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Synthesis

K₂CO₃-Mediated Intramolecular Oxa-Michael Cyclization of α,β–Unsaturated Ketoximes: Synthesis of Densely Arene-Substituted 2-Isoxazolines Bearing One Quaternary Center

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An efficient K₂CO₃-mediated intramolecular oxa-Michael cyclization of β,β-diarylated-α,β-unsaturated ketoximes has been described. This methodology features arene-rich 2-isoxazoline derivatives bearing one quaternary center in excellent yields with operationally simple experimental procedure. The deuterium scrambling experiments were carried out to shed light on the reaction pathway. To further demonstrate the synthetic utility of the method, a large-scale synthesis and Ullmann-type C-N bond formation reaction between pyrazole and dibrominated-isoxazoline have been performed.

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K_2CO_3-Mediated Intramolecular Oxa-Michael Cyclization of α,β–Unsaturated Ketoximes: Synthesis of Densely Arene-Substituted 2-Isoxazolines Bearing One Quaternary Center

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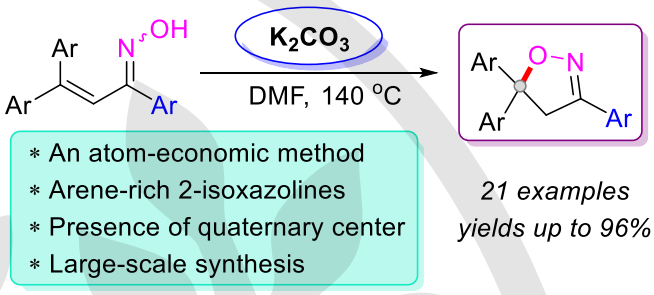

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Key words 2-Isoxazolines. α,β-unsaturated ketoximes· Oxa-Michael cyclization· Ullmann-type amination. Base-mediated reaction

Isoxazoline motifs are an important class of five-membered heterocycles met in kinds of biologically active natural products,[1] pharmaceuticals or drug candidates,[2] agrochemicals,[3] chiral ligands,[4] and key intermediates in organic and medicinal chemistry.[5]

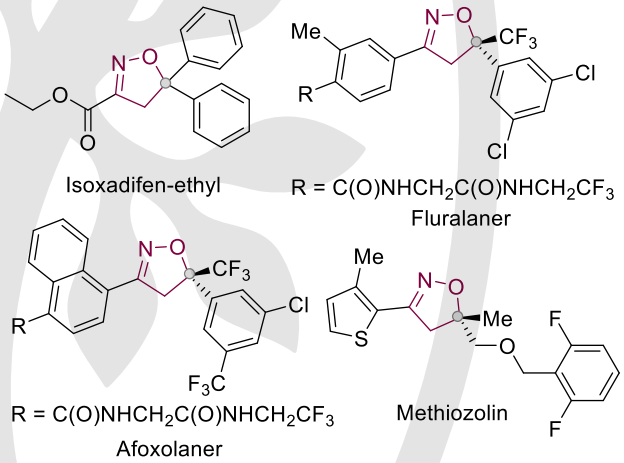


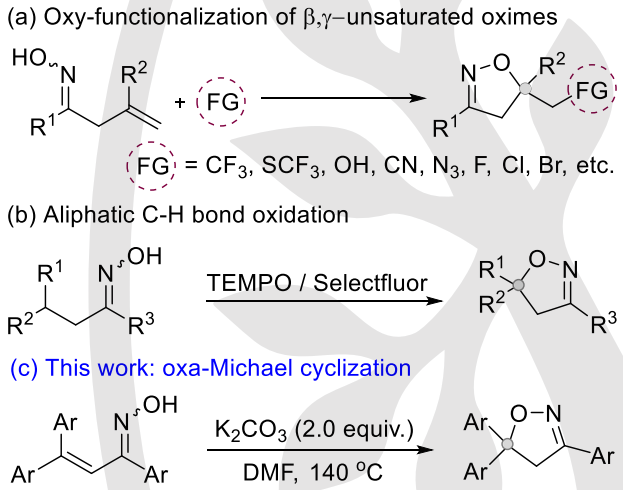
Figure 1 Selected examples of biologically active 2-isoxazoline motifs bearing one quaternary center

Due to their wide range of pharmaceutical and biological activities, Isoxazoline synthesis has been an area of intense research in synthetic organic chemistry.[6] In particular, 2-isoxazoline bearing one quaternary center has received significant attention in both the pharmaceutical and crop protection industries. For instance, the isoxadifen-ethyl used as a crop safener,[7] fluralaner and afoxolaner show insecticides as well as acaricides properties,[8] methiozolin is a selective herbicide[9] (Figure 1). Besides that, 2-isoxazolines are important precursors which has the ability to undergo various reductive ring opening reactions for the synthesis of useful building blocks including β-amino acids,[10] β-hydroxy ketones,[11] β-hydroxy nitriles,[11] and γ-amino alcohols.[12]

In this context, a plethora of methods have been reported for the synthesis of 5-substituted-2-isoxazolines. However, there are few strategies are available for the synthesis of 5,5-disubstituted-2-isoxazolines, the scaffolds in which a quaternary center present at 5th position.[6h-i,10] For example, the traditional path for the isoxazoline synthesis involve [3+2] dipolar cycloaddition of nitrile oxide intermediates to olefins.[13] Intramolecular oxy-functionalization of β,γ-unsaturated oximes using transition-

metal catalysts such as palladium,[14] copper,[15] cobalt,[16] and gold,[17] is an alternative method (Schem 1a). To note, only 2-3 examples of 2-isoxazolines bearing a quaternary center have been shown in those reports. However, to the best of our knowledge, synthesis of arene-rich 5,5-diarylated-2-isoxazolines bearing one quaternary center has not been reported starting from α,β-unsaturated ketoximes.

Representative examples of metal-free approaches using stoichiometric amount of oxidants such as TEMPO/ Selectfluor-TBAI/inorganic peroxide $K_2S_2O_8$ to access particularly 5,5-diarylated-2-isoxazoline having one quaternary center have been discussed here (Schem 1b). In 2013, Chiba and co-workers reported sp^3 C-H bond oxidation with oximes under TEMPO-mediated reaction conditions.[18] Liu and co-workers have demonstrated a selectfluor-Bu_4NI-mediated C-H oxygenation of oximes.[19] Later in 2021, a method for the selective synthesis of 2-isoxazolines bearing quaternary center have been developed by Sureshkumar et al. with the judicious combination of TEMPO and oxidants.[20] Herein, we reported an efficient K_2CO_3-mediated intramolecular oxa-Michael cyclization reaction of β,β-diarylated-α,β–unsaturated ketoximes for the synthesis of densely arene-substituted 2-isoxazolines having a quaternary center (Scheme 1c).

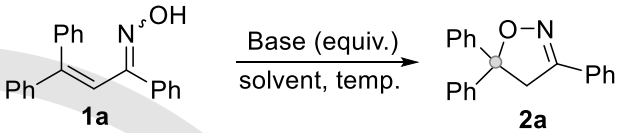


Scheme 1 Synthetic strategies to 2-isoxazolines bearing quaternary center

Our group recently reported synthesis of densely arene-substituted pyrazolines bearing quaternary center from α,β–unsaturated carbonyl compounds and arylhydrazines *via* tandem hydrazonation and intramolecular aza-Michael reaction.[21] Encouraged by that result, next, we envisioned to extend this concept to access 2-isoxazolines by reacting α,β–unsaturated carbonyl compounds with hydroxylamine hydrochloride. It has been noticed that the desired cyclized product 2-isoxazolines did not obtained and trace amount of condensation product oximes were noticed. Hence, we decided to focus on intramolecular oxa-Michael reaction beginning with α,β–unsaturated ketoximes under basic medium.

Along this line, we treated 1,3,3-triphenylprop-2-en-1-one oxime (**1a**) with potassium carbonate in DMF at 140 °C (Table 1). To our delight, using K_2CO_3 as a base the desired product **2a** was isolated in 70% yield (Table 1, entry 1). Increasing the loading of K_2CO_3 (2 equiv.) improved the yield of **2a** (entry 2). Inspired by this result, various bases were examined in DMF (entry 3-6). The results turn out that K_2CO_3 was better base than Na_2CO_3 for the reaction (entry 3). Other potassium salts such as K_3PO_4, KOH and *t*-BuOK gave **2a** in excellent yield (entry 4-6). Screening of polar aprotic solvents like DCE, and CH_3CN the yield of **2a** was decreased to a different extent (entry 7-8). In case of 1,4-dioxane and DMSO, the **2a** was obtained in 72% and 92% yields, respectively (entry 9 and 10). A trace amount of **2a** was noticed in the presence of protic solvents H_2O and MeOH (entry 11-12).

Table1 Optimization of Reaction Conditions[a]



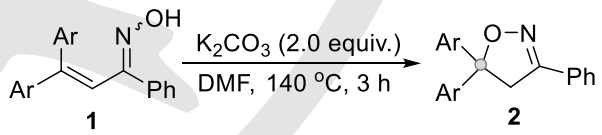
entry	base (equiv.)	solvent	temp. (°C)	yield[b] (%)
1	K_2CO_3 (1.0)	DMF	140	70
2	K_2CO_3 (2.0)	DMF	140	96
3	Na_2CO_3 (2.0)	DMF	140	24
4	K_3PO_4 (2.0)	DMF	140	90
5	KOH (2.0)	DMF	140	87
6	*t*-BuOK (2.0)	DMF	140	93
7	K_2CO_3 (2.0)	DCE	140	20
8	K_2CO_3 (2.0)	CH_3CN	140	15
9	K_2CO_3 (2.0)	1,4-dioxane	140	72
10	K_2CO_3 (2.0)	DMSO	140	92
11	K_2CO_3 (2.0)	H_2O	140	trace
12	K_2CO_3 (2.0)	MeOH	140	trace
13	K_2CO_3 (2.0)	DMF	100	10
14	---	DMF	140	trace

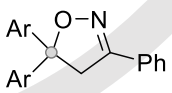
[a]Reactions were carried out using **1a** (0.5 mmol), solvent (2.0 mL) for 3 h. [b]Isolated yield.

The yield of the product **2a** was hampered upon lowering the temperature (entry 13). In the absence of the base, **2a** was noticed in trace amount. Based upon these results; K_2CO_3 (2 equiv.) as the base in DMF at 140 °C for 3 h (Table 1, entry 2) was established as the optimal reaction condition for intramolecular oxa-Michael cyclization reaction.

To assess the scope of this reaction, a series of α,β-unsaturated ketoximes **1** were subjected to the optimized reaction conditions and the results are summarized in Table 2. At first, we investigated diverse substituents on the arene at olefin side. The α,β-unsaturated ketoximes **1** with electron-donating Me and OMe groups at the *para*-position of the arene afforded the corresponding isoxazoline **2b** and **2c** in 91% and 92% yields, respectively. The arene having electron-withdrawing halo-substituents (*p*-F/*p*-Cl/*p*-Br) were transformed into the products **2d**-**2f** in good to excellent yields.

Table 2 Diversity of Isoxazolines with Respect to Arene at Olefin Side[a,b]





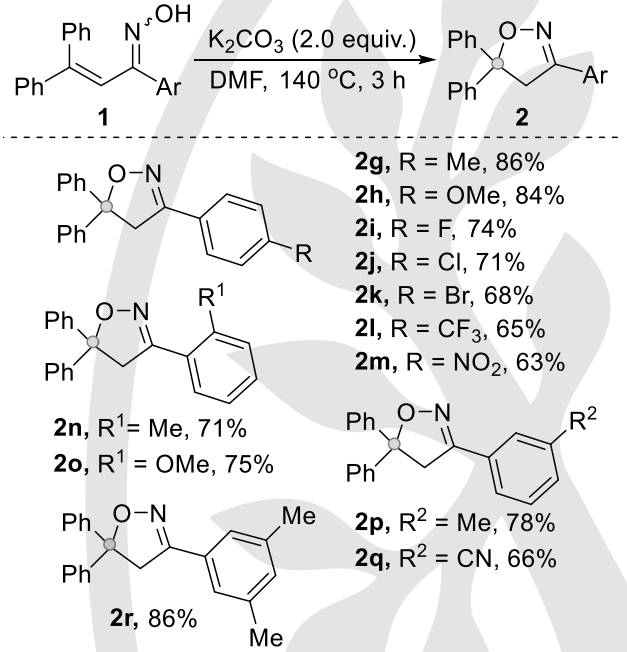
2a, Ar = Ph, 96%
2b, Ar = *p*-MeC_6H_4, 91%
2c, Ar = *p*-$OMeC_6H_4$, 92%
2d, Ar = *p*-FC_6H_4, 88%
2e, Ar = *p*-ClC_6H_4, 84%
2f, Ar = *p*-BrC_6H_4, 81%

[a]Reactions were performed with **1** (0.5 mmol, 1.0 equiv.), **K_2CO_3** (1.0 mmol, 2.0 equiv.), in DMF (2.0 mL) at 140 °C for 3 h. [b]Isolated products.

Next, we explored the scope of the arene at the oxime position, and the results are depicted in Table 3. Electron-rich Me and OMe groups at the *para*-position of the arene produced the products

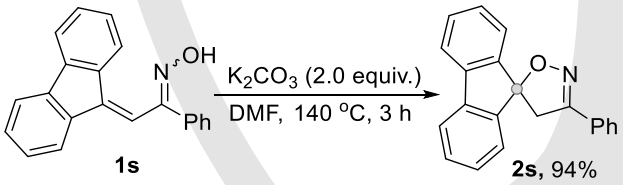
2g-**2h** in good yields. The halo-substituted (F/Cl/Br) ketoximes gave good yields of arene-rich 2-isoxazolines **2i**-**2k** up to 74% yield; the labile halo groups would find potential applications in cross-coupling reactions. Moderate yields were found in the case of reaction with ketoxime containing electron-withdrawing *p*-CF_3 (**2l**) and *p*-NO_2 (**2m**) substitution. Furthermore, *ortho*-substituents did not diminish the outcome of the reaction and the corresponding products **2n** and **2o** was isolated in acceptable yields. The structure of **2o** was confirmed by single crystal X-ray analysis (see SI). Quaternary center containing 2-isoxazolines with *meta*-substituents for instance *m*-Me (**2p**), and *m*-CN (**2q**) obtained in good yields. m-Xylyl-bearing isoxazoline **2r** was isolated in 86% yield.

Table 3 Diversity of Isoxazolines with Respect to Arene at oxime side[a,b]



[a]Reactions were performed with **1** (0.5 mmol, 1.0 equiv.), **K_2CO_3** (1.0 mmol, 2.0 equiv.), in DMF (2.0 mL) at 140 °C for 3 h. [b]Isolated products.

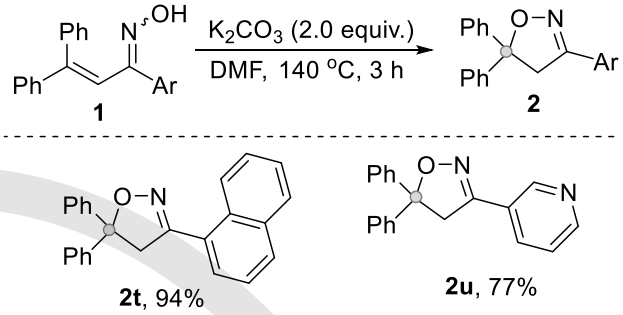
To our delight, the rigid 9-fluorenyl ketoxime **1s** was tolerated under the standard reaction conditions to provide spirocyclic isoxazoline product **2s** in 94% yield (Scheme 2).



Scheme 2 Synthesis of the Spirocyclic 2-Isoxazoline Compound

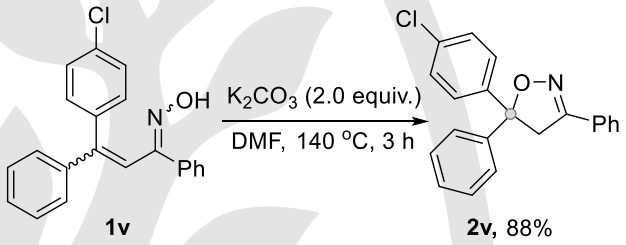
In addition, ketoxime containing naphthyl ring **1t** gave the π-extended *N*-heterocyclic compound **2t** in excellent yield. Heterocycle pyridyl group incorporated ketoxime **1u** reacted well to furnish the product **2u** in good yield.

Table 4 Synthesis of π-conjugated and pyridyl group bearing 2-isoxazolines[a,b]



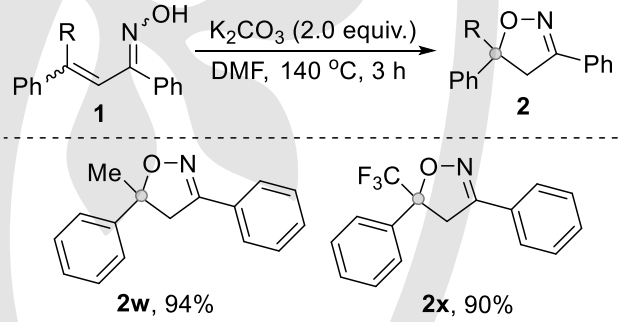
[a]Reactions were performed with **1** (0.5 mmol, 1.0 equiv.), **K_2CO_3** (1.0 mmol, 2.0 equiv.), in DMF (2.0 mL) at 140 °C for 3 h. [b]Isolated products.

To further explore the versatility of the reaction, we focused on the possibility of chiral center containing 2-isoxazoline by taking unsymmetrical arenes at olefin side **1v**. The reaction proceeded well under the optimized reaction conditions to give 5-(4-chlorophenyl)-3,5-diphenyl-4,5-dihydroisoxazole (**2v**) in 88% yield (Scheme 3).



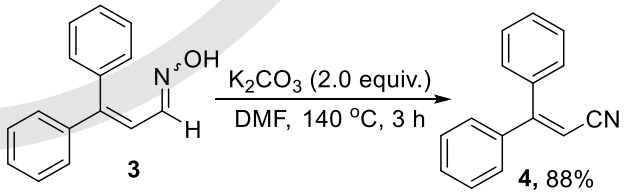
Scheme 3 Reaction with unsymmetrical arenes at olefin side

It is worthy to note that the reaction of methyl/phenyl substituted (at olefin side)-α,β–unsaturated ketoxime **1w** afforded the 2-isoxazoline **2w** in excellent yield (Scheme 4). To our delight, the core structure of Fluralaner (Figure 1) **2x** has been synthesized from the corresponding CF_3-bearing ketoxime.



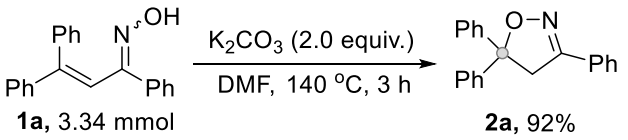
Scheme 4 Synthesis of the 5-methyl-2-isoxazoline **2w** and Fluralaner core **2x**

Motivated by good performance of the reaction with α,β–unsaturated ketoximes, we next turned our attention to examine the intramolecular oxa-Michael cyclization reaction with α,β–unsaturated aldoxime **3**. To note, the reaction profile was completely changed and conjugated nitrile **4** was obtained instead of cyclized product 2-isoxazoline (Scheme 5).[22]



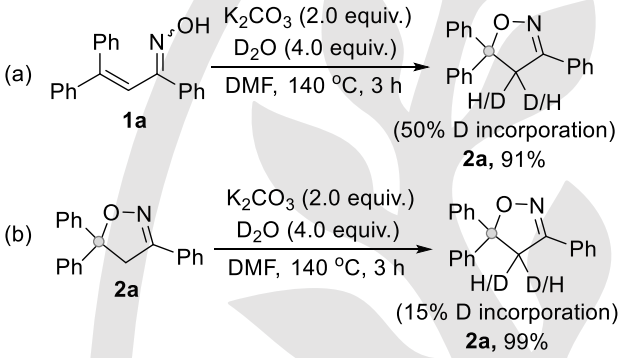
Scheme 5 Reaction with aldoxime of 3,3-diphenylacrylaldehyde (**3**)

To further demonstrate the practical utility of this reaction, we performed a large-scale synthesis. The reaction was scaled-up to 3.34 mmol of **1a** and the target compound **2a** was obtained in excellent yield without compromising the yield (Scheme 6).



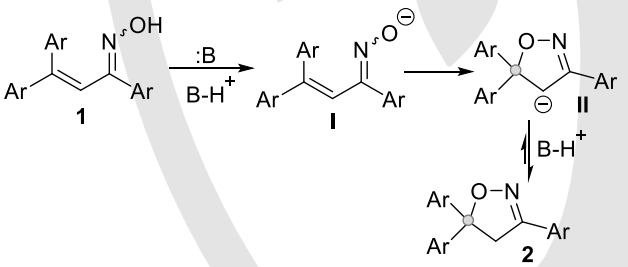
Scheme 6 Large-Scale Synthesis of **2a**

To shed light on the reaction mechanism of intramolecular oxa-Michael cyclization, several control experiments were conducted (Scheme 7). When the reaction of **1a** was performed under the optimized condition in the presence of D_2O (4.0 equiv.), the 50% D incorporation has been seen in the product **2a**, suggesting the involvement of a carbanion intermediate in the reaction (Scheme 7a). Deuterium scrambling was happened at 4th position of **2a**, indicating acidic nature of the methylene group (Scheme 7b).



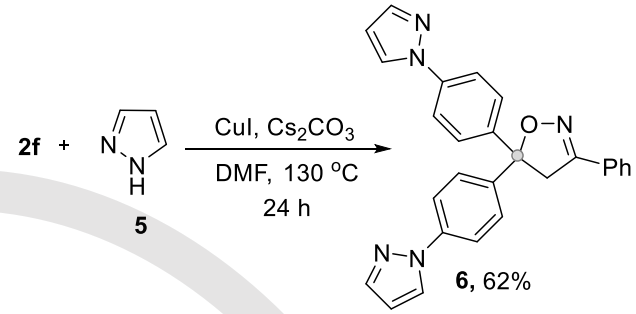
Scheme 7 The Deuterium Scrambling Experiments

Based on the above-mentioned results and the literature reports,[18,23] a plausible reaction mechanism for the intramolecular oxa-Michael cyclization reaction was illustrated in Scheme 8. Initially, an intramolecular nucleophilic attack of the O-anionic center of the oxime **I** (probably generated by the deprotonation of **1** by the K_2CO_3) to the β-carbon of the α,β–unsaturated ketoximes provides the corresponding carbanion species **II**. Subsequently, abstraction of proton by the C-4 position of **II** would afford desired 2-isoxazoline **2**.



Scheme 8 Plausible Reaction Mechanism

Finally, we wish to demonstrate the synthetic versatility of dibrominated isoxazoline product **2f.** For that we chosen Ullmann-type amination reaction with pyrazole (Scheme 9).[24] Gratifyingly, the dual C-N bonded product **6** was afforded in 62% yield.



Scheme 9 Ullmann-Type Amination Reaction of Isoxazoline Compound **2f**

In conclusion, we have demonstrated an efficient approach to access arene-rich 2-isoxazolines bearing quaternary center from β,β–diarylated–α,β–unsaturated ketoximes. The protocol features wide substrate scope with reasonable yields. Deuterium scrambling experiments were carried out to understand the reaction path and the nature of the 2-isoxazolines. Further studies on the synthesis of chiral 2-isoxazoline and related *N*-heterocyclic compounds are in progress in our laboratory.

^1H and ^{13}C NMR spectra were recorded at 25 °C on a Bruker Avance III 500 MHz spectrometer operating at 500 MHz for ^1H, 125 MHz for ^{13}C NMR experiments. Chemical shifts were calibrated to the residual proton and carbon resonance of the solvent, $CDCl_3$ (^1H δ 7.26; ^{13}C δ 77.0)/ DMSO-d_6 (^1H δ 2.50; ^{13}C δ 39.52). The following abbreviations were used to illuminate the diversities: δ= chemical shifts, *J* = coupling constant, s= singlet, d= doublet, t= triplet, q= quartet, sep= septet, m= multiplet. Chemical shifts are given in ppm relative to the internal standard of tetramethylsilane (TMS). High-resolution mass spectra (HRMS) were obtained by using a TOF analyzer in ESI mode. X-ray data were taken at 273K with a Bruker APEX-II CCD single crystal diffractometer by using graphite monochromated Mo-Kα radiation (0.71073 Å). Data integration was done using SAINT.[25a] Intensities for absorption were corrected using SADABS.[25b] Structure solution and refinement were carried out using Bruker SHELX-TL.[25c-d] TLC analysis was performed with pre-coated TLC plates (0.2 mm, Silica gel 60 F-254, Merck). Column chromatography was done using silica gel (100-200 mesh) as an adsorbent. Unless otherwise stated, all reagents and starting materials obtained from commercial suppliers were used without further purification. Benzophenone, Ethynylmagnesium bromide (0.5 M in THF), n-BuLi (1.6 M in hexane), Phenylacetylene, Hydroxylamine hydrochloride, Aryl halides, CuI, $PdCl_2(PPh_3)_2$, K_2CO_3 were purchased from Sigma-Aldrich, TCI, Avra and CDH India. DMF was vacuum distilled over 4Å molecular sieves and stored under nitrogen. All the reactions were performed in an oven-dried glass pressure tube (capacity 15 mL) procured from the Sigma-Aldrich India (catalogue No. Z181099) under an atmosphere of N_2. Reactions were monitored by thin-layer chromatography (TLC). The products were purified by column chromatography on silica gel using petroleum ether and ethyl acetate as the eluent.

General procedure for the synthesis of α,β–unsaturated ketoximes (1a as representative):[18]

A dry screw cap pressure tube (15 mL) equipped with a magnetic stirring bar was charged with 1,3,3-triphenylprop-2-en-1-one (142 mg, 0.5 mmol) in EtOH (3 mL) was added hydroxylamine hydrochloride (52 mg, 0.75 mmol) and pyridine (101 µL, 1.25 mmol) under the argon atmosphere.

The reaction mixture was stirred at 60 °C in an oil bath and upon completion the reaction (monitored by TLC) mixture was diluted with water and extracted with ethyl acetate, dried over Na_2SO_4, and concentrated under vacuum. The residue was purified by silica gel column chromatography to provide the desired product 1,3,3-triphenylprop-2-en-1-one oxime (**1a**).

General procedure for the synthesis of isoxazolines (2a as representative):

A dry screw cap pressure tube (15 mL) equipped with a magnetic stirring bar was charged with 1,3,3-triphenylprop-2-en-1-one oxime (**1a**, 150 mg, 0.5 mmol), K_2CO_3 (138 mg, 1.0 mmol) in DMF (2.0 mL) was stirrer at 140 °C in an oil bath for 3 h and mixture was diluted with water and extracted with ethyl acetate, dried over Na_2SO_4 and concentrated under vacuum. The residue was purified by silica gel column chromatography (hexane-EtOAc, 98:2) to provide 3,5,5-triphenyl-4,5-dihydroisoxazole (**2a**).

Compounds **2a,**[18] **2g-h,**[18] **2k-l,**[18] **2w,**[20] **2x,**[26] **4**[27] are previously reported and showed the identical spectra according to the literature.

3,5,5-Triphenyl-4,5-dihydroisoxazole (2a)[18]

Yield: 96% (144 mg), White solid; mp 143-144 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.73 – 7.67 (m, 2H), 7.51 – 7.45 (m, 4H), 7.42 – 7.32 (m, 7H), 7.31 – 7.26 (m, 2H), 4.00 (s, 2H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.2, 144.1, 130.1, 129.6, 128.7, 128.4, 127.6, 126.7, 126.1, 92.0, 48.2 ppm.

3-Phenyl-5,5-di-*p*-tolyl-4,5-dihydroisoxazole (2b)

Yield: 91% (149 mg), White solid; mp 107-108 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.70 (dd, *J* = 6.4, 2.8 Hz, 2H), 7.45 – 7.33 (m, 7H), 7.16 (d, *J* = 8.0 Hz, 4H), 3.96 (s, 2H), 2.34 (s, 6H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.2, 141.3, 137.3, 130.0, 129.7, 129.0, 128.6, 126.6, 126.0, 91.9, 48.1, 21.0 ppm.

HRMS (ESI-TOF): m/z [M+H]$^+$ calcd for $C_{23}H_{22}NO^+$: 328.1696; found: 328.1697.

5,5-Bis(4-methoxyphenyl)-3-phenyl-4,5-dihydroisoxazole (2c)

Yield: 92% (165 mg), Yellow solid; mp 90-91 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.74 – 7.63 (m, 2H), 7.38 (dd, *J* = 9.9, 6.0 Hz, 7H), 6.88 (d, *J* = 8.7 Hz, 4H), 3.93 (s, 2H), 3.79 (s, 6H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 159.0, 156.2, 136.3, 132.2, 130.0, 128.6, 127.4, 126.6, 113.6, 91.6, 55.2, 48.3 ppm.

HRMS (ESI-TOF): m/z [M+H]$^+$ calcd for $C_{23}H_{22}NO_3^+$: 360.1594; found: 360.1596.

5,5-Bis(4-fluorophenyl)-3-phenyl-4,5-dihydroisoxazole (2d)

Yield: 88% (147 mg), White solid; mp 105-106 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.75 – 7.64 (m, 2H), 7.42 (dd, *J* = 8.6, 5.3 Hz, 7H), 7.04 (t, *J* = 8.6 Hz, 4H), 3.95 (s, 2H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 162.2 (d, J_{C-F} = 250.0 Hz), 156.3, 139.6 (d, J_{C-F} = 3.7 Hz), 130.3, 129.3, 128.8, 127.9 (d, J_{C-F} = 7.5 Hz), 126.7, 115.3 (d, J_{C-F} = 21.2 Hz), 91.1, 48.4 ppm.

HRMS (ESI-TOF): *m/z* [M+H]$^+$ calcd for $C_{21}H_{16}F_2NO^+$: 336.1194; found: 336.1190.

5,5-Bis(4-chlorophenyl)-3-phenyl-4,5-dihydroisoxazole (2e)

Yield: 84% (155 mg), White solid; mp 100-101 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.74 – 7.63 (m, 2H), 7.46 – 7.36 (m, 7H), 7.32 (d, *J* = 8.5 Hz, 4H), 3.94 (s, 2H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.3, 142.0, 133.9, 130.4, 129.1, 128.8, 128.7, 127.5, 126.7, 91.0, 48.1 ppm.

HRMS (ESI-TOF): *m/z* [M+H]$^+$ calcd for $C_{21}H_{16}Cl_2NO^+$: 368.0603; found: 368.0606.

5,5-Bis(4-bromophenyl)-3-phenyl-4,5-dihydroisoxazole (2f)

Yield: 81% (185 mg), White solid; mp 118-119 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.67 (d, *J* = 5.4 Hz, 2H), 7.48 (d, *J* = 8.4 Hz, 4H), 7.40 (d, *J* = 5.7 Hz, 3H), 7.32 (d, *J* = 8.3 Hz, 4H), 3.92 (s, 2H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.3, 142.5, 131.7, 130.4, 129.1, 128.8, 127.8, 126.7, 122.1, 91.1, 48.0 ppm.

HRMS (ESI-TOF): *m/z* [M+H]$^+$ calcd for $C_{21}H_{16}Br_2NO^+$: 457.9573; found: 457.9571.

5,5-Diphenyl-3-(*p*-tolyl)-4,5-dihydroisoxazole (2g)[18]

Yield: 86% (135 mg), White solid; mp 129-130 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.60 (d, *J* = 8.1 Hz, 2H), 7.49 (d, *J* = 7.7 Hz, 4H), 7.36 (t, *J* = 7.6 Hz, 4H), 7.28 (dd, *J* = 12.8, 5.5 Hz, 2H), 7.21 (d, *J* = 8.0 Hz, 2H), 3.99 (s, 2H), 2.38 (s, 3H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.2, 144.1, 140.3, 129.3, 128.4, 127.6, 126.7, 126.6, 126.1, 91.7, 48.3, 21.4 ppm.

3-(4-Methoxyphenyl)-5,5-diphenyl-4,5-dihydroisoxazole (2h)[18]

Yield: 84% (138 mg), Yellow solid; mp 143-144 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.65 (d, *J* = 8.7 Hz, 2H), 7.49 (d, *J* = 7.7 Hz, 4H), 7.35 (t, *J* = 7.6 Hz, 4H), 7.28 (dd, *J* = 12.5, 5.3 Hz, 2H), 6.91 (d, *J* = 8.8 Hz, 2H), 3.98 (s, 2H), 3.82 (s, 3H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 161.0, 155.8, 144.2, 128.3, 128.2, 127.5, 126.1, 122.1, 114.1, 91.6, 55.3, 48.4 ppm.

3-(4-Fluorophenyl)-5,5-diphenyl-4,5-dihydroisoxazole (2i)

Yield: 74% (117 mg), White solid; mp 121-122 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.72 – 7.64 (m, 2H), 7.49 – 7.42 (m, 4H), 7.38 – 7.32 (m, 4H), 7.27 (t, *J* = 7.3 Hz, 2H), 7.07 (t, *J* = 8.7 Hz, 2H), 3.96 (s, 2H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 163.8 (d, J_{C-F} = 248.7 Hz), 155.2, 143.9, 128.6, 128.6, 128.4, 127.7, 126.0, 115.8 (d, J_{C-F} = 21.2 Hz), 92.1, 48.3 ppm.

HRMS (ESI-TOF): m/z [M+H]$^+$ calcd for $C_{21}H_{17}FNO^+$: 318.1289; found: 318.1287.

3-(4-Chlorophenyl)-5,5-diphenyl-4,5-dihydroisoxazole (2j)

Yield: 71% (119 mg), White solid; mp 139-140 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.63 (d, *J* = 8.5 Hz, 2H), 7.46 (d, *J* = 7.6 Hz, 4H), 7.36 (dd, *J* = 12.1, 4.9 Hz, 6H), 7.28 (t, *J* = 7.3 Hz, 2H), 3.96 (s, 2H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 155.3, 143.9, 136.1, 129.0, 128.5, 128.1, 127.9, 127.7, 126.0, 92.3, 48.0 ppm.

HRMS (ESI-TOF): m/z [M+H]$^+$ calcd for $C_{21}H_{17}ClNO^+$: 334.0993 found: 334.0991.

3-(4-Bromophenyl)-5,5-diphenyl-4,5-dihydroisoxazole (2k)[18]

Yield: 68% (129 mg), White solid; mp 170-171 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.57 (d, *J* = 8.4 Hz, 2H), 7.51 (dd, *J* = 13.3, 8.2 Hz, 6H), 7.37 (t, *J* = 7.5 Hz, 4H), 7.30 (t, *J* = 7.1 Hz, 2H), 3.98 (s, 2H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 155.4, 143.8, 131.8, 128.4, 128.0, 127.7, 126.0 (2C), 124.3, 92.3, 47.9 ppm.

5,5-Diphenyl-3-(4-(trifluoromethyl)phenyl)-4,5-dihydroisoxazole (2l)[18]

Yield: 65% (119 mg), White solid; mp 134-135 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.81 (d, J = 8.1 Hz, 2H), 7.65 (d, J = 8.2 Hz, 2H), 7.52 – 7.44 (m, 4H), 7.40 – 7.33 (m, 4H), 7.33 – 7.27 (m, 2H), 4.00 (s, 2H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 155.2, 143.7, 133.0, 131.8 (q, $J_{C\text{-}F}$ = 32.6 Hz), 128.5, 127.8, 126.9, 126.0, 125.7 (q, $J_{C\text{-}F}$ = 4.0 Hz), 123.8 (q, $J_{C\text{-}F}$ = 270.6 Hz), 92.7, 47.8 ppm.

3-(4-Nitrophenyl)-5,5-diphenyl-4,5-dihydroisoxazole (2m)

Yield: 63% (108 mg), Yellow solid; mp 139-140 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.25 (d, J = 8.8 Hz, 2H), 7.86 (d, J = 8.8 Hz, 2H), 7.46 (d, J = 7.4 Hz, 4H), 7.37 (t, J = 7.6 Hz, 4H), 7.30 (t, J = 7.3 Hz, 2H), 4.02 (s, 2H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 154.7, 148.4, 143.4, 135.6, 128.5, 127.9, 127.3, 125.9, 124.0, 93.3, 47.6 ppm.

HRMS (ESI-TOF): m/z [M+H]$^+$ calcd for $C_{21}H_{17}N_2O_3^+$: 345.1234 found: 345.1226.

5,5-Diphenyl-3-(*o*-tolyl)-4,5-dihydroisoxazole (2n)

Yield: 71% (111 mg), White solid; mp 93-94 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.49 (d, J = 7.8 Hz, 4H), 7.35 (dd, J = 15.8, 7.9 Hz, 5H), 7.27 (dd, J = 12.6, 4.7 Hz, 4H), 7.21 (t, J = 7.1 Hz, 1H), 4.03 (s, 2H), 2.53 (s, 3H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 157.3, 144.0, 138.0, 131.5, 129.4, 128.7, 128.7, 128.4, 127.6, 126.1, 125.7, 90.9, 50.5, 22.7 ppm.

HRMS (ESI-TOF): m/z [M+H]$^+$ calcd for $C_{22}H_{20}NO^+$: 314.1539 found: 314.1541.

3-(2-Methoxyphenyl)-5,5-diphenyl-4,5-dihydroisoxazole (2o)

Yield: 75% (123 mg), White solid; mp 151-152 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.76 (dd, J = 7.7, 1.7 Hz, 1H), 7.52 – 7.46 (m, 4H), 7.34 (ddd, J = 10.0, 6.1, 2.6 Hz, 5H), 7.27 (ddd, J = 7.7, 4.1, 1.4 Hz, 2H), 6.95 (td, J = 7.6, 1.0 Hz, 1H), 6.91 (d, J = 8.3 Hz, 1H), 4.09 (s, 2H), 3.83 (s, 3H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 157.5, 144.3, 131.3, 129.4, 128.4, 128.3, 127.4, 126.5, 126.2, 120.8, 111.4, 91.6, 55.5, 50.6 ppm.

HRMS (ESI-TOF): m/z [M+H]$^+$ calcd for $C_{22}H_{20}NO_2^+$: 330.1489 found: 330.1490.

5,5-Diphenyl-3-(*m*-tolyl)-4,5-dihydroisoxazole (2p)

Yield: 78% (122 mg), White solid; mp 118-119 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.54 (s, 1H), 7.48 (dd, J = 8.2, 0.9 Hz, 5H), 7.35 (dd, J = 10.4, 4.8 Hz, 4H), 7.30 – 7.25 (m, 3H), 7.21 (d, J = 7.6 Hz, 1H), 3.99 (s, 2H), 2.37 (s, 3H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.4, 144.1, 138.4, 130.9, 129.4, 128.6, 128.4, 127.6, 127.2, 126.1, 123.8, 91.9, 48.3, 21.3 ppm.

HRMS (ESI-TOF): m/z [M+H]$^+$ calcd for $C_{22}H_{20}NO^+$: 314.1539 found: 314.1539.

3-(5,5-Diphenyl-4,5-dihydroisoxazol-3-yl)benzonitrile (2q)

Yield: 66% (107 mg), White solid; mp 141-142 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, J = 7.9 Hz, 1H), 7.93 (s, 1H), 7.66 (d, J = 7.6 Hz, 1H), 7.54 – 7.49 (m, 1H), 7.47 (d, J = 7.6 Hz, 4H), 7.37 (t, J = 7.5 Hz, 4H), 7.30 (t, J = 7.2 Hz, 2H), 3.99 (s, 2H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 154.5, 143.4, 133.1, 130.9, 130.5, 130.0, 129.6, 128.5, 127.8, 125.9, 118.0, 113.0, 92.8, 47.5 ppm.

HRMS (ESI-TOF): m/z [M+H]$^+$ calcd for $C_{22}H_{17}N_2O^+$: 325.1335 found: 325.1338.

3-(3,5-Dimethylphenyl)-5,5-diphenyl-4,5-dihydroisoxazole (2r)

Yield: 86% (141 mg), White solid; mp 133-134 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.47 (d, J = 7.4 Hz, 4H), 7.34 (dd, J = 13.7, 5.8 Hz, 6H), 7.29 – 7.25 (m, 2H), 7.03 (s, 1H), 3.97 (s, 2H), 2.32 (s, 6H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.5, 144.1, 138.3, 131.8, 130.0, 128.4, 127.6, 126.1, 124.5, 91.8, 48.3, 21.2 ppm.

HRMS (ESI-TOF): m/z [M+H]$^+$ calcd for $C_{23}H_{22}NO^+$: 328.1696 found: 328.1697.

3'-Phenyl-4'*H*-spiro[fluorene-9,5'-isoxazole] (2s)

Yield: 94% (140 mg), Yellow solid; mp 131-132 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.83 – 7.76 (m, 2H), 7.65 (d, J = 7.5 Hz, 2H), 7.53 (d, J = 7.5 Hz, 2H), 7.50 – 7.45 (m, 3H), 7.41 (t, J = 7.5 Hz, 2H), 7.30 (t, J = 7.5 Hz, 2H), 3.87 (s, 2H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 157.0, 146.2, 139.8, 130.2, 129.7, 129.5, 128.8, 128.5, 126.8 (2C), 123.6, 120.0, 92.2, 45.1 ppm.

HRMS (ESI-TOF): m/z [M+H]$^+$ calcd for $C_{21}H_{16}NO^+$: 298.1226 found: 298.1228.

3-(Naphthalen-1-yl)-5,5-diphenyl-4,5-dihydroisoxazole (2t)

Yield: 94% (164 mg), White solid; mp 127-128 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.96 (d, J = 8.6 Hz, 1H), 7.88 (t, J = 7.5 Hz, 2H), 7.63 – 7.51 (m, 7H), 7.48 – 7.43 (m, 1H), 7.42 – 7.36 (m, 4H), 7.34 – 7.28 (m, 2H), 4.20 (s, 2H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 157.1, 144.0, 133.9, 130.8, 130.6, 128.5, 128.4, 127.6, 127.6, 127.5, 126.9, 126.5, 126.3, 126.1, 124.7, 90.8, 50.9 ppm.

HRMS (ESI-TOF): m/z [M+H]$^+$ calcd for $C_{25}H_{20}NO^+$: 350.1539 found: 350.1544.

5,5-Diphenyl-3-(pyridin-3-yl)-4,5-dihydroisoxazole (2u)

Yield: 77% (116 mg), White solid; mp 169-170 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.85 (s, 1H), 8.63 (s, 1H), 8.09 (d, J = 8.0 Hz, 1H), 7.47 (d, J = 7.5 Hz, 4H), 7.39 – 7.32 (m, 5H), 7.29 (t, J = 7.3 Hz, 2H), 4.00 (s, 2H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 153.9, 151.0, 147.6, 143.6, 133.7, 128.5, 127.8, 126.0 (2C), 123.7, 92.5, 47.6 ppm.

HRMS (ESI-TOF): m/z [M+H]$^+$ calcd for $C_{20}H_{17}N_2O^+$: 301.1335 found: 301.1340.

5-(4-Chlorophenyl)-3,5-diphenyl-4,5-dihydroisoxazole (2v):

Yield: 88% (147 mg), White solid; mp 161-162 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.69 (dd, J = 6.5, 3.0 Hz, 2H), 7.46 (d, J = 7.6 Hz, 2H), 7.43 – 7.39 (m, 5H), 7.36 (t, J = 7.6 Hz, 2H), 7.30 (dd, J = 14.6, 7.9 Hz, 3H), 3.96 (q, J = 16.5 Hz, 2H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.3, 143.5, 142.7, 133.6, 130.3, 129.4, 128.7, 128.6, 128.5, 127.9, 127.6, 126.7, 126.0, 91.5, 48.2 ppm.

HRMS (ESI-TOF): m/z [M+H]$^+$ calcd for $C_{21}H_{17}ClNO^+$: 334.0993; found: 334.0992.

5-Methyl-3,5-diphenyl-4,5-dihydroisoxazole (2w)[20]

Yield: 94% (112 mg), White solid.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.73 – 7.64 (m, 2H), 7.52 (d, J = 7.5 Hz, 2H), 7.43 – 7.35 (m, 5H), 7.29 (t, J = 7.3 Hz, 1H), 3.51 (q, J = 16.4 Hz, 2H), 1.83 (s, 3H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.1, 145.4, 129.9, 129.8, 128.6, 128.4, 127.3, 126.5, 124.6, 88.0, 48.7, 28.2 ppm.

3,5-Diphenyl-5-(trifluoromethyl)-4,5-dihydroisoxazole (2x)[26]

Yield: 90% (131 mg), White solid.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.69 – 7.59 (m, 4H), 7.48 – 7.36 (m, 6H), 3.93 (q, J = 17.0, 2H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.0, 135.7, 130.8, 129.3, 128.8, 128.6, 128.1, 126.8, 126.6, 124.3 (q, $J_{C\text{-}F}$ = 282.5 Hz), 87.8 (q, $J_{C\text{-}F}$ = 30.0 Hz), 44.0 ppm.

3,3-Diphenylacrylonitrile (4)[27]

Yield: 88% (90 mg), Pale yellow oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.50 – 7.42 (m, 6H), 7.38 (t, J = 7.5 Hz, 2H), 7.31 (d, J = 7.4 Hz, 2H), 5.75 (s, 1H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 163.1, 138.9, 137.0, 130.4, 130.0, 129.5, 128.6, 128.5, 128.4, 117.8, 94.8 ppm.

Ullmann-Type Amination Reaction of Isoxazoline Compound 2f with pyrazole (5):[24]

A dry screw cap pressure tube (15 mL) equipped with a magnetic stirring bar was charged with 5,5-bis(4-bromophenyl)-3-phenyl-4,5-dihydroisoxazole (**2f**, 50 mg, 0.109 mmol), pyrazole (**5,** 30 mg, 0.436 mmol), CuI (10 mg, 0.054 mmol), Cs_2CO_3 (284 mg, 0.87 mmol) in DMF (2.0 mL) was stirrer at 140 °C in an oil bath for 24 h and mixture was diluted with water and extracted with ethyl acetate, dried over Na_2SO_4 and concentrated under vacuum. The residue was purified by silica gel column chromatography (hexane-EtOAc, 80:20) to provide 5,5-bis(4-(1*H*-pyrazol-1-yl)phenyl)-3-phenyl-4,5-dihydroisoxazole (**6)** as white solid (29 mg, 0.067 mmol, 62% yield), mp 173-174 °C.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.91 (d, J = 2.4 Hz, 2H), 7.71 (dd, J = 8.5, 6.0 Hz, 8H), 7.57 (d, J = 8.7 Hz, 4H), 7.43 – 7.39 (m, 3H), 6.48 – 6.44 (m, 2H), 4.02 (s, 2H) ppm.

^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.4, 141.8, 141.3, 139.7, 130.4, 129.3, 128.8, 127.3, 126.7, 125.0, 119.1, 107.8, 91.3, 48.3 ppm.

HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{27}H_{22}N_5O^+$: 432.1819; found: 432.1820.

Conflict of Interest

The authors declare no conflict of interest.

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Supporting Information

YES (this text will be updated with links prior to publication)

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Supporting Information

for

K_2CO_3-Mediated Intramolecular Oxa-Michael Cyclization of α,β–Unsaturated Ketoximes: Synthesis of Densely Arene-Substituted 2-Isoxazolines Bearing One Quaternary Center

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1. General Information

^{1}H and ^{13}C NMR spectra were recorded at 25 ºC on a Bruker Avance III 500 MHz spectrometer operating at 500 MHz for ^{1}H, 125 MHz for ^{13}C NMR experiments. Chemical shifts were calibrated to the residual proton and carbon resonance of the solvent, $CDCl_3$ (^{1}H δ 7.26; ^{13}C δ 77.0)/ DMSO-d_6 (^{1}H δ 2.50; ^{13}C δ 39.52). The following abbreviations were used to illuminate the diversities: δ = chemical shifts, *J* = coupling constant, s = singlet, d = doublet, t = triplet, q = quartet, sep = septet, m = multiplet. Chemical shifts are given in ppm relative to the internal standard of tetramethylsilane (TMS). High-resolution mass spectra (HRMS) were obtained by using a TOF analyzer in ESI mode. X-ray data were taken at 273K with a Bruker APEX-II CCD single crystal diffractometer by using graphite monochromated Mo-Kα radiation (0.71073 Å). Data integration was done using SAINT.[1a] Intensities for absorption were corrected using SADABS.[1b] Structure solution and refinement were carried out using Bruker SHELX-TL.[1c-d] TLC analysis was performed with pre-coated TLC plates (0.2 mm, Silica gel 60 F-254, Merck). Column chromatography was done using silica gel (100-200 mesh) as an adsorbent. Unless otherwise stated, all reagents and starting materials obtained from commercial suppliers were used without further purification. Benzophenone, Ethynylmagnesium bromide (0.5 M in THF), n-BuLi (1.6 M in hexane), Phenylacetylene, Hydroxylamine hydrochloride, Aryl halides, CuI, $PdCl_2(PPh_3)_2$, K_2CO_3 were purchased from standard commercial sources (Sigma-Aldrich, TCI, Avra and CDH India). DMF was vacuum distilled over 4Å molecular sieves and stored under nitrogen. All the reactions were performed in an oven-dried glass pressure tube (capacity 15 mL) procured from the Sigma-Aldrich India (catalogue No. Z181099) under an atmosphere of N_2. Reactions were monitored by thin-layer chromatography (TLC). The products were purified by column chromatography on silica gel using petroleum ether and ethyl acetate as the eluent. In the case that oximes were obtained as *E/Z*-mixtures, the stereochemistry was assigned by ^{13}C NMR (the chemical shift of α–carbon with *syn* to the OH is farther to the higher field than that with *anti* to the OH).

2. Experimental Section

2.1 General procedure for starting materials

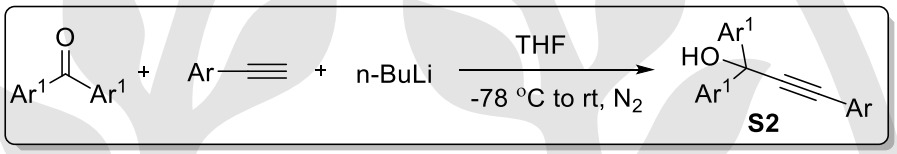
2.1.1 Procedure for the preparation of terminal propargyl alcohols: GP-1

Terminal propargyl alcohols **S1** were synthesized *via* reported procedure.[2]

In an oven dried round bottom flask added ketone (1.0 equiv.) in THF under N_2 atmosphere with continuous stirrer at room temp. Then the solution of ethynylmagnesium bromide (1.5 equiv.) was added at 0 ^oC. The reaction mixture was stirrer at 0 ^oC for 30 minutes and at room temperature for 6 h then the reaction was quenched with aqueous ammonium chloride and extracted with EtOAc. The combined organic layers were washed with H_2O and saturated $NaHCO_3$ solution, dried over Na_2SO_4 and evaporated under reduced pressure. The crude product was purified by column chromatography.

2.1.2 Procedure for the preparation of internal propargyl alcohols: GP-2

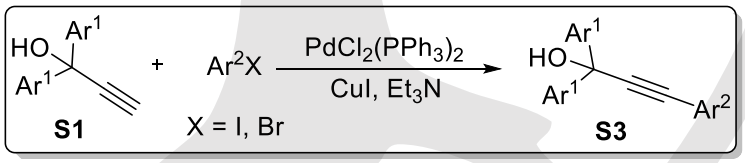
Internal propargyl alcohols **S2** were synthesized *via* reported procedure.[3]



To a solution of alkyne (3.75 equiv.) in THF at -78 ^oC was added n-BuLi solution (1.6 M, 1.4 equiv.). The solution was allowed to warm at 0 ^oC over 1 hour and then the solution was cooled to -78 ^oC and ketone (1.0 equiv.) was added. The reaction mixture was allowed to warm at room temperature and stirrer at room temp for 3 hours. The reaction was quenched with aqueous solution of NH_4Cl and the reaction mixture was extracted with EtOAc. The combined organic layers were washed with H_2O and saturated $NaHCO_3$ solution, dried over Na_2SO_4, filtered and evaporated under reduced pressure. The crude product was purified by column chromatography.

2.1.3 Procedure for the sonogashira coupling between terminal propargyl alcohol and aryl iodide: GP-3

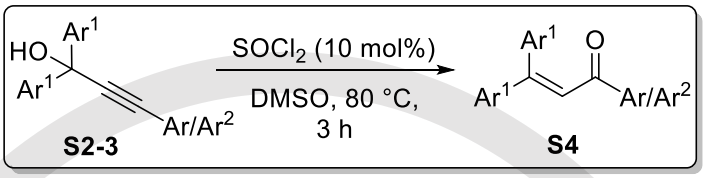
Aryl propargyl alcohols **S3** were synthesized *via* reported procedure.[4]



To a solution of the substituted aryl halide (5 mmol) in Et_3N (5 mL) was added $PdCl_2(PPh_3)_2$ (4 mol%), CuI (2 mol%) under Ar atmosphere for 5 minutes. A solution of terminal propargyl alcohol **S1** (5 mmol) in Et_3N (5 mL) was dropwise added over a period of 5 minutes at rt. Further, the resulting solution was stirrer at rt for overnight and upon completion the reaction (monitored by TLC) mixture was diluted with aqueous solution of NH_4Cl (30 mL) and extracted with ethyl acetate (30 mL), dried over Na_2SO_4, and concentrated under vacuum. The crude product was purified by column chromatography.

2.1.4 General procedure for the synthesis of α,β-unsaturated carbonyl compounds: GP-4

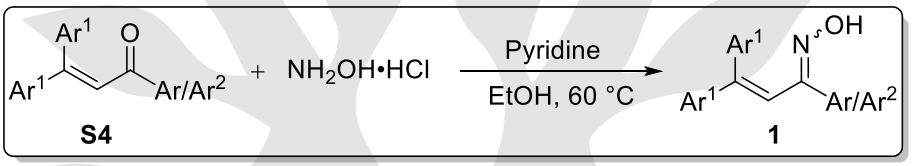
Aryl enones **S4** were synthesized *via* reported procedure.[5]



A dry screw cap pressure tube (15 mL) equipped with a magnetic stirring bar was charged with propargyl alcohols **S2-3** (1 mmol), $SOCl_2$ (0.1 mmol) in DMSO was stirrer at 80 ºC in an oil bath and upon completion the reaction (monitored by TLC) mixture was diluted with water and extracted with ethyl acetate, dried over Na_2SO_4, and concentrated under vacuum. The residue was purified by silica gel column chromatography to provide the desired α,β-unsaturated carbonyl compounds **S4**.

2.1.5 General procedure for the synthesis of α,β-unsaturated ketoximes: GP-5

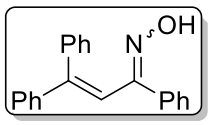
Aryl ketoximes **1** were synthesized *via* reported procedure (**1a** as representative).[6]



A dry screw cap pressure tube (15 mL) equipped with a magnetic stirring bar was charged with 1,3,3-triphenylprop-2-en-1-one (142 mg, 0.5 mmol) in EtOH (3 mL) was added hydroxylamine hydrochloride (52 mg, 0.75 mmol) and pyridine (101 µL, 1.25 mmol) under the argon atmosphere. The reaction mixture was stirred at 60 ^{0}C in an oil bath and upon completion the reaction (monitored by TLC) mixture was diluted with water and extracted with ethyl acetate, dried over Na_2SO_4, and concentrated under vacuum. The residue was purified by silica gel column chromatography to provide the desired product 1,3,3-triphenylprop-2-en-1-one oxime (**1a)**.

The NMR spectrums were described as a mixture. Compounds **1w**,[7a] **1x**,[7b] **3**[8a] are previously reported and showed the identical spectra according to the literature.

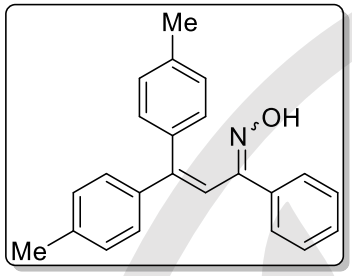
1,3,3-Triphenylprop-2-en-1-one oxime (1a):



Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 10:90); Yield: 92% (138 mg), White solid; (*E*/*Z* = 1:0.34, inseparable); mp 131-132 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.44 – 7.38 (m, 2H), 7.37 – 7.32 (m, 4.4H), 7.31 – 7.27 (m, 2.7H), 7.16 – 7.12 (m, 1.2H), 7.11 – 7.01 (m, 7.9H), 7.01 – 6.97 (m, 1.8H), 6.80 (s, 0.3H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 157.2, 156.7, 149.8, 148.7, 142.4, 141.6,

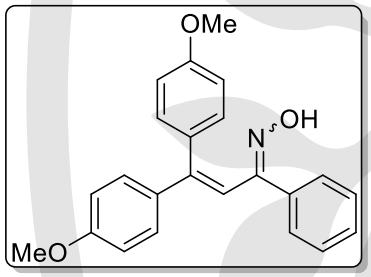
139.2, 139.1, 134.7, 132.2, 130.2, 130.0, 129.0, 128.8, 128.6, 128.5, 128.5, 128.4, 128.2, 128.2, 128.0, 127.9, 127.7, 127.6, 127.6, 127.5, 127.4, 127.2, 123.8, 118.5 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{18}NO^+$: 300.1383; found: 300.1384.

1-Phenyl-3,3-di-p-tolylprop-2-en-1-one oxime (1b):



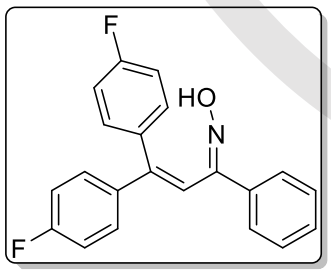
Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 12:88); Yield: 90% (147 mg), White solid; (*E*/*Z* = 1:0.17, inseparable); mp 161-162 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.34 (d, *J* = 7.0 Hz, 2.1H), 7.30 (d, *J* = 8.0 Hz, 2.3H), 7.18-7.03 (m, 6.1H), 6.92 (t, *J* = 3.8 Hz, 3H), 6.86 (dd, *J* = 17.8, 6.2 Hz, 2.7H), 2.38 (s, 3H), 2.35 (s, 0.5H), 2.24 (s, 0.5H), 2.18 (s, 3H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) Major isomer δ 157.4, 149.8, 139.0, 138.4, 137.7, 136.4, 134.9, 129.9, 128.9, 128.5, 128.4, 128.2, 127.7, 127.5, 117.1, 21.2, 21.1 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{23}H_{22}NO^+$: 328.1696; found: 328.1697.

3,3-Bis(4-methoxyphenyl)-1-phenylprop-2-en-1-one oxime (1c):



Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 16:84); Yield: 89% (160 mg), White solid; (*E*/*Z* = 1:0.76, inseparable); mp 137-138 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.42 (dd, *J* = 8.8, 2.1 Hz, 4H), 7.37 – 7.31 (m, 3.1H), 7.11 – 7.03 (m, 2.2H), 6.97 (dd, *J* = 11.8, 8.8 Hz, 3.6H), 6.88 (dd, *J* = 12.6, 6.1 Hz, 4.4H), 6.56 (d, *J* = 8.7 Hz, 1.6H), 3.86 (s, 3H), 3.84 (s, 2.3H), 3.82 (s, 3H), 3.68 (s, 2.3H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 160.6, 160.0, 159.3, 157.5, 157.1, 149.2, 134.9, 134.5, 131.9, 131.4, 131.1, 129.9, 129.4, 129.4, 129.2, 129.0, 128.4, 127.7, 127.5, 127.4, 124.9, 115.9, 113.7, 113.5, 113.5, 113.1, 113.0, 55.3, 55.3, 55.2, 55.1 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{23}H_{22}NO_3^+$: 360.1594; found: 360.1596.

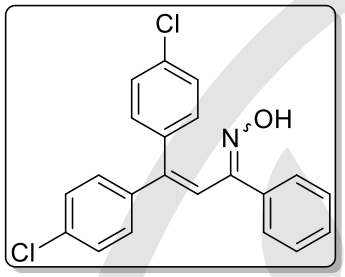
3,3-Bis(4-fluorophenyl)-1-phenylprop-2-en-1-one oxime (1d):



Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 12:88); Yield: 85% (142 mg), White solid; (single *E*-isomer); mp 151-152 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.38 – 7.33 (m, 2H), 7.31 (d, *J* = 7.1 Hz, 2H), 7.14 (t, *J* = 7.3 Hz, 1H), 7.09 (t, *J* = 7.3 Hz, 2H), 7.04 (t, *J* = 8.6 Hz, 2H), 6.98 (dd, *J* = 8.6, 5.5 Hz, 2H), 6.96 (s, 1H), 6.74 (dd, *J* = 15.1, 6.5 Hz, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 163.1

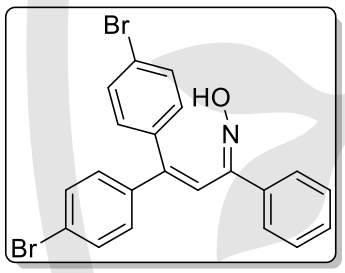
(d, $J_{C–F}$ = 246.3 Hz), 162.5 (d, $J_{C–F}$ = 246.3 Hz), 156.8, 147.7, 137.5 (d, $J_{C–F}$ = 2.5 Hz), 135.0 (d, $J_{C–F}$ = 2.5 Hz), 134.4, 131.7 (d, $J_{C–F}$ = 8.7 Hz), 130.2 (d, $J_{C–F}$ = 8.7 Hz), 128.8, 127.9, 127.4, 118.5, 115.3 (d, $J_{C–F}$ = 21.2 Hz), 114.79 (d, $J_{C–F}$ = 21.2 Hz) ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{16}F_2NO^+$: 336.1194; found: 336.1195.

3,3-Bis(4-chlorophenyl)-1-phenylprop-2-en-1-one oxime (1e):



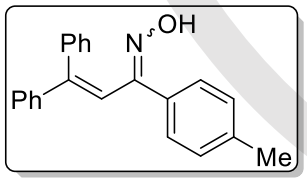
Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 12:88); Yield: 83% (152 mg), White solid; (*E*/*Z* = 1:0.19, inseparable); mp 154-155 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37 – 7.24 (m, 6.7H), 7.23 – 7.14 (m, 2H), 7.11 (t, *J* = 7.4 Hz, 2H), 7.03 (dd, *J* = 8.2, 6.4 Hz, 2.3H), 6.98 (s, 1H), 6.94 (d, *J* = 8.4 Hz, 1.9H), 6.89 (d, *J* = 8.4 Hz, 0.4H), 6.78 (s, 0.2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) Major isomer δ 156.5, 147.4, 139.5, 137.2, 134.7, 134.2, 131.4, 131.1, 129.6, 128.9, 128.6, 128.0, 128.0, 127.4, 119.3 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{16}Cl_2NO^+$: 368.0603; found: 368.0602.

3,3-Bis(4-bromophenyl)-1-phenylprop-2-en-1-one oxime (1f):



Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 12:88); Yield: 81% (185 mg), White solid; (single *E*-isomer); mp 163-164 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.48 (d, *J* = 8.5 Hz, 2H), 7.33 – 7.28 (m, 2H), 7.23 (d, *J* = 8.5 Hz, 2H), 7.20 – 7.15 (m, 3H), 7.12 (t, *J* = 7.4 Hz, 2H), 6.96 (s, 1H), 6.87 (d, *J* = 8.4 Hz, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.6, 147.4, 139.9, 137.6, 134.3, 131.6, 131.4, 131.0, 129.9, 129.0, 128.0, 127.4, 123.0, 122.5, 119.3 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{16}Br_2NO^+$: 457.9573; found: 457.9571.

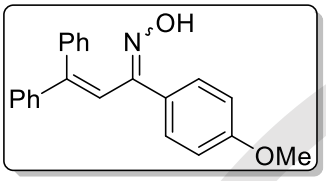
3,3-Diphenyl-1-(p-tolyl)prop-2-en-1-one oxime (1g):



Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 12:88); Yield: 89% (139 mg), Yellow semi-solid; (*E*/*Z* = 1:0.28, inseparable); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.43 – 7.38 (m, 2.2H), 7.38 – 7.32 (m, 3.1H), 7.30 (s, 1.5H), 7.25 (dd, *J* = 11.1, 2.9 Hz, 2.9H), 7.12 – 7.03 (m, 5.9H), 7.01 (dd, *J* = 7.7, 1.7 Hz, 0.6H), 6.97 (d, *J* = 7.9 Hz, 0.6H), 6.94 (s, 1H), 6.88 (d, *J* = 8.0 Hz, 2H), 6.75 (s, 0.3H), 2.25 (s, 0.8H), 2.20 (s, 3H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) Major isomer δ 157.0, 149.4, 141.7, 139.2, 138.6, 131.8, 129.9, 128.5 (2C), 128.4,

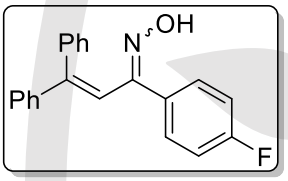
128.2, 127.9, 127.6, 127.2, 118.7, 21.1 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{22}H_{20}NO^+$: 314.1539; found: 314.1549.

1-(4-Methoxyphenyl)-3,3-diphenylprop-2-en-1-one oxime (1h):



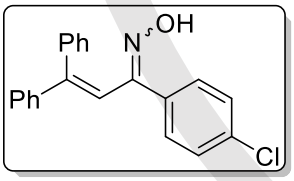
Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 14:86); Yield: 75% (123 mg), White solid; (*E*/*Z* = 1:0.14, inseparable); mp 183-184 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.40 (dt, *J* = 6.9, 3.2 Hz, 2.1H), 7.37 – 7.33 (m, 3.1H), 7.30 (d, *J* = 9.1 Hz, 2.8H), 7.12 – 7.00 (m, 5.8H), 6.94 (s, 1H), 6.61 (d, *J* = 8.8 Hz, 2H), 3.75 (s, 0.4H), 3.70 (s, 3H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) Major isomer δ 159.5, 156.6, 149.5, 141.7, 139.2, 129.9, 128.7, 128.5, 128.4, 128.2, 128.0, 127.6, 127.1, 118.7, 113.3, 55.1 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{22}H_{20}NO_2^+$: 330.1489; found: 330.1491.

