Supporting Information

Ligand-Free Ag(I)-Catalyzed Carboxylation of Terminal Alkynes with CO_2

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1. General Information

Methods. Unless otherwise statement, all manipulations were performed using standard Schlenk techniques under a dry nitrogen or CO_2 atmosphere. DMF was distilled from CaH_2 at 60 ^oC under reduced pressure and stored over 4A molecular sieves. NMR spectra were recorded on a Bruker AvanceII 400M type (^1H NMR, 400 MHz; ^{13}C NMR, 100 MHz) spectrometer. Their peak freguencies were referenced versus an internal standard (TMS) shifts at 0 ppm for ^1H NMR and against the solvent ($CDCl_3$, 77.0 ppm) for ^{13}C NMR, respectively. Multiplicity abbreviations: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet. High resolution mass spectra (HRMS) were recorded on a Q-TOF mass spectrometry (Micromass, Wythenshawe, UK) equipped with Z-spray ionization source. Infrared spectra (IR) were measured using a Nicolet NEXUS FT-IR spectrophotometer.

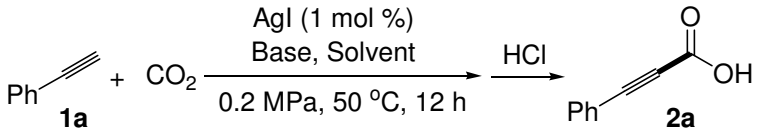
Materials. Unless otherwise noted, carbon dioxide (99.999%), ^{13}C-labeled carbon dioxide (purity >99.9%, ^{13}C 99%, ^{18}O <1%), commercially available terminal alkynes, silver(I) salt and other all reagents were used without further purification. Silver phenylacetylide[1] and silver phenylpropiolate[2] were prepared according to the literatures.

2. General Experimental Procedure for Carboxylation of Terminal Alkynes

A 70 mL oven dried autoclave containing a stir bar was charged the AgI (4.7 mg, 0.02 mmol), Cs_2CO_3 (978 mg, 3.0 mmol). Alkyne (2.0 mmol) and 20 mL dry DMF were added with syringe respectively after purging the autoclave with CO_2 three times. The sealed autoclave was pressurized to appropriate pressure with CO_2. The reaction mixture was stirred at 50 ^oC for 12 h, then the autoclave was cooled to room temperature and the remaining CO_2 was vented slowly. The reaction mixture was diluted with water (30 mL) and extracted with hexane or CH_2Cl_2 (2 × 20 mL). The aqueous layer was acidified with aqueous HCl (6 N, 20 mL) at low temperature and then extracted with diethyl ether (4 × 30 mL). The combined organic layers were washed with water and brine, dried over Na_2SO_4 and filtered. The solvent was removed under vacuum to afford the acid product.

3. Optimization of Reaction Conditions

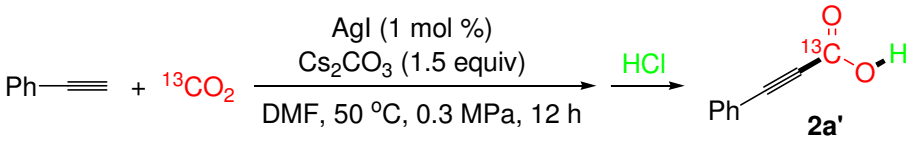
Table S1. Optimization of reaction conditions for AgI-catalyzed carboxylation of phenylacetylene (**1a**) with CO_2[a]



entry	base	solvent	yield (%)[b]
1[c]	Cs_2CO_3	DMF	86
2[d]	Cs_2CO_3	DMF	82
3[e]	Cs_2CO_3	DMF	71
4[f]	Cs_2CO_3	DMF	57
5	Cs_2CO_3	DMSO	80
6	Cs_2CO_3	DMAc	61
7	Cs_2CO_3	THF	33
8	Cs_2CO_3	CH_2Cl_2	-
9	K_2CO_3	DMF	40
10	NEt_3	DMF	-
11	K_3PO_4	DMF	-
12[g]	Cs_2CO_3	DMF	12
13[h]	Cs_2CO_3	DMF	30

[a] Reaction conditions: **1a** (2 mmol), base (3 mmol), CO_2 (0.2 MPa), 1 mol % AgI, 20 mL solvent, 50 °C, 12 h. [b] Isolated yield. [c] 5 mol% AgI. [d] 40 °C. [e] 60 °C. [f] 1 mol % (IPr)CuCl was used as catalyst. [g] In the absence of Ag catalyst, 80 °C. [h] In the absence of Ag catalyst, 100 °C. DMAc = *N*,*N*-dimethyl acetamide.

4. AgI-Catalyzed Carboxylation of Phenylacetylene with $^{13}CO_2$



A 20 mL oven dried autoclave containing a stir bar was charged the AgI (1.5 mg, 0.0063 mmol), Cs_2CO_3 (307 mg, 0.94 mmol). Phenylacetylene (64 mg, 0.63 mmol) and 6 mL dry DMF were added with syringe respectively after purging the autoclave with Ar gas three times. The sealed autoclave was pressurized to appropriate pressure with $^{13}CO_2$ (^{13}C 99%). The reaction mixture was stirred at 50 °C for 12 h, then the autoclave was cooled to room temperature and the remaining $^{13}CO_2$ was vented slowly. The reaction mixture was diluted with water (10 mL) and extracted with hexane or CH_2Cl_2 (2 × 10 mL). The

aqueous layer was acidified with aqueous HCl (6 N, 8 mL) at low temperature and then extracted with diethyl ether (4 × 15 mL). The combined organic layers were washed with water and brine, dried over Na_2SO_4 and filtered. The solvent was removed under vacuum to afford the $^{13}C_{carbonyl}$-labeled phenylpropiolic acid (**2a'**) (83 mg, 90% yield). $^{13}C_{carbonyl}$-labeled phenylpropiolic acid (**2a'**): **^{1}H NMR** (400 MHz, DMSO-d_6): δ = 13.83 (br s, 1H), 7.64-7.46 (m, 5H). **^{13}C NMR** (100 MHz, $CDCl_3$): δ = 158.6. **IR** (cm^{-1}) (neat) 2233, 1661. **HRMS** (ESI, *m/z*) calcd. for $^{12}C_8{}^{13}CH_5O_2$ $[M-H]^-$: 146.0323, found: 146.0326.

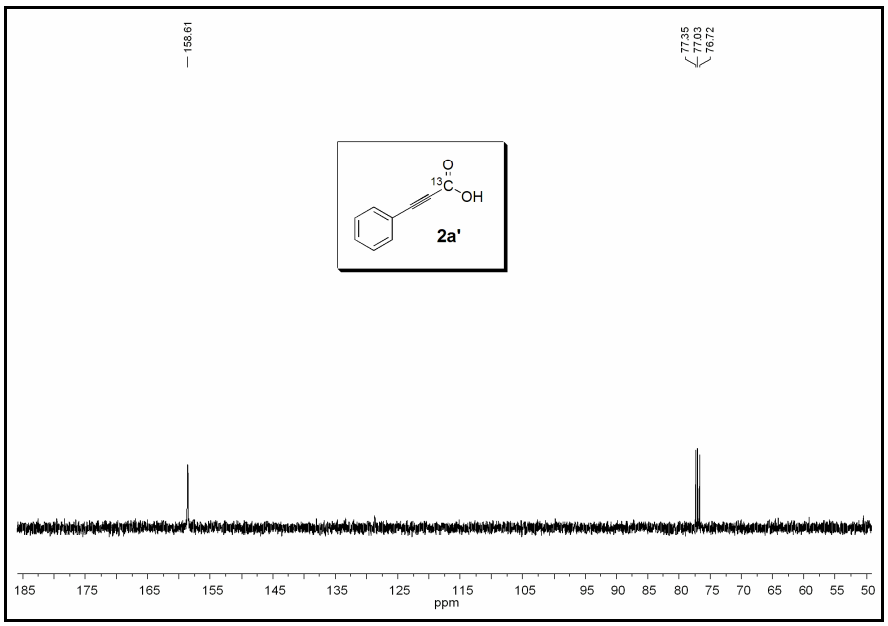


Figure S1. ^{13}C NMR spectrum of $^{13}C_{carbonyl}$-labeled phenylpropiolic acid (**2a'**)

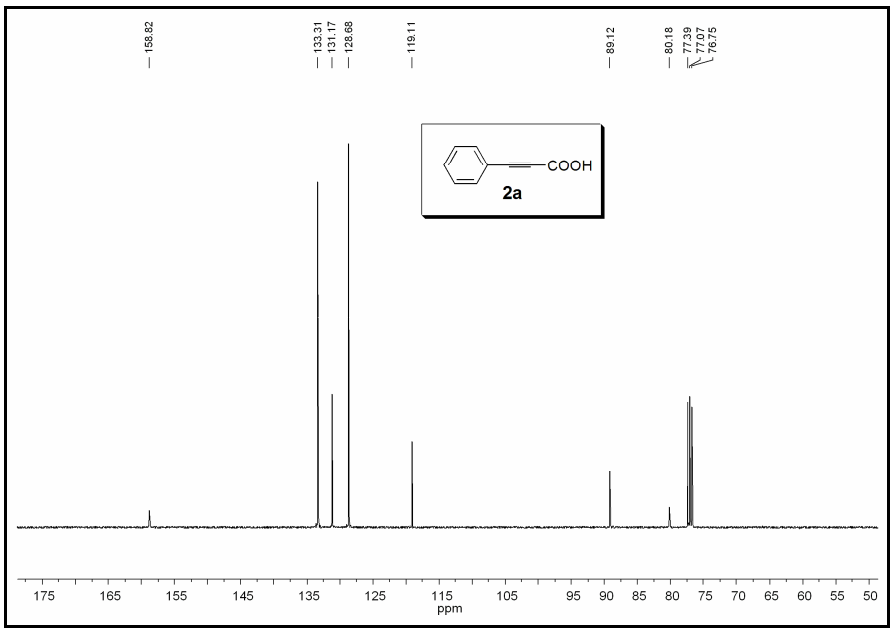


Figure S2. ^{13}C NMR spectrum of phenylpropiolic acid (**2a**)

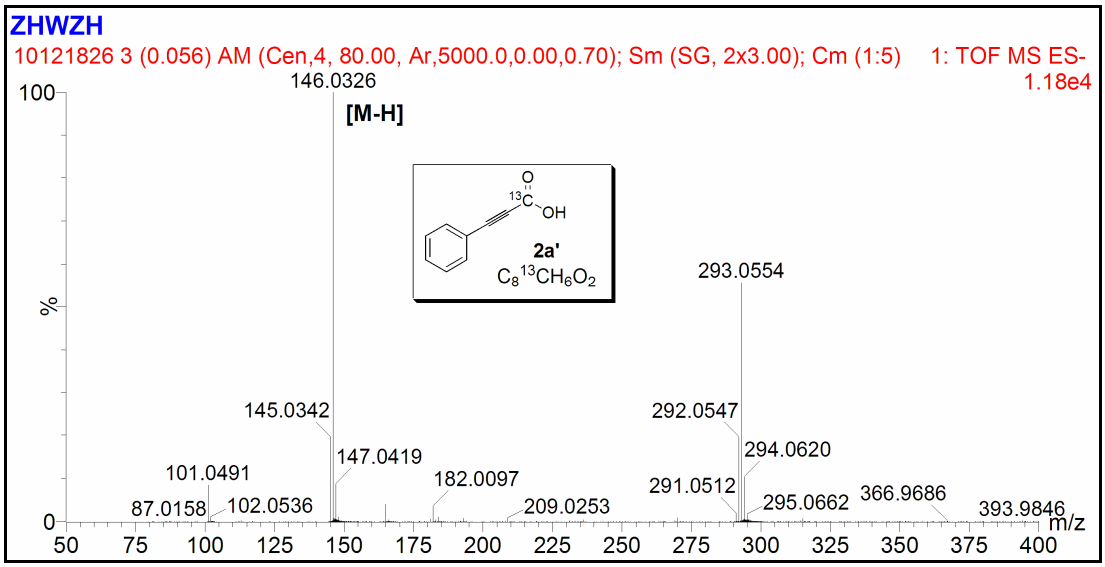
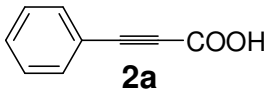


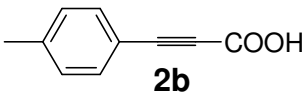
Figure S3. HRMS of $^{13}C_{carbonyl}$-labeled phenylpropiolic acid (**2a'**)

5. Characterization of Products



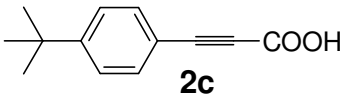
Phenylpropiolic acid (2a)

^{1}H NMR (400 MHz, DMSO-d_6): δ = 13.84 (s, 1H), 7.64-7.46 (m, 5H). **^{13}C NMR** (100 MHz, $CDCl_3$): δ = 158.8, 133.3, 131.2, 128.7, 119.1, 89.1, 80.2. **IR** (cm^{-1}) (neat) 2202, 1674. **HRMS** (ESI, *m/z*) calcd. for $C_9H_5O_2$ $[M-H]^-$: 145.0290, found: 145.0289.



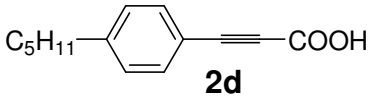
4-Methylphenylpropiolic acid (2b)

^{1}H NMR (400 MHz, $CDCl_3$): δ =10.55 (br s, 1H) 7.51 (d, J = 8.0 Hz, 2H), 7.20 (d, J = 8.0 Hz, 2H), 2.39 (s, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$): δ = 158.9, 141.9, 133.3, 129.5, 116.0, 89.8, 79.8, 21.8. **IR** (cm^{-1}) (neat) 2199, 1673. **HRMS** (ESI, *m/z*) calcd. for $C_{10}H_7O_2$ $[M-H]^-$: 159.0446, found: 159.0442.



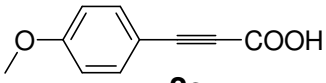
4-*tert*-Butylphenylpropiolic acid (2c)

^{1}H NMR (400 MHz, $CDCl_3$): δ = 11.19 (br s, 1H), 7.56 (d, J = 8.4 Hz, 2H), 7.41 (d, J = 8.4 Hz, 2H), 1.32 (s, 9H). **^{13}C NMR** (100 MHz, $CDCl_3$): δ = 159.1, 155.0, 133.3, 125.8, 116.0, 89.8, 79.8, 35.1, 31.0. **IR** (cm^{-1}) (neat) 2230, 1673. **HRMS** (ESI, *m*/*z*) calcd. for $C_{13}H_{13}O_2$ $[M-H]^-$: 201.0916, found: 201.0913.



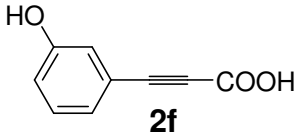
2d **4-Pentylphenylpropiolic acid (2d)**

^{1}H NMR (400 MHz, $CDCl_3$): δ = 11.60 (s, 1H), 7.52 (d, J = 8.0 Hz, 2H), 7.19 (d, J = 8.0 Hz, 2H), 2.62 (t, J = 7.6 Hz, 2H), 1.61 (m, 2H), 1.32 (m, 4H), 0.89 (t, J = 6.8 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$): δ = 159.2, 146.9, 133.4, 128.8, 116.2, 89.8, 80.0, 36.1, 31.4, 30.8, 22.5, 14.0. **IR** (cm^{-1}) (neat) 2202, 1674. **HRMS** (ESI, *m*/*z*) calcd. for $C_{14}H_{15}O_2$ $[M-H]^-$: 215.1072, found: 215.1070.



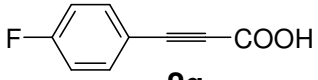
2e **4-Methoxylphenylpropiolic acid (2e)**

^{1}H NMR (400 MHz, $CDCl_3$): δ = 7.56 (d, J = 8.7 Hz, 2H), 6.89 (d, J = 8.7 Hz, 2H), 3.84 (s, 3H). **^{13}C NMR** (100 MHz, CD_3OD): δ = 161.8, 155.7, 134.5, 114.2, 111.1, 86.3, 79.9, 54.6. **IR** (cm^{-1}) (neat) 2200, 1670. **HRMS** (ESI, *m*/*z*) calcd. for $C_{10}H_7O_3$ $[M-H]^-$: 175.0395, found: 175.0391.



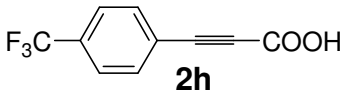
2f **3-Hydroxyphenylpropiolic acid (2f)**

^{1}H NMR (400 MHz, CD_3OD): δ = 7.24-6.90 (m, 4H). **^{13}C NMR** (100 MHz, CD_3OD): δ = 157.4, 155.4, 129.7, 123.7, 120.3, 118.7, 118.0, 85.4, 79.9. **IR** (cm^{-1}) (neat) 3272, 2220, 1692. **HRMS** (ESI, *m*/*z*) calcd. for $C_9H_5O_3$ $[M-H]^-$: 161.0239, found: 161.0236.



2g **4-Fluorophenylpropiolic acid (2g)**

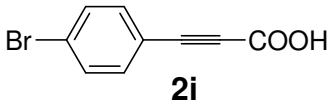
^{1}H NMR (400 MHz, CD_3OD): δ = 7.64-7.60 (m, 2H), 7.19-7.14 (m, 2H). **^{13}C NMR** (100 MHz, CD_3OD): δ = 165.2, 162.7, 155.3, 135.0, 115.9, 84.0, 80.5. **IR** (cm^{-1}) (neat) 2214, 1695. **HRMS** (ESI, *m*/*z*) calcd. for $C_9H_4O_2F$ $[M-H]^-$: 163.0195, found: 163.0198.



2h

4-Trifluoromethylphenylpropiolic acid (2h)

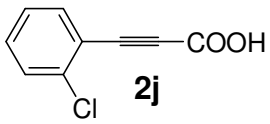
^{1}H NMR (400 MHz, CD_3OD): δ = 7.77-7.71 (m, 4H). **^{13}C NMR** (100 MHz, CD_3OD): δ = 157.0, 135.2, 134.1, 133.8, 127.6, 124.6 84.9, 84.6. **IR** (cm^{-1}) (neat) 2235, 1694. **HRMS** (ESI, *m*/*z*) calcd. for $C_{10}H_4O_2F_3$ $[M-H]^-$: 213.0163, found: 213.0166.



2i

4-Bromophenylpropiolic acid (2i)

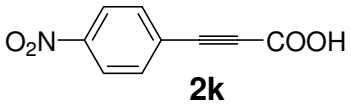
^{1}H NMR (400 MHz, CD_3OD): δ = 7.61 (d, *J* = 8.4 Hz, 2H), 7.50 (d, *J* = 8.4 Hz, 2H). **^{13}C NMR** (100 MHz, CD_3OD): δ = 154.9, 134.0, 131.9, 124.9, 118.7, 83.7, 81.4. **IR** (cm^{-1}) (neat) 2232, 1695. **HRMS** (ESI, *m*/*z*) calcd. for $C_9H_4O_2Br$ $[M-H]^-$: 222.9395, found: 222.9397.



2j

2-Chlorophenylpropiolic acid (2j)

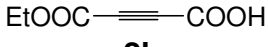
^{1}H NMR (400 MHz, CD_3OD): δ = 7.67-7.36 (m, 4H). **^{13}C NMR** (100 MHz, CD_3OD): δ = 154.8, 136.6, 134.4 131.7, 129.4, 126.8, 119.7, 85.0, 81.1. **IR** (cm^{-1}) (neat) 2230, 1699. **HRMS** (ESI, *m*/*z*) calcd. for $C_9H_4O_2Cl$ $[M-H]^-$: 178.9900, found: 178.9901.



2k

4-Nitrophenylpropiolic acid (2k)

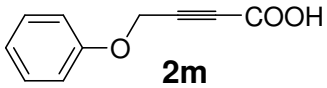
^{1}H NMR (400 MHz, CD_3OD): δ = 8.27 (d, *J* = 8.8 Hz, 2H), 7.76 (d, *J* = 8.8 Hz, 2H). **^{13}C NMR** (100 MHz, DMSO-d_6): δ = 154.3, 146.0, 131.9, 129.3, 123.2, 94.8, 72.7. **IR** (cm^{-1}) (neat) 2229, 1690. **HRMS** (ESI, *m*/*z*) calcd. for $C_9H_4NO_4$ $[M-H]^-$: 190.0140, found: 190.0142.



2l

Monoethyl acetylenedicarboxylate (2l)

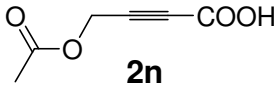
^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.37 (s, 1H), 4.29 (t, J = 7.2 Hz, 2H), 1.31 (q, J = 7.2 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$): δ = 154.7, 152.0, 76.3, 74.2, 63.6, 13.8. **IR** (cm^{-1}) (neat) 1722. **HRMS** (ESI, *m*/*z*) calcd. for $C_6H_5O_4$ $[M-H]^-$: 141.0188, found: 141.0183.



2m

4-Phenoxy-2-butynoic acid (2m)

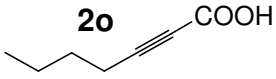
^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.23 (br s, 1H), 7.34-6.94 (m, 5H), 4.83 (s, 2H). **^{13}C NMR** (100 MHz, $CDCl_3$): δ = 157.2, 129.7, 122.2, 114.9, 84.9, 77.8, 55.5. **IR** (cm^{-1}) (neat) 2249, 1674. **HRMS** (ESI, *m*/*z*) calcd. for $C_{10}H_7O_3$ $[M-H]^-$: 175.0395, found: 175.0398.



2n

4-Acetyloxy-2-butynoic acid (2n)

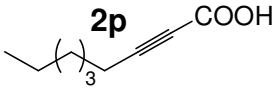
^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.69 (s, 1H), 4.78 (s, 2H), 2.10 (s, 3H. **^{13}C NMR** (100 MHz, $CDCl_3$): δ = 170.8, 155.9, 83.0, 77.5, 51.5, 20.5. **IR** (cm^{-1}) (neat) 2239, 1740, 1685. **HRMS** (ESI, *m*/*z*) calcd. for $C_6H_5O_4$ $[M-H]^-$: 140.0188, found: 140.0186.



2o

2-Heptynoic acid (2o)

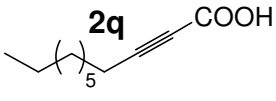
^{1}H NMR (400 MHz, $CDCl_3$): δ = 11.32 (s, 1H), 2.37 (t, J = 7.0 Hz, 2H), 1.58 (m, 2H), 1.44 (m, 2H), 0.93 (t, J = 6.8 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$): δ = 158.7, 92.8, 72.6, 29.3, 21.9, 18.4, 13.4. **IR** (cm^{-1}) (neat) 2238, 1686. **HRMS** (ESI, *m*/*z*) calcd. for $C_7H_9O_2$ $[M-H]^-$: 125.0603, found: 125.0603.



2p

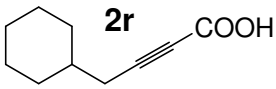
2-Nonynoic acid (2p)

^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.05 (s, 1H), 2.35 (t, J = 7.2 Hz, 2H), 1.59 (m, 2H), 1.41 (m, 2H), 1.29 (m, 4H), 0.89 (t, J = 7.2 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$): δ = 158.3, 92.5, 72.7, 31.2, 28.5, 27.4, 22.4, 18.7,14.0. **IR** (cm^{-1}) (neat) 2238, 1686. **HRMS** (ESI, *m/z*) calcd. for $C_9H_{13}O_2$ $[M-H]^-$: 153.0916, found: 153.0918.



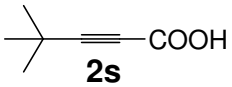
2-Decynoic acid (2q)

^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.81 (s, 1H), 2.36 (t, J = 7.2 Hz, 2H), 1.58 (m, 2H), 1.41-1.28 (m, 10H), 0.88 (t, J = 7.2 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$): δ = 157.8, 91.8, 71.7, 30.8, 28.1, 28.0, 27.8, 26.4, 21.6, 17.8, 13.1. **IR** (cm^{-1}) (neat) 2239, 1687. **HRMS** (ESI, *m/z*) calcd. for $C_{11}H_{17}O_2$ $[M-H]^-$: 181.1229, found: 181.1227.



