Supporting Information

Expedient Synthesis of Highly Functionalized 1,3-Dienes by Employing Cyclopropenes as *C_4* Units

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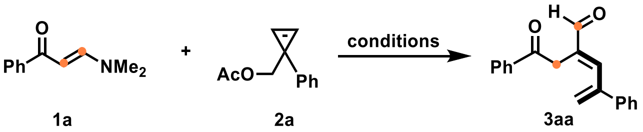
General methods:

All reactions were carried out in flame or oven-dried glassware under nitrogen atmosphere with freshly distilled dry solvents under anhydrous conditions unless otherwise indicated.Flash column chromatography was performed with silica gel (200 - 300 mesh). Chromatograms were visualized by fluorescence quenching with UV light at 254 nm or by staining with base solution of potassium permanganate and molybdate. NMR spectra were recorded at room temperature on 400 MHz Bruker spectrometers and 400 MHz JEOL spectrometers. The residual solvent signals were taken as the reference (0.00 ppm for ^{1}H NMR spectra and 77.0 ppm for ^{13}C NMR spectra in $CDCl_3$). Chemical shift (δ) is reported in ppm, coupling constants (J) are given in Hz. The following abbreviations classify the multiplicity: s = singlet, d = doublet, t = triplet, m = multiplet, dd = doublet of doublet. HRMS (ESI) spectra were recorded on a Waters Q-Tof premier TM mass spectrometer.

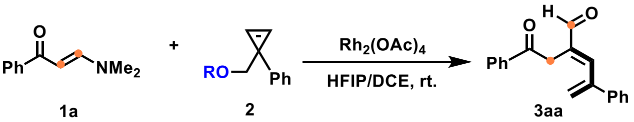
Table S1 Optimization of reaction conditions[a]

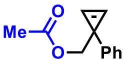
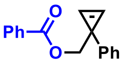
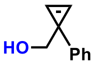
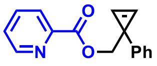
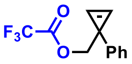
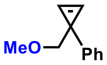
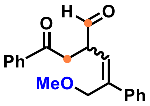
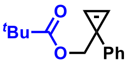


entry	catalyst	solvent	yield[b] (%)
1	$AgNO_3$[c]	DCM	10
2	$Cu(OH)_2$[c]	DCM	0
3	$Rh_2(OAc)_4$	DCM	15
4	$Rh_2(OAc)_4$	DCE	7
5	$Rh_2(OAc)_4$	Tol.	10
6	$Rh_2(OAc)_4$	THF	21
7	$Rh_2(OAc)_4$	Et_2O	27
8	$Rh_2(OAc)_4$	CF_3CH_2OH	29
9	$Rh_2(OAc)_4$	HFIP	68
10	**$Rh_2(OAc)_4$**	**HFIP:DCE = 9:1**	**84**
11	$Rh_2(TFA)_4$	HFIP:DCE = 9:1	8
12	$Rh_2(Oct)_4$	HFIP:DCE = 9:1	27
13	$Rh_2(esp)_2$	HFIP:DCE = 9:1	70

[a] Reaction conditions are as follows if no otherwise noted: **1a** (0.20 mmol), **2a** (0.40 mmol) and catalyst (1.0 mol %) were stirred in 2.00 mL solution at room temperature under nitrogen atmosphere until **1a** was consumed completely. [b] Isolated yield. [c] 10 mol % DCM = dichloromethane, DCE = 1,2-dichloroethane, Tol. = toluene, THF = tetrahydrofuran, HFIP = hexafluoroisopropan.

Table S2 Optimization of the leaving groups[a]

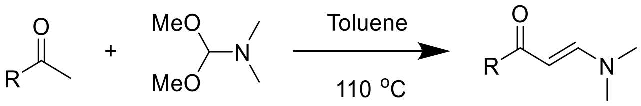


2	**product [b]**	**2**	**product [b]**
 **2a**	**3aa, 84%**	 **2ad**	**3aa, 65%**
 **2aa**	**no reaction**	 **2ae**	**3aa, 32%**
 **2ab**	**decompose**	 **2af**	 **3aa', 61%** **(*E*/*Z* = 1 : 1)**
 **2ac**	**3aa, 53%**		

[a] Conditions: **1a** (0.20 mmol), **2** (0.40 mmol) and $Rh_2(OAc)_4$ (1.0 mol %) were stirred in 2.00 mL solution (HFIP:DCE = 9:1) under nitrogen atmosphere. [b] Isolated yields.

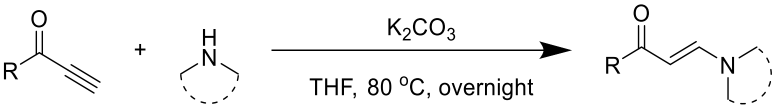
General procedure for enaminones and their spectra data:

General procedure A[1]:



To a stirred solution of ketone (5.0 mmol, 1.0 equiv.) in toluene (5.0 mL), 1,1-dimethoxy-*N*,*N*-dimethylmethanamine (7.0 mmol, 1.4 equiv.) was added and stirred at 110 ℃. After completion of the reaction (monitored by TLC), it was quenched with water, extracted with ethyl acetate and dried with anhydrous Na_2SO_4. Then the reaction mixture was concentrated under reduced pressure and purified by column chromatography (hexane : ethyl acetate = 1 : 1) to give the desired product.

General procedure B[2]:



To a stirred solution of acetylenic ketone (3.0 mmol, 1.0 equiv.) and potassium carbonate (2.0 mmol, 2.0 equiv.) in 10 mL of THF, amine (3.0 mmol, 1.0 equiv.) was added dropwise and stirred at 80 ℃. After completion of the reaction (monitored by TLC), the reaction mixture is concentrated under reduced pressure and purified by column chromatography to give the desired product.

The spectroscopic properties of these compounds were consistent with literature data: 1a, 1b, 1e-1g, 1i,1k,1m,1n,1p,1r-1t;[3] 1c;[4] 1h, 1j, 1q, 1u;[5]1v, 1w;[6] 1d;[7]1l;[8] 1o.[9]

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[1] Y. Jiang, V. Y. K. Zhong, L. Emmanuvel and C.-M. Park, *Chem. Commun.*, 2012,**48**, 3133−3135.

[2] L. Šenica, U. Grošelj, M. Kasunič, D. Kočar, B. Stanovnik and J. Svete, *Eur. J. Org. Chem.*, 2014, **15**, 3067−3071.

[3] M. Ni, J. Zhang, X. Liang, Y. Jiang and T.-P. Loh, *Chem. Commun.*, 2017,**53**, 12286−12289.

[4] Y. Tang, Y. Chen, H. Liu and M. Guo, *Tetrahedron*, 2018,**59**, 3703-3705.

[5] X. Liang, P. Guo, W. Yang, M. Li, C. Jiang, W. Sun, T.-P. Loh and Y. Jiang, *Chem. Commun.*, 2020,**56**, 2043−2046.

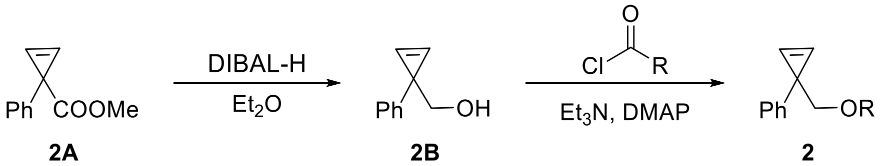
[6] J. Chen, P. Guo, J. Zhang, J. Rong, W. Sun, Y. Jiang and T.-P. Loh, *Angew. Chem., Int. Ed.*, 2019,**58**, 12674−12679.

[7] S. Zhou, J. Wang, L. Wang, C. Song, K. Chen and J. Zhu, *Angew. Chem., Int. Ed.*, 2016, **55**, 9384−9388.

[8] G. Liang, J. Rong, W. Sun, G. Chen, Y. Jiang and T.-P. Loh, *Org. Lett.*, 2018, **20**, 7326−7331.

[9] B. Qi, S. Guo, W. Zhang, X. Yu, C. Song and J. Zhu, *Org. Lett.*, 2018, **20**, 3996−3999.

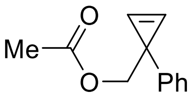
General procedure for the synthesis of cyclopropenes[10]:



Compounds **2A** were prepared according to literature procedures.To a stirred at -78 °C solution of ester **2A** (25 mmol, 1.0 equiv.) in dry ether, DIBAL-H (1.0 M solution in hexane, 50 mmol, 2.0 equiv.) was added dropwise. The mixture was stirred for 1 hour at -78 °C, then additionally for 1 hour at room temperature. Then, the mixture was quenched (saturated NH_4Cl), acidified (aqueous HCl), and extracted (ether). Combined organic phases were washed ($NaHCO_3$, brine), dried ($MgSO_4$), filtered, and concentrated. The residue was purified by preparative column chromatography on Silica gel, eluent hexane-EtOAc 3:1 to give alcohol **2B**.

To a stirred solution of alcohol **2B** (5.0 mmol, 1.0 equiv.), 4-(dimethylamino)pyridine (DMAP, 0.5 mmol, 10 mol %), and triethylamine (Et_3N, 7.5 mmol, 1.5 equiv.) in anhydrous CH_2Cl_2 (10 mL) was added acyl chloride (1.5equiv.). The mixture was stirred at room temperature. After completion of the reaction (monitored by TLC), the solution was quenched (water) and extracted (CH_2Cl_2). Combined organic phases were washed (diluted aqueous HCl, saturated $NaHCO_3$, brine), dried ($MgSO_4$), filtered, and concentrated in *vacuo*. The residue was purified by preparative column chromatography on silica gel, eluent Petroleum ether-EtOAc to give product **2**.

(1-Phenylcycloprop-2-en-1-yl)methyl acetate (2a):



The title compound was prepared according to the general procedure (EA/PE = 1/20, R_f = 0.28). The product was obtained as colorless liquid in 86% yield (809.4 mg).^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 – 7.28 (m, 2H), 7.23 - 7.21 (m, 2H), 7.21 - 7.18 (m, 3H), 4.52 (s, 2H), 2.04 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.2, 145.5, 128.1,

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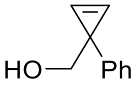
[10] M. Rubina, M. Rubin and V. Gevorgyan, *J. Am. Chem. Soc.*, 2004, **126**, 3688−3689.

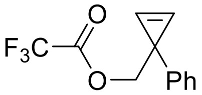
126.2, 125.8, 112.0, 71.2, 25.9, 21.0;HRMS (ESI) m/z [M+H]: Calcd for $C_{12}H_{13}O_2$: 189.0916. Found: 189.0913.

(1-Phenylcycloprop-2-en-1-yl)methanol (2aa):



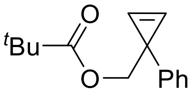
The title compound was prepared according to the general procedure (EA/PE = 1/5, R_f = 0.21). The product was obtained as white solid in 72% yield (2647.4 mg), Mp. 58 – 59°C.^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27 (s, 2H), 7.25 – 7.21 (t, J = 8.0 Hz, 2H), 7.17 – 7.15 (m, 2H), 7.13 – 7.10 (t, J = 7.2 Hz, 1H), 4.00 (s, 2H), 1.39 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.7, 128.1, 126.2, 125.7, 112.9, 67.8, 28.9; HRMS (ESI) m/z [M+H]: Calcd for $C_{10}H_{11}O$: 147.0810. Found: 147.0811.

(1-Phenylcycloprop-2-en-1-yl)methyl 2,2,2-trifluoroacetate (2ab):



The title compound was prepared according to the general procedure (EA/PE = 1/20, R_f = 0.31). The product was obtained as colorless liquid in 78% yield (947.8 mg).^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 – 7.29 (m, 2H), 7.27 (s, 2H), 7.23 – 7.21 (m, 1H), 7.19 – 7.16 (m, 2H), 4.77 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.6 (q, J = 41.9 Hz), 144.1, 128.4, 126.3, 126.1, 114.6 (q, J = 284.3 Hz), 111.7, 75.0, 25.7; ^{19}F NMR (376 MHz, $CDCl_3$) δ -74.86; HRMS (ESI) m/z [M+H]: Calcd for $C_{12}H_{10}F_3O_2$: 243.0633. Found: 243.0635.

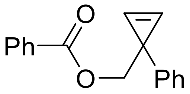
(1-Phenylcycloprop-2-en-1-yl)methyl pivalate (2ac):



The title compound was prepared according to the general procedure (EA/PE = 1/20, R_f = 0.35). The product was obtained as colorless liquid in 86% yield (993.8 mg). ^{1}H

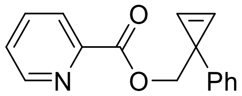
NMR (400 MHz, CDCl$_3$) δ7.35 – 7.31 (m, 2H), 7.26 (m, 3H), 7.24 – 7.19 (m, 2H), 4.55 (s, 2H), 1.21 (s, 9H); ^{13}C NMR (100 MHz, CDCl$_3$) δ178.3, 145.5, 127.9, 126.1, 125.6, 111.9, 70.4, 38.7, 27.1, 25.9; HRMS (ESI) m/z [M+H]: Calcd for $C_{15}H_{19}O_2$: 231.1385. Found: 231.1382.

(1-Phenylcycloprop-2-en-1-yl)methyl benzoate (2ad):



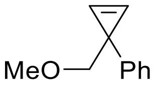
The title compound was prepared according to the general procedure (EA/PE = 1/20, R$_f$ = 0.40). The product was obtained as colorless liquid in 75% yield (941.6 mg).^{1}H NMR (400 MHz, CDCl$_3$) δ8.11 – 8.09 (m, 2H), 7.60 – 7.56 (m, 1H), 7.48 – 7.44 (m, 2H), 7.40 – 7.33 (m, 6H), 7.28 – 7.24 (m, 1H), 4.84 (s, 2H).; ^{13}C NMR (100 MHz, CDCl$_3$) δ166.5, 145.5, 132.8, 130.3, 129.5, 128.2, 128.1, 126.1, 125.7, 111.8, 71.6, 26.0; HRMS (ESI) m/z [M+H]: Calcd for $C_{17}H_{15}O_2$: 251.1072. Found: 251.1066.

(1-Phenylcycloprop-2-en-1-yl)methyl picolinate (2ae):



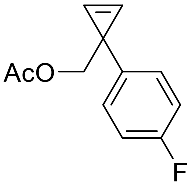
The title compound was prepared according to the general procedure (EA/PE = 1/4, R$_f$ = 0.33). The product was obtained as white solid in 74% yield (932.7 mg), Mp. 47 – 48 ℃.^{1}H NMR (400 MHz, CDCl$_3$) δ8.72 – 8.70 (m, 1H), 8.03 – 8.01 (m, 1H), 7.76 – 7.72 (m, 1H), 7.40 – 7.37 (m, 1H), 7.29– 7.27 (m, 1H), 7.26– 7.24 (m, 5H), 7.17 – 7.13 (m, 1 H), 4.85 (s, 2H); ^{13}C NMR (100 MHz, CDCl$_3$) δ164.7, 149.7, 147.8, 145.1, 136.7, 127.9, 126.5, 126.0, 125.6, 124.9, 111.5, 71.6, 25.8; HRMS (ESI) m/z [M+H]: Calcd for $C_{16}H_{14}NO_2$: 252.1025. Found: 252.1029.

(1-(Methoxymethyl)cycloprop-2-en-1-yl)benzene (2af):



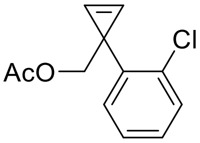
The title compound was prepared according to the general procedure (EA/PE = 1/20, R_f = 0.35). The product was obtained as colorless liquid in 80% yield (644.0 mg).^{1}H NMR (400 MHz, $CDCl_3$) δ7.35 – 7.31 (m, 4H), 7.29 – 7.26 (m, 2H), 7.23 – 7.19 (m, 1H), 3.89 (s, 2H), 3.43 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ146.4, 127.9, 126.2, 125.5, 112.5, 79.7, 58.4, 26.5; HRMS (ESI) m/z [M+H]: Calcd for $C_{11}H_{13}O$: 161.0966. Found: 161.0969.

(1-(4-Fluorophenyl)cycloprop-2-en-1-yl)methyl acetate (2b):



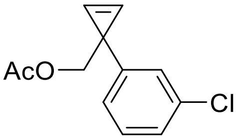
The title compound was prepared according to the general procedure (EA/PE = 1/19, R_f = 0.30). The product was obtained as yellow liquid in 83% yield (859.3 mg).^{1}H NMR (400 MHz, $CDCl_3$) δ 7.24 (s, 2H), 7.17 – 7.13 (m, 2H), 6.98 – 6.94 (m, 2H), 4.47 (s, 2H), 2.03 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.9, 161.0 (d, J = 242.1 Hz), 141.1 (d, J = 3.3 Hz), 127.6 (d, J = 7.9 Hz), 114.7 (d, J = 21.0 Hz), 112.2, 71.0, 25.3, 20.8;^{19}F NMR (376 MHz, $CDCl_3$) δ -117.36; HRMS (ESI) m/z [M+H]: Calcd for $C_{12}H_{12}FO_2$: 207.0821. Found: 207.0820.

(1-(2-Chlorophenyl)cycloprop-2-en-1-yl)methyl acetate (2c):



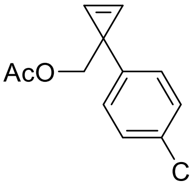
The title compound was prepared according to the general procedure (EA/PE = 1/20, R_f = 0.31). The product was obtained as yellow liquid in 71% yield (791.7 mg).^{1}H NMR (400 MHz, $CDCl_3$) δ7.46 (s, 2H), 7.24 – 7.22 (m, 1H), 7.19 –7.17 (m, 1H), 7.13 – 7.07 (m, 2H), 4.23 (s, 2H), 1.92 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ170.9, 142.0, 134.1, 130.7, 129.6, 128.1, 127.0, 116.1, 70.7, 26.9, 20.9; HRMS (ESI) m/z [M+H]: Calcd for $C_{12}H_{12}ClO_2$: 223.0526.Found: 223.0530.

(1-(3-Chlorophenyl)cycloprop-2-en-1-yl)methyl acetate (2d):



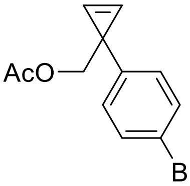
The title compound was prepared according to the general procedure (EA/PE = 1/20, R_f = 0.29). The product was obtained as yellow liquid in 73% yield (813.9 mg). ^1H NMR (400 MHz, $CDCl_3$) δ7.13 – 7.10 (m, 3H), 7.06 – 7.04 (m, 2H), 7.01 – 6.99 (m, 1H), 4.38 (s, 2H), 1.95 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 170.9, 147.7, 134.0, 129.2, 126.4, 125.8, 124.3, 111.5, 70.7, 25.6, 20.8; HRMS (ESI) m/z [M+H]: Calcd for $C_{12}H_{12}ClO_2$: 223.0526. Found: 223.0536.

(1-(4-Chlorophenyl)cycloprop-2-en-1-yl)methyl acetate (2e):



The title compound was prepared according to the general procedure (EA/PE = 1/20, R_f = 0.33). The product was obtained as yellow liquid in 82% yield (914.3 mg). ^1H NMR (400 MHz, $CDCl_3$) δ7.26 – 7.23 (m, 1H), 7.23 – 7.22 (m, 3H), 7.13 – 7.11 (m, 1H), 7.10 – 7.09 (m, 1H), 4.47 (s, 2H), 2.03 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ171.0, 143.9, 131.4, 128.0, 127.5, 111.8, 70.9, 25.4, 20.9; HRMS (ESI) m/z [M+H]: Calcd for $C_{12}H_{12}ClO_2$: 223.0526. Found: 223.0525.

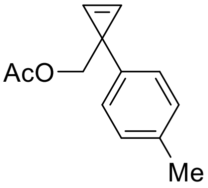
(1-(4-Bromophenyl)cycloprop-2-en-1-yl)methyl acetate (2f):



The title compound was prepared according to the general procedure (EA/PE = 1/20, R_f = 0.31). The product was obtained as yellow liquid in 76% yield (1014.5 mg). ^1H

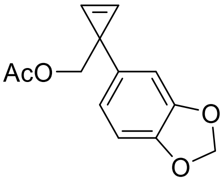
NMR (400 MHz, $CDCl_3$) δ7.38 – 7.36 (m, 2H), 7.20 (s, 2H), 7.05 – 7.03 (m, 2H), 4.46 (s, 2H), 2.02 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ170.7, 144.4, 130.8, 127.8, 119.4, 111.6, 70.6, 25.3, 20.7; HRMS (ESI) m/z [M+H]: Calcd for $C_{12}H_{12}BrO_2$: 267.0021. Found: 267.0024.

(1-(*p*-Tolyl)cycloprop-2-en-1-yl)methyl acetate (2g):



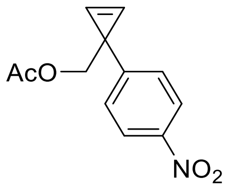
The title compound was prepared according to the general procedure (EA/PE = 1/20, R_f = 0.34). The product was obtained as yellow liquid in 79% yield (802.1 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.28 (s, 2H), 7.20 – 7.17 (m, 4H), 4.58 (s, 2H), 2.38 (s, 3H), 2.10 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ171.0, 142.3, 135.1, 128.7, 125.9, 112.0, 71.1, 25.4, 20.8, 20.7; HRMS (ESI) m/z [M+H]: Calcd for $C_{13}H_{15}O_2$: 203.1072. Found: 203.1075.

(1-(Benzo[*d*][1,3]dioxol-5-yl)cycloprop-2-en-1-yl)methyl acetate (2h):



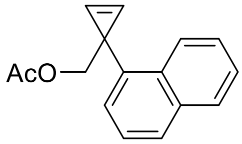
The title compound was prepared according to the general procedure (EA/PE = 1/20, R_f = 0.32). The product was obtained as yellow liquid in 82% yield (914.3 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.23 (s, 2H), 6.75 – 6.73 (m, 1H), 6.69 (m, 1H), 6.67 – 6.64 (m, 1H), 5.91 (s, 2H), 4.44 (s, 2H), 2.05 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ171.1, 147.5, 145.6, 139.7, 119.2, 112.5, 107.8, 106.9, 100.8, 71.3, 25.7, 20.9; HRMS (ESI) m/z [M+H]: Calcd for $C_{13}H_{13}O_4$: 233.0814. Found: 233.0813.

(1-(4-Nitrophenyl)cycloprop-2-en-1-yl)methyl acetate (2i):



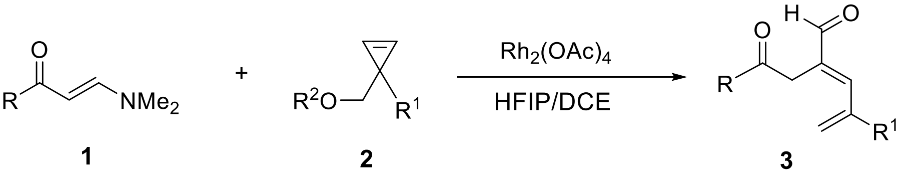
The title compound was prepared according to the general procedure (EA/PE = 1/20, R_f = 0.23). The product was obtained as yellow liquid in 77% yield (900.9 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.13 – 8.11 (m, 2H), 7.36 – 7.34 (m, 2H), 7.27 – 7.26 (m, 2H), 4.53 (s, 2H), 2.06 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ170.9, 153.5, 145.7, 126.8, 123.1, 110.8, 70.4, 26.0, 20.8; HRMS (ESI) m/z [M+H]: Calcd for $C_{12}H_{12}NO_4$: 234.0766. Found: 234.0767.

(1-(Naphthalen-1-yl)cycloprop-2-en-1-yl)methyl acetate (2j):



The title compound was prepared according to the general procedure (EA/PE = 1/20, R_f = 0.33). The product was obtained as yellow liquid in 85% yield (1015.7 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ8.43 – 8.41 (m, 1H), 7.90 – 7.88 (m, 1H), 7.78– 7.76 (m, 1H), 7.72 – 7.71 (m, 2H), 7.62 – 7.58 (m, 1H), 7.54 – 7.50 (m, 1H), 7.46 – 7.45 (m, 1H), 7.44 (d, J = 1.6 Hz, 1H), 4.46 (s, 2H), 2.03 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ170.9, 141.3, 133.9, 131.4, 128.8, 127.4, 126.0, 125.9, 125.8, 125.6, 124.3, 116.4, 70.7, 26.2, 20.9; HRMS (ESI) m/z [M+H]: Calcd for $C_{16}H_{15}O_2$: 239.1072. Found: 239.1066.

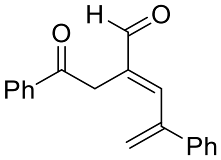
General procedure for 1,3-dienes and their spectra data:



A mixture of **1** (0.20 mmol, 1.0 equiv.), **2** (0.40 mmol, 2.0 equiv.) and $Rh_2(OAc)_4$ (0.002 mmol, 1.0 mol %) was dissolved in 2.00 mL solution (HFIP:DCE = 9:1) under nitrogen atmosphere, and the reaction was stirred at room temperature until the starting material **1a** was consumed completely. Then the mixture was diluted with ethyl acetate, washed with water and brine. The organic layer was dried over anhydrous Na_2SO_4, filtered and concentrated to give the crude product, which was purified through a flash column chromatography (EA/PE = 1/20) to give the desired product **3**.

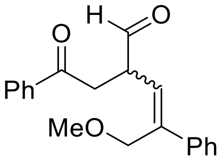
When the reaction was scaled up to 6.0 mmol, the Schlenk tube was replaced by Schlenk flask. A mixture of **1a** (6.0 mmol, 1.0 equiv.), **2a** (12.0 mmol, 2.0 equiv.) and $Rh_2(OAc)_4$ (0.06 mmol, 1 mol %) was dissolved in 60 mL solution (HFIP:DCE = 9:1) under nitrogen atmosphere in a Schlenk flask and the mixture was stirred at room temperature until the starting material **1a** was consumed completely. Then the mixture was diluted with ethyl acetate, washed with water and brine. The organic layer was dried over anhydrous Na_2SO_4, filtered and concentrated to give the crude product, which was purified through a flash column chromatography (EA/PE = 1/20) to give the desired product **3aa** in 71% yield (1171.4 mg).

(*E*)-2-(2-Oxo-2-phenylethyl)-4-phenylpenta-2,4-dienal (3aa):



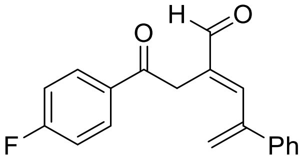
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.31). The product was obtained as yellow oil in 84% yield (46.5 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.66 (s, 1H), 7.81 (m, 1H), 7.80 (m, 1H), 7.56 – 7.52 (m, 1H), 7.43 – 7.39 (m, 3H), 7.32 – 7.27 (m, 4H), 7.26 – 7.23 (m, 1H), 5.69 (d, *J* = 1.2 Hz, 1H), 5.53 – 5.52 (t, *J* = 1.2 Hz, 1H), 3.90 (s, 2H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 195.9, 194.2, 151.8, 144.0, 138.8, 138.3, 136.4, 133.1, 128.6, 128.4, 128.3, 128.1, 126.9, 121.0, 35.4; HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{17}O_2$: 277.1229. Found: 277.1231.

5-Methoxy-2-(2-oxo-2-phenylethyl)-4-phenylpent-3-enal (3aa'):



The title compound was prepared according to the general procedure (EA/PE = 1/9, R$_f$ = 0.33). The product was obtained as yellow oil in 61% yield (37.6 mg). ^{1}H NMR (400 MHz, CDCl$_3$) δ 9.80 & 9.53 (s, 1H), 8.00 – 7.98& 7.96– 7.93 (m, 2H), 7.61 – 7.55 (m, 2H), 7.50 (m, 2H), 7.48 – 7.45 (m, 2H), 7.43 – 7.41 (m, 1H), 7.40 – 7.39 (m, 1H), 7.36 – 7.35 (m, 1H), 7.34 – 7.33 (m, 1H), 7.32 – 7.30 (m, 2H), 7.30 – 7.28 (m, 2H), 7.24 (m, 1H), 7.22 – 7.21 (m, 1H), 7.02 – 7.00 (d, *J* = 9.2 Hz, 1H), 5.74 (d, *J* = 10.0 Hz, 1H), 4.51 – 4.42 (m, 2H), 4.32 – 4.26 (m, 1H), 4.08 – 4.00 (m, 2H), 3.93 – 3.89 (m, 1H), 3.76 – 3.70 (m, 3H), 3.41 & 3.34 (s, 3H), 3.29 – 3.24 (m, 1H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 199.6, 197.3, 195.6, 193.8, 156.6, 142.2, 140.7, 139.1, 138.0, 136.4, 136.3, 133.4, 133.2, 128.9, 128.7, 128.5, 128.4, 128.3, 128.1, 127.8, 127.8, 127.3, 126.3, 126.3,75.8, 70.3, 59.0, 58.4, 47.7, 45.7, 39.0, 34.3; HRMS (ESI) m/z [M+H]: Calcd for $C_{20}H_{21}O_3$: 309.1491.Found: 309.1490.

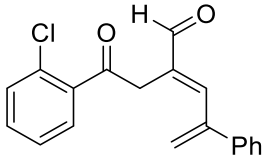
(*E*)-2-(2-(4-Fluorophenyl)-2-oxoethyl)-4-phenylpenta-2,4-dienal (3ba):



The title compound was prepared according to the general procedure (EA/PE = 1/9, R$_f$ = 0.31). The product was obtained as yellow oil in 79% yield (46.6 mg). ^{1}H NMR (400 MHz, CDCl$_3$) δ9.66 (s, 1H), 7.84 – 7.81 (m, 2H), 7.42 (d, *J* = 1.2 Hz, 1H), 7.29

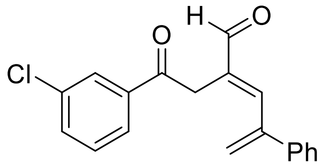
– 7.26 (m, 4H), 7.25 – 7.24 (m, 1H), 7.09 – 7.05 (m, 2H), 5.69 (d, *J* = 1.2 Hz, 1H), 5.54 (t, *J* = 1.2 Hz, 1H), 3.84 (s, 2H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 194.3, 194.2, 165.7 (d, *J* = 253.7 Hz), 151.9, 144.0, 138.7, 138.0, 132.8 (d, *J* = 3.3 Hz), 130.7 (d, *J* = 9.3 Hz), 128.6, 128.3, 127.0, 121.3, 115.5 (d, *J* = 21.6 Hz), 35.2;^{19}F NMR (376 MHz, CDCl$_3$) δ-105.56;HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{16}FO_2$: 295.1134. Found: 295.1135.

(*E*)-2-(2-(2-Chlorophenyl)-2-oxoethyl)-4-phenylpenta-2,4-dienal (3ca):



The title compound was prepared according to the general procedure (EA/PE = 1/9, R$_f$ = 0.32). The product was obtained as yellow oil in 36% yield (22.3 mg). ^{1}H NMR (400 MHz, CDCl$_3$) δ9.62 (s, 1H), 7.48 – 7.46 (m, 1H), 7.41 (s, 1H), 7.37 (m, 1H), 7.36 – 7.35 (m, 2H), 7.35 – 7.33 (m, 4H), 7.31 – 7.28 (m, 1H), 5.76 (d, *J* = 1.2 Hz, 1H), 5.61 (m, 1H), 3.87 (s, 2H); ^{13}C NMR (100 MHz, CDCl$_3$) δ198.6, 194.0, 152.0, 143.8, 138.7, 138.0, 131.8, 130.9, 130.4, 129.5, 128.7, 128.4, 126.9, 126.8, 125.9, 121.1, 39.6; HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{16}ClO_2$: 311.0839. Found: 311.0844.

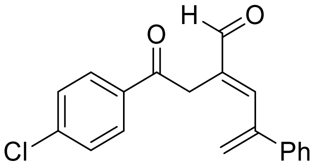
(*E*)-2-(2-(3-Chlorophenyl)-2-oxoethyl)-4-phenylpenta-2,4-dienal (3da):



The title compound was prepared according to the general procedure (EA/PE = 1/9, R$_f$ = 0.35). The product was obtained as yellow oil in 45% yield (27.9 mg). ^{1}H NMR (400 MHz, CDCl$_3$) δ9.66 (s, 1H), 7.75 – 7.74 (t, *J* = 2.0 Hz, 1H), 7.68 – 7.66 (m, 1H), 7.52 – 7.50 (m, 1H), 7.43 (s, 1H), 7.37 – 7.33 (m, 1H), 7.30 – 7.27 (m, 4H), 7.26 – 7.25 (m, 1H), 5.70 (m, 1H), 5.54 (m, 1H), 3.83 (s, 2H); ^{13}C NMR (100 MHz, CDCl$_3$)

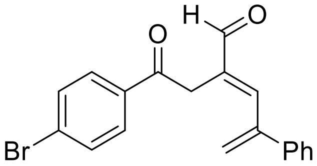
*δ*194.7, 194.1, 151.9, 144.1, 138.7, 137.9, 137.7, 134.7, 133.0, 129.8, 128.7, 128.4, 128.2, 127.0, 126.1, 121.5, 35.4; HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{16}ClO_2$: 311.0839. Found: 311.0842.

(*E*)-2-(2-(4-Chlorophenyl)-2-oxoethyl)-4-phenylpenta-2,4-dienal (3ea):



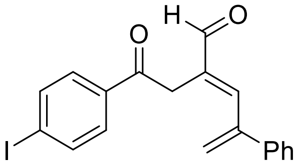
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f= 0.33). The product was obtained as yellow oil in 81% yield (50.2 mg). ^{1}H NMR (400 MHz, $CDCl_3$) *δ*9.65 (s, 1H), 7.74 – 7.72 (m, 2H), 7.42 – 7.41 (m, 1H), 7.39 – 7.36 (m, 2H), 7.28 – 7.26 (m, 4H), 7.25 (m, 1H), 5.69 (d, *J* = 1.2 Hz, 1H), 5.54 (t, *J* = 1.2 Hz, 1H), 3.82 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) *δ*194.7, 194.2, 151.9, 144.0, 139.5, 138.7, 137.8, 134.7, 129.4, 128.7, 128.6, 128.3, 127.0, 121.5, 35.2; HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{16}ClO_2$: 311.0839. Found: 311.0838.

(*E*)-2-(2-(4-Bromophenyl)-2-oxoethyl)-4-phenylpenta-2,4-dienal (3fa):



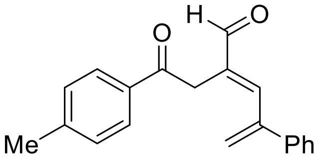
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.35). The product was obtained as yellow oil in 75% yield (53.1 mg). ^{1}H NMR (400 MHz, $CDCl_3$) *δ*9.65 (s, 1H), 7.69– 7.64 (m, 2H), 7.57– 7.53 (m, 2H), 7.44–7.42 (m, 1H), 7.31– 7.26 (m, 5H), 5.69 (d, *J* = 1.2 Hz, 1H), 5.54 (t, *J* = 1.2 Hz, 1H), 3.81 (s, 2H).; ^{13}C NMR (100 MHz, $CDCl_3$) *δ*194.9, 194.1, 151.9, 144.1, 138.7, 137.8, 135.1, 131.7, 129.5, 128.6, 128.3, 128.3, 127.0, 121.5, 35.2; HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{16}BrO_2$: 355.0334. Found: 355.0333.

(*E*)-2-(2-(4-Iodophenyl)-2-oxoethyl)-4-phenylpenta-2,4-dienal (3ga):



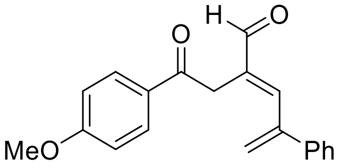
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.32). The product was obtained as yellow oil in 77% yield (61.9 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ9.65 (s, 1H), 7.78 – 7.75 (m, 2H), 7.51 – 7.48 (m, 2H), 7.41 (m, 1H), 7.30– 7.26 (m, 4H), 7.25 (m, 1H), 5.69 (d, *J* = 1.2 Hz, 1H), 5.54 – 5.53 (t, *J* = 1.2 Hz, 1H), 3.80 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ195.2, 194.1, 151.9, 144.0, 138.7, 137.8, 137.7, 135.7, 129.4, 128.6, 128.3, 127.0, 121.5, 101.1, 35.2; HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{16}IO_2$: 403.0195. Found: 403.0201.

(*E*)-2-(2-Oxo-2-(*p*-tolyl)ethyl)-4-phenylpenta-2,4-dienal (3ha):



The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.33). The product was obtained as yellow oil in 80% yield (46.6 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ9.66 (s, 1H), 7.74–7.72 (m, 2H), 7.40 (m, 1H), 7.31 – 7.28 (m, 4H), 7.26 (m, 1H), 7.22 – 7.20 (d, *J* = 8.0 Hz, 2H), 5.69 (d, *J* = 1.2 Hz, 1H), 5.51 (t, *J* = 1.2 Hz, 1H), 3.88 (s, 2H), 2.40 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ195.5, 194.3, 151.7, 143.9, 143.9, 138.8, 138.4, 134.0, 129.1, 128.6, 128.3, 128.2, 126.9, 120.7, 35.3, 21.6; HRMS (ESI) m/z [M+H]: Calcd for $C_{20}H_{19}O_2$: 291.1385. Found: 291.1389.

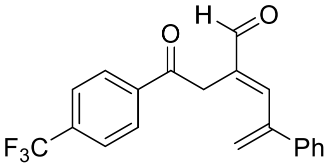
(*E*)-2-(2-(4-Methoxyphenyl)-2-oxoethyl)-4-phenylpenta-2,4-dienal (3ia):



The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f

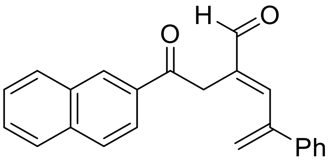
= 0.35). The product was obtained as yellow oil in 71% yield (43.5 mg). ^{1}H NMR (400 MHz, CDCl$_3$) *δ*9.66 (s, 1H), 7.83 – 7.79 (m, 2H), 7.40 (d, *J* = 1.2 Hz, 1H), 7.31 – 7.26 (m, 4H), 6.89 (m, 1H), 6.87 (m, 1H), 5.69 (d, *J* = 1.2 Hz, 1H), 5.52 (t, *J* = 1.2 Hz, 1H), 3.86 (s, 2H), 3.86, (s, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) *δ*194.4, 194.3, 163.5, 151.6, 143.9, 138.8, 138.5, 130.4, 129.5, 128.6, 128.3, 126.9, 120.7, 113.5, 55.4, 35.0; HRMS (ESI) m/z [M+H]: Calcd for $C_{20}H_{19}O_3$: 307.1334. Found: 307.1341.

(*E*)-2-(2-Oxo-2-(4-(trifluoromethyl)phenyl)ethyl)-4-phenylpenta-2,4-dienal (3ja):



The title compound was prepared according to the general procedure (EA/PE = 1/9, R$_f$ = 0.32). The product was obtained as colorless oil in 51% yield (35.1mg). ^{1}H NMR (400 MHz, CDCl$_3$) *δ*9.66 (s, 1H), 7.88 (d, *J* = 8.0 Hz, 2H), 7.67 (d, *J* = 8.4 Hz, 2H), 7.44 (d, *J* = 1.2 Hz, 1H), 7.30 – 7.27 (m, 3H), 7.25– 7.22 (m, 2H), 5.70 (m, 1H), 5.56 (t, *J* = 1.2 Hz, 1H), 3.85 (s, 2H); ^{13}C NMR (100 MHz, CDCl$_3$) *δ*195.0, 194.1, 152.1, 144.1, 139.1, 138.7, 137.6, 128.7, 128.4, 128.3, 127.0, 125.5 (q, *J* = 3.8 Hz), 125.4, 124.7, 121.8, 35.6;^{19}F NMR (376 MHz, CDCl$_3$) *δ*-62.62; HRMS (ESI) m/z [M+H]: Calcd for $C_{20}H_{16}F_3O_2$: 345.1102. Found: 345.1108.

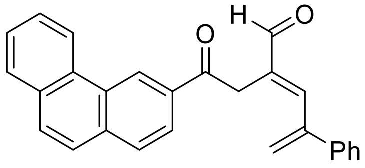
(*E*)-2-(2-(Naphthalen-2-yl)-2-oxoethyl)-4-phenylpenta-2,4-dienal (3ka):



The title compound was prepared according to the general procedure (EA/PE = 1/9, R$_f$ = 0.28). The product was obtained as yellow oil in 65% yield (42.4 mg). ^{1}H NMR (400 MHz, CDCl$_3$) *δ*9.70 (s, 1H), 8.29 (s, 1H), 7.91– 7.89 (m, 2H), 7.87 – 7.84 (m, 2H), 7.62– 7.57 (m, 1H), 7.56– 7.52 (m, 1H), 7.44 (s, 1H), 7.35– 7.31 (m, 2H), 7.28–

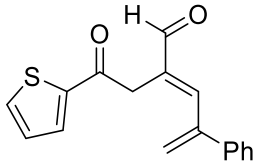
7.25 (m, 2H), 7.22– 7.17 (m, 1H), 5.70 (m, 1H), 5.56 (m, 1H), 4.04 (s, 2H); ^{13}C NMR (100 MHz, CDCl$_3$) δ195.8, 194.3, 151.8, 144.0, 138.8, 138.3, 135.5, 133.7, 132.3, 129.7, 129.5, 128.6, 128.4, 128.3, 128.3, 127.7, 126.9, 126.7, 123.8, 121.1, 35.4; HRMS (ESI) m/z [M+H]: Calcd for $C_{23}H_{19}O_2$: 327.1385. Found: 327.1389.

(*E*)-2-(2-Oxo-2-(phenanthren-3-yl)ethyl)-4-phenylpenta-2,4-dienal (3la):



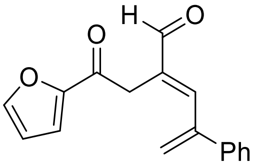
The title compound was prepared according to the general procedure (EA/PE = 1/9, R$_f$ = 0.25). The product was obtained as yellow oil in 67% yield (50.4 mg). ^{1}H NMR (400 MHz, CDCl$_3$) δ9.71 (s, 1H), 9.13 (s, 1H), 8.68 (d, *J* = 8.0 Hz, 1H), 7.99–7.96 (m, 1H), 7.92–7.90 (m, 1H), 7.88 (d, *J* = 8.4 Hz, 1H), 7.84 (d, *J* = 8.8 Hz, 1H), 7.75 – 7.70 (m, 1H), 7.68 (m, 1H), 7.66 – 7.64 (m, 1H), 7.45 (s, 1H), 7.34 (m, 1H), 7.33 – 7.32 (m, 1H), 7.25 – 7.22 (m, 2H), 7.17 – 7.15 (m, 1H), 5.71 (d, *J* = 0.8 Hz, 1H), 5.59 (m, 1H), 4.09 (s, 2H); ^{13}C NMR (100 MHz, CDCl$_3$) δ196.0, 194.3, 151.9, 144.1, 138.8, 138.3, 135.0, 134.1, 132.1, 130.6, 129.7, 129.6, 128.8, 128.7, 128.6, 128.3, 127.2, 127.2, 127.0, 126.2, 125.2, 123.6, 122.7, 121.4, 35.6;HRMS (ESI) m/z [M+H]: Calcd for $C_{27}H_{21}O_2$: 377.1542. Found: 377.1543.

(*E*)-2-(2-Oxo-2-(thiophen-2-yl)ethyl)-4-phenylpenta-2,4-dienal (3ma):



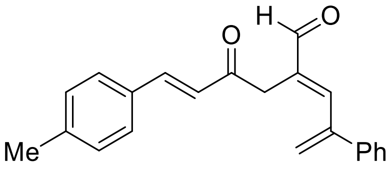
The title compound was prepared according to the general procedure (EA/PE = 1/9, R$_f$ = 0.33). The product was obtained as yellow oil in 71% yield (40.1 mg). ^{1}H NMR (400 MHz, CDCl$_3$) δ9.65 (s, 1H), 7.61–7.60 (m, 1H), 7.58–7.56 (m, 1H), 7.41 (m, 1H), 7.33– 7.27 (m, 4H), 7.26– 7.25 (m, 1H), 7.08–7.06 (m, 1H), 5.71 (d, *J* = 1.2 Hz, 1H), 5.58 (t, *J* = 1.2 Hz, 1H), 3.86 (s, 2H); ^{13}C NMR (100 MHz, CDCl$_3$) δ194.1, 188.6, 152.1, 143.8, 143.3, 138.6, 137.5, 133.6, 132.0, 128.6, 128.3, 127.9, 126.9, 121.2, 35.7; HRMS (ESI) m/z [M+H]: Calcd for $C_{17}H_{15}O_2S$: 283.0793. Found: 283.0790.

(*E*)-2-(2-(Furan-2-yl)-2-oxoethyl)-4-phenylpenta-2,4-dienal (3na):



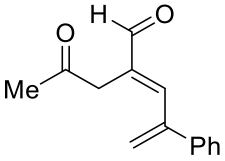
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.35). The product was obtained as yellow oil in 77% yield (40.9 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ9.64 (s, 1H), 7.53 (m, 1H), 7.41 (d, *J* = 1.2 Hz, 1H), 7.32– 7.27 (m, 5H), 7.11– 7.10 (m, 1H), 6.50 –6.49 (m, 1H), 5.71 (m, 1H), 5.57 (t, *J* = 1.2 Hz, 1H), 3.78 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ194.1, 184.9, 152.2, 152.0, 146.2, 143.7, 138.6, 137.4, 128.6, 128.3, 126.9, 121.0, 117.1, 112.2, 34.9; HRMS (ESI) m/z [M+H]: Calcd for $C_{17}H_{15}O_3$: 267.1021. Found: 267.1020.

(*2E,5E*)-4-Oxo-2-(2-phenylallylidene)-6-(*p*-tolyl)hex-5-enal (2oa):



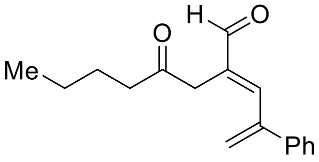
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.28). The product was obtained as yellow oil in 51% yield (32.2 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ9.64 (s, 1H), 7.44 – 7.40 (m, 2H), 7.38– 7.37 (m, 2H), 7.33– 7.31 (m, 4H), 7.25 (m, 1H), 7.20– 7.18 (m, 2H), 6.62 – 6.57 (m, 1H), 5.72 (m, 1H), 5.56 (m, 1H), 3.60 (s, 2H), 2.38 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ195.7, 194.3, 151.8, 143.8, 143.1, 141.0, 138.8, 138.2, 131.6, 129.6, 128.7, 128.3, 126.9, 124.5, 121.0, 37.2, 21.5; HRMS (ESI) m/z [M+H]: Calcd for $C_{22}H_{21}O_2$: 317.1542. Found: 317.1537.

(*E*)-2-(2-Oxopropyl)-4-phenylpenta-2,4-dienal (3pa):



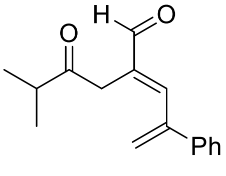
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.32). The product was obtained as yellow oil in 68% yield (29.1 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.57 (s, 1H), 7.37– 7.32 (m, 3H), 7.32 – 7.30 (m, 1H), 7.30– 7.28 (m, 2H), 5.70 (d, *J* = 1.2 Hz, 1H), 5.54– 5.53 (m, 1H), 3.30 (s, 2H), 2.01 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ204.4, 194.3, 151.8, 144.0, 138.8, 137.7, 128.6, 128.4, 127.0, 121.5, 39.7, 29.9; HRMS (ESI) m/z [M+H]: Calcd for $C_{14}H_{15}O_2$: 215.1072. Found: 215.1070.

(*E*)-4-oxo-2-(2-Phenylallylidene)octanal (3qa):



The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.34). The product was obtained as yellow oil in 65% yield (33.3 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ9.57 (s, 1H), 7.37– 7.33 (m, 3H), 7.32 – 7.26 (m, 3H), 5.69 (d, *J* = 1.2 Hz, 1H), 5.53 (t, *J* = 1.2 Hz, 1H), 3.29 (s, 2H), 2.30 – 2.23 (m, 2H), 1.51– 1.43 (m, 2H), 1.28– 1.23 (m, 2H), 0.87 (t, *J* = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ206.6, 194.3, 151.6, 144.0, 138.9, 138.0, 128.6, 128.3, 127.0, 121.1, 42.5, 38.9, 25.7, 22.2, 13.8; HRMS (ESI) m/z [M+H]: Calcd for $C_{17}H_{21}O_2$: 257.1542. Found: 257.1543.

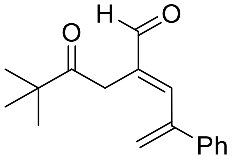
(*E*)-5-Methyl-4-oxo-2-(2-phenylallylidene)hexanal (3ra):



The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f

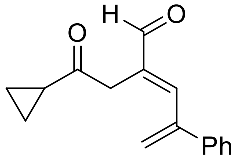
= 0.32). The product was obtained as yellow oil in 50% yield (24.2 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ9.56 (s, 1H), 7.36– 7.29 (m, 6H), 5.68 (m, 1H), 5.50 (d, *J* = 1.2 Hz, 1H), 3.35 (s, 2H), 2.50–2.47 (m, 1H), 1.02 (d, *J* = 7.2 Hz, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ210.2, 194.3, 151.7, 143.9, 138.8, 138.2, 128.6, 128.3, 127.0, 120.9, 41.0, 36.8, 18.2; HRMS (ESI) m/z [M+H]: Calcd for $C_{16}H_{19}O_2$: 243.1385. Found: 243.1388.

(*E*)-5,5-Dimethyl-4-oxo-2-(2-phenylallylidene)hexanal (3sa):



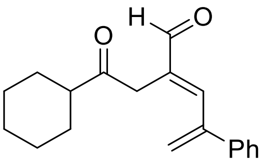
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.35). The product was obtained as yellow oil in 42% yield (21.5 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ9.55 (s, 1H), 7.35– 7.30 (m, 6H), 5.67 (d, *J* = 1.2 Hz, 1H), 5.47 (t, *J* = 1.2 Hz, 1H), 3.39 (s, 2H), 1.06 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ211.5, 194.3, 151.6, 144.1, 138.9, 138.6, 128.6, 128.3, 127.0, 120.8, 44.3, 33.7, 26.6; HRMS (ESI) m/z [M+H]: Calcd for $C_{17}H_{21}O_2$: 257.1542. Found: 257.1546.

(*E*)-2-(2-Cyclopropyl-2-oxoethyl)-4-phenylpenta-2,4-dienal (3ta):



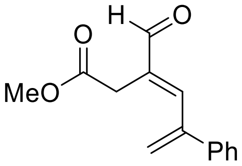
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.33). The product was obtained as yellow oil in 59% yield (28.3 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ9.58 (s, 1H), 7.38– 7.29 (m, 6H), 5.71 (m, 1H), 5.51 (m, 1H), 3.47 (s, 2H), 1.83– 1.77 (m, 1H), 0.98– 0.97 (m, 2H), 0.85– 0.80 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ206.3, 194.3, 151.7, 143.8, 138.9, 137.9, 128.6, 128.3, 126.9, 121.0, 39.5, 20.5, 11.0; HRMS (ESI) m/z [M+H]: Calcd for $C_{16}H_{17}O_2$: 241.1229. Found: 241.1233.

(*E*)-2-(2-Cyclohexyl-2-oxoethyl)-4-phenylpenta-2,4-dienal (3ua):



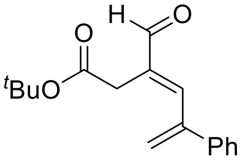
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.32). The product was obtained as yellow oil in 69% yield (38.9 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ9.49 (s, 1H), 7.29– 7.26 (m, 3H), 7.25– 7.22 (m, 3H), 5.61 (d, *J* = 1.2 Hz, 1H), 5.42 (t, *J* = 1.2 Hz, 1H), 3.28 (s, 2H), 2.19– 2.12 (m, 1H), 1.72– 1.68 (m, 2H), 1.67– 1.64 (m, 2H), 1.23– 1.08 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ209.5, 194.3, 151.6, 143.9, 138.8, 138.3, 128.6, 128.3, 127.0, 120.8, 50.8, 37.1, 28.4, 25.7, 25.5; HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{23}O_2$: 283.1698. Found: 283.1702.

Methyl (*E*)-3-formyl-5-phenylhexa-3,5-dienoate (3va):



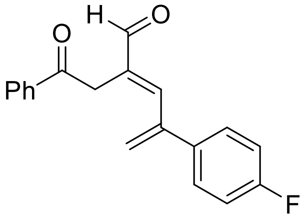
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.30). The product was obtained as yellow oil in 52% yield (23.9 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ9.60 (s, 1H), 7.38– 7.31 (m, 6H), 5.78 (m, 1H), 5.54 (t, *J* = 1.2 Hz, 1H), 3.62 (s, 3H), 3.26 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ194.1, 170.6, 151.6, 143.5, 138.5, 137.2, 128.6, 128.5, 126.8, 121.0, 52.1, 30.6; HRMS (ESI) m/z [M+H]: Calcd for $C_{14}H_{15}O_3$: 231.1021. Found: 231.1023.

***tert*-Butyl (*E*)-3-formyl-5-phenylhexa-3,5-dienoate (3wa):**



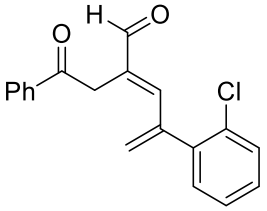
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.31). The product was obtained as yellow oil in 41% yield (22.3 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ9.60 (s, 1H), 7.36 – 7.35 (m, 5H), 7.27–7.26 (m, 1H), 5.78 (m, 1H), 5.53 (m, 1H), 3.20 (s, 2H), 1.40 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) *δ*194.2, 169.3, 151.0, 143.5, 138.7, 138.0, 128.7, 128.4, 126.8, 120.4, 81.1, 32.1, 27.9; HRMS (ESI) m/z [M+H]: Calcd for $C_{17}H_{21}O_3$: 273.1491. Found: 273.1494.

(*E*)-4-(4-Fluorophenyl)-2-(2-oxo-2-phenylethyl)penta-2,4-dienal (3ab):



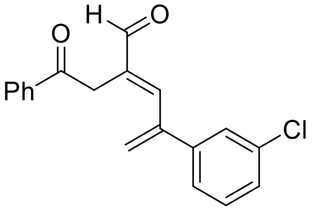
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.34). The product was obtained as yellow oil in 72% yield (42.3 mg). ^{1}H NMR (400 MHz, $CDCl_3$) *δ* 9.59 (s, 1H), 7.78 – 7.76 (m, 2H), 7.49–7.47 (m, 1H), 7.38 – 7.34 (m, 2H), 7.31 (s, 1H), 7.23 – 7.21 (m, 2H), 6.89 (t, *J* = 8.6 Hz, 2H), 5.58 (m, 1H), 5.44 (m, 1H), 3.84 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) *δ* 195.8, 194.1, 162.7 (d, *J* = 246.9 Hz), 151.5, 142.9, 138.4, 136.3, 134.8 (d, *J* = 3.3 Hz), 133.3, 128.7 (d, *J* = 8.2 Hz), 128.3 (d, *J* = 47.0 Hz), 120.8, 115.6, 115.4, 35.3; ^{19}F NMR (376 MHz, $CDCl_3$) *δ*-113.19;HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{16}FO_2$: 295.1134. Found: 295.1143.

(*E*)-4-(2-Chlorophenyl)-2-(2-oxo-2-phenylethyl)penta-2,4-dienal (3ac):



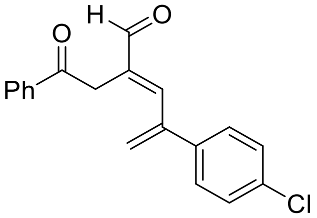
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.32). The product was obtained as yellow oil in 63% yield (39.1 mg). ^{1}H NMR (400 MHz, $CDCl_3$) *δ* 9.60 (s, 1H), 7.68 – 7.66 (m, 2H), 7.51 – 7.49 (m, 1H), 7.38 – 7.33 (m, 3H), 7.28 – 7.26 (m, 1H), 7.12 (d, *J* = 7.6 Hz, 1H), 7.03 – 6.97 (m, 2H), 5.91 (m, 1H), 5.56 (m, 1H), 3.66 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) *δ* 195.3, 194.5, 151.2, 143.4, 138.3, 136.2, 136.1, 133.0, 132.5, 130.9, 129.4, 129.3, 128.4, 128.2, 127.9, 127.0, 34.1; HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{16}ClO_2$: 311.0839. Found: 311.0834.