1-(4-Fluorophenyl)-3,3-diphenylprop-2-en-1-one oxime (1i):



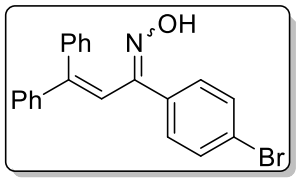
Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 12:88); Yield: 86% (136 mg), White solid; (*E*/*Z* = 1:0.14, inseparable); mp 119-120 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.39 (dd, *J* = 6.9, 2.8 Hz, 2H), 7.37 – 7.34 (m, 3.1H), 7.32 – 7.27 (m, 3H), 7.11 – 7.03 (m, 3.6H), 7.03 – 6.99 (m, 3H), 6.96 (d, *J* = 6.7 Hz, 0.4H), 6.74 (t, *J* = 8.7 Hz, 2.1H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) Major isomer δ 162.8 (d, J_{C-F} = 246.2 Hz), 156.4, 150.1, 141.4, 139.0, 130.8 (d, J_{C-F} = 3.7 Hz), 130.0, 129.3 (d, J_{C-F} = 7.5 Hz), 128.6, 128.5, 128.3, 128.1, 127.7, 118.2, 114.7 (d, J_{C-F} = 21.2 Hz) ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{17}FNO^+$: 318.1289; found: 318.1292.

1-(4-Chlorophenyl)-3,3-diphenylprop-2-en-1-one oxime (1j):



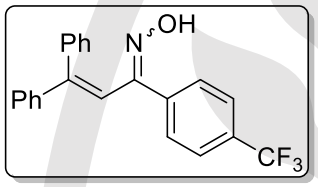
Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 12:88); Yield: 84% (140 mg), White solid; (*E*/*Z* = 1:0.29, inseparable); mp 133-134 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.39 (dd, *J* = 7.0, 2.9 Hz, 1.8H), 7.37 – 7.33 (m, 2.7H), 7.33 – 7.28 (m, 1.4H), 7.25 (d, *J* = 8.8 Hz, 2.1H), 7.18 (d, *J* = 8.5 Hz, 0.6H), 7.13 – 6.99 (m, 7.6H), 6.97 (s, 1H), 6.81 (s, 0.3H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) Major isomer δ 156.5, 150.1, 141.3, 139.0, 134.5, 133.2, 130.5, 130.0, 128.7, 128.5, 128.3, 128.2, 128.0, 127.7, 117.9 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{17}ClNO^+$: 334.0993; found: 334.0993.

1-(4-Bromophenyl)-3,3-diphenylprop-2-en-1-one oxime (1k):



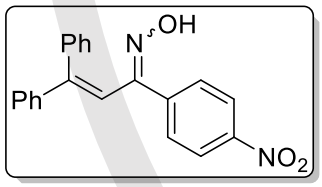
Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 12:88); Yield: 82% (161 mg), White solid; (*E*/*Z* = 1:0.20, inseparable); mp 138-139 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.39 (dd, *J* = 7.1, 2.7 Hz, 1.9H), 7.36 (dd, *J* = 5.3, 1.7 Hz, 2.9H), 7.30 (d, *J* = 1.7 Hz, 1H), 7.18 (s, 3.8H), 7.09 (ddd, *J* = 19.4, 10.4, 5.1 Hz, 3.9H), 7.03 – 6.99 (m, 1.9H), 6.98 (s, 1H), 6.81 (s, 0.2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) Major isomer δ 156.5, 150.2, 141.3, 139.0, 133.7, 130.9, 130.0, 128.9, 128.7, 128.5, 128.3, 128.2, 127.7, 122.8, 117.8 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{17}BrNO^+$: 378.0488; found: 378.0488.

3,3-Diphenyl-1-(4-(trifluoromethyl)phenyl)prop-2-en-1-one oxime (1l):



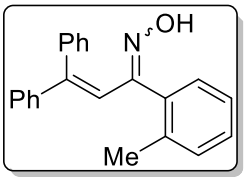
Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 13:87); Yield: 78% (143 mg), White solid; (*E*/*Z* = 1:0.14, inseparable); mp 143-144 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 9.35 (s, 1H), 7.40 (dd, *J* = 7.3, 2.5 Hz, 4H), 7.39 – 7.35 (m, 2.9H), 7.31 (t, *J* = 7.8 Hz, 2.9H), 7.09 – 7.00 (m, 4.4H), 6.98 (dd, *J* = 7.9, 1.6 Hz, 2.1H), 6.91 (s, 0.1H), 6.90 – 6.87 (m, 0.3H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) Major isomer δ 156.5, 150.6, 141.2, 138.9, 138.4, 130.2 (q, J_{C-F} = 32.5 Hz), 130.0, 129.3, 128.8, 128.5, 128.3, 127.9, 127.8, 124.6 (q, J_{C-F} = 3.7 Hz), 123.9 (q, J_{C-F} = 270.0 Hz), 117.5 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{22}H_{17}F_3NO^+$: 368.1257; found: 368.1263.

1-(4-Nitrophenyl)-3,3-diphenylprop-2-en-1-one oxime (1m):



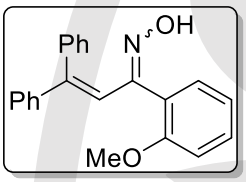
Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 18:82); Yield: 94% (162 mg), Yellow semi-solid; (*E*/*Z* = 1:0.40, inseparable); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.89 (d, *J* = 8.8 Hz, 2H), 7.44 (d, *J* = 8.9 Hz, 1.4H), 7.39 (dd, *J* = 8.7, 3.8 Hz, 3.4H), 7.34 – 7.26 (m, 2.9H), 7.07 – 6.95 (m, 5.2H), 6.90 (s, 0.4H), 6.89 – 6.86 (m, 0.8H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.0, 156.0, 150.9, 149.9, 147.5, 147.0, 141.6, 141.3, 140.9, 138.9, 138.7, 138.7, 130.3, 130.1, 130.0, 129.0, 128.7, 128.6, 128.5, 128.4, 128.3, 128.3, 127.9, 127.9, 127.8, 127.7, 122.9, 122.8, 122.5, 117.1 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{17}N_2O_3^+$: 345.1234; found: 345.1233.

3,3-Diphenyl-1-(o-tolyl)prop-2-en-1-one oxime (1n):



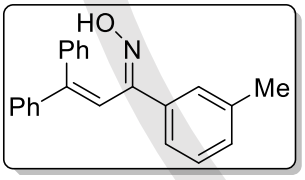
Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 12:88); Yield: 81% (127 mg), Yellow semi-solid; (*E*/*Z* = 1:0.42, inseparable); ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 – 7.31 (m, 4.8H), 7.30 (s, 1.1H), 7.27 (d, *J* = 1.3 Hz, 1.9H), 7.06 – 6.85 (m, 11.2H), 6.82 (t, *J* = 7.3 Hz, 2.2H), 2.25 (s, 3H), 2.16 (s, 1.2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 158.5, 157.6, 149.1, 147.9, 142.4, 141.6, 138.9, 138.5, 135.8, 135.4, 134.8, 132.6, 130.1, 129.9, 129.6, 129.5, 129.4, 128.5, 128.2, 128.2, 128.2, 128.1, 128.1, 127.9, 127.6, 127.6, 127.3, 127.3, 126.9, 124.9, 123.8, 118.9, 20.8, 20.1 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{22}H_{20}NO^+$: 314.1539; found: 314.1550.

1-(2-Methoxyphenyl)-3,3-diphenylprop-2-en-1-one oxime (1o):



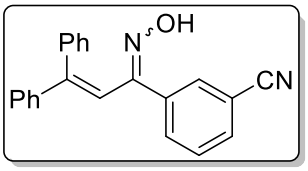
Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 14:86); Yield: 77% (127 mg), White solid; (*E*/*Z* = 1:0.41, inseparable); mp 162-163 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.43 – 7.36 (m, 2H), 7.36 – 7.32 (m, 2.9H), 7.29 (d, *J* = 6.5 Hz, 2.9H), 7.09 – 6.98 (m, 6.9H), 6.98 – 6.90 (m, 3.3H), 6.72 (t, *J* = 7.4 Hz, 0.4H), 6.63 (t, *J* = 7.4 Hz, 1H), 6.52 (dd, *J* = 8.4, 3.4 Hz, 1.4H), 3.72 (s, 4.2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.6, 156.0, 155.4, 155.1, 147.7, 147.1, 142.6, 142.1, 139.0, 138.5, 130.7, 129.8, 129.8, 129.6, 129.4, 129.4, 128.3, 128.1, 128.0 (2C), 127.9, 127.7, 127.4, 127.1, 126.9, 126.8, 124.4, 124.0, 121.8, 119.8, 119.7, 119.1, 110.2, 110.1, 55.2, 55.0 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{22}H_{20}NO_2^+$: 330.1489; found: 330.1502.

3,3-Diphenyl-1-(m-tolyl)prop-2-en-1-one oxime (1p):



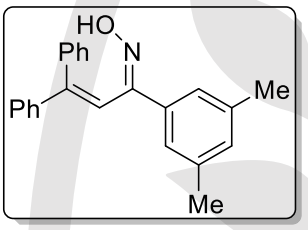
Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 12:88); Yield: 82% (128 mg), White solid; (single *E*-isomer); mp 147-148 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.46 – 7.39 (m, 2H), 7.39 – 7.34 (m, 3H), 7.18 (d, *J* = 7.7 Hz, 1H), 7.12 (s, 1H), 7.09 – 7.04 (m, 5H), 7.03 (s, 1H), 6.98 (t, *J* = 7.6 Hz, 1H), 6.92 (d, *J* = 7.5 Hz, 1H), 2.18 (s, 3H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 157.1, 149.7, 141.6, 139.3, 137.1, 134.5, 129.9, 129.3, 128.5, 128.4, 128.3, 128.2, 127.9, 127.7, 127.5, 124.6, 118.5, 21.1 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{22}H_{20}NO^+$: 314.1539; found: 314.1539.

3-(1-(Hydroxyimino)-3,3-diphenylallyl)benzonitrile (1q):



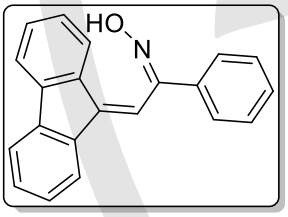
Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 16:84); Yield: 72% (117 mg), White solid; (*E*/*Z* = 1:0.47, inseparable); mp 126-127 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.52 (d, *J* = 9.0 Hz, 1.4H), 7.43 – 7.27 (m, 7H), 7.19 – 7.11 (m, 1.1H), 7.09 – 7.02 (m, 3.8H), 7.01 – 6.95 (m, 1.4H), 6.92 – 6.86 (m, 1.1H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 155.8, 155.5, 150.8, 149.7, 141.6, 140.9, 138.8, 138.6, 136.0, 133.2, 133.2, 132.8, 131.7, 131.6, 131.4, 131.3, 130.2, 130.0, 128.9, 128.6, 128.5 (2C), 128.4, 128.3, 128.3, 128.1, 127.9, 127.8, 127.8, 127.7, 122.8, 118.3, 118.3, 117.1, 111.7, 111.5 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{22}H_{17}N_2O^+$: 325.1335; found: 325.1334.

1-(3,5-Dimethylphenyl)-3,3-diphenylprop-2-en-1-one oxime (1r):



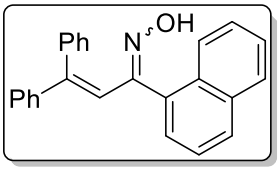
Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 11:89); Yield: 85% (139 mg), White solid; (single *E*-isomer); mp 133-134 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.49 – 7.42 (m, 2H), 7.41 – 7.34 (m, 3H), 7.11 – 7.06 (m, 5H), 7.05 (s, 1H), 6.97 (s, 2H), 6.75 (s, 1H), 2.17 (s, 6H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 157.0, 149.5, 141.7, 139.3, 137.0, 134.3, 130.1, 129.9, 128.5, 128.4, 128.2, 127.8, 127.4, 125.4, 118.6, 21.0 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{23}H_{22}NO^+$: 328.1696; found: 328.1698.

2-(9H-Fluoren-9-ylidene)-1-phenylethan-1-one oxime (1s):



Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 12:88); Yield: 74% (110 mg), Yellow solid; (single *E*-isomer); mp 210-211 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 9.03 (s, 1H), 7.83 (d, *J* = 7.5 Hz, 1H), 7.76 – 7.72 (m, 2H), 7.70 (d, *J* = 7.5 Hz, 1H), 7.66 (d, *J* = 7.6 Hz, 1H), 7.44 – 7.32 (m, 6H), 7.28 (dd, *J* = 14.9, 7.6 Hz, 1H), 7.24 (s, 1H), 7.04 (t, *J* = 7.6 Hz, 1H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 155.3, 141.4, 140.8, 140.0, 138.2, 135.9, 134.1, 129.9, 129.2, 128.8, 127.2, 127.2, 127.0 (2C), 125.6, 121.0, 119.7, 119.6, 114.9 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{16}NO^+$: 298.1226; found: 298.1232.

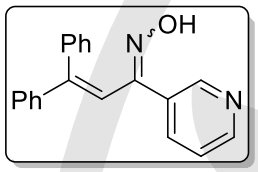
1-(Naphthalen-1-yl)-3,3-diphenylprop-2-en-1-one oxime (1t):



Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 13:87); Yield: 92% (161 mg), Yellow semi-solid; (*E*/*Z* = 1:0.37, inseparable); ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.08 (d, *J* = 8.4 Hz, 1H),

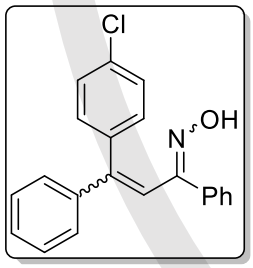
7.72 – 7.60 (m, 2H), 7.53 (d, *J* = 4.1 Hz, 1.3H), 7.50 (d, *J* = 8.3 Hz, 1.3H), 7.46 – 7.40 (m, 2H), 7.40 – 7.29 (m, 6.3H), 7.14 (dd, *J* = 8.8, 5.0 Hz, 2H), 7.07 (dd, *J* = 15.3, 7.7 Hz, 1.5H) 6.77 (t, *J* = 7.3 Hz, 1.1H), 6.73 – 6.64 (m, 2.3H), 6.60 (dd, *J* = 15.4, 7.9 Hz, 3.8H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 158.1, 157.0, 150.0, 148.4, 142.3, 141.7, 138.6, 138.1, 133.3, 133.0, 132.9, 131.4, 130.9, 130.1, 129.4, 129.3, 128.6, 128.6, 128.5, 128.2, 128.2 (2C), 128.2, 128.1, 128.0, 127.9, 127.6, 127.2, 126.8, 126.6, 126.5, 126.1, 126.1, 125.9, 125.8, 125.6, 125.6, 125.3, 124.7, 124.6, 124.3, 118.9 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{25}H_{20}NO^+$: 350.1539; found: 350.1539.

3,3-Diphenyl-1-(pyridin-3-yl)prop-2-en-1-one oxime (1u):



Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 30:70); Yield: 73% (110 mg), White solid; (*E*/*Z* = 1:0.44, inseparable); mp 147-148 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.63 (d, *J* = 1.7 Hz, 1H), 8.50 (d, *J* = 1.4 Hz, 0.4H), 8.29 – 8.22 (m, 1.5H), 7.56 (d, *J* = 8.0 Hz, 1.1H), 7.46 (d, *J* = 7.9 Hz, 0.6H), 7.39 (dd, *J* = 7.1, 2.2 Hz, 2.1H), 7.34 (dd, *J* = 5.2, 1.5 Hz, 3.1H), 7.29 (s, 2.4H), 7.20 (d, *J* = 4.3 Hz, 0.7H), 7.12 (s, 1.3H), 7.01 (d, *J* = 16.3 Hz, 7.2H), 6.96 – 6.87 (m, 2.6H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 154.0, 153.8, 149.6, 149.3, 148.3, 148.1, 148.0, 147.8, 143.4, 142.0, 141.2, 138.9, 138.8, 136.9, 135.1, 131.6, 130.3, 130.0, 129.1, 128.6, 128.5, 128.3, 128.2, 128.2, 127.9, 127.8, 127.4, 126.4, 123.9, 122.5, 122.4, 117.9 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{20}H_{17}N_2O^+$: 301.1335; found: 301.1334.

3-(4-Chlorophenyl)-1,3-diphenylprop-2-en-1-one oxime (1v):



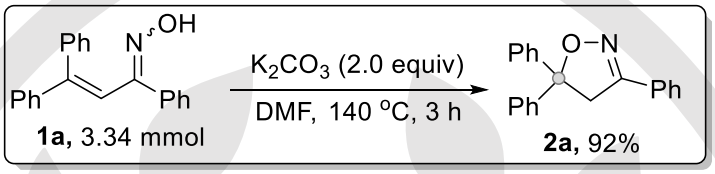
Following the general synthetic procedure GP-5. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 10:90); Yield: 84% (140 mg), White solid; (*E*/*Z* = 0.9:1, inseparable); mp 131-132 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 (s, 2.1H), 7.35 – 7.29 (m, 3.3H), 7.29 – 7.25 (m, 1.1H), 7.21 – 6.94 (m, 9.3H), 6.92 (d, *J* = 8.4 Hz, 0.3H), 6.79 (d, *J* = 13.7 Hz, 0.3H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.8, 148.6, 148.5, 141.1, 140.1, 138.7, 137.7, 134.5, 134.5, 133.9, 131.5, 131.2, 130.1, 129.9, 129.7, 128.8, 128.7, 128.7, 128.4, 128.4, 128.3, 128.2, 127.9, 127.8, 127.8, 127.7, 127.4, 119.0, 118.8 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{17}ClNO^+$: 334.0993; found: 334.0992.

2.2 General procedure for the synthesis of isoxazolines (2a as representative): GP-6

A dry screw cap pressure tube (15 mL) equipped with a magnetic stirring bar was charged with 1,3,3-triphenylprop-2-en-1-one oxime (**1a**, 150 mg, 0.5 mmol), and K_2CO_3 (138 mg, 1.0 mmol)

in DMF (2.0 mL) was stirrer at 140 °C in an oil bath for 3 h and mixture was diluted with water and extracted with ethyl acetate, dried over Na_2SO_4 and concentrated under vacuum. The residue was purified by silica gel column chromatography (hexane-EtOAc, 98:2) to provide 3,5,5-triphenyl-4,5-dihydroisoxazole (**2a)** as white solid (144 mg, 0.48 mmol, 96% yield).

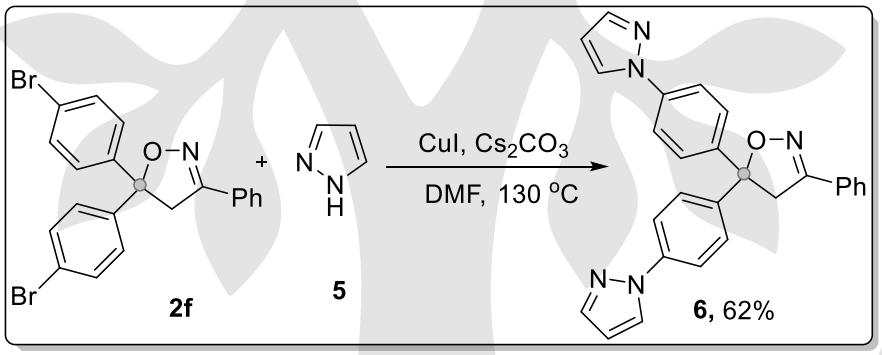
2.3 Large-scale reaction of 2a



A dry screw cap pressure tube (15 mL) equipped with a magnetic stirring bar was charged with 1,3,3-triphenylprop-2-en-1-one oxime (**1a**, 1.0 g, 3.34 mmol), and K_2CO_3 (923 mg, 6.69 mmol) in DMF (5.0 mL) was stirrer at 140 °C in an oil bath for 3 h and mixture was diluted with water and extracted with ethyl acetate, dried over Na_2SO_4 and concentrated under vacuum. The residue was purified by silica gel column chromatography (hexane-EtOAc, 98:2) to provide 3,5,5-triphenyl-4,5-dihydroisoxazole (**2a)** as white solid (0.92 g, 3.07 mmol, 92% yield).

2.4 Post-functionalization of 2-isoxazolines

2.4.1 Ullmann-type amination reaction of 2-isoxazoline compound 2f with pyrazole (5):[9]

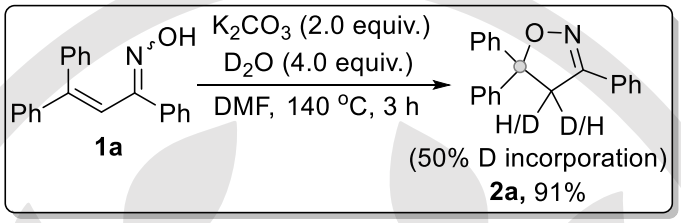


A dry screw cap pressure tube (15 mL) equipped with a magnetic stirring bar was charged with 5,5-bis(4-bromophenyl)-3-phenyl-4,5-dihydroisoxazole (**2f**, 50 mg, 0.109 mmol), pyrazole (**5,** 30 mg, 0.436 mmol), CuI (10 mg, 0.054 mmol), Cs_2CO_3 (284 mg, 0.87 mmol) in DMF (2.0 mL) was stirrer at 140 °C in an oil bath for 24 h and mixture was diluted with water and extracted with ethyl acetate, dried over Na_2SO_4 and concentrated under vacuum. The residue was purified by silica gel column chromatography (hexane-EtOAc, 80:20) to provide 5,5-bis(4-(1*H*-pyrazol-1-yl)phenyl)-3-phenyl-4,5-dihydroisoxazole (**6)** as white solid (29 mg, 0.067 mmol, 62% yield), mp 173-174 °C; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.91 (d, J = 2.4 Hz, 2H), 7.71 (dd, J = 8.5, 6.0 Hz, 8H), 7.57 (d, J = 8.7 Hz, 4H), 7.43 – 7.39 (m, 3H), 6.48 – 6.44 (m, 2H), 4.02 (s, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.4, 141.8, 141.3, 139.7, 130.4,

129.3, 128.8, 127.3, 126.7, 125.0, 119.1, 107.8, 91.3, 48.3 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{27}H_{22}N_5O^+$: 432.1819; found: 432.1820.

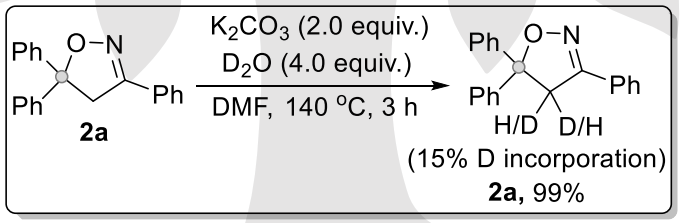
2.5 Deuterium scrambling experiments

2.5.1 Reaction of 1,3,3-triphenylprop-2-en-1-one oxime (1a) with D_2O (4.0 equiv.):



A dry screw cap pressure tube (15 mL) equipped with a magnetic stirring bar was charged with 1,3,3-triphenylprop-2-en-1-one oxime (**1a**, 150 mg, 0.5 mmol), K_2CO_3 (138 mg, 1.0 mmol), and D_2O (36 µL, 2.0 mmol) in DMF (2.0 mL) was stirrer at 140 °C in an oil bath for 3 h and mixture was diluted with water and extracted with ethyl acetate, dried over Na_2SO_4 and concentrated under vacuum. The residue was purified by silica gel column chromatography (hexane-EtOAc, 98:2) to provide 50 % D incorporated 3,5,5-triphenyl-4,5-dihydroisoxazole (**2a)** as white solid (137 mg, 0.455 mmol, 91% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.70 (dd, J = 6.6, 3.0 Hz, 2H), 7.48 (d, J = 7.7 Hz, 4H), 7.43 – 7.31 (m, 7H), 7.31 – 7.24 (m, 2H), 3.99 (d, J = 7.1 Hz, 1H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.2, 144.1, 130.1, 129.6, 128.7, 128.4, 127.6, 126.7, 126.1, 91.9, 48.2, 47.9 (t, $J_{C\text{-}D}$ = 20.0 Hz) ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{17}DNO^+$: 301.1446; found: 301.1441.

2.5.2 Reaction of 3,5,5-triphenyl-4,5-dihydroisoxazole (2a) with D_2O (4.0 equiv.):



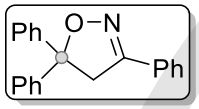
A dry screw cap pressure tube (15 mL) equipped with a magnetic stirring bar was charged with 3,5,5-triphenyl-4,5-dihydroisoxazole (**2a**, 150 mg, 0.5 mmol), K_2CO_3 (138 mg, 1.0 mmol), and D_2O (36 µL, 2.0 mmol) in DMF (2.0 mL) was stirrer at 140 °C in an oil bath for 3 h and mixture was diluted with water and extracted with ethyl acetate, dried over Na_2SO_4 and concentrated under vacuum. The residue was purified by silica gel column chromatography (hexane-EtOAc, 98:2) to provide 15 % D incorporated 3,5,5-triphenyl-4,5-dihydroisoxazole (**2a)** as white solid (149 mg, 0.496 mmol, 99% yield). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.71 (dd, J = 6.6, 3.0 Hz, 2H), 7.50 (d, J = 7.7 Hz, 4H), 7.45 – 7.33 (m, 7H), 7.29 (t, J = 7.3 Hz, 2H), 4.00 (d, J = 7.0 Hz,

1.7H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.2, 144.0, 130.1, 129.5, 128.7, 128.4, 127.6, 126.6, 126.1, 91.9, 48.2, 47.9 (t, $J_{C\text{-}D}$ = 20.0 Hz) ppm.

3. Characterization data for products

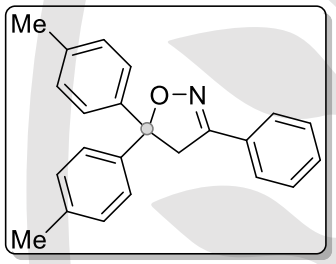
Compounds **2a**,[6] **2g-h**,[6] **2k-l**,[6] **2w**,[7c] **2x**,[7b] **4**[8] are previously reported and showed the identical spectra according to the literature.

3,5,5-Triphenyl-4,5-dihydroisoxazole (2a):[6]



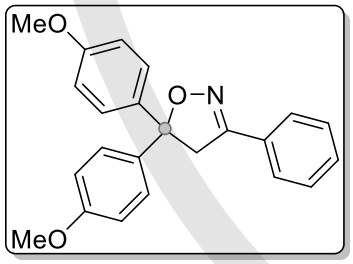
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 2:98); Yield: 96% (144 mg), White solid; mp 143-144 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.73 – 7.67 (m, 2H), 7.51 – 7.45 (m, 4H), 7.42 – 7.32 (m, 7H), 7.31 – 7.26 (m, 2H), 4.00 (s, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.2, 144.0, 130.1, 129.6, 128.7, 128.4, 127.6, 126.7, 126.1, 92.0, 48.2 ppm.

3-Phenyl-5,5-di-p-tolyl-4,5-dihydroisoxazole (2b):



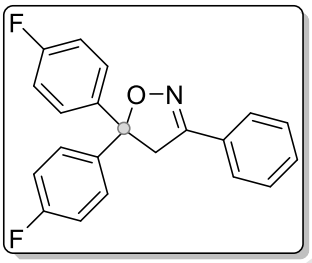
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 3:97); Yield: 91% (149 mg), White solid; mp 107-108 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.70 (dd, J = 6.4, 2.8 Hz, 2H), 7.45 – 7.33 (m, 7H), 7.16 (d, J = 8.0 Hz, 4H), 3.96 (s, 2H), 2.34 (s, 6H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.2, 141.3, 137.3, 130.0, 129.7, 129.0, 128.6, 126.6, 126.0, 91.9, 48.1, 21.0 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{23}H_{22}NO^+$: 328.1696; found: 328.1697.

5,5-Bis(4-methoxyphenyl)-3-phenyl-4,5-dihydroisoxazole (2c):



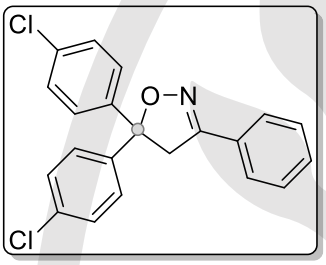
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 5:95); Yield: 92% (165 mg), Yellow solid; mp 90-91 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.74 – 7.63 (m, 2H), 7.38 (dd, J = 9.9, 6.0 Hz, 7H), 6.88 (d, J = 8.7 Hz, 4H), 3.93 (s, 2H), 3.79 (s, 6H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 159.0, 156.2, 136.3, 132.2, 130.0, 128.6, 127.4, 126.6, 113.6, 91.6, 55.2, 48.3 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{23}H_{22}NO_3^+$: 360.1594; found: 360.1596.

5,5-Bis(4-fluorophenyl)-3-phenyl-4,5-dihydroisoxazole (2d):



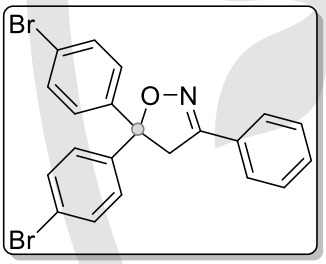
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 2:98); Yield: 88% (147 mg), White solid; mp 105-106 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.75 – 7.64 (m, 2H), 7.42 (dd, J = 8.6, 5.3 Hz, 7H), 7.04 (t, J = 8.6 Hz, 4H), 3.95 (s, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 162.2 (d, J_{C-F} = 250.0 Hz), 156.3, 139.6 (d, J_{C-F} = 3.7 Hz), 130.3, 129.3, 128.8, 127.9 (d, J_{C-F} = 7.5 Hz), 126.7, 115.3 (d, J_{C-F} = 21.2 Hz), 91.1, 48.4 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{16}F_2NO^+$: 336.1194; found: 336.1190.

5,5-Bis(4-chlorophenyl)-3-phenyl-4,5-dihydroisoxazole (2e):



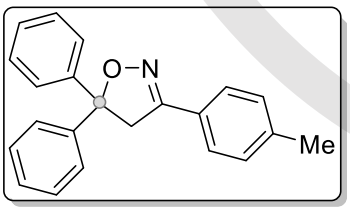
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 2:98); Yield: 84% (155 mg), White solid; mp 100-101 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.74 – 7.63 (m, 2H), 7.46 – 7.36 (m, 7H), 7.32 (d, J = 8.5 Hz, 4H), 3.94 (s, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.3, 142.0, 133.9, 130.4, 129.1, 128.8, 128.7, 127.5, 126.7, 91.0, 48.1 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{16}Cl_2NO^+$: 368.0603; found: 368.0606.

5,5-Bis(4-bromophenyl)-3-phenyl-4,5-dihydroisoxazole (2f):



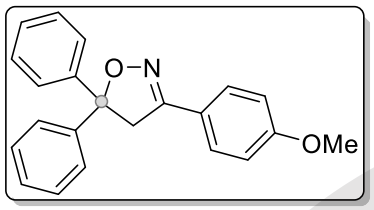
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 2:98); Yield: 81% (185 mg), White solid; mp 118-119 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.67 (d, J = 5.4 Hz, 2H), 7.48 (d, J = 8.4 Hz, 4H), 7.40 (d, J = 5.7 Hz, 3H), 7.32 (d, J = 8.3 Hz, 4H), 3.92 (s, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.3, 142.5, 131.7, 130.4, 129.1, 128.8, 127.8, 126.7, 122.1, 91.1, 48.0 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{16}Br_2NO^+$: 457.9573; found: 457.9571.

5,5-Diphenyl-3-(p-tolyl)-4,5-dihydroisoxazole (2g):[6]



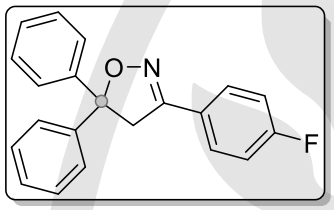
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 2:98); Yield: 86% (135 mg), White solid; mp 129-130 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.60 (d, J = 8.1 Hz, 2H), 7.49 (d, J = 7.7 Hz, 4H), 7.36 (t, J = 7.6 Hz, 4H), 7.28 (dd, J = 12.8, 5.5 Hz, 2H), 7.21 (d, J = 8.0 Hz, 2H), 3.99 (s, 2H), 2.38 (s, 3H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.2, 144.1, 140.3, 129.3, 128.4, 127.6, 126.7, 126.6, 126.1, 91.7, 48.3, 21.4 ppm.

3-(4-Methoxyphenyl)-5,5-diphenyl-4,5-dihydroisoxazole (2h):[6]



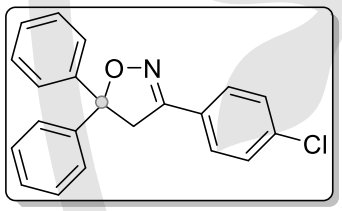
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 4:96); Yield: 84% (138 mg), Yellow solid; mp 143-144 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.65 (d, J = 8.7 Hz, 2H), 7.49 (d, J = 7.7 Hz, 4H), 7.35 (t, J = 7.6 Hz, 4H), 7.28 (dd, J = 12.5, 5.3 Hz, 2H), 6.91 (d, J = 8.8 Hz, 2H), 3.98 (s, 2H), 3.82 (s, 3H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 161.0, 155.8, 144.2, 128.3, 128.2, 127.5, 126.1, 122.1, 114.1, 91.6, 55.3, 48.4 ppm.

3-(4-Fluorophenyl)-5,5-diphenyl-4,5-dihydroisoxazole (2i):



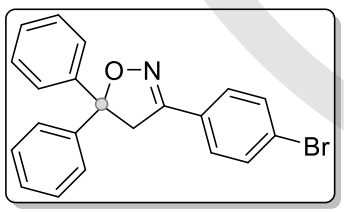
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 2:98); Yield: 74% (117 mg), White solid; mp 121-122 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.72 – 7.64 (m, 2H), 7.49 – 7.42 (m, 4H), 7.38 – 7.32 (m, 4H), 7.27 (t, J = 7.3 Hz, 2H), 7.07 (t, J = 8.7 Hz, 2H), 3.96 (s, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 163.8 (d, $J_{C–F}$ = 248.7 Hz), 155.2, 143.9, 128.6, 128.6, 128.4, 127.7, 126.0, 115.8 (d, $J_{C–F}$ = 21.2 Hz), 92.1, 48.3 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{17}FNO^+$: 318.1289; found: 318.1287.

3-(4-Chlorophenyl)-5,5-diphenyl-4,5-dihydroisoxazole (2j):



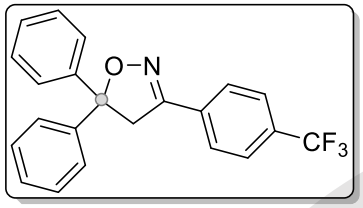
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 2:98); Yield: 71% (119 mg), White solid; mp 139-140 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.63 (d, J = 8.5 Hz, 2H), 7.46 (d, J = 7.6 Hz, 4H), 7.36 (dd, J = 12.1, 4.9 Hz, 6H), 7.28 (t, J = 7.3 Hz, 2H), 3.96 (s, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 155.3, 143.9, 136.1, 129.0, 128.5, 128.1, 127.9, 127.7, 126.0, 92.3, 48.0 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{17}ClNO^+$: 334.0993 found: 334.0991.

3-(4-Bromophenyl)-5,5-diphenyl-4,5-dihydroisoxazole (2k):[6]



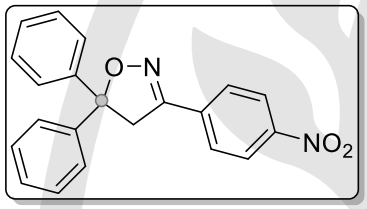
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 2:98); Yield: 68% (129 mg), White solid; mp 170-171 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.57 (d, J = 8.4 Hz, 2H), 7.51 (dd, J = 13.3, 8.2 Hz, 6H), 7.37 (t, J = 7.5 Hz, 4H), 7.30 (t, J = 7.1 Hz, 2H), 3.98 (s, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 155.4, 143.8, 131.8, 128.4, 128.0, 127.7, 126.0 (2C), 124.3, 92.3, 47.9 ppm.

5,5-Diphenyl-3-(4-(trifluoromethyl)phenyl)-4,5-dihydroisoxazole (2l):[6]



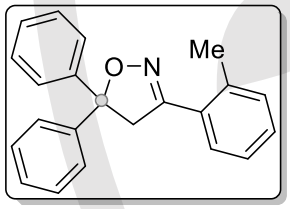
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 3:97); Yield: 65% (119 mg), White solid; mp 134-135 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.81 (d, J = 8.1 Hz, 2H), 7.65 (d, J = 8.2 Hz, 2H), 7.52 – 7.44 (m, 4H), 7.40 – 7.33 (m, 4H), 7.33 – 7.27 (m, 2H), 4.00 (s, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 155.2, 143.7, 133.0, 131.8 (q, $J_{C\text{-}F}$ = 32.6 Hz), 128.5, 127.8, 126.9, 126.0, 125.7 (q, $J_{C\text{-}F}$ = 4.0 Hz), 123.8 (q, $J_{C\text{-}F}$ = 270.6 Hz), 92.7, 47.8 ppm.

3-(4-Nitrophenyl)-5,5-diphenyl-4,5-dihydroisoxazole (2m):



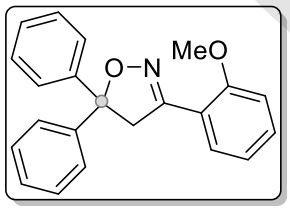
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 5:95); Yield: 63% (108 mg), Yellow solid; mp 139-140 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.25 (d, J = 8.8 Hz, 2H), 7.86 (d, J = 8.8 Hz, 2H), 7.46 (d, J = 7.4 Hz, 4H), 7.37 (t, J = 7.6 Hz, 4H), 7.30 (t, J = 7.3 Hz, 2H), 4.02 (s, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 154.7, 148.4, 143.4, 135.6, 128.5, 127.9, 127.3, 125.9, 124.0, 93.3, 47.6 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{17}N_2O_3^+$: 345.1234 found: 345.1226.

5,5-Diphenyl-3-(o-tolyl)-4,5-dihydroisoxazole (2n):



Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 2:98); Yield: 71% (111 mg), White solid; mp 93-94 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.49 (d, J = 7.8 Hz, 4H), 7.35 (dd, J = 15.8, 7.9 Hz, 5H), 7.27 (dd, J = 12.6, 4.7 Hz, 4H), 7.21 (t, J = 7.1 Hz, 1H), 4.03 (s, 2H), 2.53 (s, 3H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 157.3, 144.0, 138.0, 131.5, 129.4, 128.7, 128.7, 128.4, 127.6, 126.1, 125.7, 90.9, 50.5, 22.7 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{22}H_{20}NO^+$: 314.1539 found: 314.1541.

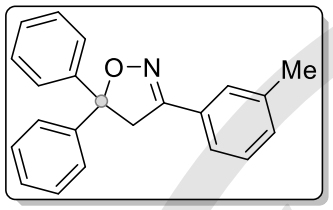
3-(2-Methoxyphenyl)-5,5-diphenyl-4,5-dihydroisoxazole (2o):



Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 3:97); Yield: 75% (123 mg), White solid; mp 151-152 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.76 (dd, J = 7.7, 1.7 Hz, 1H), 7.52 – 7.46 (m, 4H), 7.34 (ddd, J = 10.0, 6.1, 2.6 Hz, 5H), 7.27 (ddd, J = 7.7, 4.1, 1.4 Hz, 2H), 6.95 (td, J = 7.6, 1.0 Hz, 1H), 6.91 (d, J = 8.3 Hz, 1H), 4.09 (s, 2H), 3.83 (s, 3H) ppm; ^{13}C {^{1}H} NMR

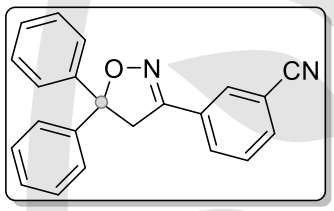
(125 MHz, $CDCl_3$) δ 157.5, 144.3, 131.3, 129.4, 128.4, 128.3, 127.4, 126.5, 126.2, 120.8, 111.4, 91.6, 55.5, 50.6 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{22}H_{20}NO_2^+$: 330.1489 found: 330.1490.

5,5-Diphenyl-3-(m-tolyl)-4,5-dihydroisoxazole (2p):



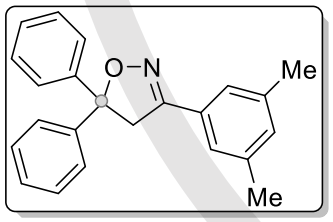
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 2:98); Yield: 78% (122 mg), White solid; mp 118-119 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.54 (s, 1H), 7.48 (dd, *J* = 8.2, 0.9 Hz, 5H), 7.35 (dd, *J* = 10.4, 4.8 Hz, 4H), 7.30 – 7.25 (m, 3H), 7.21 (d, *J* = 7.6 Hz, 1H), 3.99 (s, 2H), 2.37 (s, 3H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.4, 144.1, 138.4, 130.9, 129.4, 128.6, 128.4, 127.6, 127.2, 126.1, 123.8, 91.9, 48.3, 21.3 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{22}H_{20}NO^+$: 314.1539 found: 314.1539.

3-(5,5-Diphenyl-4,5-dihydroisoxazol-3-yl)benzonitrile (2q):



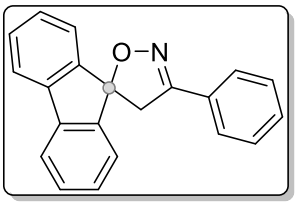
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 4:96); Yield: 66% (107 mg), White solid; mp 141-142 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 7.9 Hz, 1H), 7.93 (s, 1H), 7.66 (d, *J* = 7.6 Hz, 1H), 7.54 – 7.49 (m, 1H), 7.47 (d, *J* = 7.6 Hz, 4H), 7.37 (t, *J* = 7.5 Hz, 4H), 7.30 (t, *J* = 7.2 Hz, 2H), 3.99 (s, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 154.5, 143.4, 133.1, 130.9, 130.5, 130.0, 129.6, 128.5, 127.8, 125.9, 118.0, 113.0, 92.8, 47.5 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{22}H_{17}N_2O^+$: 325.1335 found: 325.1338.

3-(3,5-Dimethylphenyl)-5,5-diphenyl-4,5-dihydroisoxazole (2r):



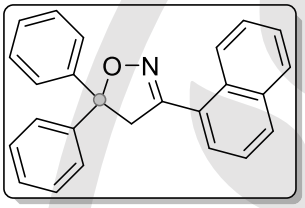
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 2:98); Yield: 86% (141 mg), White solid; mp 133-134 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.47 (d, *J* = 7.4 Hz, 4H), 7.34 (dd, *J* = 13.7, 5.8 Hz, 6H), 7.29 – 7.25 (m, 2H), 7.03 (s, 1H), 3.97 (s, 2H), 2.32 (s, 6H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.5, 144.1, 138.3, 131.8, 130.0, 128.4, 127.6, 126.1, 124.5, 91.8, 48.3, 21.2 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{23}H_{22}NO^+$: 328.1696 found: 328.1697.

3'-Phenyl-4'H-spiro[fluorene-9,5'-isoxazole] (2s):



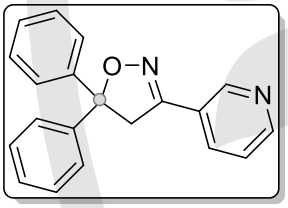
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 2:98); Yield: 94% (140 mg), Yellow solid; mp 131-132 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.83 – 7.76 (m, 2H), 7.65 (d, J = 7.5 Hz, 2H), 7.53 (d, J = 7.5 Hz, 2H), 7.50 – 7.45 (m, 3H), 7.41 (t, J = 7.5 Hz, 2H), 7.30 (t, J = 7.5 Hz, 2H), 3.87 (s, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 157.0, 146.2, 139.8, 130.2, 129.7, 129.5, 128.8, 128.5, 126.8 (2C), 123.6, 120.0, 92.2, 45.1 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{16}NO^+$: 298.1226 found: 298.1228.

3-(Naphthalen-1-yl)-5,5-diphenyl-4,5-dihydroisoxazole (2t):



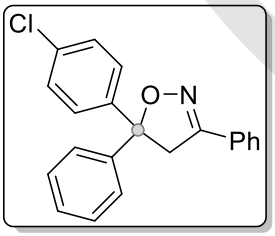
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 2:98); Yield: 94% (164 mg), White solid; mp 127-128 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.96 (d, J = 8.6 Hz, 1H), 7.88 (t, J = 7.5 Hz, 2H), 7.63 – 7.51 (m, 7H), 7.48 – 7.43 (m, 1H), 7.42 – 7.36 (m, 4H), 7.34 – 7.28 (m, 2H), 4.20 (s, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 157.1, 144.0, 133.9, 130.8, 130.6, 128.5, 128.4, 127.6, 127.6, 127.5, 126.9, 126.5, 126.3, 126.1, 124.7, 90.8, 50.9 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{25}H_{20}NO^+$: 350.1539 found: 350.1544.

5,5-Diphenyl-3-(pyridin-3-yl)-4,5-dihydroisoxazole (2u):



Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 5:95); Yield: 77% (116 mg), White solid; mp 169-170 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.85 (s, 1H), 8.63 (s, 1H), 8.09 (d, J = 8.0 Hz, 1H), 7.47 (d, J = 7.5 Hz, 4H), 7.39 – 7.32 (m, 5H), 7.29 (t, J = 7.3 Hz, 2H), 4.00 (s, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 153.9, 151.0, 147.6, 143.6, 133.7, 128.5, 127.8, 126.0 (2C), 123.7, 92.5, 47.6 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{20}H_{17}N_2O^+$: 301.1335 found: 301.1340.

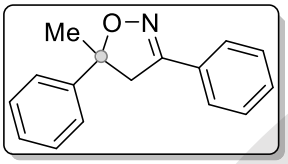
5-(4-Chlorophenyl)-3,5-diphenyl-4,5-dihydroisoxazole (2v):



Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 4:96); Yield: 88% (147 mg), White solid; mp 161-162 ºC; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.69 (dd, J = 6.5, 3.0 Hz, 2H), 7.46 (d, J = 7.6 Hz, 2H), 7.43 – 7.39 (m, 5H), 7.36 (t, J = 7.6 Hz, 2H), 7.30 (dd, J = 14.6, 7.9 Hz, 3H), 3.96 (q, J = 16.5 Hz, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.3,

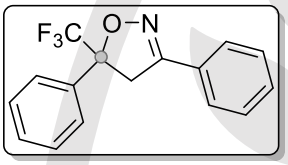
143.5, 142.7, 133.6, 130.3, 129.4, 128.7, 128.6, 128.5, 127.9, 127.6, 126.7, 126.0, 91.5, 48.2 ppm; HRMS (ESI-TOF): m/z $[M+H]^+$ calcd for $C_{21}H_{17}ClNO^+$: 334.0993; found: 334.0992.

5-Methyl-3,5-diphenyl-4,5-dihydroisoxazole (2w):[7c]



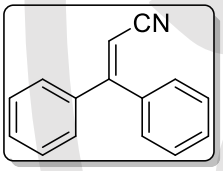
Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 2:98); Yield: 94% (112 mg), White solid; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.73 – 7.64 (m, 2H), 7.52 (d, J = 7.5 Hz, 2H), 7.43 – 7.35 (m, 5H), 7.29 (t, J = 7.3 Hz, 1H), 3.51 (q, J = 16.4 Hz, 2H), 1.83 (s, 3H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.1, 145.4, 129.9, 129.8, 128.6, 128.4, 127.3, 126.5, 124.6, 88.0, 48.7, 28.2 ppm.

3,5-Diphenyl-5-(trifluoromethyl)-4,5-dihydroisoxazole (2x):[7b]



Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 2:98); Yield: 90% (131 mg), White solid; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.69 – 7.59 (m, 4H), 7.48 – 7.36 (m, 6H), 3.93 (q, J = 17.0, 2H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 156.0, 135.7, 130.8, 129.3, 128.8, 128.6, 128.1, 126.8, 126.6, 124.3 (q, $J_{C\text{-}F}$ = 282.5 Hz), 87.8 (q, $J_{C\text{-}F}$ = 30.0 Hz), 44.0 ppm.

3,3-Diphenylacrylonitrile (4):[8]



Following the general synthetic procedure GP-6. The reaction mixture was purified by silica gel column chromatography (EtOAc: petroleum ether, 1:99); Yield: 88% (90 mg), Pale yellow oil; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.50 – 7.42 (m, 6H), 7.38 (t, J = 7.5 Hz, 2H), 7.31 (d, J = 7.4 Hz, 2H), 5.75 (s, 1H) ppm; ^{13}C {^{1}H} NMR (125 MHz, $CDCl_3$) δ 163.1, 138.9, 137.0, 130.4, 130.0, 129.5, 128.6, 128.5, 128.4, 117.8, 94.8 ppm.

4. Single Crystal X-ray Structure of 2o

Crystallization: Crystal of compound **2o** (15 mg) was grown in 1 mL of $CHCl_3$ by slow evaporation method for 5 days.

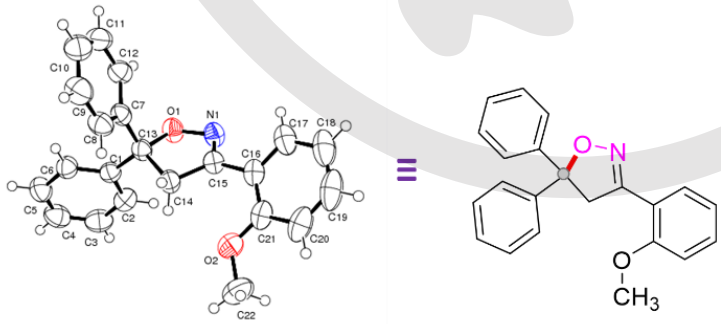


Figure S1: X–ray crystallography of **2o** (the ellipsoid contour probability level is 50%).

Table S1: Crystal data and structure refinement for **2o**.

CCDC Number	2313318	
Empirical formula	$C_{22}H_{19}NO_2$	
Formula weight	329.38	
Temperature	298(2) K	
Wavelength	1.54178 Å	
Crystal system	Triclinic	
Space group	P -1	
Unit cell dimensions	a = 9.4474(2) Å	α = 66.3850(10)°.
	b = 10.4369(2) Å	β = 89.6330(10)°.
	c = 10.8920(2) Å	g = 63.8430(10)°.
Volume	864.14(3) $Å^3$	
Z	2	
Density (calculated)	1.266 Mg/m^3	
Absorption coefficient	0.641 mm^{-1}	
F(000)	348	
Crystal size	0.155 x 0.145 x 0.070 mm^3	
Theta range for data collection	4.528 to 70.452°.	
Index ranges	-10<=h<=11, -12<=k<=12, -13<=l<=13	
Reflections collected	28945	
Independent reflections	3304 [R(int) = 0.0473]	
Completeness to theta = 67.679°	99.9 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.9424 and 0.8388	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	3304 / 0 / 228	
Goodness-of-fit on F^2	1.032	
Final R indices [I>2sigma(I)]	R_1 = 0.0386, wR_2 = 0.0938	
R indices (all data)	R_1 = 0.0497, wR_2 = 0.1031	
Extinction coefficient	0.0076(9)	
Largest diff. peak and hole	0.158 and -0.152 $e.Å^{-3}$	

5. References

1. (a) *SAINT-Plus, version 6.45,* Bruker AXS Inc., Madison, WI, 2003. (b) G. M. Sheldrick, *SADABS, Program for Empirical Absorption Correction of Area Detector Data*, University of Gottingenn, Germany, 1997. (c) *SMART (version 5.625), SHELX-TL (version 6.12)*, Bruker AXS Inc., Madison, WI, 2000. (d) G. M. Sheldrick, *SHELXS-97*, University of Gottingen, Germany, 1997.

2. (a) Liu, T.; Qiao, J. X.; Poss, M. A.; Yu, J.-Q. *Angew. Chem. Int. Ed.* **2017**, *56*, 10924. (b) Zhang, X.; Teo, W. T.; Chan, P. W. H. *Org. Lett.* **2009**, *11*, 4990−4993.

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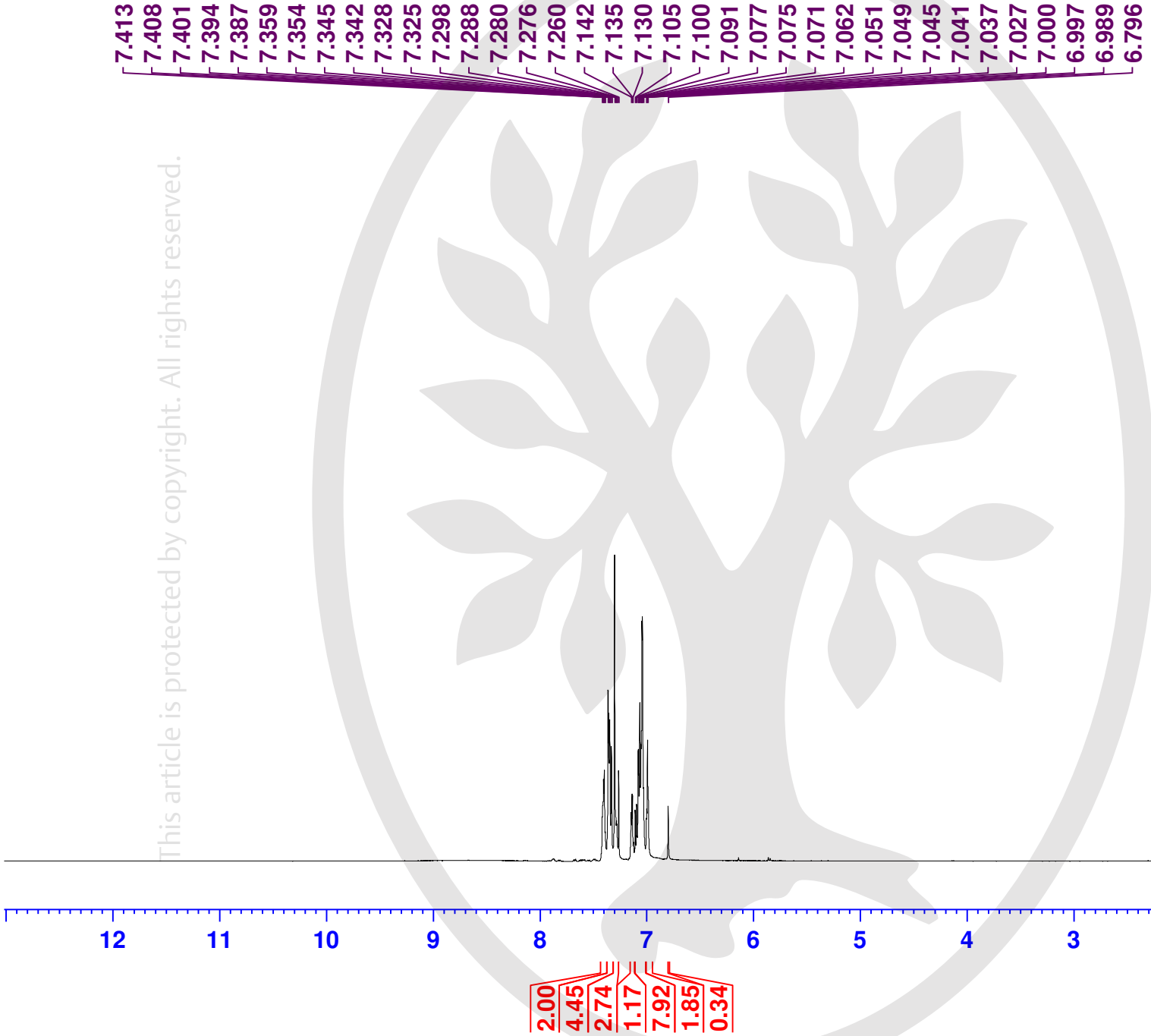
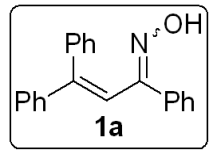
6. NMR Spectra



^{1}H NMR (500 MHz, $CDCl_3$)



(*E*/*Z* = 1:0.34)

BRUKER

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PROCNO                       1

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PULPROG                  zg30
TD                      65536
SOLVENT                 CDCl3
NS                         10
DS                          0
SWH                10000.000 Hz
FIDRES             0.305176 Hz
AQ                 3.2767999 sec
RG                        228
DW                   50.000 usec
DE                    6.50 usec
TE                       0 K
D1                 1.00000000 sec
TD0                         1
SFO1            500.2530890 MHz
NUC1                       1H
P1                    15.10 usec
PLW1               15.13599968 W

F2 - Processing parameters
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SF              500.2500137 MHz
WDW                        EM
SSB                         0
LB                     0.30 Hz
GB                          0
PC                       1.00
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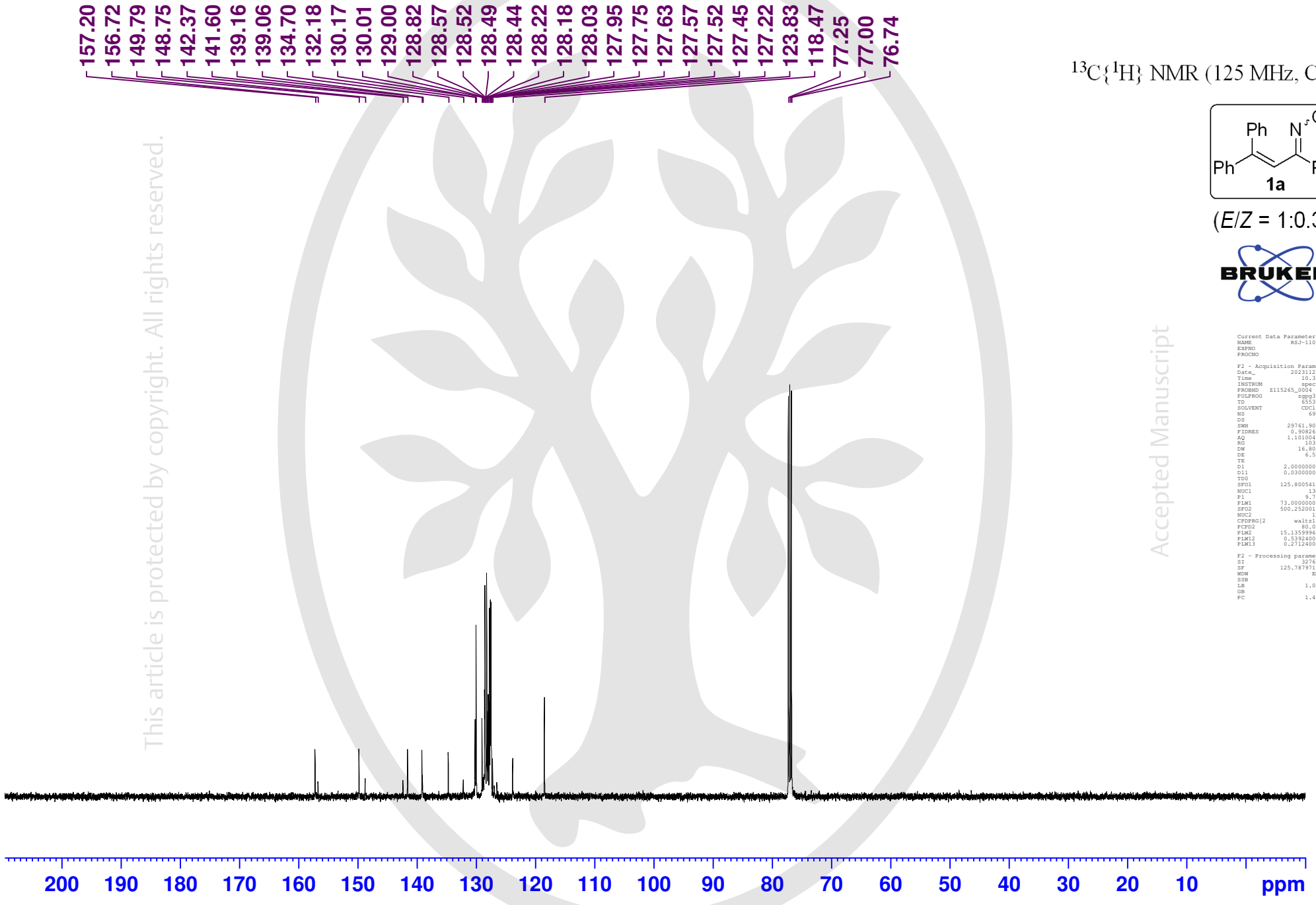

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

(*E*/*Z* = 1:0.34)

BRUKER

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Current Data Parameters
NAME                  RSJ-1100
EXPNO                        1
PROCNO                       1

F2 - Acquisition Parameters
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PULPROG              zgpg30
TD                    65536
SOLVENT               CDCl3
NS                      692
DS                        4
SWH               29761.904 Hz
FIDRES             0.908261 Hz
AQ                 1.1010048 sec
RG                     1030
DW                   16.800 usec
DE                    6.50 usec
TE                       0 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                       1
SFO1             125.8005413 MHz
NUC1                    13c
P1                    9.70 usec
PLW1             73.00000000 W
SFO2             500.2520010 MHz
NUC2                    1H
CPDPRG[2              waltz16
PCPD2                80.00 usec
PLW2             15.13599968 W
PLW12             0.53924000 W
PLW13             0.27124000 W

F2 - Processing parameters
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WDW                         EM
SSB                          0
LB                    1.00 Hz
GB                           0
PC                    1.40
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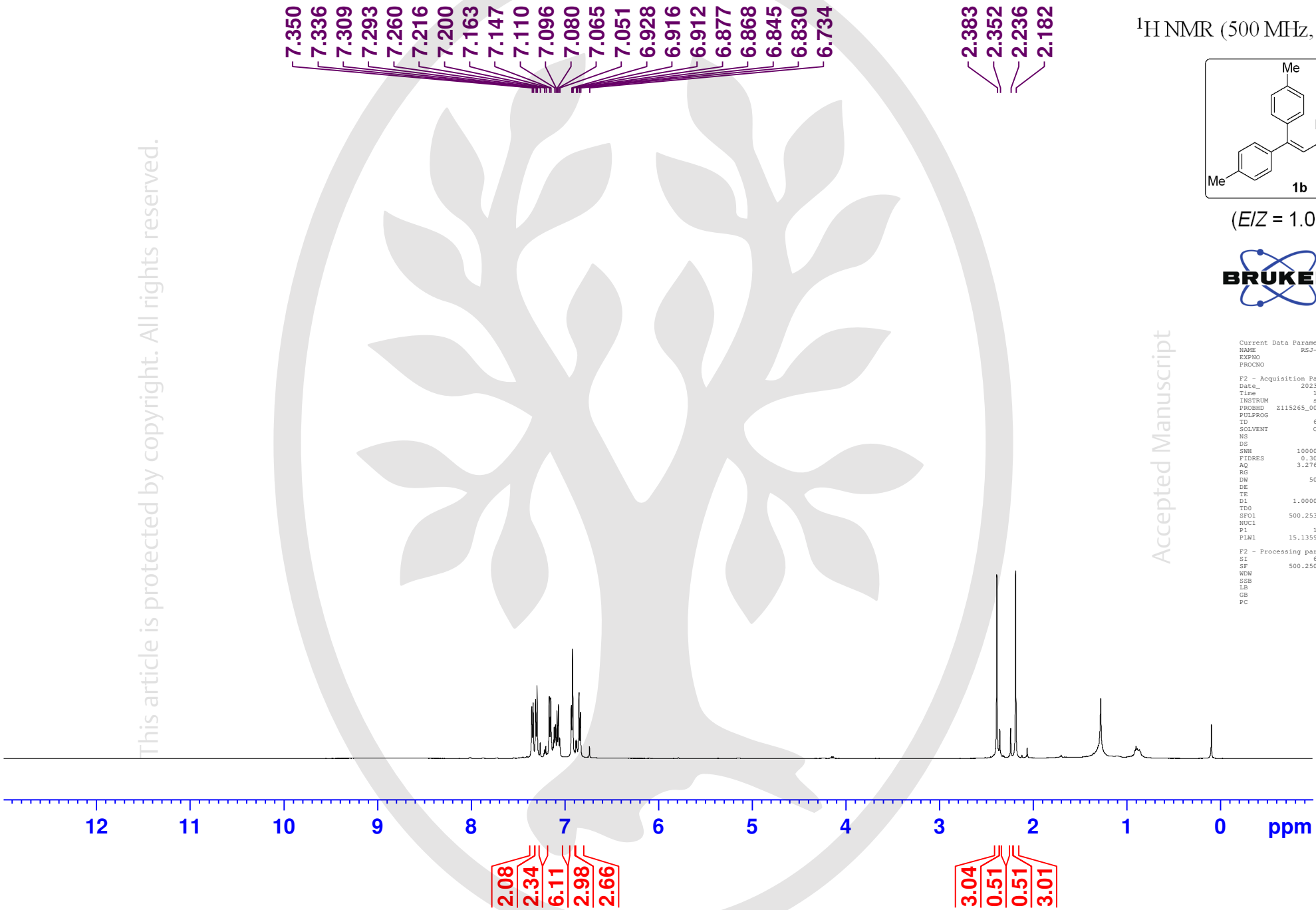

^{1}H NMR (500 MHz, $CDCl_3$)

(*E*/*Z* = 1.0.17)