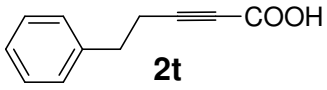
4-Cyclohexyl-2-butynoic acid (2r)

^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.68 (s, 1H), 2.26 (d, J = 6.8 Hz, 2H), 1.83-1.54 (m, 6H), 1.31-0.97 (m, 5H). **^{13}C NMR** (100 MHz, $CDCl_3$): δ = 158.6, 91.9, 73.6, 36.6, 32.6, 26.5, 26.0, 25.9. **IR** (cm^{-1}) (neat) 2238, 1675. **HRMS** (ESI, *m/z*) calcd. for $C_{10}H_{13}O_2$ $[M-H]^-$: 165.0916, found: 165.0913.



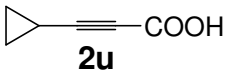
4,4-Dimethyl-2-pentynoic acid (2s)

^{1}H NMR (400 MHz, $CDCl_3$): δ = 11.59 (s, 1H), 1.30 (s, 9H). **^{13}C NMR** (100 MHz, $CDCl_3$): δ = 158.9, 99.7, 71.3, 29.8, 27.6. **IR** (cm^{-1}) (neat) 2219, 1687. **HRMS** (ESI, *m/z*) calcd. for $C_7H_9O_2$ $[M-H]^-$: 125.0603, found: 125.0605.



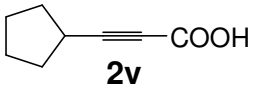
5-Phenyl-2-pentynoic acid (2t)

^{1}H NMR (400 MHz, $CDCl_3$): δ = 11.50 (s, 1H), 7.42-7.29 (m, 5H), 2.97 (d, J = 7.4 Hz, 2H), 2.70 (d, J = 7.4 Hz, 2H). **^{13}C NMR** (100 MHz, $CDCl_3$): δ = 158.7, 139.5, 128.7, 128.5, 126.9, 91.9, 73.4, 33.7, 21.0. **IR** (cm^{-1}) (neat) 2239, 1680. **HRMS** (ESI, *m*/*z*) calcd. for $C_{11}H_9O_2$ $[M-H]^-$: 173.0603, found: 173.0607.



2u **3-Cyclopropyl-2-propynoic acid (2u)**

^{1}H NMR (400 MHz, $CDCl_3$): δ = 11.29 (br s, 1H), 1.44-1.38 (m, 1H), 1.02-0.94 (m, 4H). **^{13}C NMR** (100 MHz, $CDCl_3$): δ = 158.7, 96.8, 68.1, 9.6, -0.5. **IR** (cm^{-1}) (neat) 2229, 1674. **HRMS** (ESI, *m*/*z*) calcd. for $C_6H_5O_2$ $[M-H]^-$: 109.0290, found: 109.0288.



2v **3-Cyclopentyl-2-propynoic acid (2v)**

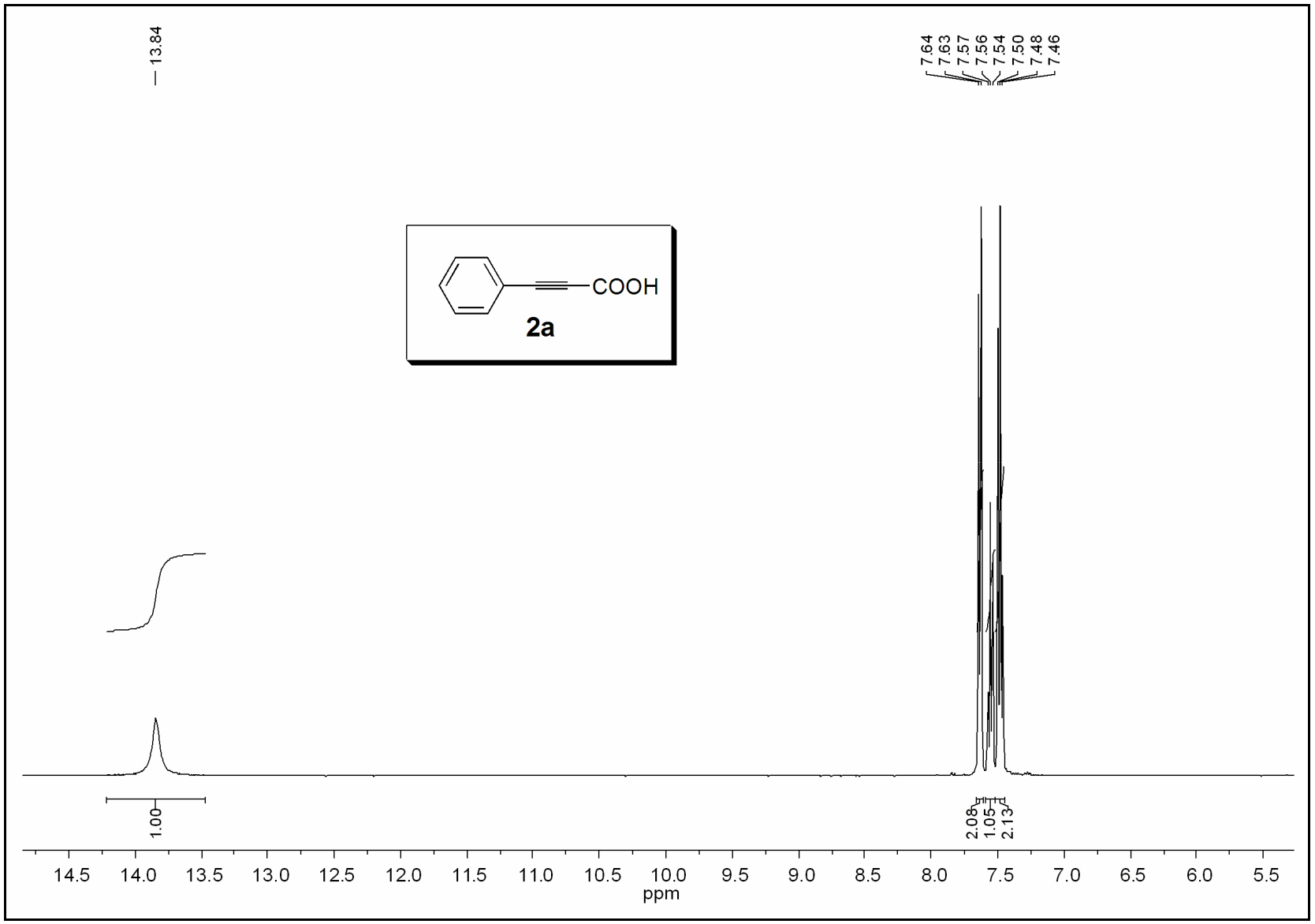
^{1}H NMR (400 MHz, $CDCl_3$): δ = 11.18 (br s, 1H), 2.81-2.74 (m, 1H), 2.00-1.59 (m, 8H). **^{13}C NMR** (100 MHz, $CDCl_3$): δ = 158.0, 95.8, 71.1, 31.9, 28.7, 24.2. **IR** (cm^{-1}) (neat) 2235, 1679. **HRMS** (ESI, *m*/*z*) calcd. for $C_8H_9O_2$ $[M-H]^-$: 137.0603, found: 137.0601.

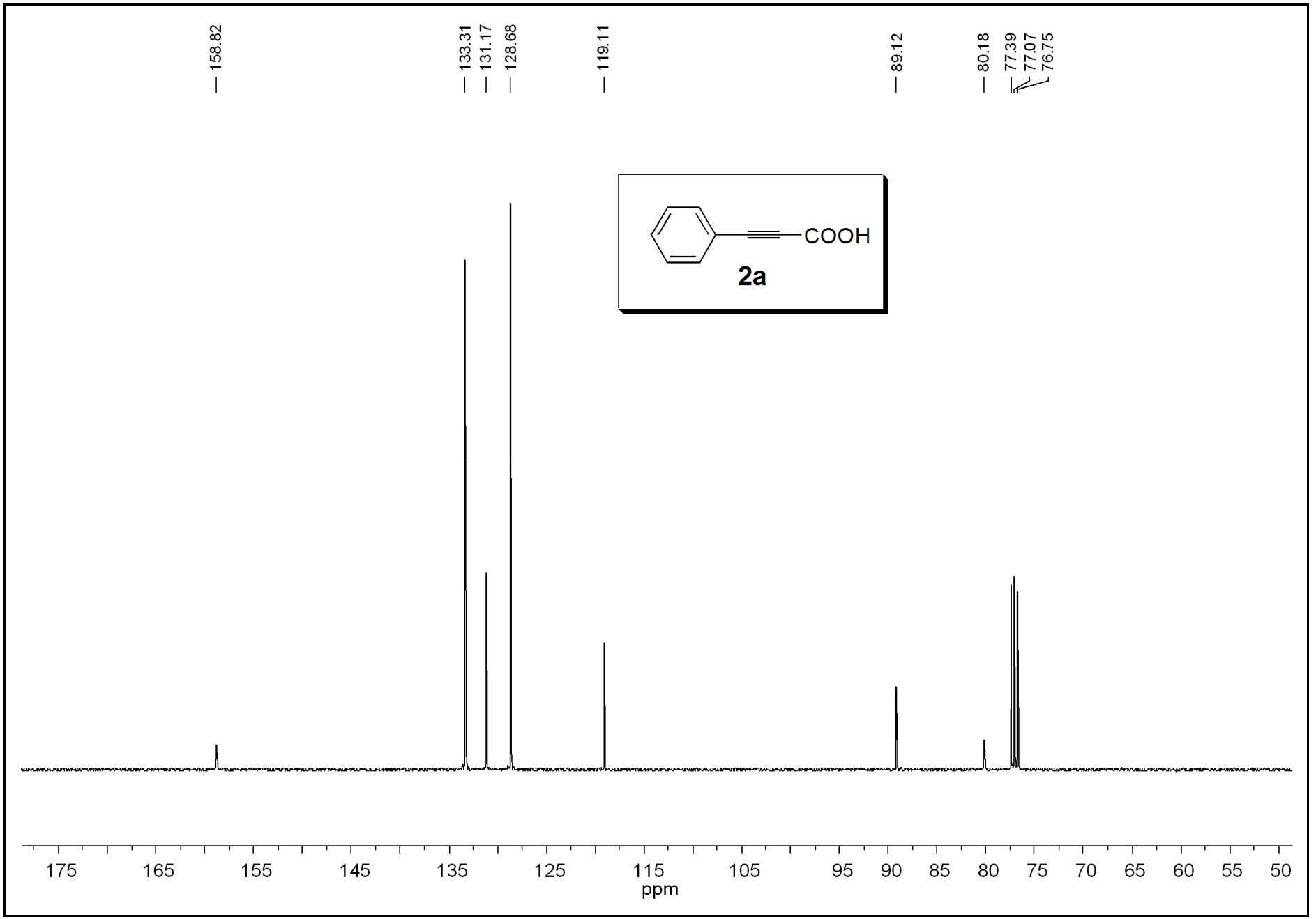
6. References

(1) Teo, B. K.; Xu, Y.-H.; Zhong, B.-Y.; He, Y.-K.; Chen, H.-Y.; Qian, W.; Deng, Y.-J.; Zou, Y. H. *Inorg. Chem.* **2001**, *40*, 6794.

(2) Hiroyuki, H.; Kozo, S.; Hiroshi, H. EP 0143424A2, **1984**.

