Supporting Information for

Bifunctional Biphenyl-2-ylphosphine Ligand Enables Tandem Gold-Catalyzed Propargylation of Aldehyde and Unexpected Cycloisomerization

Ting Li, [a,b] *and Liming Zhang**[,a]

[a]*Department of Chemistry and Biochemistry, University of California,*

Santa Barbara, California 93106, United States

E-mail: zhang@chem.ucsb.edu

[b]*College of Chemistry and Pharmaceutical Engineering, Nanyang Normal University, Nanyang,*

Henan, 473061, P. R. China

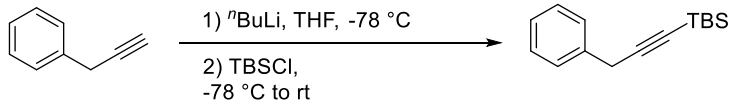
Table of Contents

1. General Information

Ethyl acetate (ACS grade), hexanes (ACS grade), dichloromethane (ACS grade) were purchased from Fisher Scientific and used without further purification. ACS grade 1,2-dichloroethane were purchased from Acros Organics and used directly. Commercially available reagents were used without further purification. Reactions were monitored by thin layer chromatography (TLC) using Silicycle precoated silica gel plates. Flash column chromatography was performed over Silicycle silica gel (230-400 mesh). ^{1}H NMR and ^{13}C NMR spectra were recorded on a Varian 400 MHz, 500 MHz and 600 MHz spectrometers using residue solvent peaks as internal standards ($CHCl_3$,^{1}H: 7.26 ppm; ^{13}C: 77.00 ppm). ^{19}F NMR spectra were recorded on Varian 400 MHz calibrated by PhF or $PhCF_3$ (PhF, ^{19}F: -113.15 ppm. $PhCF_3$, ^{19}F: -63.72 ppm). Mass spectra were recorded with Waters micromass ZQ detector using electrospray method.

2. Preparation of Silylated Alkynes

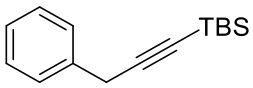
General Procedure A:



General procedure A

Taking substrate **1a** for example: To a solution of prop-2-yn-1-ylbenzene (1 equiv.) in anhydrous THF was added ^{n}BuLi (2.5 M, 1.1 equiv.) dropwise under nitrogen at -78 °C. After 30 min, anhydrous TBSCl (1.1 equiv.) in THF solution was added dropwise at -78 °C. The reaction mixture was stirred at -78 °C for 30 min before allowed to warm up to room temperature. Stirring was continued for 1 h. The reaction mixture was diluted with ether and washed with water and brine. The organic phase was dried over anhydrous $MgSO_4$, filtered and concentrated under vacuum. The residue was purified by flash column chromatography to give the target silylated alkyne.

tert-butyldimethyl(3-phenylprop-1-yn-1-yl)silane (**1a**)



1a

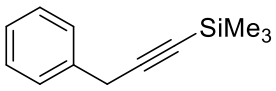
This compound was prepared from prop-2-yn-1-ylbenzene and TBSCl according to the general procedure **A** as colorless oil in 74% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.29 (m, 4H), 7.25 (t, *J* = 7.7 Hz, 1H), 3.69 (s, 2H), 0.97 (s, 9H), 0.14 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 136.45, 128.41, 127.80, 126.49, 104.69, 85.05, 26.16, 26.10, 16.56, -4.48.

HR-MS (EI-TOF) m/z calcd for $C_{15}H_{22}Si$ $[M]^+$: 230.1491, found: 230.1496.

trimethyl(3-phenylprop-1-yn-1-yl)silane (**1b**)



1b

The known compound was prepared from phenylacetylene and TMSCl according to the

general procedure **A** as colorless oil in 84% yield.

This compound is known. Its spectroscopic data are in accordance with the literature data[1].

dimethyl(phenyl)(3-phenylprop-1-yn-1-yl)silane (**1c**)

1c

This compound was prepared from prop-2-yn-1-ylbenzene and $PhMe_2SiCl$ according to the general procedure **A** as colorless oil in 90% yield.

This compound is known. Its spectroscopic data are in accordance with the literature data[2].

methyldiphenyl(3-phenylprop-1-yn-1-yl)silane (**1d**)

1d

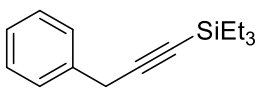
This compound was prepared from prop-2-yn-1-ylbenzene and $Ph_2MeSiCl$ according to the general procedure **A** as colorless oil in 86% yield.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.84 – 7.78 (m, 4H), 7.54 – 7.47 (m, 8H), 7.44 (t, J = 7.8 Hz, 2H), 7.37 (t, J = 7.3 Hz, 1H), 3.89 (s, 2H), 0.86 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 136.17, 135.77, 134.65, 129.75, 128.69, 128.07, 126.83, 108.07, 83.47, 26.57, -1.68.

HR-MS (EI-TOF) m/z calcd for $C_{21}H_{17}Si$ $[M\text{-}CH_3]^+$: 297.1100, found: 297.1097.

triethyl(3-phenylprop-1-yn-1-yl)silane (**1e**)



1e

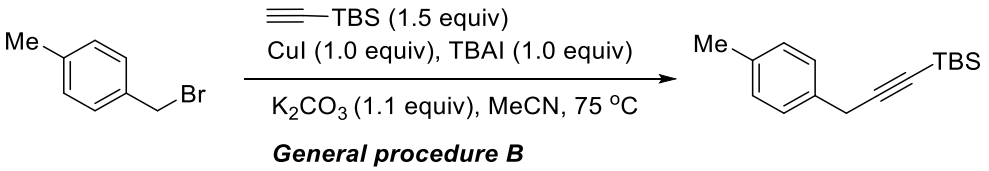
This compound was prepared from prop-2-yn-1-ylbenzene and Et_3SiCl according to the general procedure **A** as colorless oil in 85% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 – 7.29 (m, 4H), 7.25 (t, *J* = 6.5 Hz, 1H), 3.70 (s, 2H), 1.03 (dd, *J* = 9.8, 6.0 Hz, 9H), 0.64 (q, *J* = 7.9 Hz, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 136.51, 128.41, 127.80, 126.48, 105.20, 84.18, 26.20, 7.49, 4.49.

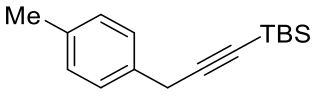
HR-MS (EI-TOF) m/z calcd for $C_{15}H_{22}Si$ $[M]^+$: 230.1491, found: 230.1483.

General Procedure B:



Taking substrate **1h** for example:[3] To a solution of 1-(bromomethyl)-4-methylbenzene (2.0 mmol), copper(I) iodide (1.0 equiv), K_2CO_3 (1.1 equiv), and tetrabutylammonium iodide (1.0 equiv) in dry acetonitrile, *tert*-butyl(ethynyl)dimethylsilane (1.5 equiv) was added. The mixture was stirred at 75 °C for 24 h. The reaction mixture was quenched with saturated NH_4Cl solution and extracted with EtOAc. The crude organic layers were washed with brine, dried using $MgSO_4$ and filtered. The filtrate was concentrated in vacuo and purified the residue by column chromatography on silica gel to give the target silylated alkyne.

tert-butyldimethyl(3-(*p*-tolyl)prop-1-yn-1-yl)silane (**1h**)



1h

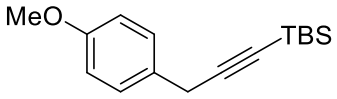
This compound was prepared from 1-(bromomethyl)-4-methylbenzene and *tert*-butyl(ethynyl)dimethylsilane according to the general procedure **B** as colorless oil in 81% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 (d, *J* = 6.8 Hz, 1H), 7.28 – 7.08 (m, 3H), 3.61 (s, 2H), 2.34 (s, 3H), 0.99 (s, 9H), 0.16 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 135.88, 134.70, 129.94, 128.11, 126.76, 126.13, 104.45, 85.24, 26.13, 24.41, 19.27, 16.60, -4.44.

HR-MS (EI-TOF) m/z calcd for $C_{16}H_{24}Si$ $[M]^+$: 244.1647, found: 244.1655.

tert-butyl(3-(4-methoxyphenyl)prop-1-yn-1-yl)dimethylsilane (**1i**)



1i

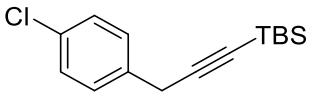
This compound was prepared from 1-(bromomethyl)-4-methoxybenzene and *tert*-butyl(ethynyl)dimethylsilane according to the general procedure **B** as colorless oil in 84% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.26 (d, *J* = 8.6 Hz, 2H), 6.86 (d, *J* = 8.6 Hz, 2H), 3.80 (s, 3H), 3.61 (s, 2H), 0.95 (s, 9H), 0.12 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 158.21, 128.74, 128.46, 113.80, 105.20, 84.69, 55.27, 26.10, 25.29, 16.57, -4.47.

HR-MS (EI-TOF) m/z calcd for $C_{26}H_{24}OSi$ $[M]^+$: 260.1596, found: 260.1596.

tert-butyl(3-(4-chlorophenyl)prop-1-yn-1-yl)dimethylsilane (**1j**)



1j

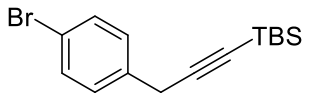
This compound was prepared from 1-(chloromethyl)-4-chlorobenzene and *tert*-butyl(ethynyl)dimethylsilane according to the general procedure **B** as colorless oil in 85% yield.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.29 (s, 4H), 3.63 (s, 2H), 0.95 (s, 9H), 0.13 (s, 6H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 134.99, 132.34, 129.17, 128.55, 104.07, 85.59, 26.10, 25.64, 16.56, -4.49.

HR-MS (EI-TOF) m/z calcd for $C_{15}H_{21}ClSi$ $[M]^+$: 264.1101, found: 264.1094.

(3-(4-bromophenyl)prop-1-yn-1-yl)(*tert*-butyl)dimethylsilane (**1k**)



1k

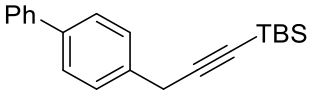
This compound was prepared from 1-bromo-4-(bromomethyl)benzene and *tert*-butyl(ethynyl)dimethylsilane according to the general procedure **B** as colorless oil in 77% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 (d, *J* = 8.4 Hz, 2H), 7.23 (d, *J* = 8.3 Hz, 2H), 3.61 (s, 2H), 0.95 (s, 9H), 0.12 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 135.49, 131.47, 129.54, 120.33, 103.92, 85.60, 26.06, 25.69, 16.53, -4.53.

HR-MS (EI-TOF) m/z calcd for $C_{15}H_{21}BrSi$ $[M]^+$: 308.0596, found: 308.0582.

(3-([1,1'-biphenyl]-4-yl)prop-1-yn-1-yl)(*tert*-butyl)dimethylsilane (**1l**)



1l

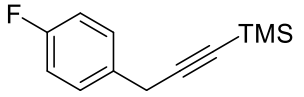
This compound was prepared from 4-(bromomethyl)-1,1'-biphenyl and *tert*-butyl(ethynyl)dimethylsilane according to the general procedure **B** as colorless oil in 66% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 – 7.55 (m, 4H), 7.47 (dd, *J* = 10.0, 4.8 Hz, 4H), 7.37 (t, *J* = 7.3 Hz, 1H), 3.75 (s, 2H), 1.01 (s, 9H), 0.18 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 140.87, 139.52, 135.56, 128.74, 128.25, 127.20, 127.17, 127.03, 104.63, 85.19, 26.15, 16.62, -4.43.

HR-MS (EI-TOF) m/z calcd for $C_{21}H_{26}Si$ $[M]^+$: 306.1804, found: 306.1806.

(3-(4-fluorophenyl)prop-1-yn-1-yl)trimethylsilane (**1m**)



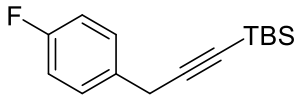
1m

This compound was prepared from 1-(bromomethyl)-4-fluorobenzene and ethynyltrimethylsilane according to the general procedure **B** as colorless oil in 78%

yield.

This compound is known. Its spectroscopic data are in accordance with the literature data[4].

tert-butyl(3-(4-fluorophenyl)prop-1-yn-1-yl)dimethylsilane (**1n**)



1n

This compound was prepared from 1-(bromomethyl)-4-fluorobenzene and *tert*-butyl(ethynyl)dimethylsilane according to the general procedure **B** as colorless oil in 76% yield.

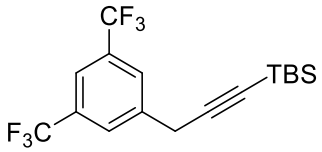
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33 – 7.28 (m, 2H), 7.05– 7.01 (m, 2H), 3.64 (s, 2H), 0.96 (s, 9H), 0.13 (s, 6H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 161.66 (d, J = 244.5 Hz), 132.12 (d, J = 3.1 Hz), 129.24 (d, J = 7.9 Hz), 115.22 (d, J = 21.4 Hz), 104.51, 85.33, 26.10, 25.45, 16.56, -4.48.

^{19}F NMR (376 MHz, $CDCl_3$) δ -118.64.

HR-MS (EI-TOF) m/z calcd for $C_{15}H_{21}FSi$ $[M]^+$: 248.1397, found: 248.1392.

(3-(3,5-bis(trifluoromethyl)phenyl)prop-1-yn-1-yl)(*tert*-butyl)dimethylsilane (**1o**)



1o

This compound was prepared from 1-(bromomethyl)-3,5-bis(trifluoromethyl)benzene and *tert*-butyl(ethynyl)dimethylsilane according to the general procedure **B** as colorless oil in 88% yield.

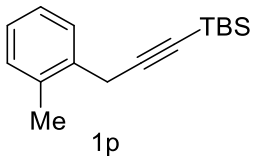
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.85 (s, 2H), 7.77 (s, 1H), 3.79 (s, 2H), 0.96 (s, 9H), 0.15 (s, 6H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 139.08, 131.73 (q, J = 33.2 Hz), 128.12 (d, J = 3.7 Hz), 123.29 (q, J = 272.7 Hz), 120.77, 121.00 (m), 102.06, 87.68, 16.47, -4.66.

^{19}F NMR (376 MHz, $CDCl_3$) δ -63.03.

HR-MS (EI-TOF) m/z calcd for $C_{17}H_{20}F_6Si$ $[M]^+$: 366.1238, found: 366.1239.

tert-butyldimethyl(3-(*o*-tolyl)prop-1-yn-1-yl)silane (**1p**)



1p

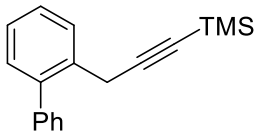
This compound was prepared from 1-(bromomethyl)-2-methylbenzene and *tert*-butyl(ethynyl)dimethylsilane according to the general procedure **B** as colorless oil in 55% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 (d, *J* = 6.8 Hz, 1H), 7.28 – 7.08 (m, 3H), 3.61 (s, 2H), 2.34 (s, 3H), 0.99 (s, 9H), 0.16 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 135.88, 134.70, 129.94, 128.11, 126.76, 126.13, 104.45, 85.24, 26.13, 24.41, 19.27, 16.60, -4.44.

HR-MS (EI-TOF) m/z calcd for $C_{16}H_{24}Si$ $[M]^+$: 244.1647, found: 244.1640.

(3-([1,1'-biphenyl]-2-yl)prop-1-yn-1-yl)trimethylsilane (**1q**)



1q

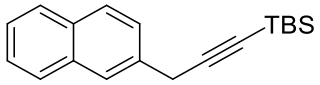
This compound was prepared from 2-(bromomethyl)-1,1'-biphenyl and ethynyltrimethylsilane according to the general procedure **B** as colorless oil in 66% yield.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.68 – 7.58 (m, 1H), 7.48 – 7.27 (m, 7H), 7.23 (dd, *J* = 7.5, 1.4 Hz, 1H), 3.54 (s, 2H), 0.16 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 141.44, 140.96, 133.94, 129.86, 129.14, 128.85, 128.19, 127.67, 127.10, 126.69, 104.95, 86.73, 24.63, 0.07.

HR-MS (EI-TOF) m/z calcd for $C_{18}H_{20}Si$ $[M]^+$: 264.1334, found: 264.1336.

tert-butyldimethyl(3-(naphthalen-2-yl)prop-1-yn-1-yl)silane (**1s**)

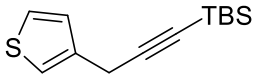


1s

This compound was prepared from 2-(bromomethyl)naphthalene and *tert*-butyl(ethynyl)dimethylsilane according to the general procedure **B** as colorless oil in 82% yield.

This compound is known. Its spectroscopic data are in accordance with the literature data[5].

tert-butyldimethyl(3-(thiophen-3-yl)prop-1-yn-1-yl)silane (**1t**)



1t

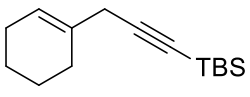
This compound was prepared from 3-(bromomethyl)thiophene and *tert*-butyl(ethynyl)dimethylsilane according to the general procedure **B** as colorless oil in 74% yield.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.27 (dd, *J* = 4.9, 3.0 Hz, 1H), 7.16 (dd, *J* = 2.8, 1.4 Hz, 1H), 7.03 – 6.99 (m, 1H), 3.63 (d, *J* = 0.9 Hz, 2H), 0.96 (s,9H), 0.13 (s, 6H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 136.78, 127.55, 125.78, 121.16, 104.51, 84.46, 26.12, 21.41, 16.56, -4.47.

HR-MS (EI-TOF) m/z calcd for $C_{13}H_{20}SSi$ $[M]^+$: 236.1055, found: 236.1057.

tert-butyl(3-(cyclohex-1-en-1-yl)prop-1-yn-1-yl)dimethylsilane (**1v**)



1v

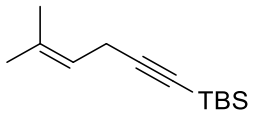
This compound was prepared from 1-(chloromethyl)cyclohex-1-ene and *tert*-butyl(ethynyl)dimethylsilane according to the general procedure **B** as colorless oil in 52% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 6.11 – 5.55 (m, 1H), 2.89 (d, *J* = 0.6 Hz, 2H), 2.03 – 1.81 (m, 4H), 1.75 – 1.60 (m, 2H), 1.60 – 1.53 (m, 2H), 0.94 (s, 9H), 0.10 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 132.47, 122.46, 104.89, 84.60, 28.42, 28.21, 26.08, 25.17, 22.78, 22.28, 16.52, -4.45.

HR-MS (EI-TOF) m/z calcd for $C_{15}H_{26}Si$ $[M]^+$: 234.1804, found: 234.1803.

tert-butyldimethyl(5-methylhex-4-en-1-yn-1-yl)silane (**1w**)

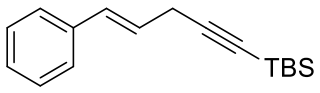


1w

This compound was prepared from 1-chloro-3-methylbut-2-ene and *tert*-butyl(ethynyl)dimethylsilane according to the general procedure **B** as colorless oil in 44% yield.

This compound is known. Its spectroscopic data are in accordance with the literature data[6].

(*E*)-tert-butyldimethyl(5-phenylpent-4-en-1-yn-1-yl)silane (**1x**)



1x

This compound was prepared from (*E*)-(3-chloroprop-1-en-1-yl)benzene and *tert*-butyl(ethynyl)dimethylsilane according to the general procedure **B** as colorless oil in 66% yield.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.18 (m, 5H), 6.70 (d, J = 15.7 Hz, 1H), 6.17 (dt, J = 15.7, 5.4 Hz, 1H), 3.20 (d, J = 5.4, 1.7 Hz, 2H), 0.98 (s, 9H), 0.14 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 137.10, 131.33, 128.49, 127.27, 126.21, 124.02, 109.98, 103.99, 26.10, 23.39, 16.52, -4.46.

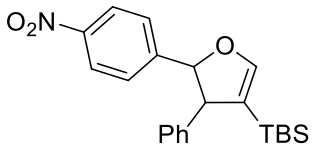
HR-MS (EI-TOF) m/z calcd for $C_{17}H_{24}Si$ $[M]^+$: 256.1647, found: 256.1641.

3. Synthesis of the Dihydrofuran

General procedure **C**: To a 3-dram vial were added sequentially 0.2 mmol silylated alkyne, 0.01 mmol indicated **L1**AuCl (5 mol%), 0.04 mmol NaBARF (20 mol%) and

2 mL anhydrous DCE as solvent. The reaction was then stirred at the indicated temperature monitored by TLC. Upon completion, the reaction was concentrated under reduced pressure. The residue was purified by silica gel flash column chromatography to obtain pure product.

tert-butyldimethyl(5-(4-nitrophenyl)-4-phenyl-4,5-dihydrofuran-3-yl)silane (**3aa**)



3aa

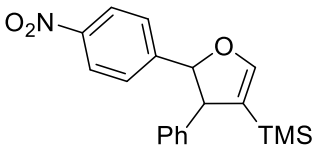
Compound **3aa** was obtained as colorless oil in a ratio of 3/1 in 78% combined yield according to general procedure **C**. The reaction was heated at 90 °C for 18 h. NMR spectra of the compound *cis*-**3aa** was reported.

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.91 (d, *J* = 8.8 Hz, 2H), 7.21 (d, *J* = 8.8 Hz, 1H), 6.99 (t, *J* = 7.1 Hz, 2H), 6.96 – 6.92 (m, 1H), 6.80 (d, *J* = 7.1 Hz, 2H), 6.71 (d, *J* = 1.2 Hz, 2H), 5.77 (d, *J* = 9.4 Hz, 1H), 4.28 (dd, *J* = 9.4, 1.2 Hz, 1H), 0.88 (s, 6H), 0.01 (s, 3H), -0.42 (s, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 152.54, 146.52, 145.67, 138.19, 128.87, 127.82, 127.02, 126.87, 122.73, 112.70, 86.90, 57.40, 26.61, 17.02, -5.35.

HR-MS (EI-TOF) m/z calcd for $C_{22}H_{27}NO_3Si$ $[M]^+$: 381.1760, found: 381.1753.

trimethyl(5-(4-nitrophenyl)-4-phenyl-4,5-dihydrofuran-3-yl)silane (**3ba**)



3ba

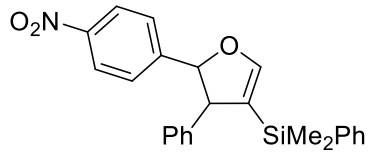
Compound **3ba** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 3 h. NMR spectra of the compound *cis*-**3ba** was reported.

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.00 – 7.87 (m, 2H), 7.23 – 7.20 (m, 2H), 7.07 – 6.92 (m, 3H), 6.89 – 6.76 (m, 2H), 6.67 (d, *J* = 9.8, 1.4 Hz, 1H), 5.81 (d, *J* = 9.8 Hz, 1H), 4.32 (dd, J = 9.8, 1.4 Hz, 1H), -0.08 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 151.40, 146.53, 145.90, 138.28, 128.93, 127.82, 127.04, 126.89, 122.76, 86.88, 56.62, -0.98.

HR-MS (EI-TOF) m/z calcd for $C_{19}H_{21}NO_3Si$ $[M]^+$: 339.1291, found: 339.1296.

dimethyl(5-(4-nitrophenyl)-4-phenyl-4,5-dihydrofuran-3-yl)(phenyl)silane (**3ca**)



3ca

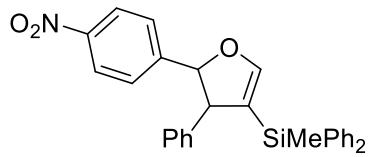
Compound **3ca** was obtained as white solid according to general procedure **C**. The reaction was heated at 90 °C for 8 h. NMR spectra of the compound *cis*-**3ca** was reported.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (dd, *J* = 16.5, 8.8 Hz, 2H), 7.46 (dt, *J* = 9.1, 4.4 Hz, 2H), 7.40 – 7.31 (m, 3H), 7.19 (d, *J* = 8.7 Hz, 2H), 7.01 – 6.94 (m, 3H), 6.84 – 6.74 (m, 2H), 6.67 (d, *J* = 1.2 Hz, 1H), 5.84 (d, *J* = 9.7, 1H), 4.27 (dd, *J* = 9.7, 1.2 Hz, 1H), 0.20 (d, *J* = 3.3 Hz,3H), 0.05 (d, *J* = 3.3 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 152.84, 146.51, 145.68, 138.07, 137.80, 133.69, 129.10, 128.92, 127.81, 127.77, 126.98, 126.90, 122.75, 113.50, 87.06, 56.47, -2.50, -2.55.

HR-MS (EI-TOF) m/z calcd for $C_{24}H_{23}NO_3Si$ $[M]^+$: 401.1447, found: 401.1448.

methyl(5-(4-nitrophenyl)-4-phenyl-4,5-dihydrofuran-3-yl)diphenylsilane (**3da**)



3da

Compound **3da** was obtained as white solid according to general procedure **C**. The reaction was heated at 90 °C for 16 h. NMR spectra of the compound *cis*-**3da** was reported.

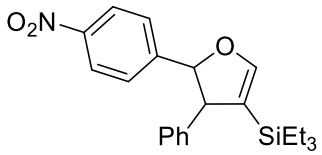
^{1}H NMR (600 MHz, $CDCl_3$) δ 7.95 – 7.87 (m, 2H), 7.51 – 7.45 (m, 4H), 7.41 – 7.36 (m, 2H), 7.36 – 7.31 (m, 4H), 7.21 (d, *J* = 8.6 Hz, 2H), 7.00 – 6.83 (m, 3H), 6.83 – 6.70

(m, 2H), 6.66 (d, *J* = 1.3 Hz, 1H), 5.90 (d, *J* = 9.6 Hz, 1H), 4.32 (dd, *J* = 9.6, 1.3 Hz, 1H), 0.21 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 155.06, 146.60, 145.47, 137.93, 135.83, 135.62, 134.74, 129.41, 129.38, 128.96, 127.84, 127.83, 127.82, 127.03, 126.94, 122.77, 111.96, 87.48, 56.56, -3.69.

HR-MS (EI-TOF) m/z calcd for $C_{29}H_{25}NO_3Si$ $[M]^+$: 463.1604, found: 463.1596.

triethyl(5-(4-nitrophenyl)-4-phenyl-4,5-dihydrofuran-3-yl)silane (**3ea**)



3ea

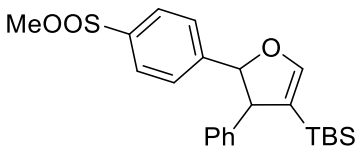
Compound **3ea** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 12 h. NMR spectra of the compound *cis*-**3ea** was reported.

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.91 (d, *J* = 8.8 Hz, 2H), 7.21 (d, *J* = 8.8 Hz, 2H), 7.03 – 6.92 (m, 2H), 6.83 – 6.78 (m, 2H), 6.68 (d, *J* = 1.2 Hz, 1H), 5.78 (d, *J* = 9.6 Hz, 1H), 4.26 (dd, *J* = 9.6, 1.2 Hz, 1H), 1.03 – 0.82 (m, 9H), 0.51 – 0.33 (m, 6H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 152.11, 146.55, 145.84, 138.34, 128.84, 127.78, 127.05, 126.91, 122.74, 111.86, 86.80, 56.77, 7.20, 3.44.

HR-MS (EI-TOF) m/z calcd for $C_{22}H_{27}NO_3Si$ $[M]^+$: 381.1760, found: 381.1753.

tert-butyldimethyl(5-(4-(methylsulfonyl)phenyl)-4-phenyl-4,5-dihydrofuran-3-yl)silane (**3ab**)



3ab

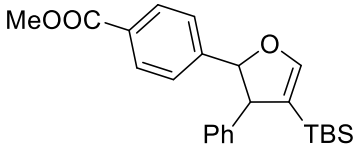
Compound **3ab** was obtained as white solid according to general procedure **C**. The reaction was heated at 90 °C for 22 h. NMR spectra of the compound *cis*-**3ab** was reported.

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.64 – 7.58 (m, 2H), 7.26 – 7.20 (m, 2H), 7.01 – 6.89 (m, 3H), 6.78 (d, J = 7.0 Hz, 2H), 6.71 (d, J = 1.1 Hz, 1H), 5.76 (d, J = 9.4 Hz, 1H), 4.27 (dd, J = 9.4, 1.1 Hz, 1H), 2.87 (s, 3H), 0.87 (s, 9H), 0.01 (s, 3H), -0.42 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 152.66, 144.56, 138.27, 128.96, 127.76, 127.20, 126.78, 126.57, 112.55, 87.07, 57.43, 44.53, 26.64, 17.04, -5.31, -5.61.

HR-MS (EI-TOF) m/z calcd for $C_{23}H_{30}SO_3Si$ $[M]^+$: 414.1685, found: 414.1688.

methyl 4-(4-(*tert*-butyldimethylsilyl)-3-phenyl-2,3-dihydrofuran-2-yl)benzoate (**3ac**)



3ac

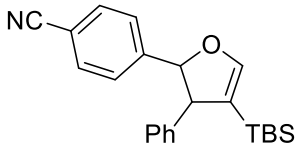
Compound **3ac** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 16 h. NMR spectra of the compound *cis*-**3ac** was reported.

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.73 (d, *J* = 8.1 Hz, 2H), 7.12 (d, *J* = 8.1 Hz, 2H), 6.98 (t, *J* = 7.7 Hz, 2H), 6.94 (t, *J* = 7.2 Hz, 1H), 6.82 (d, *J* = 7.0 Hz, 2H), 6.73 (d, *J* = 1.1 Hz, 1H), 5.75 (d, *J* = 9.3 Hz, 1H), 4.25 (dd, *J* = 9.3, 1.1 Hz, 1H), 3.83 (s, 3H), 1.00 – 0.71 (m, 9H), 0.02 (s, 3H), -0.42 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 166.89, 152.75, 143.18, 138.57, 129.00, 128.79, 128.34, 127.59, 126.54, 126.23, 112.52, 87.55, 57.27, 51.87, 26.63, 17.02, -5.35, -5.64.

HR-MS (EI-TOF) m/z calcd for $C_{24}H_{30}O_3Si$ $[M]^+$: 394.1964, found: 394.1968.

4-(4-(*tert*-butyldimethylsilyl)-3-phenyl-2,3-dihydrofuran-2-yl)benzonitrile (**3ad**)



3ad

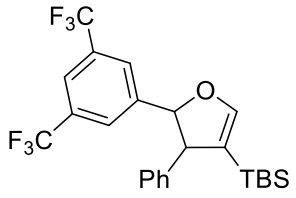
Compound **3ad** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 24 h. NMR spectra of the compound *cis*-**3ad** was reported.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.34 (d, *J* = 8.1 Hz, 2H), 7.15 (d, *J* = 8.1 Hz, 2H), 7.02 – 6.95 (m, 3H), 6.83 – 6.76 (m, 2H), 6.71 (d, *J* = 1.3 Hz, 1H), 5.74 (d, *J* = 9.4 Hz, 1H), 4.26 (dd, *J* = 9.4, 1.3 Hz, 1H), 0.88 (s, 9H), 0.02 (s, 3H), -0.41 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 152.63, 143.57, 138.29, 131.32, 128.94, 127.78, 126.95, 126.82, 118.86, 112.58, 110.38, 87.08, 57.37, 26.64, 17.04, -5.32, -5.61.

HR-MS (EI-TOF) m/z calcd for $C_{23}H_{27}NOSi$ $[M]^+$: 361.1862, found: 361.1855.

(5-(3,5-bis(trifluoromethyl)phenyl)-4-phenyl-4,5-dihydrofuran-3-yl)(*tert*-butyl)dimethylsilane (**3ae**)



3ae

Compound **3ae** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 18 h. NMR spectra of the compound *cis*-**3ae** was reported.

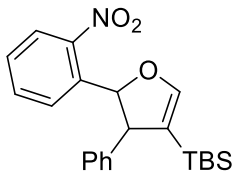
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.49 (s, 1H), 7.46 (s, 2H), 6.98 (dq, *J* = 13.0, 6.9 Hz, 3H), 6.78 (d, *J* = 6.9 Hz, 2H), 6.74 (d, *J* = 1.1 Hz, 1H), 5.80 (d, *J* = 9.4 Hz, 2H), 4.31 (dd, *J* = 9.4, 1.1 Hz, 2H), 0.90 (s, 9H), 0.04 (s, 3H), -0.39 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 152.64, 140.77, 137.93, 130.60 (d, *J* = 33.3 Hz), 128.79, 127.95, 126.95, 126.56, 123.18 (d, *J* = 272.6 Hz).120.47 (m), 112.30, 86.50, 57.49, 26.63, 17.04, -5.31, -5.58.

^{19}F NMR (376 MHz, $CDCl_3$) δ -63.00.

HR-MS (EI-TOF) m/z calcd for $C_{24}H_{26}F_6OSi$ $[M]^+$: 472.1657, found: 472.1655.

tert-butyldimethyl(5-(2-nitrophenyl)-4-phenyl-4,5-dihydrofuran-3-yl)silane (**3af**)



3af

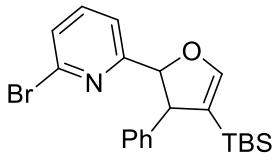
Compound **3af** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 16 h. NMR spectra of the compound *cis*-**3af** was reported.

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.85 (dd, *J* = 8.2, 1.2 Hz, 1H), 7.59 (d, *J* = 7.9 Hz, 1H), 7.36 (td, *J* = 8.0, 1.1 Hz, 1H), 7.21 – 7.11 (m, 1H), 6.93 (dq, J = 12.9, 7.0 Hz, 3H), 6.85 – 6.78 (m, 2H), 6.72 (d, *J* = 1.4 Hz, 1H), 6.33 (d, *J* = 9.5 Hz, 1H), 4.73 (dd, *J* = 9.5, 1.4 Hz, 1H), 0.89 (s, 9H), 0.01 (s, 3H), -0.43 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 151.93, 146.50, 138.99, 135.39, 132.96, 128.93, 128.89, 127.58, 127.54, 126.48, 124.28, 109.99, 84.81, 55.84, 26.64, 17.05, -5.29, -5.61.

HR-MS (EI-TOF) m/z calcd for $C_{22}H_{27}NO_3Si$ $[M]^+$: 381.1760, found: 381.1753.

2-bromo-6-(4-(*tert*-butyldimethylsilyl)-3-phenyl-2,3-dihydrofuran-2-yl)pyridine (**3ag**)



3ag

Compound **3ag** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 3 h. NMR spectra of the compound *cis*-**3ag** was reported.

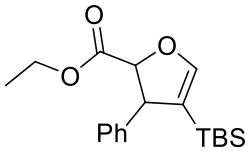
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.53 (t, *J* = 7.7 Hz, 1H), 7.38 (d, *J* = 7.8 Hz, 1H), 7.34 – 7.28 (m, 3H), 7.27 – 7.20 (m, 3H), 7.17 (dd, *J* = 8.0, 7.5 Hz, 1H), 7.07 – 7.00 (m, 4H), 6.96 (dd, *J* = 5.0, 3.7 Hz, 1H), 6.91 – 6.87 (m, 2H), 6.70 (d, *J* = 1.3 Hz, 1H), 6.61 (d, *J* = 1.6 Hz, 1H), 5.74 (d, *J* = 9.3 Hz, 1H), 5.35 (d, *J* = 4.1 Hz, 1H), 4.46 (dd, *J* = 9.3, 1.3 Hz, 1H), 4.18 (dd, *J* = 4.1, 1.6 Hz, 1H), 0.88 (s, 9H), 0.75 (s, 9H), 0.03 (s, 3H), -0.01 (s, 3H), -0.42 (s, 3H), -0.44 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 163.16, 159.84, 152.51, 151.87, 143.92, 141.75, 140.42,

138.86, 138.42, 137.93, 128.97, 128.53, 127.94, 127.52, 126.89, 126.84, 126.48, 125.73, 119.66, 118.16, 112.57, 110.43, 104.99, 90.34, 87.74, 59.84, 56.36, 26.60, 26.58, 17.17, 17.00, -5.35, -5.51, -5.64.

HR-MS (EI-TOF) m/z calcd for $C_{21}H_{26}BrNOSi$ $[M]^+$: 415.0967, found: 415.0961.

ethylc-4-(*tert*-butyldimethylsilyl)-3-phenyl-2,3-dihydrofuran-2-carboxylate (**3ah**)



3ah

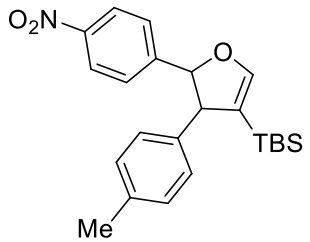
Compound **3ah** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 3 h. NMR spectra of the compound *cis*-**3ah** was reported.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.26 – 7.15 (m, 3H), 7.15 – 7.09 (m, 2H), 6.55 (d, *J* = 1.5 Hz, 1H), 5.17 (d, *J* = 10.3 Hz, 1H), 4.34 (dd, *J* = 10.3, 1.5 Hz, 1H), 3.77 (dq, *J* = 10.7, 7.1 Hz, 1H), 3.69 – 3.60 (m, 1H), 0.83 (s, 9H), 0.82 (t, *J* = 7.2 Hz, 3H), -0.03 (s, 1H), -0.45 (s, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 168.95, 152.23, 138.74, 128.92, 127.95, 127.38, 111.35, 84.18, 60.75, 55.53, 26.59, 17.00, 13.62, -5.42, -5.62.

HR-MS (EI-TOF) m/z calcd for $C_{19}H_{28}O_3Si$ $[M]^+$: 332.1808, found: 332.1806.

tert-butyldimethyl(5-(4-nitrophenyl)-4-(p-tolyl)-4,5-dihydrofuran-3-yl)silane (**3ha**)



3ha

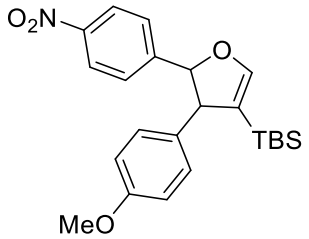
Compound **3ha** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 12 h. NMR spectra of the compound *cis*-**3ha** was reported.

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.8 Hz, 2H), 7.22 (d, *J* = 8.5 Hz, 2H), 6.80 (d, *J* = 7.7 Hz, 2H), 6.70 (dd, *J* = 9.6, 4.4 Hz, 3H), 5.75 (d, *J* = 9.4 Hz, 1H), 4.26 (dd, *J* = 9.4, 1.2 Hz, 1H), 0.89 (s, 9H), 0.02 (s, 3H), -0.41 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 152.36, 146.53, 145.88, 136.33, 128.76, 128.54, 127.08, 122.76, 112.86, 86.93, 57.05, 26.65, 20.97, 17.04, -5.30, -5.58.

HR-MS (EI-TOF) m/z calcd for $C_{23}H_{29}NO_3Si$ $[M]^+$: 395.1917, found: 395.1906.

tert-butyl(4-(4-methoxyphenyl)-5-(4-nitrophenyl)-4,5-dihydrofuran-3-yl)dimethyl silane (**3ia**)



3ia

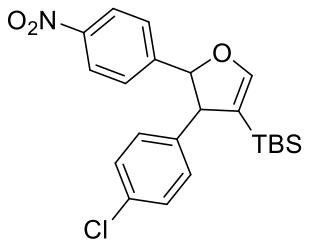
Compound **3ia** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 8 h. NMR spectra of the compound *cis*-**3ia** was reported.

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.8 Hz, 2H), 7.22 (d, *J* = 8.8 Hz, 2H), 6.72 (*d*, J = 8.1 Hz, 2H), 6.70 (d, *J* = 1.2 Hz, 1H), 6.54 (d, *J* = 8.6 Hz, 2H), 5.73 (d, *J* = 9.3 Hz, 1H), 4.25 (dd, *J* = 9.3, 1.2 Hz, 1H), 3.65 (s, 3H), 0.89 (s, 9H), 0.02 (s, 3H), -0.40 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) 158.30, 152.23, 150.18, 145.86, 129.83, 127.02, 122.77, 114.12, 113.14, 112.92, 86.89, 56.62, 54.96, 26.62, 17.01, -5.33, -5.60.

HR-MS (EI-TOF) m/z calcd for $C_{23}H_{29}NO_4Si$ $[M]^+$: 411.1866, found: 411.1847.

tert-butyl(4-(4-chlorophenyl)-5-(4-nitrophenyl)-4,5-dihydrofuran-3-yl)dimethyl silane (**3ja**)



3ja

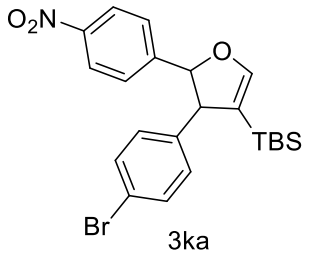
Compound **3ja** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 16 h. NMR spectra of the compound *cis*-**3ja** was reported.

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.8 Hz, 2H), 7.22 (d, *J* = 8.8 Hz, 2H), 7.00 (d, *J* = 8.5 Hz, 2H), 6.77 (d, *J* = 8.5 Hz, 2H), 6.72 (d, *J* = 1.2 Hz, 1H), 5.77 (d, *J* = 9.4 Hz, 1H), 4.26 (dd, *J* = 9.4, 1.2 Hz, 1H), 0.89 (s, 9H), 0.02 (s, 3H), -0.40 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 152.88, 146.73, 145.23, 136.98, 132.67, 130.13, 128.10, 126.96, 122.98, 112.81, 86.76, 56.71, 26.61, 26.57, 17.03, -5.32, -5.52.

HR-MS (EI-TOF) m/z calcd for $C_{22}H_{26}ClNO_3Si$ $[M]^+$: 415.1370, found: 415.1378.

(4-(4-bromophenyl)-5-(4-nitrophenyl)-4,5-dihydrofuran-3-yl)(*tert*-butyl)dimethylsi lane (**3ka**)



3ka

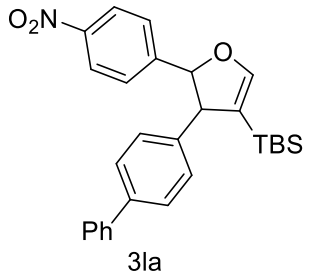
Compound **3ka** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 16 h. NMR spectra of the compound *cis*-**3ka** was reported.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.97 (d, *J* = 8.8 Hz, 2H), 7.24 – 7.17 (m, 2H), 7.15 (d, *J* = 8.5 Hz, 2H), 6.72 (d, *J* = 1.0 Hz, 1H), 6.70 (br, 2H), 5.77 (d, *J* = 9.3 Hz, 1H), 4.25 (dd, *J* = 9.3, 1.0 Hz, 1H), 0.89 (s, 6H), 0.02 (s, 3H), -0.40 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 152.91, 146.74, 145.19, 137.51, 131.05, 130.50, 126.96, 123.01, 120.82, 112.78, 86.70, 56.76, 26.62, 17.03, -5.31, -5.51.

HR-MS (EI-TOF) m/z calcd for $C_{22}H_{26}NO_3BrSi$ $[M]^+$: 459.0865, found: 459.0866.

(4-([1,1'-biphenyl]-4-yl)-5-(4-nitrophenyl)-4,5-dihydrofuran-3-yl)(tert-butyl)Dimethyl silane (**3la**)



3la

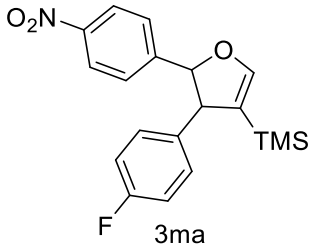
Compound **3la** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 18 h. NMR spectra of the compound *cis*-**3la** was reported.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.8 Hz, 2H), 7.46 (dd, *J* = 5.7, 3.0 Hz, 3H), 7.37 (t, *J* = 7.6 Hz, 2H), 7.27 (dd, *J* = 8.0, 2.3 Hz, 4H), 6.90 (d, *J* = 8.0 Hz, 1H), 6.75 (d, *J* = 1.0 Hz, 1H), 5.81 (d, *J* = 9.3 Hz, 1H), 4.34 (dd, *J* = 9.4, 1.0 Hz, 1H), 0.91 (s, 9H), 0.05 (s, 3H), -0.37 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 151.98, 146.85, 132.46, 126.99, 125.64, 124.66, 123.81, 122.97, 111.44, 86.03, 49.43, 26.73, 18.00, -5.07, -5.52.

HR-MS (EI-TOF) m/z calcd for $C_{28}H_{31}NO_3Si$ $[M]^+$: 457.2073, found: 457.2068.

(4-(4-fluorophenyl)-5-(4-nitrophenyl)-4,5-dihydrofuran-3-yl)trimethylsilane (**3ma**)



3ma

Compound **3ma** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 12 h.

NMR spectra for the compound *cis*-**3ma**:

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.8 Hz, 2H), 7.21 (d, *J* = 8.6 Hz, 2H), 6.82 – 6.76 (m, 2H), 6.75 – 6.69 (m, 2H), 6.67 (d, *J* = 1.3 Hz, 1H), 5.79 (d, *J* = 9.7 Hz, 1H),

4.31 (dd, *J* = 9.7, 1.3 Hz, 1H), -0.07 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 161.62 (d, *J* = 245.8 Hz), 151.53, 146.65, 145.64, 134.17 (d, *J* = 3.2 Hz), 130.30 (d, *J* = 8.0 Hz), 126.97, 122.90, 115.02, 114.77 (d, *J* = 21.3 Hz), 86.76, 55.78, -0.98.

^{19}F NMR (376 MHz, $CDCl_3$) δ -118.58.

NMR spectra for the compound *trans*-**3ma**:

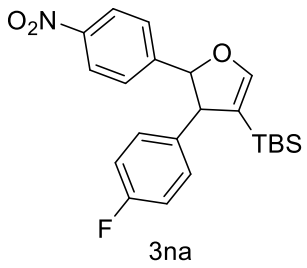
^{1}H NMR (600 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.8 Hz, 2H), 7.21 (d, *J* = 8.8 Hz, 2H), 6.82 – 6.76 (m, 2H), 6.75 – 6.69 (m, 2H), 6.67 (d, *J* = 1.3 Hz, 1H), 5.79 (d, *J* = 9.7 Hz, 1H), 4.31 (dd, *J* = 9.7, 1.3 Hz, 1H), -0.07 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 162.10 (d, *J* = 245.8 Hz), 151.09, 149.67, 147.50, 139.11 (d, *J* = 3.1 Hz), 129.39 (d, *J* = 8.0 Hz), 125.59, 124.00, 115.73 (d, *J* = 21.4 Hz), 112.68, 90.48, 61.12, -1.08.

^{19}F NMR (376 MHz, $CDCl_3$) δ -118.64.

HR-MS (EI-TOF) m/z calcd for $C_{19}H_{20}FNO_3Si$ $[M]^+$: 357.1196, found: 37.1191.

tert-butyl(4-(4-fluorophenyl)-5-(4-nitrophenyl)-4,5-dihydrofuran-3-yl)dimethyl silane (**3na**)



3na

Compound **3na** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 8 h.

NMR spectra for the compound *cis*-**3na**:

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.8 Hz, 2H), 7.22 (d, *J* = 8.4 Hz, 2H), 6.97 – 6.75 (m, 2H), 6.75 – 6.64 (m, 3H), 5.77 (d, *J* = 9.4 Hz, 1H), 4.28 (dd, *J* = 9.4, 1.2 Hz, 1H), 0.89 (s, 9H), 0.03 (s, 3H), -0.40 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 161.63 (d, *J* = 245.8 Hz), 152.69, 146.68, 145.44, 134.12 (d, *J* = 3.2 Hz), 130.28 (d, *J* = 8.0 Hz), 126.98, 122.90, 114.79 (d, *J* = 21.3 Hz),

112.90, 86.79, 56.60, 26.62, 17.03, -5.33, -5.58.

^{19}F NMR (376 MHz, $CDCl_3$) δ -118.56.

HR-MS (EI-TOF) m/z calcd for $C_{22}H_{26}NO_3Si$ $[M]^+$: 399.1666, found: 399.1661.

NMR spectra for the compound *trans*-**3na**:

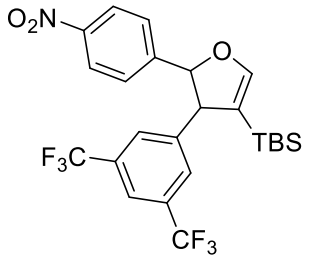
^{1}H NMR (500 MHz, $CDCl_3$) δ 8.22 (d, *J* = 8.8 Hz, 2H), 7.41 (d, *J* = 8.8 Hz, 2H), 7.20 – 7.13 (m, 2H), 7.08 – 7.01 (m, 2H), 6.66 (d, *J* = 1.7 Hz, 1H), 5.34 (d, *J* = 5.6 Hz, 1H), 3.89 (dd, *J* = 5.6, 1.7 Hz, 1H), 0.76 (s, 9H), -0.01 (s, 3H), -0.44 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 162.09 (d, *J* = 245.8 Hz), 152.47, 149.82, 147.53, 139.45 (d, *J* = 3.2 Hz), 129.29 (d, *J* = 8.0 Hz), 125.44, 124.05 115.71 (d, *J* = 21.4 Hz), 110.07, 90.30, 90.30, 61.88, 26.61, 17.18, -5.35.

^{19}F NMR (376 MHz, $CDCl_3$) δ -118.15.

HR-MS (EI-TOF) m/z calcd for $C_{22}H_{26}NO_3Si$ $[M]^+$: 399.1666, found: 399.1661.

(4-(3,5-bis(trifluoromethyl)phenyl)-5-(4-nitrophenyl)-4,5-dihydrofuran-3-yl)(*tert*-butyl)dimethylsilane (**3oa**)



3oa

Compound **3oa** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 24 h. NMR spectra of the compound *cis*-**3oa** was reported.

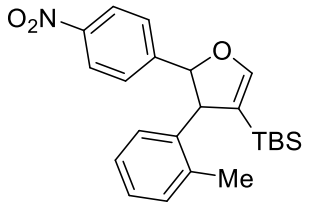
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 – 7.93 (m, 2H), 7.52 (s, 1H), 7.26 (br, 2H), 7.19 (d, *J* = 8.5 Hz, 2H), 6.83 (d, *J* = 1.2 Hz, 1H), 5.88 (d, *J* = 9.4 Hz, 1H), 4.44 (dd, *J* = 9.4, 1.2 Hz, 1H), 0.89 (s, 9H), 0.05 (s, 3H), -0.40 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 154.12, 146.94, 144.35, 141.54, 131.15 (d, *J* = 33.3 Hz), 128.92 (m), 126.68, 123.14, 124.34 (d, *J* = 33.3 Hz), 120.76 (m), 111.78, 86.57, 56.89, 26.50, 16.96, -5.41.

^{19}F NMR (376 MHz, $CDCl_3$) δ -63.00.

HR-MS (EI-TOF) m/z calcd for $C_{24}H_{25}F_6NO_3Si$ $[M]^+$: 517.1508, found: 517.1507.

tert-butyldimethyl(5-(4-nitrophenyl)-4-(o-tolyl)-4,5-dihydrofuran-3-yl)silane (**3pa**)



3pa

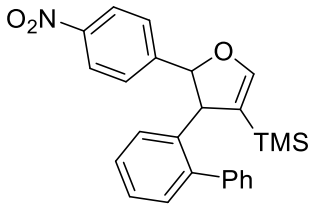
Compound **3pa** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 24 h. NMR spectra of the compound *cis*-**3pa** was reported.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.90 (d, *J* = 8.8 Hz, 1H), 7.21 (d, *J* = 8.8 Hz, 1H), 6.98 – 6.91 (m, 2H), 6.90 – 6.84 (m, 1H), 6.80 (d, *J* = 7.7 Hz, 1H), 6.74 (d, *J* = 1.4 Hz, 1H), 5.78 (d, *J* = 9.5 Hz, 1H), 4.61 (dd, *J* = 9.5, 1.4 Hz, 1H), 2.10 (s, 3H), 0.89 (s, 9H), 0.03 (s, 3H), -0.41 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 152.67, 145.58, 136.14, 134.44, 129.88, 129.52, 127.23, 126.77, 125.53, 124.05, 122.56, 112.60, 86.74, 51.70, 26.60, 19.99, 16.95, -5.21, -5.79.

HR-MS (EI-TOF) m/z calcd for $C_{23}H_{29}NO_3Si$ $[M]^+$: 395.1917, found: 395.1929.

(4-([1,1'-biphenyl]-2-yl)-5-(4-nitrophenyl)-4,5-dihydrofuran-3-yl)trimethyl Silane (**3qa**)



3qa

Compound **3qa** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 24 h. NMR spectra of the compound *cis*-**3qa** was reported.

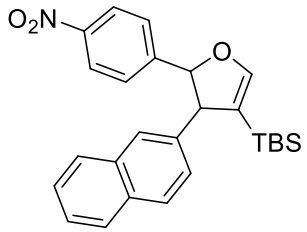
^{1}H NMR (500 MHz, $CDCl_3$) δ 8.14 – 8.04 (m, 2H), 8.02 – 7.87 (m, 2H), 7.48 – 6.86

(m, 22H), 6.67 (d, *J* = 1.5 Hz, 1H), 6.56 (d, *J* = 1.8 Hz, 1H), 5.52 (d, *J* = 9.8 Hz, 1H), 5.34 (d, *J* = 6.0 Hz, 1H), 4.67 (dd, *J* = 9.8, 1.5 Hz, 1H), 4.22 (dd, J = 6.0, 1.8 Hz, 1H), -0.03 (s, 9H), -0.16 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 151.76, 151.15, 149.03, 145.75, 141.28, 140.77, 140.37, 135.18, 129.99, 129.81, 129.71, 129.54, 129.42, 128.66, 128.19, 128.17, 127.97, 127.58, 127.09, 126.93, 126.74, 126.67, 126.39, 123.61, 122.53, 115.44, 113.34, 91.08, 87.05, 56.07, 51.15, -0.80, -0.97.

HR-MS (EI-TOF) m/z calcd for $C_{25}H_{25}NO_3Si$ $[M]^+$: 415.1604, found: 415.1609.

tert-butyldimethyl((naphthalen-2-yl)-5-(4-nitrophenyl)-4,5-dihydrofuran-3-yl) silane (**3sa**)



3sa

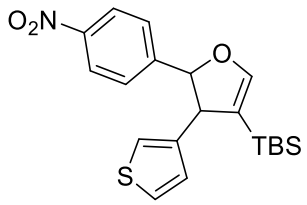
Compound **3sa** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 24 h. NMR spectra of the compound *cis*-**3sa** was reported.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.91 – 7.76 (m, 2H), 7.73 – 7.59 (m, 2H), 7.47 (d, *J* = 8.5 Hz, 1H), 7.44 – 7.32 (m, 3H), 7.27 (d, *J* = 8.6 Hz, 2H), 6.92 (d, *J* = 8.3 Hz, 1H), 6.79 (d, *J* = 1.1 Hz, 1H), 5.85 (d, *J* = 8.8 Hz, 1H), 4.48 (dd, *J* = 8.8, 1.1 Hz, 1H), 0.90 (s, 9H), 0.03 (s, 3H), -0.46 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 152.69, 146.53, 145.53, 135.98, 132.87, 132.35, 127.64, 127.60, 127.53, 127.51, 127.26, 127.02, 125.88, 125.60, 122.79, 112.88, 86.97, 57.47, 26.67, 17.07, -5.28, -5.54.

