Supplementary Information for

Ni-Catalyzed Asymmetric Hydrophosphinylation of Conjugated Enynes and Mechanistic Studies

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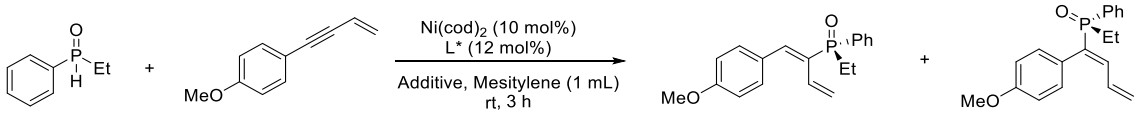
1. General Information

All reagents were obtained commercially unless otherwise noted. All reactions under standard conditions were monitored by thin-layer chromatography (TLC) on gel F_{254} plates. The silica gel (300-400 meshes) was used for column chromatography, and the distillation range of petroleum ether was 60-90 ºC. Mesitylene was purchased and used directly. ^{1}H, ^{13}C, ^{31}P, ^{11}B and ^{19}F NMR spectra were recorded in $CDCl_3$ or C_6D_6 solution on Bruker Aescend^{TM} 400 MHz and 500MHz instruments and spectral data were reported in ppm. The residual solvent peak or tetramethylsilane (TMS) was used as an internal reference: proton (TMS δ 0.0) and carbon ($CDCl_3$ δ 77.0). High-resolution mass spectral analysis (HRMS) data were measured by means of the ESI technique. Enantiomer excess was determined by HPLC analysis employing Darcel Chiracel columns (AD-H, OD-H, OJ-H, IH-3 and AS-H) and *n*-Hexane/*i*-PrOH as eluents. Optical rotations were measured by Perkin-Elmer-343 polarimeter.

Enynes were prepared according to the reference 1 and phosphine oxides were prepared according to the reference 2 and 3.

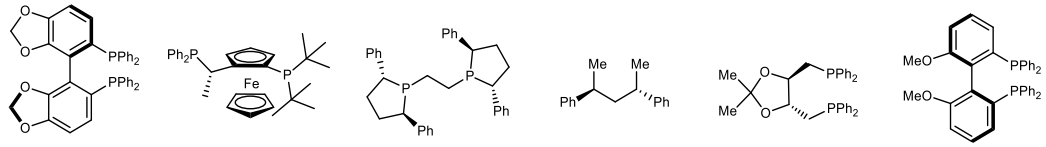
2. Optimization of reaction conditions



1a **2a** **3aa** **3aa'**

Entry[a]	Ligand	Additive	Solvent	Yield (%)[b]	rr[c]	ee (%)[d]	
						3aa	**3aa'**
1	**L1**	KOAc	Mesitylene	trace	--	--	--
2	**L2**	KOAc	Mesitylene	8%	1:1	3%	nd
3	**L3**	KOAc	Mesitylene	90%	>20:1	35%	--
4	**L4**	KOAc	Mesitylene	83%	>20:1	82%	--
5	**L5**	KOAc	Mesitylene	<5%	>20:1	--	--
6	**L6**	KOAc	Mesitylene	trace	--	--	--
7	**L4**	none	Mesitylene	78%	>20:1	54%	--
8	**L4**	K_2HPO_4	Mesitylene	74%	>20:1	80%	--
9	**L4**	KH_2PO_4	Mesitylene	78%	>20:1	59%	--
10	**L4**	$Ph_2P(O)OH$	Mesitylene	<5%	1:1	-14%	nd
				41%[e]		-21%[e]	
11	**L4**	K_3PO_4	Mesitylene	70%	>20:1	71%	--
12	**L4**	*t*-$BuCO_2K$	Mesitylene	66%	>20:1	86%	--
13[f]	**L4**	*t*-$BuCO_2K$	Mesitylene	72%	>20:1	88%	--
14[f]	**L4**	*t*-$BuCO_2K$	DCM	trace	--	--	--
15[f]	**L4**	*t*-$BuCO_2K$	Dioxane	9%	>20:1	69%	--
16[f]	**L4**	*t*-$BuCO_2K$	THF	35%	>20:1	58%	--
17[f-h]	**L4**	*t*-$BuCO_2K$	Mesitylene	60%	>20:1	91%	--
18[f-i]	**L4**	*t*-$BuCO_2K$	Mesitylene	>95%(89%)[j]	>20:1	91%	--
19[f-i, k]	**L4**	*t*-$BuCO_2K$	Mesitylene	41%	>20:1	94%	--

[a]Reaction conditions: **1a** (0.1 mmol), **2a** (0.12 mmol), [Ni] (10 mol %), L (12 mol %), Additive (1.5 equiv), solvent (1.0 mL), 3 h. [b]NMR yield and with $PO(OMe)_3$ as internal standard. [c]Determined by ^1H NMR analysis of crude reaction mixture. [d]Determined by chiral HPLC analysis. [e]24 h. [f]*t*-$BuCO_2K$ 2 equiv. [g]-20 °C. [h]5d. [i]**1a** (0.2 mmol), **2a** (0.1 mmol). [j]Isolated yield. [k]$Ni(stb^F)_3$ instead of $Ni(cod)_2$.



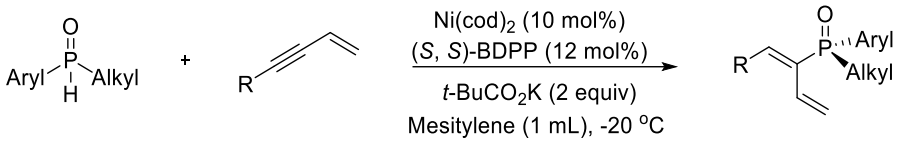
L1, (*S*)-Segphos **L2** **L3**, (*R*, *R*)-Ph-BPE **L4**, (*S*, *S*)-BDPP **L5**, (*R*, *R*)-DIOP **L6**, (*S*)-MeO-BIPHEP

3. General procedure for the synthesis of racemic products.

1 **2** **(±)-3**

To a 4 mL vial were added $Ni(cod)_2$ (2.8 mg, 0.01 mmol), DPPP (4.9 mg, 0.012 mmol), and mesitylene (1 mL) in a N_2 flushed glove box. The mixture was stirred for 10 minutes followed by the addition of enynes (0.12 mmol) and SPOs (0.1 mmol). The vial was capped, removed from the glove box, and the system was stirred at 80 °C overnight. The reaction mixture was cooled to room temperature and subjected to silica gel column chromatography directly for purification.

4. General procedure for the synthesis of chiral products.

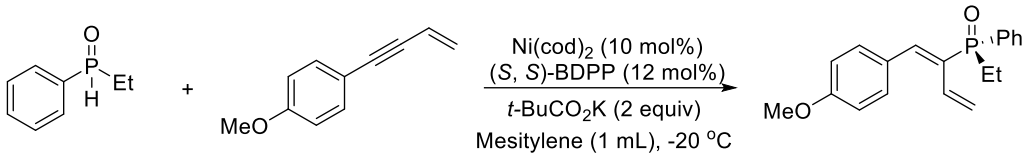


1 **2** **3**

To a 4 mL vial were added $Ni(cod)_2$ (2.8 mg, 0.01 mmol), (*S, S*)-BDPP (5.3 mg, 0.012 mmol) and mesitylene (1 mL) in a N_2 flushed glove box. The mixture was stirred for 10 minutes, cooled to -20 ^oC in the glove box followed by the addition of enynes (0.1 mmol), *t*-$BuCO_2K$ (28.0 mg, 2 mmol) and SPO (0.2 mmol). The vial was rapidly capped, removed from the glove box, and the system was stirred at -20 °C for 5 days. The reaction mixture was subjected to silica gelcolumn chromatography directly for purification.

5. Synthetic applications.

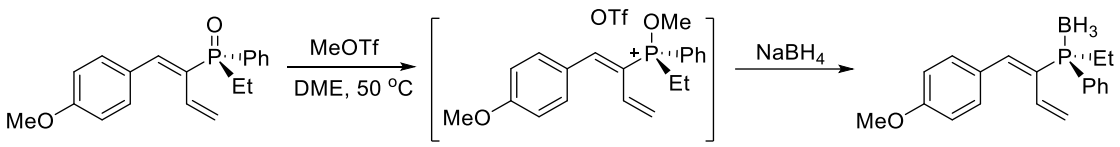
5.1 1 mmol-scale synthesis.



1a (2 mmol) **2a** (1 mmol) **3aa** 82% yield, 89% ee

To a 25 mL vial were added $Ni(cod)_2$ (27.5 mg, 0.01 mmol), (*S, S*)-BDPP (53.0 mg, 0.012 mmol) and mesitylene (10 mL) in a N_2 flushed glove box. The mixture was stirred for 10 minutes, cooled to -20 °C in the glovebox followed by the addition of **2a** (158.0mg, 1 mmol), *t*-$BuCO_2K$ (280.0 mg, 2 mmol) and **1a** (308.0 mg, 2 mmol). The vial was rapidly capped, removed from the glove box, and the system was stirred at -20 °C until disappearance of **2a** by TLC. The reaction mixture was subjected to silica gel column chromatography directly for purification to afford **3aa** (256.8 mg, 89% ee).

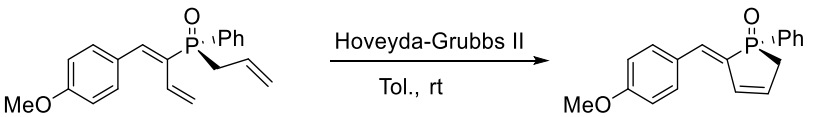
5.2 Compound 4.



3aa 89% ee **4**, 60% yield, 88% ee

According to reference 4, to a stirred solution of tertiary phosphine oxide **3aa** (31.2 mg, 0.1 mmol) in DME (0.5 mL) was added MeOTf (13.6 μL, 0.12 mmol) dropwise at room temperature under N_2. The reaction was heated at 50 °C overnight. After cooling to room temperature, a dispersion of $NaBH_4$ (11.3 mg, 0.3 mmol) in diglyme (0.5 mL) was added dropwise to the vial. The reaction mixture was stirred for additional 3 hours at 50 °C before being cooled to room temperature and diluted with DCM (5 mL). Water was then added dropwise to quench the remaining $NaBH_4$. The mixture was washed with water (5mL x 3) and the organic layer was dried over anhydrous $MgSO_4$ and removed in vacuo. The residue was purified by silica gel column chromatography afford the desired product **4** in 60% yield (18.6 mg) with 88% ee.

5.3 Compound 5.



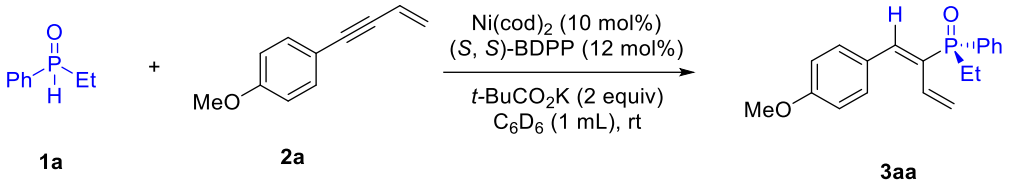
3ga 85% ee **5** 92% yield, 88% ee

A 4 mL reaction vial equipped with a magnetic stirrer under N_2 was charged with **3ga** (85% ee, 32.4 mg, 0.1 mmol) and Hoveyda-Grubbs II (3.1 mg, 0.005 mmol). toluene (1 mL) was added as solvent and the reaction mixture was stirred at rt for 5 min. The resulting mixture was subjected to column chromatography to afford the adduct **5** in 92% yield (27.3 mg) with 88% ee.

6. Mechanism experiments.

6.1. Identification of the Catalyst Resting State.

6.1.1 The NMR of the reaction mixture.

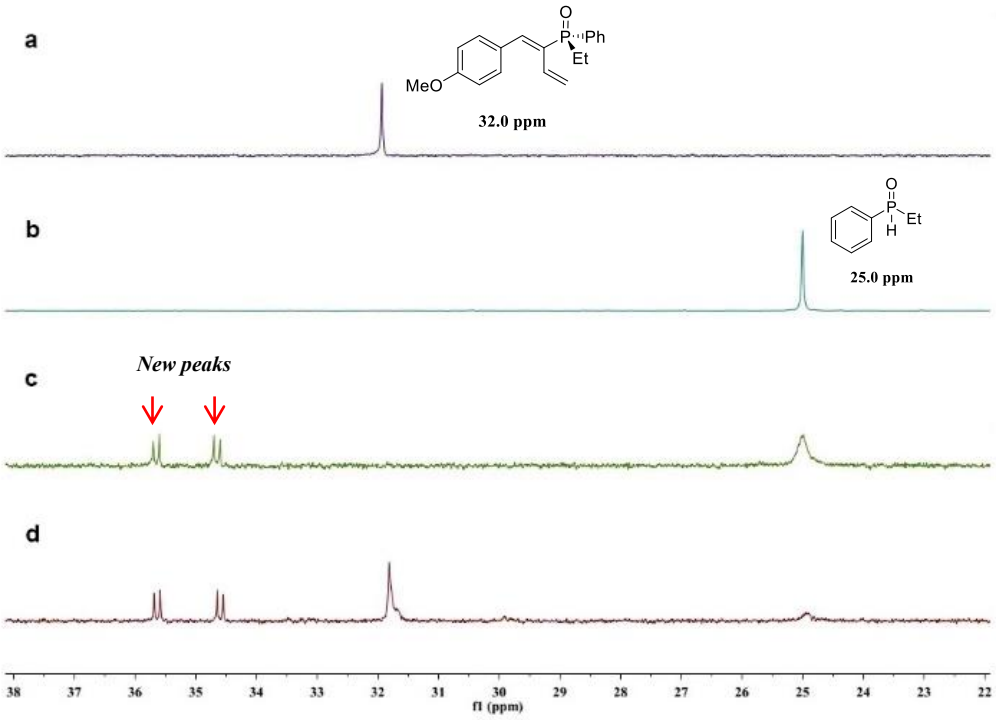


1a 0.2 mmol

2a 0.1 mmol

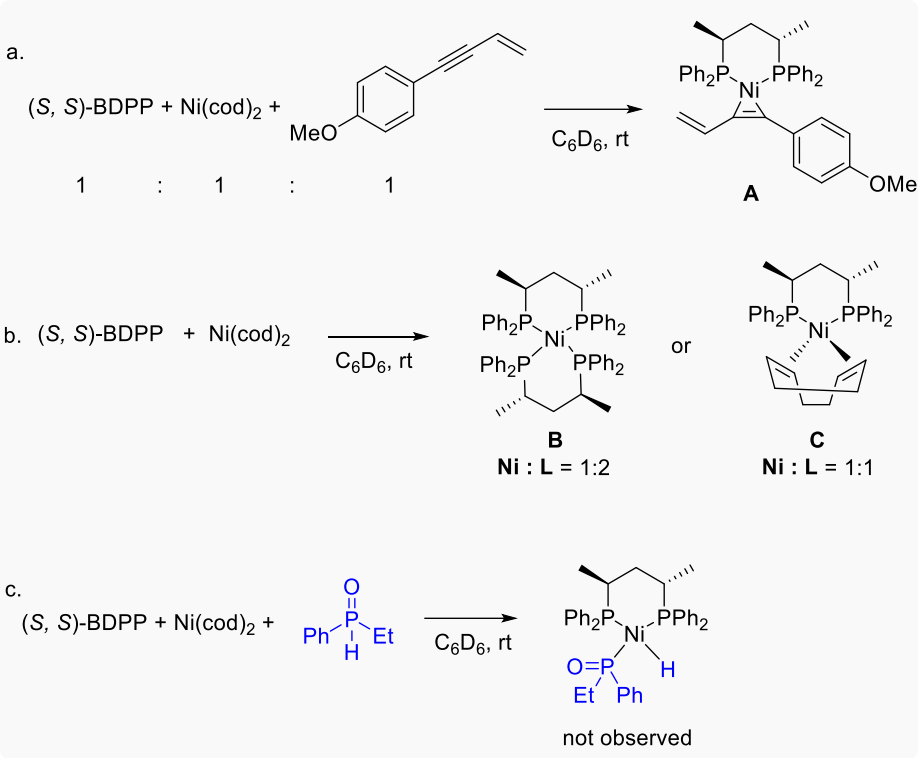
3aa

According to standard condition except that the solvent was replaced with C_6D_6 and the temperature is room temperature.



Supplementary Figure 1. (**a**) ^{31}P NMR spectra of **3aa** and (**b**) **1a**; (**c**) ^{31}P NMR spectra of reaction mixture in 10 minutes and (**d**) ^{31}P NMR spectra of reaction mixture in 6 hours.

6.1.2 Control experiments (Supplementary Figure 2).



Supplementary Figure 2. Three possible pathways can lead to the formation of the catalyst resting state.

6.1.3 The ^{31}P NMR of the mixture of the (*S, S*)-BDPP and Ni(cod)$_2$.

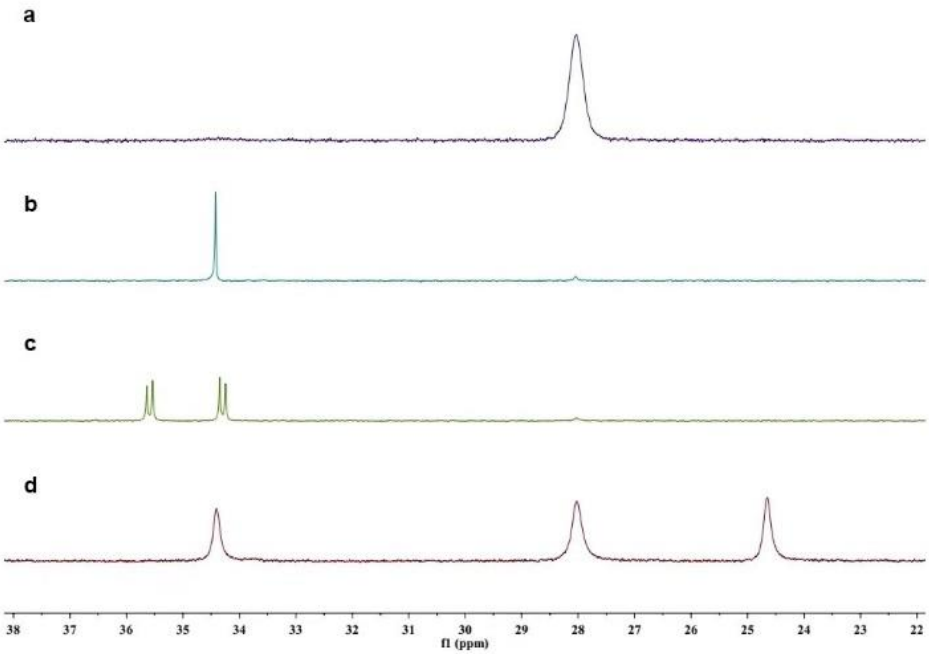
Preparation: To a 4 mL vial were added Ni(cod)$_2$ (13.8 mg, 0.05 mmol), (*S, S*)-BDPP (44.0 mg, 0.1 mmol) and C_6D_6 (1 mL) in a N_2 flushed glove box, another 4 mL vial were added Ni(cod)$_2$ (13.8 mg, 0.05 mmol), (*S, S*)-BDPP (22.0 mg, 0.05 mmol) and C_6D_6 (1 mL) in a N_2 flushed glove box. Then the mixture were stirred at rt overnight and tested by NMR. The ^{31}P NMR with ^{1}H-decoupling of the mixture was obtained in **Supplementary Figure 3a** and **b**.

6.1.4 The ^{31}P NMR of the mixture of the (*S, S*)-BDPP, Ni(cod)$_2$ and enyne 2a.

Preparation: To a 4 mL vial were added Ni(cod)$_2$ (13.8 mg, 0.05 mmol), (*S, S*)-BDPP (22.0 mg, 0.05 mmol) and C_6D_6 (0.5 mL) in a N_2 flushed glove box. Then the mixture was stirred for 10 minutes. After that, enyne **2a** (7.9 mg, 0.05 mmol) in C_6D_6 (0.5 mL) were added, the mixture was stirred at rt overnight and tested by NMR. The ^{31}P NMR with ^{1}H-decoupling of the mixture was obtained in **Supplementary Figure 3c**.

6.1.5 The ^{31}P NMR of the mixture of the (*S, S*)-BDPP, Ni(cod)$_2$ and SPO 1a.

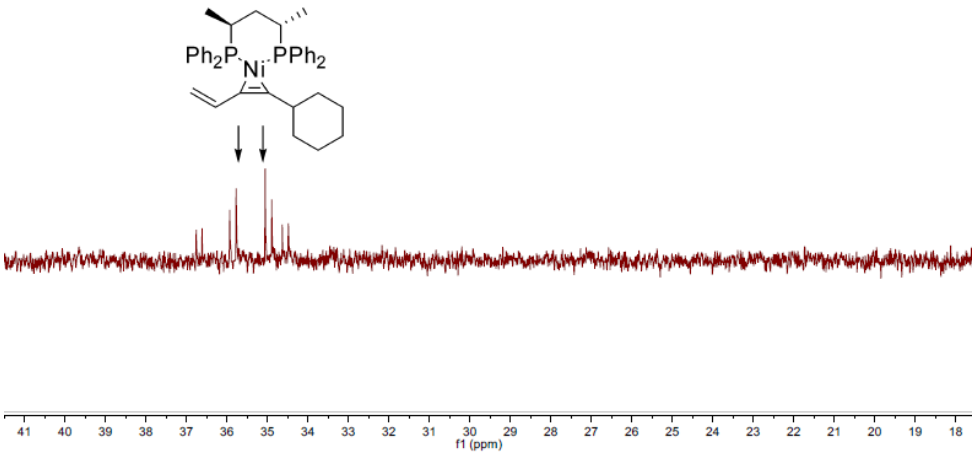
Preparation: To a 4 mL vial were added Ni(cod)$_2$ (13.8 mg, 0.05 mmol), (*S, S*)-BDPP (22.0 mg, 0.05 mmol) and C_6D_6 (0.5 mL) in a N_2 flushed glove box. Then the mixture was stirred for 10 minutes. After that, SPO **1a** (7.7 mg, 0.05 mmol) in C_6D_6 (0.5 mL) were added, the mixture was stirred at rt overnight and tested by NMR. The ^{31}P NMR of the mixture was obtained in **Supplementary Figure 3d**.



Supplementary Figure 3. ^{31}**P** NMR spectra of (**a**) (*S*, *S*)-BDPP : Ni(cod)$_2$= 2:1; (**b**) (*S*, *S*)-BDPP : Ni(cod)$_2$= 1:1; (**c**) (*S, S*)-BDPP : Ni(cod)$_2$: **2a** = 1:1:1; (**d**) (*S, S*)-BDPP : Ni(cod)$_2$: **1a** = 1:1:1.

6.1.6 The ^{31}P NMR of the mixture of the (*S, S*)-BDPP, Ni(cod)$_2$ and enyne 2u.

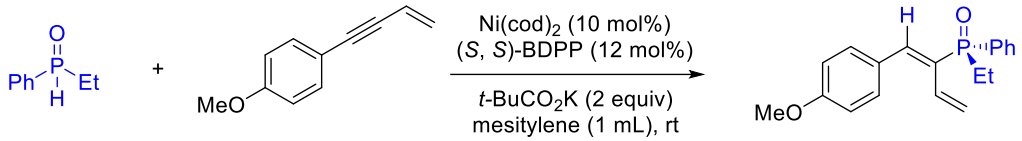
Preparation: To a 4 mL vial were added Ni(cod)$_2$ (13.8 mg, 0.05 mmol), (*S*, *S*)-BDPP (22.0 mg, 0.05 mmol) and C_6D_6 (0.5 mL) in a N_2 flushed glove box. Then the mixture was stirred for 10 minutes. After that, enyne **2u** (6.7 mg, 0.05 mmol) in C_6D_6 (0.5 mL) were added, the mixture was stirred at rt overnight and tested by NMR. The ^{31}P NMR with ^{1}H-decoupling of the mixture was obtained in **Supplementary Figure 4**.



Supplementary Figure 4. ^{31}**P** NMR spectra of (*S, S*)-BDPP : Ni(cod)$_2$: **2u** = 1:1:1

6.2. Kinetic Studies.

General procedure of kinetic experiments



1a 0.2 mmol

2a 0.1 mmol

3aa

To a 4 mL vial were added $Ni(cod)_2$ (2.8 mg, 0.01 mmol), (*S, S*)-BDPP (5.3 mg, 0.012 mmol) and mesitylene (1 mL) in a N_2 flushed glove box. The mixture was stirred for 10 minutes followed by the addition of enynes (0.1 mmol), *t*-$BuCO_2K$ (28.0 mg, 0.2 mmol) and SPO (0.2 mmol). The vial was capped, removed from the glove box, and the system was stirred at room temeperature and the aliquots were analyzed by HPLC.

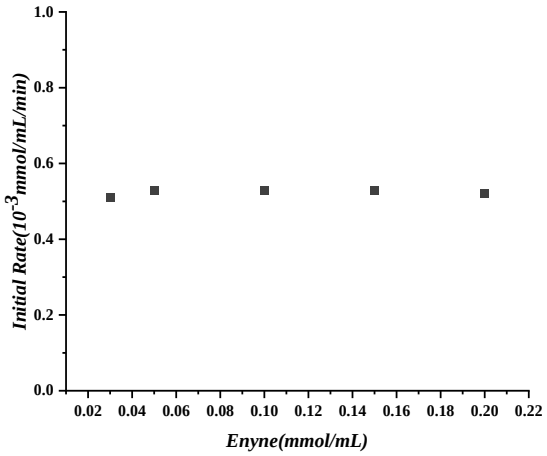
Note: The conversion of the product was detected by HPLC with Inertsil® SIL-100A column. Calibration factors are obtained at 228 nm using triphenyl phosphine oxide as the standard. 10 uL mixture was withdrawn at each time point; The wavelength was detected by HPLC, triphenoxyphosphine was used as the internal standard, and the concentration curve was made to ensure a linear relationship within the tested concentration range. The slope of integral of area/concentration between the product and the internal standard is determined to be 1.75. The concentration of the product and the initial rate were thus obtained. For each kinetic experiment we took samples every 5 minutes or 10 minutes, with three samples per experiment. The conversion of the reaction is controlled less than 15% at the end of the sampling to ensure the accuracy of the initial rate.

6.2.1 Reaction order in enyne.

According to procedure above except for the varied concentration of enyne **2a**. Kinetic data is shown in **Supplementary Table 1**. Kinetic plots for the reaction order in enyne is shown in **Supplementary Figure 5**.

Supplementary Table 1. Initial rate for the formation of **3aa** with varying concentrations of **2a** at rt.

Conc. of enyne (mmol/mL)	*Initial rate* (10^{-3} mmol/mL/min)
0.03	0.51
0.05	0.53
0.1	0.53
0.15	0.53
0.2	0.52



Supplementary Figure 5. Dependence of the initial rate on enyne **2a**

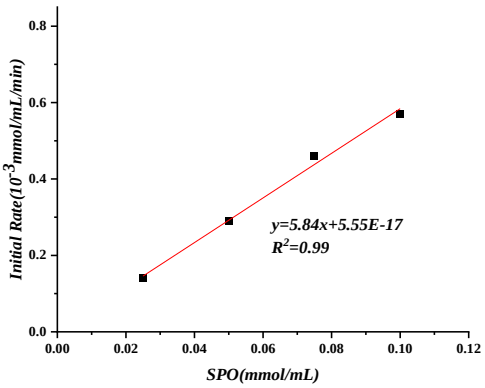
6.2.2 Reaction order in SPO

According to procedure above except for the varied concentration of **1a**. Kinetic data is shown in **Supplementary Table 2**. Kinetic plots for the reaction order in enyne is shown in **Supplementary Figure 6**.

Supplementary Table 2. Initial Rate for the formation of **3aa** with varying concentrations of **1a** at rt.

Conc. of SPO (mmol/mL)[a]	*Initial rate* (10^{-3} mmol/mL/min)
0.025	0.14
0.05	0.29
0.075	0.46
0.1	0.57

[a]Referred to the concentration of (*R*)-**1a**.



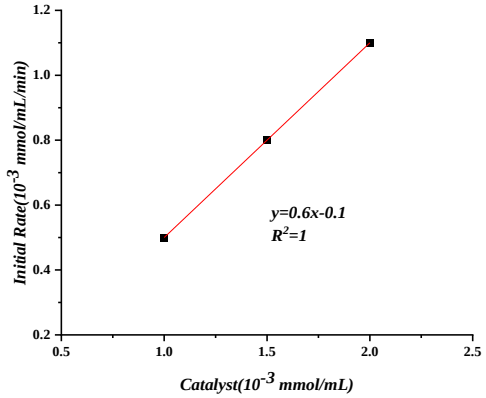
Supplementary Figure 6. Dependence of the initial rate on SPO **1a**.

6.2.3 Reaction order in catalyst

According to procedure above except for the varied concentration of $Ni(cod)_2$ and (*S, S*)-BDPP. Kinetic data is shown in **Supplementary Table 3**. Kinetic plots for the reaction order in catalyst is shown in **Supplementary Figure 7**.

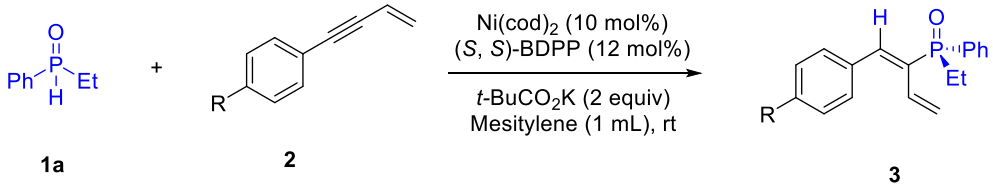
Supplementary Table 3. Initial rate for the formation of **3aa** with varying concentrations of catalyst at rt.

Conc. of catalyst (10^{-3} mmol/mL)	*Initial rate* (10^{-3} mmol/mL/min)
1	0.5
1.5	0.8
2	1.1



Supplementary Figure 7. Dependence of the initial rate on catalyst.

6.2.4 The electronic effects of substituent on enyne.

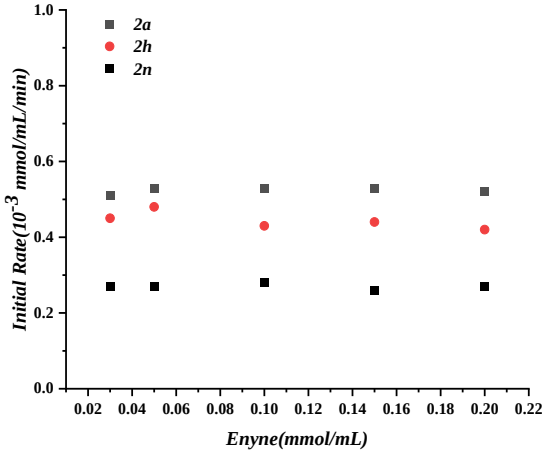


1a **2** **3**

According to the general procedure of the kinetic experiments. Kinetic data is shown in **Supplementary Table 4.** Kinetic plot is shown in **Supplementary Figure 8**.

Supplementary Table 4. Initial rate for the formation of **3** with varying concentrations and varying substituent of enyne at rt.

Conc. of enyne (mmol/mL)	*Initial rate*$_{2a}$ (10^{-3} mmol/mL/min)	*Initial rate*$_{2n}$ (10^{-3} mmol/mL/min)	*Initial rate*$_{2h}$ (10^{-3} mmol/mL/min)
0.03	0.51	0.45	0.27
0.05	0.53	0.48	0.27
0.1	0.53	0.43	0.28
0.15	0.53	0.44	0.26
0.2	0.52	0.42	0.27



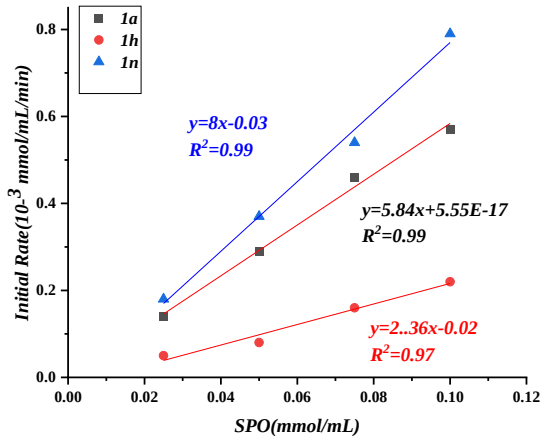
Supplementary Figure 8. Dependence of the initial rate on enynes.

6.2.5 The electronic effects of substituent on SPO.

According to the general procedure of the kinetic experiments. Kinetic data is shown in **Supplementary Table 5**. Kinetic plot is shown in **Supplementary Figure 9**.

Supplementary Table 5. Initial rate for the formation of **3** with varying concentrations and varying substituent of SPO at rt.

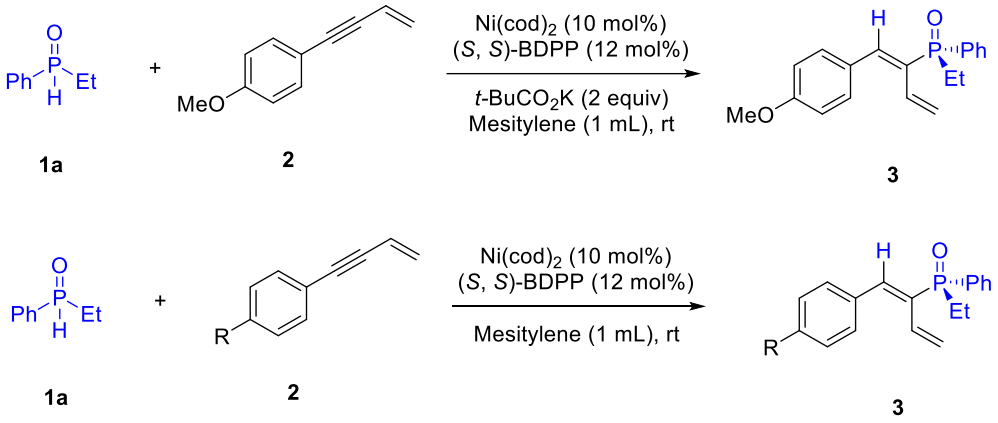
Conc. of SPO (mmol/mL)	*Initial rate*$_{1a}$ (10^{-3} min^{-1})	*Initial rate*$_{1h}$ (10^{-3} min^{-1})	*Initial rate*$_{1n}$ (10^{-3} min^{-1})
0.025	0.14	0.05	0.18
0.05	0.29	0.08	0.37
0.075	0.46	0.16	0.54
0.1	0.57	0.22	0.79



Supplementary Figure 9. Dependence of the initial rate on SPO.

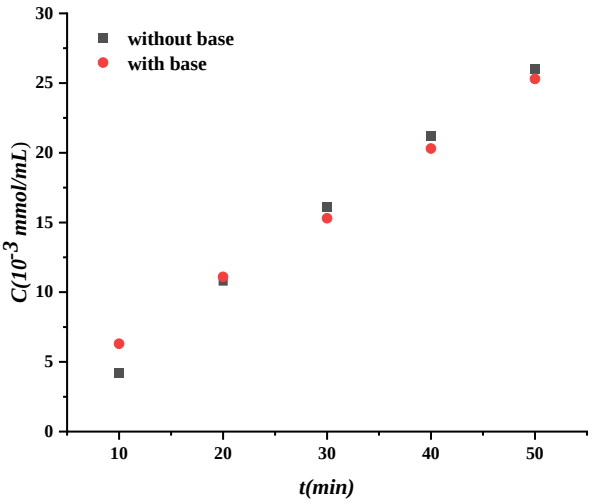
6.2.6 The deuteration experiment.

According to the general procedure of the kinetic experiment except *t*-$BuCO_2K$ was not added in eq. 2. Kinetic Data is shown in **Supplementary Table 6**, Kinetic plots is shown in **Supplementary Figure 10**.



Supplementary Table 6. Kinetic data of time-course for the reaction with or without base.

t (min)	$C_{with\ base}$ (10^{-3} mmol/mL)	$C_{without\ base}$ (10^{-3} mmol/ml)
10	6.3	4.2
20	11.1	10.8
30	15.3	16.1
40	20.3	21.2
50	25.3	26.0

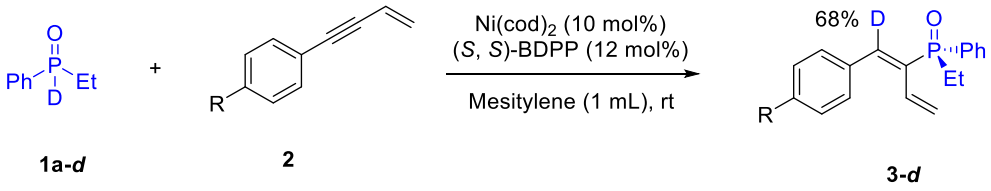


Supplementary Figure 10. Time-course for the reaction with or without base.

Synthesis of deuterated SPO

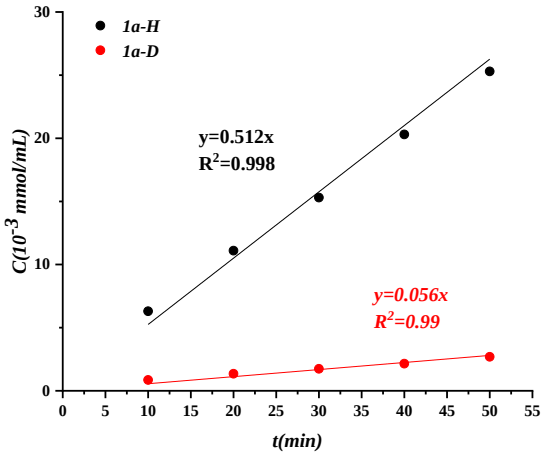
Dissolve SPO in 1 mL of D_2O under argon atmosphere and stir at 60 °C for 12 h. After completion of the reaction, the solvent was removed through the vacuum oven to obtain the deuterated SPO (±) in quantitative yield (96% D).

The deuteration experiment is conducted following the general procedure of the kinetic experiment without *t*-$BuCO_2K$. Kinetic data is shown in **Supplementary Table 7**, Kinetic plots is shown in **Supplementary Figure 11**.



Supplementary Table 7. Kinetic datas of time-course for the deuterated reaction.

t (min)	10	20	30	40	50
C (10^{-3}mmol/mL)	0.86	1.35	1.74	2.15	2.69

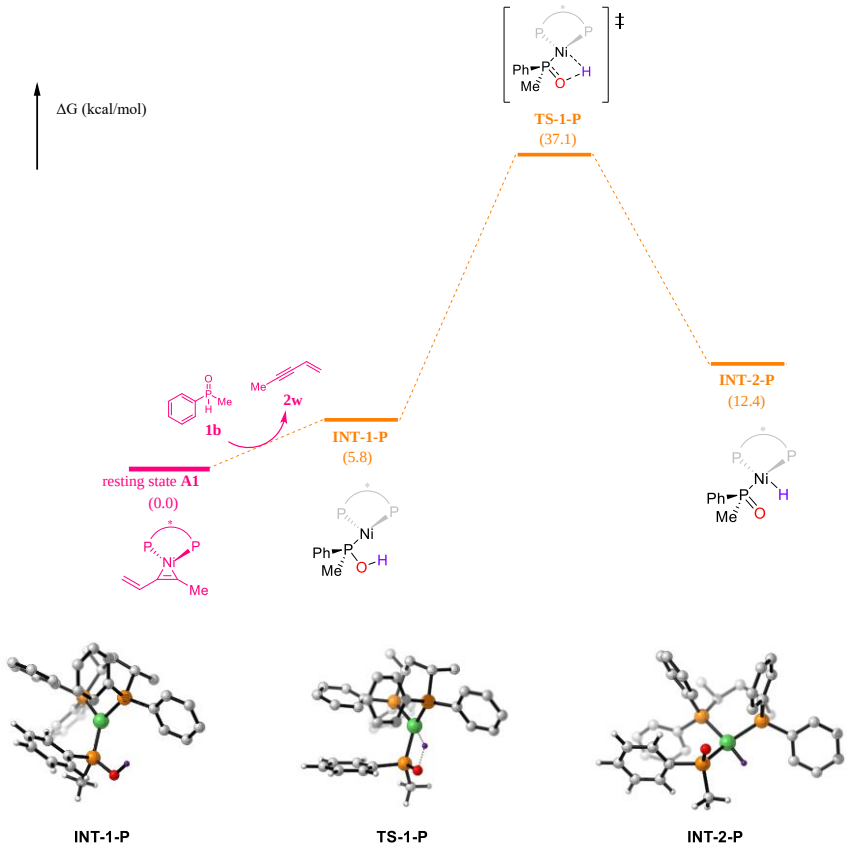


Supplementary Figure 11. Time-course for the deuterated reaction.

7. DFT Computational Studies.

All DFT calculations were performed using Gaussian 16.[5] Geometry optimizations were carried out with the B3LYP-D3(BJ) functional. The Lanl2dz basis set with ECP was used for Ni, and the 6-31G(d) basis set was used for other atoms. Frequency calculations and the intrinsic reaction coordinate (IRC) calculations at the same level as the geometry optimizations were performed to ensure each stationary point to be either a minimum or a transition state which were correctly connected. Conformational search has been performed for all starting materials, intermediates and products by crest-xTB 6.4.0.[6-8]

The single-point energies were calculated at the level of M06/SDD with ECP for Ni, and M06/6-311++g(d,p) for other atoms. Solvent effects (solvent=mesitylene) are calculated using the SMD implicit solvation model based on the optimized geometries. All of the enthalpies and Gibbs energies were calculated at standard conditions and relative energies were shown in kcal/mol (1 atm and 298.15 K). Quasi-harmonic corrected Gibbs free energy at 253.15 K (-20 ºC) of **TS-1a** and **TS-1a-S** were performed with GoodVibes-3.0.1 program.[9-10] 3D models of optimized structures were displayed with CYLview.



Supplementary Figure 12. Free energy profile for the P-H oxidative addition pathway. Computed at the SMD(mesitylene)/M06/6-311++G(d,p)/SDD//B3LYP-D3(BJ)/6-31G(d)/LANL2DZ level.

Energy Data for all Reported Structures

Supplementary Table 8. Single-Point Energies (SPEs) and Gibbs free energies (G)

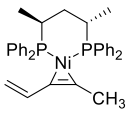
Structures	SPE(a.u.)[a]	G(a.u.)[b]
resting state A1	-2170.267979	-2,169.734147
resting state A2	-2170.268161	-2169.734073
1b	-688.598969	-688.490004
INT-1	-2858.893780	-2,858.220589
TS-1a	-2858.860894	-2858.191233
TS-1b	-2858.846037	-2858.180201
TS-1-regio	-2858.846647	-2858.180093
INT-2	-2858.896556	-2858.224544
TS-2	-2858.875785	-2858.202871
2w	-193.955914	-193.896397
3bw	-882.613494	-882.416582
TS-1a-S	-2858.855436	-2858.187252
INT-1-P	-2664.900122	-2,664.318439
TS-1-P	-2664.845354	-2,664.268558
INT-2-P	-2664.890759	-2,664.308012

[a] Single point energy computed at the levels of M06/SDD and M06/6-311++g(d,p).
[b] A standard state at 1 atm and 298K was used.

Structure	SP	ZPE	T*S	G(253.15K)[c]
TS-1a	-2858.860894	0.730931	0.089911	-2858.184201
TS-1a-S	-2858.855436	0.730461	0.097212	-2858.179447
ΔΔG(253.15k)=3.0 kcal/mol, predicted ee at -20 °C is 99%				

[c] Quasi-harmonic treatment at T = 253.15 K, c = 0.1 M with ZPE sale factor=0.977.

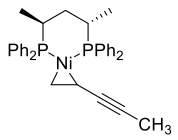
Cartesian Coordinates (Å) of Optimized Structures.



Resting state A1

P	-1.61800	-0.04809	0.51339
P	1.70919	-0.11409	0.42499
C	-1.20967	0.18392	2.32690
H	-1.99050	0.82008	2.76338
C	0.14282	0.90030	2.54271
H	0.17680	1.83154	1.96339
H	0.17156	1.20422	3.59891
C	1.43099	0.09019	2.27456
H	1.27646	-0.93381	2.63152
C	-1.27222	-1.17195	3.04620
H	-0.66952	-1.93080	2.53517
H	-2.29794	-1.54536	3.09083
H	-0.89710	-1.07449	4.07260
C	2.60847	0.68963	3.05034
H	2.74437	1.74742	2.80560
H	3.54377	0.16410	2.83467

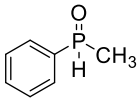
H	2.42102	0.61848	4.12906
C	-2.07483	1.63447	-0.07827
C	-2.21136	1.79047	-1.46927
H	-2.07001	0.92815	-2.11497
C	-2.49068	3.03903	-2.02044
H	-2.59372	3.14092	-3.09721
C	-2.62244	4.15811	-1.19298
H	-2.82782	5.13452	-1.62281
C	-2.48624	4.01509	0.18729
H	-2.58469	4.88013	0.83744
C	-2.21946	2.76062	0.74159
H	-2.11517	2.67482	1.81787
C	-3.24898	-0.88698	0.64200
C	-3.31224	-2.25757	0.35879
H	-2.41872	-2.76254	0.00376
C	-4.51477	-2.95052	0.50015
H	-4.55572	-4.01215	0.27319
C	-5.66541	-2.27699	0.91367
H	-6.60406	-2.81475	1.01576
C	-5.61251	-0.90735	1.18512
H	-6.50917	-0.37897	1.49773
C	-4.40906	-0.21525	1.05159
H	-4.37288	0.85169	1.25373
C	2.19534	1.58101	-0.10337
C	3.39622	2.20819	0.26915
H	4.13747	1.66204	0.84221
C	3.65340	3.52534	-0.10922
H	4.58759	3.99705	0.18338
C	2.71399	4.23825	-0.85961
H	2.91550	5.26679	-1.14640
C	1.52440	3.62158	-1.24652
H	0.78643	4.16063	-1.83350
C	1.27420	2.29888	-0.87912
H	0.35874	1.81443	-1.19479
C	3.27131	-1.07788	0.34854
C	3.41071	-2.23297	1.13402
H	2.63757	-2.50165	1.84825
C	4.52728	-3.05694	1.00035
H	4.61837	-3.94434	1.62070
C	5.52161	-2.74692	0.07004
H	6.39019	-3.39039	-0.03672
C	5.38660	-1.60915	-0.72606
H	6.14973	-1.36319	-1.45946
C	4.27061	-0.78311	-0.59001
H	4.17260	0.09211	-1.22354
C	0.68118	-1.86709	-2.16101
C	-0.60391	-1.83734	-2.24687
Ni	-0.00516	-0.90624	-0.67969
C	-1.73040	-2.25269	-3.04709
H	-1.50950	-2.98279	-3.83134
C	-2.99437	-1.81640	-2.92799
H	-3.27979	-1.09912	-2.16659
H	-3.77849	-2.17446	-3.58913
C	1.96945	-2.29791	-2.75492
H	1.81874	-2.95577	-3.62228
H	2.55553	-1.43097	-3.08477
H	2.58869	-2.82667	-2.02162



Resting state A2

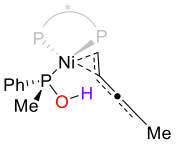
P	1.93166	-0.32861	-0.20994
P	-1.40685	-0.56807	-0.53096
C	1.74151	-0.80653	-2.00979
H	2.59303	-0.38778	-2.56190
C	0.45441	-0.21975	-2.63925
H	0.37880	0.85195	-2.41698
H	0.57920	-0.28790	-3.72959
C	-0.89261	-0.89928	-2.30795
H	-0.74584	-1.98384	-2.35601
Ni	0.16992	-0.71852	0.97607
C	-2.17034	1.41407	2.91860
C	-1.52625	0.38433	2.86839
C	-0.80309	-0.84269	2.73140
H	-1.40055	-1.75441	2.75619
C	0.60402	-0.92923	2.91906
H	1.15349	-0.08122	3.32321
H	1.04112	-1.90181	3.13823
C	1.82172	-2.33423	-2.13835
H	2.81946	-2.69649	-1.87660
H	1.10597	-2.83244	-1.47501
H	1.60456	-2.64457	-3.16799
C	-1.94959	-0.50091	-3.34555
H	-2.06870	0.58633	-3.38178
H	-1.64932	-0.84265	-4.34404
H	-2.92762	-0.93482	-3.11860
C	-2.93317	2.65785	2.89684

H	-2.26824	3.52952	2.93560
H	-3.52062	2.74270	1.97401
H	-3.62465	2.73334	3.74649
C	-2.87647	-1.64341	-0.28662
C	-3.71083	-1.37311	0.81345
C	-3.13749	-2.78161	-1.06233
C	-4.78607	-2.20730	1.10922
H	-3.50506	-0.51229	1.44257
C	-4.21250	-3.62036	-0.75883
H	-2.50660	-3.02684	-1.91014
C	-5.04291	-3.33440	0.32374
H	-5.42190	-1.97970	1.96051
H	-4.39941	-4.49639	-1.37407
H	-5.87995	-3.98601	0.55809
C	-2.12481	1.12261	-0.63484
C	-3.45449	1.37893	-0.99871
C	-1.28040	2.20590	-0.35151
C	-3.92269	2.69049	-1.08850
H	-4.12684	0.55240	-1.20349
C	-1.74333	3.51703	-0.45647
H	-0.26301	2.02156	-0.03235
C	-3.06686	3.76309	-0.82458
H	-4.95636	2.87488	-1.36867
H	-1.06877	4.33973	-0.23632
H	-3.43411	4.78316	-0.89751
C	3.58864	-1.02829	0.17689
C	4.77190	-0.52319	-0.38060
C	3.65441	-2.13147	1.03746
C	5.99833	-1.11835	-0.08831
H	4.73497	0.34559	-1.03198
C	4.88159	-2.73089	1.32571
H	2.73638	-2.50508	1.48135
C	6.05434	-2.22530	0.76292
H	6.91132	-0.71768	-0.52055
H	4.92236	-3.58644	1.99427
H	7.01107	-2.68687	0.99125
C	2.26326	1.48336	-0.26019
C	2.58697	2.20492	-1.41730
C	2.11341	2.18399	0.94898
C	2.74706	3.59148	-1.37049
H	2.70573	1.69507	-2.36749
C	2.28241	3.56640	0.99822
H	1.83478	1.63670	1.84431
C	2.59396	4.27578	-0.16457
H	2.98812	4.13605	-2.27933
H	2.15851	4.09073	1.94157
H	2.71446	5.35490	-0.13069



1b

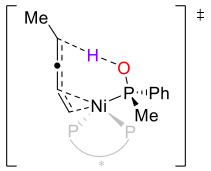
C	-0.15090	-0.00542	-0.16430
C	-0.88843	-1.17941	-0.36539
C	-0.80819	1.17954	0.18377
C	-2.27327	-1.16883	-0.21083
H	-0.38719	-2.10239	-0.64920
C	-2.19475	1.18690	0.33963
H	-0.22131	2.08247	0.32273
C	-2.92599	0.01465	0.14414
H	-2.84395	-2.07963	-0.36833
H	-2.70417	2.10741	0.60996
H	-4.00571	0.02156	0.26406
C	2.27648	-1.19844	0.85979
H	1.80596	-2.17312	0.69340
H	2.04873	-0.85999	1.87483
P	1.65880	0.04164	-0.33155
O	2.24685	1.41440	-0.20943
H	1.88022	-0.61210	-1.57569
H	3.36107	-1.29803	0.75611



INT-1

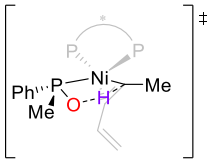
P	1.44569	0.63797	-0.55484
P	-1.92010	0.43813	-0.24831
C	0.90010	0.42275	-2.34322
H	1.59123	1.01782	-2.95564
C	-0.51877	0.96053	-2.63744
H	-0.60909	2.00607	-2.32249
H	-0.61529	0.97561	-3.73291
C	-1.75018	0.19189	-2.10369
H	-1.58057	-0.88374	-2.23137
Ni	-0.13745	-0.03124	0.93841
P	-0.07663	-2.19433	1.23858
O	1.21492	-2.71697	2.16204
H	1.67132	-1.92572	2.51698
C	2.90443	-0.05368	3.25188

C	1.71630	0.16995	3.10634	H	3.93009	1.44219	-2.01056
C	0.31097	0.36295	2.93679	C	4.72976	-1.81006	-0.06240
H	-0.32606	-0.24440	3.57823	H	2.71240	-1.67256	0.67527
C	-0.24740	1.49029	2.30955	C	5.70602	-1.22476	-0.86901
H	0.38485	2.31498	2.00041	H	6.17046	0.41172	-2.19672
H	-1.27898	1.75129	2.52505	H	4.95085	-2.71730	0.49404
C	1.04853	-1.04240	-2.77232	H	6.69267	-1.67332	-0.94639
H	2.09480	-1.35621	-2.75809	C	1.90169	2.42600	-0.46508
H	0.49547	-1.71704	-2.11740	C	1.64273	3.38117	-1.45802
H	0.66684	-1.17454	-3.79267	C	2.50204	2.85734	0.73265
C	-2.98064	0.62230	-2.91594	C	1.95265	4.72887	-1.25429
H	-3.08194	1.71204	-2.90819	H	1.19538	3.08839	-2.40063
H	-2.87401	0.30093	-3.95965	C	2.81918	4.19866	0.93204
H	-3.91283	0.20596	-2.52644	H	2.71517	2.13051	1.51144
C	4.34138	-0.27037	3.39552	C	2.53754	5.14364	-0.05875
H	4.54912	-1.14005	4.03079	H	1.73830	5.45182	-2.03698
H	4.81368	-0.44745	2.42146	H	3.28206	4.50848	1.86511
H	4.83161	0.59666	3.85602	H	2.77609	6.19156	0.09981
C	-3.39893	-0.54844	0.22481	C	0.05624	-3.37117	-0.16149
C	-3.90445	-0.35199	1.52255	C	-1.05365	-3.58141	-0.99439
C	-3.95424	-1.57239	-0.55476	C	1.27500	-3.97513	-0.49549
C	-4.93235	-1.14734	2.01978	C	-0.94167	-4.35679	-2.14711
H	-3.47696	0.42789	2.14678	H	-2.00915	-3.13546	-0.74181
C	-4.97433	-2.38456	-0.04982	C	1.38744	-4.74811	-1.65214
H	-3.59157	-1.75101	-1.56077	H	2.13059	-3.83912	0.15482
C	-5.46765	-2.17531	1.23680	C	0.28414	-4.93502	-2.48592
H	-5.30963	-0.97491	3.02402	H	-1.81076	-4.50944	-2.78194
H	-5.38369	-3.17818	-0.66897	H	2.34141	-5.20457	-1.90218
H	-6.26056	-2.80565	1.62861	H	0.37589	-5.53180	-3.38905
C	-2.57538	2.16137	-0.18322	C	-1.47961	-2.94325	2.17563
C	-3.93910	2.47670	-0.27910	H	-1.63236	-2.36767	3.09333
C	-1.64742	3.20890	-0.08919	H	-2.39873	-2.88732	1.58665
C	-4.35978	3.80700	-0.28438	H	-1.26430	-3.98625	2.42729
H	-4.67372	1.68097	-0.34720				
C	-2.06537	4.53916	-0.11423				
H	-0.59471	2.97939	0.01238				
C	-3.42451	4.84184	-0.20807				
H	-5.41998	4.03568	-0.35369				
H	-1.32508	5.33190	-0.05052				
H	-3.75551	5.87675	-0.21615	P	1.52290	0.66545	-0.51213
C	3.15562	-0.06290	-0.67051	P	-1.90624	0.40058	-0.23817
C	4.14676	0.52365	-1.47249	C	0.97747	0.50970	-2.31022
C	3.46357	-1.22839	0.03707	H	1.63627	1.18070	-2.87802
C	5.41171	-0.05332	-1.57287	C	-0.46451	0.98353	-2.59294



TS-1a

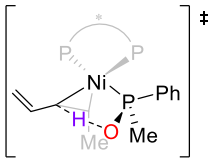
H	-0.60575	2.01833	-2.26435	H	-0.68626	3.02765	-0.14397
H	-0.55690	1.01367	-3.68820	C	-3.61151	4.73111	-0.38859
C	-1.66657	0.15002	-2.08507	H	-5.56684	3.82223	-0.42685
H	-1.44476	-0.91613	-2.20455	H	-1.53559	5.32900	-0.31936
Ni	-0.10427	0.02420	0.99747	H	-3.99308	5.74677	-0.44534
P	0.08558	-2.22770	1.15690	C	3.23607	-0.01987	-0.63152
O	1.39758	-2.72133	1.92941	C	4.20253	0.57682	-1.45772
H	1.86923	-1.78326	2.57069	C	3.58202	-1.15527	0.10729
C	2.19897	-0.72588	3.37757	C	5.48314	0.03688	-1.55290
C	1.19237	0.02911	3.24460	H	3.95530	1.47424	-2.01789
C	-0.03668	0.61962	3.02718	C	4.86853	-1.69383	0.01519
H	-0.87961	0.24075	3.60566	H	2.85032	-1.62070	0.75399
C	-0.24833	1.69428	2.11575	C	5.81936	-1.10271	-0.81533
H	0.57487	2.35754	1.87476	H	6.22191	0.50715	-2.19650
H	-1.21880	2.17911	2.15145	H	5.12131	-2.57612	0.59723
C	1.20599	-0.91073	-2.83996	H	6.81999	-1.52057	-0.88641
H	2.26184	-1.18668	-2.80232	C	1.98247	2.44666	-0.36814
H	0.65143	-1.65460	-2.26938	C	1.63789	3.45131	-1.28168
H	0.87393	-0.97182	-3.88404	C	2.68681	2.81488	0.79347
C	-2.89298	0.52852	-2.93176	C	1.97573	4.78641	-1.03853
H	-3.02047	1.61522	-2.95309	H	1.10752	3.20747	-2.19484
H	-2.75318	0.18452	-3.96400	C	3.03040	4.14265	1.03199
H	-3.82495	0.10184	-2.55507	H	2.96325	2.04681	1.51187
C	3.42647	-0.84016	4.21704	C	2.66998	5.13723	0.11773
H	3.43167	-1.79955	4.74811	H	1.69869	5.54885	-1.76180
H	4.31934	-0.82845	3.57971	H	3.57674	4.40351	1.93418
H	3.51754	-0.03510	4.95548	H	2.93188	6.17448	0.30602
C	-3.35717	-0.62235	0.23725	C	0.13131	-3.25109	-0.36612
C	-3.81386	-0.46325	1.55812	C	-1.01652	-3.43916	-1.14872
C	-3.94835	-1.61433	-0.55598	C	1.34189	-3.80997	-0.79605
C	-4.83403	-1.26241	2.06433	C	-0.95093	-4.14018	-2.35250
H	-3.35124	0.28785	2.19295	H	-1.96666	-3.04246	-0.81219
C	-4.95907	-2.43215	-0.04162	C	1.40846	-4.50957	-2.00174
H	-3.61957	-1.76725	-1.57725	H	2.22430	-3.69073	-0.17894
C	-5.40661	-2.25839	1.26669	C	0.26654	-4.66851	-2.78880
H	-5.17347	-1.12081	3.08658	H	-1.84990	-4.27730	-2.94839
H	-5.39592	-3.20330	-0.67005	H	2.35595	-4.93033	-2.32773
H	-6.19186	-2.89396	1.66527	H	0.32161	-5.20835	-3.73006
C	-2.62988	2.09902	-0.23484	C	-1.31822	-3.00336	2.07398
C	-4.00901	2.34365	-0.30664	H	-1.41805	-2.49268	3.03645
C	-1.75272	3.19469	-0.23159	H	-2.25831	-2.88814	1.52888
C	-4.49507	3.65001	-0.37656	H	-1.11566	-4.06528	2.24392
H	-4.70580	1.51216	-0.30845				
C	-2.23689	4.49905	-0.31890				



TS-1b

P	0.83773	1.46428	-0.71571
P	-1.97038	-0.34948	-0.62624
C	0.26570	1.44929	-2.49582
H	0.69752	2.32862	-2.99022
C	-1.27197	1.56886	-2.60659
H	-1.63633	2.36084	-1.94099
H	-1.49573	1.91296	-3.62664
C	-2.12545	0.30443	-2.37966
H	-1.71625	-0.49999	-3.00232
C	0.80129	-0.11643	2.06922
C	-0.28471	-0.73507	2.49679
Ni	0.01615	-0.28613	0.36200
P	0.69912	-2.47716	0.17011
O	0.07003	-3.10949	1.49403
H	-0.28707	-2.05670	2.03866
C	-2.81888	-1.97638	-0.68462
C	-3.20560	-2.63175	-1.86133
C	-2.98720	-2.63741	0.54315
C	-3.75468	-3.91525	-1.81165
H	-3.06764	-2.16009	-2.82759
C	-3.53911	-3.91404	0.59215
H	-2.65438	-2.15656	1.45635
C	-3.92418	-4.55868	-0.58611
H	-4.04465	-4.41098	-2.73400
H	-3.64886	-4.41434	1.54967
H	-4.34447	-5.55962	-0.54878
C	-3.17086	0.66995	0.32583
C	-4.55324	0.42950	0.32218
C	-2.66938	1.73495	1.08413
C	-5.41258	1.25377	1.04790
H	-4.95456	-0.40922	-0.23723
C	-3.52933	2.56793	1.79920
H	-1.59972	1.88843	1.12776
C	-4.90400	2.32935	1.78141
H	-6.48103	1.05586	1.04232
H	-3.11861	3.39414	2.37285
H	-5.57745	2.96990	2.34424
C	2.66268	1.61817	-0.91450
C	3.27237	2.77785	-1.41691
C	3.46001	0.51741	-0.57853
C	4.65491	2.82768	-1.58697
H	2.66910	3.64770	-1.65957
C	4.84471	0.56679	-0.75018
H	2.99230	-0.37155	-0.17542
C	5.44290	1.72136	-1.25505
H	5.11942	3.73114	-1.97315
H	5.44270	-0.29888	-0.48394
H	6.52090	1.76500	-1.38541
C	0.39530	3.16595	-0.14235
C	0.07651	4.23336	-0.99436
C	0.36515	3.38949	1.24406
C	-0.26802	5.48395	-0.47728
H	0.08834	4.09943	-2.07087
C	0.03247	4.64007	1.76179
H	0.58255	2.56908	1.91988
C	-0.29059	5.69191	0.90165
H	-0.51920	6.29514	-1.15527
H	0.01802	4.78975	2.83795
H	-0.56059	6.66452	1.30315
C	0.82729	0.20507	-3.19549
H	0.44787	0.13519	-4.22256
H	1.91961	0.24281	-3.23629
H	0.54956	-0.70731	-2.65820
C	-3.56763	0.59270	-2.81985
H	-3.97483	1.44732	-2.27112
H	-3.59216	0.83463	-3.88966
H	-4.23496	-0.25561	-2.65001
C	0.19660	-3.58473	-1.21937
H	-0.88675	-3.70094	-1.19188
H	0.47284	-3.14704	-2.18469
H	0.66790	-4.56748	-1.12208
C	2.49902	-2.80838	0.26911
C	3.29533	-2.99341	-0.87051
C	3.11988	-2.75585	1.52632
C	4.67992	-3.12889	-0.75654
H	2.83831	-3.02587	-1.85560
C	4.50243	-2.88765	1.63977
H	2.50618	-2.61354	2.40900
C	5.28838	-3.07522	0.49906
H	5.28295	-3.27534	-1.64893
H	4.96896	-2.84718	2.62050
H	6.36618	-3.18104	0.58882
C	-1.19436	-0.41673	3.65315

H	-0.80586	0.40205	4.27431
H	-2.18591	-0.12031	3.28801
H	-1.34061	-1.29554	4.29441
C	1.98595	0.52303	2.58054
H	2.51793	1.21005	1.92629
C	2.49203	0.26499	3.80200
H	2.02007	-0.45343	4.46646
H	3.39468	0.75532	4.15647



TS-1-regio

P	1.16778	1.02594	-0.65325
P	-1.86557	-0.32208	-0.45933
C	0.92076	0.61444	-2.45231
H	1.36281	1.42458	-3.04614
C	-0.57671	0.55831	-2.83119
H	-1.07123	1.50546	-2.58673
H	-0.61344	0.47650	-3.92661
C	-1.41909	-0.60454	-2.26658
H	-0.79238	-1.50241	-2.23958
C	0.40150	0.45575	2.90038
C	-0.80160	0.05545	2.51852
Ni	-0.07108	-0.10395	0.81490
P	0.99357	-2.09536	1.33440
O	1.98273	-1.59544	2.49020
H	1.39381	-0.51725	2.73606
C	-2.88183	-1.80543	-0.08253
C	-2.46247	-3.06957	-0.52835
C	-4.01488	-1.73393	0.74127
C	-3.15580	-4.22398	-0.16805
H	-1.58597	-3.15684	-1.16166
C	-4.70491	-2.88977	1.10871
H	-4.36454	-0.76971	1.09313
C	-4.27918	-4.13925	0.65660
H	-2.81570	-5.19042	-0.53009
H	-5.58025	-2.81062	1.74756
H	-4.81779	-5.03815	0.94189
C	-3.08384	1.05459	-0.50521
C	-4.36925	0.96496	-1.06573
C	-2.66536	2.27768	0.03765
C	-5.20244	2.08219	-1.10025
H	-4.72482	0.01845	-1.45846
C	-3.49463	3.39915	-0.00814
H	-1.68604	2.34039	0.49721
C	-4.76328	3.30336	-0.57978
H	-6.19569	2.00098	-1.53347
H	-3.14215	4.34018	0.40335
H	-5.41416	4.17277	-0.61390
C	2.99342	1.16542	-0.48405
C	3.77297	1.84235	-1.43405
C	3.60875	0.63727	0.65558
C	5.14900	1.96857	-1.25642
H	3.30480	2.28324	-2.30985
C	4.98731	0.77342	0.83735
H	3.01424	0.10318	1.38775
C	5.75938	1.43300	-0.11817
H	5.74497	2.49039	-2.00026
H	5.45353	0.35511	1.72530
H	6.83206	1.53542	0.02156
C	0.69969	2.80751	-0.53382
C	0.32638	3.61184	-1.61741
C	0.68869	3.36500	0.75553
C	-0.08029	4.93315	-1.41538
H	0.33872	3.22068	-2.62846
C	0.29544	4.68623	0.95449
H	0.97349	2.75597	1.60603
C	-0.10247	5.47329	-0.13022
H	-0.38031	5.53794	-2.26683
H	0.29414	5.09754	1.96024
H	-0.42046	6.50054	0.02527
C	1.66546	-0.68014	-2.80482
H	1.45801	-0.96200	-3.84464
H	2.74549	-0.55776	-2.69357
H	1.37232	-1.51238	-2.16212
C	-2.61653	-0.87167	-3.18624
H	-3.21395	0.03526	-3.32223
H	-2.26229	-1.18835	-4.17495
H	-3.26886	-1.65680	-2.79383
C	0.04497	-3.49949	2.07085
H	-0.52428	-3.09293	2.91225
H	-0.66705	-3.91974	1.35578
H	0.71575	-4.28500	2.43312
C	2.02276	-2.94243	0.08383
C	1.43244	-3.80771	-0.85222
C	3.38747	-2.64874	-0.03957
C	2.18170	-4.34623	-1.89759

H	0.38032	-4.06378	-0.76422
C	4.13462	-3.18046	-1.09042
H	3.85590	-2.00375	0.69291
C	3.53496	-4.02464	-2.02730
H	1.70942	-5.01511	-2.61259
H	5.19019	-2.93581	-1.17492
H	4.11793	-4.43575	-2.84670
C	-2.17404	-0.01125	3.08079
H	-2.53790	-1.04611	3.07942
H	-2.20431	0.35911	4.11464
H	-2.87890	0.57086	2.47558
C	0.75869	1.52587	3.82518
H	-0.06210	2.01169	4.36183
C	2.01185	1.95585	4.04664
H	2.85819	1.51740	3.52461
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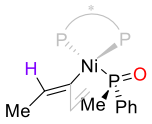

INT-2

P	1.00500	-1.45874	0.69191
P	-2.06783	-0.02015	0.64517
C	0.23831	-1.88395	2.34989
H	0.73517	-2.80405	2.68176
C	-1.27835	-2.17547	2.28906
H	-1.51610	-2.83139	1.44461
H	-1.52703	-2.74853	3.19372
C	-2.22940	-0.96829	2.25593
H	-1.90387	-0.24844	3.01417
C	-1.38892	2.48648	-1.76747
C	-0.68590	2.22303	-0.64543
Ni	0.06115	0.46201	-0.18594
C	-0.60164	3.17038	0.47040
H	-1.29124	4.01618	0.47272
C	0.23621	3.04649	1.51400
H	0.96184	2.23823	1.55530
P	1.78101	0.84283	-1.58998
O	2.70307	-0.37603	-1.73195
H	-1.44898	1.70758	-2.52745
C	1.18534	1.30704	-3.27981
C	2.76763	-1.36841	1.17742
C	3.54455	-2.52122	1.33793
C	3.32258	-0.11844	1.47314
C	4.86059	-2.42098	1.79038
H	3.12794	-3.49349	1.09283
C	4.63530	-0.01886	1.92913
H	2.73526	0.77972	1.31494
C	5.40712	-1.17134	2.08908
H	5.46135	-3.31935	1.90297
H	5.05764	0.96052	2.13385
H	6.43371	-1.09569	2.43666
C	0.87298	-3.01889	-0.27637
C	0.38390	-4.21937	0.25922
C	1.24188	-2.98007	-1.63270
C	0.23126	-5.34827	-0.54836
H	0.11897	-4.29430	1.30720
C	1.09123	-4.11221	-2.43199
H	1.67897	-2.06434	-2.02712
C	0.57442	-5.29542	-1.89857
H	-0.15483	-6.26779	-0.11707
H	1.38611	-4.06903	-3.47713
H	0.45133	-6.17314	-2.52723
C	-3.26454	1.34460	0.89095
C	-3.25540	2.06859	2.09225
C	-4.11490	1.76437	-0.14115
C	-4.09250	3.17039	2.26536
H	-2.57945	1.78947	2.89350
C	-4.95061	2.86713	0.03145
H	-4.11693	1.23320	-1.08595
C	-4.94319	3.57339	1.23528
H	-4.07300	3.71759	3.20362
H	-5.60343	3.17739	-0.77953
H	-5.59285	4.43370	1.36839
C	-2.84627	-1.11566	-0.60468
C	-2.00872	-1.70084	-1.56569
C	-4.21493	-1.43430	-0.61790
C	-2.51132	-2.61382	-2.49269
H	-0.95644	-1.44173	-1.58540
C	-4.72039	-2.33499	-1.55400
H	-4.88741	-0.96656	0.09229
C	-3.86839	-2.93459	-2.48594
H	-1.83587	-3.07304	-3.20784
H	-5.78079	-2.57156	-1.55452
H	-4.26551	-3.64349	-3.20708
C	0.57605	-0.78759	3.37171
H	0.05577	-0.97908	4.31834
H	1.64852	-0.75565	3.57380
H	0.27786	0.20478	3.01514

C	-3.65509	-1.41090	2.60436
H	-3.99839	-2.20034	1.92909
H	-3.67826	-1.81209	3.62504
H	-4.36300	-0.57890	2.55221
C	2.82130	2.29900	-1.15946
C	2.34134	3.61535	-1.13979
C	4.16494	2.05523	-0.84543
C	3.18884	4.66812	-0.79657
H	1.30444	3.81372	-1.38464
C	5.01048	3.10903	-0.49482
H	4.52688	1.03343	-0.88869
C	4.52302	4.41702	-0.46525
H	2.80743	5.68598	-0.78400
H	6.05148	2.90968	-0.25229
H	5.18018	5.23893	-0.19296
H	0.24872	3.76501	2.32892
H	0.75360	2.30806	-3.30871
H	0.43755	0.58262	-3.61878
H	2.05465	1.25585	-3.94317
C	-2.10856	3.75591	-2.14177
H	-1.67285	4.19627	-3.05050
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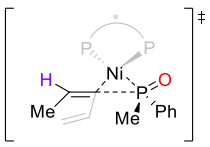

TS-2

P	-2.03689	-0.81057	0.55883
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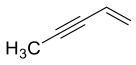
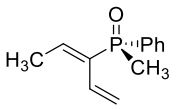
H	-3.33904	-0.26291	2.54669
C	-1.86783	1.29685	2.47229
H	-2.36160	1.91395	1.71123
H	-2.28534	1.62239	3.43571
C	-0.36055	1.62933	2.49959
H	0.17499	0.81203	2.99406
Ni	-0.07898	-0.29319	-0.25893
P	1.36759	-2.02920	-0.21995
O	1.22909	-2.06746	1.31226
H	-0.30434	-1.69643	-2.51628
C	0.39558	-0.88960	-2.71767
C	1.18299	-0.45942	-1.68876
C	2.25958	0.53585	-1.77223
H	3.12360	0.34751	-1.14068
C	2.22724	1.67925	-2.47301
H	1.36998	1.97971	-3.06624
H	3.05137	2.38389	-2.41202
C	-1.51156	-1.09577	3.29674
H	-2.00914	-2.06331	3.39635
H	-0.48484	-1.28489	2.96808
H	-1.48470	-0.62788	4.28901
C	-0.10840	2.91177	3.29921
H	-0.70773	3.74258	2.91348
H	-0.39000	2.75953	4.34867
H	0.94636	3.20297	3.27157
C	0.38649	-0.36111	-4.12556
H	0.14538	-1.15593	-4.84150
H	-0.37045	0.42708	-4.25385
H	1.35339	0.07744	-4.39071
C	2.14593	1.91873	1.12973
C	2.88173	3.00813	0.64599
C	2.81921	0.89845	1.82545
C	4.25752	3.08806	0.87021
H	2.38915	3.78274	0.07015
C	4.19139	0.98544	2.05145
H	2.27742	0.00799	2.13366
C	4.91594	2.08149	1.57707
H	4.81561	3.93684	0.48367
H	4.69951	0.18383	2.57962
H	5.98754	2.14269	1.74504
C	-0.29022	3.11950	-0.03546
C	-0.06890	4.44154	0.38529
C	-1.13420	2.89845	-1.13473
C	-0.68331	5.50680	-0.27351
H	0.58763	4.64315	1.22373
C	-1.75989	3.96113	-1.78569
H	-1.30288	1.88039	-1.46725
C	-1.53432	5.26919	-1.35578
H	-0.50072	6.52421	0.06171
H	-2.42445	3.76140	-2.62141
H	-2.01661	6.10175	-1.86070
C	-2.72831	-2.51262	0.67656
C	-4.04249	-2.83209	0.30864
C	-1.88239	-3.53277	1.14664
C	-4.50454	-4.14579	0.40837
H	-4.70524	-2.05525	-0.05936
C	-2.35248	-4.84094	1.25553

H	-0.85801	-3.29389	1.41972
C	-3.66269	-5.15219	0.88384
H	-5.52450	-4.38131	0.11604
H	-1.69015	-5.62012	1.62324
H	-4.02399	-6.17403	0.96090
C	-3.31186	0.09177	-0.41842
C	-4.36500	0.83014	0.13720
C	-3.17112	0.07689	-1.81660
C	-5.23955	1.55107	-0.67917
H	-4.50967	0.85423	1.21180
C	-4.05143	0.78311	-2.63381
H	-2.34611	-0.47641	-2.25515
C	-5.08488	1.53208	-2.06513
H	-6.04263	2.12789	-0.22874
H	-3.92464	0.75800	-3.71281
H	-5.76487	2.09519	-2.69815
C	3.17054	-2.21434	-0.56266
C	3.69400	-2.34879	-1.85608
C	4.04068	-2.23799	0.53233
C	5.06528	-2.50241	-2.04961
H	3.02968	-2.30998	-2.71476
C	5.41545	-2.38532	0.33856
H	3.61877	-2.14758	1.52713
C	5.93004	-2.51635	-0.95137
H	5.46171	-2.60435	-3.05626
H	6.08415	-2.39834	1.19533
H	7.00010	-2.62891	-1.10347
C	0.71679	-3.55684	-1.02834
H	-0.37406	-3.57504	-1.00762
H	1.07147	-3.64190	-2.05746
H	1.09823	-4.40509	-0.45115



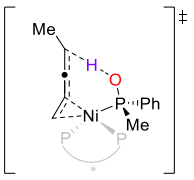
2w

C	1.13169	-0.06476	0.00000
C	-0.06909	-0.23352	-0.00000
C	2.57225	0.16135	-0.00000
H	2.88535	0.72959	-0.88470
H	2.88542	0.72913	0.88497
H	3.12457	-0.78602	-0.00027
C	-1.47018	-0.48174	-0.00000
H	-1.77329	-1.52901	-0.00002
C	-2.41398	0.47153	0.00001
H	-2.15806	1.52667	0.00002
H	-3.46814	0.21248	0.00001



3bw

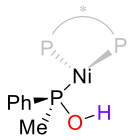
P	0.45097	1.03819	-0.38282
O	0.42518	2.36856	0.31916
C	-3.58482	-1.16179	0.05076
C	-1.12269	0.13138	-0.21281
C	-1.26942	-1.19445	-0.63926
H	-0.41856	-1.72743	-1.05626
C	2.58251	-0.70721	-0.62900
H	2.53604	-0.42494	-1.67801
C	1.70523	-0.14699	0.23070
C	-2.49816	-1.83867	-0.50919
H	-2.60890	-2.86831	-0.83794
C	-3.44065	0.15753	0.48193
H	-4.28427	0.68147	0.92250
C	-2.21126	0.80455	0.35121
H	-2.07563	1.82790	0.68796
C	0.68260	1.18861	-2.19346
H	1.65926	1.62631	-2.41797
H	0.57110	0.23535	-2.71717
C	1.06221	0.26244	2.61604
H	0.59075	1.21499	2.39825
H	1.06223	-0.07393	3.64873
C	1.65240	-0.47379	1.66463
H	2.13203	-1.40618	1.95614
H	-0.09340	1.87484	-2.54450
H	-4.54180	-1.66581	0.15403
C	3.67335	-1.68621	-0.30959
H	3.72891	-1.94225	0.74984
H	3.54163	-2.61326	-0.88335
H	4.64666	-1.27248	-0.60507



TS-1a-S

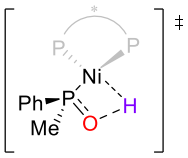
P	-2.00596	0.09989	0.37814
P	1.20553	1.31801	0.50974
C	-1.83487	1.36669	1.76637
H	-1.55668	2.30076	1.26484

C	-0.65492	0.92412	2.66283	H	-3.29150	-0.91414	-1.95737
C	0.72680	1.52783	2.32966	C	-4.70436	2.04118	-2.87811
Ni	0.16372	-0.34518	-0.45372	H	-4.53257	3.88252	-1.77026
P	1.01668	-2.12254	0.60860	H	-4.69137	0.06431	-3.74387
O	0.07383	-3.41583	0.54496	H	-5.31014	2.47501	-3.66851
C	3.04091	1.20963	0.54879	C	-3.10036	1.61389	2.59269
C	3.84173	1.31355	1.69347	H	-2.93009	2.43341	3.30244
C	3.66344	0.97760	-0.68906	H	-3.95757	1.87891	1.96706
C	5.23091	1.18363	1.60260	H	-3.37391	0.72174	3.16377
H	3.39687	1.50190	2.66461	H	-0.87978	1.20366	3.70099
C	5.04719	0.87220	-0.78343	H	-0.58619	-0.16736	2.65823
H	3.04849	0.85855	-1.57655	H	1.45839	0.91028	2.86237
C	5.83715	0.96959	0.36533	C	0.84490	2.96711	2.84409
H	5.83688	1.25947	2.50133	H	1.83275	3.39436	2.65031
H	5.50844	0.68495	-1.74849	H	0.11121	3.62326	2.36525
H	6.91680	0.87195	0.29607	H	0.66832	2.99264	3.92642
C	0.98813	3.00622	-0.20785	H	-0.68624	-3.25765	-0.38358
C	1.95891	4.01236	-0.09129	C	0.20856	-1.01126	-2.43120
C	-0.20148	3.29725	-0.88764	C	-0.09300	0.37837	-2.32488
C	1.73083	5.28171	-0.62301	H	0.65680	1.07588	-2.68908
H	2.89888	3.80154	0.40834	H	-1.11706	0.71235	-2.45025
C	-0.43702	4.56880	-1.40898	H	1.21023	-1.31582	-2.73602
H	-0.93662	2.51717	-1.02954	C	-0.67093	-2.02777	-2.09585
C	0.52960	5.56662	-1.27643	C	-1.28142	-3.04420	-1.64266
H	2.49366	6.04964	-0.52724	C	-2.22301	-4.08609	-2.15034
H	-1.36996	4.76778	-1.92939	H	-1.79477	-5.08479	-2.00140
H	0.35522	6.55636	-1.68920	H	-3.15643	-4.05988	-1.57444
C	-3.16457	-1.13785	1.10904	H	-2.46717	-3.97011	-3.21337
C	-4.55671	-0.94564	1.12794	C	1.52295	-2.06092	2.38160
C	-2.63829	-2.30439	1.67945	H	0.63901	-1.88736	3.00089
C	-5.39654	-1.89108	1.71314	H	1.97971	-3.01123	2.67340
H	-4.98536	-0.05777	0.67581	H	2.23664	-1.24991	2.55455
C	-3.48119	-3.24895	2.26934	C	2.57960	-2.65380	-0.20034
H	-1.57737	-2.51032	1.61774	C	3.83923	-2.18507	0.19386
C	-4.86029	-3.04515	2.29035	C	2.49385	-3.51742	-1.30405
H	-6.47096	-1.72742	1.71726	C	4.98835	-2.57331	-0.49665
H	-3.05316	-4.15212	2.69539	H	3.93674	-1.50543	1.03344
H	-5.51660	-3.78393	2.74240	C	3.64125	-3.89831	-1.99746
C	-3.12972	0.91656	-0.82817	H	1.52215	-3.89385	-1.60697
C	-3.48621	2.27239	-0.79844	C	4.89412	-3.42723	-1.59540
C	-3.57551	0.13306	-1.90910	H	5.95596	-2.19800	-0.17559
C	-4.26504	2.83014	-1.81618	H	3.55935	-4.57017	-2.84800
H	-3.16080	2.90897	0.01648	H	5.78927	-3.72703	-2.13370
C	-4.35766	0.68764	-2.91890				



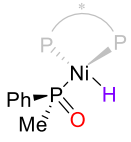
TS-1a-S

P	-1.76068	-0.81738	-0.45433
P	1.61548	-0.97393	-0.60687
C	-2.29500	0.72918	-1.30530
C	3.23799	-1.65857	-0.05814
C	-0.20696	-1.75624	-2.63783
H	-0.15553	-0.70017	-2.93048
H	-0.26164	-2.32097	-3.57977
C	-3.30732	-1.39184	0.36273
C	2.11227	0.54839	-1.51591
C	-1.54618	-2.00563	-1.90295
H	-1.50502	-2.99994	-1.44379
C	1.11577	-2.18209	-1.94985
H	1.89625	-2.19191	-2.72266
C	-1.30385	1.66873	-1.62775
H	-0.27782	1.48403	-1.33746
C	5.61003	-2.09021	-0.33080
H	6.51964	-1.99618	-0.91807
C	4.41493	-1.55397	-0.81134
H	4.39913	-1.03621	-1.76637
C	-3.93577	-0.51092	1.26090
H	-3.54765	0.49760	1.37672
C	-3.62548	1.00664	-1.65499
H	-4.40779	0.29719	-1.40580
C	-3.80941	-2.69534	0.25068
H	-3.34250	-3.40652	-0.42262
C	3.28021	-2.31074	1.18309
H	2.36398	-2.38692	1.76558
C	2.28134	0.63143	-2.90504
H	2.19264	-0.25591	-3.52308
C	2.23495	1.72289	-0.75302
H	2.08072	1.68211	0.31961
C	-3.95241	2.19406	-2.31011
H	-4.98789	2.39777	-2.56969
C	4.47321	-2.85489	1.66133
H	4.49218	-3.35894	2.62376
C	5.64120	-2.74220	0.90456
H	6.57400	-3.15567	1.27772
C	-1.62851	2.85042	-2.29392
H	-0.84070	3.55973	-2.53137
C	-4.91351	-3.10364	1.00411
H	-5.28566	-4.11960	0.90244
C	2.50866	2.94586	-1.36151
H	2.58060	3.83941	-0.74891
C	-5.04384	-0.91171	2.00089
H	-5.52010	-0.21081	2.68126
C	2.54903	1.85827	-3.51689
H	2.66644	1.90631	-4.59617
C	2.65914	3.01818	-2.74891
H	2.85851	3.97240	-3.22881
C	-5.53766	-2.21433	1.87674
H	-6.39770	-2.53129	2.45968
C	-2.95519	3.11765	-2.63473
H	-3.21411	4.04122	-3.14539
C	1.04062	-3.59355	-1.35192
H	0.39993	-3.61615	-0.46298
H	0.63269	-4.30147	-2.08417
H	2.03146	-3.94614	-1.05270
C	-2.70100	-1.97609	-2.91263
H	-2.71953	-1.02419	-3.45268
H	-2.58520	-2.78052	-3.64996
H	-3.67288	-2.10000	-2.42642
Ni	0.00953	-0.57236	0.73766
H	2.28189	-0.42253	2.90446
C	0.35301	2.06896	2.34466
C	-0.61724	2.67896	1.53423
C	1.46236	2.81885	2.75755
C	-0.48089	4.00895	1.14139
H	-1.46007	2.09597	1.17682
C	1.59944	4.15187	2.36322
H	2.21796	2.34465	3.37626
C	0.63118	4.74877	1.55229
H	-1.23194	4.45733	0.49709
H	2.46541	4.72394	2.68662
H	0.74431	5.78338	1.23948
C	-0.90785	0.20313	4.11838
H	-1.88370	0.58739	3.80479
H	-0.52717	0.79982	4.95386
P	0.23481	0.26028	2.67198
O	1.65299	-0.03696	3.53753
H	-1.03147	-0.83623	4.43744



TS-1-P

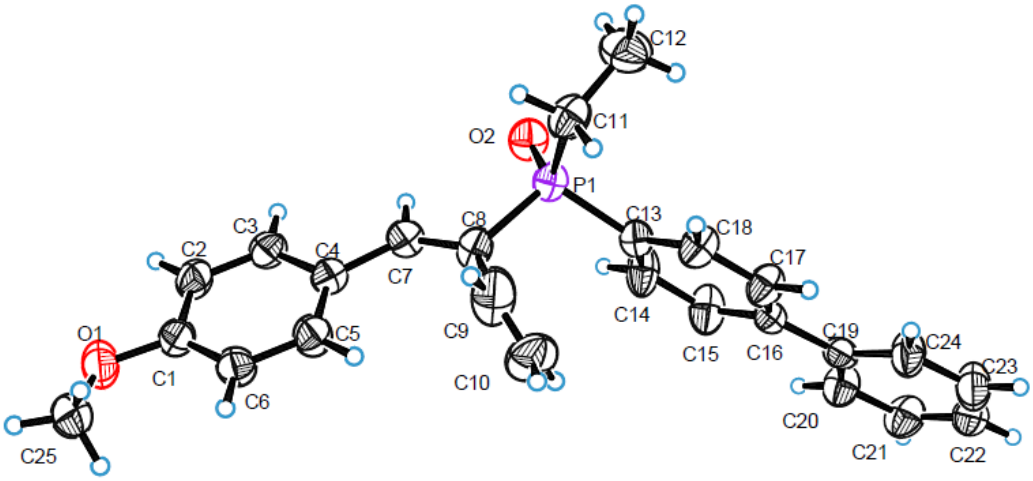
P	1.16141	-1.22550	0.63629
P	-2.11343	-0.50637	0.32238
C	1.91173	0.22471	1.47330
C	-3.79102	-0.77919	-0.37261
C	-0.80993	-1.58655	2.62135
H	-0.58149	-0.54360	2.87238
H	-1.02063	-2.08457	3.57843
C	2.58367	-2.22805	0.05520
C	-2.22047	1.18542	1.03412
C	0.45951	-2.25294	2.04379
H	0.16963	-3.19594	1.56773
C	-2.11558	-1.66504	1.79253
H	-2.93679	-1.36531	2.45681
C	1.27243	1.46104	1.30572
H	0.40223	1.53041	0.66729
C	-6.20554	-0.82030	-0.15313
H	-7.09785	-0.66275	0.44658
C	-4.94727	-0.58575	0.39745
H	-4.86394	-0.23497	1.42282
C	3.80536	-1.63439	-0.29948
H	3.95856	-0.57581	-0.12317
C	3.06849	0.16362	2.26829
H	3.59334	-0.77766	2.39103
C	2.41159	-3.60011	-0.19082
H	1.46929	-4.08344	0.05120
C	-3.91237	-1.19883	-1.70180
H	-3.01316	-1.31430	-2.30039
C	-2.42928	1.45573	2.39256
H	-2.60037	0.64798	3.09608
C	-2.00682	2.25887	0.15081
H	-1.82468	2.05972	-0.90118
C	3.56289	1.31287	2.88360
H	4.46159	1.25392	3.49168
C	-5.17342	-1.43533	-2.25256
H	-5.25879	-1.75623	-3.28685
C	-6.31930	-1.24920	-1.47902
H	-7.30109	-1.42872	-1.90833
C	1.75930	2.60785	1.93079
H	1.24750	3.55237	1.77872
C	3.43614	-4.35893	-0.75504
H	3.28415	-5.42026	-0.93118
C	-1.98806	3.56847	0.62599
H	-1.81014	4.38567	-0.06722
C	4.82785	-2.39351	-0.86896
H	5.76735	-1.91508	-1.13225
C	-2.40400	2.76942	2.86577
H	-2.55580	2.96274	3.92414
C	-2.17863	3.82781	1.98579
H	-2.15158	4.84854	2.35693
C	4.64964	-3.75873	-1.09636
H	5.44671	-4.34932	-1.53860
C	2.90597	2.53582	2.72054
H	3.29561	3.42911	3.20117
C	-2.41469	-3.08943	1.30220
H	-1.74171	-3.38456	0.48905
H	-2.29469	-3.80973	2.12077
H	-3.43748	-3.16723	0.92500
C	1.45445	-2.57291	3.16394
H	1.72296	-1.67024	3.72142
H	1.01139	-3.28473	3.87169
H	2.37321	-3.01706	2.76823
Ni	-0.34984	-0.57587	-0.85669
H	-1.37367	0.22685	-1.93519
C	1.46968	1.87249B	-2.12100
C	2.81129	1.65626	-1.77391
C	0.91724	3.14621	-1.94195
C	3.58455	2.69099	-1.25295
H	3.24671	0.66787	-1.89585
C	1.69186	4.18402	-1.41984
H	-0.11984	3.30485	-2.22168
C	3.02383	3.95798	-1.06868
H	4.62047	2.50992	-0.97823
H	1.25509	5.17068	-1.28537
H	3.62295	4.76252	-0.65106
C	1.23106	-0.10636	-4.16005
H	2.26098	-0.40426	-3.93546
H	1.23714	0.69041	-4.91246
P	0.38271	0.48389	-2.63184
O	-1.04399	1.10924	-3.02344
H	0.69118	-0.97165	-4.55554



INT-2-P

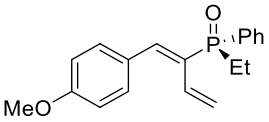
P	-0.88602	0.05252	-1.02963
P	2.37117	-0.30336	-0.34725
C	-1.35109	1.80077	-0.76020
C	3.88470	-1.25546	0.05443
C	1.29978	0.63252	-2.77869
H	1.24536	1.61911	-2.30163
H	1.53433	0.82319	-3.83512
C	-2.41580	-0.90108	-1.35328
C	2.70377	1.39089	0.27446
C	-0.08913	-0.04060	-2.73418
H	0.03500	-1.12249	-2.85895
C	2.48303	-0.17197	-2.20232
H	3.40311	0.37299	-2.44801
C	-0.89615	2.40121	0.42410
H	-0.38050	1.81187	1.17423
C	6.29771	-1.48469	0.11249
H	7.28563	-1.05604	-0.03153
C	5.16360	-0.71406	-0.13881
H	5.27251	0.31526	-0.46831
C	-3.69166	-0.34377	-1.47239
H	-3.84127	0.71456	-1.29691
C	-2.10250	2.57016	-1.66710
H	-2.49370	2.12456	-2.57257
C	-2.25740	-2.28778	-1.50967
H	-1.27519	-2.73350	-1.36851
C	3.75734	-2.57327	0.50959
H	2.76402	-2.97537	0.68497
C	3.35380	2.38041	-0.47798
H	3.70688	2.16890	-1.48236
C	2.24858	1.70277	1.56687
H	1.69138	0.97310	2.14961
C	-2.37099	3.91201	-1.40273
H	-2.95448	4.49322	-2.11146
C	4.89368	-3.34569	0.75455
H	4.78617	-4.36693	1.10924
C	6.16392	-2.80311	0.55565
H	7.04873	-3.40187	0.75292
C	-1.16247	3.74676	0.68065
H	-0.79842	4.19104	1.60220
C	-3.34915	-3.09477	-1.81927
H	-3.21299	-4.16592	-1.94036
C	2.44703	2.98006	2.08972
H	2.07528	3.20644	3.08471
C	-4.78590	-1.15568	-1.77508
H	-5.77482	-0.71287	-1.85013
C	3.54562	3.65816	0.04893
H	4.04439	4.41725	-0.54743
C	3.09360	3.95987	1.33452
H	3.23842	4.95703	1.74110
C	-4.61783	-2.52691	-1.96105
H	-5.47243	-3.15448	-2.19764
C	-1.89306	4.50620	-0.23189
H	-2.10000	5.55389	-0.03114
C	2.60572	-1.57518	-2.81492
H	1.82064	-2.24964	-2.45557
H	2.52973	-1.52024	-3.90764
H	3.56646	-2.02950	-2.56012
C	-0.95173	0.45516	-3.90148
H	-0.97095	1.54797	-3.94189
H	-0.52414	0.10017	-4.84707
H	-1.98022	0.08782	-3.83835
Ni	0.43018	-0.83929	0.54025
H	1.21337	-1.55895	1.60852
C	-2.67334	-0.69848	2.01694
C	-3.42331	-1.83509	1.68437
C	-3.32033	0.53927	2.11559
C	-4.79746	-1.73987	1.47716
H	-2.93314	-2.79887	1.57863
C	-4.69534	0.63777	1.89377
H	-2.73452	1.41108	2.38673
C	-5.43729	-0.50186	1.58125
H	-5.36794	-2.62740	1.21857
H	-5.18828	1.60329	1.97615
H	-6.50866	-0.42765	1.41362
C	-0.76252	-2.19538	3.48243
H	-1.02469	-3.12788	2.97087
H	-1.43385	-2.04466	4.33447
P	-0.85910	-0.76256	2.32512
O	-0.42270	0.54710	2.99797
H	0.27024	-2.26975	3.83315

8. ORTEP drawing of 3ka at 50% probability.



These data can be obtained free of charge from the Cambridge crystallographic data centre (**CCDC 2056434**).