7. Copies of ^{1}H NMR and ^{13}C NMR Spectra of Products

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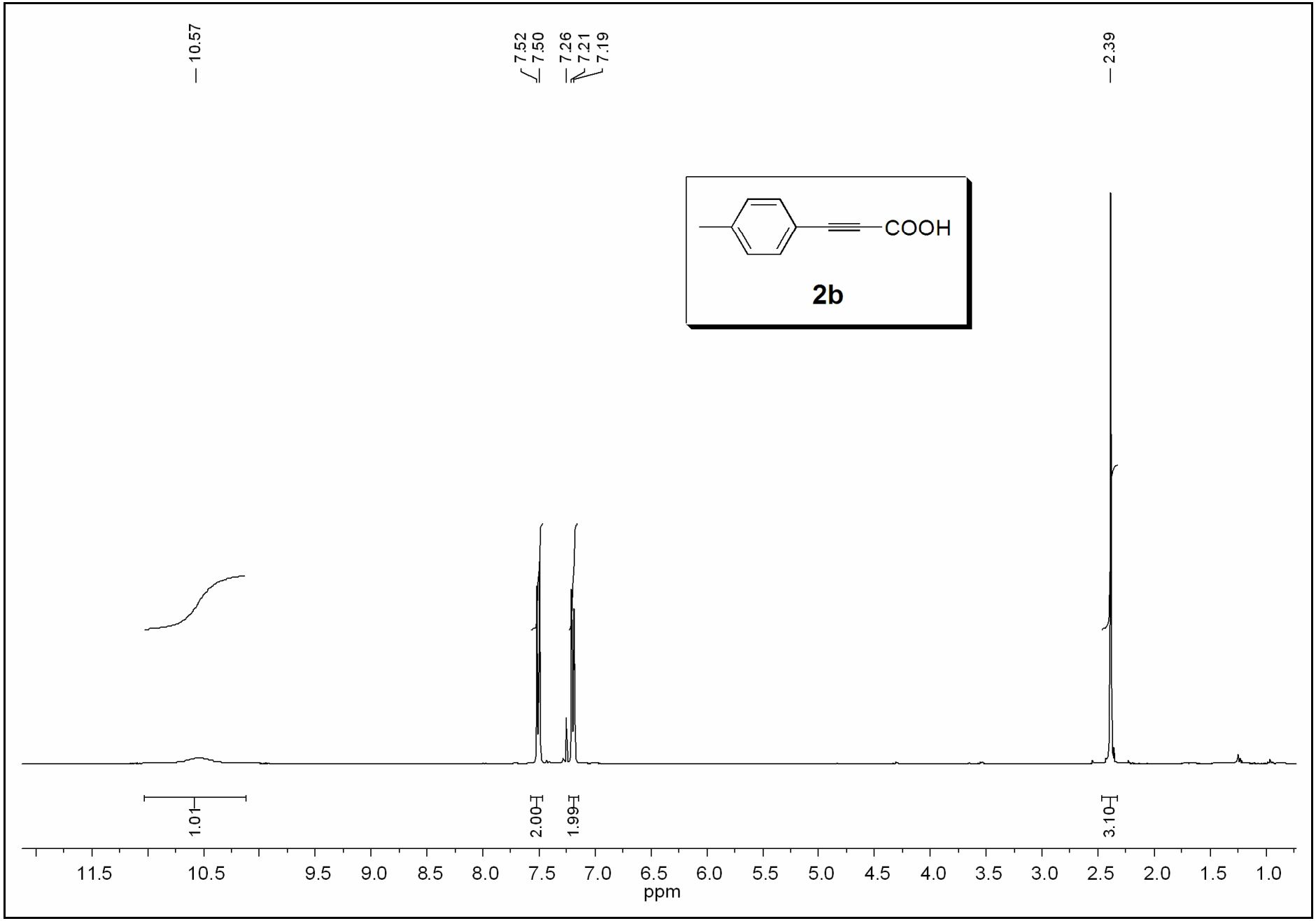
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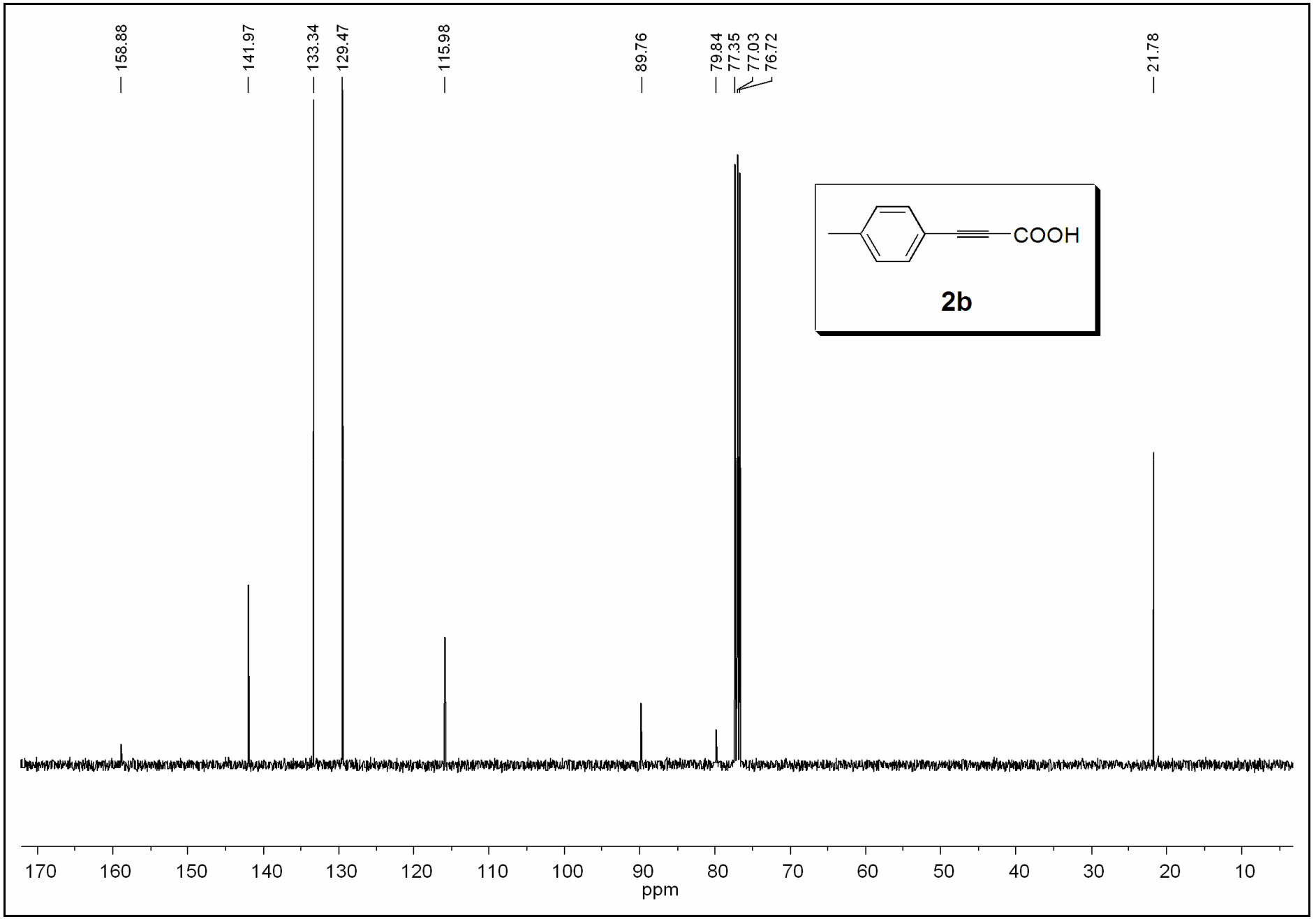
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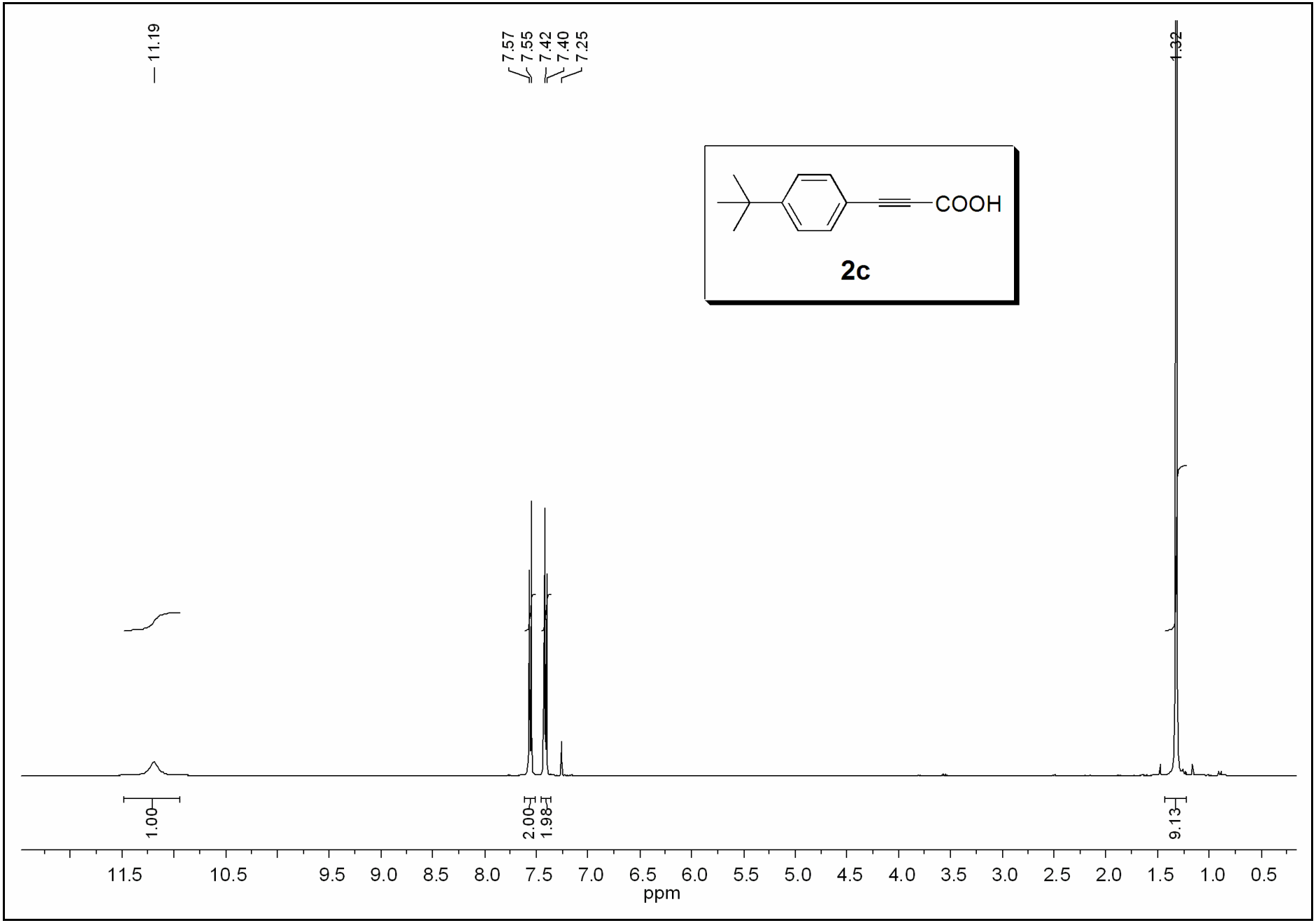
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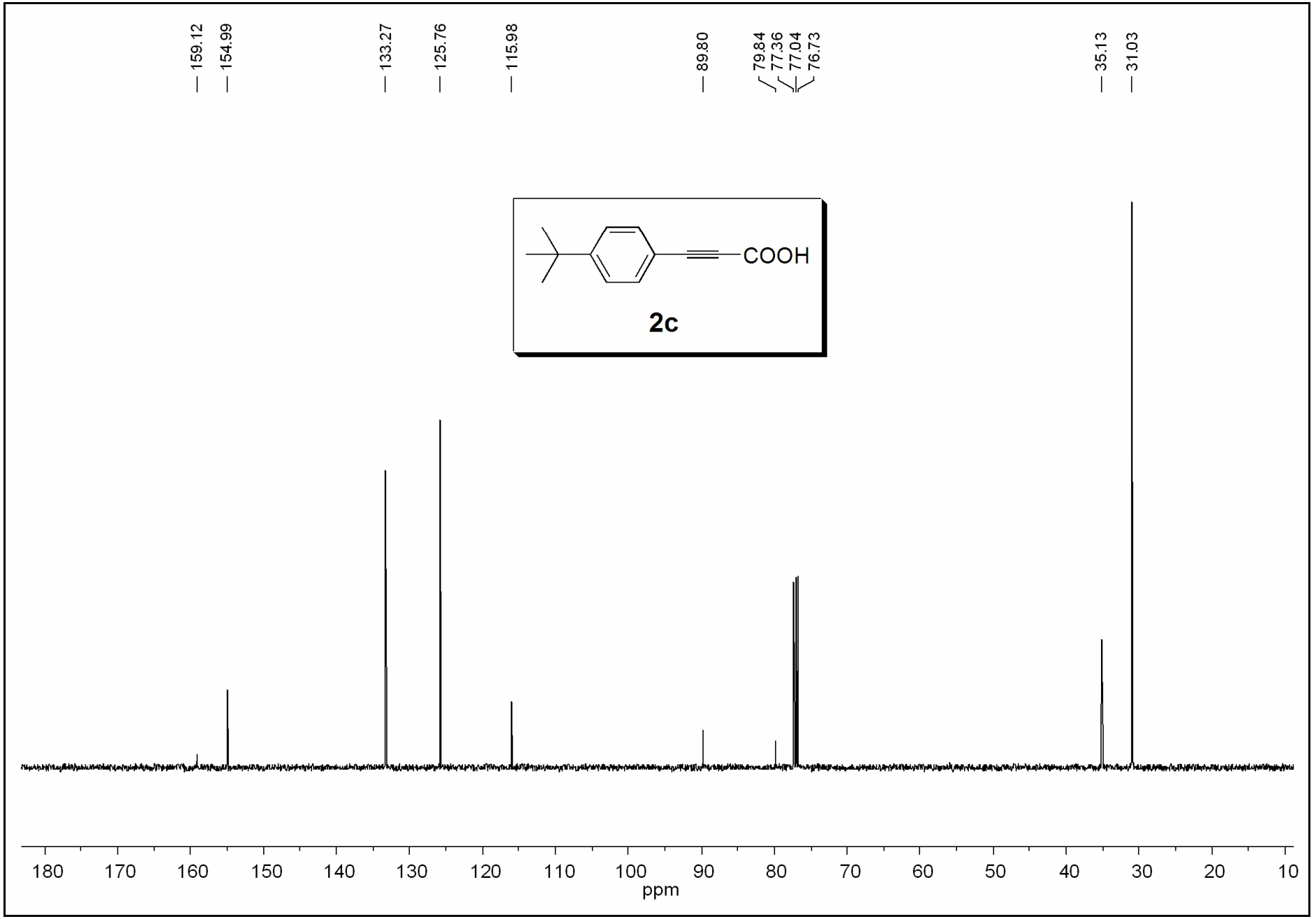
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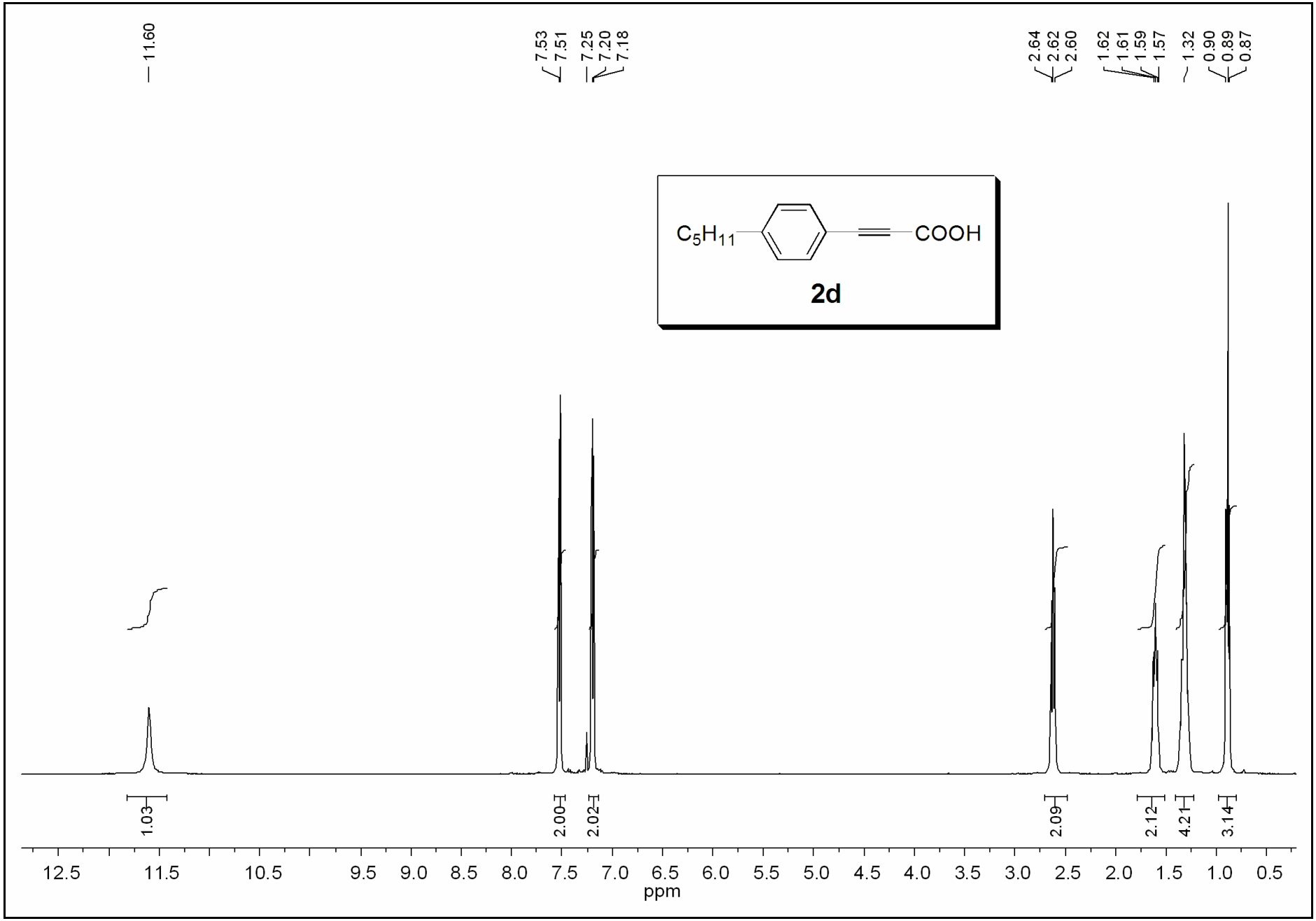
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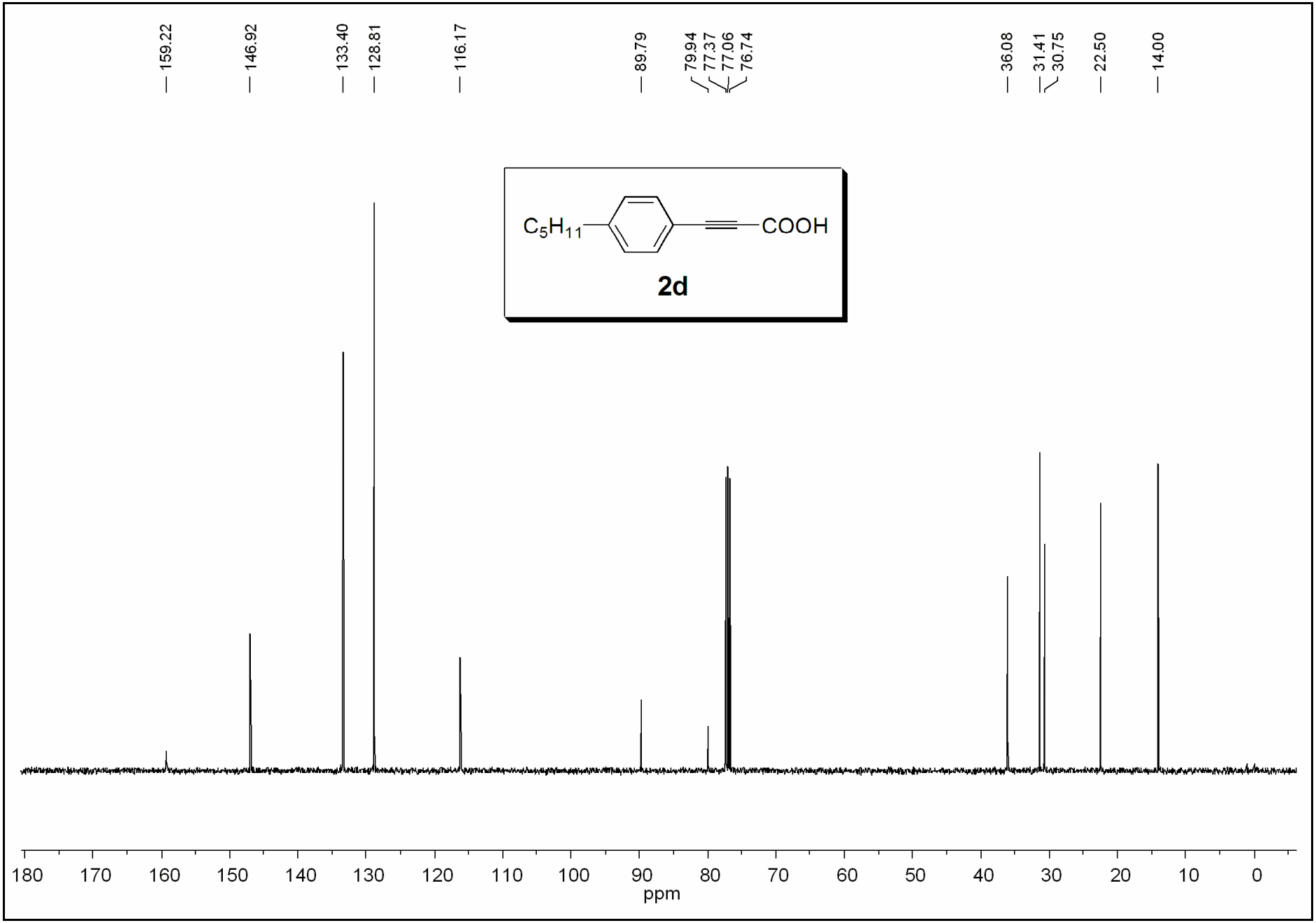
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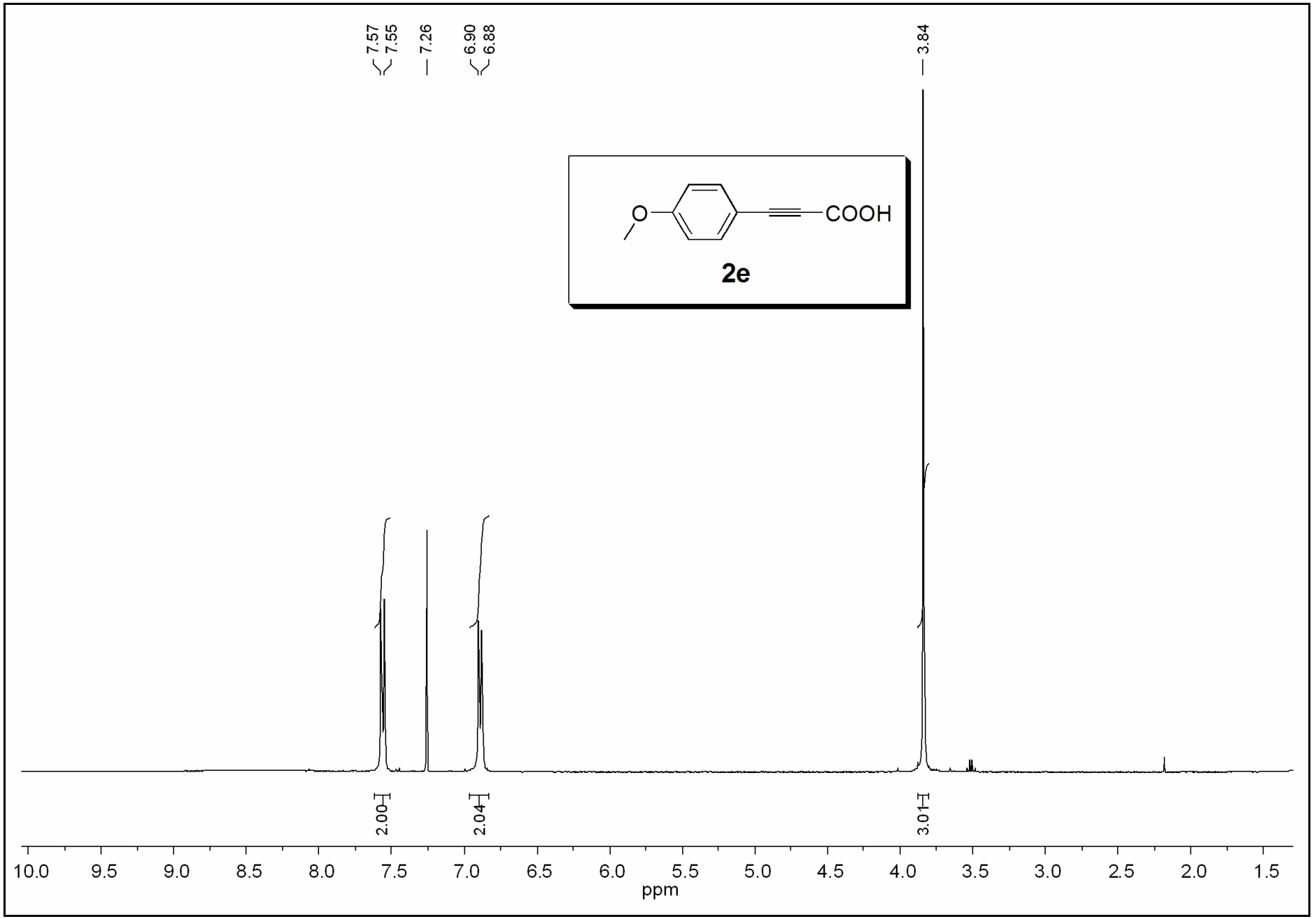
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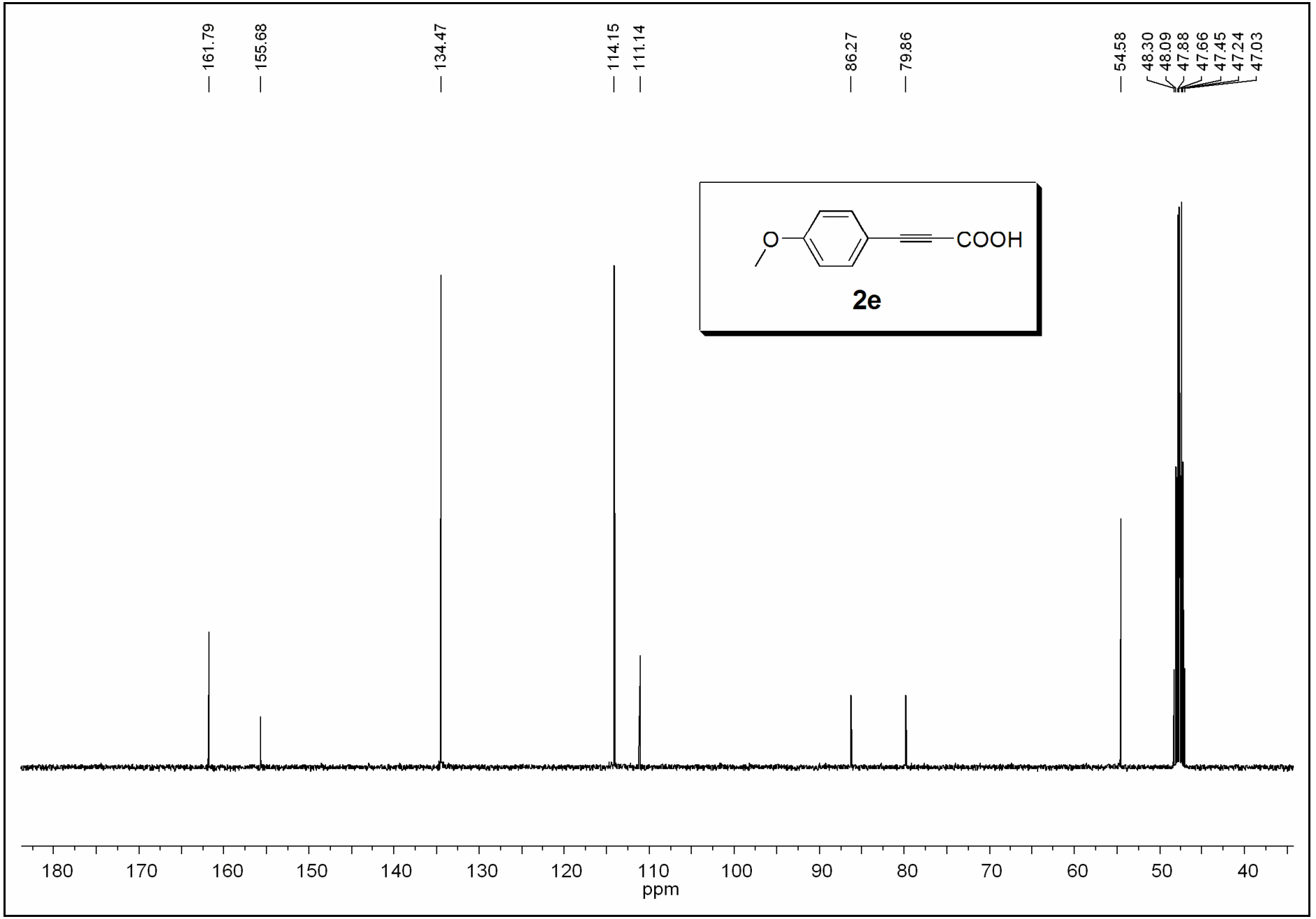
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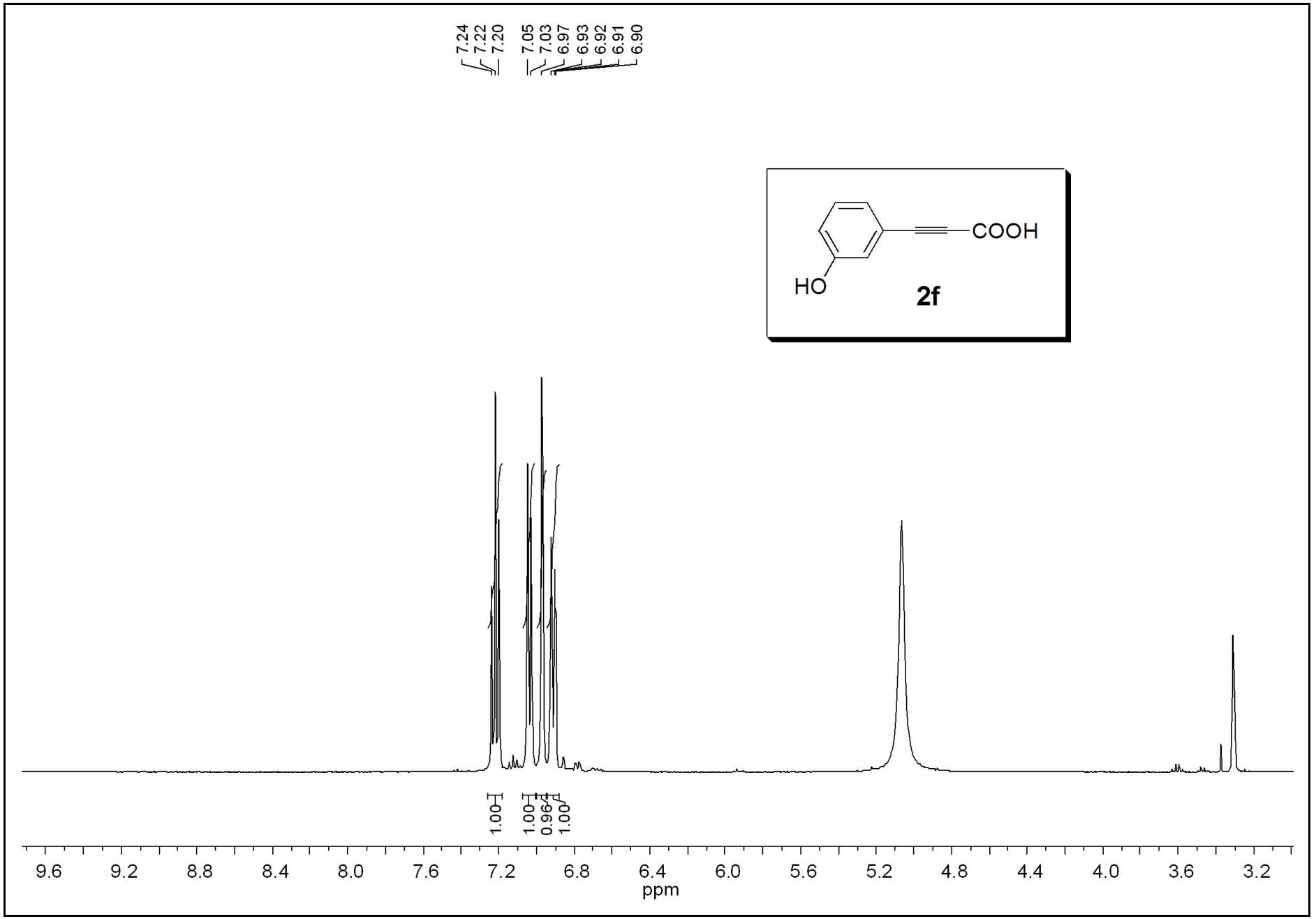
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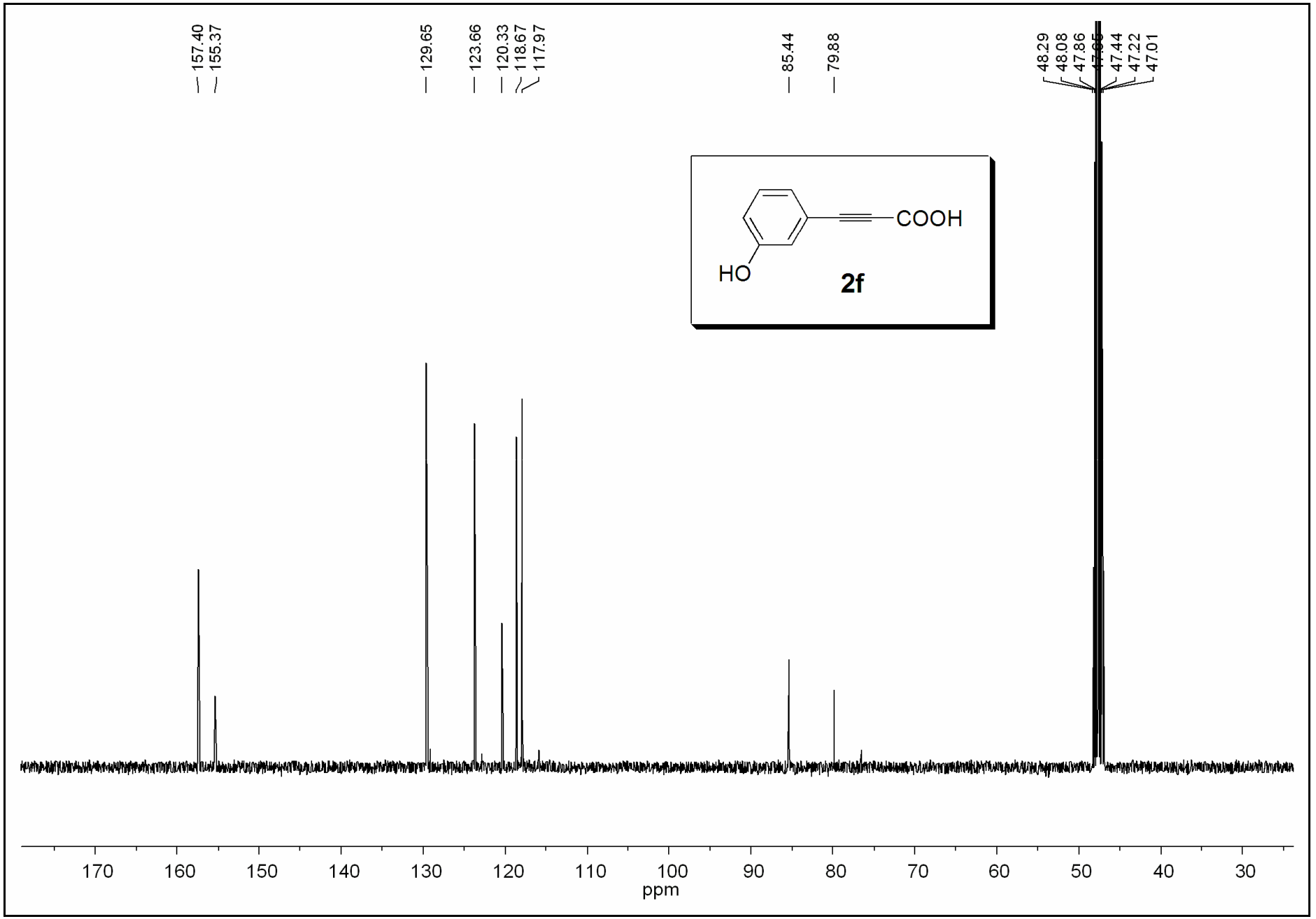
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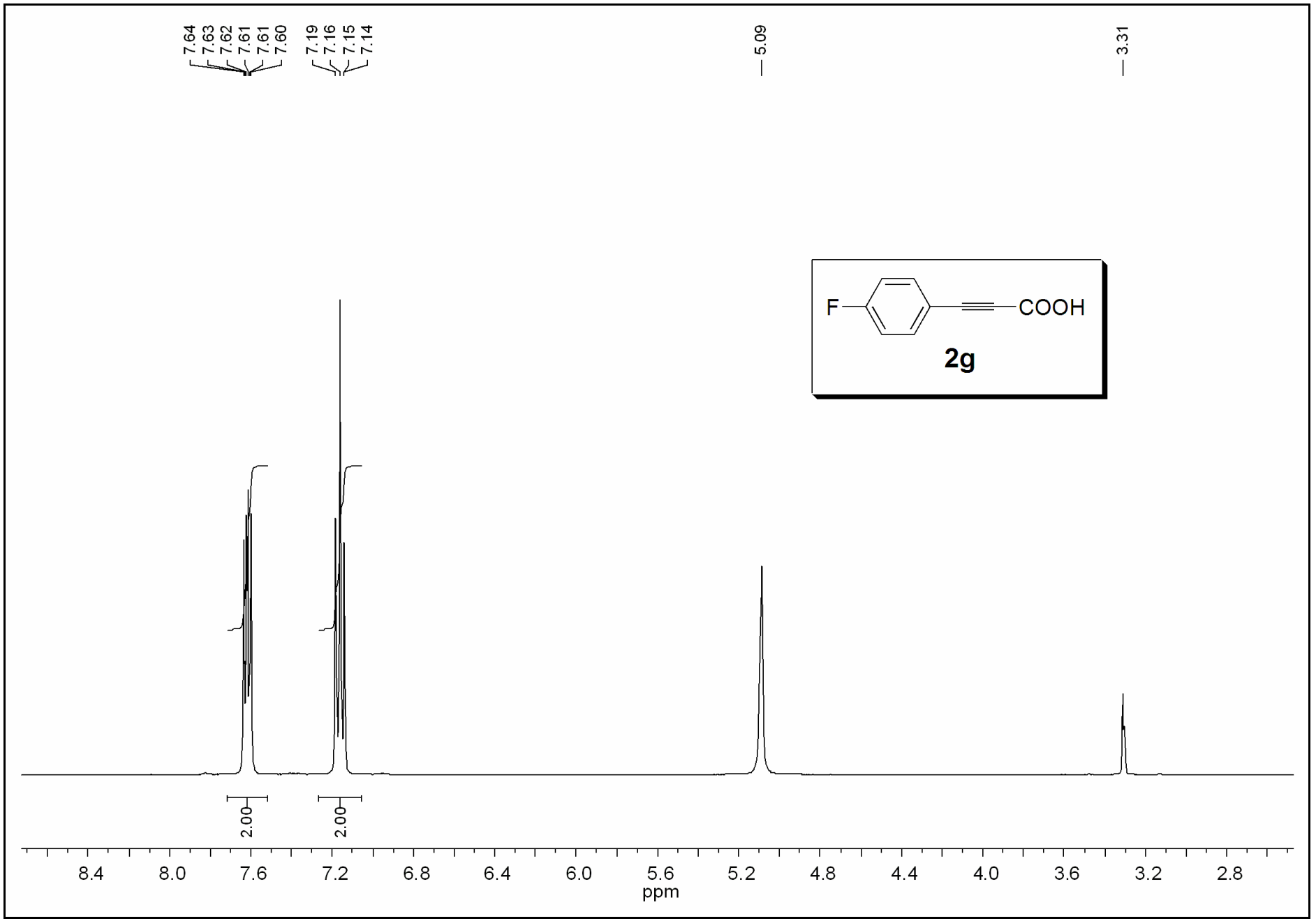
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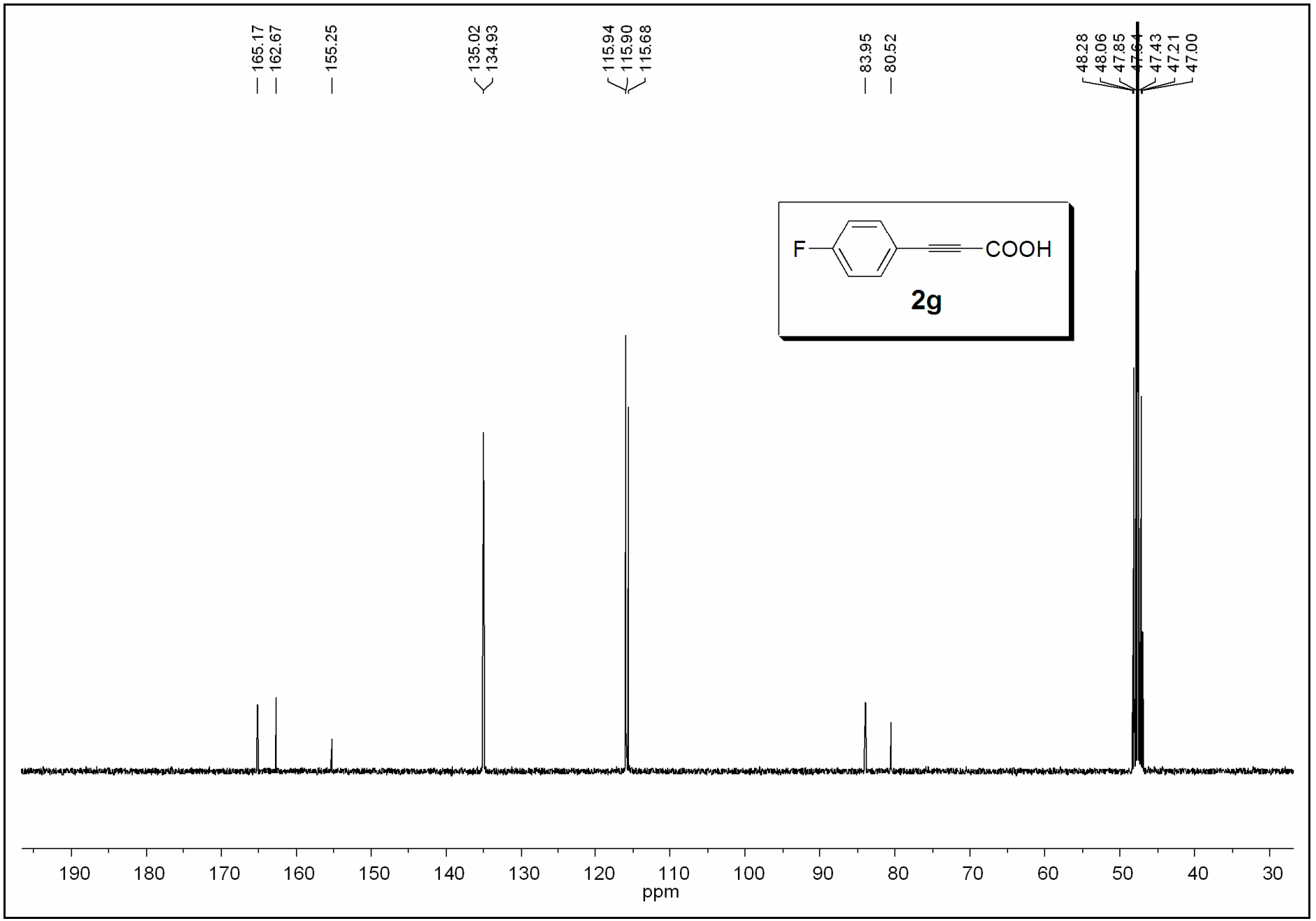
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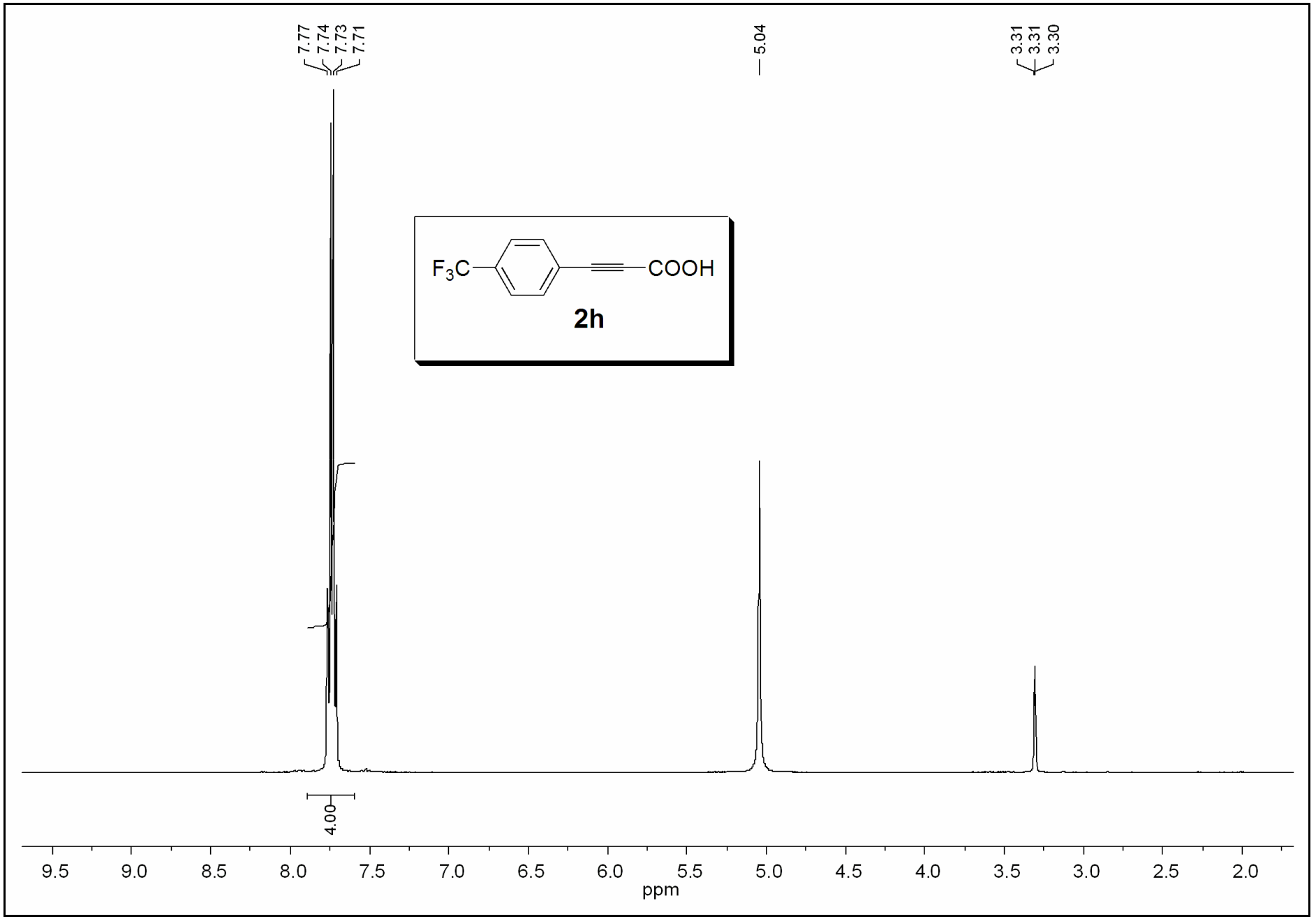
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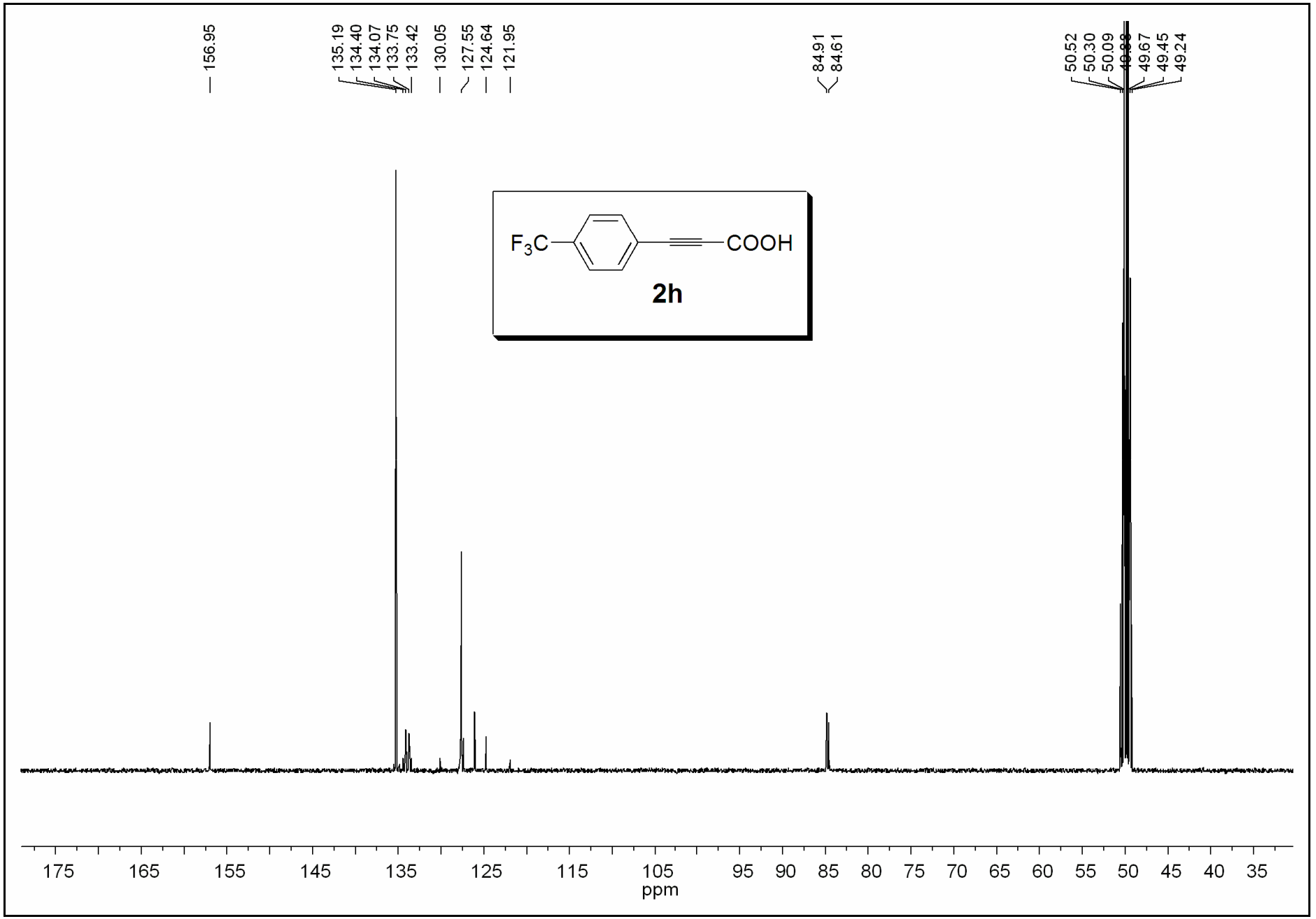
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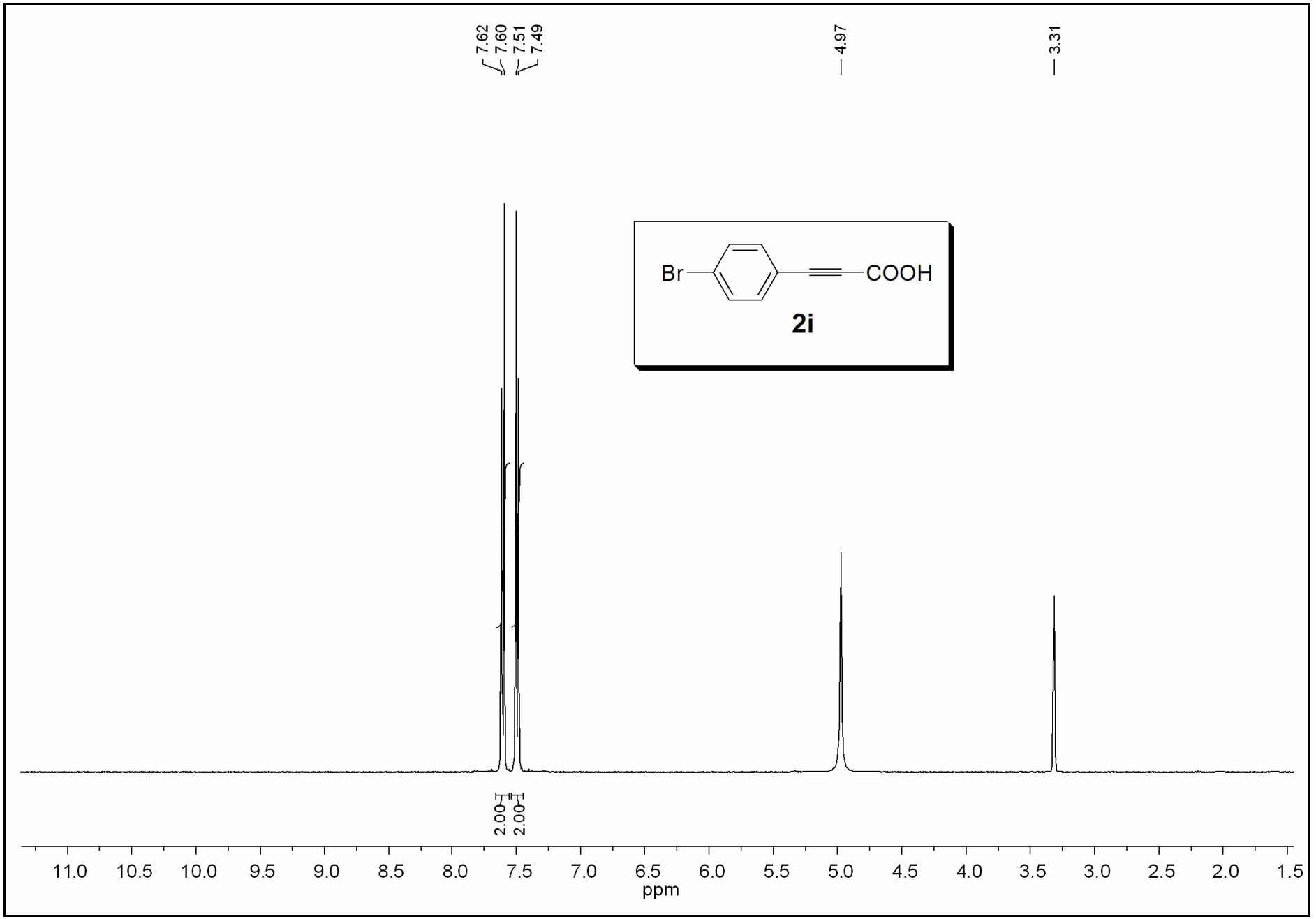