HR-MS (EI-TOF) m/z calcd for $C_{26}H_{29}NO_3Si$ $[M]^+$: 431.1917, found: 431.1911.

tert-butyldimethyl(5-(4-nitrophenyl)-4-(thiophen-3-yl)-4,5-dihydrofuran-3-yl) silane (**3ta**)



3ta

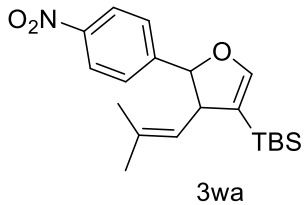
Compound **3ta** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 24 h. NMR spectra of the compound *cis*-**3ta** was reported.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.97 (d, *J* = 8.8 Hz, 1H), 7.25 (d, *J* = 8.8 Hz, 1H), 6.91 (dd, *J* = 5.0, 3.0 Hz, 1H), 6.70 (dd, *J* = 3.0, 1.2 Hz, 1H), 6.67 (d, *J* = 1.2 Hz, 1H), 6.44 (dd, *J* = 5.0, 1.2 Hz, 1H), 5.68 (d, *J* = 9.1 Hz, 1H), 4.40 (dd, *J* = 9.1, 1.2 Hz, 1H), 0.89 (s, 9H), 0.04 (s, 3H), -0.32 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 152.47, 146.74, 145.64, 139.75, 127.91, 126.91, 125.28, 122.81, 122.44, 112.52, 86.56, 52.42, 26.62, 17.04, -5.35, -5.83.

HR-MS (EI-TOF) m/z calcd for $C_{20}H_{25}NO_3SSi$ $[M]^+$: 387.1324, found: 387.1323.

tert-butyldimethyl(4-(2-methylprop-1-en-1-yl)-5-(4-nitrophenyl)-4,5-dihy drofuran-3-yl)silane (**3wa**)



3wa

Compound **3wa** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 12 h. NMR spectra of the compound *cis*-**3wa** was reported.

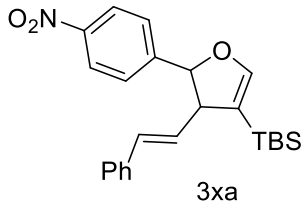
^{1}H NMR (500 MHz, $CDCl_3$) δ 8.15 (d, *J* = 8.8 Hz, 2H), 7.37 (d, *J* = 8.8 Hz, 2H), 6.49 (d, *J* = 1.4 Hz, 1H), 5.55 (d, *J* = 9.4 Hz, 1H), 4.48 – 4.38 (m, 1H), 4.01 (ddd, *J* = 11.0, 9.5, 1.5 Hz, 1H), 1.47 (*d*, J = 1.3 Hz, 3H), 1.36 (d, *J* = 1.2 Hz, 3H), 0.90 (s, 9H), 0.05 (s, 3H), -0.04 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 151.98, 146.86, 132.46, 126.99, 125.64, 124.65, 123.81,

122.97, 111.44, 86.03, 49.43, 26.73, 25.30, 18.00, 16.93, -5.07, -5.51.

HR-MS (EI-TOF) m/z calcd for $C_{20}H_{29}NO_3Si$ $[M]^+$: 359.1917, found: 359.1916.

tert-butyldimethyl(5-(4-nitrophenyl)-4-((*E*)-styryl)-4,5-dihydrofuran-3-yl) silane (**3xa**)



3xa

Compound **3xa** was obtained as colorless oil according to general procedure **C**. The reaction was heated at 90 °C for 18 h. NMR spectra of the compound *trans*-**3xa** was reported.

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.22 (d, *J* = 8.7 Hz, 2H), 7.52 – 7.45 (m, 2H), 7.35 (dt, J = 15.1, 7.4 Hz, 4H), 7.30 – 7.24 (m, 1H), 6.51 (*d*, J = 1.8 Hz, 1H), 6.34 (d, *J* = 15.7 Hz, 1H), 6.18 (dd, *J* = 15.7, 9.5 Hz, 1H), 5.28 (d, *J* = 7.1 Hz, 1H), 3.74 – 3.56 (m, 1H), 0.84 (s, 9H), 0.07 (s, 3H), 0.02 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 152.43, 149.38, 136.65, 131.37, 131.34, 128.69, 127.73, 126.31, 125.76, 123.92, 109.00, 87.42, 60.75, 26.78, 17.11, -4.47, -5.47.

HR-MS (EI-TOF) m/z calcd for $C_{24}H_{29}NO_3Si$ $[M]^+$: 407.1917, found: 407.1909.

4.X-ray of Compound 3ma

The data can be obtained free of charge from The Cambridge Crystallographic Data Centre via www.ccdc.cam.ac.uk/data_request/cif.

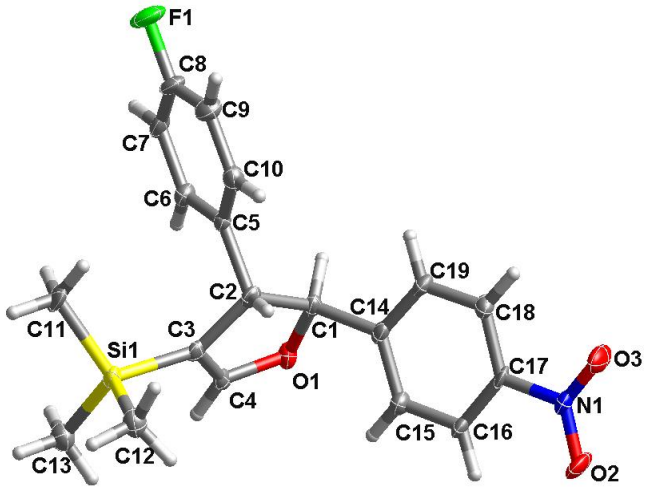


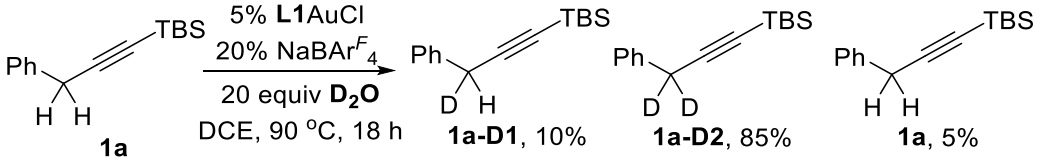
Figure S1. Ortep drawing of compound *trans*-**3ma.**

Table S1: Crystallographic Details for *trans*-**3ma**

Complex.	*Trans*-**3ma**
empirical formula	C_{19} H_{20} F N O_3 Si
formula weight	357.45
temperature, K	103(2)
radiation (Mo Kα), Å	0.71073
crystal system	triclinic
space group	P
a, Å	6.84(3)
b, Å	7.717(19)
c, Å	18.32(4)
α, °	81.71(9)
β, °	85.48(10)
γ, °	72.46(7)
V, Å^3	911(4)
Z	2
F(000)	376

crystal size, mm	0.20 x 0.10 x 0.10
θ range, °	2.5 to 24.2
indep reflns	13551 / 2613 [R(int) = 0.1266]
data-restraints-params	2613/ 0 / 199
GOF on F^2	0.636
final R ($I > 2\sigma(I)$)	R_1 = 0.0590, wR_2 = 0.1623
R indices (all data)	R_1 = 0.1454, wR_2 = 0.2243
peak and hole, e.Å^{-3}	0.184 and -0.288

5. Mechanism Studies



To a 3-dram vial were added sequentially 0.2 mmol silylated alkyne **1a**, 0.01 mmol indicated **L1**AuCl (5 mol%), 0.04 mmol NaBARF (20 mol%), 4.0 mmol D_2O (20 equiv) and 2 mL anhydrous DCE as solvent. The reaction was then stirred at the 90 °C for 18 h. The reaction was concentrated under reduced pressure. The residue was purified by silica gel flash column chromatography to obtain the compound **1a**-D.

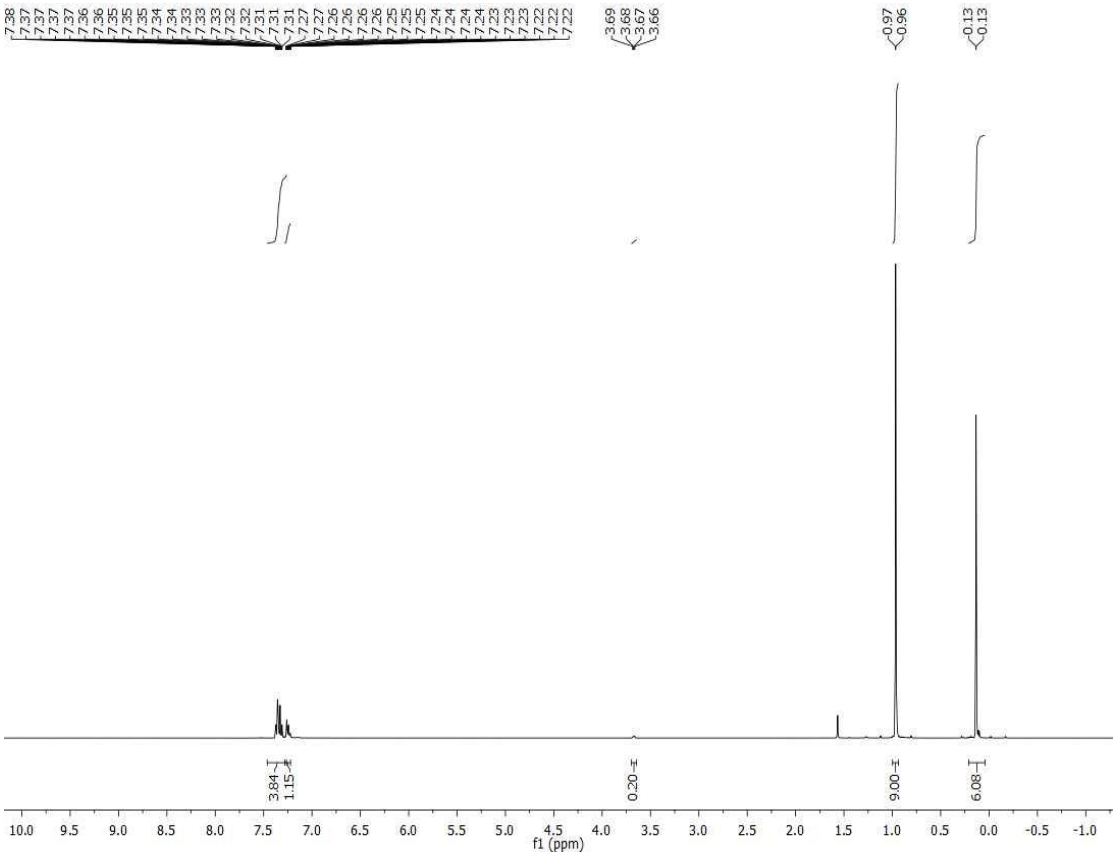
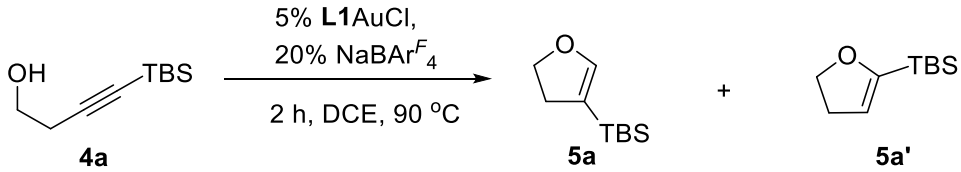


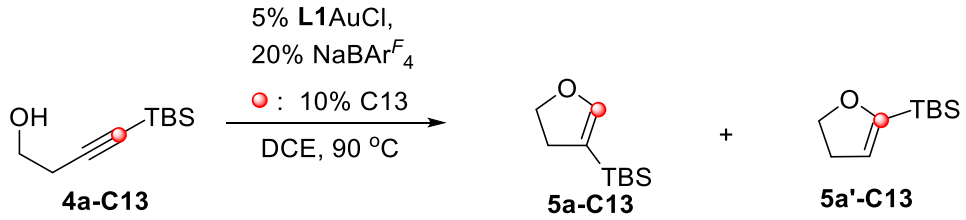
Figure S2: H[1] NMR spectra for **1a-D**



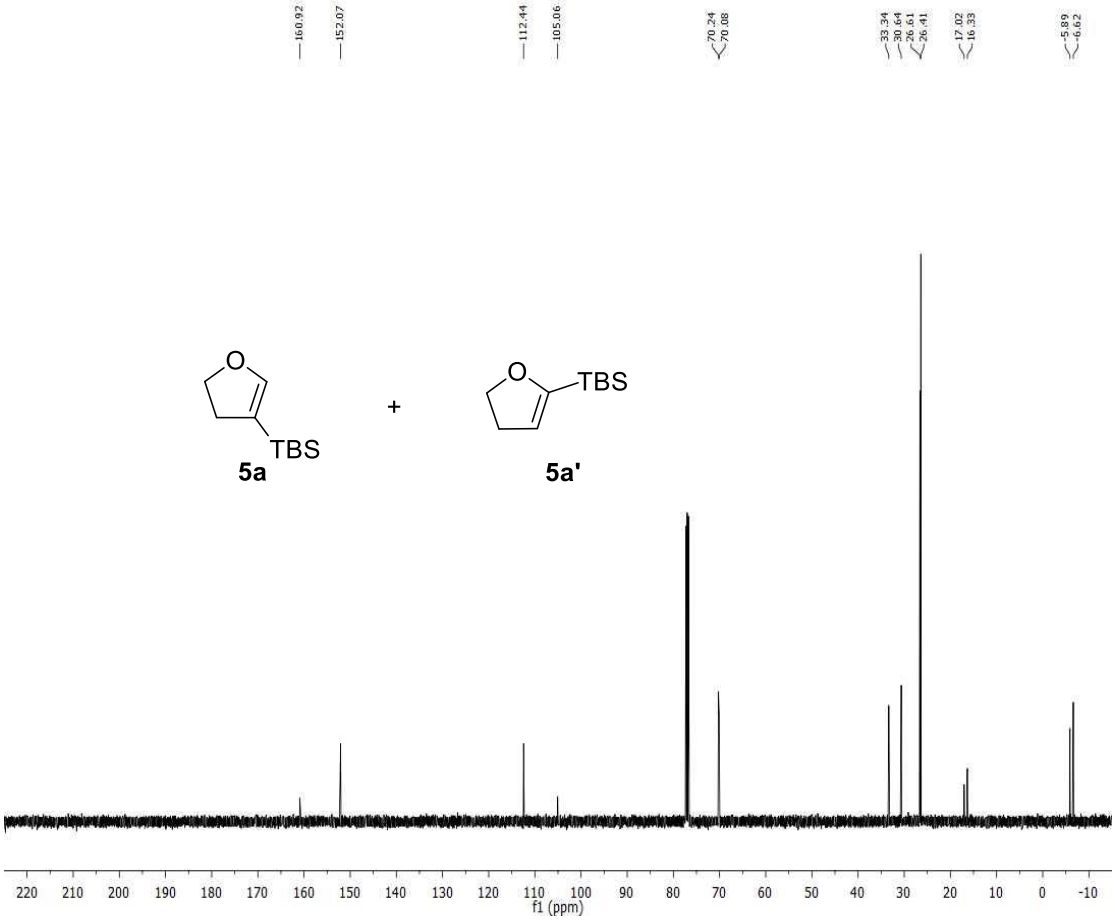
92% isolated yield, **5a**/**5a'** = 0.6/1

Compound **4a** was synthesized following the literature report. [7] To a vial were added

sequentially 0.2 mmol silylated alkyne **4a**, 0.01 mmol indicated **L1**AuCl (5 mol%), 0.04 mmol NaBARF (20 mol%), and 2 mL anhydrous DCE as solvent. The reaction was then stirred at the 90 °C for 2 h. The reaction was concentrated under reduced pressure. The residue was purified by silica gel flash column chromatography to obtain the compound **5a** and **5a'** in a ratio of 0.6/1 in 92% yield.



Compound **4a-C13** was synthesized following the literature report.[8] To a NMR tube were added sequentially 0.1 mmol silylated alkyne **4a-C13**, 0.005 mmol indicated **L1**AuCl (5 mol%), 0.02 mmol NaBARF (20 mol%), and 1 mL anhydrous DCE as solvent. The reaction was then stirred at 90 °C for 2 h. The reaction was concentrated under reduced pressure. The NMR of the residue was collected.



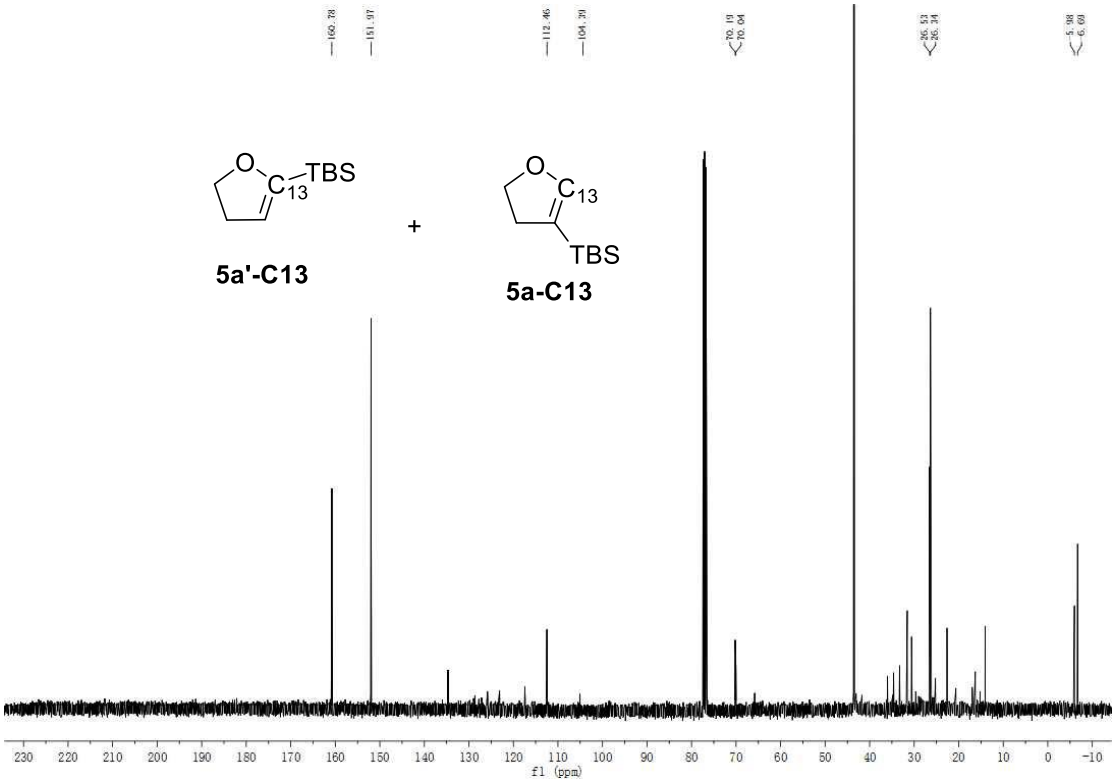
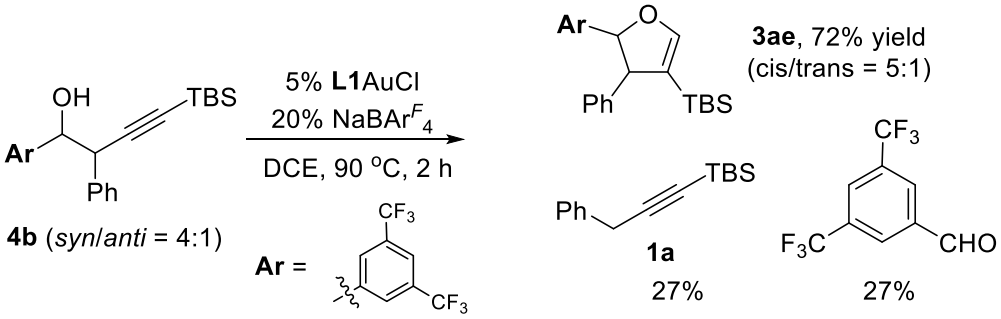
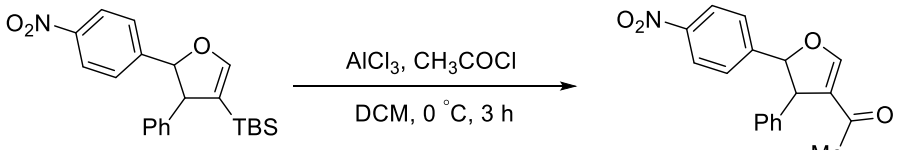


Figure S3: C^{13} NMR spectra for **5a** and **5a-C13**



To a NMR tube were added sequentially 0.1 mmol silylated alkyne **4b**, 0.005 mmol indicated **L1**AuCl (5 mol%), 0.02 mmol NaBARF (20 mol%), and 1 mL anhydrous DCE as solvent. The reaction was then stirred at the 90 °C for 2 h. The reaction was concentrated under reduced pressure. The NMR of the residue was then collected.

6.Transformation of the Product 3aa

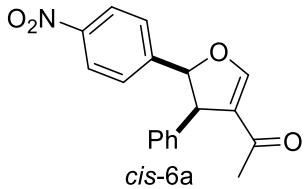


3aa **6a**

(*dr* = 3:1, 82%)

A 10 mL over-dried flask was charged with a stir bar and $AlCl_3$ (0.40 mmol). The flask was capped with a septum and DCM (1 mL) was added via syringe under N_2. A solution of **3aa** (0.20 mmol) and acetyl chloride (0.40 mmol) in DCM (2 mL) was added to the aluminum chloride suspension at 0 °C. After 3 h, the reaction was finished. The solvent was removed and the remaining oil was purified by flash chromatography to afford **6a** as colorless oil.

1-(5-(4-nitrophenyl)-4-phenyl-4,5-dihydrofuran-3-yl)ethan-1-one (*cis*-**6a**)



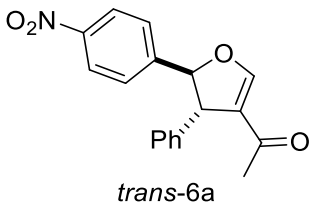
cis-6a

^{1}H NMR (400 MHz, cdcl$_3$) δ 7.96 (d, *J* = 8.8 Hz, 2H), 7.73 (s, 1H), 7.19 (*d*, J = 8.6 Hz, 2H), 7.09 – 6.94 (m, 3H), 6.83 (dd, *J* = 7.8, 1.4 Hz, 2H), 6.08 (d, *J* = 9.8 Hz, 1H), 4.64 (d, *J* = 9.8 Hz, 1H), 2.26 (s, 3H).

^{13}C NMR (101 MHz, cdcl$_3$) δ 192.16, 157.28, 147.00, 143.38, 136.41, 128.20, 128.17, 127.28, 127.07, 124.83, 122.91, 89.71, 51.37, 27.06.

HR-MS (EI-TOF) m/z calcd for $C_{18}H_{15}NO_4$ $[M]^+$: 309.1001, found: 309.0990.

1-(5-(4-nitrophenyl)-4-phenyl-4,5-dihydrofuran-3-yl)ethan-1-one (*trans*-**6a**)



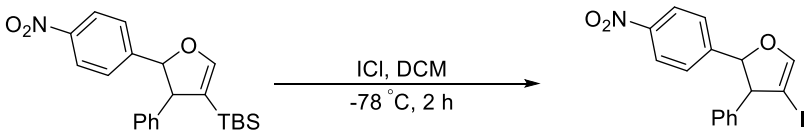
trans-6a

^{1}H NMR (400 MHz, CDCl$_3$) δ 8.26 (d, *J* = 8.8 Hz, 1H), 7.65 (d, *J* = 1.3 Hz, 1H), 7.45 (d, *J* = 8.8 Hz, 2H), 7.37 (t, *J* = 7.3 Hz, 2H), 7.31 (d, *J* = 7.2 Hz, 1H), 7.27 – 7.20 (m,

2H), 5.66 (d, J = 6.1 Hz, 1H), 4.47 – 4.13 (m, 1H), 2.22 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 192.09, 156.83, 147.82, 147.28, 141.50, 129.10, 127.58, 127.18, 125.77, 124.15, 123.33, 109.99, 93.22, 55.65, 27.16.

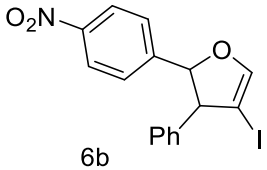
HR-MS (EI-TOF) m/z calcd for $C_{18}H_{15}NO_4$ $[M]^+$: 309.1001, found: 309.0990.



3aa **6b** (59% yield)

To a DCM solution of **3aa** (0.20 mmol) at – 78 ºC was added ICl (0.22 mmol). The mixture was left stirring at – 78 ºC for 2 h and was monitored by TLC. The reaction mixture was then poured into 10% aq. $Na_2S_2O_3$ solution and extracted with hexanes. The combined organic phases were dried over anhydrous sodium sulfate and concentrated under reduced pressure. The residue was purified by column chromatography on silica gel to afford the product **6b** as colorless oil.

cis-4-iodo-2-(4-nitrophenyl)-3-phenyl-2,3-dihydrofuran (**6b**)

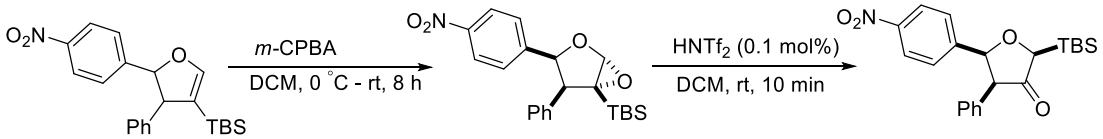


6b

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.23 – 7.78 (m, 2H), 7.19 (dd, J = 8.9, 2.6 Hz, 2H), 7.07 (dd, J = 5.7, 1.3 Hz, 3H), 6.93 – 6.74 (m, 3H), 5.99 (d, J = 10.1 Hz, 1H), 4.36 (dd, J = 10.0, 1.3 Hz, 1H).

^{13}C NMR (101 MHz, $cdcl_3$) δ 150.27, 146.56, 144.41, 135.28, 128.82, 128.62, 128.25, 127.63, 127.19, 127.08, 122.86, 122.73, 86.08, 65.55, 59.98.

HR-MS (EI-TOF) m/z calcd for $C_{16}H_{12}INO_3$ $[M]^+$: 392.9862, found: 392.9865.



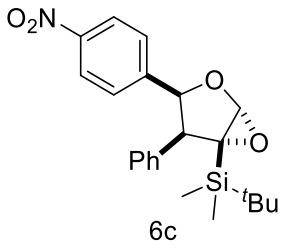
3aa **6c** (61% yield) (92% yield based on *cis*-**3aa**) **6d** (84% yield)

To a DCM solution of **3aa** (0.20 mmol) at 0 ºC was added 3-chloroperbenzoic acid

(74.4%, 0.22 mmol). The mixture was left stirring at room temperature. After 8 h, the reaction was finished. The solvent was removed and the remaining oil was purified by flash chromatography to afford **6c** as white solid.

To a DCM solution of **3aa** (0.20 mmol) at room temperature was added $HNTf_2$ solution in dichloromethane (0.2 mg/mL, 0.1 mol%). The mixture was left stirring at room temperature. After 10 min, the reaction was finished. The solvent was removed and the remaining oil was purified by flash chromatography to afford **6d** as colorless oil.

tert-butyldimethyl(3-(4-nitrophenyl)-4-phenyl-2,6-dioxabicyclo[3.1.0] hexan-5-yl) silane (**6c)**



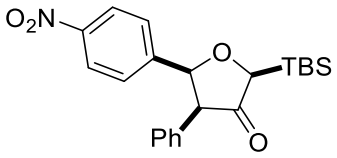
6c

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.26 – 7.15 (m, 3H), 7.15 – 7.09 (m, 2H), 6.55 (d, *J* = 1.5 Hz, 1H), 5.17 (d, *J* = 10.3 Hz, 1H), 4.34 (dd, *J* = 10.3, 1.5 Hz, 1H), 3.77 (dq, *J* = 10.7, 7.1 Hz, 1H), 3.69 – 3.60 (m, 1H), 0.83 (s, 9H), 0.82 (t, *J* = 7.2 Hz, 3H), -0.03 (s, 1H), -0.45 (s, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 168.95, 152.23, 138.74, 128.92, 127.95, 127.38, 111.35, 84.18, 60.75, 55.53, 26.59, 17.00, 13.62, -5.42, -5.62.

HR-MS (EI-TOF) m/z calcd for $C_{22}H_{27}NO_4Si$ $[M]^+$: 397.1709, found: 397.1704.

2-(*tert*-butyldimethylsilyl)-5-(4-nitrophenyl)-4-phenyldihydrofuran-3(2*H*)-one (**6d**)



6d

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.06 (d, *J* = 8.8 Hz, 2H), 7.40 (d, *J* = 8.8 Hz, 2H), 7.08 (t, *J* = 5.9 Hz, 3H), 6.97 (dd, *J* = 7.5, 1.8 Hz, 2H), 5.61 (d, *J* = 6.6 Hz, 1H), 4.23 (s, 1H), 3.96 (d, *J* = 6.67 Hz, 1H), 1.08 (s, 9H), 0.12 (s, 3H), 0.10 (s, 3H).

^{13}C NMR (101 MHz, $cdcl_3$) δ 214.24, 146.66, 145.43, 133.44, 129.07, 128.42, 127.23,

126.85, 123.21, 83.86, 58.26, 26.48, 16.97, -7.15, -7.42.

HR-MS (EI-TOF) m/z calcd for $C_{22}H_{27}NO_4Si$ $[M]^+$: 397.1709, found: 397.1704.

References:

1. Jeso, V.; Aquino, C.; Cheng, X.; Mizoguchi, H.; Nakashige, M.; Micalizio, G. C. *J. Am. Chem. Soc*., **2014**, *136* , 8209.

2. Fleming, L.; Mwaniki, J. M. *J. Chem. Soc., Perkin Trans*. 1, **1998**, 1237.

3. Shu, C,; Li, L.; Chen, C.–B.; Shen, H.-C.; Ye, L. *Chem. Asian J*. **2014**, *9*, 1525.

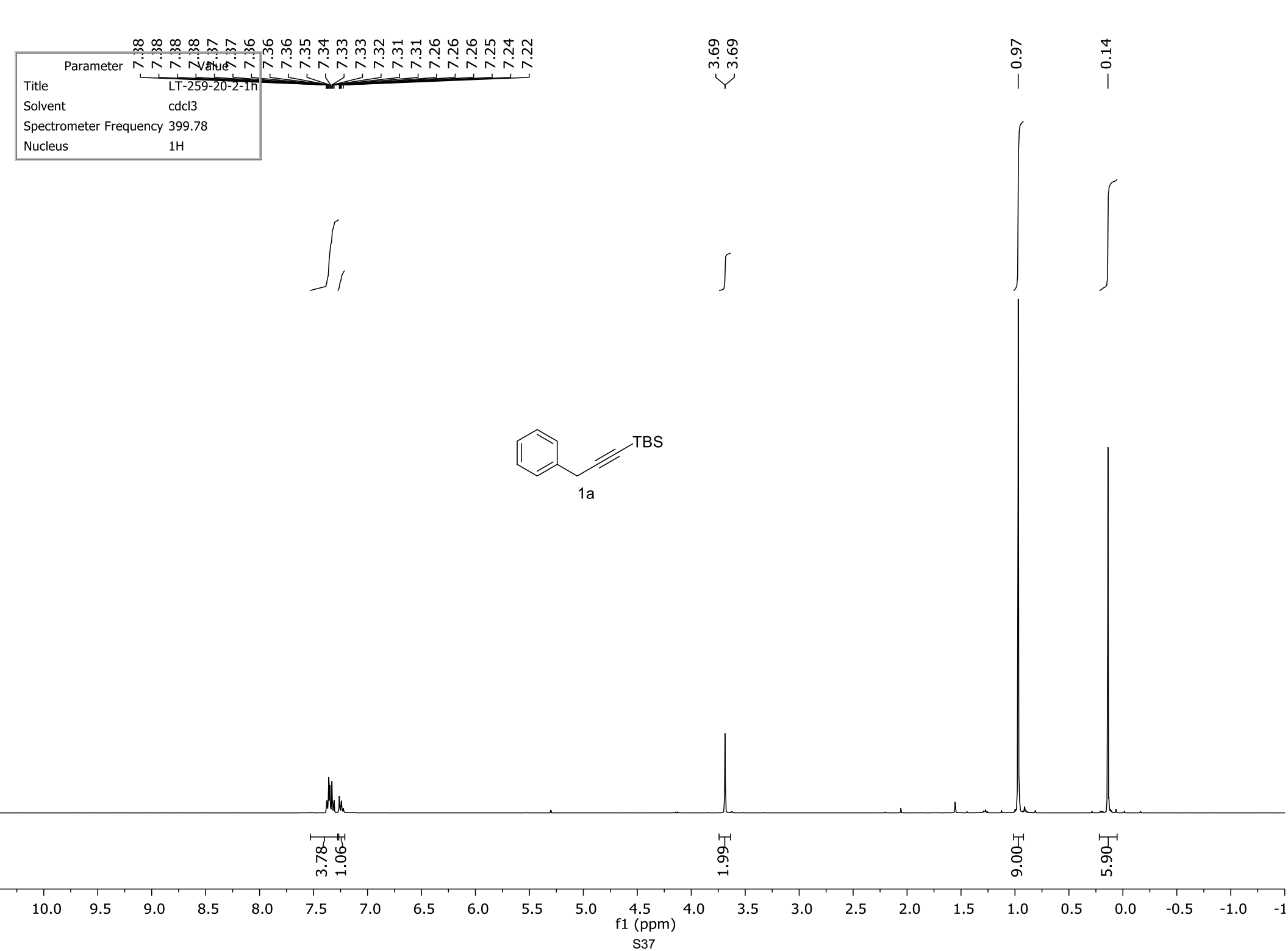
4. Rossi, R.; Crpita, A.; Lippolis, V.; Benetti, M. *Gazzetta Chimica Italiana*, **1990**, *120*, 783.

5. Chanthamath, S.; Chua, H. W.; Kimura, S.; Shibatomi, K.; Iwasa, S. *Org. Lett*., **2014**, *16*, 3408.

6. Speck, K.; Karaghiosoff, K.; Magauer, T. *Org. Lett.*, **2015**, *17*, 1982

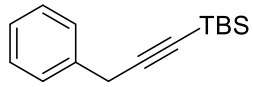
7. Lee, Y.; Rochette, E. M.; Kim, J.; Chen, D. Y. –K. *Angew.Chem. Int. Ed.* **2017***, 56*,12250.

8. Guerra, F.; Wang, K; Li, J.; Wang, W.; Liu, Y. –L.; Amin, S.; Oldfield, E. *Chemical Science*, **2014**, *5*,1642.

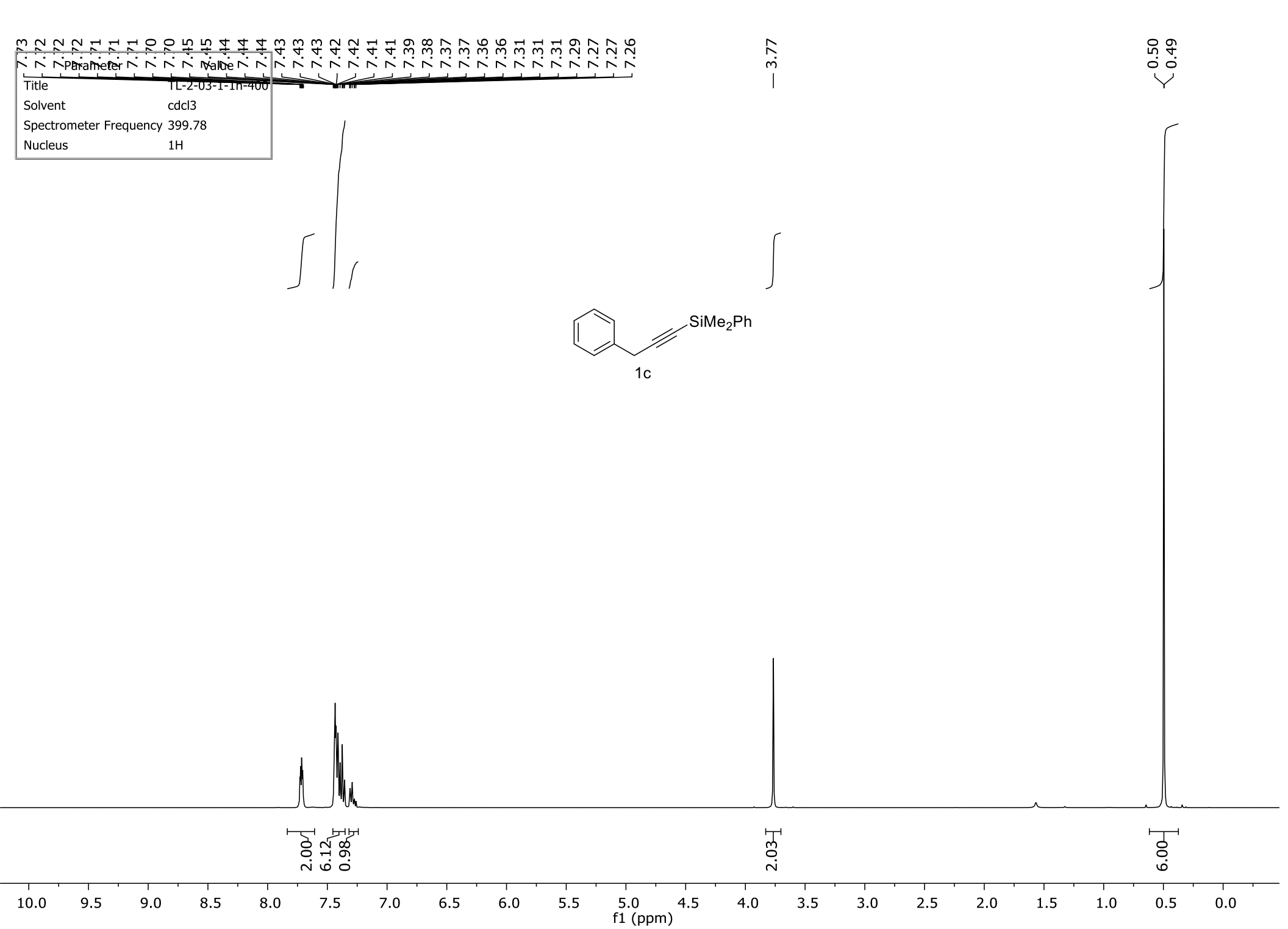

Parameter Value
Title LT-259-20-2-1h
Solvent cdcl3
Spectrometer Frequency 399.78
Nucleus 1H
7.38 7.38 7.38 7.38 7.37 7.37 7.36 7.36 7.36 7.35 7.34 7.33 7.33 7.32 7.31 7.31 7.26 7.26 7.26 7.25 7.24 7.22
3.69 3.69
0.97
0.14
TBS
1a
3.78
1.06
1.99
9.00
5.90
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

Parameter	Value
Title	LT-259-20-2-13c
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C

136.45
128.41
127.80
126.49
104.69
85.05
26.16
26.10
16.57
-4.47

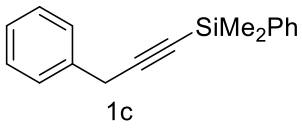


1a

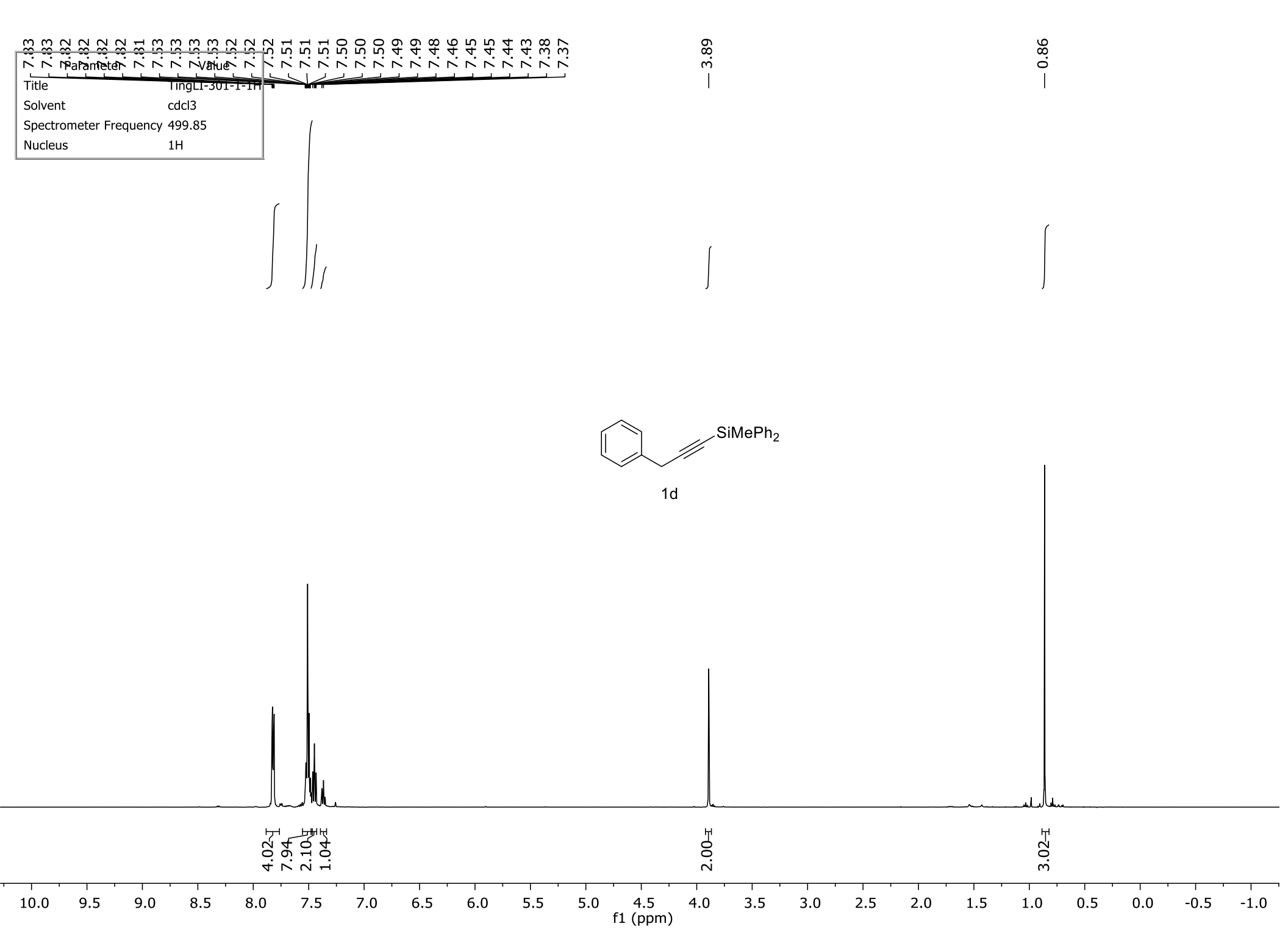

Parameter Value
Title TL-2-03-1-1h-400
Solvent cdcl3
Spectrometer Frequency 399.78
Nucleus 1H
7.73 7.72 7.72 7.72 7.71 7.71 7.71 7.70 7.70 7.70 7.45 7.45 7.44 7.44 7.44 7.43 7.43 7.43 7.42 7.42 7.41 7.41 7.39 7.38 7.37 7.37 7.36 7.36 7.31 7.31 7.31 7.29 7.27 7.27 7.26
3.77
0.50 0.49
SiMe2Ph
1c
2.00
6.12
0.98
2.03
6.00
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
f1 (ppm)

Parameter	Value
Title	TL-2-03-1-13c-400
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C

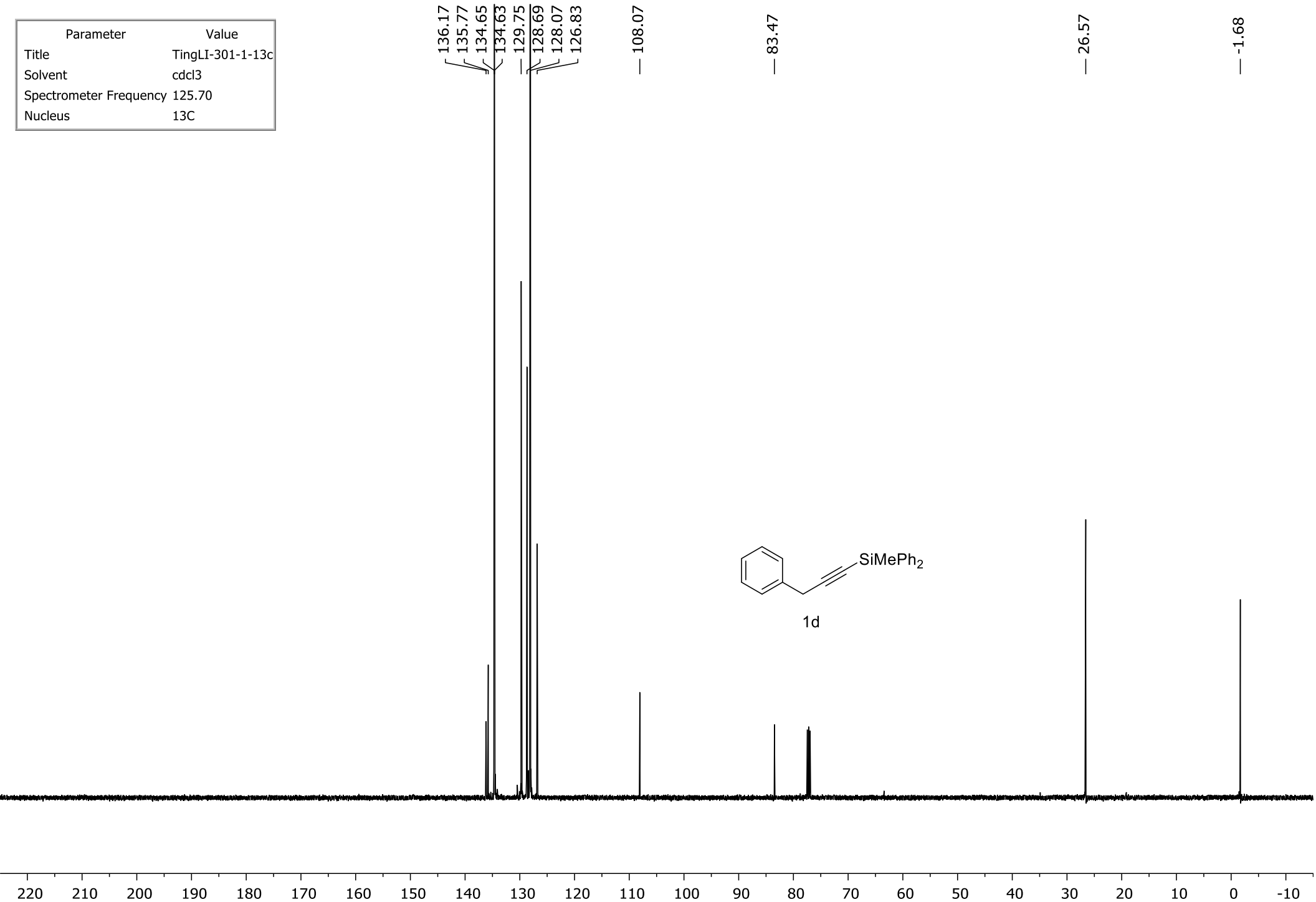
137.37
136.19
133.74
133.72
129.37
128.54
127.92
127.88
126.66
106.20
84.92
26.32
-0.64

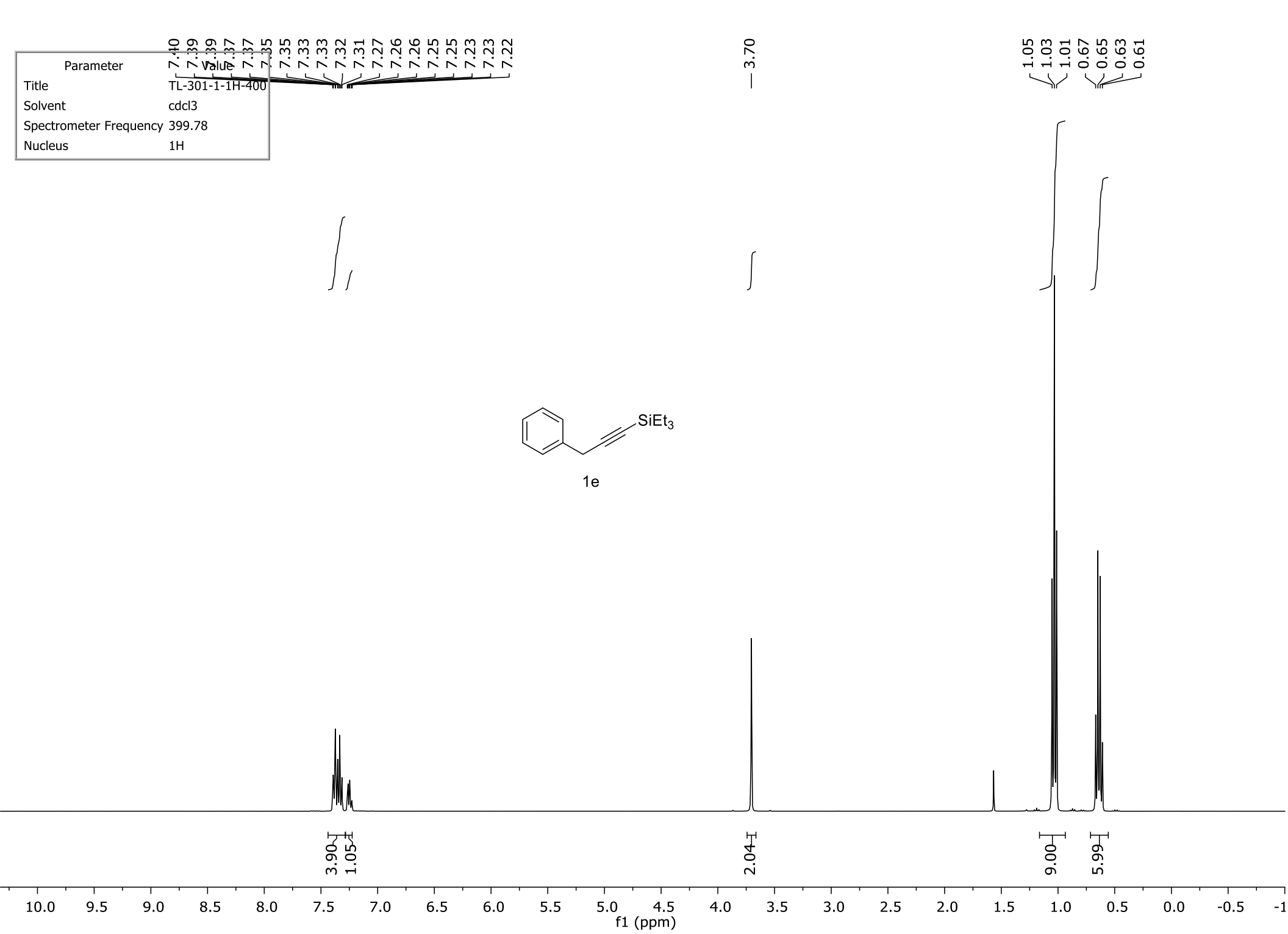


1c


Parameter Value
Title TingLI-301-1-1H
Solvent cdcl3
Spectrometer Frequency 499.85
Nucleus 1H
7.83 7.83 7.82 7.82 7.82 7.82 7.81 7.53 7.53 7.53 7.52 7.52 7.52 7.51 7.51 7.51 7.50 7.50 7.50 7.49 7.49 7.48 7.46 7.45 7.45 7.44 7.43 7.38 7.37
3.89
0.86
SiMePh2
1d
4.02
7.94
2.10
1.04
2.00
3.02
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 -1.0
f1 (ppm)

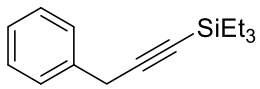
Parameter	Value
Title	TingLI-301-1-13c
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C




Parameter Value
Title TL-301-1-1H-400
Solvent cdcl3
Spectrometer Frequency 399.78
Nucleus 1H
7.40
7.39
7.39
7.37
7.37
7.35
7.35
7.33
7.33
7.32
7.31
7.27
7.26
7.26
7.25
7.25
7.23
7.23
7.22
3.70
1.05
1.03
1.01
0.67
0.65
0.63
0.61
SiEt3
1e
3.90
1.05
2.04
9.00
5.99
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
-1
f1 (ppm)

Parameter	Value
Title	TL-301-1-13c-400
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C