9. Spectroscopic data of products.



3aa: 89% yield, colorless oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.86 – 7.68 (m, 2H), 7.55 – 7.44 (m, 5H), 7.40 (d, *J* = 19.5 Hz, 1H), 6.90 (d, *J* = 8.8 Hz, 2H), 6.60 (dddd, *J* = 18.1, 16.7, 11.6, 1.5 Hz, 1H), 5.33 – 5.29 (m, 1H), 5.28 (td, *J* = 2.8, 1.2 Hz, 1H), 3.83 (s, 3H), 2.37 – 2.14 (m, 2H), 1.22 (dt, *J* = 17.3, 7.7 Hz, 3H).

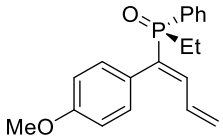
^{13}C NMR (126 MHz, Chloroform-d) δ 160.1, 142.2 (d, *J* = 8.0 Hz), 133.2 (d, *J* = 97.0 Hz), 131.9 (d, *J* = 9.2 Hz), 131.8, 131.5 (d, *J* = 2.6 Hz), 130.8 (d, *J* = 9.2 Hz), 129.0 (d, *J* = 90.7 Hz), 128.6 (d, *J* = 11.5 Hz), 128.2 (d, *J* = 17.0 Hz), 120.3 (d, *J* = 5.9 Hz), 113.8, 55.3, 20.2 (d, *J* = 73.7 Hz), 5.4 (d, *J* = 4.7 Hz).

^{31}P NMR (202 MHz, Chloroform-d) δ 36.0.

HRMS (ESI) $[M+H]^+$: calcd. 313.1357, found. 313.1360.

Optical Rotation: $[\alpha]_D^{20}$ = +99.0 (*c* = 0.847, acetone).

HPLC: Daicel Chiralcel OD-H (91 % ee), *n*-Hexanes/*i*-PrOH = 90/10, 1 mL/min, λ = 297 nm, *t* (major) = 13.4 min, *t* (minor) = 14.5 min.

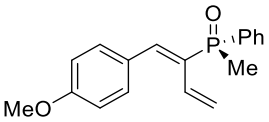


3aa': colorless oil.

^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.59 – 7.46 (m, 3H), 7.41 (td, *J* = 7.5, 2.5 Hz, 2H), 7.22 (dd, *J* = 17.6, 11.0 Hz, 1H), 6.81 (s, 4H), 6.34 – 6.14 (m, 1H), 5.56 (d, *J* = 16.9 Hz, 1H), 5.32 (dd, *J* = 10.0, 2.0 Hz, 1H), 3.80 (s, 3H), 1.98 (dq, *J* = 11.0, 7.5 Hz, 2H), 1.16 (dt, *J* = 17.0, 7.6 Hz, 3H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 159.1, 142.7 (d, *J* = 8.0 Hz), 136.2 (d, *J* = 91.0 Hz), 132.7 (d, *J* = 15.4 Hz), 131.6 (d, *J* = 97.2 Hz), 131.5 (d, *J* = 2.7 Hz), 131.1 (d, *J* = 8.7 Hz), 130.7 (d, *J* = 4.1 Hz), 128.3 (d, *J* = 11.4 Hz), 127.2 (d, *J* = 10.3 Hz), 124.1, 113.8, 55.2, 20.1 (d, *J* = 74.2 Hz), 5.2 (d, *J* = 5.0 Hz).

^{31}P NMR (162 MHz, Chloroform-*d*) δ 33.7.



3ba: 74% yield, colorless oil.

^{1}H NMR (500 MHz, Chloroform-d) δ 7.76 (ddt, *J* = 11.9, 6.7, 1.5 Hz, 2H), 7.57 – 7.47 (m, 3H), 7.45 (d, *J* = 8.7 Hz, 2H), 7.37 (d, *J* = 20.4 Hz, 1H), 6.90 (d, *J* = 8.8 Hz, 2H), 6.61 (tdd, *J* = 17.9, 11.6, 1.4 Hz, 1H), 5.37 – 5.27 (m, 1H), 5.31 (dd, *J* = 2.7, 1.4 Hz, 1H), 3.83 (s, 3H), 1.94 (d, *J* = 13.1 Hz, 3H).

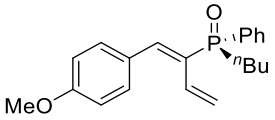
^{13}C NMR (126 MHz, Chloroform-d) δ 160.2, 141.6 (d, *J* = 8.7 Hz), 134.1 (d, *J* = 100.6 Hz), 131.8, 131.7 (d, *J* = 9.3 Hz), 131.6 (d, *J* = 2.7 Hz), 130.5 (d, *J* = 9.8 Hz), 129.9, 128.6 (d, *J* = 11.8 Hz), 128.0 (d, *J* = 17.3 Hz), 120.5 (d, *J* = 6.0 Hz), 113.8, 55.3, 14.8 (d, *J* = 74.6 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 31.8.

HRMS (ESI) $[M+H]^+$: calcd. 299.1201, found. 299.1196.

Optical Rotation: $[\alpha]_D^{20}$ = +97.3 (*c* = 0.987, acetone).

HPLC: Daicel Chiralcel AD-H (80 % ee), *n*-Hexanes/*i*-PrOH = 70/30, 1 mL/min, λ = 297 nm, *t* (major) = 7.3 min, *t* (minor) = 11.7 min.



3ca: 89% yield, yellow oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.89 – 7.69 (m, 2H), 7.55 – 7.45 (m, 5H), 7.41 (d, *J* = 19.6 Hz, 1H), 6.90 (d, *J* = 8.9 Hz, 2H), 6.60 (dddd, *J* = 18.4, 17.0, 11.7, 1.5 Hz, 1H), 5.30 (dd, *J* = 2.6, 0.8 Hz, 1H), 5.29 – 5.26 (m, 1H), 3.83 (s, 3H), 2.40 – 2.12 (m, 2H), 1.80 – 1.57 (m, 2H), 1.58 – 1.35 (m, 2H), 0.91 (t, *J* = 7.3 Hz, 3H).

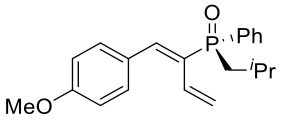
^{13}C NMR (126 MHz, Chloroform-d) δ 160.0, 142.0 (d, *J* = 7.8 Hz), 133.5 (d, *J* = 97.0 Hz), 131.9 (d, *J* = 9.2 Hz), 131.8, 131.5 (d, *J* = 2.7 Hz), 130.7 (d, *J* = 9.2 Hz), 129.2 (d, *J* = 90.8 Hz), 128.5 (d, *J* = 11.5 Hz), 128.1 (d, *J* = 16.6 Hz), 120.3 (d, *J* = 5.8 Hz), 113.7, 55.2, 26.8 (d, *J* = 73.0 Hz), 24.1 (d, *J* = 15.3 Hz), 23.3 (d, *J* = 3.8 Hz), 13.6.

^{31}P NMR (202 MHz, Chloroform-*d*) δ 34.3.

HRMS (ESI) $[M+H]^+$: calcd. 341.1670, found. 341.1677.

Optical Rotation: $[\alpha]_D^{20}$ = +79.1 (*c* = 1.45, acetone).

HPLC: Daicel Chiralcel AD-H (93 % ee), *n*-Hexanes/*i*-PrOH = 70/30, 1 mL/min, λ = 299 nm, *t* (major) = 7.4 min, *t* (minor) = 14.0 min.



3da: 85% yield, light yellow oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.76 (ddt, *J* = 9.7, 6.8, 1.5 Hz, 2H), 7.55 – 7.39 (m, 6H), 6.99 – 6.80 (m, 2H), 6.58 (dddd,*J* = 18.0, 16.4, 11.6, 1.4 Hz, 1H), 5.29 (dq, *J* = 2.5, 1.3 Hz, 1H), 5.28 (ddd, *J* = 31.1, 2.6, 1.4 Hz, 1H), 3.83 (s, 3H), 2.30 – 2.11 (m, 3H), 1.07 (dd, *J* = 9.4, 6.0 Hz, 6H).

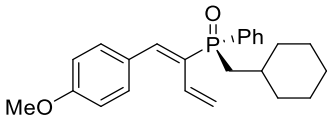
^{13}C NMR (126 MHz, Chloroform-d) δ 160.0, 141.8 (d, *J* = 7.7 Hz), 134.0 (d, *J* = 96.5 Hz), 132.1 (d, *J* = 9.2 Hz), 131.8, 131.4 (d, *J* = 2.8 Hz), 130.8 (d, *J* = 9.2 Hz), 130.1 (d, *J* = 90.2 Hz), 128.5 (d, *J* = 11.4 Hz), 128.2 (d, *J* = 16.6 Hz), 120.4 (d, *J* = 5.8 Hz), 113.7, 55.3, 35.4 (d, *J* = 71.9 Hz), 24.7 (dd, *J* = 19.5, 8.9 Hz), 23.6 (d, *J* = 3.7 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 32.6.

HRMS (ESI) $[M+H]^+$: calcd. 341.1670, found. 341.1674.

Optical Rotation: $[\alpha]_D^{20}$ = +50.6 (*c* = 0.887, acetone).

HPLC: Daicel Chiralcel AD-H (93 % ee), *n*-Hexanes/*i*-PrOH = 70/30, 1 mL/min, λ = 297 nm, *t* (major) = 6.1 min, *t* (minor) = 15.0 min.



3ea: 53% yield, colorless oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.85 – 7.67 (m, 2H), 7.53 – 7.44 (m, 5H), 7.42 (d, *J* = 19.9 Hz, 1H), 6.89 (d, *J* = 8.8 Hz, 2H), 6.58 (dddd, *J* = 18.0, 16.5, 11.6, 1.4 Hz, 1H), 5.28 (dt, *J* = 2.6, 1.5 Hz, 1H), 5.27 (ddd, *J* = 31.2, 2.6, 1.4 Hz, 1H), 3.83 (s, 3H), 2.17 (qdd, *J* = 15.1, 11.2, 6.1 Hz, 2H), 1.96 – 1.77 (m, 3H), 1.62 (ddtd, *J* = 19.6, 12.4, 3.6, 1.6 Hz, 3H), 1.25 (ddt, *J* = 12.9, 9.4, 3.3 Hz, 2H), 1.17 – 1.02 (m, 3H).

^{13}C NMR (126 MHz, Chloroform-d) δ 160.2, 142.5 (d, *J* = 7.8 Hz), 141.4 (d, *J* = 15.3 Hz), 133.2 (d, *J* = 97.5 Hz), 131.9, 131.8, 131.7 (d, *J* = 2.7 Hz), 130.8 (d, *J* = 9.3 Hz), 129.2, 128.7 (d, *J* = 11.6 Hz), 128.4,

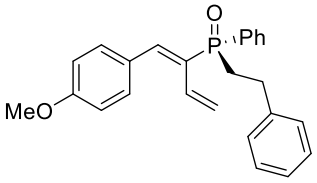
128.4 (d, *J* = 56.4 Hz), 128.0, 126.3, 120.5 (d, *J* = 5.9 Hz), 113.8, 55.3, 29.3 (d, *J* = 70.7 Hz), 27.5 (d, *J* = 2.9 Hz).

^{31}P NMR (202 MHz, Chloroform-d) δ 33.1.

HRMS(ESI) $[M+Na]^+$: calcd. 403.1803, found. 403.1804

Optical Rotation: $[\alpha]_D^{20}$ = +36.0 (*c* = 0.807, acetone).

HPLC: Daicel Chiralcel OD-H (93 % ee), *n*-Hexanes/*i*-PrOH = 95/5, 1 mL/min, λ = 296 nm, *t* (major) = 13.1 min, *t* (minor) = 15.1 min.



3fa: 93% yield, colorless oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.83 – 7.74 (m, 2H), 7.57 – 7.43 (m, 6H), 7.31 – 7.15 (m, 5H), 6.90 (d, *J* = 8.8 Hz, 2H), 6.61 (dddd, *J* = 18.0, 16.8, 12.0, 1.5 Hz, 1H), 5.32 (d, *J* = 2.5 Hz, 1H), 5.29 (dt, *J* = 8.0, 1.4 Hz, 1H), 3.83 (s, 3H), 3.03 – 2.91 (m, 2H), 2.62 – 2.49 (m, 2H).

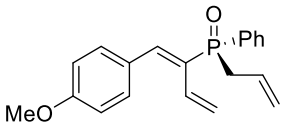
^{13}C NMR (126 MHz, Chloroform-*d*) δ 160.2, 142.5 (d, *J* = 7.8 Hz), 141.4 (d, *J* = 15.3 Hz), 133.2 (d, *J* = 97.5 Hz), 131.9, 131.8, 131.7 (d, *J* = 2.7 Hz), 130.8 (d, *J* = 9.3 Hz), 128.8 (d, *J* = 91.1 Hz), 128.8 – 128.5 (m), 128.1, 128.0, 120.5 (d, *J* = 5.9 Hz), 113.8, 55.3, 29.3 (d, *J* = 70.7 Hz), 27.5 (d, *J* = 2.9 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 33.1.

HRMS (ESI) $[M+H]^+$: calcd. 389.1670, found. 389.1663.

Optical Rotation: $[\alpha]_D^{20}$ = +80.9 (*c* = 1.45, acetone).

HPLC: Daicel Chiralcel AD-H (90 % ee), *n*-Hexanes/*i*-PrOH = 70/30, 1 mL/min, λ = 299 nm, *t* (major) = 12.3 min, *t* (minor) = 20.3 min.



3ga: 90% yield, yellow oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.80 – 7.74 (m, 2H), 7.55 – 7.47 (m, 3H), 7.46 (d, *J* = 8.8 Hz, 2H), 7.38 (d, *J* = 19.9 Hz, 1H), 6.89 (d, *J* = 8.8 Hz, 2H), 6.61 (dddd, *J* = 18.5, 17.5, 11.6, 1.4 Hz, 1H), 5.93 – 5.82 (m, 1H), 5.36 – 5.33 (m, 1H), 5.33 – 5.31 (m, 1H), 5.24 – 5.22 (m, 1H), 5.21 – 5.19 (m, 1H), 3.83 (s, 3H), 3.12 (ddt, *J* = 14.2, 7.4, 1.3 Hz, 2H).

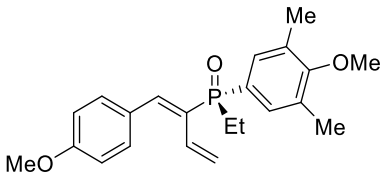
^{13}C NMR (126 MHz, Chloroform-*d*) δ 160.2, 142.7 (d, *J* = 8.0 Hz), 132.9 (d, *J* = 97.6 Hz), 131.9, 131.9 (d, *J* = 9.2 Hz), 131.7 (d, *J* = 2.7 Hz), 131.0 (d, *J* = 9.3 Hz), 128.8 (d, *J* = 92.3 Hz), 128.5 (d, *J* = 11.6 Hz), 128.0 (d, *J* = 17.1 Hz), 127.3 (d, *J* = 9.0 Hz), 120.6 (d, *J* = 18.6 Hz), 120.6, 113.8, 55.3, 33.6 (d, *J* = 69.8 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 31.7.

HRMS (ESI) $[M+H]^+$: calcd. 325.1357, found. 325.1353.

Optical Rotation: $[\alpha]_D^{20}$ = +79.6 (*c* = 0.920, acetone).

HPLC: Daicel Chiralcel AD-H (85 % ee), *n*-Hexanes/*i*-PrOH = 70/30, 1 mL/min, λ = 254 nm, *t* (major) = 7.8 min, *t* (minor) = 17.9 min.



3ha: 68% yield, colorless oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.48 (d, *J* = 8.5 Hz, 2H), 7.43 – 7.31 (m, 3H), 6.90 (d, *J* = 8.5 Hz, 2H), 6.61 (td, *J* = 17.6, 11.9 Hz, 1H), 5.36 – 5.28 (m, 1H), 5.34 – 5.27 (m, 1H), 3.83 (s, 3H), 3.74 (s, 3H), 2.31 (s, 6H), 2.24 – 2.16 (m, 2H), 1.21 (dt, *J* = 17.1, 7.6 Hz, 3H).

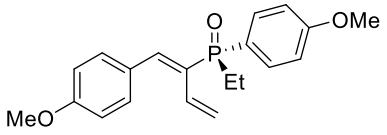
^{13}C NMR (126 MHz, Chloroform-*d*) δ 159.9, 159.7 (d, *J* = 3.2 Hz), 141.9 (d, *J* = 7.8 Hz), 131.9 (d, *J* = 9.2 Hz), 131.8, 131.4 (d, *J* = 9.9 Hz), 131.4 (d, *J* = 12.7 Hz), 129.1 (d, *J* = 90.7 Hz), 128.2 (d, *J* = 3.4 Hz), 127.8 (d, *J* = 78.9 Hz), 120.2 (d, *J* = 5.7 Hz), 113.6, 59.6, 55.2, 20.0 (d, *J* = 73.8 Hz), 16.2, 5.4 (d, *J* = 4.9 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 35.6.

HRMS (ESI) $[M+H]^+$: calcd. 371.1776, found. 371.1781.

Optical Rotation: $[\alpha]_D^{20}$ = +61.6 (*c* = 1.63, acetone).

HPLC: Daicel Chiralcel OD-H (92 % ee), *n*-Hexanes/*i*-PrOH = 90/10, 1 mL/min, λ = 296 nm, *t* (major) = 10.4 min, *t* (minor) = 12.1 min.



3ia: 53% yield, colorless oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.68 (dd, *J* = 10.9, 8.7 Hz, 2H), 7.46 (d, *J* = 8.8 Hz, 2H), 7.37 (d, *J* = 19.5 Hz, 1H), 6.99 (dd, *J* = 8.8, 2.1 Hz, 2H), 6.89 (d, *J* = 8.8 Hz, 2H), 6.60 (dddd,*J* = 18.2, 16.8, 11.7, 1.5 Hz, 1H), 5.34 – 5.30 (m, 1H), 5.29 – 5.27 (m, 1H), 3.85 (s, 3H), 3.83 (s, 3H), 2.29 – 2.15 (m, 2H), 1.20 (dt, *J* = 17.3, 7.6 Hz, 3H).

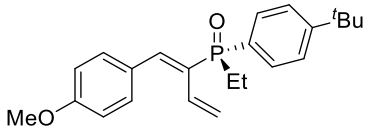
^{13}C NMR (126 MHz, Chloroform-d) δ 162.2 (d, *J* = 2.8 Hz), 160.0, 142.0 (d, *J* = 7.9 Hz), 132.7 (d, *J* = 10.5 Hz), 132.0 (d, *J* = 9.1 Hz), 131.8, 129.3 (d, *J* = 91.4 Hz), 128.2 (d, *J* = 16.8 Hz), 124.2 (d, *J* = 102.9 Hz), 120.2 (d, *J* = 5.7 Hz), 114.1 (d, *J* = 12.4 Hz), 113.7, 55.3, 55.3, 20.3 (d, *J* = 74.1 Hz), 5.5 (d, *J* = 4.9 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 35.8.

HRMS (ESI) $[M+Na]^+$: calcd. 365.1283, found. 365.1291.

Optical Rotation: $[\alpha]_D^{20}$ = +69.9 (*c* = 0.800, acetone).

HPLC: Daicel Chiralcel OD-H (95 % ee), *n*-Hexanes/*i*-PrOH = 90/10, 1 mL/min, λ = 296 nm, *t* (major) = 15.0 min, *t* (minor) = 20.1 min.



3ja: 76% yield, colorless oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.71 – 7.62 (m, 2H), 7.54 – 7.45 (m, 4H), 7.41 (d, *J* = 19.5 Hz, 1H), 6.89 (d, *J* = 8.8 Hz, 2H), 6.61 (dddd, *J* = 18.2, 16.8, 11.6, 1.4 Hz, 1H), 5.31 (ddd, *J* = 25.3, 2.6, 1.4 Hz, 1H), 5.33 – 5.30 (m, 1H), 3.83 (s, 3H), 2.37 – 2.16 (m, 2H), 1.33 (s, 9H), 1.28 – 1.13 (m, 3H).

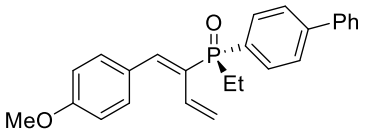
^{13}C NMR (126 MHz, Chloroform-*d*) δ 160.0, 154.96 (d, *J* = 2.7 Hz), 142.1 (d, *J* = 7.7 Hz), 132.0 (d, *J* = 9.1 Hz), 131.8, 130.6 (d, *J* = 9.4 Hz), 129.8 (d, *J* = 91.9 Hz), 129.0 (d, *J* = 83.2 Hz), 128.2 (d, *J* = 16.7 Hz), 125.5 (d, *J* = 11.5 Hz), 120.2 (d, *J* = 5.7 Hz), 113.7, 55.2, 34.9, 31.1, 20.1 (d, *J* = 73.9 Hz), 5.4 (d, *J* = 4.9 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 36.0.

HRMS (ESI) $[M+Na]^+$: calcd. 391.1803, found. 391.1799.

Optical Rotation: $[\alpha]_D^{20}$ = +73.5 (*c* = 1.55, acetone).

HPLC: Daicel Chiralcel AD-H (95 % ee), *n*-Hexanes/*i*-PrOH = 60/40, 1 mL/min, λ = 299 nm, *t* (major) = 5.4 min, *t* (minor) = 15.2 min.



3ka: 90% yield, white powder.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.86 – 7.79 (m, 2H), 7.73 – 7.68 (m, 2H), 7.64 – 7.60 (m, 2H), 7.52 – 7.36 (m, 6H), 6.90 (d, *J* = 8.8 Hz, 2H), 6.63 (dddd, *J* = 18.2, 16.8, 11.6, 1.4 Hz, 1H), 5.36 (ddd, *J* = 18.4, 2.5, 1.4 Hz, 1H), 5.34 – 5.31 (m, 1H), 3.83 (s, 3H), 2.32 – 2.24 (m, 2H), 1.35 – 1.15 (m, 3H).

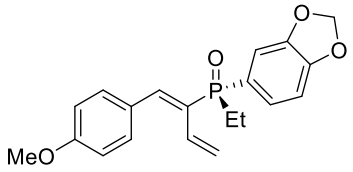
^{13}C NMR (126 MHz, Chloroform-d) δ 160.1, 144.3 (d, *J* = 2.8 Hz), 142.3 (d, *J* = 7.9 Hz), 140.0, 131.9 (d, *J* = 9.1 Hz), 131.8, 131.7 (d, *J* = 98.2 Hz), 131.4 (d, *J* = 9.5 Hz), 128.9 (d, *J* = 91.0 Hz), 128.9, 128.1 (d, *J* = 16.9 Hz), 128.0, 127.2 (d, *J* = 11.8 Hz), 127.2, 120.4 (d, *J* = 5.8 Hz), 113.8, 55.3, 20.2 (d, *J* = 74.0 Hz), 5.5 (d, *J* = 5.0 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 36.0.

HRMS (ESI) $[M+Na]^+$: calcd. 411.1490, found. 411.1491.

Optical Rotation: $[\alpha]_D^{20}$ = +61.6 (*c* = 0.947, acetone).

HPLC: Daicel Chiralcel AS-H (88 % ee), *n*-Hexanes/*i*-PrOH = 80/20, 1 mL/min, λ = 306 nm, *t* (major) = 13.4 min, *t* (minor) = 15.8 min.



3la: 80% yield, colorless oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.46 (d, *J* = 8.7 Hz, 2H), 7.37 (d, *J* = 19.6 Hz, 1H), 7.28 (ddd,*J* = 11.8, 7.9, 1.5 Hz, 1H), 7.17 (dd, *J* = 10.7, 1.5 Hz, 1H), 6.94 – 6.87 (m, 3H), 6.60 (dddd, *J* = 18.2, 16.9, 11.6, 1.4 Hz, 1H), 6.02 (s, 2H), 5.35 (dt, *J* = 18.6, 1.8 Hz, 1H), 5.33 – 5.29 (m, 1H), 3.83 (s, 3H), 2.27 – 2.12 (m, 2H), 1.21 (dt, *J* = 17.4, 7.6 Hz, 3H).

^{13}C NMR (126 MHz, Chloroform-d) δ 160.0, 150.4 (d, *J* = 2.8 Hz), 148.0 (d, *J* = 17.1 Hz), 142.0 (d, *J* = 8.0 Hz), 131.9 (d, *J* = 9.1 Hz), 131.8, 129.1 (d, *J* = 91.5 Hz), 128.1 (d, *J* = 16.8 Hz), 126.2 (d, *J* = 100.5 Hz), 126.0 (d, *J* = 10.1 Hz), 120.3 (d, *J* = 5.7 Hz), 113.7, 110.4 (d, *J* = 11.8 Hz), 108.7 (d, *J* = 14.3 Hz), 101.5, 55.3, 20.3 (d, *J* = 74.5 Hz), 5.5 (d, *J* = 4.9 Hz).

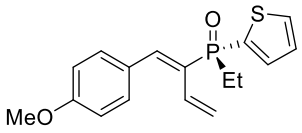
^{31}P NMR (202 MHz, Chloroform-*d*) δ 36.0.

HRMS (ESI) $[M+Na]^+$: calcd. 379.1075, found. 379.1076.

Optical Rotation: $[\alpha]_D^{20}$ = +75.8 (*c* = 0.827, acetone).

HPLC: Daicel Chiralcel OJ-H (90 % ee), *n*-Hexanes/*i*-PrOH = 80/20, 1 mL/min, λ = 296 nm, *t* (major)

= 8.9 min, *t* (minor) = 7.8 min.



3ma: 89% yield, light yellow oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.70 (ddd, *J* = 4.7, 3.7, 1.1 Hz, 1H), 7.58 (ddd, *J* = 6.7, 3.6, 1.1 Hz, 1H), 7.51 – 7.44 (m, 3H), 7.19 (ddd, *J* = 5.1, 3.5, 1.7 Hz, 1H), 6.90 (d, *J* = 8.8 Hz, 2H), 6.61 (tdd, *J* = 17.6, 12.0, 1.4 Hz, 1H), 5.38 – 5.36 (m, 1H), 5.33 (ddd, *J* = 6.5, 2.8, 1.3 Hz, 1H), 3.83 (s, 3H), 2.37 – 2.17 (m, 2H), 1.25 (dt, *J* = 18.4, 7.6 Hz, 3H).

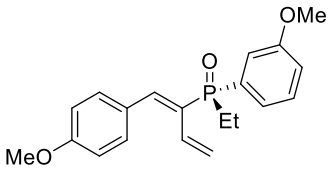
^{13}C NMR (126 MHz, Ch0loroform-*d*) δ 160.1, 142.6 (d, *J* = 8.1 Hz), 135.0 (d, *J* = 9.1 Hz), 134.0 (d, *J* = 102.1 Hz), 132.6 (d, *J* = 4.5 Hz), 131.9, 131.6 (d, *J* = 9.7 Hz), 128.7 (d, *J* = 96.2 Hz),128.1 (d, *J* = 12.8 Hz), 127.9, 120.4 (d, *J* = 6.0 Hz), 113.7, 55.2, 22.3 (d, *J* = 77.4 Hz), 5.4 (d, *J* = 5.0 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 29.6.

HRMS (ESI) $[M+Na]^+$: calcd. 341.0741, found. 341.0804

Optical Rotation: $[\alpha]_D^{20}$ = +76.7 (*c* = 1.63, acetone).

HPLC: Daicel Chiralcel AD-H (88 % ee), *n*-Hexanes/*i*-PrOH = 80/20, 1 mL/min, λ = 298 nm, *t* (major) = 10.6 min, *t* (minor) = 21.4 min.



3na: 90% yield, light yellow oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.46 (d, *J* = 8.8 Hz, 2H), 7.41 – 7.27 (m, 4H), 7.05 (dd, *J* = 8.3, 2.6 Hz, 1H), 6.90 (d, *J* = 8.7 Hz, 2H), 6.60 (dddd, *J* = 18.2, 16.8, 11.6, 1.4 Hz, 1H), 5.36 (dt, *J* = 18.2, 1.7 Hz, 1H), 5.31 (ddt, *J* = 11.6, 2.6, 1.2 Hz, 1H), 3.84 (s, 3H), 3.83 (s, 3H), 2.29 – 2.18 (m, 2H), 1.27 – 1.13 (m, 3H).

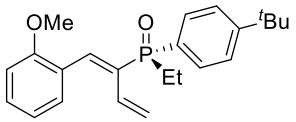
^{13}C NMR (126 MHz, Chloroform-*d*) δ 160.0, 159.6 (d, *J* = 14.2 Hz), 142.1 (d, *J* = 8.1 Hz), 134.4 (d, *J* = 96.1 Hz), 131.8 (d, *J* = 9.1 Hz), 131.8, 129.7 (d, *J* = 13.5 Hz), 128.9 (d, *J* = 90.9 Hz), 128.1 (d, *J* = 16.7 Hz), 122.8 (d, *J* = 9.4 Hz), 120.4 (d, *J* = 5.8 Hz), 117.5 (d, *J* = 2.6 Hz), 115.9 (d, *J* = 10.0 Hz), 113.7, 55.3 (d, *J* = 14.3 Hz), 20.2 (d, *J* = 73.9 Hz), 5.4 (d, *J* = 4.9 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 36.3.

HRMS (ESI) $[M+Na]^+$: calcd. 365.1283, found. 365.1289.

Optical Rotation: $[\alpha]_D^{20}$ = +84.0 (*c* = +1.45, acetone).

HPLC: Daicel Chiralcel AD-H (92 % ee), *n*-Hexanes/*i*-PrOH = 70/30, 1 mL/min, λ = 293 nm, *t* (major) = 7.4 min, *t* (minor) = 11.3 min.



3jb: 87% yield, yellow oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.71 (dd, *J* = 11.1, 8.2 Hz, 2H), 7.55 – 7.46 (m, 3H), 7.39 (d, *J* = 7.4 Hz, 1H), 7.31 (td, *J* = 7.9, 1.7 Hz, 1H), 6.95 – 6.88 (m, 2H), 6.64 – 6.52 (m, 1H), 5.57 (dt, *J* = 18.1,

1.4 Hz, 1H), 5.28 – 5.22 (m, 1H), 3.83 (s, 3H), 2.33 – 2.15 (m, 2H), 1.33 (s, 9H), 1.23 (dt, *J* = 17.3, 7.4 Hz, 3H).

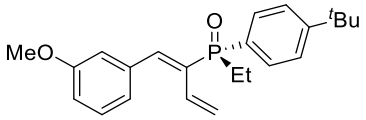
^{13}C NMR (126 MHz, Chloroform-*d*) δ 157.7, 154.9 (d, *J* = 2.7 Hz), 138.3 (d, *J* = 10.1 Hz), 131.7, 131.6, 131.0 (d, *J* = 1.7 Hz), 130.8 (d, *J* = 9.6 Hz), 130.2, 129.6 (d, *J* = 99.1 Hz), 125.5 (d, *J* = 11.8 Hz), 124.5 (d, *J* = 16.3 Hz), 120.5 (d, *J* = 5.2 Hz), 120.0, 110.6, 55.5, 35.0, 31.2, 21.2 (d, *J* = 73.5 Hz), 5.7 (d, *J* = 5.0 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 37.2.

HRMS (ESI) $[M+H]^+$: calcd. 369.1983, found. 369.1984.

Optical Rotation: $[\alpha]_D^{20}$ = +29.7 (*c* = 3.13, acetone).

HPLC: Daicel Chiralcel AD-H (89 % ee), *n*-Hexanes/*i*-PrOH = 80/20, 1 mL/min, λ = 315 nm, *t* (major) = 5.9 min, *t* (minor) = 6.6 min.



3jc: 96% yield, colorless oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.68 (dd, *J* = 11.1, 8.1 Hz, 2H), 7.49 (dd, *J* = 8.3, 2.5 Hz, 2H), 7.45 (d, *J* = 19.4 Hz, 1H), 7.31 – 7.26 (m, 1H), 7.07 (d, *J* = 7.7 Hz, 1H), 7.03 (t, *J* = 1.9 Hz, 1H), 6.88 (dd, *J* = 8.3, 2.5 Hz, 1H), 6.67 – 6.56 (m, 1H), 5.35 (dd, *J* = 18.1, 2.0 Hz, 1H), 5.33 – 5.28 (m, 1H), 3.80 (s, 3H), 2.24 (dq, *J* = 11.3, 7.6 Hz, 2H), 1.33 (s, 9H), 1.23 (dt, *J* = 17.4, 7.4 Hz, 3H).

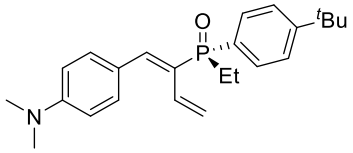
^{13}C NMR (126 MHz, Chloroform-*d*) δ 159.4, 155.2 (d, *J* = 2.8 Hz), 142.5 (d, *J* = 7.7 Hz), 136.8 (d, *J* = 16.3 Hz), 132.0 (d, *J* = 88.7 Hz), 131.7 (d, *J* = 8.9 Hz), 130.7 (d, *J* = 9.5 Hz), 129.6 (d, *J* = 99.6 Hz), 129.3, 125.7 (d, *J* = 11.8 Hz), 122.6, 120.8 (d, *J* = 5.5 Hz), 115.3, 114.6, 55.3, 35.0, 31.1, 20.3 (d, *J* = 73.9 Hz), 5.5 (d, *J* = 4.8 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 35.6.

HRMS (ESI) $[M+H]^+$: calcd. 369.1983, found. 369.1989.

Optical Rotation: $[\alpha]_D^{20}$ = +43.9 (*c* = 0.673, acetone).

HPLC: Daicel Chiralcel AD-H (97 % ee), *n*-Hexanes/*i*-PrOH = 80/20, 1 mL/min, λ = 274 nm, *t* (major) = 7.4 min, *t* (minor) = 8.8 min.



3jd: 42% yield, yellow oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.68 (dd, *J* = 11.0, 8.1 Hz, 2H), 7.50 – 7.42 (m, 4H), 7.36 (d, *J* = 19.5 Hz, 1H), 6.75 – 6.60 (m, 3H), 5.27 (dt, *J* = 25.2, 1.5 Hz, 1H), 5.28 – 5.25 (m, 1H), 3.00 (s, 6H), 2.28 – 2.17 (m, 2H), 1.32 (s, 9H), 1.20 (dt, *J* = 16.8, 7.6 Hz, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 154.7 (d, *J* = 2.6 Hz), 150.5, 142.8 (d, *J* = 7.8 Hz), 132.6 (d, *J* = 9.4 Hz), 131.8, 130.7 (d, *J* = 9.6 Hz), 130.3 (d, *J* = 99.2 Hz), 125.6 (d, *J* = 93.0 Hz), 125.4 (d, *J* = 11.6 Hz), 123.6 (d, *J* = 16.8 Hz), 119.2 (d, *J* = 5.7 Hz), 111.4, 40.1, 34.9, 31.1, 20.1 (d, *J* = 74.0 Hz), 5.5 (d, *J* = 4.8 Hz).

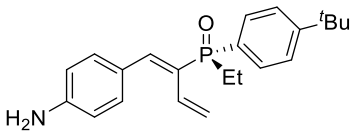
^{31}P NMR (202 MHz, Chloroform-*d*) δ 36.3.

HRMS (ESI) $[M+H]^+$: calcd. 382.2300, found. 382.2296.

Optical Rotation: $[\alpha]_D^{20}$ = +186 (*c* = 1.19, acetone).

HPLC: Daicel Chiralcel OD-H (91 % ee), *n*-Hexanes/*i*-PrOH = 90/10, 1 mL/min, λ = 343 nm, *t* (major)

= 9.7 min, *t* (minor) = 11.3 min.



3je: 95% yield, brown oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.67 (dd, *J* = 11.0, 8.0 Hz, 2H), 7.50 – 7.43 (m, 2H), 7.38 – 7.31 (m, 3H), δ 6.72 – 6.55 (m, 1H), 6.64 (d, *J* = 8.6 Hz, 2H), 5.32 – 5.24 (m, 1H), 5.27 (s, 1H), 4.01 (s, 2H), 2.32 – 2.13 (m, 2H), 1.32 (s, 9H), 1.20 (dt, *J* = 15.9, 7.6 Hz, 3H).

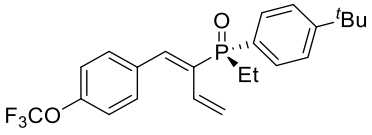
^{13}C NMR (126 MHz, Chloroform-*d*) δ 155.2 (d, *J* = 2.7 Hz), 141.0 (d, *J* = 7.7 Hz), 134.6, 133.9 (d, *J* = 16.4 Hz), 132.6 (d, *J* = 88.5 Hz), 131.3 (d, *J* = 9.0 Hz), 131.2, 130.6 (d, *J* = 9.5 Hz), 129.2 (d, *J* = 99.6 Hz), 128.5, 125.6 (d, *J* = 11.8 Hz), 121.3 (d, *J* = 5.9 Hz), 34.9, 31.1, 20.1 (d, *J* = 73.9 Hz), 5.4 (d, *J* = 5.1 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 36.1.

HRMS (ESI) $[M+H]^+$: calcd. 354.1987, found. 354.1984.

Optical Rotation: $[\alpha]_D^{20}$ = +102 (*c* = 1.69, acetone).

HPLC: Daicel Chiralcel AD-H (94 % ee), *n*-Hexanes/*i*-PrOH = 60/40, 1 mL/min, λ = 284 nm, *t* (major) = 5.6 min, *t* (minor) = 13.1 min.



3jf: 91% yield, yellow oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.68 (dd, *J* = 11.0, 8.0 Hz, 2H), 7.55 – 7.47 (m, 4H), 7.45 (d, *J* = 19.2 Hz, 1H), 7.21 (d, *J* = 8.3 Hz, 2H), 6.54 (td, *J* = 17.0, 11.6 Hz, 1H), 5.36 (d, *J* = 7.5 Hz, 1H), 5.34 (d, *J* = 2.2 Hz, 1H), 2.24 (dq, *J* = 15.2, 7.8 Hz, 2H), 1.34 (s, 9H), 1.23 (dt, *J* = 16.3, 7.4 Hz, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 155.4 (d, *J* = 2.7 Hz), 140.7 (d, *J* = 7.7 Hz), 138.9 (d, *J* = 17.0 Hz), 134.6 (d, *J* = 87.1 Hz), 131.0 (d, *J* = 8.8 Hz), 130.7 (d, *J* = 9.6 Hz), 130.3 (d, *J* = 32.8 Hz), 130.1, 129.0 (d, *J* = 99.9 Hz), 125.7 (d, *J* = 11.8 Hz), 125.2 (q, *J* = 3.8 Hz), 123.8 (q, *J* = 272.3 Hz), 121.8 (d, *J* = 5.9 Hz), 35.0, 31.1, 20.1 (d, *J* = 73.9 Hz), 5.4 (d, *J* = 5.1 Hz).

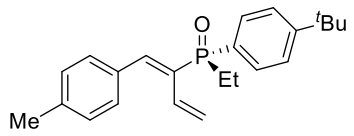
^{31}P NMR (202 MHz, Chloroform-*d*) δ 35.2.

^{19}F NMR (471 MHz, Chloroform-*d*) δ -57.8.

HRMS (ESI) $[M+H]^+$: calcd. 423.1701, found. 423.1703.

Optical Rotation: $[\alpha]_D^{20}$ = +46.1 (*c* = 1.10, acetone).

HPLC: Daicel Chiralcel AD-H (95 % ee), *n*-Hexanes/*i*-PrOH = 70/30, 1 mL/min, λ = 272 nm, *t* (major) = 4.8 min, *t* (minor) = 7.8 min.



3jg: 78% yield, yellow oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.73 – 7.64 (m, 2H), 7.49 (dd, *J* = 8.3, 2.5 Hz, 2H), 7.44 (d, *J* = 19.5 Hz, 1H), 7.39 (d, *J* = 7.9 Hz, 2H), 7.17 (d, *J* = 7.8 Hz, 2H), 6.68 – 6.55 (m, 1H), 5.37 – 5.32 (m, 1H), 5.31 – 5.27 (m, 1H), 2.36 (s, 3H), 2.29 – 2.19 (m, 2H), 1.33 (s, 9H), 1.28 – 1.17 (m, 3H).

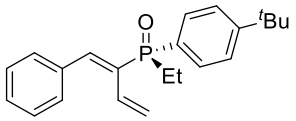
^{13}C NMR (126 MHz, Chloroform-*d*) δ 155.0 (d, *J* = 2.7 Hz), 142.6 (d, *J* = 7.8 Hz), 138.9, 132.7 (d, *J* = 16.5 Hz), 131.8 (d, *J* = 9.0 Hz), 130.6 (d, *J* = 9.5 Hz), 130.5 (d, *J* = 89.9 Hz), 130.0, 129.2, 129.0, 125.5 (d, *J* = 11.7 Hz), 120.4 (d, *J* = 5.7 Hz), 34.9, 31.0, 21.3, 20.2 (d, *J* = 73.8 Hz), 5.4 (d, *J* = 5.0 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 35.9.

HRMS (ESI) $[M+H]^+$: calcd. 353.2034, found. 353.2030.

Optical Rotation: $[\alpha]_D^{20}$ = +36.6 (*c* = 1.35, acetone).

HPLC: Daicel Chiralcel OD-H (87 % ee), *n*-Hexanes/*i*-PrOH = 93/7, 1 mL/min, λ = 281 nm, *t* (major) = 7.2 min, *t* (minor) = 8.7 min.



3jh: 95% yield, light yellow oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.73 – 7.65 (m, 2H), 7.53 – 7.43 (m, 5H), 7.35 (dt, *J* = 16.6, 7.1 Hz, 3H), 6.61 (td, *J* = 17.6, 11.7 Hz, 1H), 5.40 – 5.34 (m, 1H), 5.33 – 5.28 (m, 1H), 2.31 – 2.19 (m, 2H), 1.33 (s, 9H), 1.23 (dt, *J* = 17.0, 7.4 Hz, 3H).

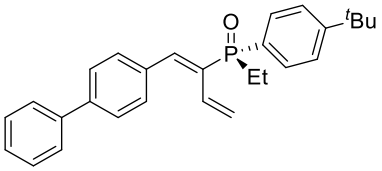
^{13}C NMR (126 MHz, Chloroform-*d*) δ 155.0 (d, *J* = 2.8 Hz), 142.5 (d, *J* = 7.6 Hz), 135.4 (d, *J* = 16.3 Hz), 131.7 (d, *J* = 89.1 Hz), 131.6 (d, *J* = 9.1 Hz), 130.6 (d, *J* = 9.5 Hz), 130.0, 129.5 (d, *J* = 99.5 Hz), 128.6, 128.2, 125.6 (d, *J* = 11.8 Hz), 120.7 (d, *J* = 5.6 Hz), 34.9, 31.0, 20.2 (d, *J* = 73.9 Hz), 5.4 (d, *J* = 5.0 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 36.1.

HRMS (ESI) $[M+H]^+$: calcd. 339.1878, found. 339.1875.

Optical Rotation: $[\alpha]_D^{20}$ = +61.2 (*c* = 1.52, acetone).

HPLC: Daicel Chiralcel AD-H (94 % ee), *n*-Hexanes/*i*-PrOH = 80/20, 1 mL/min, λ = 273 nm, *t* (major) = 7.5 min, *t* (minor) = 11.4 min.



3ji: 70% yield, light yellow oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.74 – 7.67 (m, 2H), 7.63 – 7.55 (m, 6H), 7.54 – 7.48 (m, 3H), 7.45 (t, *J* = 7.7 Hz, 2H), 7.39 – 7.33 (m, 1H), 6.66 (dddd, *J* = 18.1, 16.8, 11.6, 1.5 Hz, 1H), 5.38 (dt, *J* = 18.3, 1.8 Hz, 1H), 5.36 – 5.32 (m, 1H), 2.30 – 2.22 (m, 2H), 1.34 (s, 9H), 1.24 (dt, *J* = 17.3, 7.5 Hz, 3H).

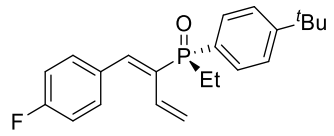
^{13}C NMR (126 MHz, Chloroform-*d*) δ 155.1 (d, *J* = 2.8 Hz), 142.0 (d, *J* = 7.6 Hz), 141.4, 140.2, 134.5 (d, *J* = 16.5 Hz), 131.7 (d, *J* = 8.9 Hz), 131.7 (d, *J* = 89.0 Hz), 130.7, 130.6, 130.6, 129.6 (d, *J* = 99.4 Hz), 128.8, 127.6,126.9 (d, *J* = 10.6 Hz), 125.6 (d, *J* = 11.7 Hz), 120.8 (d, *J* = 5.8 Hz), 34.9, 31.1, 20.2 (d, *J* = 73.9 Hz), 5.5 (d, *J* = 5.0 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 35.6.

HRMS (ESI) $[M+H]^+$: calcd. 415.2191, found. 415.2190.

Optical Rotation: $[\alpha]_D^{20}$ = +27.9 (*c* = 2.76, acetone).

HPLC: Daicel Chiralcel AD-H (94 % ee), *n*-Hexanes/*i*-PrOH = 60/40, 1 mL/min, λ = 303 nm, *t* (major) = 5.8 min, *t* (minor) = 12.4 min.



3jj: 83% yield, light yellow oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.72 – 7.64 (m, 2H), 7.54 – 7.38 (m, 5H), 7.08 – 7.01 (m, 2H), 6.55 (dddd, *J* = 17.9, 16.2, 11.7, 1.4 Hz, 1H), 5.37 – 5.33 (m, 1H), 5.33 – 5.31 (m, 1H), 2.23 (dq, *J* = 11.2, 7.6 Hz, 2H), 1.33 (s, 9H), 1.22 (dt, *J* = 17.4, 7.6 Hz, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 162.7 (d, *J* = 249.9 Hz), 155.2 (d, *J* = 2.7 Hz), 141.3 (d, *J* = 7.6 Hz), 131.9 (d, *J* = 8.0 Hz), 131.6 (dd, *J* = 16.6, 3.3 Hz), 131.5 (d, *J* = 9.0 Hz), 131.2, 130.7 (d, *J* = 9.6 Hz), 129.4 (d, *J* = 99.5 Hz), 125.6 (d, *J* = 11.6 Hz), 121.1 (d, *J* = 5.9 Hz), 115.3 (d, *J* = 21.6 Hz), 35.0, 31.1, 20.1 (d, *J* = 73.9 Hz), 5.4 (d, *J* = 5.0 Hz).

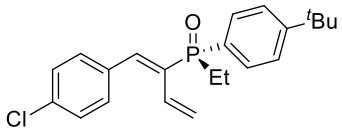
^{31}P NMR (202 MHz, Chloroform-*d*) δ 35.5.

^{19}F NMR (471 MHz, Chloroform-*d*) δ -111.6.

HRMS (ESI) $[M+H]^+$: calcd. 357.1784, found. 357.1783.

Optical Rotation: $[\alpha]_D^{20}$ = +53.4 (*c* = 1.02, acetone).

HPLC: Daicel Chiralcel AD-H (95 % ee), *n*-Hexanes/*i*-PrOH = 60/40, 1 mL/min, λ = 273 nm, *t* (major) = 4.6 min, *t* (minor) = 8.6 min.



3jk: 76% yield, yellow powder.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.68 (dd, *J* = 11.1, 8.0 Hz, 2H), 7.50 (dd, *J* = 8.3, 2.5 Hz, 2H), 7.46 – 7.38 (m, 3H), 7.33 (d, *J* = 8.2 Hz, 2H), 6.54 (td, *J* = 17.1, 11.5 Hz, 1H), 5.38 – 5.32 (m, 1H), 5.32 (d, *J* = 3.2 Hz, 1H), 2.23 (dq, *J* = 11.2, 7.6 Hz, 2H), 1.33 (s, 9H), 1.22 (dt, *J* = 17.4, 7.5 Hz, 3H).

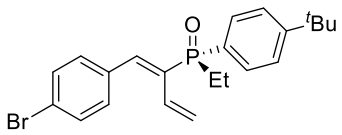
^{13}C NMR (126 MHz, Chloroform-*d*) δ 155.2 (d, *J* = 2.7 Hz), 141.1 (d, *J* = 7.7 Hz), 134.6, 133.9 (d, *J* = 16.4 Hz), 132.6 (d, *J* = 88.3 Hz), 131.4 (d, *J* = 9.1 Hz), 131.2, 130.6 (d, *J* = 9.6 Hz), 129.3 (d, *J* = 99.6 Hz), 128.5, 125.6 (d, *J* = 11.7 Hz), 121.3 (d, *J* = 5.8 Hz), 35.0, 31.1, 20.1 (d, *J* = 73.9 Hz), 5.4 (d, *J* = 4.9 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 35.4.

HRMS (ESI) $[M+H]^+$: calcd. 373.1488 (^{37}Cl), found. 373.1483.

Optical Rotation: $[\alpha]_D^{20}$ = +46.4 (*c* = 1.88, acetone).

HPLC: Daicel Chiralcel AD-H (96 % ee), *n*-Hexanes/*i*-PrOH = 60/40, 1 mL/min, λ = 279 nm, *t* (major) = 4.9 min, *t* (minor) = 10.9 min.



3jl: 90% yield, white powder.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.70 – 7.64 (m, 2H), 7.52 – 7.47 (m, 4H), 7.40 (d, *J* = 19.3 Hz, 1H), 7.35 (d, *J* = 8.4 Hz, 2H), 6.52 (dddd, *J* = 17.7, 16.1, 11.6, 1.4 Hz, 1H), 5.37 – 5.32 (m, 1H), 5.35 – 5.31 (m, 1H), 2.23 (dq, *J* = 11.2, 7.6 Hz, 2H), 1.33 (s, 9H), 1.22 (dt, *J* = 17.4, 7.7 Hz, 3H).

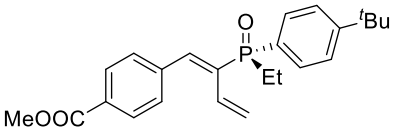
^{13}C NMR (126 MHz, Chloroform-*d*) δ 155.1, 138.9 (d, *J* = 18.7 Hz), 134.7 (d, *J* = 8.7 Hz), 132.2, 131.4 (d, *J* = 8.9 Hz), 130.6 (d, *J* = 9.6 Hz), 129.5 (d, *J* = 100.1 Hz), 129.3, 128.3 (d, *J* = 91.3 Hz), 127.1, 125.6 (d, *J* = 11.6 Hz), 122.1 (d, *J* = 6.2 Hz), 35.0, 31.1, 20.1 (d, *J* = 74.5 Hz), 5.4 (d, *J* = 5.0 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 35.2.

HRMS (ESI) $[M+H]^+$: calcd. 417.0983 (^{79}Br), found. 417.0975.

Optical Rotation: $[\alpha]_D^{20}$ = +64.2 (*c* = 1.19, acetone).

HPLC: Daicel Chiralcel AD-H (95 % ee), *n*-Hexanes/*i*-PrOH = 60/40, 1 mL/min, λ = 280 nm, *t* (major) = 5.1 min, *t* (minor) = 11.8 min.



3jm: 88% yield, yellow oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.03 (d, *J* = 7.9 Hz, 2H), 7.69 (t, *J* = 9.5 Hz, 2H), 7.56 – 7.44 (m, 5H), 6.55 (td, *J* = 17.1, 11.7 Hz, 1H), 5.37 (d, *J* = 30.3 Hz, 1H), 5.36 (s, 1H), 3.92 (s, 3H), 2.25 (dq, *J* = 15.5, 8.0 Hz, 2H), 1.34 (s, 9H), 1.24 (dt, *J* = 16.2, 7.3 Hz, 3H).

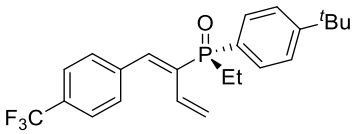
^{13}C NMR (126 MHz, Chloroform-*d*) δ 166.5, 155.3 (d, *J* = 2.7 Hz), 141.2 (d, *J* = 7.6 Hz), 139.9 (d, *J* = 16.2 Hz), 134.4 (d, *J* = 87.2 Hz), 131.2 (d, *J* = 8.8 Hz), 130.7 (d, *J* = 9.5 Hz), 129.8, 129.8, 129.4, 129.1 (d, *J* = 99.6 Hz), 125.7 (d, *J* = 11.7 Hz), 121.6 (d, *J* = 5.9 Hz), 52.2, 35.0, 31.1, 20.2 (d, *J* = 73.8 Hz), 5.4 (d, *J* = 5.0 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 35.2.

HRMS (ESI) $[M+Na]^+$: calcd. 419.1752, found. 419.1749.

Optical Rotation: $[\alpha]_D^{20}$ = +41.8 (*c* = 1.18, acetone).

HPLC: Daicel Chiralcel AD-H (93 % ee), *n*-Hexanes/*i*-PrOH = 80/20, 1 mL/min, λ = 304 nm, *t* (major) = 9.1 min, *t* (minor) = 16.6 min.



3jn: 75% yield, colorless oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.73 – 7.65 (m, 2H), 7.64 – 7.55 (m, 4H), 7.55 – 7.46 (m, 3H), 6.53 (dddd, *J* = 17.5, 15.8, 11.6, 1.4 Hz, 1H), 5.40 – 5.36 (m, 1H), 5.34 (dd, *J* = 4.2, 2.0 Hz, 1H), 2.25 (dq, *J* = 11.1, 7.6 Hz, 2H), 1.34 (s, 9H), 1.24 (dt, *J* = 17.5, 7.6 Hz, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 155.4 (d, *J* = 2.7 Hz), 140.7 (d, *J* = 7.7 Hz), 138.9 (d, *J* = 17.0 Hz), 134.6 (d, *J* = 87.1 Hz), 131.0 (d, *J* = 8.8 Hz), 130.7 (d, *J* = 9.6 Hz), 130.3 (d, *J* = 32.8 Hz), 130.1, 129.0 (d, *J* = 99.9 Hz), 125.7 (d, *J* = 11.8 Hz),125.2 (q, *J* = 3.8 Hz), 123.9 (d, *J* = 272.2 Hz), 121.8 (d, *J* = 5.9 Hz), 35.0, 31.1, 20.1 (d, *J* = 73.9 Hz), 5.4 (d, *J* = 5.1 Hz).

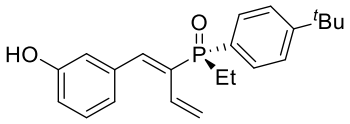
^{31}P NMR (202 MHz, Chloroform-*d*) δ 35.0.

^{19}F NMR (471 MHz, Chloroform-*d*) δ -62.8.

HRMS (ESI) $[M+H]^+$: calcd. 407.1752, found. 407.1749.

Optical Rotation: $[\alpha]_D^{20}$ = +38.2 (*c* = 1.07, acetone).

HPLC: Daicel Chiralcel AD-H (94 % ee), *n*-Hexanes/*i*-PrOH = 80/20, 1 mL/min, λ = 288 nm, *t* (major) = 6.6 min, *t* (minor) = 13.4 min.



3jo: 45% yield, white powder.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 10.19 (s, 1H), δ 7.67 (dd, *J* = 11.2, 8.0 Hz, 2H), 7.56 (d, *J* = 19.7 Hz, 1H), 7.49 (d, *J* = 6.9 Hz, 2H), 7.31 (s, 1H), 7.19 (t, *J* = 7.9 Hz, 1H), 6.99 (d, *J* = 7.6 Hz, 1H), 6.85 (d, *J* = 7.7 Hz, 1H), 6.70 (td, *J* = 18.1, 11.6 Hz, 1H), 5.32 – 5.28 (m, 1H), 5.26 (d, *J* = 3.5 Hz, 1H), 2.27 (dq, *J* = 11.0, 7.7 Hz, 2H), 1.32 (s, 9H), 1.28 – 1.15 (m, 3H).

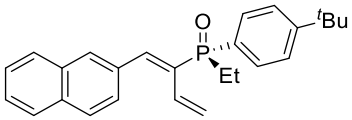
^{13}C NMR (126 MHz, Chloroform-*d*) δ 158.0, 155.4 (d, *J* = 2.7 Hz), 144.2 (d, *J* = 7.1 Hz), 136.1 (d, *J* = 16.4 Hz), 131.8 (d, *J* = 9.7 Hz), 130.7 (d, *J* = 9.8 Hz), 129.6 (d, *J* = 91.3 Hz), 129.2, 128.7 (d, *J* = 100.6 Hz), 125.8 (d, *J* = 11.9 Hz), 120.4 (d, *J* = 5.5 Hz), 120.4, 117.7, 116.9, 35.0, 31.1, 19.9 (d, *J* = 73.7 Hz), 5.4 (d, *J* = 5.0 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 38.1.

HRMS (ESI) $[M+Na]^+$: calcd. 377.1646, found. 377.1635.

Optical Rotation: $[\alpha]_D^{20}$ = +61.6 (*c* = 0.680, acetone).

HPLC: Daicel Chiralcel OD-H (96 % ee), *n*-Hexanes/*i*-PrOH = 93/7, 1 mL/min, λ = 280 nm, *t* (major) = 9.4 min, *t* (minor) = 11.8 min.



3jp: 73% yield, white powder.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.94 (s, 1H), 7.86 – 7.79 (m, 3H), 7.73 (dd, *J* = 11.1, 8.1 Hz, 2H), 7.67 – 7.58 (m, 2H), 7.50 (ddd, *J* = 10.1, 6.5, 2.1 Hz, 4H), 6.75 – 6.62 (m, 1H), 5.41 (dt, *J* = 18.0, 1.6 Hz, 1H), 5.38 – 5.32 (m, 1H), 2.32 – 2.21 (m, 2H), 1.34 (s, 9H), 1.31 – 1.19 (m, 3H).

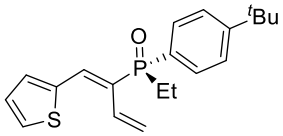
^{13}C NMR (126 MHz, Chloroform-*d*) δ 155.1 (d, *J* = 2.7 Hz), 142.6 (d, *J* = 7.8 Hz), 133.1, 132.9, 132.6 (d, *J* = 83.6 Hz), 131.7 (d, *J* = 9.0 Hz), 131.6, 130.7 (d, *J* = 9.6 Hz), 130.0, 129.5 (d, *J* = 99.6 Hz), 129.5 (d, *J* = 136.8 Hz), 128.3, 127.7 (d, *J* = 23.7 Hz), 127.1, 126.8, 126.4, 125.6 (d, *J* = 11.7 Hz), 121.0 (d, *J* = 5.7 Hz), 34.9, 31.1, 20.3 (d, *J* = 73.7 Hz), 5.5 (d, *J* = 5.0 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 35.7.

HRMS (ESI) $[M+H]^+$: calcd. 389.2034, found. 389.2031.

Optical Rotation: $[\alpha]_D^{20}$ = +48.6 (*c* = 2.40, acetone).

HPLC: Daicel Chiralcel AD-H (95 % ee), *n*-Hexanes/*i*-PrOH = 80/20, 1 mL/min, λ = 265 nm, *t* (major) = 8.2 min, *t* (minor) = 12.0 min.



3jq: 24% yield**,** light yellow oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.76 – 7.59 (m, 3H), 7.48 (dd, *J* = 8.4, 2.6 Hz, 2H), 7.42 (d, *J* = 5.1 Hz, 1H), 7.30 (d, *J* = 3.6 Hz, 1H), 7.07 (dd, *J* = 5.1, 3.7 Hz, 1H), 6.68 (dddd, *J* = 17.8, 14.4, 11.5, 1.5 Hz, 1H), 5.46 – 5.40 (m, 1H), 5.32 (ddd, *J* = 17.7, 2.6, 1.3 Hz, 1H), 2.22 (dqd, *J* = 10.4, 7.5, 3.6 Hz, 2H), 1.33 (s, 9H), 1.22 (dt, *J* = 17.3, 7.6 Hz, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 155.1 (d, *J* = 2.8 Hz), 138.9 (d, *J* = 18.7 Hz), 134.7 (d, *J* = 8.7 Hz), 132.2, 131.4 (d, *J* = 8.9 Hz), 130.6 (d, *J* = 9.6 Hz), 129.5 (d, *J* = 100.2 Hz), 129.3, 128.3 (d, *J* = 91.2

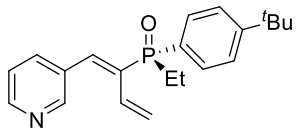
Hz), 127.1, 125.6 (d, *J* = 11.6 Hz), 122.1 (d, *J* = 6.2 Hz), 35.0, 31.1, 20.1 (d, *J* = 74.5 Hz), 5.4 (d, *J* = 5.1 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 34.9.

HRMS (ESI) $[M+H]^+$: calcd. 345.1442, found. 345.1440.

Optical Rotation: $[\alpha]_D^{20}$ = +8.00 (*c* = 2.95, acetone).

HPLC: Daicel Chiralcel AD-H (95 % ee), *n*-Hexanes/*i*-PrOH = 80/20, 1 mL/min, λ = 305 nm, *t* (major) = 7.7 min, *t* (minor) = 14.7 min.



3jr: 76% yield, yellow oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 8.64 (d, *J* = 2.3 Hz, 1H), 8.50 – 8.43 (m, 1H), 7.78 – 7.70 (m, 1H), 7.61 (dd, *J* = 11.1, 8.1 Hz, 2H), 7.44 (dd, *J* = 8.3, 2.6 Hz, 2H), 7.38 (d, *J* = 19.1 Hz, 1H), 7.26 – 7.20 (m, 1H), 6.46 (ddd, *J* = 17.9, 15.1, 11.2 Hz, 1H), 5.34 – 5.30 (m, 1H), 5.30 – 5.26 (m, 1H), 2.17 (dq, *J* = 11.0, 7.6 Hz, 2H), 1.26 (s, 9H), 1.16 (dt, *J* = 17.2, 7.6 Hz, 3H).

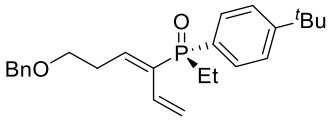
^{31}P NMR (202 MHz, Chloroform-*d*) δ 34.9.

^{13}C NMR (126 MHz, Chloroform-*d*) δ 155.3 (d, *J* = 2.7 Hz), 150.7, 149.3, 138.6 (d, *J* = 7.7 Hz), 136.8, 134.7 (d, *J* = 87.1 Hz), 131.3 (d, *J* = 16.1 Hz), 130.9 (d, *J* = 8.9 Hz), 130.6 (d, *J* = 9.6 Hz), 128.8 (d, *J* = 99.9 Hz), 125.7 (d, *J* = 11.8 Hz), 123.1, 121.9 (d, *J* = 5.9 Hz), 34.9, 31.0, 20.0 (d, *J* = 74.0 Hz), 5.4 (d, *J* = 5.1 Hz).

HRMS (ESI) $[M+Na]^+$: calcd. 362.1650, found. 362.1646.

Optical Rotation: $[\alpha]_D^{20}$ = +30.8 (*c* = 0.860, acetone).

HPLC: Daicel Chiralcel AD-H (92 % ee), *n*-Hexanes/*i*-PrOH = 70/30, 1 mL/min, λ = 261 nm, *t* (major) = 6.8 min, *t* (minor) = 11.4 min.



3js: 59% yield, colorless oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.60 (dd, *J* = 10.9, 8.0 Hz, 2H), 7.43 (dd, *J* = 8.3, 2.5 Hz, 2H), 7.31 (m, 5H), 6.60 (dt, *J* = 19.4, 7.2 Hz, 1H), 6.32 (dt, *J* = 17.7, 12.3 Hz, 1H), 5.33 (d, *J* = 10.5 Hz, 1H), 5.31 – 5.28 (m, 1H), 4.51 (s, 2H), 3.60 (t, *J* = 6.6 Hz, 2H), 2.66 (dd, *J* = 6.8, 2.8 Hz, 2H), 2.08 (dt, *J* = 15.1, 7.7 Hz, 2H), 1.31 (s, 9H), 1.22 – 1.11 (m, 3H).

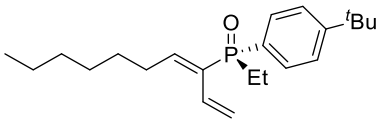
^{13}C NMR (126 MHz, Chloroform-*d*) δ 154.8 (d, *J* = 2.8 Hz), 142.8 (d, *J* = 7.0 Hz), 138.1, 133.4 (d, *J* = 91.3 Hz), 130.5 (d, *J* = 9.5 Hz), 130.0 (d, *J* = 10.7 Hz), 129.1 (d, *J* = 99.2 Hz), 128.3, 127.5 (d, *J* = 1.8 Hz), 125.4 (d, *J* = 11.5 Hz), 125.1, 120.9 (d, *J* = 7.2 Hz), 73.0, 68.8, 34.9, 31.0, 29.9 (d, *J* = 13.0 Hz), 20.7 (d, *J* = 73.4 Hz), 5.3 (d, *J* = 5.0 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 34.3.

HRMS (ESI) $[M+H]^+$: calcd. 397.2296, found. 397.2298.

Optical Rotation: $[\alpha]_D^{20}$ = +22.2 (*c* = 1.56, acetone).

HPLC: Daicel Chiralcel AD-H (>99 % ee), *n*-Hexanes/*i*-PrOH = 93/7, 0.5 mL/min, λ = 228 nm, *t* (major) = 40.9 min, *t* (minor) = 34.6 min.



3jt: 90% yield, colorless oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.66 – 7.56 (m, 2H), 7.47 (dd, *J* = 8.4, 2.5 Hz, 2H), 6.58 (dt, *J* = 19.5, 7.4 Hz, 1H), 6.34 (ddd, *J* = 17.8, 14.0, 11.5 Hz, 1H), 5.28 – 5.26 (m, 1H), 5.30 – 5.22 (m, 1H), 2.33 (qd, *J* = 7.5, 2.8 Hz, 2H), 2.10 (dddd, *J* = 15.0, 9.2, 7.5, 2.3 Hz, 2H), 1.47 (p,*J* = 7.2 Hz, 2H), 1.36 – 1.24 (m, 6H), 1.32 (s, 9H), 1.16 (dt, *J* = 17.2, 7.6 Hz, 3H), 0.88 (t, *J* = 6.7 Hz, 3H).

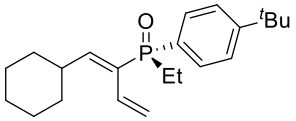
^{13}C NMR (126 MHz, Chloroform-*d*) δ 154.8 (d, *J* = 2.7 Hz), 147.3 (d, *J* = 6.0 Hz), 131.3 (d, *J* = 91.8 Hz), 130.5 (d, *J* = 9.6 Hz), 130.2 (d, *J* = 11.1 Hz), 129.5 (d, *J* = 98.8 Hz), 125.4 (d, *J* = 11.5 Hz), 120.3 (d, *J* = 7.2 Hz), 34.9, 31.5, 31.1, 29.2 (d, *J* = 12.8 Hz), 29.0, 28.8 (d, *J* = 1.6 Hz), 22.5, 20.7 (d, *J* = 73.4 Hz), 14.0, 5.4 (d, *J* = 5.0 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 34.3.

HRMS (ESI) $[M+H]^+$: calcd. 347.2504, found. 347.2504.

Optical Rotation: $[\alpha]_D^{20}$ = -5.39 (*c* = 1.32, acetone).

HPLC: Daicel Chiralcel IA-H (99 % ee), *n*-Hexanes/*i*-PrOH = 90/10, 0.5 mL/min, λ = 256 nm, *t* (major) = 14.9 min, *t* (minor) = 16.6 min.



3ju: 61% yield, colorless oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.61 (dd, *J* = 10.9, 8.0 Hz, 2H), 7.46 (dd, *J* = 8.3, 2.3 Hz, 2H), 6.55 – 6.24 (m, 2H), 5.26 (s, 1H), 5.24 – 5.21 (m, 1H), 2.58 (q, *J* = 10.8 Hz, 1H), 2.16 – 2.05 (m, 2H), 1.82 – 1.60 (m, 6H), 1.32 (s, 9H), 1.30 – 1.20 (m, 4H), 1.22 – 1.10 (m, 3H).

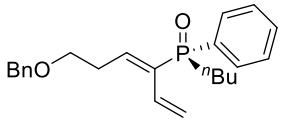
^{13}C NMR (126 MHz, Chloroform-*d*) δ 154.8 (d, *J* = 2.5 Hz), 152.1 (d, *J* = 5.4 Hz), 130.5 (d, *J* = 9.6 Hz), 130.3 (d, *J* = 11.0 Hz), 129.7 (d, *J* = 52.3 Hz), 129.0 (d, *J* = 45.1 Hz), 125.4 (d, *J* = 11.6 Hz), 120.0 (d, *J* = 7.0 Hz), 38.1 (d, *J* = 12.2 Hz), 34.9, 32.3 (d, *J* = 21.1 Hz), 31.0, 25.7, 25.4, 20.6 (d, *J* = 73.4 Hz), 5.4 (d, *J* = 5.0 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 34.3.

HRMS (ESI) $[M+Na]^+$: calcd. 367.2167, found. 367.2162.

Optical Rotation: $[\alpha]_D^{20}$ = +7.41 (*c* = 0.870, acetone).

HPLC: Daicel Chiralcel AD-H (97 % ee), *n*-Hexanes/*i*-PrOH = 95/5, 1 mL/min, λ = 235 nm, *t* (major) = 16.4 min, *t* (minor) = 19.0 min.



3jv: 92% yield, colorless oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.75 – 7.61 (m, 2H), 7.55 – 7.46 (m, 1H), 7.44 (td, *J* = 7.6, 2.6 Hz, 2H), 7.37 – 7.24 (m, 5H), 6.62 (dt, *J* = 19.6, 7.2 Hz, 1H), 6.32 (ddd, *J* = 17.6, 13.5, 11.6 Hz, 1H), 5.32 (d, *J* = 2.5 Hz, 1H), 5.30 – 5.27 (m, 1H), 4.51 (s, 2H), 3.60 (t, *J* = 6.6 Hz, 2H), 2.66 (qd, *J* = 6.7, 2.8 Hz, 2H), 2.12 (td, *J* = 10.9, 6.6 Hz, 2H), 1.56 (dt, *J* = 14.3, 7.4 Hz, 2H), 1.41 (h, *J* = 7.3 Hz, 2H), 0.89 (t, *J* = 7.3 Hz, 3H).

^{13}C NMR (126 MHz, Chloroform-*d*) δ 143.3 (d, *J* = 7.0 Hz), 138.0, 133.1 (d, *J* = 91.5 Hz), 132.2 (d, *J*= 97.1 Hz), 131.6 (d, *J* = 2.7 Hz), 130.6 (d, *J* = 9.4 Hz), 129.7 (d, *J* = 10.7 Hz), 128.5 (d, *J* = 11.5 Hz),

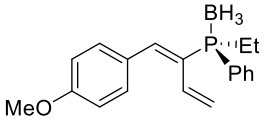
128.3, 127.5, 127.5, 121.1 (d, *J* = 7.3 Hz), 72.9, 68.6 (d, *J* = 1.6 Hz), 29.9 (d, *J* = 13.1 Hz), 27.2 (d, *J* = 72.1 Hz), 24.0 (d, *J* = 15.2 Hz), 23.2 (d, *J* = 3.9 Hz), 13.5.

^{31}P NMR (202 MHz, Chloroform-*d*) δ 34.4.

HRMS (ESI) $[M+Na]^+$: calcd.391.1803, found. 391.1806.

Optical Rotation: $[\alpha]_D^{20}$ = +12.7 (*c* = 1.79, acetone).

HPLC: Daicel Chiralcel AD-H (92 % ee), *n*-Hexanes/*i*-PrOH = 80/20, 1 mL/min, λ = 208 nm, *t* (major) = 8.0 min, *t* (minor) = 12.4 min.



4: 60% yield, colorless oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.65 (ddd, *J* = 10.0, 7.6, 1.9 Hz, 2H), 7.48 – 7.42 (m, 5H), 7.39 (d, *J* = 20.1 Hz, 1H), 6.90 (d, *J* = 8.7 Hz, 2H), 6.55 (dt, *J* = 18.0, 11.8 Hz, 1H), 5.23 (d, *J* = 11.5 Hz, 1H), 5.10 (d, *J* = 18.0 Hz, 1H), 3.84 (s, 3H), 2.32 – 2.20 (m, 1H), 2.13 (dq, *J* = 14.3, 7.9 Hz, 1H), 1.16 (dt, *J* = 17.8, 7.6 Hz, 3H), 1.06 – 0.75 (m, 3H).

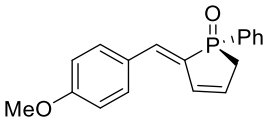
^{13}C NMR (126 MHz, Chloroform-*d*) δ 160.0, 144.7 (d, *J* = 16.8 Hz), 131.8, 131.4 (d, *J* = 8.6 Hz), 130.6 (d, *J* = 2.3 Hz), 130.3 (d, *J* = 54.7 Hz), 129.4 (d, *J* = 89.7 Hz), 128.7 (d, *J* = 9.7 Hz), 128.4 (d, *J* = 17.1 Hz), 125.2 (d, *J* = 48.2 Hz), 119.9 (d, *J* = 4.9 Hz), 113.7, 55.3, 16.1 (d, *J* = 38.7 Hz), 6.9.

^{31}P NMR (202 MHz, Chloroform-*d*) δ 24.36 (q, *J* = 58.2 Hz).

HRMS(ESI) $[M+H]^+$: calcd. 311.1736, found. 311.1729.

Optical Rotation: $[\alpha]_D^{20}$ = +34.9 (*c* = 1.51, acetone).

HPLC: Daicel Chiralcel AD-H (88 % ee), *n*-Hexanes/*i*-PrOH = 90/10, 1 mL/min, λ = 297 nm, *t* (major) = 6.7 min, *t* (minor) = 8.5 min.



5: 92% yield, yellow oil.

^{1}H NMR (500 MHz, Chloroform-*d*) δ 7.83 – 7.72 (m, 2H), 7.54 (td, *J* = 7.2, 1.5 Hz, 1H), 7.47 (td, *J* = 7.5, 2.3 Hz, 2H), 7.38 (d, *J* = 8.6 Hz, 2H), 7.34 – 7.23 (m, 1H), 6.90 (d, *J* = 8.8 Hz, 2H), 6.79 (d, *J* = 18.7 Hz, 1H), 6.31 (dddd, *J* = 24.9, 6.3, 3.4, 1.6 Hz, 1H), 3.82 (s, 3H), 2.95 (ddt, *J* = 18.4, 15.4, 2.8 Hz, 1H), 2.77 (dddd, *J* = 19.3, 6.2, 3.4, 2.2 Hz, 1H).

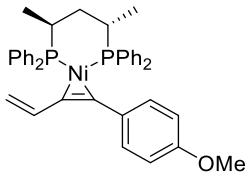
^{13}C NMR (126 MHz, Chloroform-*d*) δ 159.9, 134.6 (d, *J* = 9.6 Hz), 133.9 (d, *J* = 75.7 Hz), 133.1 (d, *J* = 75.3 Hz), 131.9 (d, *J* = 3.0 Hz), 131.7 (d, *J* = 31.3 Hz), 131.2 (d, *J* = 8.1 Hz), 130.6, 130.2 (d, *J* = 10.2 Hz), 129.2 (d, *J* = 17.5 Hz), 128.6 (d, *J* = 12.0 Hz), 114.0, 55.3, 33.0 (d, *J* = 70.5 Hz).

^{31}P NMR (202 MHz, Chloroform-*d*) δ 45.4.

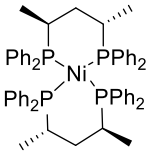
HRMS (ESI) $[M+H]^+$: calcd. 297.1044, found.297.1045.

Optical Rotation: $[\alpha]_D^{20}$ = +39.8 (*c* = 1.40, acetone).

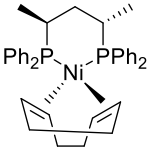
HPLC: Daicel Chiralcel OJ-H (88 % ee), *n*-Hexanes/*i*-PrOH = 90/10, 1 mL/min, λ = 315 nm, *t* (major) = 19.4 min, *t* (minor) = 25.0 min.



A: **^{1}H NMR** (500 MHz, Benzene-d_6) δ 7.87 – 7.68 (m, 4H), 7.51 (t, *J* = 8.6 Hz, 2H), 7.49 – 7.41 (m, 2H), 7.08 (d, *J* = 8.2 Hz, 2H), 6.96 (t, *J* = 7.4 Hz, 2H), 6.85 – 6.75 (m, 7H), 6.70 (d, *J* = 8.1 Hz, 3H), 6.63 (dt, *J* = 10.5, 6.0 Hz, 1H), 6.27 (d, *J* = 8.2 Hz, 2H), 5.09 (d, *J* = 17.1 Hz, 1H), 4.73 (d, *J* = 9.5 Hz, 1H), 2.94 (s, 3H), 2.42 – 2.18 (m, 2H), 1.62 – 1.38 (m, 2H), 0.69 – 0.55 (m, 6H).
^{31}P NMR (202 MHz, Benzene-d_6) δ 35.6 (d, *J* = 20.2 Hz), 34.6 (d, *J* = 20.1 Hz).



B: **^{1}H NMR** (400 MHz, Benzene-d_6) δ 7.66 (s, 7H), 7.22 (s, 8H), 7.10 (dd, *J* = 12.3, 7.0 Hz, 12H), 6.94 (t, *J* = 7.3 Hz, 5H), 6.77 (t, *J* = 7.5 Hz, 8H), 2.38 (q, *J* = 6.5 Hz, 4H), 1.75 (d, *J* = 13.5 Hz, 4H), 0.92 (dt, *J* = 11.3, 5.3 Hz, 12H).
^{31}P NMR (162 MHz, Benzene-d_6) δ 28.0.



C: **^{1}H NMR** (400 MHz, Benzene-d_6) δ 7.71 – 7.55 (m, 4H), 7.41 (t, *J* = 7.4 Hz, 4H), 7.13 (d, *J* = 11.5 Hz, 4H), 7.10 – 7.03 (m, 8H), 4.61 – 4.35 (m, 4H), 2.75 – 2.64 (m, 2H), 2.34 – 2.26 (m, 2H), 2.07 (s, 2H), 1.93 – 1.82 (m, 2H), 1.79 – 1.71 (m, 2H), 1.61 – 1.46 (m, 2H), 0.95 (dd, *J* = 10.5, 6.8 Hz, 6H).
^{31}P NMR (162 MHz, Benzene-d_6) δ 34.4.

