Accessing Alternative Reaction Pathways of the Intermolecular Condensation between Homo-Propargyl Alcohols and Terminal Alkynes through Divergent Gold Catalysis

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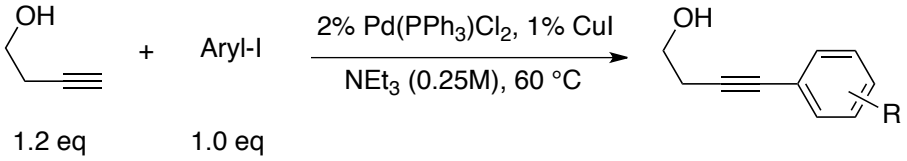
I. Materials and Methods

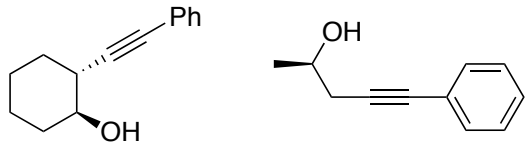
Unless otherwise noted, all reagents and solvents were obtained from a commercial provider and used without further purification. All reactions were run in oven-dried or flame-dried glassware under an atmosphere of N_2. Chloroform was dried over 3Å MS prior to use. ^{1}H- and ^{13}C-NMR data was recorded on an Agilent 400 or 500 MHz NMR spectrometer. Reaction monitoring was carried out using either ^{1}H-NMR or analytical thin-layer chromatography. Analytical thin-layer chromatography was performed with pre-coated, glass-baked plates (250μ) and visualized by fluorescence or charring with potassium permanganate stain. Flash column chromatography was performed on 230-430 mesh silica gel. Chemical shifts for starting materials and products were recorded relative to internal TMS (0.00 ppm) for ^{1}H-NMR and $CDCl_3$ (77.00 ppm) for ^{13}C-NMR data. HRMS were recorded on a LTQ-FTUHRA spectrometer.

1.1: General coupling procedure for synthesizing compounds 1a-1j, 1l.



Aryl-substituted homopropargyl alcohols (**1a-1j**; **1l**) were synthesized according to a modified literature procedure.[1] To a flame-dried flask was added aryl-iodide (1.0 eq, 4 mmol), alkynol (1.2 eq, 4.8 mmol), and triethylamine (0.25M). The mixture was placed under inert atmosphere and $Pd(PPh_3)Cl_2$ (2 mol %, 0.08 mmol) then CuI (1 mol %, 0.04 mmol) were sequentially added. The reaction was heated to 60 °C and stirred for 2-12 h, monitoring by TLC until completion. The crude was filtered through a short pad of silica, eluting with EtOAc (2 x 50 mL), then concentrated *in vacuo*. The mixture was purified via flash column chromatography on silica gel (eluting with 3:1 hexanes/ethyl acetate) to afford the corresponding aryl-substituted alkynols.

1.2: General procedure for synthesizing compounds 1p, 1q.

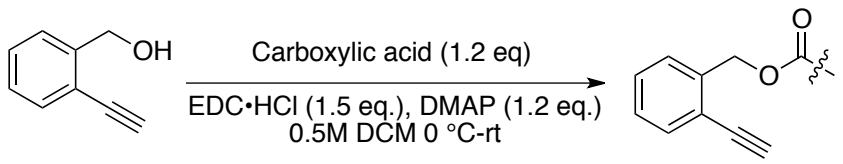


1p **1q**

Chiral aryl-substituted homopropargyl alcohols (**1p, 1q**) were synthesized according to literature procedure.[2]

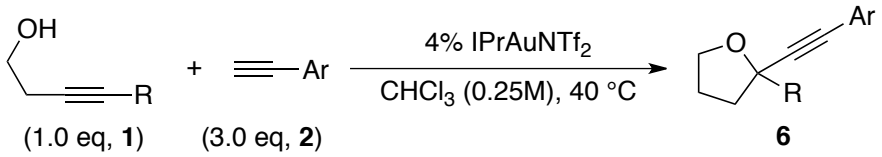
[1] D. Y. Li, H. J. Chen, and P. N. Liu, *Agnew. Chem.* 2016, **128**, 381.
[2] R. D. Grigg, J. W. Rigoli, S. D. Pearce, and J. M. Schomaker, *Org. Lett.* 2012, **14**, 280.

1.3: General EDC coupling procedure for synthesizing compounds 2p, 2q, 2s, 2t.



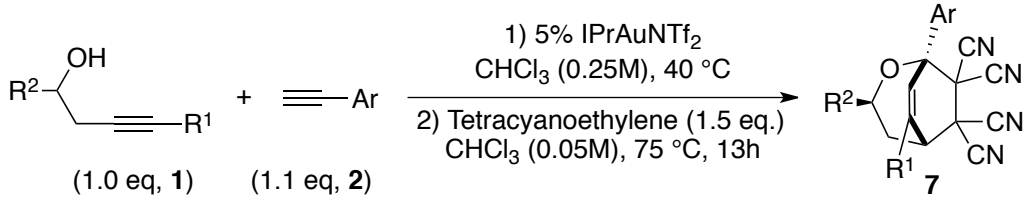
To an oven-dried flask was added the corresponding carboxylic acid (1.2 eq, 4.8 mmol) in dichloromethane (0.5M). DMAP (1.2 eq, 4.8 mmol) then alcohol (1.0 eq, 4.0 mmol) were added sequentially. The mixture was cooled to 0 °C. After cooling, EDC•HCl (1.5 eq, 6.0 mmol) was added slowly and the reaction was stirred at 0 °C for 5 minutes. The mixture was warmed to room temperature and stirred until completion, monitoring by TLC. The reaction was then diluted with water (20 mL), extracted with DCM (3 x 15 mL), and washed with brine (5 mL). The mixture was purified via flash column chromatography on silica gel (eluting with 5:1 hexanes/ethyl acetate) to afford the corresponding alkynes.

1.3: General procedure A for synthesizing compounds 6.



To a 2 mL vial charged with $IPrAuNTf_2$ (6.9 mg, 0.008 mmol) was sequentially added $CHCl_3$ (0.8 mL), **1** (1.0 eq, 0.2 mmol), and **2** (3.0 eq, 0.6 mmol). The reaction mixture was purged with argon for at least 1 minute and then stirred at 40 °C. After the reaction is complete (0.25h-7h), the mixture was directly purified via flash column chromatography on silica gel or by preparatory TLC to afford the desired product.

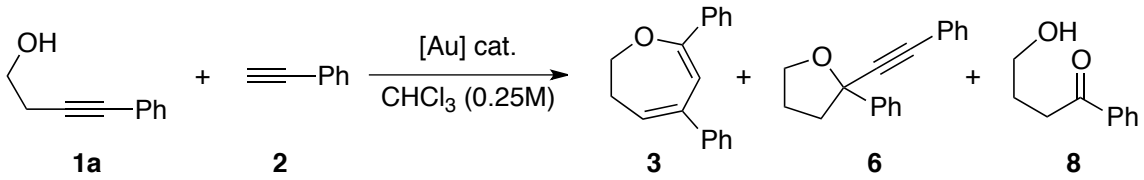
General procedure B for synthesizing compounds 7.



To a 2 mL vial charged with $IPrAuNTf_2$ (17.33 mg, 0.02 mmol) was sequentially added $CHCl_3$ (1.6 mL), **1** (1.0 eq, 0.4 mmol), and **2** (1.1 eq, 0.44 mmol). The reaction mixture was purged with argon for at least 1 minute and then stirred at 40 °C. After the reaction is complete (6h-16h), the mixture was passed through a short silica pad and collected in a

new 5mL-vial. The silica pad was rinsed with 2.0 mL $CHCl_3$. The dienophile was then added (0.6 mmol), the vial sealed securely with parafilm, and the resulting mixture was stirred for 13h at 75 °C. The reaction was concentrated *in vacuo* and purified via flash column chromatography on silica gel with 3:1 hexanes/ethyl acetate as eluent to afford the desired product.

Comprehensive screening table of catalytic conditions.



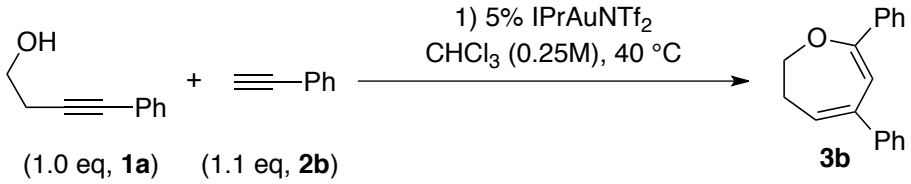
1a **2** **3** **6** **8**

Entry	Conditions	T °C	t (h)	eq 2	convn (%)	yield (%)[a] 3	6	8
1	5% [XPhosAu(TA)]OTf, 1% $Cu(OTf)_2$, $PhCH_3$	rt	24h	3	100	>5%	n.d.	n.d.
2	5% $RuPhosAuNTf_2$	rt	12h	3	100	n.d.	47	n.d.
3	5% $RuPhosAuNTf_2$	40	4h	3	100	n.d.	61	n.d.
4	5% $IPrAuNTf_2$	40	4h	3	100	n.d.	91	n.d.
5	5% $IPrAuNTf_2$	40	4h	2	100	56	36	n.d.
6	5% $IPrAuNTTf_2$	40	11h	1.1	100	74	n.d.	n.d.
7	4% $IPrAuNTf_2$	40	4h	3	100	n.d.	87	n.d.
8	1% $IPrAuNTf_2$	40	4h	3	100	n.d.	34	53
9	5% $PPh_3AuCl/AgOTf$	40	4h	3	100	n.d.	32	61
10	5% PPh_3AuCl	40	4h	3	44	n.d.	n.d.	44
11	5% PPh_3AuNTf_2	40	4h	3	100	n.d.	28	64
12	5% $(tBu)_3PAuNTf_2$	40	4h	3	100	n.d.	32	60
13	$(OAr)_3PAuNTf_2$[b]	40	4h	3	100	n.d.	32	58
14	5% $JohnPhosAuNTf_2$	40	4h	3	100	n.d.	27	66
15	5% $XPhosAuNTf_2$	40	4h	3	100	n.d.	22	69
16	5% [RuPhosAu(TA-H)]OTf	40	4h	3	100	n.d.	29	47
17	5% [RuPhosAu(TA-Me)]OTf	40	4h	3	100	n.d.	37	32
18	5% $AuCl_3$	40	4h	3	100	n.d.	n.d.	n.d.
19	10% $AgSbF_6$	40	4h	3	46	n.d.	n.d.	23
20	10% AgOTf	40	4h	3	16	n.d.	n.d.	16

21	10% $In(OTf)_3$	40	4h	3	100	n.d.	<5%	n.d.
22	10% HOTf	40	4h	3	100	n.d.	n.d.	15
23	10% $ZnBr_2$	40	4h	3	45	n.d.	n.d.	38
24	5% CuBr	40	4h	3	0	n.d.	<5%	n.d.
25	5% CuI	40	4h	3	0	n.d.	<5%	n.d.
26	5% $Cu(OTf)_2$	40	4h	3	0	n.d.	<5%	n.d.
27	5% $Pd(OAc)_2$	40	4h	3	0	n.d.	<5%	n.d.

[a] The yield was determined by ^{1}H-NMR using 1,3,5-trimethoxybenzene as the internal standard. [b] Ar = 2,4-Di-^{t}ButylBenzene

II. ^{1}H-NMR Monitoring of Ring Expansion



To a 2 mL vial charged with $IPrAuNTf_2$ (17.33 mg, 0.02 mmol) was sequentially added $CHCl_3$ (1.6 mL), **1a** (1.0 eq, 0.4 mmol), and **2b** (1.1 eq, 0.44 mmol). The reaction mixture was purged with argon for at least 1 minute and then stirred at 40 °C. The yield of the products was determined via 1H-NMR with 1,3,5-trimethoxybenzene as the internal standard.

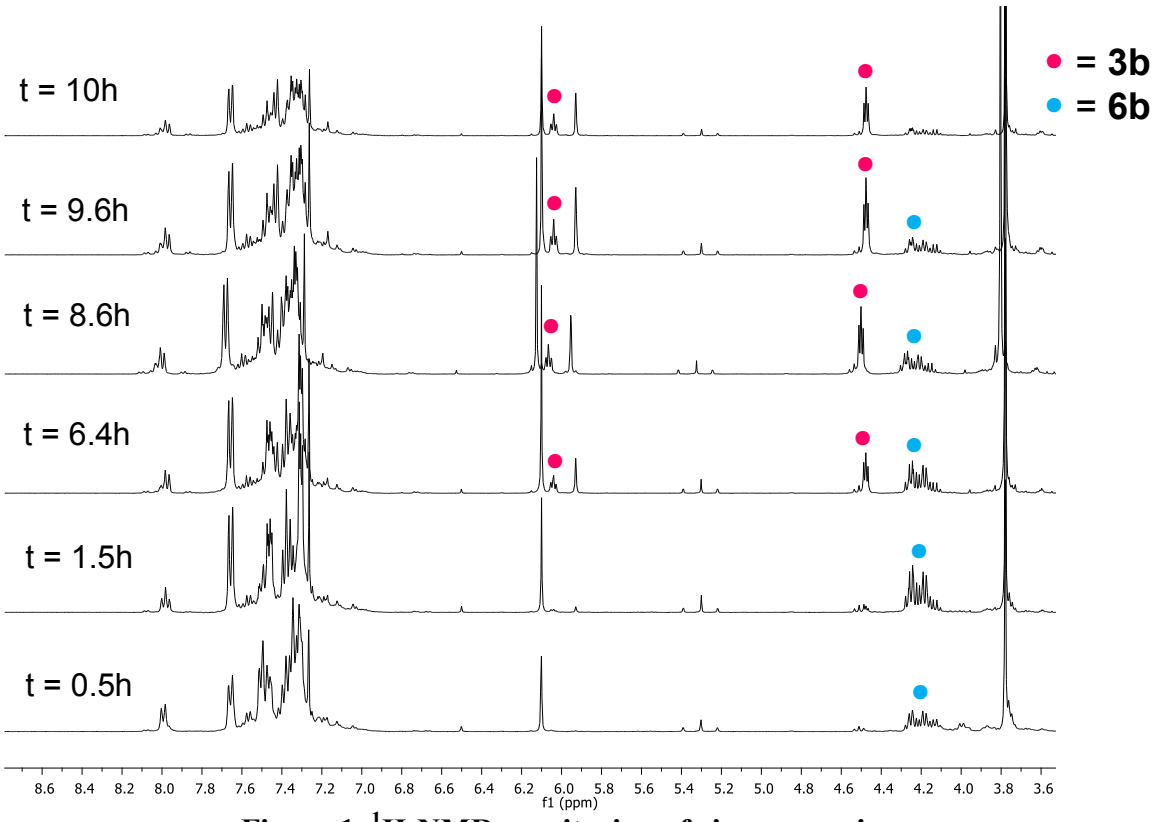


Figure 1. ^{1}H-NMR monitoring of ring expansion

III. X-Ray Crystallographic Data for 6m, 7b, and 7g

The X-ray diffraction data for all compounds were measured on Bruker D8 Venture PHOTON 100 CMOS system equipped with a Cu K_α INCOATEC ImuS micro-focus source (λ = 1.54178 Å). Indexing was performed using *APEX3* [1] (Difference Vectors method). Data integration and reduction were performed using SaintPlus 6.01 [2]. Absorption correction was performed by a multi-scan method implemented in SADABS [3]. Space groups were determined using XPREP implemented in APEX3 [1]. Structures were solved using SHELXS-97 (direct methods) and refined using SHELXL-2014 [4-6] (full-matrix least-squares on F^2) through OLEX2 interface program [7]. All non-hydrogen atoms were refined anisotropically. Hydrogen atoms of -CH and -CH_2 groups were placed in geometrically calculated positions and were included in the refinement process using riding model with isotropic thermal parameters: Uiso(H) = 1.2Ueq(-CH,-CH_2).

Compound 7b: Crystal was a twin. The data have been integrated using two orientation matrices (twin law: -1 0 0 0 -1 0 0.4 0 1) and HKLF5 reflection file was used for refinement.

Compound 7g: The disordered –CF_3 group has been refined using distance (DFIX), angular (DANG) restraints and ADP restraints (RIGU). EADP constraint has been used for closely overlapping atoms C70A and C70B. Crystal data and refinement conditions are shown in Tables 1-3.

[1] Bruker (2016). *APEX3* (Version 2015.9). Bruker AXS Inc., Madison, Wisconsin, USA.
[2] Bruker (2016) SAINT V8.35A. Data Reduction Software.
[3] Sheldrick, G. M. (1996). *SADABS. Program for Empirical Absorption Correction.* University of Gottingen, Germany.
[4] Sheldrick, G.M. (1997) SHELXL-97. Program for the Refinement of Crystal
[5] Sheldrick, G.M. (1990) Acta Cryst. A46, 467-473
[6] Sheldrick, G. M. (2008). Acta Cryst. A64, 112-122.
[7] Dolomanov, O.V.; Bourhis, L.J.; Gildea, R.J.; Howard, J.A.K.; Puschmann, H., OLEX2: A complete structure solution, refinement and analysis program (2009). J. Appl. Cryst., 42, 339-341

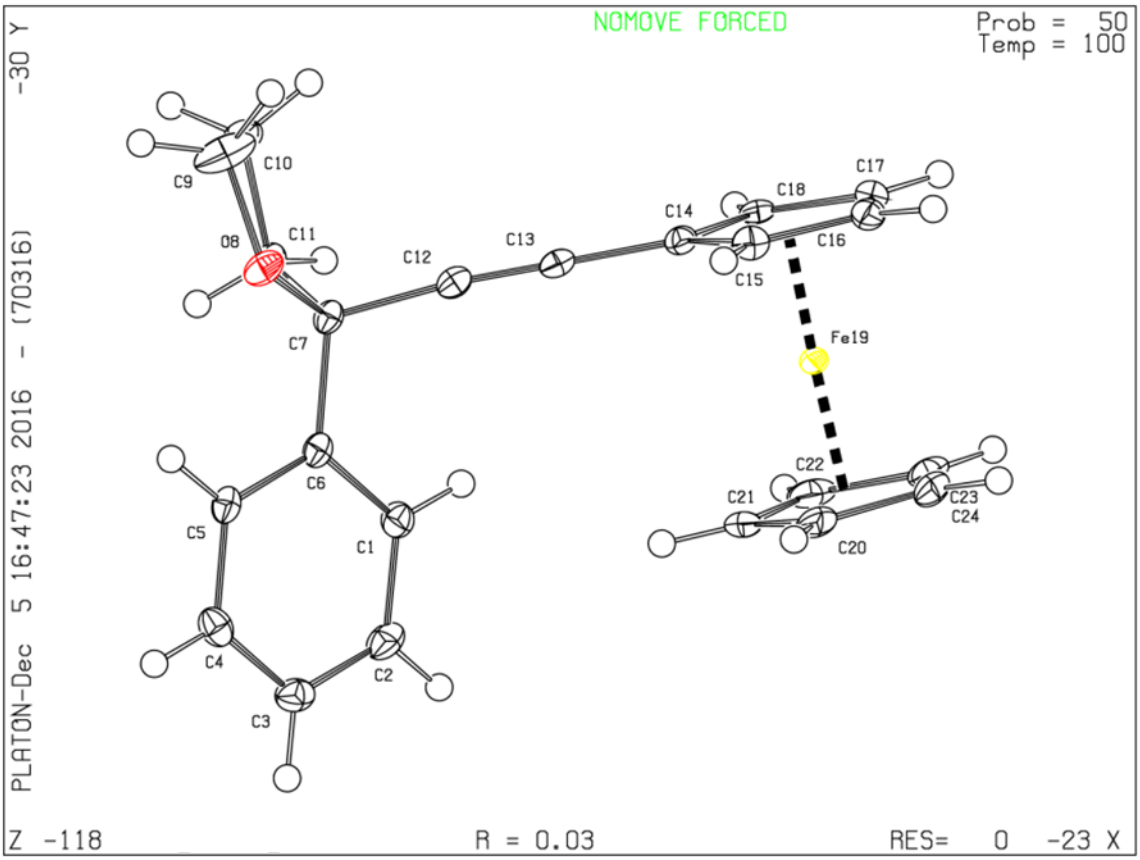


Figure 2. Perspective view of molecular structure $C_{22}H_{20}FeO$ with atom labeling. CCDC 1521359

Table 1. Crystal data and structure refinement for 6m.

Identification code	6m
Empirical formula	$C_{22}H_{20}FeO$
Formula weight	356.23
Temperature/K	100.0
Crystal system	triclinic
Space group	P-1
a/Å	7.2823(2)
b/Å	10.5512(3)
c/Å	11.3059(3)
α/°	92.6290(10)
β/°	100.8210(10)
γ/°	101.1970(10)
Volume/Å^3	833.96(4)
Z	2
ρ_{calc}g/cm^3	1.419
μ/mm^{-1}	7.265
F(000)	372.0
Crystal size/mm^3	0.2 × 0.2 × 0.05
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/°	7.99 to 133.044
Index ranges	$-8 \leq h \leq 8$, $-12 \leq k \leq 12$, $-12 \leq l \leq 13$
Reflections collected	9825
Independent reflections	2911 [R_{int} = 0.0480, R_{sigma} = 0.0440]
Data/restraints/parameters	2911/0/217
Goodness-of-fit on F^2	1.033
Final R indexes [I>=2σ (I)]	R_1 = 0.0329, wR_2 = 0.0734
Final R indexes [all data]	R_1 = 0.0373, wR_2 = 0.0761
Largest diff. peak/hole / e Å^{-3}	0.30/-0.32

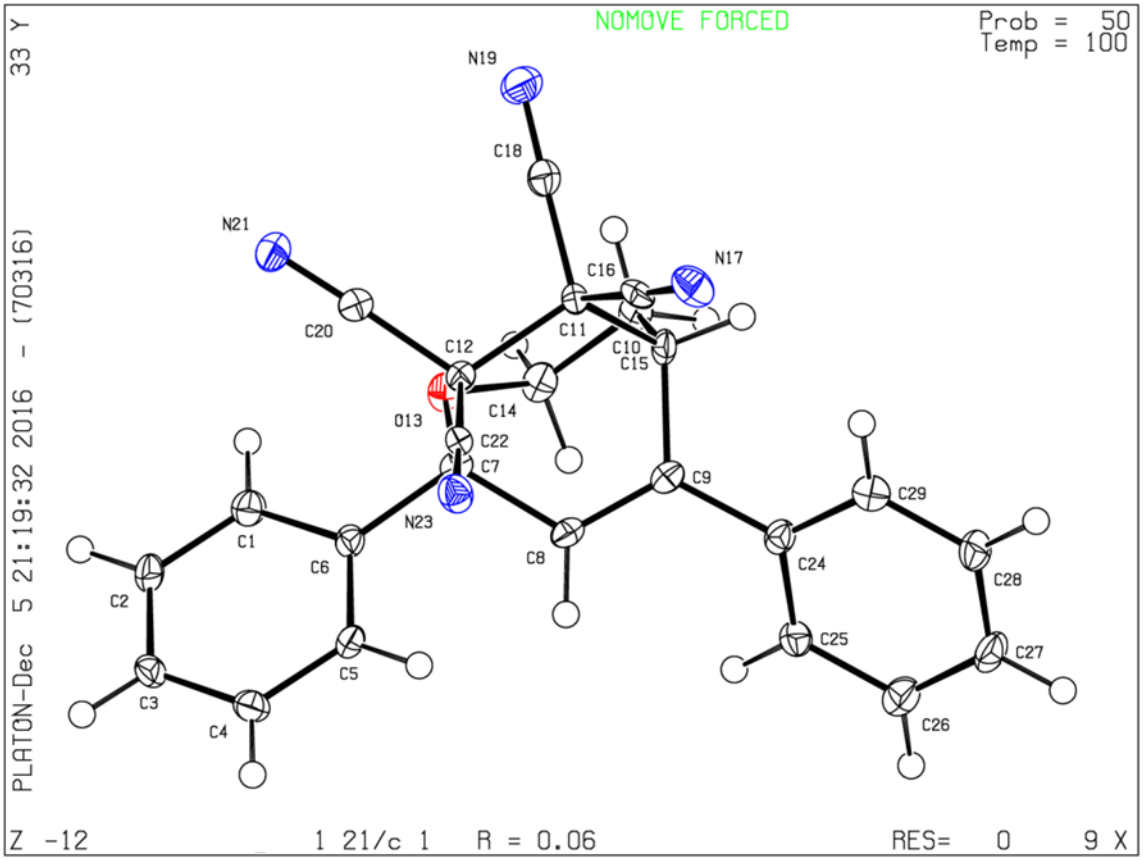


Figure 3. Perspective view of molecular structure $C_{24}H_{16}N_4O$ with atom labeling. CCDC 1521360

Table 2. Crystal data and structure refinement for 7b.

Identification code	7b
Empirical formula	$C_{24}H_{16}N_4O$
Formula weight	376.41
Temperature/K	100.03
Crystal system	monoclinic
Space group	$P2_1/c$
a/Å	14.4429(4)
b/Å	8.4127(2)
c/Å	15.5871(4)
α/°	90
β/°	100.5300(10)
γ/°	90
Volume/Å^3	1862.00(8)
Z	4
ρ_{calc}g/cm^3	1.343
μ/mm^{-1}	0.680
F(000)	784.0
Crystal size/mm^3	0.276 × 0.192 × 0.088
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/°	6.224 to 136.462
Index ranges	$-17 \leq h \leq 17$, $0 \leq k \leq 10$, $0 \leq l \leq 18$
Reflections collected	3385
Independent reflections	3385 [R_{int} = ?, R_{sigma} = 0.0493]
Data/restraints/parameters	3385/0/263
Goodness-of-fit on F^2	1.165
Final R indexes [I>=2σ (I)]	R_1 = 0.0649, wR_2 = 0.1210
Final R indexes [all data]	R_1 = 0.0819, wR_2 = 0.1291
Largest diff. peak/hole / e Å^{-3}	0.26/-0.26

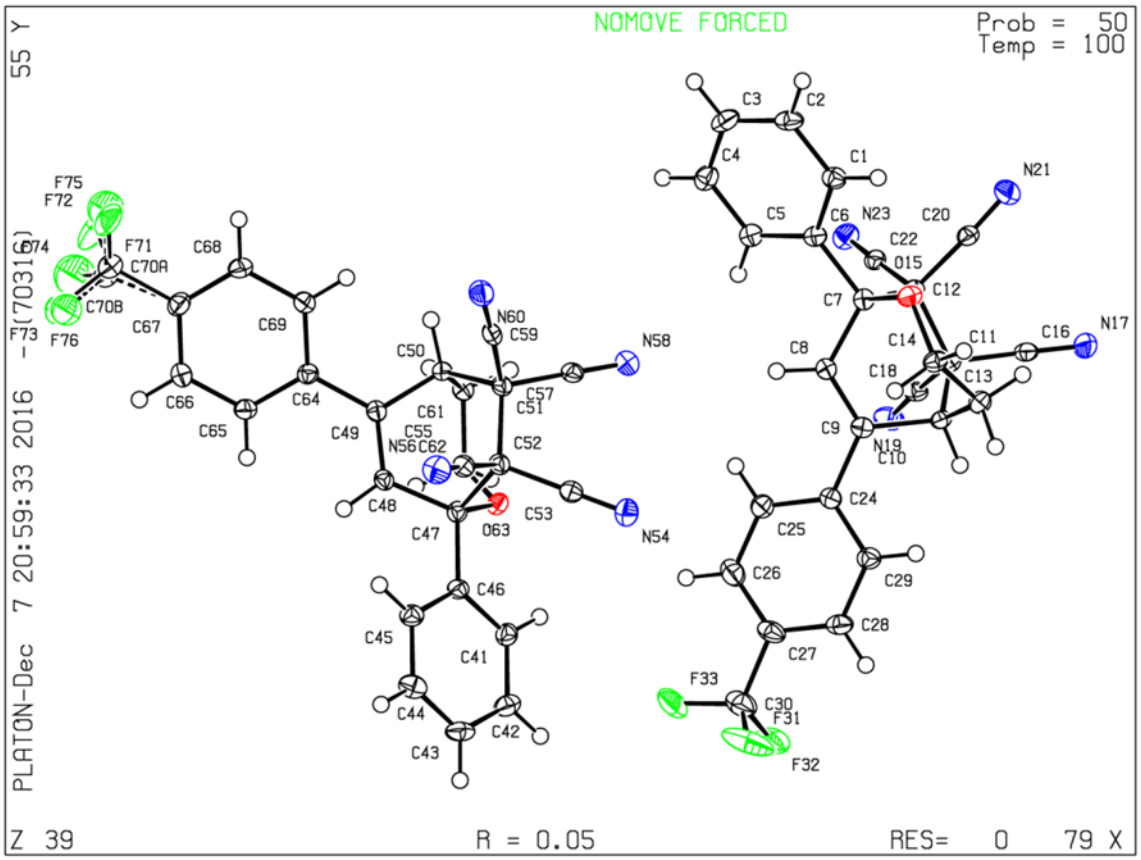
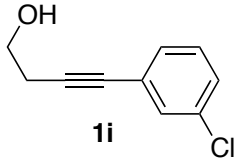


Figure 4. Perspective view of molecular structure $C_{25}H_{15}F_3N_4O$ with atom labeling. CCDC 1521361

Table 3 - Crystal data and structure refinement for 7g.

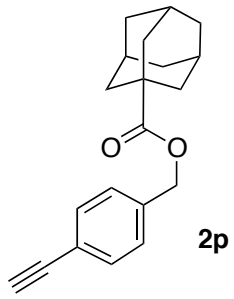
Identification code	7g
Empirical formula	$C_{25}H_{15}F_3N_4O$
Formula weight	444.41
Temperature/K	100.04
Crystal system	triclinic
Space group	P-1
a/Å	10.3921(3)
b/Å	11.9914(3)
c/Å	17.5331(4)
α/°	80.3565(12)
β/°	89.9964(14)
γ/°	76.6551(13)
Volume/Å^3	2094.17(9)
Z	4
ρ_{calc}g/cm^3	1.410
μ/mm^{-1}	0.907
F(000)	912.0
Crystal size/mm^3	0.31 × 0.23 × 0.19
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/°	5.116 to 154.388
Index ranges	$-12 \leq h \leq 13$, $-15 \leq k \leq 15$, $-21 \leq l \leq 22$
Reflections collected	30098
Independent reflections	8427 [R_{int} = 0.0517, R_{sigma} = 0.0460]
Data/restraints/parameters	8427/34/612
Goodness-of-fit on F^2	1.047
Final R indexes [I>=2σ (I)]	R_1 = 0.0463, wR_2 = 0.0938
Final R indexes [all data]	R_1 = 0.0719, wR_2 = 0.1060
Largest diff. peak/hole / e Å^{-3}	0.31/-0.24

IV. Characterization Data



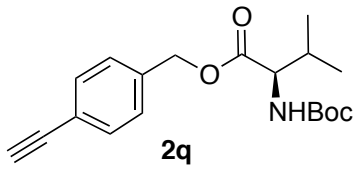
1i

The title compound **1i** was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 3/1) as a pale-yellow oil (621 mg, 86% yield).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.45 – 7.34 (m, 1H), 7.28 – 7.12 (m, 3H), 3.83 – 3.73 (m, 2H), 3.01 (s, 1H), 2.68 – 2.60 (m, 2H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 133.97, 131.52, 129.76, 129.45, 128.14, 125.11, 88.09, 80.88, 60.93, 23.63.
HRMS calculated for $C_{10}H_{10}ClO$ $[M+H]^+$: 181.0420, Found: 181.0402



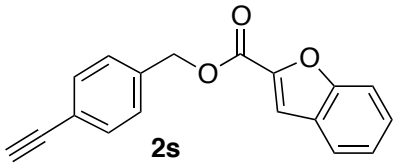
2p

The title compound **2p** was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 5/1) as a white solid (754 mg, 64% yield).
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.55 – 7.39 (m, 2H), 7.30 – 7.21 (m, 2H), 5.07 (s, 2H), 3.05 (s, 1H), 2.05 – 1.54 (m, 15H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 177.31, 137.29, 132.23, 127.47, 121.67, 83.31, 77.44, 65.17, 40.76, 38.80, 36.45, 27.89.
HRMS calculated for $C_{20}H_{23}O_2$ $[M+H]^+$: 295.1698, Found: 295.1674



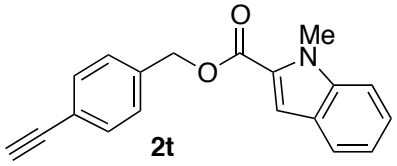
2q

The title compound **2q** was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 5/1) as a white solid (716 mg, 54% yield).
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.40 (d, J = 8.0 Hz, 2H), 7.24 (d, J = 8.0 Hz, 1.4H), 7.16 (d, J = 8.2 Hz, 0.6H), 5.16 – 4.97 (m, 3H), 4.25 – 4.16 (m, 1H), 3.05 (s, 1H), 2.24 – 1.96 (m, 1H), 1.37 (s, 9H), 0.87 (d, J = 6.8 Hz, 3H), 0.79 (d, J = 6.8 Hz, 3H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 172.14, 155.61, 136.11, 134.47, 132.22, 131.65, 129.95, 128.06, 122.35, 122.13, 83.13, 79.68, 77.86, 66.17, 58.55, 31.16, 28.26, 18.99, 17.50.
HRMS calculated for $C_{19}H_{26}NO_4$ $[M+H]^+$: 332.1862, Found: 332.1846



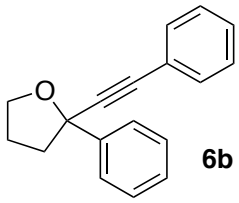
2s

The title compound **2s** was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 5/1) as a white solid (906 mg, 82% yield).
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.66 (d, *J* = 7.8 Hz, 1H), 7.59 – 7.47 (m, 4H), 7.47 – 7.36 (m, 3H), 7.29 (t, *J* = 7.5 Hz, 1H), 5.39 (s, 2H), 3.08 (s, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 159.28, 155.81, 145.13, 136.04, 132.39, 128.20, 127.79, 126.86, 123.85, 122.86, 122.30, 114.39, 112.39, 83.17, 77.77, 66.42.
HRMS calculated for $C_{18}H_{12}NaO_3$ $[M+Na]^+$: 299.0684, Found: 299.0670



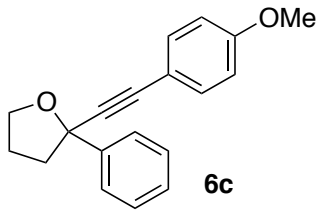
2t

The title compound **2t** was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 5/1) as a white solid (706 mg, 61% yield).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.69 – 7.62 (m, *J* = 8.0 Hz, 1H), 7.50 (d, *J* = 8.2 Hz, 2H), 7.43 – 7.33 (m, 5H), 7.17 – 7.10 (m, 1H), 5.34 (s, 2H), 4.07 (s, 3H), 3.08 (s, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 161.83, 139.78, 136.82, 132.35, 127.80, 127.32, 125.81, 125.19, 122.63, 121.99, 120.64, 110.64, 110.25, 83.265, 77.61, 65.56, 31.63.
HRMS calculated for $C_{19}H_{16}NO_2$ $[M+H]^+$: 290.1181, Found: 290.1168



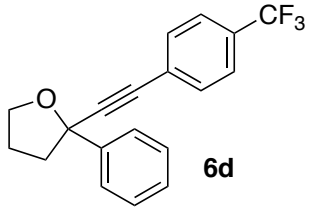
6b

6b was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 24h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 20/1) as a yellow oil (43 mg, 87%).
^{1}H NMR (500 MHz, $CDCl_3$): δ 7.70 – 7.63 (m, 2H), 7.50 – 7.44 (m, 2H), 7.40 – 7.33 (m, 2H), 7.32 – 7.27 (m, 4H), 4.32 – 4.10 (m, 2H), 2.62 (ddd, *J* = 12.2, 7.6, 4.7 Hz, 1H), 2.36 – 2.24 (m, 1H), 2.19 (dt, *J* = 12.0, 8.0 Hz, 1H), 2.13 – 2.02 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): 143.64, 131.74, 128.25, 128.22, 128.18, 127.49, 125.32, 122.87, 91.26, 84.98, 80.92, 68.47, 43.02, 25.87.
HRMS calculated for $C_{18}H_{17}O$ $[M+H]^+$: 249.1279, Found: 249.1278



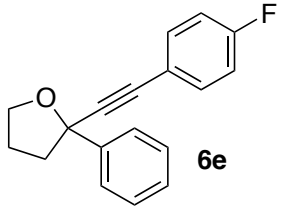
6c

6c was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 20/1) as a pale-yellow oil (40 mg, 72%).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.64 (d, J = 7.8 Hz, 2H), 7.48 – 7.20 (m, 5H), 6.82 (d, J = 8.8 Hz, 2H), 4.20 (m, 2H), 3.81 (s, 3H), 2.65 – 2.49 (m, 1H), 2.33 – 1.98 (m, 3H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 159.53, 143.85, 133.17, 128.18, 127.40, 125.33, 114.98, 113.78, 89.81, 84.86, 80.95, 68.40, 55.26, 43.02, 25.86.
HRMS calculated for $C_{19}H_{19}O_2$ $[M+H]^+$: 279.1385, Found: 279.1390



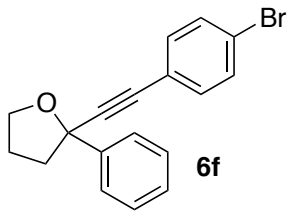
6d

6d was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via preparatory TLC (Elution: hexanes/ethyl acetate = 20/1) as a yellow oil (54 mg, 86%).
^{1}H NMR: (500 MHz; $CDCl_3$): δ 7.67 – 7.60 (m, 2H), 7.58 – 7.52 (m, 4H), 7.38 (m, 2H), 7.36 – 7.28 (m, 1H), 4.22 (m, 2H), 2.62 (m, 1H), 2.32 – 2.18 (m, 2H), 2.12 – 2.04 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 143.26, 131.97, 130.00 (q, $J_{C\text{-}F}$ = 32.58 Hz), 128.31, 127.64, 126.66, 125.19, 125.15, 122.79, 93.88, 83.54, 80.79, 68.62, 42.87, 25.86.
HRMS calculated for $C_{19}H_{16}F_3O$ $[M+H]^+$: 317.1153, Found: 317.1149



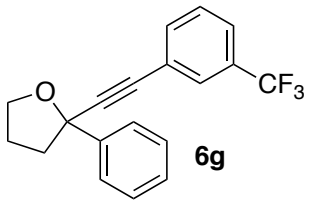
6e

6e was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 20/1) as a yellow oil (44 mg, 82%).
^{1}H NMR: (500 MHz; $CDCl_3$): δ 7.67 – 7.60 (m, 2H), 7.47 – 7.40 (m, 2H), 7.37 (t, J = 7.6 Hz, 2H), 7.30 (t, J = 7.3 Hz, 1H), 7.03 – 6.95 (m, 2H), 4.25 – 4.15 (m, 2H), 2.60 (m, 1H), 2.31 – 2.13 (m, 2H), 2.11 – 2.01 (m, 1H).
^{13}C NMR: (126 MHz; $CDCl_3$): δ 162.29 (d, $J_{C\text{-}F}$ = 249.33 Hz), 143.59, 133.63 (d, $J_{C\text{-}F}$ = 8.35 Hz), 128.24, 127.52, 125.25, 118.92 (d, $J_{C\text{-}F}$ = 3.14 Hz), 115.45 (d, $J_{C\text{-}F}$ = 22.04 Hz), 91.00, 83.85, 80.84, 68.50, 42.94, 25.86.
HRMS calculated for $C_{18}H_{16}FO$ $[M+H]^+$: 267.1185, Found: 267.1180.



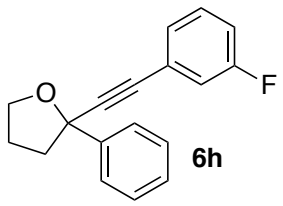
6f

6f was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 30/1) as a yellow oil (44 mg, 68%).
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.63 – 7.52 (m, 2H), 7.41 (d, J = 8.5 Hz, 2H), 7.35 (t, J = 7.5 Hz, 2H), 7.30 – 7.27 (m, 3H), 4.34 – 4.08 (m, 2H), 2.62 – 2.53 (m, 1H), 2.29 – 2.14 (m, 2H), 2.09 – 2.01 (m, 1H).
^{13}C NMR (101 MHz; $CDCl_3$): δ 143.42, 133.16, 131.42, 128.24, 127.54, 125.20, 122.47, 121.79, 92.50, 83.82, 80.82, 68.52, 42.85, 25.83.
HRMS calculated for $C_{18}H_{16}BrO$ $[M+H]^+$: 327.0385, Found: 327.0371



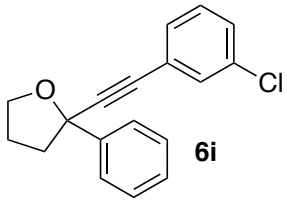
6g

6g was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 20/1) as a colorless oil (39 mg, 61%).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.71 (s, 1H), 7.64 – 7.60 (m, 3H), 7.55 (d, J = 7.9 Hz, 1H), 7.45 – 7.36 (m, 3H), 7.31 (m, 1H), 4.21 (m, 2H), 2.62 (ddd, J = 12.2, 7.3, 4.7 Hz, 1H), 2.36 – 2.16 (m, 2H), 2.16 – 2.02 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$) δ 143.29, 134.83, 130.81 (q, $J_{C\text{-}F}$ = 32.75 Hz), 128.72, 128.54, 128.31, 127.63, 125.19, 124.82, 123.77, 122.59, 93.01, 83.36, 80.77, 68.60, 42.86, 25.86
HRMS calculated for $C_{19}H_{16}F_3O$ $[M+H]^+$: 317.1153, Found: 317.1155



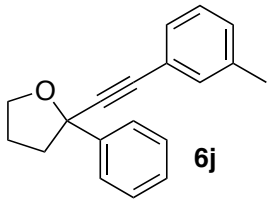
6h

6h was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 20/1) as a colorless oil (47 mg, 89%).
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.62 (d, J = 7.4 Hz, 2H), 7.37 (t, J = 7.5 Hz, 2H), 7.34 – 7.18 (m, 3H), 7.14 (d, J = 9.7 Hz, 1H), 7.07 – 6.95 (m, 1H), 4.32 – 4.10 (m, 2H), 2.66 – 2.54 (m, 1H), 2.35 – 1.97 (m, 3H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 163.24, 161.28, 143.38, 129.74 (d, $J_{C\text{-}F}$ = 8.58 Hz), 128.27, 127.58, 125.23, 124.68 (d, $J_{C\text{-}F}$ = 9.66 Hz) 118.54 (d, $J_{C\text{-}F}$ = 22.82 Hz), 115.60 (d, $J_{C\text{-}F}$ = 21.11 Hz), 92.28, 83.71, 80.80, 68.55, 42.91, 25.85.
HRMS calculated for $C_{18}H_{16}FO$ $[M+H]^+$: 267.1185, Found: 267.1189



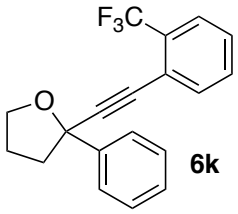
6i

6i was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 1.5h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 50/1) as a colorless oil (41 mg, 73%).
MW=282.77
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.62 (d, *J* = 7.7 Hz, 2H), 7.44 (s, 1H), 7.40 – 7.15 (m, 6H), 4.41 – 4.02 (m, 2H), 2.73 – 2.43 (m, 1H), 2.48 – 1.92 (m, 3H).
^{13}C NMR (101 MHz; $CDCl_3$): δ 143.33, 133.99, 131.59, 129.82, 129.39, 128.51, 128.25, 127.56, 125.20, 124.53, 92.57, 83.50, 80.78, 68.52, 42.88, 25.82.
HRMS calculated for $C_{18}H_{16}ClO$ $[M+H]^+$: 283.0890, Found: 283.0889



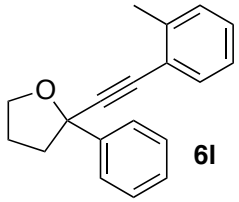
6j

6j was synthesized with 4 mol% $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 50/1) as a yellow oil (43 mg, 82%).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.66 – 7.61 (m, 2H), 7.36 (t, *J* = 7.6 Hz, 2H), 7.28 (t, *J* = 8.3 Hz, 1H), 7.18 (t, *J* = 7.6 Hz, 1H), 7.11 (d, *J* = 7.6 Hz, 1H), 4.27 – 4.13 (m, 2H), 2.59 (ddd, *J* = 12.2, 7.6, 4.6 Hz, 1H), 2.31 – 2.24 (m, 4H), 2.17 (m, 1H), 2.12 – 2.02 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 143.68, 137.85, 132.33, 129.12, 128.79, 128.20, 128.08, 127.46, 125.33, 122.66, 90.87, 85.16, 80.93, 68.43, 43.03, 25.87, 21.18.
HRMS calculated for $C_{19}H_{19}O$ $[M+H]^+$: 263.1436, Found: 263.1434



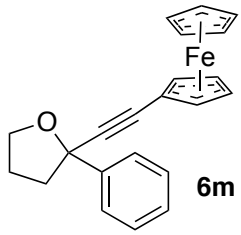
6k

6k was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via preparatory TLC (Elution: hexanes/ethyl acetate = 20/1) as a colorless oil (37 mg, 58%).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.67 – 7.61 (m, 3H), 7.57 (d, *J* = 7.7 Hz, 1H), 7.46 (t, *J* = 7.5 Hz, 1H), 7.38 (m, 3H), 7.29 (m, 1H), 4.28 – 4.14 (m, 2H), 2.64 (ddd, *J* = 11.3, 7.6, 3.7 Hz, 1H), 2.40 – 2.24 (m, 1H), 2.20 – 2.02 (m, 2H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 143.00, 133.96, 131.56 (q, $J_{C\text{-}F}$ = 30.36 Hz), 131.33, 128.24, 128.02, 127.59, 125.72 (q, $J_{C\text{-}F}$ = 4.97 Hz) , 125.26, 124.65, 122.47, 121.14, 96.99, 81.00, 68.53, 42.94, 25.71.
HRMS calculated for $C_{19}H_{16}F_3O$ $[M+H]^+$: 317.1153, Found: 317.1148



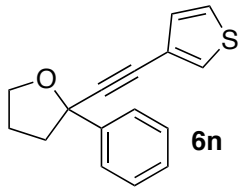
6l

6l was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 15m, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 50/1) as a pale-yellow oil (49 mg, 94%).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.67 (d, *J* = 7.5 Hz, 2H), 7.42 (d, *J* = 7.6 Hz, 1H), 7.38 (t, *J* = 7.6 Hz, 2H), 7.30 (t, *J* = 7.3 Hz, 1H), 7.23 – 7.17 (m, 2H), 7.15 – 7.09 (m, 1H), 4.29 – 4.16 (m, 2H), 2.61 (ddd, *J* = 12.3, 7.8, 4.5 Hz, 1H), 2.44 (s, 3H), 2.39 – 2.25 (m, 1H), 2.24 – 2.14 (m, 1H), 2.14 – 2.03 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 143.59, 140.23, 131.96, 129.33, 128.27, 128.20, 127.48, 125.44, 125.34, 122.63, 95.21, 84.07, 81.12, 68.35, 43.16, 25.87, 20.73.
HRMS calculated for $C_{19}H_{19}O$ $[M+H]^+$: 263.1436, Found: 263.1434.



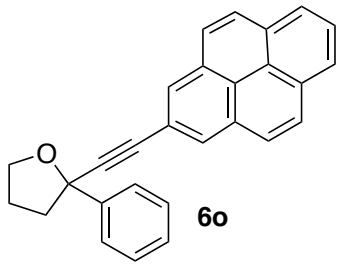
6m

6m was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 5h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 20/1) as an orange solid (59 mg, 83%) and crystallized by slow evaporation of a DCM/Hexanes solution at room temperature.
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.69 – 7.61 (m, 2H), 7.37 (t, *J* = 7.6 Hz, 2H), 7.29 (t, *J* = 7.3 Hz, 1H), 4.43 (t, *J* = 1.8 Hz, 2H), 4.27 – 4.13 (m, 9H), 2.55 (ddd, *J* = 12.1, 7.7, 4.6 Hz, 1H), 2.33 – 2.22 (m, 1H), 2.20 – 2.10 (m, 1H), 2.10 – 2.02 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 143.91, 128.15, 127.40, 125.36, 87.40, 83.64, 81.11, 71.57, 71.43, 69.80, 68.57, 68.26, 64.90, 43.04, 25.86.
HRMS calculated for $C_{22}H_{21}FeO$ $[M+H]^+$: 357.0942, Found: 357.0924



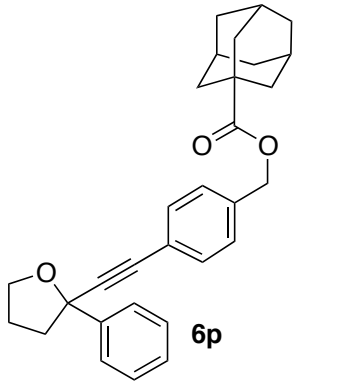
6n

6n was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 20/1) as a yellow oil (47 mg, 93%).
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.68 – 7.56 (m, 2H), 7.47 – 7.43 (m, 1H), 7.36 (t, *J* = 7.5 Hz, 2H), 7.30 – 7.23 (m, 2H), 7.11 (d, *J* = 5.0 Hz, 1H), 4.31 – 3.98 (m, 2H), 2.59 (ddd, *J* = 12.1, 7.2, 4.8 Hz, 1H), 2.43 – 1.93 (m, 3H).
^{13}C NMR (101 MHz; $CDCl_3$): δ 143.62, 129.97, 128.77, 128.19, 127.45, 125.27, 125.09, 121.85, 90.81, 80.89, 80.03, 68.44, 42.89, 25.83.
HRMS calculated for $C_{16}H_{15}OS$ $[M+H]^+$: 255.0844, Found: 255.0840.



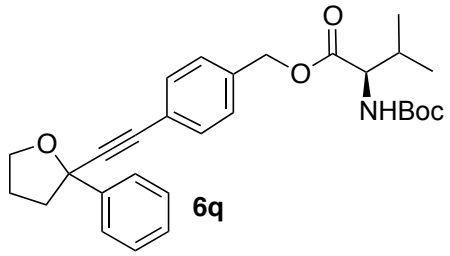
6o

6o was synthesized with 4 mol% $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 20/1) as a pale-yellow oil (42 mg, 56%).
^{1}H NMR (400 MHz; $CDCl_3$): δ 8.49 (d, *J* = 9.1 Hz, 1H), 8.18 (t, *J* = 6.86, 2H), 8.14 – 7.97 (m, 7H), 7.82 – 7.74 (m, 1H), 7.42 (t, *J* = 7.6 Hz, 2H), 7.32 (t, *J* = 7.3 Hz, 1H), 4.38 (td, *J* = 8.1, 6.0 Hz, 1H), 4.29 – 4.24 (m, 1H), 2.79 (ddd, J = 12.2, 7.5, 4.6 Hz, 1H), 2.53 – 2.35 (m, 1H), 2.35 – 2.25 (m, 1H), 2.25 – 2.08 (m, 1H).
^{13}C NMR (101 MHz; $CDCl_3$): δ 143.69, 132.01, 131.20, 131.18, 130.99, 129.76, 128.32, 128.08, 127.58, 127.19, 126.16, 125.53, 125.50, 125.41, 124.34, 124.24, 117.37, 96.97, 84.13, 81.34, 68.57, 43.22, 26.02.
HRMS calculated for $C_{28}H_{21}O$ $[M+H]^+$: 373.1592, Found: 373.1587



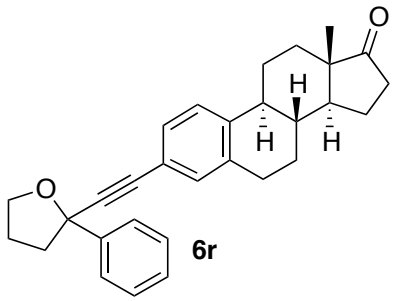
6p

6p was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 1.5h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 15/1) as a colorless oil (58 mg, 66%).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.67 – 7.60 (m, 2H), 7.44 (d, *J* = 8.2 Hz, 2H), 7.41 – 7.33 (m, 2H), 7.32 – 7.24 (m, 3H), 5.07 (s, 2H), 4.29 – 4.10 (m, 2H), 2.60 (ddd, *J* = 12.2, 7.5, 4.7 Hz, 1H), 2.28 (ddd, *J* = 11.7, 7.8, 6.1 Hz, 1H), 2.23 – 2.15 (m, 1H), 2.12 – 1.97 (m, 4H), 1.93 – 1.86 (m, 6H), 1.75 – 1.67 (m, 6H).
^{13}C NMR (101 MHz; $CDCl_3$): δ 177.31, 143.56, 136.69, 131.83, 128.21, 127.47, 125.28, 122.48, 91.59, 84.64, 80.89, 68.46, 65.25, 42.98, 40.75, 38.79, 36.45, 27.89, 25.84.
HRMS calculated for $C_{30}H_{33}O_3$ $[M+H]^+$: 441.2430, Found: 441.2412



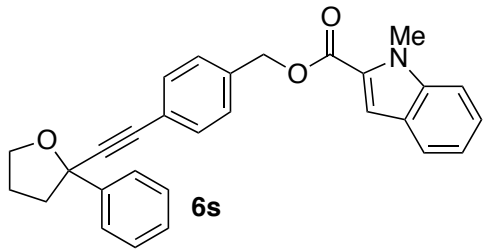
6q

6q was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 7h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 19/1) as a colorless oil (82 mg, 86%).
MW=477.60
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.63 (d, *J* = 7.4 Hz, 2H), 7.44 (d, *J* = 8.1 Hz, 2H), 7.37 (t, *J* = 7.6 Hz, 2H), 7.33 – 7.27 (m, 3H), 5.19 (d, *J* = 12.5 Hz, 1H), 5.09 (d, *J* = 12.5 Hz, 1H), 4.99 (d, *J* = 8.8 Hz, 1H), 4.30 – 4.12 (m, 3H), 2.60 (ddd, *J* = 12.23, 7.46, 4.81 Hz, 1H), 2.36 – 2.00 (m, 4H), 1.44 (s, 9H), 0.93 (d, *J* = 6.8 Hz, 3H), 0.84 (d, *J* = 6.8 Hz, 3H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 172.21, 155.65, 143.54, 135.51, 131.91, 128.23, 128.09, 127.51, 125.27, 122.96, 91.88, 84.47, 80.87, 79.81, 68.51, 66.36, 58.53, 42.96, 31.25, 28.30, 25.86, 19.00, 17.49.
HRMS calculated for $C_{29}H_{36}NO_5$ $[M+H]^+$: 478.2594, Found: 478.2582



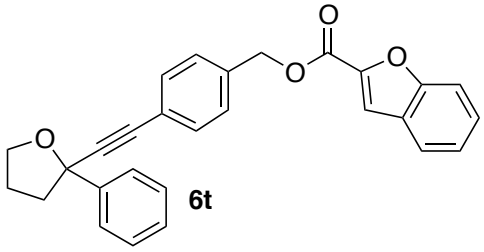
6r

6r was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 19/1) as a colorless oil (59 mg, 69%).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.69 – 7.61 (m, 2H), 7.40 – 7.34 (m, 2H), 7.32 – 7.19 (m, 4H), 4.27 – 4.13 (m, 2H), 2.87 (dd, *J* = 8.7, 3.9 Hz, 2H), 2.59 (ddd, *J* = 12.2, 7.6, 4.7 Hz, 1H), 2.51 (dd, *J* = 19.0, 8.7 Hz, 1H), 2.44 – 2.38 (m, 1H), 2.34 – 2.23 (m, 2H), 2.23 – 1.92 (m, 6H), 1.74 – 1.35 (m, 6H), 0.91 (s, 3H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 220.71, 143.71, 140.19, 136.45, 132.21, 129.03, 128.18, 127.43, 125.33, 125.23, 120.17, 90.57, 85.03, 80.95, 68.41, 50.48, 47.93, 44.41, 43.05, 37.96, 35.82, 31.53, 29.05, 26.32, 25.86, 25.58, 21.56, 13.82.
HRMS calculated for $C_{30}H_{33}O_2$ $[M+H]^+$: 425.2481, Found: 425.2480



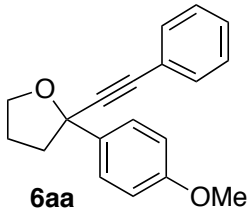
6s

6s was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 1.5h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 15/1) as a white solid (69 mg, 79%).
MW= 435.52
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.69 – 7.61 (m, 3H), 7.47 (d, *J* = 8.2 Hz, 2H), 7.42 – 7.33 (m, 7H), 7.30 – 7.27 (m, 1H), 7.16 – 7.13 (m, 1H), 5.34 (s, 2H), 4.30 – 4.12 (m, 2H), 4.07 (s, 3H), 2.61 (ddd, *J* = 12.2, 7.5, 4.8 Hz, 1H), 2.34 – 2.21 (m, 1H), 2.21 – 2.13 (m, 1H), 2.13 – 2.01 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 178.32, 161.85, 143.57, 139.77, 136.20, 131.97, 128.24, 127.79, 127.52, 125.82, 125.30, 125.15, 122.80, 122.62, 120.62, 110.61, 110.25, 91.78, 84.59, 80.91, 68.51, 65.68, 43.00, 31.63, 25.87.
HRMS calculated for $C_{29}H_{26}NO_3$ $[M+H]^+$: 436.1913, Found: 436.1897



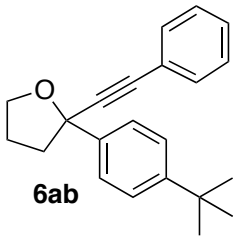
6t

6t was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 6h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 15/1) as a colorless oil (80 mg, 95%).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.68 (d, *J* = 7.8 Hz, 1H), 7.66 – 7.62 (m, 2H), 7.62 – 7.55 (m, 2H), 7.52 – 7.35 (m, 7H), 7.35 – 7.27 (m, 2H), 5.40 (s, 2H), 4.32 – 4.10 (m, 2H), 2.61 (ddd, *J* = 12.2, 7.5, 4.8 Hz, 1H), 2.36 – 1.97 (m, 3H).
^{13}C NMR (126 MHz; $CDCl_3$): 159.30, 155.81, 145.19, 143.53, 135.43, 132.00, 128.24, 128.17, 127.76, 127.52, 126.87, 125.28, 123.83, 123.12, 122.85, 114.34, 112.39, 91.94, 84.49, 80.89, 68.51, 66.53, 42.98, 25.86.
HRMS calculated for $C_{28}H_{23}O_4$ $[M+H]^+$: 423.1596, Found: 423.1586



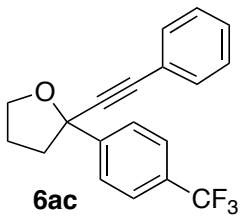
6aa

6aa was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 20/1) as a yellow oil (37 mg, 67%).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.57 (d, J = 8.8 Hz, 2H), 7.47 – 7.43 (m, 2H), 7.33 – 7.26 (m, 3H), 6.90 (d, J = 8.8 Hz, 2H), 4.27 – 4.11 (m, 2H), 3.81 (s, 3H), 2.57 (ddd, J = 11.9, 7.5, 4.5 Hz, 1H), 2.37 – 2.01 (m, 3H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 158.99, 135.65, 131.72, 128.19, 128.17, 126.62, 122.90, 113.53, 91.34, 84.93, 80.65, 68.27, 55.29, 42.82, 25.85.
HRMS calculated for $C_{19}H_{19}O_2$ $[M+H]^+$: 279.1385, Found: 279.1393



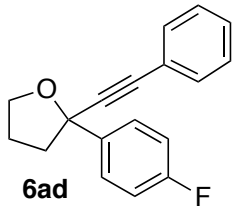
6ab

6ab was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 50/1) as a yellow oil (51 mg, 83%).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.57 (d, J = 8.5 Hz, 2H), 7.47 – 7.44 (m, 2H), 7.39 (d, J = 8.5 Hz, 2H), 7.31 – 7.28 (m, 3H), 4.26 – 4.13 (m, 2H), 2.59 (ddd, J = 12.2, 7.3, 4.6 Hz, 1H), 2.33 – 2.16 (m, 2H), 2.12 – 2.04 (m, 1H), 1.33 (s, 9H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 150.35, 140.50, 131.73, 128.15, 126.10, 125.13, 125.04, 122.97, 91.47, 84.82, 80.77, 77.25, 77.00, 76.74, 68.38, 42.74, 34.48, 31.35, 31.25, 25.90.
HRMS calculated for $C_{22}H_{25}O$ $[M+H]^+$: 305.1905, Found: 305.1903



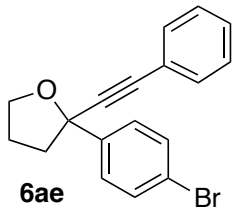
6ac

6ac was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 2.5h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 20/1) as a yellow oil (47 mg, 74%).
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.74 (d, J = 8.2 Hz, 2H), 7.61 (d, J = 8.3 Hz, 2H), 7.45 – 7.41 (m, 2H), 7.32 – 7.27 (m, 3H), 4.33 – 4.10 (m, 2H), 2.62 (ddd, J = 11.4, 7.5, 4.3 Hz, 1H), 2.37 – 2.20 (m, 1H), 2.20 – 1.99 (m, 2H).
^{13}C NMR (101 MHz; $CDCl_3$): δ 147.75, 131.72, 129.69 (q, $J_{C\text{-}F}$ = 32.26 Hz), 128.47, 128.22, 125.66, 125.48, 125.21 (q, $J_{C\text{-}F}$ = 3.31 Hz), 122.44, 90.42, 85.41, 80.50, 68.65, 43.10, 25.81.
HRMS calculated for $C_{19}H_{16}F_3O$ $[M+H]^+$: 317.1153, Found: 317.1152



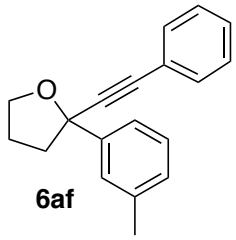
6ad

6ad was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 50/1) as a pale-yellow oil (42 mg, 78%).
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.64 – 7.55 (m, 2H), 7.47 – 7.39 (m, 2H), 7.31 – 7.26 (m, 3H), 7.03 (t, J = 8.7 Hz, 2H), 4.31 – 4.07 (m, 2H), 2.64 – 2.50 (m, 1H), 2.37 – 2.20 (m, 1H), 2.20 – 2.00 (m, 2H).
^{13}C NMR (101 MHz; $CDCl_3$): δ 162.18 (d, $J_{C\text{-}F}$ = 245.67 Hz), 139.39, 131.70, 128.33, 128.19, 127.09 (d, $J_{C\text{-}F}$ = 8.07 Hz), 122.66, 114.95 (d, $J_{C\text{-}F}$ = 21.47 Hz), 90.88, 85.18, 80.50, 68.40, 43.07, 25.82.
HRMS calculated for $C_{18}H_{16}FO$ $[M+H]^+$: 267.1185, Found: 267.1145



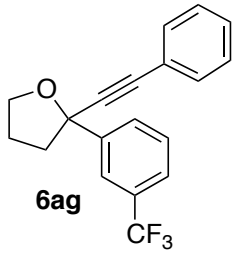
6ae

6ae was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 2.5h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 20/1) as a pale-yellow oil (58 mg, 88%).
MW=327.22
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.55 – 7.39 (m, 6H), 7.32 – 7.26 (m, 3H), 4.27 – 4.07 (m, 2H), 2.57 (ddd, J = 11.2, 7.5, 4.0 Hz, 1H), 2.33 – 2.18 (m, 1H), 2.18 – 1.97 (m, 2H).
^{13}C NMR (101 MHz; $CDCl_3$): δ 142.82, 131.71, 131.27, 128.38, 128.20, 127.14, 122.57, 121.41, 90.61, 85.23, 80.47, 68.50, 43.00, 25.80.
HRMS calculated for $C_{18}H_{16}BrO$ $[M+H]^+$: 327.0385, Found: 327.0366



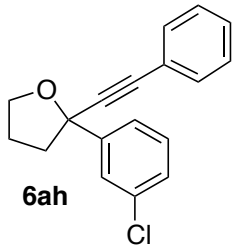
6af

6af was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 50/1) as a pale-yellow oil (40 mg, 76%).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.49 – 7.41 (m, 4H), 7.36 – 7.23 (m, 4H), 7.11 (d, J = 7.6 Hz, 1H), 4.27 – 4.14 (m, 2H), 2.60 (ddd, J = 12.2, 7.6, 4.6 Hz, 1H), 2.39 (s, 3H), 2.36 – 2.15 (m, 2H), 2.12 – 2.01 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 143.53, 137.85, 131.75, 128.24, 128.20, 128.16, 128.13, 125.89, 122.93, 122.44, 91.38, 84.84, 80.88, 68.39, 42.91, 25.84, 21.58.
HRMS calculated for $C_{19}H_{19}O$ $[M+H]^+$: 263.1436, Found: 263.1433



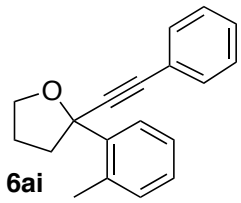
6ag

6ag was synthesized with 4 mol% $IPrAuNTf_2$, 3 equiv. alkyne, 60 °C, 3h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 20/1) as a yellow oil (51 mg, 81%).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.91 (s, 1H), 7.84 (d, J = 7.8 Hz, 1H), 7.56 (d, J = 7.8 Hz, 1H), 7.53 – 7.42 (m, 3H), 7.36 – 7.27 (m, 3H), 4.33 – 4.16 (m, 2H), 2.71 – 2.58 (m, 1H), 2.40 – 2.24 (m, 1H), 2.21 – 1.99 (m, 2H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 144.83, 131.75, 130.72 (q, $J_{C\text{-}F}$ = 32.24 Hz), 128.88, 128.72, 128.49, 128.25, 124.38 (q, $J_{C\text{-}F}$ = 3.41 Hz), 124.16 (q, $J_{C\text{-}F}$ = 272.15 Hz), 122.47, 122.14 (q, $J_{C\text{-}F}$ = 3.58 Hz), 90.40, 85.50, 80.51, 68.63, 43.16, 25.84.
HRMS calculated for $C_{19}H_{16}F_3O$ $[M+H]^+$: 317.1153, Found: 317.1151



