0$ Hz, 1H), 2.42 (dd, $J = 12.0, 2.4$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 138.3, 135.1, 133.9, 132.4, 129.2, 128.6, 128.0(0), 127.9(7), 125.6, 123.7, 62.0, 56.4, 45.3, 44.7; HRMS-ESI Calcd for $[\text{C}_{18}\text{H}_{20}\text{BrN}_2\text{O}_3\text{S}]^+$ ($\text{M} + \text{H}^+$) 423.0373, found 423.0374.



2r

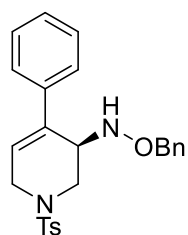
Compound **2r** was obtained in 63% yield (47.2 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 8:1). Colorless oil. $[\alpha]_{\text{D}}^{20} = -53.6^\circ$ ($c = 2.0$, CH_2Cl_2). 95% ee (determined by HPLC:

Chiralpak OZH Column, 30/70 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 16.982 min (major), 22.383 min (minor)). ¹H NMR (400 MHz, CDCl₃) δ 7.63 (d, *J* = 8.8 Hz, 2H), 7.31 (d, *J* = 7.2 Hz, 2H), 7.20 – 7.07 (m, 3H), 6.85 (d, *J* = 8.8 Hz, 2H), 5.93 (dd, *J* = 4.4, 2.4 Hz, 1H), 5.57 (s, 1H), 4.09 (dd, *J* = 12.0, 1.6 Hz, 1H), 3.98 (dd, *J* = 17.2, 4.4 Hz, 1H), 3.91 (s, 1H), 3.71 (s, 3H), 3.43 (s, 3H), 3.14 (d, *J* = 17.2 Hz, 1H), 2.37 (dd, *J* = 12.0, 2.4 Hz, 1H); ¹³C NMR (100 MHz, CDCl₃) δ 163.1, 138.4, 133.7, 129.8, 128.6, 127.9, 127.5, 125.6, 124.0, 114.2, 62.0, 56.4, 55.6, 45.4, 44.8; HRMS-ESI Calcd for [C₁₉H₂₃N₂O₄S]⁺ (M + H⁺) 375.1373, found 375.1375.



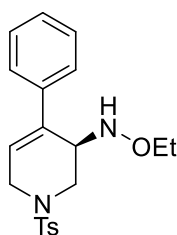
2s

Compound **2s** was obtained in 42% yield (24.9 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 10:1). Colorless oil. [α]_D²⁰ = -39.1° (c = 1.0, CH₂Cl₂). 71% ee (determined by HPLC: Chiralpak OZH Column, 20/80 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 10.898 min (major), 13.568 min (minor)). ¹H NMR (400 MHz, CDCl₃) δ 7.68 (d, *J* = 8.0 Hz, 2H), 7.31 (d, *J* = 8.0 Hz, 2H), 5.48 (s, 1H), 4.00 (dd, *J* = 12.0, 2.0 Hz, 1H), 3.85 (d, *J* = 16.0 Hz, 1H), 3.55 (s, 3H), 3.35 (s, 1H), 3.08 (dd, *J* = 16.0, 2.0 Hz, 1H), 2.48 – 2.38 (m, 4H), 1.77 (d, *J* = 1.6 Hz, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 143.6, 133.0, 131.1, 129.6, 127.7, 121.6, 61.6, 58.5, 44.9, 44.7, 21.5, 21.0; HRMS-ESI Calcd for [C₁₄H₂₁N₂O₃S]⁺ (M + H⁺) 297.1267, found 297.1269.



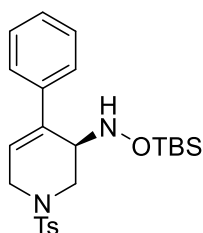
2t

Compound **2t** was obtained in 64% yield (55.6 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 10:1). White solid. $[\alpha]_D^{20} = -58.7^\circ$ ($c = 2.0$, CH_2Cl_2). 92% ee (determined by HPLC: Chiralpak OZH Column, 20/80 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 15.311 min (major), 17.454 min (minor)). ^1H NMR (400 MHz, CDCl_3) δ 7.59 (d, $J = 8.4$ Hz, 2H), 7.23 – 7.06 (m, 12H), 5.89 (dd, $J = 4.4, 2.4$ Hz, 1H), 5.59 (s, 1H), 4.66 (d, $J = 12.0$ Hz, 1H), 4.55 (d, $J = 12.0$ Hz, 1H), 4.21 (dd, $J = 11.6, 1.6$ Hz, 1H), 3.98 (dd, $J = 17.6, 4.4$ Hz, 1H), 3.82 (s, 1H), 3.13 (d, $J = 17.6$ Hz, 1H), 2.35 (dd, $J = 12.0, 2.4$ Hz, 1H), 2.27 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 143.8, 138.2(3), 138.2(1), 133.7, 132.9, 129.7, 128.6, 128.4, 128.3, 127.8, 127.7, 125.5, 123.7, 76.2, 56.9, 45.4, 44.7, 21.5; HRMS-ESI Calcd for $[\text{C}_{25}\text{H}_{27}\text{N}_2\text{O}_3\text{S}]^+$ ($\text{M} + \text{H}^+$) 435.1737, found 435.1736.



2u

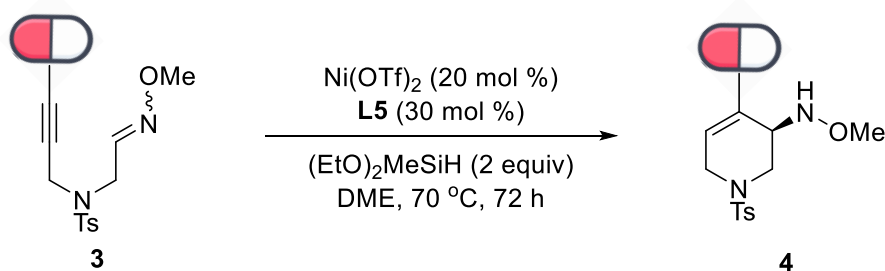
Compound **2u** was obtained in 51% yield (38.0 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 10:1). Colorless oil. $[\alpha]_D^{20} = -85.2^\circ$ ($c = 0.8$, CH_2Cl_2). 94% ee (determined by HPLC: Chiralpak OZH Column, 20/80 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 14.371 min (major), 18.042 min (minor)). ^1H NMR (400 MHz, CDCl_3) δ 7.75 (d, $J = 8.0$ Hz, 2H), 7.45 (d, $J = 7.2$ Hz, 2H), 7.36 – 7.28 (m, 5H), 6.09 (dd, $J = 4.0, 2.4$ Hz, 1H), 4.29 (dd, $J = 11.6, 2.4$ Hz, 1H), 4.16 (dd, $J = 17.6, 4.4$ Hz, 1H), 4.09 (s, 1H), 3.82 (q, $J = 6.8$ Hz, 2H), 3.32 (d, $J = 17.4$ Hz, 1H), 2.58 (dd, $J = 11.6, 1.6$ Hz, 1H), 2.44 (s, 3H), 1.16 (t, $J = 6.8$ Hz, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 143.8, 138.5, 133.7, 132.8, 129.7, 128.6, 127.9, 127.8, 125.7, 124.3, 69.6, 56.7, 45.5, 44.8, 21.5, 14.2; HRMS-ESI Calcd for $[\text{C}_{20}\text{H}_{25}\text{N}_2\text{O}_3\text{S}]^+$ ($\text{M} + \text{H}^+$) 373.1580, found 373.1580.



2v

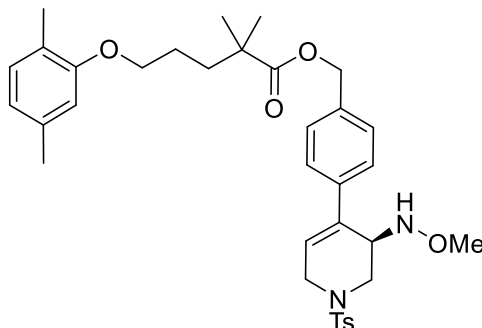
Compound **2v** was obtained in 25% yield (22.9 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 10:1). Colorless oil. $[\alpha]_D^{20} = -36.4^\circ$ ($c = 2.0$, CH_2Cl_2). 44% ee (determined by HPLC: Chiralpak OZH Column, 10/90 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 8.816 min (minor), 10.167 min (major)). ^1H NMR (400 MHz, CDCl_3) δ 7.76 (d, $J = 8.0$ Hz, 2H), 7.48 – 7.41 (m, 2H), 7.37 – 7.27 (m, 5H), 6.03 (dd, $J = 4.4, 2.4$ Hz, 1H), 5.16 (s, 1H), 4.47 (d, $J = 11.2$ Hz, 1H), 4.13 (dd, $J = 17.6, 4.0$ Hz, 1H), 3.82 (s, 1H), 3.36 (dt, $J = 17.2, 2.0$ Hz, 1H), 2.53 (dd, $J = 11.6, 1.6$ Hz, 1H), 2.44 (s, 3H), 0.88 (s, 9H), 0.06 (s, 3H), 0.05 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 143.7, 139.3, 134.8, 133.4, 129.7, 128.3, 127.8, 127.6, 126.1, 124.0, 59.1, 45.3, 43.7, 26.2, 21.5, 17.9, -5.3, -5.4; HRMS-ESI Calcd for $[\text{C}_{24}\text{H}_{35}\text{N}_2\text{O}_3\text{SSi}]^+$ ($\text{M} + \text{H}^+$) 459.2132, found 459.2133.

4.2 General procedure for the synthesis of chiral hydroxylamine ethers **4**:



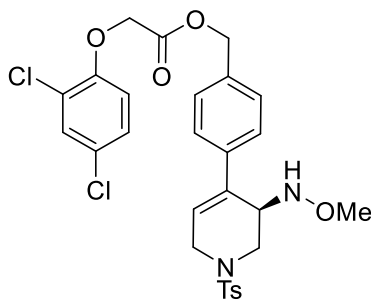
$\text{Ni}(\text{OTf})_2$ (0.02 mmol, 7.1 mg), **L5** (0.03 mmol, 10.0 mg) and DME (4 mL) were introduced into an oven-dried Schlenk tube under nitrogen atmosphere. The resultant solution was stirred at 25 °C under the N_2 atmosphere for 0.5 h. Then, alkyne-oxime ethers **3** (0.2 mmol) and $(\text{EtO})_2\text{MeSiH}$ (0.4 mmol, 64 μL) were introduced into the system. The resulting mixture was stirred at 70 °C (oil bath) for 72 h. Upon completion, the mixture was concentrated and the residue was purified

bychromatography on silica gel (eluent: hexanes/ethyl acetate) to afford the desired products **4**.



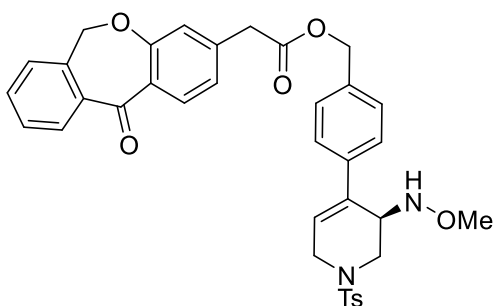
4a

Compound **4a** was obtained in 51% yield (63.3 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 5:1). Pale yellow oil. $[\alpha]_D^{20} = -33.5^\circ$ ($c = 2.5$, CH_2Cl_2). 95% ee (determined by HPLC: Chiralpak ASH Column, 10/90 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 31.104 min (minor), 38.144 min (major)). ^1H NMR (400 MHz, CDCl_3) δ 7.74 (d, $J = 8.4$ Hz, 2H), 7.45 (d, $J = 8.4$ Hz, 2H), 7.36 (d, $J = 8.4$ Hz, 2H), 7.30 (d, $J = 8.4$ Hz, 2H), 6.98 (d, $J = 7.2$ Hz, 1H), 6.64 (d, $J = 7.2$ Hz, 1H), 6.57 (s, 1H), 6.07 (dd, $J = 4.4, 2.4$ Hz, 1H), 5.72 (s, 1H), 5.09 (s, 2H), 4.27 (dd, $J = 11.6, 1.6$ Hz, 1H), 4.15 (dd, $J = 17.2, 4.4$ Hz, 1H), 4.03 (s, 1H), 3.89 – 3.83 (m, 2H), 3.59 (s, 3H), 3.28 (d, $J = 17.6$ Hz, 1H), 2.49 (dd, $J = 11.6, 2.4$ Hz, 1H), 2.44 (s, 3H), 2.29 (s, 3H), 2.13 (s, 3H), 1.76 – 1.65 (m, 4H) 1.24 (s, 6H); ^{13}C NMR (100 MHz, CDCl_3) δ 177.6, 156.9, 143.8, 138.2, 136.4, 136.0, 133.3, 132.9, 130.2, 129.7, 128.1, 127.8, 125.7, 124.3, 123.5, 120.6, 111.8, 67.8, 65.7, 62.0, 56.4, 45.5, 44.8, 42.1, 37.0, 25.1, 21.5, 21.4, 15.7; HRMS-ESI Calcd for $[\text{C}_{35}\text{H}_{45}\text{N}_2\text{O}_6\text{S}]^+$ ($\text{M} + \text{H}^+$) 621.2993, found 621.2996.



4b

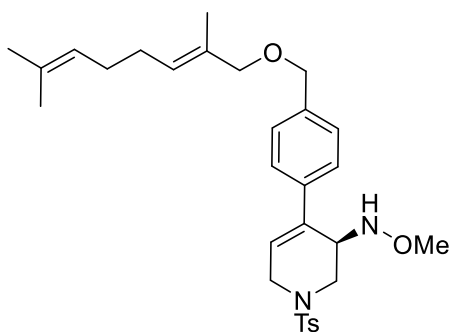
Compound **4b** was obtained in 52% yield (61.5 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 2:1). White solid. $[\alpha]_{\text{D}}^{20} = -36.4^{\circ}$ ($c = 2.5$, CH_2Cl_2). 95% ee (determined by HPLC: Chiralpak OZH Column, 50/50 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 30.631 min (major), 44.955 min (minor)). ^1H NMR (400 MHz, CDCl_3) δ 7.74 (d, $J = 8.4$ Hz, 2H), 7.47 (d, $J = 8.4$ Hz, 2H), 7.38 – 7.33 (m, 3H), 7.29 (d, $J = 8.0$ Hz, 2H), 7.10 (dd, $J = 8.8, 2.4$ Hz, 1H), 6.72 (d, $J = 8.8$ Hz, 1H), 6.11 (dd, $J = 4.4, 2.4$ Hz, 1H), 5.72 (s, 1H), 5.20 (s, 2H), 4.70 (s, 2H), 4.28 (dd, $J = 12.0, 1.6$ Hz, 1H), 4.16 (dd, $J = 17.6, 4.4$ Hz, 1H), 4.04 (s, 1H), 3.59 (s, 3H), 3.30 (d, $J = 17.6$ Hz, 1H), 2.52 (dd, $J = 12.0, 2.4$ Hz, 1H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, CDCl_3) δ 167.9, 152.3, 143.8, 138.9, 134.5, 133.3, 132.9, 130.3, 129.7, 128.7, 127.7, 127.5, 127.1, 125.8, 124.6, 124.2, 114.7, 66.7, 66.3, 62.0, 56.4, 45.4, 44.7, 21.5; HRMS-ESI Calcd for $[\text{C}_{28}\text{H}_{29}\text{Cl}_2\text{N}_2\text{O}_6\text{S}]^+$ ($\text{M} + \text{H}^+$) 591.1118, found 591.1120.



4c

Compound **4c** was obtained in 52% yield (66.4 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 2:1). White solid. $[\alpha]_{\text{D}}^{20} = -35.6^{\circ}$ ($c = 2.5$, CH_2Cl_2). 94% ee (determined by HPLC:

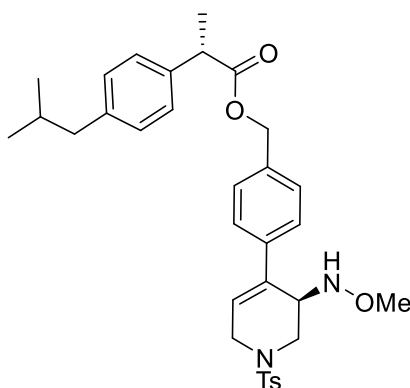
Chiralpak ADH Column, 50/50 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 39.377 min (major), 53.527 min (minor)). ¹H NMR (400 MHz, CDCl₃) δ 8.11 (d, *J* = 2.4 Hz, 1H), 7.87 (dd, *J* = 7.6, 0.8 Hz, 1H), 7.74 (d, *J* = 8.0 Hz, 2H), 7.58 – 7.52 (m, 1H), 7.48 – 7.44 (m, 3H), 7.41 (dd, *J* = 8.4, 2.4 Hz, 1H), 7.37 – 7.33 (m, 3H), 7.30 (d, *J* = 8.4 Hz, 2H), 7.01 (d, *J* = 8.4 Hz, 1H), 6.09 (dd, *J* = 4.4, 2.4 Hz, 1H), 5.71 (s, 1H), 5.17 (s, 2H), 5.12 (s, 2H), 4.27 (dd, *J* = 12.0, 1.6 Hz, 1H), 4.15 (dd, *J* = 17.6, 4.4 Hz, 1H), 4.04 (s, 1H), 3.68 (s, 2H), 3.59 (s, 3H), 3.29 (d, *J* = 17.6 Hz, 1H), 2.51 (dd, *J* = 12.0, 2.4 Hz, 1H), 2.43 (s, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 190.8, 171.2, 160.4, 143.8, 140.3, 138.5, 136.3, 135.5, 135.3, 133.3, 132.9, 132.8, 132.4, 129.7, 129.4, 129.2, 128.5, 127.8, 127.7, 127.5, 125.8, 125.1, 124.4, 121.0, 73.6, 66.3, 62.0, 56.4, 45.4, 44.7, 40.1, 21.5; HRMS-ESI Calcd for [C₃₆H₃₅N₂O₇S]⁺ (M + H⁺) 639.2159, found 639.2159.



4d

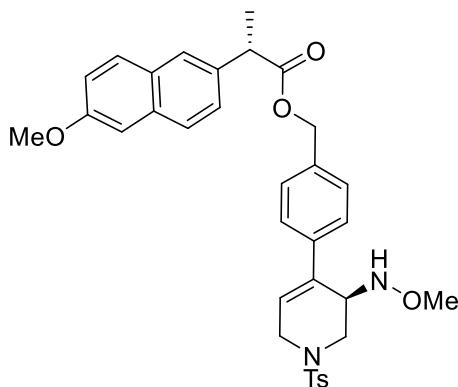
Compound **4d** was obtained in 46% yield (48.3 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 10:1). Pale yellow oil. $[\alpha]_D^{20} = -39.8^\circ$ (*c* = 1.9, CH₂Cl₂). 86% ee (determined by HPLC: Chiralpak OZH Column, 20/80 *i*-PrOH/hexane, 1.0 mL/min, 254 nm; TR = 18.042 min (major), 23.713 min (minor)). ¹H NMR (400 MHz, CDCl₃) δ 7.74 (d, *J* = 8.0 Hz, 2H), 7.44 (d, *J* = 8.0 Hz, 2H), 7.35 (d, *J* = 8.0 Hz, 2H), 7.31 (d, *J* = 8.0 Hz, 2H), 6.08 (dd, *J* = 4.0, 2.4 Hz, 1H), 5.71 (s, 1H), 5.38 (dd, *J* = 6.8, 6.0 Hz, 1H), 5.09 (t, *J* = 6.8 Hz, 1H), 4.47 (s, 2H), 4.25 (dd, *J* = 11.6, 1.6 Hz, 1H), 4.13 (dd, *J* = 17.6, 4.0 Hz, 1H), 4.08 – 3.97 (m, 3H), 3.59 (s, 3H), 3.30 (d, *J* = 17.2 Hz, 1H), 2.53 (dd, *J* = 11.6, 2.4 Hz, 1H), 2.43 (s, 3H), 2.12 – 1.99 (m, 4H), 1.67 (s, 3H), 1.64 (s, 3H), 1.59 (s, 3H); ¹³C

NMR (100 MHz, CDCl₃) δ 143.8, 140.5, 138.4, 137.7, 133.5, 132.9, 131.6, 129.7, 128.1, 127.8, 125.6, 123.9(2), 123.8(7), 120.7, 71.5, 66.7, 62.0, 56.5, 45.5, 44.8, 39.6, 26.3, 25.7, 21.5, 17.7, 16.5; HRMS-ESI Calcd for [C₃₀H₄₁N₂O₄S]⁺ (M + H⁺) 525.2782, found 525.2780.



4e

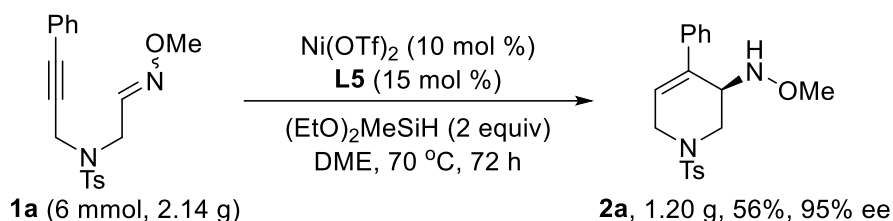
Compound **4e** was obtained in 61% yield (70.4 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 8:1). Pale yellow oil. $[\alpha]_D^{20} = -32.6^\circ$ (c = 2.5, CH₂Cl₂). >20:1 dr. ¹H NMR (400 MHz, CDCl₃) δ 7.74 (d, *J* = 8.0 Hz, 2H), 7.41 (d, *J* = 8.0 Hz, 2H), 7.35 (d, *J* = 8.0 Hz, 2H), 7.23 – 7.15 (m, 4H), 7.08 (d, *J* = 8.0 Hz, 2H), 6.08 (dd, *J* = 4.4, 2.4 Hz, 1H), 5.72 (s, 1H), 5.10 (d, *J* = 12.8 Hz, 1H), 5.06 (d, *J* = 12.8 Hz, 1H), 4.27 (d, *J* = 10.4 Hz, 1H), 4.16 (dd, *J* = 17.2, 4.4 Hz, 1H), 4.04 (s, 1H), 3.74 (q, *J* = 6.8 Hz, 1H), 3.60 (s, 3H), 3.30 (d, *J* = 17.2 Hz, 1H), 2.51 (dd, *J* = 11.6, 2.4 Hz, 1H), 2.48 – 2.40 (m, 5H), 1.88 – 1.80 (m, 1H), 1.50 (d, *J* = 6.8 Hz, 3H), 0.90 (d, *J* = 6.4 Hz, 6H); ¹³C NMR (100 MHz, CDCl₃) δ 174.4, 143.8, 140.5, 138.2, 137.5, 135.7, 133.3, 132.8, 129.7, 129.2, 128.0, 127.7, 127.1, 125.6, 124.2, 65.8, 62.0, 56.4, 45.4, 45.0, 44.9, 44.7, 30.1, 22.3, 21.5, 18.3; HRMS-ESI Calcd for [C₃₃H₄₁N₂O₅S]⁺ (M + H⁺) 577.2731, found 577.2732.



4f

Compound **4f** was obtained in 50% yield (60.1 mg) according to the general procedure and purified by chromatography (petroleum ether/ethyl acetate = 3:1). White solid. $[\alpha]_D^{20} = -34.2^\circ$ ($c = 2.0$, CH_2Cl_2). >20:1 dr. $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.74 (d, $J = 8.4$ Hz, 2H), 7.71 – 7.61 (m, 3H), 7.43 – 7.31 (m, 5H), 7.19 (d, $J = 8.4$ Hz, 2H), 7.14 – 7.10 (m, 2H), 6.05 (dd, $J = 4.4, 2.4$ Hz, 1H), 5.71 (s, 1H), 5.12 (d, $J = 12.8$ Hz, 1H), 5.06 (d, $J = 12.8$ Hz, 1H), 4.27 (dd, $J = 12.0, 1.6$ Hz, 1H), 4.12 (dd, $J = 17.6, 4.4$ Hz, 1H), 4.02 (s, 1H), 3.93 – 3.87 (m, 4H), 3.59 (s, 3H), 3.29 (d, $J = 17.2$ Hz, 1H), 2.50 (dd, $J = 11.6, 2.4$ Hz, 1H), 2.44 (s, 3H), 1.59 (d, $J = 7.2$ Hz, 3H); $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 174.4, 157.6, 143.8, 138.2, 135.6, 135.4, 133.6, 133.3, 132.8, 129.7, 129.2, 128.8, 128.1, 127.7, 127.1, 126.2, 125.9, 125.6, 124.3, 118.9, 105.5, 66.0, 62.0, 56.4, 55.2, 45.4(2), 45.3(7), 44.7, 21.5, 18.4; HRMS-ESI Calcd for $[\text{C}_{34}\text{H}_{37}\text{N}_2\text{O}_6\text{S}]^+$ ($\text{M} + \text{H}^+$) 601.2367, found 601.2367.

4.3 Gram scale experiment for the synthesis of **2a**:



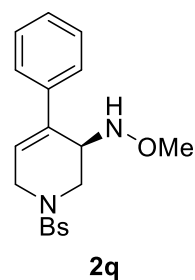
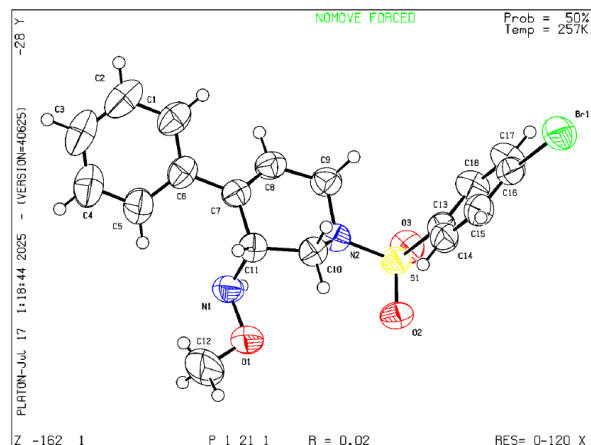
Ni(OTf)_2 (0.6 mmol, 214.1 mg), **L5** (0.9 mmol, 300.1 mg) and DME (60 mL) were introduced into an oven-dried Schlenk tube under nitrogen atmosphere. The resultant solution was stirred at 25 °C under the N_2 atmosphere for 0.5 h. Then, alkyne-oxime ether **1a** (6 mmol) and $(\text{EtO})_2\text{MeSiH}$ (12 mmol, 1.92 mL) were introduced into the

system. The resulting mixture was stirred at 70 °C (oil bath) for 72 h. Upon completion, the mixture was concentrated and the residue was purified by chromatography on silica gel (eluent: hexanes/ethyl acetate) to afford the desired product **2a** (1.20g, 56%, 95% ee).

5. Crystal Date

Crystal data and structure refinement for 2q. CCDC Number = 2524659.

Single crystals suitable for X-ray diffraction were obtained by slow evaporation of the solvent from a petroleum ether/ dichloromethane (3:1) solution of compound **2q** (CCDC 2524659) within 3 days under aerobic conditions.



Bond precision: C-C = 0.0044 Å Wavelength=1.54178

Cell: a=10.9109 (2) b=5.4517 (1) c=16.0369 (3)
 alpha=90 beta=95.255 (1) gamma=90

Temperature: 257 K

	Calculated	Reported
Volume	949.91 (3)	949.91 (3)
Space group	P 21	P 1 21 1
Hall group	P 2yb	P 2yb
Moiety formula	C18 H19 Br N2 O3 S	C18 H19 Br N2 O3 S
Sum formula	C18 H19 Br N2 O3 S	C18 H18 Br N2 O3 S
Mr	423.31	422.31
Dx, g cm ⁻³	1.480	1.476
Z	2	2
Mu (mm ⁻¹)	4.139	4.139
F000	432.0	430.0
F000'	432.34	
h, k, lmax	13, 6, 19	13, 6, 19
Nref	3501 [1951]	3372
Tmin, Tmax	0.444, 0.419	0.468, 0.753
Tmin'	0.336	

Correction method= # Reported T Limits: Tmin=0.468 Tmax=0.753
 AbsCorr = MULTI-SCAN

Data completeness= 1.73/0.96 Theta(max)= 68.286

R(reflections)= 0.0224 (3308) wR2(reflections)=
 0.0614 (3372)

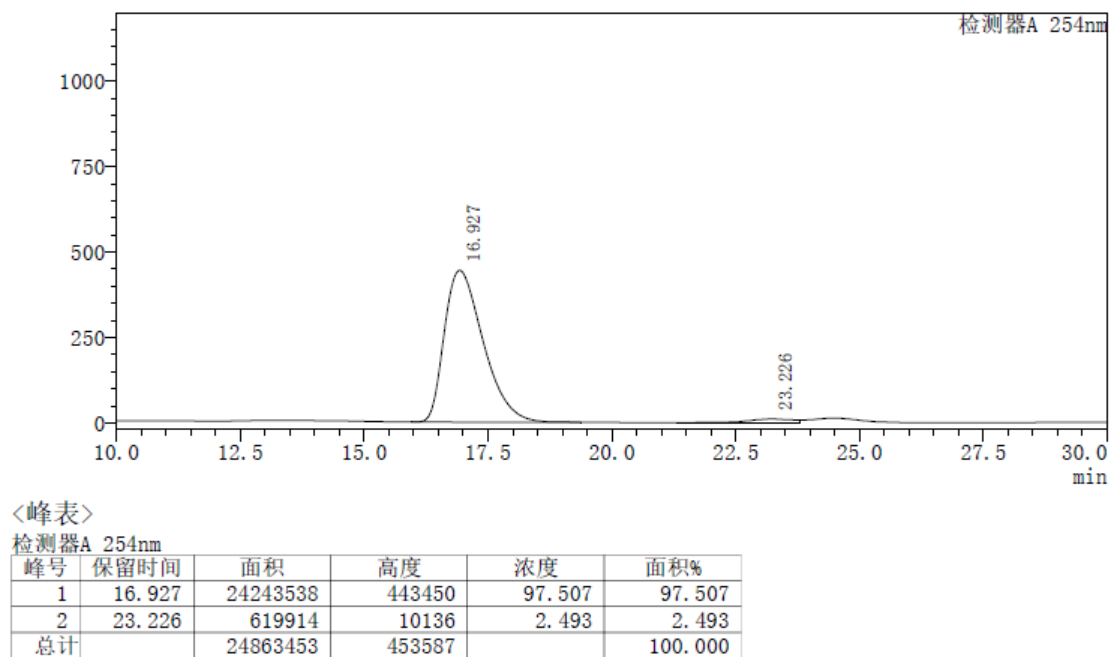
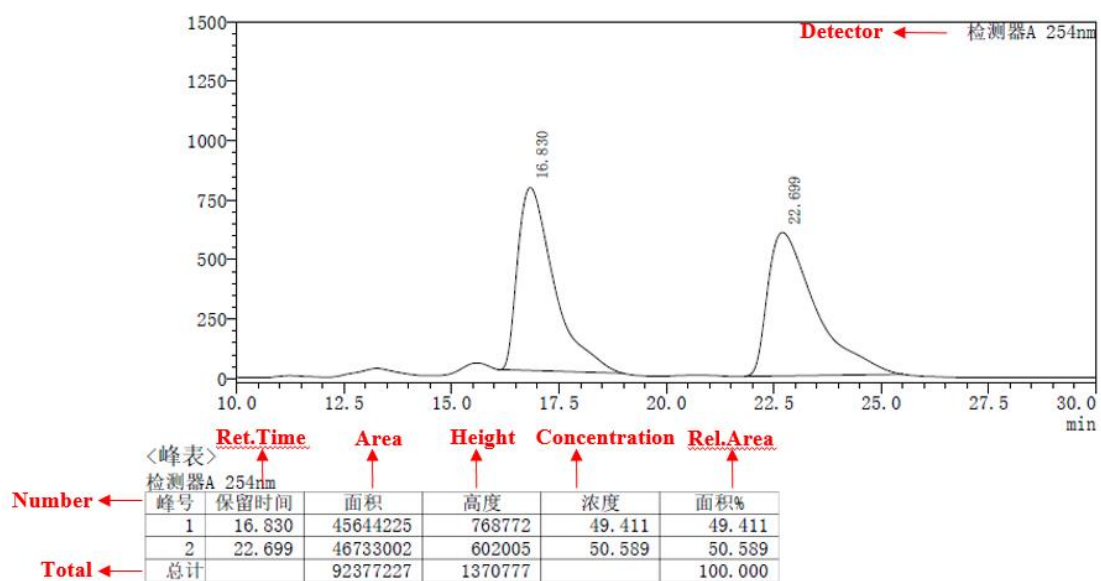
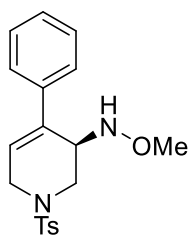
S = 1.051 Npar= 239

6. References

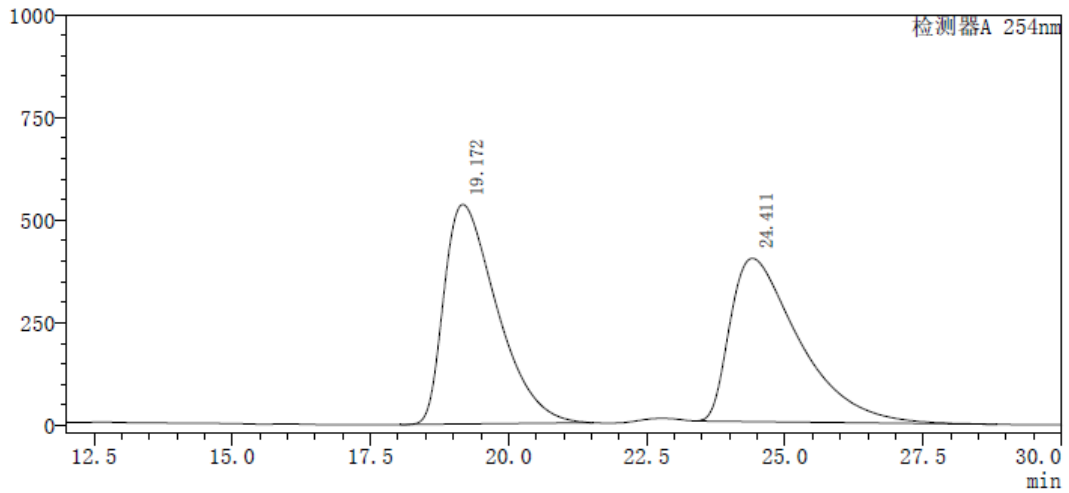
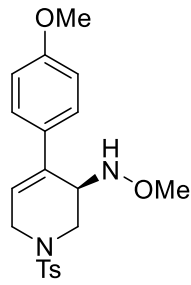
1. S. Yu, Z. Jin, X. Tong and L. Qi, *Org. Lett.* 2025, **27**, 3697.
2. Z. Yu, L. Liu, and J. Zhang, *Chem. - Eur. J.* 2016, **22**, 8488.

7. HPLC Chromatograms

2a: OZH *i*-PrOH/hexane = 20/80, $v = 1.0$ mL/min, $\lambda = 254$ nm



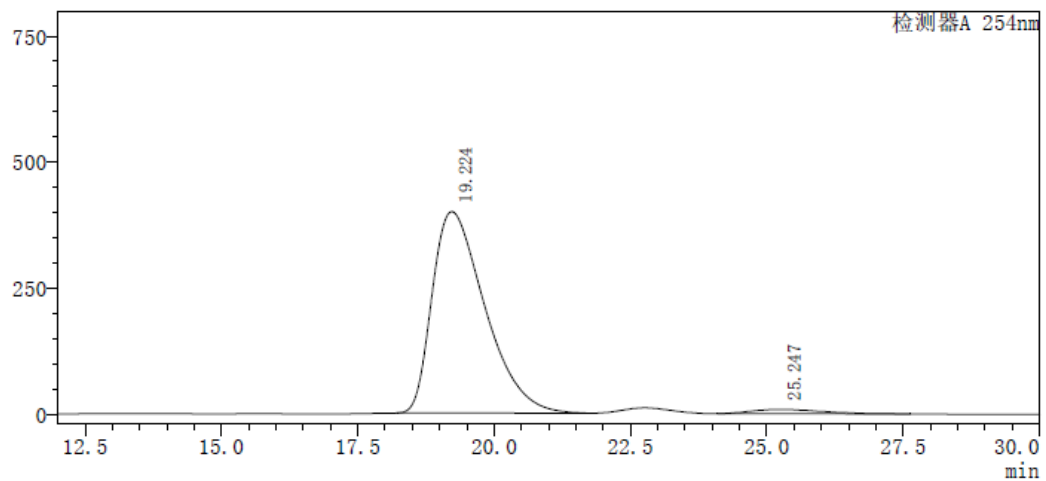
2b: OZH, *i*-PrOH/hexane = 30/70, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	19.172	35740524	534310	50.732	50.732
2	24.411	34709618	397480	49.268	49.268
总计		70450142	931789		100.000

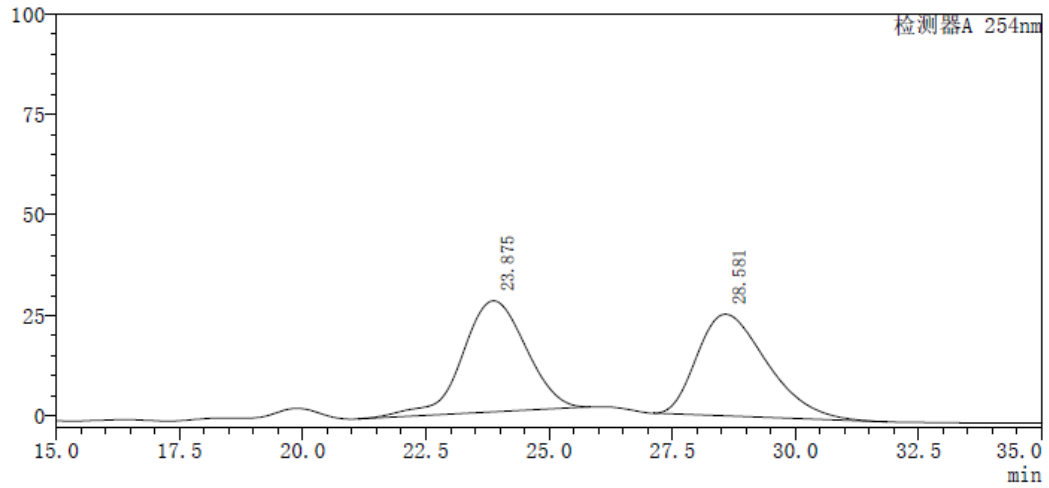
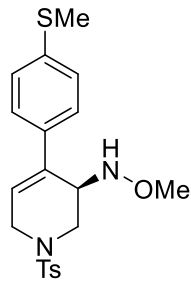


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	19.224	26909034	399496	97.288	97.288
2	25.247	750009	8344	2.712	2.712
总计		27659043	407840		100.000

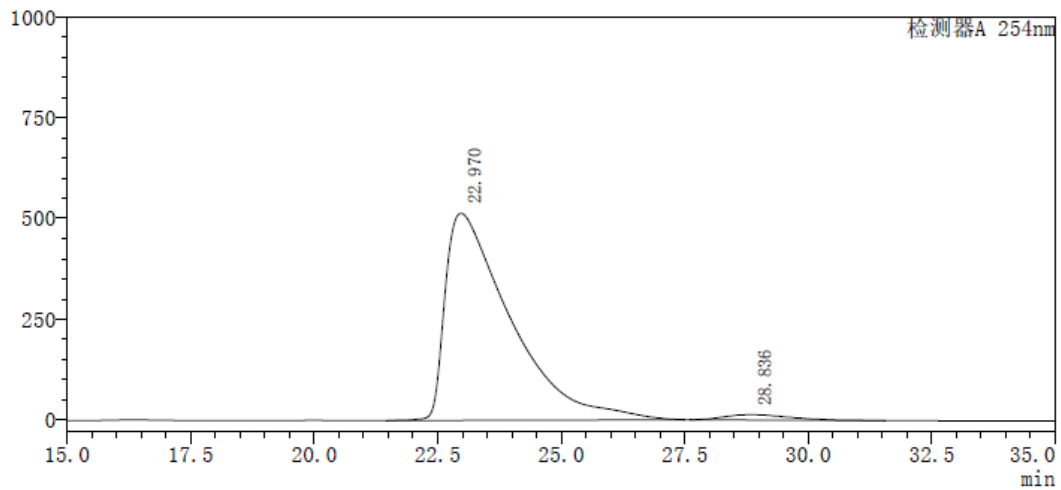
2c: OZH, *i*-PrOH/hexane = 30/70, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	23.875	2482741	27568	49.840	49.840
2	28.581	2498643	25250	50.160	50.160
总计		4981384	52819		100.000

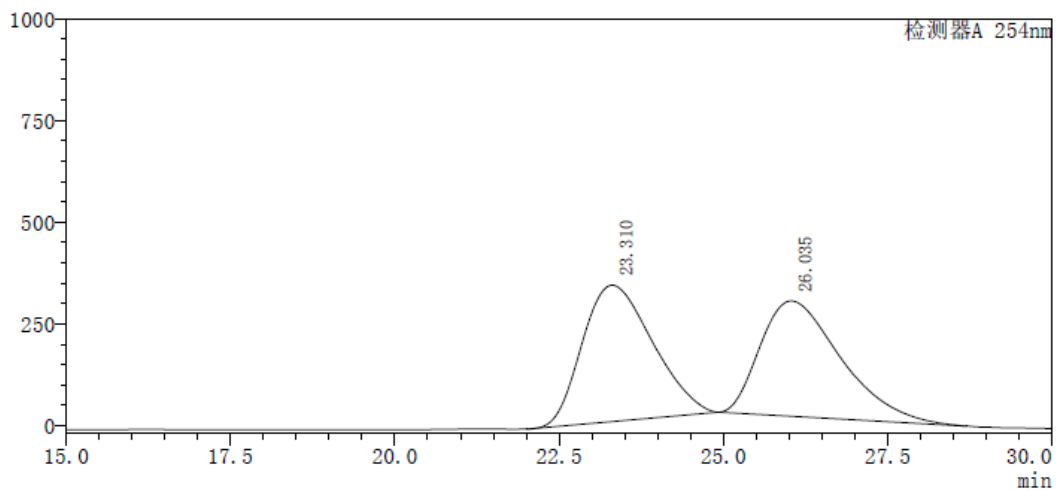
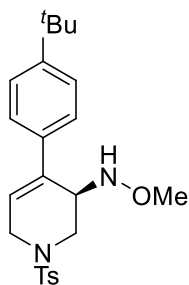


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	22.970	47247904	513297	97.489	97.489
2	28.836	1216918	13474	2.511	2.511
总计		48464822	526772		100.000

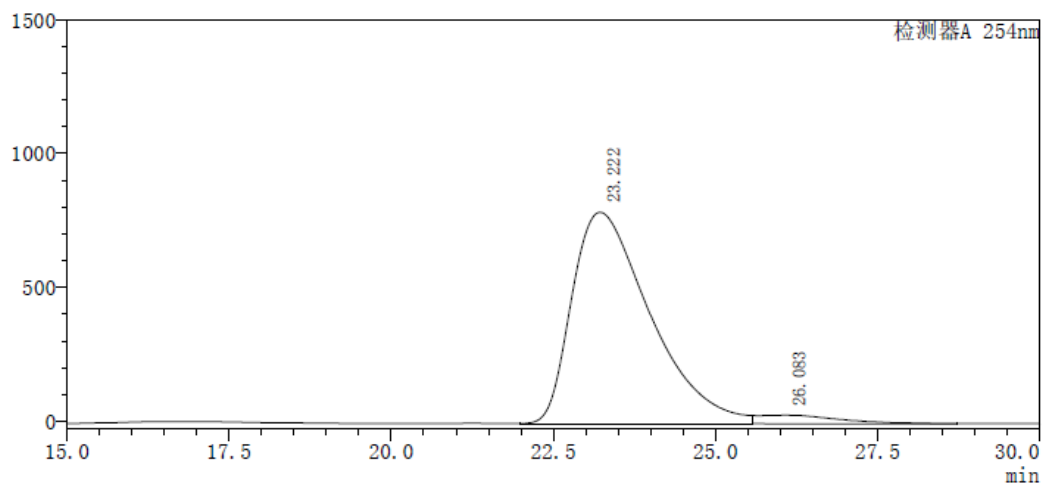
2d: ASH, *i*-PrOH/hexane = 5/95, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	23.310	24849981	334823	50.686	50.686
2	26.035	24177402	283095	49.314	49.314
总计		49027383	617918		100.000

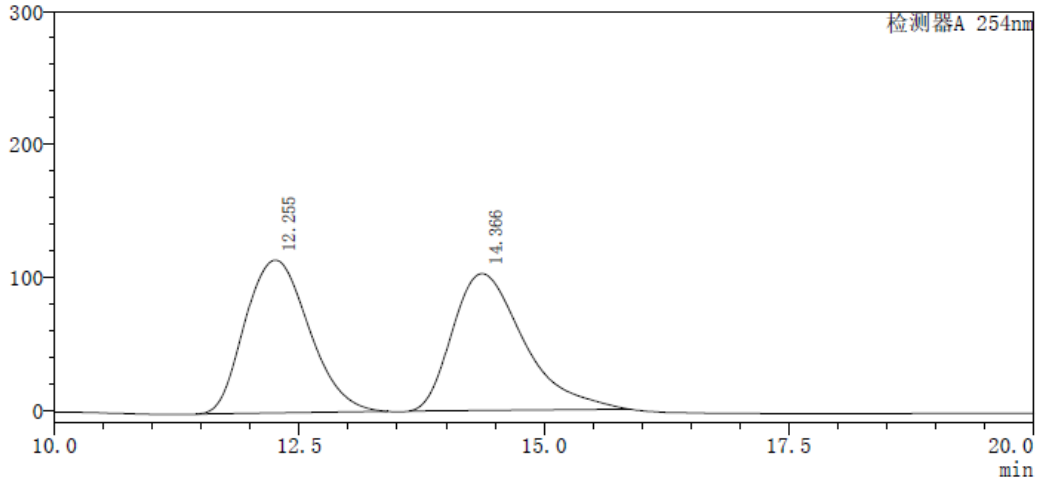
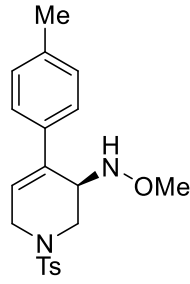


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	23.222	66313130	788649	95.909	95.909
2	26.083	2828906	31918	4.091	4.091
总计		69142036	820567		100.000

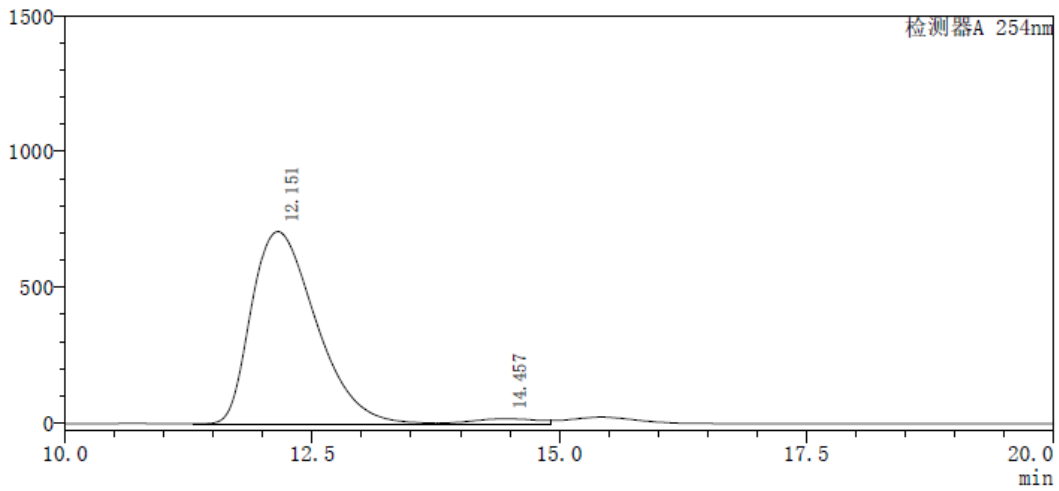
2e: OZH, *i*-PrOH/hexane = 30/70, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	12.255	5241332	115063	50.054	50.054
2	14.366	5230119	102905	49.946	49.946
总计		10471451	217968		100.000