(*E*)-4-(3-Chlorophenyl)-2-(2-oxo-2-phenylethyl)penta-2,4-dienal (3ad):



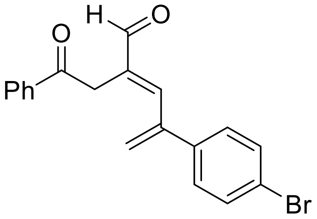
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.31). The product was obtained as yellow oil in 56% yield (34.7 mg). ^1H NMR (400 MHz, $CDCl_3$) δ 9.67 (s, 1H), 7.84 (d, *J* = 7.6 Hz, 2H), 7.56 (m, 1H), 7.42 (t, *J* = 7.6 Hz, 2H), 7.36 (s, 1H), 7.29 (s, 1H), 7.20 (s, 3H), 5.70 (m, 1H), 5.56 (m, 1H), 3.92 (s, 2H); ^{13}C NMR (100 MHz, $(CD_3)_2SO$) δ 196.6, 195.5, 151.4, 142.2, 140.9, 139.2, 136.5, 134.0, 134.0, 131.0, 129.2, 128.7, 128.5, 126.9, 125.7, 121.7, 35.8; HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{16}ClO_2$: 311.0839. Found: 311.0841.

(*E*)-4-(4-Chlorophenyl)-2-(2-oxo-2-phenylethyl)penta-2,4-dienal (3ae):



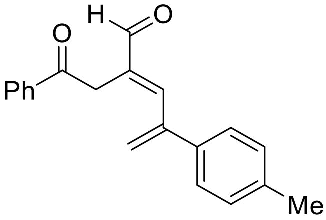
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.33). The product was obtained as yellow oil in 82% yield (50.8 mg). ^1H NMR (400 MHz, $CDCl_3$) δ 9.66 (s, 1H), 7.84 – 7.81 (m, 2H), 7.56 – 7.54 (m, 1H), 7.45 – 7.41 (m, 2H), 7.37 – 7.26 (m, 1H), 7.23 (s, 4H), 5.67 (d, *J* = 1.2 Hz, 1H), 5.53 (t, *J* = 1.2 Hz, 1H), 3.91 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.8, 194.0, 151.0, 142.8, 138.5, 137.1, 136.3, 134.4, 133.3, 128.8, 128.5, 128.3, 128.0, 121.2, 35.3; HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{16}ClO_2$: 311.0839. Found: 311.0840.

(*E*)-4-(4-Bromophenyl)-2-(2-oxo-2-phenylethyl)penta-2,4-dienal (3af):



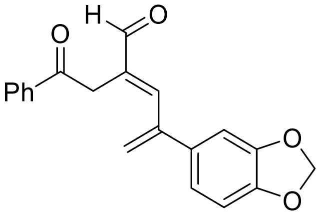
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.35). The product was obtained as yellow oil in 73% yield (51.7 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.66 (s, 1H), 7.83 – 7.81 (m, 2H), 7.56 – 7.54 (m, 1H), 7.45 – 7.43 (m, 2H), 7.41 – 7.36 (m, 3H), 7.18 – 7.16 (m, 2H), 5.68 (m, 1H), 5.54 (m, 1H), 3.90 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.8, 194.0, 151.0, 142.9, 138.5, 137.6, 136.2, 133.3, 131.7, 128.6, 128.5, 128.0, 122.5, 121.3, 35.2; HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{16}BrO_2$: 355.0334. Found: 355.0330.

(*E*)-2-(2-Oxo-2-phenylethyl)-4-(p-tolyl)penta-2,4-dienal (3ag):



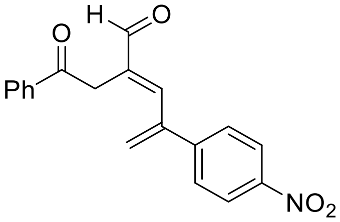
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.32). The product was obtained as yellow oil in 77% yield (44.7 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.66 (s, 1H), 7.82 – 7.80 (m, 2H), 7.54 – 7.52 (m, 1H), 7.43 – 7.39 (m, 3H), 7.19 – 7.17 (m, 2H), 7.07 – 7.05 (m, 2H), 5.65 (d, J = 1.2 Hz, 1H), 5.48 (t, J = 1.2 Hz, 1H), 3.89 (s, 2H), 2.24 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.9, 194.3, 152.1, 143.8, 138.2, 138.1, 136.4, 135.8, 133.1, 129.3, 128.4, 128.0, 126.8, 120.4, 35.3, 21.0; HRMS (ESI) m/z [M+H]: Calcd for $C_{20}H_{19}O_2$: 291.1385. Found: 291.1388.

(*E*)-4-(Benzo[d][1,3]dioxol-5-yl)-2-(2-oxo-2-phenylethyl)penta-2,4-dienal (3ah):



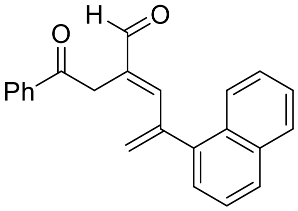
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.31). The product was obtained as yellow oil in 70% yield (44.8 mg). ^1H NMR (400 MHz, $CDCl_3$) δ 9.66 (s, 1H), 7.85 (d, J = 8.0 Hz, 2H), 7.57 – 7.54 (m, 1H), 7.45 – 7.41 (m, 2H), 7.36 (s, 1H), 6.77 – 6.75 (m, 2H), 6.72 – 6.69 (m, 1H), 5.81 (m, 2H), 5.60 (m, 1H), 5.45 (m, 1H), 3.91 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.8, 194.2, 151.8, 147.8, 147.6, 143.5, 138.1, 136.4, 133.1, 132.8, 128.4, 128.1, 120.8, 120.2, 108.2, 107.4, 101.1, 35.3; HRMS (ESI) m/z [M+H]: Calcd for $C_{20}H_{17}O_4$: 321.1127. Found: 321.1132.

(*E*)-4-(4-Nitrophenyl)-2-(2-oxo-2-phenylethyl)penta-2,4-dienal (3ai):



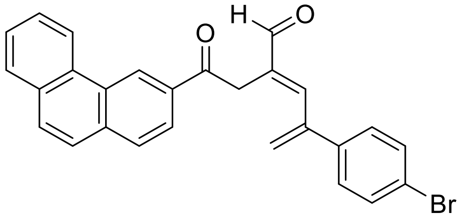
The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.21). The product was obtained as red oil in 43% yield (27.6 mg).^1H NMR (400 MHz, $CDCl_3$) δ 9.69 – 9.67 (m, 1H), 8.13 – 8.09 (m, 2H), 7.81 – 7.80 (m, 2H), 7.55 – 7.54 (m, 1H), 7.50 – 7.45 (m, 2H), 7.42 – 7.37 (m, 3H), 5.80 (m, 1H), 5.69 (m, 1H), 3.92 – 3.90 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.5, 193.7, 149.7, 147.5, 145.0, 142.2, 139.1, 136.0, 133.5, 128.6, 128.0, 127.9, 123.9, 123.4, 35.2; HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{16}NO_4$: 322.1079.Found: 322.1085.

(*E*)-4-(Naphthalen-1-yl)-2-(2-oxo-2-phenylethyl)penta-2,4-dienal (3aj):



The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.28). The product was obtained as yellow oil in 62% yield (40.4 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.62 (s, 1H), 7.75 (m, 1H), 7.66 (m,1H), 7.54 – 7.42 (m, 6H), 7.21 (m, 5H), 6.09 – 6.08 (m, 1H), 5.66 (m, 1H), 3.27 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.1, 194.7, 152.3, 144.5, 137.1, 136.2, 135.8, 133.3, 132.7, 131.0, 129.4, 128.3, 128.2, 127.9, 127.6, 126.6, 126.5, 126.2, 125.3, 99.9, 34.0; HRMS (ESI) m/z [M+H]: Calcd for $C_{23}H_{19}O_2$: 327.1385. Found: 327.1389.

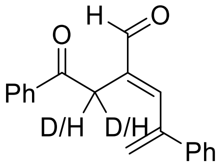
(*E*)-4-(4-Bromophenyl)-2-(2-oxo-2-(phenanthren-3-yl)ethyl)penta-2,4-dienal (3ak):



The title compound was prepared according to the general procedure (EA/PE = 1/9, R_f = 0.25). The product was obtained as yellow solid in 71% yield (64.5 mg), Mp. 163 – 164 ℃. ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.72 (s, 1H), 9.18 (s, 1H), 8.71 (d, *J* = 8.4 Hz, 1H), 8.01 – 7.98 (m, 1H), 7.94 – 7.91 (m, 2H), 7.88 – 7.86 (m, 1H), 7.77 – 7.75 (m, 1H), 7.74 – 7.67 (m, 1H), 7.65 (t, *J* = 7.4 Hz, 1H), 7.41 (s, 1H), 7.36 (d, *J* = 8.4 Hz, 2H), 7.21 – 7.19 (m, 2H), 5.71 (s, 1H), 5.60 (s, 1H), 4.13 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.9, 194.1, 151.1, 142.9, 138.7, 137.6, 135.1, 134.0, 132.1, 131.8, 130.6, 129.8, 129.7, 128.9, 128.8, 128.6, 127.3, 127.2, 126.2, 125.1, 123.6, 122.7, 122.6, 121.4, 35.5; HRMS (ESI) m/z [M+Na]: Calcd for $C_{27}H_{19}BrO_2Na$: 477.0466. Found: 477.0457.

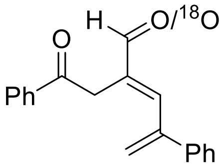
Spectral data of mechanistic investigations:

3aa-I:



The title compound was prepared under standard conditions with $(CF_3)_2CDOD$ instead of HFIP (EA/PE = 1/9, R_f = 0.31). The product was obtained as yellow oil in 81% yield (44.6 mg). ^1H NMR (400 MHz, $CDCl_3$) δ 9.67 (s, 1H), 7.83 – 7.81 (m, 2H), 7.56 – 7.52 (m,1H), 7.43 – 7.39 (m, 3H), 7.32 – 7.27 (m, 4H), 7.26 – 7.22 (m, 1H), 5.69 (m, 1H), 5.53 (s, 1H), 3.90 (s, 0.32H), 3.87 (s, 0.40H);^{13}C NMR (100 MHz, $CDCl_3$) δ 196.0, 195.9, 195.9, 194.3, 151.9, 143.8, 138.7, 138.2, 138.1, 138.1, 136.3, 133.1, 128.6, 128.4, 128.3, 128.0, 126.9, 121.0, 35.4, 35.3, 35.1, 34.9; HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{15}D_2O_2$: 279.1354. Found: 279.1360.

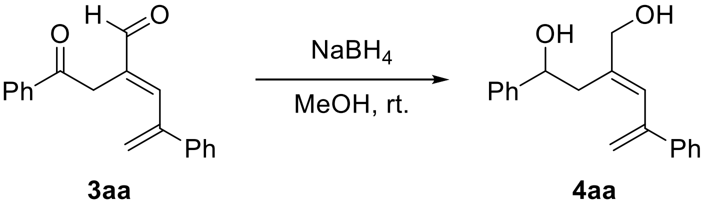
3aa-II:



The title compound was prepared under standard conditions with $H_2{}^{18}O$ (2.0 equiv.) (EA/PE = 1/9, R_f = 0.30). The product was obtained as yellow oil in 72% yield (39.8 mg). ^1H NMR (400 MHz, $CDCl_3$) δ 9.66 (s, 1H), 7.83 – 7.82 (m, 1H), 7.80 (m, 1H), 7.56 – 7.52 (m, 1H), 7.43 – 7.39 (m, 3H), 7.32 – 7.26 (m, 4H), 7.26 – 7.23 (m, 1H), 5.69 (m, 1H), 5.53 – 5.52 (t, *J* = 1.2 Hz, 1H), 3.90 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.9, 194.3, 194.2, 151.8, 143.8, 138.7, 138.2, 136.3, 133.1, 128.6, 128.4, 128.3, 128.0, 126.9, 121.0, 35.3; HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{17}O^{18}O$: 279.1271. Found: 279.1264.

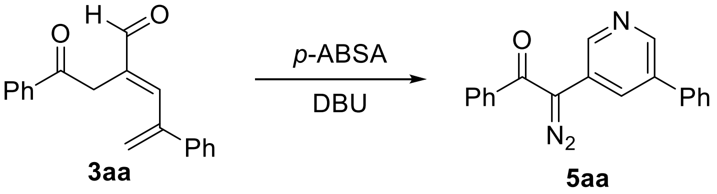
General procedure for applications and their spectral data:

(*E*)-1-Phenyl-3-(2-phenylallylidene)butane-1,4-diol (4aa)[11]:



A mixture of **3aa** (0.10 mmol, 27.7 mg) in MeOH (2.00 mL) was cooled to 0 ℃, $NaBH_4$ (0.4 mmol, 16 mg) was added and the reaction mixture was stirred at the same temperature for 30 min under nitrogen atmosphere. The mixture was poured into H_2O (5 mL) and extracted with EtOAc (10 mL). The organic layer was washed with brine (10 mL) and dried with Na_2SO_4. After removal of the solvent, the residue was subjected to column chromatography (EA/PE = 1/3, R_f = 0.24) to give **4aa** as white solid in 92% yield (25.8 mg), Mp. 106 – 107 ℃.^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 – 7.33 (m, 3H), 7.32 – 7.31 (m, 1H), 7.30 – 7.26 (m, 3H), 7.25 (m, 1H), 7.23 – 7.19 (m, 3H), 6.36 (s, 1H), 5.58 (s, 1H), 5.17 (t, *J* = 1.2 Hz, 1H), 4.78 – 4.75 (m, 1H), 4.23 (s, 2H), 3.37 (s, 2H), 2.76 – 2.72 (m, 1H), 2.51 – 2.45 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.3, 144.3, 140.1, 139.9, 130.3, 128.4, 127.8, 127.5, 126.5, 125.5, 115.5, 74.0, 68.5, 40.1; HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{21}O_2$: 281.1542. Found: 281.1538.

2-Diazo-1-phenyl-2-(5-phenylpyridin-3-yl)ethan-1-one (5aa)[12]:



To a solution of **3aa** (0.10 mmol, 27.7 mg) and *p*-acetamidobenzenesulfonyl azide (0.12mmol, 57.7 mg) in CH_3CN at 0 ℃ was added DBU (0.15 mmol, 22.9 mg)

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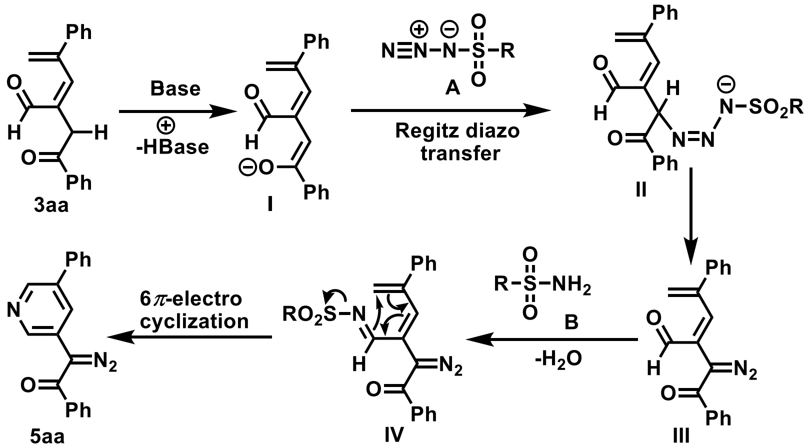
[11] H. Suzuki, S. Yoshioka, A. Igesaka, H. Nishioka and Y. Takeuchi, *Tetrahedron*, 2013, **69**, 6399−6403.
[12] J. Sarabia, Q. Li and M. Ferreira, *Angew. Chem. Int. Ed.*, 2018, **57**, 11015−11019.

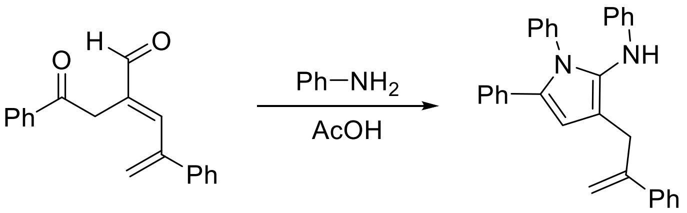
dropwise slowly. The reaction mixture was allowed to warm to room temperature and monitored by TLC. After completion of the reaction, the solvent was removed in *vacuo*. The crude residue was purified by flash chromatography (EA/PE = 1/20, R_f = 0.22) to afford product **5aa** as yellow oil in 67% yield (20.1 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.97 (d, *J* = 2.4 Hz, 1H), 8.17 – 8.15 (m, 1H),8.12 (m, 1H), 8.11 – 8.08 (m, 2H),7.68 – 7.67 (m, 1H), 7.66 – 7.65 (m, 1H), 7.63 – 7.59 (m, 1H),7.56 – 7.53 (m, 2H),7.52 – 7.45 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 193.7, 153.4, 147.0, 139.0, 136.8, 136.4, 135.2, 132.9, 130.9, 129.3, 128.9, 128.2, 127.3, 124.9, 77.2; HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{13}N_3ONa$: 322.0956. Found: 322.0958.

Possible reaction pathway for **5aa**[13]:

Under basic conditions, **3aa** was initially going through a well known diazo transfer process led to diazo **III**. The imine intermediate **IV** could be generated by condensation of **III** with tosyl amine **B**. Finally, the product **5aa** might be obtained by the tramolecular 6*π*-electrocyclization.



N,1,5-Triphenyl-3-(2-phenylallyl)-1H-pyrrol-2-amine (6aa)[14]:



3aa **6aa**

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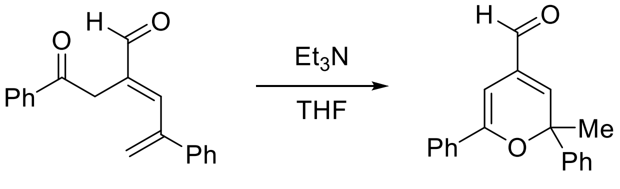
[13] Y. Jiang and C.-M Park, *Chem. Sci.*, 2014, **5**, 2347–2351.

[14] C. Zhu, R. Zhu, H. Zeng, F. Chen, C. Liu, W. Wu and H. Jiang, *Angew. Chem. Int. Ed.* 2017, **56**, 13324–13328.

Acetic acid (12.0 mg, 0.2 mmol) was added to the mixture of **3aa** (27.7 mg, 0.1 mmol), aniline (18.7 mg, 0.2 mmol) in MeOH (1 mL). Then the reaction mixture was stirred at room temperature and monitored by TLC. After completion of the reaction, brine (2 mL) was added, and extracted with DCM (5 ml × 3). The combined organic layer were dried over Na_2SO_4, and concentrated in *vacuo*. The residue was purified by flash column chromatography (EA/PE = 1/20, R_f = 0.22) on silica gel give the desired product **6aa** as red solid in 72% yield (30.7 mg), Mp. 115 – 116 ℃.^{1}H NMR (400 MHz, $CDCl_3$)δ 7.43 – 7.40 (m, 2H), 7.36 – 7.32 (m, 3H), 7.25 (m, 1H), 7.24 – 7.23 (m, 1H), 7.23 – 7.21 (m, 1H), 7.20 – 7.16 (m, 2H), 7.13 – 7.12 (m, 1H), 7.12 – 7.10 (m, 2H), 7.01 – 6.98 (m, 2H), 6.92 – 6.90 (m, 2H), 6.72 – 6.68 (m, 3H), 6.56, (s, 1H), 6.54 (d, *J* = 2.0 Hz, 1H), 5.72 (d, *J* = 2.0 Hz, 1H), 4.09 (s, 2H), 3.99 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.1, 140.7, 139.9, 135.2, 133.5, 132.4, 129.2, 128.9, 128.8, 128.7, 128.1, 127.9, 127.4, 126.5, 126.3, 125.3, 124.5, 121.5, 120.1, 117.3, 113.1, 110.6, 52.2;HRMS (ESI) m/z [M+H]: Calcd for $C_{31}H_{27}N_2$: 427.2174. Found: 427.2167.

2-Methyl-2,6-diphenyl-2*H*-pyran-4-carbaldehyde (7aa)[15]:



3aa **7aa**

Triethylamine (20.3 mg, 0.2 mmol) was added to the mixture of **3aa** (27.7 mg, 0.1 mmol) in THF (1 mL). Then the reaction mixture was stirred at room temperature and monitored by TLC. After completion of the reaction, the combined organic layer were concentrated in *vacuo*. The residue was purified by flash column chromatography (EA/PE = 1/20, R_f = 0.21) on silica gel give the desired product **7aa** as yellow oil in 79% yield (21.8 mg). ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.55 (s, 1H), 7.79 – 7.77 (m, 2H), 7.51 – 7.49 (m, 2H), 7.42 – 7.36 (m, 6H), 7.33 – 7.30 (m, 1H), 6.38 (d, *J* = 1.2 Hz,

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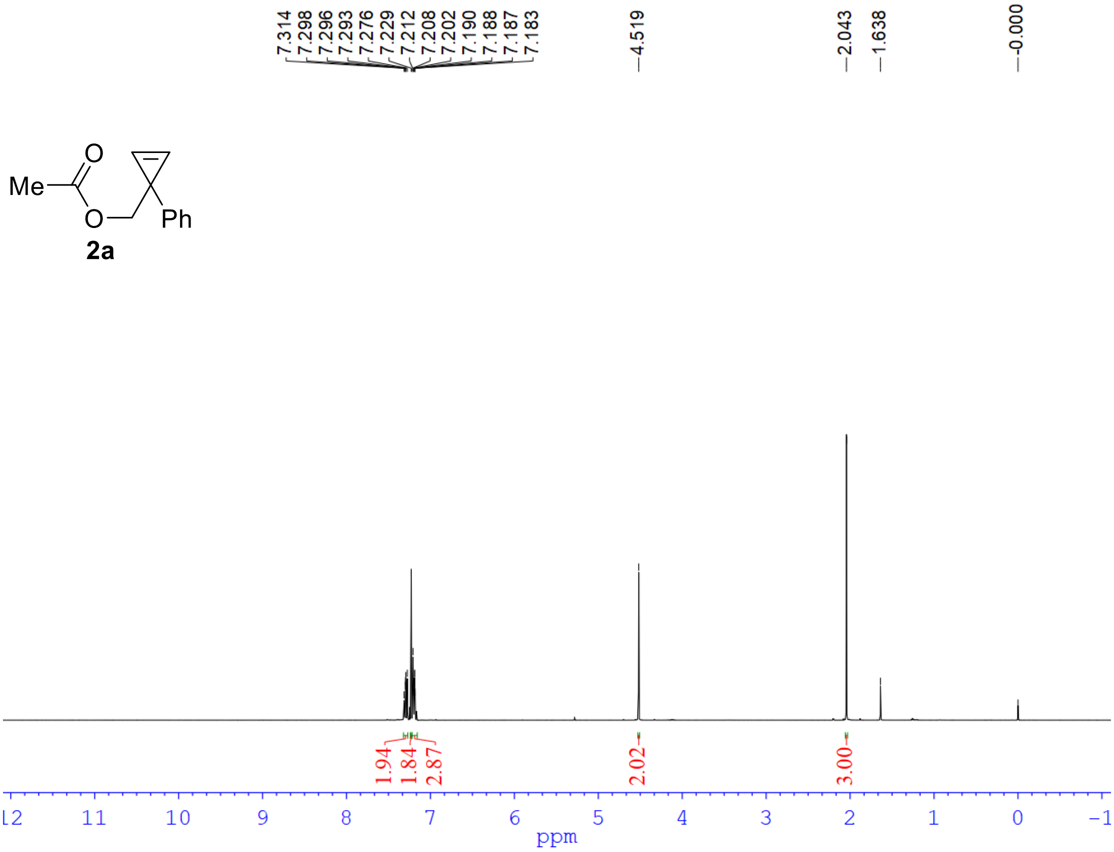
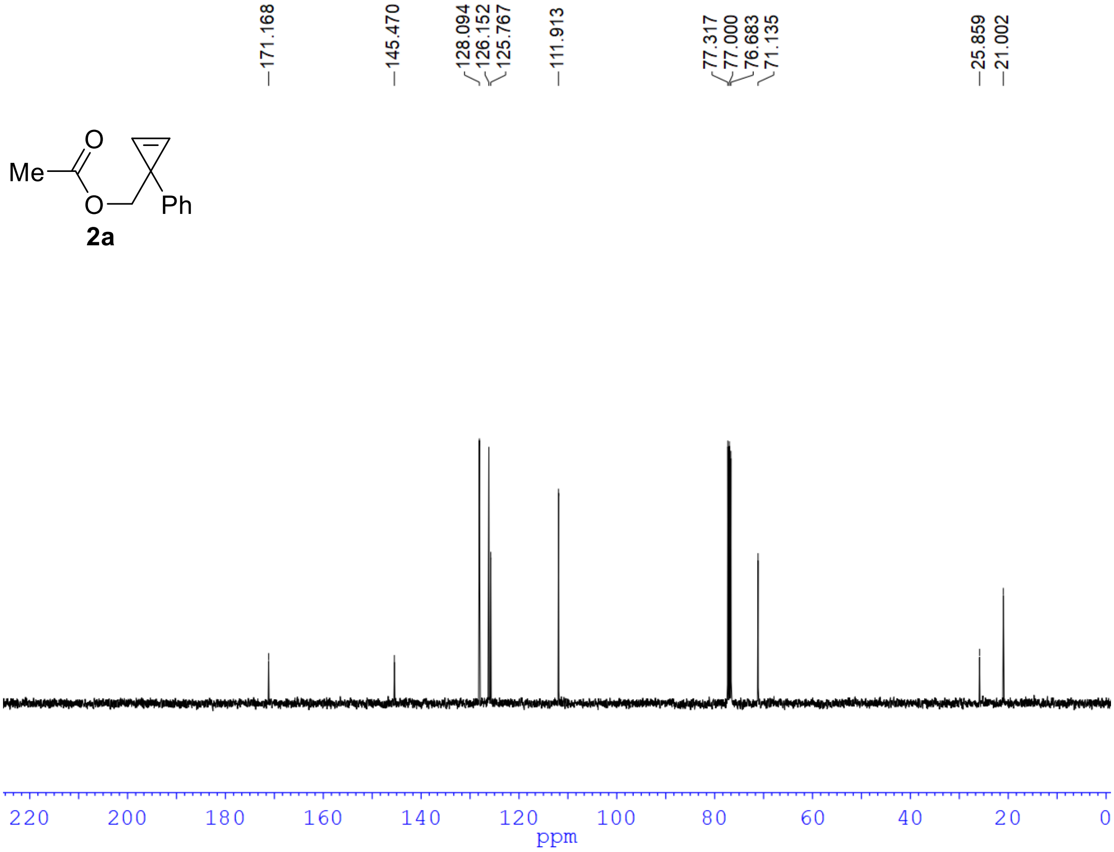
[15] T.-L. Shie, C.-H. Lin, S.-L. Lin and D.-Y. Yang, *Eur. J. Org. Chem.*, 2007, **29**, 4831−4836.

1H),6.33 (d, *J* = 1.2Hz, 1H), 1.89 (s, 3H);^{13}C NMR (100 MHz, $CDCl_3$) δ 189.9, 153.1, 144.0, 138.9, 134.5, 133.7, 129.4, 128.5, 128.4, 127.9, 125.3, 124.8, 91.1, 79.9, 27.7; HRMS (ESI) m/z [M+H]: Calcd for $C_{19}H_{17}O_2$: 277.1229. Found: 277.1228.

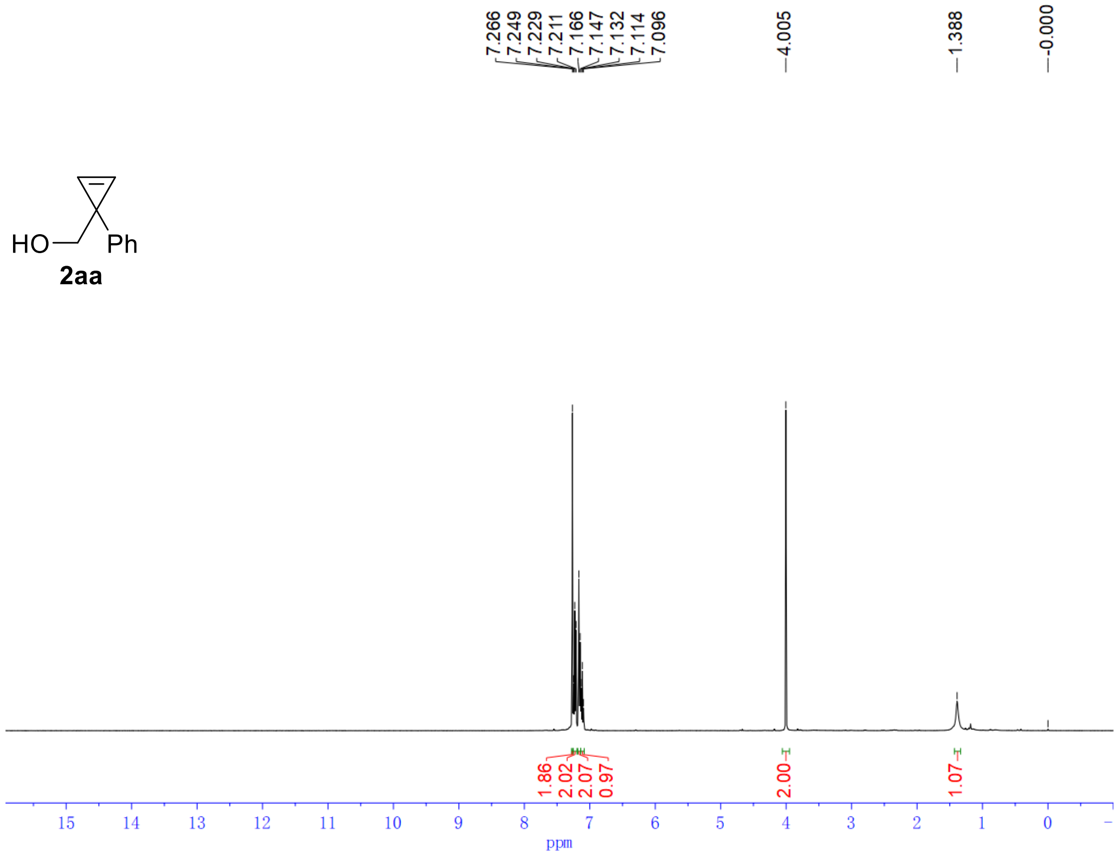
^{1}H and ^{13}C NMR spectra of Cyclopropenes:



2a



2a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-0.000
HO
Ph
2aa
1.86
2.02
2.07
0.97
2.00
1.07
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14
13
12
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6
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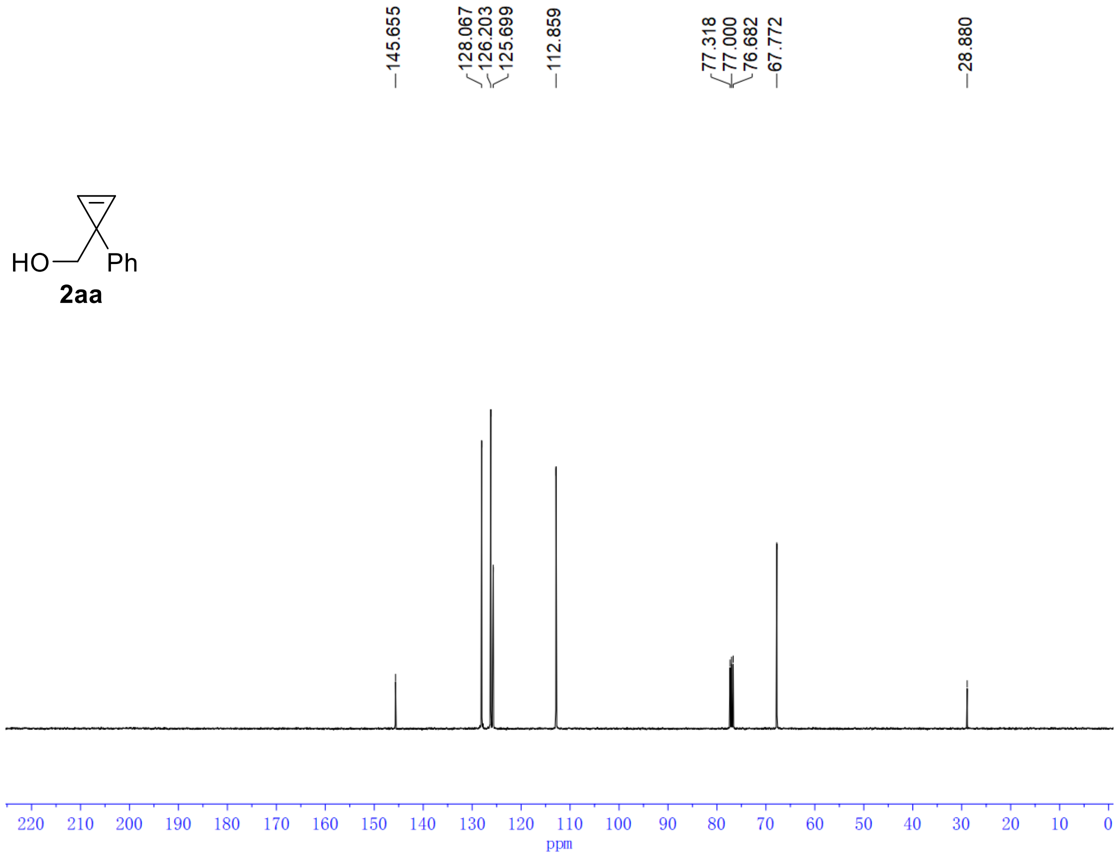
ppm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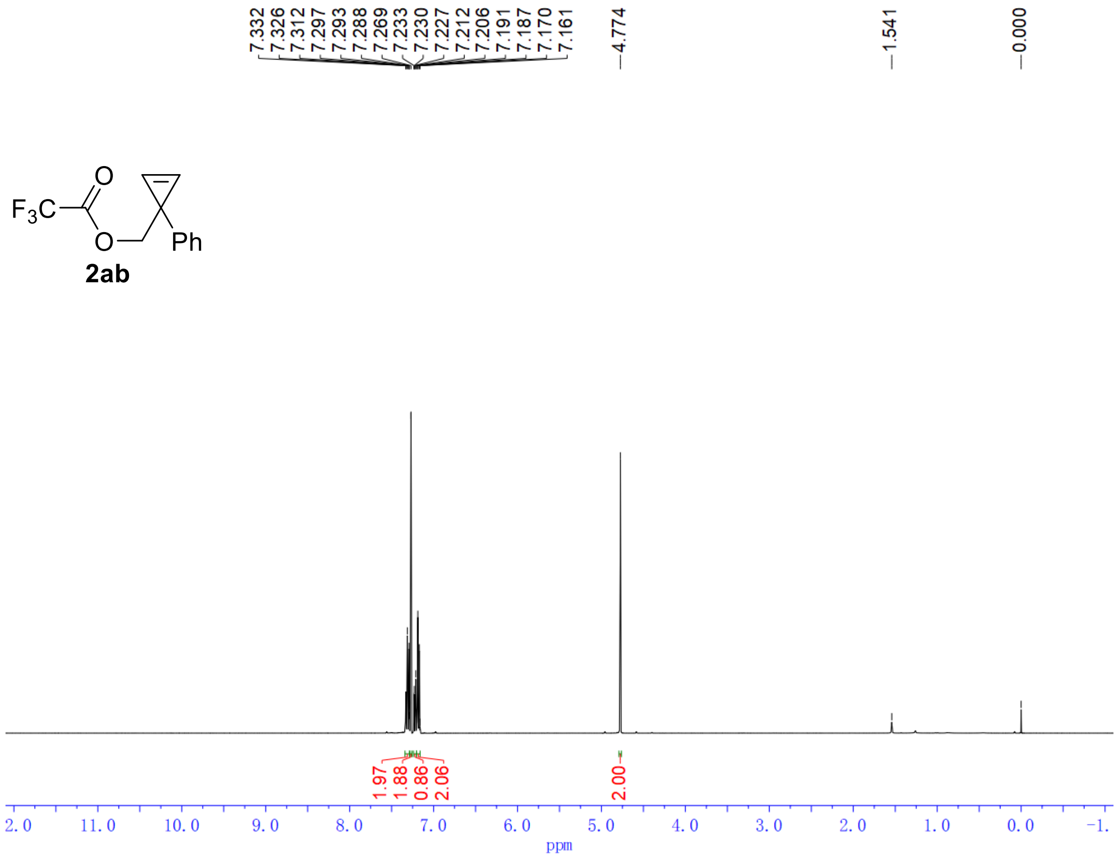
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7.187
7.170
7.161
4.774
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O
O
Ph
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1.88
0.86
2.06
2.00
2.0
11.0
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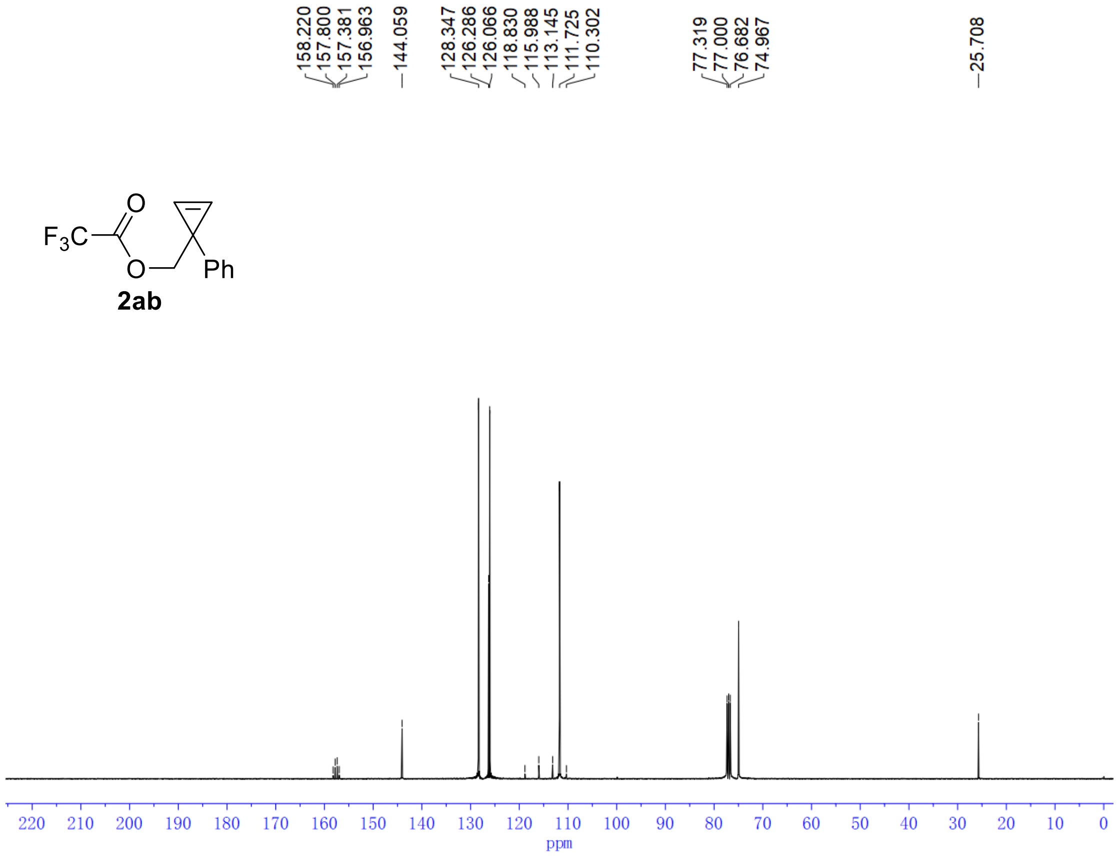
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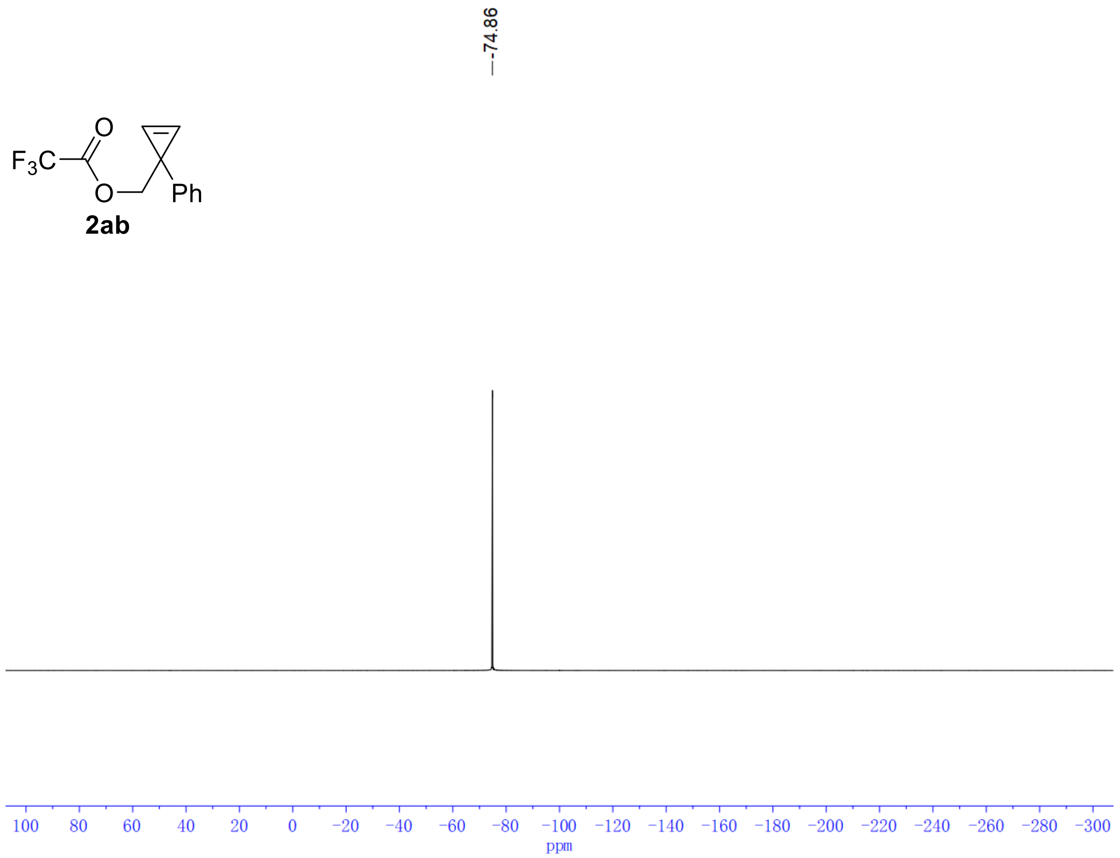
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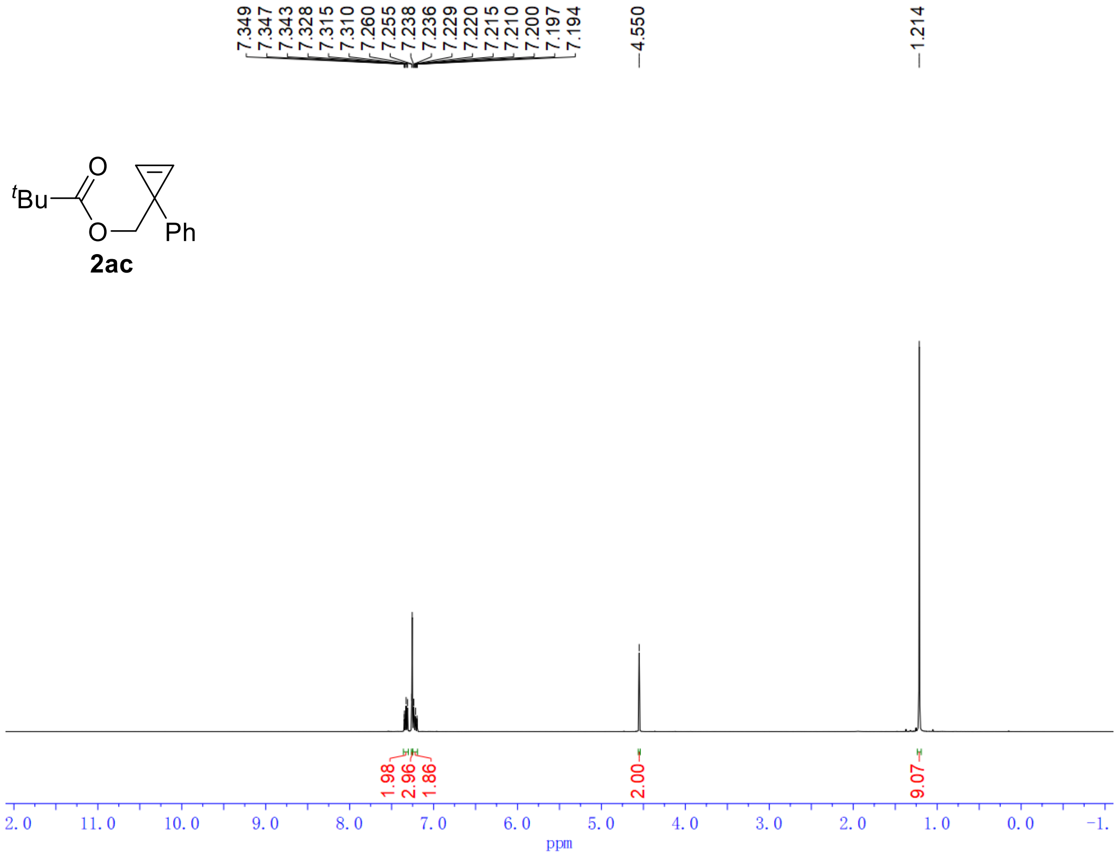
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7.197
7.194
4.550
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O
O
Ph
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1.98
2.96
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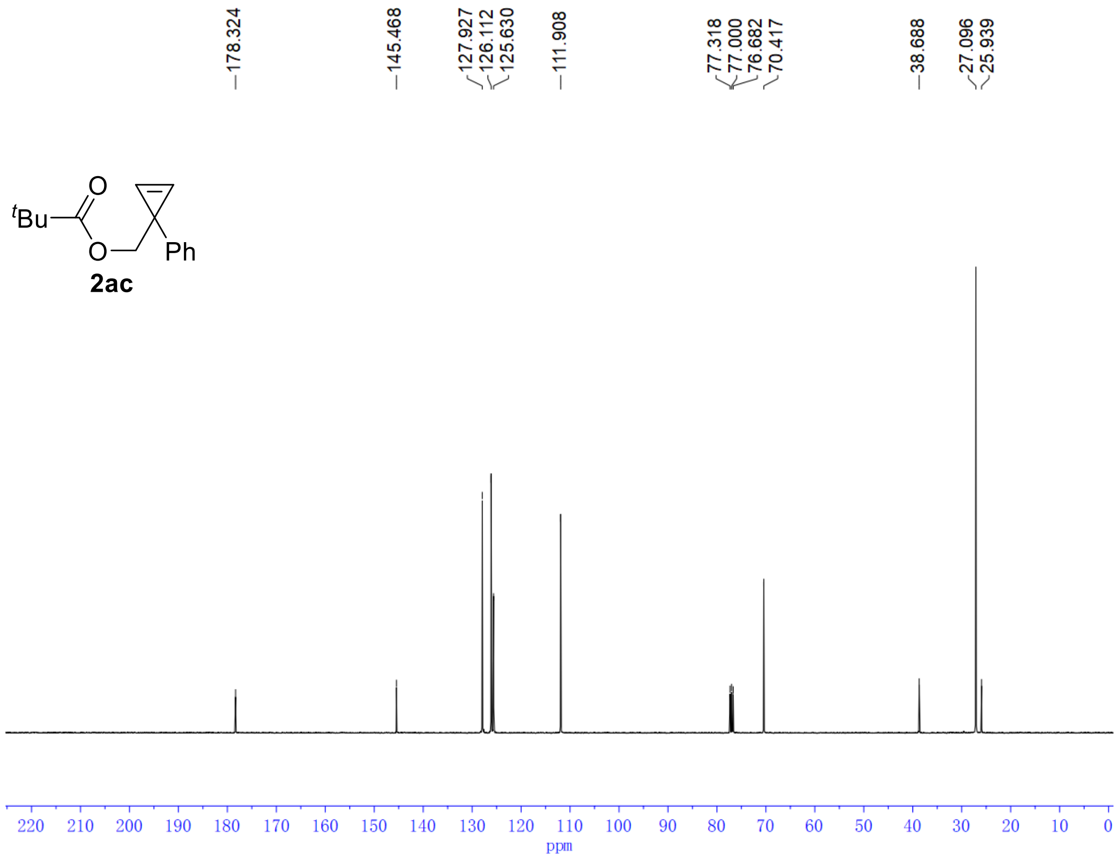

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O
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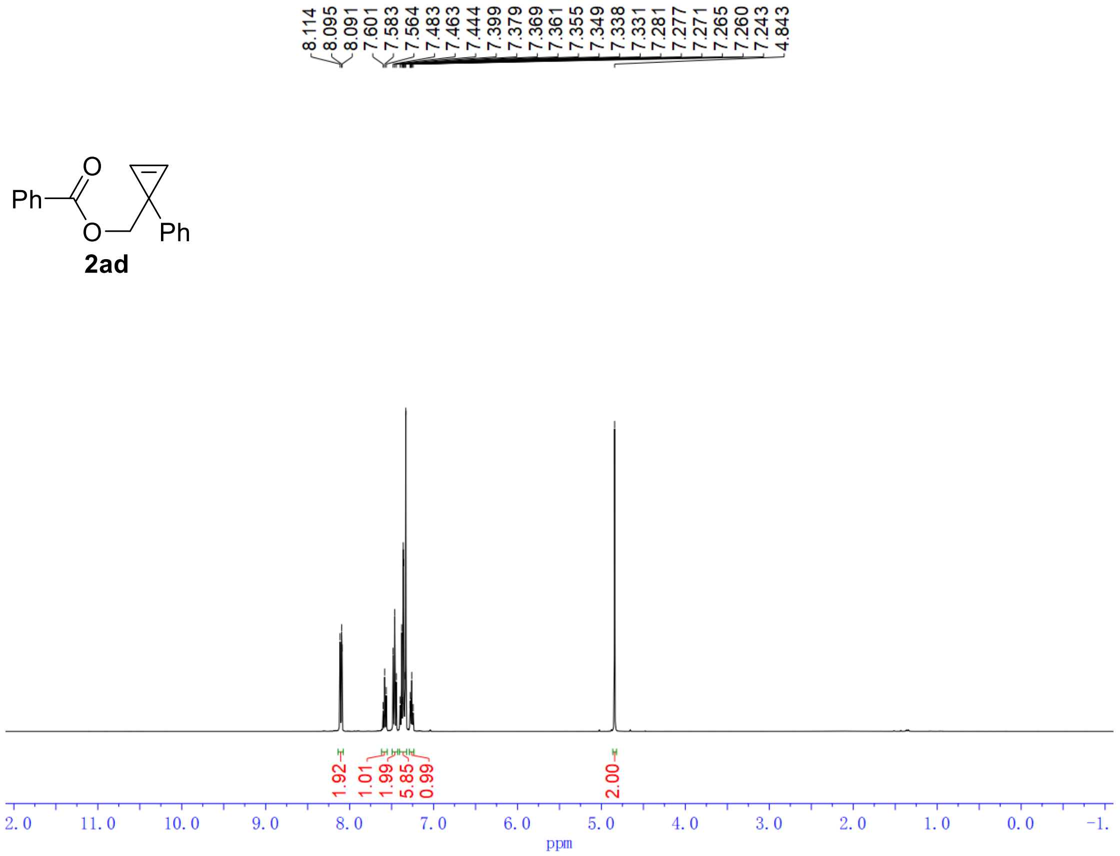

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O
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1.99
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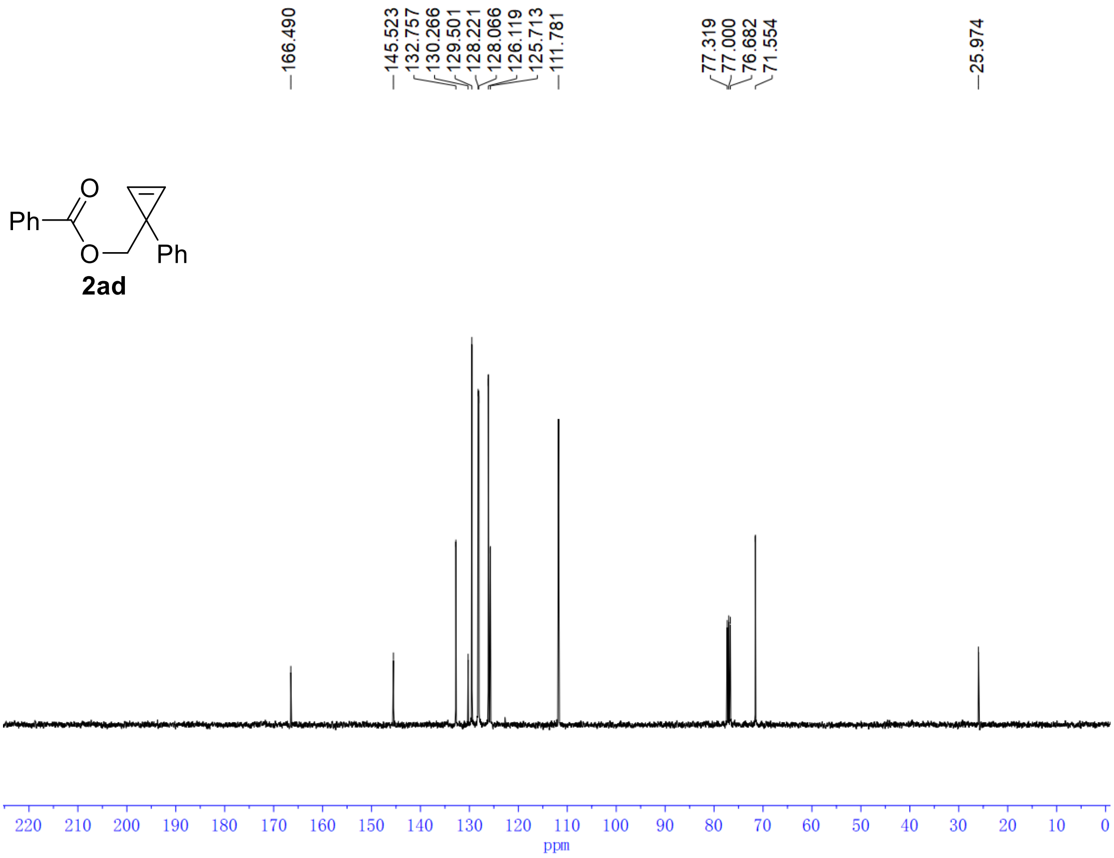
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100
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80
70
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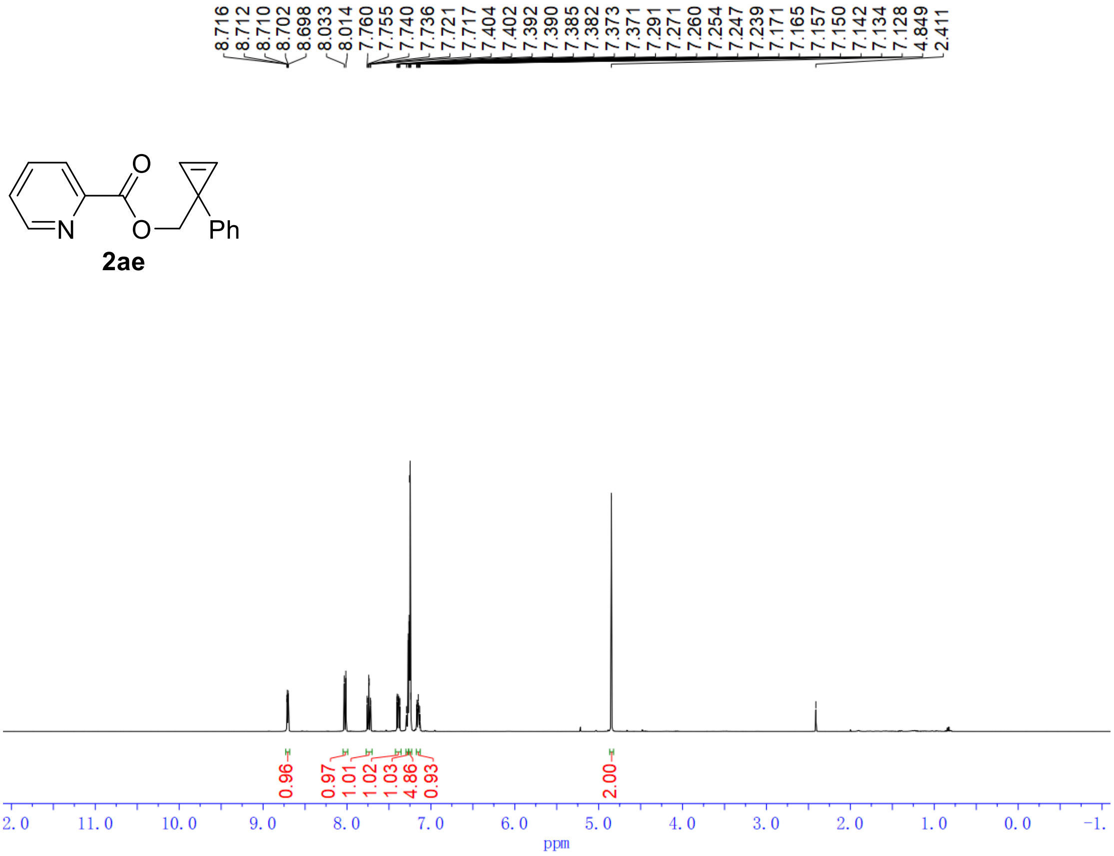
50
40
30
20
10
0
ppm