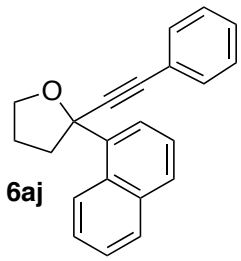
6ah

6ah was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 50/1) as a pale-yellow oil (48 mg, 84%).
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.61 (s, 1H), 7.55 – 7.47 (m, 1H), 7.46 – 7.41 (m, 2H), 7.32 – 7.22 (m, 5H), 4.29 – 4.08 (m, 2H), 2.58 (ddd, J = 11.7, 7.5, 4.5 Hz, 1H), 2.35 – 2.19 (m, 1H), 2.19 – 1.96 (m, 2H).
^{13}C NMR (101 MHz; $CDCl_3$): δ 145.82, 134.14, 131.73, 129.50, 128.39, 128.19, 127.62, 125.55, 123.58, 122.55, 90.54, 85.26, 80.39, 68.58, 43.08, 25.80.
HRMS calculated for $C_{18}H_{16}ClO$ $[M+H]^+$: 283.0890, Found: 283.0891



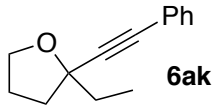
6ai

6ai was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 50/1) as a colorless oil (49 mg, 93%).
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.67 (dd, J = 6.1, 2.9 Hz, 1H), 7.41 – 7.33 (m, 2H), 7.28 – 7.22 (m, 3H), 7.18 (d, J = 2.9 Hz, 3H), 4.30 – 4.17 (m, 1H), 4.13 – 3.97 (m, 1H), 2.79 – 2.69 (m, 1H), 2.61 (s, 3H), 2.30 – 2.15 (m, 2H), 2.07 – 1.94 (m, 1H).
^{13}C NMR (101 MHz; $CDCl_3$): δ 141.45, 135.17, 131.70, 131.59, 128.11, 127.80, 127.40, 125.61, 124.51, 122.95, 91.09, 84.05, 79.78, 67.49, 40.36, 25.70, 21.08.
HRMS calculated for $C_{19}H_{19}O$ $[M+H]^+$: 263.1436, Found: 263.1438



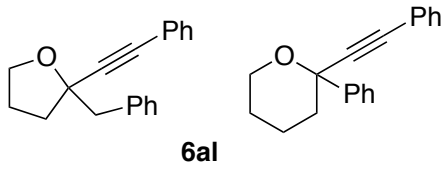
6aj

6aj was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 50/1) as a pale-yellow oil (48 mg, 81%).
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.63 (d, *J* = 8.5 Hz, 1H), 7.86 (dd, *J* = 7.3, 3.2 Hz, 2H), 7.80 (d, *J* = 8.2 Hz, 1H), 7.58 – 7.42 (m, 3H), 7.40 – 7.32 (m, *J* = 6.6, 3.0 Hz, 2H), 7.26 – 7.19 (m, 3H), 4.37 – 4.09 (m, 2H), 3.00 – 2.87 (m, 1H), 2.56 – 2.42 (m, 1H), 2.42 – 2.20 (m, 1H), 2.08 – 1.93 (m, 1H).
^{13}C NMR (101 MHz; $CDCl_3$): δ 138.97, 134.50, 131.64, 130.09, 128.76, 128.59, 128.13, 128.08, 126.10, 125.42, 125.29, 125.04, 122.88, 122.19, 91.95, 84.93, 79.66, 67.76, 41.31, 25.83.
HRMS calculated for $C_{22}H_{19}O$ $[M+H]^+$: 299.1436, Found: 299.1433



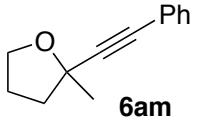
6ak

6ak was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 1.5h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 20/1) as a colorless oil (36 mg, 91%).
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.42 – 7.38 (m, 2H), 7.30 – 7.24 (m, 3H), 4.08 – 3.86 (m, 2H), 2.28 – 2.08 (m, 2H), 1.99 – 1.70 (m, 4H), 1.11 (t, *J* = 7.4 Hz, 3H).
^{13}C NMR (101 MHz; $CDCl_3$): δ 131.48, 127.93, 127.79, 122.91, 91.17, 83.68, 80.41, 67.37, 38.17, 33.60, 25.30, 9.48.
HRMS calculated for $C_{14}H_{17}O$ $[M+H]^+$: 201.1279, Found: 201.1274



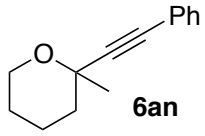
6al

6al was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 1.5h, in $CHCl_3$.
The title compound was isolated as a mixture of isomers via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 33/1) as a yellow oil (46 mg, 87%, 10:3 *exo:endo* mixture).
^{1}H NMR (400 MHz; $CDCl_3$): 7.50 – 7.08 (m, 10H), 4.37 – 4.06 (m, 0.26H, *endo*), 4.06 – 3.80 (m, 1.74H), 3.18 – 3.03 (m, 1H), 2.24 – 1.78 (m, 5H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 149.63, 145.10, 143.48, 136.99, 135.86, 134.95, 131.58, 130.60, 129.45, 128.14, 128.06, 127.89, 127.17, 126.60, 126.15, 122.99, 121.18, 119.11, 93.44, 91.49, 84.80, 79.92, 69.76, 67.84, 46.50, 38.05, 33.88, 27.02, 25.51, 11.27.
HRMS calculated for $C_{19}H_{19}O$ $[M+H]^+$: 263.14359, Found: 263.1431



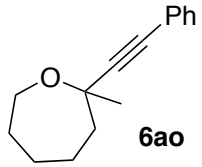
6am

6am was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 2.5h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 25/1) as a colorless oil (31 mg, 84%).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.44 – 7.40 (m, 2H), 7.30 – 7.27 (m, 3H), 4.06 – 3.91 (m, 2H), 2.30 (ddd, *J* = 12.2, 8.2, 4.4 Hz, 1H), 2.22 – 2.09 (m, 1H), 2.05 – 1.95 (m, 1H), 1.92 – 1.81 (m, 1H), 1.64 (s, 3H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 131.66, 128.14, 128.04, 122.98, 92.33, 82.70, 76.39, 67.64, 40.16, 27.70, 25.70.
HRMS calculated for $C_{13}H_{15}O$ $[M+H]^+$: 187.1123, Found: 187.1117



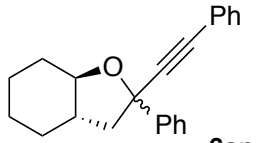
6an

6an was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 30/1) as a pale-yellow oil (37 mg, 93%).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.48 – 7.42 (m, 2H), 7.33 – 7.28 (m, 3H), 4.02 (td, *J* = 11.5, 3.6 Hz, 1H), 3.85 – 3.78 (m, 1H), 1.96 – 1.83 (m, 2H), 1.76 – 1.69 (m, 1H), 1.61 – 1.53 (m, 6H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 131.70, 128.22, 128.13, 122.97, 90.28, 85.66, 70.71, 64.20, 38.09, 30.05, 25.47, 20.76.
HRMS calculated for $C_{14}H_{17}O$ $[M+H]^+$: 201.1279, Found: 201.1273



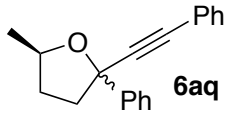
6ao

6ao was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 40/1) as a pale-yellow oil (34 mg, 79%).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.46 – 7.40 (m, 2H), 7.32 – 7.28 (m, 3H), 3.87 (ddd, *J* = 11.9, 8.6, 3.1 Hz, 1H), 3.75 (dt, *J* = 12.7, 4.0 Hz, 1H), 2.09 (dd, *J* = 14.7, 9.4 Hz, 1H), 1.96 (dd, *J* = 14.7, 8.2 Hz, 1H), 1.77 – 1.57 (m, 5H), 1.57 – 1.40 (m, 4H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 131.70, 128.17, 128.02, 123.09, 93.08, 83.07, 73.27, 64.88, 42.51, 30.86, 29.29, 28.47, 23.01.
HRMS calculated for $C_{15}H_{19}O$ $[M+H]^+$: 215.1436, Found: 215.1425



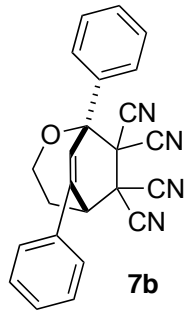
6ap

6ap was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated as a mixture of isomers via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 25/1) as a colorless oil (40 mg, 66%, 1:1 dr).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.69 – 7.60 (m, 2H), 7.50 – 7.43 (m, 2H), 7.37 (td, *J* = 7.7, 3.1 Hz, 2H), 7.32 – 7.27 (m, 4H), 3.64 (td, *J* = 10.7, 3.8 Hz, 0.5H), 3.51 – 3.39 (m, 0.5H), 2.77 (dd, *J* = 11.4, 5.2 Hz, 0.5H), 2.51 – 2.35 (m, 1H), 2.33 – 2.22 (m, 1H), 2.13 – 1.85 (m, 3.5H), 1.76 (dd, *J* = 6.4, 3.1 Hz, 1H), 1.63 – 1.50 (m, 1H), 1.44 – 1.08 (m, 3H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 145.65, 145.30, 131.77, 131.73, 128.32, 128.15, 128.11, 128.05, 127.25, 127.19, 125.48, 124.92, 123.04, 123.01, 93.33, 92.92, 85.17, 84.16, 84.00, 79.81, 78.99, 49.91, 49.76, 46.31, 44.25, 31.83, 31.12, 28.65, 25.70, 25.54, 24.33, 24.26.
HRMS calculated for $C_{22}H_{23}O$ $[M+H]^+$: 303.1749, Found: 303.1761



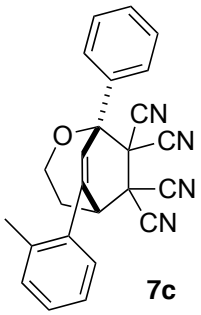
6aq

6aq was synthesized with 4 mol % $IPrAuNTf_2$, 3 equiv. alkyne, 40 °C, 4h, in $CHCl_3$.
The title compound was isolated as a mixture of isomers via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 30/1) as a colorless oil (50 mg, 95%, 3:2 dr).
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.71 – 7.59 (m, 2H), 7.49 – 7.18 (m, 8H), 4.59 – 4.47 (m, 0.6H), 4.46 – 4.34 (m, 0.4H), 2.70 – 2.53 (m, 1H), 2.40 – 2.14 (m, 2H), 2.08 – 1.95 (m, 0.4H), 1.72 – 1.56 (m, 0.6H), 1.46 (d, *J* = 6.1 Hz, 1.2H), 1.40 (d, *J* = 6.1 Hz, 1.8H).
^{13}C NMR (101 MHz; $CDCl_3$): δ 144.22, 143.96, 131.72, 131.62, 128.14, 127.39, 127.34, 125.37, 125.19, 123.05, 122.93, 92.56, 91.78, 84.80, 84.63, 81.04, 80.74, 75.70, 44.02, 43.27, 34.28, 32.89, 22.39, 21.04.
HRMS calculated for $C_{19}H_{19}O$ $[M+H]^+$: 263.1436, Found: 263.1430



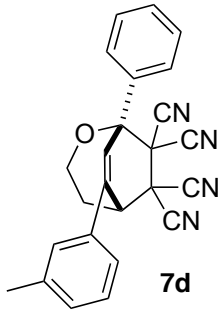
7b

7b was synthesized using general procedure B.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 3/1) as a yellow oil (107 mg, 71% yield) and crystallized by slow evaporation of a $CHCl_3$/DCM/Hexanes solution at room temperature.
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.83 – 7.76 (m, 2H), 7.61 – 7.45 (m, 8H), 6.75 (s, 1H), 4.19 – 4.10 (m, 2H), 3.80 (td, *J* = 12.3, 4.0 Hz, 1H), 2.93 – 2.81 (m, 1H), 2.08 – 1.97 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 144.83, 136.45, 135.11, 130.78, 130.36, 129.61, 128.72, 127.18, 125.89, 122.74, 112.92, 111.35, 111.22, 110.28, 81.89, 62.09, 47.12, 45.49, 29.70, 29.09.
HRMS calculated for $C_{24}H_{17}N_4O$ $[M+H]^+$: 377.1402, Found: 377.1394



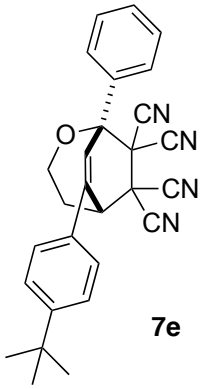
7c

7c was synthesized using general procedure B.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 3/1) as a yellow oil (114 mg, 73% yield).
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.79 – 7.71 (m, 2H), 7.56 – 7.47 (m, 3H), 7.39 – 7.19 (m, 4H), 6.56 (s, 1H), 4.24 (dd, *J* = 12.8, 6.8 Hz, 1H), 3.95 (td, *J* = 12.2, 4.3 Hz, 1H), 3.88 – 3.82 (m, 1H), 3.01 – 2.86 (m, 1H), 2.55 (s, 3H), 2.21 – 2.01 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 144.81, 136.32, 136.03, 135.40, 131.73, 130.36, 129.78, 128.77, 127.80, 127.07, 126.85, 126.72, 113.04, 111.55, 111.25, 110.22, 81.97, 62.50, 56.15, 48.52, 45.11, 29.60, 20.89.
HRMS calculated for $C_{25}H_{19}N_4O$ $[M+H]^+$: 391.1559, Found: 391.1563



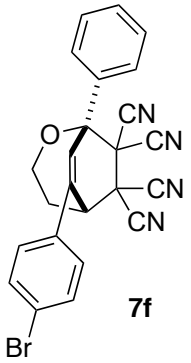
7d

7d was synthesized using general procedure B.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 3/1) as a yellow oil (95 mg, 61% yield).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.83 – 7.71 (m, 2H), 7.57 – 7.45 (m, 3H), 7.45 – 7.27 (m, 4H), 6.72 (s, 1H), 4.18 – 4.07 (m, 2H), 3.79 (td, *J* = 12.3, 4.0 Hz, 1H), 2.95 – 2.80 (m, 1H), 2.42 (s, 3H), 2.08 – 1.99 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 144.89, 139.48, 136.47, 135.09, 131.54, 130.32, 129.46, 128.70, 127.17, 126.46, 122.96, 122.43, 112.87, 111.31, 111.20, 110.23, 81.86, 62.03, 47.13, 45.45, 35.85, 29.10, 21.47.
HRMS calculated for $C_{25}H_{19}N_4O$ $[M+H]^+$: 391.1559, Found: 391.1547



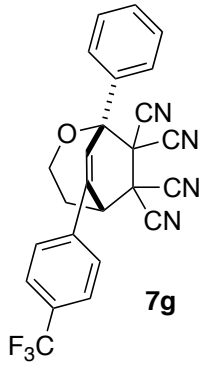
7e

7e was synthesized using general procedure B.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 3/1) as a yellow oil (112 mg, 65% yield).
^{1}H NMR (400 MHz; $CDCl_3$): δ 7.89 – 7.68 (m, 2H), 7.68 – 7.44 (m, 7H), 6.72 (s, 1H), 4.28 – 4.01 (m, 2H), 3.90 – 3.64 (m, 1H), 2.99 – 2.73 (m, 1H), 2.15 – 1.89 (m, 1H), 1.45 – 1.27 (m, 9H).
^{13}C NMR (101 MHz; $CDCl_3$): 154.43, 144.53, 136.54, 132.06, 130.28, 128.67, 127.16, 126.54, 125.58, 121.66, 112.89, 111.33, 111.24, 110.27, 81.91, 62.04, 61.99, 46.95, 45.46, 34.96, 34.92, 31.39, 31.10, 29.06.
HRMS calculated for $C_{28}H_{25}N_4O$ $[M+H]^+$: 433.2028, Found: 433.2012



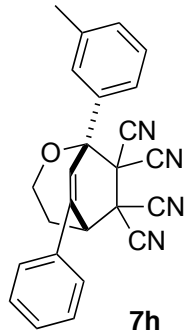
7f

7f was synthesized using general procedure B.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 3/1) as a yellow solid (122 mg, 67% yield).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.81 – 7.77 (m, 2H), 7.65 (d, J = 8.3 Hz, 2H), 7.56 – 7.51 (m, 3H), 7.43 (d, J = 8.3 Hz, 2H), 6.78 (s, 1H), 4.22 – 4.08 (m, 2H), 3.78 (td, J = 12.3, 3.8 Hz, 1H), 2.95 – 2.78 (m, 1H), 2.08 – 1.99 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 143.83, 136.24, 133.94, 132.85, 130.45, 128.77, 127.40, 127.13, 125.32, 123.32, 112.87, 111.28, 111.07, 110.15, 81.85, 77.32, 77.07, 76.82, 62.09, 56.23, 46.98, 45.47, 29.03.
HRMS calculated for $C_{24}H_{16}BrN_4O$ $[M+H]^+$: 455.0508, Found: 455.0490



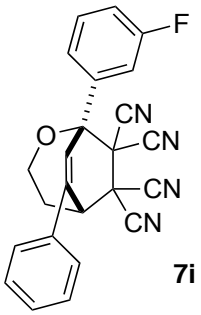
7g

7g was synthesized using general procedure B.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 3/1) as a colorless oil (105 mg, 59% yield) and crystallized by slow evaporation of a $CDCl_3$ solution at room temperature.
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.82 – 7.73 (m, 4H), 7.66 (d, J = 8.2 Hz, 2H), 7.55 – 7.49 (m, 3H), 6.84 (s, 1H), 4.24 – 4.08 (m, 2H), 3.79 (td, J = 12.3, 4.0 Hz, 1H), 3.01 – 2.84 (m, 1H), 2.12 – 1.98 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 138.50, 136.01, 132.63 (q, $J_{C\text{-}F}$ = 33.08 Hz), 130.54, 128.82, 127.89, 127.09, 126.66 (q, $J_{C\text{-}F}$ = 3.22 Hz), 126.40, 125.17, 123.49 (q, $J_{C\text{-}F}$ = 272.64 Hz), 112.83, 111.17, 110.92, 109.99, 81.77, 62.11, 56.23, 47.22, 45.46, 29.01.
HRMS calculated for $C_{25}H_{16}F_3N_4O$ $[M+H]^+$: 445.1276, Found: 445.1246



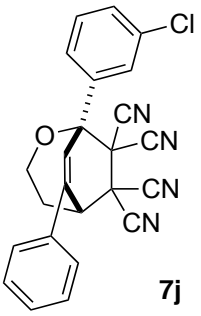
7h

7h was synthesized using general procedure B.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 3/1) as a yellow solid (95 mg, 61% yield).
^{1}H NMR (400 MHz; $CDCl_3$): 7.64 – 7.27 (m, 9H), 6.74 (s, 1H), 4.18 – 4.08 (m, 2H), 3.79 (td, J = 12.2, 4.1 Hz, 1H), 2.96 – 2.78 (m, 1H), 2.43 (s, 3H), 2.10 – 1.97 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 144.68, 138.60, 136.38, 135.16, 131.08, 130.73, 129.59, 128.58, 127.70, 125.88, 124.24, 122.91, 112.92, 111.33, 111.23, 110.29, 81.86, 62.02, 56.33, 47.15, 45.53, 29.05, 21.68.
HRMS calculated for $C_{25}H_{19}N_4O$ $[M+H]^+$: 391.1559, Found: 391.2515



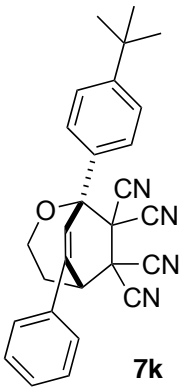
7i

7i was synthesized using general procedure B.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 3/1) as a pale-yellow foam (107 mg, 68% yield).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.65 – 7.50 (m, 7H), 7.25 – 7.20 (m, 2H), 6.70 (d, J = 1.1 Hz, 1H), 4.30 – 4.09 (m, 2H), 3.82 (td, J = 12.3, 4.1 Hz, 1H), 3.01 – 2.60 (m, 1H), 2.16 – 1.99 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 162.65 (d, $J_{C\text{-}F}$ = 248.16 Hz), 145.22, 138.95 (d, $J_{C\text{-}F}$ = 7.09 Hz), 134.89, 130.93, 130.39 (d, $J_{C\text{-}F}$ = 8.02 Hz), 129.65, 127.51(d, $J_{C\text{-}F}$ = 199.51 Hz), 125.88, 122.88 (d, $J_{C\text{-}F}$ = 2.20 Hz), 122.13, 117.48 (d, $J_{C\text{-}F}$ = 21.04 Hz), 114.84 (d, $J_{C\text{-}F}$ = 24.33 Hz), 112.76, 111.11 (d, $J_{C\text{-}F}$ = 17.34 Hz), 110.01, 81.47, 62.23, 56.07, 47.14, 45.40, 29.03.
HRMS calculated for $C_{24}H_{16}FN_4O$ $[M+H]^+$: 395.1308, Found: 395.1290



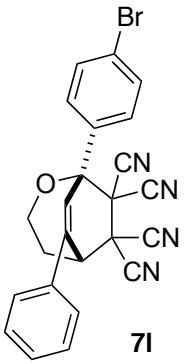
7j

7j was synthesized using general procedure B.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 3/1) as a yellow oil (97 mg, 59% yield).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.81 (t, J = 1.7 Hz, 1H), 7.69 – 7.64 (m, 1H), 7.59 – 7.44 (m, 7H), 6.68 (s, 1H), 4.22 – 4.13 (m, 2H), 3.81 (td, J = 12.2, 4.1 Hz, 1H), 2.96 – 2.84 (m, 1H), 2.10 – 2.03 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 145.30, 138.40, 135.04, 134.88, 130.94, 130.61, 129.96, 129.64, 127.53, 125.87, 125.35, 122.01, 112.72, 111.13, 111.00, 109.93, 81.43, 62.21, 47.18, 45.38, 29.69, 29.01.
HRMS calculated for $C_{24}H_{16}ClN_4O$ $[M+H]^+$: 411.1013, Found: 411.0985



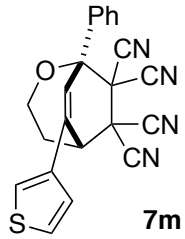
7k

7k was synthesized using general procedure B.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 5/1) as a white solid (111 mg, 64% yield).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.80 – 7.69 (m, 2H), 7.61 – 7.48 (m, 7H), 6.78 (d, *J* = 1.1 Hz, 1H), 4.20 – 4.11 (m, 2H), 3.80 (td, *J* = 12.3, 4.0 Hz, 1H), 2.95 – 2.85 (m, 1H), 2.09 – 1.98 (m, 1H), 1.38 (s, 9H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 153.54, 144.55, 135.16, 133.47, 130.74, 129.60, 126.96, 125.89, 125.69, 123.07, 113.03, 111.44, 111.28, 110.41, 81.90, 62.03, 56.34, 47.17, 45.53, 34.80, 31.22, 29.16.
HRMS calculated for $C_{28}H_{25}N_4O$ $[M+H]^+$: 433.2028, Found: 433.2014



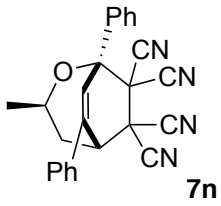
7l

7l was synthesized using general procedure B.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 3/1) as a yellow solid (98 mg, 54% yield).
^{1}H NMR (500 MHz; $CDCl_3$): 7.65 (d, *J* = 9.2 Hz, 4H), 7.59 – 7.48 (m, 5H), 6.68 (s, 1H), 4.24 – 4.11 (m, 2H), 3.81 (td, *J* = 12.1, 4.0 Hz, 1H), 2.95 – 2.83 (m, 1H), 2.09 – 2.00 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 145.26, 135.43, 134.92, 131.94, 130.92, 129.64, 128.87, 125.86, 125.19, 122.04, 112.74, 111.22, 111.01, 110.03, 81.69, 62.16, 47.17, 45.31, 29.69, 29.01.
HRMS calculated for $C_{24}H_{16}BrN_4O$ $[M+H]^+$: 455.0508, Found: 455.0471



7m

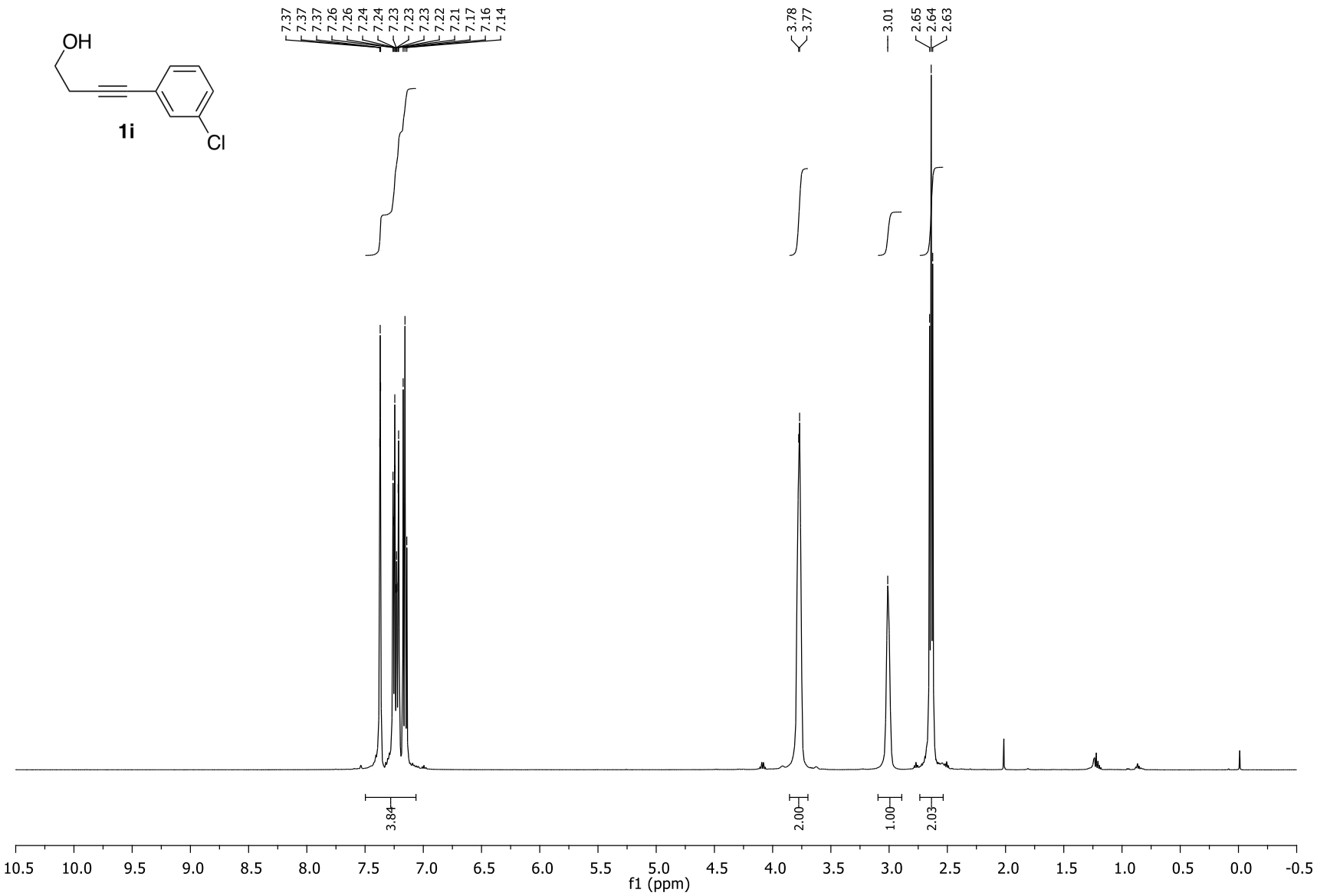
7m was synthesized using general procedure B.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 3/1) as a yellow solid (124 mg, 81% yield).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.71 (d, *J* = 2.0 Hz, 1H), 7.61 – 7.35 (m, 7H), 6.69 (s, 1H), 4.16 – 4.02 (m, 2H), 3.81 (td, *J* = 12.2, 4.0 Hz, 1H), 2.93 – 2.76 (m, 1H), 2.07 – 1.90 (m, 1H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 144.67, 138.45, 134.92, 130.84, 129.61, 127.13, 126.23, 125.91, 122.89, 112.90, 111.39, 111.13, 110.35, 81.30, 62.12, 55.87, 47.12, 45.34, 29.14.
HRMS calculated for $C_{22}H_{15}N_4OS$ $[M+H]^+$: 383.0967, Found: 383.0951

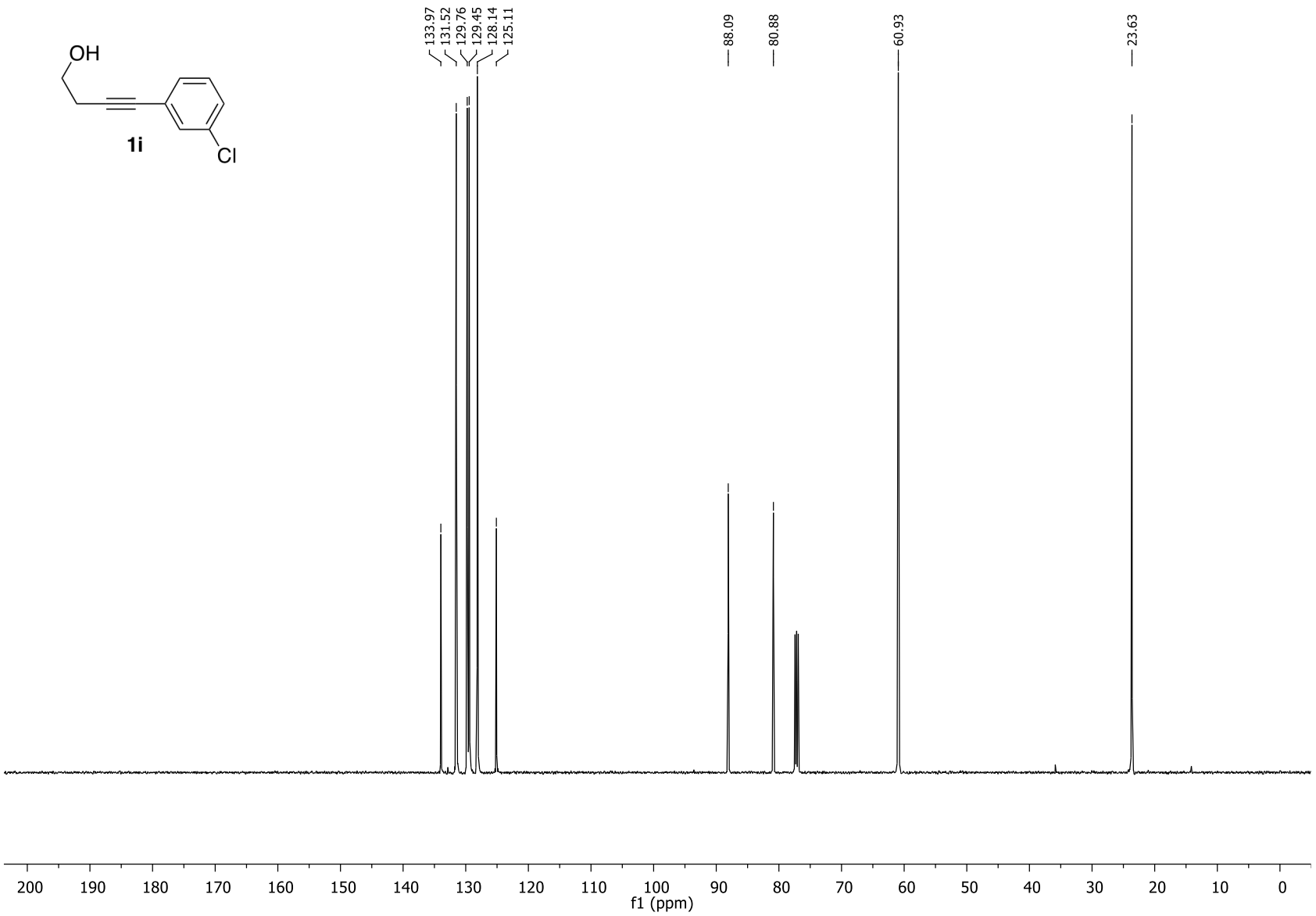


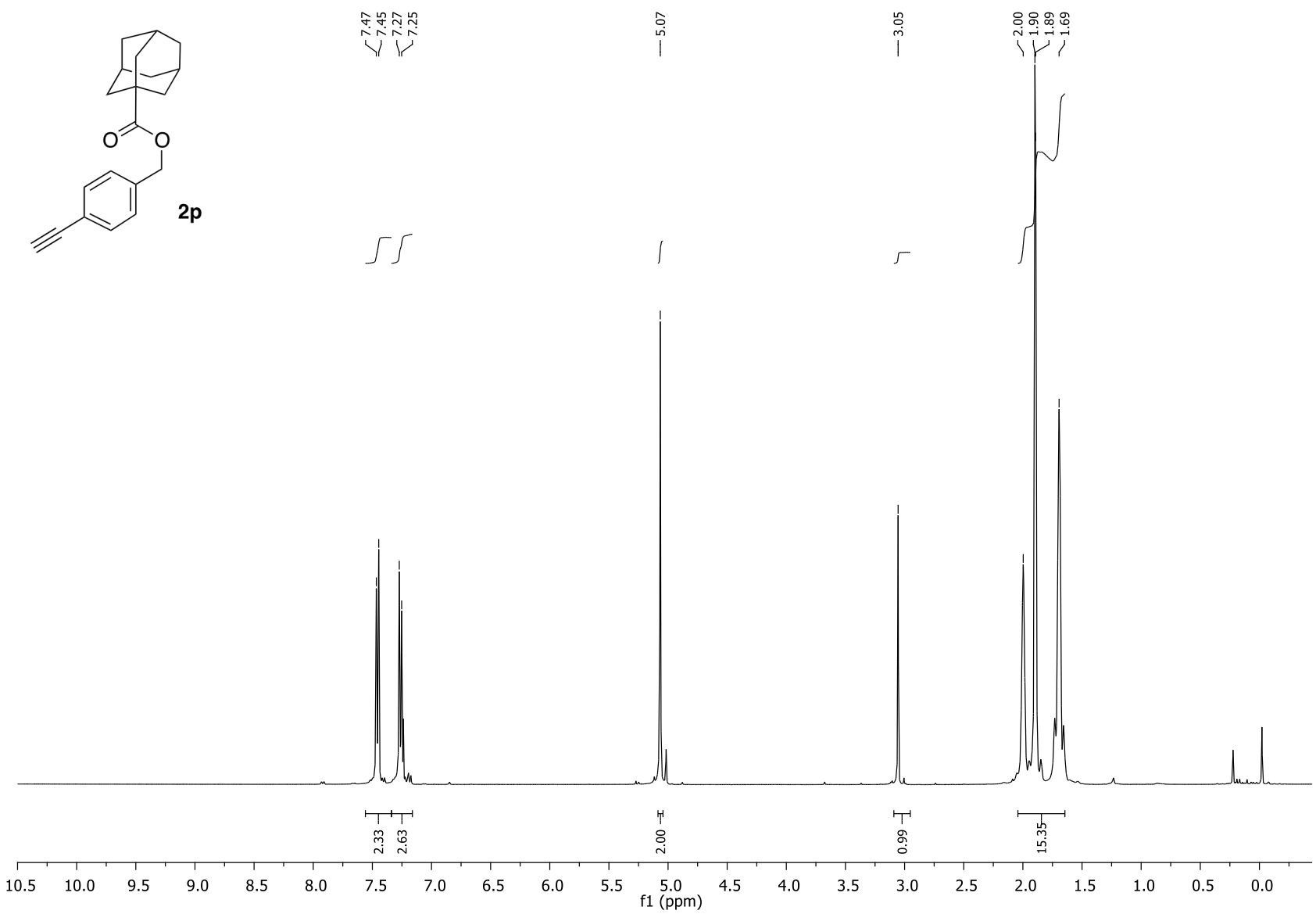
7n

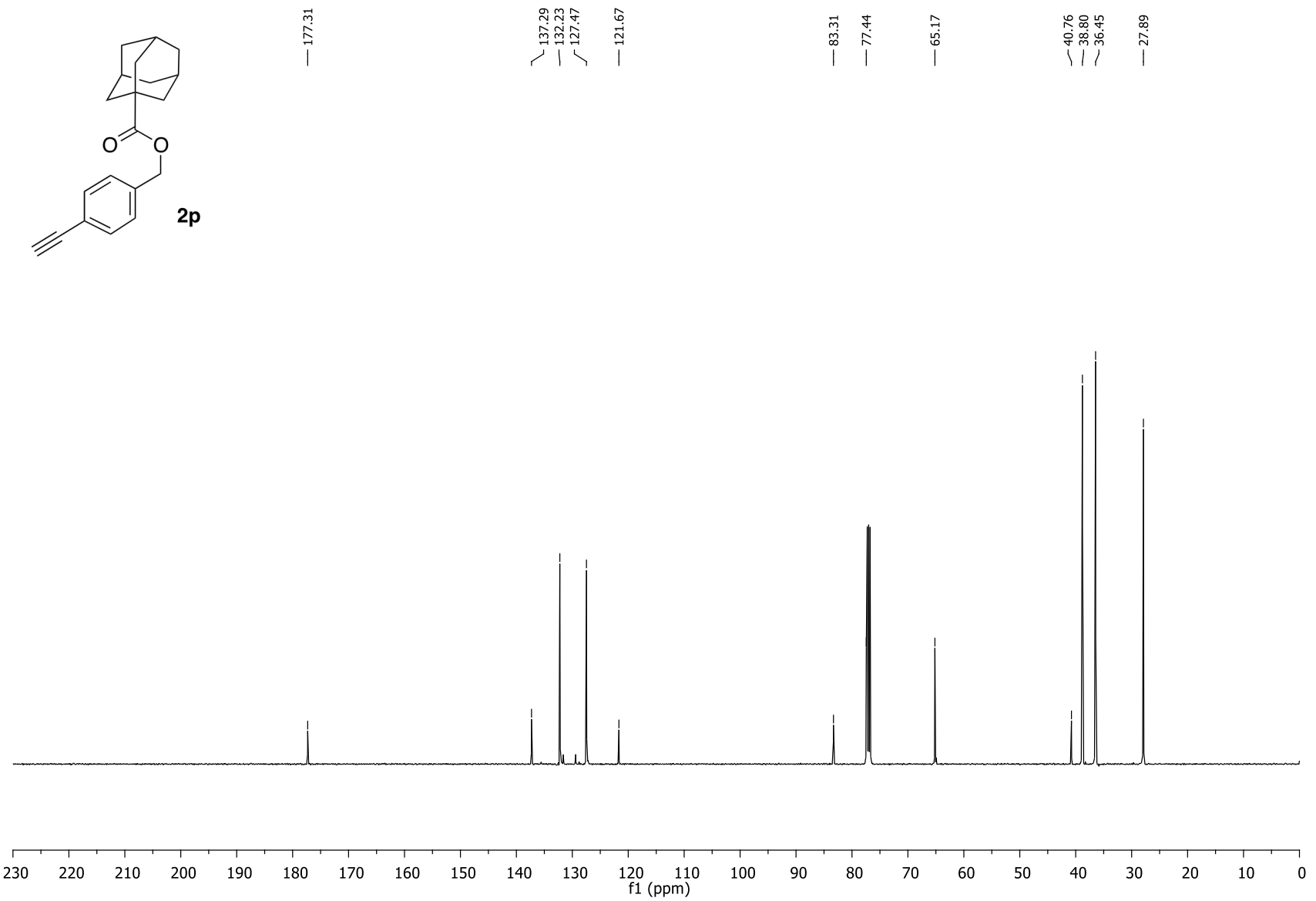
7n was synthesized using general procedure B.
The title compound was isolated via flash chromatography on silica gel (Elution: hexanes/ethyl acetate = 3/1) as a pale-yellow oil (116 mg, 74% yield).
^{1}H NMR (500 MHz; $CDCl_3$): δ 7.90 – 7.77 (m, 2H), 7.63 – 7.43 (m, 8H), 6.78 (s, 1H), 4.11 (d, *J* = 6.4 Hz, 1H), 4.06 – 3.97 (m, 1H), 2.55 (dd, *J* = 15.4, 10.7 Hz, 1H), 2.27 – 2.10 (m, 1H), 1.43 (d, *J* = 6.2 Hz, 3H).
^{13}C NMR (126 MHz; $CDCl_3$): δ 145.03, 136.70, 135.11, 130.70, 130.30, 129.58, 128.75, 127.14, 125.85, 123.55, 112.95, 111.39, 111.21, 110.26, 81.39, 77.30, 77.04, 76.79, 69.75, 56.34, 46.76, 45.32, 36.37, 20.27.
HRMS calculated for $C_{25}H_{19}N_4O$ $[M+H]^+$: 391.1559, Found: 391.1542

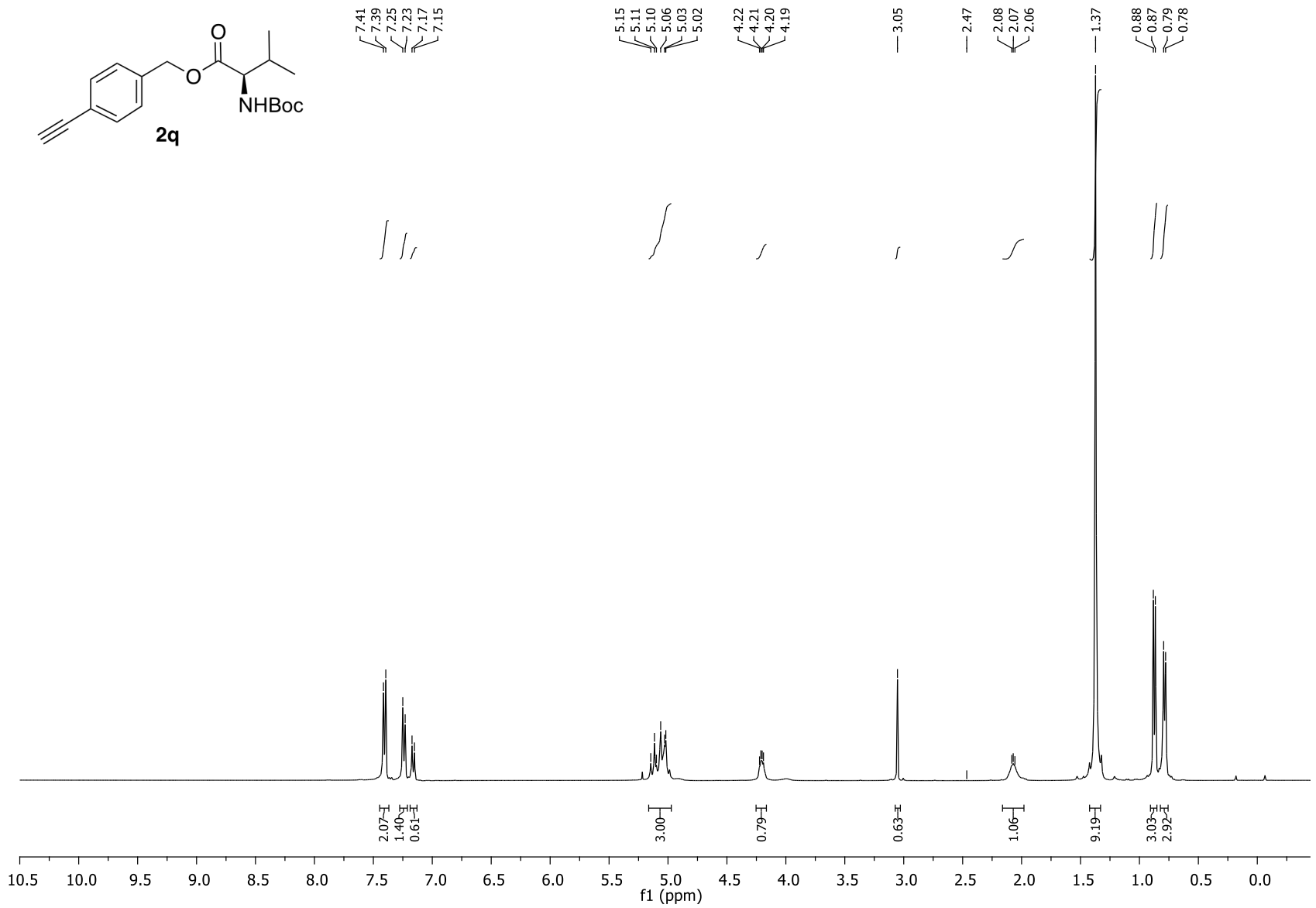
V. NMR Spectral Data

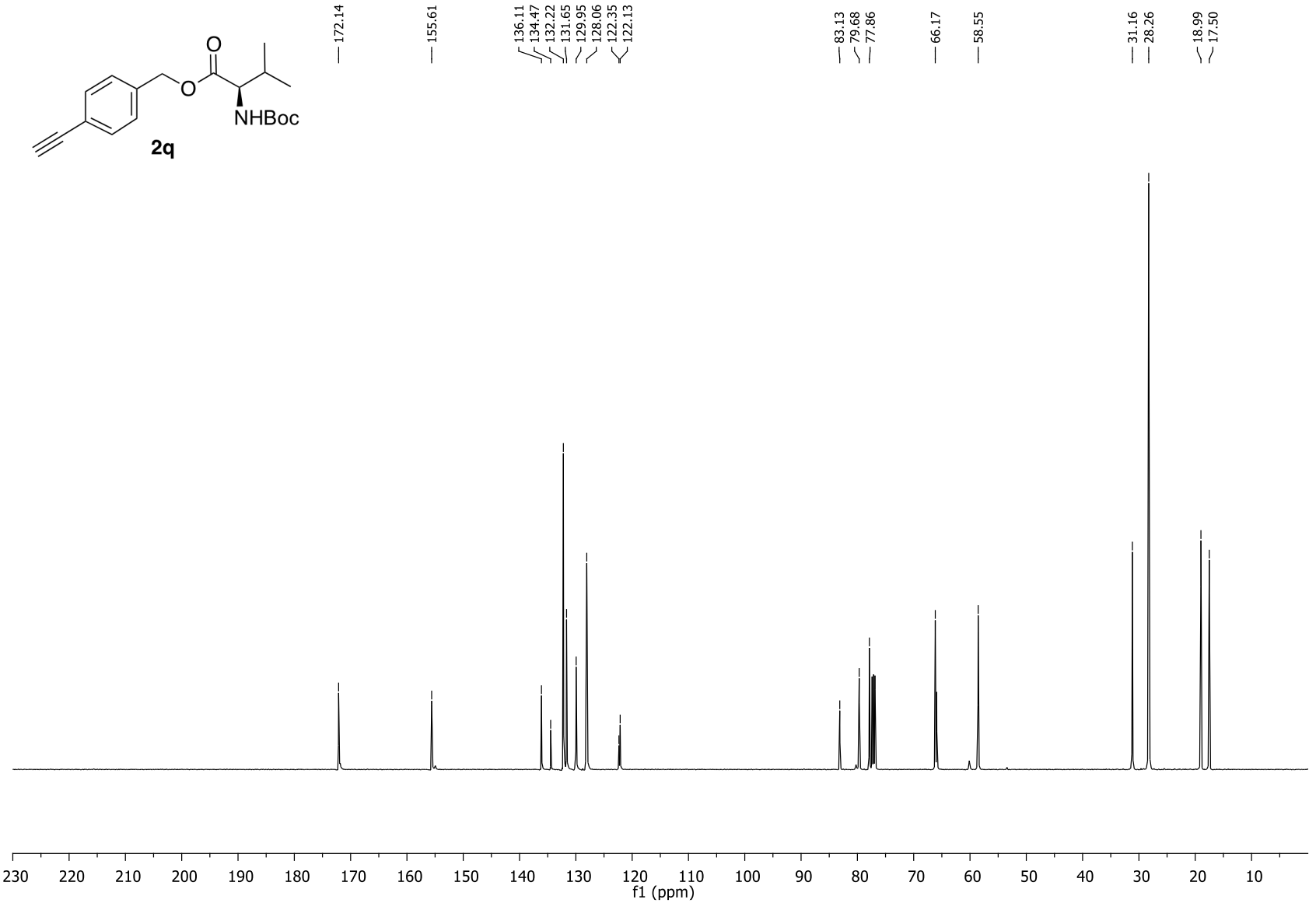


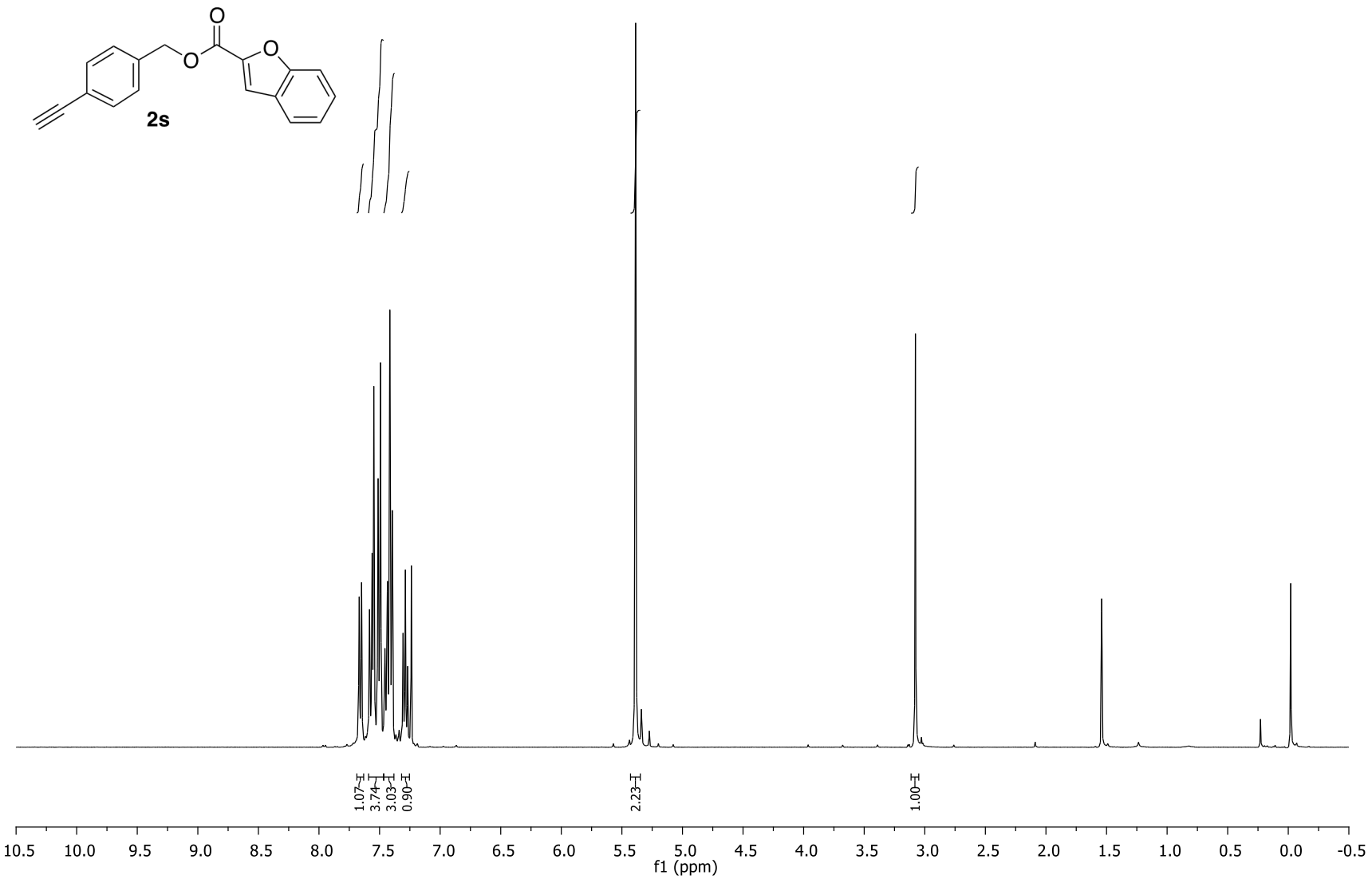

OH
1i
Cl
133.97
131.52
129.76
129.45
128.14
125.11
88.09
80.88
60.93
23.63
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

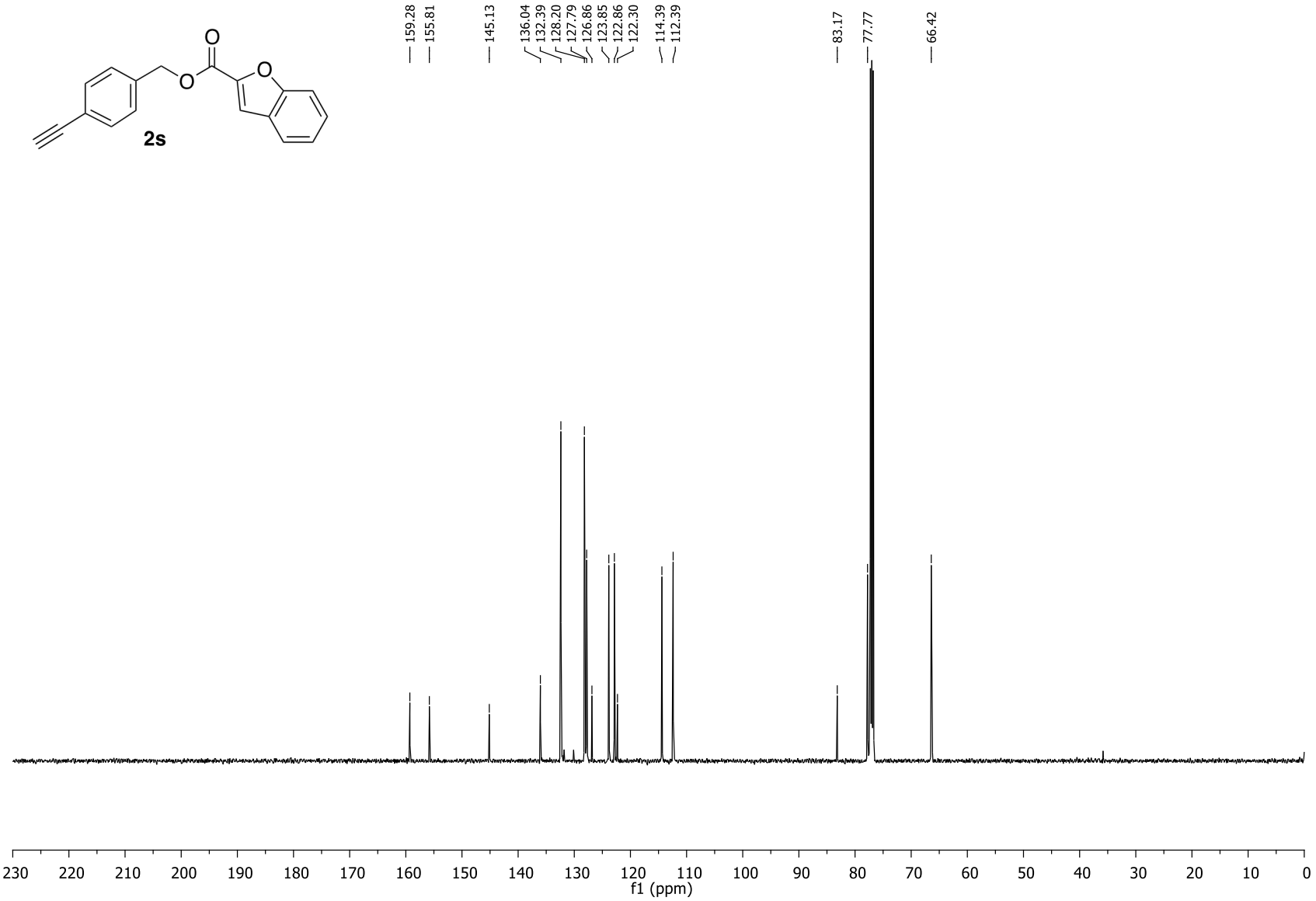

2p
7.47
7.45
7.27
7.25
5.07
3.05
2.00
1.90
1.89
1.69
2.33
2.63
2.00
0.99
15.35
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

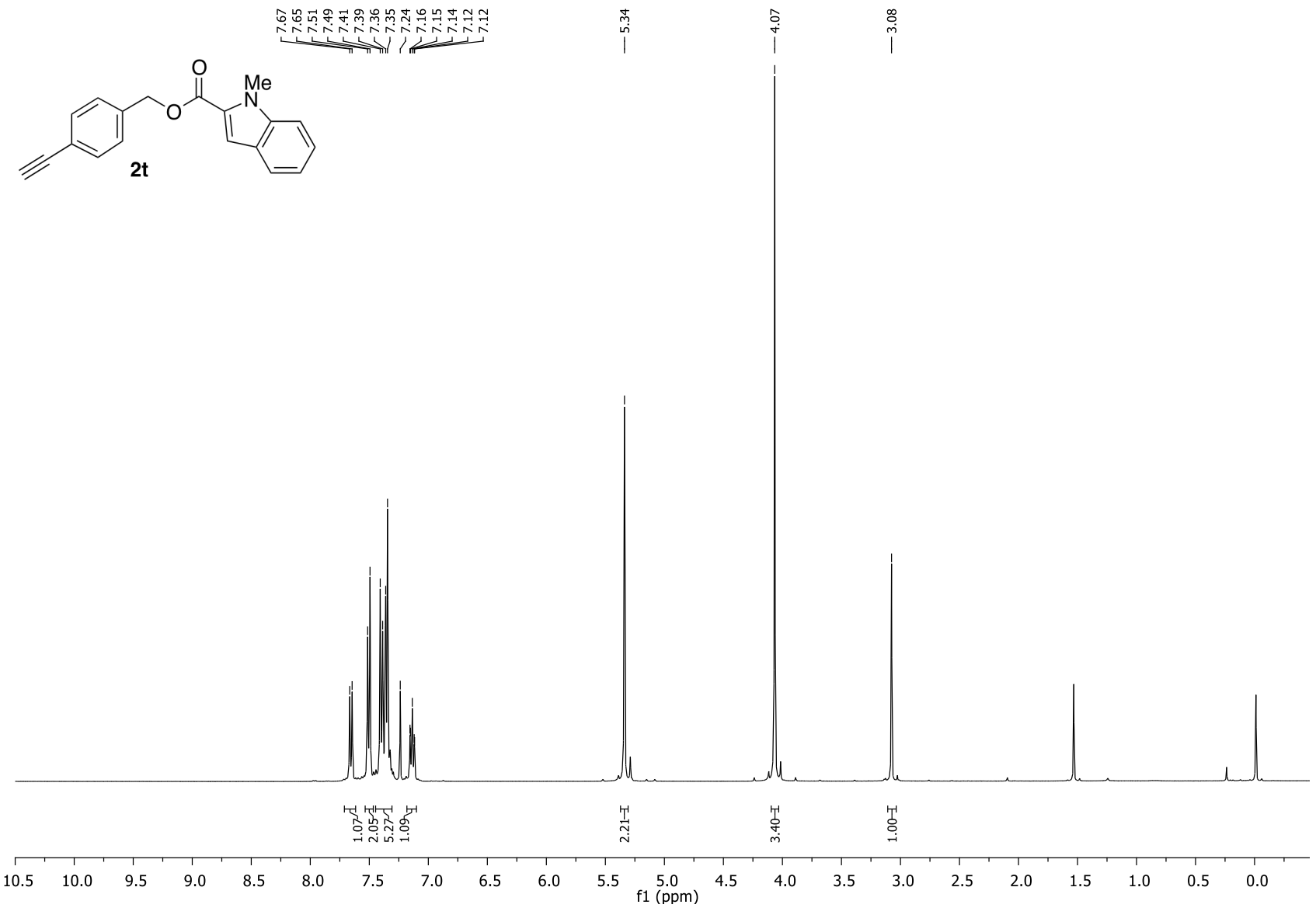

177.31
137.29
132.23
127.47
121.67
83.31
77.44
65.17
40.76
38.80
36.45
27.89
2p
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

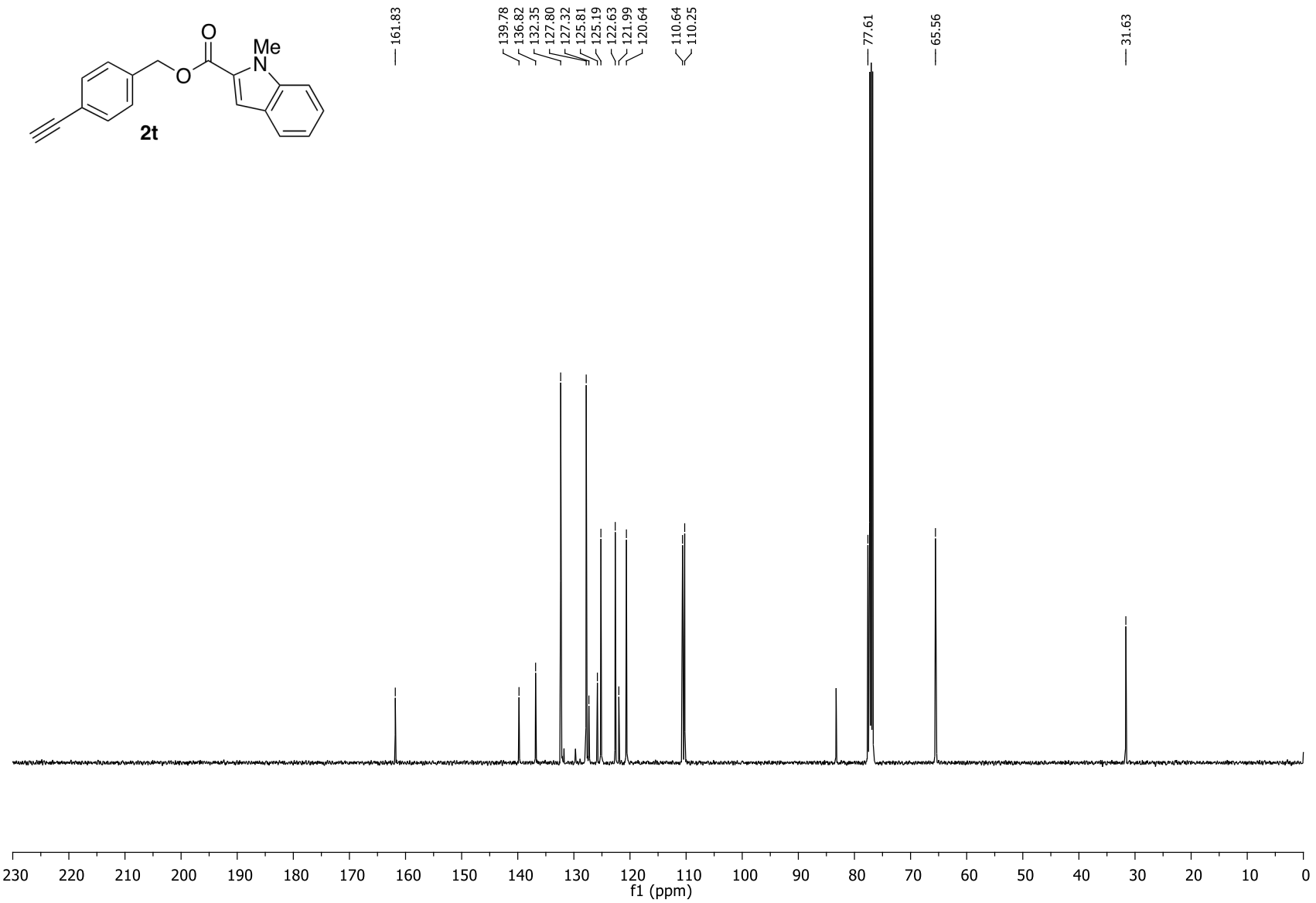

O
O
NHBoc
2q
7.41
7.39
7.25
7.23
7.17
7.15
5.15
5.11
5.10
5.06
5.03
5.02
4.22
4.21
4.20
4.19
3.05
2.47
2.08
2.07
2.06
1.37
0.88
0.87
0.79
0.78
2.07
1.40
0.61
3.00
0.79
0.63
1.06
9.19
3.03
2.92
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

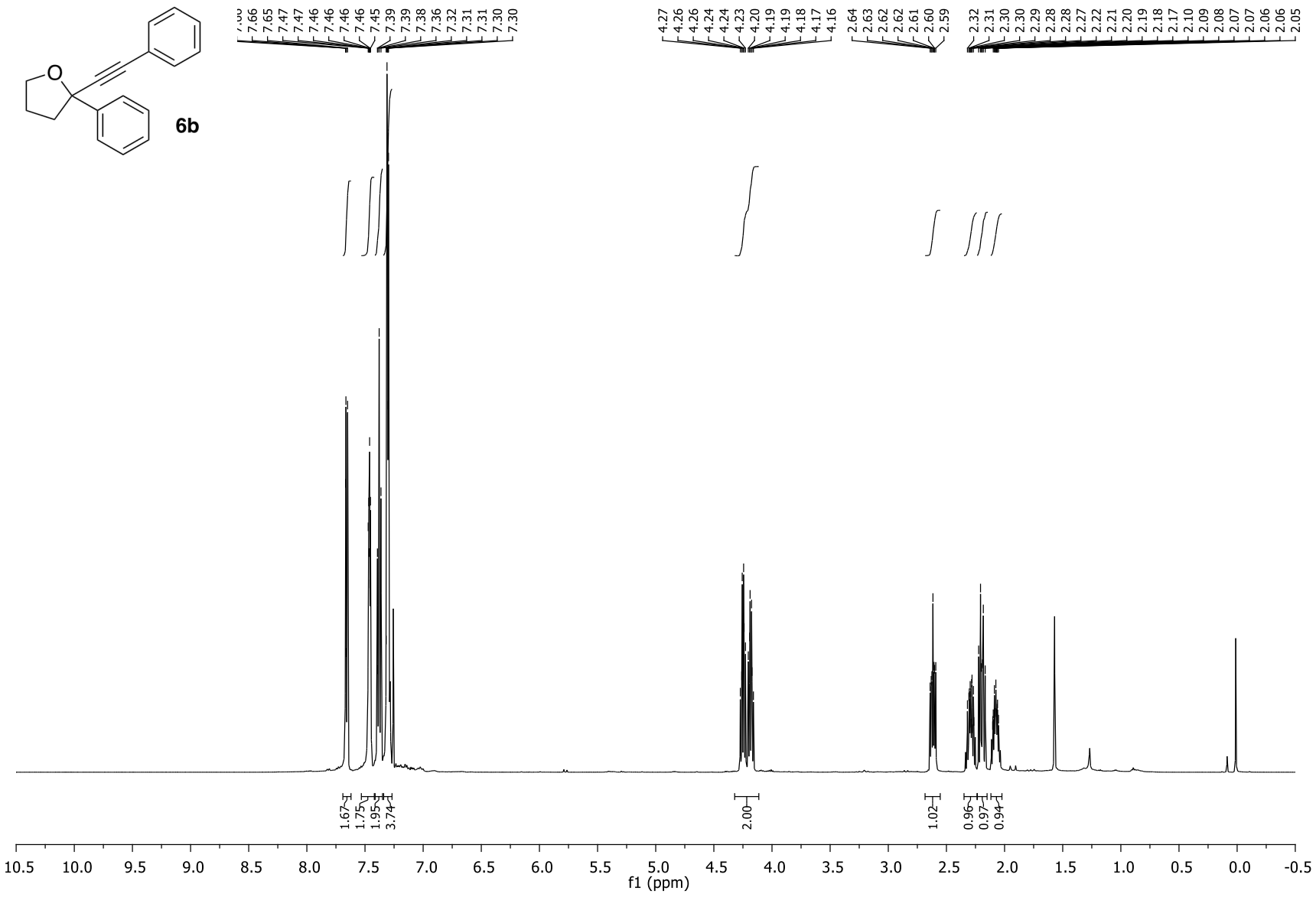

172.14
155.61
136.11
134.47
132.22
131.65
129.95
128.06
122.35
122.13
83.13
79.68
77.86
66.17
58.55
31.16
28.26
18.99
17.50
O
O
NHBoc
2q
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