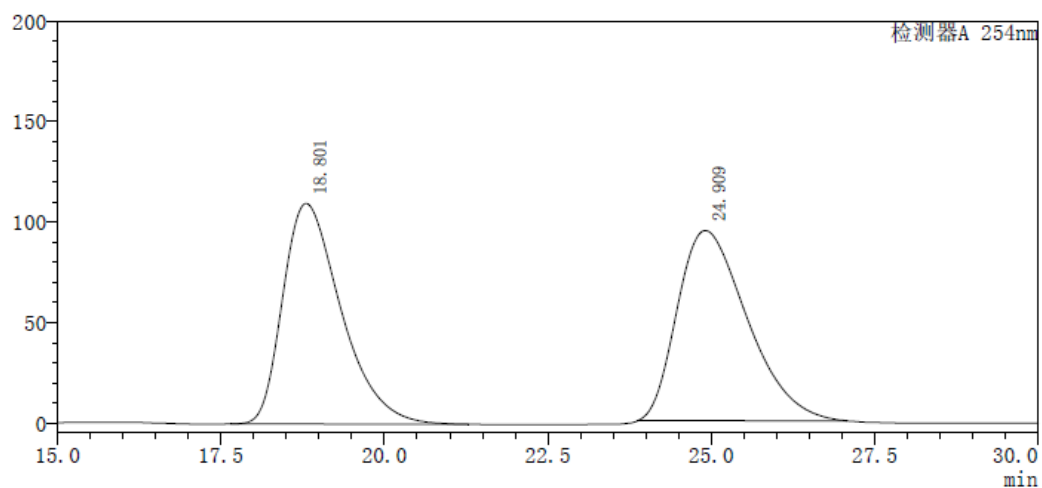
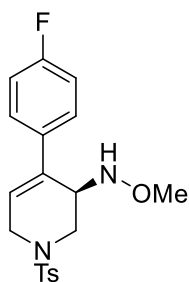


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	12.151	32245745	707348	97.424	97.424
2	14.457	852744	18742	2.576	2.576
总计		33098490	726090		100.000

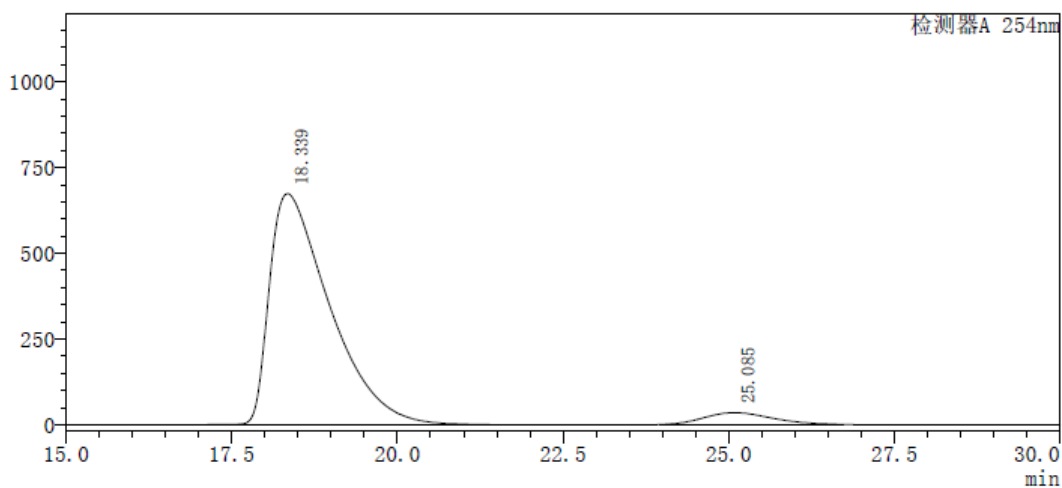
2f: OZH, *i*-PrOH/hexane = 20/80, $\nu = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	18.801	6825066	109681	49.119	49.119
2	24.909	7069981	94589	50.881	50.881
总计		13895047	204270		100.000

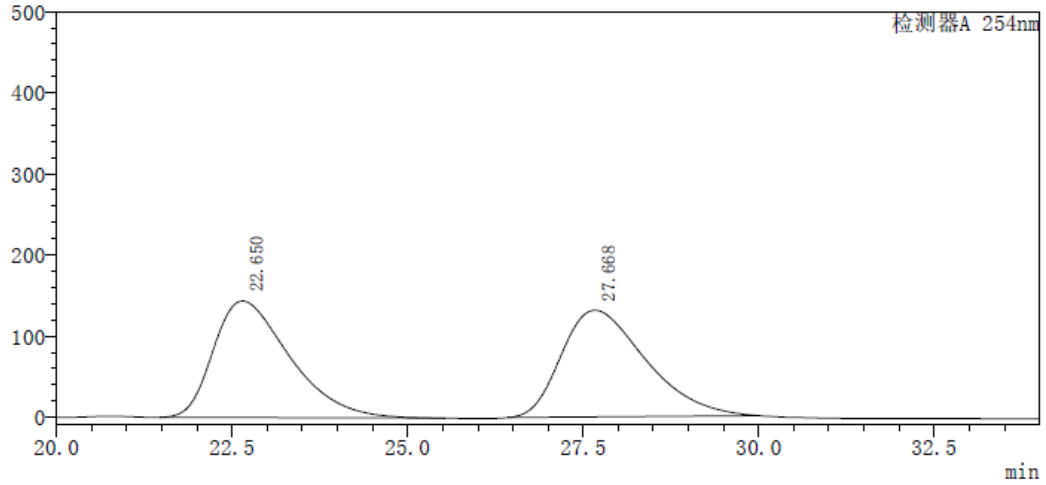
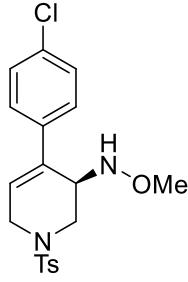


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	18.339	42698854	673524	94.631	94.631
2	25.085	2422749	34338	5.369	5.369
总计		45121603	707862		100.000

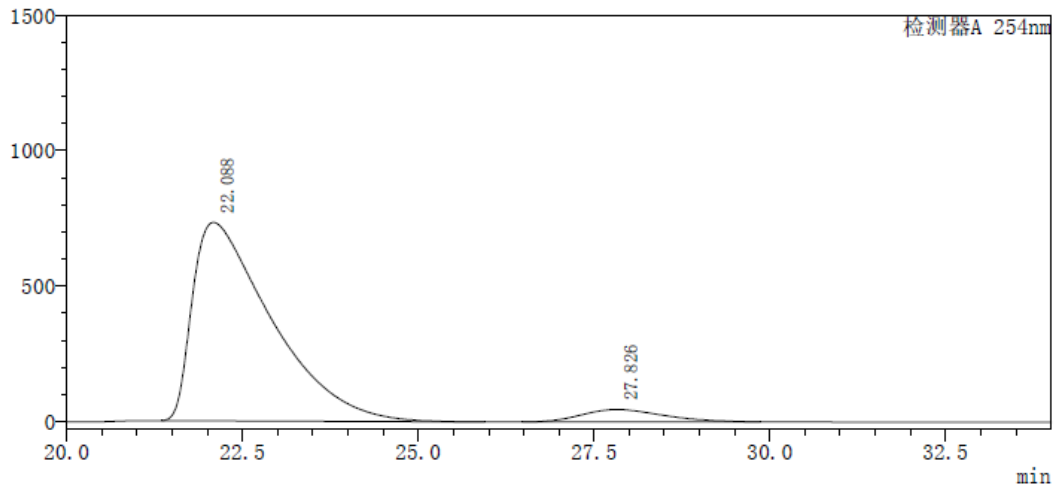
2g: OZH, *i*-PrOH/hexane = 20/80, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	22.650	10852233	143551	49.700	49.700
2	27.668	10983367	131453	50.300	50.300
总计		21835600	275003		100.000

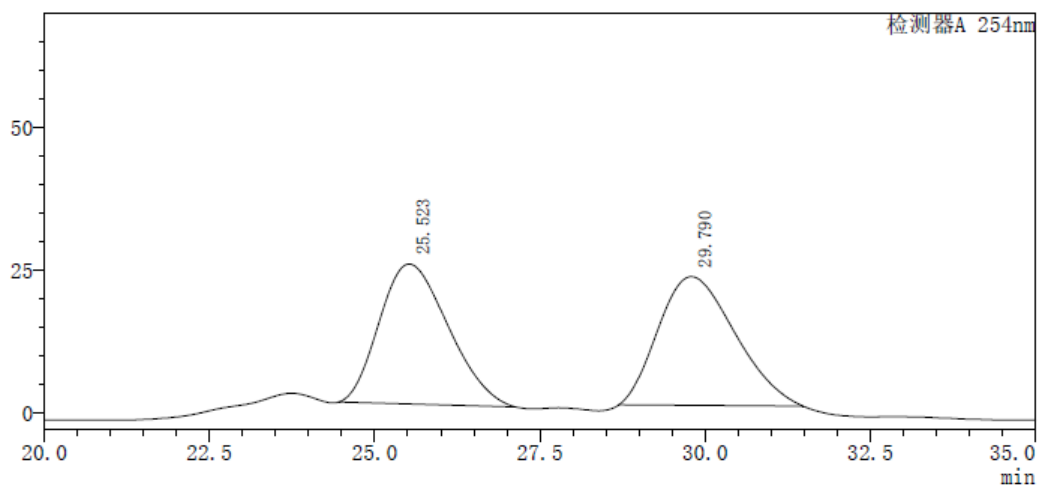
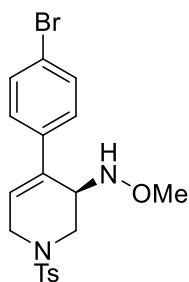


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	22.088	57391692	732116	94.013	94.013
2	27.826	3654739	45438	5.987	5.987
总计		61046431	777554		100.000

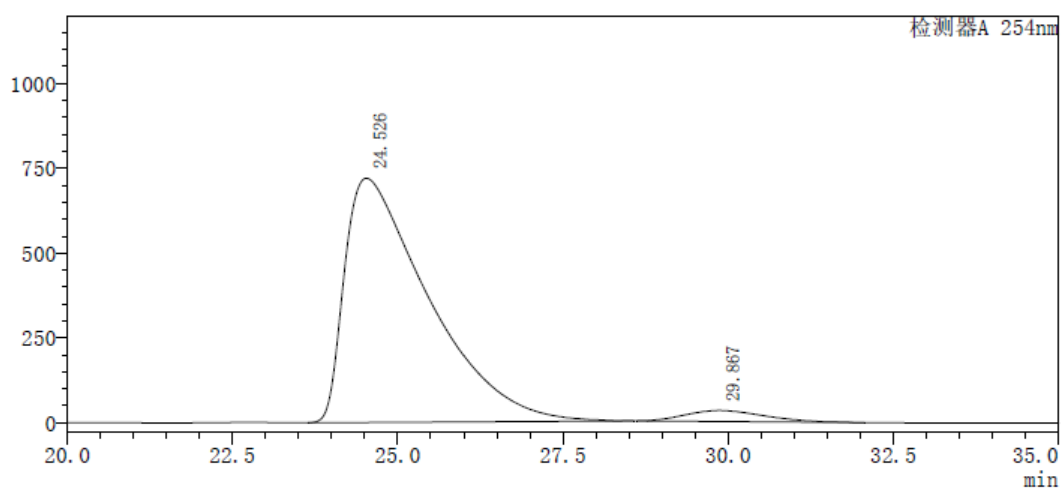
2h: OZH, *i*-PrOH/hexane = 20/80, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	25.523	1771835	24472	49.344	49.344
2	29.790	1818916	22486	50.656	50.656
总计		3590751	46958		100.000

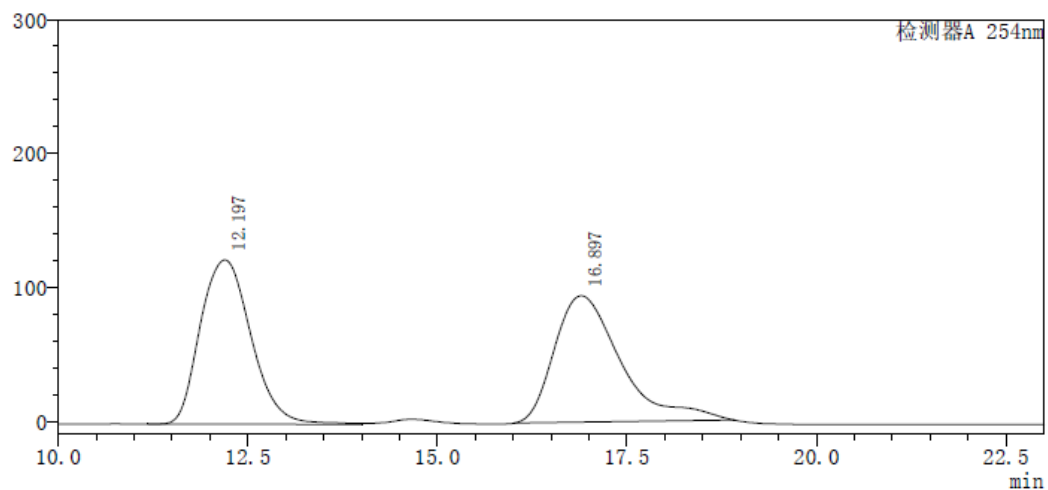
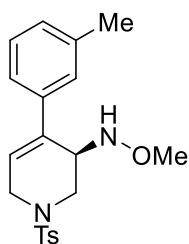


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	24.526	63796022	719889	95.916	95.916
2	29.867	2716283	32320	4.084	4.084
总计		66512305	752209		100.000

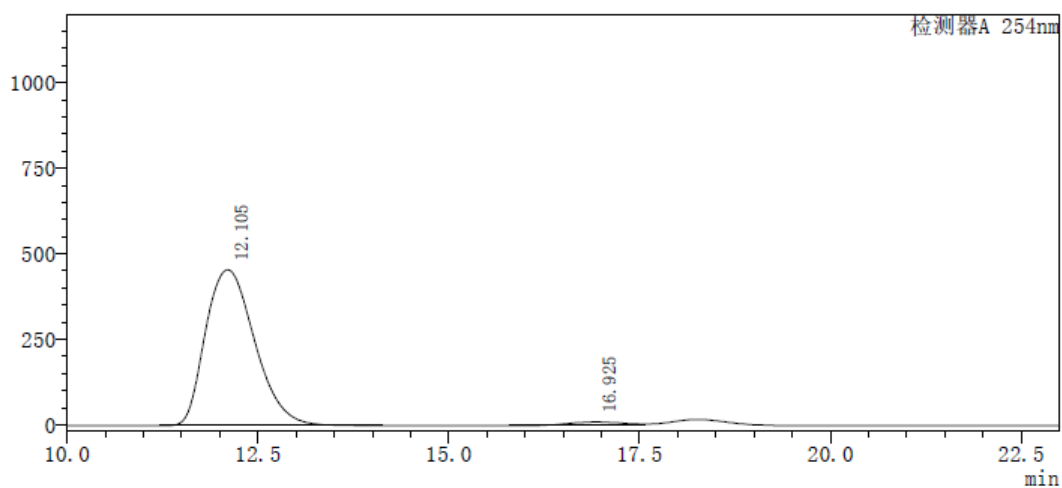
2i: OZH, *i*-PrOH/hexane = 25/75, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	12.197	5722906	122722	49.823	49.823
2	16.897	5763497	94428	50.177	50.177
总计		11486403	217151		100.000

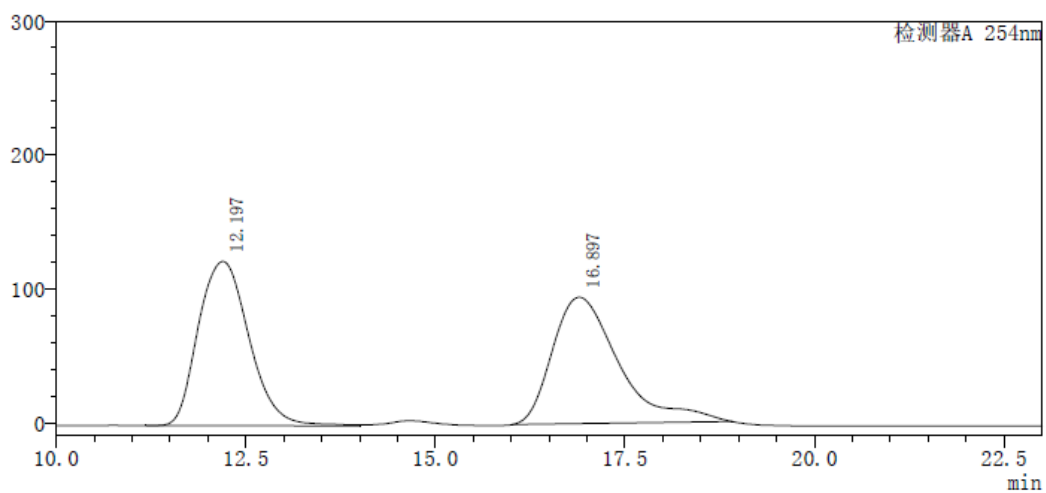
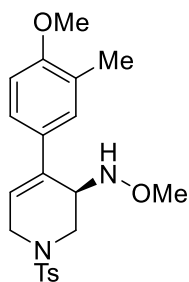


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	12.105	20446340	455251	97.316	97.316
2	16.925	563828	10581	2.684	2.684
总计		21010168	465832		100.000

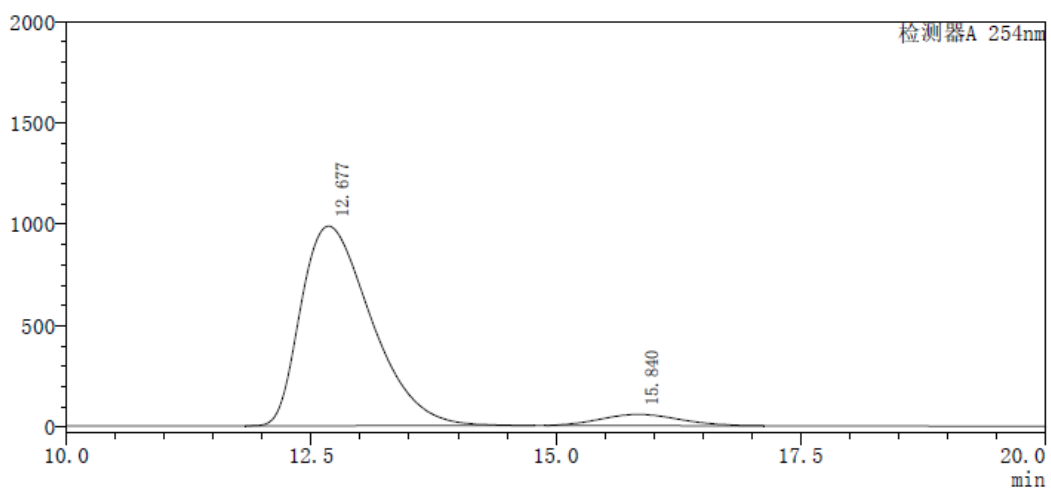
2j: OZH, *i*-PrOH/hexane =35/65, $v = 1.0 \text{ mL/min}$, $\lambda = 254 \text{ nm}$



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	12.197	5722906	122722	49.823	49.823
2	16.897	5763497	94428	50.177	50.177
总计		11486403	217151		100.000

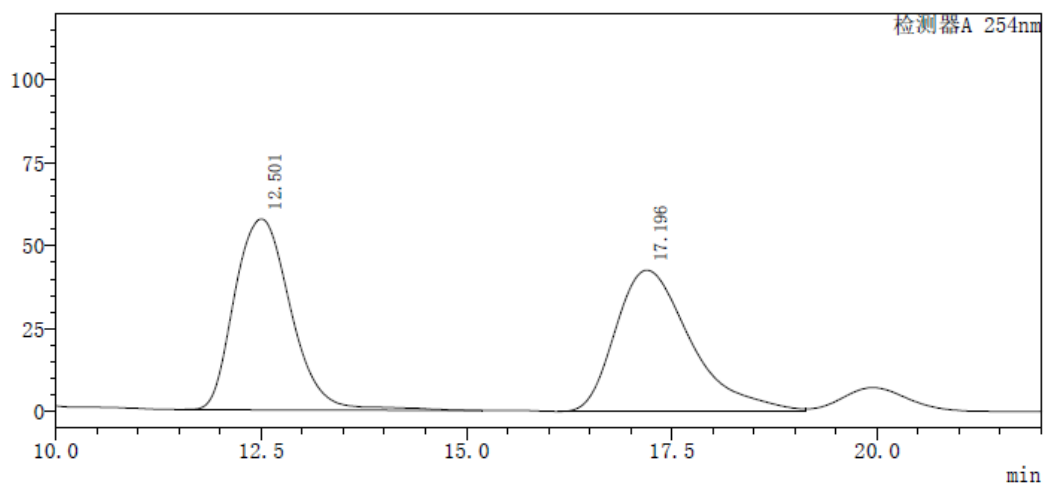
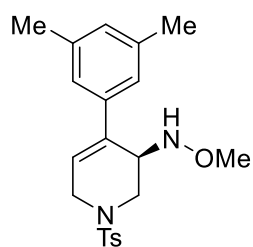


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	12.677	49404921	983532	94.105	94.105
2	15.840	3094771	54971	5.895	5.895
总计		52499692	1038503		100.000

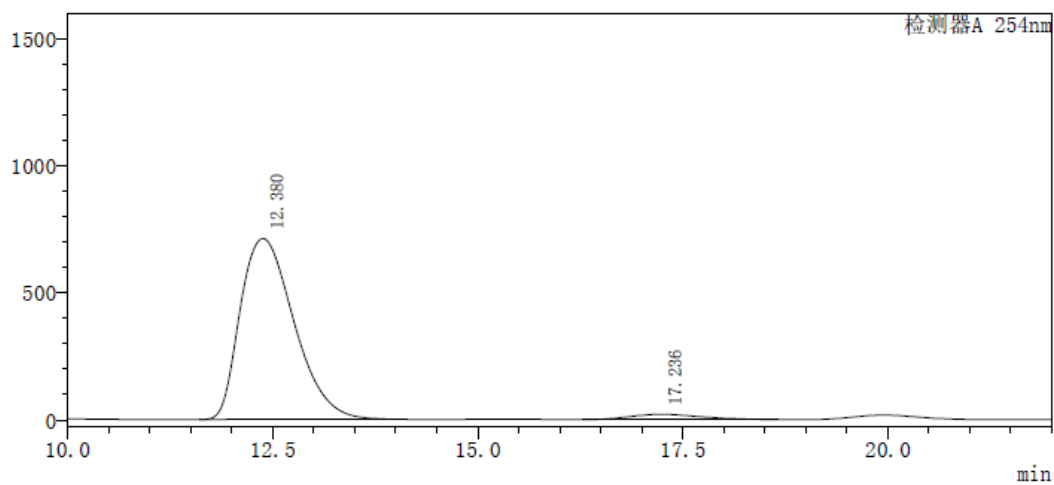
2k: OZH, *i*-PrOH/hexane = 20/80, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	12.501	2742155	57438	50.192	50.192
2	17.196	2721209	42530	49.808	49.808
总计		5463364	99969		100.000

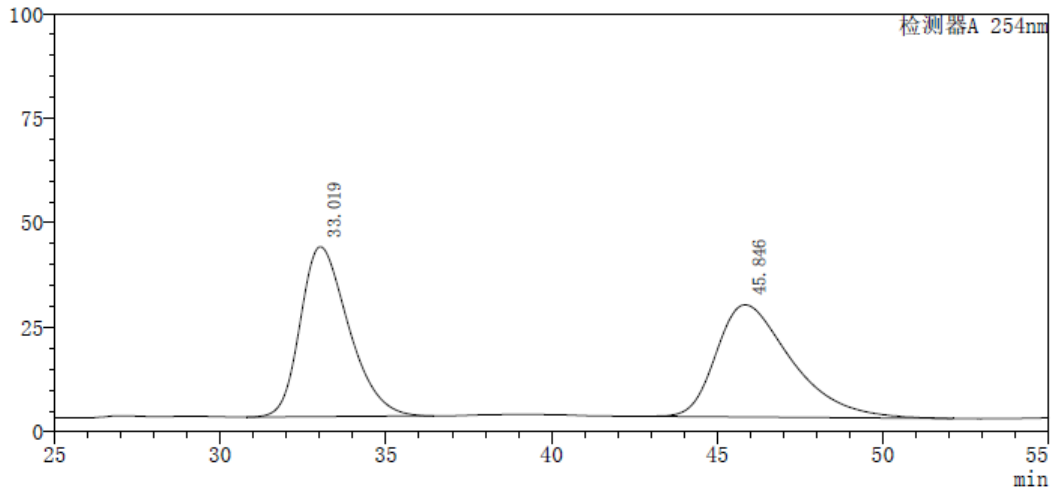
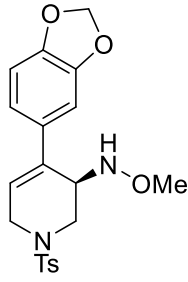


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	12.380	32472193	711449	96.491	96.491
2	17.236	1180879	19998	3.509	3.509
总计		33653072	731447		100.000

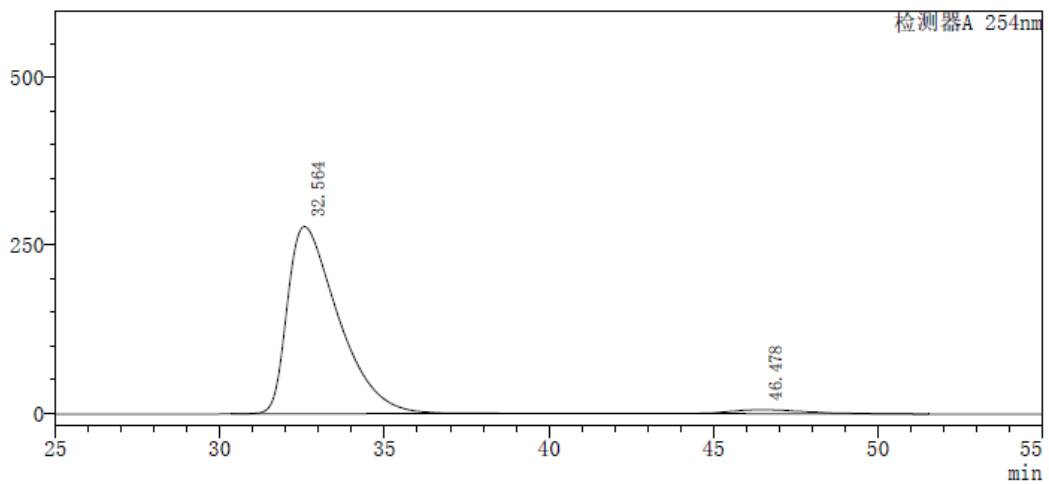
2l: OZH, *i*-PrOH/hexane = 30/70, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	33.019	4131544	40588	49.348	49.348
2	45.846	4240681	26791	50.652	50.652
总计		8372225	67379		100.000

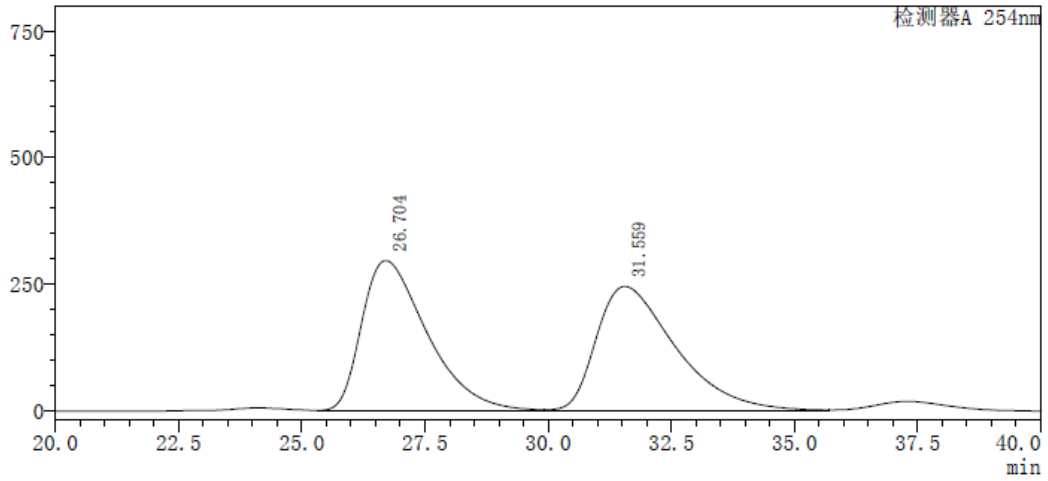
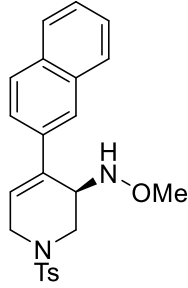


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	32.564	30223583	279168	96.932	96.932
2	46.478	956676	6143	3.068	3.068
总计		31180259	285311		100.000

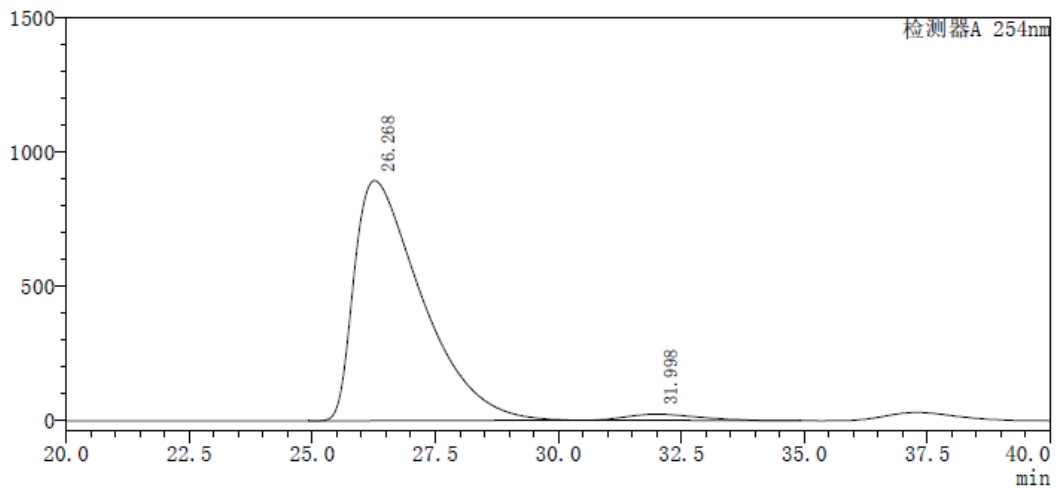
2m: OZH, *i*-PrOH/hexane = 20/80, $v = 1.0 \text{ mL/min}$, $\lambda = 254 \text{ nm}$



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	26.704	27830557	298209	49.828	49.828
2	31.559	28023068	247045	50.172	50.172
总计		55853625	545254		100.000

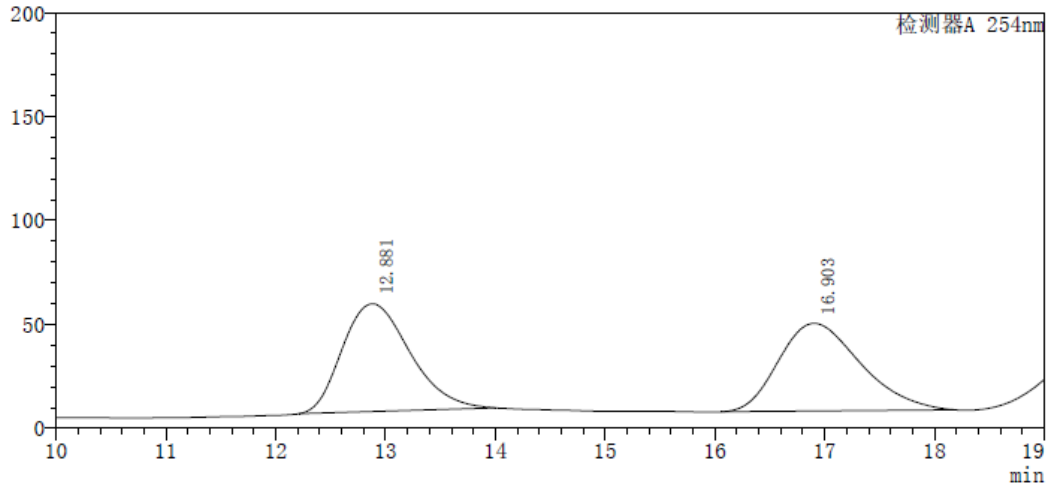
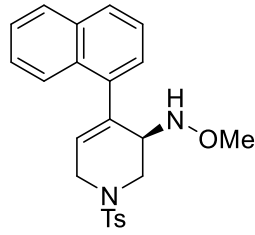


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	26.268	85433455	892490	97.337	97.337
2	31.998	2337034	22627	2.663	2.663
总计		87770489	915117		100.000

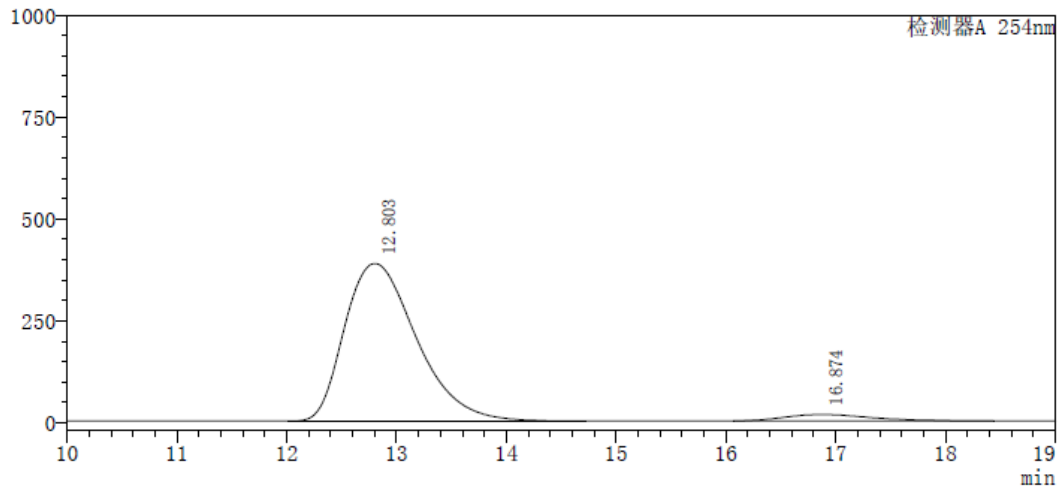
2n: OZH, *i*-PrOH/hexane = 20/80, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	12.881	2222016	51775	50.335	50.335
2	16.903	2192407	42187	49.665	49.665
总计		4414423	93963		100.000

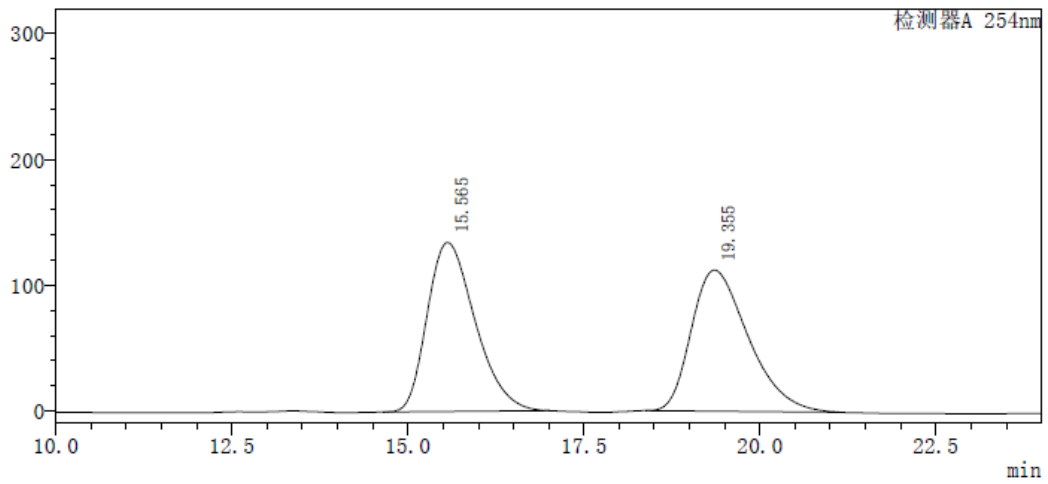
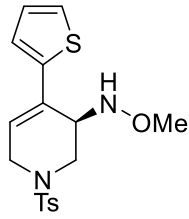


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	12.803	17613761	386515	95.238	95.238
2	16.874	880694	16036	4.762	4.762
总计		18494454	402551		100.000

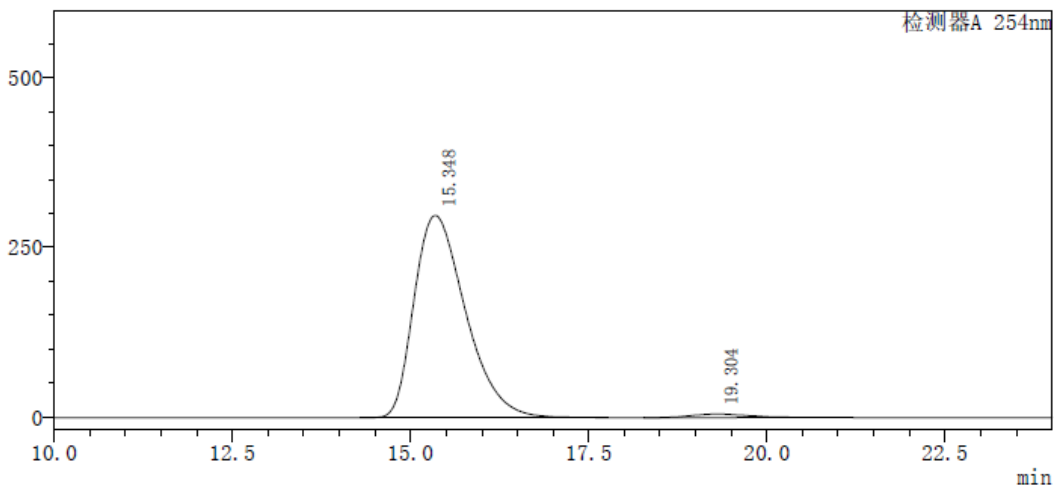
2o: OZH, *i*-PrOH/hexane = 25/75, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	15.565	6370454	134423	50.204	50.204
2	19.355	6318612	112200	49.796	49.796
总计		12689067	246624		100.000

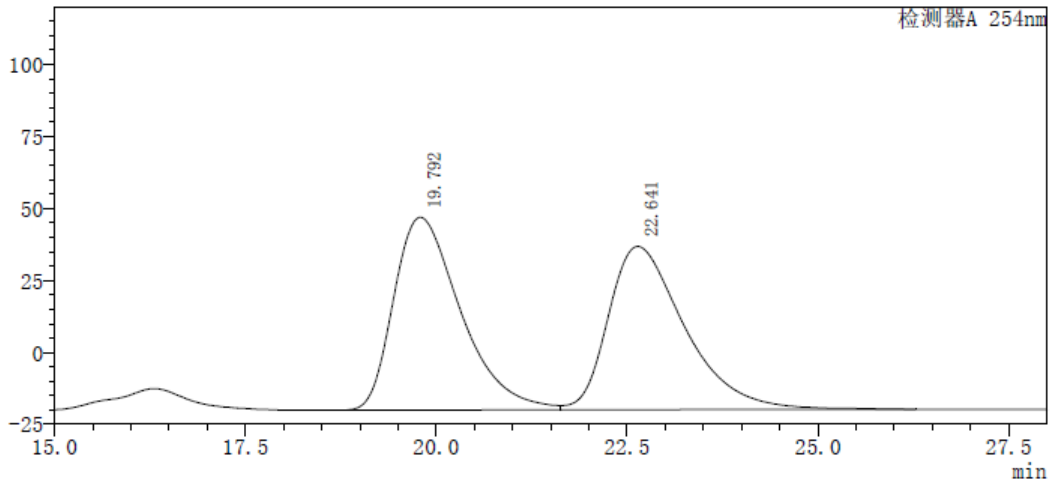
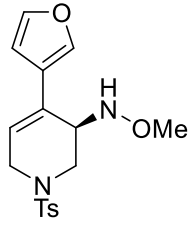


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	15.348	15033062	298626	98.074	98.074
2	19.304	295265	5208	1.926	1.926
总计		15328327	303834		100.000

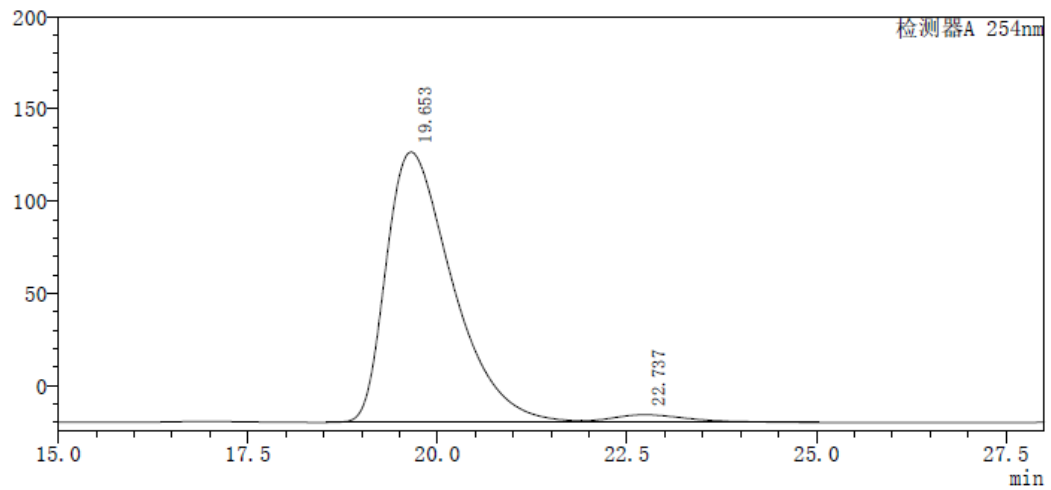
2p: OZH, *i*-PrOH/hexane = 20/80, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	19.792	4090974	66930	50.846	50.846
2	22.641	3954827	56677	49.154	49.154
总计		8045800	123607		100.000

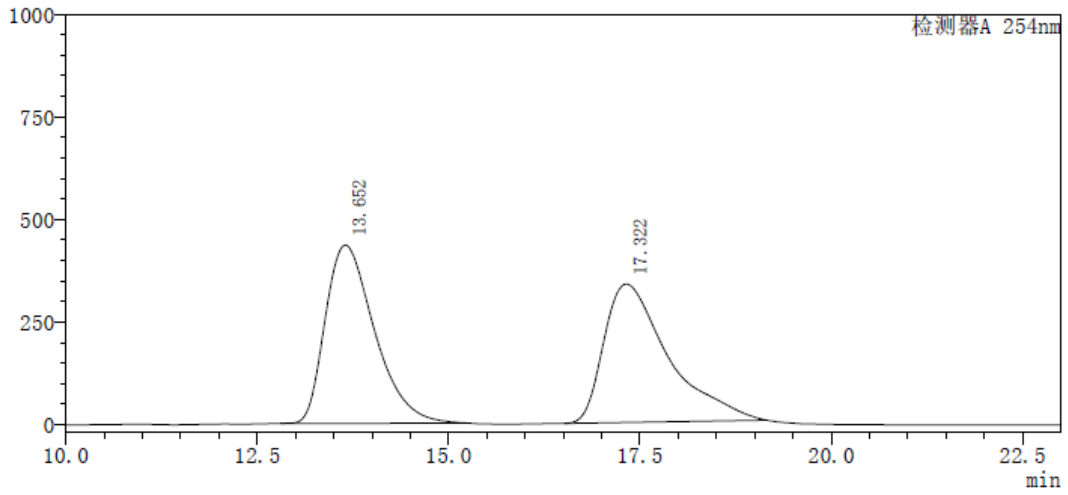
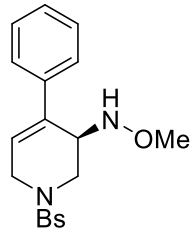


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	19.653	8955223	146517	96.834	96.834
2	22.737	292780	4150	3.166	3.166
总计		9248002	150668		100.000

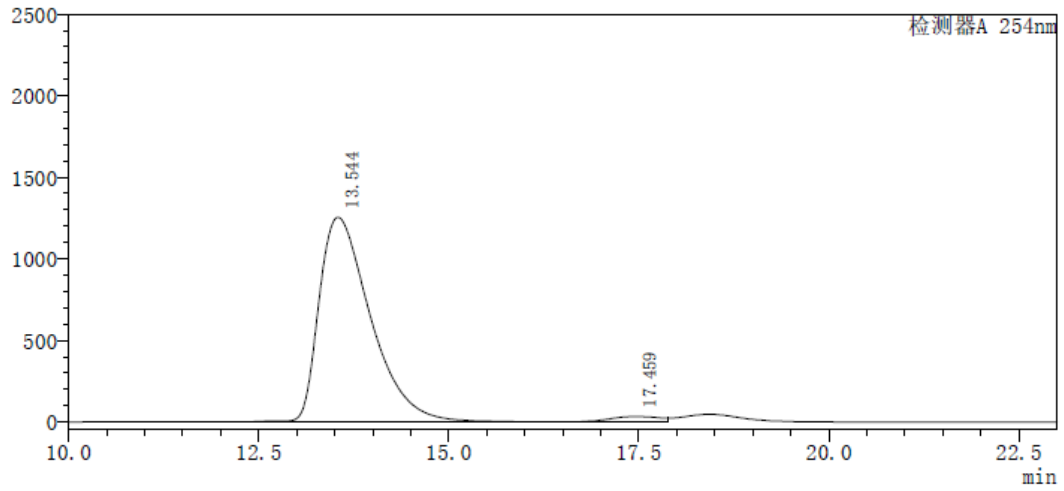
2q: OZH, *i*-PrOH/hexane = 20/80, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	13.652	19444945	434063	49.710	49.710
2	17.322	19671522	337209	50.290	50.290
总计		39116467	771272		100.000

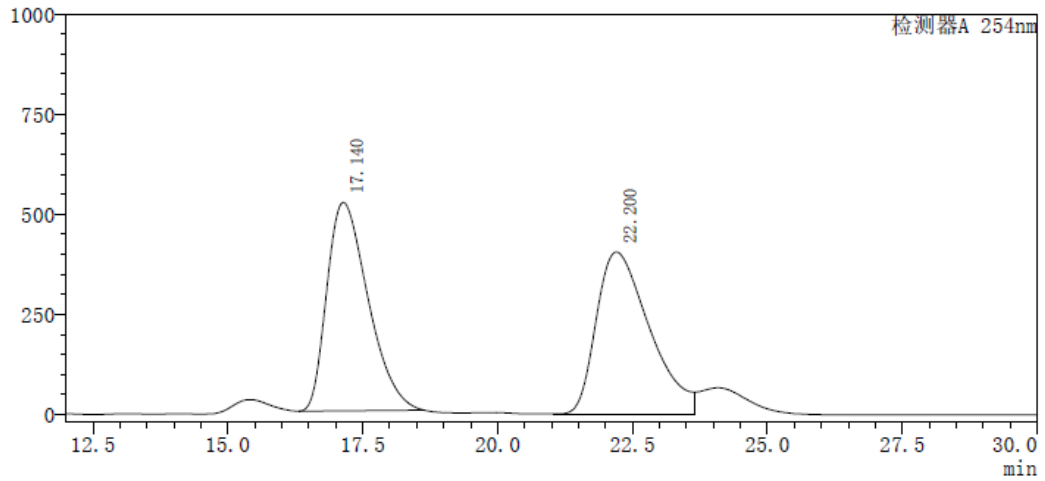
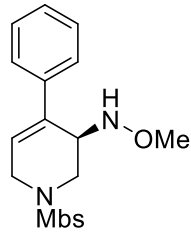


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	13.544	58974242	1253560	97.567	97.567
2	17.459	1470643	32717	2.433	2.433
总计		60444885	1286277		100.000

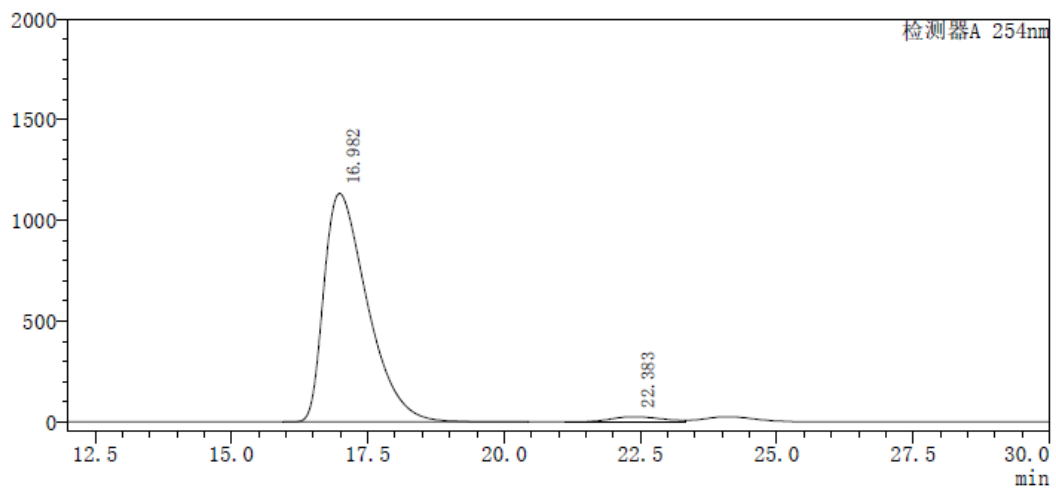
2r: OZH, *i*-PrOH/hexane = 30/70, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	17.140	27641132	520008	49.589	49.589
2	22.200	28099517	406697	50.411	50.411
总计		55740649	926705		100.000