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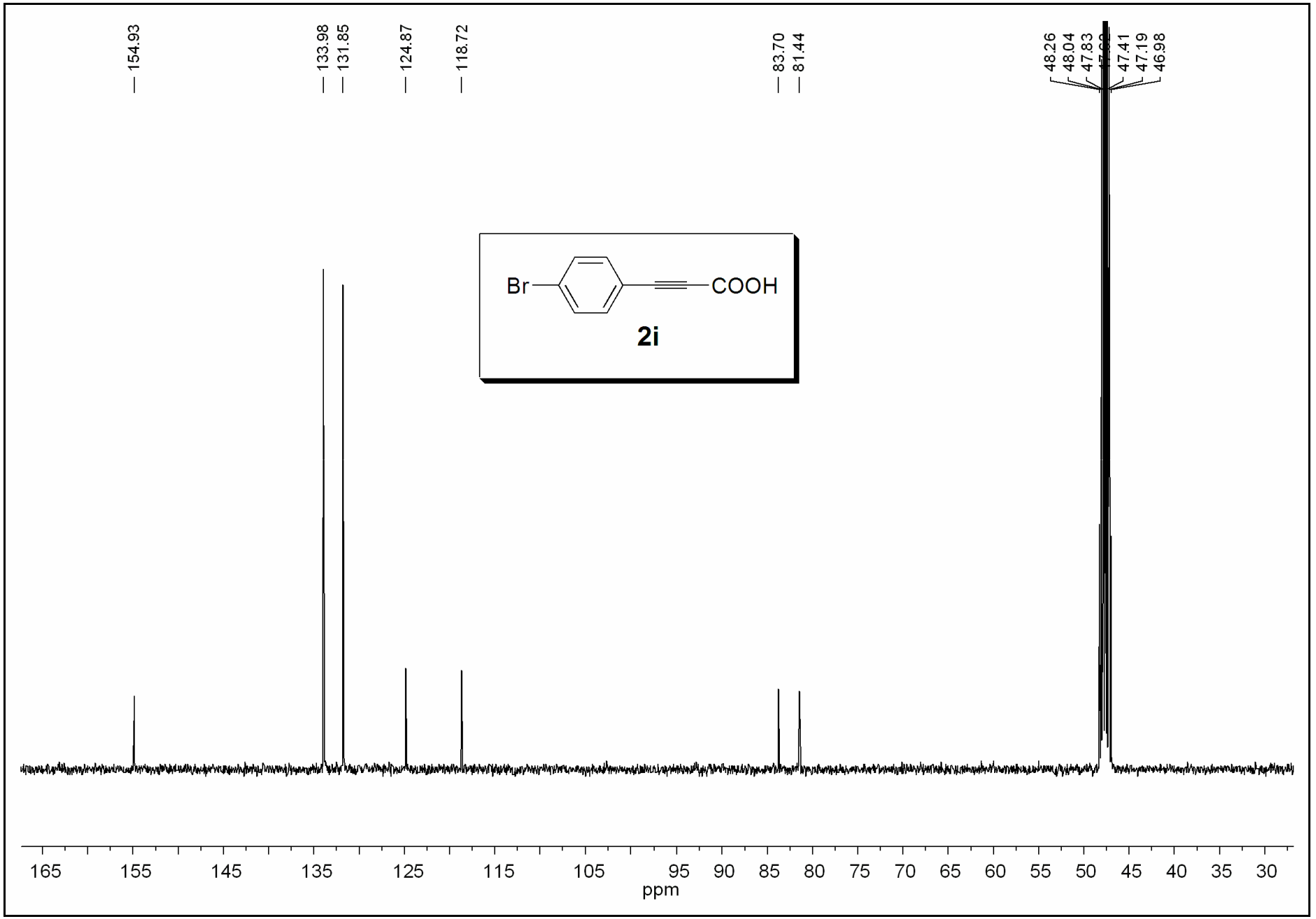
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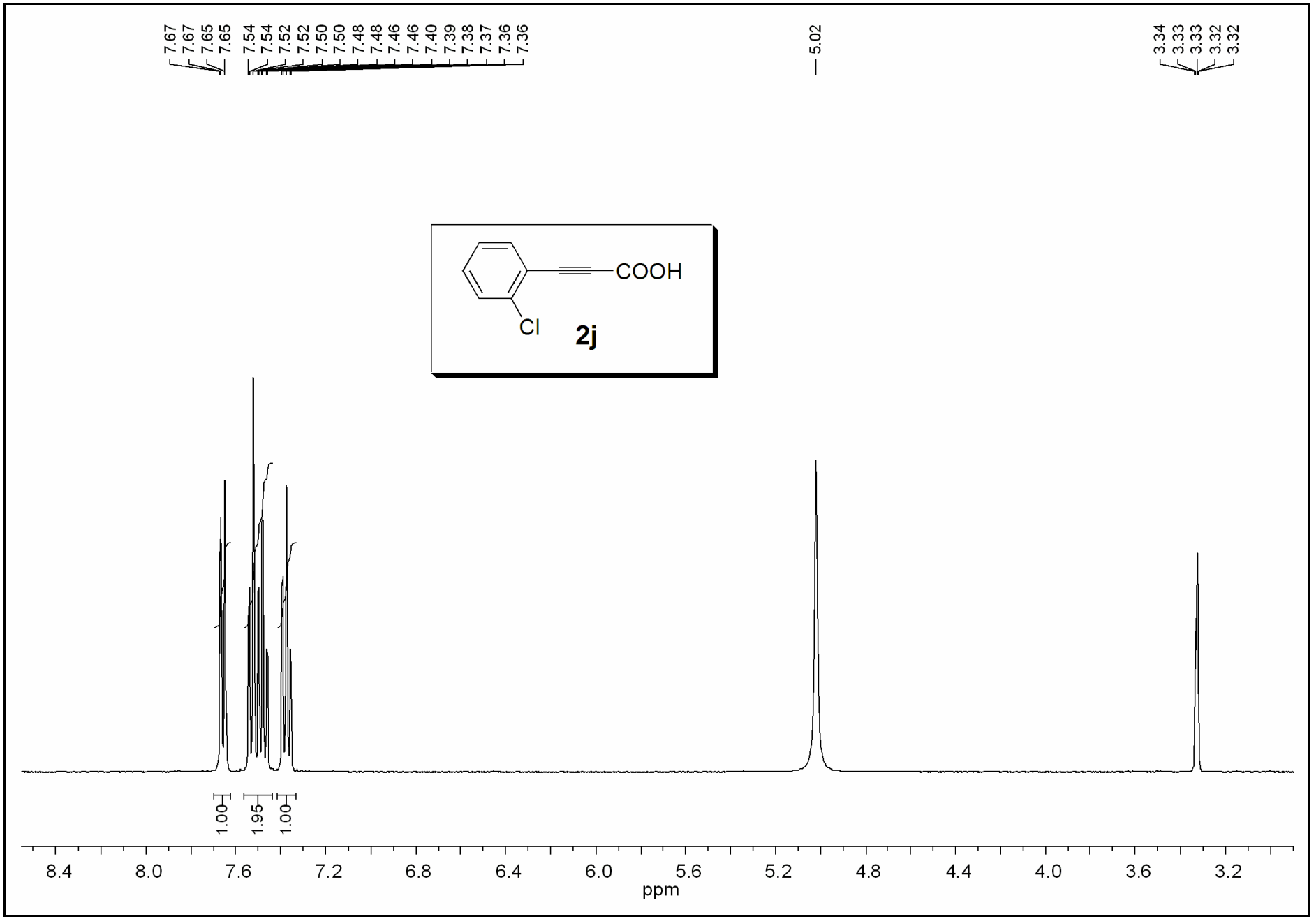
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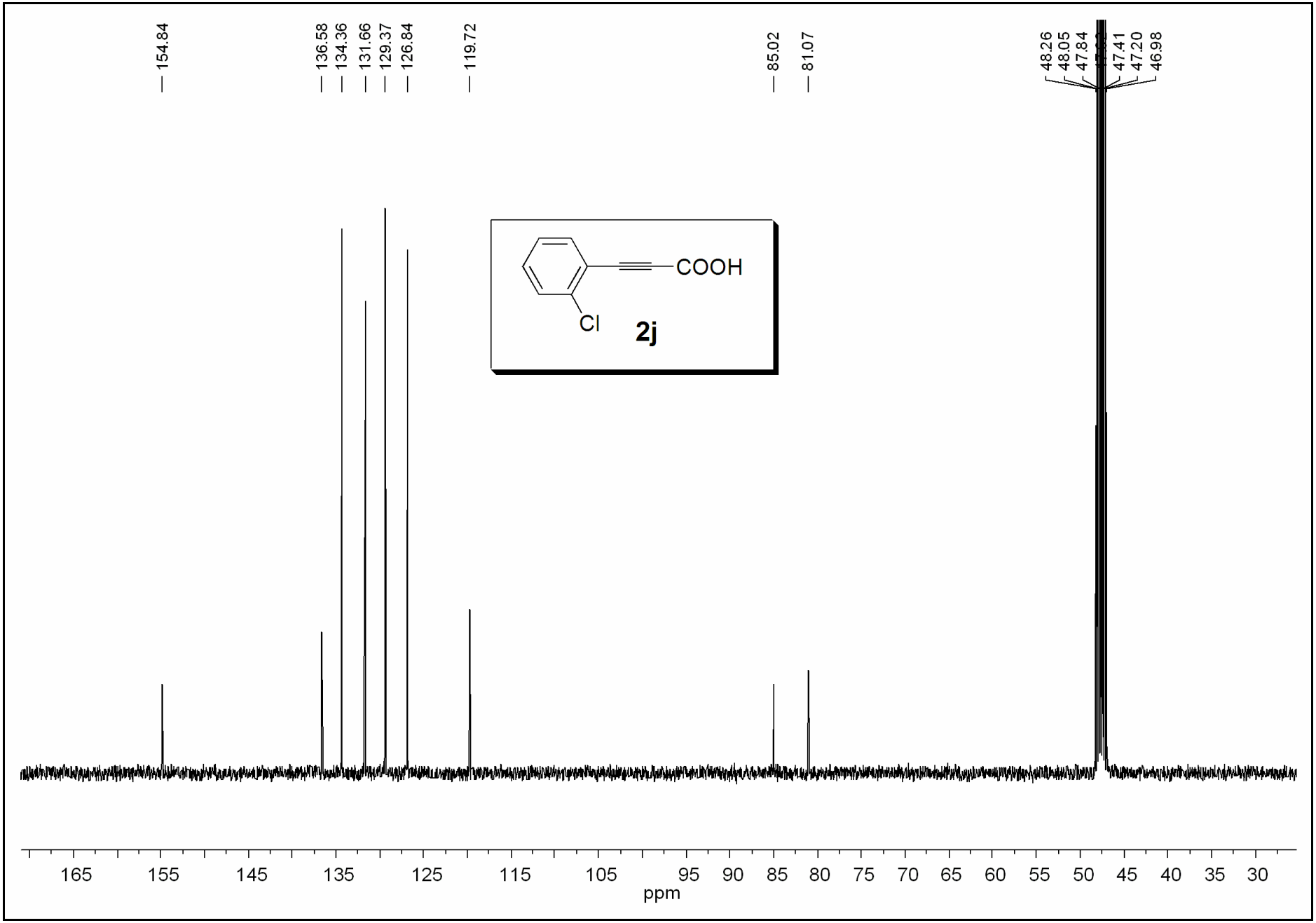
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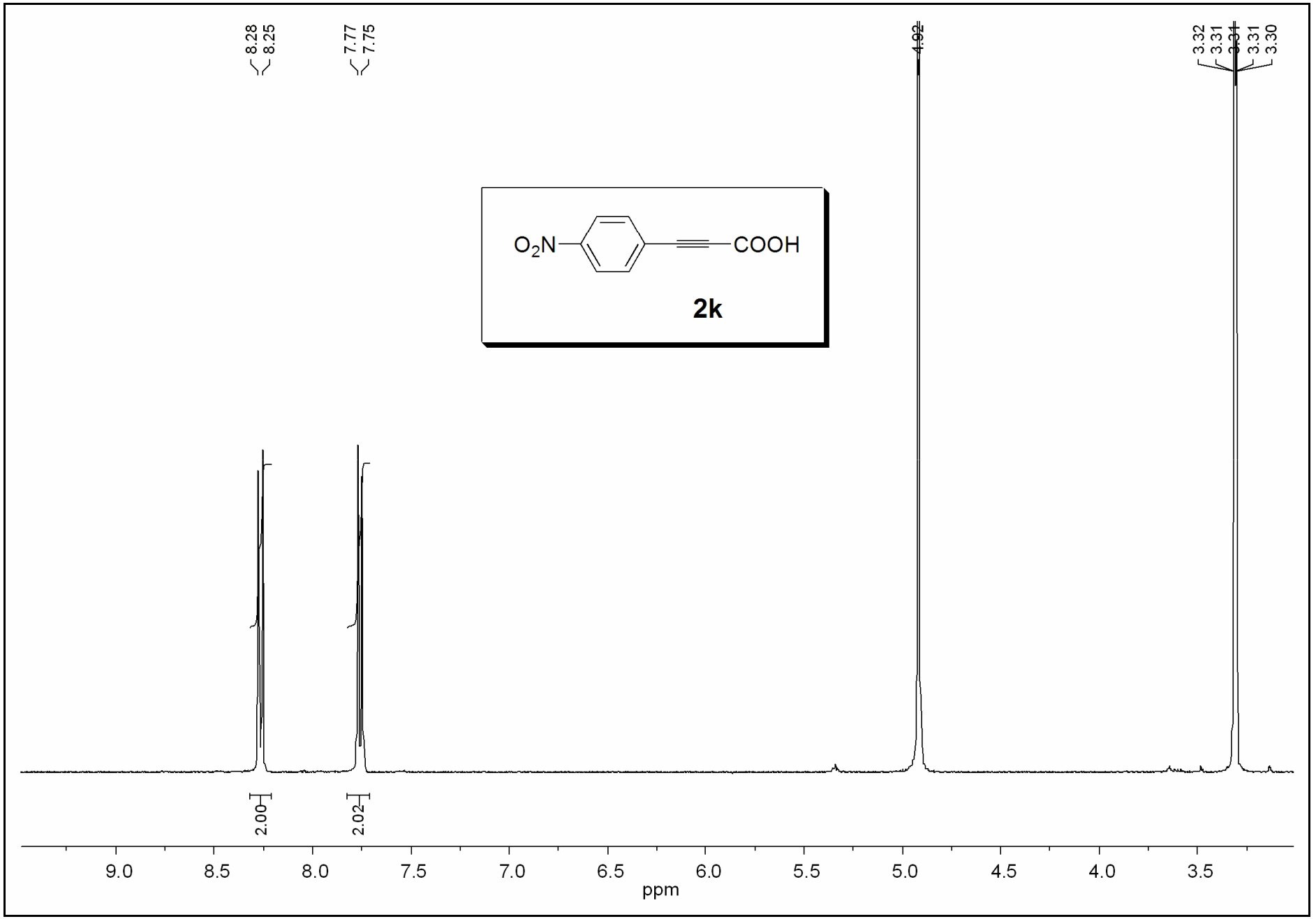
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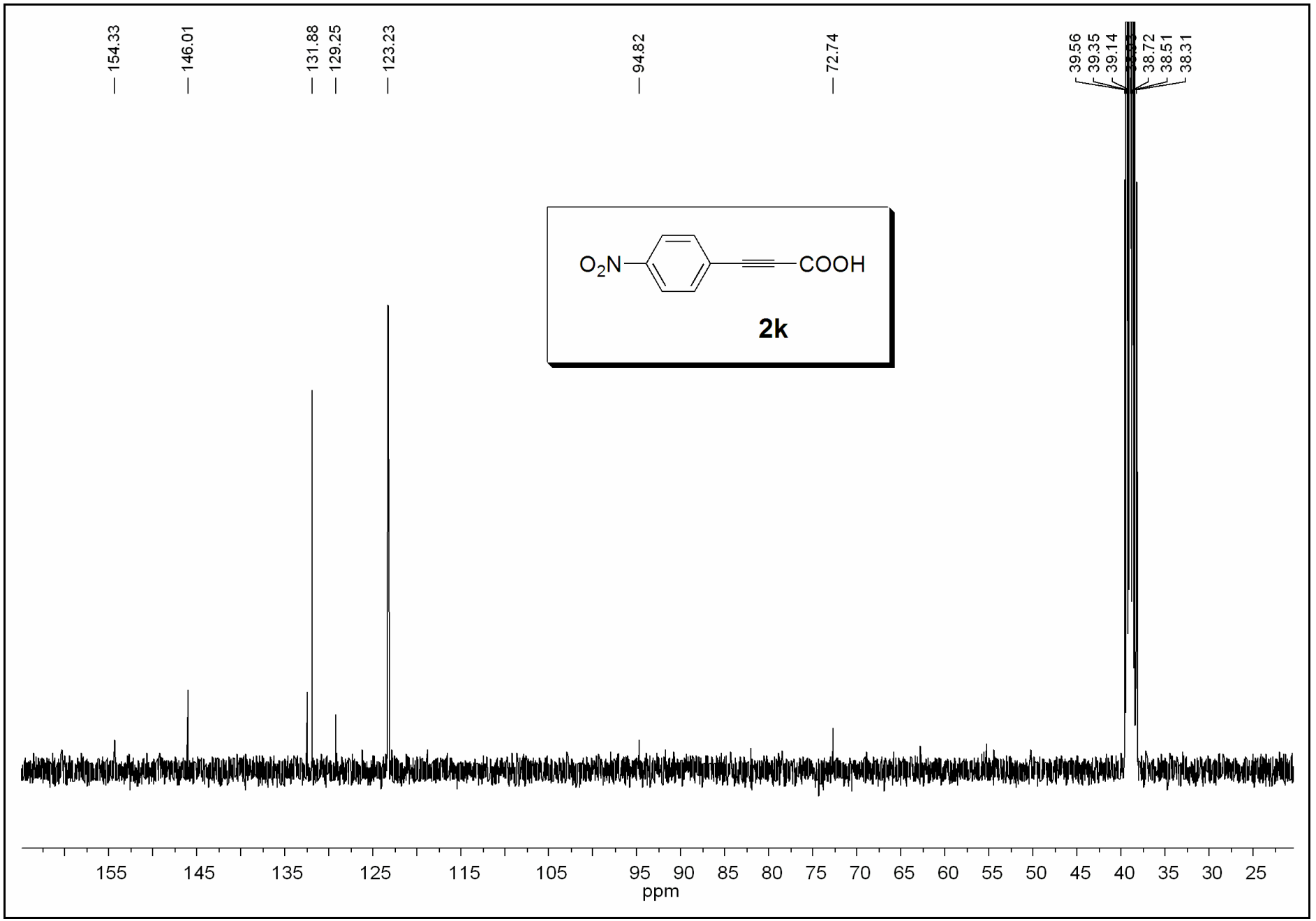
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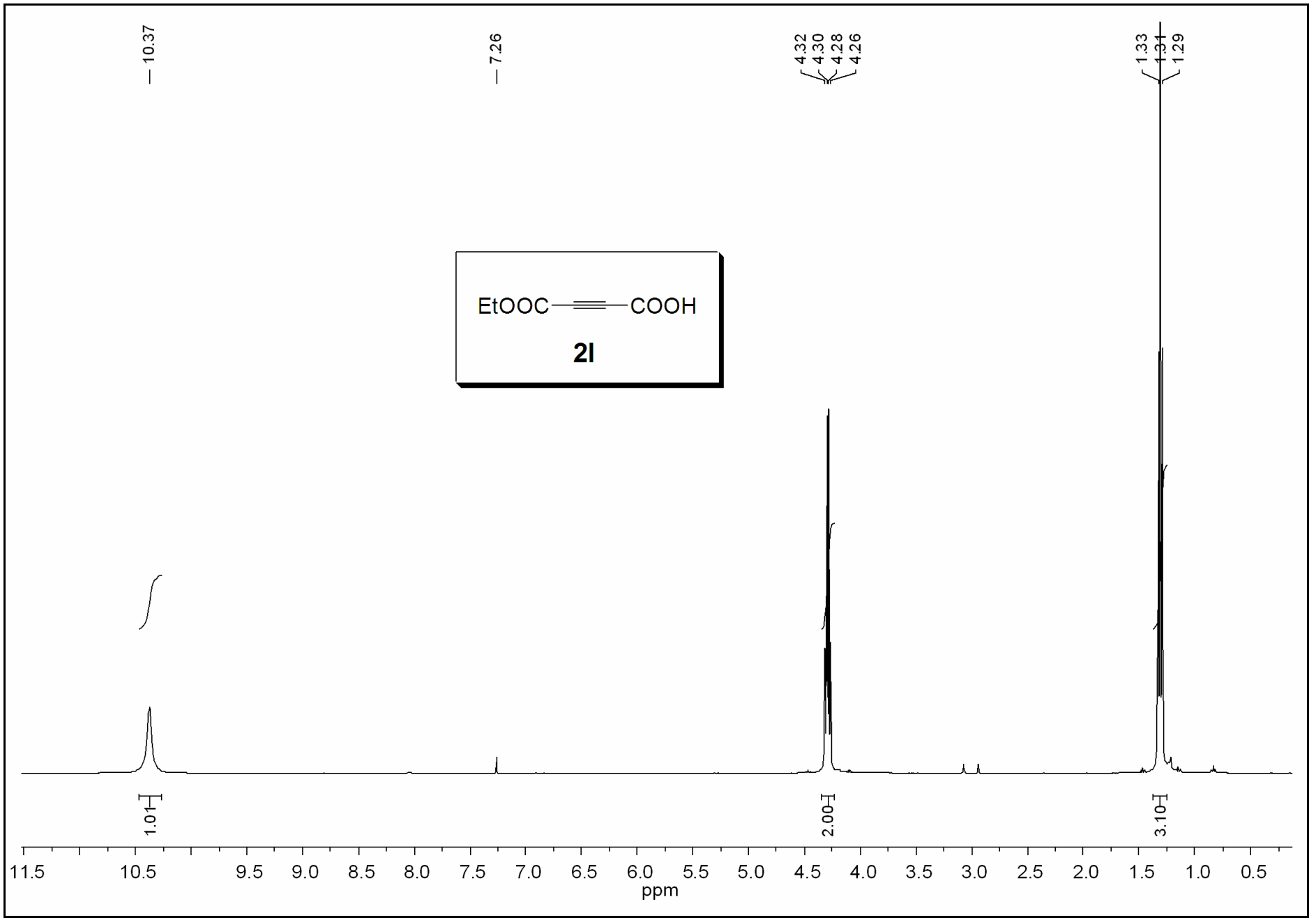
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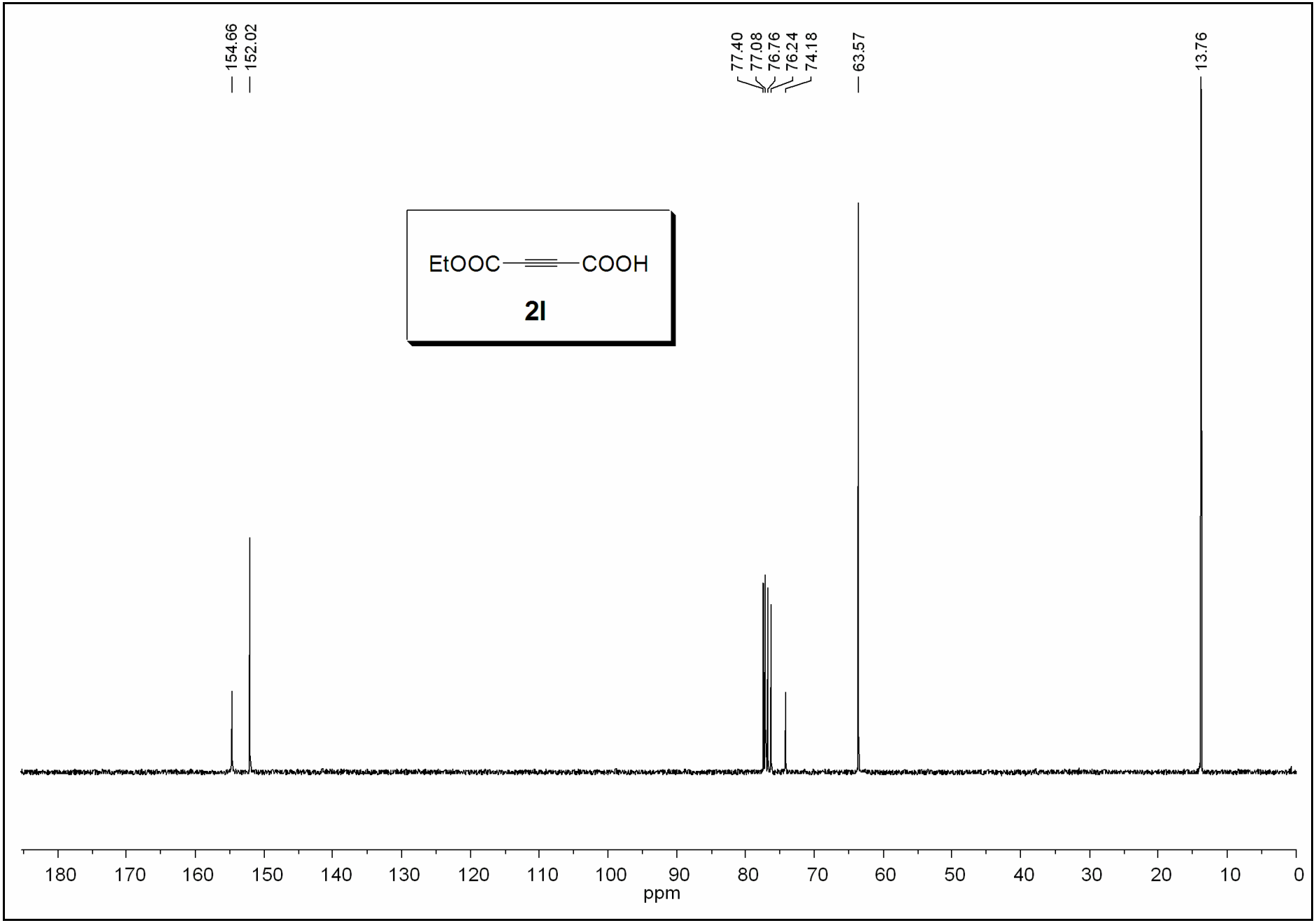
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COOH
2l
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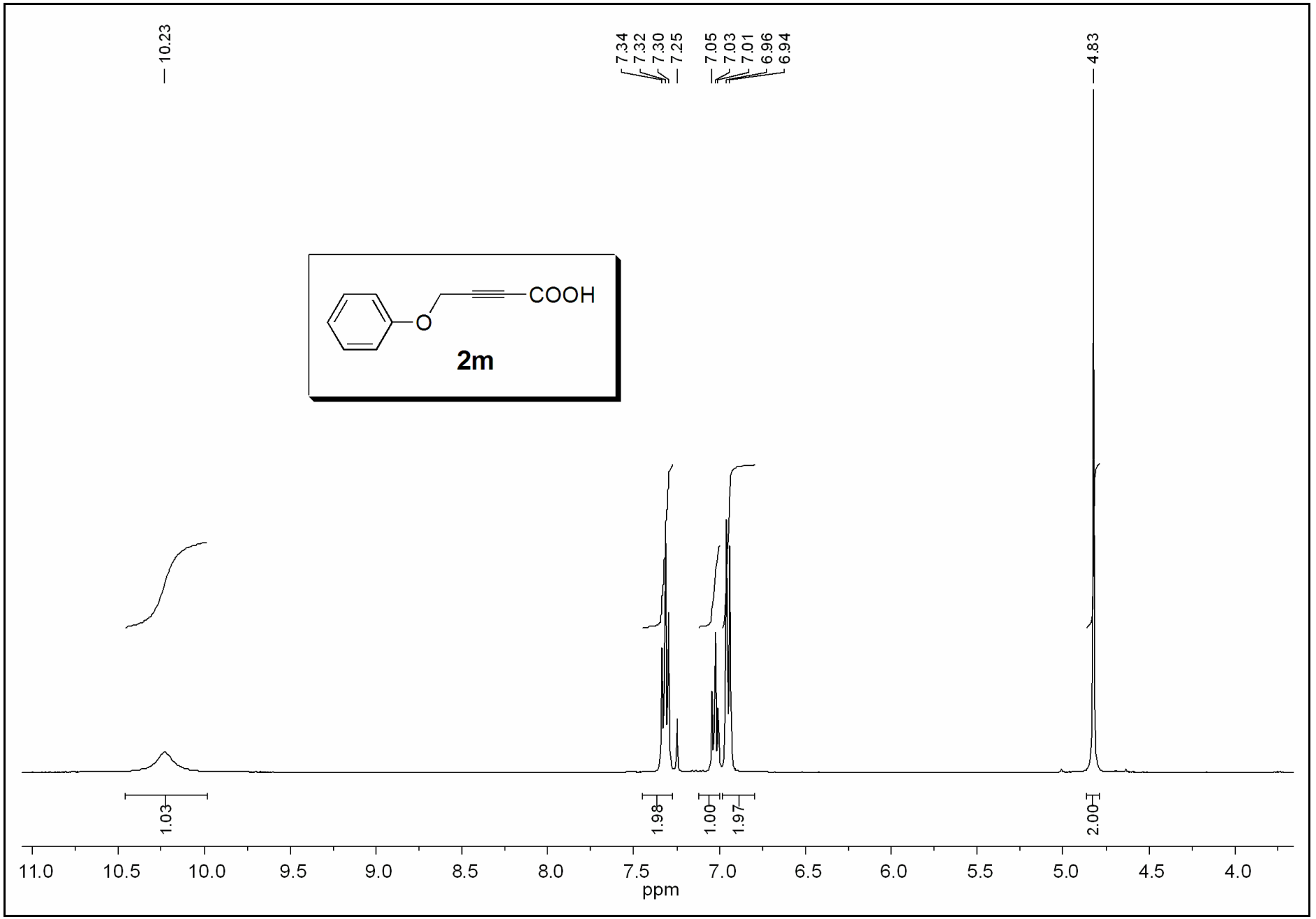
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7.01
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6.94
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O
2m
1.03
1.98
1.00
1.97
2.00
11.0
10.5
10.0
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4.0
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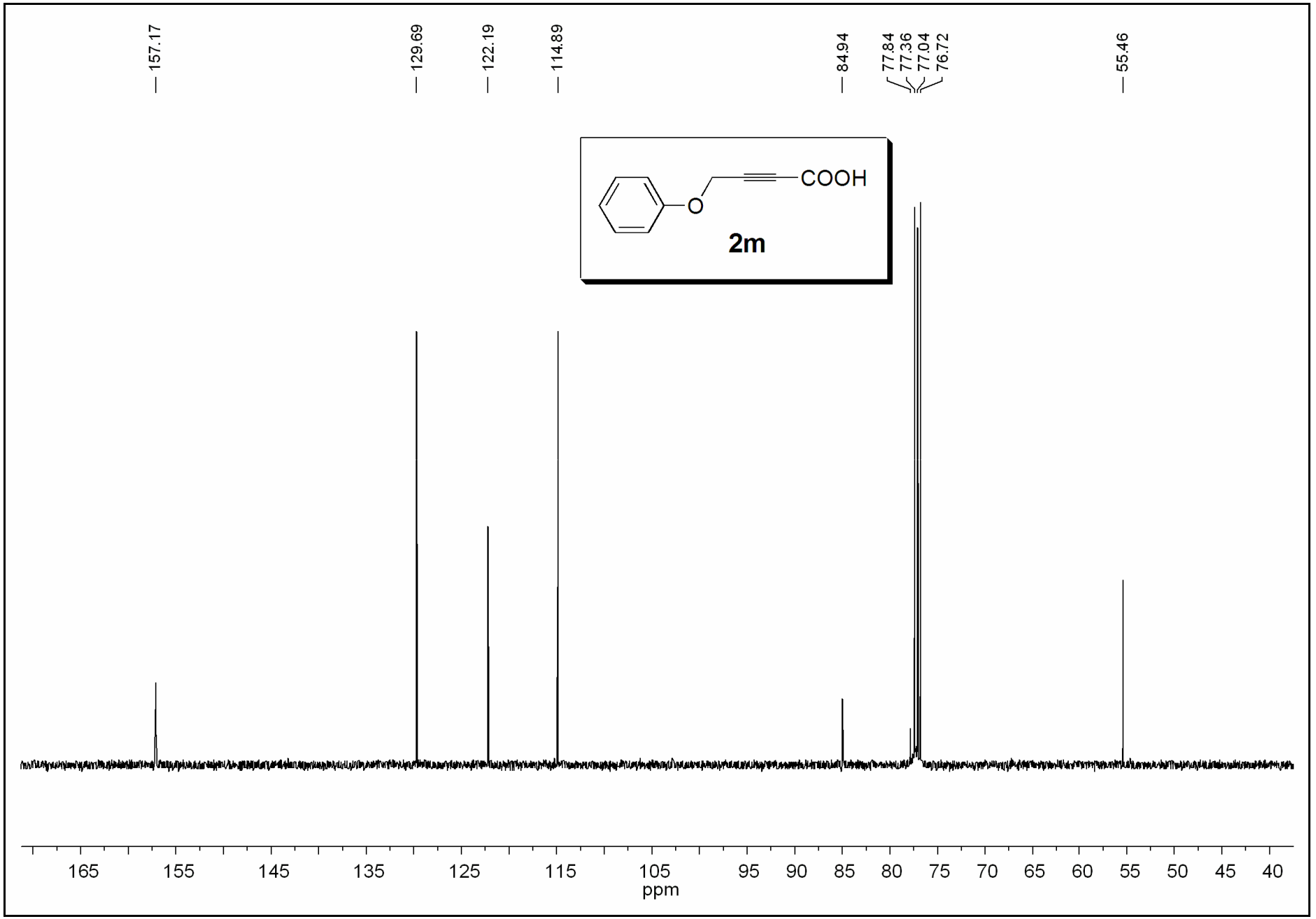
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129.69
122.19
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84.94
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77.04
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55.46
COOH
O
2m
165
155
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125
115
105
95
90
85
80