136.51
128.41
127.80
126.48
105.20
84.18
26.20
7.50
4.49

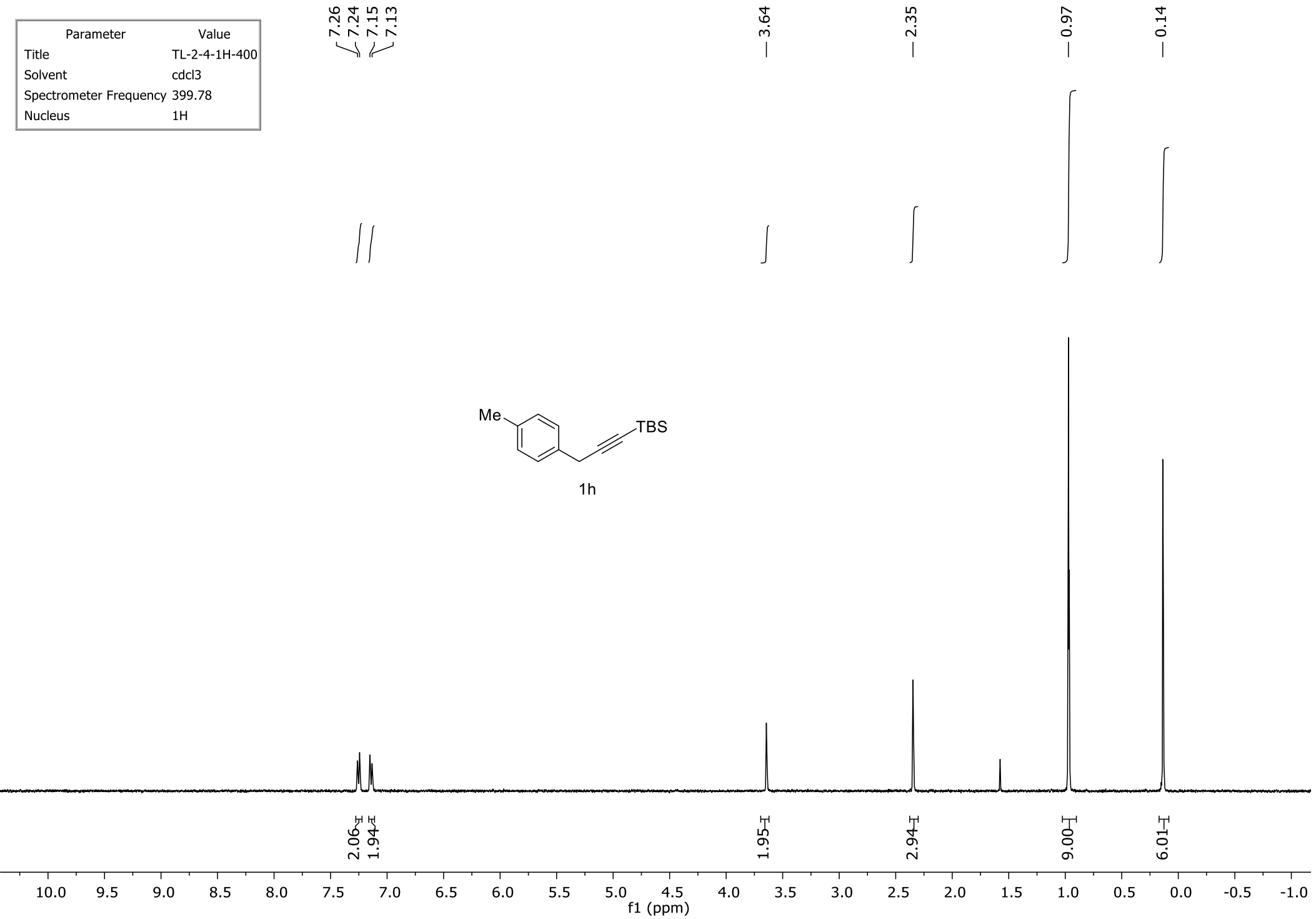


1e

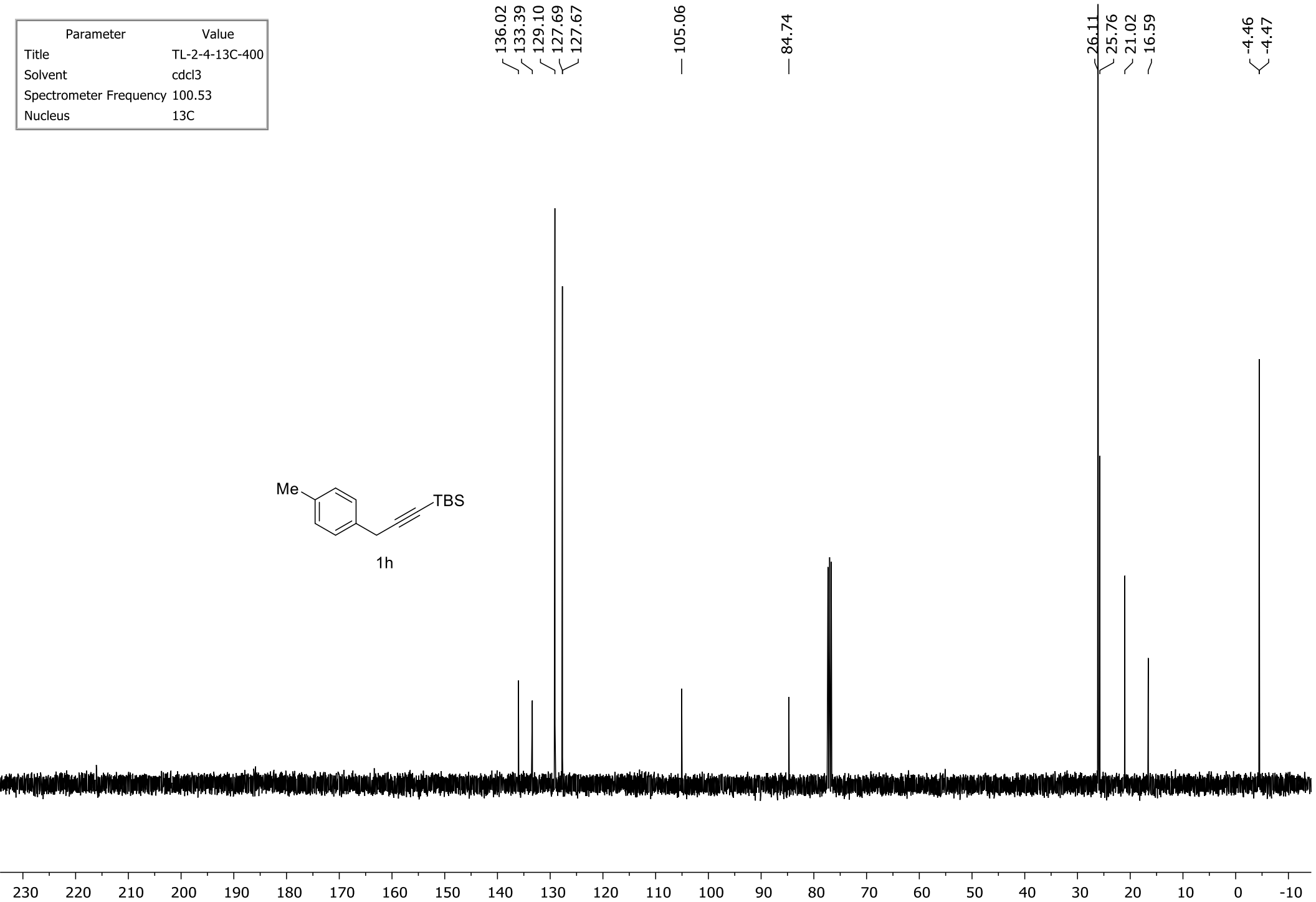
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10

f1 (ppm)

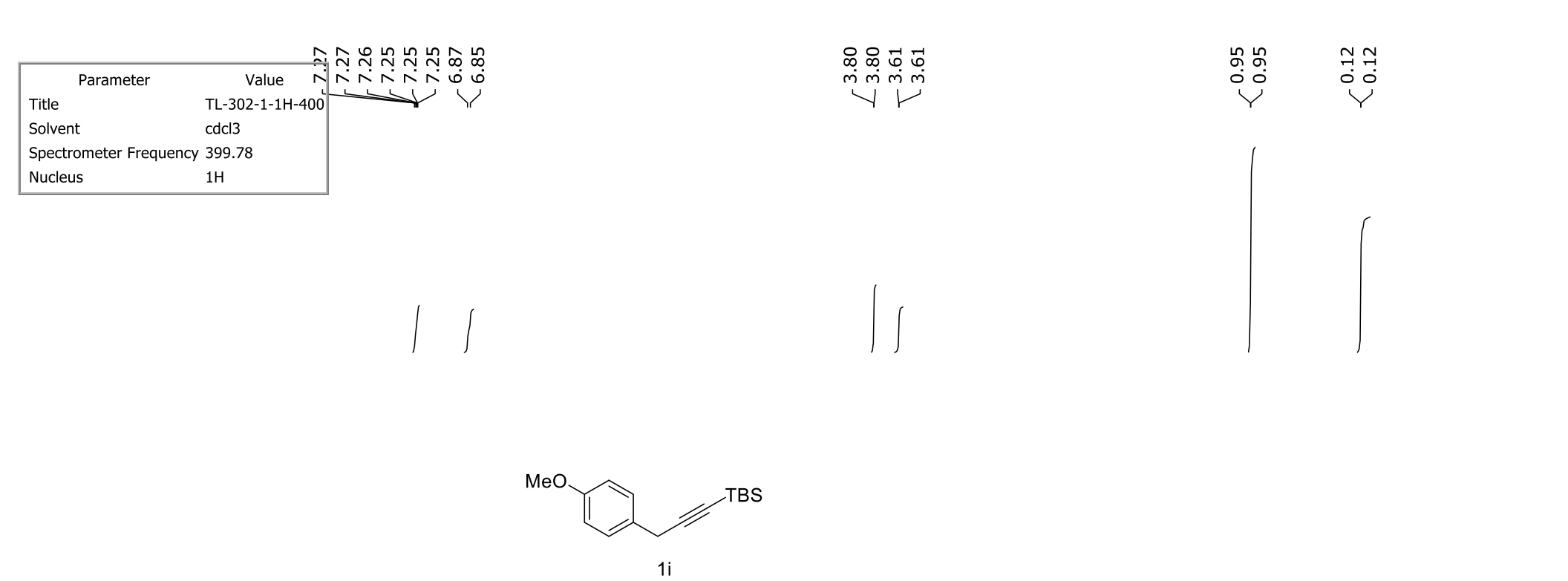
Parameter	Value
Title	TL-2-4-1H-400
Solvent	cdcl3
Spectrometer Frequency	399.78
Nucleus	1H



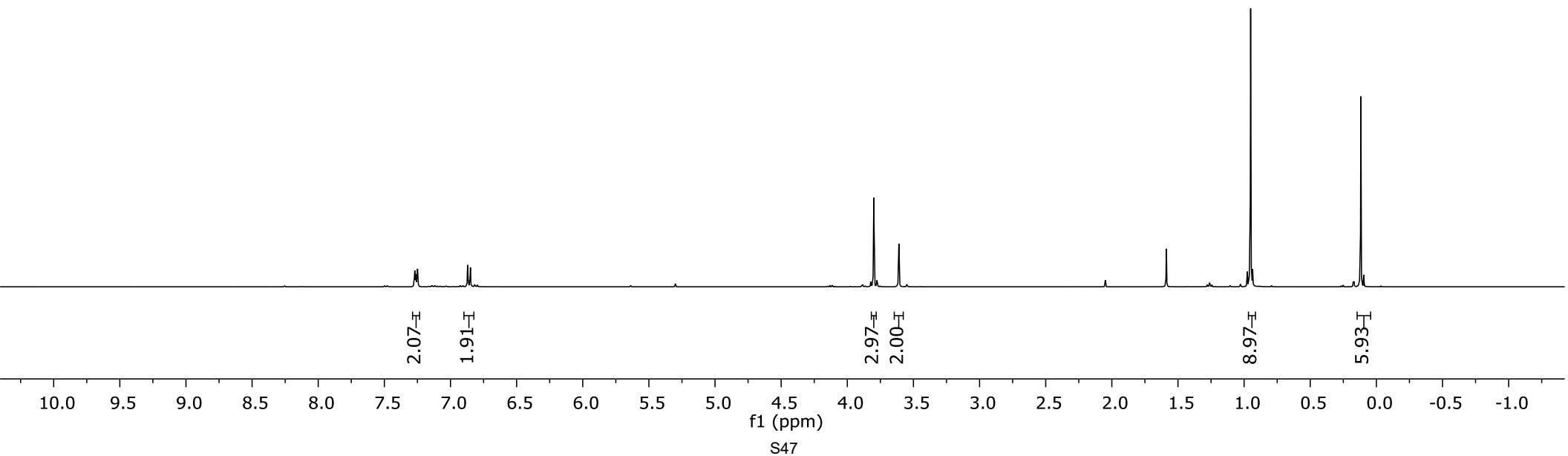
Parameter	Value
Title	TL-2-4-13C-400
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C



Parameter	Value
Title	TL-302-1-1H-400
Solvent	cdcl3
Spectrometer Frequency	399.78
Nucleus	1H

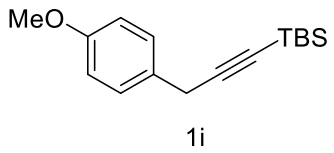


1i



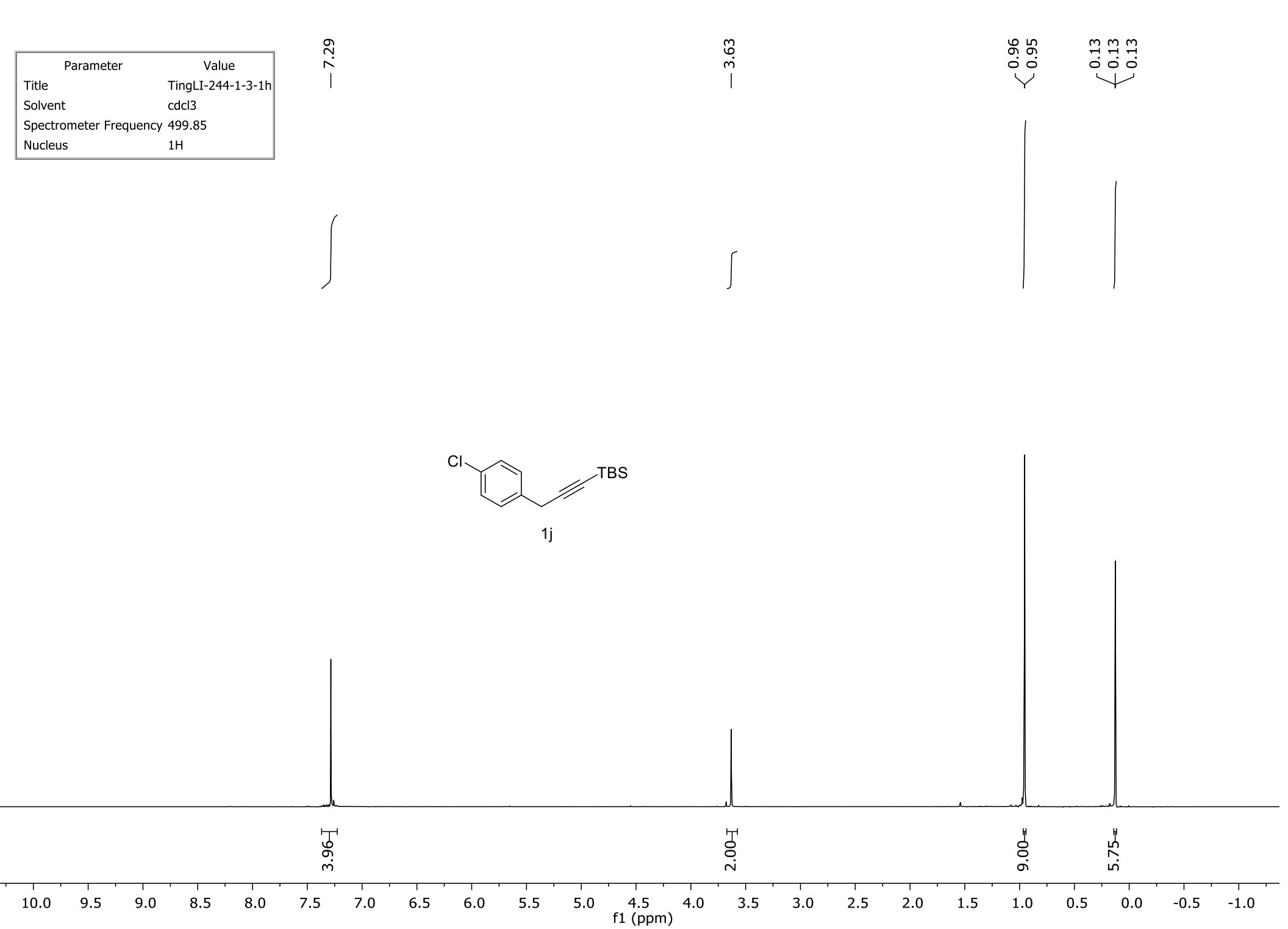
Parameter	Value
Title	TL-302-1-13c-400
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C

158.21
128.74
128.46
113.80
105.20
84.69
55.27
26.10
25.30
16.57
-4.47



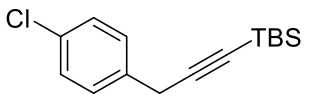
1i

Parameter	Value
Title	TingLI-244-1-3-1h
Solvent	cdcl3
Spectrometer Frequency	499.85
Nucleus	1H

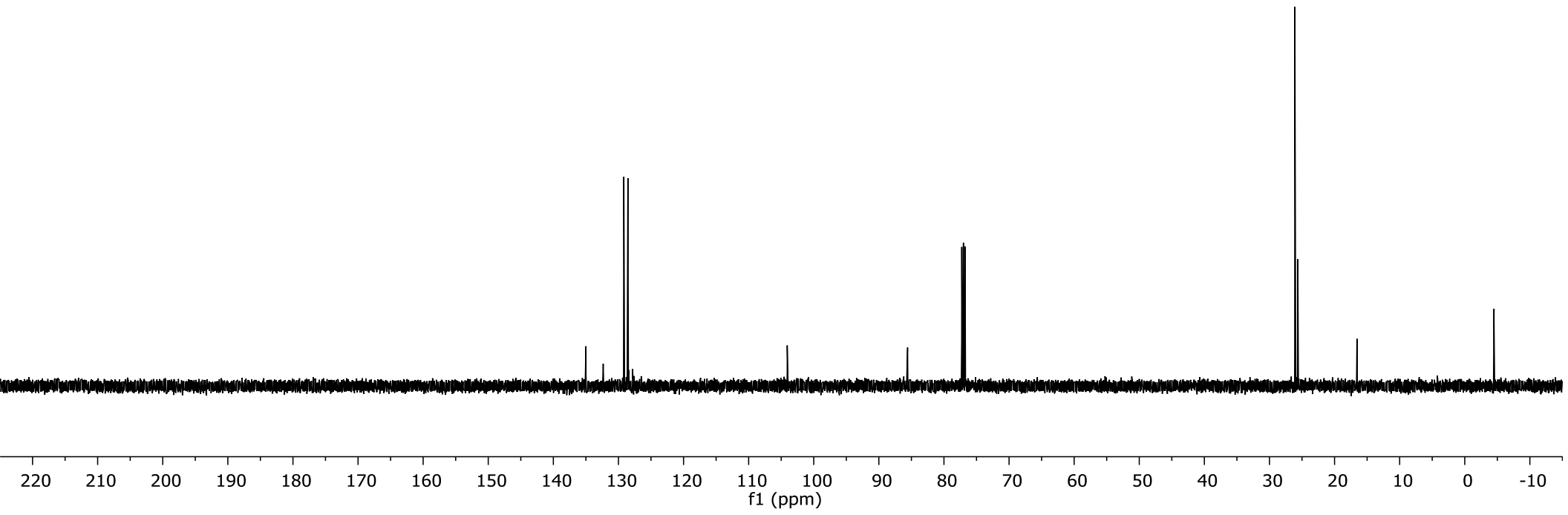


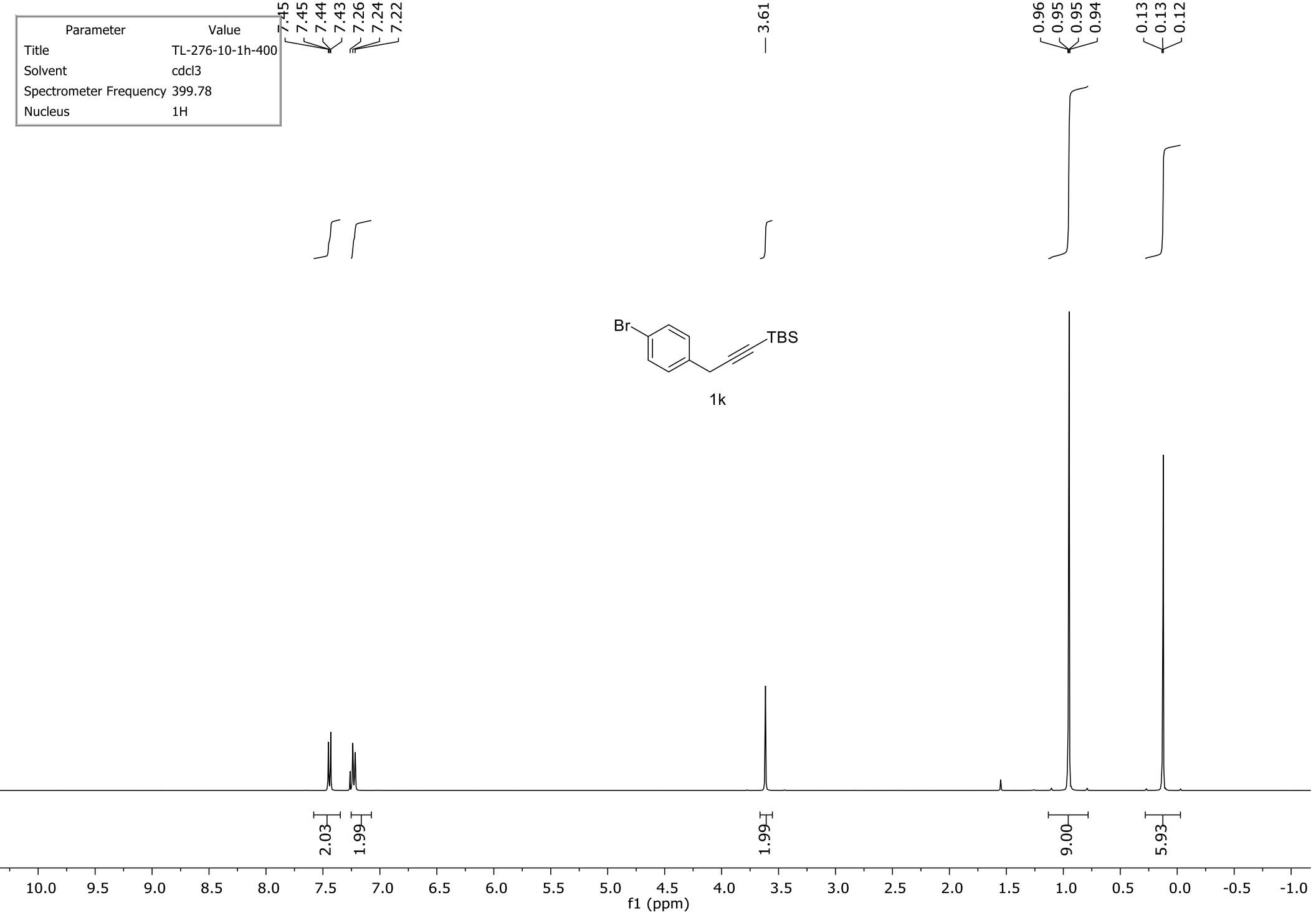
Parameter	Value
Title	TingLI-244-1-3-13c
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C

134.99
132.34
129.17
128.55
104.07
85.59
26.12
26.10
25.64
16.56
-4.49

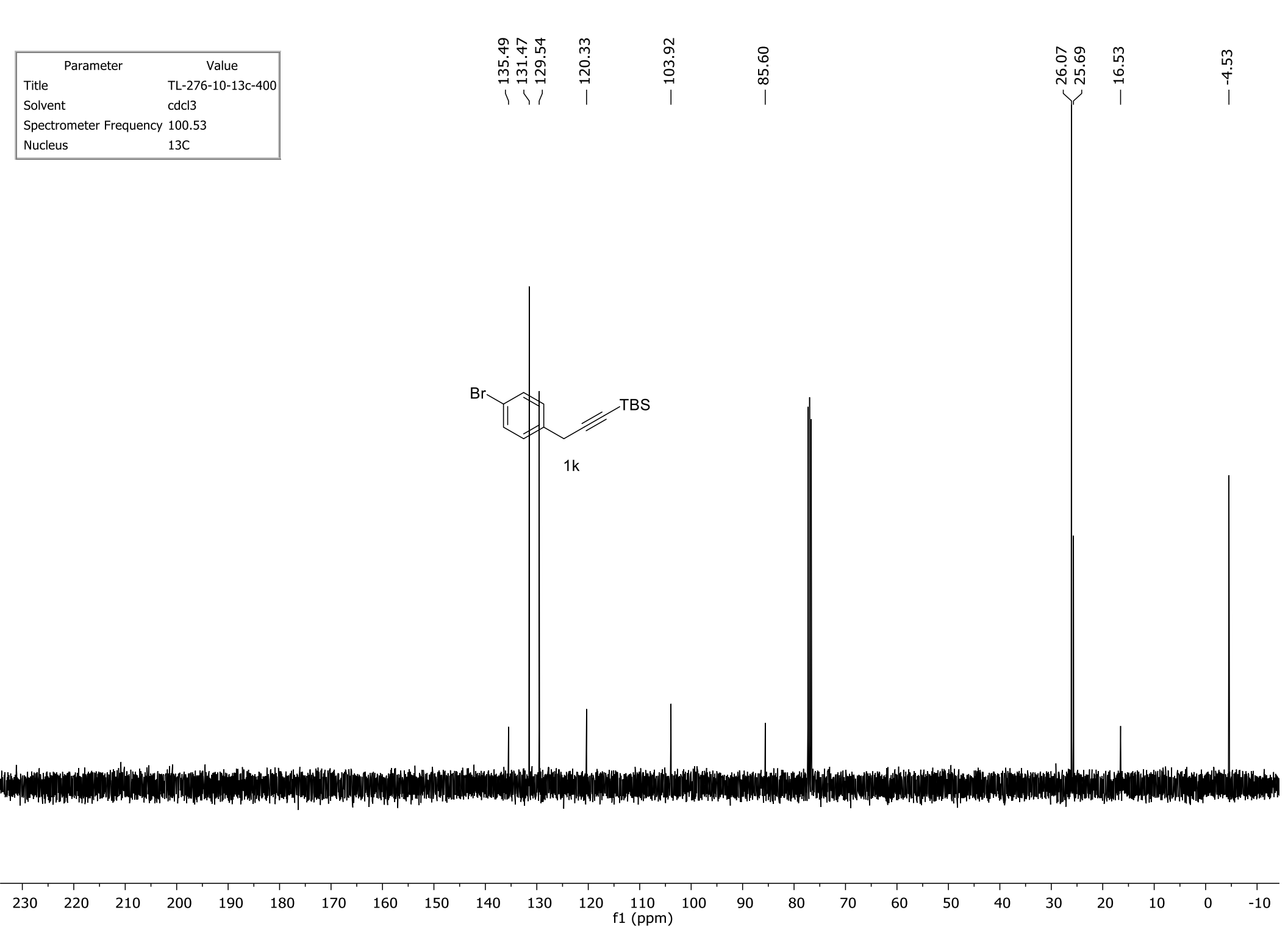


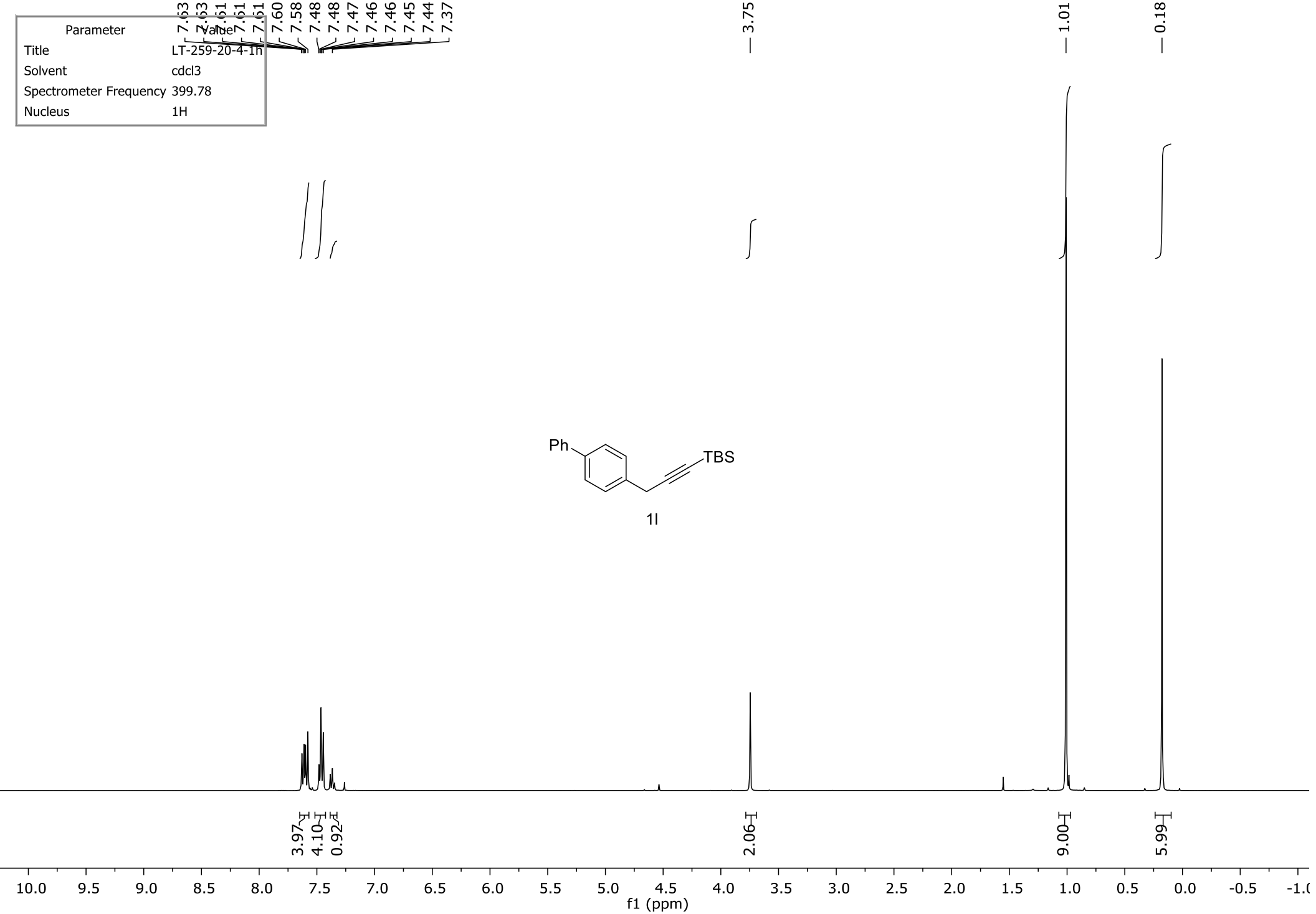
1j



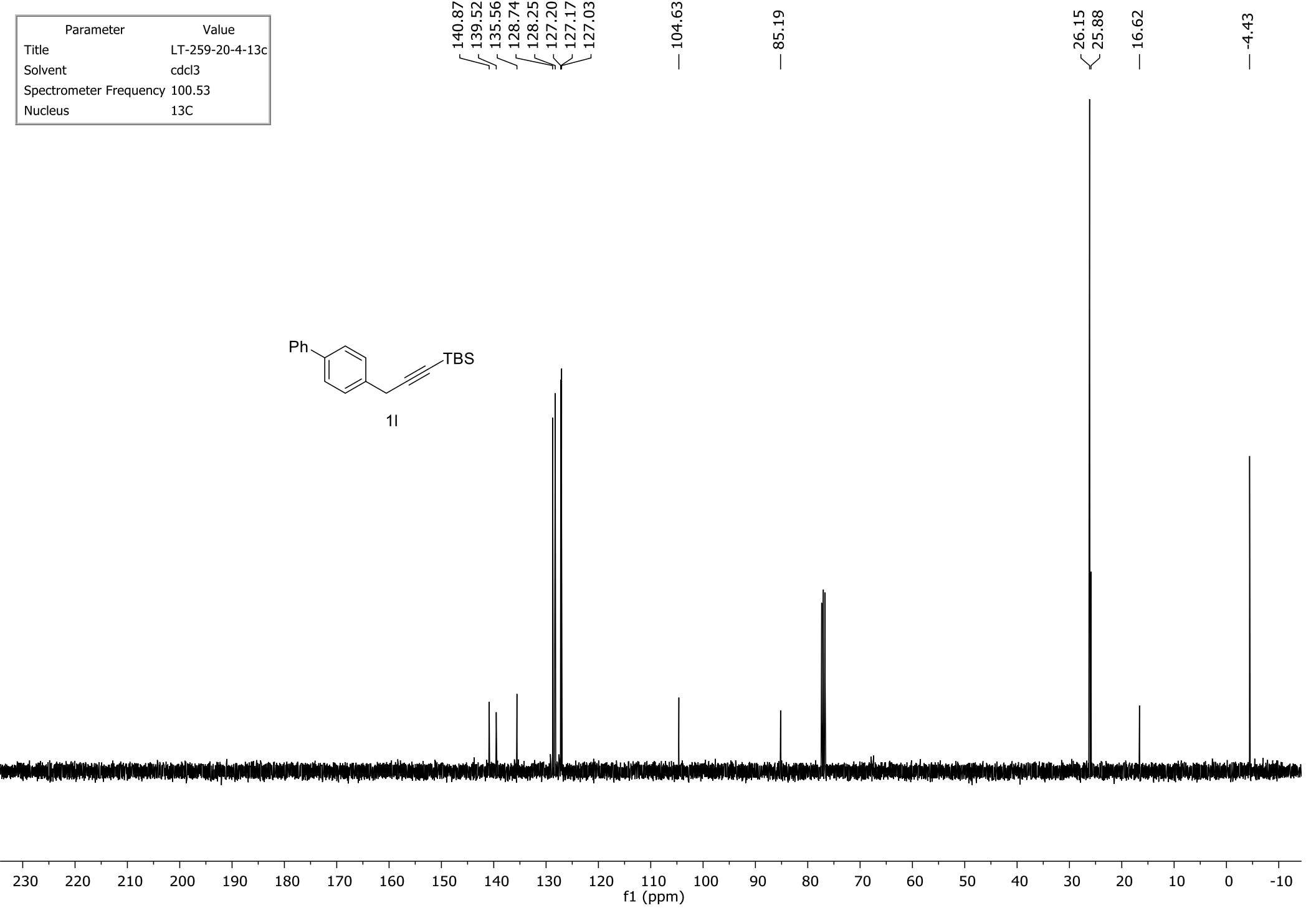

Parameter Value
Title TL-276-10-1h-400
Solvent cdcl3
Spectrometer Frequency 399.78
Nucleus 1H
7.45
7.45
7.44
7.43
7.26
7.24
7.22
3.61
0.96
0.95
0.95
0.94
0.13
0.13
0.12
Br
TBS
1k
2.03
1.99
1.99
9.00
5.93
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

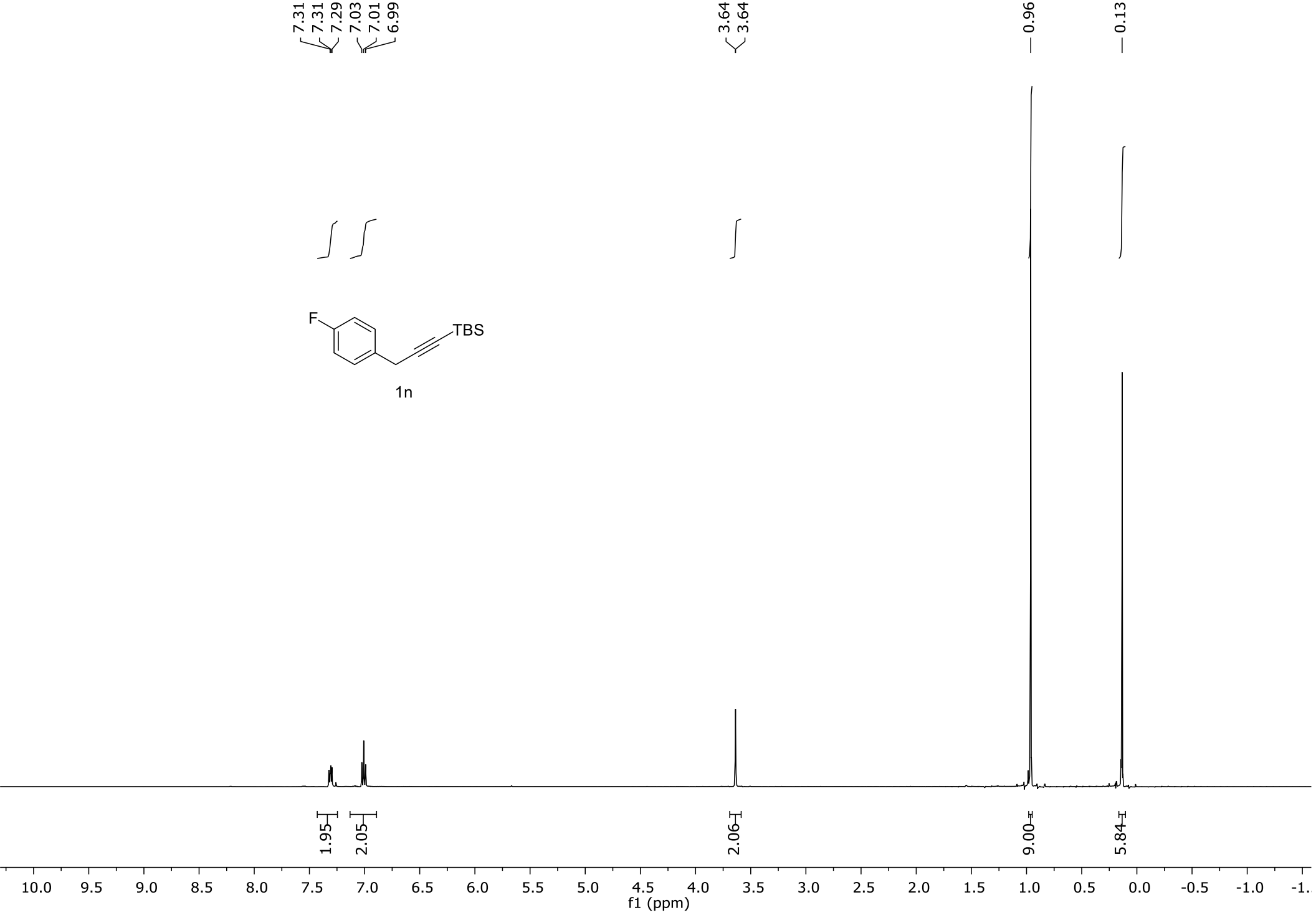
Parameter	Value
Title	TL-276-10-13c-400
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C



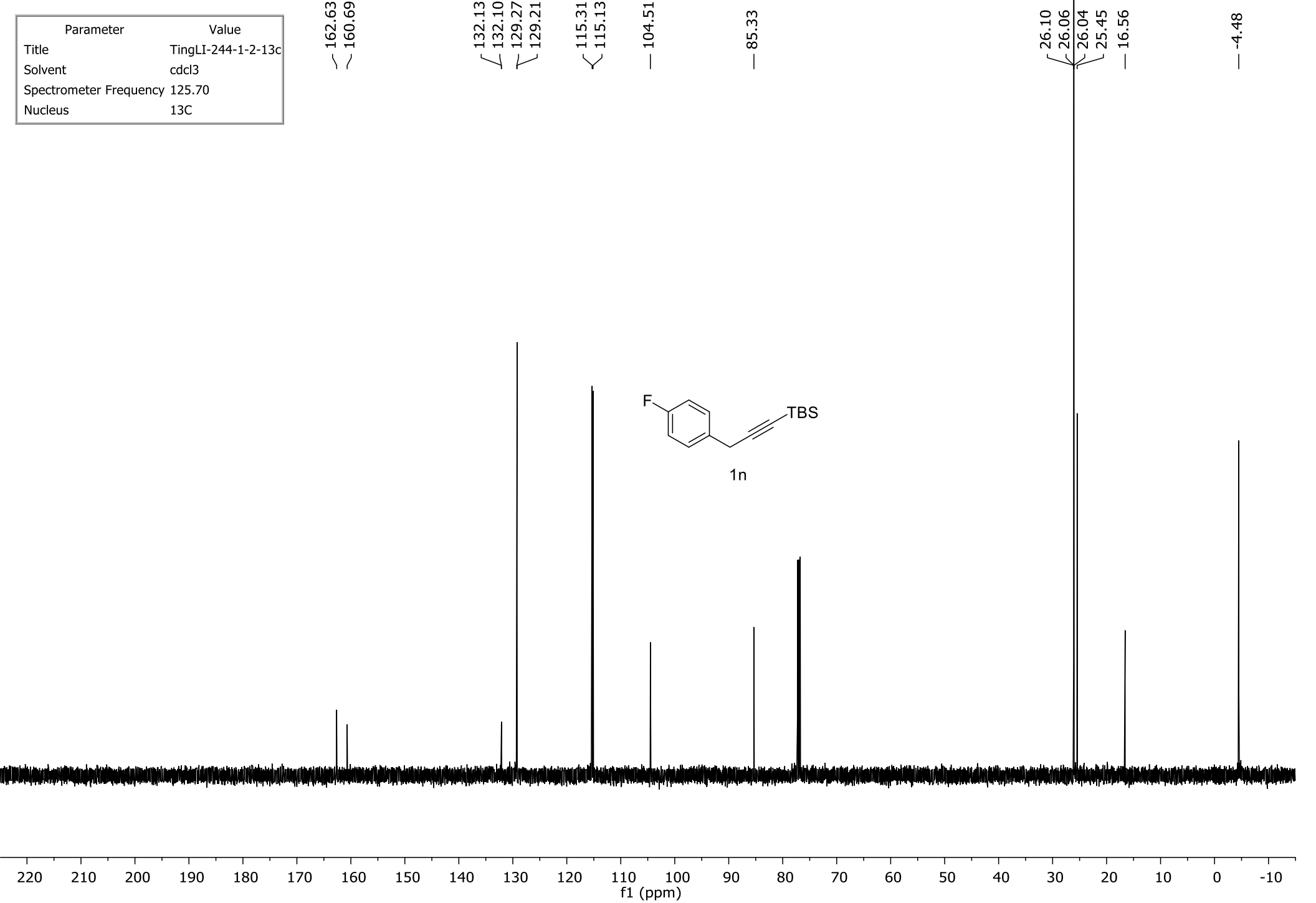

Parameter Value
Title LT-259-20-4-1h
Solvent cdcl3
Spectrometer Frequency 399.78
Nucleus 1H
7.63
7.63
7.61
7.61
7.61
7.60
7.58
7.48
7.48
7.47
7.46
7.46
7.45
7.44
7.37
3.75
1.01
0.18
Ph
TBS
1l
3.97
4.10
0.92
2.06
9.00
5.99
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

Parameter	Value
Title	LT-259-20-4-13c
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C




7.31
7.31
7.29
7.03
7.01
6.99
3.64
3.64
0.96
0.13
F
TBS
1n
1.95
2.05
2.06
9.00
5.84
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
-1.0
f1 (ppm)

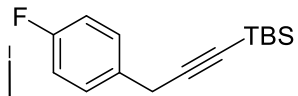
Parameter	Value
Title	TingLI-244-1-2-13c
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C



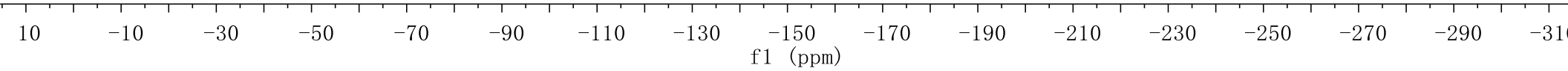
Parameters	
Parameter	Value
Title	LT-2-300-3-19F
Spectrometer Frequency	376.11

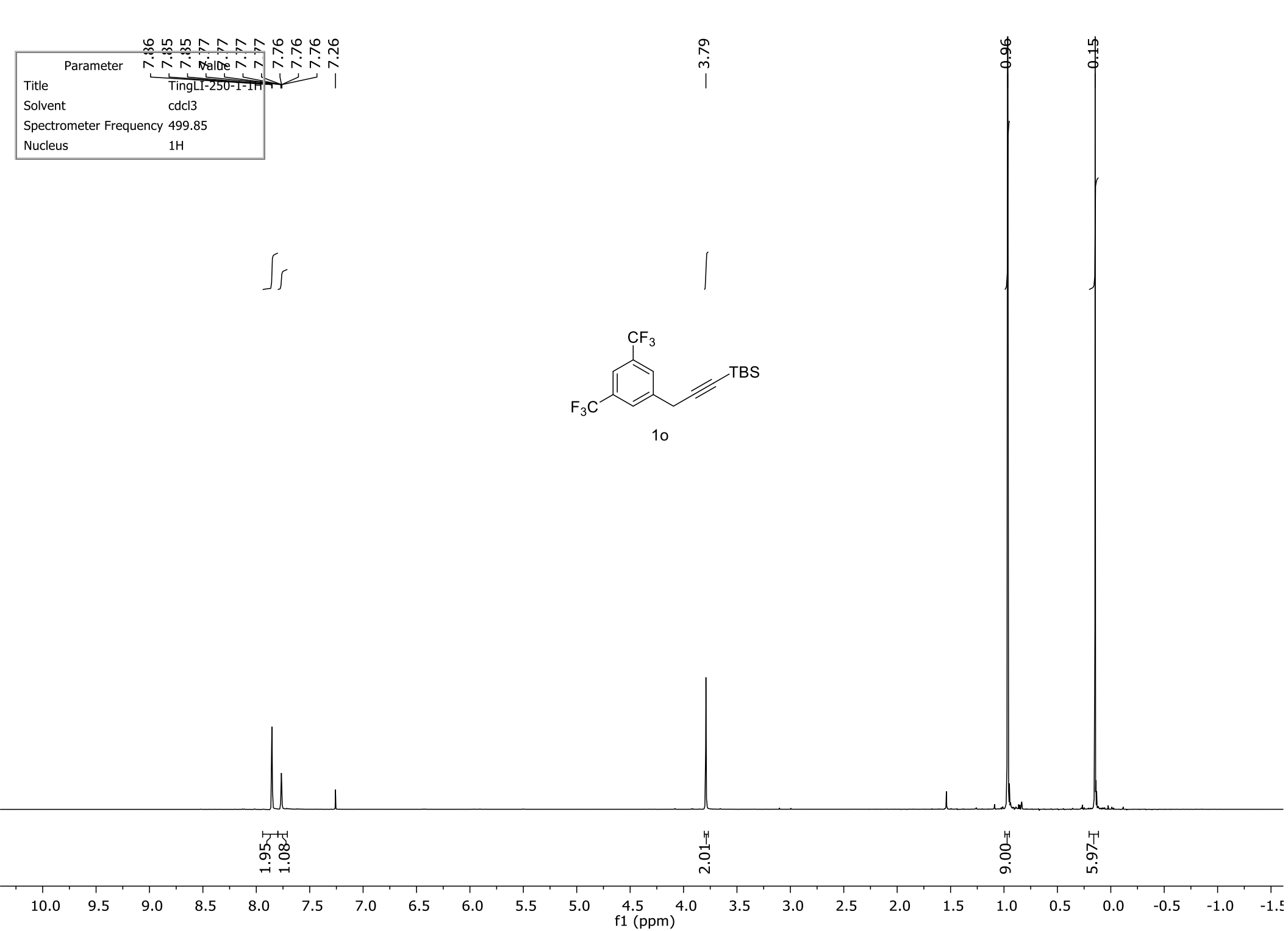
-63.72

-118.64

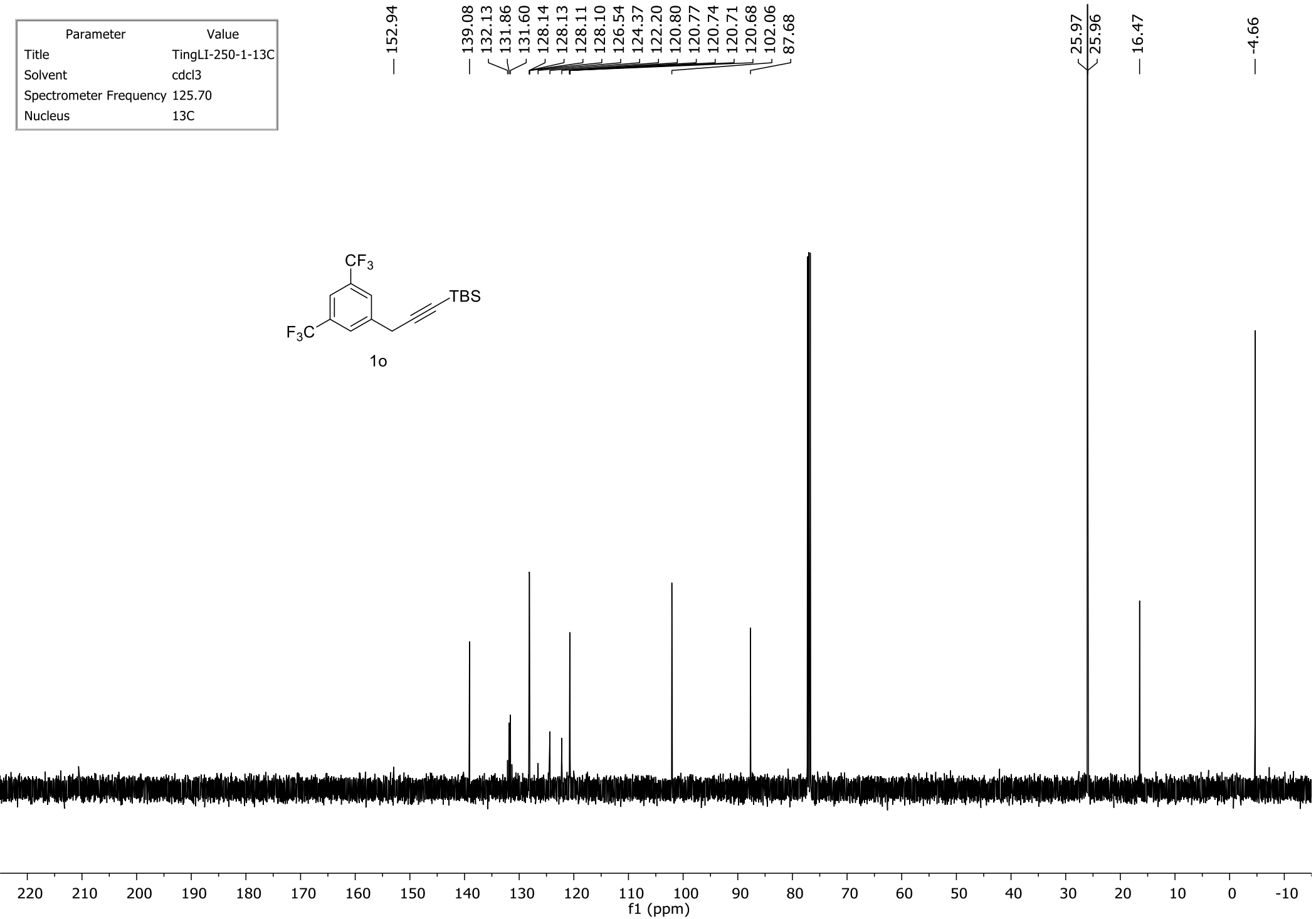


1n




Parameter Value
Title TingLI-250-1-1H
Solvent cdcl3
Spectrometer Frequency 499.85
Nucleus 1H
7.86
7.85
7.85
7.77
7.77
7.77
7.77
7.76
7.76
7.76
7.26
3.79
0.96
0.15
CF3
F3C
TBS
1o
1.95
1.08
2.01
9.00
5.97
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
-1.0
f1 (ppm)

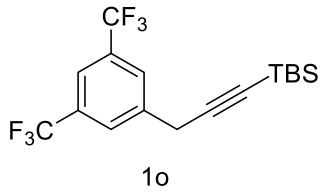
Parameter	Value
Title	TingLI-250-1-13C
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C



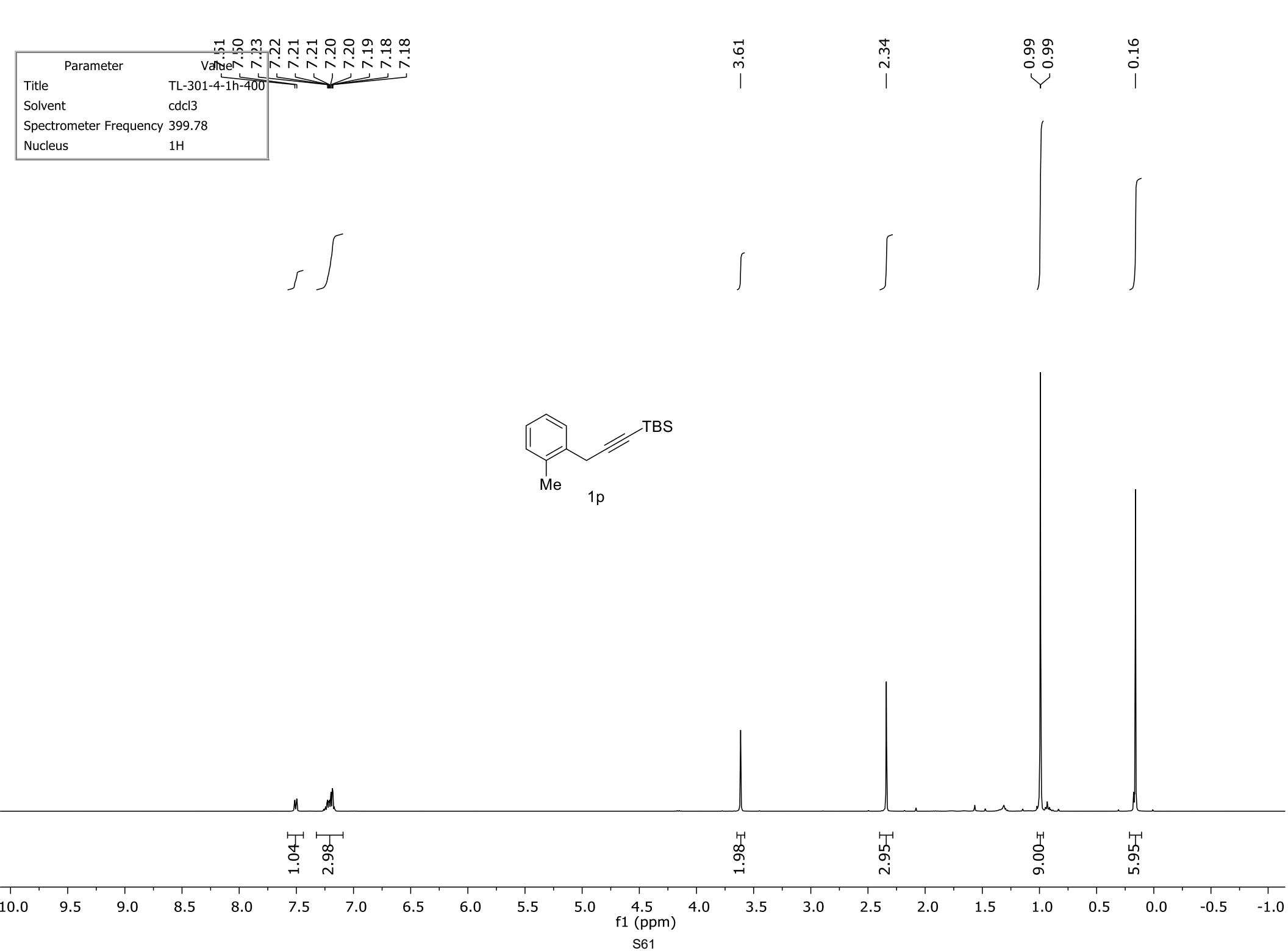
Parameters	
Parameter	Value
Title	LT-2-300-6-19F
Spectrometer Frequency	376.11