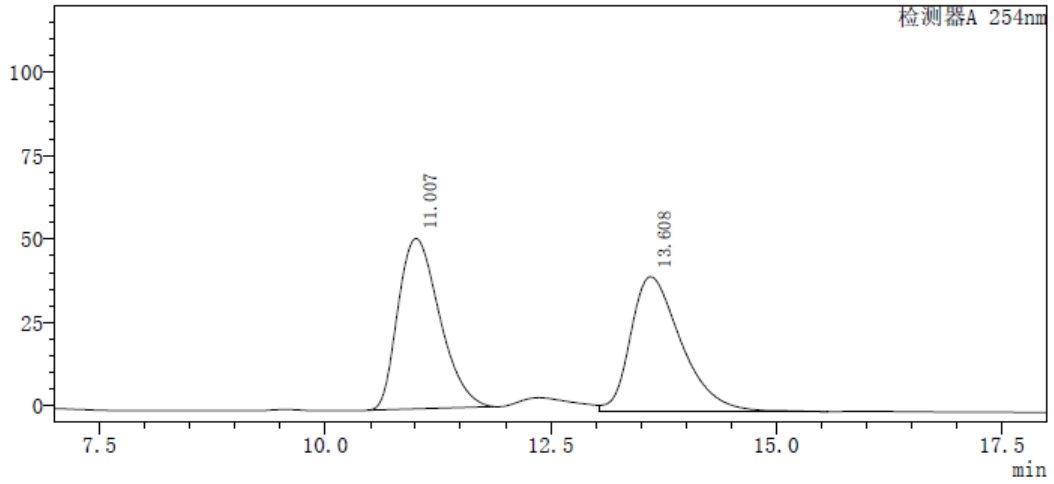
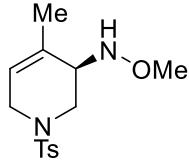


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	16.982	62780085	1134023	97.449	97.449
2	22.383	1643516	25656	2.551	2.551
总计		64423602	1159679		100.000

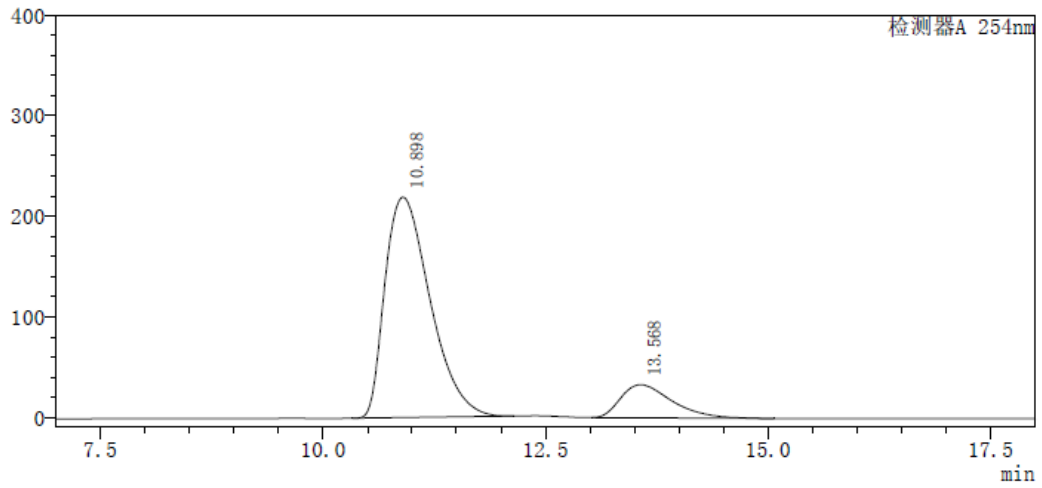
2s: OZH, *i*-PrOH/hexane = 20/80, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	11.007	1638260	50973	50.961	50.961
2	13.608	1576450	40277	49.039	49.039
总计		3214710	91250		100.000

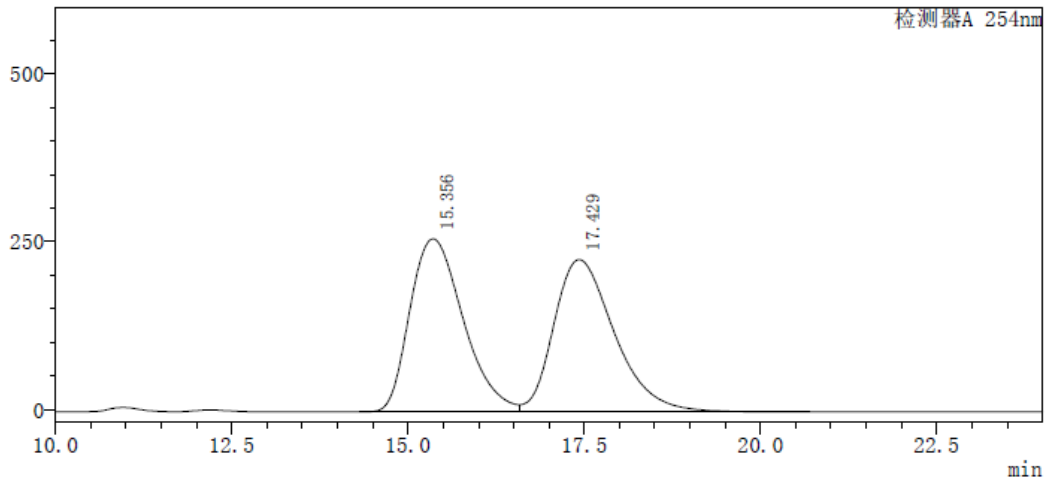
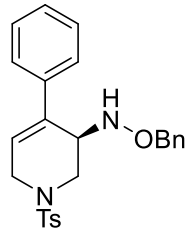


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	10.898	7738061	219064	85.413	85.413
2	13.568	1321476	32938	14.587	14.587
总计		9059537	252003		100.000

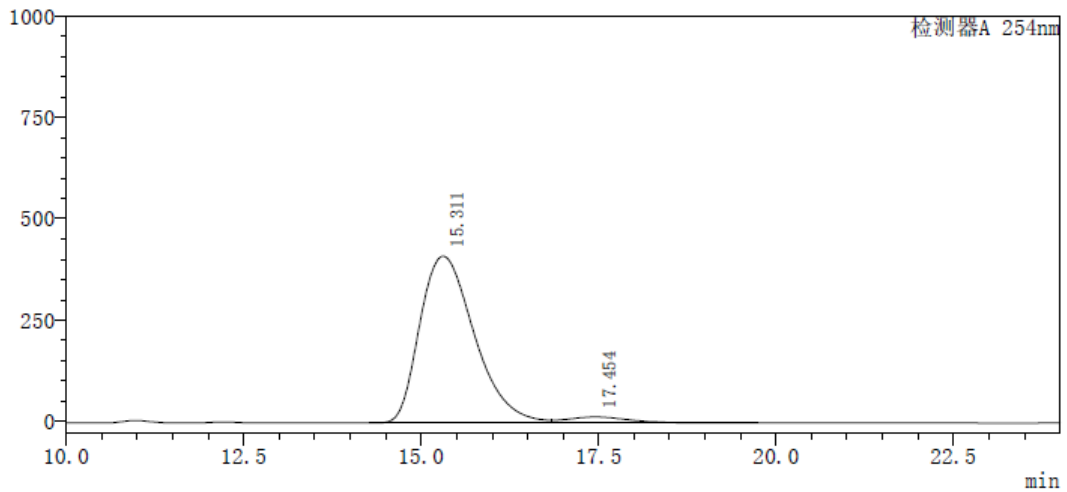
2t: OZH, *i*-PrOH/hexane = 20/80, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	15.356	13606897	258144	50.010	50.010
2	17.429	13601253	227110	49.990	49.990
总计		27208150	485255		100.000

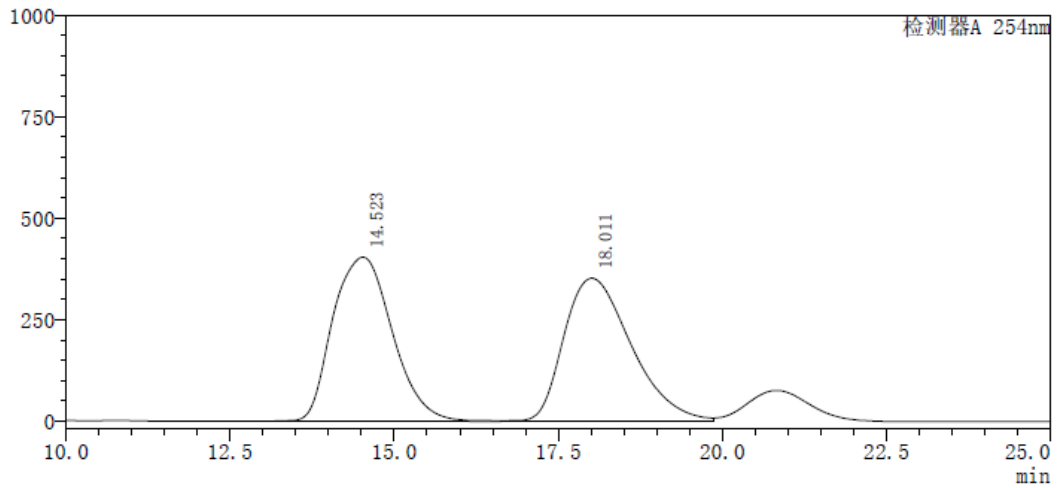
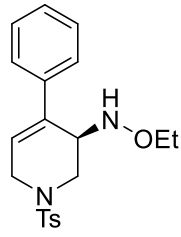


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	15.311	22078706	410926	95.990	95.990
2	17.454	922298	15067	4.010	4.010
总计		23001004	425993		100.000

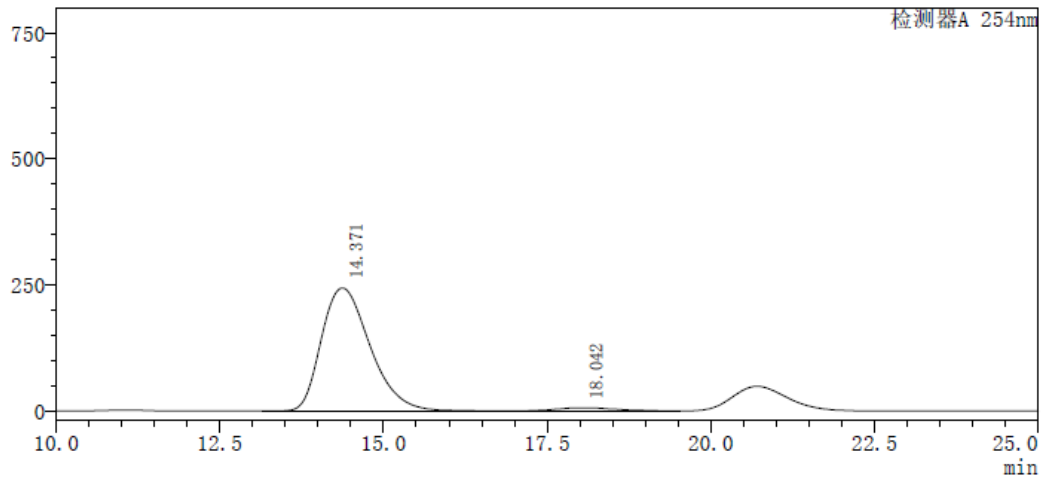
2u: OZH, *i*-PrOH/hexane = 20/80, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	14.523	25559707	404039	50.333	50.333
2	18.011	25221766	352257	49.667	49.667
总计		50781472	756296		100.000

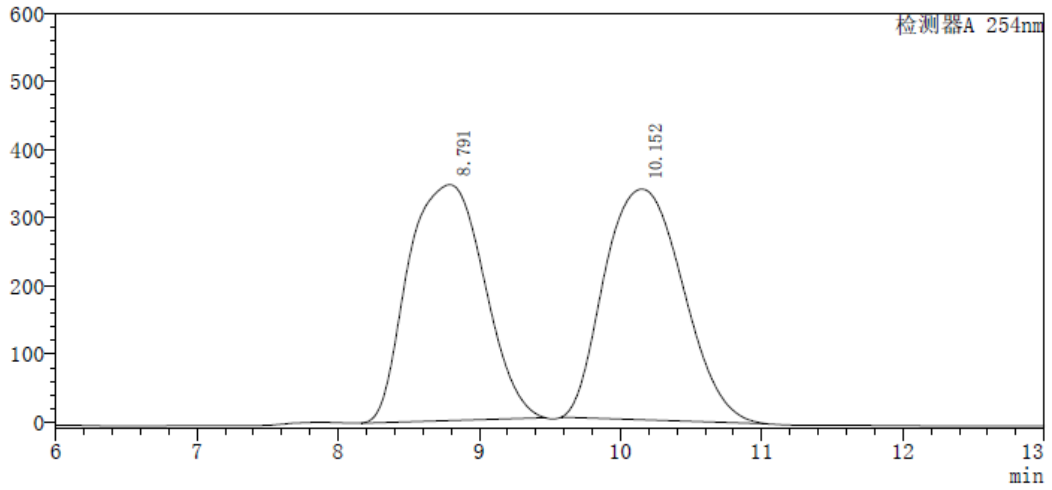
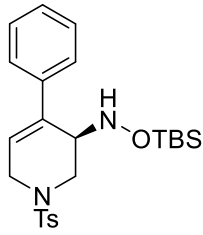


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	14.371	12649085	243853	96.934	96.934
2	18.042	400053	6275	3.066	3.066
总计		13049139	250128		100.000

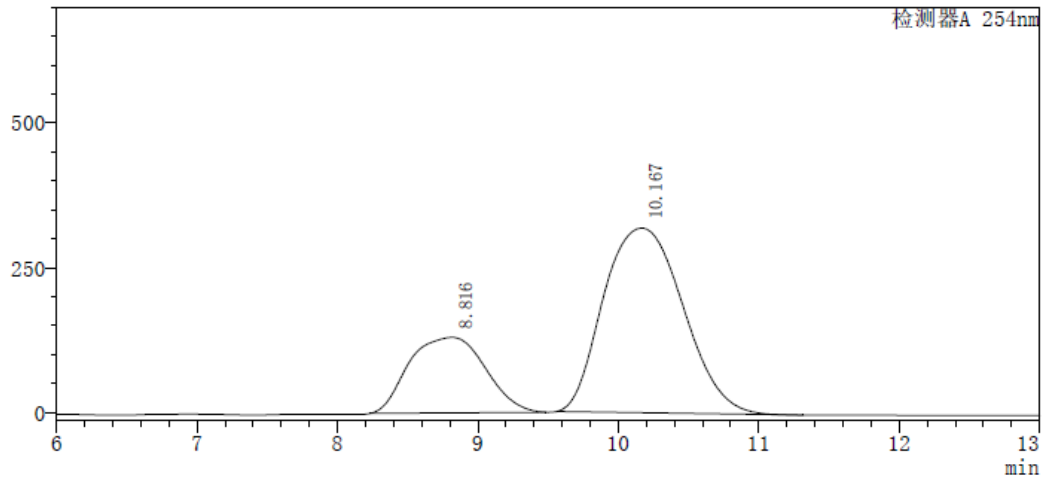
2v: OZH, *i*-PrOH/hexane = 10/90, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	8.791	12991047	345864	49.762	49.762
2	10.152	13115157	338149	50.238	50.238
总计		26106203	684013		100.000

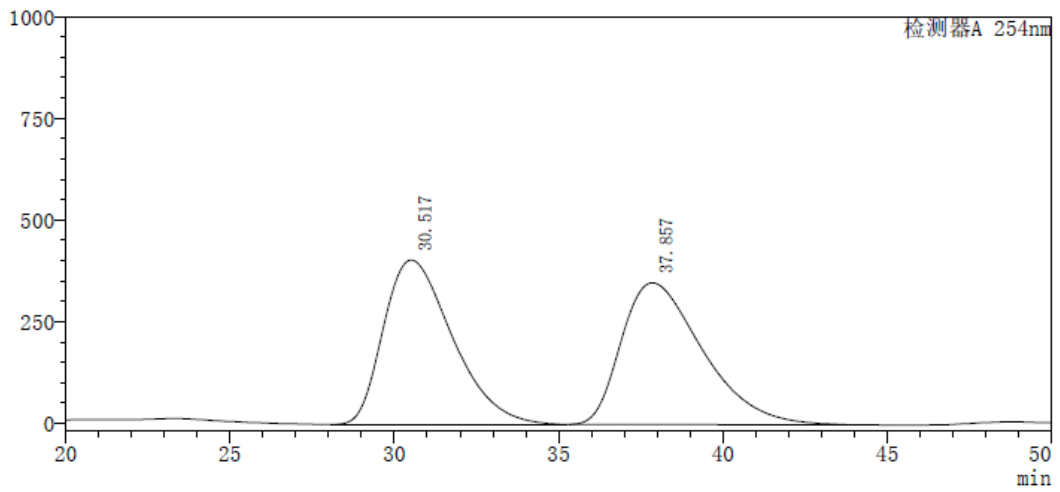
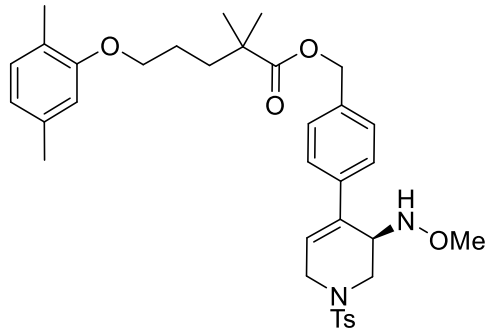


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	8.816	4917678	130343	28.084	28.084
2	10.167	12592796	318681	71.916	71.916
总计		17510474	449024		100.000

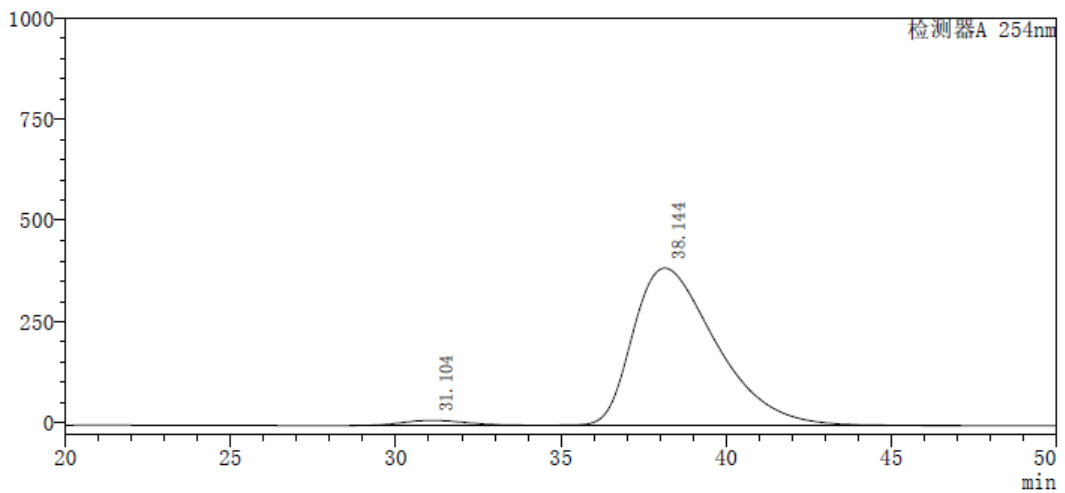
4a: ASH, *i*-PrOH/hexane = 10/90, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	30.517	58969731	404011	49.601	49.601
2	37.857	59917526	348210	50.399	50.399
总计		118887257	752221		100.000

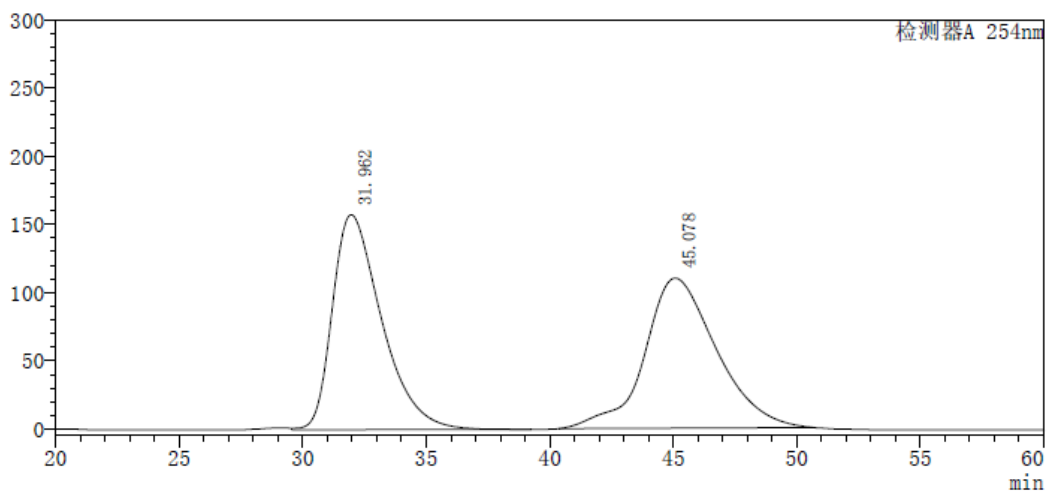
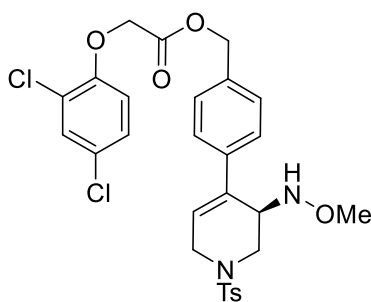


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	31.104	1818185	12963	2.592	2.592
2	38.144	68330090	388398	97.408	97.408
总计		70148275	401361		100.000

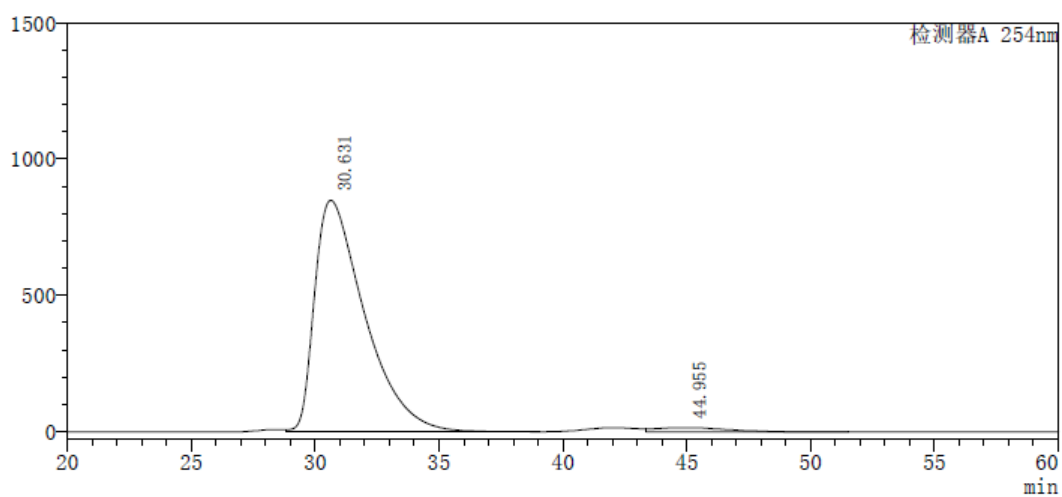
4b: OZH, *i*-PrOH/hexane = 50/50, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	31.962	21851082	157539	49.552	49.552
2	45.078	22245872	109841	50.448	50.448
总计		44096954	267380		100.000

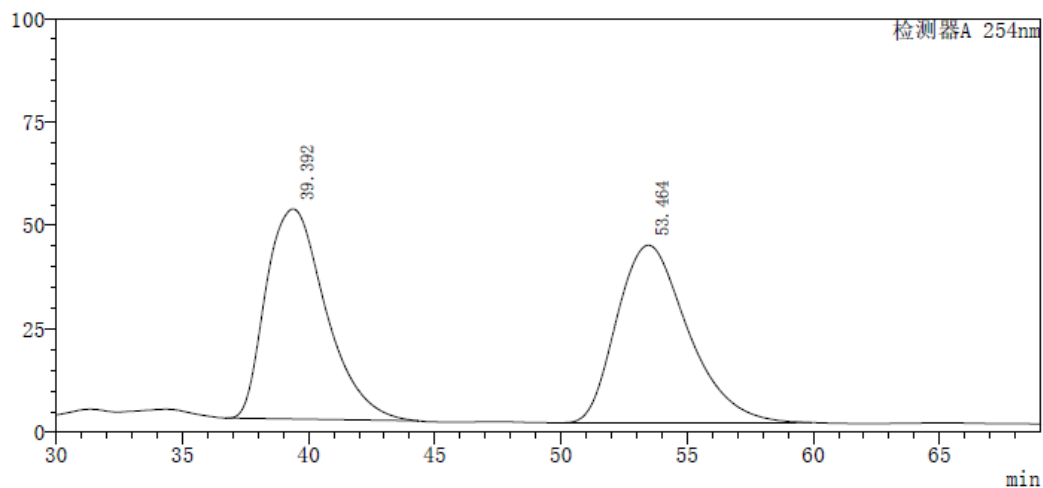
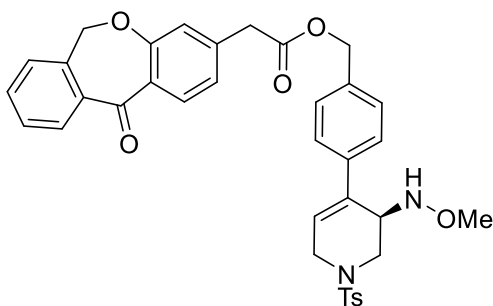


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	30.631	119655241	849177	97.516	97.516
2	44.955	3048338	15529	2.484	2.484
总计		122703578	864707		100.000

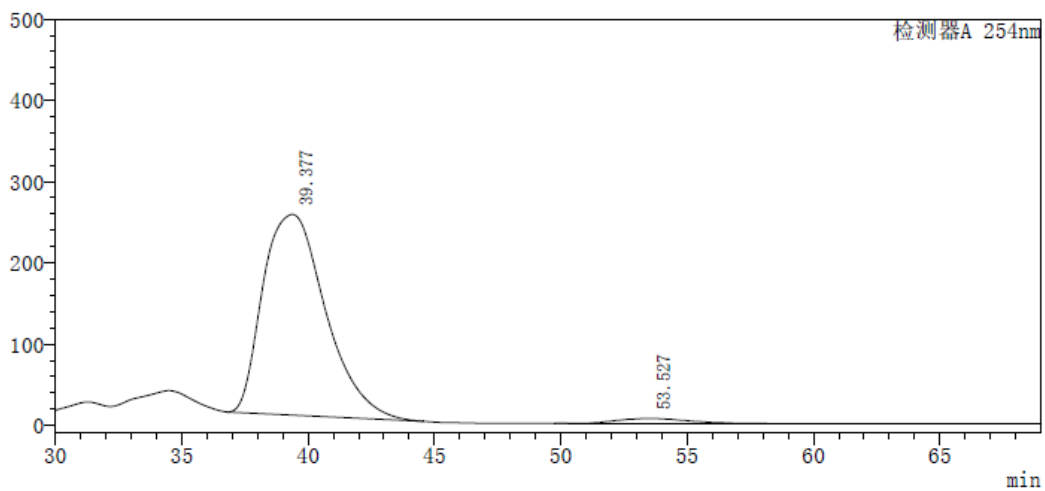
4c: ADH, *i*-PrOH/hexane = 50/50, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	39.392	8398926	50729	49.897	49.897
2	53.464	8433559	42902	50.103	50.103
总计		16832485	93631		100.000

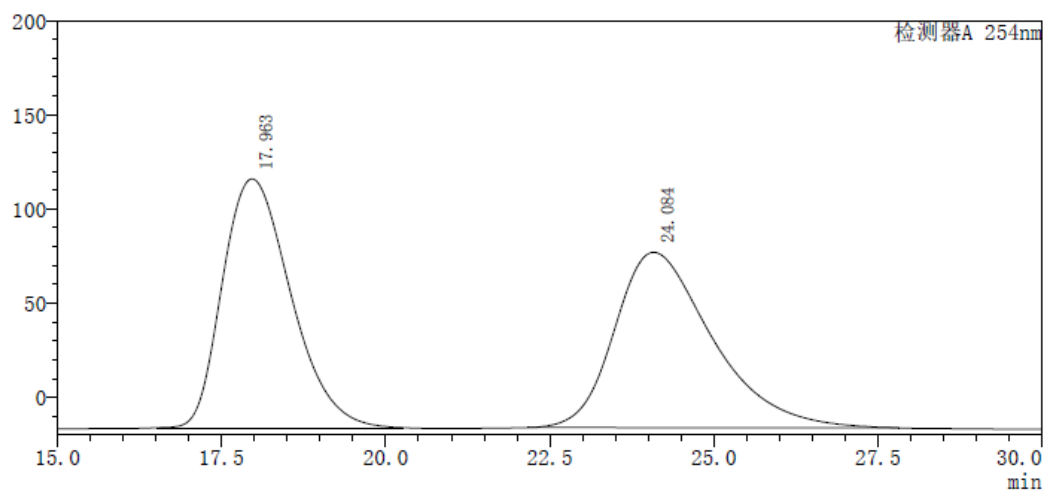
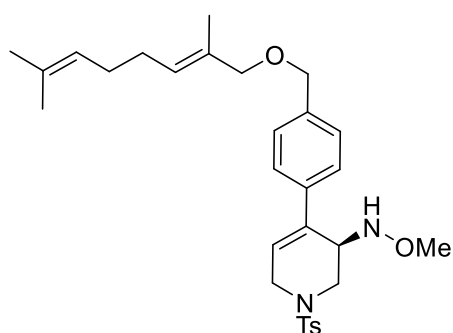


<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	39.377	42728501	246926	97.121	97.121
2	53.527	1266426	6287	2.879	2.879
总计		43994927	253213		100.000

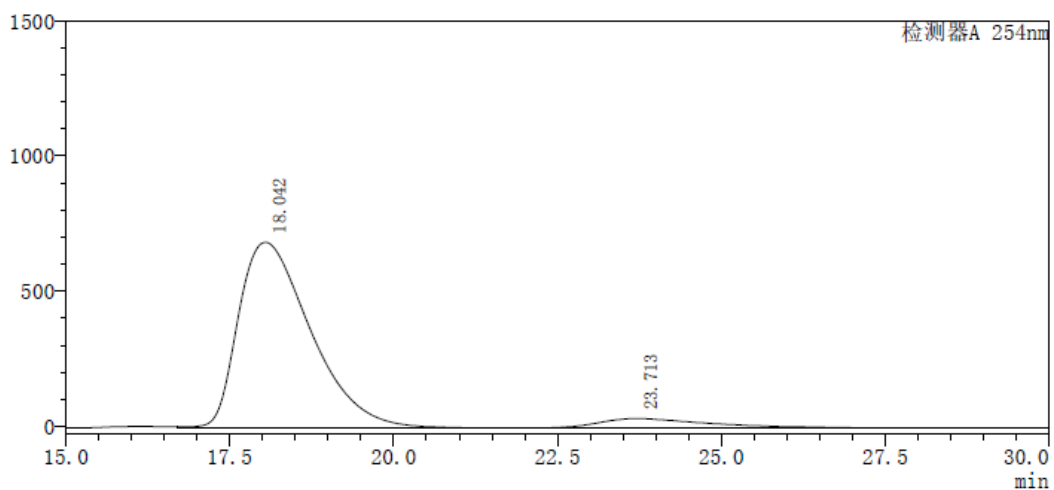
4d: OZH, *i*-PrOH/hexane = 20/80, $v = 1.0$ mL/min, $\lambda = 254$ nm



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	17.963	9533805	131966	49.700	49.700
2	24.084	9649061	93051	50.300	50.300
总计		19182866	225017		100.000



<峰表>

检测器A 254nm

峰号	保留时间	面积	高度	浓度	面积%
1	18.042	52416460	685311	93.007	93.007
2	23.713	3941314	34073	6.993	6.993
总计		56357774	719384		100.000

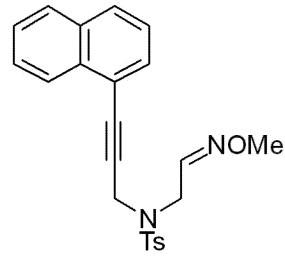
8. NMR Spectra

Parameter	Value
1 Title	qlj-7-120-H;
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	297.9
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2024-03-18T16:17:21
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1636.4
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

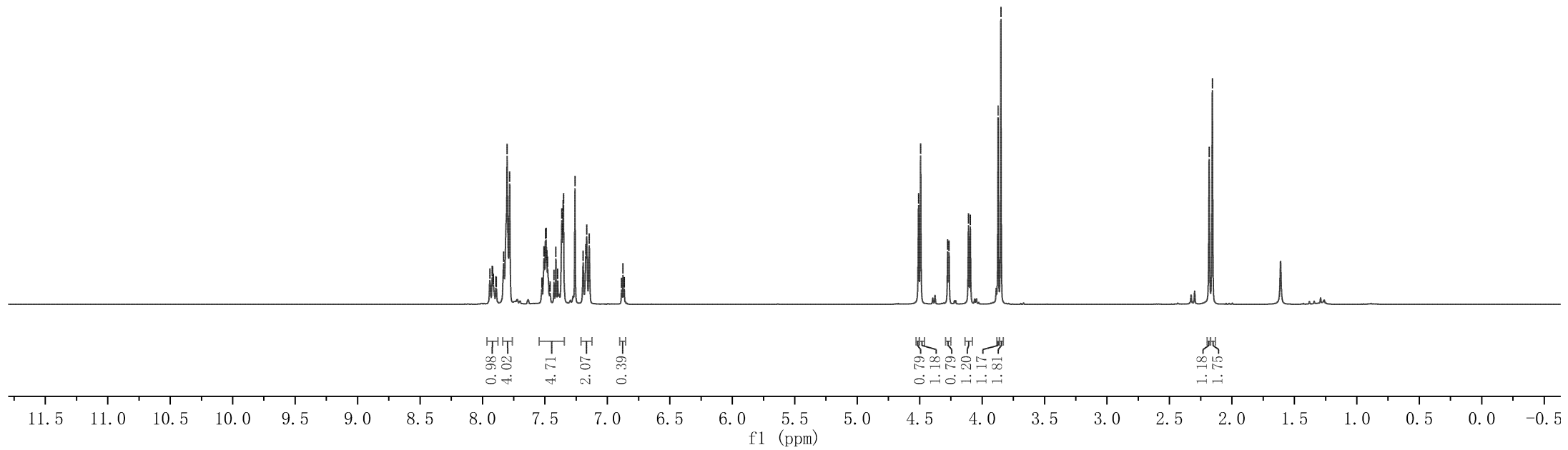
7.941
7.922
7.919
7.912
7.893
7.889
7.831
7.803
7.782
7.365
7.360
7.355
7.351
7.250
6.886
6.876
6.865

4.509
4.493
4.276
4.265
4.109
4.094
3.872
3.850

2.182
2.157



1n



Parameter	Value
1 Title	qlj-7-120-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	298.9
5 Number of Scans	300
6 Acquisition Time	1.3763
7 Acquisition Date	2024-03-18T12:01:54
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1848.8
11 Nucleus	¹³ C
12 Acquired Size	32768
13 Spectral Size	32768

147.20
144.93
143.96
143.89

130.64
129.69
129.62
127.66
126.67
126.35
124.99
119.73
119.62

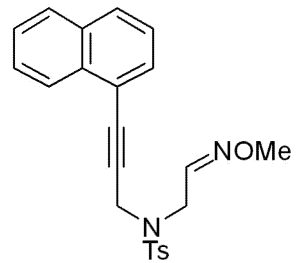
86.27
86.08
84.21

77.32
77.00
76.68

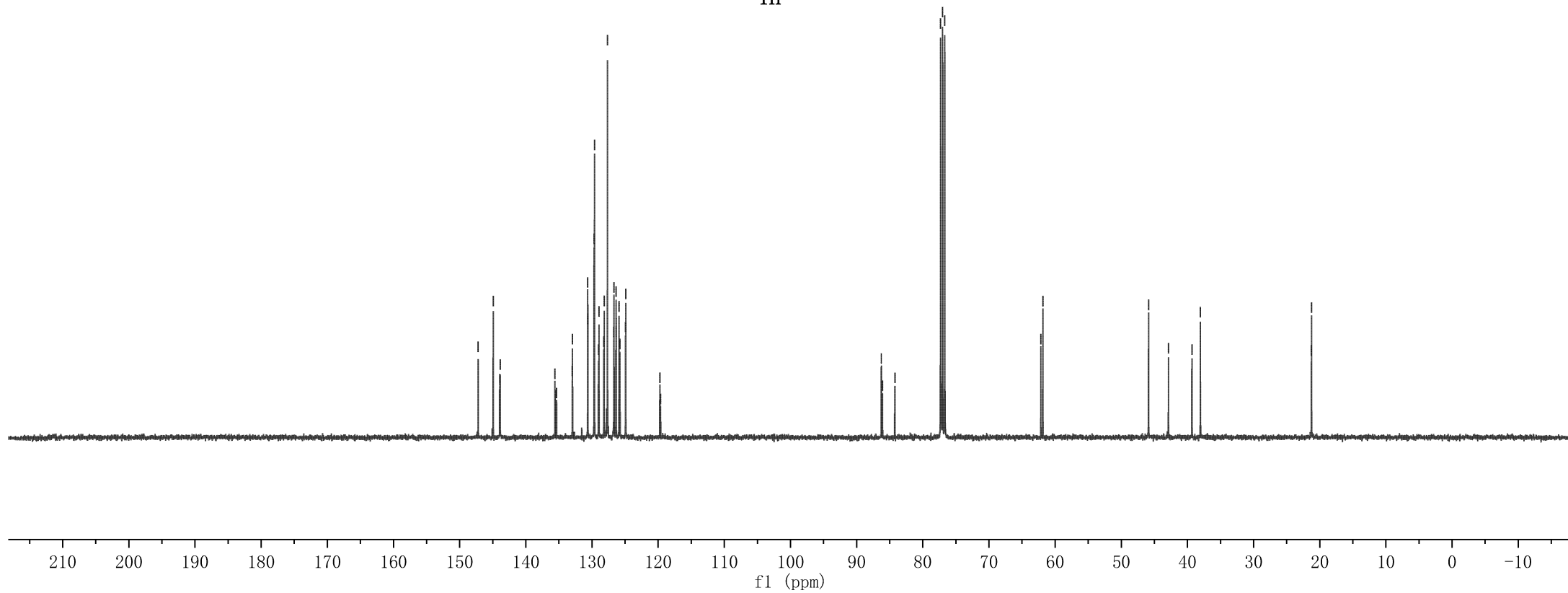
62.16
61.85

45.88
42.87
39.32
38.05

21.27
21.24

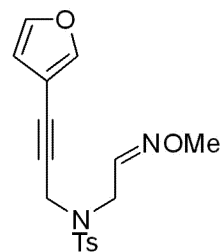


ln

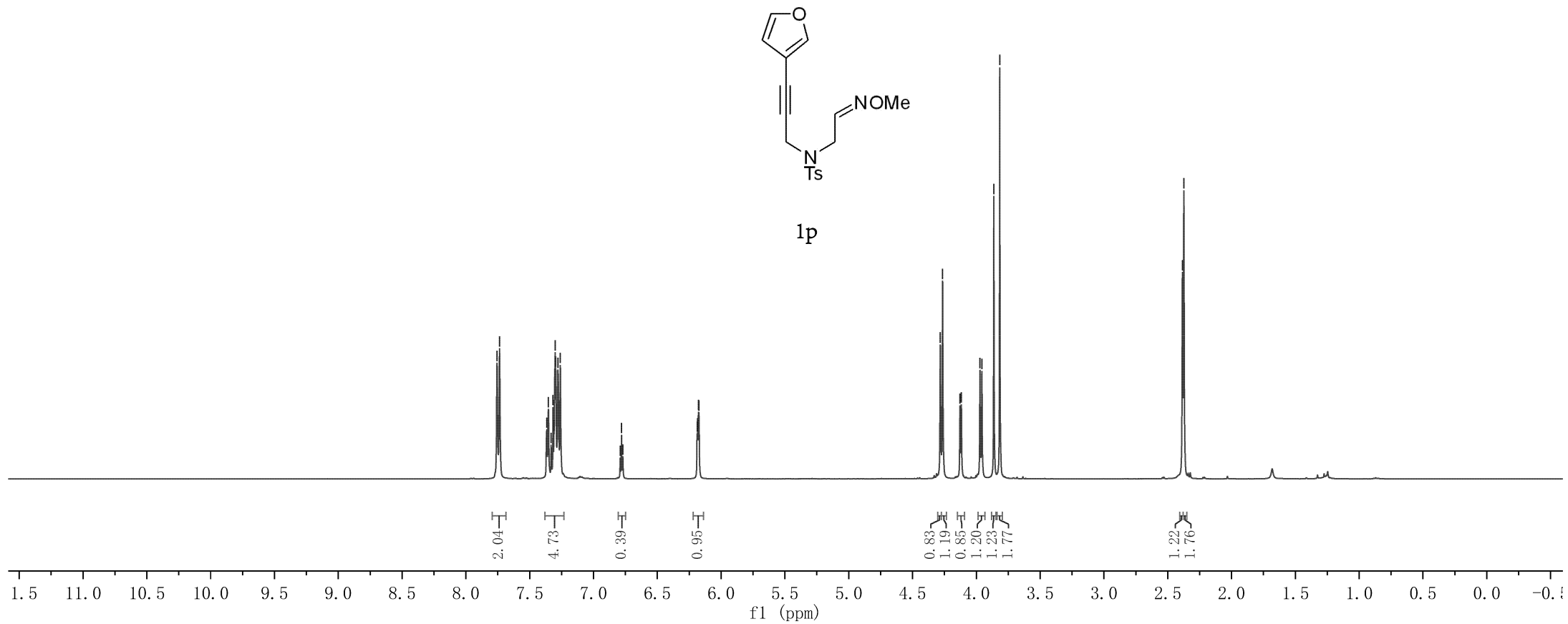


Parameter	Value
1 Title	qlj-11-40-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.3
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-19T08:43:57
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1636.4
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

7.756
7.736
7.317
7.300
7.296
7.279
7.269
6.780
6.770
6.187
6.184
6.183
6.177
6.174
4.282
4.264
4.128
4.118
3.971
3.957
3.863
3.817
2.385
2.374



1p



Parameter	Value
1 Title	qlj-11-40-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.1
5 Number of Scans	250
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-19T08:58:39
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1848.4
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768

147.37
145.82
145.80
145.06
143.84
143.75
142.68
142.61
135.68
135.40
129.62
129.54
127.74

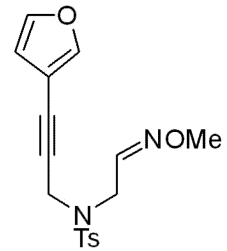
112.22
112.16
106.48
106.38

83.53
83.30
77.32
77.17
77.00
76.68

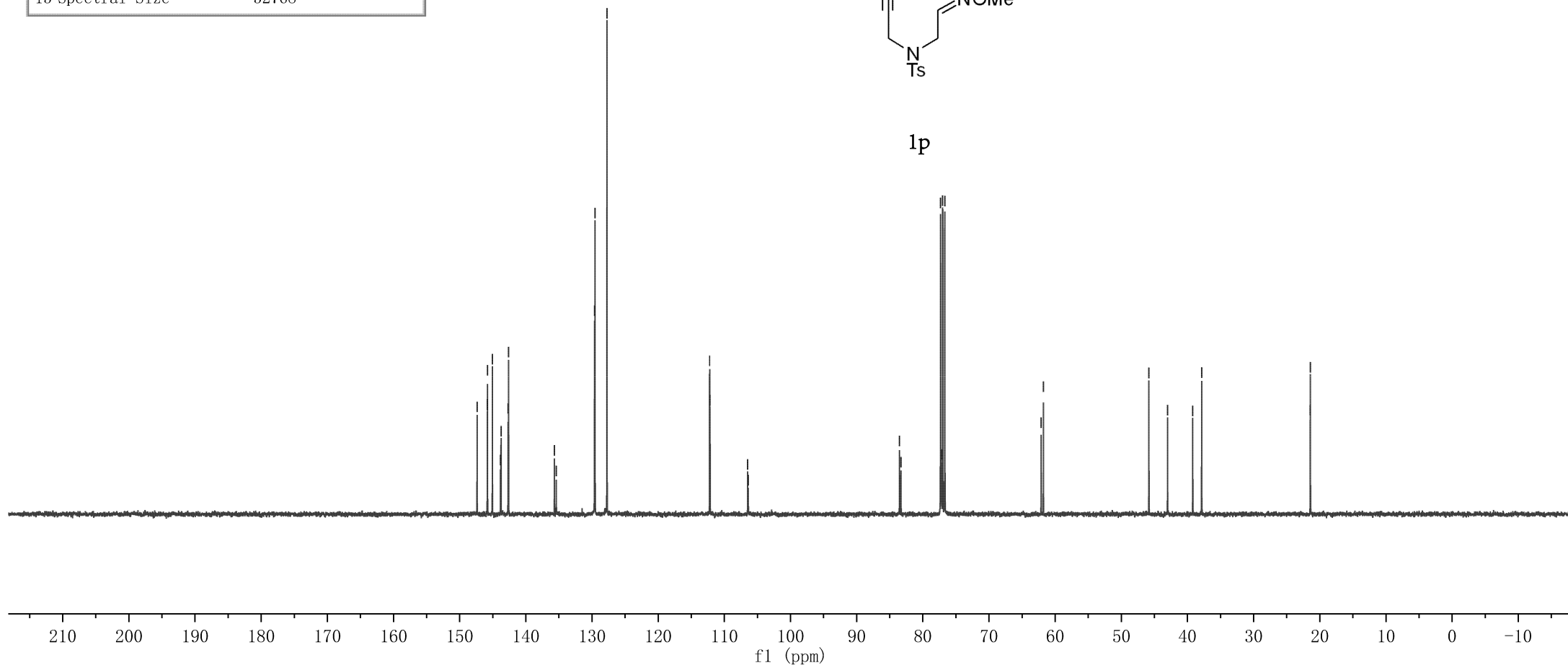
62.11
61.78

45.83
43.01
39.20
37.85

21.44
21.42



1p



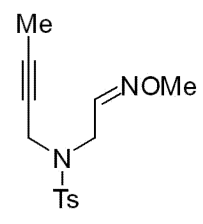
Parameter	Value
1 Title	ysh-0220
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	293.0
5 Number of Scans	16
6 Acquisition Time	4.0894
7 Acquisition Date	2023-02-07T11:08:00
8 Spectrometer Frequency	400.13
9 Spectral Width	8012.8
10 Lowest Frequency	-1548.9
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

7.646
7.637
7.626
7.617
7.251
7.229
7.210
7.196
7.181
6.674
6.664
6.654

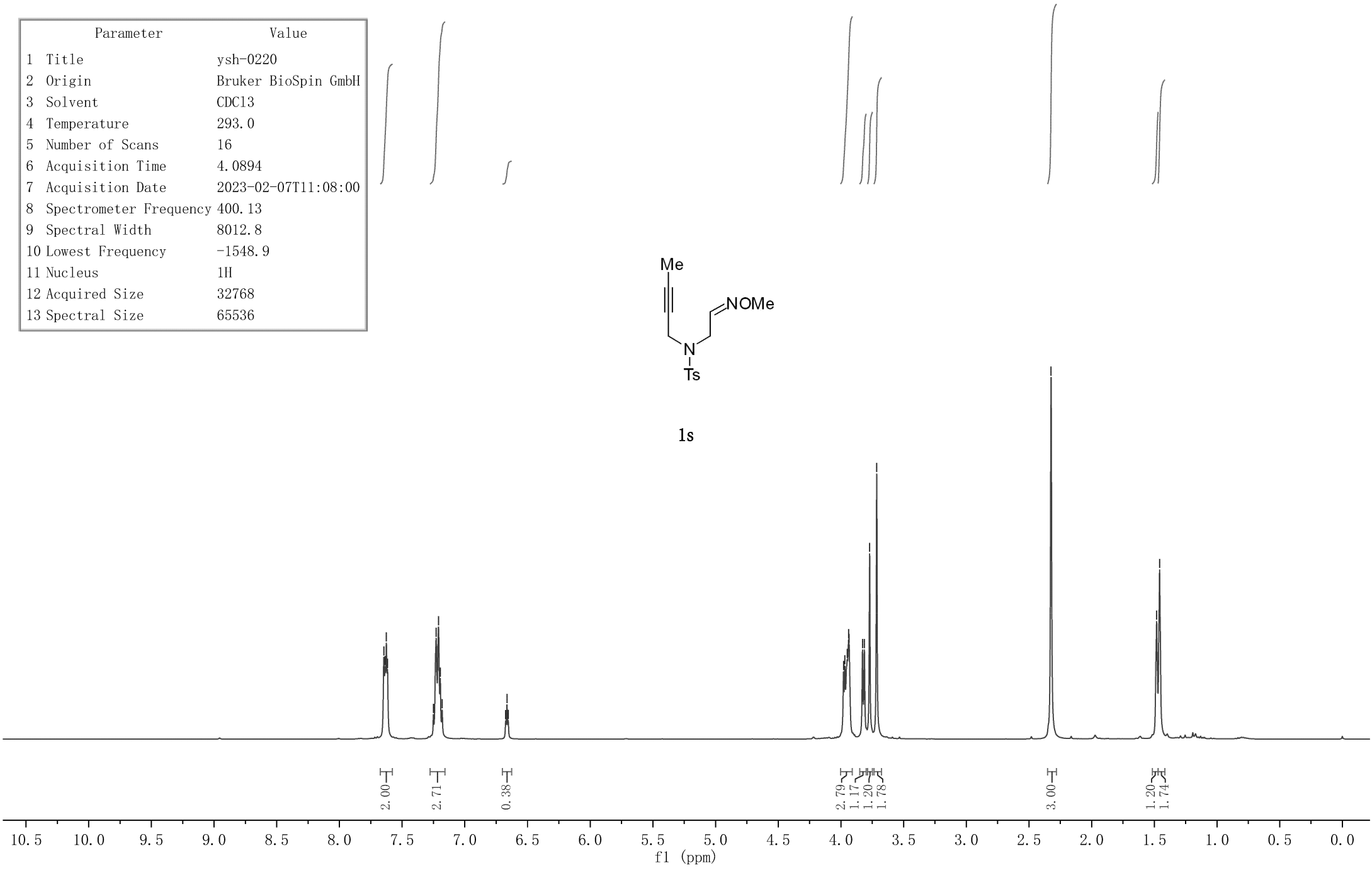
3.979
3.969
3.950
3.939
3.935
3.827
3.813
3.771
3.714