10. Supplementary References:

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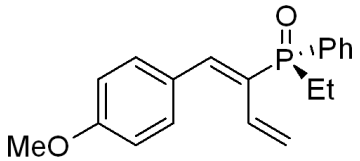
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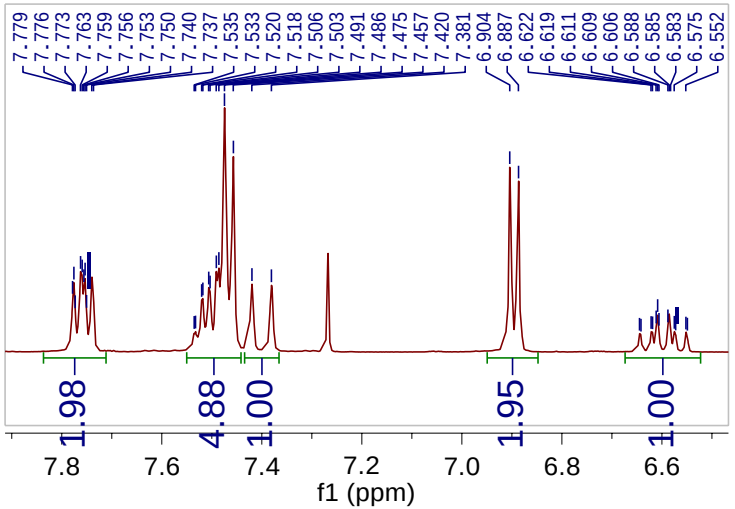
Et
MeO

3aa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6.6
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4.88
1.00
1.95
1.00
1.97
2.97
2.05
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9.0
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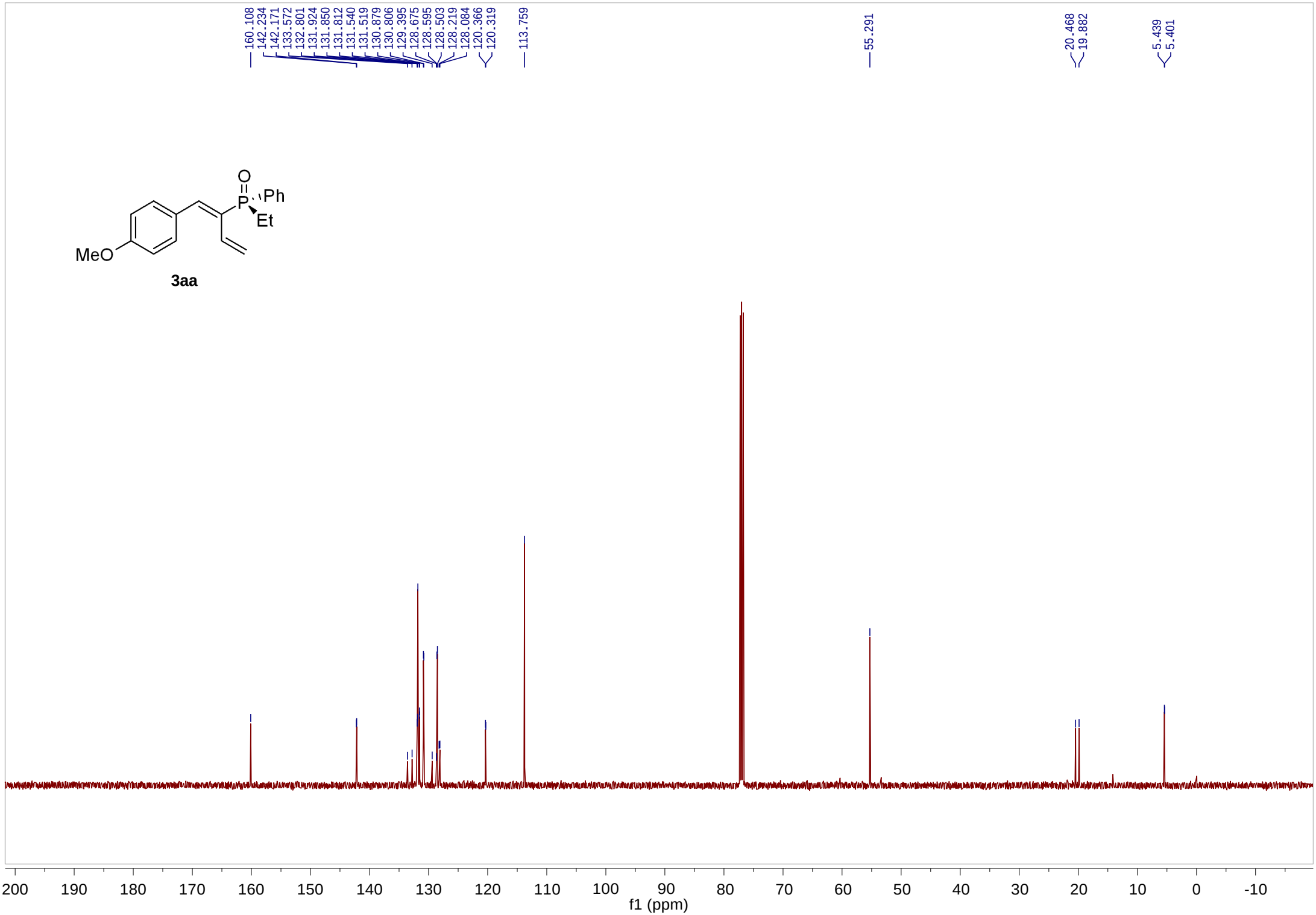
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O
P
Ph
Et
MeO
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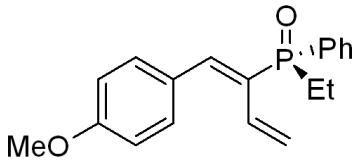

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35.954

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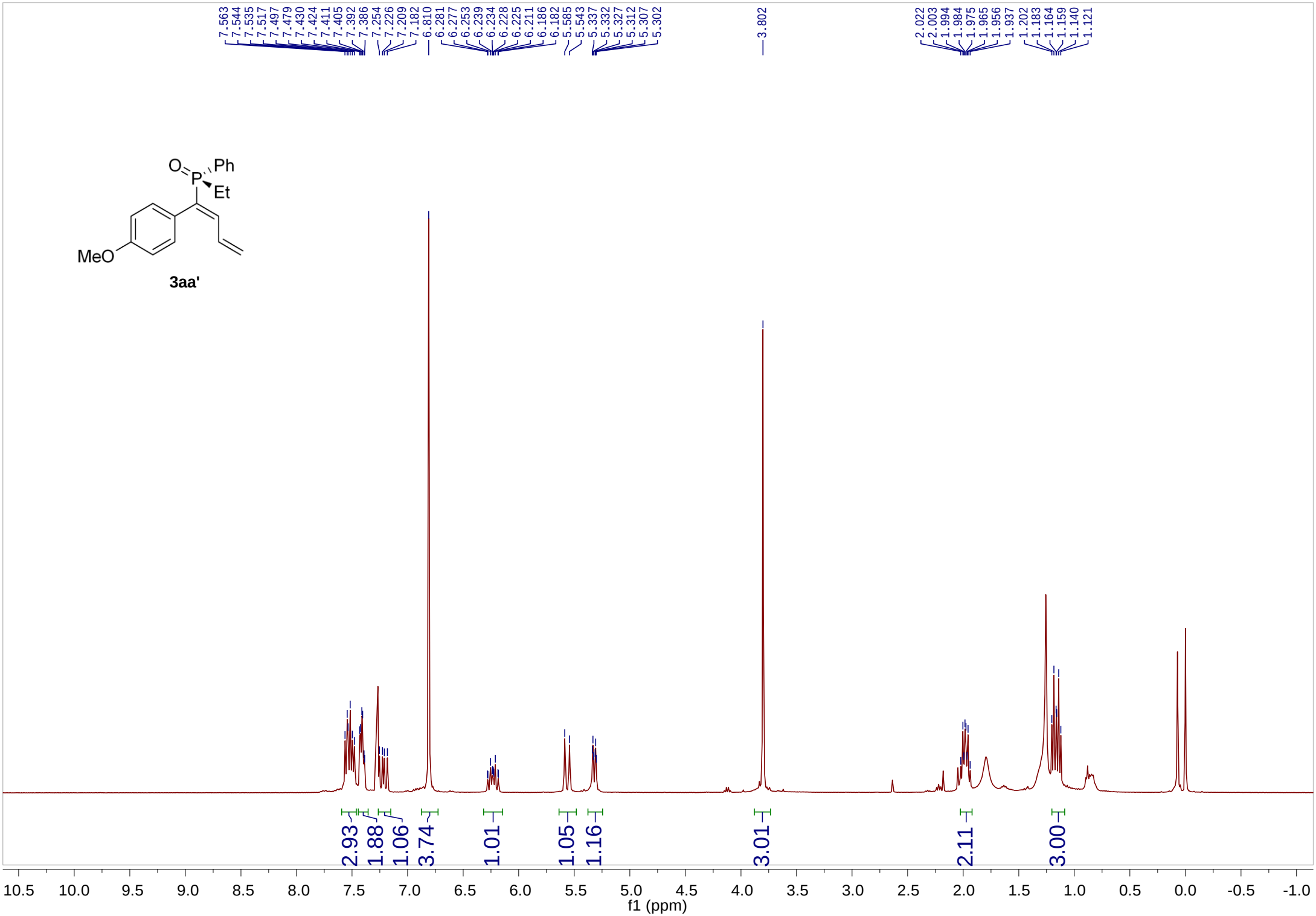
f1 (ppm)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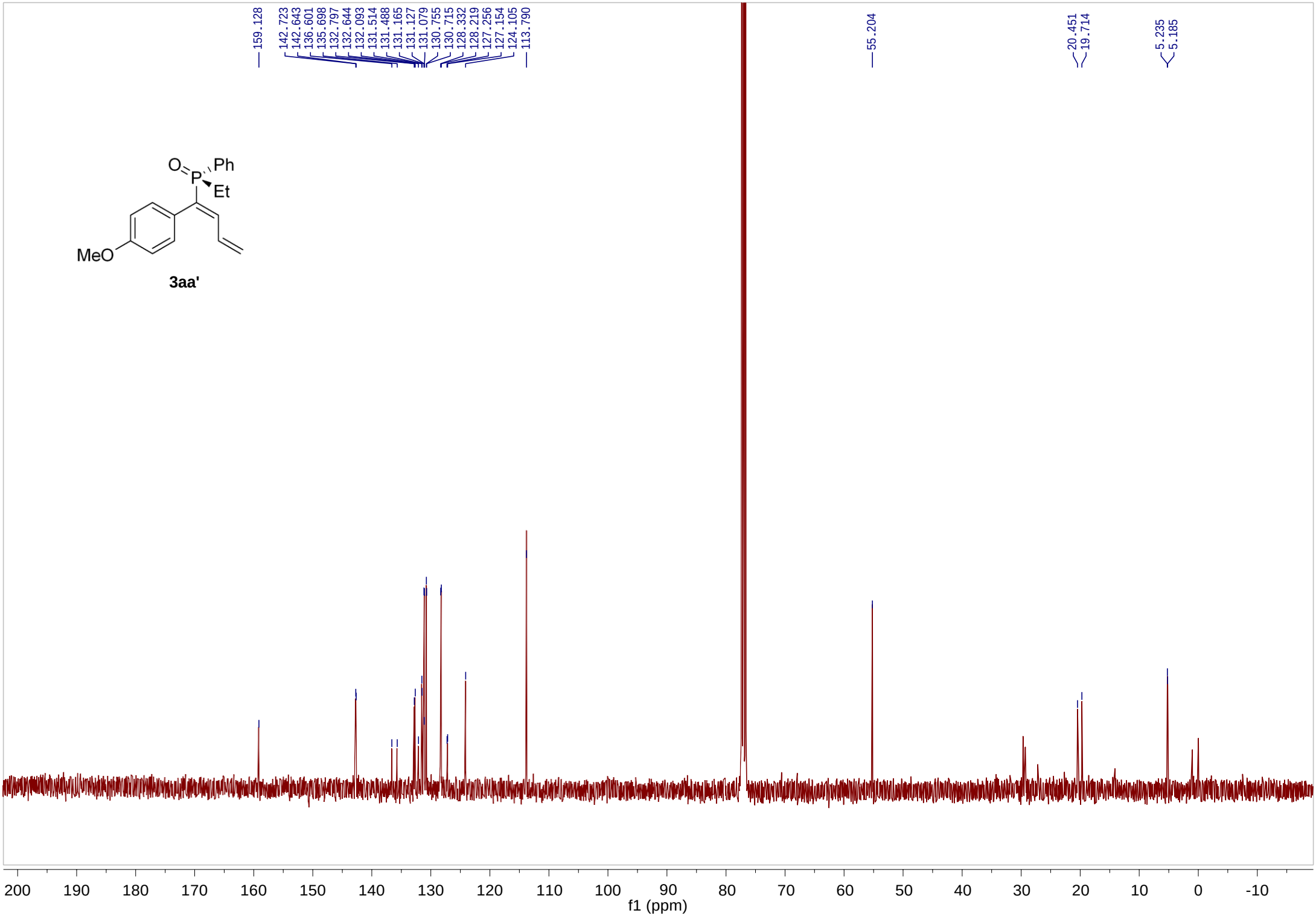
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MeO
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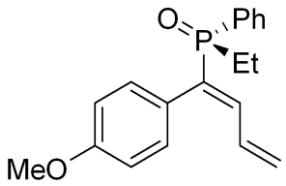

3aa'

33.731

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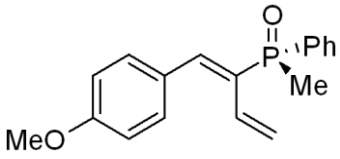
f1 (ppm)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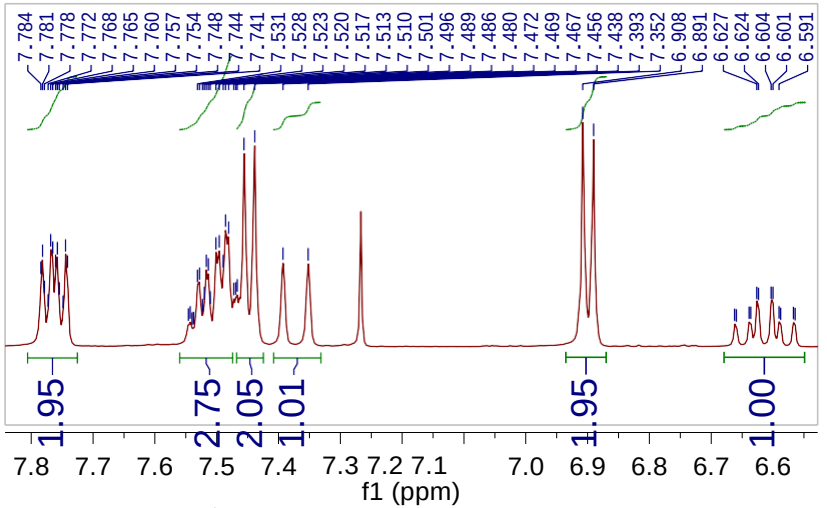
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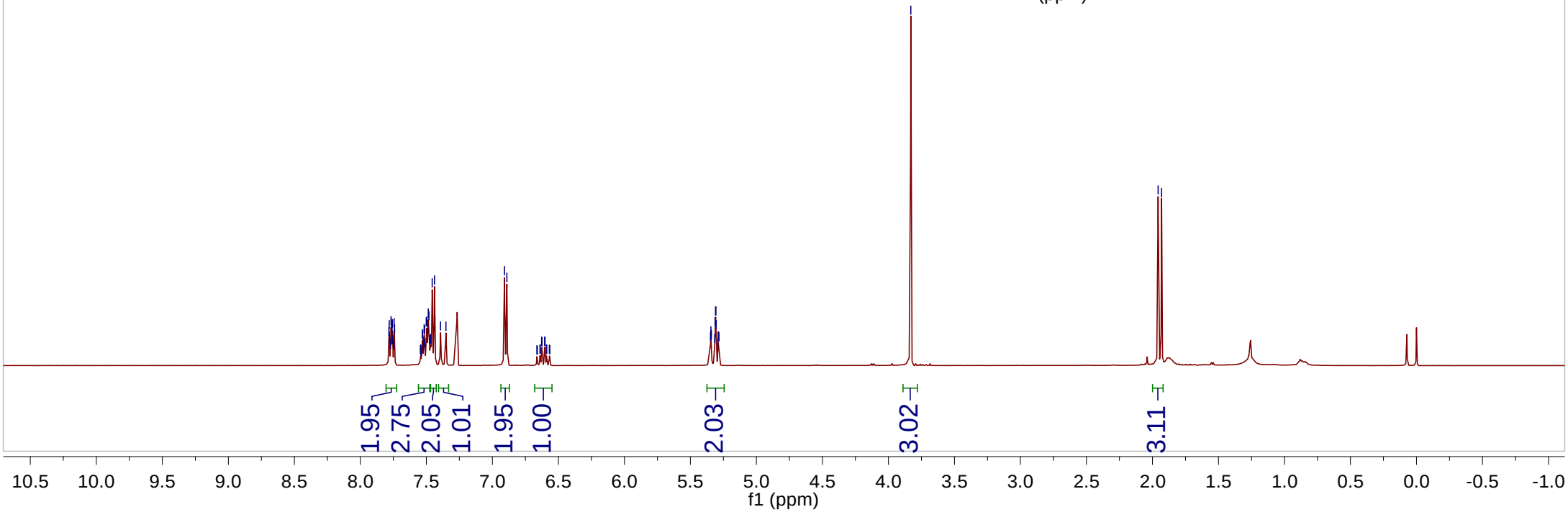
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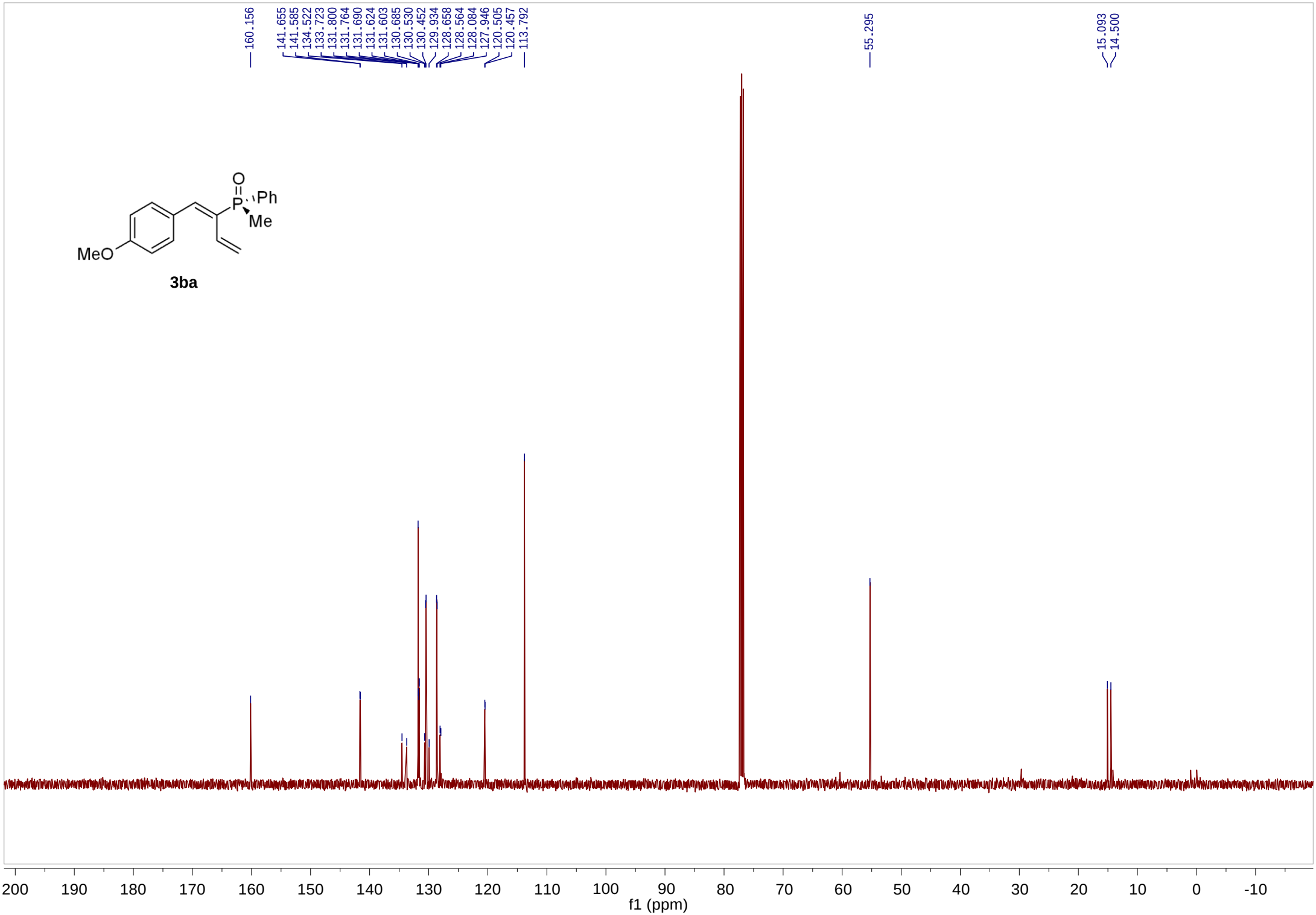
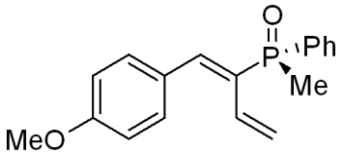
1.95
1.00
2.03
3.02
3.11
f1 (ppm)


160.156
141.655
141.585
134.522
133.723
131.800
131.764
131.690
131.624
131.603
130.685
130.530
130.452
129.934
128.658
128.564
128.084
127.946
120.505
120.457
113.792
55.295
15.093
14.500
O
P
Ph
Me
MeO
3ba
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

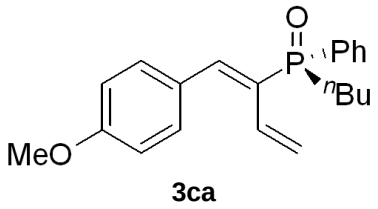


3ba

31.729

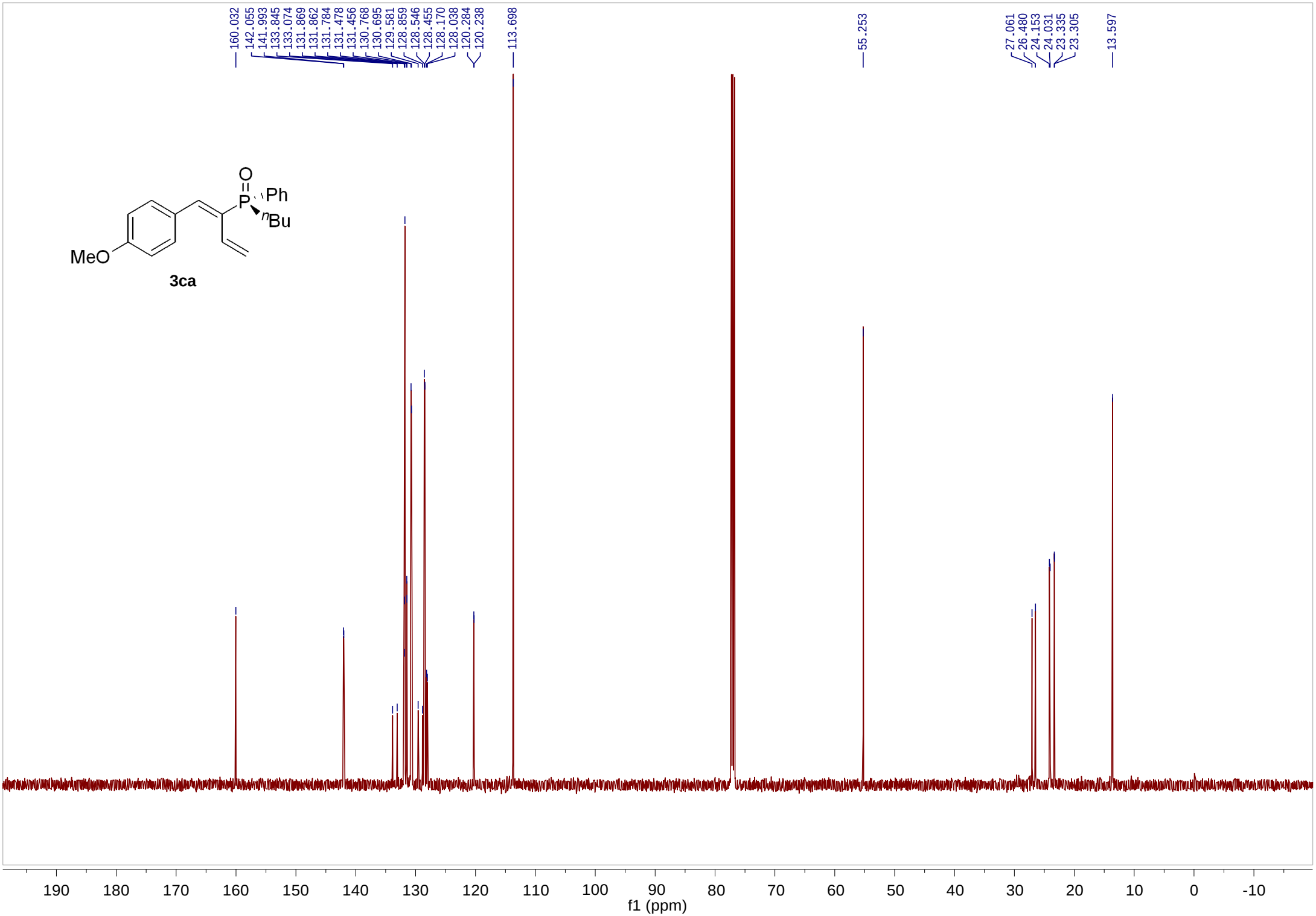
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

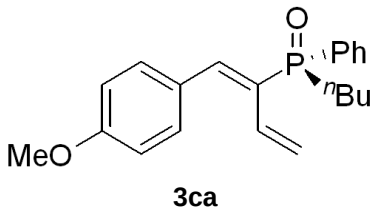
f1 (ppm)



3ca

f1 (ppm)


160.032
142.055
141.993
133.845
133.074
131.869
131.862
131.784
131.478
131.456
130.768
130.695
129.581
128.859
128.546
128.455
128.170
128.038
120.284
120.238
113.698
55.253
27.061
26.480
24.153
24.031
23.335
23.305
13.597
O
P
Ph
nBu
MeO
3ca
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

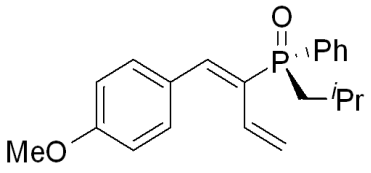


3ca

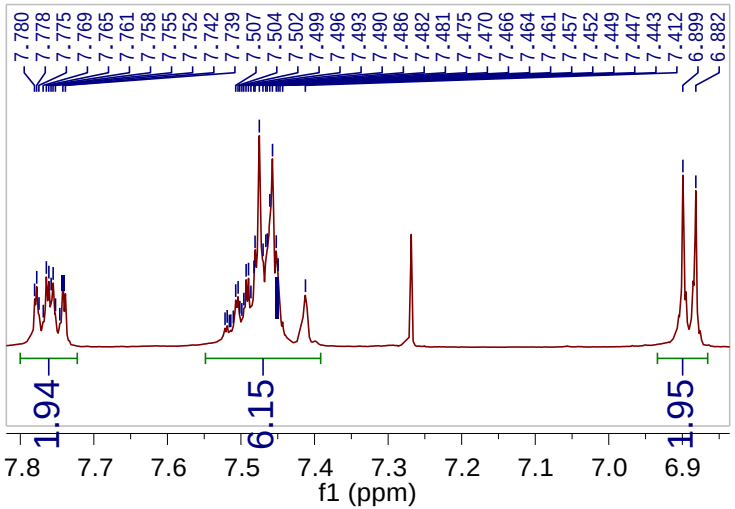
34.301

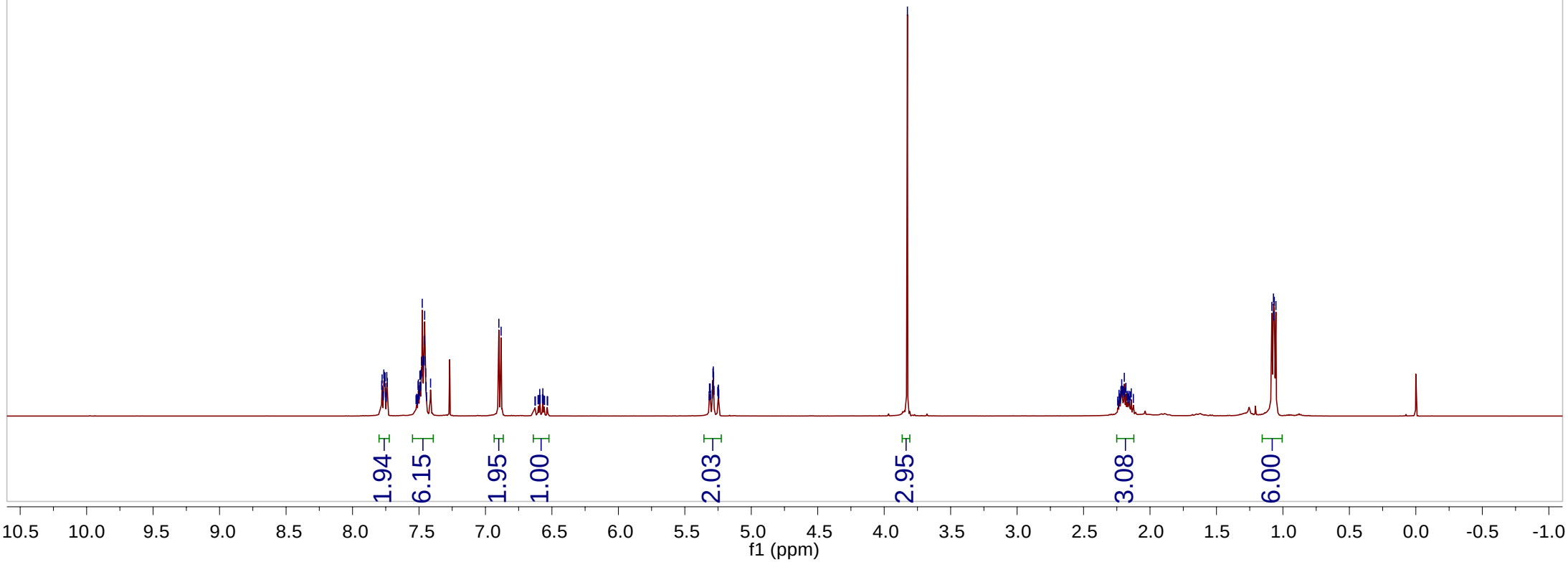
00 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

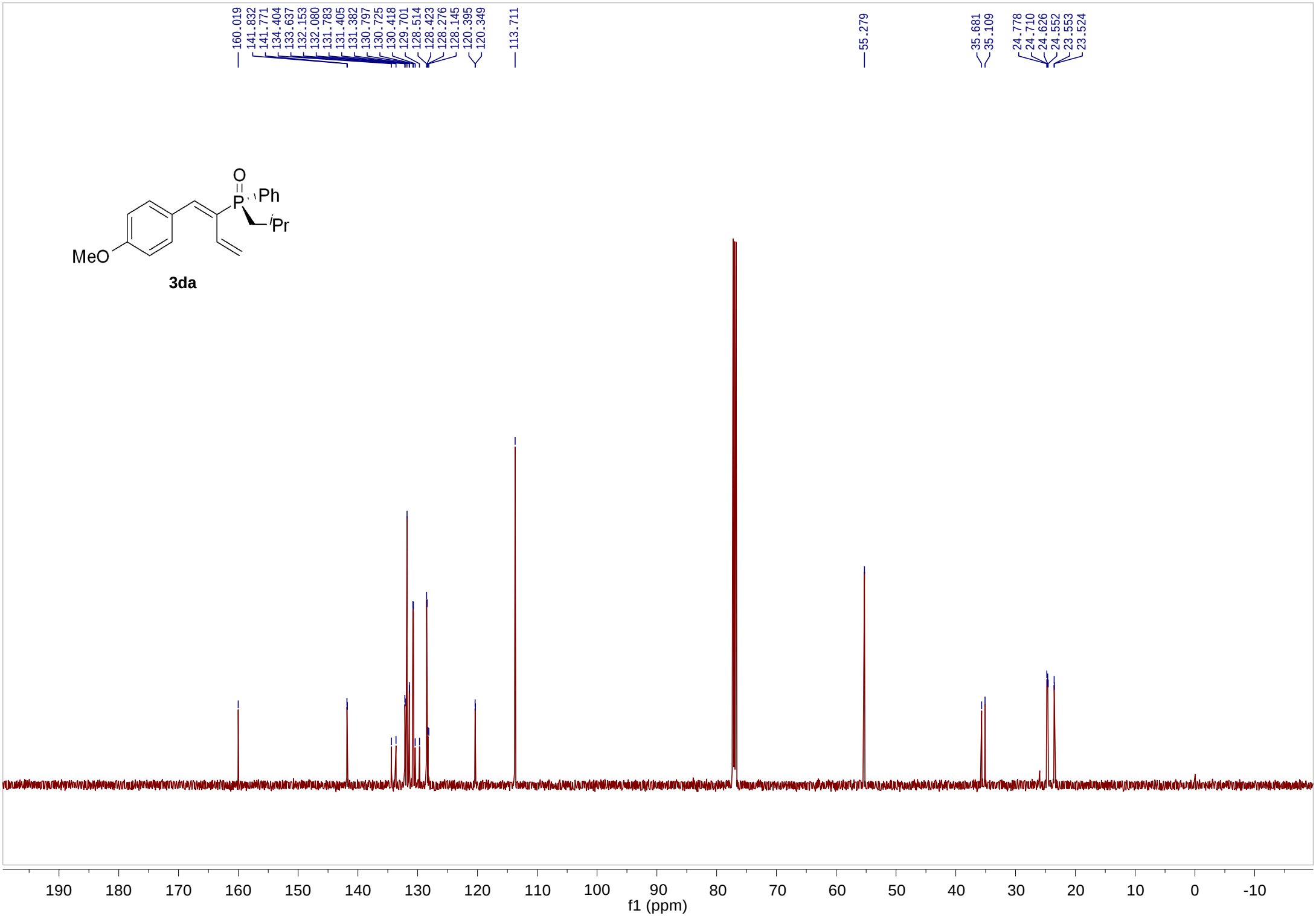
f1 (ppm)

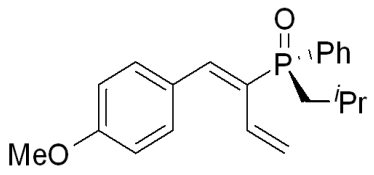

O
P
Ph
iPr
MeO

3da


1.94
6.15
1.95
7.8
7.7
7.6
7.5
7.4
7.3
7.2
7.1
7.0
6.9
f1 (ppm)


1.94
6.15
1.95
1.00
2.03
2.95
3.08
6.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)


160.019
141.832
141.771
134.404
133.637
132.153
132.080
131.783
131.405
131.382
130.797
130.725
130.418
129.701
128.514
128.423
128.276
128.145
120.395
120.349
113.711
55.279
35.681
35.109
24.778
24.710
24.626
24.552
23.553
23.524
O
P
Ph
iPr
MeO
3da
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

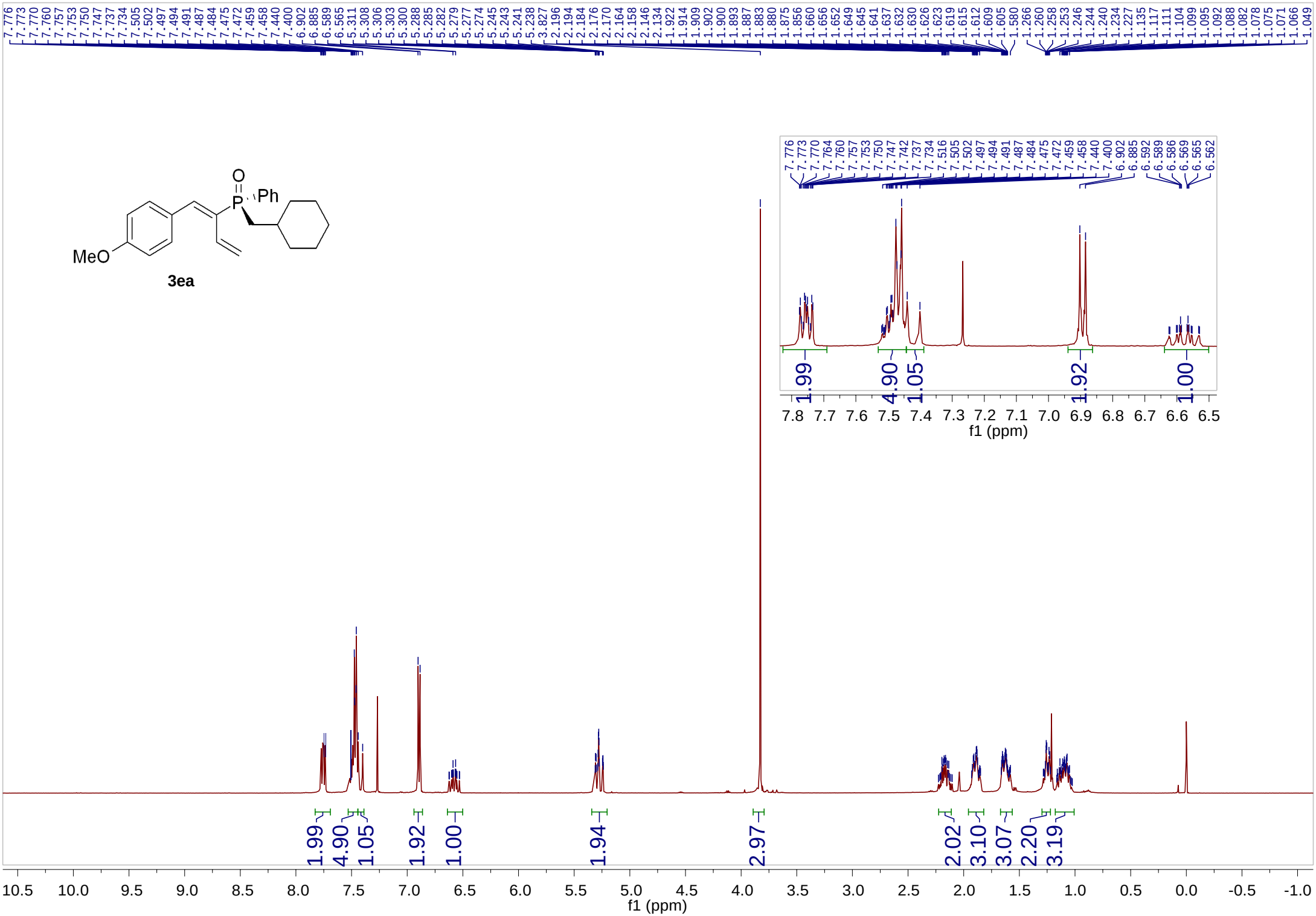


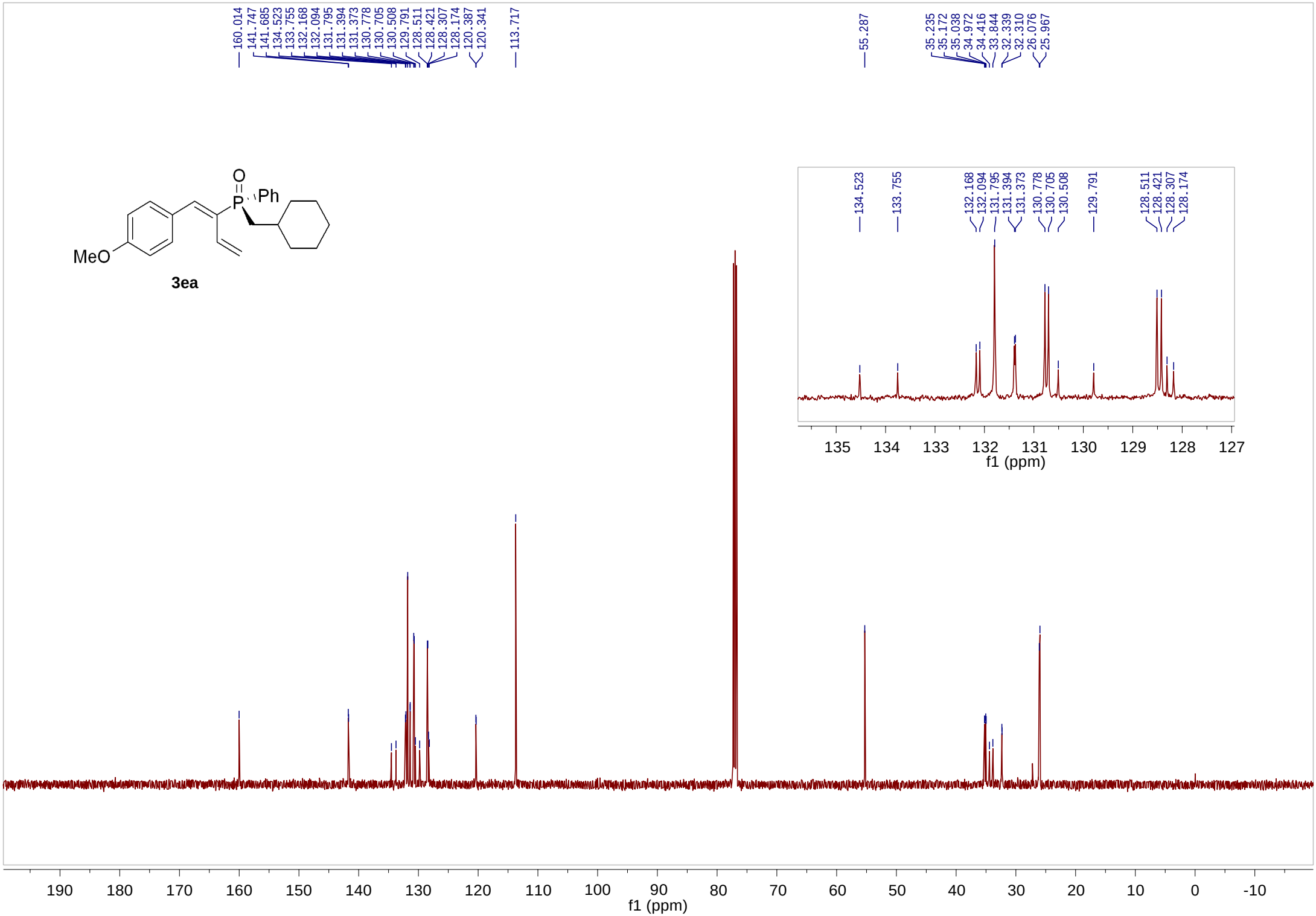
3da

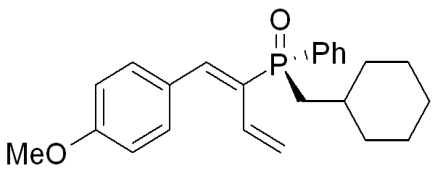
32.599

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

f1 (ppm)


MeO
O
P
Ph
3ea
f1 (ppm)


160.014
141.747
141.685
134.523
133.755
132.168
132.094
131.795
131.394
131.373
130.778
130.705
130.508
129.791
128.511
128.421
128.307
128.174
120.387
120.341
113.717
55.287
35.235
35.172
35.038
34.972
34.416
33.844
32.339
32.310
26.076
25.967
O
P
Ph
MeO
3ea
134.523
133.755
132.168
132.094
131.795
131.394
131.373
130.778
130.705
130.508
129.791
128.511
128.421
128.307
128.174
135
134
133
132
131
130
129
128
127
f1 (ppm)
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

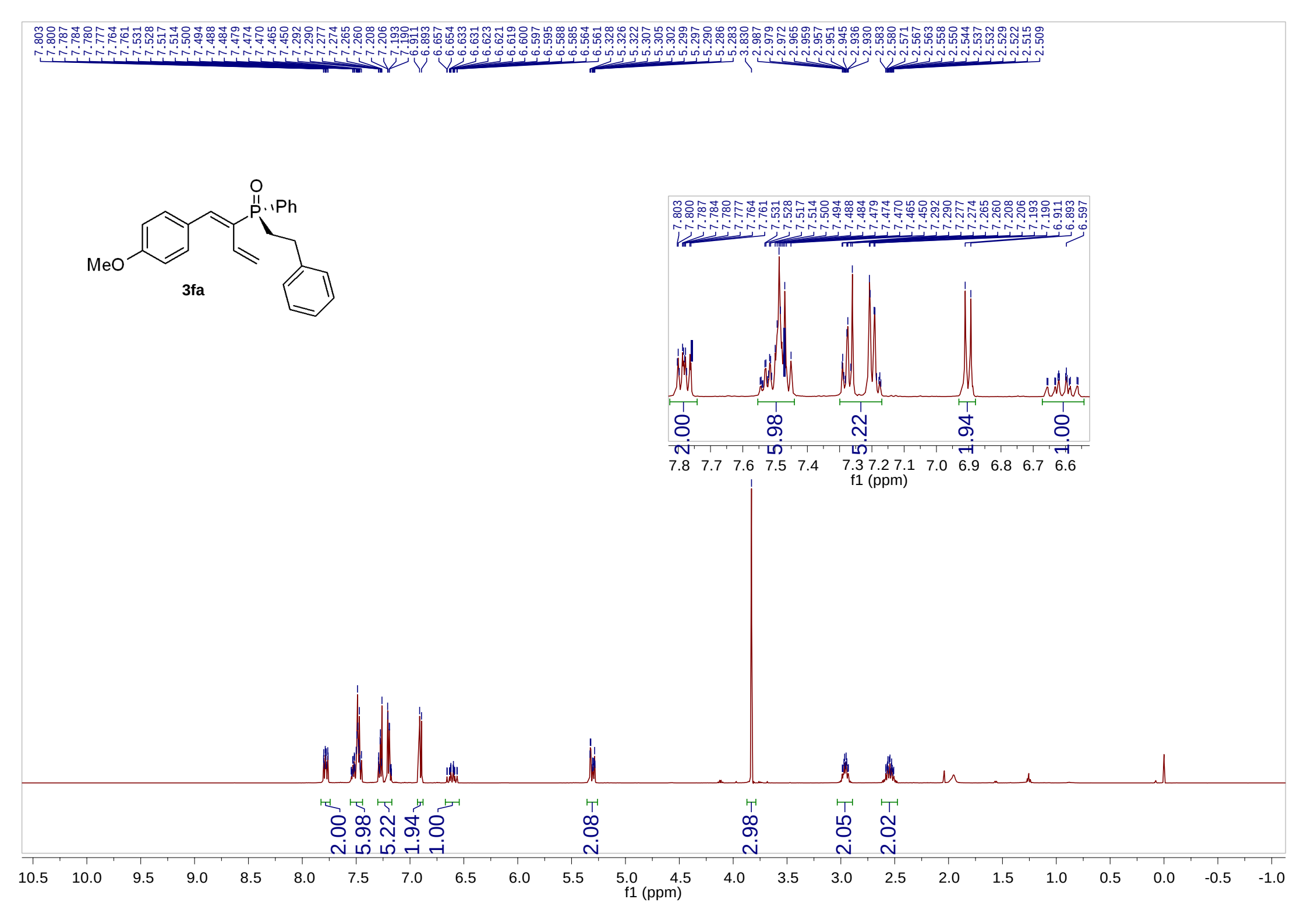


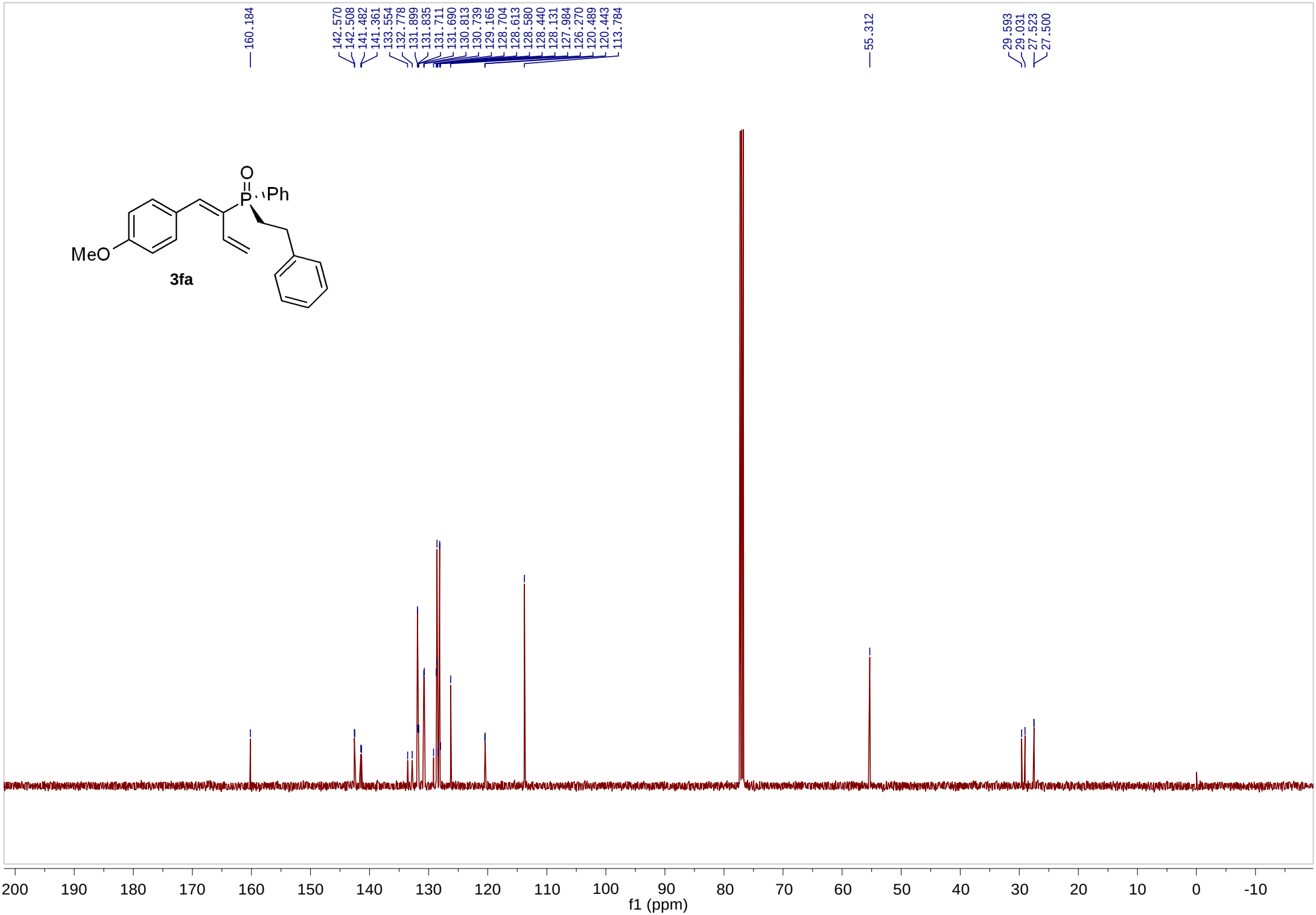
3ea

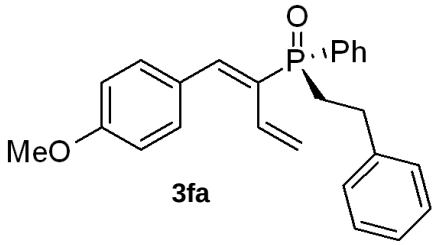
32.798

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

f1 (ppm)


7.803 7.800 7.787 7.784 7.780 7.777 7.764 7.761 7.531 7.528 7.517 7.514 7.500 7.494 7.488 7.484 7.479 7.474 7.470 7.465 7.450 7.292 7.290 7.277 7.274 7.265 7.260 7.208 7.206 7.193 7.190 6.911 6.893 6.657 6.654 6.633 6.631 6.623 6.621 6.619 6.600 6.597 6.595 6.588 6.585 6.564 6.561 5.328 5.326 5.322 5.307 5.305 5.302 5.299 5.297 5.290 5.286 5.283 3.830 2.987 2.979 2.972 2.965 2.959 2.957 2.951 2.945 2.936 2.930 2.583 2.580 2.571 2.567 2.563 2.558 2.550 2.544 2.537 2.532 2.529 2.522 2.515 2.509
O
P
Ph
MeO
3fa
7.803 7.800 7.787 7.784 7.780 7.777 7.764 7.761 7.531 7.528 7.517 7.514 7.500 7.494 7.488 7.484 7.479 7.474 7.470 7.465 7.450 7.292 7.290 7.277 7.274 7.265 7.260 7.208 7.206 7.193 7.190 6.911 6.893 6.597
2.00 5.98 5.22 1.94 1.00
7.8 7.7 7.6 7.5 7.4 7.3 7.2 7.1 7.0 6.9 6.8 6.7 6.6
f1 (ppm)
2.00 5.98 5.22 1.94 1.00 2.08 2.98 2.05 2.02
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


160.184
142.570
142.508
141.482
141.361
133.554
132.778
131.899
131.835
131.711
131.690
130.813
130.739
129.165
128.704
128.613
128.580
128.440
128.131
127.984
126.270
120.489
120.443
113.784
55.312
29.593
29.031
27.523
27.500
O
P
Ph
MeO
3fa
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

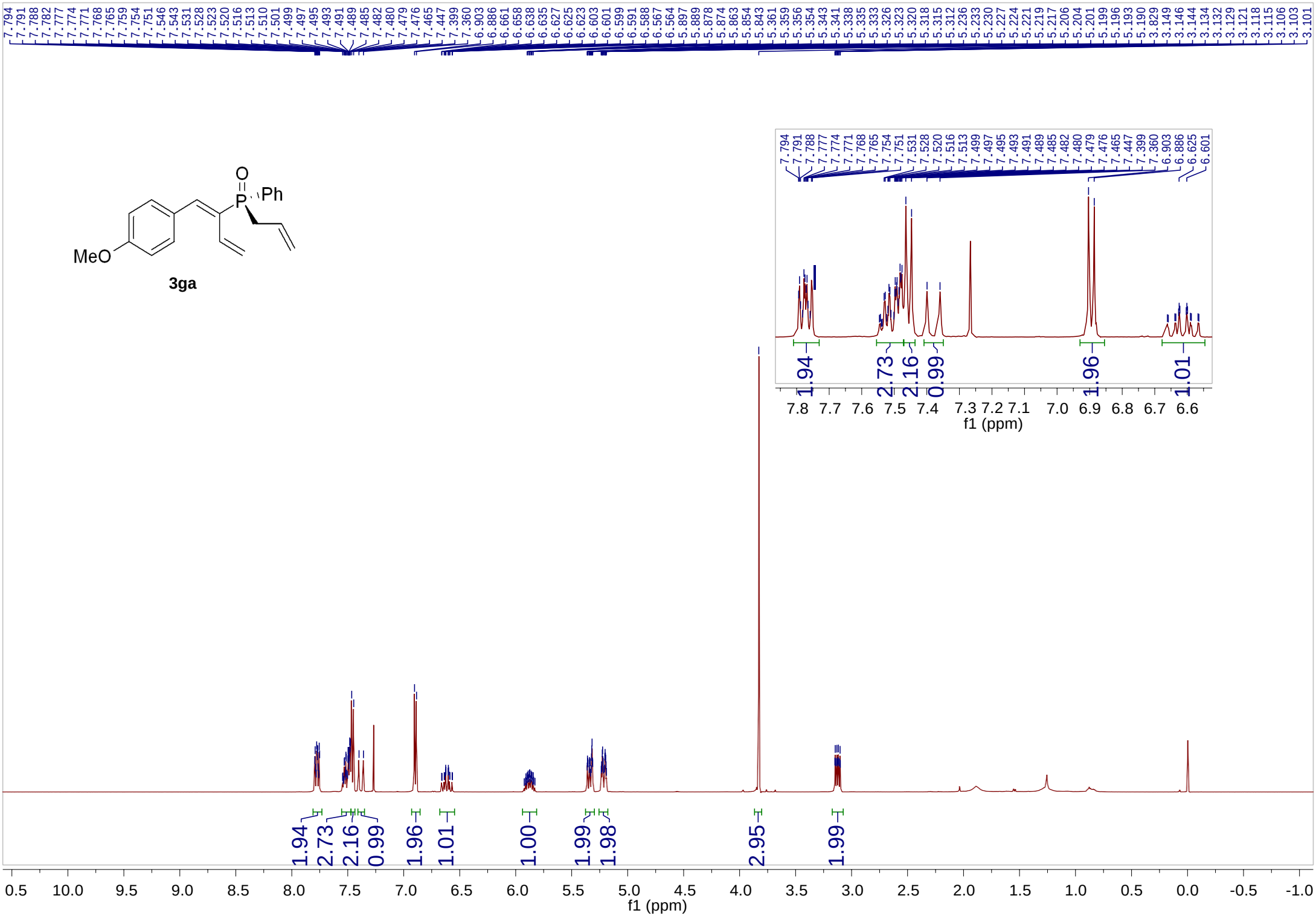


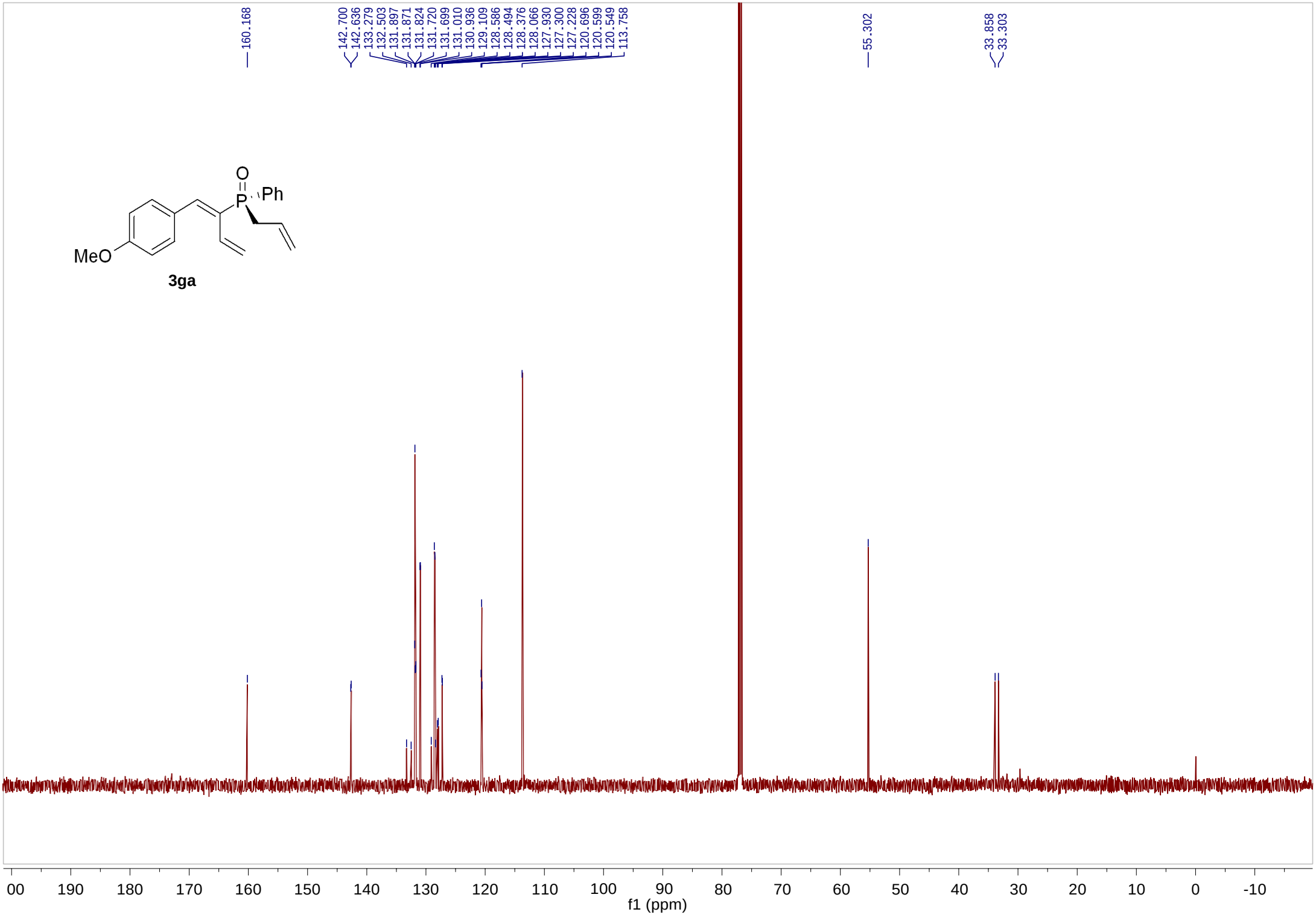
3fa

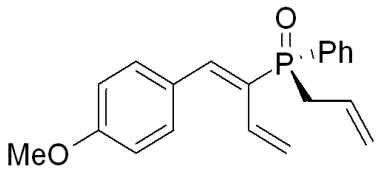
33.125

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

f1 (ppm)


MeO
O
P
Ph
3ga
f1 (ppm)


160.168
142.700
142.636
133.279
132.503
131.897
131.871
131.824
131.720
131.699
131.010
130.936
129.109
128.586
128.494
128.376
128.066
127.930
127.300
127.228
120.696
120.599
120.549
113.758
55.302
33.858
33.303
O
P
Ph
MeO
3ga
00
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

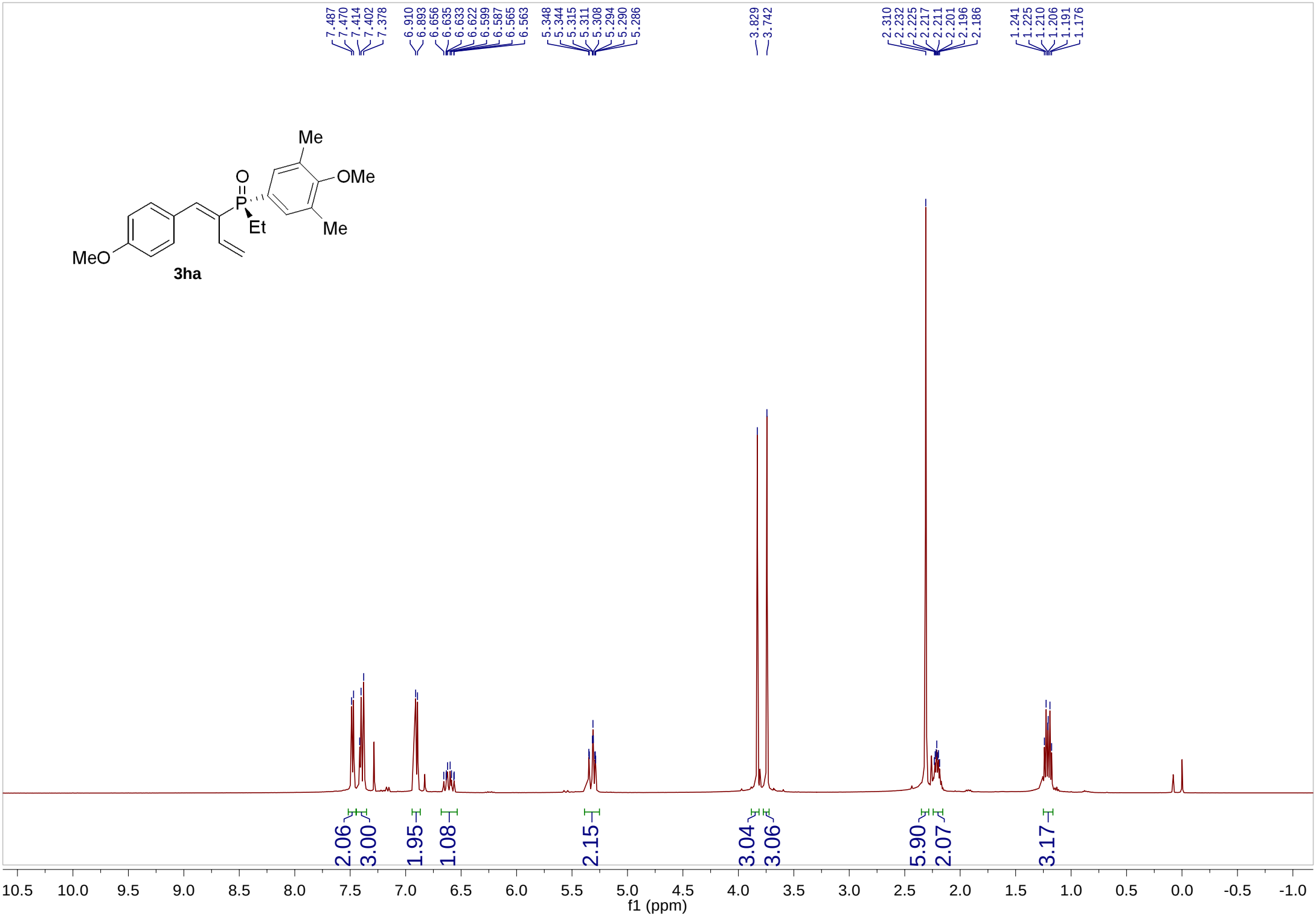


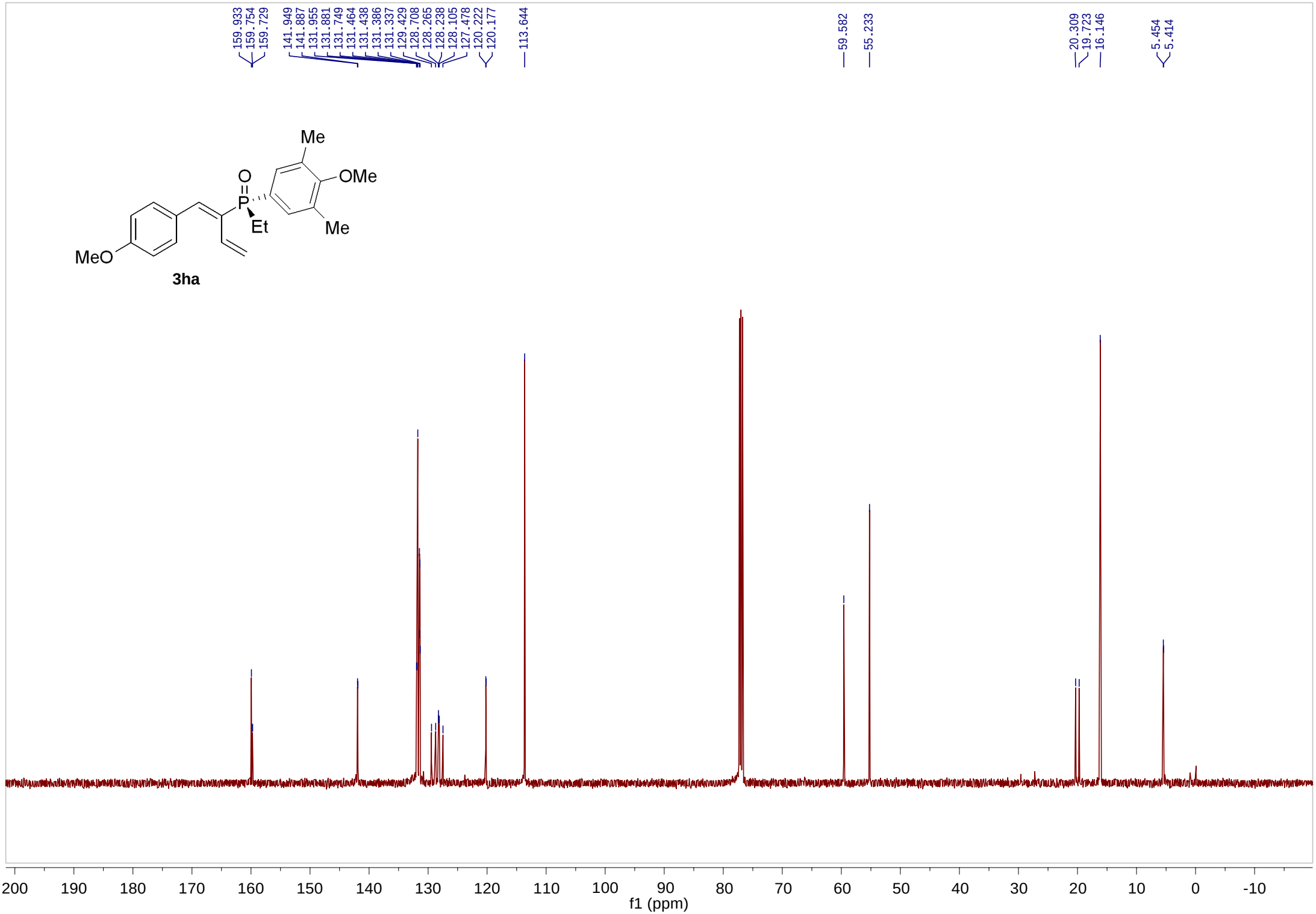
3ga

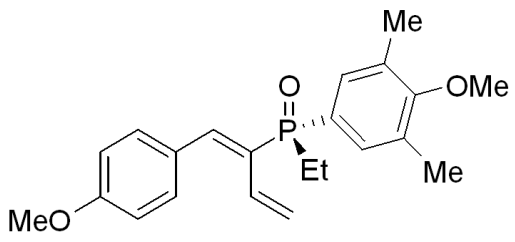
31.690

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

f1 (ppm)


7.487
7.470
7.414
7.402
7.378
6.910
6.893
6.656
6.635
6.633
6.622
6.599
6.587
6.565
6.563
5.348
5.344
5.315
5.311
5.308
5.294
5.290
5.286
3.829
3.742
2.310
2.232
2.225
2.217
2.211
2.201
2.196
2.186
1.241
1.225
1.210
1.206
1.191
1.176
Me
OMe
O
P
Et
Me
MeO
3ha
2.06
3.00
1.95
1.08
2.15
3.04
3.06
5.90
2.07
3.17
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)


159.933
159.754
159.729
141.949
141.887
131.955
131.881
131.749
131.464
131.438
131.386
131.337
129.429
128.708
128.265
128.238
128.105
127.478
120.222
120.177
113.644
59.582
55.233
20.309
19.723
16.146
5.454
5.414
Me
OMe
O
P
Et
Me
MeO
3ha
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

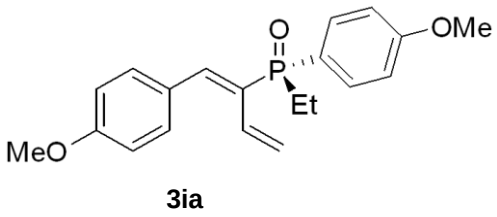


3ha

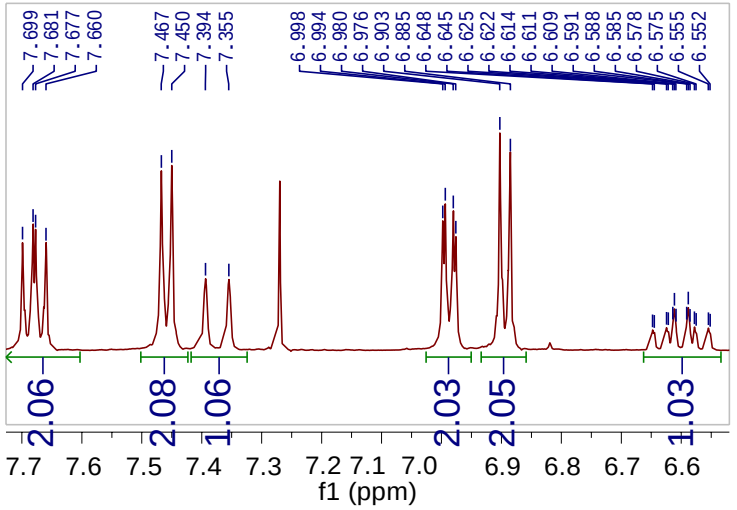
35.620

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

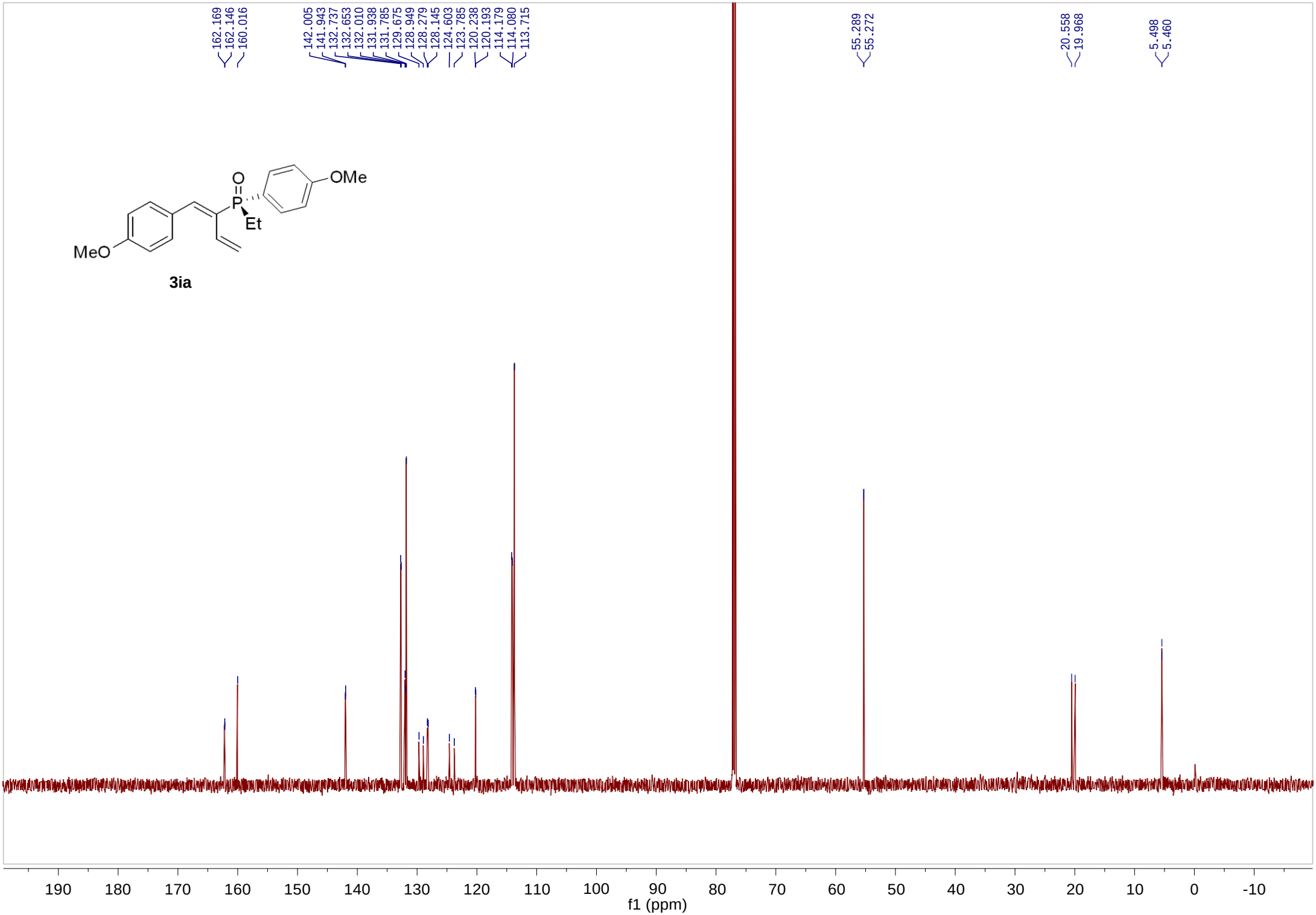
f1 (ppm)

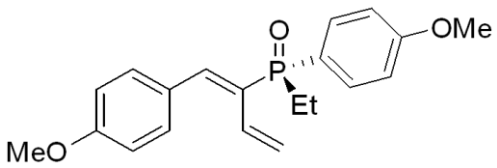

O
P
Et
OMe
MeO

3ia


2.06
2.08
1.06
2.03
2.05
1.03
7.7 7.6 7.5 7.4 7.3 7.2 7.1 7.0 6.9 6.8 6.7 6.6
f1 (ppm)

2.06
2.08
1.06
2.03
2.05
1.03
2.04
3.00
2.87
2.03
3.20
0.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


162.169
162.146
160.016
142.005
141.943
132.737
132.653
132.010
131.938
131.785
129.675
128.949
128.279
128.145
124.603
123.785
120.238
120.193
114.179
114.080
113.715
55.289
55.272
20.558
19.968
5.498
5.460
O
P
Et
OMe
MeO
3ia
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

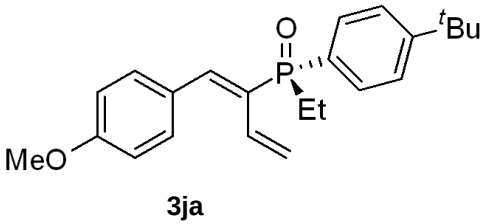


3ia

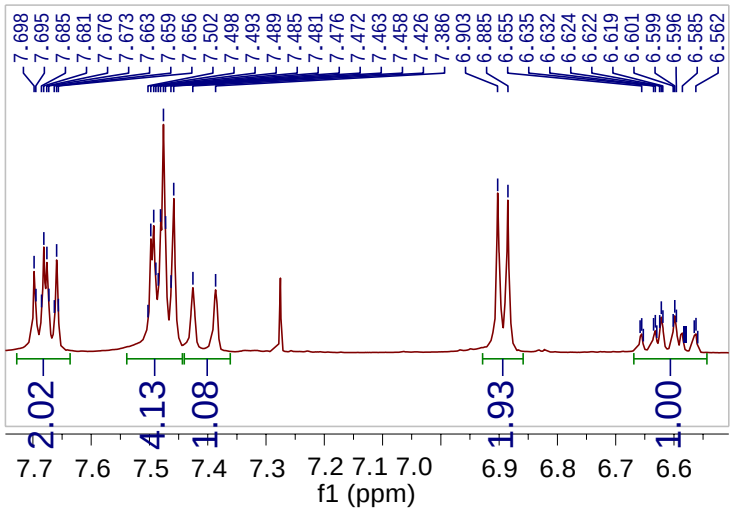
35.806

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

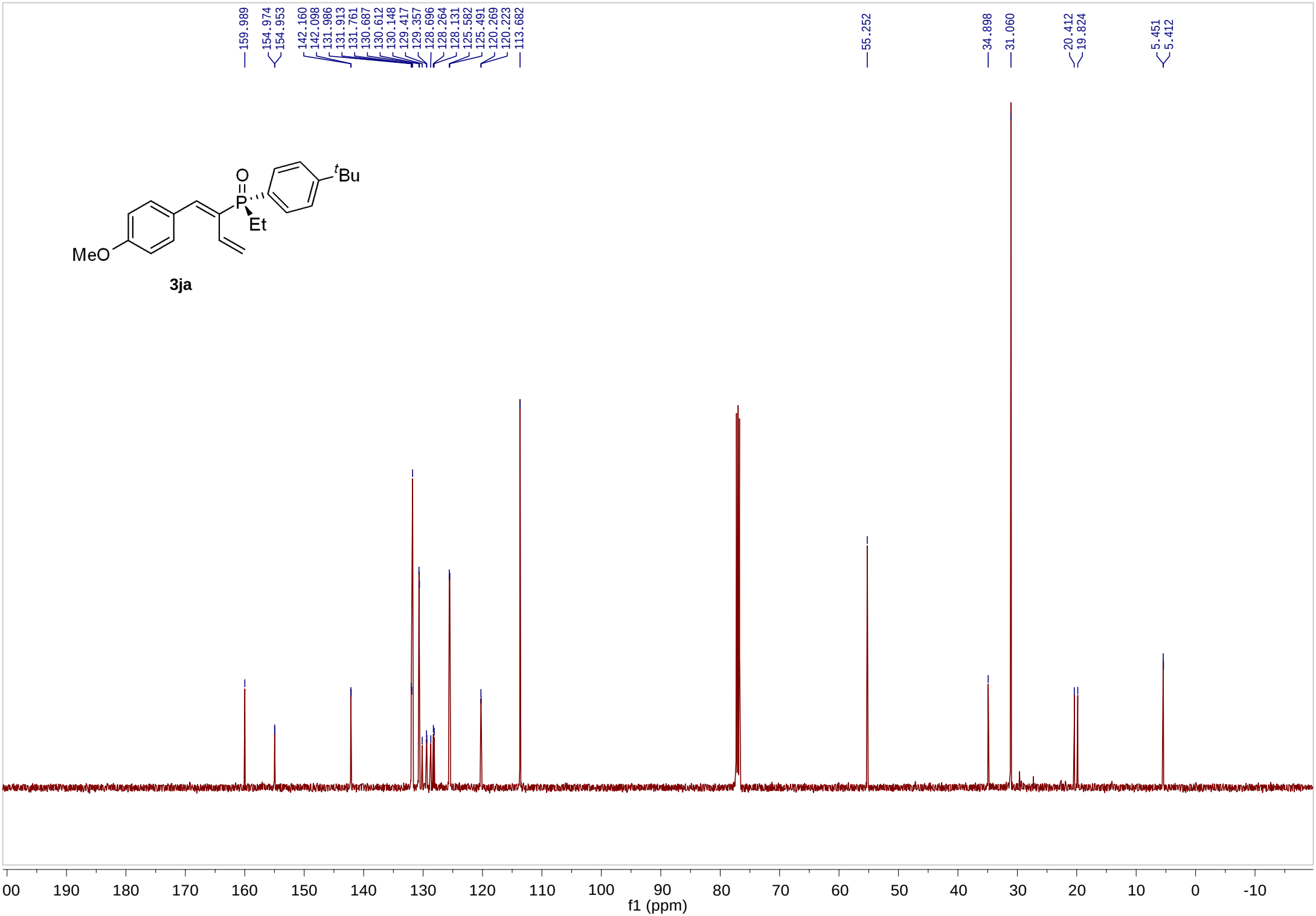
f1 (ppm)

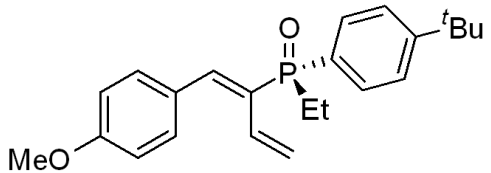

O
P
Et
tBu
MeO

3ja


2.02
4.13
1.08
1.93
1.00
7.7 7.6 7.5 7.4 7.3 7.2 7.1 7.0 6.9 6.8 6.7 6.6
f1 (ppm)

2.02
4.13
1.08
1.93
1.00
2.00
3.07
2.17
9.06
3.30
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


159.989
154.974
154.953
142.160
142.098
131.986
131.913
131.761
130.687
130.612
130.148
129.417
129.357
128.696
128.264
128.131
125.582
125.491
120.269
120.223
113.682
55.252
34.898
31.060
20.412
19.824
5.451
5.412
O
P
Et
tBu
MeO
3ja
f1 (ppm)

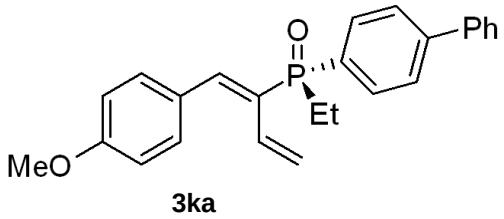


3ja

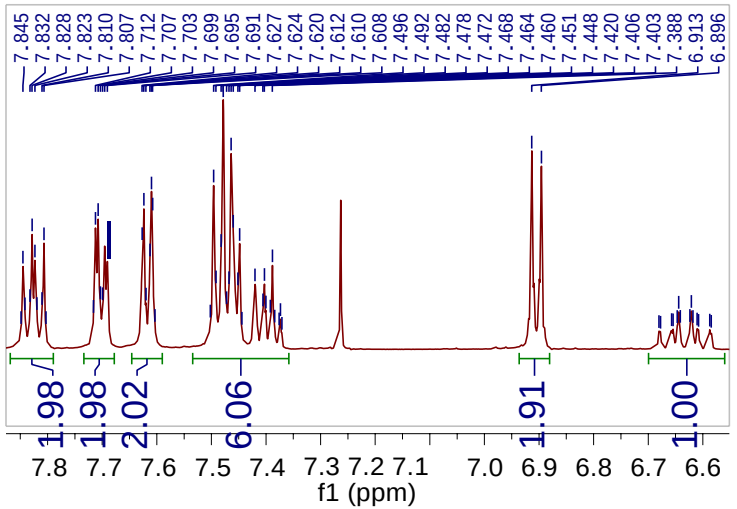
35.973

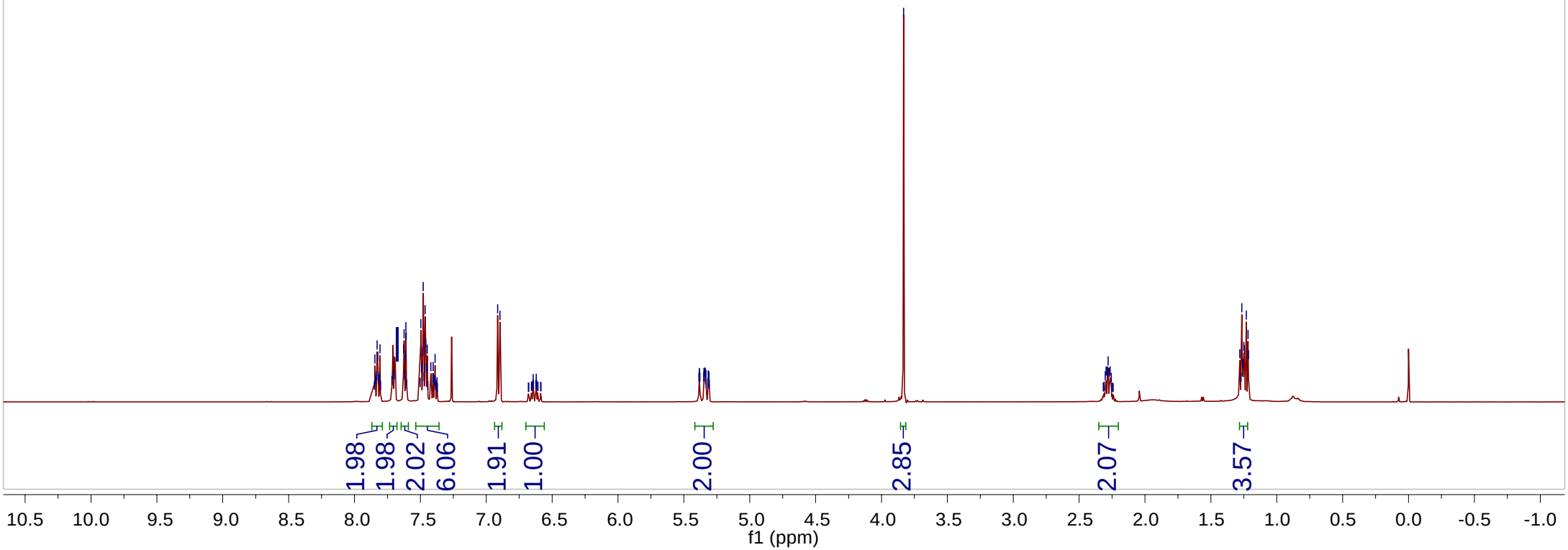
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

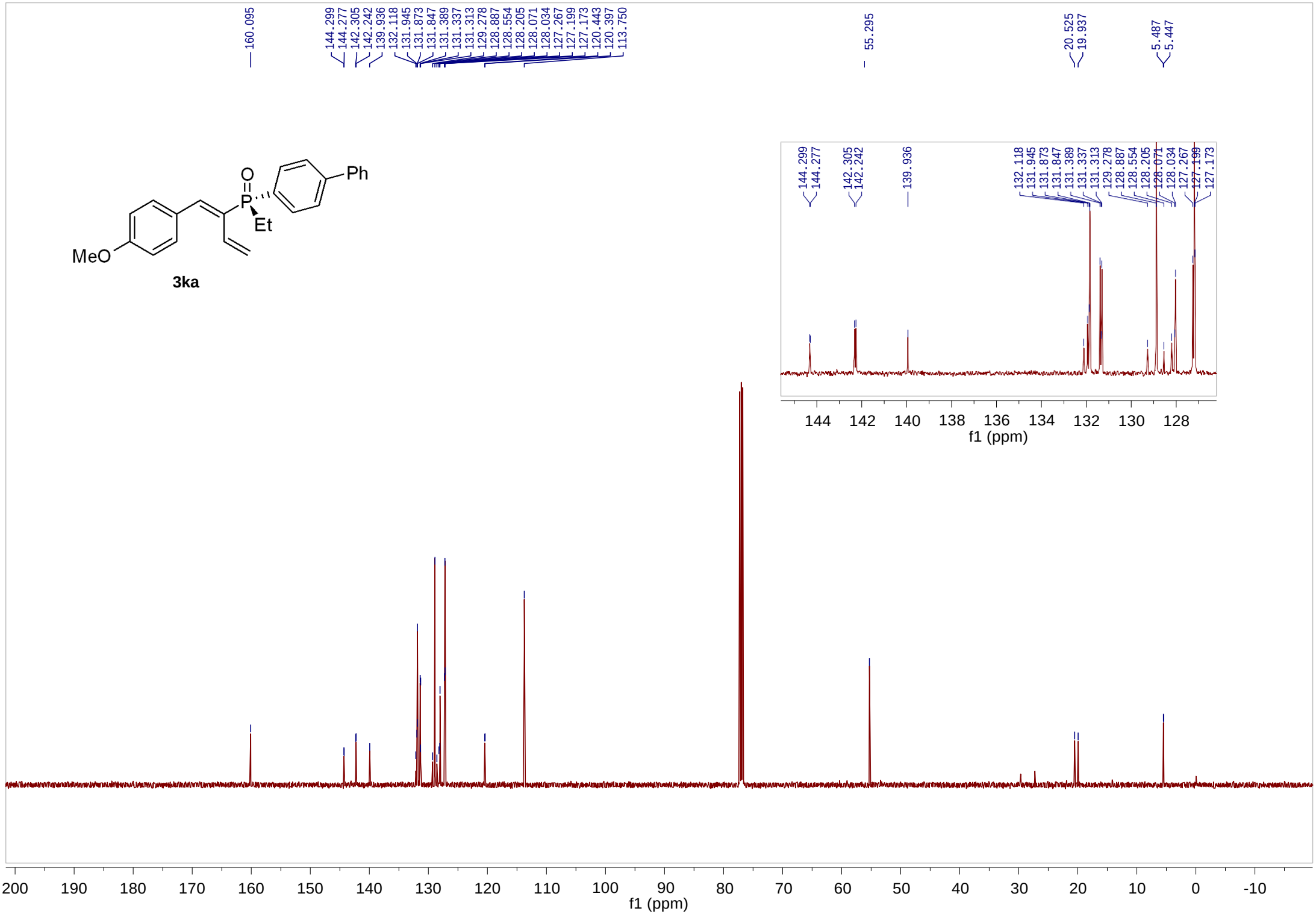
f1 (ppm)

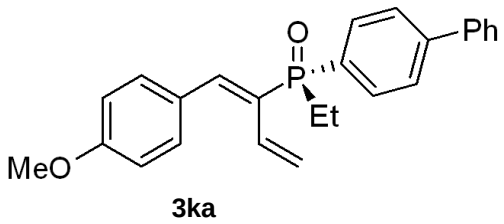

O
P
Et
Ph
MeO

3ka


1.98
1.98
2.02
6.06
1.91
1.00
7.8 7.7 7.6 7.5 7.4 7.3 7.2 7.1 7.0 6.9 6.8 6.7 6.6
f1 (ppm)


1.98
1.98
2.02
6.06
1.91
1.00
2.00
2.85
2.07
3.57
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


160.095
144.299
144.277
142.305
142.242
139.936
132.118
131.945
131.873
131.847
131.389
131.337
131.313
129.278
128.887
128.554
128.205
128.071
128.034
127.267
127.199
127.173
120.443
120.397
113.750
55.295
20.525
19.937
5.487
5.447
O
P
Et
Ph
MeO
3ka
f1 (ppm)
f1 (ppm)

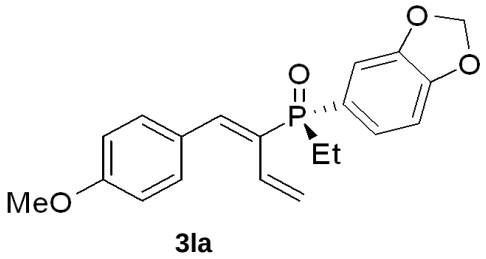


3ka

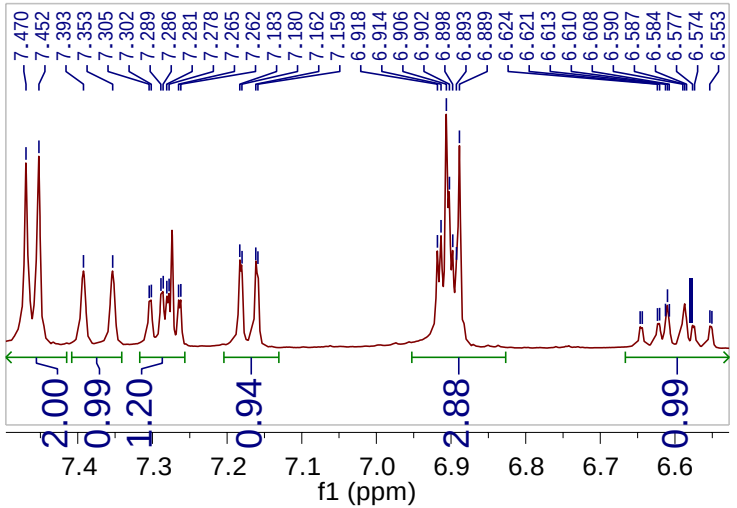
35.928

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

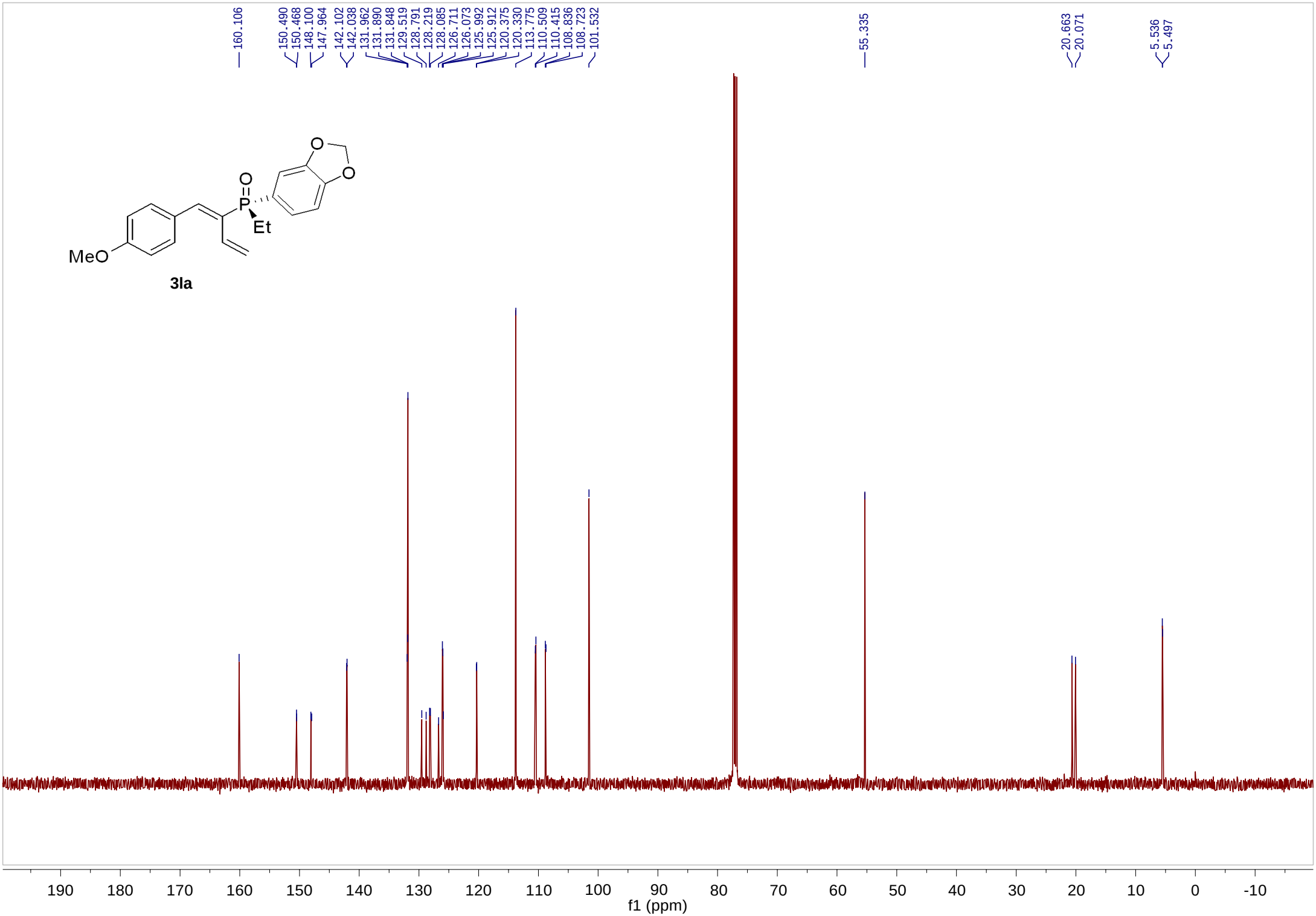
f1 (ppm)

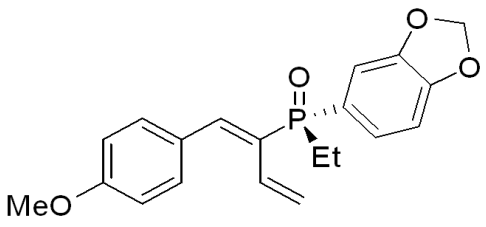

O
O
O
P
Et
MeO

3la


2.00
0.99
1.20
0.94
2.88
0.99
7.4
7.3
7.2
7.1
7.0
6.9
6.8
6.7
6.6
f1 (ppm)

2.00
0.99
1.20
0.94
2.88
0.99
1.89
1.93
2.90
2.00
3.02
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)


160.106
150.490
150.468
148.100
147.964
142.102
142.038
131.962
131.890
131.848
129.519
128.791
128.219
128.085
126.711
126.073
125.992
125.912
120.375
120.330
113.775
110.509
110.415
108.836
108.723
101.532
55.335
20.663
20.071
5.536
5.497
O
O
O
P
Et
MeO
3la
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