-63.03

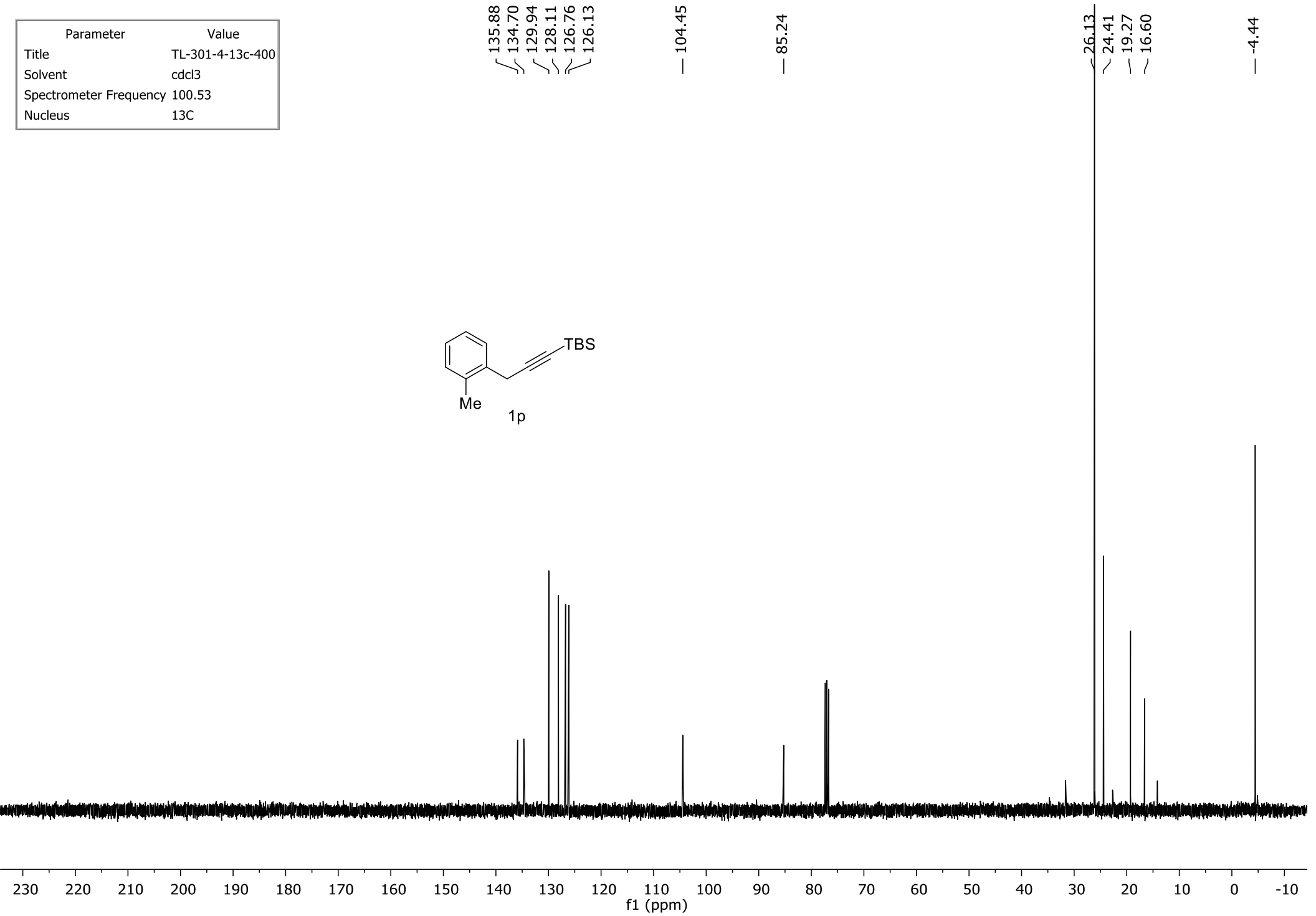
-113.15

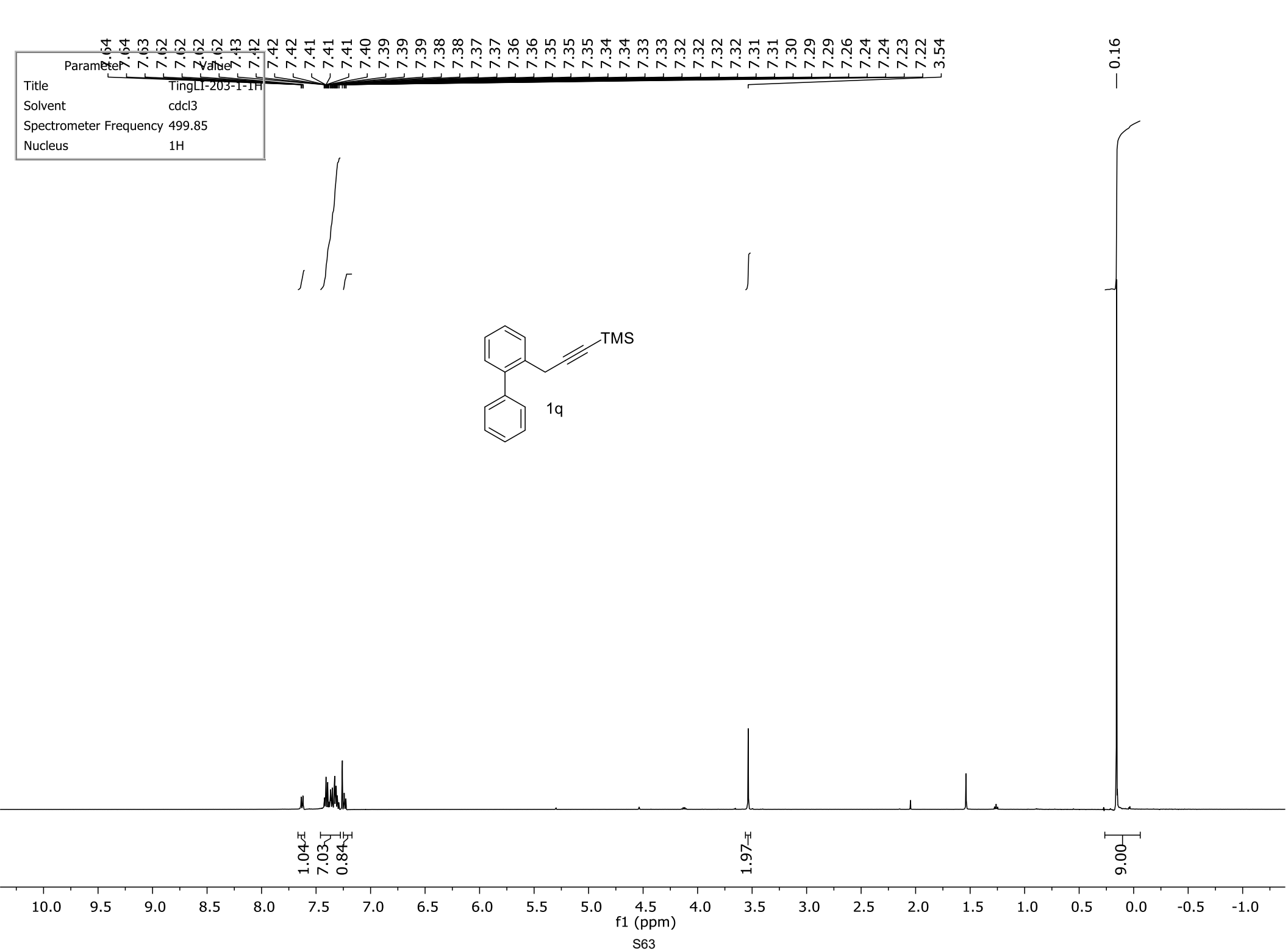


1o


Parameter Value
Title TL-301-4-1h-400
Solvent cdcl3
Spectrometer Frequency 399.78
Nucleus 1H
7.51 7.50 7.23 7.22 7.21 7.21 7.20 7.20 7.19 7.18 7.18
3.61
2.34
0.99 0.99
0.16
TBS
Me
1p
1.04 2.98 1.98 2.95 9.00 5.95
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 -1.0
f1 (ppm)

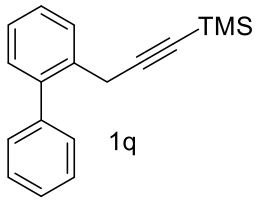
Parameter	Value
Title	TL-301-4-13c-400
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C



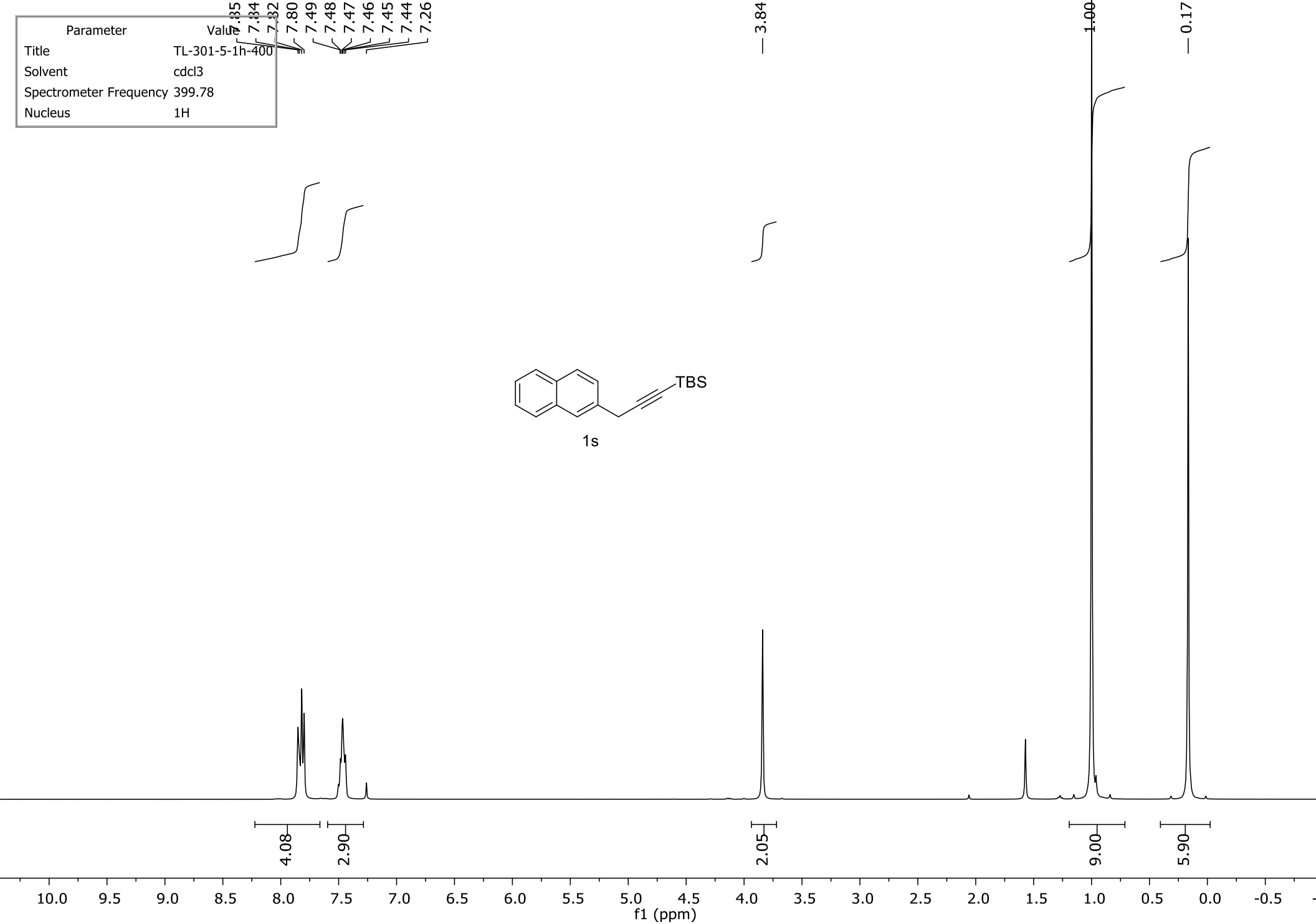

Parameter Value
Title TingLI-203-1-1H
Solvent cdcl3
Spectrometer Frequency 499.85
Nucleus 1H
TMS
1q
1.04
7.03
0.84
1.97
9.00
f1 (ppm)

Parameter	Value
Title	TingLI-203-1-13C
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C

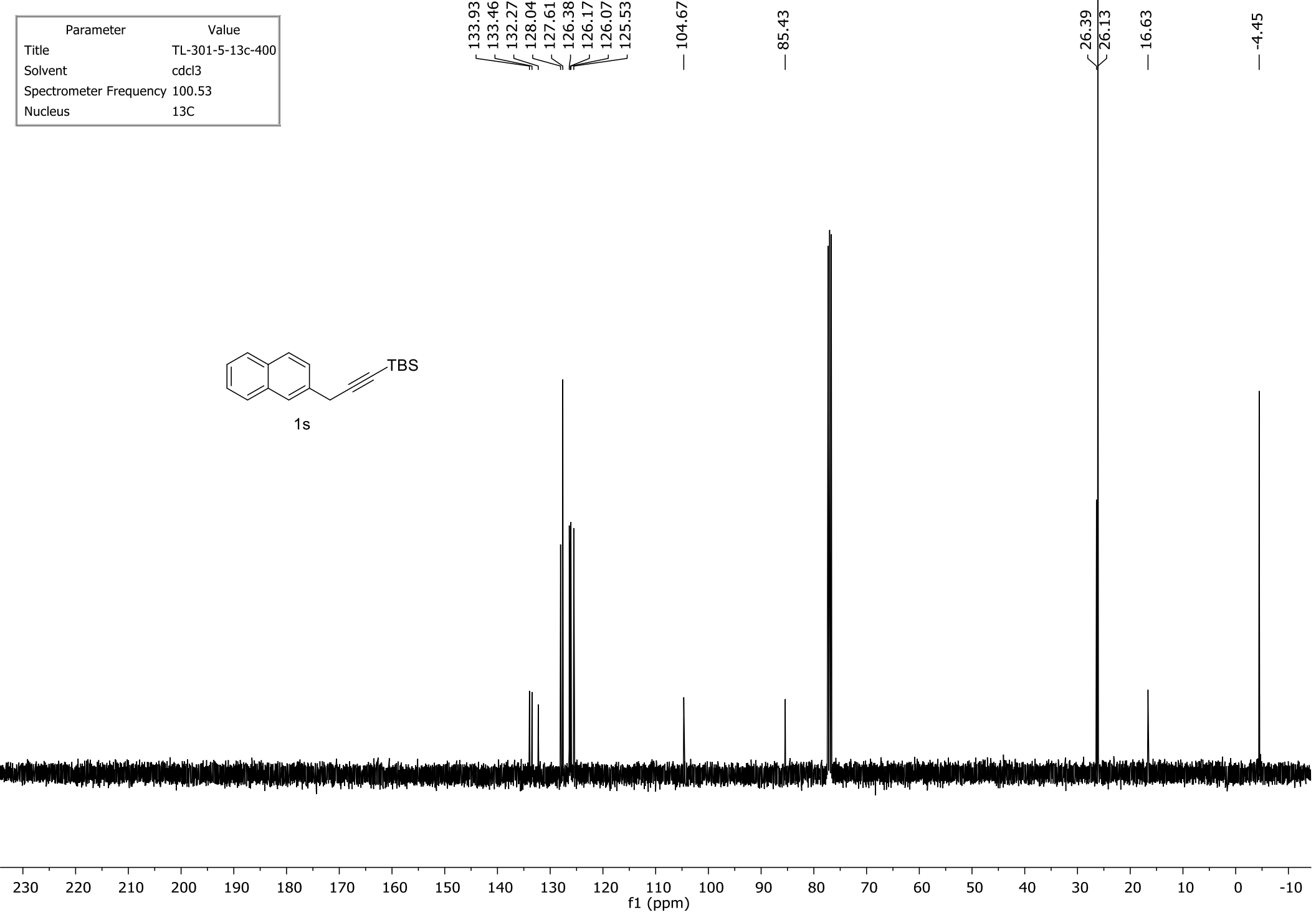
141.44
140.96
133.94
129.86
129.14
128.85
128.19
127.67
127.10
126.69
104.95
86.73
24.63
0.07

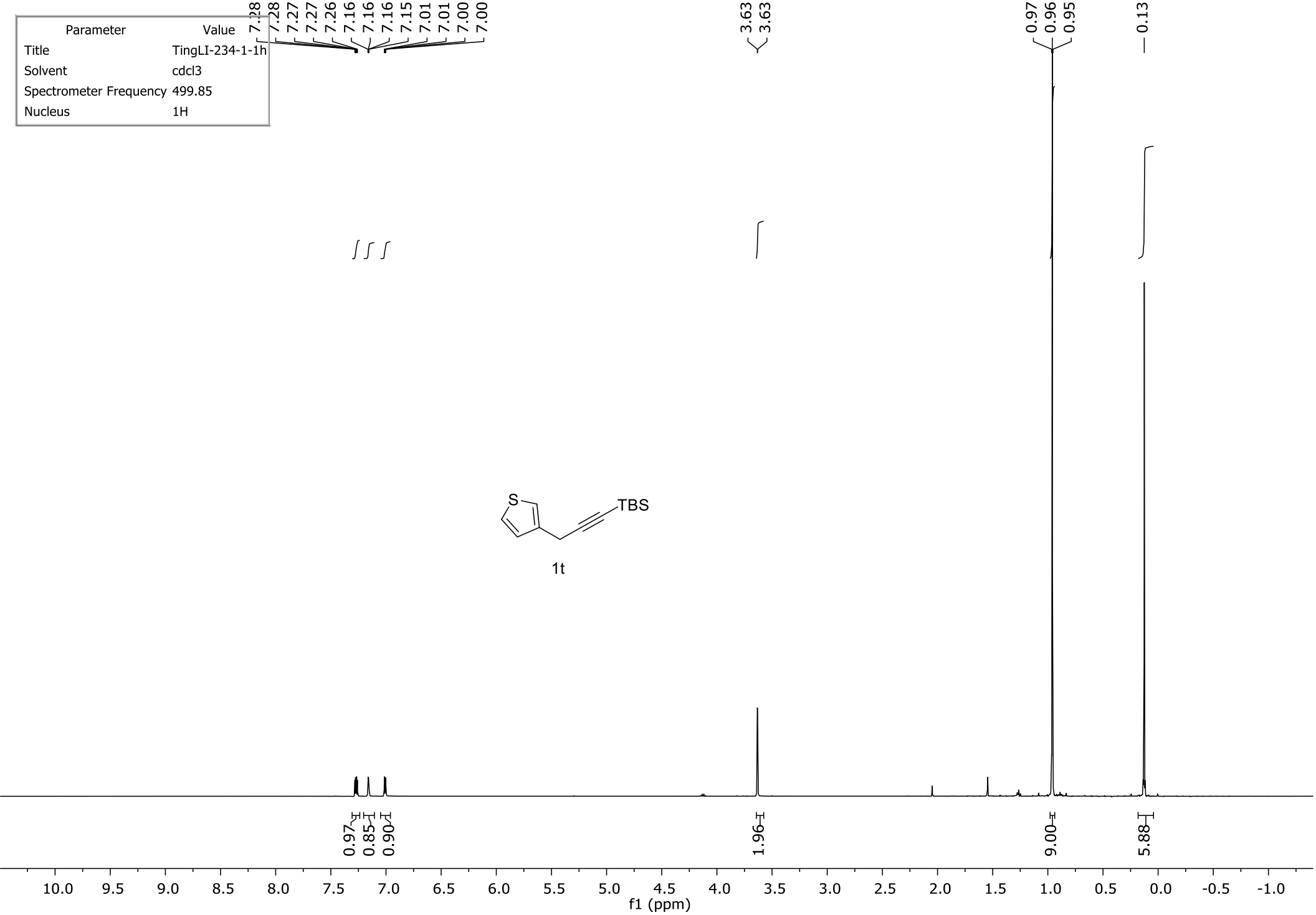


1q


Parameter Value
Title TL-301-5-1h-400
Solvent cdcl3
Spectrometer Frequency 399.78
Nucleus 1H
7.85
7.84
7.82
7.80
7.49
7.48
7.47
7.46
7.45
7.44
7.26
3.84
1.00
0.17
TBS
1s
4.08
2.90
2.05
9.00
5.90
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)

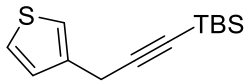
Parameter	Value
Title	TL-301-5-13c-400
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C



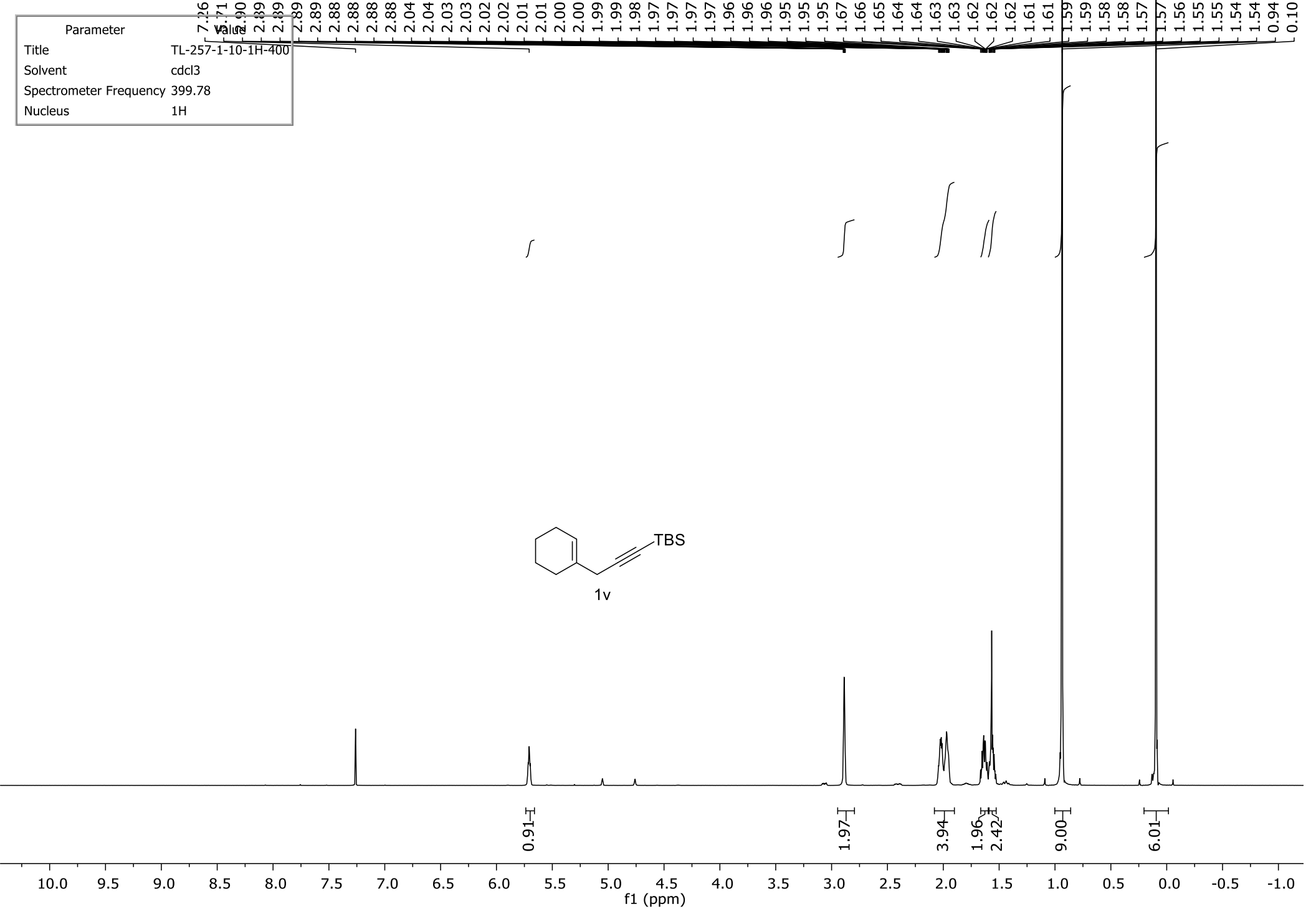

Parameter Value
Title TingLI-234-1-1h
Solvent cdcl3
Spectrometer Frequency 499.85
Nucleus 1H
7.28
7.28
7.27
7.27
7.26
7.16
7.16
7.16
7.15
7.01
7.01
7.00
7.00
3.63
3.63
0.97
0.96
0.95
0.13
S
TBS
1t
0.97
0.85
0.90
1.96
9.00
5.88
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

Parameter	Value
Title	TingLI-234-1-13c
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C

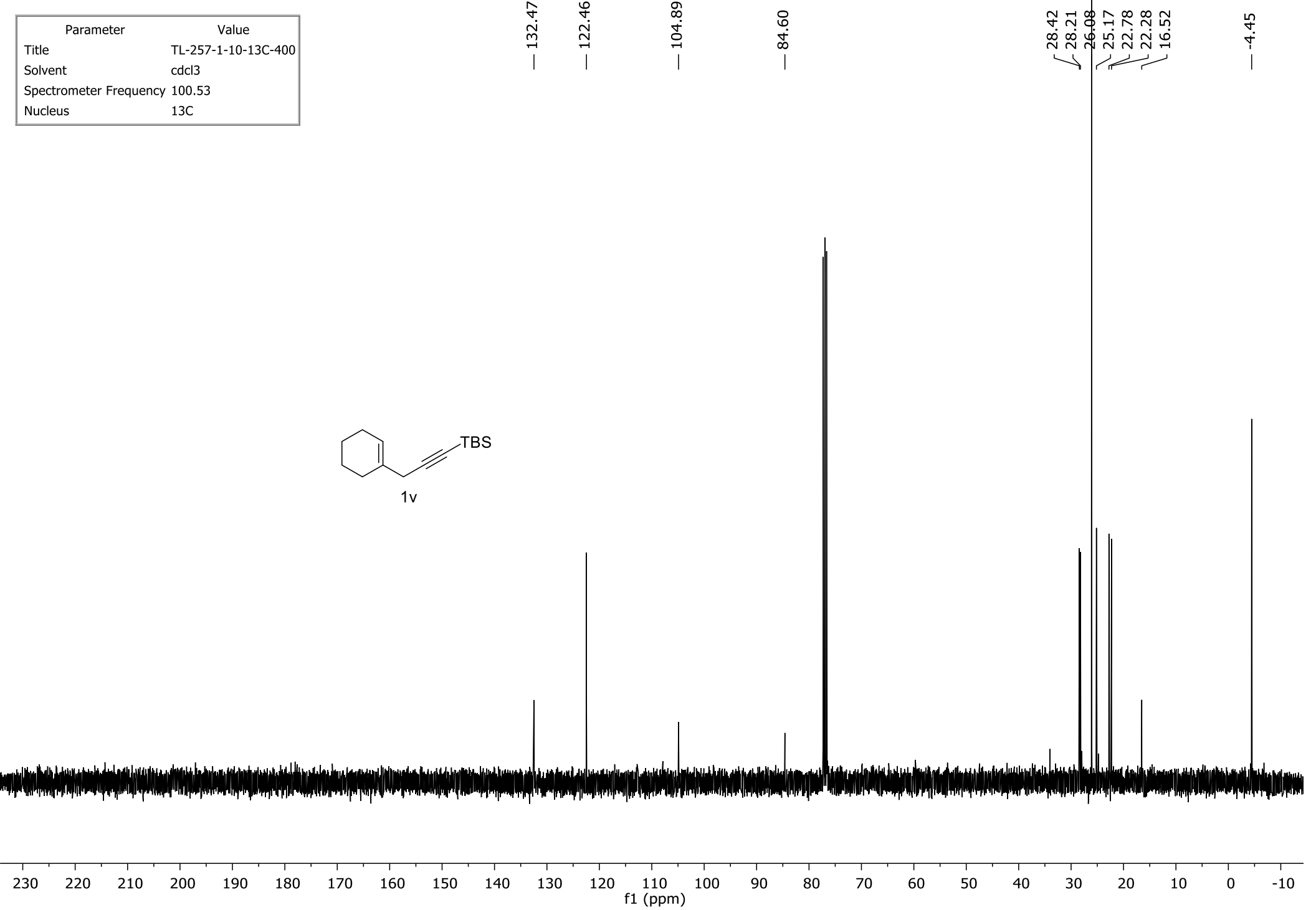
136.78
127.55
125.78
121.16
104.51
84.46
26.12
21.41
16.56
-4.47

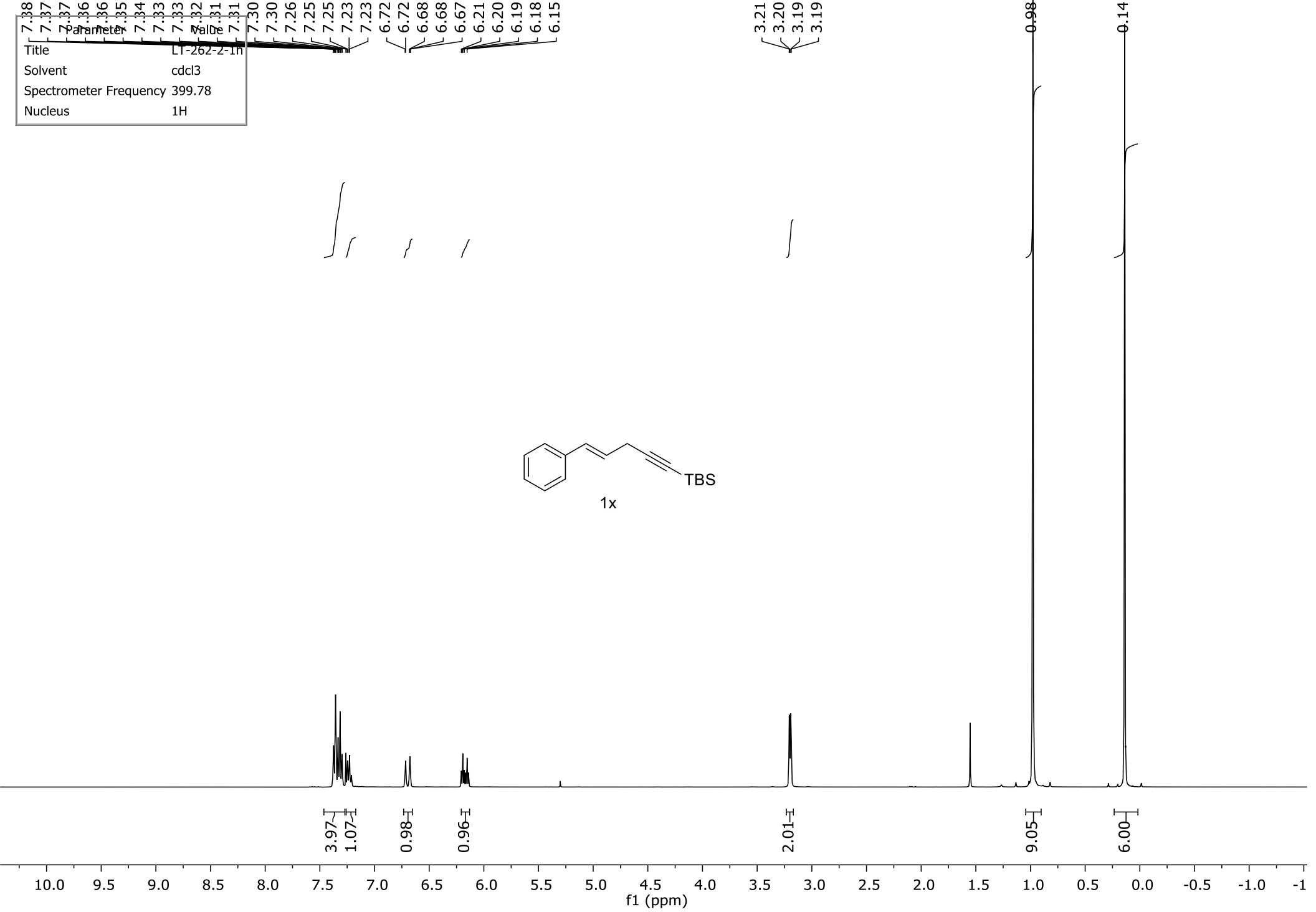


1t


Parameter Value
Title TL-257-1-10-1H-400
Solvent cdcl3
Spectrometer Frequency 399.78
Nucleus 1H
TBS
1v
0.91
1.97
3.94
1.96
2.42
9.00
6.01
f1 (ppm)

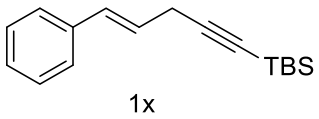
Parameter	Value
Title	TL-257-1-10-13C-400
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C



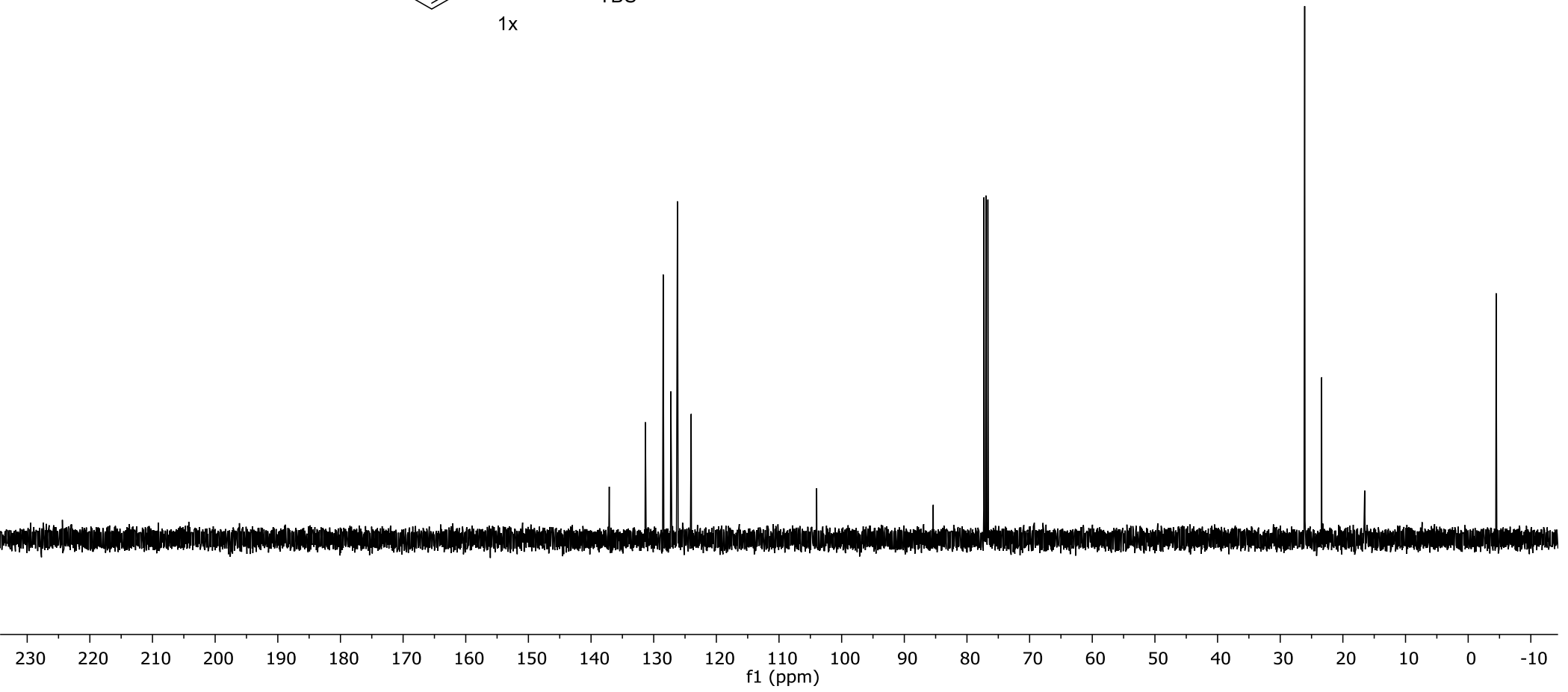

Parameter Value
Title LT-262-2-1h
Solvent cdcl3
Spectrometer Frequency 399.78
Nucleus 1H
7.38 7.37 7.37 7.36 7.36 7.35 7.34 7.33 7.33 7.32 7.31 7.31 7.30 7.30 7.26 7.25 7.25 7.23 7.23
6.72 6.72 6.68 6.68 6.67 6.21 6.20 6.19 6.18 6.15
3.21 3.20 3.19 3.19
0.98
0.14
TBS
1x
3.97 1.07 0.98 0.96 2.01 9.05 6.00
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 -1.0 -1
f1 (ppm)

Parameter	Value
Title	LT-262-2-13c
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C

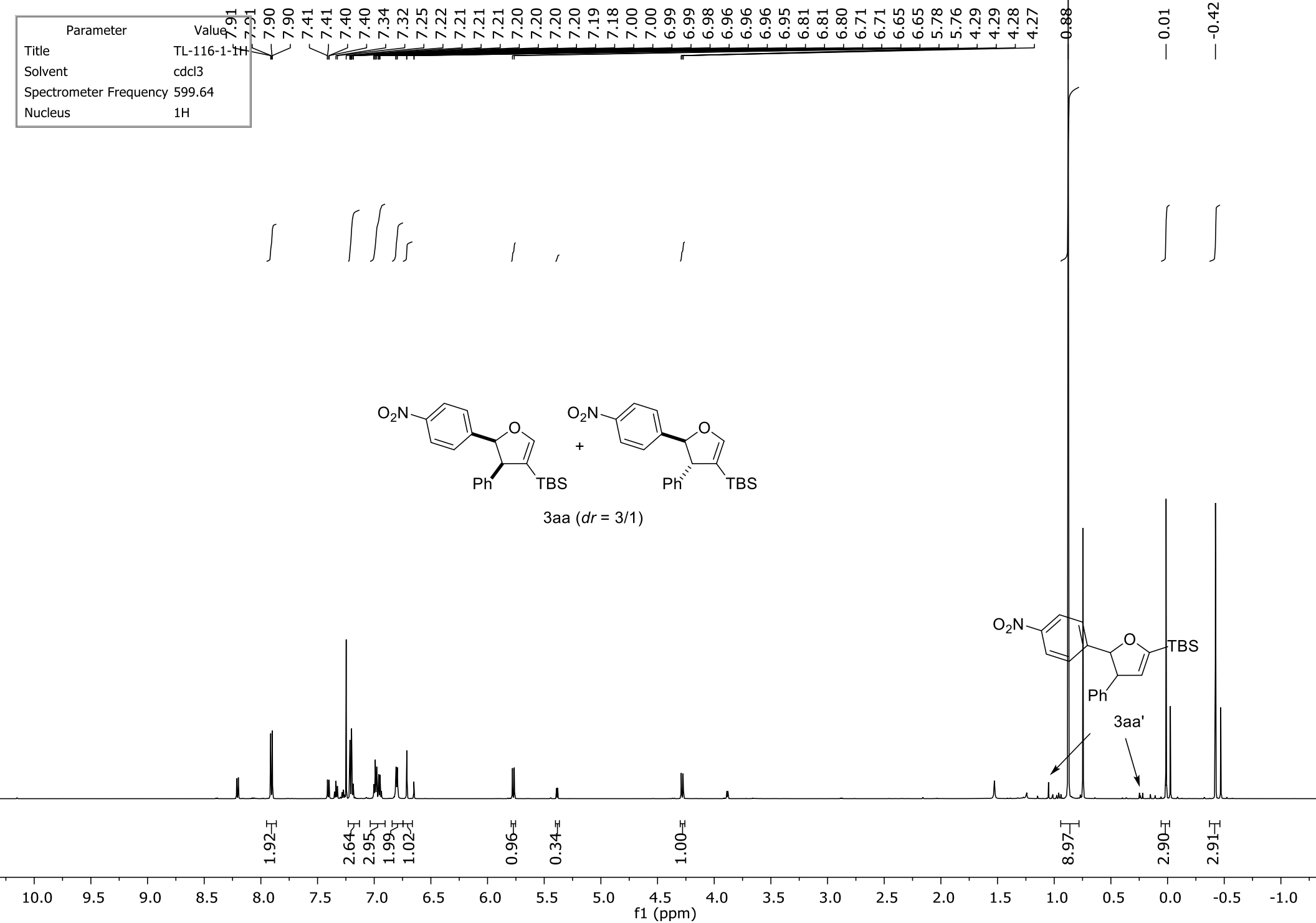
137.10
131.33
128.49
127.27
126.21
124.02
103.99
85.38
26.10
23.39
16.52
-4.46



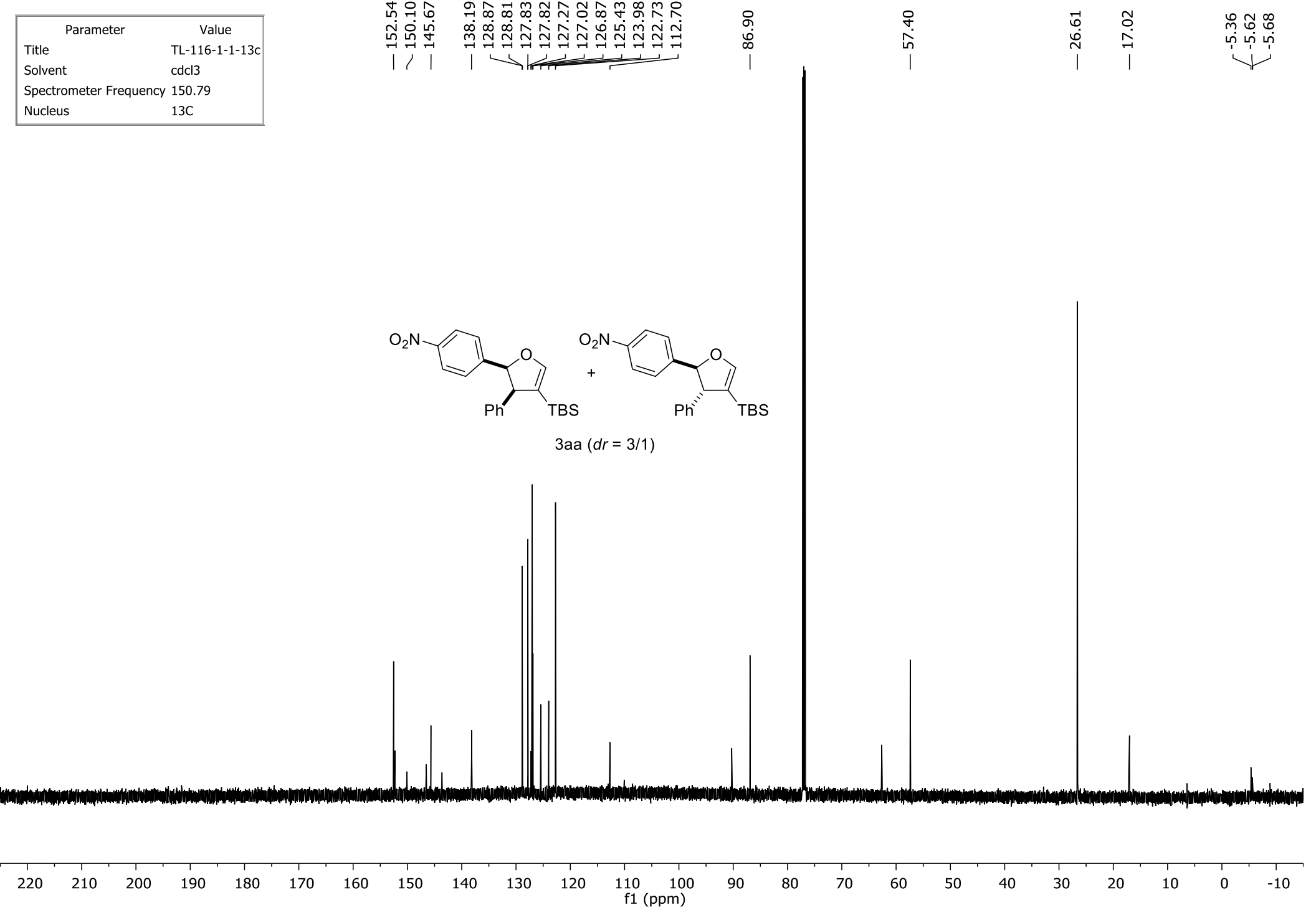
1x



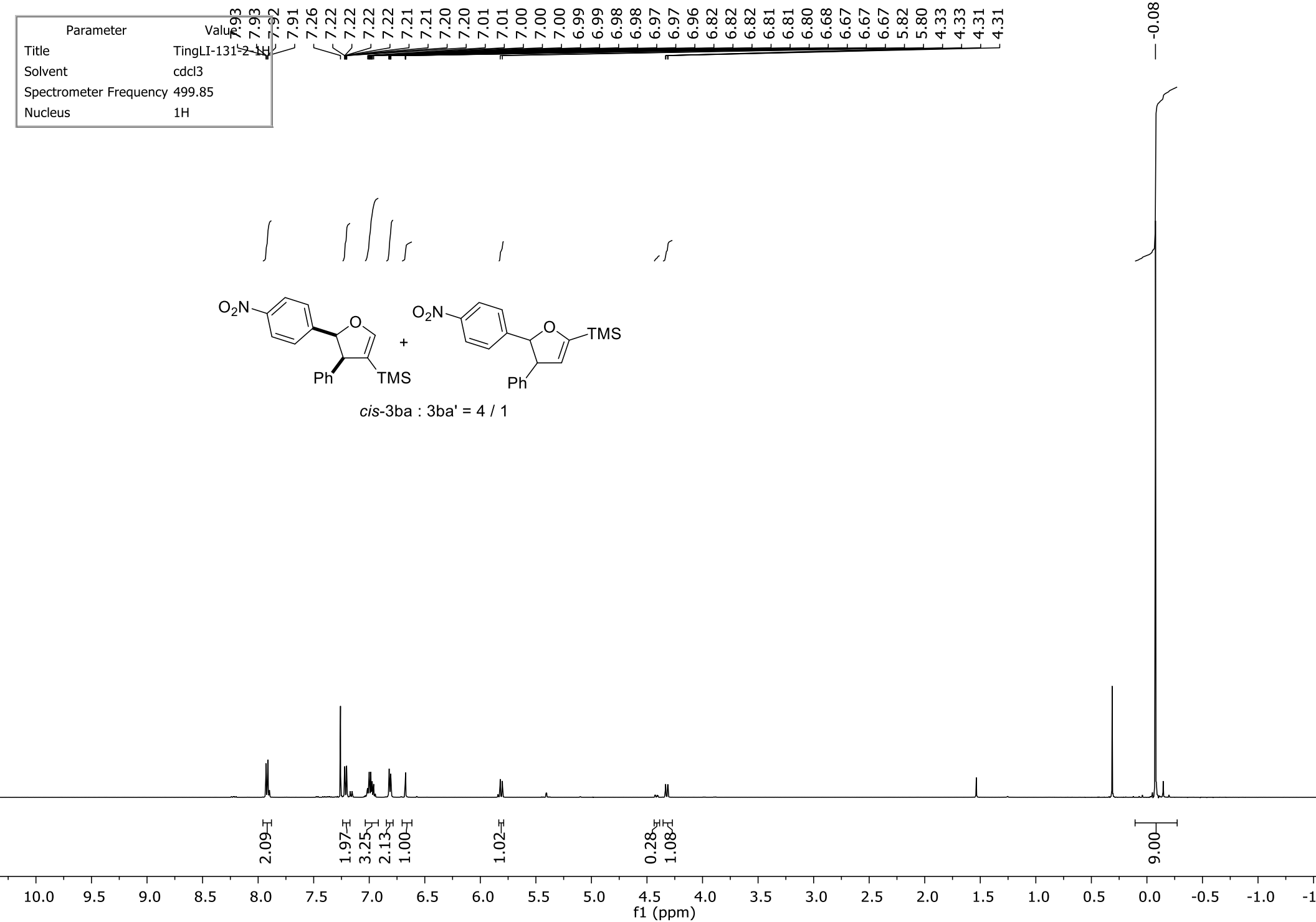
Parameter	Value
Title	TL-116-1-1H
Solvent	cdcl3
Spectrometer Frequency	599.64
Nucleus	1H



Parameter	Value
Title	TL-116-1-1-13c
Solvent	cdcl3
Spectrometer Frequency	150.79
Nucleus	13C



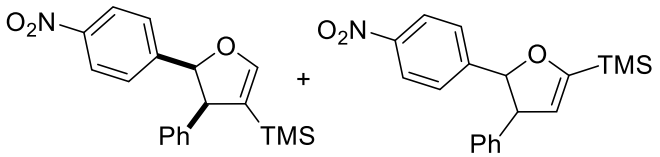
Parameter	Value
Title	TingLI-131-2-1H
Solvent	cdcl3
Spectrometer Frequency	499.85
Nucleus	1H



cis-3ba : 3ba' = 4 / 1

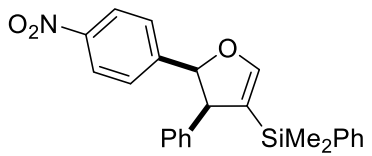
Parameter	Value
Title	TingLI-130-1-13c
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C

151.40
146.46
145.90
138.28
128.93
128.66
127.95
127.82
127.27
127.04
126.89
126.85
122.76
122.67
114.90
86.88
56.62
-0.98

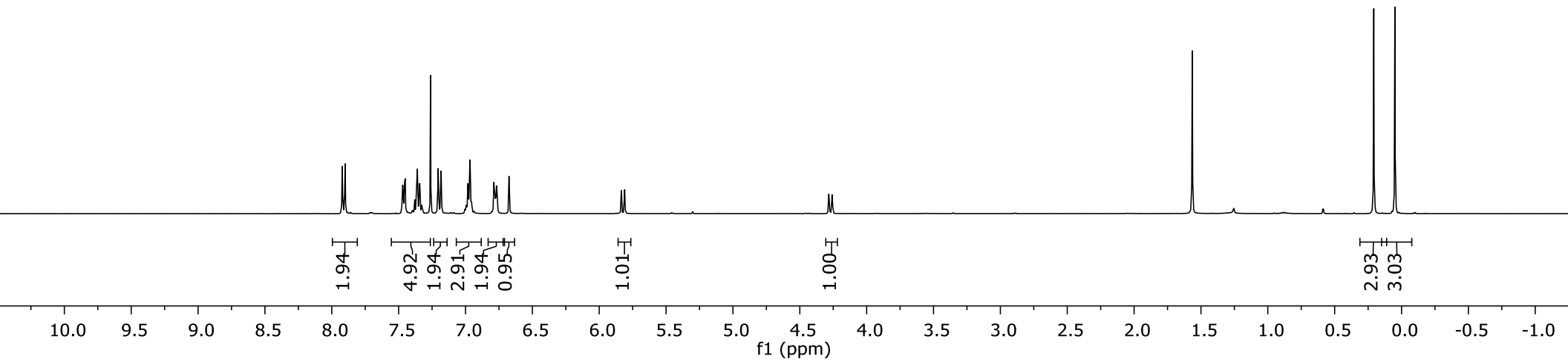


cis-3ba : 3ba' = 4 / 1

Parameter	Value
Title	lt-132-12-12-1h
Solvent	cdcl3
Spectrometer Frequency	399.78
Nucleus	1H

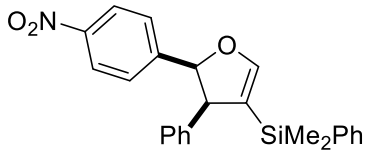


cis-3ca

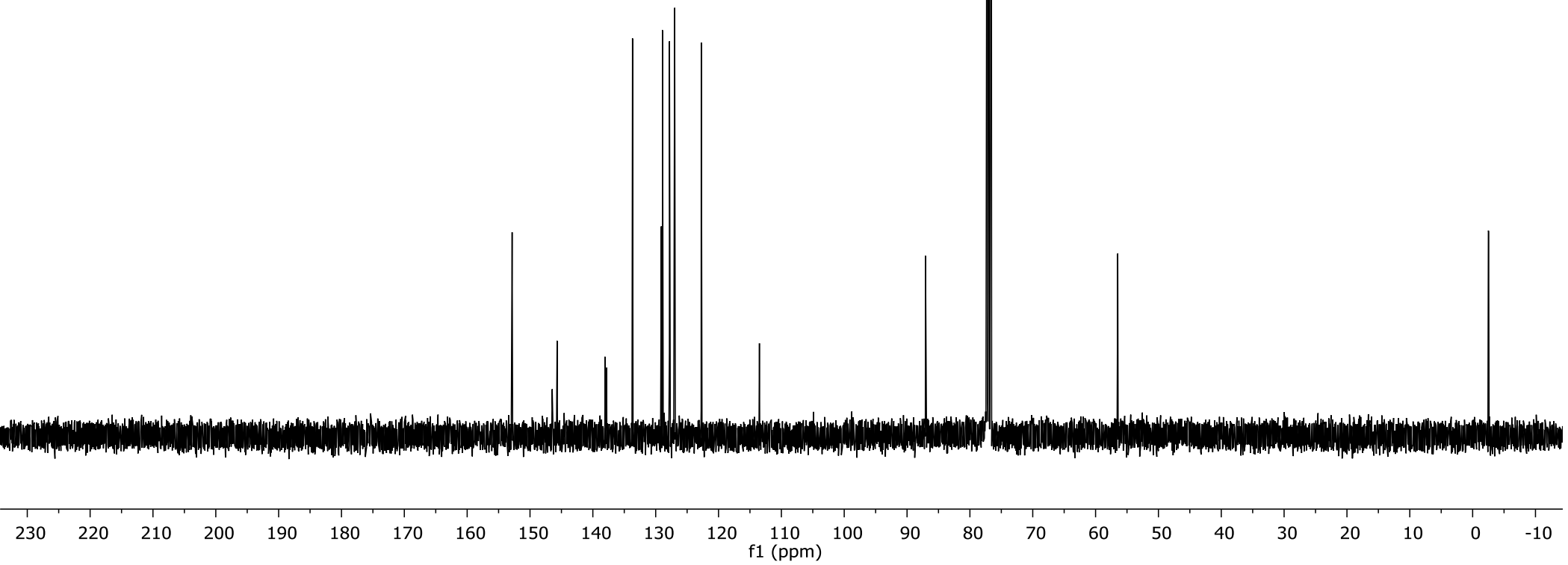


Parameter	Value
Title	lt-132-12-12-13c
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C