BRUKER

```
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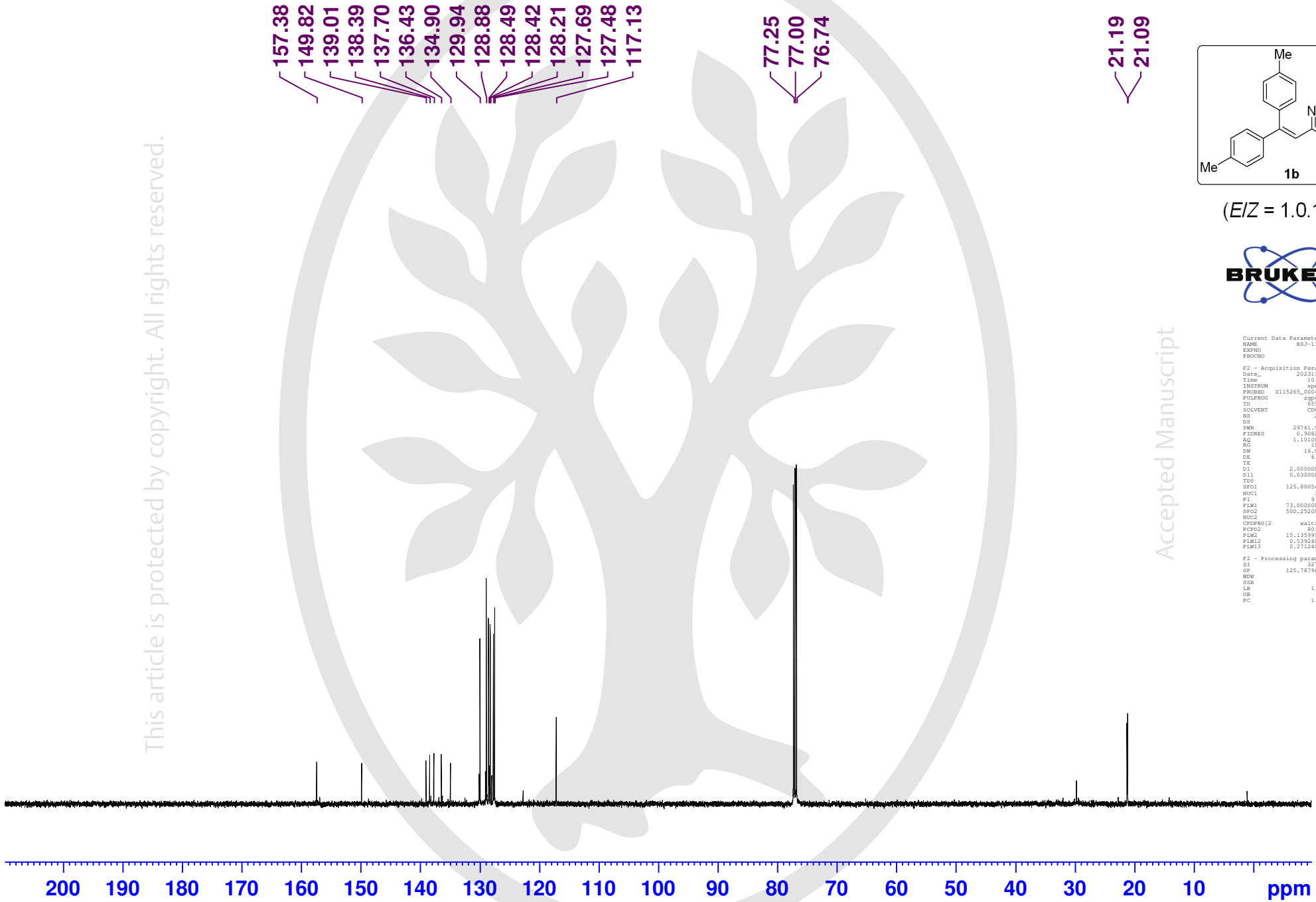
EXPNO                        2
PROCNO                       1

F2 - Acquisition Parameters
Date_              20231126
Time                 10.39 h
INSTRUM                spect
PROBHD    Z115265_0004 (
PULPROG                 zg30
TD                     65536
SOLVENT                CDCl3
NS                           8
DS                           0
SWH              10000.000 Hz
FIDRES               0.305176 Hz
AQ                3.2767999 sec
RG                         114
DW                  50.000 usec
DE                   6.50 usec
TE                         0 K
D1              1.00000000 sec
TD0                          1
SFO1             500.2530890 MHz
NUC1                       1H
P1                   15.10 usec
PLW1             15.13599968 W

F2 - Processing parameters
SI                       65536
SF               500.2500154 MHz
WDW                         EM
SSB                          0
LB                    0.30 Hz
GB                           0
PC                        1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)



(*E*/*Z* = 1.0.17)

BRUKER

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EXPNO                        3
PROCNO                       1

F2 - Acquisition Parameters
Date_              20231126
Time                  10.55 h
INSTRUM                 spect
PROBHD     Z115265_0004 (
PULPROG               zgpg30
TD                     65536
SOLVENT                CDCl3
NS                       261
DS                         4
SWH               29761.904 Hz
FIDRES             0.908261 Hz
AQ                1.1010048 sec
RG                      1030
DW                  16.800 usec
DE                   6.50 usec
TE                      0 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                        1
SFO1           125.8005413 MHz
NUC1                     13c
P1                    9.70 usec
PLW1           73.00000000 W
SFO2           500.2520010 MHz
NUC2                     1H
CPDPRG[2              waltz16
PCPD2                80.00 usec
PLW2           15.13599968 W
PLW12           0.53924000 W
PLW13           0.27124000 W

F2 - Processing parameters
SI                      32768
SF             125.7879683 MHz
WDW                        EM
SSB                         0
LB                    1.00 Hz
GB                          0
PC                     1.40
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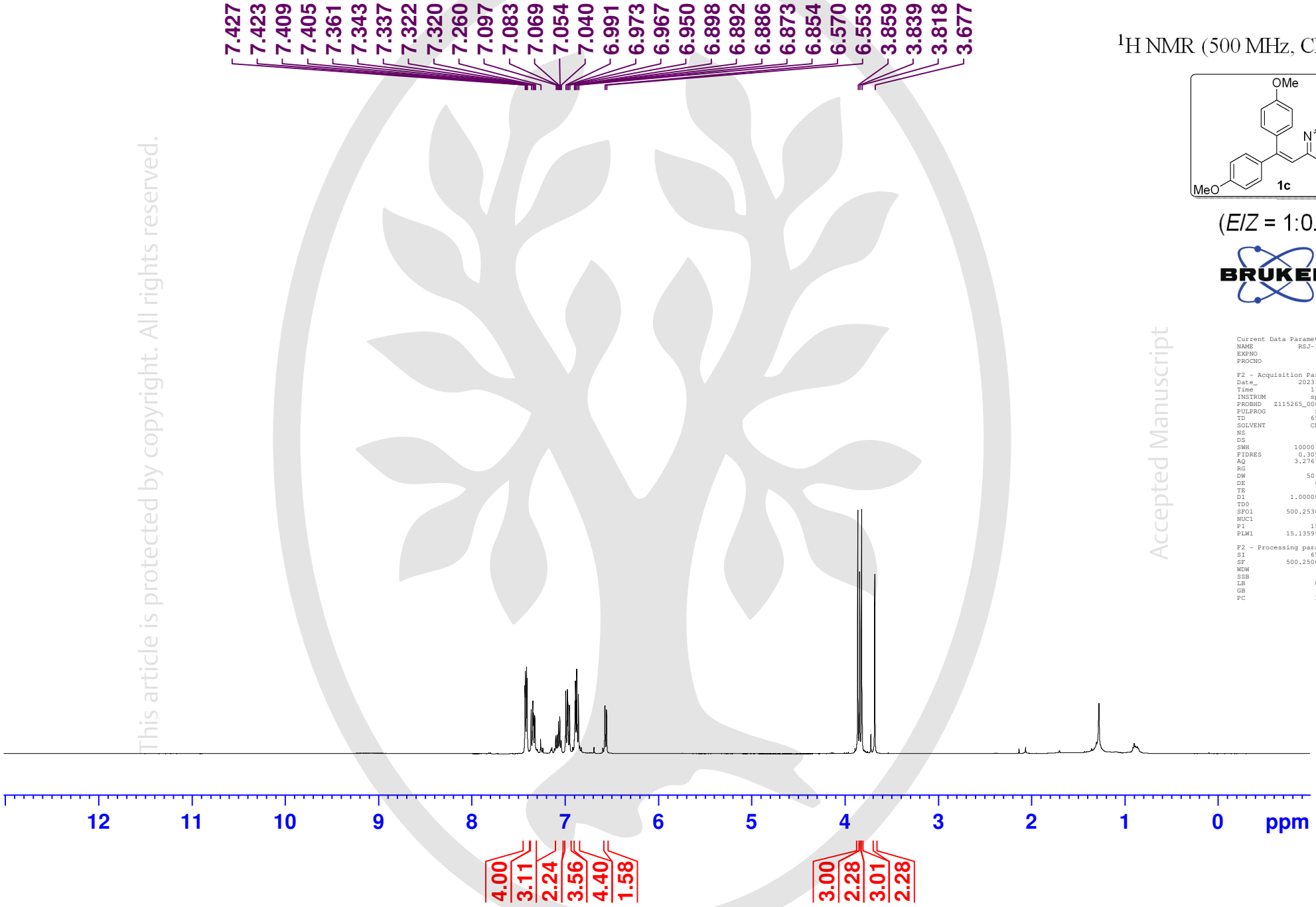

^{1}H NMR (500 MHz, $CDCl_3$)

(*E*/*Z* = 1:0.76)

BRUKER

```
Current Data Parameters
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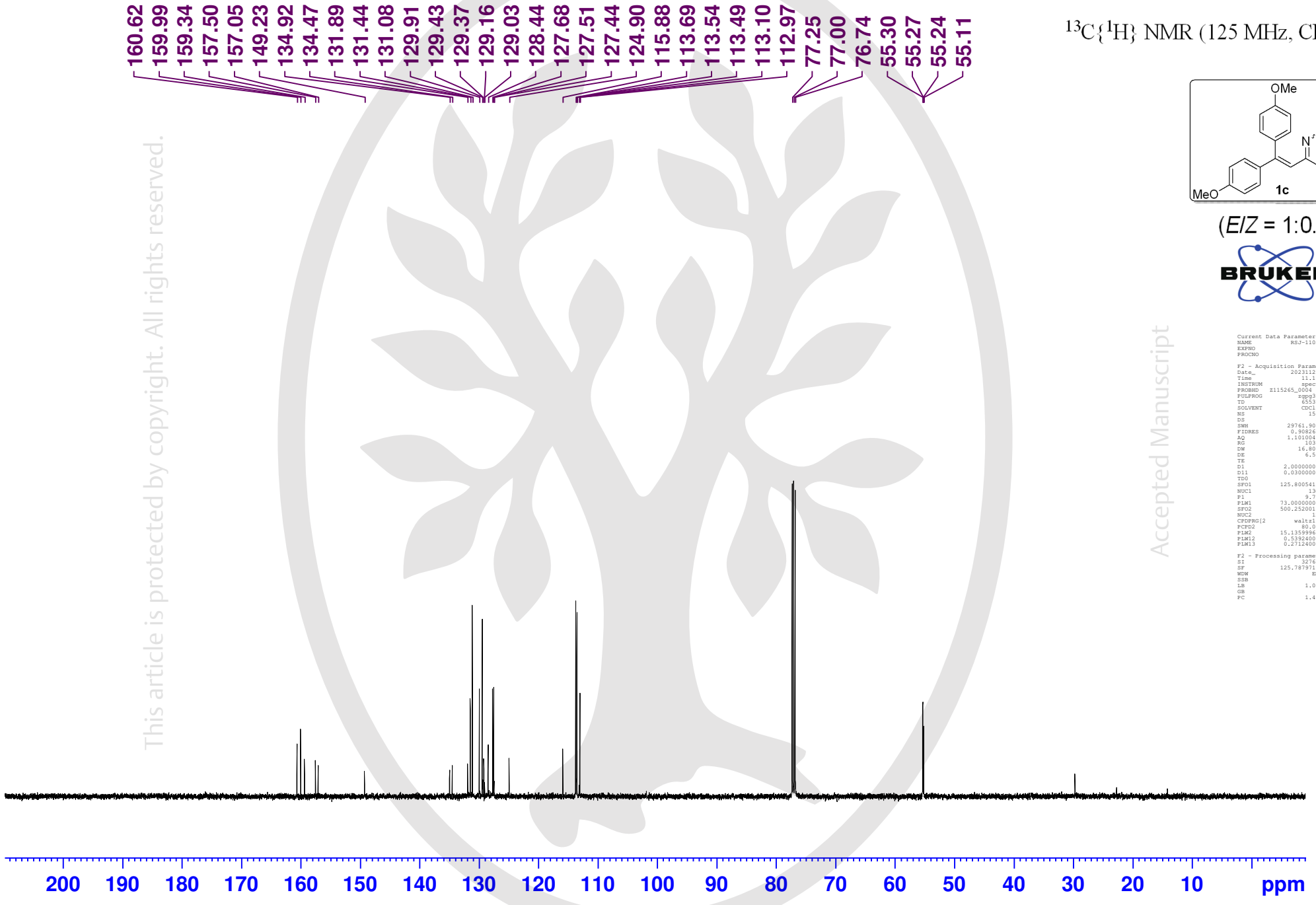
EXPNO                        4
PROCNO                       1

F2 - Acquisition Parameters
Date_              20231126
Time                    11.00 h
INSTRUM                  spect
PROBHD     Z115265_0004 (
PULPROG                  zg30
TD                      65536
SOLVENT                 CDCl3
NS                           8
DS                           0
SWH                10000.000 Hz
FIDRES             0.305176 Hz
AQ                 3.2767999 sec
RG                         114
DW                    50.000 usec
DE                     6.50 usec
TE                         0 K
D1                 1.00000000 sec
TD0                          1
SFO1               500.2530890 MHz
NUC1                        1H
P1                      15.10 usec
PLW1               15.13599968 W

F2 - Processing parameters
SI                       65536
SF                 500.2500133 MHz
WDW                         EM
SSB                          0
LB                        0.30 Hz
GB                           0
PC                        1.00
```



$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

(*E*/*Z* = 1:0.76)

BRUKER

```
Current Data Parameters
NAME                  RSJ-1102
EXPNO                        5
PROCNO                       1

F2 - Acquisition Parameters
Date_                 20231126
Time                     11.11 h
INSTRUM                  spect
PROBHD    Z115265_0004 (
PULPROG                 zgpg30
TD                       65536
SOLVENT                  CDCl3
NS                         158
DS                           4
SWH                  29761.904 Hz
FIDRES                0.908261 Hz
AQ                    1.1010048 sec
RG                        1030
DW                      16.800 usec
DE                       6.50 usec
TE                          0 K
D1                   2.00000000 sec
D11                  0.03000000 sec
TD0                          1
SFO1                125.8005413 MHz
NUC1                        13c
P1                       9.70 usec
PLW1                73.00000000 W
SFO2                500.2520010 MHz
NUC2                        1H
CPDPRG[2                waltz16
PCPD2                    80.00 usec
PLW2                15.13599968 W
PLW12                0.53924000 W
PLW13                0.27124000 W

F2 - Processing parameters
SI                       32768
SF                  125.7879710 MHz
WDW                         EM
SSB                          0
LB                        1.00 Hz
GB                           0
PC                        1.40
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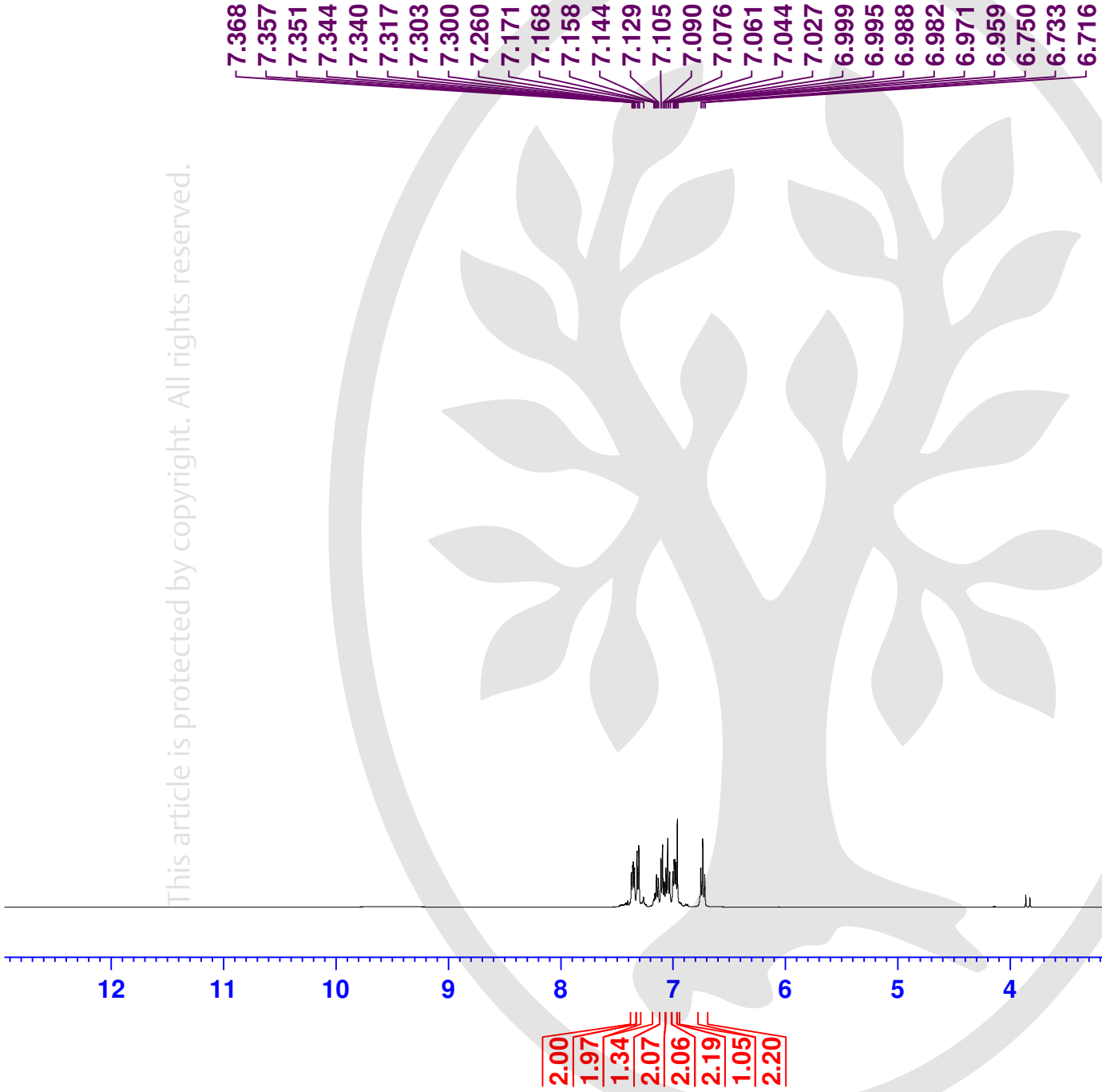
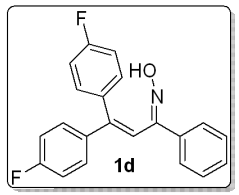


^{1}H NMR (500 MHz, $CDCl_3$)



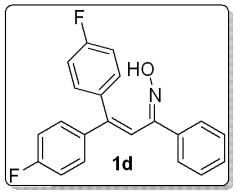
BRUKER

```
Current Data Parameters
NAME                  RSJ-1103
EXPNO                        6
PROCNO                       1

F2 - Acquisition Parameters
Date_              20231126
Time                  11.15 h
INSTRUM                 spect
PROBHD    Z115265_0004 (
PULPROG                 zg30
TD                     65536
SOLVENT                CDCl3
NS                           8
DS                           0
SWH               10000.000 Hz
FIDRES                0.305176 Hz
AQ                3.2767999 sec
RG                         114
DW                   50.000 usec
DE                    6.50 usec
TE                         0 K
D1              1.00000000 sec
TD0                          1
SFO1            500.2530890 MHz
NUC1                       1H
P1                    15.10 usec
PLW1            15.13599968 W

F2 - Processing parameters
SI                       65536
SF              500.2500138 MHz
WDW                         EM
SSB                          0
LB                    0.30 Hz
GB                           0
PC                        1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)



BRUKER


```
Current Data Parameters
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EXPNO                        7
PROCNO                       1

F2 - Acquisition Parameters
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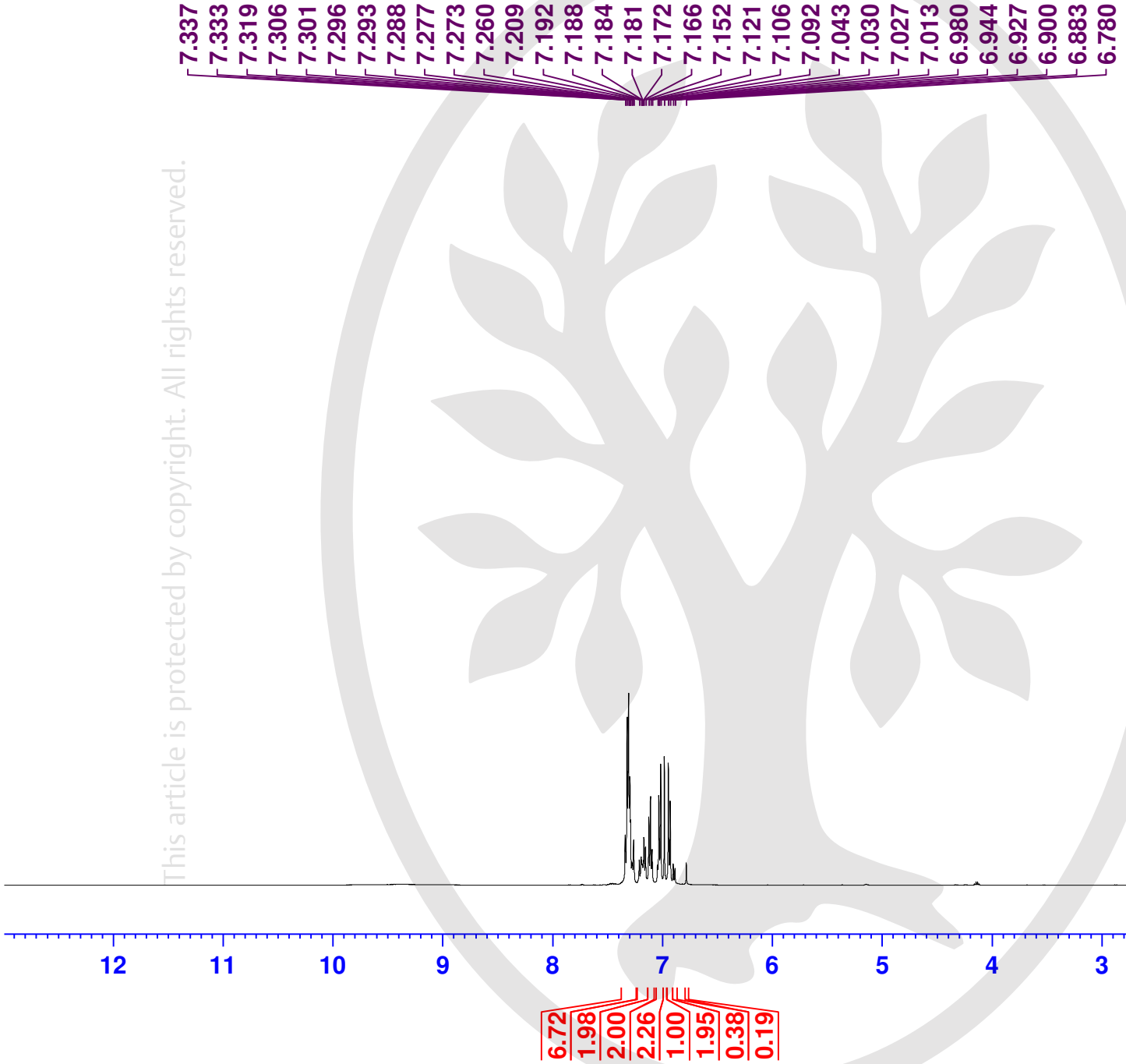
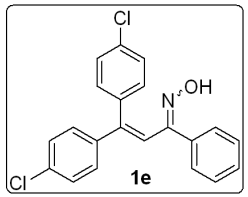
Time                     11.24 h
INSTRUM                  spect
PROBHD    Z115265_0004 (
PULPROG                 zgpg30
TD                       65536
SOLVENT                  CDCl3
NS                         111
DS                           4
SWH                  29761.904 Hz
FIDRES                0.908261 Hz
AQ                    1.1010048 sec
RG                        1030
DW                       16.800 usec
DE                        6.50 usec
TE                           0 K
D1                    2.00000000 sec
D11                   0.03000000 sec
TD0                          1
SFO1                125.8005413 MHz
NUC1                        13c
P1                        9.70 usec
PLW1                 73.00000000 W
SFO2                500.2520010 MHz
NUC2                        1H
CPDPRG[2                waltz16
PCPD2                    80.00 usec
PLW2                 15.13599968 W
PLW12                 0.53924000 W
PLW13                 0.27124000 W

F2 - Processing parameters
SI                        32768
SF                  125.7879683 MHz
WDW                          EM
SSB                          0
LB                        1.00 Hz
GB                           0
PC                        1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)



(*E*/*Z* = 1:0.19)

BRUKER

```
Current Data Parameters
NAME                  RSJ-1104
EXPNO                        8
PROCNO                       1

F2 - Acquisition Parameters
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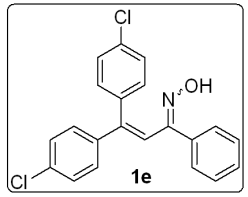
Time                    11.28 h
INSTRUM                  spect
PROBHD     Z115265_0004 (
PULPROG                  zg30
TD                      65536
SOLVENT                 CDCl3
NS                           8
DS                           0
SWH                10000.000 Hz
FIDRES                0.305176 Hz
AQ                    3.2767999 sec
RG                         114
DW                     50.000 usec
DE                      6.50 usec
TE                         0 K
D1                 1.00000000 sec
TD0                          1
SFO1               500.2530890 MHz
NUC1                        1H
P1                      15.10 usec
PLW1               15.13599968 W

F2 - Processing parameters
SI                       65536
SF                 500.2500137 MHz
WDW                         EM
SSB                          0
LB                        0.30 Hz
GB                           0
PC                        1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)



(*E*/*Z* = 1:0.19)

BRUKER


```
Current Data Parameters
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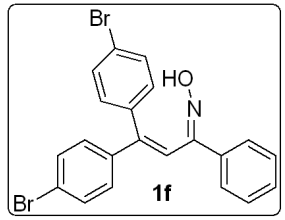
EXPNO                        9
PROCNO                       1

F2 - Acquisition Parameters
Date_                 20231126
Time                     11.36 h
INSTRUM                  spect
PROBHD     Z115265_0004 (
PULPROG                 zgpg30
TD                       65536
SOLVENT                  CDCl3
NS                         107
DS                           4
SWH                  29761.904 Hz
FIDRES                0.908261 Hz
AQ                    1.1010048 sec
RG                        1030
DW                      16.800 usec
DE                       6.50 usec
TE                          0 K
D1                   2.00000000 sec
D11                  0.03000000 sec
TD0                          1
SFO1                125.8005413 MHz
NUC1                        13c
P1                       9.70 usec
PLW1                73.00000000 W
SFO2                500.2520010 MHz
NUC2                        1H
CPDPRG[2                waltz16
PCPD2                   80.00 usec
PLW2                15.13599968 W
PLW12                0.53924000 W
PLW13                0.27124000 W

F2 - Processing parameters
SI                       32768
SF                  125.7879692 MHz
WDW                         EM
SSB                          0
LB                        1.00 Hz
GB                           0
PC                        1.40
```

^{1}H NMR (500 MHz, $CDCl_3$)



BRUKER

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Current Data Parameters
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EXPNO                       10
PROCNO                       1

F2 - Acquisition Parameters
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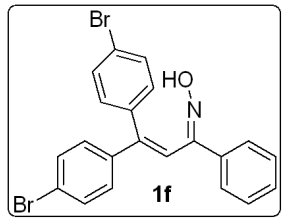
Time                   11.40 h
INSTRUM                spect
PROBHD     Z115265_0004 (
PULPROG                 zg30
TD                     65536
SOLVENT                CDCl3
NS                         8
DS                         0
SWH              10000.000 Hz
FIDRES               0.305176 Hz
AQ                 3.2767999 sec
RG                       203
DW                    50.000 usec
DE                     6.50 usec
TE                 0 K
D1                 1.00000000 sec
TD0                        1
SFO1            500.2530890 MHz
NUC1                      1H
P1                    15.10 usec
PLW1            15.13599968 W

F2 - Processing parameters
SI                     65536
SF              500.2500136 MHz
WDW                       EM
SSB                0
LB                    0.30 Hz
GB                 0
PC                    1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)



BRUKER

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Current Data Parameters
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EXPNO                  11
PROCNO                  1

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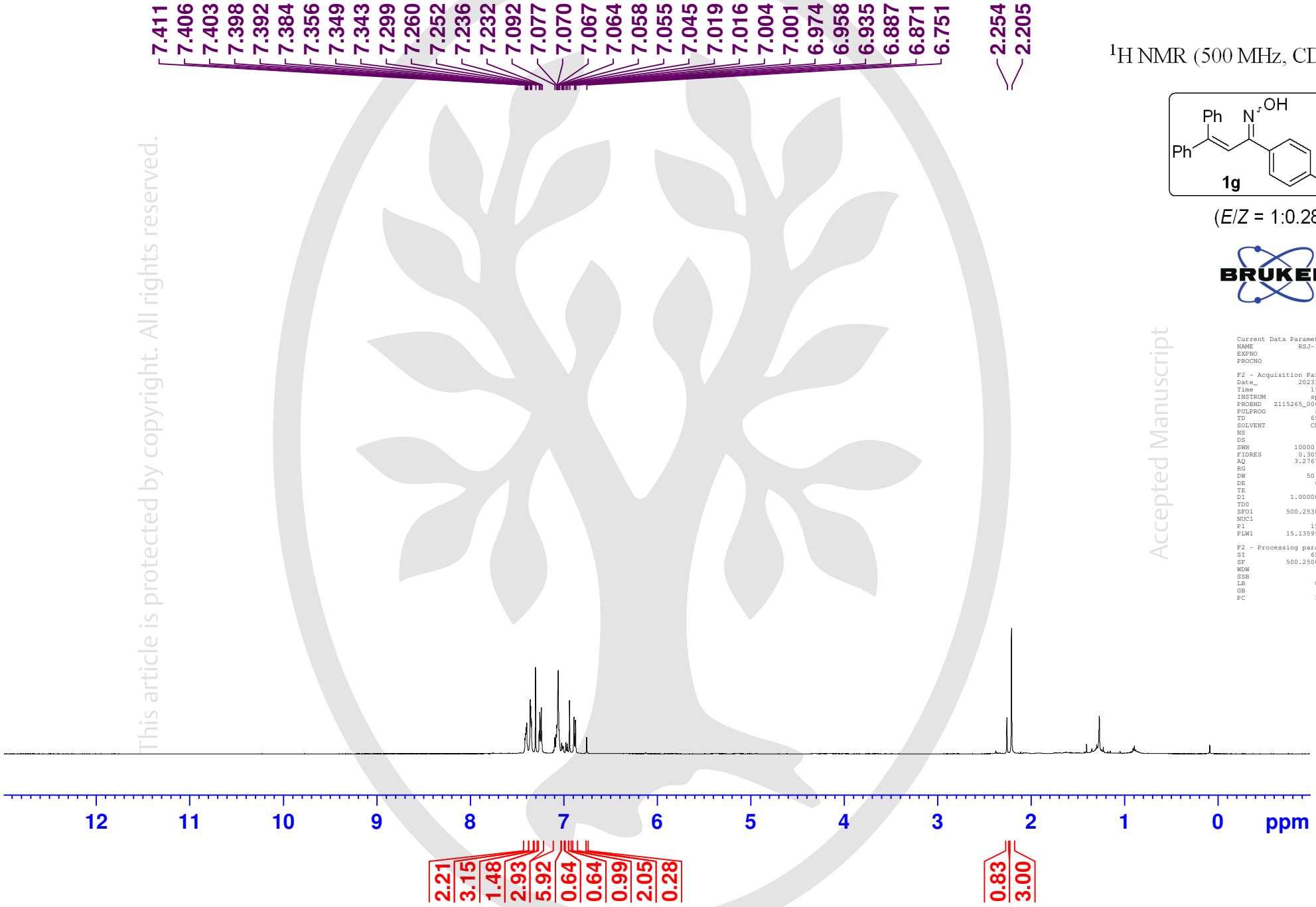
Time                 12.07 h
INSTRUM                spect
PROBHD  Z115265_0004 (
PULPROG              zgpg30
TD                    65536
SOLVENT               CDCl3
NS                      480
DS                        4
SWH              29761.904 Hz
FIDRES           0.908261 Hz
AQ               1.1010048 sec
RG                     1030
DW                 16.800 usec
DE                  6.50 usec
TE         0 K
D1               2.00000000 sec
D11              0.03000000 sec
TD0                       1
SFO1           125.8005413 MHz
NUC1                    13C
P1                   9.70 usec
PLW1           73.00000000 W
SFO2           500.2520010 MHz
NUC2                    1H
CPDPRG[2            waltz16
PCPD2               80.00 usec
PLW2           15.13599968 W
PLW12           0.53924000 W
PLW13           0.27124000 W

F2 - Processing parameters
SI                     32768
SF             125.7879656 MHz
WDW                       EM
SSB          0
LB                   1.00 Hz
GB           0
PC                   1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)

(*E*/*Z* = 1:0.28)

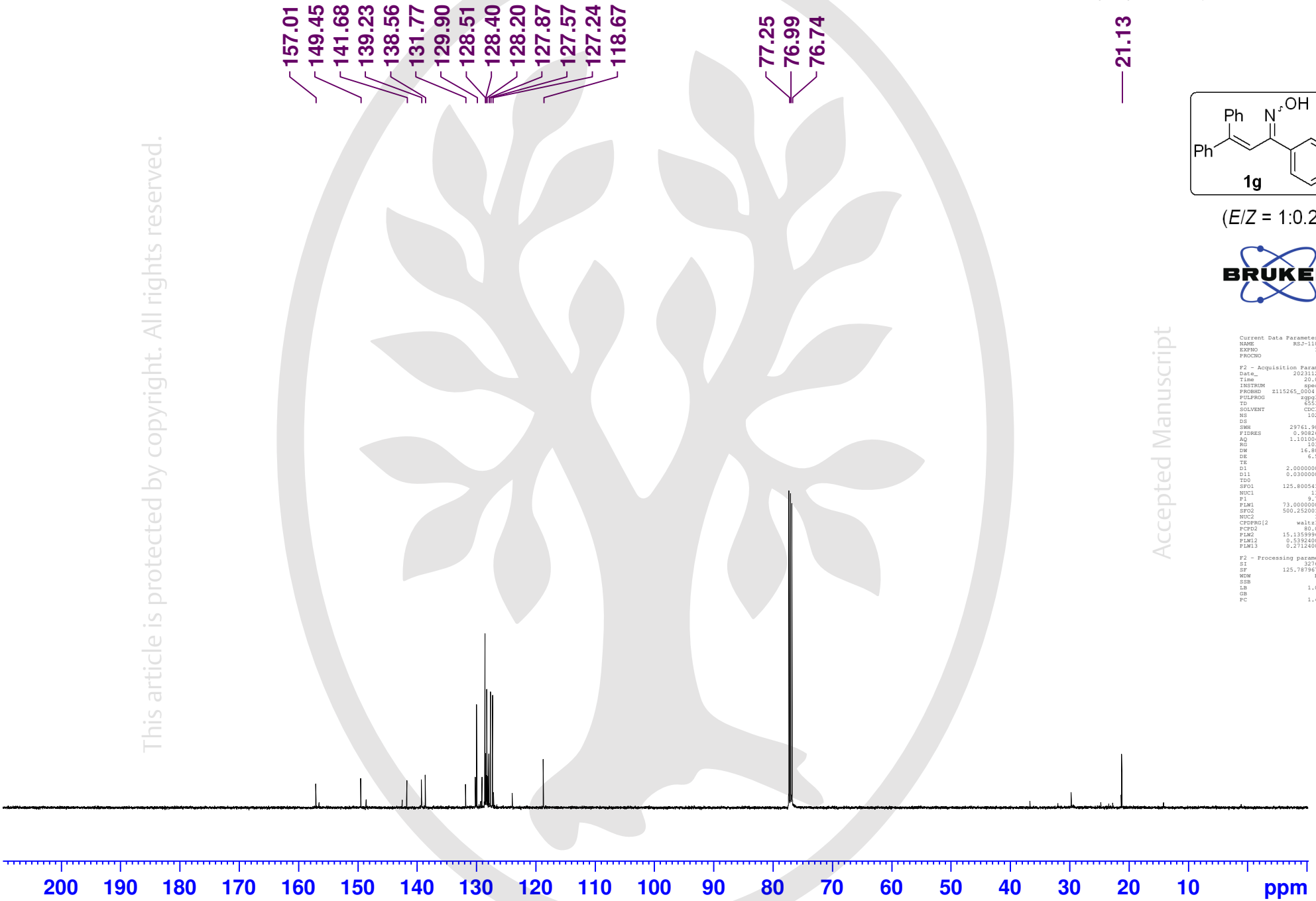
BRUKER

```
Current Data Parameters
NAME                  RSJ-1106
EXPNO                       16
PROCNO                       1

F2 - Acquisition Parameters
Date_                 20231125
Time                     19.04 h
INSTRUM                   spect
PROBHD    Z115265_0004 (
PULPROG                   zg30
TD                       65536
SOLVENT                  CDCl3
NS                          10
DS                           0
SWH                  10000.000 Hz
FIDRES                0.305176 Hz
AQ                    3.2767999 sec
RG                         161
DW                    50.000 usec
DE                     6.50 usec
TE                         0 K
D1                1.00000000 sec
TD0                          1
SFO1               500.2530890 MHz
NUC1                        1H
P1                      15.10 usec
PLW1              15.13599968 W

F2 - Processing parameters
SI                       65536
SF                 500.2500140 MHz
WDW                         EM
SSB                          0
LB                        0.30 Hz
GB                           0
PC                        1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)



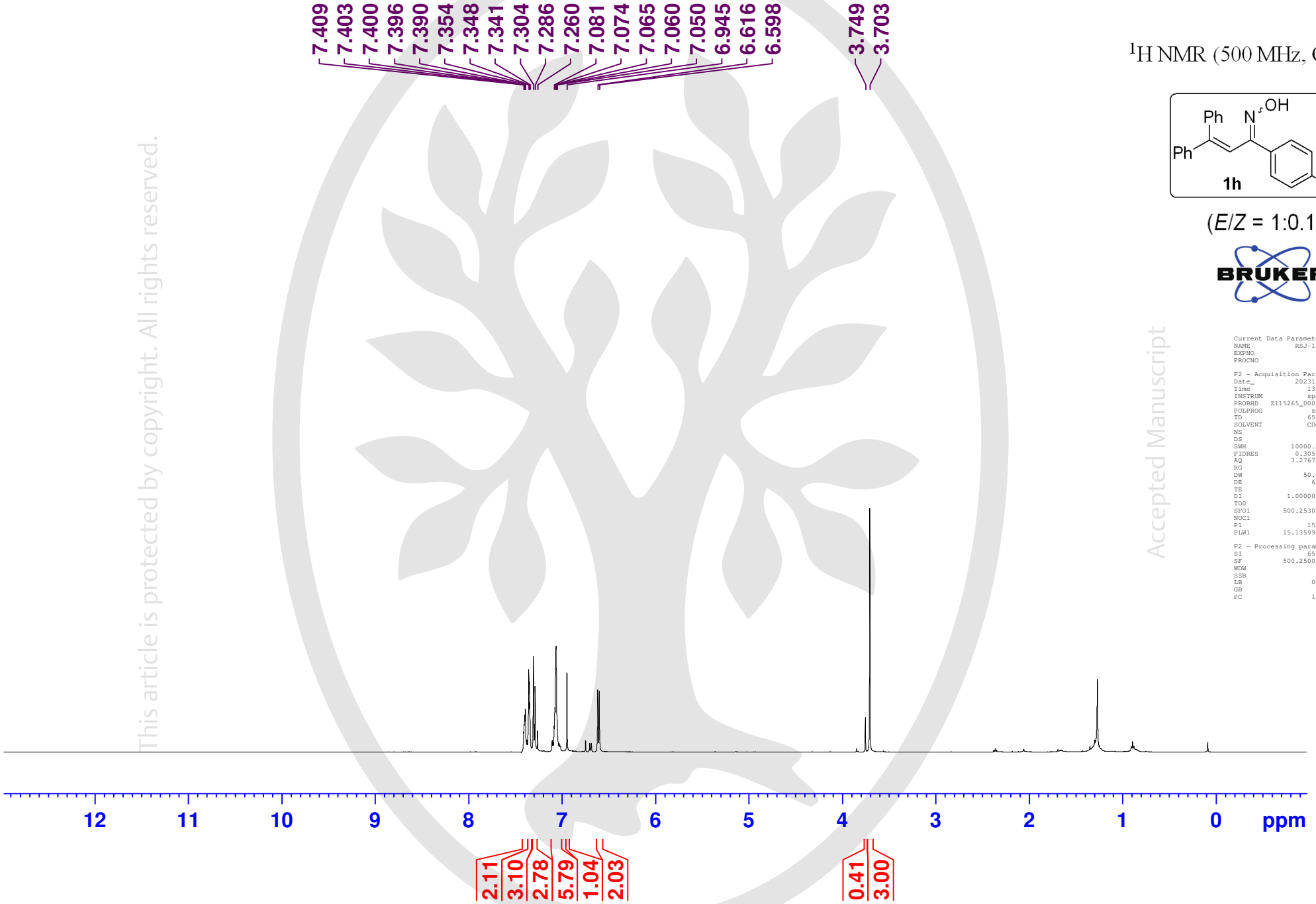
(*E*/*Z* = 1:0.28)

BRUKER

```
Current Data Parameters
NAME                  RSJ-1106
EXPNO                       17
PROCNO                       1

F2 - Acquisition Parameters
Date_               20231125
Time                  20.00 h
INSTRUM                 spect
PROBHD     Z115265_0004 (
PULPROG               zgpg30
TD                     65536
SOLVENT                CDCl3
NS                      1024
DS                         4
SWH                29761.904 Hz
FIDRES             0.908261 Hz
AQ                 1.1010048 sec
RG                      1030
DW                   16.800 usec
DE                    6.50 usec
TE                       0 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                        1
SFO1              125.8005413 MHz
NUC1                     13c
P1                    9.70 usec
PLW1              73.00000000 W
SFO2              500.2520010 MHz
NUC2                     1H
CPDPRG[2               waltz16
PCPD2                 80.00 usec
PLW2              15.13599968 W
PLW12              0.53924000 W
PLW13              0.27124000 W

F2 - Processing parameters
SI                        32768
SF                125.7879674 MHz
WDW                         EM
SSB                          0
LB                    1.00 Hz
GB                           0
PC                    1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)

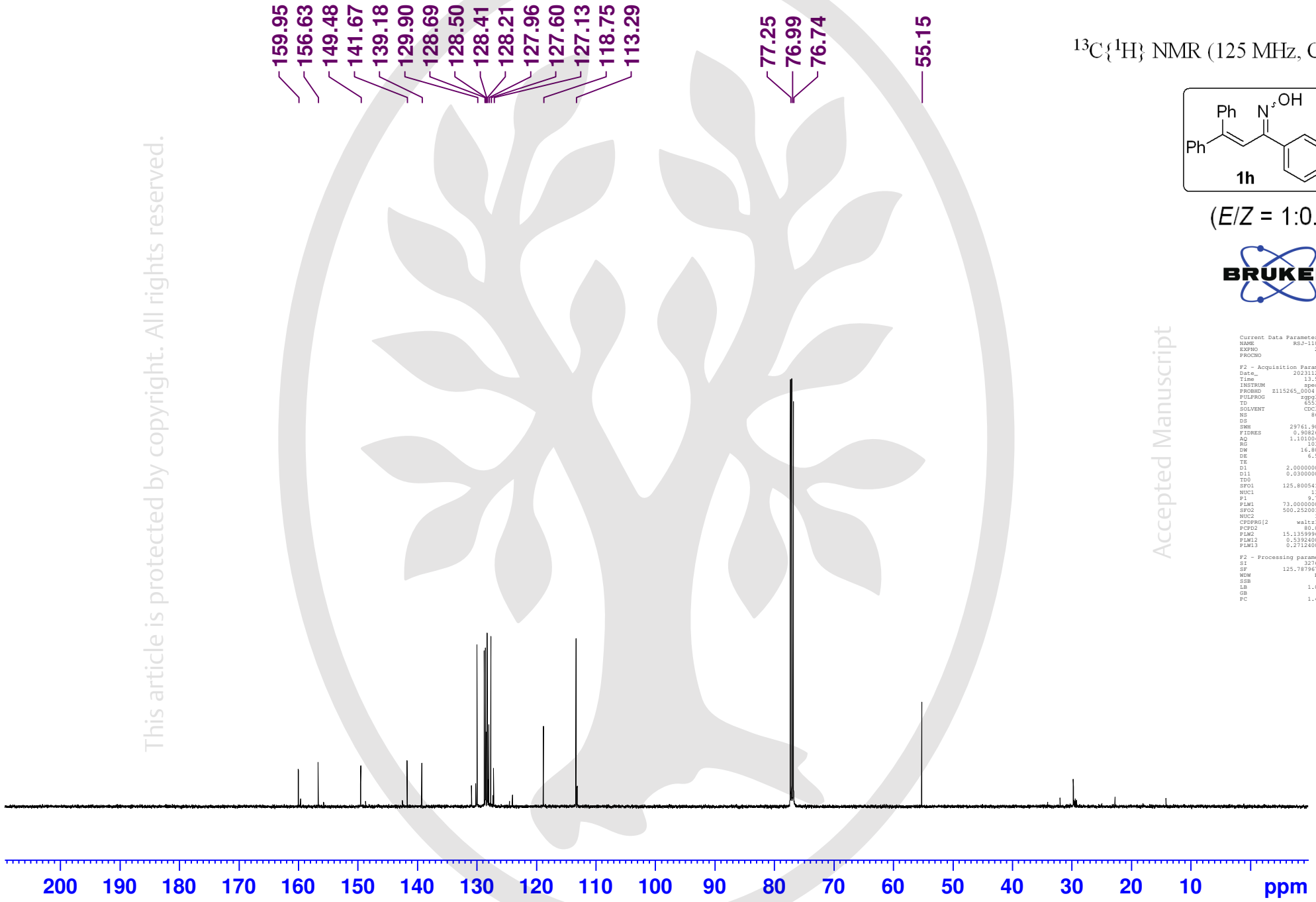
(*E*/*Z* = 1:0.14)

BRUKER

```
Current Data Parameters
NAME                  RSJ-1107
EXPNO                       20
PROCNO                       1

F2 - Acquisition Parameters
Date_               20231126
Time                    13.12 h
INSTRUM                  spect
PROBHD     Z115265_0004 (
PULPROG                  zg30
TD                      65536
SOLVENT                 CDCl3
NS                          8
DS                          0
SWH                 10000.000 Hz
FIDRES                0.305176 Hz
AQ                    3.2767999 sec
RG                        161
DW                     50.000 usec
DE                      6.50 usec
TE                         0 K
D1                  1.00000000 sec
TD0                         1
SFO1                500.2530890 MHz
NUC1                        1H
P1                      15.10 usec
PLW1                15.13599968 W

F2 - Processing parameters
SI                      65536
SF                  500.2500131 MHz
WDW                        EM
SSB                         0
LB                      0.30 Hz
GB                          0
PC                       1.00
```



$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

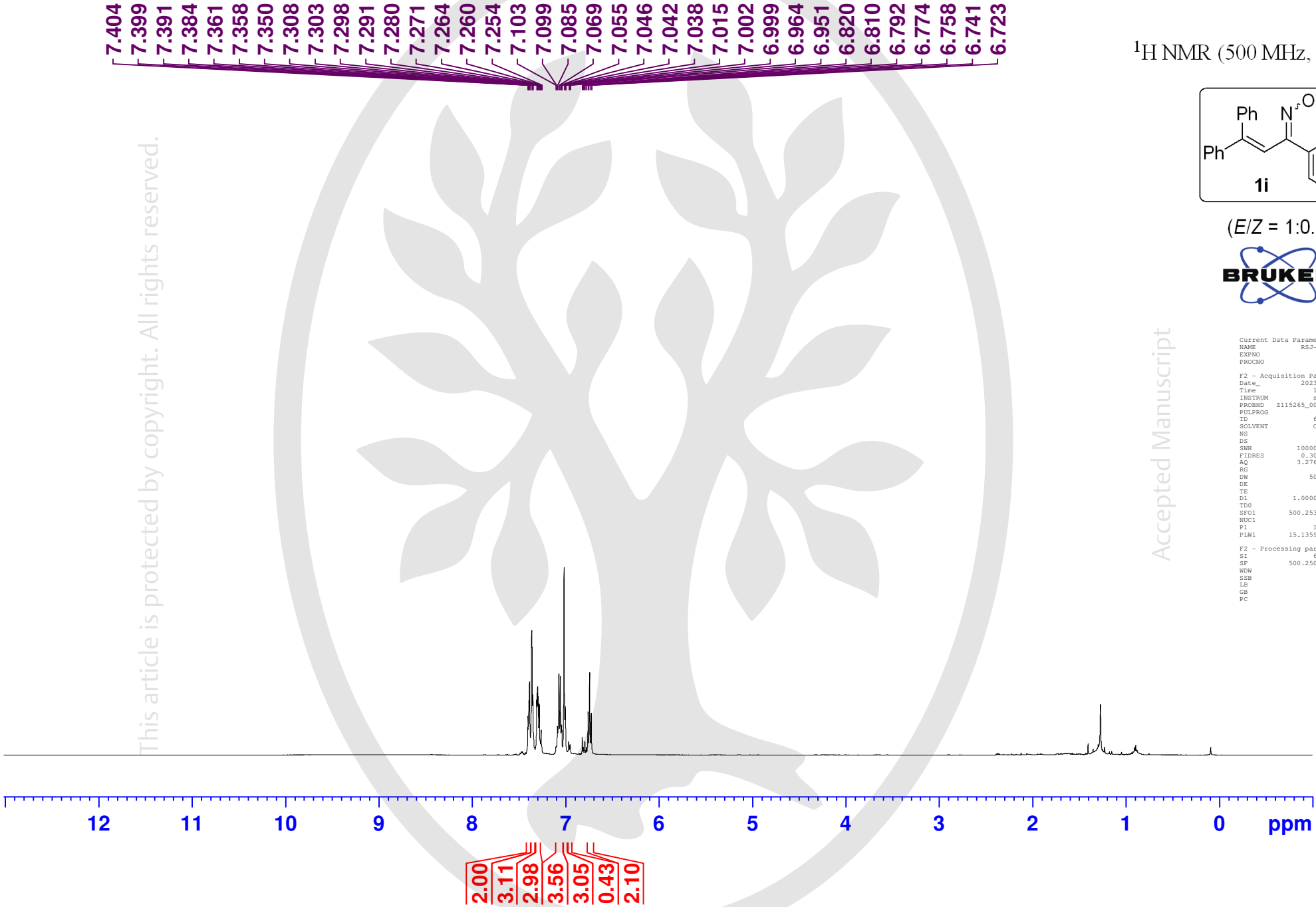
(*E*/*Z* = 1:0.14)

BRUKER

Current Data Parameters
NAME RSJ-1107
EXPNO 21
PROCNO 1

F2 - Acquisition Parameters
Date_ 20231126
Time 13.59 h
INSTRUM spect
PROBHD Z115265_0004 (
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 862
DS 4
SWH 29761.904 Hz
FIDRES 0.908261 Hz
AQ 1.1010048 sec
RG 1030
DW 16.800 usec
DE 6.50 usec
TE 0 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
SFO1 125.8005413 MHz
NUC1 13c
P1 9.70 usec
PLW1 73.00000000 W
SFO2 500.2520010 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 80.00 usec
PLW2 15.13599968 W
PLW12 0.53924000 W
PLW13 0.27124000 W

F2 - Processing parameters
SI 32768
SF 125.7879674 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40



^{1}H NMR (500 MHz, $CDCl_3$)

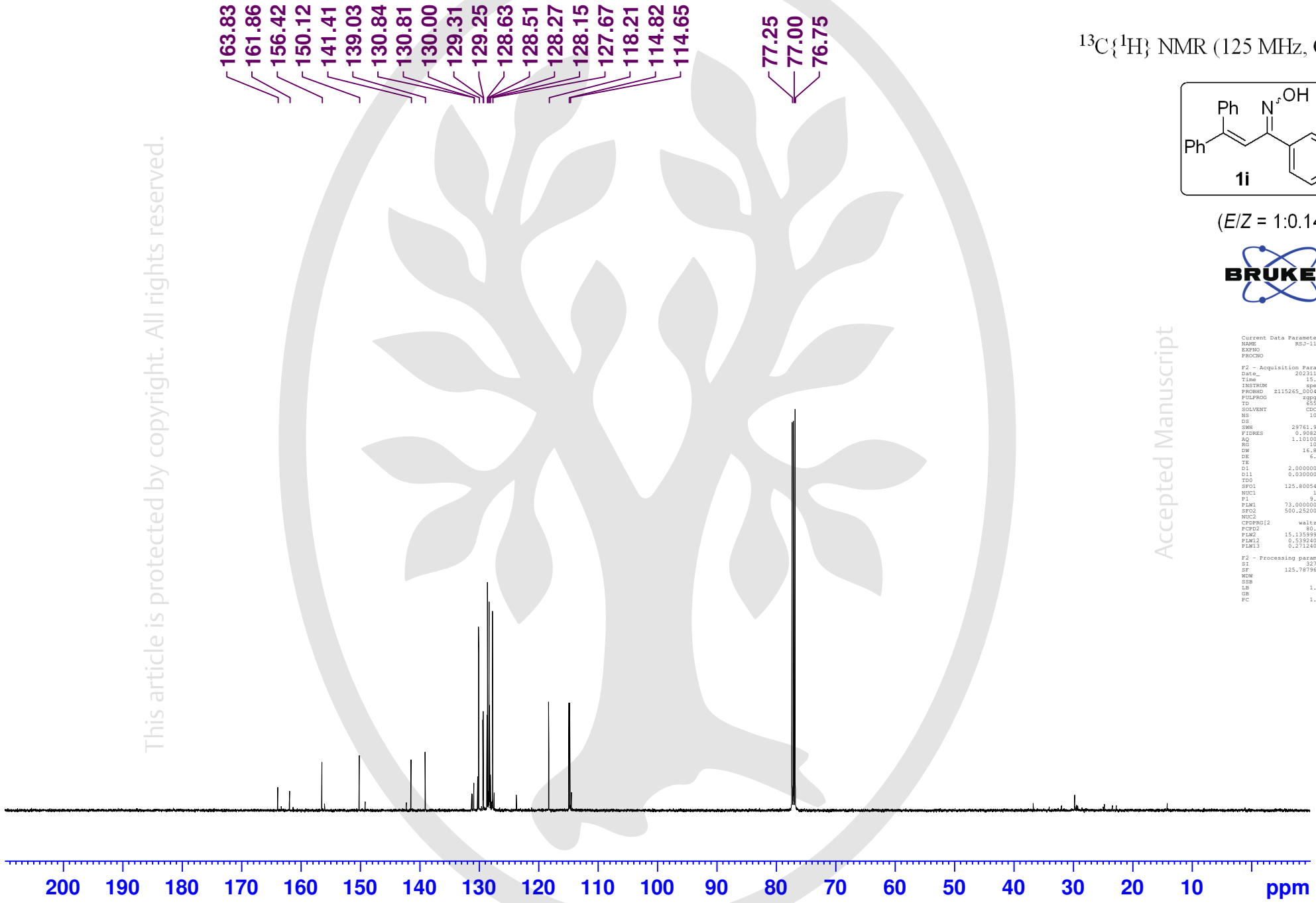
(*E*/*Z* = 1:0.14)

BRUKER

```
Current Data Parameters
NAME                  RSJ-1108
EXPNO                       22
PROCNO                       1

F2 - Acquisition Parameters
Date_               20231126
Time                    14.04 h
INSTRUM                  spect
PROBHD     Z115265_0004 (
PULPROG                  zg30
TD                      65536
SOLVENT                 CDCl3
NS                          8
DS                          0
SWH                 10000.000 Hz
FIDRES                0.305176 Hz
AQ                    3.2767999 sec
RG                        161
DW                     50.000 usec
DE                      6.50 usec
TE                          0 K
D1                  1.00000000 sec
TD0                         1
SFO1                500.2530890 MHz
NUC1                        1H
P1                      15.10 usec
PLW1                15.13599968 W

F2 - Processing parameters
SI                      65536
SF                  500.2500139 MHz
WDW                        EM
SSB                         0
LB                      0.30 Hz
GB                          0
PC                       1.00
```



$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

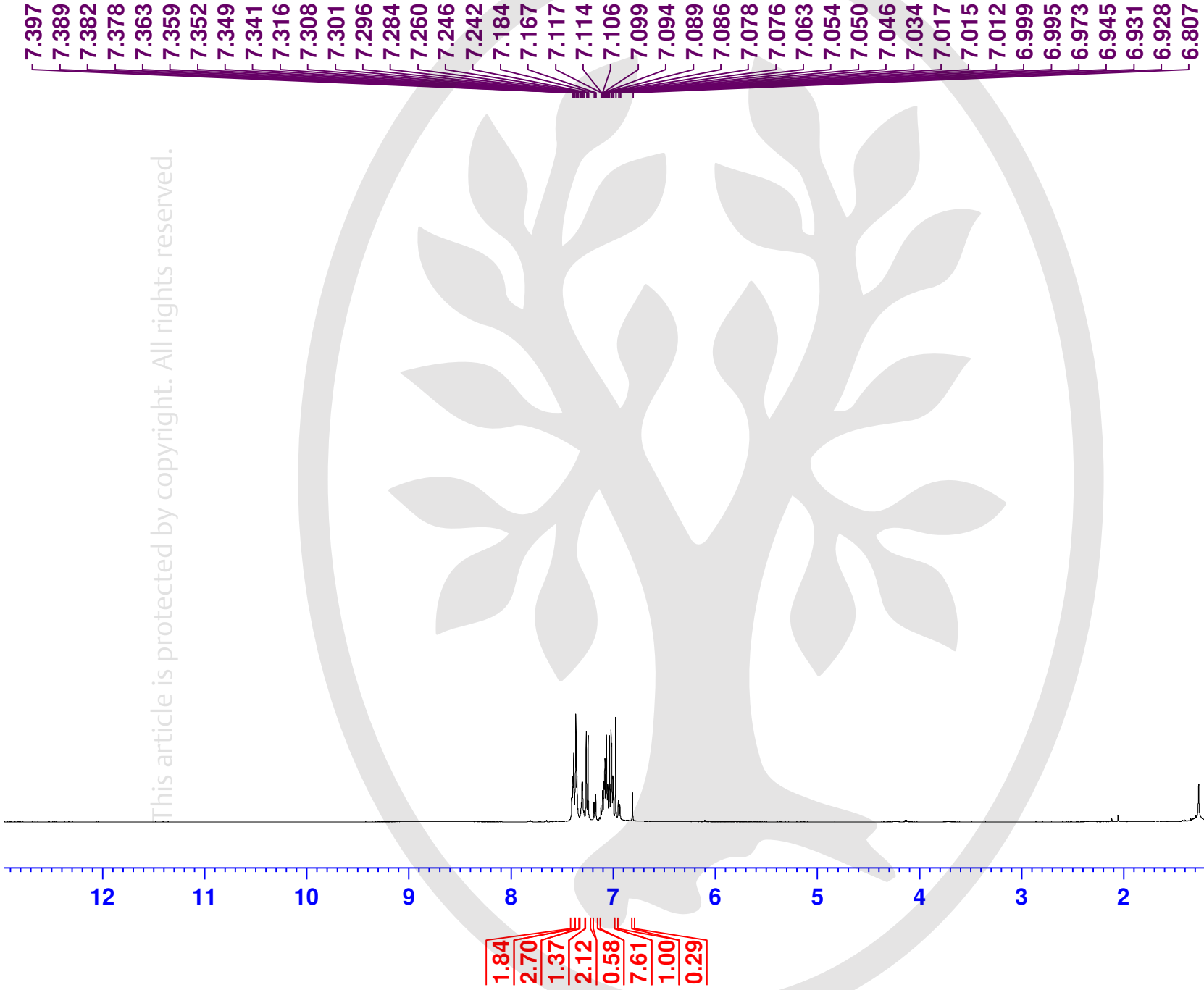
(*E*/*Z* = 1:0.14)

BRUKER

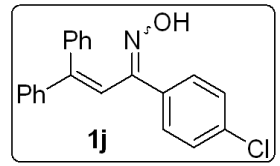
```
Current Data Parameters
NAME                  RSJ-1108
EXPNO                       23
PROCNO                       1

F2 - Acquisition Parameters
Date_               20231126
Time                  15.00 h
INSTRUM                 spect
PROBHD    Z115265_0004 (
PULPROG               zgpg30
TD                     65536
SOLVENT                CDCl3
NS                      1024
DS                         4
SWH                29761.904 Hz
FIDRES             0.908261 Hz
AQ                 1.1010048 sec
RG                      1030
DW                   16.800 usec
DE                    6.50 usec
TE                       0 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                        1
SFO1             125.8005413 MHz
NUC1                     13c
P1                    9.70 usec
PLW1             73.00000000 W
SFO2             500.2520010 MHz
NUC2                     1H
CPDPRG[2               waltz16
PCPD2                80.00 usec
PLW2             15.13599968 W
PLW12             0.53924000 W
PLW13             0.27124000 W

F2 - Processing parameters
SI                      32768
SF               125.7879674 MHz
WDW                        EM
SSB                         0
LB                    1.00 Hz
GB                          0
PC                    1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)



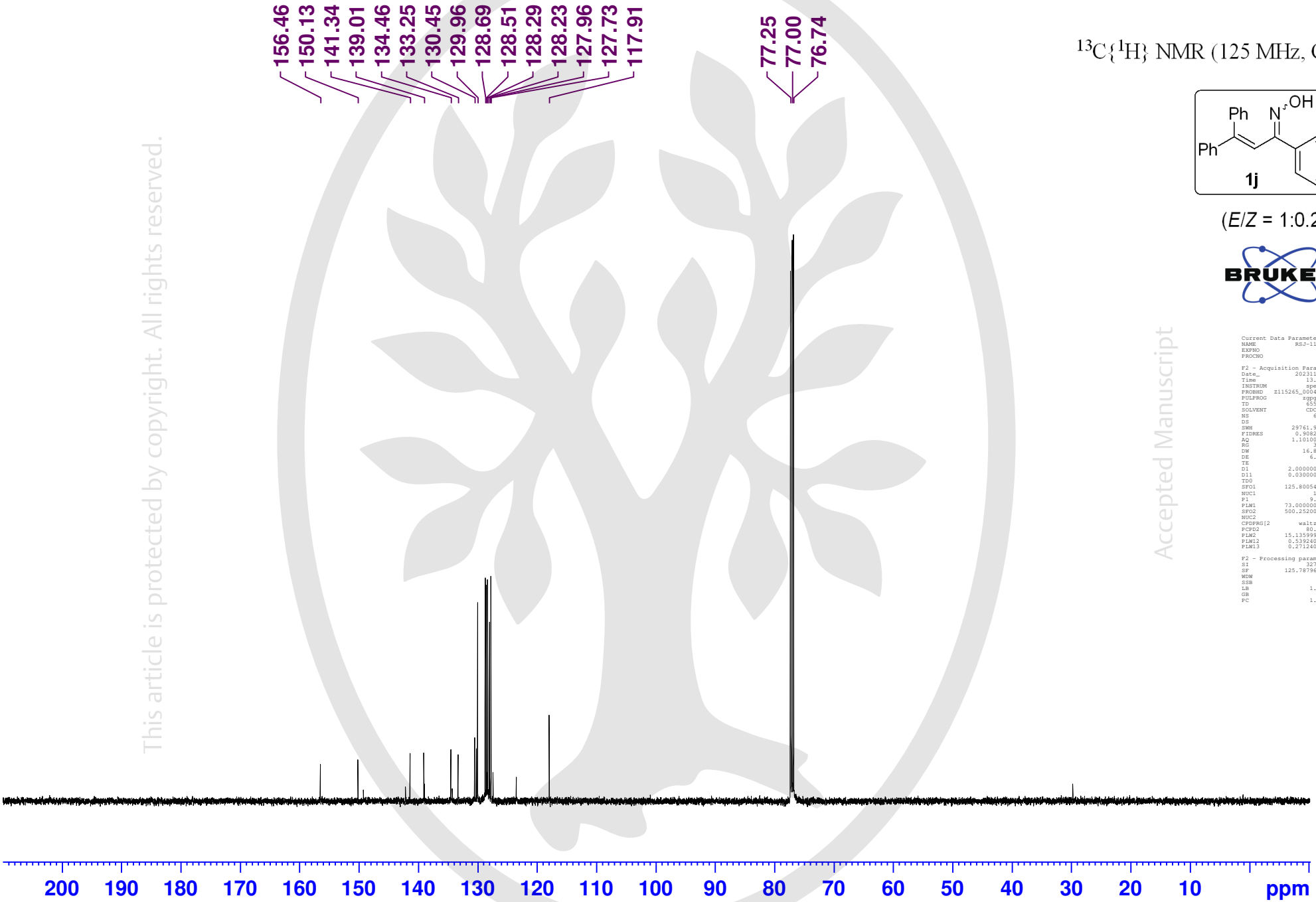
(*E*/*Z* = 1:0.29)