2.323

1.482
1.458



1s



Parameter	Value
1 Title	ysh-0220C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	293.5
5 Number of Scans	120
6 Acquisition Time	1.3631
7 Acquisition Date	2023-02-07T11:06:00
8 Spectrometer Frequency	100.61
9 Spectral Width	24038.5
10 Lowest Frequency	-1987.2
11 Nucleus	¹³ C
12 Acquired Size	32768
13 Spectral Size	65536

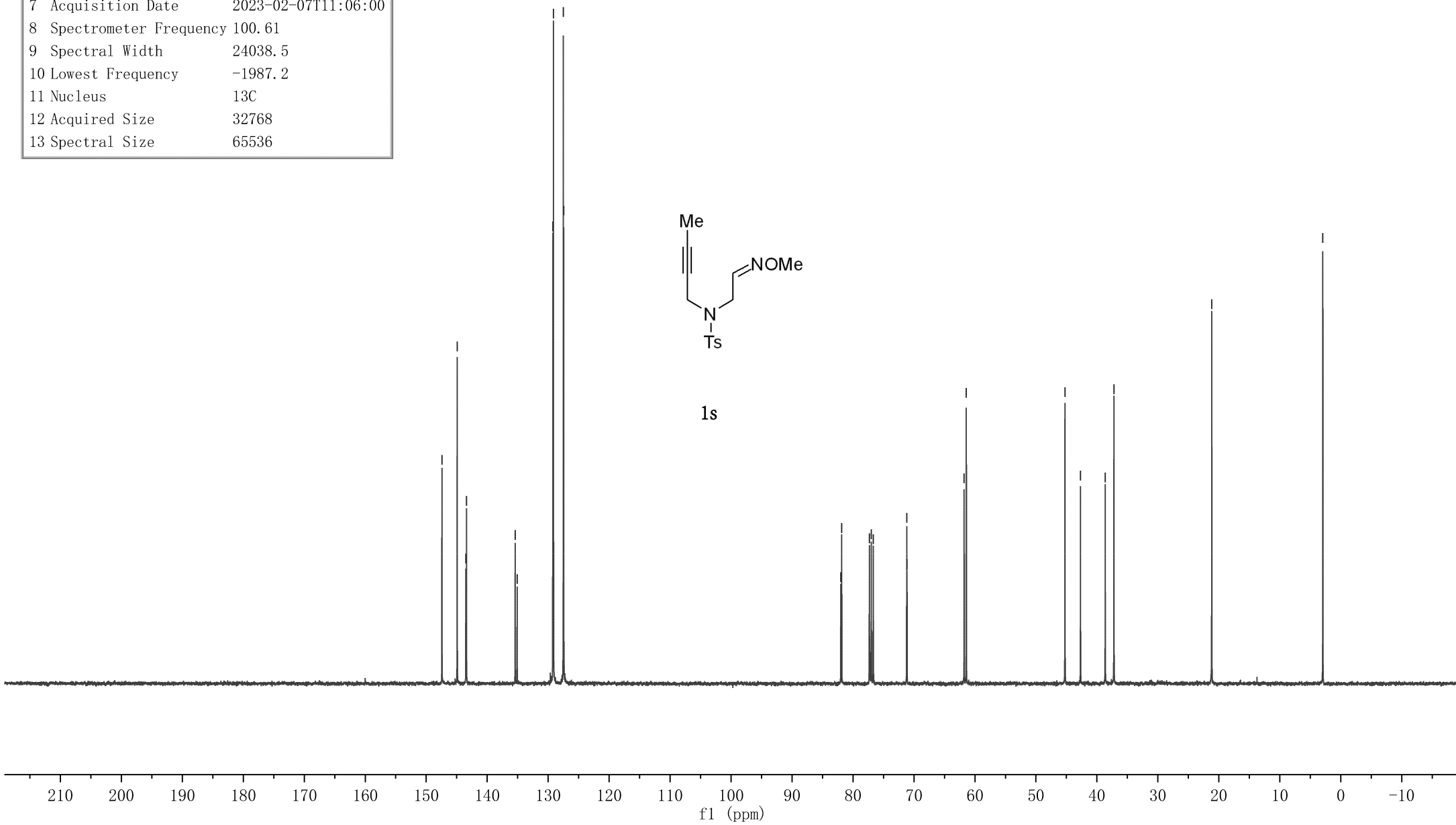
147.42
144.92
143.51
143.40
135.41
135.09
129.23
129.13
127.50
127.45

82.01
81.85
77.32
77.00
76.68
71.19
71.14
61.77
61.42

45.24
42.69
38.63
37.21

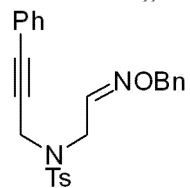
21.16

2.95

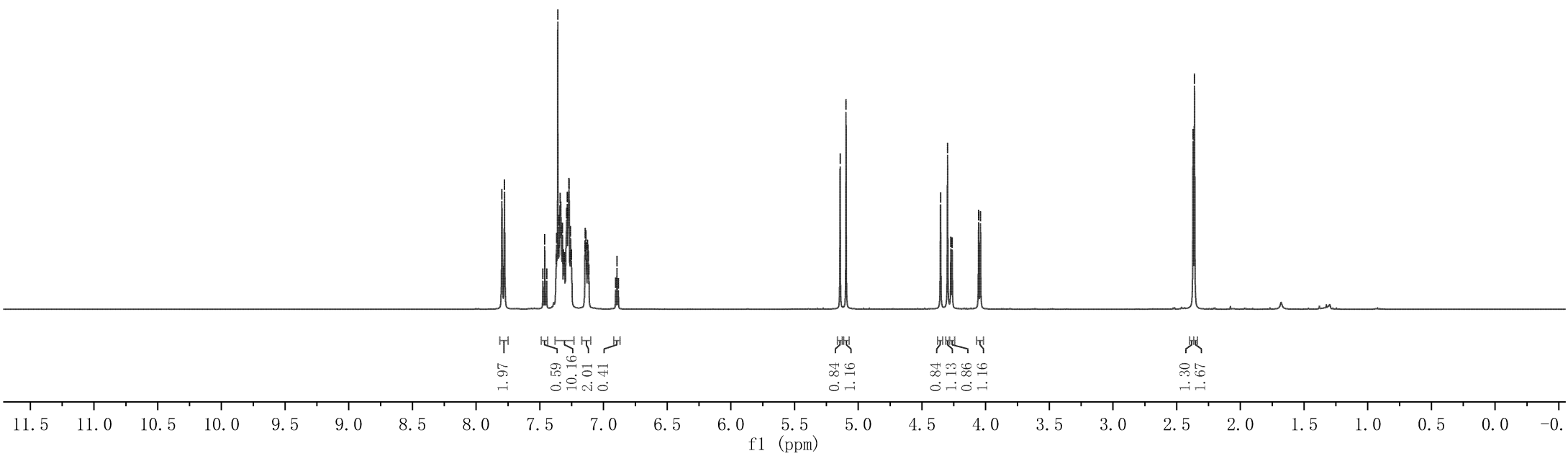


Parameter	Value
1 Title	qlj-11-47-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.3
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-27T08:50:28
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1626.8
11 Nucleus	1H
12 Acquired Size	32768
13 Spectral Size	65536

7.798 7.777 7.461 7.368 7.359 7.347 7.341 7.336 7.334 7.329 7.322 7.290 7.284 7.279 7.272 7.270 7.259 7.146 7.143 7.139 5.142 5.096 4.354 4.299 4.273 4.262 4.055 4.040 2.371 2.360



1t



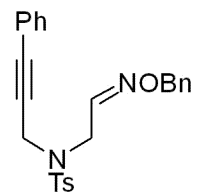
Parameter	Value
1 Title	qlj-11-47-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.1
5 Number of Scans	200
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-27T09:02:18
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1850.6
11 Nucleus	¹³ C
12 Acquired Size	32768
13 Spectral Size	32768

147.87
145.64
143.88
143.79
131.50
129.59
128.36
128.24
128.11
128.06
127.74
127.64
121.88

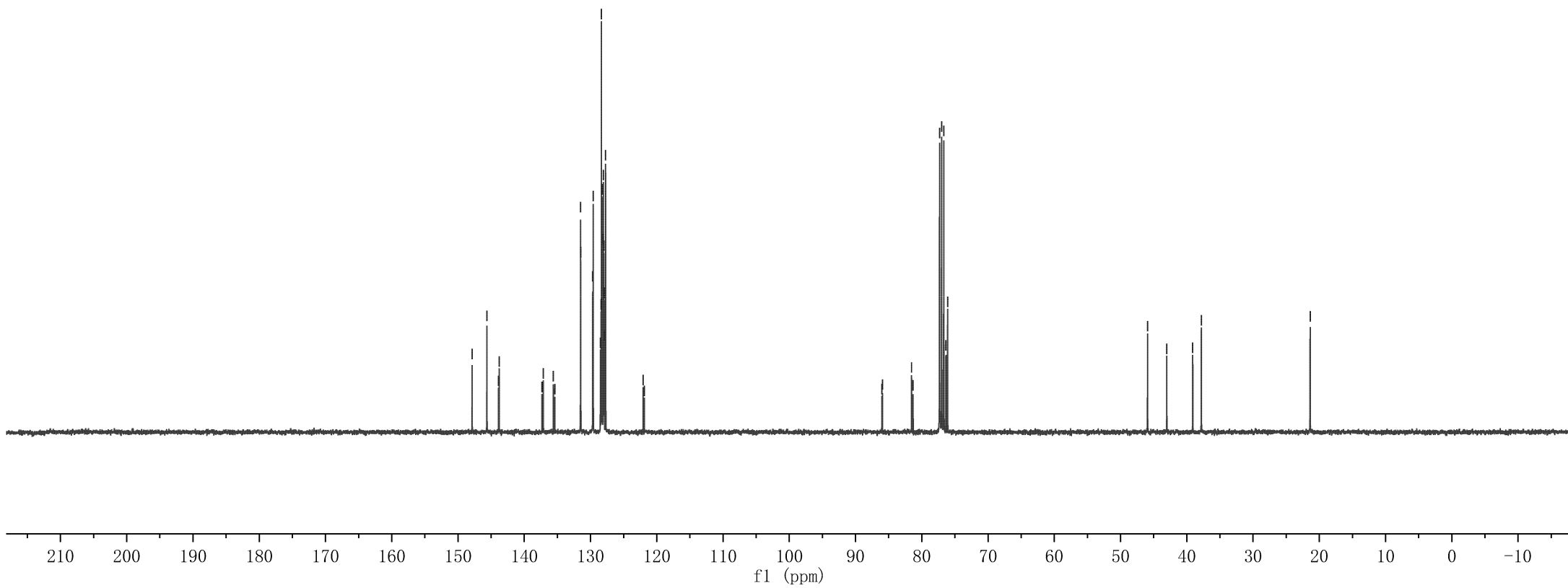
86.02
85.93
81.55
81.31
77.32
77.00
76.68
76.35
76.10

45.92
43.02
39.10
37.81

21.38

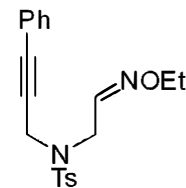
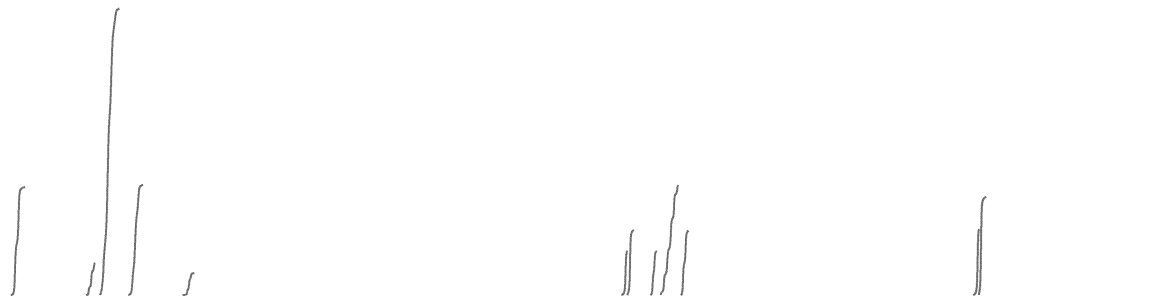


1t



Parameter	Value
1 Title	qlj-11-152-II
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	291.7
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2026-03-21T12:07:57
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1626.8
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

7.806 7.786 7.288 7.284 7.267 7.263 7.133 6.841 6.831 6.820 4.365 4.339 4.212 4.202 4.166 4.149 4.131 4.109 4.092 4.074 4.041 4.026 2.375 2.356 1.264 1.246 1.229



lu

11.5 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 -0.5

f1 (ppm)

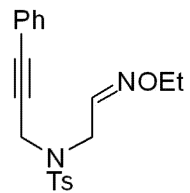
Parameter	Value
1 Title	qlj-11-152-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	292.4
5 Number of Scans	250
6 Acquisition Time	1.3763
7 Acquisition Date	2026-03-21T12:23:45
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1847.6
11 Nucleus	¹³ C
12 Acquired Size	32768
13 Spectral Size	32768

146.97
144.69
143.88
143.81
131.52
131.47
129.61
128.12
128.06
127.75
127.06
121.94

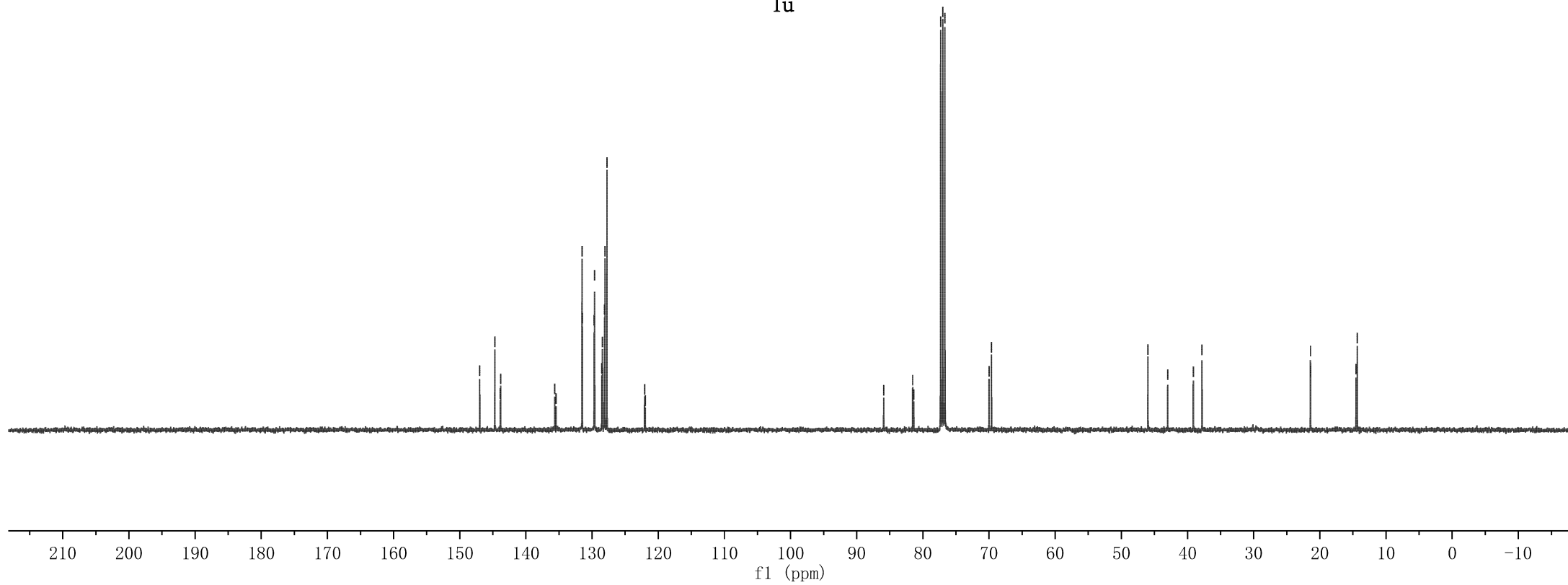
85.91
81.54
81.37
77.32
77.00
76.68
70.00
69.62

45.99
43.00
39.13
37.81

21.44
21.41
14.53
14.36



1u



Parameter	Value
1 Title	qlj-11-46-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.2
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-25T18:16:29
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1693.5
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

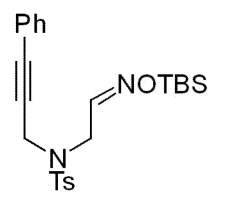
7.641
7.620
7.374
7.359
7.344
7.146
7.139
7.133
7.122
7.118
7.110
7.102
7.097
7.091
7.080
7.074
6.981
6.963
6.946
6.942
6.888
6.877
6.867

4.192
4.162
4.119
4.109
3.905
3.891

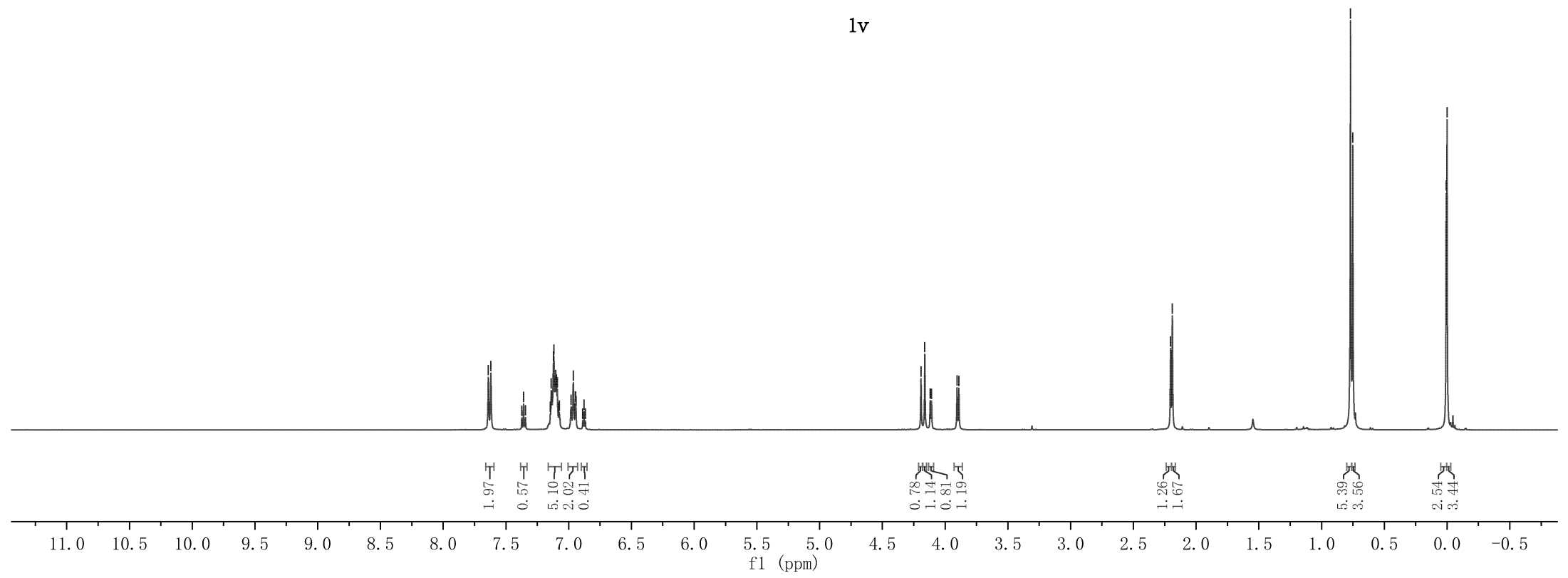
2.204
2.189

0.770
0.751

0.007
0.000



1v



Parameter	Value
1 Title	qlj-11-46-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.9
5 Number of Scans	200
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-25T18:28:20
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1849.6
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768

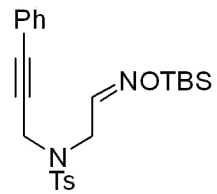
151.75
149.73
143.85
143.77
131.50
129.65
129.60
128.07
128.02
127.74
122.68

85.92
81.45
81.35
77.32
77.00
76.68

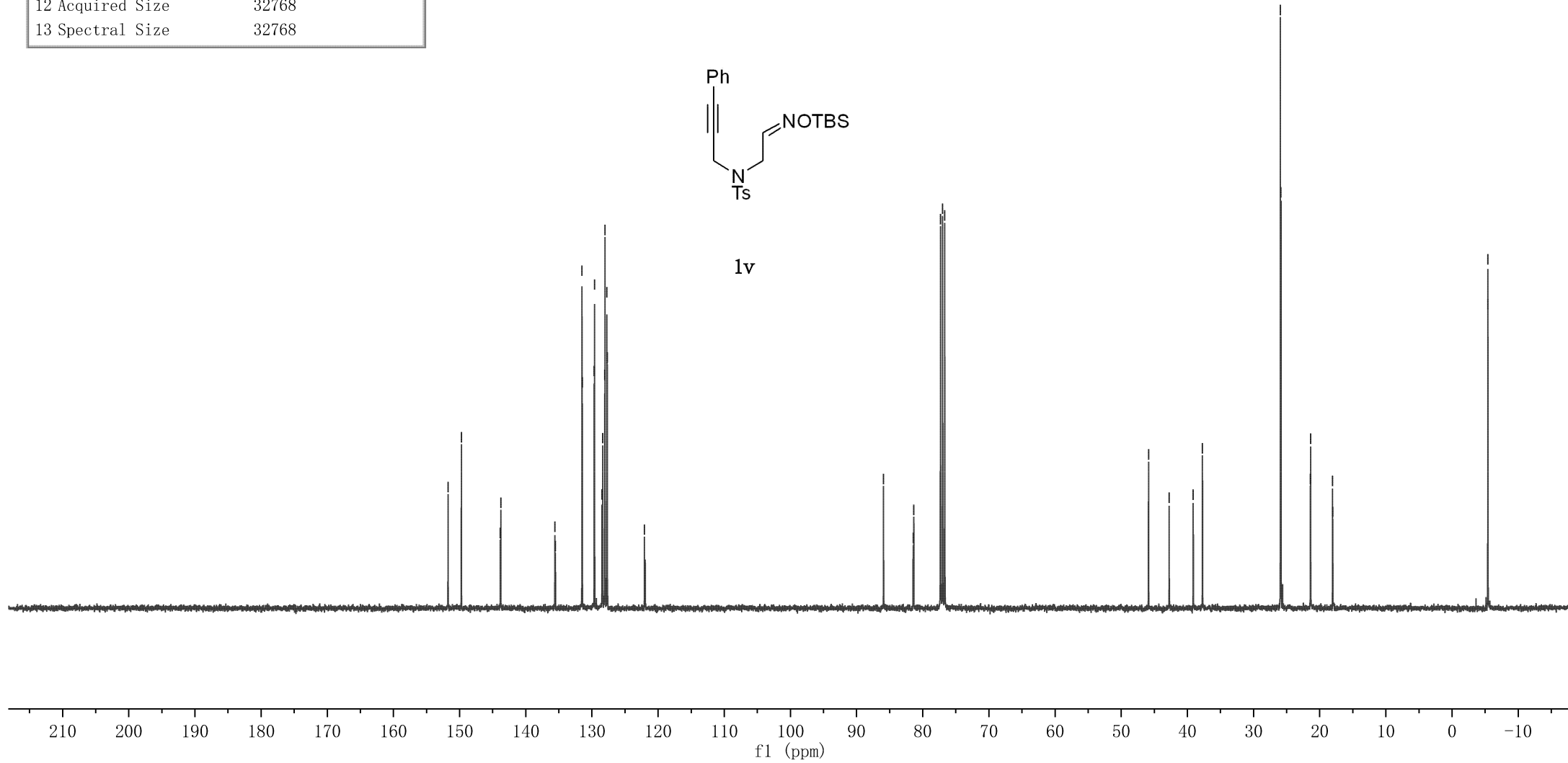
45.87
42.75
39.12
37.72

25.94
25.86
21.39
21.37
18.06
18.02

-5.41
-5.42



1v



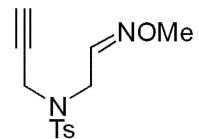
Parameter	Value
1 Title	qlj-7-178-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	294.4
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2024-04-25T12:01:59
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1626.8
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

7.748
7.744
7.728
7.723

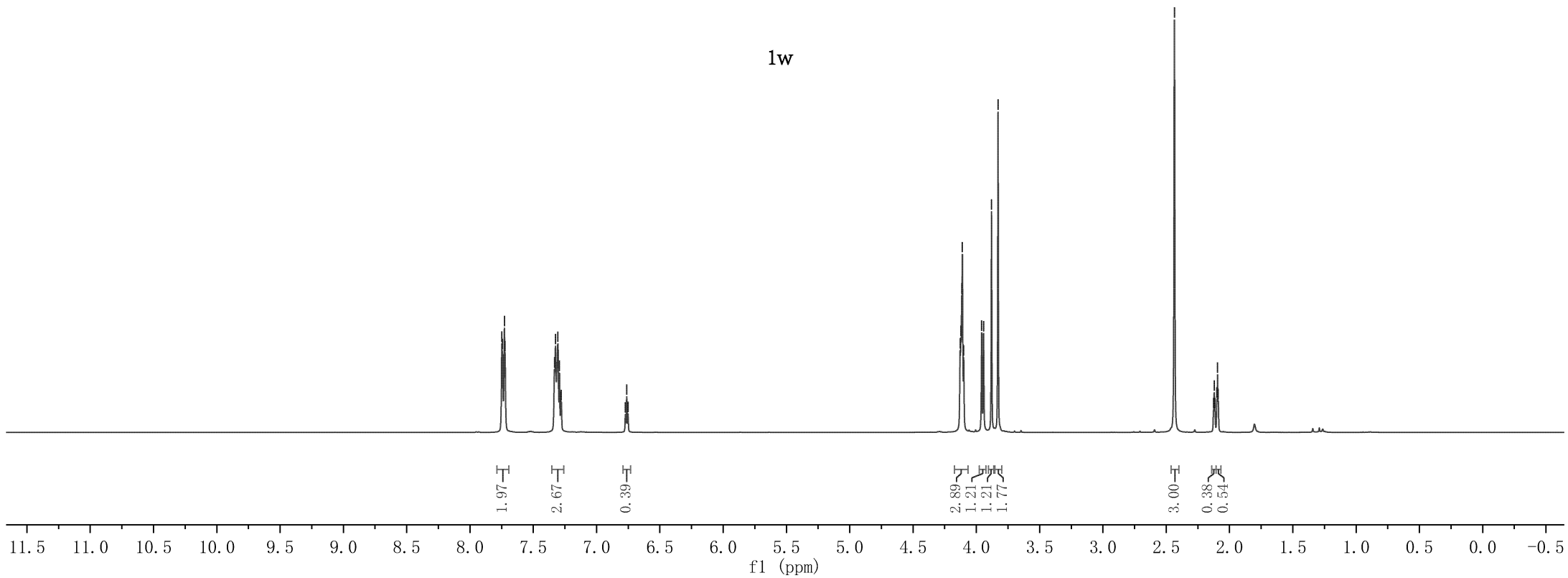
7.332
7.325
7.306
7.293
7.279
6.762
6.752

4.128
4.122
4.115
4.110
4.100
3.958
3.943
3.880
3.829

2.435
2.126
2.121
2.115
2.100
2.094
2.089



1w



Parameter	Value
1 Title	qlj-7-178-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.2
5 Number of Scans	250
6 Acquisition Time	1.3763
7 Acquisition Date	2024-04-25T12:16:40
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1850.3
11 Nucleus	¹³ C
12 Acquired Size	32768
13 Spectral Size	32768

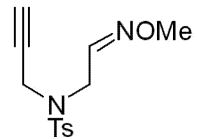
147.22
144.75
143.98
143.89
135.55
135.24
129.65
129.56
127.64
127.63

77.32
77.00
76.68
76.34
76.21
74.28
74.12

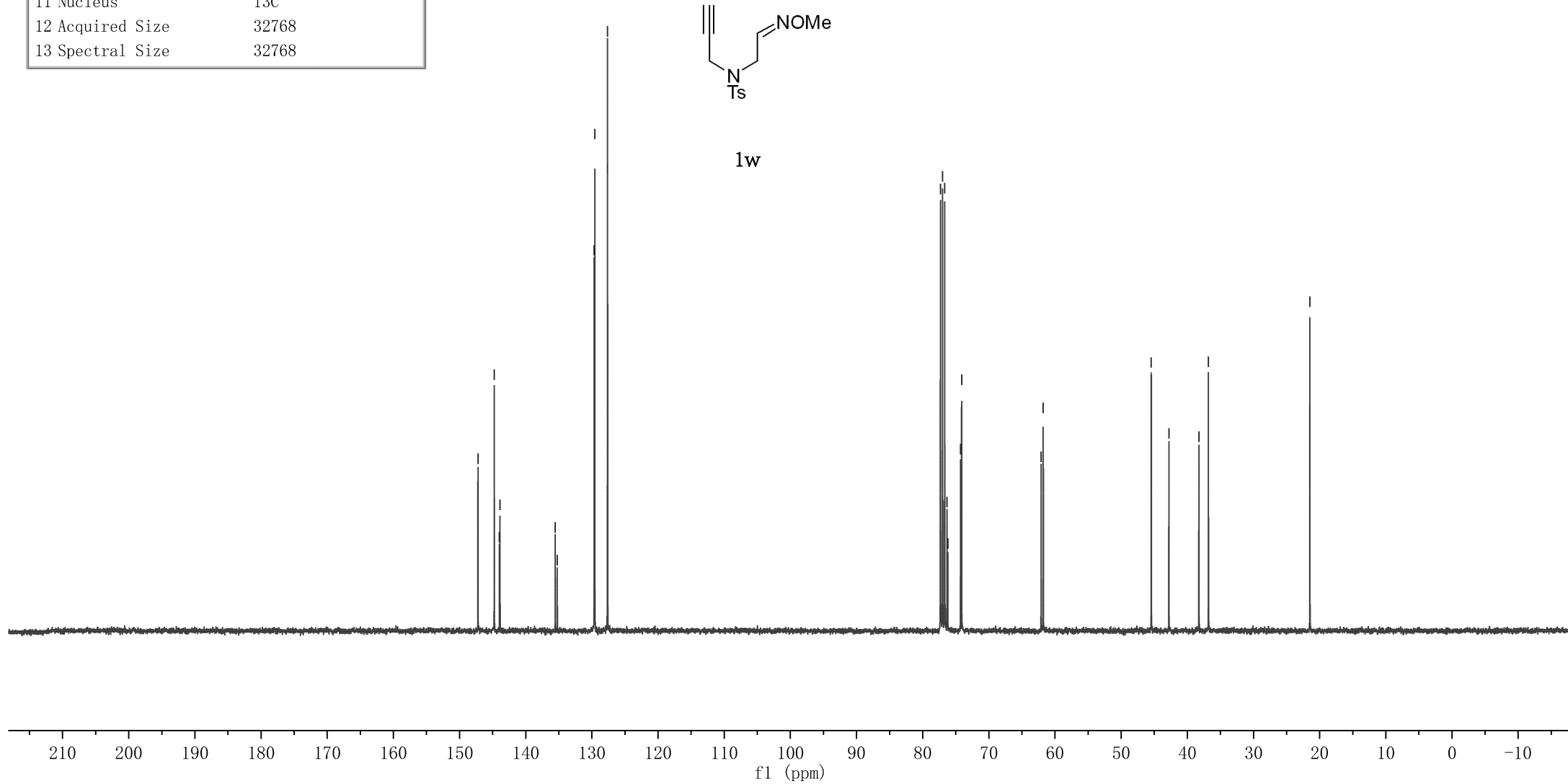
62.10
61.78

45.45
42.79
38.26
36.81

21.48

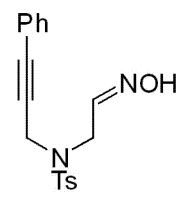


1w

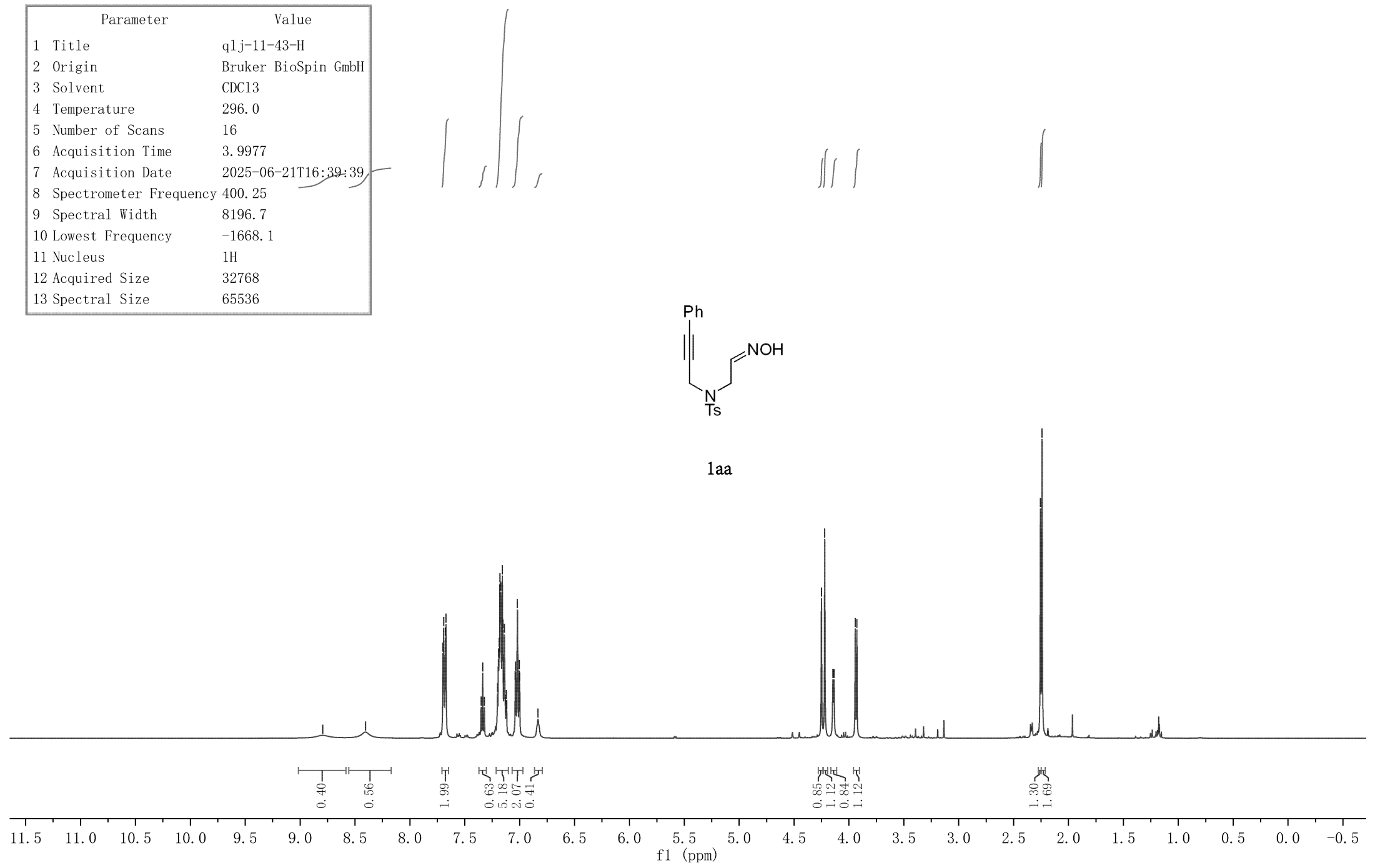


Parameter	Value
1 Title	qlj-11-43-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.0
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-21T16:39:39
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1668.1
11 Nucleus	1H
12 Acquired Size	32768
13 Spectral Size	65536

8.794 8.404 7.698 7.692 7.677 7.671 7.351 7.336 7.321 7.202 7.193 7.187 7.184 7.180 7.173 7.158 7.153 7.143 7.139 7.131 7.122 7.117 7.040 7.037 7.020 7.003 6.999 6.833 4.250 4.220 4.146 4.136 3.943 3.928 2.256 2.241



1aa



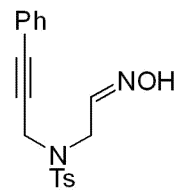
Parameter	Value
1 Title	qlj-11-43-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.7
5 Number of Scans	111
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-21T16:46:22
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1850.9
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768

148.71
146.57
143.97
143.91
131.50
131.46
129.63
128.09
128.04
127.73
127.89
121.83

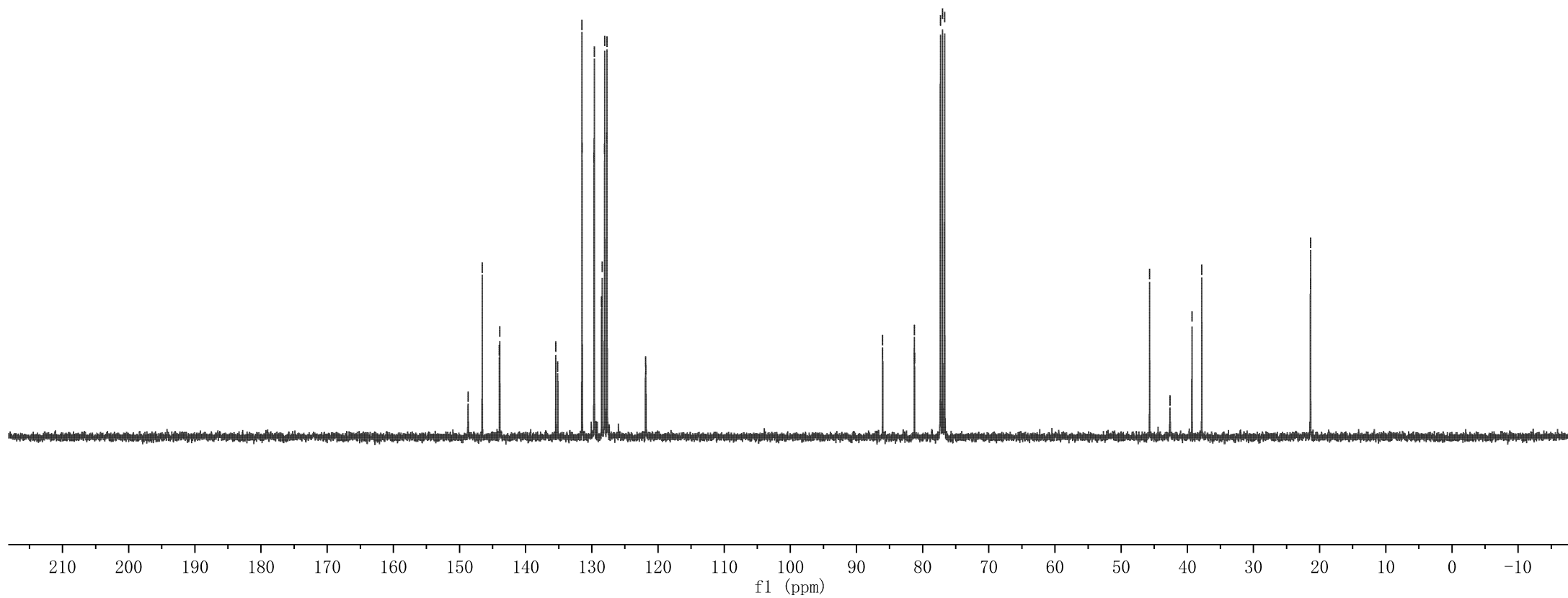
86.06
86.04
81.26
81.23
77.32
77.00
76.68

45.70
42.62
39.30
37.81

21.38
21.36

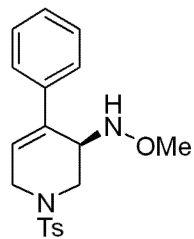


1aa

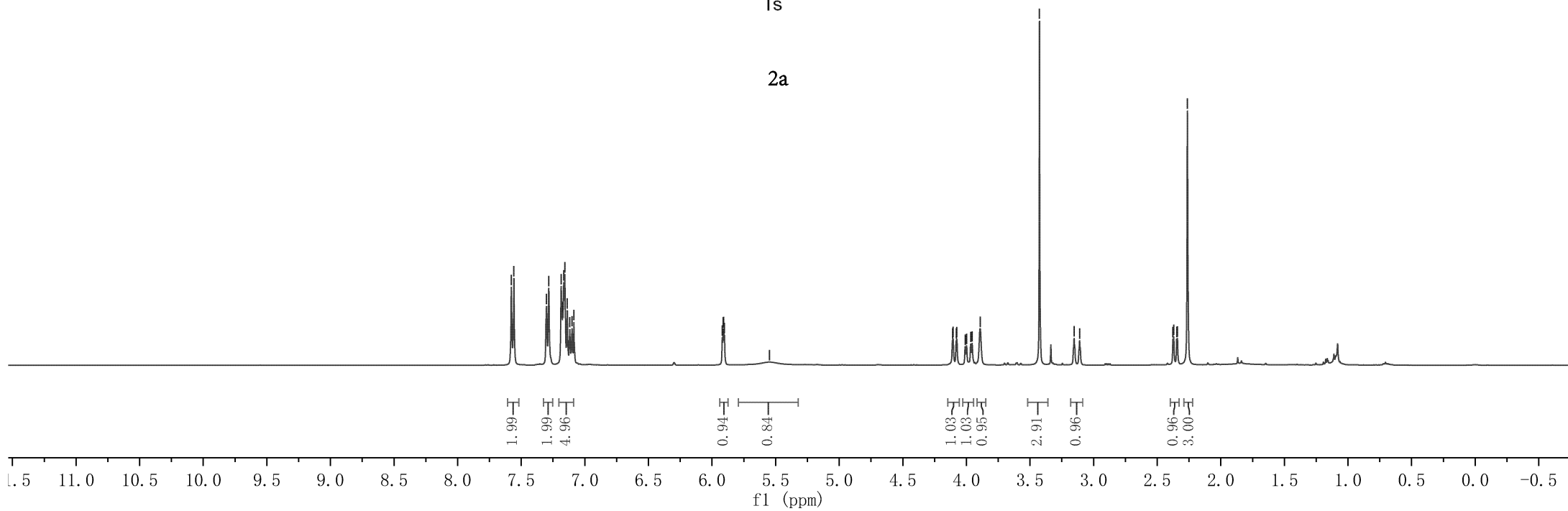


Parameter	Value
1 Title	qlj-11-32-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.5
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-06T14:01:27
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1706.0
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

7.578 7.558 7.302 7.284 7.186 7.174 7.166 7.157 7.138 7.118 7.100 7.086 5.919 5.913 5.909 5.902 5.549 4.109 4.105 4.079 4.076 4.010 3.999 3.966 3.955 3.892 3.425 3.153 3.110 2.376 2.370 2.347 2.341 2.262



2a



Parameter	Value
1 Title	qlj-11-32-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.7
5 Number of Scans	250
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-06T14:16:08
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1850.3
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768

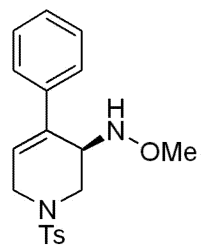
143.77
138.43
133.71
132.87
129.70
128.58
127.86
127.73
125.56
124.00

77.32
77.00
76.68

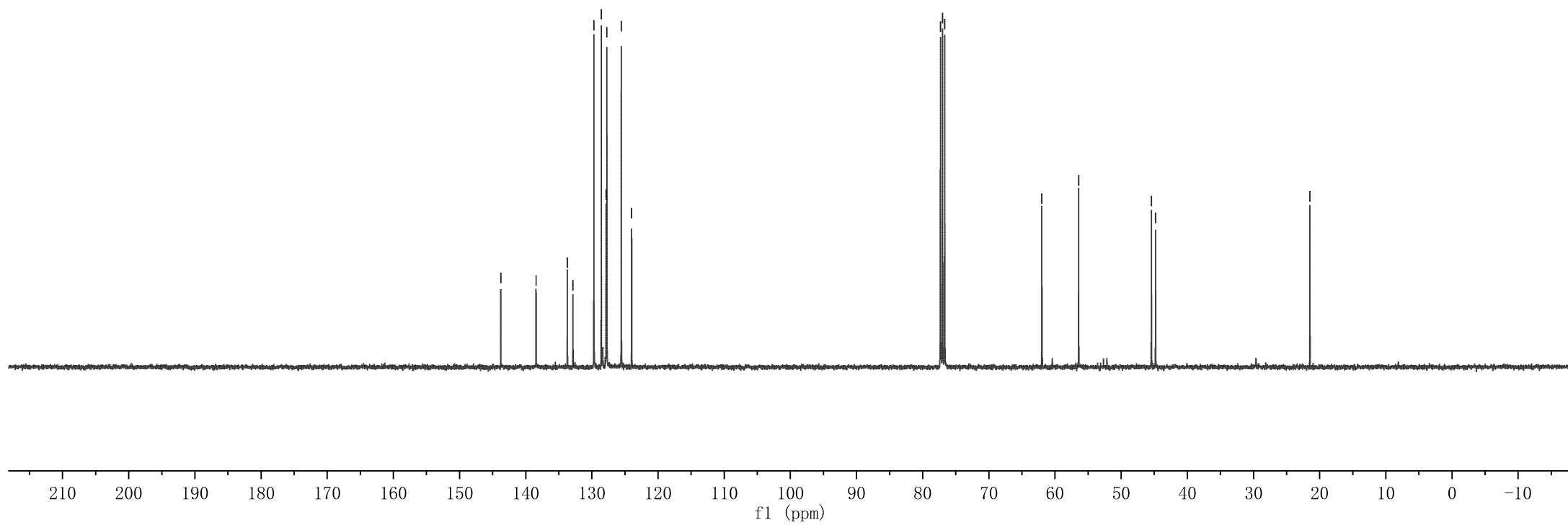
61.99
56.43

45.43
44.80

21.47

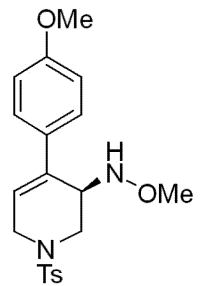


2a

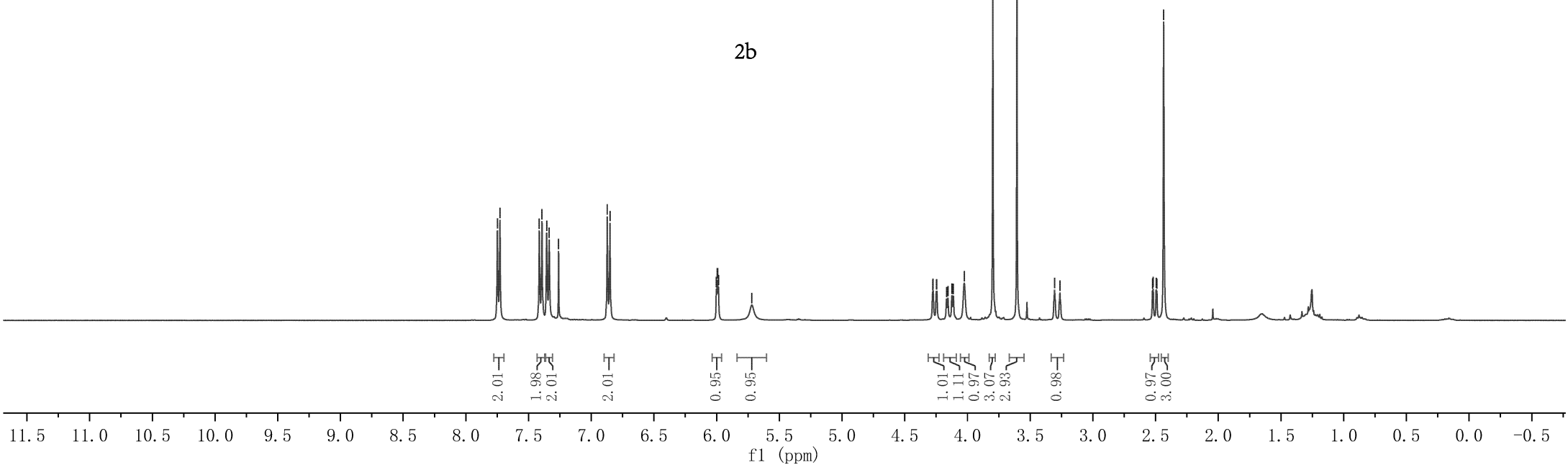


Parameter	Value
1 Title	qlj-11-33-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	294.8
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-05T14:03:09
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1636.3
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