2ad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8.712
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8.702
8.698
8.033
8.014
7.760
7.755
7.740
7.736
7.721
7.717
7.404
7.402
7.392
7.390
7.385
7.382
7.373
7.371
7.291
7.271
7.260
7.254
7.247
7.239
7.171
7.165
7.157
7.150
7.142
7.134
7.128
4.849
2.411
N
O
O
Ph
0.96
0.97
1.01
1.02
1.03
4.86
0.93
2.00
2.0
11.0
10.0
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6.0
5.0
4.0
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2.0
1.0
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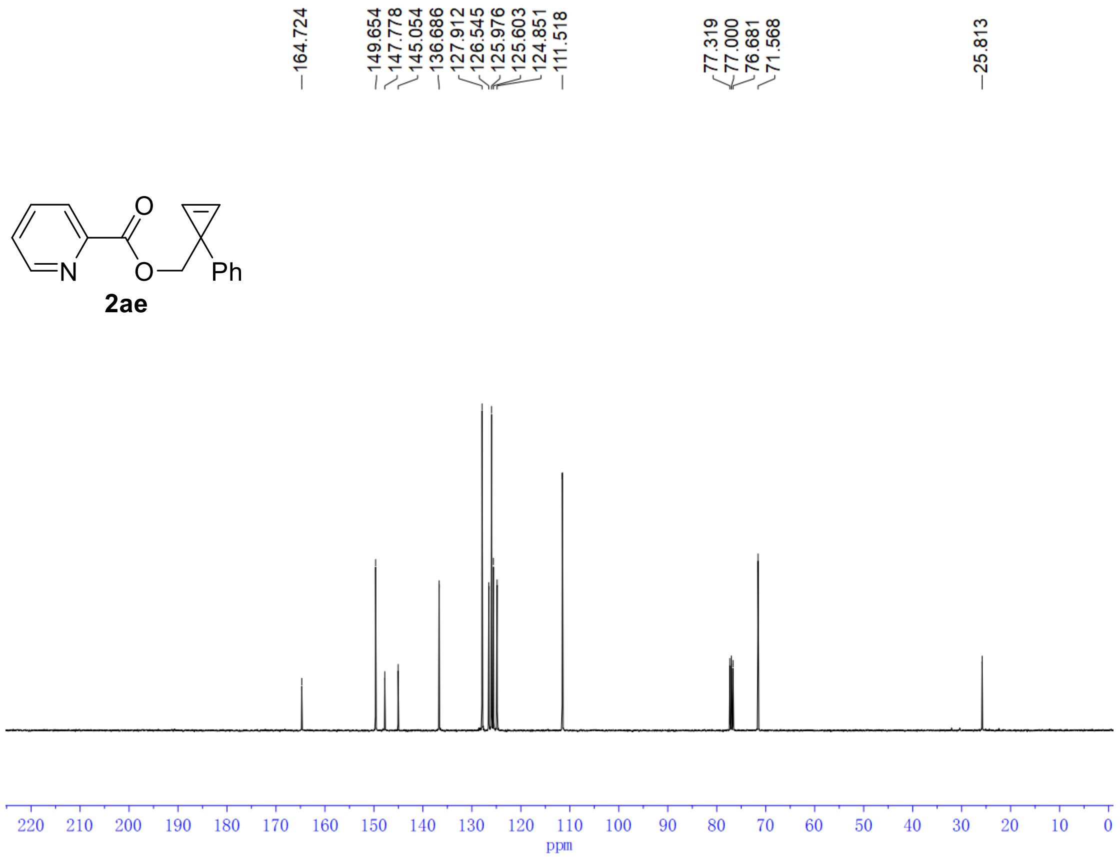
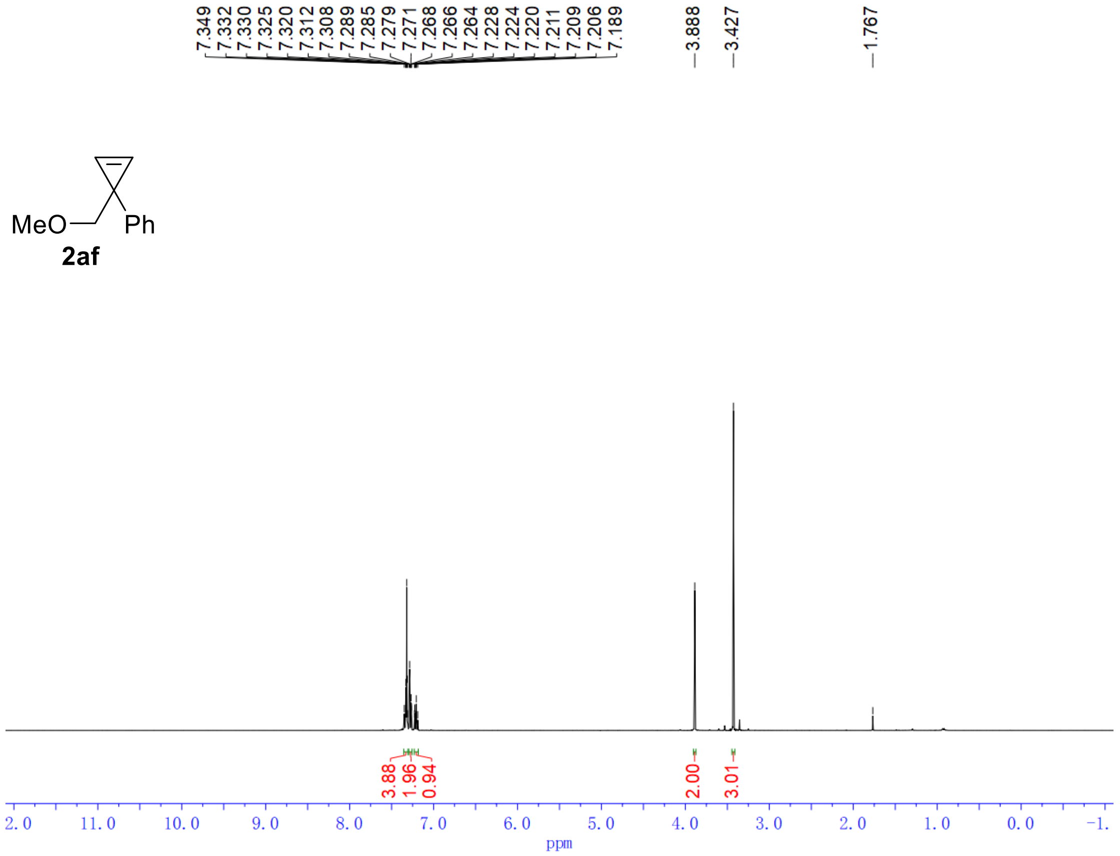
-1.
ppm

2ae



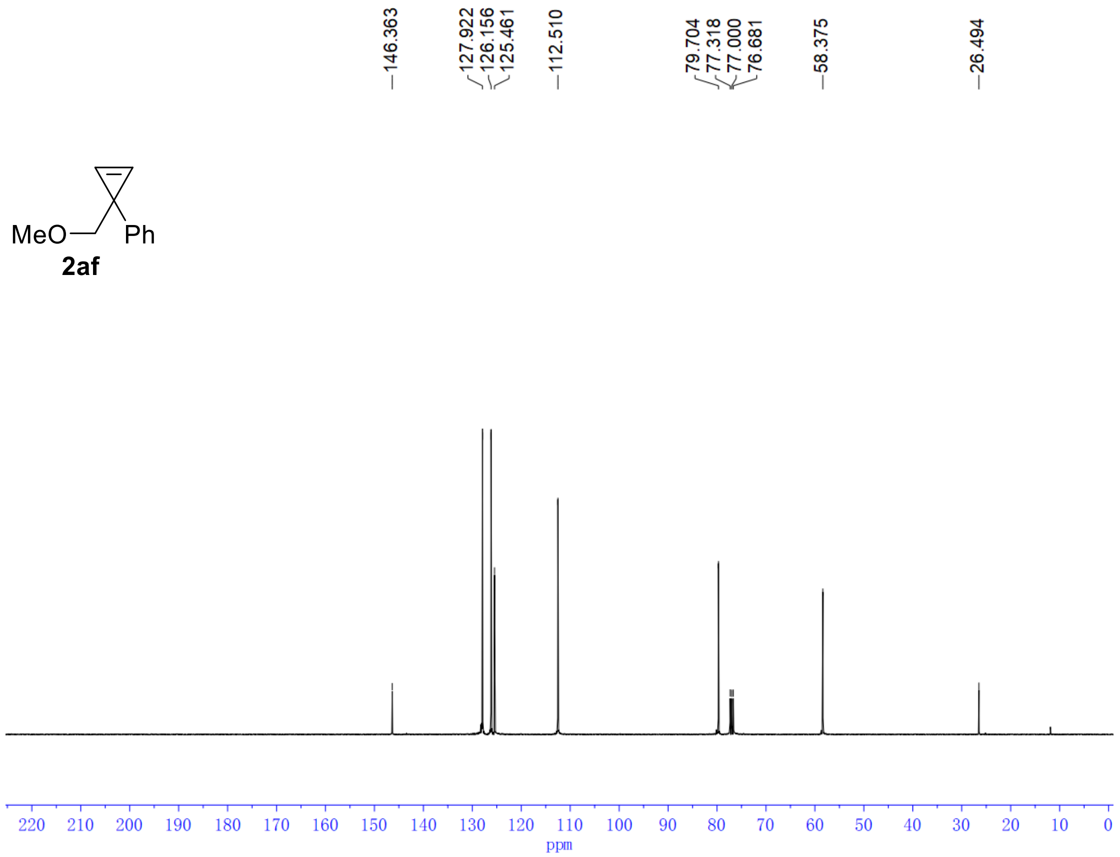
164.724
149.654
147.778
145.054
136.686
127.912
126.545
125.976
125.603
124.851
111.518
77.319
77.000
76.681
71.568
25.813
O
N
O
Ph
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
ppm

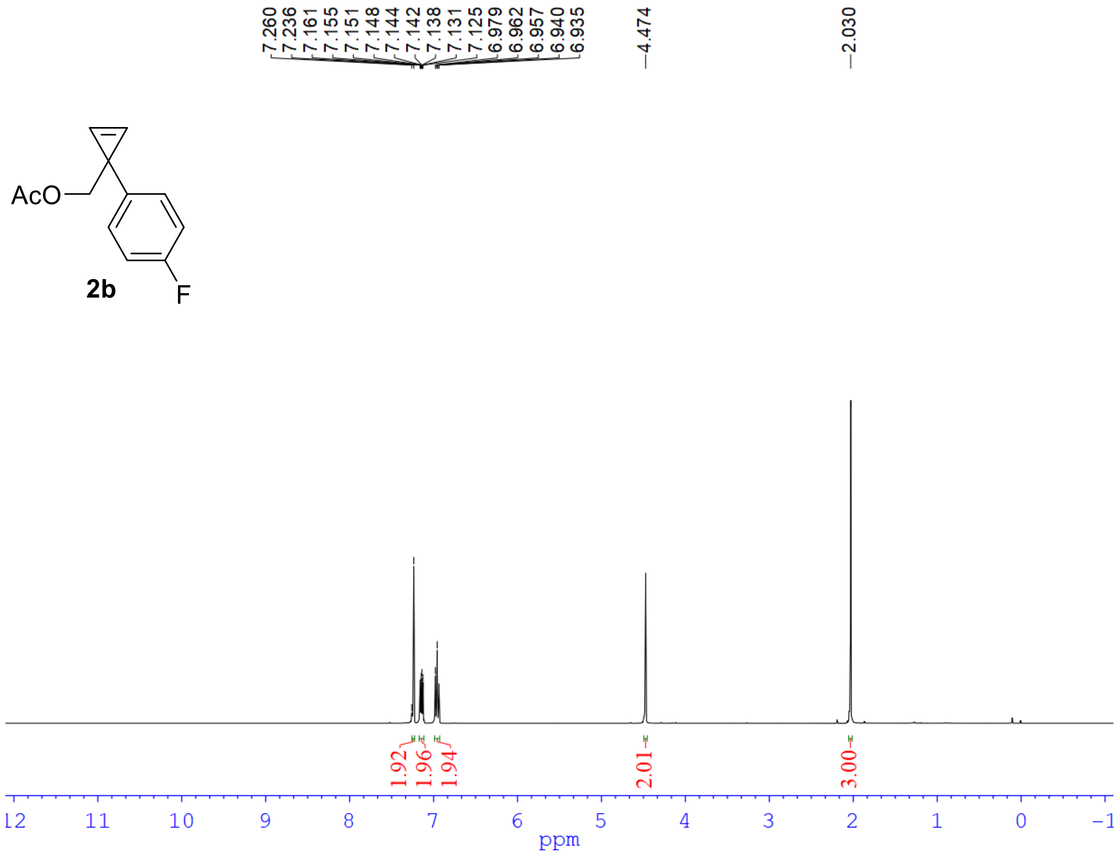
2ae

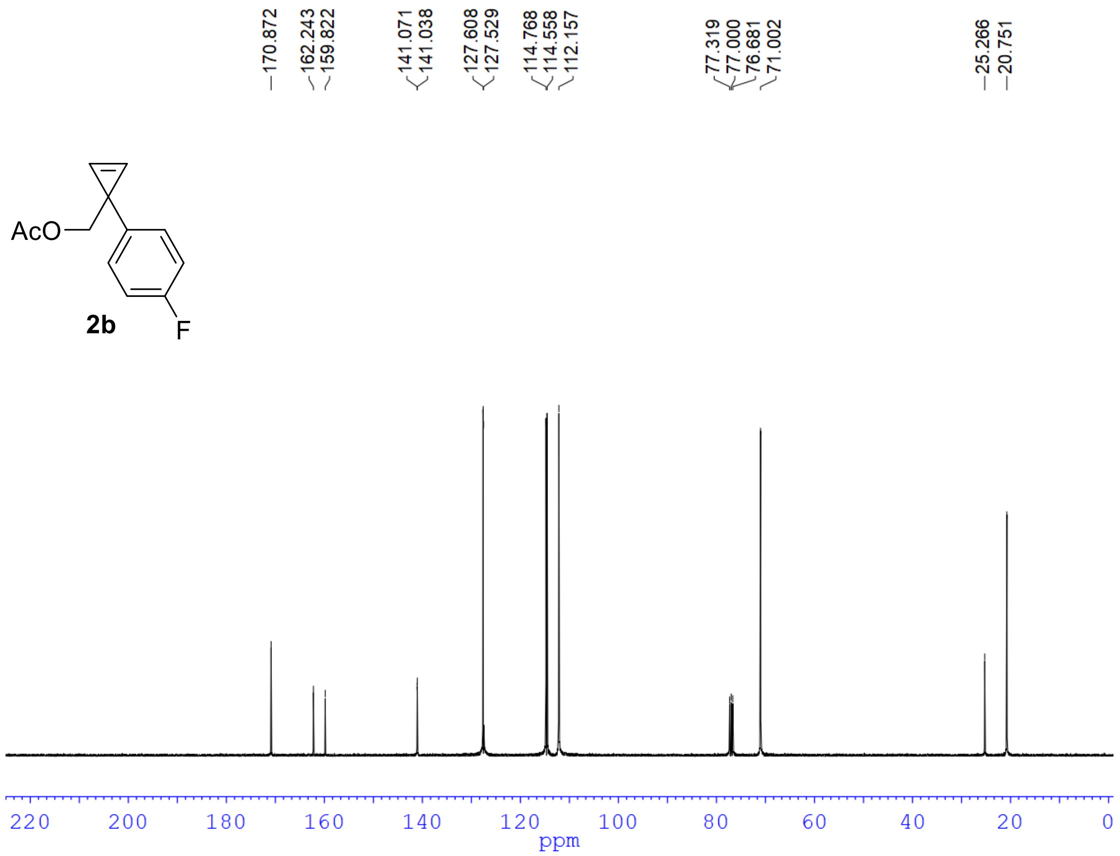


7.349
7.332
7.330
7.325
7.320
7.312
7.308
7.289
7.285
7.279
7.271
7.268
7.266
7.264
7.228
7.224
7.220
7.211
7.209
7.206
7.189
3.888
3.427
1.767
MeO
Ph
3.88
1.96
0.94
2.00
3.01
2.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.
ppm

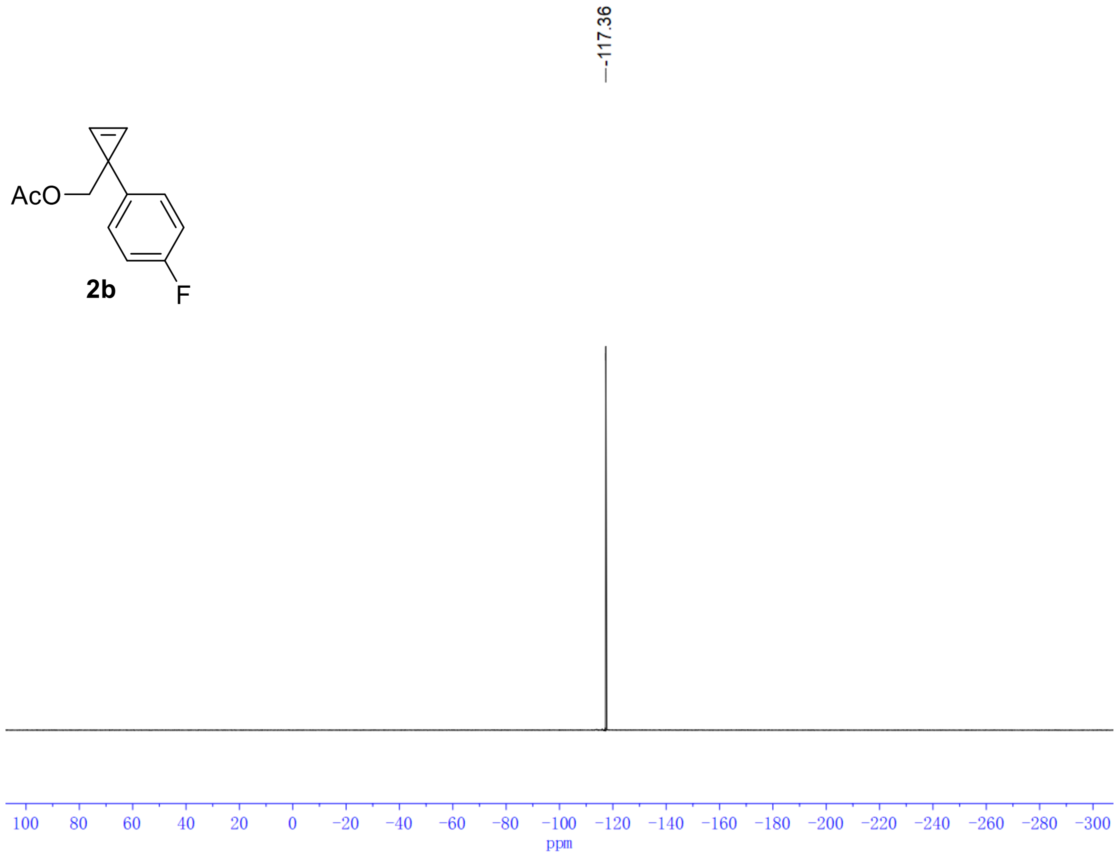
2af


146.363
127.922
126.156
125.461
112.510
79.704
77.318
77.000
76.681
58.375
26.494
MeO
Ph
2af
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
ppm


7.260
7.236
7.161
7.155
7.151
7.148
7.144
7.142
7.138
7.131
7.125
6.979
6.962
6.957
6.940
6.935
4.474
2.030
AcO
F
2b
1.92
1.96
1.94
2.01
3.00
12 11 10 9 8 7 6 5 4 3 2 1 0 −1
ppm


170.872
162.243
159.822
141.071
141.038
127.608
127.529
114.768
114.558
112.157
77.319
77.000
76.681
71.002
25.266
20.751
AcO
F
220
200
180
160
140
120
100
80
60
40
20
0
ppm

2b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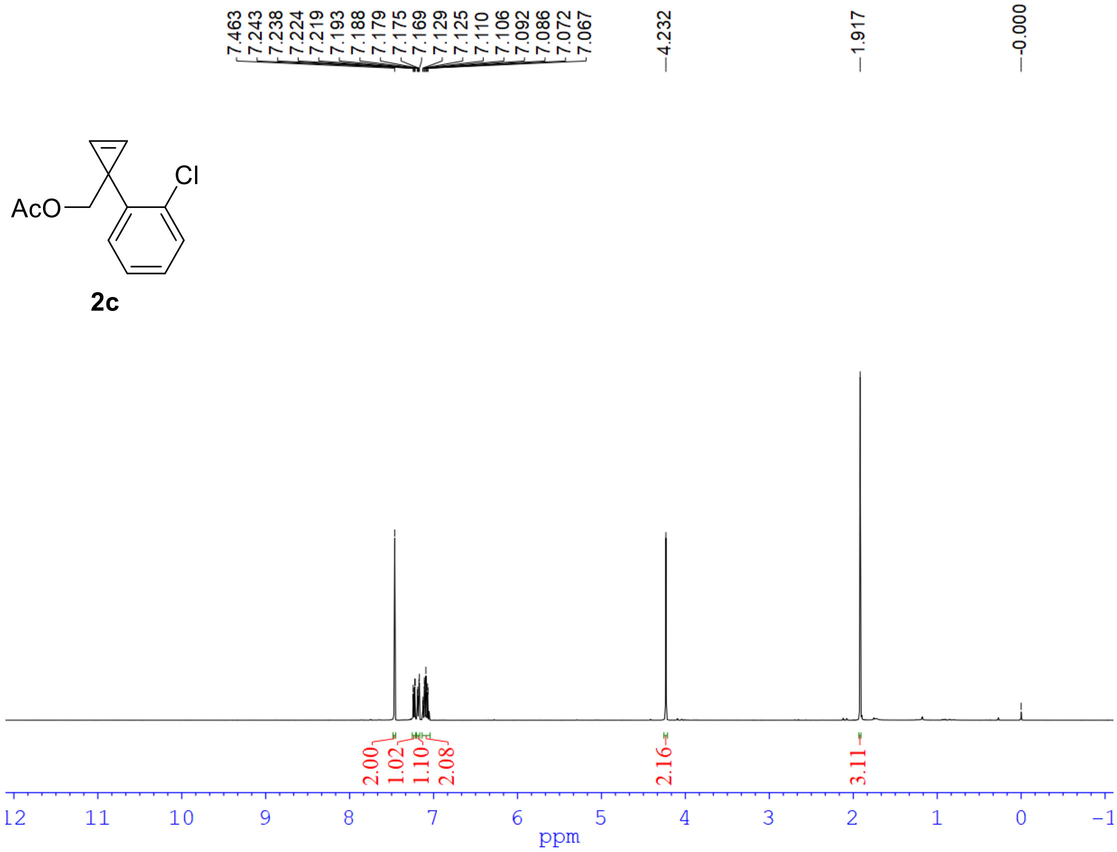
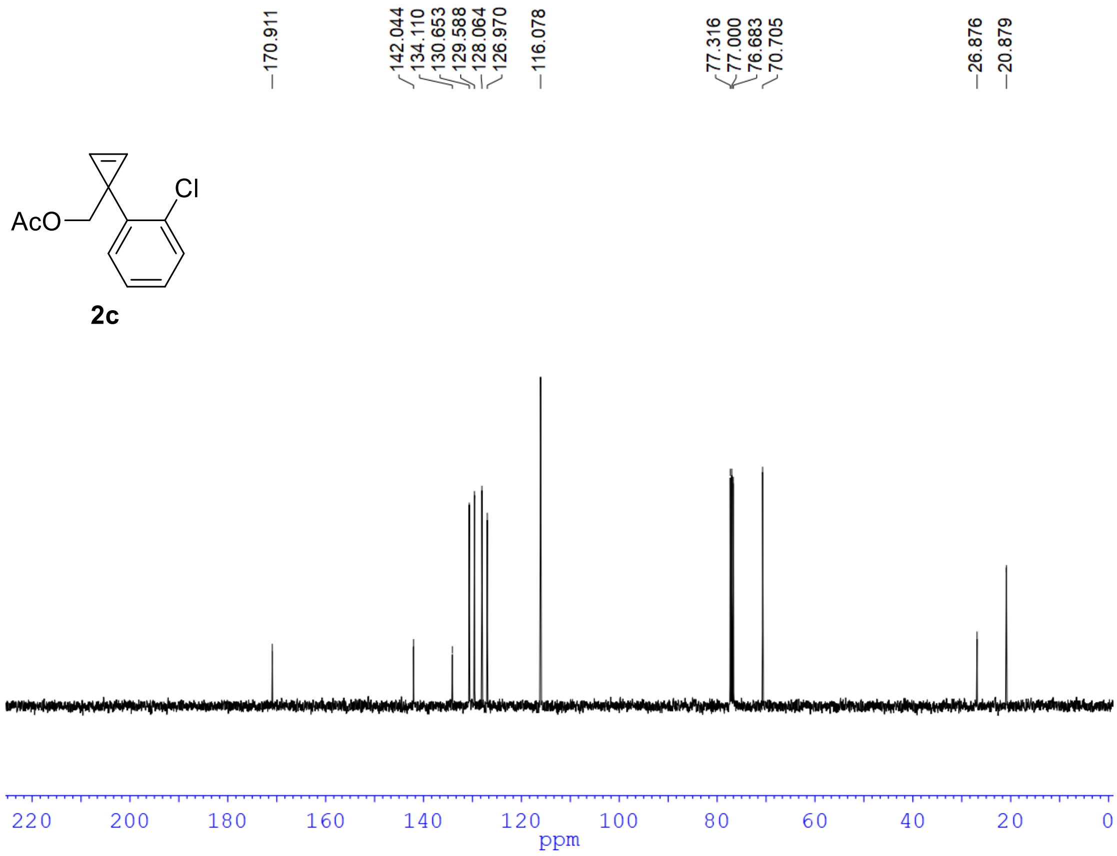
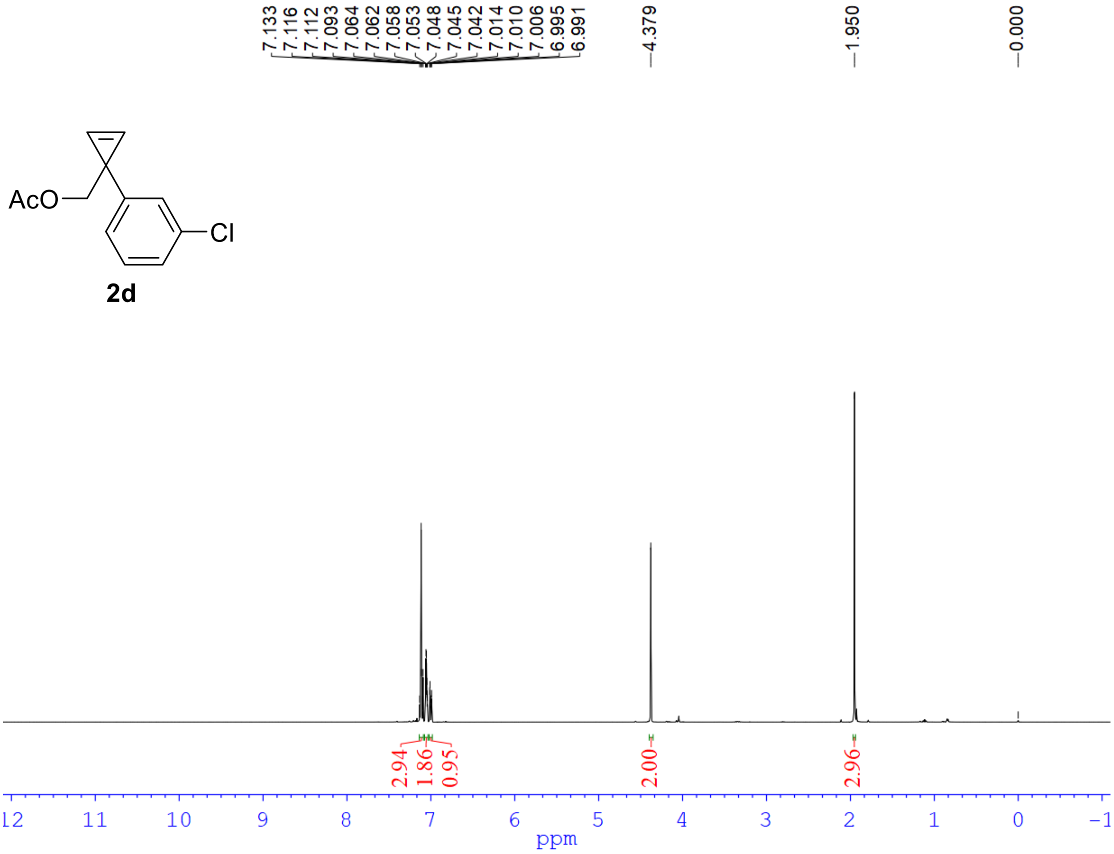
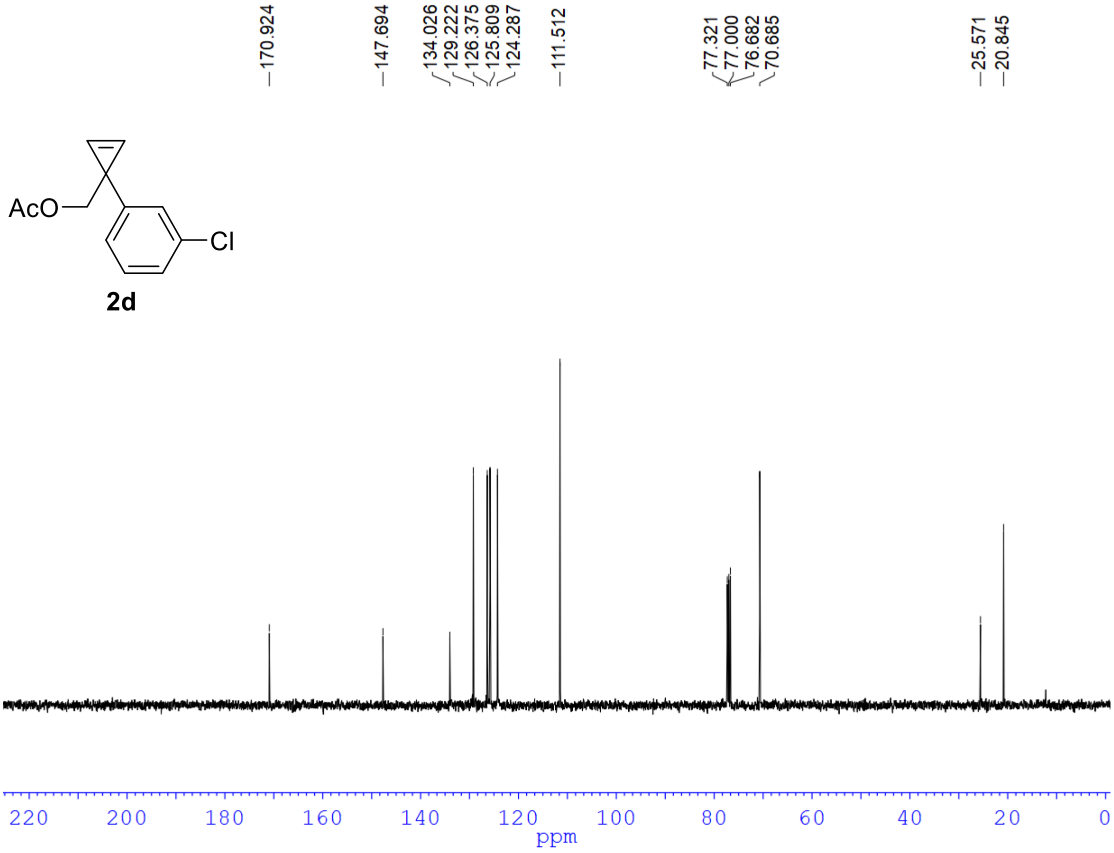
AcO
F
100
80
60
40
20
0
−20
−40
−60
−80
−100
−120
−140
−160
−180
−200
−220
−240
−260
−280
−300
ppm

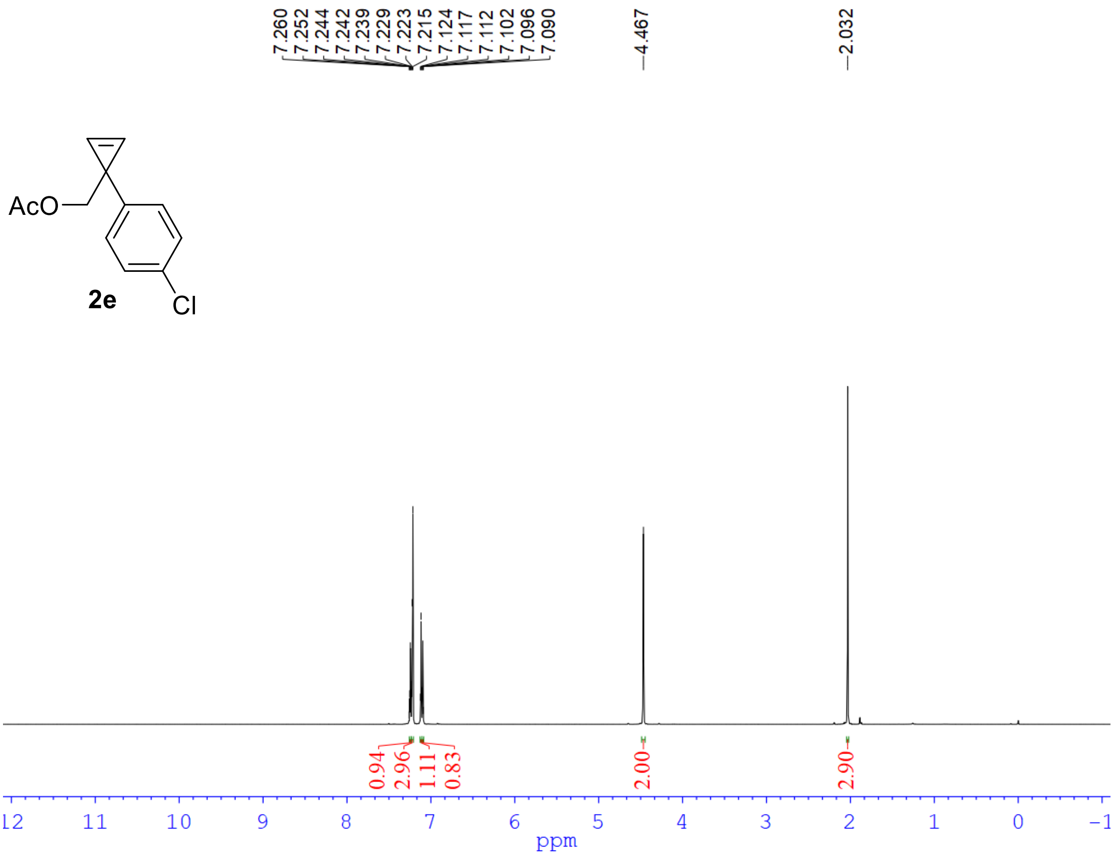
2b

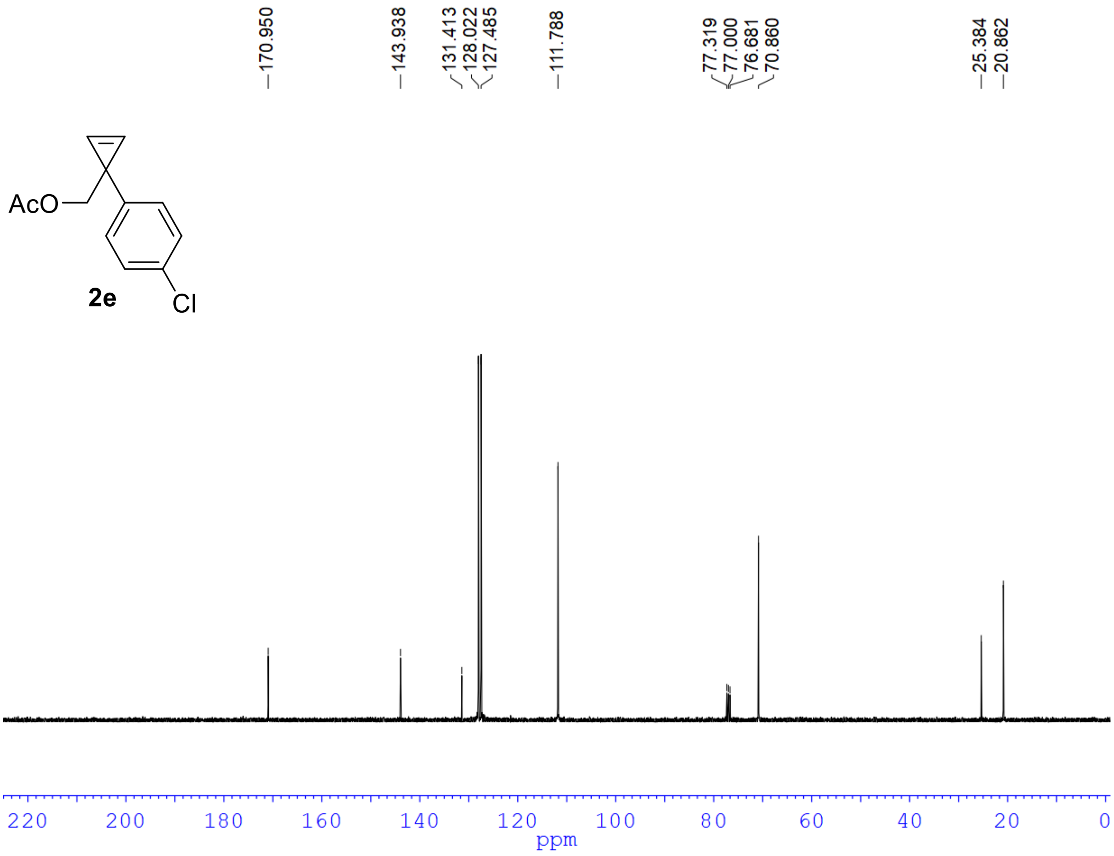

7.463
7.243
7.238
7.224
7.219
7.193
7.188
7.179
7.175
7.169
7.129
7.125
7.110
7.106
7.092
7.086
7.072
7.067
4.232
1.917
-0.000
Cl
AcO
2c
2.00
1.02
1.10
2.08
2.16
3.11
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm


170.911
142.044
134.110
130.653
129.588
128.064
126.970
116.078
77.316
77.000
76.683
70.705
26.876
20.879
Cl
AcO
2c
220
200
180
160
140
120
100
80
60
40
20
0
ppm


7.133
7.116
7.112
7.093
7.064
7.062
7.058
7.053
7.048
7.045
7.042
7.014
7.010
7.006
6.995
6.991
4.379
1.950
0.000
AcO
Cl
2d
2.94
1.86
0.95
2.00
2.96
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm


170.924
147.694
134.026
129.222
126.375
125.809
124.287
111.512
77.321
77.000
76.682
70.685
25.571
20.845
AcO
Cl
2d
220
200
180
160
140
120
100
80
60
40
20
0
ppm


7.260
7.252
7.244
7.242
7.239
7.229
7.223
7.215
7.124
7.117
7.112
7.102
7.096
7.090
4.467
2.032
AcO
2e
Cl
0.94
2.96
1.11
0.83
2.00
2.90
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm


170.950
143.938
131.413
128.022
127.485
111.788
77.319
77.000
76.681
70.860
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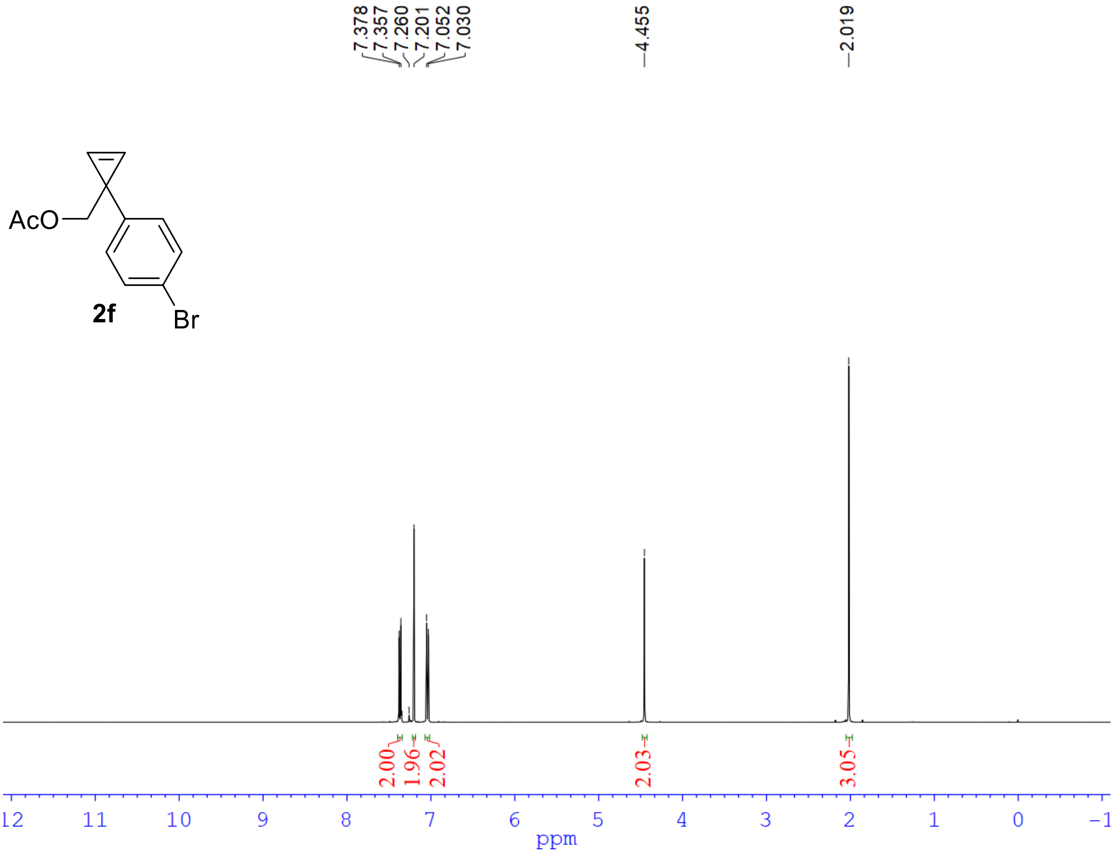
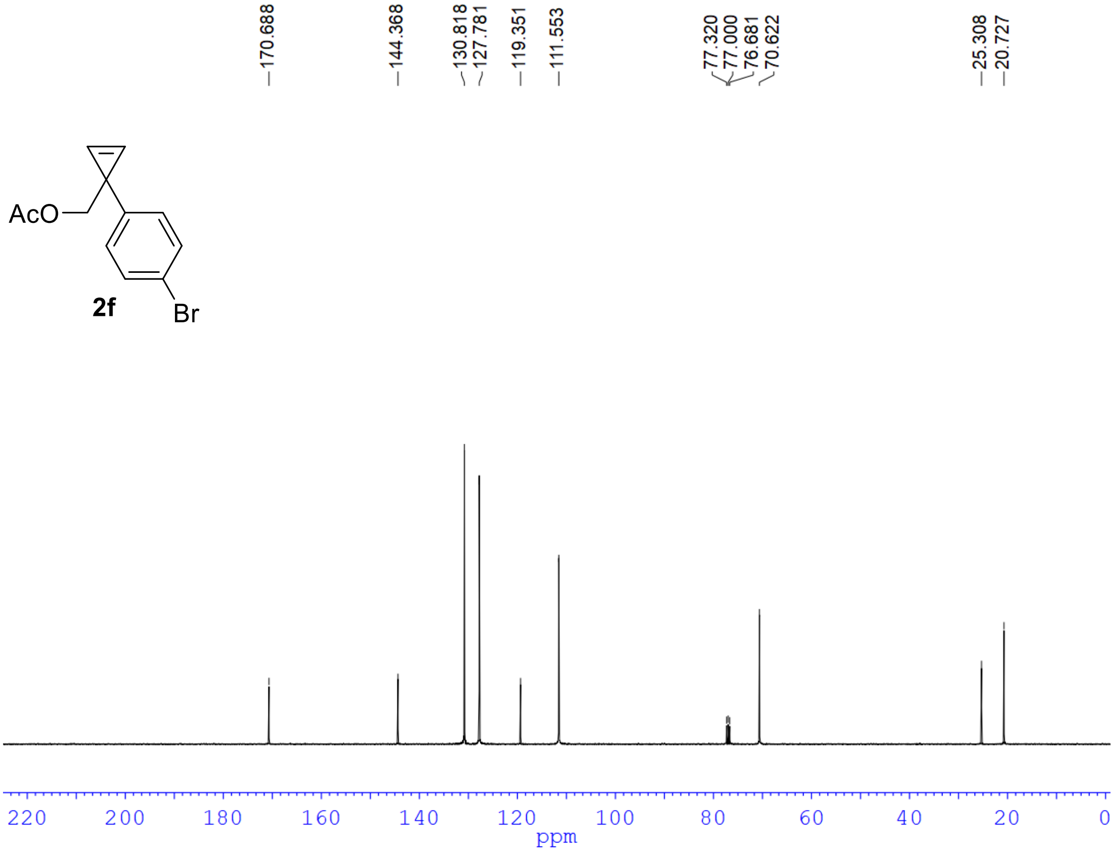
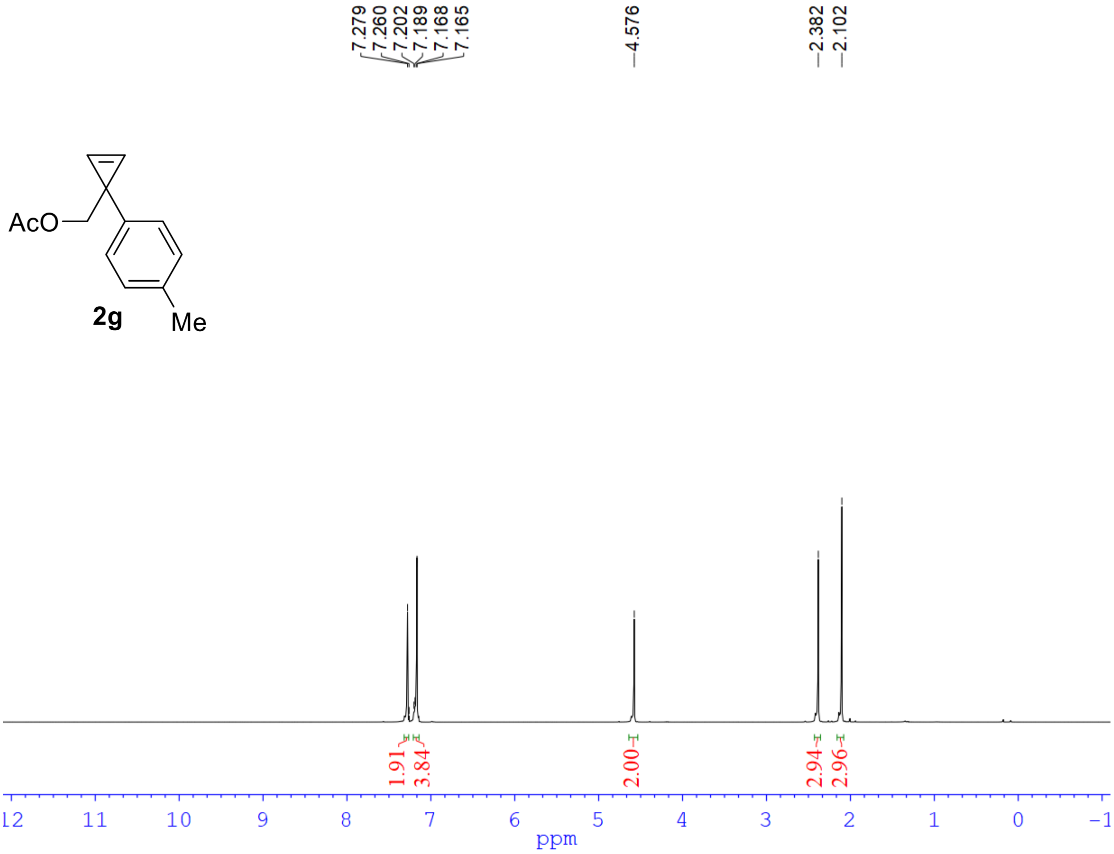
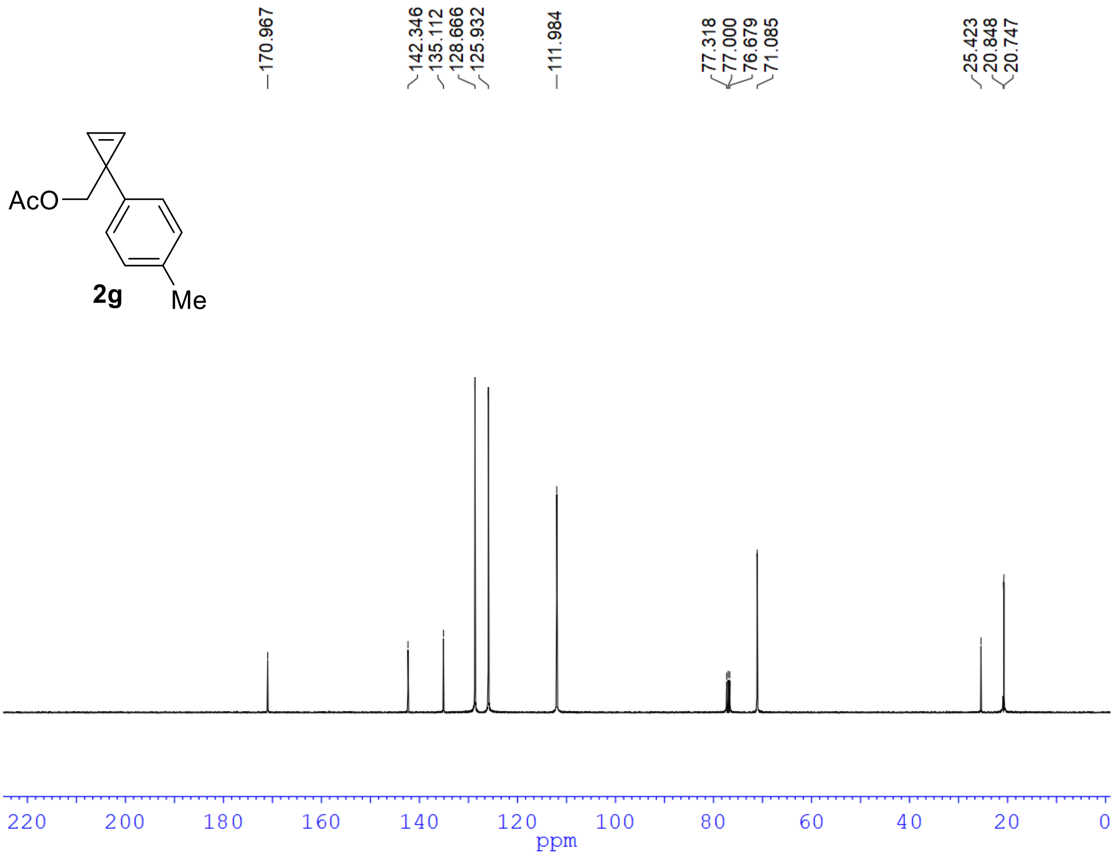
20.862
AcO
2e
Cl
220
200
180
160
140
120
100
80
60
40
20
0
ppm


7.378
7.357
7.260
7.201
7.052
7.030
4.455
2.019
AcO
Br
2f
2.00
1.96
2.02
2.03
3.05
12
11
10
9
8
7
6
5
4
3
2
1
0
−1
ppm

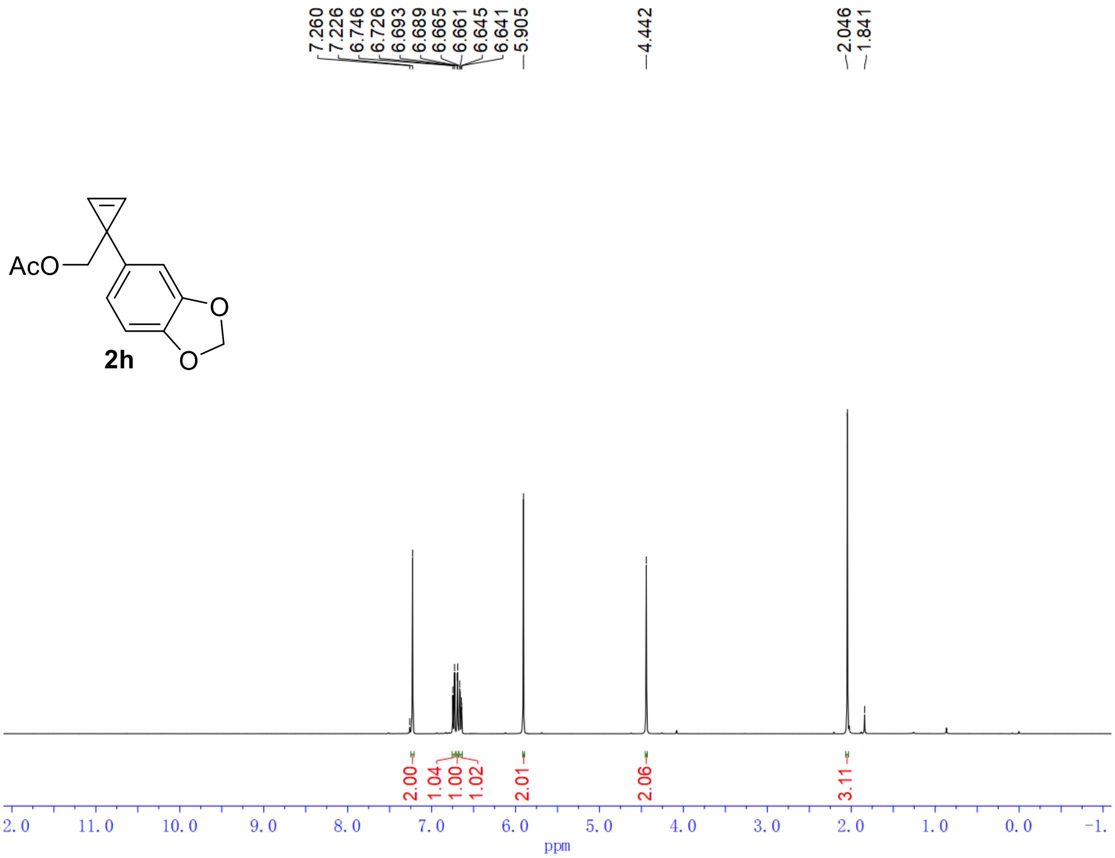

170.688
144.368
130.818
127.781
119.351
111.553
77.320
77.000
76.681
70.622
25.308
20.727
AcO
Br
2f
220
200
180
160
140
120
100
80
60
40
20
0
ppm