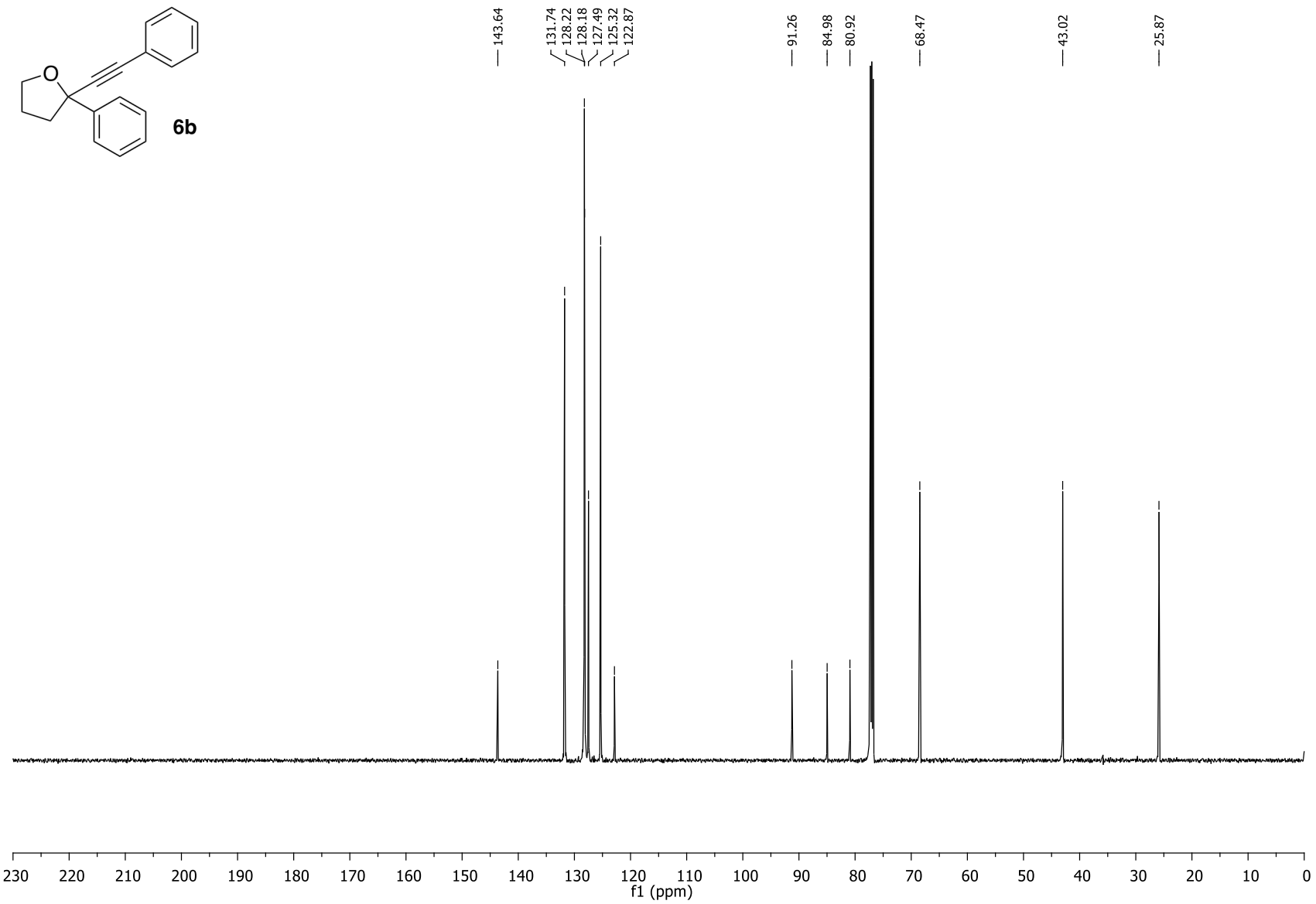

O
O
O
2s
1.07
3.74
3.03
0.90
2.23
1.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

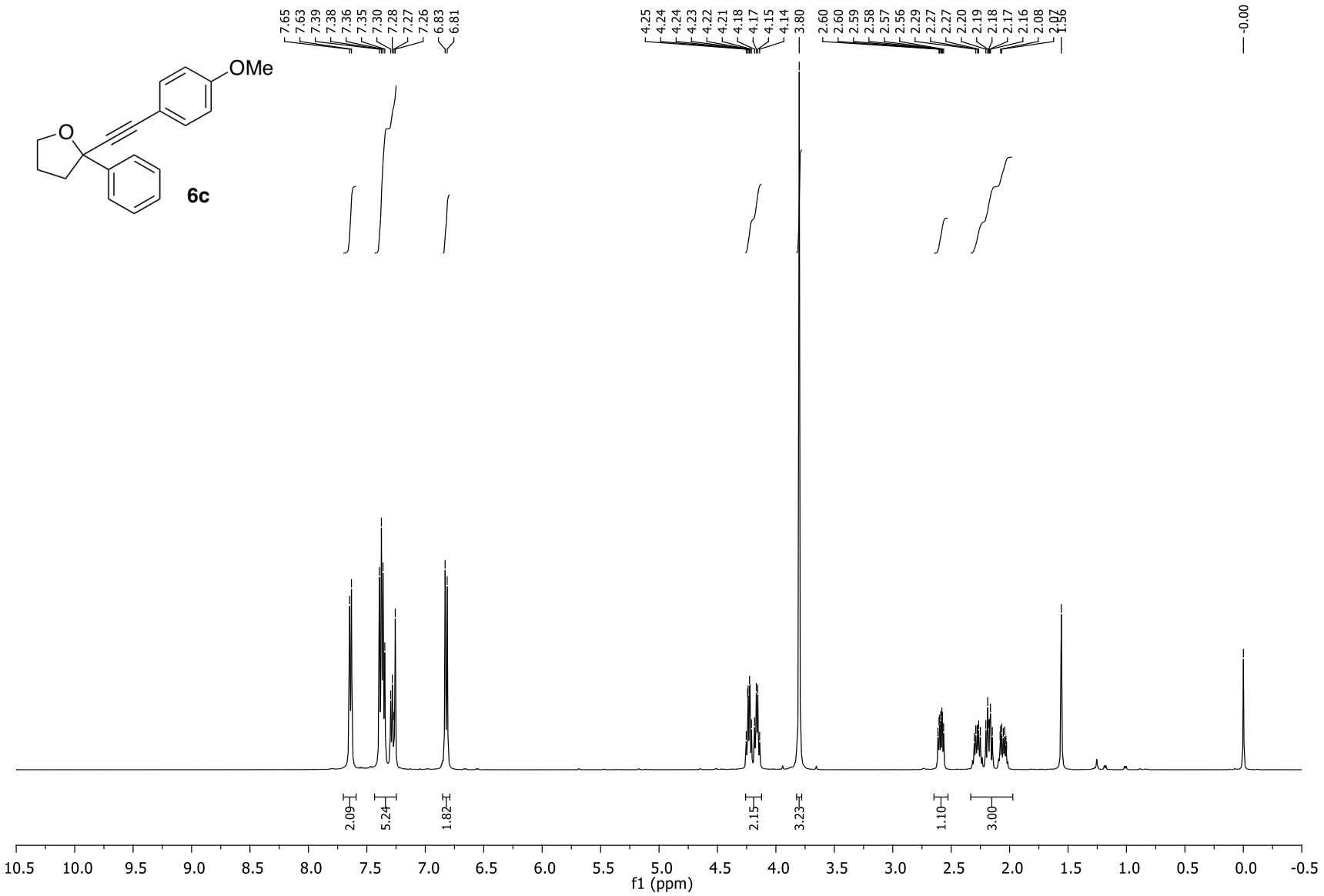

2s
159.28
155.81
145.13
136.04
132.39
128.20
127.79
126.86
123.85
122.86
122.30
114.39
112.39
83.17
77.77
66.42
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

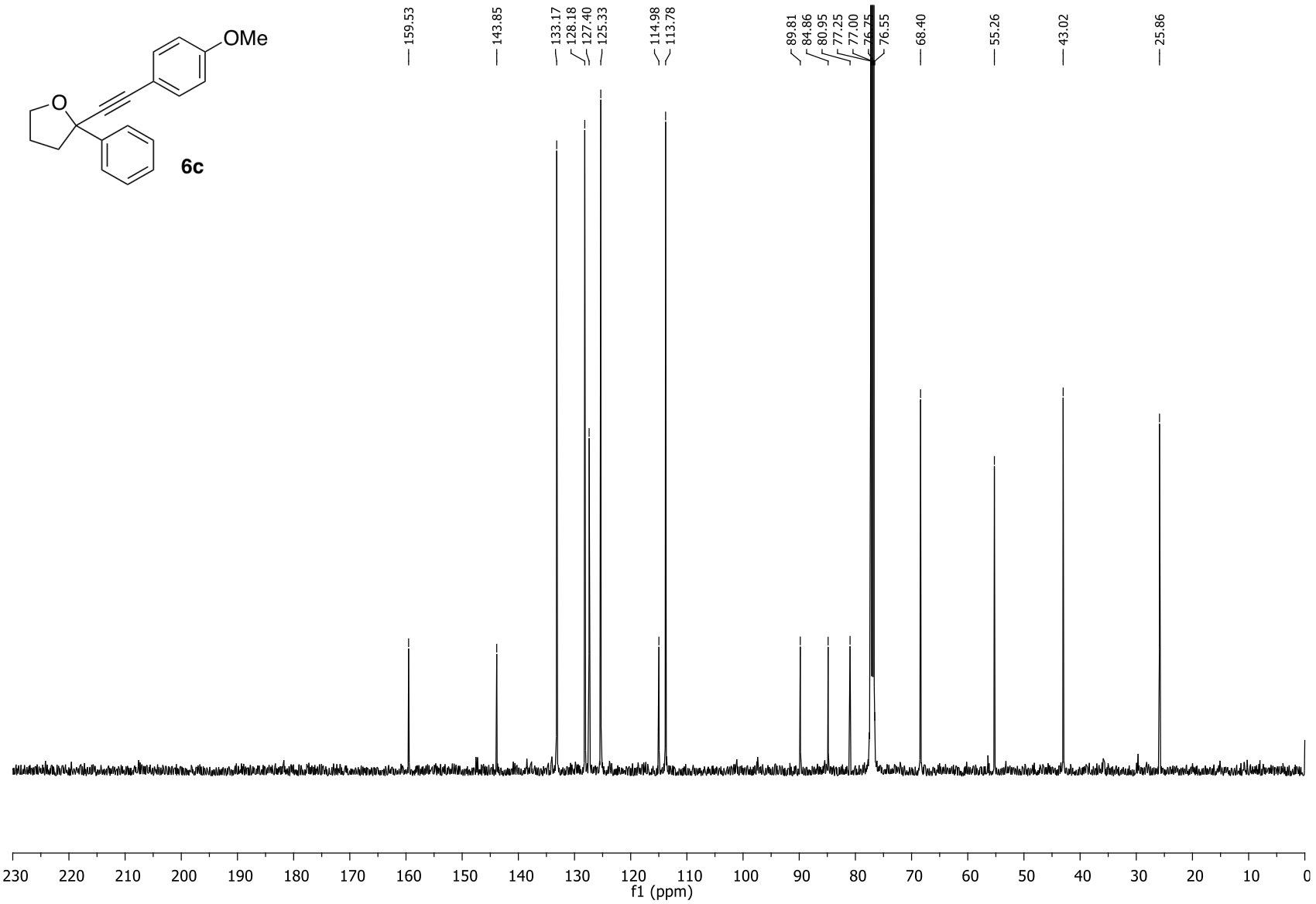

7.67
7.65
7.51
7.49
7.41
7.39
7.36
7.35
7.24
7.16
7.15
7.14
7.12
7.12
5.34
4.07
3.08
O
Me
N
O
2t
1.07
2.05
5.27
1.09
2.21
3.40
1.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

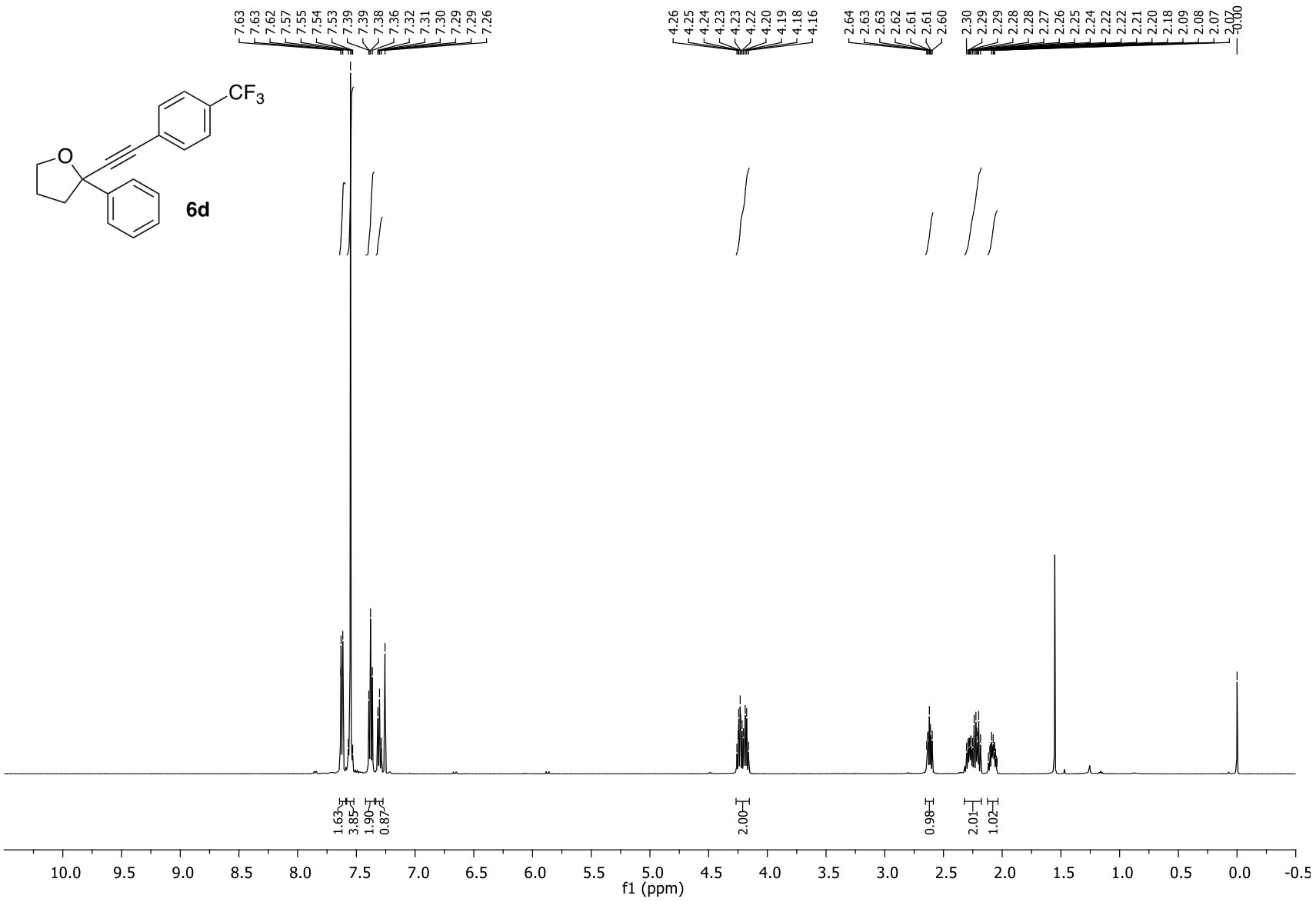

O
Me
N
O
2t
161.83
139.78
136.82
132.35
127.80
127.32
125.81
125.19
122.63
121.99
120.64
110.64
110.25
77.61
65.56
31.63
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

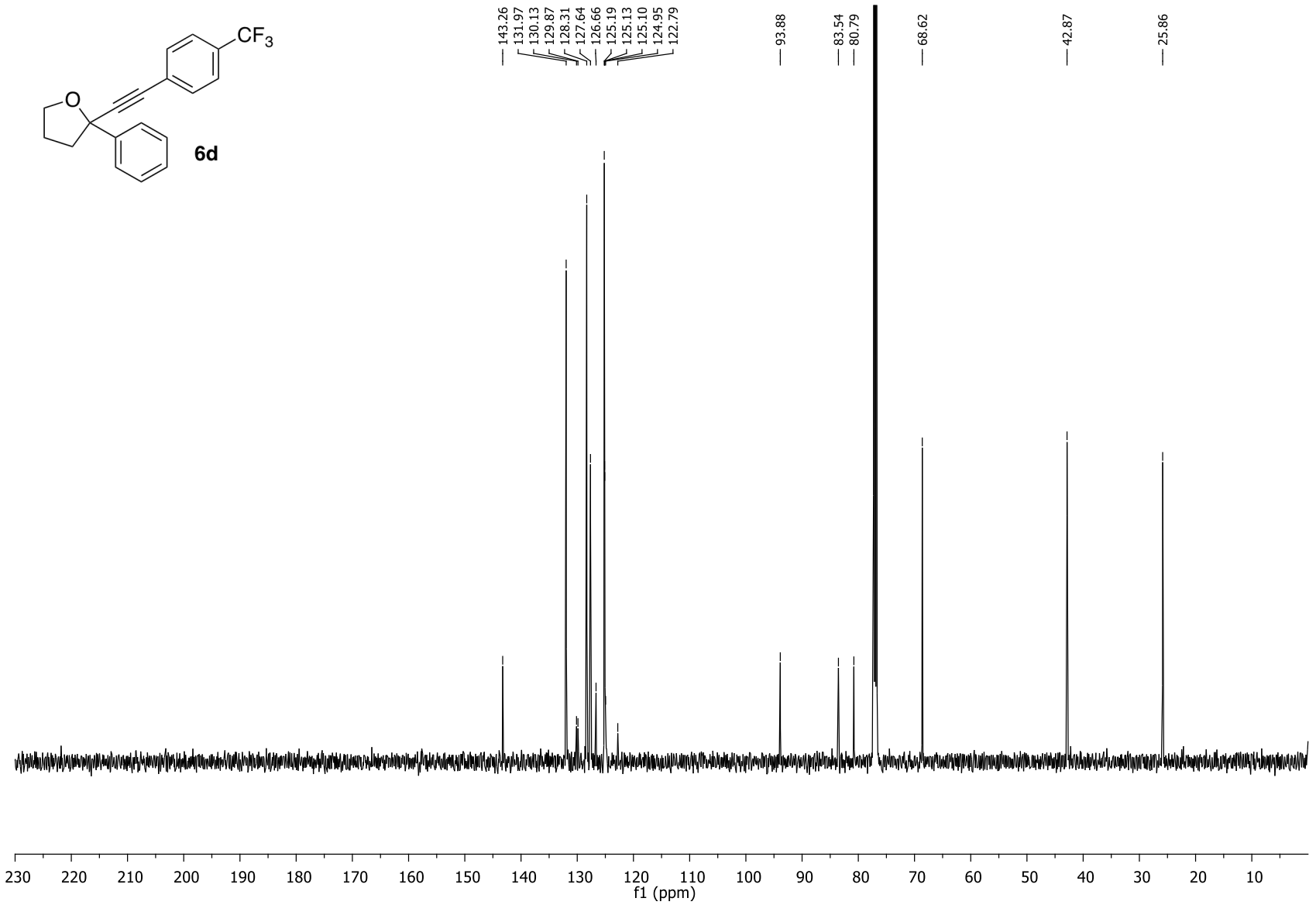

6b
7.66
7.65
7.47
7.47
7.46
7.46
7.46
7.46
7.45
7.39
7.39
7.38
7.36
7.32
7.31
7.31
7.30
7.30
4.27
4.26
4.26
4.24
4.24
4.23
4.20
4.19
4.19
4.18
4.17
4.16
2.64
2.63
2.62
2.62
2.61
2.60
2.59
2.32
2.31
2.30
2.30
2.29
2.28
2.28
2.27
2.22
2.21
2.20
2.19
2.18
2.17
2.10
2.09
2.08
2.07
2.07
2.06
2.06
2.05
1.67
1.75
1.95
3.74
2.00
1.02
0.96
0.97
0.94
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

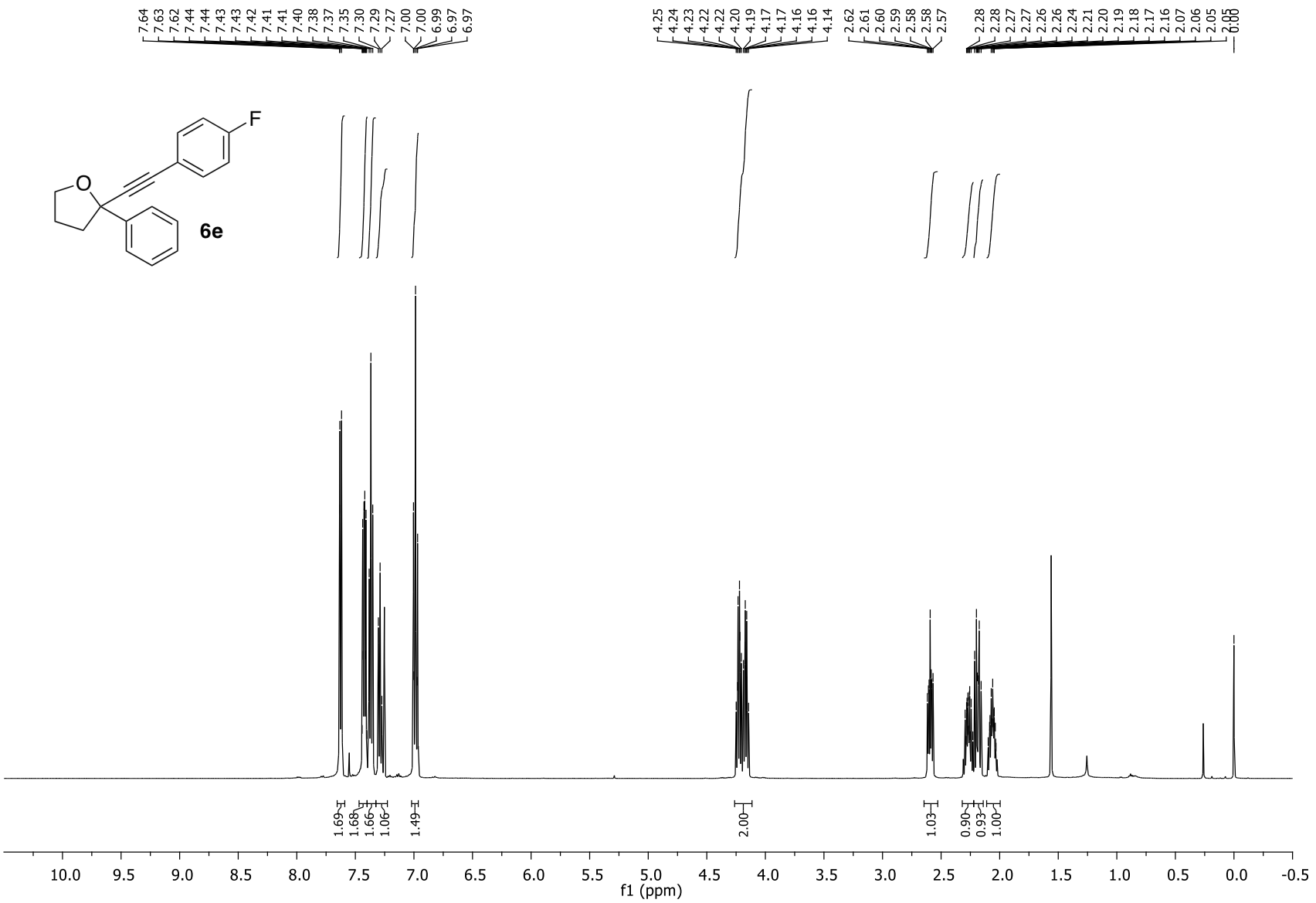

6b
143.64
131.74
128.22
128.18
127.49
125.32
122.87
91.26
84.98
80.92
68.47
43.02
25.87
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

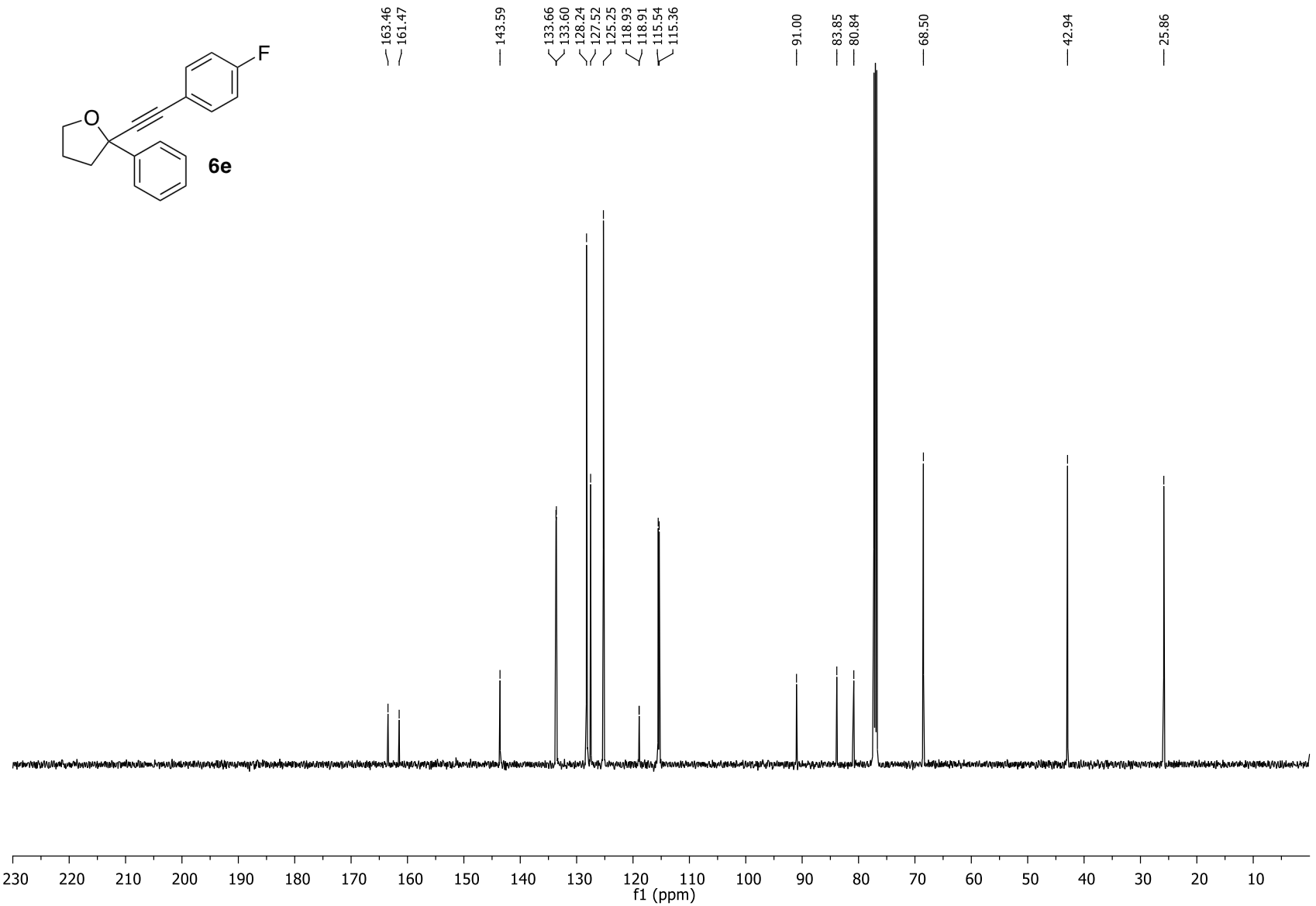

OMe
O
6c
7.65
7.63
7.39
7.38
7.36
7.35
7.30
7.28
7.27
7.26
6.83
6.81
4.25
4.24
4.24
4.23
4.22
4.21
4.18
4.17
4.15
4.14
3.80
2.60
2.60
2.59
2.58
2.57
2.56
2.29
2.27
2.27
2.20
2.19
2.18
2.17
2.16
2.08
2.07
1.56
-0.00
2.09
5.24
1.82
2.15
3.23
1.10
3.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

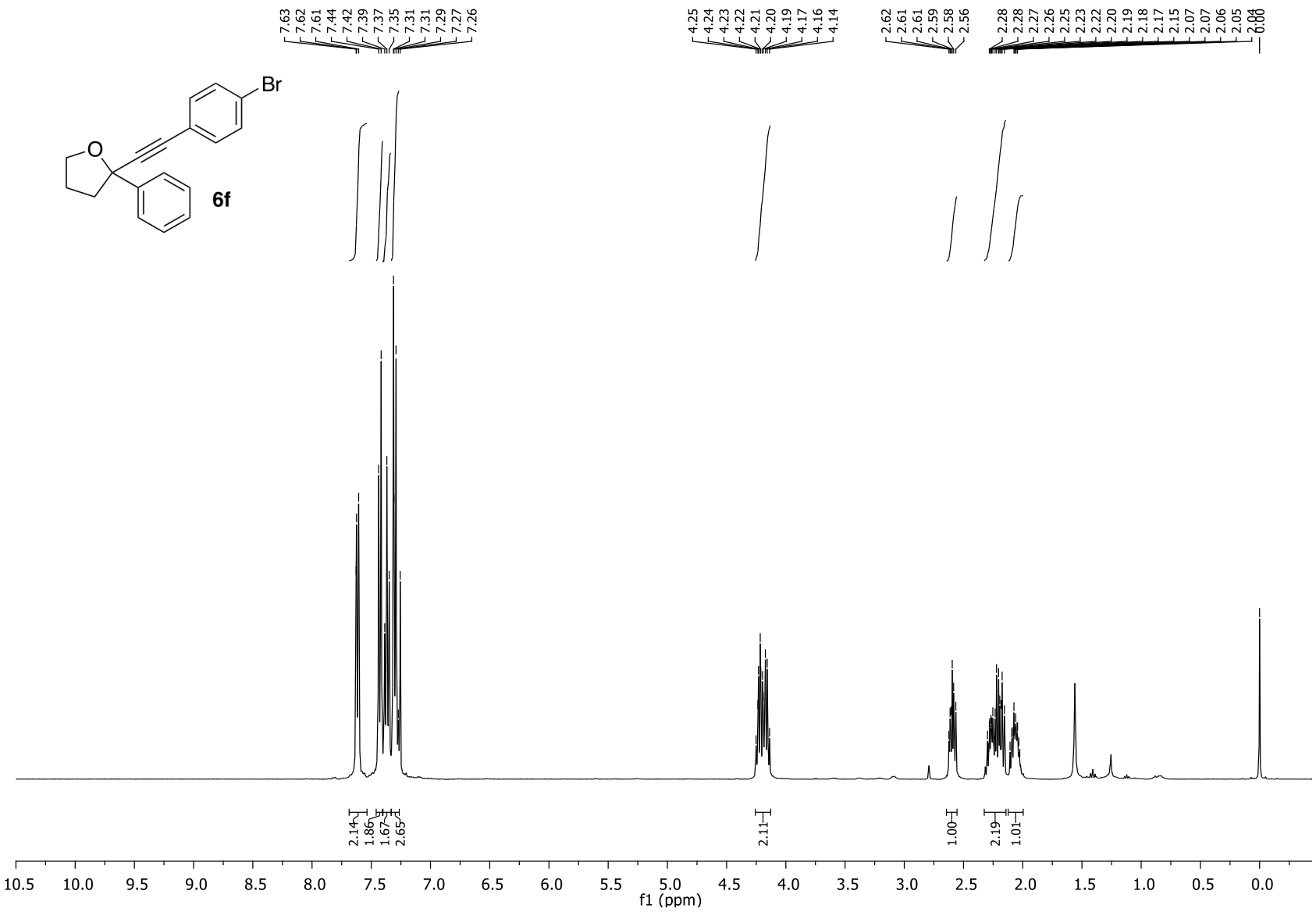

OMe
O
6c
159.53
143.85
133.17
128.18
127.40
125.33
114.98
113.78
89.81
84.86
80.95
77.25
77.00
76.75
76.55
68.40
55.26
43.02
25.86
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

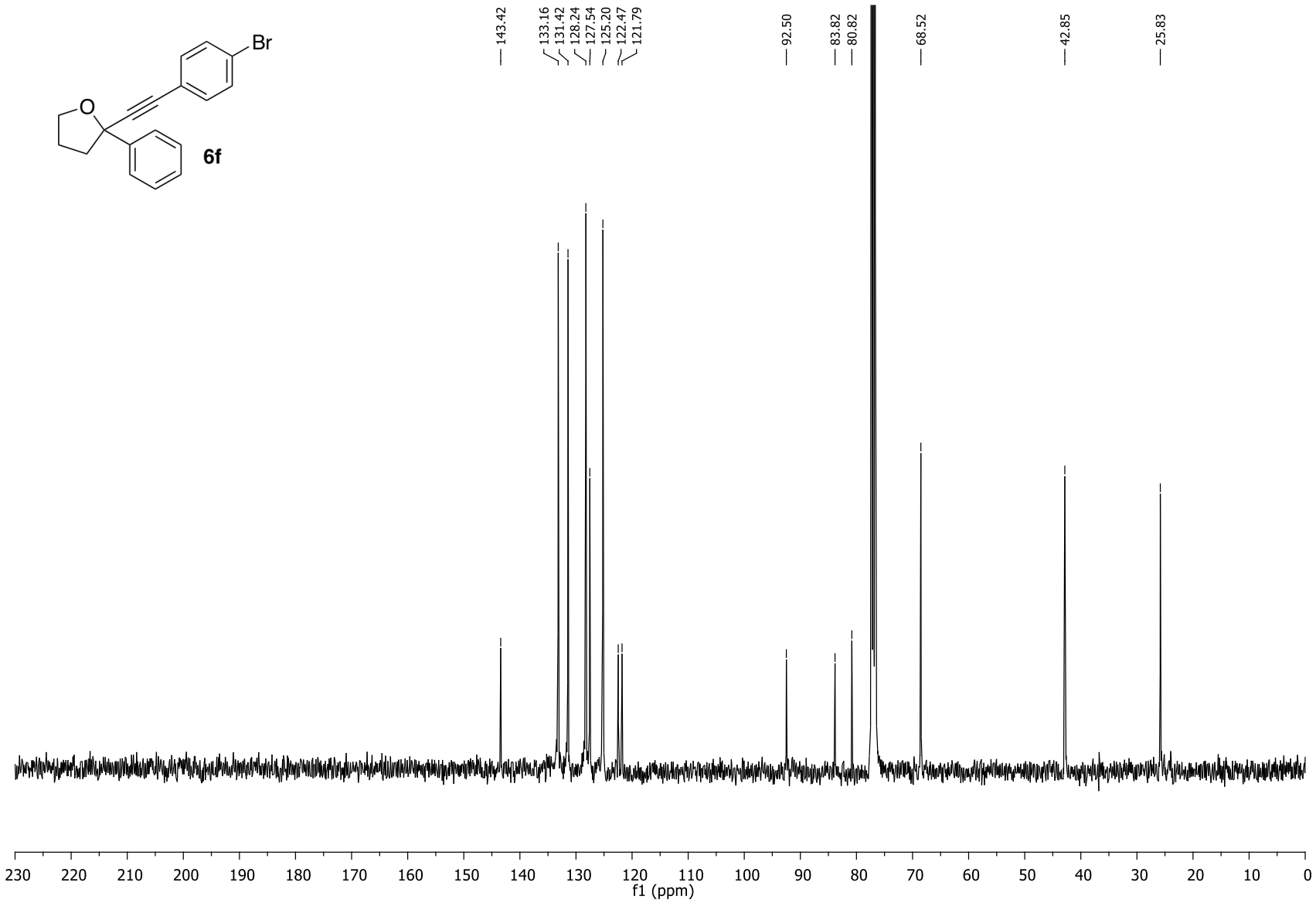

7.63
7.63
7.62
7.57
7.55
7.54
7.53
7.39
7.39
7.38
7.36
7.32
7.31
7.30
7.29
7.29
7.26
4.26
4.25
4.24
4.23
4.23
4.22
4.20
4.19
4.18
4.16
2.64
2.63
2.63
2.62
2.61
2.61
2.60
2.30
2.29
2.29
2.28
2.27
2.26
2.25
2.24
2.22
2.22
2.21
2.20
2.18
2.09
2.08
2.07
0.00
CF3
O
6d
1.63
3.85
1.90
0.87
2.00
0.98
2.01
1.02
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
f1 (ppm)

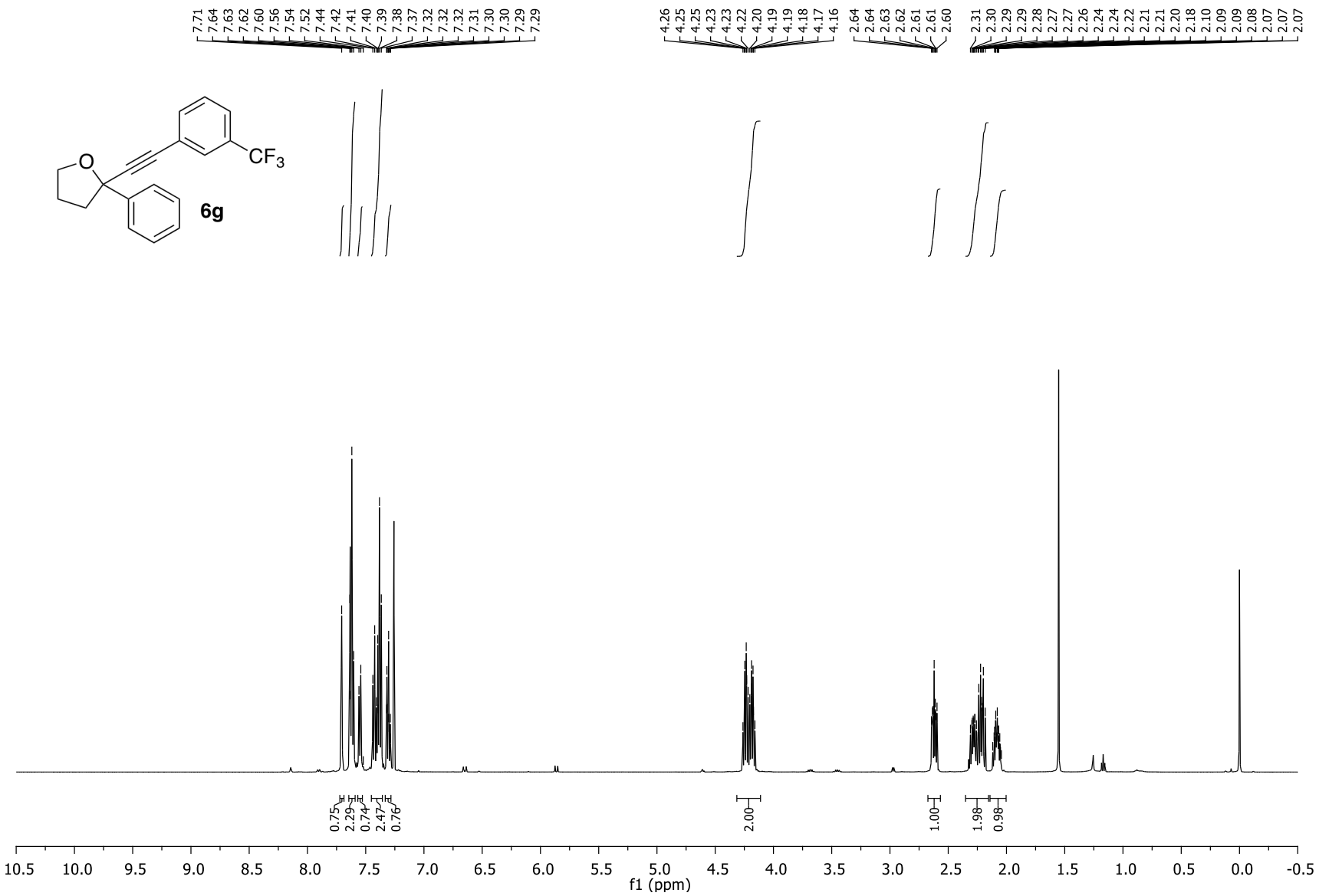

CF3
O
6d
143.26
131.97
130.13
129.87
128.31
127.64
126.66
125.19
125.13
125.10
124.95
122.79
93.88
83.54
80.79
68.62
42.87
25.86
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

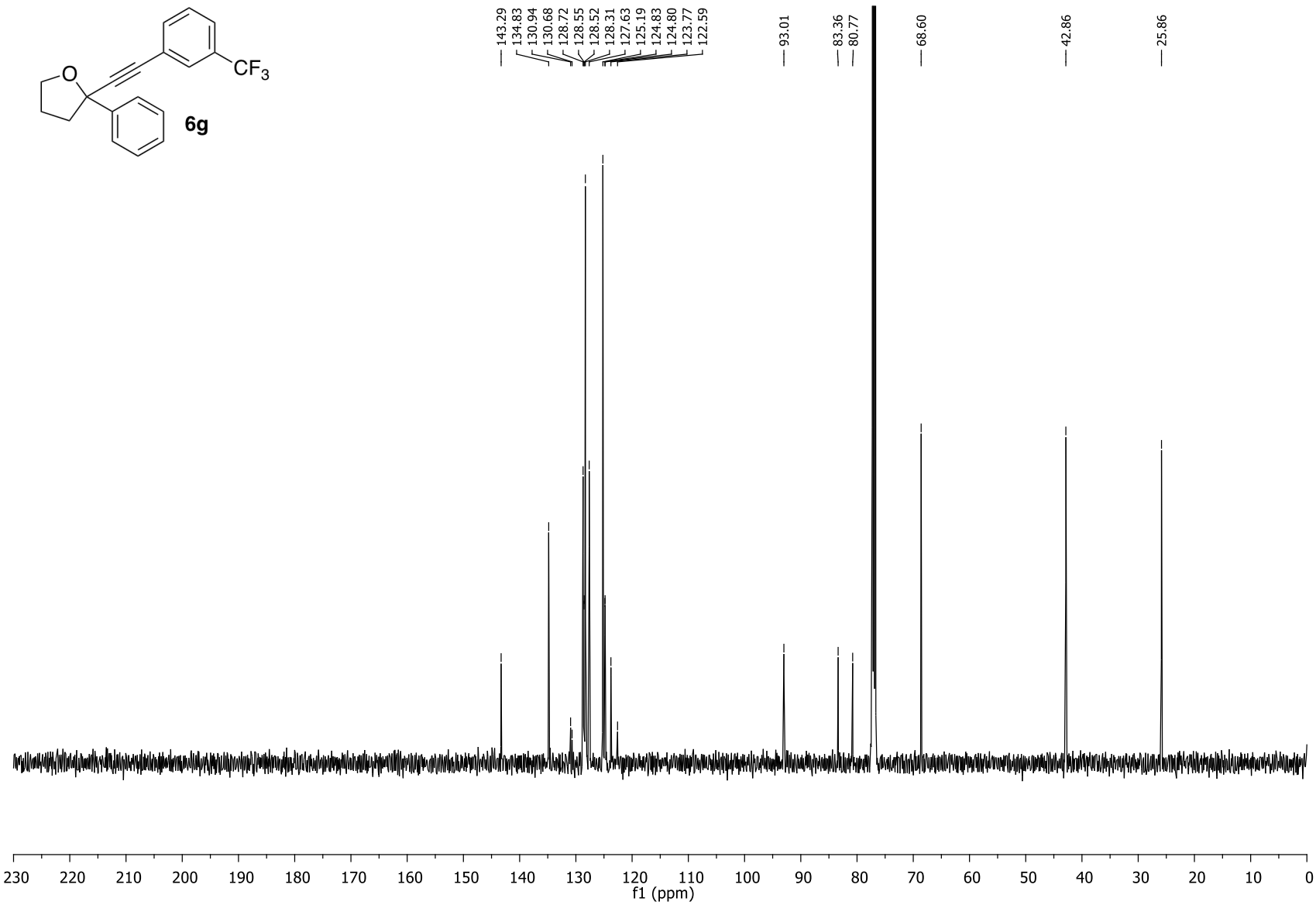

7.64
7.63
7.62
7.44
7.44
7.43
7.43
7.42
7.41
7.41
7.40
7.38
7.37
7.35
7.30
7.29
7.27
7.00
7.00
6.99
6.97
6.97
4.25
4.24
4.23
4.22
4.22
4.20
4.19
4.17
4.17
4.16
4.16
4.14
2.62
2.61
2.60
2.59
2.58
2.58
2.57
2.28
2.28
2.27
2.27
2.26
2.26
2.24
2.21
2.20
2.19
2.18
2.17
2.16
2.07
2.06
2.05
2.00
0.00
F
O
6e
1.69
1.68
1.66
1.06
1.49
2.00
1.03
0.90
0.93
1.00
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
f1 (ppm)


F
O
6e
163.46
161.47
143.59
133.66
133.60
128.24
127.52
125.25
118.93
118.91
115.54
115.36
91.00
83.85
80.84
68.50
42.94
25.86
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


7.63
7.62
7.61
7.44
7.42
7.39
7.37
7.35
7.31
7.31
7.29
7.27
7.26
4.25
4.24
4.23
4.22
4.21
4.20
4.19
4.17
4.16
4.14
2.62
2.61
2.61
2.59
2.58
2.56
2.28
2.28
2.27
2.26
2.25
2.23
2.22
2.20
2.19
2.18
2.17
2.15
2.07
2.07
2.06
2.05
2.04
0.00
Br
O
6f
2.14
1.86
1.67
2.65
2.11
1.00
2.19
1.01
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


Br
O
6f
143.42
133.16
131.42
128.24
127.54
125.20
122.47
121.79
92.50
83.82
80.82
68.52
42.85
25.83
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.71 7.64 7.63 7.62 7.60 7.56 7.54 7.52 7.44 7.42 7.41 7.40 7.39 7.38 7.37 7.32 7.32 7.32 7.31 7.30 7.30 7.29 7.29
4.26 4.25 4.25 4.23 4.23 4.22 4.20 4.19 4.19 4.18 4.17 4.16
2.64 2.64 2.63 2.62 2.61 2.61 2.60
2.31 2.30 2.29 2.29 2.28 2.27 2.27 2.26 2.24 2.24 2.22 2.21 2.21 2.20 2.18 2.10 2.09 2.09 2.08 2.07 2.07 2.07
O
CF3
6g
0.75 2.29 0.74 2.47 0.76
2.00
1.00
1.98 0.98
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


O
CF3
6g
143.29
134.83
130.94
130.68
128.72
128.55
128.52
128.31
127.63
125.19
124.83
124.80
123.77
122.59
93.01
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80.77
68.60
42.86
25.86
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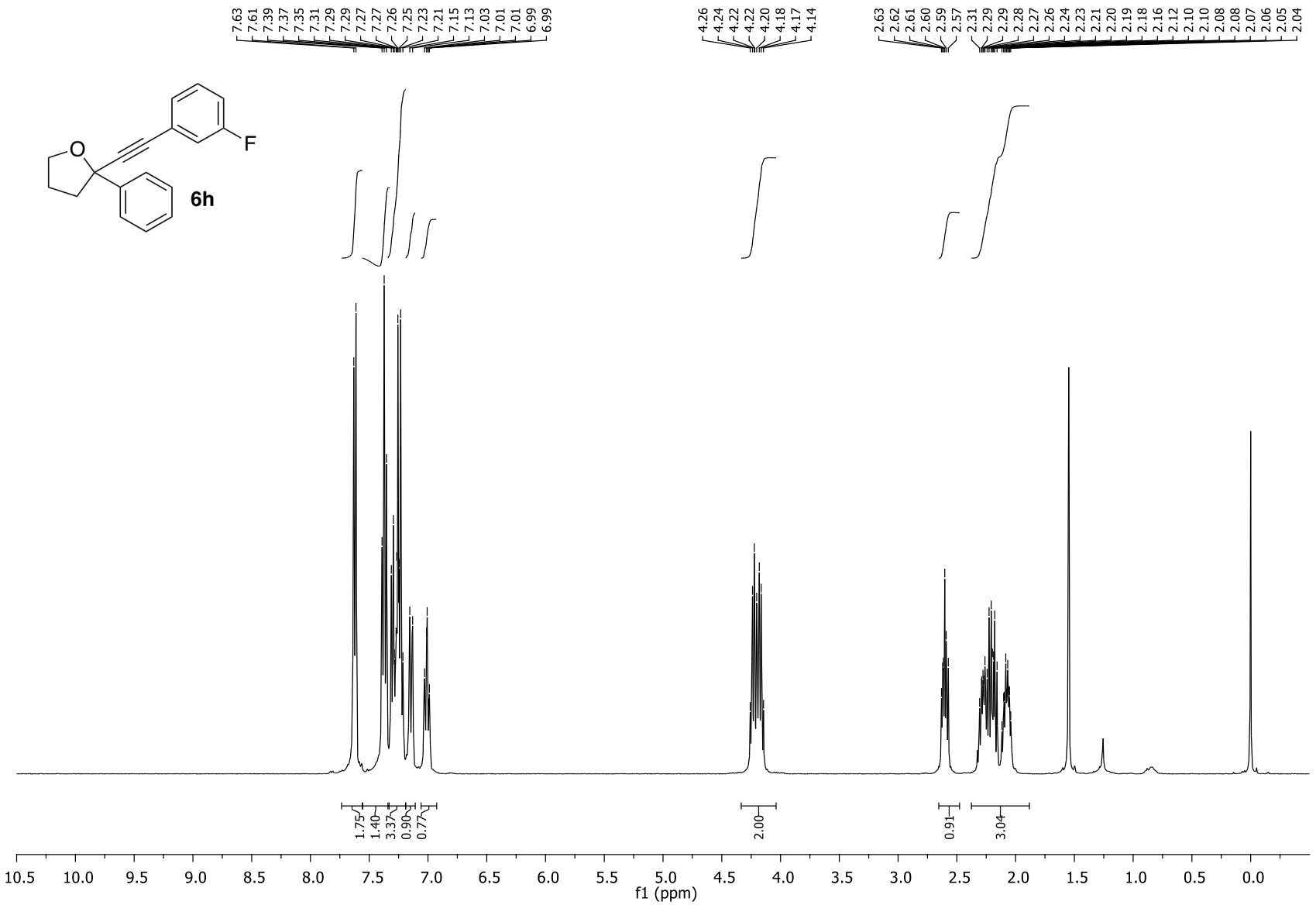
f1 (ppm)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7.27
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7.25
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7.21
7.15
7.13
7.03
7.01
7.01
6.99
6.99
4.26
4.24
4.22
4.22
4.20
4.18
4.17
4.14
2.63
2.62
2.61
2.60
2.59
2.57
2.31
2.29
2.29
2.28
2.27
2.26
2.24
2.23
2.21
2.20
2.19
2.18
2.16
2.12
2.10
2.10
2.08
2.08
2.07
2.06
2.05
2.04
O
F
6h
1.75
1.40
3.37
0.90
0.77
2.00
0.91
3.04
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
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3.5
3.0
2.5
2.0
1.5
1.0
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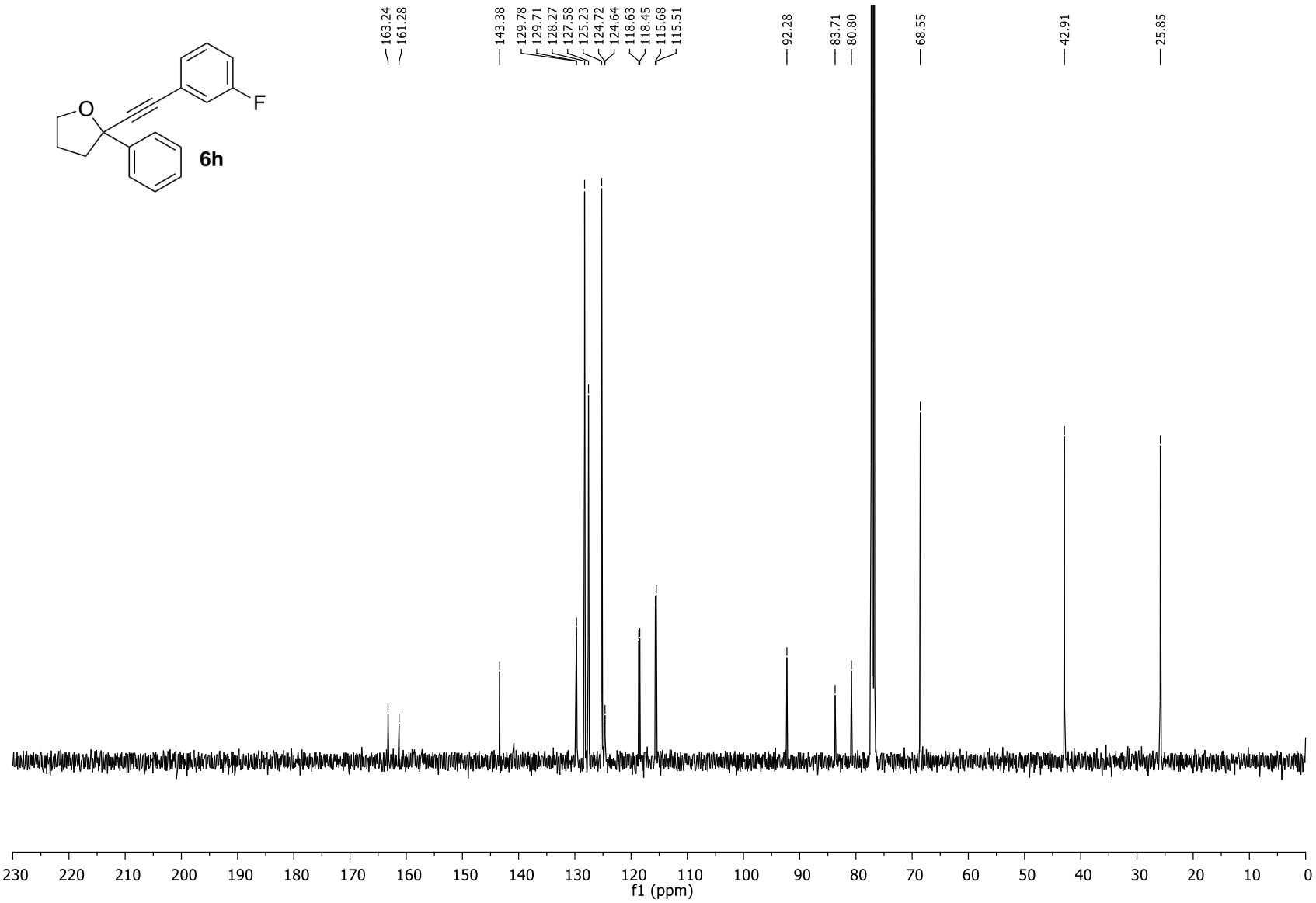
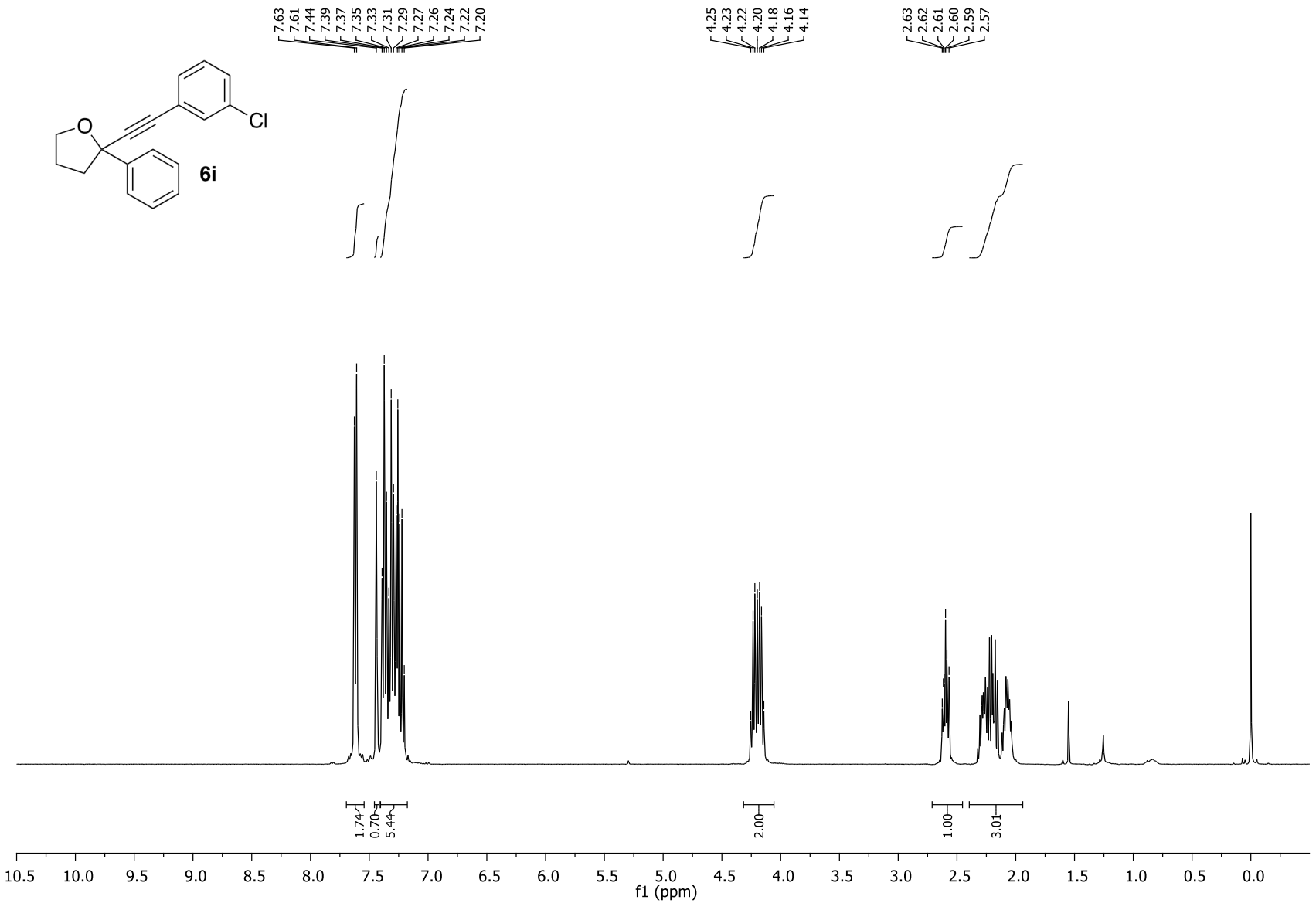
0.0
f1 (ppm)