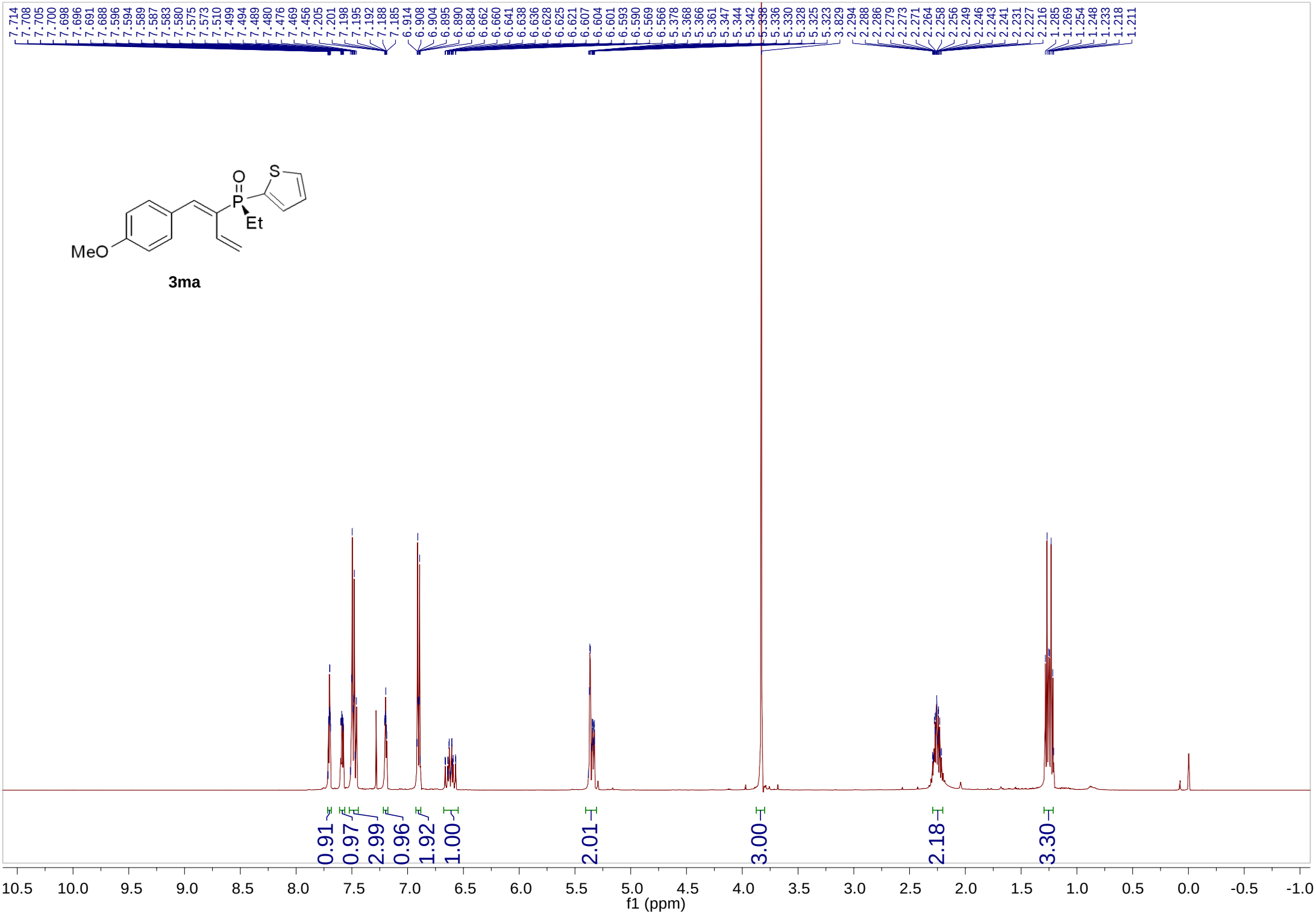


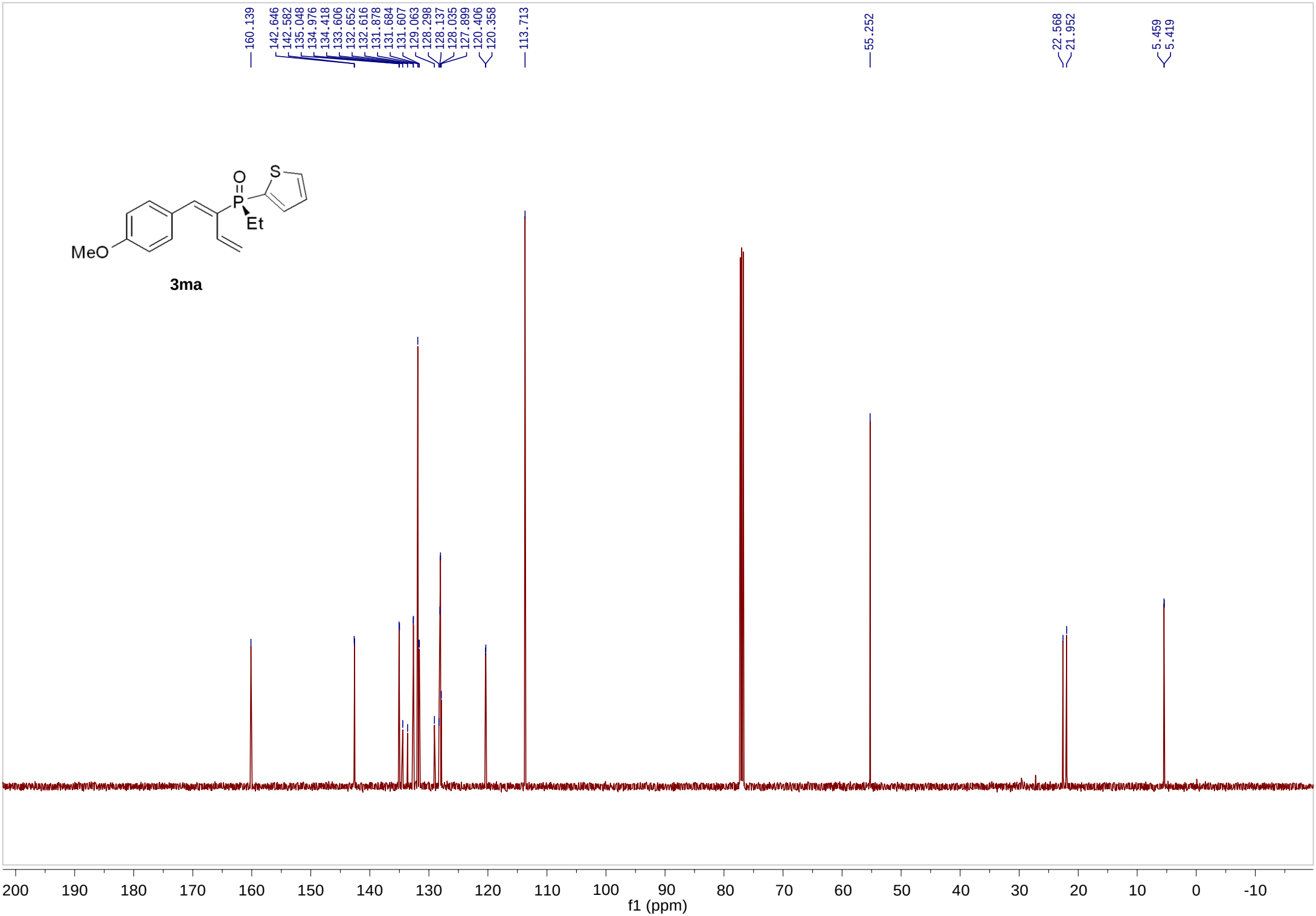
3la

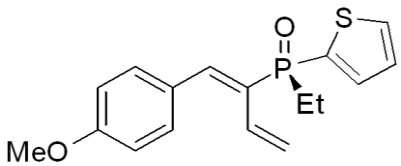
35.917

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

f1 (ppm)


7.714 7.708 7.705 7.700 7.698 7.696 7.691 7.688 7.596 7.594 7.589 7.587 7.583 7.580 7.575 7.573 7.510 7.499 7.494 7.489 7.480 7.476 7.469 7.456 7.205 7.201 7.198 7.195 7.192 7.188 7.185 6.914 6.908 6.904 6.895 6.890 6.884 6.662 6.660 6.641 6.638 6.636 6.628 6.625 6.621 6.607 6.604 6.601 6.593 6.590 6.569 6.566 5.378 5.368 5.366 5.361 5.347 5.344 5.342 5.338 5.336 5.330 5.328 5.325 5.323 3.829 2.294 2.288 2.286 2.279 2.273 2.271 2.264 2.258 2.256 2.249 2.246 2.243 2.241 2.231 2.227 2.216 1.285 1.269 1.254 1.248 1.233 1.218 1.211
O
S
P
Et
MeO
3ma
0.91
0.97
2.99
0.96
1.92
1.00
2.01
3.00
2.18
3.30
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


160.139
142.646
142.582
135.048
134.976
134.418
133.606
132.652
132.616
131.878
131.684
131.607
129.063
128.298
128.137
128.035
127.899
120.406
120.358
113.713
55.252
22.568
21.952
5.459
5.419
O
S
P
Et
MeO
3ma
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

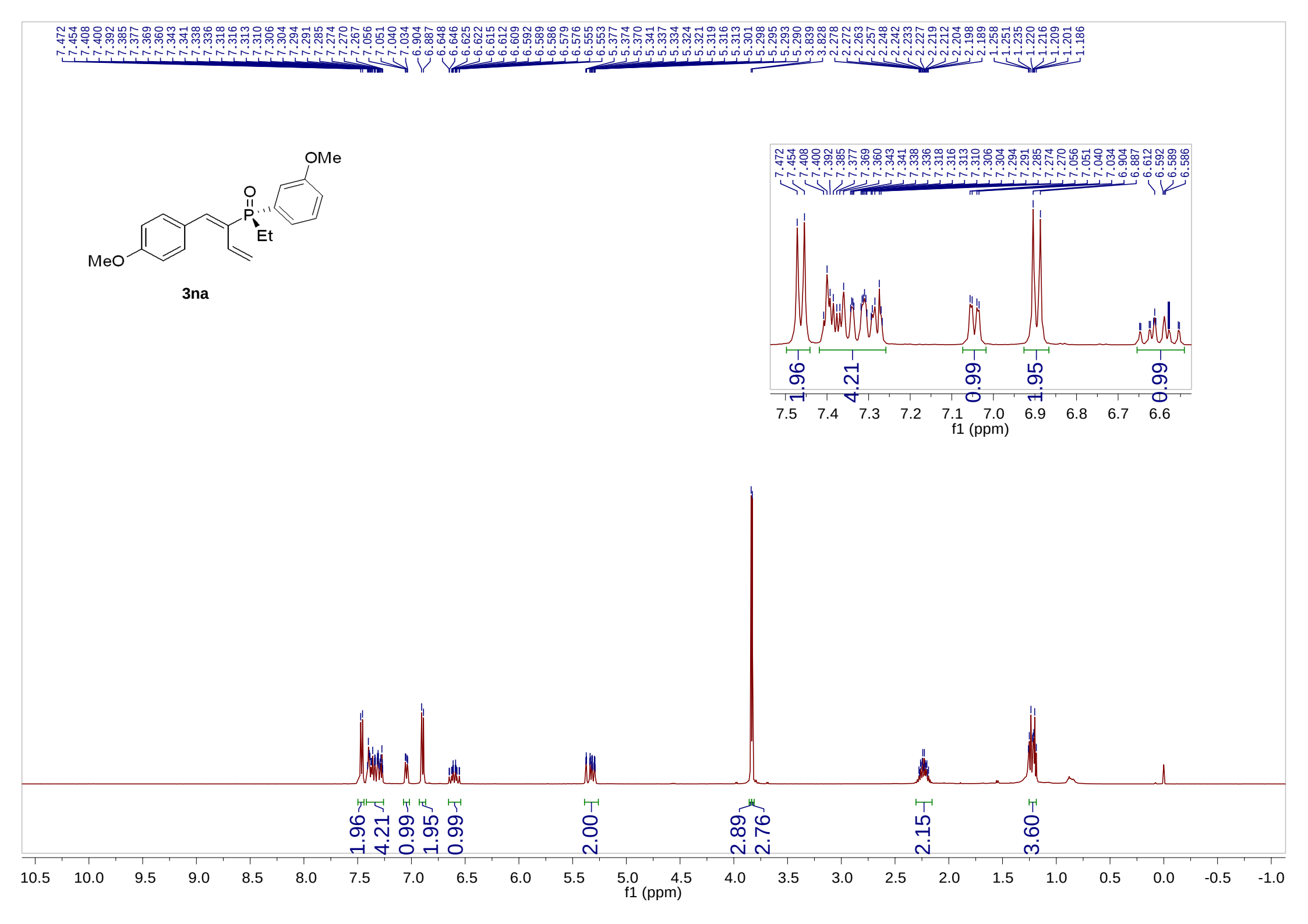


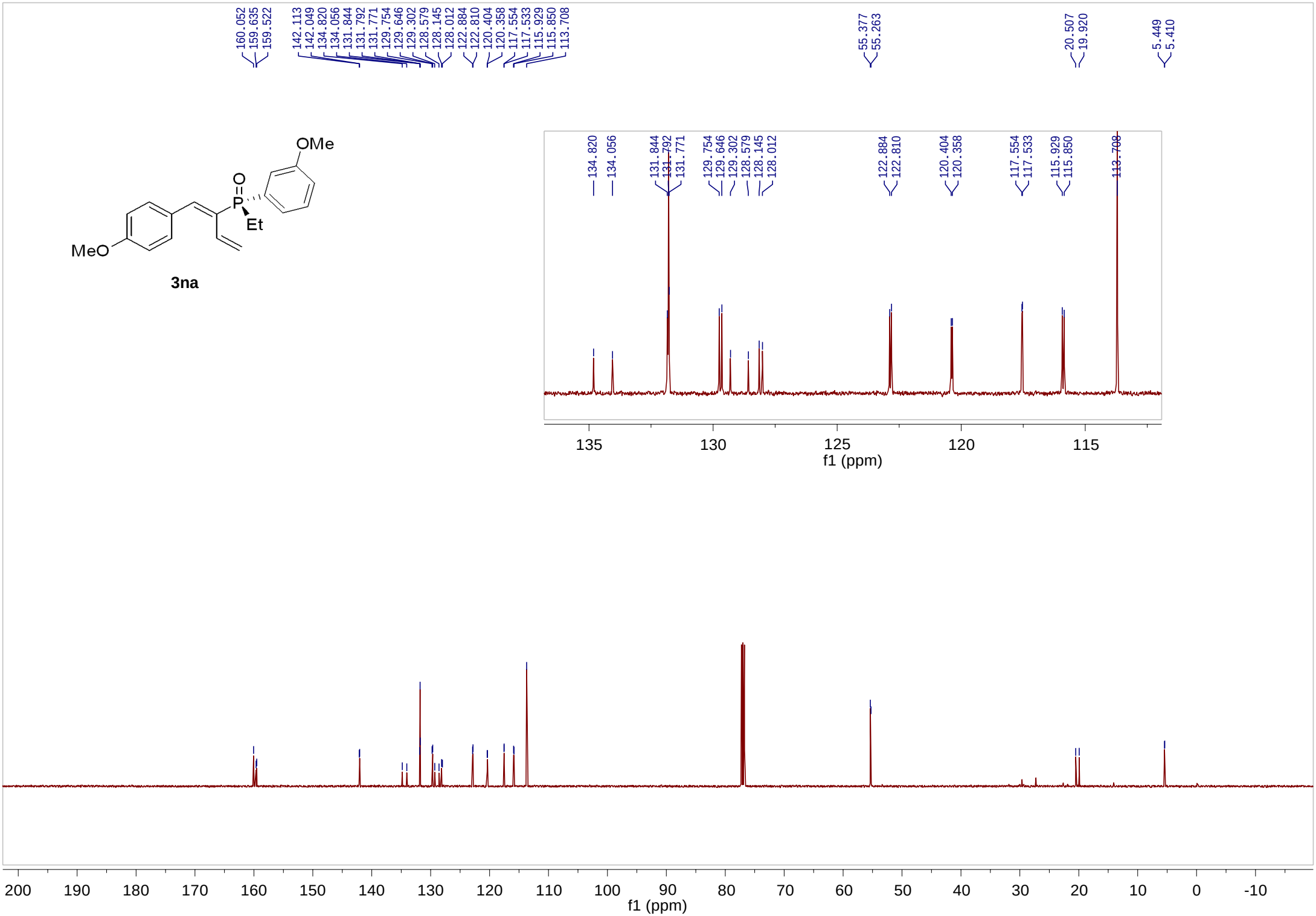
3ma

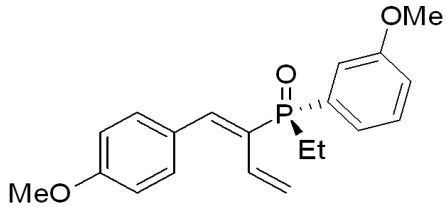
29.609

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

f1 (ppm)


7.472 7.454 7.408 7.400 7.392 7.385 7.377 7.369 7.360 7.343 7.341 7.338 7.336 7.318 7.316 7.313 7.310 7.306 7.304 7.294 7.291 7.285 7.274 7.270 7.267 7.056 7.051 7.040 7.034 6.904 6.887 6.648 6.646 6.625 6.622 6.615 6.612 6.609 6.592 6.589 6.586 6.579 6.576 6.555 6.553 5.377 5.374 5.370 5.341 5.337 5.334 5.324 5.321 5.319 5.316 5.313 5.301 5.298 5.295 5.293 5.290 3.839 3.828 2.278 2.272 2.263 2.257 2.248 2.242 2.233 2.227 2.219 2.212 2.204 2.198 2.189 1.258 1.251 1.235 1.220 1.216 1.209 1.201 1.186
OMe
O
P
Et
MeO
3na
7.472 7.454 7.408 7.400 7.392 7.385 7.377 7.369 7.360 7.343 7.341 7.338 7.336 7.318 7.316 7.313 7.310 7.306 7.304 7.294 7.291 7.285 7.274 7.270 7.056 7.051 7.040 7.034 6.904 6.887 6.612 6.592 6.589 6.586
1.96 4.21 0.99 1.95 0.99
7.5 7.4 7.3 7.2 7.1 7.0 6.9 6.8 6.7 6.6
f1 (ppm)
1.96 4.21 0.99 1.95 0.99 2.00 2.89 2.76 2.15 3.60
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


160.052
159.635
159.522
142.113
142.049
134.820
134.056
131.844
131.792
131.771
129.754
129.646
129.302
128.579
128.145
128.012
122.884
122.810
120.404
120.358
117.554
117.533
115.929
115.850
113.708
55.377
55.263
20.507
19.920
5.449
5.410
OMe
O
P
Et
MeO
3na
f1 (ppm)
f1 (ppm)

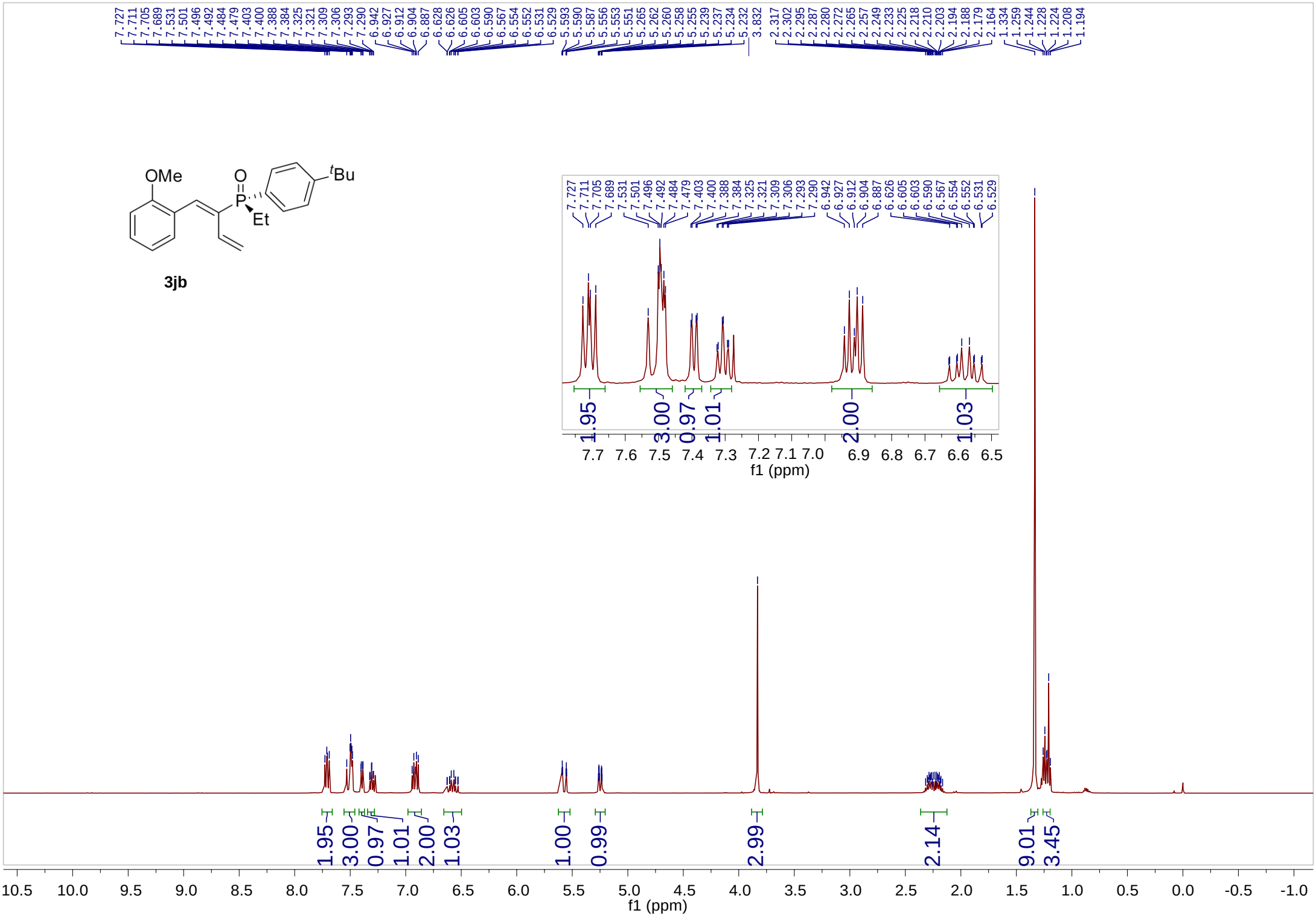


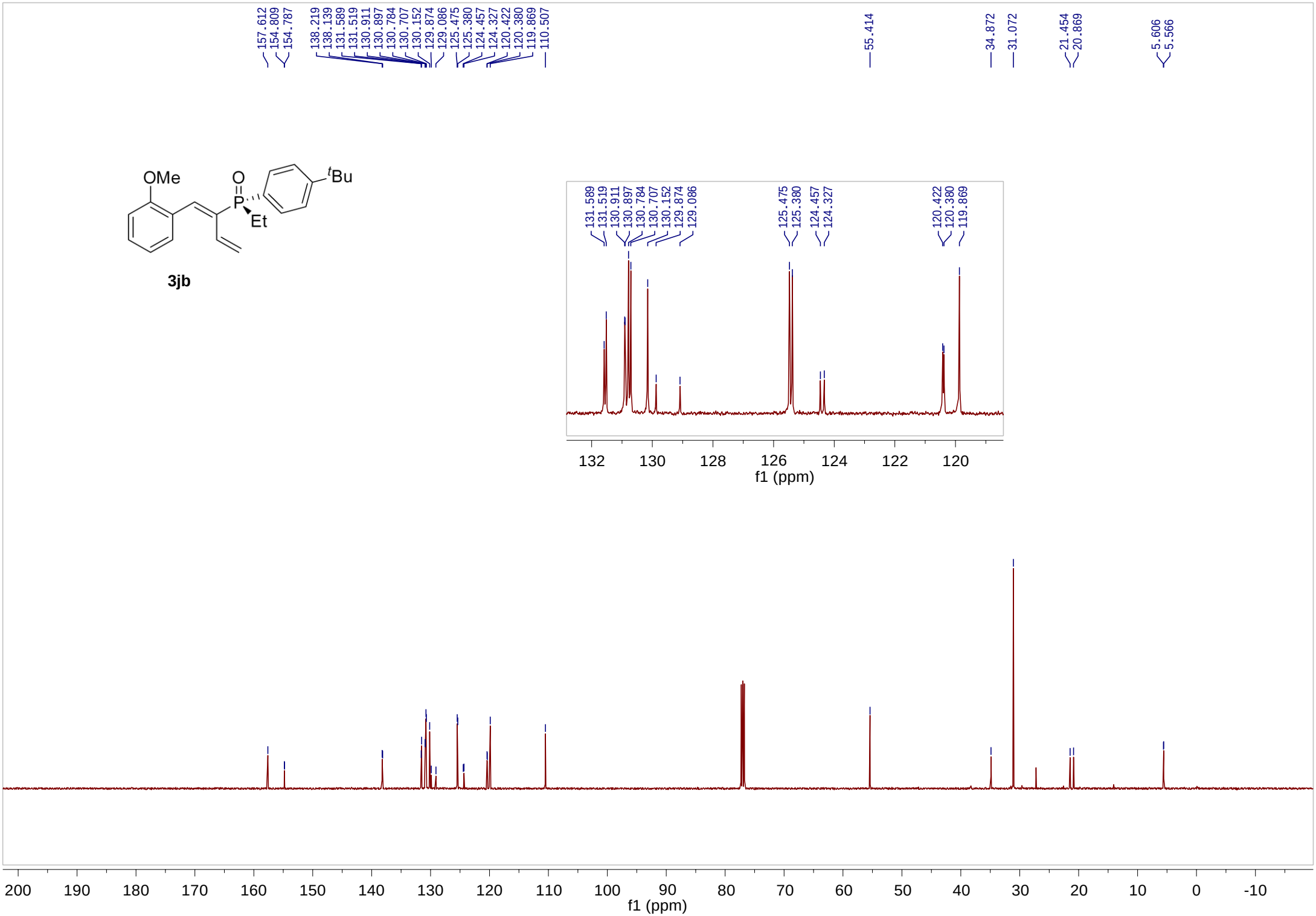
3na

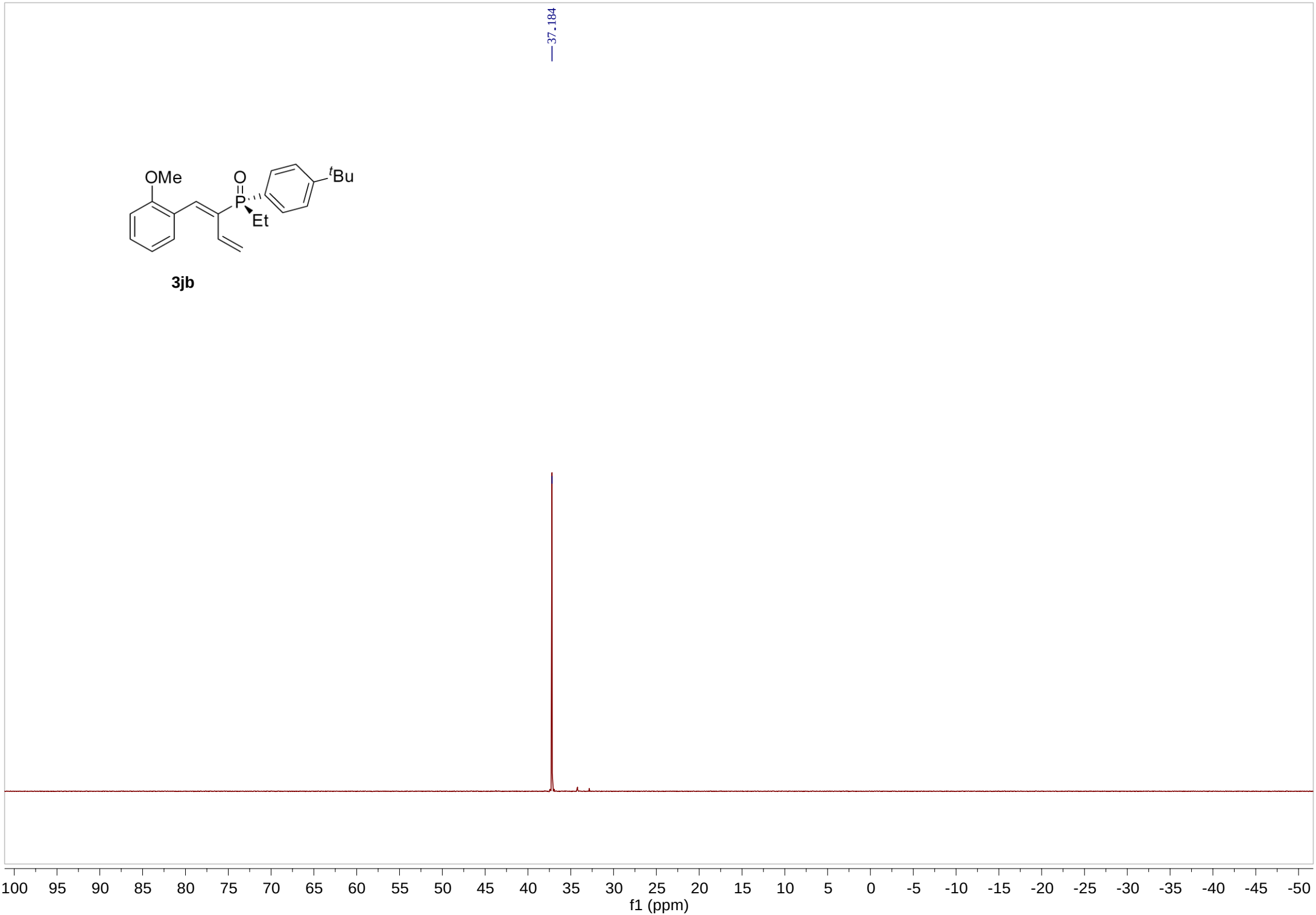
36.270

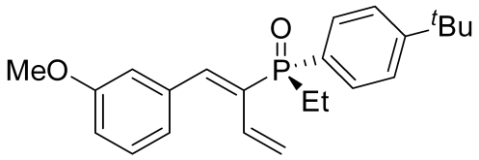
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

f1 (ppm)


OMe
O
P
Et
tBu
3jb
f1 (ppm)

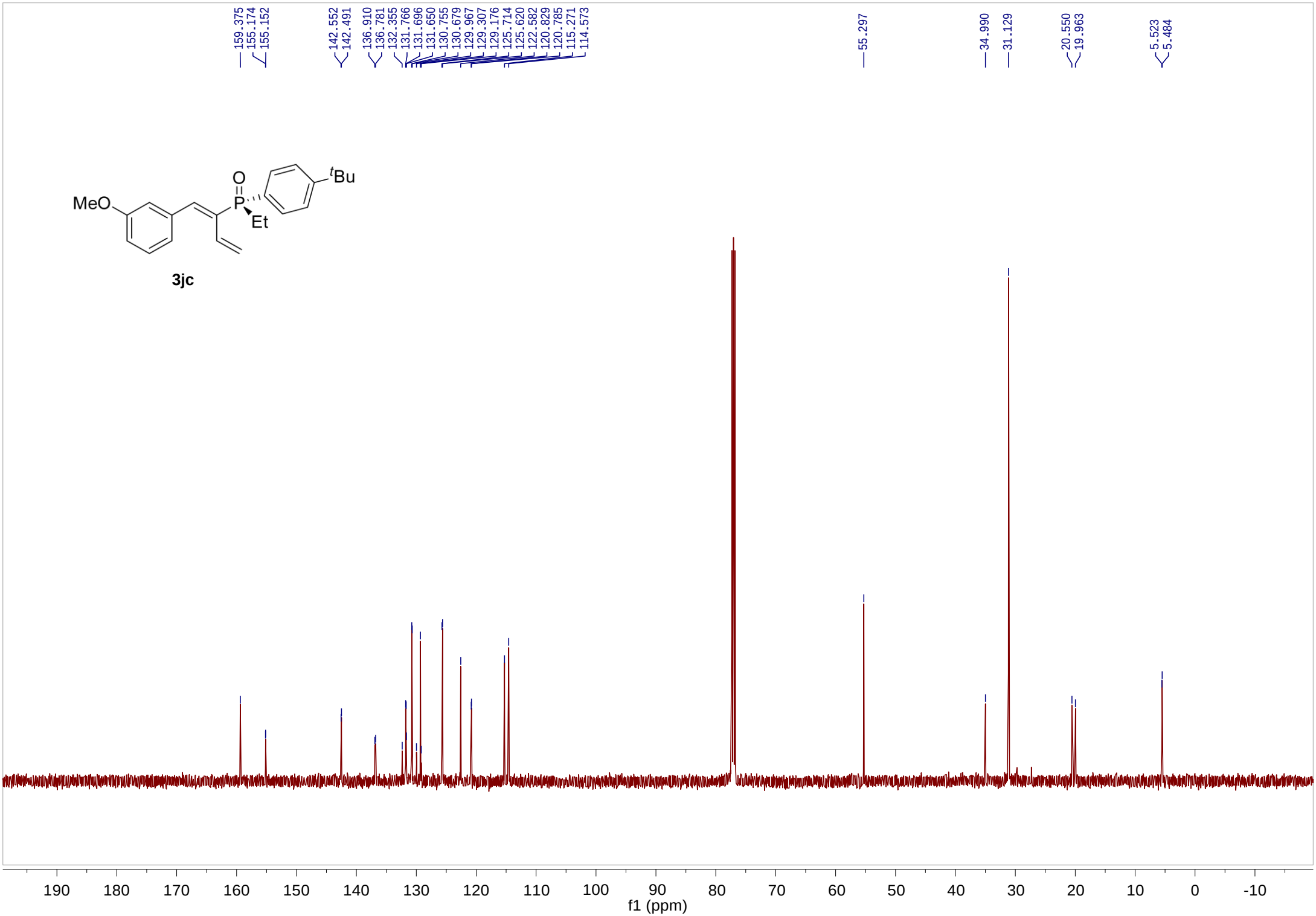

157.612
154.809
154.787
138.219
138.139
131.589
131.519
130.911
130.897
130.784
130.707
130.152
129.874
129.086
125.475
125.380
124.457
124.327
120.422
120.380
119.869
110.507
55.414
34.872
31.072
21.454
20.869
5.606
5.566
OMe
O
P
Et
tBu
3jb
f1 (ppm)
f1 (ppm)

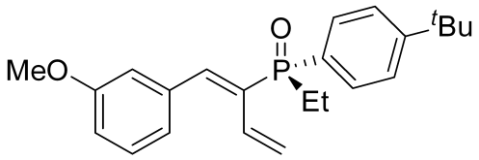

37.184
OMe
O
P
Et
tBu
3jb
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50
f1 (ppm)



3jc

f1 (ppm)


159.375
155.174
155.152
142.552
142.491
136.910
136.781
132.355
131.766
131.696
131.650
130.755
130.679
129.967
129.307
129.176
125.714
125.620
122.582
120.829
120.785
115.271
114.573
55.297
34.990
31.129
20.550
19.963
5.523
5.484
MeO
O
P
Et
tBu
3jc
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

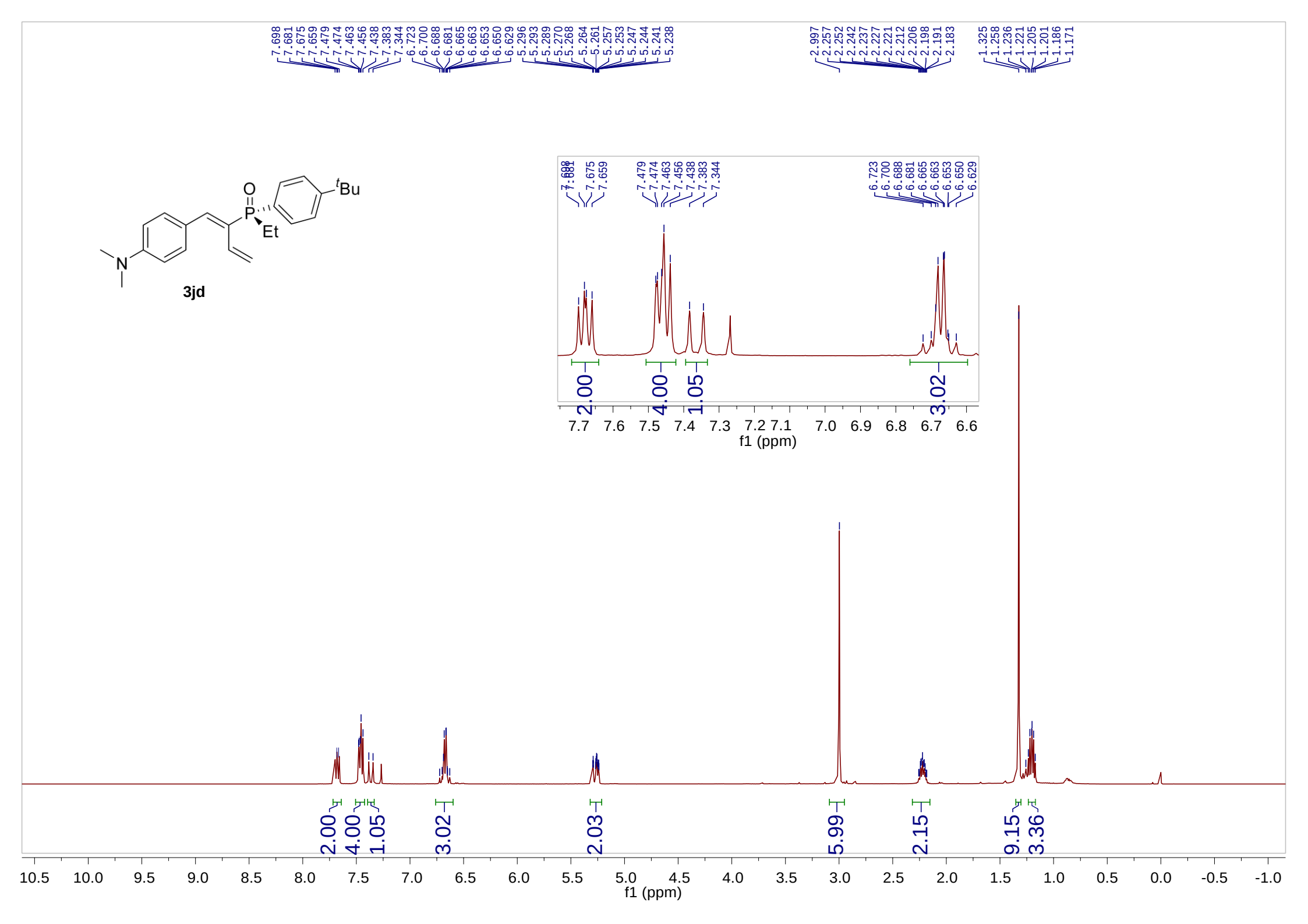


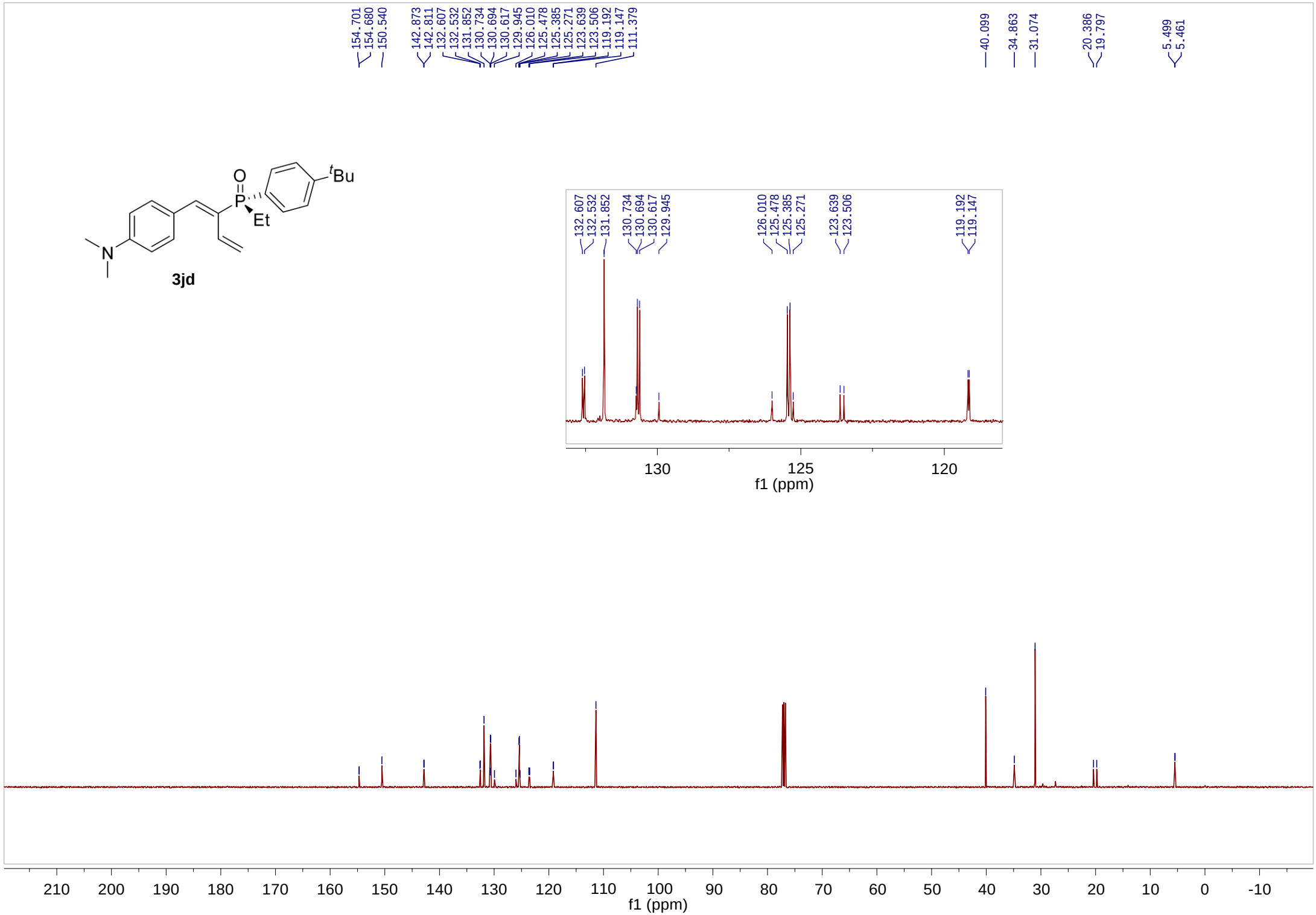
3jc

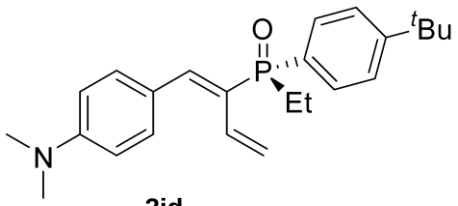
35.565

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

f1 (ppm)


7.698
7.681
7.675
7.659
7.479
7.474
7.463
7.456
7.438
7.383
7.344
6.723
6.700
6.688
6.681
6.665
6.663
6.653
6.650
6.629
5.296
5.293
5.289
5.270
5.268
5.264
5.261
5.257
5.253
5.247
5.244
5.241
5.238
2.997
2.257
2.252
2.242
2.237
2.227
2.221
2.212
2.206
2.198
2.191
2.183
1.325
1.258
1.236
1.221
1.205
1.201
1.186
1.171
O
P
Et
tBu
N
3jd
2.00
4.00
1.05
3.02
f1 (ppm)
2.00
4.00
1.05
3.02
2.03
5.99
2.15
9.15
3.36
f1 (ppm)


154.701
154.680
150.540
142.873
142.811
132.607
132.532
131.852
130.734
130.694
130.617
129.945
126.010
125.478
125.385
125.271
123.639
123.506
119.192
119.147
111.379
40.099
34.863
31.074
20.386
19.797
5.499
5.461
O
P
Et
tBu
N
3jd
f1 (ppm)
f1 (ppm)

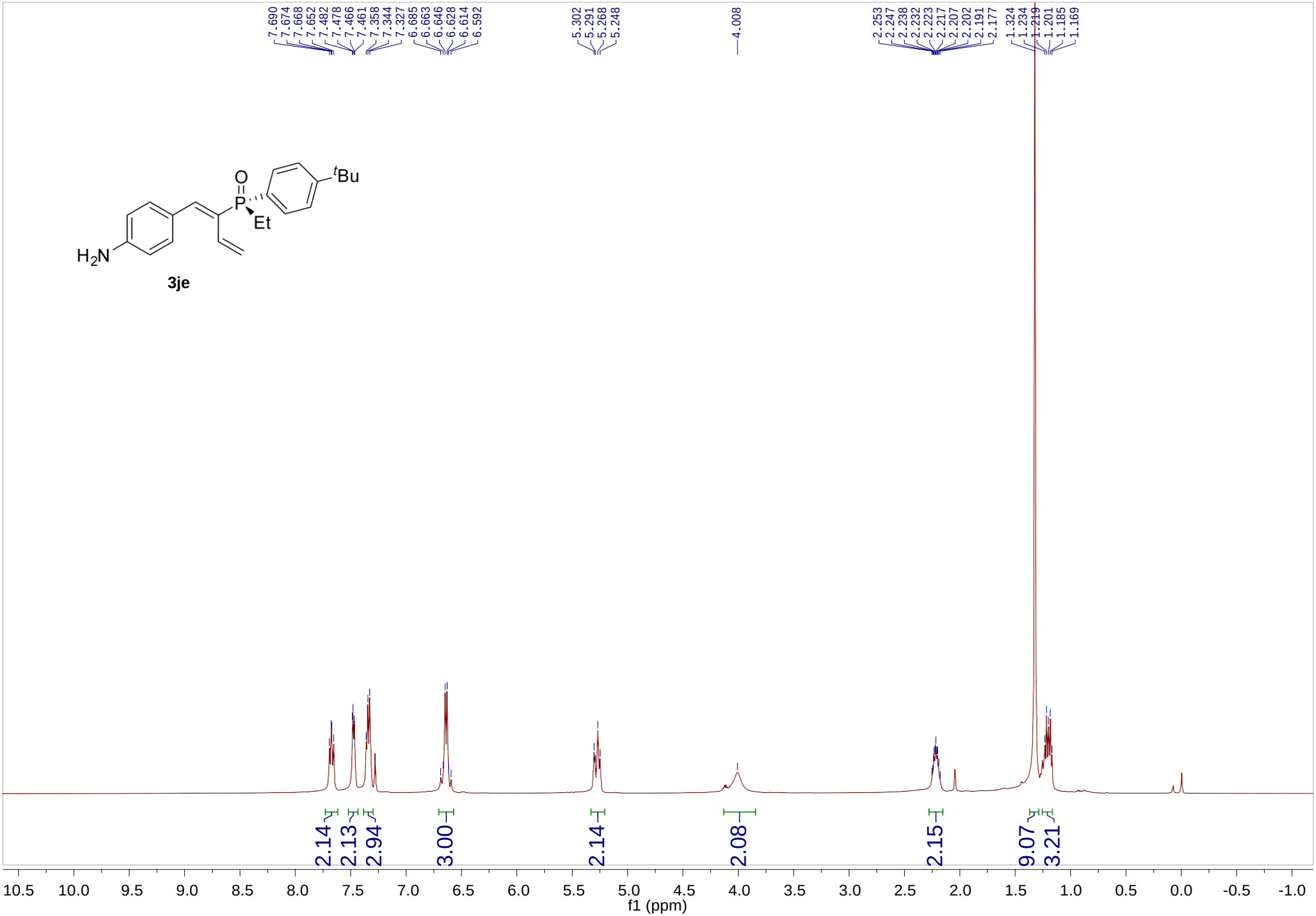


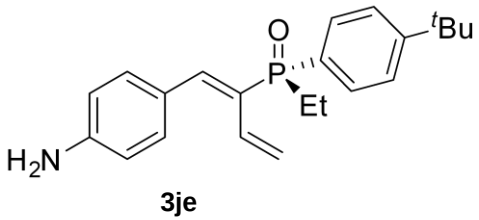
3jd

36.336

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

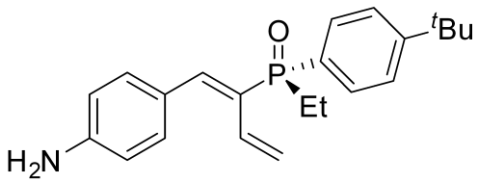
f1 (ppm)


7.690
7.674
7.668
7.652
7.482
7.478
7.466
7.461
7.358
7.344
7.327
6.685
6.663
6.646
6.628
6.614
6.592
5.302
5.291
5.268
5.248
4.008
2.253
2.247
2.238
2.232
2.223
2.217
2.207
2.202
2.191
2.177
1.324
1.234
1.219
1.201
1.185
1.169
O
P
Et
tBu
H2N
3je
2.14
2.13
2.94
3.00
2.14
2.08
2.15
9.07
3.21
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)


O
P
Et
tBu
H2N

3je

154.759
154.738
147.426
142.694
142.631
132.360
132.287
131.915
130.644
130.569
130.536
129.748
127.127
126.394
125.746
125.611
125.498
125.406
119.521
119.476
114.287
34.852
31.048
20.349
19.761
5.484
5.445
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

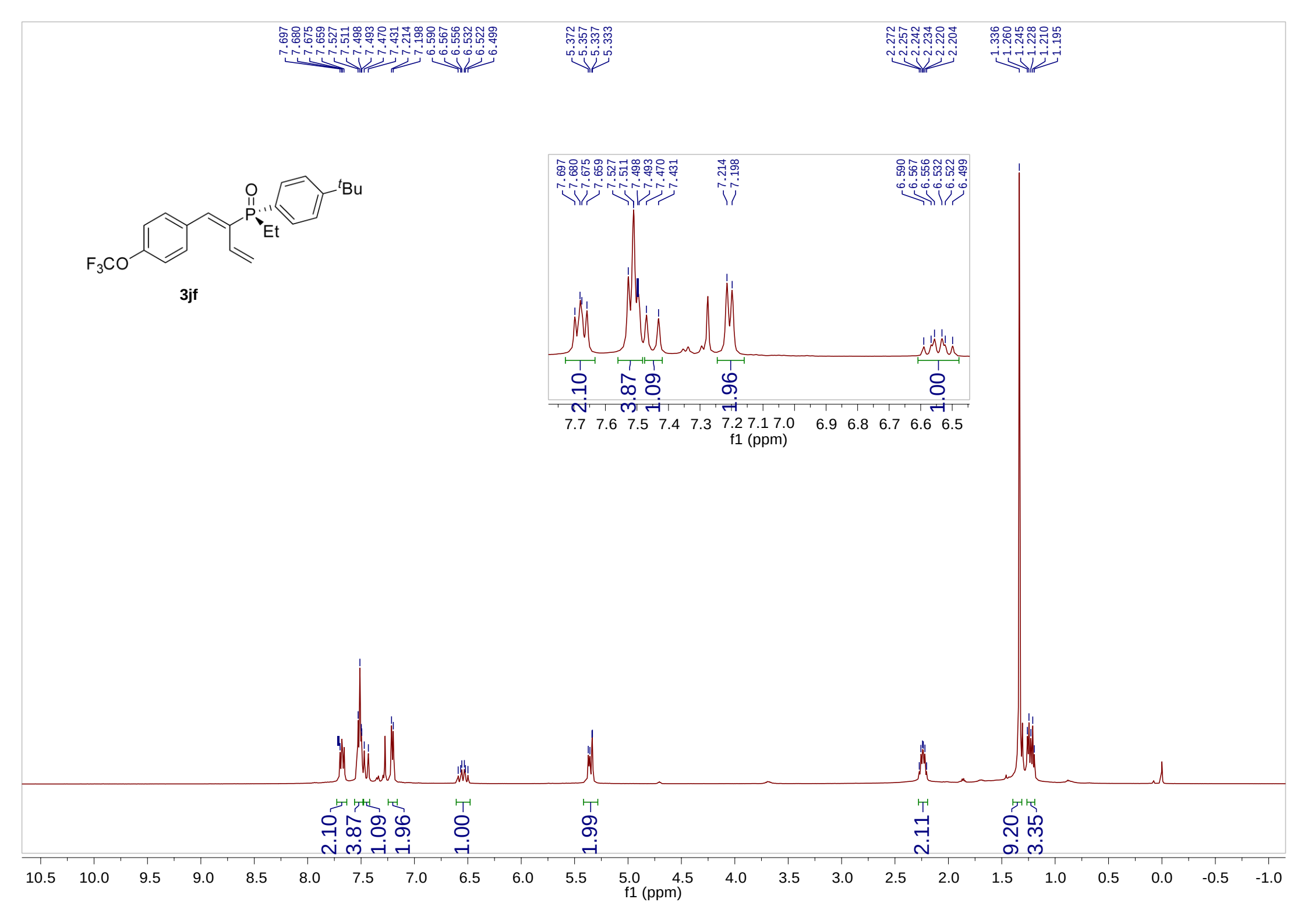


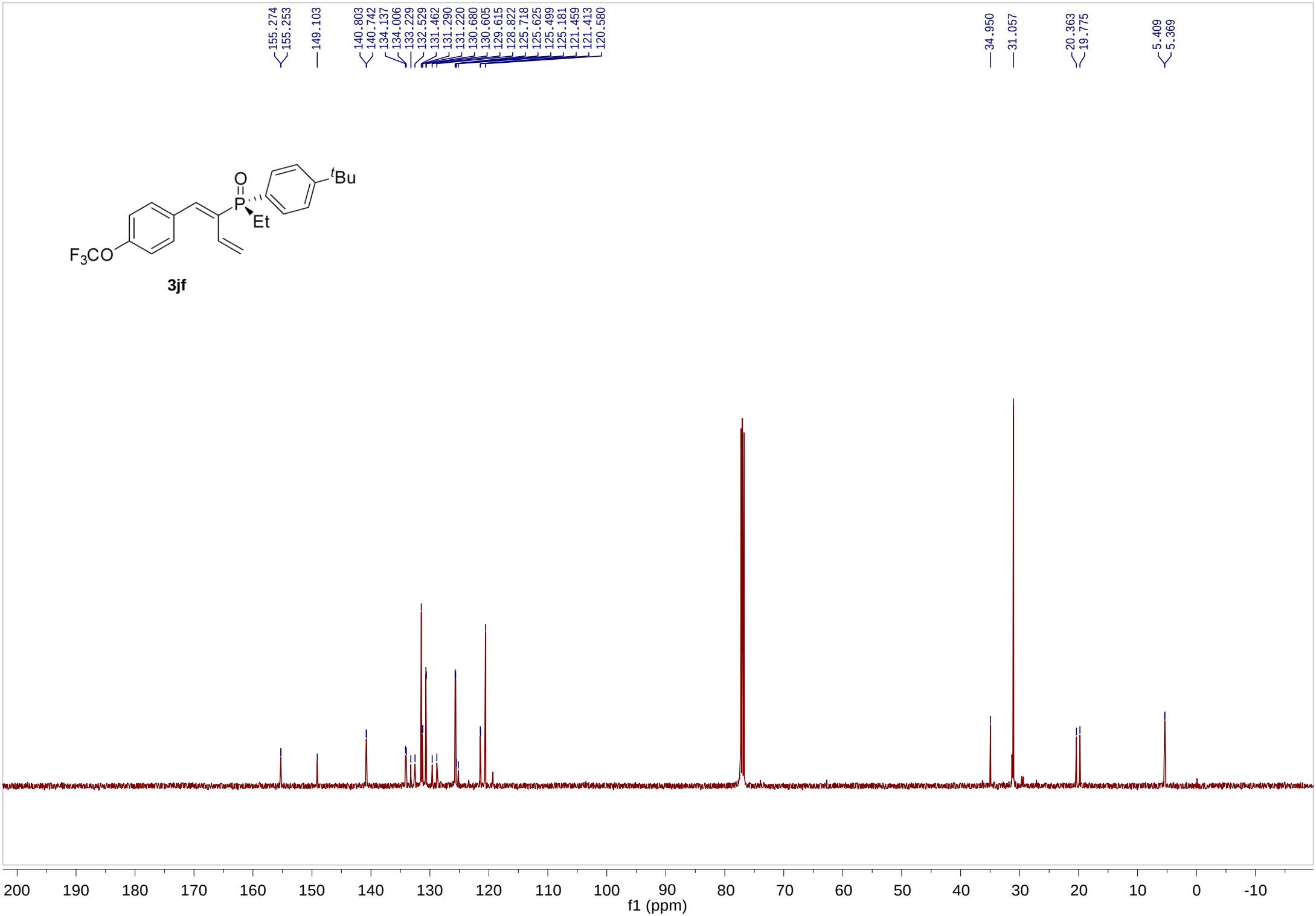
3je

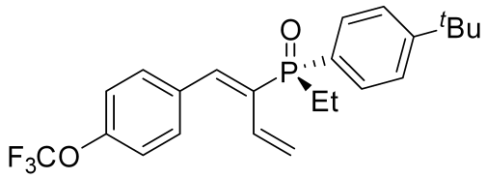
36.133

50 130 110 90 70 50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230 -25

f1 (ppm)


7.697
7.680
7.675
7.659
7.527
7.511
7.498
7.493
7.470
7.431
7.214
7.198
6.590
6.567
6.556
6.532
6.522
6.499
5.372
5.357
5.337
5.333
2.272
2.257
2.242
2.234
2.220
2.204
1.336
1.260
1.245
1.228
1.210
1.195
O
P
Et
tBu
F3CO
3jf
2.10
3.87
1.09
1.96
1.00
f1 (ppm)
2.10
3.87
1.09
1.96
1.00
1.99
2.11
9.20
3.35
f1 (ppm)


155.274
155.253
149.103
140.803
140.742
134.137
134.006
133.229
132.529
131.462
131.290
131.220
130.680
130.605
129.615
128.822
125.718
125.625
125.499
125.181
121.459
121.413
120.580
34.950
31.057
20.363
19.775
5.409
5.369
O
P
Et
tBu
F3CO
3jf
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

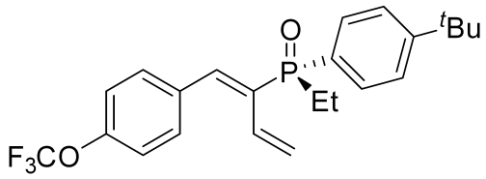


3jf

35.238

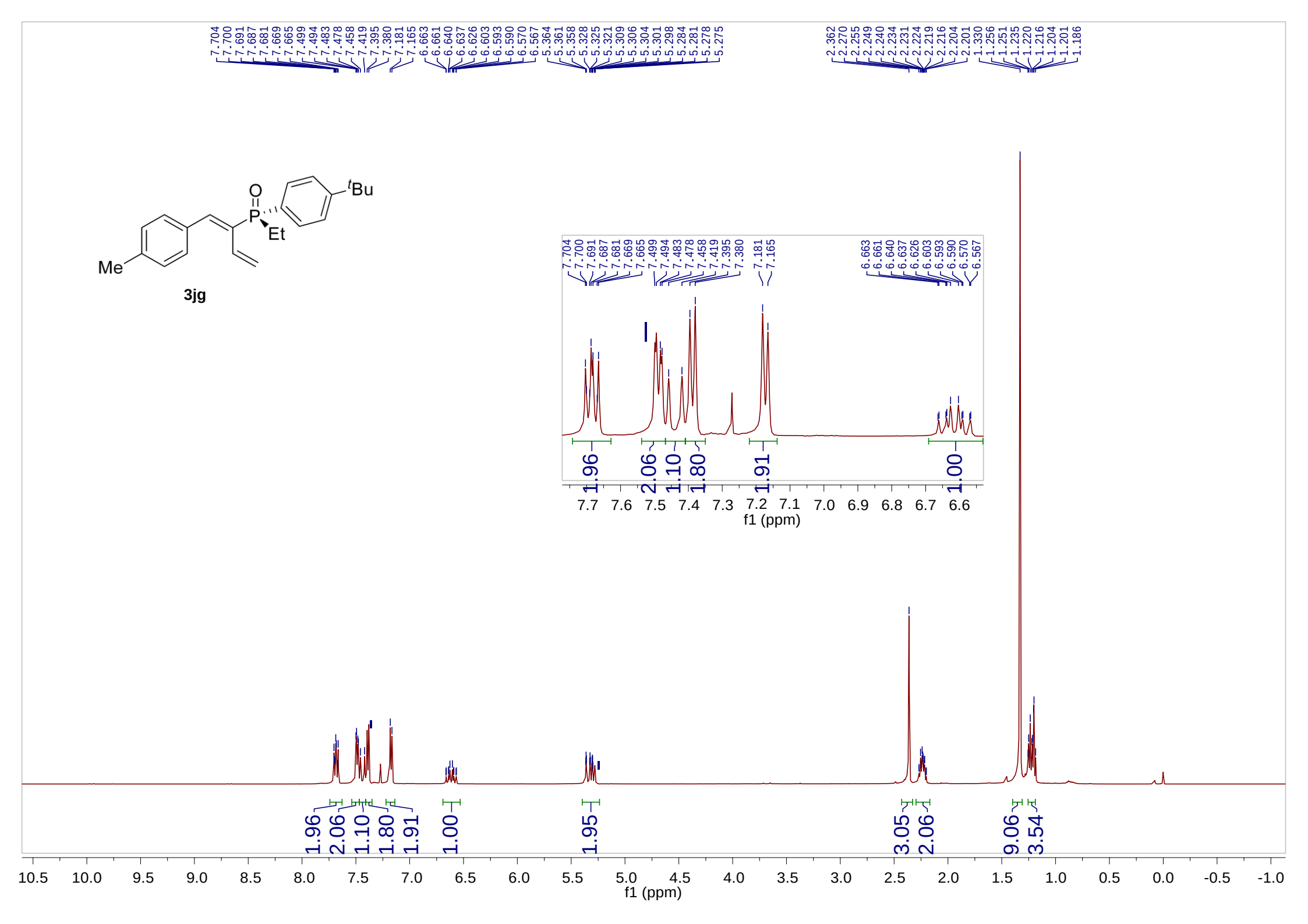
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

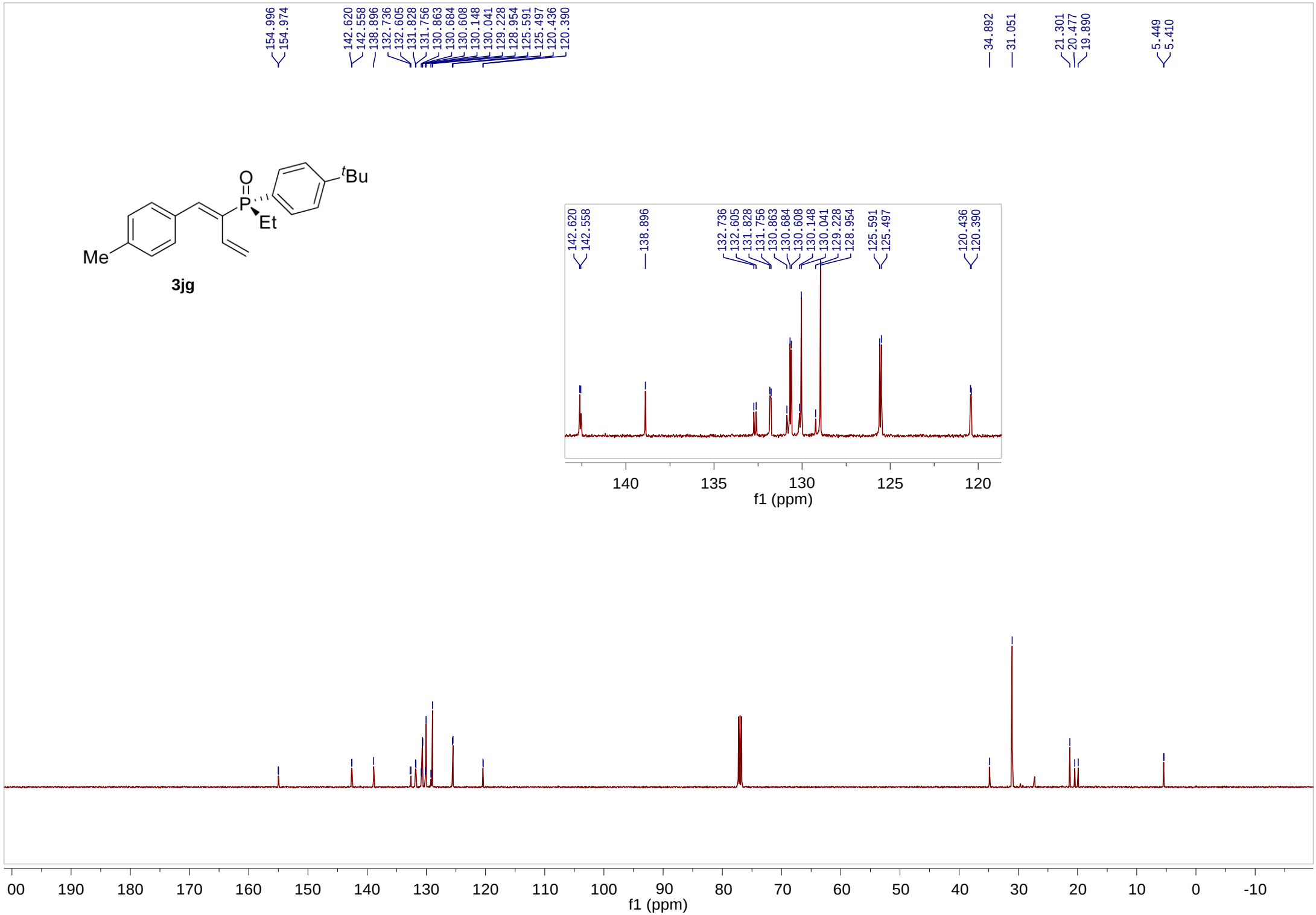
f1 (ppm)

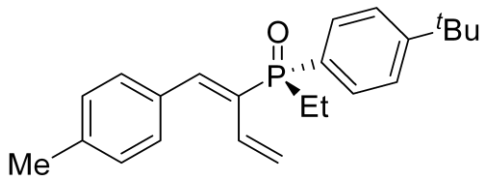

O
P
Et
tBu
F3CO

3jf

-57.759
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
-90
-95
-100
-105
-110
-115
-120
-125
-130
f1 (ppm)


7.704 7.700 7.691 7.687 7.681 7.669 7.665 7.499 7.494 7.483 7.478 7.458 7.419 7.395 7.380 7.181 7.165 6.663 6.661 6.640 6.637 6.626 6.603 6.593 6.590 6.570 6.567 5.364 5.361 5.358 5.328 5.325 5.321 5.309 5.306 5.304 5.301 5.298 5.284 5.281 5.278 5.275
2.362 2.270 2.255 2.249 2.240 2.234 2.231 2.224 2.219 2.216 2.204 2.201 1.330 1.256 1.251 1.235 1.220 1.216 1.204 1.201 1.186
O
P
Et
tBu
Me
3jg
1.96 2.06 1.10 1.80 1.91 1.00 1.95 3.05 2.06 9.06 3.54
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)
1.96 2.06 1.10 1.80 1.91 1.00
7.7 7.6 7.5 7.4 7.3 7.2 7.1 7.0 6.9 6.8 6.7 6.6
f1 (ppm)


154.996
154.974
142.620
142.558
138.896
132.736
132.605
131.828
131.756
130.863
130.684
130.608
130.148
130.041
129.228
128.954
125.591
125.497
120.436
120.390
34.892
31.051
21.301
20.477
19.890
5.449
5.410
O
P
Et
tBu
Me
3jg
140
135
130
125
120
f1 (ppm)
00
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

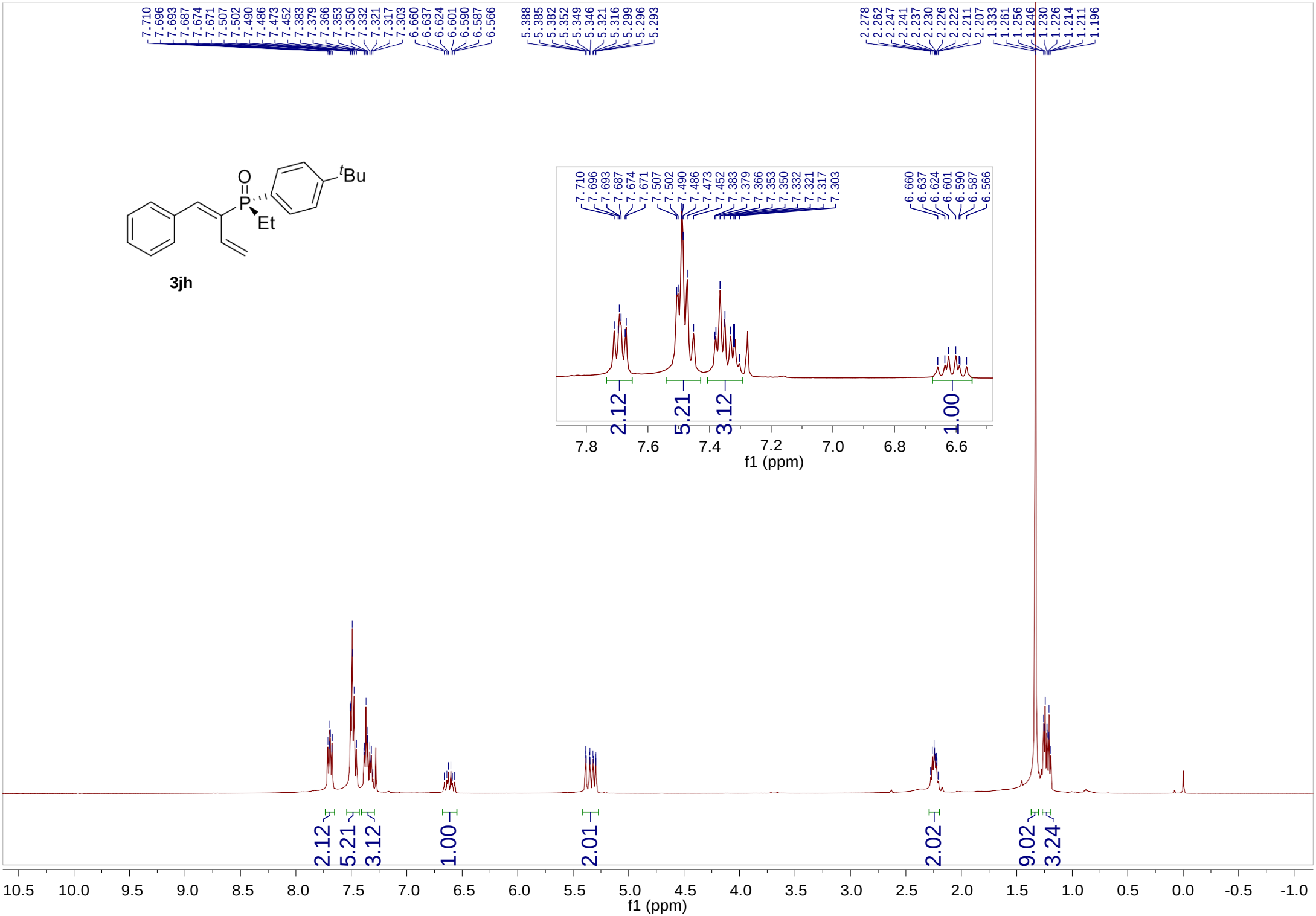


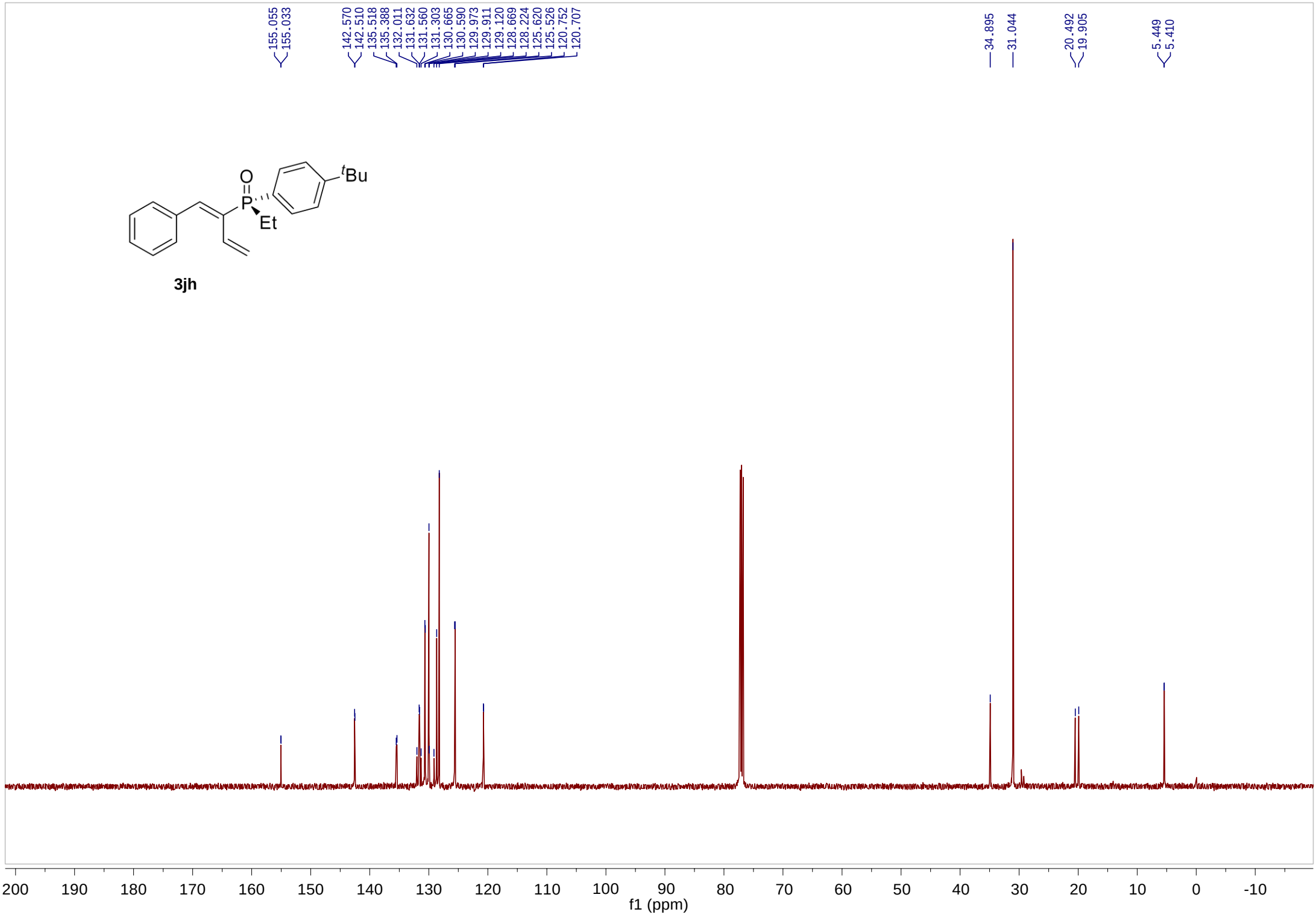
3jg

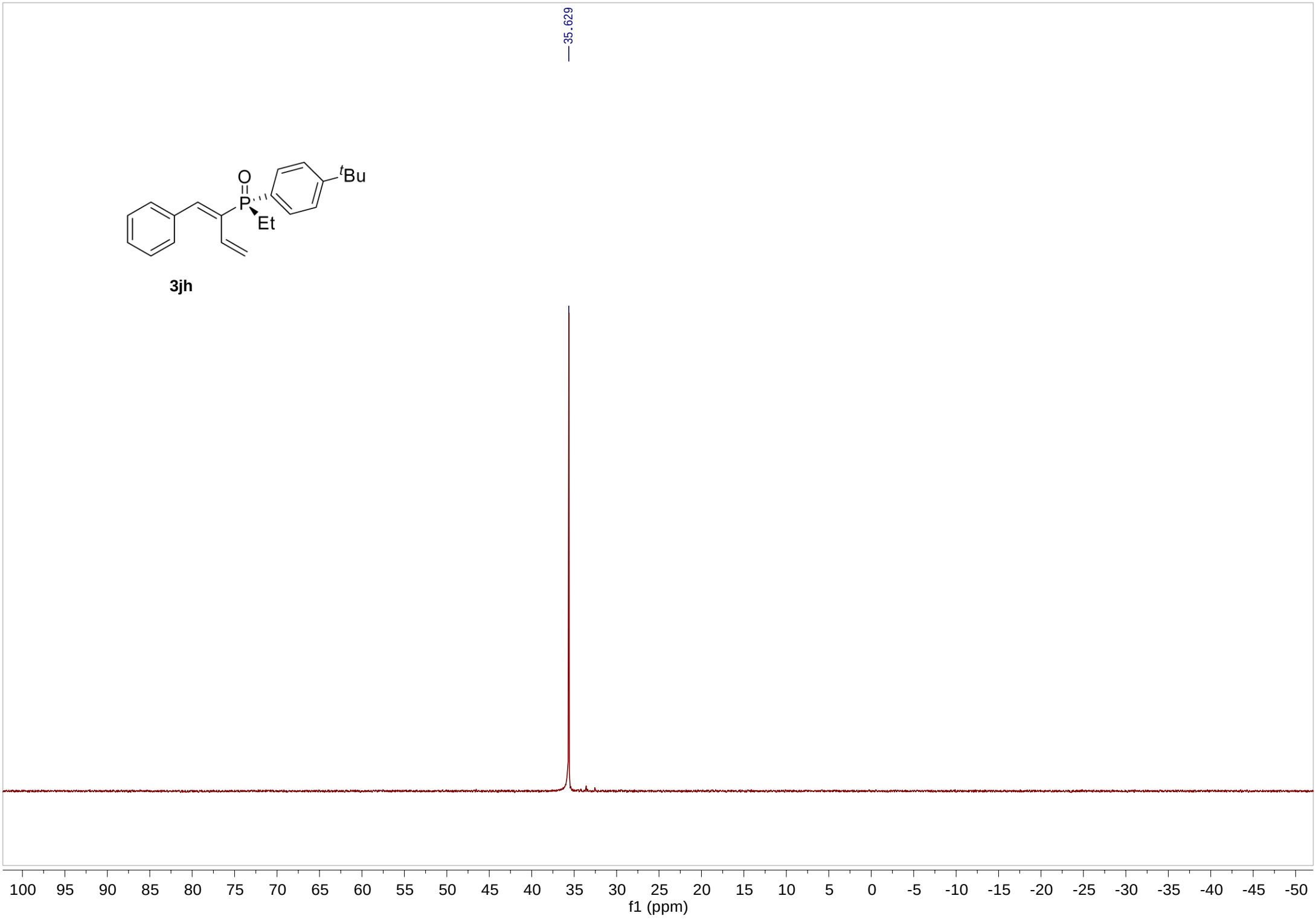
35.881

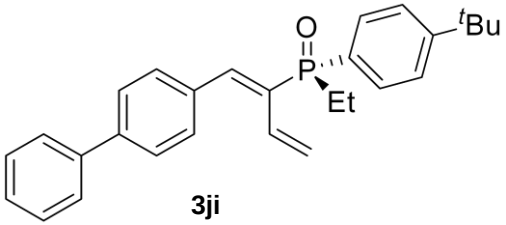
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

f1 (ppm)

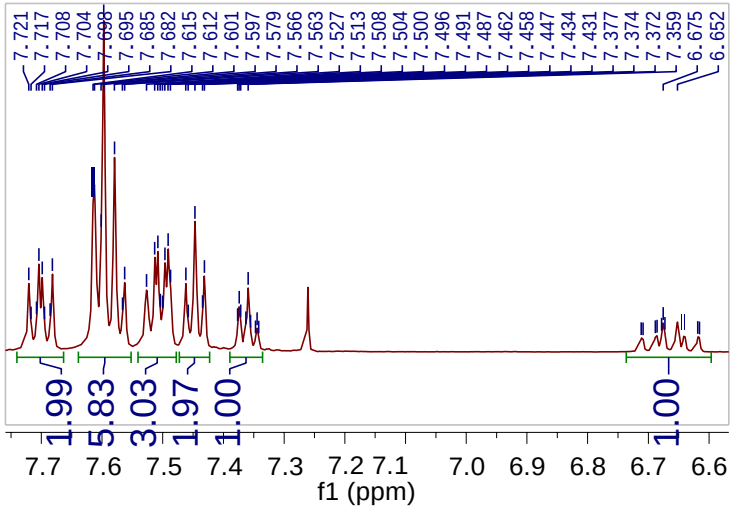

7.710 7.696 7.693 7.687 7.674 7.671 7.507 7.502 7.490 7.486 7.473 7.452 7.383 7.379 7.366 7.353 7.350 7.332 7.321 7.317 7.303 6.660 6.637 6.624 6.601 6.590 6.587 6.566
5.388 5.385 5.382 5.352 5.349 5.346 5.321 5.316 5.299 5.296 5.293
2.278 2.262 2.247 2.241 2.237 2.230 2.226 2.222 2.211 2.207 1.333 1.261 1.256 1.246 1.230 1.226 1.214 1.211 1.196
O
P
Et
tBu
3jh
2.12 5.21 3.12 1.00
7.8 7.6 7.4 7.2 7.0 6.8 6.6
f1 (ppm)
2.12 5.21 3.12 1.00 2.01 2.02 9.02 3.24
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


155.055
155.033
142.570
142.510
135.518
135.388
132.011
131.632
131.560
131.303
130.665
130.590
129.973
129.911
129.120
128.669
128.224
125.620
125.526
120.752
120.707
34.895
31.044
20.492
19.905
5.449
5.410
O
P
Et
tBu
3jh
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

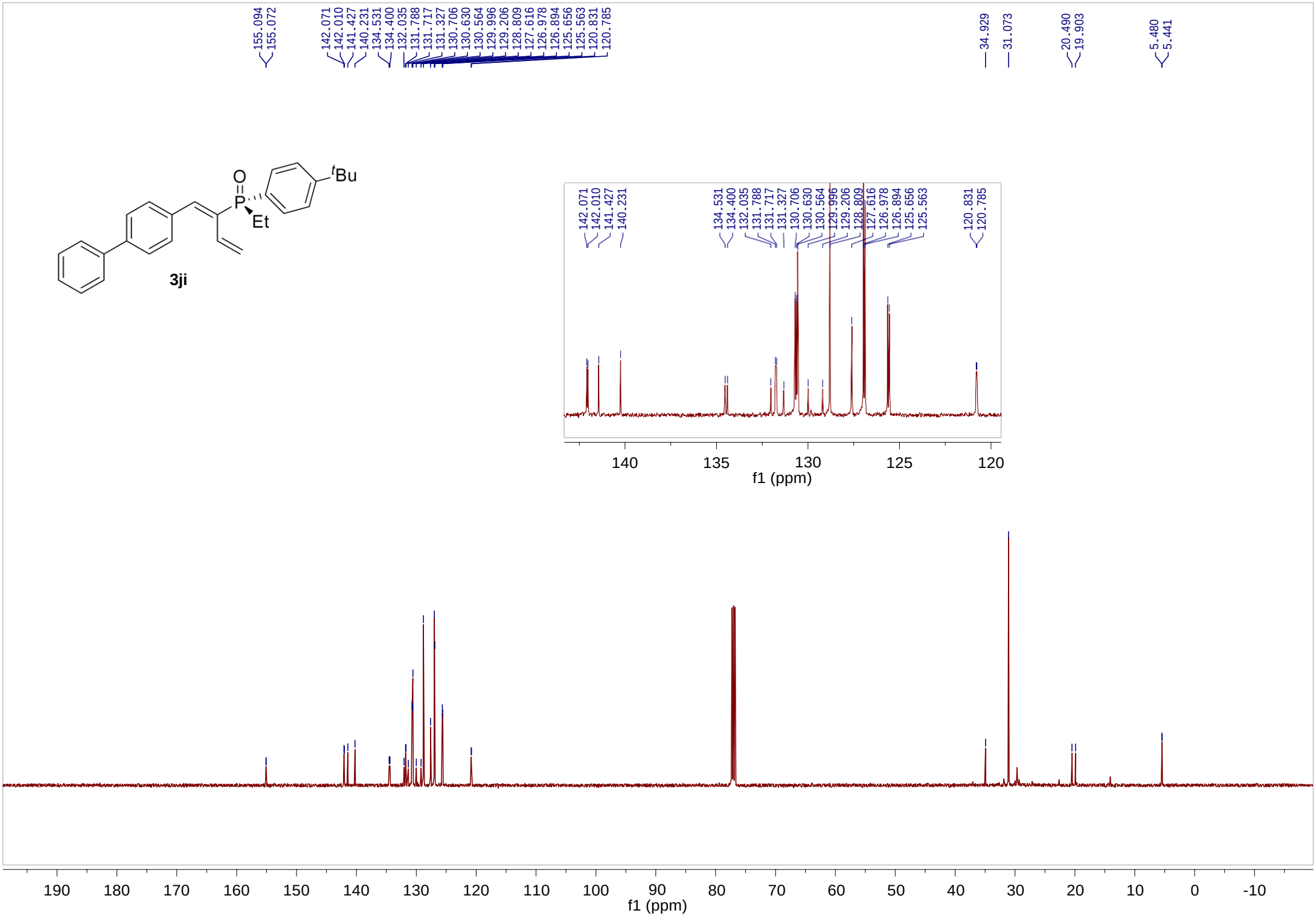

35.629
O
P
Et
tBu
3jh
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50
f1 (ppm)

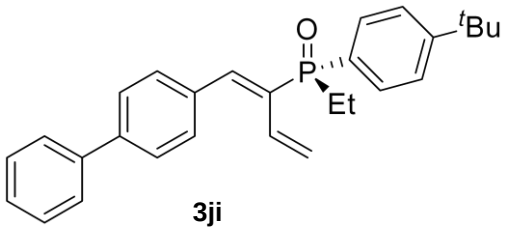

O
P
Et
tBu

3ji


1.99
5.83
3.03
1.97
1.00
1.00
7.7
7.6
7.5
7.4
7.3
7.2
7.1
7.0
6.9
6.8
6.7
6.6
f1 (ppm)

1.99
5.83
3.03
1.97
1.00
1.00
2.02
2.09
8.97
3.59
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)


155.094
155.072
142.071
142.010
141.427
140.231
134.531
134.400
132.035
131.788
131.717
131.327
130.706
130.630
130.564
129.996
129.206
128.809
127.616
126.978
126.894
125.656
125.563
120.831
120.785
34.929
31.073
20.490
19.903
5.480
5.441
O
P
Et
tBu
3ji
f1 (ppm)
f1 (ppm)

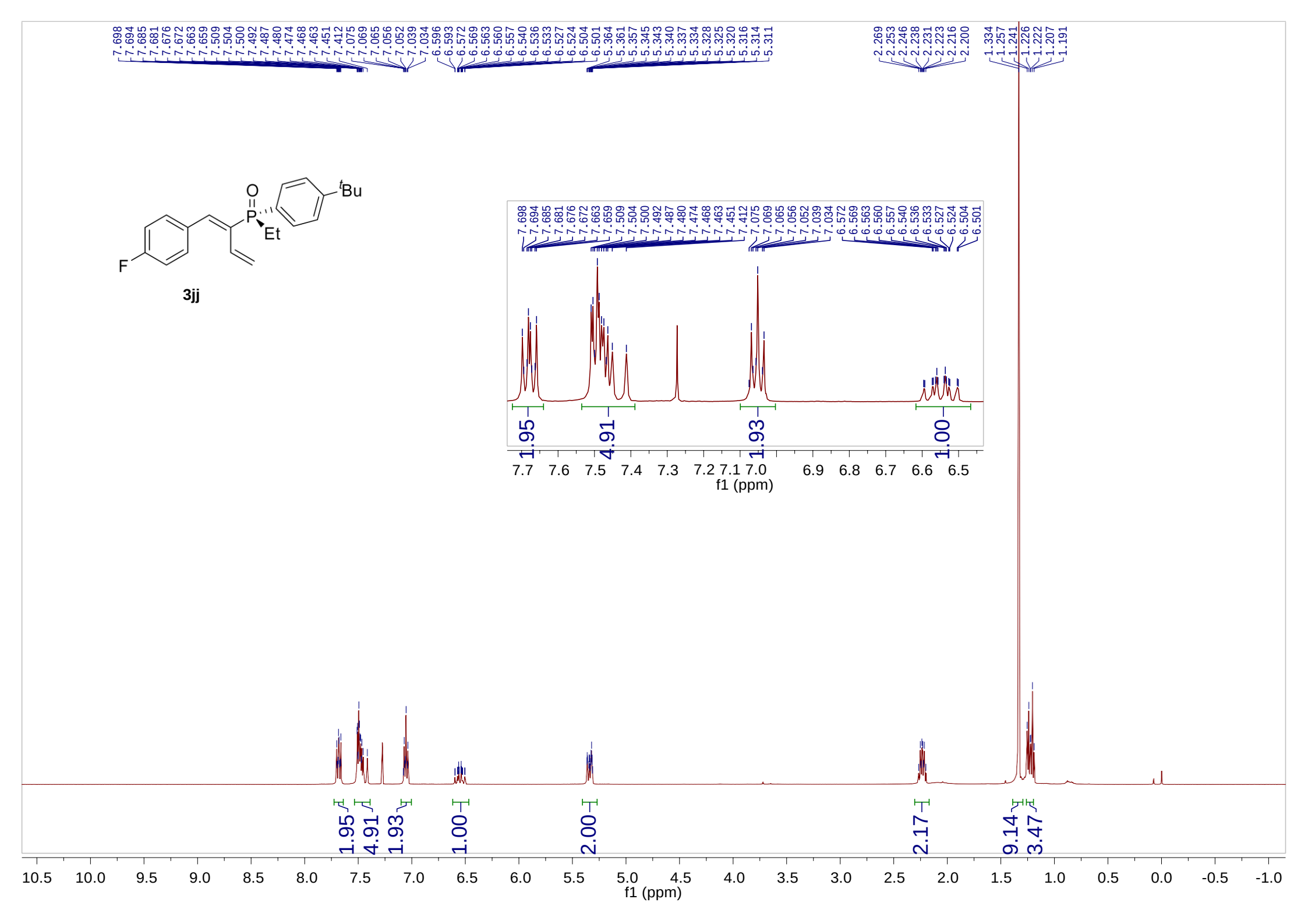


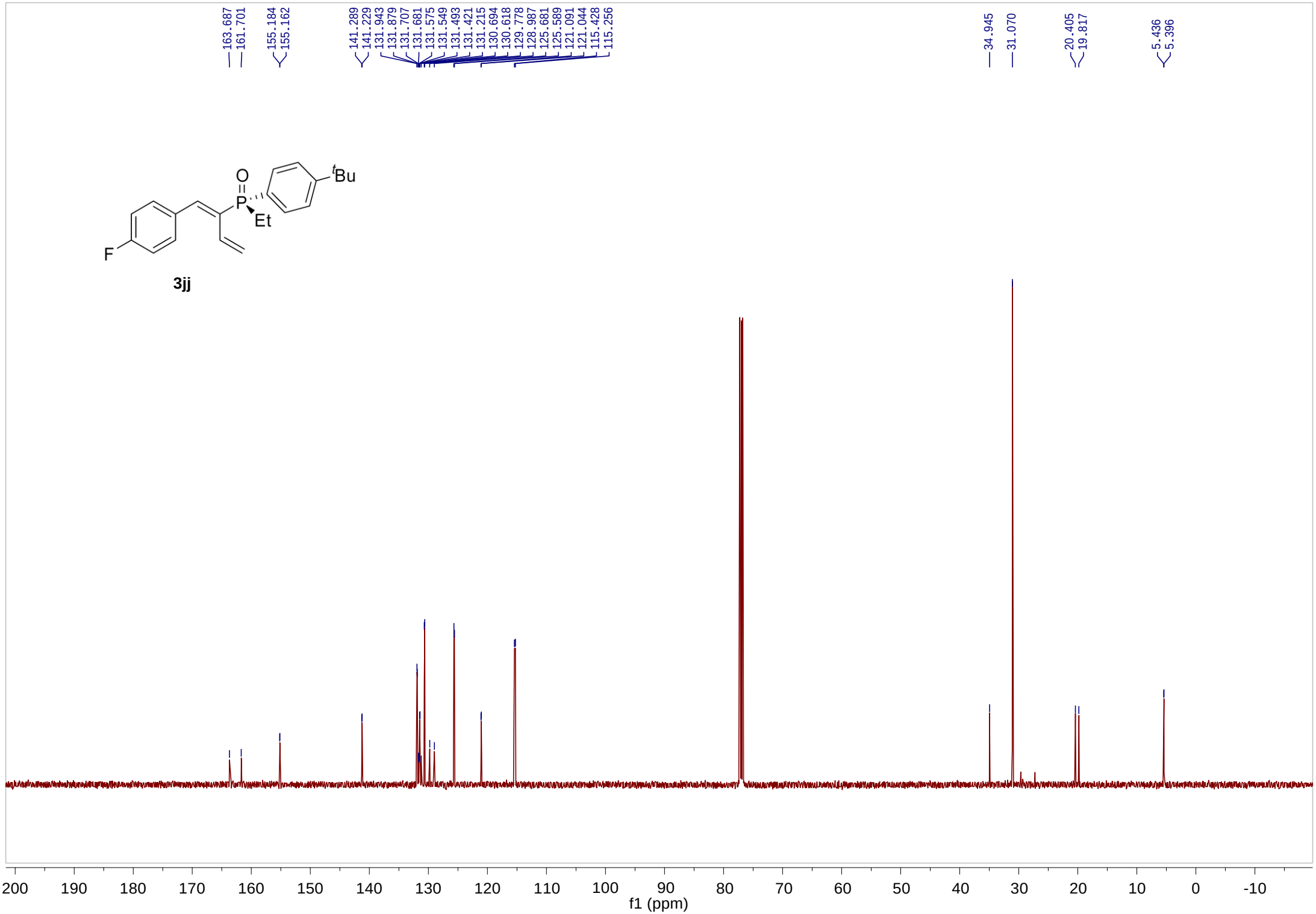
3ji

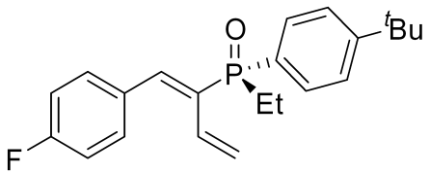
35.546

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

f1 (ppm)


7.698 7.694 7.685 7.681 7.676 7.672 7.663 7.659 7.509 7.504 7.500 7.492 7.487 7.480 7.474 7.468 7.463 7.451 7.412 7.075 7.069 7.065 7.056 7.052 7.039 7.034 6.596 6.593 6.572 6.569 6.563 6.560 6.557 6.540 6.536 6.533 6.527 6.524 6.504 6.501 5.364 5.361 5.357 5.345 5.343 5.340 5.337 5.334 5.328 5.325 5.320 5.316 5.314 5.311
2.269 2.253 2.246 2.238 2.231 2.223 2.216 2.200
1.334 1.257 1.241 1.226 1.222 1.207 1.191
O
P
Et
tBu
F
3jj
1.95 4.91 1.93 1.00
7.7 7.6 7.5 7.4 7.3 7.2 7.1 7.0 6.9 6.8 6.7 6.6 6.5
f1 (ppm)
1.95 4.91 1.93 1.00 2.00 2.17 9.14 3.47
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


163.687
161.701
155.184
155.162
141.289
141.229
131.943
131.879
131.707
131.681
131.575
131.549
131.493
131.421
131.215
130.694
130.618
129.778
128.987
125.681
125.589
121.091
121.044
115.428
115.256
34.945
31.070
20.405
19.817
5.436
5.396
O
P
Et
F
tBu
3jj
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

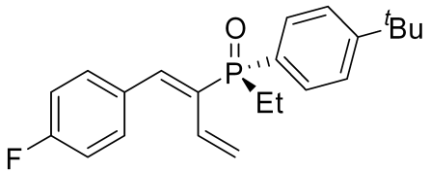


3jj

35.455

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

f1 (ppm)

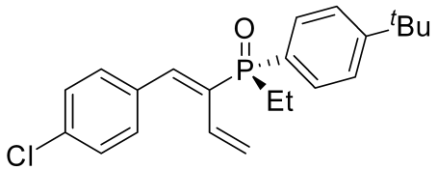


3jj

-111.580

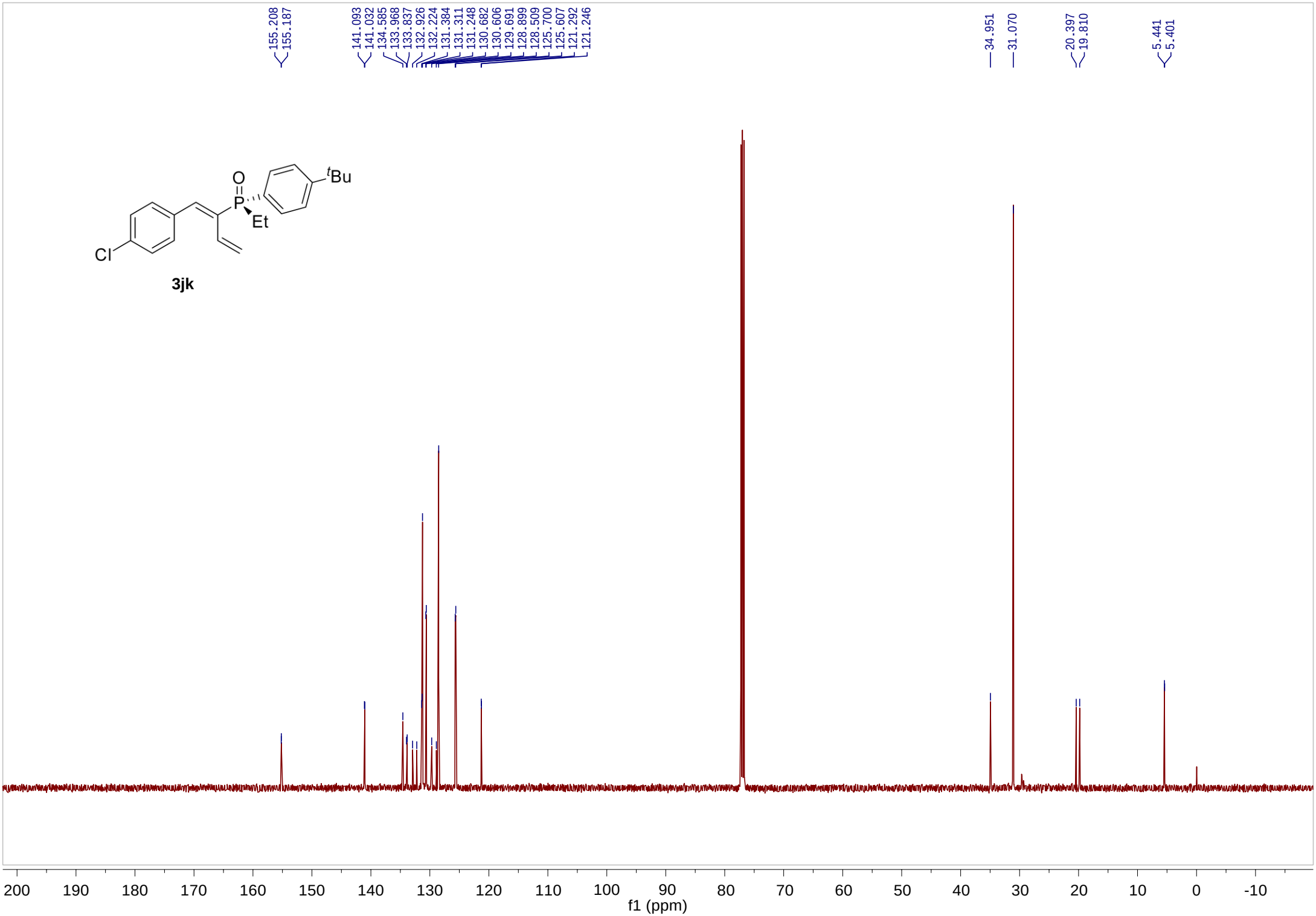
-10 -15 -20 -25 -30 -35 -40 -45 -50 -55 -60 -65 -70 -75 -80 -85 -90 -95 -100 -105 -110 -115 -120 -125 -130

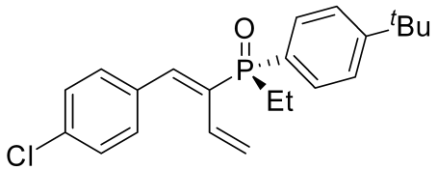
f1 (ppm)


O
P
Et
tBu
Cl

3jk

7.695
7.679
7.673
7.657
7.510
7.505
7.494
7.489
7.442
7.427
7.410
7.404
7.340
7.323
6.583
6.560
6.549
6.526
6.515
6.492
5.365
5.361
5.345
5.340
5.329
5.323
5.317
2.267
2.252
2.245
2.237
2.230
2.222
2.214
2.199
1.334
1.255
1.240
1.225
1.221
1.206
1.190
2.00
2.13
2.96
2.02
1.00
2.07
2.04
9.18
3.27
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)


155.208
155.187
141.093
141.032
134.585
133.968
133.837
132.926
132.224
131.384
131.311
131.248
130.682
130.606
129.691
128.899
128.509
125.700
125.607
121.292
121.246
34.951
31.070
20.397
19.810
5.441
5.401
O
P
Et
tBu
Cl
3jk
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

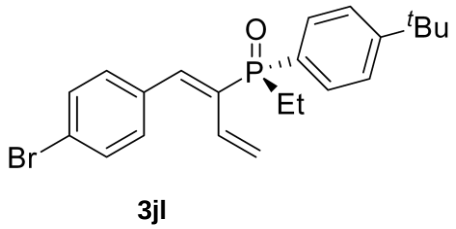


3jk

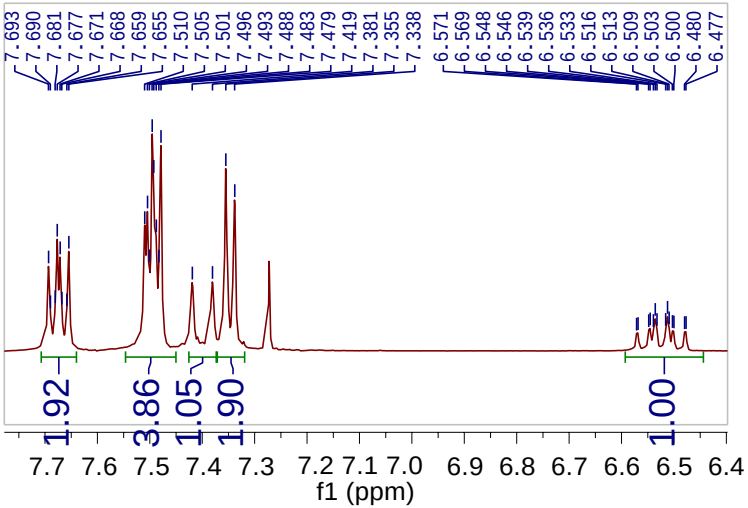
35.402

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

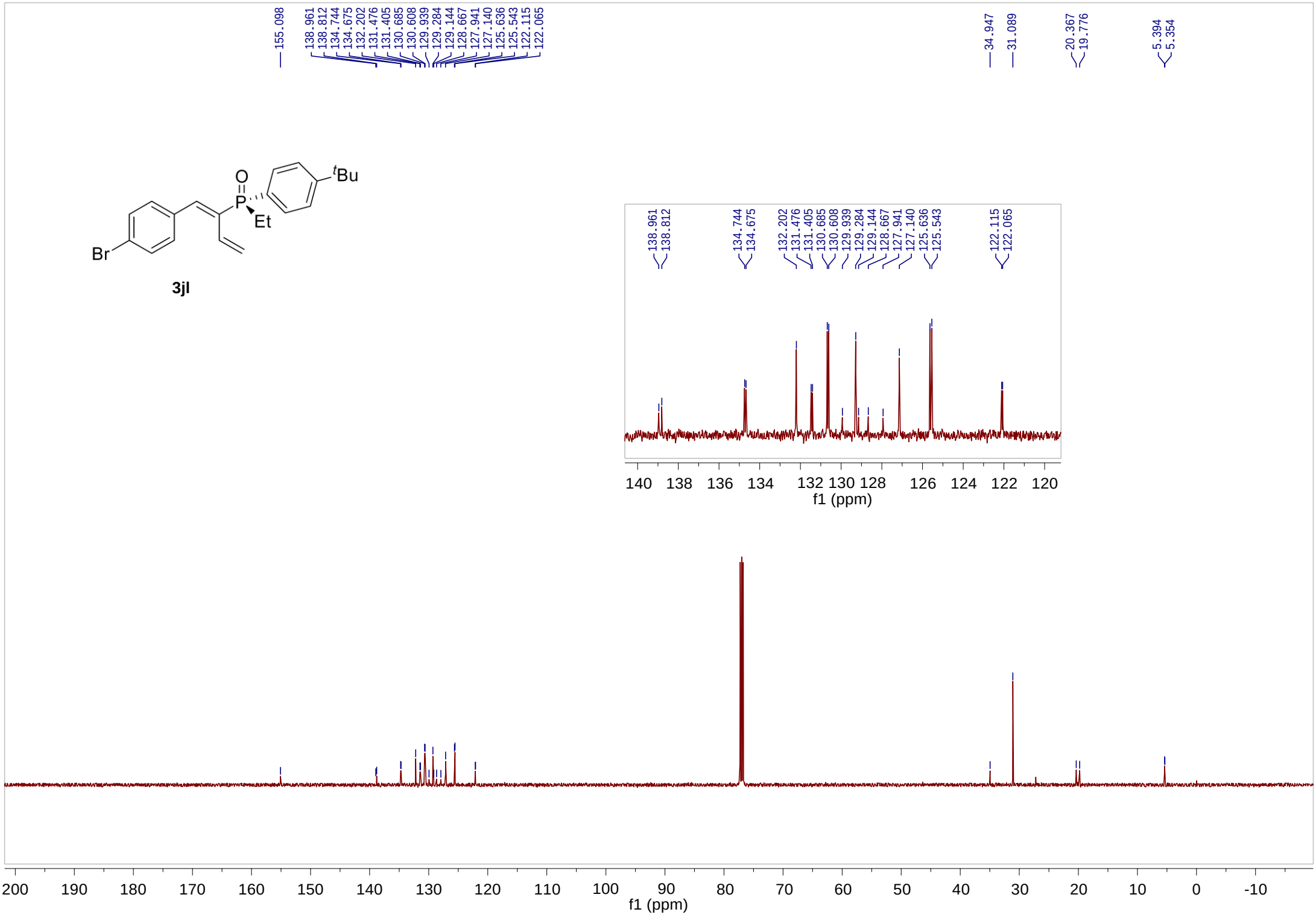
f1 (ppm)

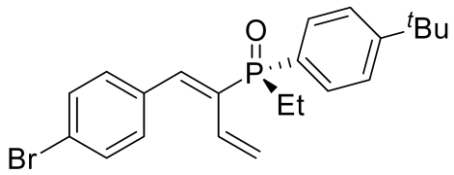

O
P
Et
tBu
Br

3jl


1.92
3.86
1.05
1.90
1.00
7.7 7.6 7.5 7.4 7.3 7.2 7.1 7.0 6.9 6.8 6.7 6.6 6.5 6.4
f1 (ppm)

1.92
3.86
1.05
1.90
1.00
1.98
2.04
8.80
3.69
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


155.098
138.961
138.812
134.744
134.675
132.202
131.476
131.405
130.685
130.608
129.939
129.284
129.144
128.667
127.941
127.140
125.636
125.543
122.115
122.065
34.947
31.089
20.367
19.776
5.394
5.354
O
P
Et
tBu
Br
3jl
f1 (ppm)
f1 (ppm)

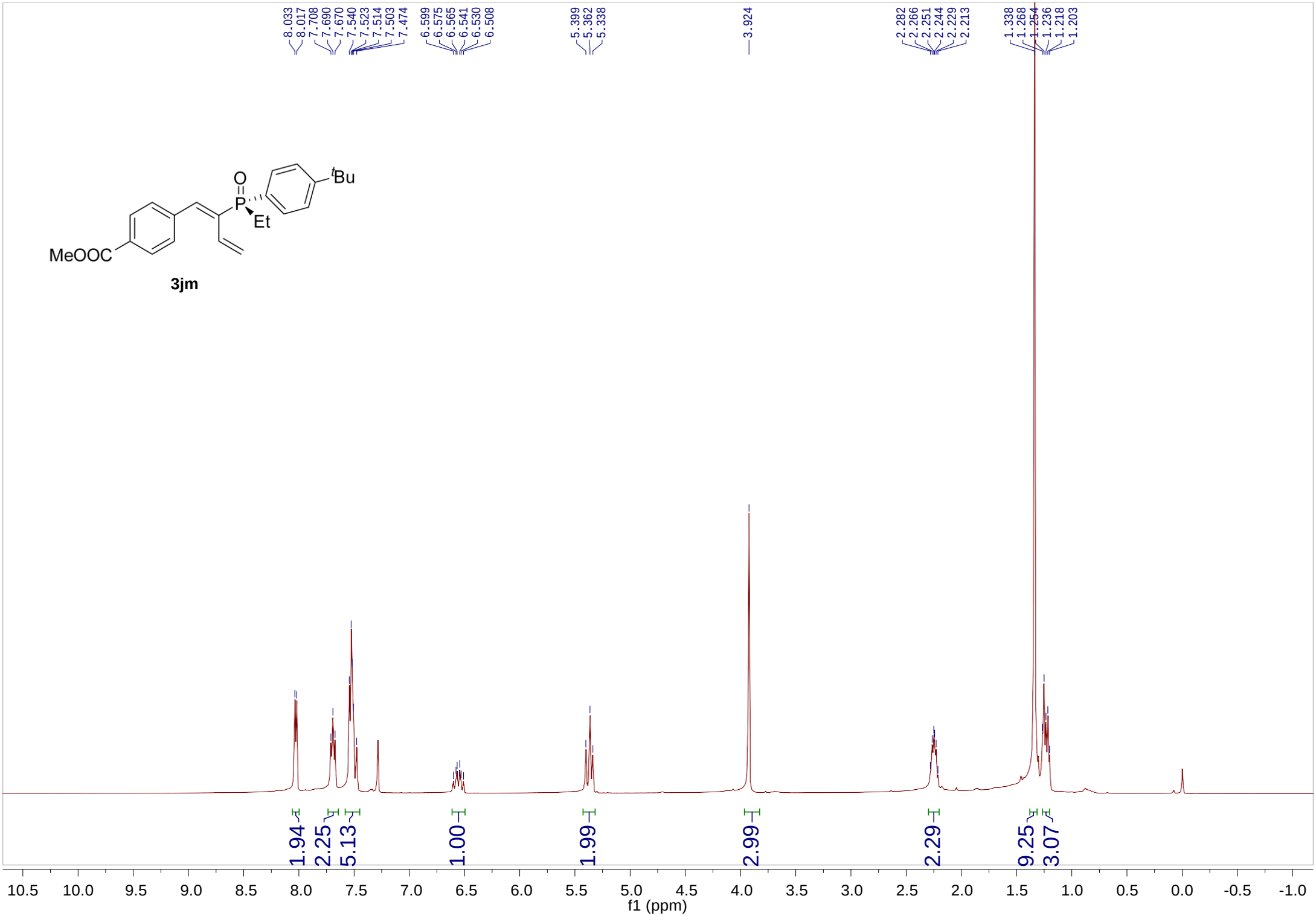


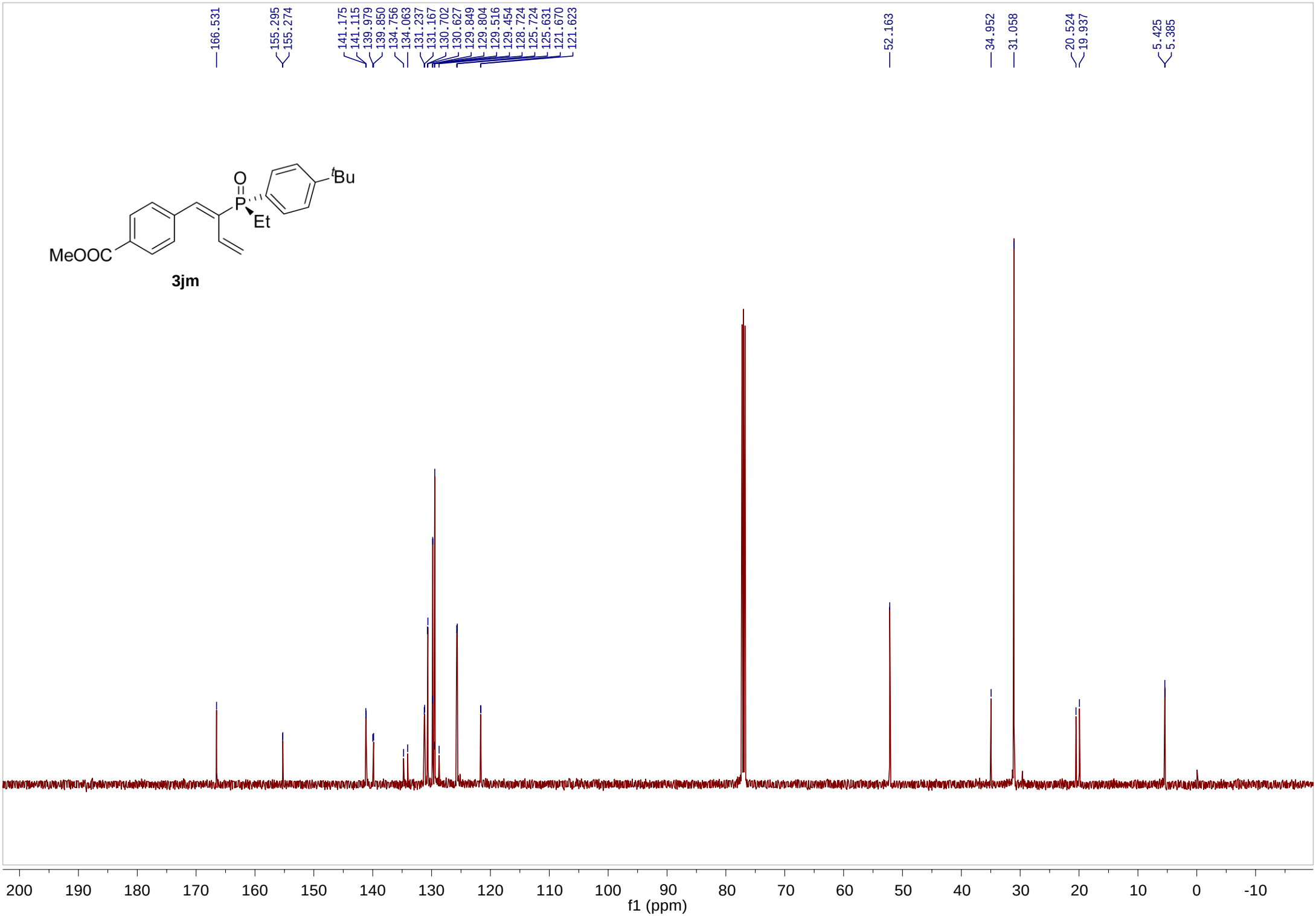
3jl

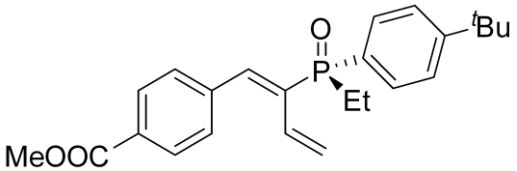
35.188

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

f1 (ppm)


8.033
8.017
7.708
7.690
7.670
7.540
7.523
7.514
7.503
7.474
6.599
6.575
6.565
6.541
6.530
6.508
5.399
5.362
5.338
3.924
2.282
2.266
2.251
2.244
2.229
2.213
1.338
1.268
1.254
1.236
1.218
1.203
O
P
Et
tBu
MeOOC
3jm
1.94
2.25
5.13
1.00
1.99
2.99
2.29
9.25
3.07
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)


166.531
155.295
155.274
141.175
141.115
139.979
139.850
134.756
134.063
131.237
131.167
130.702
130.627
129.849
129.804
129.516
129.454
128.724
125.724
125.631
121.670
121.623
52.163
34.952
31.058
20.524
19.937
5.425
5.385
O
P
Et
tBu
MeOOC
3jm
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

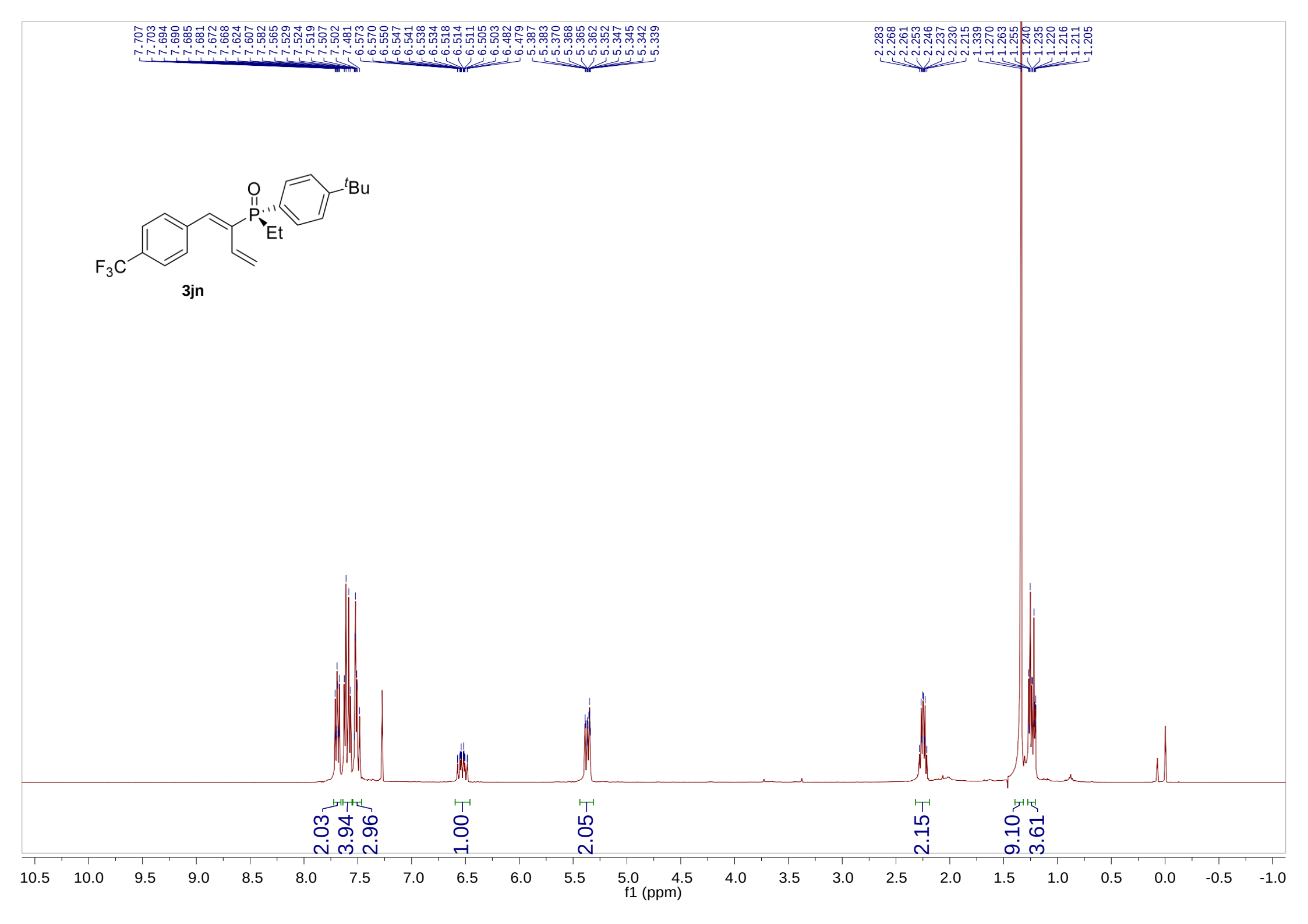


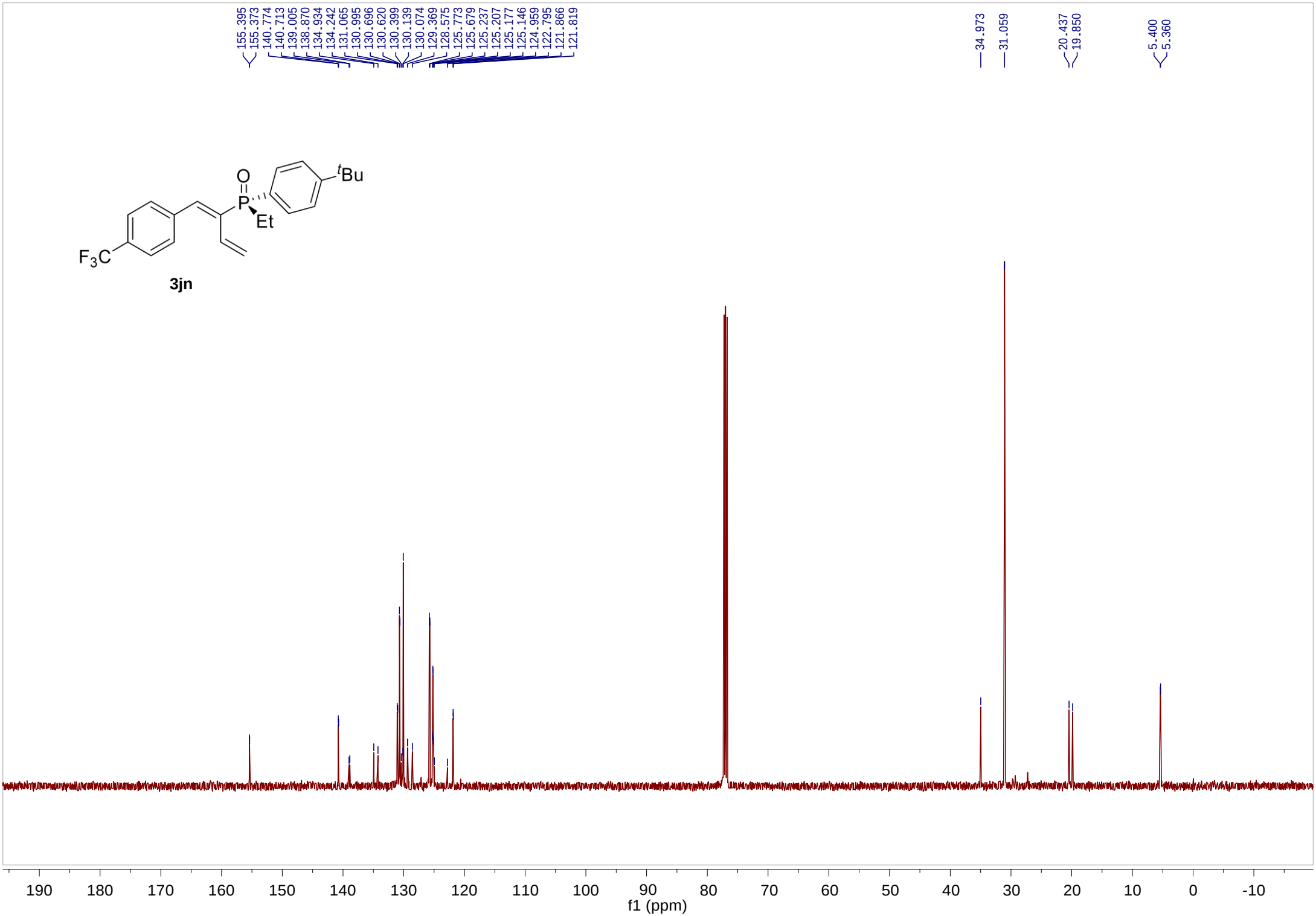
3jm

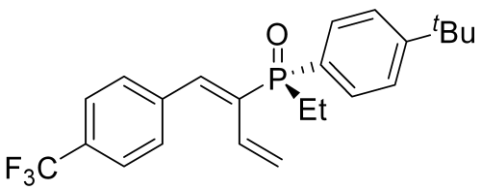
35.169

100 90 80 70 60 50 40 30 20 10 0 -10 -20 -30 -40 -50

f1 (ppm)


7.707
7.703
7.694
7.690
7.685
7.681
7.672
7.668
7.624
7.607
7.582
7.565
7.529
7.524
7.519
7.507
7.502
7.481
6.573
6.570
6.550
6.547
6.541
6.538
6.534
6.518
6.514
6.511
6.505
6.503
6.482
6.479
5.387
5.383
5.370
5.368
5.365
5.362
5.352
5.347
5.345
5.342
5.339
2.283
2.268
2.261
2.253
2.246
2.237
2.230
2.215
1.339
1.270
1.263
1.255
1.240
1.235
1.220
1.216
1.211
1.205
O
P
Et
tBu
F3C
3jn
2.03
3.94
2.96
1.00
2.05
2.15
9.10
3.61
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)


155.395
155.373
140.774
140.713
139.005
138.870
134.934
134.242
131.065
130.995
130.696
130.620
130.399
130.139
130.074
129.369
128.575
125.773
125.679
125.237
125.207
125.177
125.146
124.959
122.795
121.866
121.819
34.973
31.059
20.437
19.850
5.400
5.360
O
P
Et
tBu
F3C
3jn
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

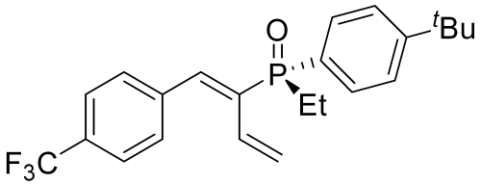


3jn

35.008

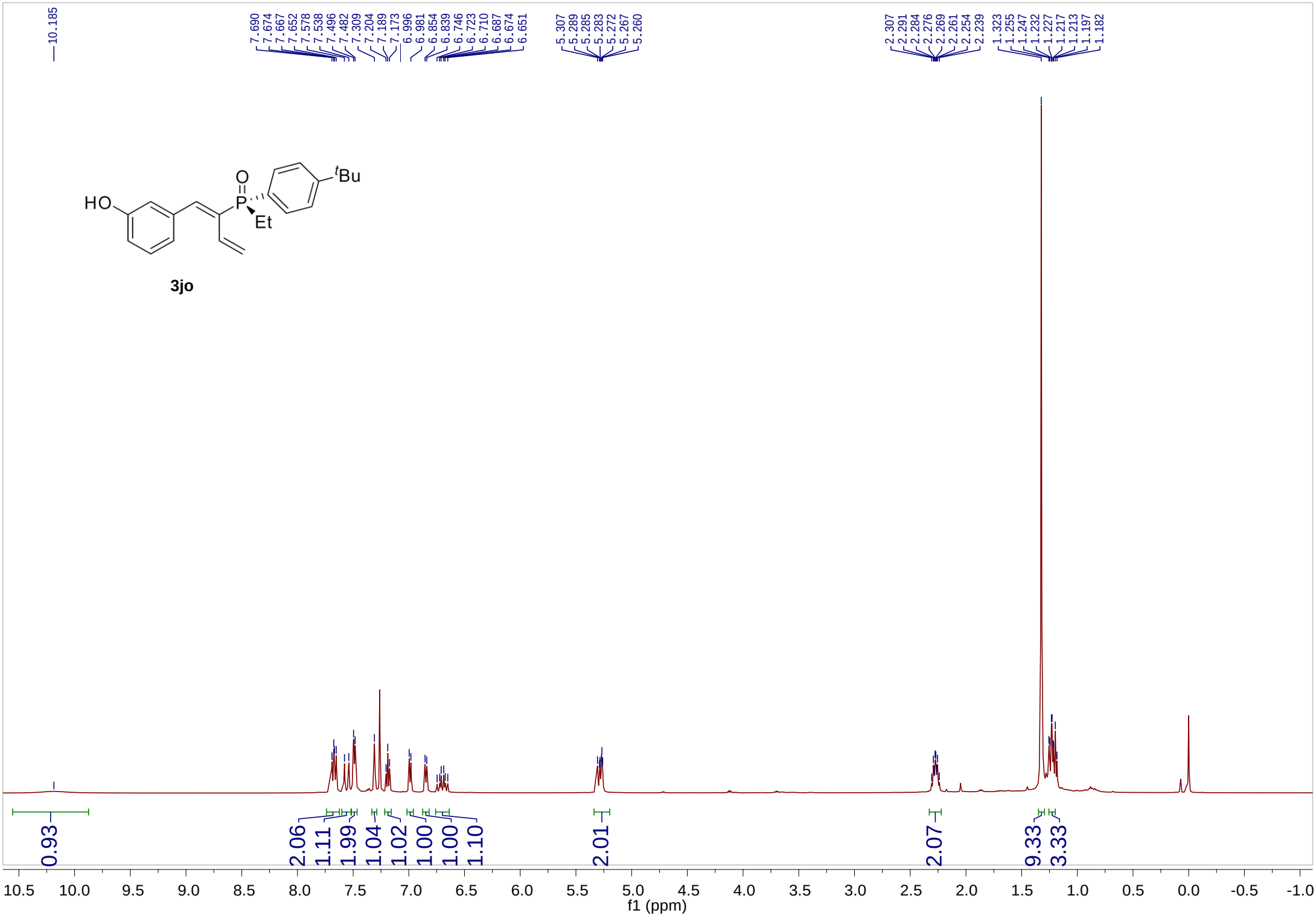
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

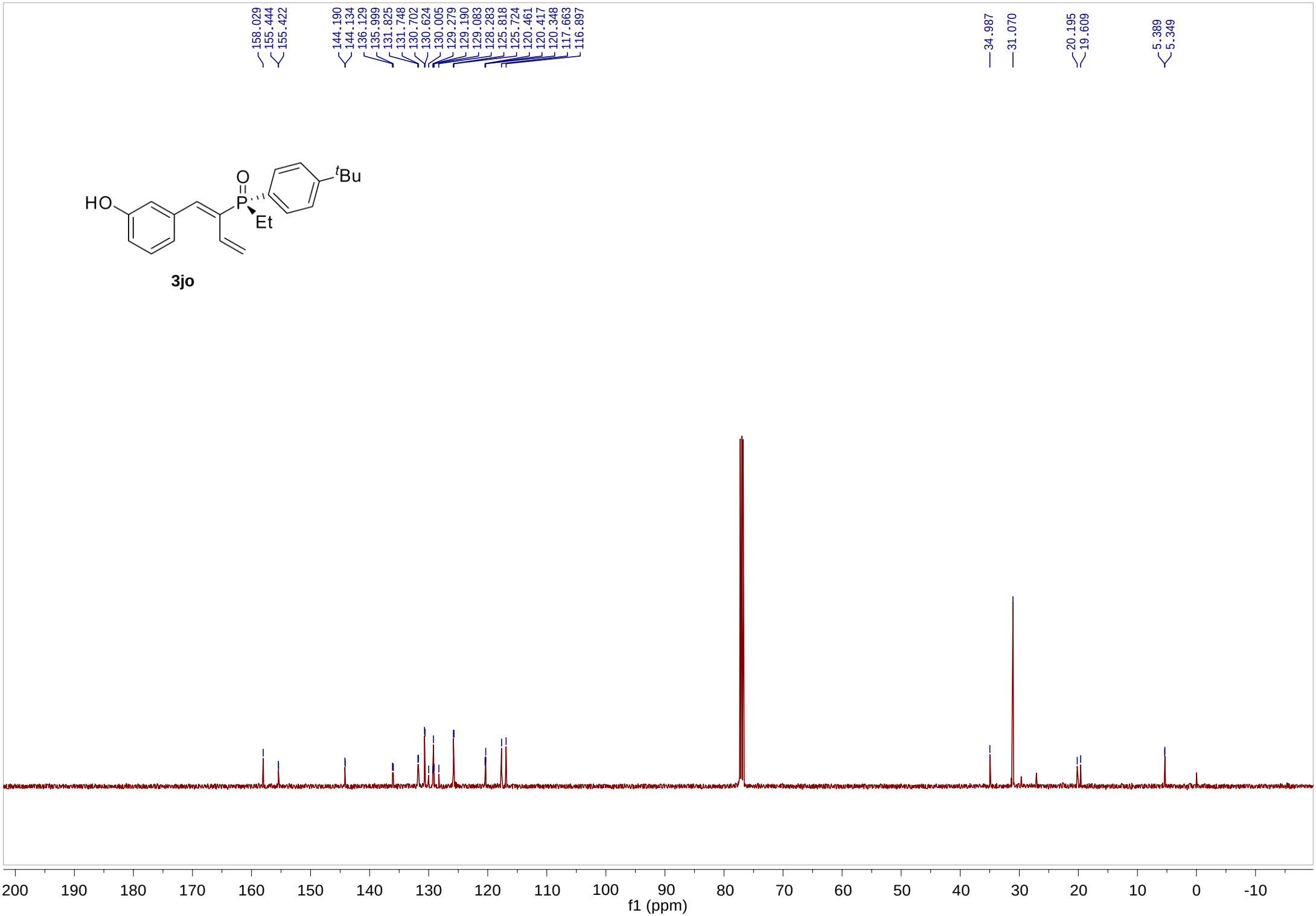
f1 (ppm)

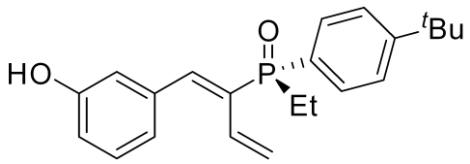

O
P
Et
tBu
F3C

3jn

-62.759
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
-90
-95
-100
-105
-110
-115
-120
f1 (ppm)


10.185
7.690
7.674
7.667
7.652
7.578
7.538
7.496
7.482
7.309
7.204
7.189
7.173
6.996
6.981
6.854
6.839
6.746
6.723
6.710
6.687
6.674
6.651
5.307
5.289
5.285
5.283
5.272
5.267
5.260
2.307
2.291
2.284
2.276
2.269
2.261
2.254
2.239
1.323
1.255
1.247
1.232
1.227
1.217
1.213
1.197
1.182
HO
O
P
Et
tBu
3jo
0.93
2.06
1.11
1.99
1.04
1.02
1.00
1.00
1.10
2.01
2.07
9.33
3.33
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)


158.029
155.444
155.422
144.190
144.134
136.129
135.999
131.825
131.748
130.702
130.624
130.005
129.279
129.190
129.083
128.283
125.818
125.724
120.461
120.417
120.348
117.663
116.897
34.987
31.070
20.195
19.609
5.389
5.349
HO
O
P
Et
tBu
3jo
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

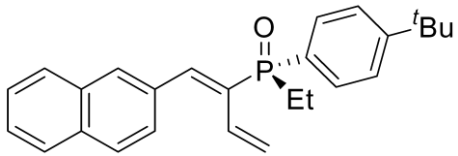


3jo

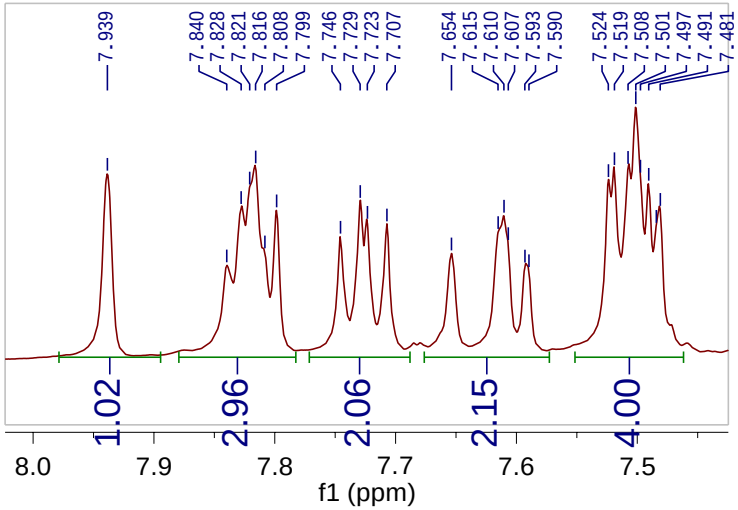
37.942

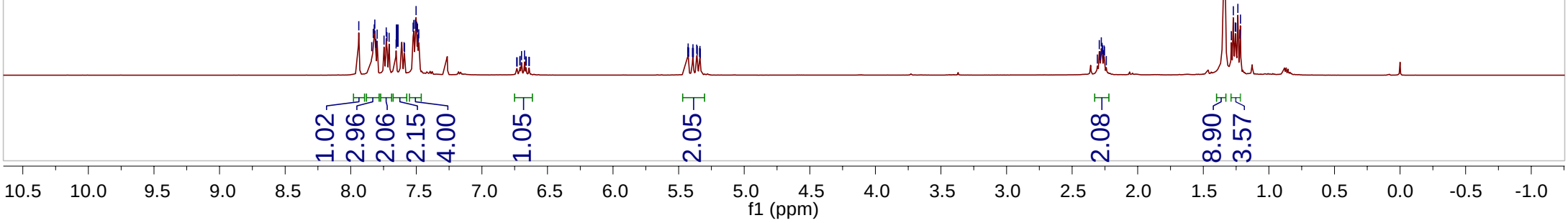
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

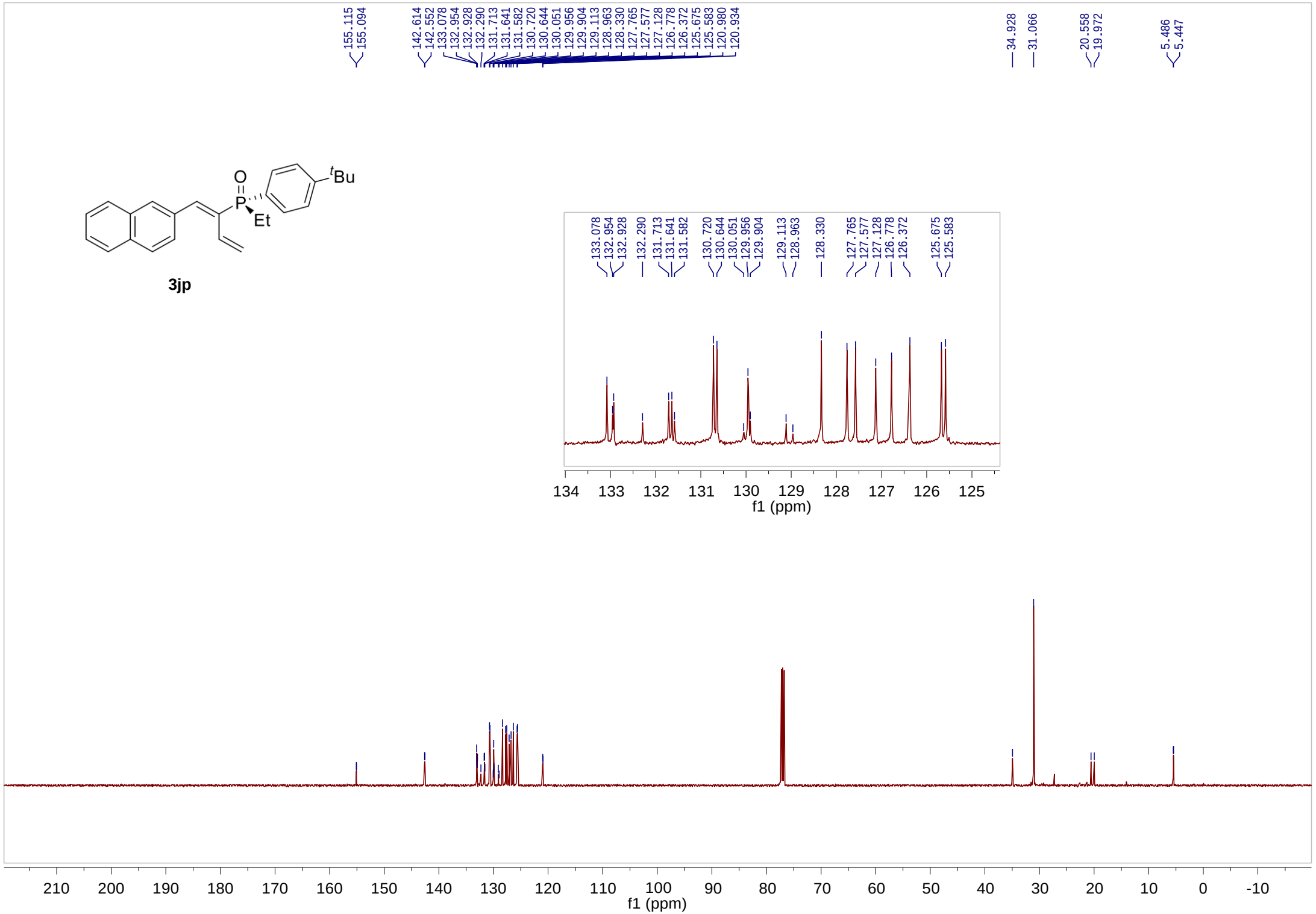
f1 (ppm)

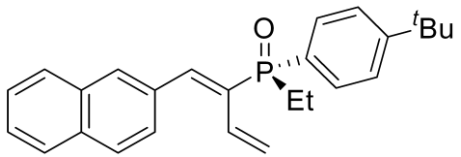

O
P
Et
tBu

3jp


1.02
2.96
2.06
2.15
4.00
8.0
7.9
7.8
7.7
7.6
7.5
f1 (ppm)


1.02
2.96
2.06
2.15
4.00
1.05
2.05
2.08
8.90
3.57
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)


155.115
155.094
142.614
142.552
133.078
132.954
132.928
132.290
131.713
131.641
131.582
130.720
130.644
130.051
129.956
129.904
129.113
128.963
128.330
127.765
127.577
127.128
126.778
126.372
125.675
125.583
120.980
120.934
34.928
31.066
20.558
19.972
5.486
5.447
O
P
Et
tBu
3jp
f1 (ppm)
f1 (ppm)

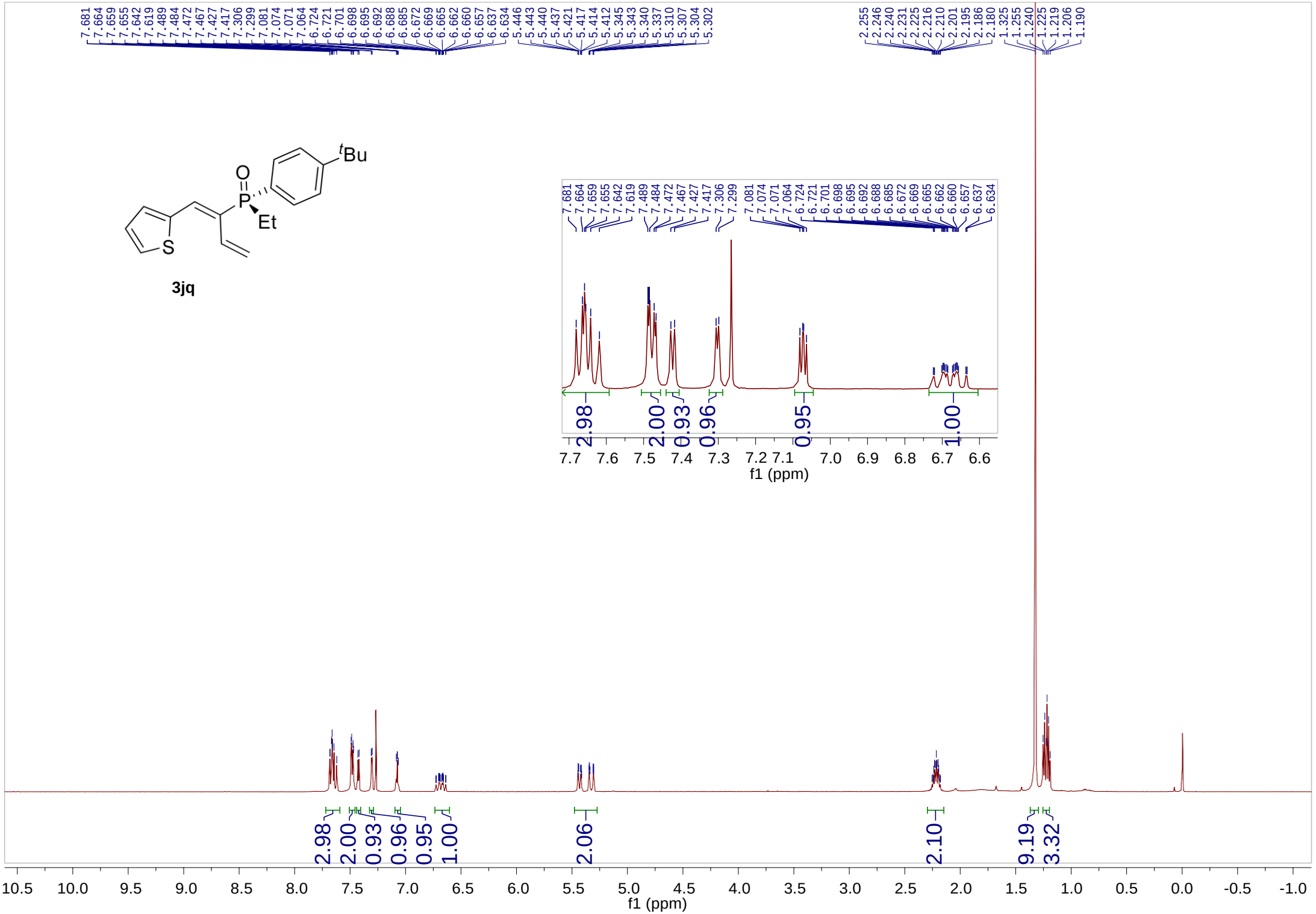


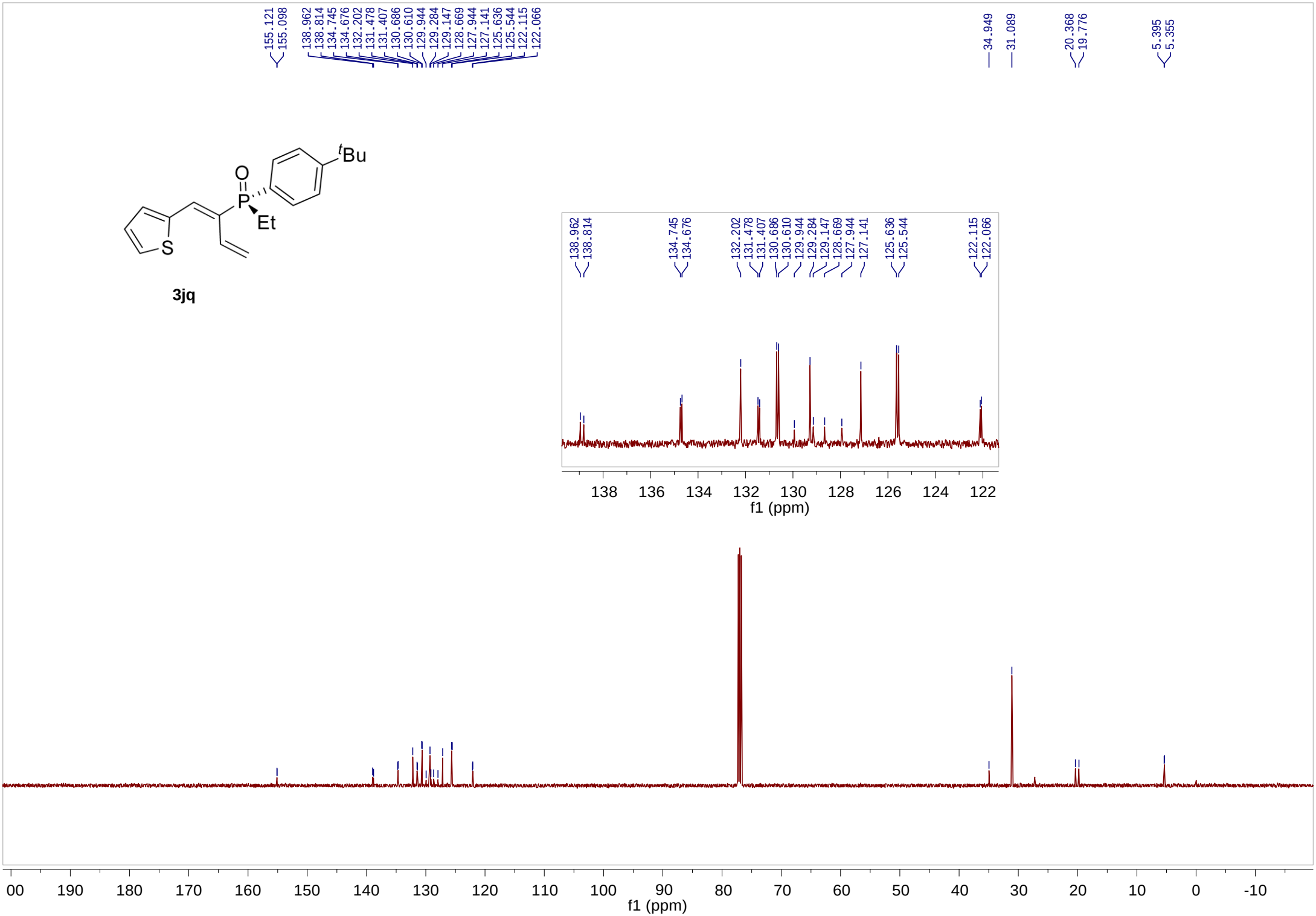
3jp

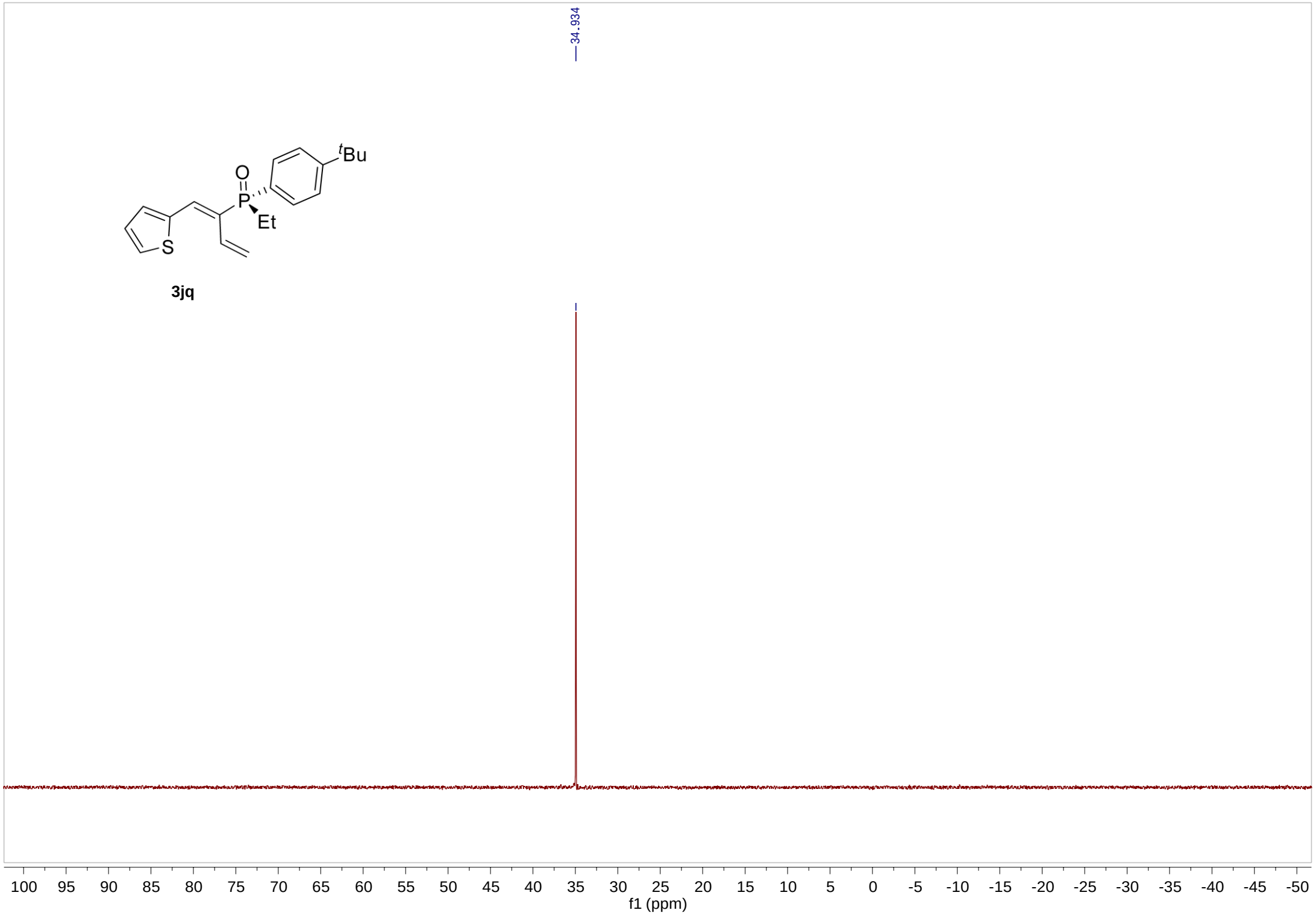
35.681

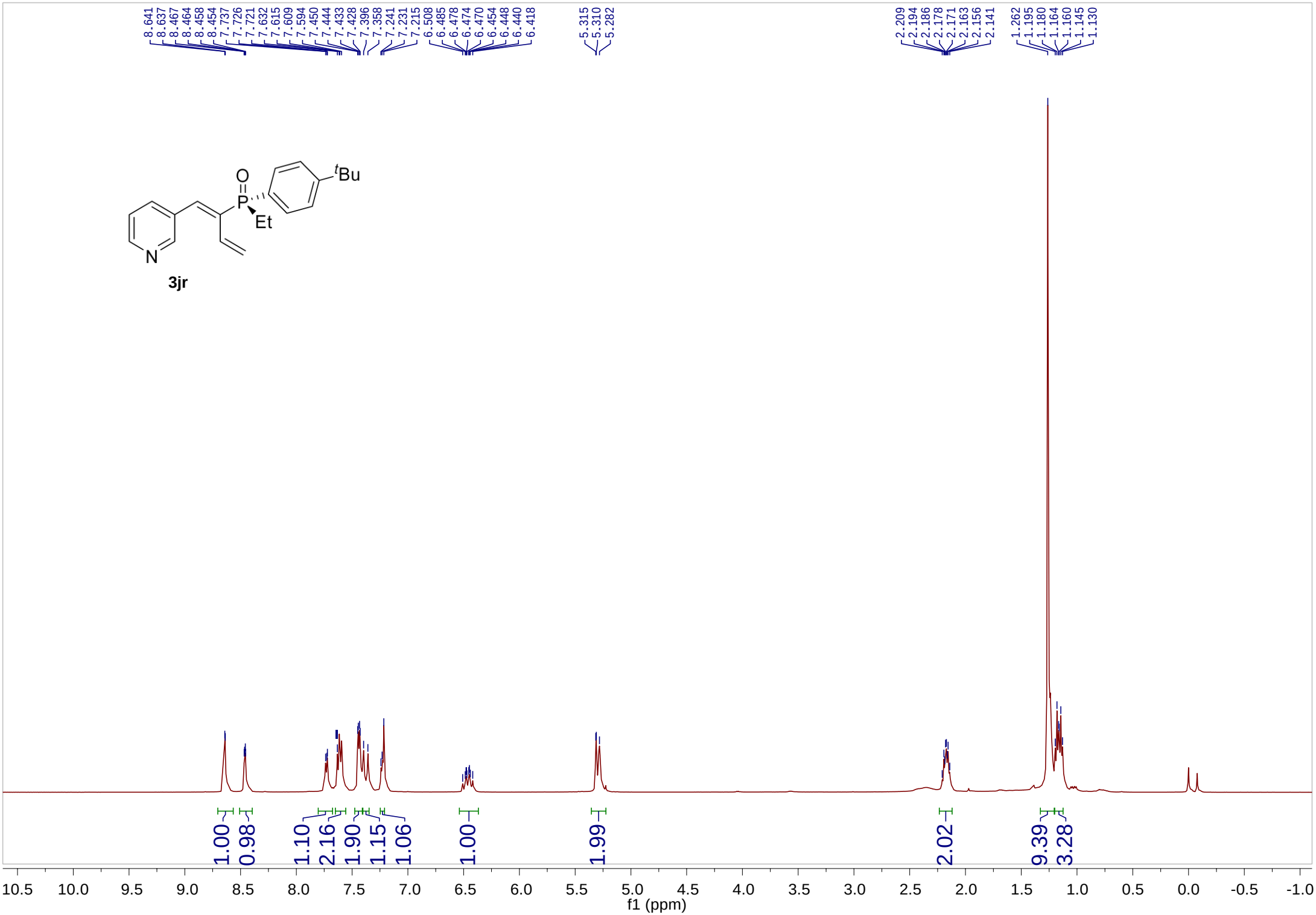
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

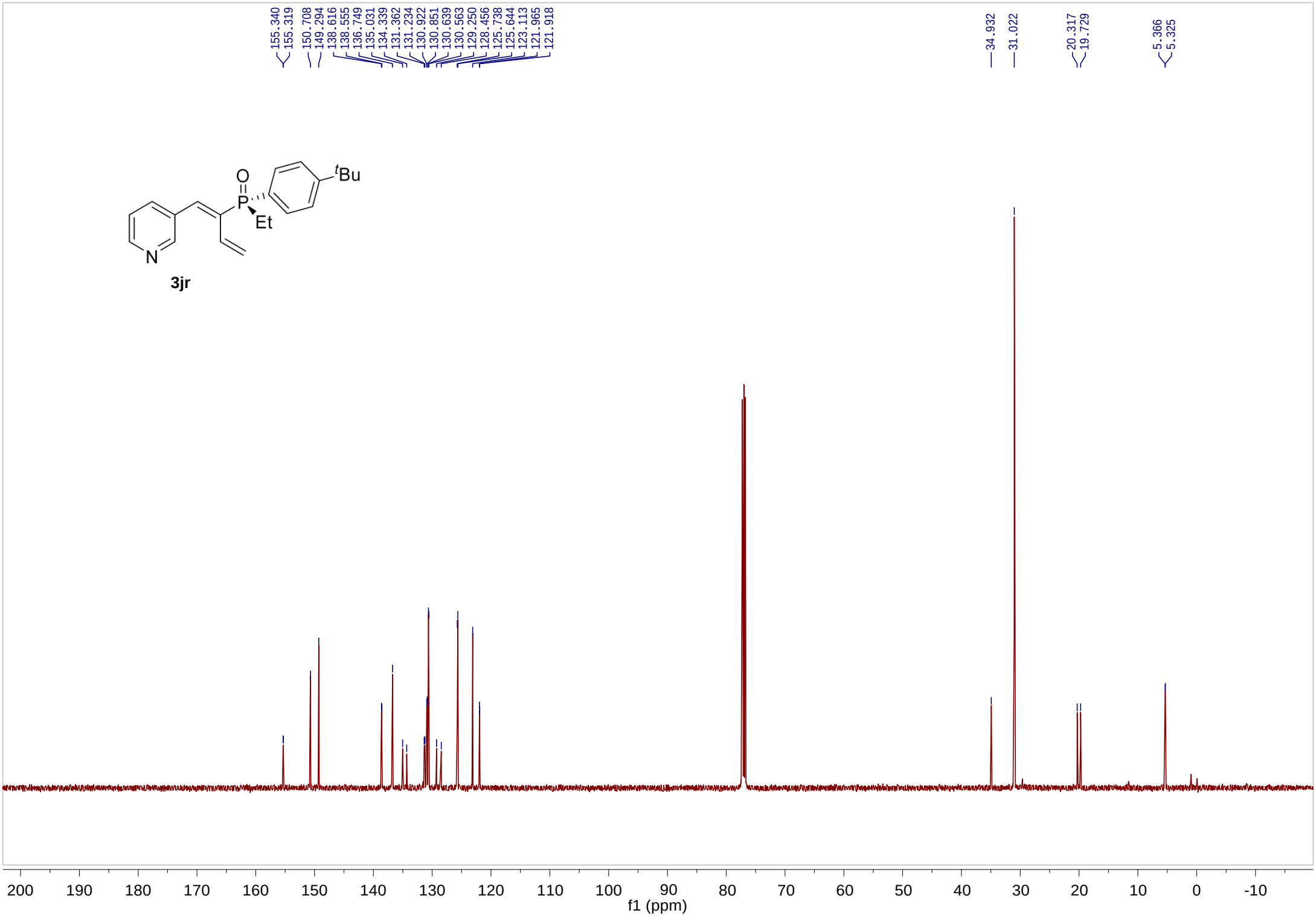
f1 (ppm)

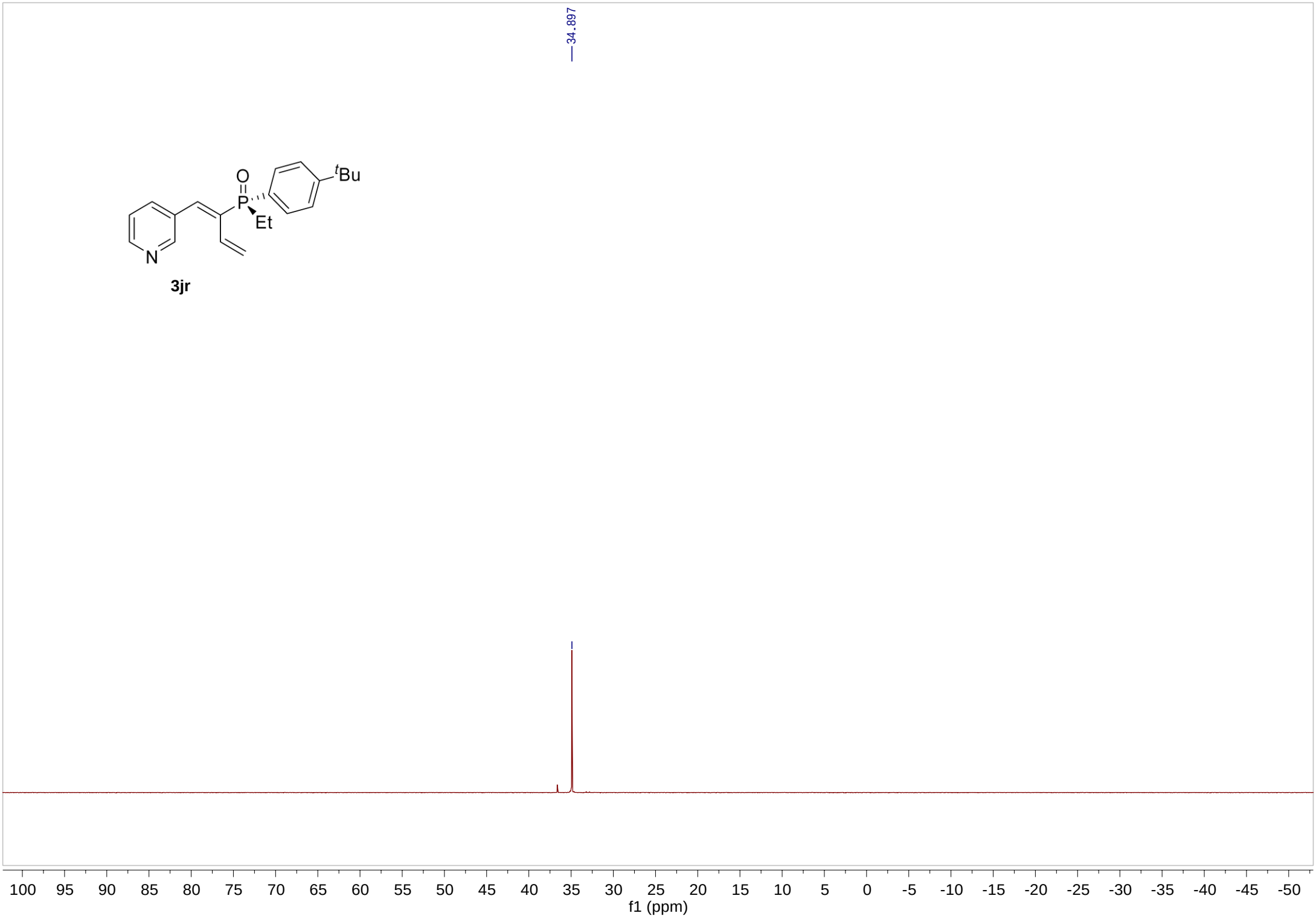

7.681 7.664 7.659 7.655 7.642 7.619 7.489 7.484 7.472 7.467 7.427 7.417 7.306 7.299 7.081 7.074 7.071 7.064 6.724 6.721 6.701 6.698 6.695 6.692 6.688 6.685 6.672 6.669 6.665 6.662 6.660 6.657 6.637 6.634 5.446 5.443 5.440 5.437 5.421 5.417 5.414 5.412 5.345 5.343 5.340 5.337 5.310 5.307 5.304 5.302
2.255 2.246 2.240 2.231 2.225 2.216 2.210 2.201 2.195 2.186 2.180 1.325 1.255 1.240 1.225 1.219 1.206 1.190
tBu
O
P
Et
S
3jq
2.98 2.00 0.93 0.96 0.95 1.00
7.7 7.6 7.5 7.4 7.3 7.2 7.1 7.0 6.9 6.8 6.7 6.6
f1 (ppm)
2.98 2.00 0.93 0.96 0.95 1.00 2.06 2.10 9.19 3.32
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

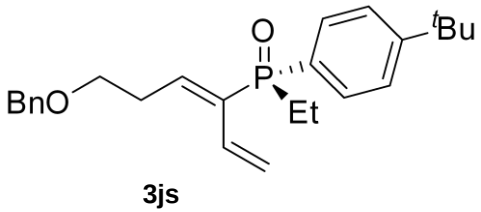

155.121
155.098
138.962
138.814
134.745
134.676
132.202
131.478
131.407
130.686
130.610
129.944
129.284
129.147
128.669
127.944
127.141
125.636
125.544
122.115
122.066
34.949
31.089
20.368
19.776
5.395
5.355
tBu
O
P
Et
S
3jq
f1 (ppm)
f1 (ppm)


34.934
tBu
O
P
Et
S
3jq
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50
f1 (ppm)


8.641
8.637
8.467
8.464
8.458
8.454
7.737
7.726
7.721
7.632
7.615
7.609
7.594
7.450
7.444
7.433
7.428
7.396
7.358
7.241
7.231
7.215
6.508
6.485
6.478
6.474
6.470
6.454
6.448
6.440
6.418
5.315
5.310
5.282
2.209
2.194
2.186
2.178
2.171
2.163
2.156
2.141
1.262
1.195
1.180
1.164
1.160
1.145
1.130
O
P
Et
tBu
N
3jr
1.00
0.98
1.10
2.16
1.90
1.15
1.06
1.00
1.99
2.02
9.39
3.28
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)

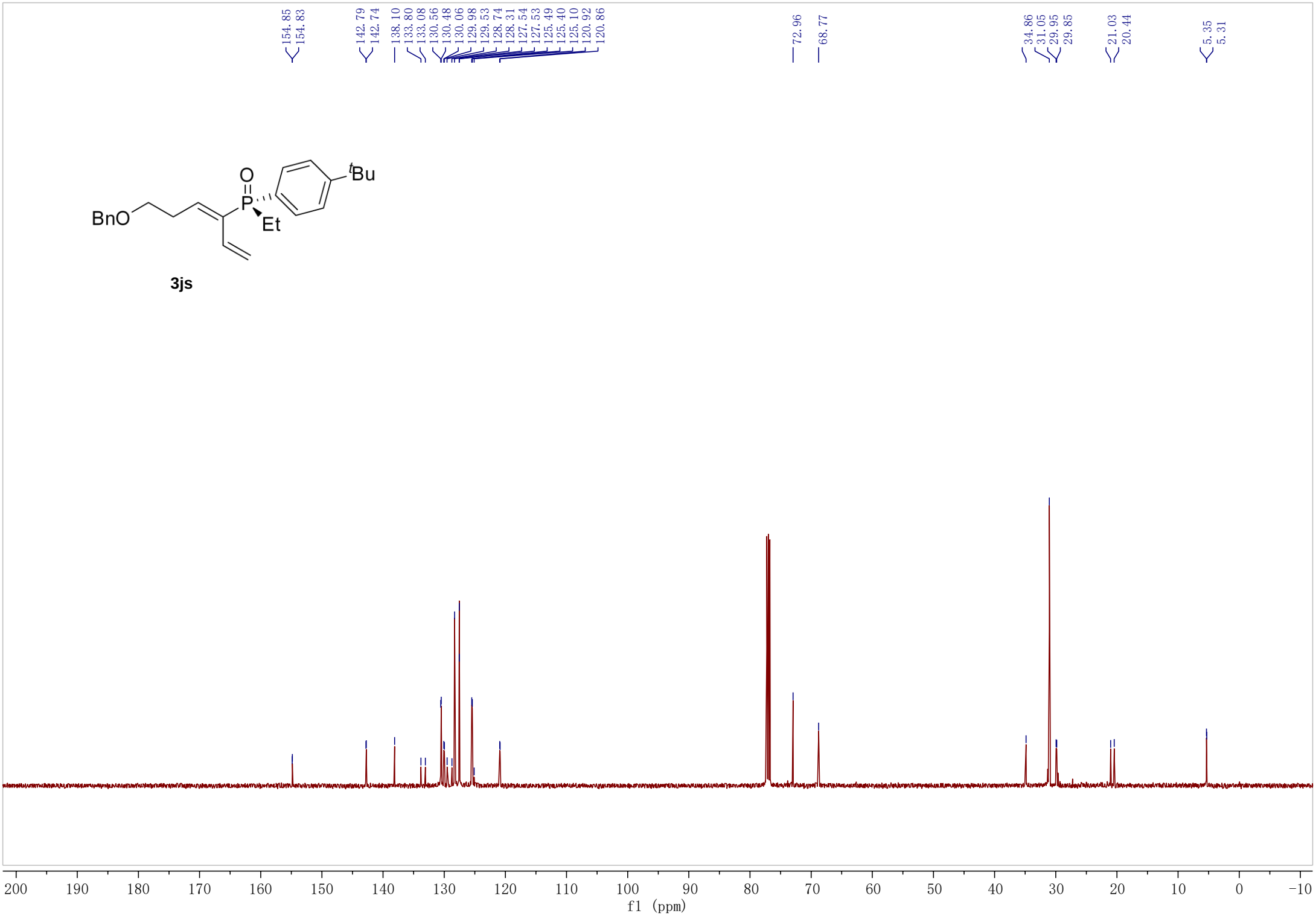

155.340
155.319
150.708
149.294
138.616
138.555
136.749
135.031
134.339
131.362
131.234
130.922
130.851
130.639
130.563
129.250
128.456
125.738
125.644
123.113
121.965
121.918
34.932
31.022
20.317
19.729
5.366
5.325
O
P
Et
tBu
N
3jr
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

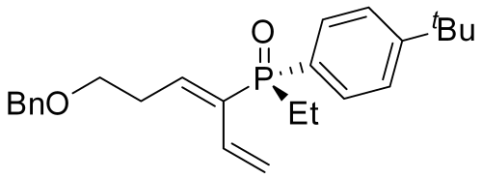

34.897
O
P
Et
tBu
N
3jr
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50
f1 (ppm)


O
P
tBu
BnO
Et

3js

7.62 7.61 7.60 7.59 7.44 7.44 7.43 7.42 7.35 7.33 7.32 7.31 7.30 7.29 7.29 7.28 7.27 6.64 6.62 6.61 6.60 6.58 6.57 6.36 6.34 6.33 6.31 6.30 6.28 5.34 5.32 5.30 5.30 5.29
4.51
3.61 3.60 3.58
2.67 2.67 2.66 2.65 2.12 2.11 2.09 2.08 2.07 2.05
1.31 1.20 1.18 1.17 1.15 1.15 1.14 1.12
2.04 2.12 5.07 1.02 0.99 1.84 1.82 1.95 1.89 2.00 8.87 3.12
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


154.85
154.83
142.79
142.74
138.10
133.80
133.08
130.56
130.48
130.06
129.98
129.53
128.74
128.31
127.54
127.53
125.49
125.40
125.10
120.92
120.86
72.96
68.77
34.86
31.05
29.95
29.85
21.03
20.44
5.35
5.31
O
P
Et
BnO
tBu
3js
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

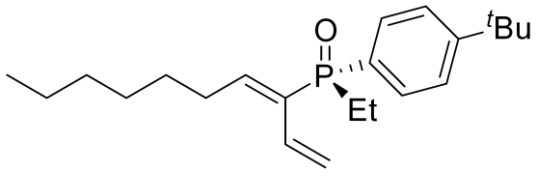


3js

34.29

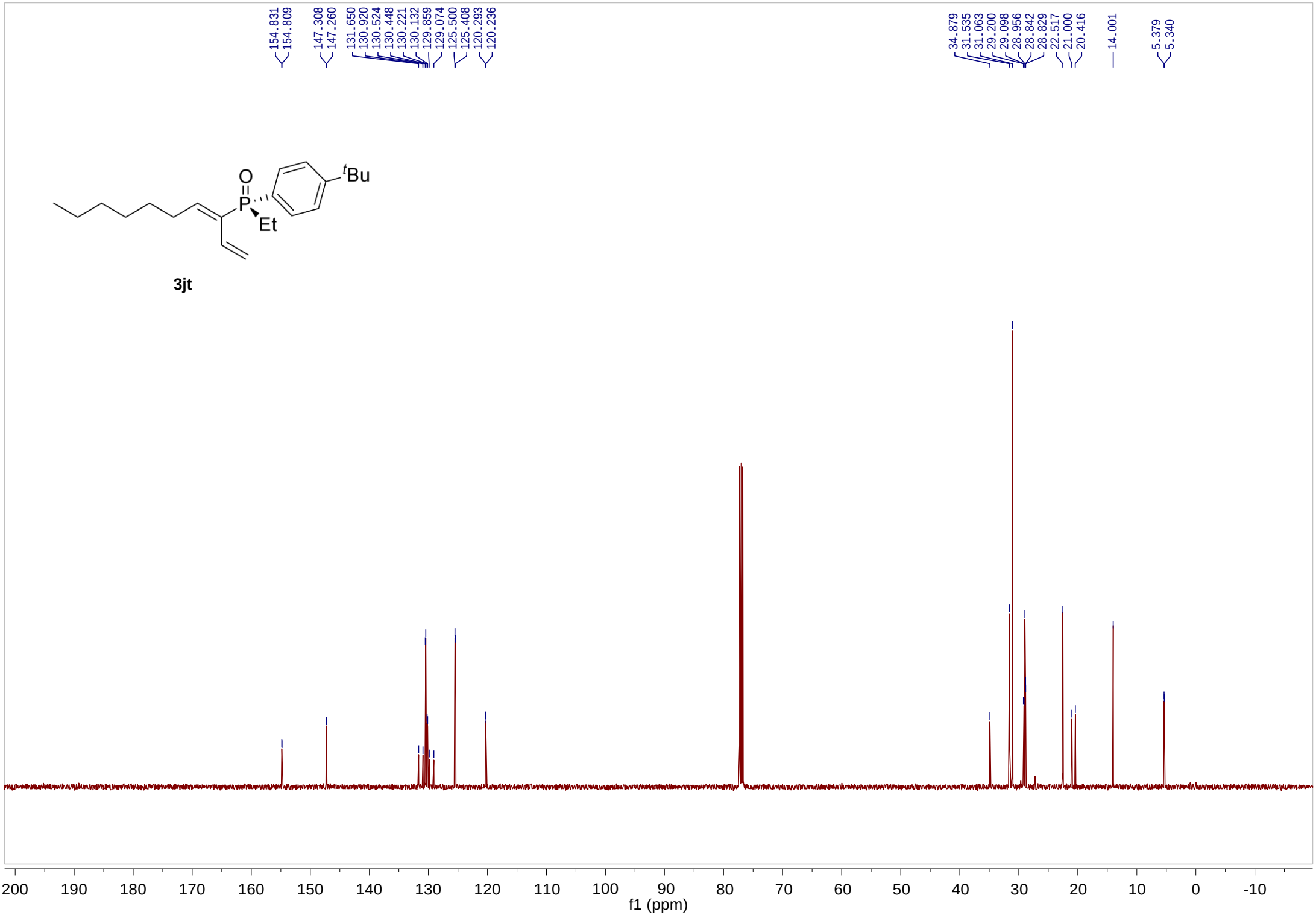
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50

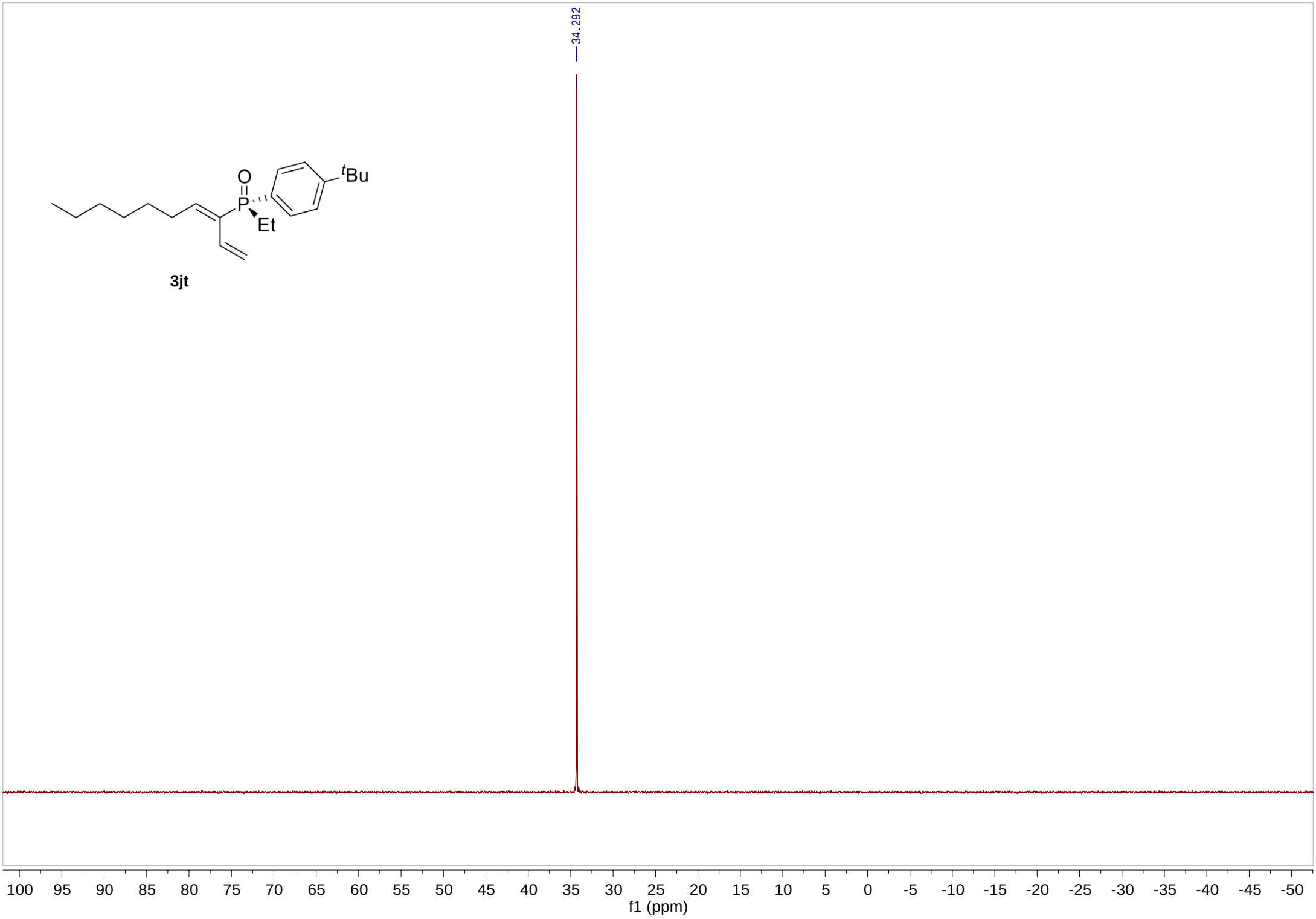
f1 (ppm)

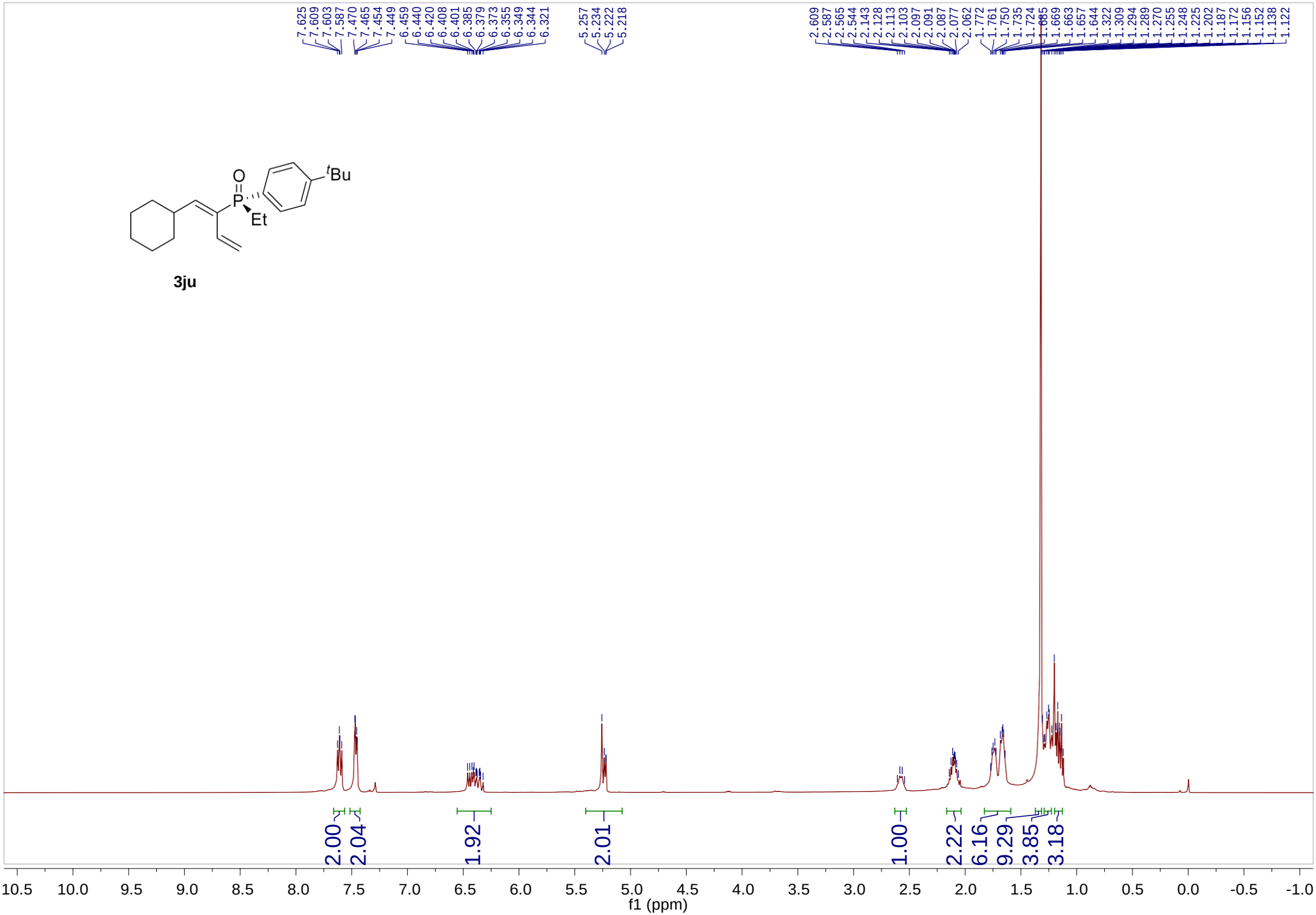

O
P
Et
tBu

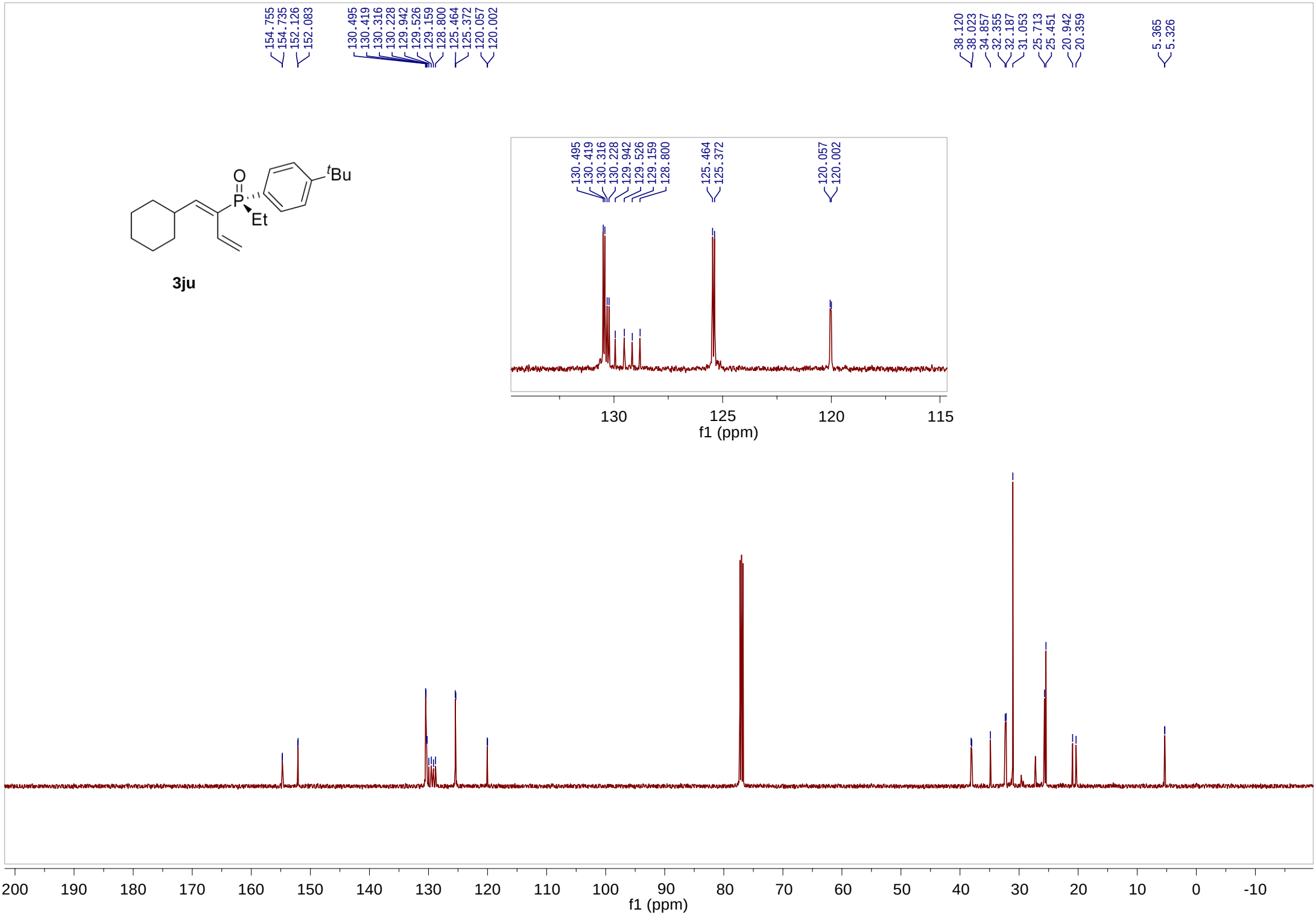
3jt

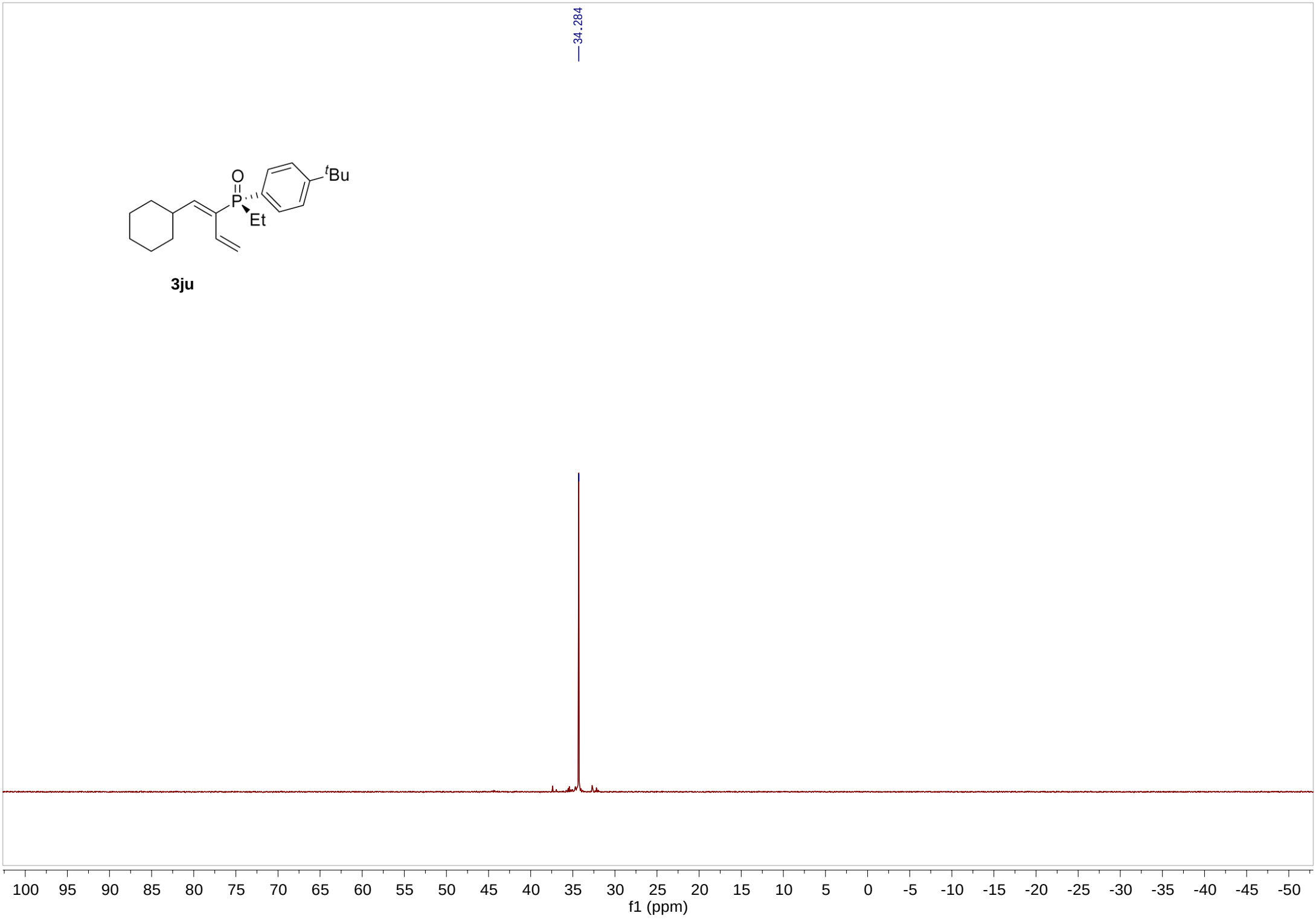
7.632 7.629 7.620 7.616 7.610 7.607 7.598 7.594 7.476 7.471 7.467 7.459 7.454
6.619 6.604 6.589 6.580 6.565 6.550 6.380 6.357 6.352 6.344 6.329 6.321 6.316 6.293
5.293 5.290 5.288 5.277 5.273 5.270 5.267 5.265 5.242 5.238 5.235
2.358 2.352 2.343 2.337 2.328 2.322 2.313 2.307 2.140 2.134 2.125 2.119 2.116 2.110 2.104 2.101 2.098 2.094 2.089 2.086 2.083 2.071 2.068
1.495 1.481 1.466 1.451 1.436 1.359 1.353 1.346 1.340 1.332 1.324 1.312 1.304 1.301 1.289 1.280 1.274 1.269 1.266 1.259 1.255
1.97 2.01 1.00 1.00 2.00 2.23 2.20 2.14 11.05 3.99 3.20 2.90
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

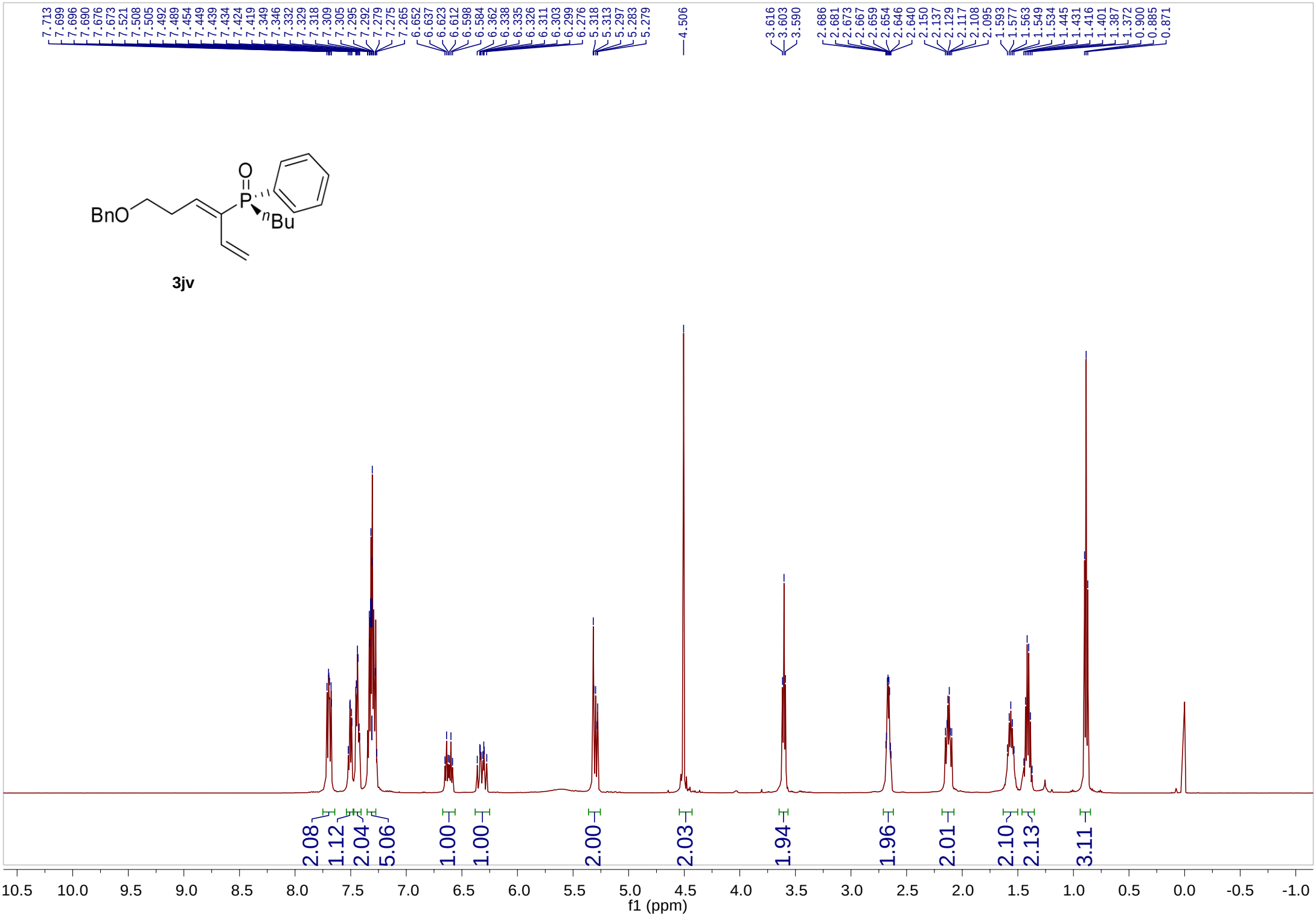

154.831
154.809
147.308
147.260
131.650
130.920
130.524
130.448
130.221
130.132
129.859
129.074
125.500
125.408
120.293
120.236
34.879
31.535
31.063
29.200
29.098
28.956
28.842
28.829
22.517
21.000
20.416
14.001
5.379
5.340
O
P
Et
tBu
3jt
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

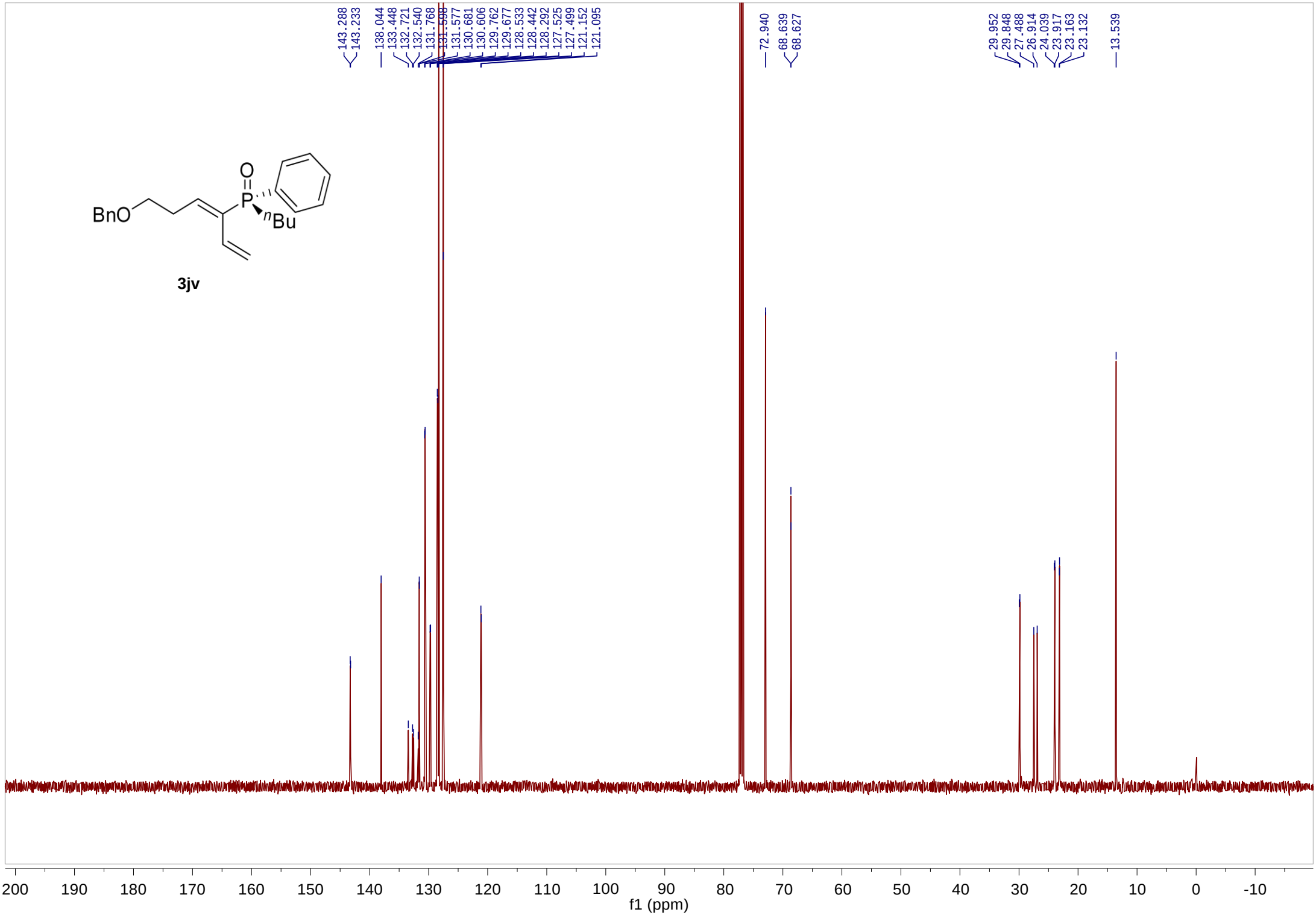

34.292
O
P
Et
tBu
3jt
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50
f1 (ppm)

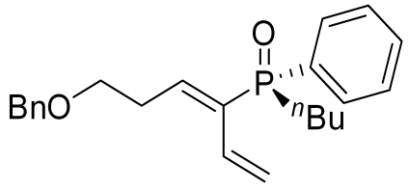

7.625
7.609
7.603
7.587
7.470
7.465
7.454
7.449
6.459
6.440
6.420
6.408
6.401
6.385
6.379
6.373
6.355
6.349
6.344
6.321
5.257
5.234
5.222
5.218
2.609
2.587
2.565
2.544
2.143
2.128
2.113
2.103
2.097
2.091
2.087
2.077
2.062
1.772
1.761
1.750
1.735
1.724
1.685
1.669
1.663
1.657
1.644
1.322
1.309
1.294
1.289
1.270
1.255
1.248
1.225
1.202
1.187
1.172
1.156
1.152
1.138
1.122
O
P
Et
tBu
3ju
2.00
2.04
1.92
2.01
1.00
2.22
6.16
9.29
3.85
3.18
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)


154.755
154.735
152.126
152.083
130.495
130.419
130.316
130.228
129.942
129.526
129.159
128.800
125.464
125.372
120.057
120.002
38.120
38.023
34.857
32.355
32.187
31.053
25.713
25.451
20.942
20.359
5.365
5.326
O
P
Et
tBu
3ju
130
125
120
115
f1 (ppm)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


34.284
O
P
Et
tBu
3ju
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50
f1 (ppm)


7.713
7.699
7.696
7.690
7.676
7.673
7.521
7.508
7.505
7.492
7.489
7.454
7.449
7.439
7.434
7.424
7.419
7.349
7.346
7.332
7.329
7.318
7.309
7.305
7.295
7.292
7.279
7.275
7.265
6.652
6.637
6.623
6.612
6.598
6.584
6.362
6.338
6.335
6.326
6.311
6.303
6.299
6.276
5.318
5.313
5.297
5.283
5.279
4.506
3.616
3.603
3.590
2.686
2.681
2.673
2.667
2.659
2.654
2.646
2.640
2.150
2.137
2.129
2.117
2.108
2.095
1.593
1.577
1.563
1.549
1.534
1.445
1.431
1.416
1.401
1.387
1.372
0.900
0.885
0.871
O
P
nBu
BnO
3jv
2.08
1.12
2.04
5.06
1.00
1.00
2.00
2.03
1.94
1.96
2.01
2.10
2.13
3.11
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)


143.288
143.233
138.044
133.448
132.721
132.540
131.768
131.598
131.577
130.681
130.606
129.762
129.677
128.533
128.442
128.292
127.525
127.499
121.152
121.095
72.940
68.639
68.627
29.952
29.848
27.488
26.914
24.039
23.917
23.163
23.132
13.539
BnO
O
P
nBu
3jv
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

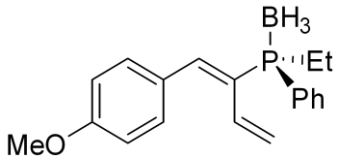


3jv

34.452

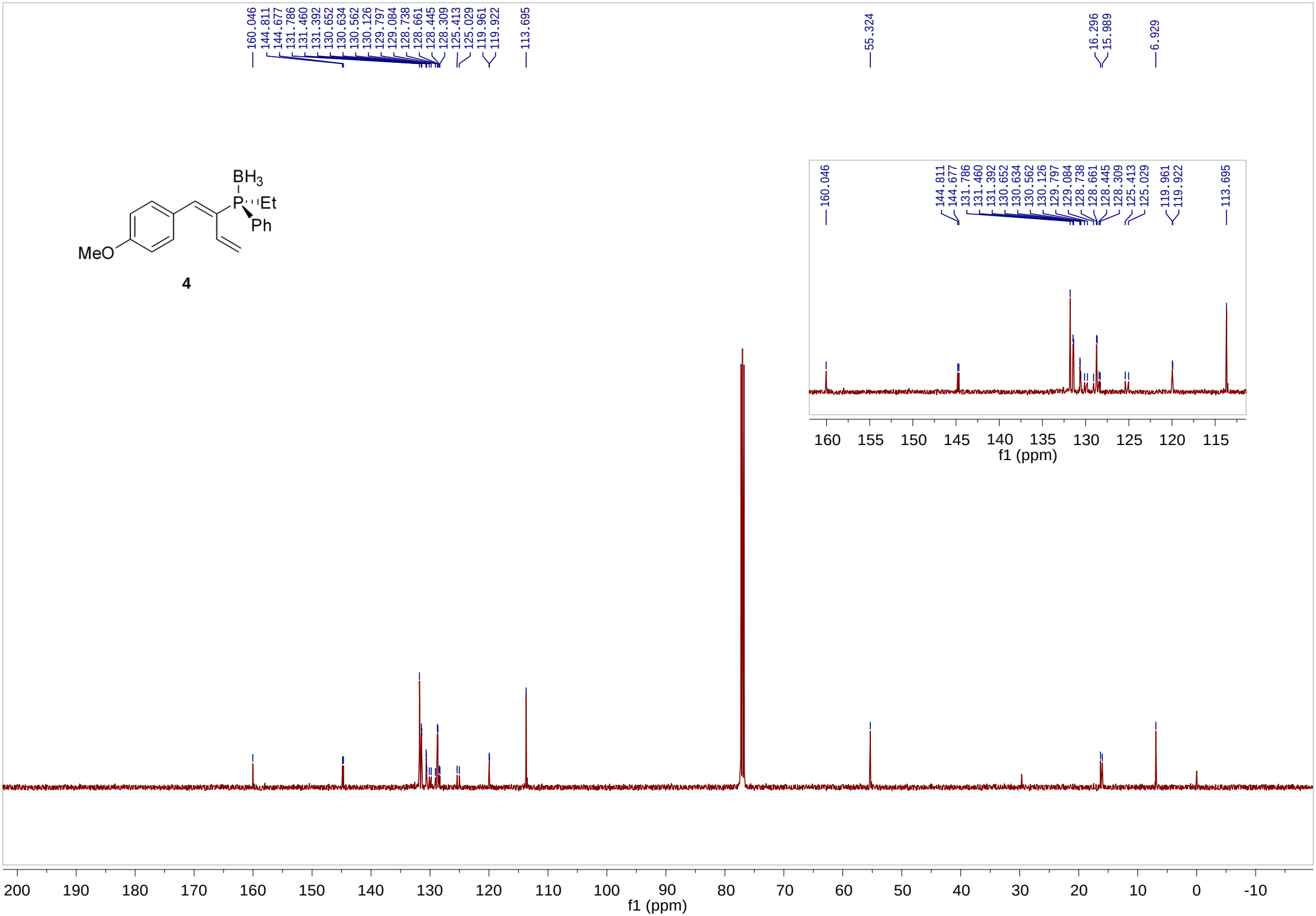
100 90 80 70 60 50 40 30 20 10 0 -10 -20 -30 -40 -50

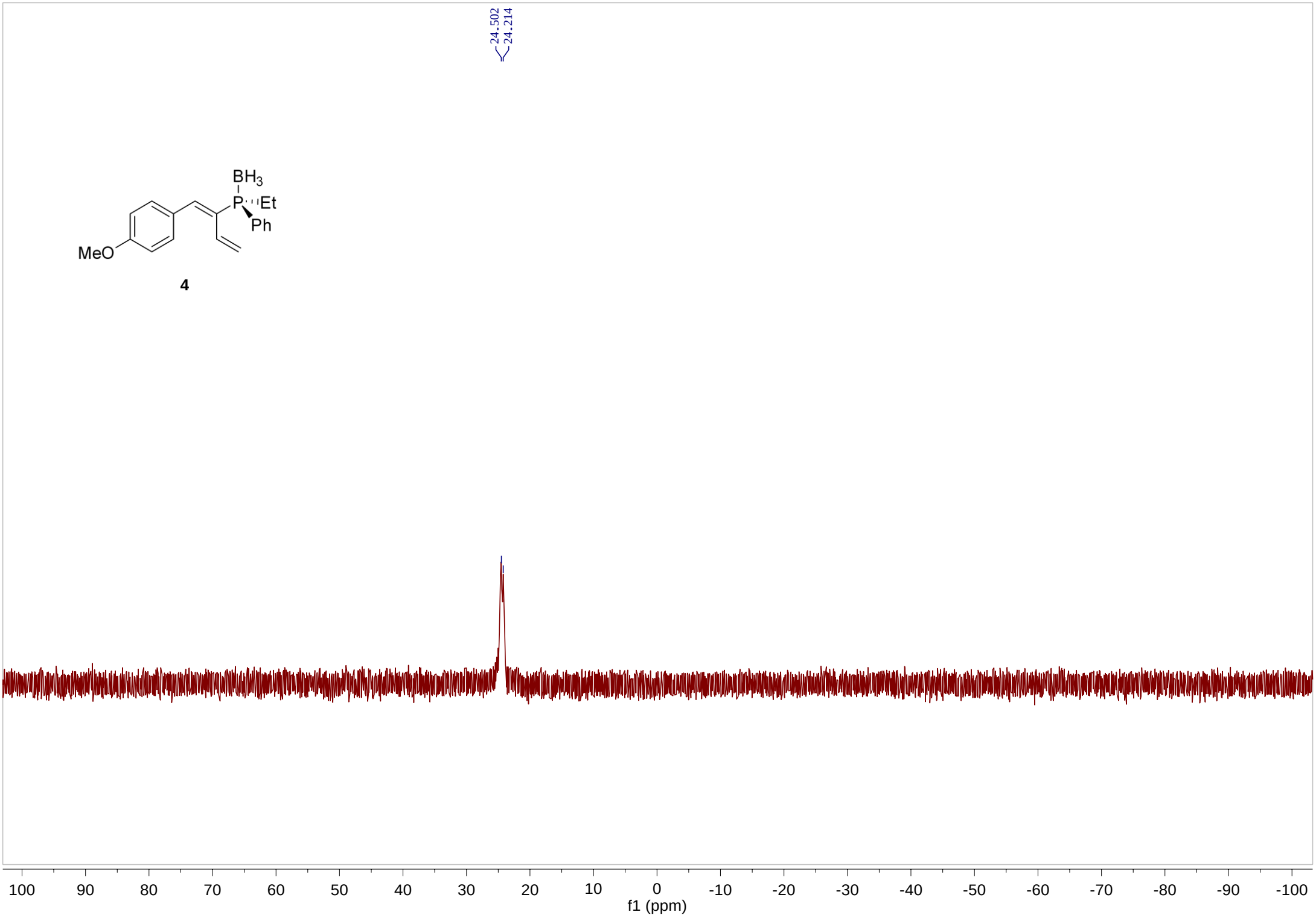
f1 (ppm)

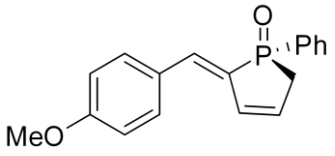

BH3
P
Et
Ph
MeO

4

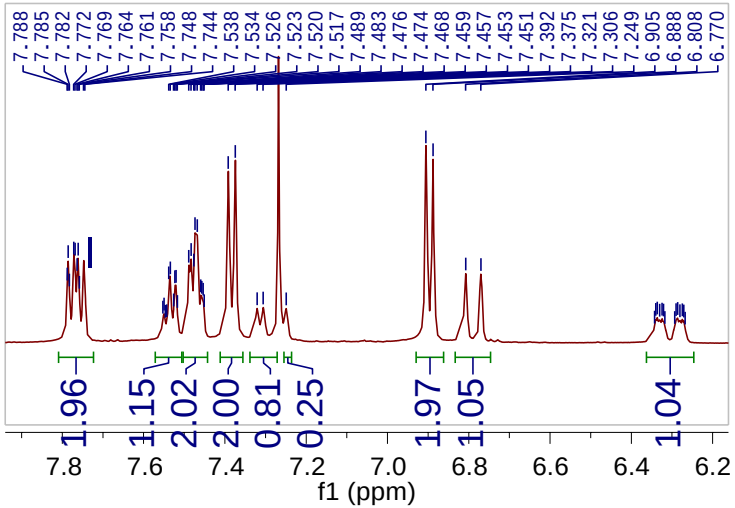
7.670
7.667
7.655
7.650
7.646
7.634
7.630
7.470
7.465
7.453
7.448
7.445
7.437
7.433
7.408
7.367
6.906
6.889
6.588
6.565
6.553
6.541
6.529
6.505
5.237
5.214
5.119
5.083
3.837
2.310
2.295
2.280
2.267
2.253
2.241
2.237
2.226
2.211
2.172
2.156
2.140
2.125
2.112
2.096
2.081
1.197
1.182
1.167
1.162
1.147
1.131
1.027
1.011
1.007
0.996
0.992
0.978
0.972
0.963
0.956
0.941
0.928
0.893
0.880
0.866
0.860
0.843
0.828
0.807
2.12
5.10
1.22
2.21
1.16
1.10
1.13
3.00
1.27
1.21
3.44
3.23
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)

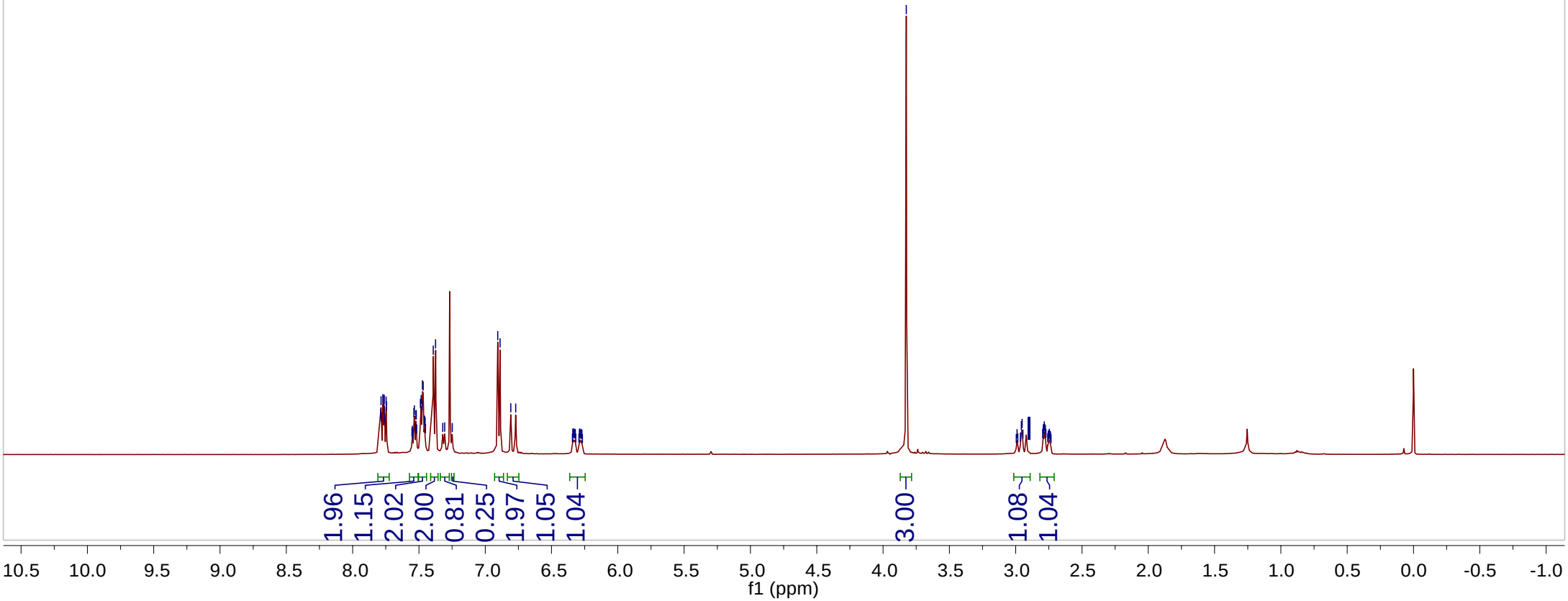

160.046
144.811
144.677
131.786
131.460
131.392
130.652
130.634
130.562
130.126
129.797
129.084
128.738
128.661
128.445
128.309
125.413
125.029
119.961
119.922
113.695
55.324
16.296
15.989
6.929
BH3
P
Et
Ph
MeO
4
f1 (ppm)

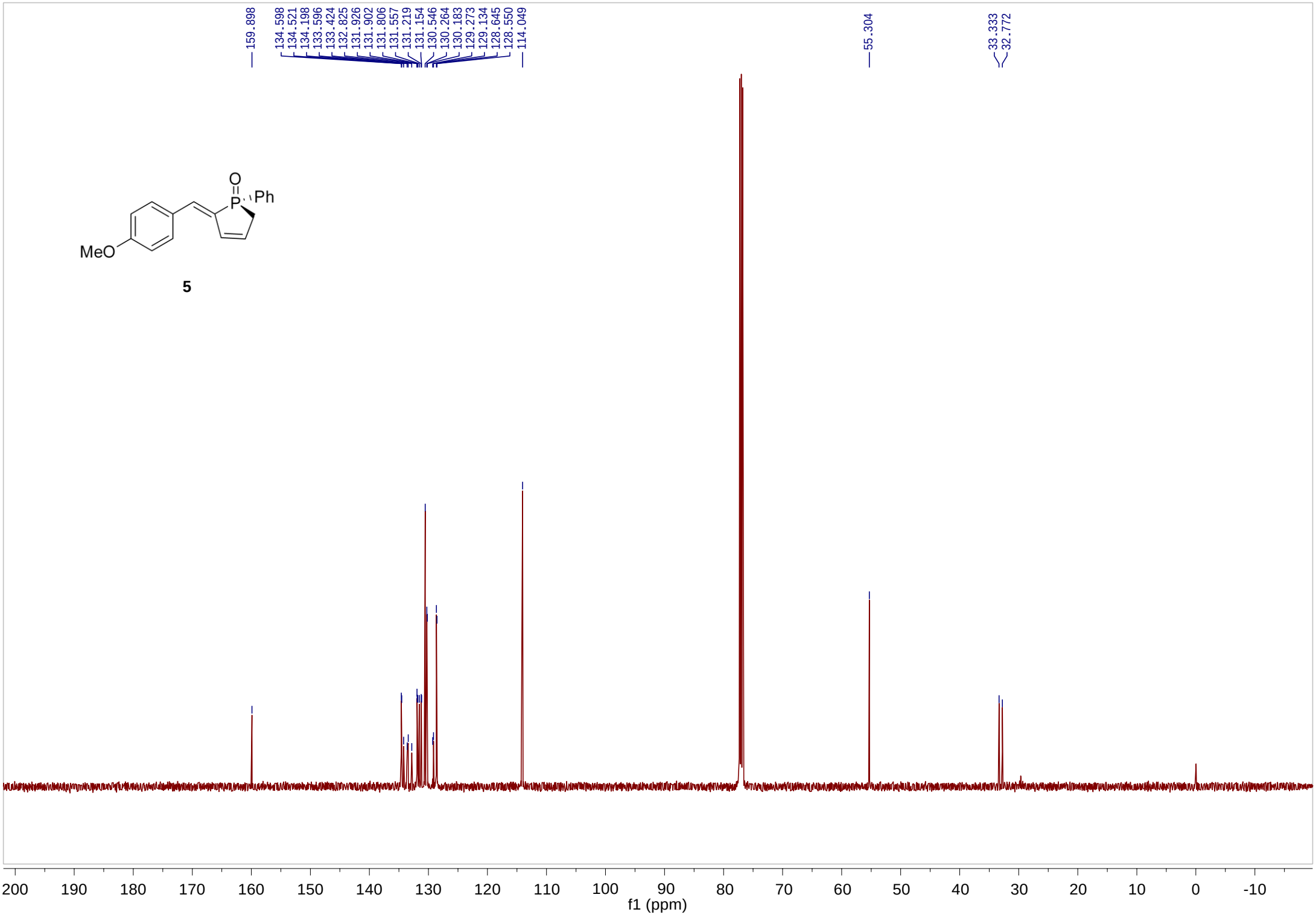

24.502
24.214
BH3
P
Et
Ph
MeO
4
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
f1 (ppm)

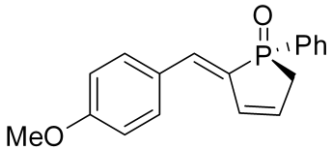

O
P
Ph
MeO

5


1.96
1.15
2.02
2.00
0.81
0.25
1.97
1.05
1.04
f1 (ppm)

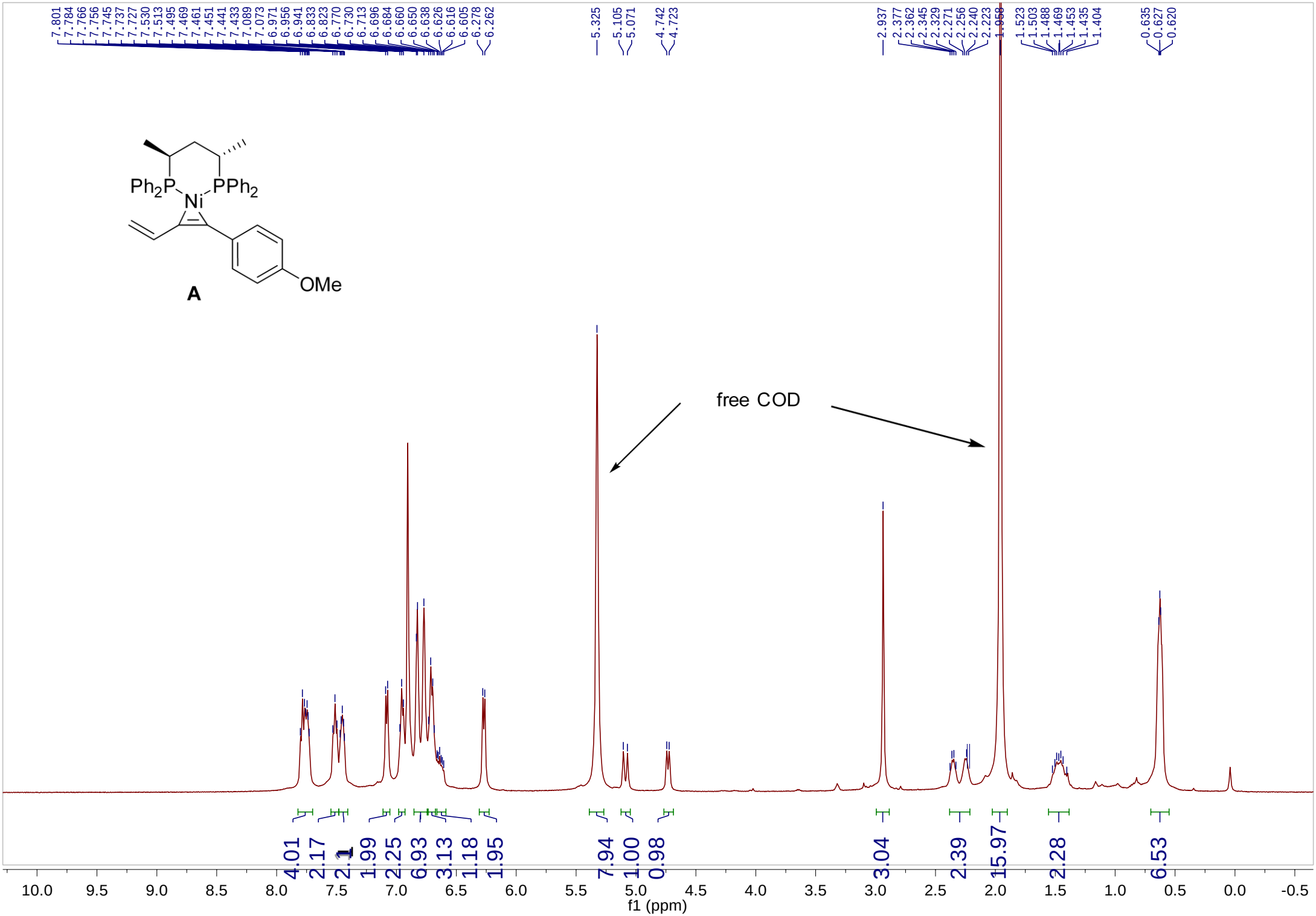

1.96
1.15
2.02
2.00
0.81
0.25
1.97
1.05
1.04
3.00
1.08
1.04
f1 (ppm)

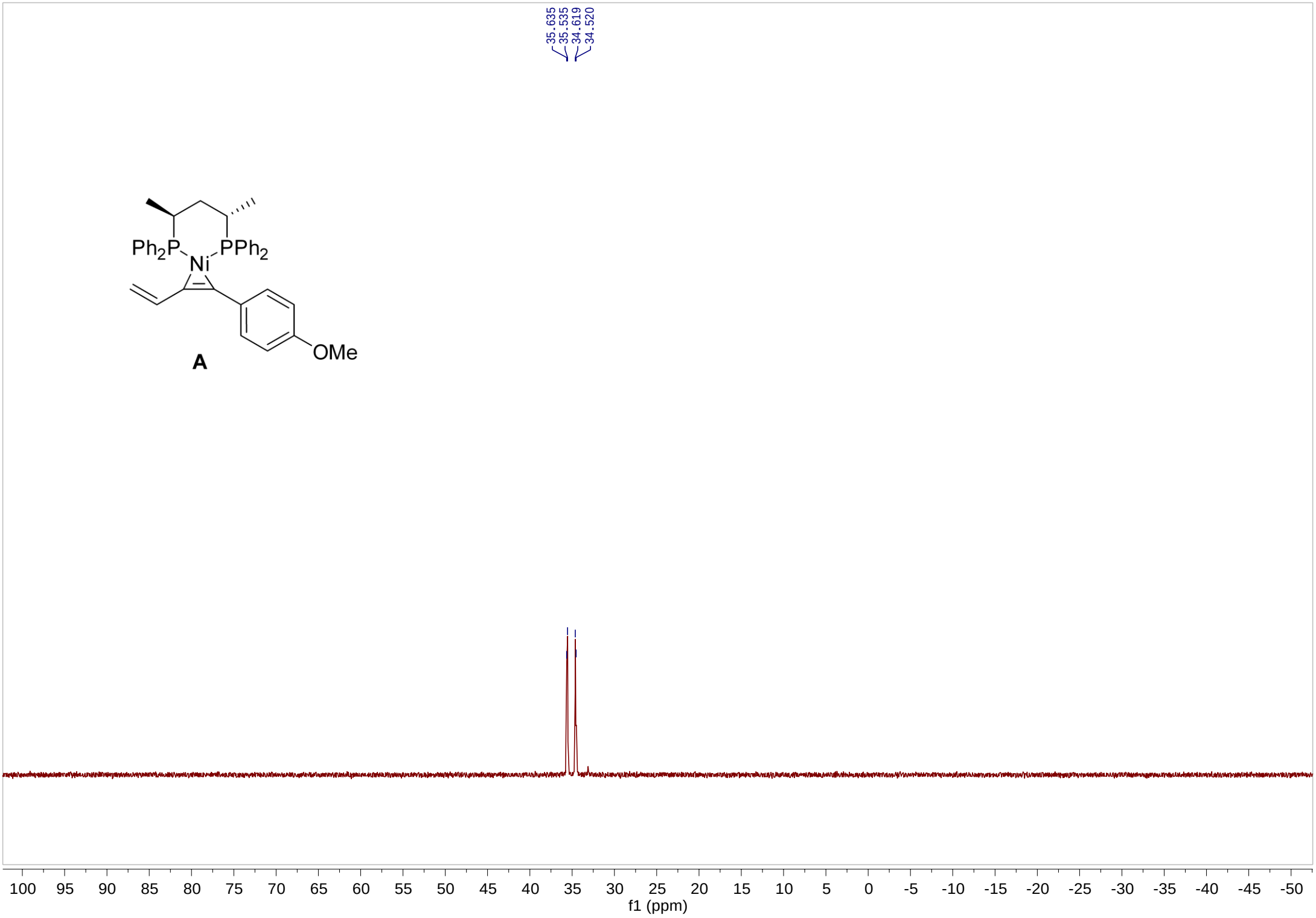

159.898
134.598
134.521
134.198
133.596
133.424
132.825
131.926
131.902
131.806
131.557
131.219
131.154
130.546
130.264
130.183
129.273
129.134
128.645
128.550
114.049
55.304
33.333
32.772
O
P
Ph
MeO
5
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

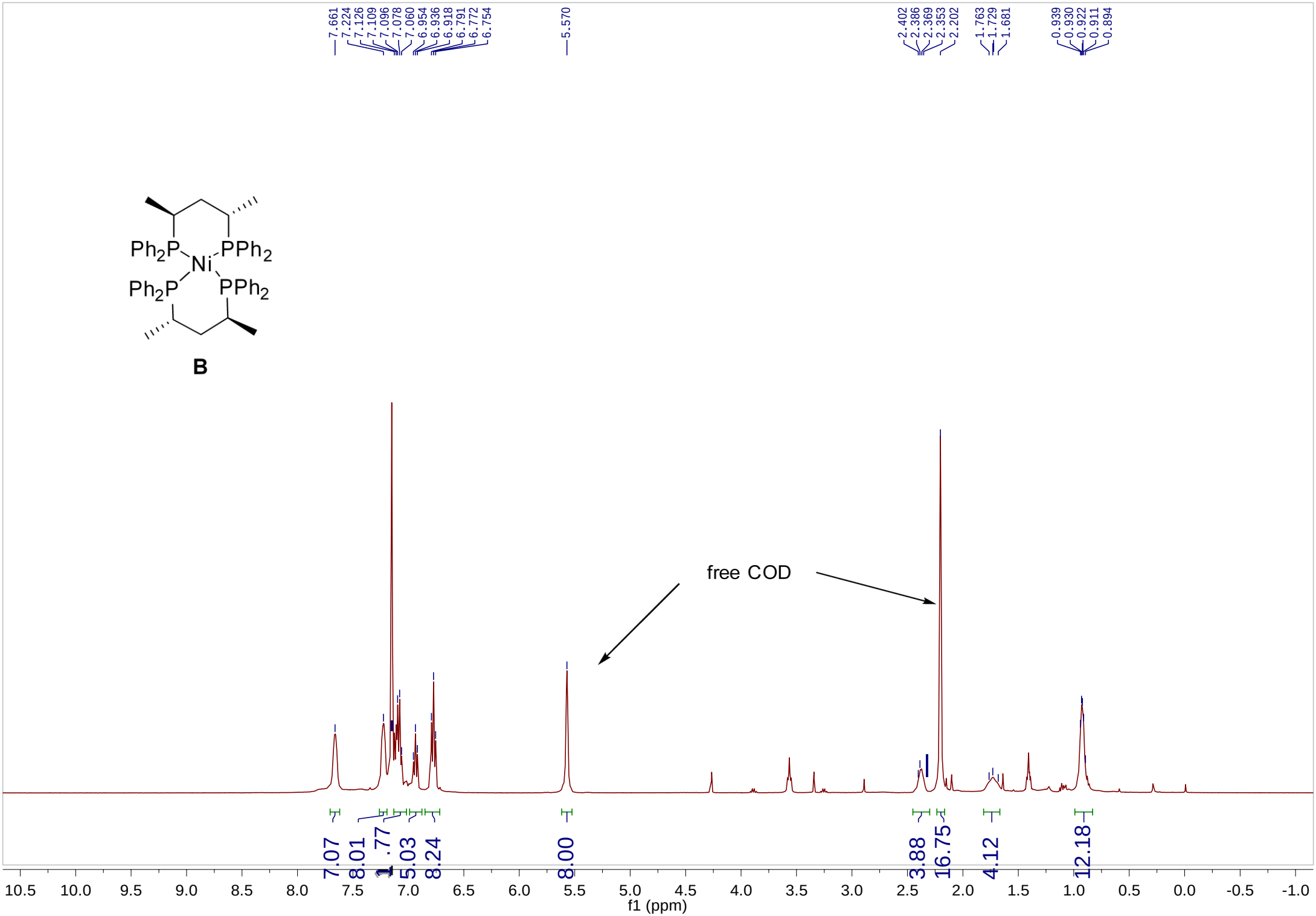

O
P
Ph
MeO

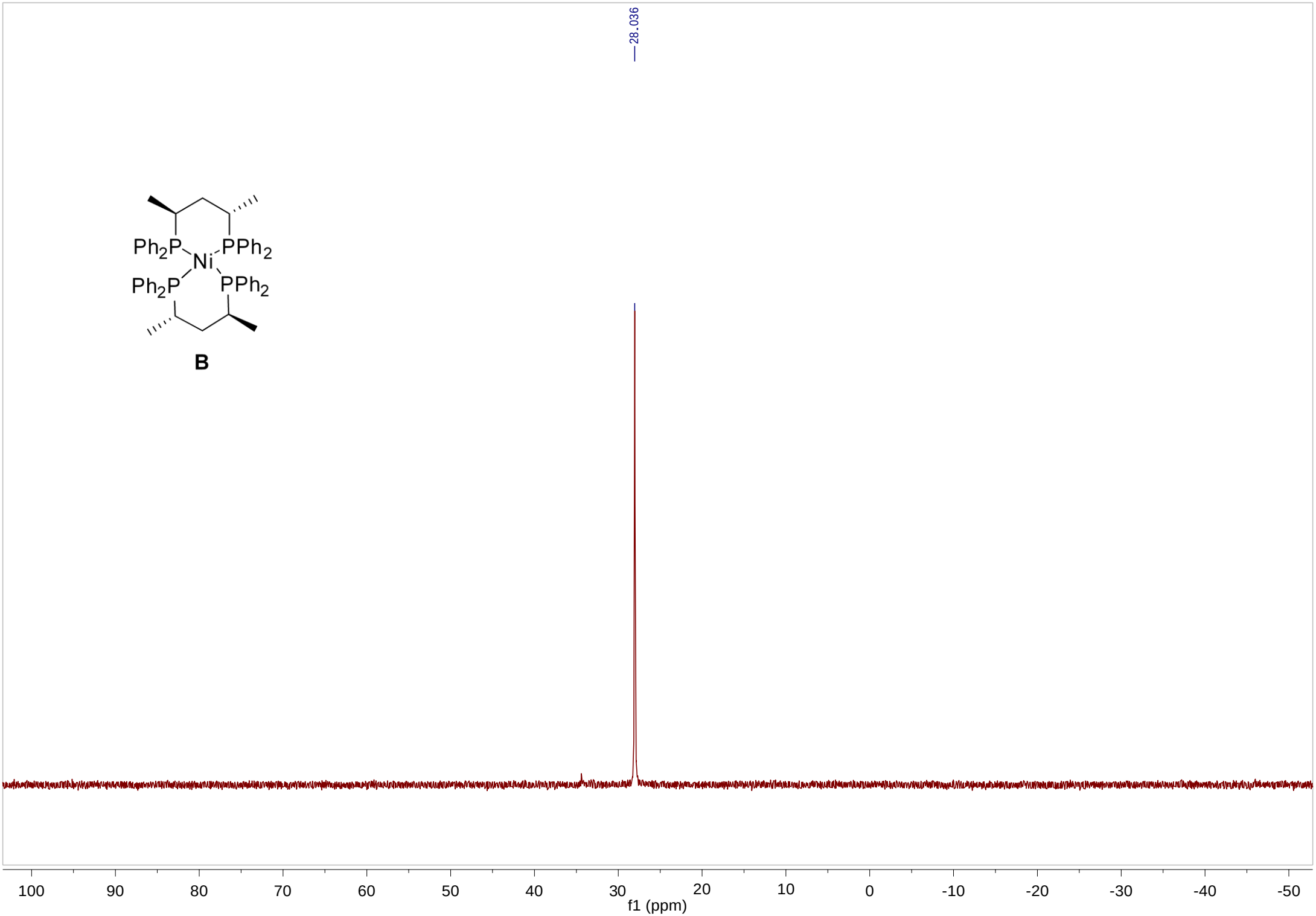
5

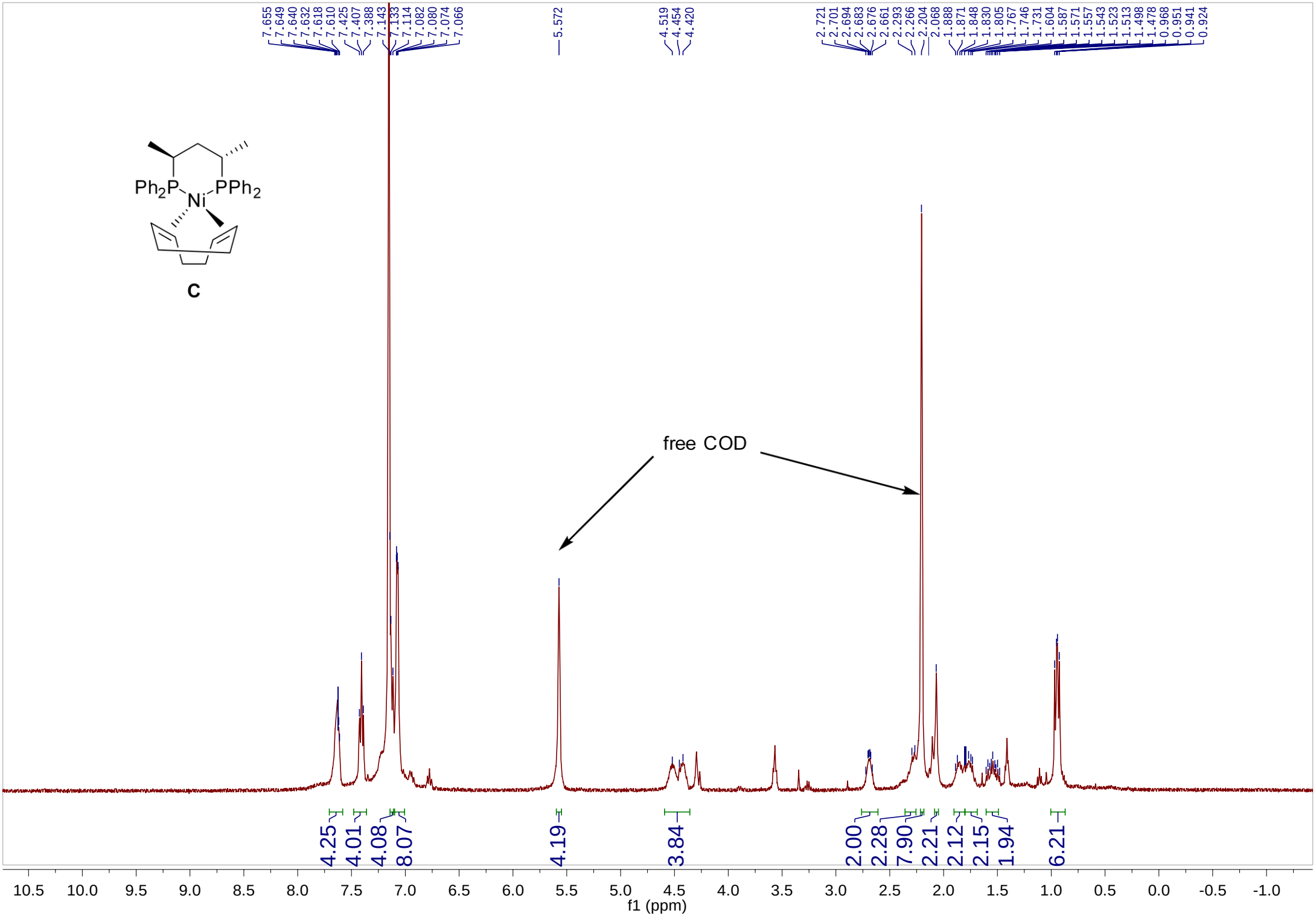
45.359
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50
f1 (ppm)

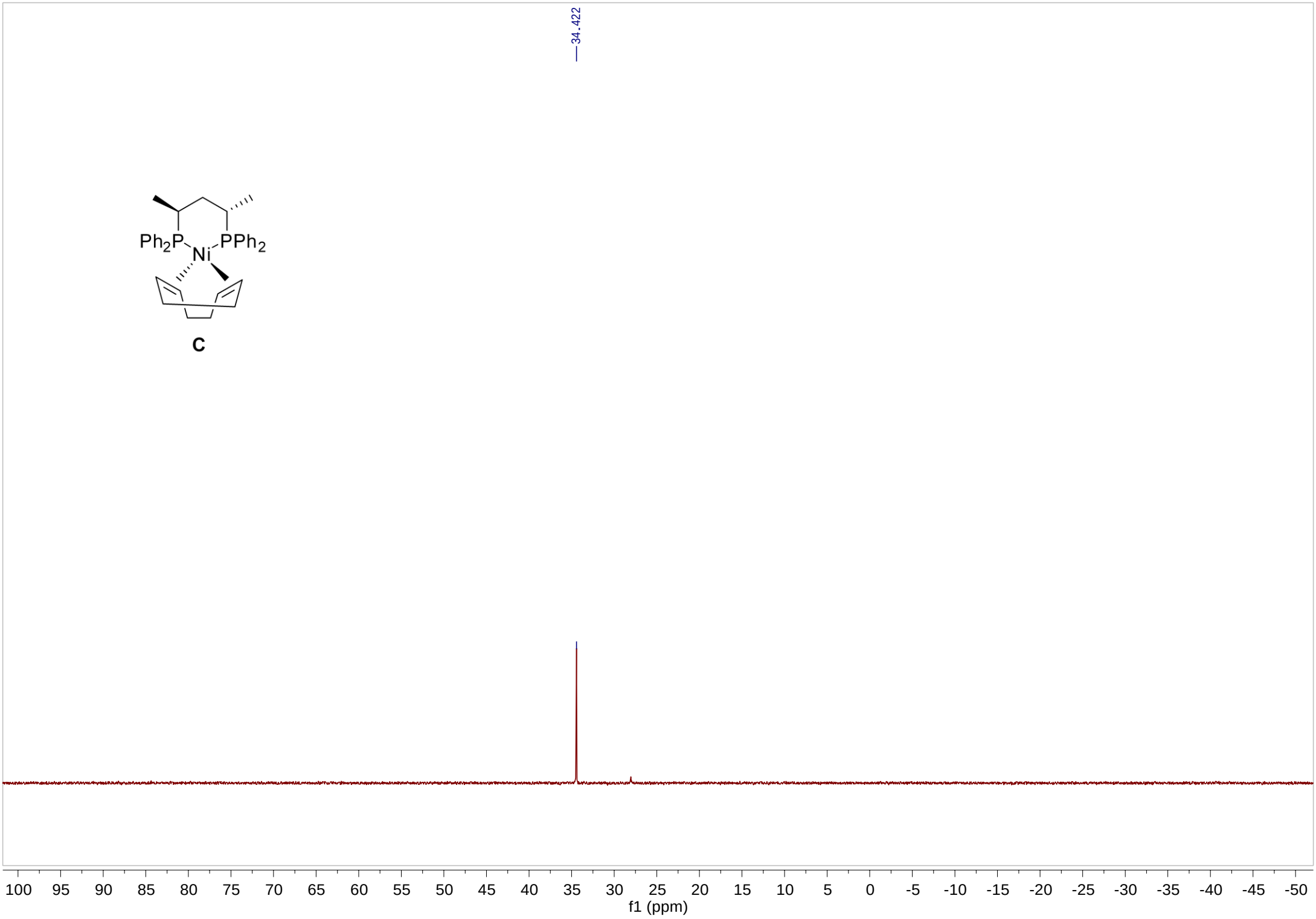

7.801
7.784
7.766
7.756
7.745
7.737
7.727
7.530
7.513
7.495
7.469
7.461
7.451
7.441
7.433
7.089
7.073
6.971
6.956
6.941
6.833
6.823
6.770
6.730
6.713
6.696
6.684
6.660
6.650
6.638
6.626
6.616
6.605
6.278
6.262
5.325
5.105
5.071
4.742
4.723
2.937
2.377
2.362
2.345
2.329
2.271
2.256
2.240
2.223
1.958
1.523
1.503
1.488
1.469
1.453
1.435
1.404
0.635
0.627
0.620
Ph2P
Ni
PPh2
OMe
A
free COD
4.01
2.17
2.11
1.99
2.25
6.93
3.13
1.18
1.95
7.94
1.00
0.98
3.04
2.39
15.97
2.28
6.53
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


35.635
35.535
34.619
34.520
Ph2P
Ni
PPh2
OMe
A
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50
f1 (ppm)

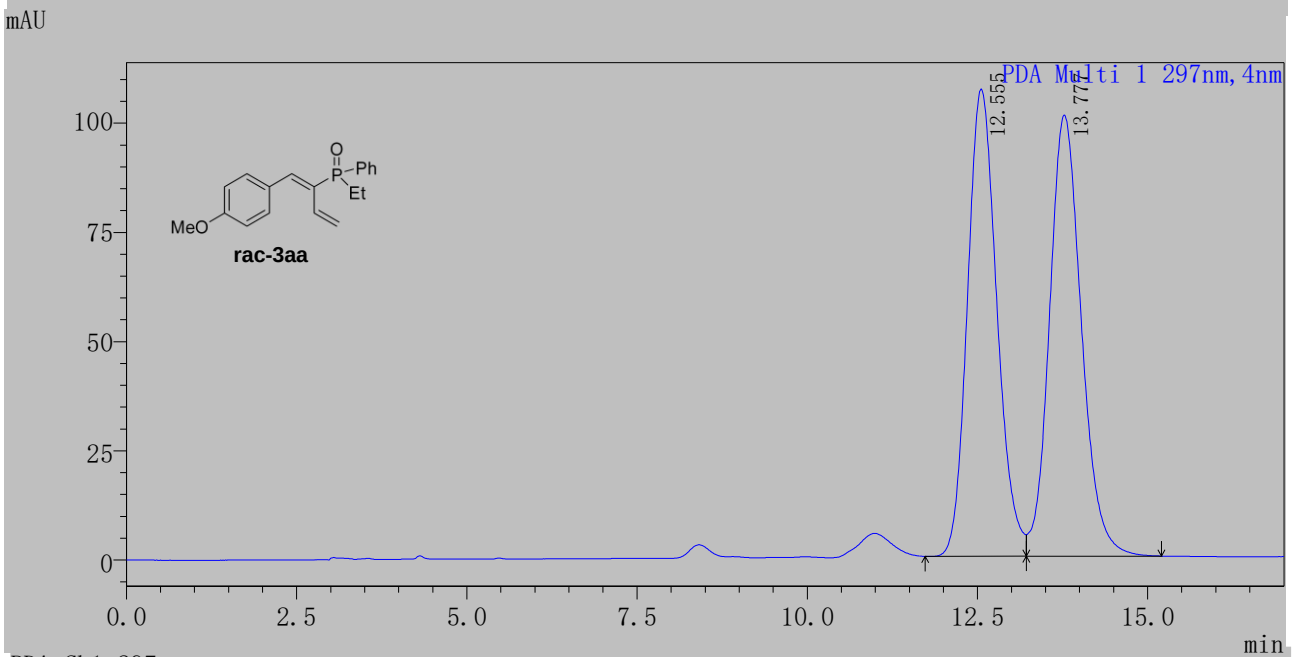

7.661
7.224
7.126
7.109
7.096
7.078
7.060
6.954
6.936
6.918
6.791
6.772
6.754
5.570
2.402
2.386
2.369
2.353
2.202
1.763
1.729
1.681
0.939
0.930
0.922
0.911
0.894
Ph2P
Ni
PPh2
Ph2P
PPh2
B
free COD
7.07
8.01
1.77
5.03
8.24
8.00
3.88
16.75
4.12
12.18
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)


28.036
Ph2P
Ni
PPh2
Ph2P
PPh2
B
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
f1 (ppm)


7.655
7.649
7.640
7.632
7.618
7.610
7.425
7.407
7.388
7.143
7.133
7.114
7.082
7.080
7.074
7.066
5.572
4.519
4.454
4.420
2.721
2.701
2.694
2.683
2.676
2.661
2.293
2.266
2.204
2.068
1.888
1.871
1.848
1.830
1.805
1.767
1.746
1.731
1.604
1.587
1.571
1.557
1.543
1.523
1.513
1.498
1.478
0.968
0.951
0.941
0.924
Ph2P
Ni
PPh2
C
free COD
4.25
4.01
4.08
8.07
4.19
3.84
2.00
2.28
7.90
2.21
2.12
2.15
1.94
6.21
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)


34.422
Ph2P
Ni
PPh2
C
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50
f1 (ppm)

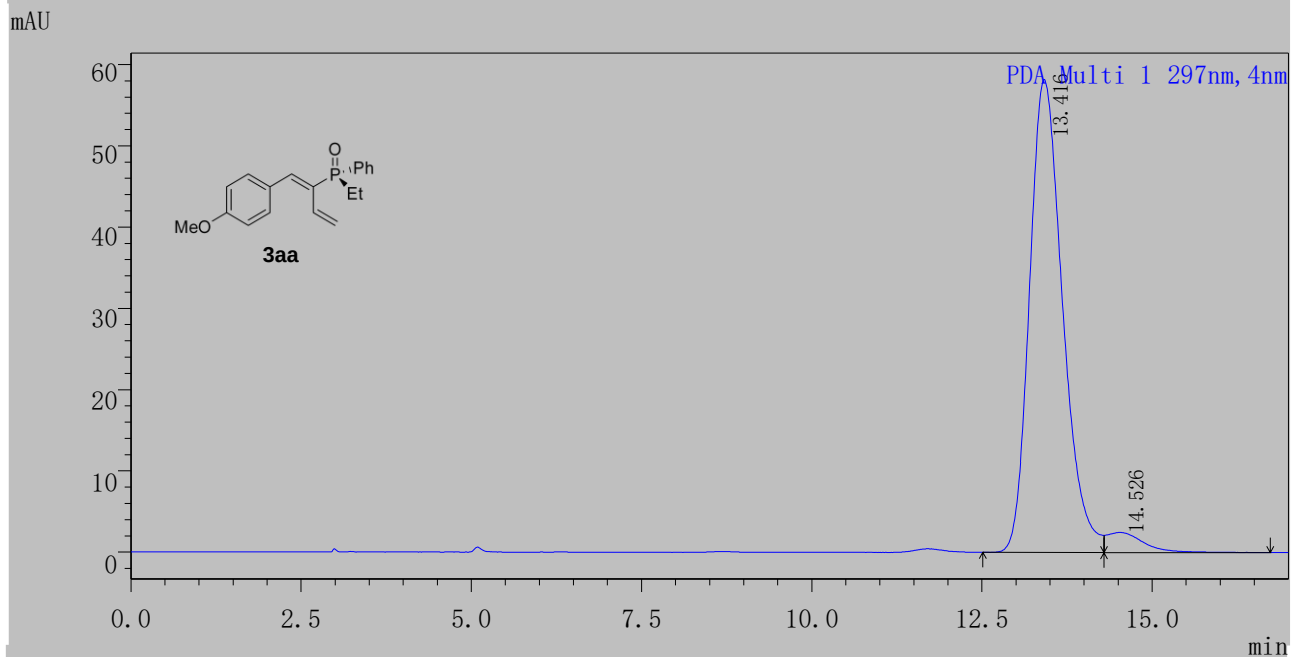
Chromatogram



PDA Ch1 297nm

Peak#	Ret. Time	Area	Area%
1	12.555	3216473	49.388
2	13.777	3296123	50.612
Total		6512596	100.000

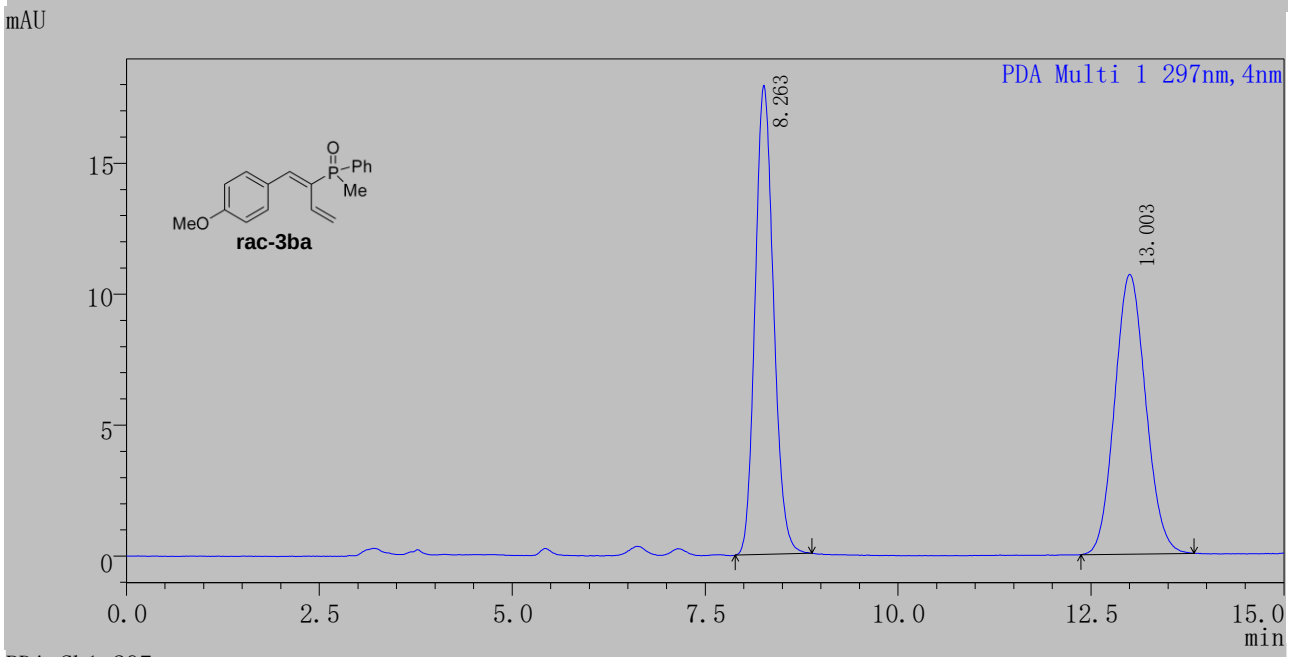
Chromatogram



PDA Ch1 297nm

Peak#	Ret. Time	Area	Area%
1	13.416	1965438	95.503
2	14.526	92551	4.497
Total		2057989	100.000

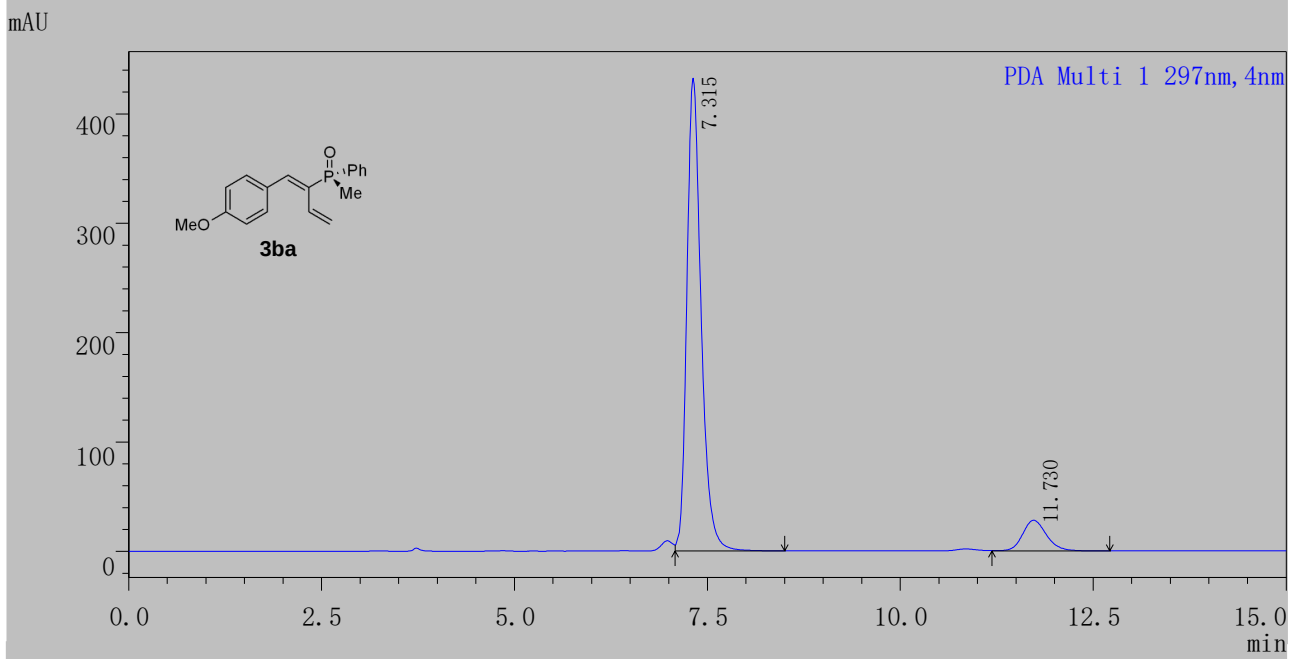
Chromatogram



PDA Ch1 297nm

Peak#	Ret. Time	Area	Area%
1	8.263	297537	49.869
2	13.003	299102	50.131
Total		596638	100.000

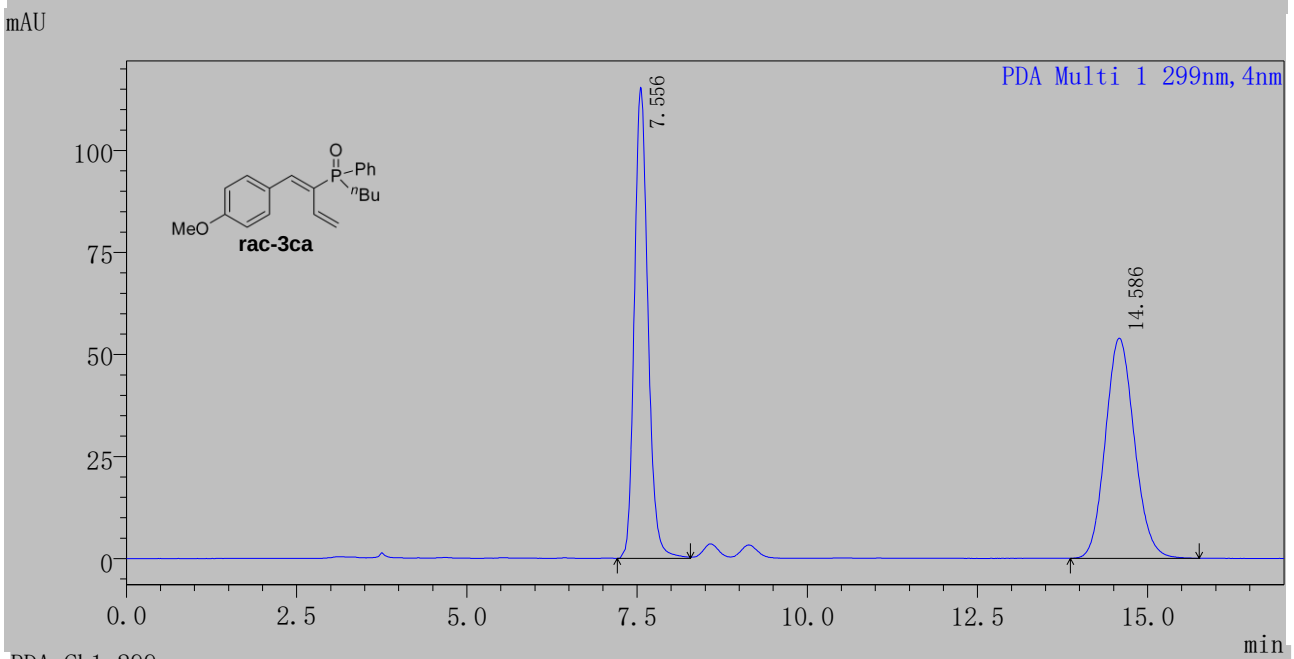
Chromatogram



PDA Ch1 297nm

Peak#	Ret. Time	Area	Area%
1	7.315	5531584	90.137
2	11.730	605299	9.863
Total		6136883	100.000

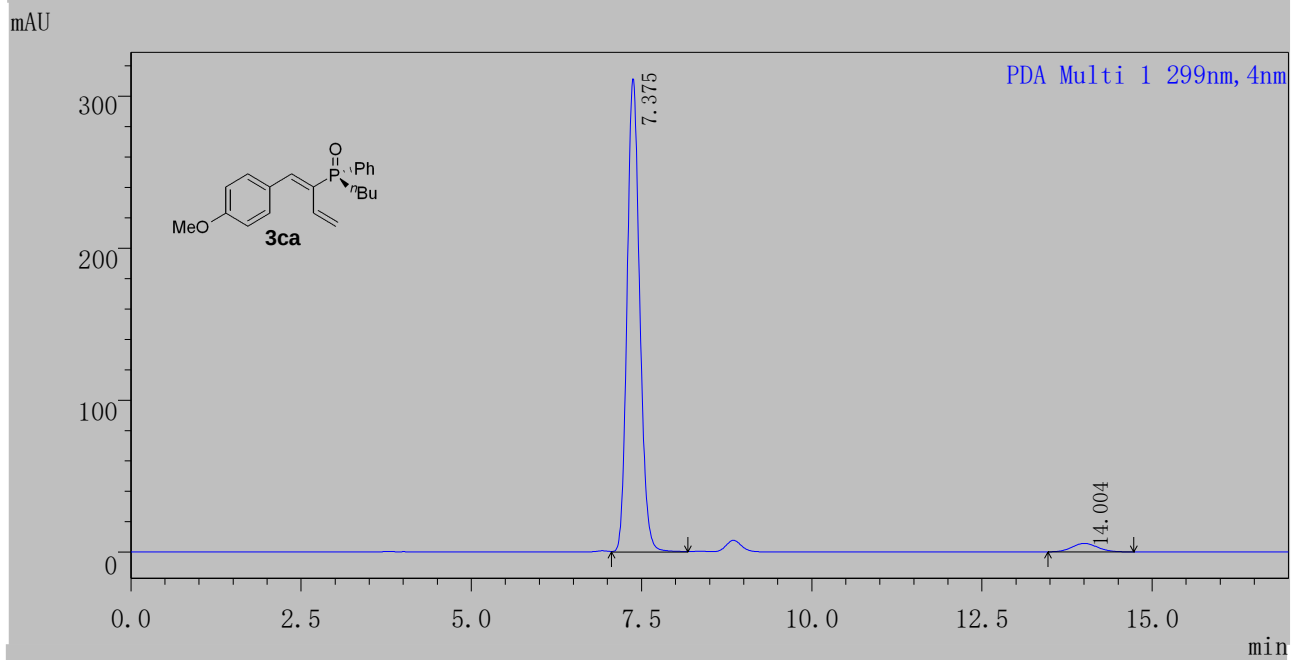
Chromatogram



PDA Ch1 299nm

Peak#	Ret. Time	Area	Area%
1	7.556	1598703	50.049
2	14.586	1595564	49.951
Total		3194267	100.000

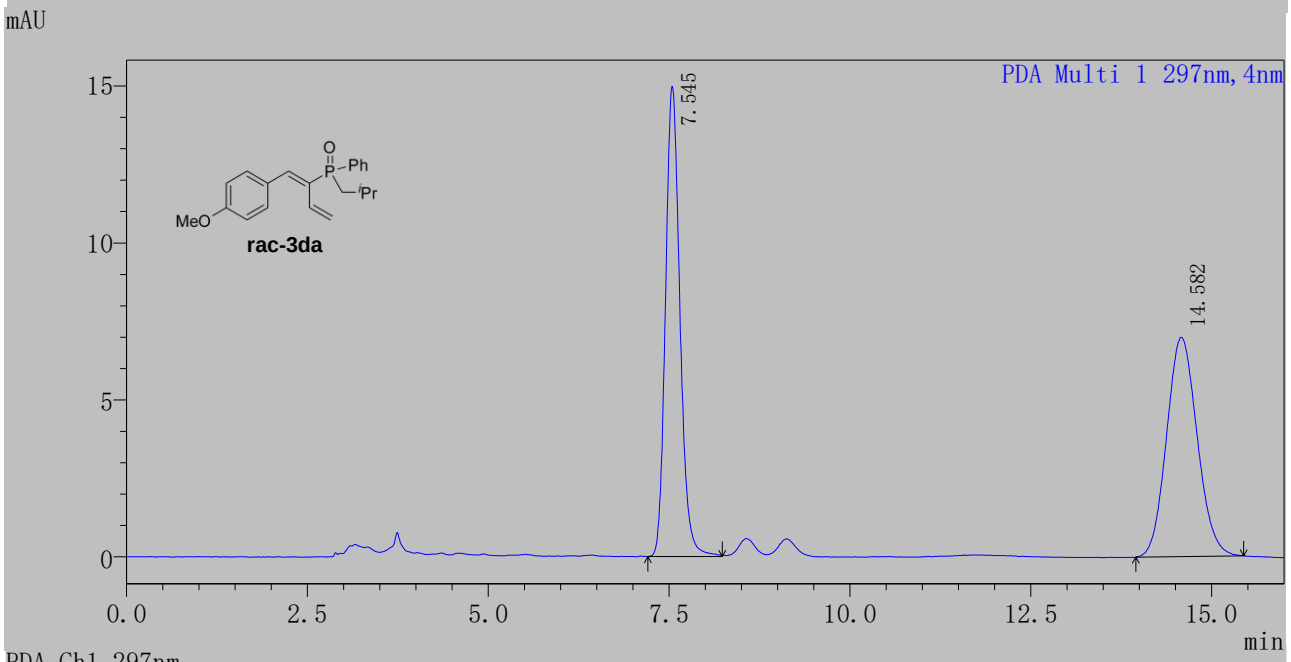
Chromatogram



PDA Ch1 299nm

Peak#	Ret. Time	Area	Area%
1	7.375	4007382	96.478
2	14.004	146291	3.522
Total		4153673	100.000

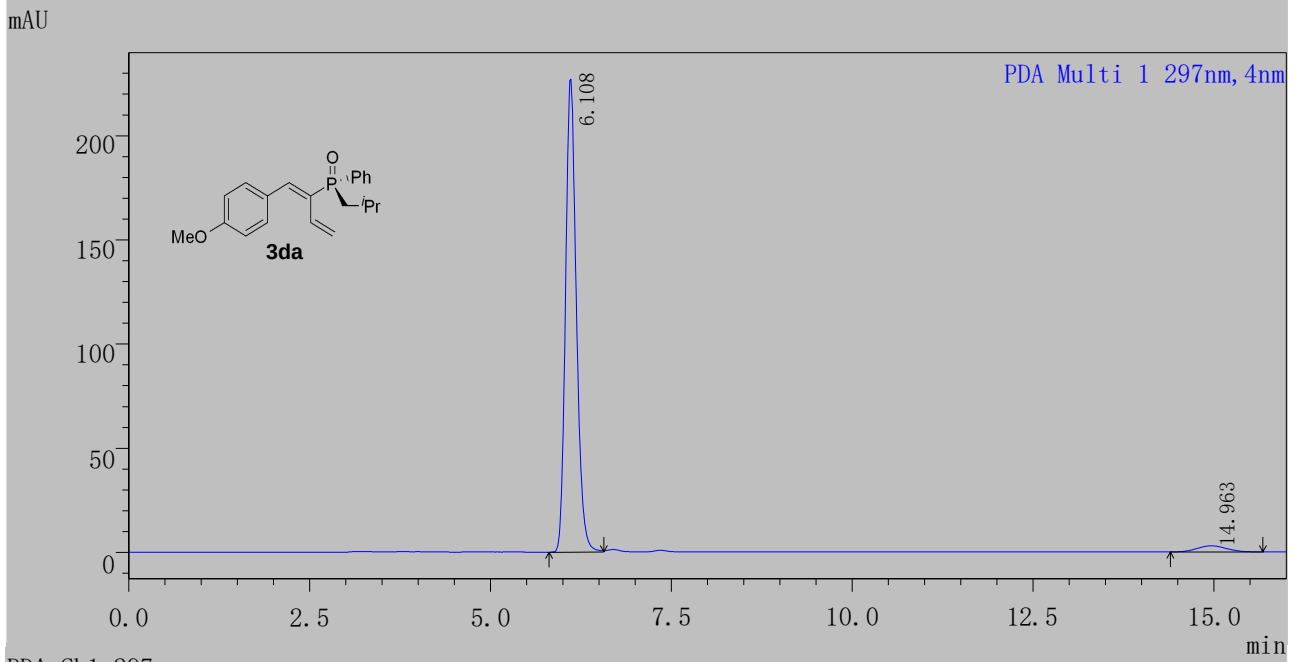
Chromatogram



PDA Ch1 297nm

Peak#	Ret. Time	Area	Area%
1	7.545	207810	50.284
2	14.582	205463	49.716
Total		413273	100.000

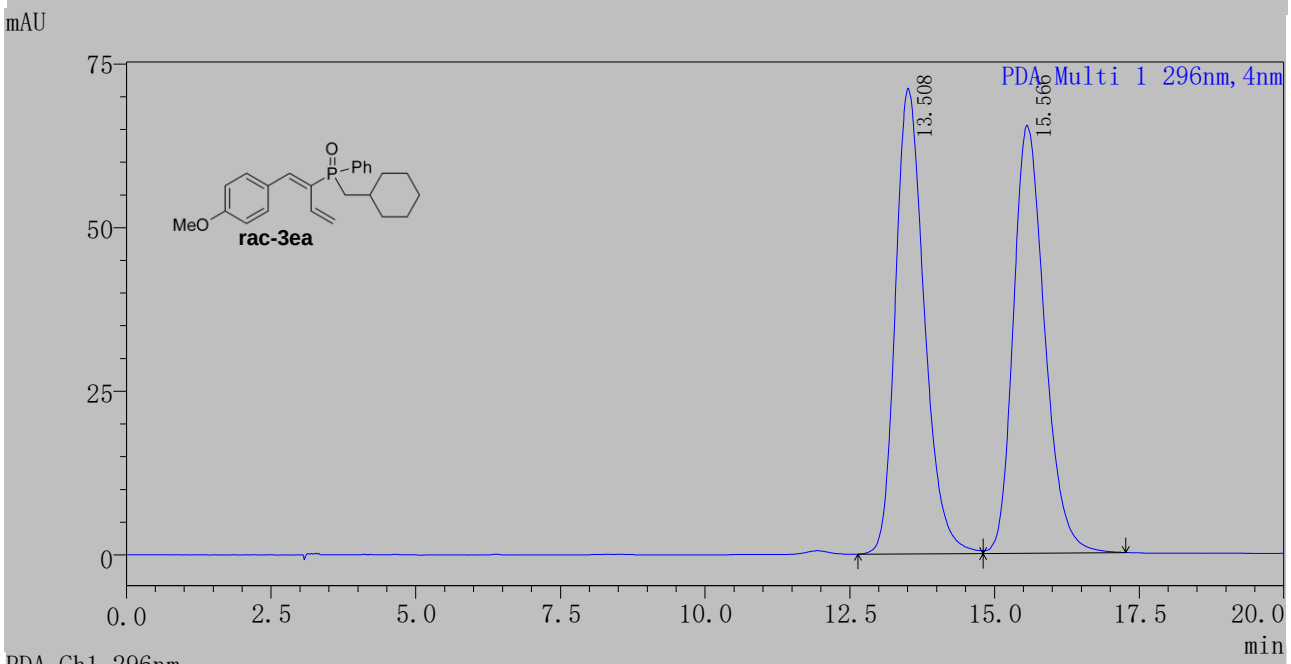
Chromatogram



PDA Ch1 297nm

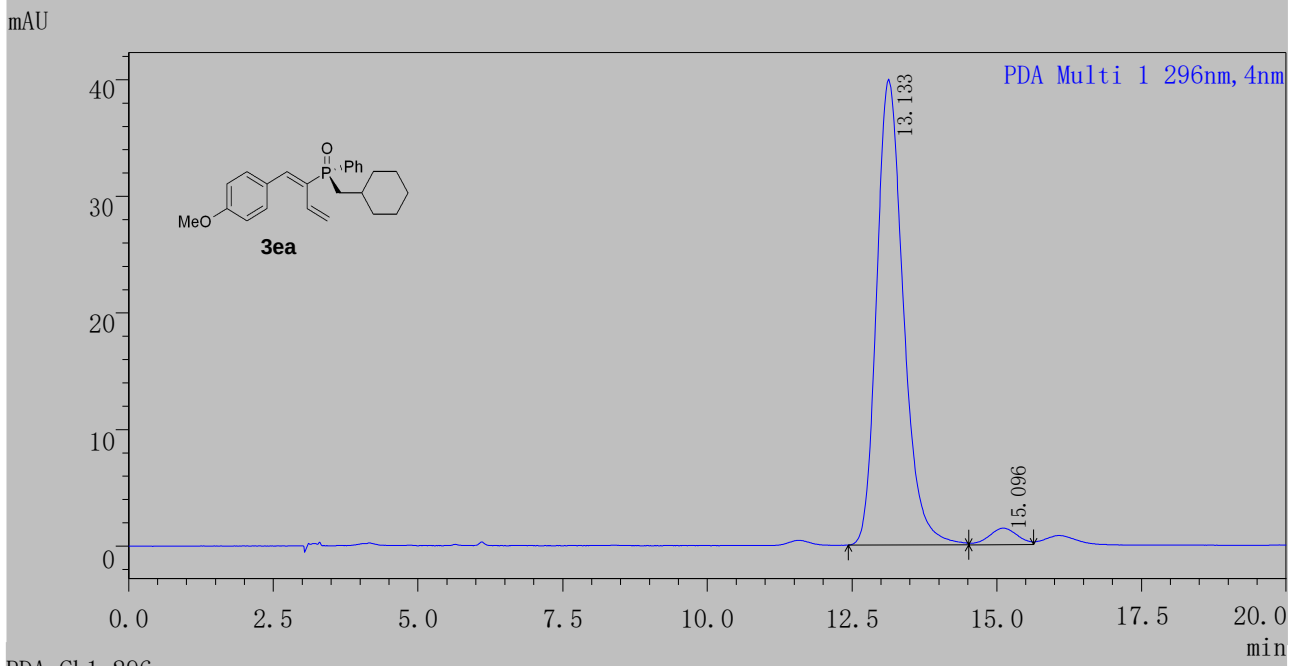
Peak#	Ret. Time	Area	Area%
1	6.108	2369362	96.545
2	14.963	84789	3.455
Total		2454151	100.000

Chromatogram



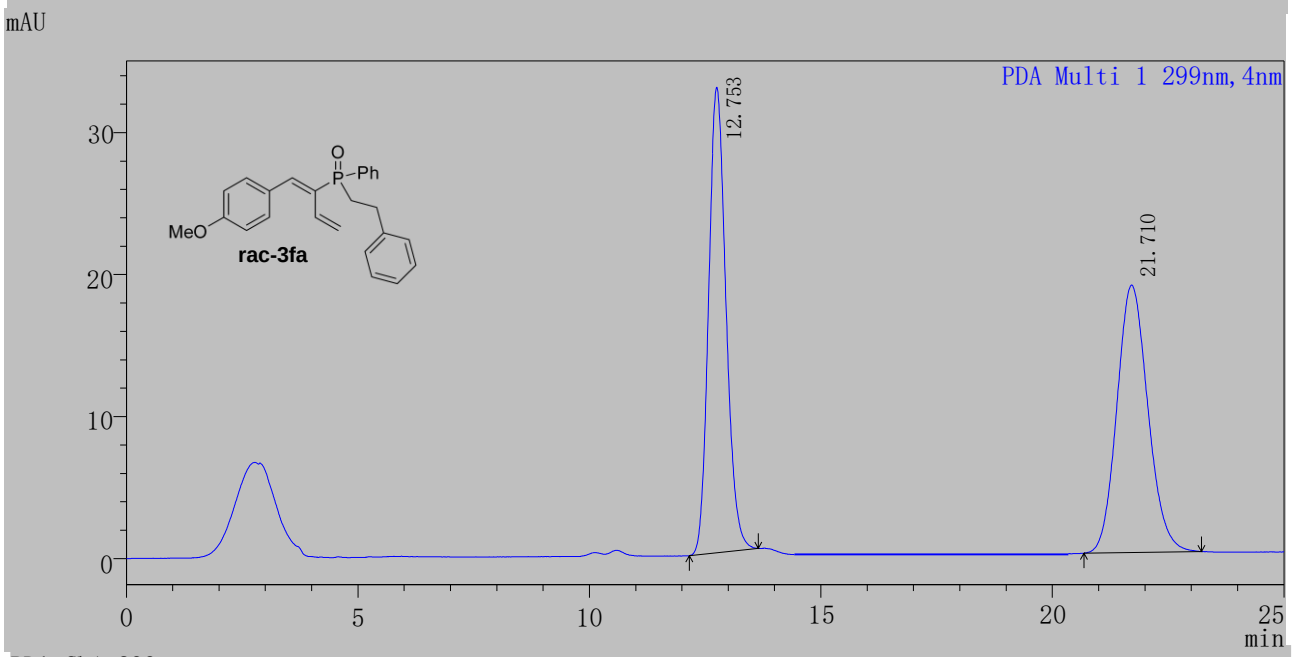
Peak#	Ret. Time	Area	Area%
1	13.508	2463290	50.054
2	15.566	2457974	49.946
Total		4921264	100.000

Chromatogram



Peak#	Ret. Time	Area	Area%
1	13.133	1278002	96.377
2	15.096	48049	3.623
Total		1326051	100.000