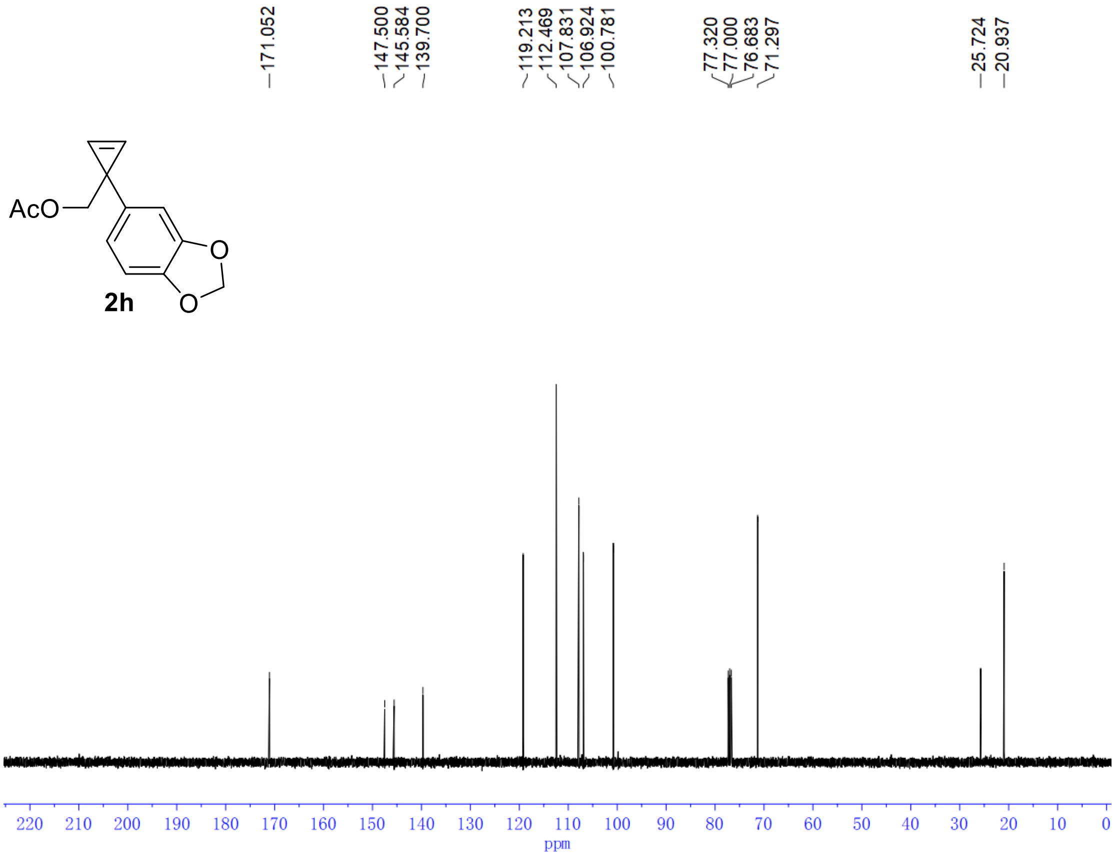

7.279
7.260
7.202
7.189
7.168
7.165
4.576
2.382
2.102
AcO
Me
1.91
3.84
2.00
2.94
2.96
12
11
10
9
8
7
6
5
4
3
2
1
0
−1
ppm

2g


170.967
142.346
135.112
128.666
125.932
111.984
77.318
77.000
76.679
71.085
25.423
20.848
20.747
AcO
Me
220
200
180
160
140
120
100
80
60
40
20
0
ppm

2g


7.260
7.226
6.746
6.726
6.693
6.689
6.665
6.661
6.645
6.641
5.905
4.442
2.046
1.841
AcO
O
O
2h
2.00
1.04
1.00
1.02
2.01
2.06
3.11
2.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.
ppm


171.052
147.500
145.584
139.700
119.213
112.469
107.831
106.924
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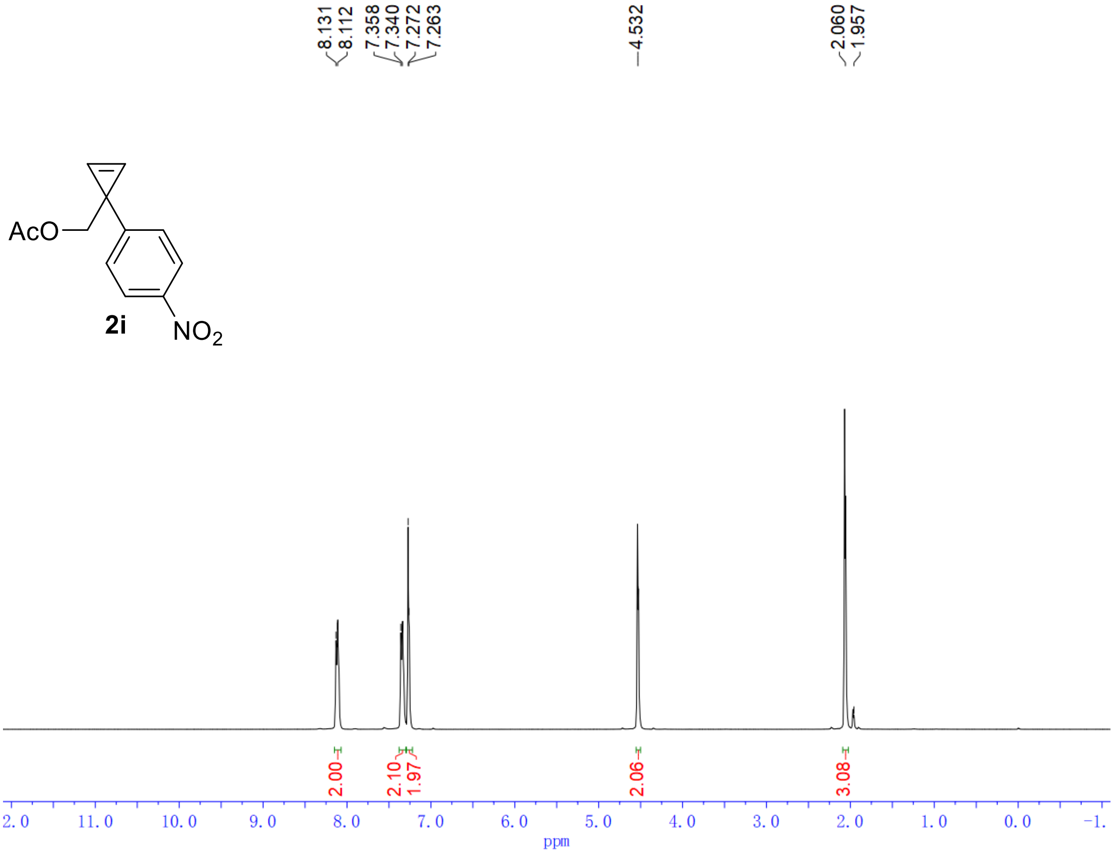
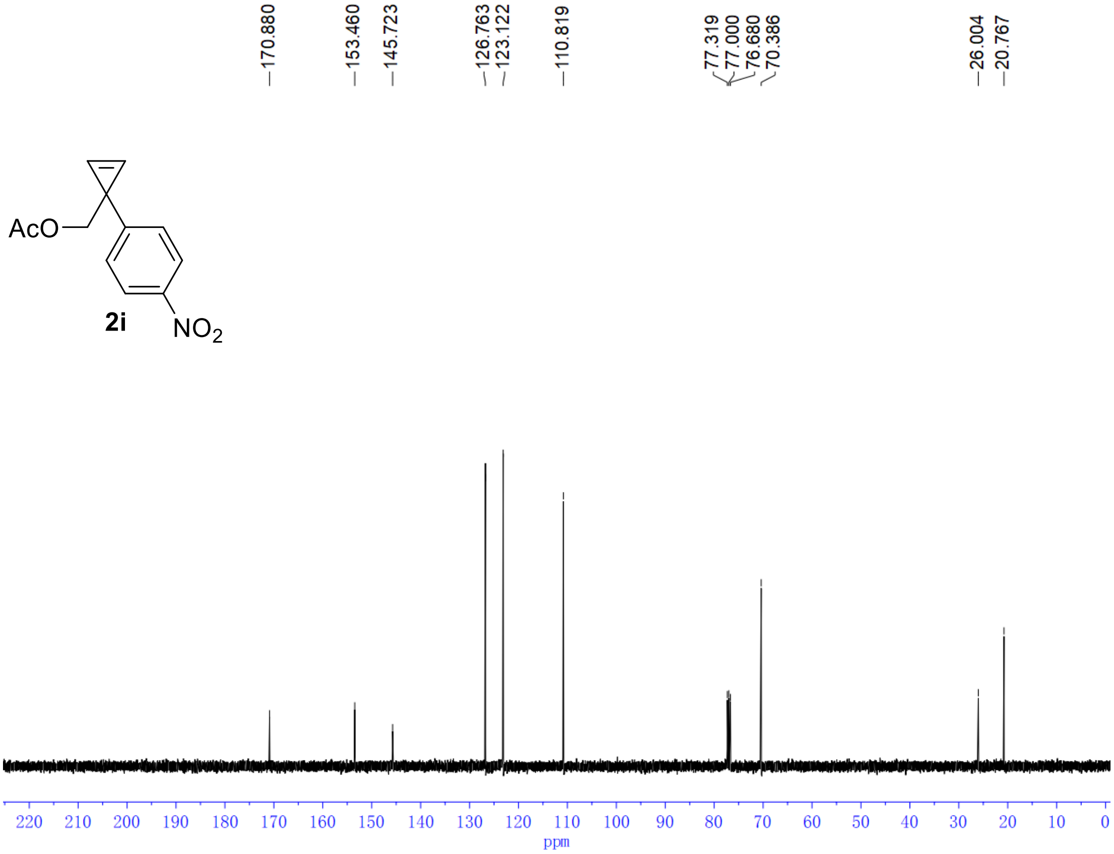
77.320
77.000
76.683
71.297
25.724
20.937
AcO
O
O
2h
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm


8.131
8.112
7.358
7.340
7.272
7.263
4.532
2.060
1.957
AcO
NO2
2i
2.00
2.10
1.97
2.06
3.08
2.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.
ppm


170.880
153.460
145.723
126.763
123.122
110.819
77.319
77.000
76.680
70.386
26.004
20.767
AcO
NO2
2i
220
210
200
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180
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150
140
130
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80
70
60
50
40
30
20
10
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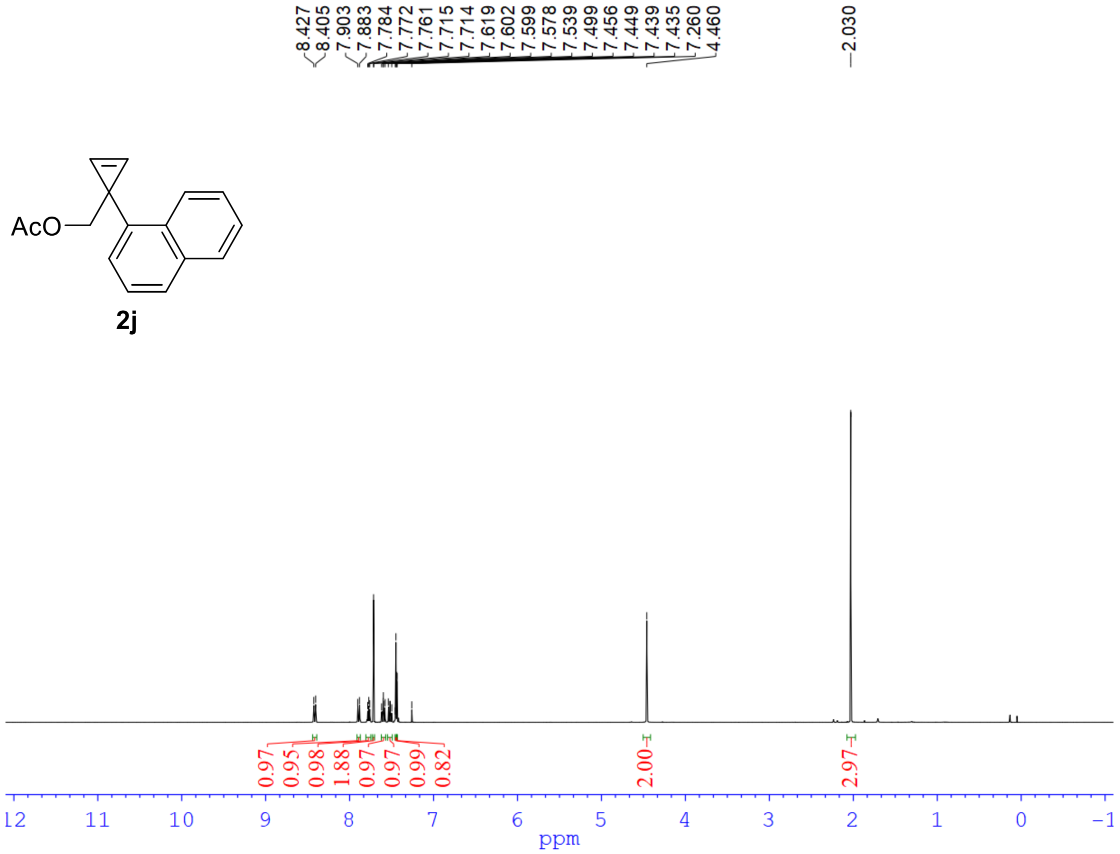
ppm


2j

8.427
8.405
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7.784
7.772
7.761
7.715
7.714
7.619
7.602
7.599
7.578
7.539
7.499
7.456
7.449
7.439
7.435
7.260
4.460
2.030
AcO
0.97
0.95
0.98
1.88
0.97
0.97
0.99
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12
11
10
9
8
7
6
5
4
3
2
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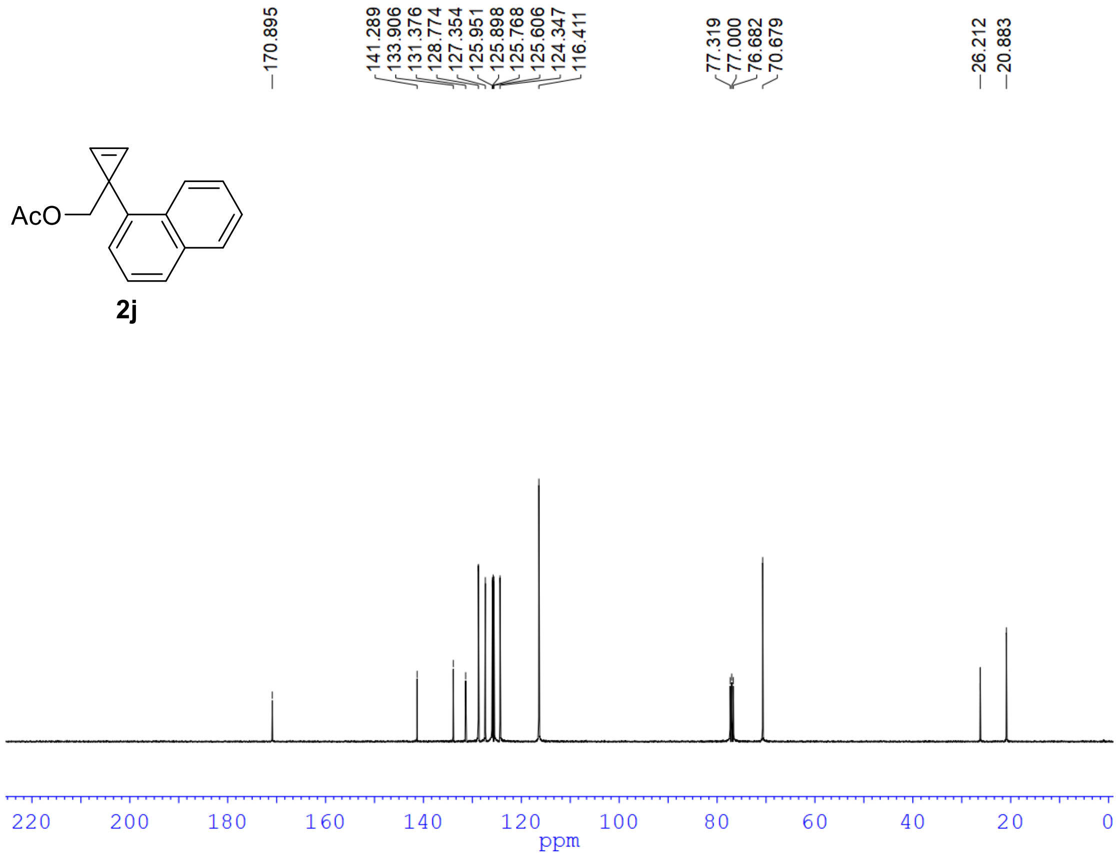
−1
ppm


2j

170.895
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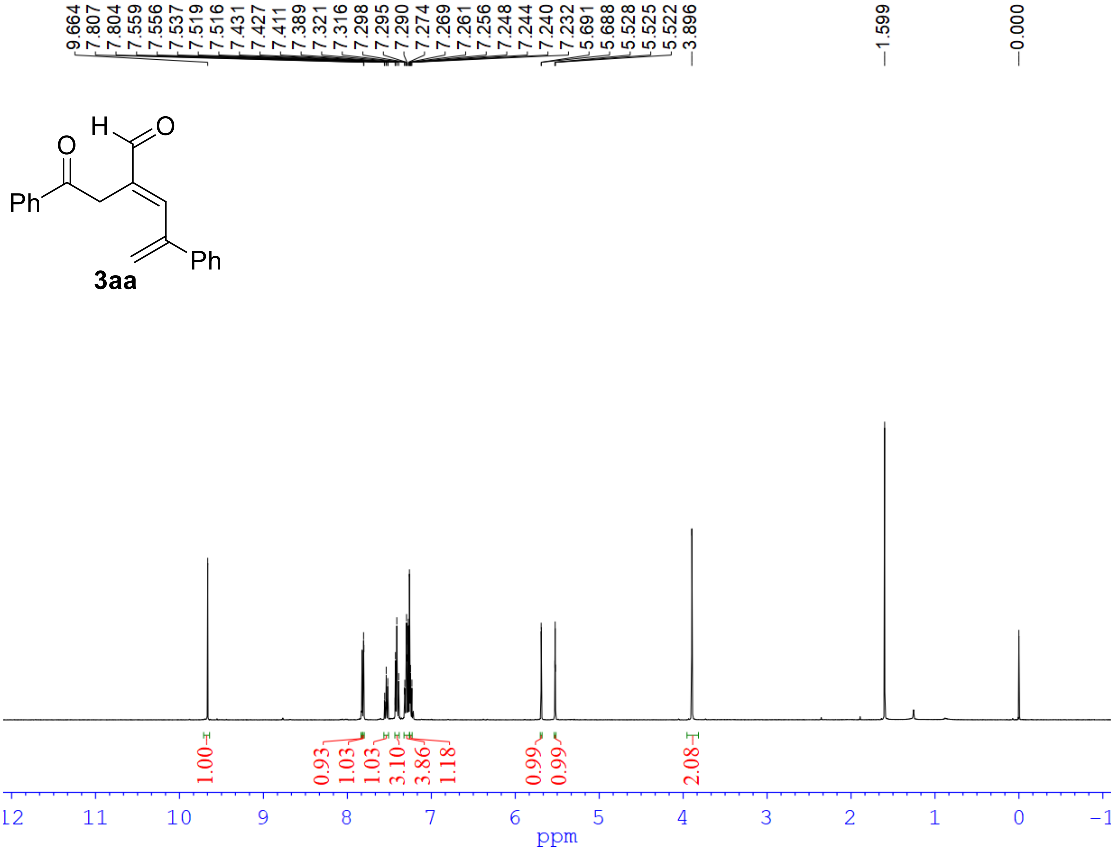
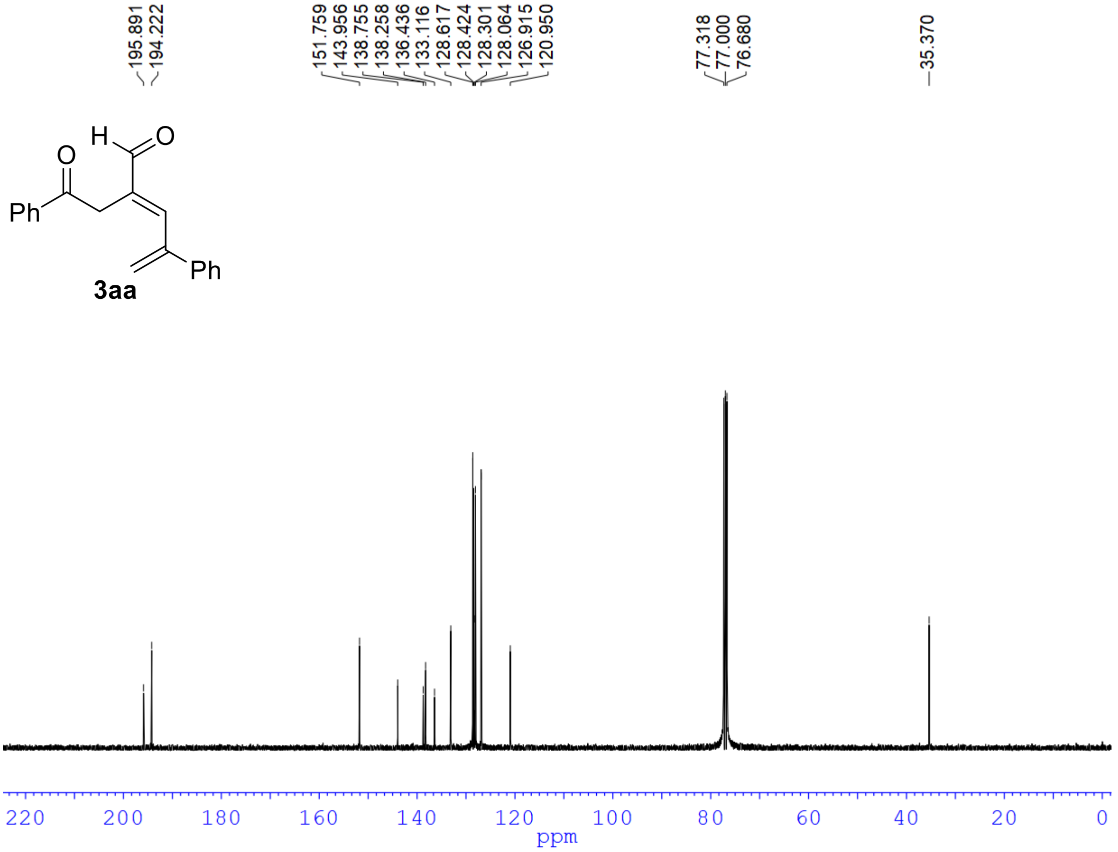
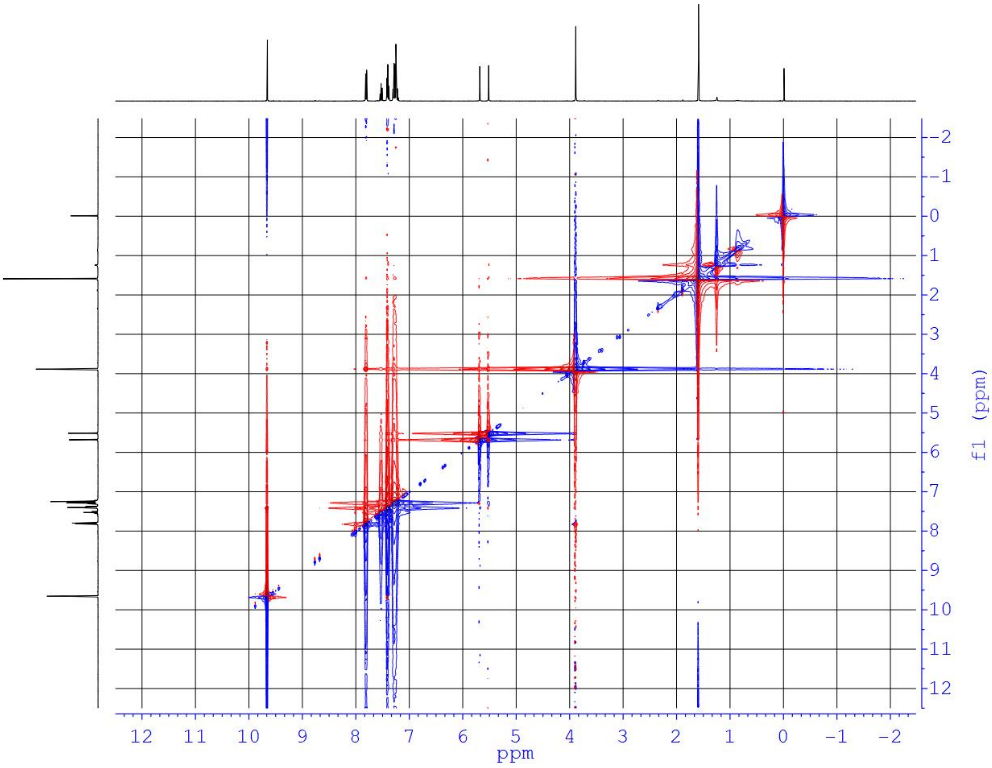
133.906
131.376
128.774
127.354
125.951
125.898
125.768
125.606
124.347
116.411
77.319
77.000
76.682
70.679
26.212
20.883
AcO
220
200
180
160
140
120
100
80
60
40
20
0
ppm

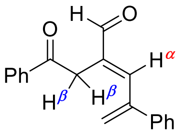
^{1}H and ^{13}C NMR spectra of 1,3-dienes:





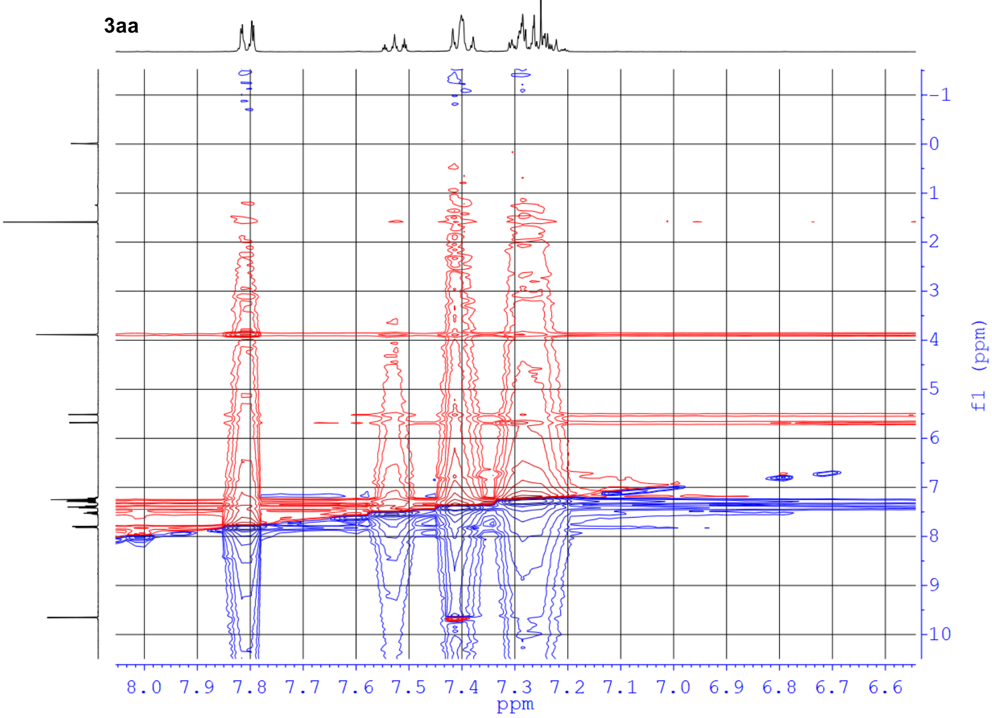
NOESY:

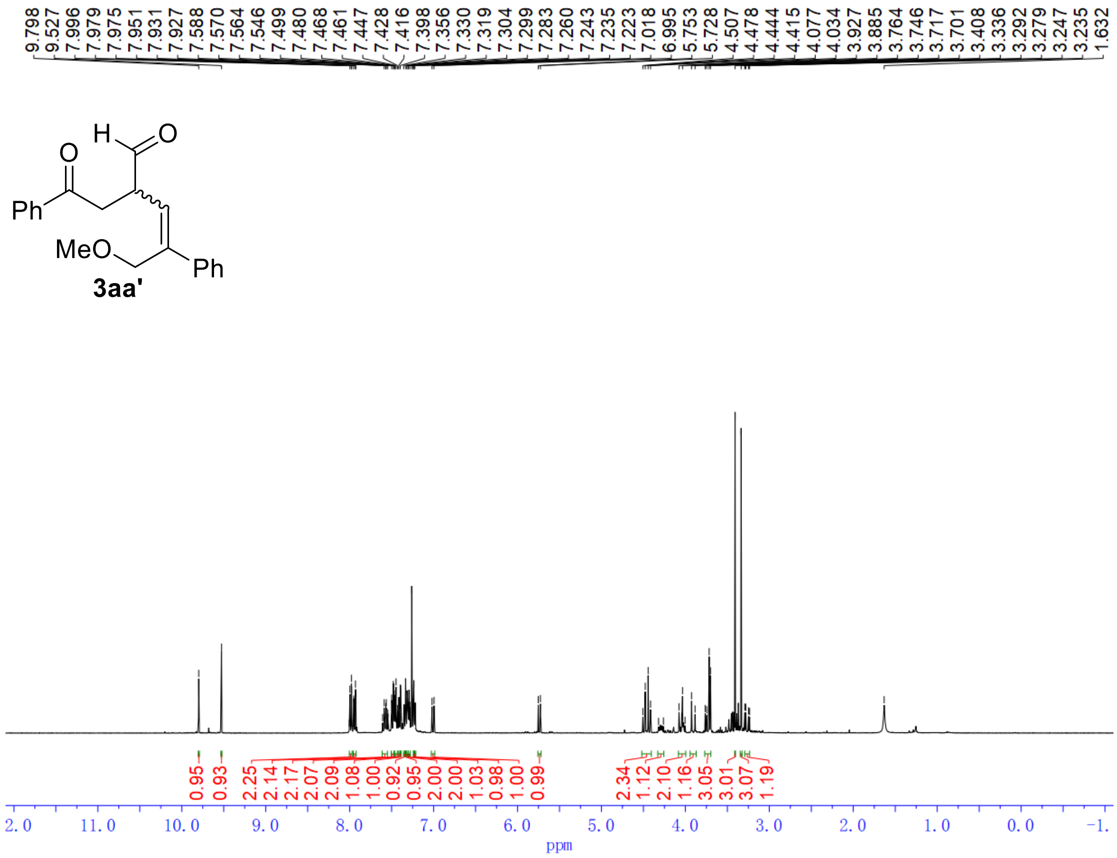




3aa

NO NOE was observed between H^{α} and H^{β}




3aa'

9.798
9.527
7.996
7.979
7.975
7.951
7.931
7.927
7.588
7.570
7.564
7.546
7.499
7.480
7.468
7.461
7.447
7.428
7.416
7.398
7.356
7.330
7.319
7.304
7.299
7.283
7.260
7.243
7.235
7.223
7.018
6.995
5.753
5.728
4.507
4.478
4.444
4.415
4.077
4.034
3.927
3.885
3.764
3.746
3.717
3.701
3.408
3.336
3.292
3.279
3.247
3.235
1.632
H
O
O
Ph
MeO
Ph
0.95
0.93
2.25
2.14
2.17
2.07
2.09
1.08
1.00
0.92
0.95
2.00
2.00
1.03
0.98
1.00
0.99
2.34
1.12
2.10
1.16
3.05
3.01
3.07
1.19
2.0
11.0
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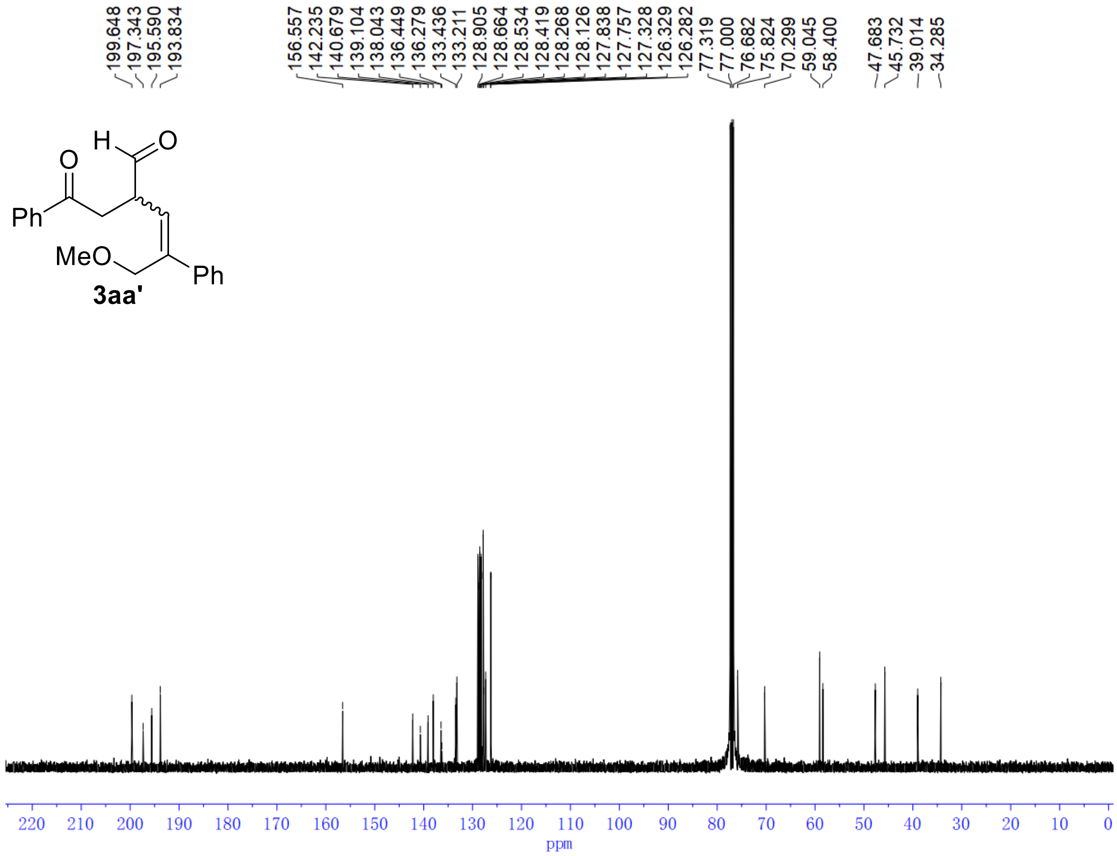
ppm


3aa'

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193.834
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140.679
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136.449
136.279
133.436
133.211
128.905
128.664
128.534
128.419
128.268
128.126
127.838
127.757
127.328
126.329
126.282
77.319
77.000
76.682
75.824
70.299
59.045
58.400
47.683
45.732
39.014
34.285
H
O
O
Ph
MeO
Ph
220
210
200
190
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60
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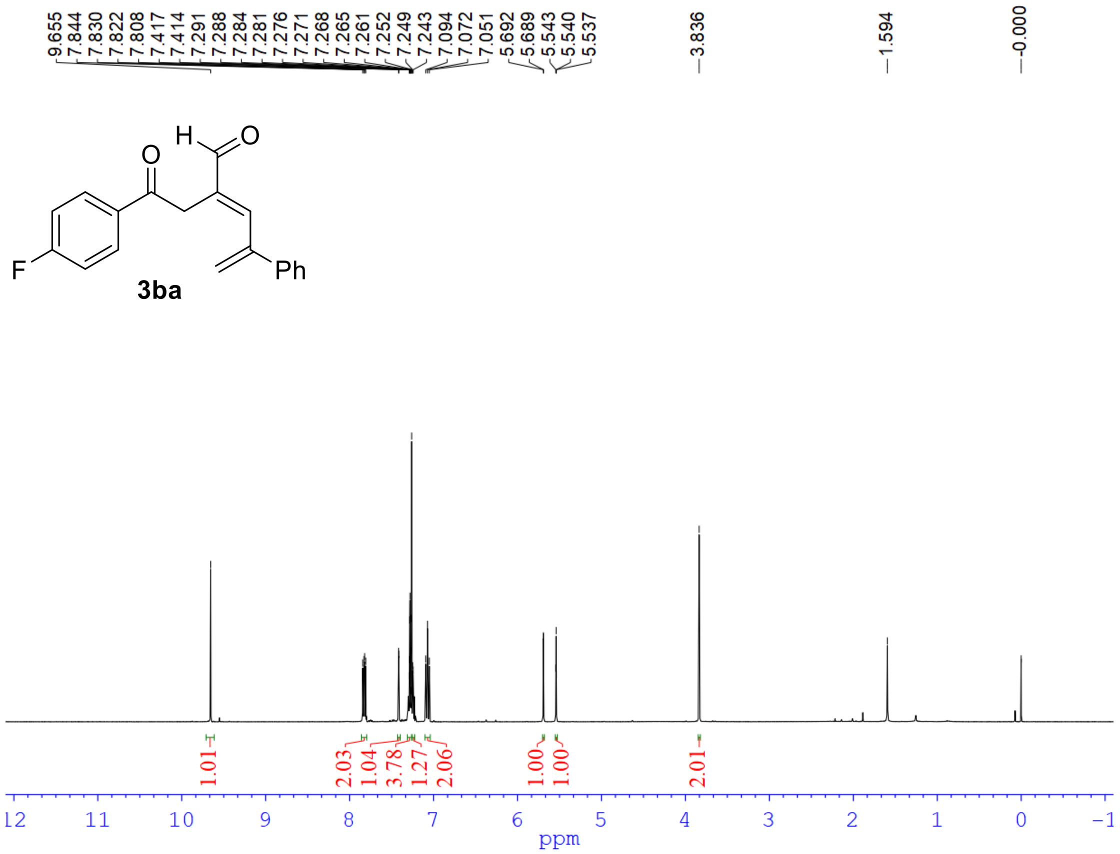
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7.414
7.291
7.288
7.284
7.281
7.276
7.271
7.268
7.265
7.261
7.252
7.249
7.243
7.094
7.072
7.051
5.692
5.689
5.543
5.540
5.537
3.836
1.594
-0.000
H
O
O
F
Ph
3ba
1.01
2.03
1.04
3.78
1.27
2.06
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12
11
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9
8
7
6
5
4
3
2
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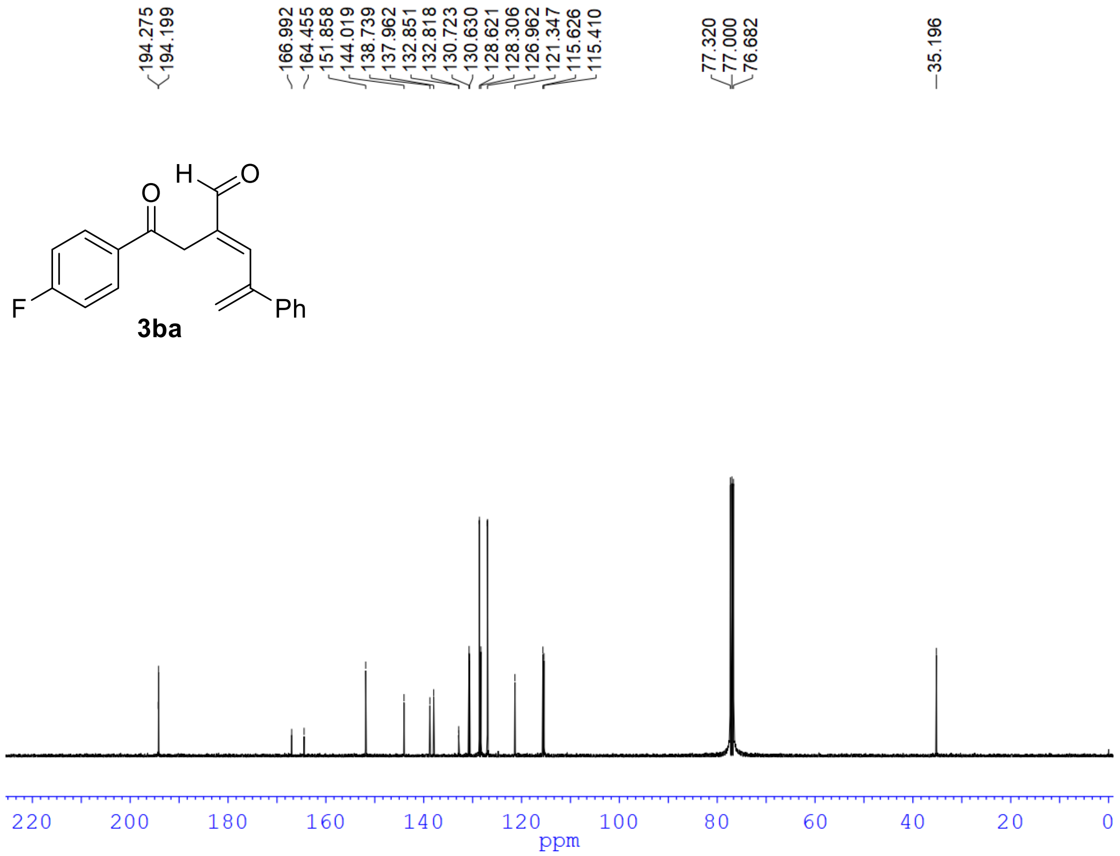
-1
ppm


194.275
194.199
166.992
164.455
151.858
144.019
138.739
137.962
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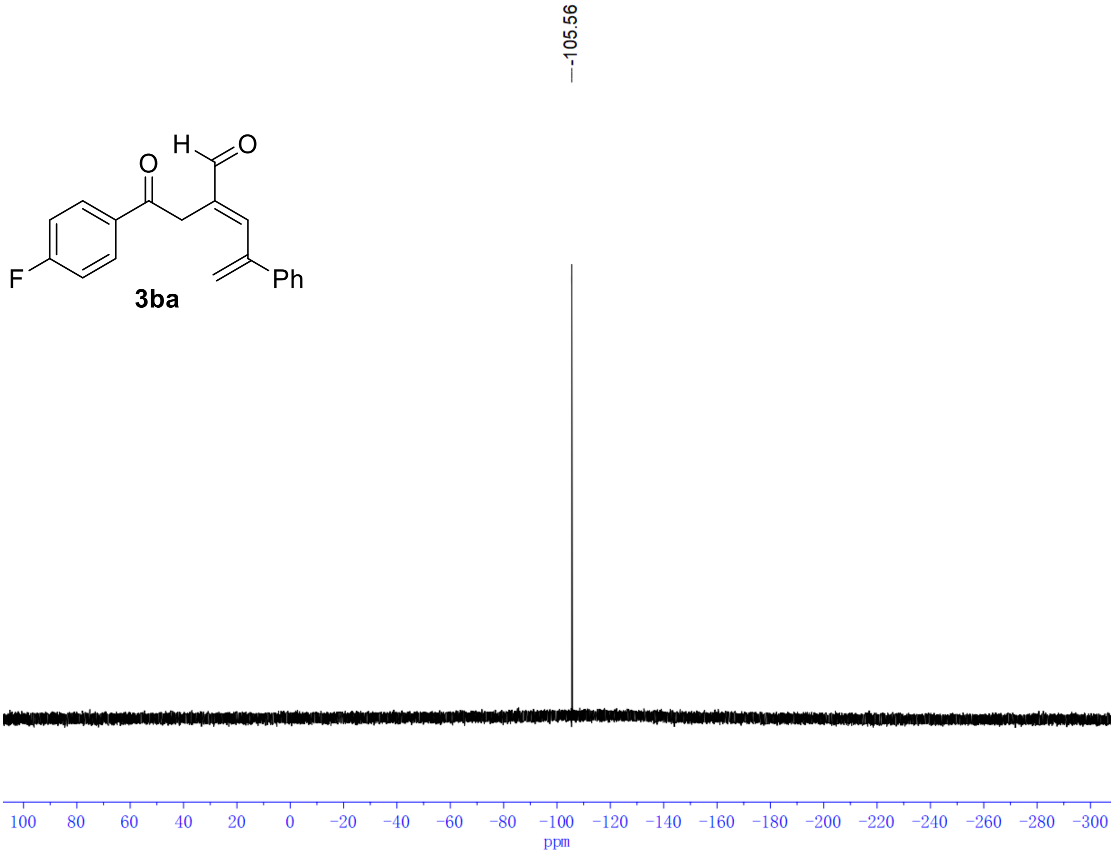
132.818
130.723
130.630
128.621
128.306
126.962
121.347
115.626
115.410
77.320
77.000
76.682
35.196
H
O
O
F
Ph
3ba
220
200
180
160
140
120
100
80
60
40
20
0
ppm


3ba

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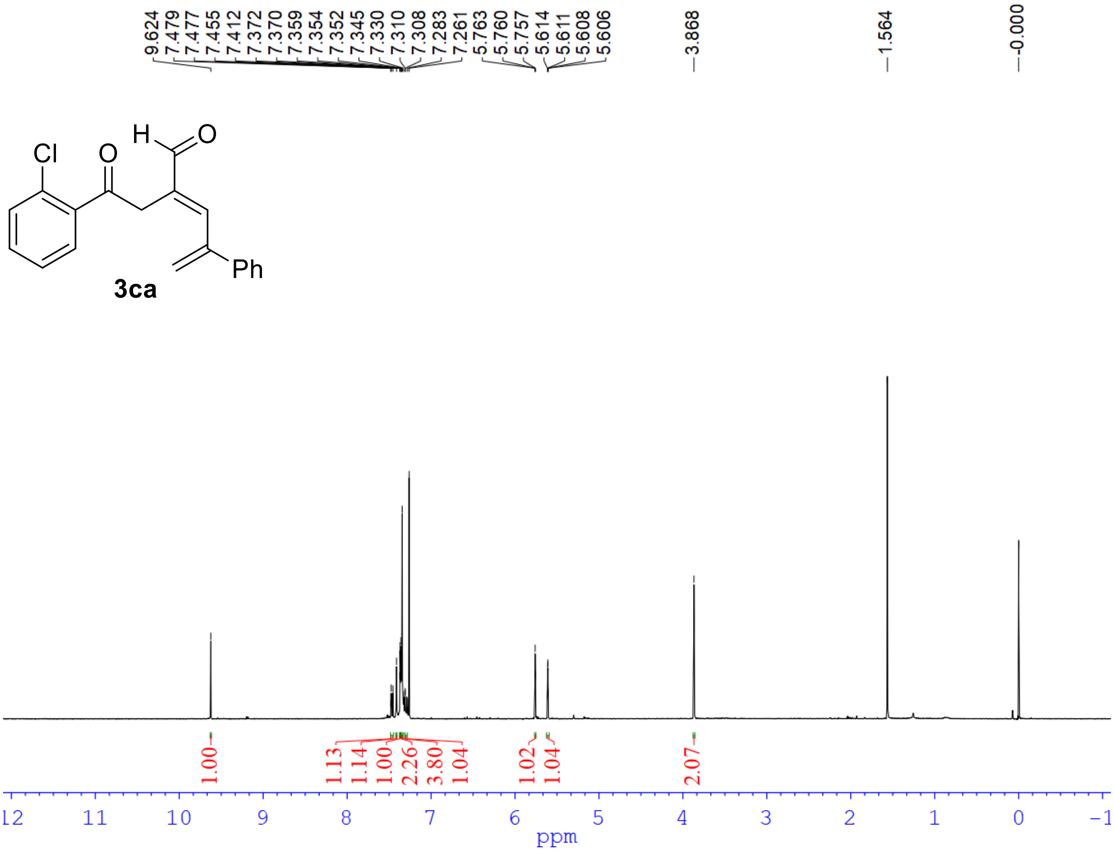
O
H
O
Ph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7.330
7.310
7.308
7.283
7.261
5.763
5.760
5.757
5.614
5.611
5.608
5.606
3.868
1.564
-0.000
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1.13
1.14
1.00
2.26
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1.04
2.07
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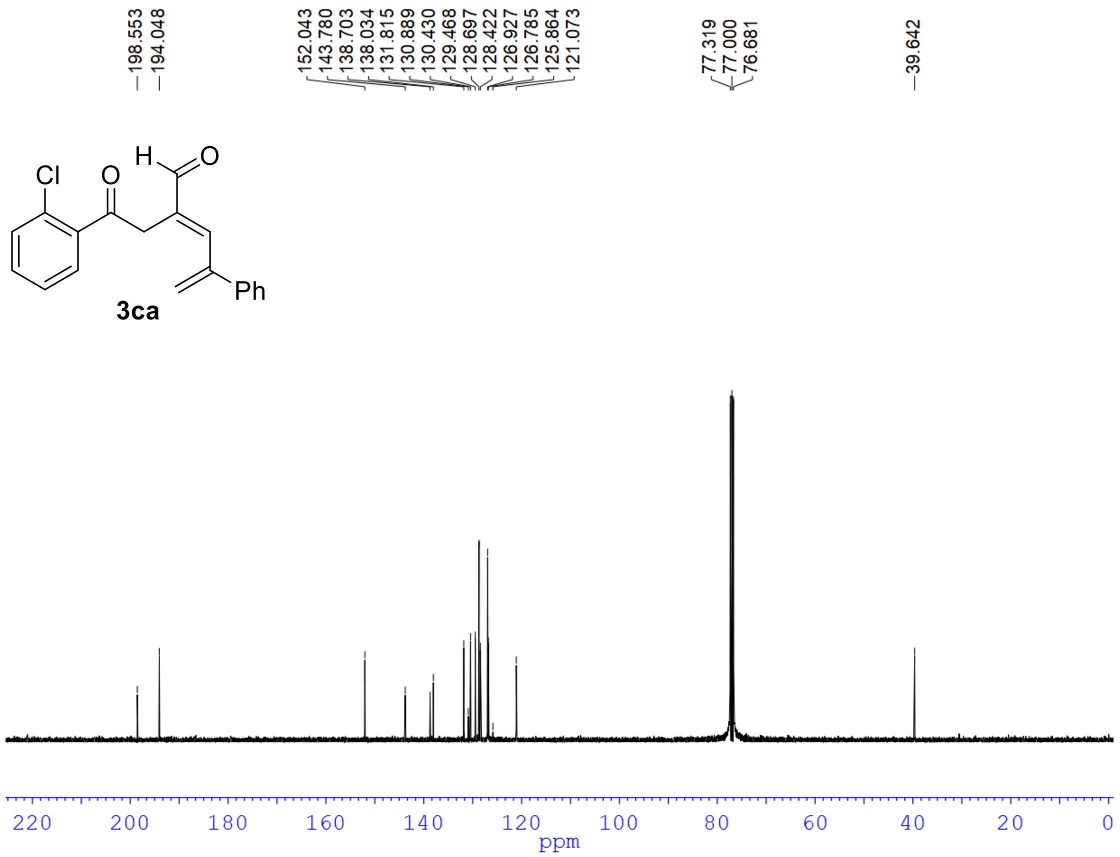
ppm
Cl
O
H
O
Ph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126.927
126.785
125.864
121.073
77.319
77.000
76.681
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O
Ph
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80
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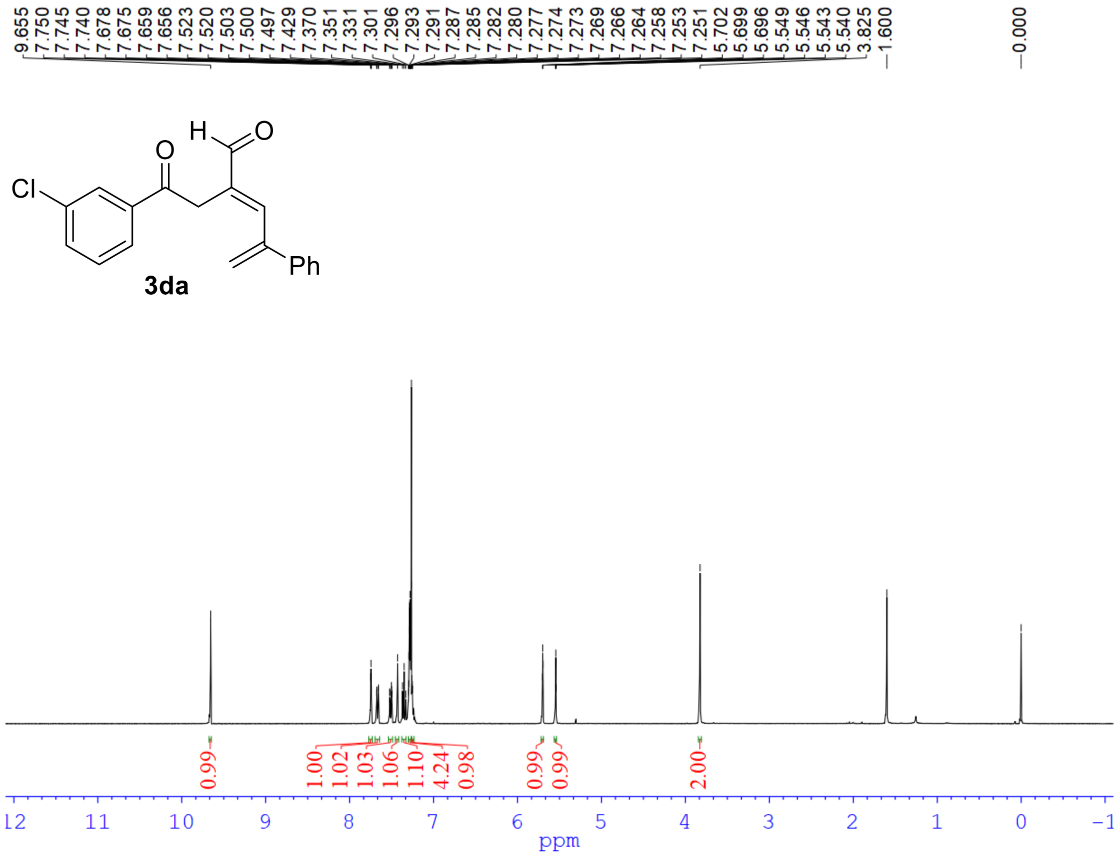
20
0
ppm

3ca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7.520
7.503
7.500
7.497
7.429
7.370
7.351
7.331
7.301
7.296
7.293
7.291
7.287
7.285
7.282
7.280
7.277
7.274
7.273
7.269
7.266
7.264
7.258
7.253
7.251
5.702
5.699
5.696
5.549
5.546
5.543
5.540
3.825
1.600
0.000
Cl
O
H
O
Ph
0.99
1.00
1.02
1.03
1.06
1.10
4.24
0.98
0.99
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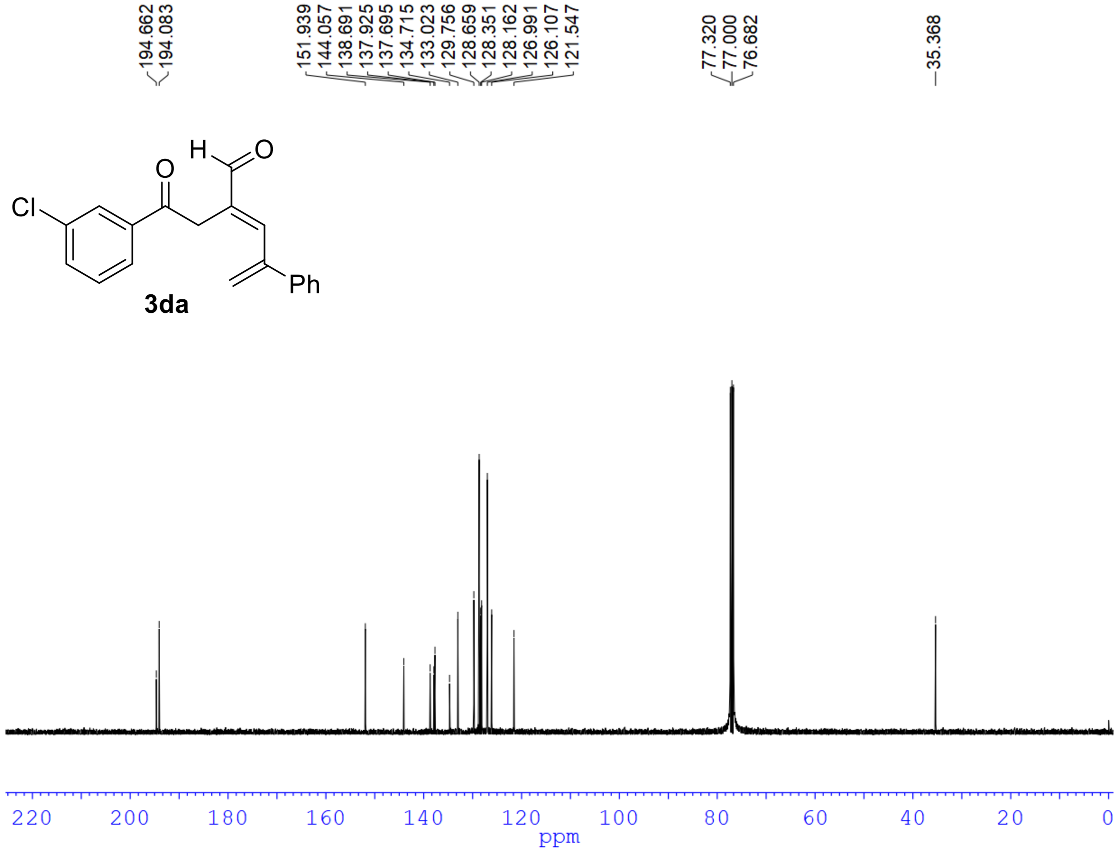
ppm