BRUKER

```
Current Data Parameters
NAME                  RSJ-1109
EXPNO                       18
PROCNO                       1

F2 - Acquisition Parameters
Date_                 20231126
Time                     12.30 h
INSTRUM                   spect
PROBHD    Z115265_0004 (
PULPROG                   zg30
TD                       65536
SOLVENT                  CDCl3
NS                           8
DS                           0
SWH                  10000.000 Hz
FIDRES               0.305176 Hz
AQ                   3.2767999 sec
RG                         161
DW                    50.000 usec
DE                     6.50 usec
TE                           0 K
D1                1.00000000 sec
TD0                          1
SFO1               500.2530890 MHz
NUC1                        1H
P1                      15.10 usec
PLW1              15.13599968 W

F2 - Processing parameters
SI                       65536
SF                 500.2500139 MHz
WDW                         EM
SSB                          0
LB                        0.30 Hz
GB                           0
PC                        1.00
```



$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

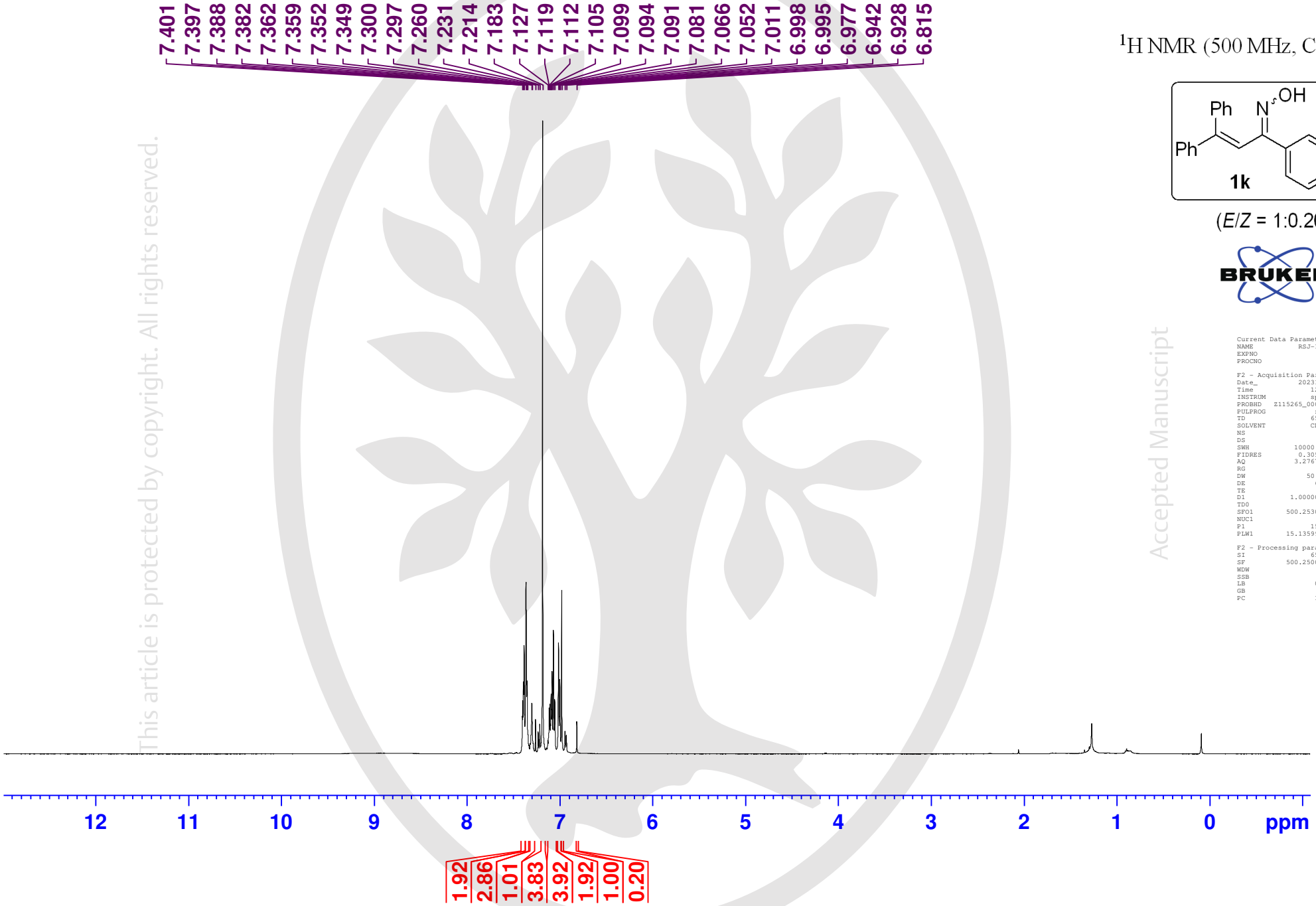
(*E*/*Z* = 1:0.29)

BRUKER

```
Current Data Parameters
NAME                  RSJ-1109
EXPNO                       19
PROCNO                       1

F2 - Acquisition Parameters
Date_                 20231126
Time                     13.07 h
INSTRUM                  spect
PROBHD     Z115265_0004 (
PULPROG                 zgpg30
TD                       65536
SOLVENT                  CDCl3
NS                         659
DS                           4
SWH                  29761.904 Hz
FIDRES                0.908261 Hz
AQ                    1.1010048 sec
RG                         322
DW                      16.800 usec
DE                       6.50 usec
TE                          0 K
D1                   2.00000000 sec
D11                  0.03000000 sec
TD0                          1
SFO1                125.8005413 MHz
NUC1                        13c
P1                       9.70 usec
PLW1                73.00000000 W
SFO2                500.2520010 MHz
NUC2                        1H
CPDPRG[2                waltz16
PCPD2                    80.00 usec
PLW2                15.13599968 W
PLW12                0.53924000 W
PLW13                0.27124000 W

F2 - Processing parameters
SI                       32768
SF                  125.7879656 MHz
WDW                         EM
SSB                          0
LB                        1.00 Hz
GB                           0
PC                        1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)

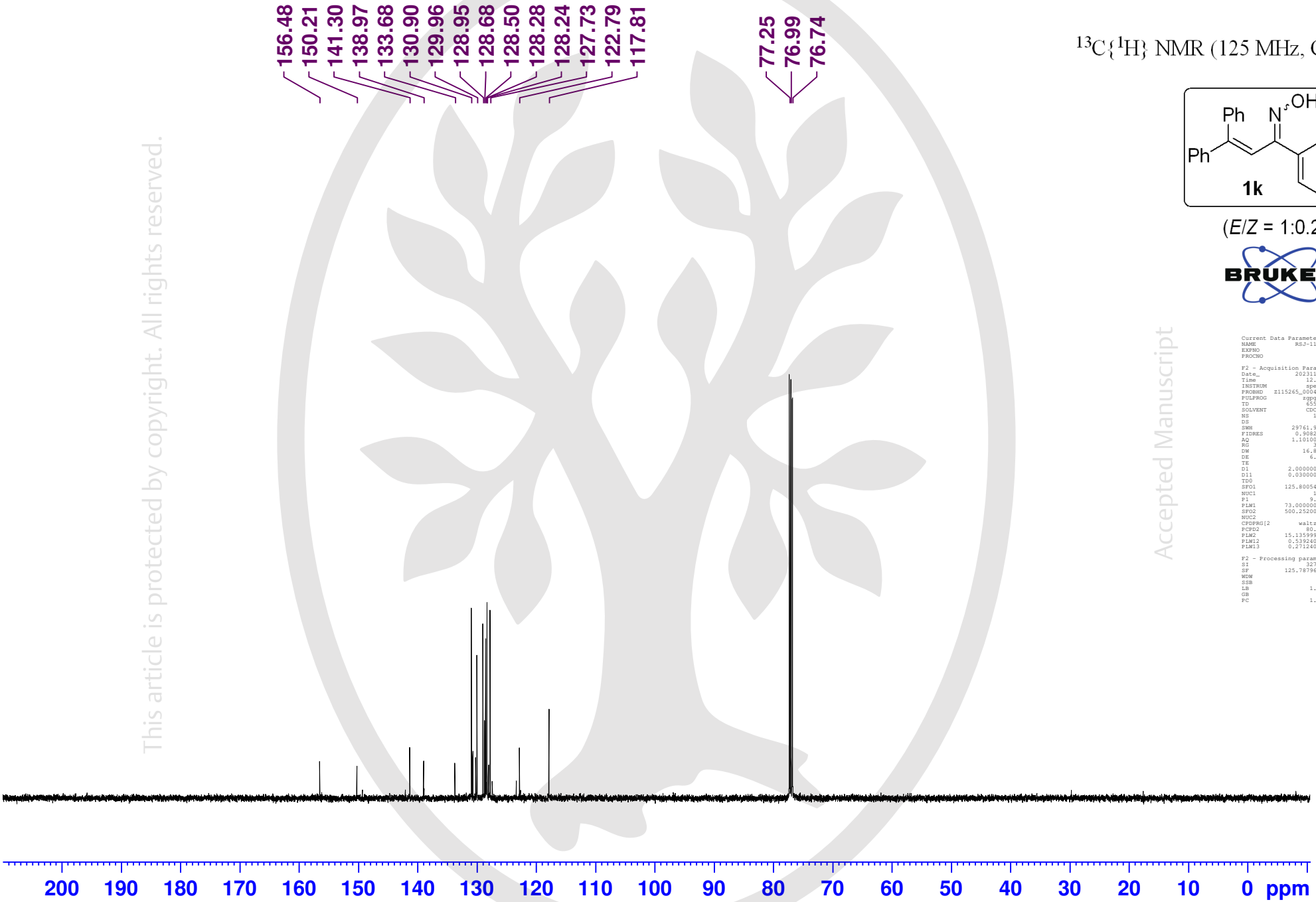
(*E*/*Z* = 1:0.20)

BRUKER

```
Current Data Parameters
NAME                  RSJ-1110
EXPNO                       12
PROCNO                       1

F2 - Acquisition Parameters
Date_               20231126
Time                    12.12 h
INSTRUM                  spect
PROBHD     Z115265_0004 (
PULPROG                  zg30
TD                      65536
SOLVENT                 CDCl3
NS                          8
DS                          0
SWH                10000.000 Hz
FIDRES             0.305176 Hz
AQ                 3.2767999 sec
RG                        161
DW                   50.000 usec
DE                    6.50 usec
TE                       0 K
D1                 1.00000000 sec
TD0                         1
SFO1               500.2530890 MHz
NUC1                       1H
P1                    15.10 usec
PLW1               15.13599968 W

F2 - Processing parameters
SI                      65536
SF                 500.2500135 MHz
WDW                        EM
SSB                         0
LB                     0.30 Hz
GB                          0
PC                       1.00
```



$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

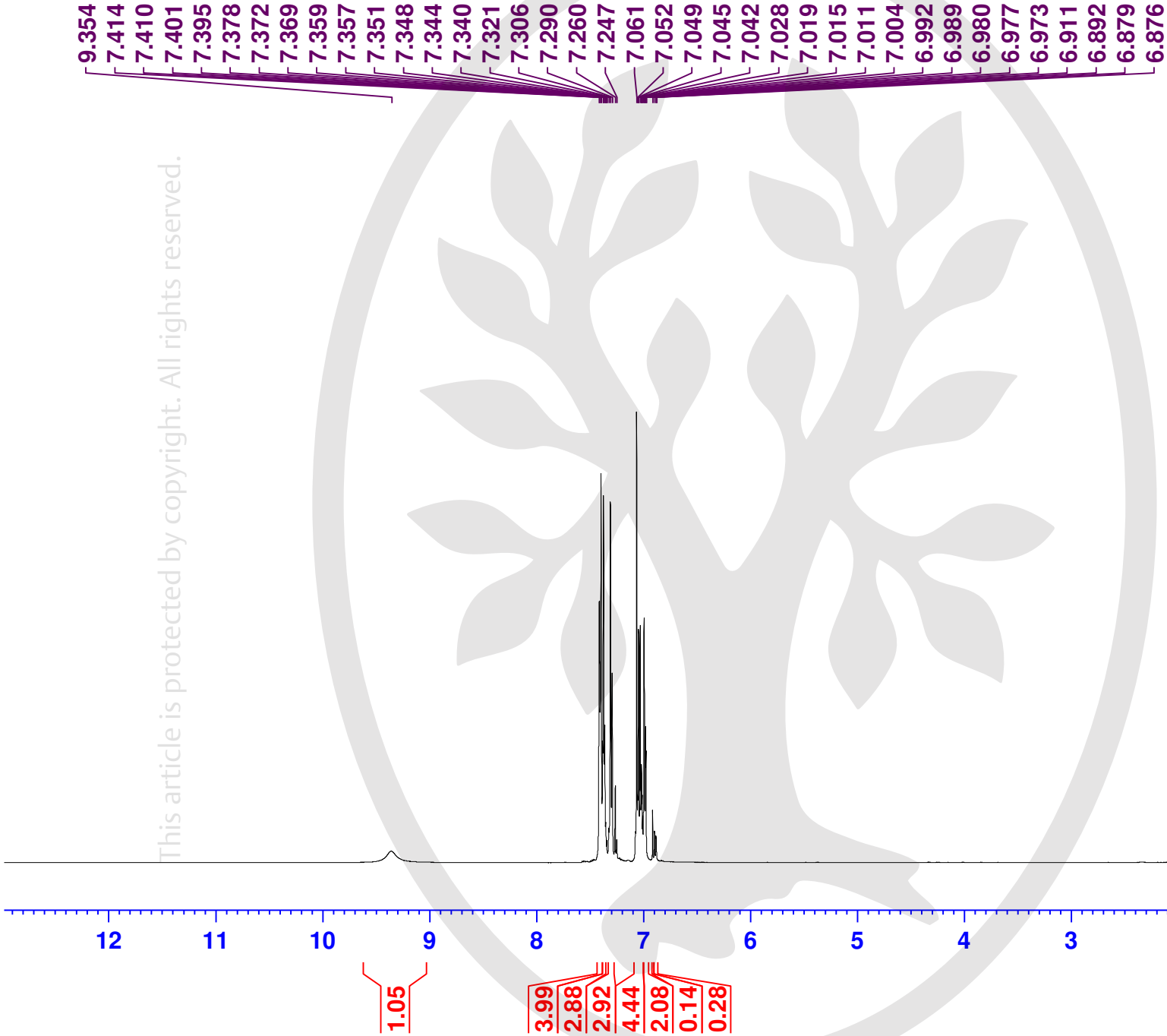
(*E*/*Z* = 1:0.20)

BRUKER

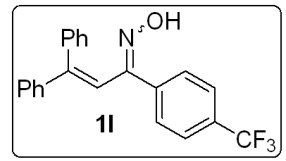
```
Current Data Parameters
NAME                  RSJ-1110
EXPNO                       13
PROCNO                       1

F2 - Acquisition Parameters
Date_                 20231126
Time                     12.23 h
INSTRUM                  spect
PROBHD     Z115265_0004 (
PULPROG                 zgpg30
TD                       65536
SOLVENT                  CDCl3
NS                         176
DS                           4
SWH                  29761.904 Hz
FIDRES                0.908261 Hz
AQ                    1.1010048 sec
RG                         322
DW                      16.800 usec
DE                       6.50 usec
TE                          0 K
D1                   2.00000000 sec
D11                  0.03000000 sec
TD0                          1
SFO1                125.8005413 MHz
NUC1                        13c
P1                       9.70 usec
PLW1                73.00000000 W
SFO2                500.2520010 MHz
NUC2                        1H
CPDPRG[2                waltz16
PCPD2                   80.00 usec
PLW2                15.13599968 W
PLW12                0.53924000 W
PLW13                0.27124000 W

F2 - Processing parameters
SI                       32768
SF                  125.7879683 MHz
WDW                         EM
SSB                          0
LB                        1.00 Hz
GB                           0
PC                        1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)



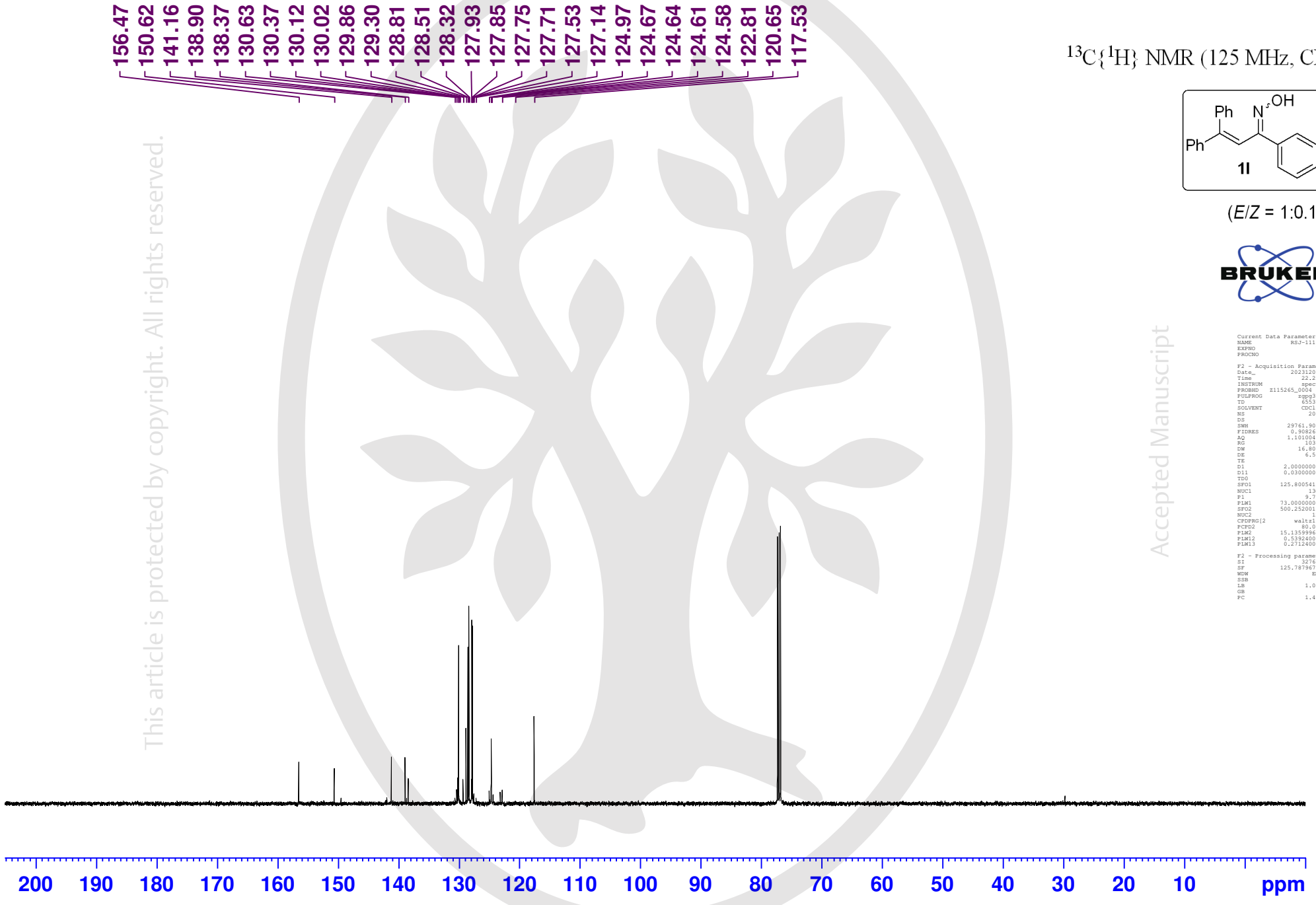
(*E*/*Z* = 1:0.14)

BRUKER

```
Current Data Parameters
NAME                  RSJ-1111
EXPNO                        6
PROCNO                       1

F2 - Acquisition Parameters
Date_              20231201
Time                    22.16 h
INSTRUM                  spect
PROBHD     Z115265_0004 (
PULPROG                  zg30
TD                      65536
SOLVENT                 CDCl3
NS                           8
DS                           0
SWH                10000.000 Hz
FIDRES             0.305176 Hz
AQ                 3.2767999 sec
RG                         144
DW                    50.000 usec
DE                     6.50 usec
TE                         0 K
D1                 1.00000000 sec
TD0                          1
SFO1               500.2530890 MHz
NUC1                        1H
P1                     15.10 usec
PLW1               15.13599968 W

F2 - Processing parameters
SI                       65536
SF                 500.2500134 MHz
WDW                         EM
SSB                          0
LB                      0.30 Hz
GB                           0
PC                        1.00
```



$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

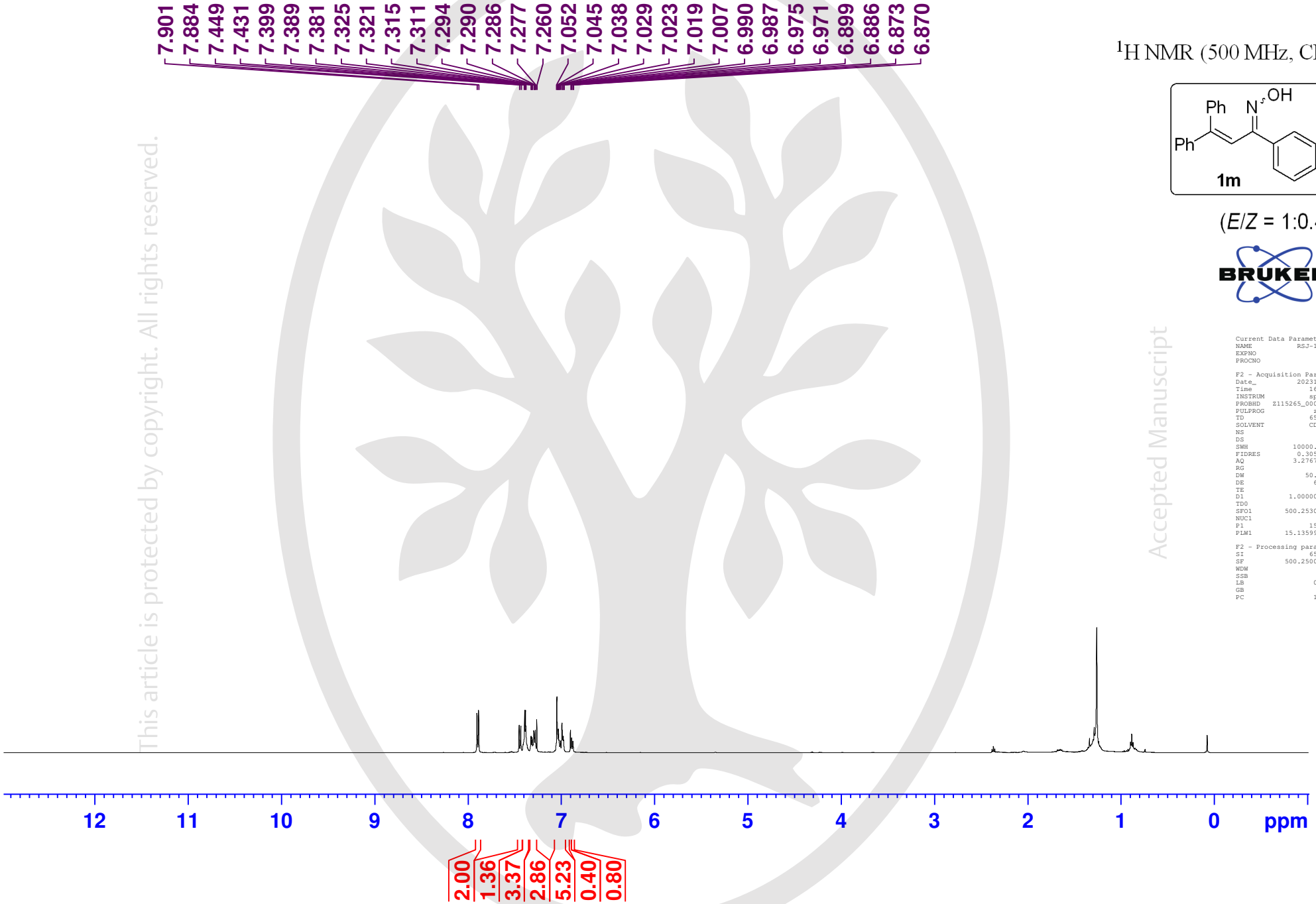
(*E*/*Z* = 1:0.14)

BRUKER

```
Current Data Parameters
NAME                  RSJ-1111
EXPNO                        7
PROCNO                       1

F2 - Acquisition Parameters
Date_              20231201
Time                 22.28 h
INSTRUM                spect
PROBHD    Z115265_0004 (
PULPROG              zgpg30
TD                    65536
SOLVENT               CDCl3
NS                      200
DS                        4
SWH               29761.904 Hz
FIDRES            0.908261 Hz
AQ                1.1010048 sec
RG                     1030
DW                  16.800 usec
DE                   6.50 usec
TE                      0 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                       1
SFO1             125.8005413 MHz
NUC1                    13c
P1                    9.70 usec
PLW1             73.00000000 W
SFO2             500.2520010 MHz
NUC2                    1H
CPDPRG[2              waltz16
PCPD2                80.00 usec
PLW2             15.13599968 W
PLW12             0.53924000 W
PLW13             0.27124000 W

F2 - Processing parameters
SI                    32768
SF               125.7879674 MHz
WDW                      EM
SSB                       0
LB                     1.00 Hz
GB                        0
PC                     1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)

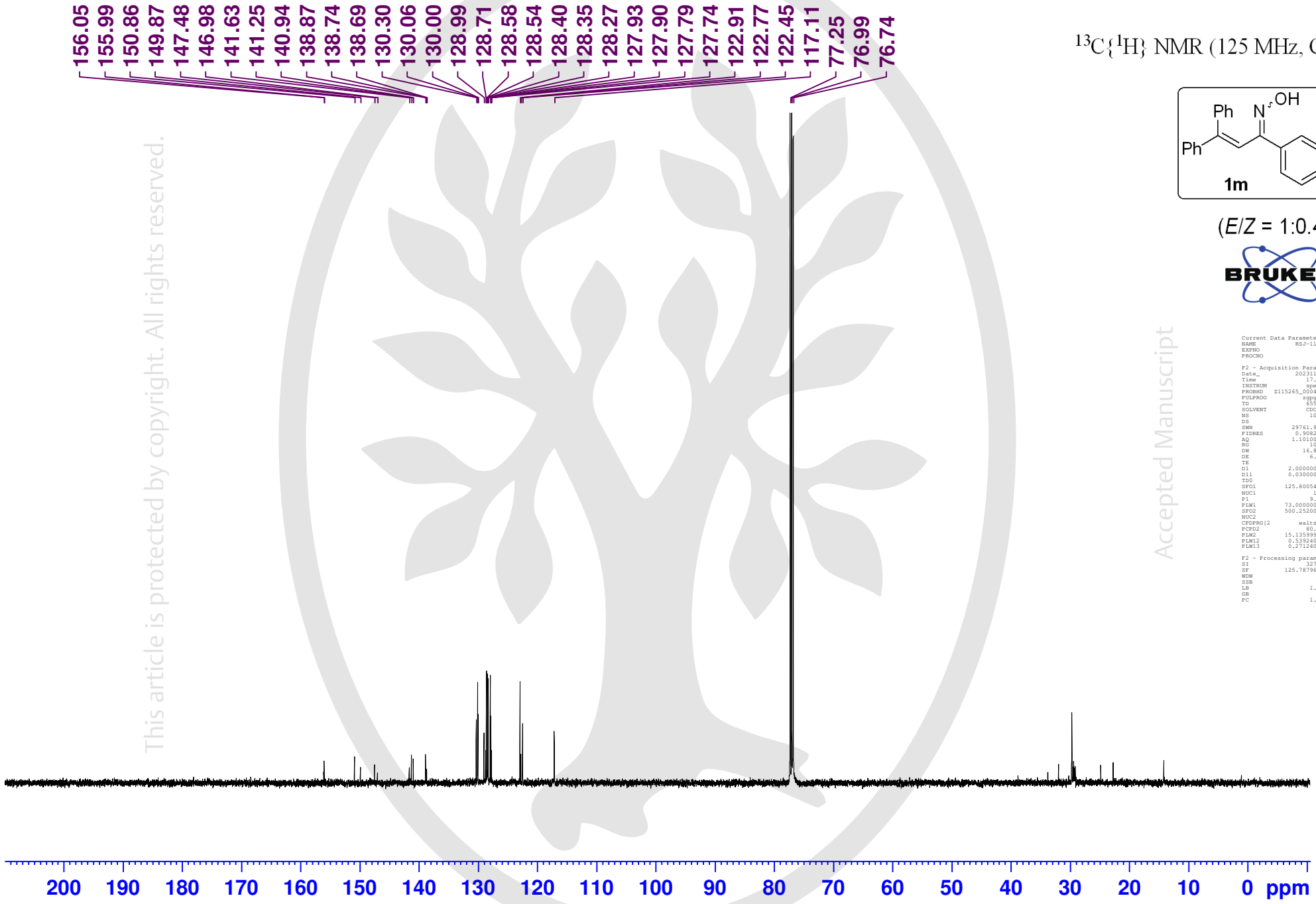
(*E*/*Z* = 1:0.40)

BRUKER

```
Current Data Parameters
NAME                  RSJ-1112
EXPNO                        3
PROCNO                       1

F2 - Acquisition Parameters
Date_              20231127
Time                    16.19 h
INSTRUM                  spect
PROBHD     Z115265_0004 (
PULPROG                  zg30
TD                      65536
SOLVENT                 CDCl3
NS                           8
DS                           0
SWH                10000.000 Hz
FIDRES                 0.305176 Hz
AQ                 3.2767999 sec
RG                         203
DW                      50.000 usec
DE                       6.50 usec
TE                          0 K
D1                 1.00000000 sec
TD0                          1
SFO1               500.2530890 MHz
NUC1                        1H
P1                       15.10 usec
PLW1               15.13599968 W

F2 - Processing parameters
SI                       65536
SF                 500.2500131 MHz
WDW                         EM
SSB                          0
LB                        0.30 Hz
GB                           0
PC                        1.00
```



$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

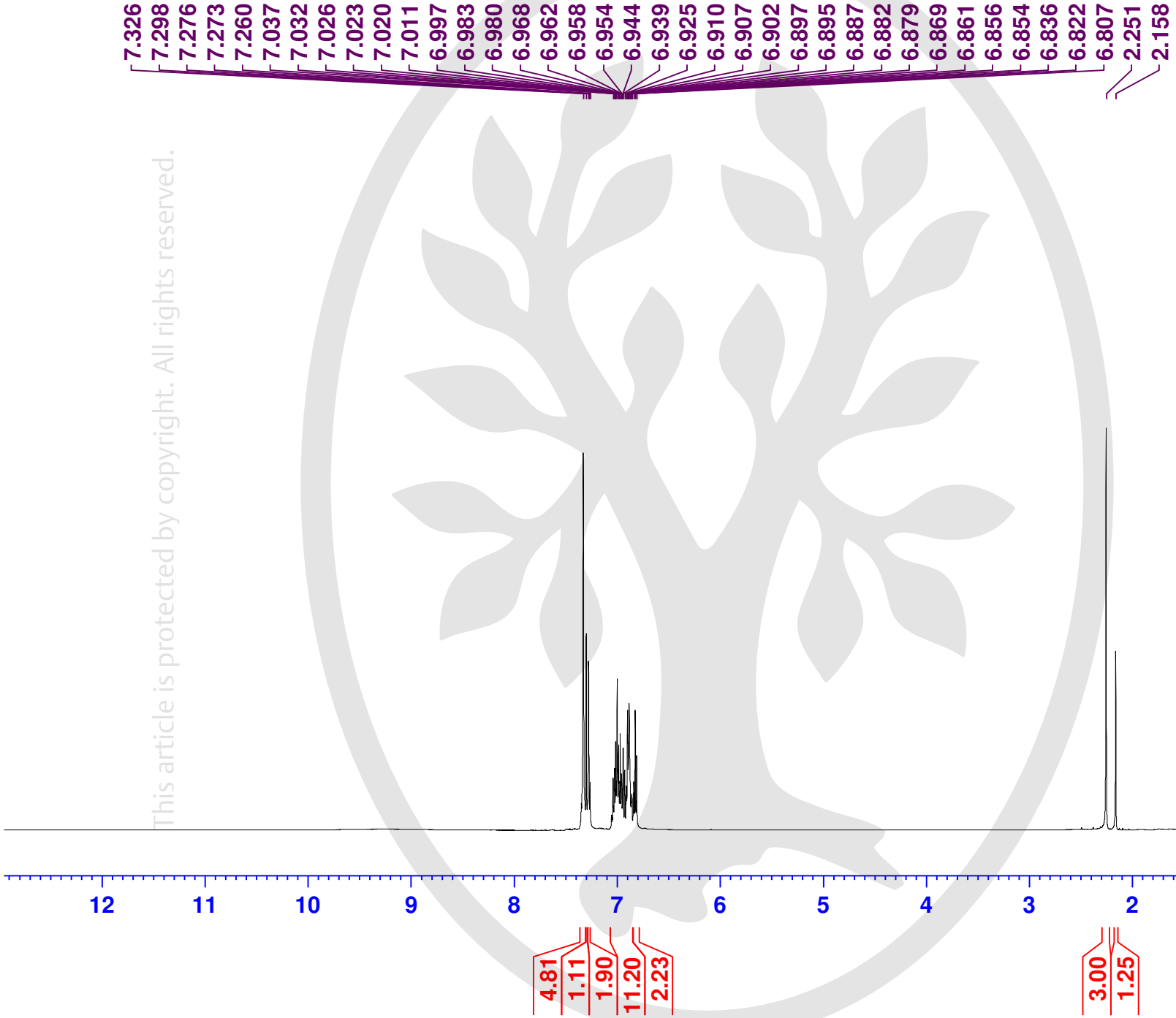
(*E*/*Z* = 1:0.40)

BRUKER

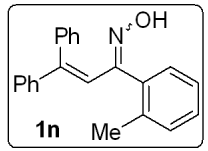
```
Current Data Parameters
NAME                  RSJ-1112
EXPNO                        4
PROCNO                       1

F2 - Acquisition Parameters
Date_              20231127
Time                 17.15 h
INSTRUM                spect
PROBHD    Z115265_0004 (
PULPROG              zgpg30
TD                    65536
SOLVENT               CDCl3
NS                     1024
DS                        4
SWH               29761.904 Hz
FIDRES            0.908261 Hz
AQ                1.1010048 sec
RG                     1030
DW                  16.800 usec
DE                   6.50 usec
TE                      0 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                       1
SFO1             125.8005413 MHz
NUC1                    13c
P1                    9.70 usec
PLW1             73.00000000 W
SFO2             500.2520010 MHz
NUC2                    1H
CPDPRG[2              waltz16
PCPD2                80.00 usec
PLW2             15.13599968 W
PLW12             0.53924000 W
PLW13             0.27124000 W

F2 - Processing parameters
SI                       32768
SF               125.7879646 MHz
WDW                         EM
SSB                          0
LB                    1.00 Hz
GB                           0
PC                    1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)



(*E*/*Z* = 1:0.42)

BRUKER

```
Current Data Parameters
NAME                  RSJ-1113
EXPNO                        8
PROCNO                       1

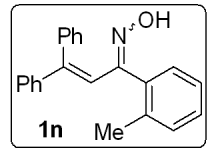
F2 - Acquisition Parameters
Date_              20231201
Time                    22.33 h
INSTRUM                  spect
PROBHD     Z115265_0004 (
PULPROG                  zg30
TD                      65536
SOLVENT                 CDCl3
NS                           8
DS                           0
SWH                10000.000 Hz
FIDRES             0.305176 Hz
AQ                 3.2767999 sec
RG                         101
DW                    50.000 usec
DE                     6.50 usec
TE                        0 K
D1                 1.00000000 sec
TD0                          1
SFO1               500.2530890 MHz
NUC1                        1H
P1                     15.10 usec
PLW1               15.13599968 W

F2 - Processing parameters
SI                       65536
SF                 500.2500135 MHz
WDW                         EM
SSB                          0
LB                      0.30 Hz
GB                           0
PC                        1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

158.52 157.60 149.12 147.88 142.38 141.61 138.85 138.46 135.80 135.40 134.78 132.57 130.07 129.92 129.60 129.50 129.38 128.46 128.22 128.19 128.18 128.13 128.05 127.90 127.65 127.63 127.33 127.29 126.95 124.95 123.82 118.87 77.25 76.99 76.74

20.81 20.06



(*E*/*Z* = 1:0.42)

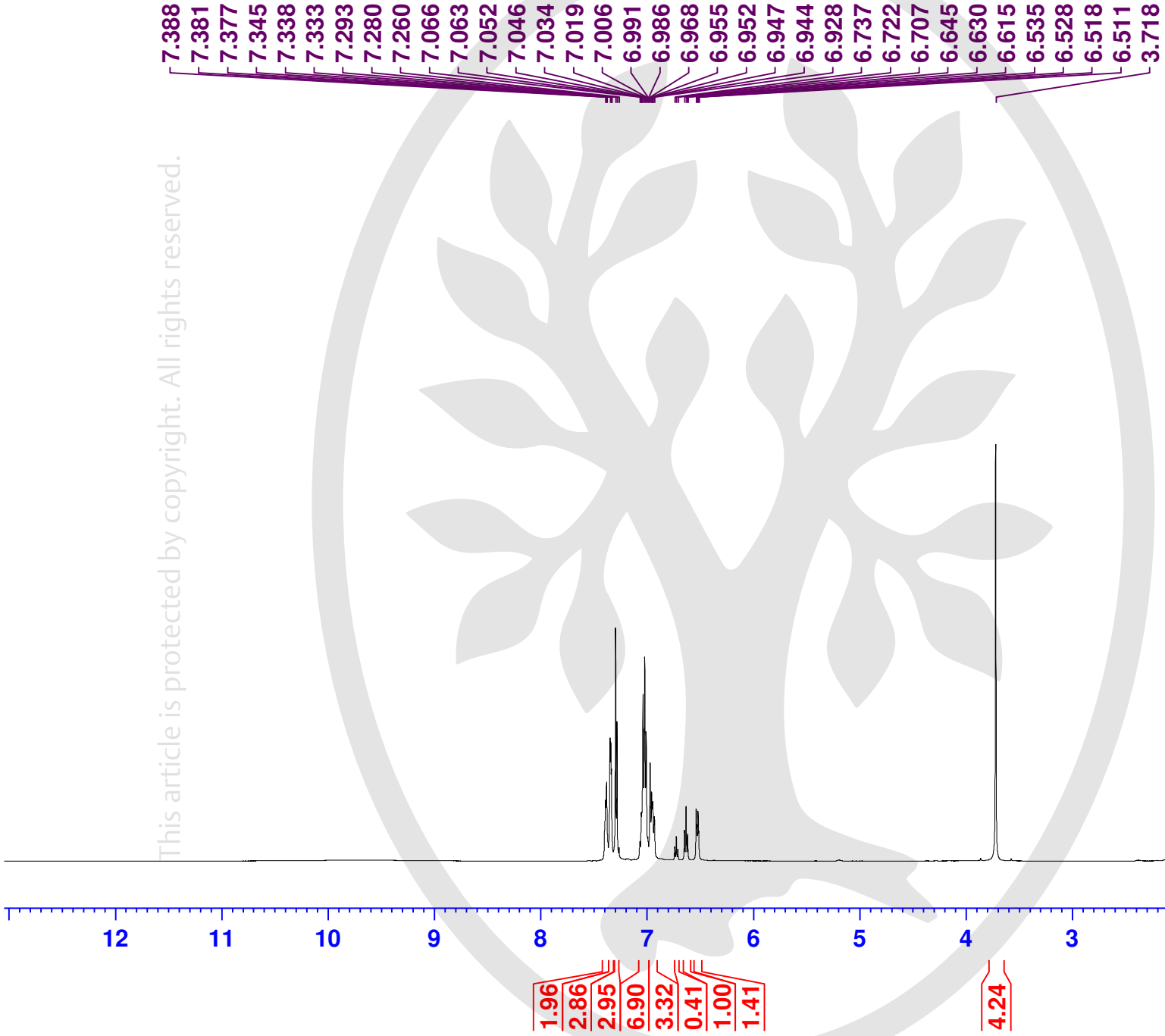
BRUKER

```
Current Data Parameters
NAME                  RSJ-1113
EXPNO                        9
PROCNO                       1

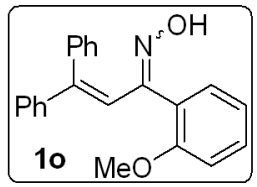
F2 - Acquisition Parameters
Date_              20231201
Time                  22.57 h
INSTRUM                 spect
PROBHD    Z115265_0004 (
PULPROG               zgpg30
TD                     65536
SOLVENT                CDCl3
NS                       417
DS                         4
SWH               29761.904 Hz
FIDRES            0.908261 Hz
AQ                1.1010048 sec
RG                      1030
DW                  16.800 usec
DE                   6.50 usec
TE                      0 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                        1
SFO1             125.8005413 MHz
NUC1                     13c
P1                    9.70 usec
PLW1             73.00000000 W
SFO2             500.2520010 MHz
NUC2                     1H
CPDPRG[2              waltz16
PCPD2                80.00 usec
PLW2             15.13599968 W
PLW12             0.53924000 W
PLW13             0.27124000 W

F2 - Processing parameters
SI                       32768
SF               125.7879701 MHz
WDW                         EM
SSB                          0
LB                    1.00 Hz
GB                           0
PC                    1.40
```

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



^{1}H NMR (500 MHz, $CDCl_3$)



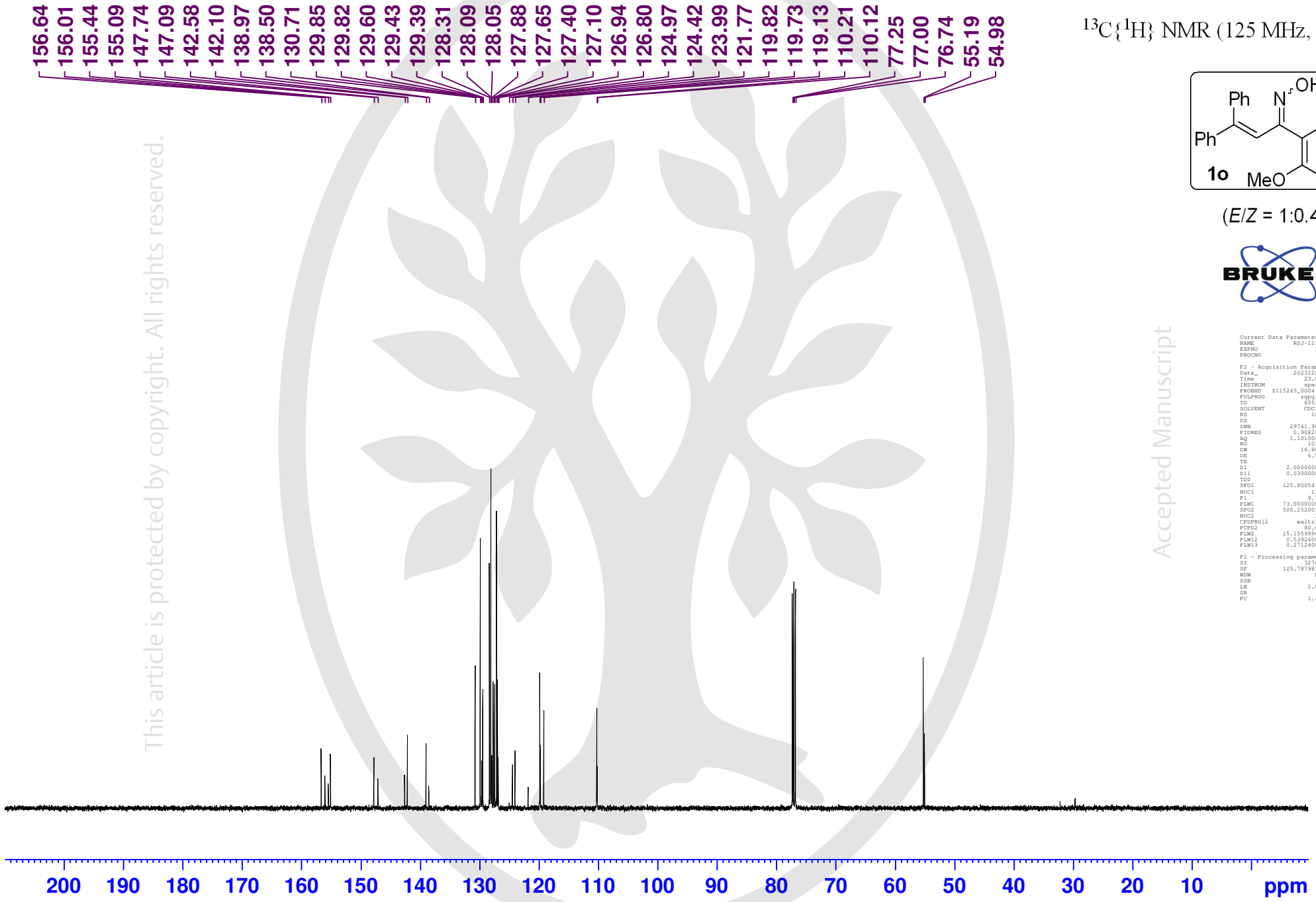
(*E*/*Z* = 1:0.41)

BRUKER

```
Current Data Parameters
NAME                  RSJ-1114
EXPNO                       10
PROCNO                       1

F2 - Acquisition Parameters
Date_                 20231201
Time                     23.02 h
INSTRUM                  spect
PROBHD     Z115265_0004 (
PULPROG                  zg30
TD                      65536
SOLVENT                 CDCl3
NS                          8
DS                          0
SWH                10000.000 Hz
FIDRES             0.305176 Hz
AQ                 3.2767999 sec
RG                         32
DW                    50.000 usec
DE                     6.50 usec
TE                        0 K
D1                 1.00000000 sec
TD0                         1
SFO1               500.2530890 MHz
NUC1                       1H
P1                      15.10 usec
PLW1               15.13599968 W

F2 - Processing parameters
SI                      65536
SF                 500.2500138 MHz
WDW                        EM
SSB                         0
LB                      0.30 Hz
GB                          0
PC                       1.00
```



$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

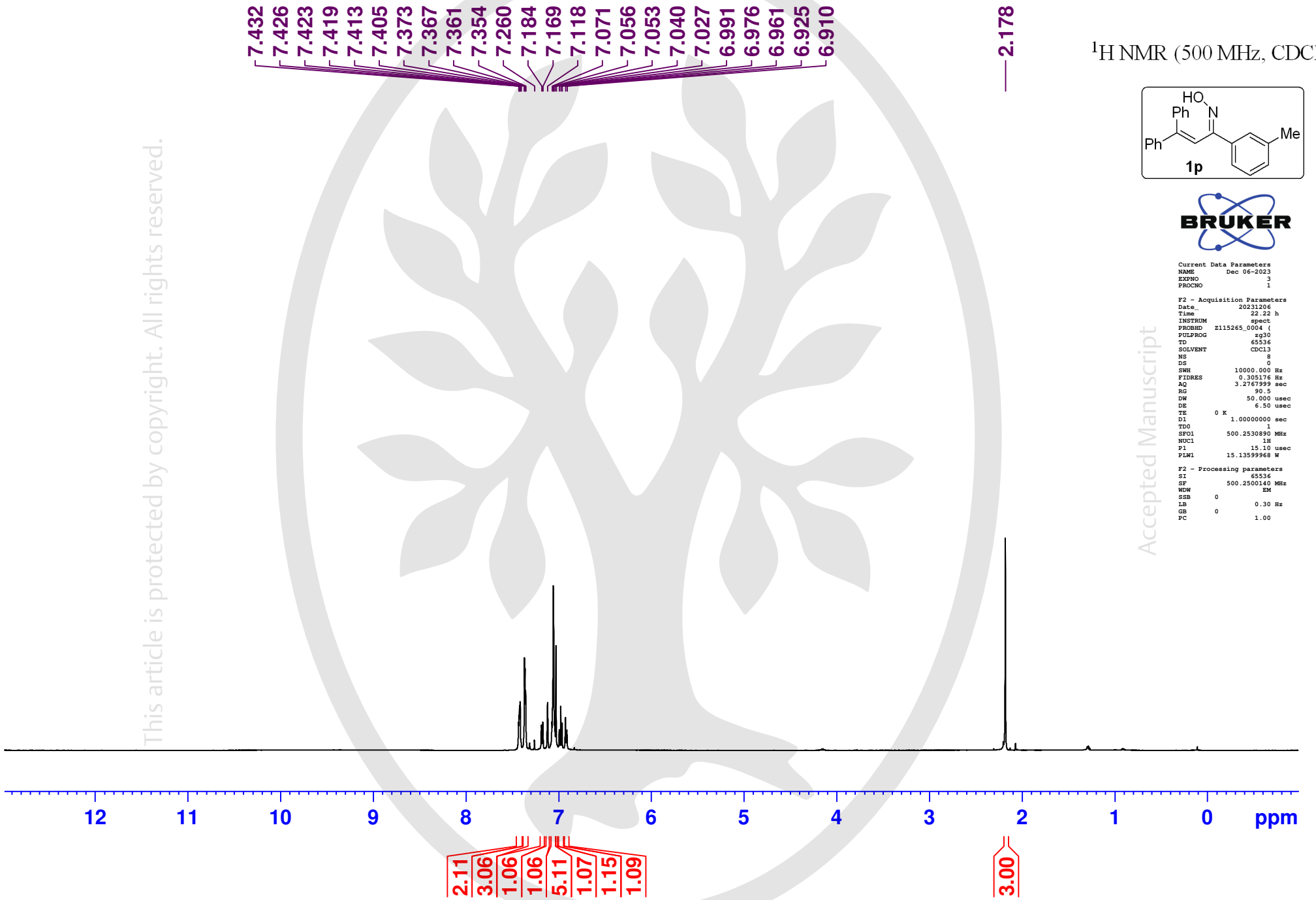
(*E*/*Z* = 1:0.41)

BRUKER

```
Current Data Parameters
NAME                  RSJ-1114
EXPNO                       11
PROCNO                       1

F2 - Acquisition Parameters
Date_               20231201
Time                  23.09 h
INSTRUM                 spect
PROBHD    Z115265_0004 (
PULPROG               zgpg30
TD                     65536
SOLVENT                CDCl3
NS                       104
DS                         4
SWH                29761.904 Hz
FIDRES             0.908261 Hz
AQ                 1.1010048 sec
RG                      1030
DW                   16.800 usec
DE                    6.50 usec
TE                       0 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                        1
SFO1              125.8005413 MHz
NUC1                     13c
P1                    9.70 usec
PLW1              73.00000000 W
SFO2              500.2520010 MHz
NUC2                     1H
CPDPRG[2               waltz16
PCPD2                 80.00 usec
PLW2              15.13599968 W
PLW12              0.53924000 W
PLW13              0.27124000 W

F2 - Processing parameters
SI                       32768
SF                125.7879810 MHz
WDW                         EM
SSB                          0
LB                    1.00 Hz
GB                           0
PC                    1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)

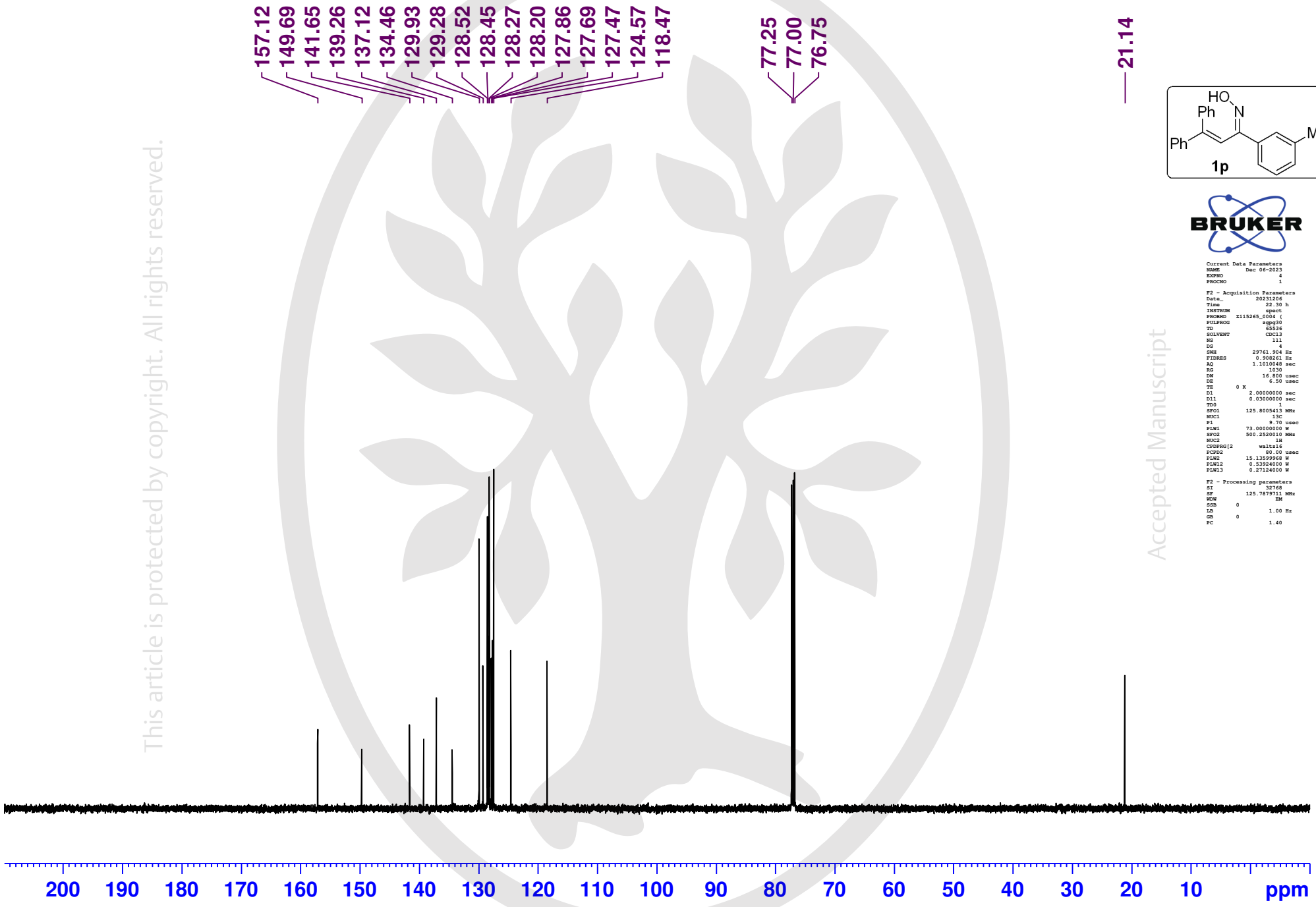
BRUKER

```
Current Data Parameters
NAME          Dec 06-2023
EXPNO                   3
PROCNO                  1

F2 - Acquisition Parameters
Date_              20231206
Time                22.22 h
INSTRUM               spect
PROBHD    Z115265_0004 (
PULPROG                zg30
TD                    65536
SOLVENT               CDCl3
NS                        8
DS                        0
SWH               10000.000 Hz
FIDRES                0.305176 Hz
AQ                3.2767999 sec
RG                      90.5
DW                   50.000 usec
DE                    6.50 usec
TE          0 K
D1             1.00000000 sec
TD0                       1
SFO1           500.2530890 MHz
NUC1                    1H
P1                   15.10 usec
PLW1           15.13599968 W

F2 - Processing parameters
SI                    65536
SF           500.2500140 MHz
WDW                     EM
SSB         0
LB                    0.30 Hz
GB          0
PC                    1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)



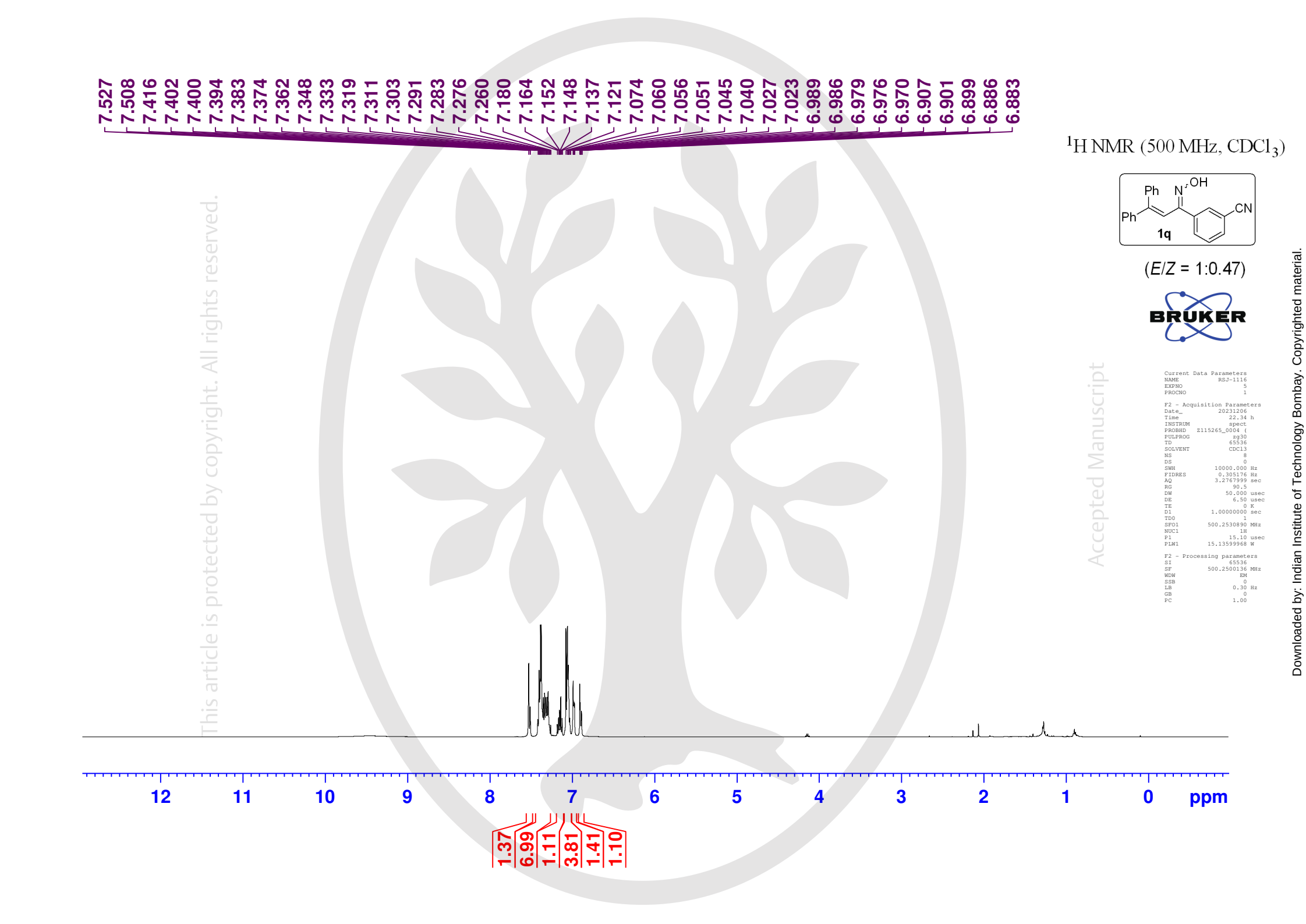
1p

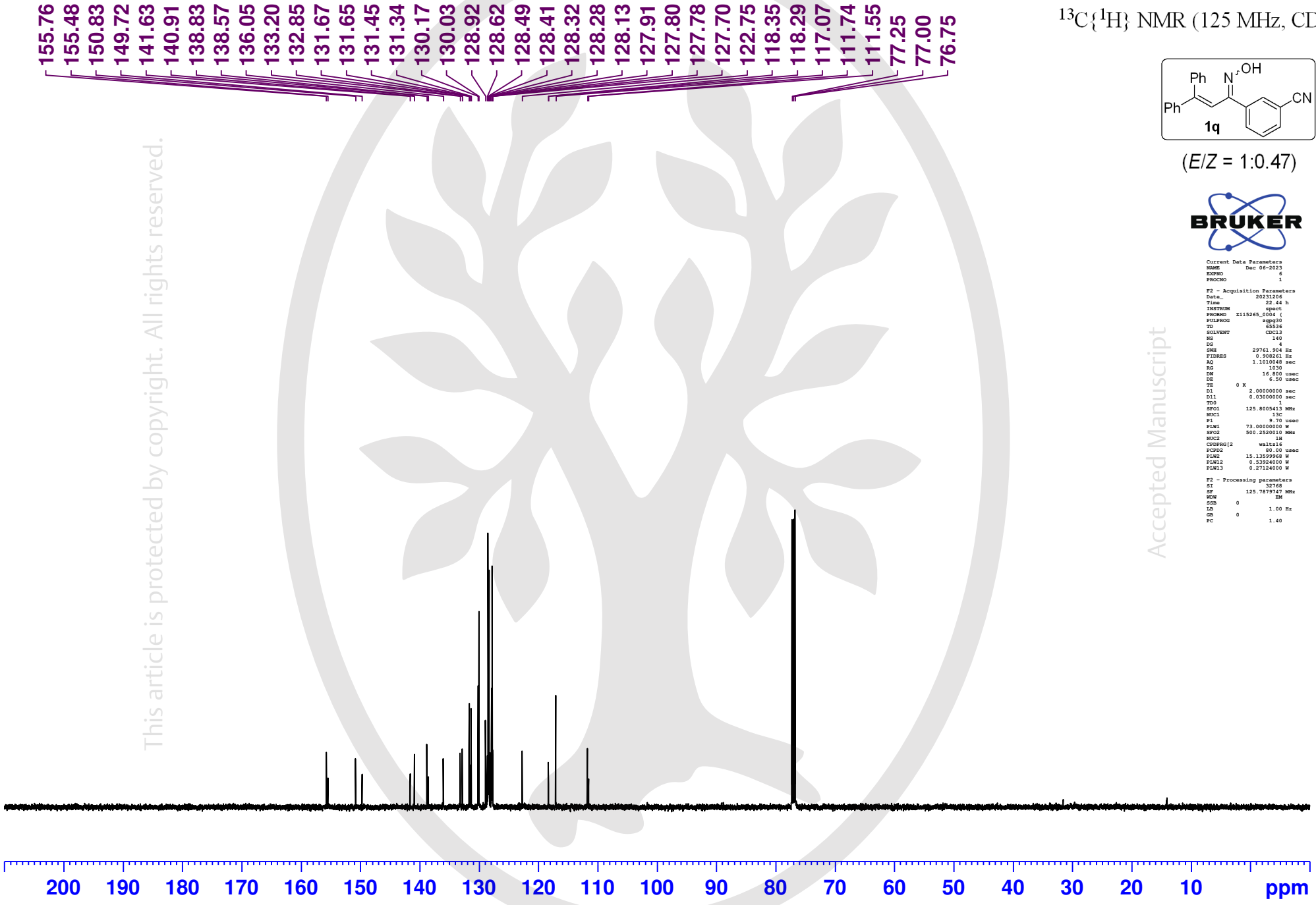
BRUKER

Current Data Parameters
NAME Dec 06-2023
EXPNO 4
PROCNO 1

F2 - Acquisition Parameters
Date_ 20231206
Time 22.30 h
INSTRUM spect
PROBHD Z115265_0004 (
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 111
DS 4
SWH 29761.904 Hz
FIDRES 0.908261 Hz
AQ 1.1010048 sec
RG 1030
DW 16.800 usec
DE 6.50 usec
TE 0 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
SFO1 125.8005413 MHz
NUC1 13C
P1 9.70 usec
PLW1 73.00000000 W
SFO2 500.2520010 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 80.00 usec
PLW2 15.13599968 W
PLW12 0.53924000 W
PLW13 0.27124000 W

F2 - Processing parameters
SI 32768
SF 125.7879711 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40





$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

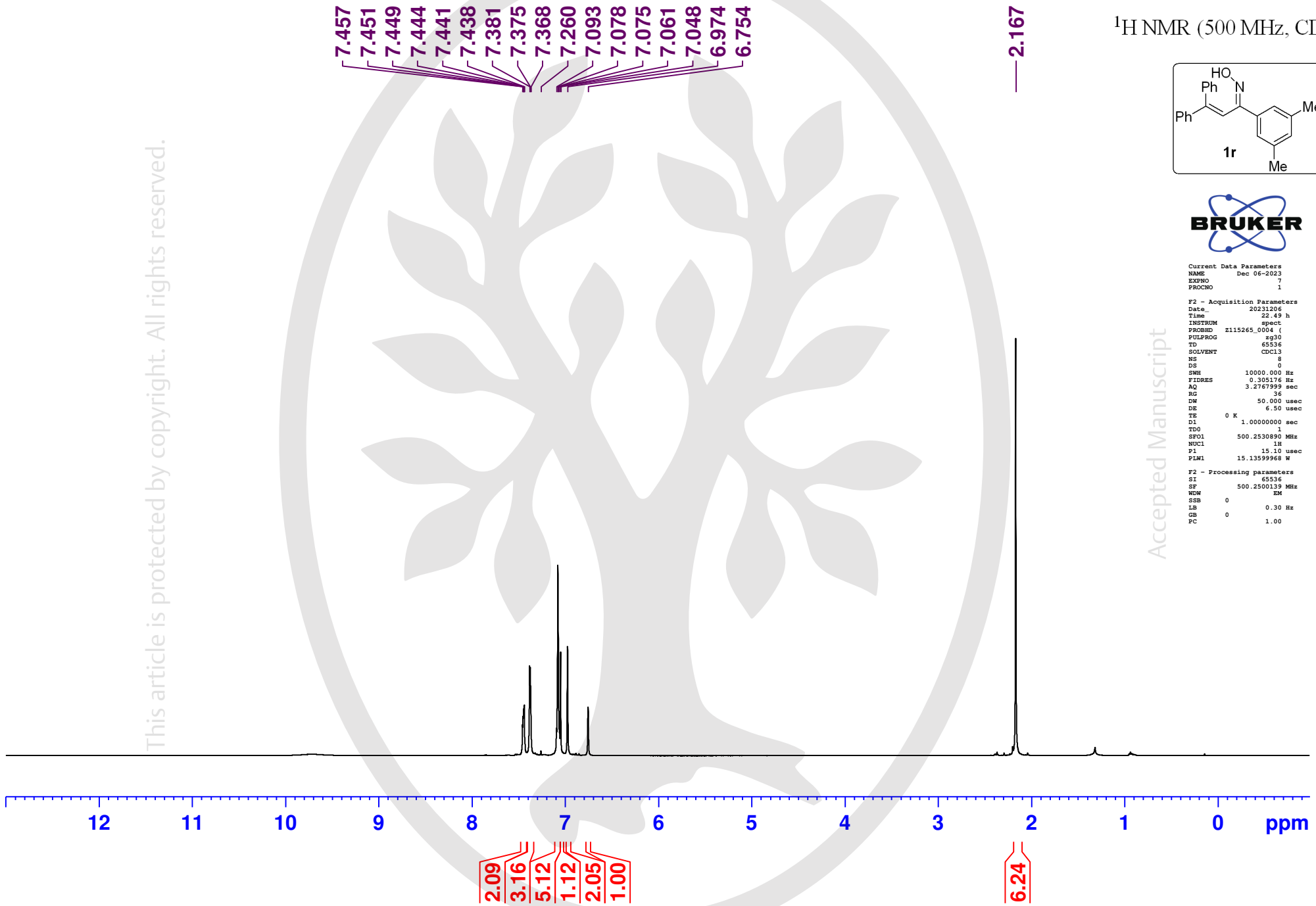
(*E*/*Z* = 1:0.47)

BRUKER