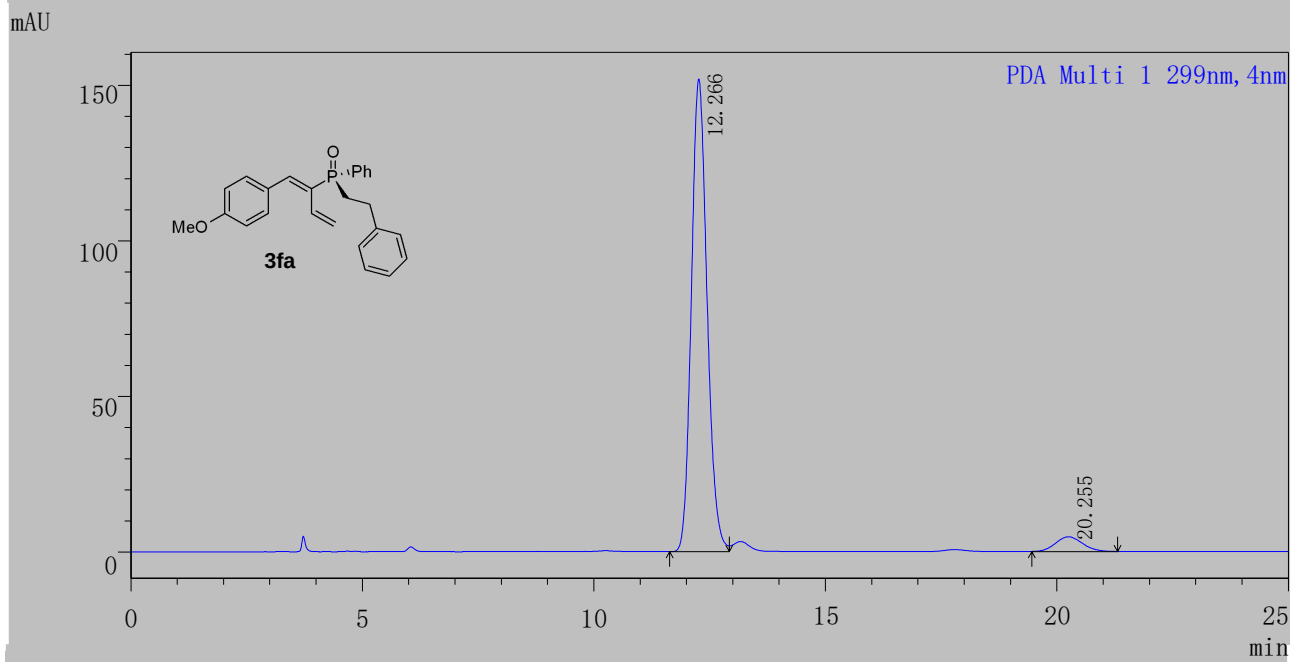
Chromatogram



PDA Ch1 299nm

Peak#	Ret. Time	Area	Area%
1	12.753	860985	49.520
2	21.710	877677	50.480
Total		1738662	100.000

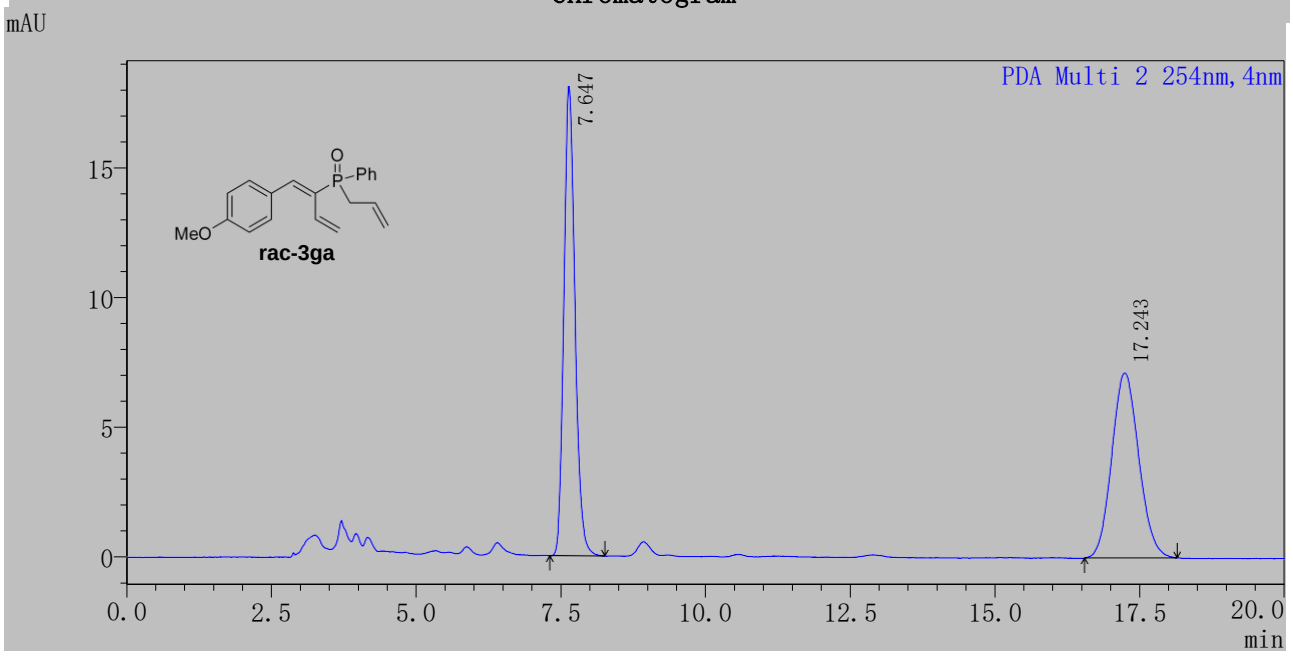
Chromatogram



PDA Ch1 299nm

Peak#	Ret. Time	Area	Area%
1	12.266	3584795	94.930
2	20.255	191454	5.070
Total		3776249	100.000

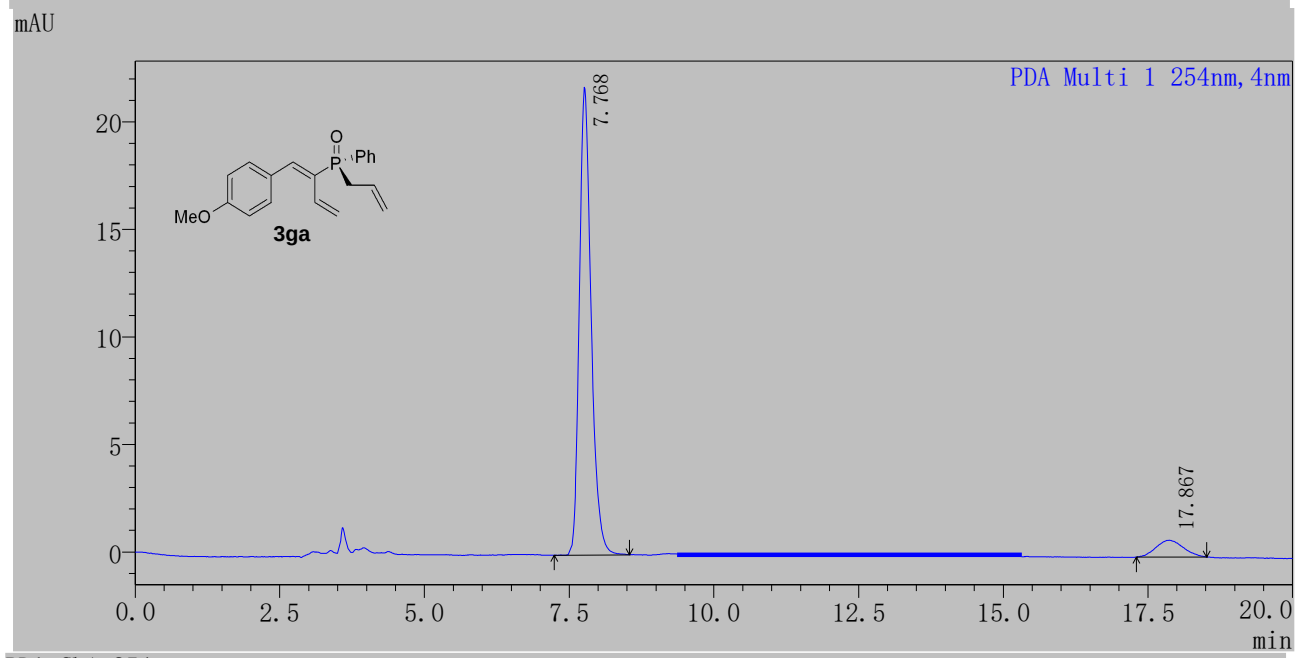
Chromatogram



PDA Ch2 254nm

Peak#	Ret. Time	Area	Area%
1	7.647	240978	51.084
2	17.243	230752	48.916
Total		471730	100.000

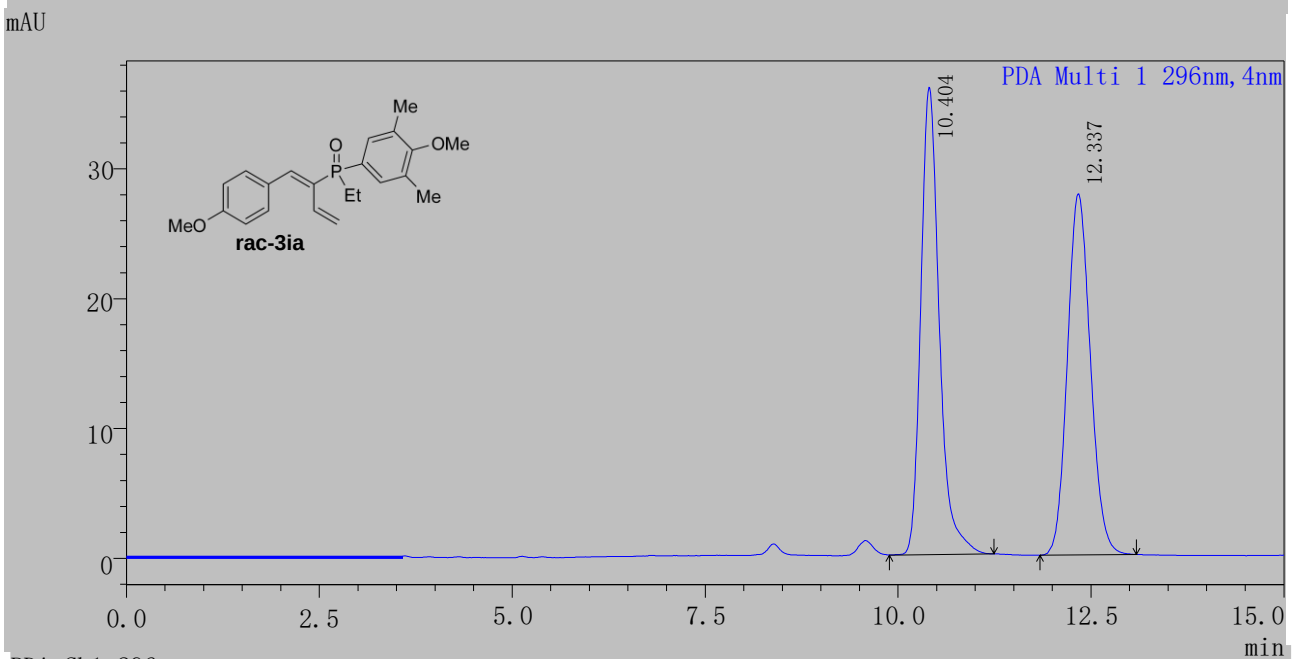
Chromatogram



PDA Ch1 254nm

Peak#	Ret. Time	Area	Area%
1	7.768	307909	92.384
2	17.867	25383	7.616
Total		333292	100.000

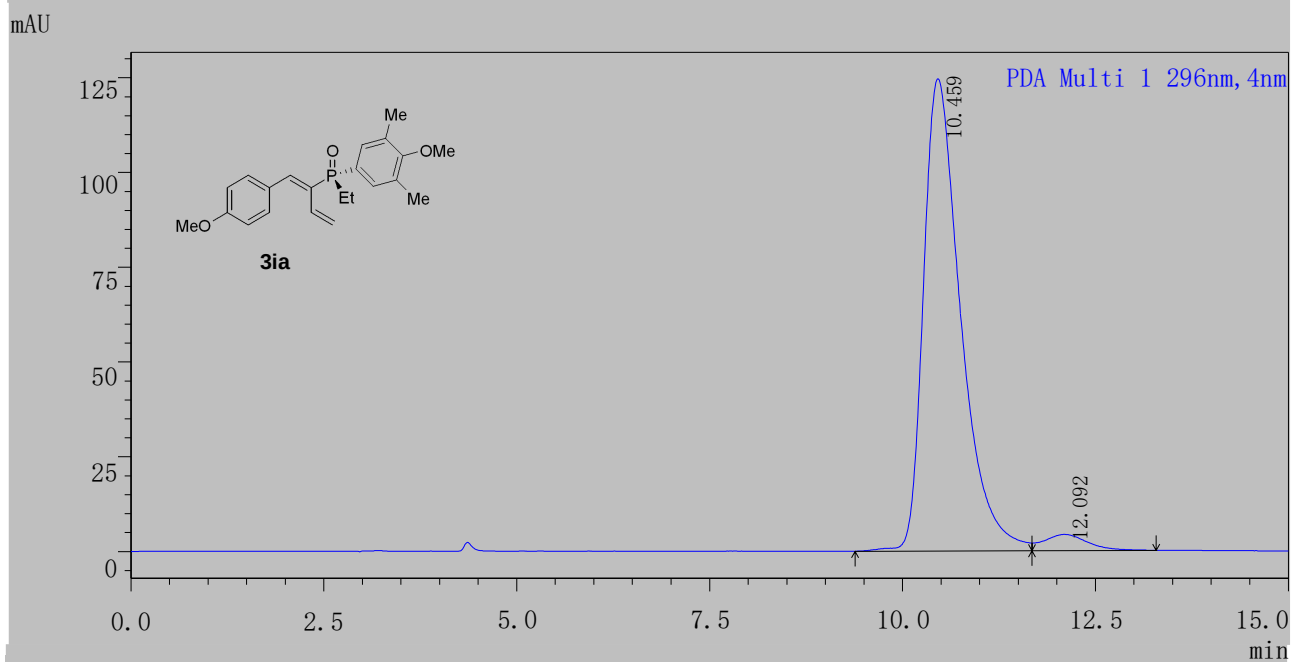
Chromatogram



PDA Ch1 296nm

Peak#	Ret. Time	Area	Area%
1	10.404	599850	50.988
2	12.337	576599	49.012
Total		1176450	100.000

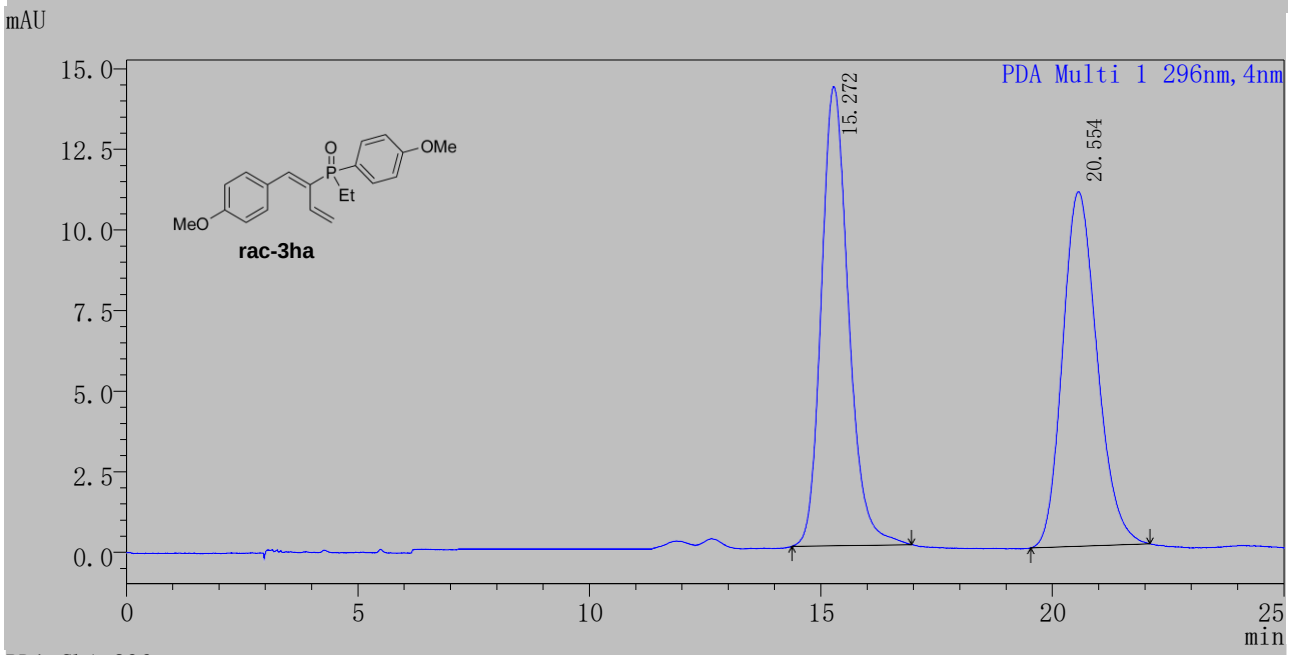
Chromatogram



PDA Ch1 296nm

Peak#	Ret. Time	Area	Area%
1	10.459	4175577	96.158
2	12.092	166845	3.842
Total		4342421	100.000

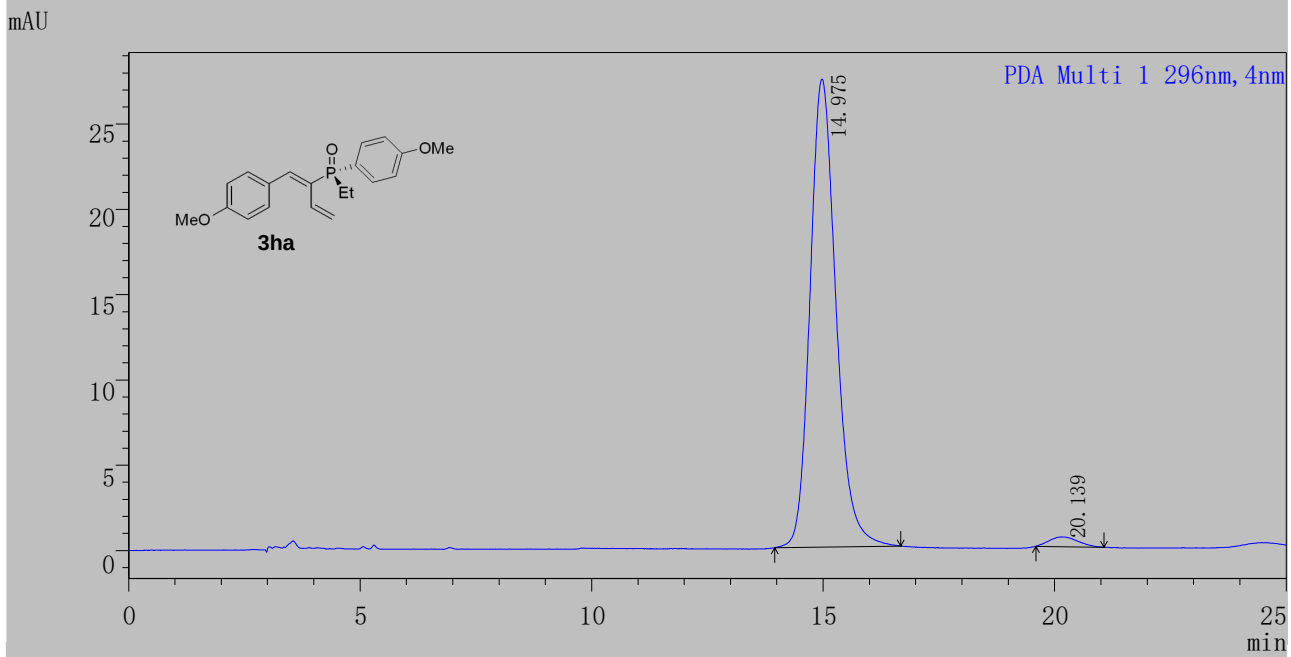
Chromatogram



PDA Ch1 296nm

Peak#	Ret. Time	Area	Area%
1	15.272	580456	50.446
2	20.554	570184	49.554
Total		1150640	100.000

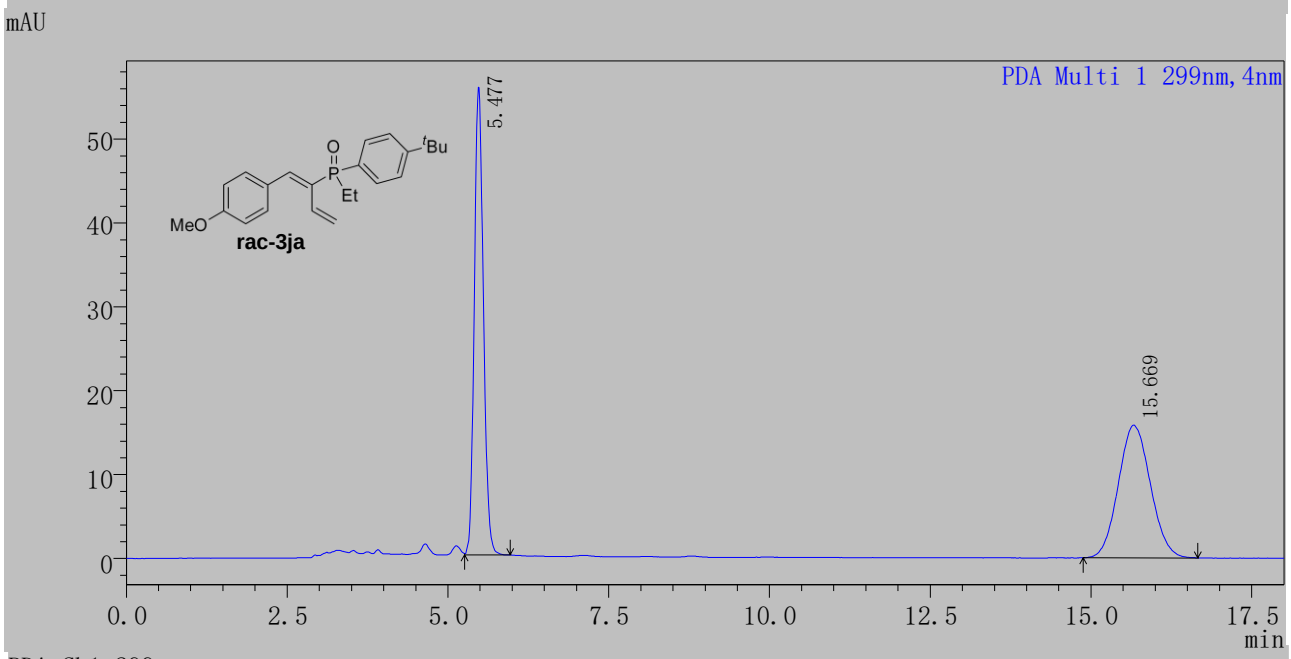
Chromatogram



PDA Ch1 296nm

Peak#	Ret. Time	Area	Area%
1	14.975	1071506	97.719
2	20.139	25007	2.281
Total		1096513	100.000

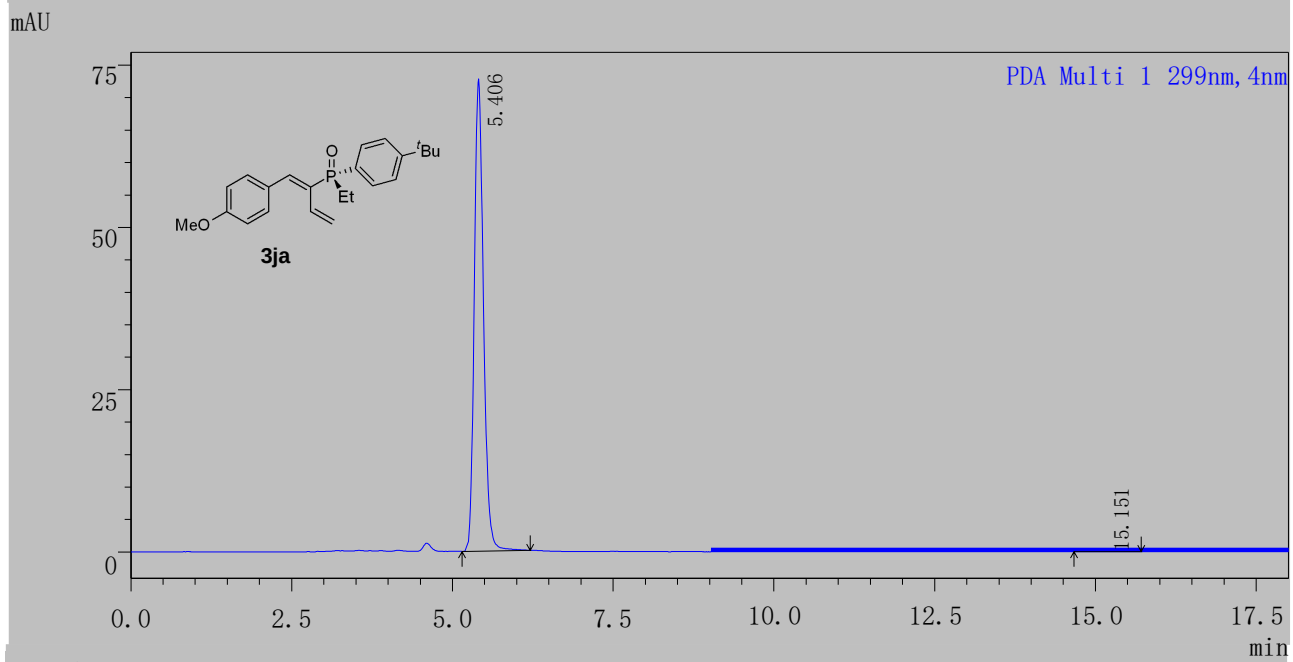
Chromatogram



PDA Ch1 299nm

Peak#	Ret. Time	Area	Area%
1	5.477	550109	50.005
2	15.669	550004	49.995
Total		1100113	100.000

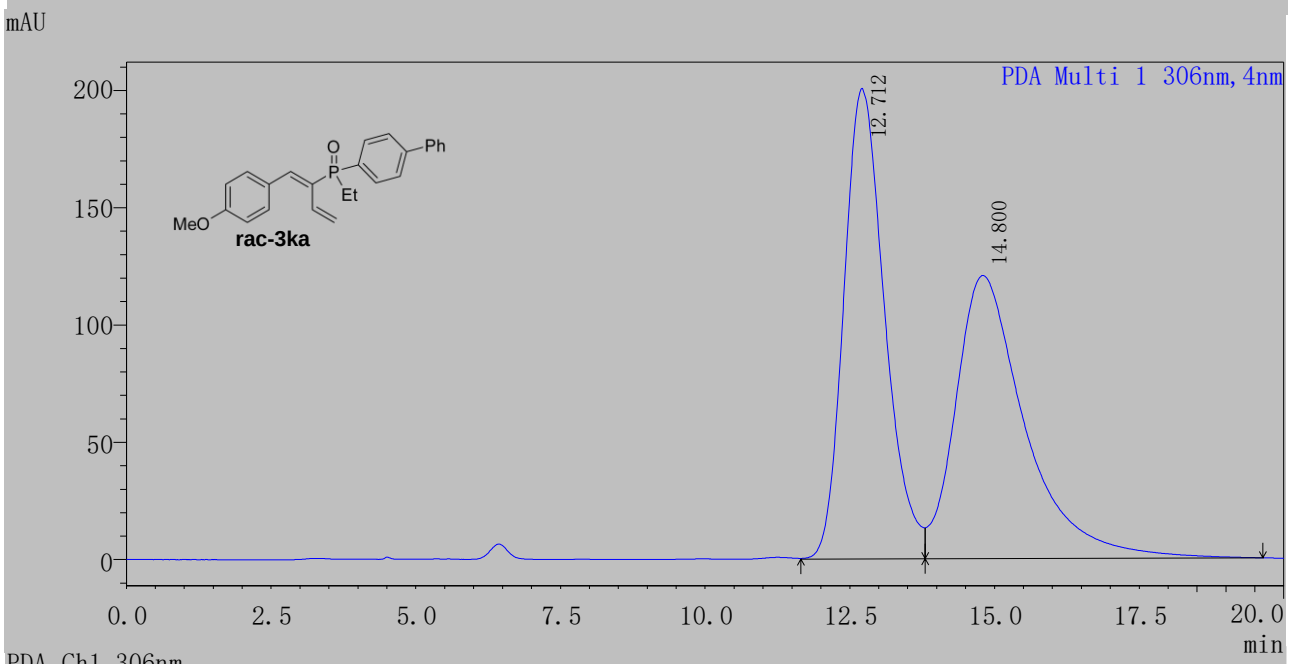
Chromatogram



PDA Ch1 299nm

Peak#	Ret. Time	Area	Area%
1	5.406	724363	97.726
2	15.151	16853	2.274
Total		741216	100.000

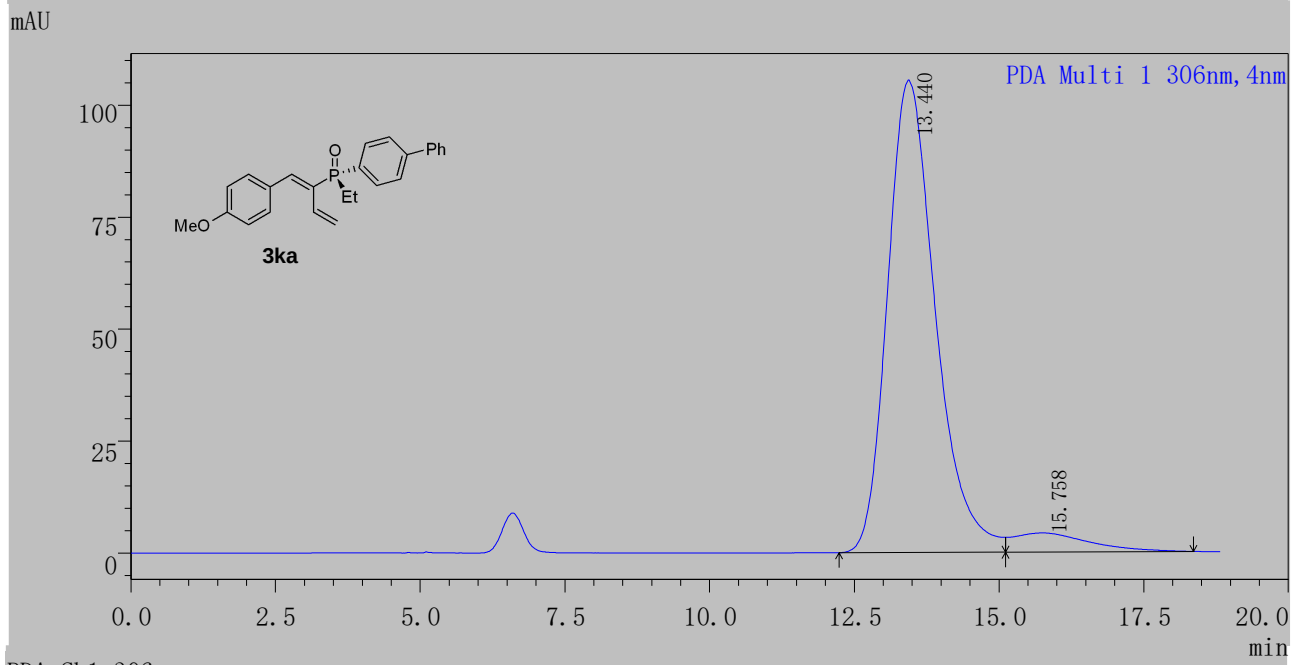
Chromatogram



PDA Ch1 306nm

Peak#	Ret. Time	Area	Area%
1	12.712	9848840	49.420
2	14.800	10080066	50.580
Total		19928906	100.000

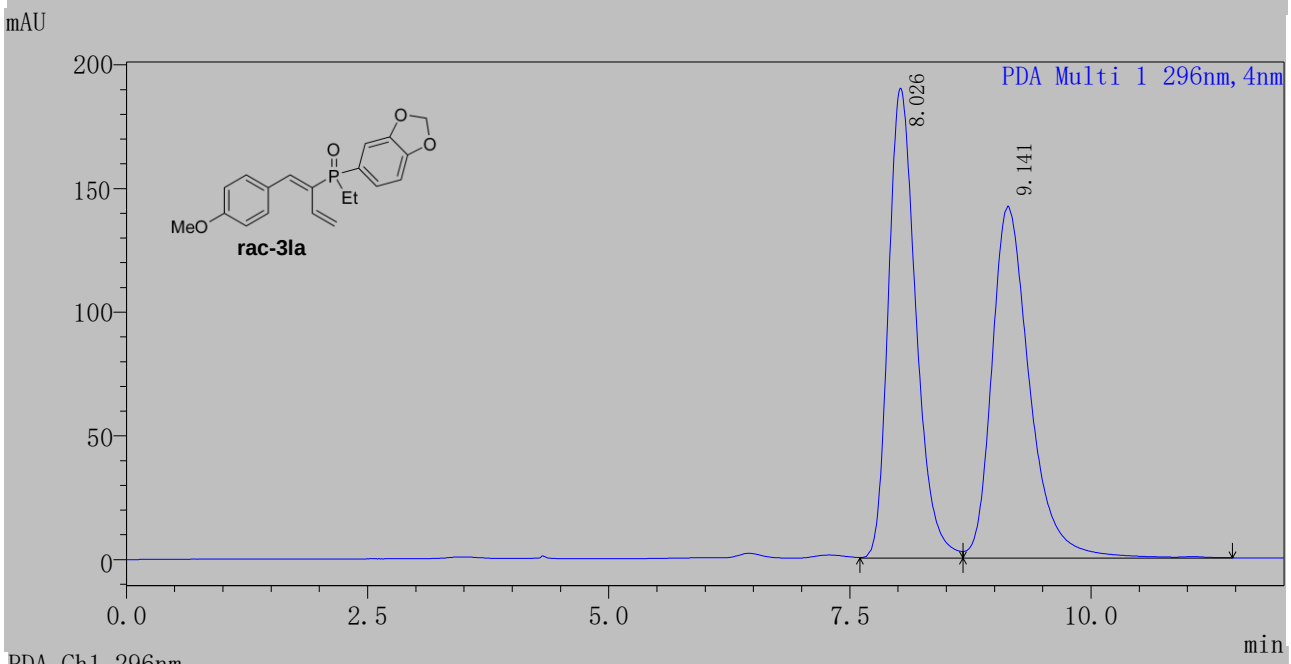
Chromatogram



PDA Ch1 306nm

Peak#	Ret. Time	Area	Area%
1	13.440	6069398	94.018
2	15.758	386145	5.982
Total		6455543	100.000

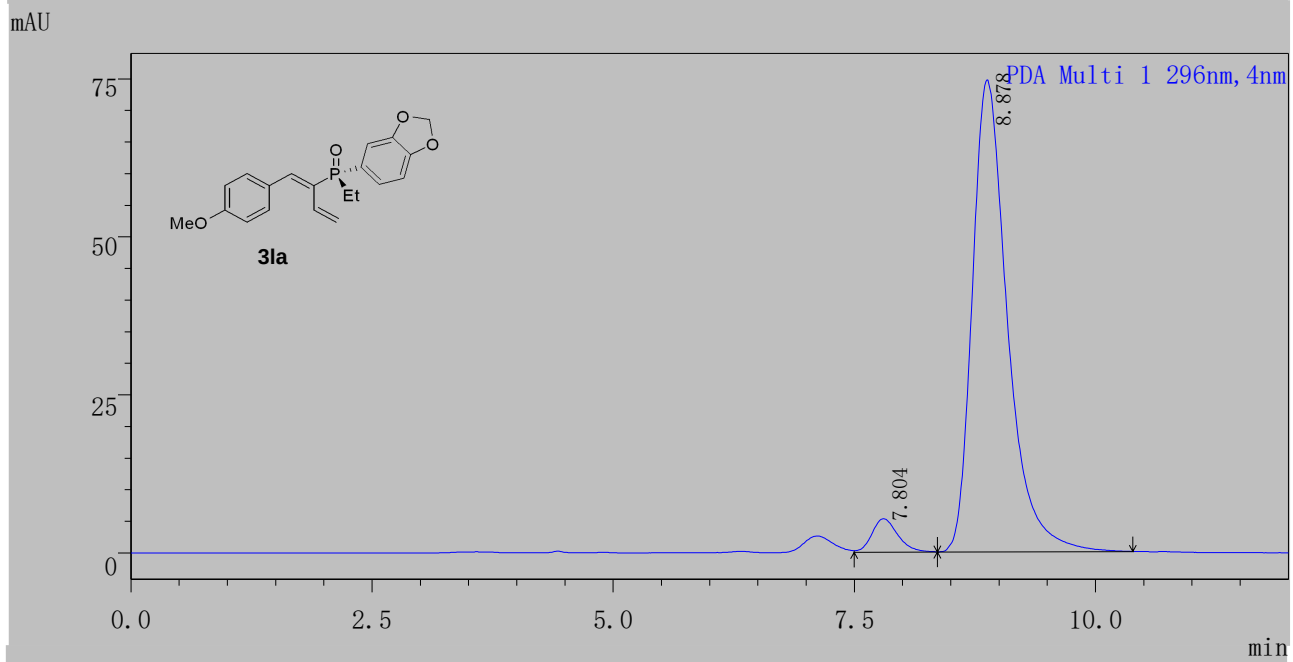
Chromatogram



PDA Ch1 296nm

Peak#	Ret. Time	Area	Area%
1	8.026	3787720	49.415
2	9.141	3877421	50.585
Total		7665142	100.000

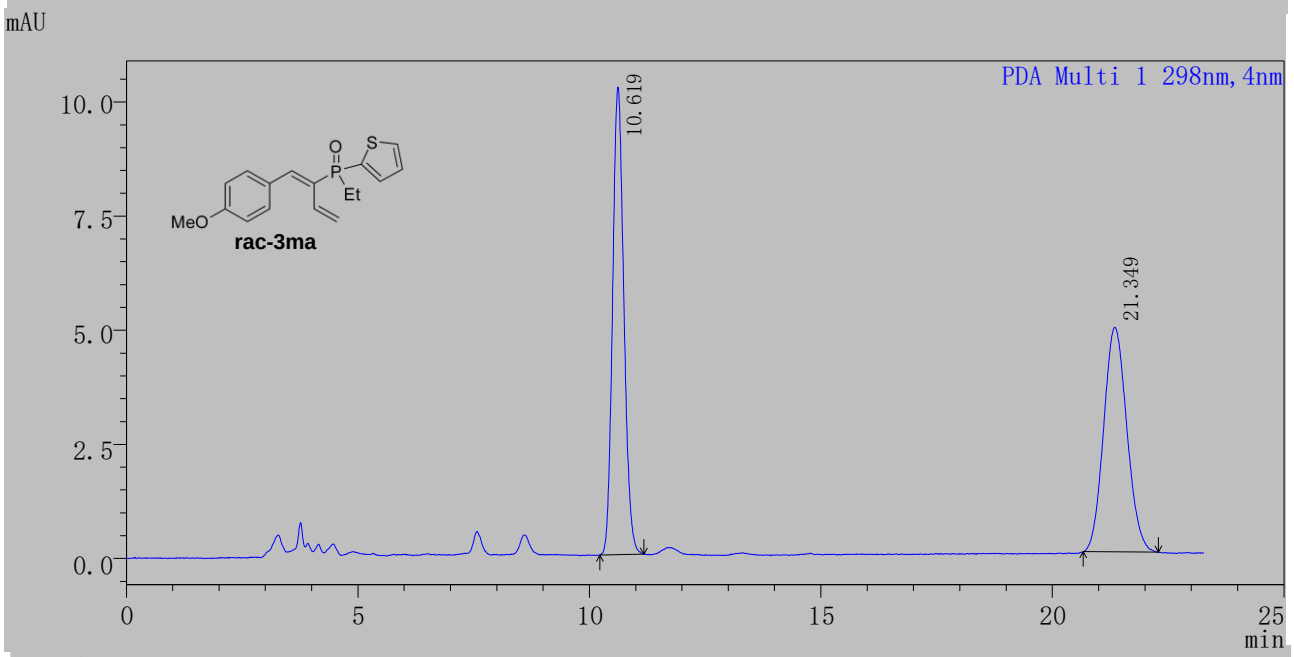
Chromatogram



PDA Ch1 296nm

Peak#	Ret. Time	Area	Area%
1	7.804	99387	4.988
2	8.878	1893156	95.012
Total		1992543	100.000

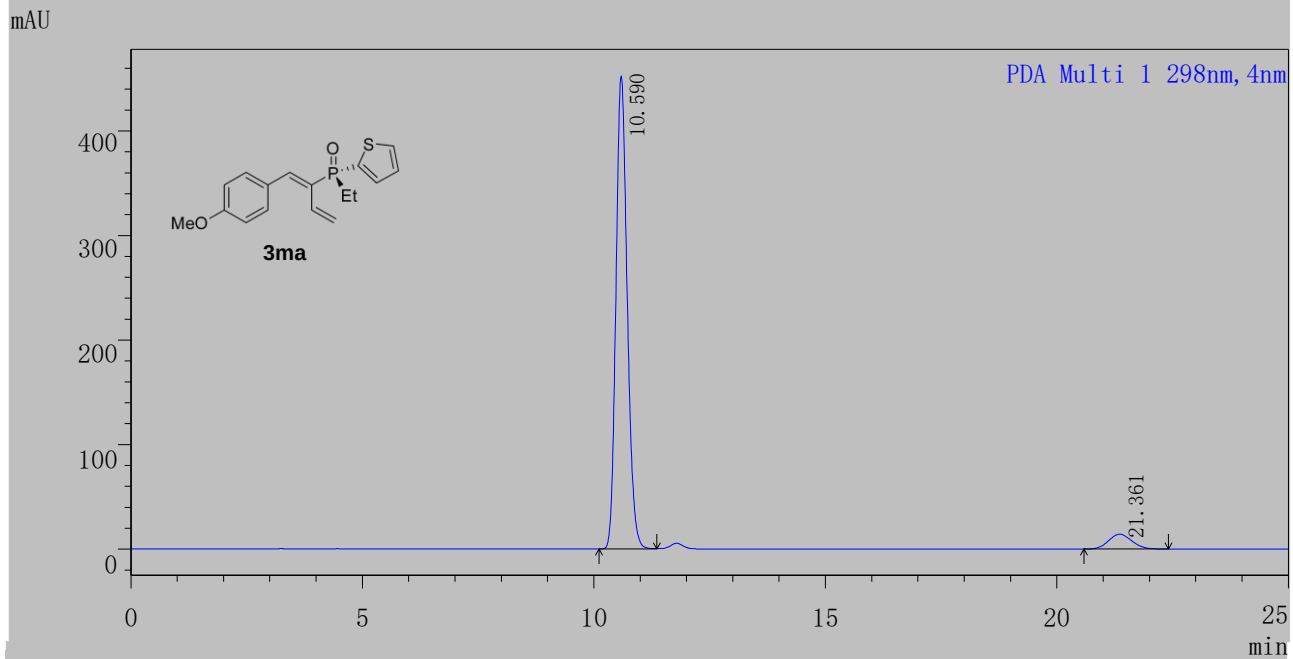
Chromatogram



PDA Ch1 298nm

Peak#	Ret. Time	Area	Area%
1	10.619	173723	50.286
2	21.349	171745	49.714
Total		345468	100.000

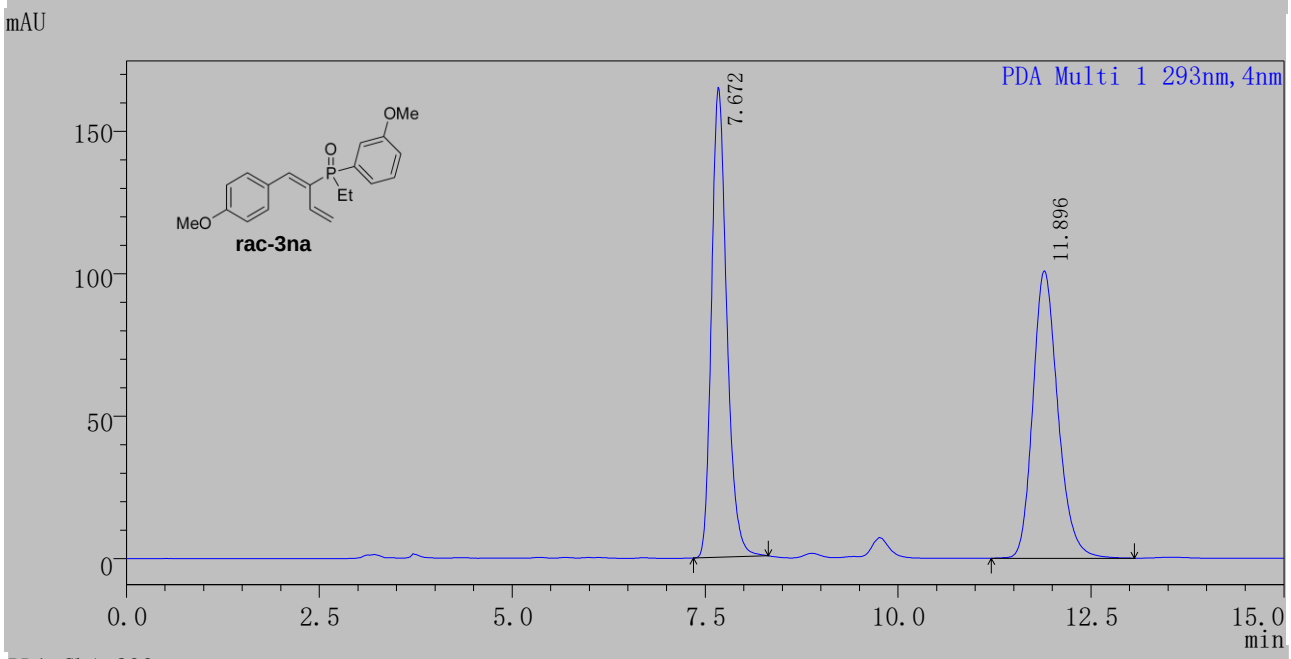
Chromatogram



PDA Ch1 298nm

Peak#	Ret. Time	Area	Area%
1	10.590	7637215	93.824
2	21.361	502705	6.176
Total		8139920	100.000

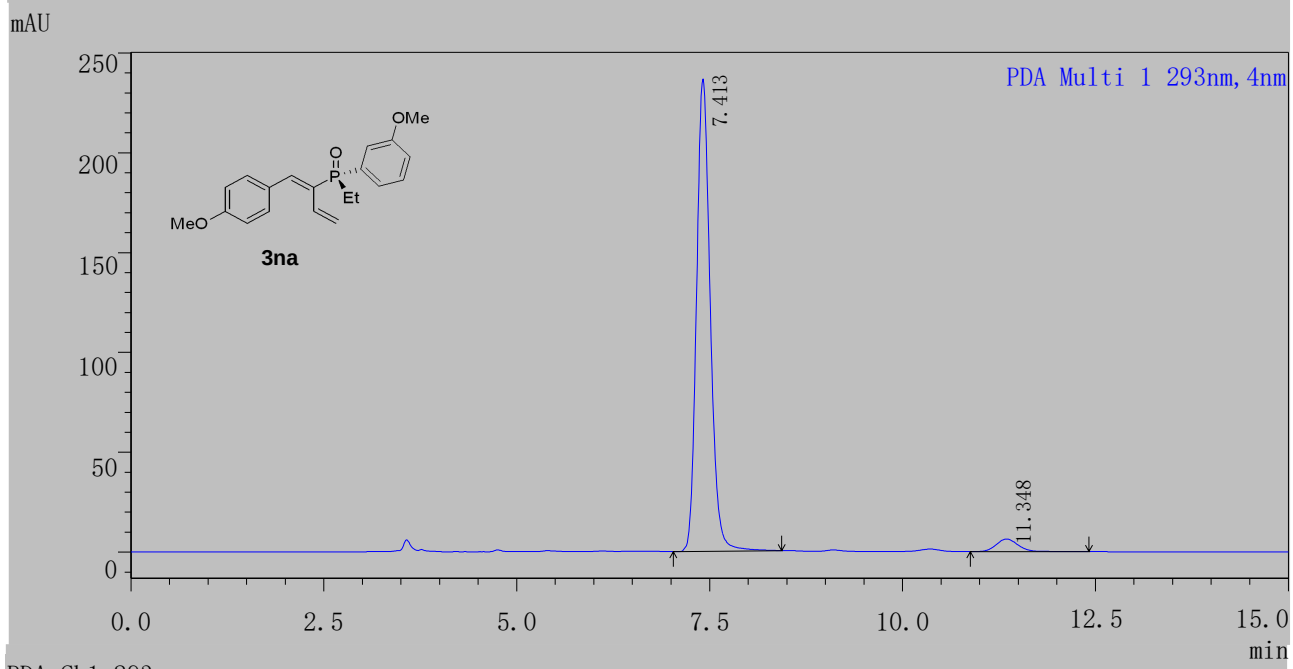
Chromatogram



PDA Ch1 293nm

Peak#	Ret. Time	Area	Area%
1	7.672	2272441	49.914
2	11.896	2280287	50.086
Total		4552728	100.000

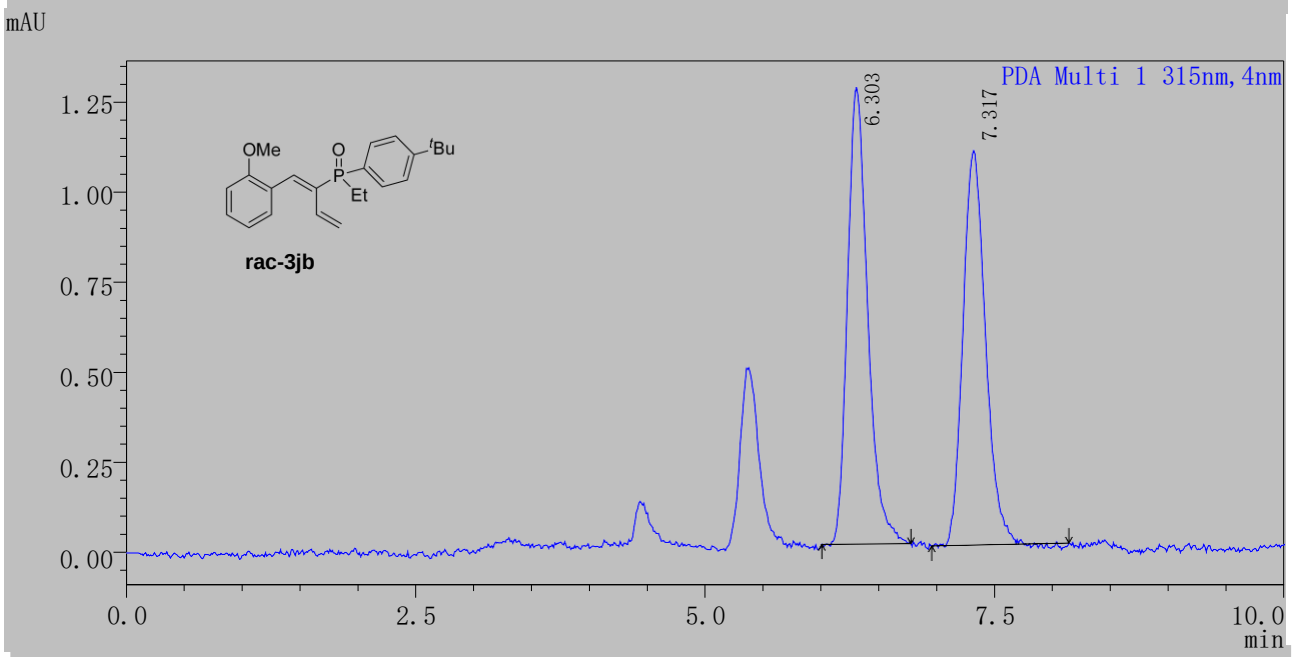
Chromatogram



PDA Ch1 293nm

Peak#	Ret. Time	Area	Area%
1	7.413	2915667	95.901
2	11.348	124633	4.099
Total		3040300	100.000

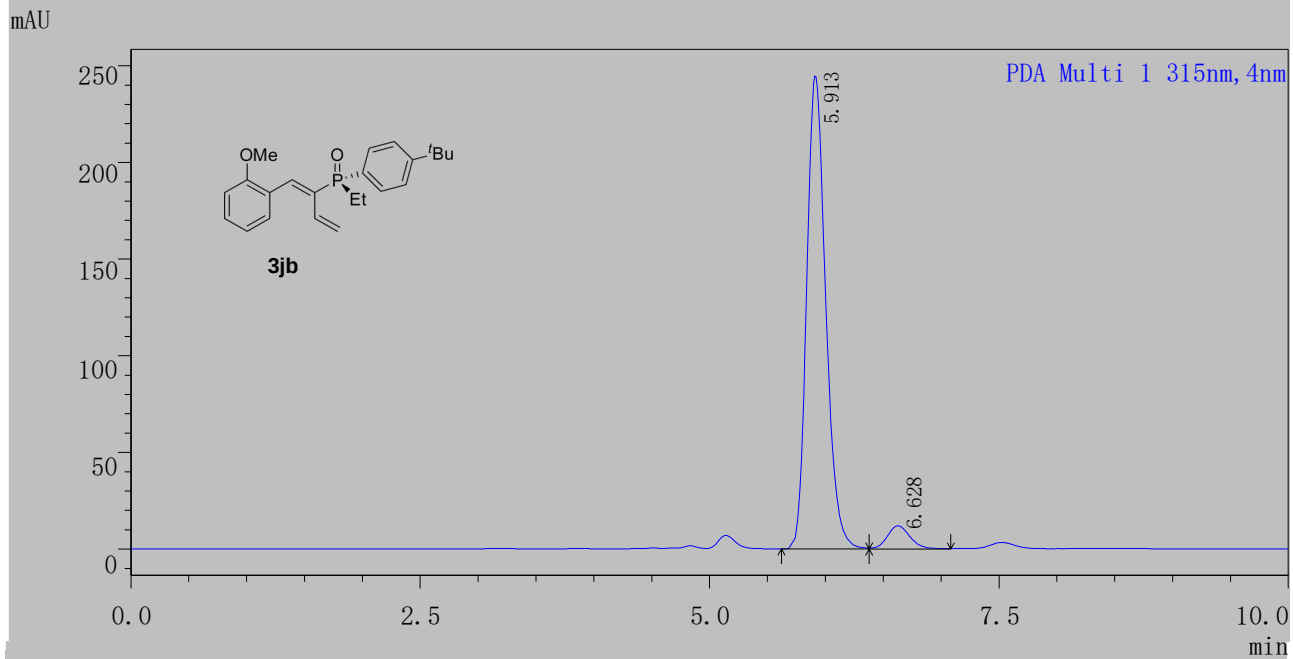
Chromatogram



PDA Ch1 315nm

Peak#	Ret. Time	Area	Area%
1	6.303	15364	51.170
2	7.317	14661	48.830
Total		30025	100.000

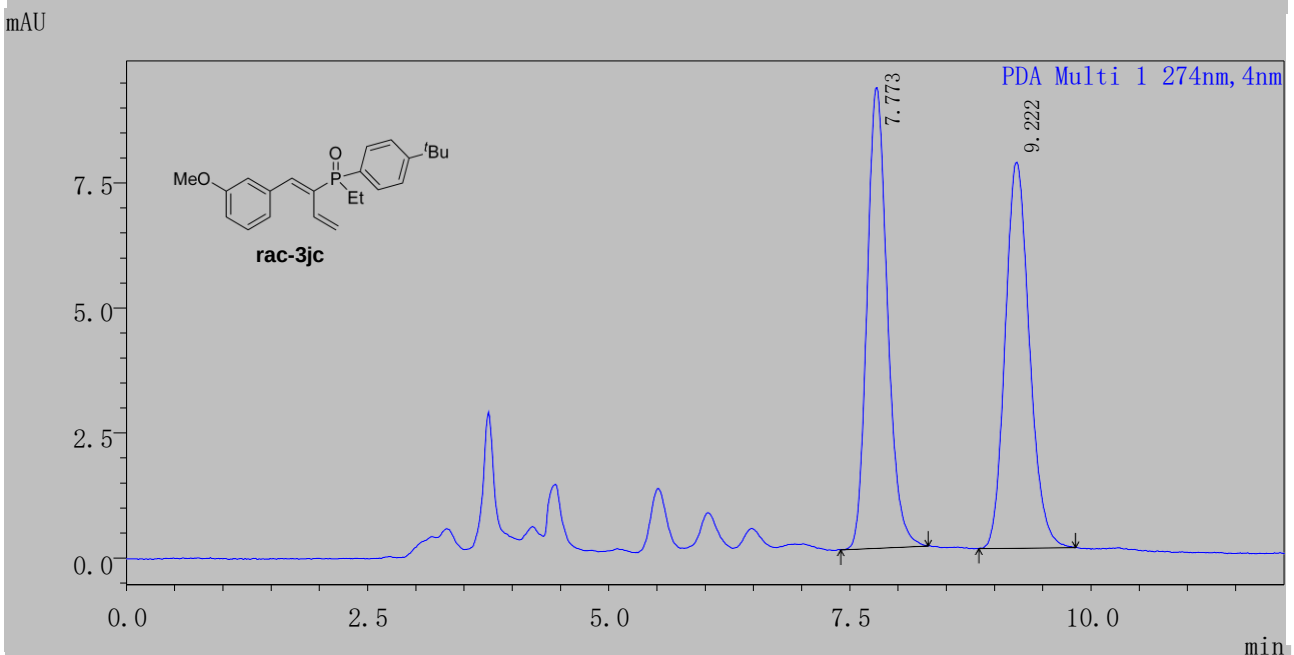
Chromatogram



PDA Ch1 315nm

Peak#	Ret. Time	Area	Area%
1	5.913	2790944	94.540
2	6.628	161173	5.460
Total		2952117	100.000

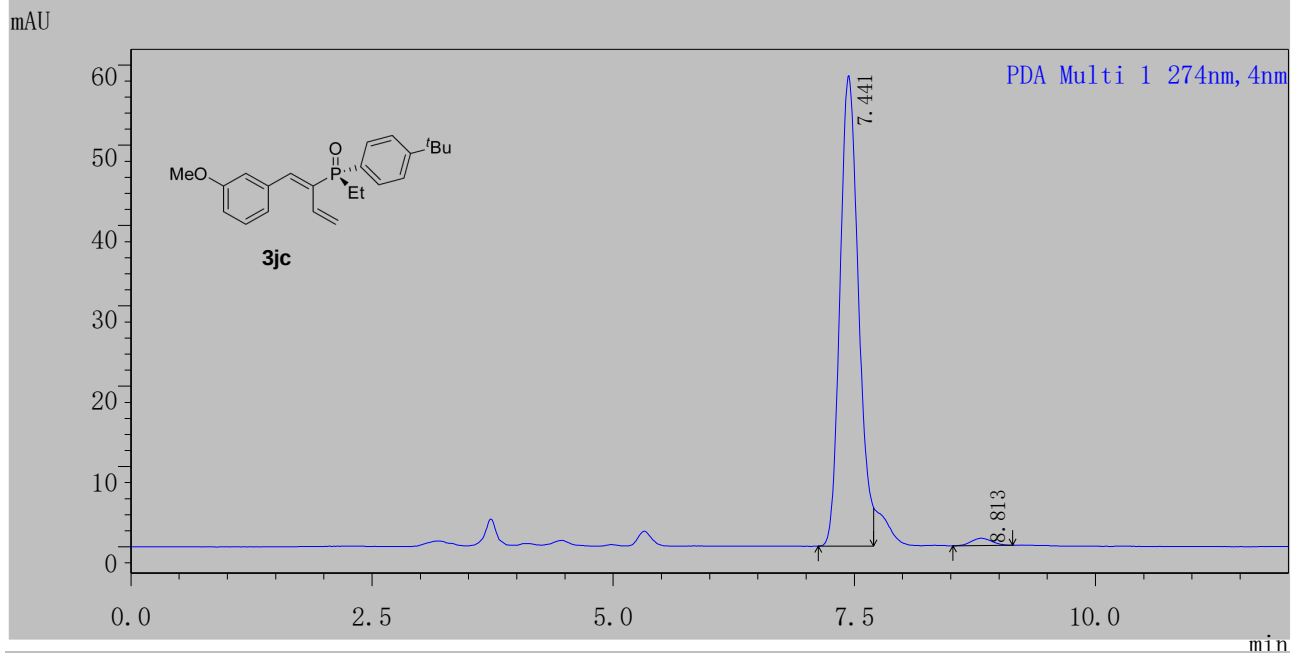
Chromatogram



PDA Ch1 274nm

Peak#	Ret. Time	Area	Area%
1	7.773	135178	50.069
2	9.222	134806	49.931
Total		269984	100.000

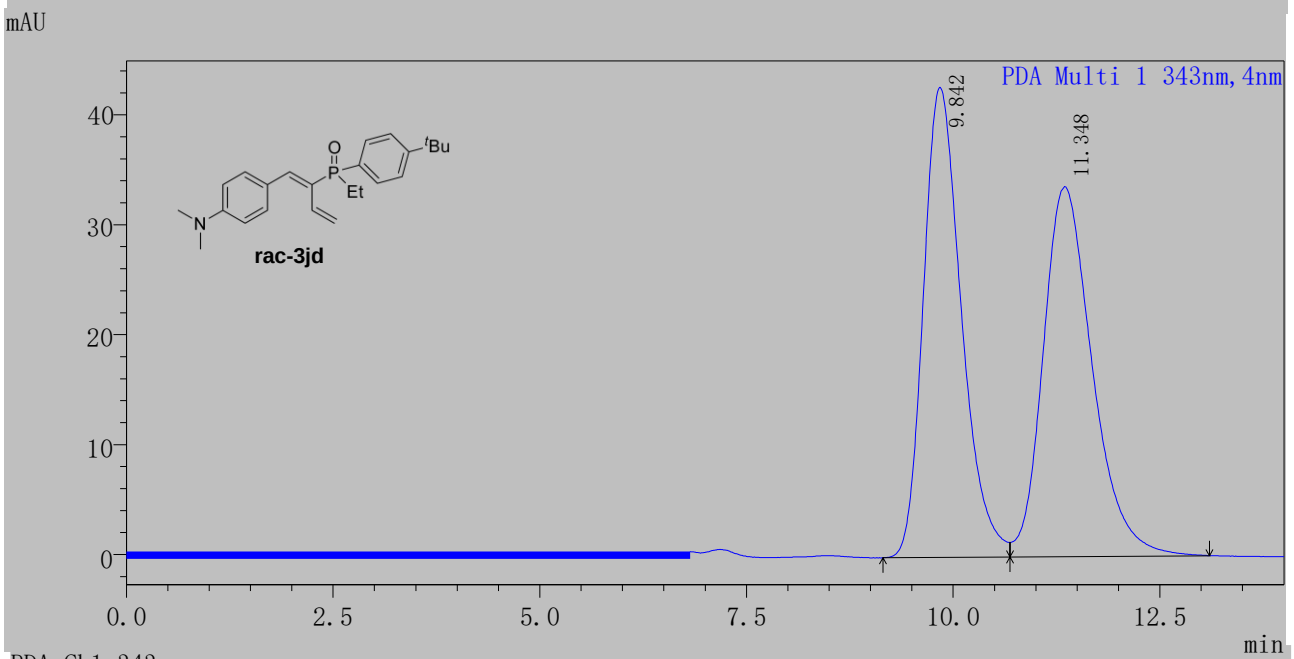
Chromatogram



PDA Ch1 274nm

Peak#	Ret. Time	Area	Area%
1	7.441	779174	98.308
2	8.813	13412	1.692
Total		792587	100.000

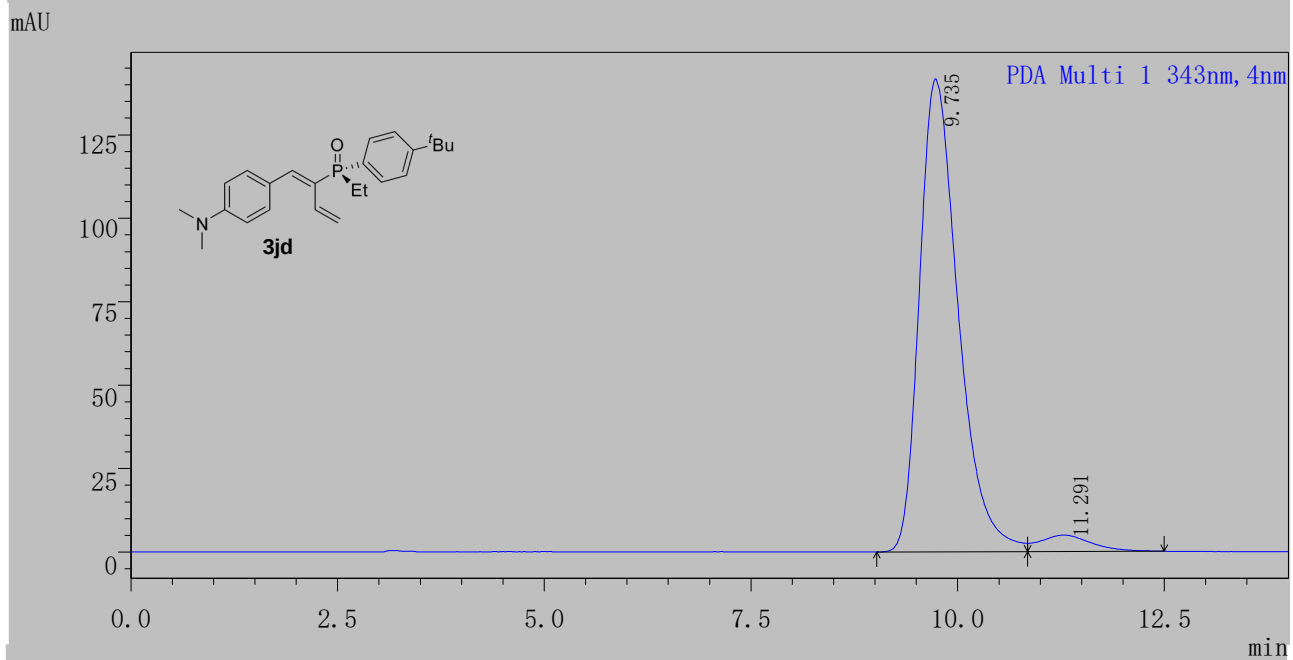
Chromatogram



PDA Ch1 343nm

Peak#	Ret. Time	Area	Area%
1	9.842	1371038	49.678
2	11.348	1388839	50.322
Total		2759877	100.000

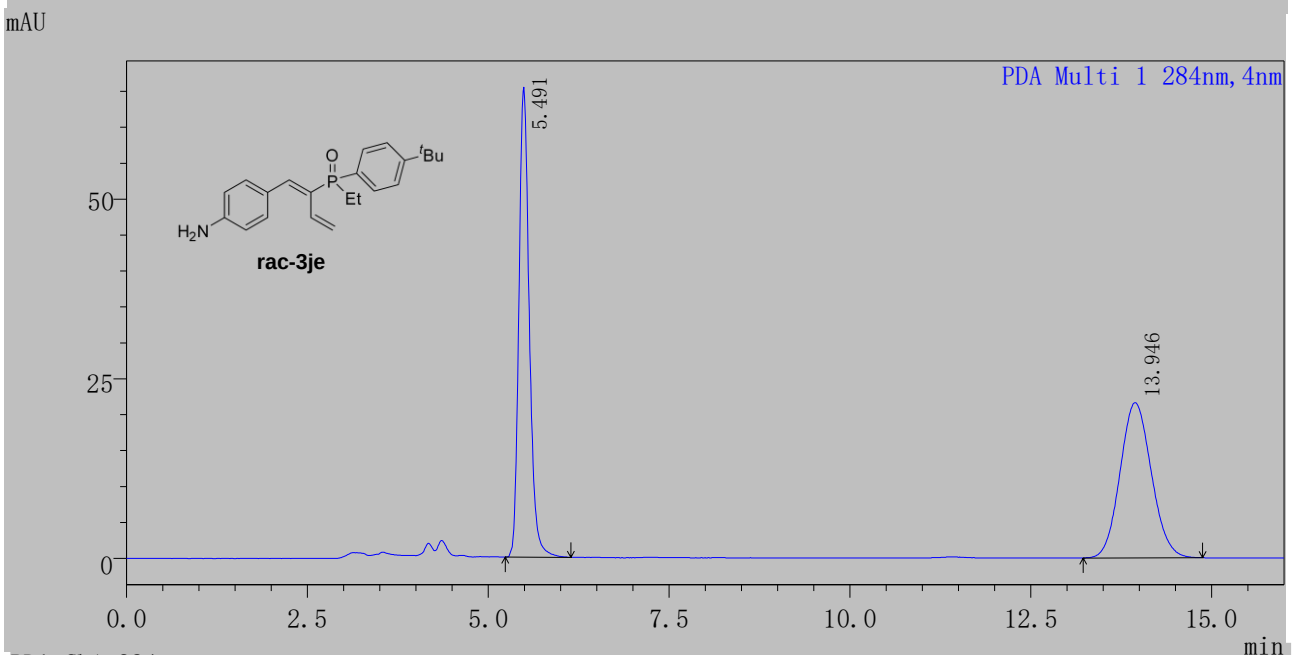
Chromatogram



PDA Ch1 343nm

Peak#	Ret. Time	Area	Area%
1	9.735	4628949	95.615
2	11.291	212293	4.385
Total		4841242	100.000

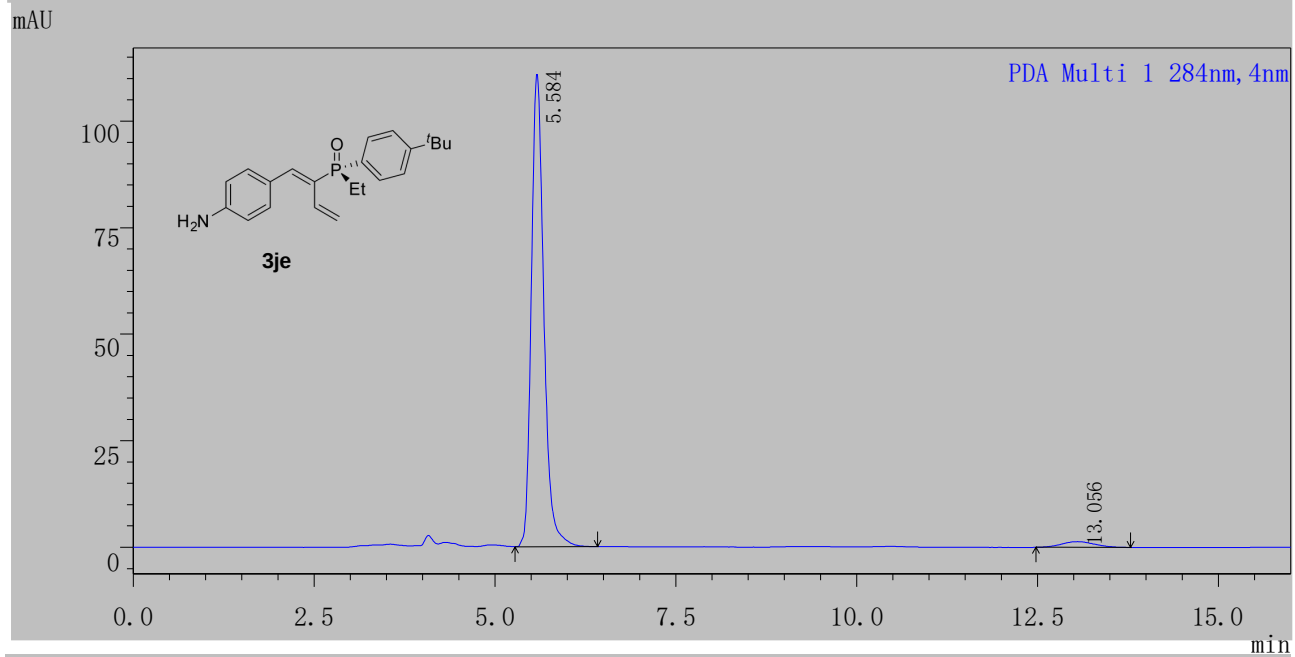
Chromatogram



PDA Ch1 284nm

Peak#	Ret. Time	Area	Area%
1	5.491	653735	50.122
2	13.946	650553	49.878
Total		1304288	100.000

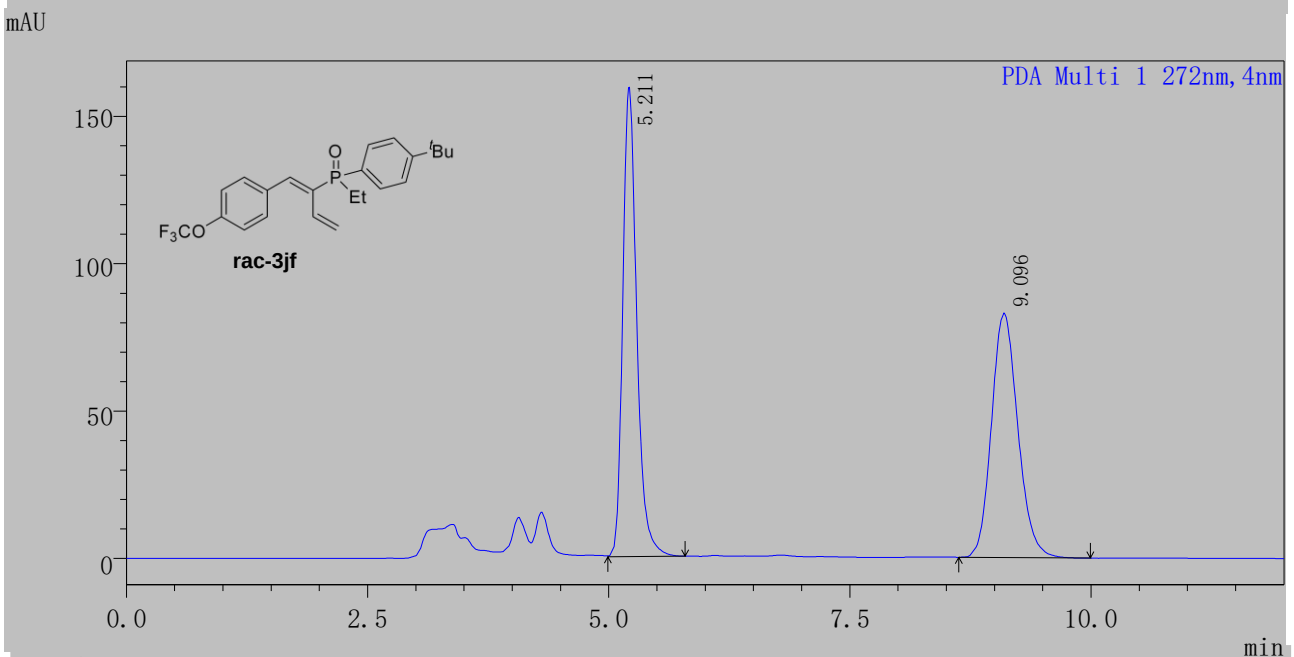
Chromatogram



PDA Ch1 284nm

Peak#	Ret. Time	Area	Area%
1	5.584	1329652	96.864
2	13.056	43054	3.136
Total		1372706	100.000

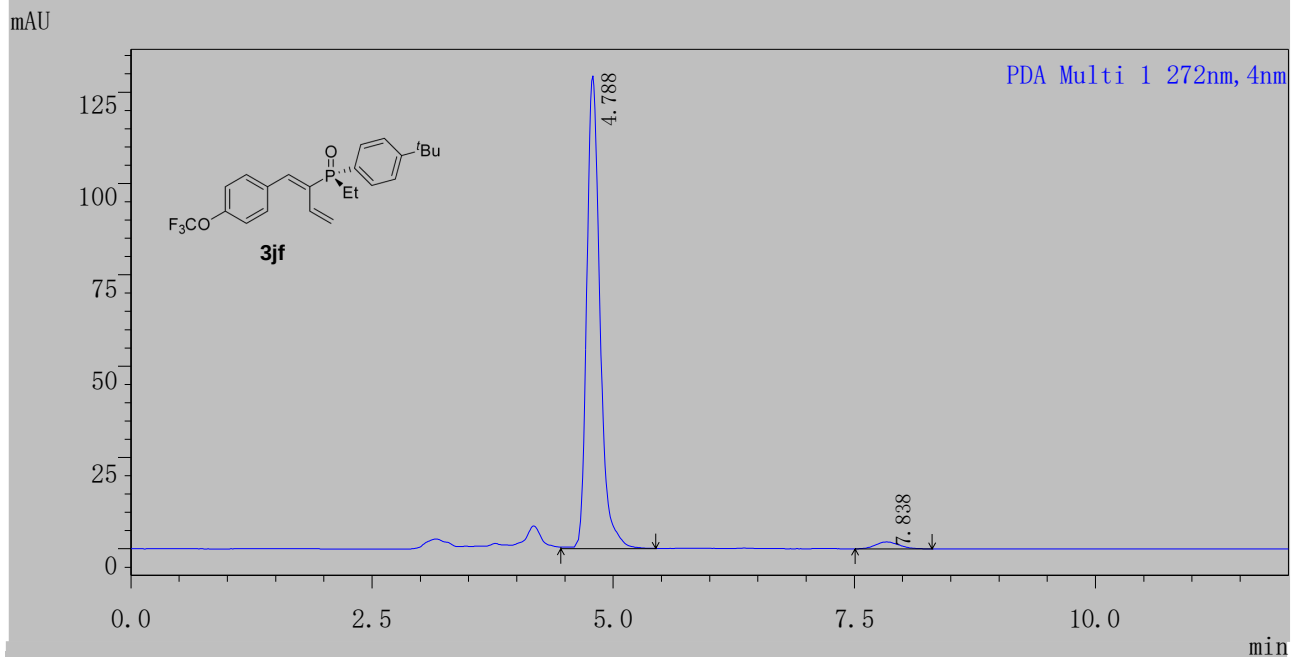
Chromatogram



PDA Ch1 272nm

Peak#	Ret. Time	Area	Area%
1	5.211	1603874	50.400
2	9.096	1578396	49.600
Total		3182269	100.000

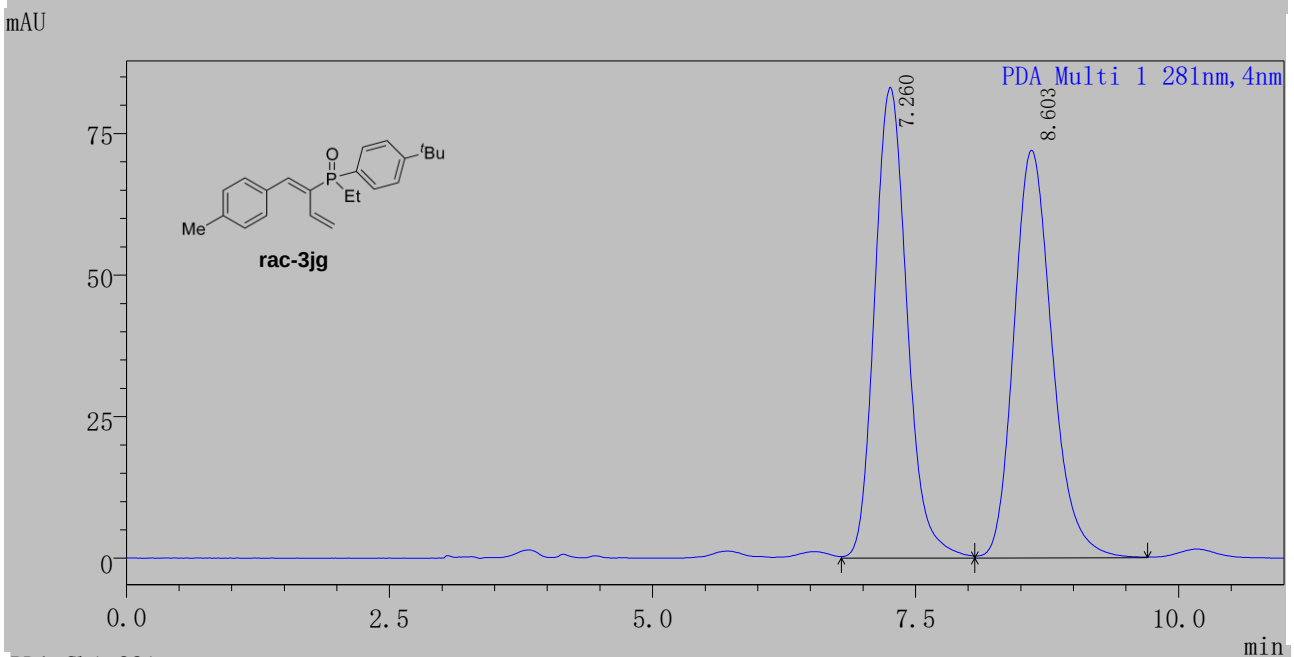
Chromatogram



PDA Ch1 272nm

Peak#	Ret. Time	Area	Area%
1	4.788	1232286	97.422
2	7.838	32603	2.578
Total		1264889	100.000

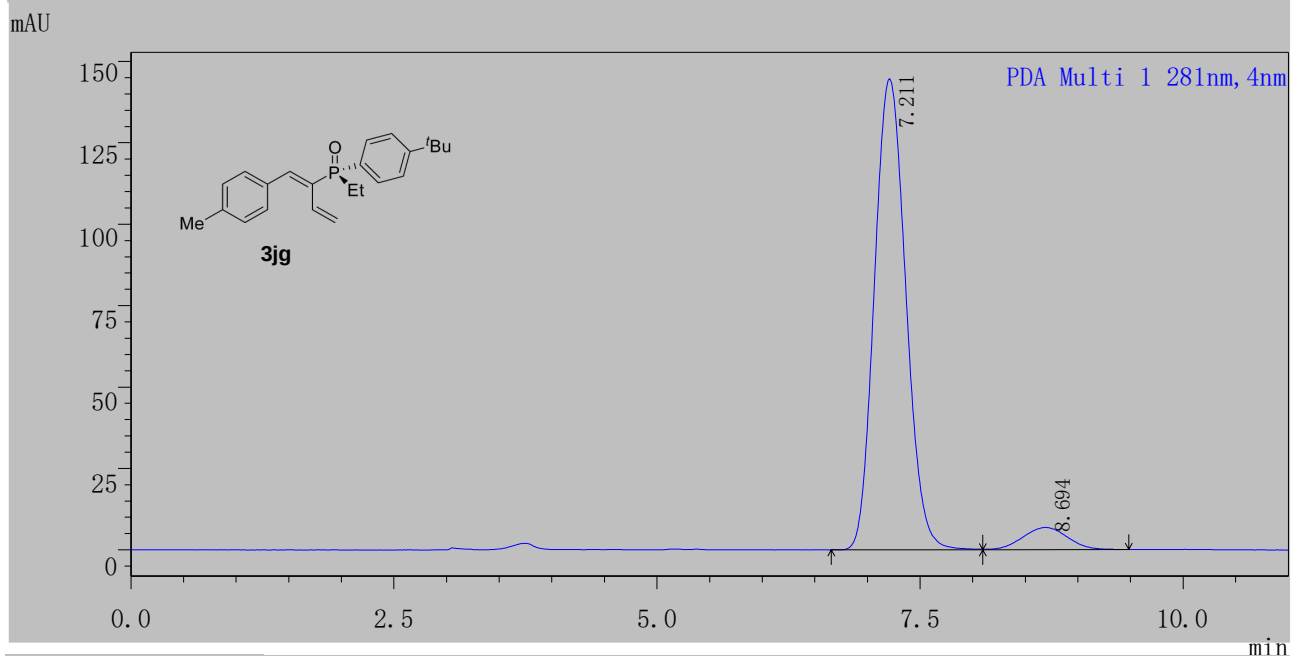
Chromatogram



PDA Ch1 281nm

Peak#	Ret. Time	Area	Area%
1	7.260	1781023	49.499
2	8.603	1817051	50.501
Total		3598074	100.000

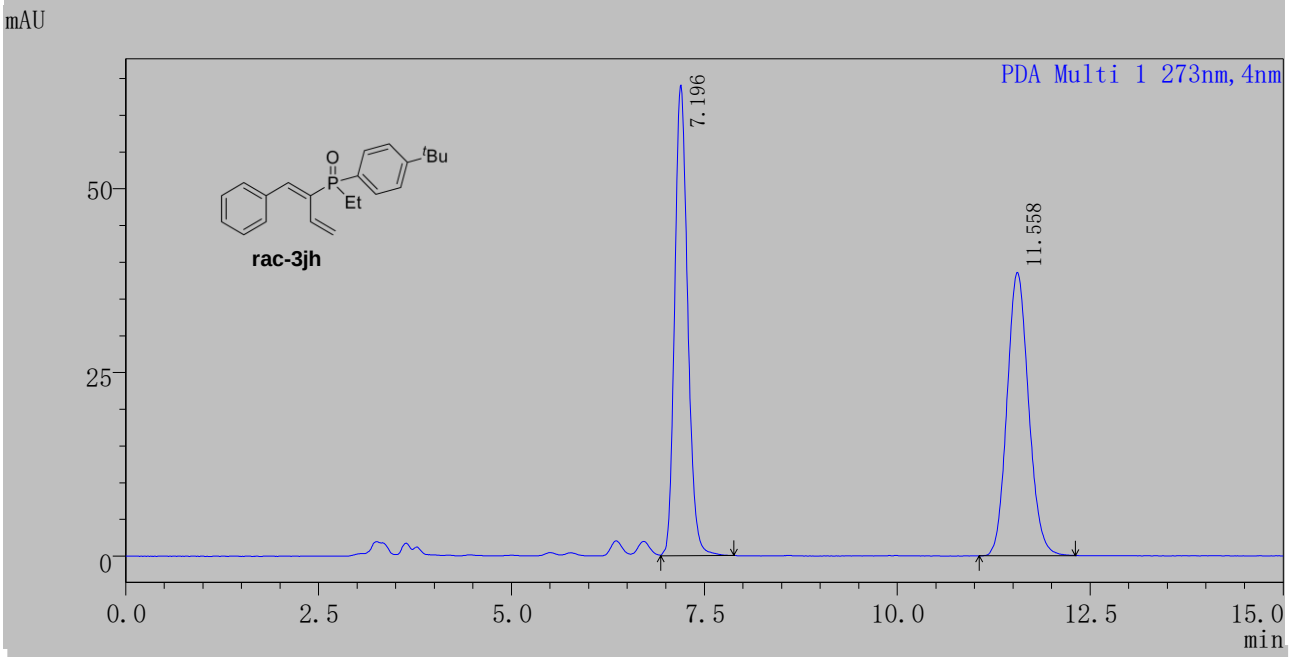
Chromatogram



PDA Ch1 281nm

Peak#	Ret. Time	Area	Area%
1	7.211	3004033	93.709
2	8.694	201679	6.291
Total		3205713	100.000

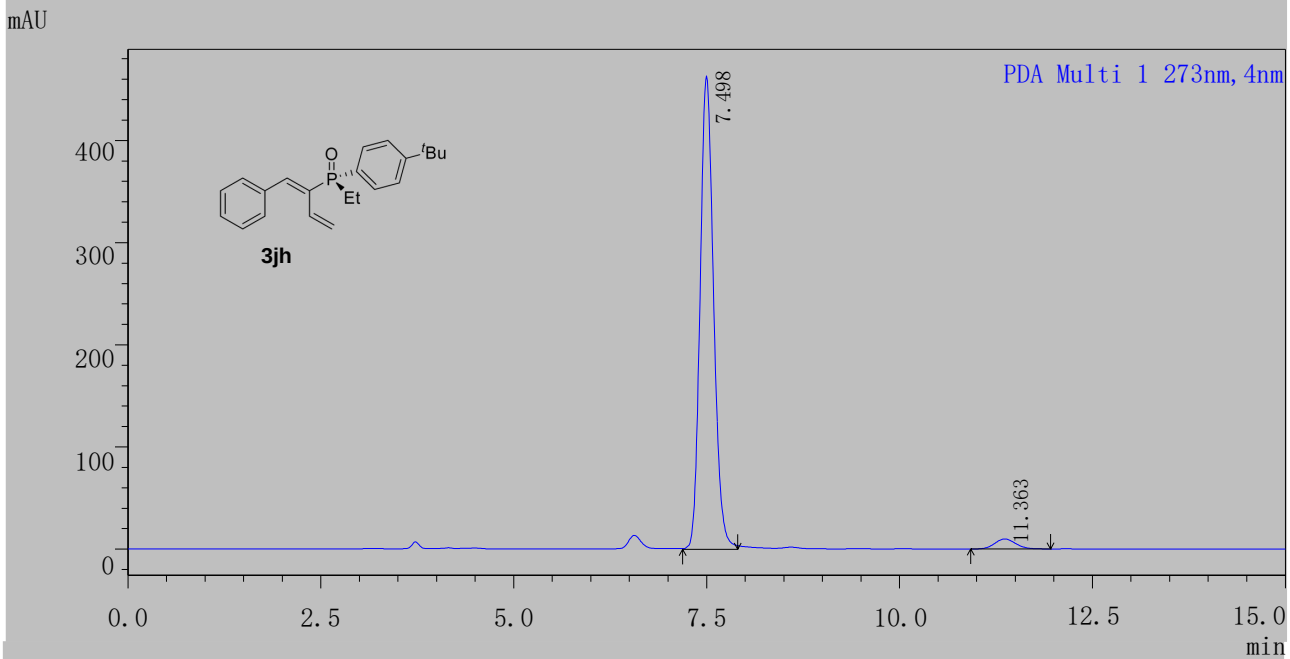
Chromatogram



PDA Ch1 273nm

Peak#	Ret. Time	Area	Area%
1	7.196	751270	50.030
2	11.558	750364	49.970
Total		1501633	100.000

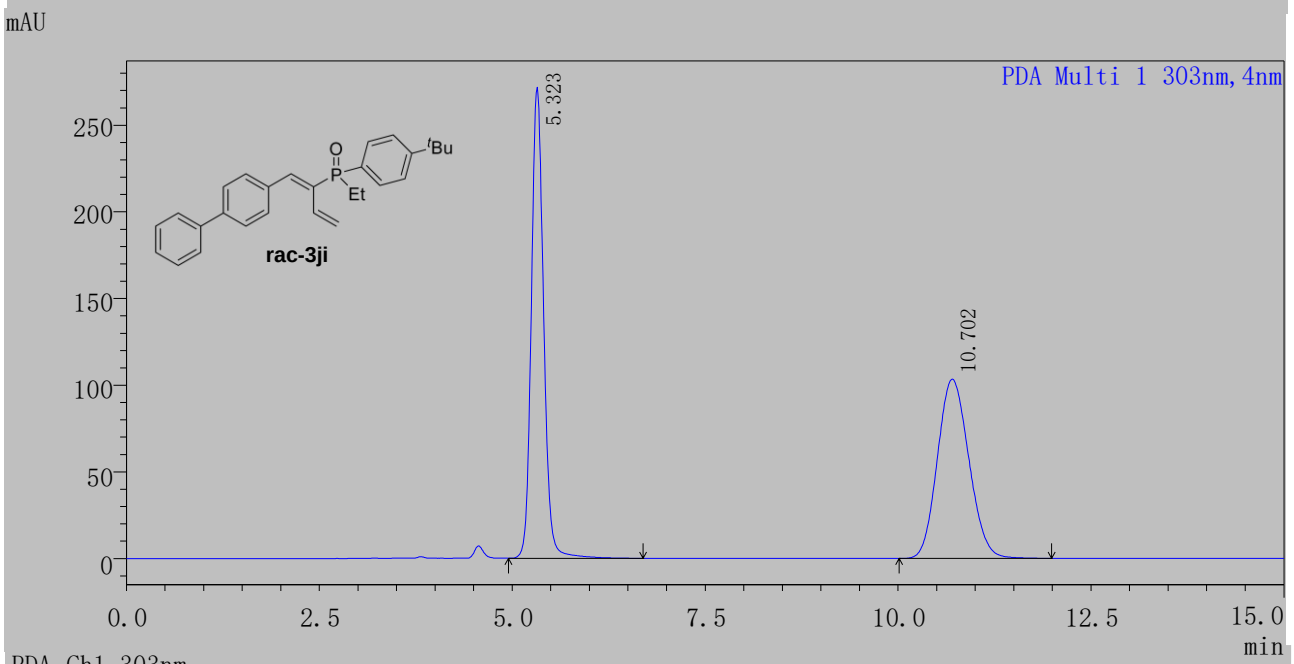
Chromatogram



PDA Ch1 273nm

Peak#	Ret. Time	Area	Area%
1	7.498	5646809	96.805
2	11.363	186380	3.195
Total		5833189	100.000

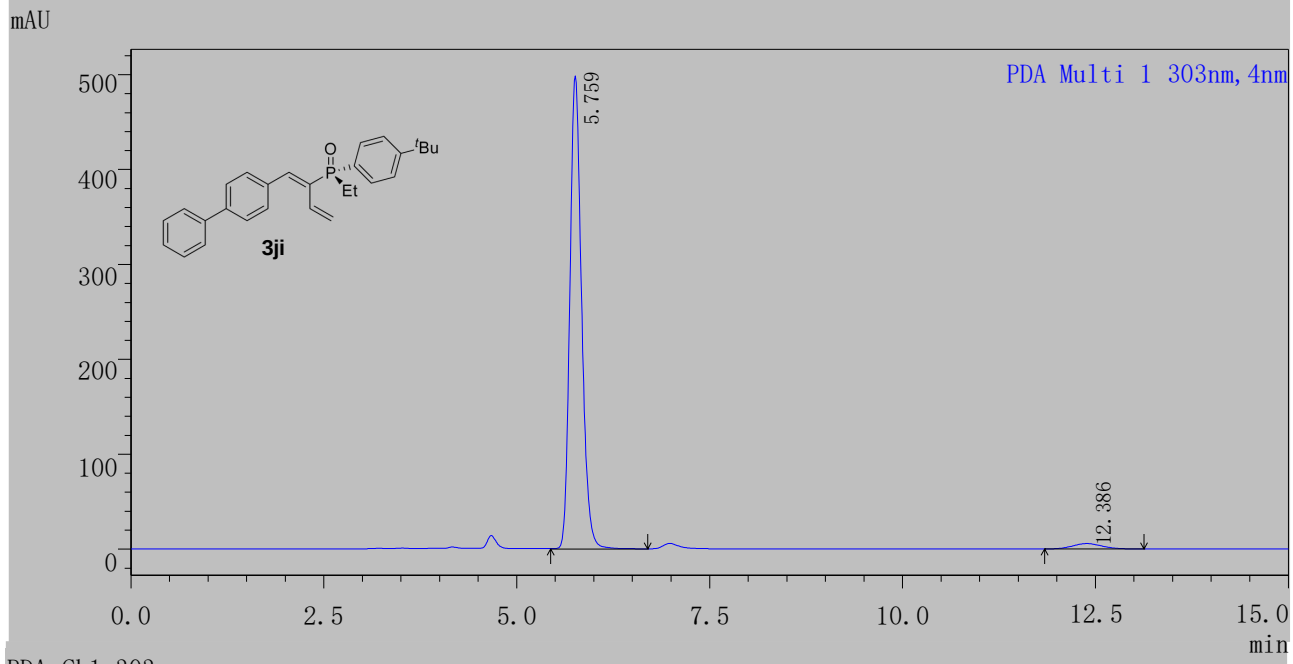
Chromatogram



PDA Ch1 303nm

Peak#	Ret. Time	Area	Area%
1	5.323	3008702	50.572
2	10.702	2940591	49.428
Total		5949293	100.000

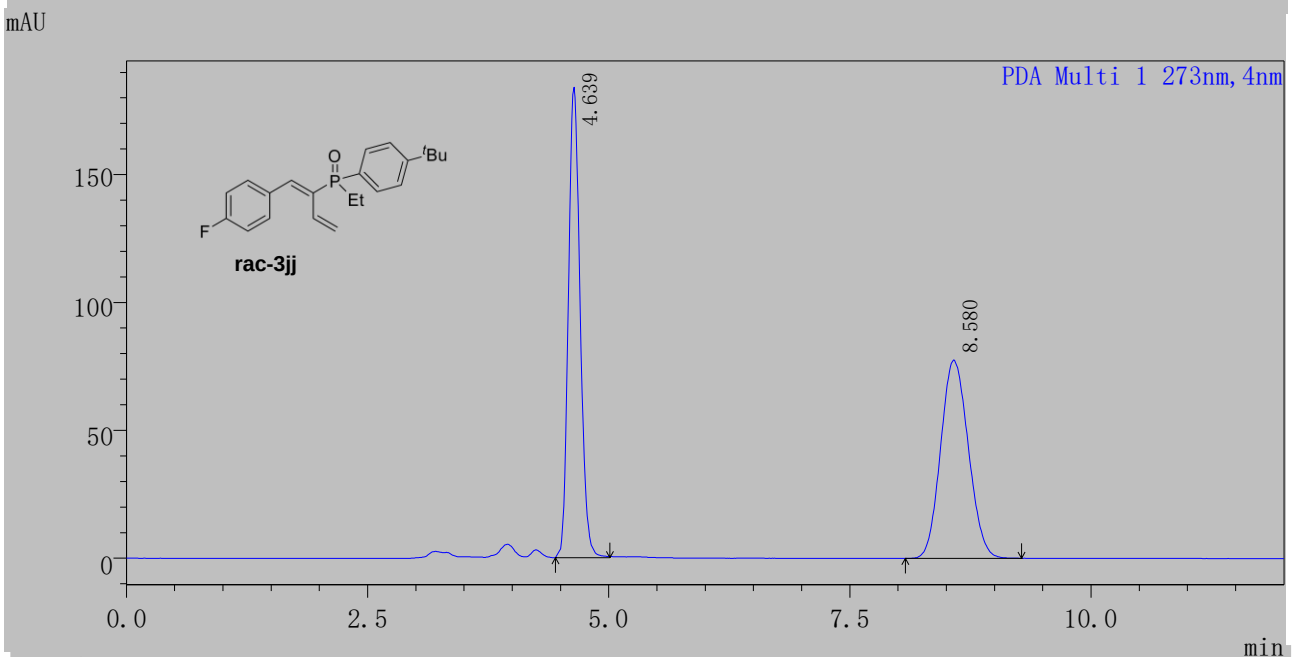
Chromatogram



PDA Ch1 303nm

Peak#	Ret. Time	Area	Area%
1	5.759	5256359	97.262
2	12.386	147955	2.738
Total		5404314	100.000

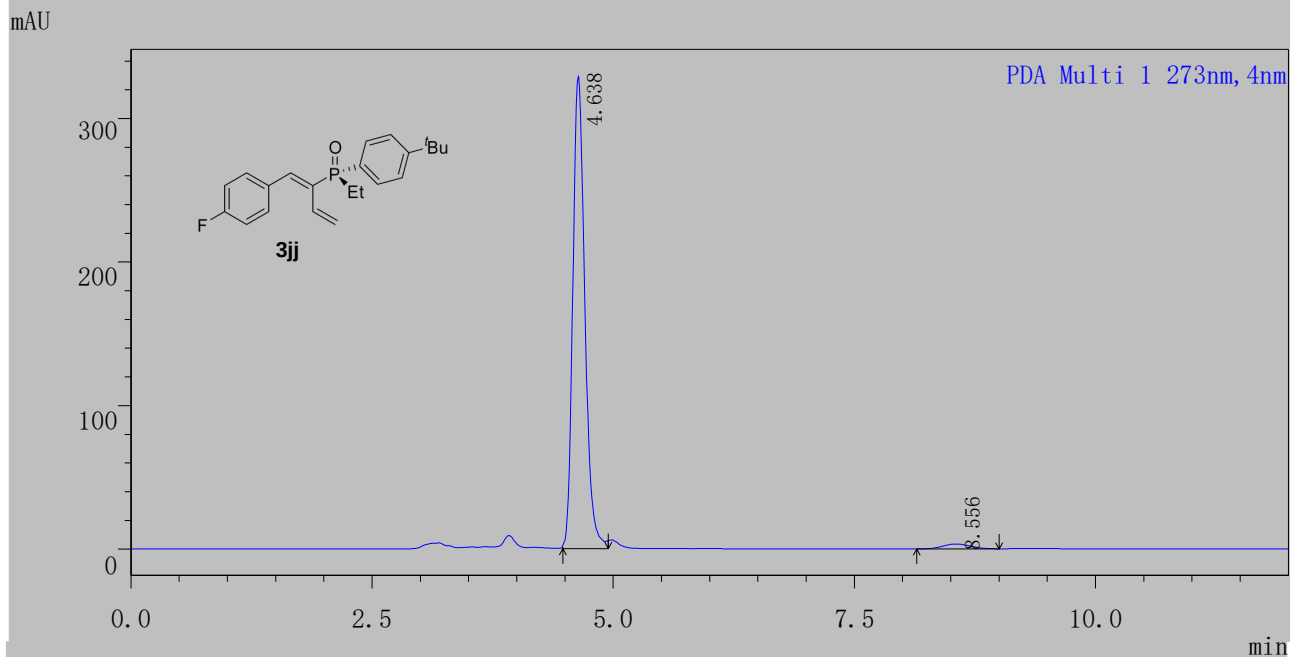
Chromatogram



PDA Ch1 273nm

Peak#	Ret. Time	Area	Area%
1	4.639	1557154	50.085
2	8.580	1551867	49.915
Total		3109021	100.000

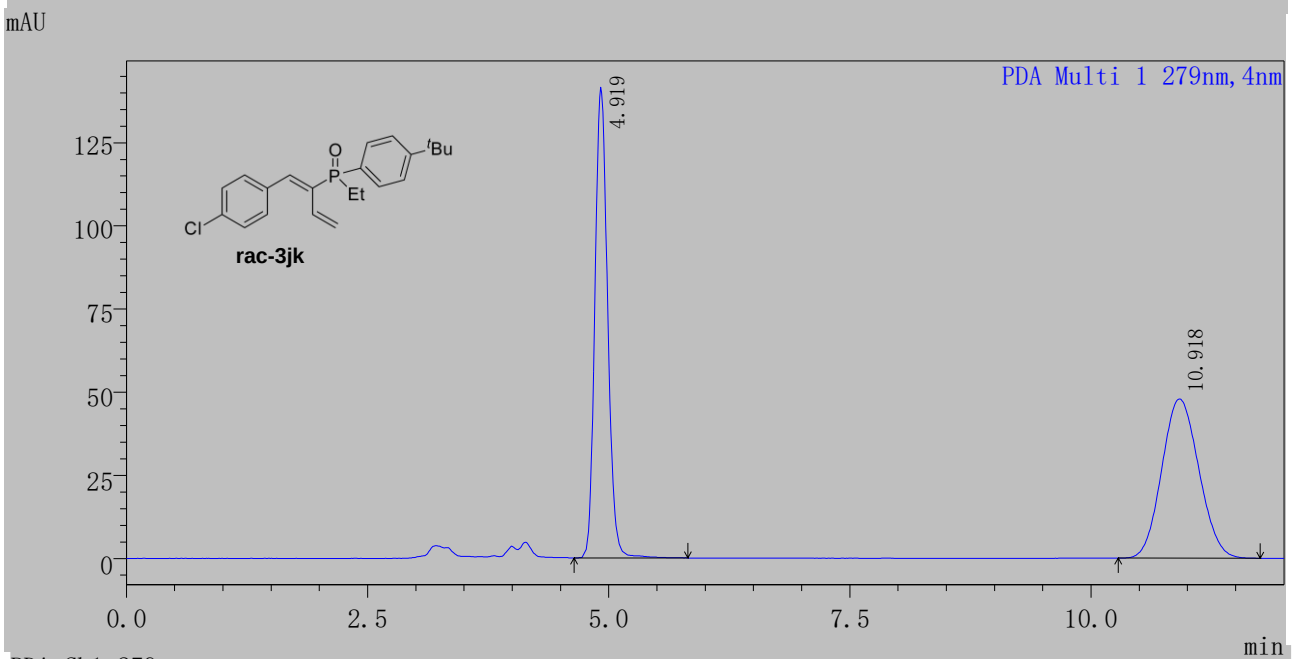
Chromatogram



PDA Ch1 273nm

Peak#	Ret. Time	Area	Area%
1	4.638	2850473	97.651
2	8.556	68576	2.349
Total		2919050	100.000

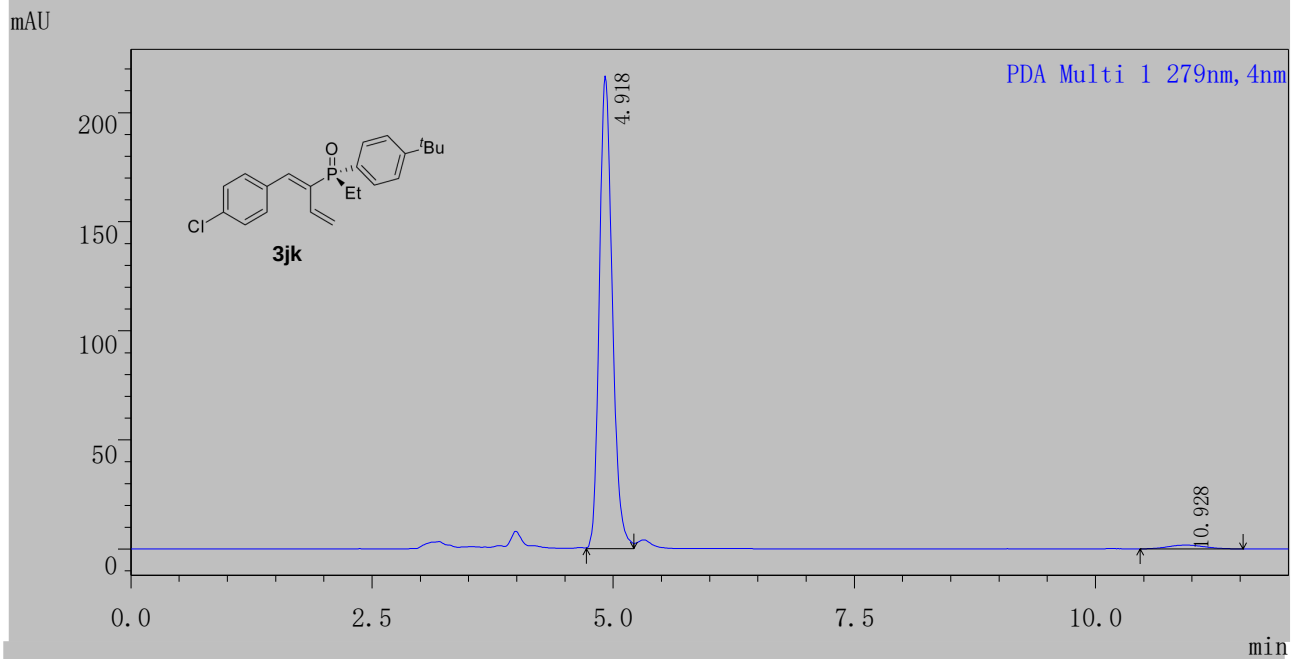
Chromatogram



PDA Ch1 279nm

Peak#	Ret. Time	Area	Area%
1	4.919	1299431	50.339
2	10.918	1281905	49.661
Total		2581336	100.000

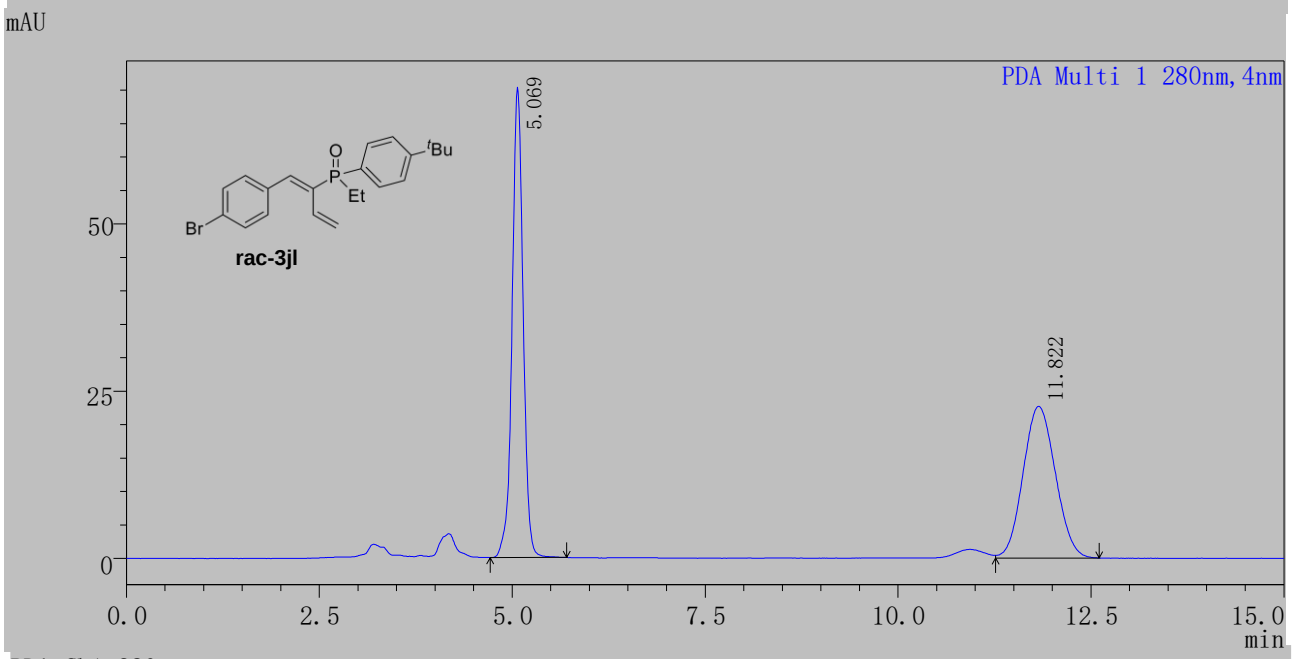
Chromatogram



PDA Ch1 279nm

Peak#	Ret. Time	Area	Area%
1	4.918	2022148	97.801
2	10.928	45471	2.199
Total		2067618	100.000

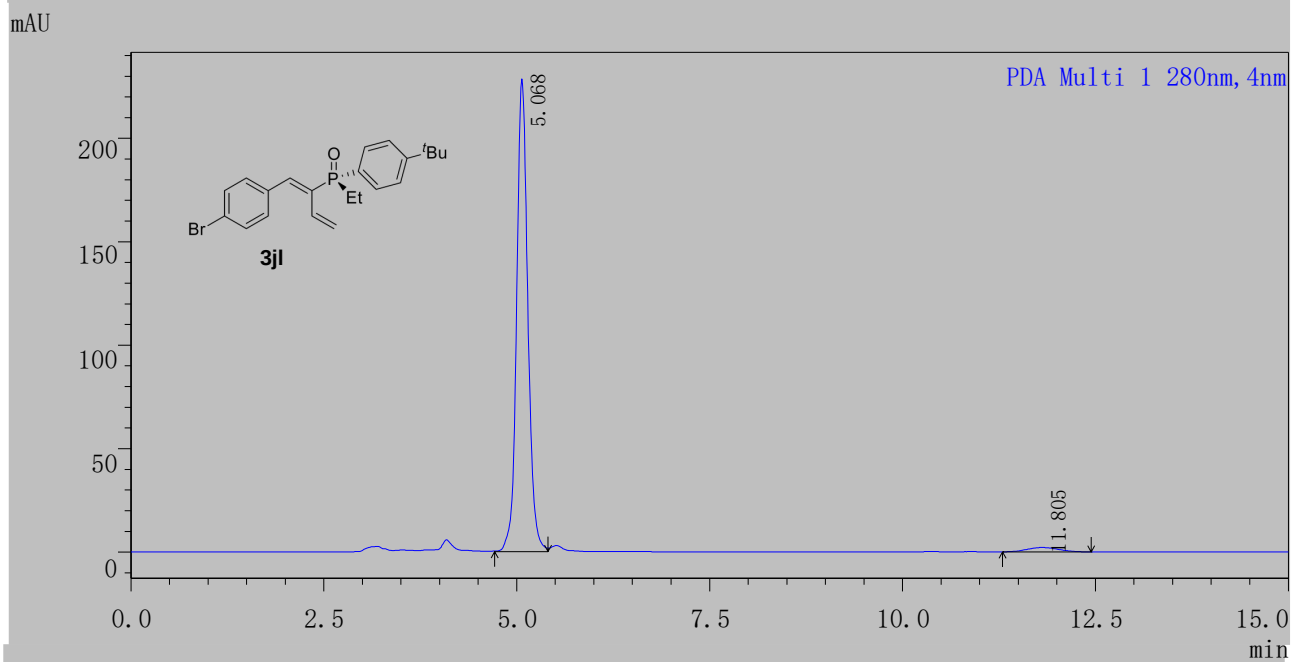
Chromatogram



PDA Ch1 280nm

Peak#	Ret. Time	Area	Area%
1	5.069	698973	51.485
2	11.822	658647	48.515
Total		1357620	100.000

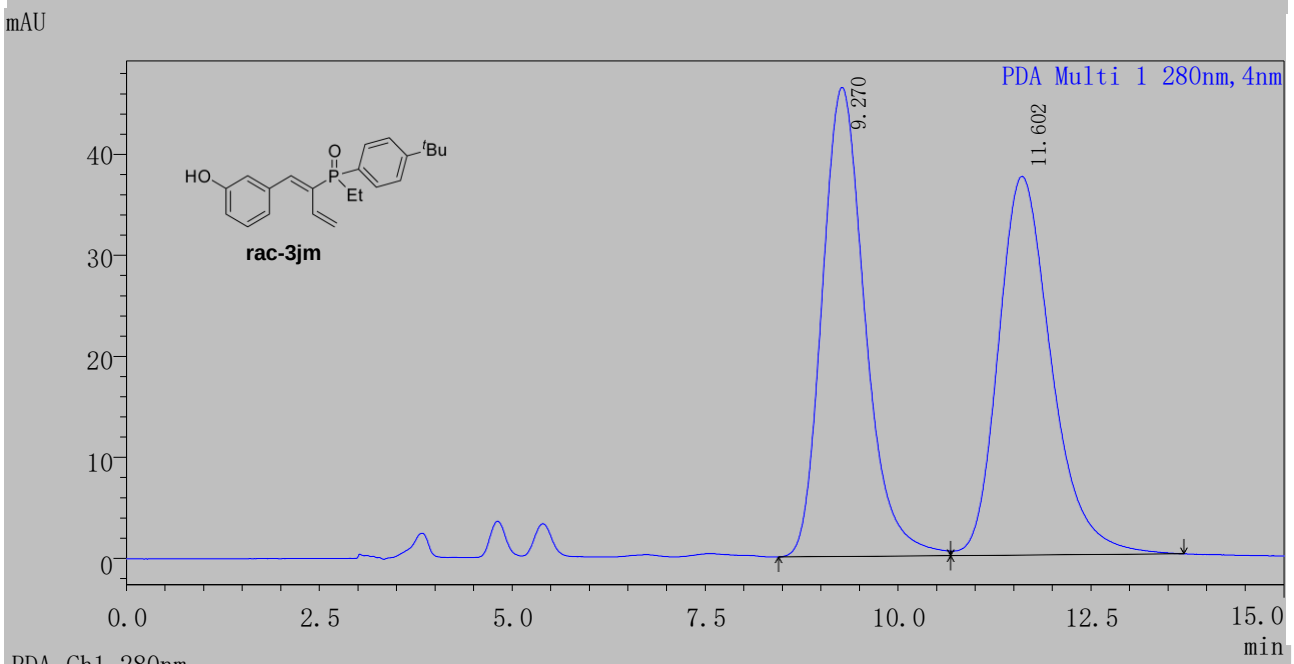
Chromatogram



PDA Ch1 280nm

Peak#	Ret. Time	Area	Area%
1	5.068	2300025	97.432
2	11.805	60613	2.568
Total		2360638	100.000

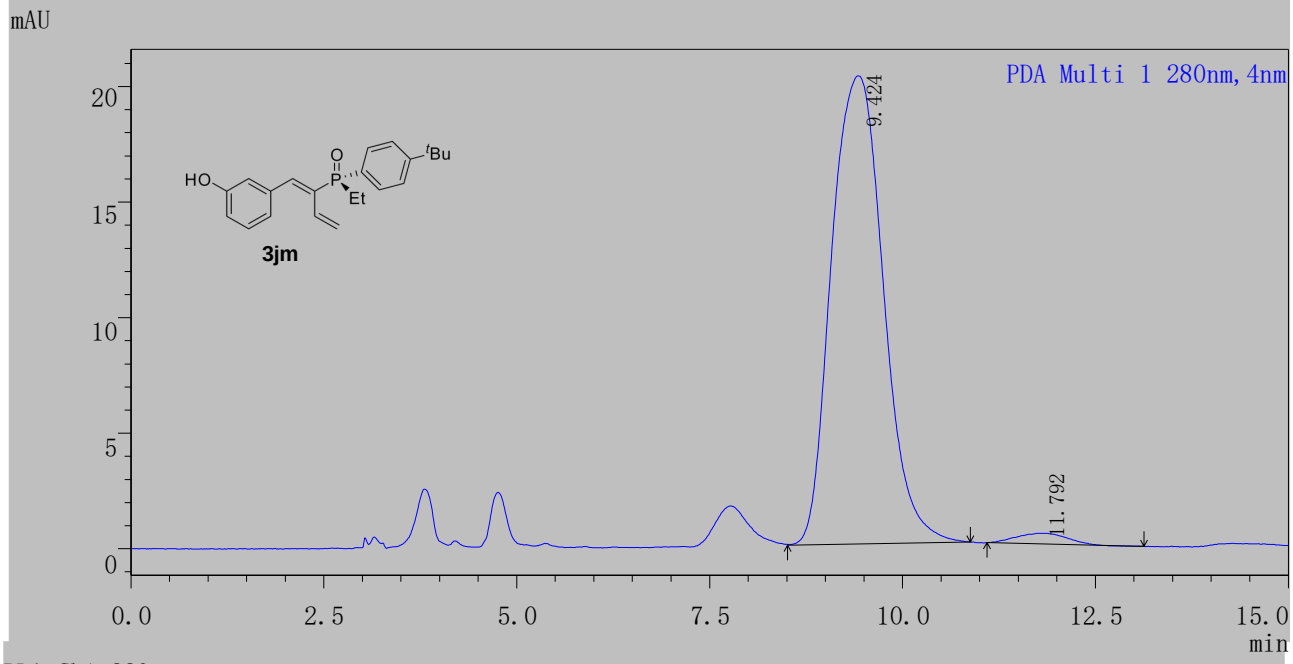
Chromatogram



PDA Ch1 280nm

Peak#	Ret. Time	Area	Area%
1	9.270	1791471	50.065
2	11.602	1786842	49.935
Total		3578313	100.000

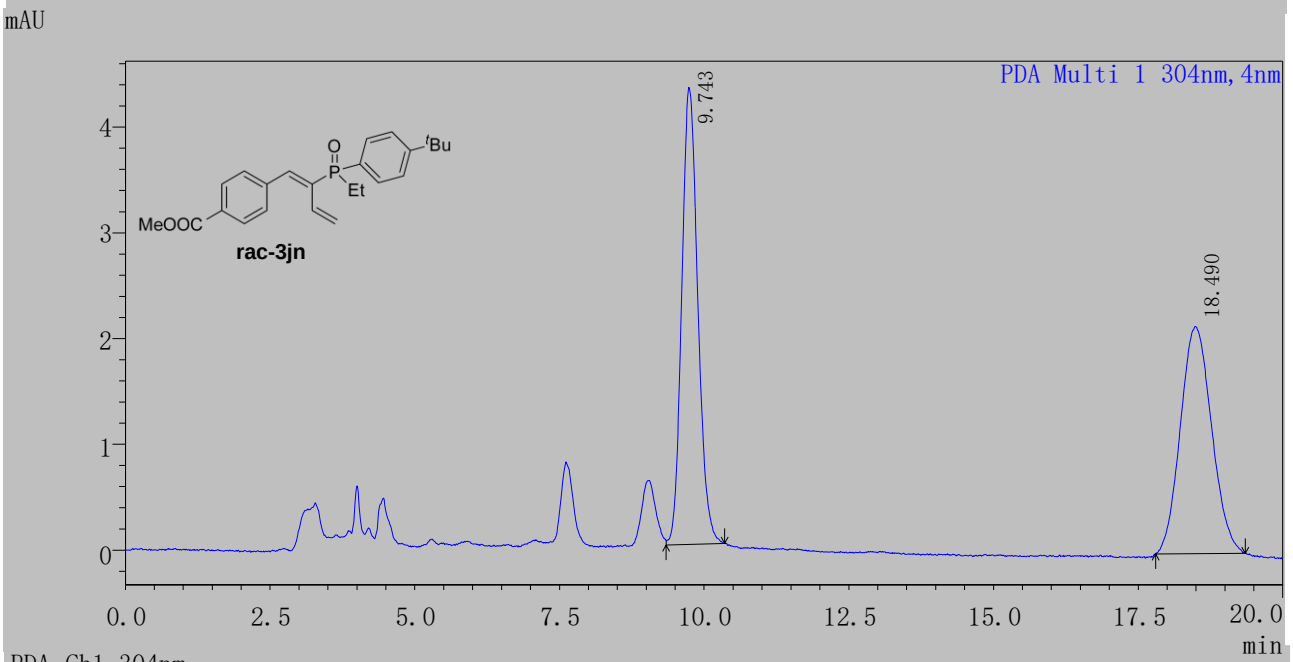
Chromatogram



PDA Ch1 280nm

Peak#	Ret. Time	Area	Area%
1	9.424	948283	97.765
2	11.792	21678	2.235
Total		969961	100.000

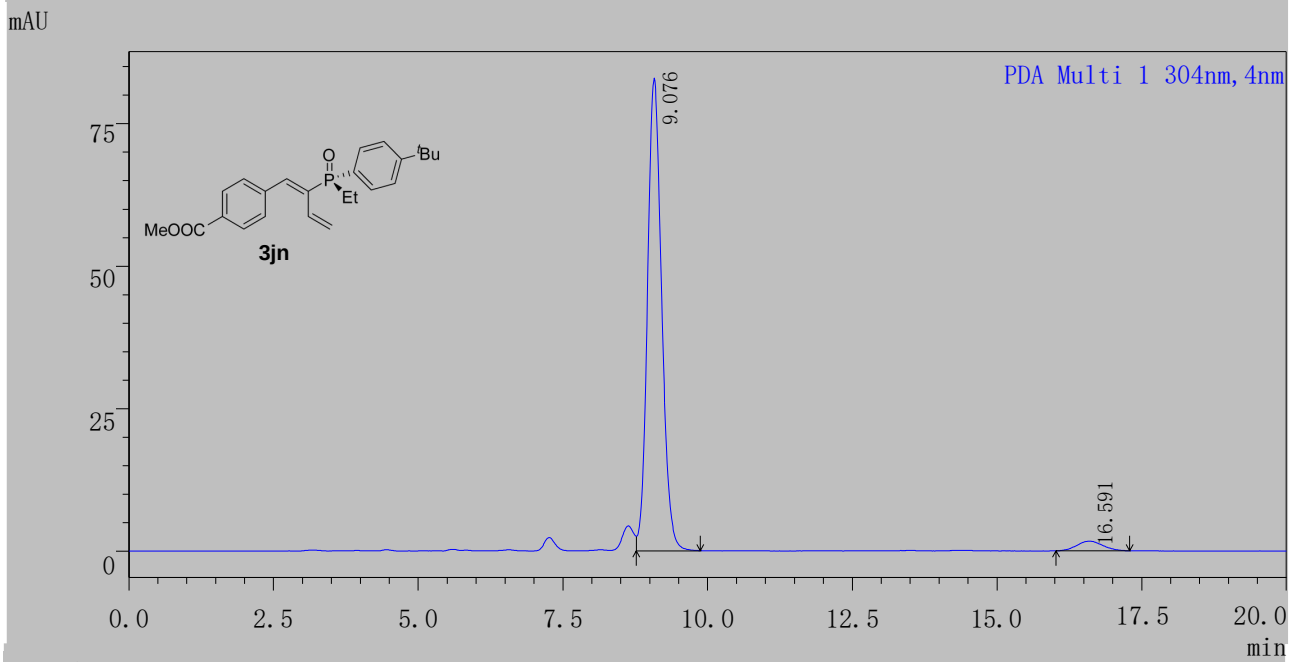
Chromatogram



PDA Ch1 304nm

Peak#	Ret. Time	Area	Area%
1	9.743	83263	50.762
2	18.490	80763	49.238
Total		164026	100.000

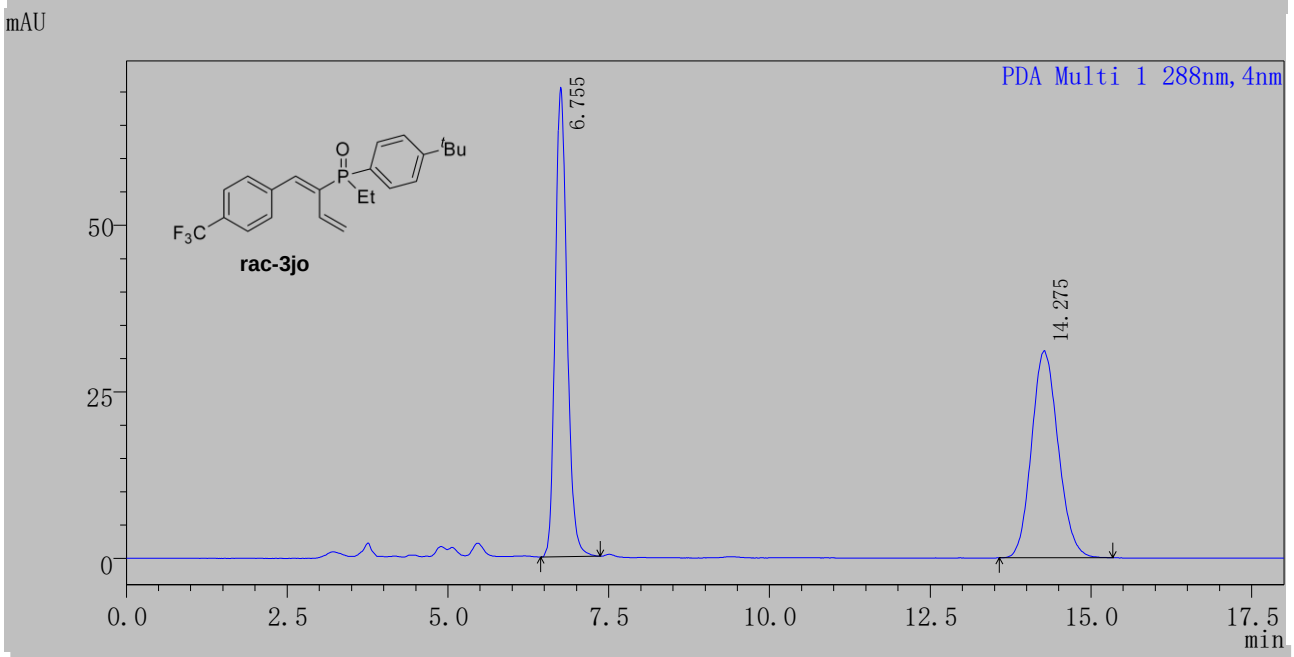
Chromatogram



PDA Ch1 304nm

Peak#	Ret. Time	Area	Area%
1	9.076	1406398	96.366
2	16.591	53039	3.634
Total		1459437	100.000

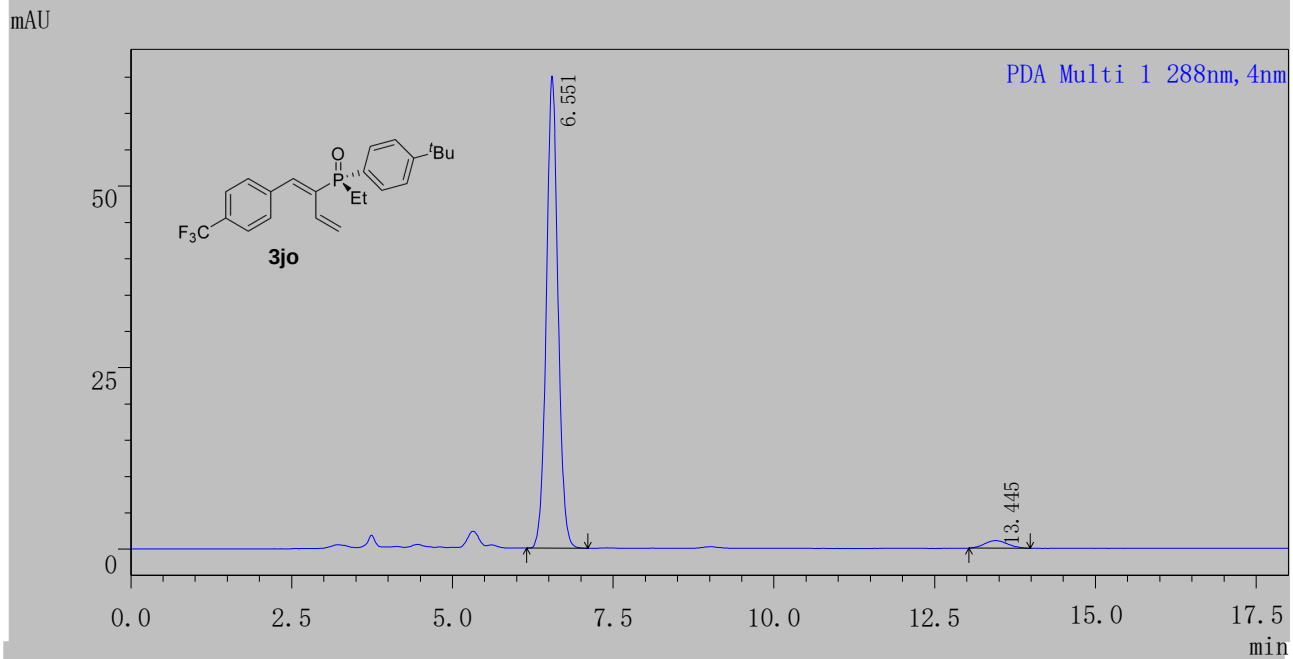
Chromatogram



PDA Ch1 288nm

Peak#	Ret. Time	Area	Area%
1	6.755	893376	49.926
2	14.275	896017	50.074
Total		1789393	100.000

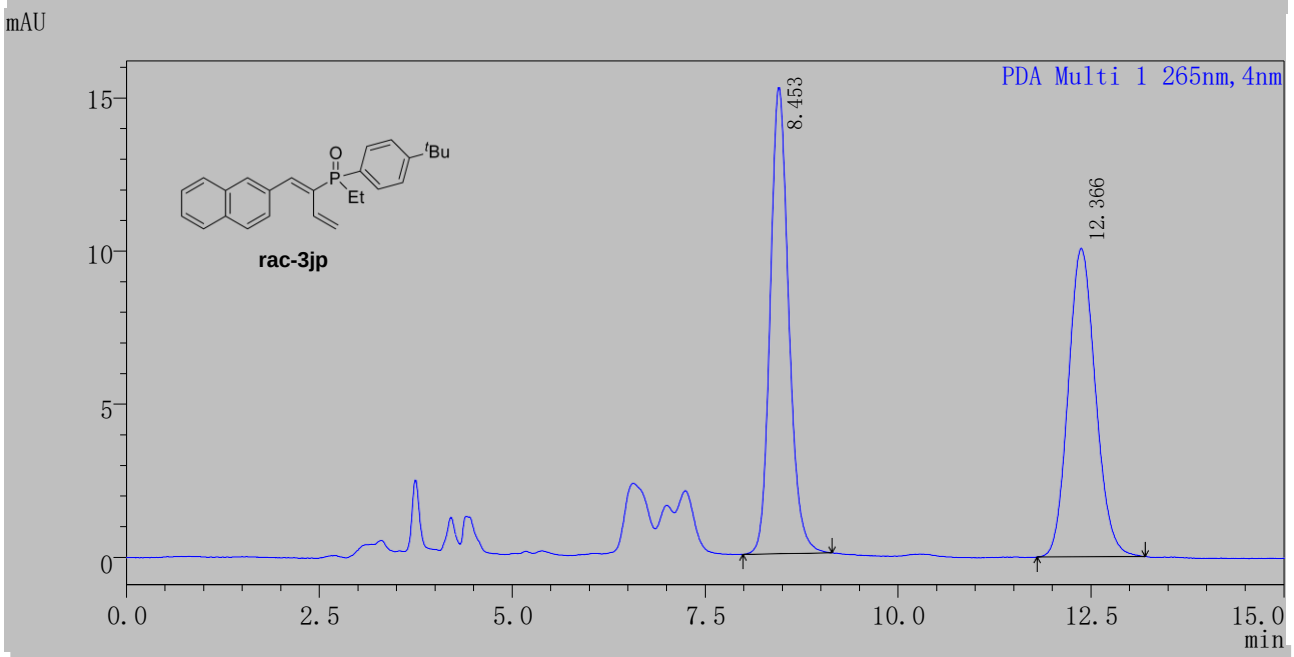
Chromatogram



PDA Ch1 288nm

Peak#	Ret. Time	Area	Area%
1	6.551	824915	96.994
2	13.445	25570	3.006
Total		850484	100.000

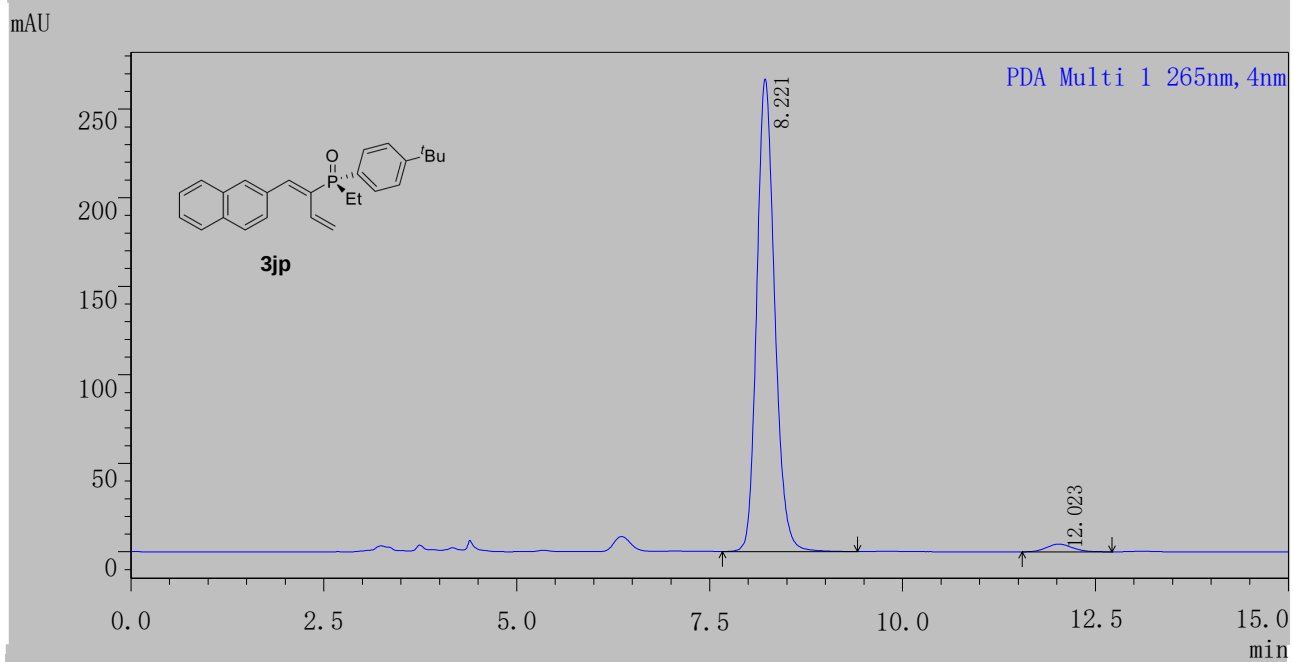
Chromatogram



PDA Ch1 265nm

Peak#	Ret. Time	Area	Area%
1	8.453	253919	50.627
2	12.366	247634	49.373
Total		501553	100.000

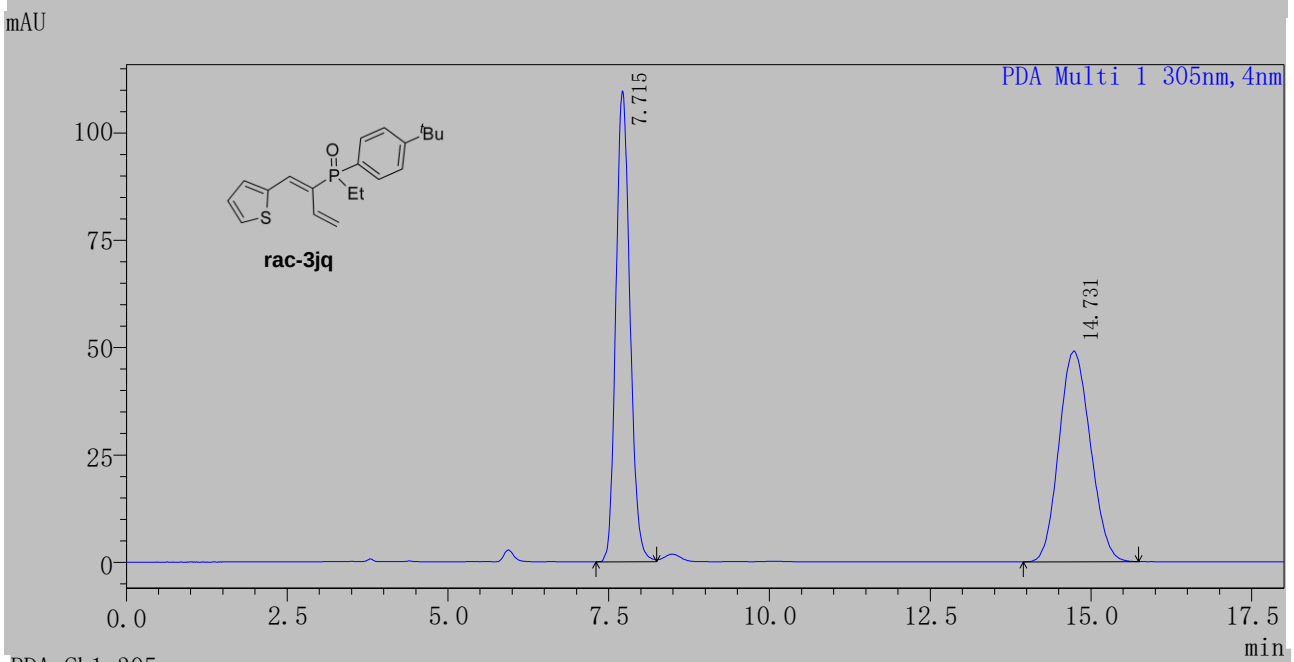
Chromatogram



PDA Ch1 265nm

Peak#	Ret. Time	Area	Area%
1	8.221	4298086	97.676
2	12.023	102258	2.324
Total		4400344	100.000

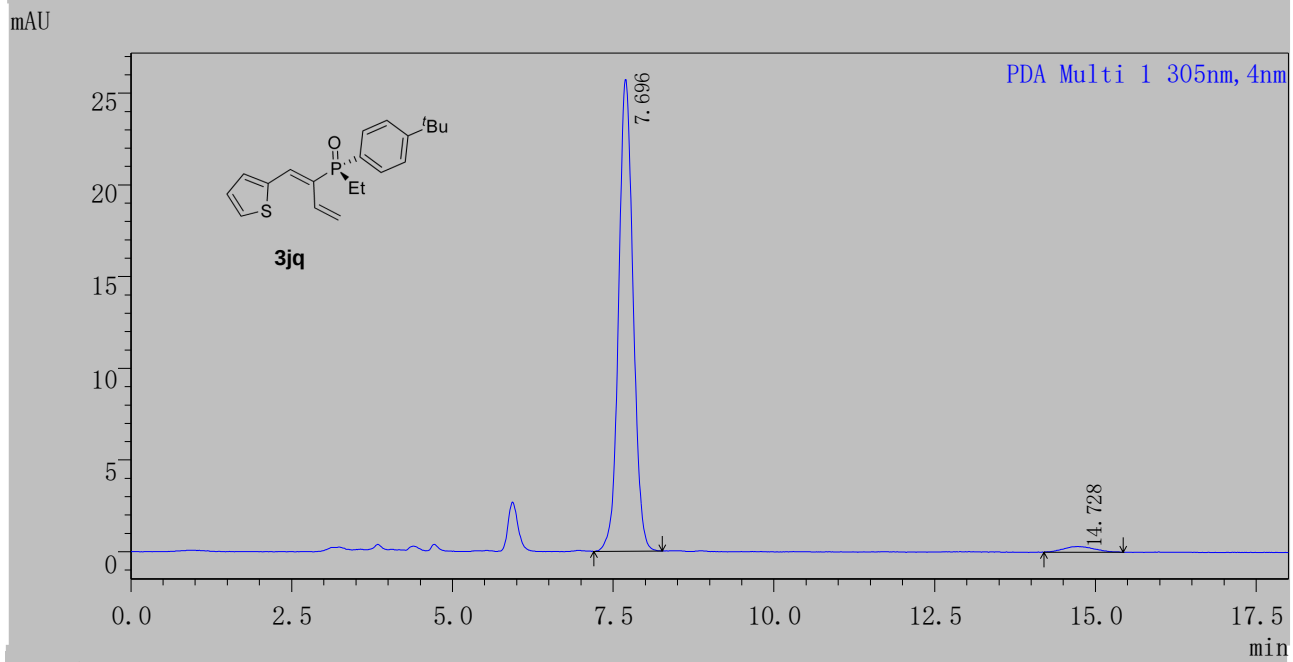
Chromatogram



PDA Ch1 305nm

Peak#	Ret. Time	Area	Area%
1	7.715	1675284	50.070
2	14.731	1670624	49.930
Total		3345908	100.000

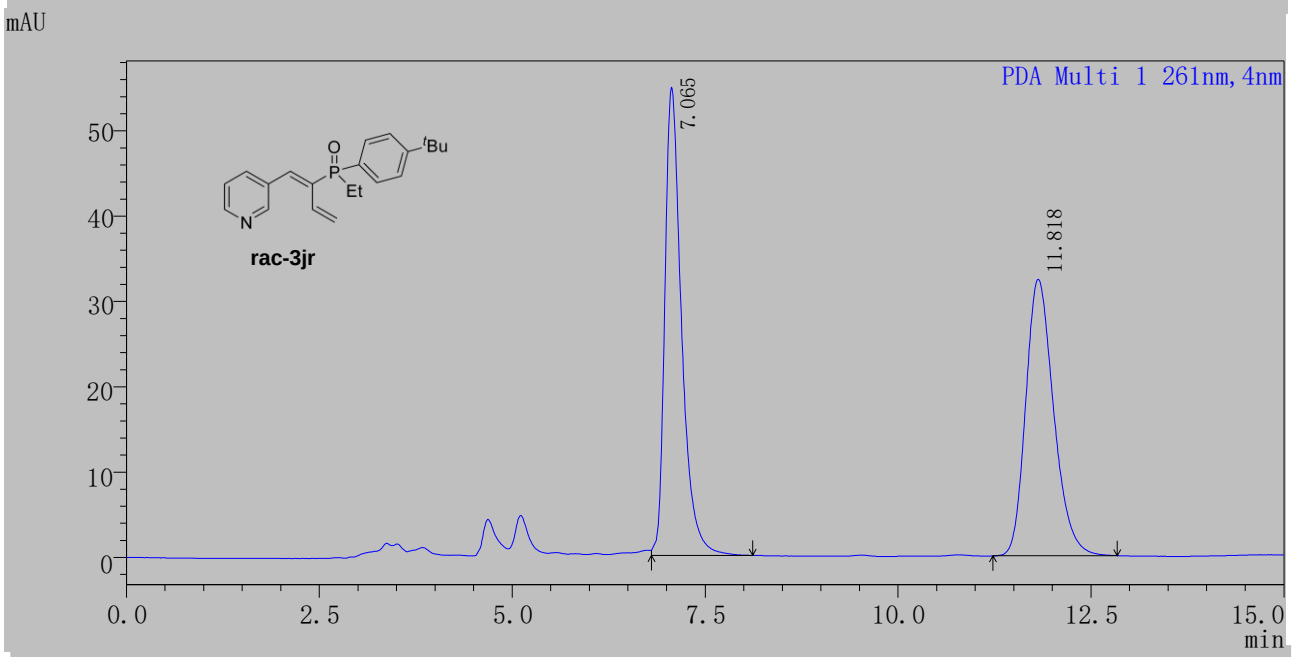
Chromatogram



PDA Ch1 305nm

Peak#	Ret. Time	Area	Area%
1	7.696	402478	97.484
2	14.728	10389	2.516
Total		412867	100.000

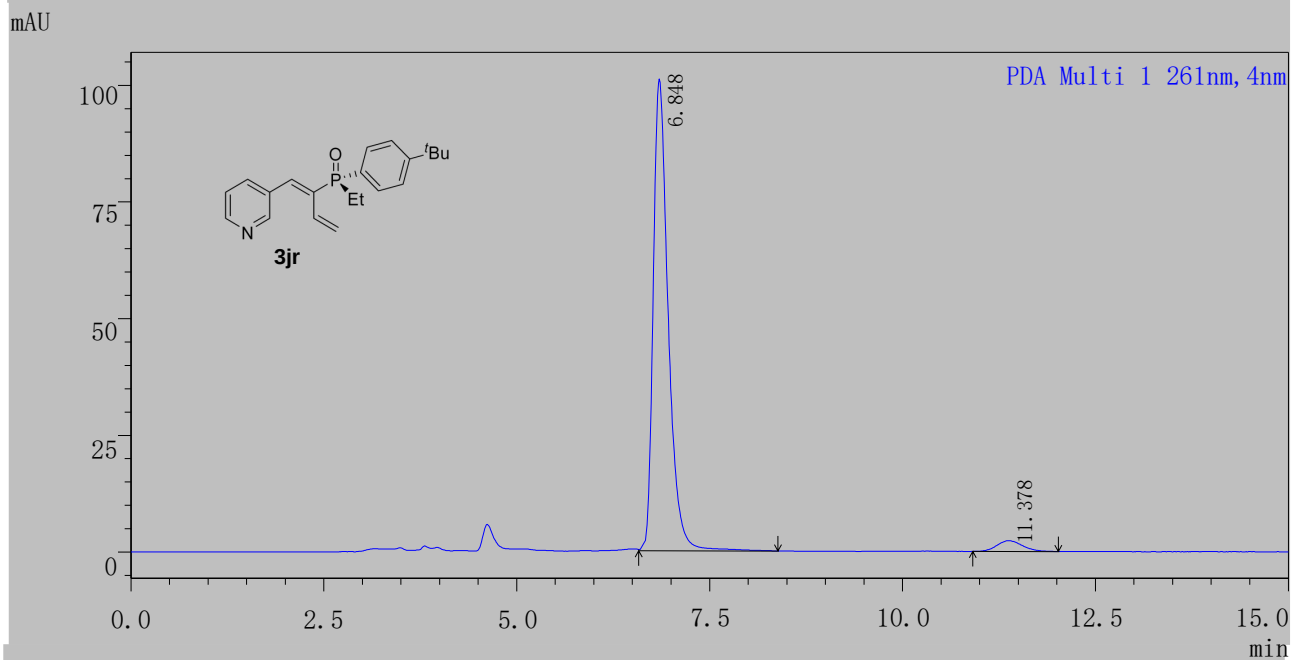
Chromatogram



PDA Ch1 261nm

Peak#	Ret. Time	Area	Area%
1	7.065	828156	50.294
2	11.818	818471	49.706
Total		1646626	100.000

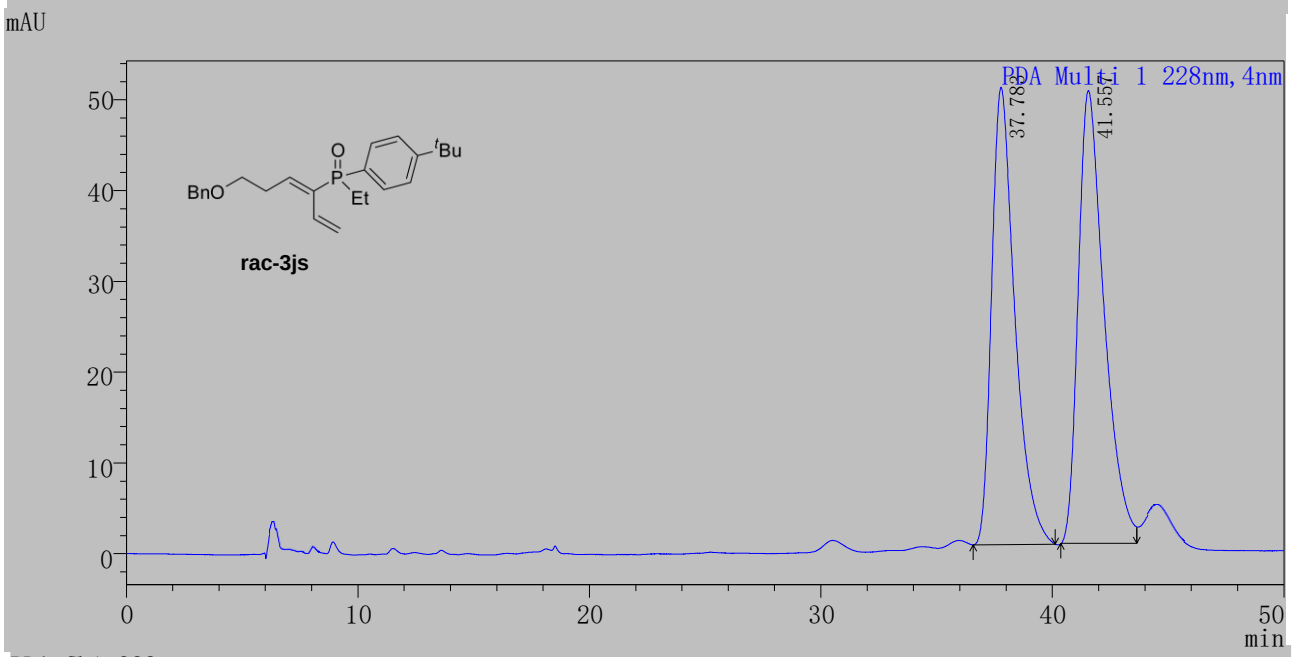
Chromatogram



PDA Ch1 261nm

Peak#	Ret. Time	Area	Area%
1	6.848	1364398	96.212
2	11.378	53723	3.788
Total		1418120	100.000

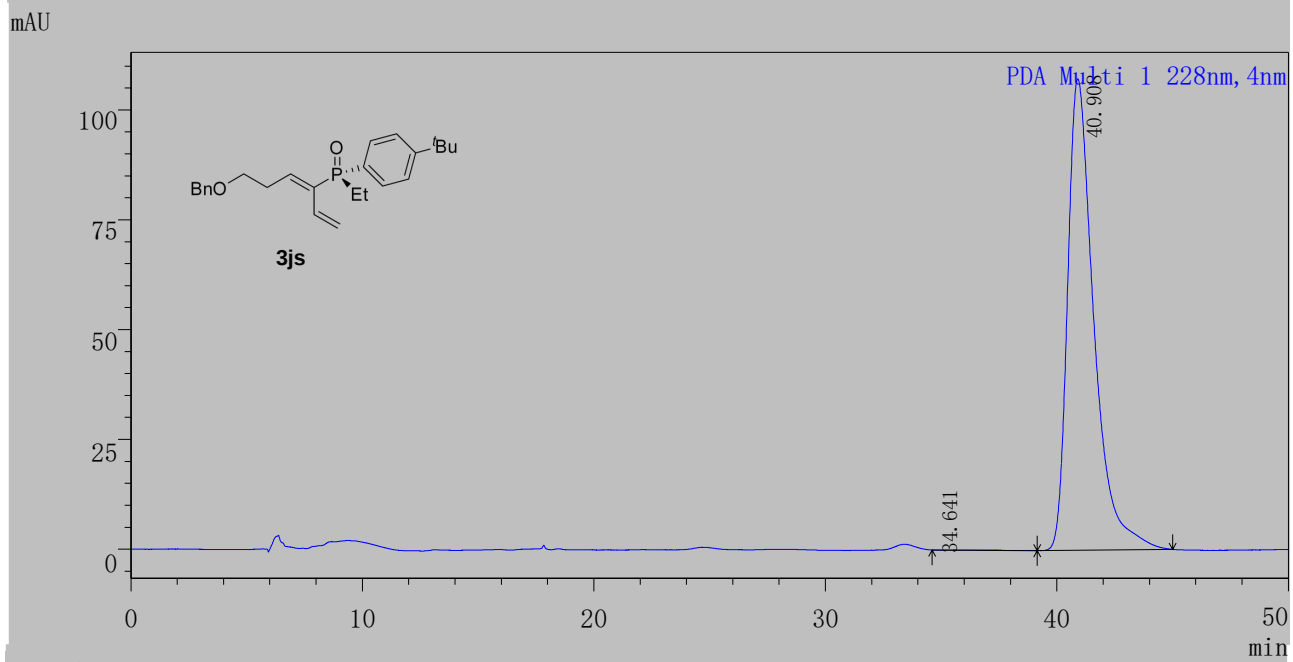
Chromatogram



PDA Ch1 228nm

Peak#	Ret. Time	Area	Area%
1	37.783	3528024	47.607
2	41.557	3882683	52.393
Total		7410707	100.000

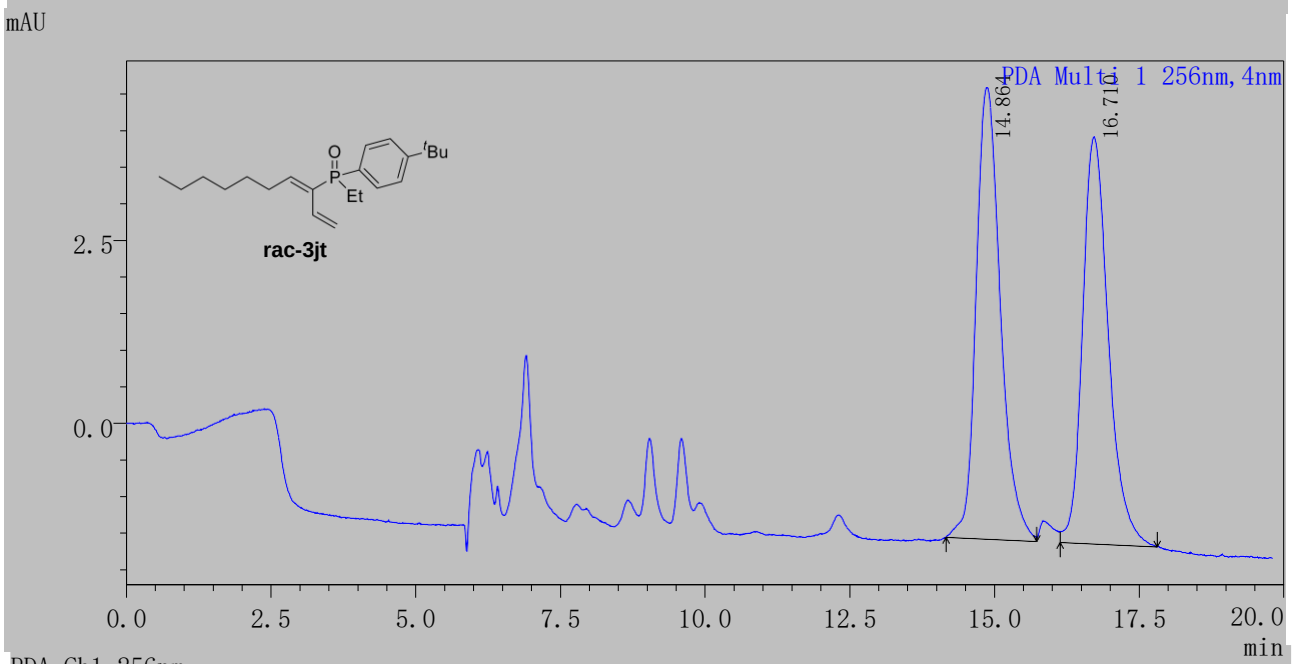
Chromatogram



PDA Ch1 228nm

Peak#	Ret. Time	Area	Area%
1	34.641	2222	0.026
2	40.908	8465432	99.974
Total		8467654	100.000

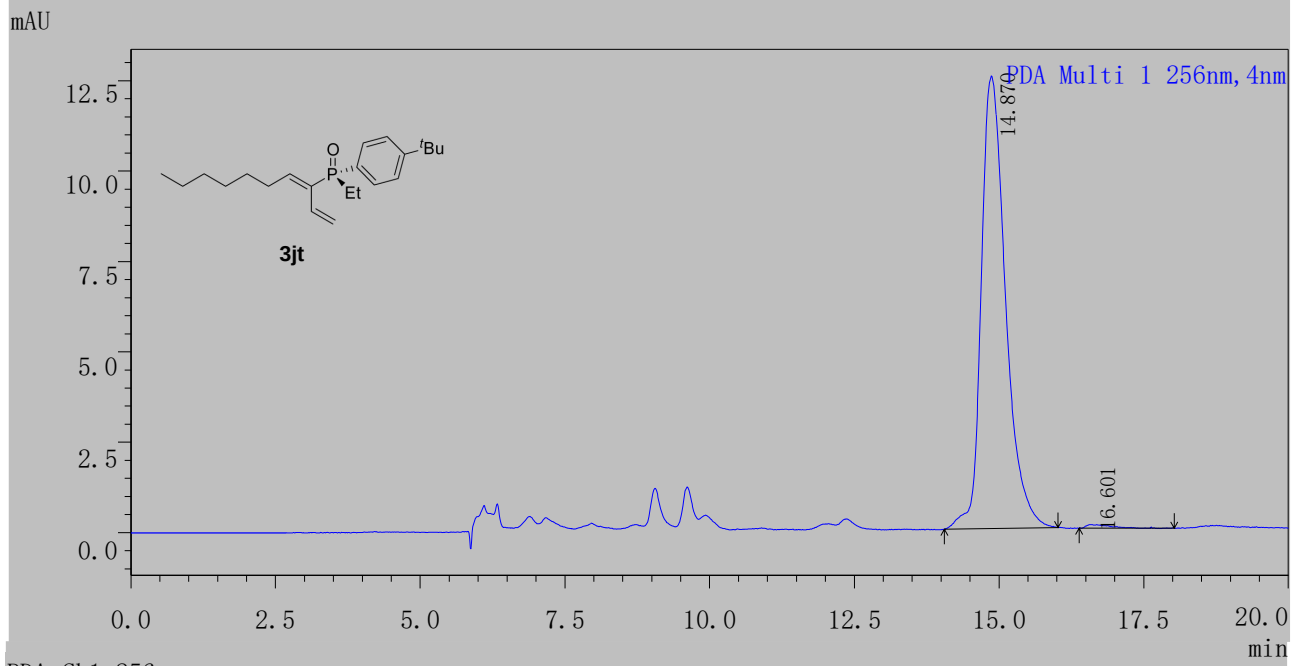
Chromatogram



PDA Ch1 256nm

Peak#	Ret. Time	Area	Area%
1	14.864	180485	51.096
2	16.710	172742	48.904
Total		353226	100.000

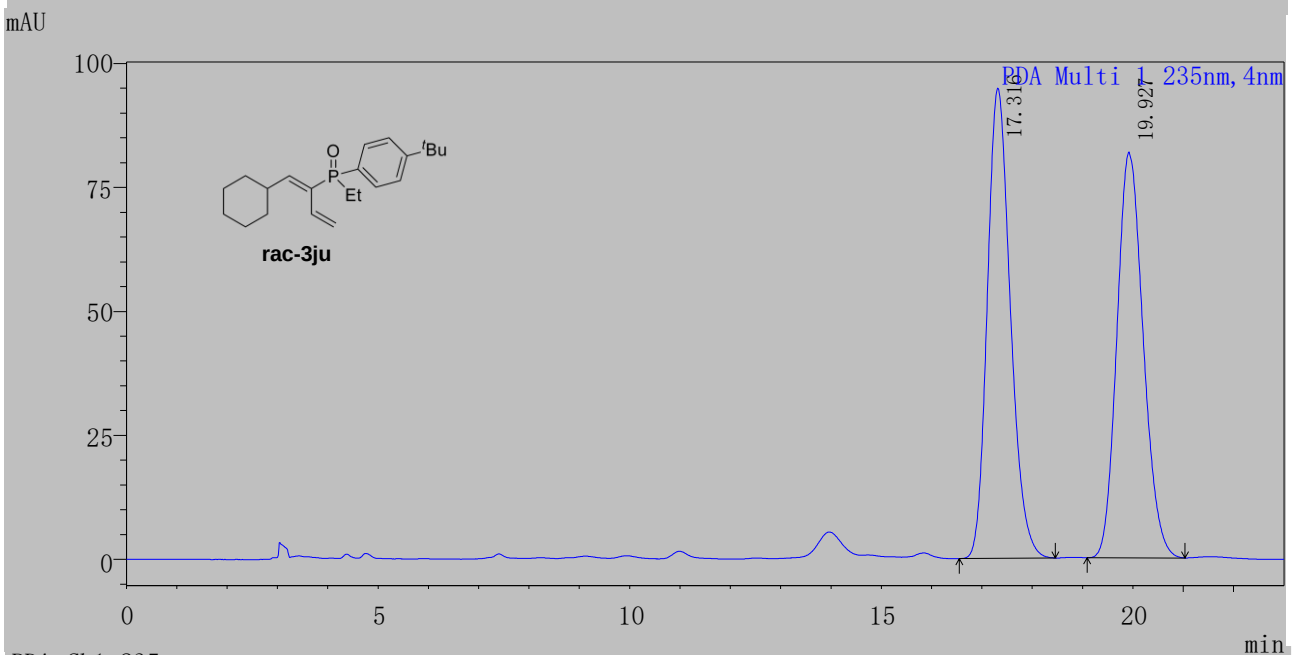
Chromatogram



PDA Ch1 256nm

Peak#	Ret. Time	Area	Area%
1	14.870	365018	99.306
2	16.601	2552	0.694
Total		367570	100.000

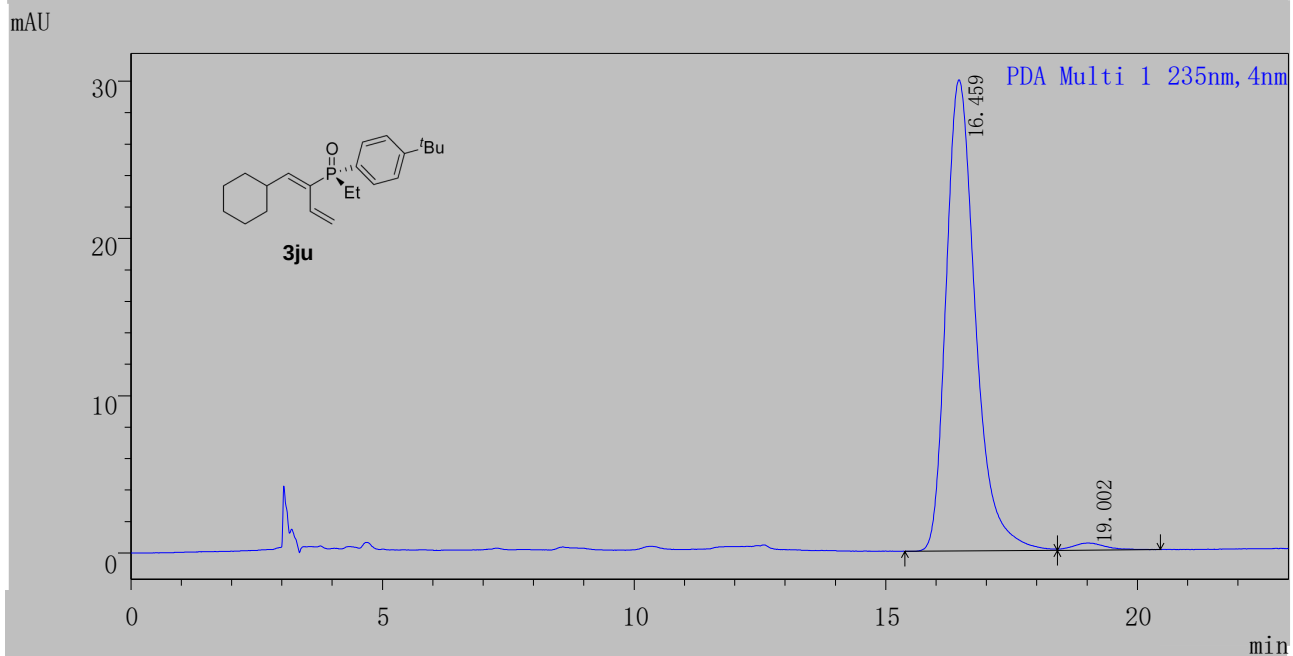
Chromatogram



PDA Ch1 235nm

Peak#	Ret. Time	Area	Area%
1	17.316	3028071	50.483
2	19.927	2970073	49.517
Total		5998145	100.000

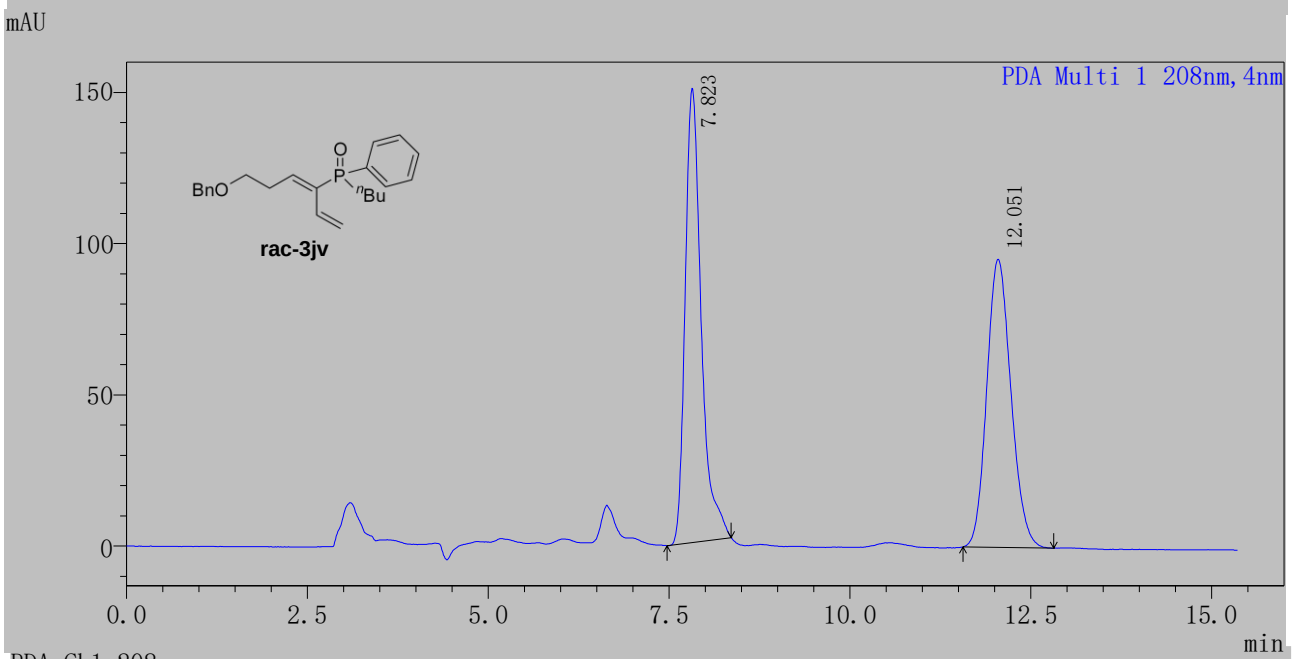
Chromatogram



PDA Ch1 235nm

Peak#	Ret. Time	Area	Area%
1	16.459	1213909	98.402
2	19.002	19708	1.598
Total		1233617	100.000

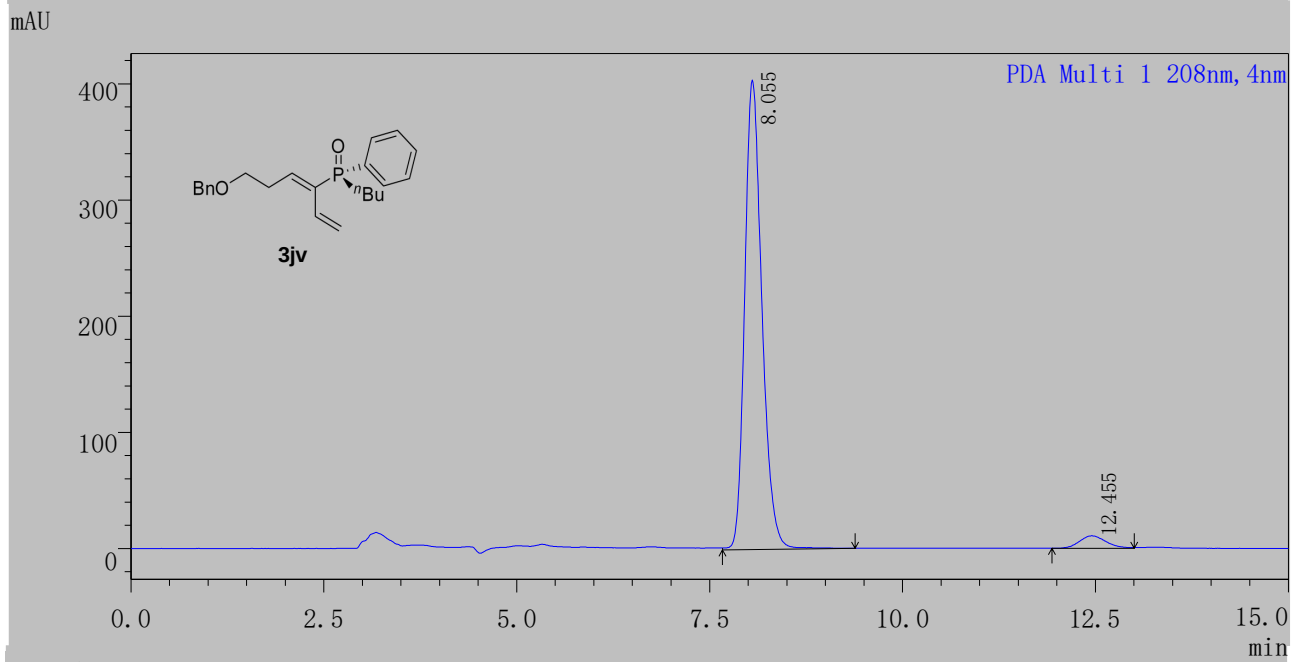
Chromatogram



PDA Ch1 208nm

Peak#	Ret. Time	Area	Area%
1	7.823	2312092	51.050
2	12.051	2216968	48.950
Total		4529060	100.000

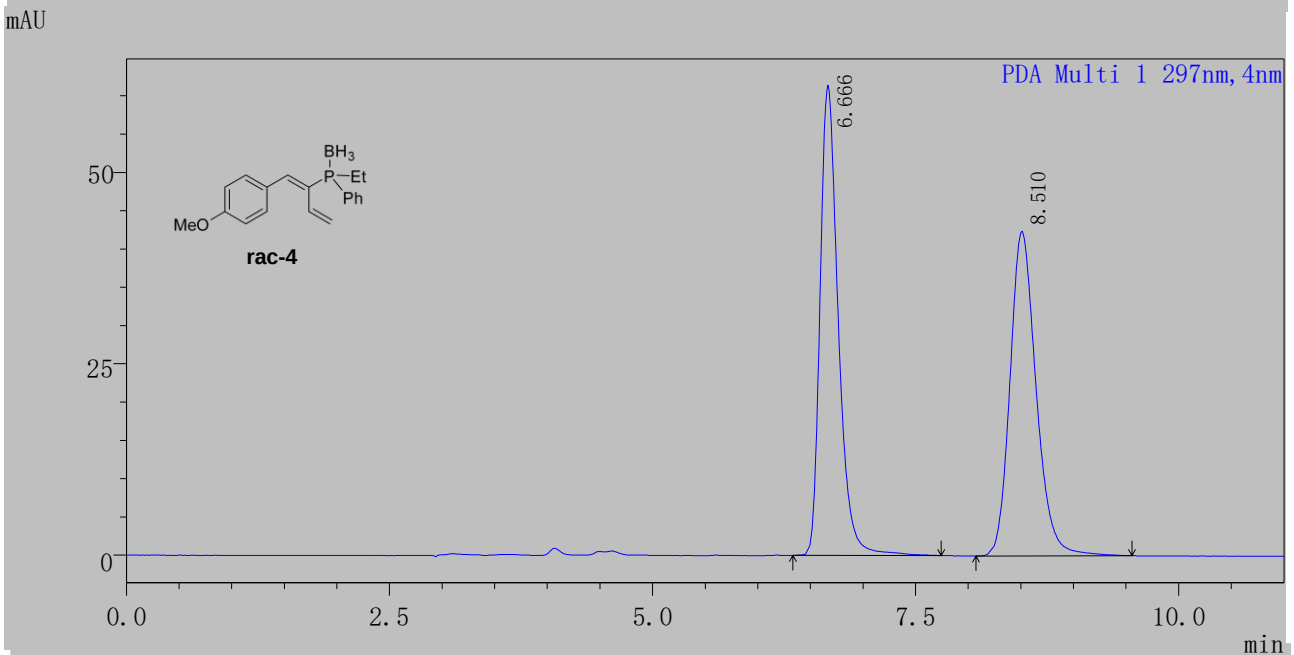
Chromatogram



PDA Ch1 208nm

Peak#	Ret. Time	Area	Area%
1	8.055	6259165	96.007
2	12.455	260335	3.993
Total		6519500	100.000

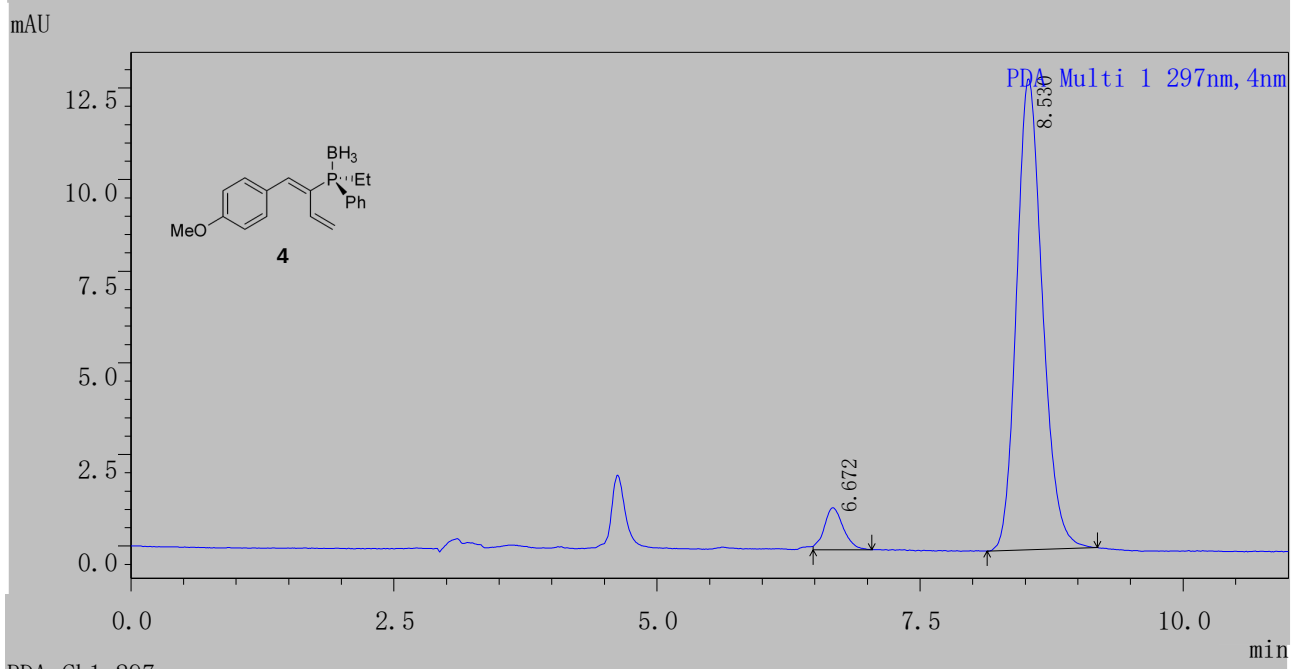
Chromatogram



PDA Ch1 297nm

Peak#	Ret. Time	Area	Area%
1	6.666	734780	50.095
2	8.510	731994	49.905
Total		1466774	100.000

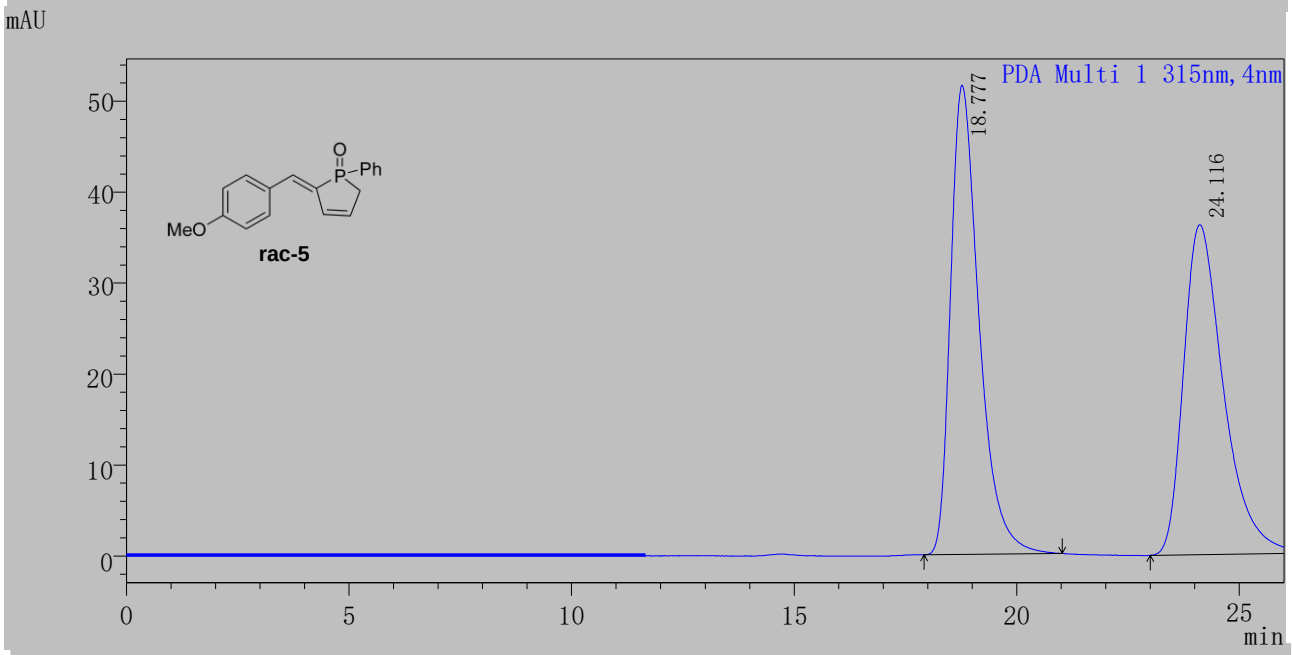
Chromatogram



PDA Ch1 297nm

Peak#	Ret. Time	Area	Area%
1	6.672	14235	6.071
2	8.530	220232	93.929
Total		234467	100.000

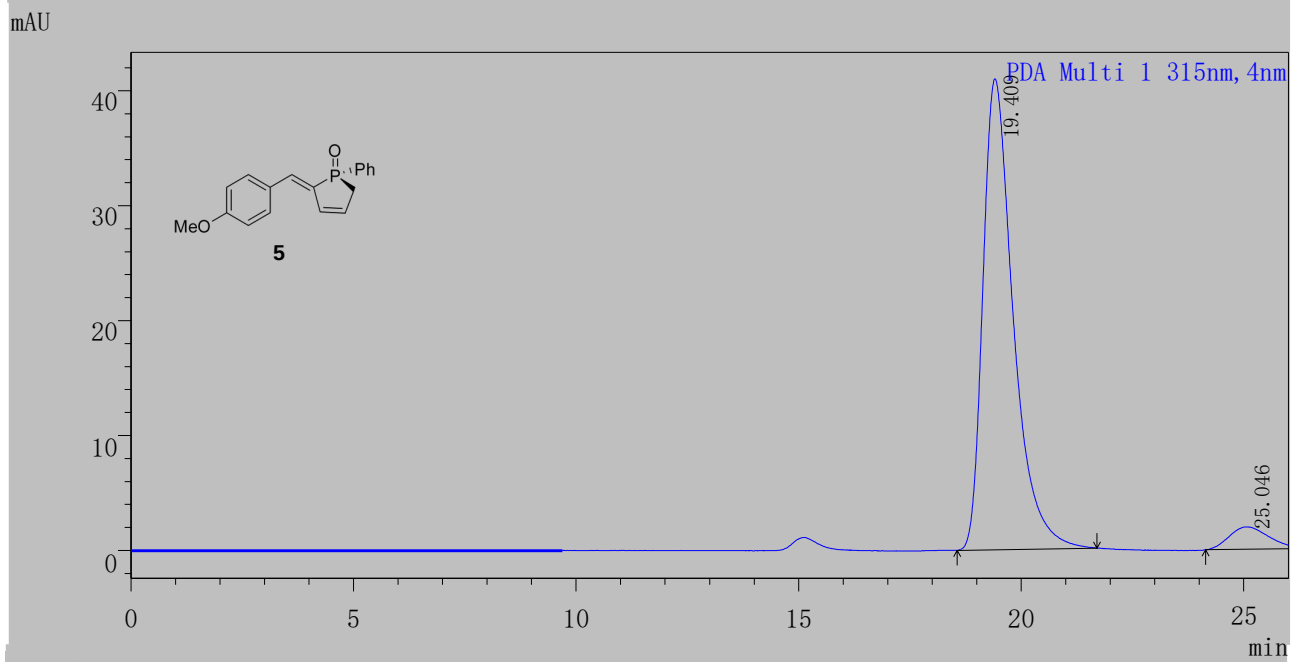
Chromatogram



PDA Ch1 315nm

Peak#	Ret. Time	Area	Area%
1	18.777	2290014	50.282
2	24.116	2264314	49.718
Total		4554328	100.000

Chromatogram



PDA Ch1 315nm

Peak#	Ret. Time	Area	Area%
1	19.409	1942185	94.131
2	25.046	121100	5.869
Total		2063285	100.000