3da



3da

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133.023
129.756
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128.351
128.162
126.991
126.107
121.547
77.320
77.000
76.682
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O
Cl
Ph
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200
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120
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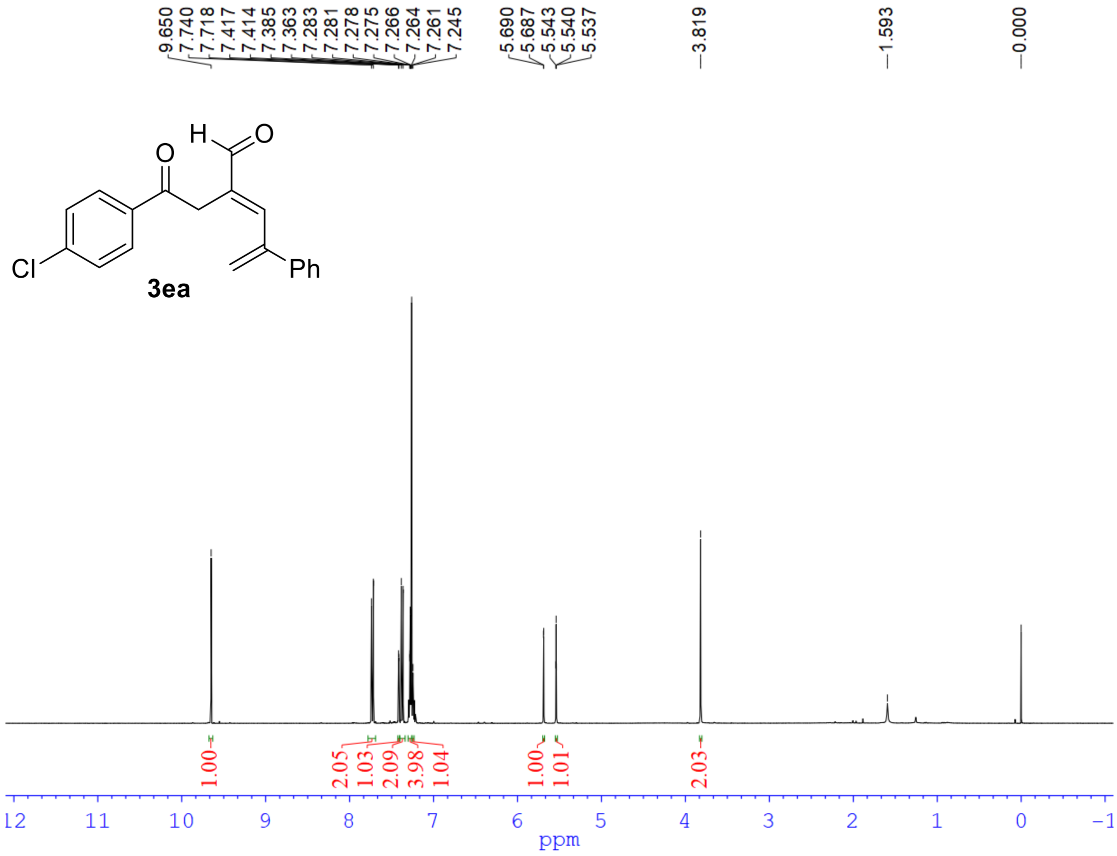

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7.363
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7.281
7.278
7.275
7.266
7.264
7.261
7.245
5.690
5.687
5.543
5.540
5.537
3.819
1.593
0.000
O
H
O
Cl
Ph
1.00
2.05
1.03
2.09
3.98
1.04
1.00
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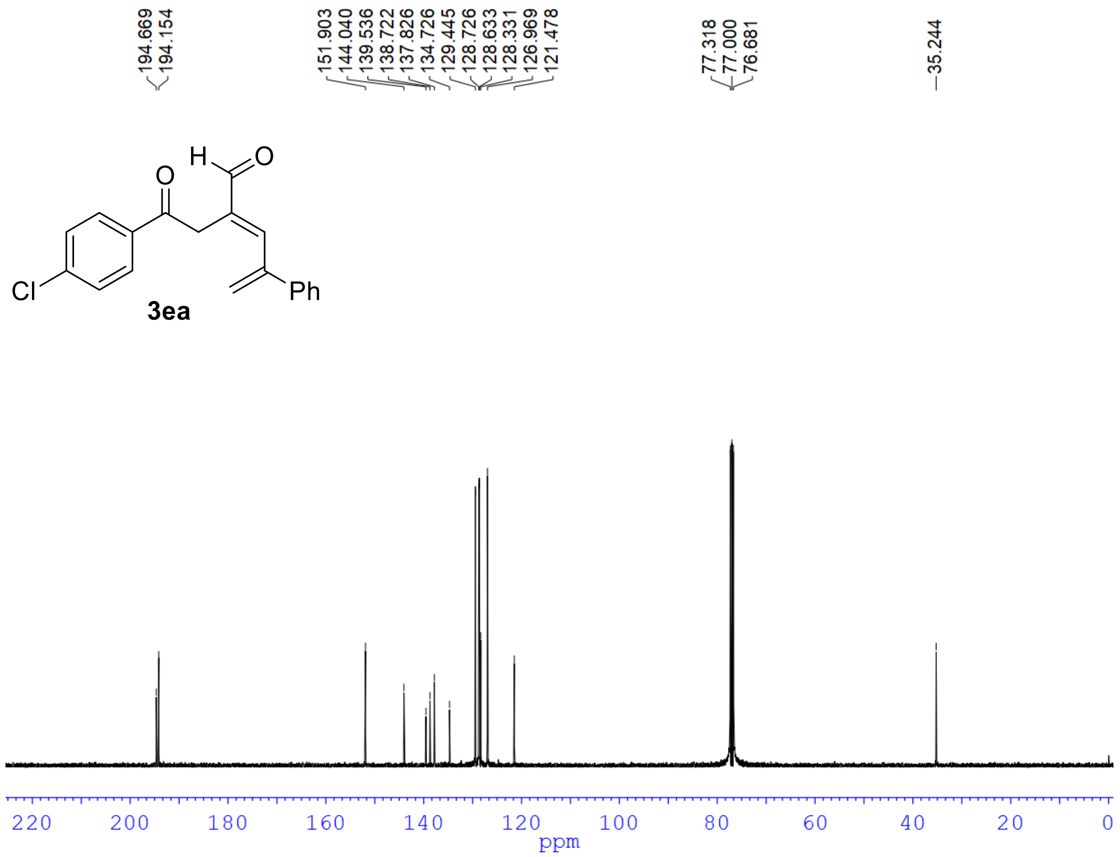
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134.726
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128.331
126.969
121.478
77.318
77.000
76.681
35.244
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H
O
Cl
Ph
3ea
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200
180
160
140
120
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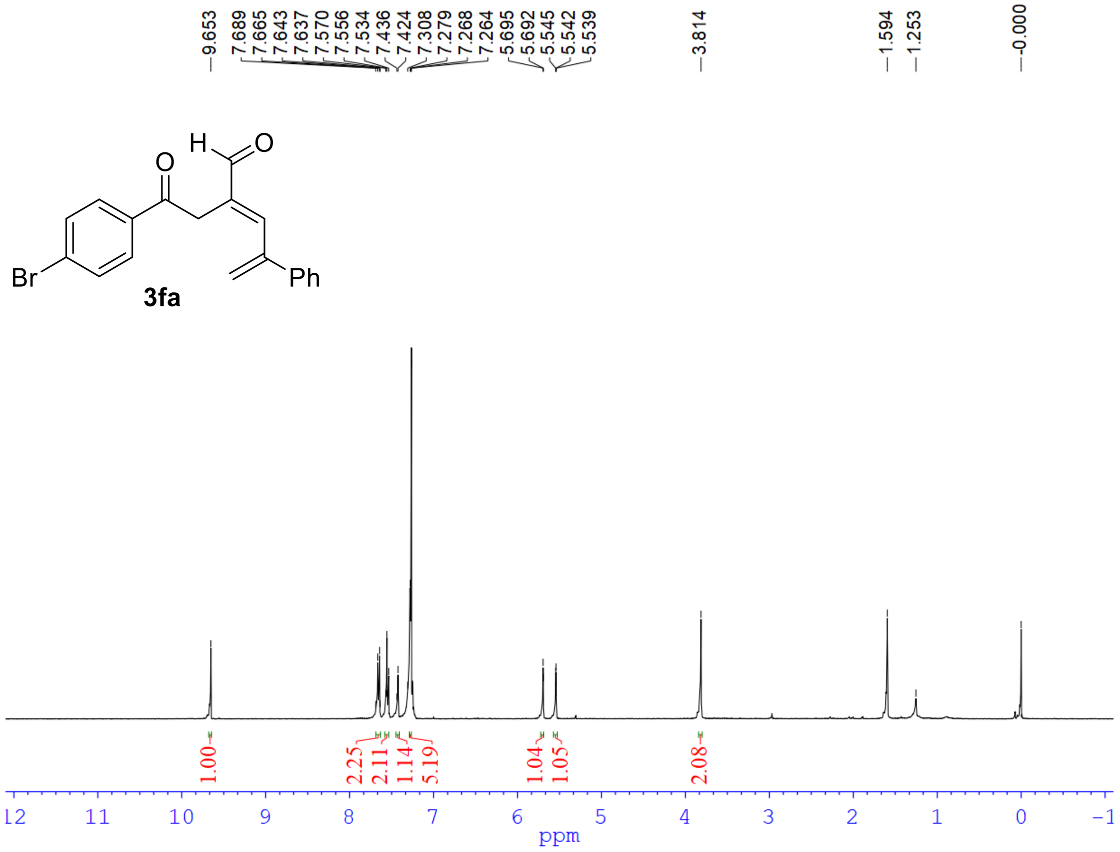
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7.643
7.637
7.570
7.556
7.534
7.436
7.424
7.308
7.279
7.268
7.264
5.695
5.692
5.545
5.542
5.539
3.814
1.594
1.253
-0.000
O
H
O
Br
Ph
3fa
1.00
2.25
2.11
1.14
5.19
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1.05
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12
11
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9
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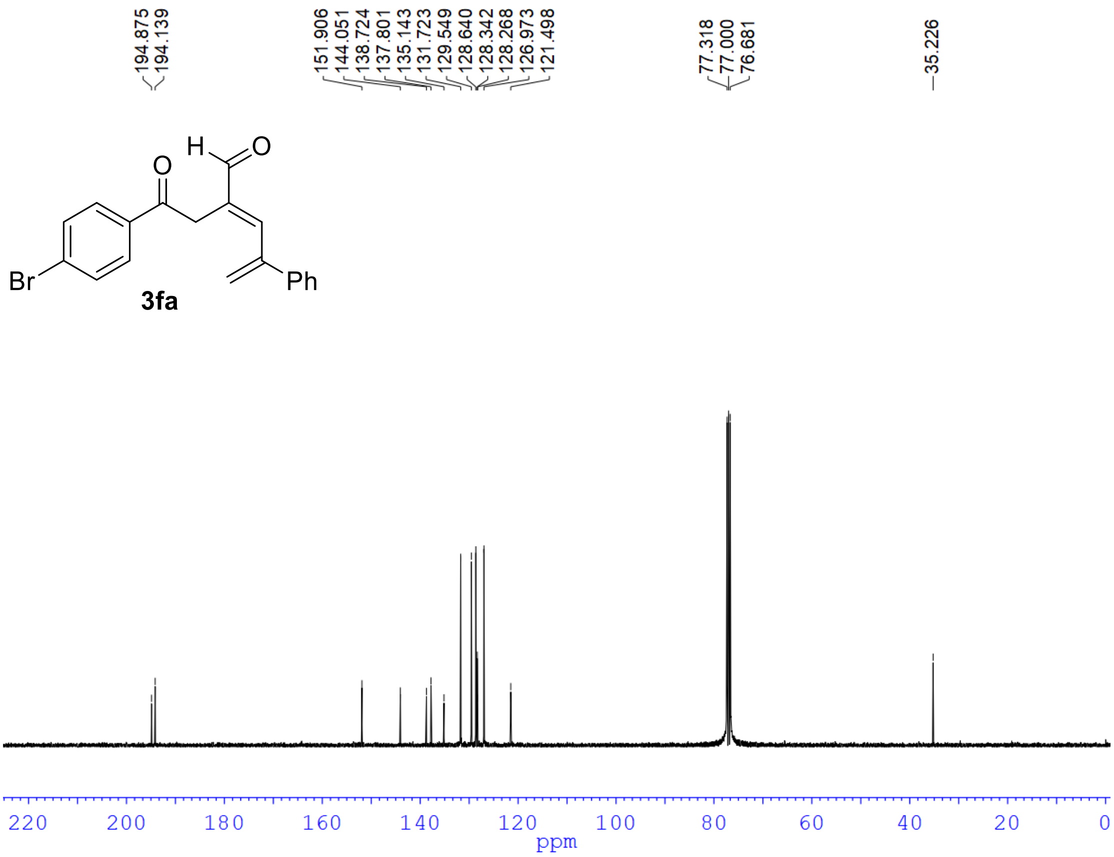
-1
ppm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137.801
135.143
131.723
129.549
128.640
128.342
128.268
126.973
121.498
77.318
77.000
76.681
35.226
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O
O
Br
Ph
220
200
180
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140
120
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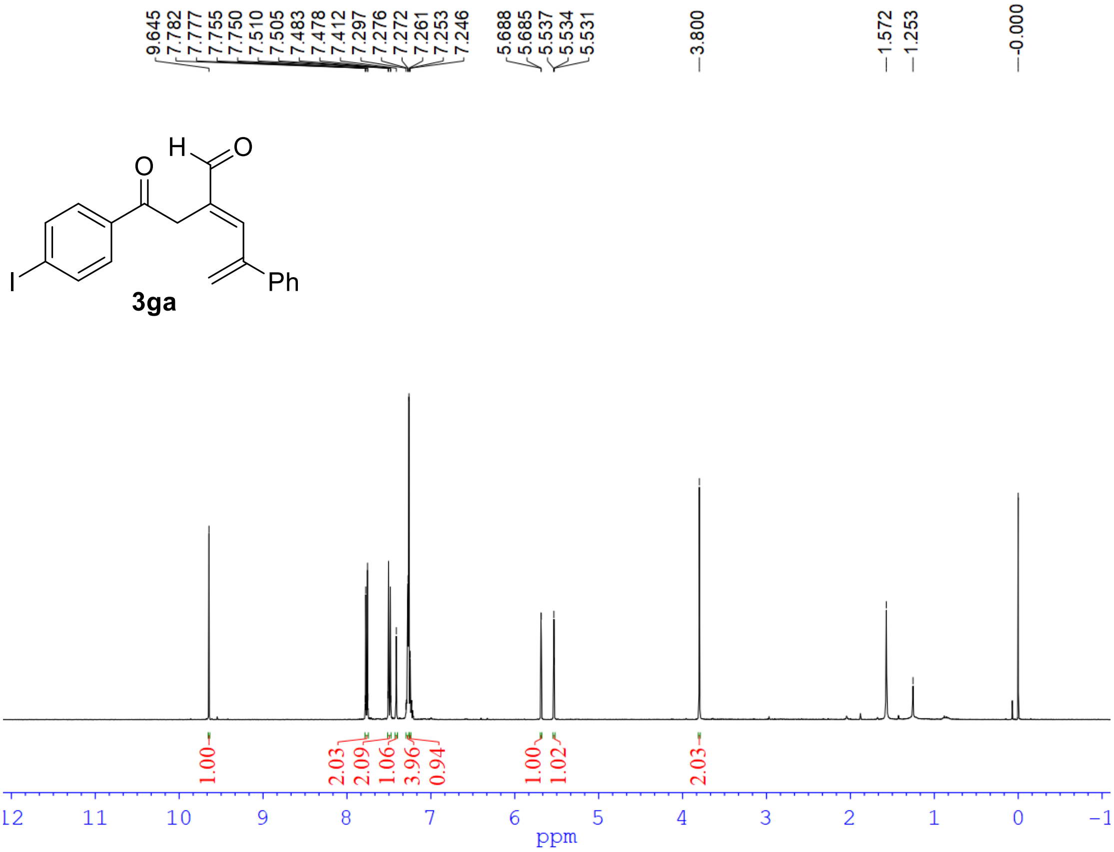
80
60
40
20
0
ppm

3fa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7.483
7.478
7.412
7.297
7.276
7.272
7.261
7.253
7.246
5.688
5.685
5.537
5.534
5.531
3.800
1.572
1.253
-0.000
H
O
O
I
Ph
1.00
2.03
2.09
1.06
3.96
0.94
1.00
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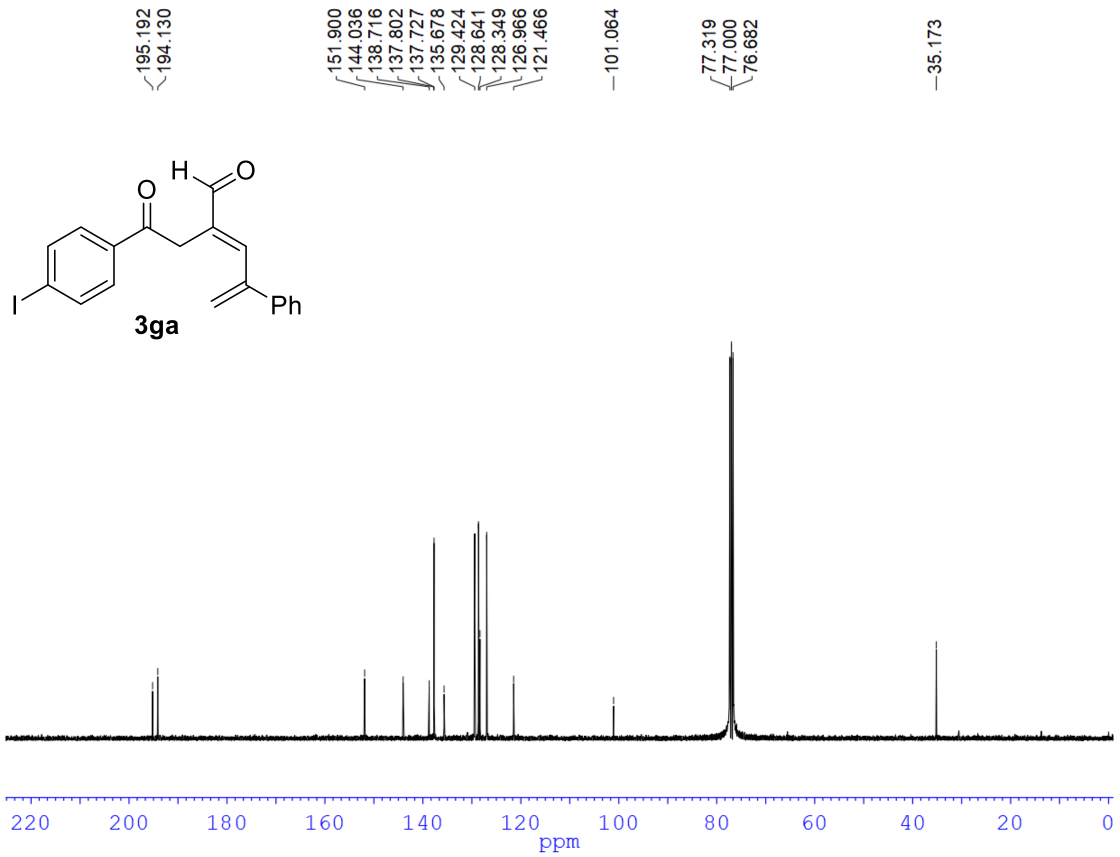
ppm

3ga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137.802
137.727
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128.349
126.966
121.466
101.064
77.319
77.000
76.682
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O
O
I
Ph
3ga
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200
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100
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0
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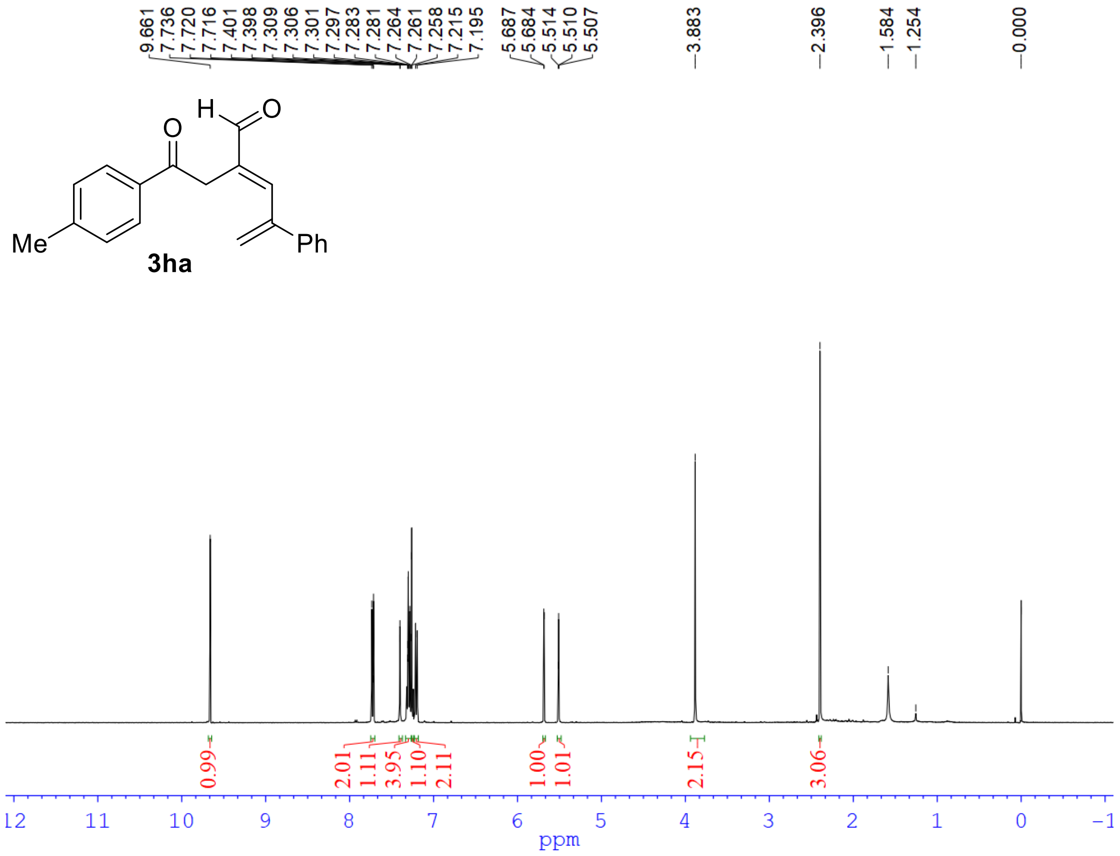
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7.297
7.283
7.281
7.264
7.261
7.258
7.215
7.195
5.687
5.684
5.514
5.510
5.507
3.883
2.396
1.584
1.254
0.000
H
O
O
Me
Ph
3ha
0.99
2.01
1.11
3.95
1.10
2.11
1.00
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12
11
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9
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7
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5
4
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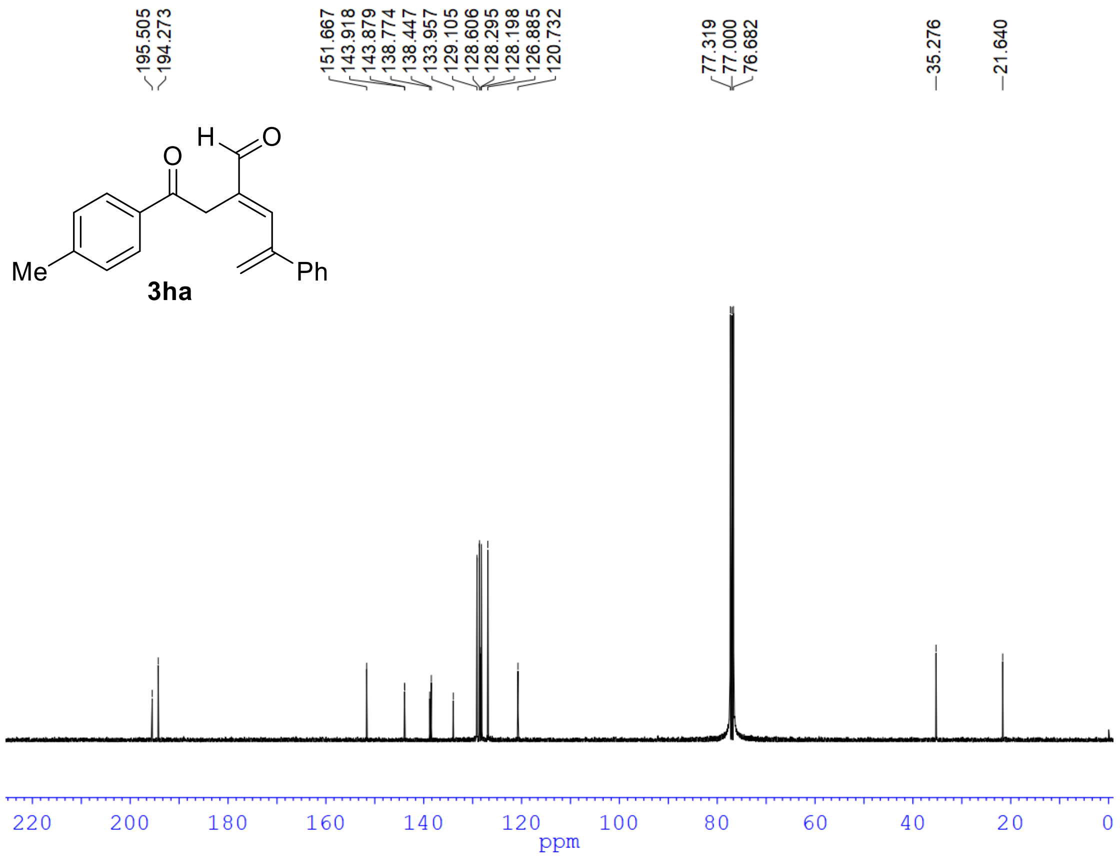
1
0
−1
ppm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133.957
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77.000
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35.276
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O
Me
3ha
Ph
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120
100
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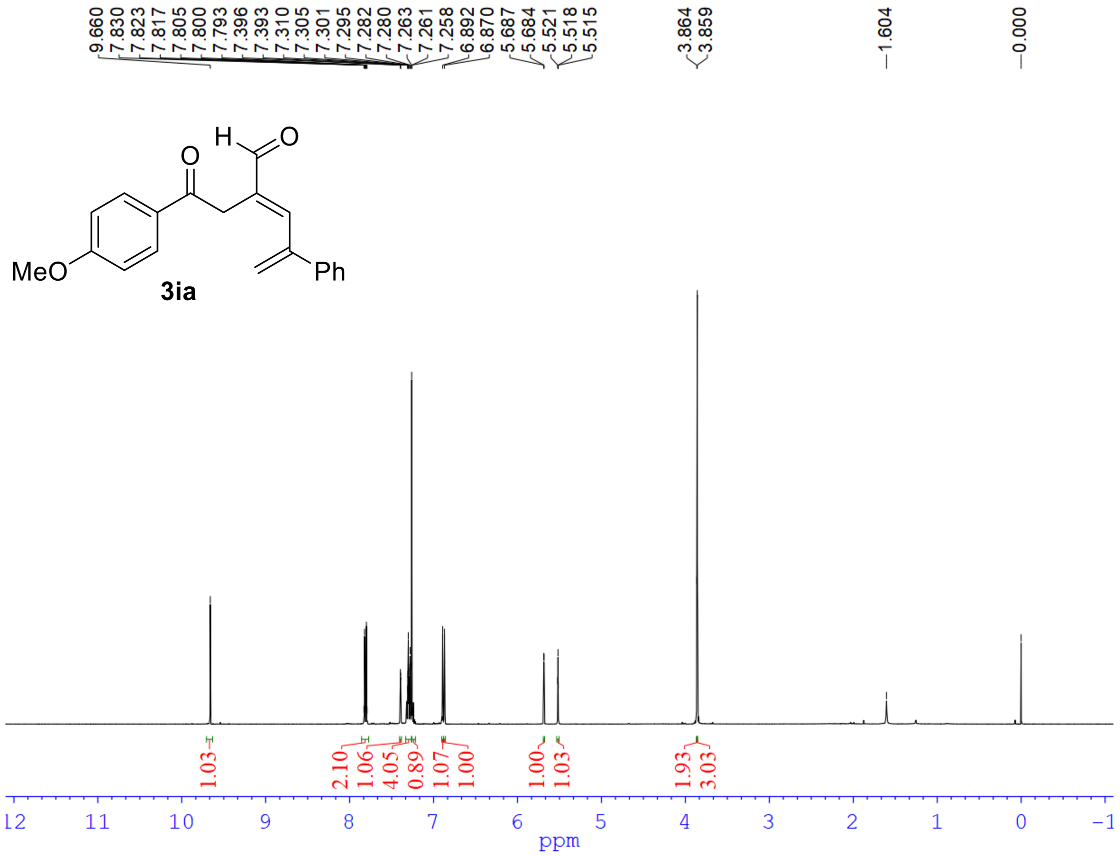
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7.295
7.282
7.280
7.263
7.261
7.258
6.892
6.870
5.687
5.684
5.521
5.518
5.515
3.864
3.859
1.604
0.000
H
O
O
MeO
3ia
Ph
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2.10
1.06
4.05
0.89
1.07
1.00
1.00
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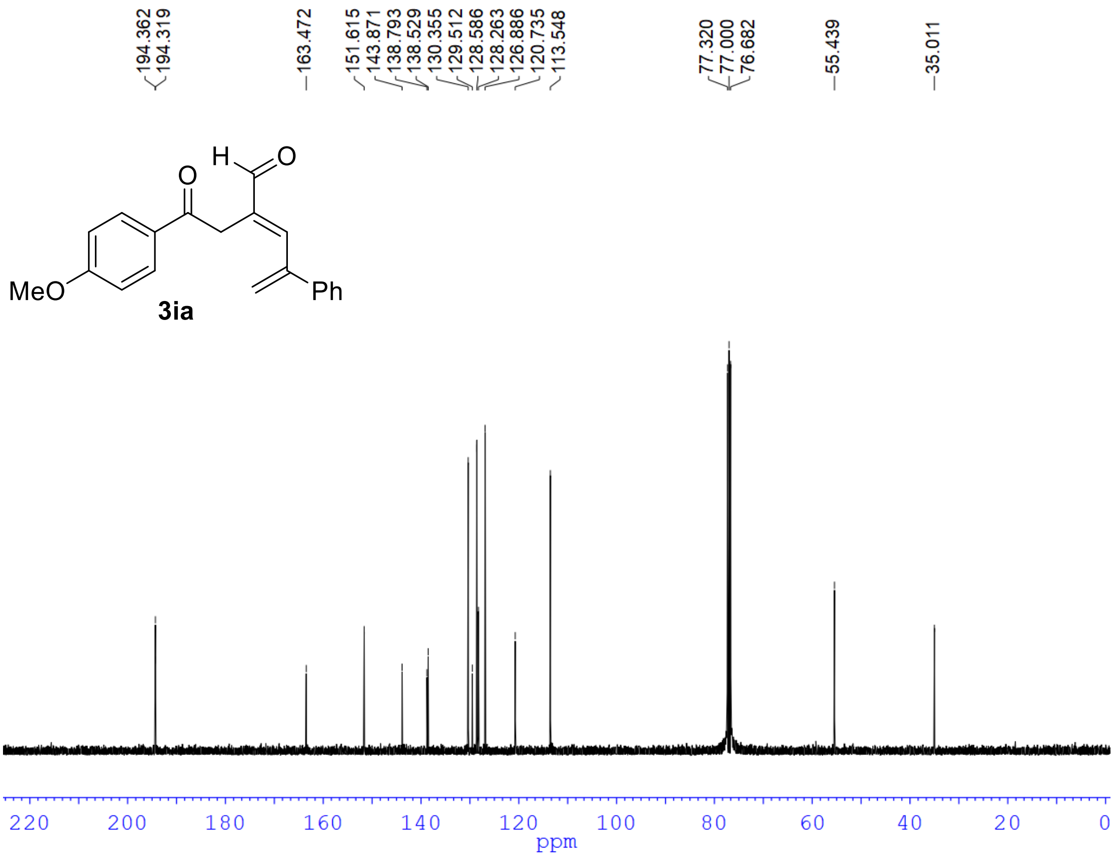
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120.735
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77.000
76.682
55.439
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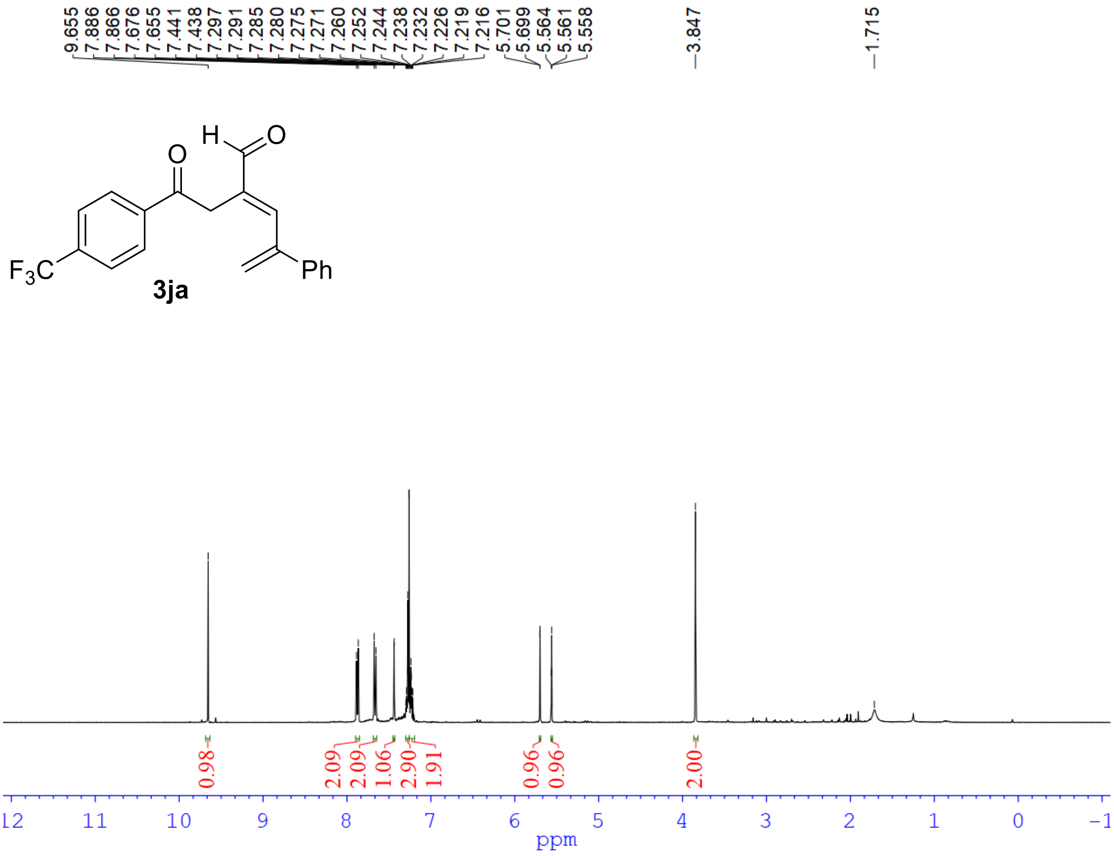
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7.271
7.260
7.252
7.244
7.238
7.232
7.226
7.219
7.216
5.701
5.699
5.564
5.561
5.558
3.847
1.715
O
H
O
F3C
Ph
0.98
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2.09
1.06
2.90
1.91
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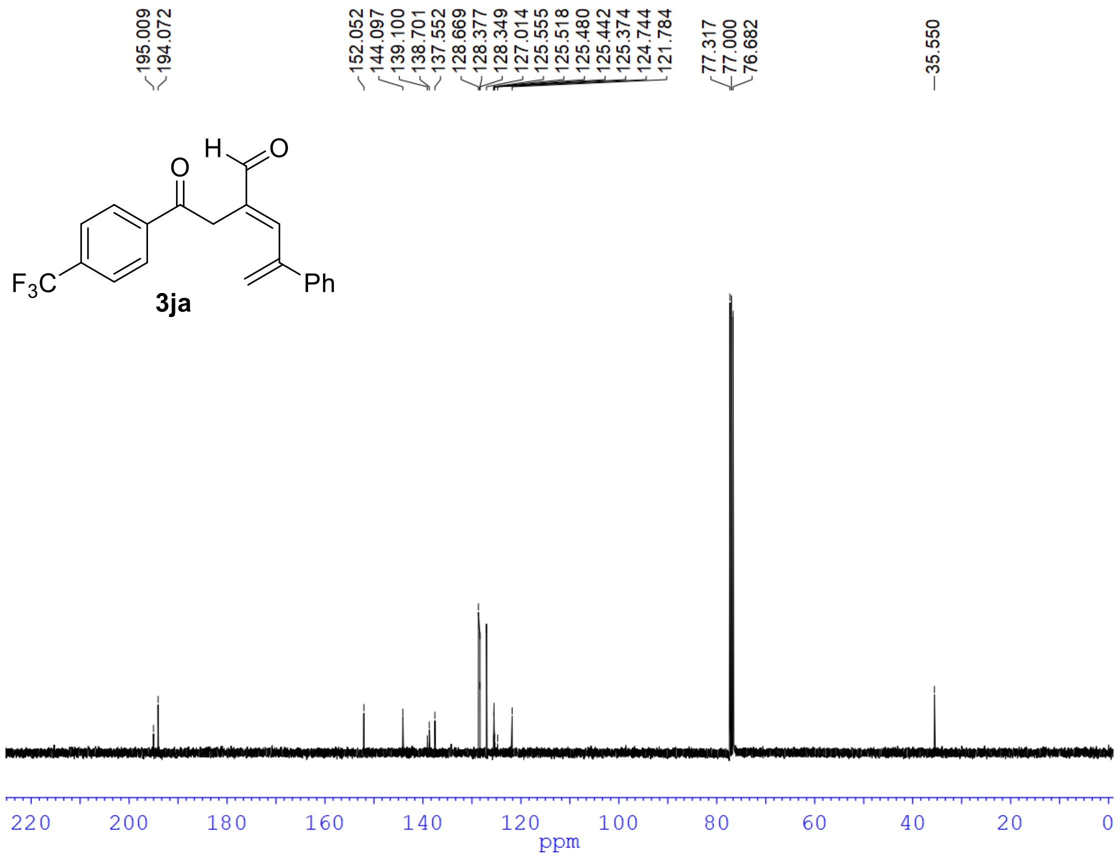
0
−1
ppm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125.480
125.442
125.374
124.744
121.784
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Ph
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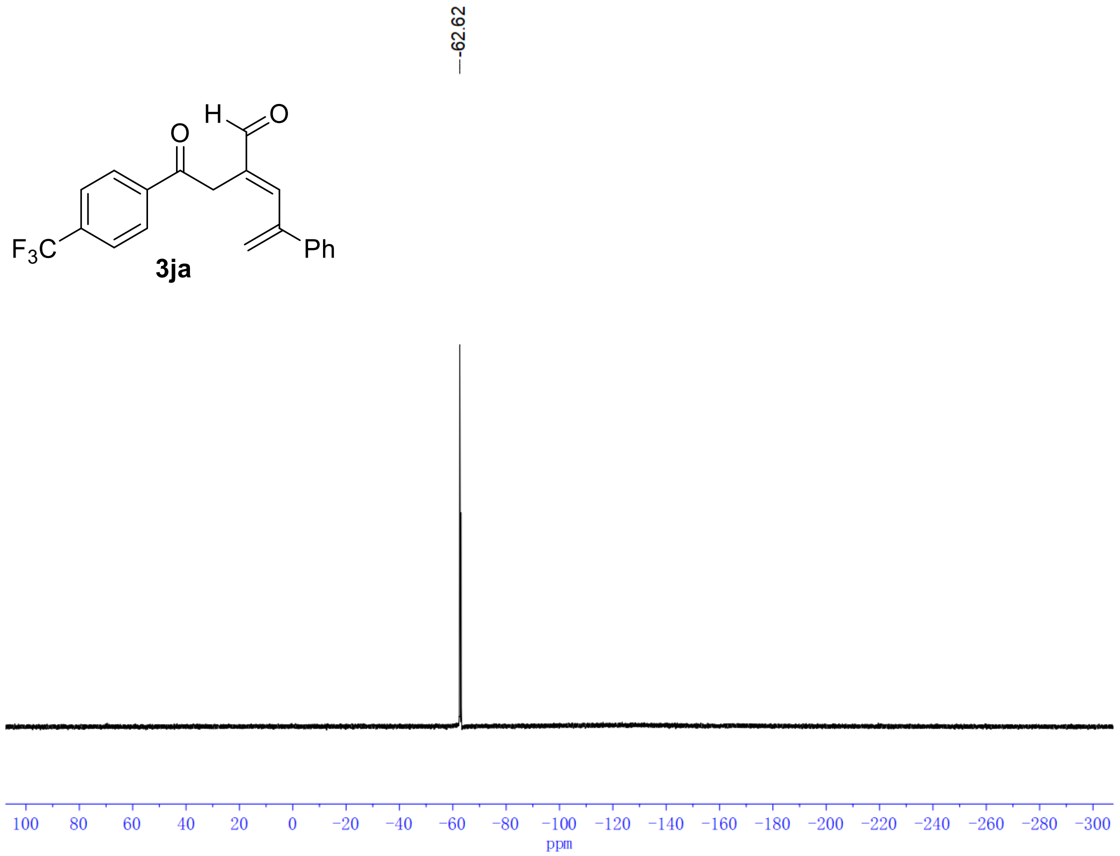
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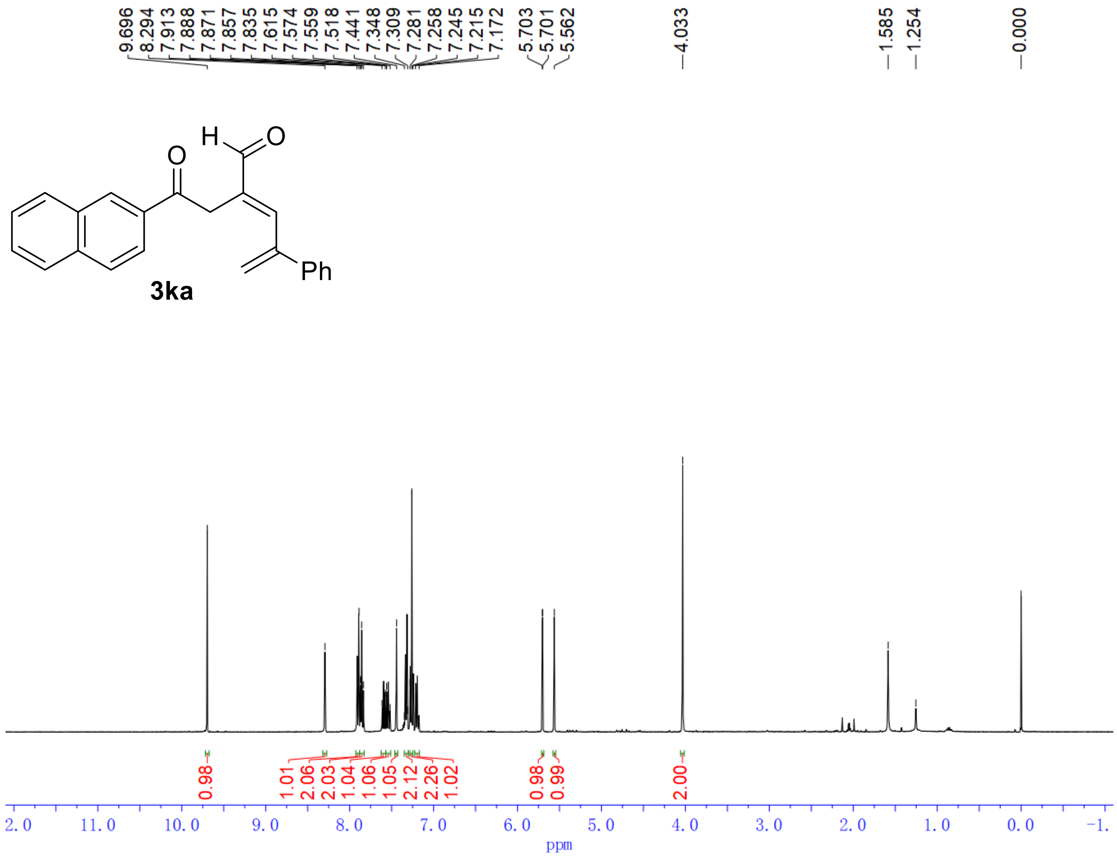
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7.441
7.348
7.309
7.281
7.258
7.245
7.215
7.172
5.703
5.701
5.562
4.033
1.585
1.254
0.000
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O
O
Ph
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1.01
2.06
2.03
1.04
1.06
1.05
2.12
2.26
1.02
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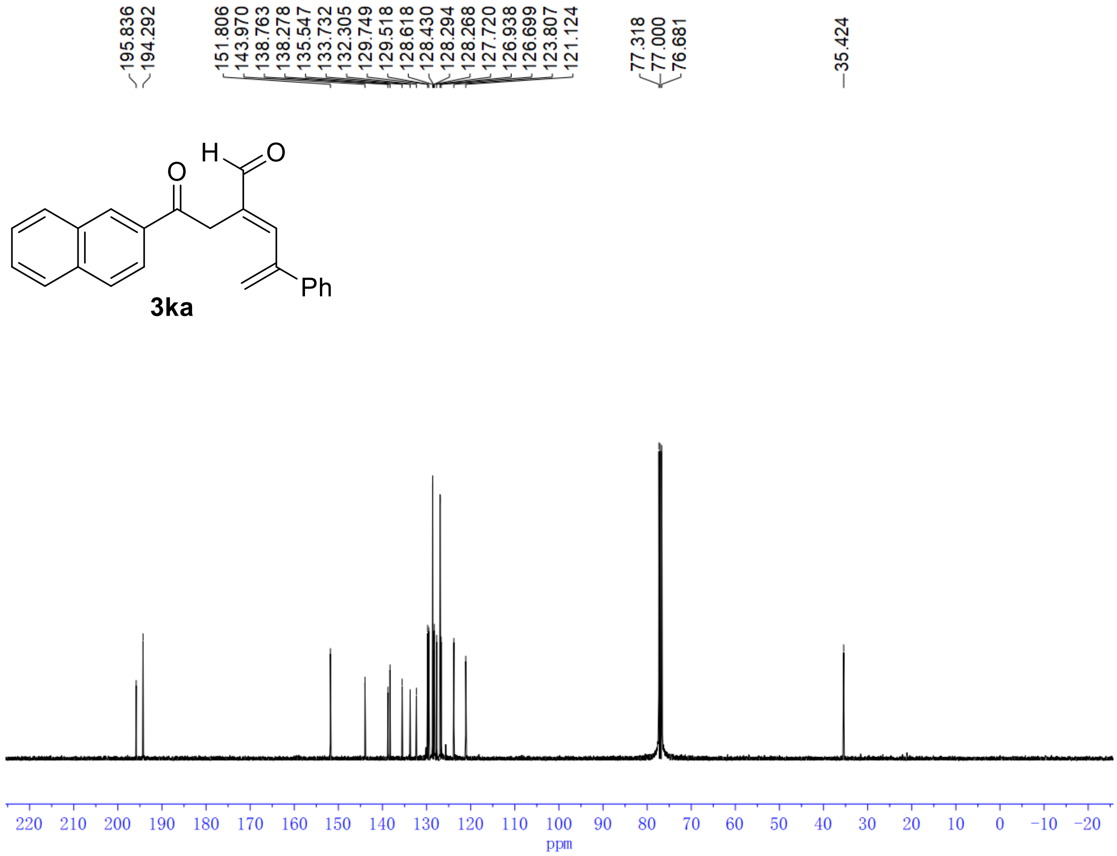
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128.430
128.294
128.268
127.720
126.938
126.699
123.807
121.124
77.318
77.000
76.681
35.424
H
O
O
Ph
220
210
200
190
180
170
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80
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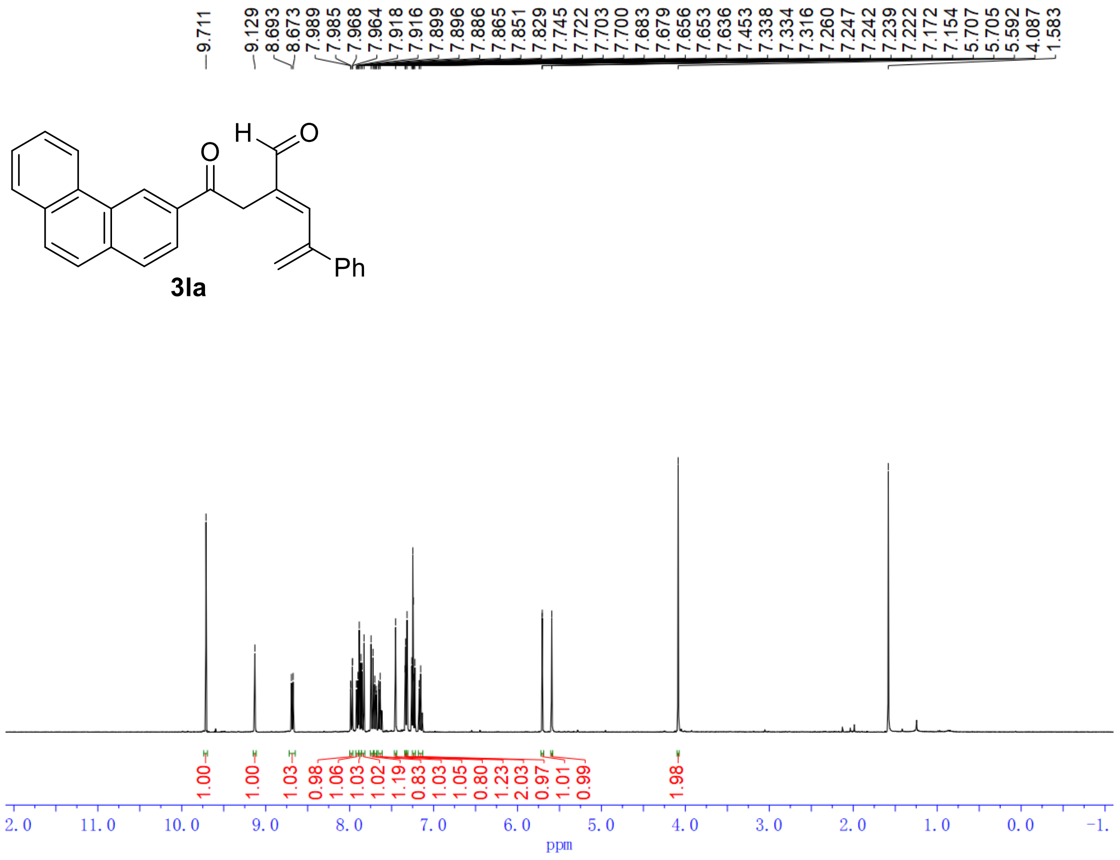
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7.683
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7.653
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7.260
7.247
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7.239
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O
Ph
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1.00
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1.01
0.99
1.98
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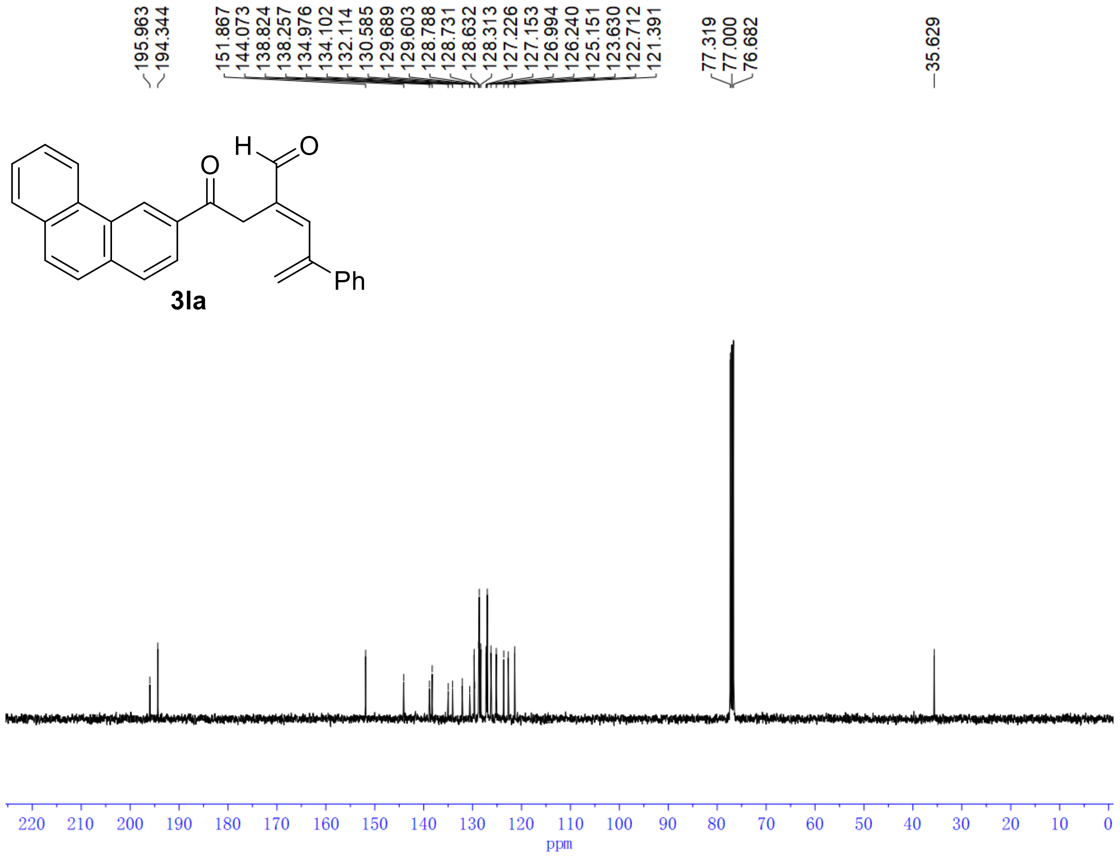
3la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77.000
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O
O
Ph
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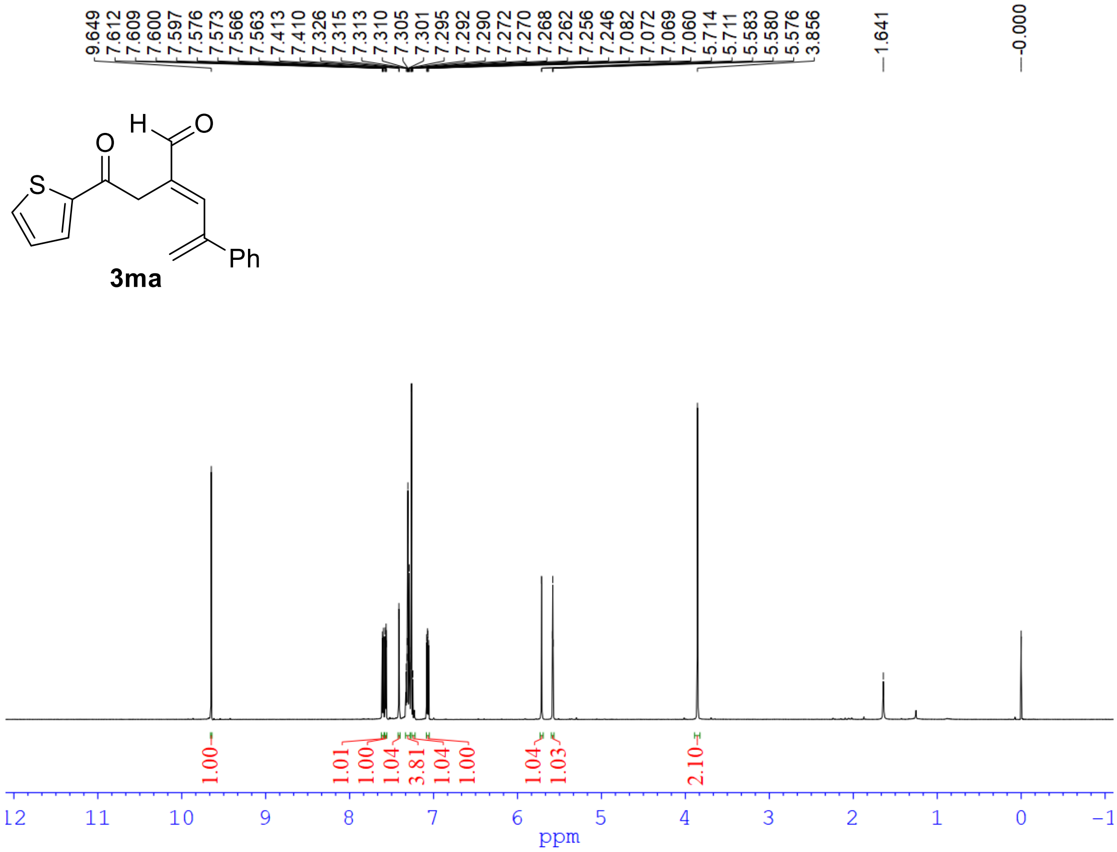
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7.305
7.301
7.295
7.292
7.290
7.272
7.270
7.268
7.262
7.256
7.246
7.082
7.072
7.069
7.060
5.714
5.711
5.583
5.580
5.576
3.856
1.641
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S
O
H
O
Ph
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1.00
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1.00
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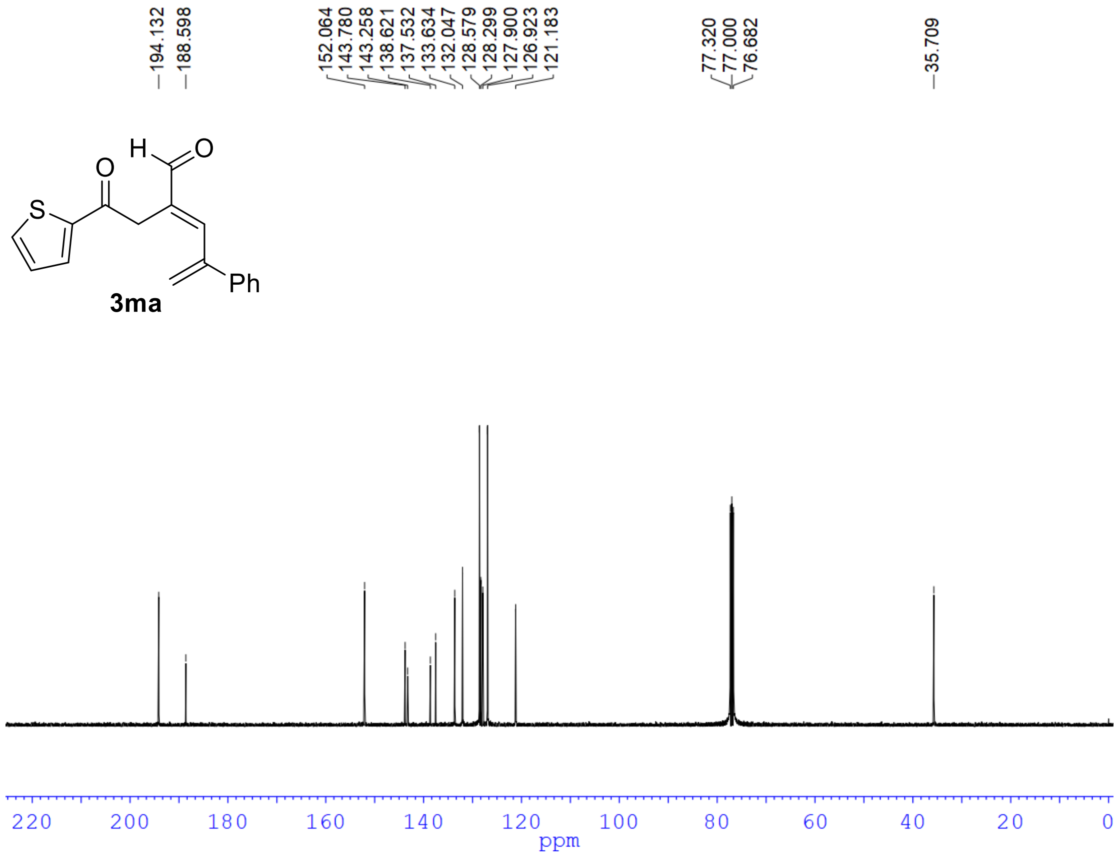
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126.923
121.183
77.320
77.000
76.682
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Ph
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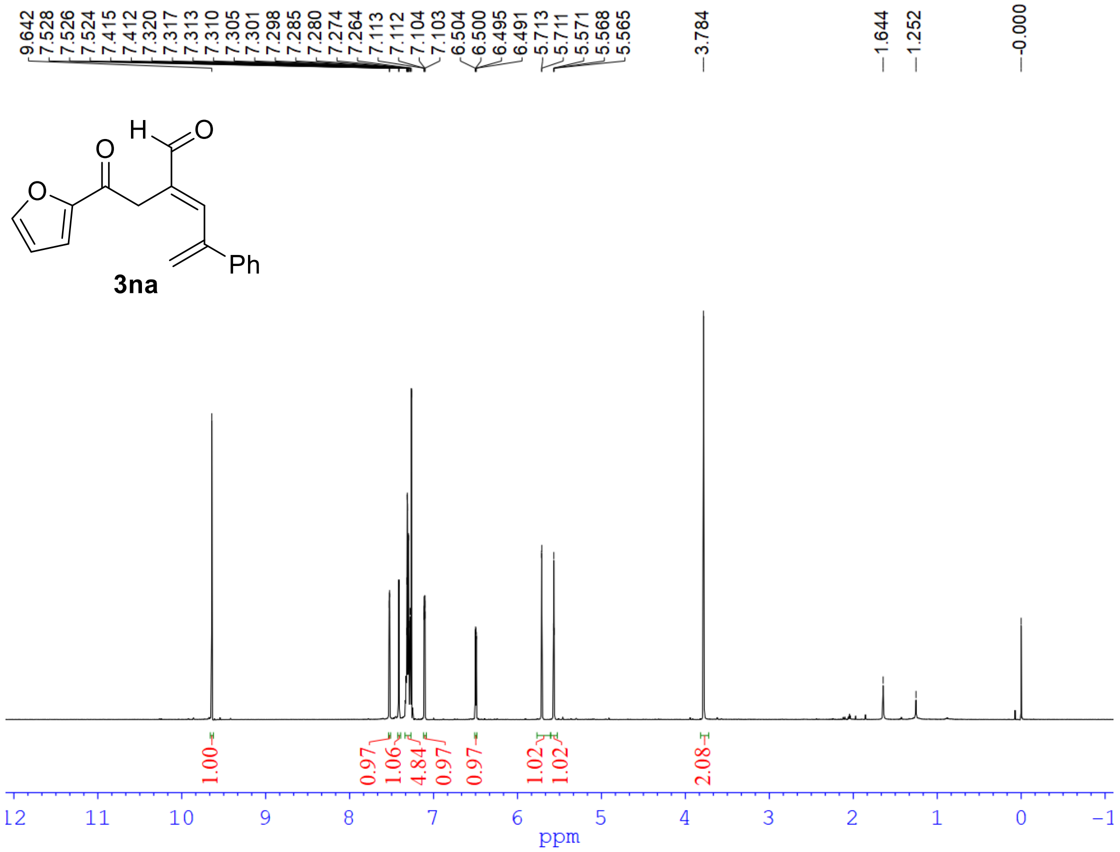
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7.280
7.274
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5.565
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1.252
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O
O
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Ph
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0.97
0.97
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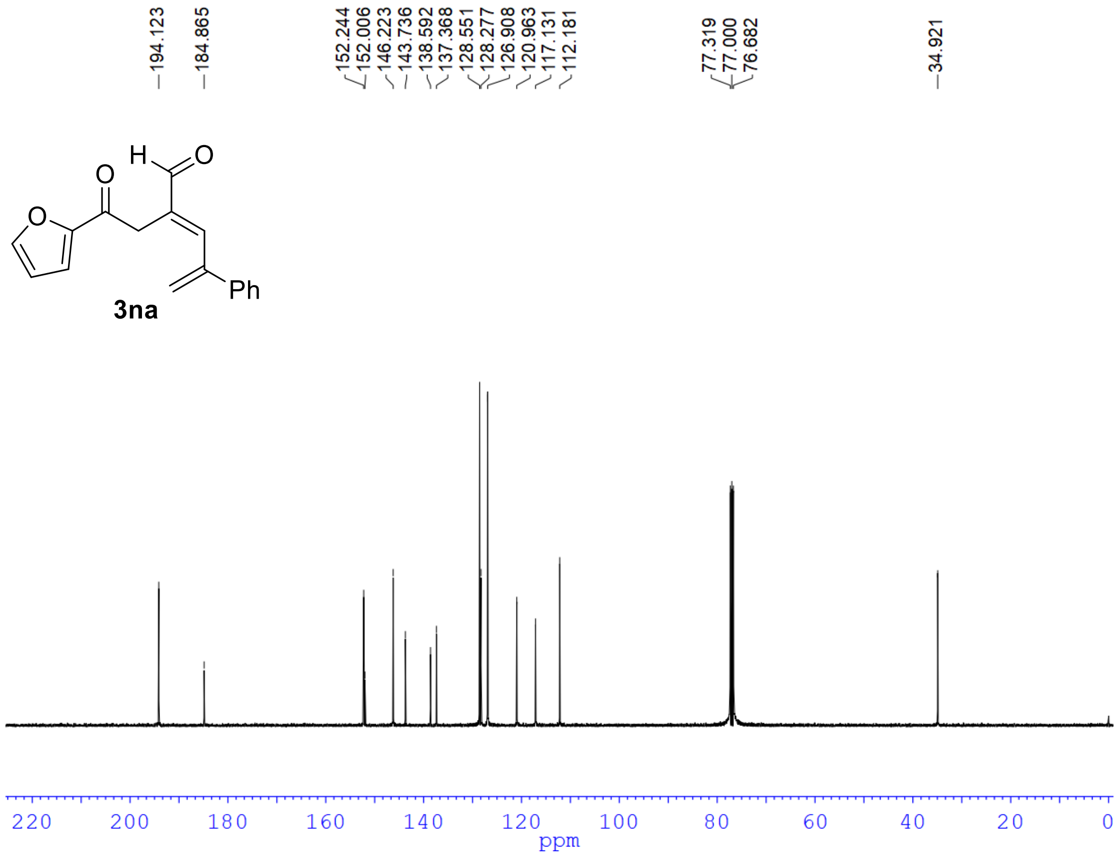
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112.181
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77.000
76.682
34.921
H
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O
O
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220
200
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160
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80
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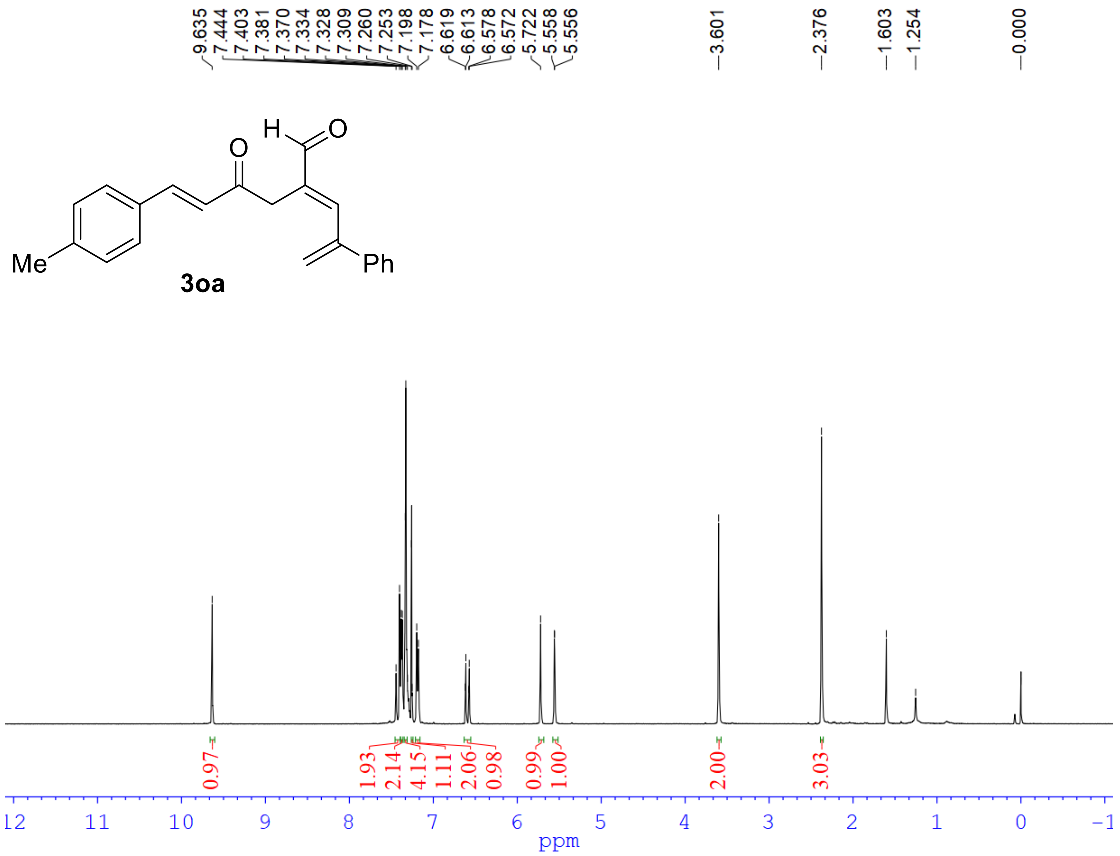