```
Current Data Parameters
NAME          Dec 06-2023
EXPNO                   6
PROCNO                  1

F2 - Acquisition Parameters
Date_              20231206
Time                 22.44 h
INSTRUM                spect
PROBHD     Z115265_0004 (
PULPROG              sgpg30
TD                    65536
SOLVENT               CDCl3
NS                      140
DS                        4
SWH              29761.904 Hz
FIDRES            0.908261 Hz
AQ                1.1010048 sec
RG                     1030
DW                   16.800 usec
DE                    6.50 usec
TE                  0 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                       1
SFO1           125.8005413 MHz
NUC1                    13C
P1                    9.70 usec
PLW1           73.00000000 W
SFO2           500.2520010 MHz
NUC2                    1H
CPDPRG[2           waltz16
PCPD2                80.00 usec
PLW2           15.13599968 W
PLW12           0.53924000 W
PLW13           0.27124000 W

F2 - Processing parameters
SI                    32768
SF             125.7879747 MHz
WDW                      EM
SSB                   0
LB                    1.00 Hz
GB                    0
PC                    1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)

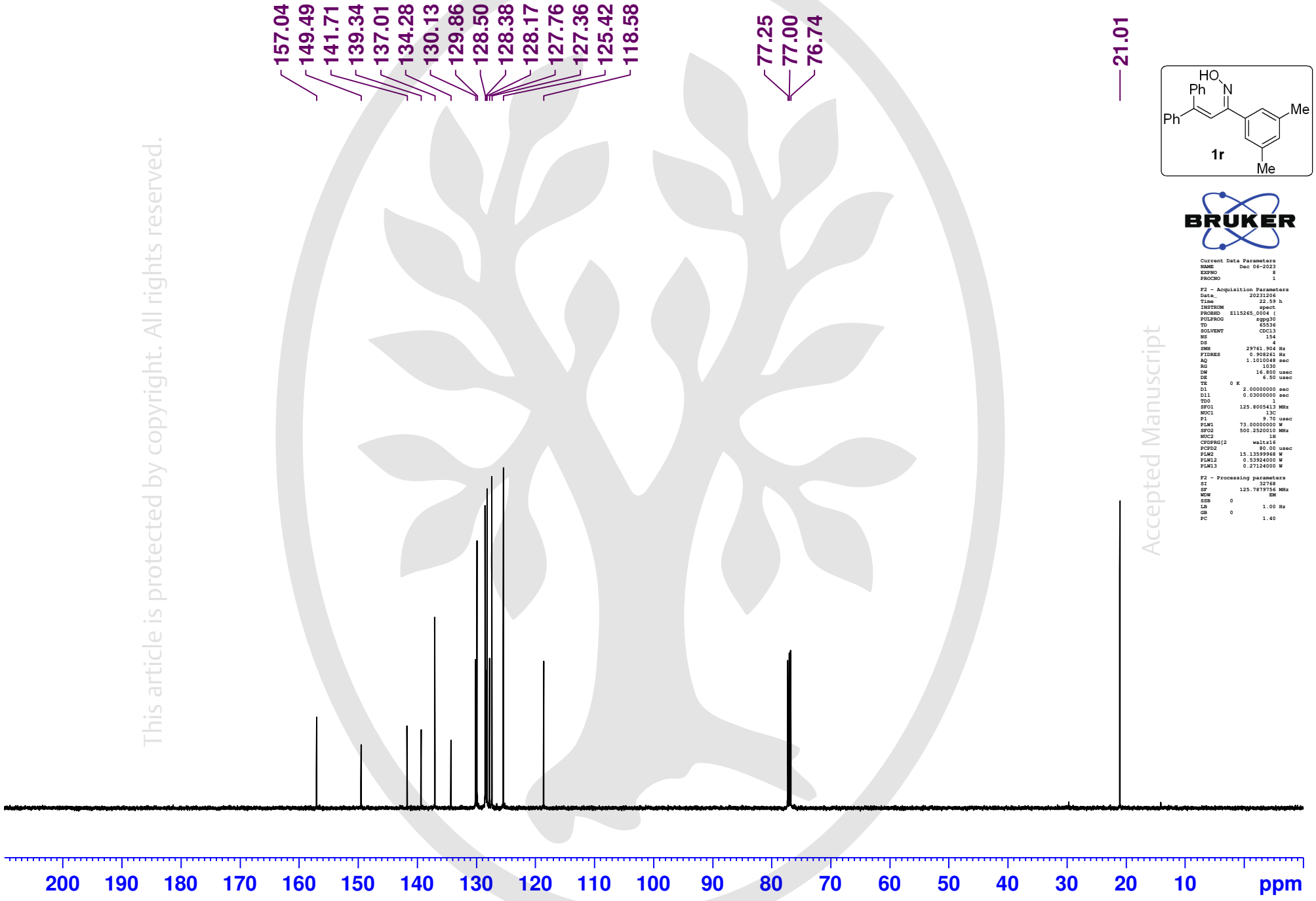
BRUKER

```
Current Data Parameters
NAME          Dec 06-2023
EXPNO                   7
PROCNO                  1

F2 - Acquisition Parameters
Date_              20231206
Time                 22.49 h
INSTRUM                spect
PROBHD   Z115265_0004 (
PULPROG                zg30
TD                    65536
SOLVENT               CDCl3
NS                        8
DS                        0
SWH               10000.000 Hz
FIDRES                0.305176 Hz
AQ                3.2767999 sec
RG                       36
DW                    50.000 usec
DE                     6.50 usec
TE          0 K
D1             1.00000000 sec
TD0                       1
SFO1           500.2530890 MHz
NUC1                    1H
P1                    15.10 usec
PLW1           15.13599968 W

F2 - Processing parameters
SI                    65536
SF             500.2500139 MHz
WDW                     EM
SSB         0
LB                    0.30 Hz
GB          0
PC                    1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

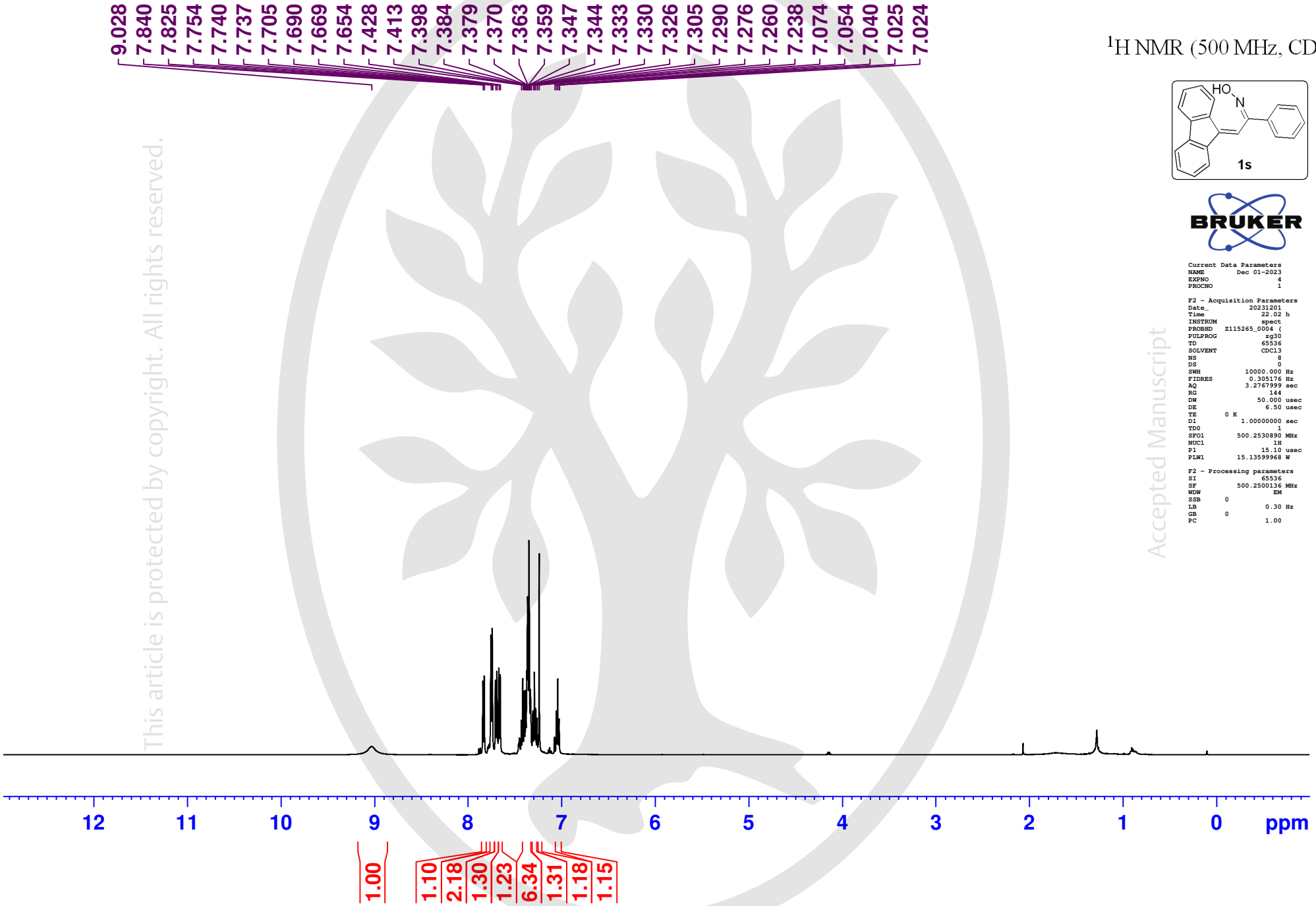


BRUKER

```
Current Data Parameters
NAME         Dec 06-2023
EXPNO                  8
PROCNO                 1

F2 - Acquisition Parameters
Date_             20231206
Time                22.59 h
INSTRUM              spect
PROBHD  Z115265_0004 (
PULPROG            zgpg30
TD                  65536
SOLVENT             CDCl3
NS                    154
DS                      4
SWH              29761.904 Hz
FIDRES            0.908261 Hz
AQ                1.1010048 sec
RG                     1030
DW                 16.800 usec
DE                  6.50 usec
TE                  0 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                        1
SFO1           125.8005413 MHz
NUC1                     13C
P1                    9.70 usec
PLW1           73.00000000 W
SFO2           500.2520010 MHz
NUC2                     1H
CPDPRG[2           waltz16
PCPD2                80.00 usec
PLW2           15.13599968 W
PLW12           0.53924000 W
PLW13           0.27124000 W

F2 - Processing parameters
SI                    32768
SF             125.7879756 MHz
WDW                      EM
SSB                    0
LB                    1.00 Hz
GB                     0
PC                    1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)

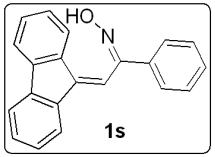
BRUKER

```
Current Data Parameters
NAME          Dec 01-2023
EXPNO                   4
PROCNO                  1

F2 - Acquisition Parameters
Date_              20231201
Time                 22.02 h
INSTRUM                spect
PROBHD    Z115265_0004 (
PULPROG                zg30
TD                    65536
SOLVENT               CDCl3
NS                        8
DS                        0
SWH               10000.000 Hz
FIDRES                0.305176 Hz
AQ                3.2767999 sec
RG                      144
DW                   50.000 usec
DE                    6.50 usec
TE          0 K
D1             1.00000000 sec
TD0                       1
SFO1           500.2530890 MHz
NUC1                    1H
P1                   15.10 usec
PLW1           15.13599968 W

F2 - Processing parameters
SI                    65536
SF             500.2500136 MHz
WDW                     EM
SSB         0
LB                    0.30 Hz
GB          0
PC                    1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

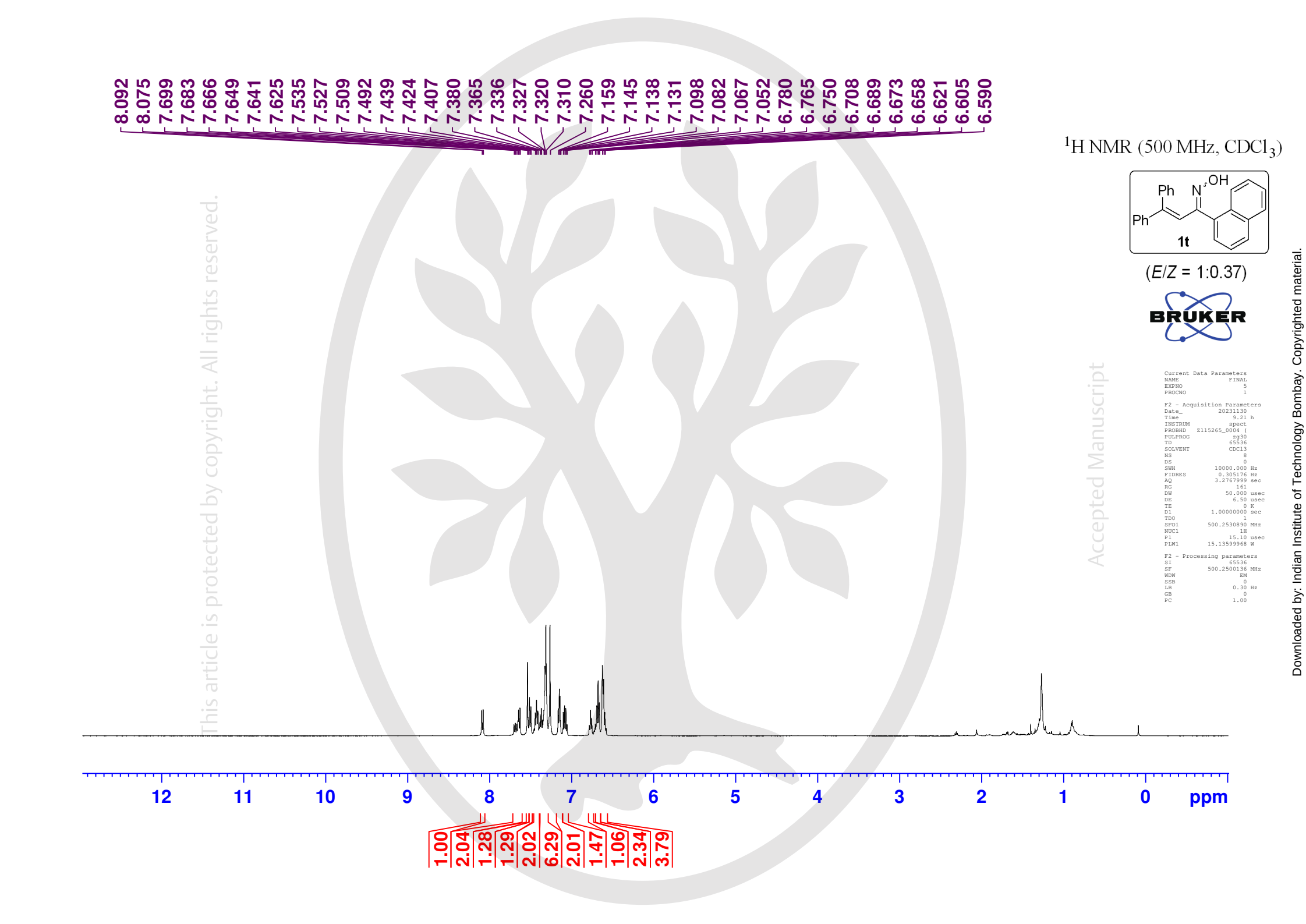


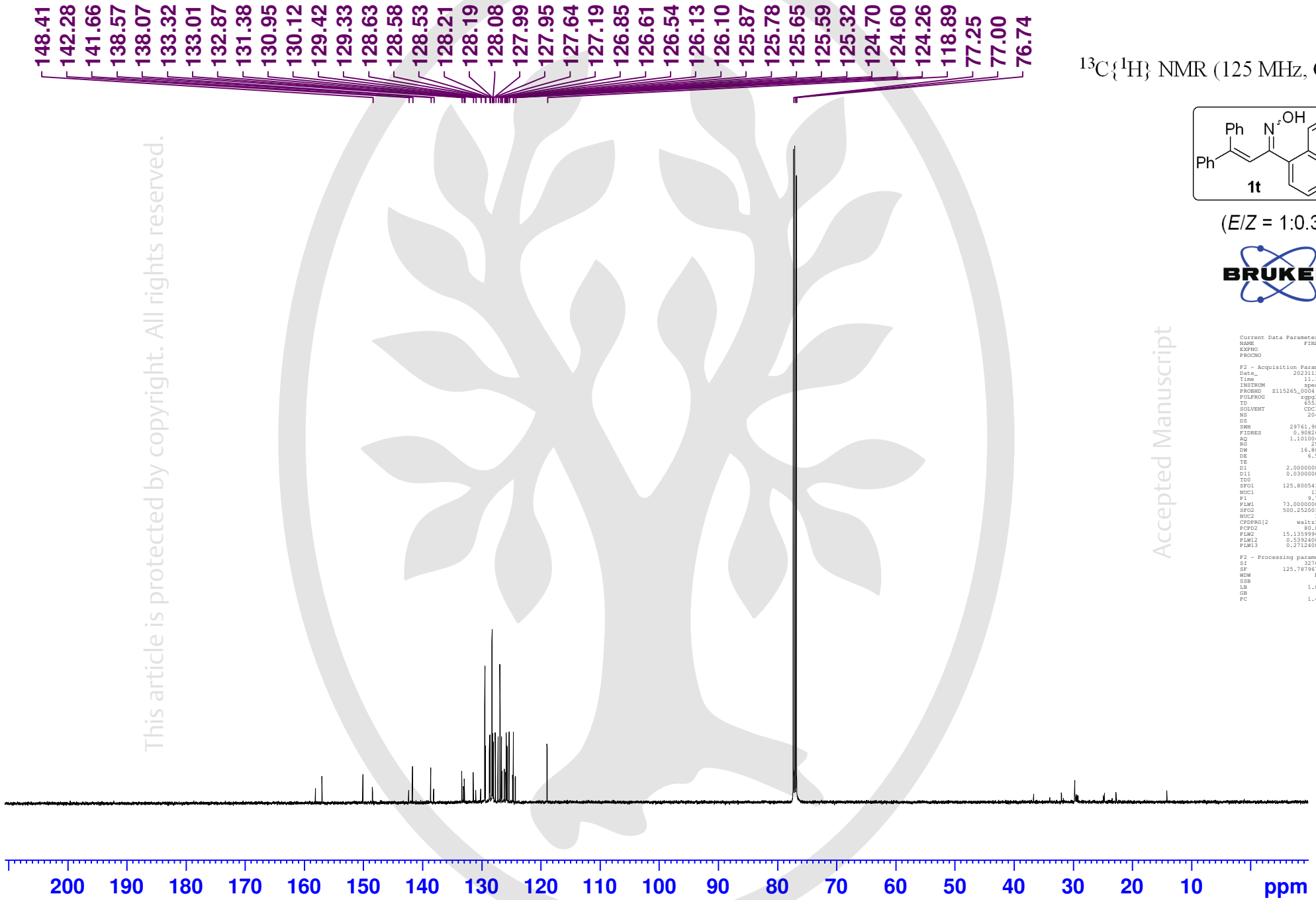
BRUKER

```
Current Data Parameters
NAME         Dec 01-2023
EXPNO                  5
PROCNO                 1

F2 - Acquisition Parameters
Date_           20231201
Time              22.12 h
INSTRUM             spect
PROBHD  Z115265_0004 (
PULPROG          zgpg30
TD                65536
SOLVENT            CDCl3
NS                   139
DS                     4
SWH           29761.904 Hz
FIDRES        0.908261 Hz
AQ            1.1010048 sec
RG                   575
DW               16.800 usec
DE                6.50 usec
TE        0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1
SFO1         125.8005413 MHz
NUC1                 13C
P1                9.70 usec
PLW1         73.00000000 W
SFO2         500.2520010 MHz
NUC2                 1H
CPDPRG[2         waltz16
PCPD2            80.00 usec
PLW2         15.13599968 W
PLW12         0.53924000 W
PLW13         0.27124000 W

F2 - Processing parameters
SI                  32768
SF           125.7879692 MHz
WDW                    EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```





$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

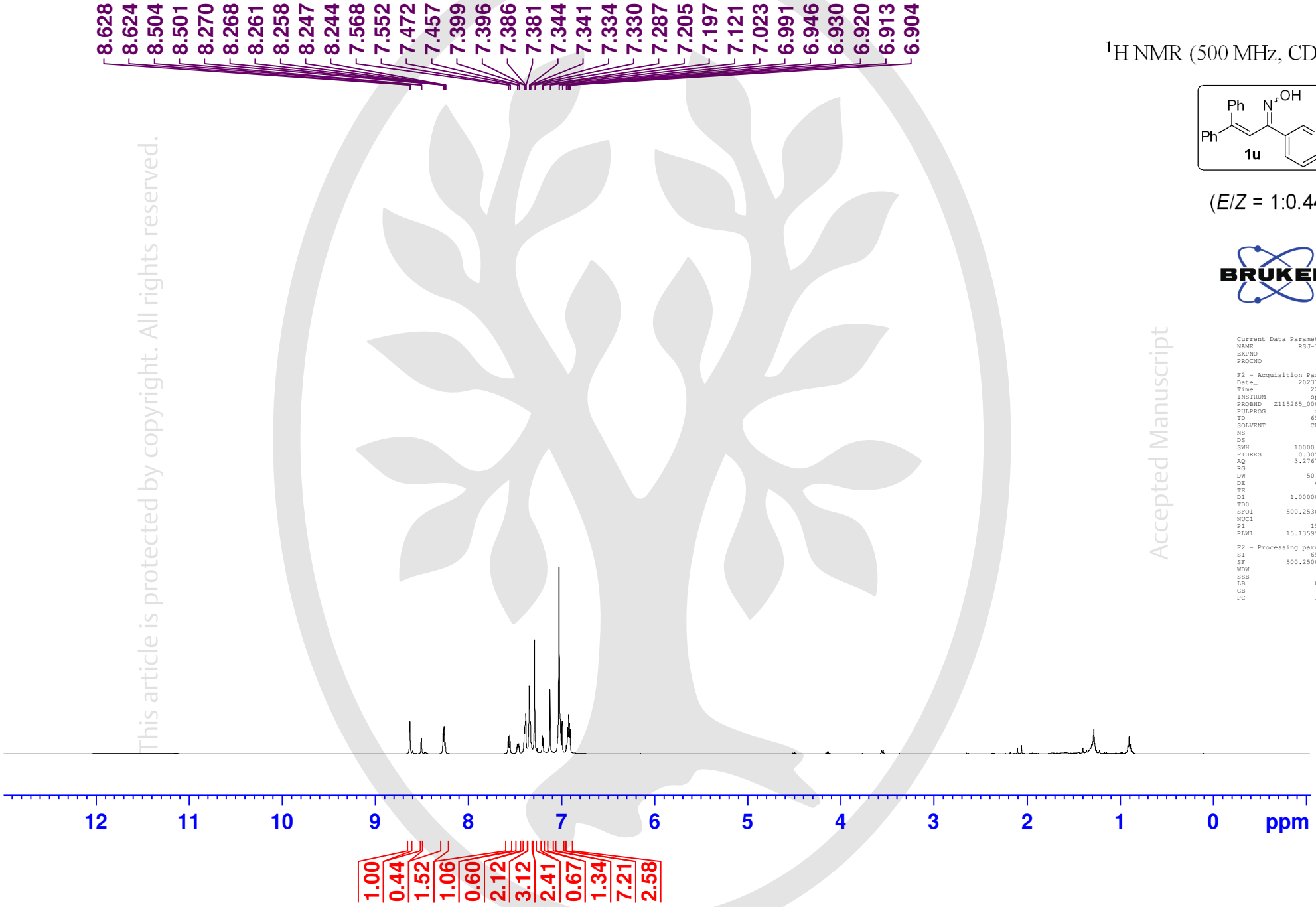
(*E*/*Z* = 1:0.37)

BRUKER

```
Current Data Parameters
NAME                  FINAL
EXPNO                     6
PROCNO                    1

F2 - Acquisition Parameters
Date_              20231130
Time                 11.11 h
INSTRUM                spect
PROBHD    Z115265_0004 (
PULPROG              zgpg30
TD                    65536
SOLVENT               CDCl3
NS                     2048
DS                        4
SWH               29761.904 Hz
FIDRES            0.908261 Hz
AQ                1.1010048 sec
RG                      256
DW                   16.800 usec
DE                    6.50 usec
TE                       0 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                       1
SFO1              125.8005413 MHz
NUC1                    13c
P1                    9.70 usec
PLW1              73.00000000 W
SFO2              500.2520010 MHz
NUC2                    1H
CPDPRG[2             waltz16
PCPD2                80.00 usec
PLW2              15.13599968 W
PLW12              0.53924000 W
PLW13              0.27124000 W

F2 - Processing parameters
SI                    32768
SF                125.7879674 MHz
WDW                      EM
SSB                       0
LB                     1.00 Hz
GB                        0
PC                     1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)

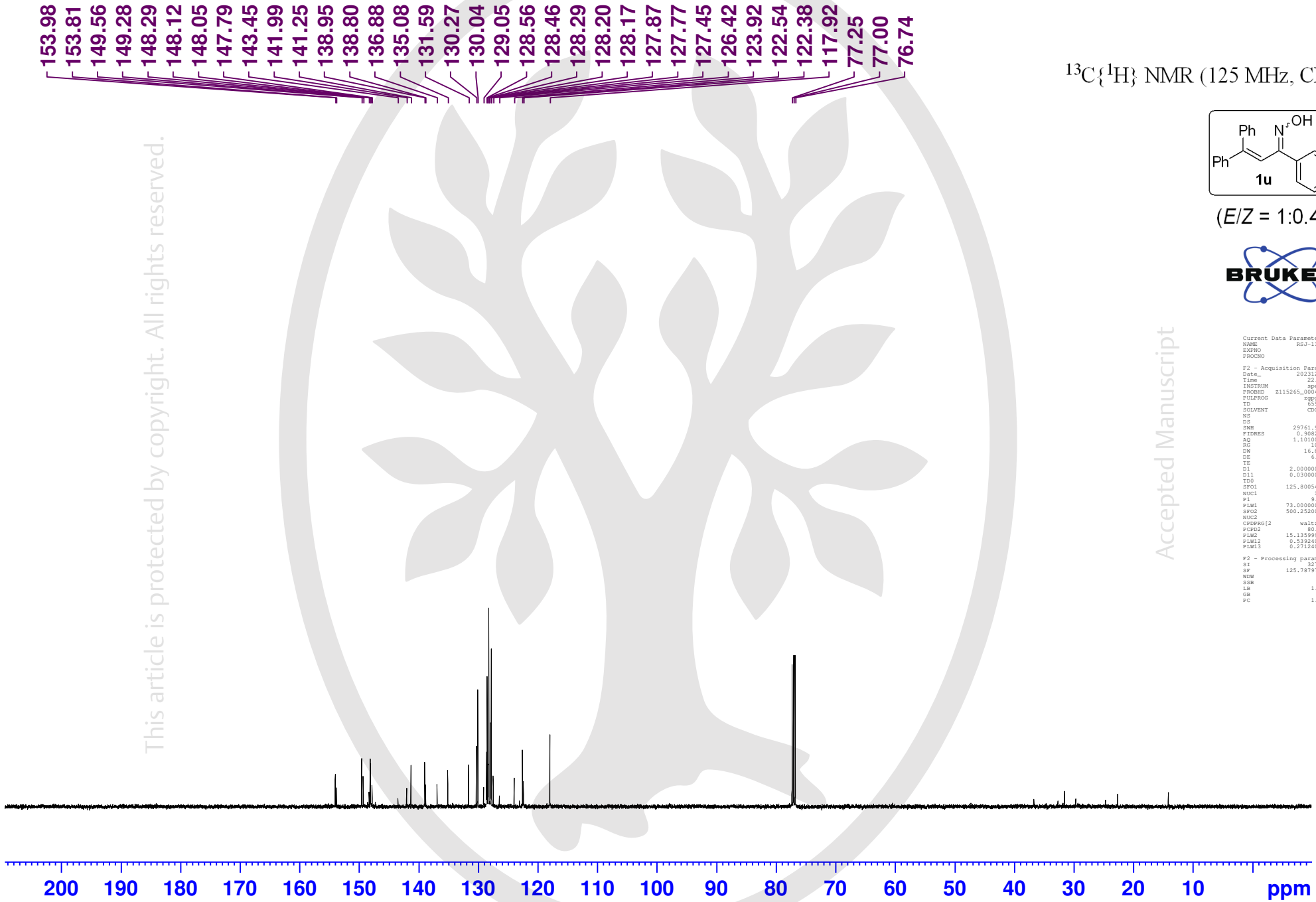
(*E*/*Z* = 1:0.44)

BRUKER

```
Current Data Parameters
NAME                  RSJ-1120
EXPNO                        1
PROCNO                       1

F2 - Acquisition Parameters
Date_              20231206
Time                 22.10 h
INSTRUM                spect
PROBHD   Z115265_0004 (
PULPROG                 zg30
TD                     65536
SOLVENT                CDCl3
NS                           8
DS                           0
SWH              10000.000 Hz
FIDRES               0.305176 Hz
AQ                3.2767999 sec
RG                          36
DW                   50.000 usec
DE                    6.50 usec
TE                          0 K
D1              1.00000000 sec
TD0                          1
SFO1           500.2530890 MHz
NUC1                        1H
P1                    15.10 usec
PLW1           15.13599968 W

F2 - Processing parameters
SI                       65536
SF             500.2500140 MHz
WDW                         EM
SSB                          0
LB                    0.30 Hz
GB                           0
PC                        1.00
```



$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

(*E*/*Z* = 1:0.44)

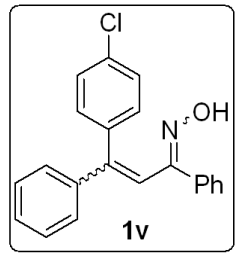
BRUKER

```
Current Data Parameters
NAME                  RSJ-1120
EXPNO                        2
PROCNO                       1

F2 - Acquisition Parameters
Date_                 20231206
Time                     22.16 h
INSTRUM                  spect
PROBHD     Z115265_0004 (
PULPROG                 zgpg30
TD                       65536
SOLVENT                  CDCl3
NS                          88
DS                           4
SWH                  29761.904 Hz
FIDRES                0.908261 Hz
AQ                    1.1010048 sec
RG                        1030
DW                      16.800 usec
DE                       6.50 usec
TE                          0 K
D1                   2.00000000 sec
D11                  0.03000000 sec
TD0                          1
SFO1                125.8005413 MHz
NUC1                        13c
P1                       9.70 usec
PLW1                73.00000000 W
SFO2                500.2520010 MHz
NUC2                        1H
CPDPRG[2                waltz16
PCPD2                    80.00 usec
PLW2                15.13599968 W
PLW12                0.53924000 W
PLW13                0.27124000 W

F2 - Processing parameters
SI                       32768
SF                  125.7879765 MHz
WDW                         EM
SSB                          0
LB                        1.00 Hz
GB                           0
PC                        1.40
```

^{1}H NMR (500 MHz, $CDCl_3$)



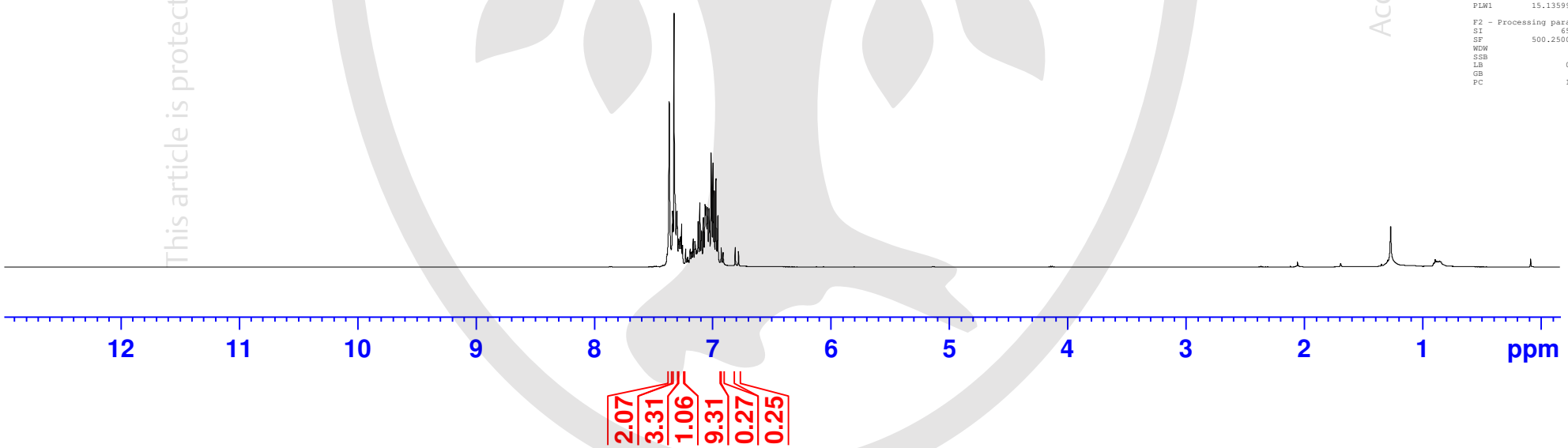
(*E*/*Z* = 0.9:1)

BRUKER

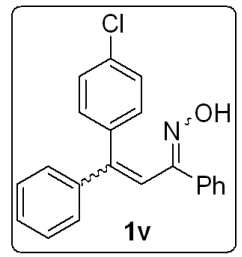
```
Current Data Parameters
NAME                  RSJ-957
EXPNO                       7
PROCNO                      1

F2 - Acquisition Parameters
Date_              20230908
Time                  15.58 h
INSTRUM                 spect
PROBHD    Z115265_0004 (
PULPROG                 zg30
TD                     65536
SOLVENT                CDCl3
NS                         16
DS                          0
SWH               10000.000 Hz
FIDRES                0.305176 Hz
AQ                3.2767999 sec
RG                        144
DW                   50.000 usec
DE                    6.50 usec
TE                        0 K
D1                1.00000000 sec
TD0                         1
SFO1              500.2530890 MHz
NUC1                       1H
P1                    15.10 usec
PLW1              15.13599968 W

F2 - Processing parameters
SI                        65536
SF                500.2500137 MHz
WDW                        EM
SSB                         0
LB                     0.30 Hz
GB                          0
PC                       1.00
```



$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)



1v

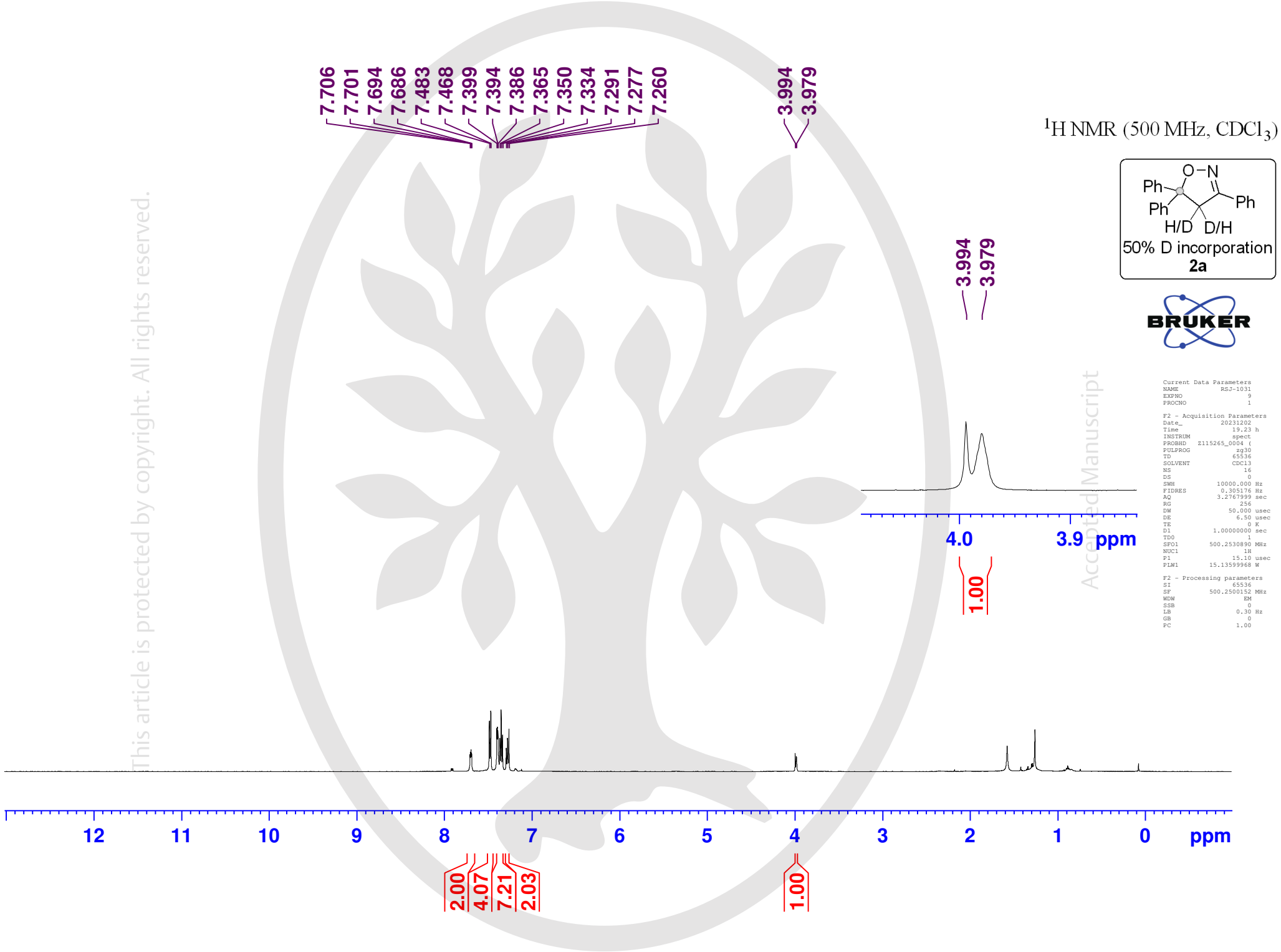
(*E*/*Z* = 0.9:1)

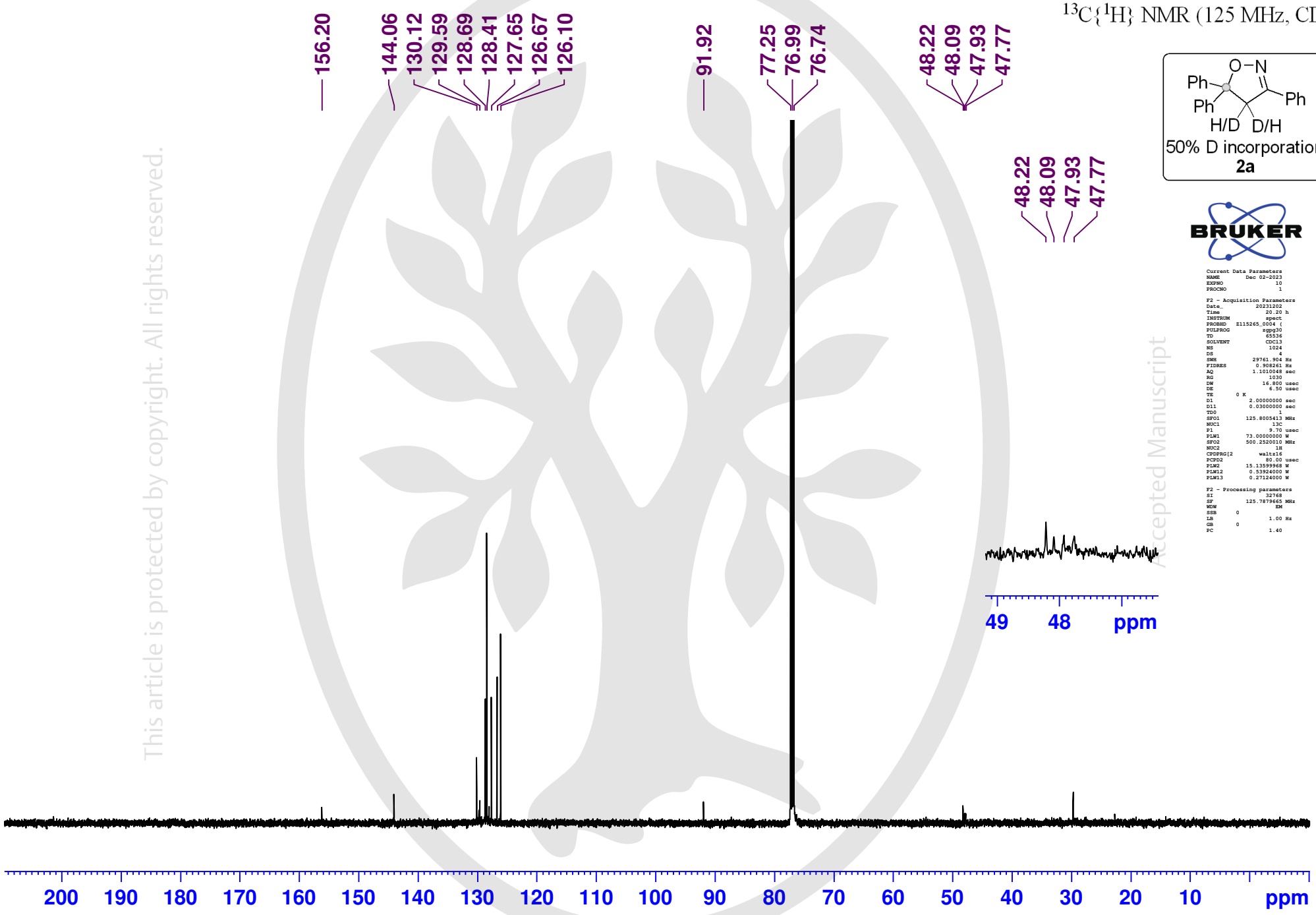
156.84 148.62 148.49 141.12 140.07 138.69 137.69 134.55 134.50 133.90 131.47 131.24 130.10 129.91 129.75 128.85 128.70 128.68 128.44 128.42 128.35 128.18 127.95 127.84 127.80 127.71 127.41 119.01 118.77 77.25 77.00 76.74

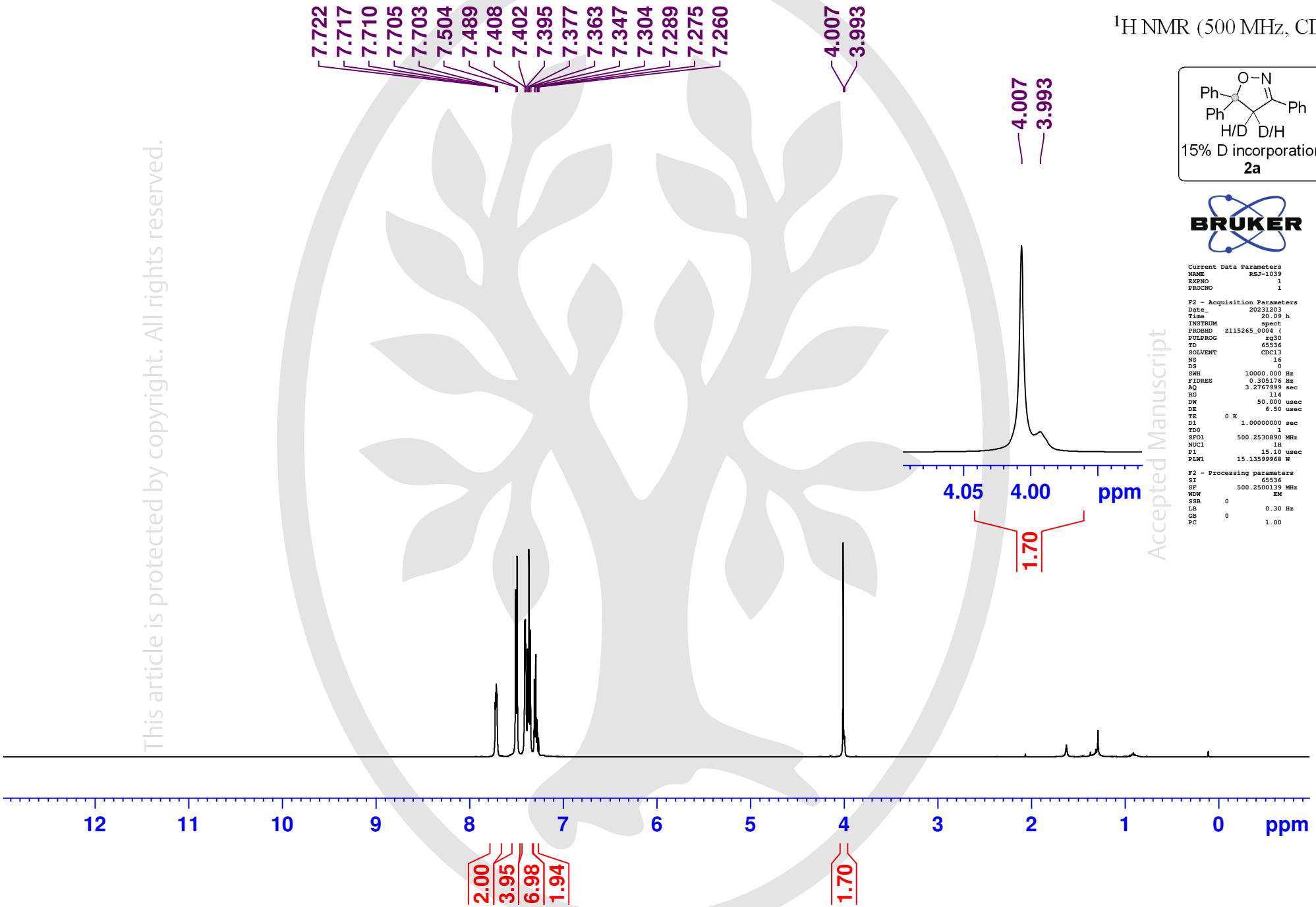

```
Current Data Parameters
NAME                  RSJ-957
EXPNO                       8
PROCNO                      1

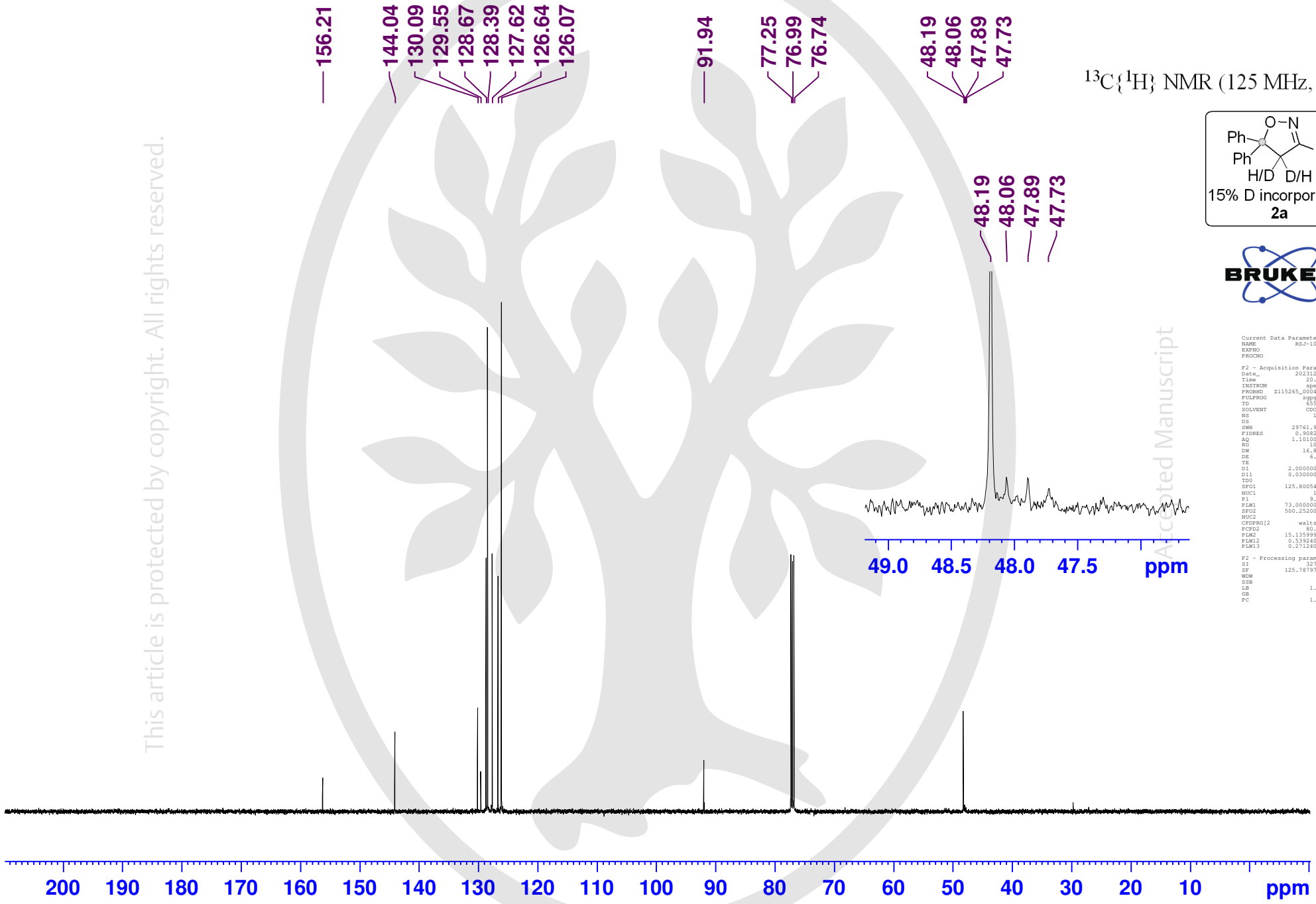
F2 - Acquisition Parameters
Date_               20230908
Time                  16.54 h
INSTRUM                spect
PROBHD    Z115265_0004 (
PULPROG              zgpg30
TD                    65536
SOLVENT               CDCl3
NS                     1024
DS                        4
SWH                29761.904 Hz
FIDRES             0.908261 Hz
AQ                 1.1010048 sec
RG                      1030
DW                   16.800 usec
DE                    6.50 usec
TE                       0 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                       1
SFO1             125.8005413 MHz
NUC1                    13c
P1                    9.70 usec
PLW1             73.00000000 W
SFO2             500.2520010 MHz
NUC2                    1H
CPDPRG[2             waltz16
PCPD2                80.00 usec
PLW2             15.13599968 W
PLW12             0.53924000 W
PLW13             0.27124000 W

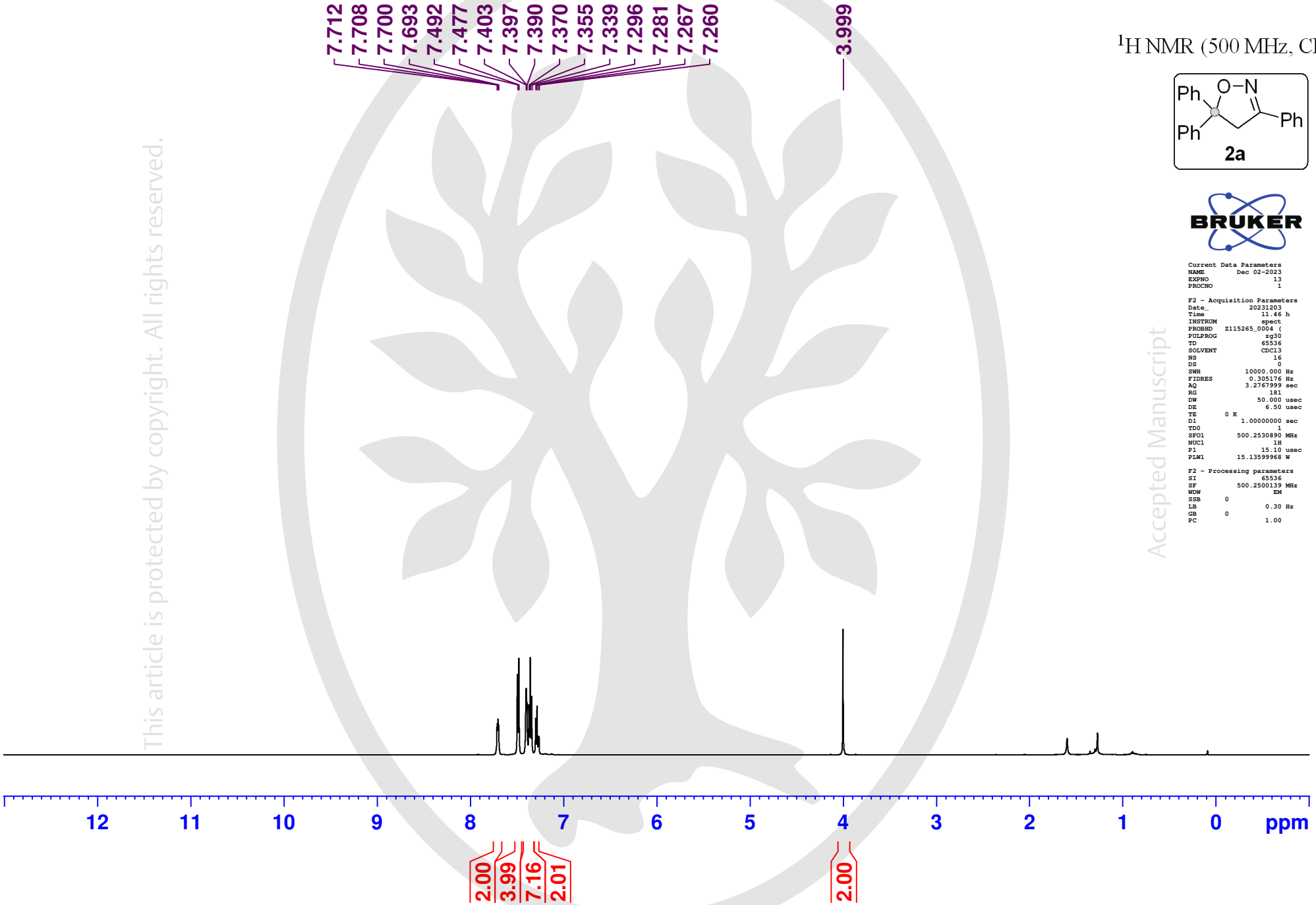
F2 - Processing parameters
SI                    32768
SF               125.7879674 MHz
WDW                      EM
SSB                       0
LB                     1.00 Hz
GB                        0
PC                     1.40
```











^{1}H NMR (500 MHz, $CDCl_3$)

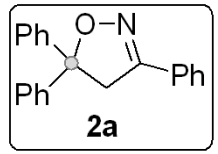
BRUKER

```
Current Data Parameters
NAME          Dec 02-2023
EXPNO                  13
PROCNO                  1

F2 - Acquisition Parameters
Date_            20231203
Time                11.46 h
INSTRUM              spect
PROBHD   Z115265_0004 (
PULPROG                zg30
TD                    65536
SOLVENT               CDCl3
NS                       16
DS                        0
SWH               10000.000 Hz
FIDRES                0.305176 Hz
AQ                3.2767999 sec
RG                      181
DW                   50.000 usec
DE                    6.50 usec
TE                  0 K
D1                1.00000000 sec
TD0                       1
SFO1           500.2530890 MHz
NUC1                     1H
P1                   15.10 usec
PLW1           15.13599968 W

F2 - Processing parameters
SI                    65536
SF             500.2500139 MHz
WDW                      EM
SSB                   0
LB                    0.30 Hz
GB                    0
PC                    1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

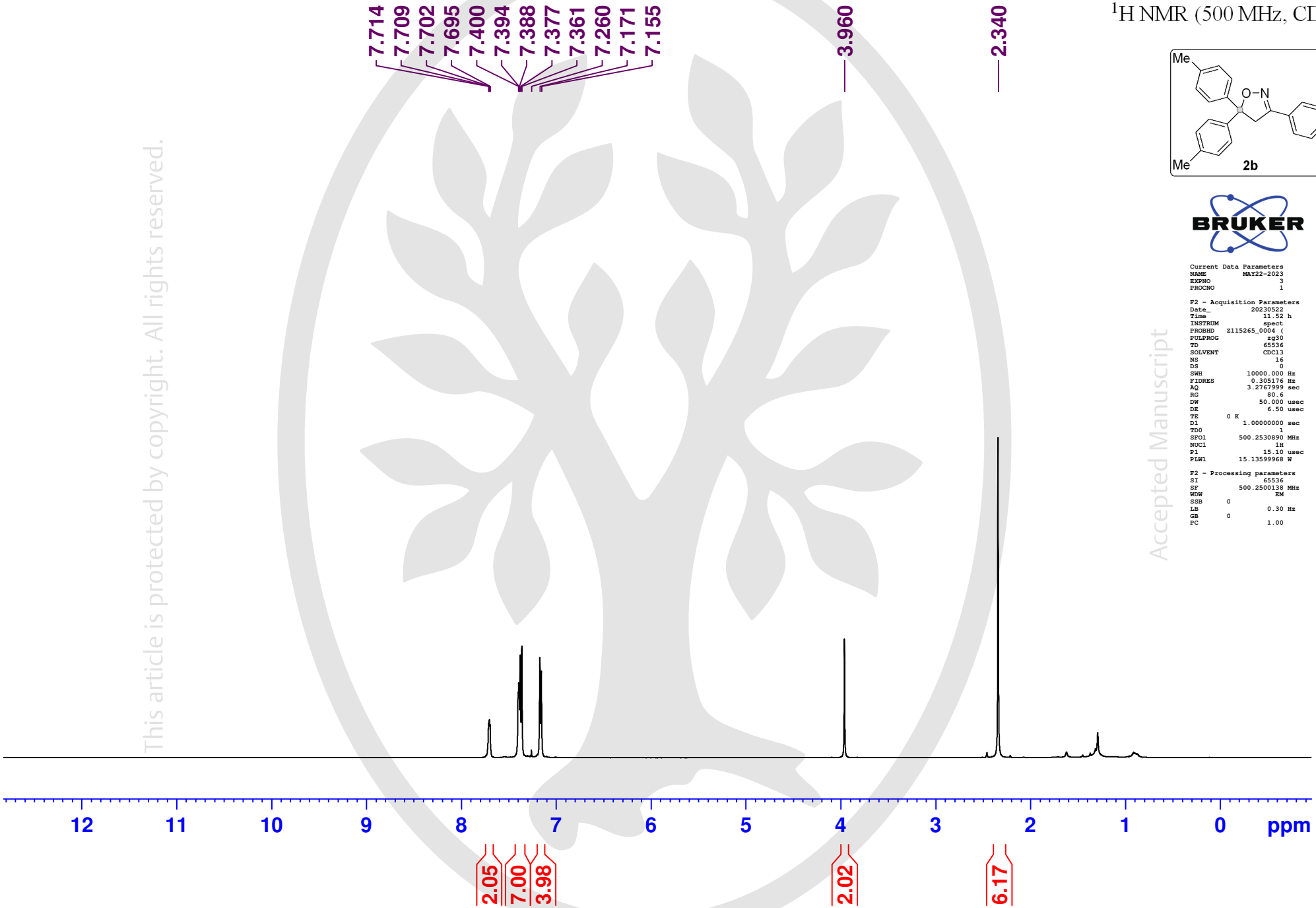


BRUKER

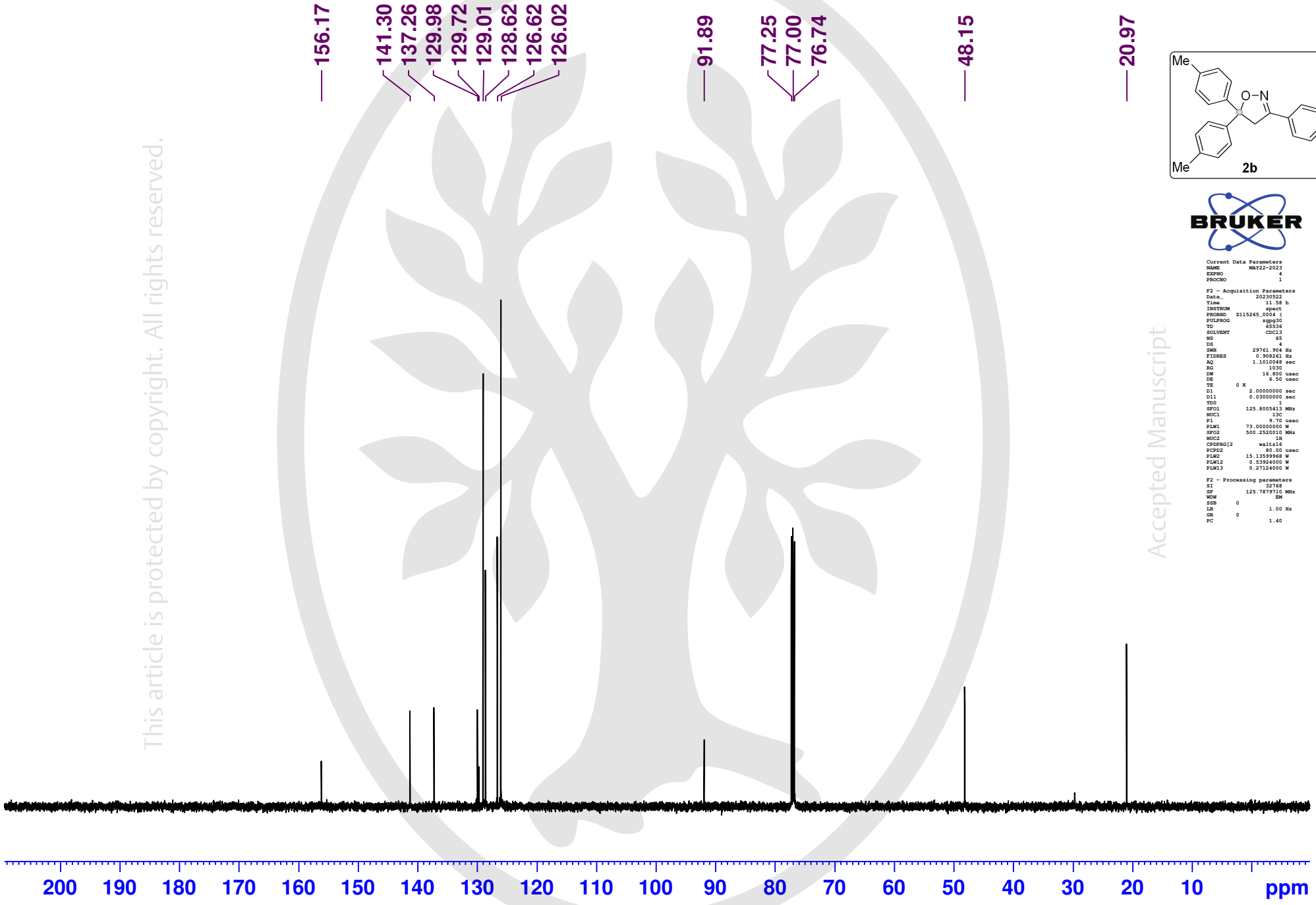
```
Current Data Parameters
NAME         Dec 02-2023
EXPNO                 14
PROCNO                 1

F2 - Acquisition Parameters
Date_           20231203
Time              11.54 h
INSTRUM             spect
PROBHD  Z115265_0004 (
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                  111
DS                    4
SWH           29761.904 Hz
FIDRES        0.908261 Hz
AQ            1.1010048 sec
RG                 1030
DW               16.800 usec
DE                6.50 usec
TE        0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1
SFO1         125.8005413 MHz
NUC1                 13C
P1                9.70 usec
PLW1         73.00000000 W
SFO2         500.2520010 MHz
NUC2                 1H
CPDPRG[2         waltz16
PCPD2             80.00 usec
PLW2         15.13599968 W
PLW12         0.53924000 W
PLW13         0.27124000 W

F2 - Processing parameters
SI                32768
SF           125.7879683 MHz
WDW                  EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```



$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)



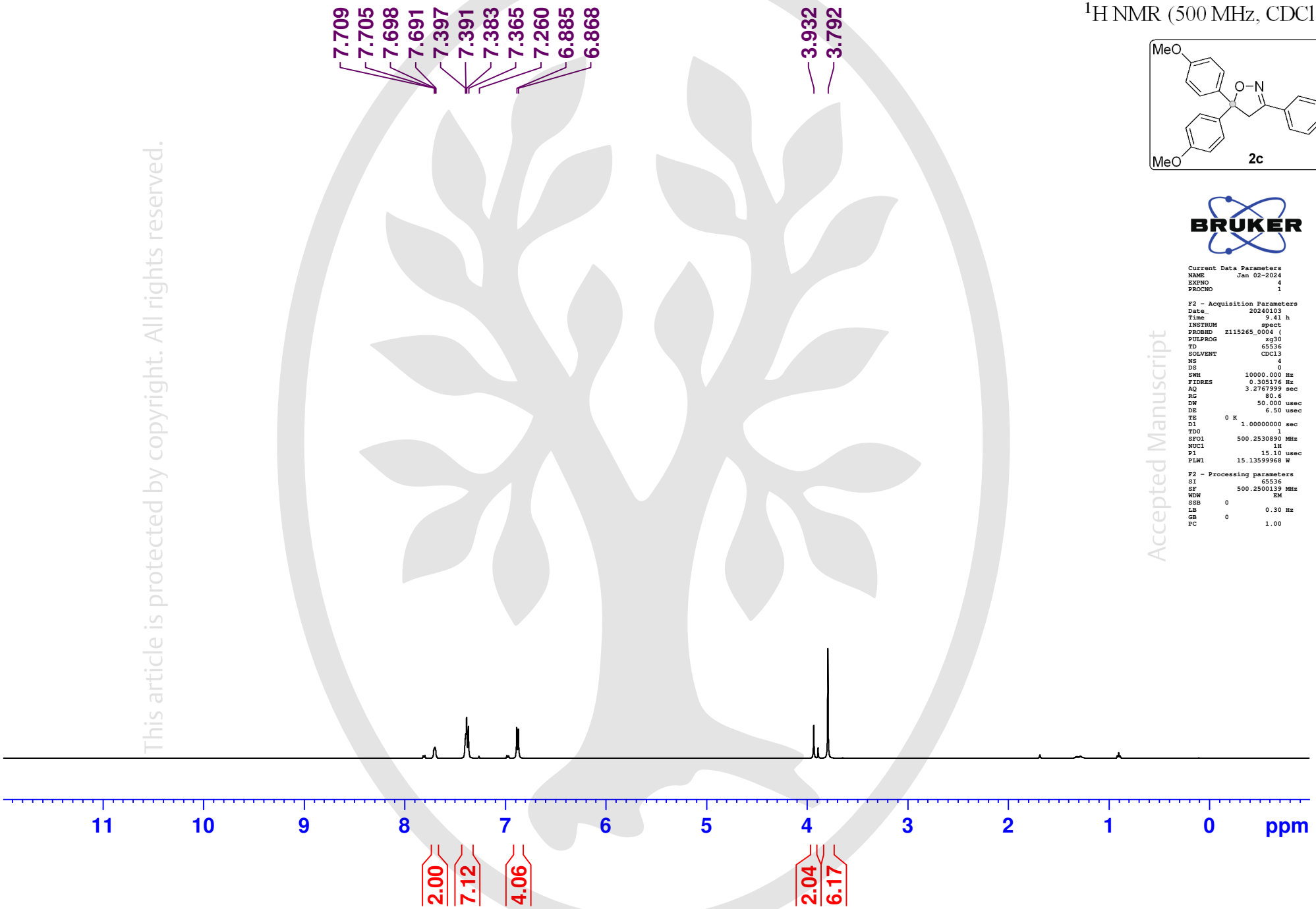
2b

BRUKER