152.84
146.47
145.68
138.07
137.80
133.69
129.10
128.92
127.81
127.77
126.98
126.90
122.75
113.50
87.06
56.47
-2.50
-2.55



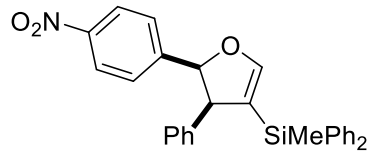
cis-3ca



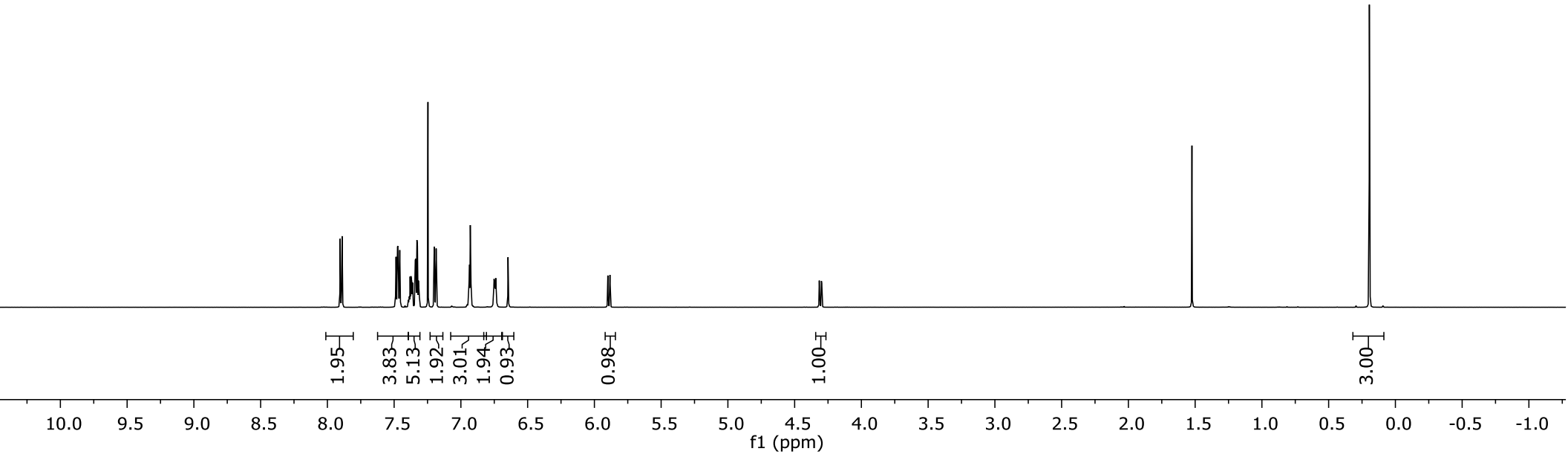
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10

f1 (ppm)

Parameter	Value
Title	TL-217-8-8-1H
Solvent	cdcl3
Spectrometer Frequency	599.64
Nucleus	1H

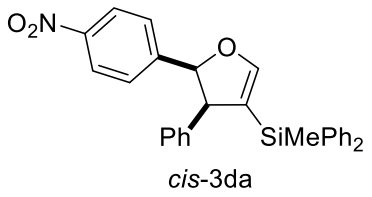


cis-3da

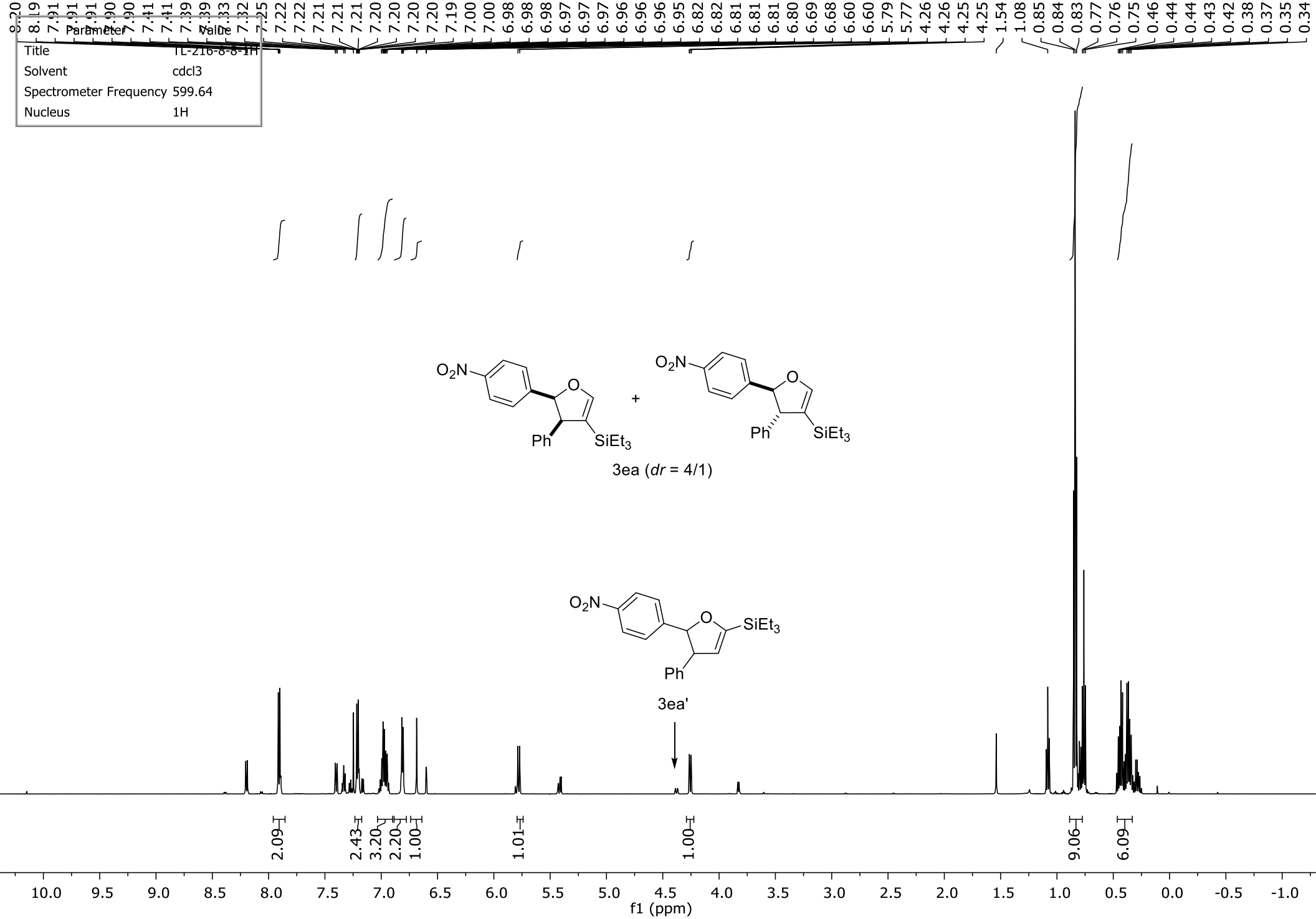


Parameter	Value
Title	TingLI-219-9-13C
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C

155.06
146.60
145.47
137.93
135.83
135.62
134.74
129.41
129.38
128.96
127.84
127.83
127.82
127.03
126.94
122.77
111.97
87.48
56.56
-3.69

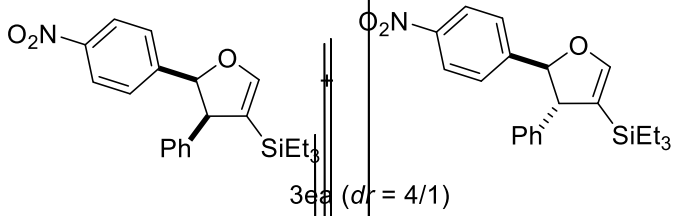


cis-3da


Parameter Value
Title TL-216-8-8-1H
Solvent cdcl3
Spectrometer Frequency 599.64
Nucleus 1H
3ea (dr = 4/1)
3ea'
2.09
2.43
3.20
2.20
1.00
1.01
1.00
9.06
6.09
f1 (ppm)

Parameter	Value
Title	TingLI-216-8-1-13c
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C

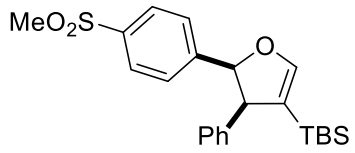
152.11
150.09
145.84
138.34
128.84
128.79
128.68
127.94
127.78
127.77
127.32
127.29
127.05
126.91
125.54
123.96
122.74
122.67
111.86
86.80
56.77
7.20
3.44



+

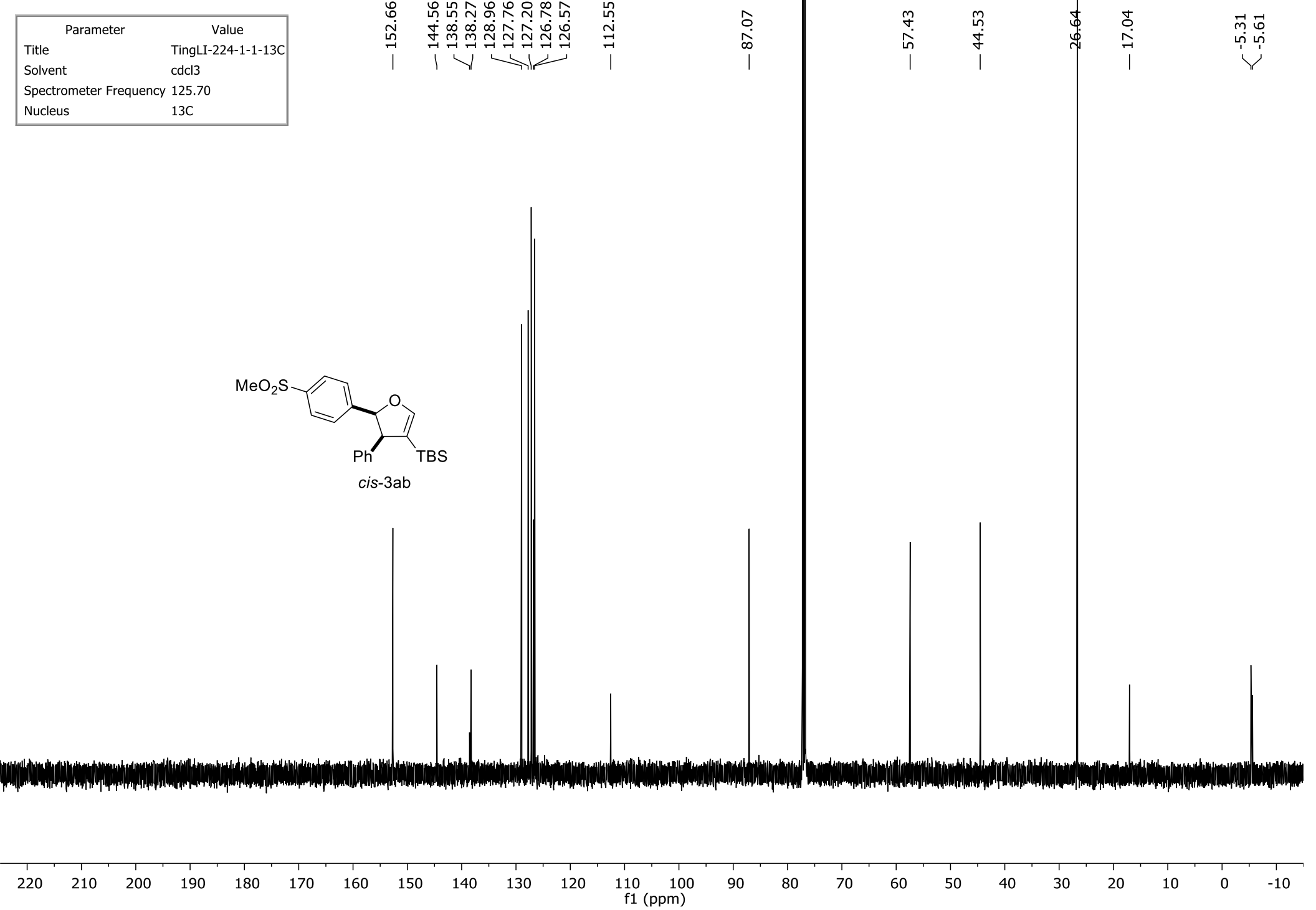
3ea (*dr* = 4/1)

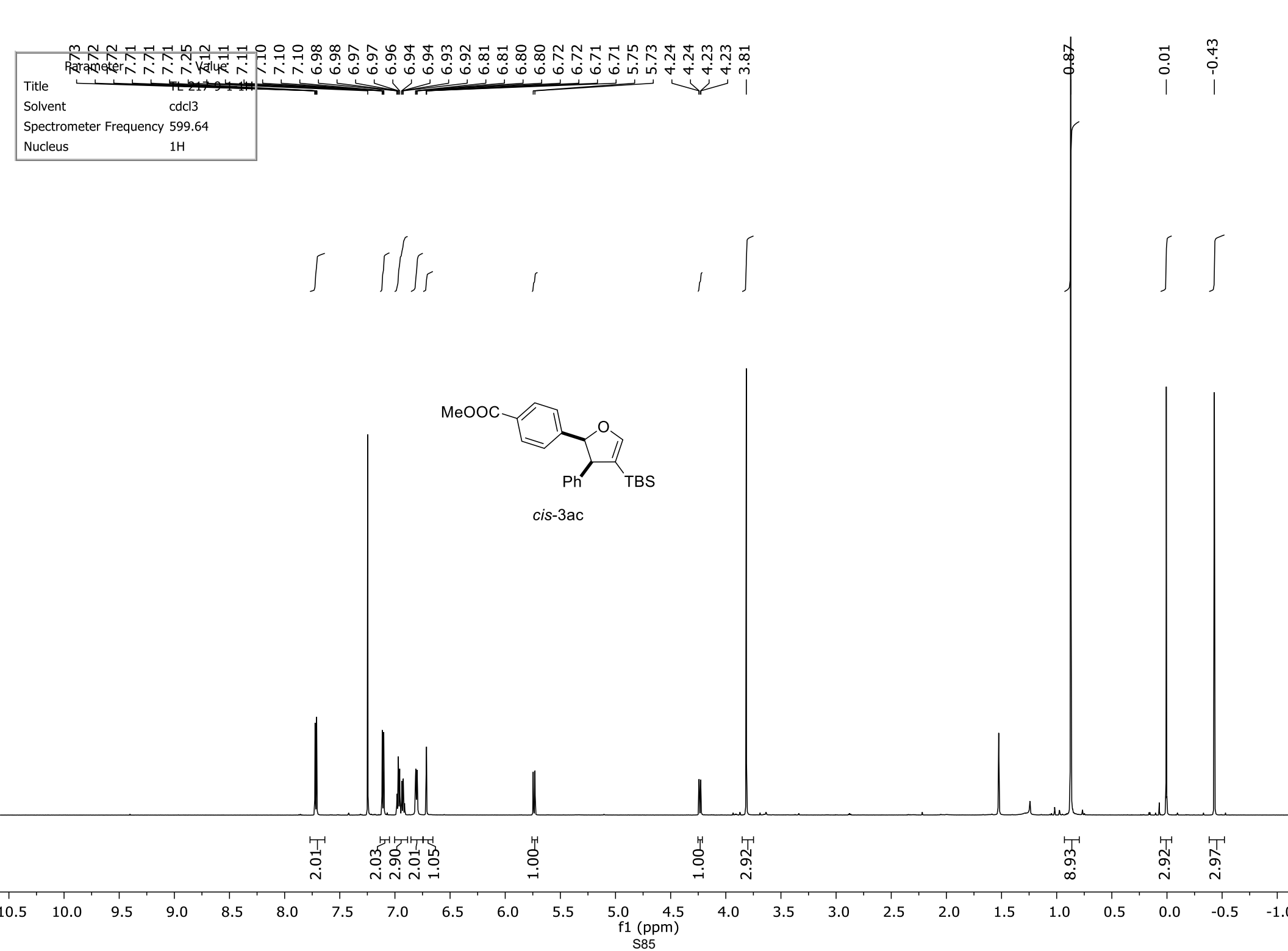
Parameter	Value
Title	TL-224-1-1-1H
Solvent	cdcl3
Spectrometer Frequency	599.64
Nucleus	1H



cis-3ab

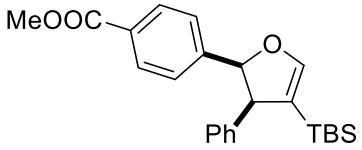
Parameter	Value
Title	TingLI-224-1-1-13C
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C



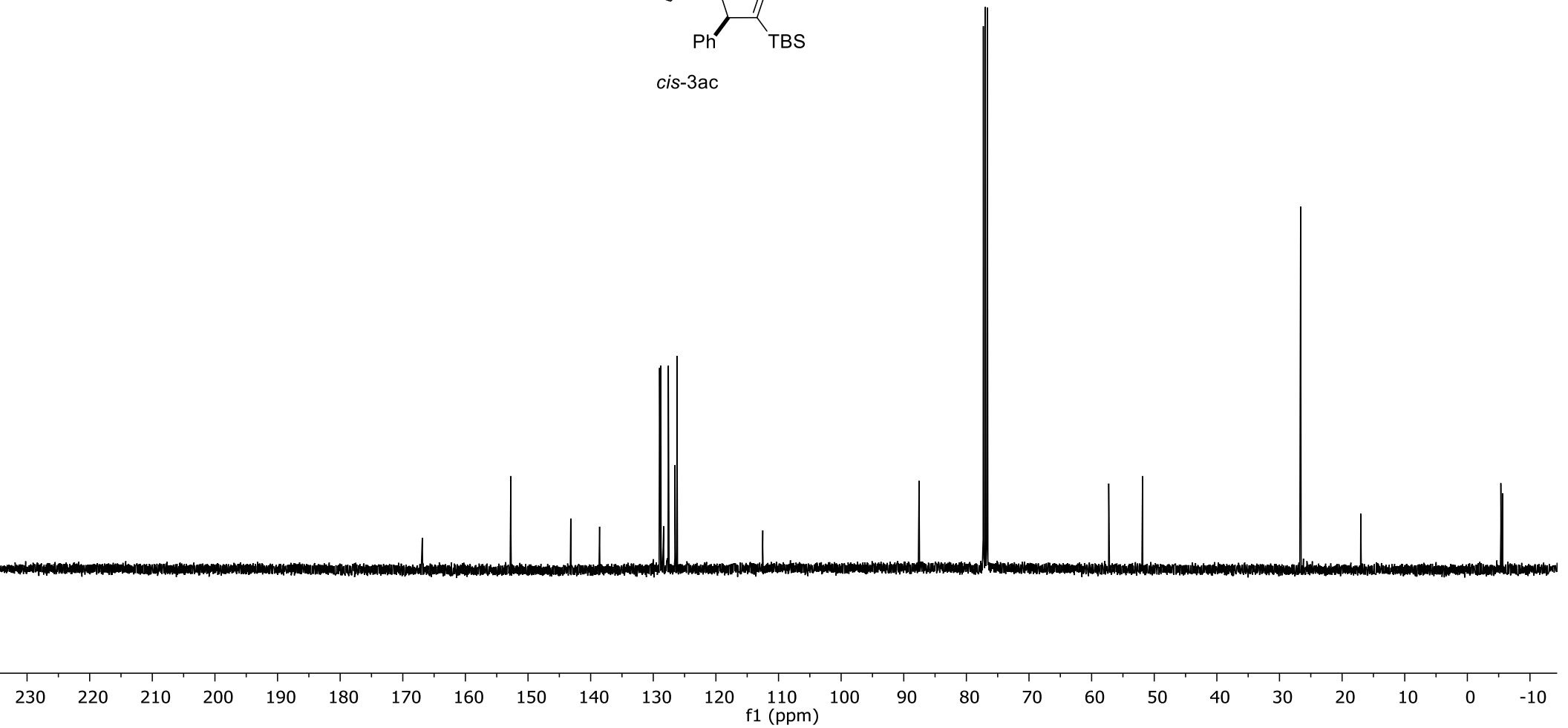

Parameter Value
Title
Solvent cdcl3
Spectrometer Frequency 599.64
Nucleus 1H
MeOOC
O
Ph
TBS
cis-3ac
f1 (ppm)

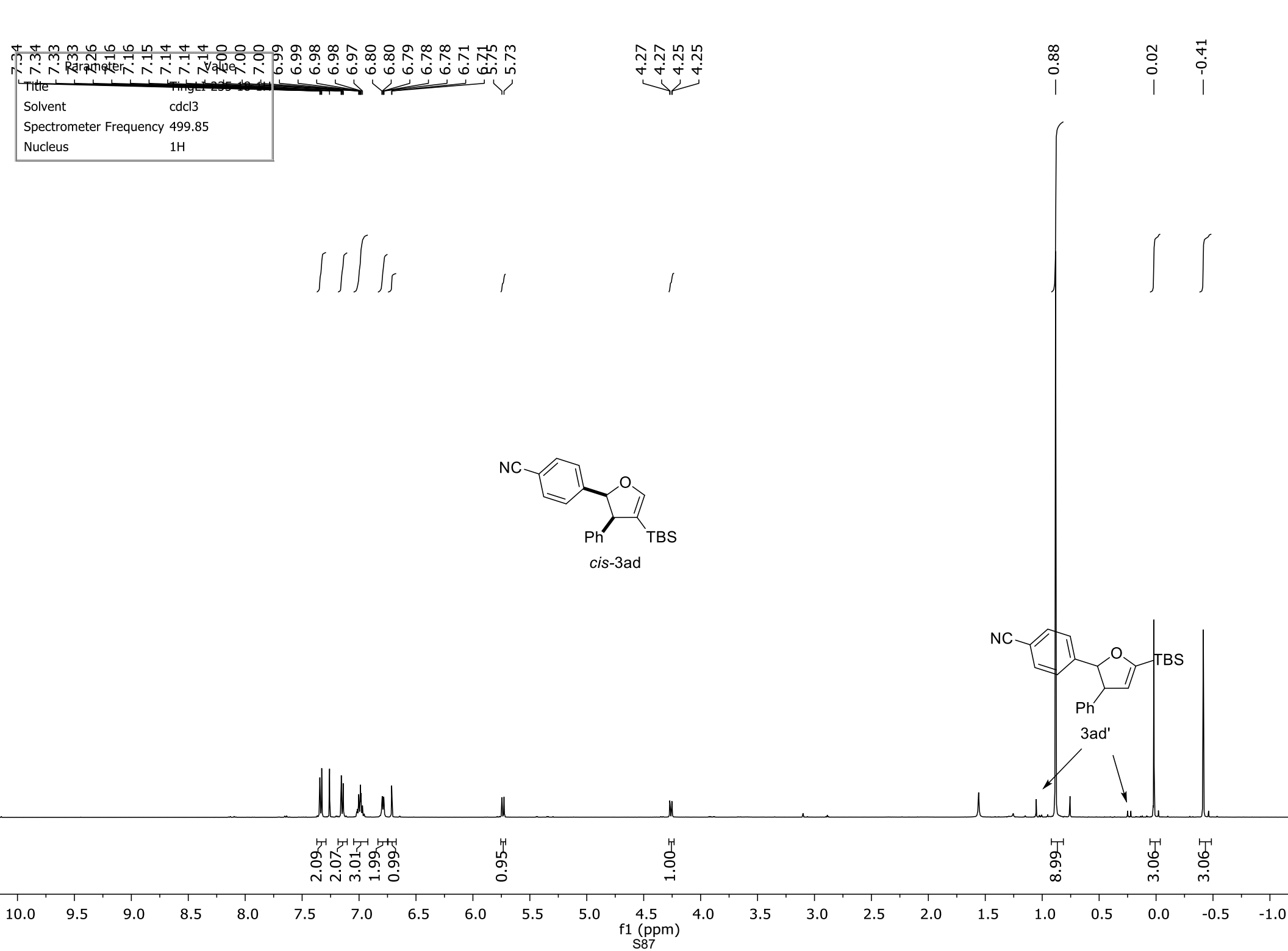
Parameter	Value
Title	TL-217-2-2-13c
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C

166.89
152.75
143.18
138.57
129.00
128.79
128.75
128.34
127.59
126.54
126.49
126.23
112.52
87.55
57.27
51.87
26.63
17.02
-5.35
-5.64



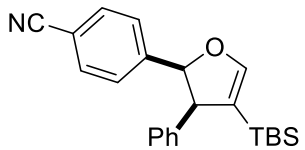
cis-3ac




Parameter Value
Title
Solvent cdcl3
Spectrometer Frequency 499.85
Nucleus 1H
7.34 7.34 7.33 7.33 7.26 7.16 7.16 7.15 7.14 7.14 7.14 7.00 7.00 7.00 6.99 6.99 6.98 6.98 6.97 6.80 6.80 6.79 6.78 6.78 6.71 5.75 5.73
4.27 4.27 4.25 4.25
0.88 0.02 -0.41
NC
O
Ph
TBS
cis-3ad
NC
O
TBS
Ph
3ad'
2.09 2.07 3.01 1.99 0.99 0.95 1.00 8.99 3.06 3.06
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 -1.0
f1 (ppm)

Parameter	Value
Title	TingLI-235-18-13c
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C

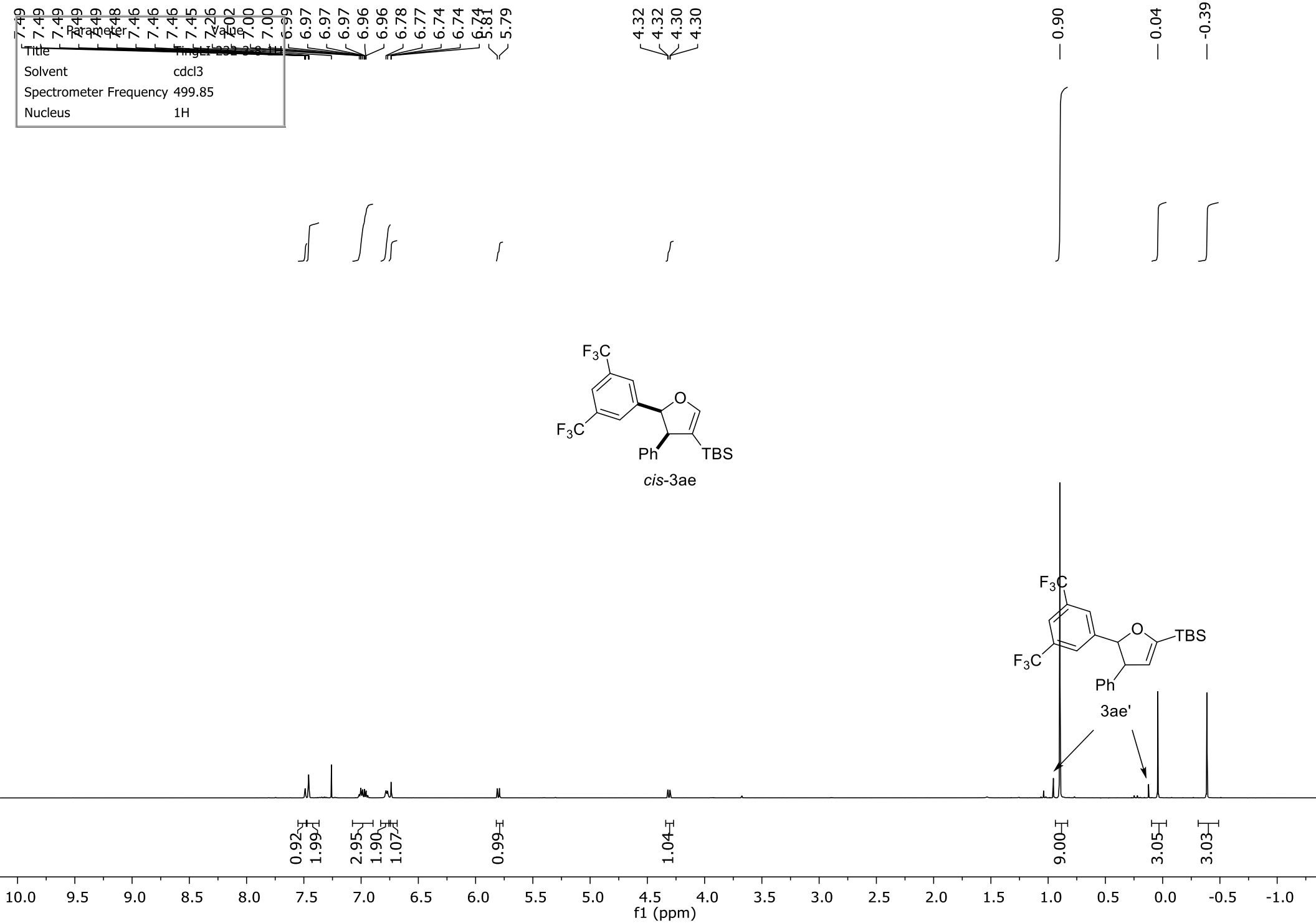
152.63
143.57
138.29
132.53
131.32
128.94
128.69
127.78
126.95
126.82
118.86
112.58
110.38
87.08
57.37
26.64
26.59
17.04
-5.32
-5.61



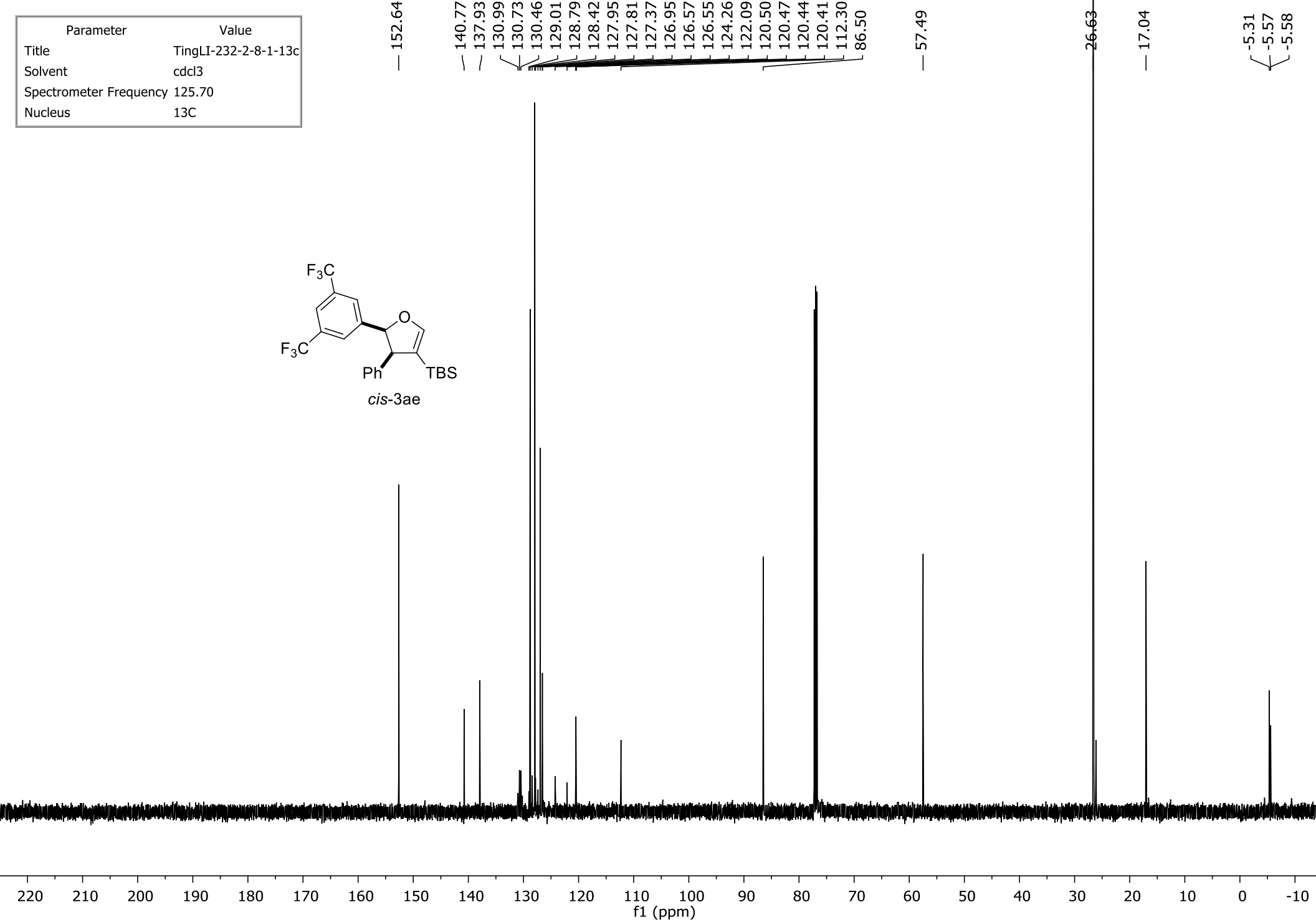
cis-3ad

220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10

f1 (ppm)


Parameter Value
Title
Solvent cdcl3
Spectrometer Frequency 499.85
Nucleus 1H
F3C
F3C
O
Ph
TBS
cis-3ae
F3C
F3C
O
TBS
Ph
3ae'
0.92
1.99
2.95
1.90
1.07
0.99
1.04
9.00
3.05
3.03
f1 (ppm)

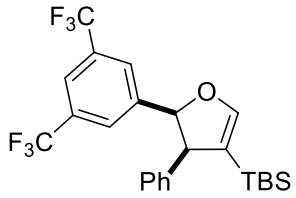
Parameter	Value
Title	TingLI-232-2-8-1-13c
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C



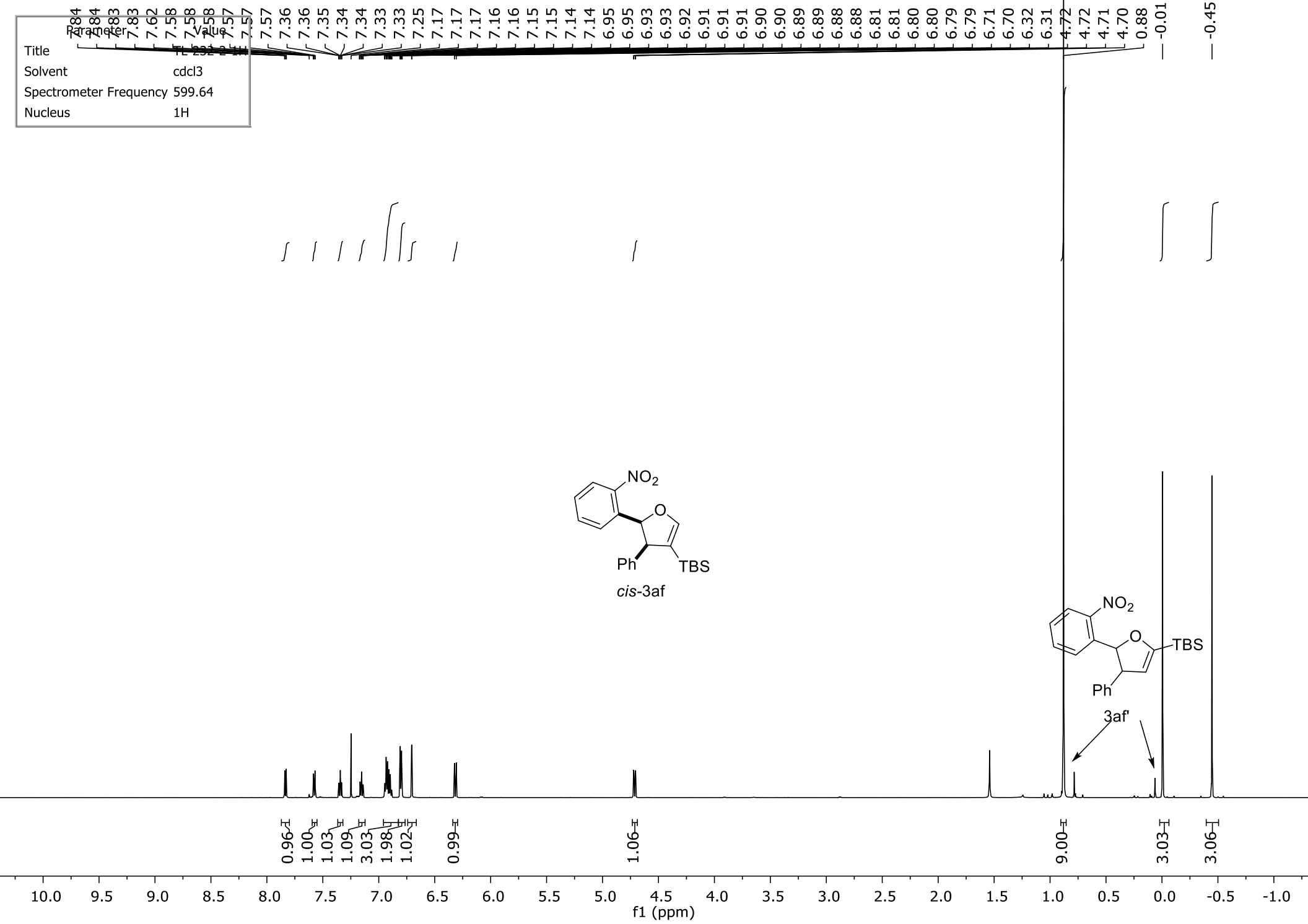
Parameters	
Parameter	Value
Title	LT-2-300-7-19F
Spectrometer Frequency	376.11

-63.00

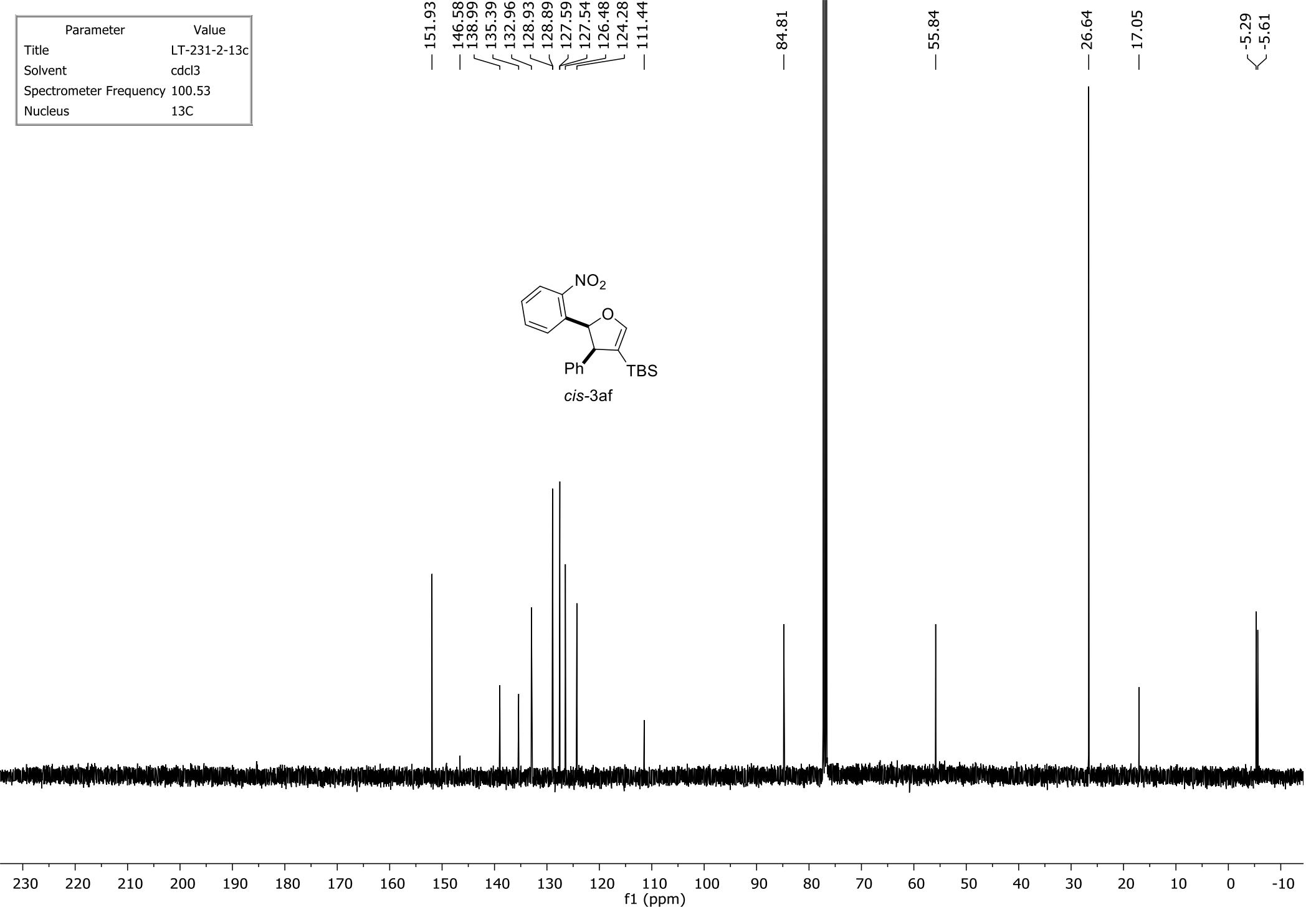
-113.15

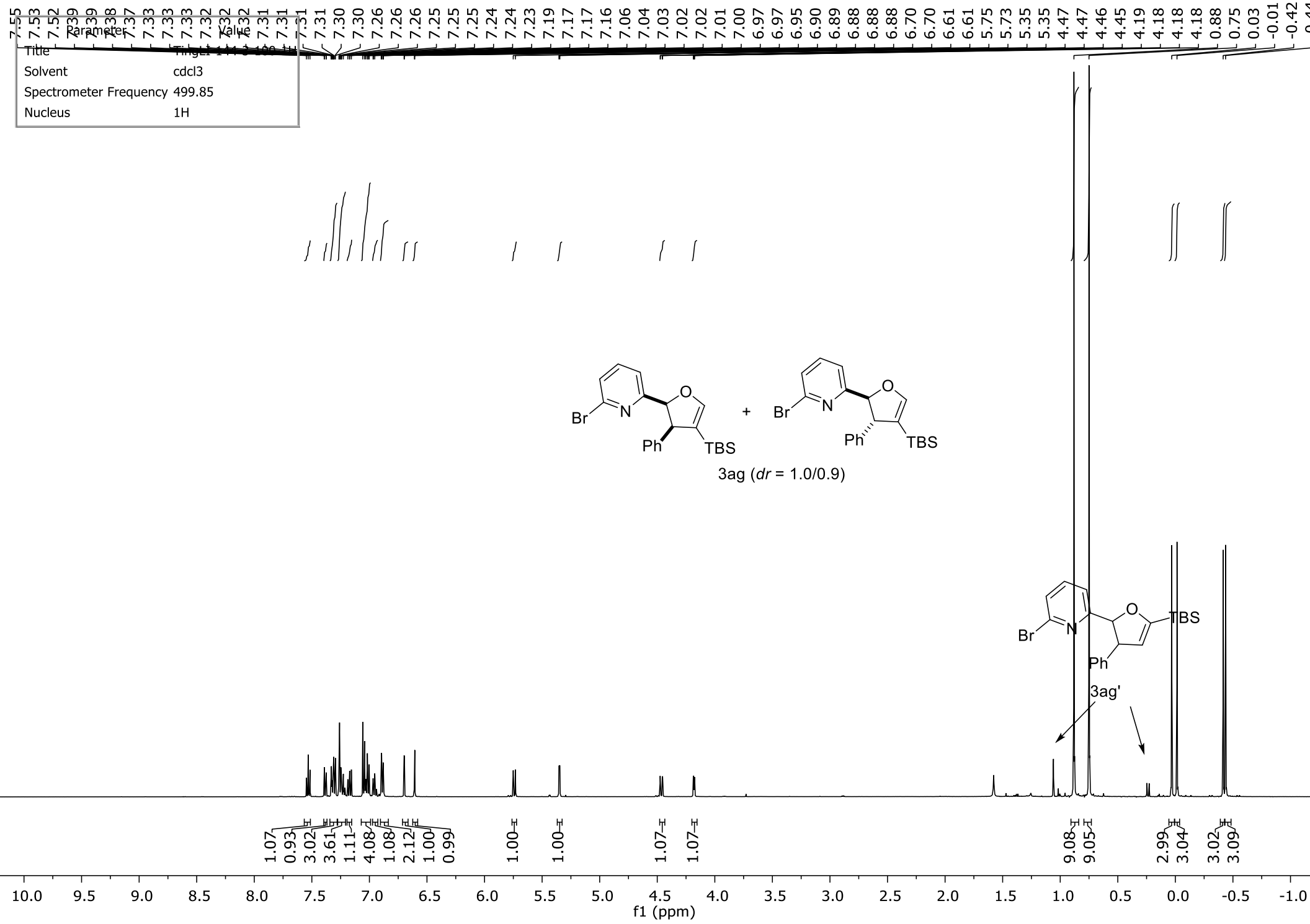


cis-3ae

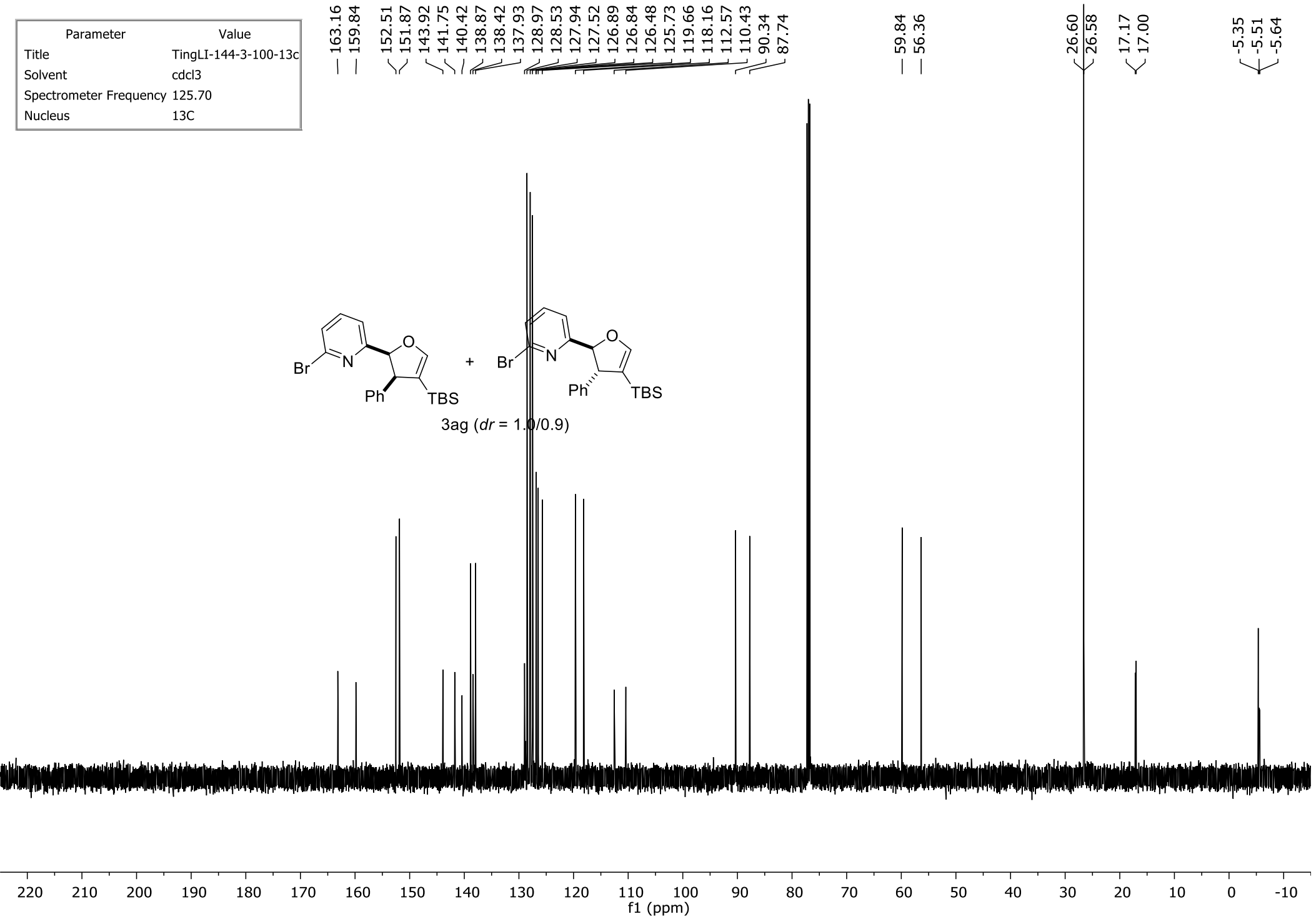

Parameter Value
Title TL-232-2-1H
Solvent cdcl3
Spectrometer Frequency 599.64
Nucleus 1H
NO2
O
Ph
TBS
cis-3af
NO2
O
TBS
Ph
3af'
0.96
1.00
1.03
1.09
3.03
1.98
1.02
0.99
1.06
9.00
3.03
3.06
f1 (ppm)

Parameter	Value
Title	LT-231-2-13c
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C

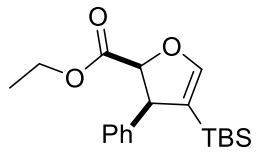



Parameter Value
Title
Solvent cdcl3
Spectrometer Frequency 499.85
Nucleus 1H
Br
N
O
Ph
TBS
+
3ag (dr = 1.0/0.9)
3ag'
1.07
0.93
3.02
3.61
1.11
4.08
1.08
2.12
1.00
0.99
1.00
1.00
1.07
1.07
9.08
9.05
2.99
3.04
3.02
3.09
f1 (ppm)

Parameter	Value
Title	TingLI-144-3-100-13c
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C



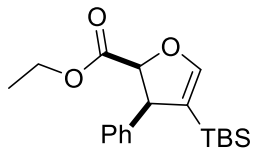
Parameter	Value
Title	TingLi-150-2-1H
Solvent	cdcl3
Spectrometer Frequency	499.85
Nucleus	1H



cis-3ah

Parameter	Value
Title	TingLI-150-2-1-13c
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C

168.95
152.23
138.74
128.92
127.95
127.38
111.35
84.18
60.75
55.53
26.59
17.00
13.62
-5.42
-5.62

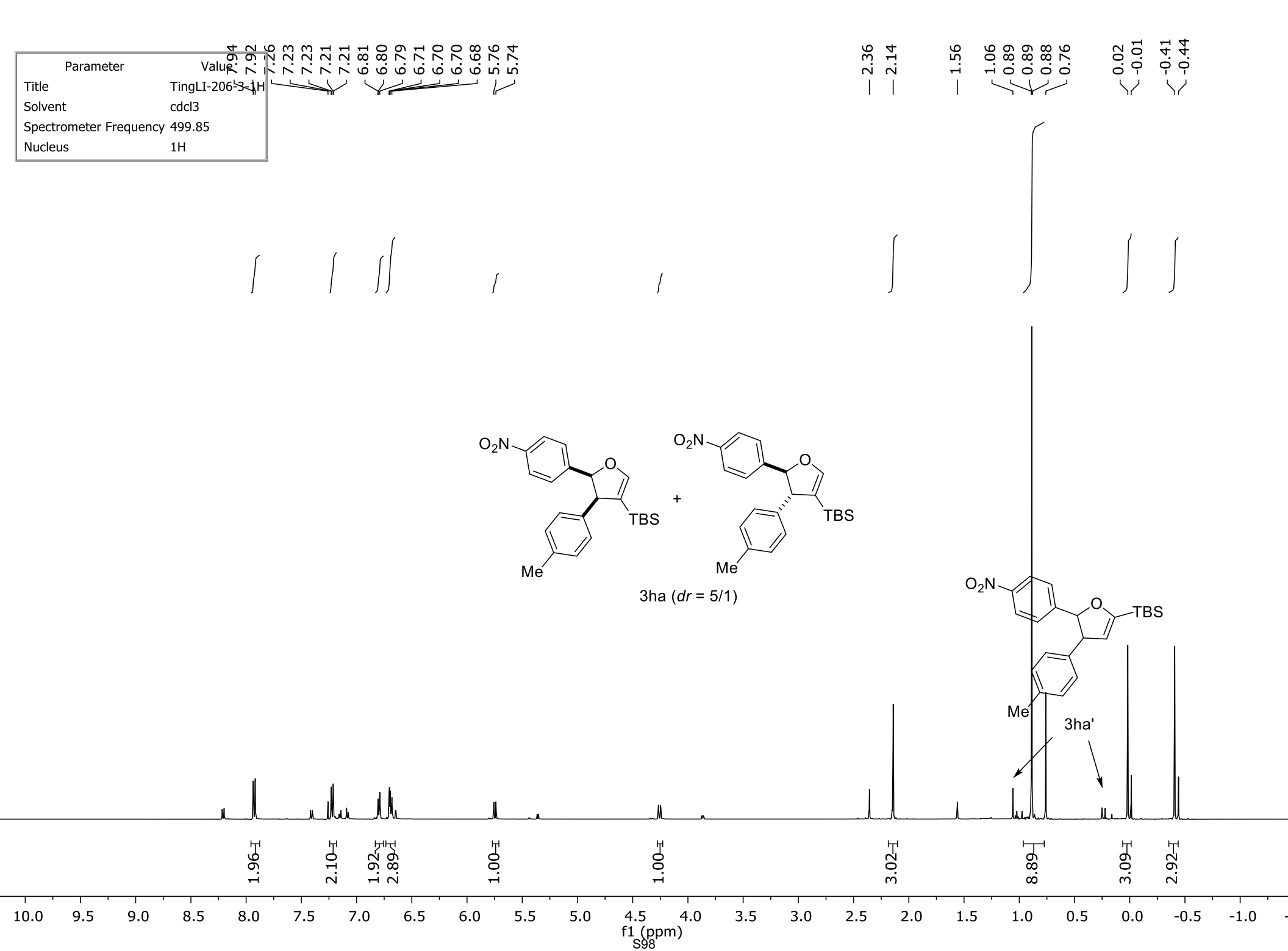


cis-3ah

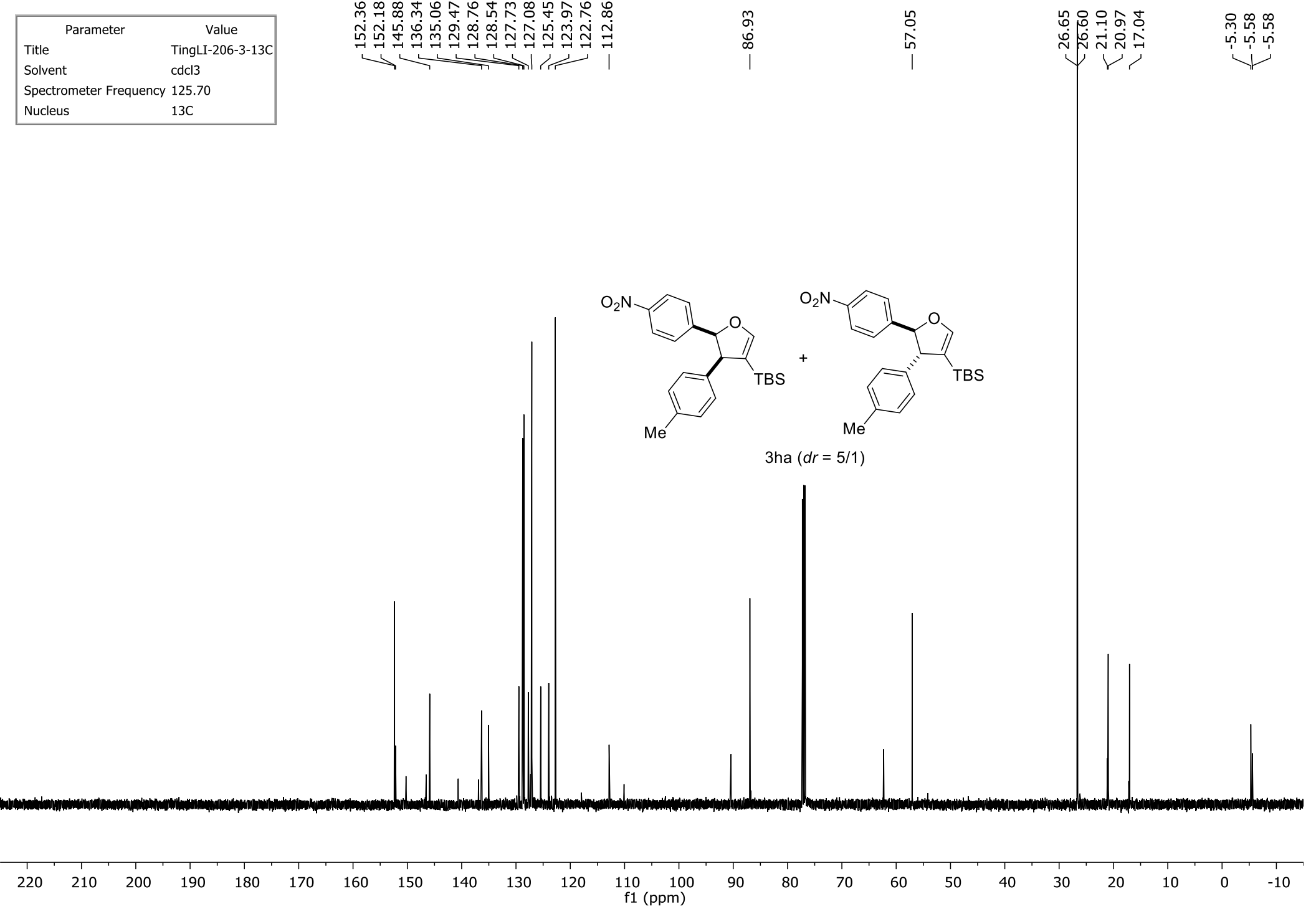
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10