O
F
6h
163.24
161.28
143.38
129.78
129.71
128.27
127.58
125.23
124.72
124.64
118.63
118.45
115.68
115.51
92.28
83.71
80.80
68.55
42.91
25.85
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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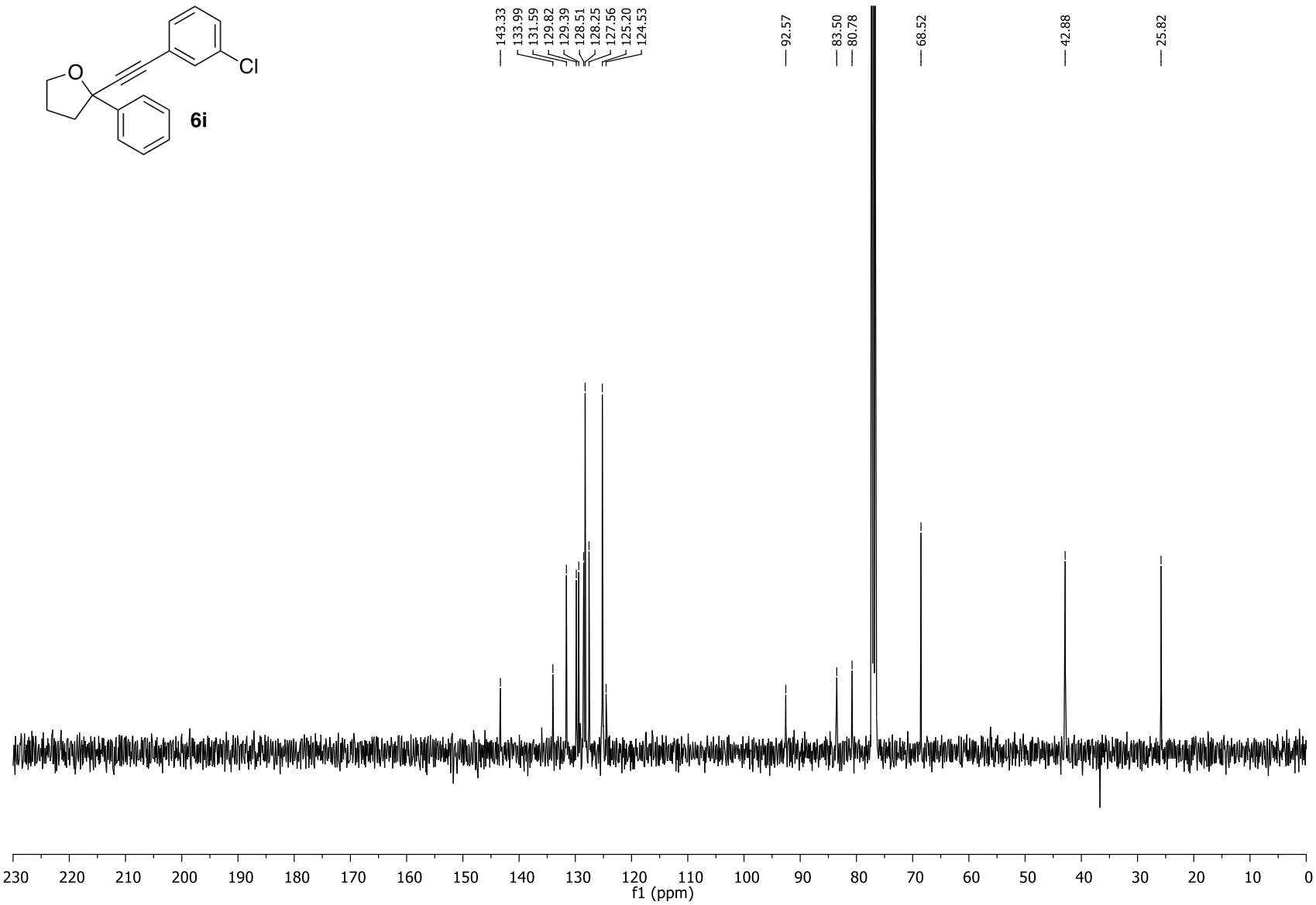
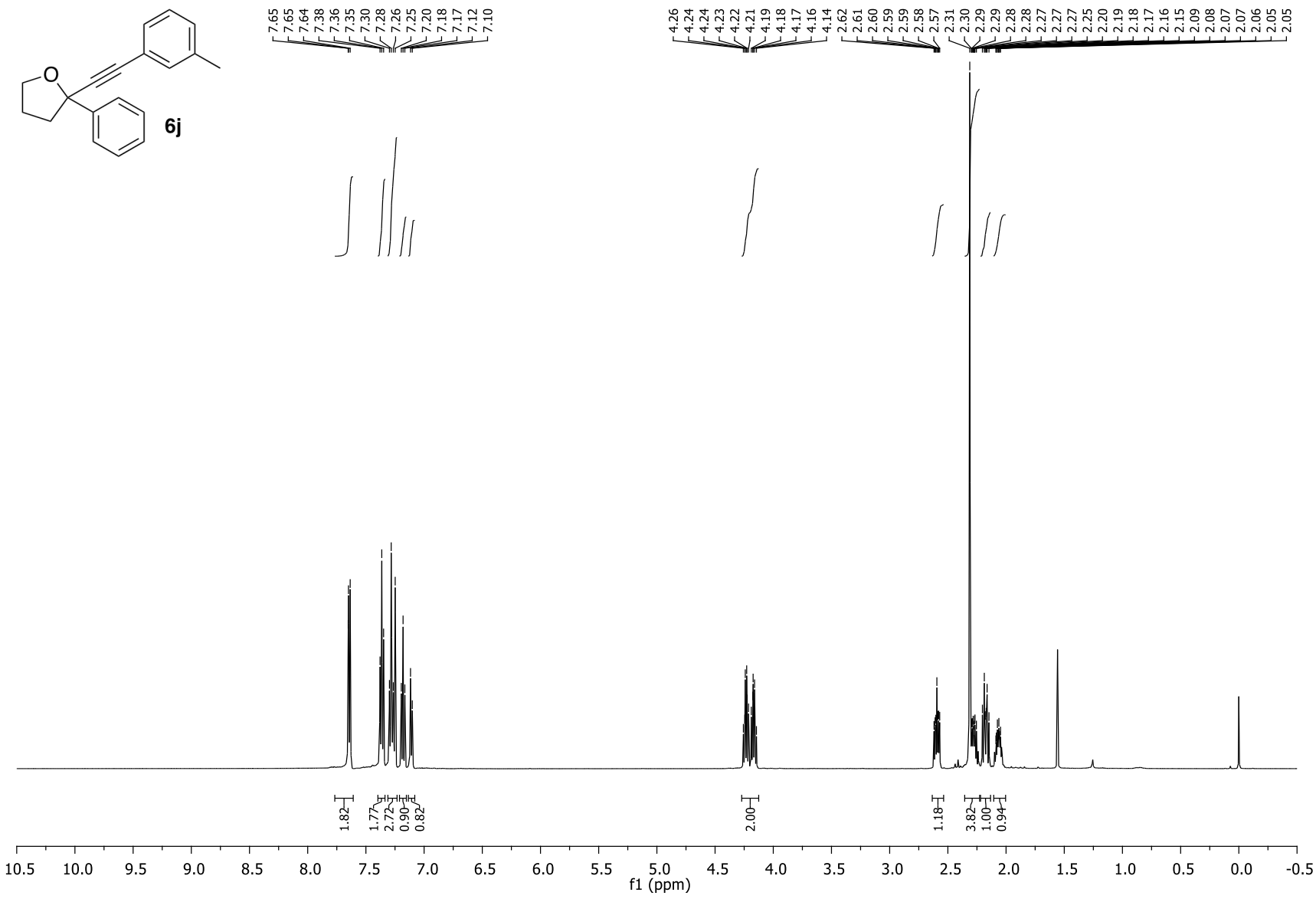
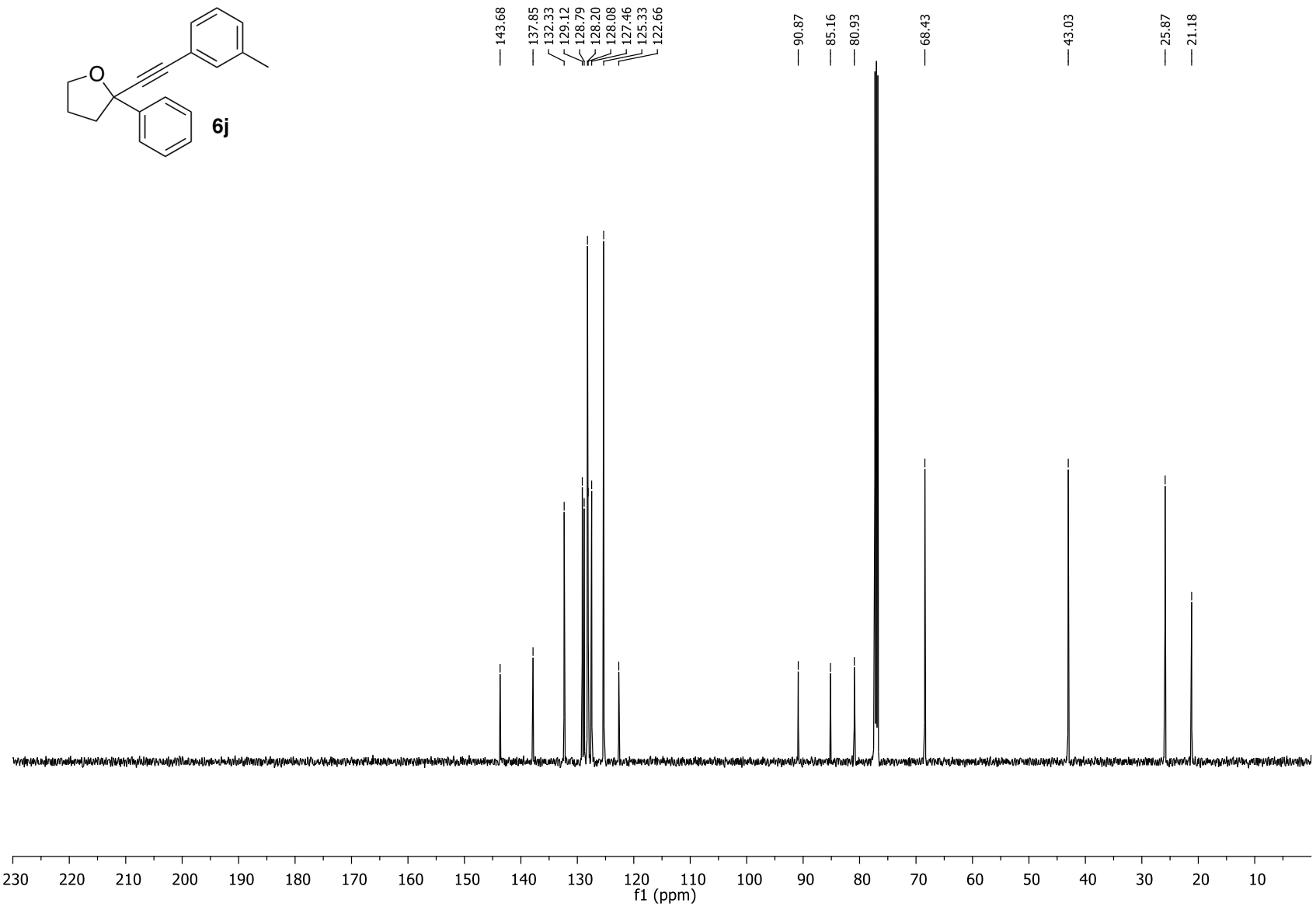
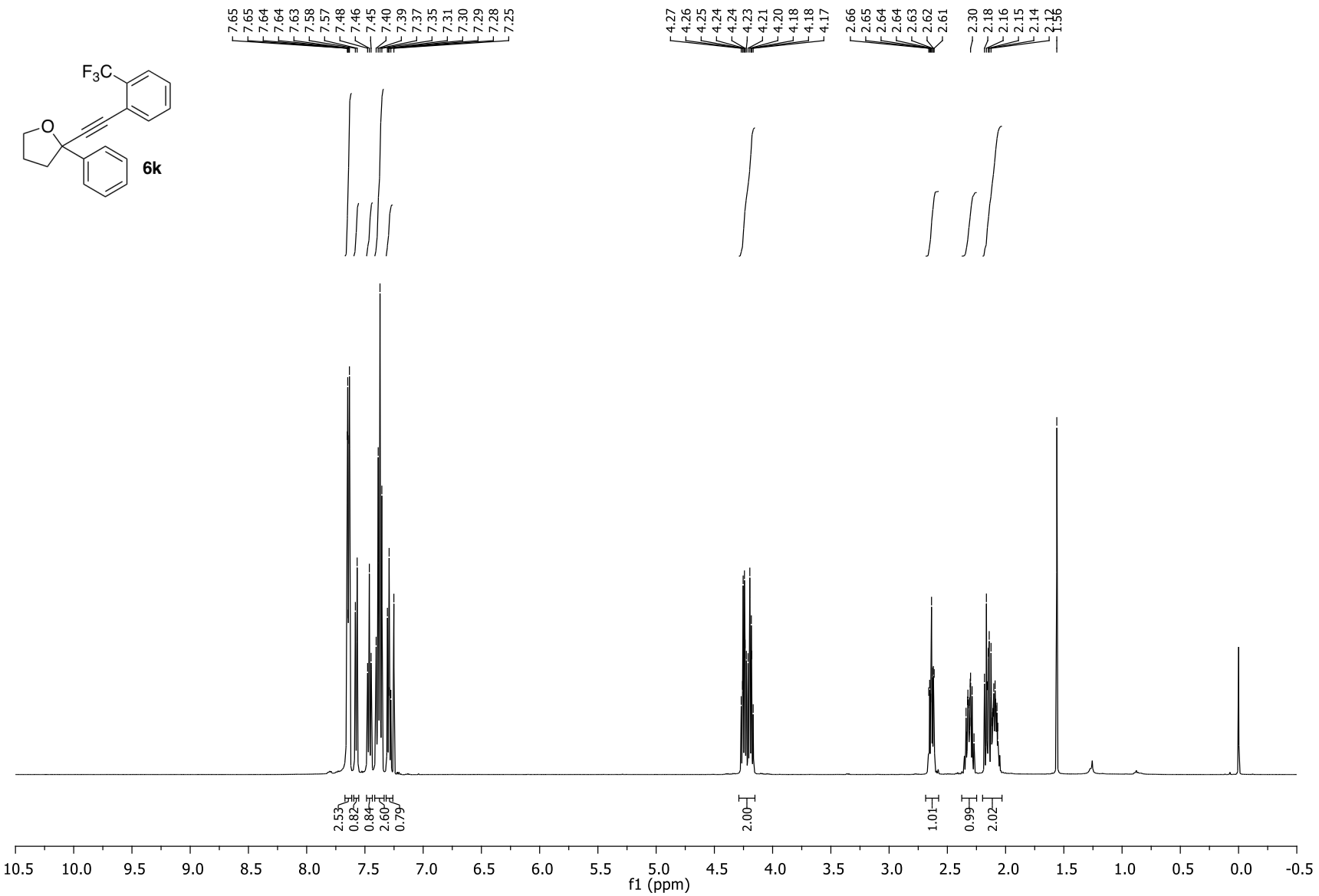
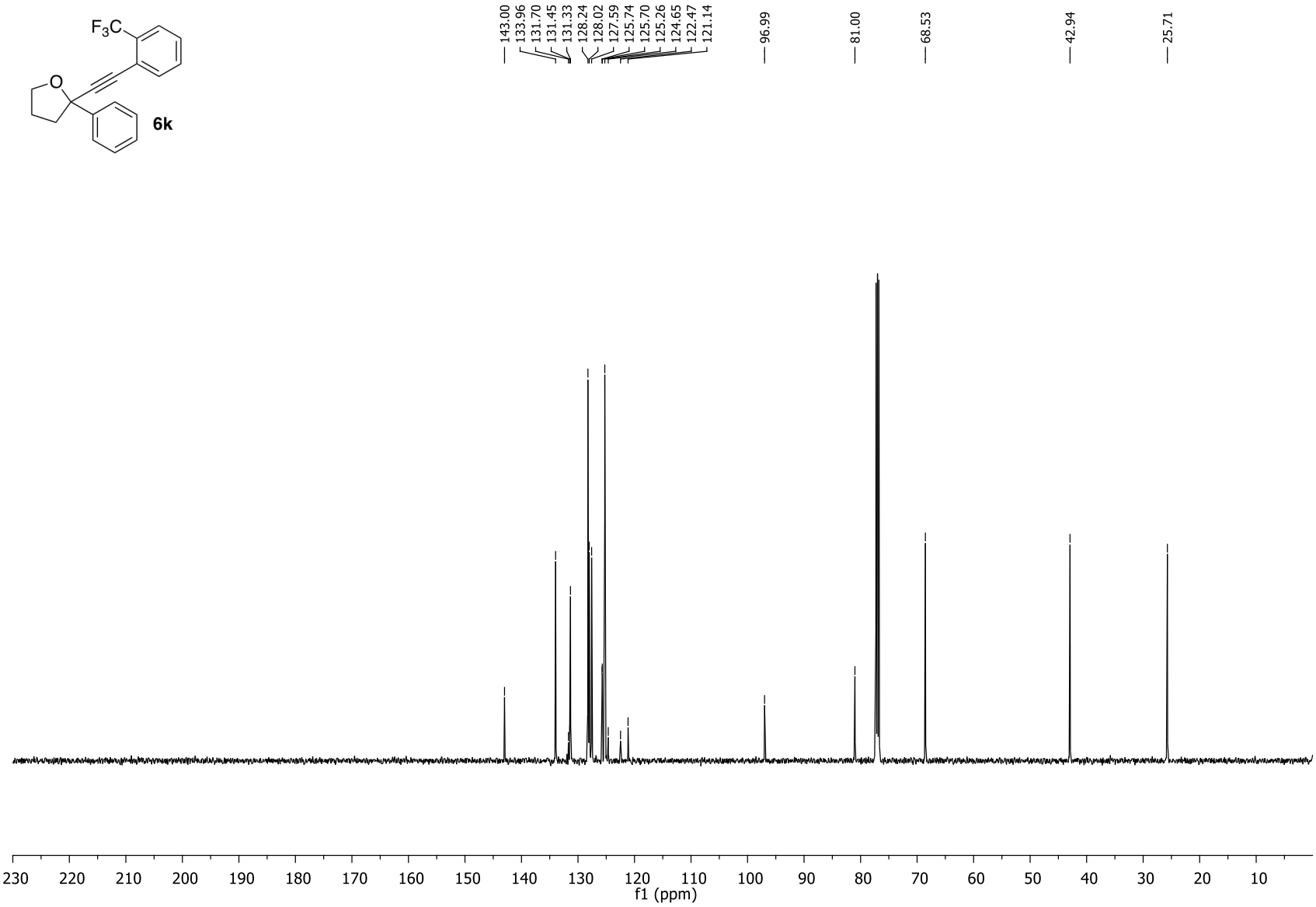
7.31
7.29
7.27
7.26
7.24
7.22
7.20
4.25
4.23
4.22
4.20
4.18
4.16
4.14
2.63
2.62
2.61
2.60
2.59
2.57
O
Cl
6i
1.74
0.70
5.44
2.00
1.00
3.01
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

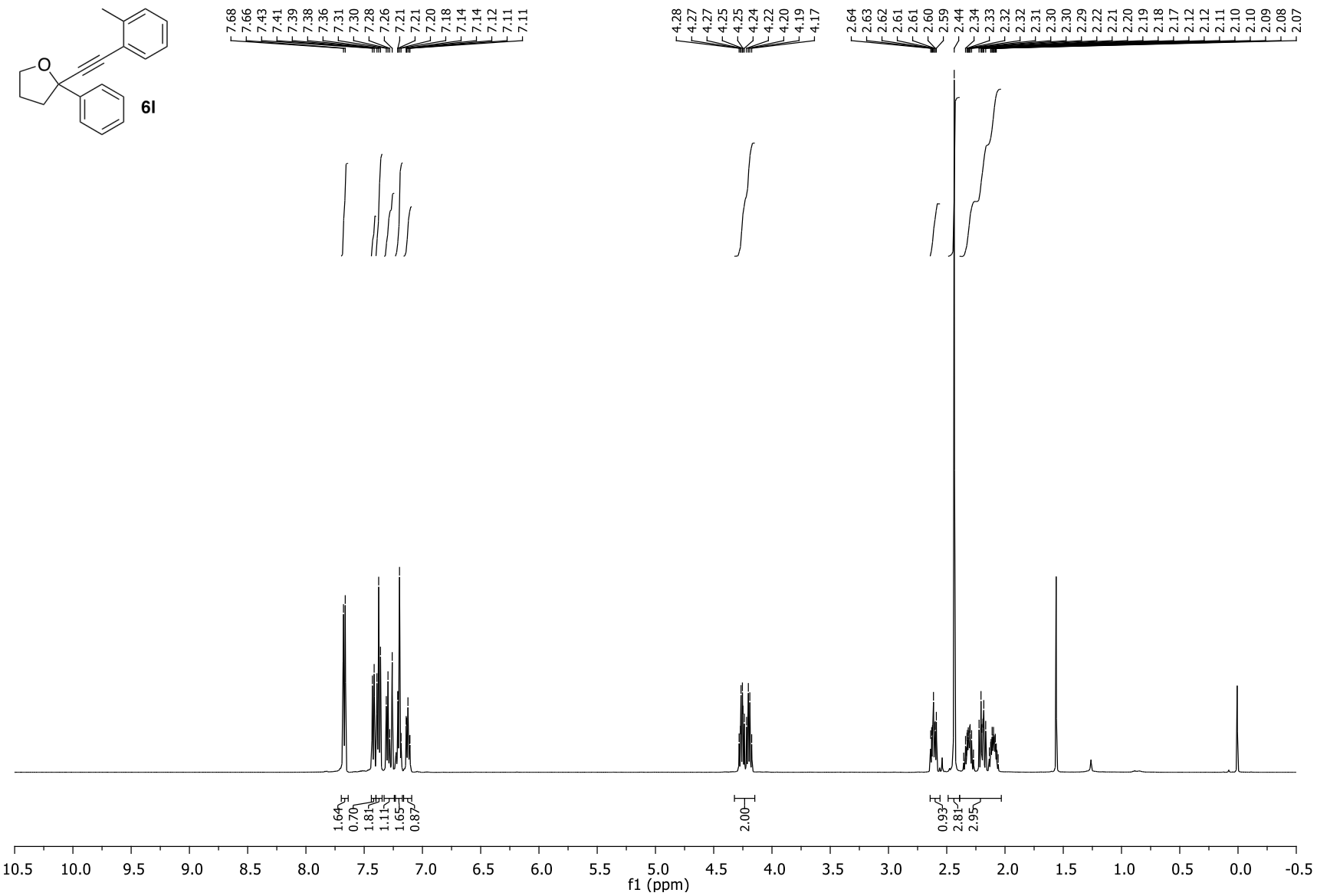

O
Cl
6i
143.33
133.99
131.59
129.82
129.39
128.51
128.25
127.56
125.20
124.53
92.57
83.50
80.78
68.52
42.88
25.82
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

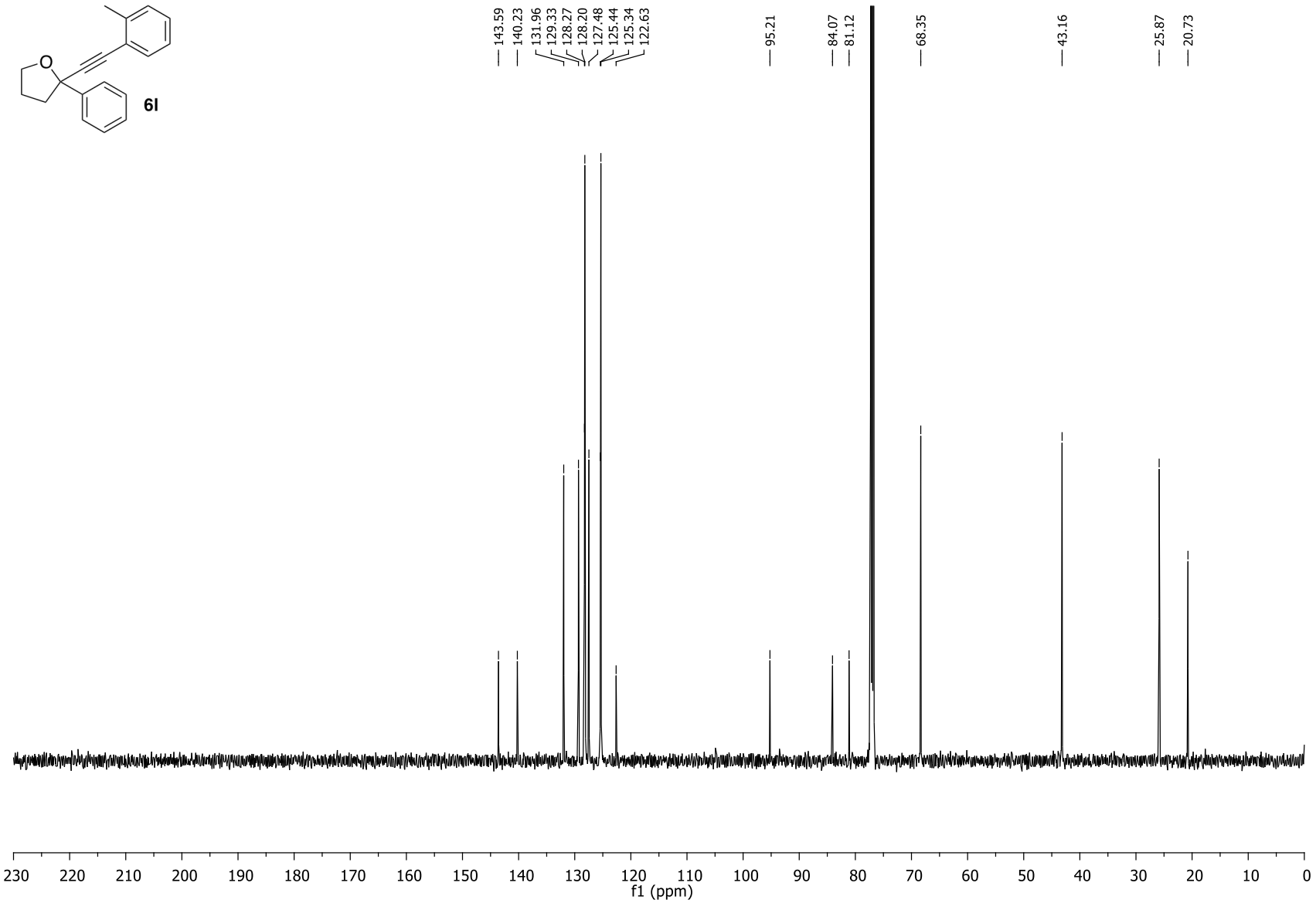

6j
7.65 7.65 7.64 7.38 7.36 7.35 7.30 7.28 7.26 7.25 7.20 7.18 7.17 7.12 7.10
4.26 4.24 4.24 4.23 4.22 4.21 4.19 4.18 4.17 4.16 4.14 2.62 2.61 2.60 2.59 2.59 2.58 2.57 2.31 2.30 2.29 2.29 2.28 2.28 2.27 2.27 2.27 2.25 2.20 2.19 2.18 2.17 2.16 2.15 2.09 2.08 2.07 2.07 2.06 2.05 2.05
1.82 1.77 2.72 0.90 0.82 2.00 1.18 3.82 1.00 0.94
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

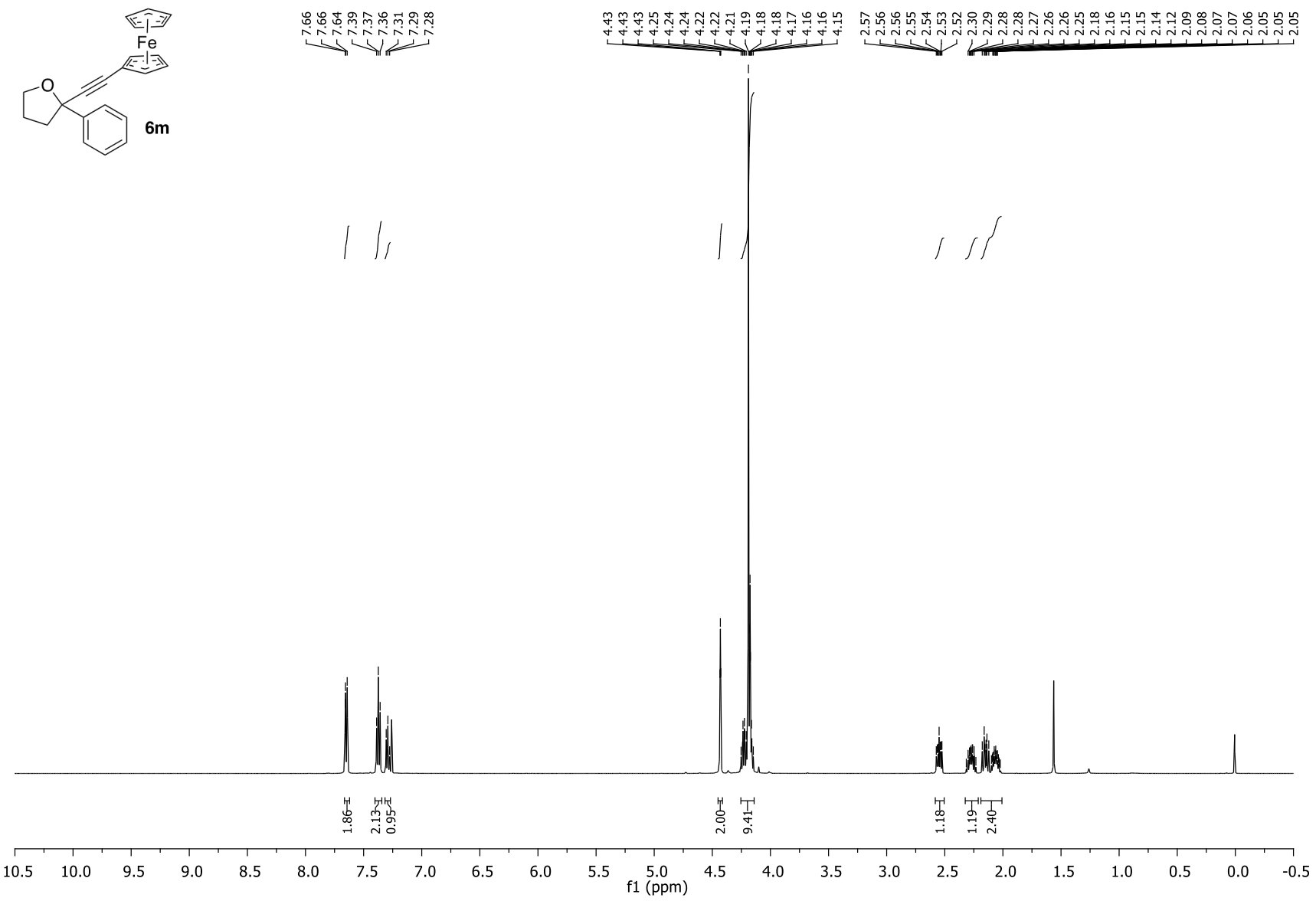

6j
143.68
137.85
132.33
129.12
128.79
128.20
128.08
127.46
125.33
122.66
90.87
85.16
80.93
68.43
43.03
25.87
21.18
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


F3C
O
6k
7.65
7.65
7.64
7.64
7.63
7.58
7.57
7.48
7.46
7.45
7.40
7.39
7.37
7.35
7.31
7.30
7.29
7.28
7.25
4.27
4.26
4.25
4.24
4.24
4.23
4.21
4.20
4.18
4.18
4.17
2.66
2.65
2.64
2.64
2.63
2.62
2.61
2.30
2.18
2.16
2.15
2.14
2.12
1.56
2.53
0.82
0.84
2.60
0.79
2.00
1.01
0.99
2.02
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


F3C
O
6k
143.00
133.96
131.70
131.45
131.33
128.24
128.02
127.59
125.74
125.70
125.26
124.65
122.47
121.14
96.99
81.00
68.53
42.94
25.71
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


6l
7.68 7.66 7.43 7.41 7.39 7.38 7.36 7.31 7.30 7.28 7.26 7.21 7.21 7.20 7.18 7.14 7.14 7.12 7.11 7.11
4.28 4.27 4.27 4.25 4.25 4.24 4.22 4.20 4.19 4.17
2.64 2.63 2.62 2.61 2.61 2.60 2.59 2.44 2.34 2.33 2.32 2.32 2.31 2.30 2.30 2.29 2.22 2.21 2.20 2.19 2.18 2.17 2.12 2.12 2.11 2.10 2.10 2.09 2.08 2.07
1.64 0.70 1.81 1.11 1.65 0.87
2.00
0.93 2.81 2.95
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


6l
143.59
140.23
131.96
129.33
128.27
128.20
127.48
125.44
125.34
122.63
95.21
84.07
81.12
68.35
43.16
25.87
20.73
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


Fe
O
6m
7.66
7.66
7.64
7.39
7.37
7.36
7.31
7.29
7.28
4.43
4.43
4.43
4.25
4.24
4.24
4.22
4.22
4.21
4.19
4.18
4.18
4.17
4.16
4.16
4.15
2.57
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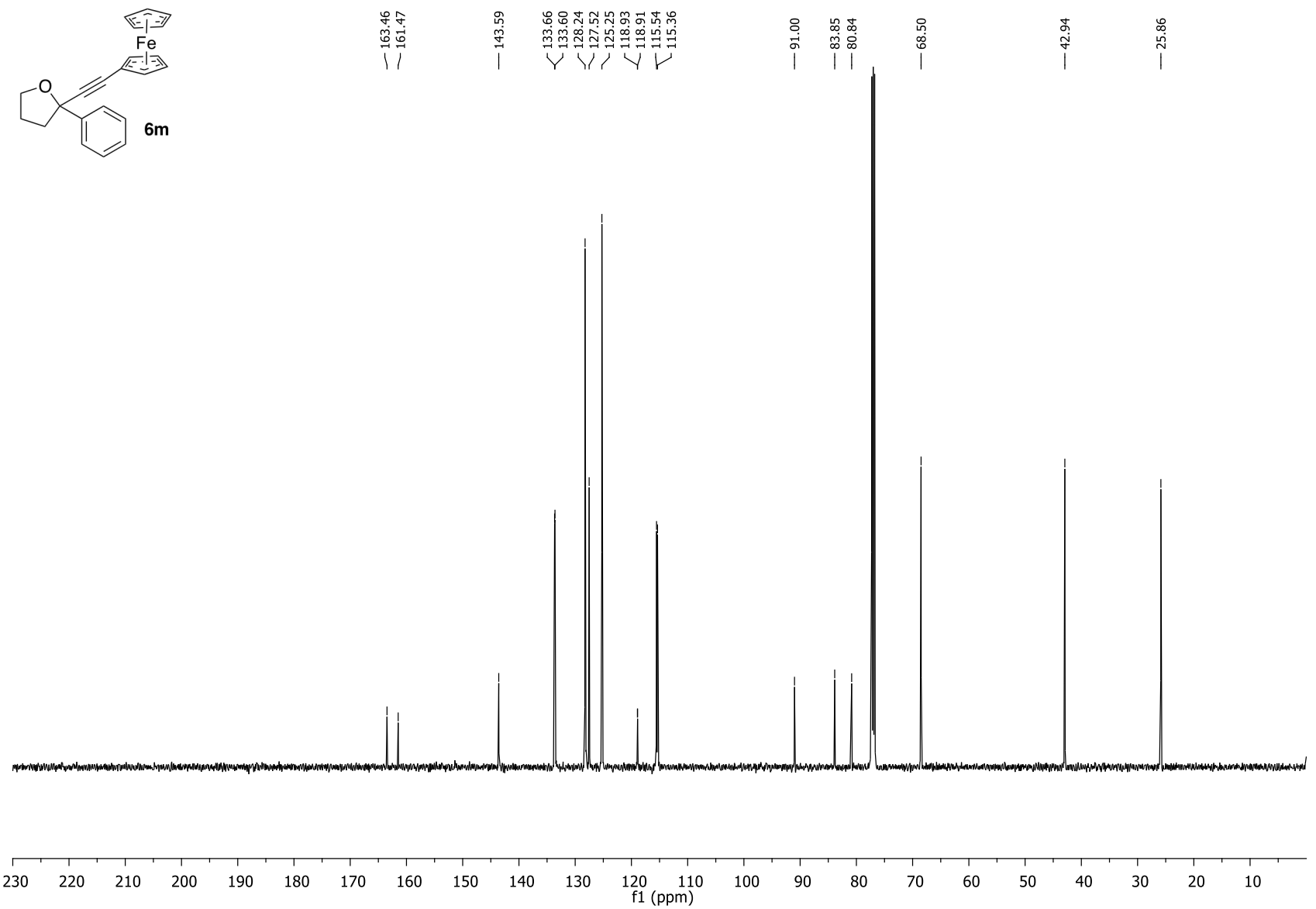
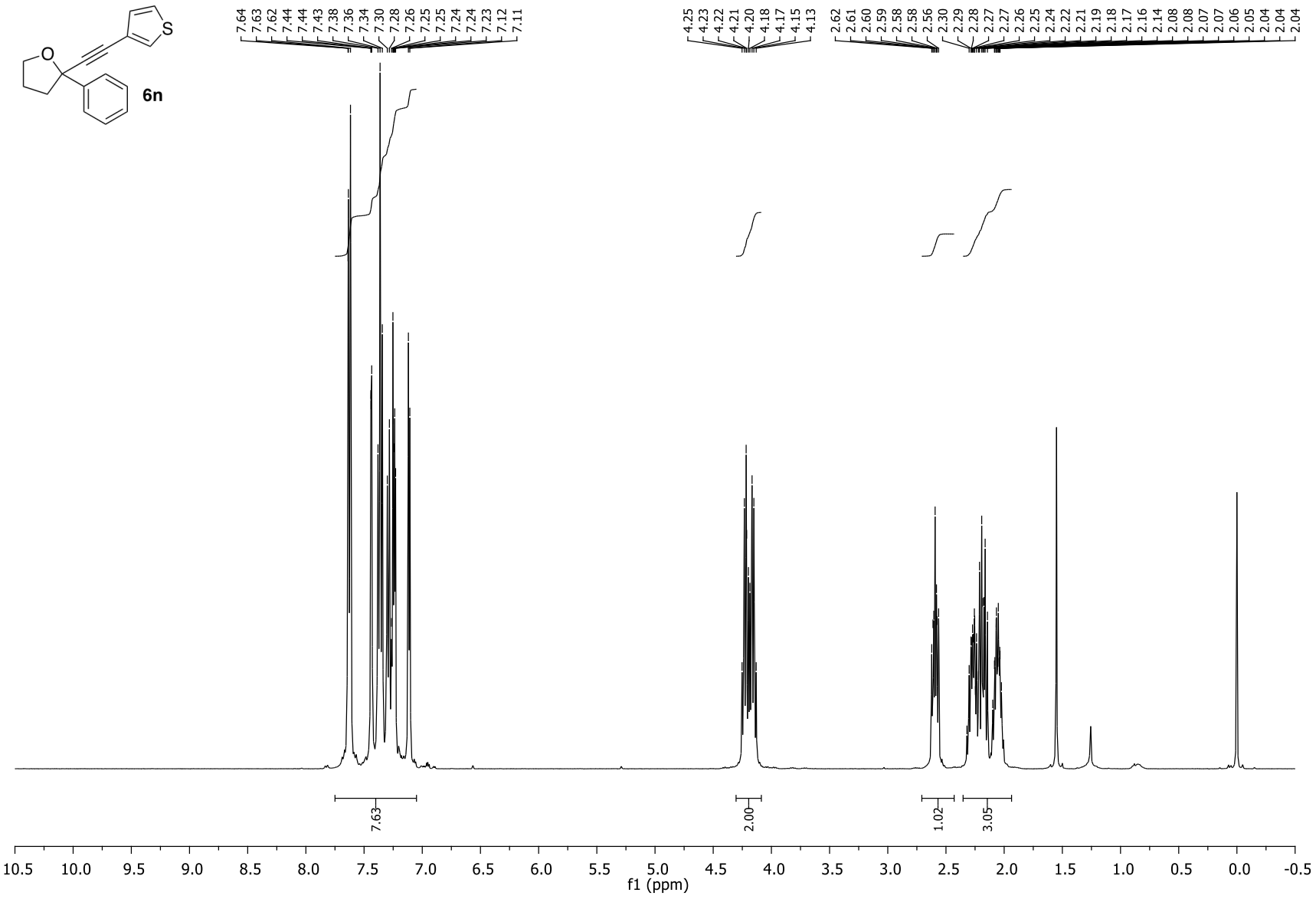
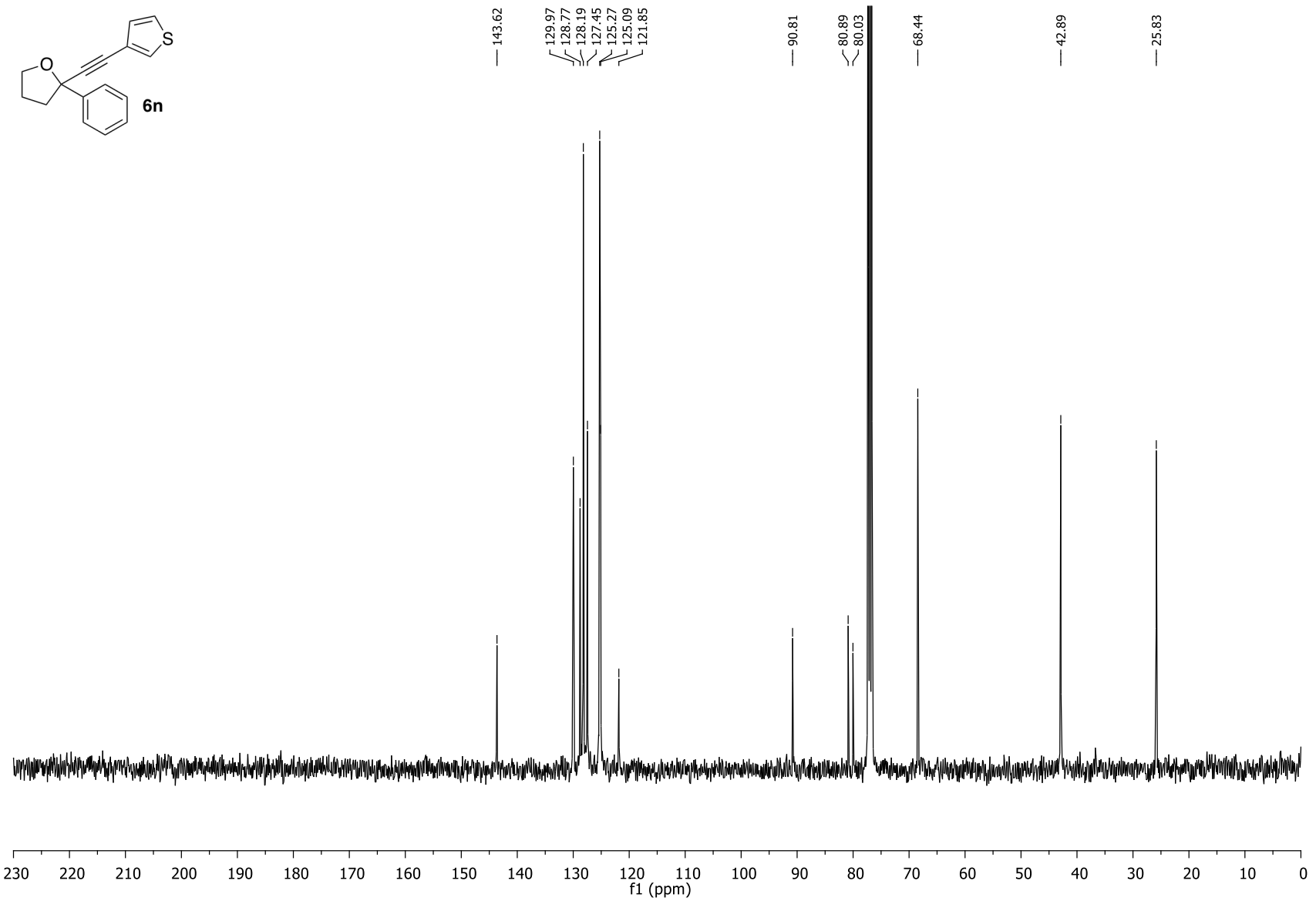
2.52
2.30
2.29
2.28
2.28
2.27
2.26
2.26
2.25
2.18
2.16
2.15
2.15
2.14
2.12
2.09
2.08
2.07
2.07
2.06
2.05
2.05
2.05
1.86
2.13
0.95
2.00
9.41
1.18
1.19
2.40
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


Fe
O
6m
163.46
161.47
143.59
133.66
133.60
128.24
127.52
125.25
118.93
118.91
115.54
115.36
91.00
83.85
80.84
68.50
42.94
25.86
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


6n
7.64 7.63 7.62 7.44 7.44 7.43 7.38 7.36 7.34 7.30 7.28 7.26 7.25 7.25 7.24 7.24 7.23 7.12 7.11
4.25 4.23 4.22 4.21 4.20 4.18 4.17 4.15 4.13
2.62 2.61 2.60 2.59 2.58 2.58 2.56 2.30 2.29 2.28 2.27 2.27 2.26 2.25 2.24 2.22 2.21 2.19 2.18 2.17 2.16 2.14 2.08 2.08 2.07 2.07 2.06 2.05 2.04 2.04 2.04
7.63
2.00
1.02
3.05
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


6n
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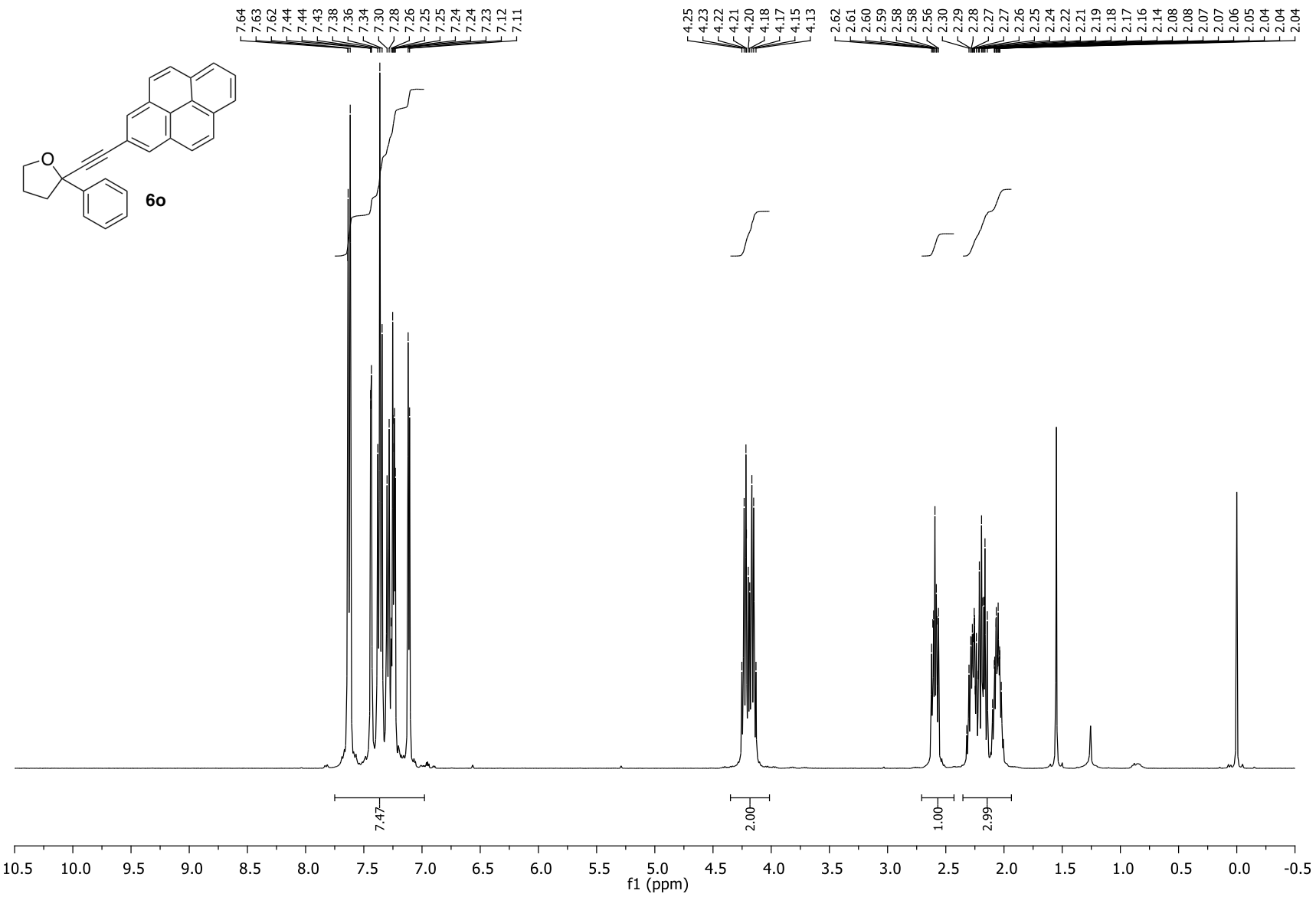
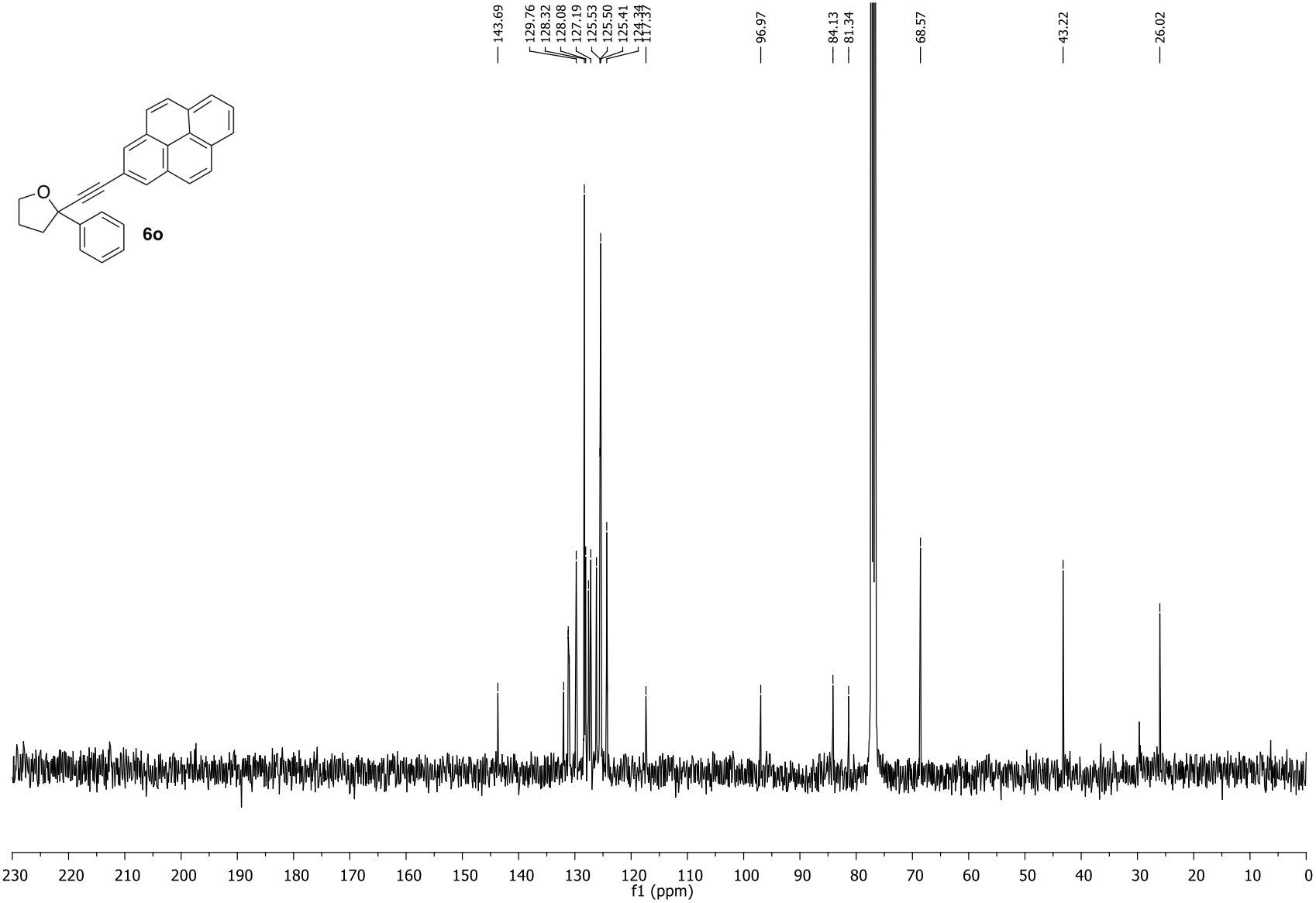
128.19
127.45
125.27
125.09
121.85
90.81
80.89
80.03
68.44
42.89
25.83
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.64
7.63
7.62
7.44
7.44
7.43
7.38
7.36
7.34
7.30
7.28
7.26
7.25
7.25
7.24
7.24
7.23
7.12
7.11
4.25
4.23
4.22
4.21
4.20
4.18
4.17
4.15
4.13
2.62
2.61
2.60
2.59
2.58
2.58
2.56
2.30
2.29
2.28
2.27
2.27
2.26
2.25
2.24
2.22
2.21
2.19
2.18
2.17
2.16
2.14
2.08
2.08
2.07
2.07
2.06
2.05
2.04
2.04
2.04
O
6o
7.47
2.00
1.00
2.99
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)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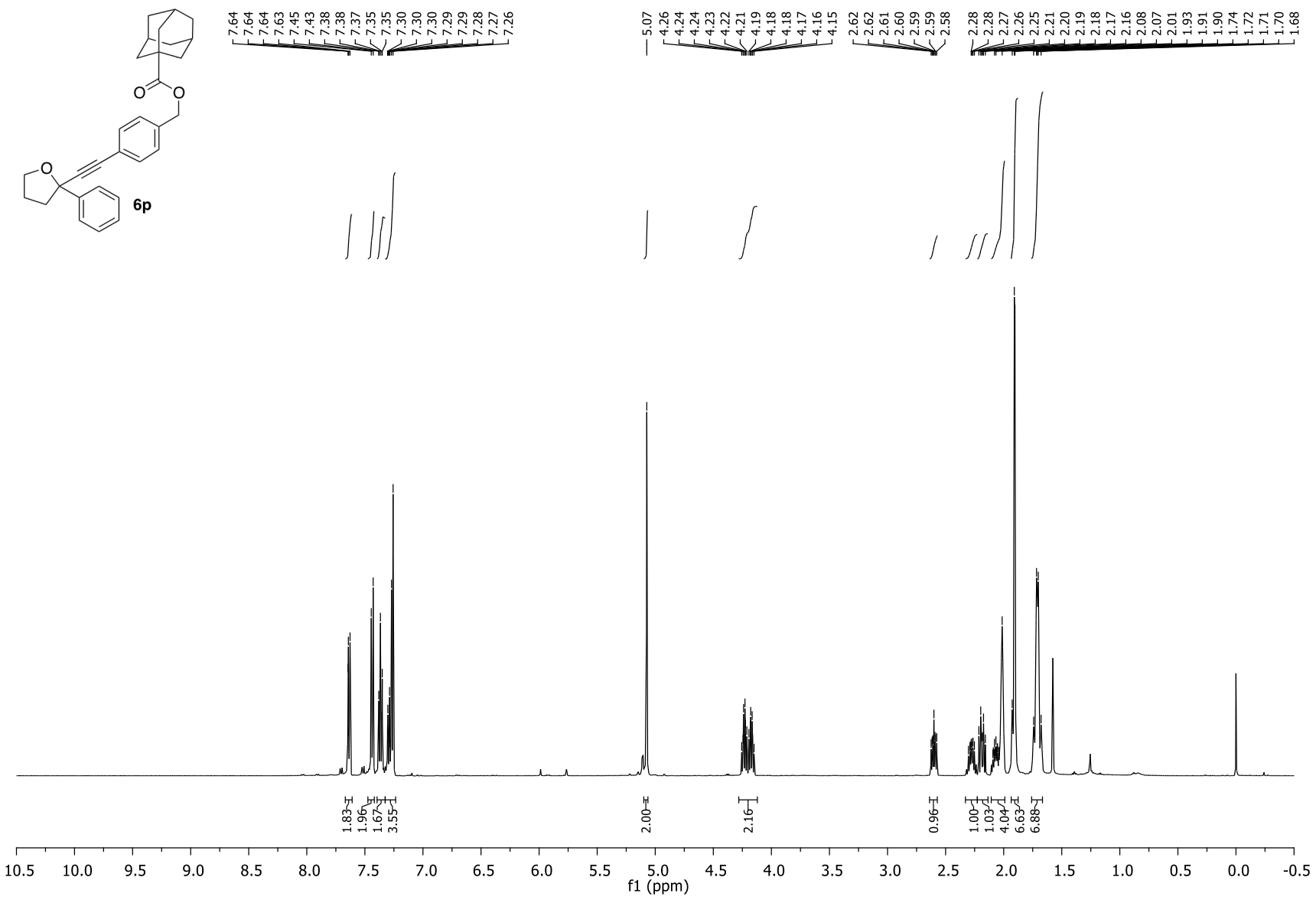
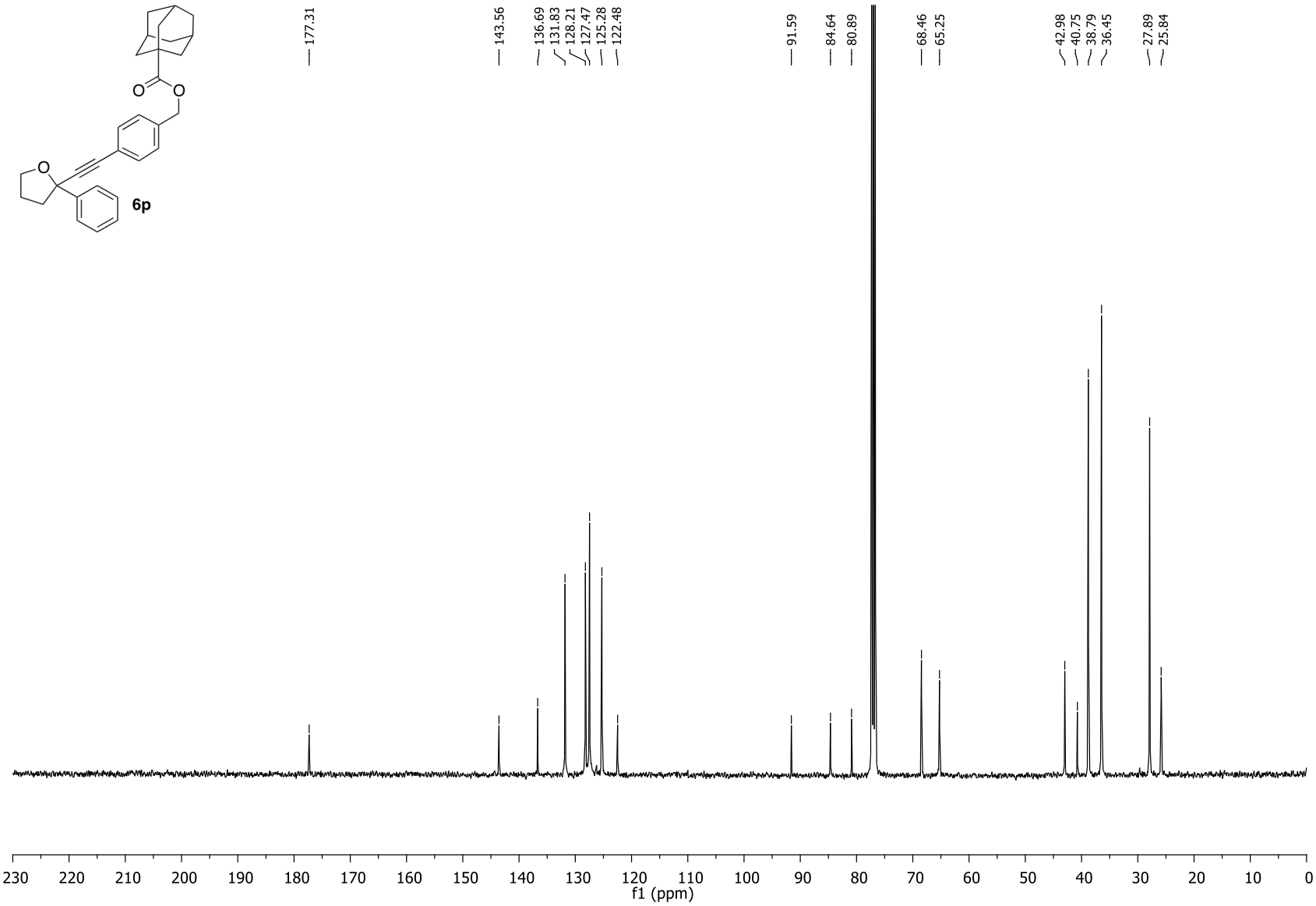
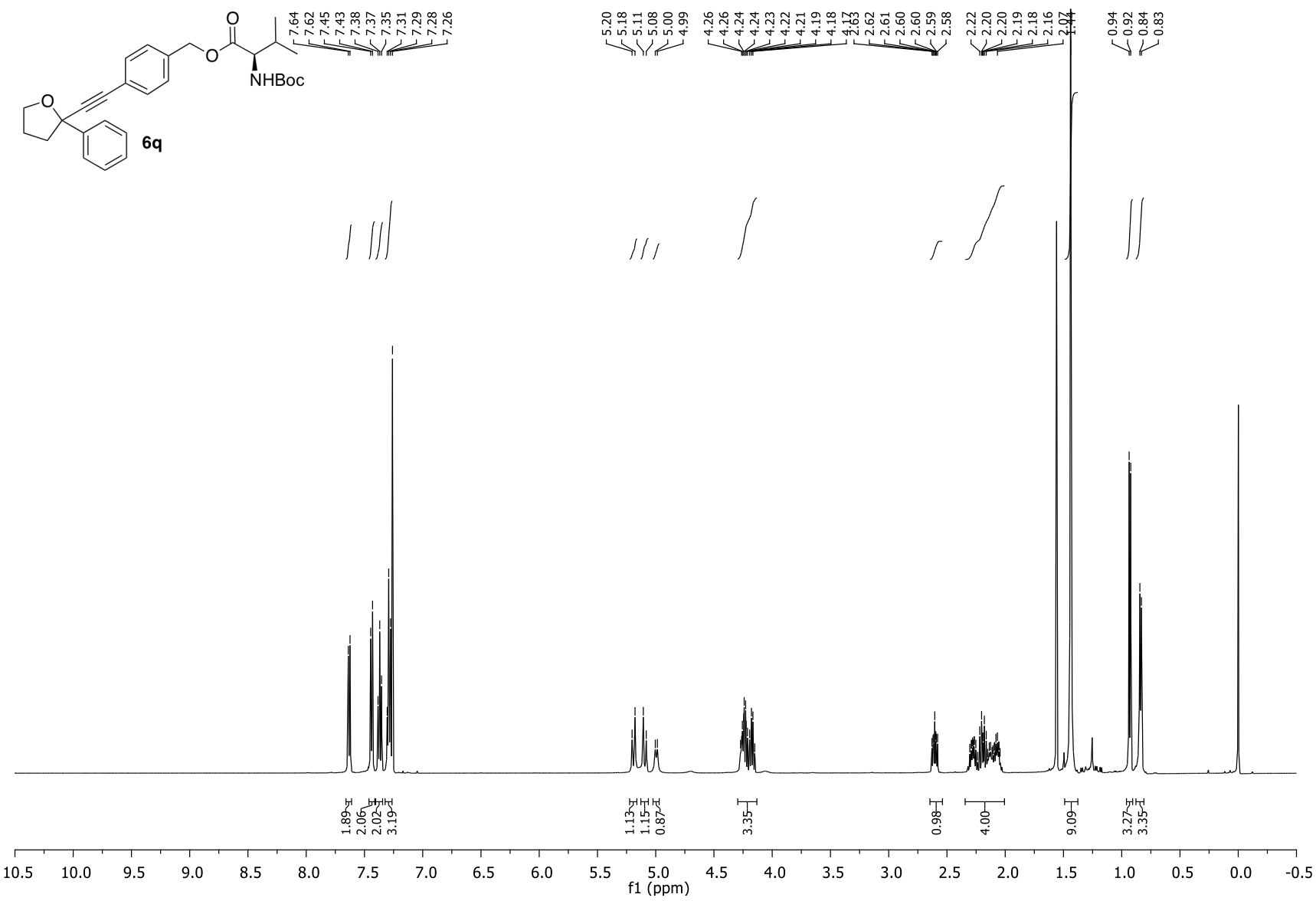
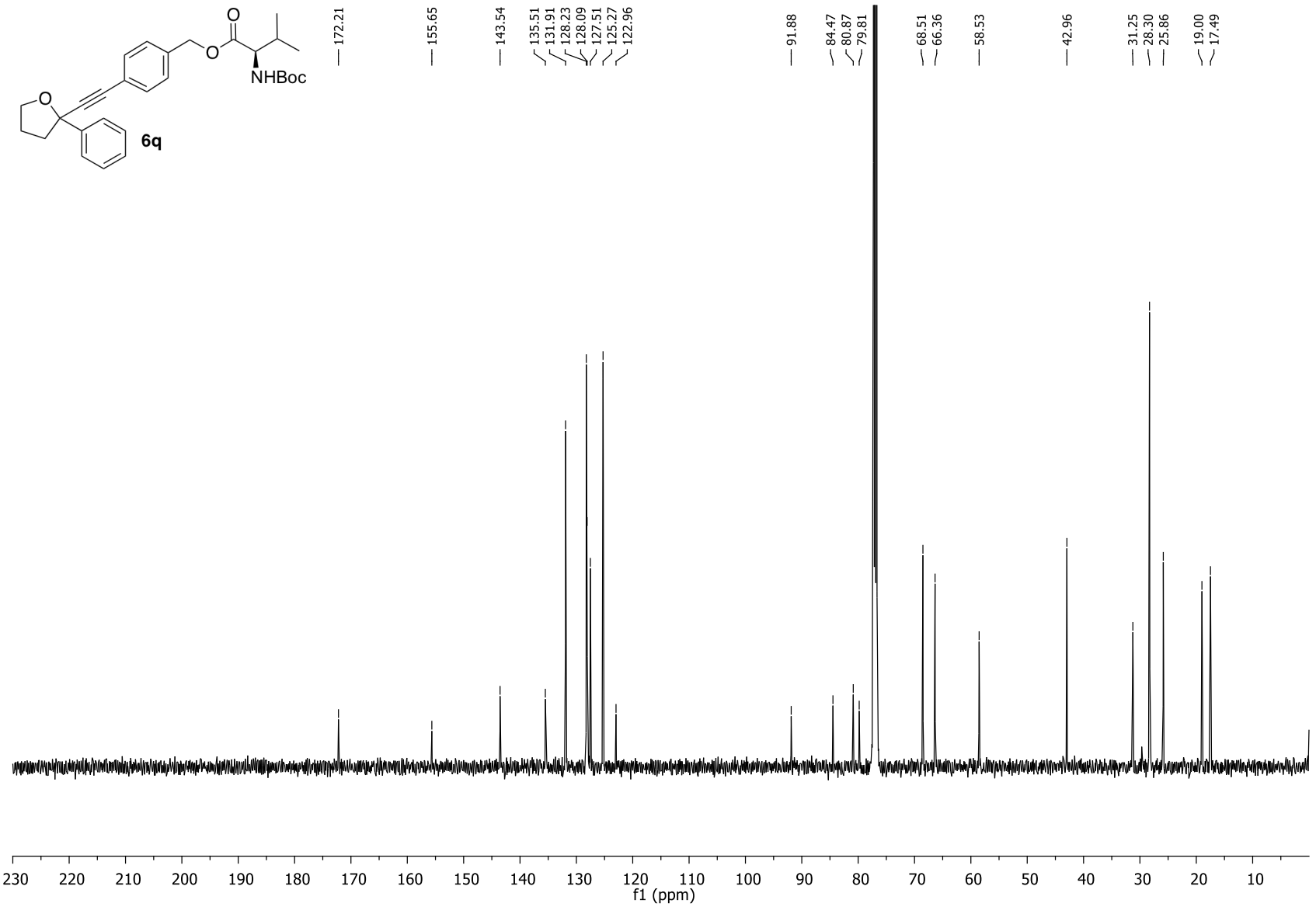
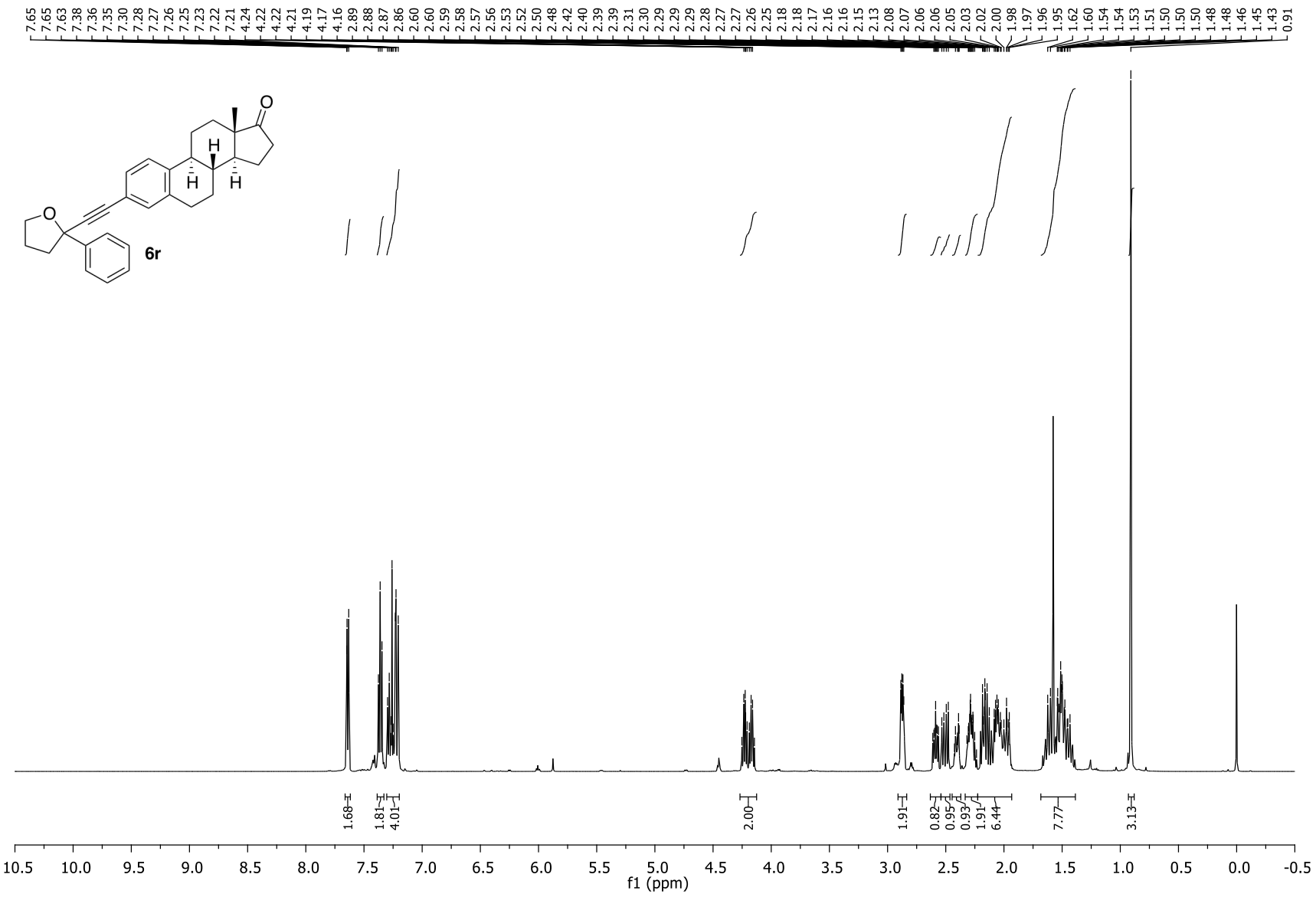
128.08
127.19
125.53
125.50
125.41
124.34
117.37
96.97
84.13
81.34
68.57
43.22
26.02
O
6o
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