```
Current Data Parameters
NAME          MAY22-2023
EXPNO                  4
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230522
Time              11.58 h
INSTRUM             spect
PROBHD  Z115265_0004 (
PULPROG           zgpg30
TD                65536
SOLVENT           CDCl3
NS                   65
DS                    4
SWH           29761.904 Hz
FIDRES        0.908261 Hz
AQ            1.1010048 sec
RG                 1030
DW               16.800 usec
DE                6.50 usec
TE        0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1
SFO1         125.8005413 MHz
NUC1                 13C
P1                9.70 usec
PLW1         73.00000000 W
SFO2         500.2520010 MHz
NUC2                 1H
CPDPRG[2          waltz16
PCPD2             80.00 usec
PLW2         15.13599968 W
PLW12         0.53924000 W
PLW13         0.27124000 W

F2 - Processing parameters
SI                32768
SF           125.7879710 MHz
WDW                  EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```



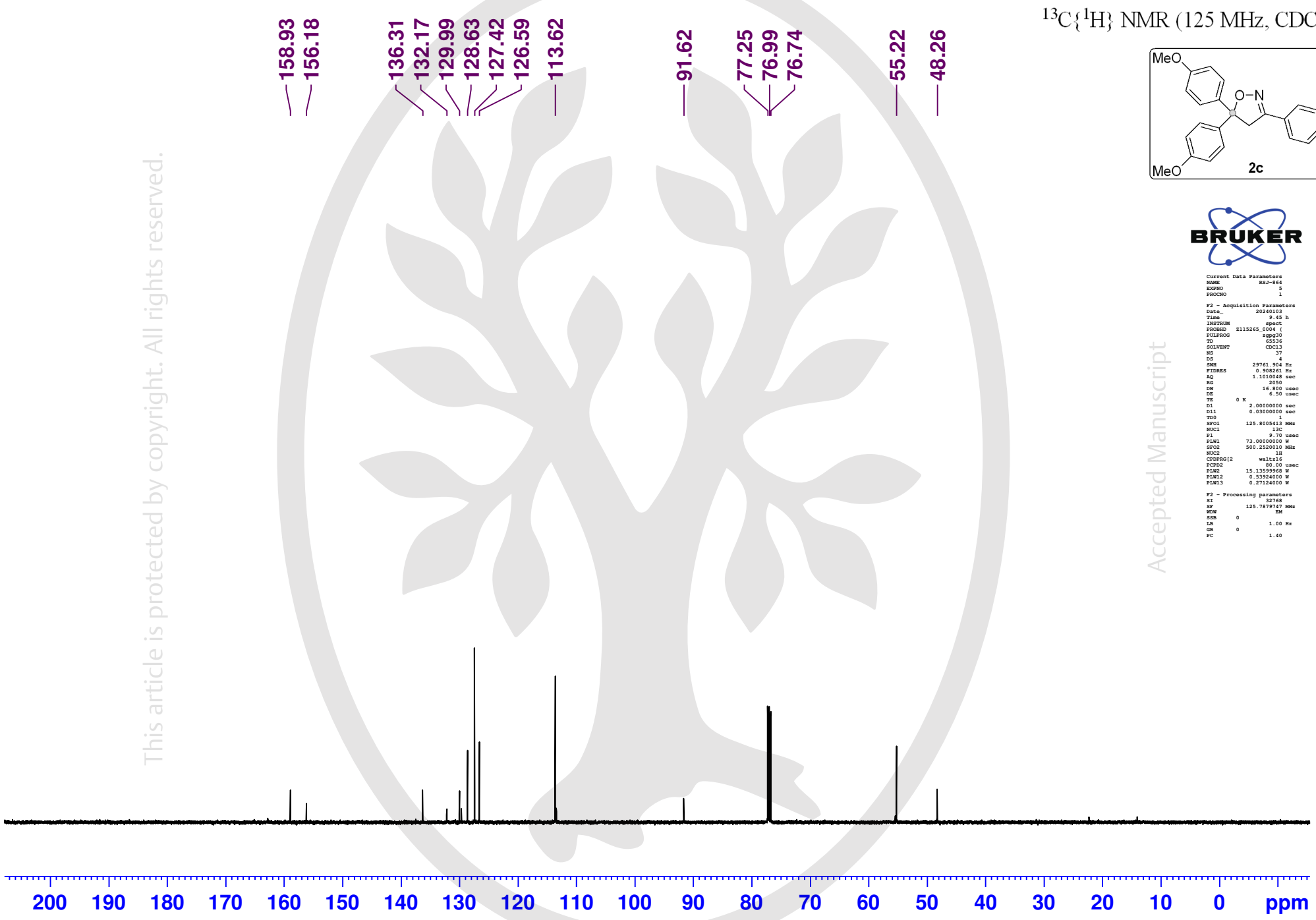
^{1}H NMR (500 MHz, $CDCl_3$)

BRUKER

```
Current Data Parameters
NAME          Jan 02-2024
EXPNO                   4
PROCNO                  1

F2 - Acquisition Parameters
Date_              20240103
Time                9.41 h
INSTRUM              spect
PROBHD   Z115265_0004 (
PULPROG                zg30
TD                    65536
SOLVENT               CDCl3
NS                        4
DS                        0
SWH               10000.000 Hz
FIDRES                0.305176 Hz
AQ                3.2767999 sec
RG                     80.6
DW                   50.000 usec
DE                    6.50 usec
TE                  0 K
D1                1.00000000 sec
TD0                       1
SFO1           500.2530890 MHz
NUC1                     1H
P1                    15.10 usec
PLW1           15.13599968 W

F2 - Processing parameters
SI                    65536
SF             500.2500139 MHz
WDW                      EM
SSB                   0
LB                    0.30 Hz
GB                    0
PC                    1.00
```



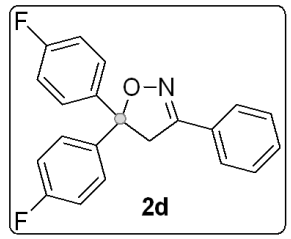
BRUKER

```
Current Data Parameters
NAME                  RSJ-864
EXPNO                       5
PROCNO                      1

F2 - Acquisition Parameters
Date_              20240103
Time                    9.45 h
INSTRUM                 spect
PROBHD     Z115265_0004 (
PULPROG                 zgpg30
TD                      65536
SOLVENT                 CDCl3
NS                         37
DS                          4
SWH                 29761.904 Hz
FIDRES                0.908261 Hz
AQ                    1.1010048 sec
RG                       2050
DW                     16.800 usec
DE                      6.50 usec
TE              0 K
D1                    2.00000000 sec
D11                   0.03000000 sec
TD0                         1
SFO1                125.8005413 MHz
NUC1                      13C
P1                        9.70 usec
PLW1                73.00000000 W
SFO2                500.2520010 MHz
NUC2                      1H
CPDPRG[2                waltz16
PCPD2                   80.00 usec
PLW2                15.13599968 W
PLW12                0.53924000 W
PLW13                0.27124000 W

F2 - Processing parameters
SI                        32768
SF                  125.7879747 MHz
WDW                        EM
SSB             0
LB                      1.00 Hz
GB              0
PC                      1.40
```

^{1}H NMR (500 MHz, $CDCl_3$)



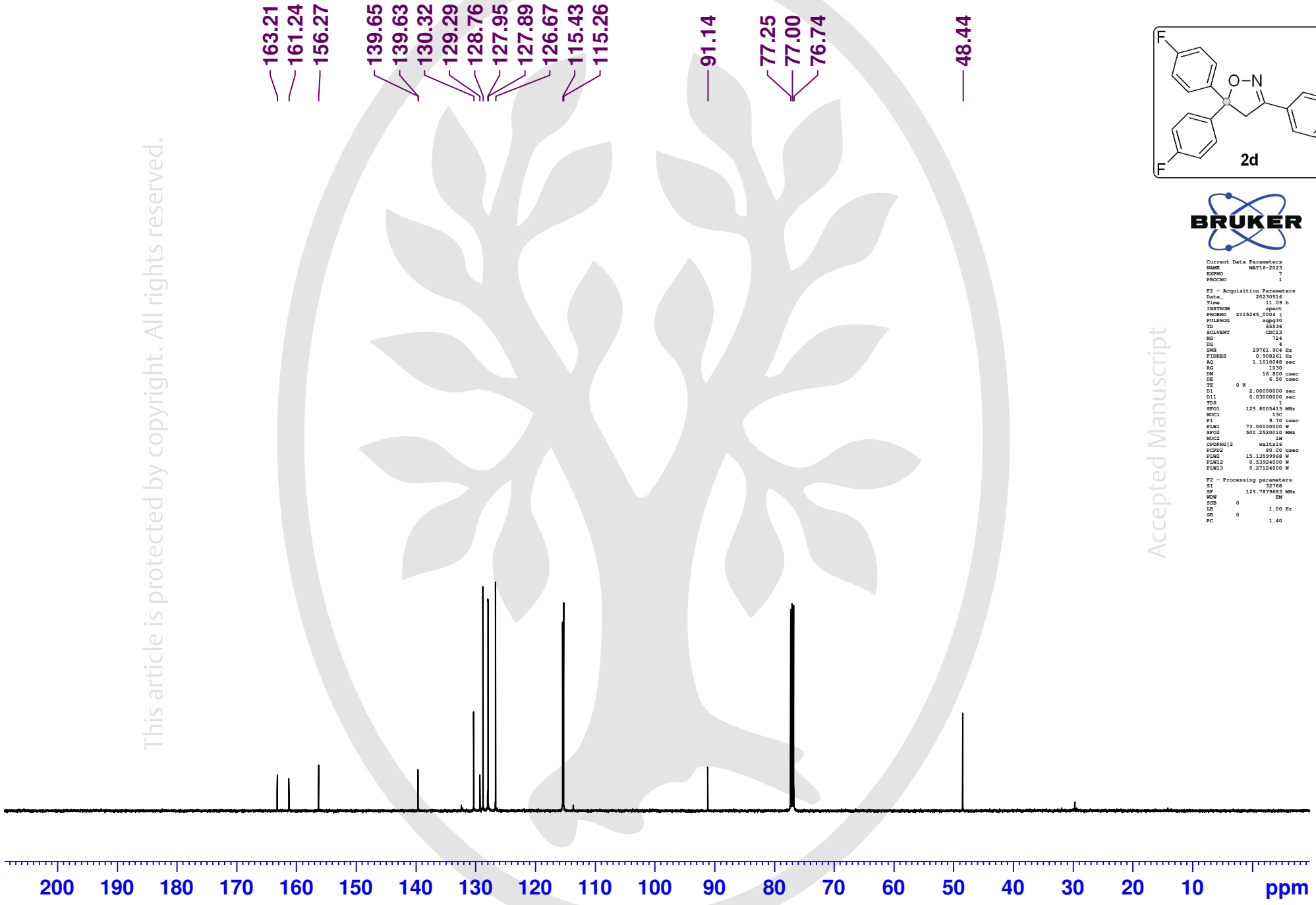
BRUKER

```
Current Data Parameters
NAME            MAY16-2023
EXPNO                    6
PROCNO                   1

F2 - Acquisition Parameters
Date_             20230516
Time                10.29 h
INSTRUM               spect
PROBHD    Z115265_0004 (
PULPROG                zg30
TD                    65536
SOLVENT               CDCl3
NS                        4
DS                        0
SWH           10000.000 Hz
FIDRES            0.305176 Hz
AQ                3.2767999 sec
RG                      114
DW                 50.000 usec
DE                  6.50 usec
TE                  0 K
D1             1.00000000 sec
TD0                       1
SFO1          500.2530890 MHz
NUC1                    1H
P1                 15.10 usec
PLW1          15.13599968 W

F2 - Processing parameters
SI                    65536
SF            500.2500146 MHz
WDW                     EM
SSB                   0
LB                 0.30 Hz
GB                    0
PC                 1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)



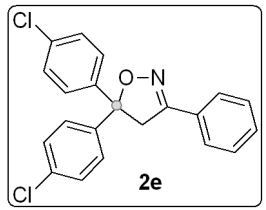
BRUKER

```
Current Data Parameters
NAME          MAY16-2023
EXPNO                  7
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230516
Time              11.09 h
INSTRUM             spect
PROBHD   Z115265_0004 (
PULPROG           zgpg30
TD                 65536
SOLVENT            CDCl3
NS                   724
DS                     4
SWH            29761.904 Hz
FIDRES         0.908261 Hz
AQ             1.1010048 sec
RG                  1030
DW                16.800 usec
DE                 6.50 usec
TE         0 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1
SFO1          125.8005413 MHz
NUC1                  13C
P1                  9.70 usec
PLW1          73.00000000 W
SFO2          500.2520010 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2              80.00 usec
PLW2          15.13599968 W
PLW12          0.53924000 W
PLW13          0.27124000 W

F2 - Processing parameters
SI                  32768
SF            125.7879683 MHz
WDW                    EM
SSB          0
LB                 1.00 Hz
GB           0
PC                 1.40
```

^{1}H NMR (500 MHz, $CDCl_3$)



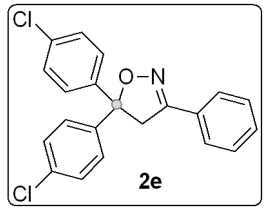
BRUKER

```
Current Data Parameters
NAME          MAY13-2023
EXPNO                  1
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230513
Time              16.51 h
INSTRUM             spect
PROBHD   Z115265_0004 (
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                    16
DS                     0
SWH           10000.000 Hz
FIDRES        0.305176 Hz
AQ            3.2767999 sec
RG                   101
DW               50.000 usec
DE                6.50 usec
TE                293.8 K
D1            1.00000000 sec
TD0                    1
SFO1          500.2530890 MHz
NUC1                  1H
P1                15.10 usec
PLW1          15.13599968 W

F2 - Processing parameters
SI                 65536
SF            500.2500148 MHz
WDW                   EM
SSB       0
LB                0.30 Hz
GB        0
PC                1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)



156.29
142.04
133.87
130.41
129.09
128.78
128.69
127.48
126.67
91.00
77.25
77.00
76.74
48.14

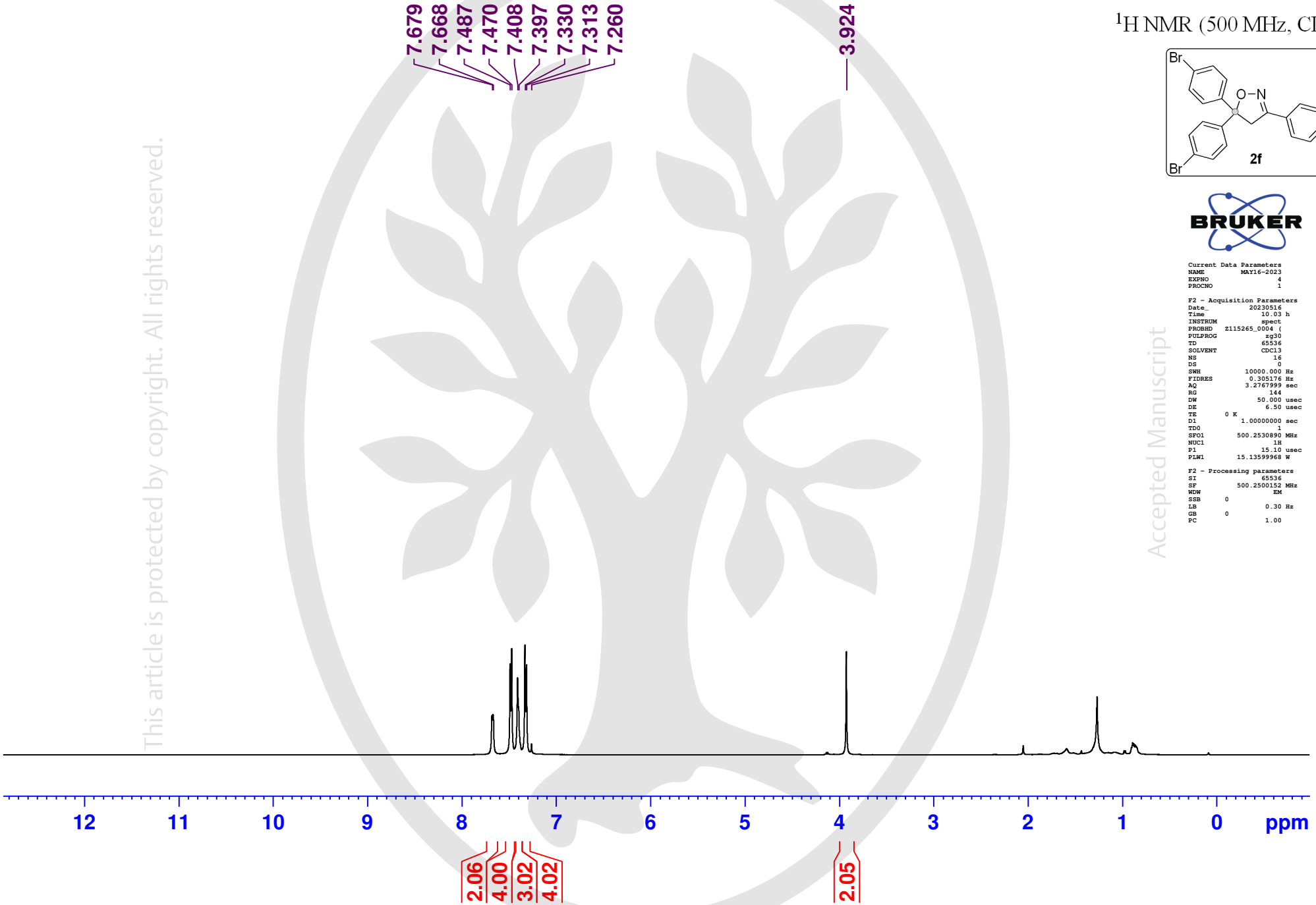
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

BRUKER

```
Current Data Parameters
NAME          MAY13-2023
EXPNO                  2
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230513
Time              17.01 h
INSTRUM             spect
PROBHD  Z115265_0004 (
PULPROG           zgpg30
TD                 65536
SOLVENT            CDCl3
NS                   132
DS                     4
SWH            29761.904 Hz
FIDRES         0.908261 Hz
AQ             1.1010048 sec
RG                  1030
DW                16.800 usec
DE                 6.50 usec
TE                294.4 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1
SFO1          125.8005413 MHz
NUC1                  13C
P1                 9.70 usec
PLW1          73.00000000 W
SFO2          500.2520010 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2             80.00 usec
PLW2          15.13599968 W
PLW12          0.53924000 W
PLW13          0.27124000 W

F2 - Processing parameters
SI                 32768
SF            125.7879701 MHz
WDW                   EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)

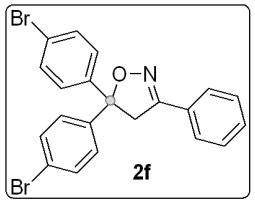
BRUKER

```
Current Data Parameters
NAME          MAY16-2023
EXPNO                  4
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230516
Time              10.03 h
INSTRUM             spect
PROBHD   Z115265_0004 (
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                    16
DS                     0
SWH           10000.000 Hz
FIDRES        0.305176 Hz
AQ            3.2767999 sec
RG                   144
DW                50.000 usec
DE                 6.50 usec
TE         0 K
D1          1.00000000 sec
TD0                    1
SFO1        500.2530890 MHz
NUC1                  1H
P1                15.10 usec
PLW1        15.13599968 W

F2 - Processing parameters
SI                 65536
SF          500.2500152 MHz
WDW                   EM
SSB        0
LB                 0.30 Hz
GB         0
PC                 1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)



156.29
142.52
131.67
130.42
129.09
128.78
127.80
126.68
122.06
91.07
77.25
76.99
76.74
48.04

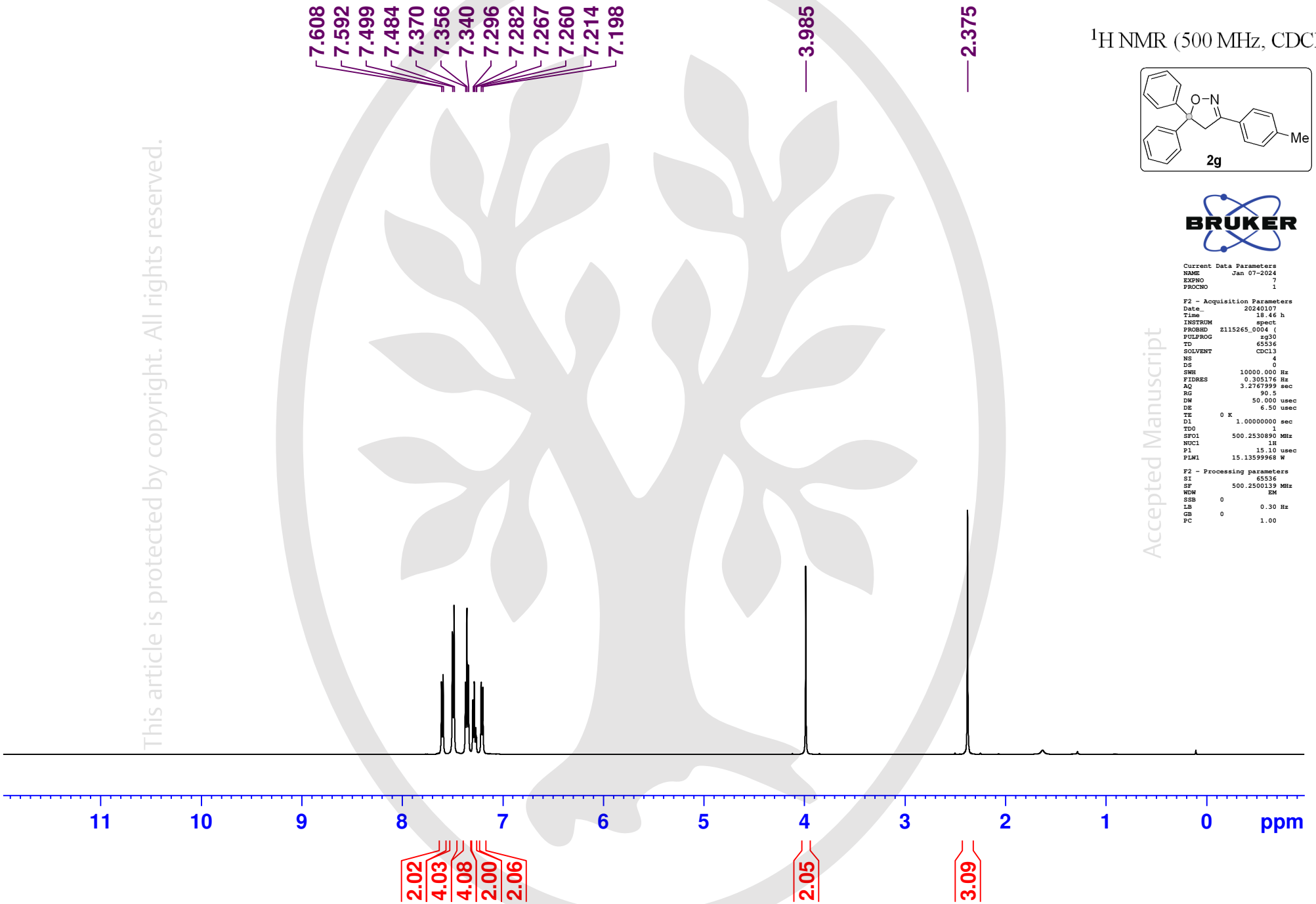
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 ppm

BRUKER

```
Current Data Parameters
NAME          MAY16-2023
EXPNO                  5
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230516
Time              10.10 h
INSTRUM             spect
PROBHD  Z115265_0004 (
PULPROG           zgpg30
TD                 65536
SOLVENT            CDCl3
NS                   103
DS                     4
SWH           29761.904 Hz
FIDRES        0.908261 Hz
AQ            1.1010048 sec
RG                  1030
DW               16.800 usec
DE                6.50 usec
TE                 0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1
SFO1         125.8005413 MHz
NUC1                 13C
P1                9.70 usec
PLW1         73.00000000 W
SFO2         500.2520010 MHz
NUC2                 1H
CPDPRG[2          waltz16
PCPD2             80.00 usec
PLW2         15.13599968 W
PLW12         0.53924000 W
PLW13         0.27124000 W

F2 - Processing parameters
SI                 32768
SF           125.7879683 MHz
WDW                   EM
SSB                    0
LB                1.00 Hz
GB                     0
PC                1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)

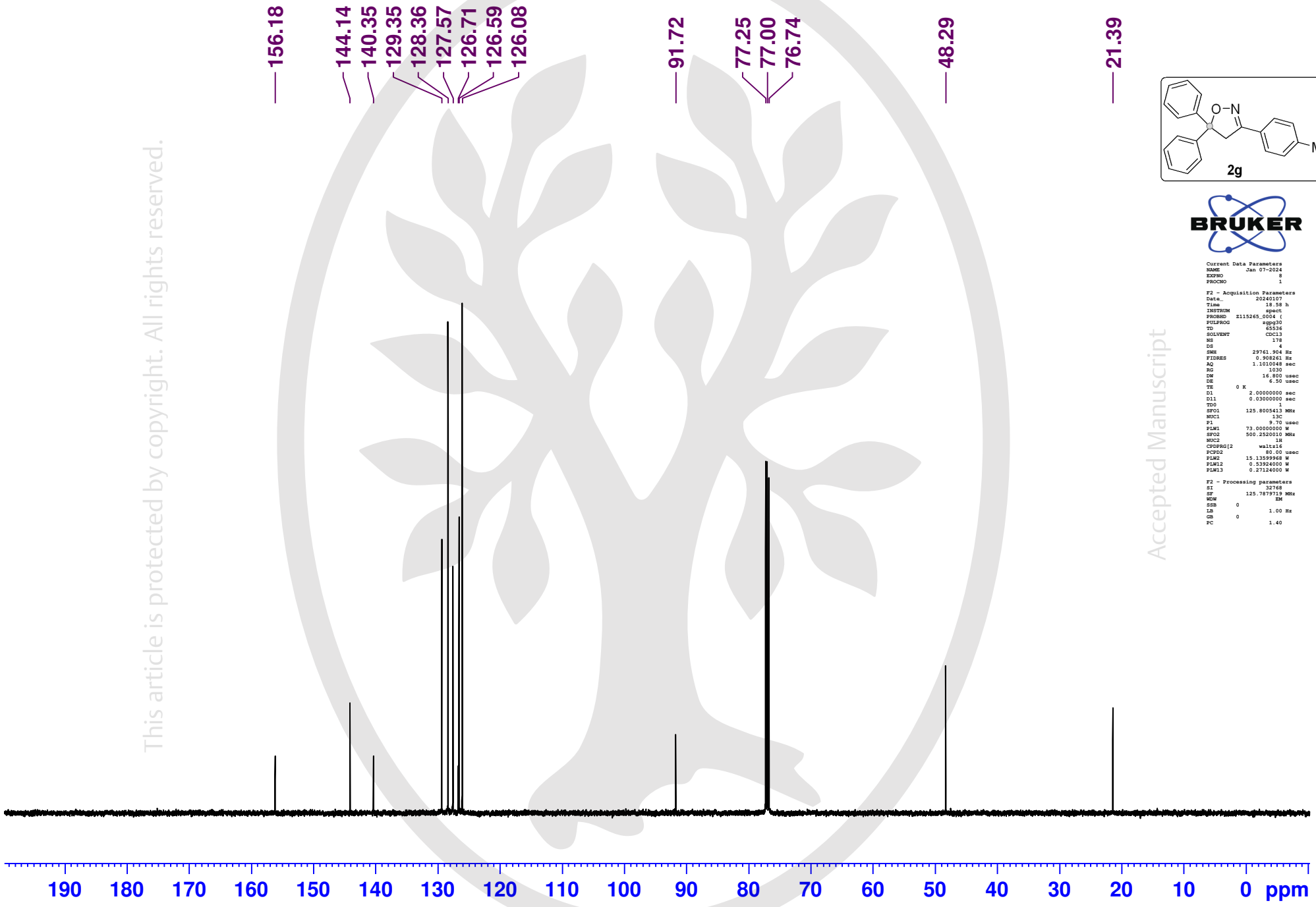
BRUKER

```
Current Data Parameters
NAME          Jan 07-2024
EXPNO                   7
PROCNO                  1

F2 - Acquisition Parameters
Date_              20240107
Time                18.46 h
INSTRUM               spect
PROBHD   Z115265_0004 (
PULPROG                zg30
TD                    65536
SOLVENT               CDCl3
NS                        4
DS                        0
SWH               10000.000 Hz
FIDRES                0.305176 Hz
AQ                3.2767999 sec
RG                     90.5
DW                   50.000 usec
DE                    6.50 usec
TE                  0 K
D1                1.00000000 sec
TD0                       1
SFO1           500.2530890 MHz
NUC1                      1H
P1                   15.10 usec
PLW1          15.13599968 W

F2 - Processing parameters
SI                    65536
SF             500.2500139 MHz
WDW                      EM
SSB                   0
LB                    0.30 Hz
GB                    0
PC                    1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

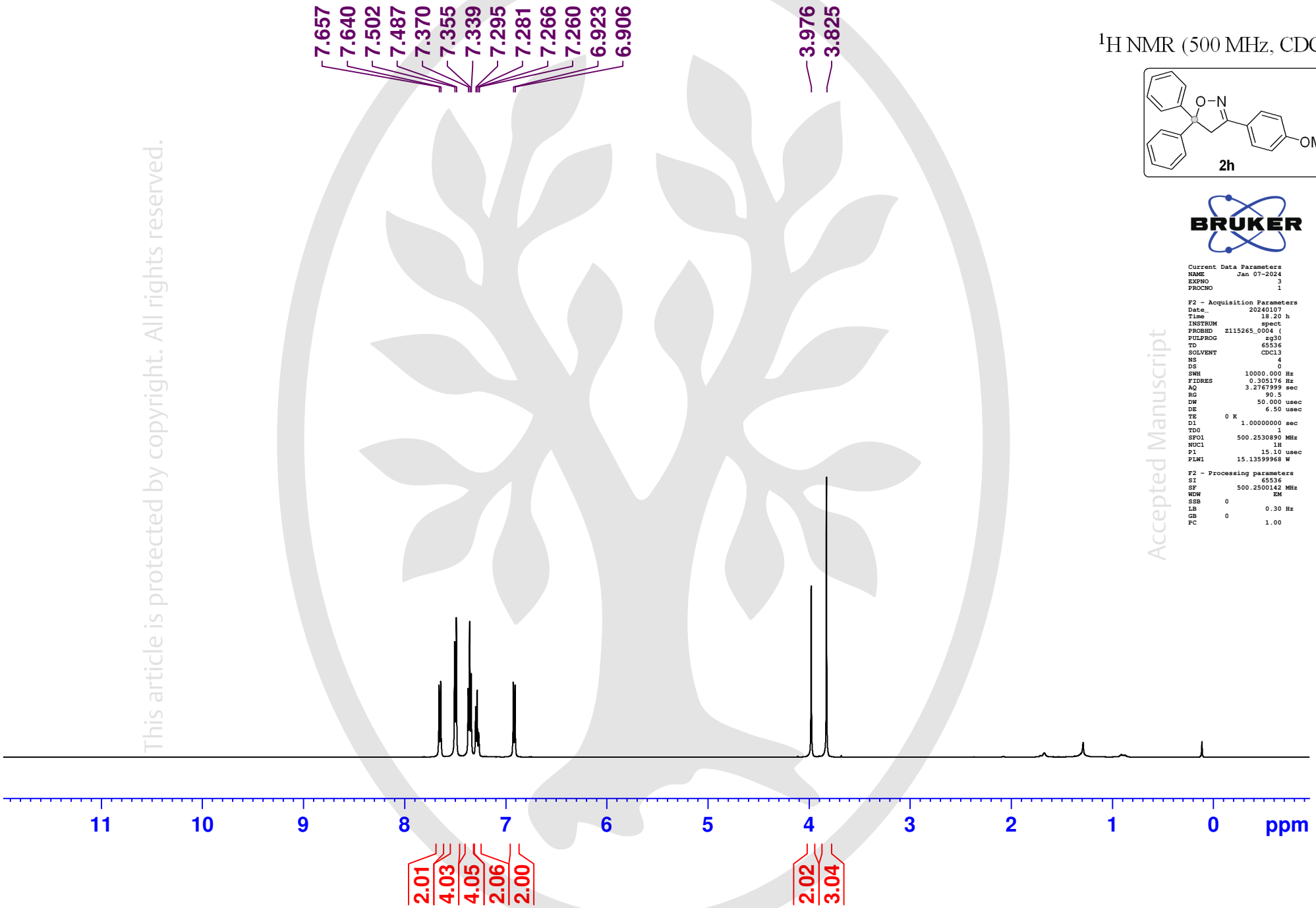


BRUKER

```
Current Data Parameters
NAME        Jan 07-2024
EXPNO               8
PROCNO              1

F2 - Acquisition Parameters
Date_          20240107
Time             18.58 h
INSTRUM           spect
PROBHD  Z115265_0004 (
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                  178
DS                    4
SWH           29761.904 Hz
FIDRES        0.908261 Hz
AQ            1.1010048 sec
RG                 1030
DW               16.800 usec
DE                6.50 usec
TE        0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1
SFO1         125.8005413 MHz
NUC1               13C
P1                 9.70 usec
PLW1         73.00000000 W
SFO2         500.2520010 MHz
NUC2               1H
CPDPRG[2         waltz16
PCPD2             80.00 usec
PLW2         15.13599968 W
PLW12         0.53924000 W
PLW13         0.27124000 W

F2 - Processing parameters
SI                32768
SF           125.7879719 MHz
WDW                 EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)

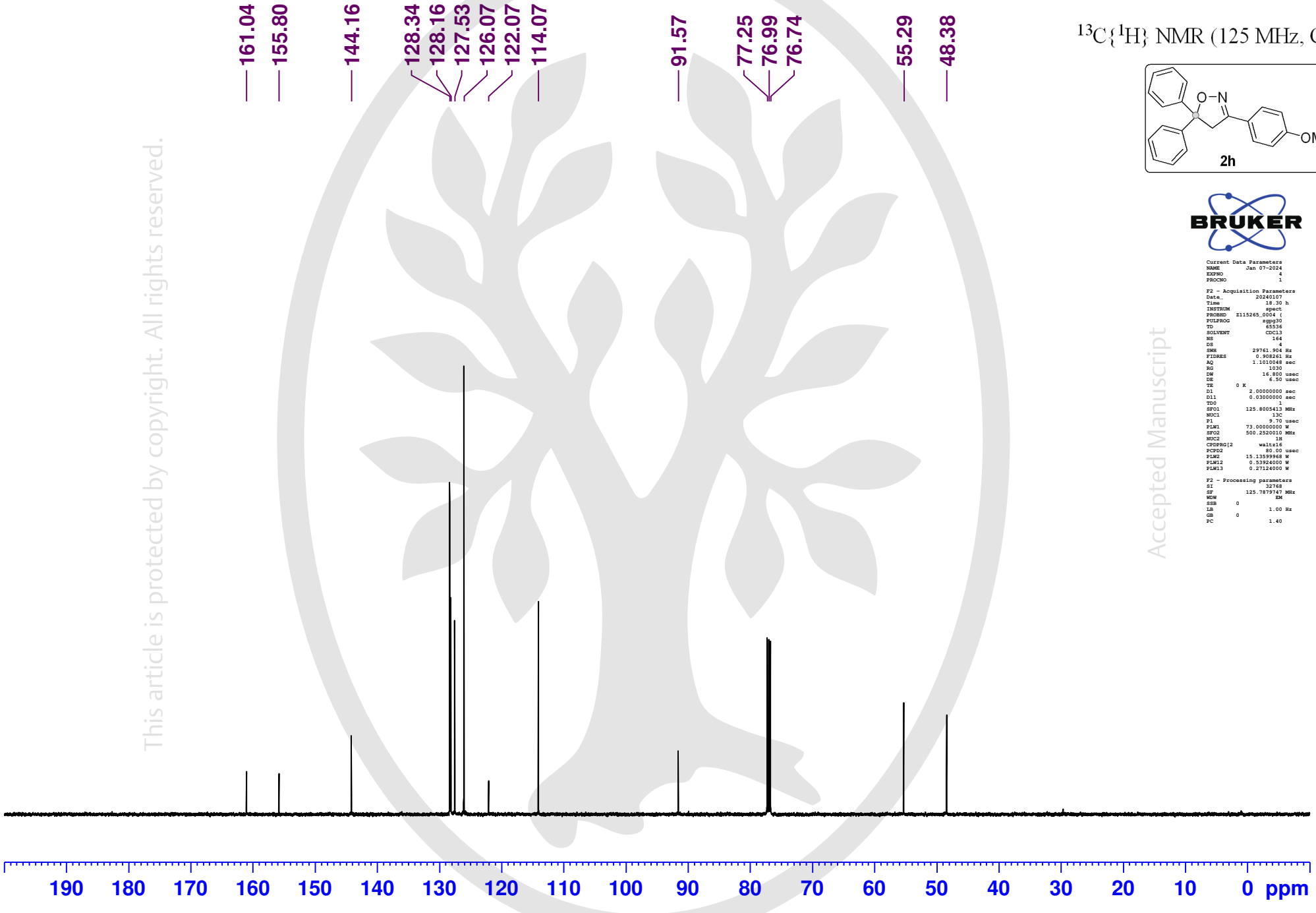
2h

BRUKER

```
Current Data Parameters
NAME          Jan 07-2024
EXPNO                   3
PROCNO                  1

F2 - Acquisition Parameters
Date_              20240107
Time                18.20 h
INSTRUM               spect
PROBHD    Z115265_0004 (
PULPROG                zg30
TD                    65536
SOLVENT               CDCl3
NS                        4
DS                        0
SWH               10000.000 Hz
FIDRES            0.305176 Hz
AQ                3.2767999 sec
RG                      90.5
DW                 50.000 usec
DE                  6.50 usec
TE          0 K
D1             1.00000000 sec
TD0                       1
SFO1           500.2530890 MHz
NUC1                    1H
P1                  15.10 usec
PLW1           15.13599968 W

F2 - Processing parameters
SI                    65536
SF           500.2500142 MHz
WDW                     EM
SSB         0
LB                  0.30 Hz
GB          0
PC                  1.00
```



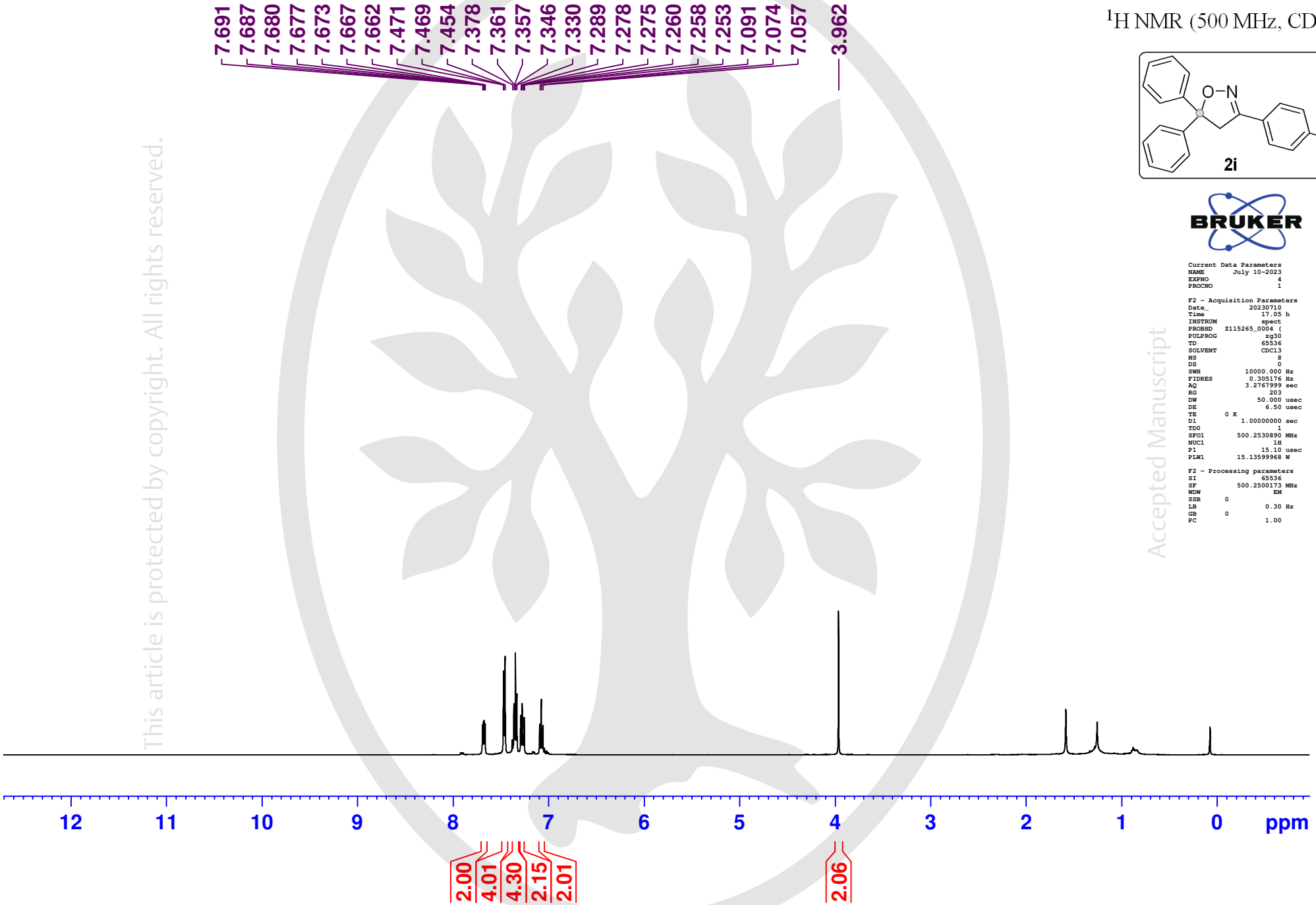
$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

BRUKER

```
Current Data Parameters
NAME        Jan 07-2024
EXPNO               4
PROCNO              1

F2 - Acquisition Parameters
Date_          20240107
Time              18.30 h
INSTRUM            spect
PROBHD  Z115265_0004 (
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                  164
DS                    4
SWH           29761.904 Hz
FIDRES        0.908261 Hz
AQ            1.1010048 sec
RG                 1030
DW               16.800 usec
DE                6.50 usec
TE        0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1
SFO1         125.8005413 MHz
NUC1                 13C
P1                9.70 usec
PLW1         73.00000000 W
SFO2         500.2520010 MHz
NUC2                 1H
CPDPRG[2         waltz16
PCPD2             80.00 usec
PLW2         15.13599968 W
PLW12         0.53924000 W
PLW13         0.27124000 W

F2 - Processing parameters
SI                 32768
SF           125.7879747 MHz
WDW                   EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```



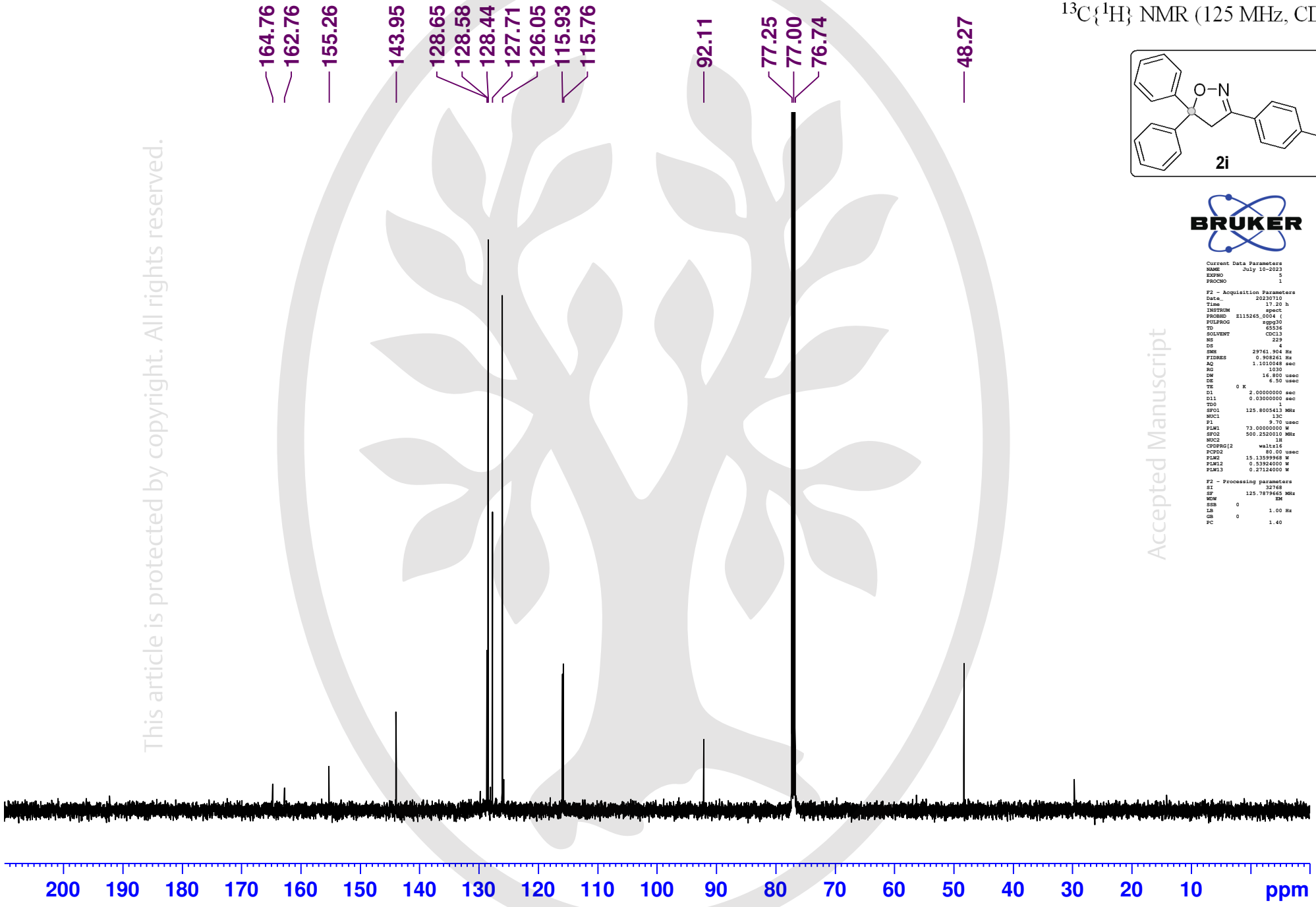
^{1}H NMR (500 MHz, $CDCl_3$)

BRUKER

```
Current Data Parameters
NAME        July 10-2023
EXPNO                  4
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230710
Time              17.05 h
INSTRUM             spect
PROBHD   Z115265_0004 (
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                     8
DS                     0
SWH           10000.000 Hz
FIDRES        0.305176 Hz
AQ            3.2767999 sec
RG                   203
DW               50.000 usec
DE                6.50 usec
TE        0 K
D1           1.00000000 sec
TD0                    1
SFO1         500.2530890 MHz
NUC1                  1H
P1                15.10 usec
PLW1         15.13599968 W

F2 - Processing parameters
SI                 65536
SF           500.2500173 MHz
WDW                   EM
SSB       0
LB                0.30 Hz
GB        0
PC                1.00
```



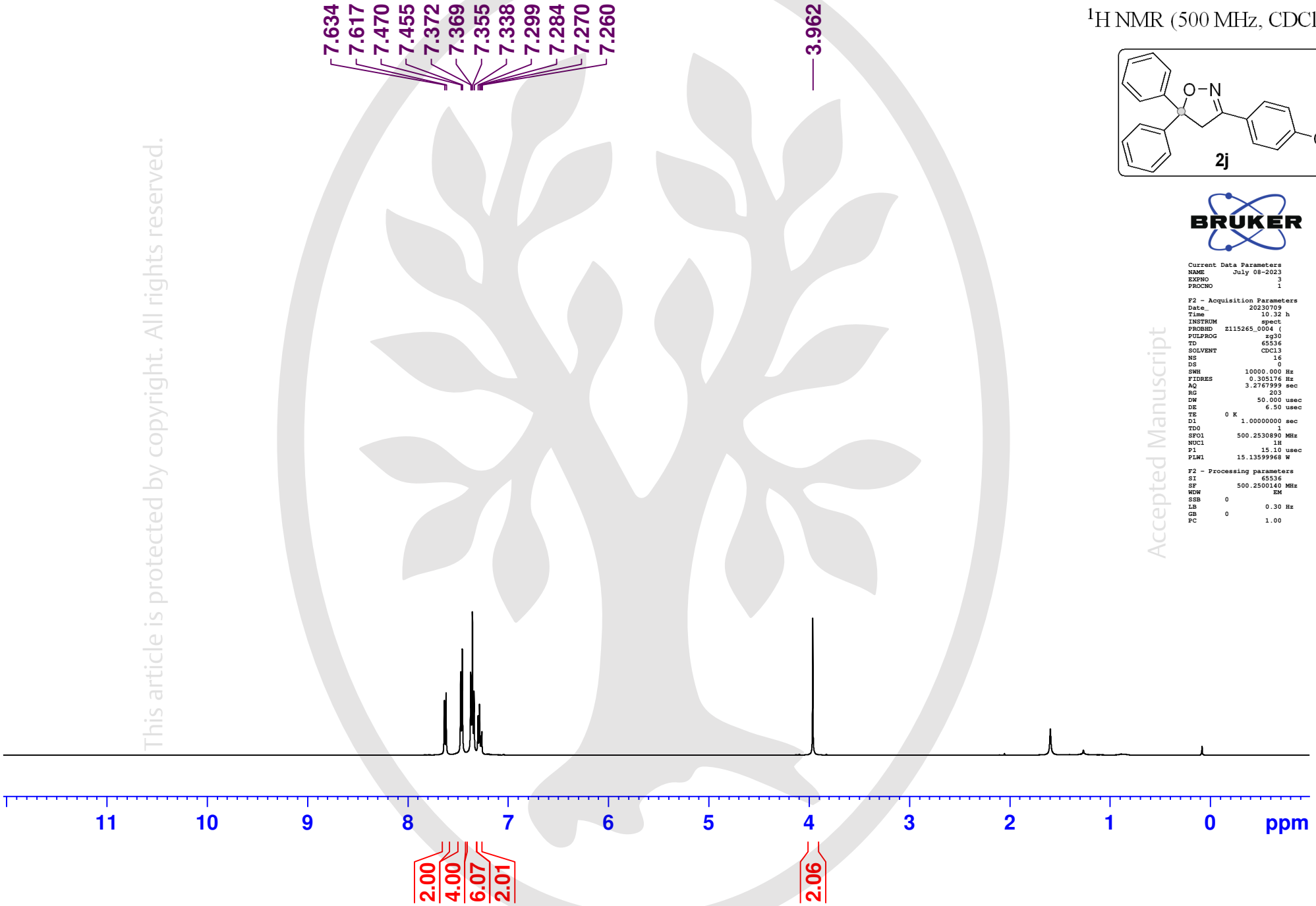
$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

BRUKER

```
Current Data Parameters
NAME        July 10-2023
EXPNO                  5
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230710
Time              17.20 h
INSTRUM             spect
PROBHD  Z115265_0004 (
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                  229
DS                    4
SWH           29761.904 Hz
FIDRES        0.908261 Hz
AQ            1.1010048 sec
RG                 1030
DW               16.800 usec
DE                6.50 usec
TE        0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1
SFO1         125.8005413 MHz
NUC1                 13C
P1                 9.70 usec
PLW1         73.00000000 W
SFO2         500.2520010 MHz
NUC2                 1H
CPDPRG[2          waltz16
PCPD2             80.00 usec
PLW2         15.13599968 W
PLW12         0.53924000 W
PLW13         0.27124000 W

F2 - Processing parameters
SI                 32768
SF           125.7879665 MHz
WDW                   EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)

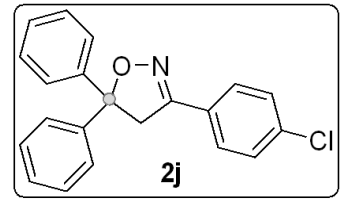
BRUKER

```
Current Data Parameters
NAME        July 08-2023
EXPNO                  3
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230709
Time              10.32 h
INSTRUM             spect
PROBHD   Z115265_0004 (
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                    16
DS                     0
SWH           10000.000 Hz
FIDRES        0.305176 Hz
AQ            3.2767999 sec
RG                   203
DW               50.000 usec
DE                6.50 usec
TE                 0 K
D1            1.00000000 sec
TD0                    1
SFO1          500.2530890 MHz
NUC1                  1H
P1                15.10 usec
PLW1          15.13599968 W

F2 - Processing parameters
SI                 65536
SF            500.2500140 MHz
WDW                   EM
SSB                    0
LB                0.30 Hz
GB                     0
PC                1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

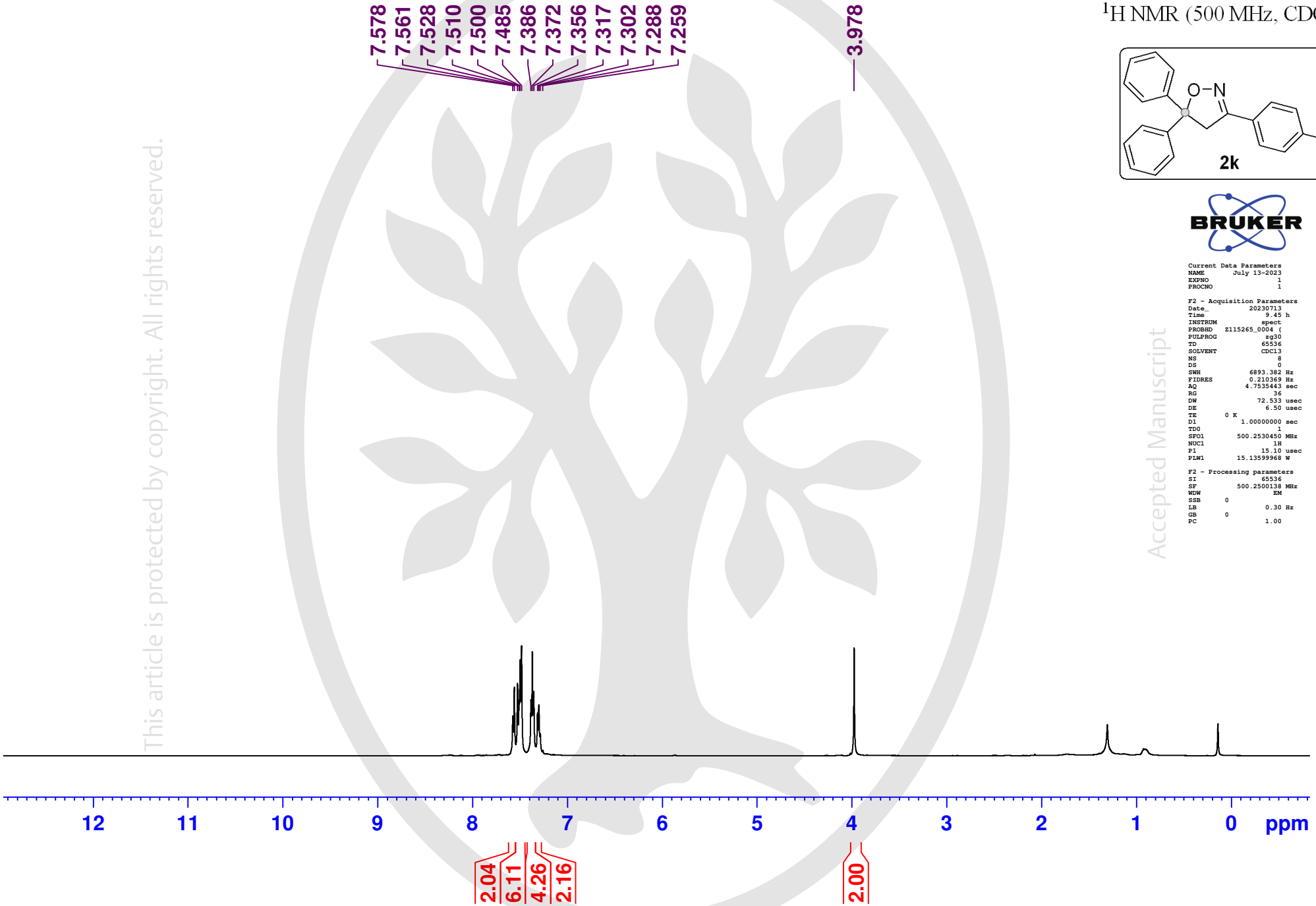


BRUKER

```
Current Data Parameters
NAME        July 08-2023
EXPNO                  4
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230709
Time              10.47 h
INSTRUM             spect
PROBHD  Z115265_0004 (
PULPROG           zgpg30
TD                65536
SOLVENT             CDCl3
NS                    246
DS                      4
SWH           29761.904 Hz
FIDRES         0.908261 Hz
AQ             1.1010048 sec
RG                   2050
DW                16.800 usec
DE                 6.50 usec
TE         0 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                     1
SFO1          125.8005413 MHz
NUC1                  13C
P1                  9.70 usec
PLW1          73.00000000 W
SFO2          500.2520010 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2              80.00 usec
PLW2          15.13599968 W
PLW12          0.53924000 W
PLW13          0.27124000 W

F2 - Processing parameters
SI                  32768
SF            125.7879674 MHz
WDW                    EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
```



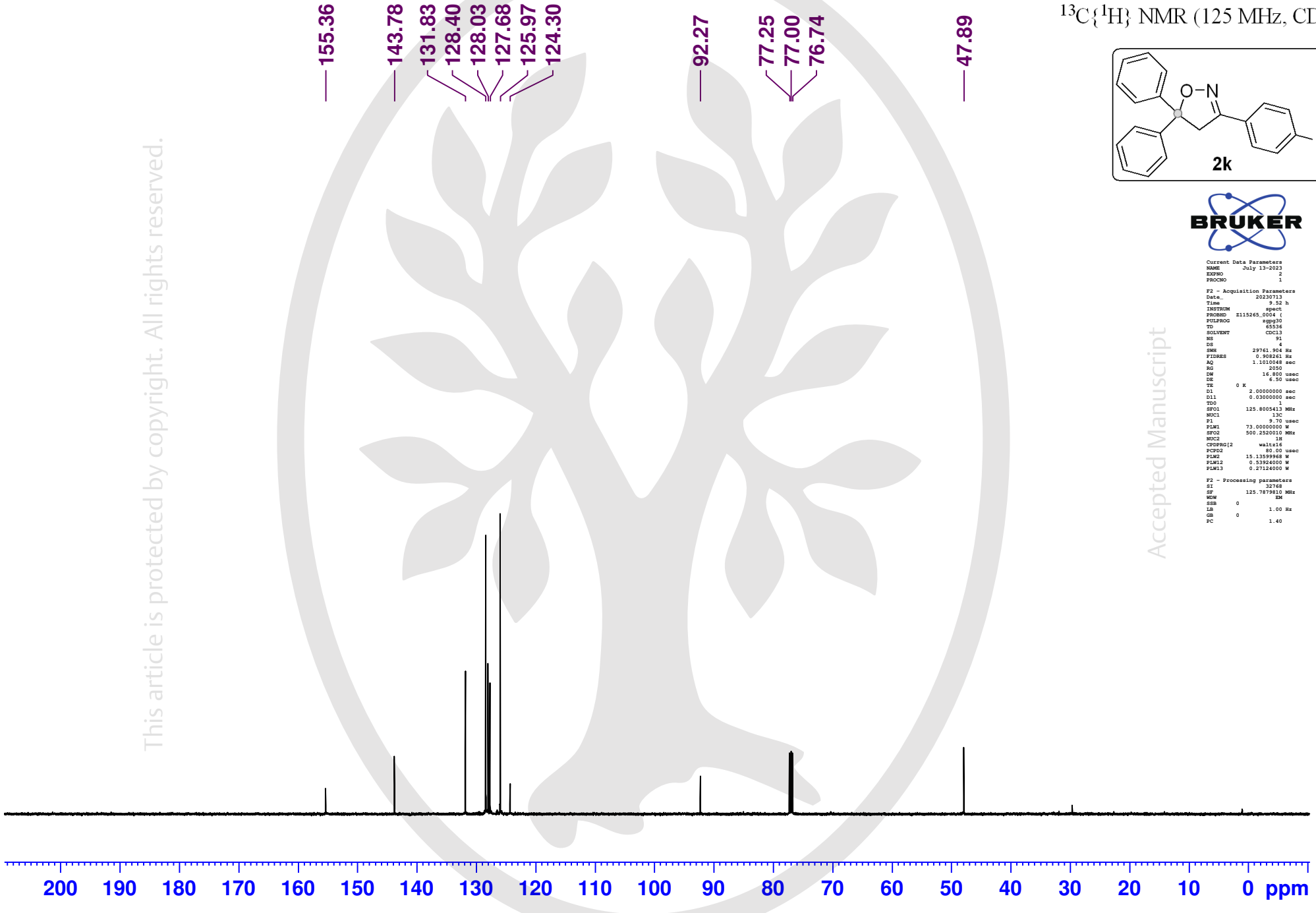
^{1}H NMR (500 MHz, $CDCl_3$)

BRUKER

```
Current Data Parameters
NAME        July 13-2023
EXPNO                  1
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230713
Time               9.45 h
INSTRUM             spect
PROBHD   Z115265_0004 (
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                     8
DS                     0
SWH           6893.382 Hz
FIDRES        0.210369 Hz
AQ            4.7535443 sec
RG                    36
DW               72.533 usec
DE                6.50 usec
TE                 0 K
D1            1.00000000 sec
TD0                    1
SFO1        500.2530450 MHz
NUC1                  1H
P1                15.10 usec
PLW1         15.13599968 W

F2 - Processing parameters
SI                 65536
SF          500.2500138 MHz
WDW                   EM
SSB                    0
LB                0.30 Hz
GB                     0
PC                1.00
```