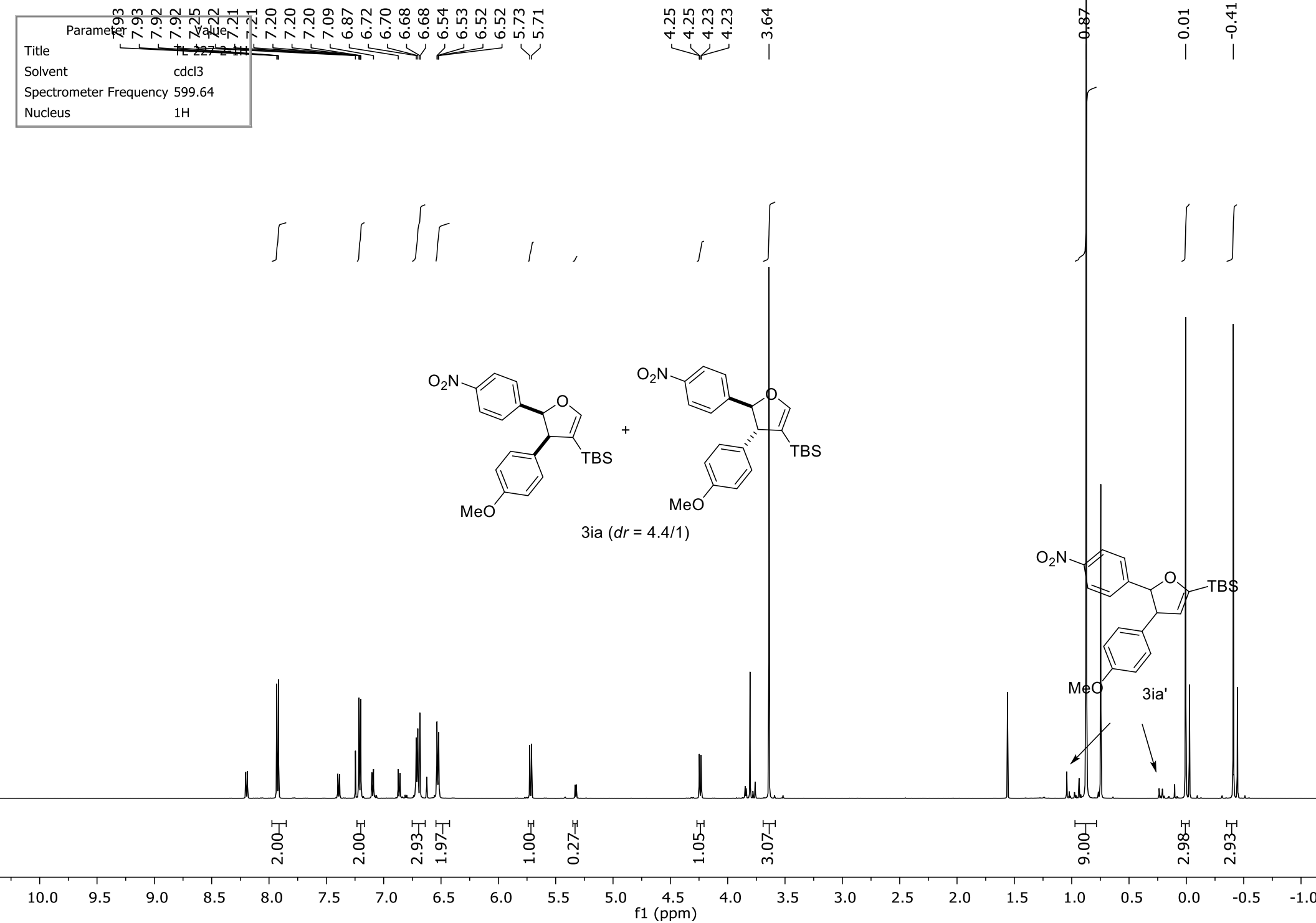
f1 (ppm)

Parameter	Value
Title	TingLI-206-3-1H
Solvent	cdcl3
Spectrometer Frequency	499.85
Nucleus	1H



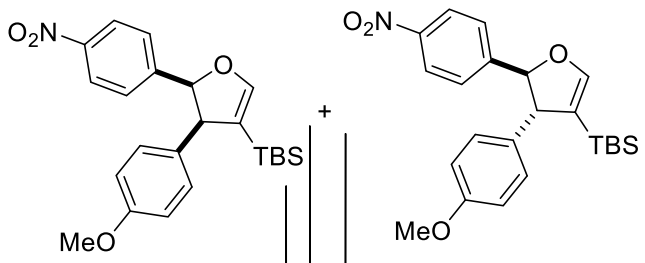
Parameter	Value
Title	TingLI-206-3-13C
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C




Parameter Value
Title TL-127-2-1H
Solvent cdcl3
Spectrometer Frequency 599.64
Nucleus 1H
7.93
7.93
7.92
7.92
7.25
7.22
7.21
7.21
7.20
7.20
7.20
7.09
6.87
6.72
6.70
6.68
6.68
6.54
6.53
6.52
6.52
5.73
5.71
4.25
4.25
4.23
4.23
3.64
0.87
0.01
-0.41
O2N
O
TBS
MeO
+
3ia (dr = 4.4/1)
3ia'
2.00
2.00
2.93
1.97
1.00
0.27
1.05
3.07
9.00
2.98
2.93
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 -1.0
f1 (ppm)

Parameter	Value
Title	LT227-2-1-1-400NMR-13c
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C

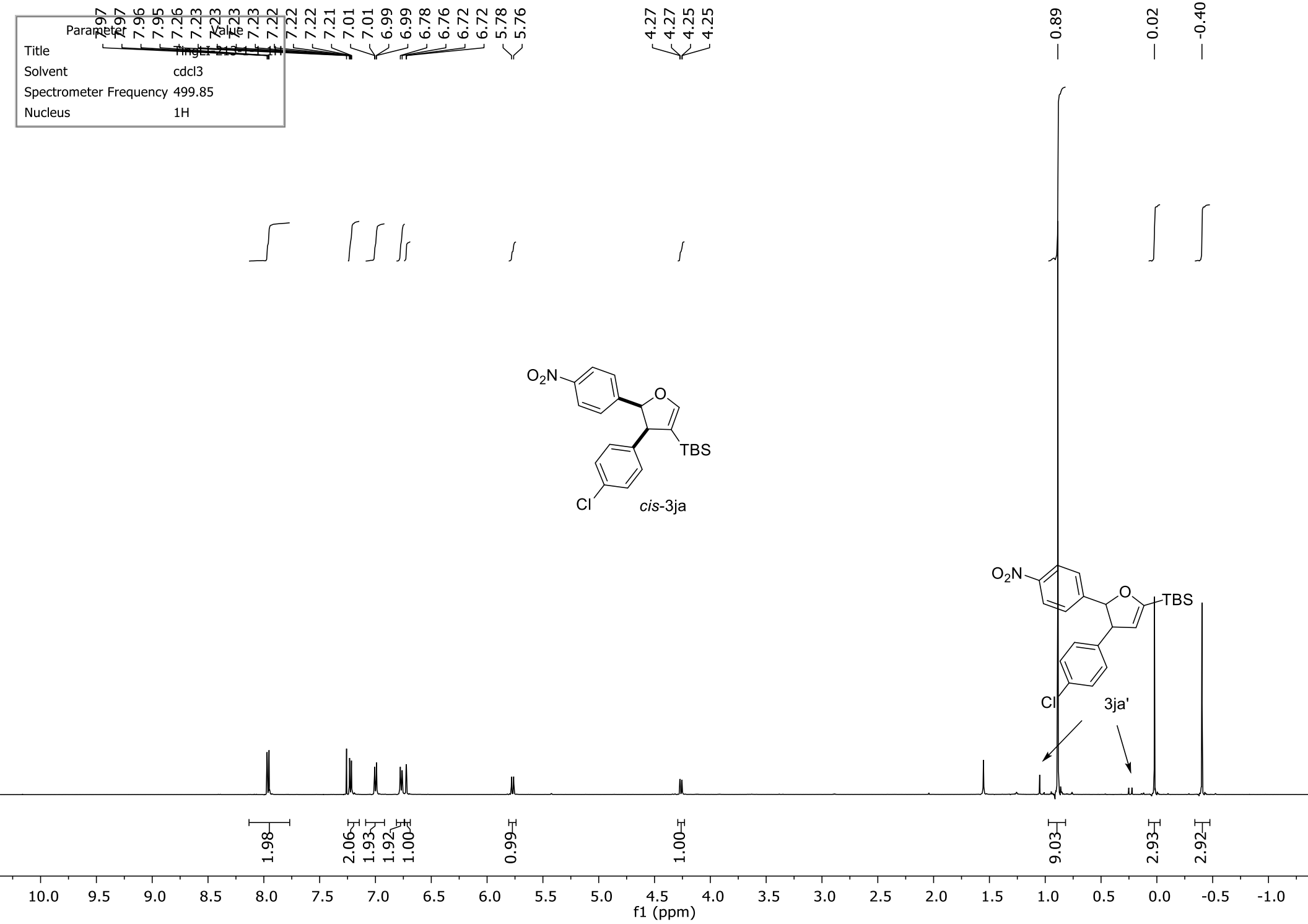
158.30
152.23
152.06
146.53
145.87
130.23
129.83
128.81
127.02
125.41
123.94
122.77
114.12
113.14
112.92
86.89
56.62
54.96
26.62
17.01
-5.33
-5.60



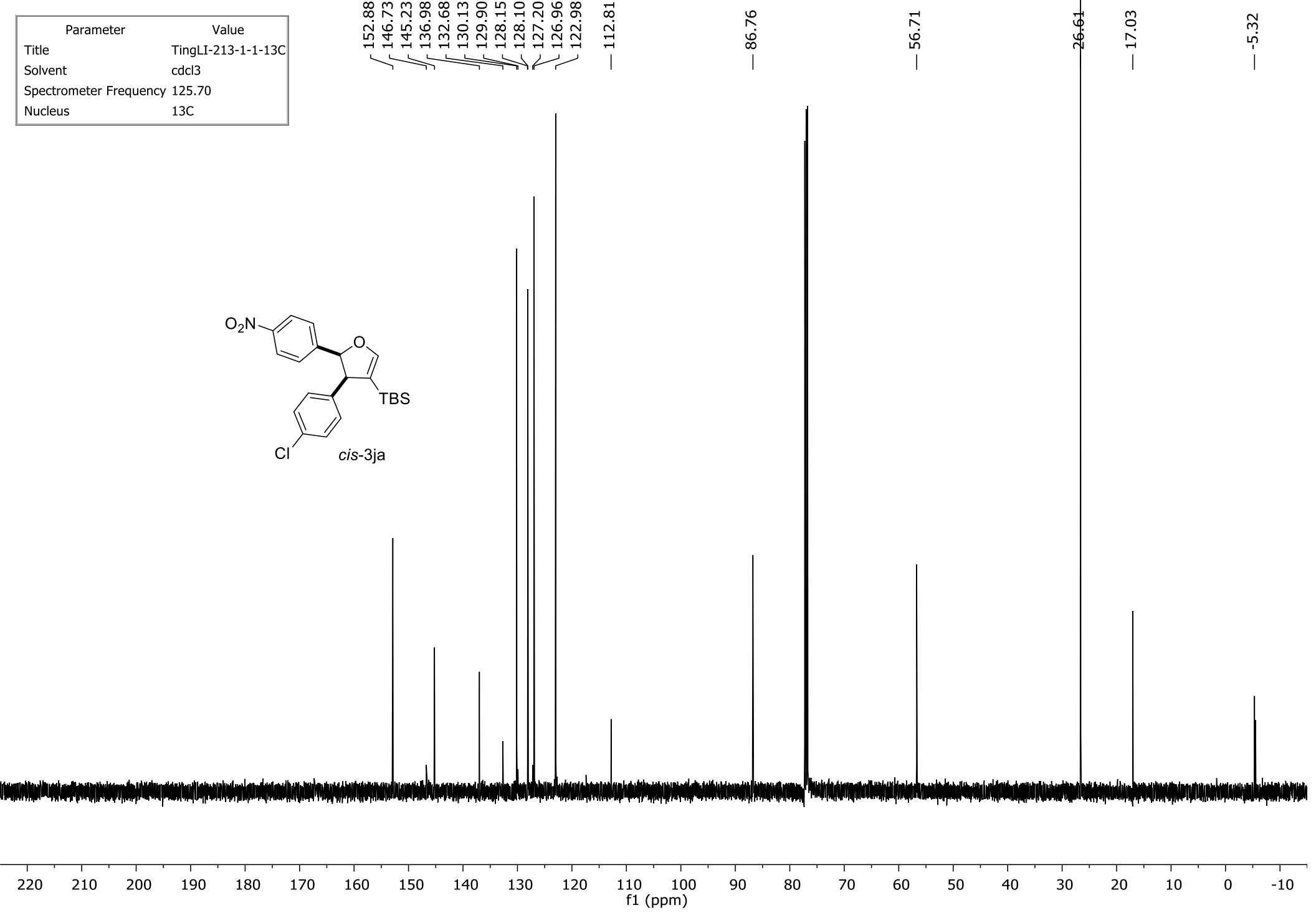
3ia (*dr* = 4.4/1)

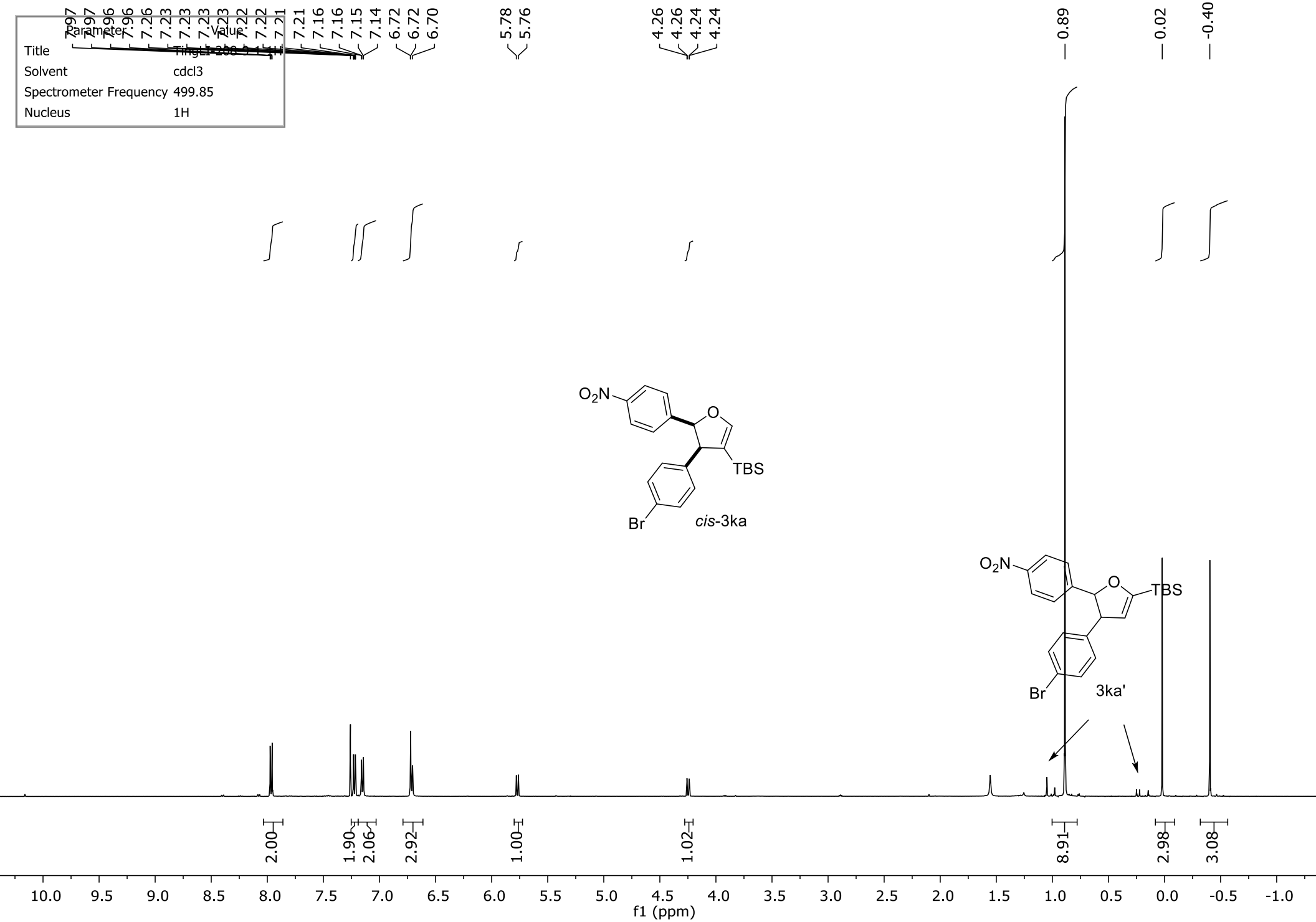
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10

f1 (ppm)

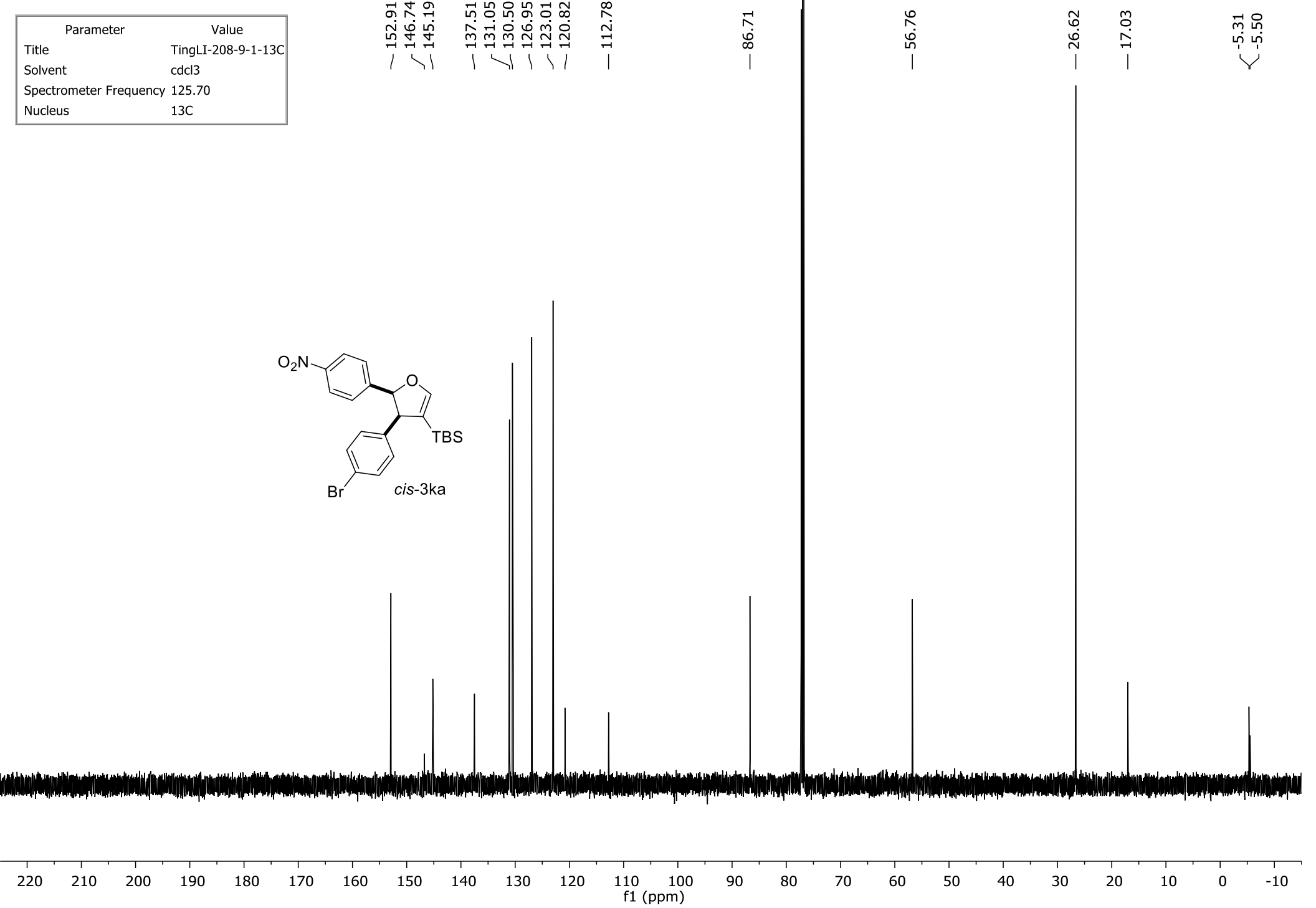

Parameter Value
Title
Solvent cdcl3
Spectrometer Frequency 499.85
Nucleus 1H
7.97 7.97 7.96 7.95 7.26 7.23 7.23 7.23 7.23 7.22 7.22 7.22 7.21 7.01 7.01 6.99 6.99 6.78 6.76 6.72 6.72 5.78 5.76 4.27 4.27 4.25 4.25 0.89 0.02 -0.40
O2N
O
TBS
Cl
cis-3ja
O2N
O
TBS
Cl
3ja'
1.98 2.06 1.93 1.92 1.00 0.99 1.00 9.03 2.93 2.92
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 -1.0
f1 (ppm)

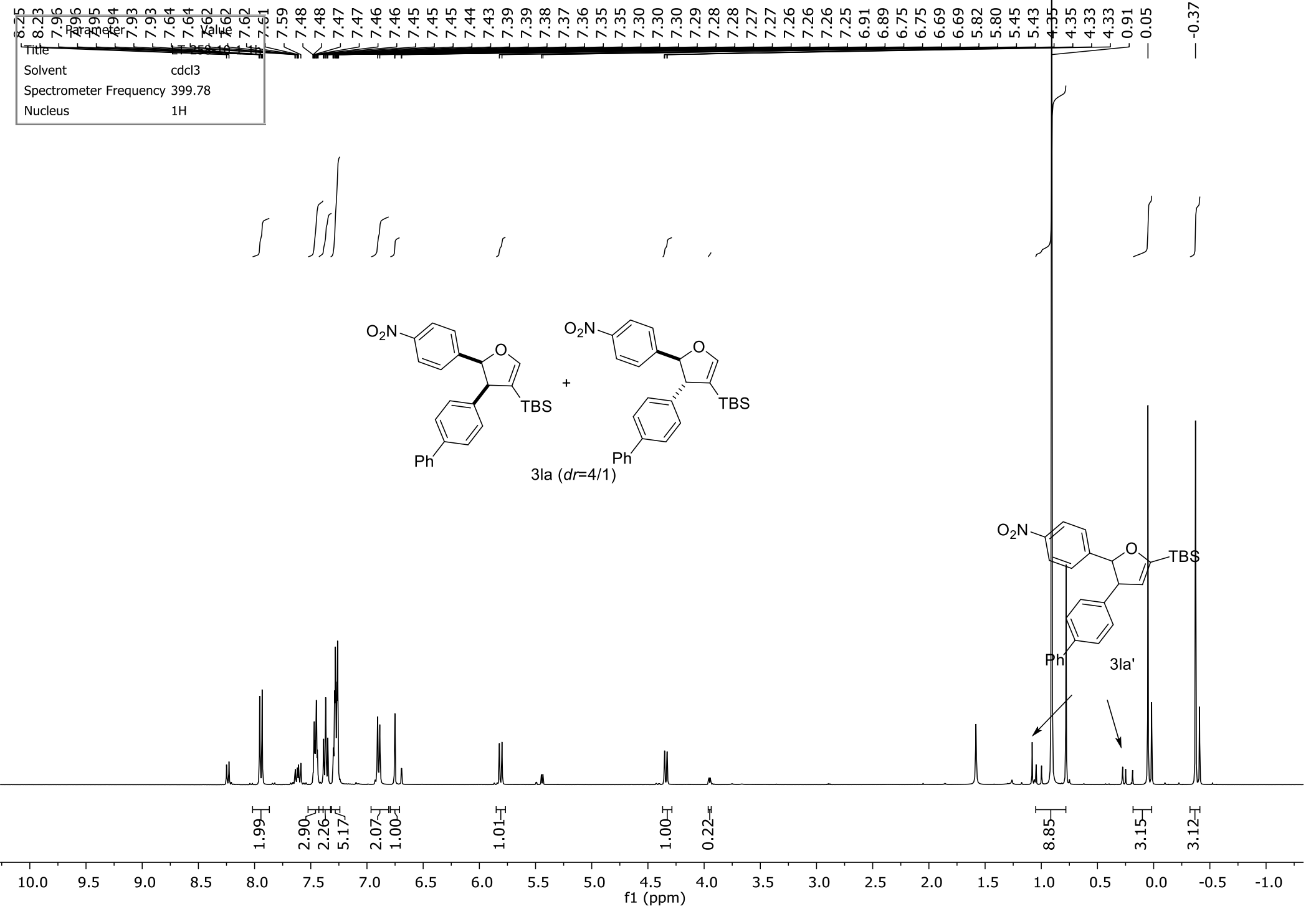
Parameter	Value
Title	TingLI-213-1-1-13C
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C



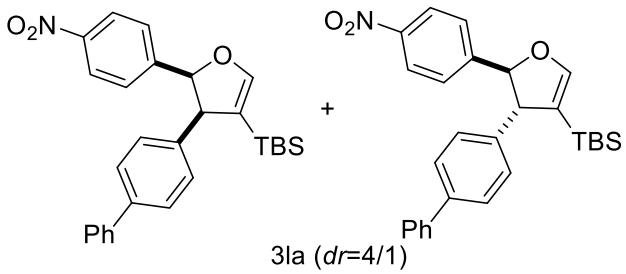

Parameter Value
Title
Solvent cdcl3
Spectrometer Frequency 499.85
Nucleus 1H
7.97 7.97 7.96 7.96 7.26 7.23 7.23 7.23 7.23 7.22 7.22 7.21 7.21 7.16 7.16 7.15 7.14 6.72 6.72 6.70
5.78 5.76
4.26 4.26 4.24 4.24
0.89 0.02 -0.40
O2N
O
TBS
Br
cis-3ka
O2N
O
TBS
Br
3ka'
2.00 1.90 2.06 2.92 1.00 1.02 8.91 2.98 3.08
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 -1.0
f1 (ppm)

Parameter	Value
Title	TingLI-208-9-1-13C
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C




Parameter Value
Title
Solvent cdcl3
Spectrometer Frequency 399.78
Nucleus 1H
O2N
O
TBS
Ph
+
3la (dr=4/1)
3la'
1.99
2.90
2.26
5.17
2.07
1.00
1.01
1.00
0.22
8.85
3.15
3.12
f1 (ppm)

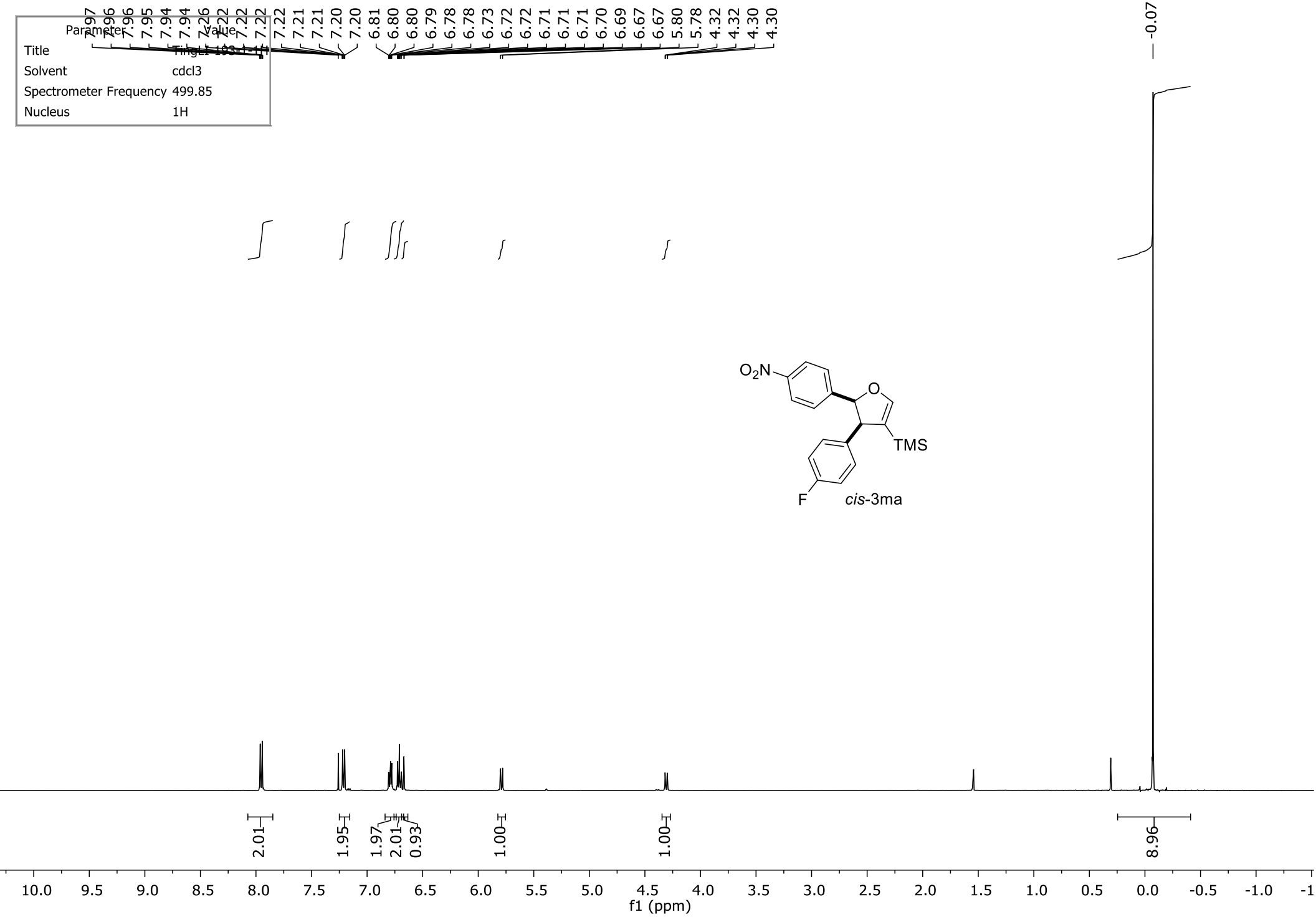
Parameter	Value
Title	TingLI-256-8-13C
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C



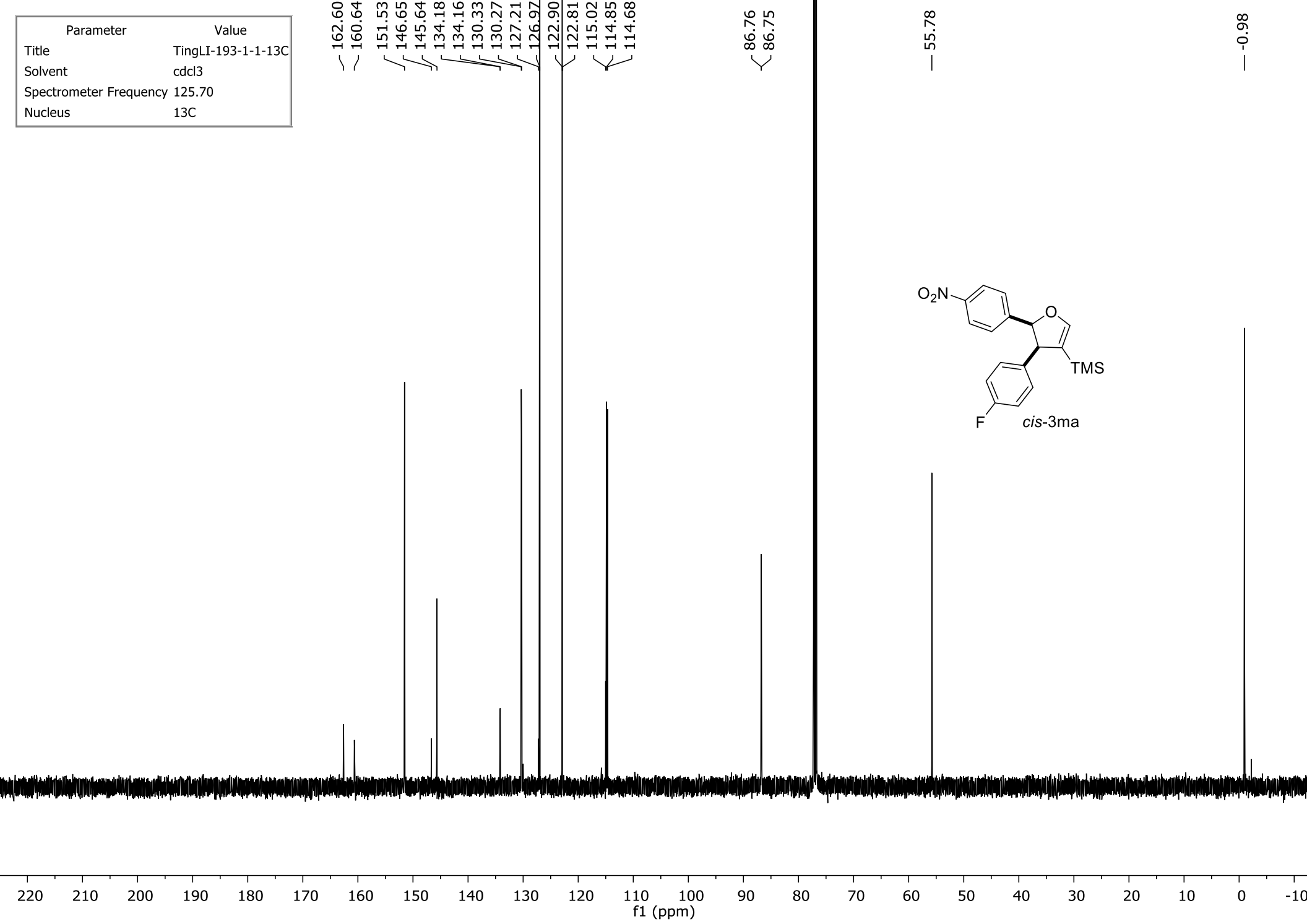
+

3la (*dr*=4/1)

f1 (ppm)


Parameter Value
Title TingLi-103-1-1-1
Solvent cdcl3
Spectrometer Frequency 499.85
Nucleus 1H
7.97 7.96 7.96 7.95 7.94 7.94 7.26 7.22 7.22 7.22 7.22 7.21 7.21 7.20 7.20 6.81 6.80 6.80 6.79 6.78 6.78 6.73 6.72 6.72 6.71 6.71 6.70 6.69 6.67 6.67 5.80 5.78 4.32 4.32 4.30 4.30
-0.07
O2N
O
TMS
F
cis-3ma
2.01
1.95
1.97
2.01
0.93
1.00
1.00
8.96
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 -1.0
f1 (ppm)

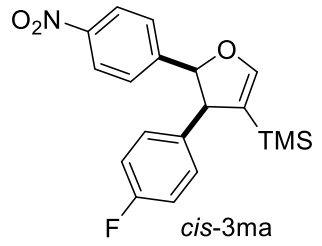
Parameter	Value
Title	TingLI-193-1-1-13C
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C



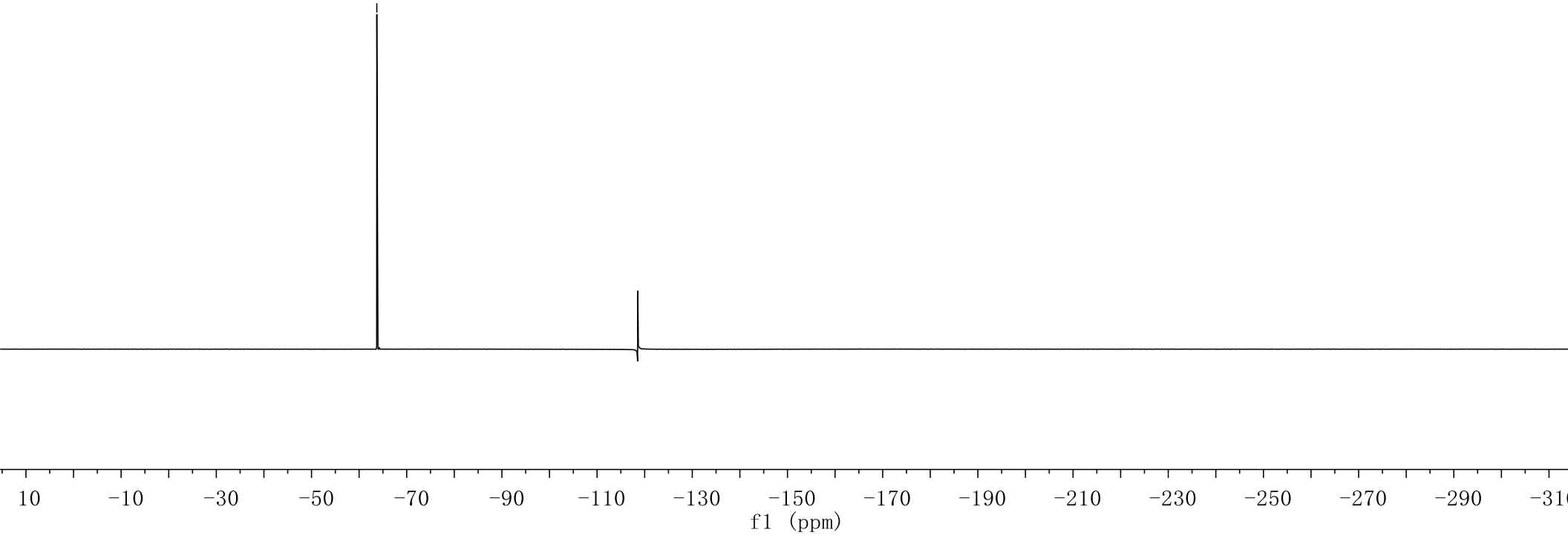
Parameters	
Parameter	Value
Title	LT-2-300-2-19F
Spectrometer Frequency	376.11

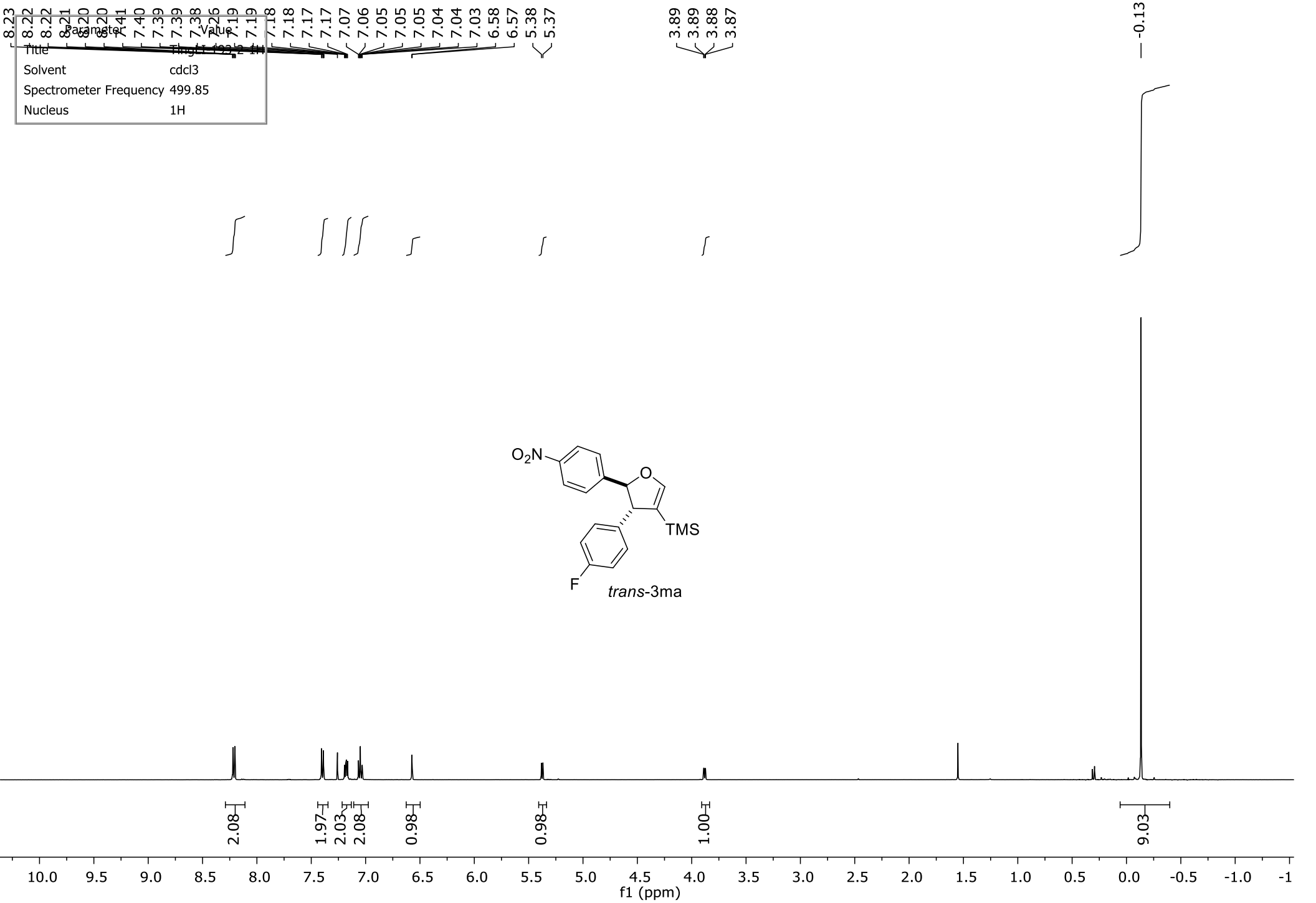
-63.72

-118.58



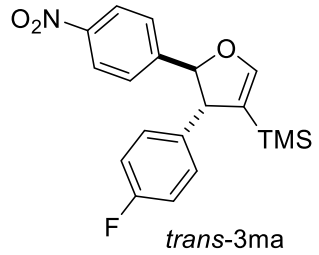
cis-3ma




8.23
8.22
8.22
8.21
8.20
8.20
7.41
7.40
7.39
7.39
7.38
7.26
7.19
7.19
7.18
7.18
7.17
7.17
7.07
7.06
7.05
7.05
7.05
7.04
7.04
7.03
6.58
6.57
5.38
5.37
3.89
3.89
3.88
3.87
-0.13
Parameter
Value
Title
Solvent
cdcl3
Spectrometer Frequency
499.85
Nucleus
1H
O2N
O
TMS
F
trans-3ma
2.08
1.97
2.03
2.08
0.98
0.98
1.00
9.03
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
-1.0
-1
f1 (ppm)

Parameter	Value
Title	TingLI-193-2-1-13C
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C

163.07
161.12
151.10
149.68
147.50
139.13
139.10
129.42
129.36
125.59
124.00
115.81
115.64
112.68
90.48
90.47
61.12
-1.07
-1.08

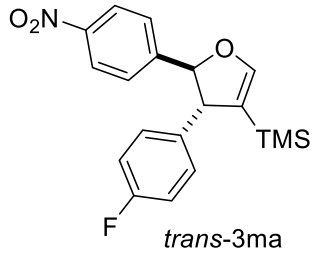


trans-3ma

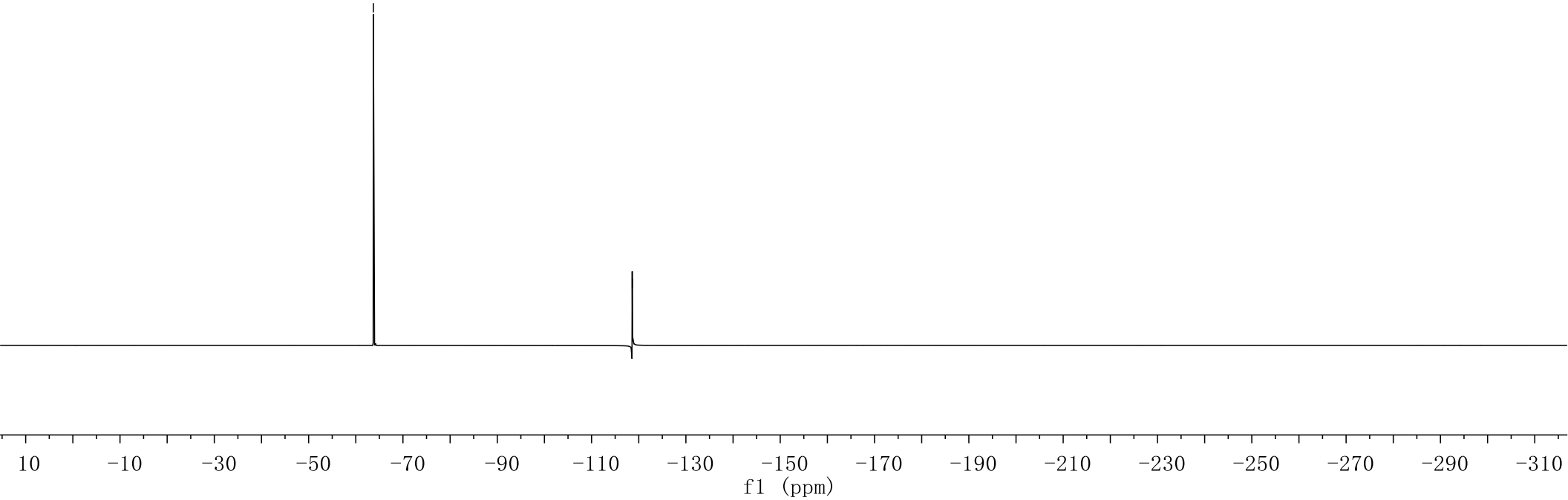
Parameters	
Parameter	Value
Title	LT-2-300-3-19F
Spectrometer Frequency	376.11

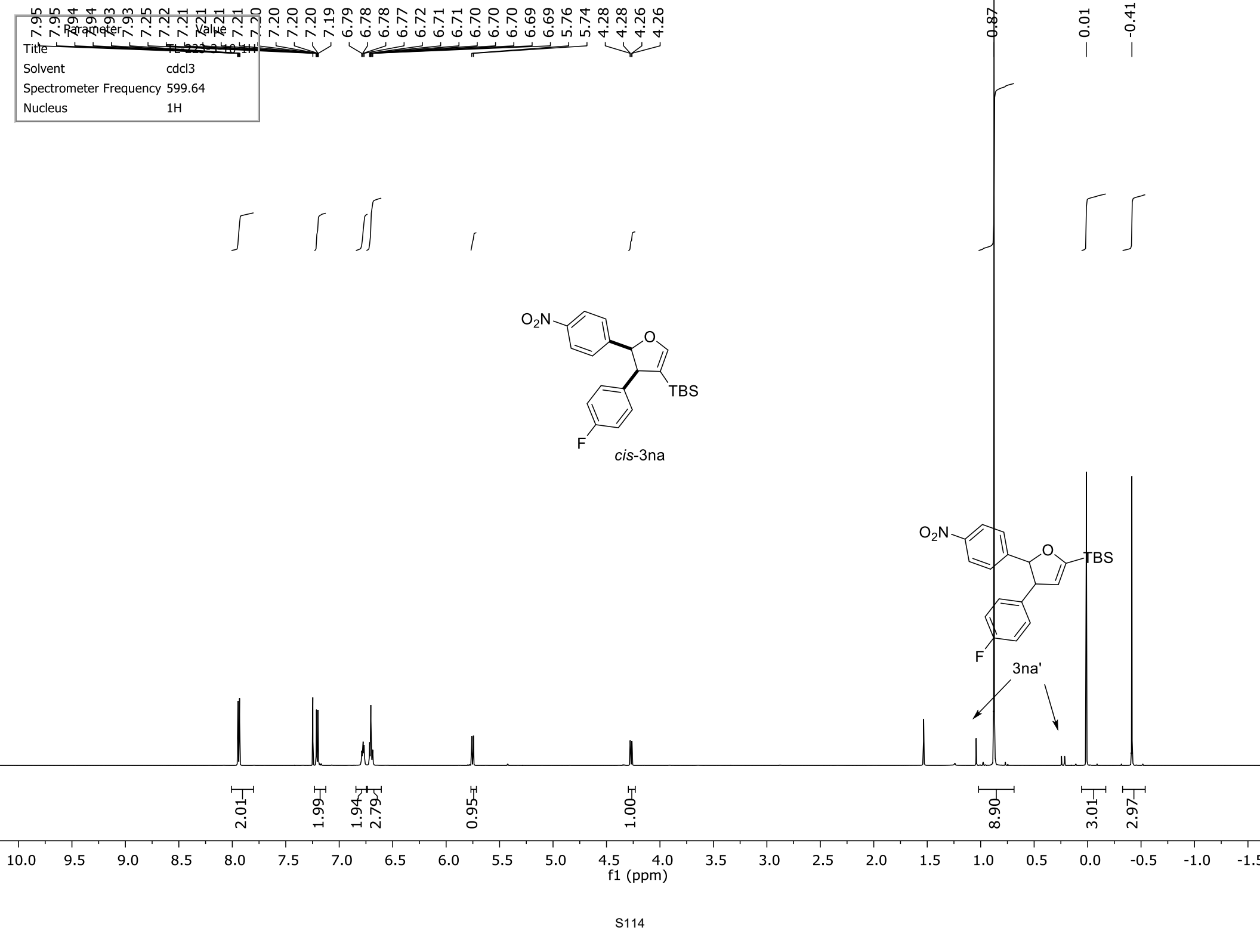
-63.72

-118.64

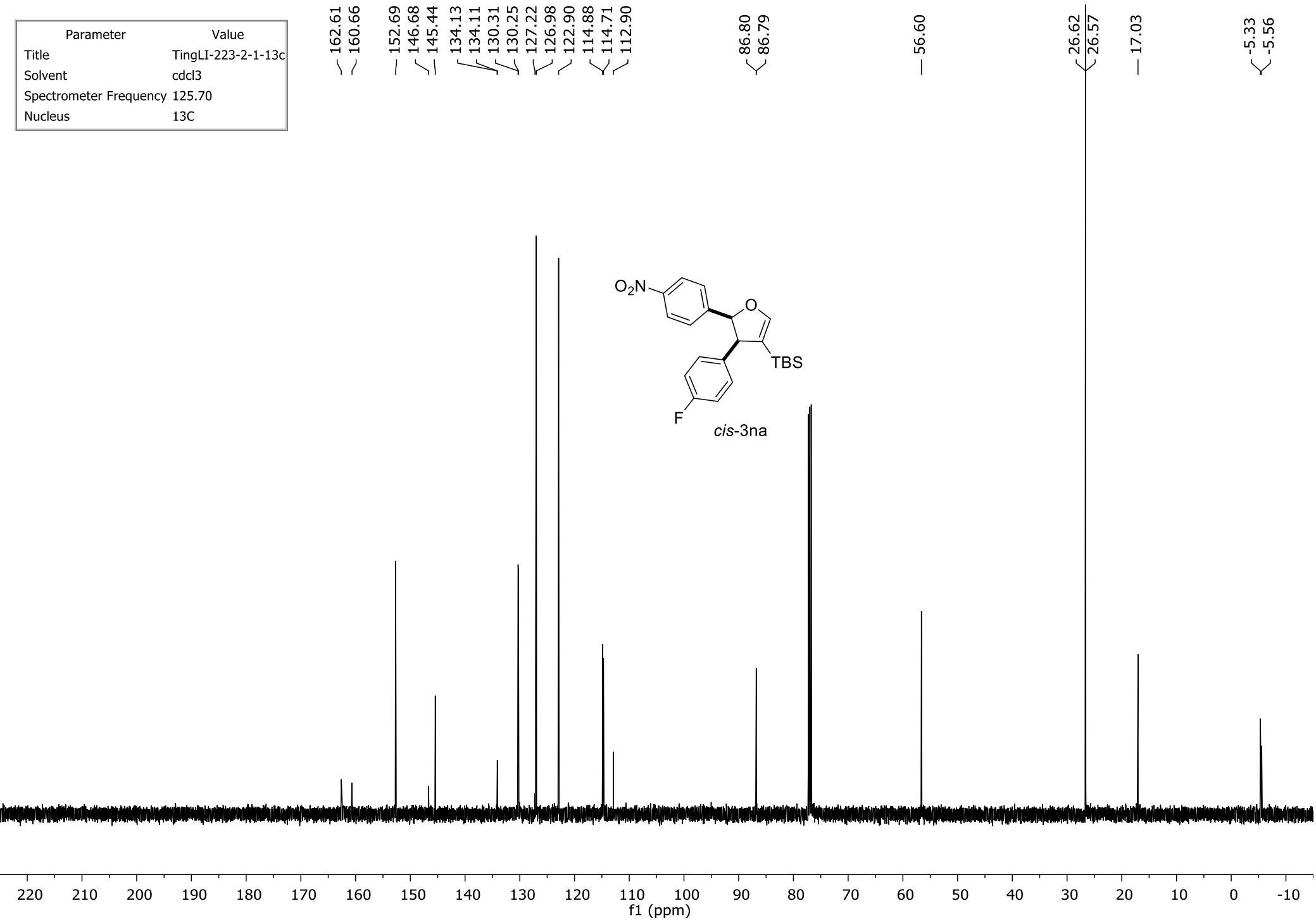


trans-3ma




Parameter Value
Title
Solvent cdcl3
Spectrometer Frequency 599.64
Nucleus 1H
7.95 7.95 7.94 7.94 7.93 7.93 7.25 7.22 7.21 7.21 7.21 7.21 7.20 7.20 7.20 7.20 7.19 6.79 6.78 6.78 6.77 6.72 6.71 6.71 6.70 6.70 6.70 6.69 6.69 5.76 5.74 4.28 4.28 4.26 4.26
0.87
0.01
-0.41
O2N
O
TBS
F
cis-3na
O2N
O
TBS
F
3na'
2.01
1.99
1.94
2.79
0.95
1.00
8.90
3.01
2.97
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 -1.0 -1.5
f1 (ppm)