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70
65
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55
50
45
40
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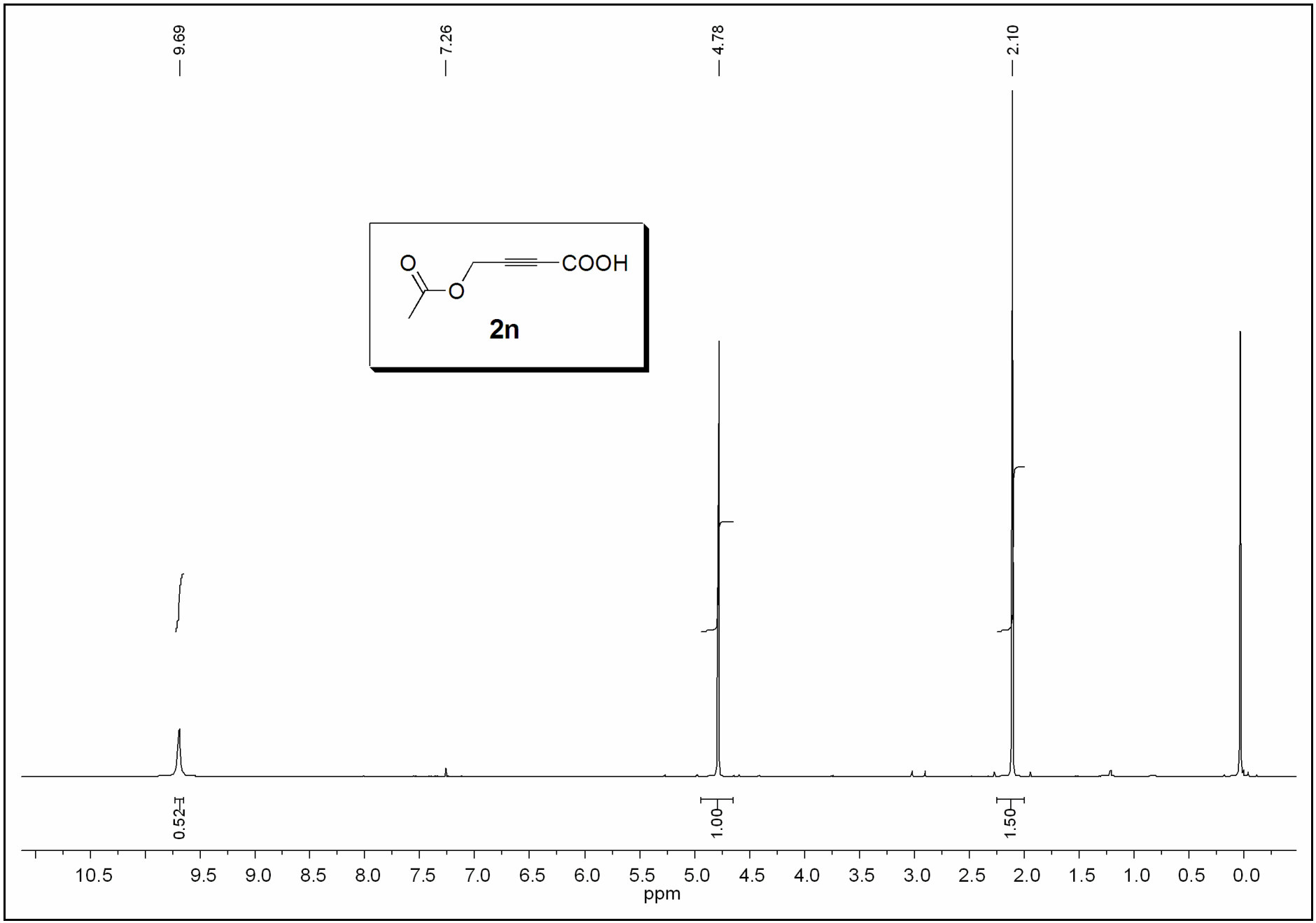
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O
COOH
2n
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8.5
8.0
7.5
7.0
6.5
6.0
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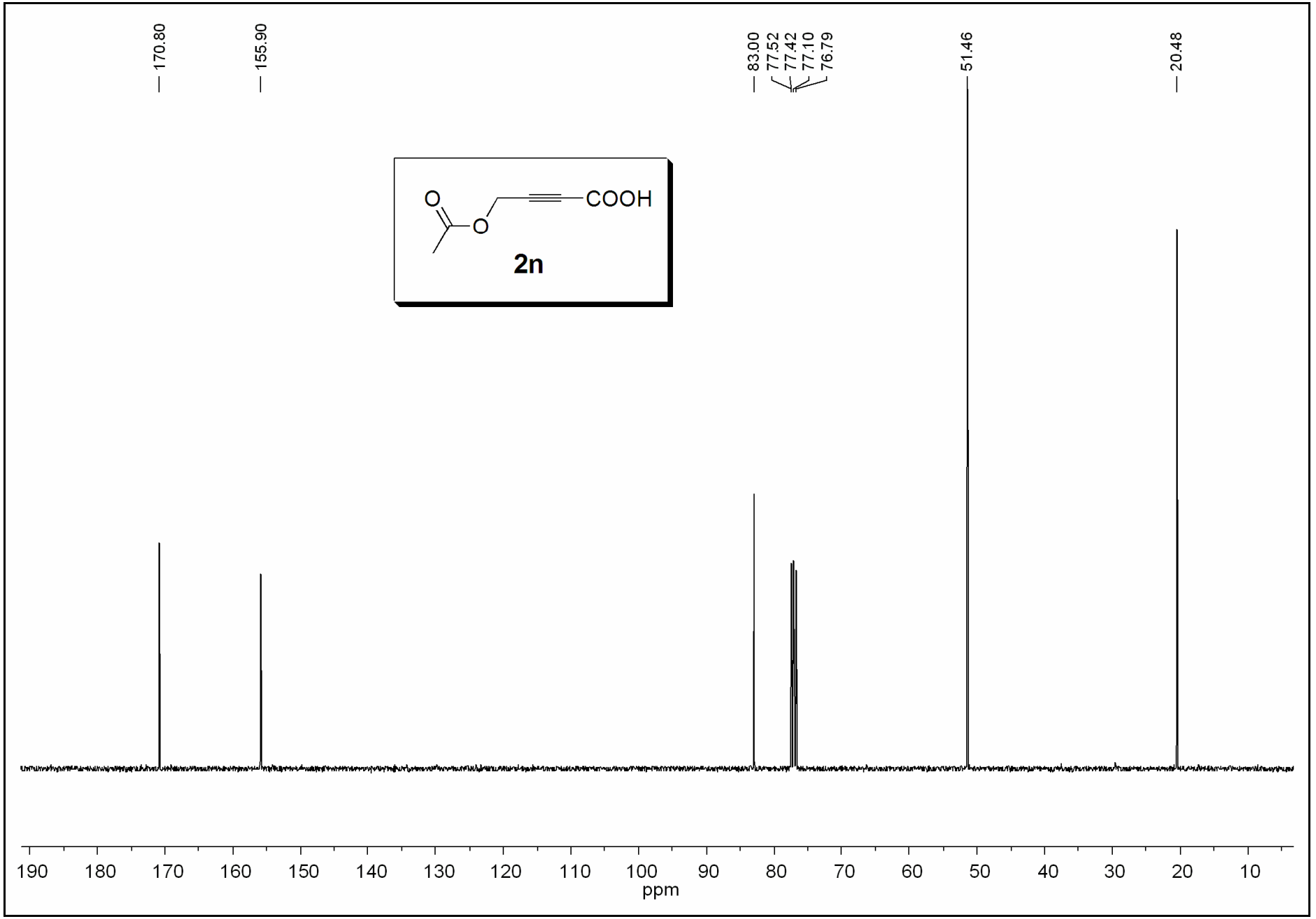
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O
O
COOH
2n
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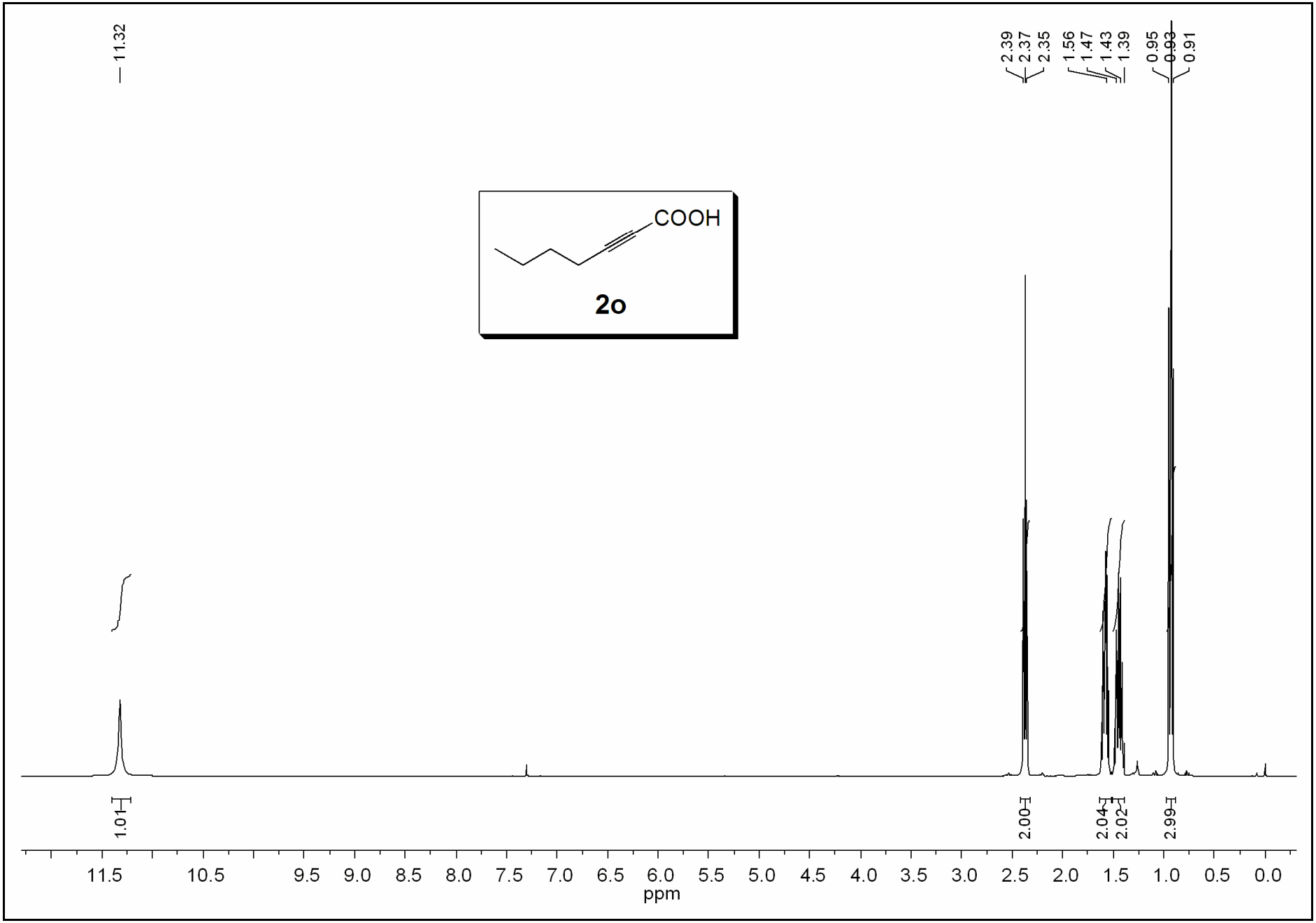
ppm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1.39
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0.93
0.91
COOH
2o
1.01
2.00
2.04
2.02
2.99
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
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4.0
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3.0
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1.5
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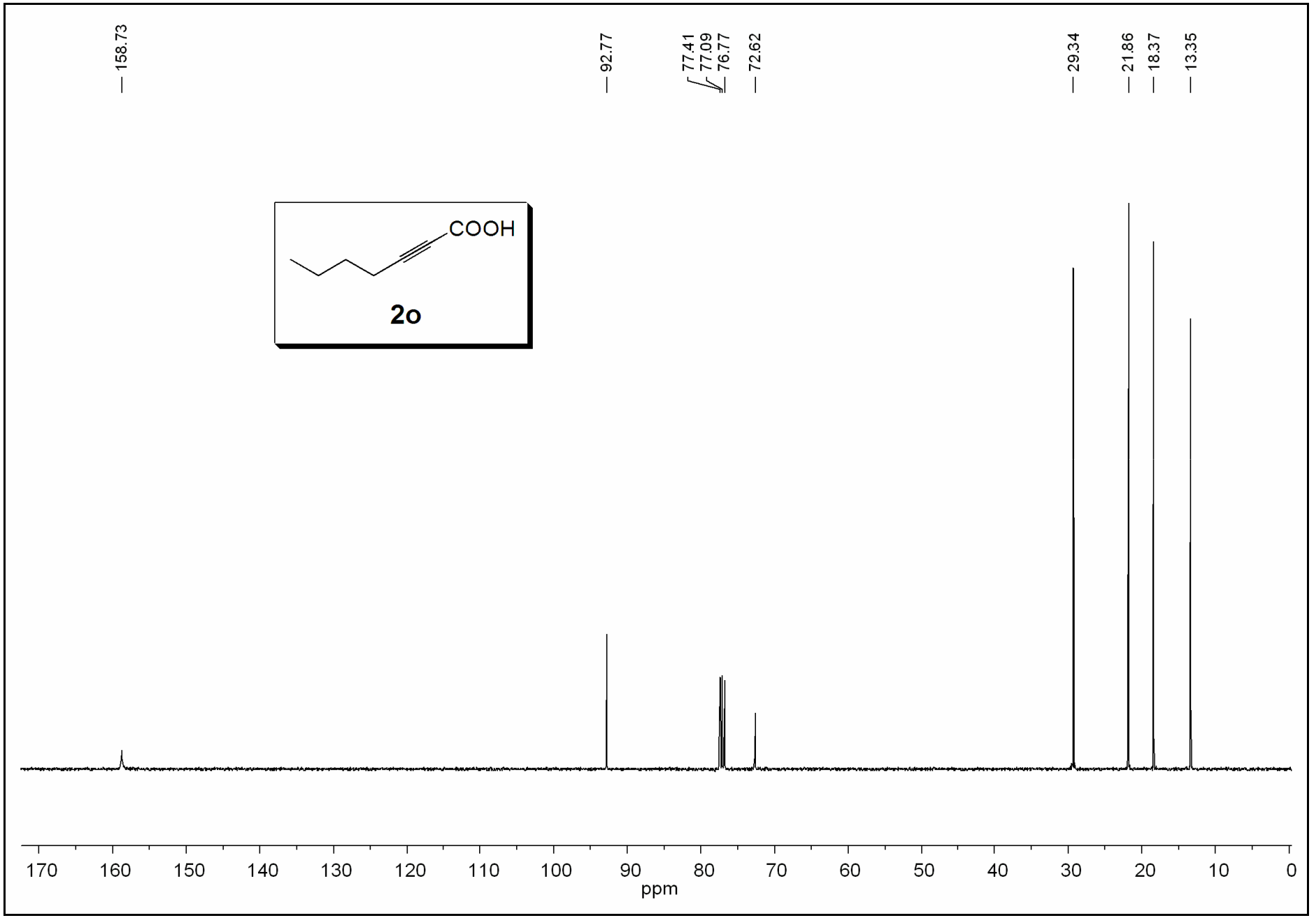
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92.77
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76.77
72.62
29.34
21.86
18.37
13.35
COOH
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140
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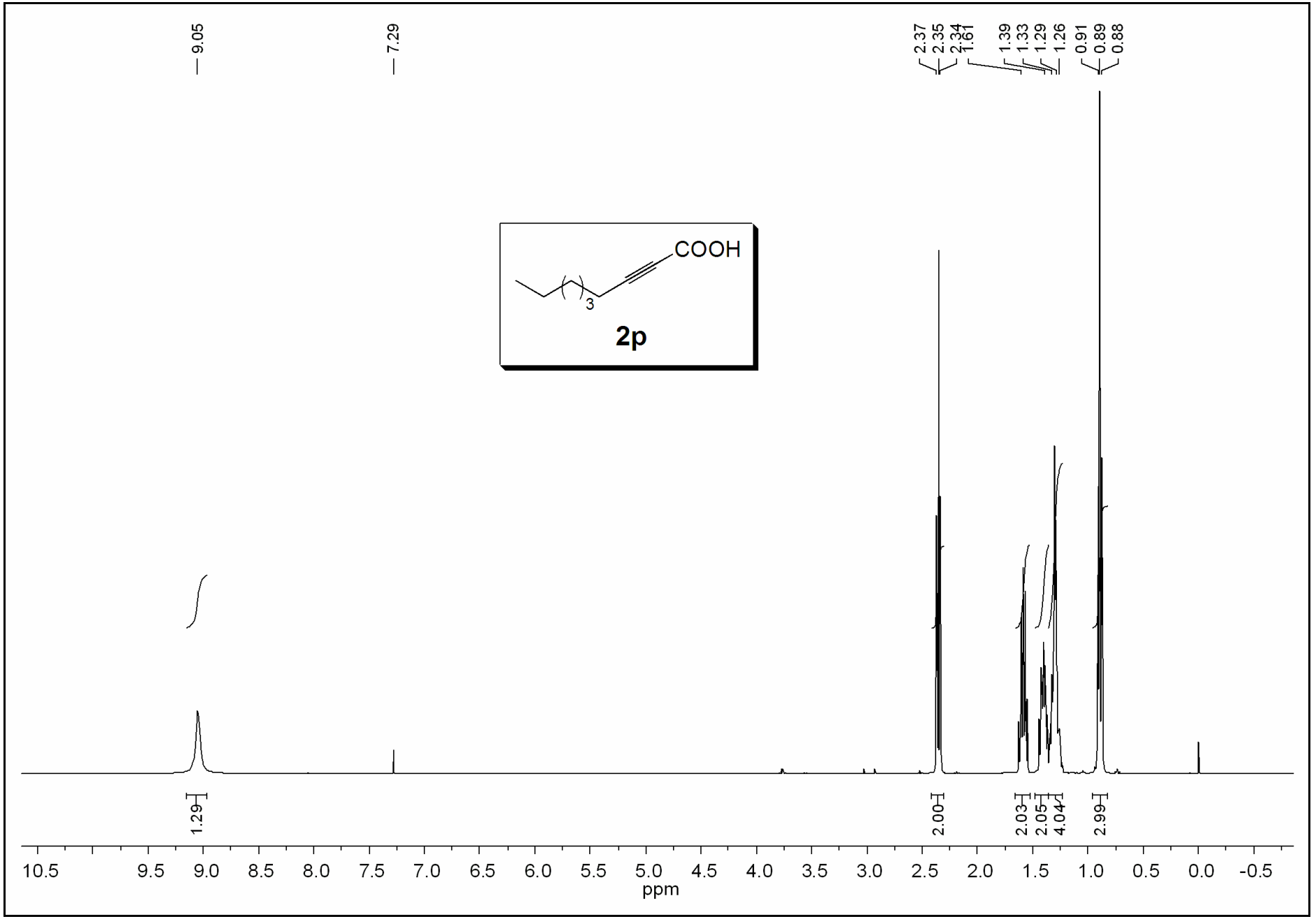
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1.33
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0.88