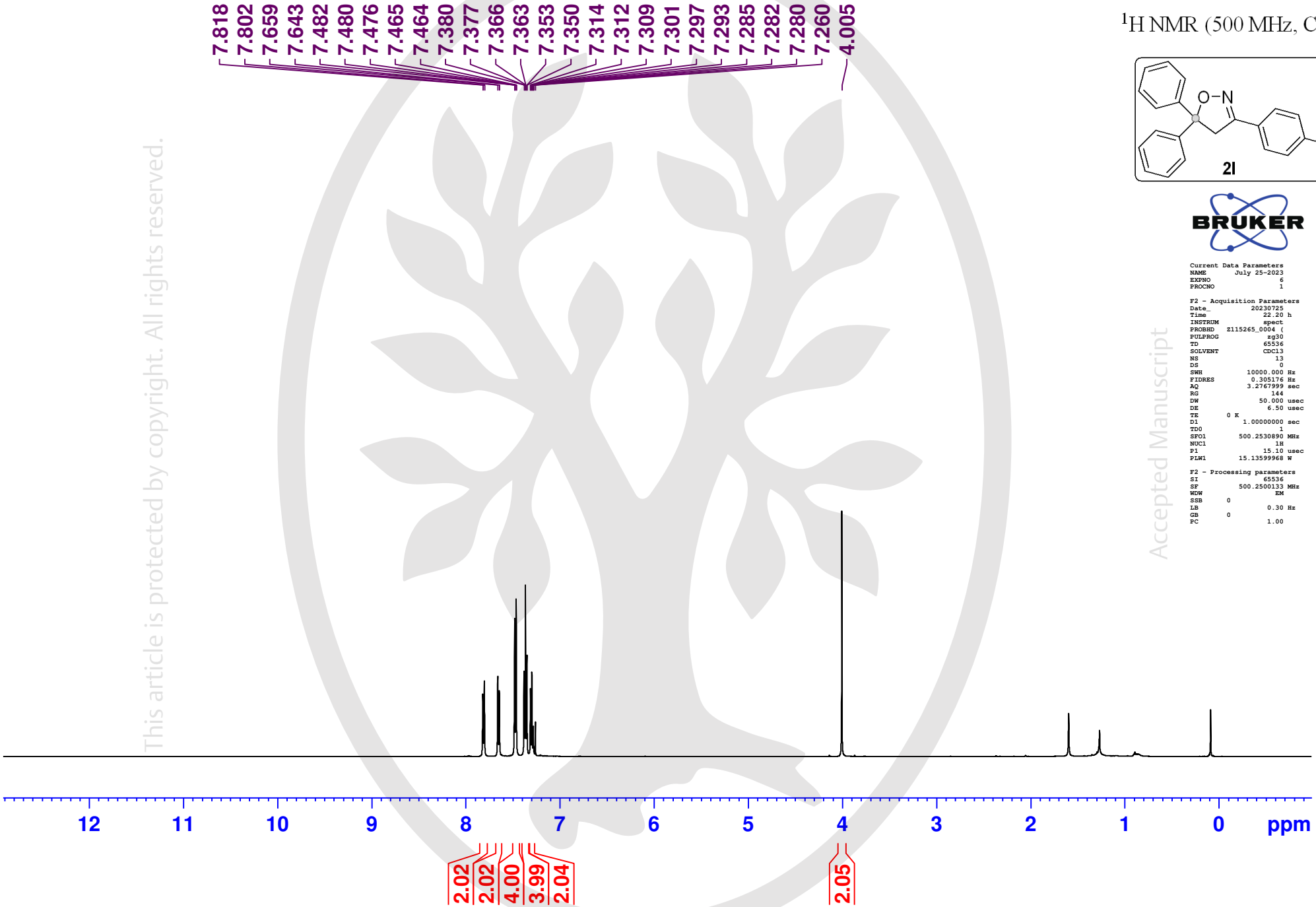
$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

BRUKER

```
Current Data Parameters
NAME        July 13-2023
EXPNO                  2
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230713
Time              9.52 h
INSTRUM             spect
PROBHD  Z115265_0004 (
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                   91
DS                    4
SWH           29761.904 Hz
FIDRES        0.908261 Hz
AQ            1.1010048 sec
RG                 2050
DW               16.800 usec
DE                6.50 usec
TE        0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1
SFO1        125.8005413 MHz
NUC1                13C
P1                 9.70 usec
PLW1         73.00000000 W
SFO2        500.2520010 MHz
NUC2                1H
CPDPRG[2         waltz16
PCPD2             80.00 usec
PLW2         15.13599968 W
PLW12         0.53924000 W
PLW13         0.27124000 W

F2 - Processing parameters
SI                 32768
SF          125.7879810 MHz
WDW                   EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)

2l

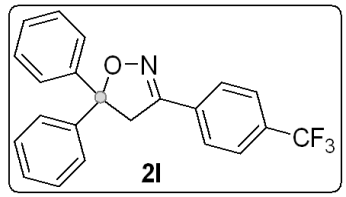
BRUKER

```
Current Data Parameters
NAME        July 25-2023
EXPNO                  6
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230725
Time              22.20 h
INSTRUM             spect
PROBHD   Z115265_0004 (
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                    13
DS                     0
SWH           10000.000 Hz
FIDRES        0.305176 Hz
AQ            3.2767999 sec
RG                   144
DW                50.000 usec
DE                 6.50 usec
TE                 0 K
D1            1.00000000 sec
TD0                    1
SFO1          500.2530890 MHz
NUC1                  1H
P1                15.10 usec
PLW1          15.13599968 W

F2 - Processing parameters
SI                 65536
SF            500.2500133 MHz
WDW                   EM
SSB                    0
LB                  0.30 Hz
GB                     0
PC                  1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

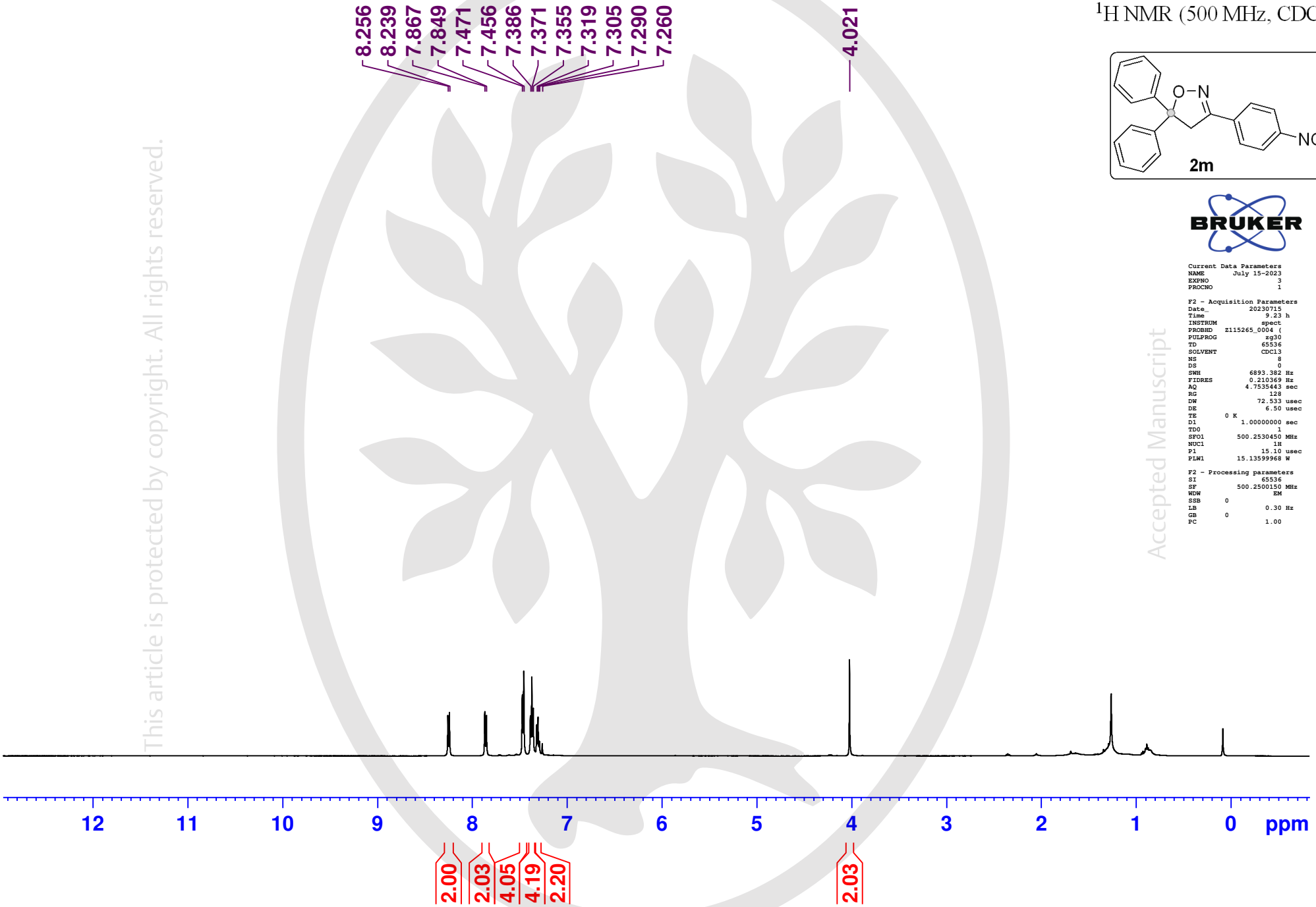


BRUKER

```
Current Data Parameters
NAME        July 25-2023
EXPNO                  7
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230725
Time              22.27 h
INSTRUM             spect
PROBHD  Z115265_0004 (
PULPROG           zgpg30
TD                65536
SOLVENT             CDCl3
NS                    100
DS                      4
SWH             29761.904 Hz
FIDRES          0.908261 Hz
AQ              1.1010048 sec
RG                   1030
DW                16.800 usec
DE                 6.50 usec
TE        0 K
D1              2.00000000 sec
D11             0.03000000 sec
TD0                     1
SFO1          125.8005413 MHz
NUC1                  13C
P1                   9.70 usec
PLW1          73.00000000 W
SFO2          500.2520010 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2               80.00 usec
PLW2          15.13599968 W
PLW12          0.53924000 W
PLW13          0.27124000 W

F2 - Processing parameters
SI                   32768
SF            125.7879683 MHz
WDW                    EM
SSB       0
LB                  1.00 Hz
GB        0
PC                  1.40
```



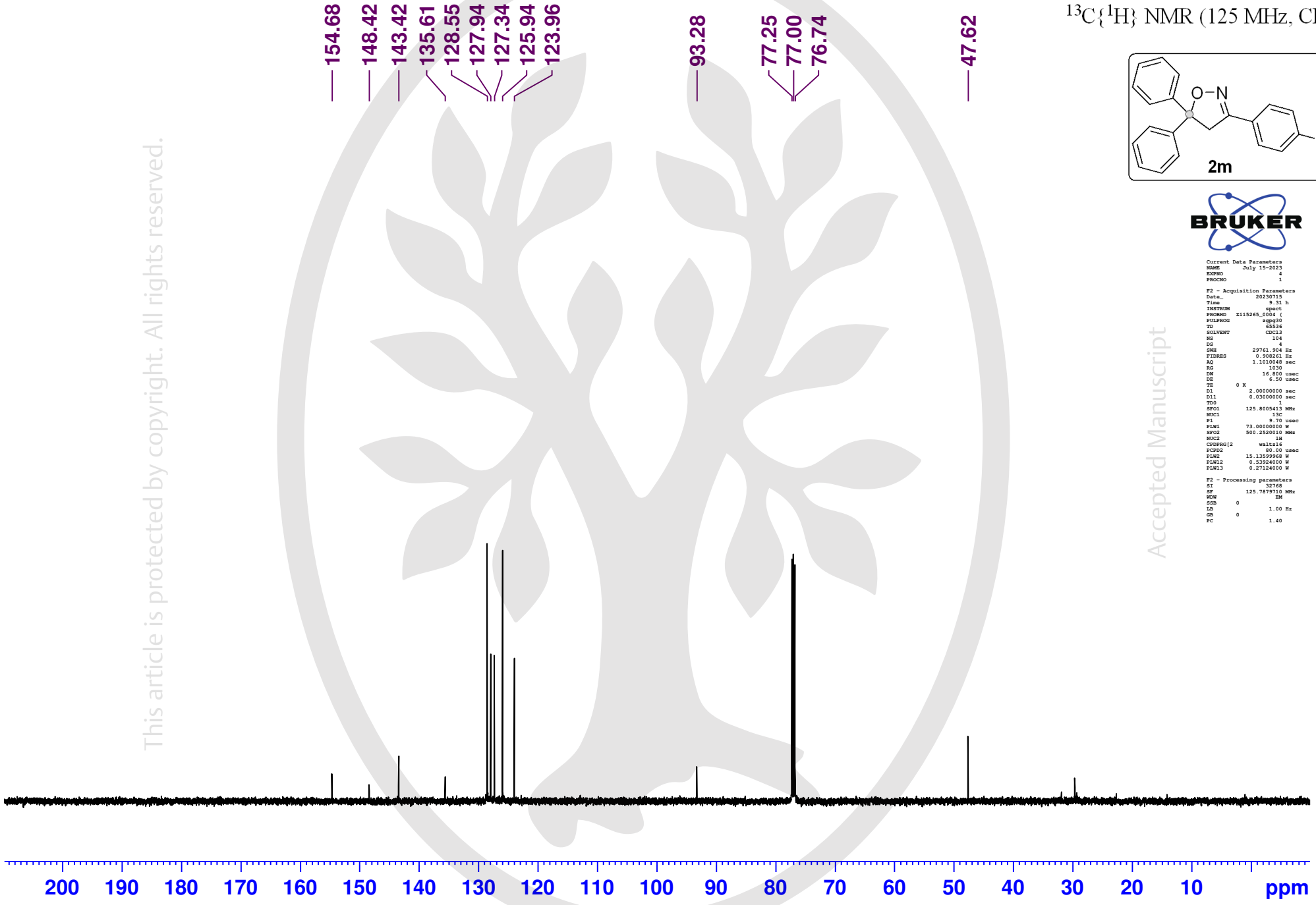
^{1}H NMR (500 MHz, $CDCl_3$)

BRUKER

```
Current Data Parameters
NAME        July 15-2023
EXPNO                  3
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230715
Time               9.23 h
INSTRUM             spect
PROBHD   Z115265_0004 (
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                     8
DS                     0
SWH           6893.382 Hz
FIDRES        0.210369 Hz
AQ            4.7535443 sec
RG                   128
DW               72.533 usec
DE                6.50 usec
TE                 0 K
D1            1.00000000 sec
TD0                    1
SFO1        500.2530450 MHz
NUC1                  1H
P1                15.10 usec
PLW1         15.13599968 W

F2 - Processing parameters
SI                 65536
SF          500.2500150 MHz
WDW                   EM
SSB                    0
LB                  0.30 Hz
GB                     0
PC                  1.00
```



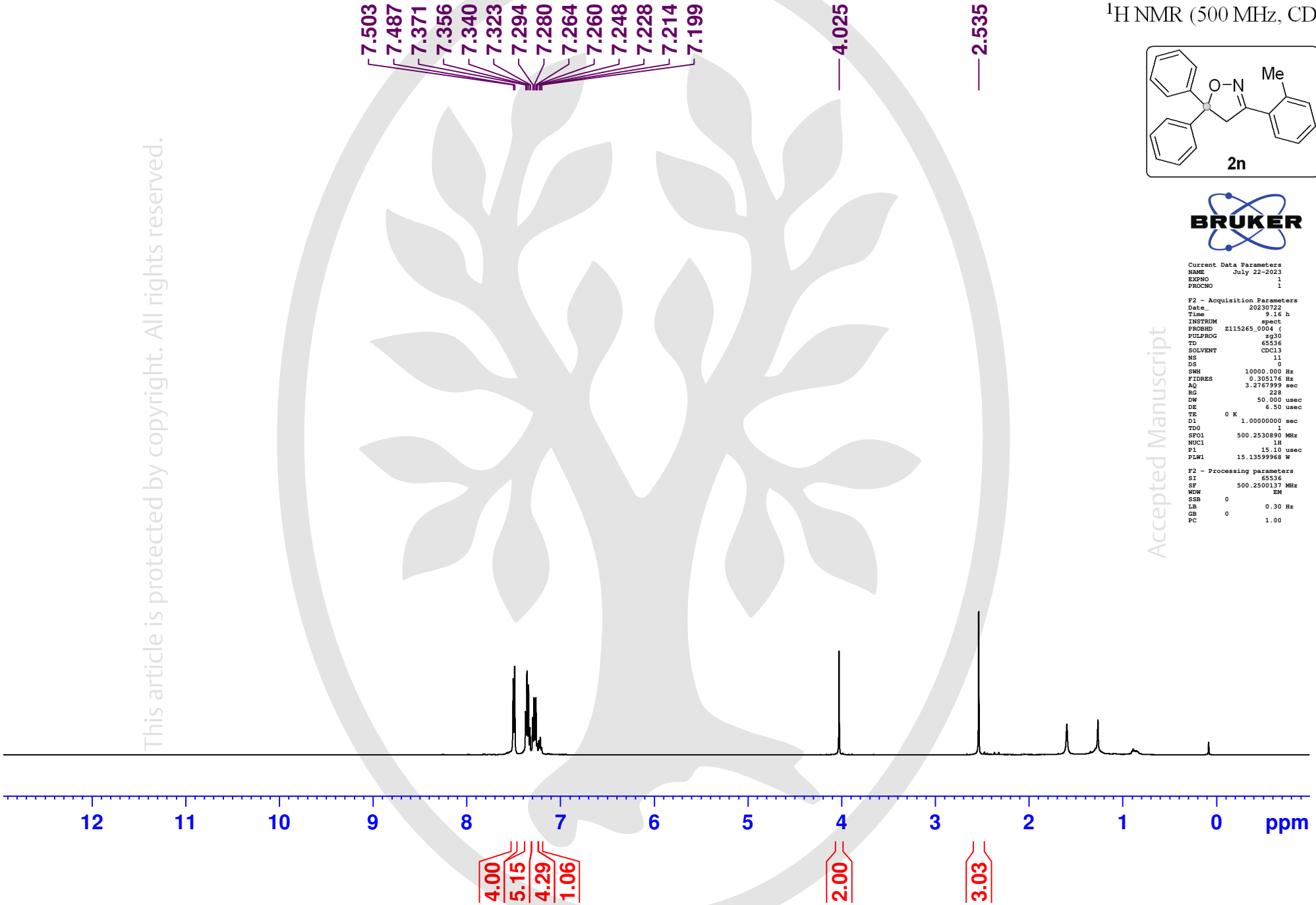
$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

BRUKER

```
Current Data Parameters
NAME        July 15-2023
EXPNO                  4
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230715
Time              9.31 h
INSTRUM             spect
PROBHD  Z115265_0004 (
PULPROG           zgpg30
TD                65536
SOLVENT             CDCl3
NS                    104
DS                      4
SWH           29761.904 Hz
FIDRES        0.908261 Hz
AQ            1.1010048 sec
RG                 1030
DW               16.800 usec
DE                6.50 usec
TE        0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1
SFO1         125.8005413 MHz
NUC1                 13C
P1                 9.70 usec
PLW1         73.00000000 W
SFO2         500.2520010 MHz
NUC2                 1H
CPDPRG[2         waltz16
PCPD2             80.00 usec
PLW2         15.13599968 W
PLW12         0.53924000 W
PLW13         0.27124000 W

F2 - Processing parameters
SI                 32768
SF           125.7879710 MHz
WDW                  EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)

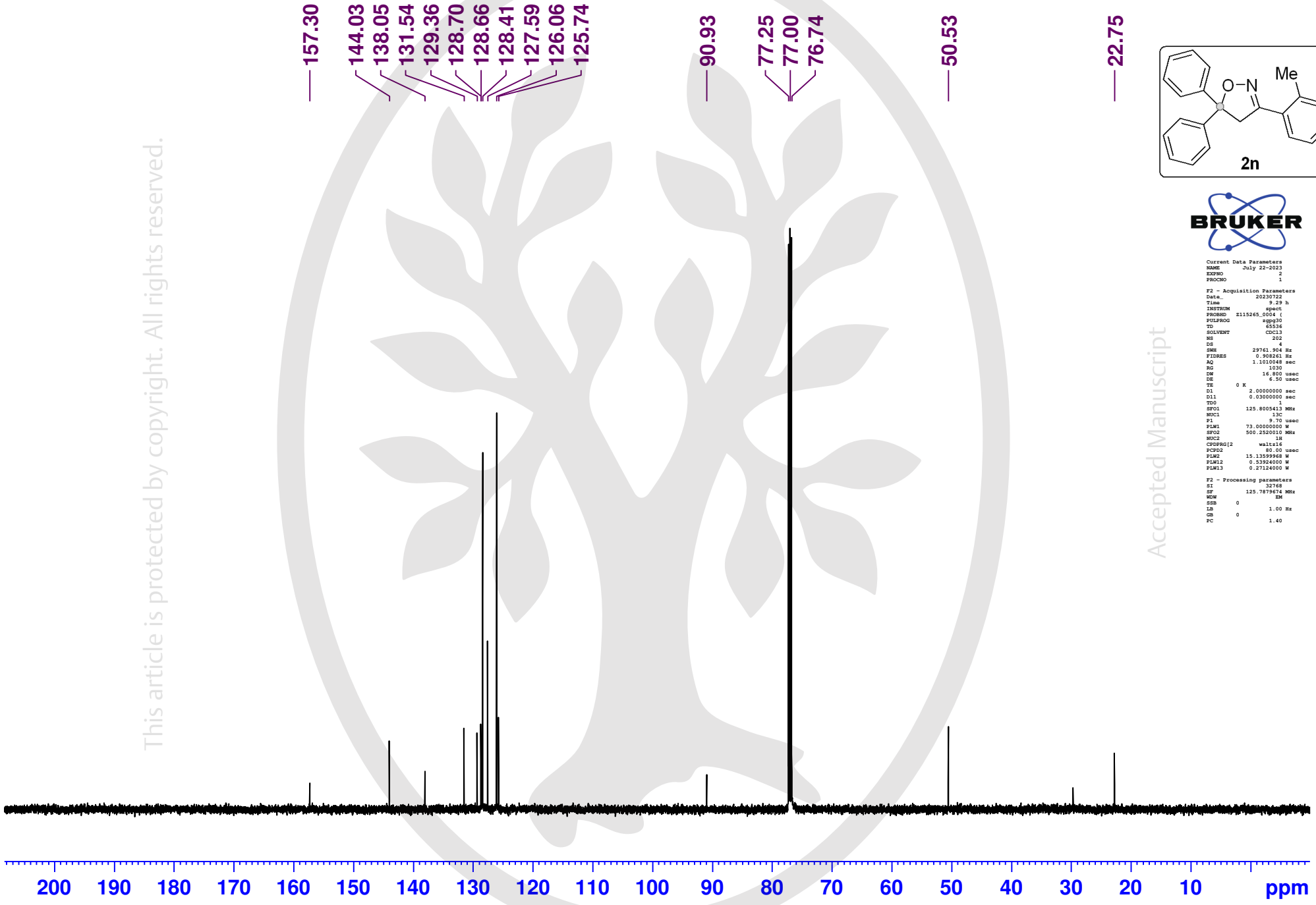
BRUKER

```
Current Data Parameters
NAME        July 22-2023
EXPNO                  1
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230722
Time               9.16 h
INSTRUM            spect
PROBHD   Z115265_0004 (
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                    11
DS                     0
SWH            10000.000 Hz
FIDRES         0.305176 Hz
AQ             3.2767999 sec
RG                   228
DW                50.000 usec
DE                 6.50 usec
TE         0 K
D1          1.00000000 sec
TD0                    1
SFO1        500.2530890 MHz
NUC1                  1H
P1                15.10 usec
PLW1        15.13599968 W

F2 - Processing parameters
SI                 65536
SF          500.2500137 MHz
WDW                   EM
SSB        0
LB                 0.30 Hz
GB         0
PC                 1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

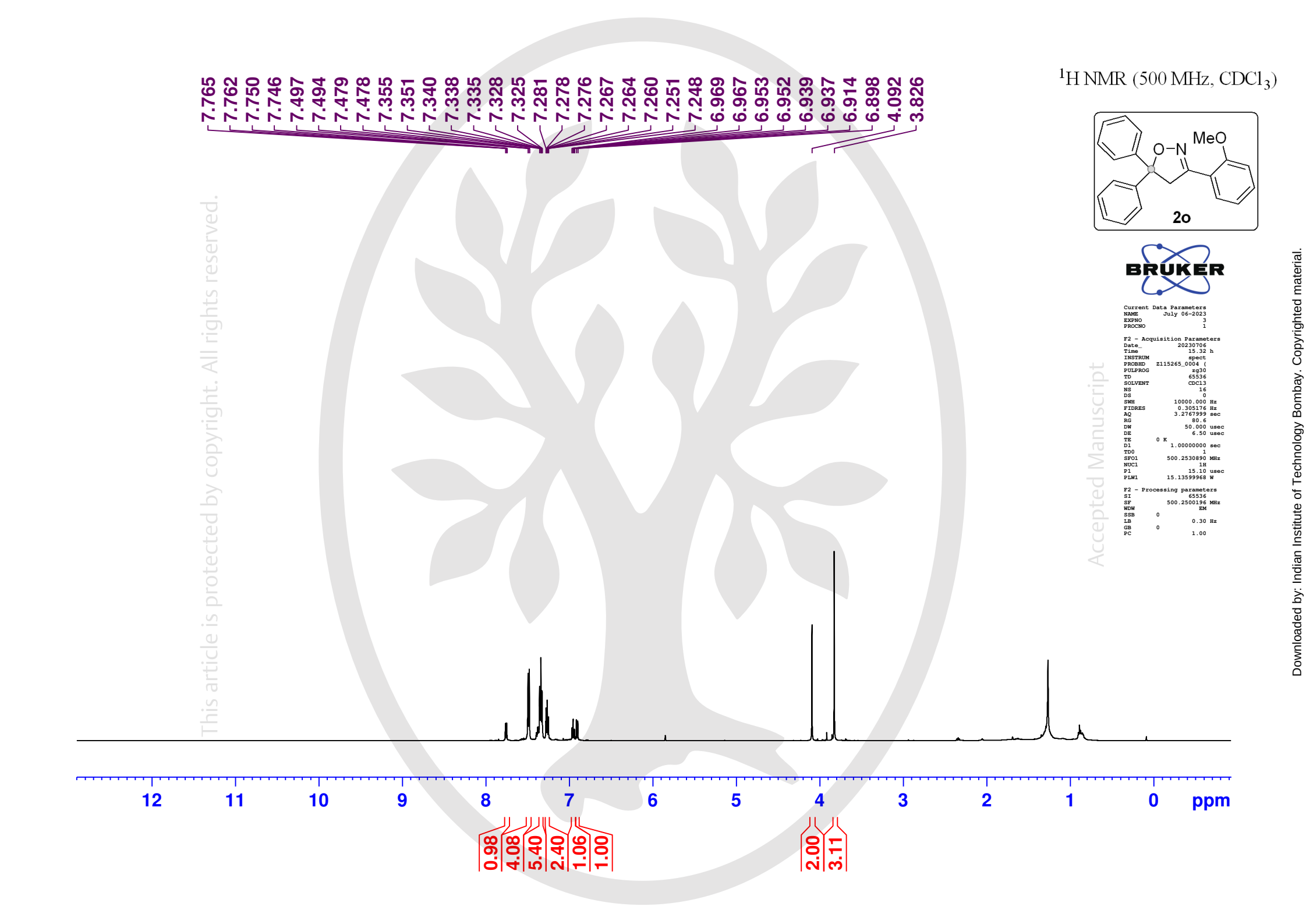


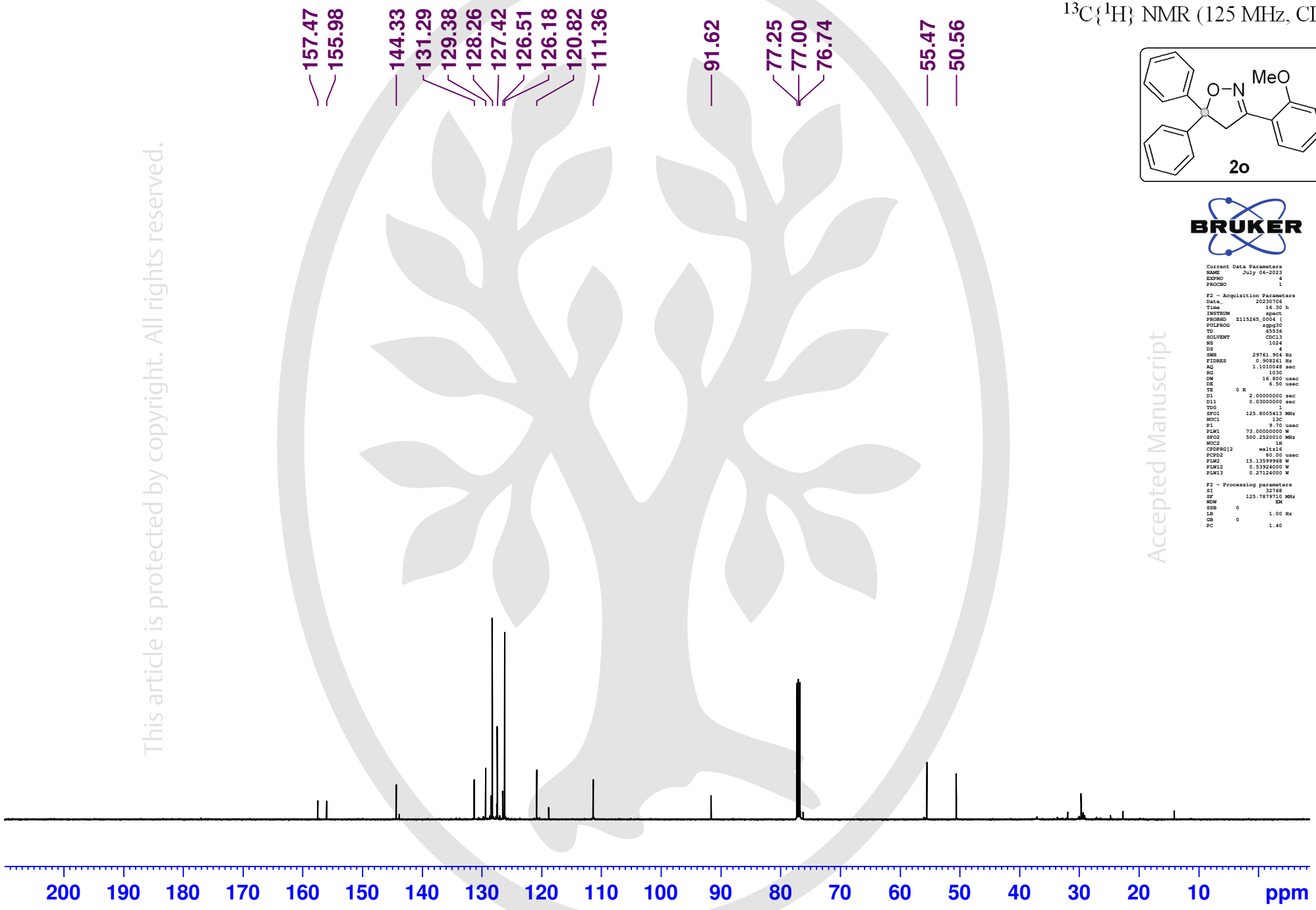
BRUKER

```
Current Data Parameters
NAME        July 22-2023
EXPNO                  2
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230722
Time              9.29 h
INSTRUM             spect
PROBHD  Z115265_0004 (
PULPROG           zgpg30
TD                65536
SOLVENT             CDCl3
NS                    202
DS                      4
SWH           29761.904 Hz
FIDRES        0.908261 Hz
AQ            1.1010048 sec
RG                   1030
DW               16.800 usec
DE                6.50 usec
TE        0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                     1
SFO1         125.8005413 MHz
NUC1                  13C
P1                 9.70 usec
PLW1         73.00000000 W
SFO2         500.2520010 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2             80.00 usec
PLW2         15.13599968 W
PLW12         0.53924000 W
PLW13         0.27124000 W

F2 - Processing parameters
SI                    32768
SF           125.7879674 MHz
WDW                     EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
```





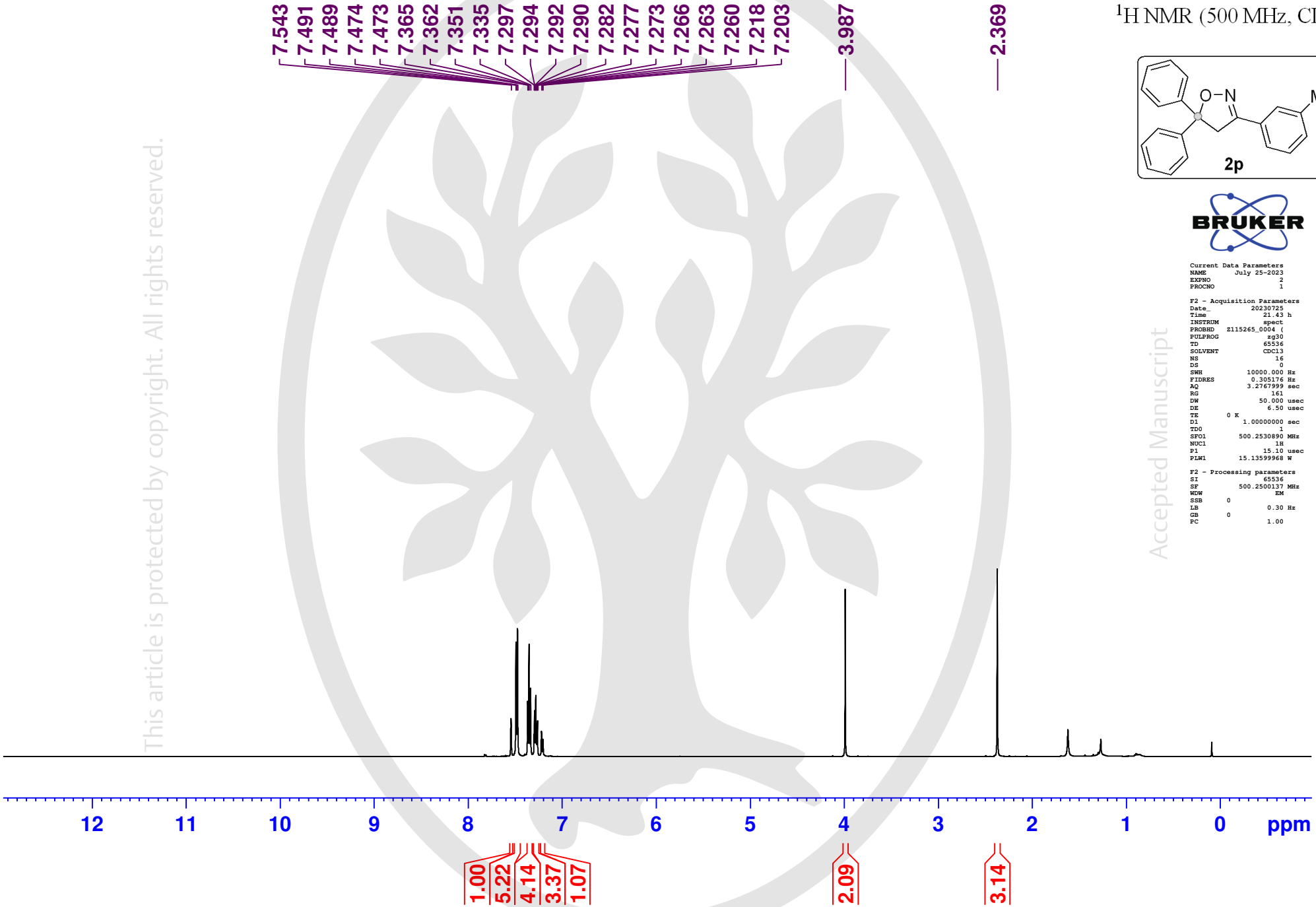
$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

BRUKER

```
Current Data Parameters
NAME        July 06-2023
EXPNO                  4
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230706
Time              16.30 h
INSTRUM             spect
PROBHD  Z115265_0004 (
PULPROG           zgpg30
TD                65536
SOLVENT            CDCl3
NS                  1024
DS                     4
SWH           29761.904 Hz
FIDRES         0.908261 Hz
AQ             1.1010048 sec
RG                  1030
DW                16.800 usec
DE                 6.50 usec
TE         0 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                    1
SFO1          125.8005413 MHz
NUC1                  13C
P1                  9.70 usec
PLW1          73.00000000 W
SFO2          500.2520010 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2              80.00 usec
PLW2          15.13599968 W
PLW12          0.53924000 W
PLW13          0.27124000 W

F2 - Processing parameters
SI                 32768
SF          125.7879710 MHz
WDW                   EM
SSB        0
LB                 1.00 Hz
GB         0
PC                 1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)

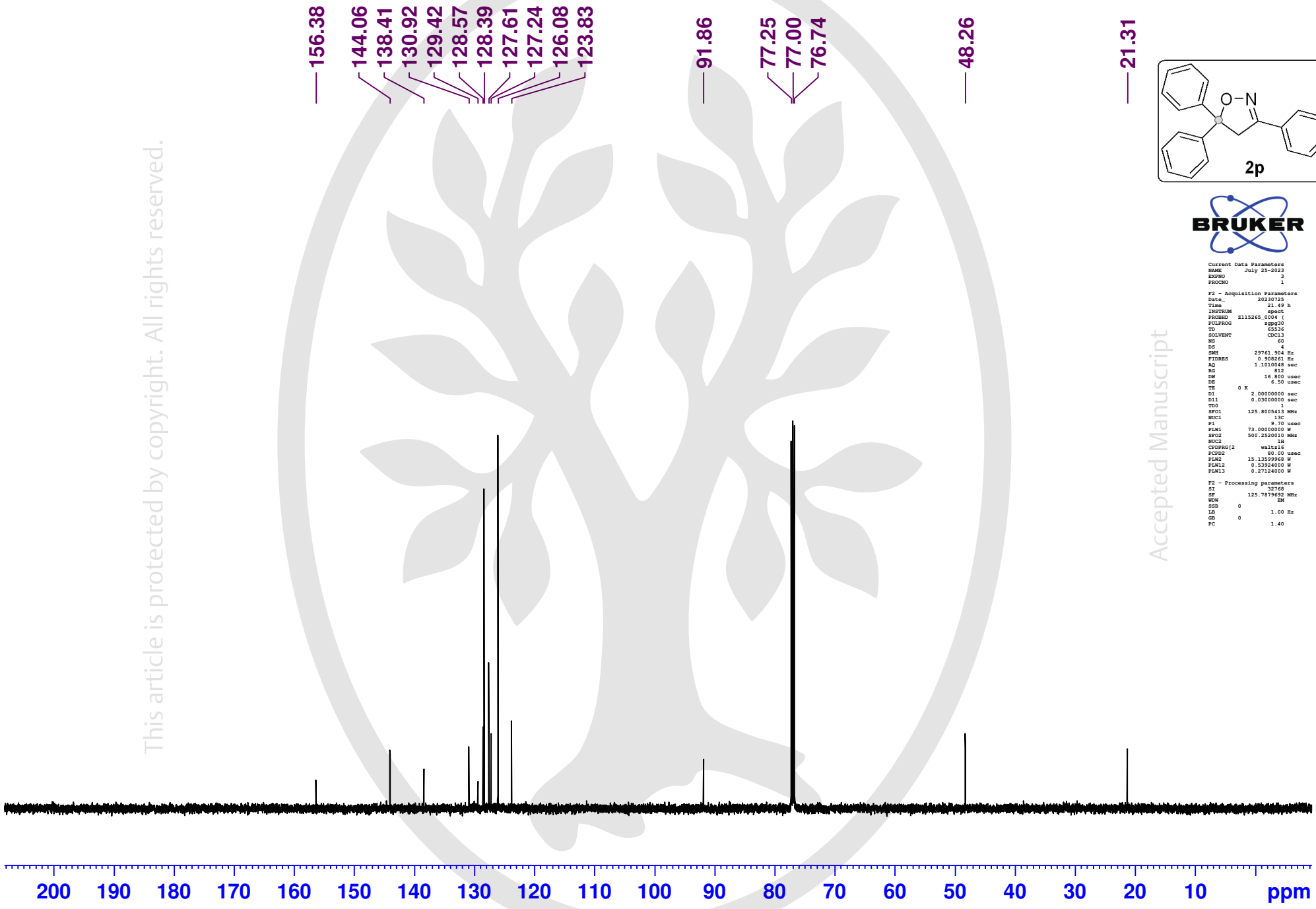
BRUKER

```
Current Data Parameters
NAME        July 25-2023
EXPNO                  2
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230725
Time              21.43 h
INSTRUM             spect
PROBHD   Z115265_0004 (
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                    16
DS                     0
SWH           10000.000 Hz
FIDRES        0.305176 Hz
AQ            3.2767999 sec
RG                   161
DW                50.000 usec
DE                 6.50 usec
TE         0 K
D1          1.00000000 sec
TD0                    1
SFO1        500.2530890 MHz
NUC1                  1H
P1                15.10 usec
PLW1        15.13599968 W

F2 - Processing parameters
SI                 65536
SF          500.2500137 MHz
WDW                   EM
SSB        0
LB                 0.30 Hz
GB         0
PC                 1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

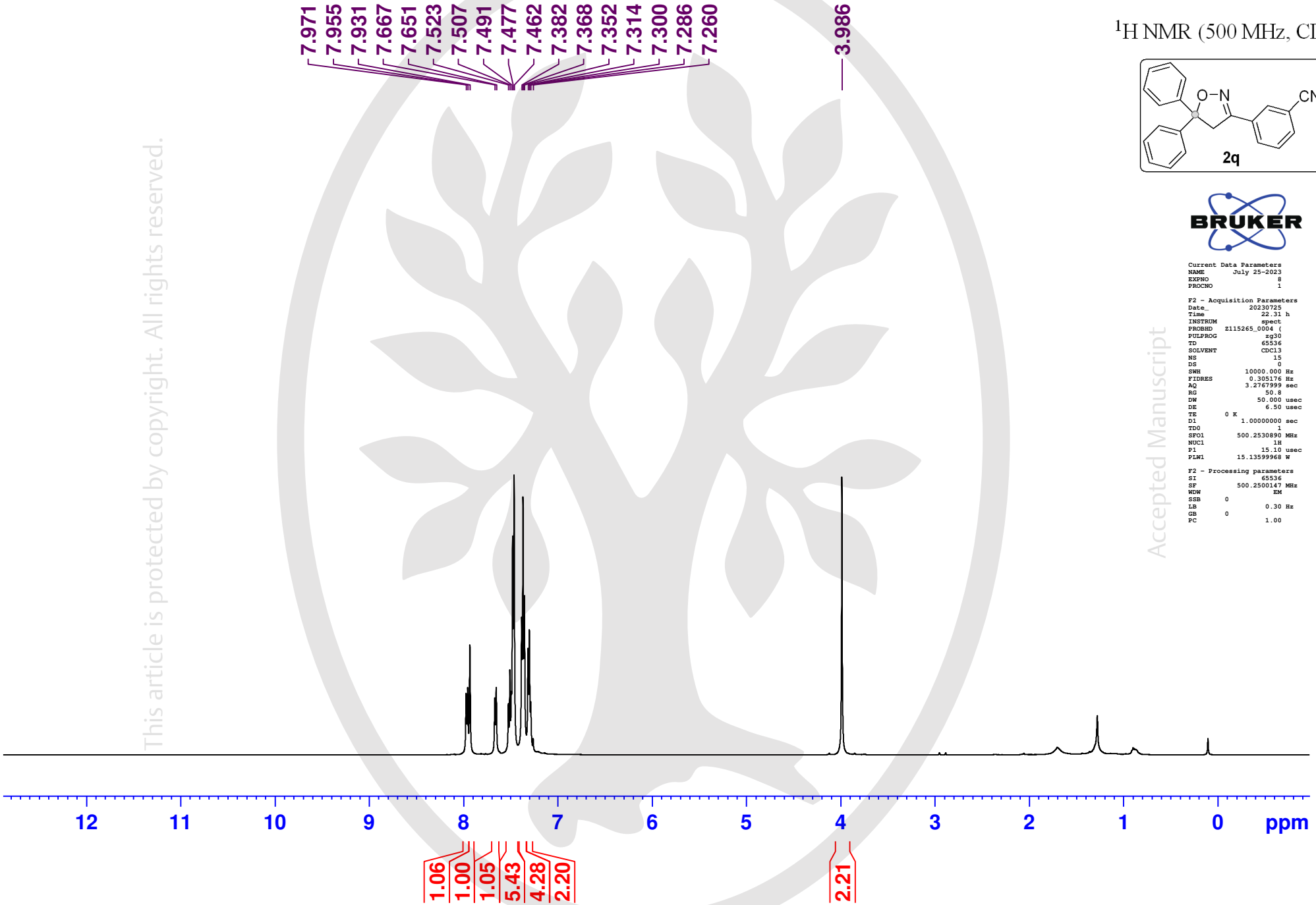


BRUKER

```
Current Data Parameters
NAME        July 25-2023
EXPNO                  3
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230725
Time              21.49 h
INSTRUM             spect
PROBHD  Z115265_0004 (
PULPROG           zgpg30
TD                65536
SOLVENT           CDCl3
NS                   60
DS                    4
SWH           29761.904 Hz
FIDRES        0.908261 Hz
AQ            1.1010048 sec
RG                  812
DW               16.800 usec
DE                6.50 usec
TE        0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1
SFO1         125.8005413 MHz
NUC1                 13C
P1                9.70 usec
PLW1         73.00000000 W
SFO2         500.2520010 MHz
NUC2                 1H
CPDPRG[2          waltz16
PCPD2            80.00 usec
PLW2         15.13599968 W
PLW12         0.53924000 W
PLW13         0.27124000 W

F2 - Processing parameters
SI                 32768
SF           125.7879692 MHz
WDW                  EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```



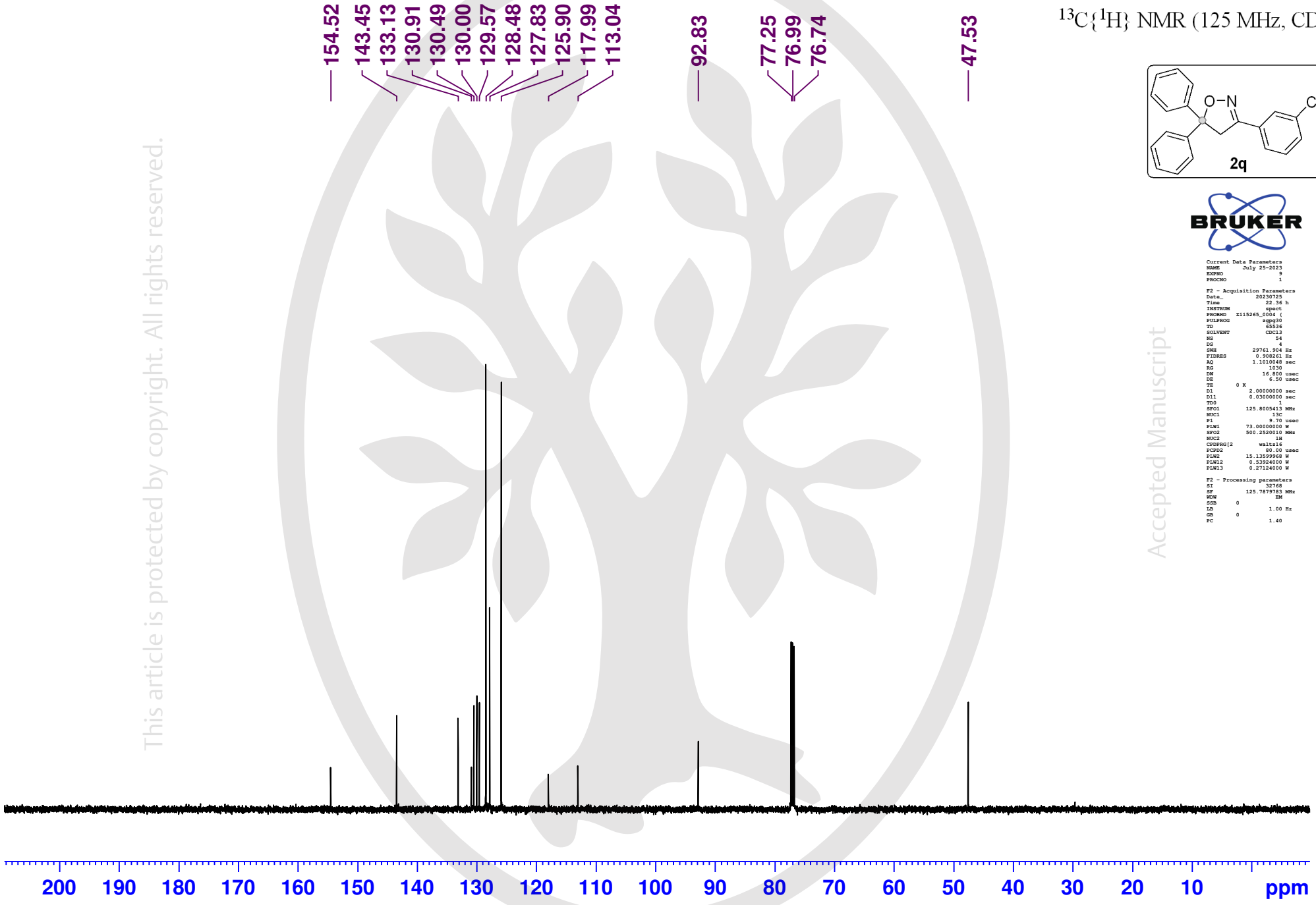
^{1}H NMR (500 MHz, $CDCl_3$)

BRUKER

```
Current Data Parameters
NAME        July 25-2023
EXPNO                  8
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230725
Time              22.31 h
INSTRUM             spect
PROBHD   Z115265_0004 (
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                    15
DS                     0
SWH           10000.000 Hz
FIDRES        0.305176 Hz
AQ            3.2767999 sec
RG                  50.8
DW                50.000 usec
DE                 6.50 usec
TE                 0 K
D1            1.00000000 sec
TD0                    1
SFO1          500.2530890 MHz
NUC1                  1H
P1                 15.10 usec
PLW1          15.13599968 W

F2 - Processing parameters
SI                 65536
SF            500.2500147 MHz
WDW                   EM
SSB                0
LB                 0.30 Hz
GB                 0
PC                 1.00
```



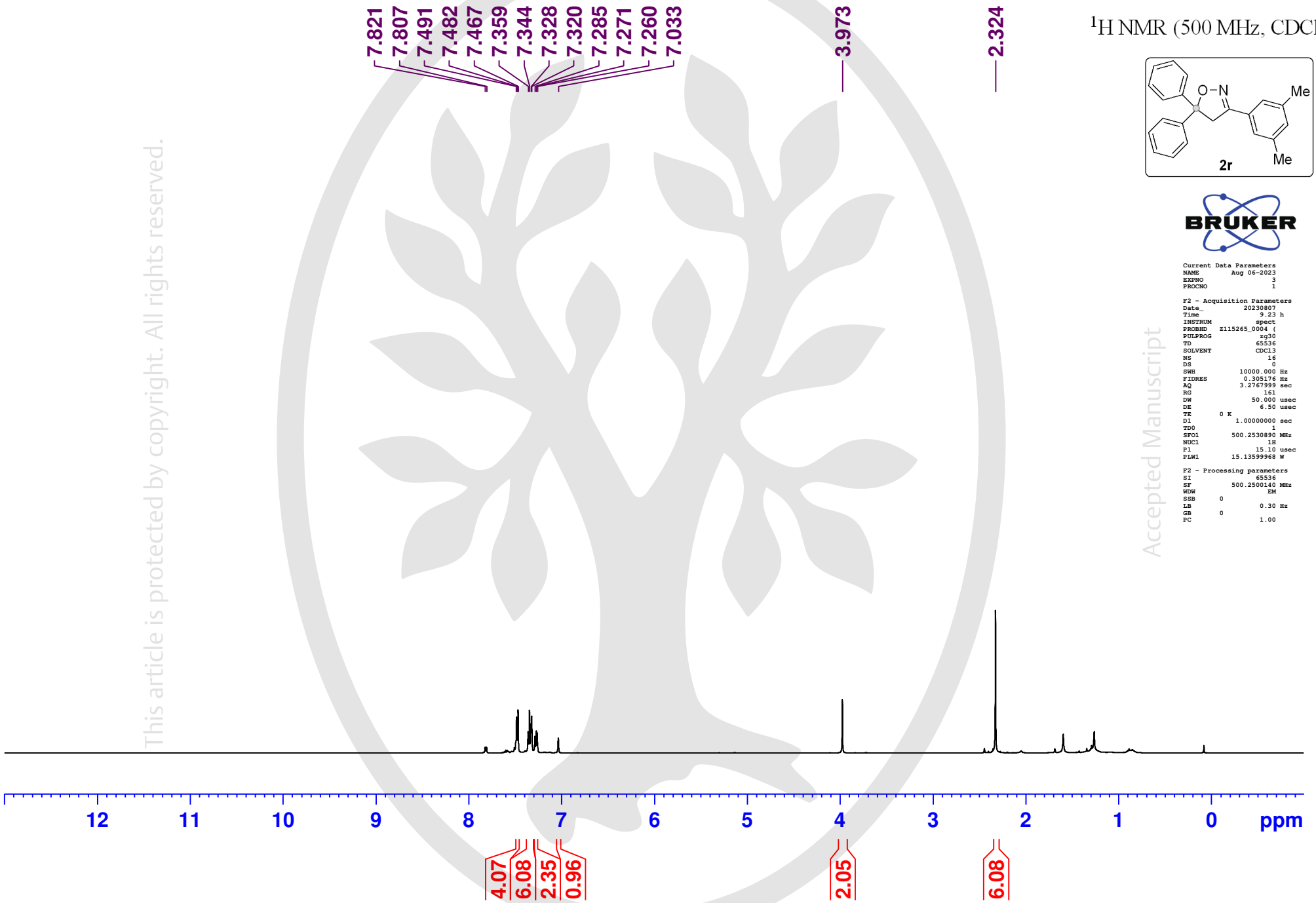
$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

BRUKER

```
Current Data Parameters
NAME        July 25-2023
EXPNO                  9
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230725
Time              22.36 h
INSTRUM             spect
PROBHD  Z115265_0004 (
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                   54
DS                    4
SWH           29761.904 Hz
FIDRES        0.908261 Hz
AQ            1.1010048 sec
RG                 1030
DW               16.800 usec
DE                6.50 usec
TE        0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1
SFO1         125.8005413 MHz
NUC1                 13C
P1                9.70 usec
PLW1         73.00000000 W
SFO2         500.2520010 MHz
NUC2                 1H
CPDPRG[2          waltz16
PCPD2             80.00 usec
PLW2         15.13599968 W
PLW12         0.53924000 W
PLW13         0.27124000 W

F2 - Processing parameters
SI                 32768
SF           125.7879783 MHz
WDW                   EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)

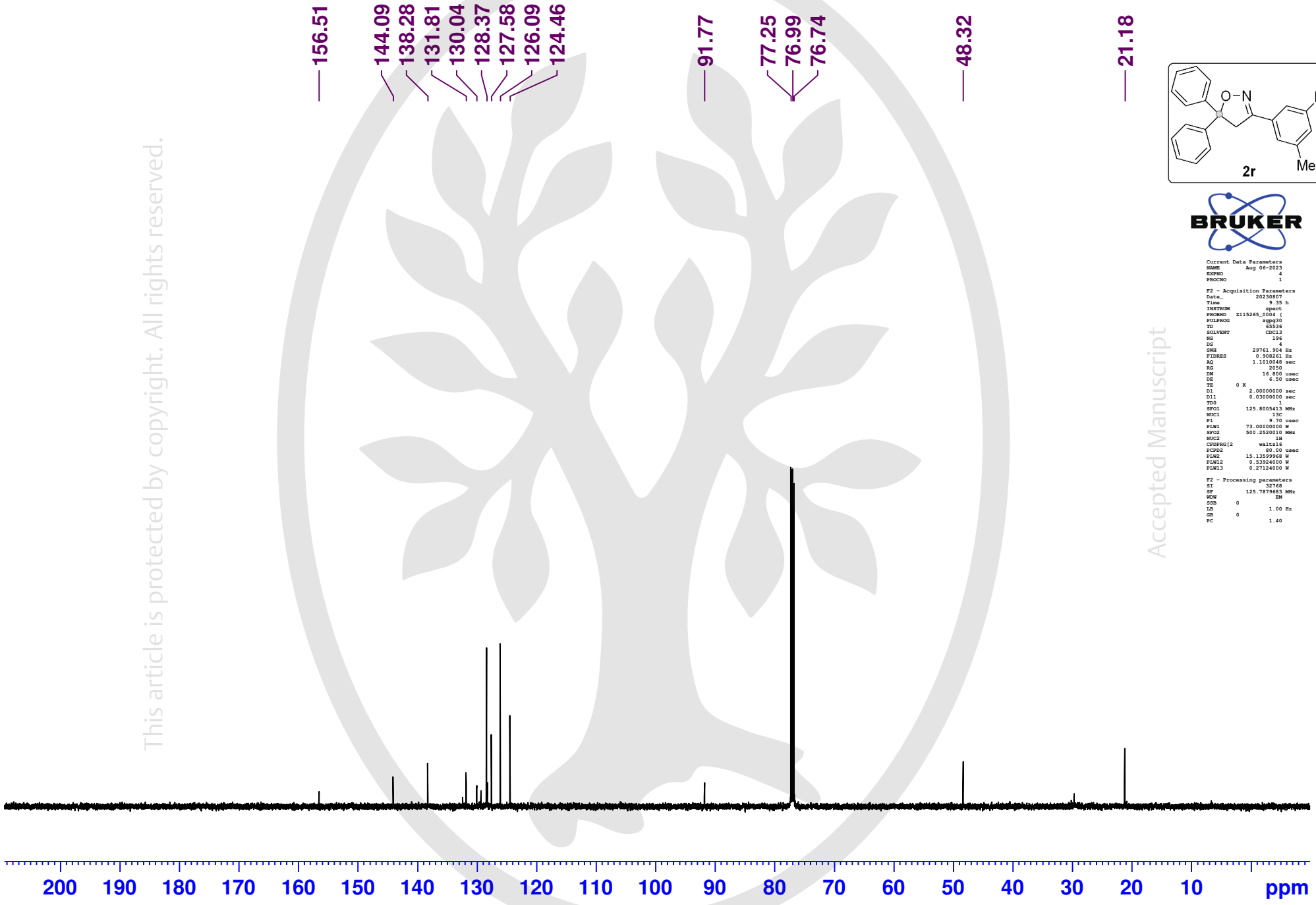
BRUKER

```
Current Data Parameters
NAME          Aug 06-2023
EXPNO                   3
PROCNO                  1

F2 - Acquisition Parameters
Date_              20230807
Time                9.23 h
INSTRUM              spect
PROBHD   Z115265_0004 (
PULPROG                zg30
TD                    65536
SOLVENT               CDCl3
NS                       16
DS                        0
SWH               10000.000 Hz
FIDRES                0.305176 Hz
AQ                3.2767999 sec
RG                      161
DW                   50.000 usec
DE                    6.50 usec
TE                  0 K
D1                1.00000000 sec
TD0                       1
SFO1           500.2530890 MHz
NUC1                     1H
P1                    15.10 usec
PLW1           15.13599968 W

F2 - Processing parameters
SI                    65536
SF             500.2500140 MHz
WDW                      EM
SSB                   0
LB                    0.30 Hz
GB                    0
PC                    1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)



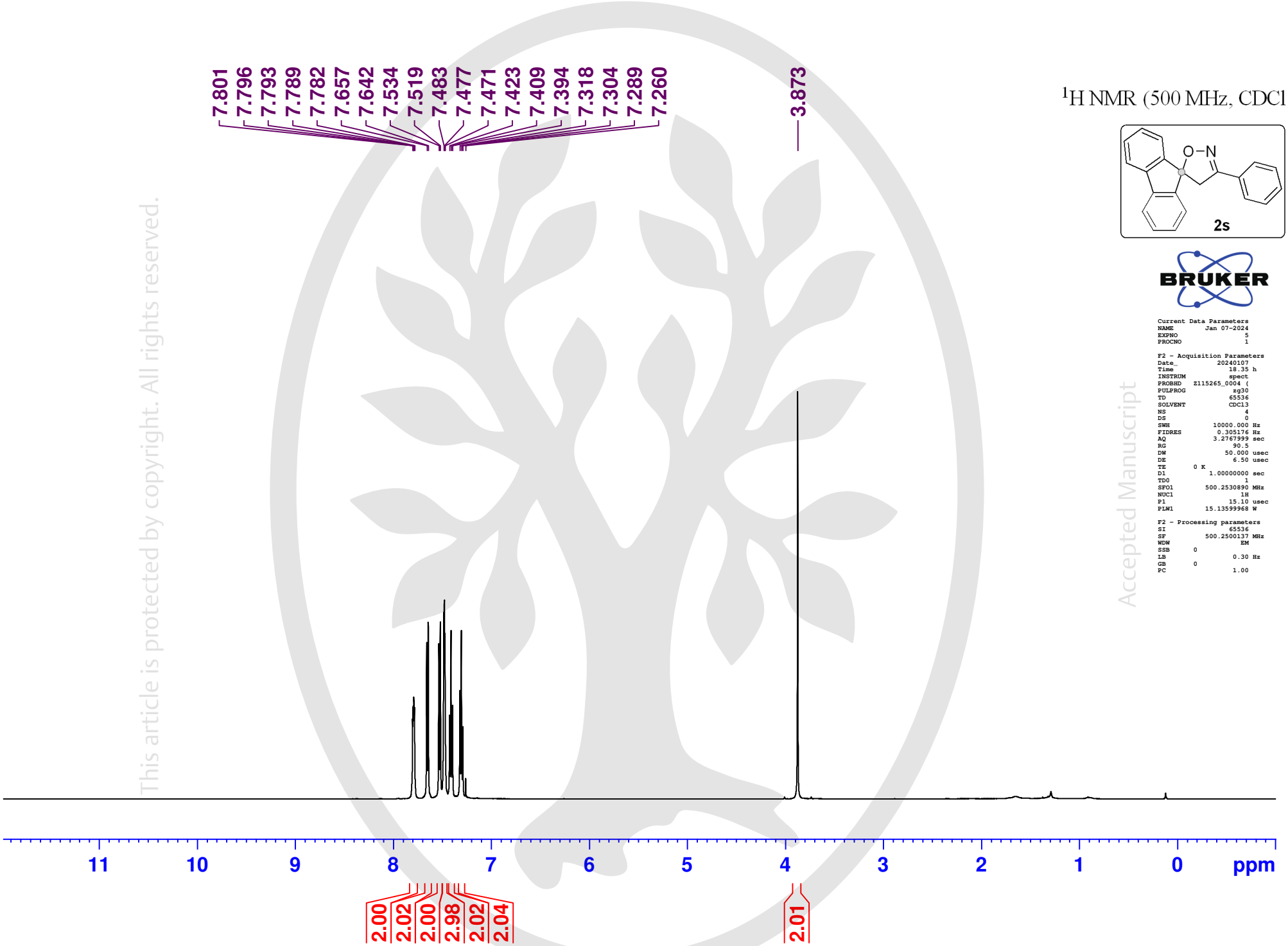
2r

BRUKER

```
Current Data Parameters
NAME          Aug 06-2023
EXPNO                   4
PROCNO                  1

F2 - Acquisition Parameters
Date_              20230807
Time                9.35 h
INSTRUM               spect
PROBHD  Z115265_0004 (
PULPROG             zgpg30
TD                   65536
SOLVENT              CDCl3
NS                     196
DS                       4
SWH              29761.904 Hz
FIDRES           0.908261 Hz
AQ               1.1010048 sec
RG                    2050
DW                 16.800 usec
DE                  6.50 usec
TE          0 K
D1               2.00000000 sec
D11              0.03000000 sec
TD0                      1
SFO1           125.8005413 MHz
NUC1                   13C
P1                   9.70 usec
PLW1           73.00000000 W
SFO2           500.2520010 MHz
NUC2                   1H
CPDPRG[2           waltz16
PCPD2               80.00 usec
PLW2           15.13599968 W
PLW12           0.53924000 W
PLW13           0.27124000 W