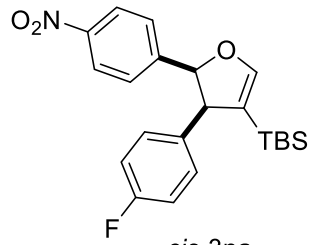
Parameter	Value
Title	TingLI-223-2-1-13c
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C



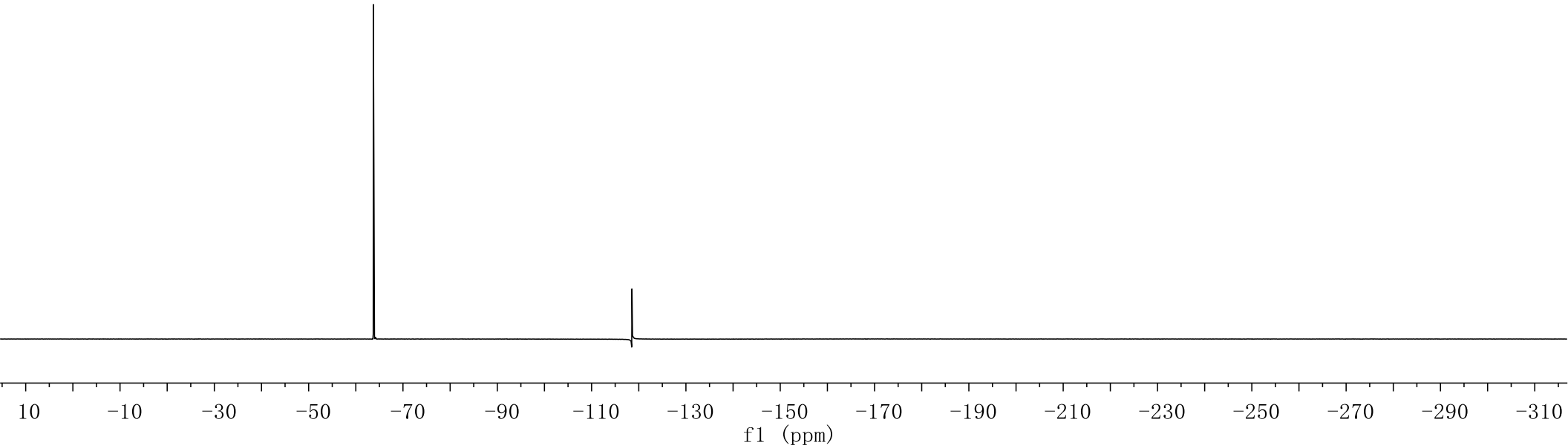
Parameter	Value
Title	LT-2-300-1-19F
Spectrometer Frequency	376.11

-63.72

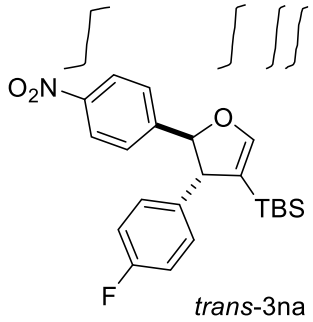
-118.56



cis-3na

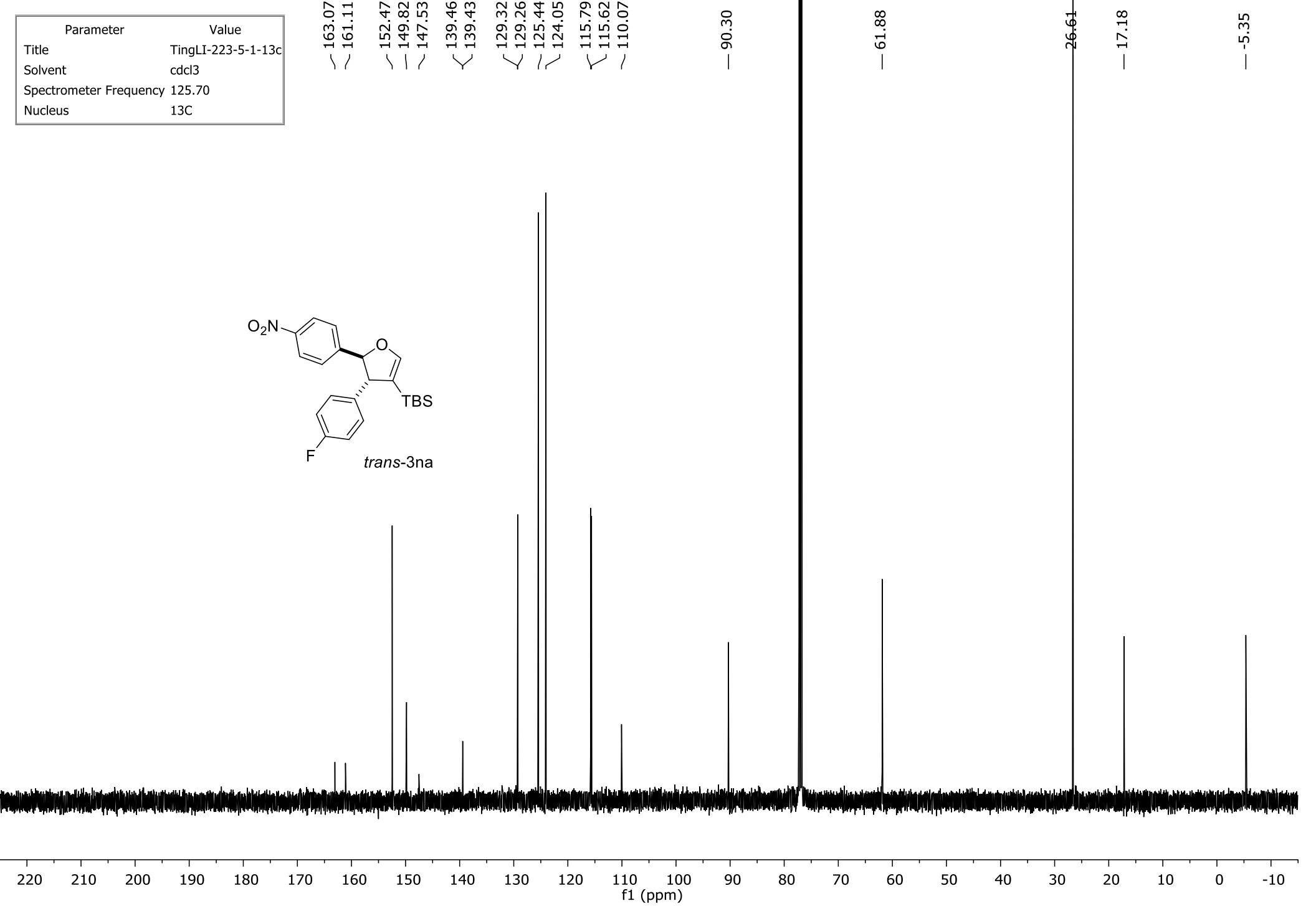


Parameter	Value
Title	TingLi-213-5-1H
Solvent	cdcl3
Spectrometer Frequency	499.85
Nucleus	1H



trans-3na

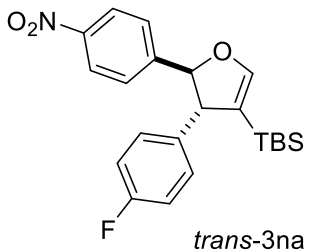
Parameter	Value
Title	TingLI-223-5-1-13c
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C



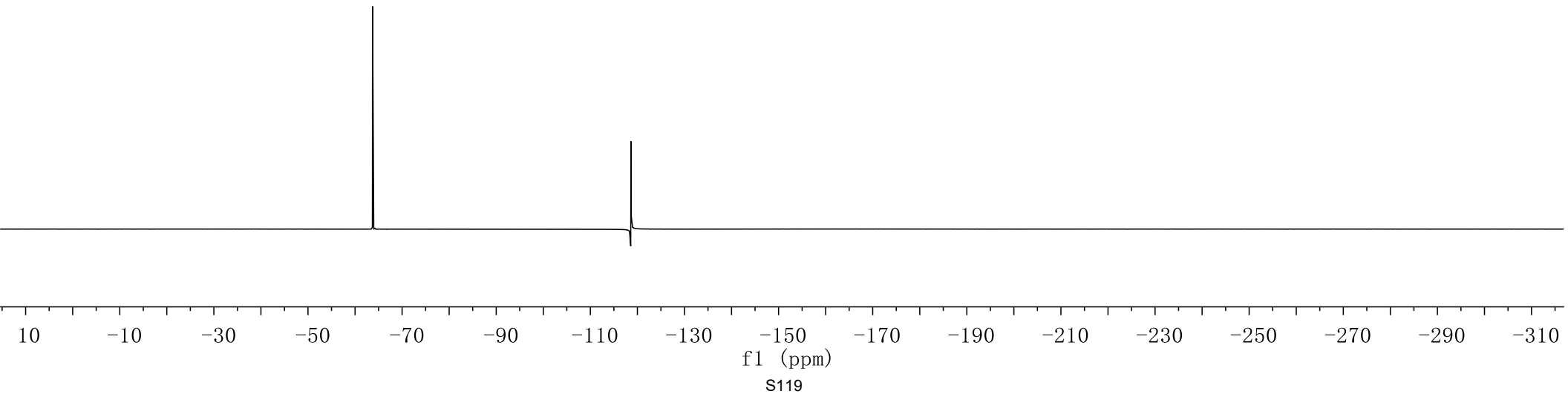
Parameters	
Parameter	Value
Title	LT-2-300-4-19F
Spectrometer Frequency	376.11

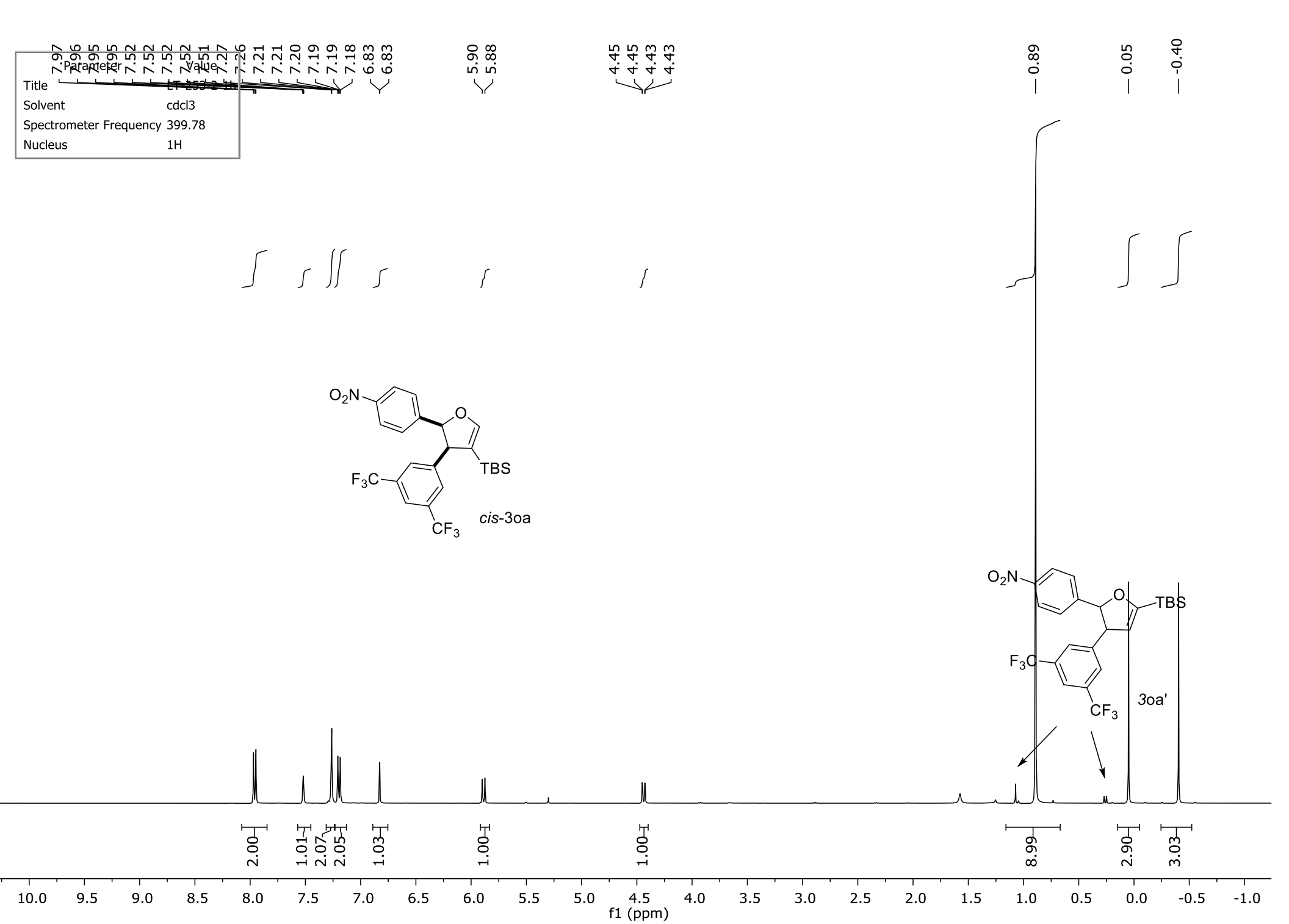
-63.72

-118.15

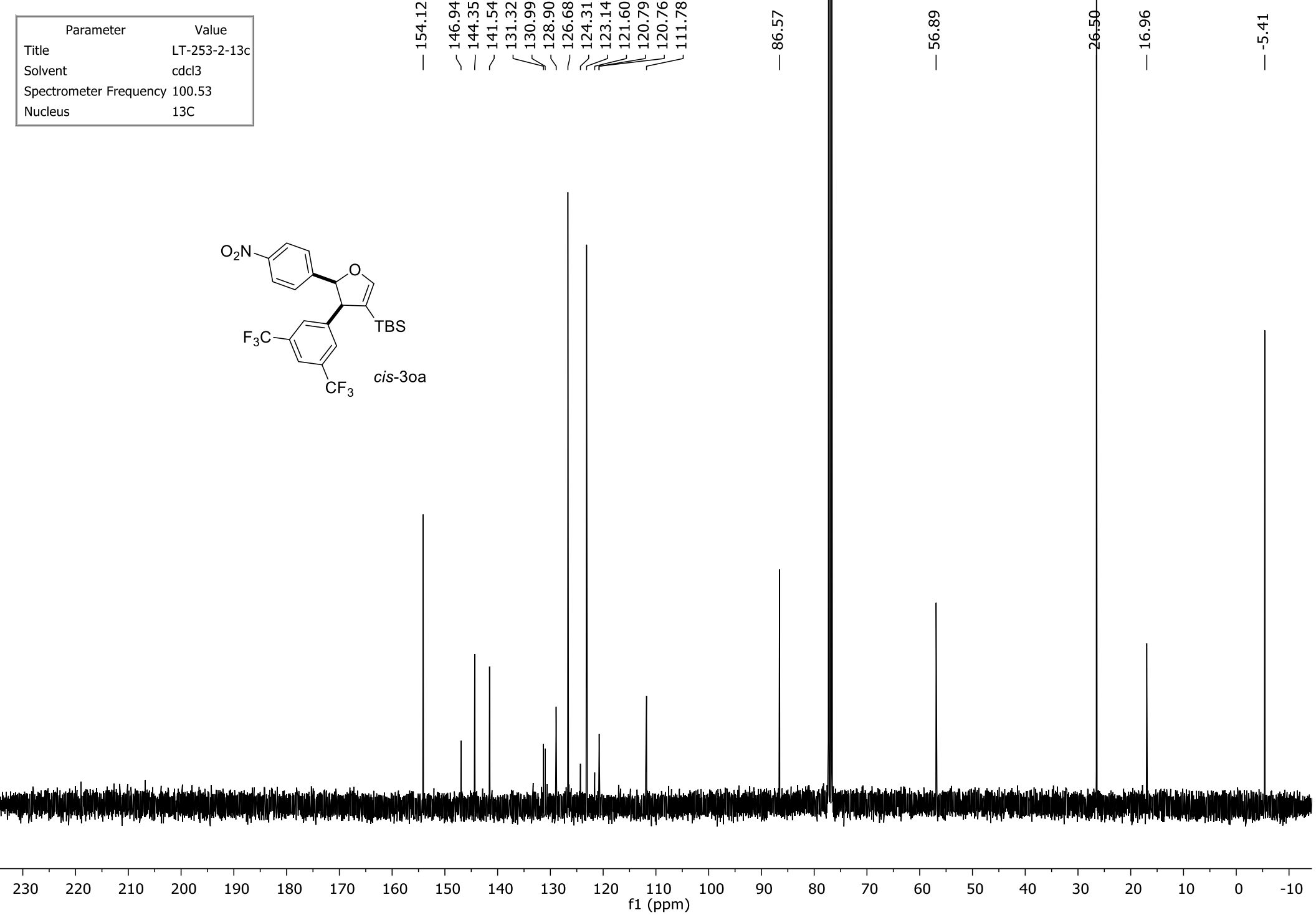


trans-3na




Parameter Value
Title
Solvent cdcl3
Spectrometer Frequency 399.78
Nucleus 1H
7.97
7.96
7.95
7.52
7.52
7.52
7.51
7.27
7.26
7.21
7.21
7.20
7.19
7.19
7.18
6.83
6.83
5.90
5.88
4.45
4.45
4.43
4.43
0.89
0.05
-0.40
O2N
O
TBS
F3C
CF3
cis-3oa
O2N
O
TBS
F3C
CF3
3oa'
2.00
1.01
2.07
2.05
1.03
1.00
1.00
8.99
2.90
3.03
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
-1.0
f1 (ppm)

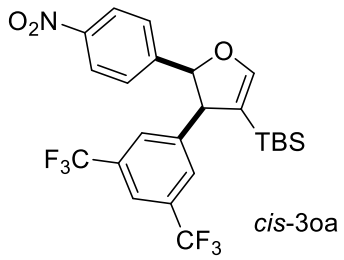
Parameter	Value
Title	LT-253-2-13c
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C



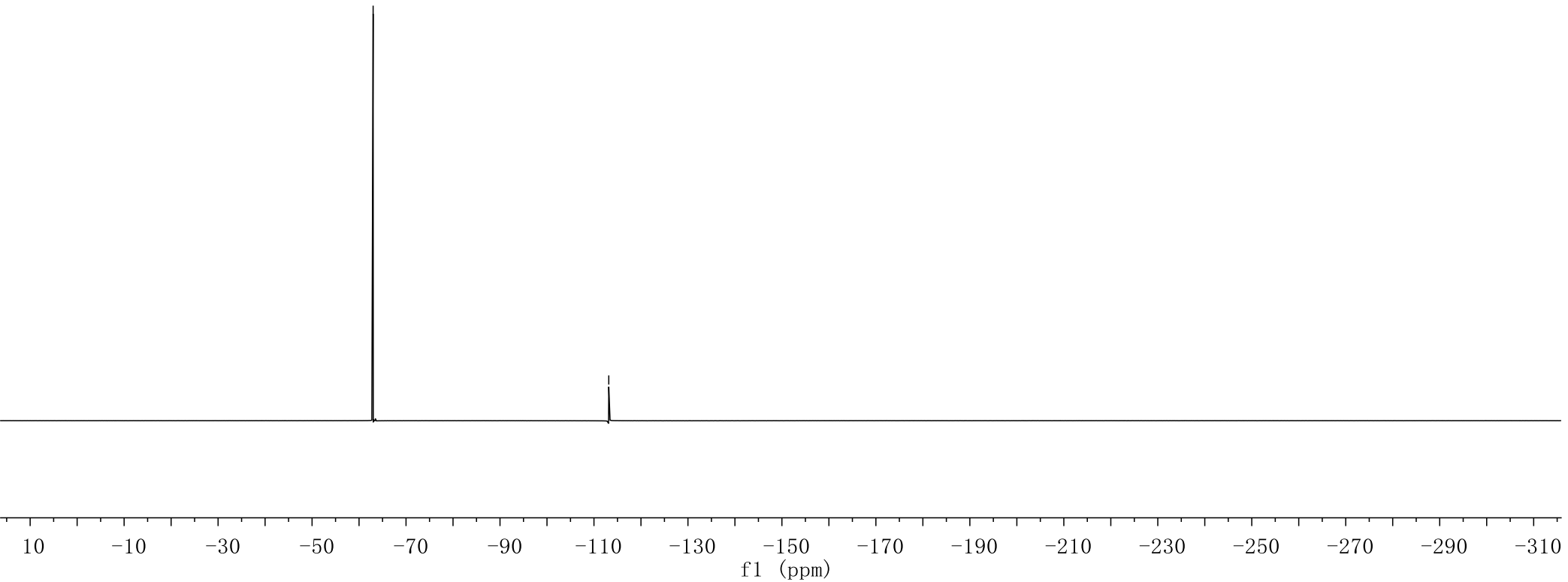
Parameters	
Parameter	Value
Title	LT-2-300-7-19F
Spectrometer Frequency	376.11

-63.00

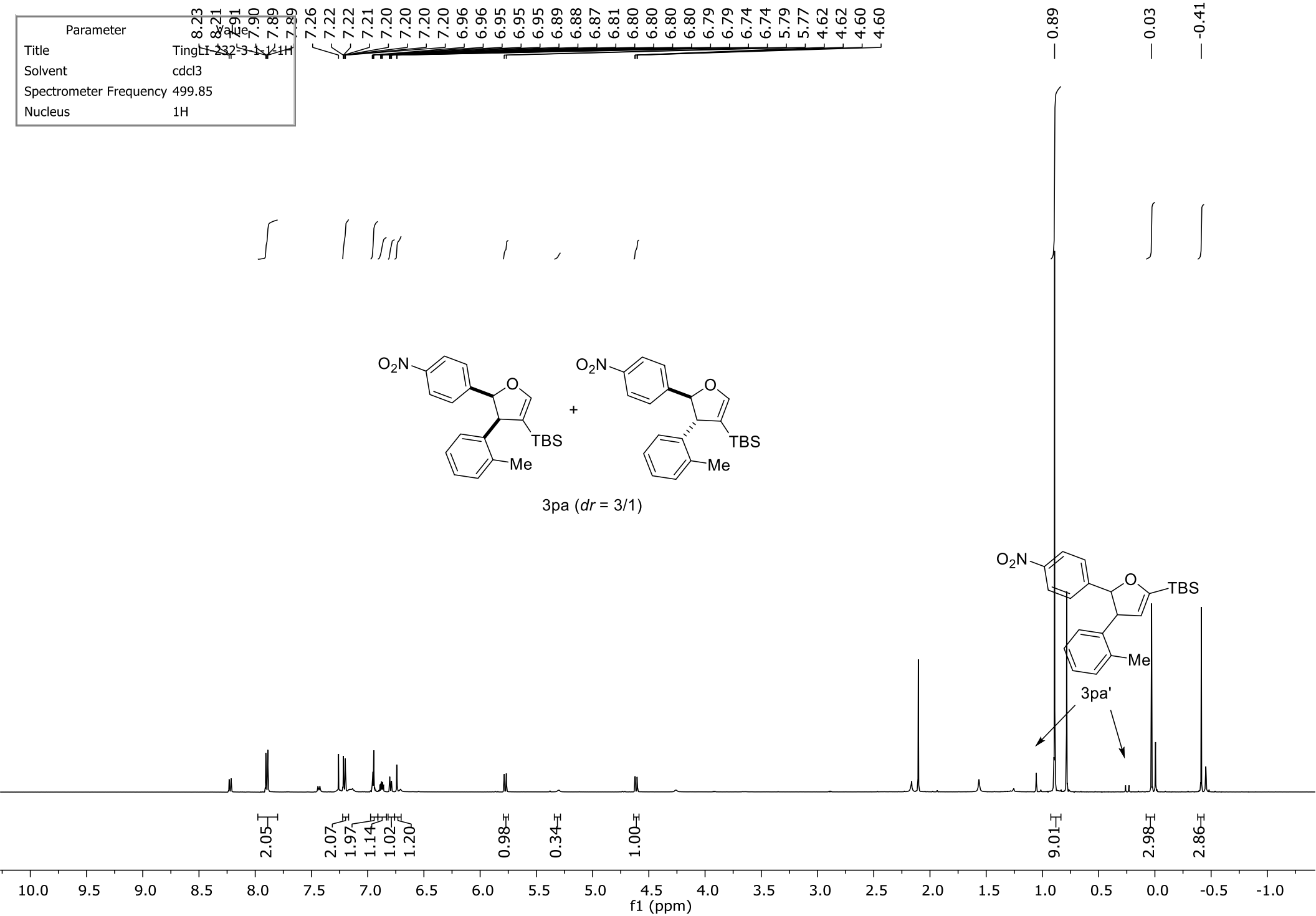
-113.15



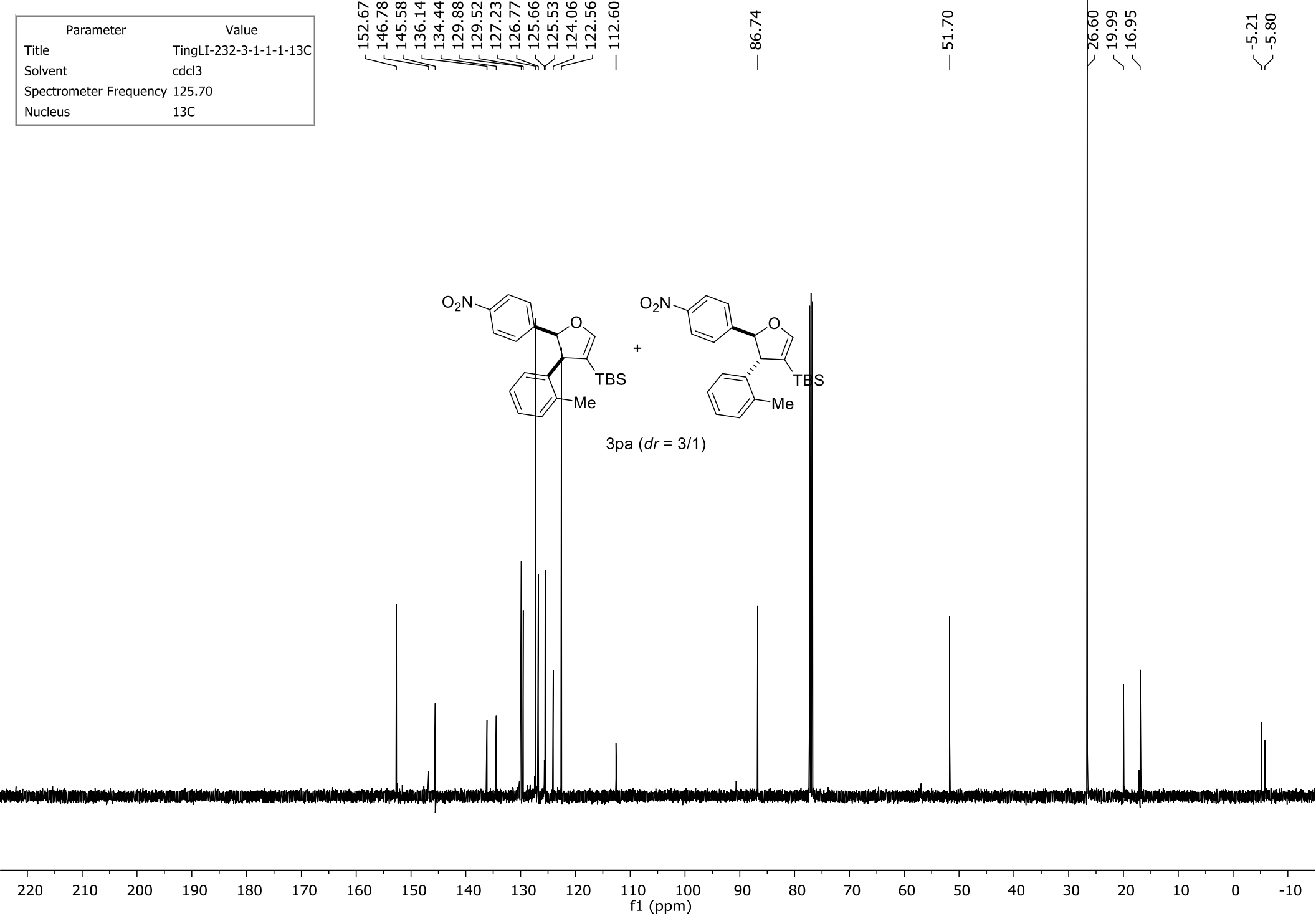
cis-3oa



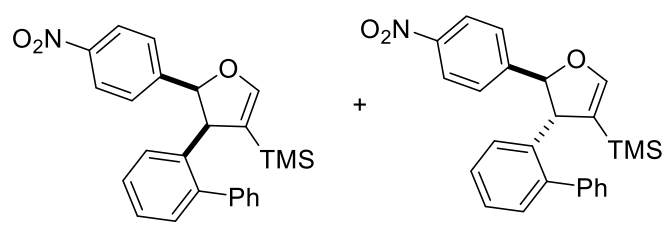
Parameter	Value
Title	TingLi-232-3-1-1H
Solvent	cdcl3
Spectrometer Frequency	499.85
Nucleus	1H



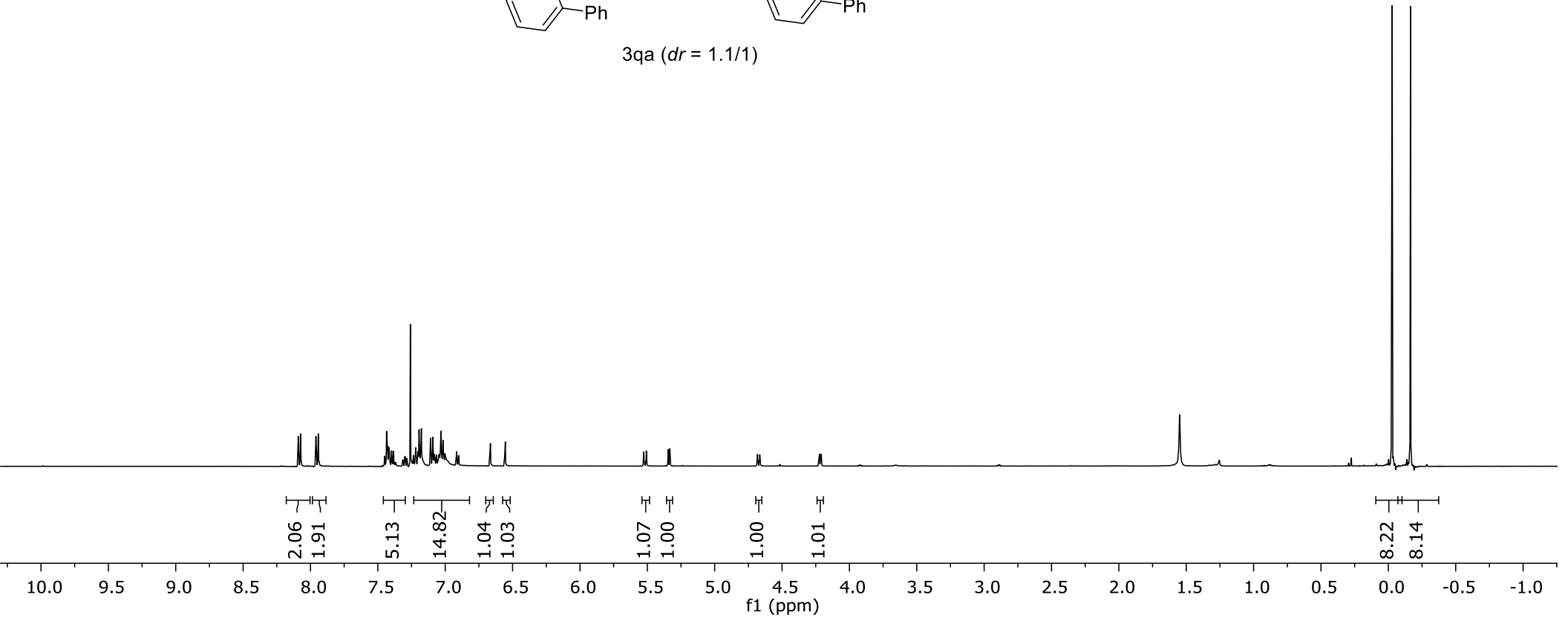
Parameter	Value
Title	TingLI-232-3-1-1-1-13C
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C



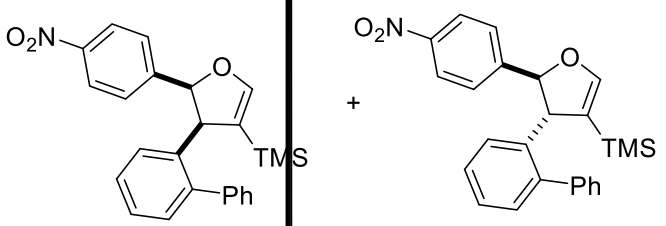
Parameter	Value
Title	
Solvent	cdcl3
Spectrometer Frequency	499.85
Nucleus	1H



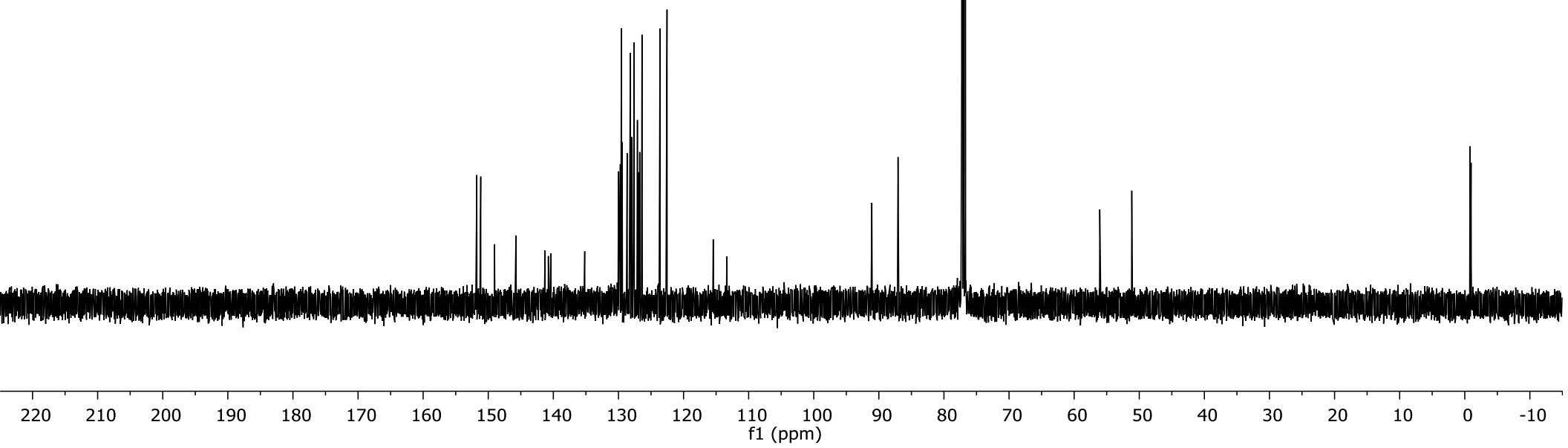
3qa (*dr* = 1.1/1)

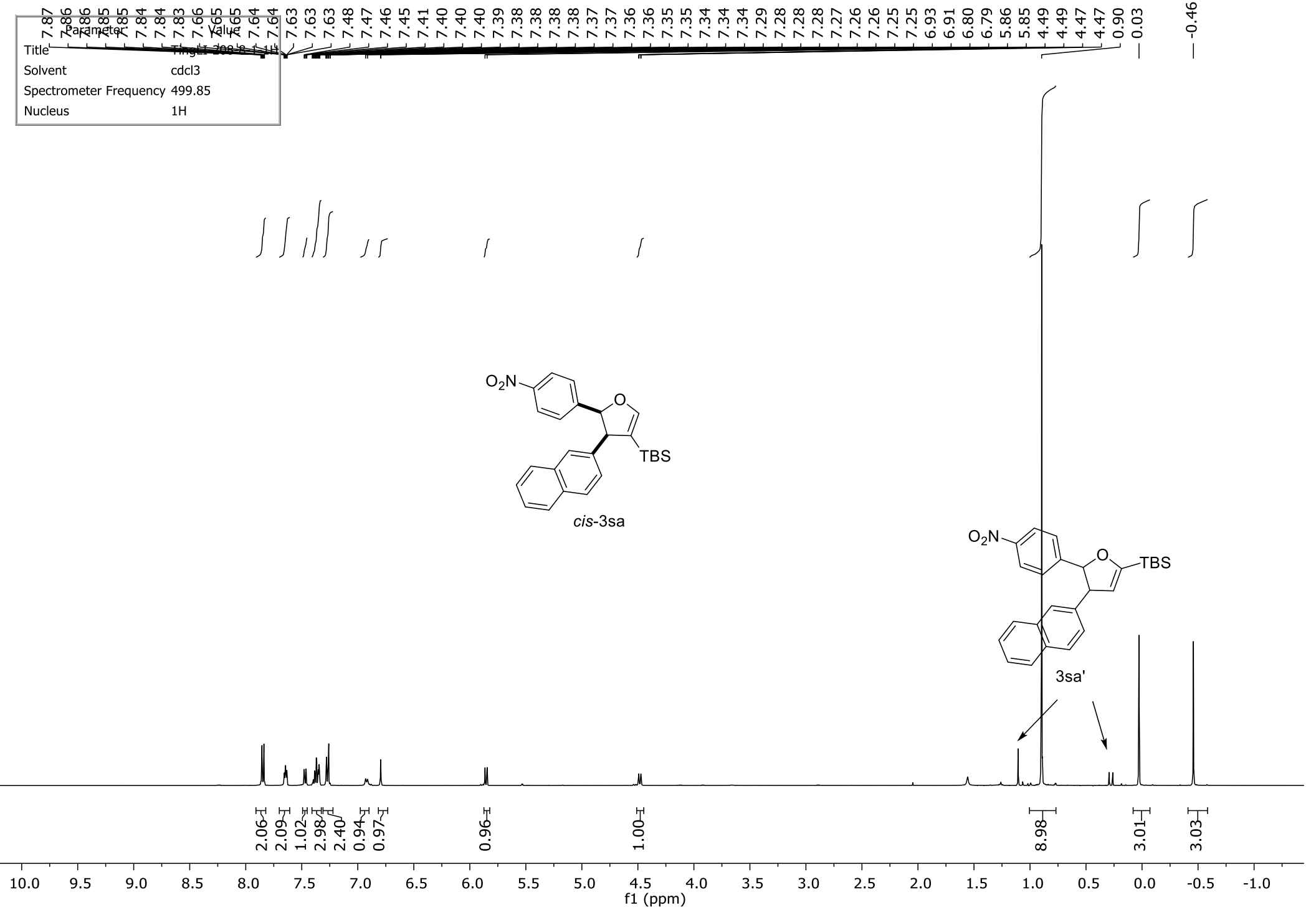


Parameter	Value
Title	TingLI-203-18-13C
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C

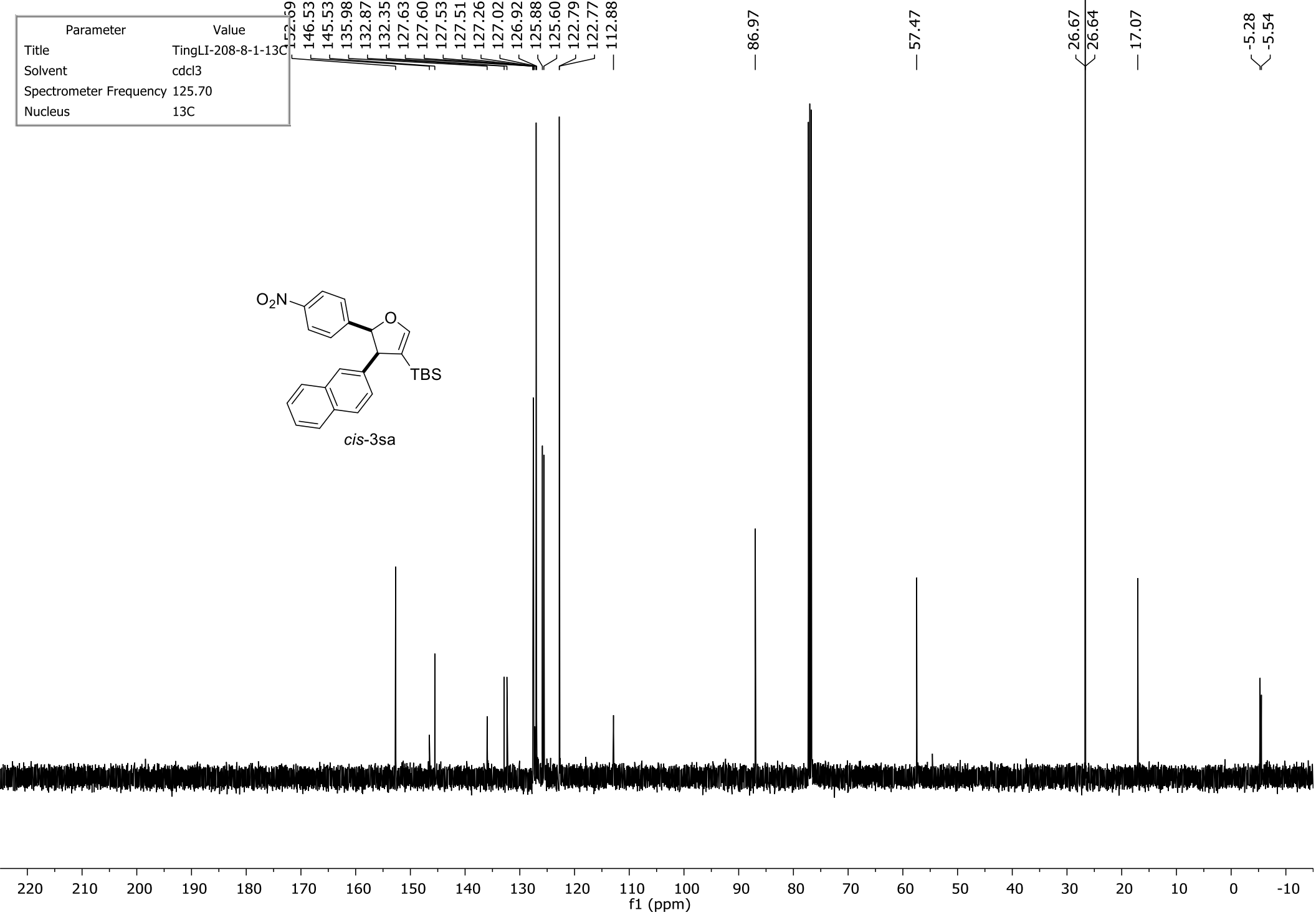


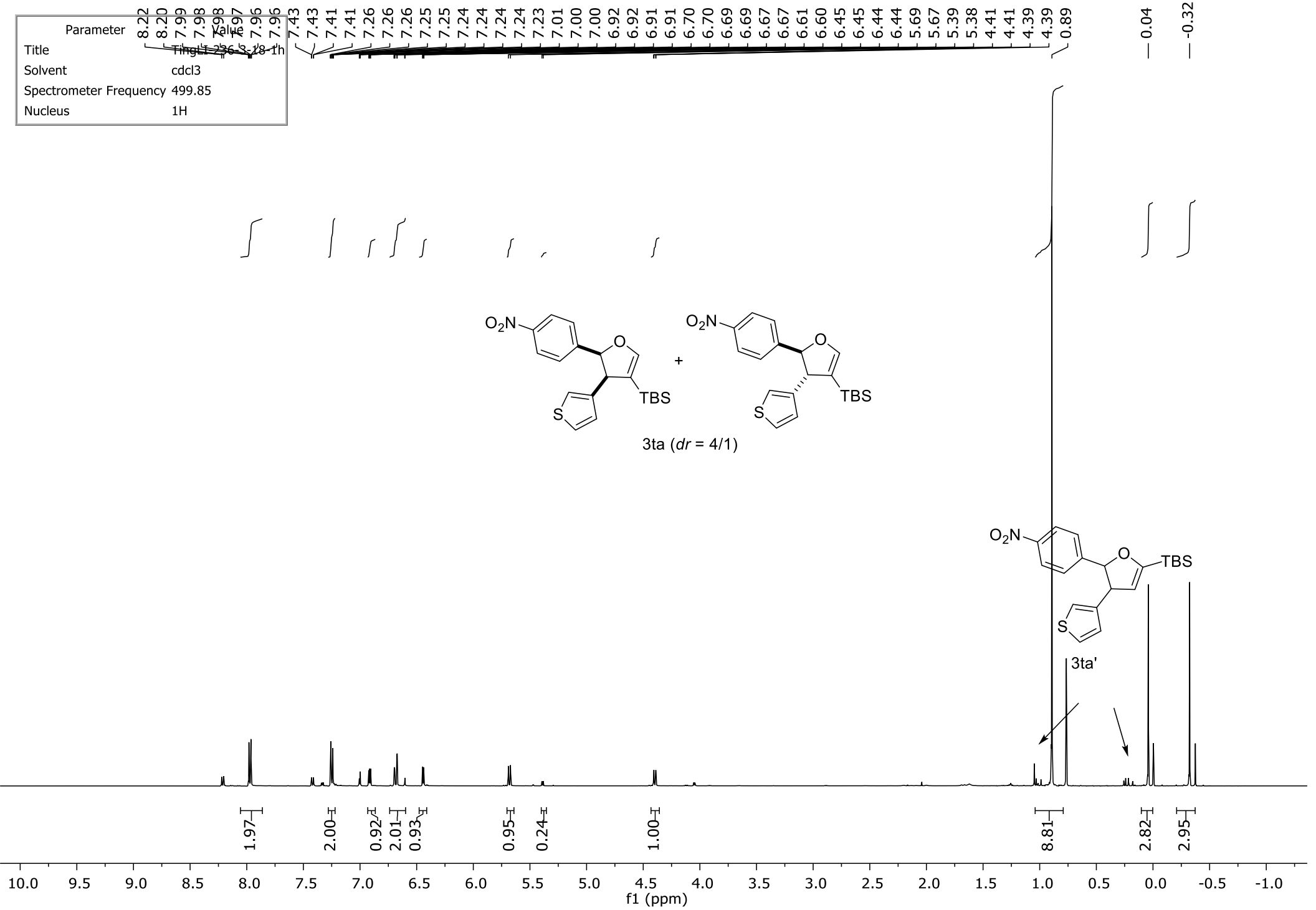
3qa (*dr* = 1.1/1)



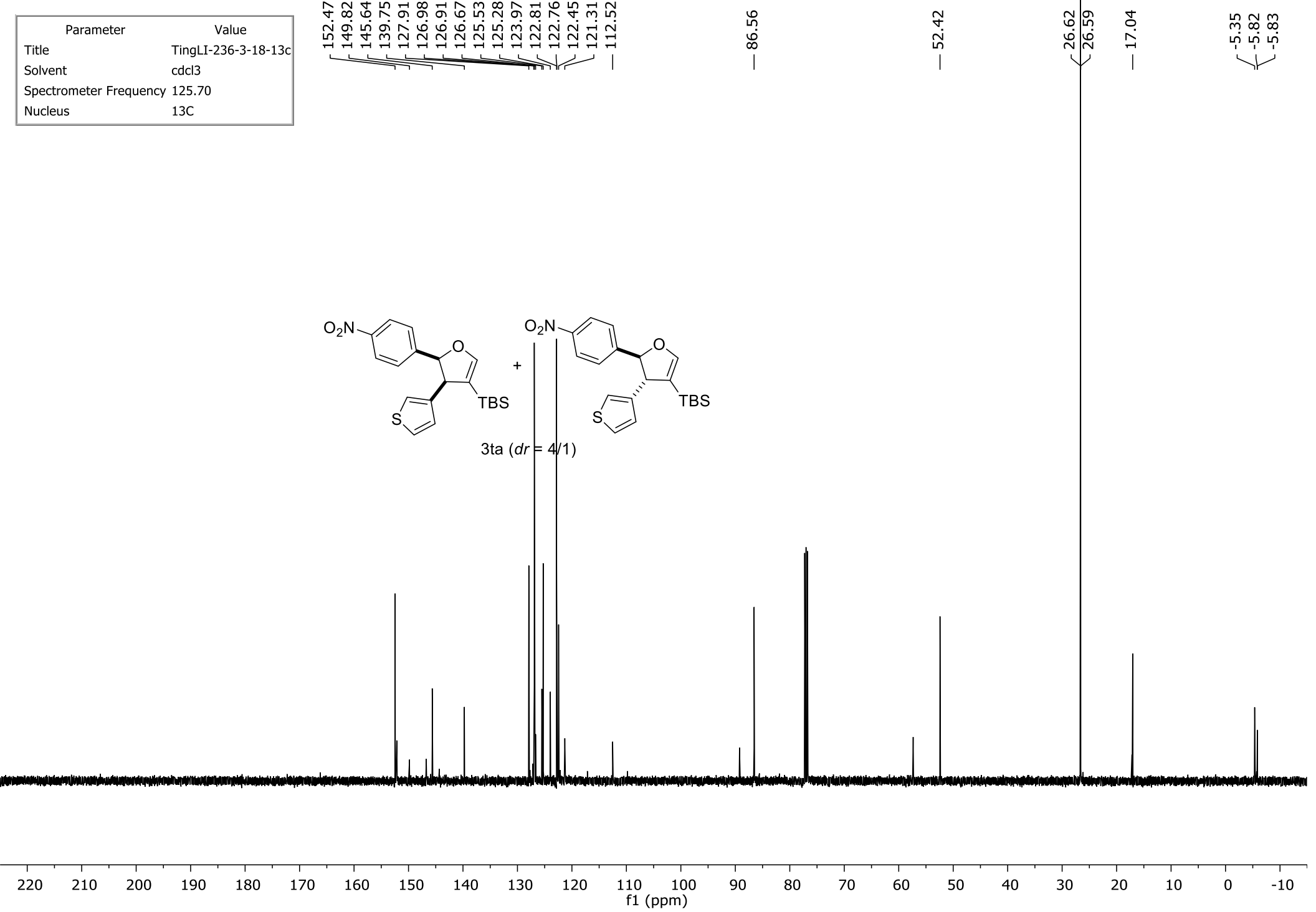

Parameter Value
Title
Solvent cdcl3
Spectrometer Frequency 499.85
Nucleus 1H
7.87 7.86 7.86 7.85 7.85 7.84 7.84 7.83 7.66 7.65 7.64 7.64 7.63 7.63 7.63 7.48 7.47 7.46 7.45 7.41 7.40 7.40 7.39 7.38 7.38 7.38 7.38 7.37 7.37 7.36 7.36 7.35 7.35 7.34 7.34 7.34 7.29 7.28 7.28 7.28 7.27 7.26 7.26 7.25 7.25 6.93 6.91 6.80 6.79 5.86 5.85 4.49 4.49 4.47 4.47 0.90 0.03 -0.46
O2N
O
TBS
cis-3sa
O2N
O
TBS
3sa'
2.06 2.09 1.02 2.98 2.40 0.94 0.97 0.96 1.00 8.98 3.01 3.03
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 -1.0
f1 (ppm)

Parameter	Value
Title	TingLI-208-8-1-13C
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C