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O
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Ph
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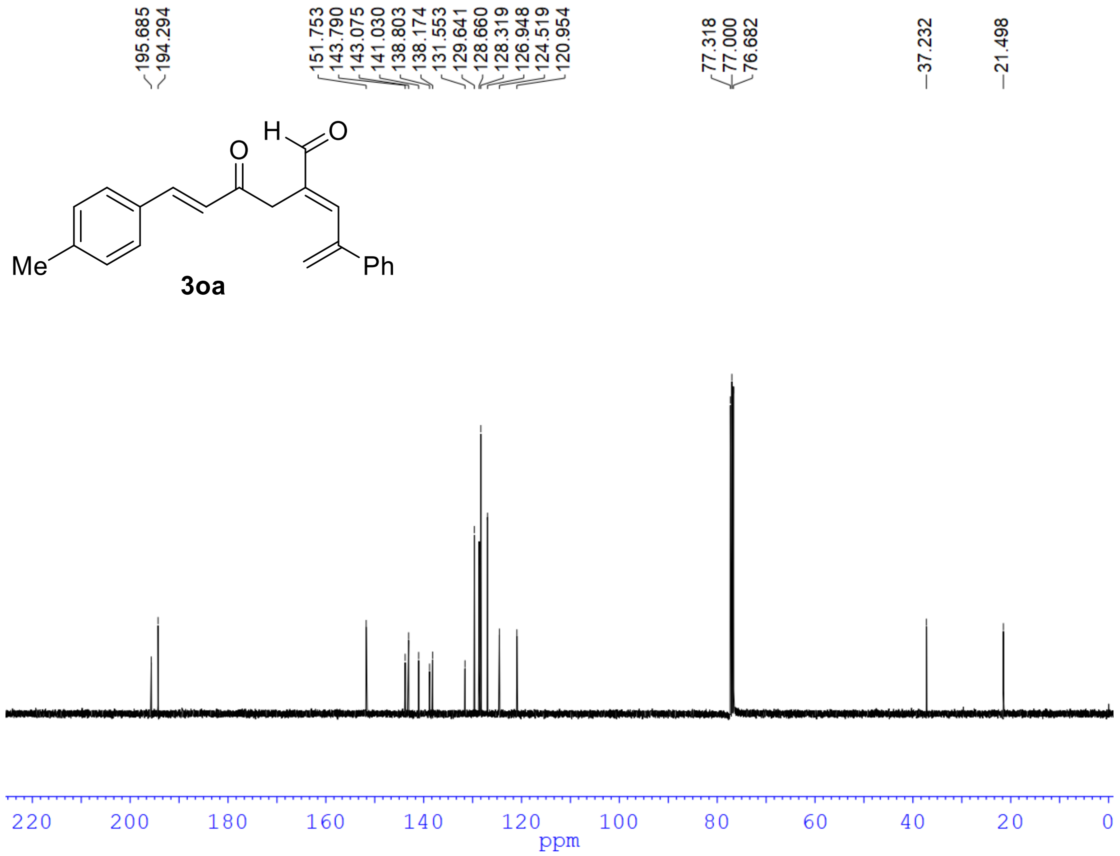

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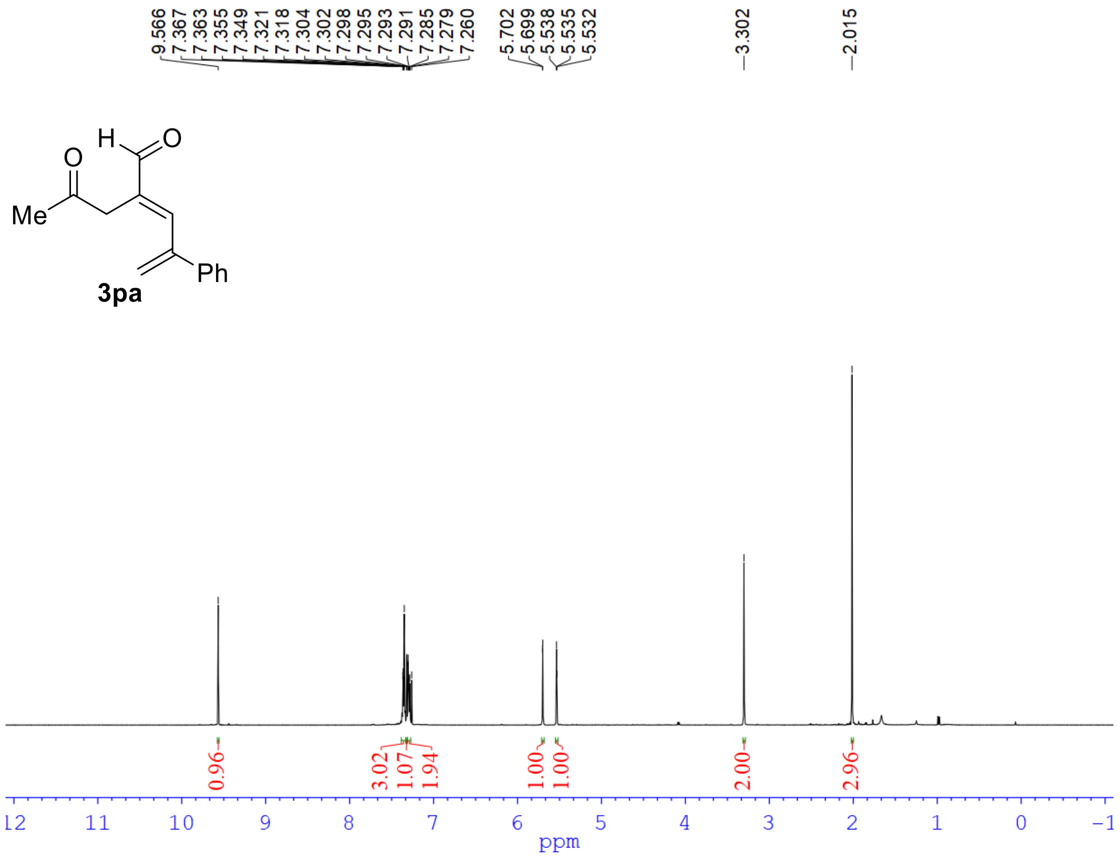
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5.532
3.302
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H
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O
Me
Ph
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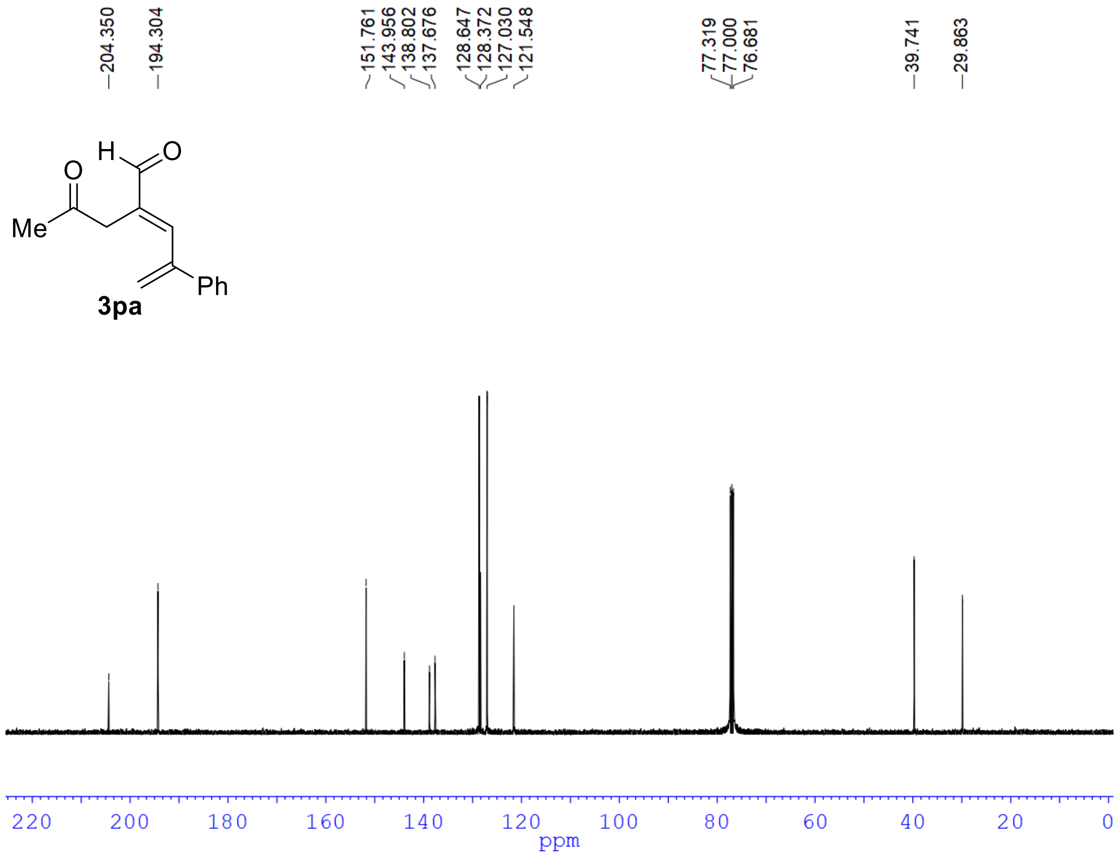
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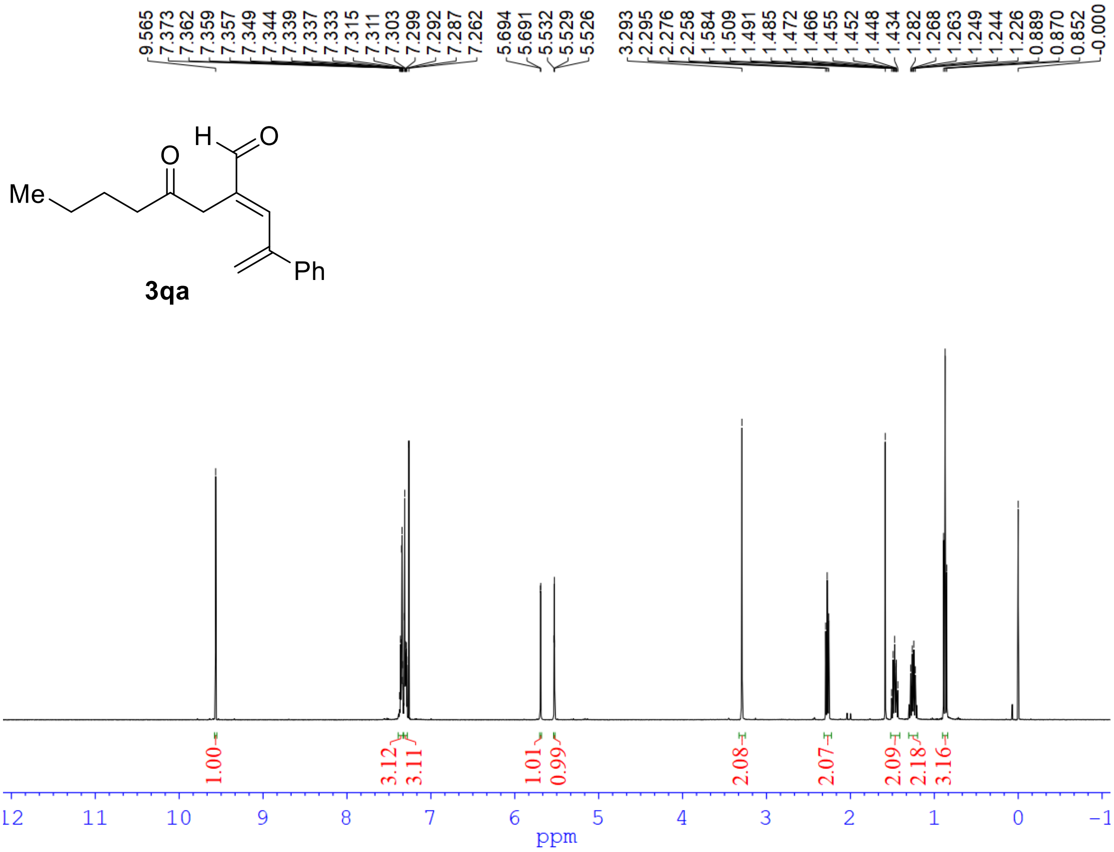
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7.292
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O
Me
Ph
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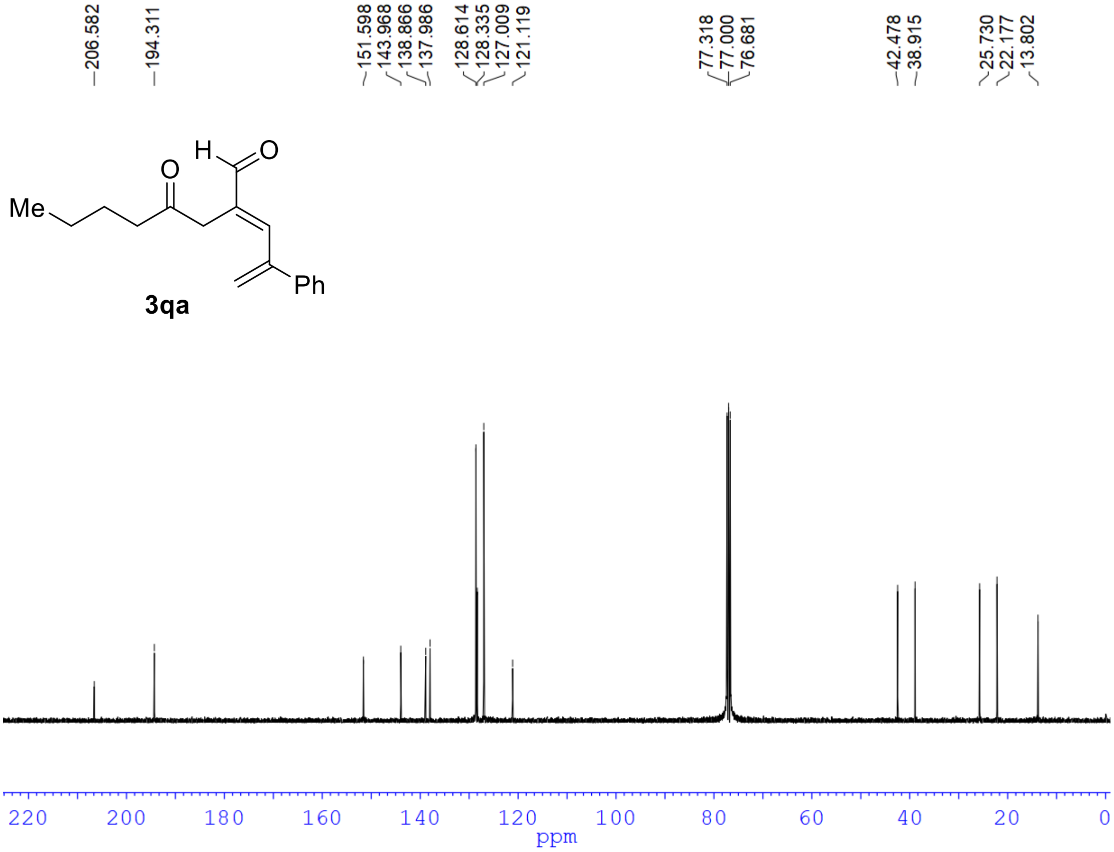
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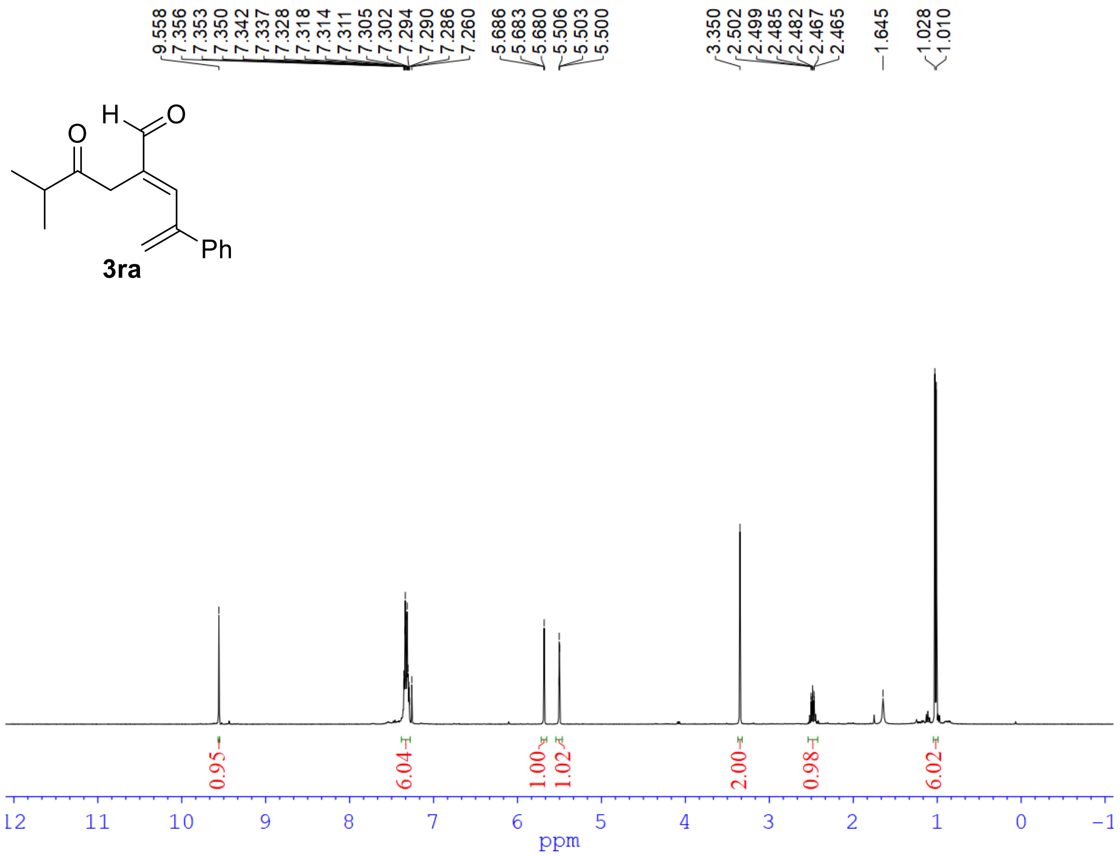
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5.506
5.503
5.500
3.350
2.502
2.499
2.485
2.482
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2.465
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1.028
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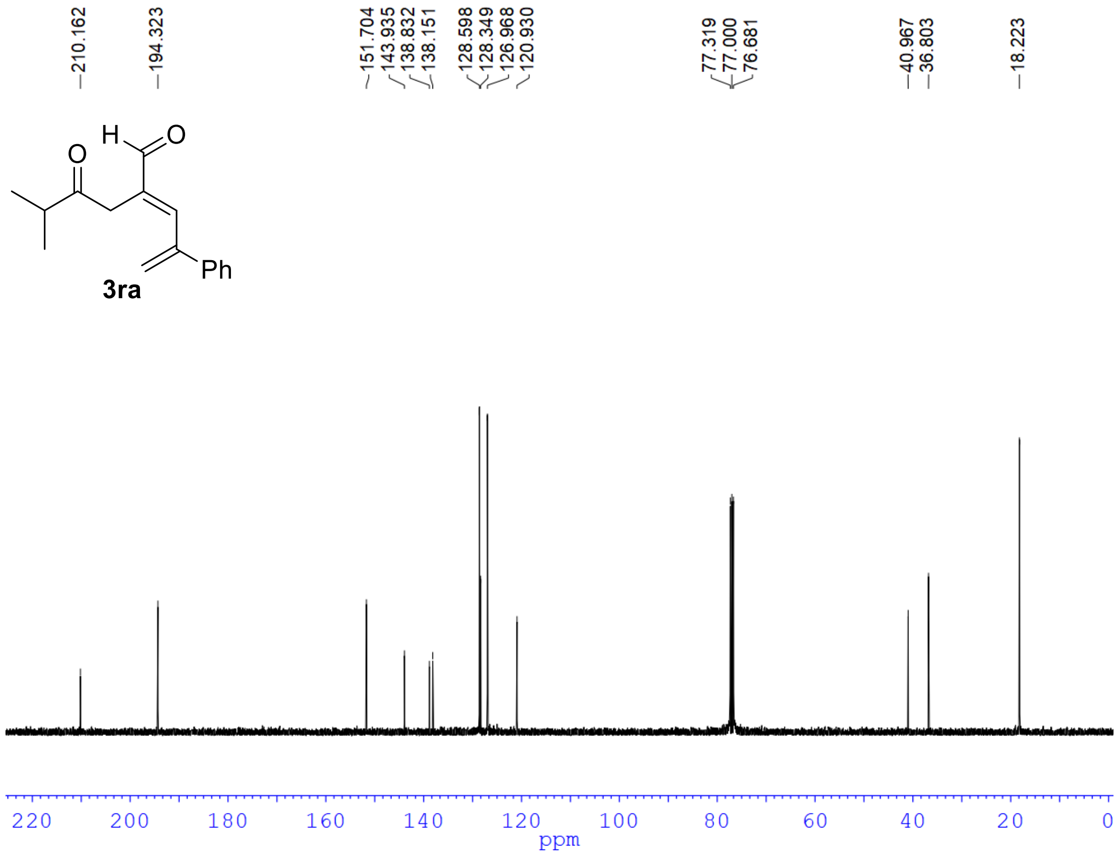
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36.803
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Ph
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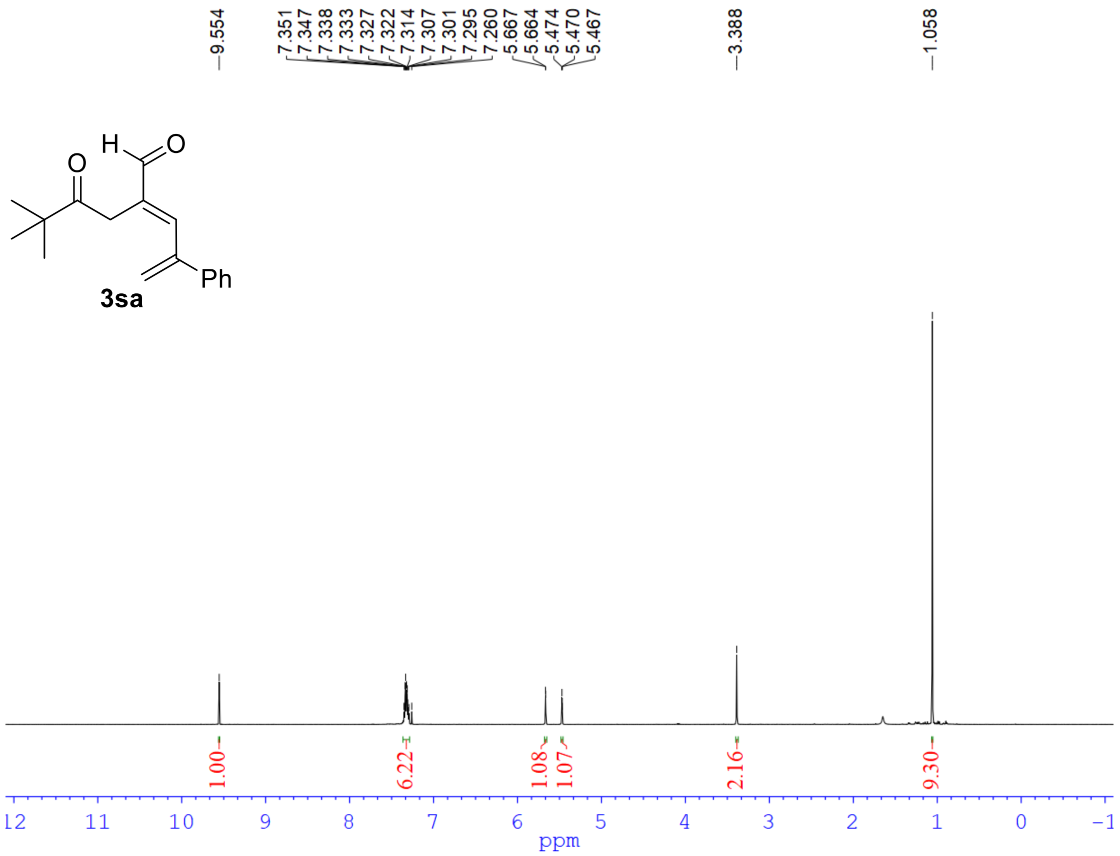
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7.295
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5.664
5.474
5.470
5.467
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O
O
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1.08
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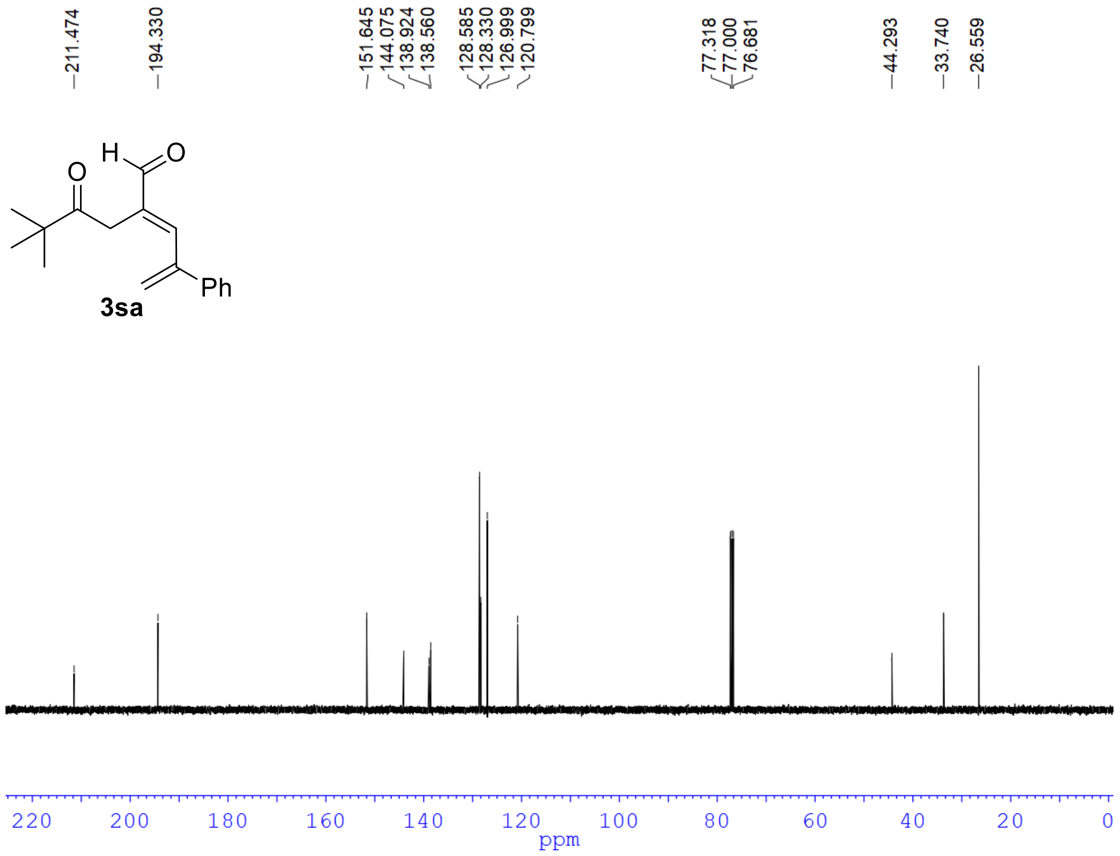
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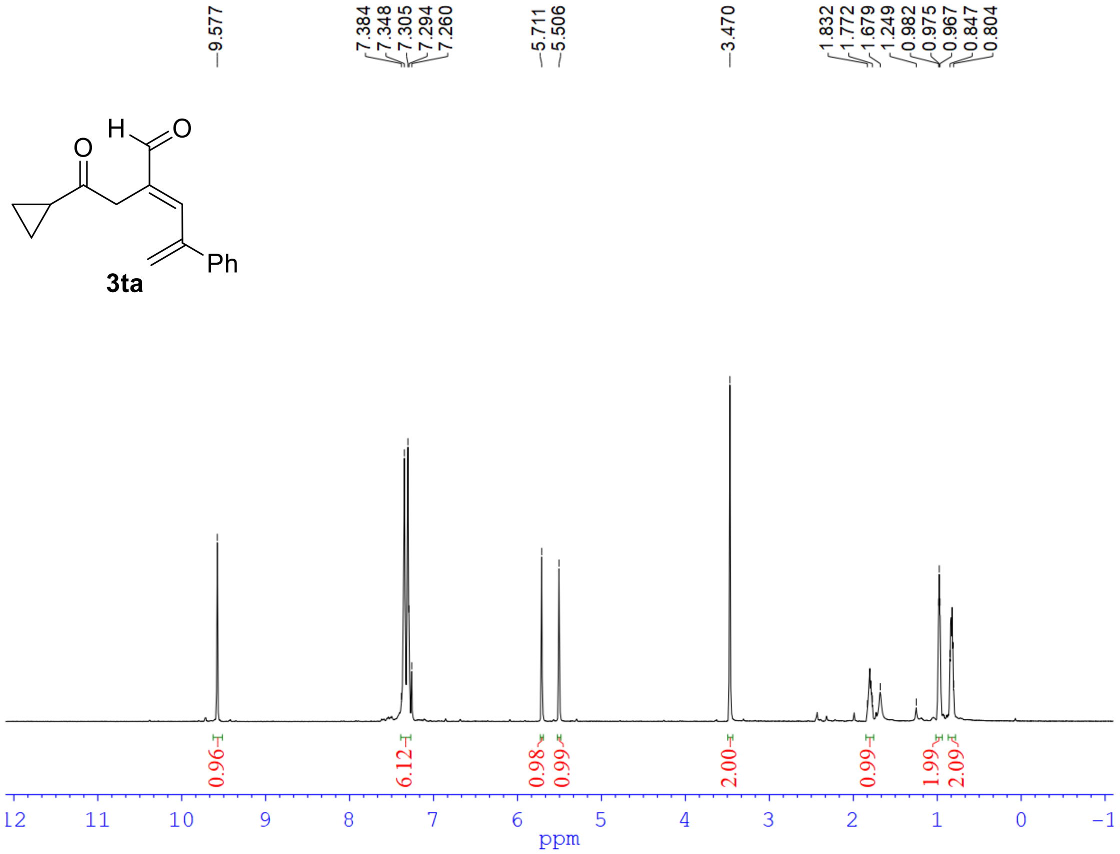
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6.12
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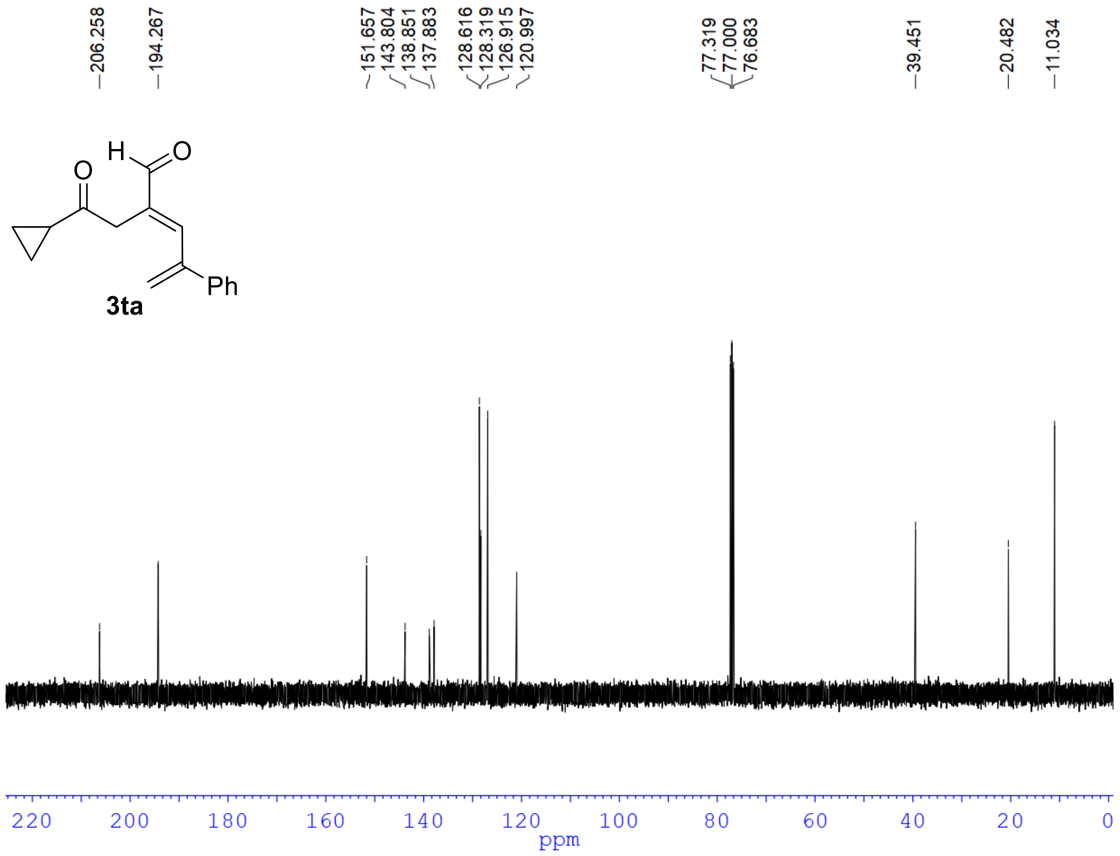
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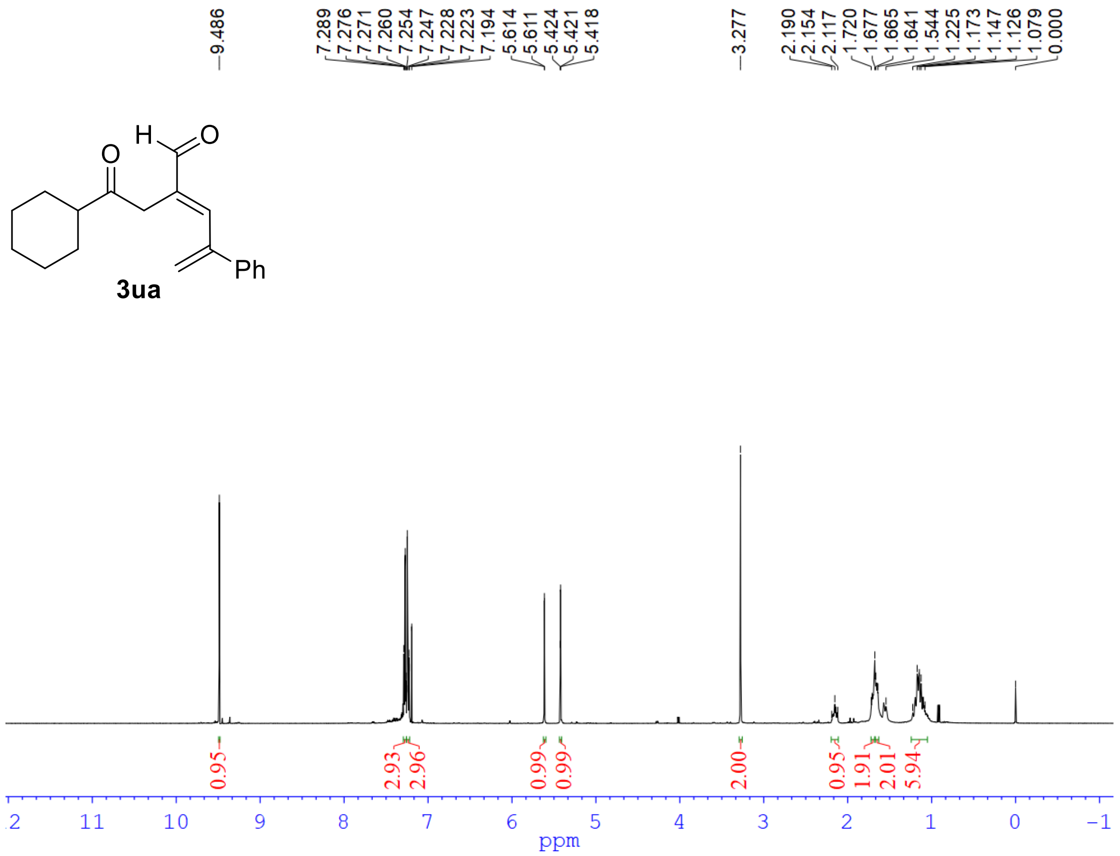
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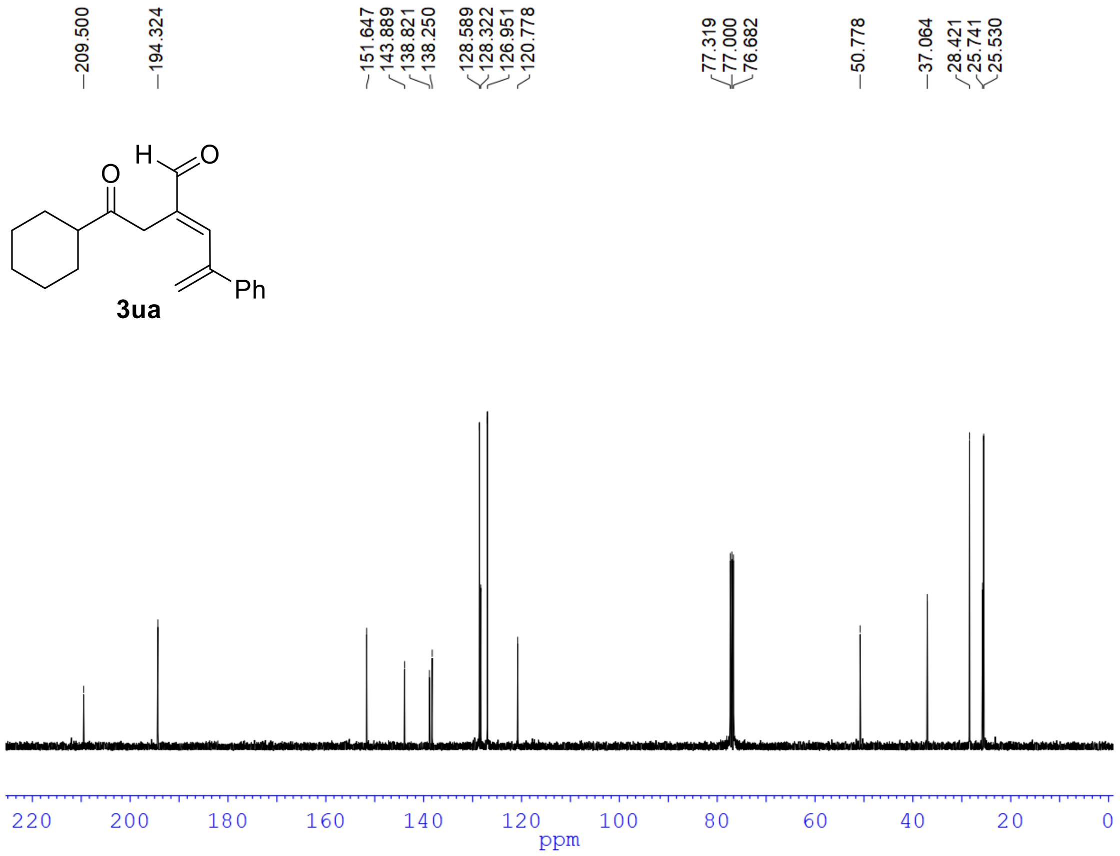
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50.778
37.064
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25.741
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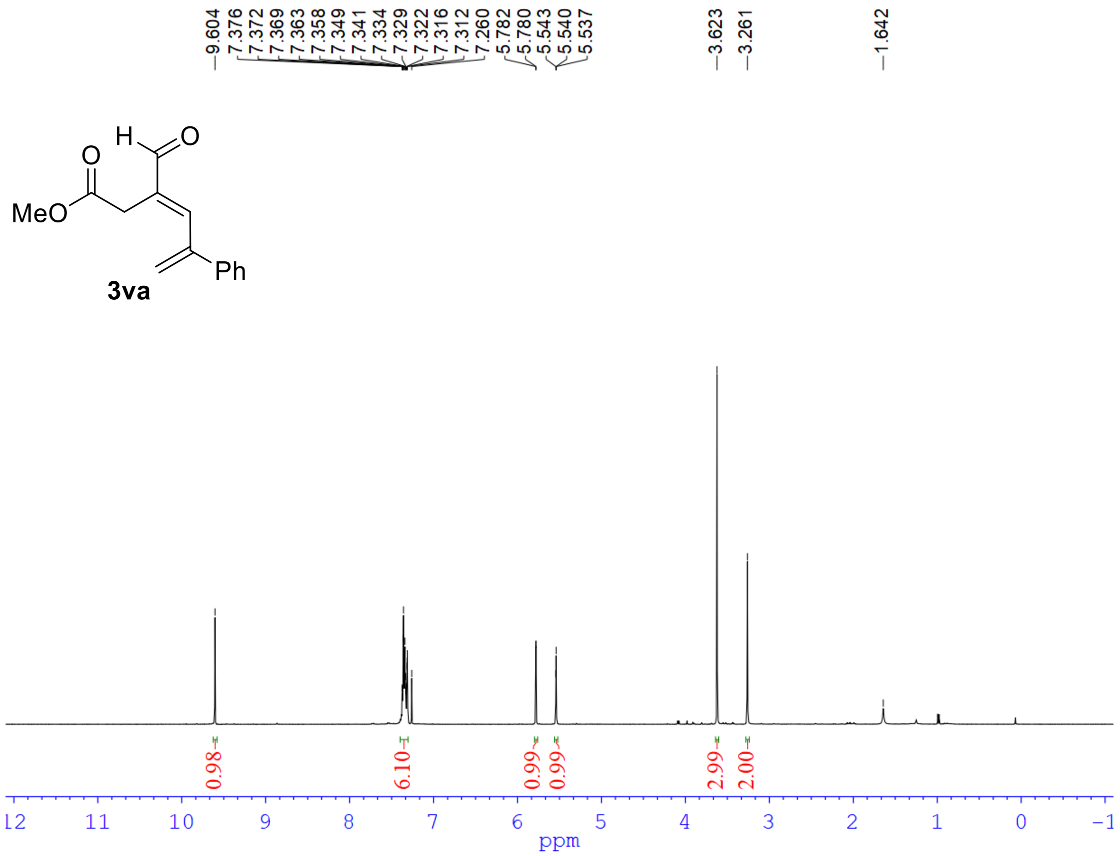
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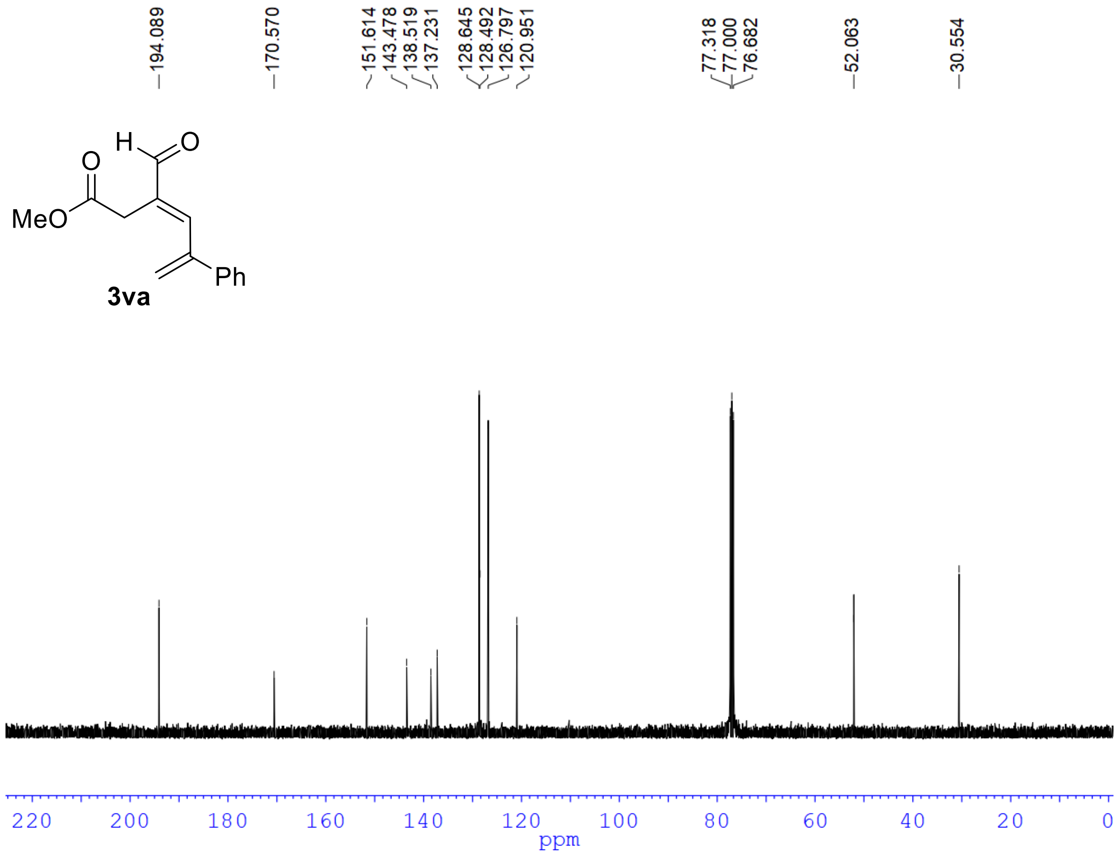
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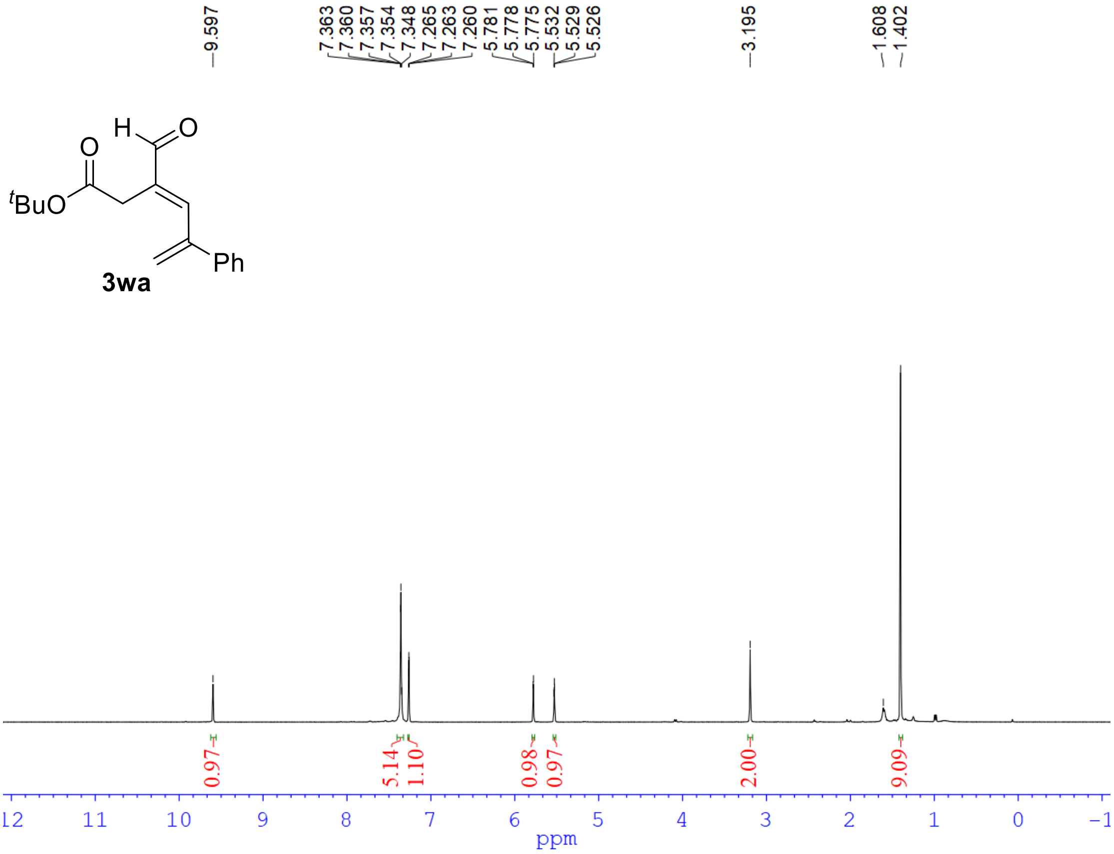
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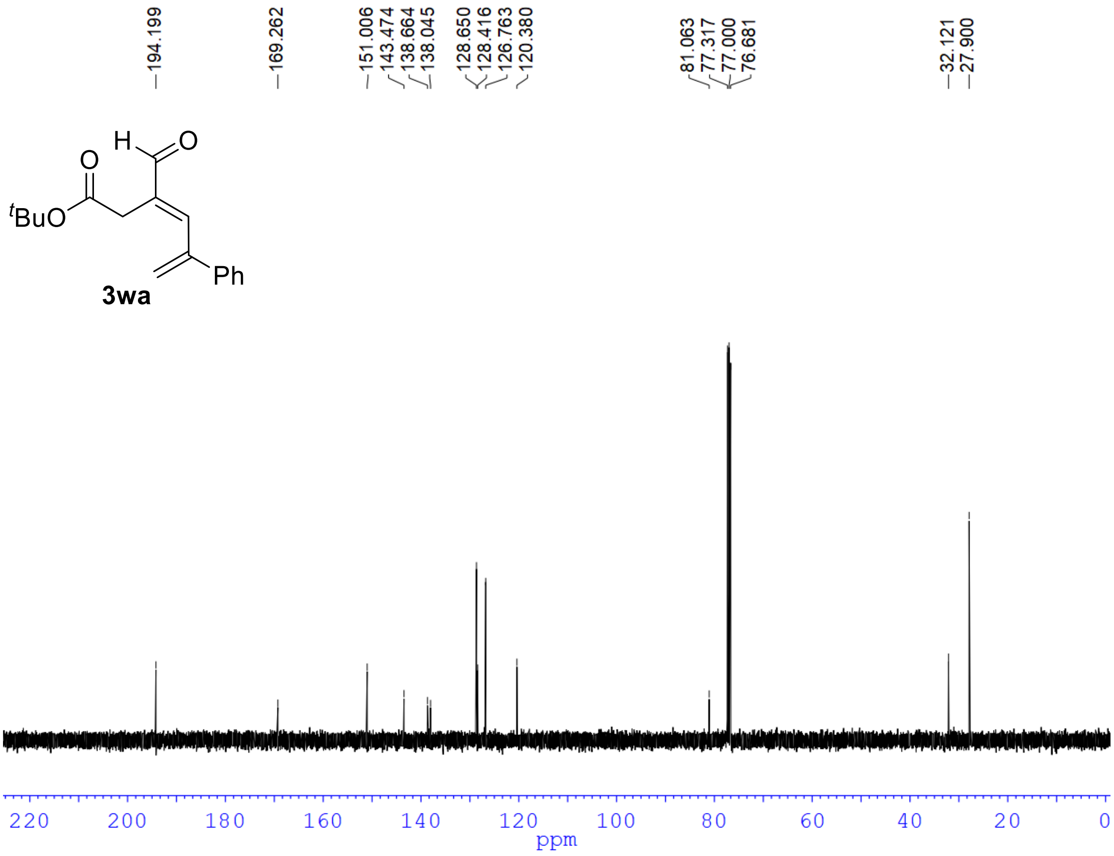
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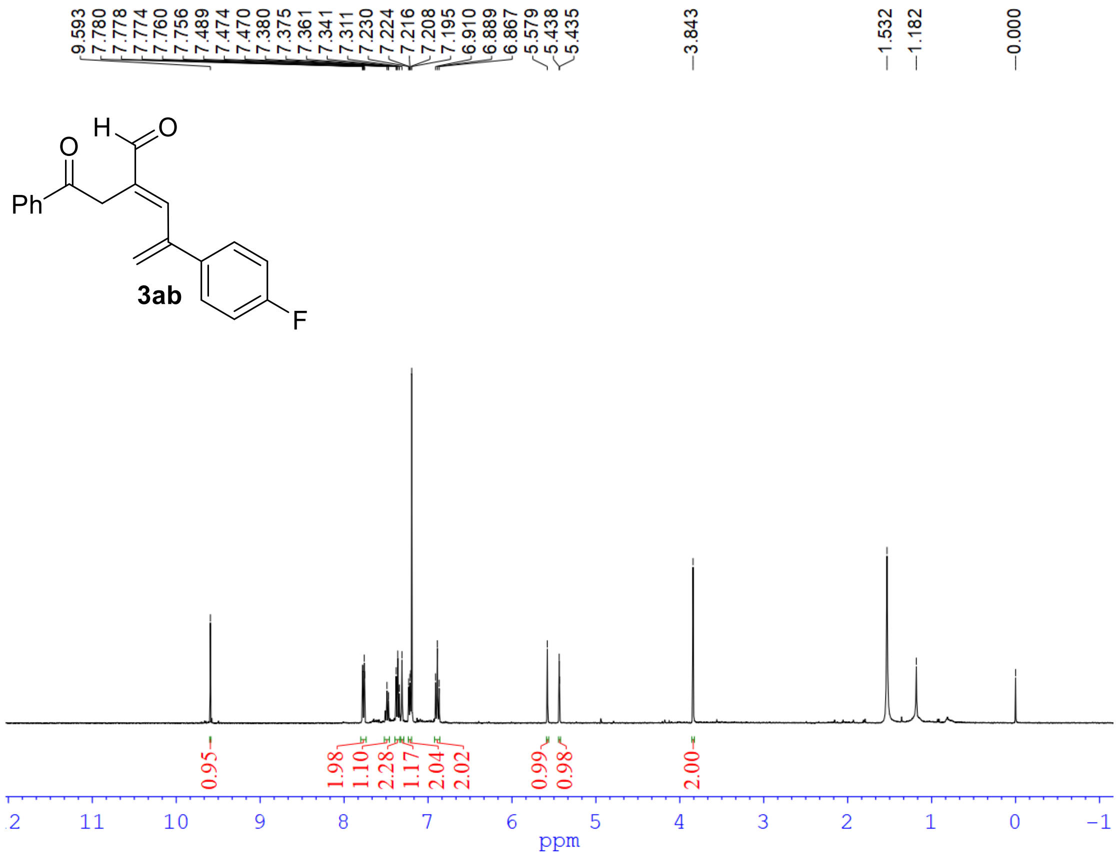
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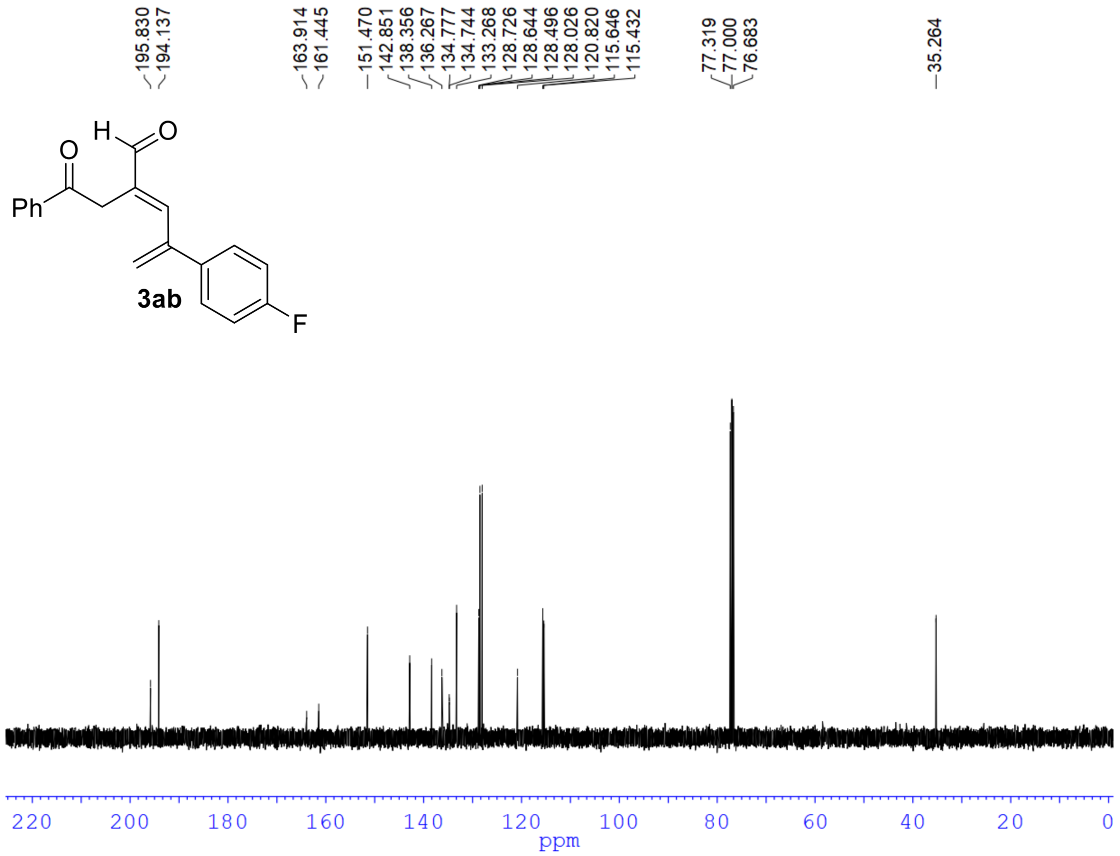
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128.496
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77.319
77.000
76.683
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Ph
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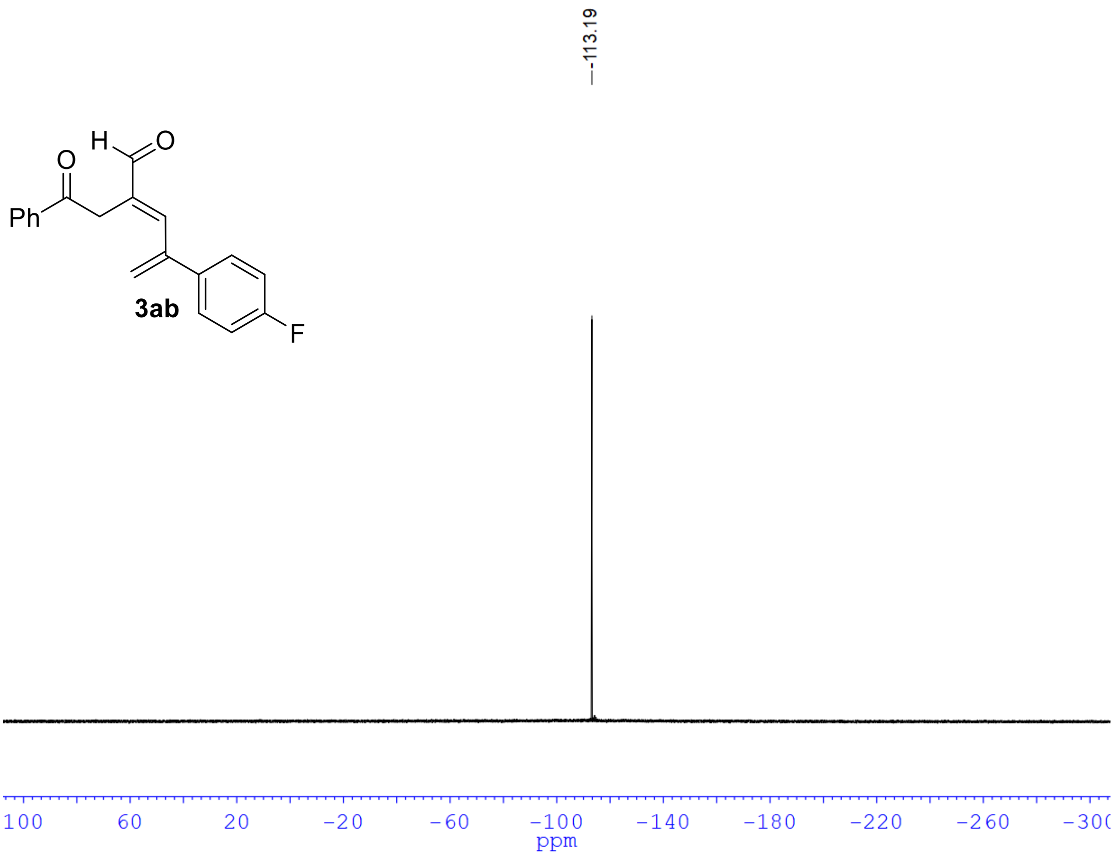
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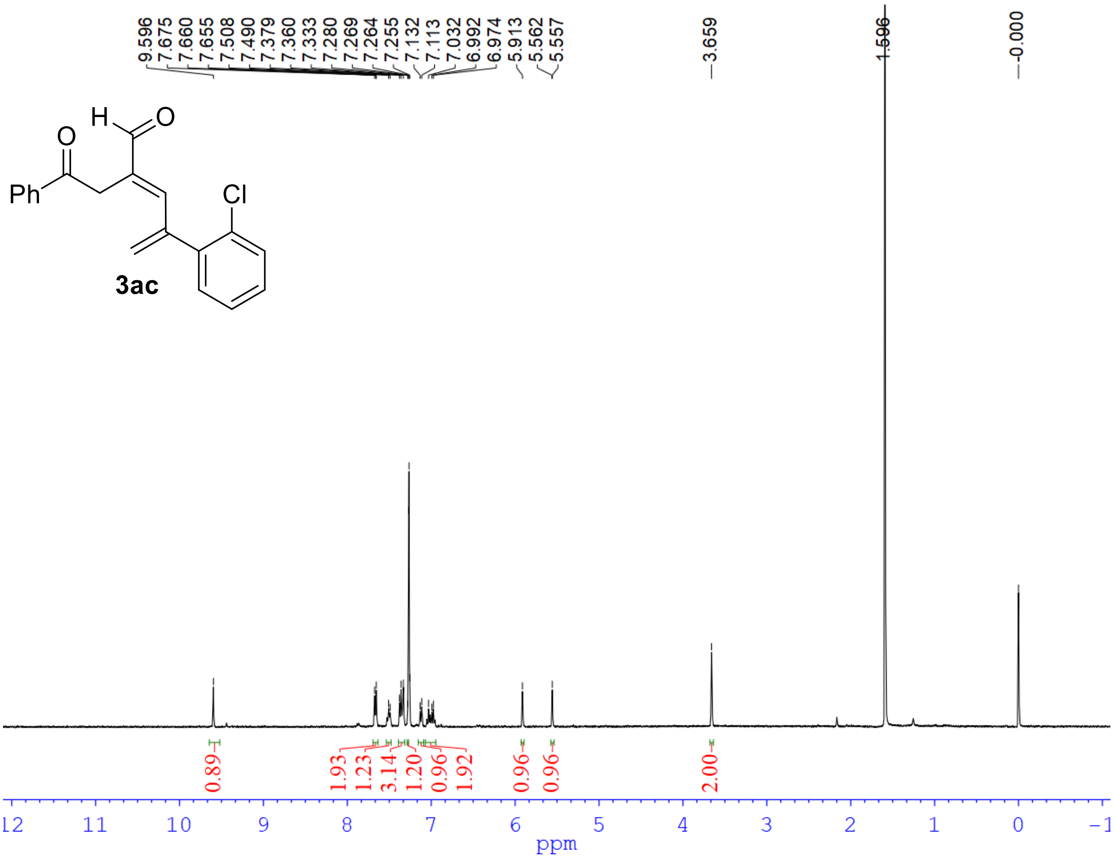
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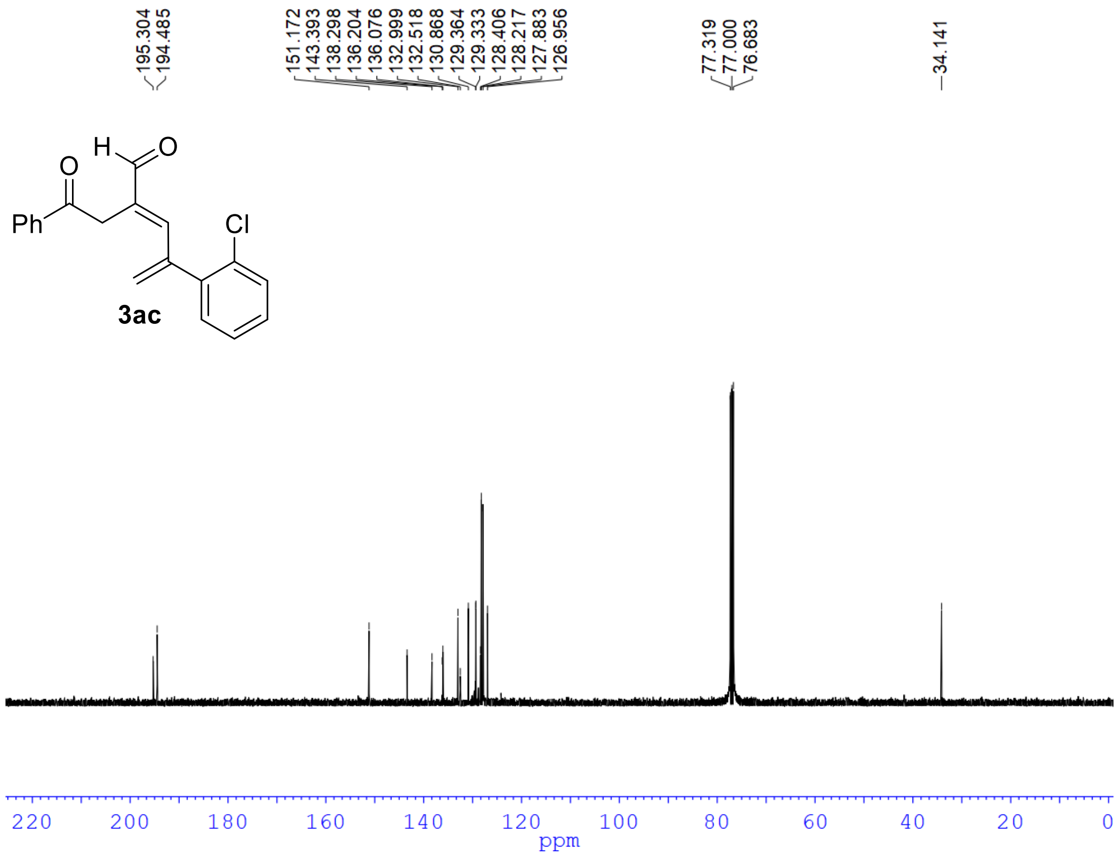
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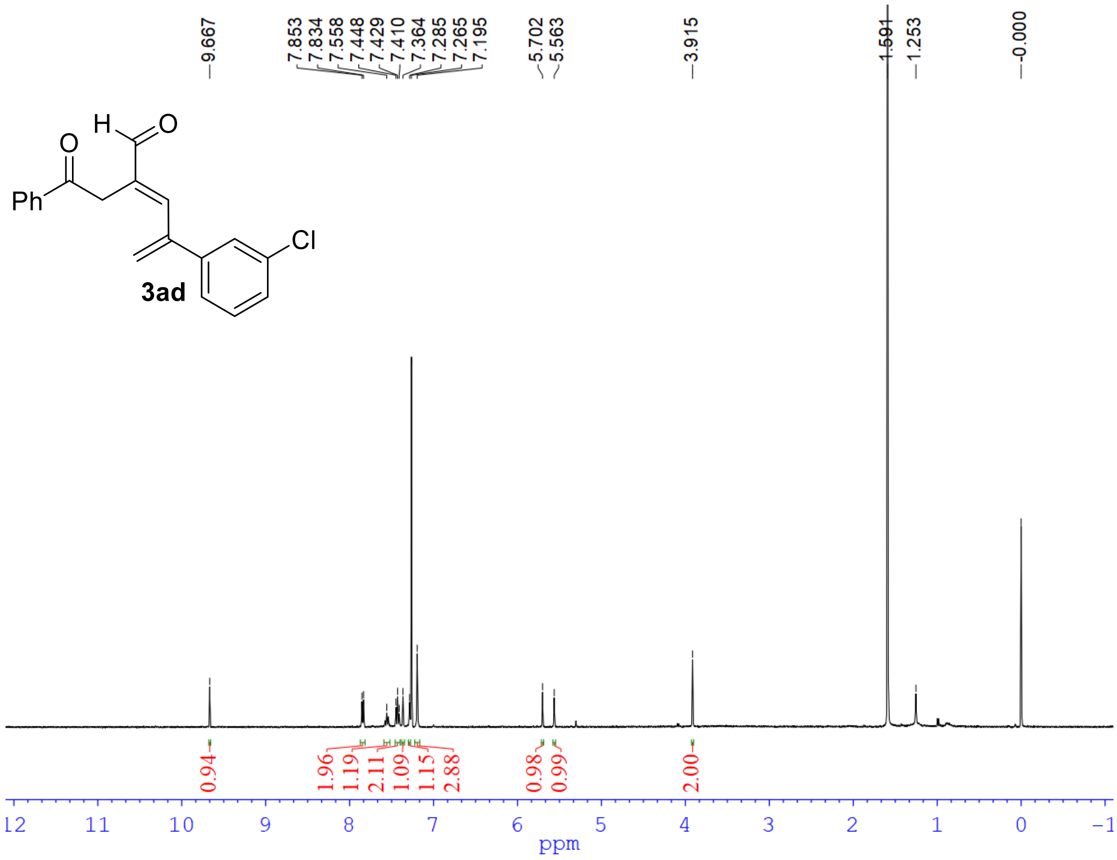
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Ph
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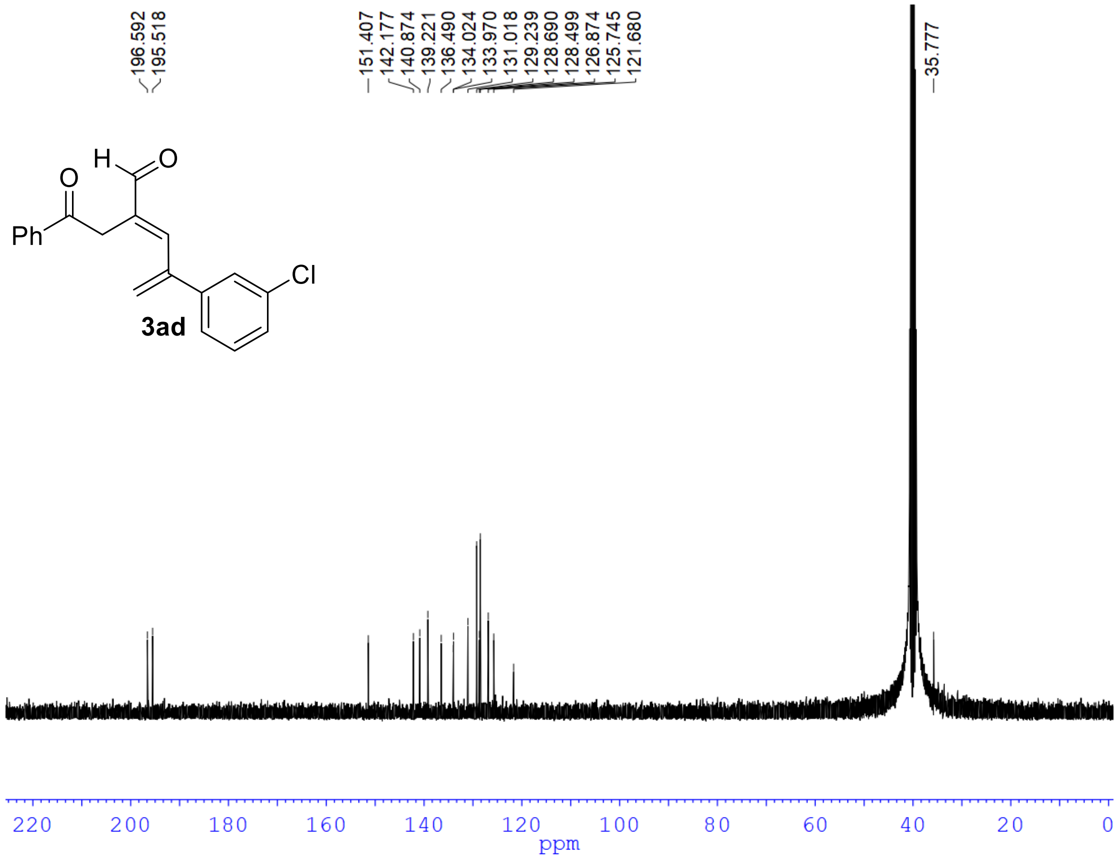
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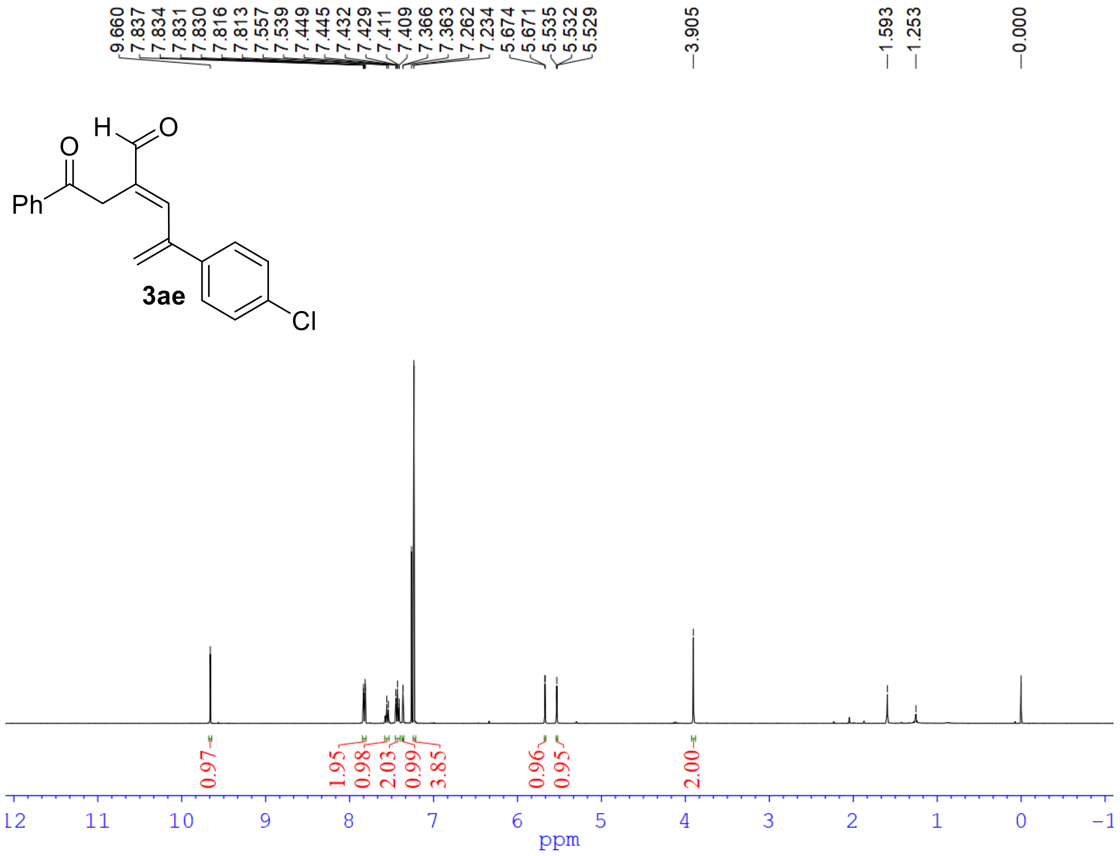
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1.253
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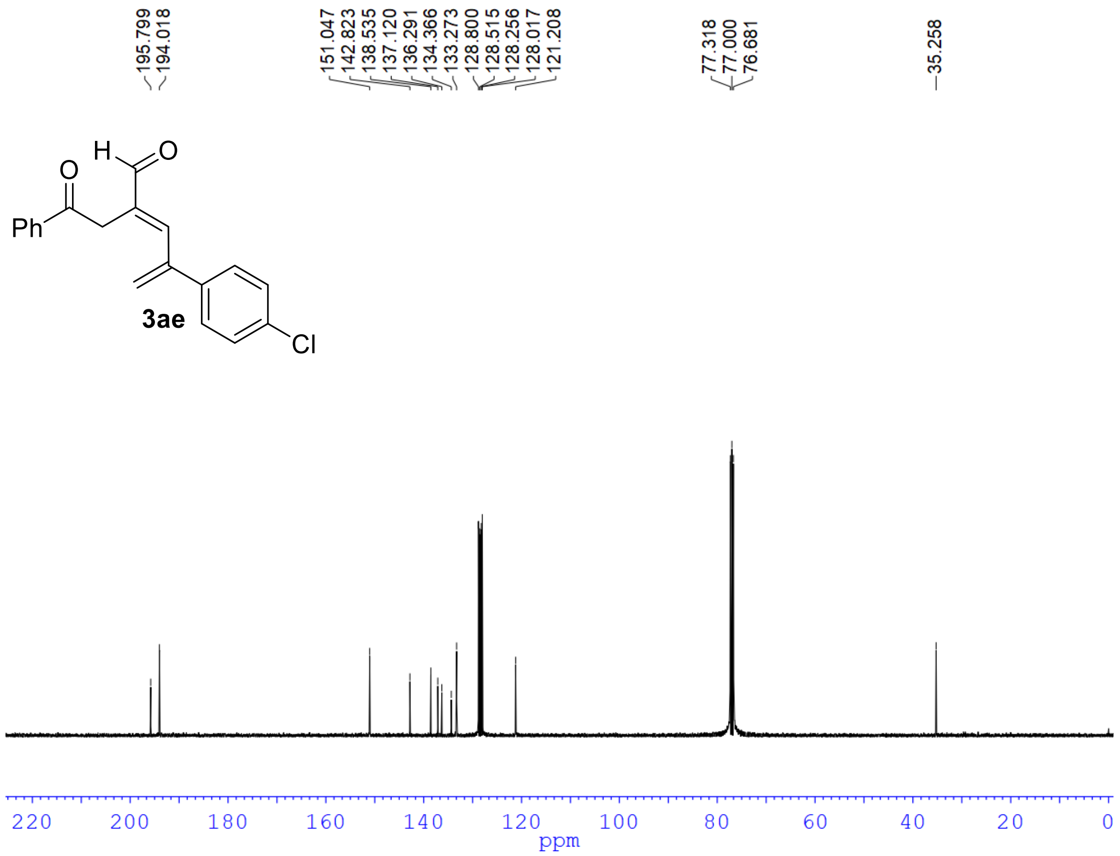
3ae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77.000
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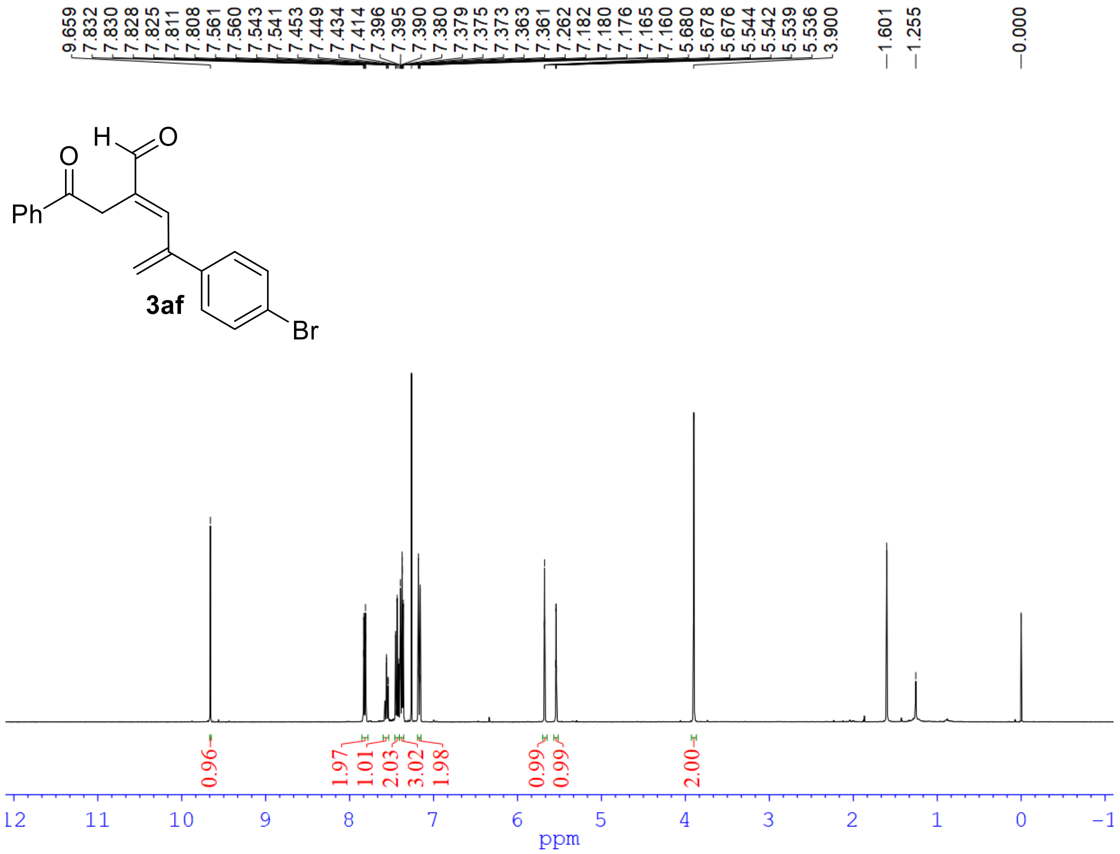
3ae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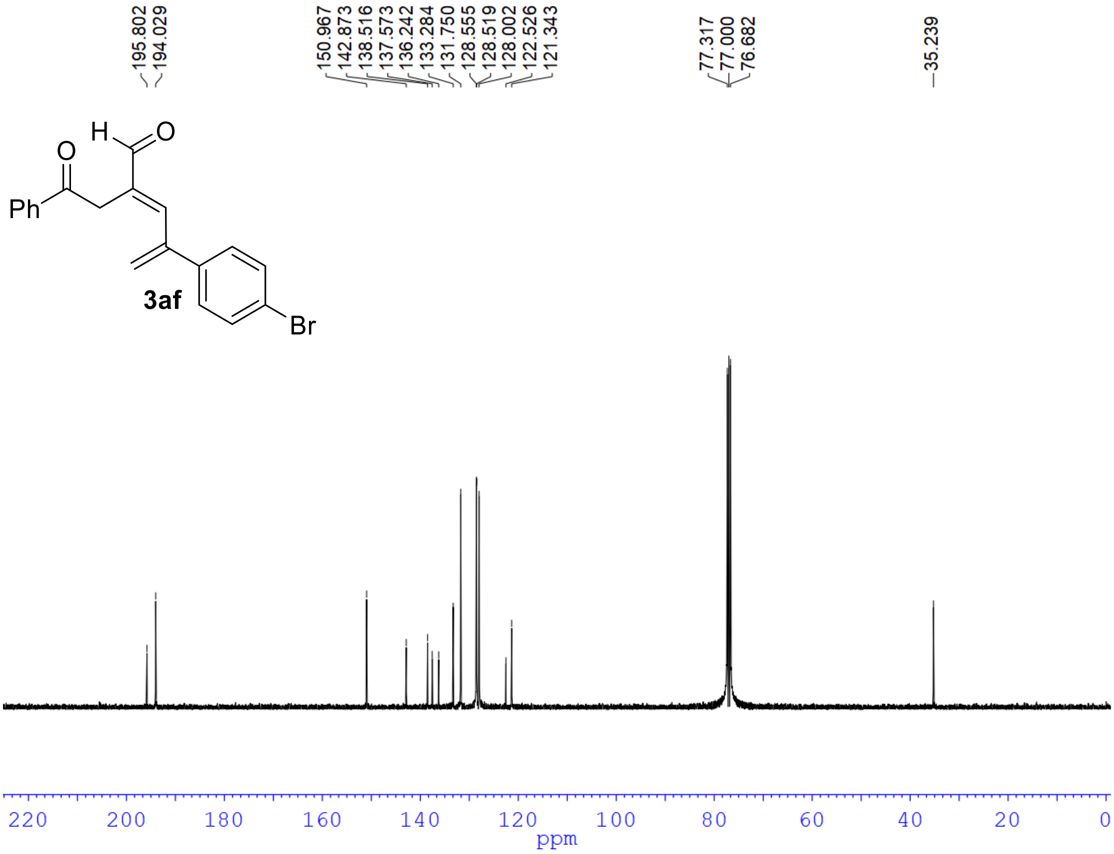
5.542
5.539
5.536
3.900
1.601
1.255
0.000
H
O
O
Ph
Br
0.96
1.97
1.01
2.03
3.02
1.98
0.99
0.99
2.00
12
11
10
9
8
7
6
5
4
3
2
1
0
−1
ppm