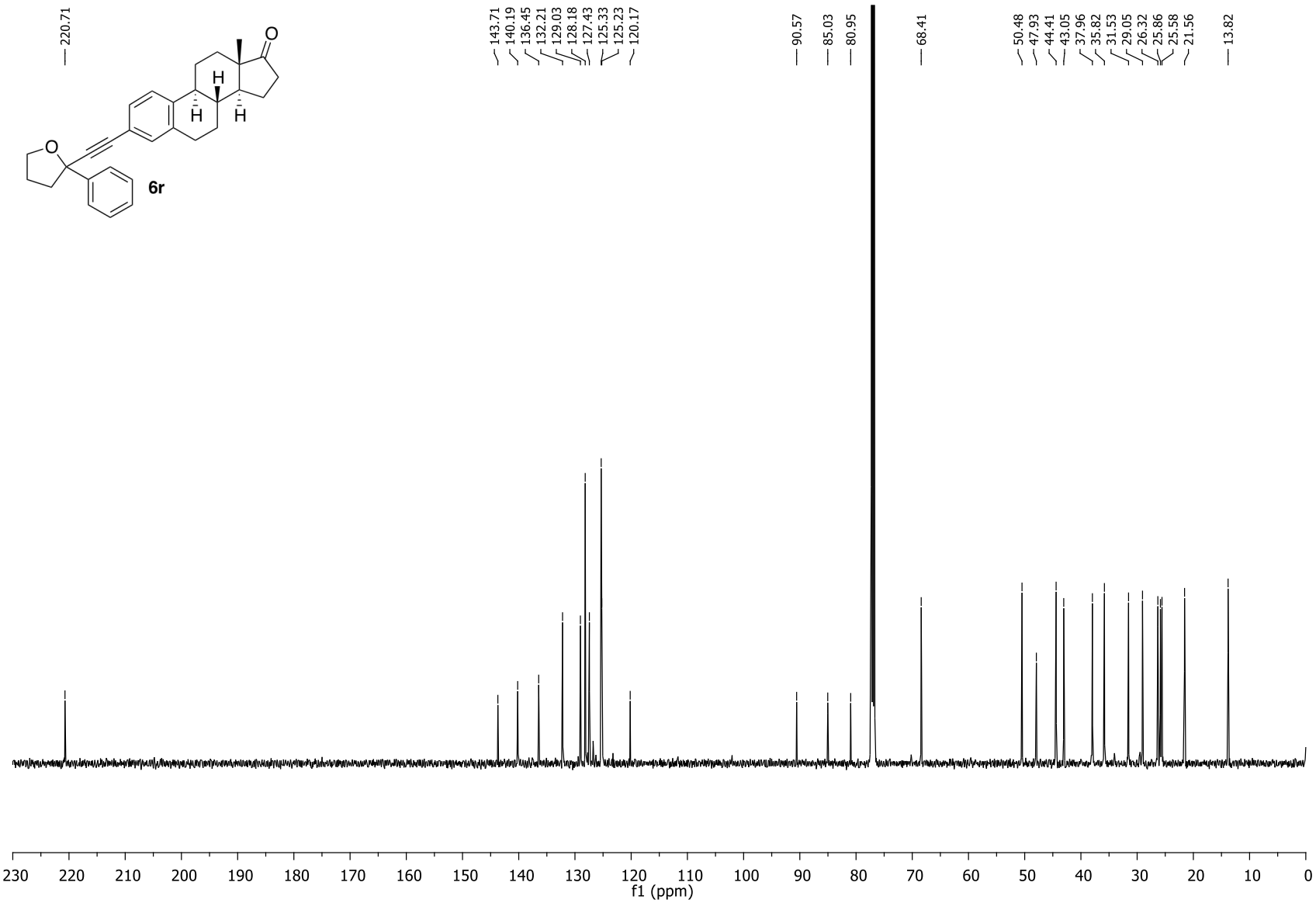

6p
7.64 7.64 7.64 7.63 7.45 7.43 7.38 7.38 7.37 7.35 7.35 7.30 7.30 7.30 7.29 7.29 7.28 7.27 7.26
5.07
4.26 4.24 4.24 4.23 4.22 4.21 4.19 4.18 4.18 4.17 4.16 4.15
2.62 2.62 2.61 2.60 2.59 2.59 2.58
2.28 2.28 2.27 2.26 2.25 2.21 2.20 2.19 2.18 2.17 2.16 2.08 2.07 2.01 1.93 1.91 1.90 1.74 1.72 1.71 1.70 1.68
1.83 1.96 1.67 3.55 2.00 2.16 0.96 1.00 1.03 4.04 6.63 6.88
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

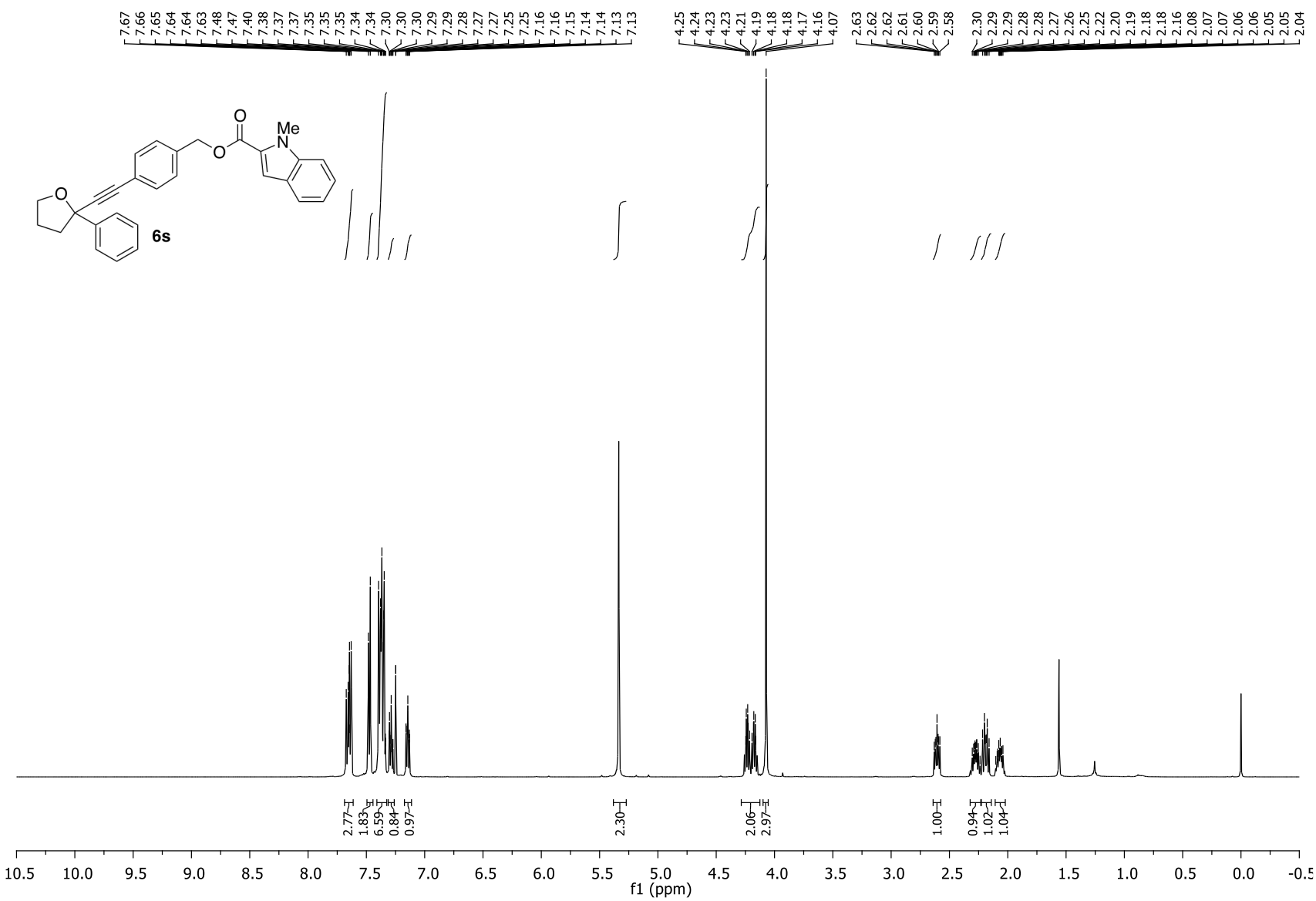

6p
177.31
143.56
136.69
131.83
128.21
127.47
125.28
122.48
91.59
84.64
80.89
68.46
65.25
42.98
40.75
38.79
36.45
27.89
25.84
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

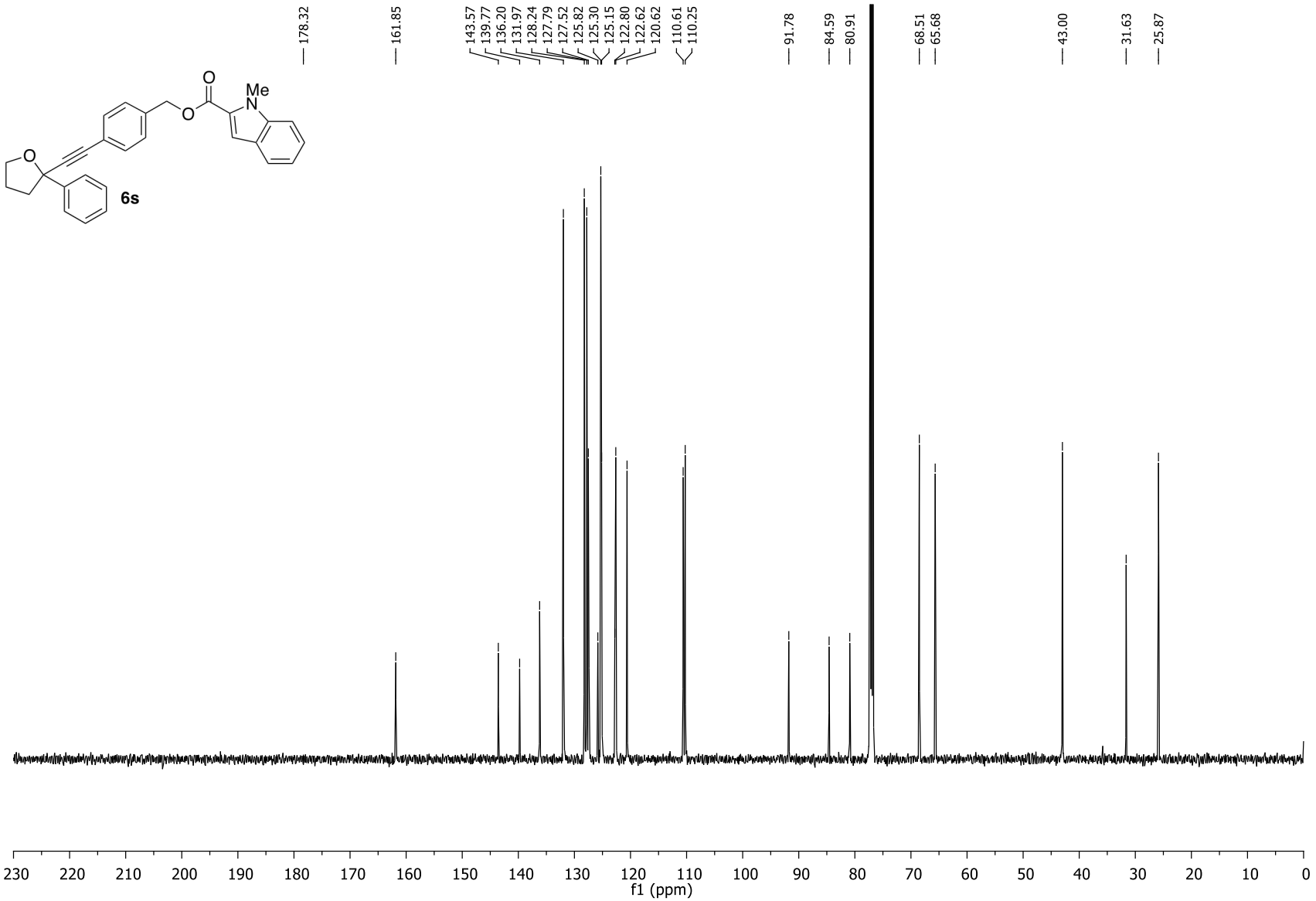

O
O
NHBoc
O
6q
7.64
7.62
7.45
7.43
7.38
7.37
7.35
7.31
7.29
7.28
7.26
5.20
5.18
5.11
5.08
5.00
4.99
4.26
4.26
4.24
4.24
4.23
4.22
4.21
4.19
4.18
4.17
2.63
2.62
2.61
2.60
2.60
2.59
2.58
2.22
2.20
2.20
2.19
2.18
2.16
1.97
1.44
0.94
0.92
0.84
0.83
1.89
2.06
2.02
3.19
1.13
1.15
0.87
3.35
0.98
4.00
9.09
3.27
3.35
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


O
O
NHBoc
O
6q
172.21
155.65
143.54
135.51
131.91
128.23
128.09
127.51
125.27
122.96
91.88
84.47
80.87
79.81
68.51
66.36
58.53
42.96
31.25
28.30
25.86
19.00
17.49
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


7.65 7.65 7.63 7.38 7.36 7.35 7.30 7.28 7.27 7.26 7.25 7.23 7.22 7.21 4.24 4.22 4.22 4.21 4.19 4.17 4.16 2.89 2.88 2.87 2.86 2.60 2.60 2.59 2.58 2.57 2.56 2.53 2.52 2.50 2.48 2.42 2.40 2.39 2.39 2.31 2.30 2.29 2.29 2.28 2.27 2.27 2.26 2.25 2.18 2.18 2.17 2.16 2.16 2.15 2.13 2.08 2.07 2.06 2.06 2.05 2.03 2.02 2.00 1.98 1.97 1.96 1.95 1.62 1.60 1.54 1.54 1.53 1.51 1.50 1.50 1.50 1.48 1.46 1.45 1.43 0.91
O
H
H
H
O
6r
1.68
1.81
4.01
2.00
1.91
0.82
0.95
0.93
1.91
6.44
7.77
3.13
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


220.71
143.71
140.19
136.45
132.21
129.03
128.18
127.43
125.33
125.23
120.17
90.57
85.03
80.95
68.41
50.48
47.93
44.41
43.05
37.96
35.82
31.53
29.05
26.32
25.86
25.58
21.56
13.82
O
H
H
H
O
6r
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.67 7.66 7.65 7.64 7.64 7.63 7.48 7.47 7.40 7.38 7.37 7.37 7.35 7.35 7.35 7.34 7.34 7.30 7.30 7.30 7.29 7.29 7.28 7.27 7.27 7.25 7.25 7.16 7.16 7.15 7.14 7.14 7.13 7.13
4.25 4.24 4.23 4.23 4.21 4.19 4.18 4.18 4.17 4.16 4.07
2.63 2.62 2.62 2.61 2.60 2.59 2.58
2.30 2.29 2.29 2.28 2.28 2.27 2.26 2.25 2.22 2.20 2.19 2.18 2.18 2.16 2.08 2.07 2.07 2.06 2.06 2.05 2.05 2.04
O
Me
N
O
O
6s
2.77
1.83
6.59
0.84
0.97
2.30
2.06
2.97
1.00
0.94
1.02
1.04
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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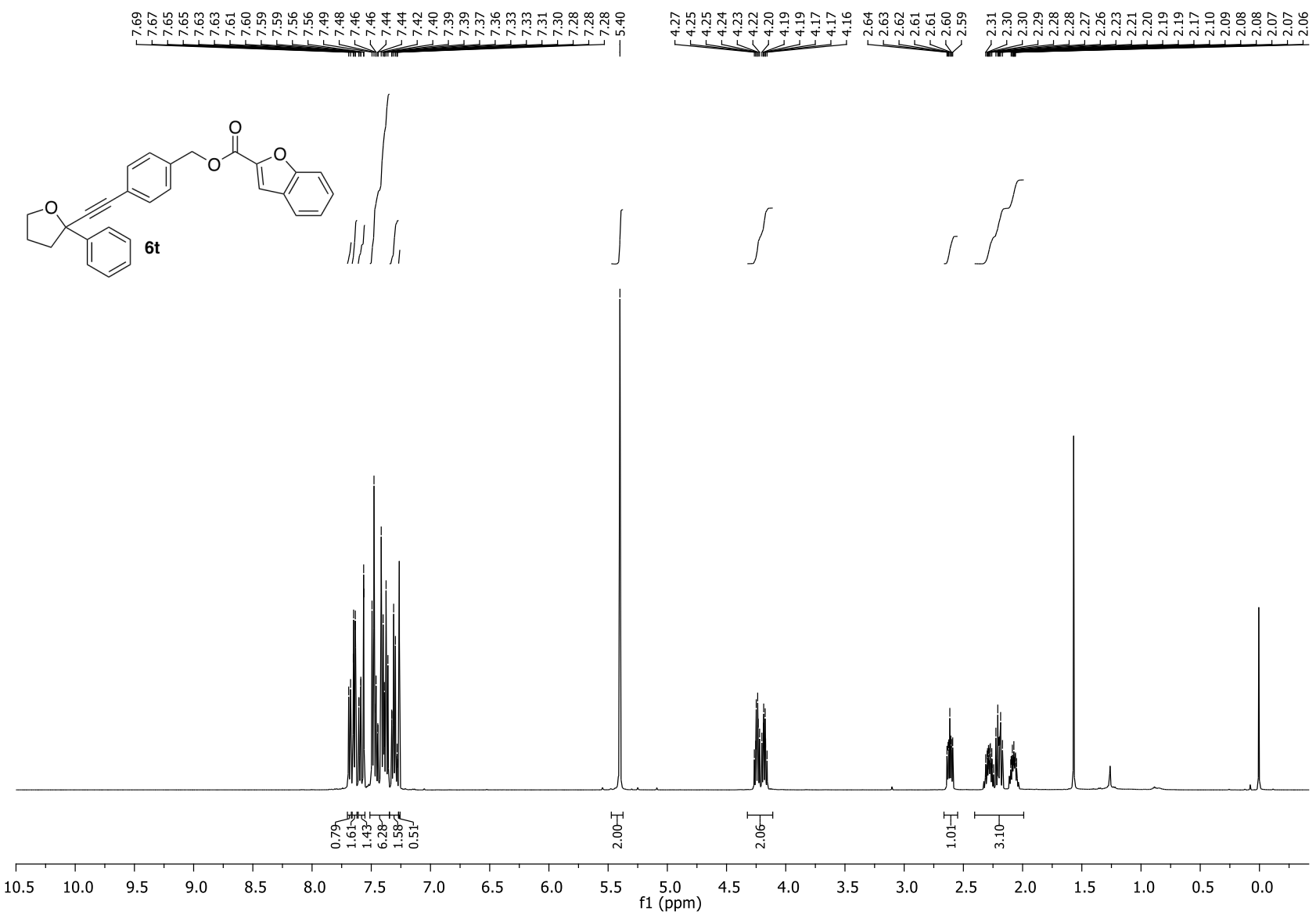
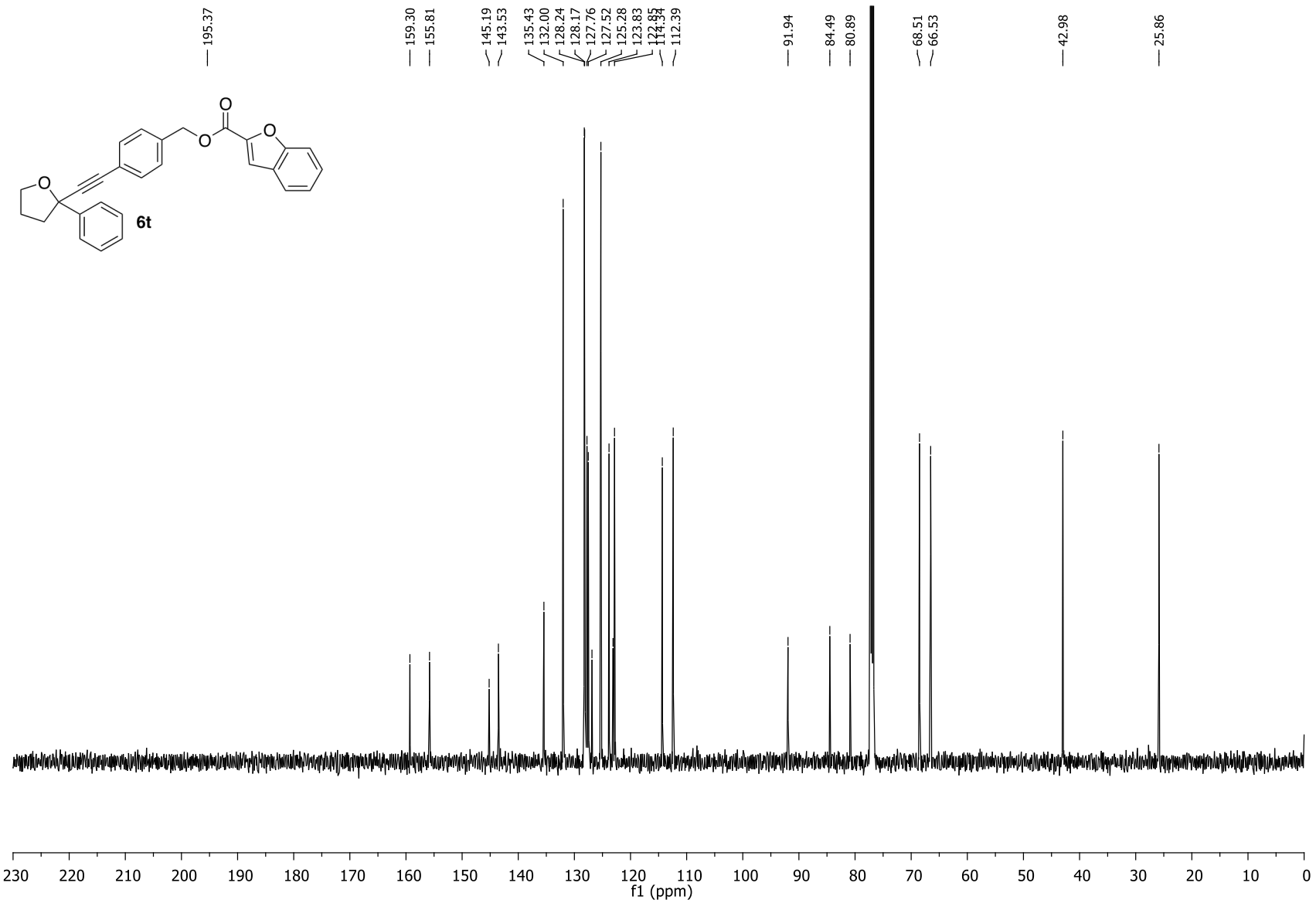
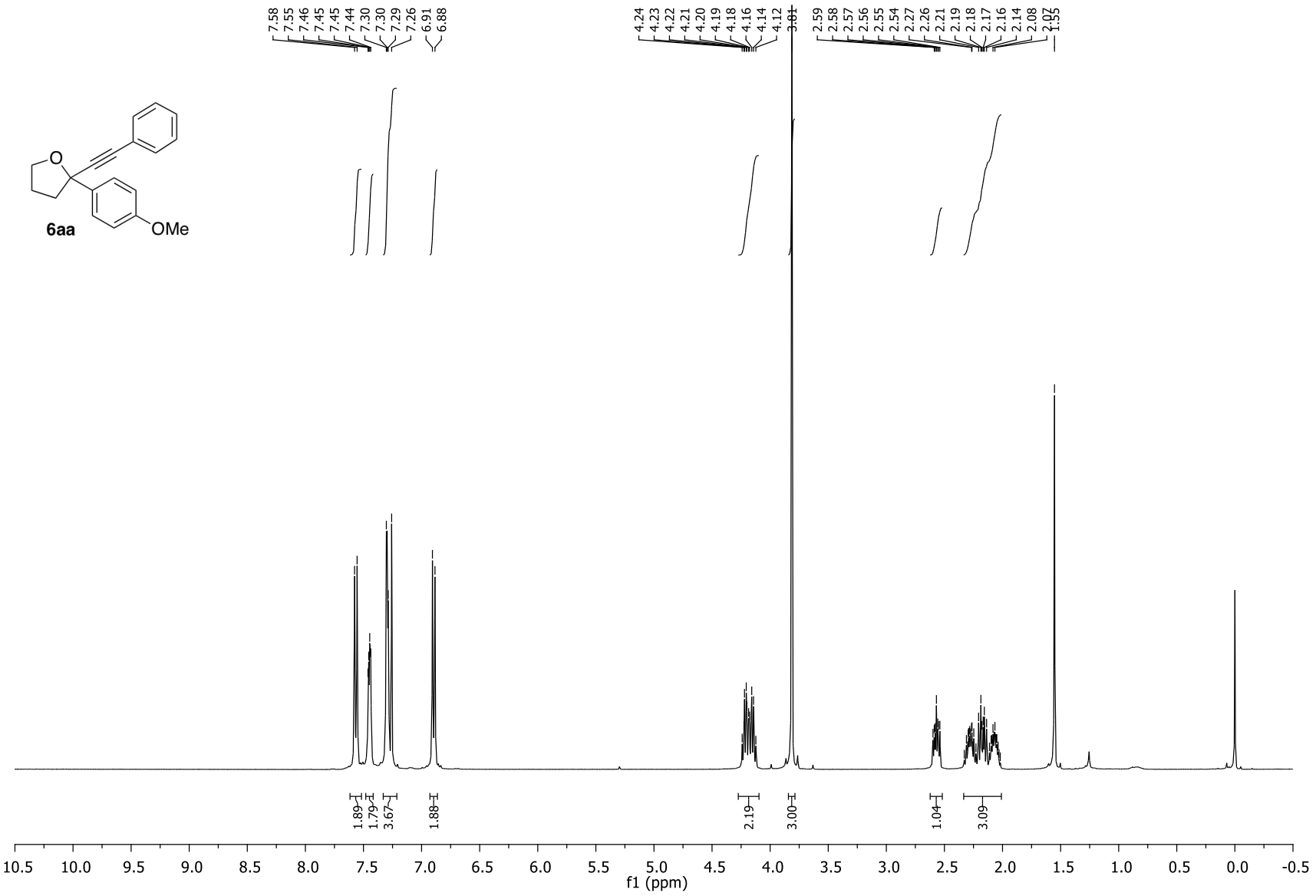
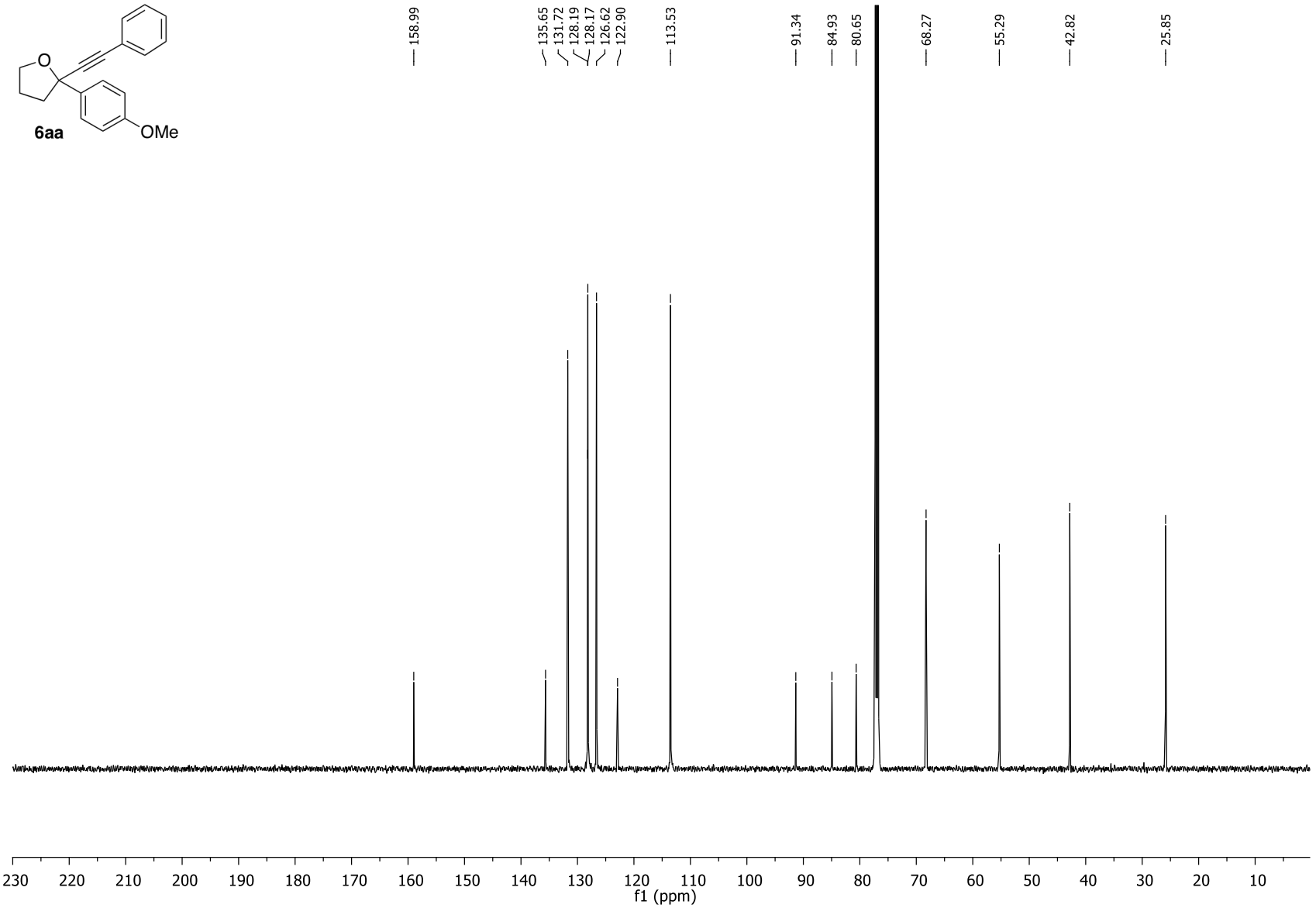
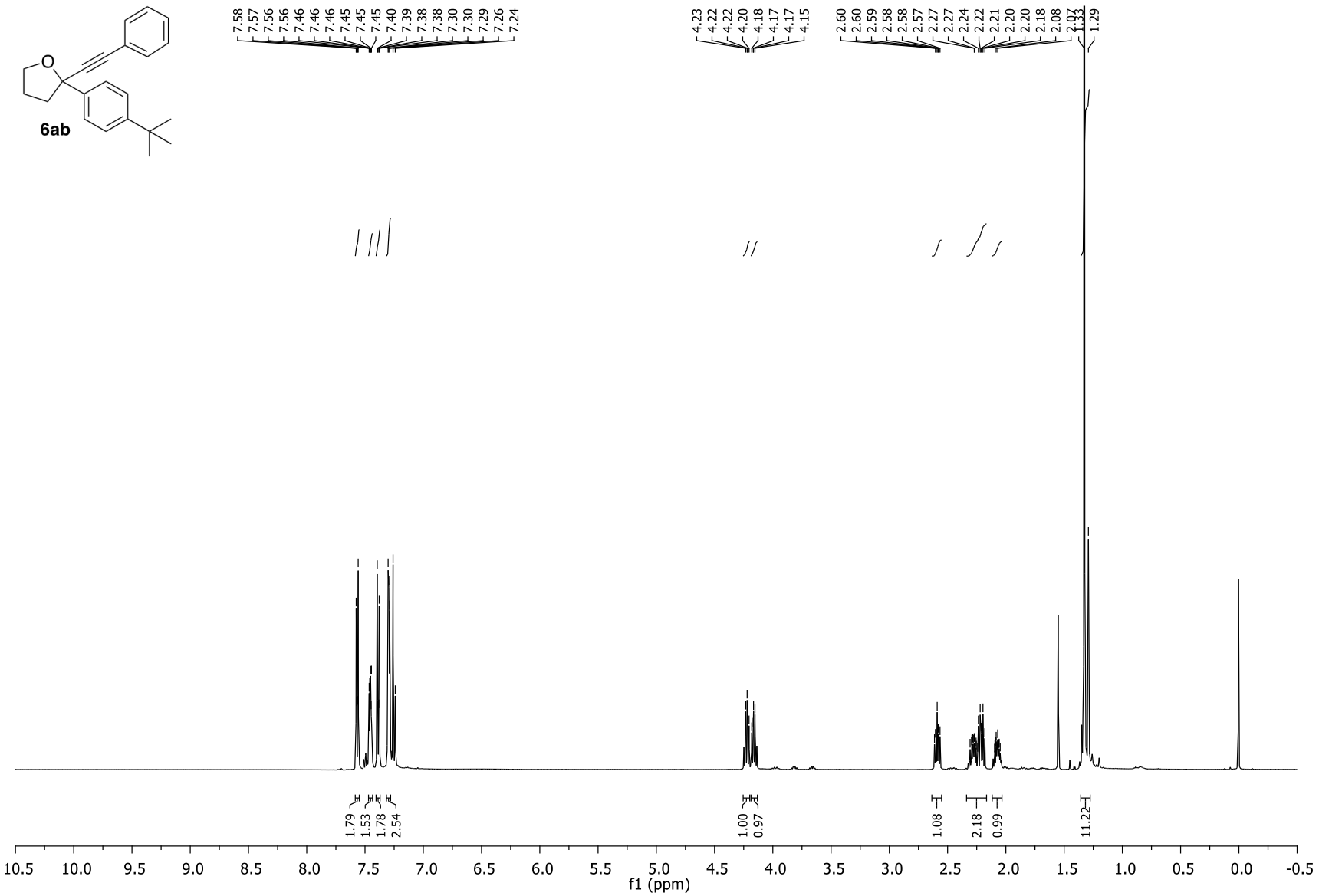
161.85
143.57
139.77
136.20
131.97
128.24
127.79
127.52
125.82
125.30
125.15
122.80
122.62
120.62
110.61
110.25
91.78
84.59
80.91
68.51
65.68
43.00
31.63
25.87
O
Me
N
O
O
6s
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

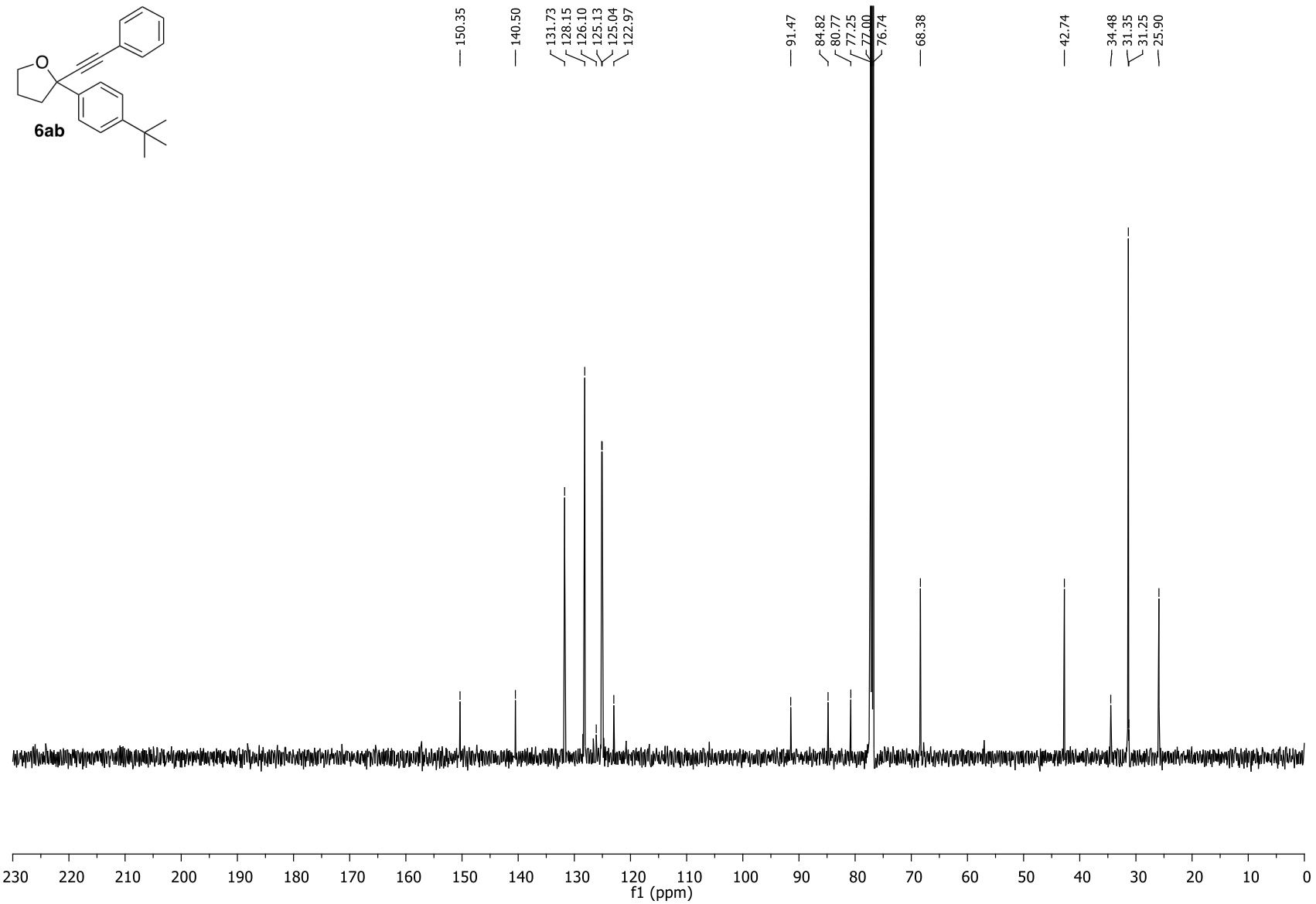

7.69 7.67 7.65 7.65 7.63 7.63 7.61 7.60 7.59 7.59 7.56 7.56 7.49 7.48 7.46 7.46 7.44 7.44 7.42 7.40 7.39 7.39 7.37 7.36 7.33 7.33 7.31 7.30 7.28 7.28 7.28 5.40
4.27 4.25 4.25 4.24 4.23 4.22 4.20 4.19 4.19 4.17 4.17 4.16
2.64 2.63 2.62 2.61 2.61 2.60 2.59
2.31 2.30 2.30 2.29 2.28 2.28 2.27 2.26 2.23 2.21 2.20 2.19 2.19 2.17 2.10 2.09 2.08 2.08 2.07 2.07 2.06
O
O
O
O
O
6t
0.79
1.61
1.43
6.28
1.58
0.51
2.00
2.06
1.01
3.10
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

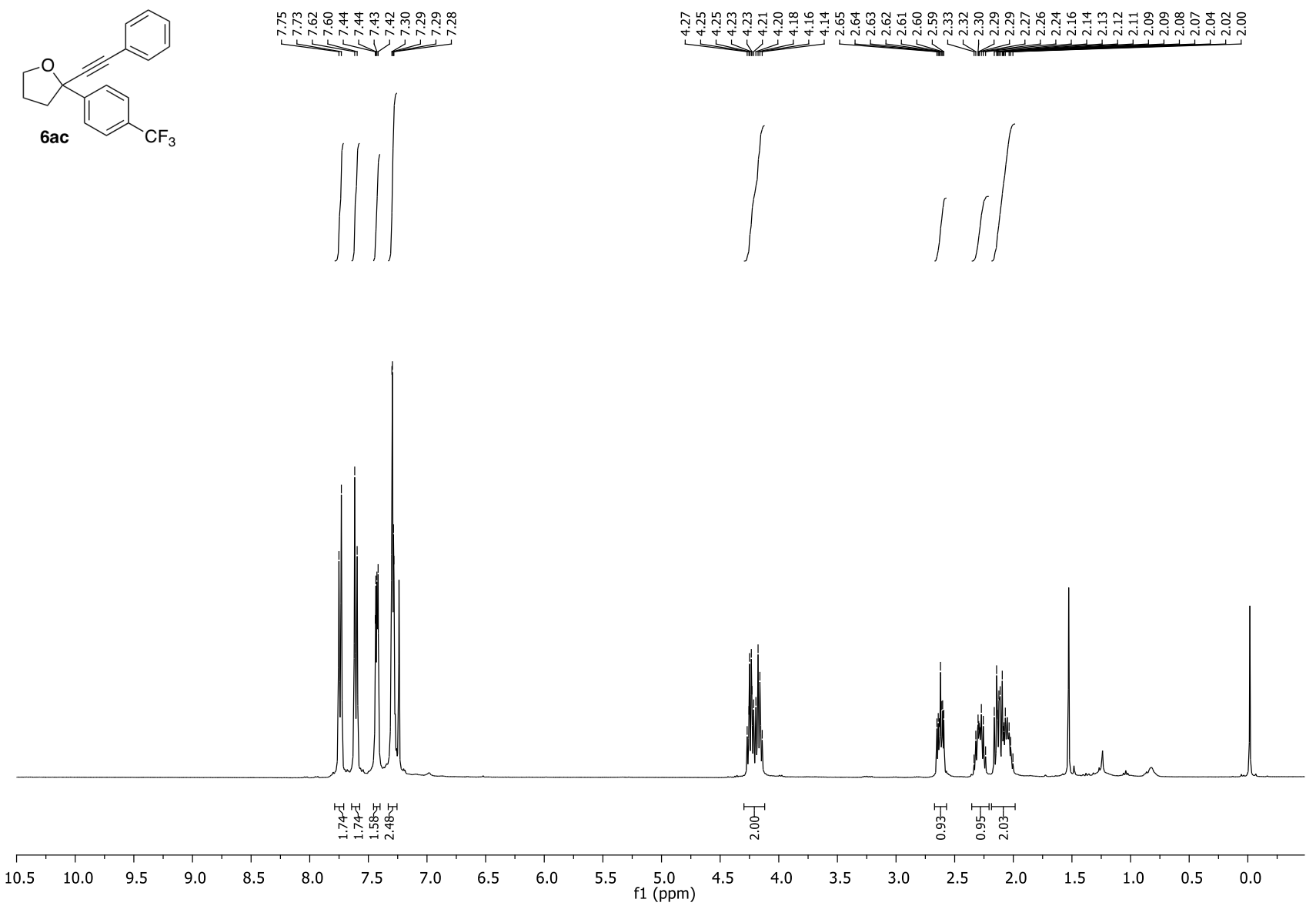

195.37
159.30
155.81
145.19
143.53
135.43
132.00
128.24
128.17
127.76
127.52
125.28
123.83
112.39
91.94
84.49
80.89
68.51
66.53
42.98
25.86
6t
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

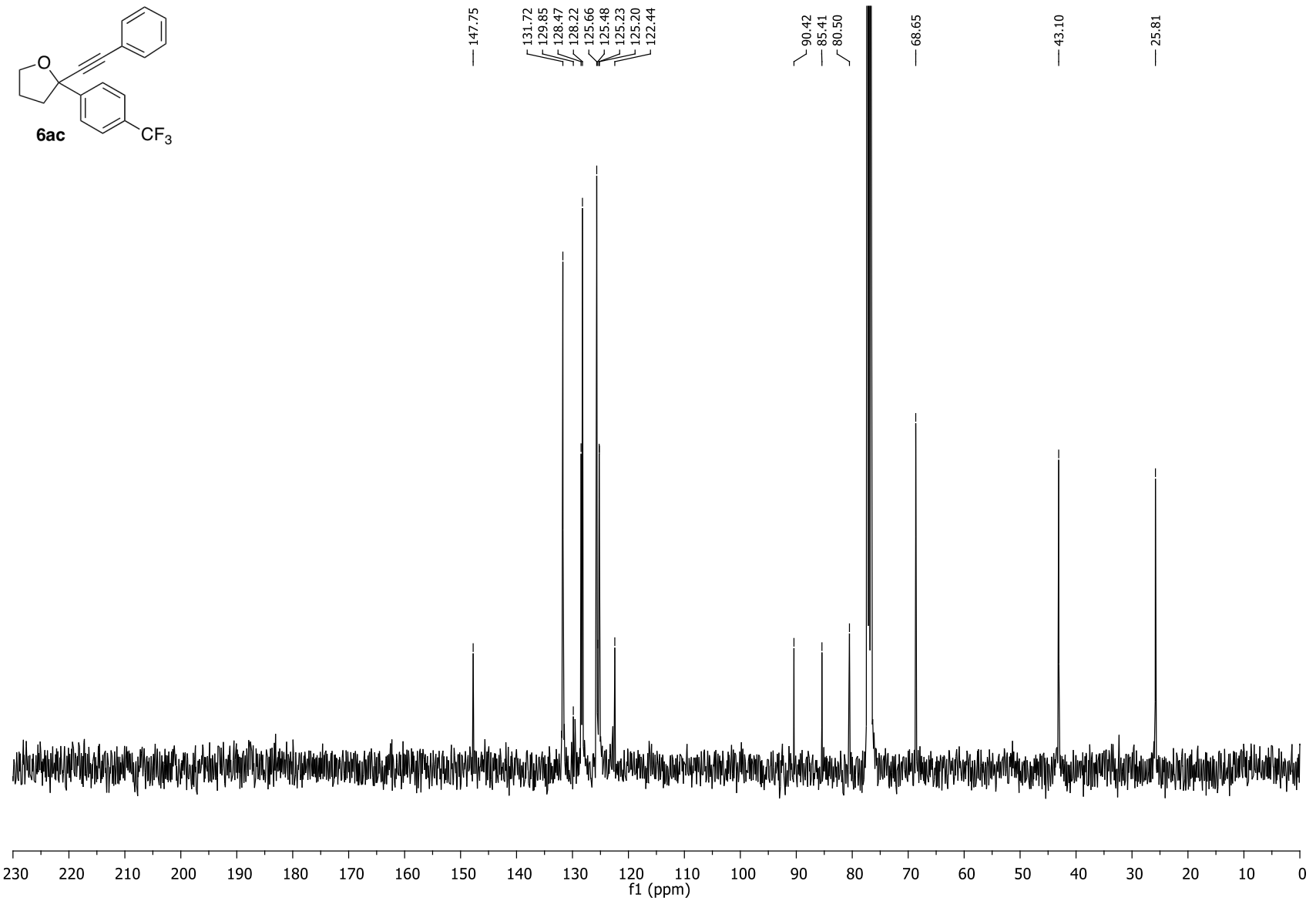

7.58
7.55
7.46
7.45
7.45
7.44
7.30
7.30
7.29
7.26
6.91
6.88
4.24
4.23
4.22
4.21
4.20
4.19
4.18
4.16
4.14
4.12
3.01
2.59
2.58
2.57
2.56
2.55
2.54
2.27
2.26
2.21
2.19
2.18
2.17
2.16
2.14
2.08
2.07
1.55
O
OMe
6aa
1.89
1.79
3.67
1.88
2.19
3.00
1.04
3.09
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

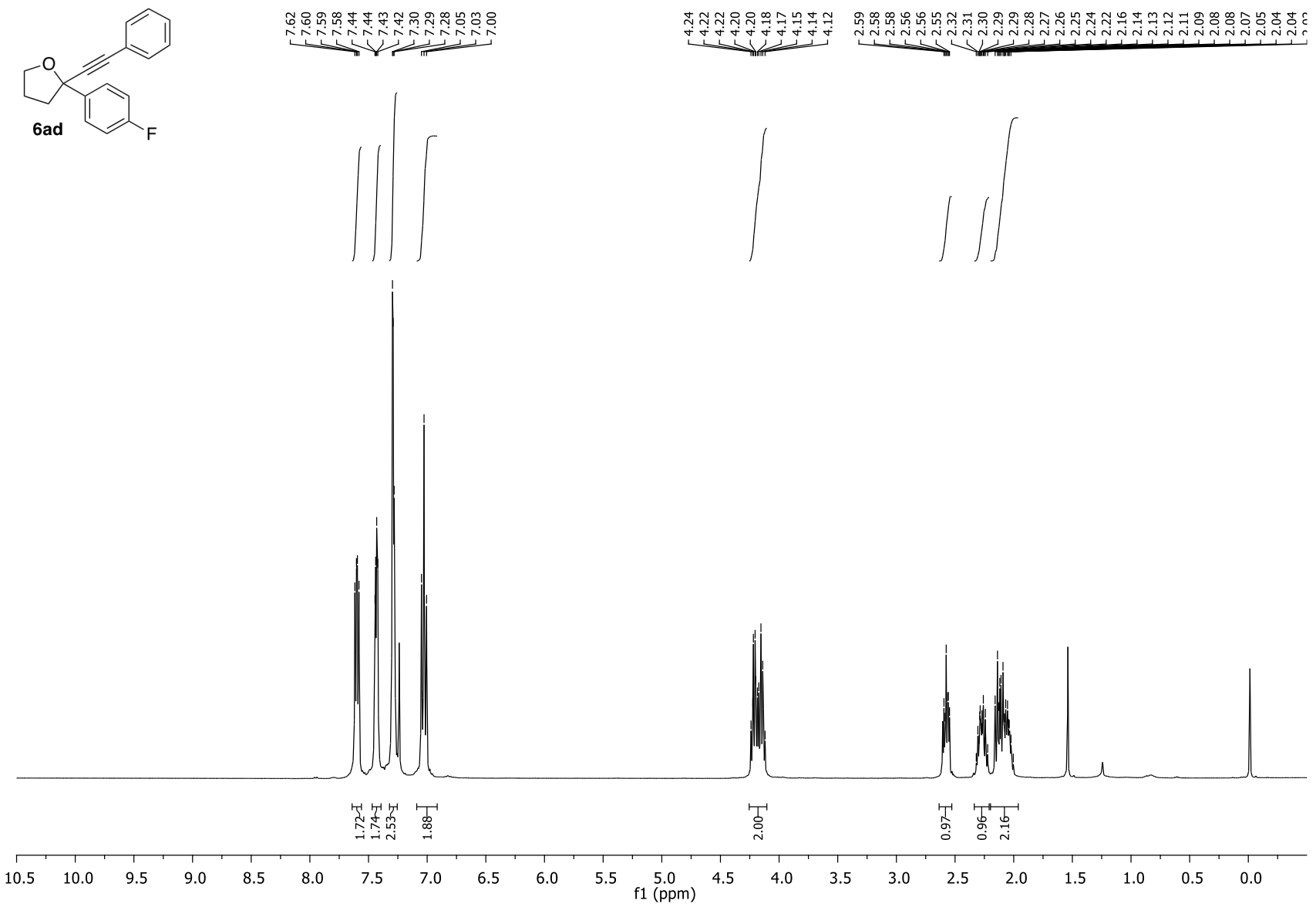

6aa
OMe
158.99
135.65
131.72
128.19
128.17
126.62
122.90
113.53
91.34
84.93
80.65
68.27
55.29
42.82
25.85
f1 (ppm)

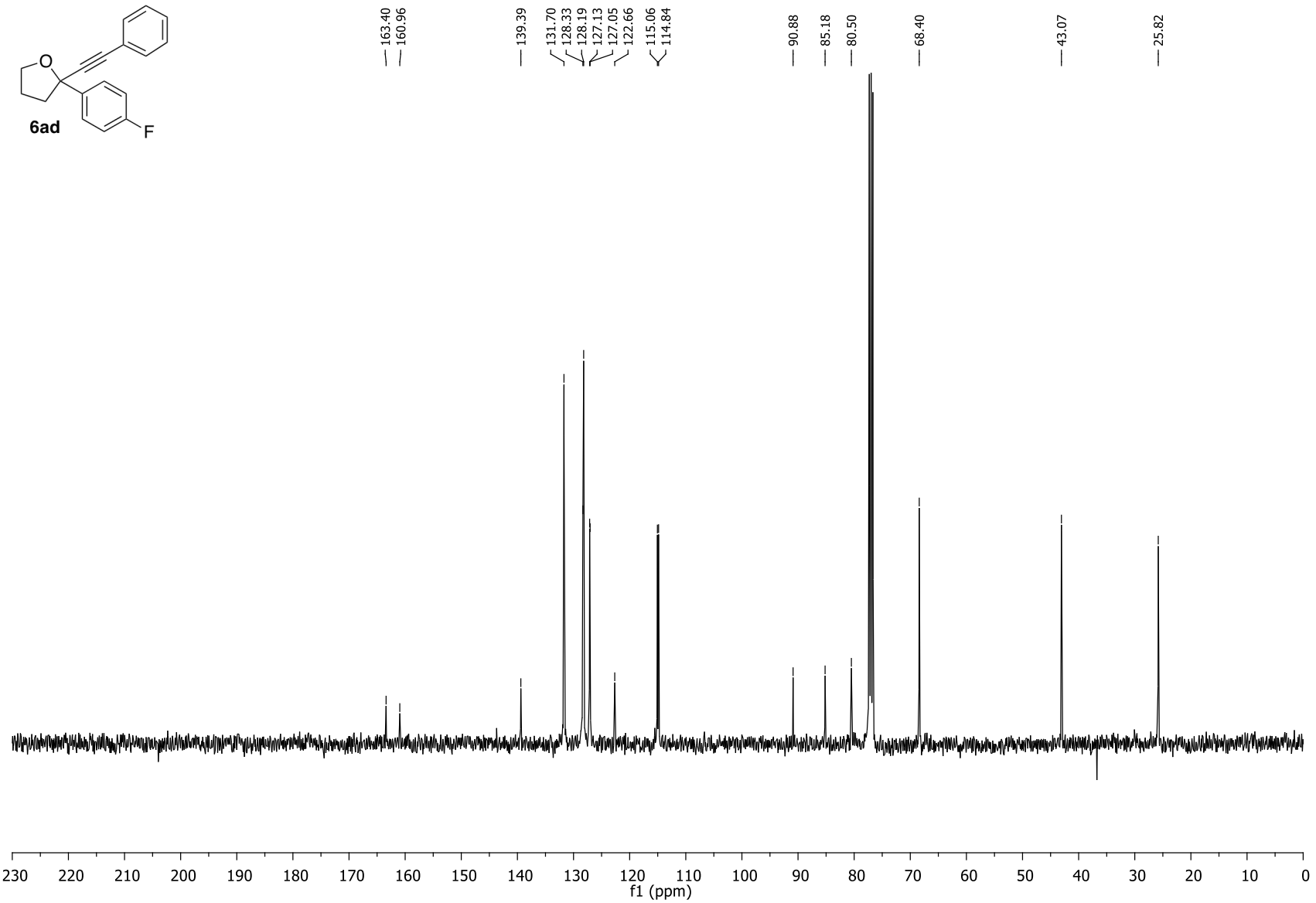

6ab
7.58
7.57
7.56
7.56
7.46
7.46
7.46
7.45
7.45
7.45
7.40
7.39
7.38
7.38
7.30
7.30
7.29
7.26
7.24
4.23
4.22
4.22
4.20
4.18
4.17
4.17
4.15
2.60
2.60
2.59
2.58
2.58
2.57
2.27
2.27
2.24
2.22
2.21
2.20
2.20
2.18
2.08
2.07
1.33
1.29
1.79
1.53
1.78
2.54
1.00
0.97
1.08
2.18
0.99
11.22
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

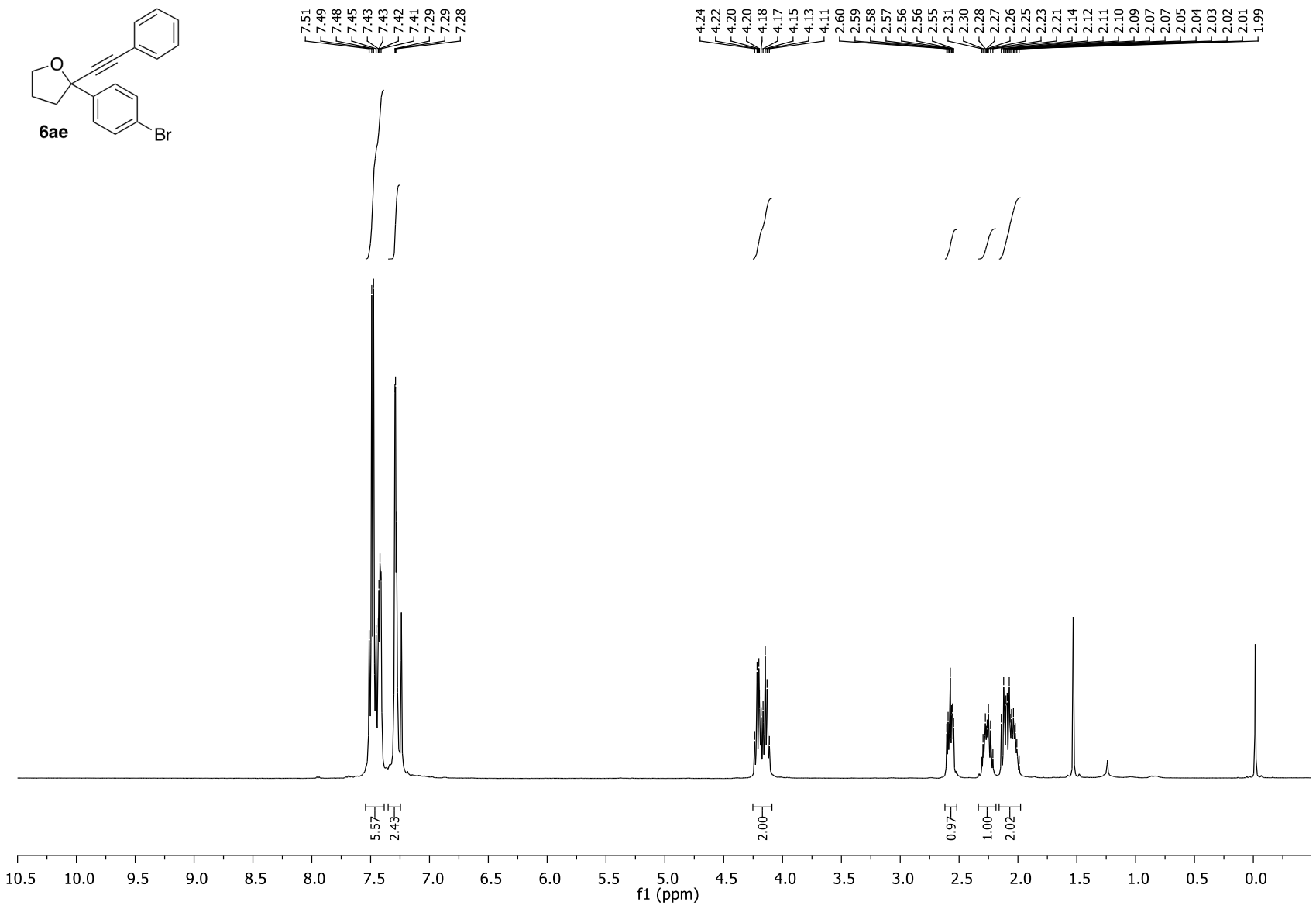

6ab
150.35
140.50
131.73
128.15
126.10
125.13
125.04
122.97
91.47
84.82
80.77
77.25
77.00
76.74
68.38
42.74
34.48
31.35
31.25
25.90
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

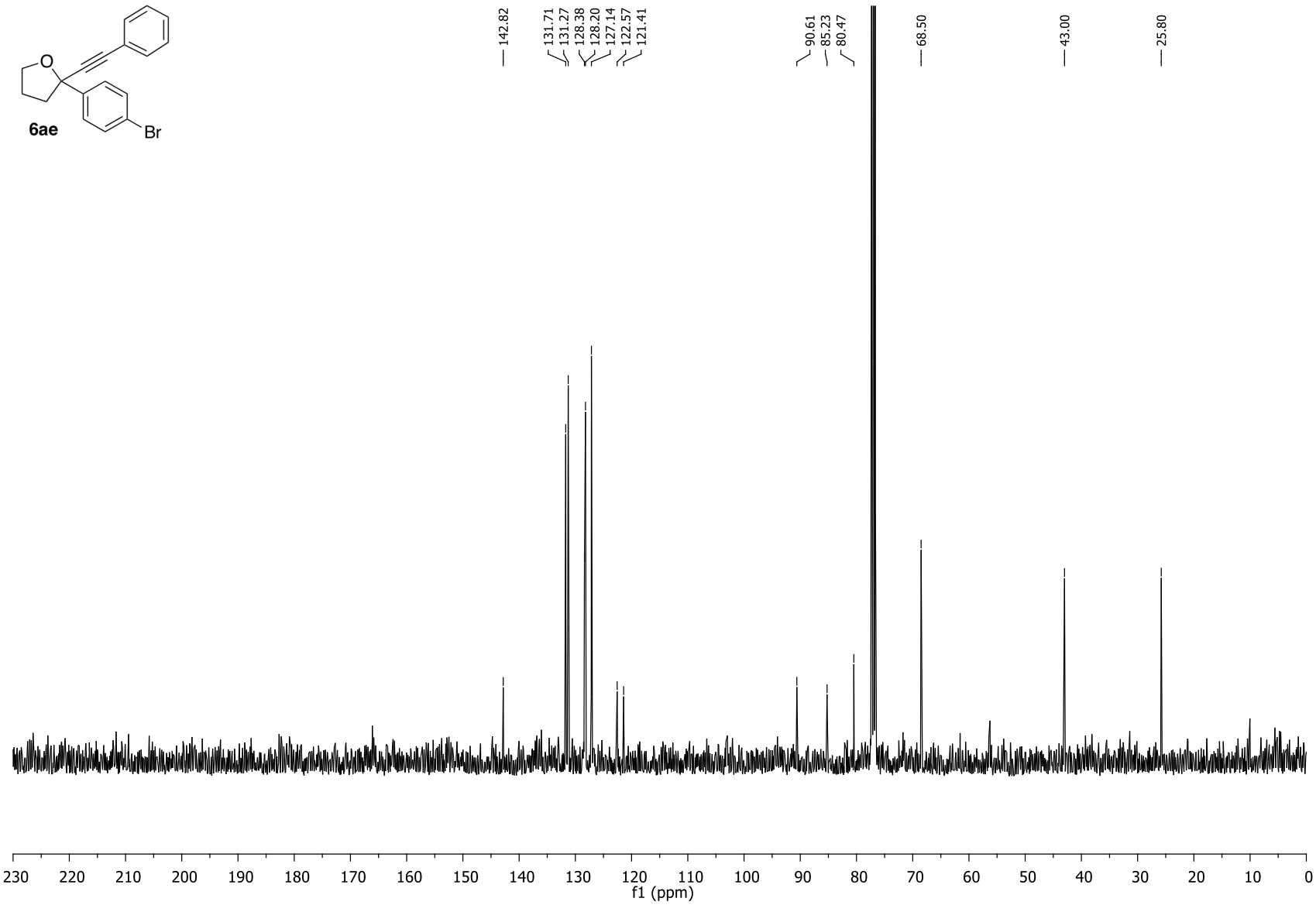

6ac
CF3
7.75
7.73
7.62
7.60
7.44
7.44
7.43
7.42
7.30
7.29
7.29
7.28
4.27
4.25
4.25
4.23
4.23
4.21
4.20
4.18
4.16
4.14
2.65
2.64
2.63
2.62
2.61
2.60
2.59
2.33
2.32
2.30
2.29
2.29
2.27
2.26
2.24
2.16
2.14
2.13
2.12
2.11
2.09
2.09
2.08
2.07
2.04
2.02
2.00
1.74
1.74
1.58
2.48
2.00
0.93
0.95
2.03
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

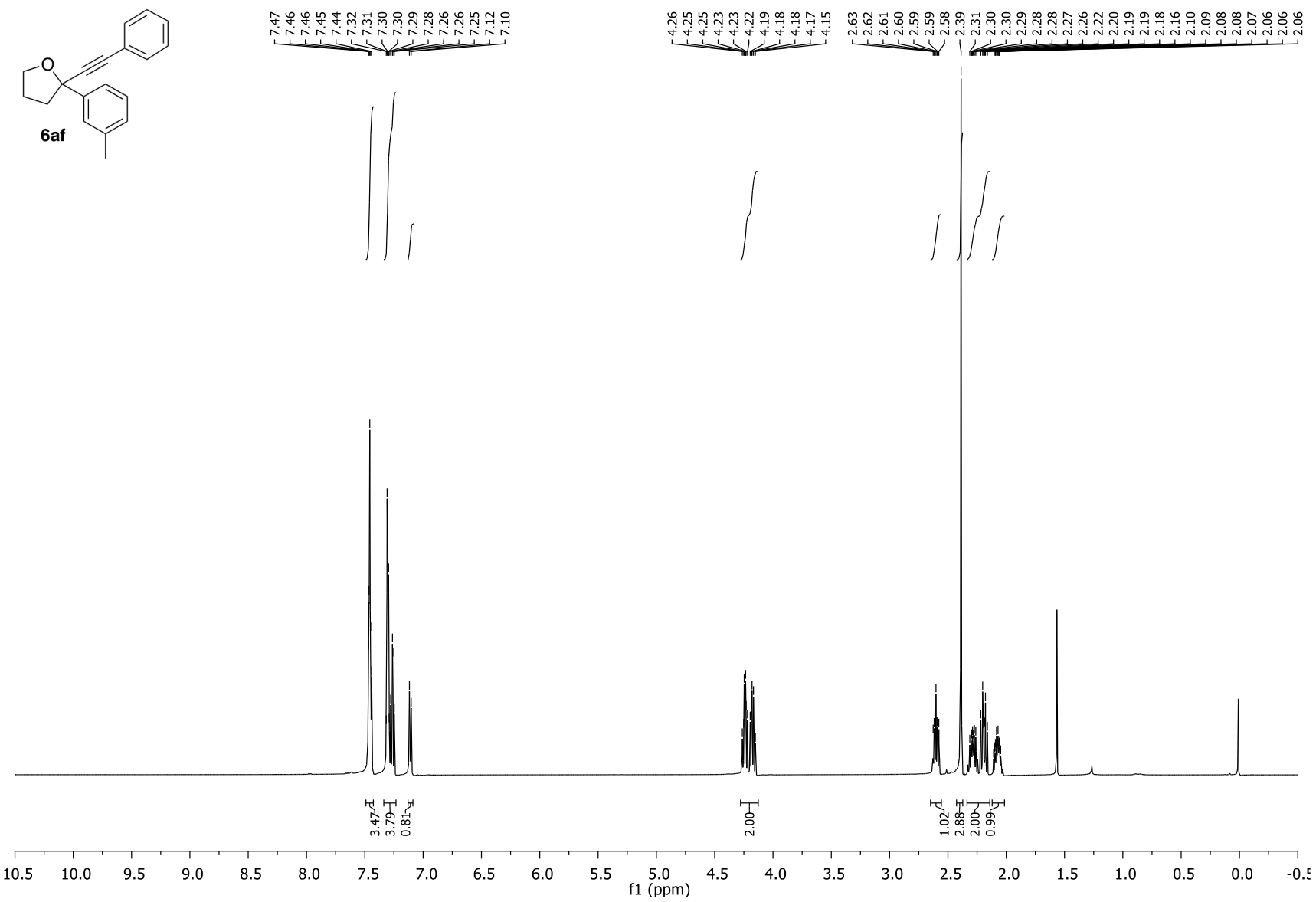

6ac
CF3
147.75
131.72
129.85
128.47
128.22
125.66
125.48
125.23
125.20
122.44
90.42
85.41
80.50
68.65
43.10
25.81
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