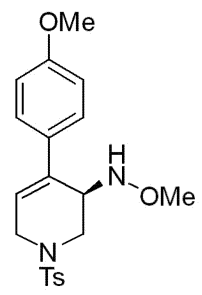
7.748
7.728
7.415
7.393
7.355
7.335
7.260
6.873
6.850
6.002
5.996
5.991
5.985
5.719
4.277
4.274
4.248
4.245
4.167
4.156
4.124
4.113
4.026
3.798
3.606
3.305
3.263
2.525
2.519
2.495
2.490
2.435



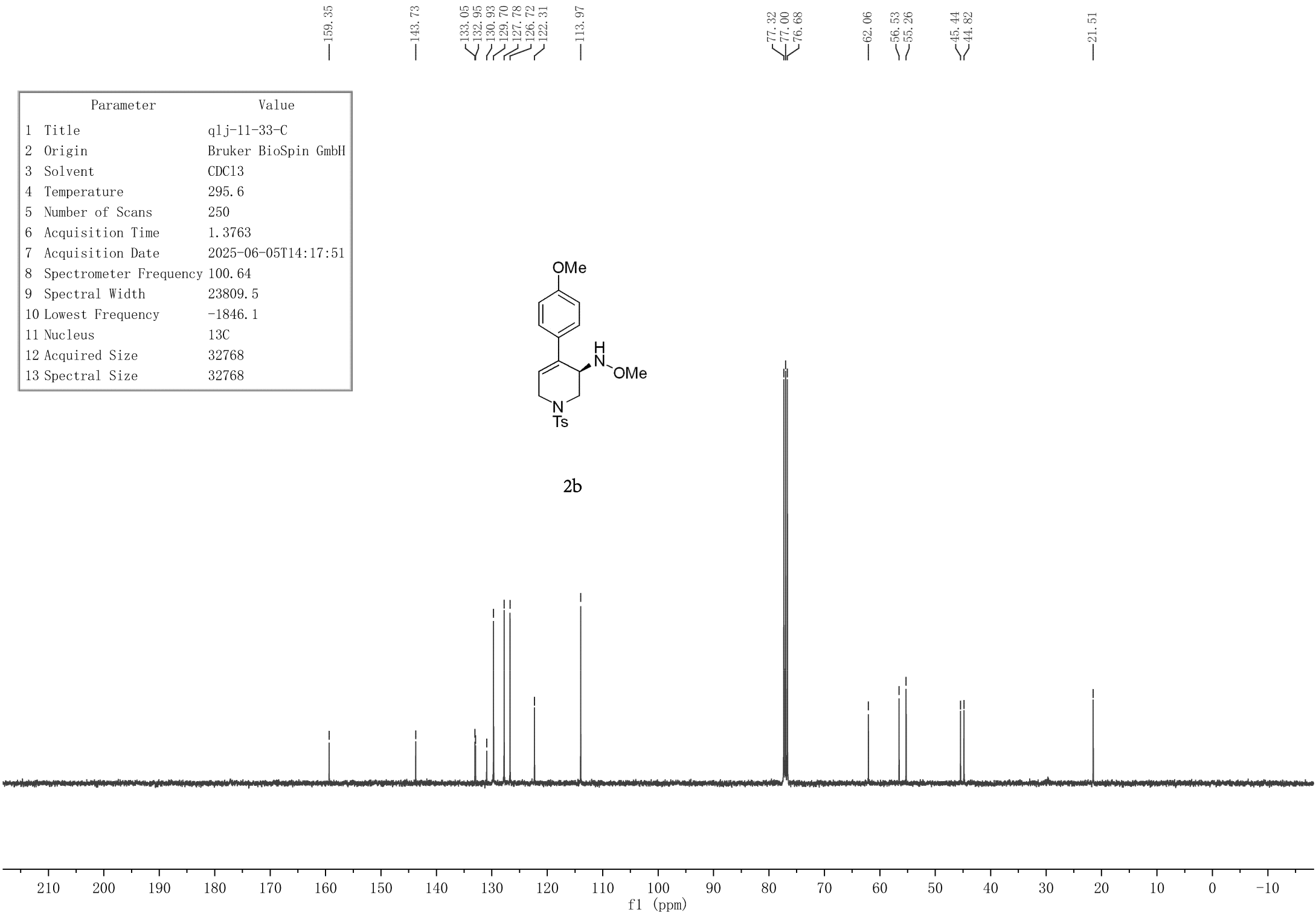
2b



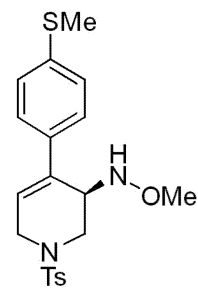
Parameter	Value
1 Title	qlj-11-33-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.6
5 Number of Scans	250
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-05T14:17:51
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1846.1
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768



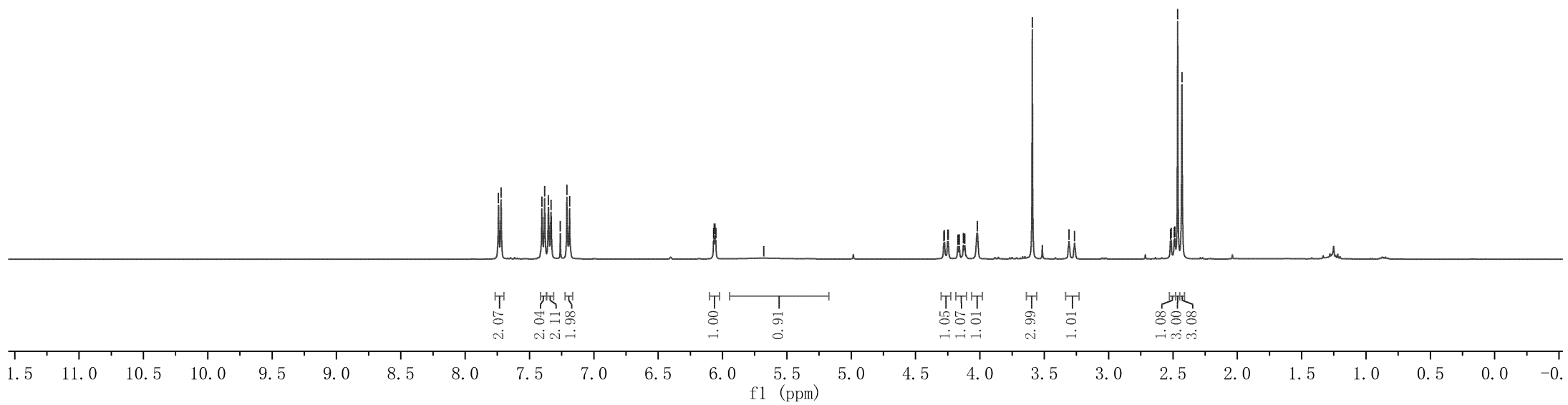
2b



Parameter	Value
1 Title	qlj-11-34-3-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.2
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-09T16:24:41
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1699.5
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536



2c



Parameter	Value
1 Title	qlj-11-34-3-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.9
5 Number of Scans	141
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-09T16:33:08
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1849.8
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768

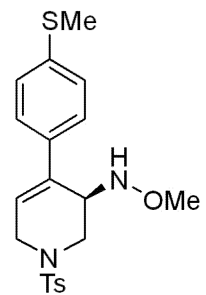
143.77
138.26
135.14
133.05
132.86
129.69
127.73
126.47
123.91
123.40

77.32
77.00
76.68

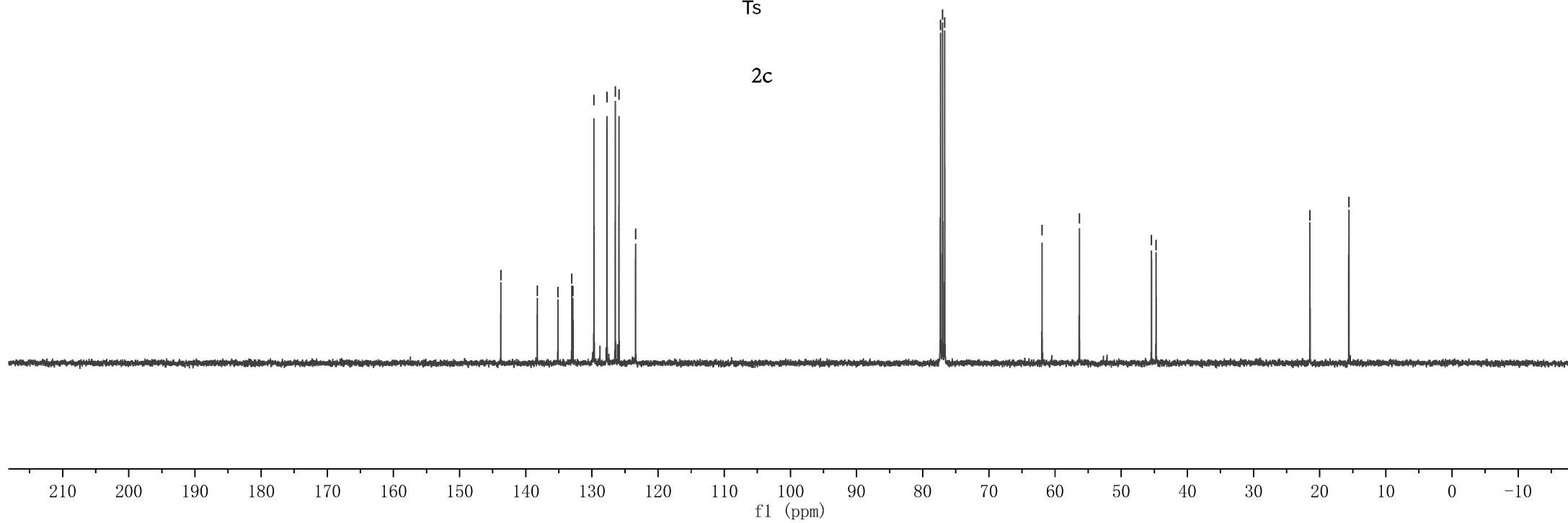
61.97
56.32

45.42
44.73

21.47
15.60

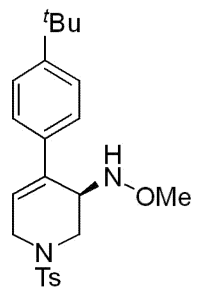


2c

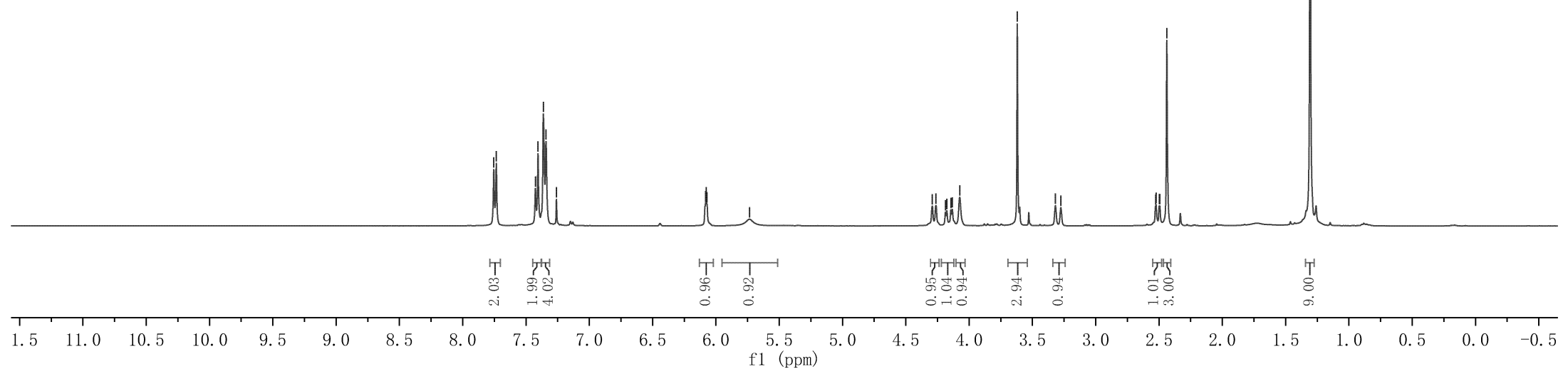


Parameter	Value
1 Title	qlj-11-34-2-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.4
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-09T15:40:30
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1703.0
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

7.755 7.735 7.426 7.406 7.363 7.342 7.260
6.082 6.077 6.071 5.735
4.291 4.262 4.187 4.176 4.144 4.133 4.074 3.620 3.318 3.275
2.527 2.523 2.498 2.494 2.438
1.307

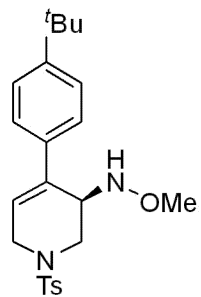


2d

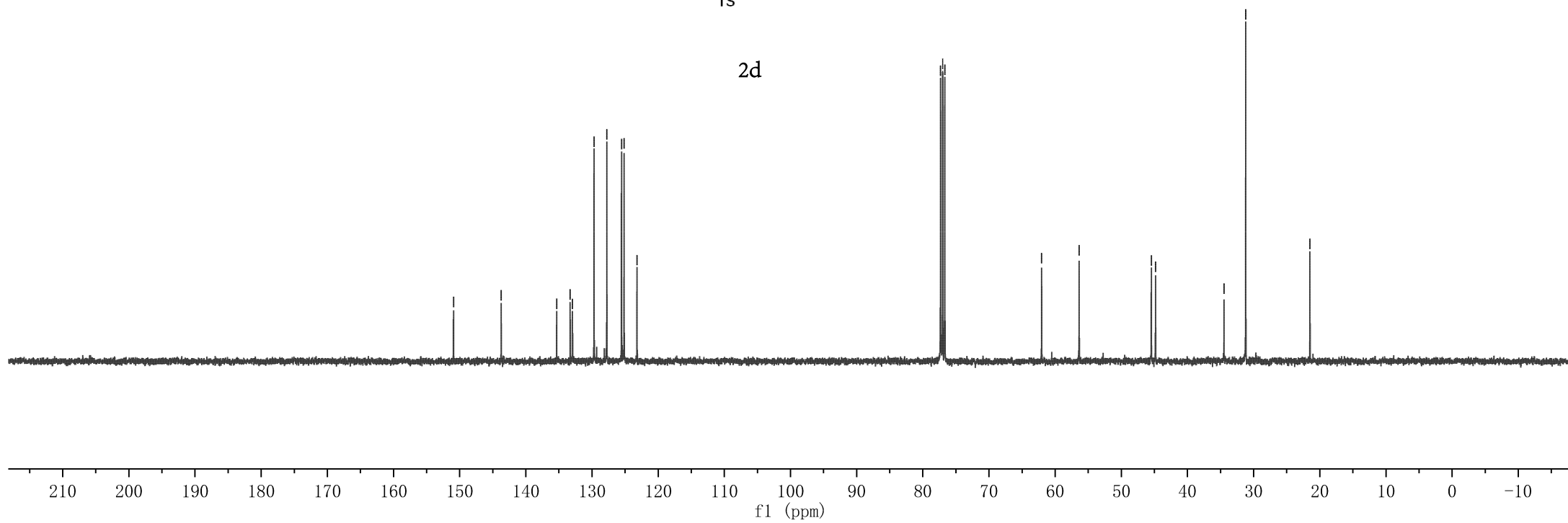


Parameter	Value
1 Title	qlj-11-34-2-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.7
5 Number of Scans	105
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-09T15:46:53
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1848.3
11 Nucleus	¹³ C
12 Acquired Size	32768
13 Spectral Size	32768

150.93 — 143.73 — 135.34 133.30 132.95 129.70 127.76 125.54 125.15 123.21 — 77.32 77.00 76.68 — 62.04 — 56.37 — 45.46 44.82 — 34.47 — 31.20 — 21.49

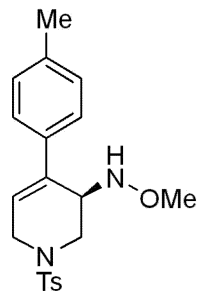
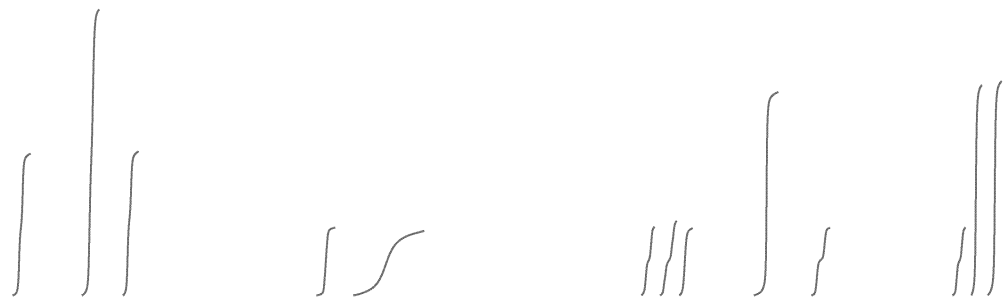


2d

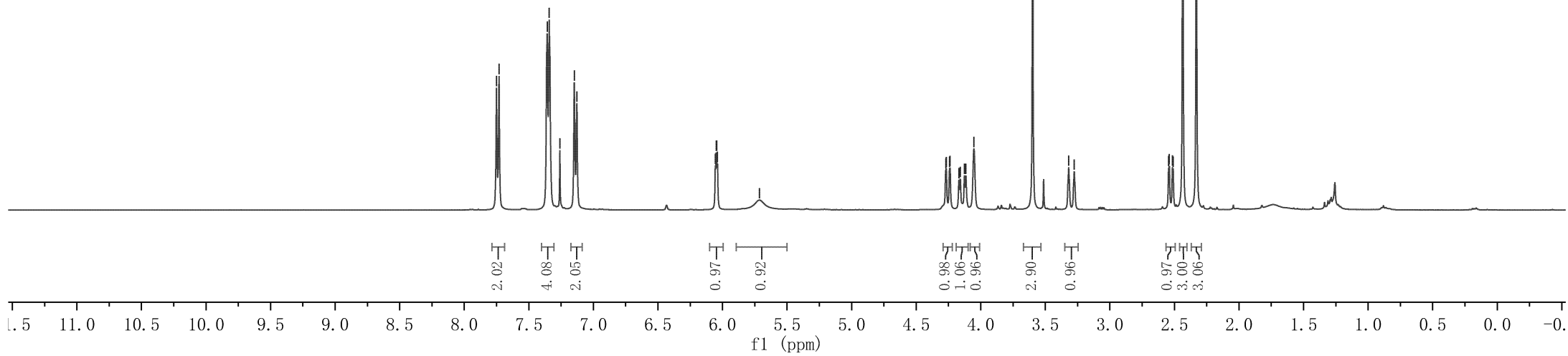


Parameter	Value
1 Title	qlj-11-34-1-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.3
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-09T15:21:09
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1636.5
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

7.751 7.731 7.358 7.342 7.260 7.148 7.128
6.055 6.049 6.045 6.039 5.715
4.270 4.268 4.241 4.238 4.169 4.158 4.126 4.115 4.053 3.599 3.319 3.276
2.545 2.540 2.516 2.510 2.436 2.331



2e



Parameter	Value
1 Title	qlj-11-34-1-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	297.0
5 Number of Scans	217
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-09T15:35:07
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1848.3
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768

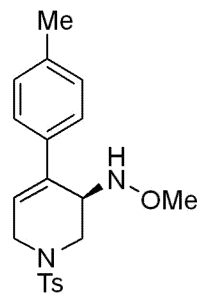
143.73
137.73
135.51
133.51
132.94
129.69
129.30
127.76
125.42
123.15

77.32
77.00
76.68

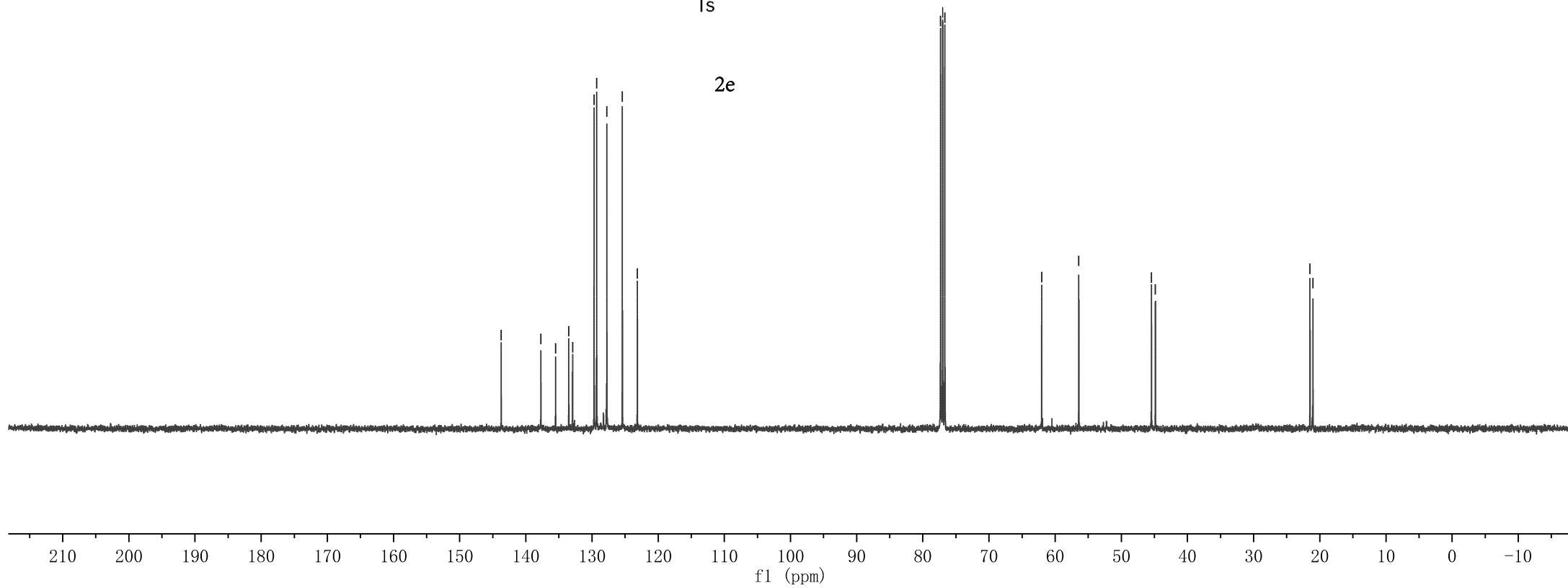
62.03
56.43

45.44
44.85

21.48
21.04

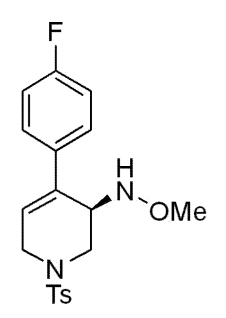


2e

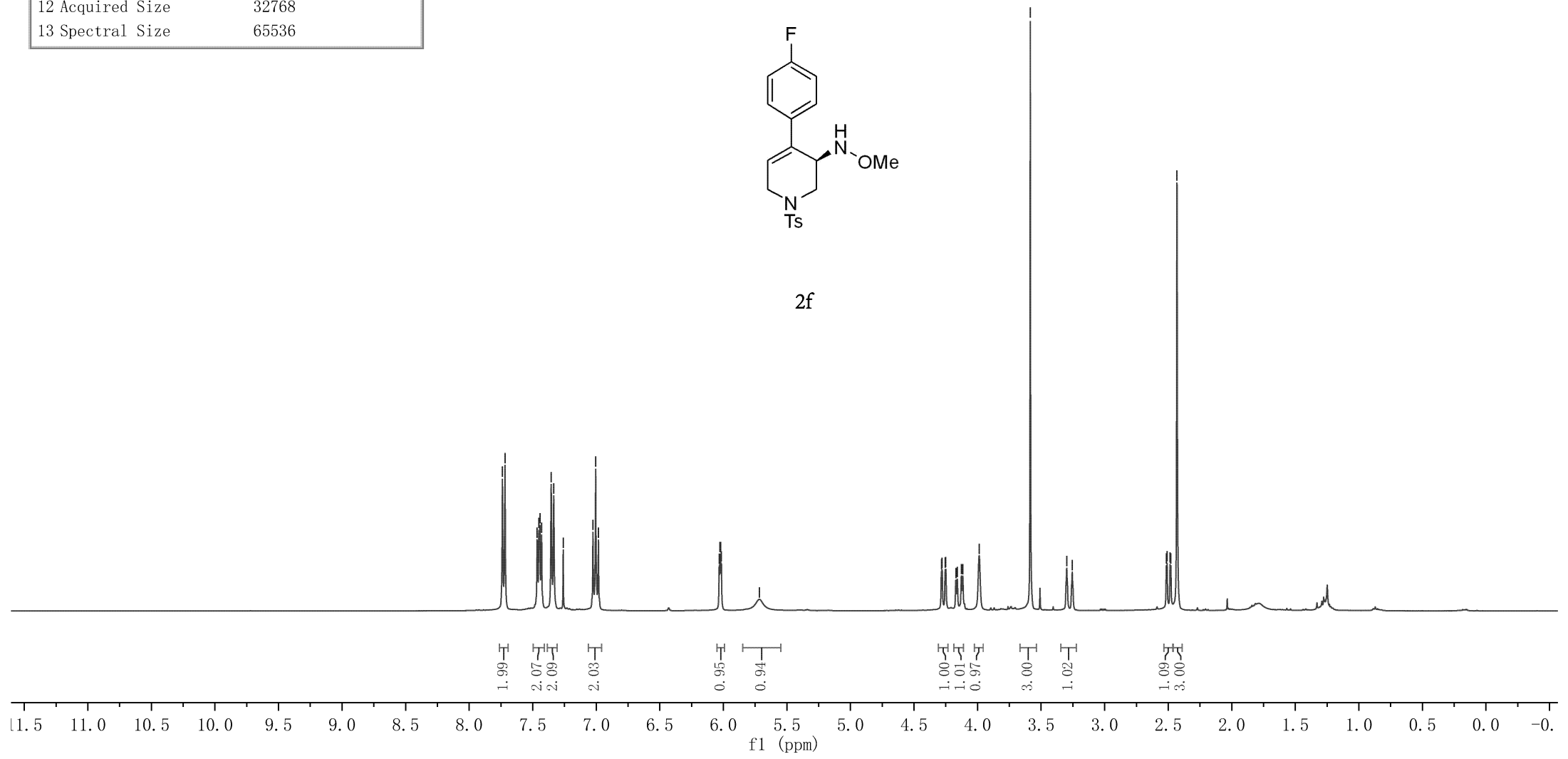


Parameter	Value
1 Title	qlj-11-36-1-H;
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.0
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-13T16:29:06
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1636.4
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

7.738 7.718 7.465 7.452 7.443 7.430 7.355 7.335 7.260 7.026 7.004 6.983 6.033 6.026 6.022 6.016 5.717 4.283 4.280 4.254 4.250 4.170 4.159 4.127 4.116 3.987 3.585 3.298 3.255 2.515 2.509 2.485 2.479 2.431



2f



163.63
161.17

143.83
134.74
134.70
132.87
129.72
127.72
127.35
127.27
123.93
115.50
115.29

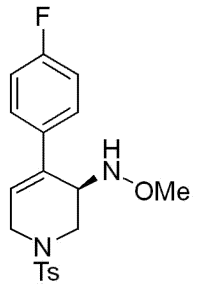
77.32
77.00
76.68

61.91
56.59

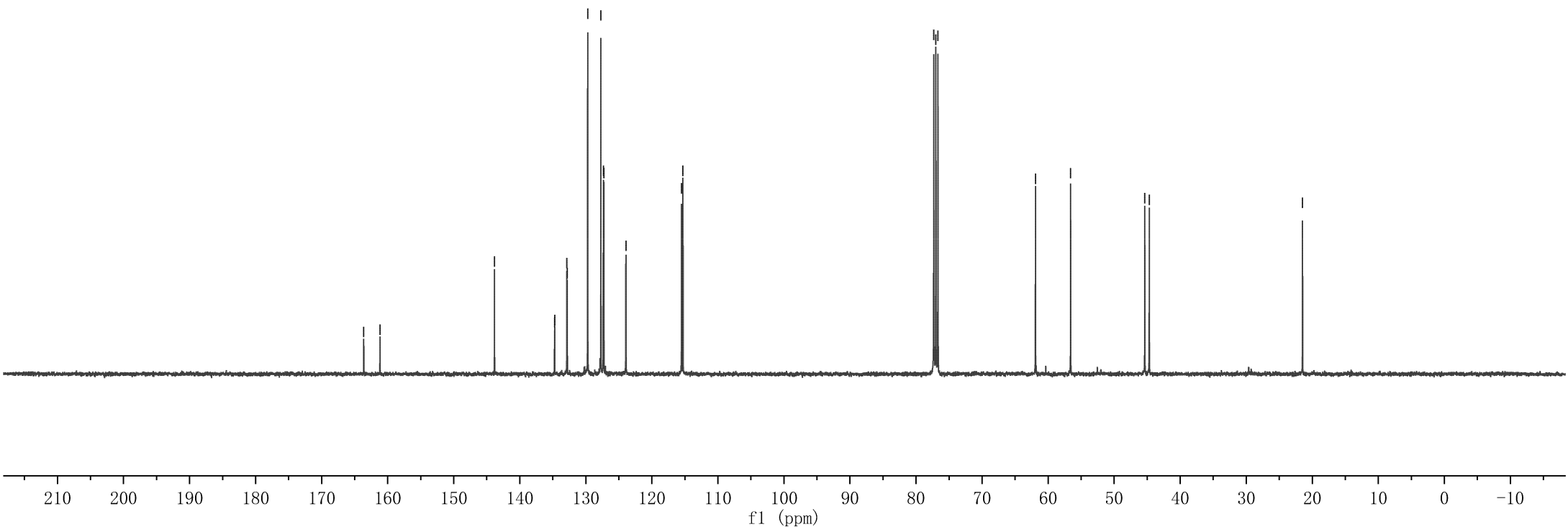
45.36
44.68

21.47

Parameter	Value
1 Title	qlj-11-36-1-C;
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.8
5 Number of Scans	451
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-13T16:55:18
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1849.3
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768

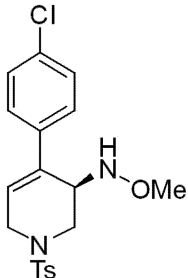
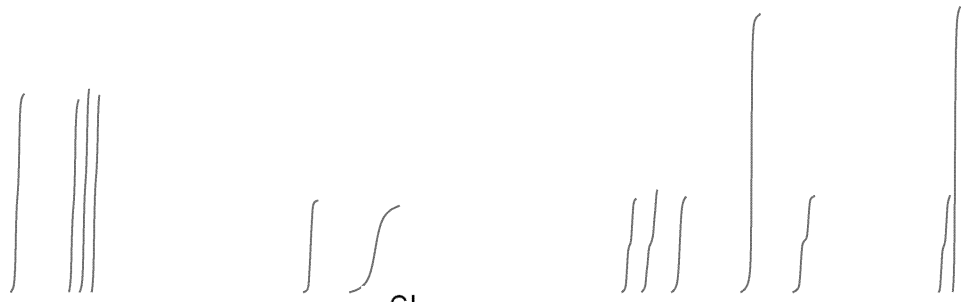


2f



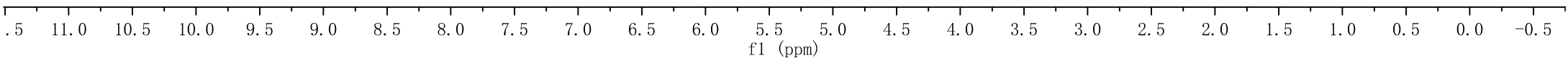
Parameter	Value
1 Title	qlj-11-35-2-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.4
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-10T12:53:49
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1699.7
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

7.739 7.718 7.424 7.402 7.355 7.335 7.296 7.275 7.260
6.081 6.075 6.070 6.064 5.708
4.287 4.284 4.257 4.254 4.177 4.166 4.134 4.123 3.987 3.581 3.304 3.260
2.513 2.507 2.483 2.478 2.432



2g

2.08 2.02 2.14 2.07 0.96 0.91 0.98 1.08 1.01 2.92 1.01 1.02 3.00



Parameter	Value
1 Title	qlj-11-35-2-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.1
5 Number of Scans	250
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-10T13:09:06
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1848.3
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768

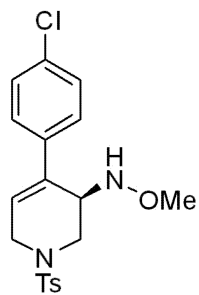
143.85
137.07
133.64
132.85
132.83
129.73
128.69
127.73
126.93
124.49

77.32
77.00
76.68

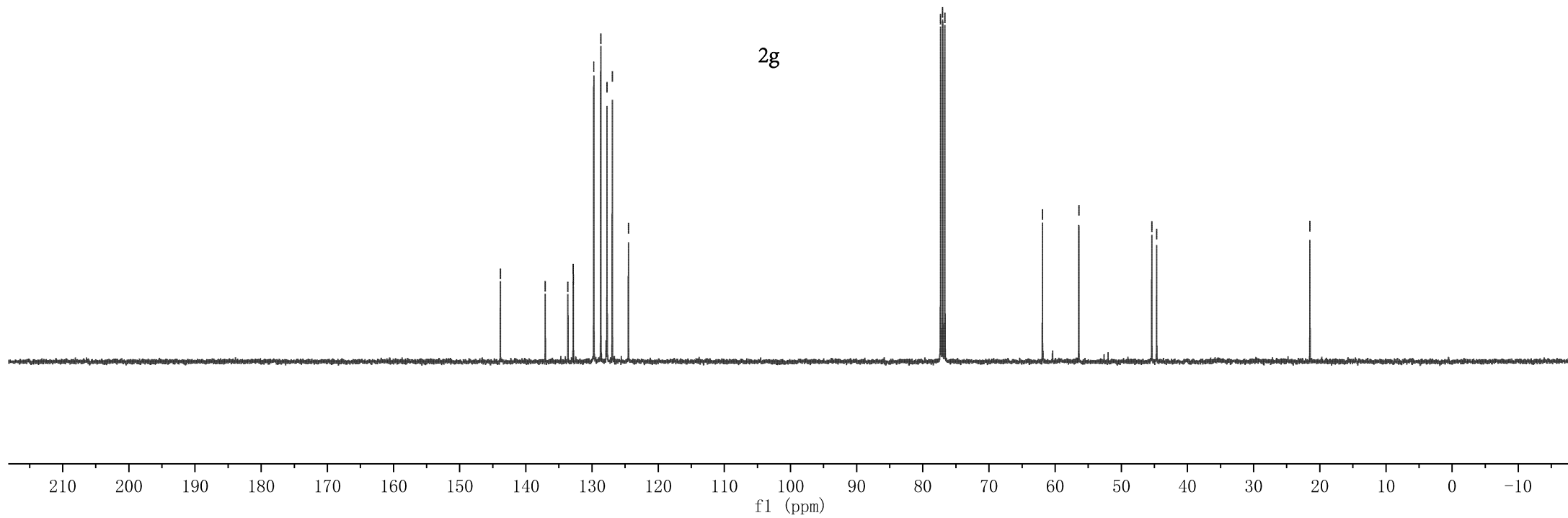
61.92
56.42

45.39
44.66

21.49

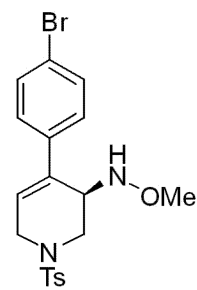


2g

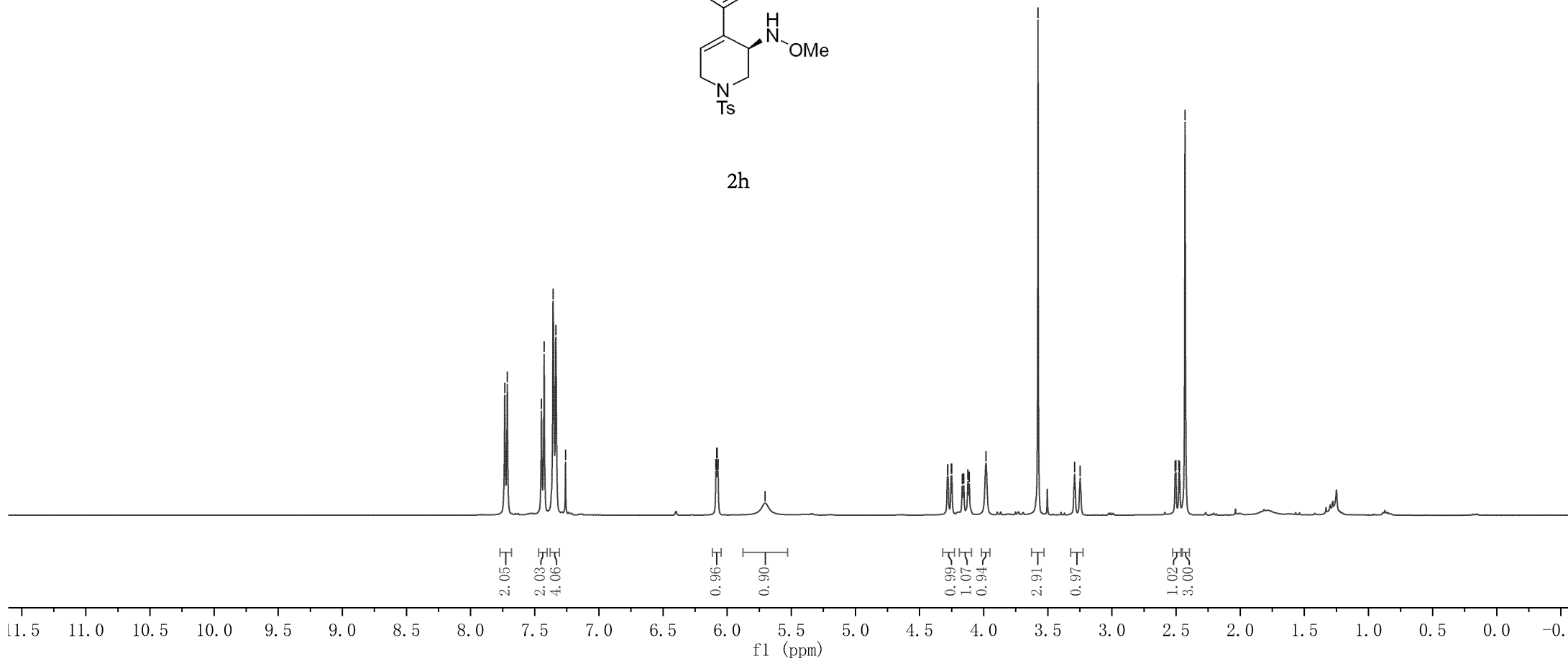


Parameter	Value
1 Title	qlj-11-36-2-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	294.9
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-13T16:08:22
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1699.1
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

7.734 7.714 7.448 7.427 7.357 7.336 7.260
6.088 6.082 6.077 6.071 5.704
4.282 4.279 4.253 4.250 4.167 4.156 4.123 4.112 3.982 3.577 3.291 3.248
2.507 2.502 2.478 2.472 2.430

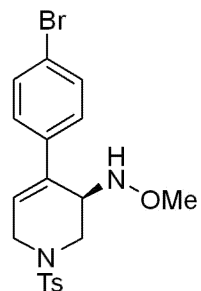


2h

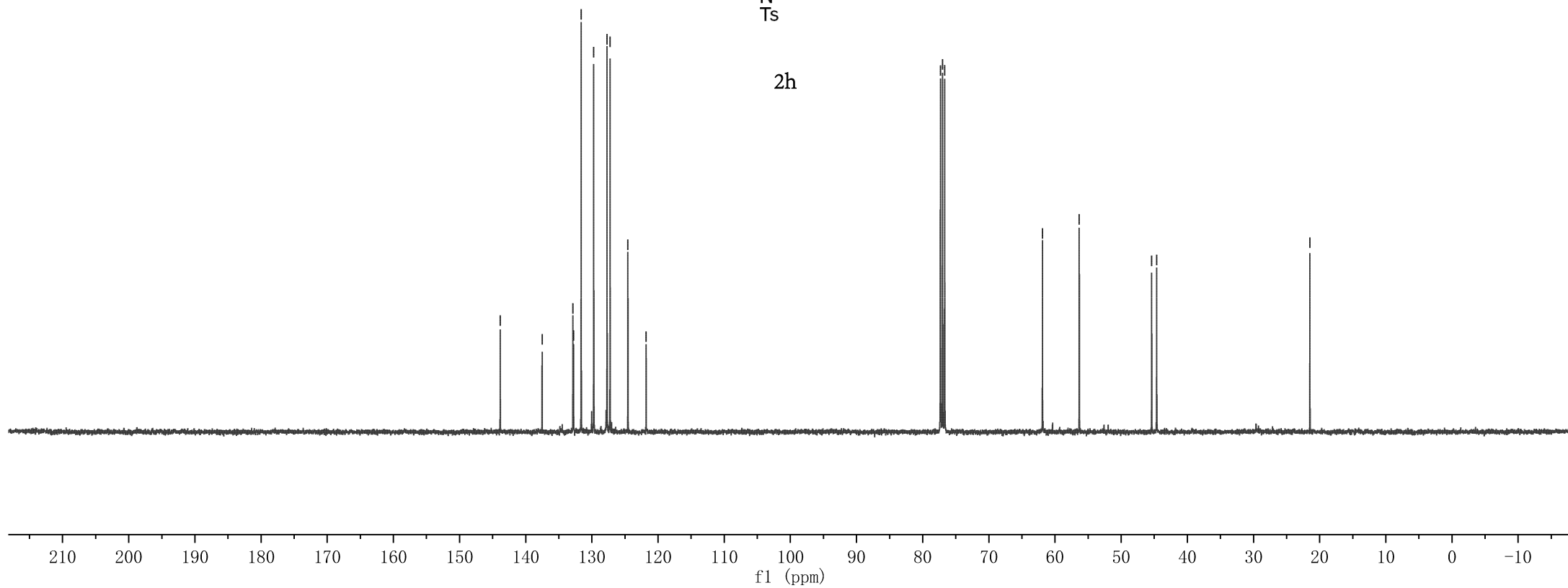


Parameter	Value
1 Title	qlj-11-36-2-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.7
5 Number of Scans	250
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-13T16:24:01
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1850.3
11 Nucleus	¹³ C
12 Acquired Size	32768
13 Spectral Size	32768

143.85
 137.52
 132.87
 132.77
 131.62
 129.73
 127.70
 127.25
 124.56
 121.80
 77.32
 77.00
 76.68
 61.90
 56.34
 45.39
 44.63
 21.48

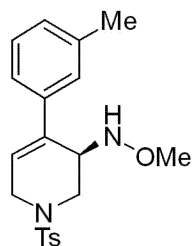


2h

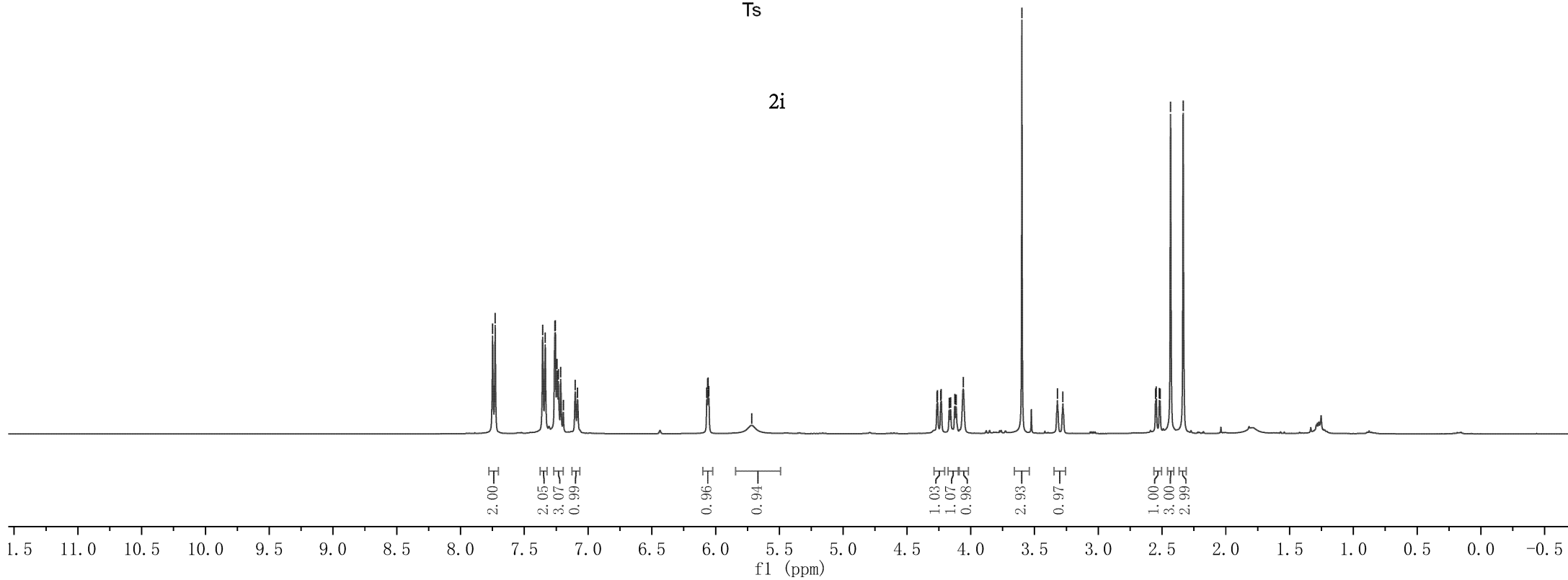


Parameter	Value
1 Title	qlj-11-36-3-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.2
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-14T16:29:41
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1702.2
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

7.749 7.728 7.356 7.336 7.260 7.256 7.243 7.233 7.215 7.194 7.100 7.083 6.069 6.063 6.059 6.053 5.717 4.264 4.260 4.235 4.231 4.168 4.158 4.125 4.114 4.059 3.599 3.321 3.278 2.551 2.545 2.521 2.515 2.433 2.334



2i



Parameter	Value
1 Title	qlj-11-36-3-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.9
5 Number of Scans	172
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-14T16:40:25
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1850.5
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768

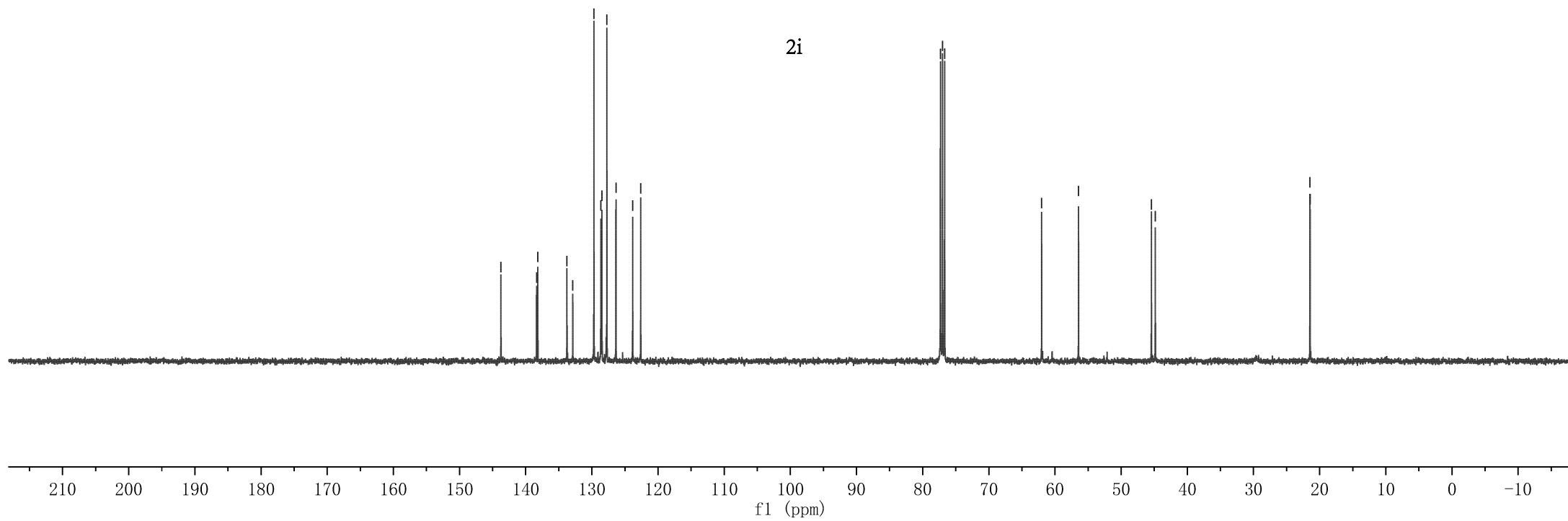
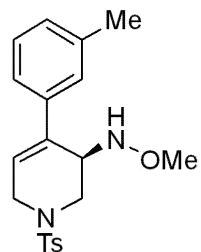
143.74
138.36
138.17
133.77
132.89
129.69
128.64
128.48
127.73
126.36
123.83
122.61