3af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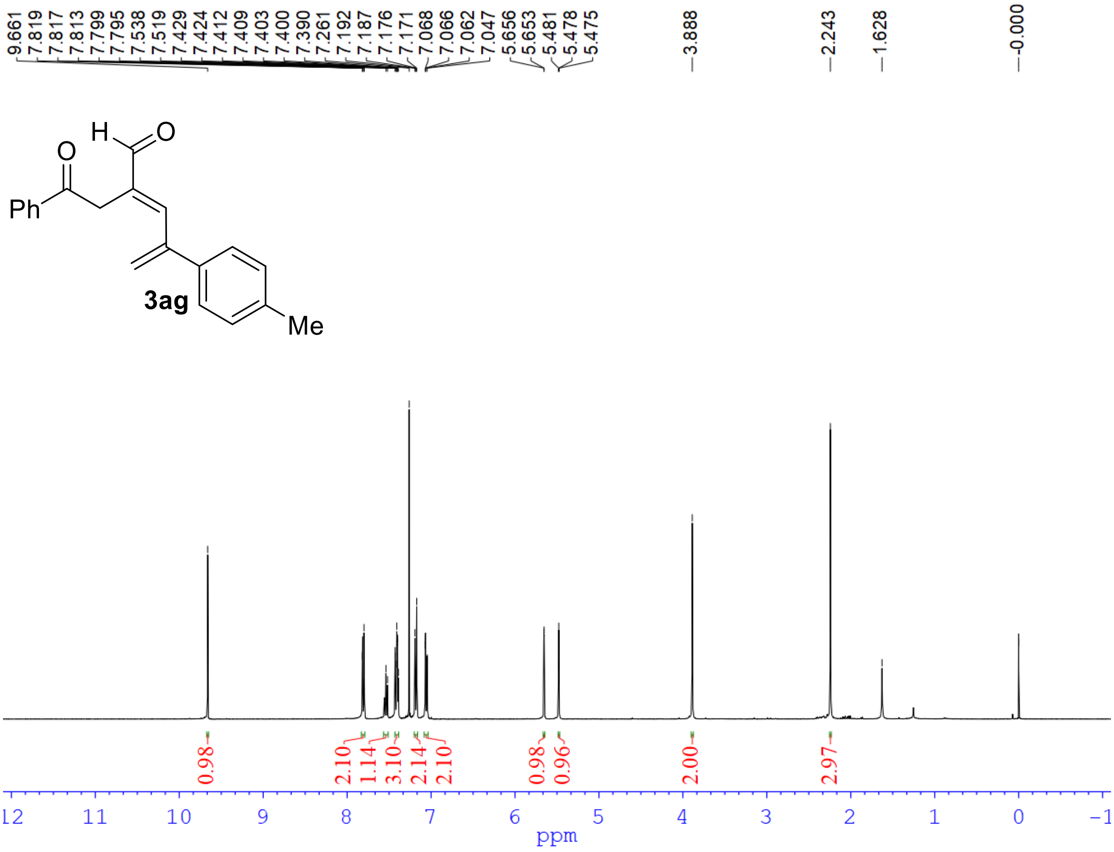
194.029
150.967
142.873
138.516
137.573
136.242
133.284
131.750
128.555
128.519
128.002
122.526
121.343
77.317
77.000
76.682
35.239
H
O
O
Ph
Br
220
200
180
160
140
120
100
80
60
40
20
0
ppm


3ag
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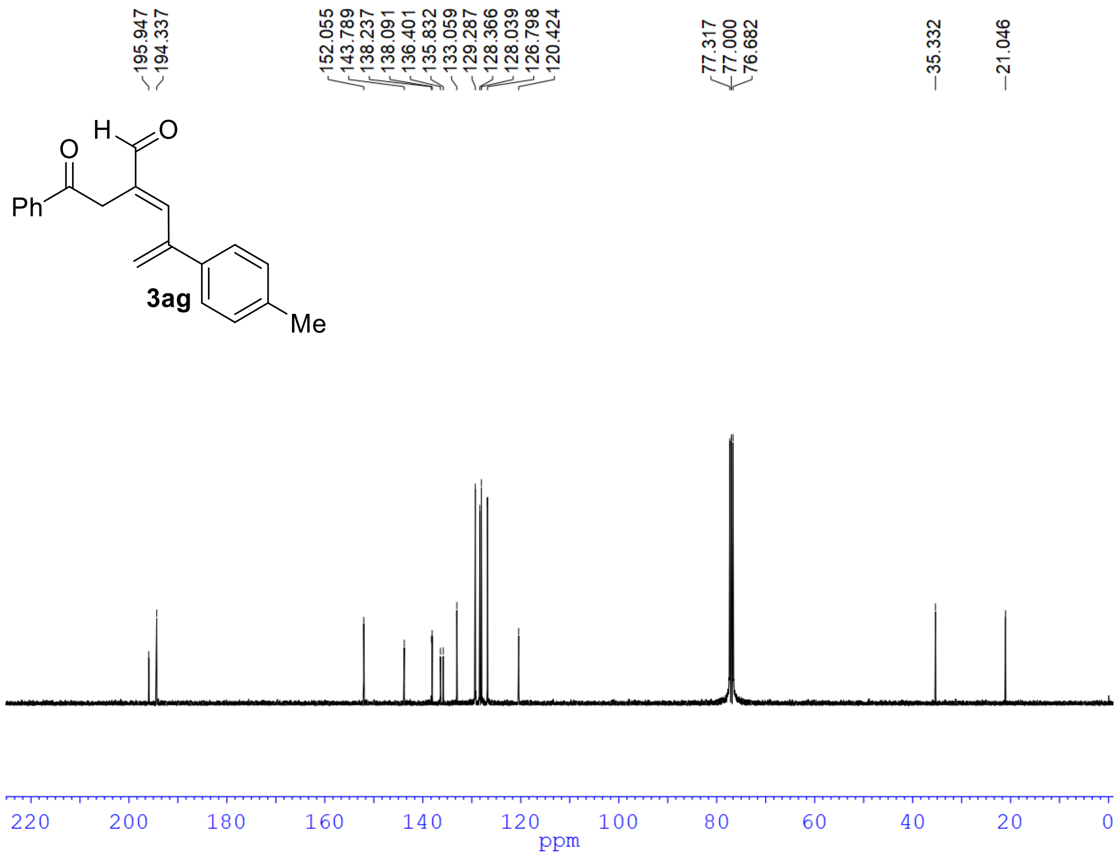
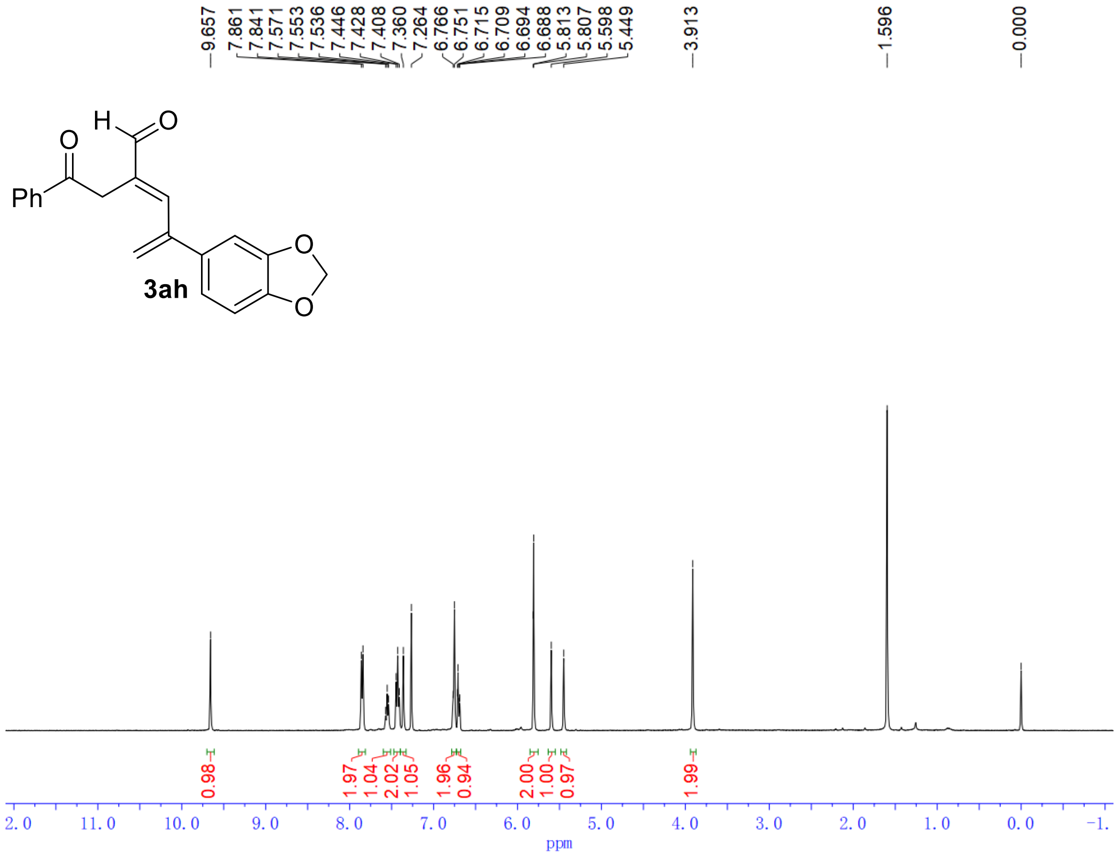
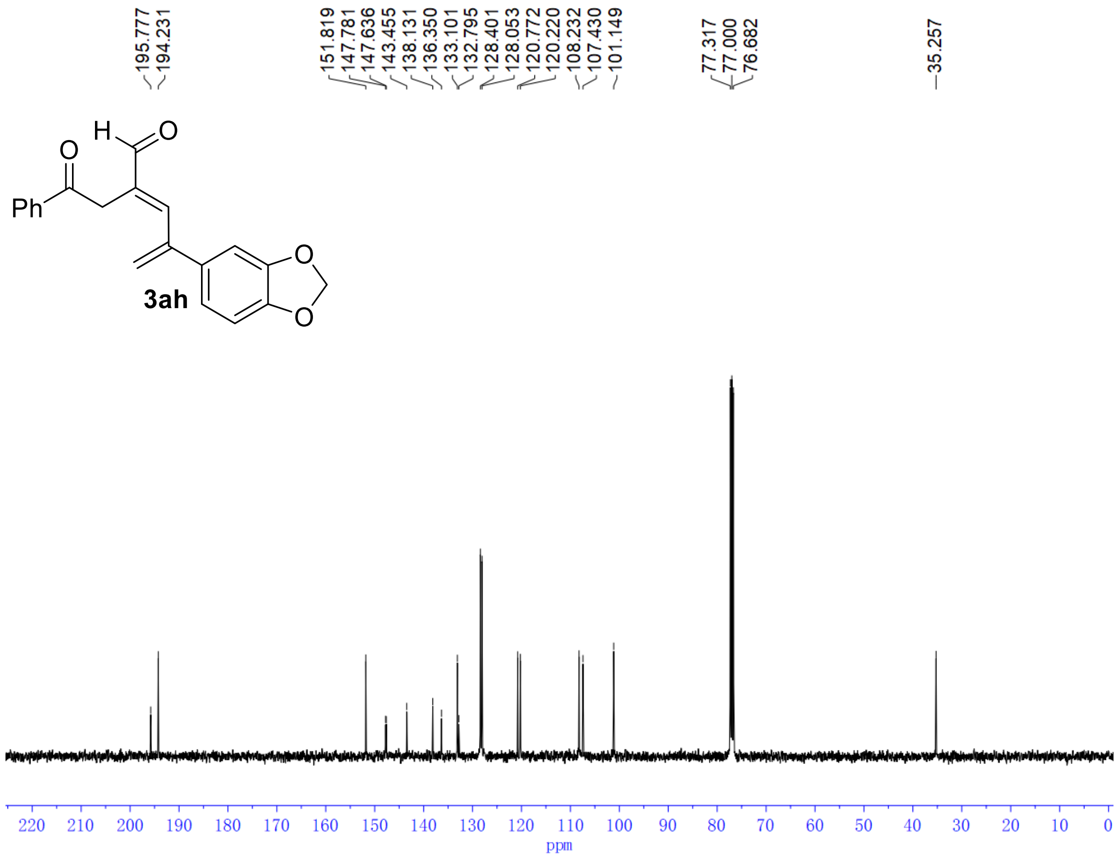
7.819
7.817
7.813
7.799
7.795
7.538
7.519
7.429
7.424
7.412
7.409
7.403
7.400
7.390
7.261
7.192
7.187
7.176
7.171
7.068
7.066
7.062
7.047
5.656
5.653
5.481
5.478
5.475
3.888
2.243
1.628
-0.000
H
O
O
Ph
Me
0.98
2.10
1.14
3.10
2.14
2.10
0.98
0.96
2.00
2.97
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

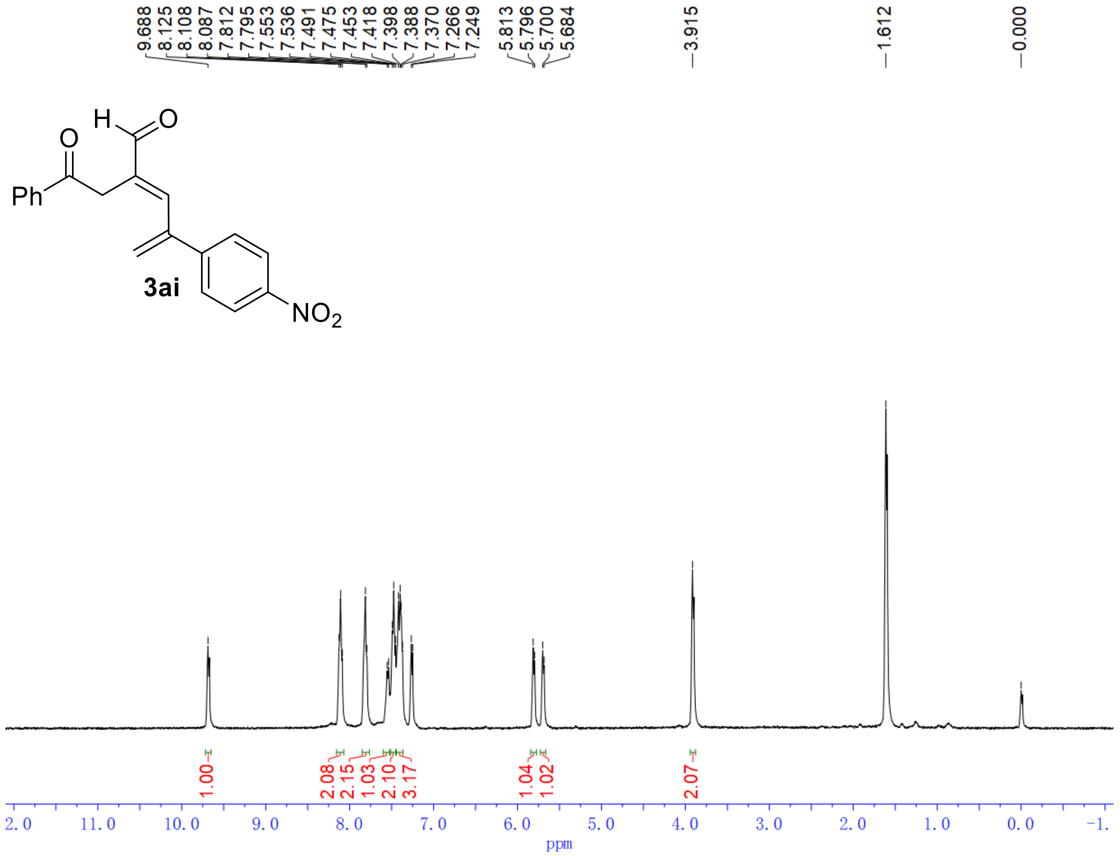

195.947
194.337
152.055
143.789
138.237
138.091
136.401
135.832
133.059
129.287
128.366
128.039
126.798
120.424
77.317
77.000
76.682
35.332
21.046
H
O
O
Ph
Me
3ag
220
200
180
160
140
120
100
80
60
40
20
0
ppm