COOH
3
2p
1.29
2.00
2.03
2.05
4.04
2.99
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
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1.0
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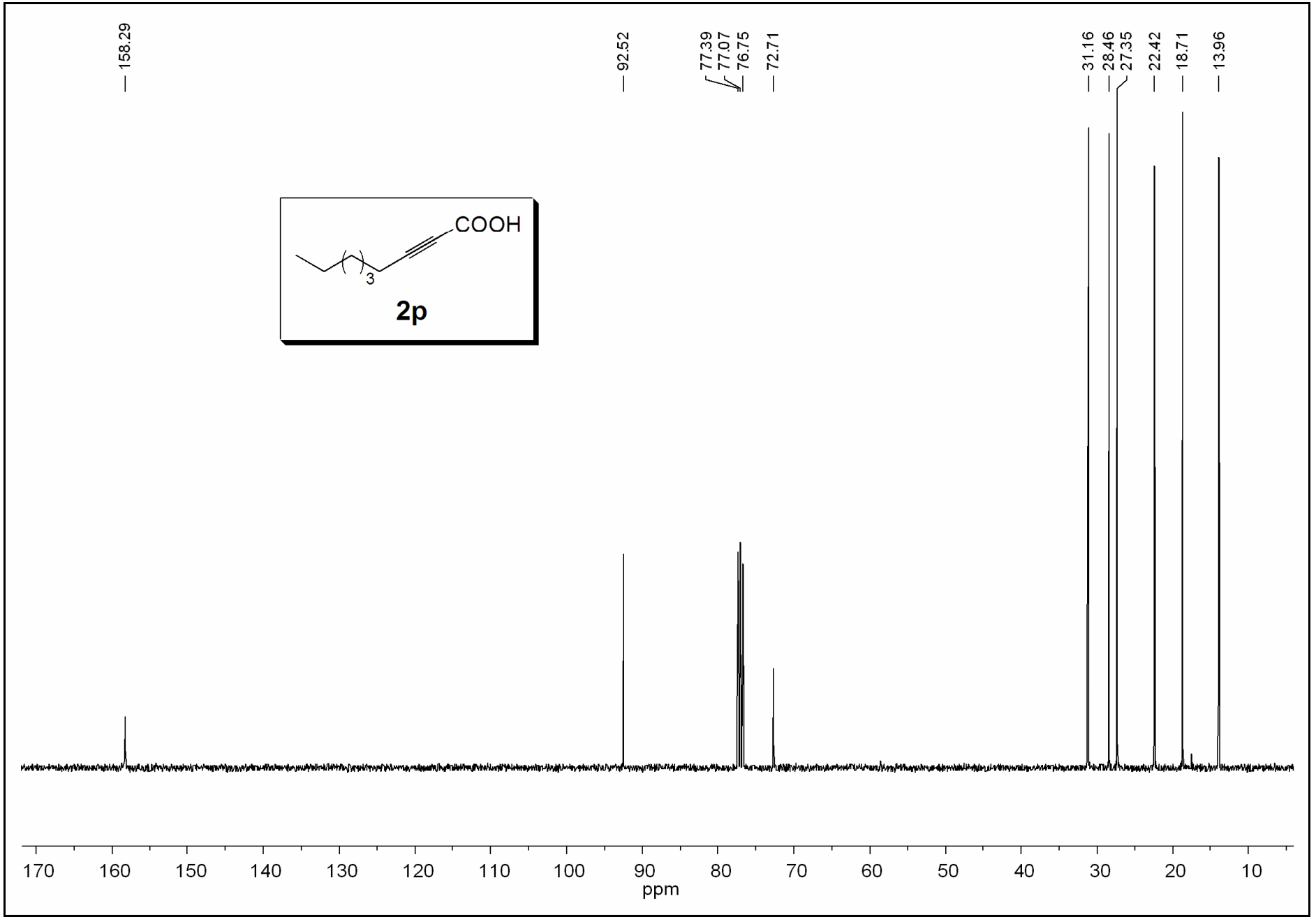
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77.07
76.75
72.71
31.16
28.46
27.35
22.42
18.71
13.96
COOH
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150
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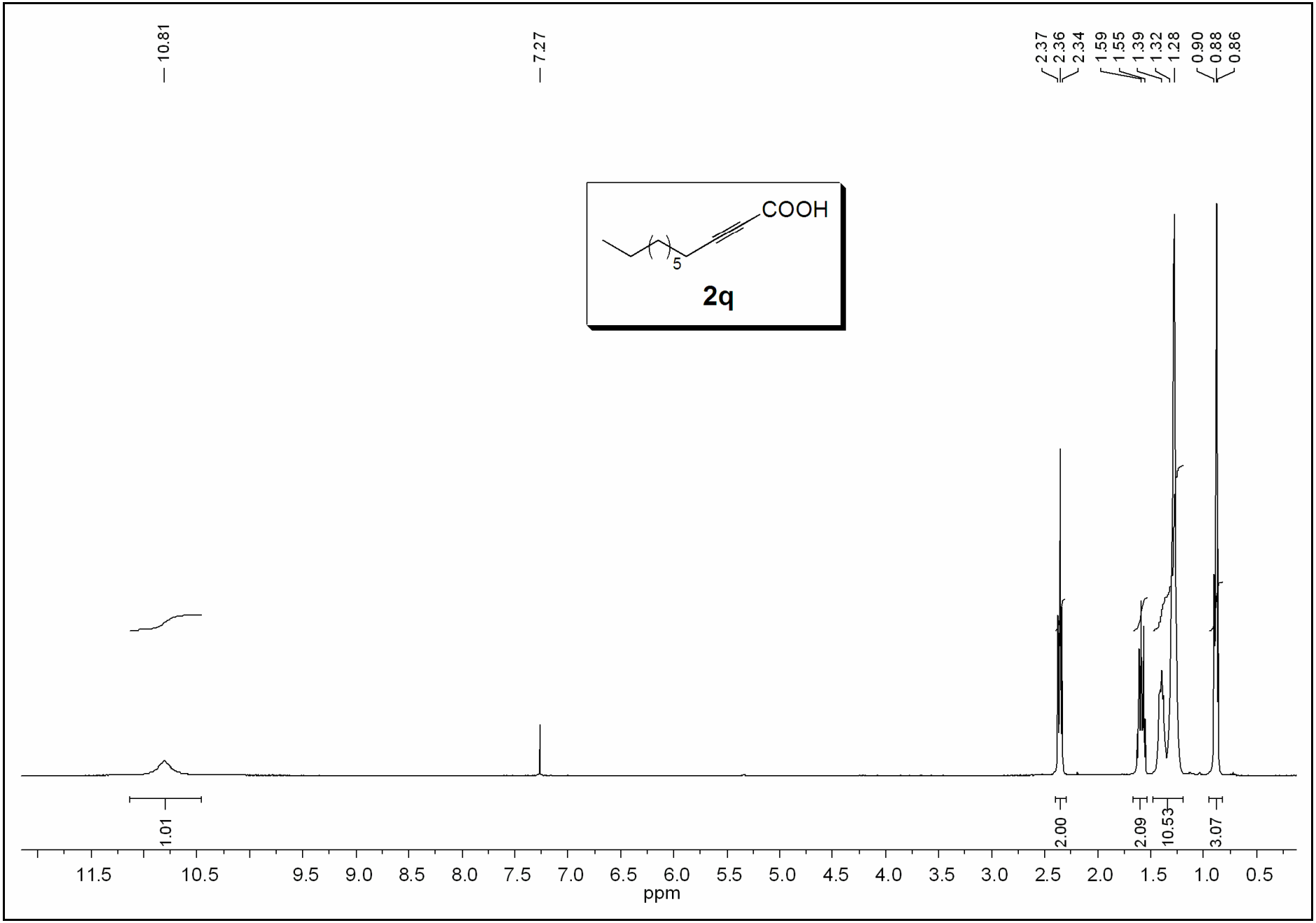
ppm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2.37
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1.39
1.32
1.28
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0.88
0.86
COOH
5
2q
1.01
2.00
2.09
10.53
3.07
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
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1.0
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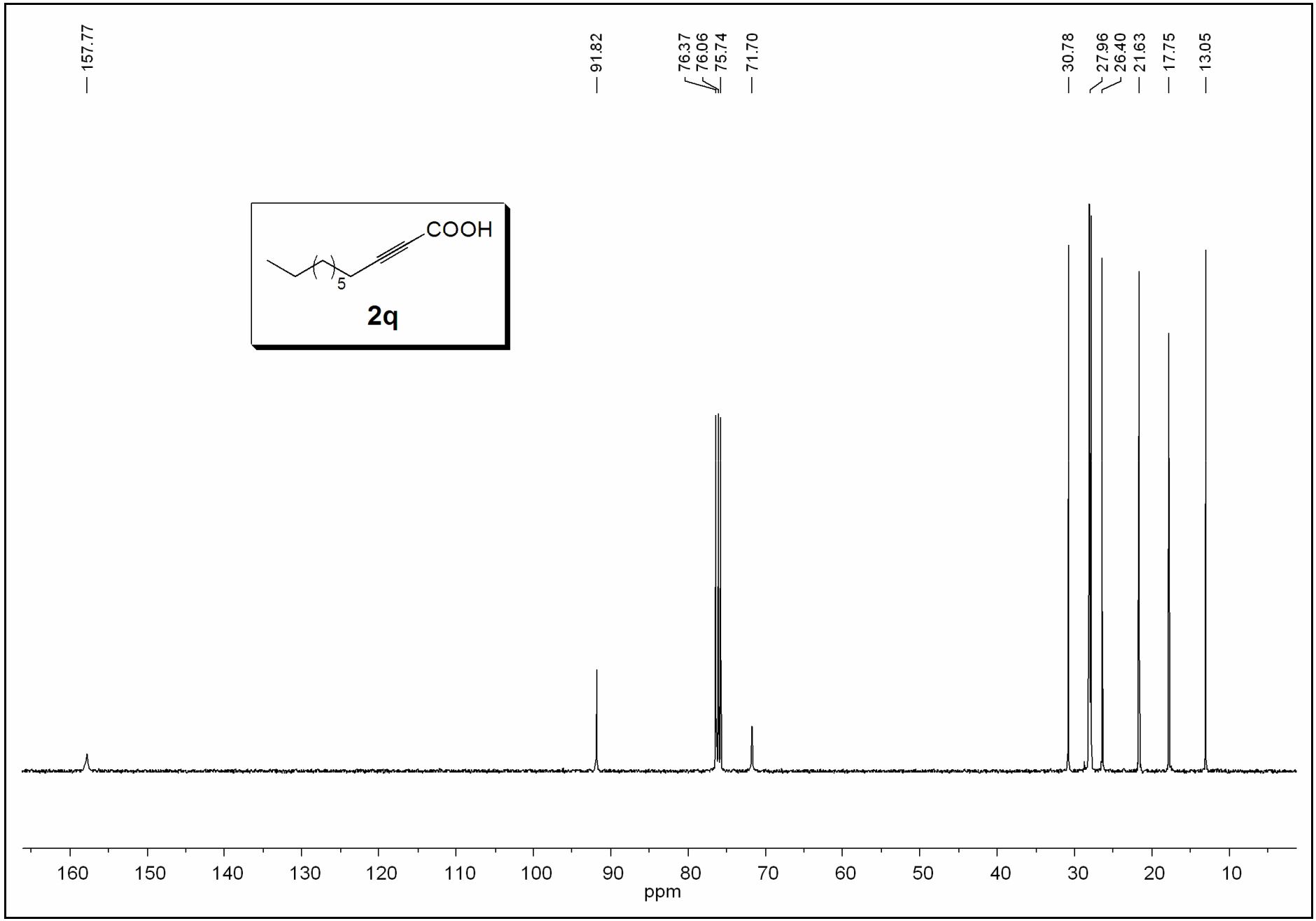
ppm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71.70
30.78
27.96
26.40
21.63
17.75
13.05
COOH
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150
140
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30
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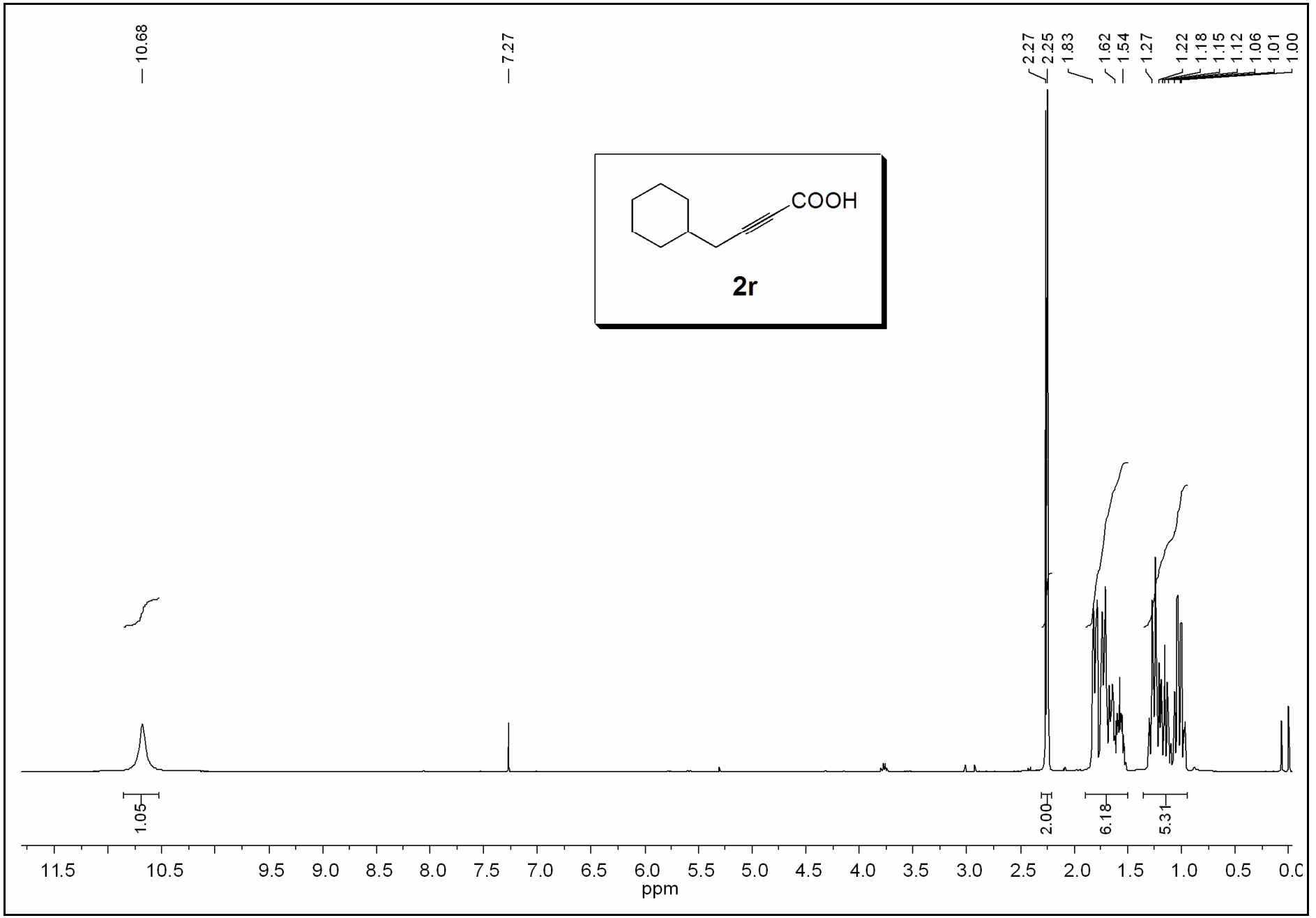
10
ppm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1.15
1.12
1.06
1.01
1.00
COOH
2r
1.05
2.00
6.18
5.31
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
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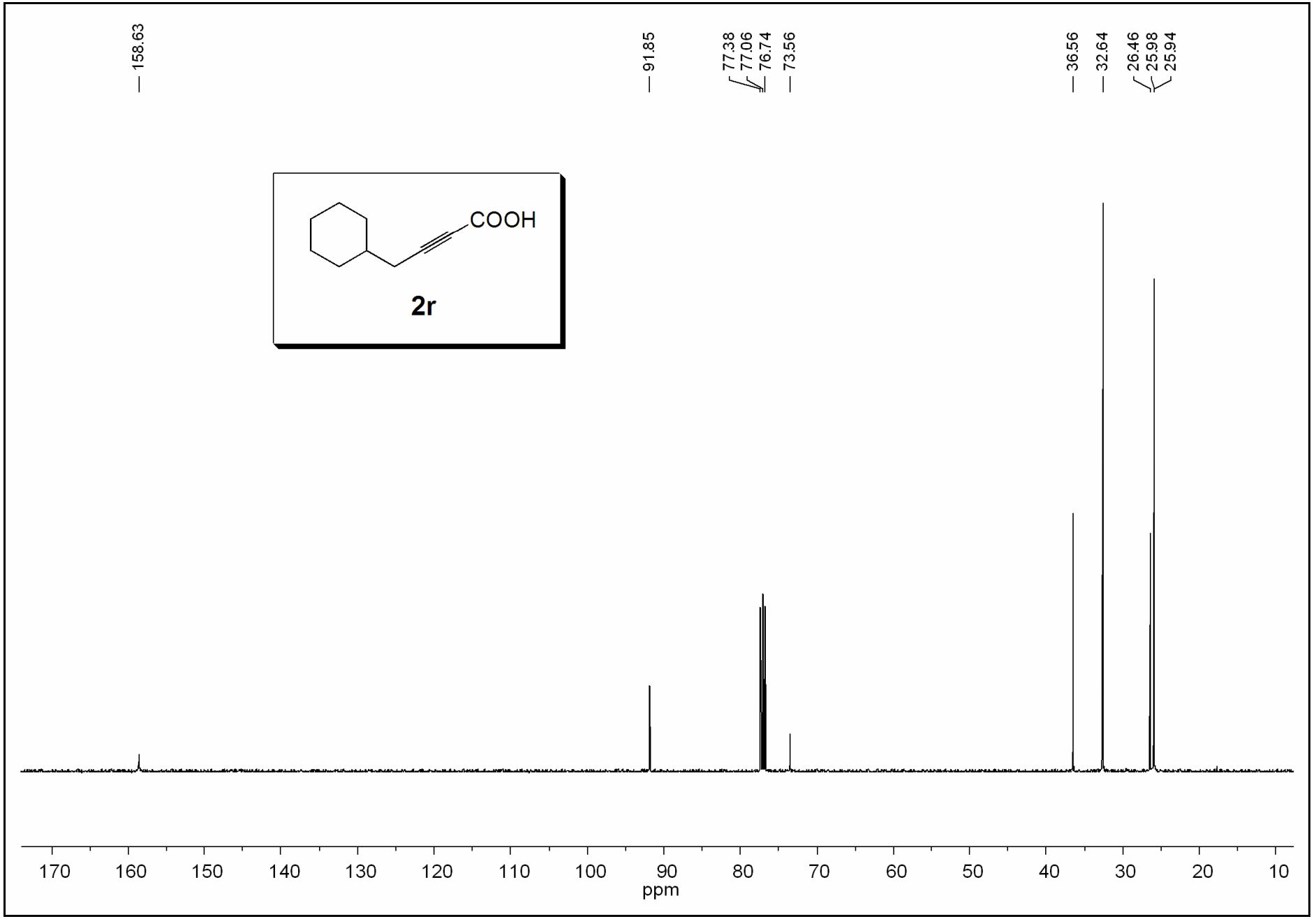