77.32
77.00
76.68

62.02
56.44

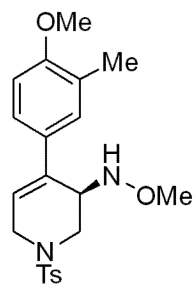
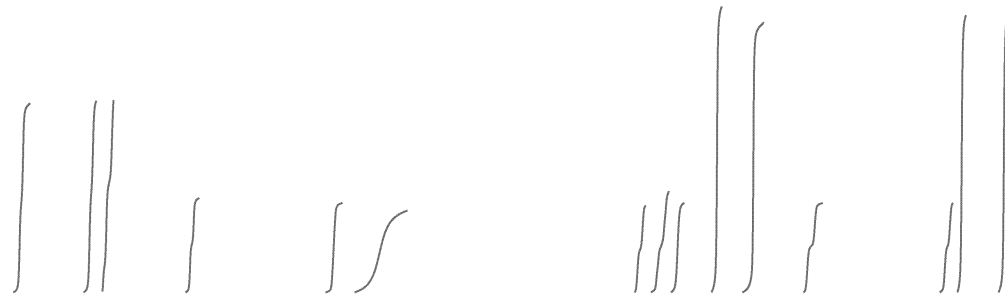
45.43
44.84

21.47
21.45

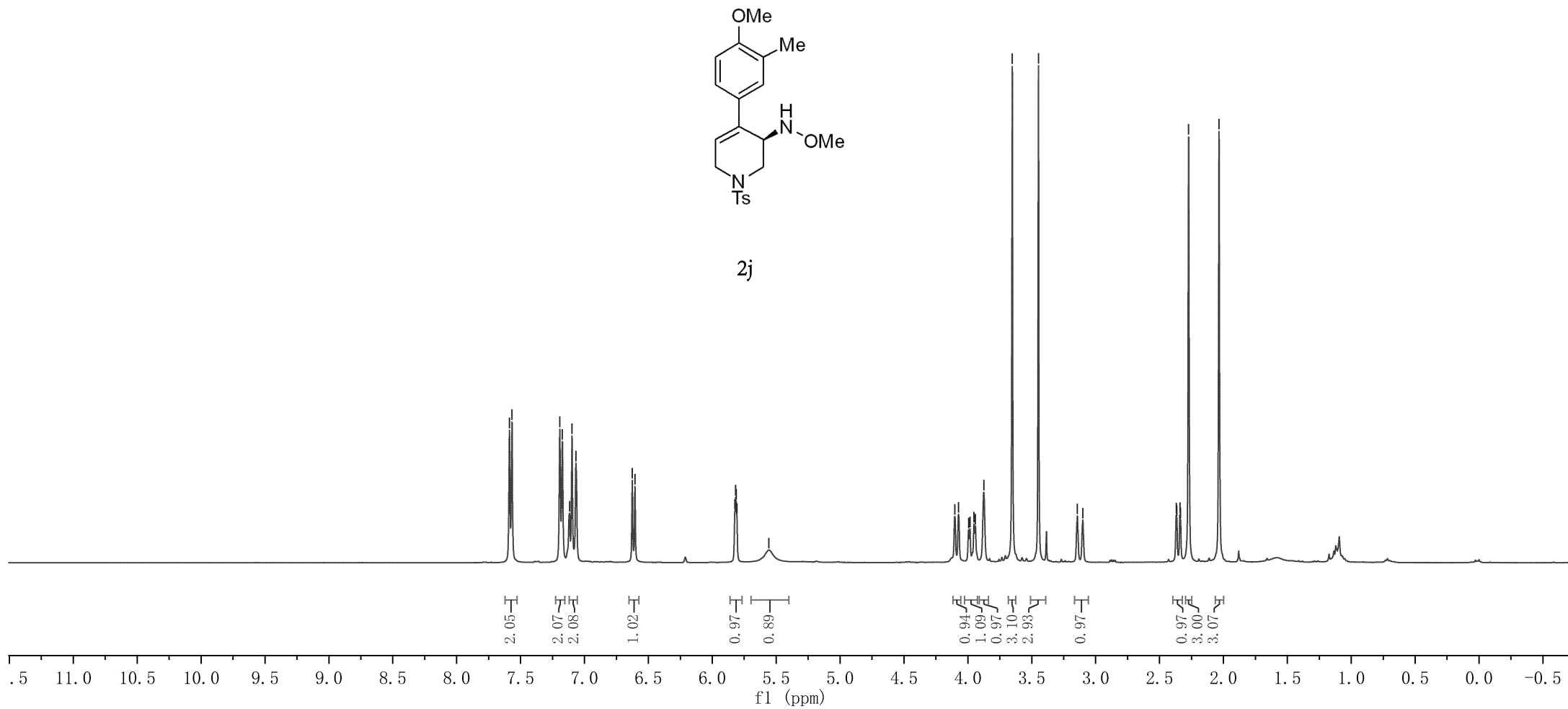


Parameter	Value
1 Title	qlj-11-37-2-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.1
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-16T18:19:09
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1701.3
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

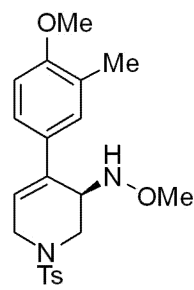
7.587 7.567 7.193 7.173 7.116 7.097 7.067 6.626 6.605 5.823 5.817 5.813 5.808 5.557 4.103 4.073 3.995 3.984 3.952 3.941 3.876 3.652 3.447 3.143 3.101 2.370 2.365 2.340 2.336 2.272 2.035



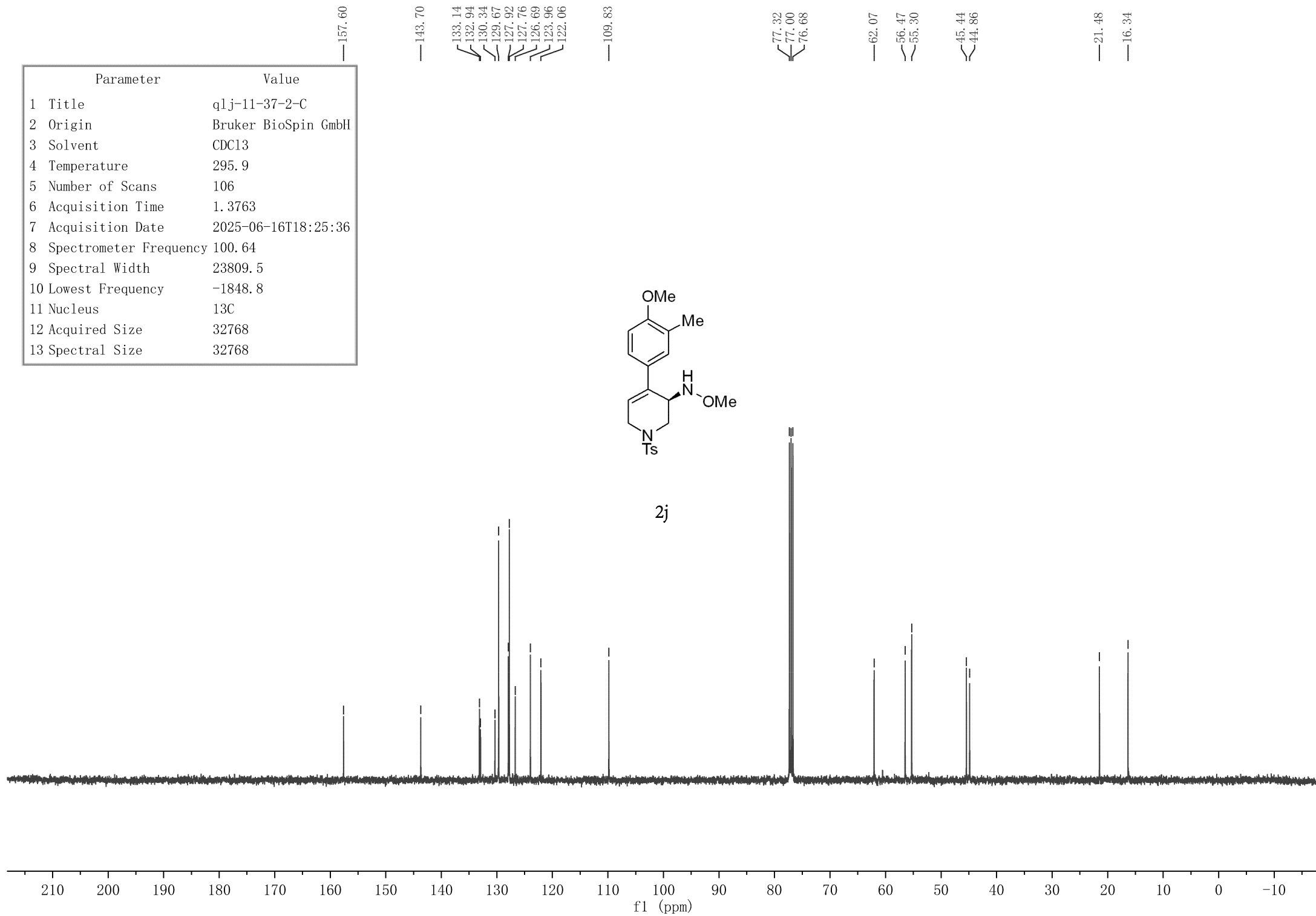
2j



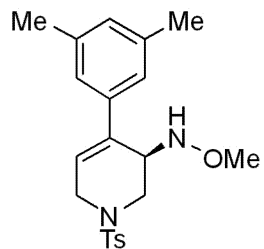
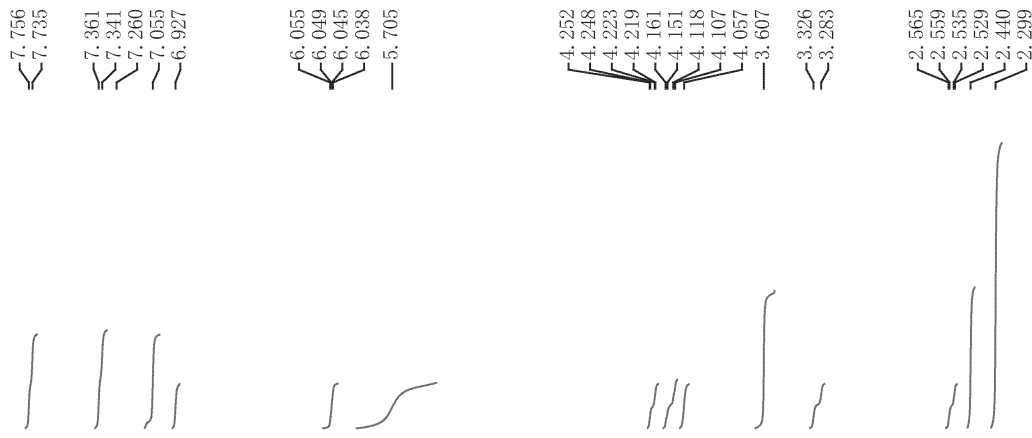
Parameter	Value
1 Title	qlj-11-37-2-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.9
5 Number of Scans	106
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-16T18:25:36
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1848.8
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768



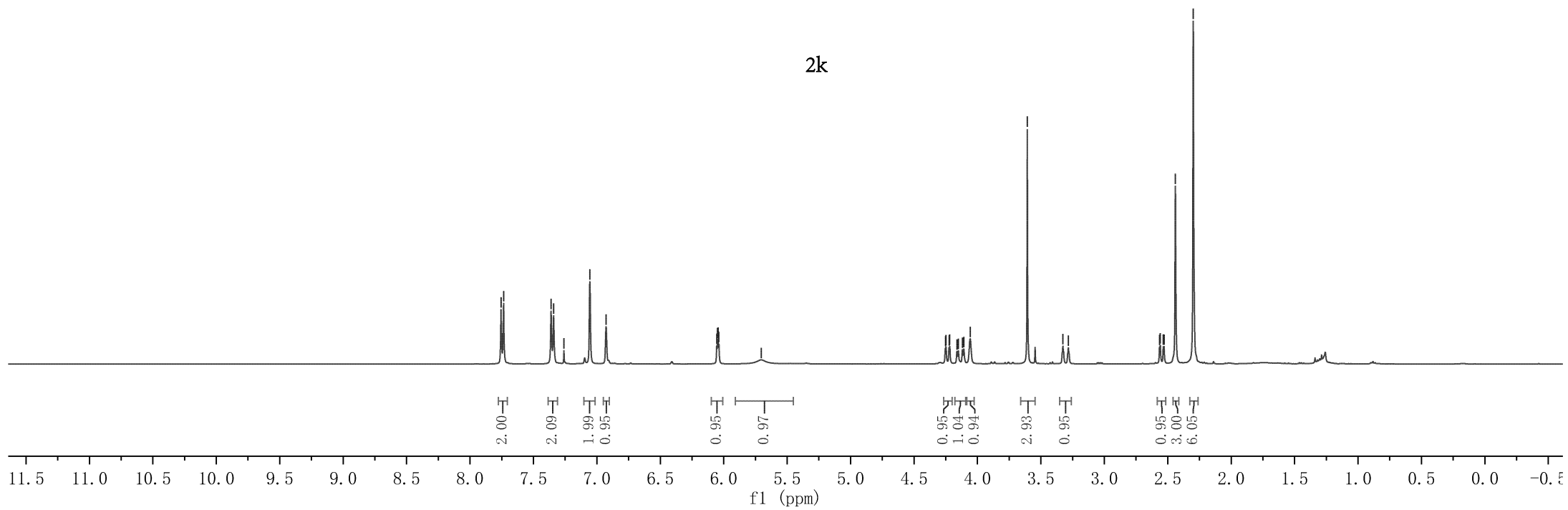
2j



Parameter	Value
1 Title	qlj-11-37-1-H;;
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.2
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-17T02:37:53
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1699.8
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536



2k



Parameter	Value
1 Title	qlj-11-37-1-C;;
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.9
5 Number of Scans	250
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-17T02:53:44
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1848.9
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768

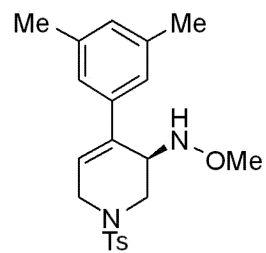
143.72
138.33
138.09
133.85
132.96
129.69
129.59
127.75
123.68
123.47

77.32
77.00
76.68

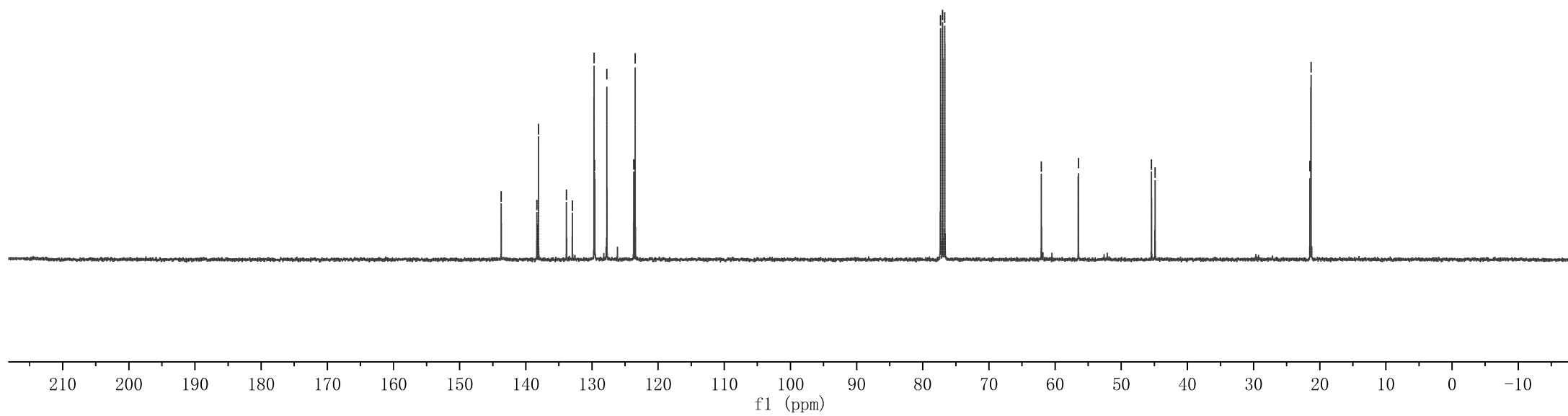
62.08
56.49

45.44
44.89

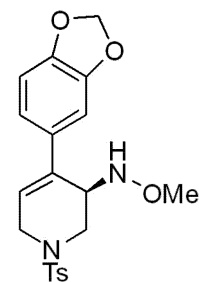
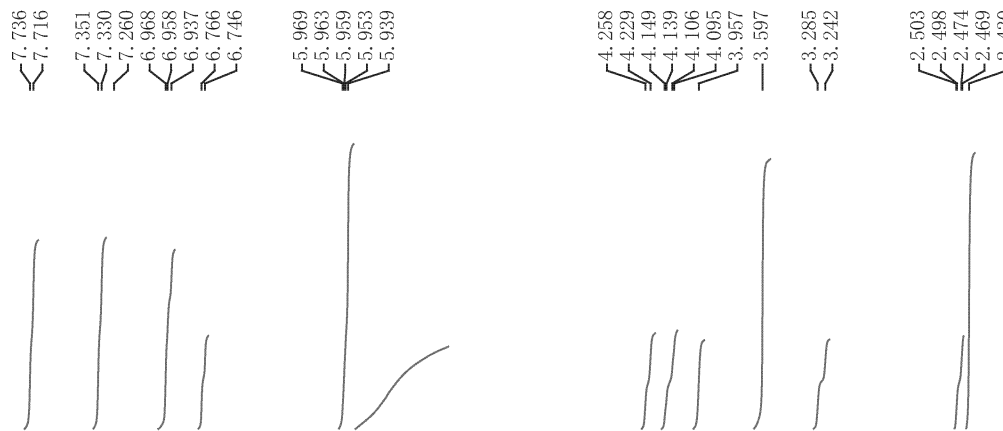
21.49
21.33



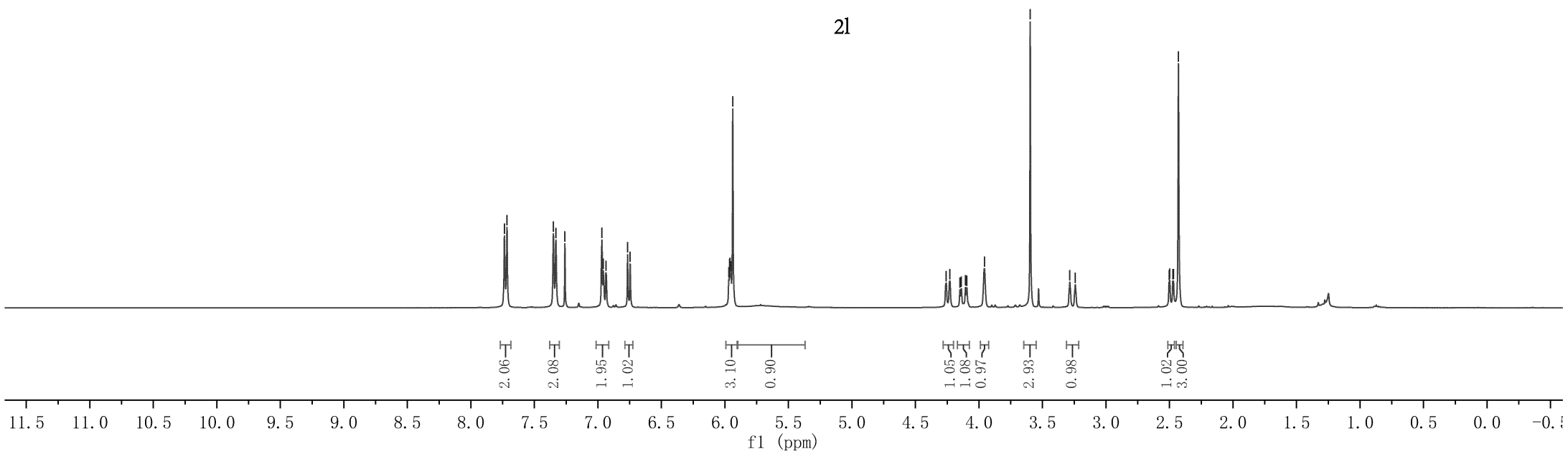
2k



Parameter	Value
1 Title	qlj-11-35-4-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	294.9
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-12T16:00:04
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1664.2
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

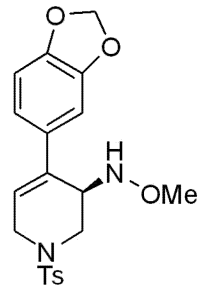


2l

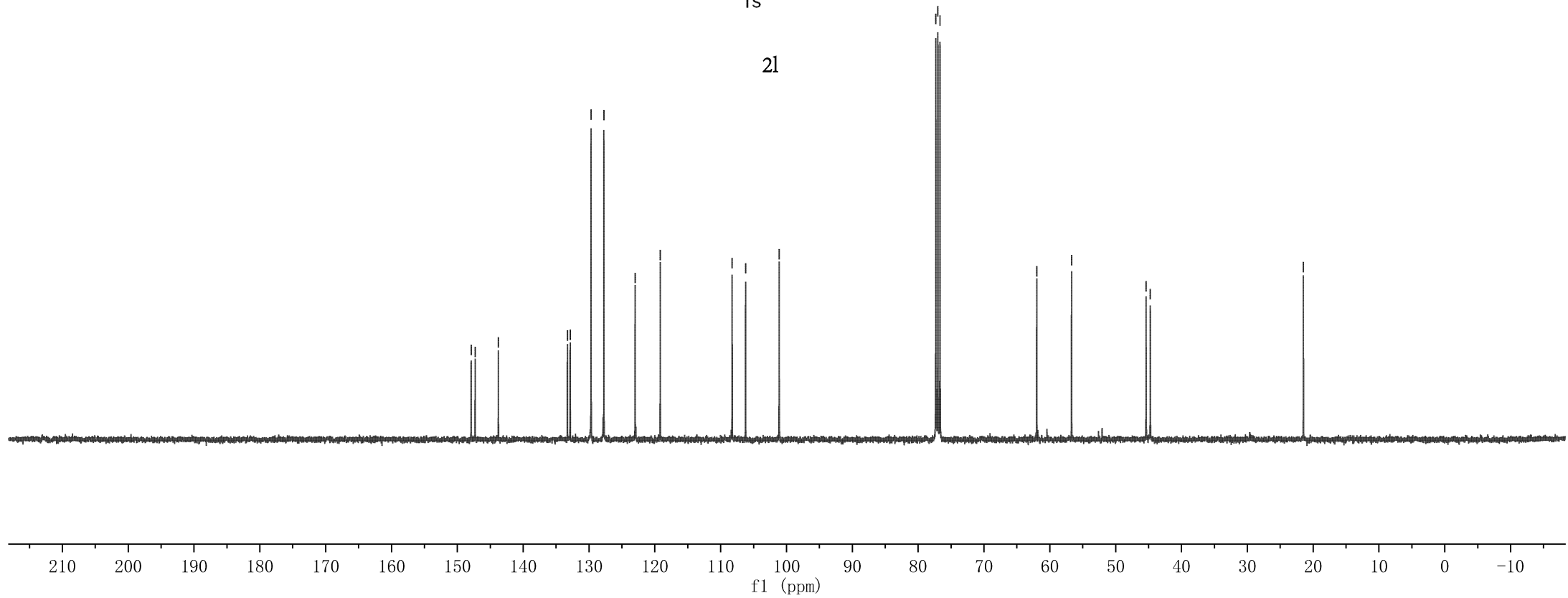


Parameter	Value
1 Title	qlj-11-35-4-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.5
5 Number of Scans	250
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-12T16:14:46
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1848.7
11 Nucleus	¹³ C
12 Acquired Size	32768
13 Spectral Size	32768

¹³C NMR chemical shifts (ppm):
 147.90, 147.30, 143.77, 133.28, 132.85, 129.69, 127.74, 122.99, 119.18, 108.25, 106.22, 101.11, 77.32, 77.00, 76.68, 61.99, 56.69, 45.37, 44.74, 21.48



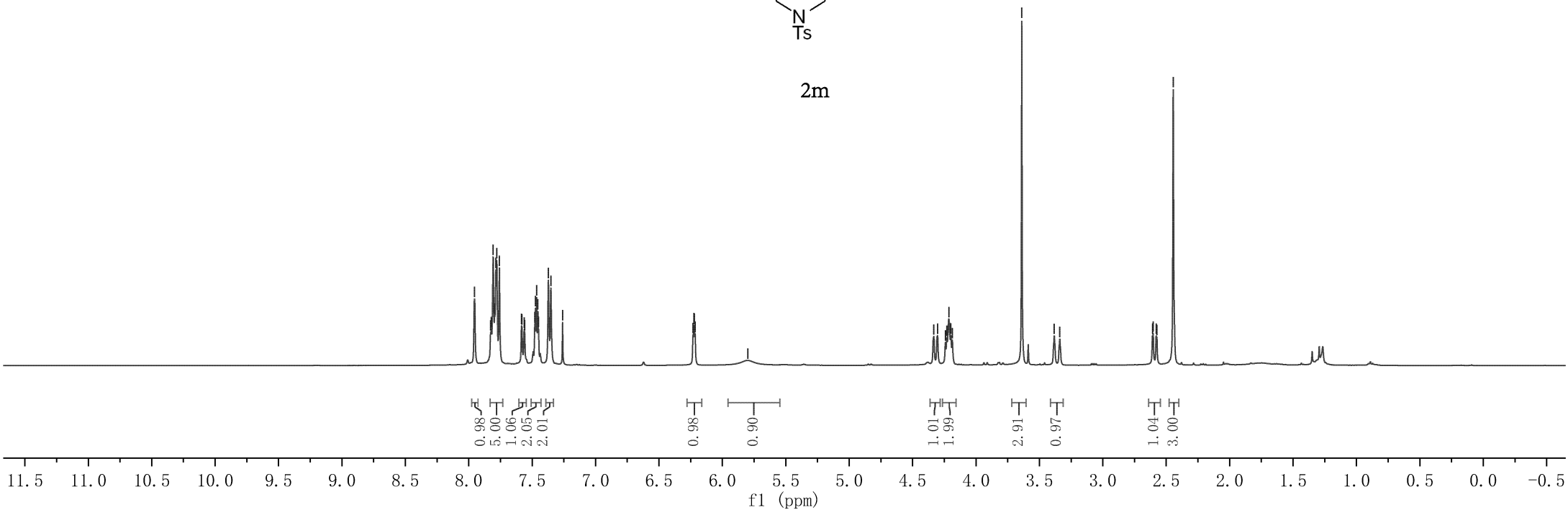
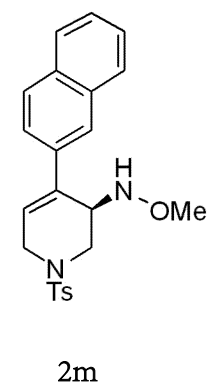
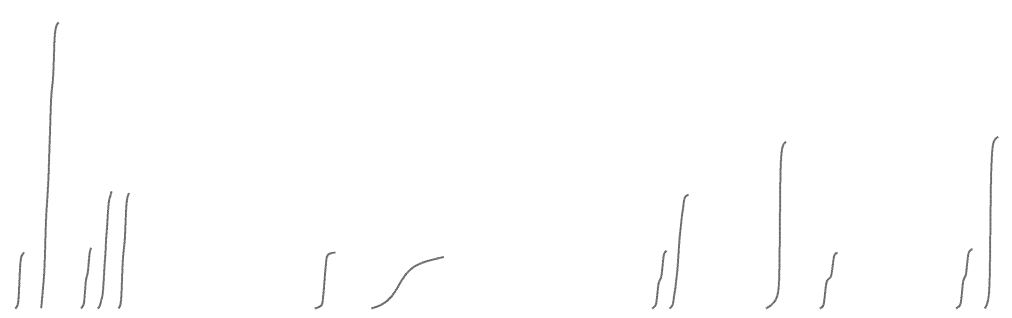
21



Parameter	Value
1 Title	qlj-11-35-1-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.7
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-10T15:59:03
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1636.3
11 Nucleus	1H
12 Acquired Size	32768
13 Spectral Size	65536

7.955
7.827
7.822
7.808
7.795
7.786
7.779
7.758
7.584
7.581
7.563
7.559
7.479
7.473
7.464
7.455
7.450
7.372
7.352
7.260
6.231
6.225
6.221
6.215
— 5.800

4.333
4.303
4.241
4.230
4.214
4.199
4.187
— 3.639
3.383
3.339
2.609
2.603
2.579
2.574
2.445



Parameter	Value
1 Title	qlj-11-35-1-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.5
5 Number of Scans	250
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-10T16:13:45
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1850.5
11 Nucleus	¹³ C
12 Acquired Size	32768
13 Spectral Size	32768

143.79
135.65
133.60
133.30
132.90
132.85
129.71
128.21
128.17
127.76
127.48
126.29
126.10
124.48
123.65

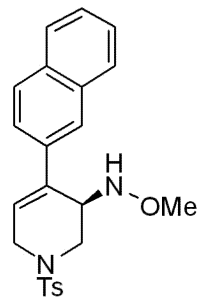
77.32
77.00
76.68

62.07

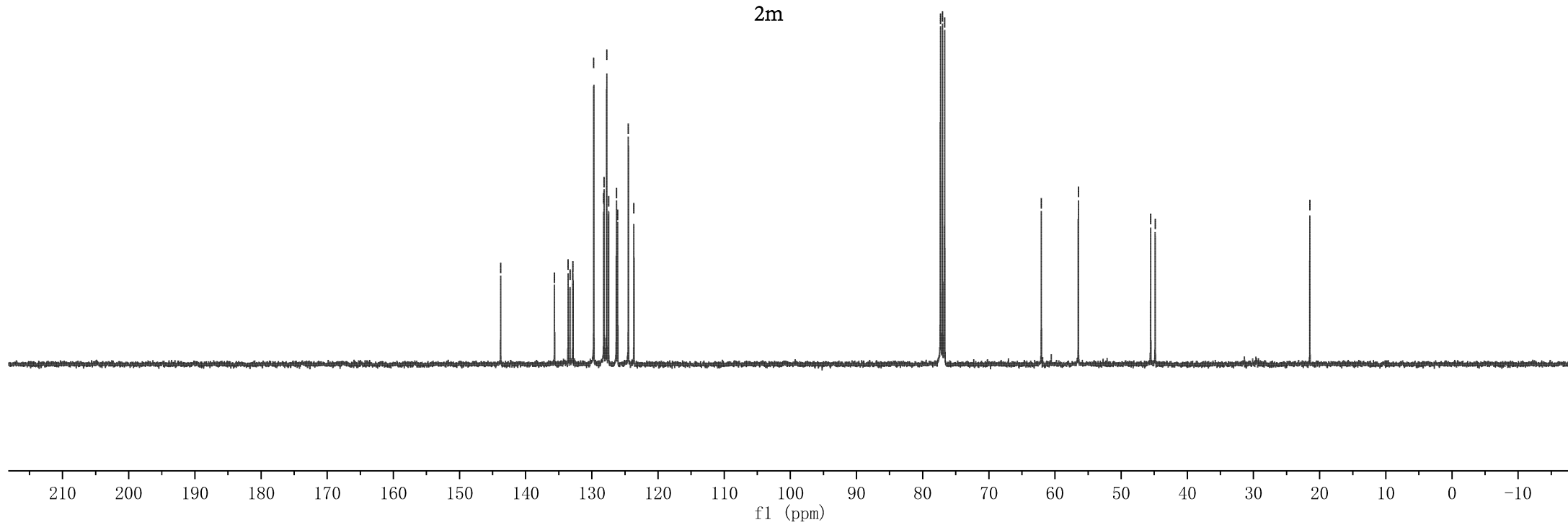
56.47

45.54
44.86

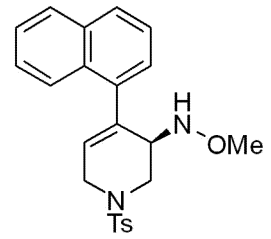
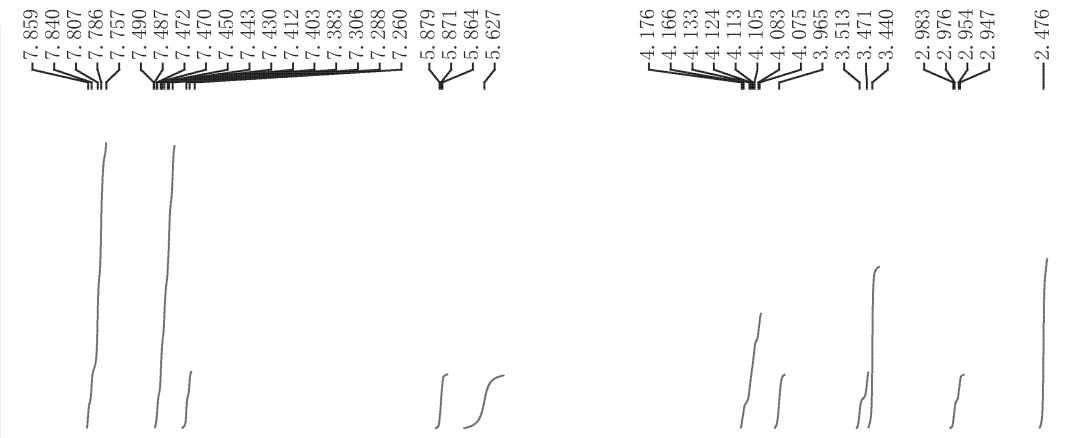
21.48



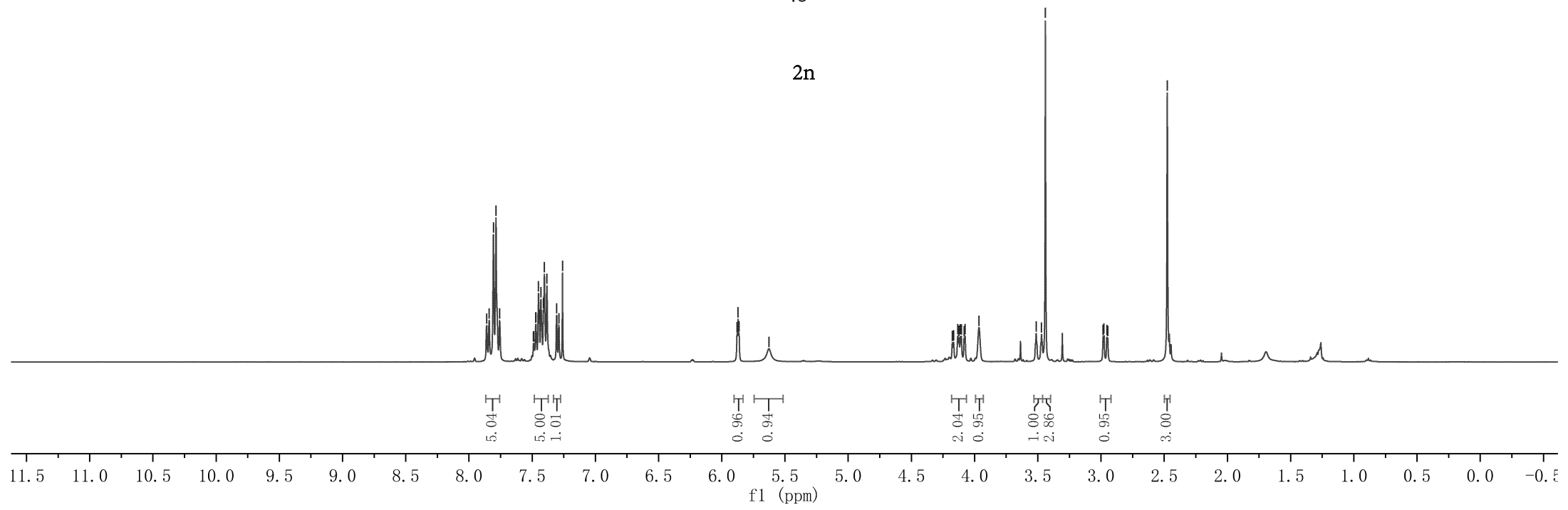
2m



Parameter	Value
1 Title	qlj-11-39-1-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.3
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-17T17:00:19
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1704.1
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536



2n



Parameter	Value
1 Title	qlj-11-39-1-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.1
5 Number of Scans	250
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-17T17:15:02
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1847.9
11 Nucleus	¹³ C
12 Acquired Size	32768
13 Spectral Size	32768

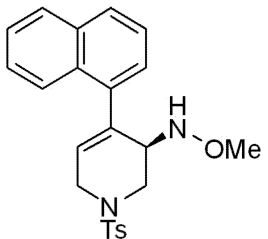
143.78
137.26
134.30
133.69
133.09
131.41
129.77
128.44
128.05
127.82
127.47
126.07
125.98
125.82
125.16
125.05

77.32
77.00
76.68

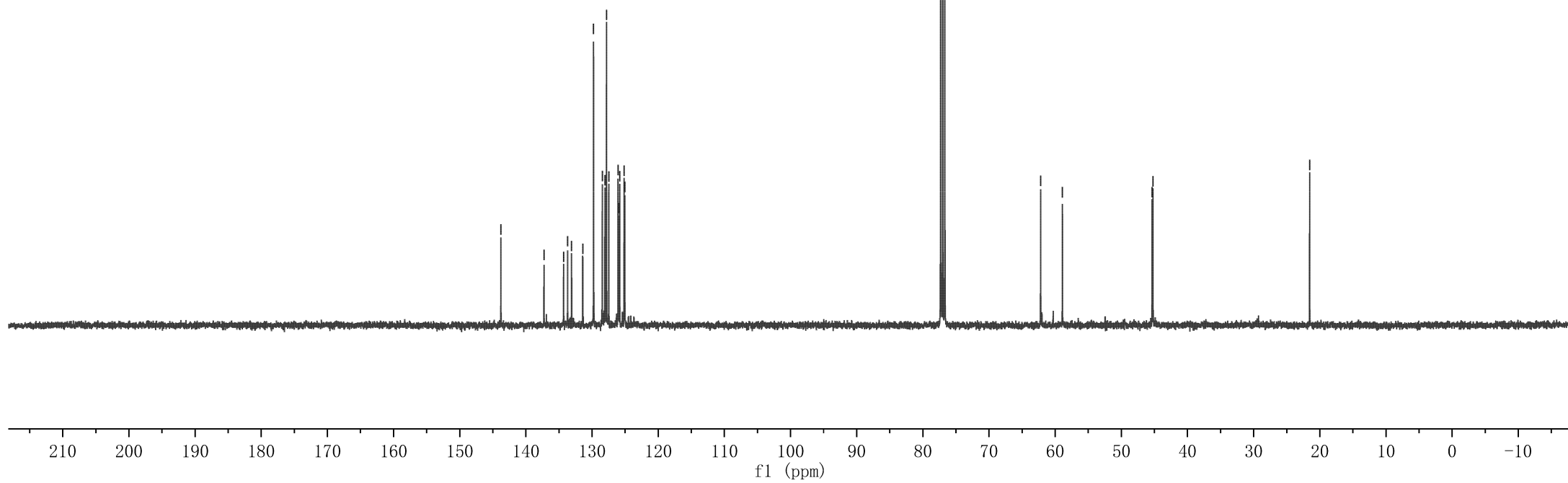
62.20
58.91

45.35
45.22

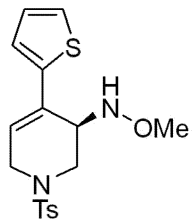
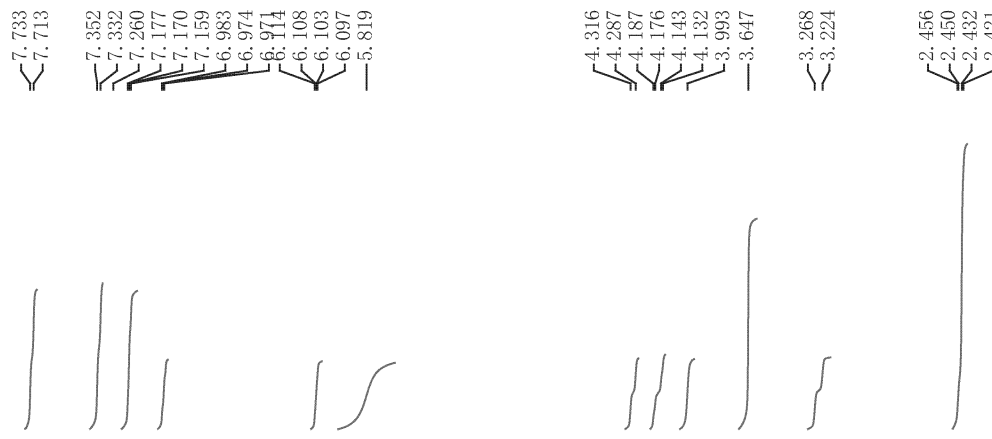
21.54



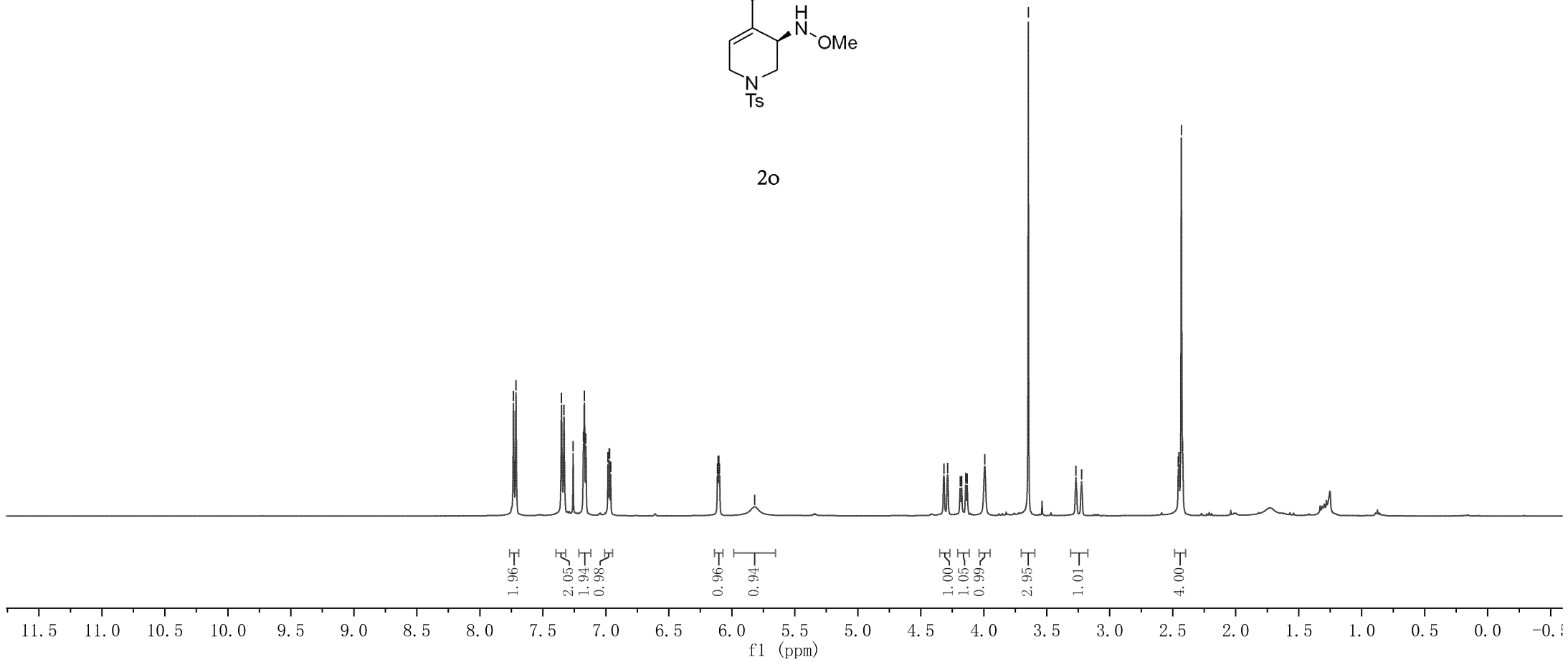
2n



Parameter	Value
1 Title	qlj-11-36-4-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.3
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-14T16:46:04
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1700.2
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536



2o



Parameter	Value
1 Title	qlj-11-36-4-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.0
5 Number of Scans	250
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-14T17:00:46
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1847.7
11 Nucleus	¹³ C
12 Acquired Size	32768
13 Spectral Size	32768

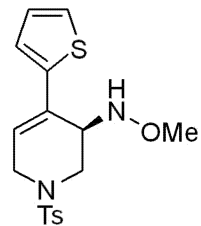
143.85
142.59
132.86
129.74
128.20
127.72
127.44
124.46
123.35
122.39

77.32
77.00
76.68

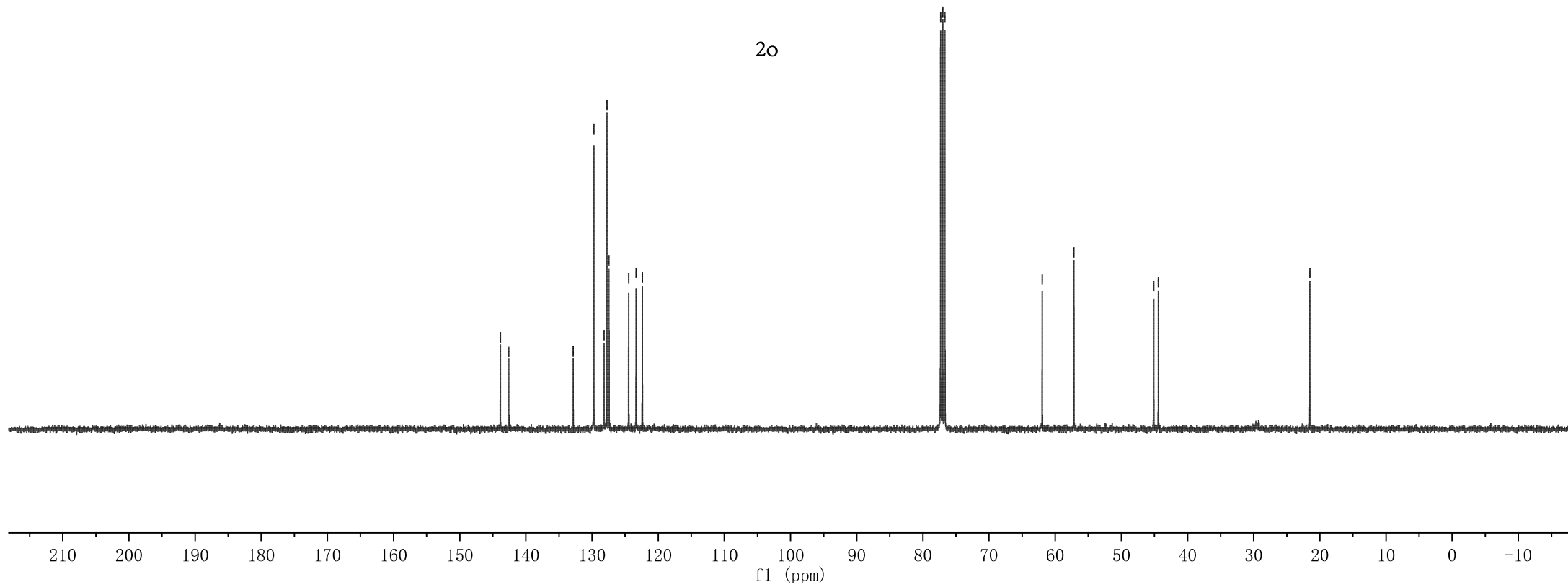
61.96
57.17

45.11
44.40

21.49

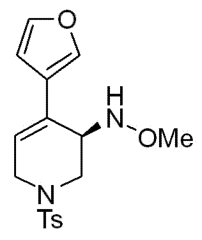


2o

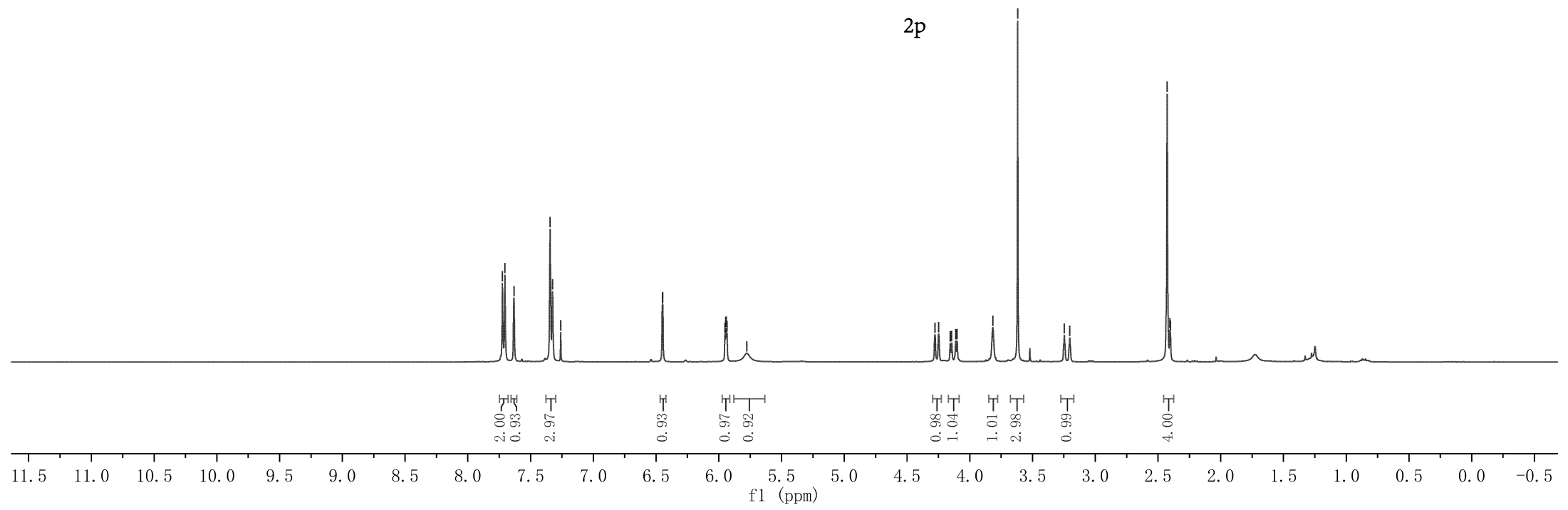


Parameter	Value
1 Title	qlj-11-41-3-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.2
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-24T07:38:18
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1636.6
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