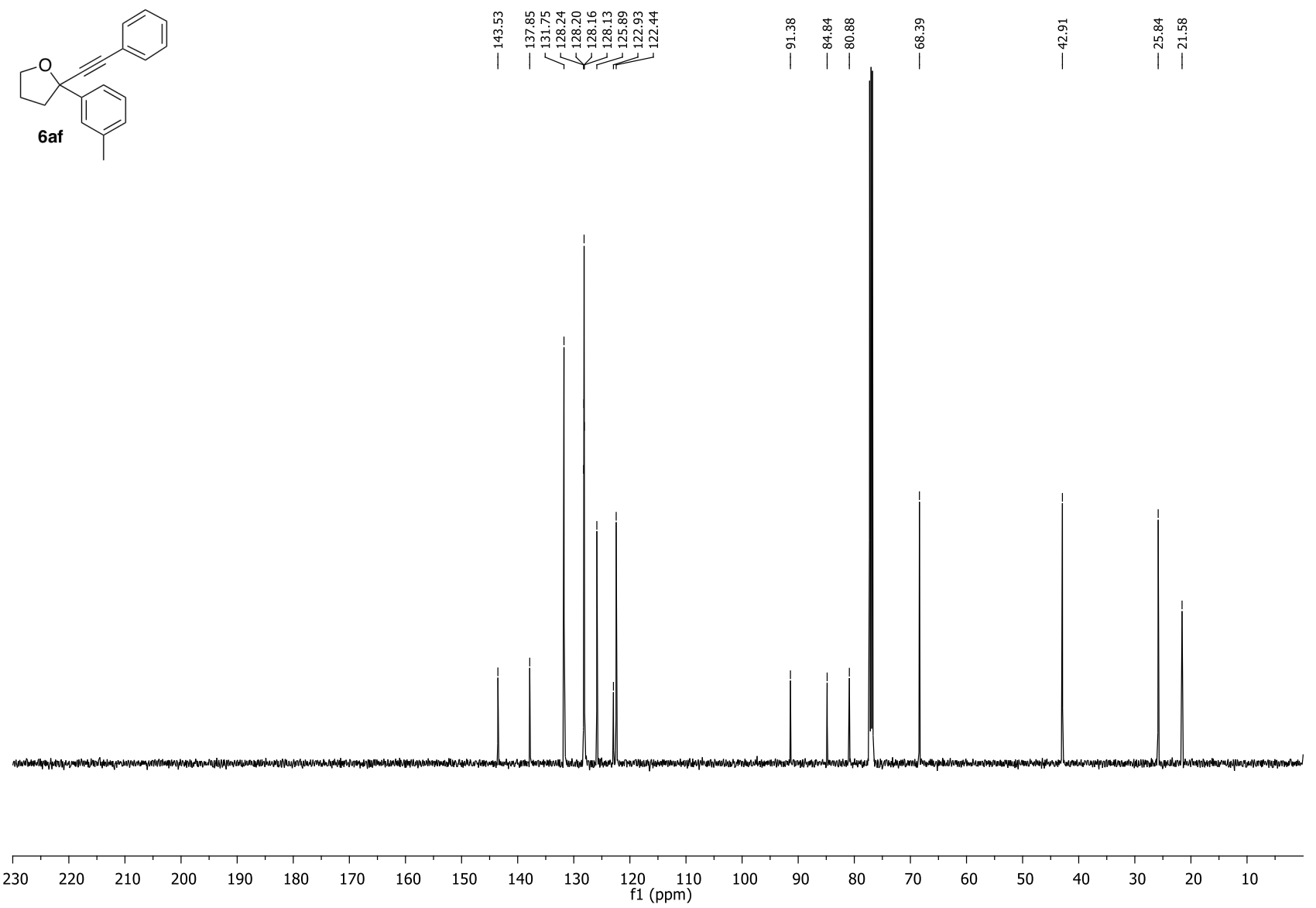

6ad
F
7.62
7.60
7.59
7.58
7.44
7.44
7.43
7.42
7.30
7.29
7.28
7.05
7.03
7.00
4.24
4.22
4.22
4.20
4.20
4.18
4.17
4.15
4.14
4.12
2.59
2.58
2.58
2.56
2.56
2.55
2.32
2.31
2.30
2.29
2.29
2.28
2.27
2.26
2.25
2.24
2.22
2.16
2.14
2.13
2.12
2.11
2.09
2.08
2.08
2.07
2.05
2.04
2.04
1.72
1.74
2.53
1.88
2.00
0.97
0.96
2.16
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

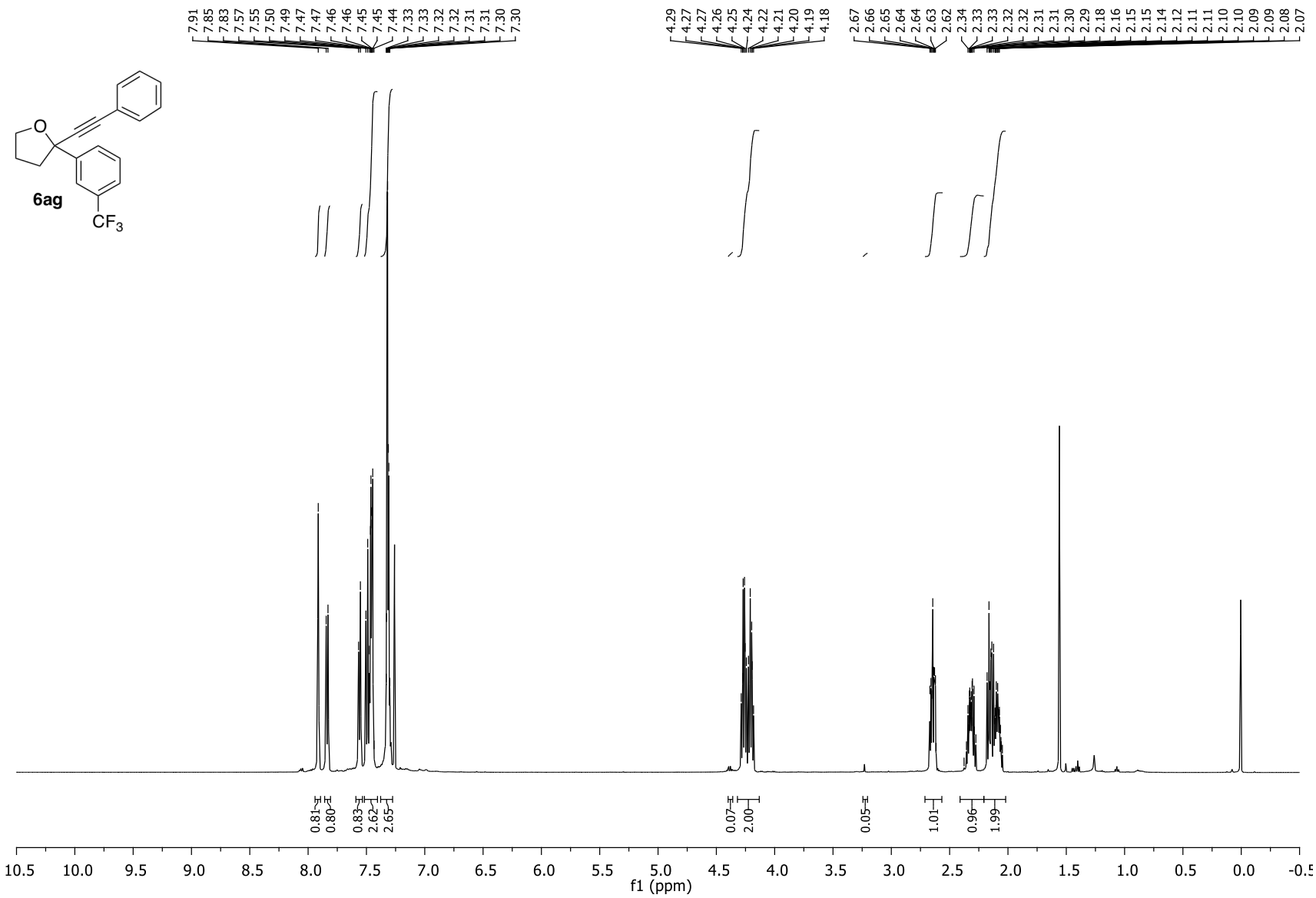

6ad
O
F
163.40
160.96
139.39
131.70
128.33
128.19
127.13
127.05
122.66
115.06
114.84
90.88
85.18
80.50
68.40
43.07
25.82
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

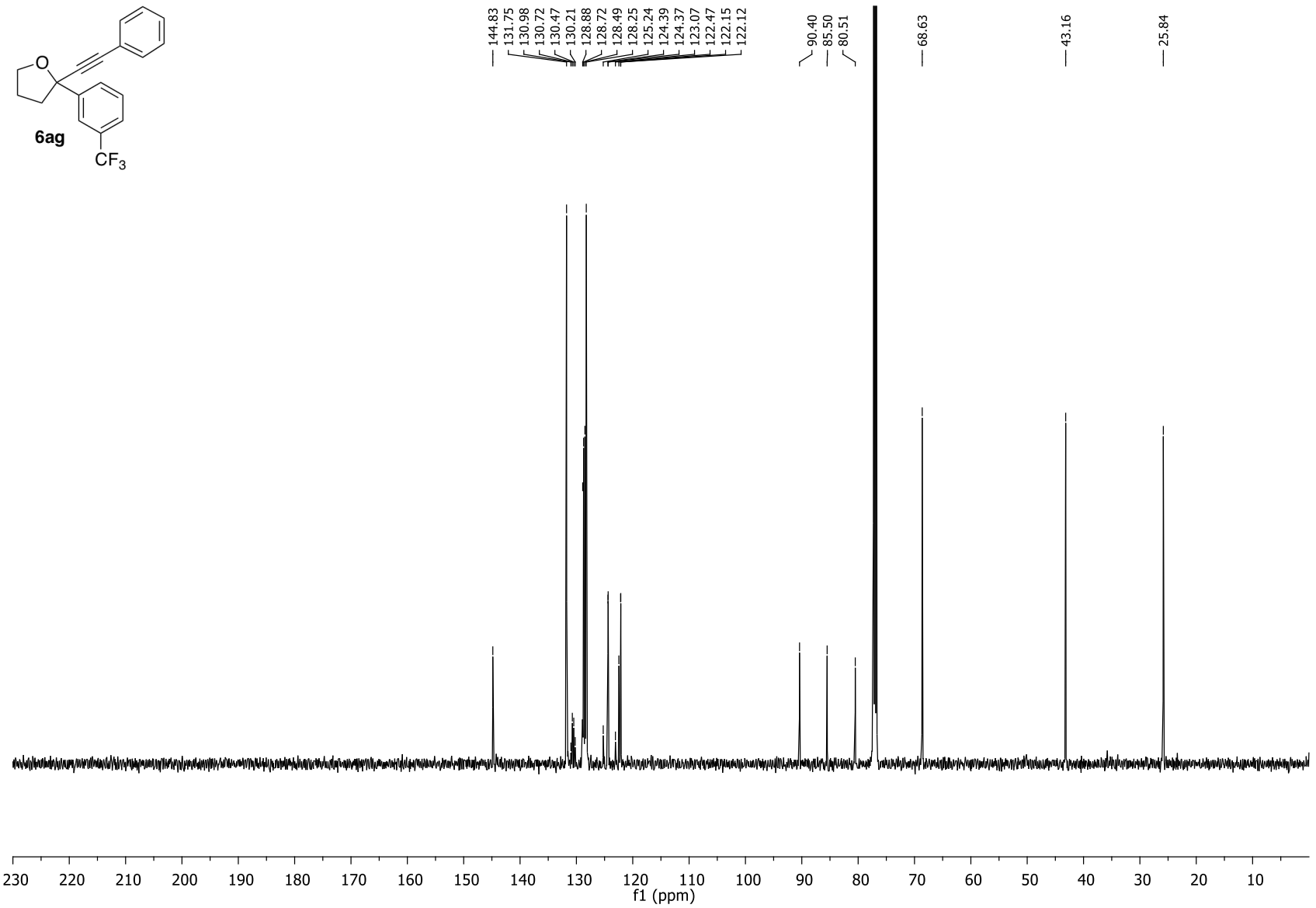

6ae
O
Br
7.51
7.49
7.48
7.45
7.43
7.43
7.42
7.41
7.29
7.28
4.24
4.22
4.20
4.20
4.18
4.17
4.15
4.13
4.11
2.60
2.59
2.58
2.57
2.56
2.56
2.55
2.31
2.30
2.28
2.27
2.26
2.25
2.23
2.21
2.14
2.12
2.11
2.10
2.09
2.07
2.07
2.05
2.04
2.03
2.02
2.01
1.99
5.57
2.43
2.00
0.97
1.00
2.02
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

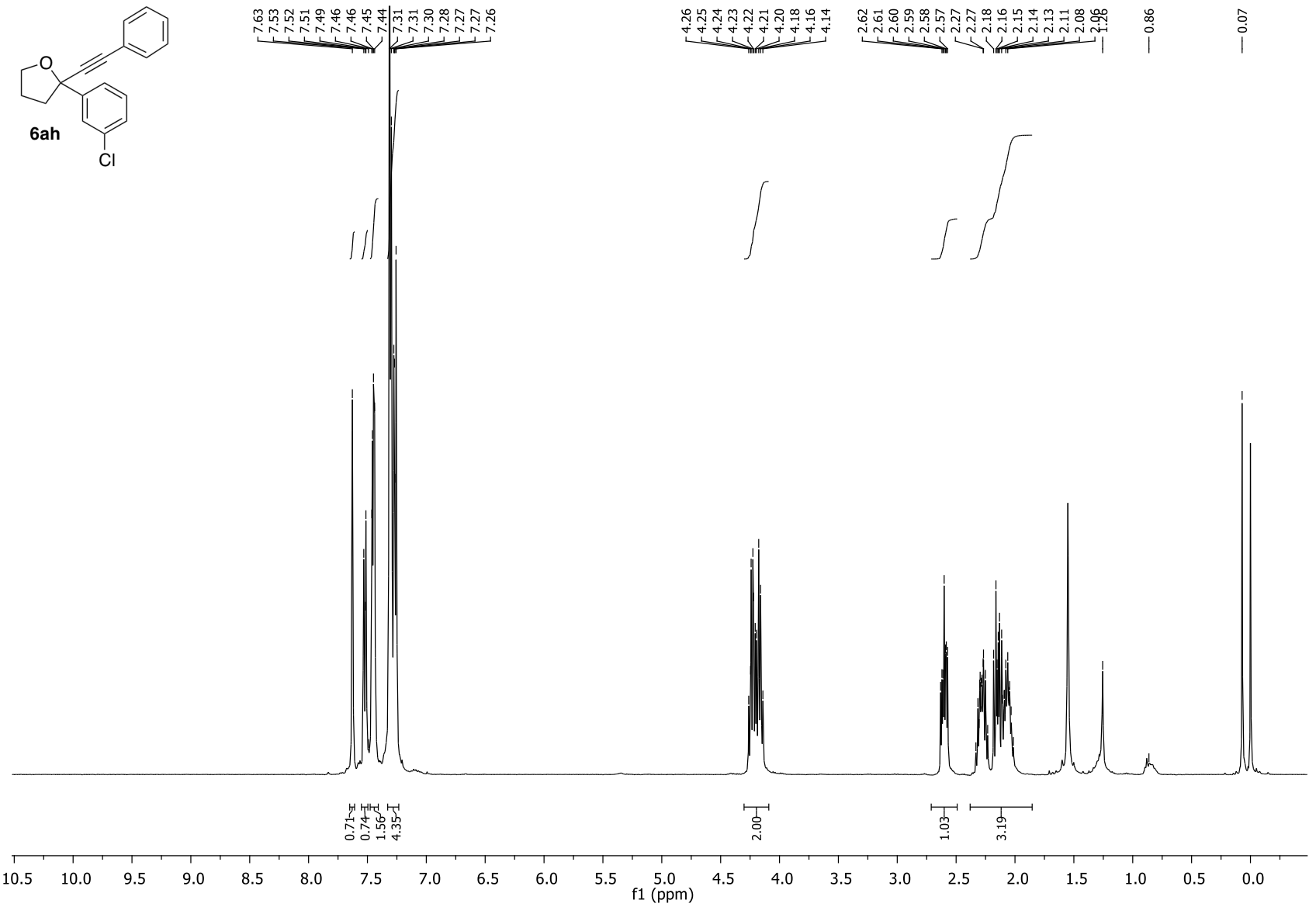

6ae
O
Br
142.82
131.71
131.27
128.38
128.20
127.14
122.57
121.41
90.61
85.23
80.47
68.50
43.00
25.80
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

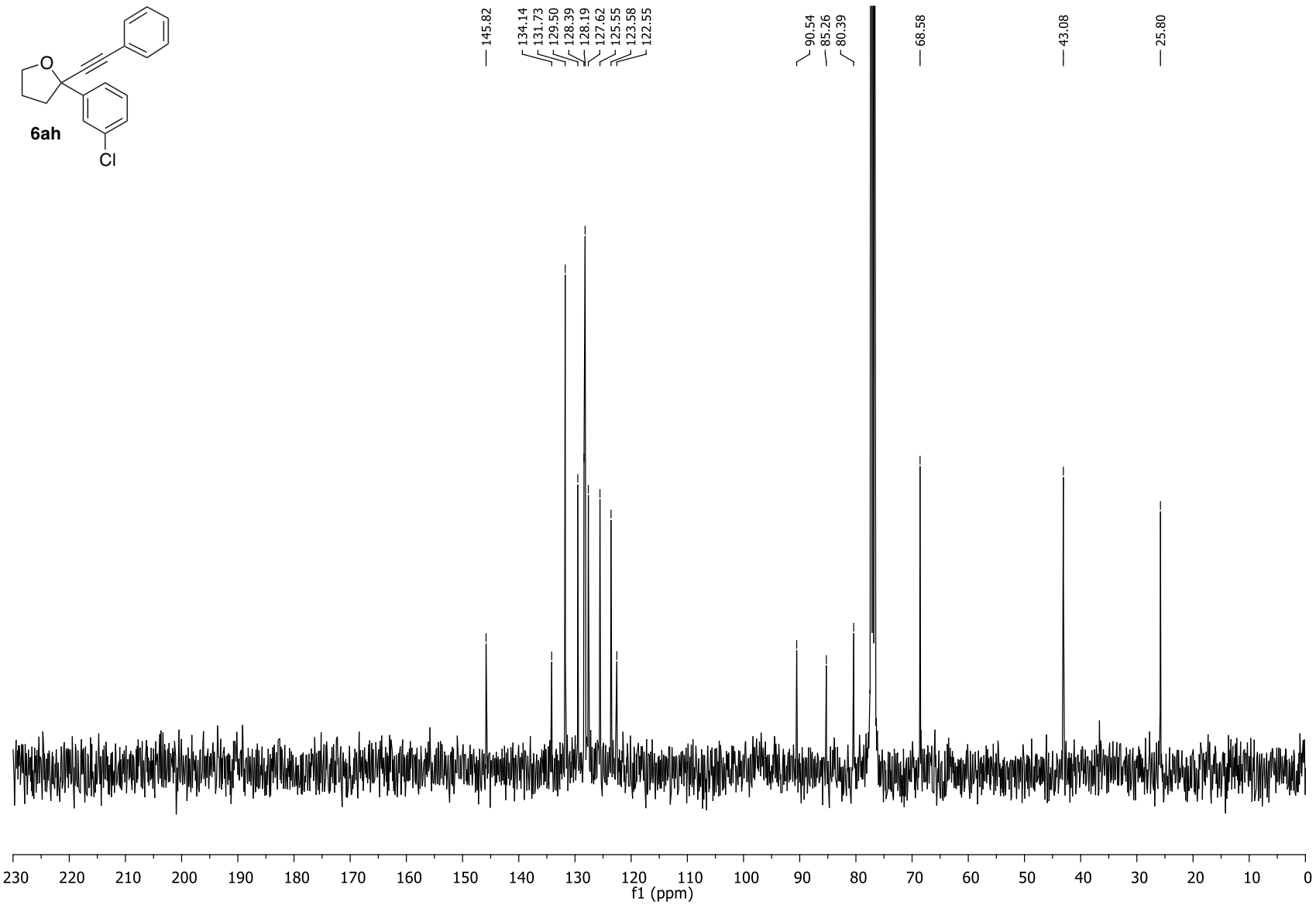

6af
7.47
7.46
7.46
7.45
7.44
7.32
7.31
7.30
7.30
7.29
7.28
7.26
7.26
7.25
7.12
7.10
4.26
4.25
4.25
4.23
4.23
4.22
4.19
4.18
4.18
4.17
4.15
2.63
2.62
2.61
2.60
2.59
2.59
2.58
2.39
2.31
2.30
2.30
2.29
2.28
2.28
2.27
2.26
2.22
2.20
2.19
2.19
2.18
2.16
2.10
2.09
2.08
2.08
2.07
2.06
2.06
2.06
3.47
3.79
0.81
2.00
1.02
2.88
2.00
0.99
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


6af
143.53
137.85
131.75
128.24
128.20
128.16
128.13
125.89
122.93
122.44
91.38
84.84
80.88
68.39
42.91
25.84
21.58
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


7.91 7.85 7.83 7.57 7.55 7.50 7.49 7.47 7.47 7.46 7.46 7.45 7.45 7.44 7.33 7.33 7.32 7.32 7.31 7.31 7.30 7.30
4.29 4.27 4.27 4.26 4.25 4.24 4.22 4.21 4.20 4.19 4.18
2.67 2.66 2.65 2.64 2.64 2.63 2.62 2.34 2.33 2.32 2.32 2.31 2.31 2.30 2.29 2.18 2.16 2.15 2.15 2.14 2.12 2.11 2.11 2.10 2.10 2.09 2.09 2.08 2.07
O
6ag
CF3
0.81 0.80 0.83 2.62 2.65 0.07 2.00 0.05 1.01 0.96 1.99
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


6ag
CF3
144.83
131.75
130.98
130.72
130.47
130.21
128.88
128.72
128.49
128.25
125.24
124.39
124.37
123.07
122.47
122.15
122.12
90.40
85.50
80.51
68.63
43.16
25.84
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


6ah
O
Cl
7.63
7.53
7.52
7.51
7.49
7.46
7.46
7.45
7.44
7.31
7.31
7.30
7.28
7.27
7.27
7.26
4.26
4.25
4.24
4.23
4.22
4.21
4.20
4.18
4.16
4.14
2.62
2.61
2.60
2.59
2.58
2.57
2.27
2.27
2.18
2.16
2.15
2.14
2.13
2.11
2.08
2.06
1.26
0.86
0.07
0.71
0.74
1.56
4.35
2.00
1.03
3.19
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


6ah
O
Cl
145.82
134.14
131.73
129.50
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128.19
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125.55
123.58
122.55
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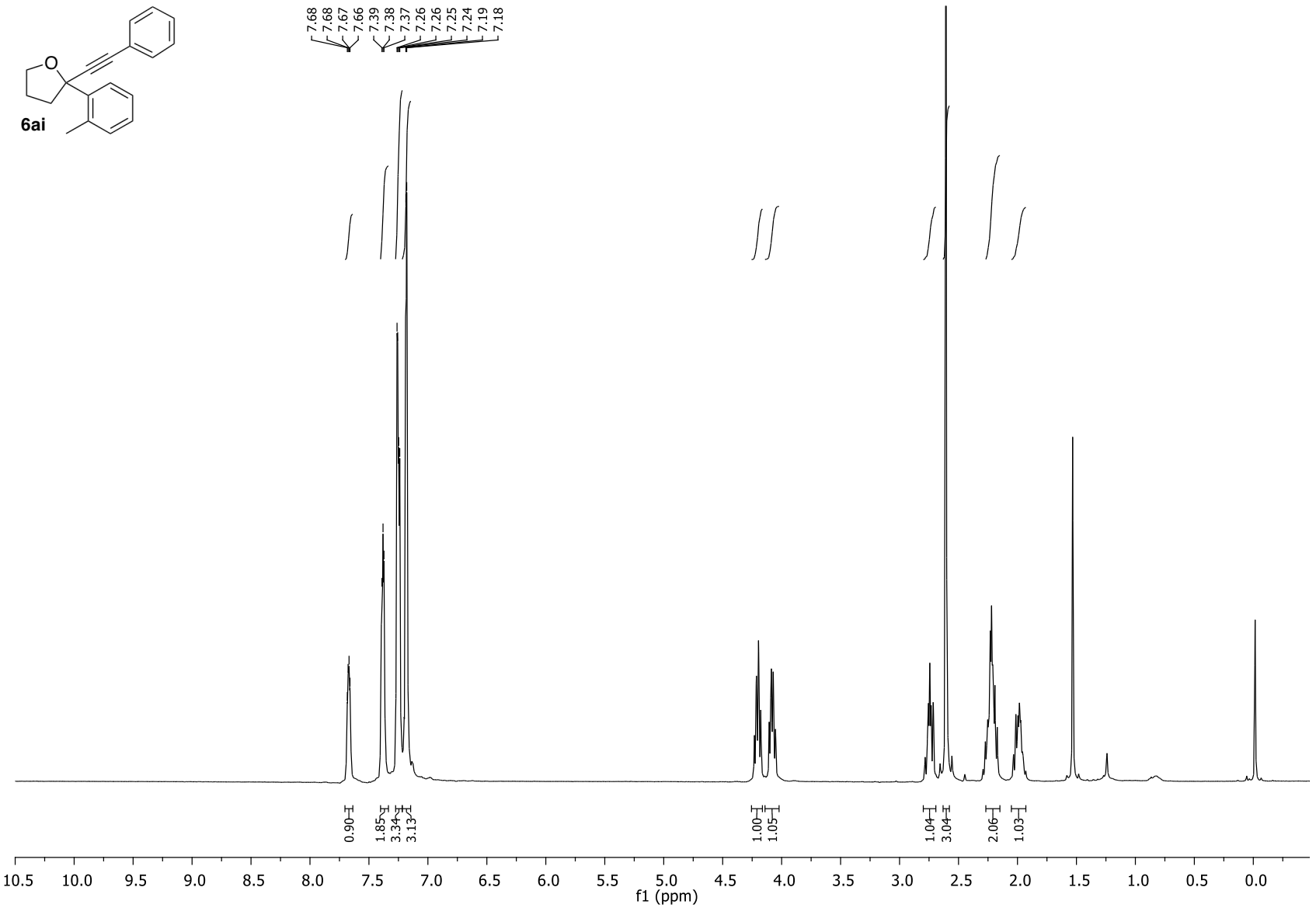
68.58
43.08
25.80
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


6ai
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7.68
7.67
7.66
7.39
7.38
7.37
7.26
7.26
7.25
7.24
7.19
7.18
0.90
1.85
3.34
3.13
1.00
1.05
1.04
3.04
2.06
1.03
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
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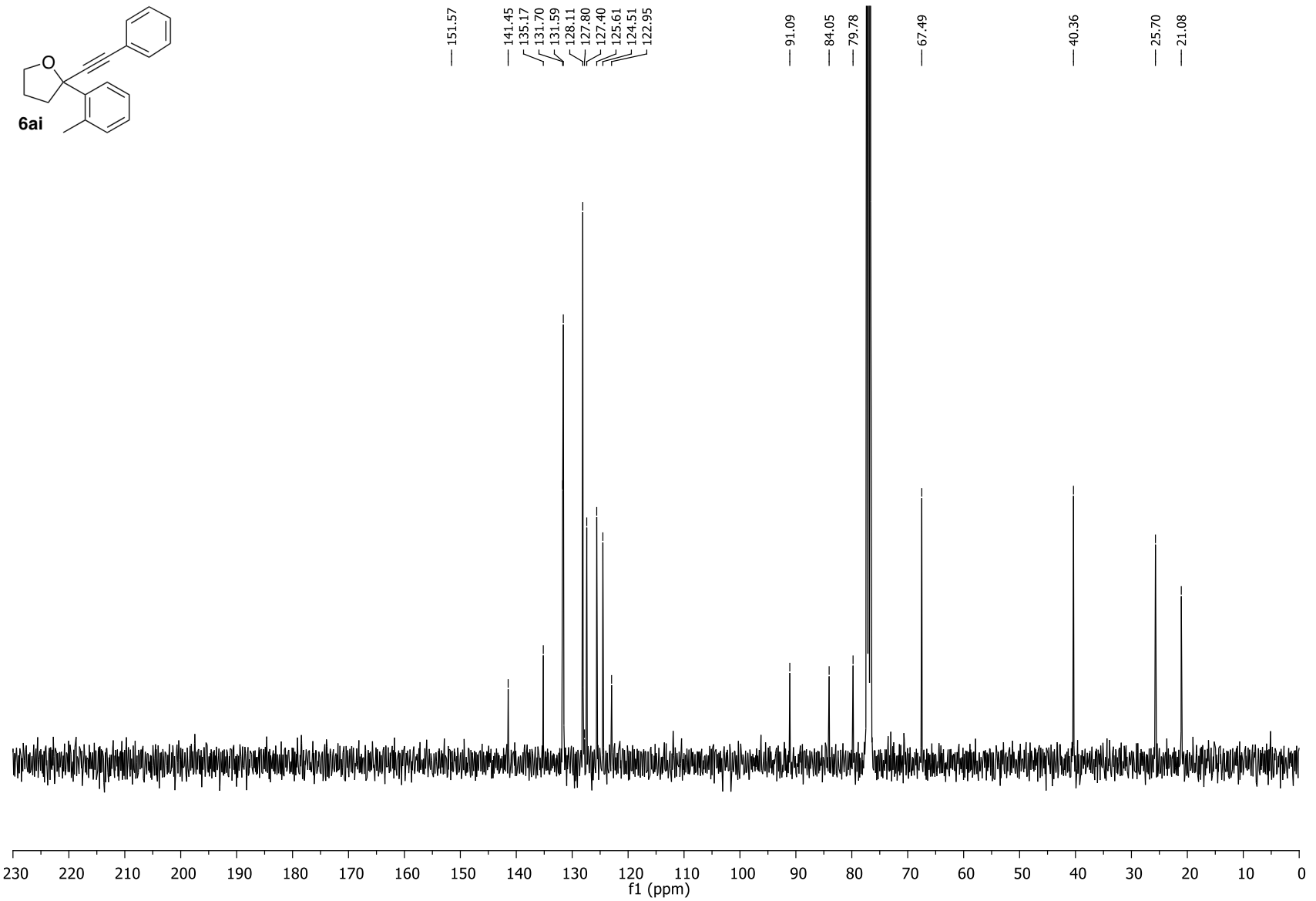
0.0
f1 (ppm)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135.17
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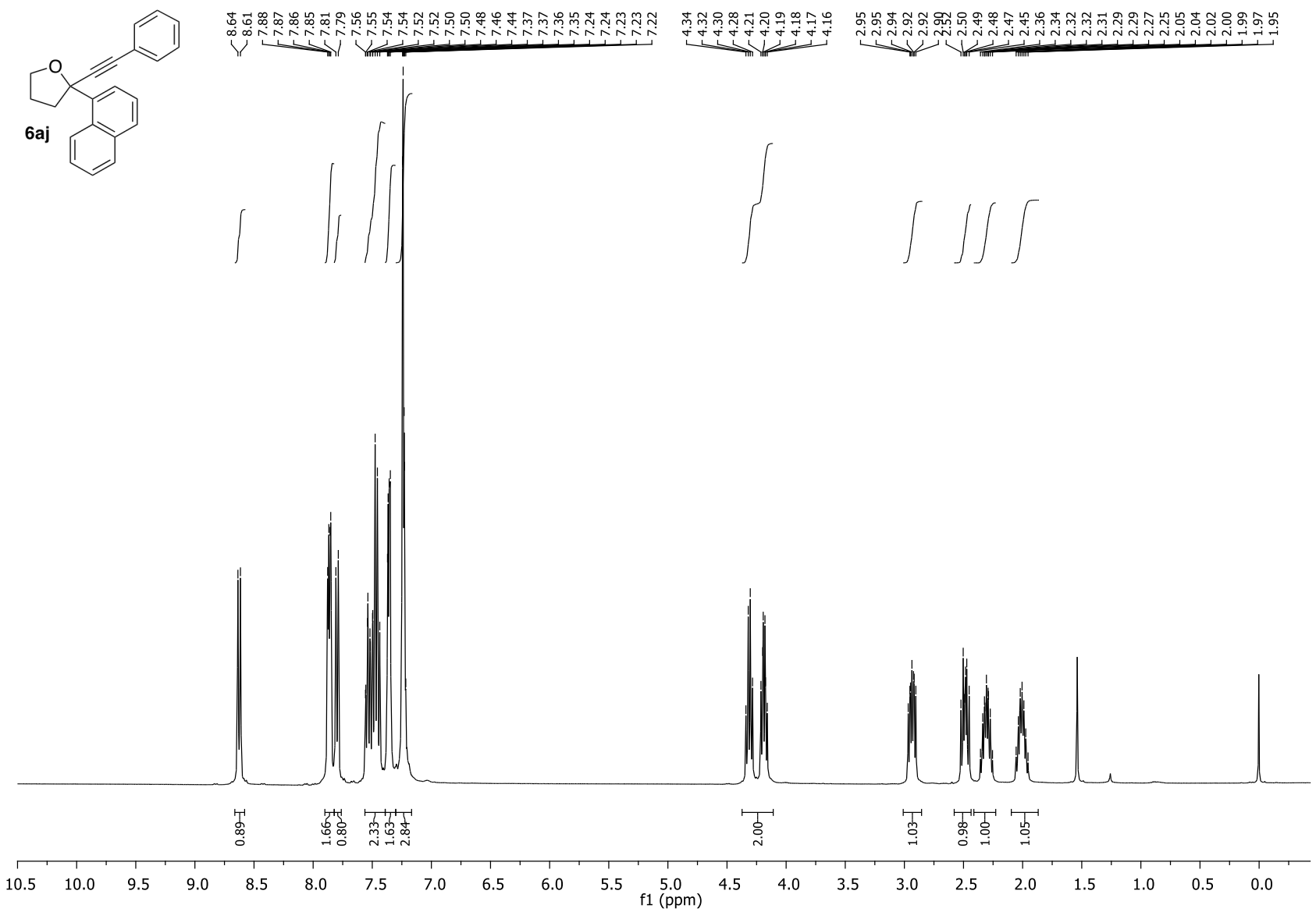
131.59
128.11
127.80
127.40
125.61
124.51
122.95
91.09
84.05
79.78
67.49
40.36
25.70
21.08
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


6aj
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8.61
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7.86
7.85
7.81
7.79
7.56
7.55
7.54
7.54
7.52
7.52
7.50
7.50
7.48
7.46
7.44
7.37
7.37
7.36
7.35
7.24
7.24
7.23
7.23
7.22
4.34
4.32
4.30
4.28
4.21
4.20
4.19
4.18
4.17
4.16
2.95
2.95
2.94
2.92
2.92
2.90
2.52
2.50
2.49
2.48
2.47
2.45
2.36
2.34
2.32
2.32
2.31
2.29
2.29
2.27
2.25
2.05
2.04
2.02
2.00
1.99
1.97
1.95
0.89
1.66
0.80
2.33
1.63
2.84
2.00
1.03
0.98
1.00
1.05
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
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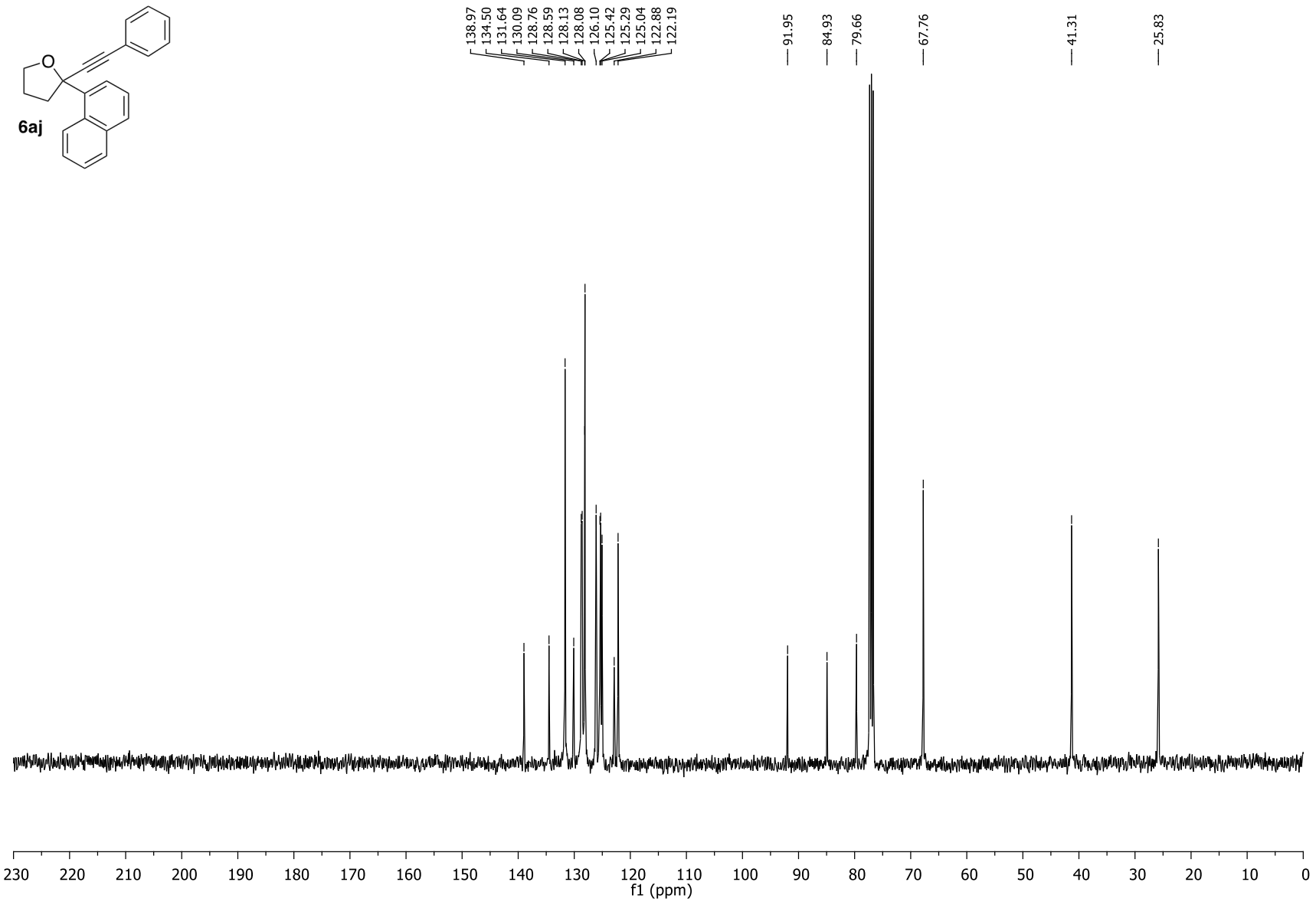
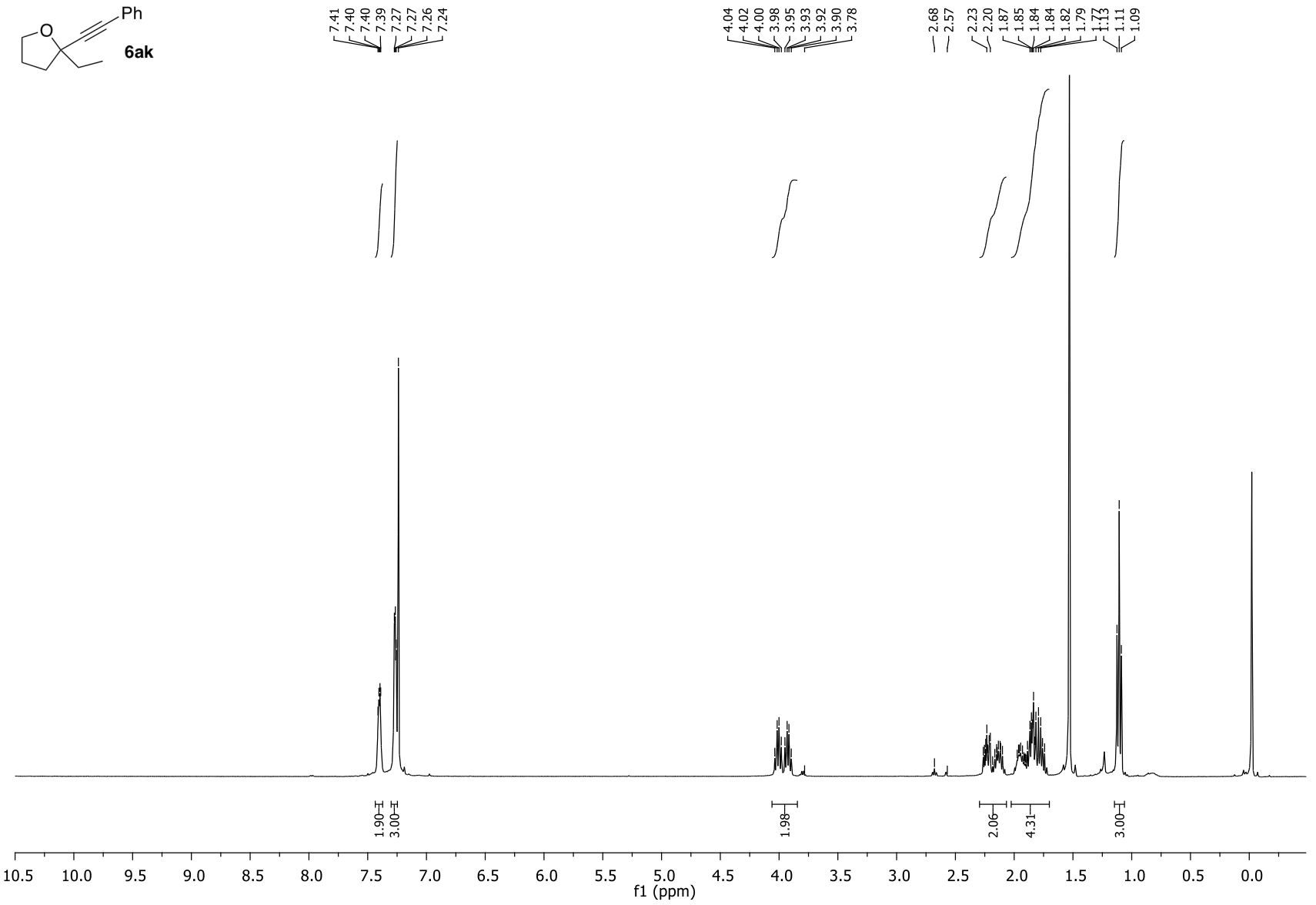
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


6aj
O
138.97
134.50
131.64
130.09
128.76
128.59
128.13
128.08
126.10
125.42
125.29
125.04
122.88
122.19
91.95
84.93
79.66
67.76
41.31
25.83
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


Ph
O
6ak
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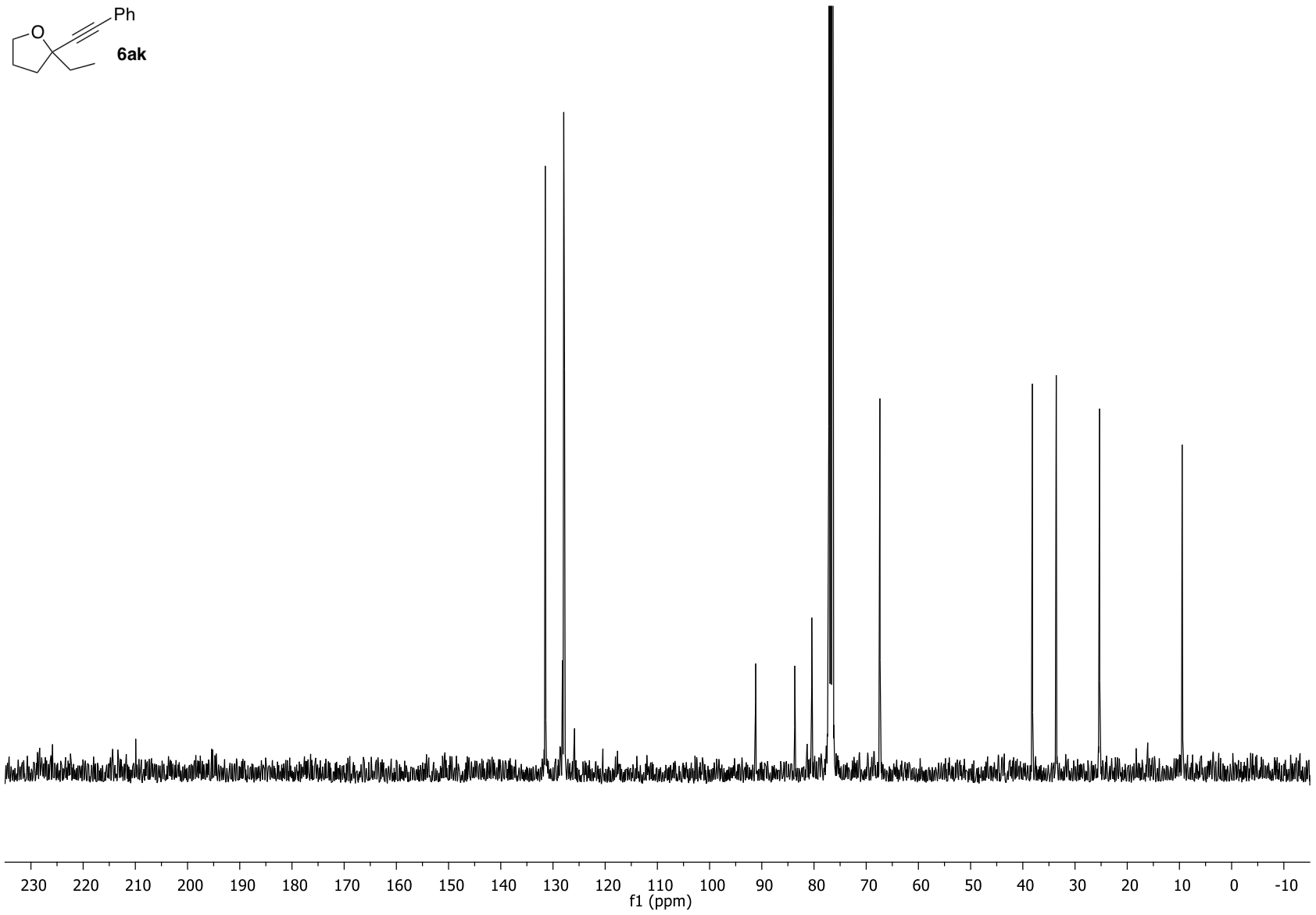
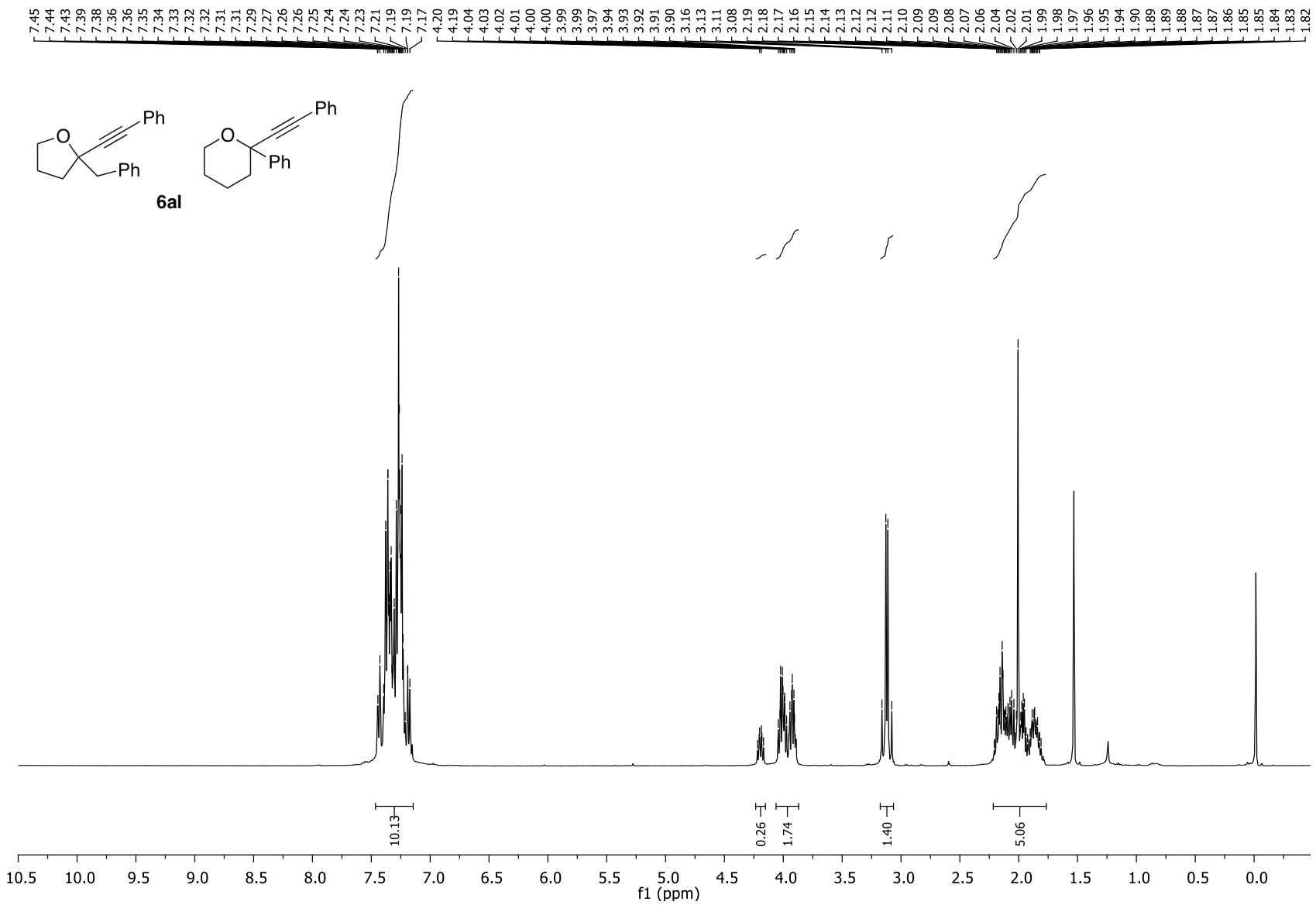
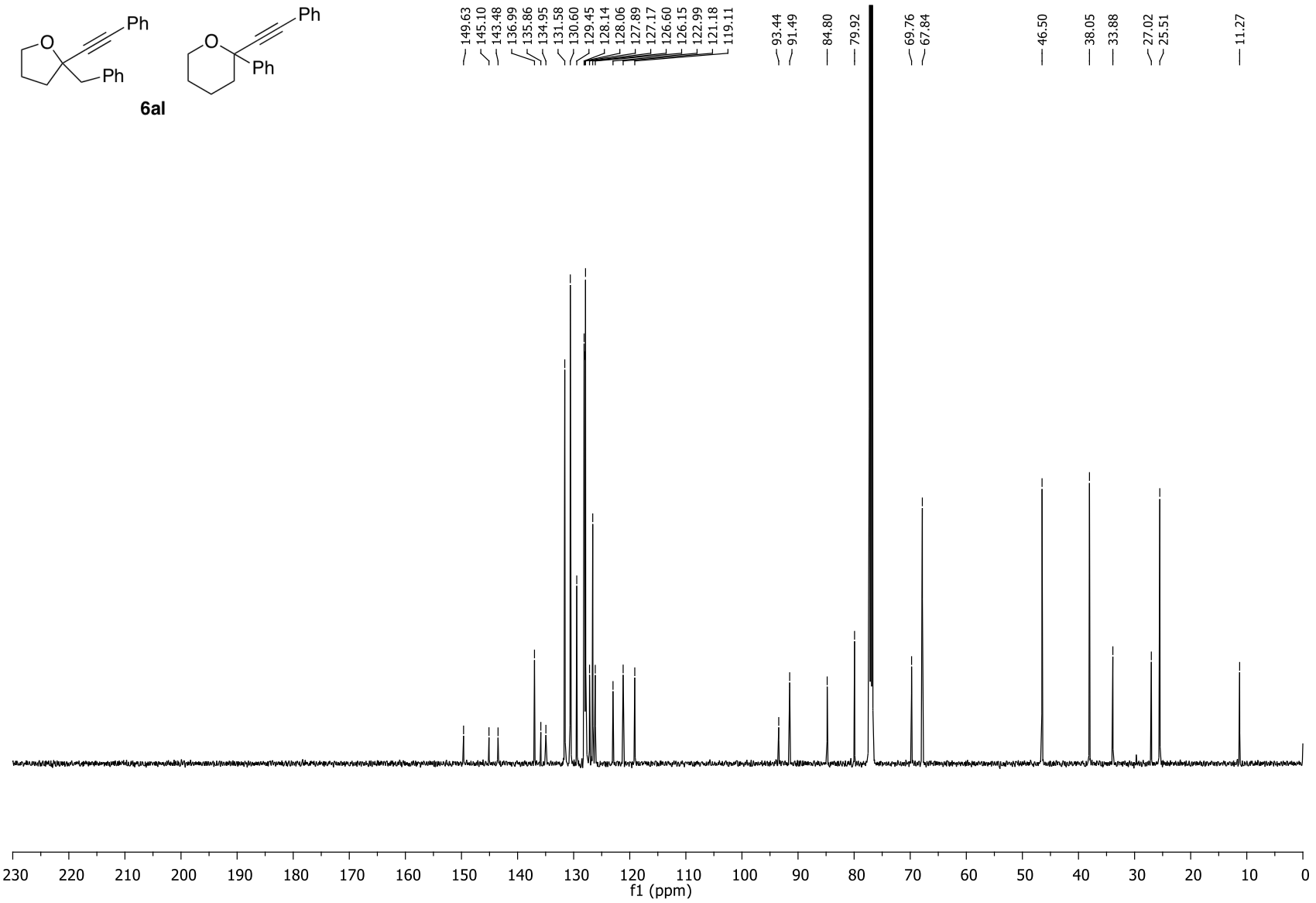
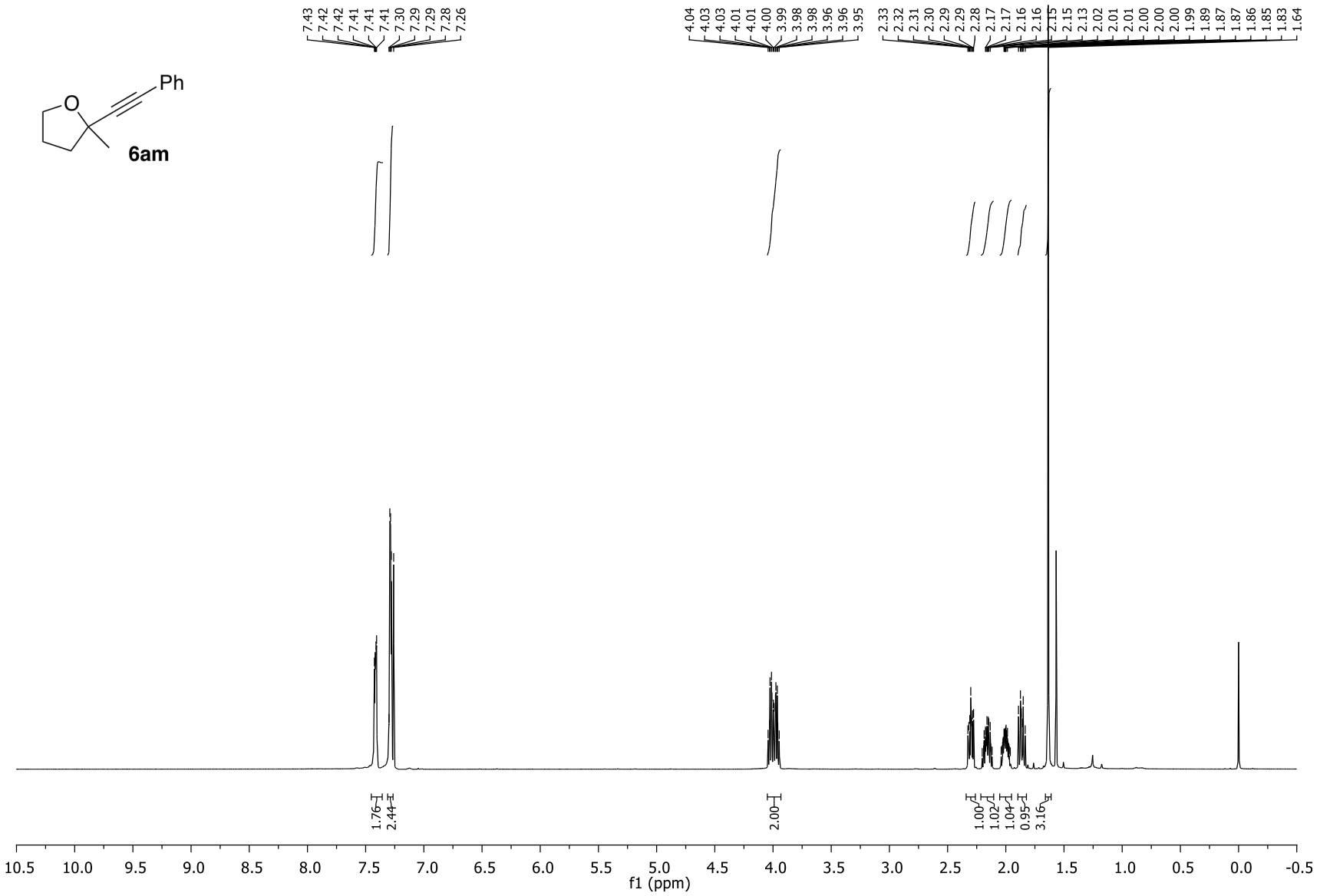
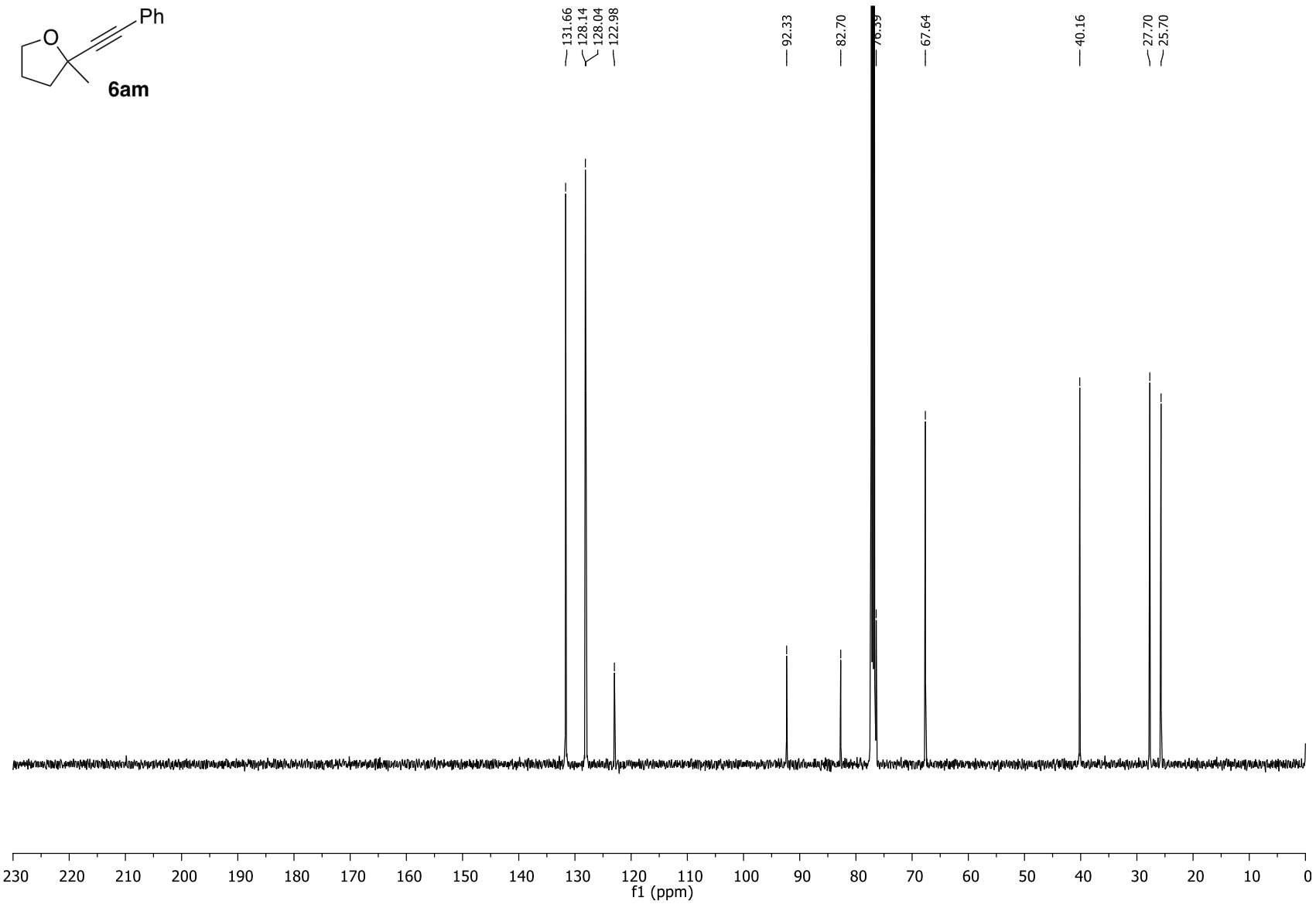
7.40
7.39
7.27
7.27
7.26
7.24
4.04
4.02
4.00
3.98
3.95
3.93
3.92
3.90
3.78
2.68
2.57
2.23
2.20
1.87
1.85
1.84
1.84
1.82
1.79
1.77
1.73
1.11
1.09
1.90
3.00
1.98
2.06
4.31
3.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