F2 - Processing parameters
SI                    32768
SF             125.7879683 MHz
WDW                     EM
SSB          0
LB                   1.00 Hz
GB           0
PC                   1.40
```



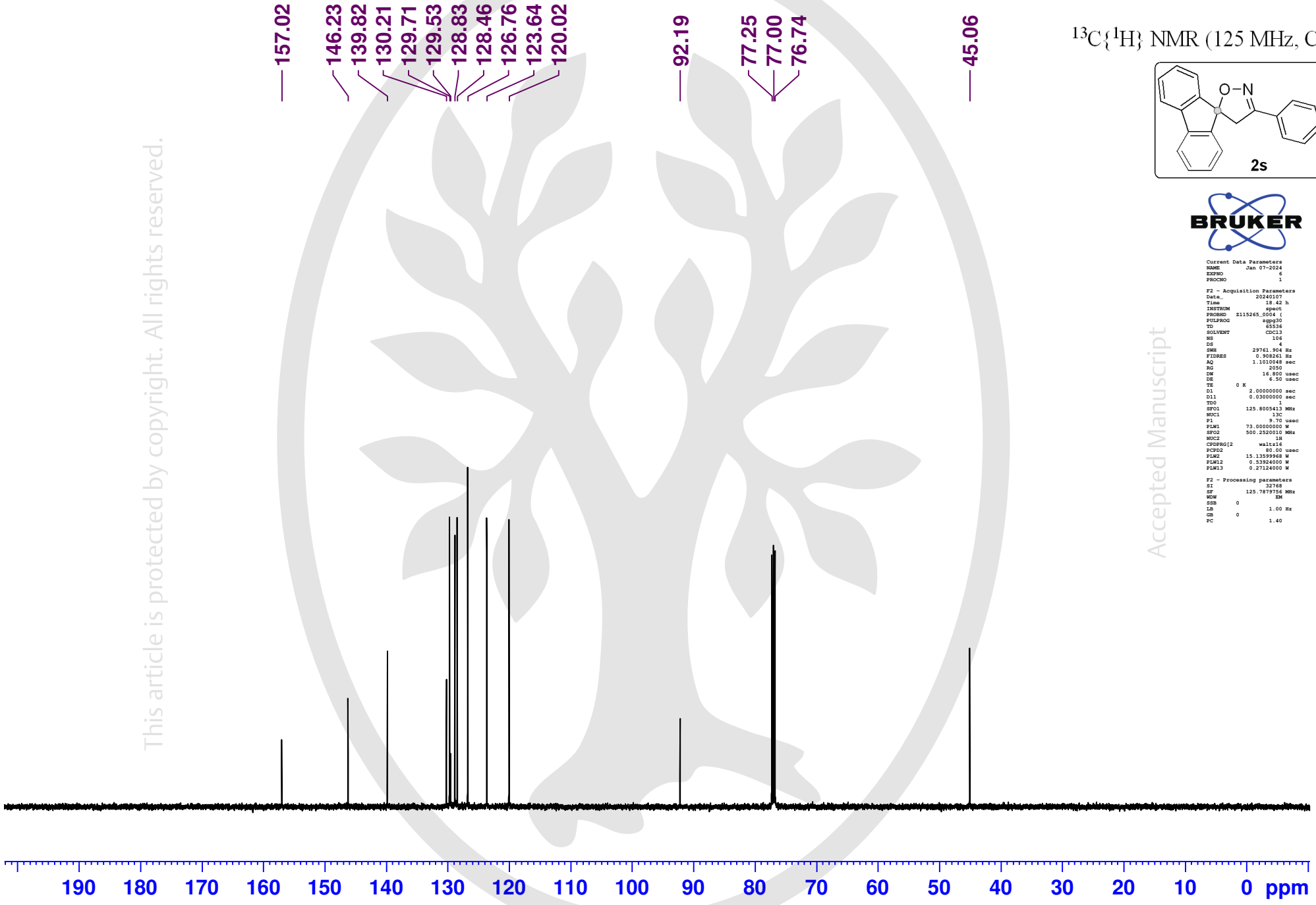
^{1}H NMR (500 MHz, $CDCl_3$)

BRUKER

```
Current Data Parameters
NAME          Jan 07-2024
EXPNO                   5
PROCNO                  1

F2 - Acquisition Parameters
Date_              20240107
Time                18.35 h
INSTRUM               spect
PROBHD    Z115265_0004 (
PULPROG                zg30
TD                    65536
SOLVENT               CDCl3
NS                        4
DS                        0
SWH               10000.000 Hz
FIDRES            0.305176 Hz
AQ                3.2767999 sec
RG                      90.5
DW                  50.000 usec
DE                   6.50 usec
TE                    0 K
D1                1.00000000 sec
TD0                       1
SFO1           500.2530890 MHz
NUC1                     1H
P1                   15.10 usec
PLW1           15.13599968 W

F2 - Processing parameters
SI                    65536
SF             500.2500137 MHz
WDW                      EM
SSB                   0
LB                    0.30 Hz
GB                    0
PC                    1.00
```



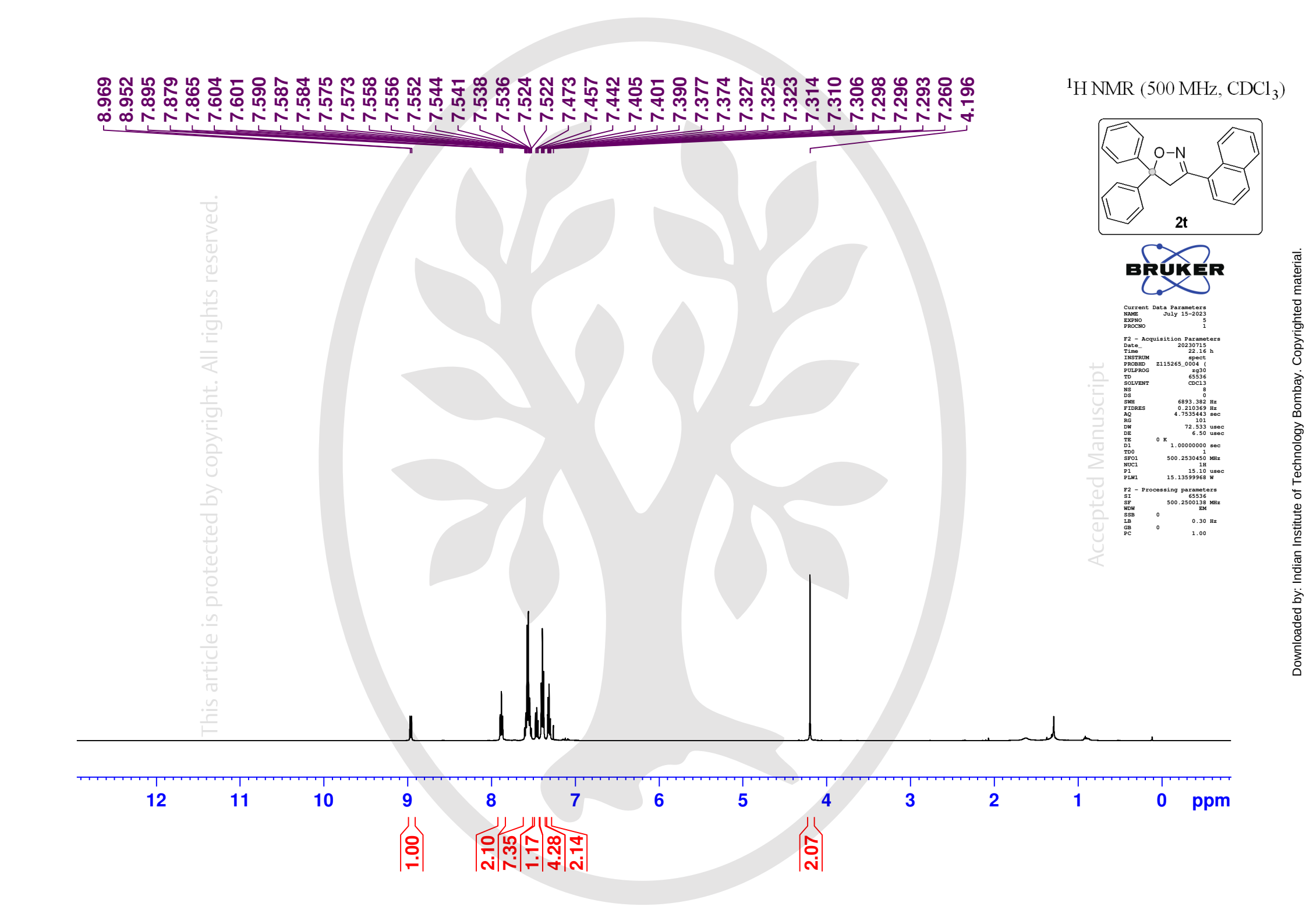
$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

BRUKER

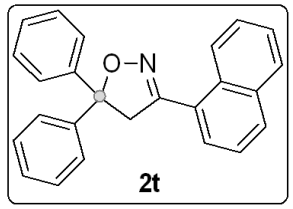
```
Current Data Parameters
NAME          Jan 07-2024
EXPNO                   6
PROCNO                  1

F2 - Acquisition Parameters
Date_              20240107
Time                18.42 h
INSTRUM               spect
PROBHD  Z115265_0004 (
PULPROG             zgpg30
TD                   65536
SOLVENT              CDCl3
NS                     106
DS                       4
SWH              29761.904 Hz
FIDRES           0.908261 Hz
AQ               1.1010048 sec
RG                    2050
DW                 16.800 usec
DE                  6.50 usec
TE         0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                      1
SFO1          125.8005413 MHz
NUC1                  13C
P1                   9.70 usec
PLW1          73.00000000 W
SFO2          500.2520010 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2               80.00 usec
PLW2          15.13599968 W
PLW12          0.53924000 W
PLW13          0.27124000 W

F2 - Processing parameters
SI                   32768
SF            125.7879756 MHz
WDW                     EM
SSB       0
LB                   1.00 Hz
GB        0
PC                   1.40
```



$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

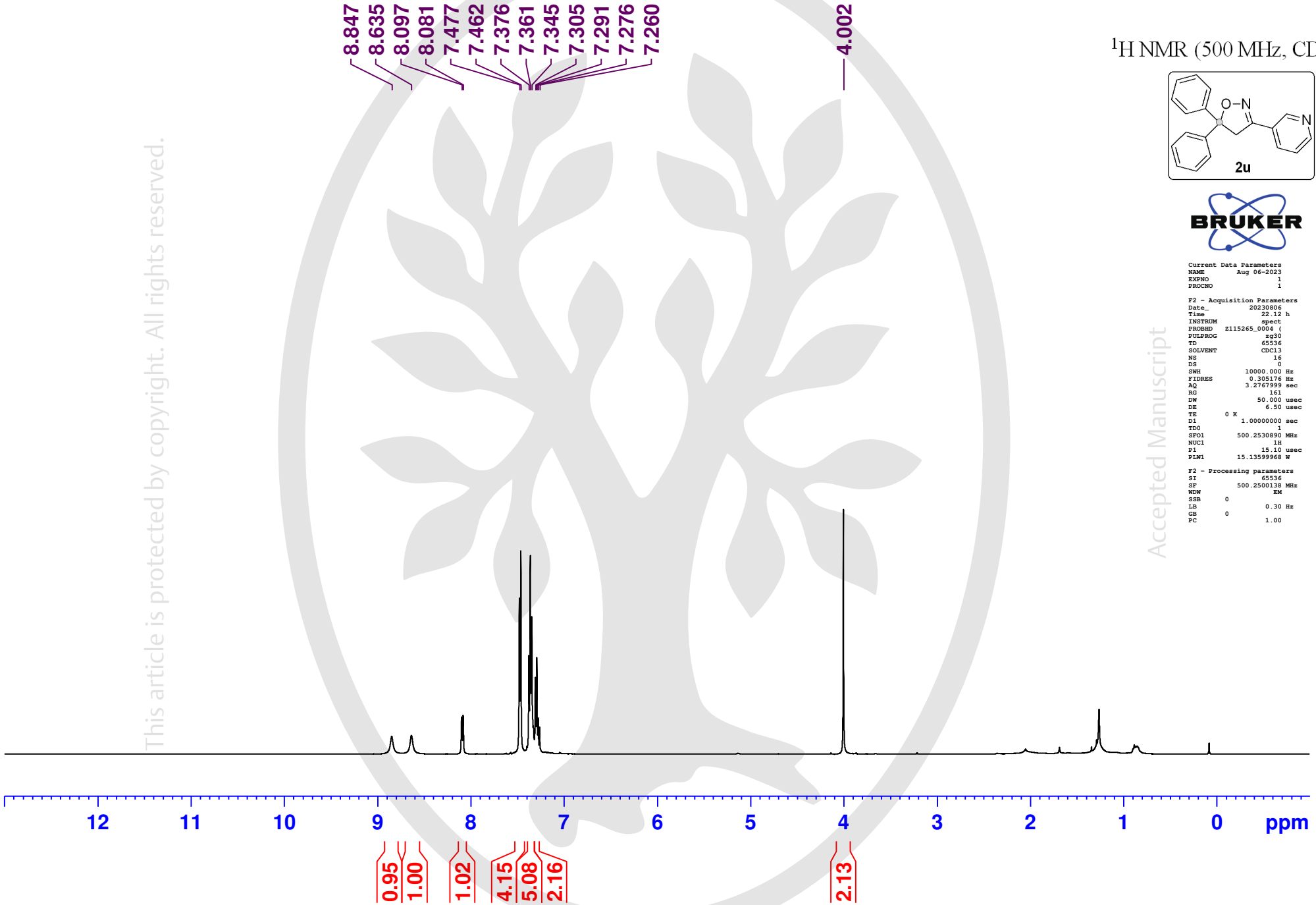


BRUKER

```
Current Data Parameters
NAME        July 15-2023
EXPNO                  6
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230715
Time              22.21 h
INSTRUM             spect
PROBHD  Z115265_0004 (
PULPROG           zgpg30
TD                 65536
SOLVENT             CDCl3
NS                     57
DS                      4
SWH             29761.904 Hz
FIDRES          0.908261 Hz
AQ              1.1010048 sec
RG                   1030
DW                 16.800 usec
DE                  6.50 usec
TE         0 K
D1              2.00000000 sec
D11             0.03000000 sec
TD0                     1
SFO1          125.8005413 MHz
NUC1                  13C
P1                   9.70 usec
PLW1          73.00000000 W
SFO2          500.2520010 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2               80.00 usec
PLW2          15.13599968 W
PLW12          0.53924000 W
PLW13          0.27124000 W

F2 - Processing parameters
SI                   32768
SF            125.7879733 MHz
WDW                    EM
SSB       0
LB                   1.00 Hz
GB        0
PC                   1.40
```



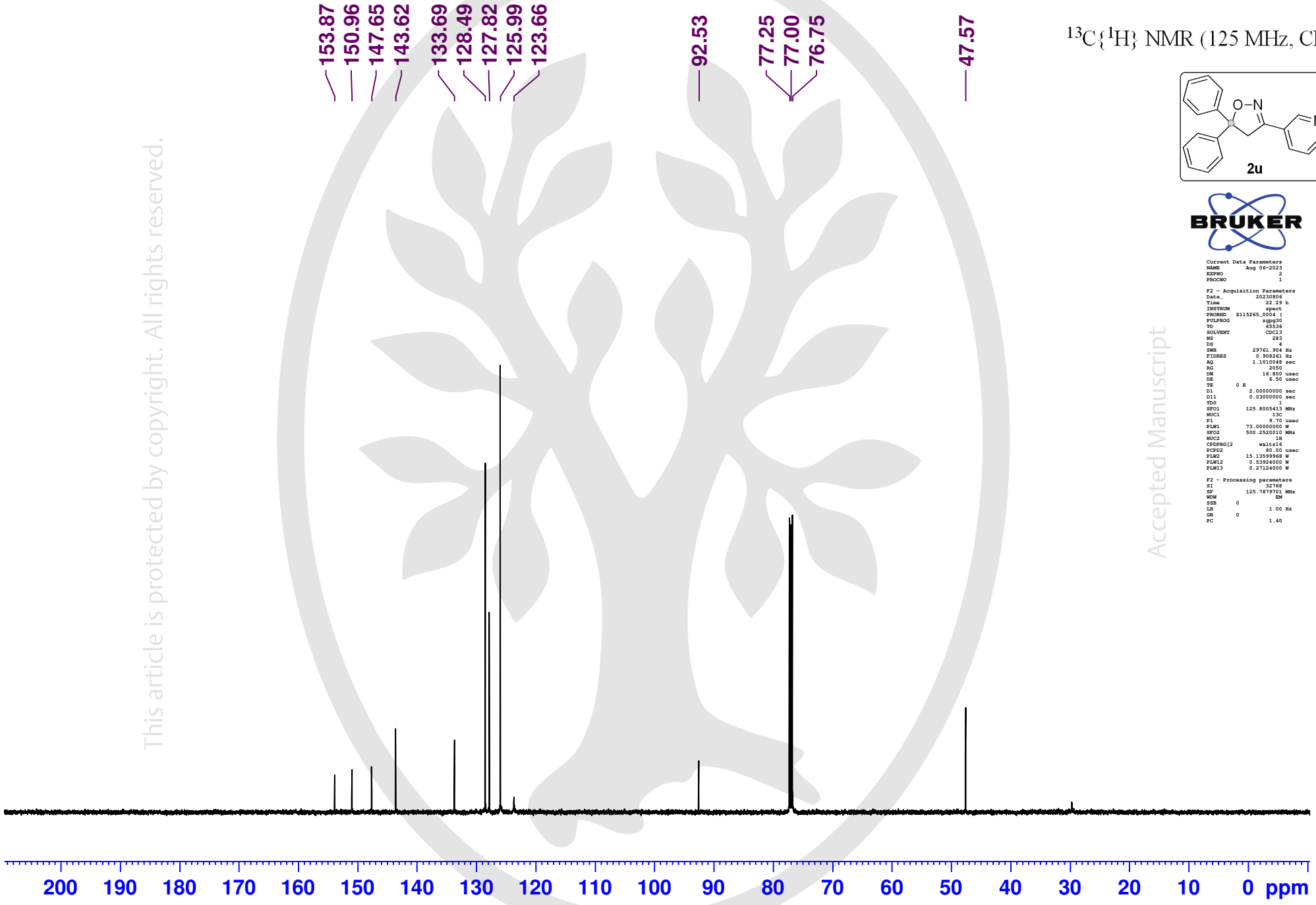
^{1}H NMR (500 MHz, $CDCl_3$)

BRUKER

```
Current Data Parameters
NAME          Aug 06-2023
EXPNO                   1
PROCNO                  1

F2 - Acquisition Parameters
Date_              20230806
Time                 22.12 h
INSTRUM               spect
PROBHD    Z115265_0004 (
PULPROG                zg30
TD                    65536
SOLVENT               CDCl3
NS                       16
DS                        0
SWH               10000.000 Hz
FIDRES                0.305176 Hz
AQ                3.2767999 sec
RG                      161
DW                   50.000 usec
DE                    6.50 usec
TE          0 K
D1             1.00000000 sec
TD0                       1
SFO1           500.2530890 MHz
NUC1                    1H
P1                   15.10 usec
PLW1           15.13599968 W

F2 - Processing parameters
SI                    65536
SF             500.2500138 MHz
WDW                     EM
SSB         0
LB                    0.30 Hz
GB          0
PC                    1.00
```



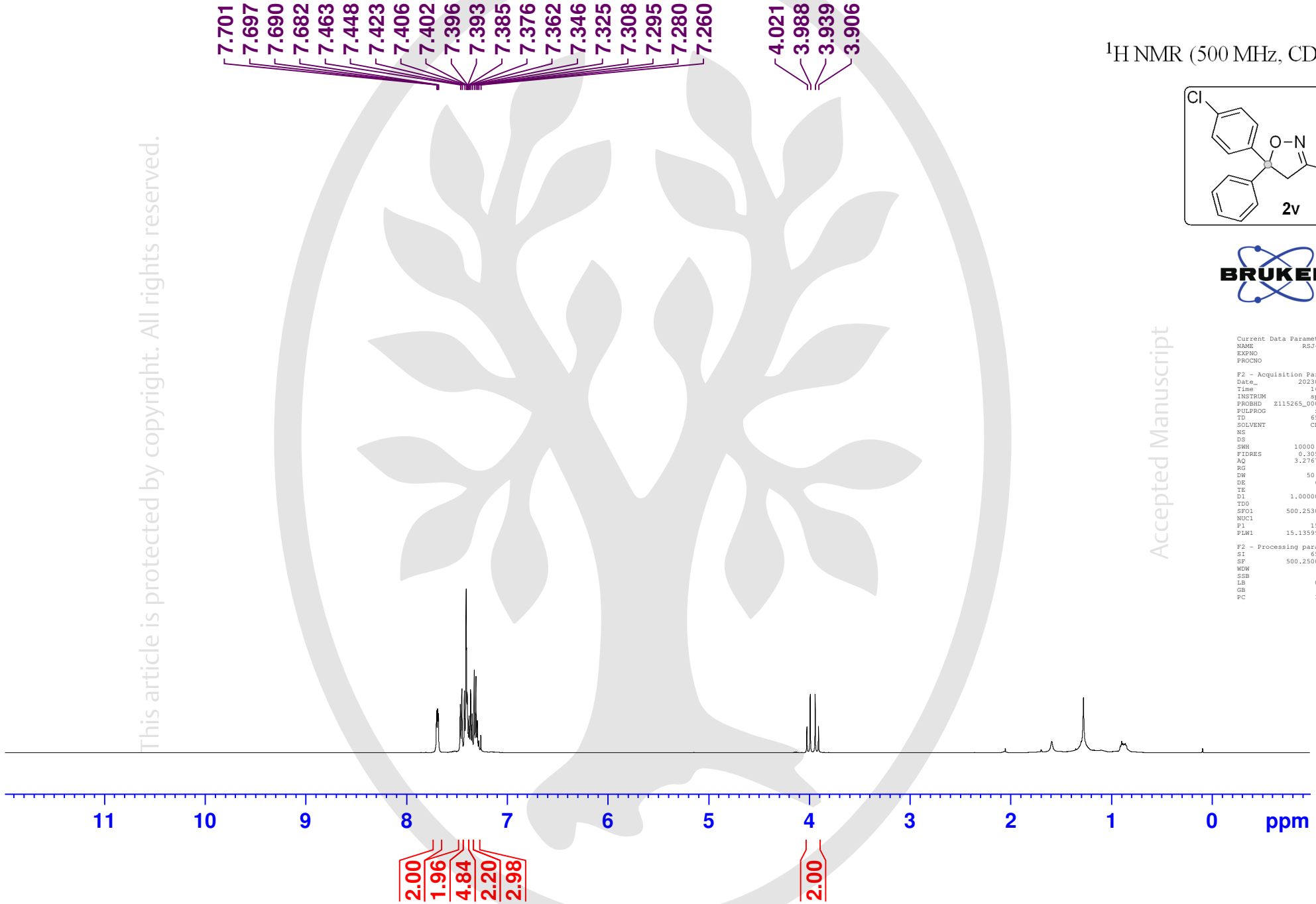
$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

BRUKER

```
Current Data Parameters
NAME         Aug 06-2023
EXPNO                  2
PROCNO                 1

F2 - Acquisition Parameters
Date_           20230806
Time              22.29 h
INSTRUM             spect
PROBHD  Z115265_0004 (
PULPROG           zgpg30
TD                 65536
SOLVENT            CDCl3
NS                   283
DS                     4
SWH           29761.904 Hz
FIDRES        0.908261 Hz
AQ            1.1010048 sec
RG                  2050
DW               16.800 usec
DE                6.50 usec
TE                 0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                    1
SFO1         125.8005413 MHz
NUC1                  13C
P1                 9.70 usec
PLW1         73.00000000 W
SFO2         500.2520010 MHz
NUC2                  1H
CPDPRG[2         waltz16
PCPD2             80.00 usec
PLW2         15.13599968 W
PLW12         0.53924000 W
PLW13         0.27124000 W

F2 - Processing parameters
SI                 32768
SF           125.7879701 MHz
WDW                   EM
SSB                    0
LB                 1.00 Hz
GB                     0
PC                 1.40
```



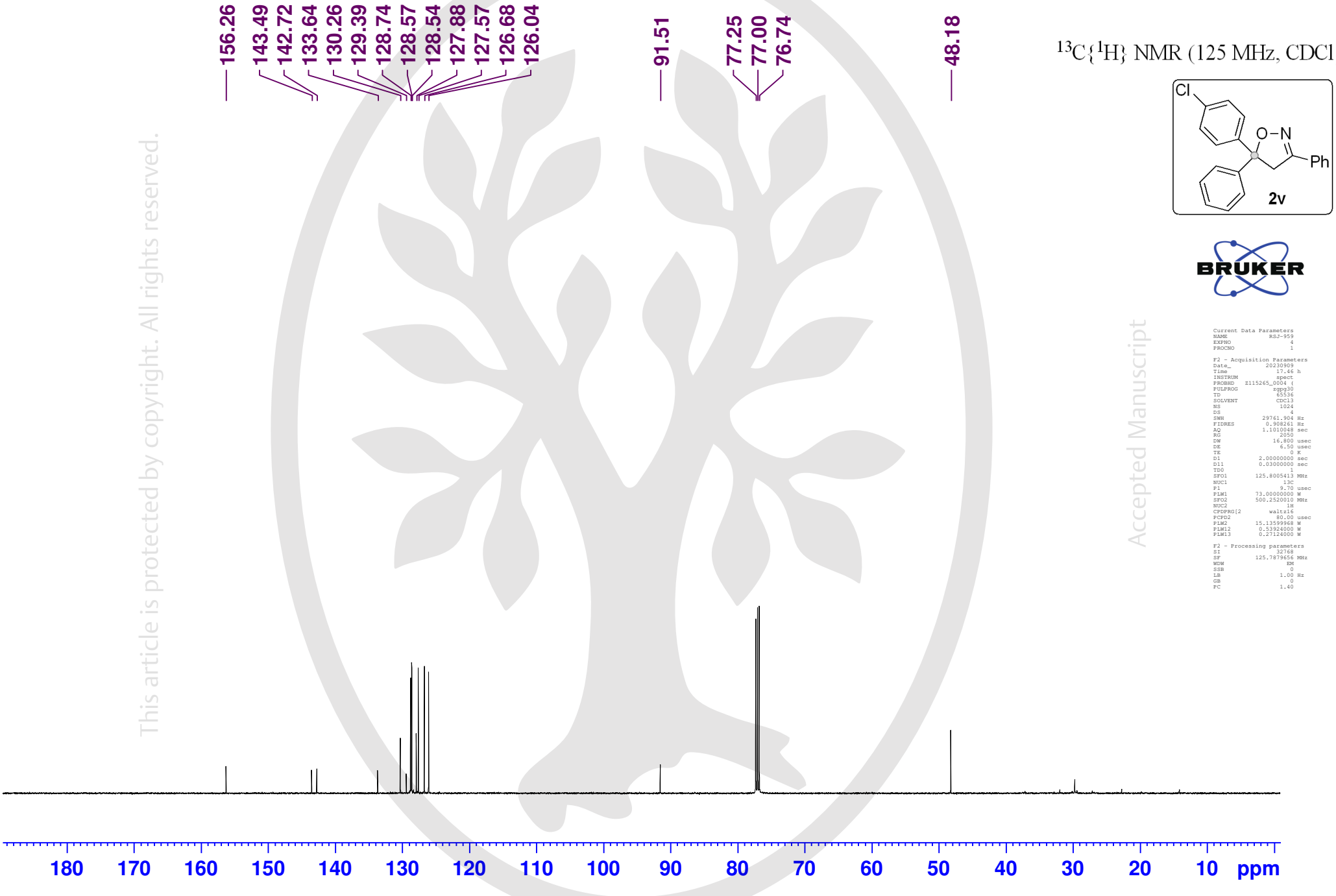
^{1}H NMR (500 MHz, $CDCl_3$)

BRUKER

```
Current Data Parameters
NAME                  RSJ-959
EXPNO                       3
PROCNO                      1

F2 - Acquisition Parameters
Date_              20230909
Time                  16.50 h
INSTRUM                spect
PROBHD    Z115265_0004 (
PULPROG                 zg30
TD                     65536
SOLVENT                CDCl3
NS                        16
DS                         0
SWH               10000.000 Hz
FIDRES                0.305176 Hz
AQ                3.2767999 sec
RG                       144
DW                    50.000 usec
DE                     6.50 usec
TE                        0 K
D1              1.00000000 sec
TD0                        1
SFO1            500.2530890 MHz
NUC1                      1H
P1                    15.10 usec
PLW1            15.13599968 W

F2 - Processing parameters
SI                     65536
SF              500.2500139 MHz
WDW                       EM
SSB                        0
LB                      0.30 Hz
GB                         0
PC                      1.00
```



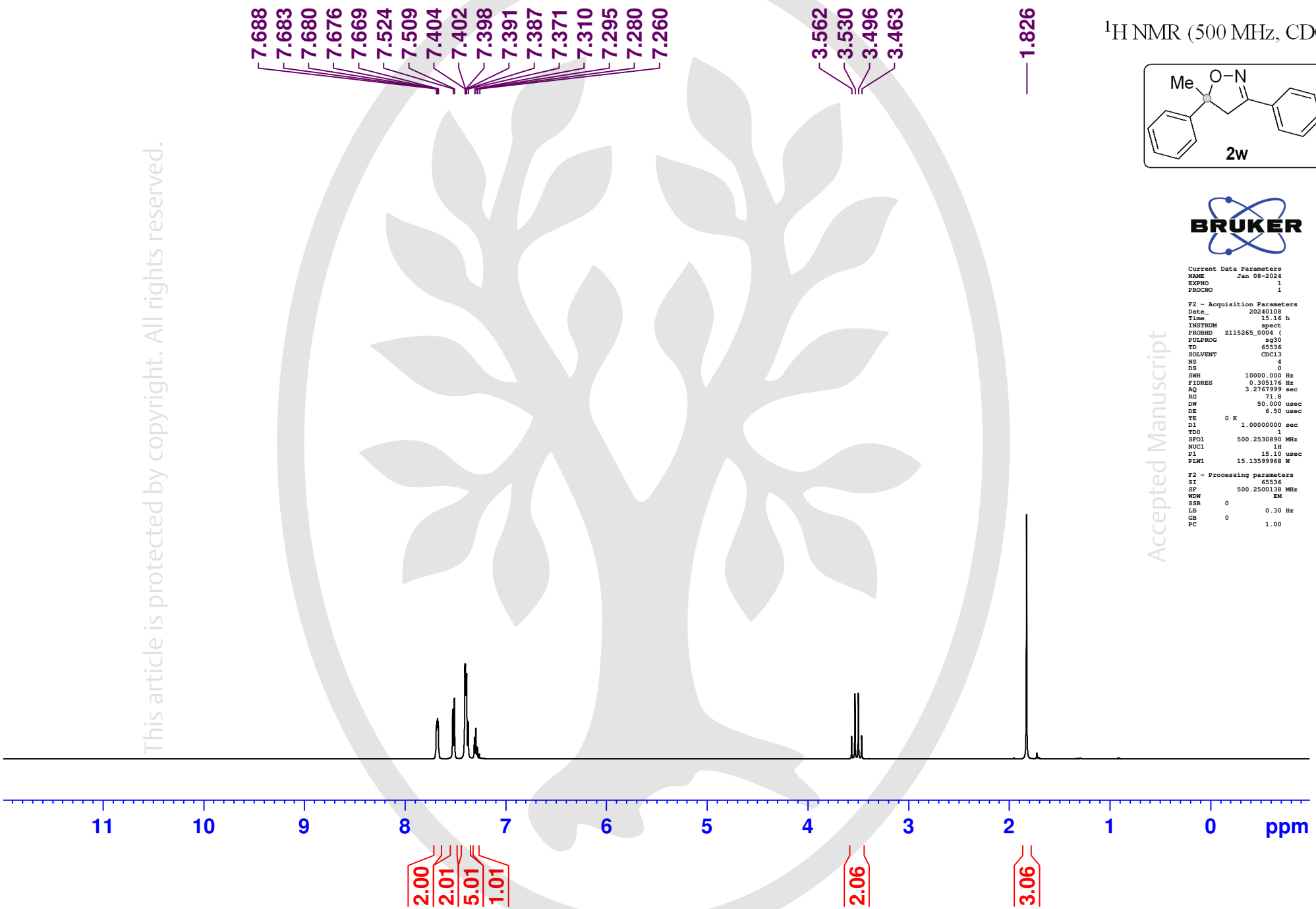
$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

BRUKER

```
Current Data Parameters
NAME                  RSJ-959
EXPNO                       4
PROCNO                      1

F2 - Acquisition Parameters
Date_              20230909
Time                  17.46 h
INSTRUM                 spect
PROBHD    Z115265_0004 (
PULPROG               zgpg30
TD                     65536
SOLVENT                CDCl3
NS                      1024
DS                         4
SWH               29761.904 Hz
FIDRES             0.908261 Hz
AQ                1.1010048 sec
RG                      2050
DW                   16.800 usec
DE                    6.50 usec
TE                       0 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                        1
SFO1           125.8005413 MHz
NUC1                    13c
P1                    9.70 usec
PLW1           73.00000000 W
SFO2           500.2520010 MHz
NUC2                    1H
CPDPRG[2              waltz16
PCPD2                80.00 usec
PLW2           15.13599968 W
PLW12           0.53924000 W
PLW13           0.27124000 W

F2 - Processing parameters
SI                     32768
SF            125.7879656 MHz
WDW                       EM
SSB                        0
LB                    1.00 Hz
GB                         0
PC                    1.40
```



^{1}H NMR (500 MHz, $CDCl_3$)

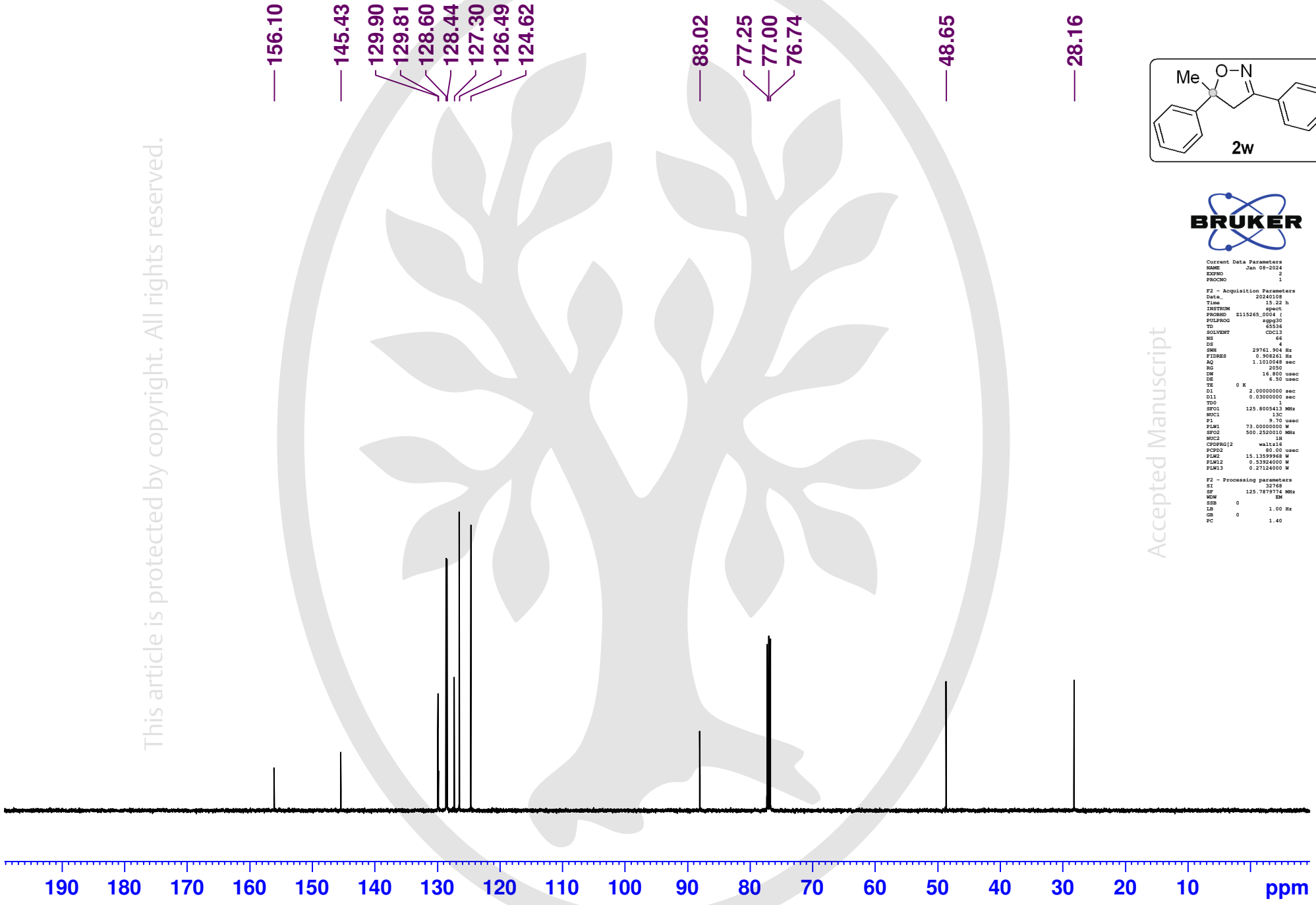
BRUKER

```
Current Data Parameters
NAME          Jan 08-2024
EXPNO                   1
PROCNO                  1

F2 - Acquisition Parameters
Date_              20240108
Time                15.16 h
INSTRUM              spect
PROBHD   Z115265_0004 (
PULPROG                zg30
TD                    65536
SOLVENT               CDCl3
NS                        4
DS                        0
SWH               10000.000 Hz
FIDRES            0.305176 Hz
AQ                3.2767999 sec
RG                      71.8
DW                   50.000 usec
DE                    6.50 usec
TE                    0 K
D1             1.00000000 sec
TD0                       1
SFO1           500.2530890 MHz
NUC1                     1H
P1                    15.10 usec
PLW1           15.13599968 W

F2 - Processing parameters
SI                    65536
SF             500.2500138 MHz
WDW                      EM
SSB                   0
LB                    0.30 Hz
GB                    0
PC                    1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

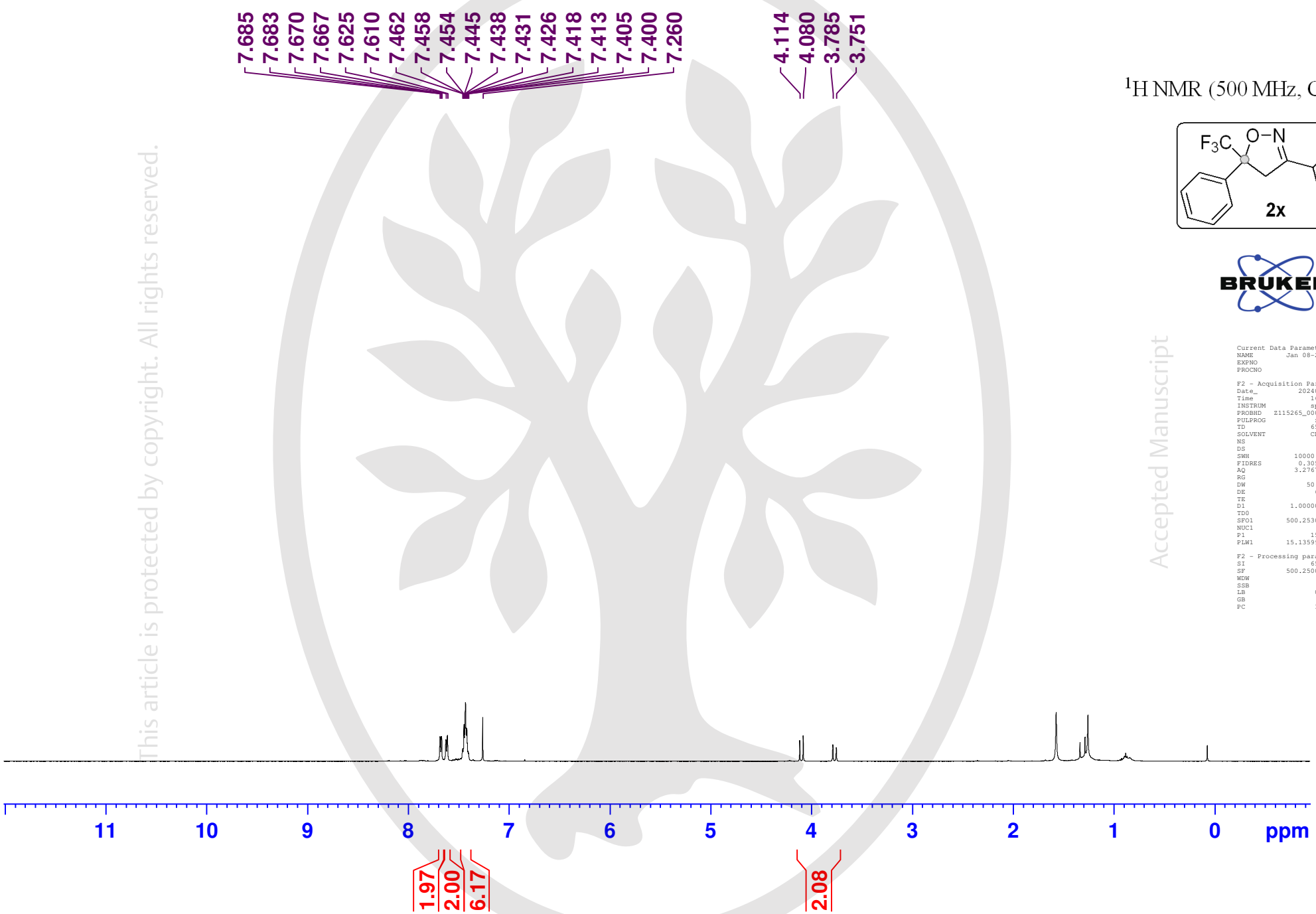


BRUKER

```
Current Data Parameters
NAME        Jan 08-2024
EXPNO               2
PROCNO              1

F2 - Acquisition Parameters
Date_          20240108
Time              15.22 h
INSTRUM            spect
PROBHD  Z115265_0004 (
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                   66
DS                    4
SWH           29761.904 Hz
FIDRES        0.908261 Hz
AQ            1.1010048 sec
RG                 2050
DW               16.800 usec
DE                6.50 usec
TE        0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1
SFO1         125.8005413 MHz
NUC1                 13C
P1                9.70 usec
PLW1         73.00000000 W
SFO2         500.2520010 MHz
NUC2                 1H
CPDPRG[2         waltz16
PCPD2             80.00 usec
PLW2         15.13599968 W
PLW12         0.53924000 W
PLW13         0.27124000 W

F2 - Processing parameters
SI                 32768
SF           125.7879774 MHz
WDW                  EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```



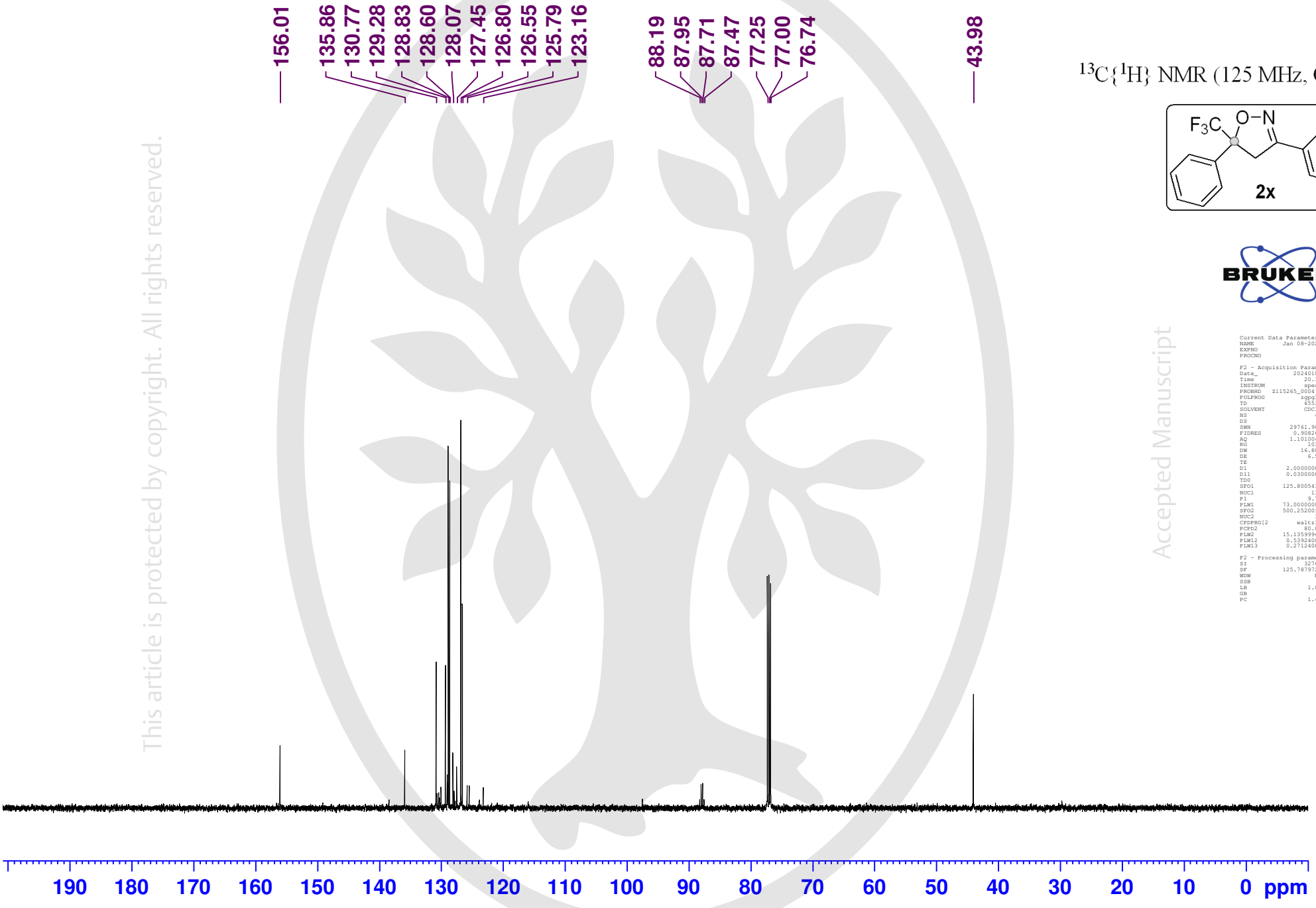
^{1}H NMR (500 MHz, $CDCl_3$)

BRUKER

```
Current Data Parameters
NAME          Jan 08-2024
EXPNO                   3
PROCNO                  1

F2 - Acquisition Parameters
Date_              20240108
Time                 16.44 h
INSTRUM               spect
PROBHD    Z115265_0004 (
PULPROG                zg30
TD                    65536
SOLVENT               CDCl3
NS                        8
DS                        0
SWH              10000.000 Hz
FIDRES               0.305176 Hz
AQ                3.2767999 sec
RG                      287
DW                   50.000 usec
DE                    6.50 usec
TE                       0 K
D1              1.00000000 sec
TD0                       1
SFO1             500.2530890 MHz
NUC1                     1H
P1                    15.10 usec
PLW1             15.13599968 W

F2 - Processing parameters
SI                    65536
SF               500.2500138 MHz
WDW                      EM
SSB                       0
LB                     0.30 Hz
GB                        0
PC                     1.00
```



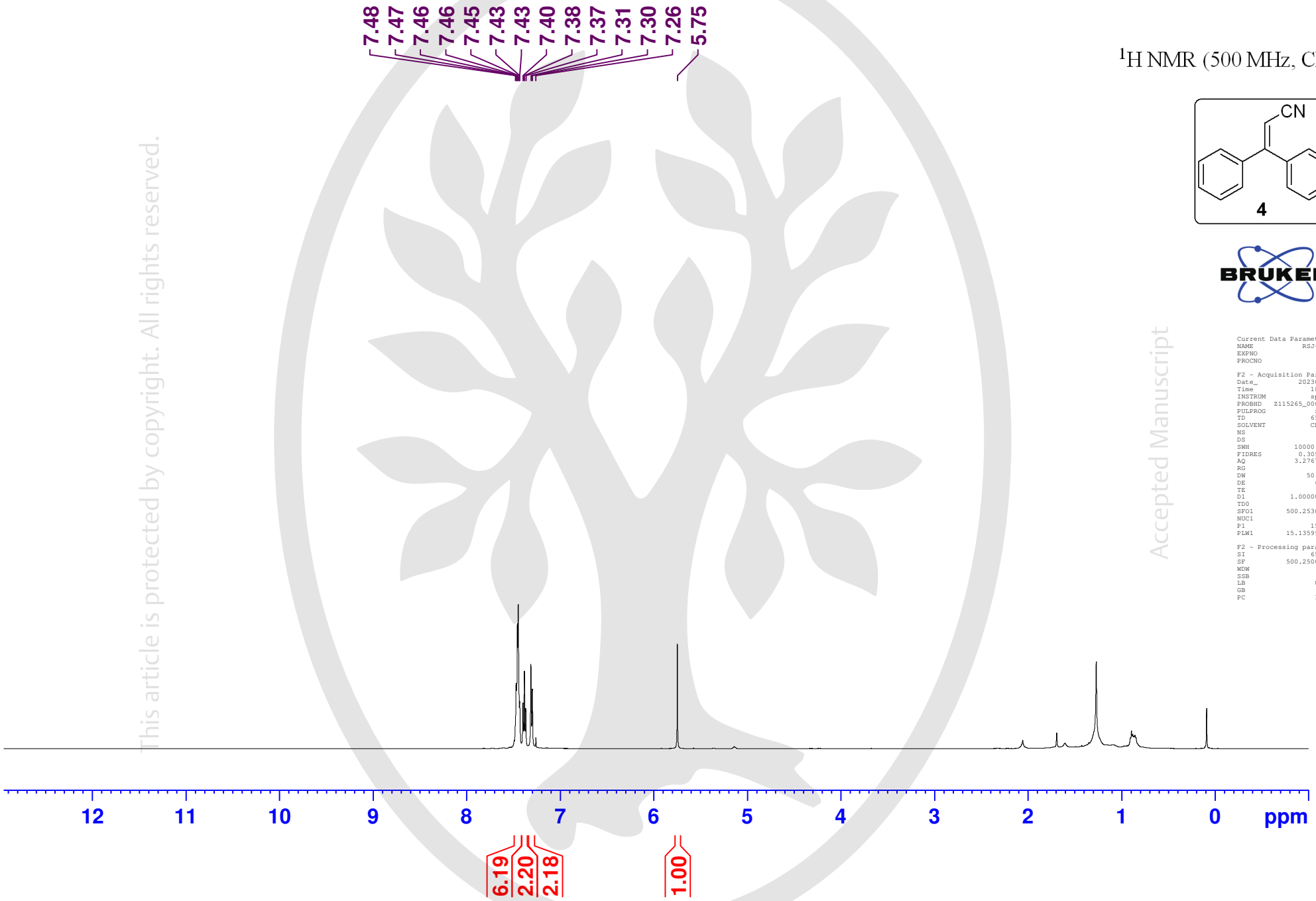
$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

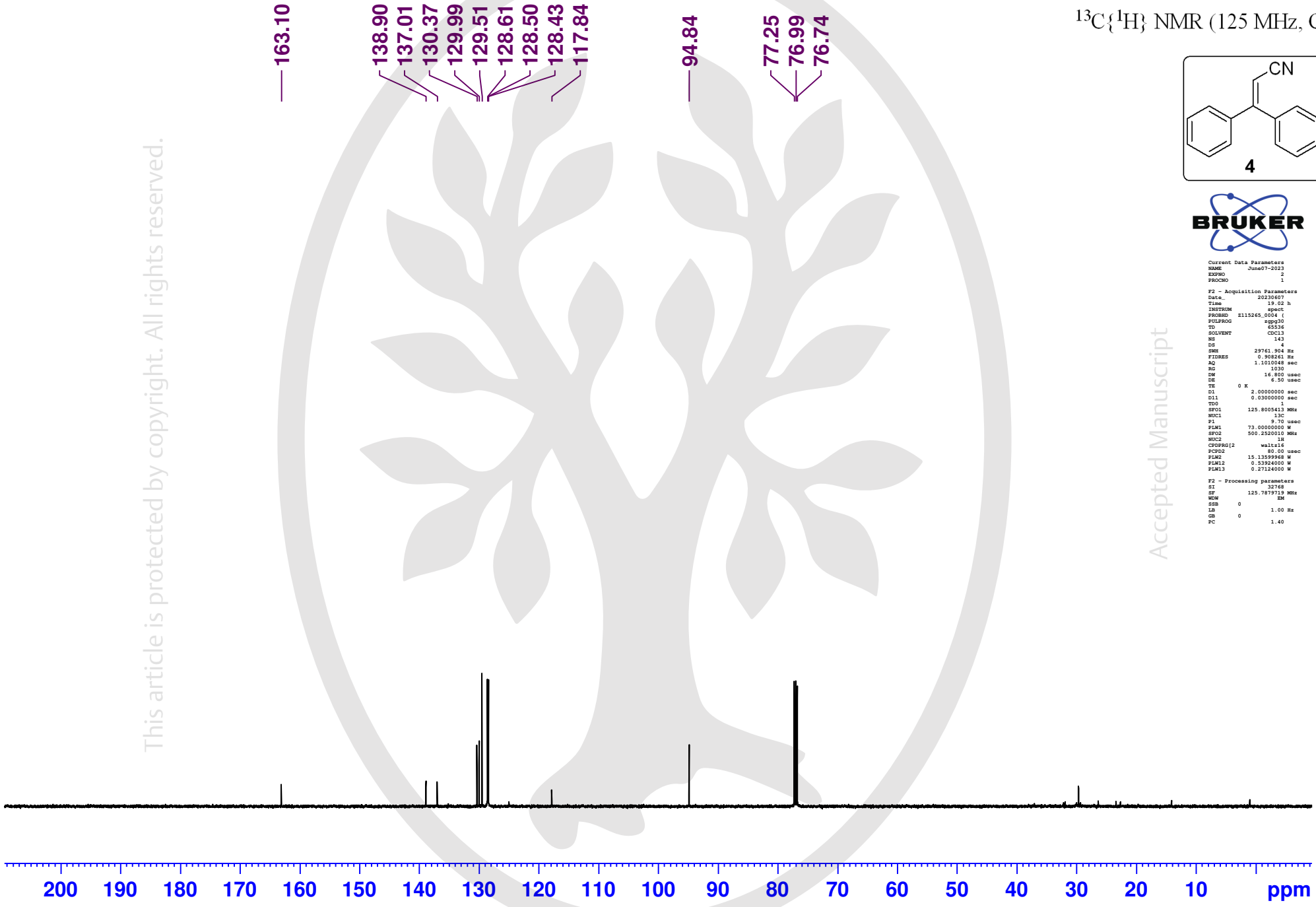
BRUKER

```
Current Data Parameters
NAME          Jan 08-2024
EXPNO                   6
PROCNO                  1

F2 - Acquisition Parameters
Date_              20240108
Time                 20.31 h
INSTRUM                spect
PROBHD    Z115265_0004 (
PULPROG              zgpg30
TD                    65536
SOLVENT               CDCl3
NS                       48
DS                        4
SWH               29761.904 Hz
FIDRES             0.908261 Hz
AQ                1.1010048 sec
RG                     1030
DW                  16.800 usec
DE                   6.50 usec
TE                      0 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                       1
SFO1           125.8005413 MHz
NUC1                    13c
P1                    9.70 usec
PLW1           73.00000000 W
SFO2           500.2520010 MHz
NUC2                    1H
CPDPRG[2              waltz16
PCPD2                80.00 usec
PLW2           15.13599968 W
PLW12           0.53924000 W
PLW13           0.27124000 W

F2 - Processing parameters
SI                    32768
SF             125.7879729 MHz
WDW                     EM
SSB                      0
LB                    1.00 Hz
GB                       0
PC                    1.40
```





$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)

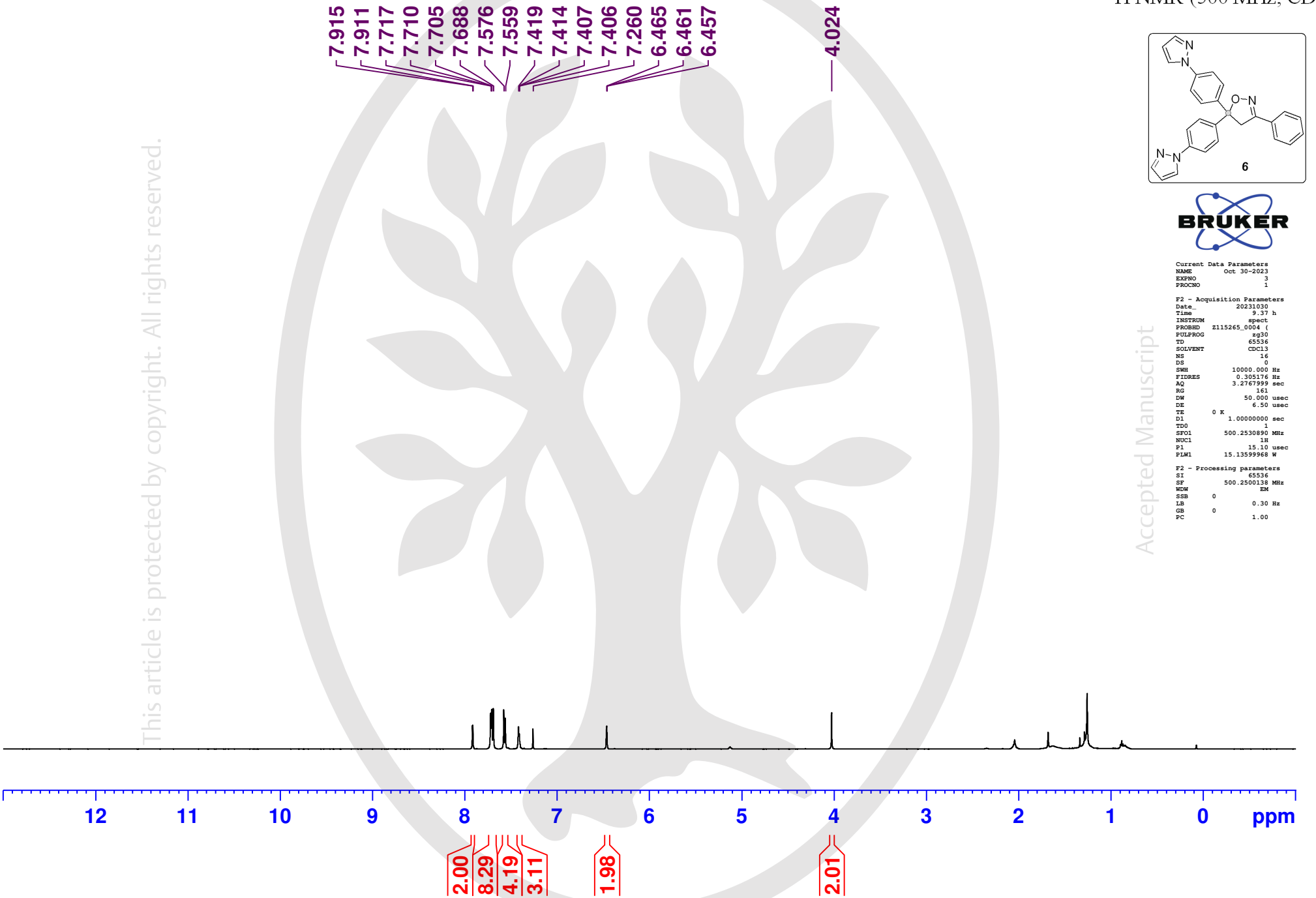
BRUKER

```
Current Data Parameters
NAME          June07-2023
EXPNO                   2
PROCNO                  1

F2 - Acquisition Parameters
Date_              20230607
Time                19.02 h
INSTRUM               spect
PROBHD  Z115265_0004 (
PULPROG             zgpg30
TD                   65536
SOLVENT              CDCl3
NS                     143
DS                       4
SWH              29761.904 Hz
FIDRES           0.908261 Hz
AQ               1.1010048 sec
RG                    1030
DW                 16.800 usec
DE                  6.50 usec
TE         0 K
D1              2.00000000 sec
D11             0.03000000 sec
TD0                      1
SFO1           125.8005413 MHz
NUC1                   13C
P1                   9.70 usec
PLW1           73.00000000 W
SFO2           500.2520010 MHz
NUC2                   1H
CPDPRG[2           waltz16
PCPD2               80.00 usec
PLW2           15.13599968 W
PLW12           0.53924000 W
PLW13           0.27124000 W

F2 - Processing parameters
SI                    32768
SF             125.7879719 MHz
WDW                     EM
SSB          0
LB                   1.00 Hz
GB           0
PC                   1.40
```

^{1}H NMR (500 MHz, $CDCl_3$)



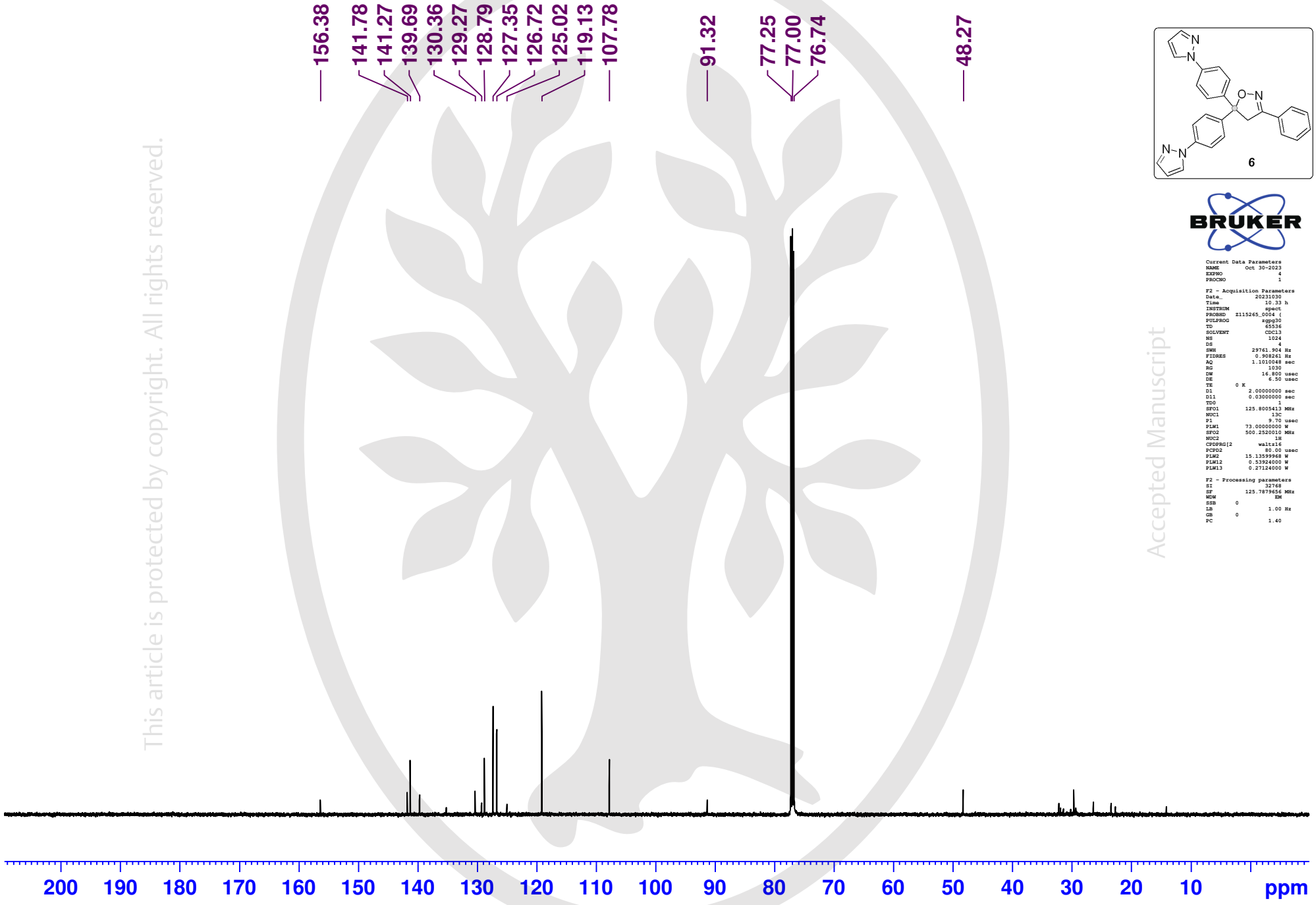
BRUKER

```
Current Data Parameters
NAME          Oct 30-2023
EXPNO                   3
PROCNO                  1

F2 - Acquisition Parameters
Date_              20231030
Time                9.37 h
INSTRUM              spect
PROBHD   Z115265_0004 (
PULPROG                zg30
TD                    65536
SOLVENT               CDCl3
NS                       16
DS                        0
SWH               10000.000 Hz
FIDRES                0.305176 Hz
AQ                3.2767999 sec
RG                      161
DW                   50.000 usec
DE                    6.50 usec
TE                  0 K
D1                1.00000000 sec
TD0                       1
SFO1           500.2530890 MHz
NUC1                     1H
P1                   15.10 usec
PLW1           15.13599968 W

F2 - Processing parameters
SI                    65536
SF             500.2500138 MHz
WDW                     EM
SSB                   0
LB                    0.30 Hz
GB                    0
PC                    1.00
```

$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$)



BRUKER

```
Current Data Parameters
NAME          Oct 30-2023
EXPNO                   4
PROCNO                  1

F2 - Acquisition Parameters
Date_              20231030
Time                 10.33 h
INSTRUM                spect
PROBHD     Z115265_0004 (
PULPROG              zgpg30
TD                    65536
SOLVENT               CDCl3
NS                     1024
DS                        4
SWH               29761.904 Hz
FIDRES            0.908261 Hz
AQ                1.1010048 sec
RG                      1030
DW                  16.800 usec
DE                   6.50 usec
TE                  0 K
D1                2.00000000 sec
D11               0.03000000 sec
TD0                        1
SFO1           125.8005413 MHz
NUC1                     13C
P1                    9.70 usec
PLW1           73.00000000 W
SFO2           500.2520010 MHz
NUC2                     1H
CPDPRG[2           waltz16
PCPD2                80.00 usec
PLW2           15.13599968 W
PLW12           0.53924000 W
PLW13           0.27124000 W

F2 - Processing parameters
SI                     32768
SF           125.7879656 MHz
WDW                       EM
SSB                0
LB                    1.00 Hz
GB                 0
PC                    1.40
```