ppm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36.56
32.64
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25.98
25.94
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150
140
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110
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70
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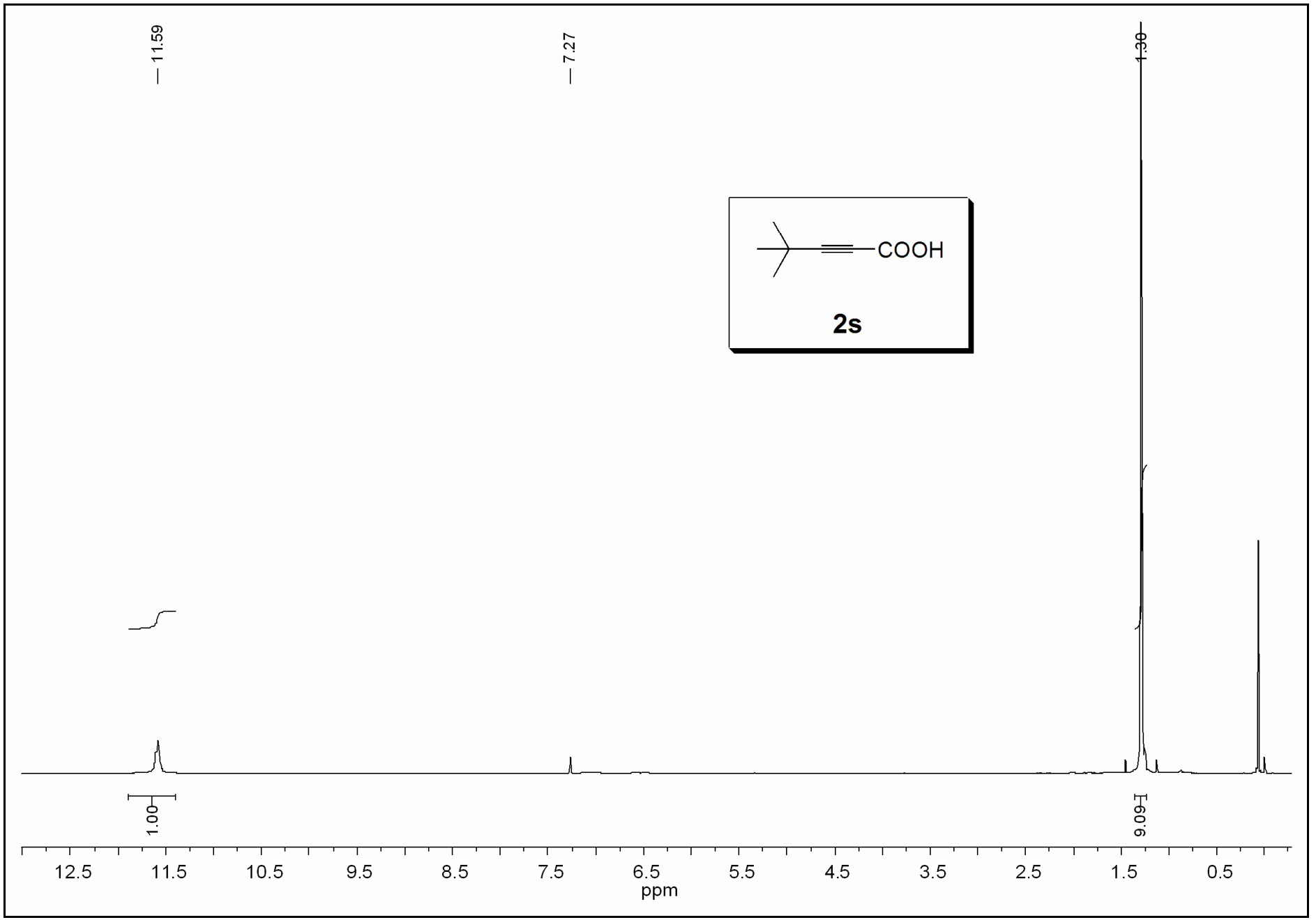
30
20
10
ppm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9.09
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11.5
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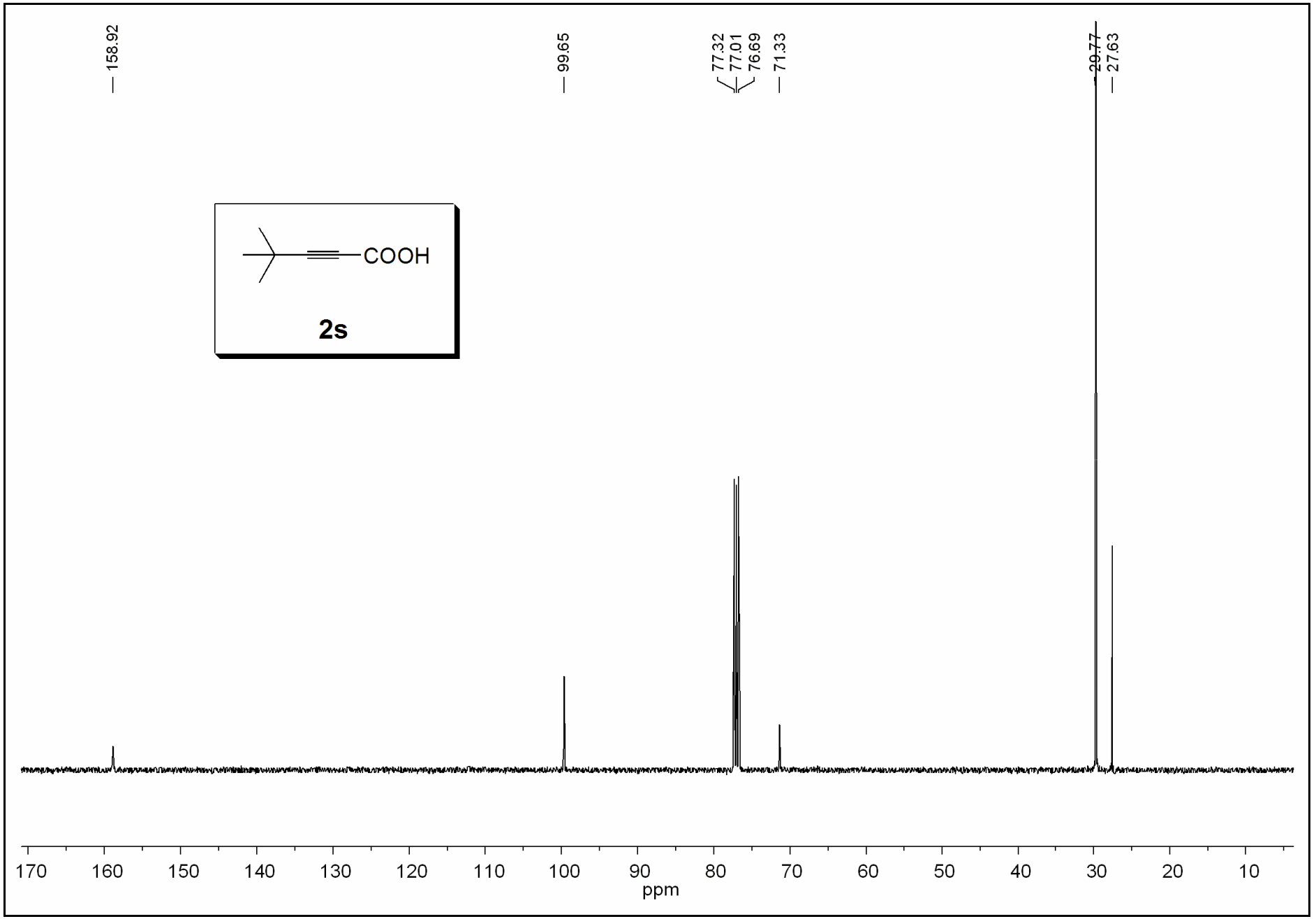
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
ppm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77.01
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71.33
29.77
27.63
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150
140
130
120
110
100
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70
60
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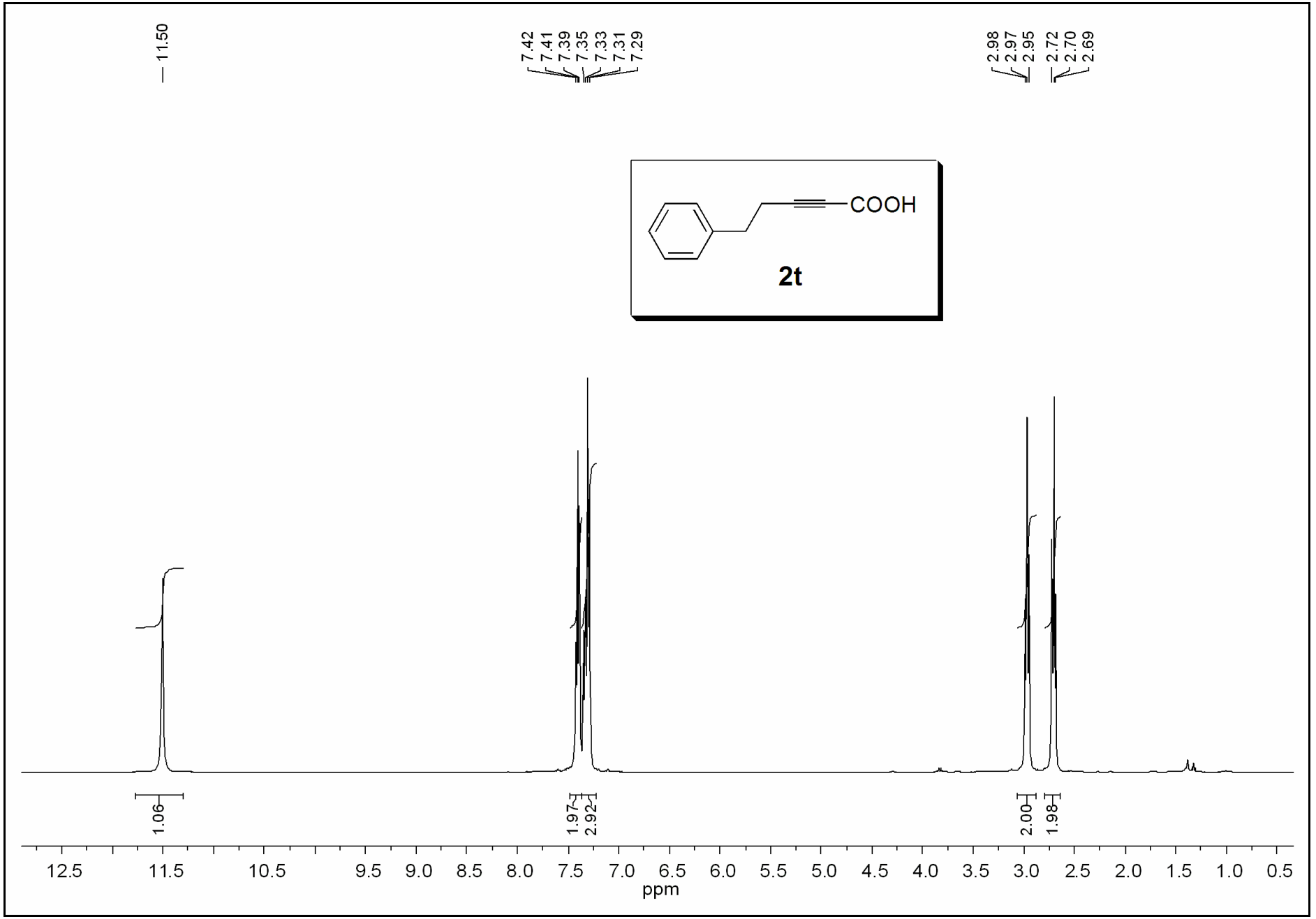
40
30
20
10
ppm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7.31
7.29
2.98
2.97
2.95
2.72
2.70
2.69
COOH
2t
1.06
1.97
2.92
2.00
1.98
12.5
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
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4.5
4.0
3.5
3.0
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2.0
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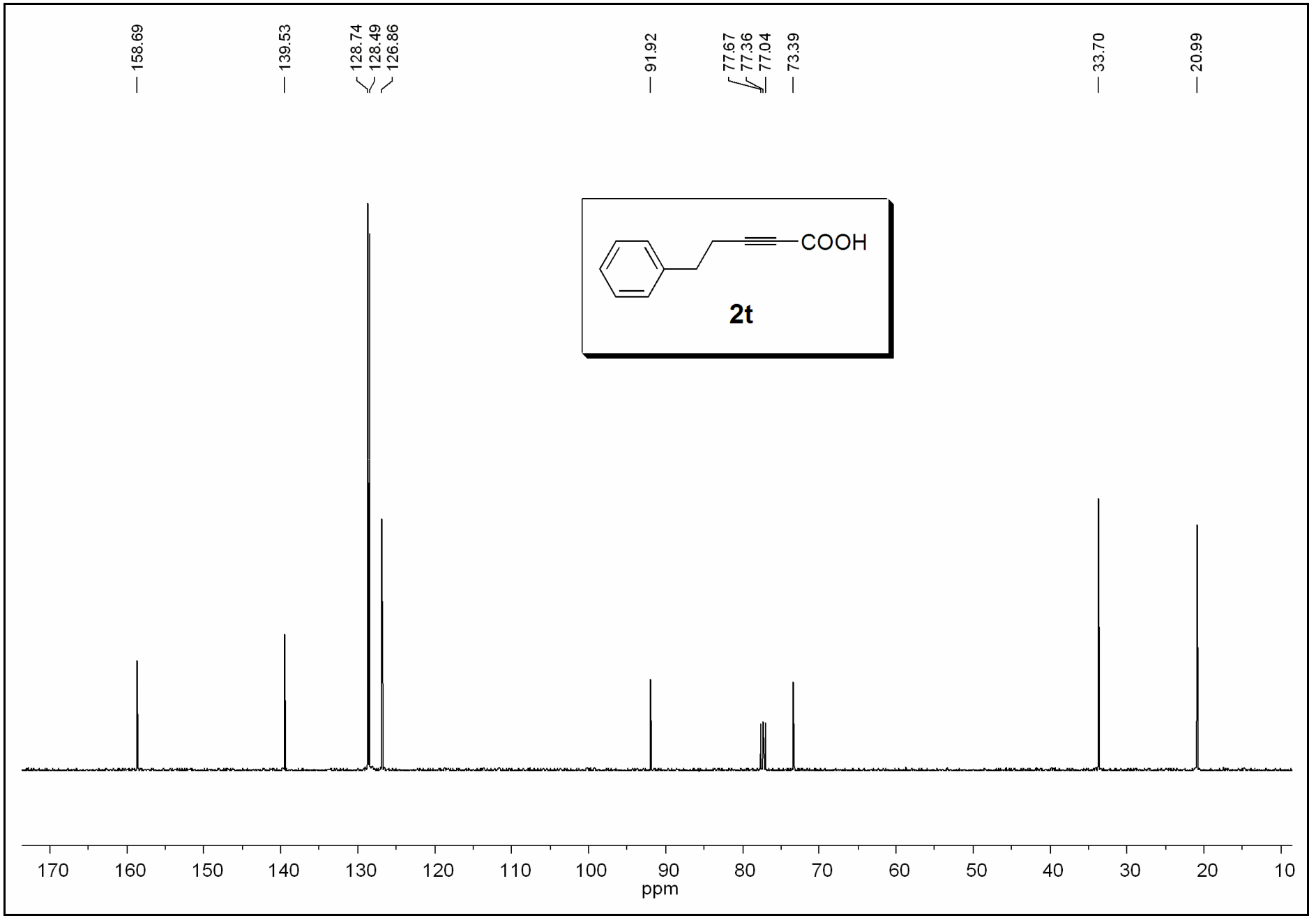