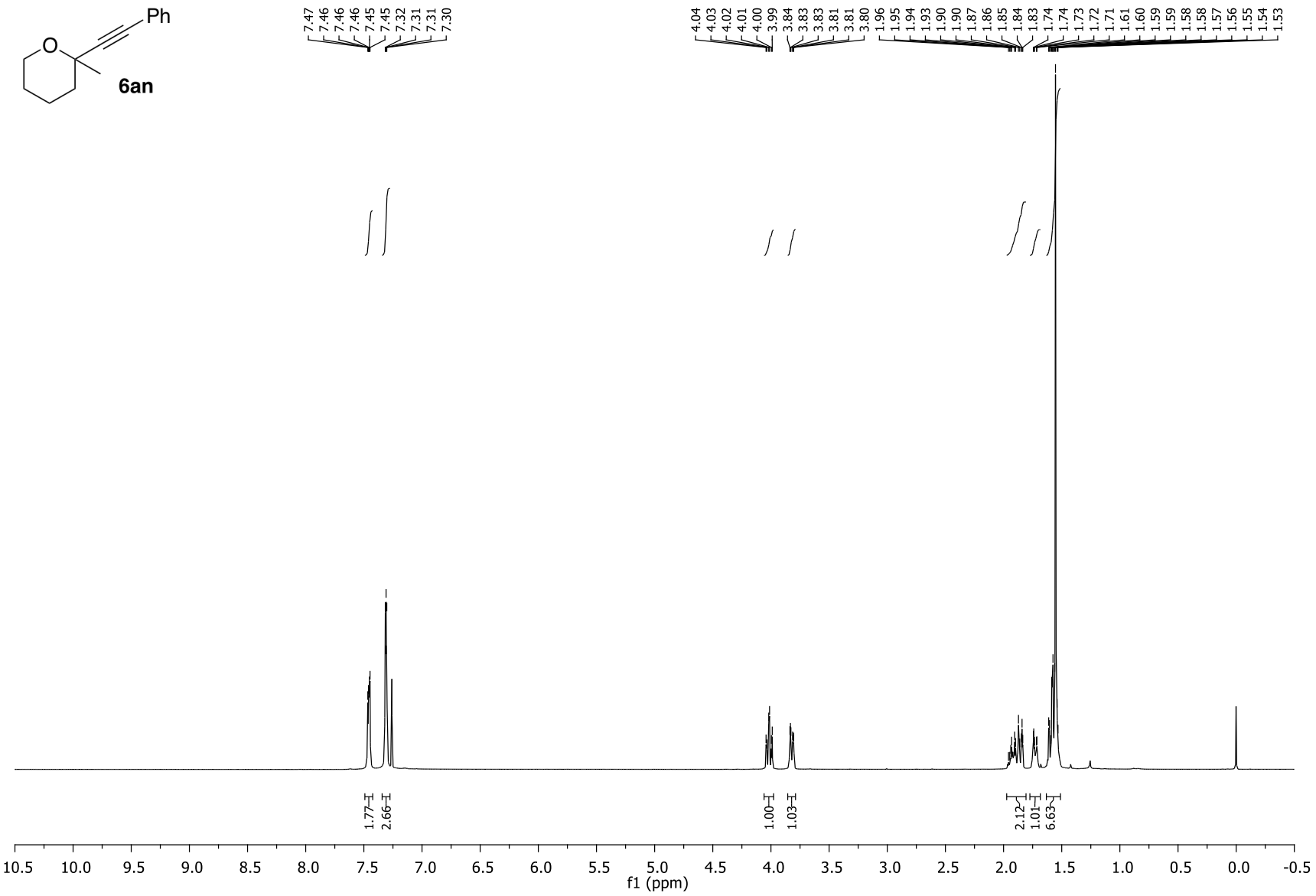

Ph
O
6ak
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

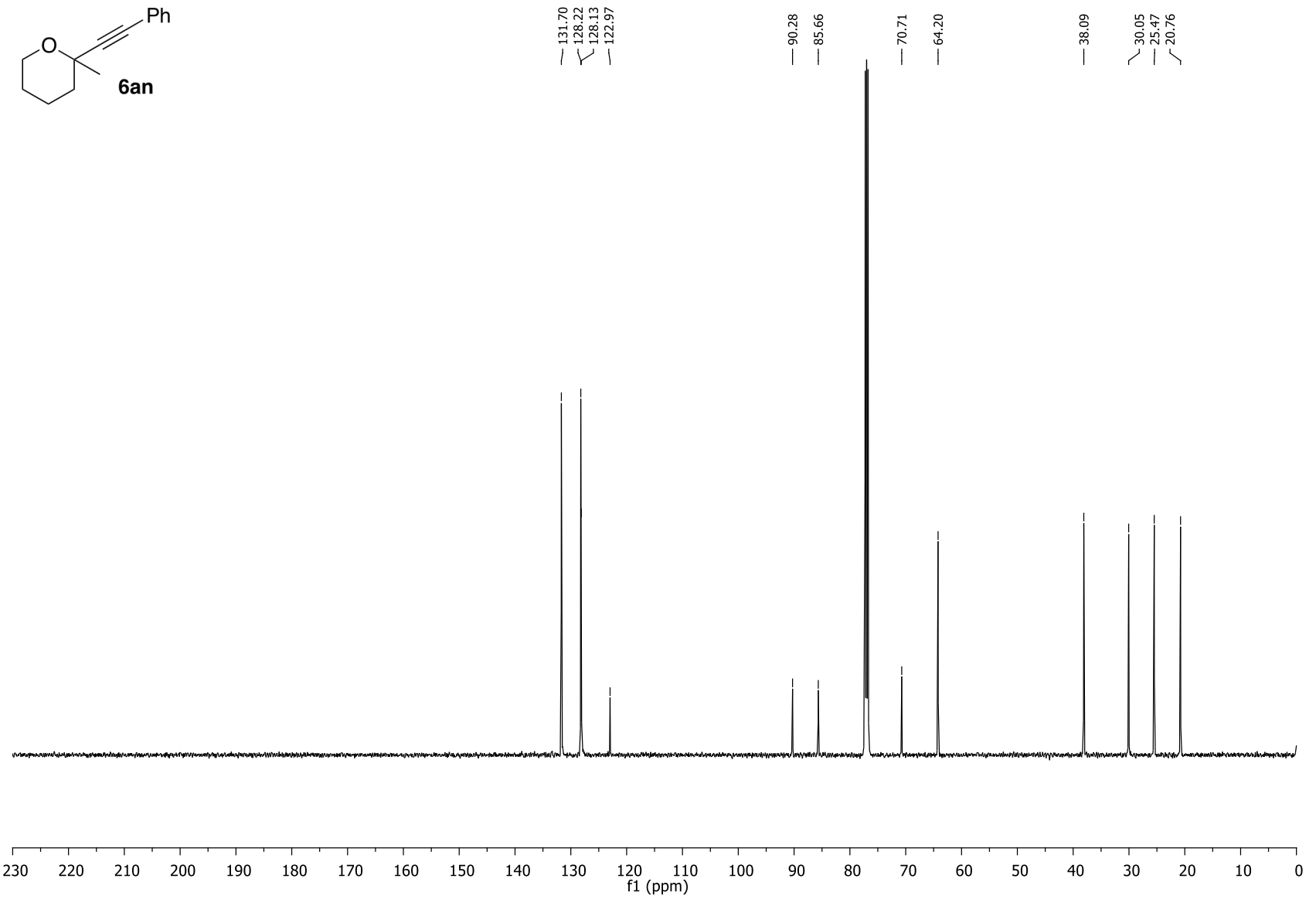

7.45 7.44 7.43 7.39 7.38 7.36 7.36 7.35 7.34 7.33 7.32 7.32 7.31 7.31 7.29 7.27 7.26 7.25 7.24 7.24 7.23 7.21 7.19 7.19 7.17
4.20 4.19 4.04 4.03 4.02 4.01 4.00 4.00 3.99 3.99 3.97 3.94 3.93 3.92 3.91 3.90 3.16 3.13 3.11 3.08 2.19 2.18 2.17 2.16 2.15 2.14 2.13 2.12 2.12 2.11 2.10 2.09 2.09 2.08 2.07 2.06 2.04 2.02 2.01 1.99 1.98 1.97 1.96 1.95 1.94 1.90 1.89 1.89 1.88 1.87 1.87 1.86 1.85 1.85 1.84 1.83 1.82
Ph
O
Ph
Ph
O
Ph
6al
10.13
0.26
1.74
1.40
5.06
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

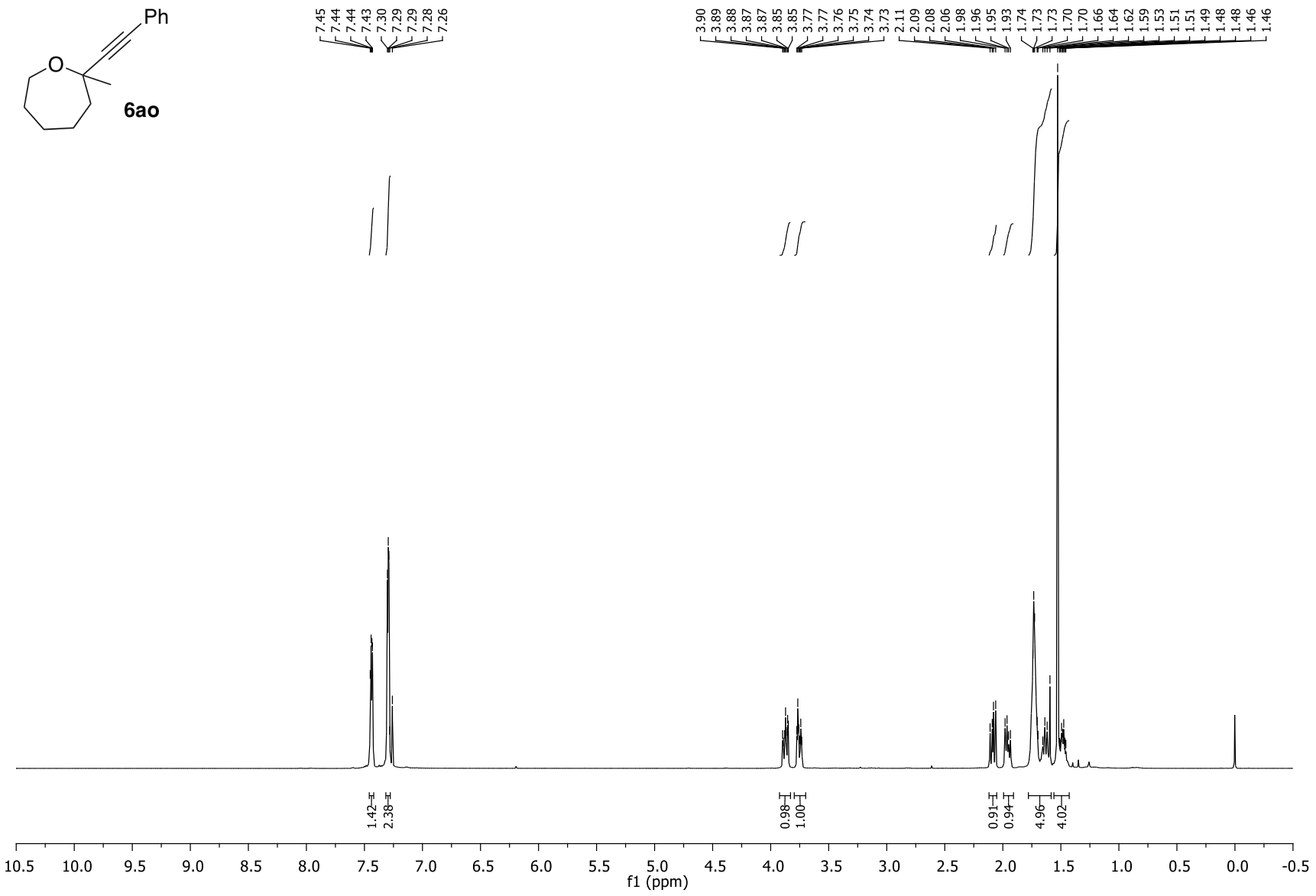

Ph
O
Ph
Ph
O
Ph
6al
149.63
145.10
143.48
136.99
135.86
134.95
131.58
130.60
129.45
128.14
128.06
127.89
127.17
126.60
126.15
122.99
121.18
119.11
93.44
91.49
84.80
79.92
69.76
67.84
46.50
38.05
33.88
27.02
25.51
11.27
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


Ph
O
6am
7.43 7.42 7.42 7.41 7.41 7.41 7.30 7.29 7.29 7.28 7.26
4.04 4.03 4.03 4.01 4.01 4.00 3.99 3.98 3.98 3.96 3.96 3.95
2.33 2.32 2.31 2.30 2.29 2.29 2.28 2.17 2.17 2.16 2.16 2.15 2.15 2.13 2.02 2.01 2.01 2.00 2.00 2.00 1.99 1.89 1.87 1.87 1.86 1.85 1.83 1.64
1.76
2.44
2.00
1.00
1.02
1.04
0.95
3.16
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


Ph
O
6am
131.66
128.14
128.04
122.98
92.33
82.70
76.39
67.64
40.16
27.70
25.70
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


Ph
O
6an
7.47
7.46
7.46
7.46
7.45
7.45
7.32
7.31
7.30
4.04
4.03
4.02
4.01
4.00
3.99
3.84
3.83
3.83
3.81
3.81
3.80
1.96
1.95
1.94
1.93
1.90
1.90
1.87
1.86
1.85
1.84
1.83
1.74
1.74
1.73
1.72
1.71
1.61
1.60
1.59
1.59
1.58
1.58
1.57
1.56
1.55
1.54
1.53
1.77
2.66
1.00
1.03
2.12
1.01
6.63
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


Ph
O
6an
131.70
128.22
128.13
122.97
90.28
85.66
70.71
64.20
38.09
30.05
25.47
20.76
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


Ph
O
6ao
7.45
7.44
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7.43
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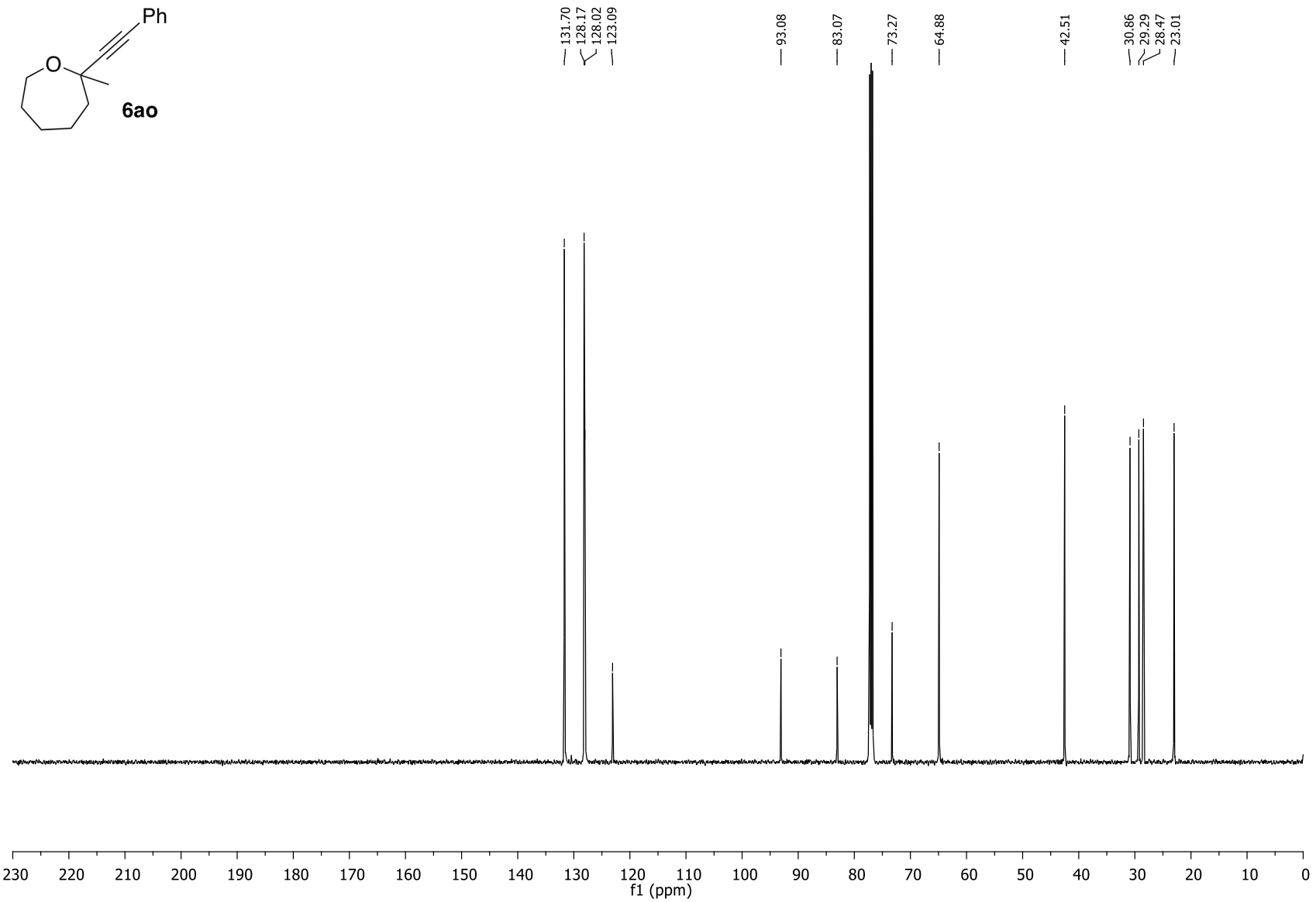
7.29
7.29
7.28
7.26
3.90
3.89
3.88
3.87
3.87
3.85
3.85
3.77
3.77
3.76
3.75
3.74
3.73
2.11
2.09
2.08
2.06
1.98
1.96
1.95
1.93
1.74
1.73
1.73
1.70
1.70
1.66
1.64
1.62
1.59
1.53
1.51
1.51
1.49
1.48
1.48
1.46
1.46
1.42
2.38
0.98
1.00
0.91
0.94
4.96
4.02
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


Ph
O
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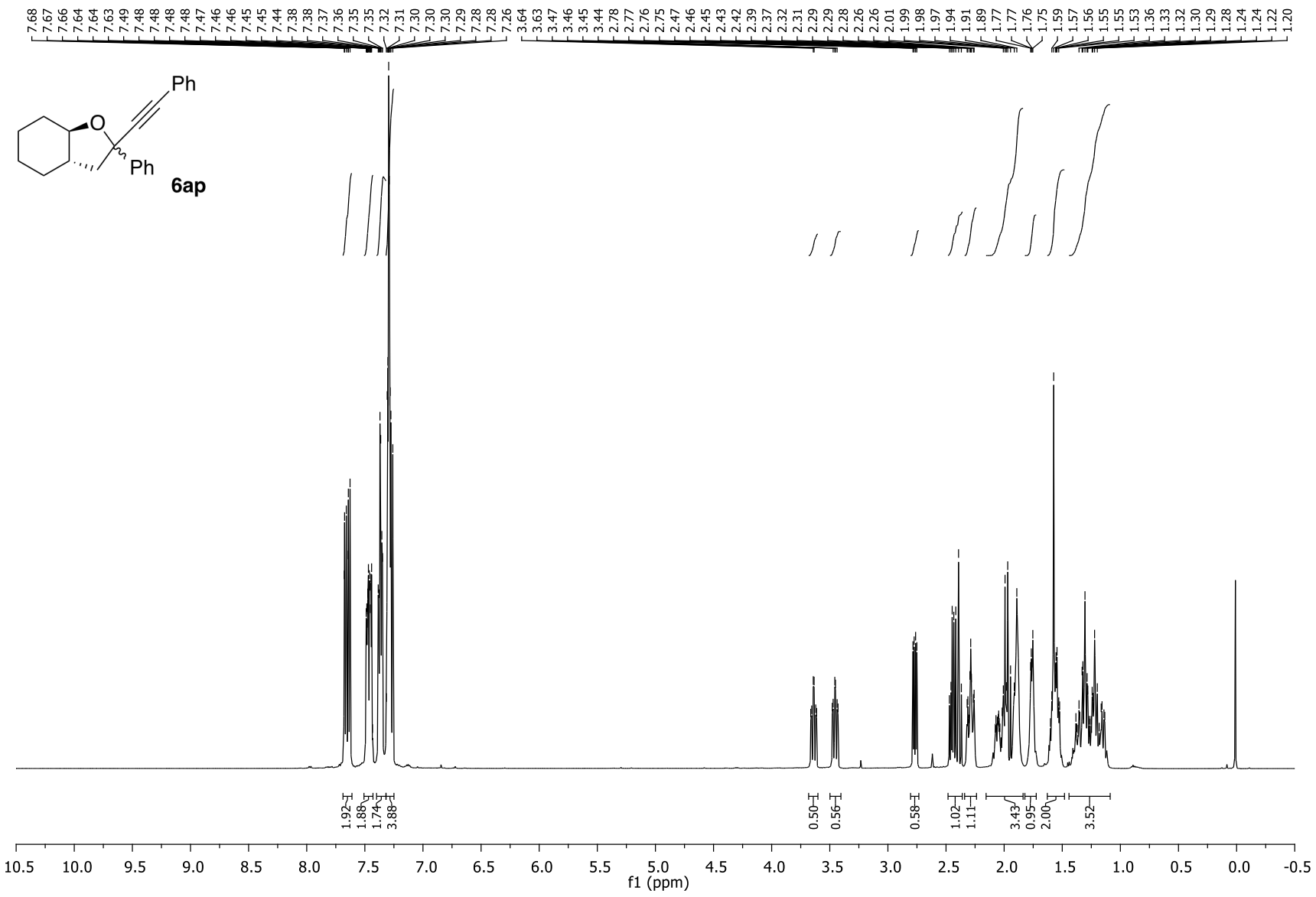
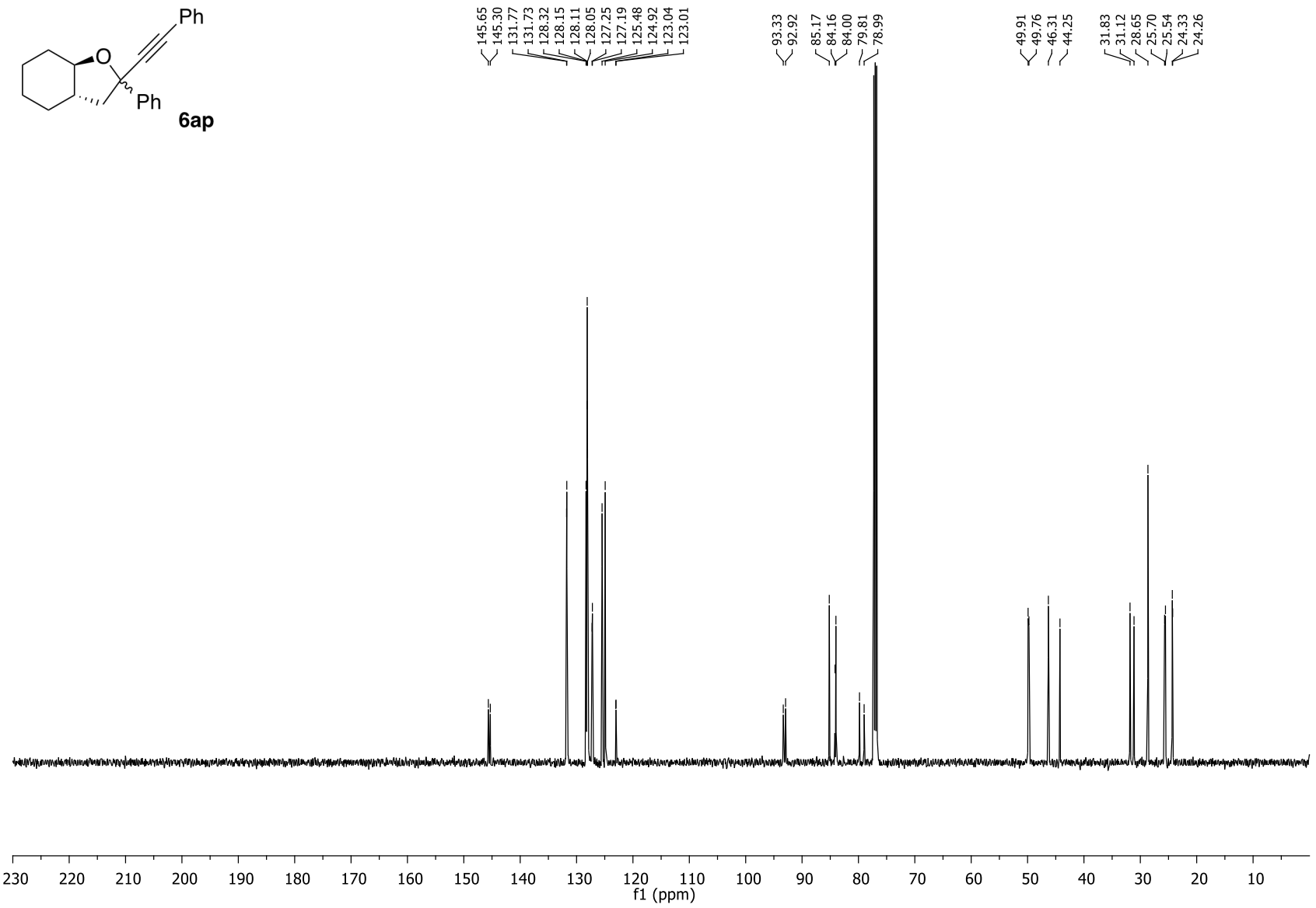
128.17
128.02
123.09
93.08
83.07
73.27
64.88
42.51
30.86
29.29
28.47
23.01
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


Ph
O
Ph
6ap
f1 (ppm)


Ph
O
Ph
6ap
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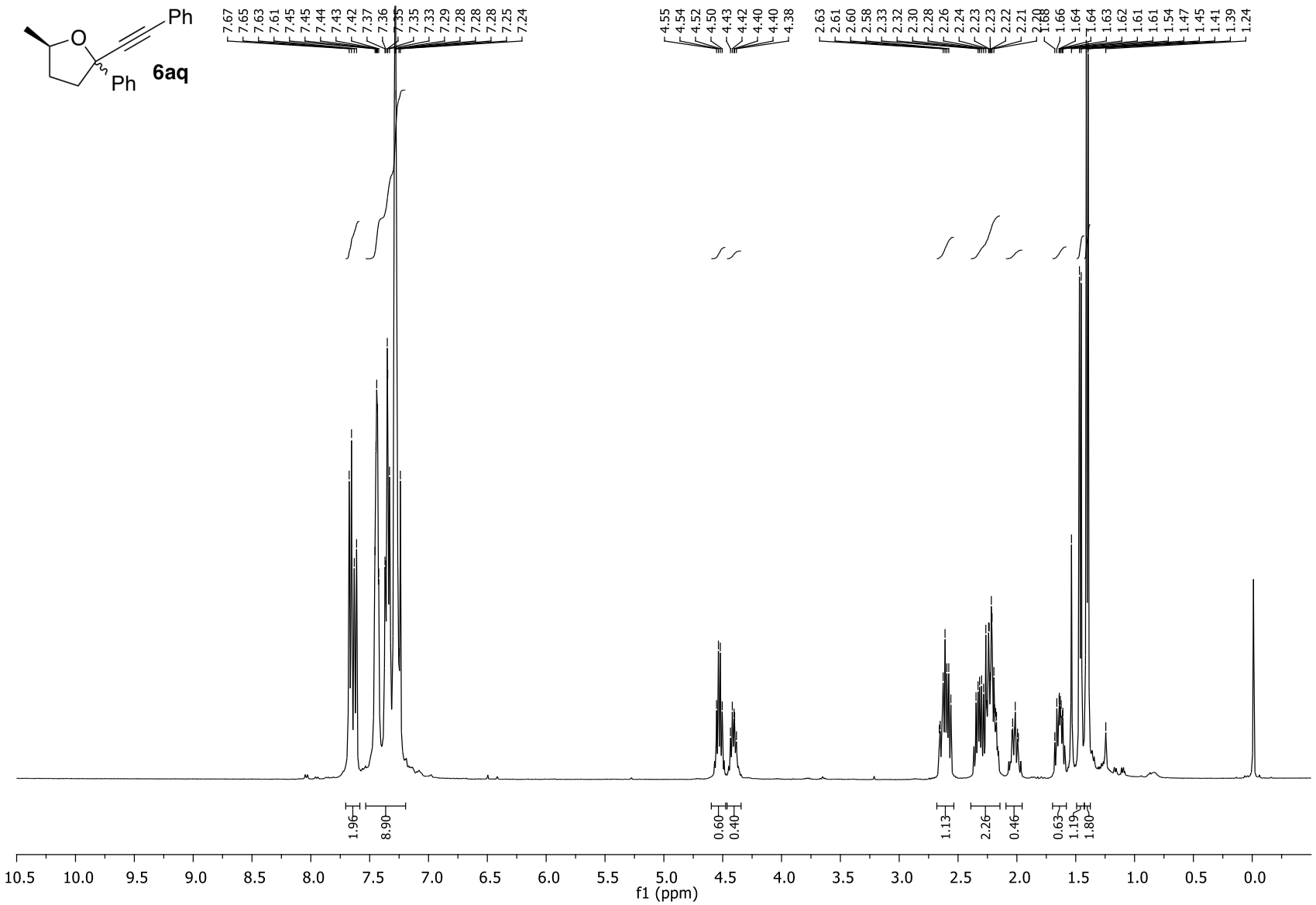
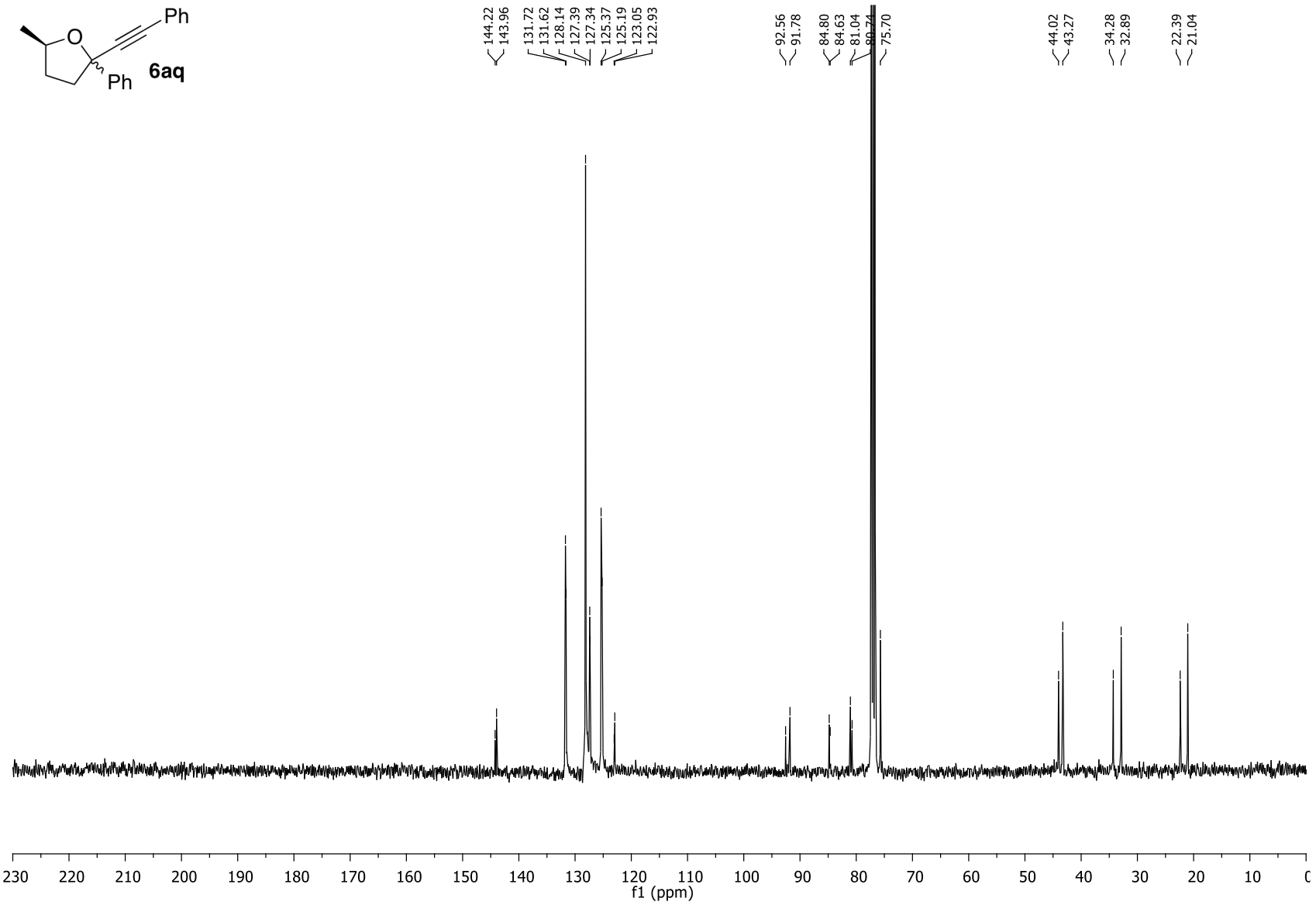
145.30
131.77
131.73
128.32
128.15
128.11
128.05
127.25
127.19
125.48
124.92
123.04
123.01
93.33
92.92
85.17
84.16
84.00
79.81
78.99
49.91
49.76
46.31
44.25
31.83
31.12
28.65
25.70
25.54
24.33
24.26
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


Ph
O
Ph
6aq
7.67 7.65 7.63 7.61 7.45 7.45 7.44 7.43 7.42 7.37 7.36 7.35 7.35 7.33 7.29 7.28 7.28 7.28 7.25 7.24
4.55 4.54 4.52 4.50 4.43 4.42 4.40 4.40 4.38
2.63 2.61 2.60 2.58 2.33 2.32 2.30 2.28 2.26 2.24 2.23 2.23 2.22 2.21 1.68 1.66 1.64 1.64 1.63 1.62 1.61 1.61 1.54 1.47 1.45 1.41 1.39 1.24
1.96 8.90 0.60 0.40 1.13 2.26 0.46 0.63 1.19 1.80
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


Ph
O
Ph
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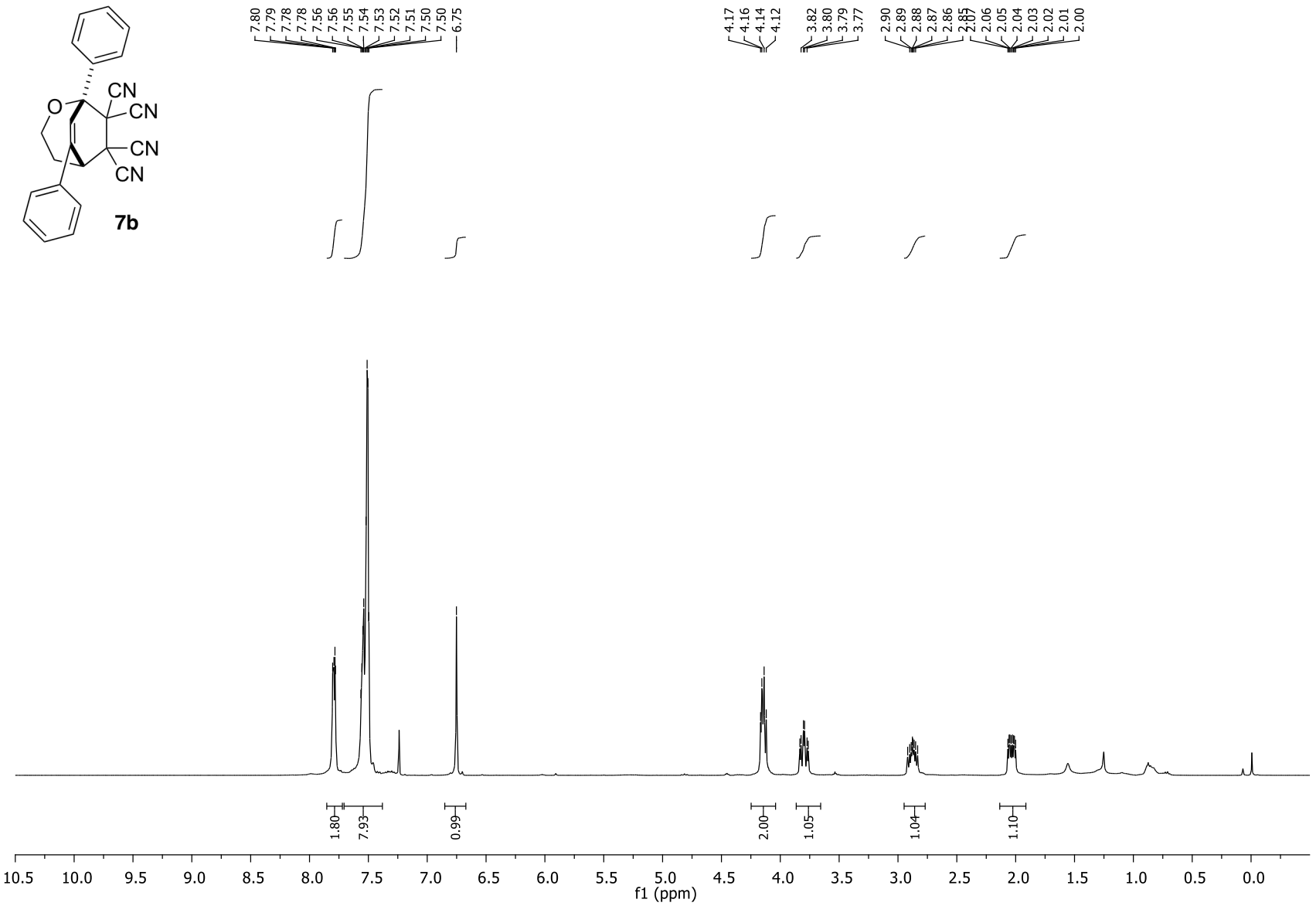
127.39
127.34
125.37
125.19
123.05
122.93
92.56
91.78
84.80
84.63
81.04
80.24
75.70
44.02
43.27
34.28
32.89
22.39
21.04
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.80
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7.56
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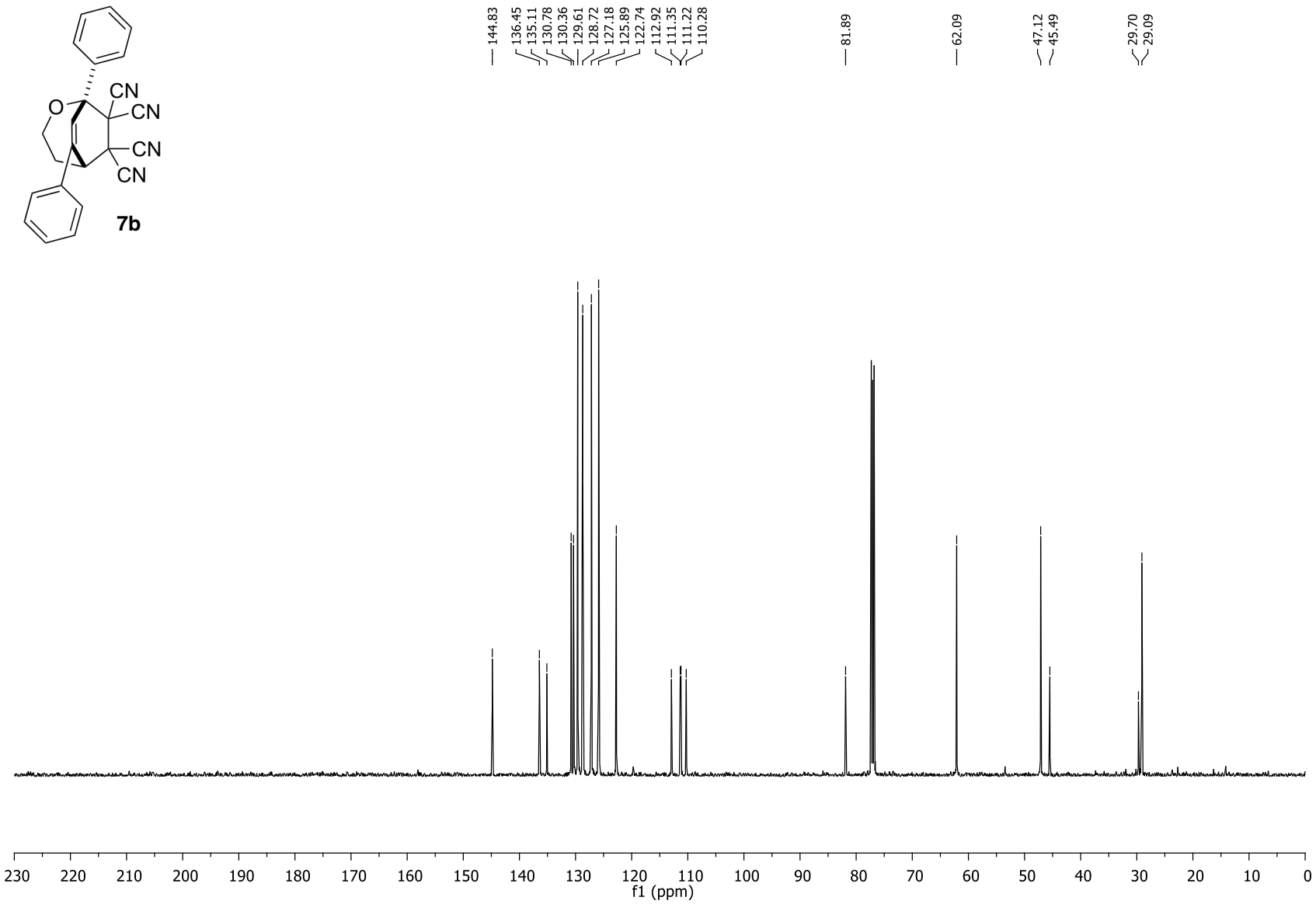
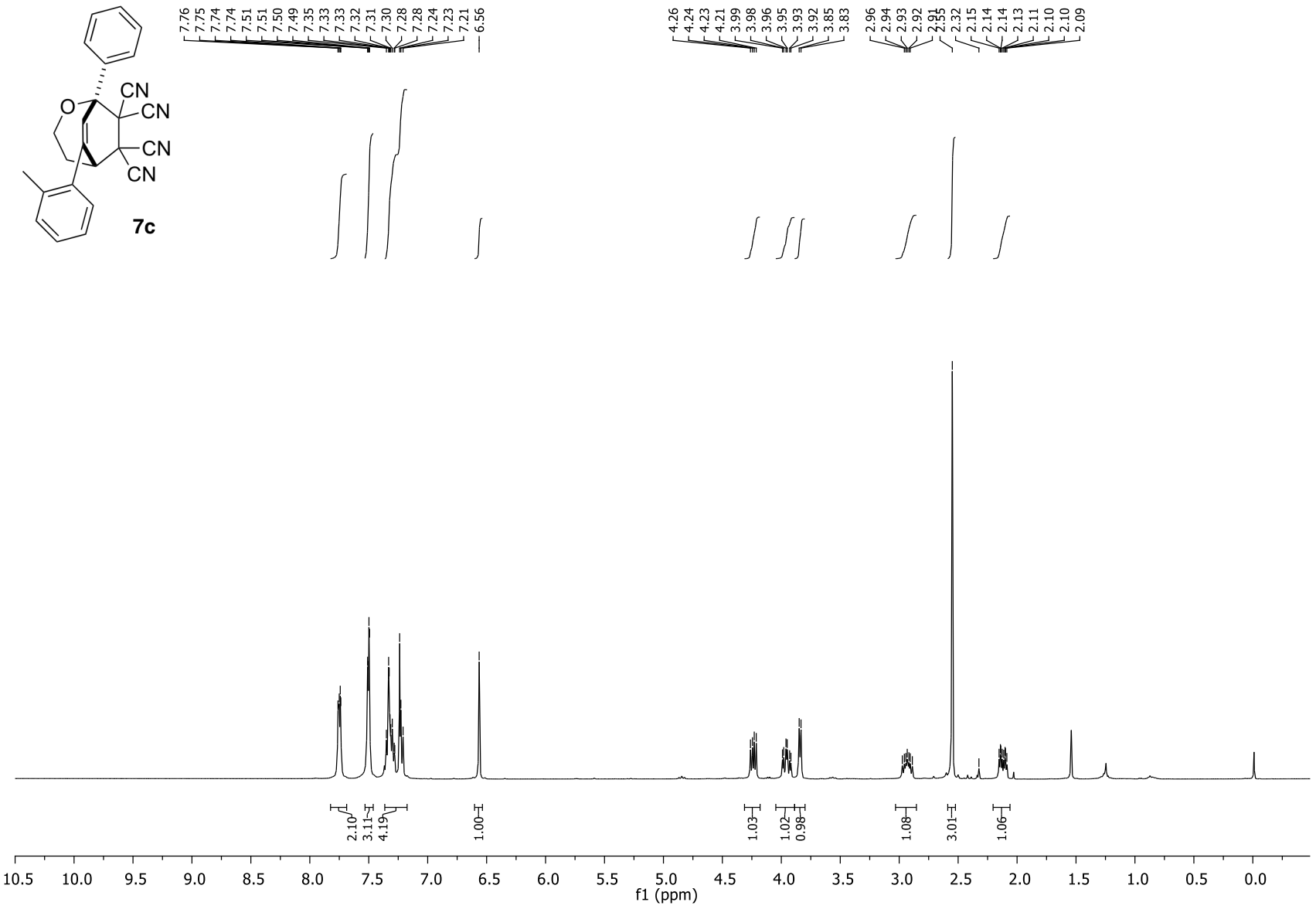
7.54
7.53
7.52
7.51
7.50
7.50
6.75
4.17
4.16
4.14
4.12
3.82
3.80
3.79
3.77
2.90
2.89
2.88
2.87
2.86
2.85
2.07
2.06
2.05
2.04
2.03
2.02
2.01
2.00
CN
CN
CN
CN
O
7b
1.80
7.93
0.99
2.00
1.05
1.04
1.10
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


CN
CN
CN
CN
O
7b
144.83
136.45
135.11
130.78
130.36
129.61
128.72
127.18
125.89
122.74
112.92
111.35
111.22
110.28
81.89
62.09
47.12
45.49
29.70
29.09
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.76
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7.74
7.51
7.51
7.50
7.49
7.35
7.33
7.33
7.32
7.31
7.30
7.28
7.28
7.24
7.23
7.21
6.56
4.26
4.24
4.23
4.21
3.99
3.98
3.96
3.95
3.93
3.92
3.85
3.83
2.96
2.94
2.93
2.92
2.91
2.55
2.32
2.15
2.14
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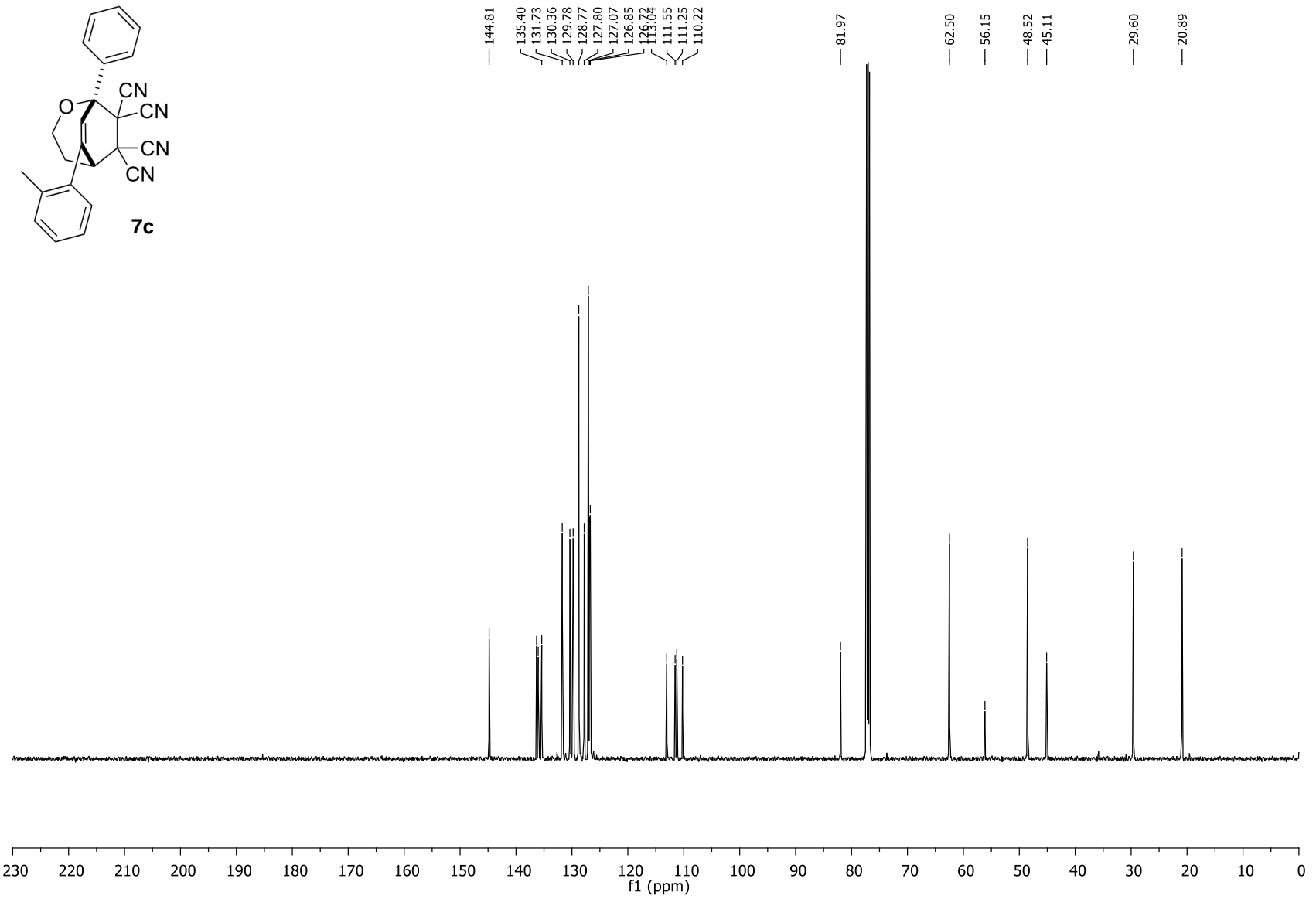
2.13
2.11
2.10
2.10
2.09
CN
CN
CN
CN
O
7c
2.10
3.11
4.19
1.00
1.03
1.02
0.98
1.08
3.01
1.06
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


CN
CN
CN
CN
O
7c
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135.40
131.73
130.36
129.78
128.77
127.80
127.07
126.85
113.04
111.55
111.25
110.22
81.97
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20.89
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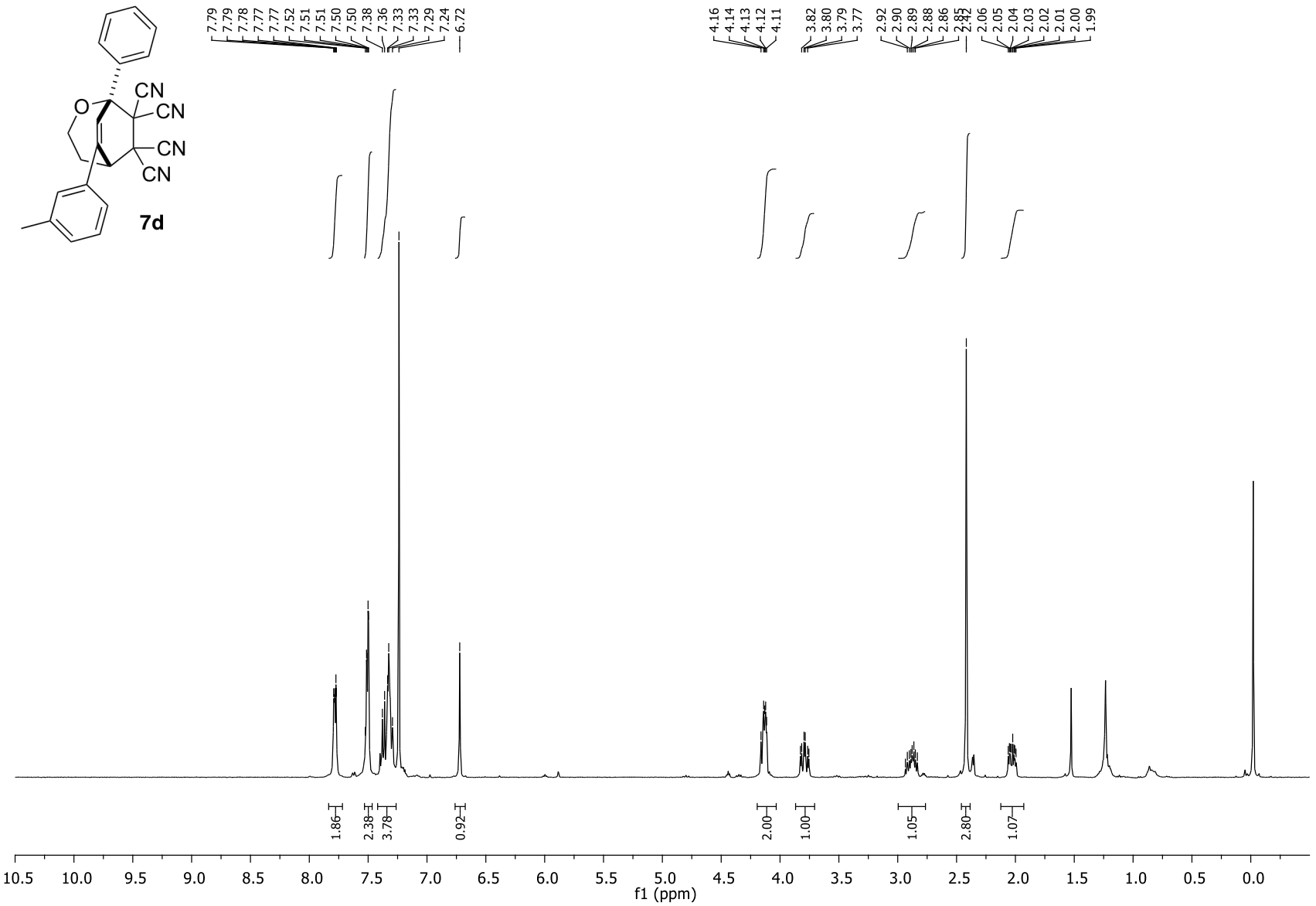
f1 (ppm)


7d
CN
CN
CN
CN
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7.50
7.50
7.38
7.36
7.33
7.33
7.29
7.24
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4.16
4.14
4.13
4.12
4.11
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3.80
3.79
3.77
2.92
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2.89
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2.05
2.04
2.03
2.02
2.01
2.00
1.99
1.86
2.38
3.78
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2.00
1.00
1.05
2.80
1.07
10.5
10.0
9.5
9.0
8.5
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7.0
6.5
6.0
5.5
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2.5
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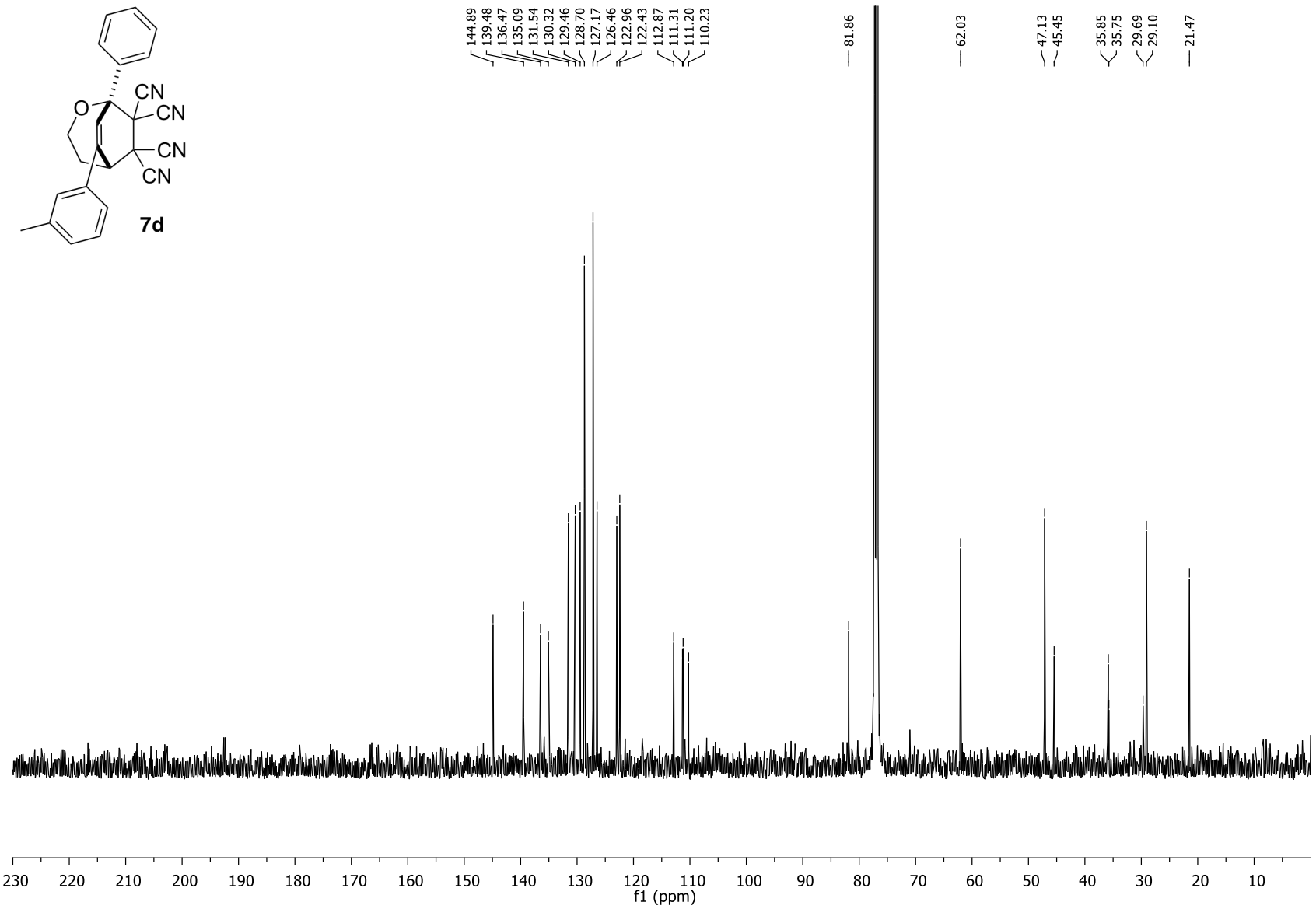
f1 (ppm)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122.43
112.87
111.31
111.20
110.23
81.86
62.03
47.13
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29.69
29.10
21.47
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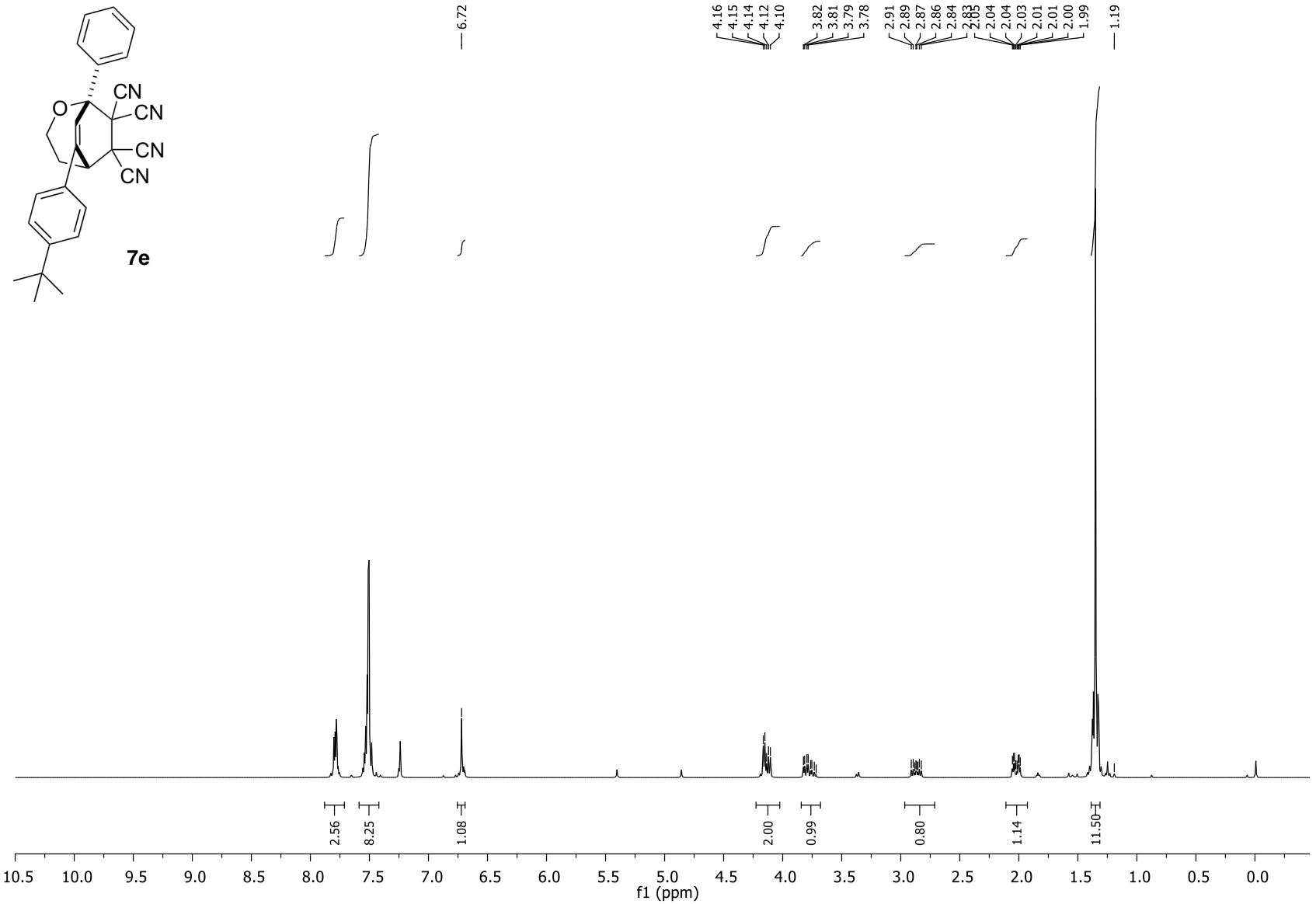
f1 (ppm)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CN
CN
O
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4.16
4.15
4.14
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4.10
3.82
3.81
3.79
3.78
2.91
2.89
2.87
2.86
2.84
2.04
2.04
2.03
2.01
2.01
2.00
1.99
1.19
2.56
8.25
1.08
2.00
0.99
0.80
1.14
11.50
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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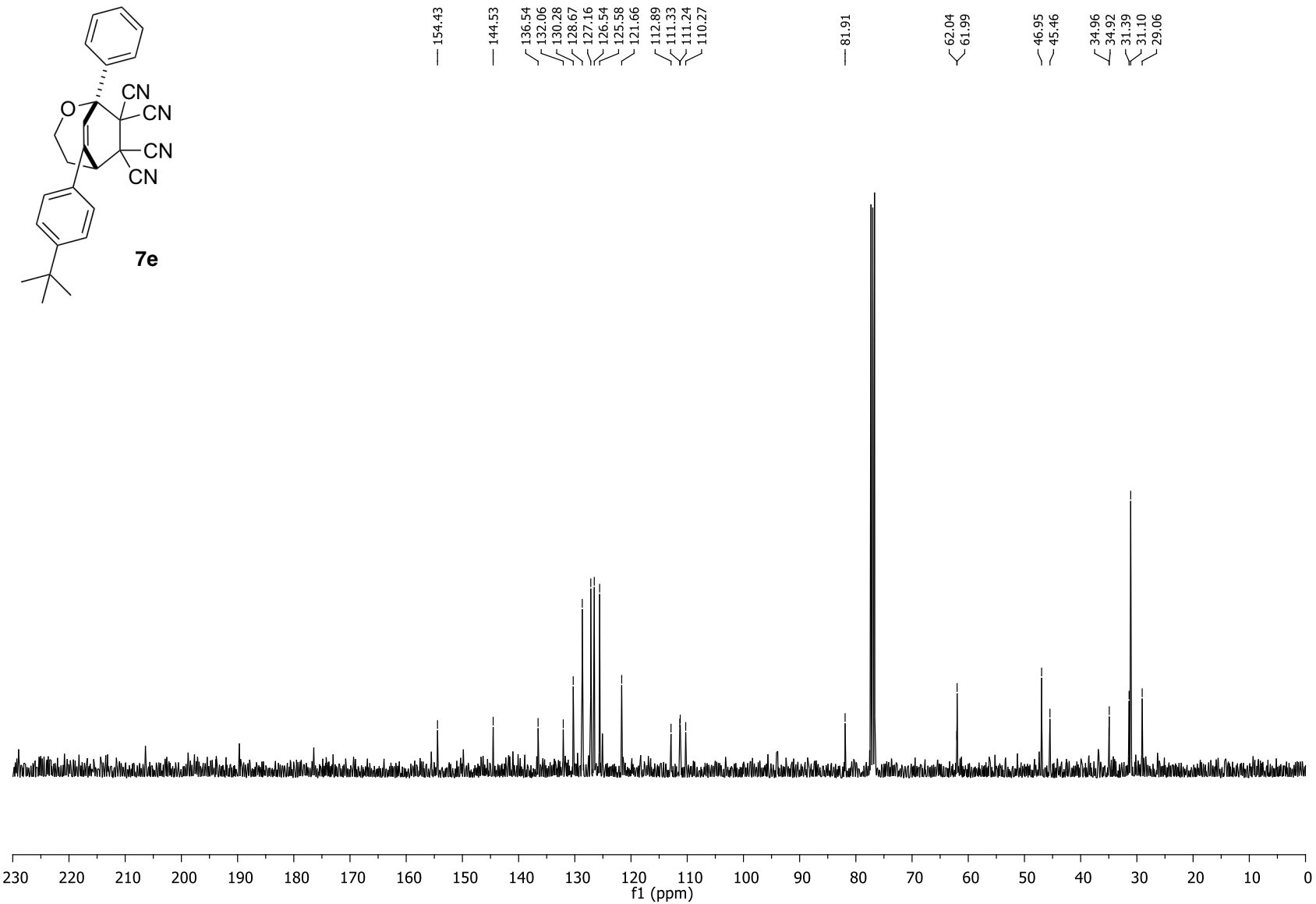
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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CN
CN
O
7e
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144.53
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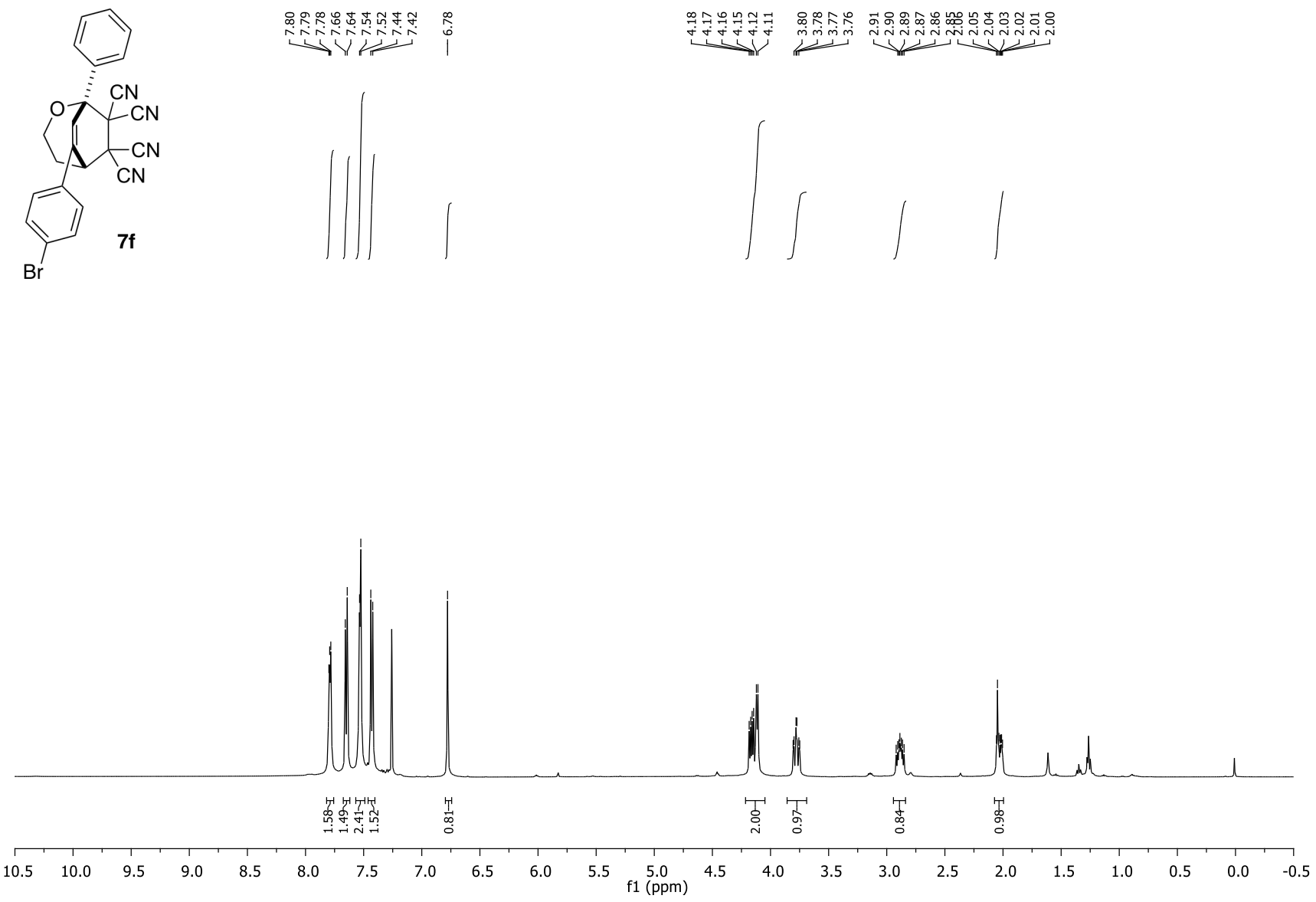
125.58
121.66
112.89
111.33
111.24
110.27
81.91
62.04
61.99
46.95
45.46
34.96
34.92
31.39
31.10
29.06
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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4.17
4.16
4.15
4.12
4.11
3.80
3.78
3.77
3.76
2.91
2.90
2.89
2.87
2.86
2.05
2.04
2.03
2.02
2.01
2.00
CN
CN
CN
CN
O
Br
7f
1.58
1.49
2.41
1.52
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2.00
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0.84
0.98
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9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
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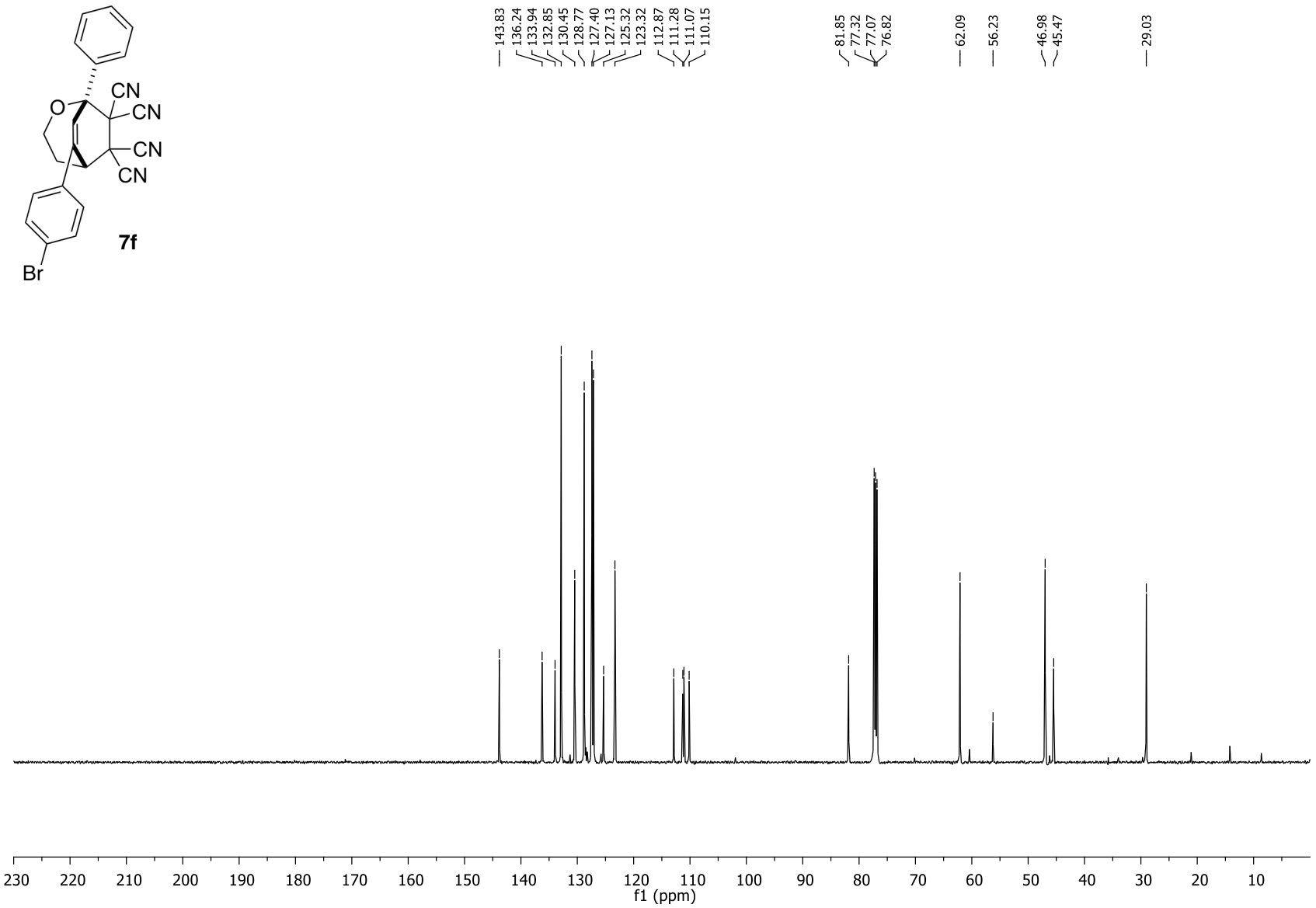
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)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127.13
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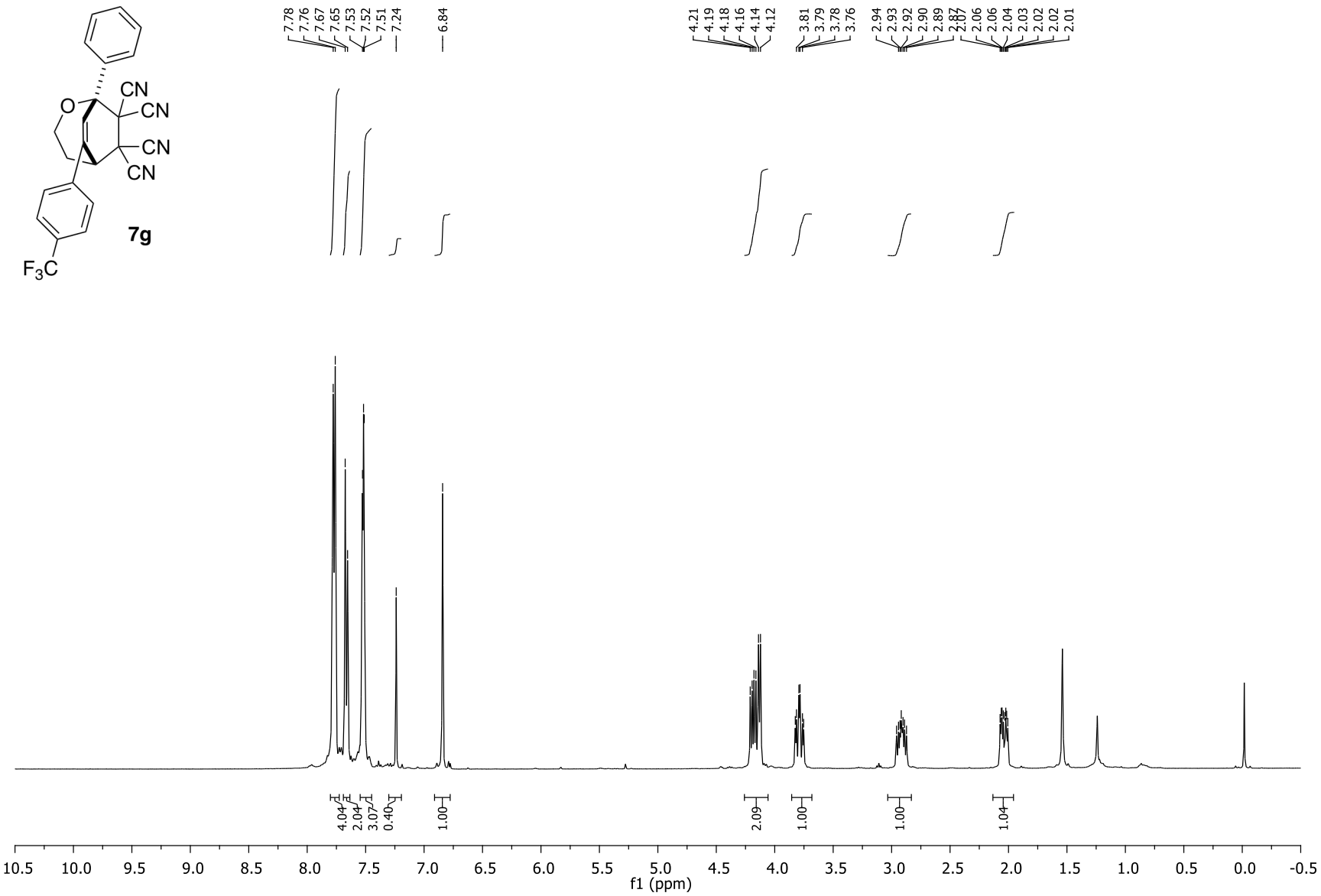
123.32
112.87
111.28
111.07
110.15
81.85
77.32
77.07
76.82
62.09
56.23
46.98
45.47
29.03
CN
CN
CN
CN
O
Br
7f
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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7.53
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7.51
7.24
6.84
4.21
4.19
4.18
4.16
4.14
4.12
3.81
3.79
3.78
3.76
2.94
2.93
2.92
2.90
2.89
2.06
2.06
2.04
2.03
2.02
2.02
2.01
CN
CN
CN
CN
O
7g
F3C
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2.04
3.07
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1.00
1.00
1.04
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8.0
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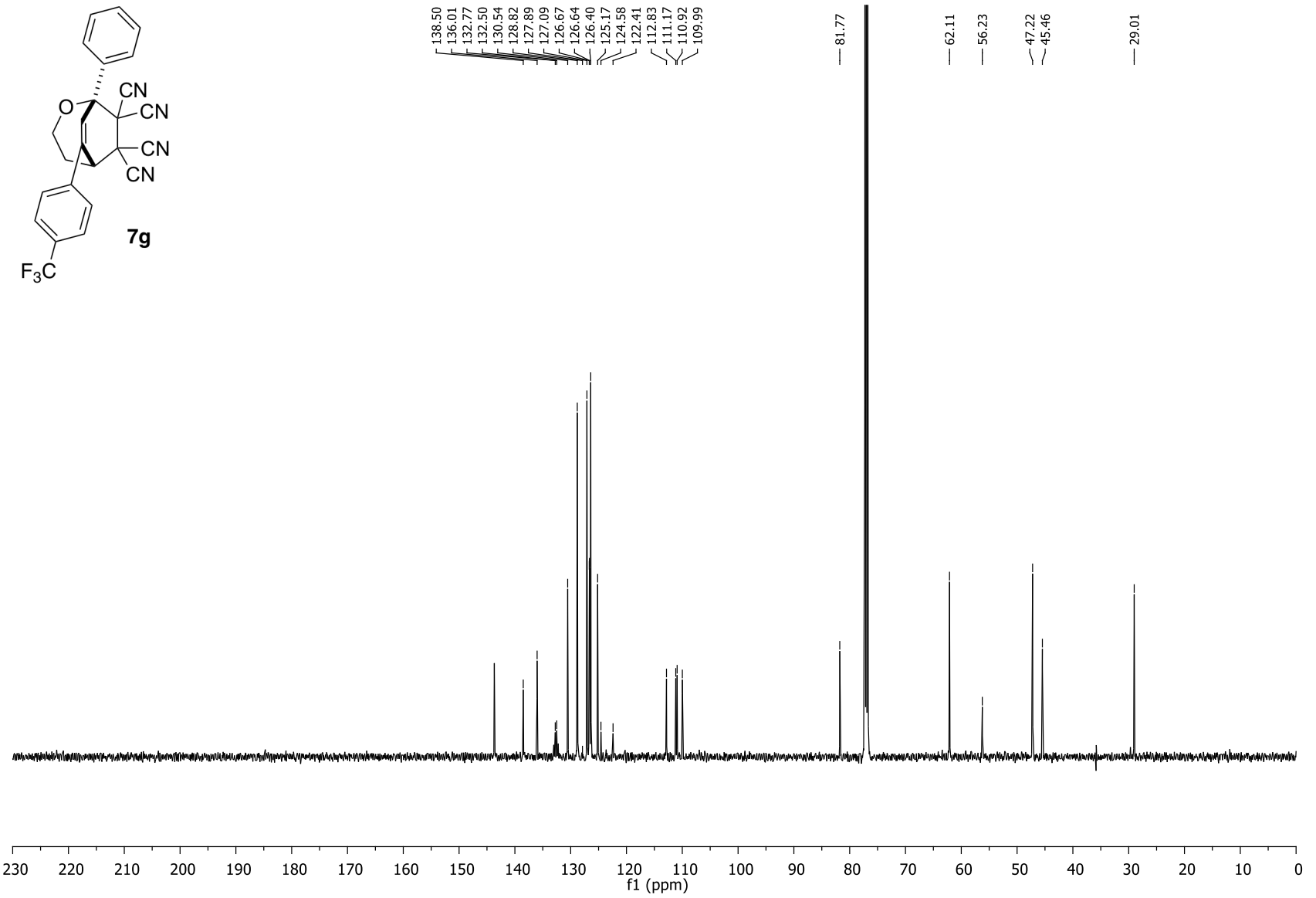
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