9.657
7.861
7.841
7.571
7.553
7.536
7.446
7.428
7.408
7.360
7.264
6.766
6.751
6.715
6.709
6.694
6.688
5.813
5.807
5.598
5.449
3.913
1.596
0.000
H
O
O
Ph
O
O
3ah
0.98
1.97
1.04
2.02
1.05
1.96
0.94
2.00
1.00
0.97
1.99
2.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.
ppm



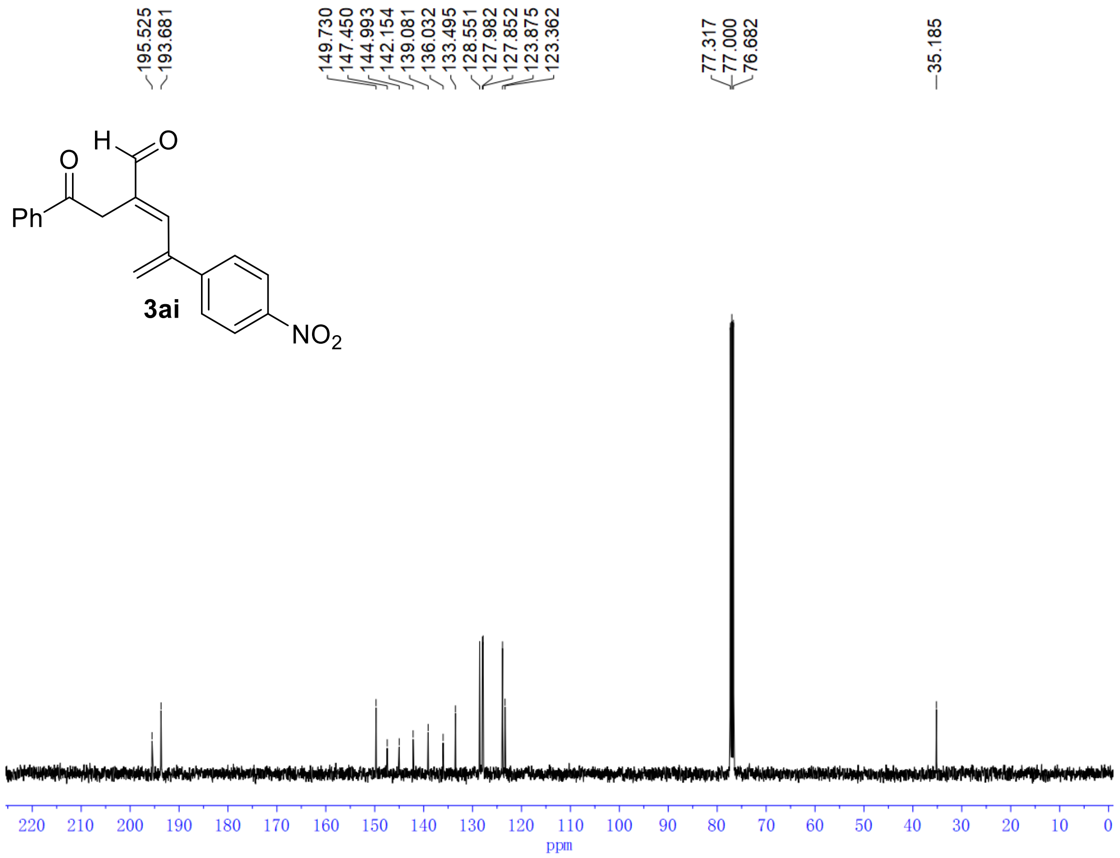
3ah

195.777
194.231
151.819
147.781
147.636
143.455
138.131
136.350
133.101
132.795
128.401
128.053
120.772
120.220
108.232
107.430
101.149
77.317
77.000
76.682
35.257
H
O
O
Ph
O
O
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
ppm

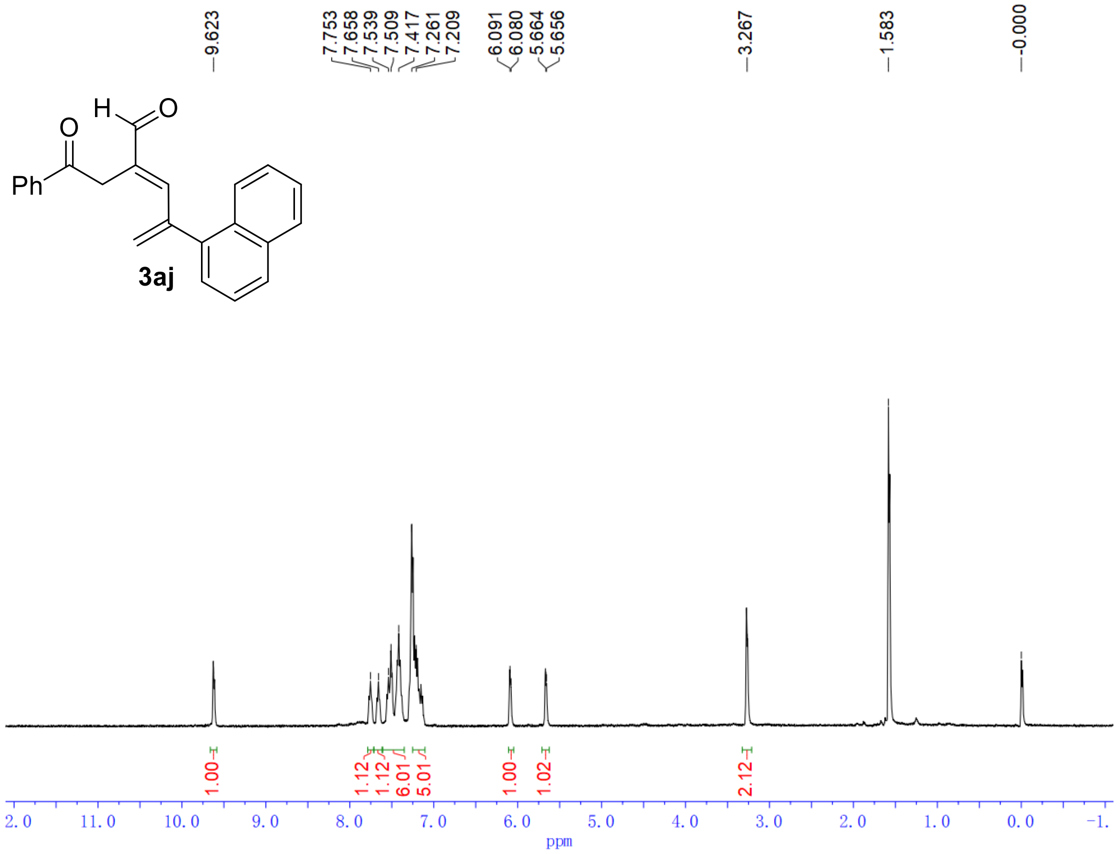


3ai

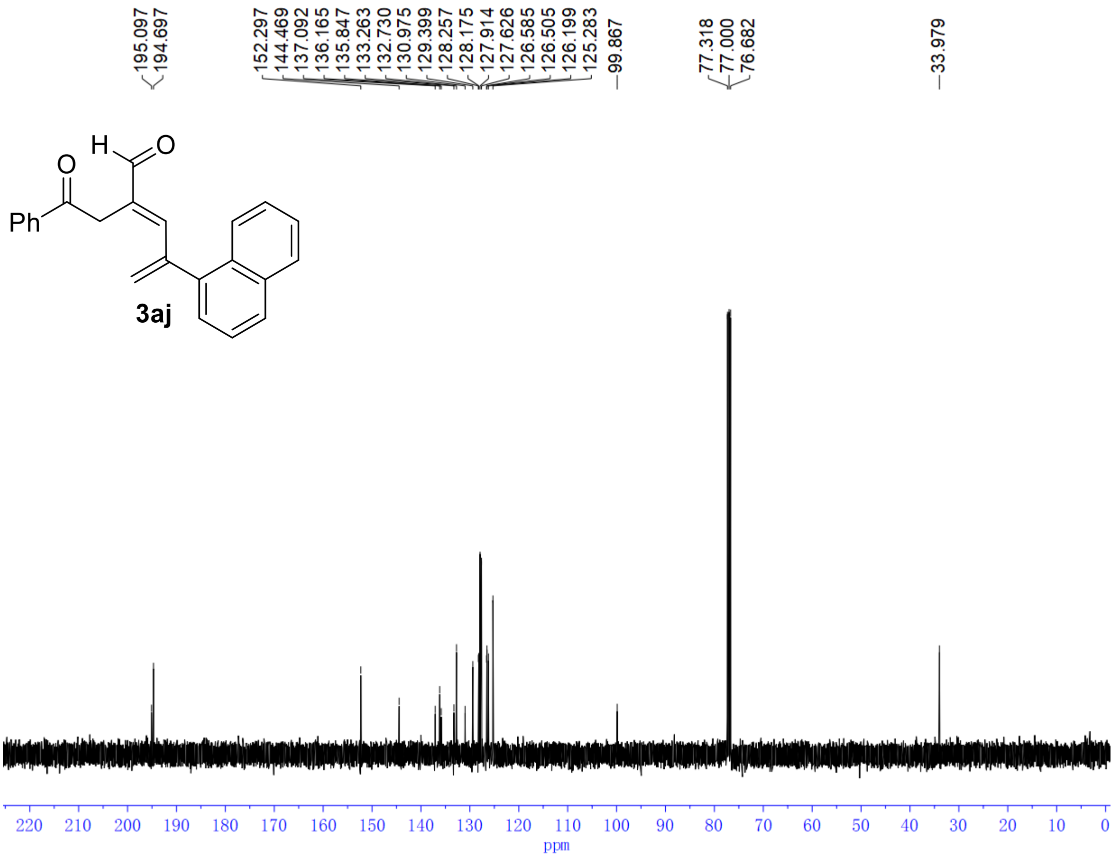
9.688
8.125
8.108
8.087
7.812
7.795
7.553
7.536
7.491
7.475
7.453
7.418
7.398
7.388
7.370
7.266
7.249
5.813
5.796
5.700
5.684
3.915
1.612
0.000
H
O
O
Ph
NO2
1.00
2.08
2.15
1.03
2.10
3.17
1.04
1.02
2.07
2.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.
ppm


195.525
193.681
149.730
147.450
144.993
142.154
139.081
136.032
133.495
128.551
127.982
127.852
123.875
123.362
77.317
77.000
76.682
35.185
H
O
O
Ph
NO$_2$
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
ppm

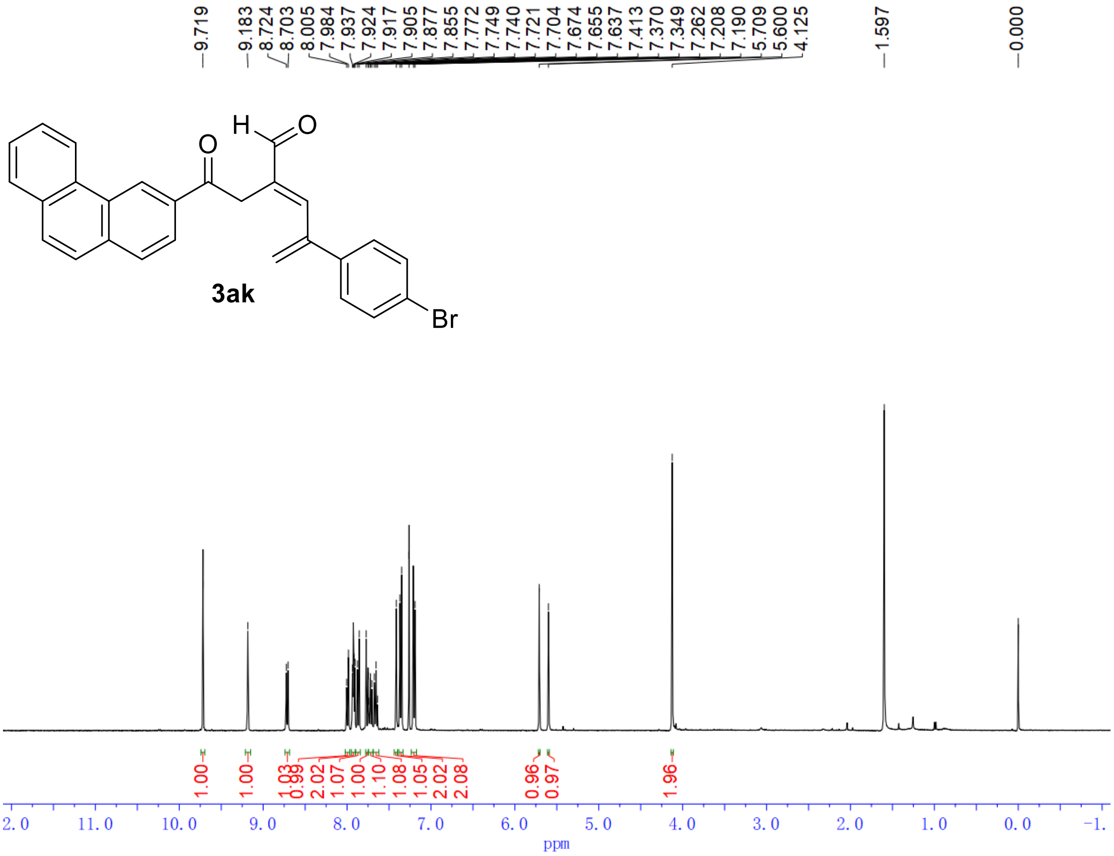
3ai


9.623
7.753
7.658
7.539
7.509
7.417
7.261
7.209
6.091
6.080
5.664
5.656
3.267
1.583
-0.000
H
O
O
Ph
1.00
1.12
1.12
6.01
5.01
1.00
1.02
2.12
2.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.
ppm

3aj


195.097
194.697
152.297
144.469
137.092
136.165
135.847
133.263
132.730
130.975
129.399
128.257
128.175
127.914
127.626
126.585
126.505
126.199
125.283
99.867
77.318
77.000
76.682
33.979
H
O
O
Ph
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

3aj


9.719
9.183
8.724
8.703
8.005
7.984
7.937
7.924
7.917
7.905
7.877
7.855
7.772
7.749
7.740
7.721
7.704
7.674
7.655
7.637
7.413
7.370
7.349
7.262
7.208
7.190
5.709
5.600
4.125
1.597
0.000
H
O
O
Br
1.00
1.00
1.03
0.99
2.02
1.07
1.00
1.10
1.08
1.05
2.02
2.08
0.96
0.97
1.96
2.0
11.0
10.0
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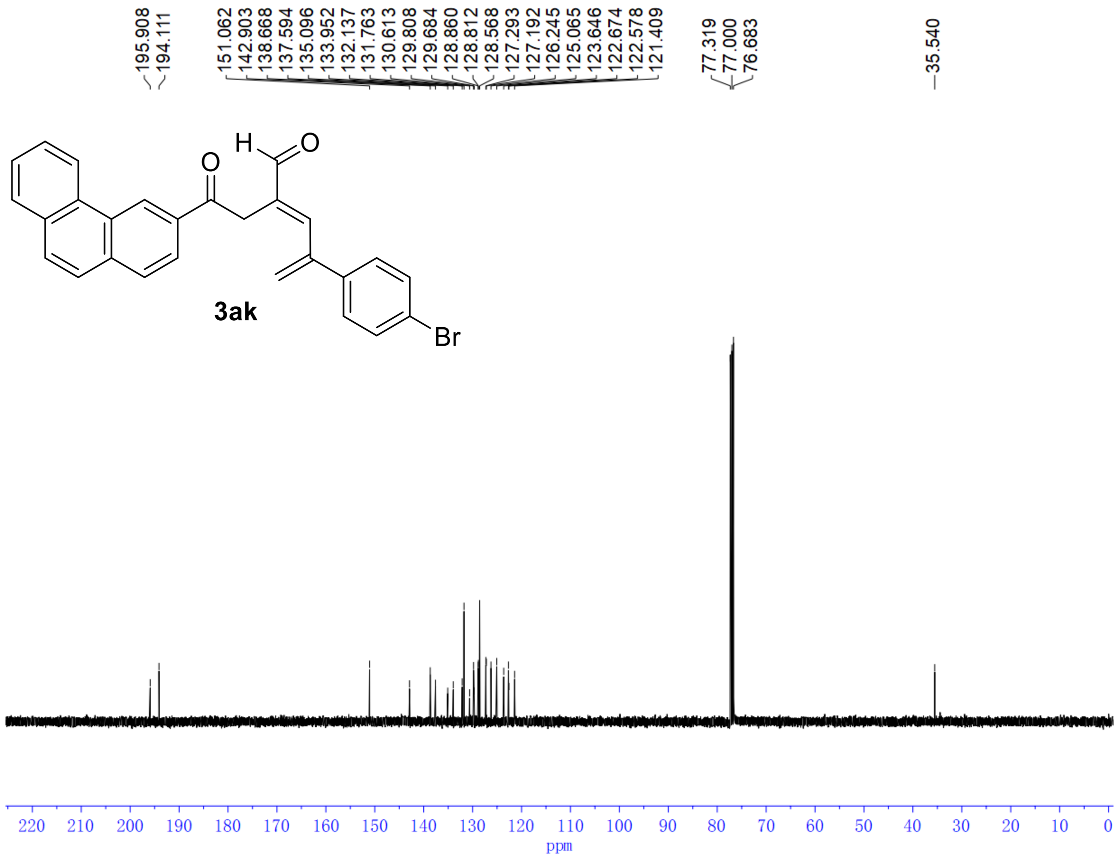
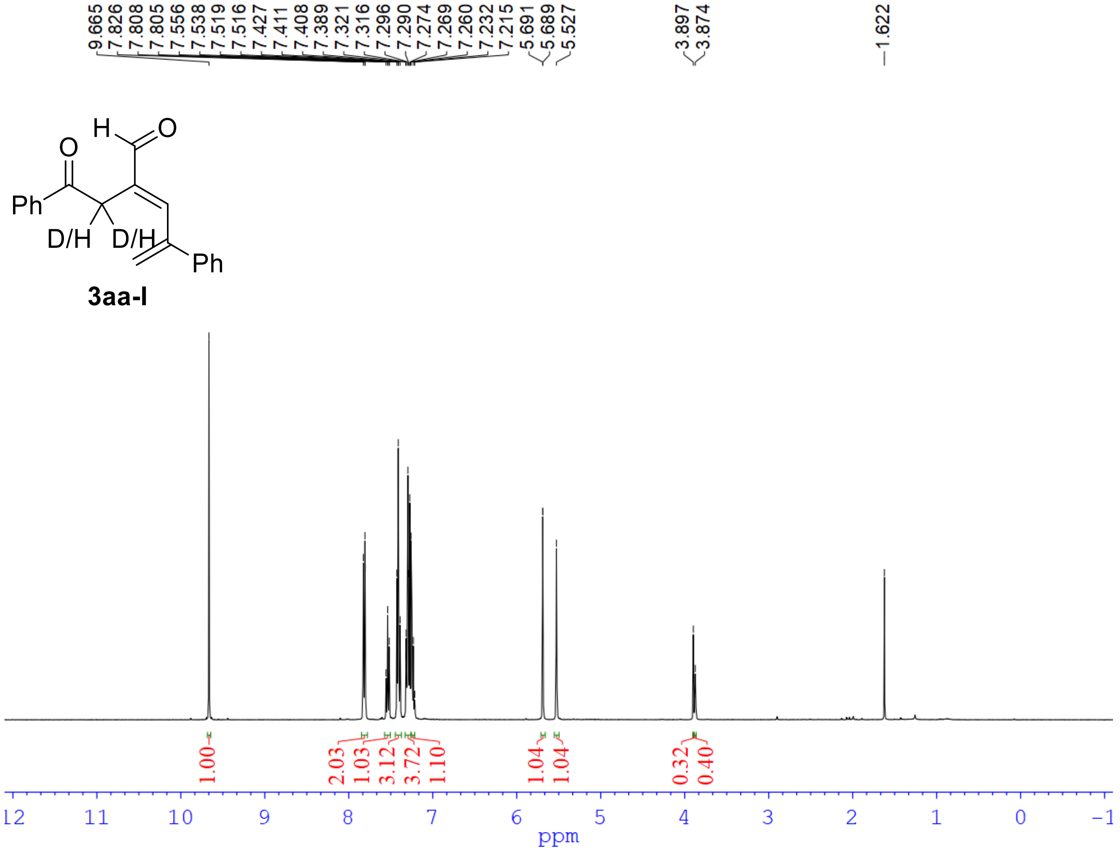
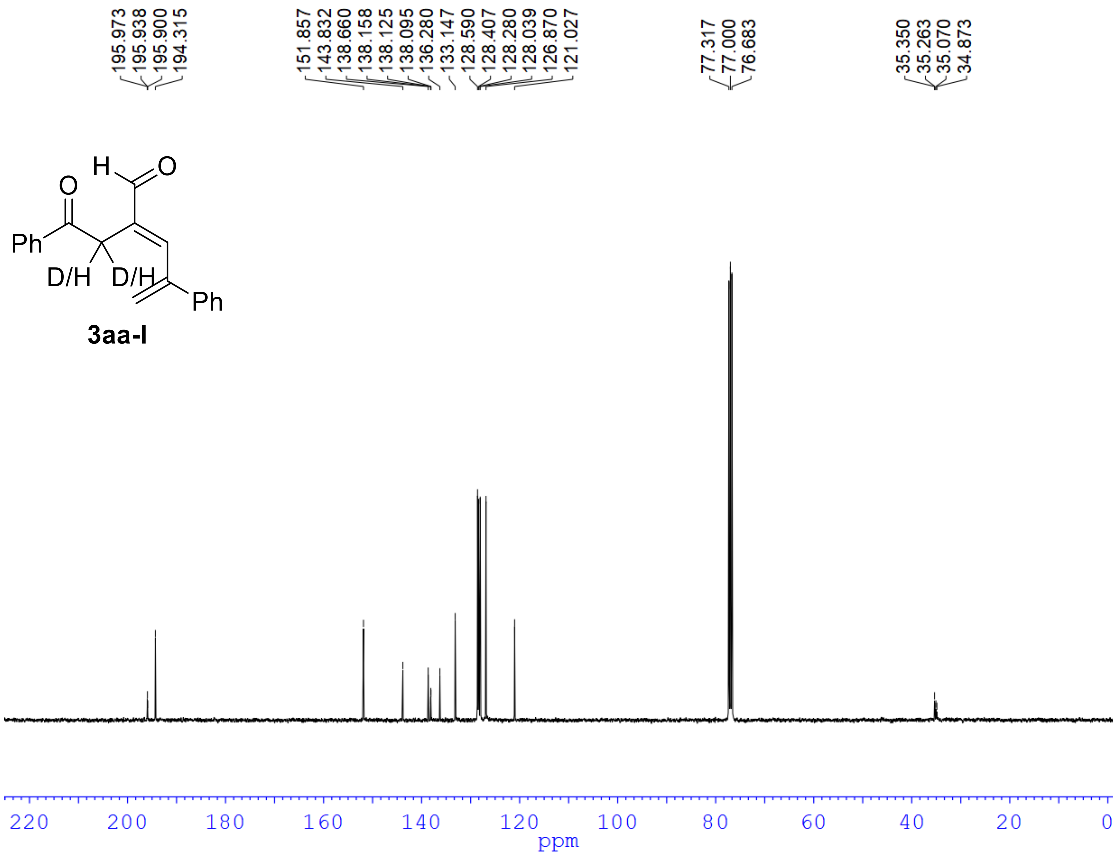
1.0
0.0
-1.
ppm

3ak



^{1}H and ^{13}C NMR spectra of mechanistic investigations:

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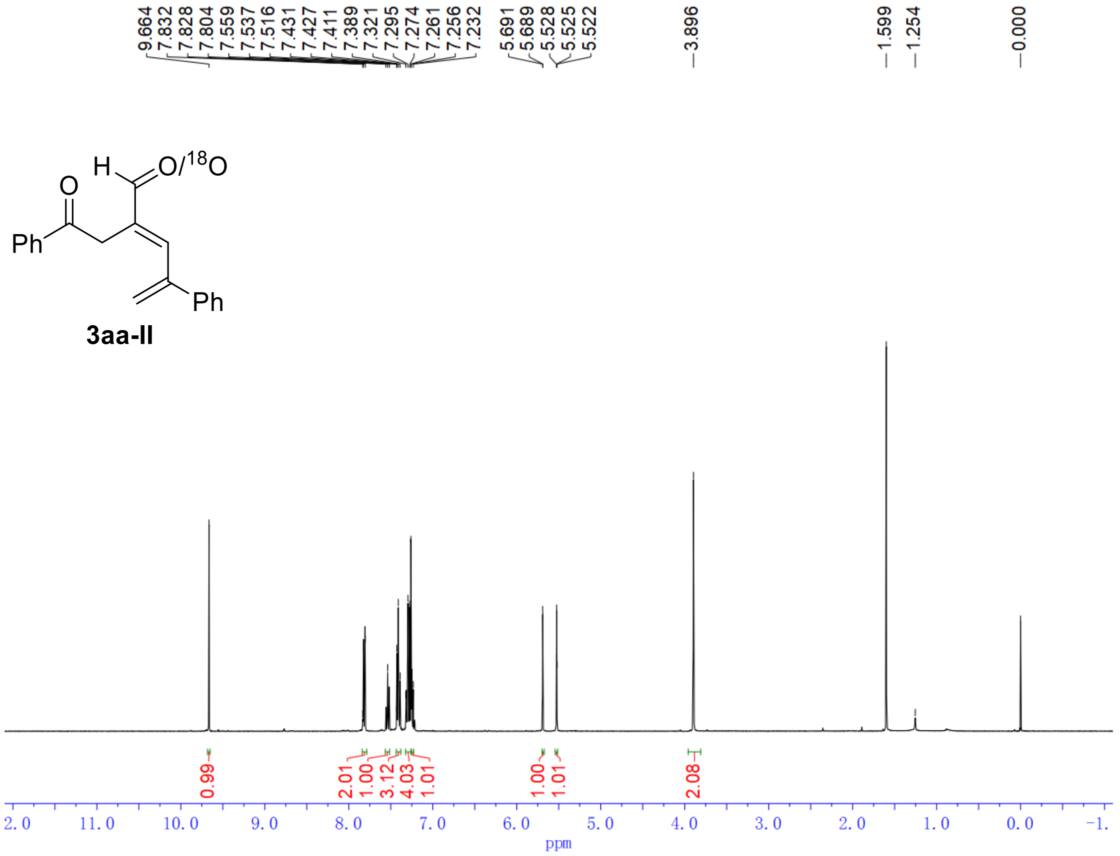
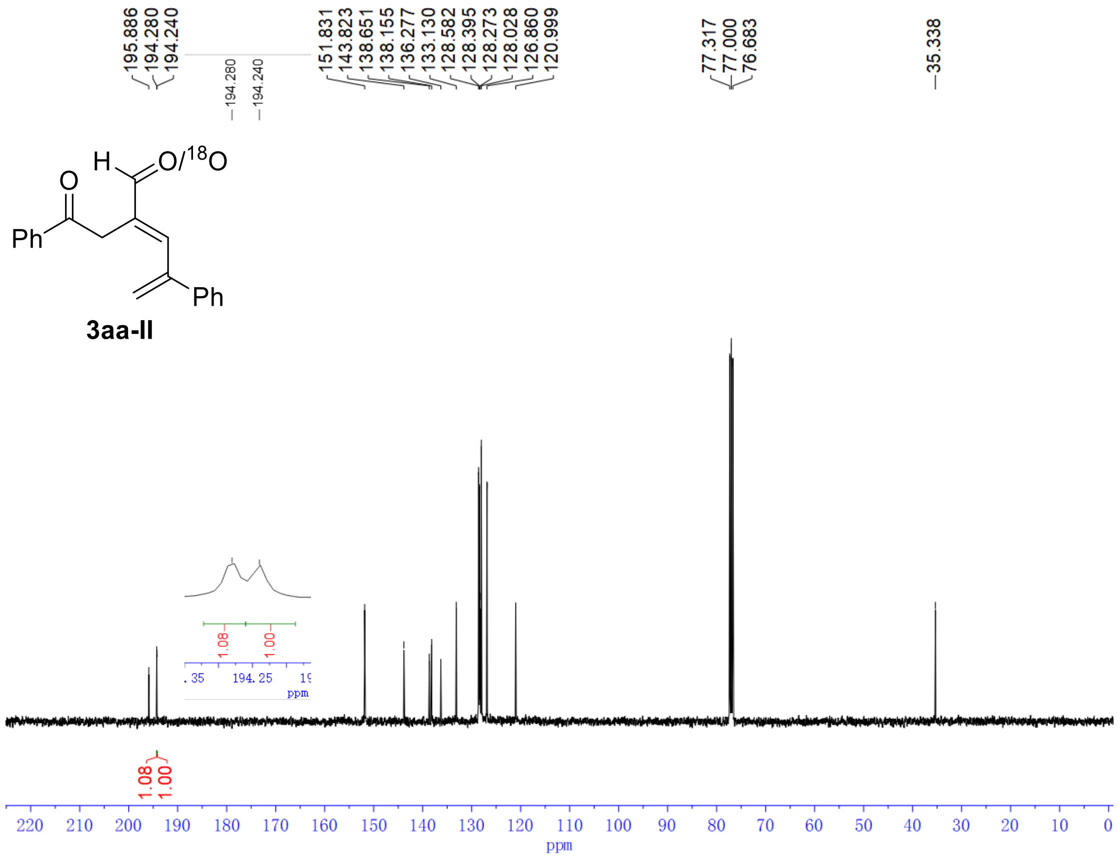
195.938
195.900
194.315
151.857
143.832
138.660
138.158
138.125
138.095
136.280
133.147
128.590
128.407
128.280
128.039
126.870
121.027
77.317
77.000
76.683
35.350
35.263
35.070
34.873
H
O
O
Ph
D/H
D/H
Ph
220
200
180
160
140
120
100
80
60
40
20
0
ppm

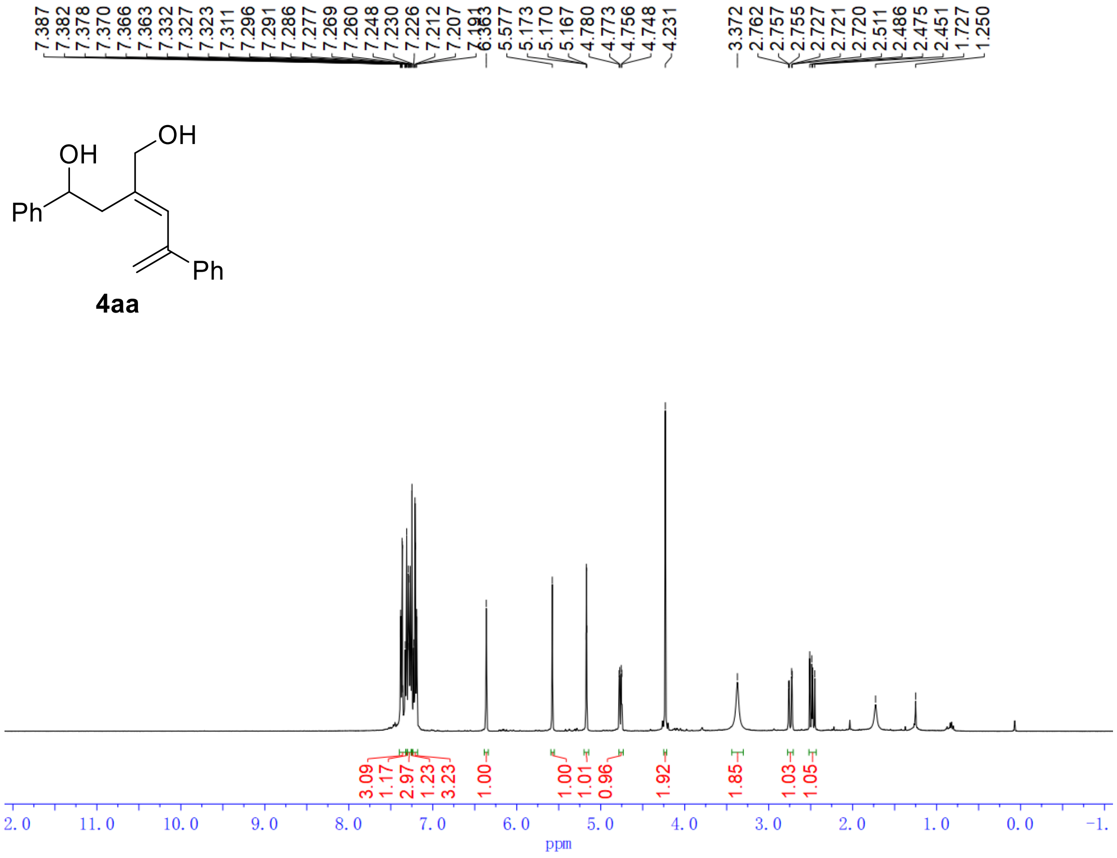
3aa-I

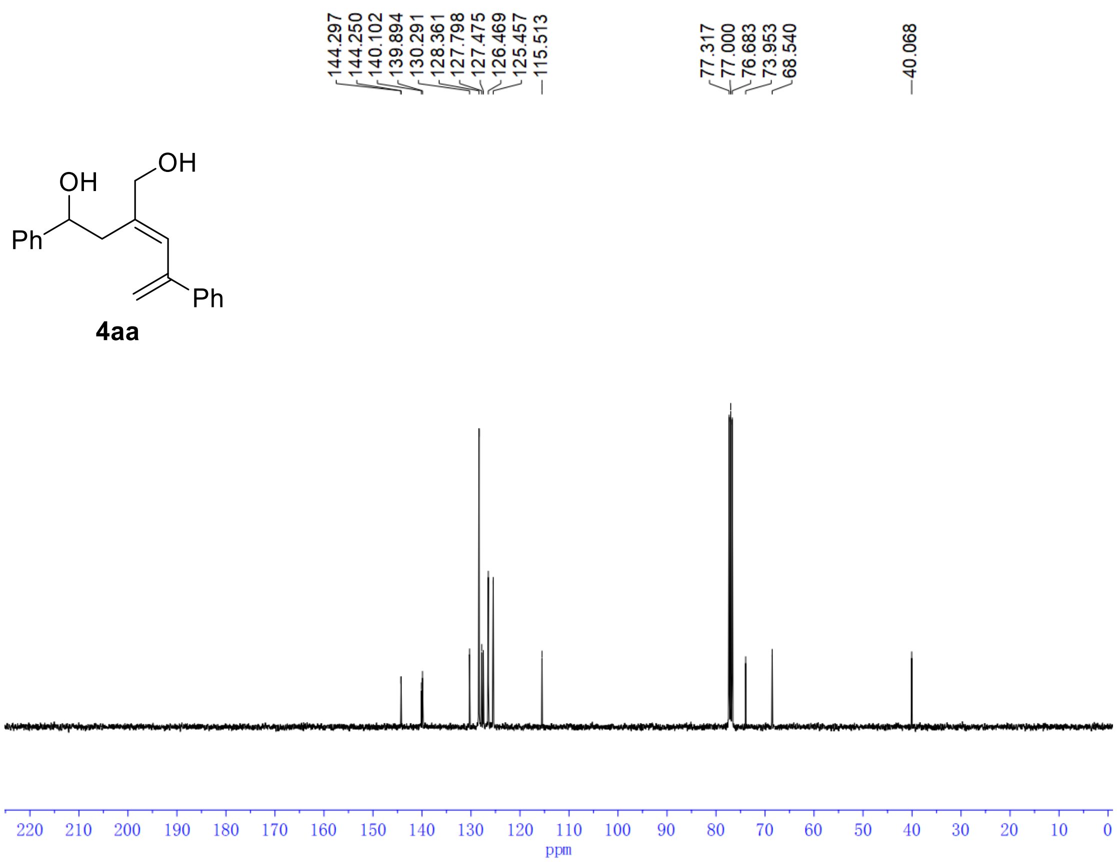

9.664
7.832
7.828
7.804
7.559
7.537
7.516
7.431
7.427
7.411
7.389
7.321
7.295
7.274
7.261
7.256
7.232
5.691
5.689
5.528
5.525
5.522
3.896
1.599
1.254
0.000
H
O/18O
O
Ph
Ph
0.99
2.01
1.00
3.12
4.03
1.01
1.00
1.01
2.08
2.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.
ppm

3aa-II



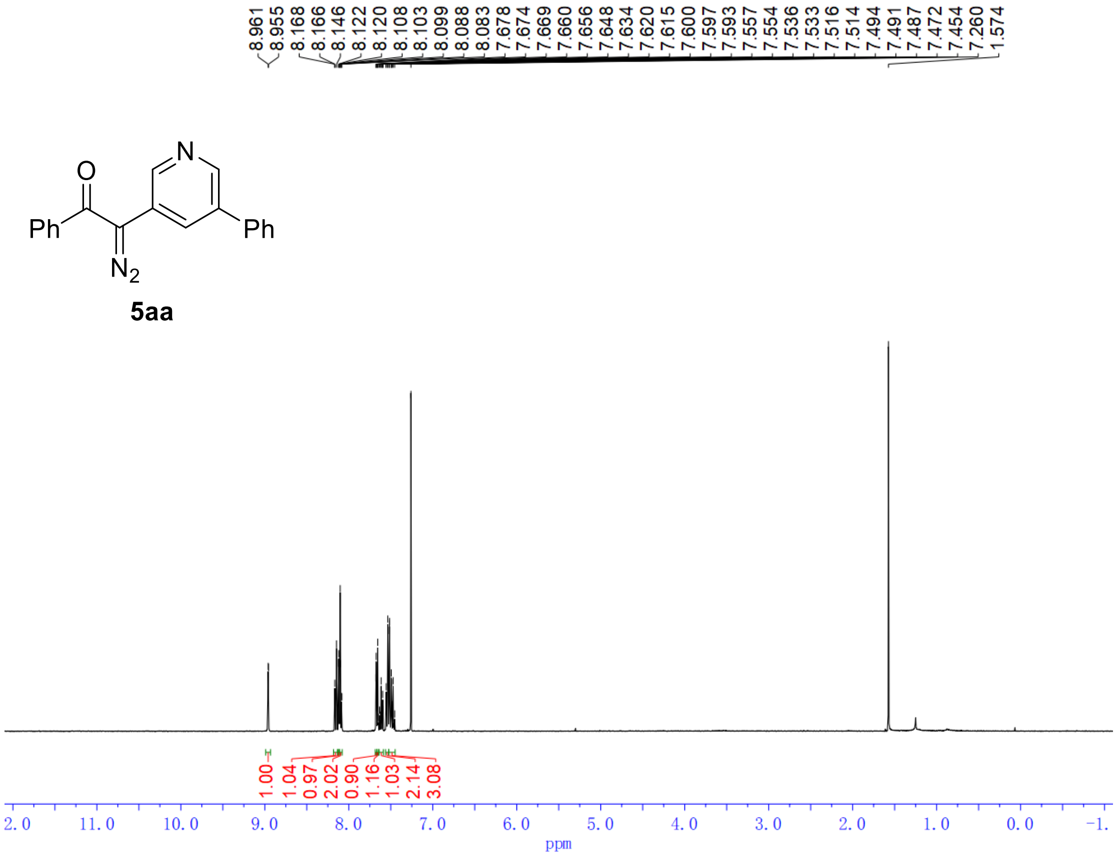
^{1}H and ^{13}C NMR spectra of applications:





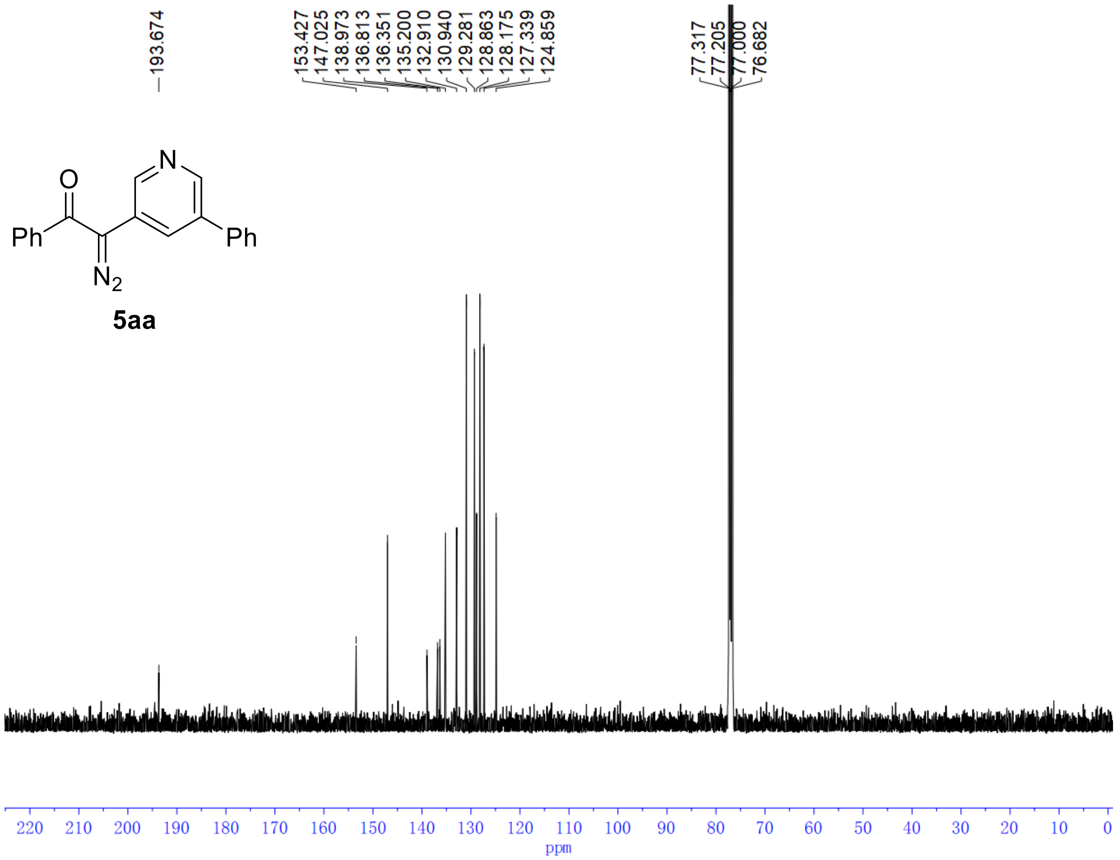
4aa

144.297
144.250
140.102
139.894
130.291
128.361
127.798
127.475
126.469
125.457
115.513
77.317
77.000
76.683
73.953
68.540
40.068
OH
OH
Ph
Ph
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
ppm



5aa

8.961
8.955
8.168
8.166
8.146
8.122
8.120
8.108
8.103
8.099
8.088
8.083
7.678
7.674
7.669
7.660
7.656
7.648
7.634
7.620
7.615
7.600
7.597
7.593
7.557
7.554
7.536
7.533
7.516
7.514
7.494
7.491
7.487
7.472
7.454
7.260
1.574
O
N
Ph
Ph
N2
1.00
1.04
0.97
2.02
0.90
1.16
1.03
2.14
3.08
2.0 11.0 10.0 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.0 -1.
ppm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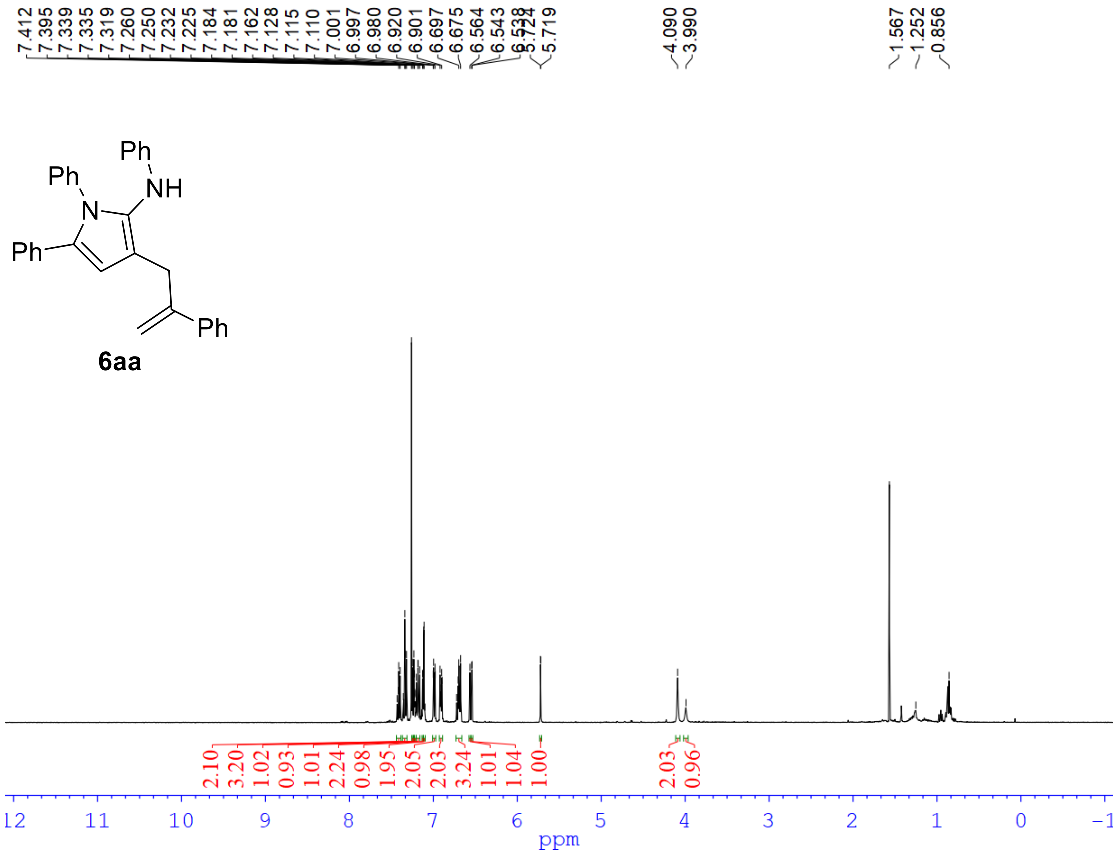
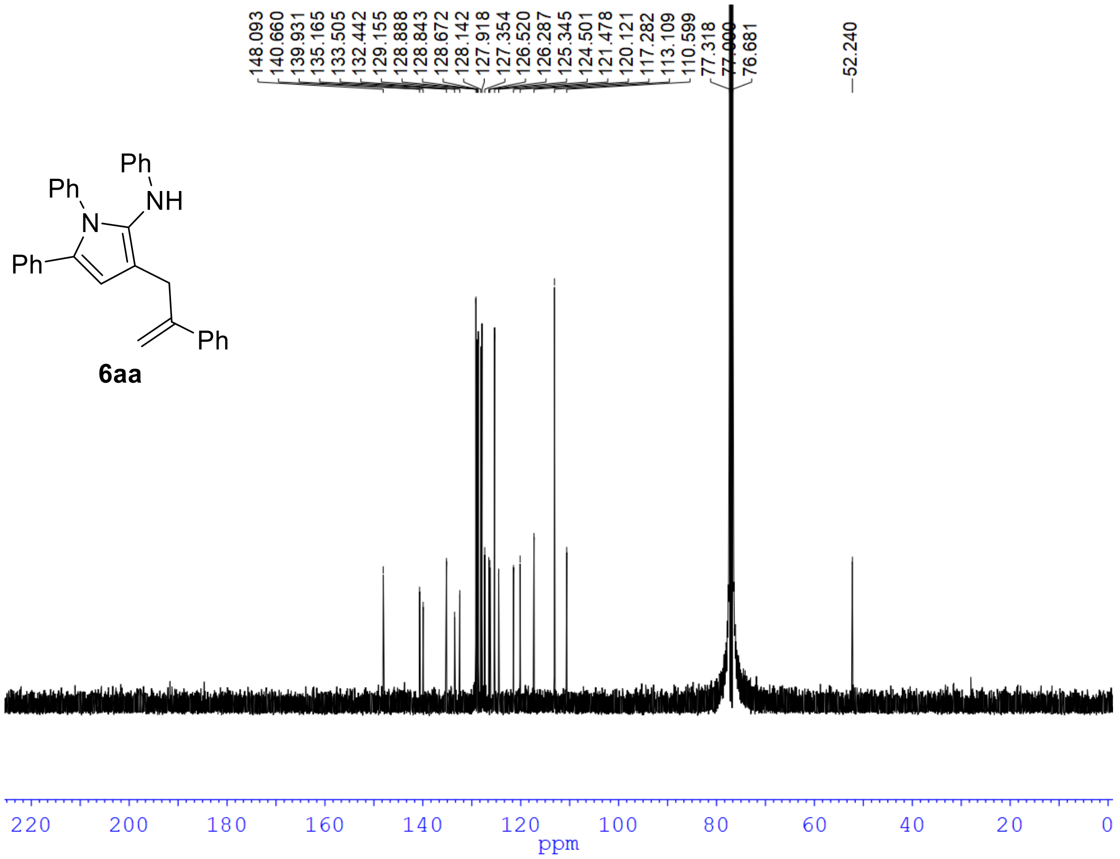
147.025
138.973
136.813
136.351
135.200
132.910
130.940
129.281
128.863
128.175
127.339
124.859
77.317
77.205
77.000
76.682
O
N
Ph
Ph
N_2
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
ppm

5aa


7.412
7.395
7.339
7.335
7.319
7.260
7.250
7.232
7.225
7.184
7.181
7.162
7.128
7.115
7.110
7.001
6.997
6.980
6.920
6.901
6.697
6.675
6.564
6.543
6.538
5.724
5.719
4.090
3.990
1.567
1.252
0.856
Ph
Ph
NH
N
Ph
Ph
2.10
3.20
1.02
0.93
1.01
2.24
0.98
1.95
2.05
2.03
3.24
1.01
1.04
1.00
2.03
0.96
12 11 10 9 8 7 6 5 4 3 2 1 0 −1
ppm

6aa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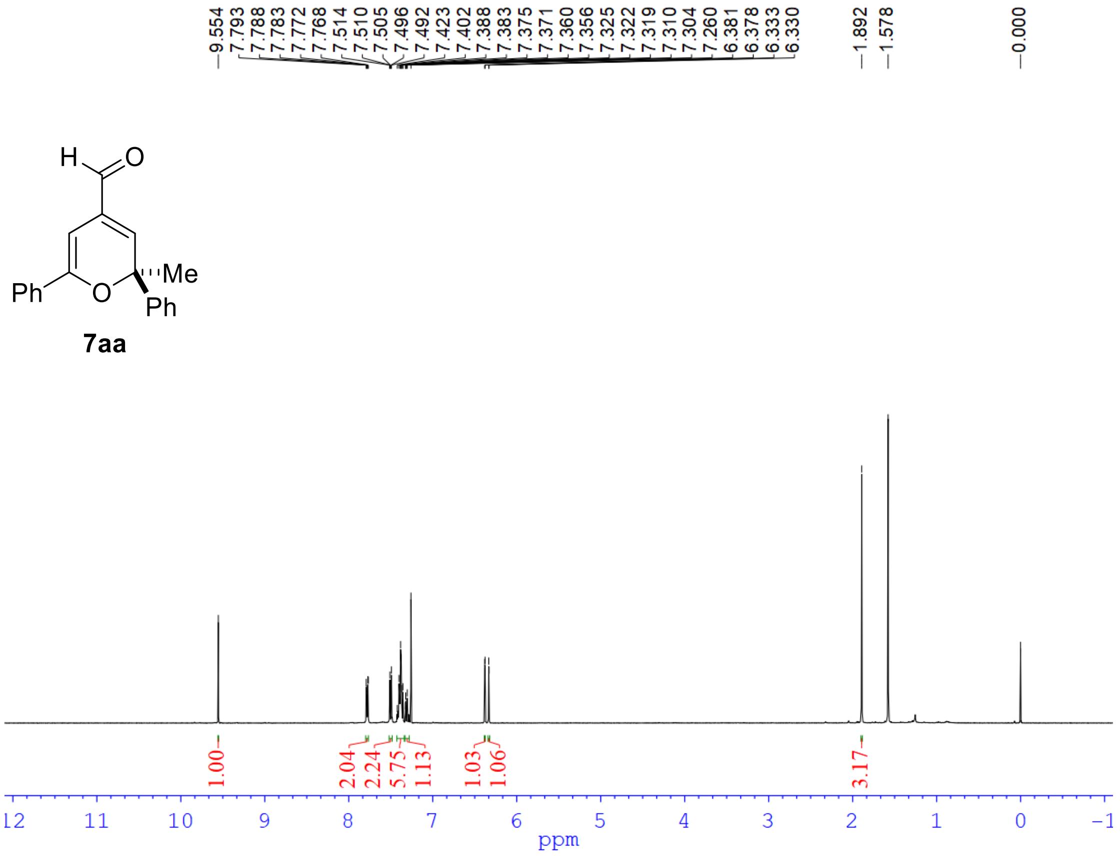
139.931
135.165
133.505
132.442
129.155
128.888
128.843
128.672
128.142
127.918
127.354
126.520
126.287
125.345
124.501
121.478
120.121
117.282
113.109
110.599
77.318
77.000
76.681
52.240
Ph
NH
Ph
N
Ph
Ph
220
200
180
160
140
120
100
80
60
40
20
0
ppm

6aa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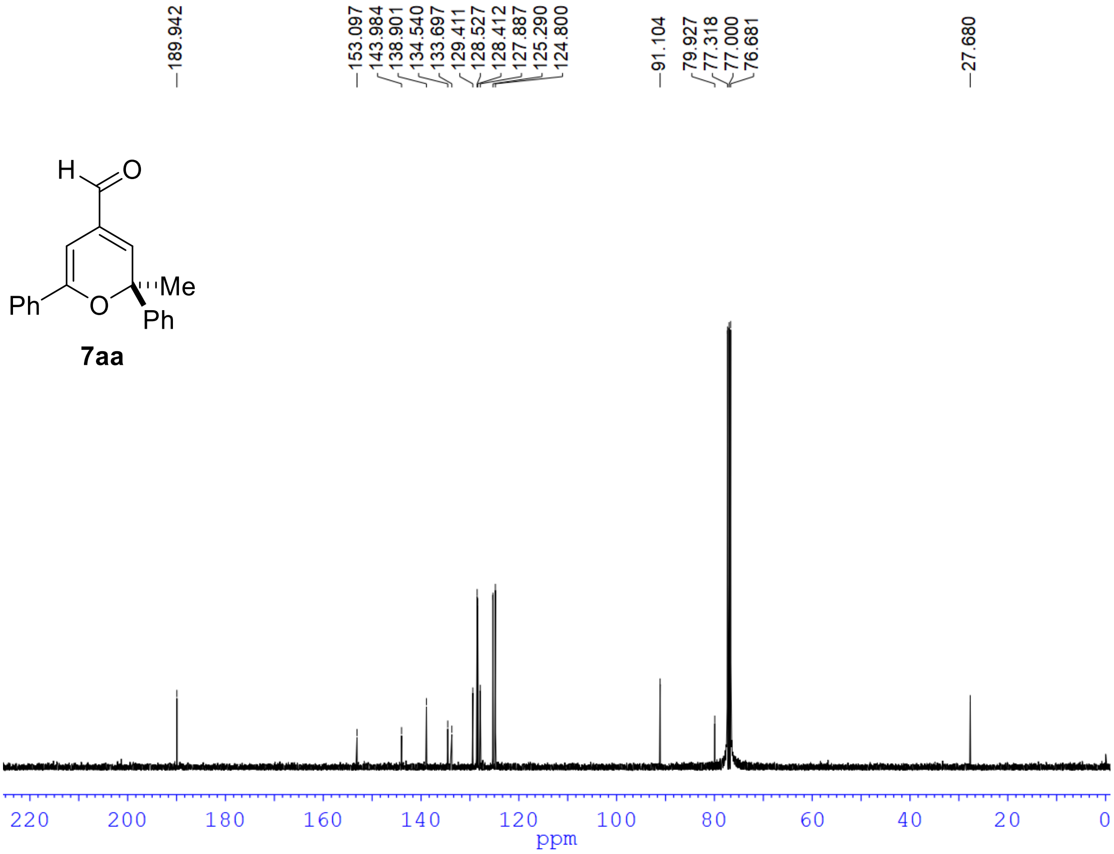
7.793
7.788
7.783
7.772
7.768
7.514
7.510
7.505
7.496
7.492
7.423
7.402
7.388
7.383
7.375
7.371
7.360
7.356
7.325
7.322
7.319
7.310
7.304
7.260
6.381
6.378
6.333
6.330
1.892
1.578
0.000
H
O
Ph
O
Me
Ph
1.00
2.04
2.24
5.75
1.13
1.03
1.06
3.17
12
11
10
9
8
7
6
5
4
3
2
1
0
−1
ppm

7aa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143.984
138.901
134.540
133.697
129.411
128.527
128.412
127.887
125.290
124.800
91.104
79.927
77.318
77.000
76.681
27.680
H
O
Me
Ph
O
Ph
220
200
180
160
140
120
100
80
60
40
20
0
ppm

7aa