7.724 7.704 7.633 7.344 7.325 7.260 6.449 6.447 5.951 5.945 5.940 5.934 5.776 4.277 4.248 4.155 4.144 4.142 4.101 3.816 3.619 3.246 3.203 2.427 2.407 2.401

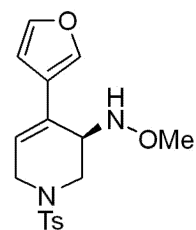


2p

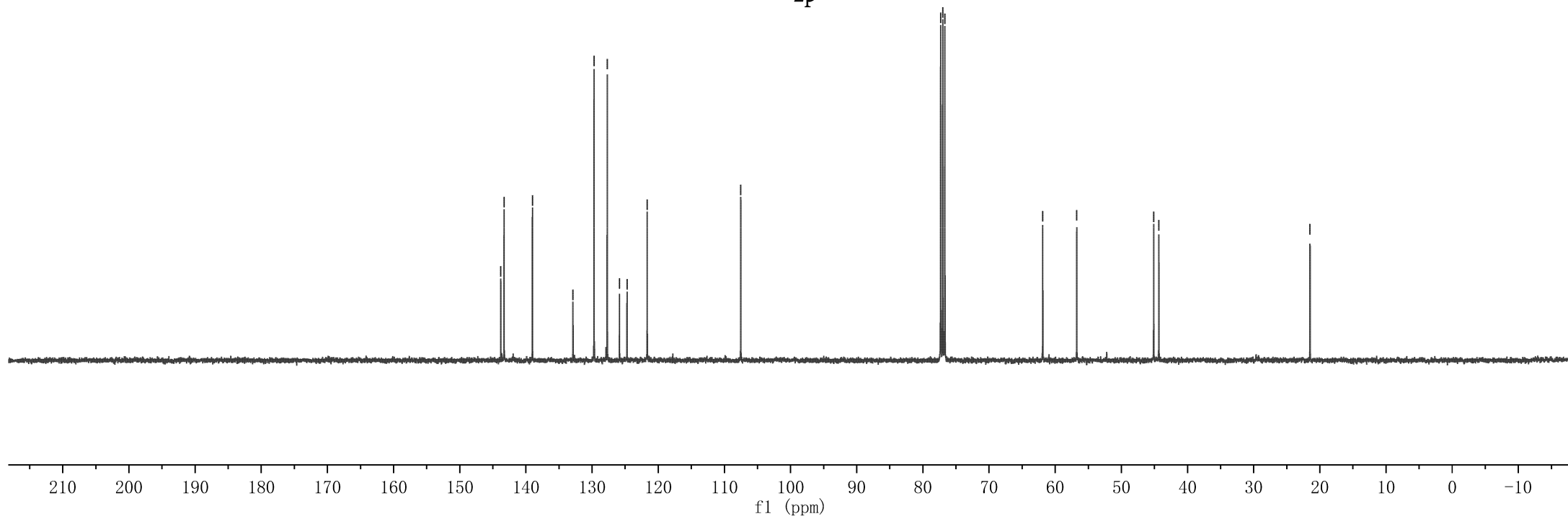


Parameter	Value
1 Title	qlj-11-41-3-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.0
5 Number of Scans	250
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-24T07:53:01
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1847.5
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768

143.80 143.31 139.02 132.89 129.70 127.71 125.86 124.72 121.67 107.53 77.32 77.00 76.68 61.88 56.74 45.11 44.33 21.48

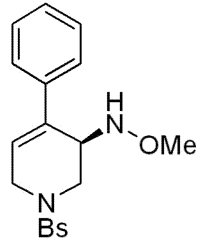
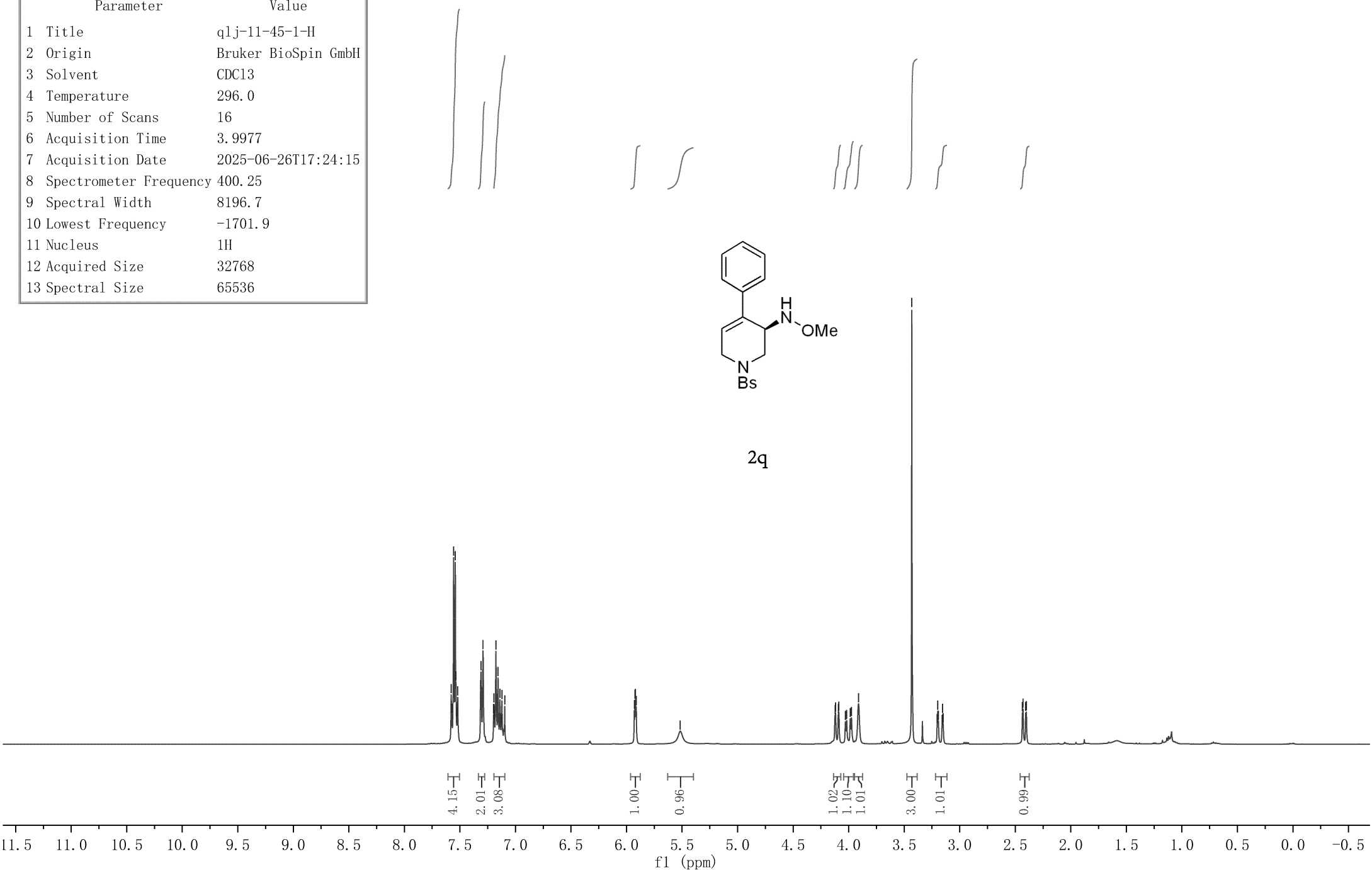


2p



Parameter	Value
1 Title	qlj-11-45-1-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.0
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-26T17:24:15
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1701.9
11 Nucleus	1H
12 Acquired Size	32768
13 Spectral Size	65536

7.579 7.573 7.557 7.542 7.536 7.525 7.520 7.314 7.310 7.293 7.196 7.193 7.189 7.176 7.157 7.139 7.128 7.122 7.096 5.930 5.924 5.919 5.913 5.516 4.123 4.119 4.093 4.089 4.029 4.018 3.986 3.975 3.911 3.432 3.203 3.198 3.193 3.159 3.154 3.149 2.436 2.430 2.406 2.400



2q

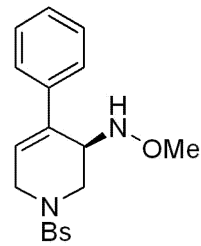
Parameter	Value
1 Title	qlj-11-45-1-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.7
5 Number of Scans	200
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-26T17:37:11
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1850.6
11 Nucleus	¹³ C
12 Acquired Size	32768
13 Spectral Size	32768

138.27
135.13
133.85
132.40
129.15
128.62
128.00
127.97
125.57
123.69

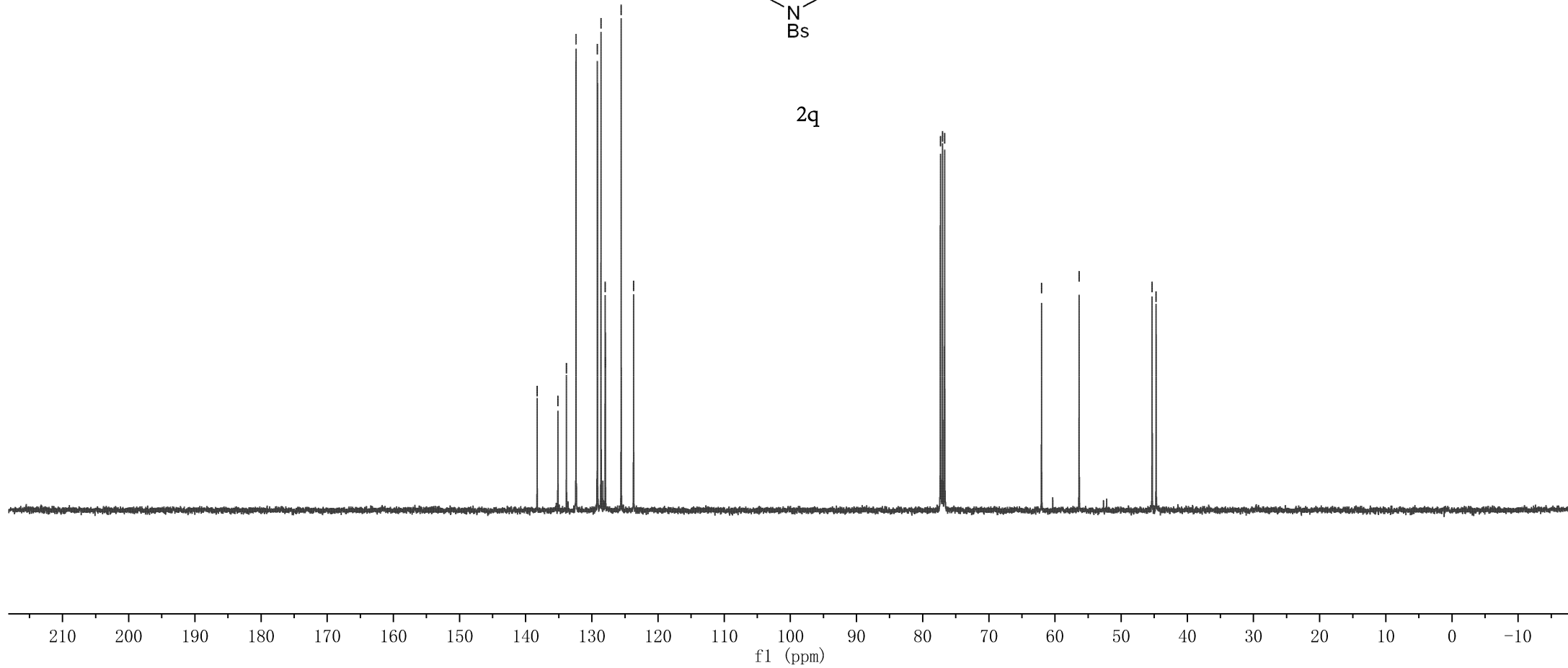
77.32
77.00
76.68

62.04
56.35

45.32
44.72

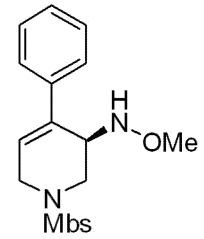


2q

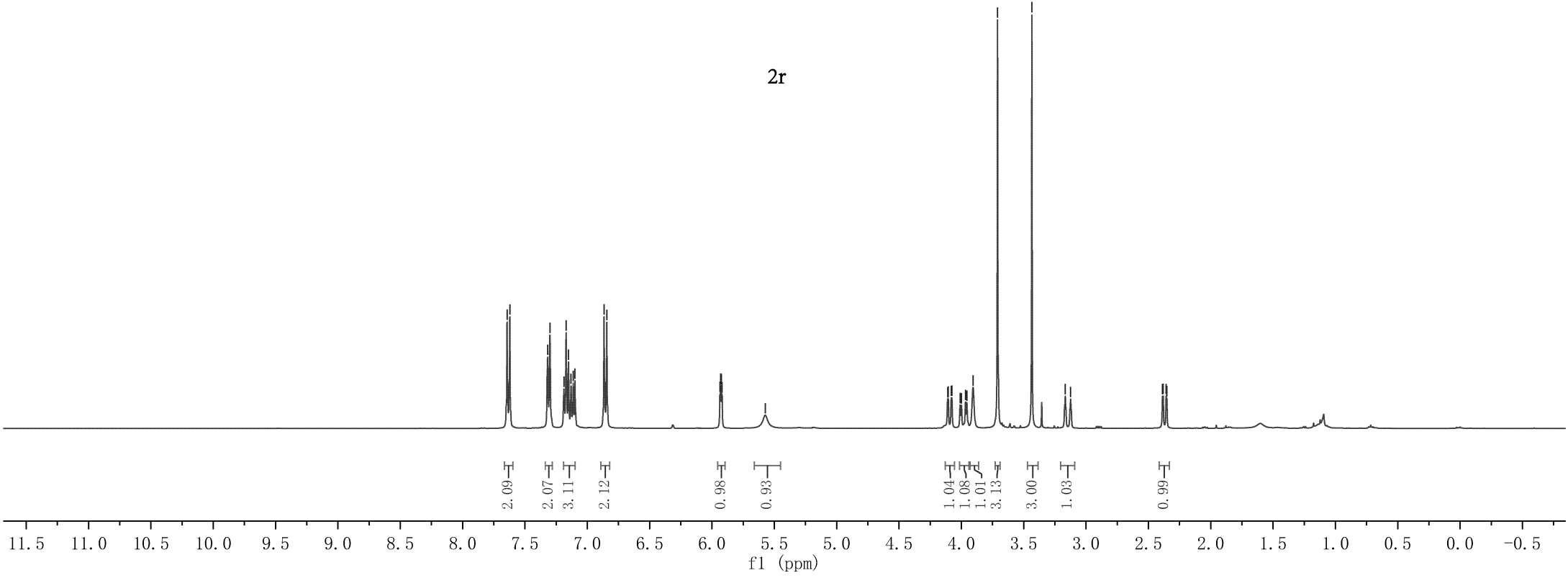


Parameter	Value
1 Title	qlj-11-45-2-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.1
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-26T17:42:11
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1700.8
11 Nucleus	1H
12 Acquired Size	32768
13 Spectral Size	65536

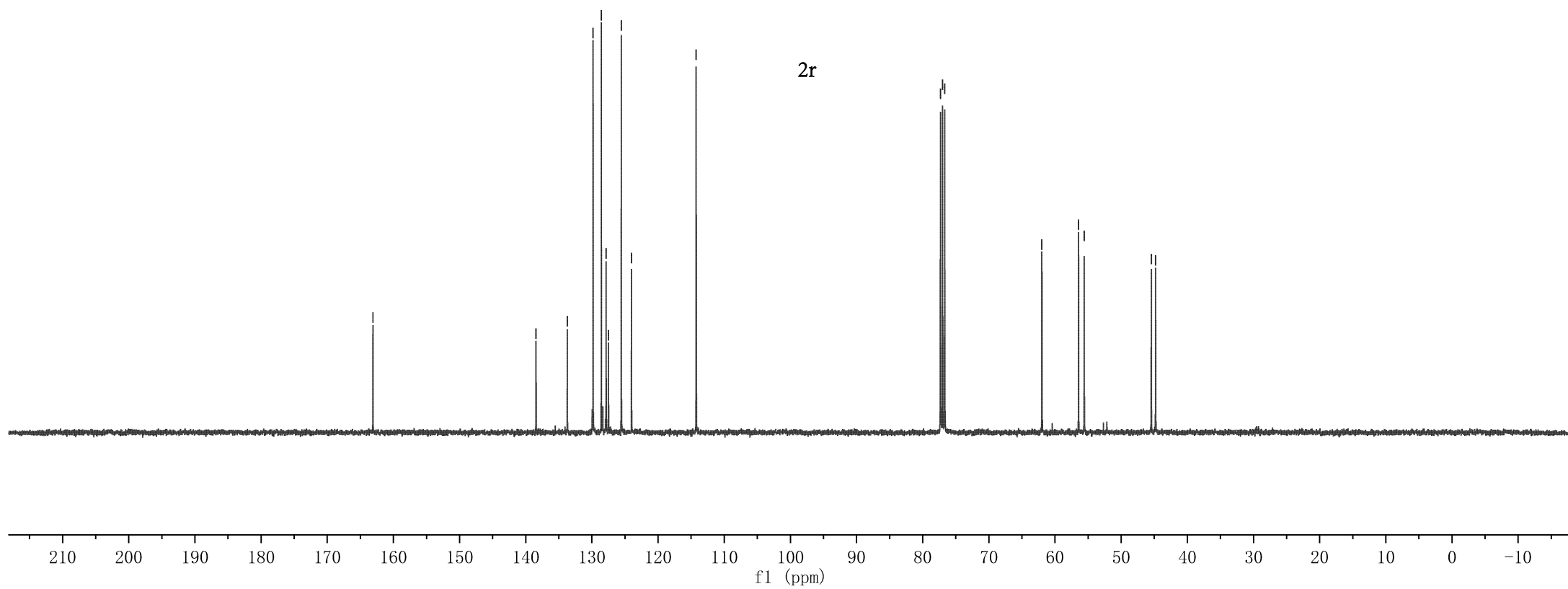
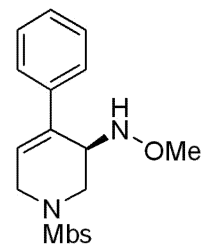
7.643 7.621 7.318 7.300 7.187 7.170 7.151 7.130 7.113 7.099 6.866 6.844 5.936 5.930 5.925 5.919 5.573 4.110 4.106 4.080 4.076 4.010 3.999 3.967 3.956 3.906 3.710 3.434 3.167 3.123 2.387 2.381 2.357 2.352



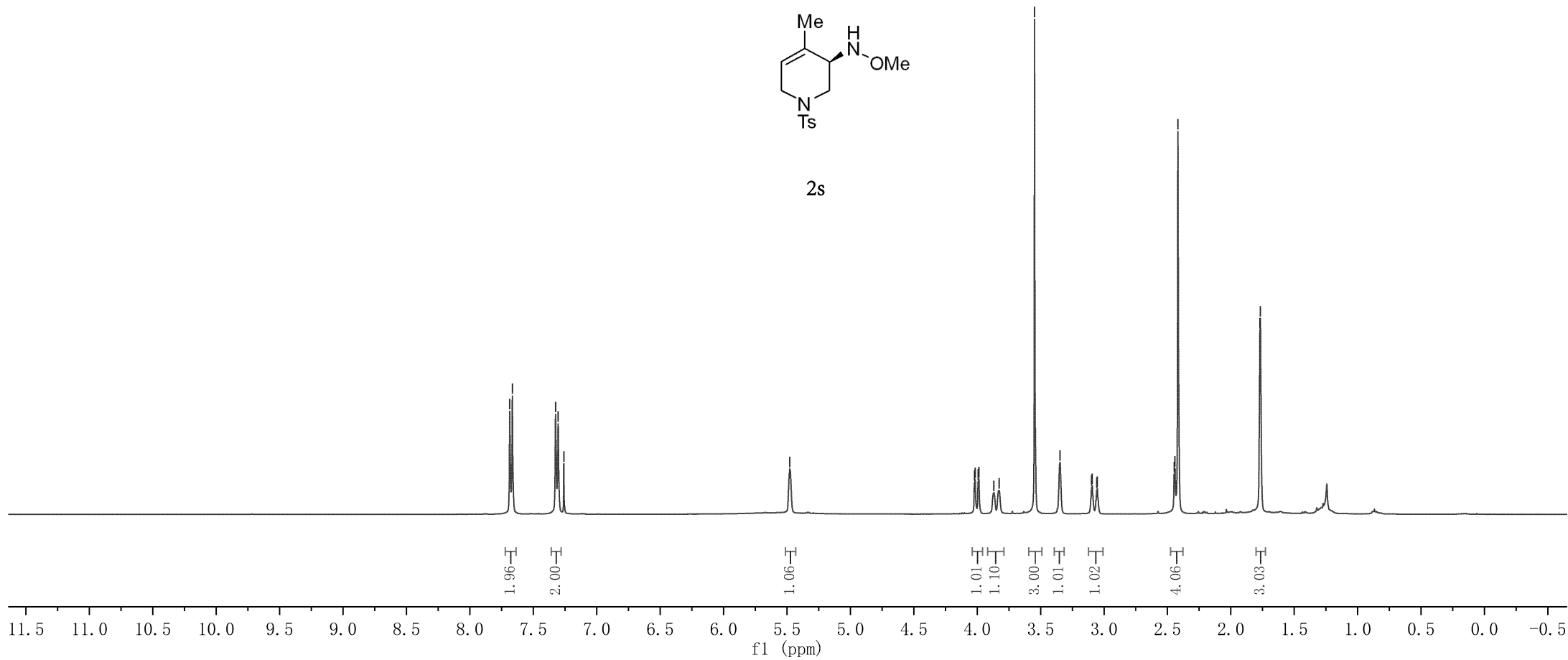
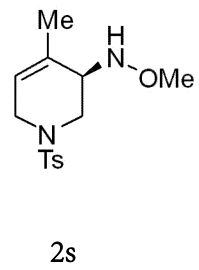
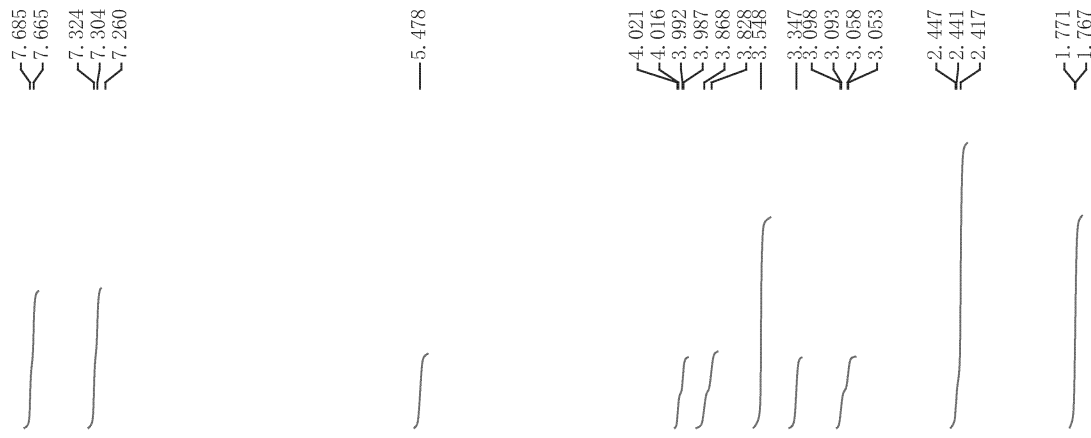
2r



Parameter	Value
1 Title	qlj-11-45-2-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.8
5 Number of Scans	200
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-26T17:54:02
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1850.1
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768

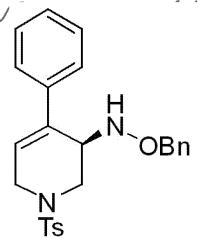


Parameter	Value
1 Title	qlj-11-39-3-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.2
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-25T17:43:01
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1636.9
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

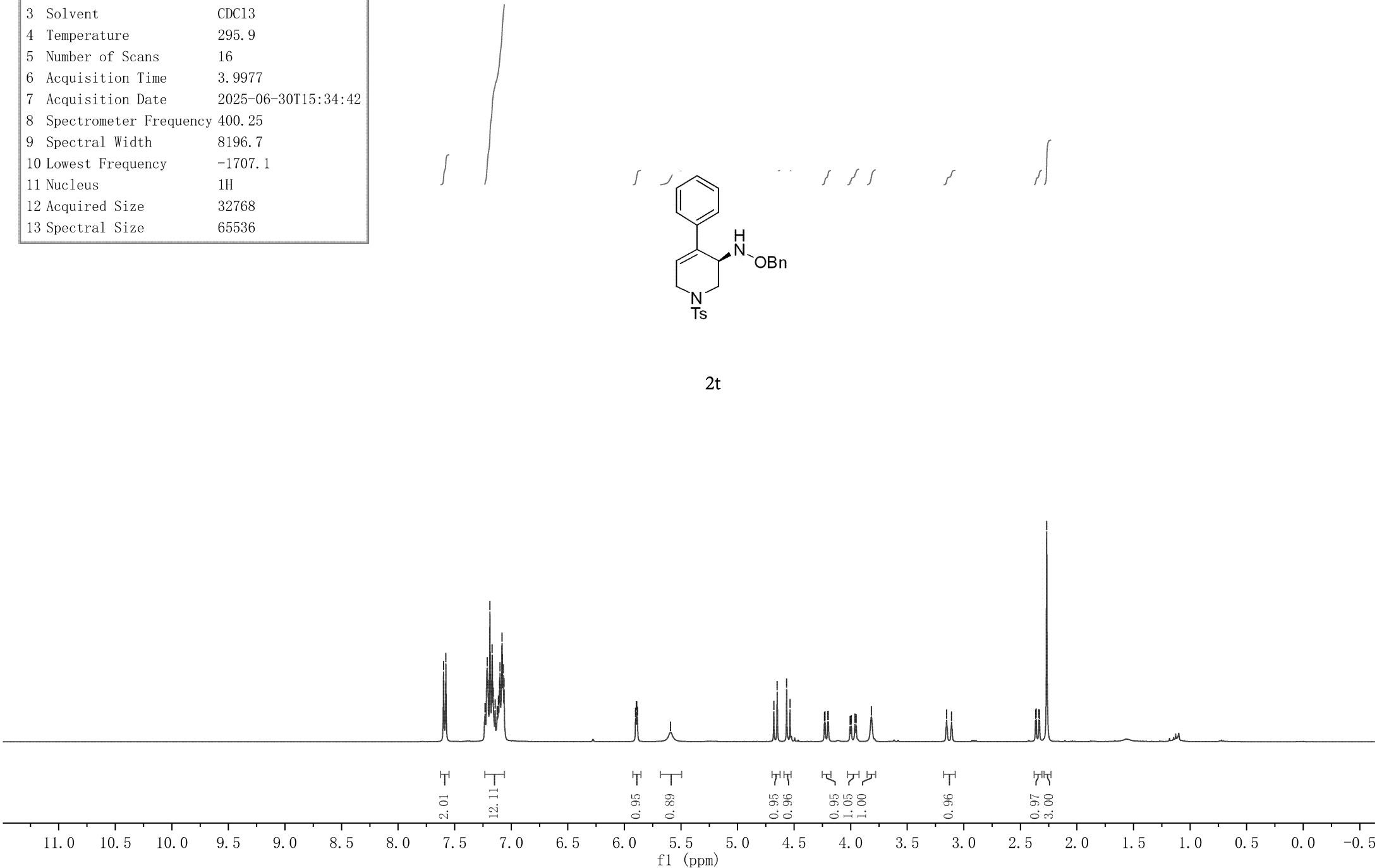


Parameter	Value
1 Title	qlj-11-48-3-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.9
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-06-30T15:34:42
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1707.1
11 Nucleus	1H
12 Acquired Size	32768
13 Spectral Size	65536

7.599 7.578 7.213 7.206 7.189 7.169 7.160 7.104 7.100 7.082 7.071 5.962 5.895 5.891 5.884 5.592 4.679 4.650 4.566 4.536 4.231 4.227 4.202 4.198 4.006 3.995 3.962 3.952 3.817 3.152 3.108 2.366 2.360 2.336 2.331 2.267



2t



Parameter	Value
1 Title	qlj-11-48-3-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.6
5 Number of Scans	250
6 Acquisition Time	1.3763
7 Acquisition Date	2025-06-30T15:49:24
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1852.1
11 Nucleus	¹³ C
12 Acquired Size	32768
13 Spectral Size	32768

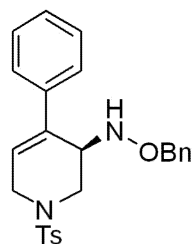
143.75
138.23
138.21
133.70
132.94
129.69
128.55
128.44
128.27
127.75
127.67
125.52
123.68

77.32
77.00
76.68
76.22

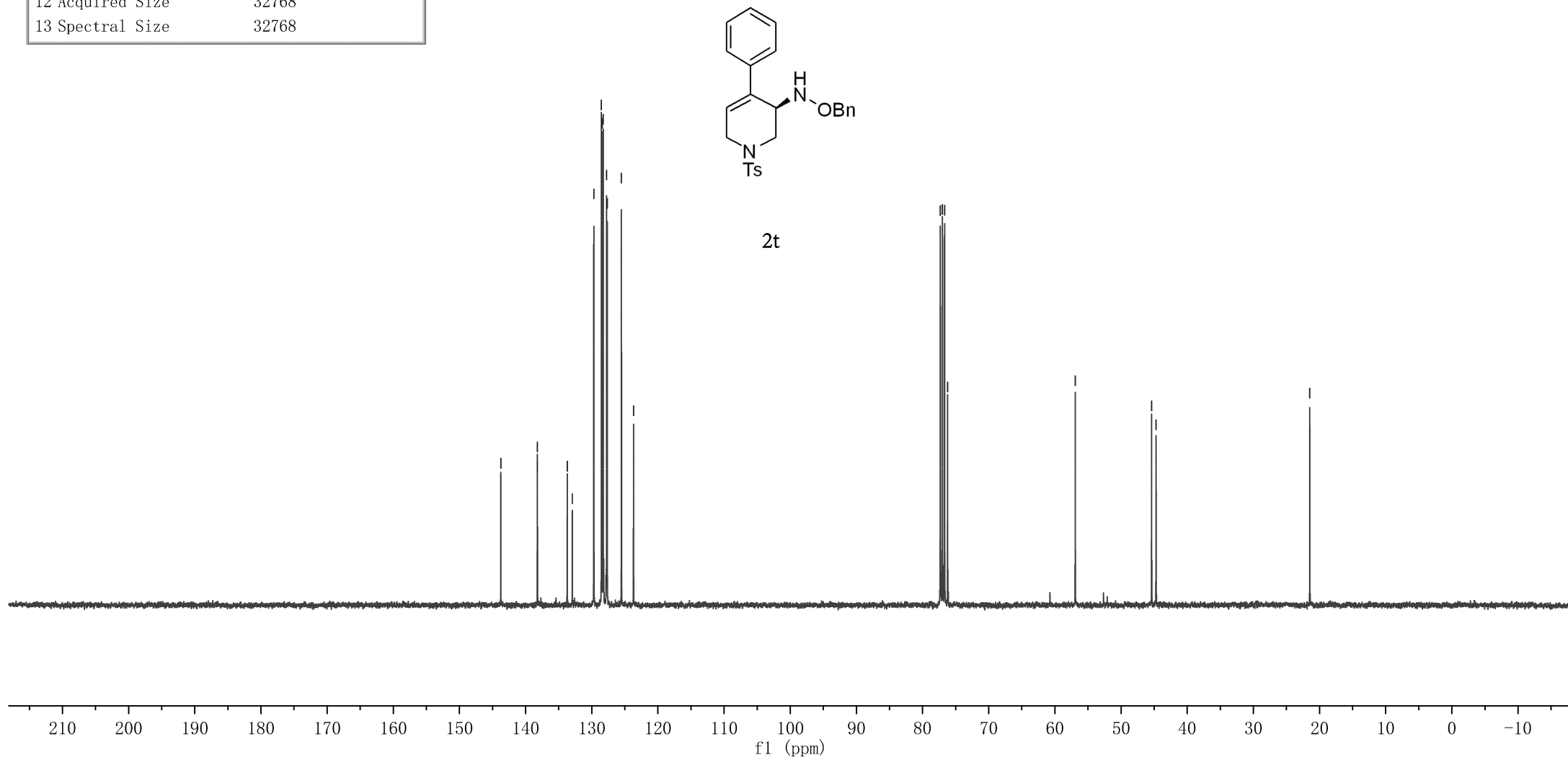
56.93

45.38
44.71

21.48

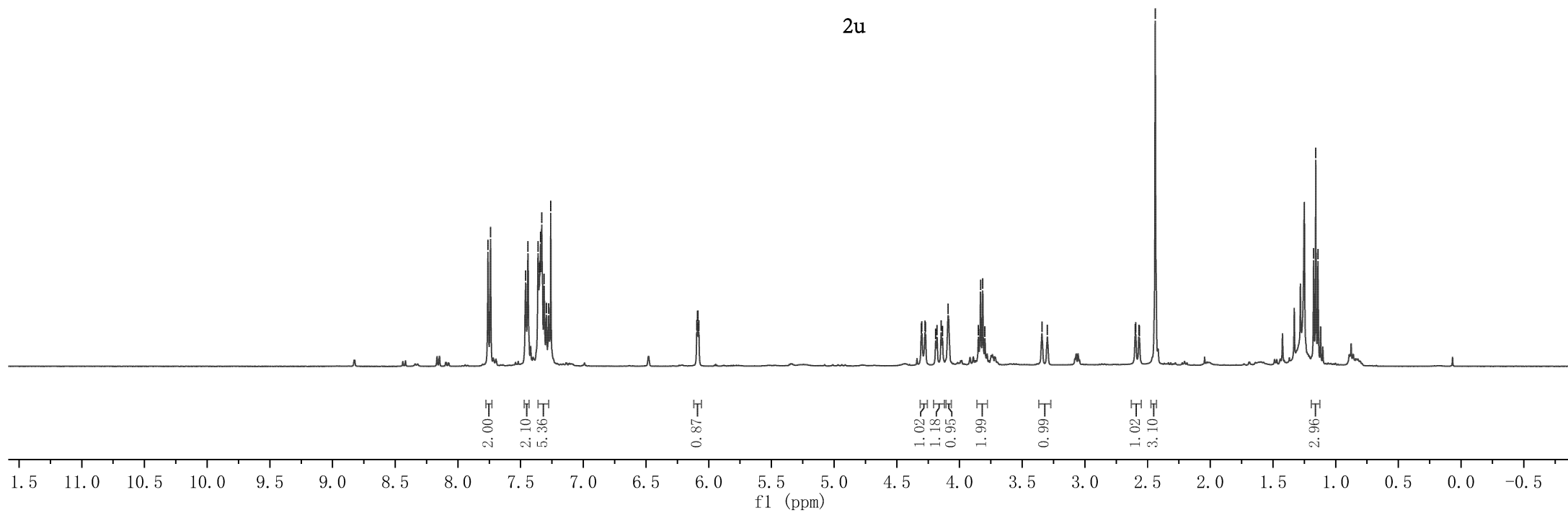
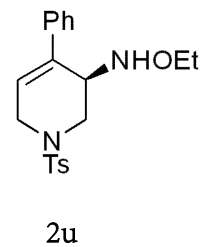


2t



Parameter	Value
1 Title	qlj-11-154-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	292.3
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2026-03-23T15:49:41
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1636.6
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

7.760 7.740 7.460 7.442 7.361 7.348 7.341 7.332 7.312 7.295 7.260 7.239 7.229 6.089 6.085 6.079 4.304 4.300 4.275 4.271 4.190 4.179 4.146 4.136 4.090 3.849 3.832 3.815 3.797 3.343 3.299 2.599 2.595 2.570 2.566 2.439 1.176 1.159 1.141



Parameter	Value
1 Title	qlj-11-154-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	293.0
5 Number of Scans	520
6 Acquisition Time	1.3763
7 Acquisition Date	2026-03-23T16:19:51
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1846.0
11 Nucleus	¹³ C
12 Acquired Size	32768
13 Spectral Size	32768

143.82
138.45
133.68
132.84
129.73
128.61
127.92
127.84
125.71
124.32

77.32
77.00
76.68

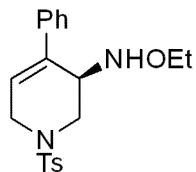
69.62

56.72

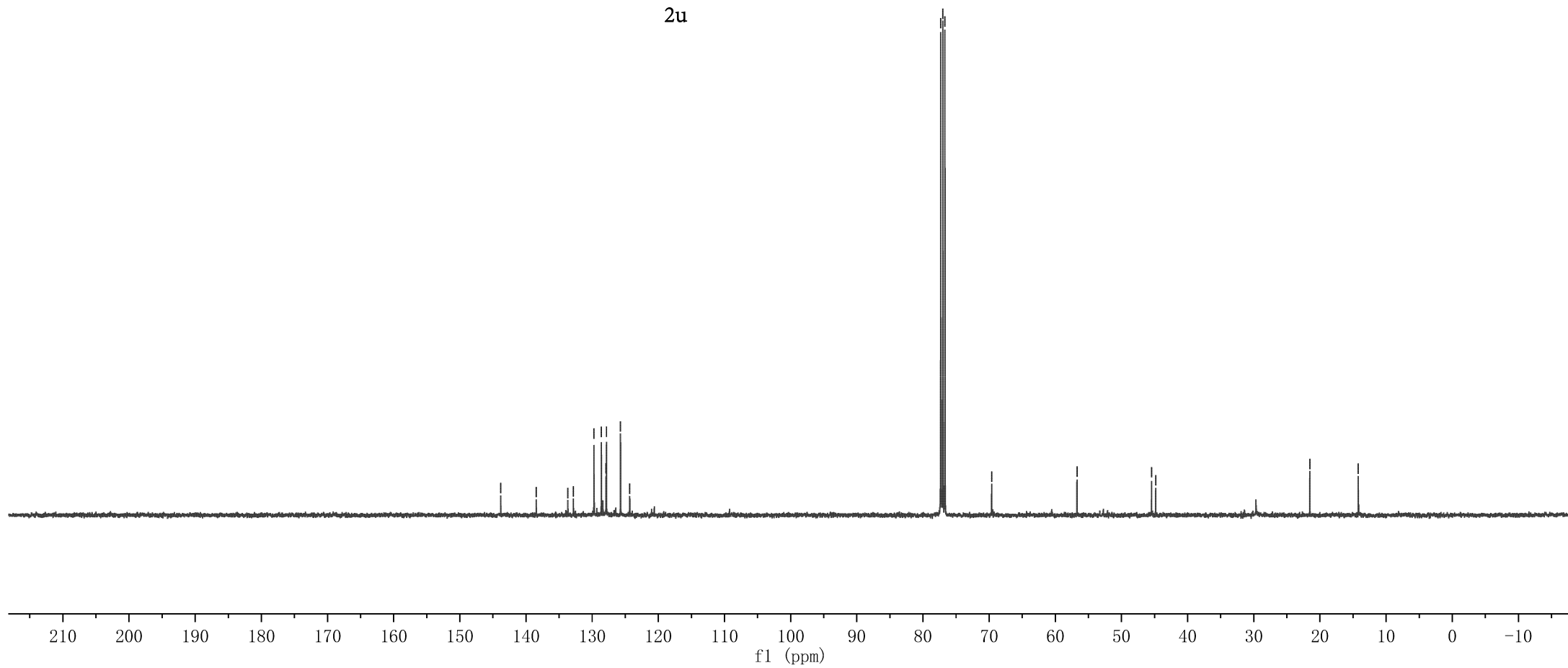
45.45
44.83

21.53

14.22

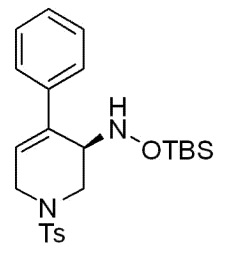
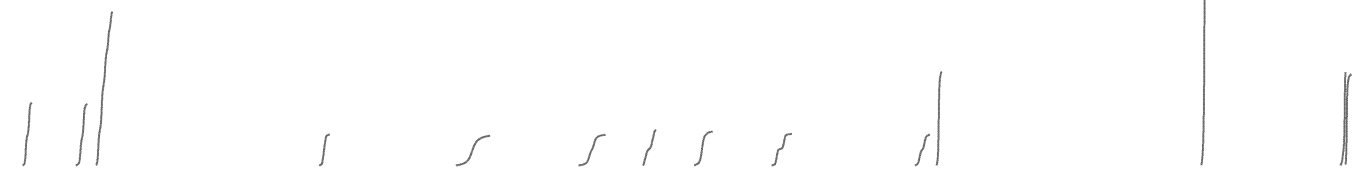


2u

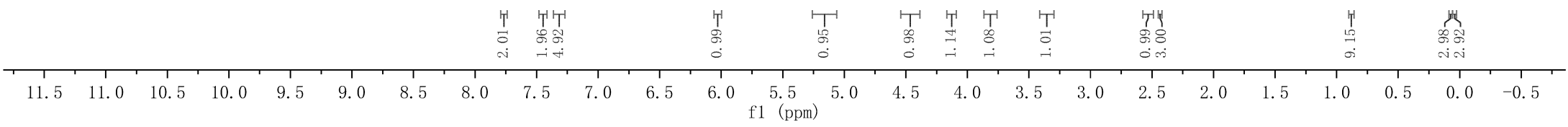


Parameter	Value
1 Title	qlj-11-51-1-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.7
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-07-04T13:24:12
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1636.4
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

7.774
7.754
7.457
7.453
7.436
7.350
7.331
7.310
7.306
7.291
7.277
7.269
6.033
6.028
6.022
5.165
4.480
4.452
4.147
4.114
4.104
4.094
3.389
3.384
3.379
3.346
3.341
3.336
2.551
2.547
2.522
2.518
2.437
0.883
0.063
0.051



2v



Parameter	Value
1 Title	qlj-11-51-1-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.5
5 Number of Scans	500
6 Acquisition Time	1.3763
7 Acquisition Date	2025-07-04T13:53:47
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1845.3
11 Nucleus	¹³ C
12 Acquired Size	32768
13 Spectral Size	32768

143.73
139.32
134.80
133.37
129.69
128.27
127.82
127.60
126.05
124.04

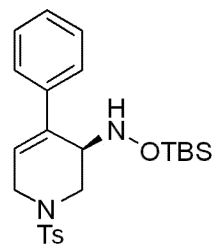
77.32
77.00
76.68

59.05

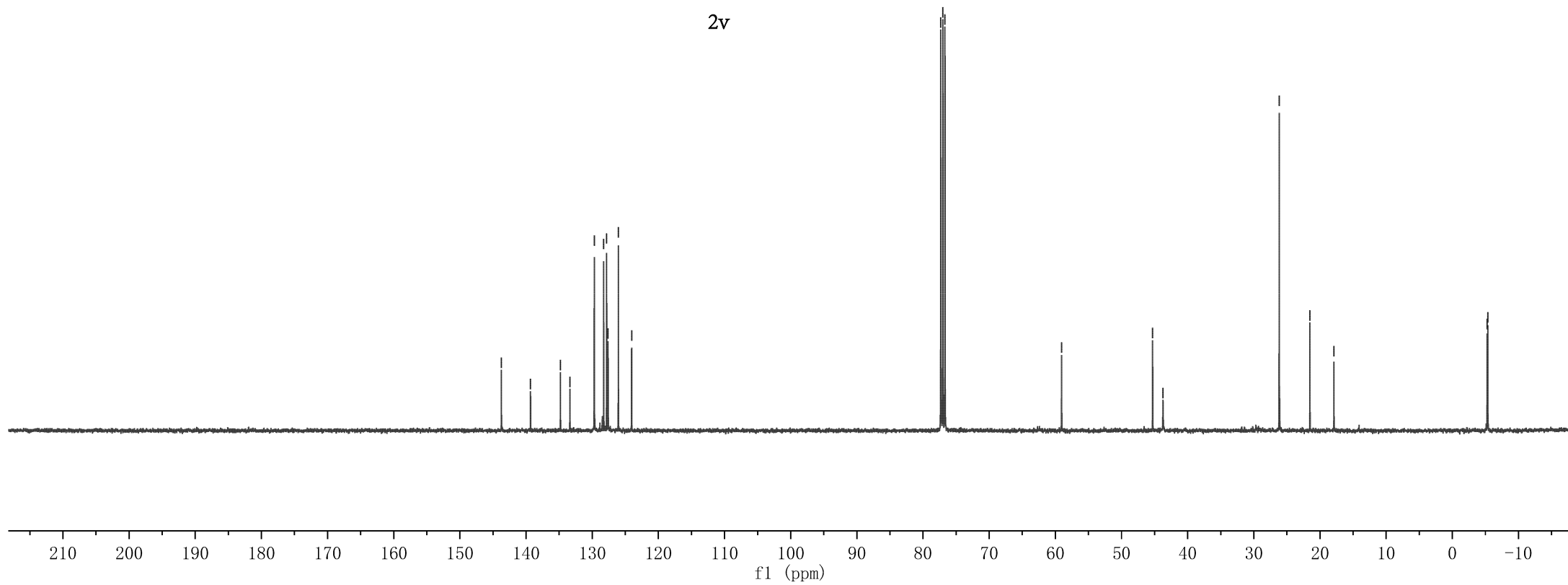
45.30
43.73

26.17
21.52
17.90

-5.26
-5.36



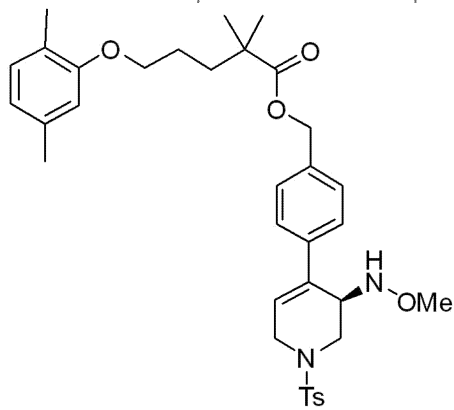
2v



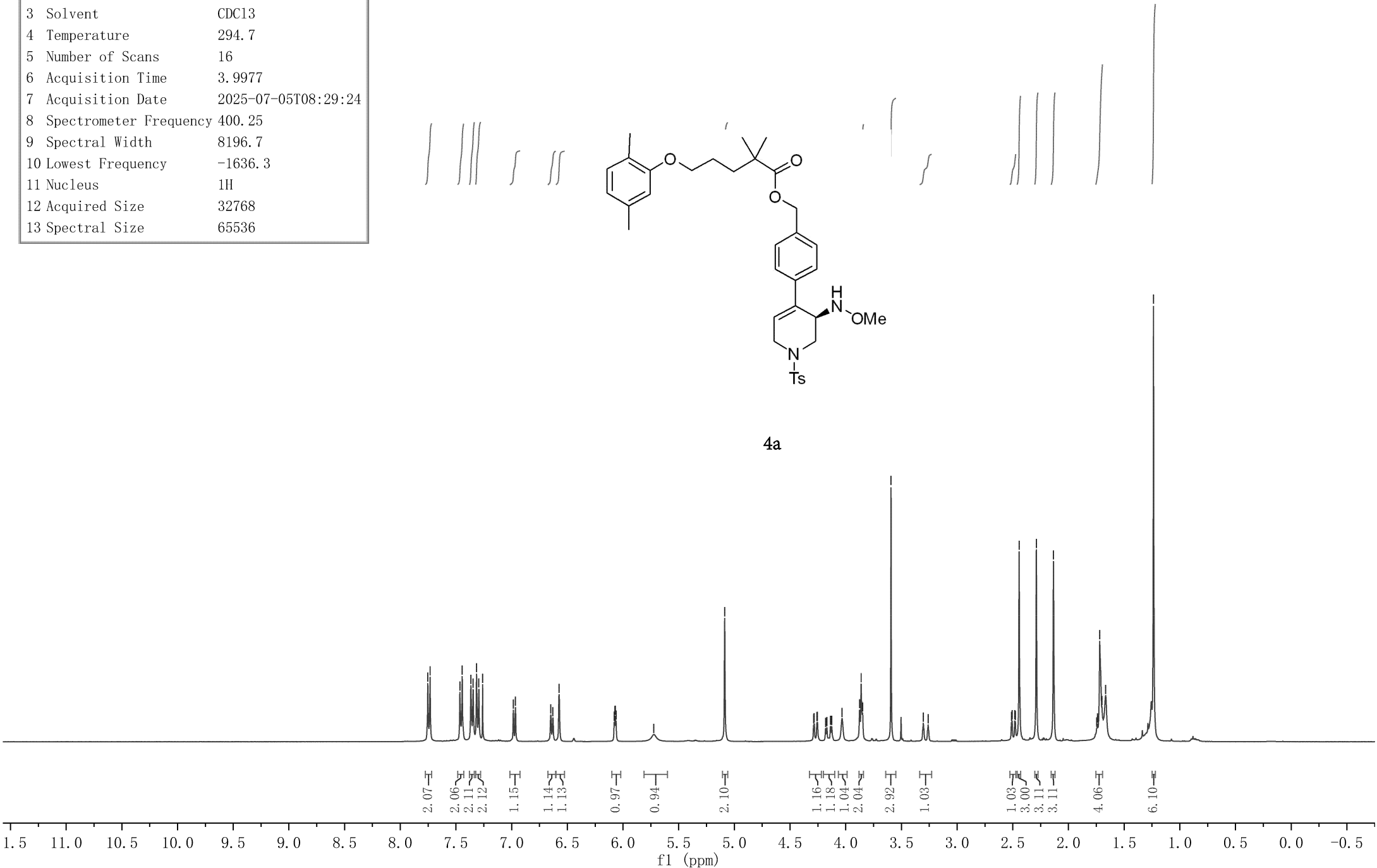
Parameter	Value
1 Title	qlj-11-54-1-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	294.7
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-07-05T08:29:24
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1636.3
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