CN
CN
CN
CN
O
F3C
7g
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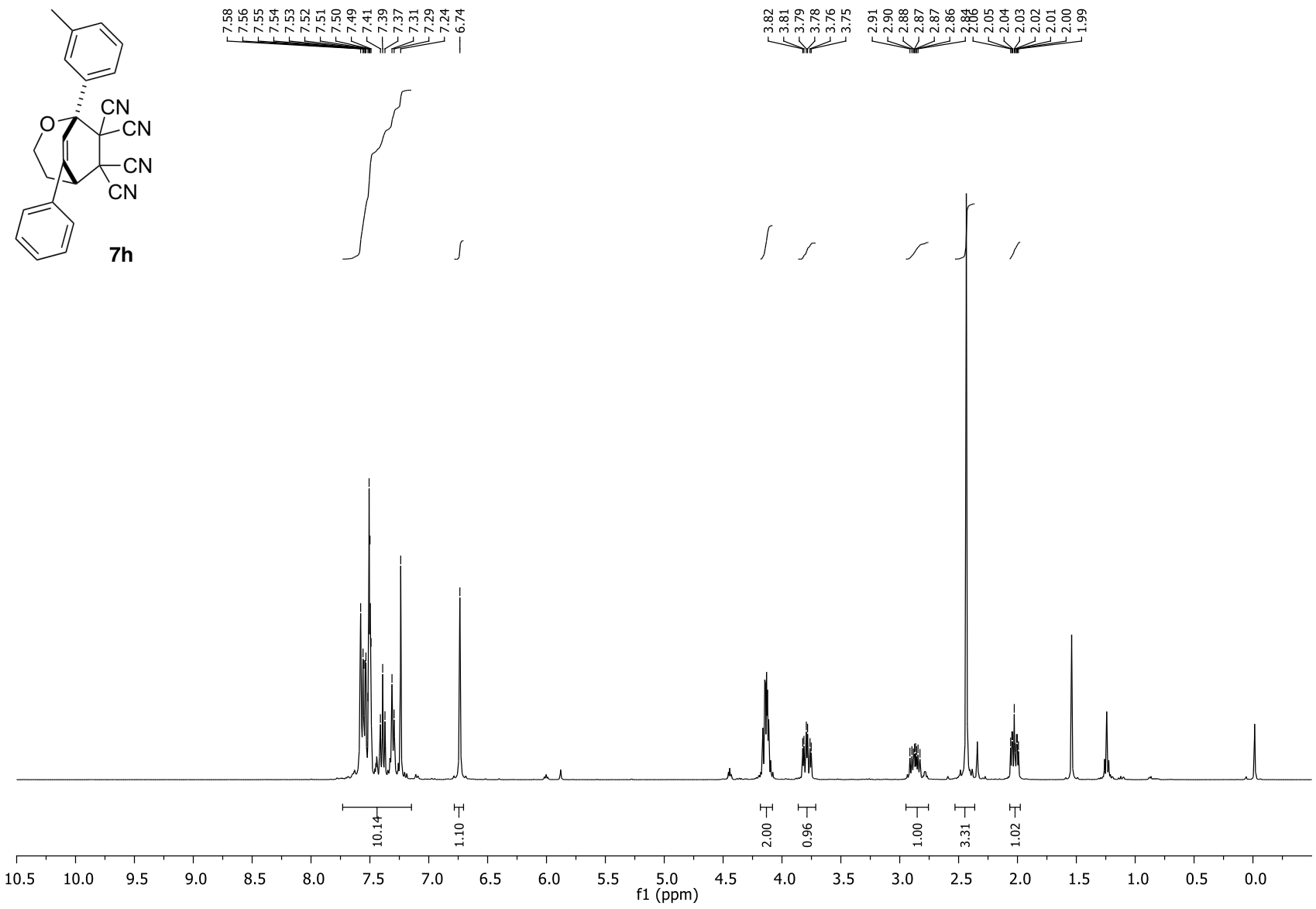
136.01
132.77
132.50
130.54
128.82
127.89
127.09
126.67
126.64
126.40
125.17
124.58
122.41
112.83
111.17
110.92
109.99
81.77
62.11
56.23
47.22
45.46
29.01
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.52
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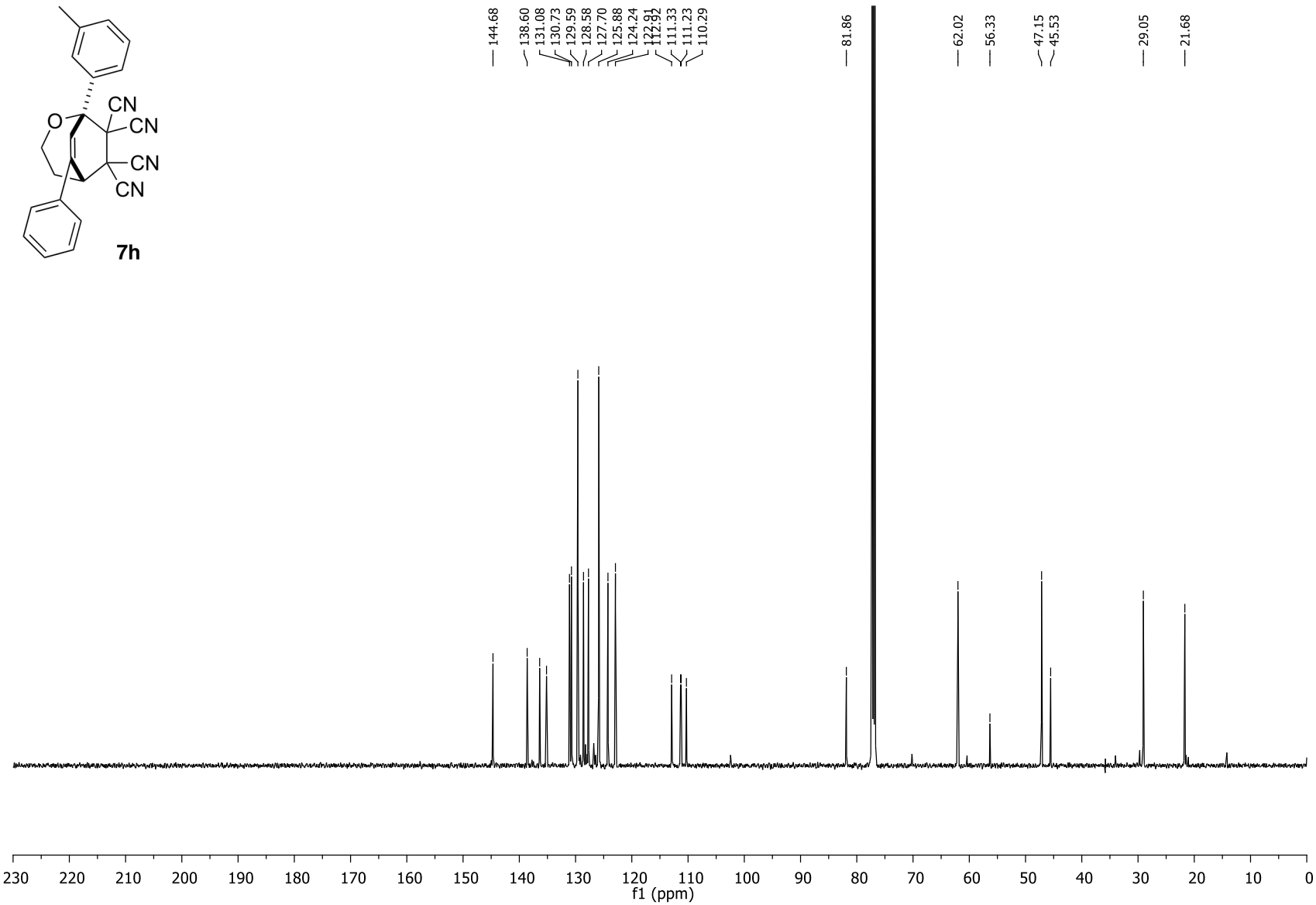
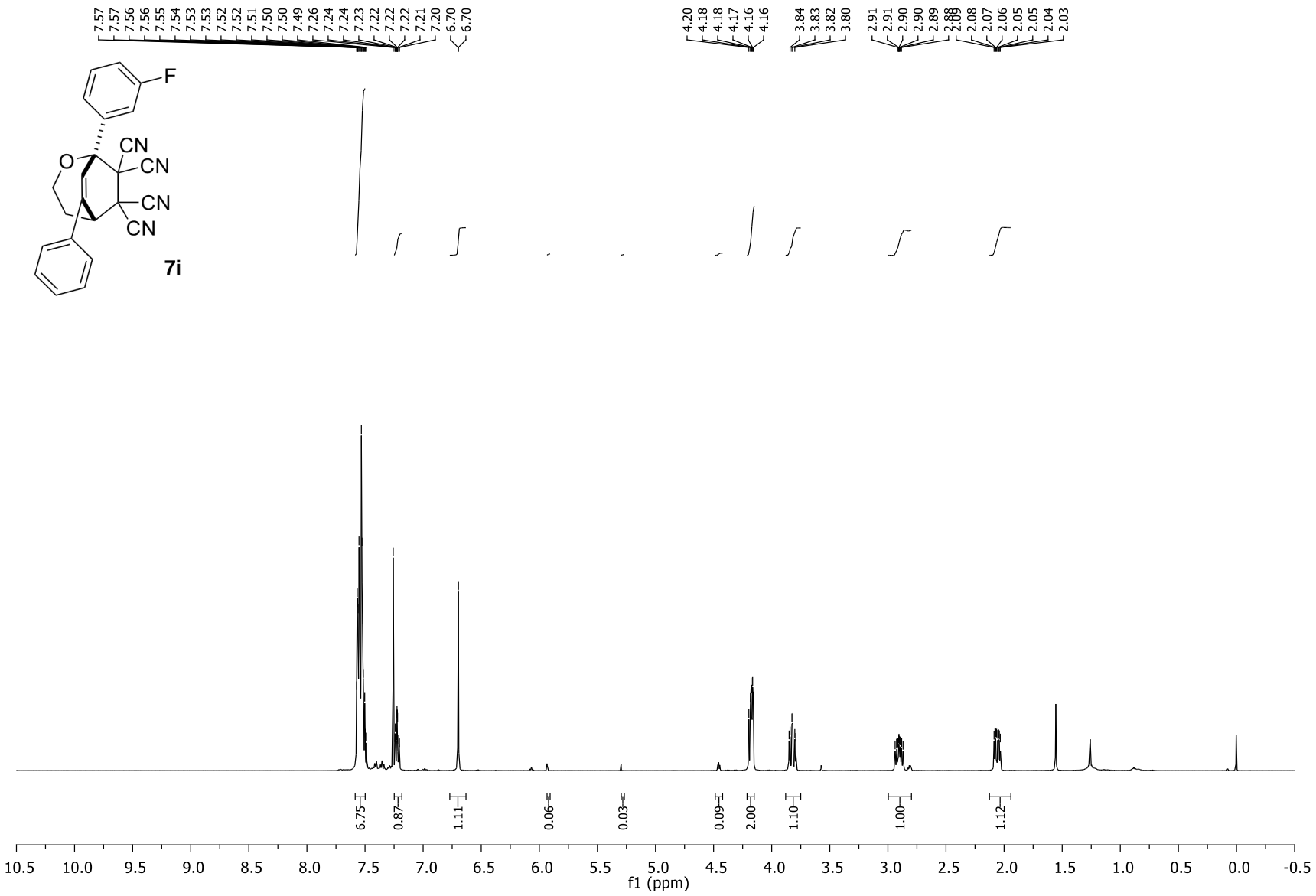
7.41
7.39
7.37
7.31
7.29
7.24
6.74
3.82
3.81
3.79
3.78
3.76
3.75
2.91
2.90
2.88
2.87
2.87
2.86
2.84
2.06
2.05
2.04
2.03
2.02
2.01
2.00
1.99
CN
CN
CN
CN
O
7h
10.14
1.10
2.00
0.96
1.00
3.31
1.02
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


CN
CN
CN
CN
O
7h
144.68
138.60
131.08
130.73
129.59
128.58
127.70
125.88
124.24
122.81
122.92
111.33
111.23
110.29
81.86
62.02
56.33
47.15
45.53
29.05
21.68
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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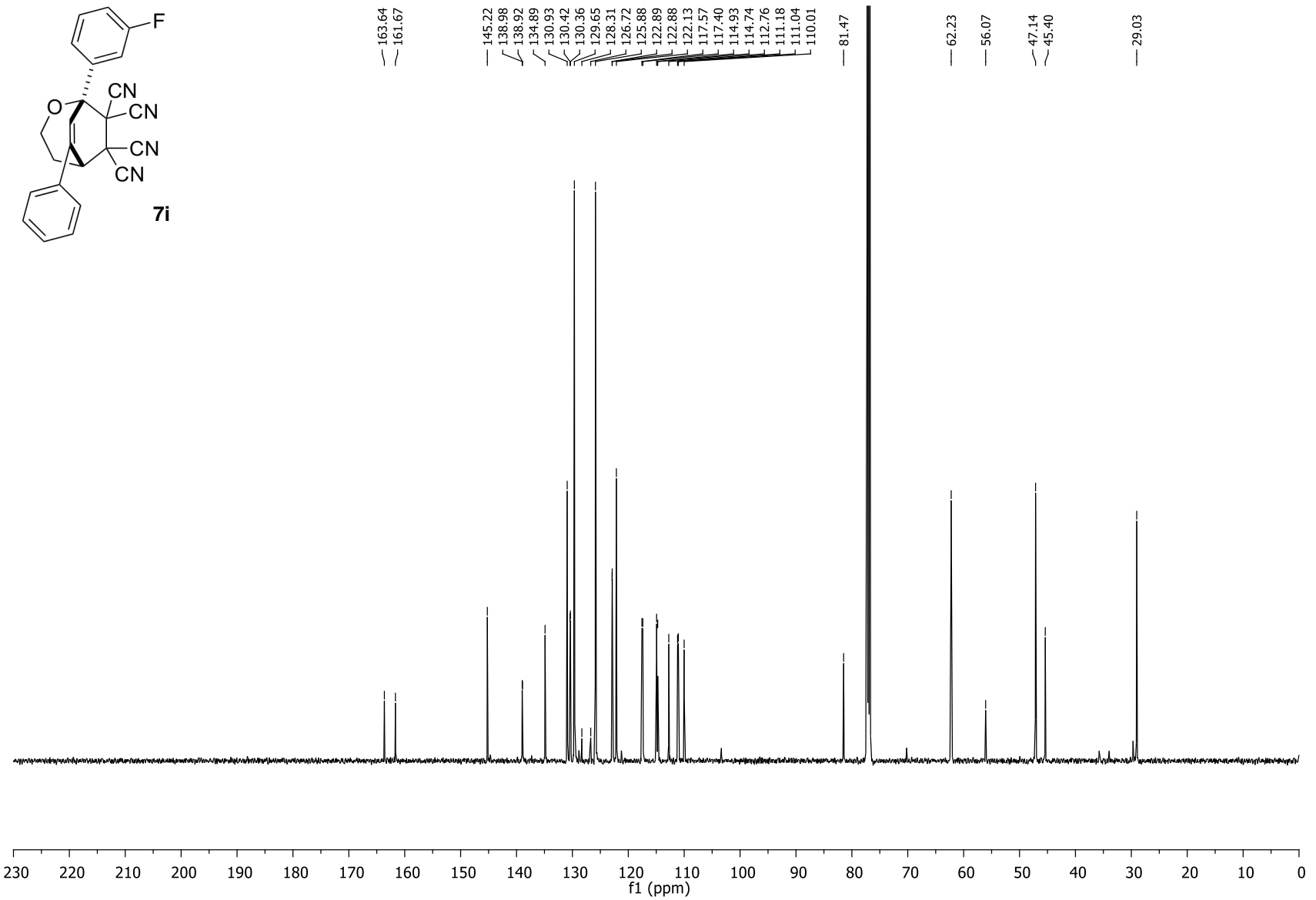
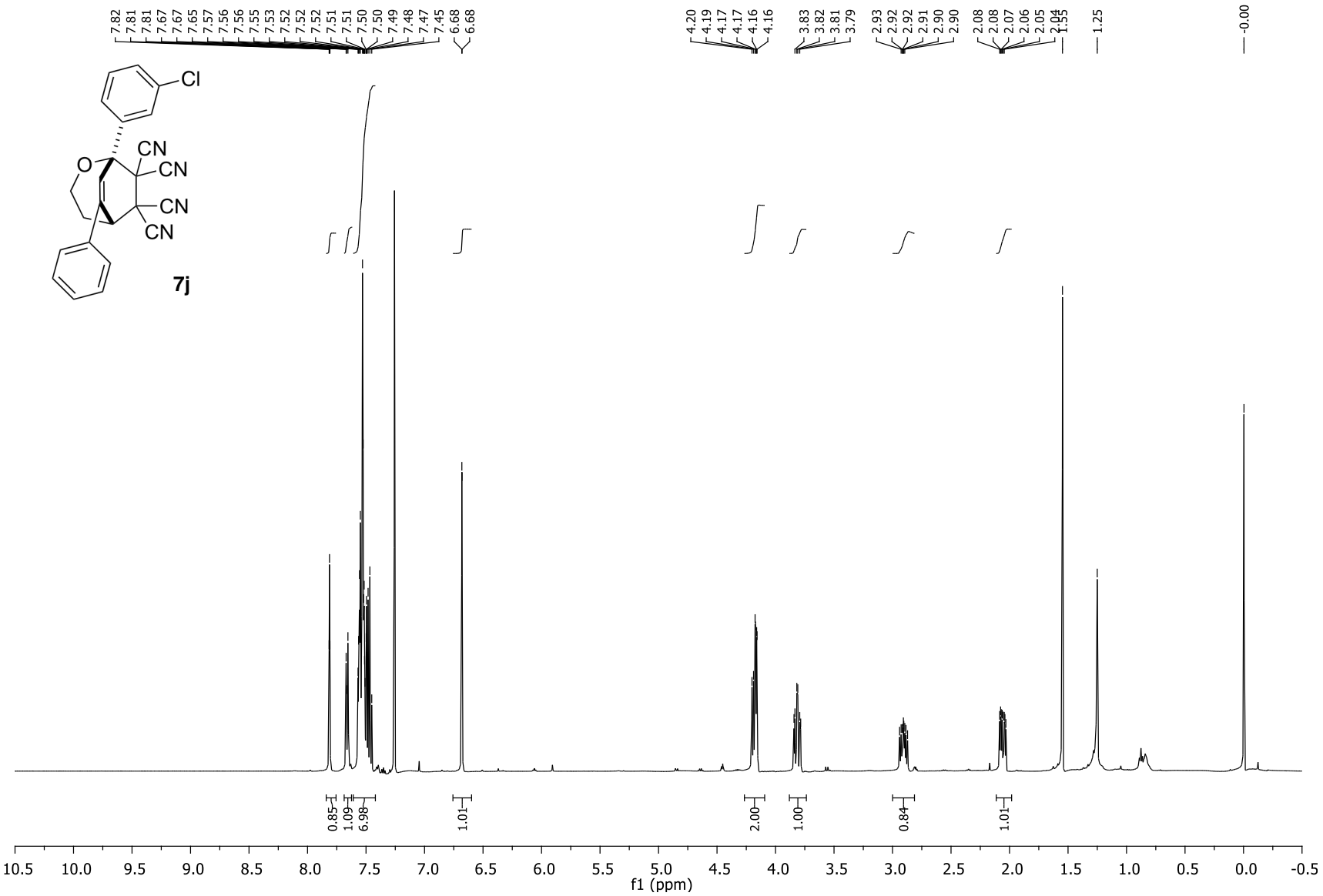
4.20 4.18 4.18 4.17 4.16 4.16
3.84 3.83 3.82 3.80
2.91 2.91 2.90 2.90 2.89 2.08 2.07 2.06 2.05 2.05 2.04 2.03
F
CN
CN
CN
CN
O
7i
6.75 0.87 1.11 0.06 0.03 0.09 2.00 1.10 1.00 1.12
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


F
CN
CN
CN
CN
O
7i
163.64
161.67
145.22
138.98
138.92
134.89
130.93
130.42
130.36
129.65
128.31
126.72
125.88
122.89
122.88
122.13
117.57
117.40
114.93
114.74
112.76
111.18
111.04
110.01
81.47
62.23
56.07
47.14
45.40
29.03
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.55
7.53
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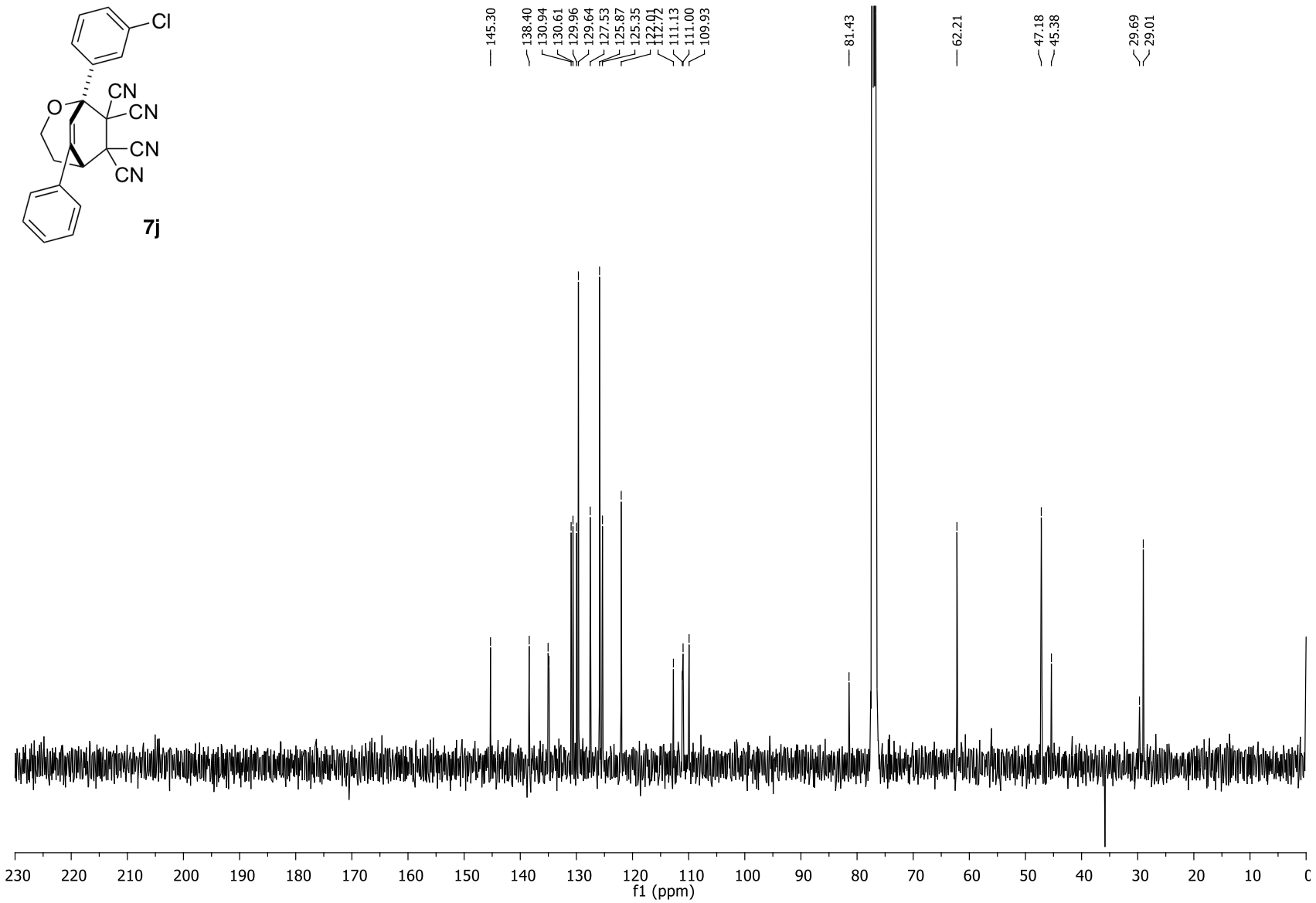
7.52
7.51
7.51
7.50
7.50
7.49
7.48
7.47
7.45
6.68
6.68
4.20
4.19
4.17
4.17
4.16
4.16
3.83
3.82
3.81
3.79
2.93
2.92
2.92
2.91
2.90
2.90
2.08
2.08
2.07
2.06
2.05
2.04
1.55
1.25
-0.00
Cl
CN
CN
CN
CN
O
7j
0.85
1.09
6.98
1.01
2.00
1.00
0.84
1.01
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


Cl
CN
CN
CN
CN
O
7j
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130.61
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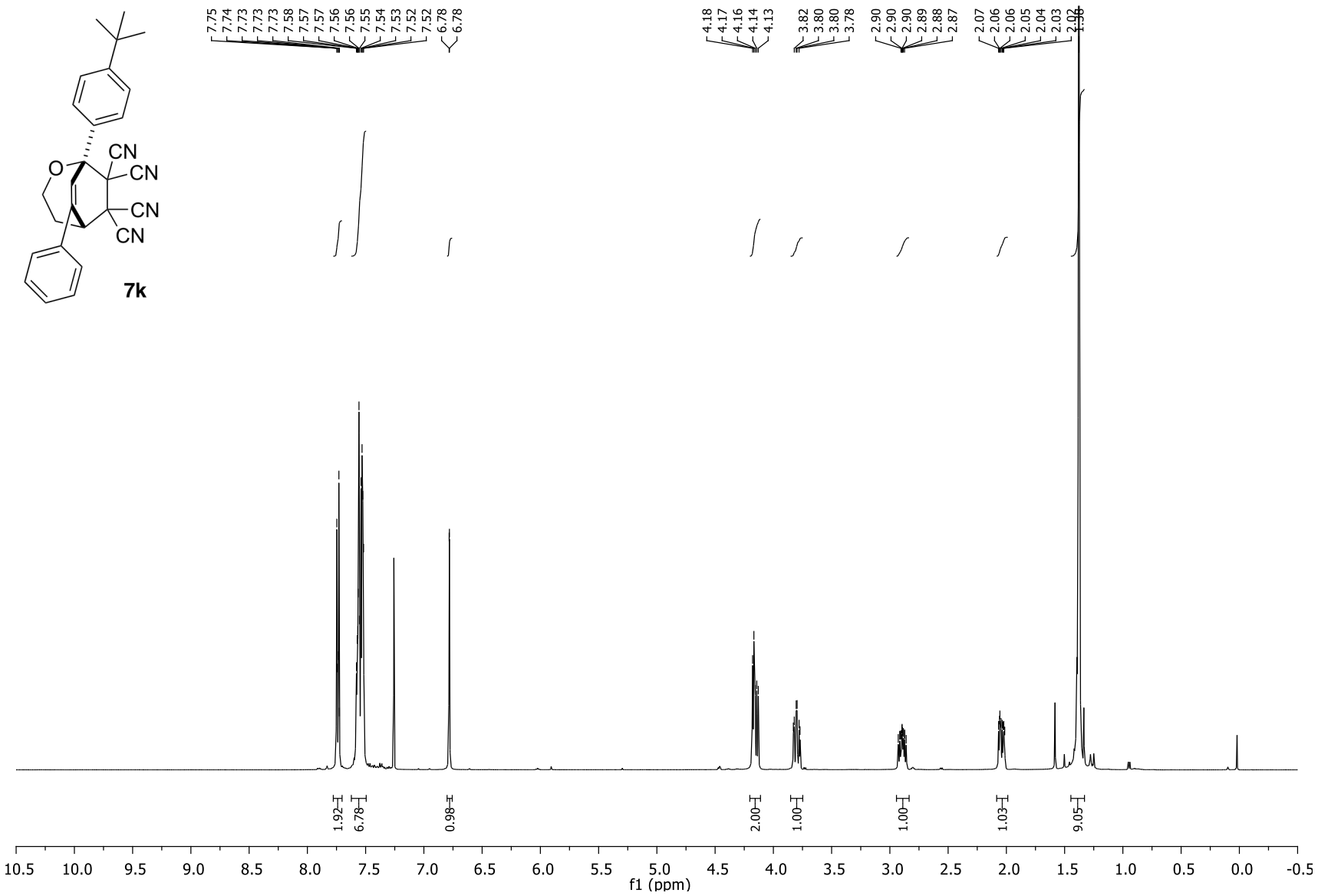
129.64
127.53
125.87
125.35
122.01
112.72
111.13
111.00
109.93
81.43
62.21
47.18
45.38
29.69
29.01
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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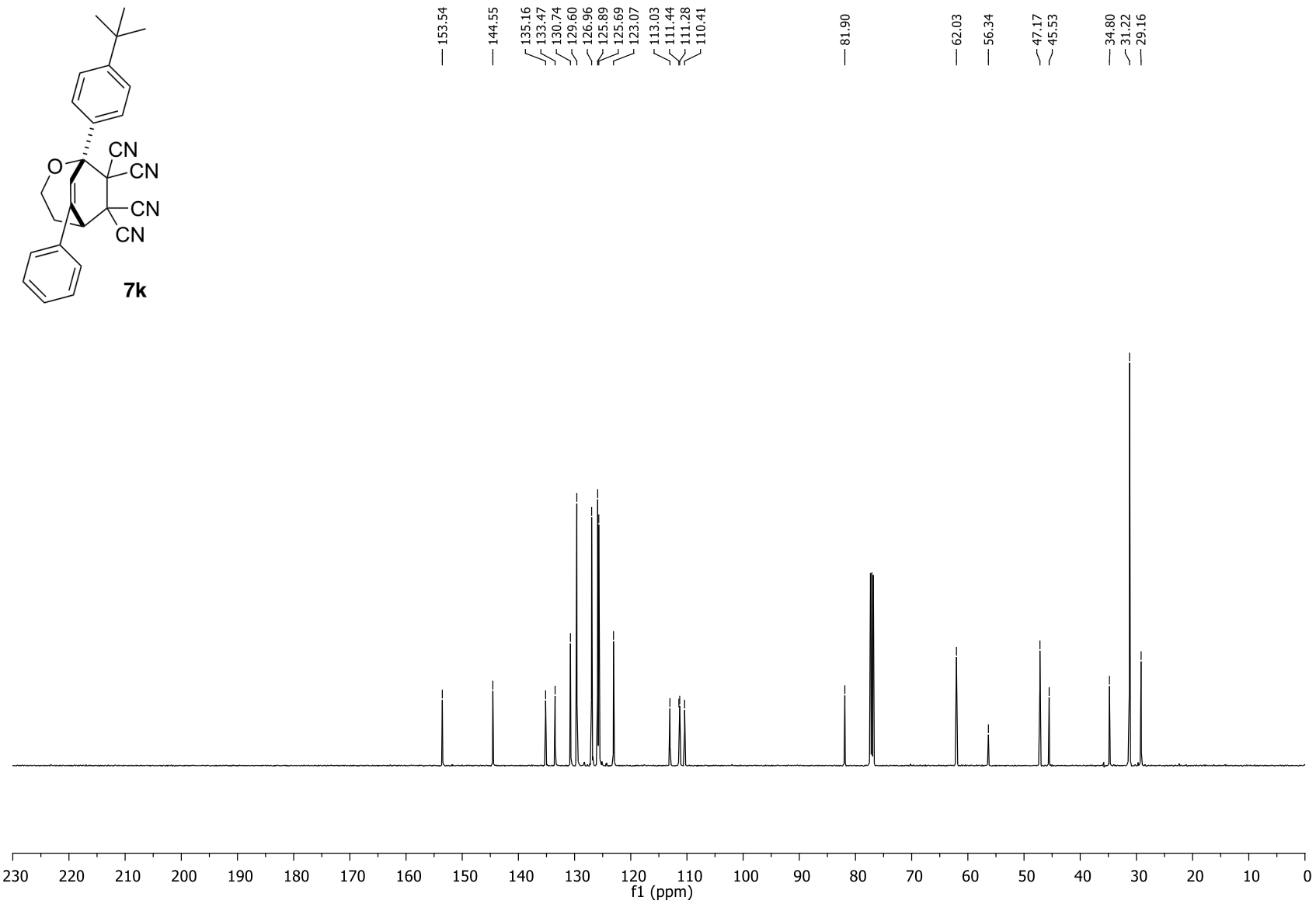
7.54
7.53
7.52
7.52
6.78
6.78
4.18
4.17
4.16
4.14
4.13
3.82
3.80
3.80
3.78
2.90
2.90
2.90
2.89
2.88
2.87
2.07
2.06
2.06
2.05
2.04
2.03
2.02
1.98
CN
CN
CN
CN
O
7k
1.92
6.78
0.98
2.00
1.00
1.00
1.03
9.05
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)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125.89
125.69
123.07
113.03
111.44
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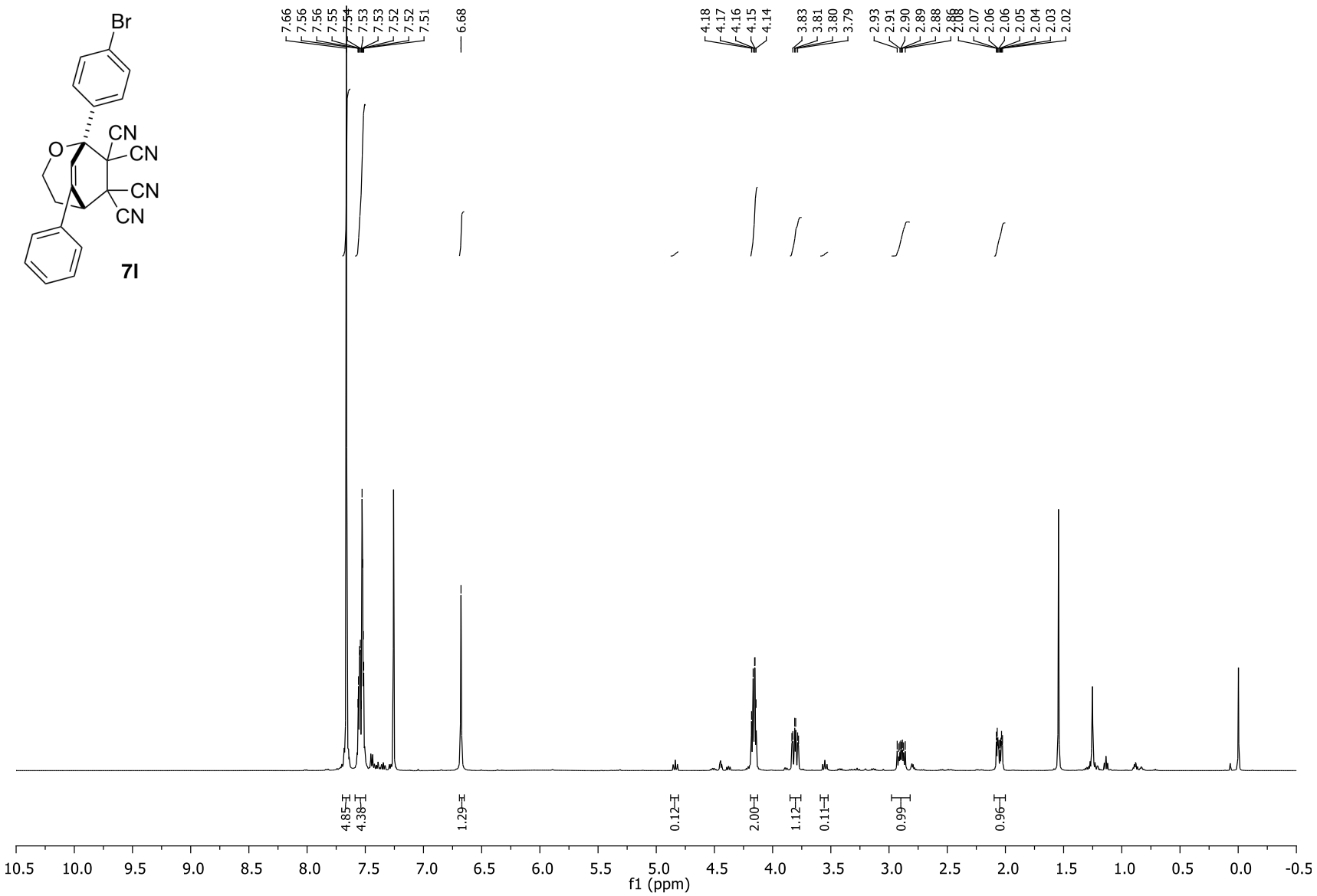
81.90
62.03
56.34
47.17
45.53
34.80
31.22
29.16
CN
CN
CN
CN
O
7k
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


Br
CN
CN
CN
CN
O
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7.56
7.56
7.55
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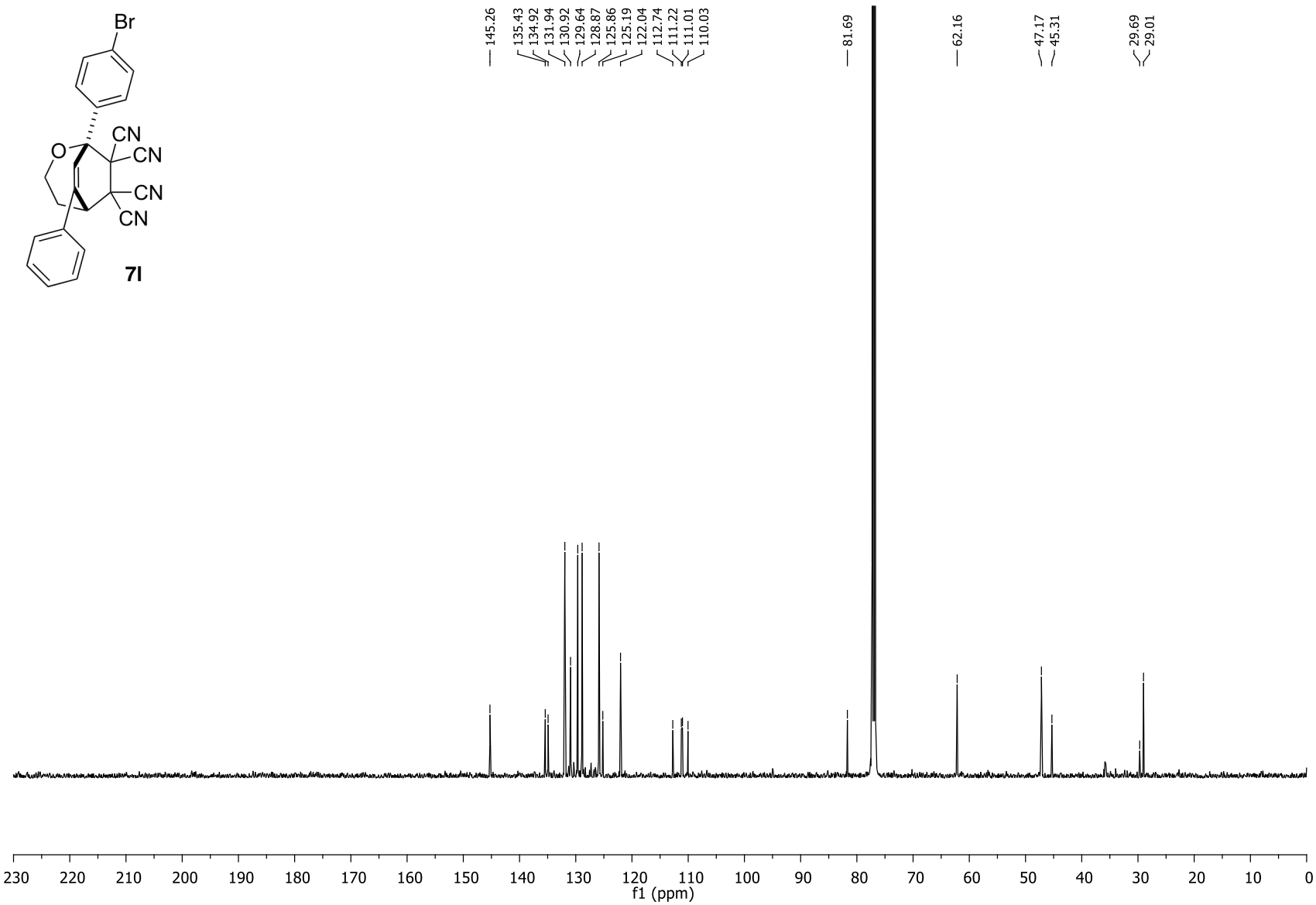
7.53
7.53
7.52
7.52
7.51
6.68
4.18
4.17
4.16
4.15
4.14
3.83
3.81
3.80
3.79
2.93
2.91
2.90
2.89
2.88
2.07
2.06
2.06
2.05
2.04
2.03
2.02
4.85
4.38
1.29
0.12
2.00
1.12
0.11
0.99
0.96
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

7l


Br
CN
CN
CN
CN
O
7l
145.26
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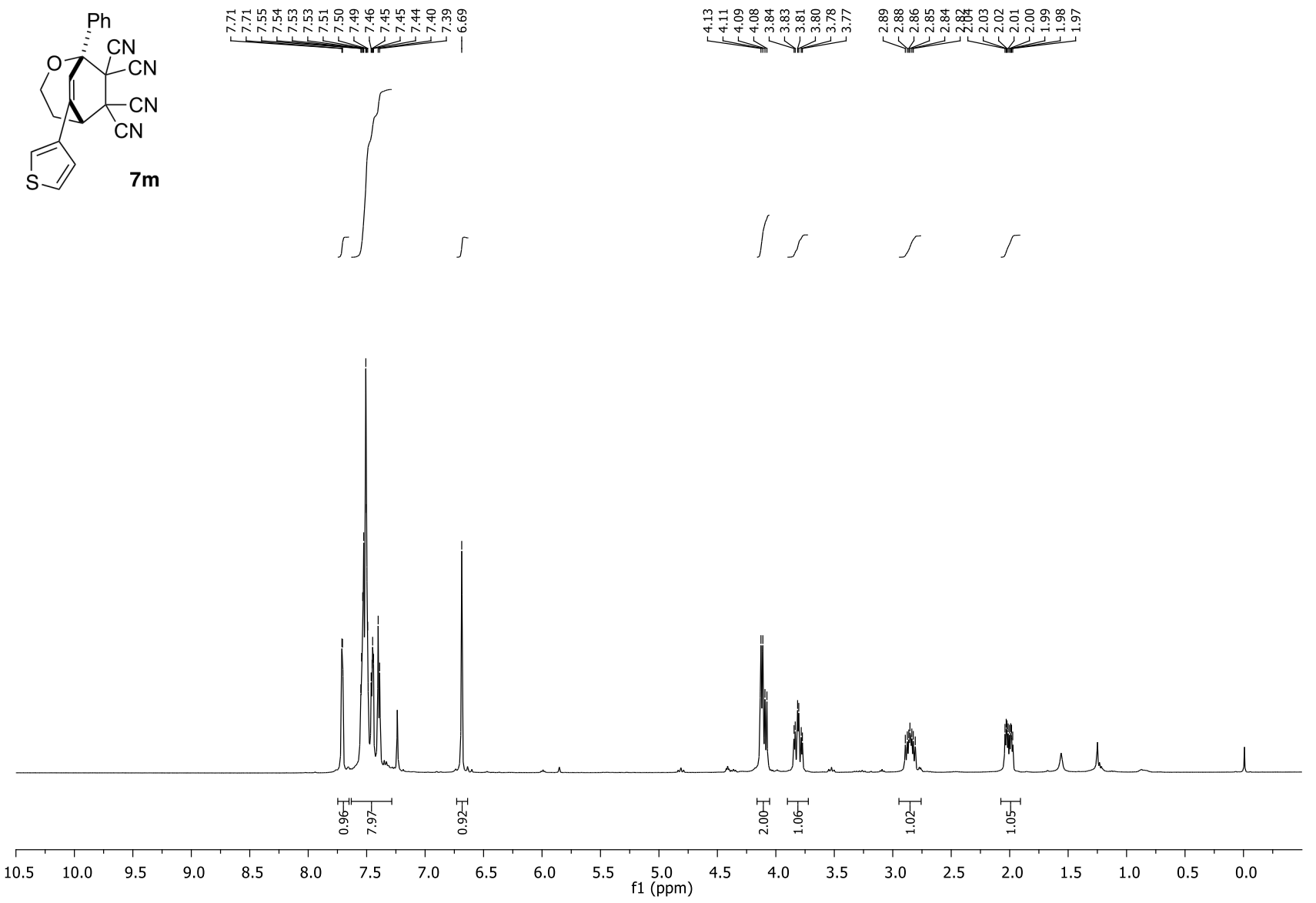
134.92
131.94
130.92
129.64
128.87
125.86
125.19
122.04
112.74
111.22
111.01
110.03
81.69
62.16
47.17
45.31
29.69
29.01
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


Ph
CN
CN
CN
CN
O
S
7m
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7.55
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7.53
7.51
7.50
7.49
7.46
7.45
7.45
7.44
7.40
7.39
6.69
4.13
4.11
4.09
4.08
3.84
3.83
3.81
3.80
3.78
3.77
2.89
2.88
2.86
2.85
2.84
2.82
2.03
2.02
2.01
2.00
1.99
1.98
1.97
0.96
7.97
0.92
2.00
1.06
1.02
1.05
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
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3.5
3.0
2.5
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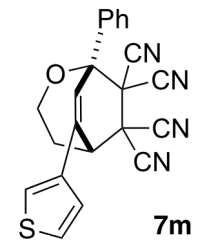
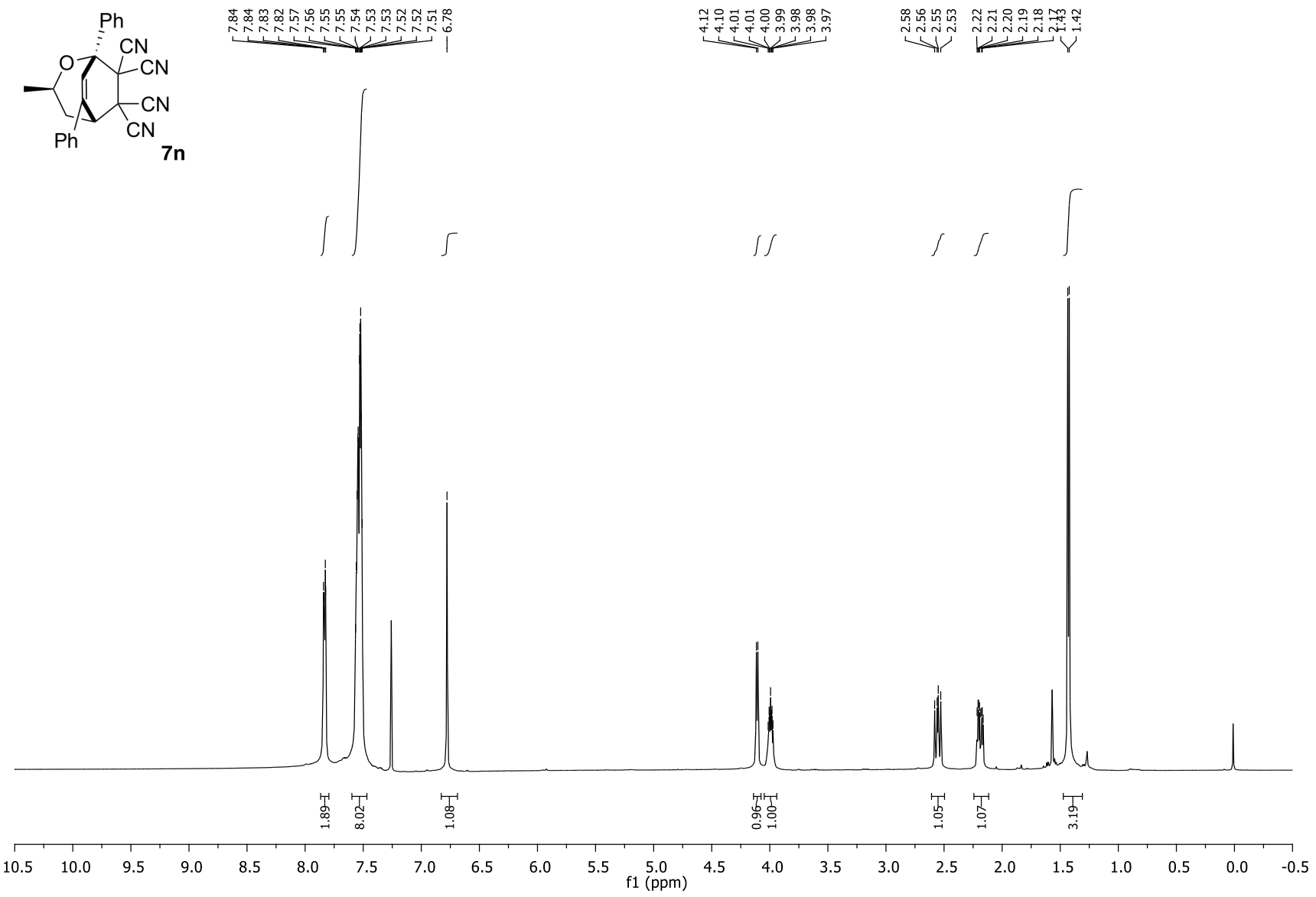
1.5
1.0
0.5
0.0
f1 (ppm)


Ph
CN
CN
CN
CN
O
S

7m

144.67
138.45
134.92
130.84
129.61
127.13
126.23
125.91
122.89
112.90
111.39
111.13
110.35
81.30
62.12
55.87
47.12
45.34
29.14
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


Ph
CN
CN
O
CN
CN
Ph
7n
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7.84
7.83
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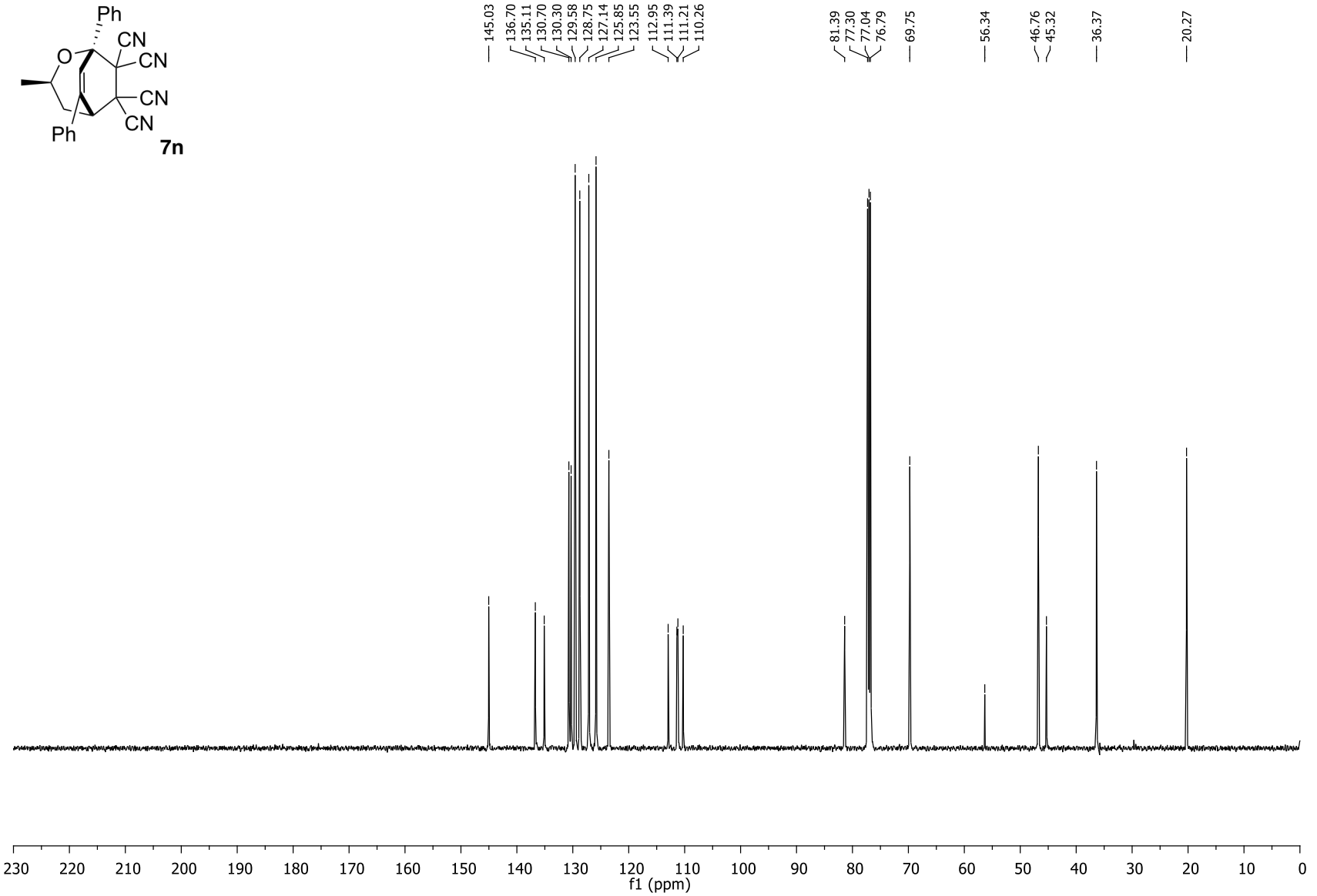
7.55
7.54
7.53
7.53
7.52
7.52
7.51
6.78
4.12
4.10
4.01
4.01
4.00
3.99
3.98
3.98
3.97
2.58
2.56
2.55
2.53
2.22
2.21
2.20
2.19
2.18
1.43
1.42
1.89
8.02
1.08
0.96
1.00
1.05
1.07
3.19
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


Ph
CN
CN
O
CN
CN
Ph
7n
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135.11
130.70
130.30
129.58
128.75
127.14
125.85
123.55
112.95
111.39
111.21
110.26
81.39
77.30
77.04
76.79
69.75
56.34
46.76
45.32
36.37
20.27
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)