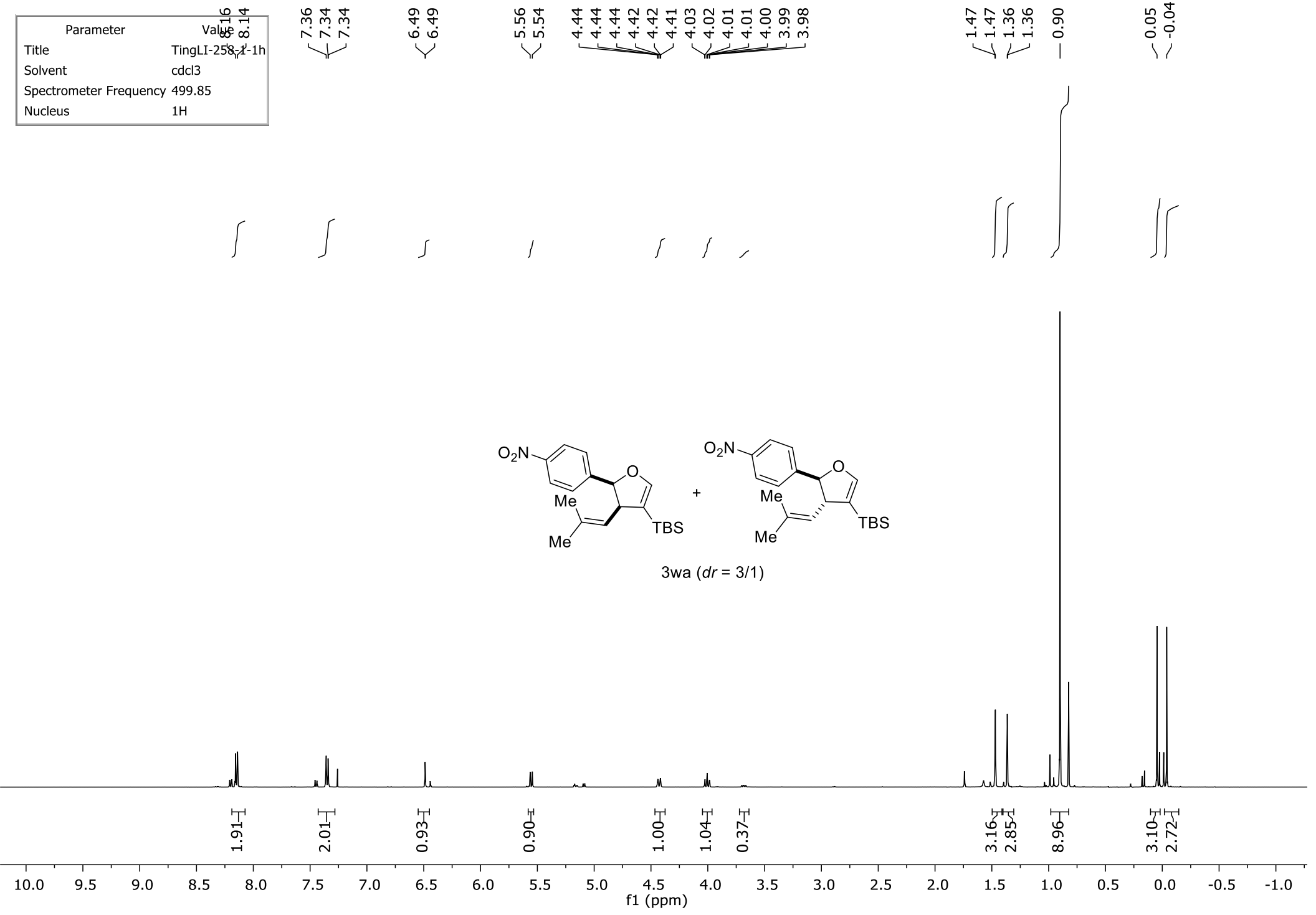



Parameter Value
Title TingLi-236-3-18-1h
Solvent cdcl3
Spectrometer Frequency 499.85
Nucleus 1H
8.22 8.20 7.99 7.98 7.98 7.97 7.96 7.96 7.43 7.43 7.41 7.41 7.26 7.26 7.26 7.25 7.25 7.24 7.24 7.24 7.24 7.23 7.01 7.00 7.00 6.92 6.92 6.91 6.91 6.70 6.70 6.69 6.69 6.67 6.67 6.61 6.60 6.45 6.45 6.44 6.44 5.69 5.67 5.39 5.38 4.41 4.41 4.39 4.39 0.89 0.04 -0.32
O2N
O
TBS
S
+
3ta (dr = 4/1)
3ta'
1.97 2.00 0.92 2.01 0.93 0.95 0.24 1.00 8.81 2.82 2.95
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 -1.0
f1 (ppm)

Parameter	Value
Title	TingLI-236-3-18-13c
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C



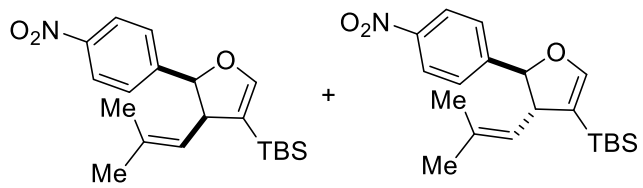
Parameter	Value
Title	TingLI-258-1-1h
Solvent	cdcl3
Spectrometer Frequency	499.85
Nucleus	1H



3wa (*dr* = 3/1)

Parameter	Value
Title	TingLI-258-1-1-13c
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C

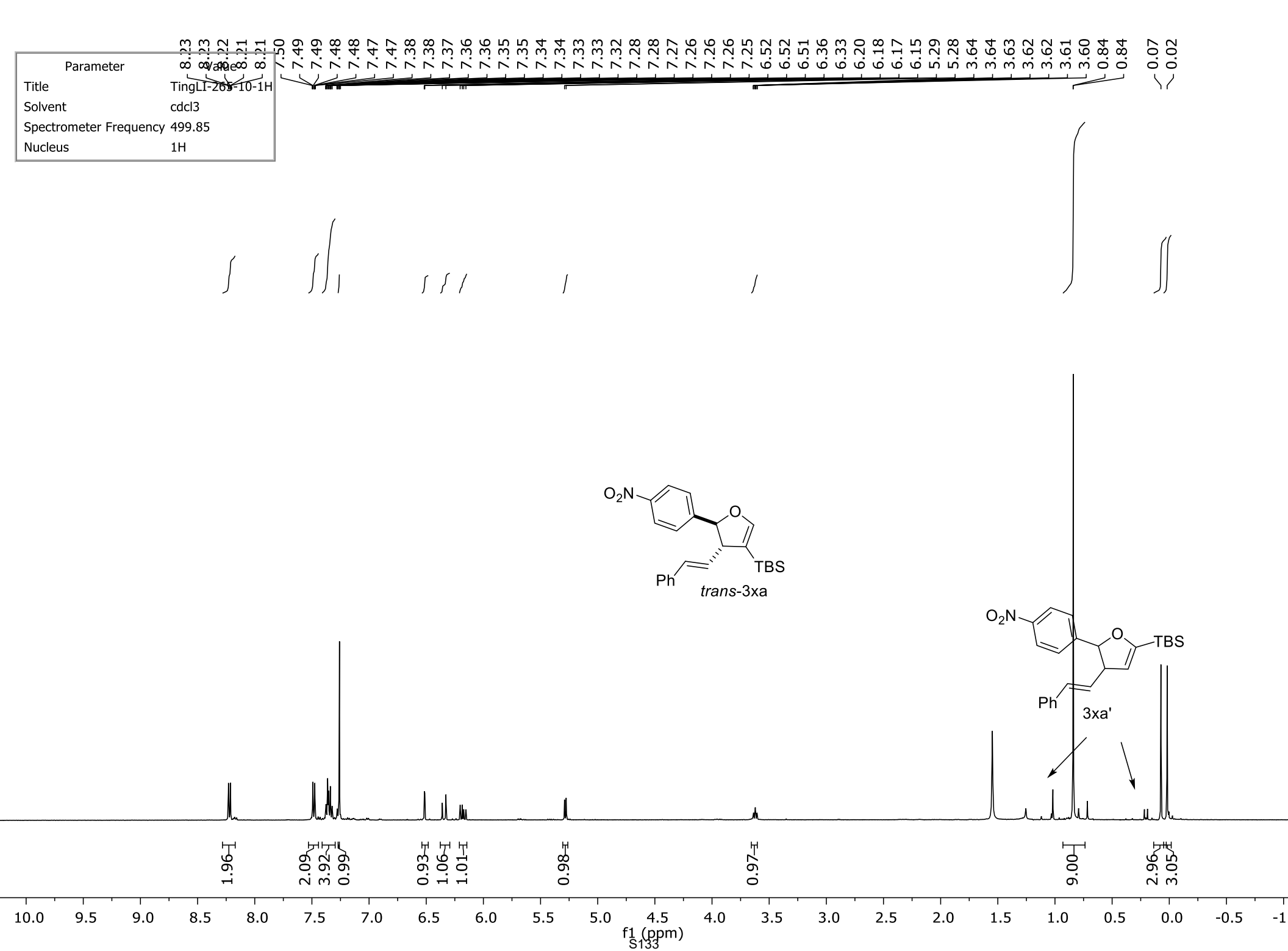
151.98
151.93
146.85
132.46
126.99
125.64
124.66
123.81
122.97
111.44
86.03
49.43
26.73
26.71
25.30
18.00
-5.07
-5.51



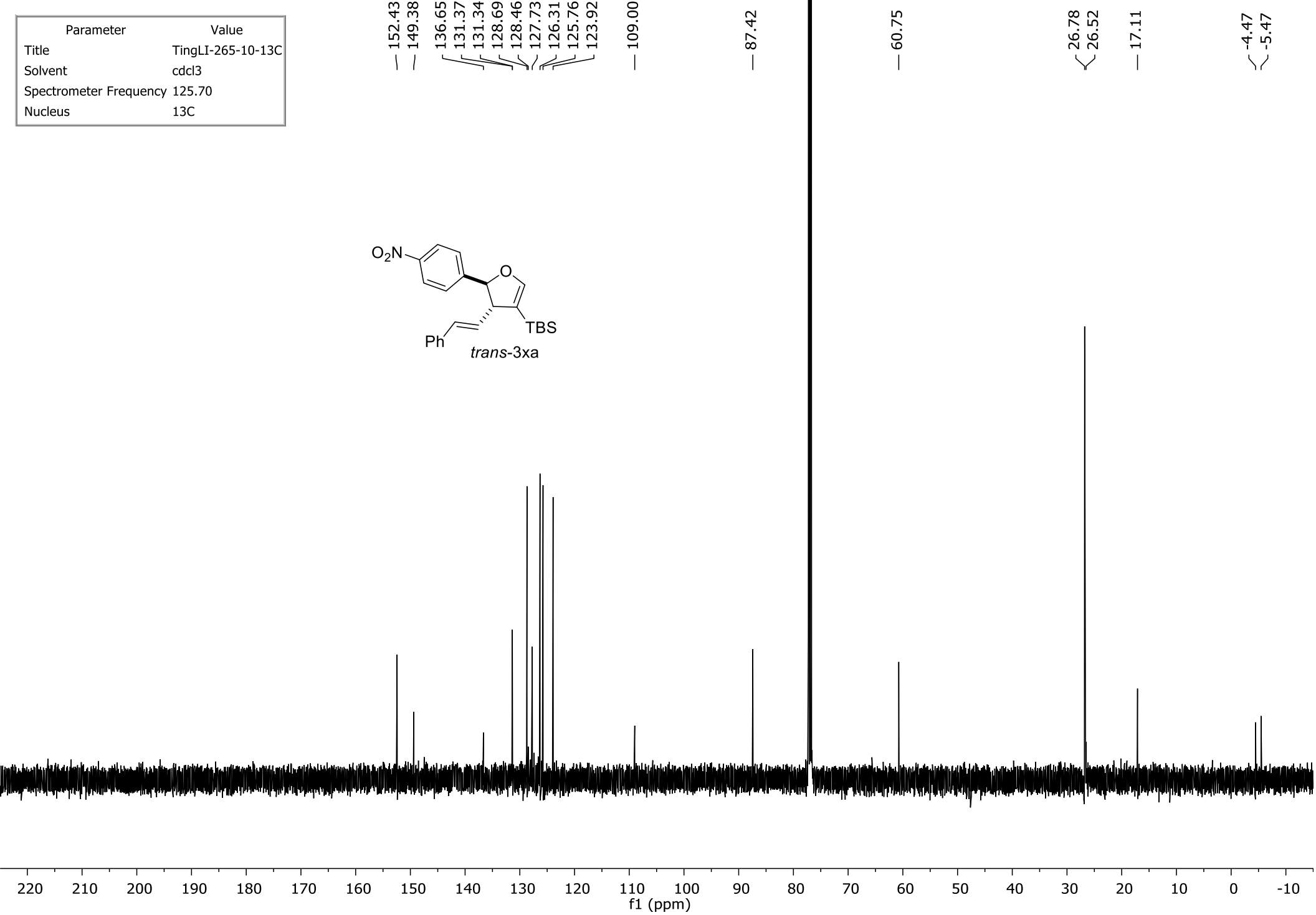
3wa (*dr* = 3/1)

220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

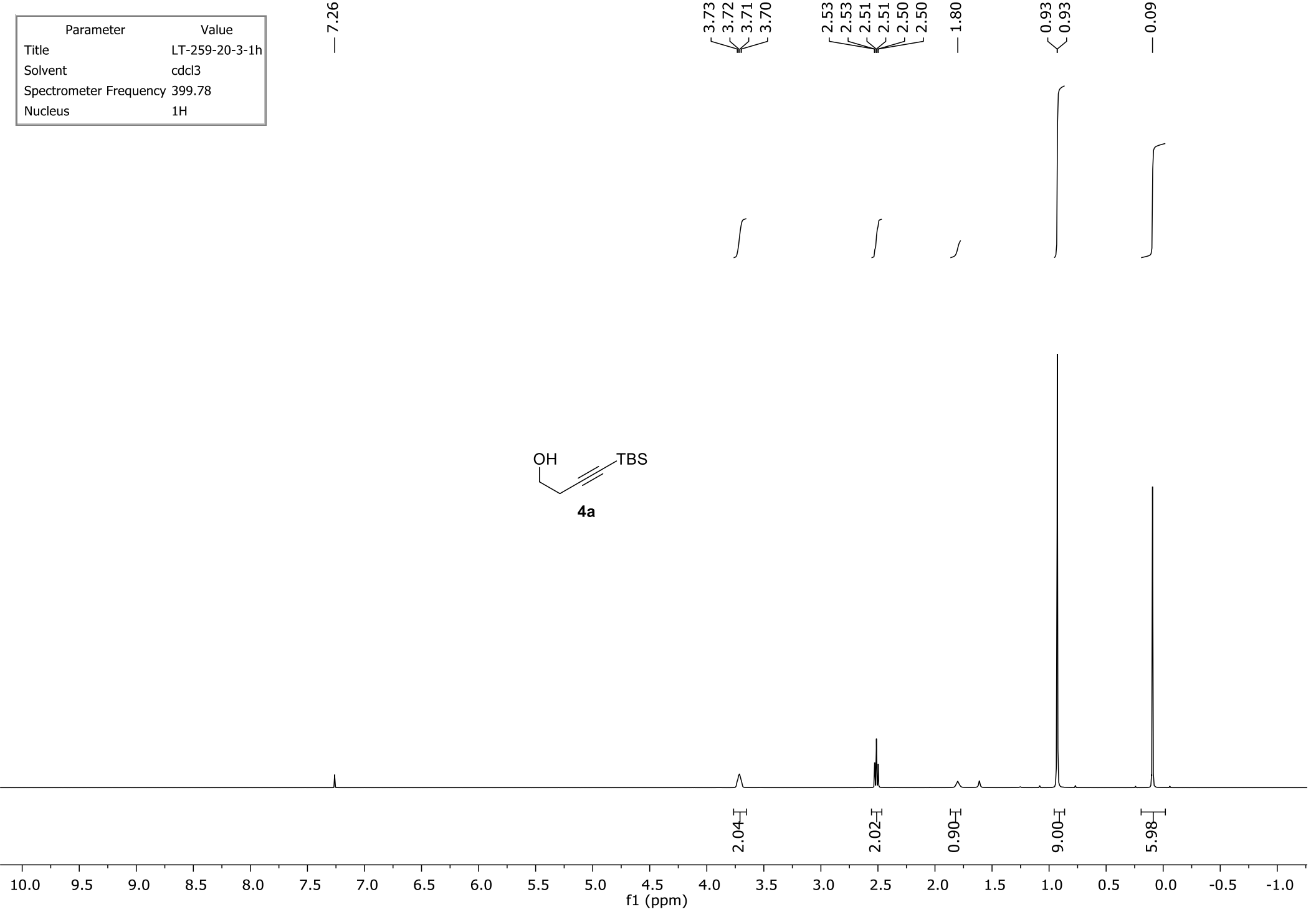
Parameter	Value
Title	TingLI-269-10-1H
Solvent	cdcl3
Spectrometer Frequency	499.85
Nucleus	1H



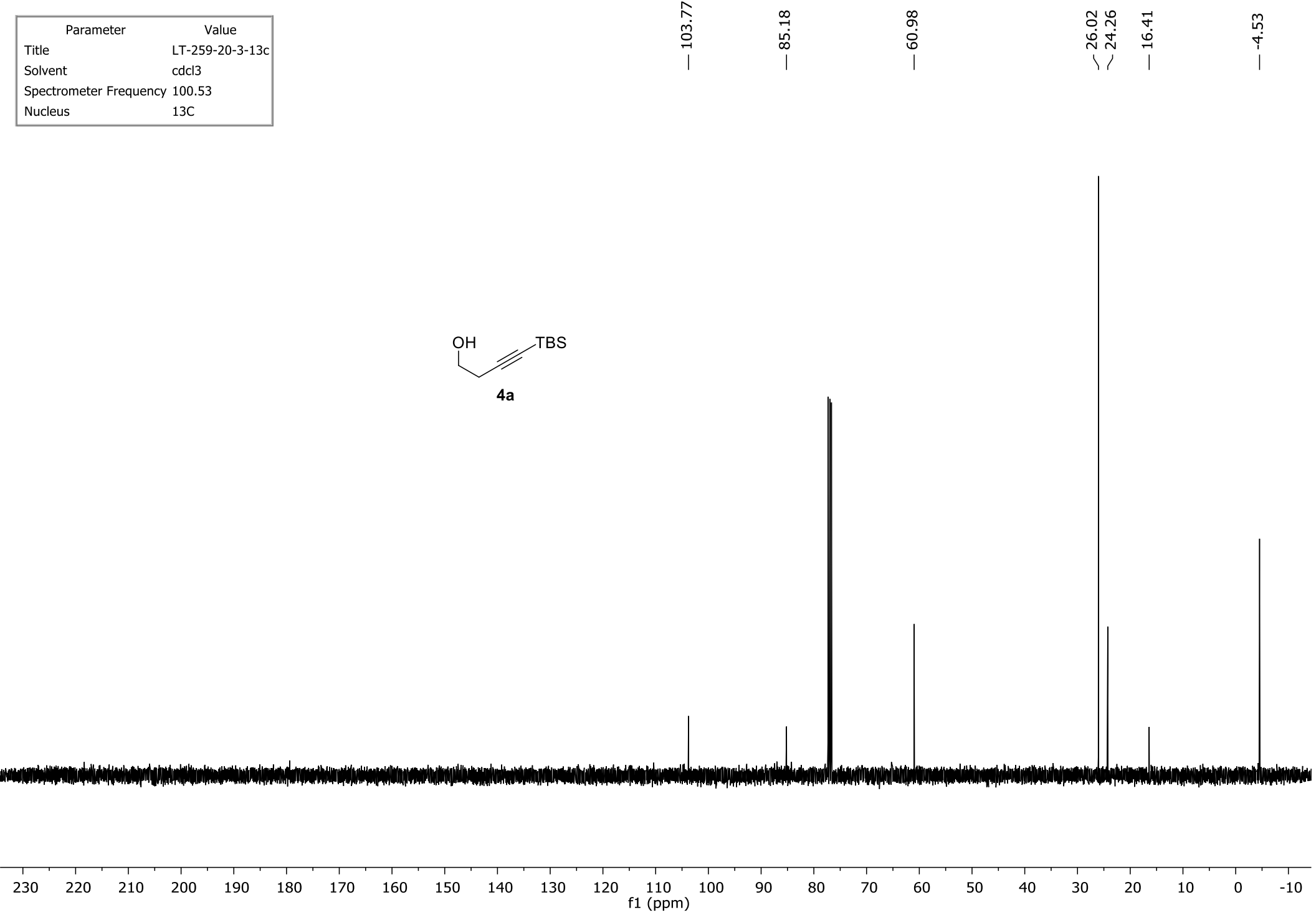
Parameter	Value
Title	TingLI-265-10-13C
Solvent	cdcl3
Spectrometer Frequency	125.70
Nucleus	13C



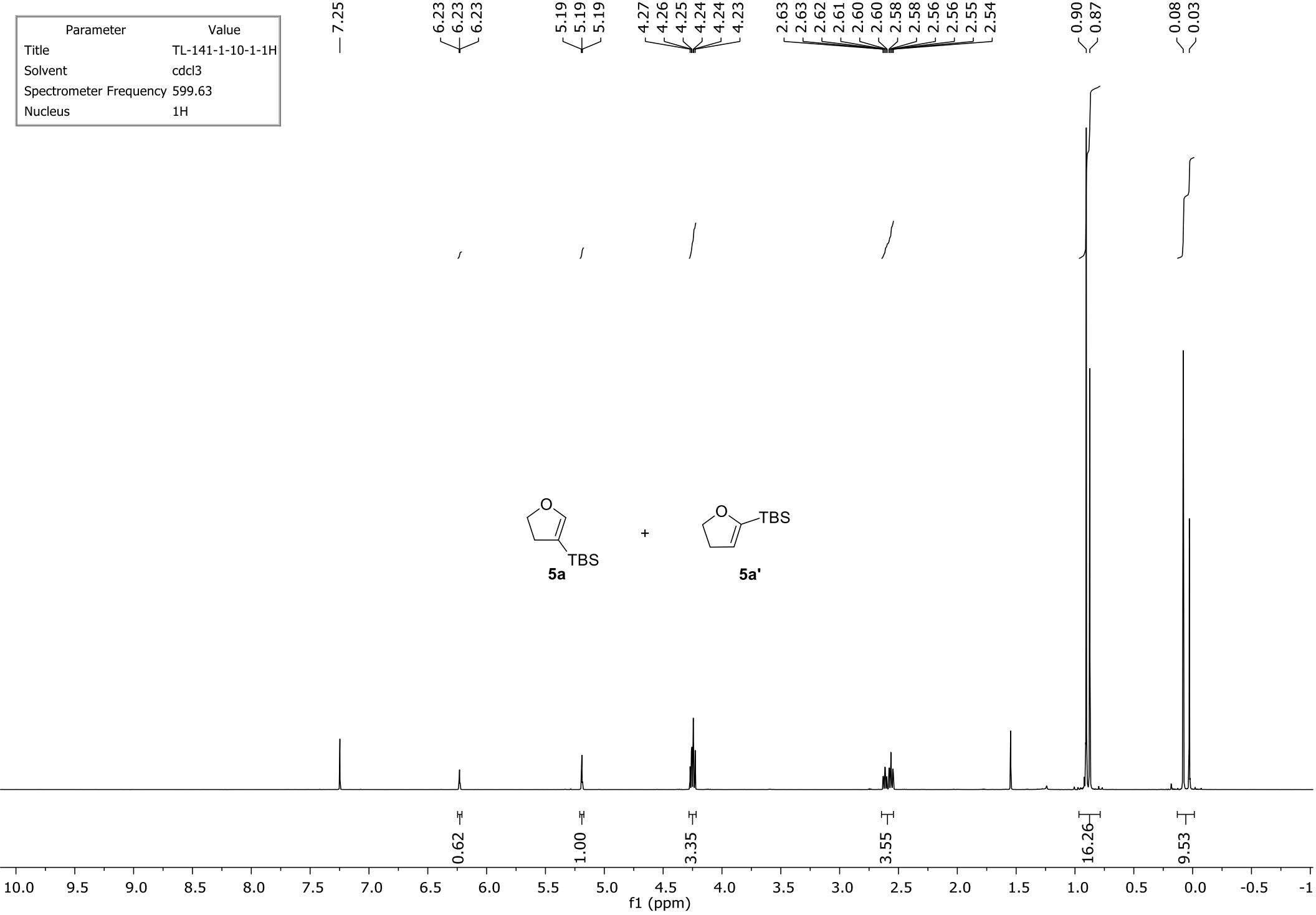
Parameter	Value
Title	LT-259-20-3-1h
Solvent	cdcl3
Spectrometer Frequency	399.78
Nucleus	1H



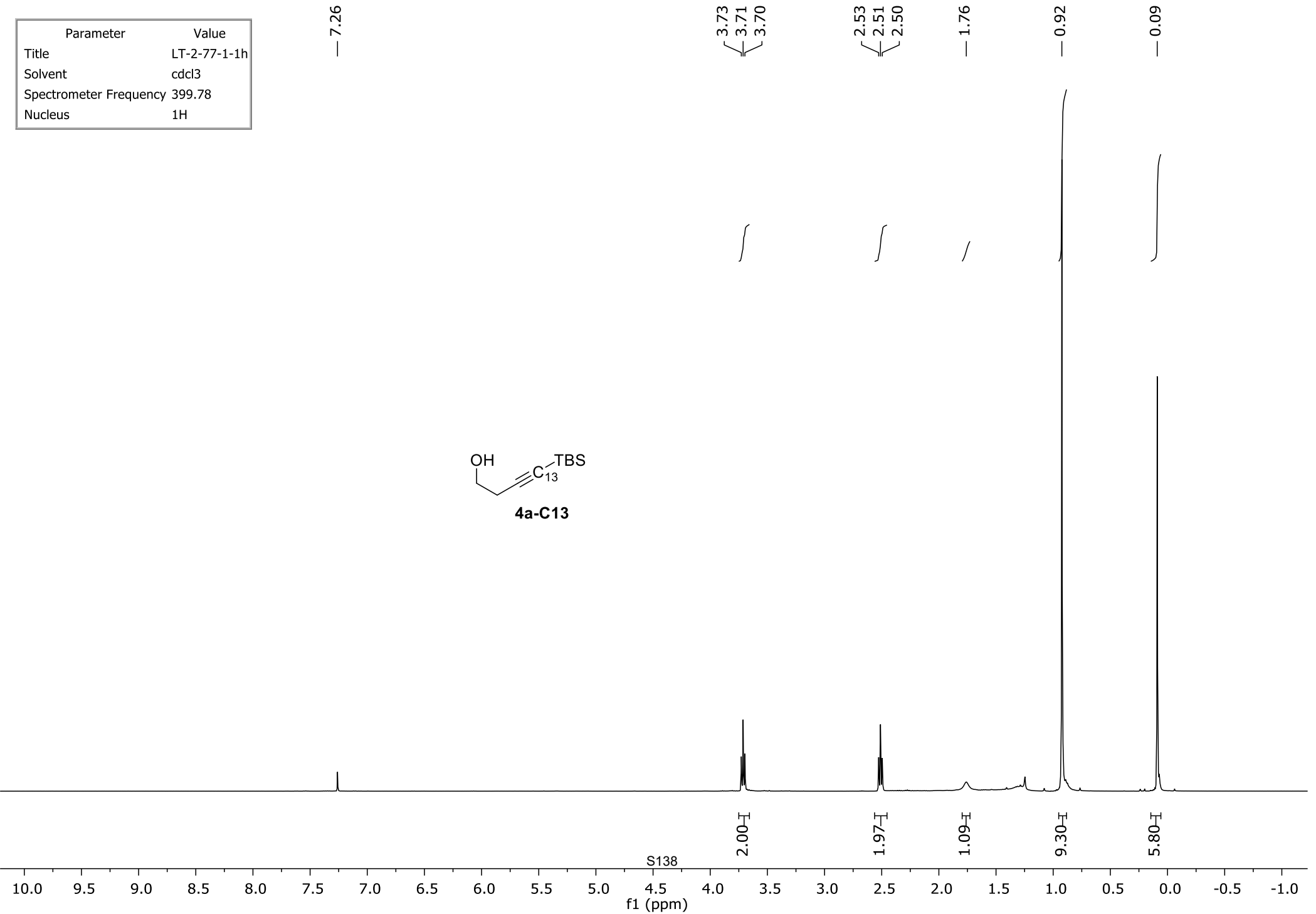
Parameter	Value
Title	LT-259-20-3-13c
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C



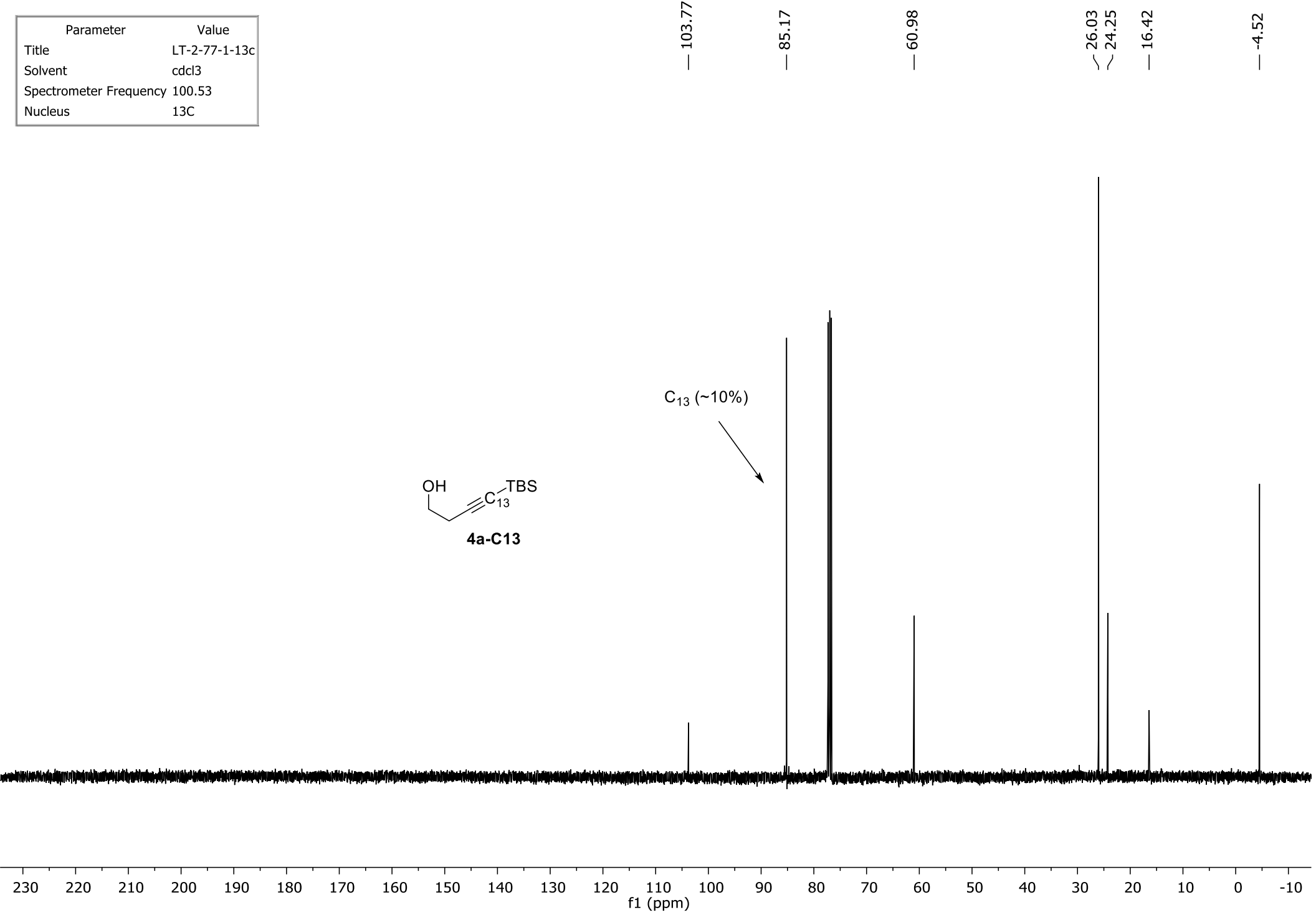
Parameter	Value
Title	TL-141-1-10-1-1H
Solvent	cdcl3
Spectrometer Frequency	599.63
Nucleus	1H



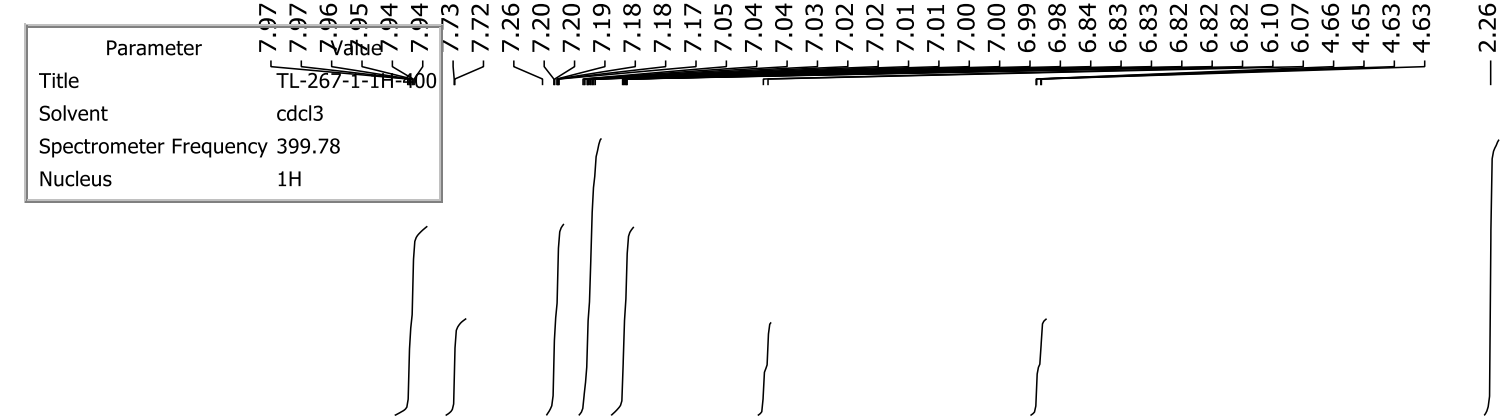
Parameter	Value
Title	LT-2-77-1-1h
Solvent	cdcl3
Spectrometer Frequency	399.78
Nucleus	1H

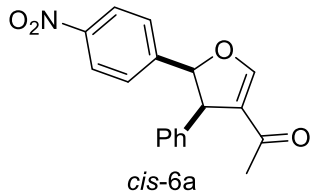


Parameter	Value
Title	LT-2-77-1-13c
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C

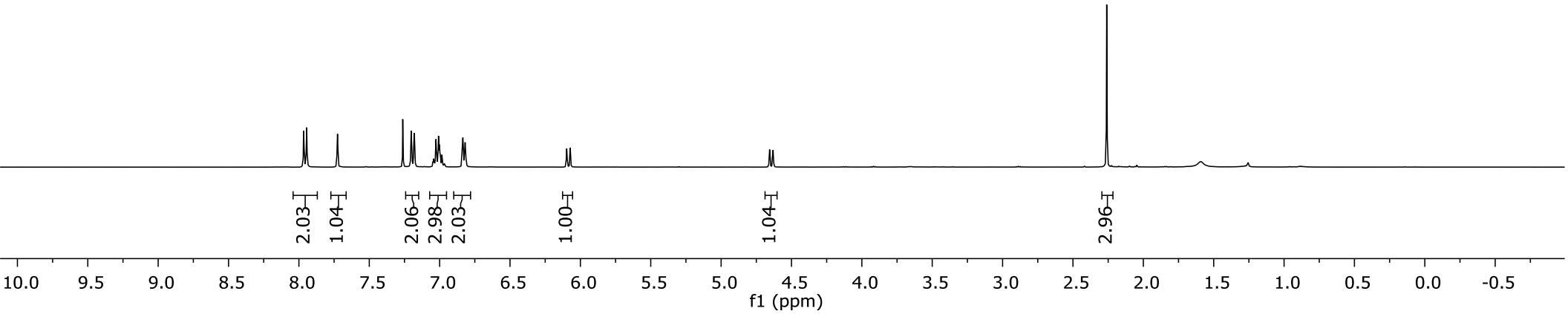


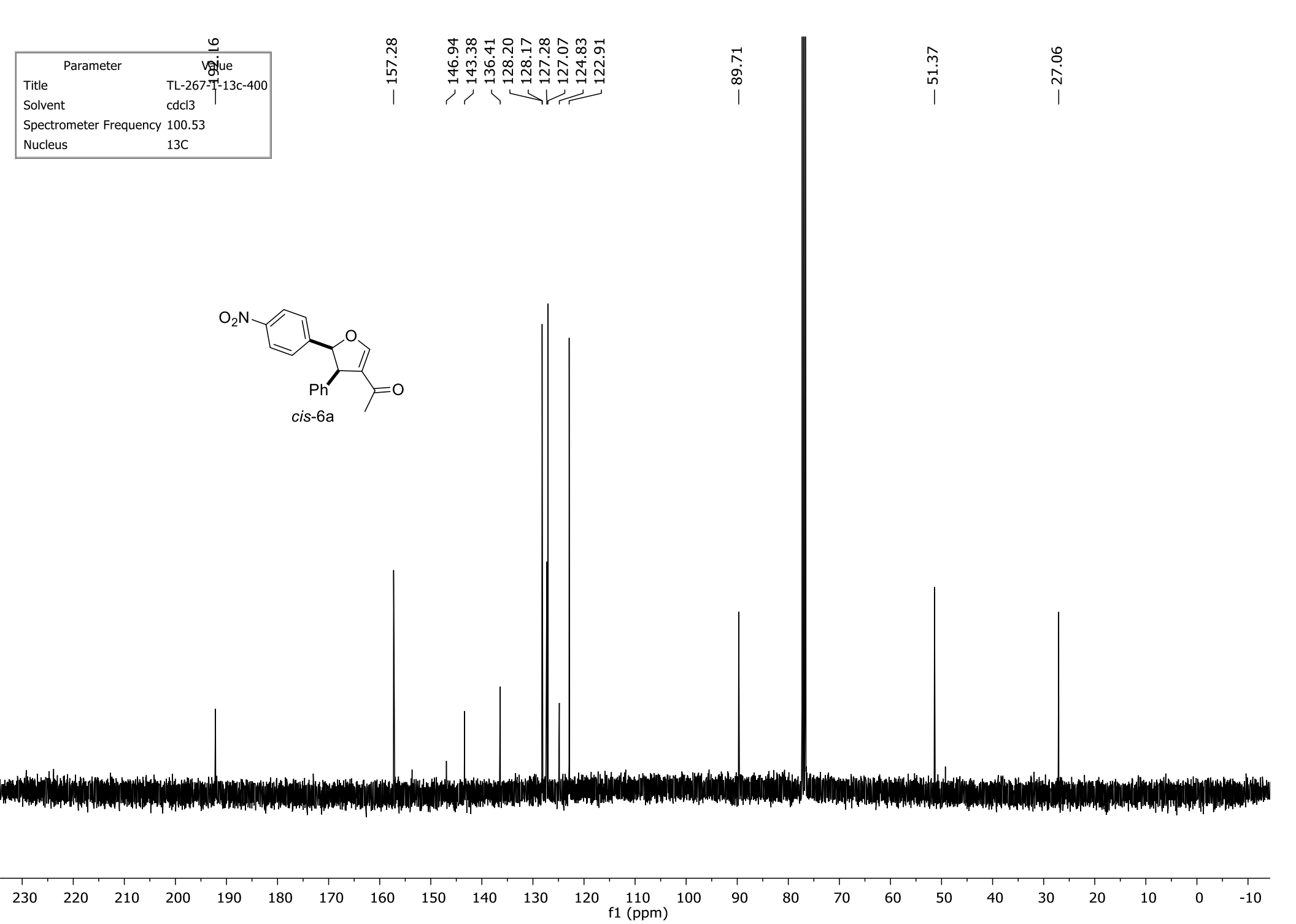
Parameter	Value
Title	TL-267-1-1H-400
Solvent	cdcl3
Spectrometer Frequency	399.78
Nucleus	1H



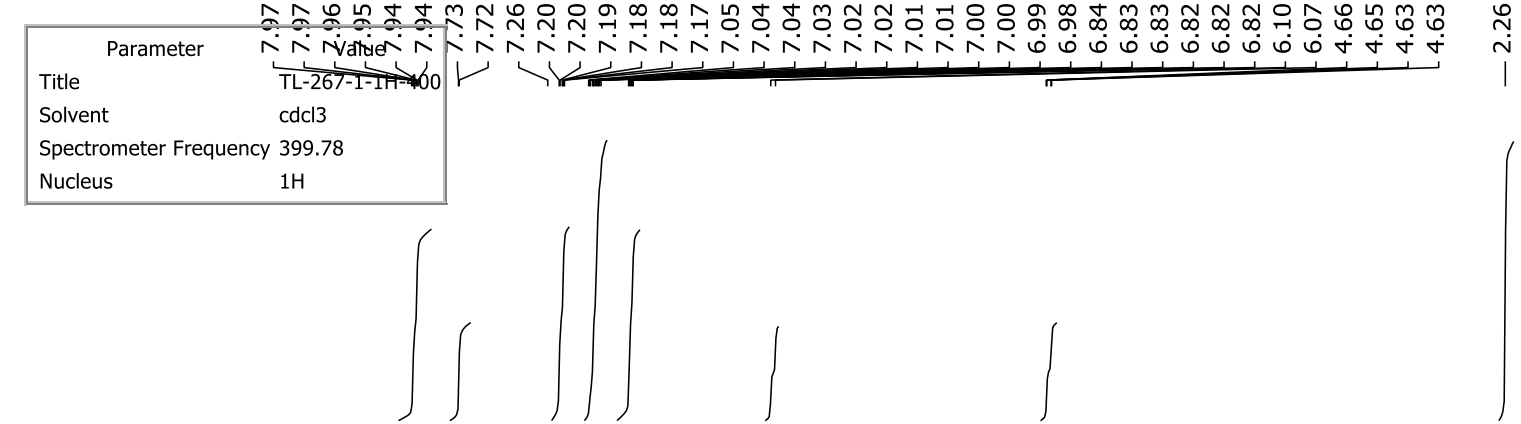


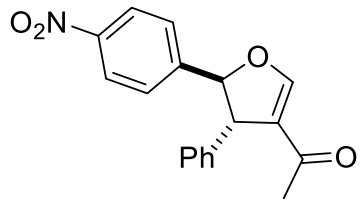
cis-6a



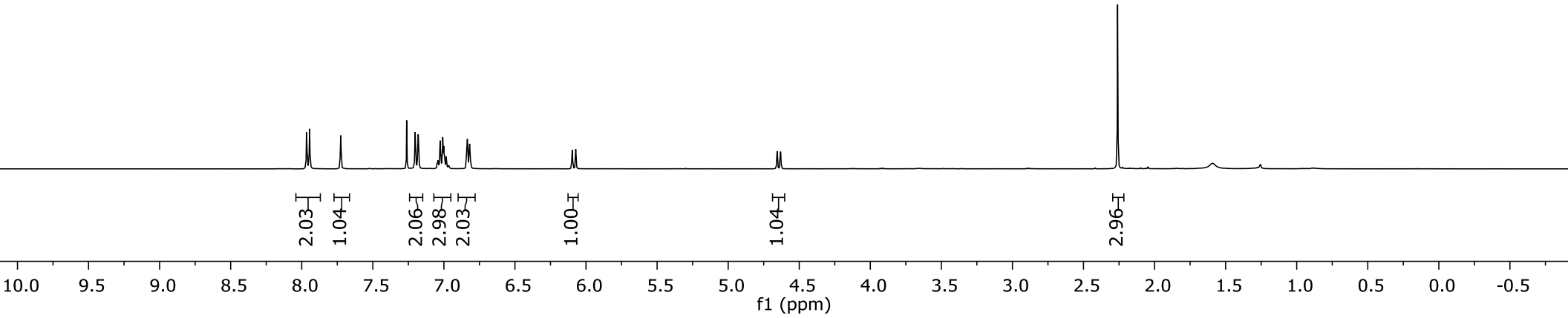

Parameter Value
Title TL-267-1-13c-400
Solvent cdcl3
Spectrometer Frequency 100.53
Nucleus 13C
99.16
157.28
146.94
143.38
136.41
128.20
128.17
127.28
127.07
124.83
122.91
89.71
51.37
27.06
O2N
O
Ph
O
cis-6a
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

Parameter	Value
Title	TL-267-1-1H-400
Solvent	cdcl3
Spectrometer Frequency	399.78
Nucleus	1H

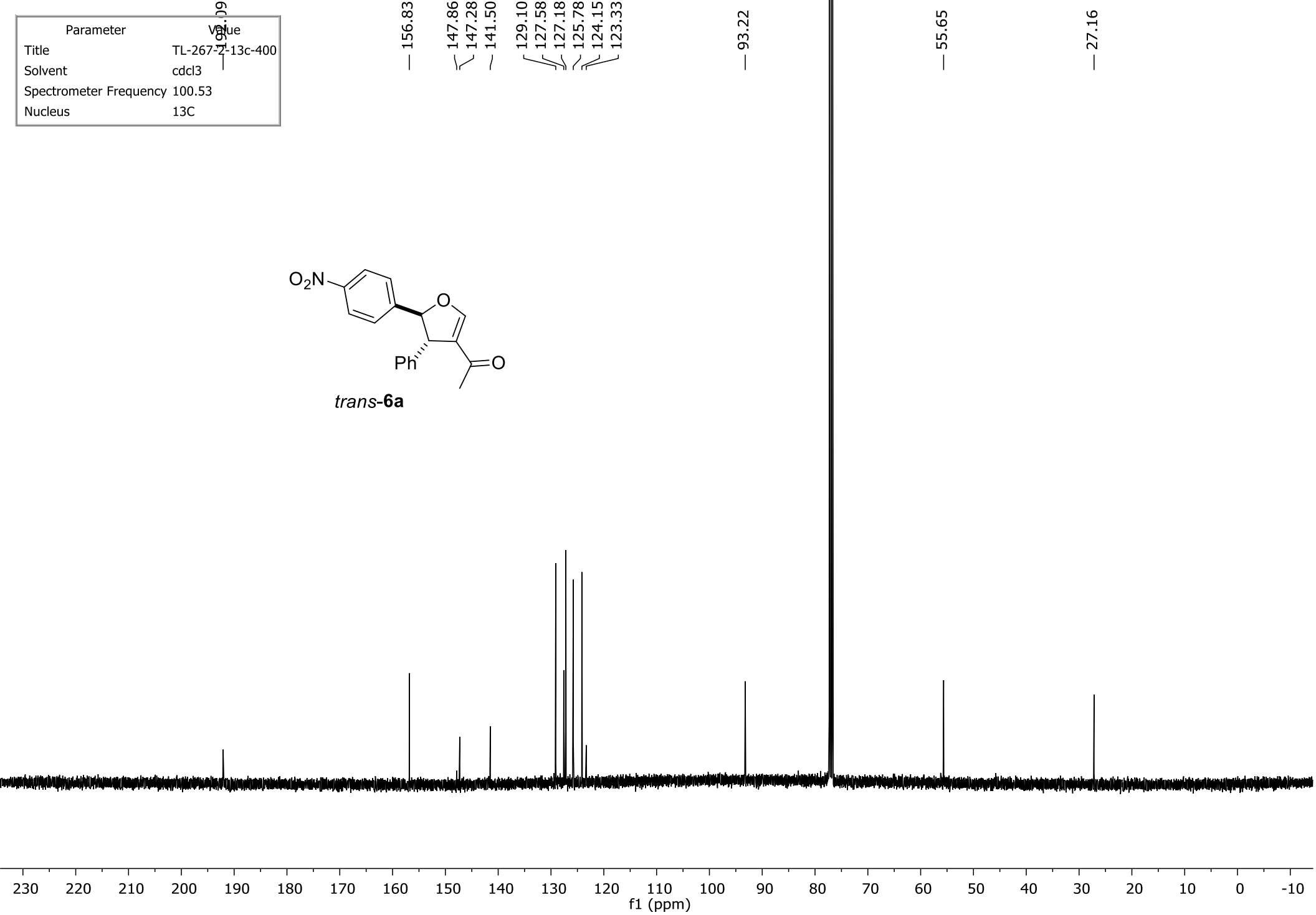




trans-**6a**

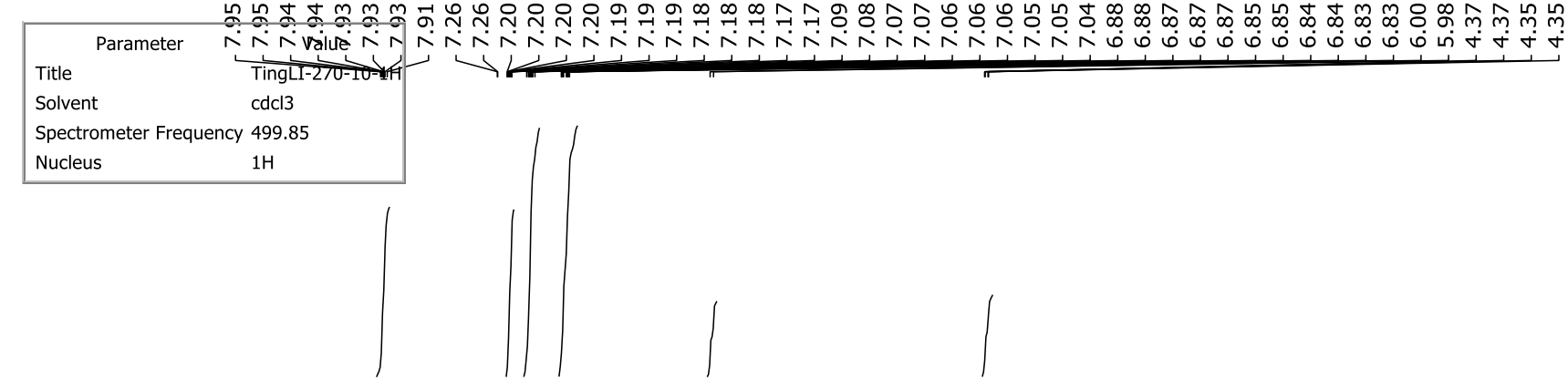


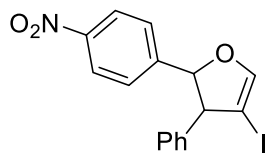
Parameter	Value
Title	TL-267-2-13c-400
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C



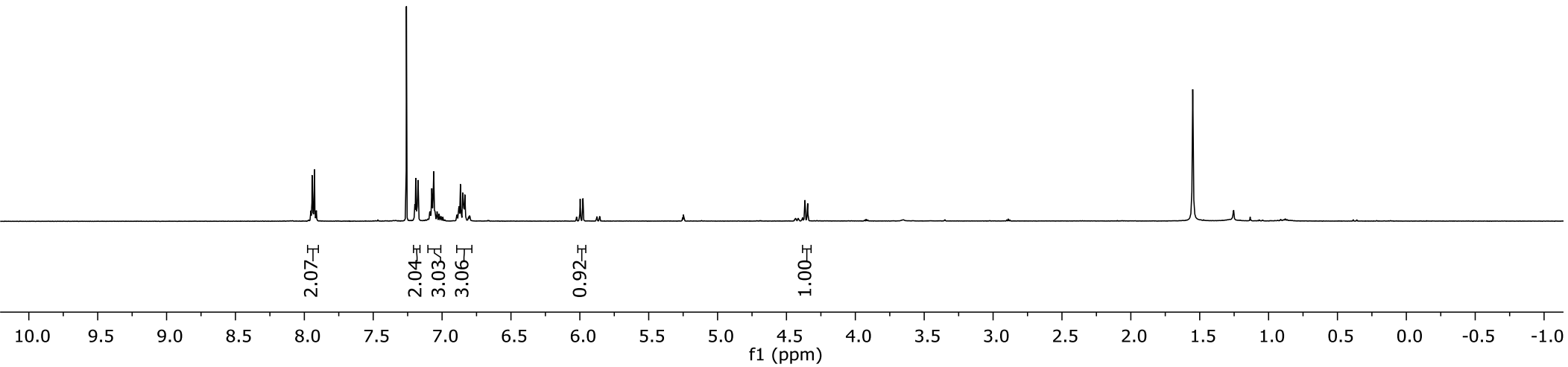
trans-**6a**

Parameter	Value
Title	TingLI-270-10-1H
Solvent	cdcl3
Spectrometer Frequency	499.85
Nucleus	1H



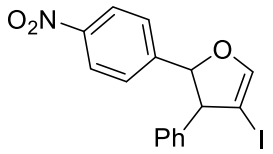


6b



Parameter	Value
Title	LT-270-1-13c
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C

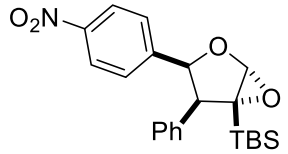
150.27
146.60
144.33
128.82
128.62
128.25
127.63
127.08
122.86
86.08
65.55
59.98



6b

Parameter	Value
Title	TL-272-1 1h 400
Solvent	cdcl3
Spectrometer Frequency	399.78
Nucleus	1H

7.93 7.93 7.92 7.91 7.91 7.90 7.26 7.26 7.23 7.22 7.22 7.22 7.21 7.20 7.20 7.20 7.20 7.19 7.19 7.09 7.08 7.07 7.06 7.05 7.05 7.04 7.03 7.02 7.01 6.94 6.92 6.91 6.85 6.84 6.84 6.83 6.83 5.49 5.44 5.42 3.92 3.90 0.96 -0.18 -0.58



6c

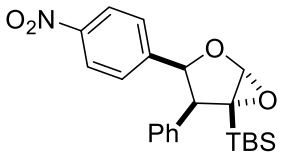
1.99 2.00 3.09 1.04 1.06 1.01 1.01 1.00 8.93 3.08 3.09

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 -1.0

f1 (ppm)

Parameter	Value
Title	TL-272-1-13c-400
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C

146.38
144.88
135.82
130.03
129.07
128.75
128.42
128.22
128.14
127.48
126.85
126.76
123.21
122.80
85.18
79.46
62.98
53.94
26.97
17.92
-6.03
-6.68

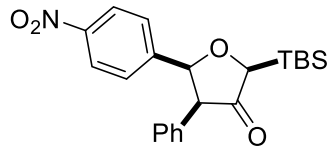


6c

230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

Parameter	Value
Title	TL-276-1-1h-400
Solvent	cdcl3
Spectrometer Frequency	399.78
Nucleus	1H

8.08 8.07 8.06 8.05 7.42 7.41 7.41 7.39 7.39 7.26 7.09 7.09 7.08 7.08 7.06 6.98 6.97 6.96 6.96 6.96 5.62 5.61 4.23 3.96 3.95 1.08 0.12 0.10



6d

1.98 2.09 2.92 1.95 1.00 1.03 1.07 8.93 5.93

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 -1.0

f1 (ppm)

Parameter	Value
Title	TL-276-1-13c-400
Solvent	cdcl3
Spectrometer Frequency	100.53
Nucleus	13C