1.0
0.5
ppm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73.39
33.70
20.99
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140
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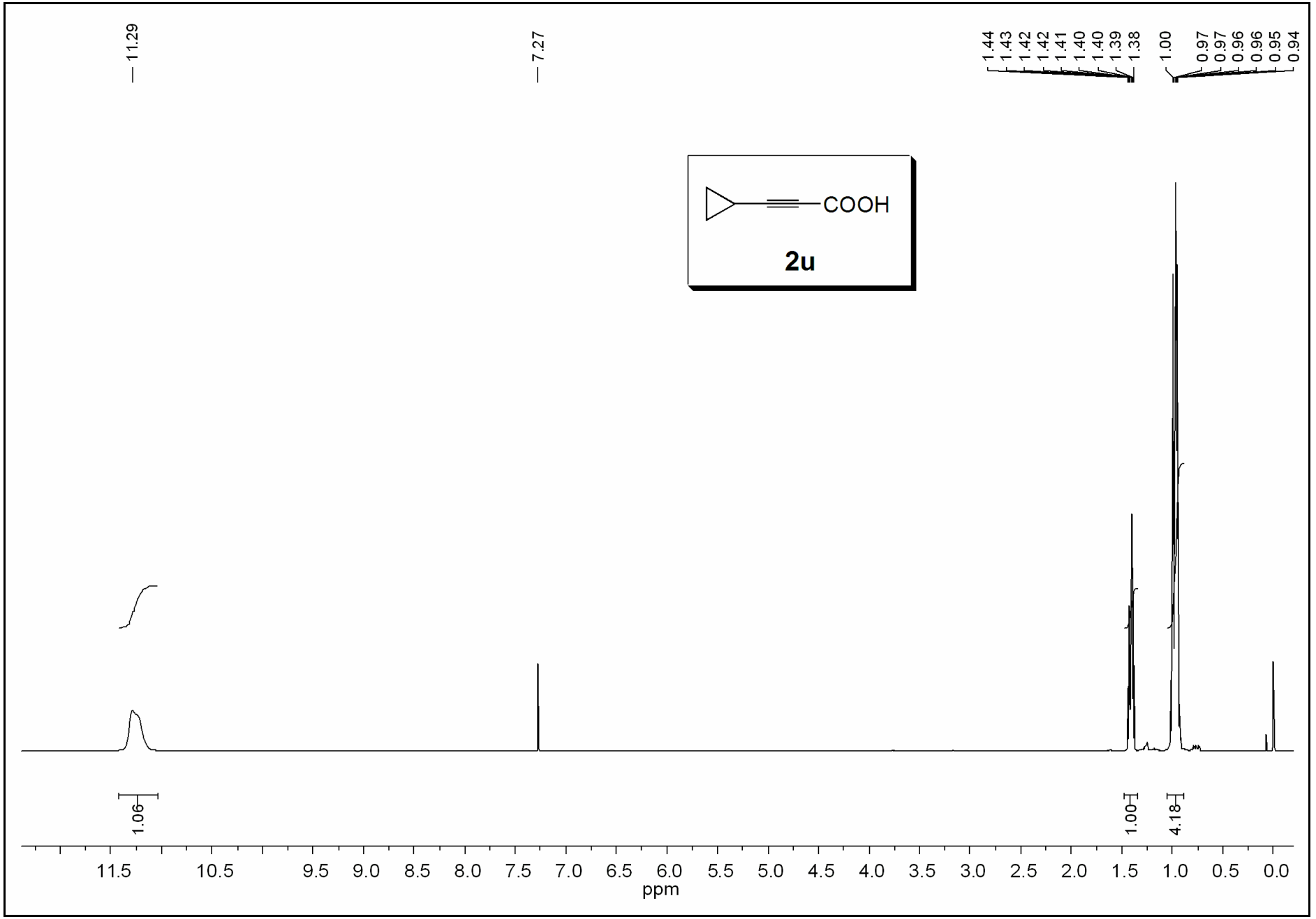
ppm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0.97
0.96
0.96
0.95
0.94
COOH
2u
1.06
1.00
4.18
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
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4.0
3.5
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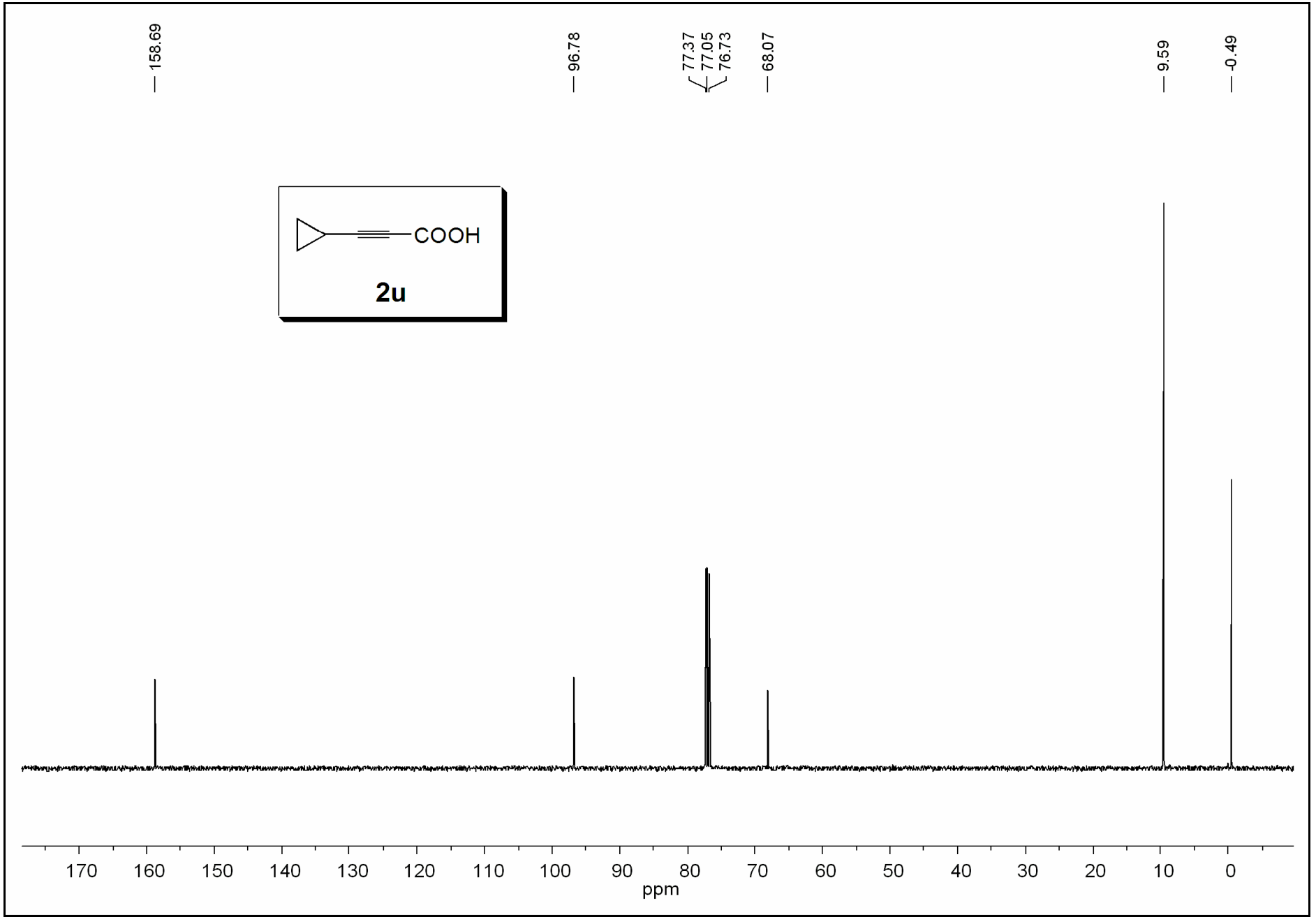
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77.05
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68.07
9.59
-0.49
COOH
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140
130
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100
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60
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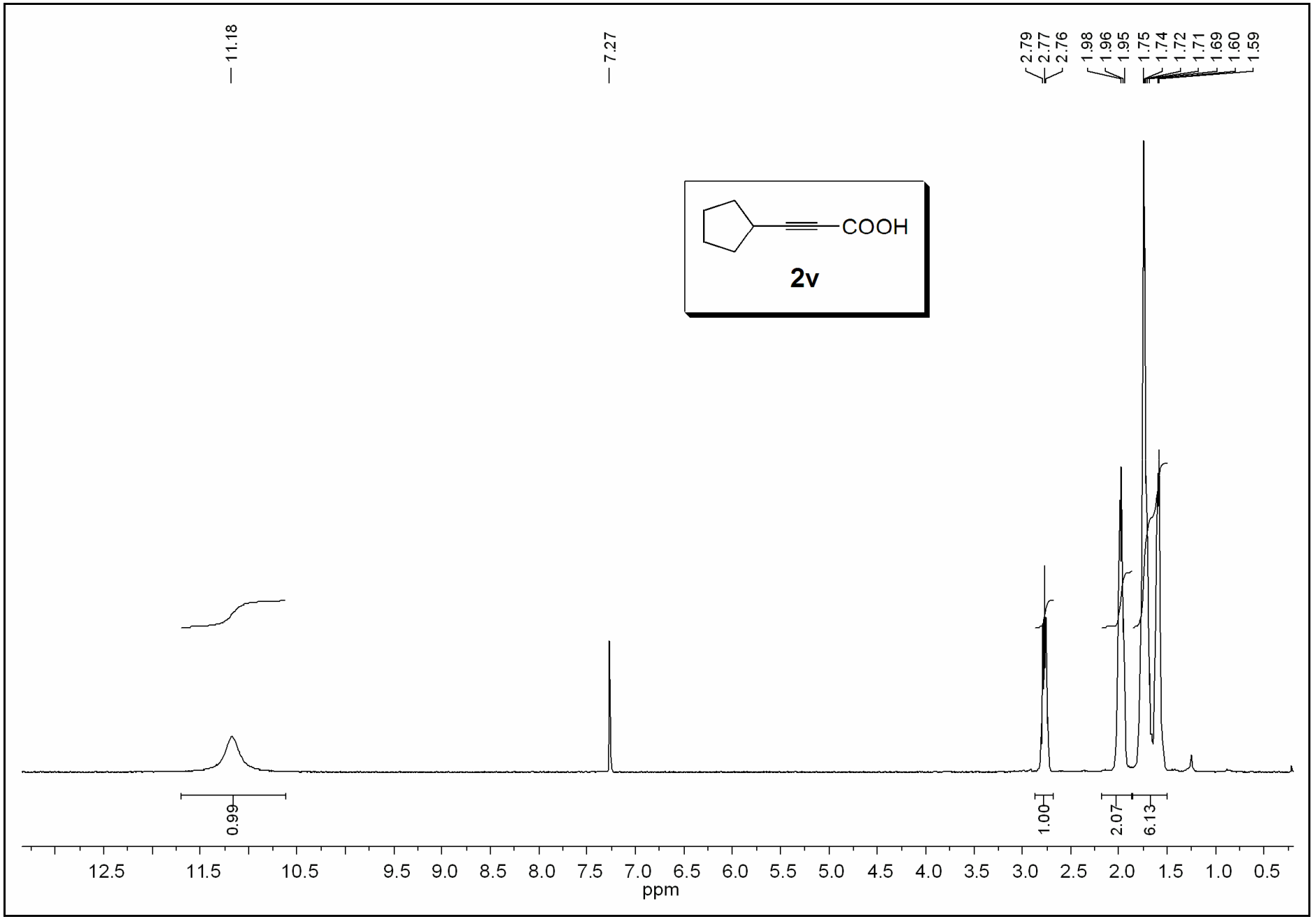
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1.95
1.75
1.74
1.72
1.71
1.69
1.60
1.59
COOH
2v
0.99
1.00
2.07
6.13
12.5
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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4.5
4.0
3.5
3.0
2.5
2.0
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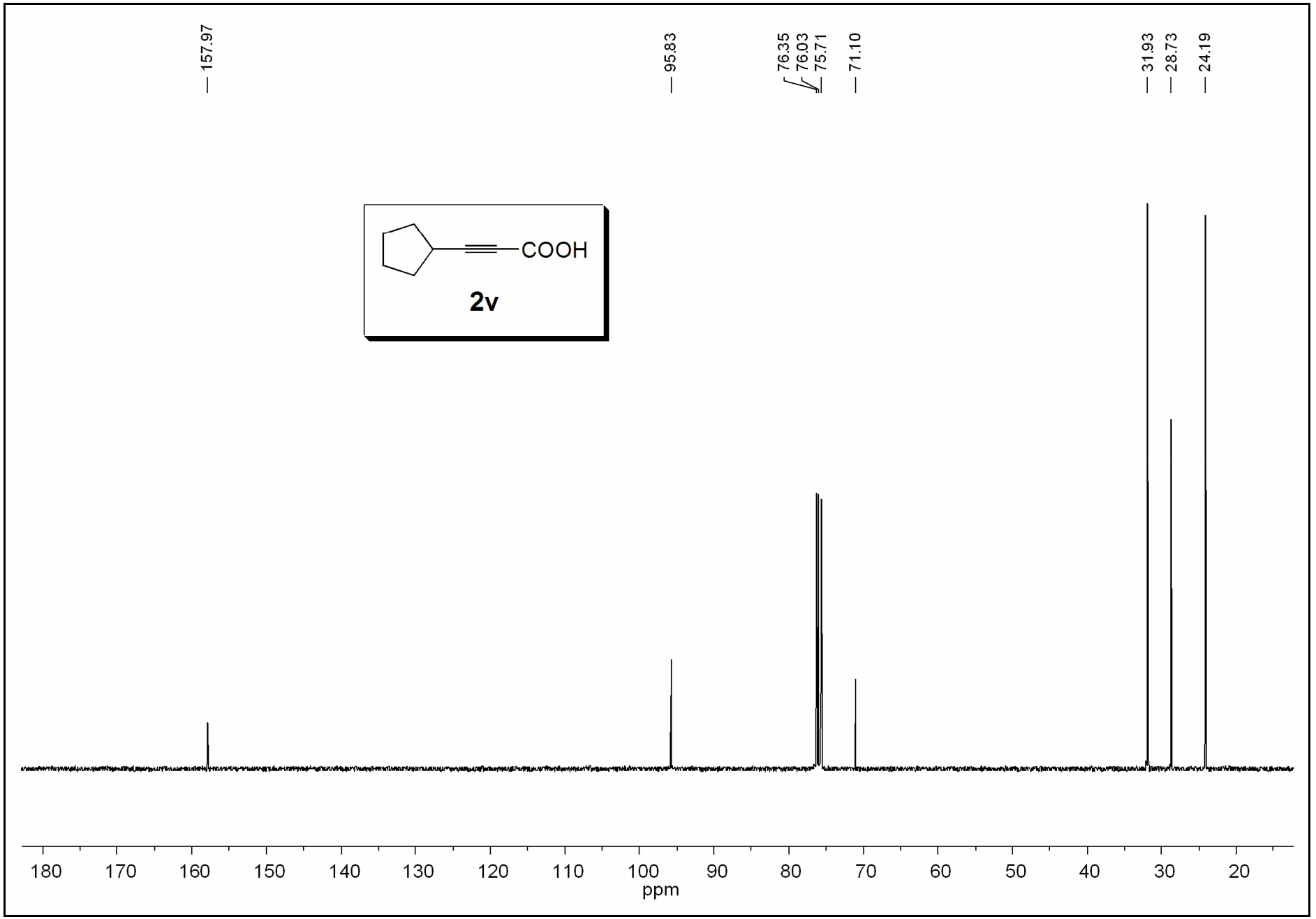
1.0
0.5
ppm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24.19
COOH
2v
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150
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm