Supporting Information for:

Automated reaction progress monitoring of heterogeneous reactions: Crystallization-induced stereoselectivity in amine-catalyzed aldol reactions

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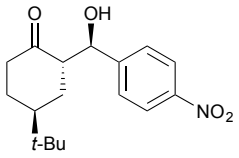
General Experimental Procedure

All reagents and solvents were purchased from Fisher Scientific, Alfa Aesar and VWR and were used without further purification. NMR spectra were recorded on a Bruker spectrospin 300 Instrument (300MHz and 75MHz for 1H and 13C, respectively) or on an Agilent (400MHz and 100 MHz for 1H and 13C, respectively) and were calibrated with the solvent ($CDCl_3$: 7.26ppm for 1H NMR and 77.00 for 13C NMR). NMR spectra were analyzed by using the software MNova. The LC/MS samples were analyzed by UPLC/MS conducted on an Agilent 1290 Infinity and a ES quadrupole Agilent 6150 under the following conditions: Poroshell 120 SB-C18, 2.1 x 100 mm, 2.7 µm column; Temperature = 25 ºC; Solvent A = water, 0.05 % trifluoroacetic acid; Solvent B = acetonitrile, 0.05 % trifluoroacetic acid; Flow Rate = 0.700 mL/min; Starting Conditions = 90 % A, 10 % B; 0.1 min, 80 % A; 2.3-4 min = 0 % A. ES quadrupole LC-MS 6150

The chiral LC samples (≈ 1 mg/mL) were analyzed on a Chiracel® AS-RH reverse phase chiral column (4.6mm ID x 250 mm, 5µ pore size, Chiral Technologies) with a 8:2 MeCN:H_2O mixture as mobile phase at 0.4 mL/min.

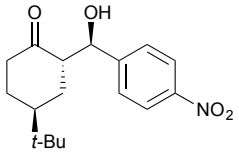
Synthesis



(*rac*)-**11**

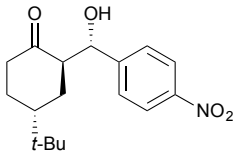
4-(tert-butyl)-2-(hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one - (*rac*)-11 : 4-(*tert*-butyl)cyclohexanone (16.84 g, 109 mmol) was dissolved in MTBE (125 mL) then 4-nitrobenzaldehyde (15 g, 99 mmol) and pyrrolidine (16,49 mL, 199 mmol) were added. The reaction mixture was stirred overnight at RT then the solid was filtered, washed with MTBE (3x) then dried under vacuum to give 10.52 g (35% yield) of a white powder. ^{1}H NMR (300MHz, $CDCl_3$): δ = 0.78 (s, 9H), 1.38-1.61 (m, 3H), 1.94-1.98 (m ,1H), 2,37-2.46 (m, 1H), 2.50-2.56 (m, 1H), 2.63-2.69 (m, 1H), 3.61-3.62 (m, 1H), 4.94-4.97 (d, 1H), 7.53-7.55 (m, 2H), 8.22-8.24 (m, 2H). ^{13}C NMR (75MHz, $CDCl_3$): δ = 24.07, 26.85, 26.99, 32.89, 39.31,

54.24, 74.00, 123.69, 127.75, 147.74, 148.49, 215.81. MS ESI+ (calc. for C17H23NO4, 305.16): m/z = 288.2 $[M-H_2O+H]^+$, 328.2 $[M+Na]^+$.



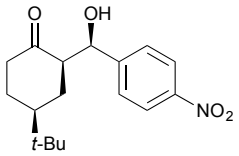
(*enantiopure*)-**11**

(2S,4S)-4-(tert-butyl)-2-((R)-hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one (*S,S,R*-11): 4-(tert-butyl)cyclohexanone (6.4 g, 41.5 mmol) was dissolved in MTBE (70 mL) then 4-nitrobenzaldehyde (5.7 g, 37.7 mmol), L-proline (0.8 g, 6.95 mmol) and glass beads (50 g) were added. The reaction mixture was stirred at 500 rpm for 3 days at RT then the solid was filtered, washed with MTBE (3x) and water (3x) then dried under vacuum to give 7.0 g (61% yield, *ee* > 99.5 %) of (2S,4S)-4-(tert-butyl)-2-((R)-hydroxy(4-nitrophenyl)-methyl)cyclohexan-1-one as a white powder. ^{1}H NMR (300MHz, $CDCl_3$): δ = 0.78 (s, 9H), 1.34-1.64 (m, 3H), 1.95-2.00 (m ,1H), 2,37-2.46 (m, 1H), 2.50-2.56 (m, 1H), 2,63-2.68 (m, 1H), 3.62-3.63 (s, 1H), 4.95-4.97 (d, 1H), 7.53-7.55 (m, 2H), 8.22-8.24 (m, 2H). ^{13}C NMR (75MHz, $CDCl_3$): δ = 24.09, 26.86, 26.99, 32.89, 39.31, 42,37, 54.27, 73.99, 123.70, 127.75, 147.72, 148.50, 215.83. MS ESI+ (calc. for C17H23NO4, 305.16): m/z = 288.2 $[M-H_2O+H]^+$, 328.2 $[M+Na]^+$.



(*enantiopure*)-**11**

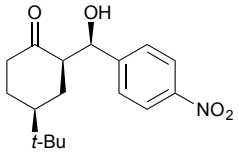
(2R,4R)-4-(tert-butyl)-2-((S)-hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one (*R,R,S*-11): Identical experimental procedure as for **(*S,S,R*-11)**, substituting D-proline as the organocatalyst. ^{1}H NMR (300MHz, $CDCl_3$): δ = 0.84 (s, 9H), 1.34-1.64 (m, 3H), 1.95-2.00 (m ,1H), 2,37-2.46 (m, 1H), 2.50-2.56 (m, 1H), 2,63-2.68 (m, 1H), 3.62-3.63 (m, 1H), 4.94-4.97 (m, 1H), 7.53-7.55 (m, J=8.67 Hz, 2H), 8.22-8.24 (m, J=8.72 Hz, 2H). ^{13}C NMR (75MHz, $CDCl_3$): δ =24.09, 26.86, 26.99, 32.89, 39.31, 42.37, 74.00, 123.70, 127.75, 147.73, 148.49, 215.82. MS ESI+ (calc. for C17H23NO4, 305.16): m/z = 288.2 $[M-H_2O+H]^+$, 328.2 $[M+Na]^+$



(*rac*)-**12**

4-(tert-butyl)-2-(hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one - (*rac*)-12: Racemic anti 4-(tert-butyl)-2-(hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one (1.5 g, 4.91 mmol) was suspended in DMSO (12.28 ml) then pyrrolidine (0.082 ml, 0.982 mmol) was added. The reaction mixture was stirred at RT for 24 h then the crude product was purified on silicagel (petroleum ether/ethyl acetate 9/1) to give 1,40 g (93% yield) of racemic 4-(tert-butyl)-2-(hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one as a colorless solid. ^{1}H NMR (300MHz, $CDCl_3$): δ = 0.81 (s, 9H), 1.44-1.67 (m, 3H), 2.10-2.15 (m, 1H), 2.36-2.52 (m, 2H), 2.62-2.67

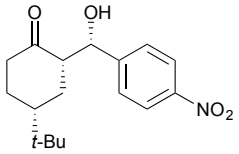
(m, 1H), 3.11 (s, 1H), 5.48 (s, 1H), 7.48-7.51 (d, J=8.3 Hz, 2H), 8.20-8.23 (d, J=8.7 Hz, 2H). MS ESI+ (calc. for C17H23NO4, 305.16): m/z = 288.1 $[M-H_2O+H]^+$, 328.1 $[M+Na]^+$



(*enantipure*)-**12**

(**2R,4S)-4-(tert-butyl)-2-((R)-hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one:**

(*R,S,R*-12): (2S,4S)-4-(tert-butyl)-2-((R)-hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one **11** (1 g, 3.27 mmol) was suspended in DMSO (4.00 ml) then pyrrolidine (0.027 ml, 0.327 mmol) was added. The reaction mixture was stirred at RT for 4 days then the crude product was purified on silicagel (petroleum ether/EtOAc 10/0 to 85/15) to give 0.63 g (63% yield, *ee* > 99%) as a colorless solid. ^{1}H NMR (300MHz, $CDCl_3$): δ = 0.80 (s, 9H), 1.42-1.63 (m, 3H), 2.07-2.13 (m, 1H), 2.39-2.49 (m, 2H), 2.62-2.68 (m, 1H), 3.19-3.20 (d, 1H), 5.47 (s, 1H), 7.47-7.50 (d, J=8.6 Hz, 2H), 8.17-8.20 (d, J=8.8 Hz, 2H). ^{13}C NMR (75MHz, $CDCl_3$): δ = 26.77, 27.56, 28.58, 32.60, 41.83, 46.52, 55.87, 70.19, 123.45, 126.63, 147.02, 149.25, 214.23. MS ESI+ (calc. for C17H23NO4, 305.16): m/z = 288.2 $[M-H_2O+H]^+$, 328.1 $[M+Na]^+$



(*enantipure*)-**12**

(**2S,4R)-4-(tert-butyl)-2-((S)-hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one:**

(*S,R,S*-12) - (2R,4R)-4-(tert-butyl)-2-((S)-hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one **11** (1 g, 3.27 mmol) was suspended in DMSO (4.09 ml) then pyrrolidine (0.027 ml, 0.327 mmol) was added. The reaction mixture was stirred at RT for one week then the crude product was purified on silicagel (petroleum ether/EtOAc 10/0 to 85/15) to give 0.42 g (42% yield, *ee* > 99%) as a colorless solid. ^{1}H NMR (300MHz, $CDCl_3$): δ = 0.80 (s, 9H), 1.43-1.66 (m, 3H), 2.10-2.12 (m, 1H), 2.35-2.50 (m, 2H), 2.66-2.67 (m, 1H), 3.16-3.16 (d, 1H), 5.48 (s, 1H), 7.47-7.50 (d, J=8.2 Hz, 2H), 8.19-8.22 (d, J=8.7 Hz, 2H). ^{13}C NMR (75MHz, $CDCl_3$): δ = 26.77, 27.57, 28.60, 32.60, 41.84, 46.53, 55.87, 70.20, 123.47, 126.63, 147.02, 149.22, 214.27. MS ESI+ (calc. for C17H23NO4, 305.16): m/z = 288.1 $[M-H_2O+H]^+$, 328.2 $[M+Na]^+$

Easy Sampler Actuator Controller – Gilson Interface

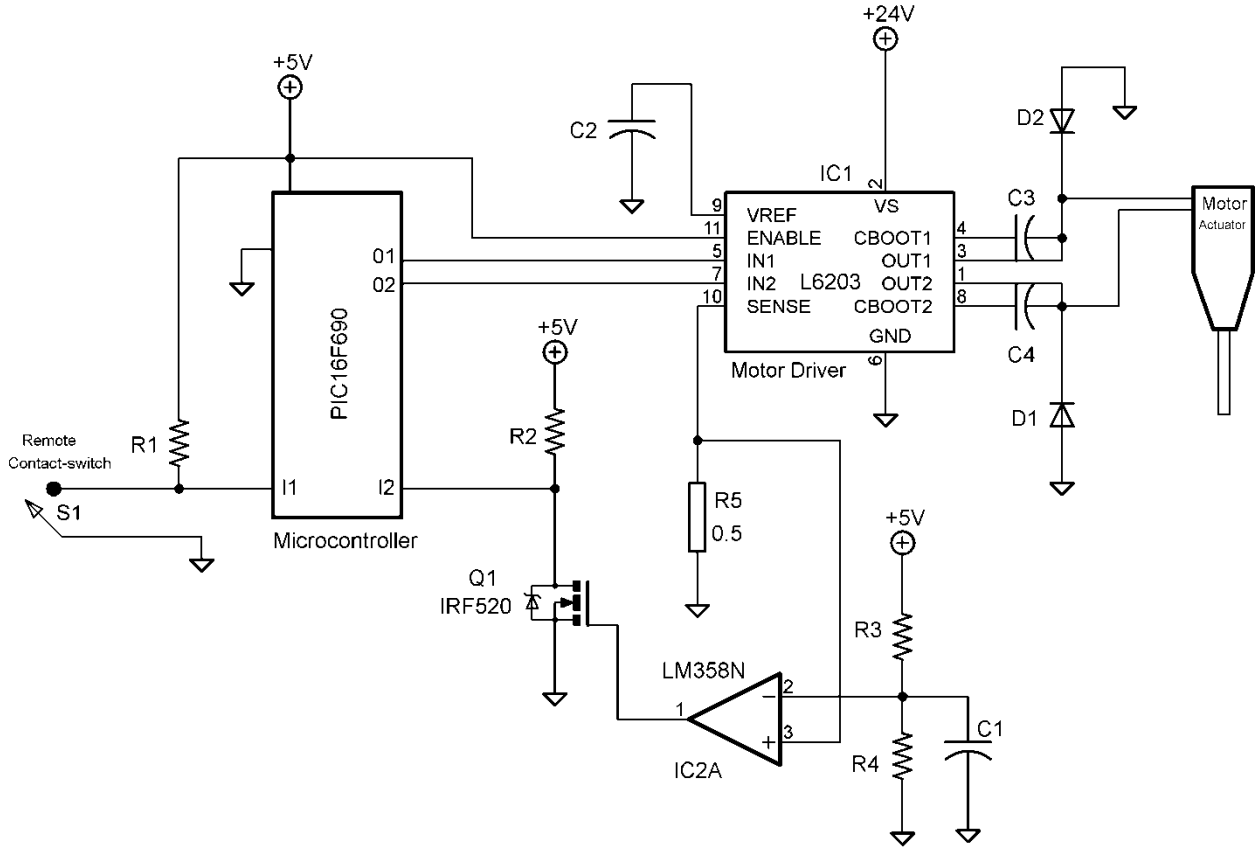


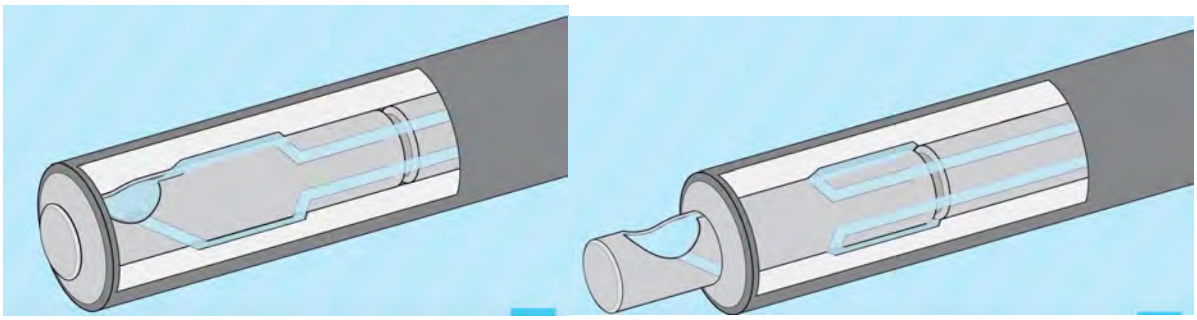
Figure S1: Circuit diagram of actuator controller

The actuator is a motor driven scoop, with the CW/CCW motion of the motor the scoop goes DOWN and UP, capturing 20μL of reaction sample from the reactor. The above circuit controls the actuator motion, upon receiving a signal from a remotely located switch, which is the output relay from the Gilson GX-281. The first switch ON/OFF makes the actuator extend down and the second signal makes will retract the sample tip. The control circuit is implemented using a microcontroller (PIC16F690), a comparator (IC2A, LM358), a motor driver (IC1, L6203) and other discrete components such as resistors, capacitors and a transistor as needed. The microcontroller is programmed to accept the input signal from the remote-switch and gives out two output signals to the motor driver for CW and CCW rotation. As there are no limit switches inside the actuator, the extreme ends of the actuator are detected by sensing the current through the motor. When the actuator reaches of the stroke, the motor stops as a result of the armature current going higher than that for the motor in motion. For the specific actuator, we found that the normal operational current is ~ 700 mA; when the stroke limit is reached the current goes to a little over ~1000 mA. A sense resistor (R5) is used to detect the over-at each limit. The voltage divider resistors (R3 and R4) connected to the comparator are chosen such that, when the motor-current is ~800 mA or less the comparator output remains low. Whenever the current goes ~1A or higher the output goes high. A proper logic high and low level for the microcontroller is translated by a MOSFET transistor, Q1. Upon receiving the high current signal the microcontroller stops sending output signal to motor driver. Two power supplies are used, a 5V supply is used to power the microcontroller, comparator and the logic level translator. A 24V supply is used by the motor driver to adequately drive the motor-actuator.

EasySampler Probe Function and Geometry

The sampling head consists of a Hasteloy sampling pocket housed inside a PTFE sleeve. While in the closed position (Figure S2; left) the sampling pocket is housed inside the shaft of the probe head. A linear actuator drives the head into the reaction media allowing the sampling pocket to be exposed to the media (Figure S2; right). This process can be visualized in an animation published on YouTube.

https://www.youtube.com/watch?v=IMVZw3wMhU0



Closed Open

Figure S2: Cut-away schematic for the EasySampler Probe head. Figure illustrates both the closed (left) and open (right) geometries of the sampler.

Crystal structures

CIF files for all crystal structures reported here have been uploaded to the Cambridge Crystallization Data Center – Reference codes for each are located in the data table

The single crystal X-ray diffraction studies were carried out on a Bruker Kappa APEX II CCD diffractometer equipped with Cu K_α radiation (λ = 1. 54178). The data were integrated using the Bruker SAINT software program and scaled using the SADABS and TWINABS software programs. Solution by direct methods (SHELXT) produced a complete phasing model consistent with the proposed structure.

All nonhydrogen atoms were refined anisotropically by full-matrix least-squares (SHELXL). The solvent hydroxyl hydrogen atom was found via the difference map and the bond distance was restrained relative to the parent oxygen atom using the appropriate DFIX command in SHELXL. All remaining hydrogen atoms were placed using a riding model. Their positions were constrained relative to their parent atom using the appropriate HFIX command in SHELXL.

Crystal structure of the anhydrous racemic anti 4-(tert-butyl)-2-(hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one:

Single crystals were obtained from slow evaporation of a solution of racemic material in methanol.

Table S-1. Crystal data of the anhydrous racemic anti 4-(tert-butyl)-2-(hydroxy(4-nitrophenyl)-methyl)cyclohexan-1-one

Compound reference	(*Rac*)-**11**
Chemical formula	C17 H23 N O4
Formula Mass	305.36
CCSD reference #	1518449
Crystal system	Monoclinic
a/Å	10.6988(5)
b/Å	6.7233(3)
c/Å	22.0228(10)
α/°	90
β/°	97.913(3)
γ/°	90
Unit cell volume/Å^3	1569.04(12)
Calculated density	1.293
Temperature/K	100
Space group	$P2_1/n$
No. of formula units per unit cell, *Z, Z'*	4, 1
Data / restraints / parameters	2879 / 1 / 207
Final R_1 values ($I > 2\sigma(I)$)	0.0618
Final $wR(F^2)$ values ($I > 2\sigma(I)$)	0.1798
Final R_1 values (all data)	0.0653
Final $wR(F^2)$ values (all data)	0.1834
Goodness of fit on F^2	1.051

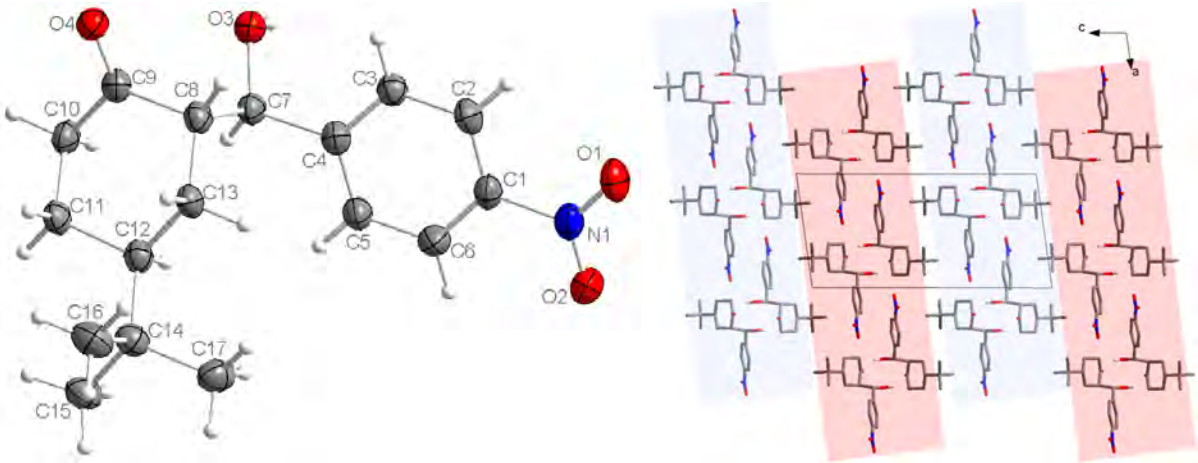


Figure S-1. Left: asymmetric unit of the racemic anhydrous phase, and right: projections along *b* axis showing the stacking of homochiral slices in anhydrous racemic compound.

Crystal structure of the DMSO solvate of racemic anti 4-(tert-butyl)-2-(hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one:

Single crystals were obtained from slow cooling of a solution of racemic material in DMSO.

Table S-2. Crystal data of the DMSO solvate of the racemic anti 4-(tert-butyl)-2-(hydroxy(4-nitrophenyl)-methyl)cyclohexan-1-one

Compound reference	(*Rac*)-**11** - DMSO
Chemical formula	C19 H29 N O5 S
Formula Mass	383.49
CCSD reference #	1518460
Crystal system	Monoclinic
a/Å	22.9497(11)
b/Å	10.3144(5)
c/Å	17.5465(9)
α/°	90
β/°	100.7980(19)
γ/°	90
Unit cell volume/Å^3	4079.9(3)
Calculated density	1.249
Temperature/K	296
Space group	*C*2/c
No. of formula units per unit cell, *Z, Z'*	8, 1
Data / restraints / parameters	3846 / 0 / 245
Final R_1 values ($I > 2\sigma(I)$)	0.0403
Final $wR(F^2)$ values ($I > 2\sigma(I)$)	0.1142
Final R_1 values (all data)	0.0422
Final $wR(F^2)$ values (all data)	0.1164
Goodness of fit on F^2	1.056

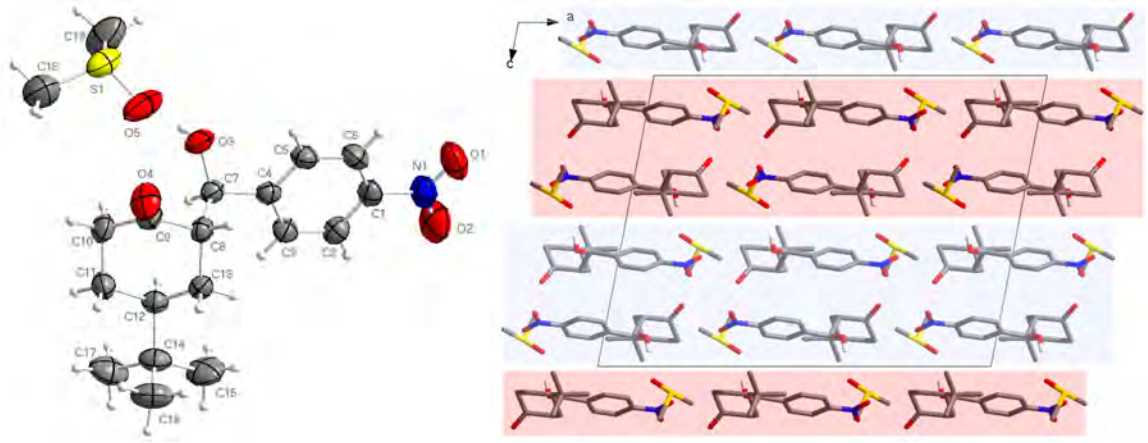


Figure S-2. Left: asymmetric unit of the DMSO solvate, and right: projections along *b* axis showing the stacking of homochiral slices in the DMSO solvate.

(2*S*,4*S*)-4-(tert-butyl)-2-((*R*)-hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one:
Single crystals were obtained from slow cooling of a solution of the (2*S*,4*S*)-4-(tert-butyl)-2-((*R*)-hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one in chloroform.

Table S-3. Crystal data of the (2*S*,4*S*)-4-(tert-butyl)-2-((*R*)-hydroxy(4-nitrophenyl)methyl) cyclohexan-1-one

Compound reference	(*S,S,R*)-**11**
Chemical formula	C17 H23 N O4
Formula Mass	305.36
CCDC Reference #	1518461
Crystal system	Orthorhombic
a/Å	6.7333(3)
b/Å	10.6583(5)
c/Å	21.8918(11)
α/°	90
β/°	90
γ/°	90
Unit cell volume/Å^3	1571.08(13)
Calculated density	1.291
Temperature/K	100
Space group	$P2_12_12_1$
No. of formula units per unit cell, *Z, Z'*	4, 1
Data / restraints / parameters	2829 / 1 / 206
Final R_1 values ($I > 2\sigma(I)$)	0.0296
Final $wR(F^2)$ values ($I > 2\sigma(I)$)	0.0768
Final R_1 values (all data)	0.0304
Final $wR(F^2)$ values (all data)	0.0778
Goodness of fit on F^2	1.060

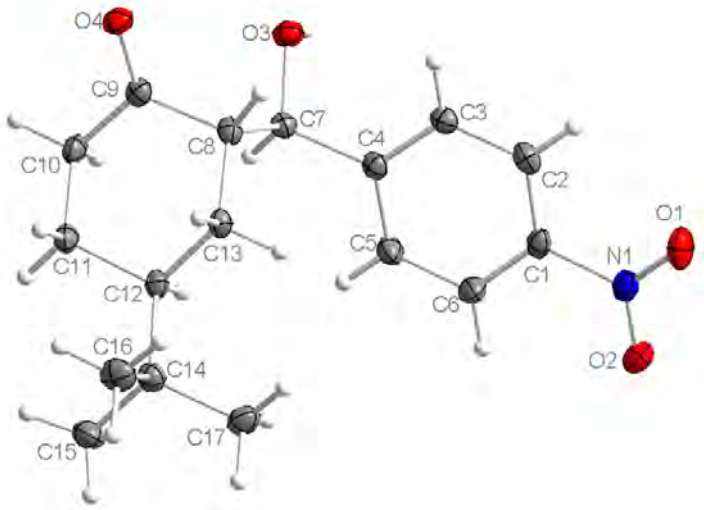


Figure S-3. Asymmetric unit of the (2*S*,4*S*)-4-(tert-butyl)-2-((*R*)-hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one.

(2*R*,4*R*)-4-(tert-butyl)-2-((*S*)-hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one:

Single crystals were obtained from slow cooling of a solution of the (2*R*,4*R*)-4-(tert-butyl)-2-((*S*)-hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one in chloroform.

Table S-4. Crystal data of the (2*R*,4*R*)-4-(tert-butyl)-2-((*S*)-hydroxy(4-nitrophenyl)methyl) cyclohexan-1-one

Compound reference	(*R,R,S*)-**11**
Chemical formula	C17 H23 N O4
Formula Mass	305.36
CCDC Reference #	1518463
Crystal system	Orthorhombic
a/Å	6.7249(8)
b/Å	10.6574(10)
c/Å	21.866(3)
α/°	90
β/°	90
γ/°	90
Unit cell volume/Å^3	1567.1(3)
Calculated density	1.294
Temperature/K	100
Space group	$P2_12_12_1$
No. of formula units per unit cell, *Z, Z'*	4, 1
Data / restraints / parameters	2816 / 1 / 206
Final R_1 values ($I > 2\sigma(I)$)	0.0440
Final $wR(F^2)$ values ($I > 2\sigma(I)$)	0.1214
Final R_1 values (all data)	0.0452
Final $wR(F^2)$ values (all data)	0.1226
Goodness of fit on F^2	1.066

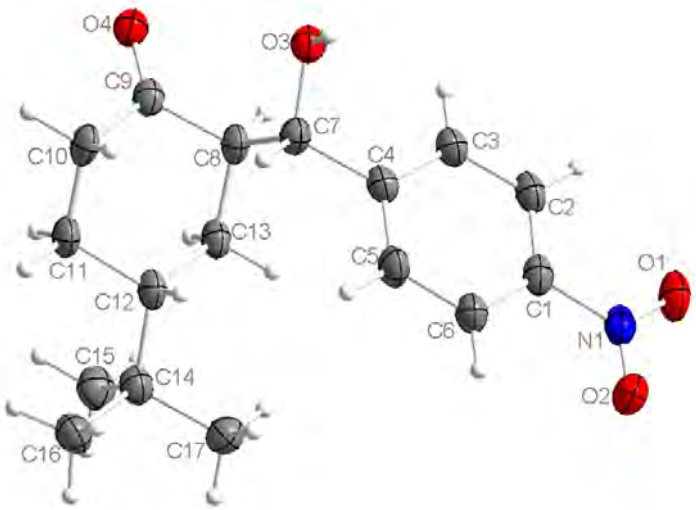


Figure S-4. Aasymmetric unit of the (2*R*,4*R*)-4-(tert-butyl)-2-((*S*)-hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one.

(2R,4S)-4-(tert-butyl)-2-((R)-hydroxy(4-nitrophenyl)-methyl)cyclohexan-1-onecyclohexan-1-one:
Single crystals were obtained by evaporation from a dichloromethane solution

Table S-5. Crystal data of the (2R,4S)-4-(tert-butyl)-2-((R)-hydroxy(4-nitrophenyl)-methyl)cyclohexan-1-onecyclohexan-1-one

Compound reference	*(R,S,R)*-**12**
Chemical formula	C17 H23 N O4
Formula Mass	305.36
CCDC Reference #	1518464
Crystal system	Orthorhombic
a/Å	8.53290(10)
b/Å	9.00540(10)
c/Å	21.1167(3)
α/°	90
β/°	90
γ/°	90
Unit cell volume/Å^3	1622.65(3)
Calculated density	1.250
Temperature/K	296
Space group	$P2_12_12_1$
No. of formula units per unit cell, *Z, Z'*	4, 1
Data / restraints / parameters	2956 / 0 / 203
Final R_1 values ($I > 2\sigma(I)$)	0.0448
Final $wR(F^2)$ values ($I > 2\sigma(I)$)	0.1182
Final R_1 values (all data)	0.0526
Final $wR(F^2)$ values (all data)	0.1275
Goodness of fit on F^2	0.887

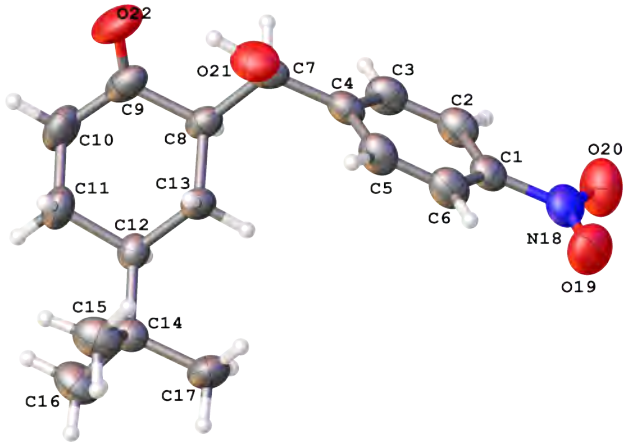


Figure S-5. Asymmetric unit of the (2R,4S)-4-(tert-butyl)-2-((R)-hydroxy(4-nitrophenyl)-methyl)cyclohexan-1-onecyclohexan-1-one

(2S,4R)-4-(tert-butyl)-2-((S)-hydroxy(4-nitrophenyl)-methyl)cyclohexan-1-onecyclohexan-1-one:

Single crystals were obtained by evaporation from a dichloromethane solution

Table S-6. Crystal data of the (2S,4R)-4-(tert-butyl)-2-((S)-hydroxy(4-nitrophenyl)-methyl)cyclohexan-1-onecyclohexan-1-one

Compound reference	(*S,R,S*)-**12**
Chemical formula	C17 H23 N O4
Formula Mass	305.36
CCDC Reference #	1518466
Crystal system	Orthorhombic
a/Å	8.5316(1)
b/Å	9.0058(1)
c/Å	21.1190(3)
α/°	90
β/°	90
γ/°	90
Unit cell volume/Å^3	1622.65(4)
Calculated density	1.250
Temperature/K	296
Space group	$P2_12_12_1$
No. of formula units per unit cell, *Z, Z'*	4, 1
Data / restraints / parameters	2938 / 0 / 203
Final R_1 values ($I > 2\sigma(I)$)	0.0453
Final $wR(F^2)$ values ($I > 2\sigma(I)$)	0.1261
Final R_1 values (all data)	0.0499
Final $wR(F^2)$ values (all data)	0.1184
Goodness of fit on F^2	0.967

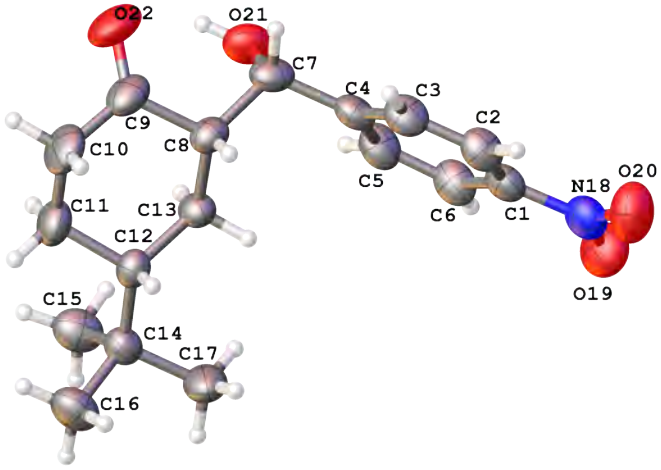


Figure S-6. Asymmetric unit of the (2S,4R)-4-(tert-butyl)-2-((S)-hydroxy(4-nitrophenyl)-methyl)cyclohexan-1-onecyclohexan-1-one

Racemic 4-(tert-butyl)-2-(hydroxy(4-nitrophenyl)-methyl)cyclohexan-1-onecyclohexan-1-one:

Single crystals were obtained by evaporation from a dichloromethane solution

Table S-7. Crystal data of the (2R,4S)-4-(tert-butyl)-2-((R)-hydroxy(4-nitrophenyl)-methyl)cyclohexan-1-onecyclohexan-1-one

Compound reference	(*Rac*)-**12**
Chemical formula	C17 H23 N O4
Formula Mass	305.36
CCDC Reference #	1518465
Crystal system	Monoclinic
a/Å	21.1435(15)
b/Å	5.9117(4)
c/Å	26.304(2)
α/°	90
β/°	91.427(2)
γ/°	90
Unit cell volume/Å^3	3286.8(4)
Calculated density	1.234
Temperature/K	296
Space group	*C2/c*
No. of formula units per unit cell, *Z, Z'*	8, 1
Data / restraints / parameters	3612 / 0 / 203
Final R_1 values ($I > 2\sigma(I)$)	0.0578
Final $wR(F^2)$ values ($I > 2\sigma(I)$)	0.1771
Final R_1 values (all data)	0.0850
Final $wR(F^2)$ values (all data)	0.1972
Goodness of fit on F^2	1.279

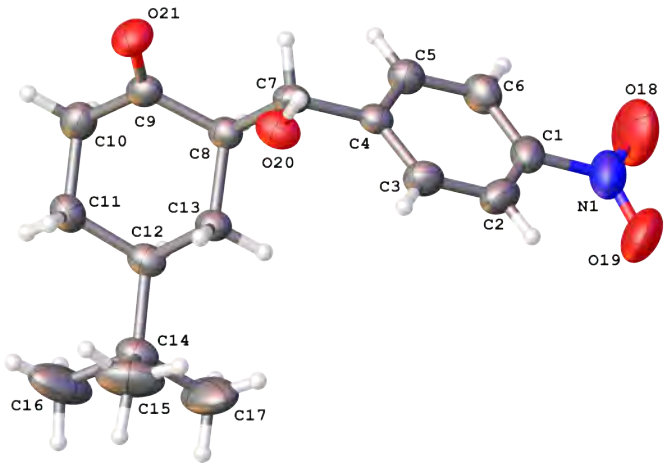
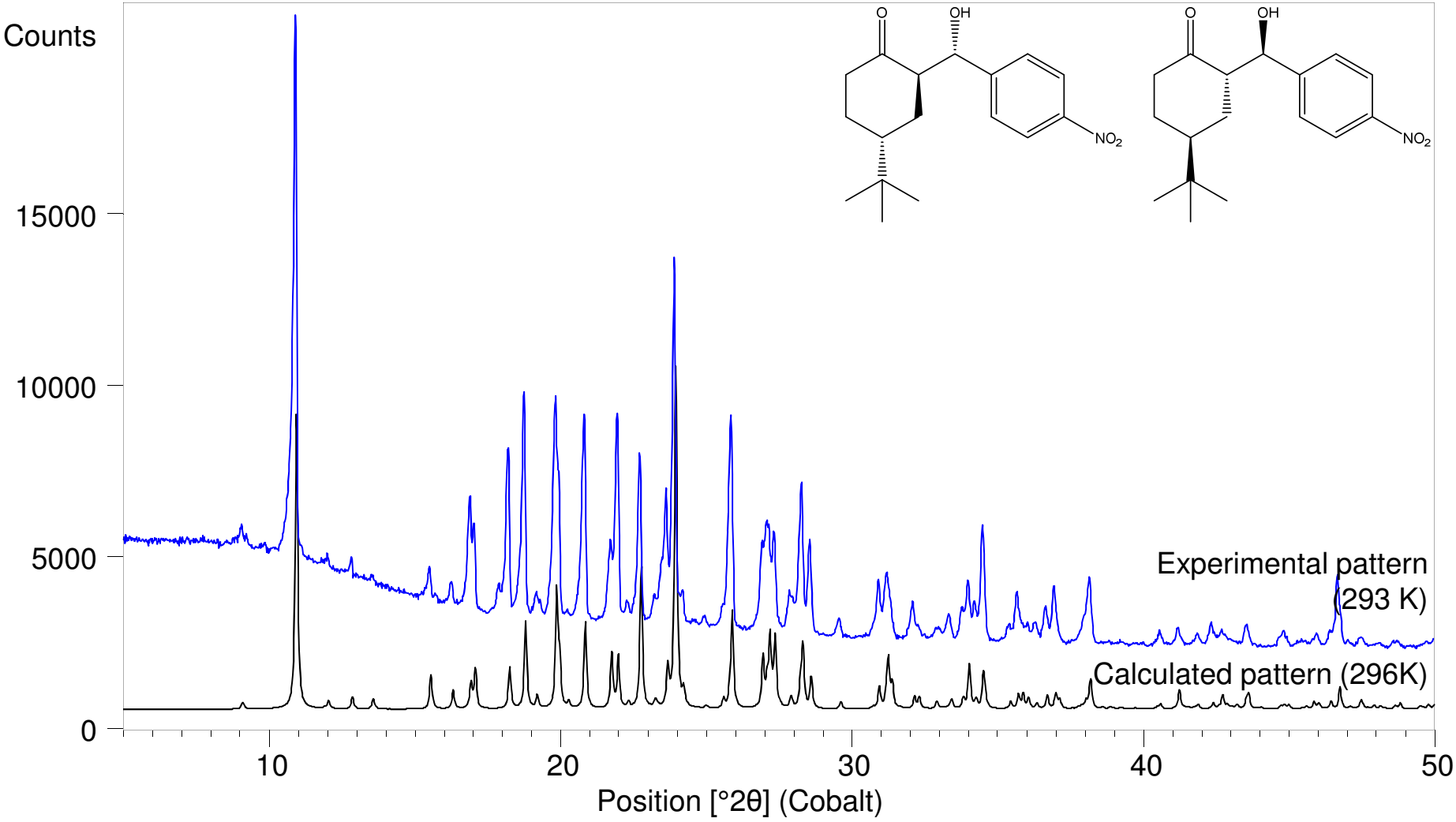
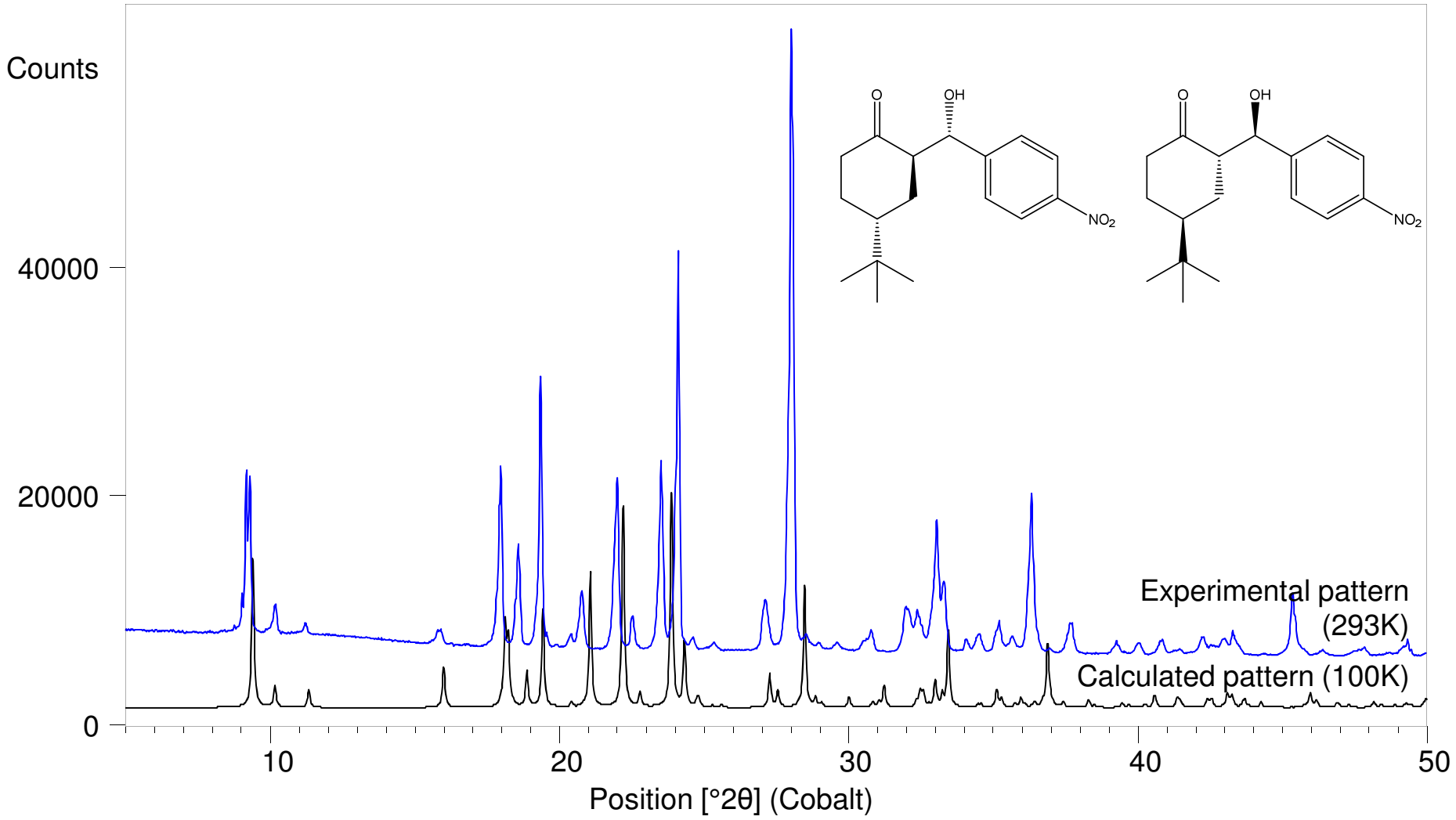


Figure S-7. Asymmetric unit of the racemic 4-(tert-butyl)-2-(hydroxy(4-nitrophenyl)-methyl)cyclohexan-1-onecyclohexan-1-one

Racemic mixture, DMSO solvate, *C*2/c

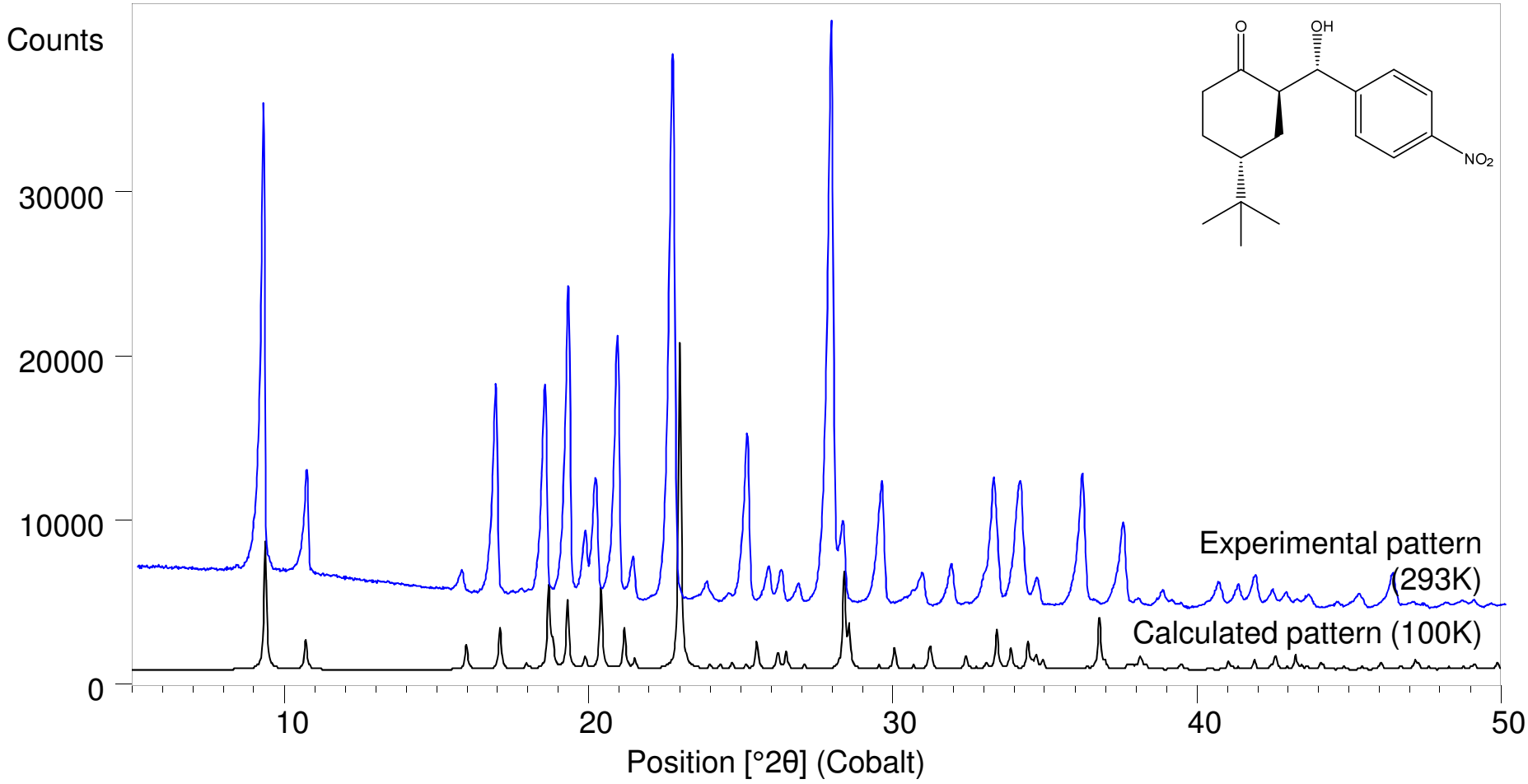


Racemic mixture, anhydrous solid, $P2_1/n$



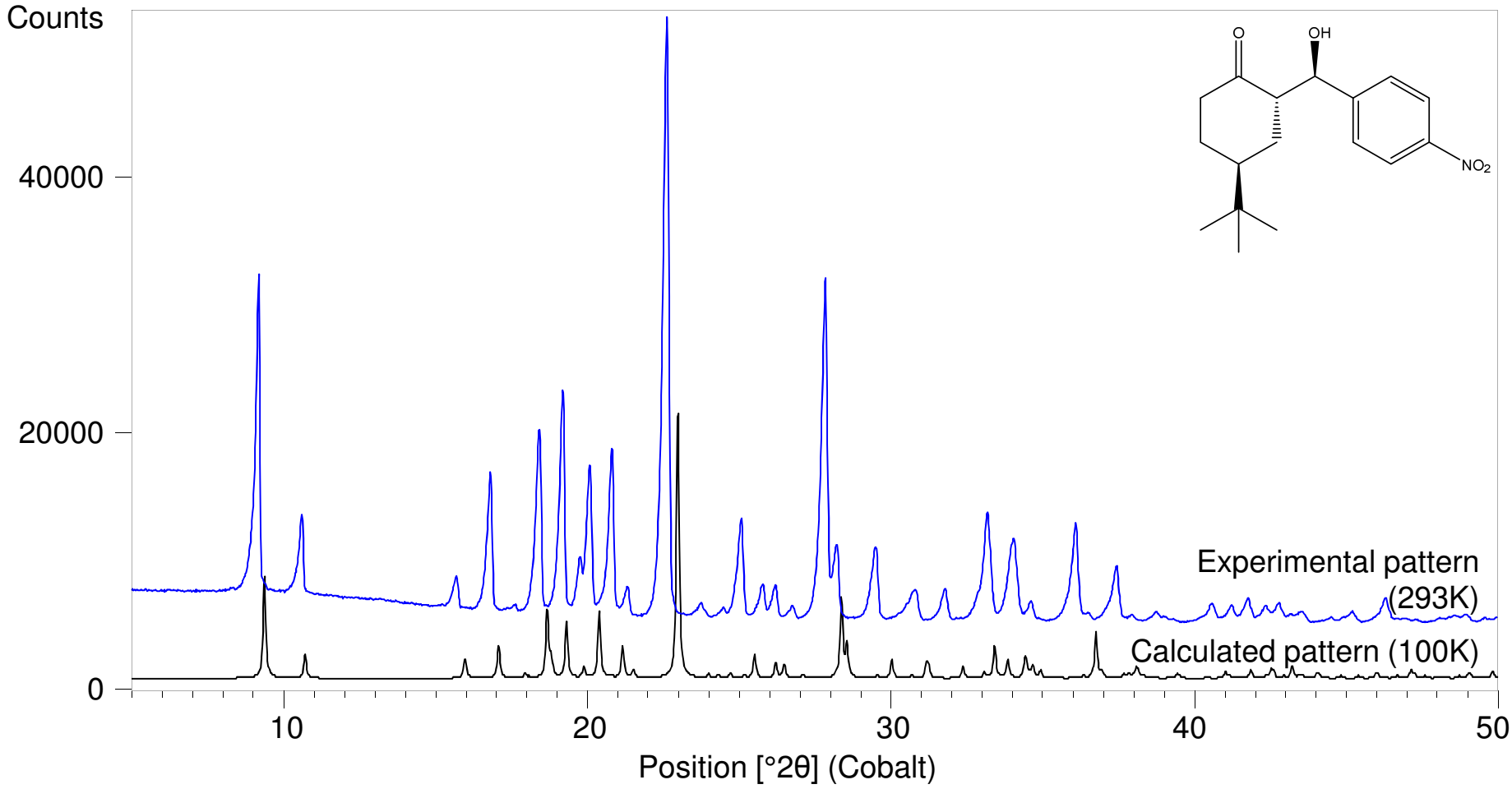
Pure enantiomer, anhydrous solid, $P2_12_12_1$

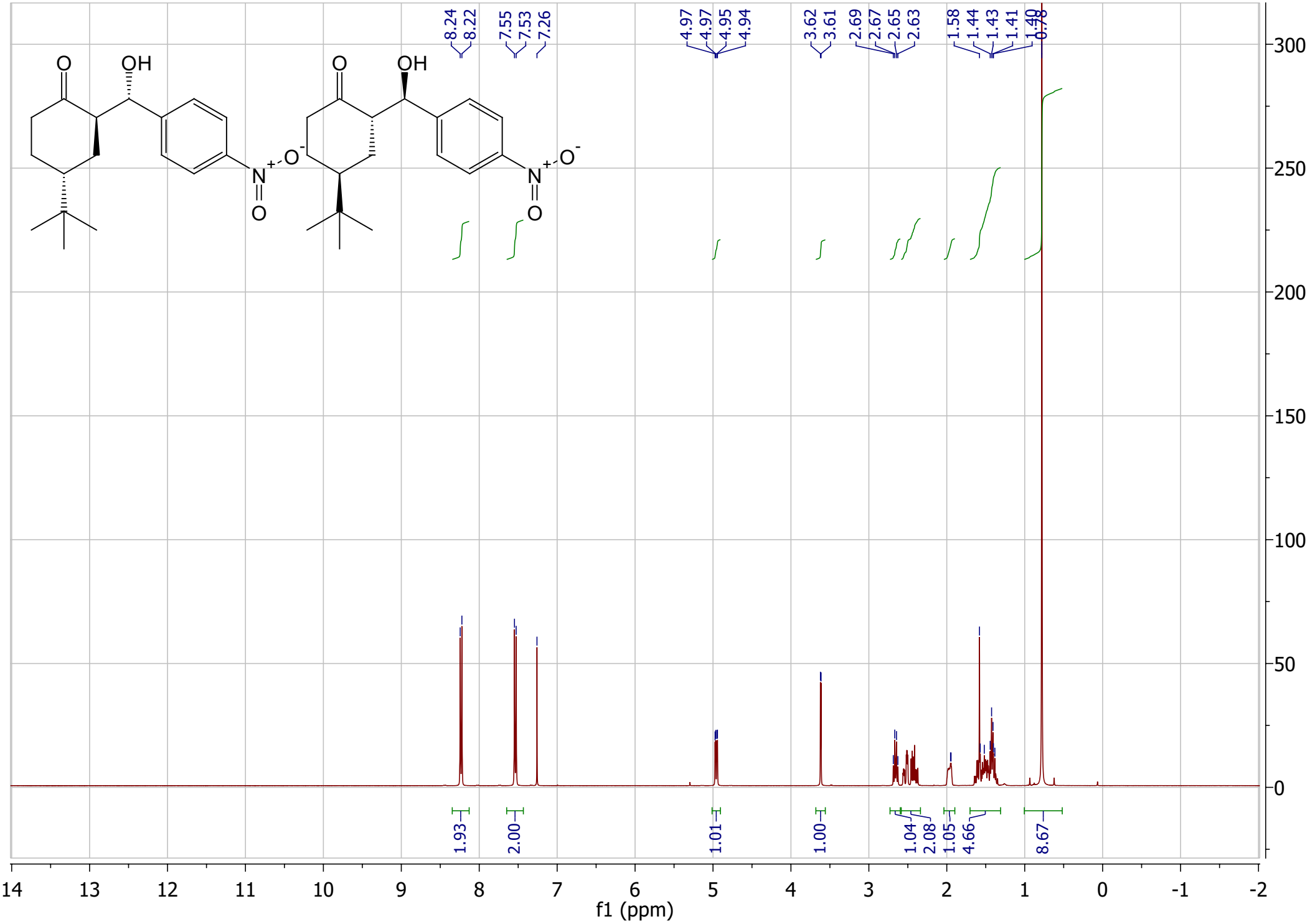
(2R,4R)-4-(tert-butyl)-2-((S)-hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one



Pure enantiomer, anhydrous solid, $P2_12_12_1$

(2S,4S)-4-(tert-butyl)-2-((R)-hydroxy(4-nitrophenyl)methyl)cyclohexan-1-one

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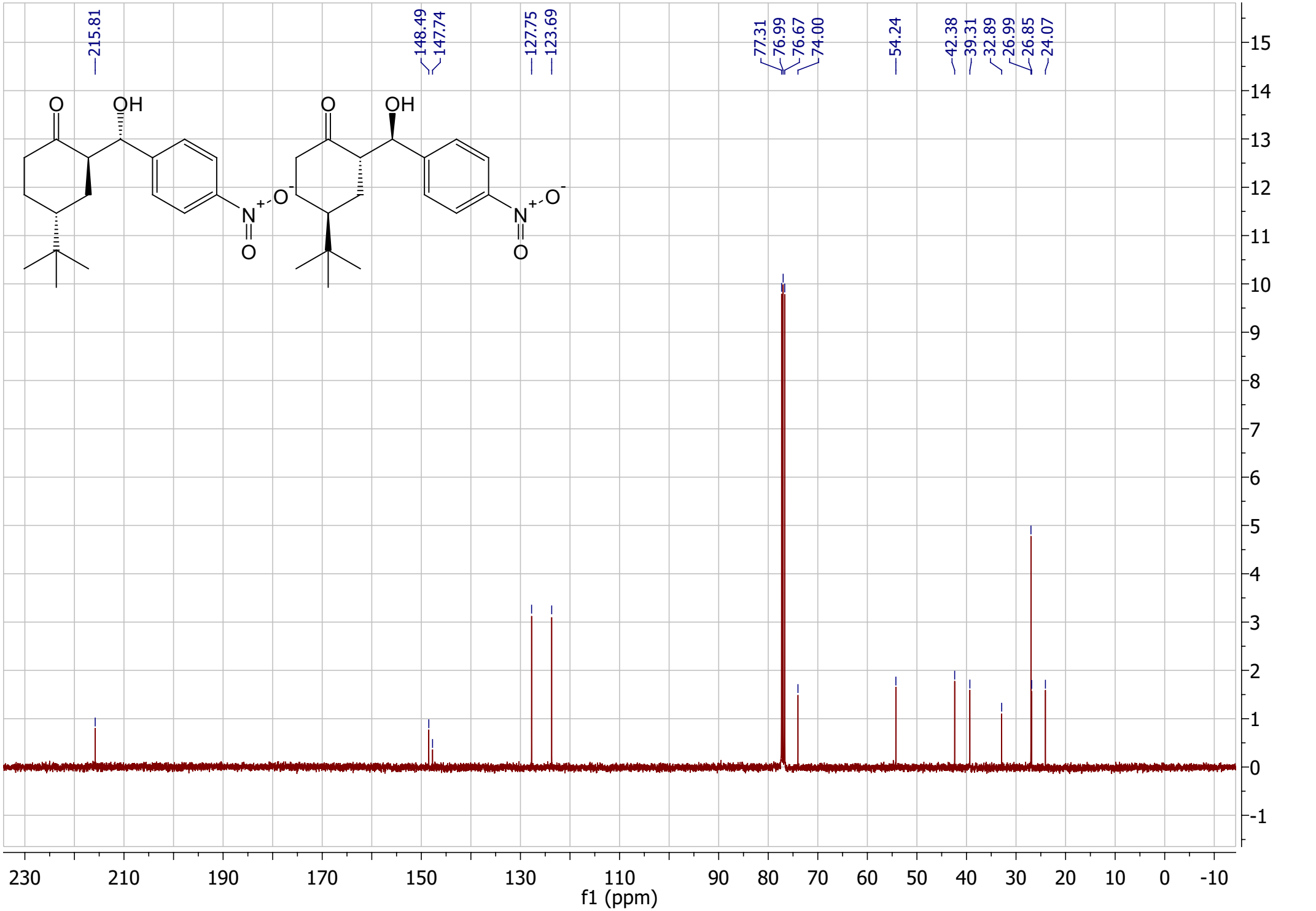
8.22
7.55
7.53
7.26
4.97
4.97
4.95
4.94
3.62
3.61
2.69
2.67
2.65
2.63
1.58
1.44
1.43
1.41
1.40
0.78
O
OH
N+
O-
O
O
OH
N+
O-
O
1.93
2.00
1.01
1.00
1.04
2.08
1.05
4.66
8.67
300
250
200
150
100
50
0
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
f1 (ppm)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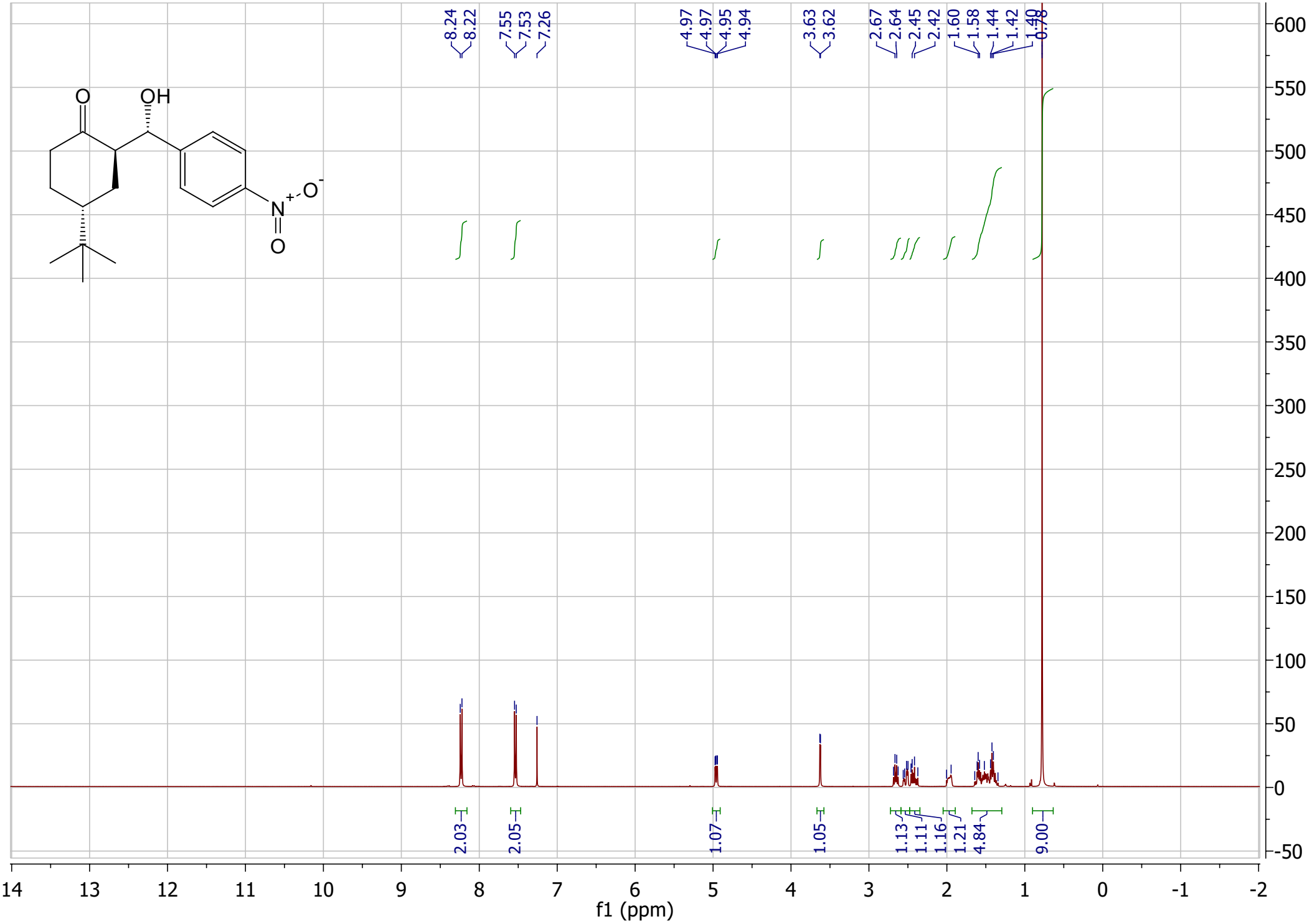
148.49
147.74
127.75
123.69
77.31
76.99
76.67
74.00
54.24
42.38
39.31
32.89
26.99
26.85
24.07
O
OH
N+
O-
O
f1 (ppm)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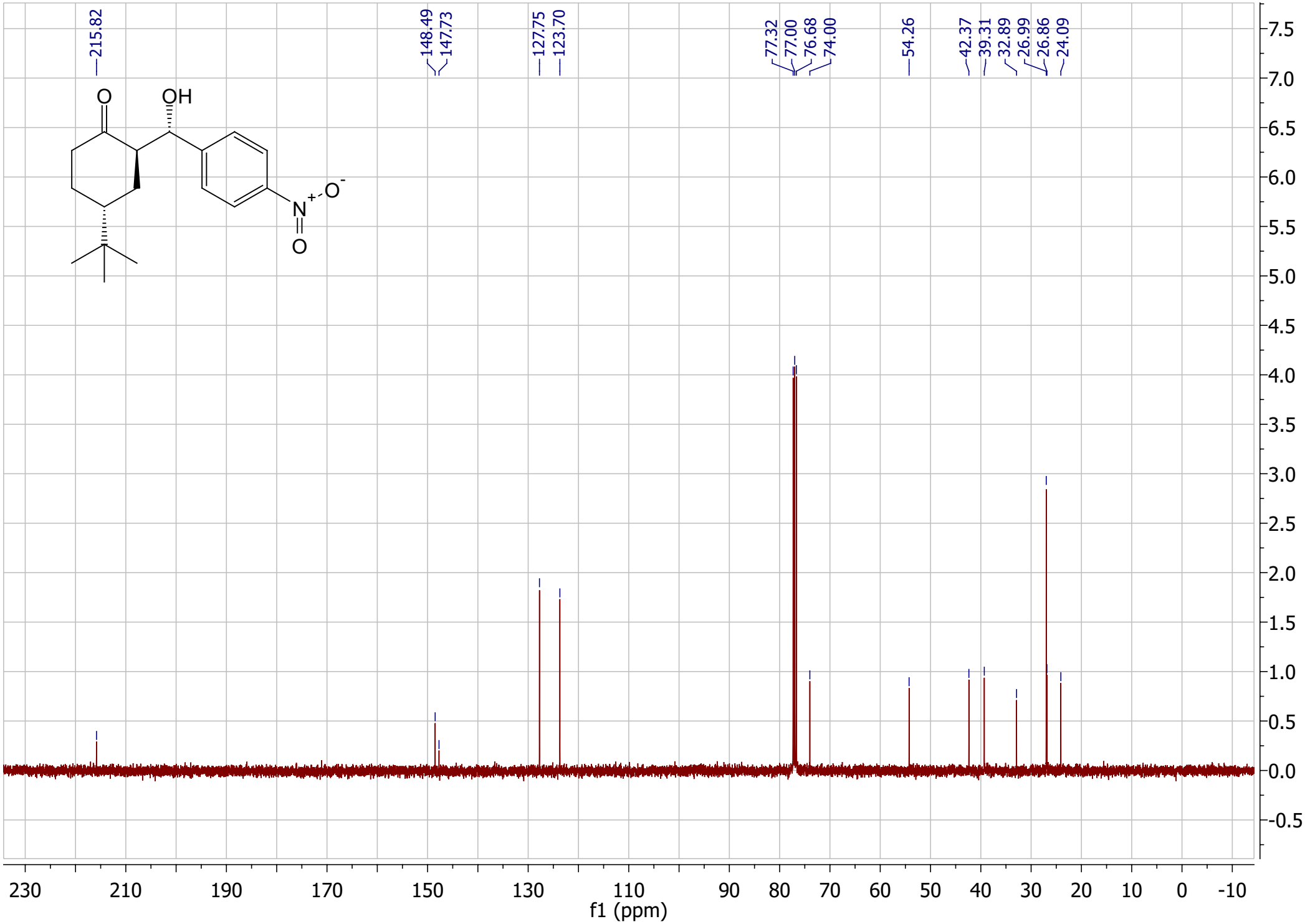
8.22
7.55
7.53
7.26
4.97
4.97
4.95
4.94
3.63
3.62
2.67
2.64
2.45
2.42
1.60
1.58
1.44
1.42
1.40
0.78
O
OH
N+
O-
O
2.03
2.05
1.07
1.05
1.13
1.11
1.16
1.21
4.84
9.00
f1 (ppm)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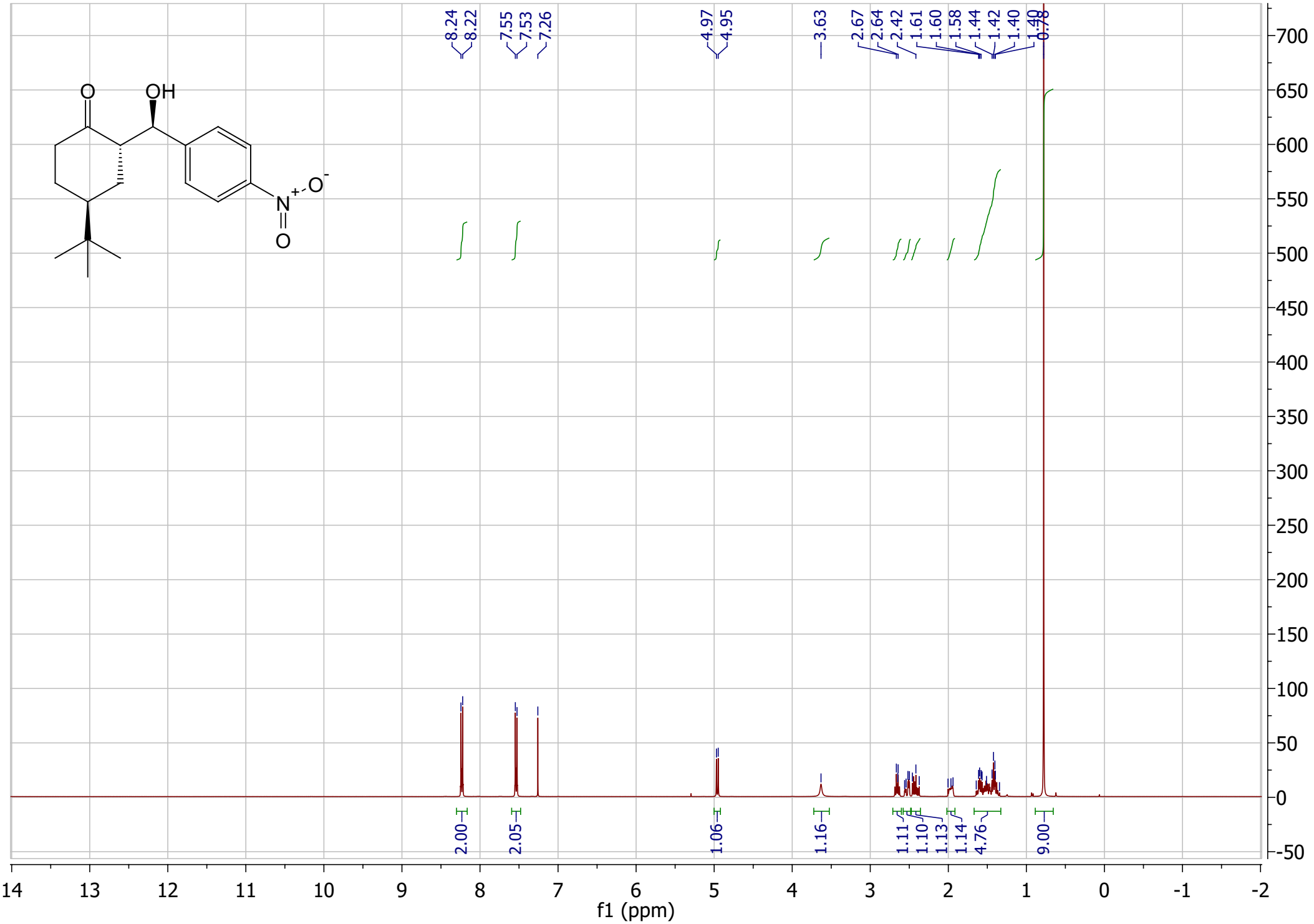
147.73
127.75
123.70
77.32
77.00
76.68
74.00
54.26
42.37
39.31
32.89
26.99
26.86
24.09
O
OH
N+
O-
O
f1 (ppm)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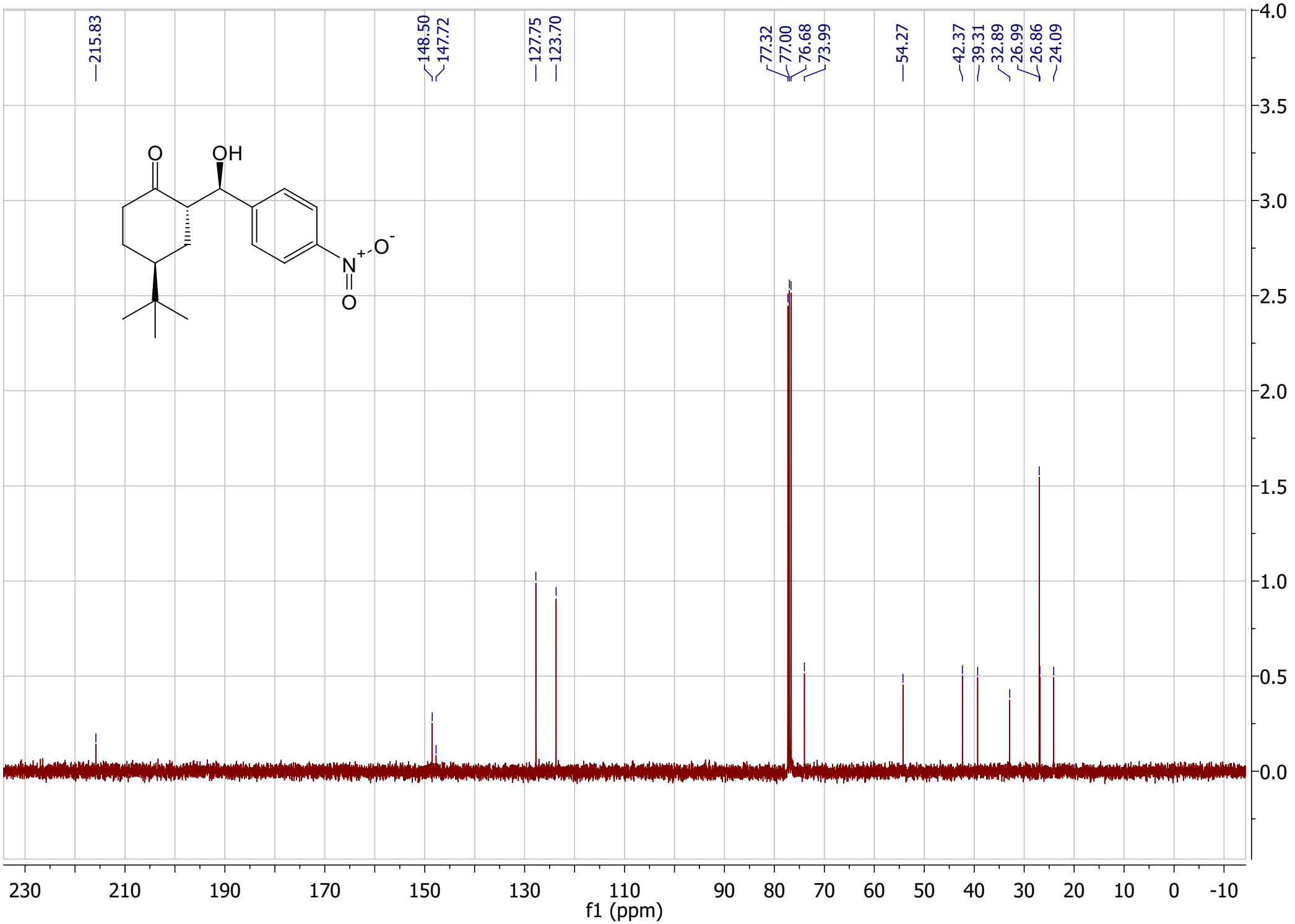
8.22
7.55
7.53
7.26
4.97
4.95
3.63
2.67
2.64
2.42
1.61
1.60
1.58
1.44
1.42
1.40
1.40
0.78
O
OH
N
O
O
2.00
2.05
1.06
1.16
1.11
1.10
1.13
1.14
4.76
9.00
f1 (ppm)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147.72
127.75
123.70
77.32
77.00
76.68
73.99
54.27
42.37
39.31
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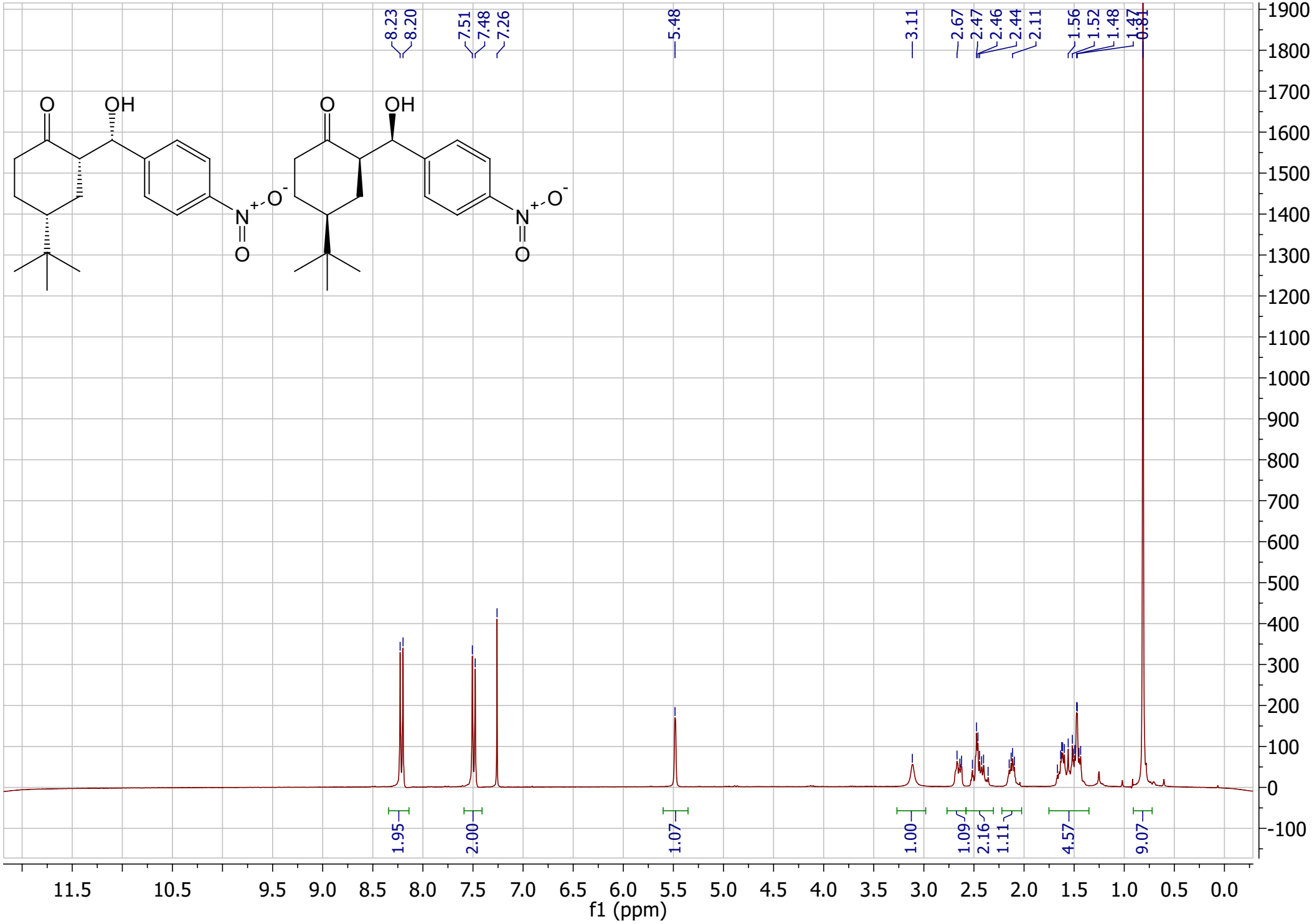
26.99
26.86
24.09
O
OH
N+
O-
O
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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8.20
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7.48
7.26
5.48
3.11
2.67
2.47
2.46
2.44
2.11
1.56
1.52
1.48
1.47
0.81
O
OH
N+
O-
O
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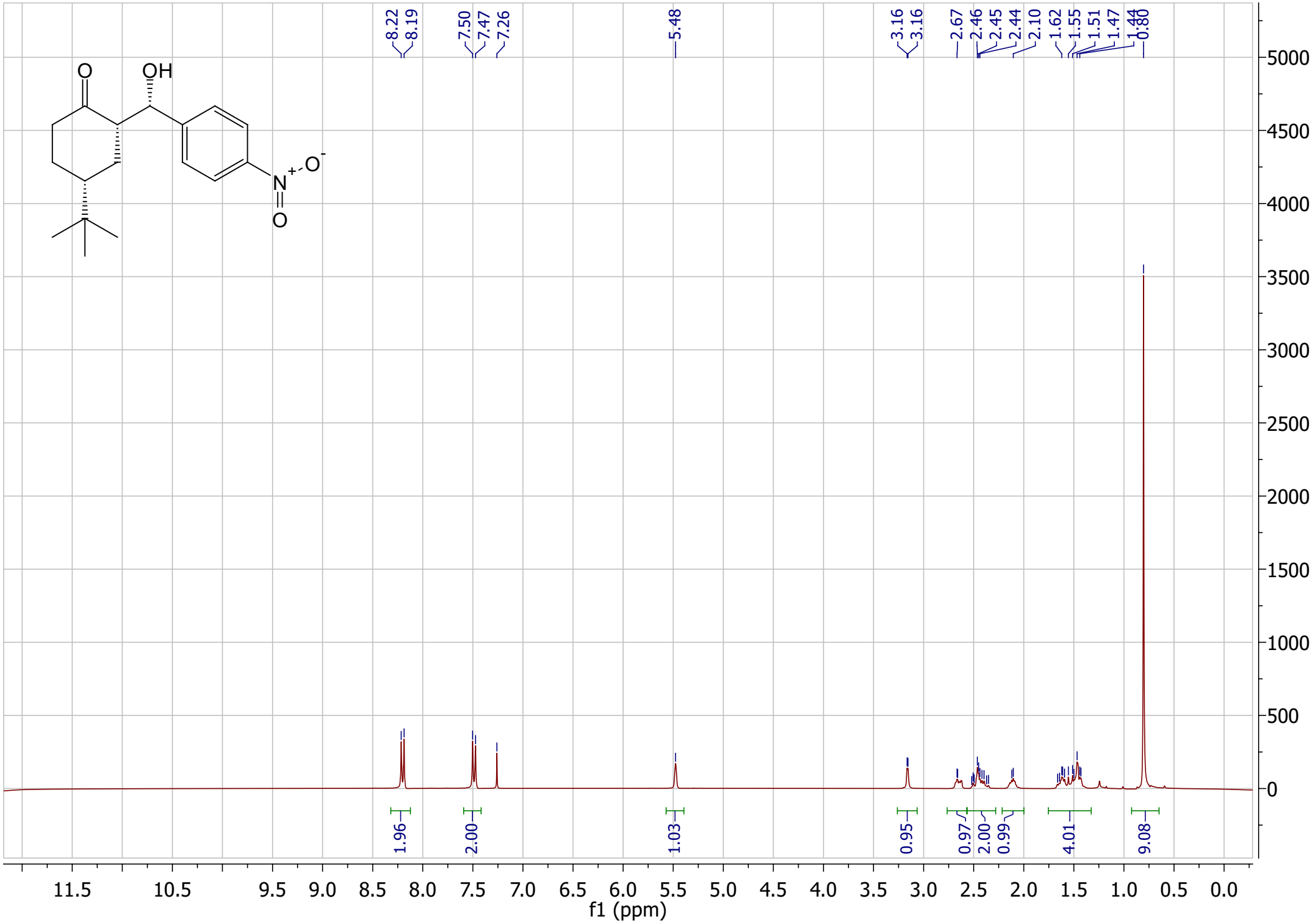
2.00
1.07
1.00
1.09
2.16
1.11
4.57
9.07
f1 (ppm)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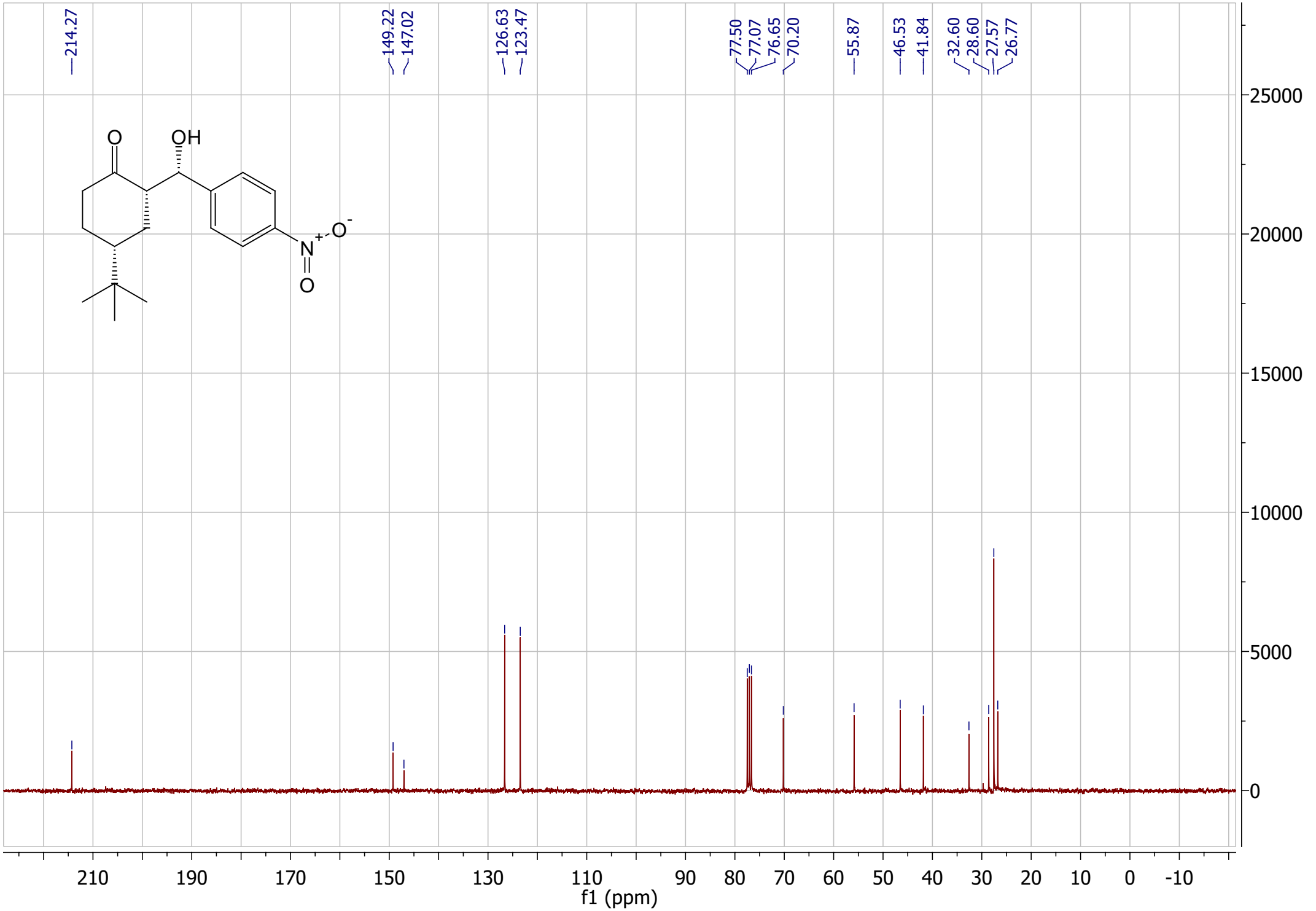
8.19
7.50
7.47
7.26
5.48
3.16
3.16
2.67
2.46
2.45
2.44
2.10
1.62
1.55
1.51
1.47
1.44
0.80
O
OH
N+
O-
O
1.96
2.00
1.03
0.95
0.97
2.00
0.99
4.01
9.08
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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149.22
147.02
126.63
123.47
77.50
77.07
76.65
70.20
55.87
46.53
41.84
32.60
28.60
27.57
26.77
O
OH
N+
O-
O
25000
20000
15000
10000
5000
0
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190
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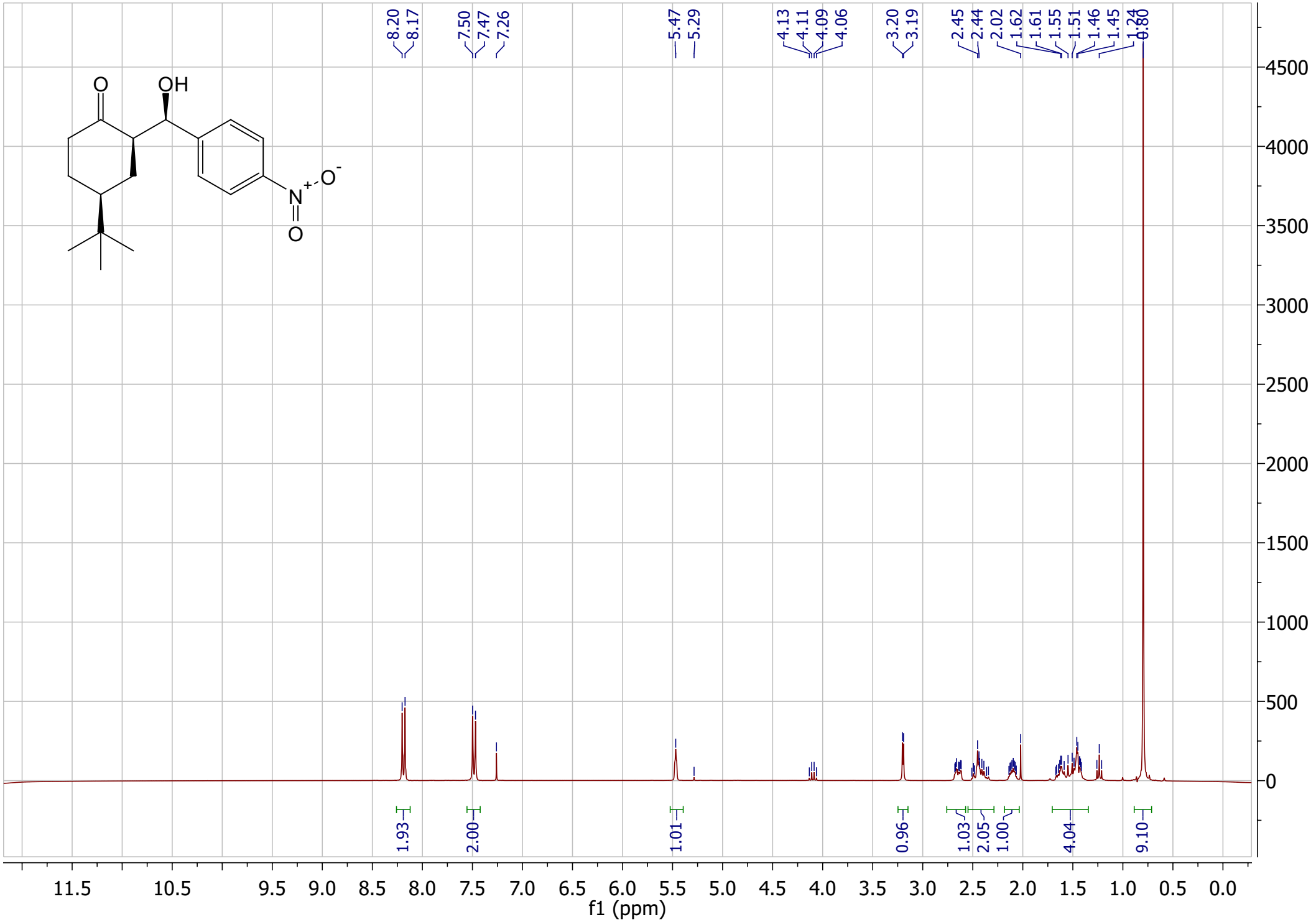
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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8.17
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5.47
5.29
4.13
4.11
4.09
4.06
3.20
3.19
2.45
2.44
2.02
1.62
1.61
1.55
1.51
1.46
1.45
1.24
0.80
O
OH
N+
O-
O
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1.01
0.96
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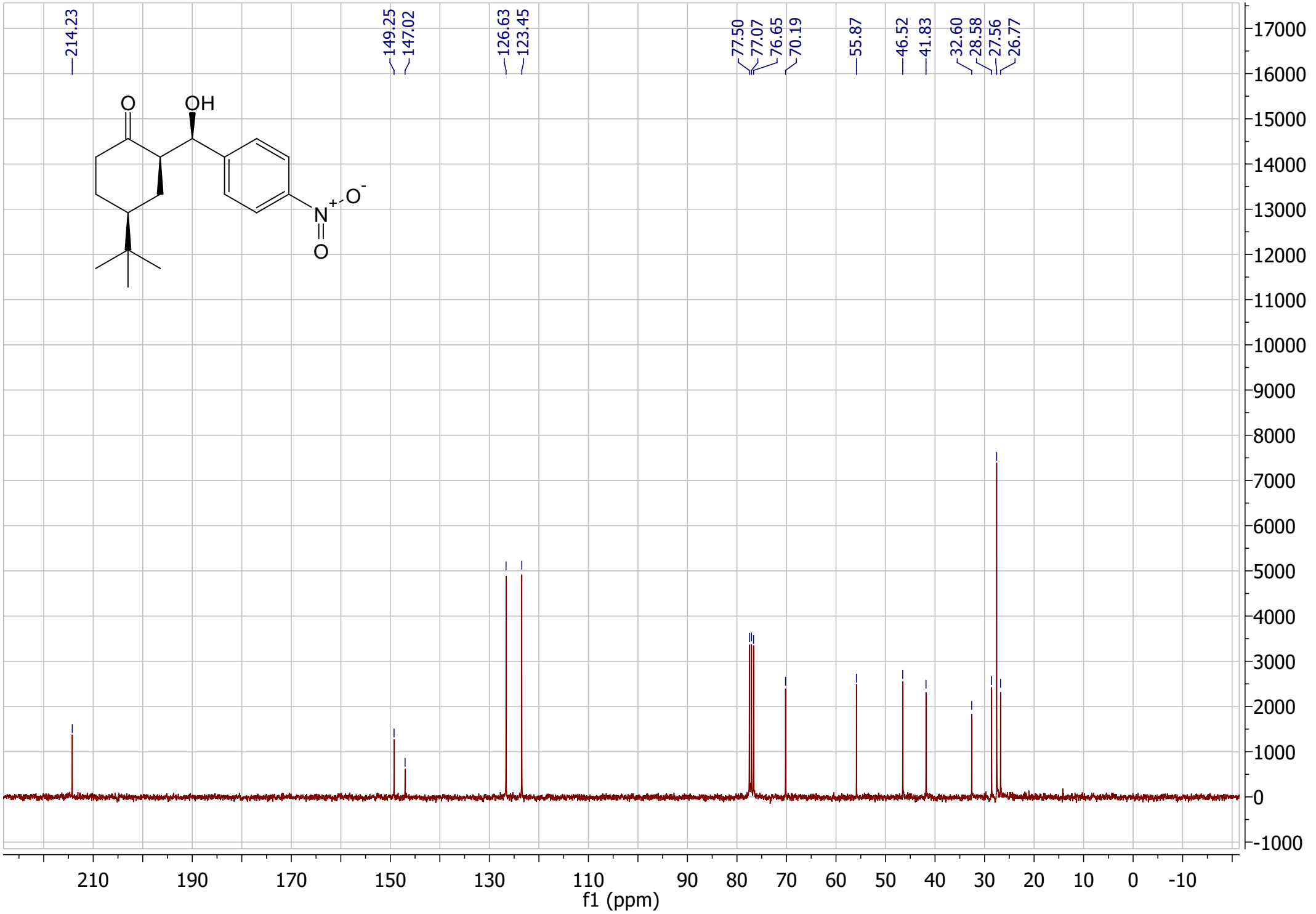
2.05
1.00
4.04
9.10
f1 (ppm)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147.02
126.63
123.45
77.50
77.07
76.65
70.19
55.87
46.52
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32.60
28.58
27.56
26.77
O
OH
N+
O-
O
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)