7.753 7.732 7.444 7.366 7.315 7.280 6.984 6.966 6.648 6.630 6.574 6.079 6.073 6.068 6.062 5.724 5.087 4.287 4.284 4.258 4.254 4.169 4.137 4.126 4.033 3.876 3.862 3.849 3.833 3.304 3.260 2.512 2.506 2.483 2.477 2.443 2.288 2.135 1.746 1.739 1.719 1.700 1.666 1.236

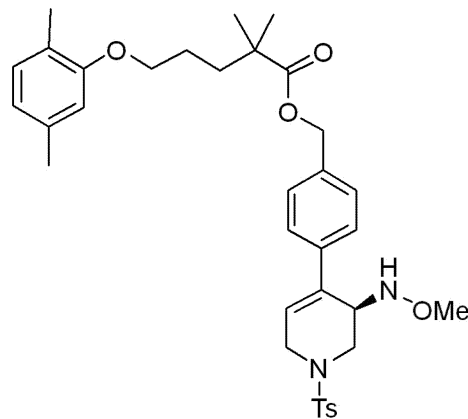
2.07 2.06 2.11 2.12 1.15 1.14 1.13 0.97 0.94 2.10 1.16 1.18 1.04 2.04 2.92 1.03 1.03 3.00 3.11 3.11 4.06 6.10



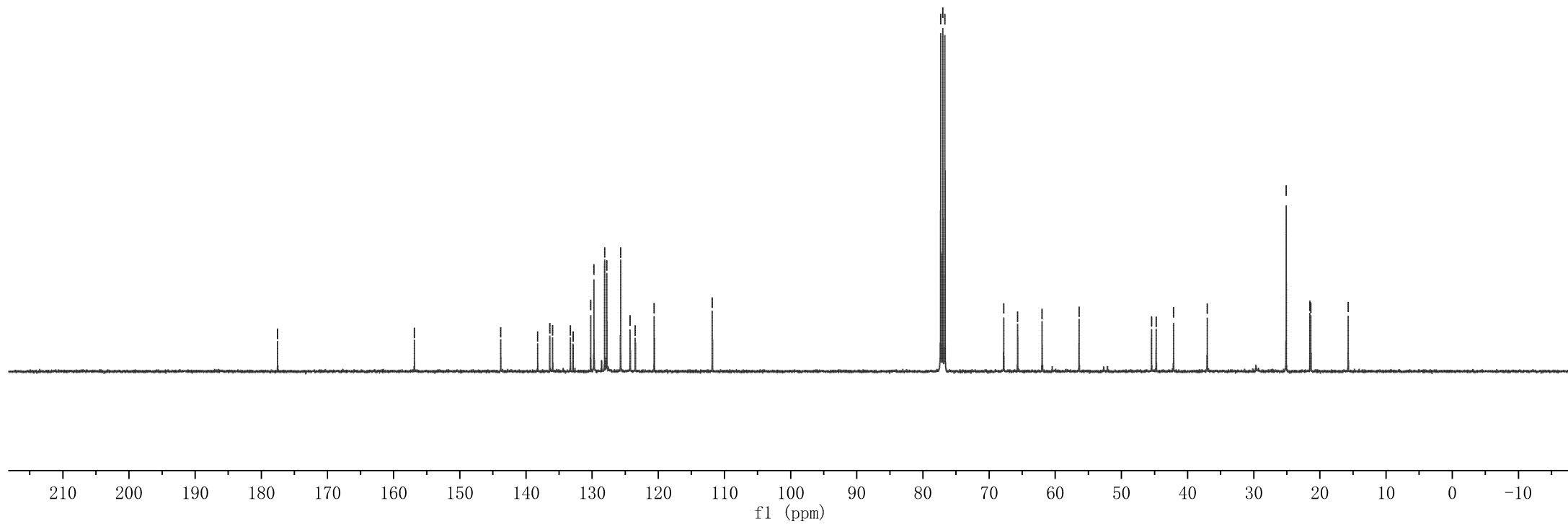
4a



Parameter	Value
1 Title	qlj-11-54-1-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.8
5 Number of Scans	1024
6 Acquisition Time	1.3763
7 Acquisition Date	2025-07-05T09:28:33
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1840.5
11 Nucleus	¹³ C
12 Acquired Size	32768
13 Spectral Size	32768

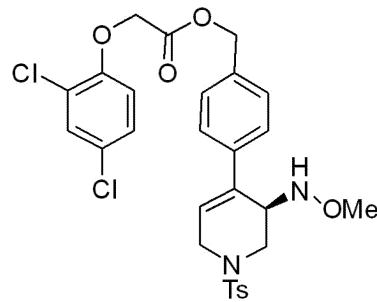


4a

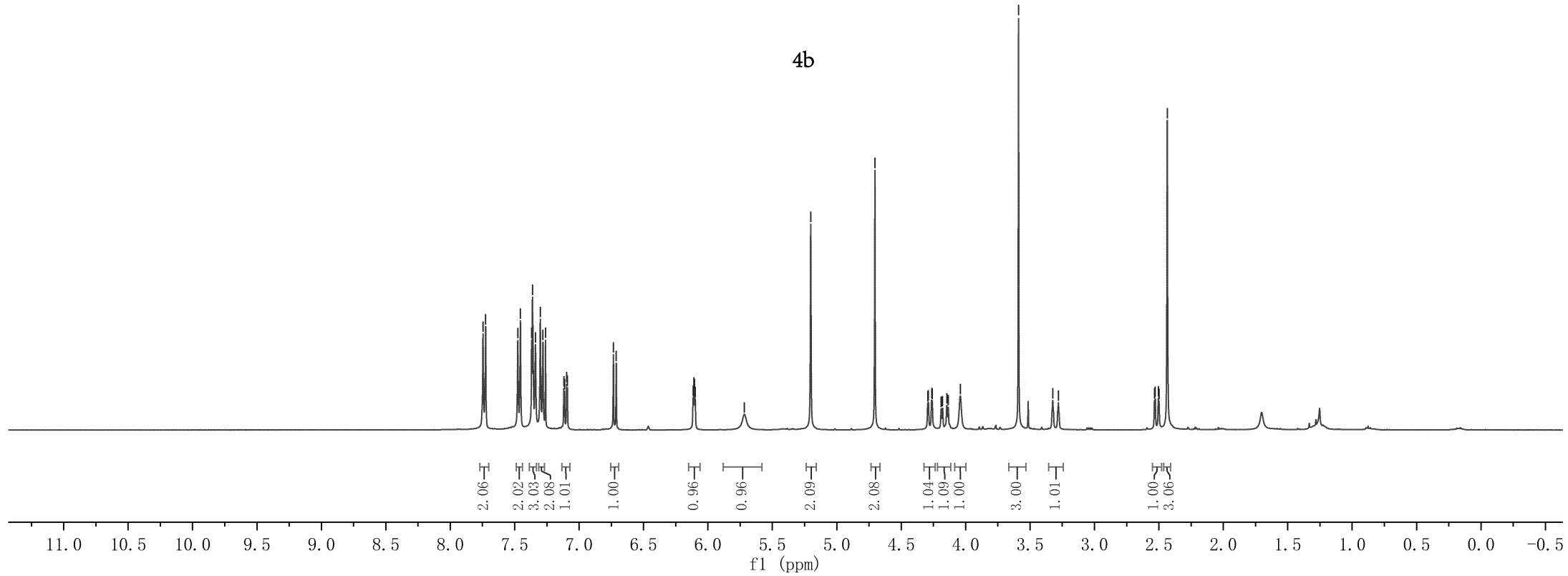


Parameter	Value
1 Title	qlj-11-59-1-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.9
5 Number of Scans	16
6 Acquisition Time	4.0894
7 Acquisition Date	2025-07-09T18:48:00
8 Spectrometer Frequency	400.13
9 Spectral Width	8012.8
10 Lowest Frequency	-1608.9
11 Nucleus	1H
12 Acquired Size	32768
13 Spectral Size	65536

7.746
7.725
7.476
7.455
7.368
7.362
7.301
7.289
6.733
6.711
6.115
6.109
6.104
6.098
5.717
5.202
4.704
4.293
4.289
4.263
4.260
4.179
4.146
4.135
4.044
3.589
3.324
3.280
2.534
2.528
2.504
2.499
2.435

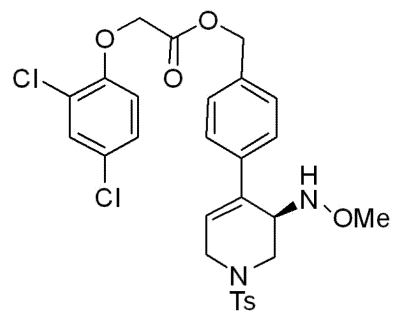


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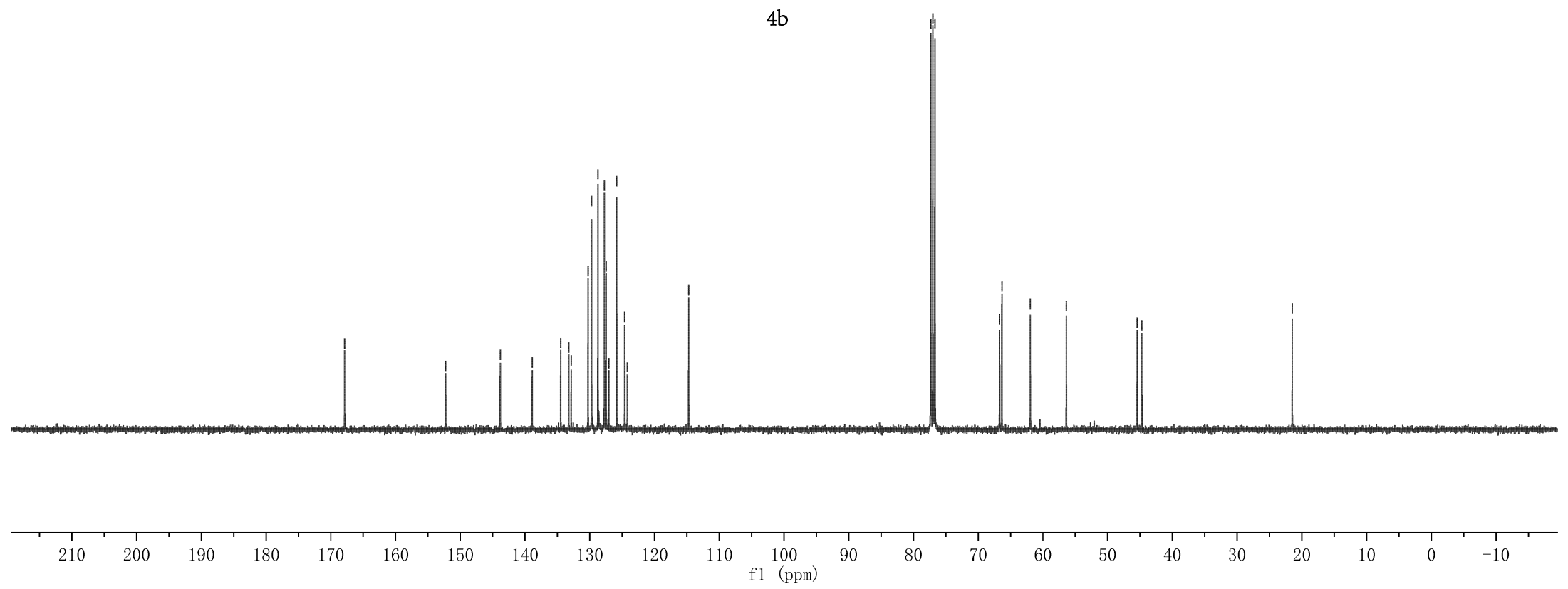


— 167.87 — 152.25 — 143.83 — 138.90 — 134.49 — 133.26 — 132.87 — 130.26 — 129.73 — 128.74 — 127.74 — 127.48 — 125.84 — 124.61 — 124.72 — 77.32 — 77.00 — 76.68 — 66.70 — 66.34 — 61.95 — 56.38 — 45.44 — 44.73 — 21.49

Parameter	Value
1 Title	qlj-11-59-1-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	297.4
5 Number of Scans	250
6 Acquisition Time	1.3631
7 Acquisition Date	2025-07-09T18:51:00
8 Spectrometer Frequency	100.61
9 Spectral Width	24038.5
10 Lowest Frequency	-1966.4
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768

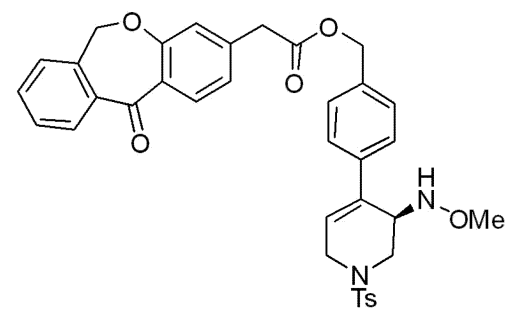
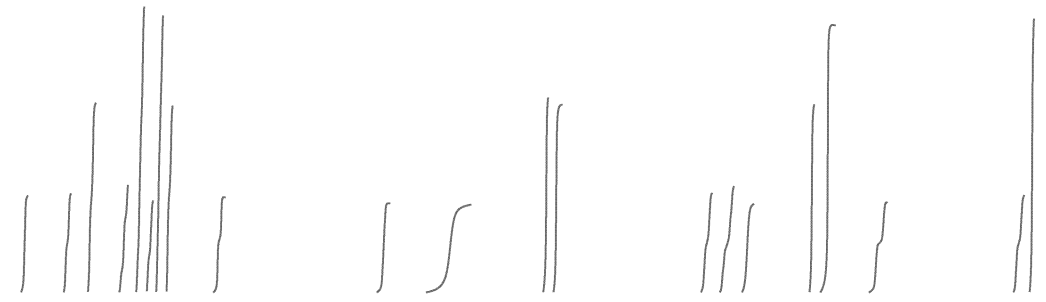


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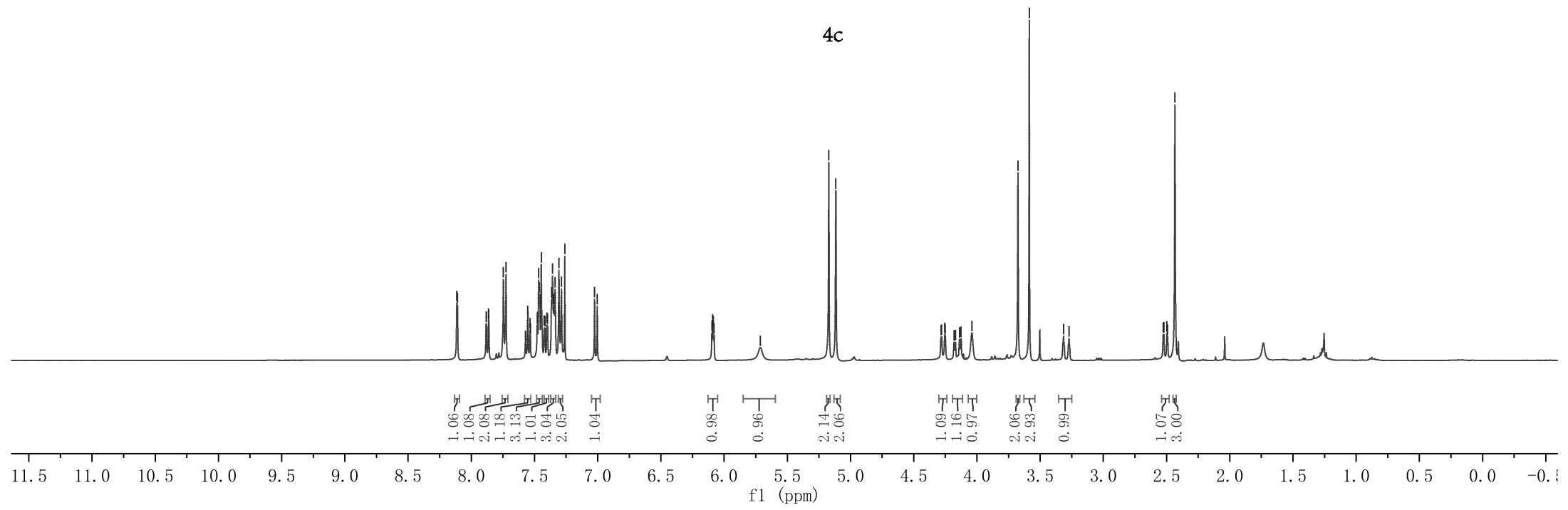


Parameter	Value
1 Title	qlj-11-59-3-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.4
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-07-10T14:09:41
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1636.3
11 Nucleus	1H
12 Acquired Size	32768
13 Spectral Size	65536

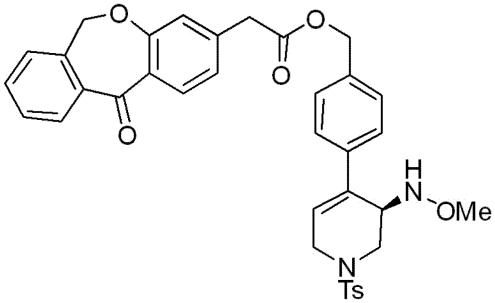
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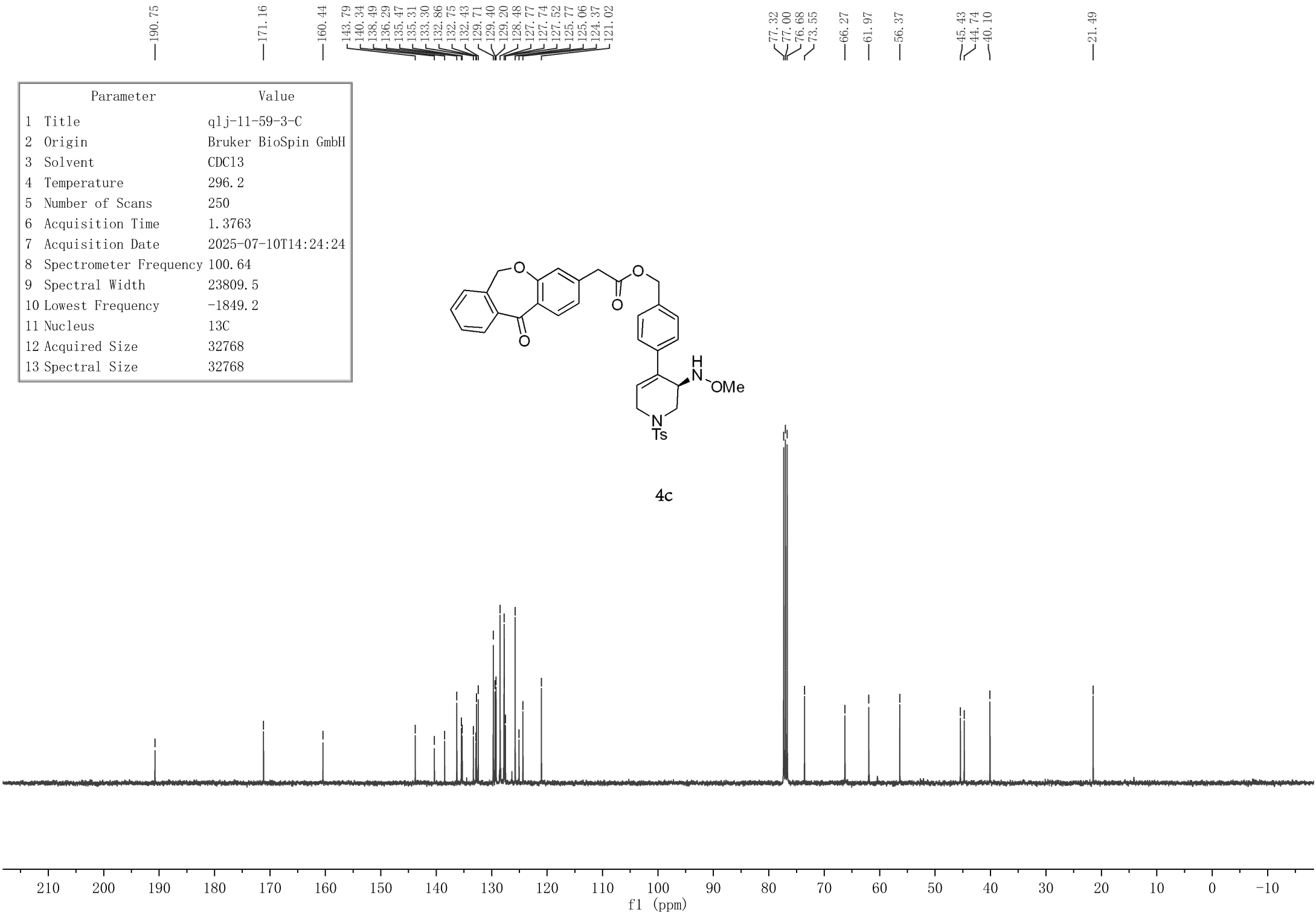
4c



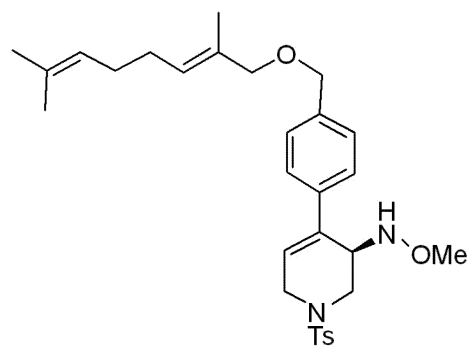
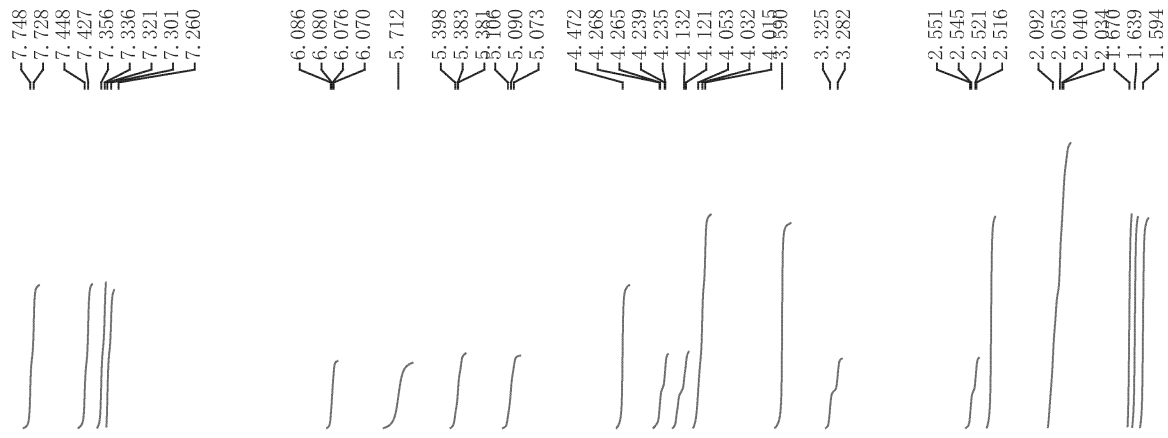
Parameter	Value
1 Title	qlj-11-59-3-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.2
5 Number of Scans	250
6 Acquisition Time	1.3763
7 Acquisition Date	2025-07-10T14:24:24
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1849.2
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768



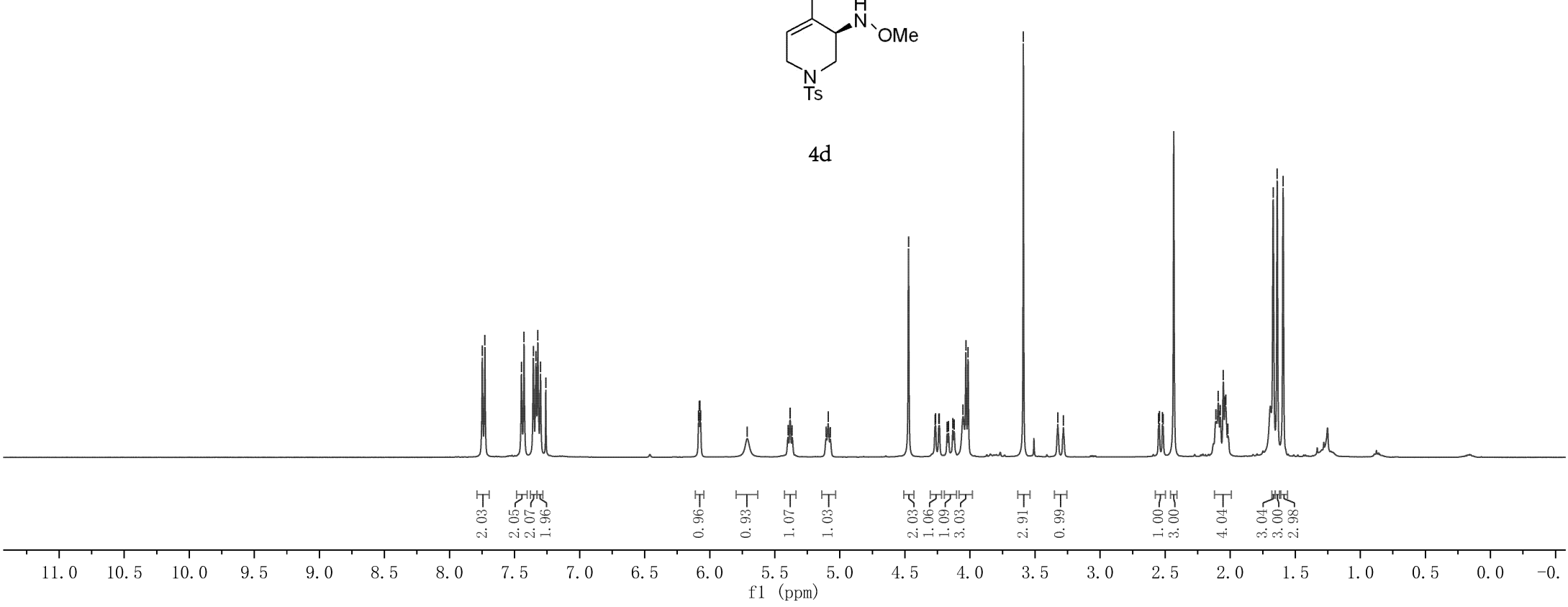
4c



Parameter	Value
1 Title	qlj-11-59-4-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.5
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-07-09T19:29:27
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1636.5
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536



4d



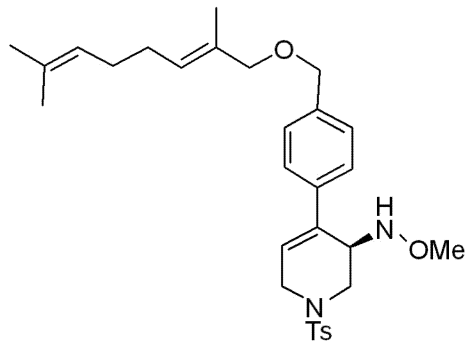
Parameter	Value
1 Title	qlj-11-59-4-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	296.2
5 Number of Scans	312
6 Acquisition Time	1.3763
7 Acquisition Date	2025-07-09T19:47:41
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1846.8
11 Nucleus	¹³ C
12 Acquired Size	32768
13 Spectral Size	32768

143.77
140.49
138.37
137.70
133.54
132.92
131.63
129.71
128.07
127.77
125.60
123.92
123.87
120.65

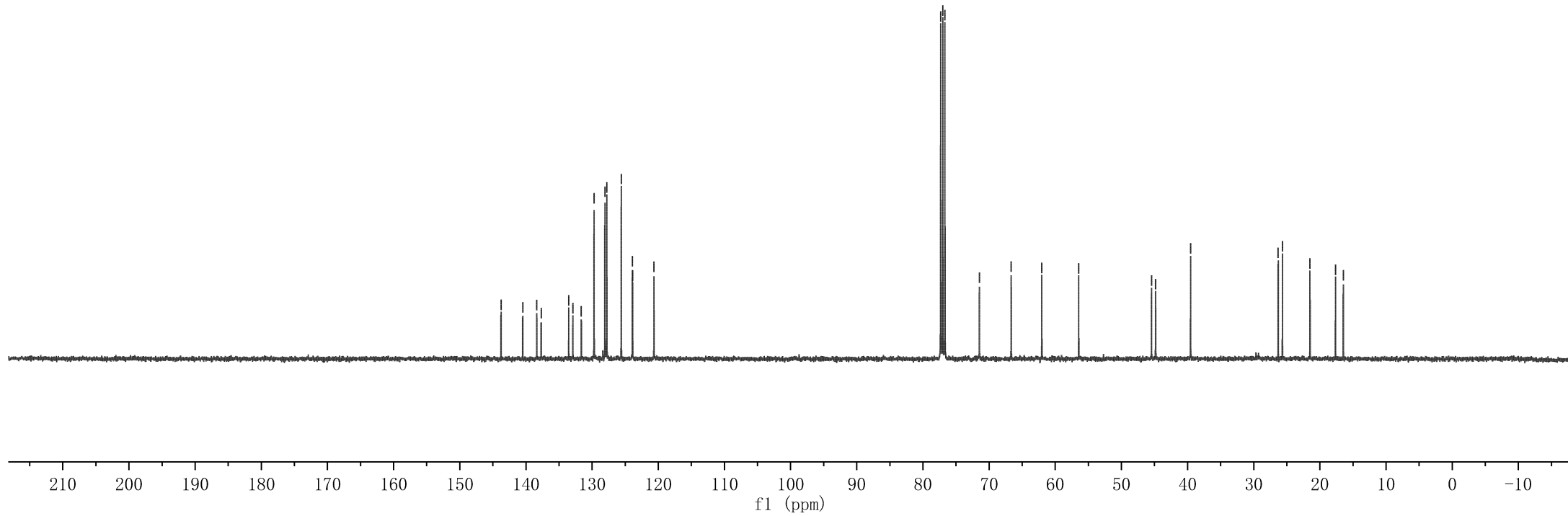
77.32
77.00
76.68
71.47
66.66
62.03
56.45

45.45
44.83
39.55

26.30
25.66
21.50
17.65
16.47

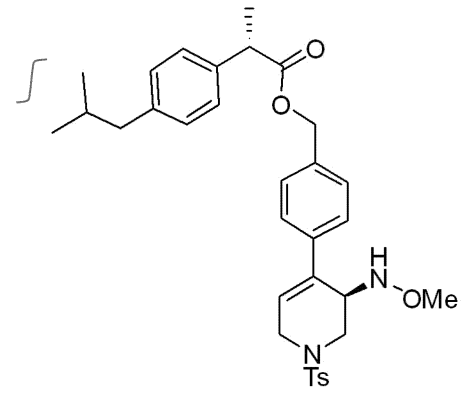
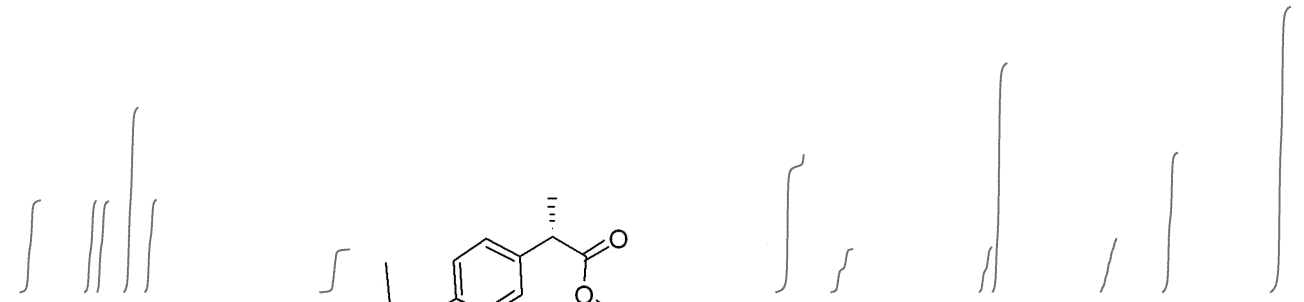


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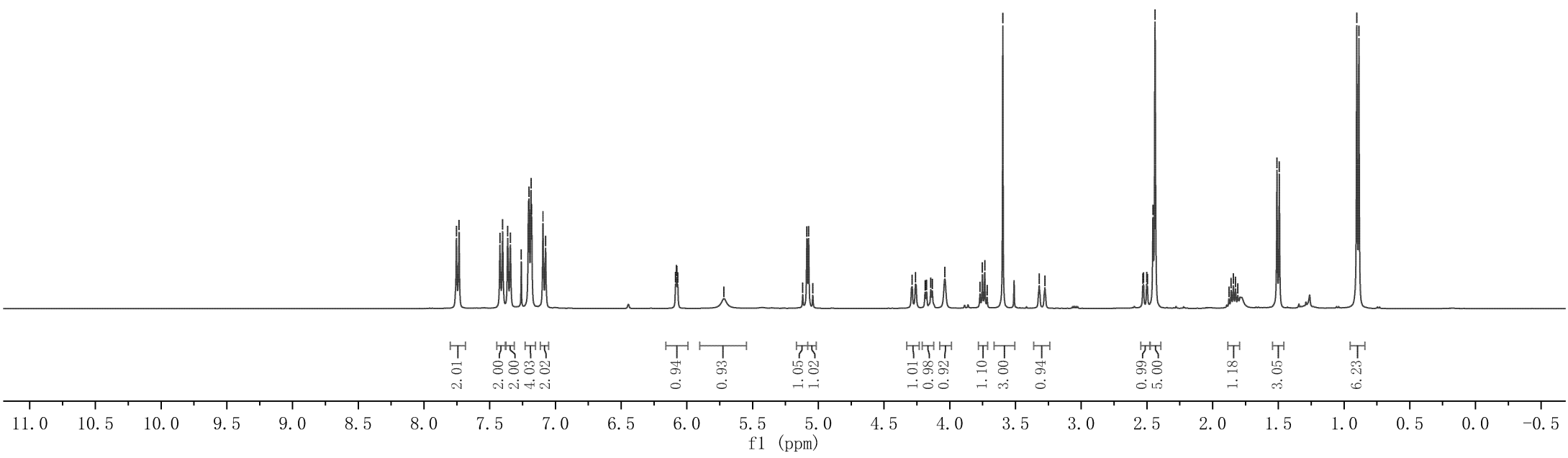


Parameter	Value
1 Title	qlj-11-60-1-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	294.7
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-07-12T16:57:47
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1636.4
11 Nucleus	¹ H
12 Acquired Size	32768
13 Spectral Size	65536

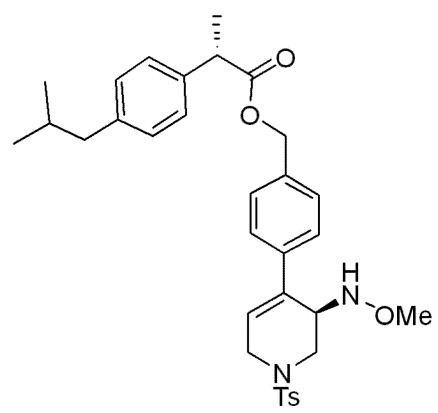
7.753 7.733 7.422 7.402 7.363 7.343 7.260 7.205 7.201 7.186 7.181 7.095 7.075 6.086 6.080 6.075 6.069 5.718 5.118 5.087 5.074 5.042 4.286 4.260 4.187 4.176 4.144 4.133 4.037 3.769 3.751 3.733 3.596 3.579 3.276 2.531 2.525 2.501 2.496 2.454 2.438 1.859 1.842 1.825 1.808 1.510 1.493 0.903 0.887



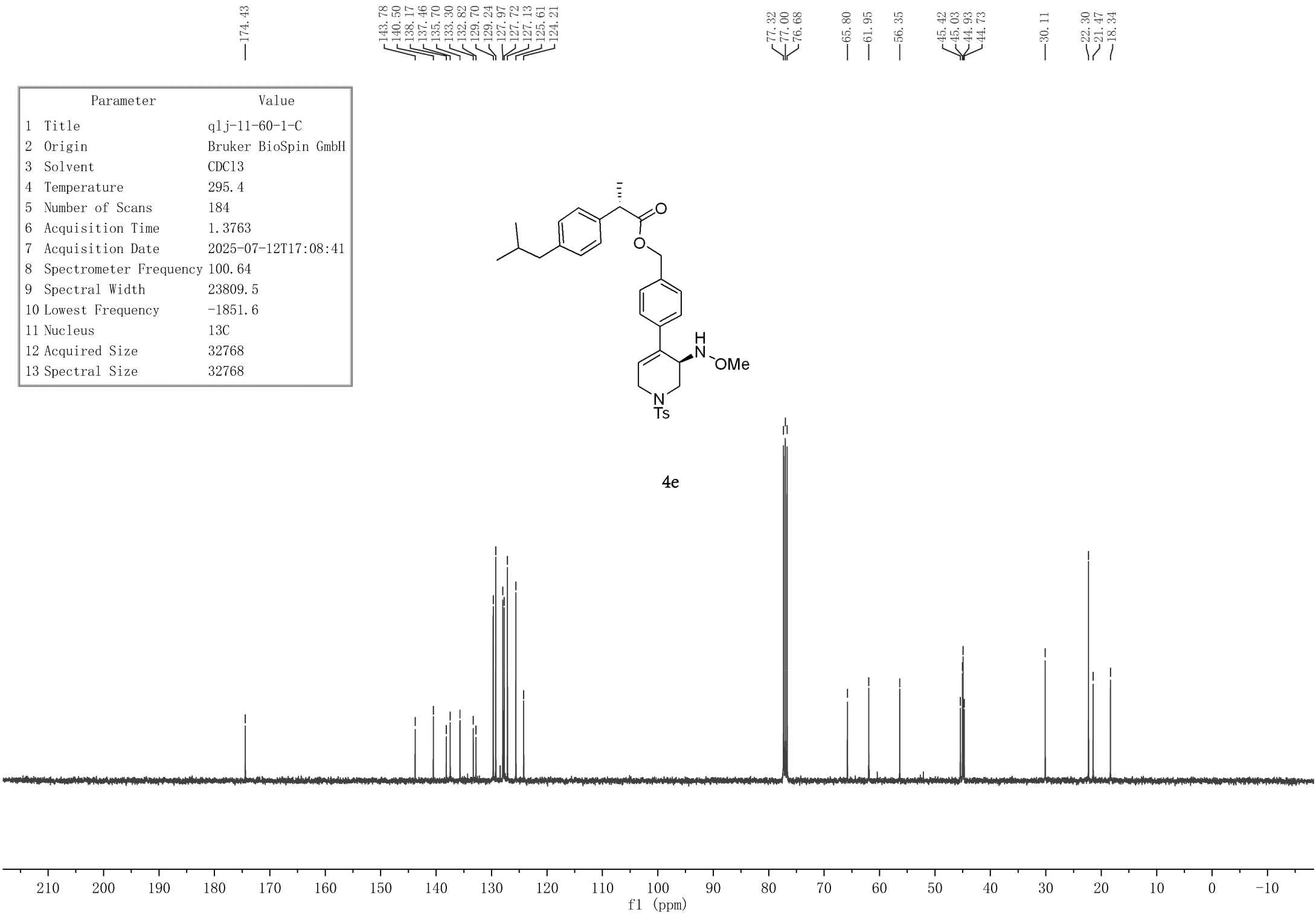
4e



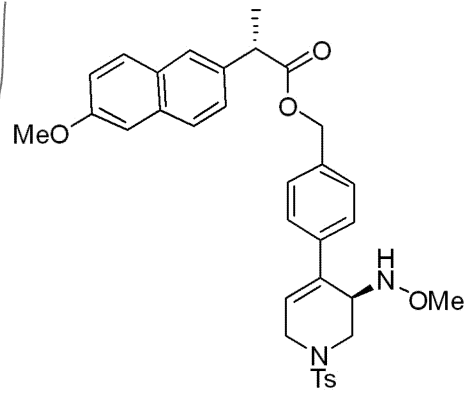
Parameter	Value
1 Title	qlj-11-60-1-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.4
5 Number of Scans	184
6 Acquisition Time	1.3763
7 Acquisition Date	2025-07-12T17:08:41
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1851.6
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768



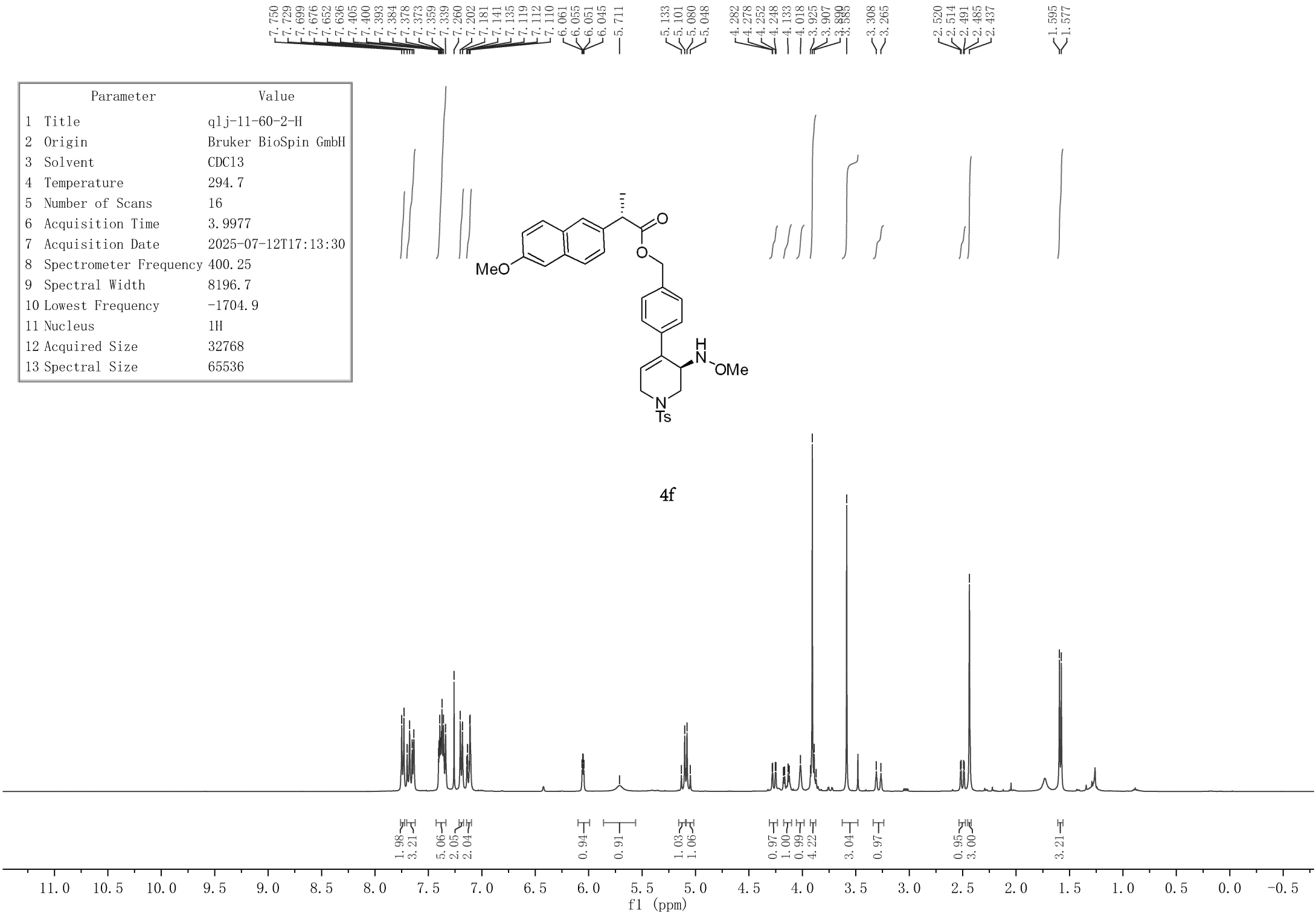
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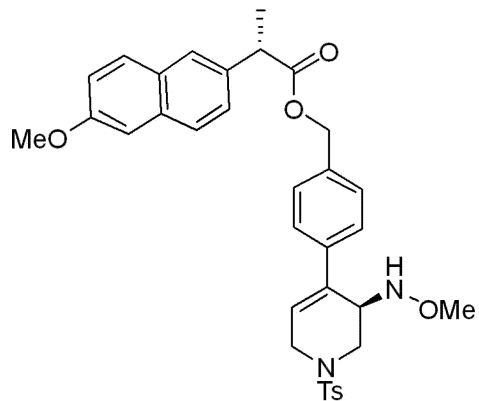
Parameter	Value
1 Title	qlj-11-60-2-H
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	294.7
5 Number of Scans	16
6 Acquisition Time	3.9977
7 Acquisition Date	2025-07-12T17:13:30
8 Spectrometer Frequency	400.25
9 Spectral Width	8196.7
10 Lowest Frequency	-1704.9
11 Nucleus	1H
12 Acquired Size	32768
13 Spectral Size	65536



4f



Parameter	Value
1 Title	qlj-11-60-2-C
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDC13
4 Temperature	295.5
5 Number of Scans	224
6 Acquisition Time	1.3763
7 Acquisition Date	2025-07-12T17:26:42
8 Spectrometer Frequency	100.64
9 Spectral Width	23809.5
10 Lowest Frequency	-1849.6
11 Nucleus	13C
12 Acquired Size	32768
13 Spectral Size	32768



4f

174.38 157.56 143.80 129.71 129.20 128.14 127.74 127.08 126.20 125.92 125.64 124.97 118.97 105.48 77.32 77.00 76.68 65.97 61.97 56.35 55.24 45.42 45.37 44.74 21.48 18.43

